N4917BSCB 400G Optical Receiver Test Application - User Guide

KEYSIGHT

USER GUIDE

Notices

Manual Part Number

N4917-91040

Edition

Edition 9.1, November 2023

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1 Introduction

This chapter provides an introduction to the Keysight N4917BSCB 400G Optical Receiver Test Application and the related documents that can be consulted to gather more background information.

N4917BSCB 400G Optical Receiver Test Application—At a Glance

Compliance Tests for Optical Transceivers

The IEEE 802.3bs, IEEE 802.3cd, and IEEE 802.3db standards define a series of procedures to test the correct operation of optical transceivers at the physical layer to ensure minimum required performance and interoperability (see Figure 1). Keysight solution software are available for each interface: Chip-to-module (C2M) interface including electrical transmitter and receiver tests and the optical interface with transmitter and receiver tests.

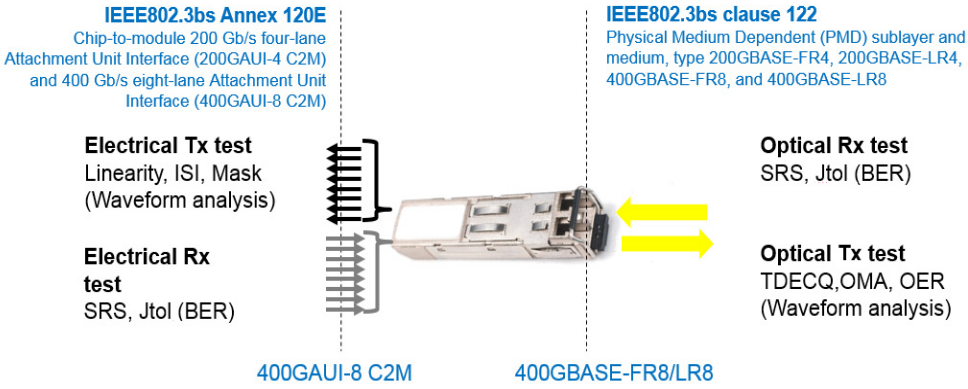


Figure 1 Overview of physical layer compliance tests for a typical 400GBASE-FR8 transceiver

In particular, the purpose of the optical receiver test is to test the receiver sensitivity and jitter tolerance with a stress optical signal, whose characteristics are defined by the standard. This stress signal is supposed to emulate the signal coming out of a standard-compliant transceiver after the worst possible optical channel.

N4917BSCB Optical Receiver Stress Test

N4917BSCB 400G Optical Receiver Test Application provides a platform for stressed receiver sensitivity test, which is compliant to automated standards for 200GBASE and 400GBASE Optical Receiver Stress Testing.

Additionally, the application supports compliance testing for a subset of 100GBASE and 50GBASE standards as per the specifications. The solution consists of several test instruments such as a Bit Error Rate Tester (BERT), an arbitrary waveform generator (AWG), Digital Sampling Scope (DCA), Optical Reference Transmitter, Tunable Laser, and Optical Attenuator operating together with the N4917BSCB software package.

Salient features of the N4917BSCB 400G Optical Receiver Test Application include:

- Remote control of all the test instrumentation
- Automated calibration of the optical stressed eye parameters (ER, SECQ, and OMA) following the procedure recommended by IEEE
- Adjustable target values for ER, SECQ, and OMA
- Automated Stress Receiver Sensitivity test
- Automated jitter tolerance compliance and margin tests

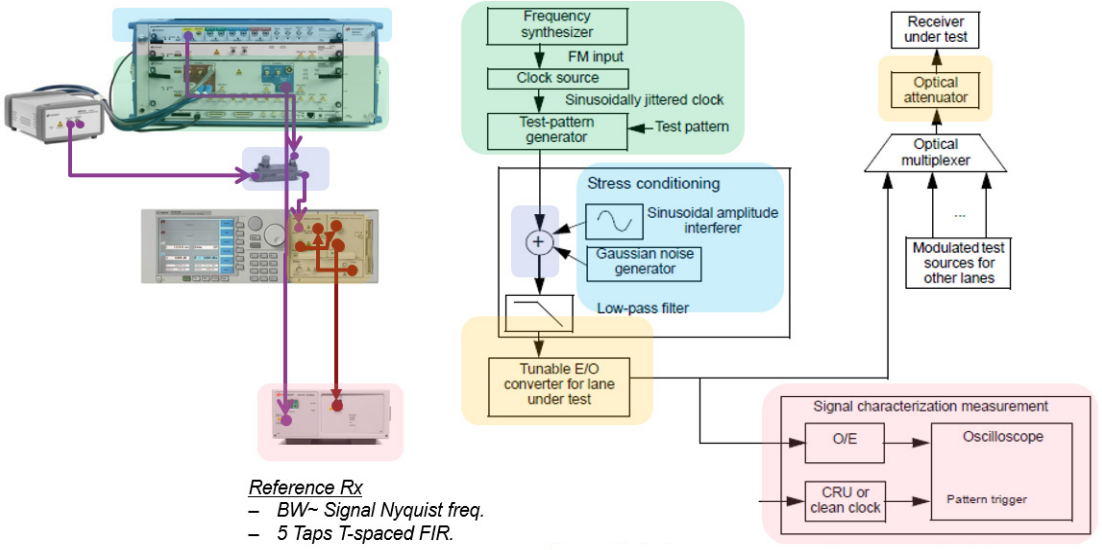


Figure 2 Stress receiver conformance test according to the IEEE and corresponding N4917BSCB equipment configuration

Applicable Standards

The N4917BSCB 400G Optical Receiver Test Application supports automated optical stressed receiver sensitivity test, based on the following IEEE standards:

Test Name	Reference Standard
200GBASE-FR4, LR4, and DR4	IEEE P802.3bs (Clauses 121 & 122)
400GBASE-FR8 and LR8	IEEE P802.3bs (Clauses 121 & 122)
400GBASE-DR4	IEEE P802.3bs (Clause 124)
400G-FR4	100G lambda MSA
100G-FR, LR	100G lambda MSA
100GBASE-DR	IEEE P802.3cd (Clause 140)
50G-SR/100G-SR2/200G-SR4/400G-SR8	IEEE P802.3cd (Clause 138)
100G-SR/200G-SR2/400G-SR4	IEEE P802.3db (Clause 167)
50GBASE-FR and LR	IEEE P802.3cd (Clause 139)

Updated standards

The original IEEE 802.3bs/cd standards used in the N4917BSCB application were subsequently changed by IEEE 802.3cn, 802.3cm, and 802.3cu standards and are now fully incorporated into the current IEEE 802.3-2022 standard.
You can refer to Table 1 for some of the original 802.3bs/cd calibration target values and Table 2 for their revised values from the IEEE 802.3cn, 802.3cm, and 802.3cu standards.

To perform test runs using revised calibration target values from the updated IEEE 802.3cn, 802.3cm, and 802.3cu standards, follow the below steps:

1 In the **Set Up** tab,

- For single-mode standards at 26.5625 GBd, select Physical Layer **50GBASE IEEE 802.3cd** and Type **FR**.
- For multi-mode standards at 26.5625 GBd, select Physical Layer **50/100/200/400-SR IEEE 802.3cd**.

- For single-mode standards at 53.125 GBd, select Physical Layer **100GBASE IEEE P802.3cd** and Type **DR**.

2 Go to the **Configure** tab and select **Debug** mode.

3 Refer to Table 2 and change the Transmitter Wavelength to the wavelength corresponding to the lane under test.

4 Expand the **Stressed Receiver Signal Calibration** item and then expand the **Calibration Target Values**.

5 Refer to Table 2 and edit the ER, SECQ and OMA Targets using values from Table 2. Optionally, edit the Initial SECQ Target.
Note that there is no editable field for SECQ-10log(Ceq) or Transition Time but the default targets will be correct provided the Physical Layer has been chosen as detailed above in step 1.

NOTE In the current application version, only the IEEE 802.3db standard supports the new calibration target values listed in Table 2.

If required, you can save this project file with new calibration target values by using **Save Project (Settings Only) As** ..feature from the application's main menu and use it as template for repeat testing.
For more information on using "**Save Project (Settings Only) As..**" feature, refer to the "Saving Test Projects" topic in the *Keysight N4917BSCB 400G Optical Receiver Test Application Online Help.*

Table 1 Original 802.3bs/cd Calibration Targets

N4917BSCB supported stds		Original Std.	Clause	OER (dB)	SECQ (dB)	SECQ-10 log(Ceq) (dB)	OOMA (dBm)	Transition Time (ps)
200GBASE	FR4	802.3bs	122	3.5	3.3	-	- 3.6	-
	LR4	802.3bs	122	3.5	3.4	-	- 5.2	-
	DR4	802.3bs	122	3.5	3.4	-	- 4.1	-
400GBASE	FR8	802.3bs	122	3.5	3.1	-	- 3.1	-
	LR8	802.3bs	122	3.5	3.3	-	- 4.7	-
	DR4	802.3bs	124	3.5	3.4	-	- 1.9	-

N4917BSCB supported stds		Original Std.	Clause	OER (dB)	SECQ (dB)	SECQ-10 log(Ceq) (dB)	OOMA (dBm)	Transition Time (ps)
50GBASE	FR	802.3cd	139	3.5	3.0	3.0	-5.3	34
	LR	802.3cd	139	3.5	3.2	3.2	-6.6	34
	SR	802.3cd	138	3.0	4.5	4.5	-3.4	34
100GBASE	SR2	802.3cd	138	3.0	4.5	4.5	-3.4	34
200GBASE	SR4	802.3cd	138	3.0	4.5	4.5	-3.4	34
100GBASE	DR	802.3cd	140	3.5	3.4	3.4	-1.9	17
100GBASE	SR	802.3db	167	2.5	4.4	-	-2.0	17
200GBASE	SR2	802.3db	167	2.5	4.4	-	-2.0	17
400GBASE	SR4	802.3db	167	2.5	4.4	-	-2.0	17
100G	FR	100G/LAMBDA MSA	-	3.5	3.4	3.4	-2.5	17
	LR	100G/LAMBDA MSA	-	3.5	3.4	3.4	-4.1	17
400G	FR4	100G/LAMBDA MSA	-	3.5	3.4	3.4	-2.6	17

Revised calibration targets from **802.3cn**, **802.3cm**, **802.3cu** standards are highlighted in Table 2.

Table 2 New Calibration Targets from 802.3cn, 802.3cm and 802.3cu

N4917BSCB supported stds		Original Std.	Clause	Modifed by	OER (dB)	SECQ (dB)	SECQ-10log(Ceq) (dB)	OOMA (dBm)	Transition Time (ps)	Incorp orated into 802.3-2022
200GBASE	FR4	802.3bs	122	**802.3cn**	3.5	**3.1**	**3.1**	**- 3.8**	**34**	Y
	LR4	802.3bs	122	**802.3cn**	3.5	**3.2**	**3.2**	**- 5.4**	**34**	Y
	ER4	**802.3cn**	**122**		**6.0**	**3.2**	**3.2**	**-13.3**	**34**	Y
	DR4	802.3bs	122	**802.3cn**	3.5	**3.2**	**3.2**	**- 4.3**	**34**	Y

N4917BSCB supported stds		Original Std.	Clause	Modifed by	OER (dB)	SECQ (dB)	SECQ-10log(Ceq) (dB)	OOMA (dBm)	Transition Time (ps)	Incorporated into 802.3-2022
400GBASE	FR8	802.3bs	122	802.3cn	3.5	2.9	2.9	- 3.3	34	Y
	LR8	802.3bs	122	802.3cn	3.5	3.1	3.1	- 4.9	34	Y
	ER4	802.3cn	122		6.0	3.4	3.4	-14.1	34	Y
	DR4	802.3bs	124	802.3cn	3.5	3.4	3.4	-1.9	17	Y
50GBASE	FR	802.3cd	139	802.3cn	3.5	3.0	3.0	-5.3	34	Y
	LR	802.3cd	139	802.3cn	3.5	3.2	3.2	-6.6	34	Y
	ER	802.3cn	139		6.0	3.2	3.2	-13.3	34	Y
	SR	802.3cd	138	802.3cn	3.0	4.5	4.5	-3.4	34	Y
100GBASE	SR2	802.3cd	138	802.3cn	3.0	4.5	4.5	-3.4	34	Y
200GBASE	SR4	802.3cd	138	802.3cn	3.0	4.5	4.5	-3.4	34	Y
400GBASE	SR8	802.3cm	138		3.0	4.5	4.5	-3.4	34	Y
100GBASE	DR	802.3cd	140	802.3cn	3.5	3.4	3.4	-1.9	17	Y
	FR1	802.3cu	140		3.5	3.4	-	-2.5	17	Y
	LR1	802.3cu	140		3.5	3.4	-	-4.1	17	Y

System Description

The N4917BSCB Test Solution for Optical Stressed Eye consists of:

- a PAM4 capable M8045A pattern generator
- an Arbitrary Waveform Generator for stress conditioning
- an electrical-optical converter that modulates the optical signal from a fixed or tunable laser
- a digital sampling oscilloscope for calibration of the stressed eye
- up to two M8046A error detectors and up to two N107x optical/electrical clock recovery. (Internal clock recovery in M8046A error detector module is also supported.)
- the N4917BSCB 400G Optical Receiver Test Application

For comprehensive information related to the system requirements, refer to Chapter 2, “Installing the N4917BSCB 400G Optical Receiver Test Application”.

Contacting Keysight Technologies

For more information on products, applications or services associated with Keysight Technologies, contact your local Keysight office.

The complete list is available at: www.keysight.com/find/contactus.

2 Installing the N4917BSCB 400G Optical Receiver Test Application

As a prerequisite for installing the N4917BSCB 400G Optical Receiver Test Application, you require the necessary hardware and software along with various licenses. This chapter describes these requirements and steps for installing the application.

Hardware and Software Requirements

PC Hardware Requirements

Operating system

- Microsoft Windows 7 (64 bit)
- Microsoft Windows 8 (64 bit)
- Microsoft Windows 10 (64 bit)

Memory

- 8 GB RAM [minimum]

Monitor Resolution

- WXGA+ (1440 x 900) [minimum]

PC Software Requirements

Keysight IO Libraries Suite (Software)

- Ver. 18.1

M8070B system software for M8000 series

- Ver. 9.5.560.12

M8070ADVB Advanced Measurement Package for M8000 Series

- Ver. 1.0.70.0 - Refer to Table 4 to view a list of available licenses for this mandatory package.

M8195A Soft Front Panel

- Ver. 4.0.0.0

M8196A Soft Front Panel

- Ver. 2.1.1.0

N1010A FlexDCA Sampling Oscilloscope Software

- A.07.40.319

In the newer releases of FlexDCA, analysis packages that combine many separate items that were available previously under individual licenses, are now available. Refer to the FlexDCA Data Sheet to see how features of

previous FlexDCA releases map into the more recent FlexDCA packages. For the N4917BSCB 400G Optical Receiver Test Application, you require the following analysis package:

- N1010100A R&D Package

Alternatively, use the older licenses:

- N1010A-9FP (PAM-N Analysis Software)
- N1010A-TFP (TDECQ Transmitter and Dispersion Eye Closure for PAM4)

PC Interfaces

- USB
- LAN
- GPIB (optional)

Instrument Firmware Requirements

M8040A BERT

- M8070B System Software as specified earlier. Ensure that you install M8070ADVB Advanced Measurement Package for M8000 Series, as well. Refer to the previous section for the software version requirements.

86100D/N1000A DCA-X

- FlexDCA version A.07.40.319

8163B LMS

- Ver.V5.25 or later

8164B LMS

- Ver.V5.25 or later

8149xA Ref Tx

- Ver.5.01 or later

Supported Equipment

As mentioned earlier, the N4917BSCB 400G Optical RX Test Solution comprises of a variety of instruments. For some of the instruments, alternative selections are supported. The following sections detail the equipment, including the **minimum** option requirements, which are compatible with the N4917BSCB Optical RX Test Solution.

NOTE An "*" (asterisk) in this section indicates options required for 53.125Gbaud-based standards.

BERT

- M8040A-BU2: M9505A 5-slot AXIe chassis with USB option
- M8070B-M8070ADVB Advanced Measurement Package for M8000 Series of BERT Test Solutions. To view the list of available licenses, see Table 4 on page -25.
- M8045A-G32/G64*/0G3/0G4/0P3/0P6*/801 High Performance BERT module
- M8057A/B: Remote head for M8045A pattern generator, 1 channel
- M8046A-A32/0A4/0A5/0P3*/801 Analyzer module

Signal Generator for Sinusoidal and Gaussian Noise Interference

- M8195A-002 Arbitrary Waveform Generator or
- M8196A-002 Arbitrary Waveform Generator or
- M8054A Interference Source, 32 GHz

Lightwave Measurement System

- 8163B 2-slot lightwave multimeter
- 8164B 5-slot lightwave measurement system mainframe

Tunable lasers

- N7776C Tunable Laser 1240-1380 nm or
- N7778C Tunable Laser 1240-1380 nm or
- N7779C Tunable Laser 1240-1380 nm or

- 81602A-013 Tunable Laser 1250-1370 nm or
- 81606A-113 Tunable Laser 1240-1380 nm or
- 81608A-113 Tunable Laser 1240-1380 nm or
- 81609A-113 Tunable Laser 1240-1380 nm

Reference Transmitters

- 81490A-E05 Reference Transmitter or
- 81490A-E09 Reference Transmitter
- 81490A-E10 Reference Transmitter (multimode - for SR only)
- 81491A-085 Reference Transmitter (multimode - for SR only)
- 81491A-135 Reference Transmitter
- 81492A-E01* Reference Transmitter
- 81492A-135* Reference Transmitter

- 81000FI Optical Connector Interface
- 81000NI Optical Connector Interface

Optical attenuators:

- 81576A Attenuator module (straight SMF) or
- 81577A Attenuator module (angled SMF) or
- N7761A external Attenuator (1 ch straight SMF) or
- N7762A external Attenuator (2 ch straight SMF) or
- N7764A external Attenuator (4 ch straight SMF)
- N7751A external Attenuator (1 ch with 2 optical power meter channels, SMF)
- N7752A external Attenuator (2 ch with 2 optical power meter channels, SMF)
- 8490D-010 - Coaxial Fixed Attenuator, DC to 50 GHz
- N7766A external Attenuator (2 ch multimode)
- N7768A external Attenuator (4 ch multimode)

DCA-X Oscilloscope

- N1000A- DCA-X mainframe with N1000A-PTB option
- N1030A/B Optical plug-in module for the N1000A DCA-X mainframe

DCA-M Oscilloscope

- N1092A one optical channel or
- N1092B two optical channels or
- N1092C one optical, two electrical channels or
- N1092D four optical channels or
- N1092E two optical, two electrical channels
- options LOJ/PLK/IRC/200/201/300/500

Clock Recovery

- N1078A Optical/Electrical Clock Recovery
- N1077A-232/SMS/JSA Optical/Electrical Clock Recovery
- N1076A-Electrical Clock Recovery

For the complete list of available hardware options and accessories, refer to the Configuration Guide section in the *N4917BSCB Data Sheet*.

License Requirements

The N4917BSCB Optical 400G RX Test software is a BERT compliance test application which requires a valid license installed in Keysight License Manager and an active VISA connection to an M8070B session connected to a M8040A 32 or 64 GBaud High-performance BERT with the module licenses shown below installed. Most of the required licenses have also been listed in the “Supported Equipment” section. For a comprehensive list, refer to the *N4917BSCB 400G Optical Receiver Stress Test Solution - Data Sheet*.

N4917BSCB 400G Optical Receiver Stress Test Software Configuration

Table 3 License Requirements for N4917BSCB

Product	Option	Description
N4917BSCB-1FP	1FP	Optical Receiver Stress Test compliance app single mode 200G and 400G IEEE, node-locked, perpetual license
N4917BSCB-1TP	1TP	Optical Receiver Stress Test compliance app single mode 200G and 400G IEEE, transportable, perpetual license
N4917BSCB-1NP	1NP	Optical Receiver Stress Test compliance app single mode 200G and 400G IEEE, network/floating, perpetual license
N4917BSCB-1UP	1UP	Optical Receiver Stress Test compliance app single mode 200G and 400G IEEE, USB portable, perpetual license
N4917BSCB-1FL	1FL	Optical Receiver Stress Test compliance app single mode 200G and 400G IEEE, node-locked, 12 month license
N4917BSCB-1TL	1TL	Optical Receiver Stress Test compliance app single mode 200G and 400G IEEE, transportable, 12 month license
N4917BSCB-1NL	1NL	Optical Receiver Stress Test compliance app single mode 200G and 400G IEEE, network/floating, 12 month license
N4917BSCB-1UL	1UL	Optical Receiver Stress Test compliance app single mode 200G and 400G IEEE, USB portable, 12 month license
N4917BSCB-1FX	1FX	Optical Receiver Stress Test compliance app single mode 200G and 400G IEEE, node-locked, 24 month license
N4917BSCB-1TX	1TX	Optical Receiver Stress Test compliance app single mode 200G and 400G IEEE, transportable, 24 month license

Product	Option	Description
N4917BSCB-1NX	1NX	Optical Receiver Stress Test compliance app single mode 200G and 400G IEEE, network/floating, 24 month license
N4917BSCB-1UX	1UX	Optical Receiver Stress Test compliance app single mode 200G and 400G IEEE, USB portable, 24 month license
N4917BSCB-1FY	1FY	Optical Receiver Stress Test compliance app single mode 200G and 400G IEEE, node-locked, 36 month license
N4917BSCB-1TY	1TY	Optical Receiver Stress Test compliance app single mode 200G and 400G IEEE, transportable, 36 month license
N4917BSCB-1NY	1NY	Optical Receiver Stress Test compliance app single mode 200G and 400G IEEE, network/floating, 36 month license
N4917BSCB-1UY	1UY	Optical Receiver Stress Test compliance app single mode 200G and 400G IEEE, USB portable, 36 month license
N4917BSCB-1FF	1FF	Optical Receiver Stress Test compliance app single mode 200G and 400G IEEE, node-locked, 6 month license
N4917BSCB-1TF	1TF	Optical Receiver Stress Test compliance app single mode 200G and 400G IEEE, transportable, 6 month license
N4917BSCB-1NF	1NF	Optical Receiver Stress Test compliance app single mode 200G and 400G IEEE, network/floating, 6 month license
N4917BSCB-1UF	1UF	Optical Receiver Stress Test compliance app single mode 200G and 400G IEEE, USB portable, 6 month license
N4917BSCB-TRL	TRL	Optical Receiver Stress Test compliance app single mode 200G and 400G IEEE, USB portable, 30 days free trial license
M8045A	G32 or G64 0G3 or UG3 0G4 or UG4 0P3 or UP3 or 0P6 or UP6	32GBaud or 64GBaud PG Jitter Deemphasis PAM4 32GBaud or PAM4 extension to 64GBaud
M8046A	A32 or A64 0P3 or UP3	32GBaud or 64GBaud ED PAM4 32GBaud

Table 4 on page -25 shows licenses available for M8070ADVB Advanced Measurement Package for M8000 Series:

Table 4 Advanced Measurement Package Licenses

License	Description
M8070ADVB-1FP	Advanced Measurement Package for M8000 Series BERT Test Solutions, node-locked perpetual license
M8070ADVB-1TP	Advanced Measurement Package for M8000 Series BERT Test Solutions, transportable perpetual license
M8070ADVB-1NP	Advanced Measurement Package for M8000 Series BERT Test Solutions, floating perpetual license
M8070ADVB-1UP	Advanced Measurement Package for M8000 Series BERT Test Solutions, USB portable perpetual license
M8070ADVB-1FL	Advanced Measurement Package for M8000 Series BERT Test Solutions, node-locked 12 month license
M8070ADVB-1TL	Advanced Measurement Package for M8000 Series BERT Test Solutions, transportable 12 month license
M8070ADVB-1NL	Advanced Measurement Package for M8000 Series BERT Test Solutions, floating 12 month license
M8070ADVB-1UL	Advanced Measurement Package for M8000 Series BERT Test Solutions, USB portable 12 month license
M8070ADVB-1FX	Advanced Measurement Package for M8000 Series BERT Test Solutions,node-locked 24 month license
M8070ADVB-1TX	Advanced Measurement Package for M8000 Series BERT Test Solutions, transportable 24 month license
M8070ADVB-1NX	Advanced Measurement Package for M8000 Series BERT Test Solutions, floating 24 month license
M8070ADVB-1UX	Advanced Measurement Package for M8000 Series BERT Test Solutions, USB portable 24month license
M8070ADVB-1FY	Advanced Measurement Package for M8000 Series BERT Test Solutions, node-locked 36 month license
M8070ADVB-1TY	Advanced Measurement Package for M8000 Series BERT Test Solutions, transportable 36 month license
M8070ADVB-1NY	Advanced Measurement Package for M8000 Series BERT Test Solutions, floating 36 month license
M8070ADVB-1UY	Advanced Measurement Package for M8000 Series BERT Test Solutions, USB portable 36 month license
M8070ADVB-1FF	Advanced Measurement Package for M8000 Series BERT Test Solutions, node-locked 6 month license
M8070ADVB-1TF	Advanced Measurement Package for M8000 Series BERT Test Solutions, transportable 6 month license
M8070ADVB-1NF	Advanced Measurement Package for M8000 Series BERT Test Solutions, floating 6 month license
M8070ADVB-1UF	Advanced Measurement Package for M8000 Series BERT Test Solutions, USB portable 6 month license
M8070ADVB-TRL	Advanced Measurement Package for M8000 Series BERT Test Solutions, 30 days free Trial

Table 5 on page -26 describes which of the above discussed licenses are mandatory for some features of the N4917BSCB application.

Table 5 N4917BSCB License Configuration

License	Description	Description
N4917BSCB-1xx	Application license	Mandatory
M8080ADVB-1xx	Advanced Measurement Package for M8000 Series BERT Test Solutions	Mandatory for the following features: - External CDR control - Jitter tolerance testing - DUT control interface (DCI)
M8045A-G32	32 GBd PG	Mandatory
M8045A-G64	64 GBd PG	Mandatory for all 53GBd based standards: 100GBASE-DR, 100GBASE-FR, 100GBASE-LR, 400GBASE-DR4, 400GBASE-FR4, 100GBASE-SR, 200GGBASE-SR2, 400GGBASE-SR4
M8045A-0G3 or UG3	Jitter	Mandatory
M8045A-0G4 or UG4	Deemphasis	Mandatory
M8045A-0P3 or UP3	PAM4 32GBd	Mandatory
M8045A-0P6 or UP6	PAM4 extension to 64 GBd	Mandatory for all 53GBd based standards: 100GBASE-DR, 100GBASE-FR, 100GBASE-LR, 400GBASE-DR4, 400GBASE-FR4, 100GBASE-SR, 200GBASE-SR2, 400GBASE-SR4
M8046A-A32	32 GBd ED	Mandatory for receiver testing with M8046A error detector
M8046A-A64	64GBd ED	Mandatory for receiver testing of 53GBd based standards with M8046A error detector
M8046A-0P3 or UP3	PAM4 32 GBd	Mandatory for ED BER measurement of PAM4 data patterns
M8046A-0A4 or UA4	Clock Recovery for 32GBd	Mandatory for ED BER measurements with internal clock recovery

You can install the required licenses for the N4917BSCB application using Keysight License Manager.

Keysight License Manager

Keysight License Manager is a software utility that enables end users to easily manage right-to-use licenses for software and hardware capabilities on Keysight instruments or systems. The graphical user interface (GUI) gives you a visual representation of the licenses installed on your Keysight Technologies systems and provides access to the following features:

- View the licenses installed on a system
- Install licenses for new capabilities
- Transport licenses from one controller to another
- Borrow the licenses
- Remove licenses for capabilities no longer needed

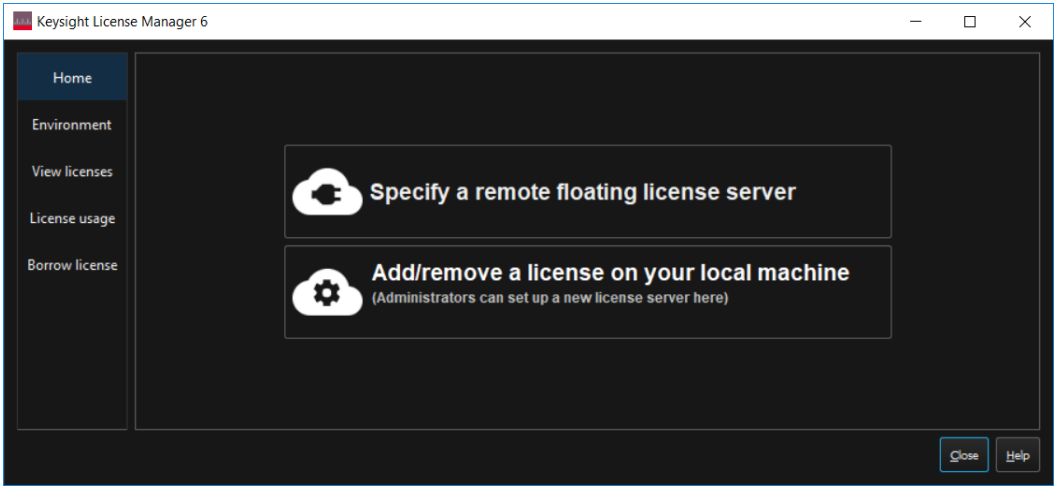
For detailed information on **Keysight License Manager**, refer to the *Keysight License Manager Help*. You can access the *Keysight License Manager Help* from the **Keysight License Manager** web page: http://www.keysight.com/find/LicenseManager

NOTE **Please note that the Keysight License Manager 6 and Keysight License Manager 5 are installed on your system when you install N4917BSCB software.**

There are two versions of Keysight License Manager, which can be used to manage the licenses:

Keysight License Manager 6

This license management application allows you to manage floating and USB portable licenses for a variety of software products and instruments.



USB portable licenses:	Install, view, delete
Floating licenses:	Install, view, delete, borrow, and configure license server

You can use the Keysight License Manager 6 to configure remote license servers for sharing licenses across a network, or to configure a local license server (used with certain types of node-locked licenses) on the computer or instrument where your Keysight software is installed.

Although the Keysight License Manager 6 is installed on your system when you install the N4917BSCB software, however, you can download it from: Keysight License Manager 6.

Keysight License Manager 5

This license management application allows you to manage node-locked and transportable licenses for a variety of software products and instruments.

Node-locked licenses:	Install, view, delete
Transportable licenses:	Install, view, delete, and transport

Although the Keysight License Manager 5 is installed on your system when you install the N4917BSCB software, however, you can download it at: Keysight License Manager 5.

Installing the Licenses

Adding License using Keysight License Manager 6

Adding a Floating License

1 On the license server machine, start **Keysight License Manager 6** from your computer's **Start** screen or **Start** menu.

2 Click **Add a license to your local machine**.

3 Select **Add a license to this floating license server**.

4 In the **Add (install) a license window**, click **Browse...** and browse to the location of your license file. You can repeat this as many times as needed to install all your licenses.

5 If you want the license server process to start automatically each time the server machine is restarted, make sure that **Automatically start license server after every reboot** is selected.

For more information, you can also refer the *Keysight Licensing Administrator's Guide*: https://literature.cdn.keysight.com/litweb/pdf/5951-5739.pdf

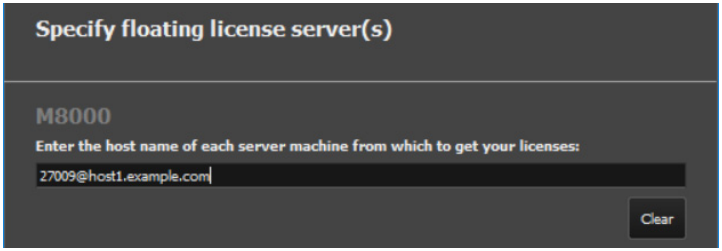
Specify remote license servers

To tell your Keysight product where to get its floating (network) licenses, do the following.

1 From the **Keysight License Manager 6** home screen, click Specify remote license server(s).

2 If you did not run **License Manager** from a menu in a Keysight product, you will see a product selection dialog box. Select the product to be licensed from the drop-down list.

3 In the **License Setup Wizard** for <Product Name> dialog box, type in the port_number@host_name of each server. If you have more than one server, separate them with semicolons (;). For example:



4 Once you've entered your server name(s), click **Next** to complete your setup.

Adding a USB License

Before adding a USB license, you must ensure that:

- Your Keysight product software is installed on this machine.
- You have a license file on this machine. If you don't have a license file, go to **Keysight Software Manager** to get one.
- If your license is locked to a dongle (USB key) rather than to a host ID:
  - The dongle driver is installed on this machine. To install:
    - Run Setup64.exe and accept the defaults.
    - Get the FLEXID10 USB Dongle Driver from http://www.keysight.com/find/LicensingUsbDriver.
    - Extract the .zip file to this machine.
  - The dongle is connected to a USB port on this machine.

To license a Keysight product for use on this machine, select the product from the drop-down menu. Once you have selected your product, browse to the license file, then click **Next** to add the license.

Counted node-locked or USB portable licenses require a license server process: your local machine is both server and client for this license type. If your local machine was not already running a license server process, that process will be started when you click **Next** to complete the operation. To make sure the server process starts automatically each time you reboot the machine, ensure that **Automatically start license server after every reboot** is selected.

For more information, you can also refer the *Keysight Licensing Administrator's Guide*:
https://literature.cdn.keysight.com/litweb/pdf/5951-5739.pdf

Adding License using Keysight License Manager 5

Adding a Node-Locked License

You can add a license to your system by installing a license (*.lic) file if you receive one from Keysight.

1 Select the > **Install License File...** menu option. This displays a Windows file selection window.

2 Use the file window to browse to and select the license file (<filename>.lic) that you want to add.

3 Click **Open**. License Manager automatically installs the license file in the folder and notifies you with a pop-up that the license has been stored in your license directory. The license now appears on the main license view.

For more information, you can also refer the *Keysight Licensing Administrator's Guide*:
https://literature.cdn.keysight.com/litweb/pdf/5951-5739.pdf

Transporting a License

Transportable licenses are licenses that can be moved from one host controller to another using the **Keysight License Manager**.

1 Start the **Keysight License Manager** by double clicking the **Keysight License Notifier** icon or click **Start** > **(All) Programs** > **Keysight License Manager** > **Keysight License Manager**.

2 In the **Keysight License Manager**, click on **Help** > **Keysight License Manager Help** and perform the procedure in the **Transporting Licenses** help topic.

3 Additionally, you can also refer the *Keysight Licensing Administrator's Guide*: https://literature.cdn.keysight.com/litweb/pdf/5951-5739.pdf

NOTE Click **Help** > **Technical Support** > **My Support Subscriptions** to view a list of license subscriptions for your application.

Installing the Software

The installer for the N4917BSCB 400G Optical Receiver Test Application can be downloaded from the Keysight website.

Download the installer file from:
https://www.keysight.com/main/techSupport.jspx?nid=-31929.1252867

To install the N4917BSCB 400G Optical Receiver Test Application, perform the following steps:

1 Double-click the downloaded installer file on your PC.

2 Click **Run**. The following screen is displayed.

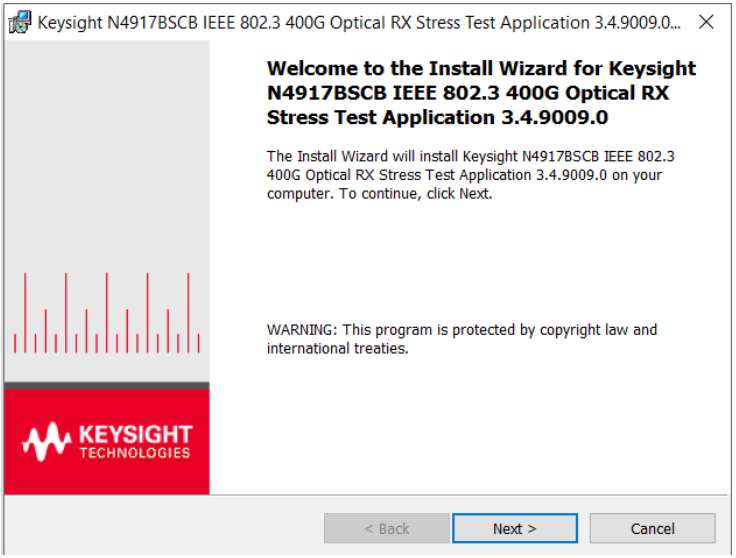


Figure 3 Welcome screen

NOTE The installer version displayed on your Welcome screen will depend on the version of the N4917BSCB software you have downloaded from the Keysight website.

3 Click **Next**. The **Keysight Software End-User License Agreement** window is displayed.

4 Select **Agree** to agree to the license agreement and to enable the **Next** button.

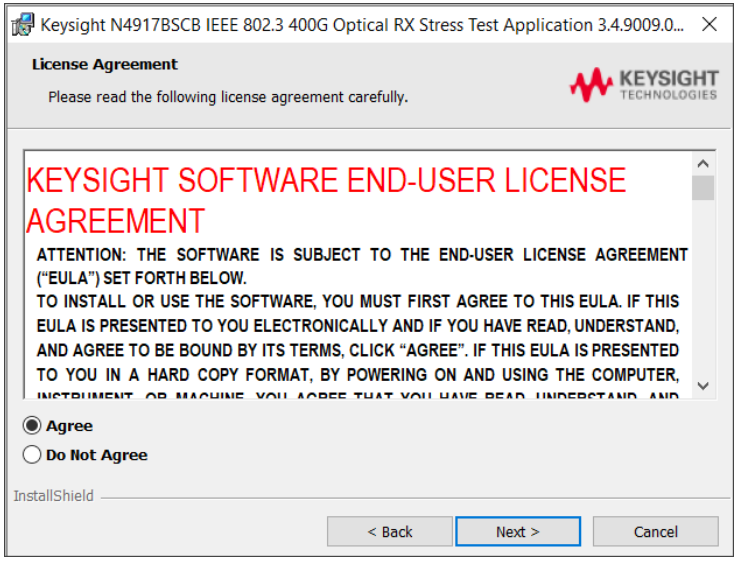


Figure 4 License Agreement window

5 Click **Install**.

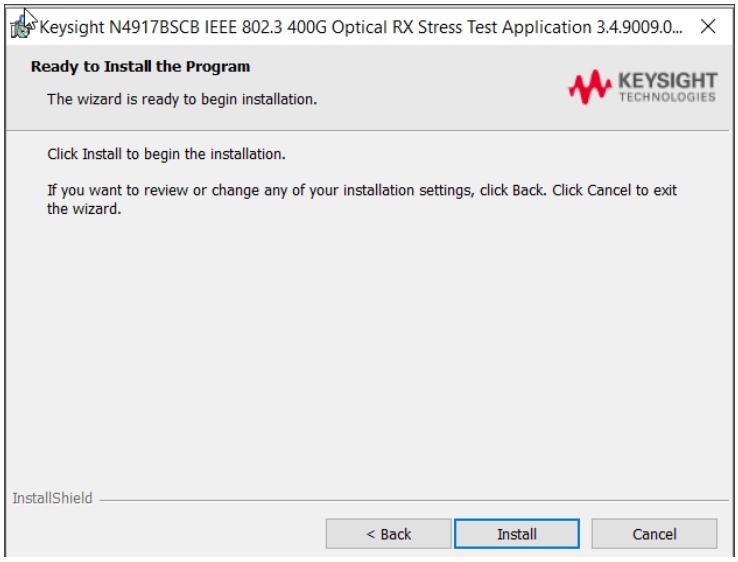


Figure 5 Ready to install window

6 Once the installation of the N4917BSCB 400G Optical Receiver Test Application begins, its status is displayed.

7 Once the installation is complete, the following window is displayed. Click **Finish** to complete the installation and exit the wizard.

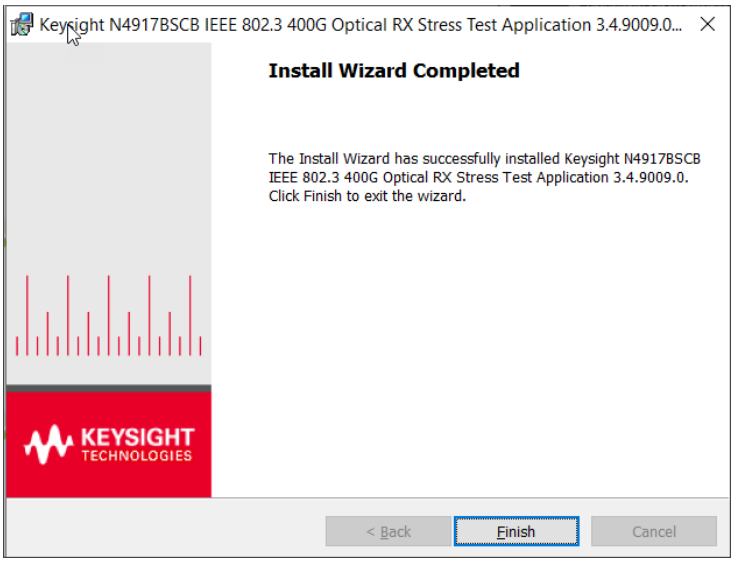


Figure 6 Window indicating end of installation

3 Concepts and Features of N4917BSCB Software

This chapter provides an overview of the underlying concepts and features of the N4917BSCB 400G Optical Receiver Test Application.

Software Concept and Flow of Optical Receiver Test

The N4917BSCB solution software controls the complete hardware required to perform an automated stressed signal calibration and system performance test in accordance with IEEE 802.3bs (clauses 121, 122, and 124), IEEE 802.3cd (clauses 138, 139, and 140), and IEEE 802.3db (clause 167) specifications for the following standards:

- 200GBASE-FR4/-LR4/-DR4 (IEEE 802.3bs)
- 400GBASE-FR8/-LR8 (IEEE 802.3bs)
- 400GBASE-DR4 (IEEE 802.3bs)
- 400G-FR4 (100G per lambda MSA)
- 100G-FR/-LR (100G per lambda MSA)
- 100GBASE-DR (IEEE 802.3cd)
- 50G-SR/100G-SR2/200G-SR4/400G-SR8 (IEEE 802.3cd)
- 100G-SR/200G-SR2/400G-SR4 (IEEE 802.3db)
- 50G-FR/-LR (IEEE 802.3cd)

The software is based on a generic framework that already supports a wide range of automated compliance test applications for electrical transmission standards, such as, OIF CEI, XAUI, CAUI and many others.

The workflow of a generic compliance test application consists of five basic steps, which are explained in detail in Chapter 4, “Using the N4917BSCB Software”.

The following table briefly explains each of these steps in the workflow.

Step	Description
Set Up	Select standard to be tested and specify instrument connection settings.
Select Tests	Adjust your equipment setting using Utility Functions and select tasks to perform from the list of available tests. The list of available tasks depends on the selected transmission standard and equipment configuration.
Configure	Adjust specific test settings (in compliance or debug mode).
Connect	Check the actual hardware connection with the provided reference diagram.

Step	Description
Run Test	Run the selected tests (either once or multiple times). User-defined "Tags" can be added for each calibration or test.
Automate	Lets you construct scripts of commands that drive execution of the application.
Results	Contains more detailed information about the tests that have been run. You can change the thresholds at which marginal or critical warnings appear.
HTML Report	Shows a test report that can be printed.

The N4917BSCB solution software offers different measurement and calibration functions to perform a full 200GBASE, 400GBASE, 100GBASE, and 50GBASE optical receiver compliance test in accordance with IEEE 802.3bs, 802.3cd, and 802.3db specifications. (For the list of supported standards, see "Applicable Standards" on page 10.)

The following flow chart explains the basic steps to perform a stressed optical receiver test.

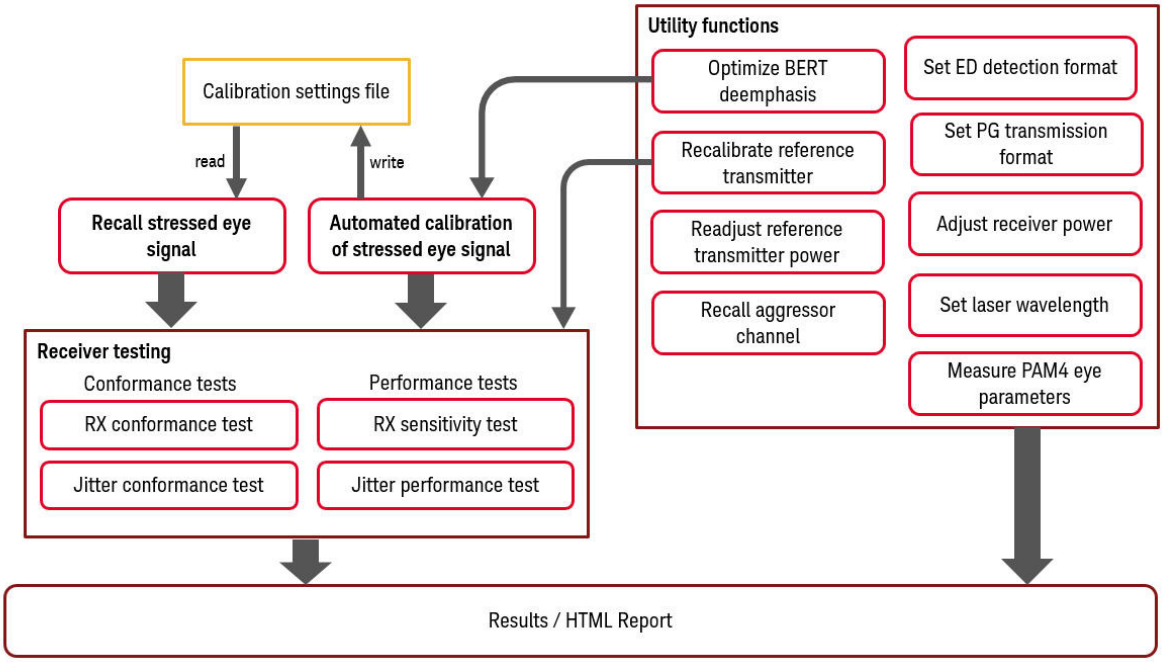


Figure 7 N4917BSCB Optical Receiver Testing Flow Chart

Typical Setup for Optical Stress Test

The setups for stressed eye signal calibration are shown in Figure 8, Figure 9, Figure 10, and Figure 11. The table below lists differences between these figures.

Figure 8	Figure 9	Figure 10	Figure 11
▪ Illustrates configuration for stressed eye calibration test step ▪ 26GBd signaling rate standards ▪ Single mode (SM) configuration ▪ Clean clock configuration ▪ Applicable for all SM standards that use a clean clock	▪ Illustrates configuration for stressed eye calibration test step ▪ 26GBd signaling rate standards ▪ Single mode (SM) configuration ▪ Recovered clock configuration ▪ Applicable for all SM standards that use a recovered clock	▪ Illustrates configuration for stressed eye calibration test step ▪ 53GBd signaling rate standards (with additional electrical attenuator in interference signal path) ▪ Single mode (SM) configuration ▪ Additional electrical attenuator in interference signal path ▪ Clean clock configuration ▪ Applicable for all SM standards that use a clean clock	▪ Illustrates configuration for stressed eye RX DUT test ▪ 26GBd signaling rate standards ▪ Multi mode (MM) configuration ▪ With MM optical clock recovery (CDR) configuration for RX DUT and BERT ED ▪ DCA (used for calibration test step) shown but not connected ▪ Applicable for all MM standards that use a recovered clock

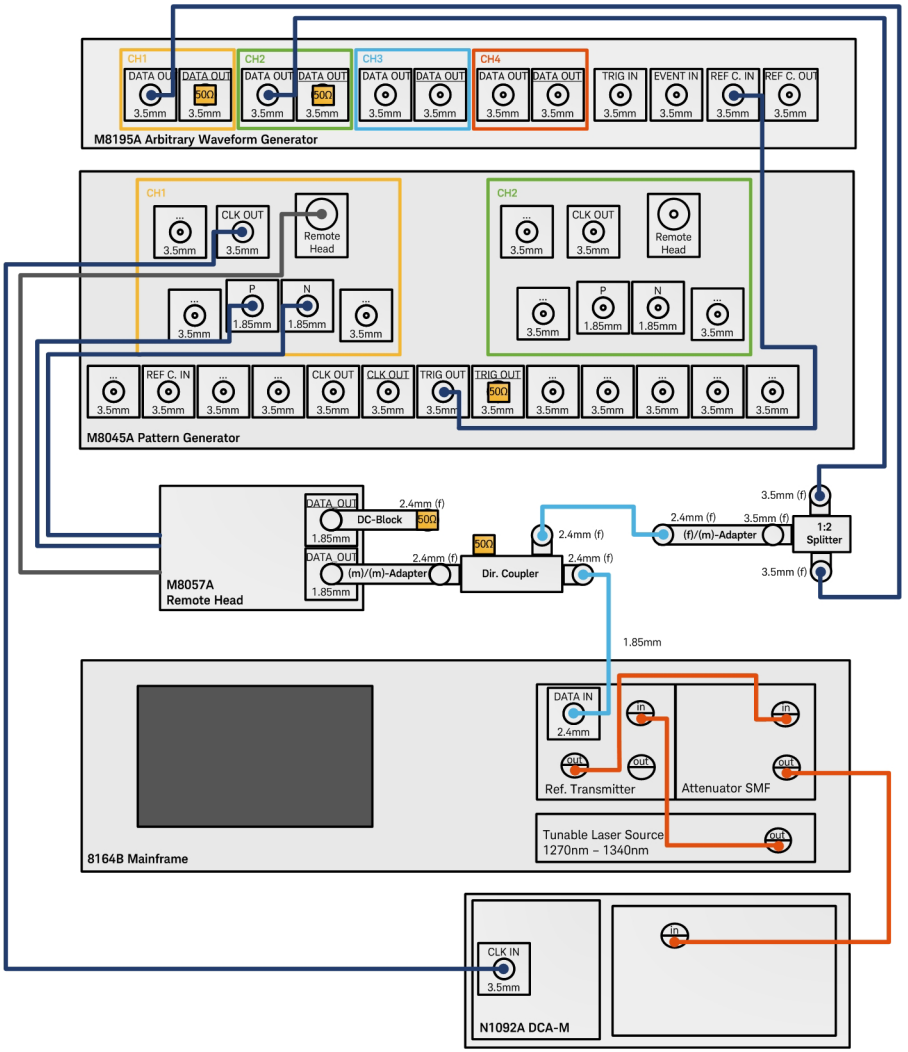


Figure 8 Setup for stressed eye signal calibration for 200GBASE-FR4/-LR4/-DR4 & 400 GBASE-FR8/LR8 with clean clock

Note: The setup for 50GBASE-FR and 50GBASE-LR is the same as in Figure 8, with the exception that the tunable laser is not required; the internal laser source of transmitter can be used.

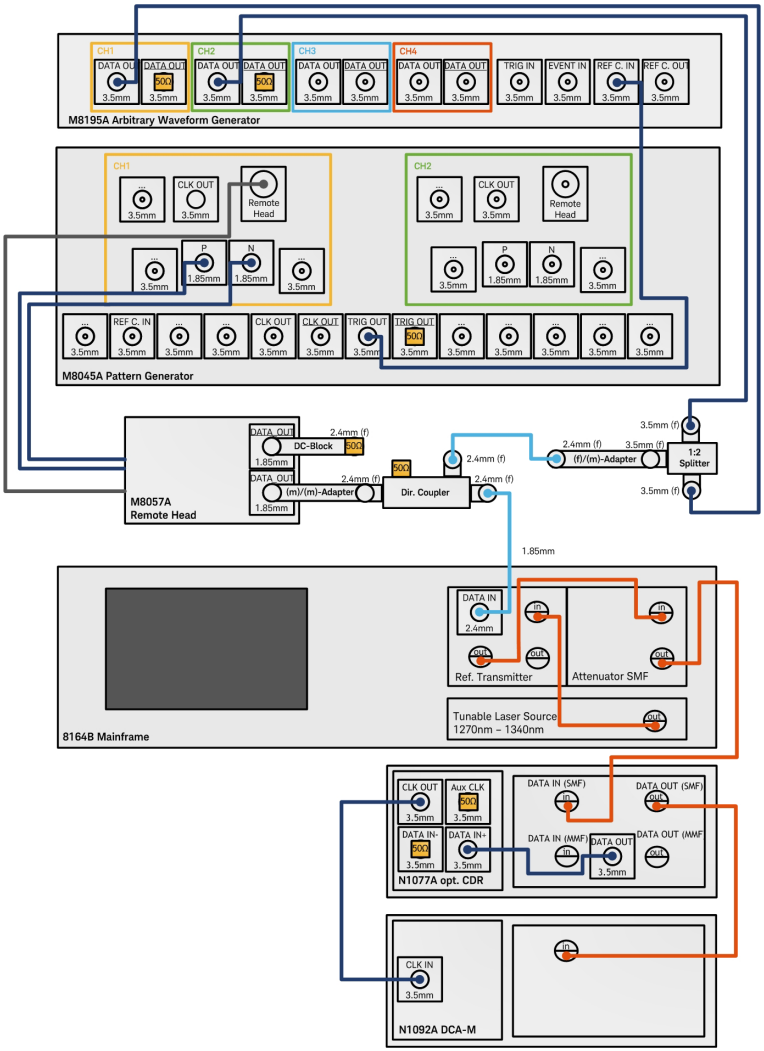


Figure 9 Setup for stressed eye signal calibration for 200 GBASE-FR4/-LR4/-DR4 & 400 GBASE-FR8/LR8 with recovered clock

Note: The setup for 50GBASE-FR and 50GBASE-LR is the same as in Figure 9, with the exception that the tunable laser is not required; the internal laser source of transmitter can be used.

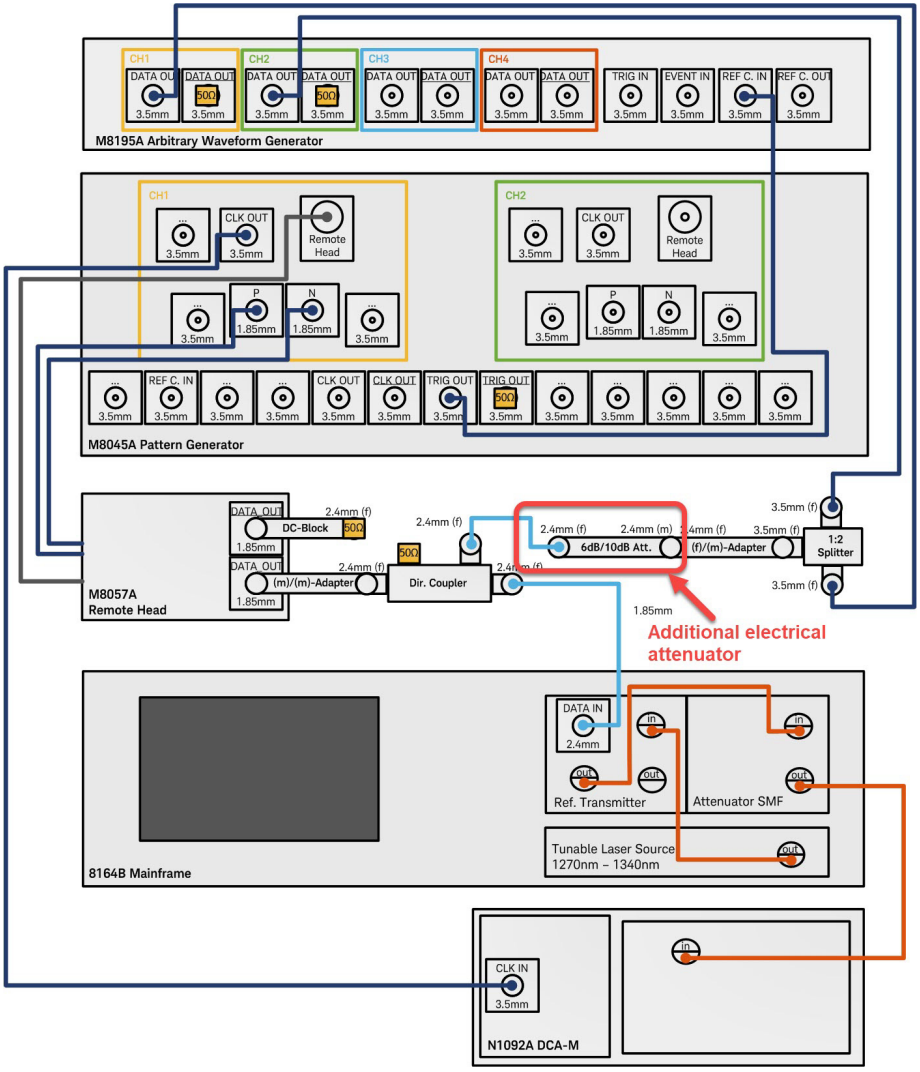


Figure 10 Setup for stressed eye signal calibration for 400GBASE-DR4 and 400G-FR4 (with additional electrical attenuator)

The setups for 100GBASE-DR and 100G-FR, 100G-LR is the same as in Figure 10, with the exception that the tunable laser is not required; the internal laser source of transmitter can be used.

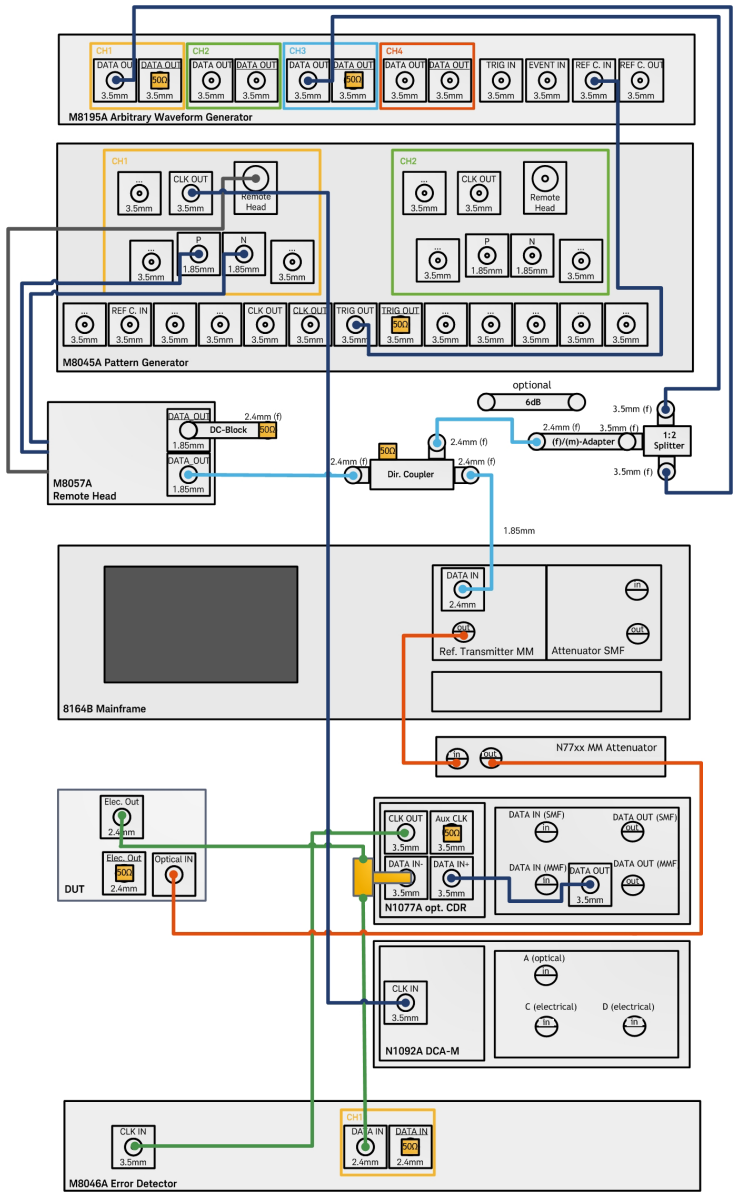


Figure 11 Setup for stressed eye signal calibration for 50G-SR/100G-SR2/200G-SR4/400G-SR8/100G-SR/200G-SR2/400G-SR4

An example setup for 200GBASE-LR4/-FR4 using four 50 Gb/s lanes on four wavelengths in the O-band is shown in Figure 12, which assumes the use of a 200 GAUI-8 electrical interface.

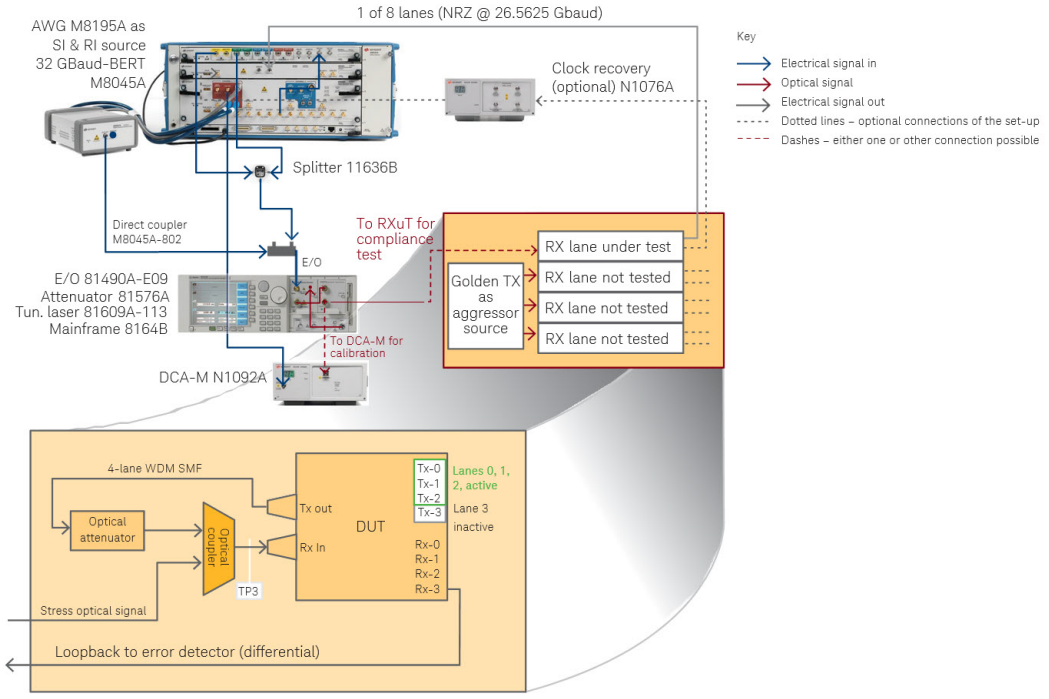


Figure 12 Optical receiver stress test setup for 200 GBASE-LR4/-FR4

Controlling N1076A/77A from M8070B System Software

For seamless integration of clock recovery in the N4917BSCB 400G Compliance Application, an instance of the N1076A/77A clock recovery must run the FlexDCA N1000-Series system software prior to starting the M8070B software.

Setting up the required connections involves starting the FlexDCA software and connecting to the CDR module(s), configuring and starting the SCPI server in FlexDCA, giving VISA connection to corresponding FlexDCA session alias name: N1076A_PROXY, and starting the M8070B and observing the new connection to the DCA modules. Refer to the *Controlling N1076A/77A from M8070B* topic in the *Keysight M8070B Advanced Measurement Package User Guide* to understand the procedure for the N1076A/77A control via M8070B and FlexDCA system software.

NOTE **N4917BSCB also supports the use of N1076B and N1078A CDR modules.**

Figure 13 shows the block diagram depicting the recommended setup to connect an N1076A/77A clock data recovery module to the M8046A error detector module.

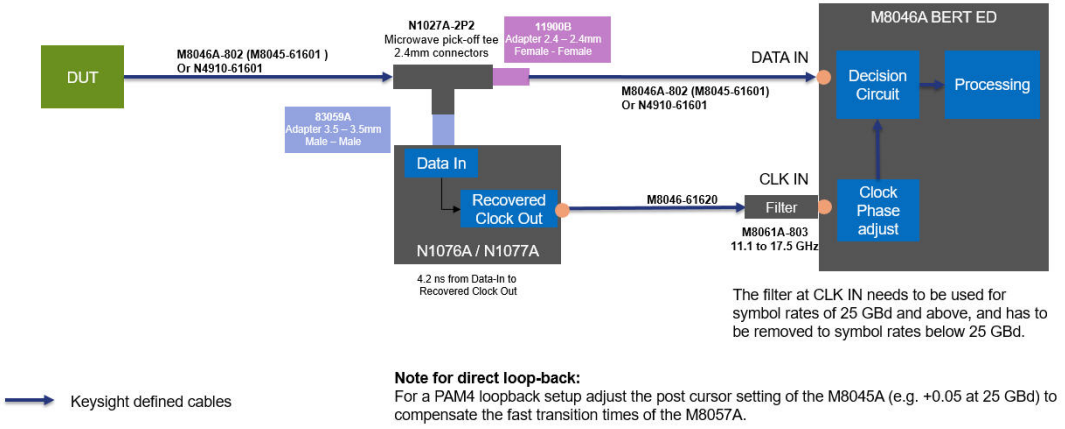


Figure 13 Recommended connection setup for N1076A/77A control

NOTE To understand the further connection setups (supporting higher data rates), refer to the *Keysight M8070B Advanced Measurement Package User Guide*.

Automated Calibration

One of the main features of the N4917BSCB solution software is the automated calibration of stressed receiver conformance test signal as specified in the IEEE specification.

The signal metrics and the calibration procedure is very similar to those of NRZ-based 100GBASE transmission standards (as defined in IEEE 802.3ba) but there are noticeable differences:

- A new TDECQ/SECQ metric is employed to characterize the quality of a transmitted/received signal instead of the traditional eye mask analysis.
- A digital reference equalizer is required to compute various signal metrics during transmitter performance testing or during stress signal calibration for receiver stress testing.

Therefore, achieving accurate, stable and repeatable stress signal calibration, to ensure reliable transceiver performance test and qualification, has become even more challenging. Optical receiver stress test procedures, defined by the IEEE, are performed using several instruments such as a bit error ratio tester, digital sampling oscilloscope, optical reference transmitter and tunable laser source. The purpose of the test is to generate a stable and repeatable stressed optical signal with specific characteristics, and send it to the receiver under test to measure the resulting bit error ratio. However, achieving this is not a trivial task as the combination of different stress factors (inter symbol interference, jitter, sinusoidal interferences, Gaussian noise, optical power level) gives rise to complex dependencies on the target metrics.

Composition of IEEE 802.3bs Stressed Receiver Conformance Test Signal

The N4917BSCB software calibrates the stressed receiver conformance test signal according to the definitions in the IEEE 802.3 and 400G MSA's. Note that you can change the target values of the metrics to be optimized (select **Debug** in the **Configure** tab).

The M8045A BERT pattern generator generates a test pattern with the signal parameters listed in the following table. The calibration procedure then performs the following steps to create an impaired signal using the specified stress components and measuring the stress signal calibration metrics listed in the following table.

Table 6 Stressed receiver compliance test signal characteristics

Transmission Standard	Signal Parameter	Value
200GBASE-FR4, LR4, and DR4 400GBASE-FR8 and LR8 50GBASE-FR and LR 50G/100G/200G/400G-SR	Signaling rate Modulation format Calibration test pattern Stressed receiver test pattern	26.5625 +/- 100ppm GBd PAM4 SSPRQ (as defined in 120.5.11.2.3) PRBS31Q (as defined in 120.5.11.2.2)
	Stress Components Sinusoidal jitter (sinusoidally jittered clock) Sinusoidal amplitude interferer (SI) Gaussian noise (GN) Inter-symbol-interference (ISI)	 as defined in Table 121-12 between 100 MHz - 2GHz, non-harmonic to data signal and other stress components Bandwidth of at least half the signal baud rate
	Stress Signal Target Metrics Stressed eye closure (SECQ) SECQ-10log$_{10}$(C_{eq}) Extinction ratio (ER) Transition time Stressed receiver sensitivity (OMAouter)	 Stressed eye closure quaternary for PAM4 as defined in 121.8.10.2 as defined in 121.8.6 as defined in 121.8.9
400GBASE-DR4, 400G-FR4 100G-FR,LR 100GBASE-DR	Signaling rate Modulation format Calibration test pattern Stressed receiver test pattern	53.125 +/- 100ppm GBd PAM4 SSPRQ PRBS31Q
	Stress Components Sinusoidal jitter (sinusoidally jittered clock) Sinusoidal amplitude interferer (SI) Gaussian noise (GN) Inter-symbol-interference (ISI)	 Same as for the other supported 400GBASE and 200GBASE standards
	Stress Signal Target Metrics Stressed eye closure (SECQ) SECQ-10log$_{10}$(C_{eq}) Extinction ratio (ER) Transition time Stressed receiver sensitivity (OMAouter)	 Stressed eye closure quaternary for PAM4 as defined in 124.8.10

Transmission Standard	Signal Parameter	Value
100G/200G/400G-SR	Signaling rate	53.125 +/- 100ppm GBd
	Modulation format	PAM4
	Calibration test pattern	SSPRQ
	Stressed receiver test pattern	PRBS31Q
	Stress Components	
	Sinusoidal jitter (sinusoidally jittered clock)	
	Sinusoidal amplitude interferer (SI)	
	Gaussian noise (GN)	
	Inter-symbol-interference (ISI)	
	Stress Signal Target Metrics	
	Stressed eye closure (SECQ)	
	Extinction ratio (ER)	
	Transition time	
	Stressed receiver sensitivity (OMAouter)	

1 The pattern generator output amplitude is adjusted so that the clean eye signal (i.e., sinusoidal jitter, sinusoidal interferer and Gaussian noise turned off) has approximately the minimum extinction ratio as specified in the standard.

2 The N4917BSCB software stress signal calibration offers an automated procedure that adjusts the initial SECQ value by means of changing the BERT deemphasis coefficients to emulate the ISI resulting from the frequency response of an E/O converter. ISI calibration Method 3 uses some improved readjustment algorithms and should give the best ISI calibration results for all transmission standards; Keysight recommends using it for the initial SECQ adjustment.

NOTE ISI generation Method 3 is now the default method for all transmission standards.

3 After turning on the sinusoidal jitter (SJ), sinusoidal interferer (SI) and Gaussian noise (GN), the software changes iteratively the amplitudes of the stress components until all stressed signal metrics are met.

4 The parameters of the stressed receiver test signal are stored in a calibration file to be recalled for the same setup at a later point in time.

The stressed receiver conformance test signal as defined in the IEEE standard allows certain degrees of freedom to meet the specified target metrics SECQ, ER and OMAouter. For example, the frequencies of sinusoidal jitter and sinusoidal amplitude interferer are not exactly

specified by the standard but can be set in the given range (see Table 121-12). Also, the ratio between sinusoidal interferer and Gaussian noise is not specified in the IEEE 802.3bs standard but may be specified by the user.

The N4917BSCB software also offers to change these parameters by using the calibration configuration variables (explained in Chapter 5, "Performing Stressed Receiver Compliance Tests with N4917BSCB Software").

- Periodic Jitter Frequency (default: 119.2 MHz)
- Sinusoidal Interferer Frequency (default: 1.9431 GHz)
- Sinusoidal Interferer to Noise Ratio (default: 10 dB)
- Initial SECQ (default ~half of target SECQ)

Figure 28 depicts the N4917BSCB software stress signal calibration procedure.

Support for transmission standards compliant with IEEE 802.3cd or IEEE 802.3db specification – Comparison with original IEEE 802.3bs standard

The IEEE 802.3cd or IEEE 802.3db standard introduces a number of changes for the stressed receiver sensitivity (SRS) testing compared to the previous IEEE 802.3bs standard. The definitions can be found in IEEE 802.3cd clauses 138, 139, and 140 or in IEEE 802.3db clause 167 and affect the following new transmission standards:

- 100GBASE-DR
- 50GBASE-FR, 50GBASE-LR
- 50G/100G/200G/400G-SR (Multi-mode)
- 100G-SR/200G-SR2/400G-SR4 (IEEE 802.3db)
- 400G-FR4 MSA (specification updated to comply with IEEE 802.3cd)
- 100G-FR MSA, 100G-LR MSA

Some of these changes are:

- **New Stressed receiver condition SECQ – $10\log_{10}(Ceq)$**

  The coefficent Ceq was already introduced in IEEE 802.3bs (121.8.5.3) and describes the noise enhancement factor for the reference (TDECQ) filter. According to the new cd standard, the Ceq coefficient must be at least 1 or larger (i.e. $10*\log_{10}(Ceq) >= 0$). The N4917BSCB software uses a modified initial SECQ optimization procedure (see configuration variable "ISI generation method"), which. ensures that Ceq is larger

than the specified value (“Ceq target value”) before noise is added to the signal.

- **RINxx.xOMA parameter condition (not measured in current revision)**

  While the RINxx.xOMA parameter was already defined in the IEEE 802.3bs as transmit characteristic, the IEEE 802.3cd standard adds it as a new requirement during SRS testing stating that the RINxx.xOMA should not exceed the value specified in the corresponding transmit characteristic when the Gaussian noise generator is turned on and the sinusoidal jitter and sinusoidal interferer are turned off (clause 140.7.10).

  This means the RINxx.xOMA can be controlled by the SI to GN ratio (see configuration variable “Sinusoidal Interferer to Noise Ratio”) and the user has to increase the SI/GN ratio, if necessary, to meet the RINxx.xOMA condition.

- **Rx sensitivity (not stressed) dependent on Tx SECQ**

  Contrary to the IEEE 802.3bs standard, the receiver sensitivity (not stressed) is not defined by a single OMA value but dependent on the transmitter SECQ used to measure the receiver sensitivity.

- **New multimode standards**

  The PAM4 multimode standards (-SR/SR2/SR4) defined in the IEEE 802.cd/db are not based on the 100GBASE-SR4 recommendations (clause 95) but have the following main differences:

  - Clean clock (instead of recovered clock)
  - No jitter calibration

Automated Compliance and Performance Tests

The automated compliance and performance tests use nearly the same setup as used for the stressed receiver signal calibration. The difference is that the optical fiber from the attenuator output is connected to the optical input of the receiver/lane under test instead of the input of the DCA. You can use an optical switch to swap the connections. This optical switch can be controlled using the *Auxiliary Instrument VISA Address* and *Auxiliary Instrument SCPI Command* variables under the Configure tab.

The optical receiver is stressed with the calibrated compliance test signal on the lane under test and the received bit error rate (BER) is measured and compared against the target value under various conditions. Note that all the other optical lanes are supposed to be activated to serve as optical cross-talk source. A possible realization of such requirement is illustrated in Figure 12.

Different approaches to recover the BER are supported:

- The BER can be retrieved from the transceiver internal error counter – if any. In this case the communication between the device under test and the N4917SCB solution software is realized using the DCI interface of the M807B software.
- If no internal error counter is available on the transceiver, an M8046A error detector should be employed to measure the BER of the lane under test. The clock signal used for the error detector should be extracted from the recovered signal (either provided by the DUT or extracted from another lane using an external CDR. Using the internal clock recovery in the new M8046A error detector module is also an option).

The following tests can be performed automatically:

- **Rx Compliance Test**: measures the Rx BER compliance at the stressed receiver sensitivity (OMAouter) as defined in the IEEE standards.
- **Jitter Compliance Test**: measures the Rx BER compliance at different jitter frequencies with maximum jitter amplitude as defined in IEEE 802.3bs Table 121-12, IEEE 802.3cd Table 138-13, and IEEE 802.3db Table 167-13.
- **Rx Sensitivity Measurement**: measures the Rx BER versus stressed receiver sensitivity (OMAouter).
- **Jitter Performance Measurement**: measures the Rx BER versus jitter frequency and amplitude.

Table 7 Stressed receiver compliance target metric

Transmission Standard	Signal Parameter	Value
200GBASE-FR4, LR4, and DR4 400GBASE-FR8, LR8, and DR4 400G-FR4 100G-FR and LR 100GBASE-DR 50G-SR/100G-SR2/200G-SR4/400G-SR8 100G-SR/200G-SR2/400G-SR4 50GBASE-FR and LR	Target error ratio	2.4e-4

4 Using the N4917BSCB Software

As a prerequisite for using the N4917BSCB software, ensure that all the required instruments specified in "Supported Equipment" on page 20 are defined in the *Keysight Connection Expert* on the PC, where the Keysight N4917BSCB 400G Optical Receiver Test Application is installed.

Starting the N4917BSCB 400G Optical Receiver Test Application

The N4917BSCB 400G Optical Receiver Test Application is available to be run as a standalone application on a PC, and either connecting locally or remotely to the hardware setup.

Before you launch the N4917BSCB 400G Optical Receiver Test Application, make sure that the following software are running and online:

- FlexDCA N1000-Series System Software for connecting to all the available DCA and CDR modules (used for stressed receiver compliance signal calibration)
- M8195A/M8196A/M8054A soft front panel software (used to control the sinusoidal interferer and Gaussian noise signal generator). For M8054A Interference Source, see "Using M8054A Interference Source" on page 59.
- Keysight M8070B software to connect to M8040A High-performance BERT, which, in turn tries to connect to the FlexDCA using an available “N1076A_PROXY”.

NOTE

It is recommended to start the various software tools in the following order to make sure all the connected instruments are recognized and initialized correctly:

1. Start FlexDCA software and configure CDR modules (optional)

2. Start AWG soft front panel. For M8054A Interference Source, see "Using M8054A Interference Source" on page 59.

3. Start M8070B system software with option /IgnoreAWG

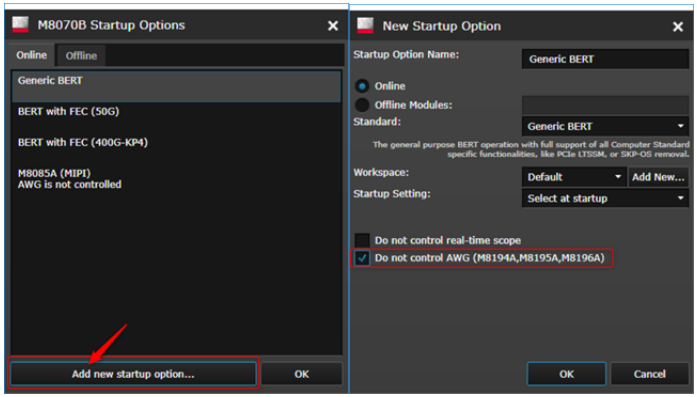
Ensure that proper connections with the testing instruments are established. Ensure that the measurement instruments are connected on the same LAN as the remote PC, where the N4917BSCB 400G Optical Receiver Test Application is installed.

Using M8054A Interference Source

The M8054A Interference Source must be used in an almost identical way as the M8195A and M8196A AWG modules. However, there are some differences. Perform the following steps:

1 Connect M8045A pattern generator TRIG OUT to M8054A REF CLK IN (similar to M8195A and M8196A).

2 Start the M8070B system software with the "/IgnoreAWG" option. Either use the command line to start the M8070B software in this manner or add this option as a new startup option from the M8070B Startup Options dialog.



3 Start the M8054A soft front panel (SFP) separately and manually.

NOTE

As opposed to M8195A and M8196A, the N4917BSCB ORST application must run on the same machine as the M8054A SFP (which, in turn must run on the machine connected to the AXI mainframe where the M8054A is installed). Also, the M8054A SFP does not need to be installed manually by the user but will automatically be installed with the latest M8070B software.

a Since there is no entry to start the M8054A SFP from the Windows **Start** menu, navigate to "C:\Program Files (x86)\Keysight\M8054\bin\" and start the executable: "AgM8054SFP.exe". For subsequent use, consider adding a shortcut on the desktop to be able to start the SFP.

The M8054A does not show any GUI elements to control the IF source (i.e., the SFP window is mostly empty)

b Get the VISA address of the M8054A Interference Source by selecting **Help > About**.

4 Use the VISA address of M8054A SFP for Sinusoidal and Gaussian Noise signal generator in N4917BSCB software.

To access the N4917BSCB 400G Optical Receiver Test Application, perform the following steps:

1 From the **Start** menu of the Windows 7 or 8 Operating System, select **All Programs > Keysight M8070B Applications > Keysight N4917BSCB > Launch Keysight N4917BSCB**.
On Windows 10 Operating System, select **Keysight M8070B Applications > Launch Keysight N4917BSCB**

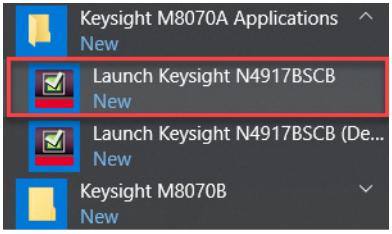


Figure 14 Launching the N4917BSCB Rx Test Application on Windows 10

Alternatively, type **N4917BSCB** in the Windows **Search** box to locate the application.

NOTE

If you do not see the required entries on the **Start** menu, the N4917BSCB 400G Optical Receiver Test Application has not yet been installed on the PC.

Refer to "Installing the Software" on page 32 for installation instructions.

- If you are launching the Keysight N4917BSCB 400G Optical Receiver Test Application for the first time, the End-User License Agreement window appears. Select **Agree** to continue.
- The N4917BSCB 400G Optical Receiver Test Application banner is displayed.
- If there is a single instance of the M8070B software running locally, the N4917BSCB 400G Optical Receiver Test Application launches after automatically getting connected to the M8070B software.
- If the N4917BSCB 400G Optical Receiver Test Application does not detect any instance of the M8070B software running locally, the **Connect to M8070** window appears.

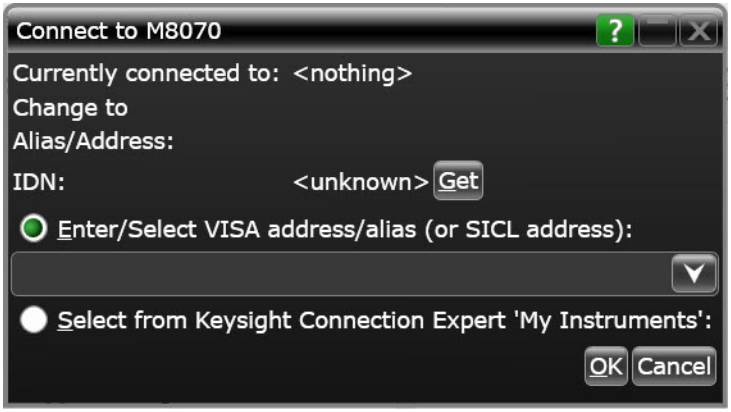


Figure 15 Connecting to M8070B

2 Perform one of the following actions:

- In the **Enter/Select VISA address/alias (or SICL address):** text field, you can either type or copy the VISA/SICL address directly from the Keysight M8070B Software and paste it here. To verify the correct VISA address to connect to M8070B, access the **SCPI Server Information** window. by clicking **Utilities > SCPI Server Information...** from the main menu of the Keysight M8070B software.

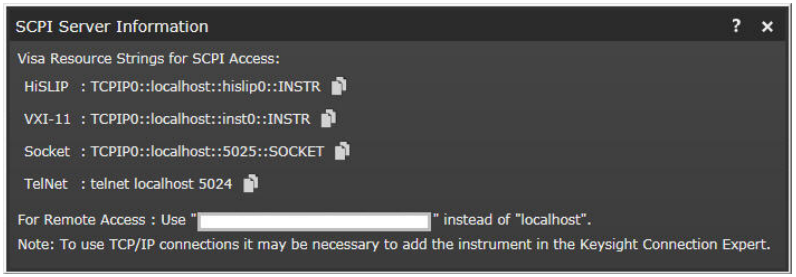


Figure 16 SCPI Server Information window on the M8070B Software

- If the BERT device is online and defined in the *Keysight Connection Expert*, click **Select from Keysight Connection Expert favorites:**. The VISA address list defined in the Keysight Connection Expert software for each online instrument is displayed. After you verify the VISA/SICL address, select the correct VISA Address from the list.

3 Click **Get** on the **Connect to M8070** window. The **IDN:** field displays the instrument name.

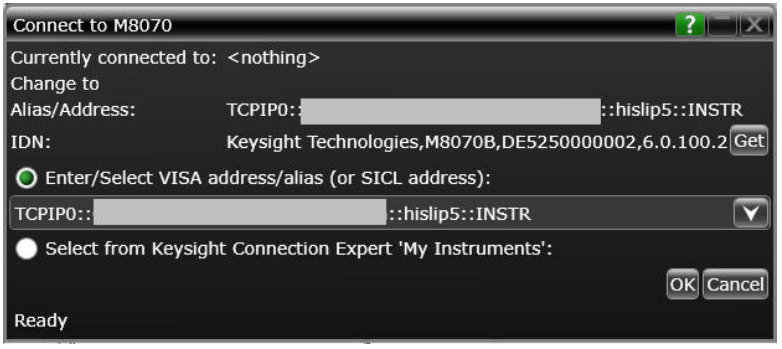


Figure 17 IDN field displaying successful connection to M8070B

4 Click **OK** to establish connection with M8070B and to launch the N4917BSCB 400G Optical Receiver Test Application. If the connection cannot be established, the application start will be aborted. If the required licenses are missing, a message is displayed.

5 When the application starts successfully it will start with the default layout and will show the **Set Up** tab.

NOTE The **Message** tab will show info, warning and error messages while running the N4917BSCB application as well as intermediate results of measurements. Scroll up and down to display relevant messages.

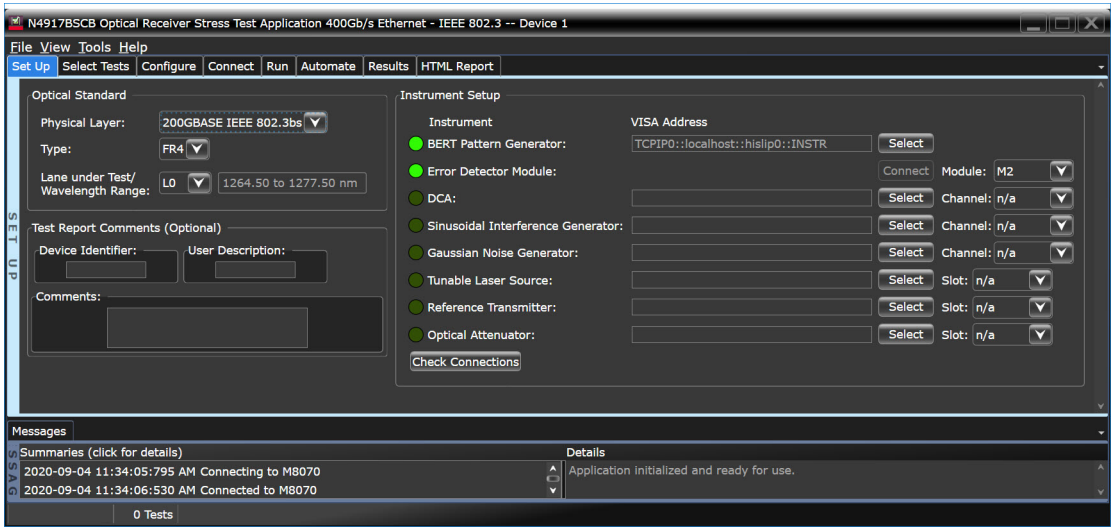


Figure 18 Default view of the N4917BSCB 400G Optical Receiver Stress Test Application

NOTE The application framework enables you to use docking and floating windows, so the GUI can be customized to meet your requirements. If you want to reset the GUI to its default layout, select **View > Reset > Tab Layout** in the application menu.

For more information on how to use the various features in the N4917BSCB 400G Optical Receiver Test Application, refer to the *Keysight N4917BSCB 400G Optical Receiver Test Application Online Help*.

Setup tab - Setting up the N4917BSCB 400G Optical Receiver Test Application

Before you start any stressed signal calibrations or receiver testing with the N4917BSCB application, you must set up the application first.

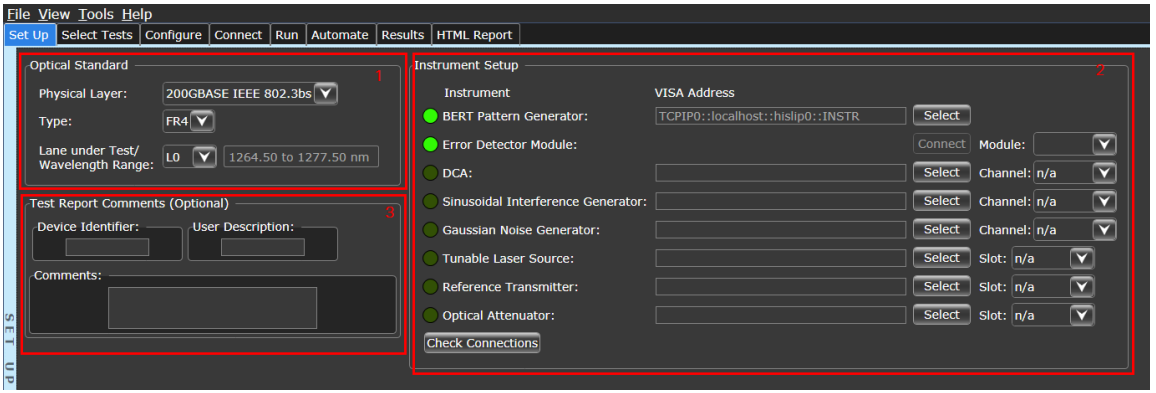


Figure 19 Setting up the N4917BSCB Optical Receiver Stress Test BERT Compliance Application

Under the **Set Up** tab,

1 In the **Optical Standard** area,

i Select one out of these options - **200GBASE IEEE 802.3bs, 400GBASE IEEE 802.3bs, 400G-FR4 100G Lambda MSA Group, 100G-FR/LR 100G Lambda MSA Group, 100GBASE-DR IEEE P802.3cd, 50G/100G/200G/400G-SR IEEE 802.3cd, 100G/200G/400G-SR IEEE 802.3db** or **50GBASE IEEE 802.3cd** in the **Physical Layer** area, to indicate the physical medium attachment (PMA) sublayer type on which the calibrations/tests are to be performed. The **Select Tests** tab displays the respective calibrations and tests. By default, **200GBASE IEEE 802.3bs** is selected.

ii Select the physical medium dependent (PMD) sublayer. The following table displays the available PMD sublayers for the physical layer standards:

Physical Layer	Type
200GBASE IEEE 802.3bs	FR4, LR4, DR4
400GBASE IEEE 802.3bs	FR8, LR8, DR4
400G-FR4 100G Lambda MSA Group	FR4
100G-FR/LR 100G Lambda MSA Group	FR, LR
100GBASE-DR IEEE P802.3cd	DR
50G/100G/200G/400G-SR IEEE 802.3cd	SR/SR2/SR4/SR8
100G/200G/400G-SR IEEE 802.3db	SR/SR2/SR4
50GBASE IEEE 802.3cd	FR, LR

iii Specify the lane under test for the selected optical standard and type. The transmission lane refers to the center transmission wavelength for a wavelength-division-multiplexed physical layer type. Hence the number of available lanes might vary between selected transmission standards. **DR** and **SR** sublayer types do not have lanes assignments but use multiple fiber pairs for transmission and will show “n/a” instead. Similar is the case for 100G-FR and 100G-LR sublayer types that are based on 100GBASE-DR standard.

2 In the **Instrument Setup** area, specify the VISA/SICL address for the following instruments:

- BERT Pattern Generator
- Error Detector Module
- DCA
- Sinusoidal Interference Generator
- Gaussian Noise Generator
- Tunable Laser Source
- Reference Transmitter
- Optical Attenuator

NOTE In the FlexDCA software, go to **Tools-> SCPI Programming Tools-> SCPI server** to activate the SCPI server or retrieve its information.

NOTE

In the M819xA soft front panel, go to **Help-> About** to find the AWG SCPI server address.

For connecting to M8054A Interference Source, refer to "Using M8054A Interference Source" on page 59.

NOTE

The Tunable Laser Source can be ignored if the internal laser source of the reference transmitter is used. In this case, the exact emission wavelength must be specified in the “Transmitter Wavelength” configuration variable under the Configure tab. For more information, see "Connecting to the Internal Laser Source of the Reference Transmitter" on page 68.

i Click **Select...** corresponding to the above instruments to connect to them using the SICL/VISA address, if not connected already. By default, when you start the N4917BSCB 400G Optical Receiver Test Application, a connection dialog is displayed to connect at least to the BERT device, else the application fails to launch. A green LED indicates that the instrument has been connected successfully.

ii Select an appropriate module, channel, or slot, wherever appropriate.

NOTE

N4917BSCB supports the usage of up to two error detector modules (ED) to make combined BER measurements on multiple DUT output lines. If more than one ED is found, an additional entry for the combined modules will be shown in the drop-down list (for example, for detected error detector modules M2 and M3, combined module “M2+M3” is shown.)

iii Click **Check Connections** to verify that the instruments are properly connected to the N4917BSCB 400G Optical Receiver

Test Application.

NOTE Some instruments might be a module in a multi-module mainframe (e.g. tunable laser source as module in Keysight's 8164B Lightwave Measurement System) and thus shares the same VISA address as other instruments in that mainframe. Select the appropriate module, channel or slot to connect to these instruments. A message in the logging tab might give more information about the model code of the connected module.

3 In the **Test Report Comments (Optional)** area, enter appropriate values in the **Device Identifier:**, **Device User Description:** and **Comments:** text fields, respectively, such that they appear in the HTML Report that is generated after test runs. Performing this step is optional. However, Keysight recommends entering these values to identify the test results for the corresponding DUT when there are large number of DUTs to be tested.

Connecting to the Internal Laser Source of the Reference Transmitter

The internal laser source of the reference transmitter can be used instead of the tunable laser source. Perform the following steps:

1 If a TLS is available and has been connected in the test application, set the slot selector to "not used". If no TLS is available or the test application has not been connected to it yet, leave slot selector at "n/a".

2 Provide the exact laser wavelength of the internal reference transmitter source in the “Transmitter Wavelength” configuration variable under the Configure tab.

3 Connect the optical laser output of the reference transmitter to the optical modulator input.

Select Tests tab – Select test and measurement task to be performed

The **Select Tests** tab is the main area in the N4917BSCB where tests can be selected to be performed during the next **Run** command. Each test is part of a test group which can be expanded or collapsed by clicking on the preceding arrow. The info area below the test tree shows additional information about the selected test.

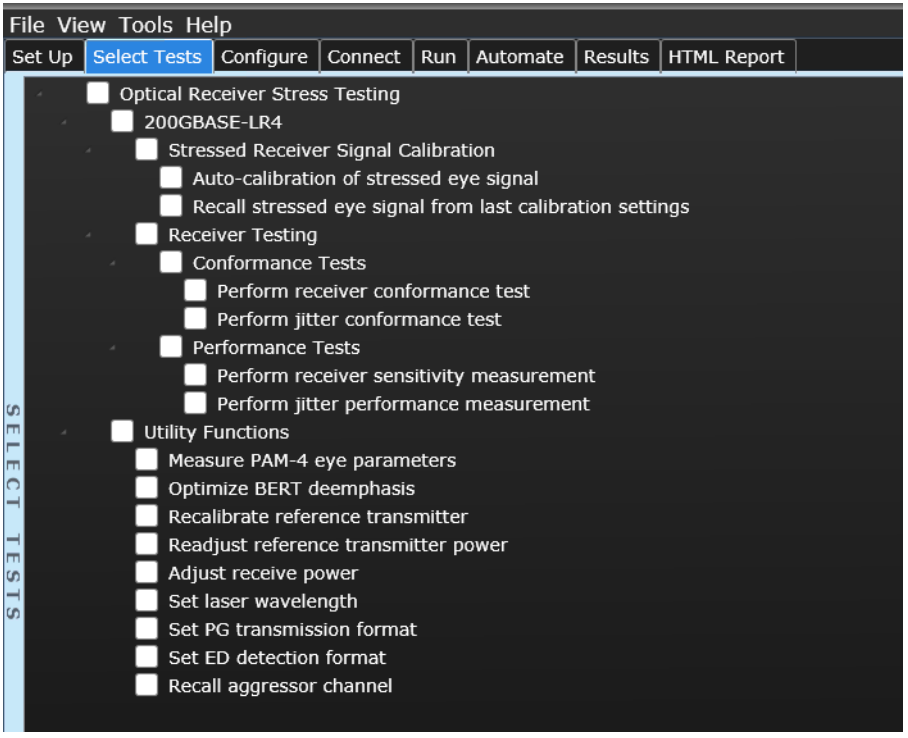


Figure 20 Select Tests tab

NOTE All selected tests will be performed successively (from top to bottom of list) during the next Run command. If a certain test needs be performed before other tests (e.g. optimization of BERT deemphasis), please run this test separately with all other tests deactivated. In the current release, the Optimize BERT deemphasis test can be configured to run automatically before Stressed receiver signal calibration using the “Optimize deemphasis on calibration start” configuration parameter.

NOTE When activating/deactivating a test group, all child tests will be activated/deactivated accordingly.

Configure tab – Configure application and test specific settings

The **Configure** tab lists all user configuration variables available for the selected transmission standard and sublayer. The configuration variables are subdivided into the same groups as the test structure and can likewise be expanded or collapsed by clicking on the small preceding arrow. The groups of configuration variables are further divided into logical subgroups. For example, the Stressed receiver signal calibration group contains some variables and subgroups called Sequence Control, Connection Settings, Calibration Target Values and Stress Signal Parameters. Likewise, the Receiver Testing group contains some variables and BERT Settings, Jitter Measurement Settings, and RX Sensitivity Measurement subgroups.

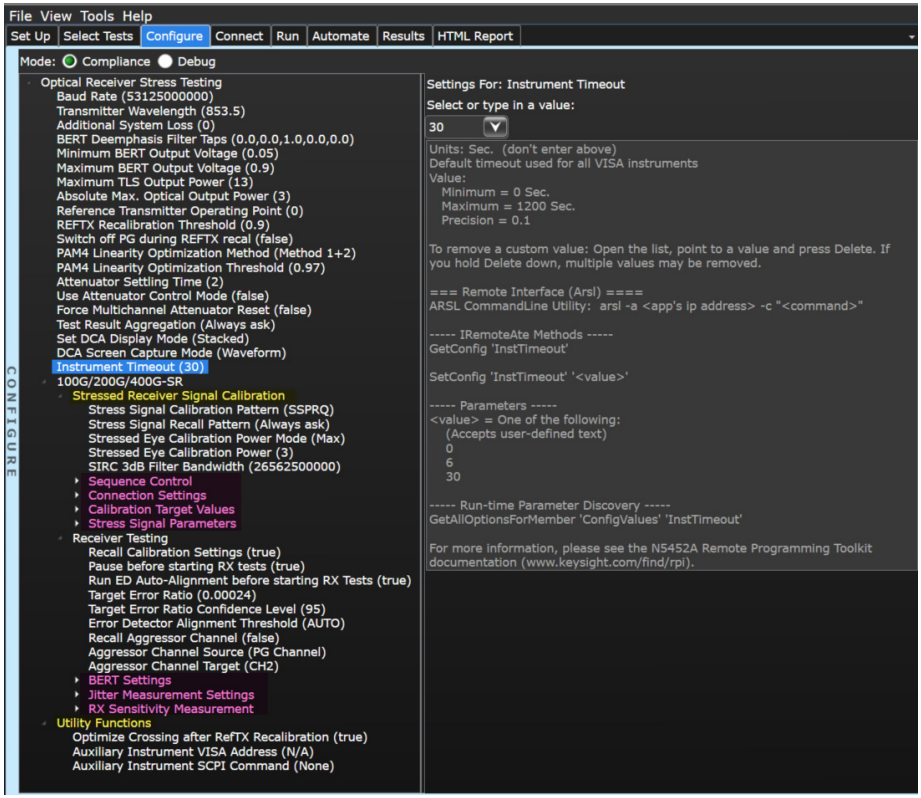


Figure 21 Configure tab

The current value of a variable is show in parentheses behind the variable name. To change a value, select an existing value from the corresponding drop down box or type in a new one.

The information text below the drop box shows additional information about the configuration variable, for example, its minimum or maximum value as well as its precision (only applicable for numeric types)

The N4917BSCB compliance test application offers two configuration modes:

- Compliance mode and Debug mode

In Compliance mode, specific user variables which represent specifications cannot be edited. To allow changing these values (thus deviating from the standard), switch to Debug mode.

Connect tab – Display hardware connection diagrams and test specific information

The **Connect** tab displays hardware connection diagrams before the start of a test. This optional step allows the user to check the physical connections between the devices to ensure compliance with the standards.

Run tab – Run selected tests or measurements

The **Run** tab defines various settings to run tests and starts the selected tests or the automation script created in the **Automate** tab. The user-defined “Tags” can be added for each calibration or test.

Automate tab – Run automated scripts

The **Automate** tab starts any automation scripts created in the Test Application.

Results & HTML Report tabs – Display test results

The **Results** tab and the **HTML Report** tab display the high-level and detailed test and measurement results. Some tests return only a pass/fail value and others return detailed measurement results (such as, scalar values, tables or images captured from an Oscilloscope’s display).

The N4917BSCB 400G Optical Receiver Test Application also facilitates exporting the measurement results and HTML reports into CSV, PDF files or even to a Web Dataset Repository. For a detailed understanding of the functionality of each tab and various features within the N4917BSCB 400G Optical Receiver Test Application, refer to the *Keysight N4917BSCB 400G Optical Receiver Test Application Online Help*.

NOTE

The functionality of the **Upload Results to Repository** feature is not fully supported in the current version of the N4917BSCB 400G Optical Receiver Test Application.

Technical Support

Check the **Help** menu for various user assistance documents. For technical support, contact Keysight Technical Support (**Help > Technical Support > Contact Technical Support**) or your Keysight representative. When reporting a software crash, go to **Help > Technical Support > Collect Files**. Send the zip file to your Keysight Technical Support representative.

5 Performing Stressed Receiver Compliance Tests with N4917BSCB Software

This section describes the calibration and test procedures in the N4917BSCB 400G Optical Receiver Test Application that correspond to the applicable IEEE standard.

Setting Up and Preparing the Compliance Test Setup

Before launching the N4917BSCB Optical Receiver Stress Test software and performing an optical receiver compliance test you need to set up the required instruments and make the physical connections shown in Figure 22. To ensure stable operation, observe the specified warm up times of the instruments being used. Also ensure that the BERT M8070B System software, the DCA N1010A FlexDCA software, and the M8195A/M8196A Soft Front Panel software are running. Refer to the Note below on the order of starting the software.

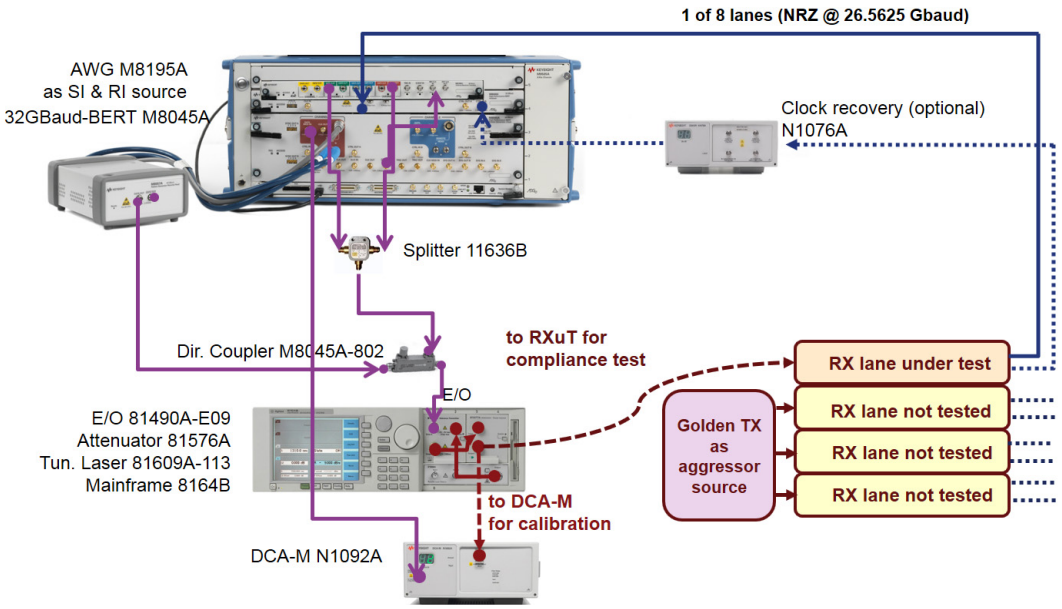


Figure 22 Equipment connections for IEEE802.3bs/cd calibrations and tests

NOTE

The required system software must be started in the following order:
1. DCA N1010A FlexDCA software
2. M8195A/M8196A/M8054A Soft Front Panel software
3. M8070B System software

Configure global test settings

After selecting the transmission standard in the **Set Up** tab, the N4917BSCB software loads the corresponding test limit file (check also: **Tools-> Compliance limits -> Activate/Refresh** limit set) and sets the respective configuration variables in the **Configure** tab. All global test settings, such as the signal baud rate, transmission wavelength or the BERT deemphasis tap values are listed in the root group (see Figure 23). Please note that some value cannot be changed in Compliance mode but only in Debug mode.

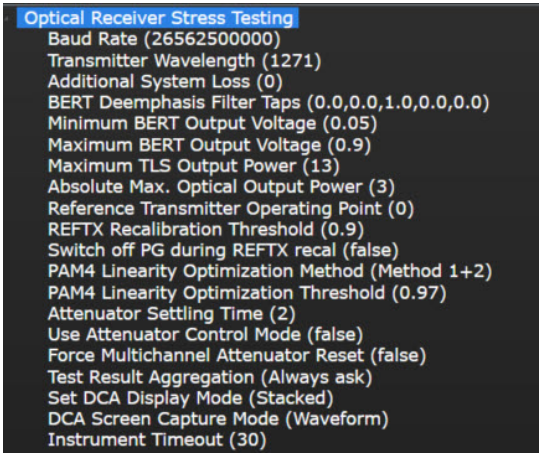


Figure 23 Global configuration variables

Calibrating the stressed receiver conformance test signal

The normative requirement for optical receivers to be compliant according to the IEEE 802.3bs/cd/db standards is the stressed receiver sensitivity, which is measured with the methods defined in IEEE 802.3bs section 121.8.9 using the conformance test signal described in section 121.8.9.2, in IEEE 802.3cd sections 138.8.10, 139.7.10, and 140.7.10, and in IEEE 802.3db section 167.8.14 for the relevant standards.

The N4917BSCB compliance test solution offers a fully automated calibration procedure to generate this compliance test signal which is then used to perform the stressed receiver sensitivity measurement and determine the receiver compliance.

NOTE **To run the automated calibration from the test tree (Select tests tab), all instruments in the Set Up tab needs to be connected and configured successfully, otherwise one or more tests will be unavailable.**

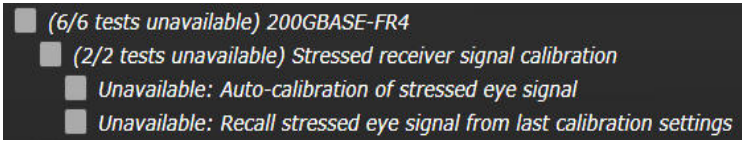


Figure 24 Unavailable tests due to missing instrument connections

Optimizing the BERT deemphasis

Running the automated conformance test signal calibration requires an optimized BERT output that compensates the non-ideal frequency response on the signal path due to amplifiers and E/O converter.

Hence, it is recommended to run an automated BERT deemphasis optimization prior to the stressed receiver conformance test signal calibration. By default, running the “Auto-calibration of stressed eye signal” automatically performs a BERT deemphasis optimization prior to starting the actual calibration procedure. This feature can be disabled by changing the value of the “Optimize deemphasis on calibration start" configuration variable to false. Alternatively, the BERT deemphasis optimization can be performed separately by running the “Optimize BERT deemphasis” test from the Utility functions.

The BERT deemphasis optimization procedure generates a PAM4 test pattern and determines the optimum 4 tap (2 pre-cursor, 1 post-cursor) deemphasis coefficients. After successfully running the test, the measurement result is reported in the Results tab (applies only when running it as a separate test from the Utility functions) and automatically set as active values in the corresponding configuration variable (BERT deemphasis taps in main group).

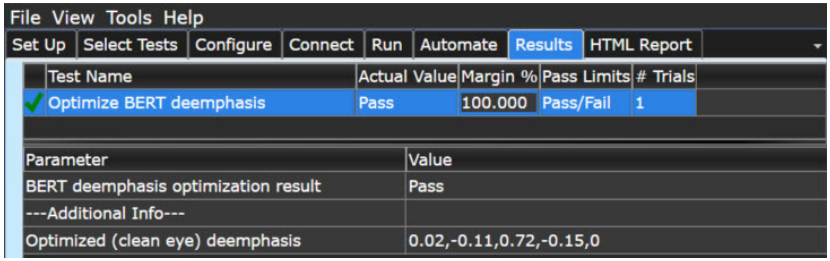


Figure 25 Exemplary BERT deemphasis optimization result when running the test from the Utility functions

Configuring calibration specific settings

The calibration specific configuration variables such as the calibration data pattern and the calibration target metrics can be found in the Stressed Receiver Signal Calibration settings. Figure 26 shows the exemplary calibration settings for the **400GBASE-FR8** transmission standard. The Stressed Receiver Signal Calibration settings are logically grouped in the following categories:

- General variables (These do not have an associated category name.)
- Sequence Control
- Connection Settings
- Calibration Target Values
- Stress Signal Parameters

Highlighted in blue are generic configuration settings which control the overall behavior of the calibration procedure. The Sequence Control and Connection Settings subgroups are the next groups displaying the relevant parameters for optimizations and clock-related settings.

Highlighted in yellow are the calibration target values (according to IEEE 802.3bs standard) and the corresponding calibration tolerances.

- Transmitter TX Extinction ratio (ER)
- ER Calibration Tolerance

- Target Stressed Eye Closure (SECQ)
- SECQ Calibration Tolerance
- Target Receiver Power (OMAouter)
- OMAouter Calibration Tolerance
- Initial SECQ Target
- Initial SECQ Target Tolerance

Shown in green are the stress ccomponent settings (sinusoidal jitter and sinusoidal interferer frequency) to be used for the calibration.

Figure 26 Exemplary stressed receiver signal calibration configuration variables for 400GBASE-FR8

NOTE

To ensure the optimum measurement results, it is recommended to activate the Perform dark level calibration feature. This feature checks the DCA channel calibration status prior to each test and triggers a recalibration, if required.

NOTE

A Dark Current Calibration triggered without switching off the light at the optical input port might result in invalid sampling scope calibration. An error message similar to *11, "Instrument Error; Channel Nx Offset is set to limit: Entry was out of range"* might be reported.

In this case, navigate to the FlexDCA menu option Tools > Calibrations to clear and recalibrate the DCA module. Ensure that the optical sampling scope (DCA) gets recalibrated on a regular basis.

NOTE

Due to the limited output voltage range (75mV to 1V) of the used AWG modules (M8195A or M8196A) as interference source, the use of an additional RF attenuator in the interference signal (SI + GN) path is required in specific hardware configurations. These include the use of IEEE 802.3cd transmission standards in combination with the new 81492A-E01 reference transmitter or the 81491A-085 multimode transmitter. In these or other cases, when the N4917BSCB application aborts the stress signal calibration with an error message indicating that the AWG voltage has been clipped to its lower range, insert an RF attenuator (6dB or 10dB) in the interference signal path as shown in Figure 27.

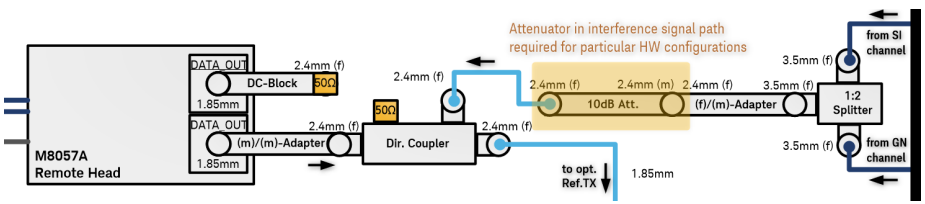


Figure 27 Placement of RF Attenuator

The flowchart below depicts the N4917BSCB software stress signal calibration procedure.

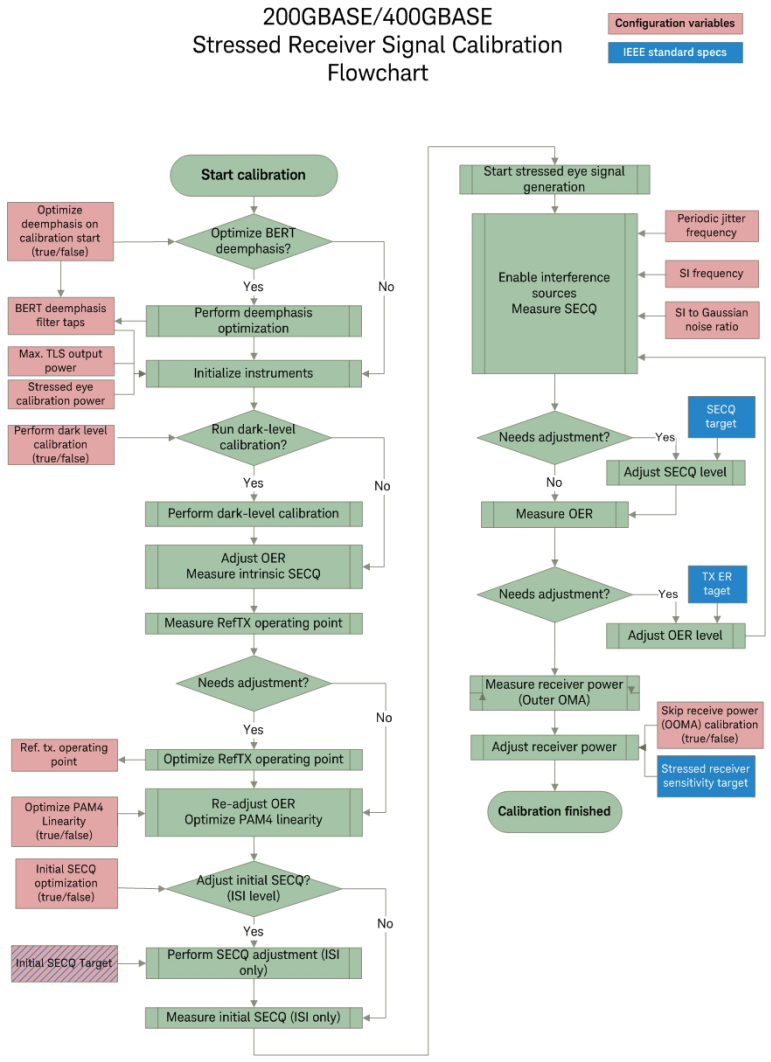


Figure 28 Stress signal calibration procedure

Configuring TDECQ presets in FlexDCA

Occasionally TDECQ preset names in a FlexDCA release are updated or renamed, usually when a standard moves from draft to final. As a result, the default configuration settings of the N4917BSCB compliance test application may request a TDECQ preset that is no longer available in the FlexDCA software.
In this release, the test application fails to load the TDECQ Filter Preset value while running the stressed eye signal calibration for the IEEE 802.3 dB optical standard and aborts the calibration.

For the successful completion of the stressed eye calibration for the IEEE 802.3 dB standard, please follow the below steps to create/save new TDECQ settings in the FlexDCA:

1 From the FlexDCA main menu, click **Measure** > **Waveform Signal Processing (Math)**. The Waveform Signal Processing Setup window is displayed.

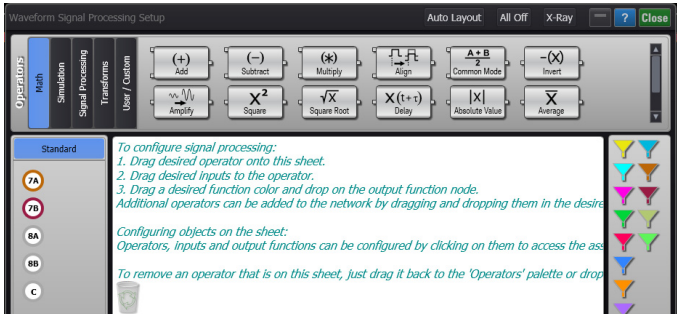


Figure 29 Waveform Signal Processing Setup window

2 From the operators categories shown in the top-left corner of the window, click **Signal Processing**. The TDECQ operator is displayed.

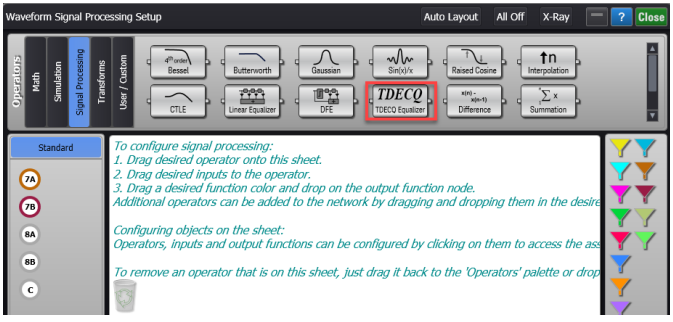


Figure 30 Signal Processing - TDECQ operator

3 To configure TDECQ presets, drag **TDECQ** operator into the window's operator's palette.

Figure 31 TDECQ operator dragged into the window's operator palette

4 Now, click on **TDECQ** operator. The TDECQ Reference Equalizer Setup window is displayed. By default, Reference Rx tab is selected.

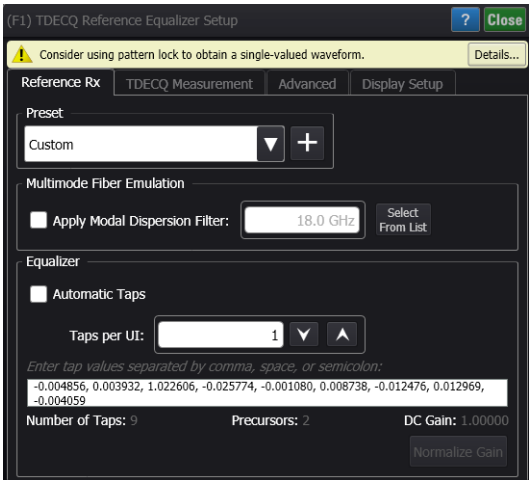


Figure 32 TDECQ Reference Equalizer Setup window

5 In the **Reference Rx** tab, first select the **IEEE 802.3db/D2.0 SR (844-863 nm)** preset, then uncheck the **Apply Modal Dispersion Filter** check box. To

save these settings as a new preset value, click **+** button next to the **Preset** field. The Enter a name for this new preset window is displayed.

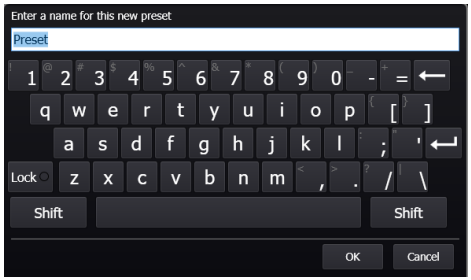


Figure 33 Enter a name for this new preset window

6 Enter preset name as **IEEE 802.3db/D2.0 SR SECQ** and click **OK**. The new preset name displays in the **Preset** field.
Make sure all the settings agree with the screen shot below i.e. Automatic Taps checked, Auto Precursors checked, Taps per UI = 1, Number of Taps = 9, Max Precursors = 3.

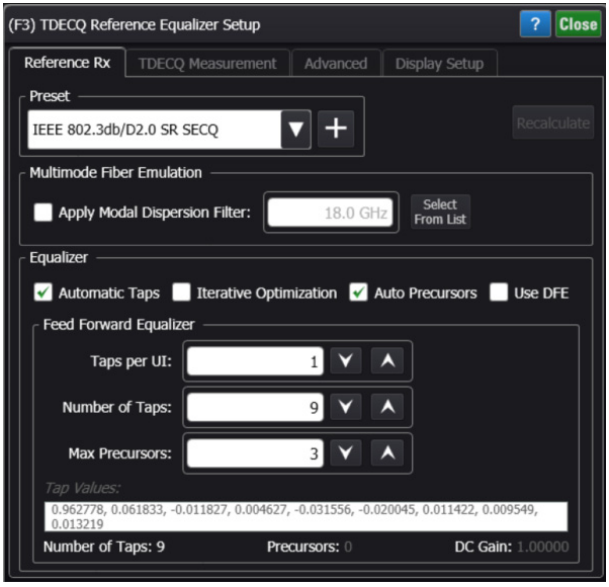


Figure 34 Preset field with IEEE802.3db/D2.0 SR SECQ preset

7 Next, go to **TDECQ Measurement** tab, then select the **IEEE 802.3db/D2.0** preset, then to save these settings, click **+** button next to the **Preset** field and add the same preset name as added under **Reference Rx** tab in step 6.
Make sure all the settings agree with the screen shot below i.e. Target SER = 4.80E-4, Histogram Width = 0.04 UI, Optimize Histogram Times is checked, Histogram Spacing = 0.10 UI, Adjustment Limit = 1.00 UI, OMA/ER Definition Minimum Zero Level Run = 6 and Minimum Three Level Run = 7, Threshold Optimization Enable is checked and Adjustment Limit = 2.0%.

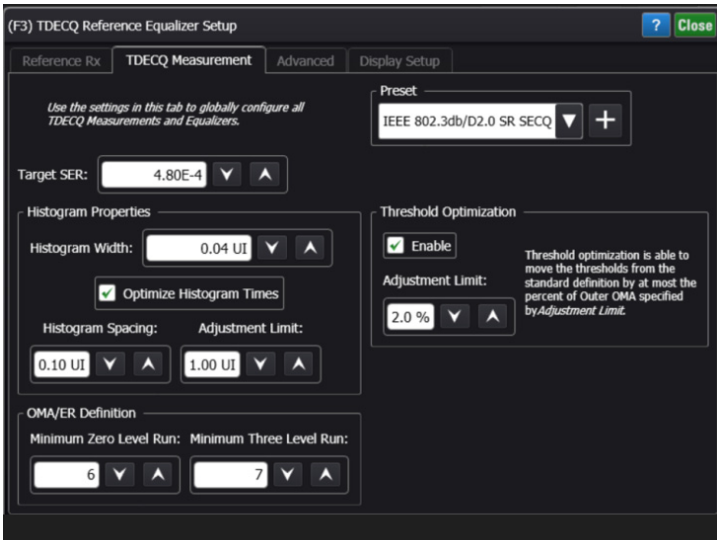


Figure 35 TDECQ Measurement tab with IEEE 802.3db/D2.0 SR SECQ preset

8 Once, you have configured the same TDECQ preset value **IEEE 802.3db/D2.0 SR SECQ** in both the **Reference Rx** and **TDECQ Measurement** tab, launch the N4917BSCB compliance application.

9 To use the new TDECQ preset, within the N4917BSCB application, follow the steps below:

a Under the **Set Up** tab, select the **100G/200G/400G-SR IEEE 802.3db** Optical Standard option.

b Select the **Configure** tab, and change to **Debug** mode.

c Expand the **Stressed Receiver Signal Calibration** item, then expand the **Stress Signal Parameters** item.

d Click the **TDECQ Filter Preset** item and in the right pane type the name of the new preset i.e. **IEEE 802.3db/D2.0 SR SECQ** and press enter.

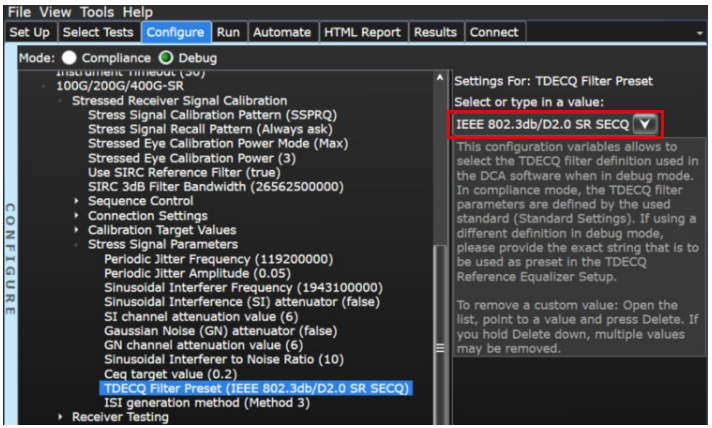


Figure 36 Manually selecting TDECQ Filter Preset in Debug mode

Starting the stressed receiver conformance test signal calibration

To start the actual stressed receiver conformance test signal calibration, activate the corresponding check box in the test tree and click the **Run** button on the **Run** tab or right-click in the test tree and select **Run checked tests**.

During the calibration, status messages in the message window show the progress of the run and display the currently performed action and intermediate measurement results.

NOTE The automated stress signal calibration will reset and reconfigure all used hardware instruments at the beginning of each calibration run. Hence any manual settings will be lost. So, make sure to save these settings prior to starting a calibration run.

NOTE The automated stress signal calibration might take several minutes (more than 20 min), depending on the used hardware and calibration settings. In case the calibration aborts during the run due to a timeout error, please try to increase the instrument timeout variable in global settings in the Configuration tab.

NOTE The running calibration process can be aborted by clicking the Stop button on the Run tab.

NOTE The intrinsic SECQ must be lower than initial target SECQ. Therefore, BERT de-emphasis optimization is recommended before each calibration.

Calibration step	Class	Relevant configuration variables	Access	Default value
Instrument Initializations	BERT	Baud Rate	Debug Mode	26.5625 GBaud (53.125 GBaud for 400GBASE-DR4, 400G-FR4, 100GBASE-DR, 100G-FR, 100G-LR, 100G-SR, 200G-SR2, 400G-SR4)
		Calibration Pattern	Debug Mode	SSPRQ
		Optimize deemphasis on calibration start		TRUE
		BERT Deemphasis		0.0,0.0,1.0,0.0,0.0
	DCA	Use SIRC Reference Filter	Debug Mode	TRUE
		SIRC 3dB Filter Bandwidth		13.28126 GHz (26.5626 GHz for 400GBASE-DR4, 400G-FR4, 100G-FR, 100G-LR, 100GBASE-DR, and 100G-SR, 200G-SR2, 400G-SR4)
		Set Display Mode		Stacked
		Perform Dark Level Calibration		TRUE
	TLS	Transmitter Wavelength		Set by standard
	ATT	Stressed Eye Calibration Power Mode		Max
		Stressed Eye Calibration Power		3 dBm
		Set Attenuator Control State		FALSE
Initial ER Optimization				
REFTX Operating Point Optimization				

Calibration step	Class	Relevant configuration variables	Access	Default value
PAM4 Linearity Optimization				
Clean Eye Measurement				
Generate Stressed Eye Signal	SJ	Periodic Jitter Frequency		119.2 MHz
		Periodic Jitter Amplitude		0.05 UI
	SI	Sinusoidal Interferer Frequency		1.9431 GHz
	GN	Sinusoidal Interferer to Gaussian Noise Ratio		10 dB
	DCA	TDECQ Filter Preset	Debug Mode	Standard Definition
		Ceq target value		0.2 dB (Applicable for IEEE 802.3cd-based flavors)
		ISI generation method		Method 3 (default for all transmission standards)
TDECQ Equalization Filter Optimization	DCA	Use TDECQ Filter Optimization Feature		TRUE
Stressed Eye Parameter Optimization		Target TX Extinction Ratio (ER)		Set by standard
		ER Calibration Tolerance		0.1 dB
		Target Stressed Eye Closure (SECQ)		Set by standard
		SECQ Calibration Tolerance		0.1 dB
		Target Receiver Power (OMAouter)		Set by standard
		OMAouter Calibration Tolerance		0.1 dB

After successful completion of the calibration run, the calibration results are reported in the **Results** tab.

The calibration results include the following measurements:

- Currently used BERT deemphasis taps
- Measured NRZ crossing points (from reference transmitter operating point optimization)
- Measured PAM4 linearity
- Measured clean eye SECQ (ISI only) (“initial SECQ)
- Measured calibration target metrics

- Screenshot of stressed receiver test signal (without TDECQ filter / with TDECQ filter)

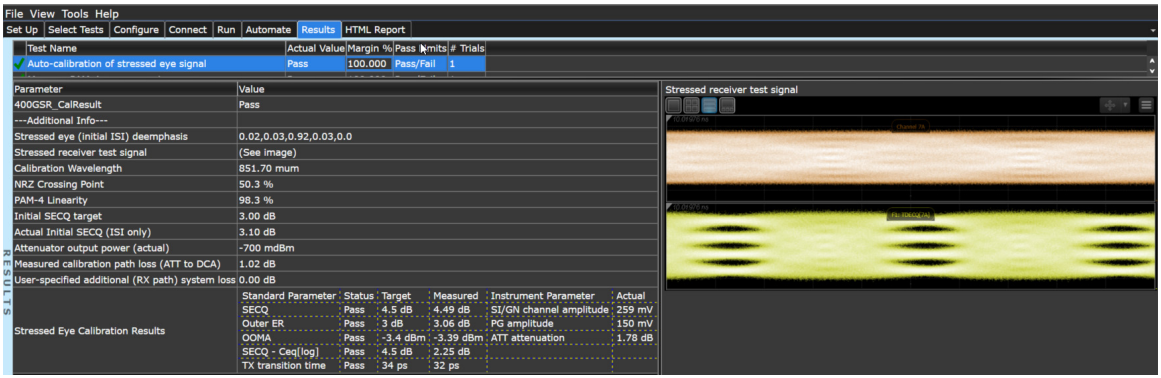


Figure 37 Calibration results

Calibration tasks

Auto calibration of stressed eye signal

Overview This calibration automatically adjusts the stress parameters (ER, SECQ, OMA) for a 200G, 400G, 100G or 50G stressed eye signal.

Connection Diagram Connect the instruments as shown in "Setting Up and Preparing the Compliance Test Setup" on page 76.

ID

Type	Test ID
200GBASE FR4	1000
200GBASE LR4	2000
200GBASE DR4	3000
400GBASE FR8	4000
400GBASE LR8	5000
400GBASE DR4	6000
400G-FR4	7000
100G-FR	14000
100G-LR	15000

Type	Test ID
100GBASE-DR	8000
50G-SR/100G-SR2/200G-SR4/400G-SR8	9000
100G-SR/200G-SR2/400G-SR4	16000
50G FR	12000
50G LR	13000

Configuration Parameters

You may modify the following parameters for this calibration:

- Stress Signal Calibration Pattern (SSPRQ)
- Stress Signal Recall Pattern
- Stressed Eye Calibration Power Mode (Max)
- Stressed Eye Calibration Power
- Use SIRC Reference Filter
- SIRC 3dB Filter Bandwidth

Sequence control values

- Optimize deemphasis on calibration start
- Perform Dark Level Configuration
- Optimize PAM4 Linearity
- Initial SECQ Optimization
- Use TDECQ Filter Optimization Feature
- Calibration Iteration Limit
- Skip receive power (OOMA) calibration

Connection Settings

- DCA Clock Source
- Clock Data Recovery Module
- Clock Data Recovery Loop Bandwidth
- PG ClockOut Divider

Calibration target values

- Target TX Extinction Ratio (ER)
- ER Calibration Tolerance
- Target Stressed Eye Closure (SECQ)
- SECQ Calibration Tolerance
- Target Receiver Power (OMAouter)

- OMAouter Calibration Tolerance
- Initial SECQ Target
- Initial SECQ Target Tolerance

Stress signal parameters

- Periodic Jitter Frequency
- Periodic Jitter Amplitude
- Sinusoidal Interferer Frequency
- Sinusoidal Interference (SI) attenuator
- SI channel attenuation value
- Gaussian noise (GN) attenuator
- GN channel attenuation value
- Sinusoidal Interferer to Noise Ratio
- TDECQ Filter Preset
- Ceq target value (applicable only for IEEE 802.3cd and IEEE 802.3db based flavors)
- ISI generation method

Procedure Refer to "Automated Calibration" on page 49.

Results Pass/Fail

Recall stressed eye signal from last calibration settings

Overview This task recalls and applies the latest stressed eye calibration settings.

Connection Diagram Connect the instruments as shown in "Setting Up and Preparing the Compliance Test Setup" on page 76.

ID

Type	Test ID
200GBASE FR4	1004
200GBASE LR4	2004
200GBASE DR4	3004
400GBASE FR8	4004
400GBASE LR8	5004
400GBASE DR4	6004
400G-FR4	7004

Type	Test ID
100G-FR	14004
100G-LR	15004
100GBASE-DR	8000
50G-SR/100G-SR2/200G-SR4/400G-SR8	9004
100G-SR/200G-SR2/400G-SR4	16004
50G FR	12004
50G LR	13004

Configuration Parameters

Procedure Refer to "Automated Calibration" on page 49.

Results Pass/Fail

Testing the stressed DUT receiver compliance

As introduced in "Automated Compliance and Performance Tests" on page 54, the N4917BSCB software offers four automated receiver test procedures divided into the two groups - Conformance Tests and Performance Tests. All the receiver tests imply a calibrated and compliant stress test signal to be connected to the optical lane under test of the receiver under test, whereas the stress test signal can be either recalled from a previous calibration setting file (default) or is assumed to be already running from a previous test.

Configuring receiver tests settings

Depending on the used test setup, different hardware configurations as well as test specific settings must be made prior to starting a receiver test. Figure 38 shows all the receiver test related configuration variables, which have been divided in several sub-groups. The calibration related variables have been highlighted in yellow; the variables highlighted in pink are hardware-related settings that apply to all the receiver tests, whereas the configuration variables highlighted in blue control the behavior of specific receiver tests.

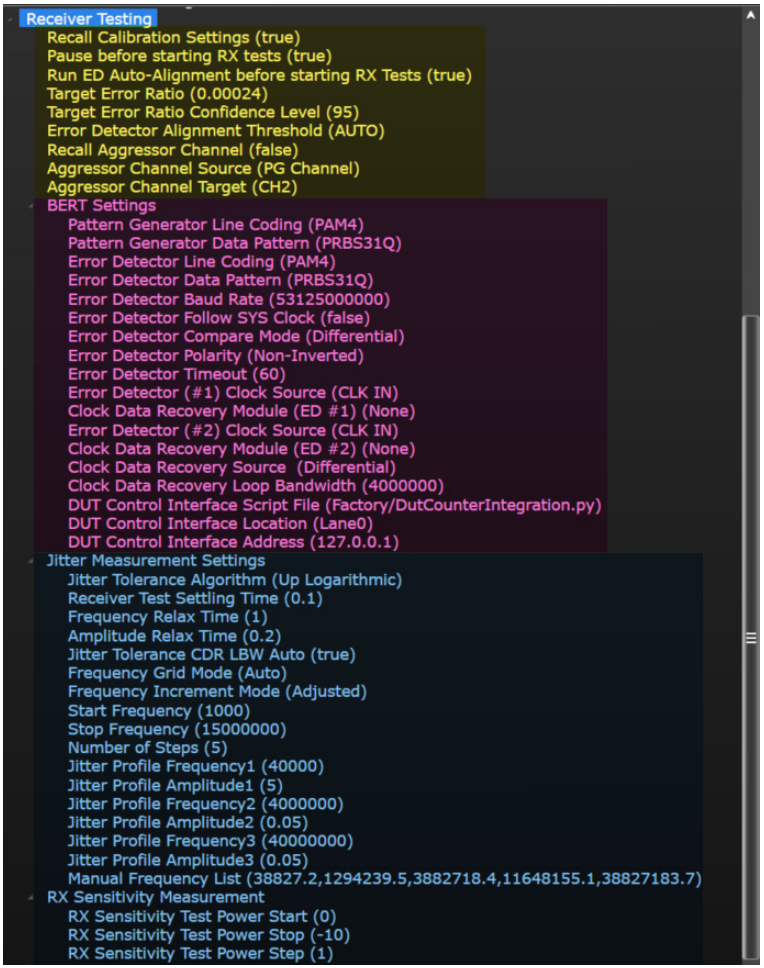
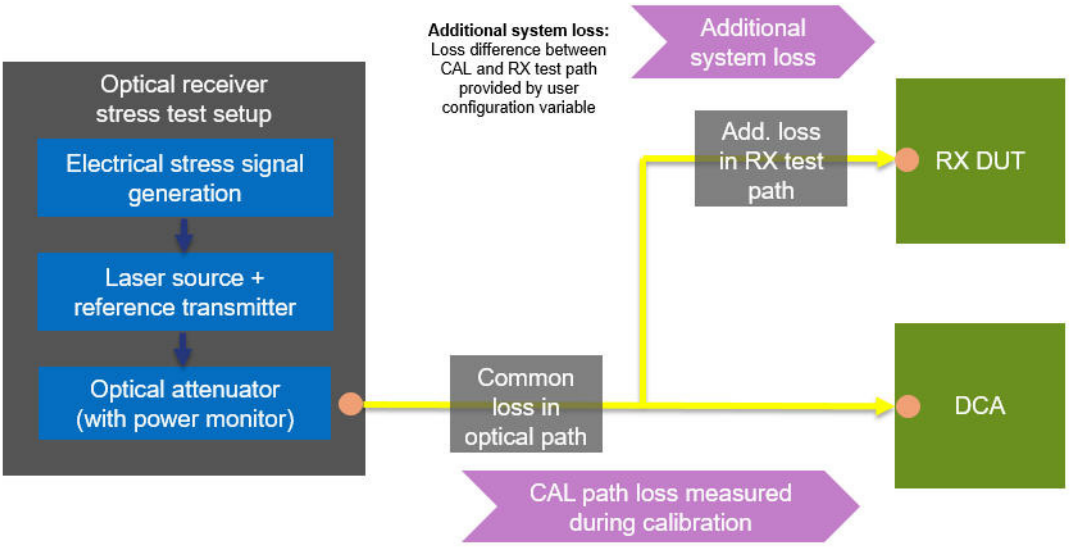


Figure 38 Configuration variables for receiver testing

Compensation of optical loss in receiver test path

To ensure compliant receiver testing, the automated test procedure must compensate for any additional loss in the receiver test path (see Figure 39 for a schematic of stressed receiver optical path loss definitions). Since the calibration procedure can only measure the common loss in the optical path, any additional loss in the receiver test path must be measured

manually by the user and provided as dB value (positive numbers represent a loss, negative numbers a gain) in the “Additional System Loss” configuration variable (default is 0dB).



Note to ensure compliant RX testing:
Any optical power loss on the calibration or receiver test path must be compensated by the appropriate optical attenuator output power setting.

Figure 39 Stressed receiver optical path loss definitions

NOTE

A full receiver compliance test might require other optical stress signals (“aggressor lanes”) to be connected to the other lanes of the receiver under test. For further information, check specification of the corresponding IEEE standard.

The flowcharts on the following pages depict the receiver test procedures available in the N4917BSCB software.

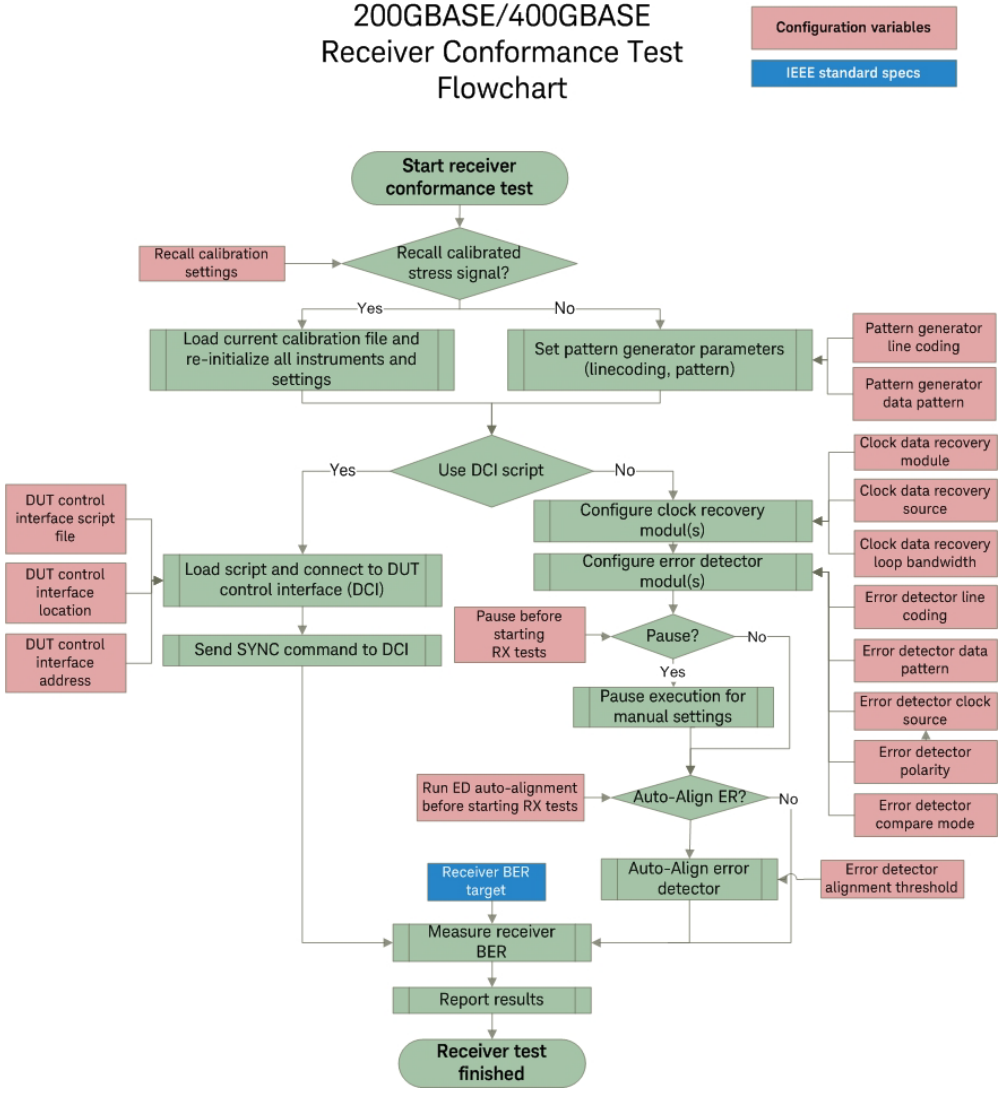


Figure 40 Receiver conformance test procedure

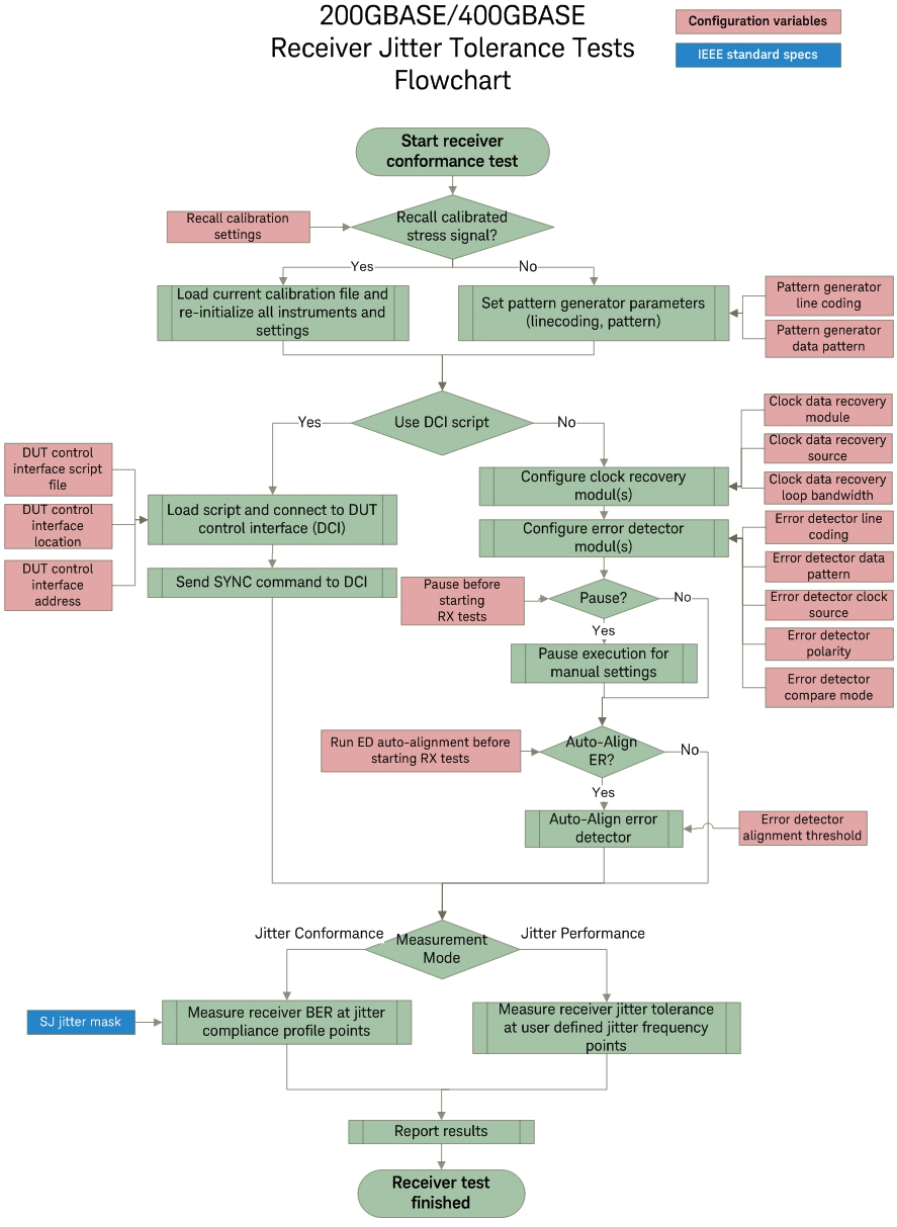


Figure 41 Receiver jitter tolerance tests procedure

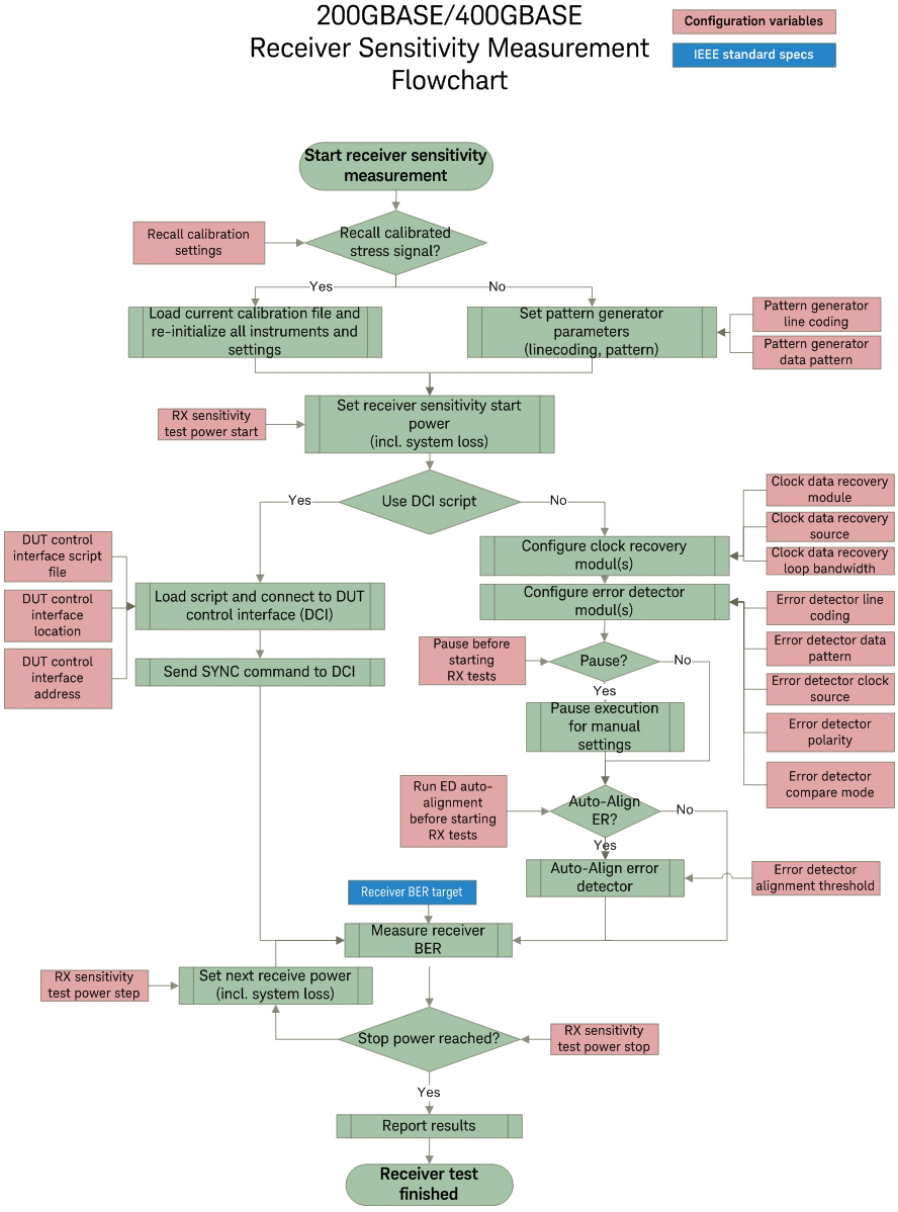


Figure 42 Receiver sensitivity measurement test procedure

Receiver tests

Conformance Tests

Perform receiver conformance test

Overview This tests measures the receiver conformance.

Connection Diagram Connect the instruments as shown in "Setting Up and Preparing the Compliance Test Setup" on page 76.

ID

Type	Test ID
200GBASE FR4	1100
200GBASE LR4	2100
200GBASE DR4	3100
400GBASE FR8	4100
400GBASE LR8	5100
400GBASE DR4	6100
400G-FR4	7100
100G-FR	14100
100G-LR	15100
100GBASE-DR	8100
50G-SR/100G-SR2/200G-SR4/400G-SR8	9100
100G-SR/200G-SR2/400G-SR4	16100
50G FR	12100
50G LR	13100

Configuration Parameters You may modify the following parameters for this test:

- Recall Calibration Settings
- Pause before starting RX tests
- Run ED Auto-Alignment before starting RX tests
- Target Error Ratio
- Target Error Ratio Confidence Level
- Error Detector Alignment Threshold

- Recall Aggressor Channel
- Aggressor Channel Source
- Aggressor Channel Target

BERT Settings

- Pattern Generator Line Coding
- Pattern Generator Data Pattern
- Error Detector Line Coding
- Error Detector Data Pattern
- Error Detector Baud Rate
- Error Detector Follow SYS Clock
- Error Detector Compare Mode
- Error Detector Polarity
- Error Detector Timeout
- Error Detector (#1) Clock Source (CLK IN)
- Clock Data Recovery Module (ED #1)
- Error Detector (#2) Clock Source (CLK IN)
- Clock Data Recovery Module (ED #2)
- Clock Data Recovery Source
- Clock Data Recovery Loop Bandwidth
- DUT Control Interface Script File
- DUT Control Interface Location
- DUT Control Interface Address

Jitter Measurement Settings

- Jitter Tolerance Algorithm
- Receiver Test Settling Time
- Frequency Relax Time
- Amplitude Relax Time
- Jitter Tolerance CDR LBW Auto
- Frequency Grid Mode
- Frequency Increment Mode
- Start Frequency
- Stop Frequency
- Number of Steps
- Jitter Profile Frequency1
- Jitter Profile Amplitude1

- Jitter Profile Frequency2
- Jitter Profile Amplitude2
- Jitter Profile Frequency3
- Jitter Profile Amplitude3
- Manual Frequency List

RX Sensitivity Measurement

- RX Sensitivity Test Power Start
- RX Sensitivity Test Power Stop
- RX Sensitivity Test Power Step

Procedure Refer to "Automated Compliance and Performance Tests" on page 54.

Results Pass/Fail

Perform jitter conformance test

Overview This tests measures the receiver jitter conformance.

Connection Diagram Connect the instruments as shown in "Setting Up and Preparing the Compliance Test Setup" on page 76.

ID

Type	Test ID
200GBASE FR4	1101
200GBASE LR4	2101
200GBASE DR4	3101
400GBASE FR8	4101
400GBASE LR8	5101
400GBASE DR4	6101
400G-FR4	7101
100G-FR	14101
100G-LR	15101
100GBASE-DR	8101
50G-SR/100G-SR2/200G-SR4/400G-SR8	9101

Type	Test ID
100G-SR/200G-SR2/400G-SR4	16101
50G FR	12101
50G LR	13101

Configuration Parameters

You may modify the following parameters for this test:

- Recall Calibration Settings
- Pause before starting RX tests
- Run ED Auto-Alignment before starting RX tests
- Target Error Ratio
- Target Error Ratio Confidence Level
- Error Detector Alignment Threshold
- Recall Aggressor Channel
- Aggressor Channel Source
- Aggressor Channel Target

BERT Settings

- Pattern Generator Line Coding
- Pattern Generator Data Pattern
- Error Detector Line Coding
- Error Detector Data Pattern
- Error Detector Baud Rate
- Error Detector Follow SYS Clock
- Error Detector Compare Mode
- Error Detector Polarity
- Error Detector Timeout
- Error Detector (#1) Clock Source (CLK IN)
- Clock Data Recovery Module (ED #1)
- Error Detector (#2) Clock Source (CLK IN)
- Clock Data Recovery Module (ED #2)
- Clock Data Recovery Source
- Clock Data Recovery Loop Bandwidth
- DUT Control Interface Script File
- DUT Control Interface Location
- DUT Control Interface Address

Jitter Measurement Settings

- Jitter Tolerance Algorithm
- Receiver Test Settling Time
- Frequency Relax Time
- Amplitude Relax Time
- Jitter Tolerance CDR LBW Auto
- Frequency Grid Mode
- Frequency Increment Mode
- Start Frequency
- Stop Frequency
- Number of Steps
- Jitter Profile Frequency1
- Jitter Profile Amplitude1
- Jitter Profile Frequency2
- Jitter Profile Amplitude2
- Jitter Profile Frequency3
- Jitter Profile Amplitude3
- Manual Frequency List

RX Sensitivity Measurement

- RX Sensitivity Test Power Start
- RX Sensitivity Test Power Stop
- RX Sensitivity Test Power Step

Procedure Refer to "Automated Compliance and Performance Tests" on page 54.

Results Pass/Fail

Performance Tests

Perform receiver sensitivity measurement

Overview This tests measures the receiver sensitivity.

Connection Diagram Connect the instruments as shown in "Setting Up and Preparing the Compliance Test Setup" on page 76.

ID

Type	Test ID
200GBASE FR4	1103
200GBASE LR4	2103
200GBASE DR4	3103
400GBASE FR8	4103
400GBASE LR8	5103
400GBASE DR4	6103
400G-FR4	7103
100G-FR	14103
100G-LR	15103
100GBASE-DR	8103
50G-SR/100G-SR2/200G-SR4/400G-SR8	9103
100G-SR/200G-SR2/400G-SR4	16103
50G FR	12103
50G LR	13103

Configuration Parameters

You may modify the following parameters for this test:

- Recall Calibration Settings
- Pause before starting RX tests
- Run ED Auto-Alignment before starting RX tests
- Target Error Ratio
- Target Error Ratio Confidence Level
- Error Detector Alignment Threshold
- Recall Aggressor Channel
- Aggressor Channel Source
- Aggressor Channel Target

BERT Settings

- Pattern Generator Line Coding
- Pattern Generator Data Pattern
- Error Detector Line Coding
- Error Detector Data Pattern

- Error Detector Baud Rate
- Error Detector Follow SYS Clock
- Error Detector Compare Mode
- Error Detector Polarity
- Error Detector Timeout
- Error Detector (#1) Clock Source (CLK IN)
- Clock Data Recovery Module (ED #1)
- Error Detector (#2) Clock Source (CLK IN)
- Clock Data Recovery Module (ED #2)
- Clock Data Recovery Source
- Clock Data Recovery Loop Bandwidth
- DUT Control Interface Script File
- DUT Control Interface Location
- DUT Control Interface Address

Jitter Measurement Settings

- Jitter Tolerance Algorithm
- Receiver Test Settling Time
- Frequency Relax Time
- Amplitude Relax Time
- Jitter Tolerance CDR LBW Auto
- Frequency Grid Mode
- Frequency Increment Mode
- Start Frequency
- Stop Frequency
- Number of Steps
- Jitter Profile Frequency1
- Jitter Profile Amplitude1
- Jitter Profile Frequency2
- Jitter Profile Amplitude2
- Jitter Profile Frequency3
- Jitter Profile Amplitude3
- Manual Frequency List

RX Sensitivity Measurement

- RX Sensitivity Test Power Start
- RX Sensitivity Test Power Stop

- RX Sensitivity Test Power Step

Procedure Refer to "Automated Compliance and Performance Tests" on page 54.

Results Pass/Fail

Perform jitter performance measurement

Overview This tests measures the receiver jitter performance.

Connection Diagram Connect the instruments as shown in "Setting Up and Preparing the Compliance Test Setup" on page 76.

ID

Type	Test ID
200GBASE FR4	1102
200GBASE LR4	2102
200GBASE DR4	3102
400GBASE FR8	4102
400GBASE LR8	5102
400GBASE DR4	6102
400G-FR4	7102
100G-FR	14102
100G-LR	15102
100GBASE-DR	8102
50G-SR/100G-SR2/200G-SR4/400G-SR8	9102
100G-SR/200G-SR2/400G-SR4	16102
50G FR	12102
50G LR	13102

Configuration Parameters You may modify the following parameters for this test:

- Recall Calibration Settings
- Pause before starting RX tests
- Run ED Auto-Alignment before starting RX tests
- Target Error Ratio
- Target Error Ratio Confidence Level

- Error Detector Alignment Threshold
- Recall Aggressor Channel
- Aggressor Channel Source
- Aggressor Channel Target

BERT Settings

- Pattern Generator Line Coding
- Pattern Generator Data Pattern
- Error Detector Line Coding
- Error Detector Data Pattern
- Error Detector Baud Rate
- Error Detector Follow SYS Clock
- Error Detector Compare Mode
- Error Detector Polarity
- Error Detector Timeout
- Error Detector (#1) Clock Source (CLK IN)
- Clock Data Recovery Module (ED #1)
- Error Detector (#2) Clock Source (CLK IN)
- Clock Data Recovery Module (ED #2)
- Clock Data Recovery Source
- Clock Data Recovery Loop Bandwidth
- DUT Control Interface Script File
- DUT Control Interface Location
- DUT Control Interface Address

Jitter Measurement Settings

- Jitter Tolerance Algorithm
- Receiver Test Settling Time
- Frequency Relax Time
- Amplitude Relax Time
- Jitter Tolerance CDR LBW Auto
- Frequency Grid Mode
- Frequency Increment Mode
- Start Frequency
- Stop Frequency
- Number of Steps
- Jitter Profile Frequency1

- Jitter Profile Amplitude1
- Jitter Profile Frequency2
- Jitter Profile Amplitude2
- Jitter Profile Frequency3
- Jitter Profile Amplitude3
- Manual Frequency List

RX Sensitivity Measurement

- RX Sensitivity Test Power Start
- RX Sensitivity Test Power Stop
- RX Sensitivity Test Power Step

Procedure Refer to "Automated Compliance and Performance Tests" on page 54.

Results Pass/Fail

Utility Functions

Measure PAM4 eye parameters

Overview This step measures the PAM4 eye parameters - TDECQ, OER, OOMA, AvgPower.

Connection Diagram Connect the instruments as shown in "Setting Up and Preparing the Compliance Test Setup" on page 76.

ID

Type	Test ID
200GBASE FR4, 200GBASE LR4, 200GBASE DR4, 400GBASE FR8, 400GBASE LR8, 400GBASE DR4, 400G-FR4, 100G-FR, 100G-LR, 100GBASE-DR, 50G-SR/100G-SR2/200G-SR4/400G-SR8 100G-SR/200G-SR2/400G-SR4, 50GBASE-FR, 50GBASE-LR	10005

Configuration Parameters You may modify the following parameter for this test:

- Optimize crossing after RefTX Recalibration
- Auxiliary Instrument VISA Address
- Auxiliary Instrument SCPI Command

Results Pass/Fail

Optimize BERT deemphasis

Overview This test performs a BERT deemphasis optimization.

Connection Diagram Connect the instruments as shown in "Setting Up and Preparing the Compliance Test Setup" on page 76.

ID

Type	Test ID
200GBASE FR4, 200GBASE LR4, 200GBASE DR4, 400GBASE FR8, 400GBASE LR8, 400GBASE DR4, 400G-FR4, 100G-FR, 100G-LR, 100GBASE-DR, 50G-SR/100G-SR2/200G-SR4/400G-SR8, 100G-SR/200G-SR2/400G-SR4, 50GBASE-FR, 50GBASE-LR	10004

Configuration Parameters

- Optimize crossing after RefTX recalibration
- Auxiliary Instrument VISA Address
- Auxiliary Instrument SCPI Command

Results Pass/Fail

Recalibrate Reference Transmitter

Overview This step recalibrates the reference transmitter.

Connection Diagram Connect the instruments as shown in "Setting Up and Preparing the Compliance Test Setup" on page 76.

ID

Type	Test ID
200GBASE FR4, 200GBASE LR4, 200GBASE DR4, 400GBASE FR8, 400GBASE LR8, 400GBASE DR4, 400G-FR4, 100GBASE-DR, 50G-SR/100G-SR2/200G-SR4/400G-SR8, 100G-SR/200G-SR2/400G-SR4, 50GBASE-FR, 50GBASE-LR	10000

Configuration Parameters

- Optimize crossing after RefTX recalibration
- Auxiliary Instrument VISA Address
- Auxiliary Instrument SCPI Command

Results Pass/Fail

Readjust reference transmitter power

Overview This step readjusts the previously calibrated output power of the REFTX measured at the optical attenuator by means of fine-tuning the REFTX operating point.

Connection Diagram Connect the instruments as shown in "Setting Up and Preparing the Compliance Test Setup" on page 76.

ID

Type	Test ID
200GBASE FR4, 200GBASE LR4, 200GBASE DR4, 400GBASE FR8, 400GBASE LR8, 400GBASE DR4, 400G-FR4, 100G-FR, 100G-LR, 100GBASE-DR, 50G-SR/100G-SR2/200G-SR4/400G-SR8, 100G-SR/200G-SR2/400G-SR4, 50GBASE-FR, 50GBASE-LR	10009

Configuration Parameters

- Optimize crossing after RefTX recalibration
- Auxiliary Instrument VISA Address
- Auxiliary Instrument SCPI Command

Results Pass/Fail

Adjust Receive Power

Overview This step adjusts the receive power.

Connection Diagram Connect the instruments as shown in "Setting Up and Preparing the Compliance Test Setup" on page 76.

ID

Type	Test ID
200GBASE FR4, 200GBASE LR4, 200GBASE DR4, 400GBASE FR8, 400GBASE LR8, 400GBASE DR4, 400G-FR4, 100G-FR, 100G-LR, 100GBASE-DR, 50G-SR/100G-SR2/200G-SR4/400G-SR8, 100G-SR/200G-SR2/400G-SR4, 50GBASE-FR, 50GBASE-LR	10001

Configuration Parameters

- Optimize crossing after RefTX recalibration

- Auxiliary Instrument VISA Address
- Auxiliary Instrument SCPI Command

Results Pass/Fail

Set laser wavelength

Overview This step sets the laser wavelength.

Connection Diagram Connect the instruments as shown in "Setting Up and Preparing the Compliance Test Setup" on page 76.

ID

Type	Test ID
200GBASE FR4, 200GBASE LR4, 200GBASE DR4, 400GBASE FR8, 400GBASE LR8, 400GBASE DR4, 400G-FR4, 100G-FR, 100G-LR, 100GBASE-DR, 50G-SR/100G-SR2/200G-SR4/400G-SR8, 100G-SR/200G-SR2/400G-SR4, 50GBASE-FR, 50GBASE-LR	10003

Configuration Parameters

- Optimize crossing after RefTX recalibration
- Auxiliary Instrument VISA Address
- Auxiliary Instrument SCPI Command

Results Pass/Fail

Set PG transmission format

Overview This step sets the line coding and transmission data pattern for the connected pattern generator.

Connection Diagram Connect the instruments as shown in "Setting Up and Preparing the Compliance Test Setup" on page 76.

ID

Type	Test ID
200GBASE FR4, 200GBASE LR4, 200GBASE DR4, 400GBASE FR8, 400GBASE LR8, 400GBASE DR4, 400G-FR4, 100G-FR, 100G-LR, 100GBASE-DR, 50G-SR/100G-SR2/200G-SR4/400G-SR8, 100G-SR/200G-SR2/400G-SR4, 50GBASE-FR, 50GBASE-LR	10006

Configuration Parameters

- Pattern Generator Line Coding
- Pattern Generator Data Pattern

Results Pass/Fail

Set ED detection format

Overview This step sets the line coding and analysis data pattern for all connected error detectors.

Connection Diagram Connect the instruments as shown in "Setting Up and Preparing the Compliance Test Setup" on page 76.

ID

Type	Test ID
200GBASE FR4, 200GBASE LR4, 200GBASE DR4, 400GBASE FR8, 400GBASE LR8, 400GBASE DR4, 400G-FR4, 100G-FR, 100G-LR, 100GBASE-DR, 50G-SR/100G-SR2/200G-SR4/400G-SR8, 100G-SR/200G-SR2/400G-SR4, 50GBASE-FR, 50GBASE-LR	10007

Configuration Parameters

- Error Detector Line Coding
- Error Detector Data Pattern

Results Pass/Fail

Recall aggressor channel

Overview This step recalls the aggressor channel on BERT output channel 2 using the settings according to the configuration variable "Aggressor Channel Source".

Connection Diagram Connect the instruments as shown in "Setting Up and Preparing the Compliance Test Setup" on page 76.

ID

Type	Test ID
200GBASE FR4, 200GBASE LR4, 200GBASE DR4, 400GBASE FR8, 400GBASE LR8, 400GBASE DR4, 400G-FR4, 100G-FR, 100G-LR, 100GBASE-DR, 50G-SR/100G-SR2/200G-SR4/400G-SR8, 100G-SR/200G-SR2/400G-SR4, 50GBASE-FR, 50GBASE-LR	10008

Configuration Parameters

- Recall Aggressor Channel
- Aggressor Channel Source
- Aggressor Channel Target

Results Pass/Fail

Edition 9.1, November 2023

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