
N5991 Test Automation Software Platform - Getting Started Guide

Notices

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1 Introduction

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Overview

This N5991 Getting Started Guide provides information for an initial setup of the N5991 Test Automation Software Platform.

This guide focuses on how to start the N5991 Software, run the procedures with the desired hardware configurations, and obtain the results.

NOTE

The N5991 Test Automation Software Platform “ValiFrame” is a solution for testing a wide range of digital buses for compliance with various standards. It is not possible to apply all the new features described in this guide simultaneously to all standards. Instead, they will be added when a new release of the corresponding software appears. This means that in some cases not all features will be available.

Test Automation Software Platform

The N5991 Test Automation Software Platform “ValiFrame” is an open and flexible framework for automating tests such as electrical compliance tests for digital buses. The N5991 supports a wide range of buses, for example, PCI Express, USB, HDMI, and MIPI.

The product runs on a standard PC that controls a wide range of test hardware. Typically, the hardware comprises instruments for stimulus and response tests such as AWGs, BERTs, and oscilloscopes.

N5991 is implemented in C# within the Microsoft .NET Framework.

NOTE

The acronyms and abbreviations used in this Guide are defined in **Chapter 8, Appendix: Acronyms and Abbreviations**, beginning on page 75.

Document History

First Edition (September 2020)

The first edition of this user guide describes the functionality of the N5991 Test Automation Software Platform based on Framework version 1.0.

Second Edition (August 2021)

The second edition of this user guide describes the functionality of the N5991 Test Automation Software Platform based on Framework version 1.13.

Third Edition (August 2022)

The third edition of this user guide describes the functionality of the N5991 Test Automation Software Platform based on Framework version 1.51.

Fourth Edition (February 2024)

The fourth edition of this user guide describes the functionality of the N5991 Test Automation Software Platform based on Framework version 1.618.

2 Software Prerequisites

Other Required Software / 12

Certain prerequisites have to be fulfilled in order for the N5991 Test Automation Software to be installed.

Other Required Software

Before the Test Automation Software can be installed, the following software requirements must be met:

- 1 Windows 10 Operating System
- 2 Microsoft .NET Framework
- 3 Keysight IO Libraries Suite

The exact software versions required are listed in the changelogs or data sheets of the Test Automation Software for the respective standards, which can be found by visiting <https://www.bitifeye.com/>.

During the installation process of the Test Automation Software, the installer setup program will check for the required software (refer to [Figure 5](#) on page 17). If any is missing, a link to the specific internet page for downloading will be available.

3

Installing and Updating the Software

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The N5991 Test Automation Software runs on a standard PC, which controls the test instruments. This chapter provides details of the installation. If N5991 is already installed on the PC and it is not to be updated, proceed to the next chapter.

Downloading the Software

Finding and Downloading the N5991 Software

The N5991 installers can be found on the download page of the BitfiEye web portal, which can be reached either directly at <https://www.bitifeye.com/download/> or via the [BitfiEye homepage](#) (see Figure 1).

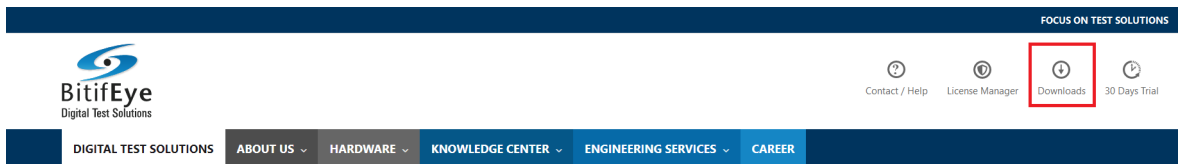


Figure 1 BitfiEye homepage banner with download button

Click on the standard you are interested in to see the software that is available to download. This may include:

- Receiver Tests — The N5991 ValiFrame receiver test automation software.
- Debugging Tools — For some standards, debugging tools are available, for example, the Link Training Suite for PCI Express and the Frame Generator for MIPI® standards.
- Changelogs for receiver tests and debugging tools.
- Additional Tools — For some standards, additional tools are required. For example, for PCI Express, several versions of the VFSeasim software (required for Rx testing, for different transfer rates) are required in order to be able to run the N5991 ValiFrame receiver test software.

User Guides and Data Sheets

For each standard, User Guides, Data Sheets and, in some cases, Language Guides for the software can be downloaded from the corresponding standard page of the BitifEye website. Go to [BitifEye.com](https://www.bitifeye.com) > Digital Test Solutions > “Standard”. The page for the standard PCI Express is shown in [Figure 2](#).

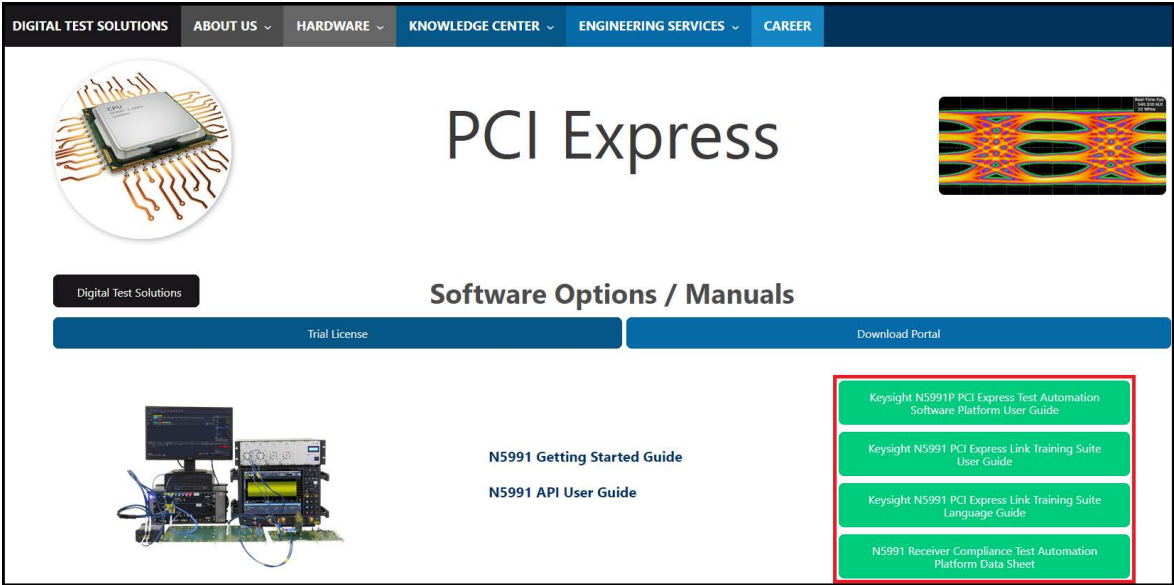


Figure 2 Part of the PCI Express page on the BitifEye web portal

The colored buttons on the right (outlined in red in [Figure 2](#)) link to the User Guides, Language Guide and Data Sheet for PCI Express (in this case), which can be downloaded.

Installing the Software

To install a product just execute the corresponding installer and follow the steps of the Setup program.

As an example, [Figure 3](#)–[Figure 6](#) show the installation of the PCI Express N5991 ValiFrame software.

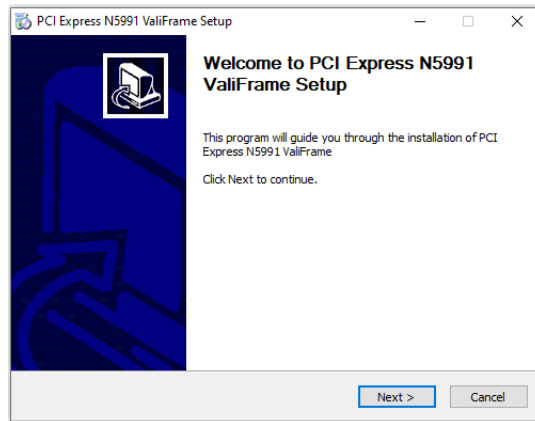


Figure 3 Installer 'Welcome to Setup' window

The second page of the installer wizard will show the software license agreement (see [Figure 4](#)). Read it carefully and select **I accept the terms of the License Agreement** option. Then, click **Next** to continue.

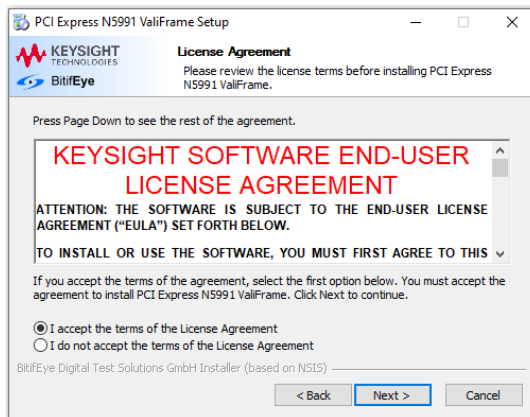


Figure 4 Installer 'License Agreement' window

A list of additional software required by the N5991 software and also the status of individual software is then shown (Figure 5). If any required software is not yet installed, the N5991 Required Software window shows that the missing software needs to be installed. Click **Next** to go to the next step.

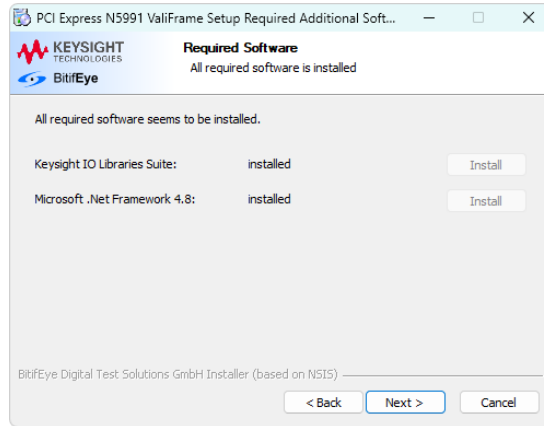


Figure 5 Installer 'Required Software' window

The **Choose Install Location** window is displayed as shown in Figure 6. If you do not wish to install the N5991 ValiFrame software in the default destination folder, click **Browse...** to select the destination folder in which the software is to be installed. Then, click **Install** to install the software.

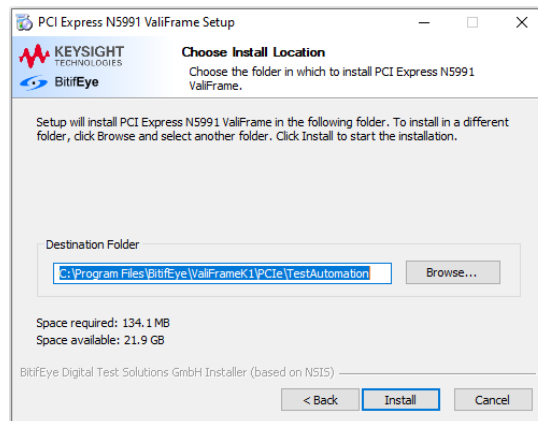


Figure 6 Installer 'Choose Location' window

The next panel that appears shows the status of the installation. Once the installation is completed, click **Next** to continue. In the final window you have the chance to open the changelog, if wished.

If you try to install a version of the Test Automation Software that has a release date after the software maintenance expiration date of one or more of the relevant licenses, a warning appears (Figure 7). Click 'No' to exit and update the license(s). See [Registering the Software](#) on page 22.

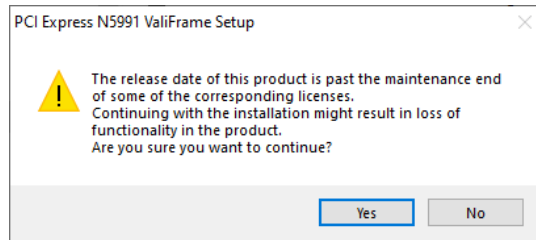


Figure 7 'Past end of license maintenance' warning

Once the software has been successfully installed, two shortcut icons will appear on the desktop: one for the Station Configurator and one for ValiFrame (Figure 8).

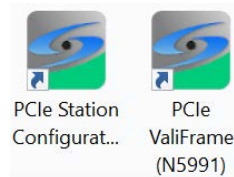


Figure 8 Desktop icons for the Station Configurator and ValiFrame (example for PCI Express)

Updating the Software

To keep your software settings when upgrading to a new version of the Test Automation Software Platform, see the [N5991 Data Structure](#) section of this Guide.

Then download the software (see [Downloading the Software](#) on page 14) and install it (see [Installing the Software](#) on page 16).

At the beginning of the installation you will be asked if you want to uninstall the currently installed version of the Test Automation Software Platform from the PC. If you do, the Uninstaller will open. In the 'Choose Components' window of the Uninstaller ([Figure 9](#)), you can specify whether your data, in addition to the program files, should be removed from the PC. Only if you no longer require this data should you check the box "User Data" before clicking **Uninstall**.

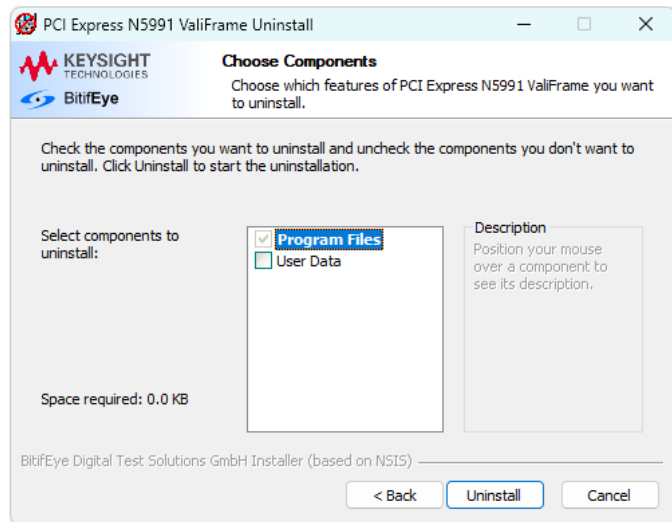


Figure 9 Uninstaller 'Choose Components' window

NOTE

If you have already performed calibrations and tests, when you update ValiFrame and open it, you may see several log messages saying that the measurements are not compliant. This is because ValiFrame now records the exact setup and software version used for the calibrations and, even if your setup has not changed, the information required by ValiFrame to categorize the results as compliant is not available. Compliance information is also available in the result report of each procedure.

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This chapter explains how to start the Test Automation Software and how to obtain the licenses that you require in order to use it.

Starting the Software

Double-click the ValiFrame icon on the desktop that corresponds to the standard you wish to use, e.g. PCIe ValiFrame (N5991) or USB4 ValiFrame (N5991). Alternatively, start the N5991 Test Automation Software from the Windows 10 Start menu, e.g.

Start > BitifEye PCIe N5991 > PCIe ValiFrame (N5991) or

Start > BitifEye USB4 N5991 > USB4 ValiFrame (N5991).

If the N5991 Software is already registered, it will start automatically. In that case, proceed to the next chapter, [Using the Software](#) on page 27.

Registering the Software

If the software is started without a valid license, the following panel ([Figure 10](#)) will open.

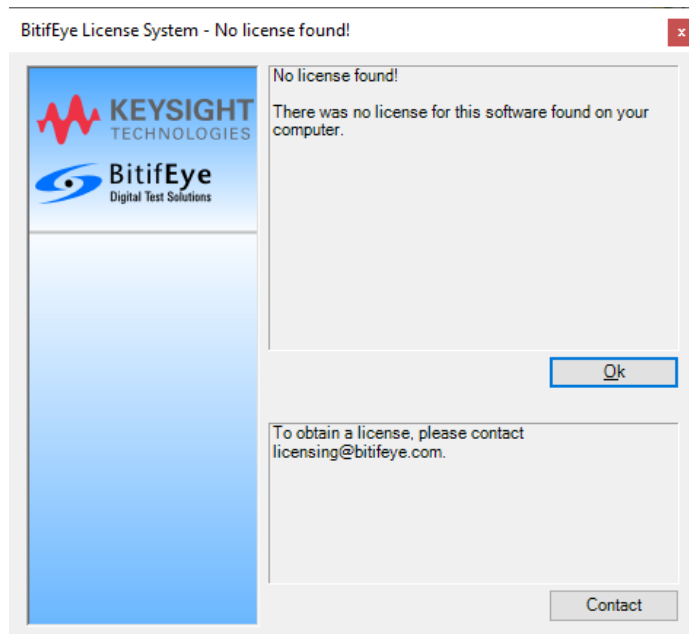


Figure 10 'No license found' dialog window

To get a valid license, use the BitfEye License Manager (BLM) portal: <https://licensing.bitfeye.com/>. The first time you access it, you will need to create an account.

For detailed instructions on how to use the BLM, refer to the [BitfEye License Manager User Guide](#). There are also [tutorial videos](#) on the BitfEye web portal.

Once you have the license certificate, you can add the license to your PC and activate it.

While the N5991 Software is running, license information can be reviewed by clicking **About** in the taskbar (see [Figure 11](#)).

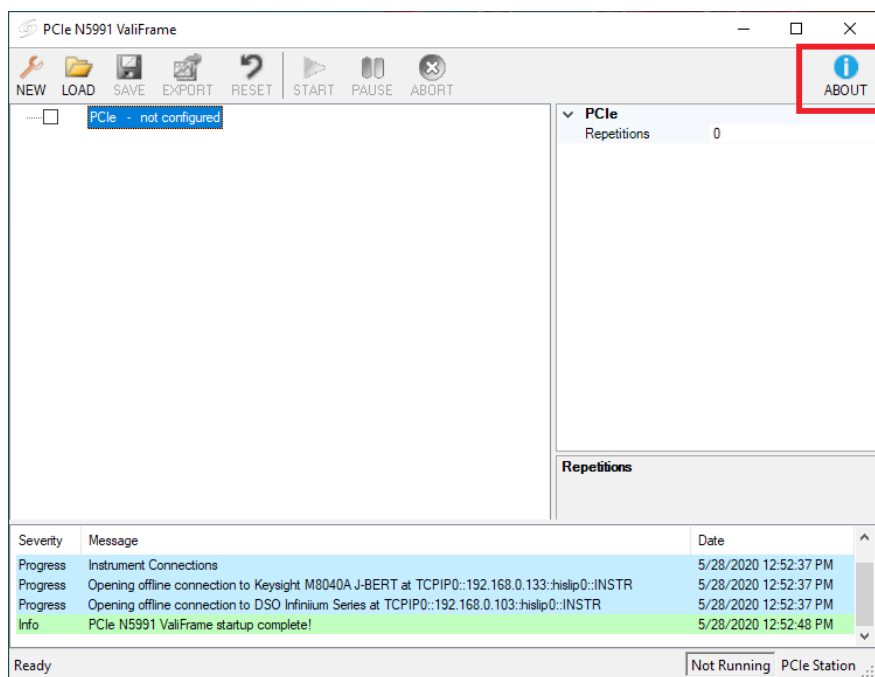


Figure 11 How to view N5991 software information

Software Maintenance Licenses

A software maintenance license ensures that new releases of the software can be installed as long as the license is valid. Ninety days before a software maintenance license expires, a warning will be shown in the ValiFrame main window. See the yellow areas in [Figure 12](#).

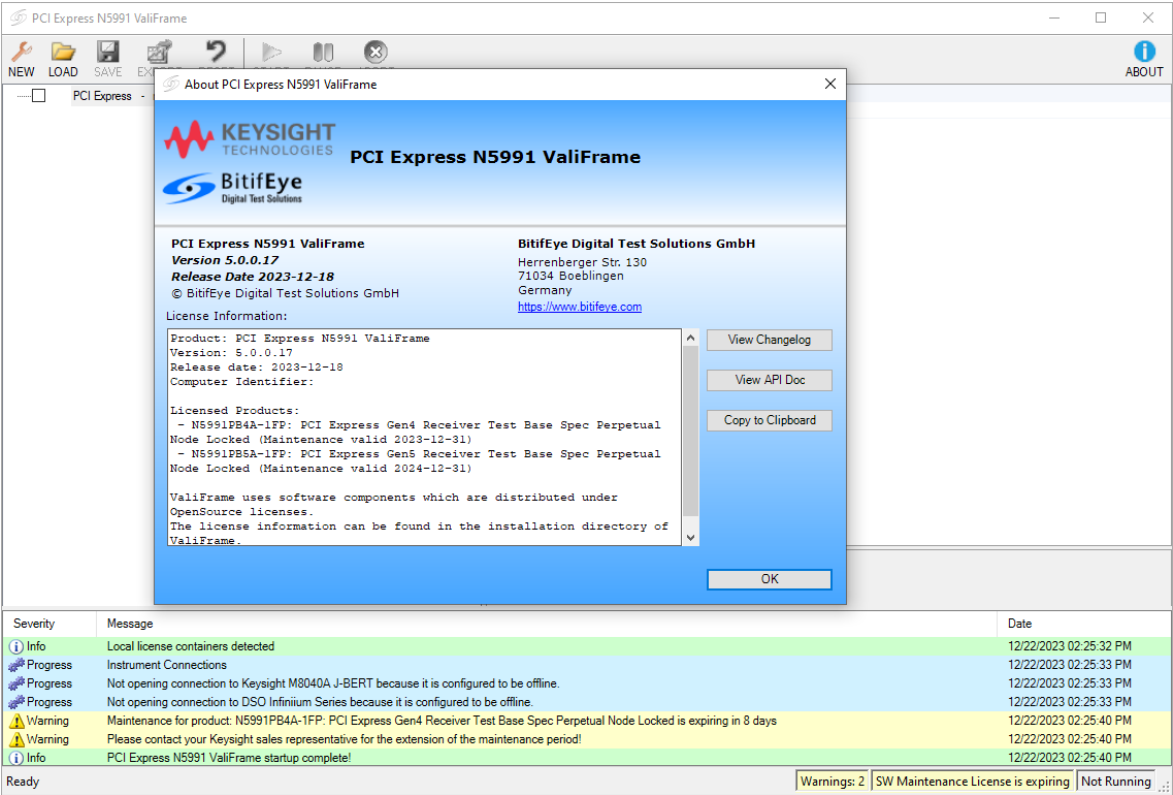


Figure 12 Warning that the software maintenance license will expire shortly

Once the maintenance license has expired, a warning will be shown in red in the ValiFrame main window (see Figure 13). Versions of ValiFrame released before the date the software maintenance license expired can still be used, but for newer releases the license needs to be renewed.

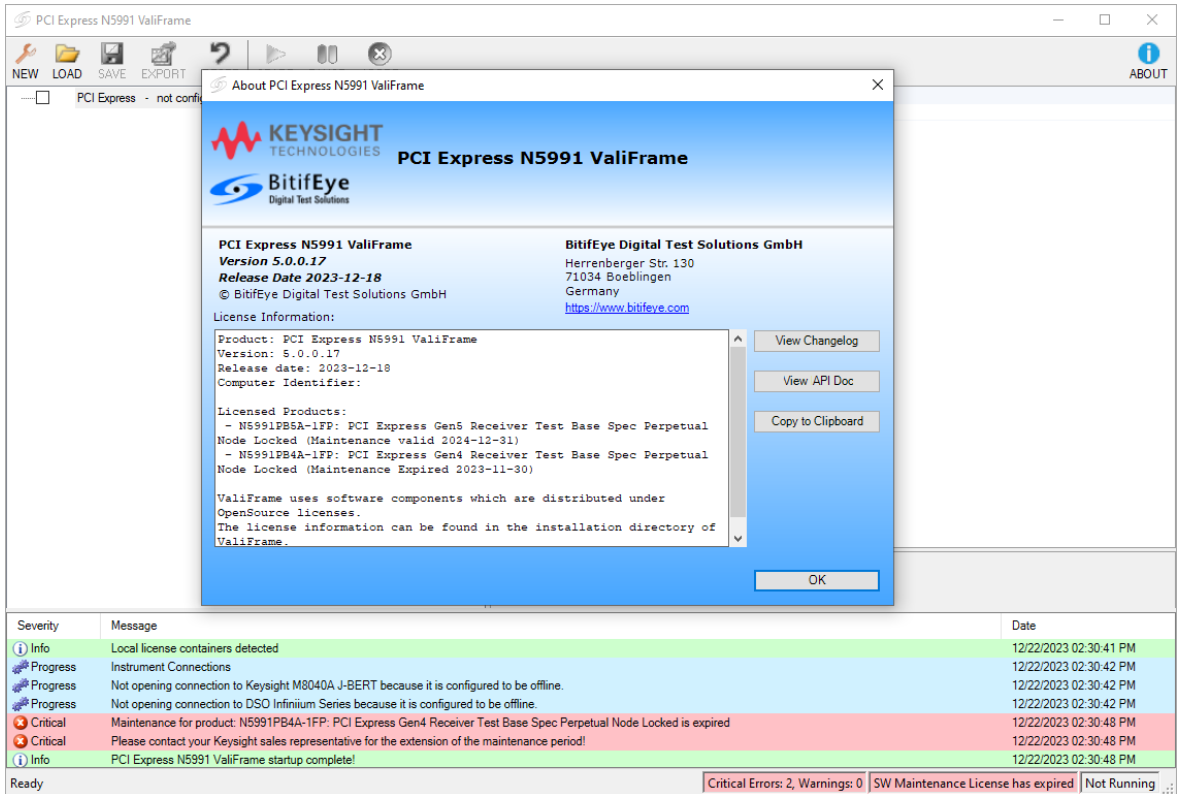


Figure 13 Warning that the software maintenance license has expired

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This chapter describes, first, how to configure and start the test station, and then, how to select the calibrations and test procedures that are to be run.

Normal Workflow

When testing a DUT, the normal procedure is as listed below. More details about each step are provided in the following sections.

- **Run the Station Configurator**
(see [Station Configuration](#) on page 29)
 - Station selection
 - Station configuration
 - Instrument configuration
- **Start ValiFrame**
(see [Starting the Test Station](#) on page 36)
- **Configure the DUT**
(see [Configuring the DUT](#) on page 37)
- **Calibrate the system**
 - Select calibration procedure(s)
(see [Selecting Procedures](#) on page 42)
 - Modify parameters
(see [Modifying Parameters](#) on page 42)
 - View connection diagram and connect setup
(see [Connection Diagrams](#) on page 50)
 - Run calibration procedure(s)
(see [Running Procedures](#) on page 48)
 - Save/export calibration results
(see [Results](#) on page 56)
- **Run test procedures**
 - Select test procedure(s)
(see [Selecting Procedures](#) on page 42)
 - Modify parameters
(see [Modifying Parameters](#) on page 42)
 - View connection diagram and connect setup
(see [Connection Diagrams](#) on page 50)
 - Run test procedure(s)
(see [Running Procedures](#) on page 48)
 - Save/export test results
(see [Results](#) on page 56)

Starting the Test Station Configurator

Station Configuration

The set of test instruments that are used for a specific application are referred to in the following as the 'Test Station' or simply 'Station'. The test station is controlled by a suitable PC and the N5991 Test Automation Software Platform. Once the N5991 Software has been installed successfully, two icons (see [Figure 8](#) on page 18) will appear on the desktop, one for a Station Configurator (e.g., the 'PCIe Station Configurator') and one for ValiFrame (e.g., 'PCIe ValiFrame').

The Station Configurator must be started prior to launching ValiFrame. It allows you to select the required set of instruments. Double-click the Station Configurator icon to launch the software. Alternatively, to access the Station Configurator in Windows 10, click

Start > BitifEye “Application” N5991 > “Application” Station Configurator (N5991)

where “Application” is PCIe, USB4, SATA, etc., as required.

When the ValiFrame Station Configurator is launched, the ValiFrame Station Selection window appears as shown in Figure 14. The station (application) is already selected.

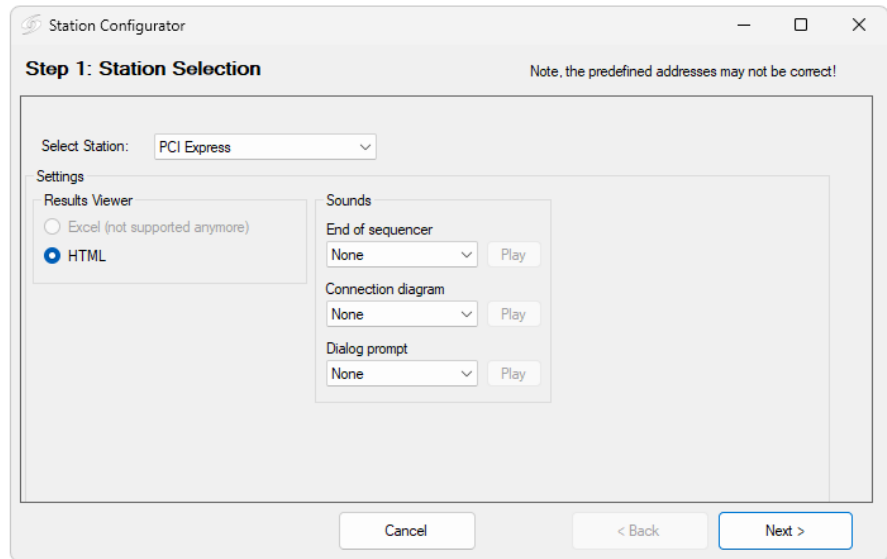


Figure 14 Station Selection window (example for PCI Express)

You may optionally assign sounds to mark different states of the program being reached.

- 1 **End of sequencer** plays the selected sound at the end of a sequence.
- 2 **Connection diagram** plays the selected sound every time a connection diagram pops up.
- 3 **Dialog prompt** plays the selected sound at each dialog prompt.

In each case, select a sound from the drop-down options. 'None' disables the sound for the respective action. Click **Play** to test a sound before assigning it to an action.

When you have finished, click **Next** to continue.

The Station Configuration stage of the configurator is then displayed, an example of which is shown in [Figure 15](#). It shows the various options for instruments that can be used for testing, which vary according to the station in use.

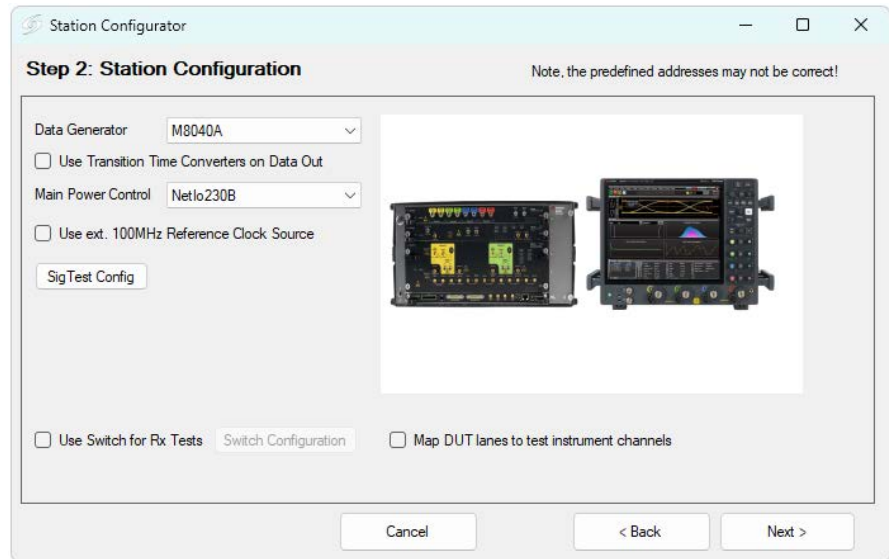


Figure 15 Station Configuration window (example for PCI Express)

Once all required instruments have been selected, those are listed in the Instrument Configuration window (Figure 16).

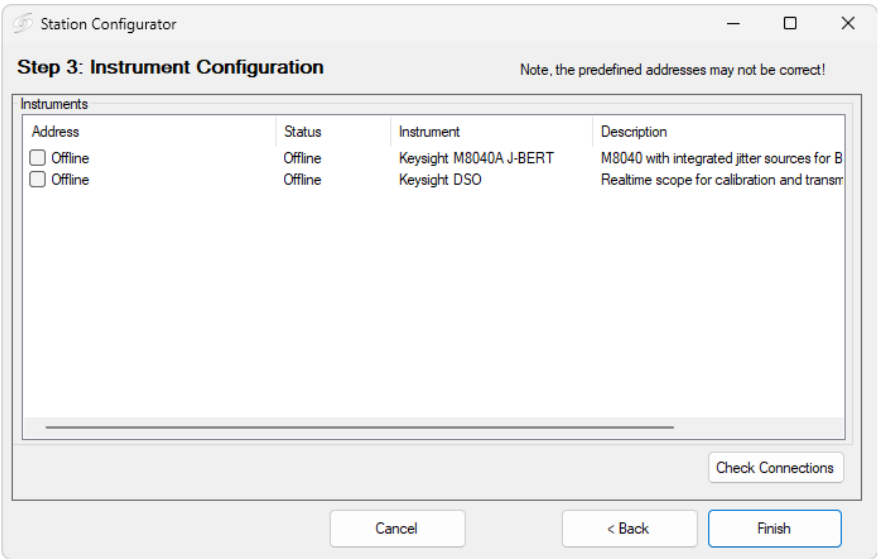


Figure 16 Instrument Configuration window (example for PCI Express)

NOTE

When starting a specific test station configuration for the first time, all instruments are set to 'Offline' mode. In this mode the test automation software does not connect to any instrument. This mode can be used for demonstrations or checks only. **'Offline' mode does not produce valid data.**

In order to control the instruments that are connected to the PC, the instrument address must be entered. The address depends on the bus type used for the connection, for example, USB or LAN.

Most of the instruments require a VISA connection. To determine the VISA address, run the **VISA Connection Expert** (refer to [Using Keysight IO VISA Connection Expert](#) on page 34). Copy the address string for each instrument from the **Connection Expert** entries and paste it as the instrument address in the **Instrument Configuration** window of the **Station Configurator**.

The applications running on the oscilloscope use a different technology to provide remote access to ValiFrame, called .NET Remoting. Remote access is only possible using a LAN connection to the oscilloscope, and for this reason the IP address needs to be used with this type of instrument.

Still other instruments use neither VISA nor .NET Remoting but require other connections and thus other address formats. Details vary depending on the instrument. Typically these instruments are only used for one specific standard.

NOTE

If a standard requires an oscilloscope application to be used, configure the controller's firewall to allow communication to ports 9945 and 9946.

After the address strings have been entered, click **Check Connections** to verify that the connections for the instruments have been established successfully. If anything is wrong with the instrument address, a window is displayed with a message describing the problem.

Finally, click **Finish** to save the changes and close the ValiFrame Station Configurator.

Using Keysight IO VISA Connection Expert

The Keysight Connection Expert is recommended for setting up new connections or verifying existing connections. Perform the following steps:

- 1 Start the **Connection Expert**. Either click the **Keysight IO Libraries Suite** icon in the taskbar and select **Connection Expert** or, alternatively, click **Start > Keysight Connection Expert**.
- 2 A window similar to that shown in **Figure 17** is displayed. If you are not familiar with the Connection Expert, click the question mark (top right) for help or to watch a short introductory video.
- 3 Select **Instruments** (top left). If the instruments you are looking for are not listed in the left column, click **Rescan**.
- 4 Select one of the instruments you want to connect and verify that its **VISA Address** appears as shown (larger red frame in **Figure 17**) with a tick beside it.

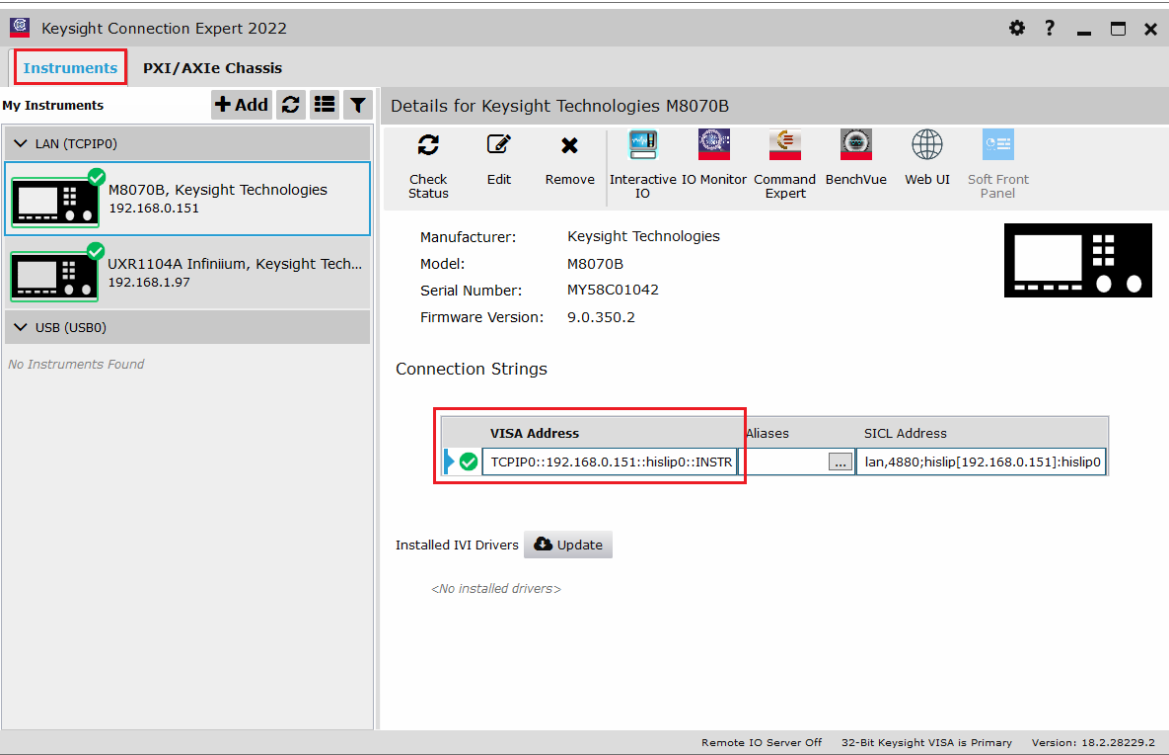


Figure 17 Keysight Connection Expert

- 5 Repeat for all required instruments that use VISA addresses.
- 6 Transfer these addresses (connection strings) to the Station Configurator as follows:
 - a Copy one of the VISA addresses from the Connection Expert.
 - b Select the same instrument in the Instrument Configuration window of the ValiFrame Station Configurator (Figure 16) and paste the address in the corresponding Address text field.
 - c Repeat this procedure for all the required instruments that use VISA addresses.

Starting the Test Station

Start the ValiFrame station with a double-click on the **“Application” ValiFrame (N5991)** icon on the desktop (see [Figure 8](#) on page 18). Here and below, “Application” is PCIe, USB4, SATA, etc., as required.

Alternatively, start the ValiFrame station by clicking **Start > BitifEye “Application” N5991 > “Application” ValiFrame (N5991)**.

The ValiFrame N5991 connects automatically to the instruments that are set to “Online” mode in the ValiFrame Instrument Configuration (see [Figure 16](#)). The application is ready for use once all the connections have been initialized successfully, and the main window will appear as shown in [Figure 18](#).

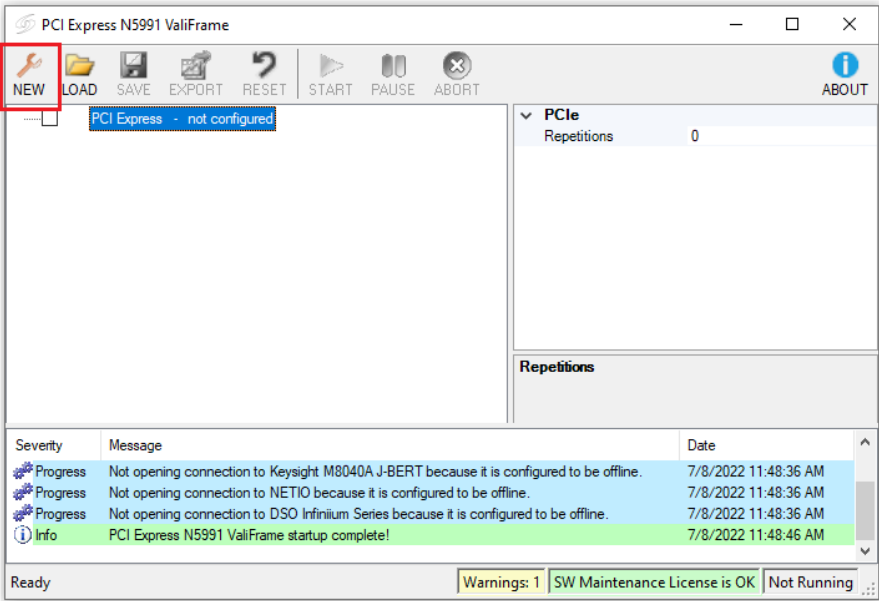


Figure 18 ValiFrame GUI main window (example for PCI Express)

The test parameters need to be configured before any test or calibration procedure is run. Click **NEW** (red box in [Figure 18](#)) to open the Configure DUT dialog.

Configuring the DUT

The parameter selections available in the **Configure DUT** panel depend on the specific application. An example is shown in [Figure 19](#). In the text fields, enter all the information that is relevant for the DUT and the procedures to be run. The selected DUT parameters and the information entered by you will be shown in the measurement reports.

The screenshot shows the 'Configure DUT' dialog box with the following sections and fields:

- DUT Section:**
 - Serial Number: [Dropdown]
 - DUT Name: PCIe [Dropdown]
 - Version: 6.0 [Dropdown]
 - Interface Type: ASIC [Dropdown]
 - DUT Type: End Point [Dropdown]
 - Clock Architecture: Common Clock [Dropdown]
 - Description: [Text Area]
- Test Section:**
 - User Name: Unknown User [Text Field]
 - Comment: [Text Area]
 - Initial Start Date: 12/20/2023 5:01:47 PM [Text Field]
 - Last Test Date: 12/20/2023 5:01:47 PM [Text Field]
- Parameters Section:**
 - ☒ Compliance Mode
 - ☒ 2.5 GT/s
 - ☒ 5.0 GT/s
 - ☒ 8.0 GT/s
 - ☒ 16.0 GT/s
 - ☒ 32.0 GT/s
 - ☒ 64.0 GT/s
 - ☐ Expert Mode
 - Show Parameters [Button]
 - Lanes Configuration [Button]

An OK button is located at the bottom right of the dialog.

Figure 19 Configure DUT panel (example for PCI Express)

NOTE

In most applications, either **Compliance Mode** or **Expert Mode** must be selected. In compliance mode, the tests are run according to the specific compliance test specification, whereas in expert mode the DUT can be characterized to determine performance margins, for example. Expert mode is provided so that advanced users can run additional tests. Also, the tests may be implemented differently than in compliance mode.

Main ValiFrame Window

Once the DUT has been configured, press the **OK** button in the **Configure DUT** Panel. The Test Automation Software Platform main window is displayed with the procedure tree, as shown in **Figure 20**. It contains the list of calibration and test procedures, the top-level groups typically being

- Calibration
- Receiver

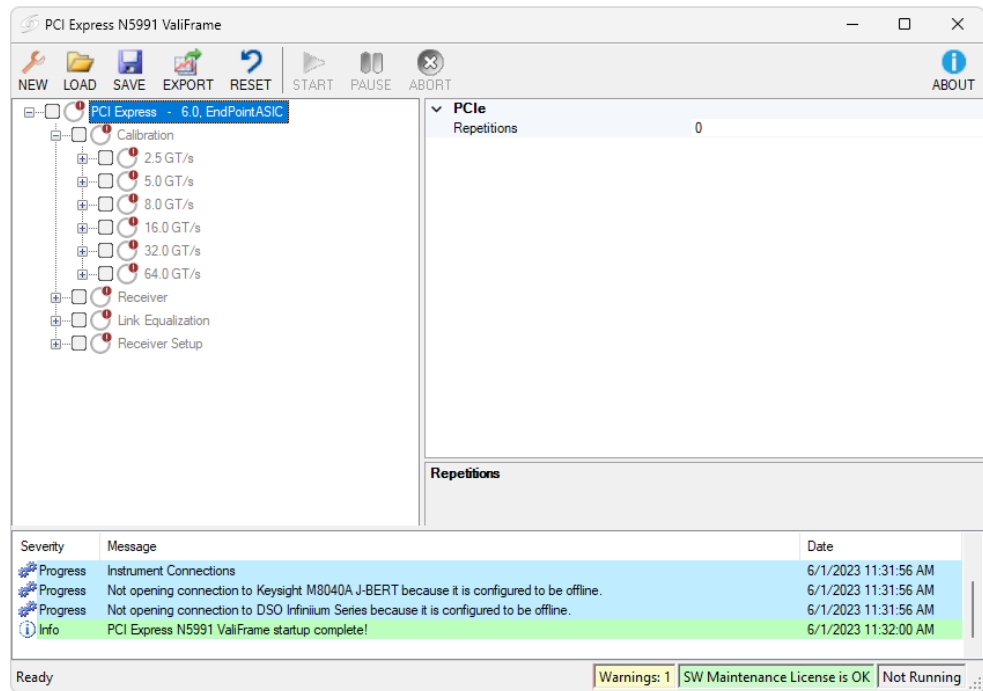


Figure 20 Main window (example for PCI Express)

Menu Buttons

The **menu buttons** at the top allow the main actions to be performed, such as configuring a new DUT, saving/loading a project or starting the calibrations and tests.

NEW

Use the NEW button to configure the DUT and the test parameters, for example when a new DUT is being tested or you wish to swap between Expert and Compliance Modes.

LOAD

The LOAD button makes it possible to load a previously saved configuration (.vfc) or project (.vfp) file, which avoids having to configure the DUT again. This can save a lot of time.

NOTE

When loading a .vfc or .vfp file, it can happen that it is rejected because it was created with/for a station configuration that is incompatible with the current one. When that occurs, an error message will appear listing the incompatible settings.

SAVE

Once a DUT has been configured, the N5991 configuration can be stored as a single “.vfc” (ValiFrame configuration) file using the SAVE button. Similarly, once some procedures have been run, the SAVE button can be used to save a “.vfp” (ValiFrame project) file. See [Running Procedures](#) on page 48 for more details.

EXPORT

Use the EXPORT button to save calibration and test data results. See [Exporting Results](#) on page 60.

RESET

The RESET button sets all properties/parameters to their default values.

START

When the START button is enabled (green), pressing it starts the next marked procedure.

PAUSE

Press PAUSE to stop the current procedure from running and press it again to start it again.

ABORT

Press ABORT to abandon the current procedure.

Other Parts of the Main Window

The **parameter grid** on the right-hand side of the window shows the parameters that are related to the individual procedure or group of procedures selected on the left.

The **log list** pane at the bottom of the window shows calibration and test status messages (regular progress updates as well as warnings and error messages). Right-clicking the log list pane opens a context menu (Figure 21).

- 'Show Log File' is required for troubleshooting (see [Troubleshooting](#) on page 72).
- If 'Show Icons' is ticked, icons appear at the left of the log list depending on the function of each message (examples in the red frame in Figure 21).
- Error messages are shown on a red background, for example, if 'Use Severity Color' is checked.

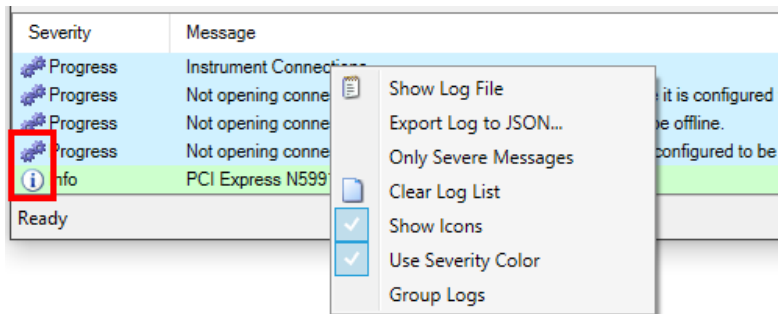


Figure 21 Customizing the log list

The **status bar** at the very bottom of the main window provides information about how many error messages and warnings have been sent, the software license and whether ValiFrame is running.

Selecting, Modifying, and Running Tests

System Calibration

It is necessary to calibrate the test system before you run the first test, in order to ensure that test results are consistent from run to run. Provided the equipment has achieved thermal stability before the calibration is started (typically after 30 min of warm-up), the thermal environment is stable, and no system elements have been exchanged, the calibration is very stable and may only have to be repeated once a week or even less frequently. The calibration interval depends on the degree of accuracy desired. If the station is not calibrated prior to a DUT test, the results of the previous calibration will be used for the current tests.

Selecting Procedures

The calibration, receiver and transmitter test procedure groups can be selected globally by clicking the check box next to the name of the group. Alternatively, one or more individual test procedures can be selected by checking the specific selection boxes in front of the test names. Only the procedures that are selected will be executed.

To start one or more procedures, select the corresponding check box(es). Then the Start button in the taskbar is enabled and turns green. Click **Start** to run the selected procedure(s).

Modifying Parameters

Most calibration and test procedures as well as the groups containing them have parameters that control the details of how the procedures are run. In compliance mode most of these parameters are read-only. In expert mode almost all parameters can be modified. First, select a specific calibration or test procedure or one of the groups contained in the N5991 procedure tree. The parameters are displayed in a property list (parameter grid) on the right-hand side of the screen (see [Figure 22](#)). Click on the parameter to be modified. These parameters can be set only before the execution of the procedure subgroup or procedure is started. The selected values of the test parameters are listed in the test results.

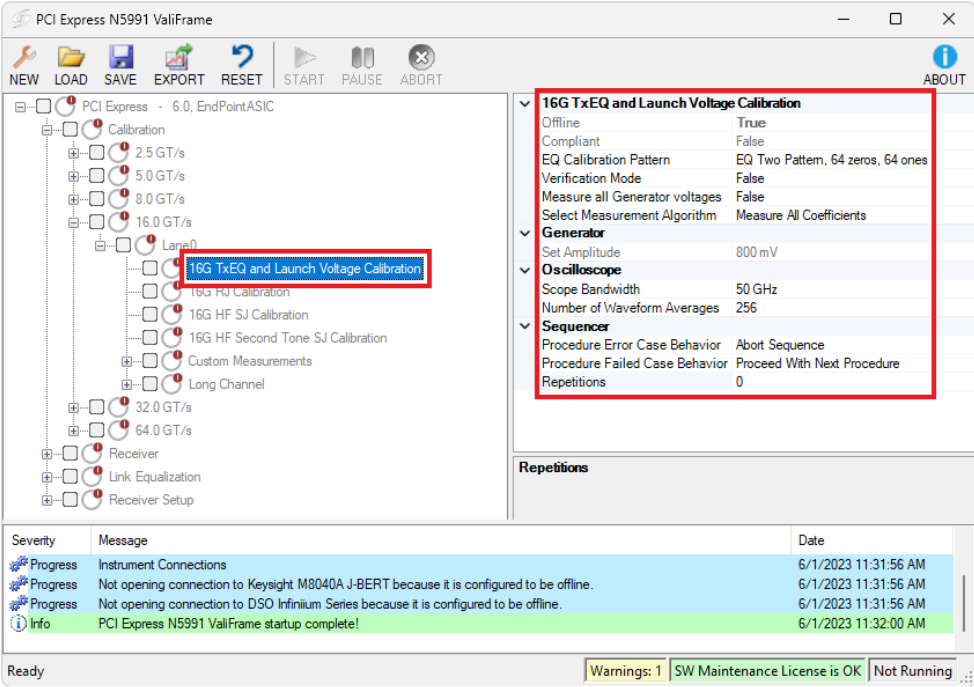


Figure 22 Modifying parameters

Sequencer Parameters

The sequencer parameters control the flow of the test sequencer, not the behavior of individual procedures. They are identical across all versions of ValiFrame. One of them, Repetitions, is available for all procedures and groups in the procedure tree. The others are only available for procedures. Like all other parameters, the sequencer parameters are shown on the right side of the ValiFrame user interface (Figure 22) and they can be changed by the user.

The sequencer parameters are listed and described in Table 1.

Table 1 Sequencer Parameters

Parameter	Parameter Description
Procedure Error Case Behavior	“Proceed With Next Procedure”: If an error occurs in the current test or calibration procedure, continue by running the next procedure in the sequence. “Abort Sequence”: Abort the execution of the sequence.
Procedure Failed Case Behavior	“Proceed With Next Procedure”: If the current test or calibration procedure fails, continue by running the next procedure in the sequence. “Abort Sequence”: Abort the execution of the sequence.
Repetitions	The number of times the group or procedure is going to be repeated. If the value is '0', it runs only once.

Common Parameters

‘Common parameters’ are used for several related calibration or test procedures. They are shown on the right side of the ValiFrame user interface when the selected entry of the procedure tree on the left is a group instead of an individual procedure.

Procedure Parameters

‘Procedure parameters’ are all parameters that do not fall into one of the previously described categories. They are shown on the right side of the ValiFrame user interface when the selected entry of the procedure tree on the left is an individual procedure. They only change the behavior of that single procedure. Different procedures often have parameters with the same name, but the settings that are set always apply just to the selected procedure, and the meaning may vary slightly for different procedures.

Parameters for All Individual Procedures

The values of several parameters are displayed, read-only, in the parameter grid for (nearly) all individual procedures. They are defined in [Table 2](#). Keep an eye on these parameters to ensure that you produce valid data.

Table 2 Parameters for (Nearly) All Individual Procedures

Parameter	Description
Calibration Data Version	The version of the N5991 ValiFrame software that was used to obtain the data of the prerequisite calibrations, i.e., the calibration data required in order to perform the current procedure (test or calibration).
Compliant	<p>Read-only in the parameter grid. It indicates whether the procedure you are running is compliant with the corresponding standard specification.</p> <ul style="list-style-type: none"> ▪ True: You are working in Compliance Mode OR you are working in Expert Mode but all parameters that can be edited only in Expert Mode have their default values. ▪ False: You are working in Expert mode and a parameter that can be edited only in Expert Mode does not have its default value. <p>The mode can be selected in the Configure DUT panel.</p> <p>False is also shown if you are working offline or if any of the prerequisite calibrations were not performed in compliant conditions.</p> <p>If the value is False, an additional property (Non-compliance reason(s)) is shown to indicate why the data is not compliant.</p>
Non-compliance reason(s)	Possible reasons include: the required calibrations were run offline, with unreleased software, with old firmware.
Offline	<ul style="list-style-type: none"> ▪ If True, the test automation software is not connected to any instrument. This mode should be used for demonstrations and checks only. It is not valid for calibrations or measurements. ▪ If False, the software is connected to instruments and produces valid data. It is read-only in the parameter grid. It can be set in the Instrument Configuration step of the Station Configurator.
Software Version	The version of the N5991 ValiFrame software currently being used.

Context Menu for Procedures

The context menu is a convenient way of finding out more about the procedures. When you right-click the name of a group, calibration or test in the procedure tree, a menu appears with several entries (see [Figure 23](#)), depending on the state of the procedure.

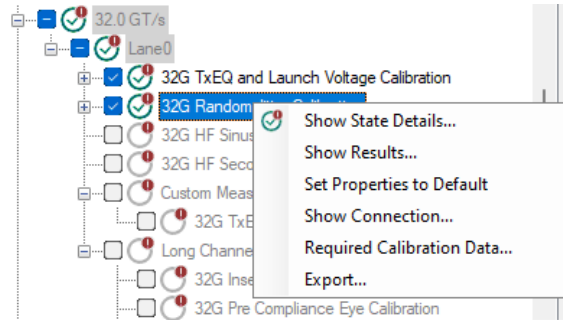


Figure 23 Example Context Menu for procedures

Show State Details...

Select this to reveal what the state icon next to the name of the procedure means. All state icons and their definitions are listed in [Table 3](#) on page 63.

Show Results...

After the procedure has been run, click here to open the results viewer. For more details see the section [Results](#) on page 56.

Set Properties to Default

If you are working in Expert mode, click here to return the parameters to their default values.

Show Connection...

Clicking here opens the Connection Diagram. For more details see [Connection Diagrams](#) on page 50.

Required Calibration Data...

Click here to open the list of calibrations that must be performed before the current procedure is run (Figure 24).

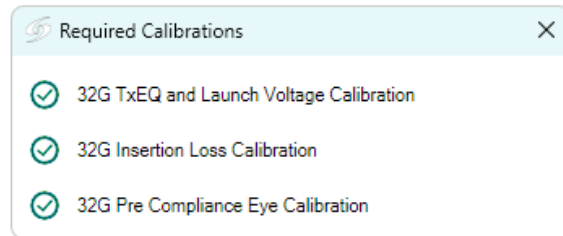


Figure 24 List of required calibrations (example for PCI Express 32G Compliance Eye Calibration)

Export...

You can export the results of all or just selected procedures by clicking here. The process is described in [Exporting Results](#) on page 60.

Running Procedures

To run the selected procedures, press the **START** button. The procedures are run in the order shown in the procedure selection tree. Some prerequisite procedures require other procedures to have been run previously. These prerequisite procedures are arranged above their dependents in the procedure tree. Some procedures may require user interaction, such as changing cable connections or entering DUT parameters. The required action is prompted in a pop-up dialog box prior to execution as shown in [Figure 25](#).

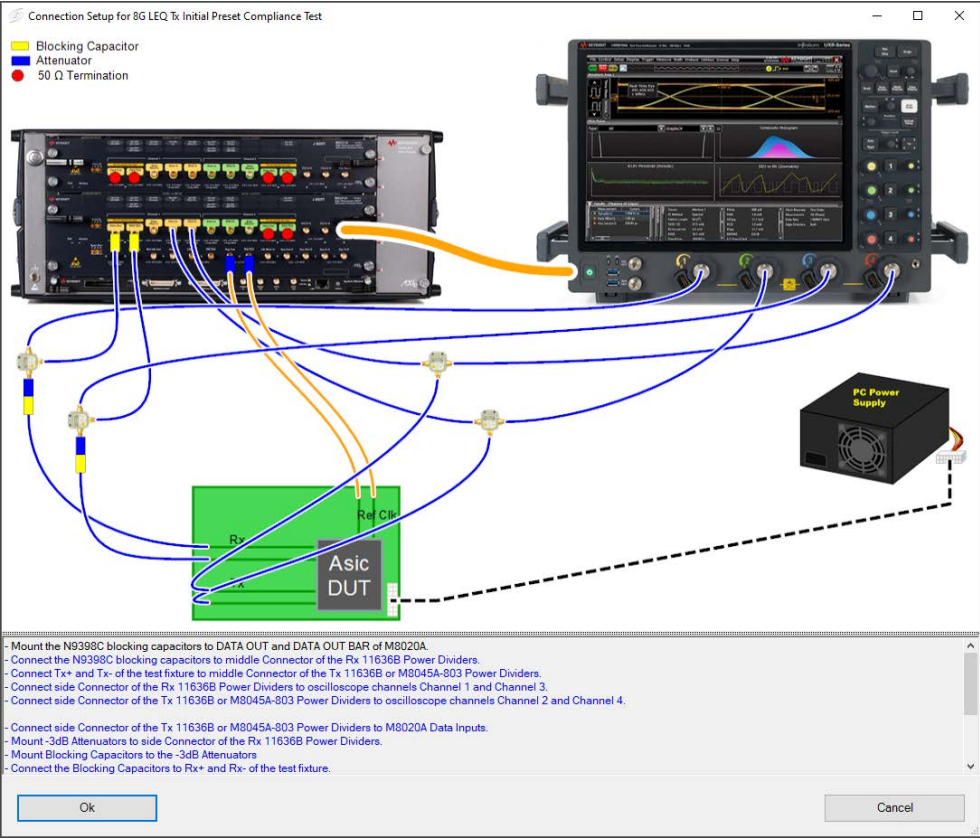


Figure 25 Pop-up dialog for user interaction

When a test is running, use the **PAUSE** button to pause the test at the next step of the procedure sequence. Once the test is paused, you have two choices.

- Press the **STEP** button to continue the test and pause at the next step.
- Press the **PAUSE** button again to toggle the state of the **START/STEP** button. Then press the **START** button to continue the test until the end of the procedure.

This feature is useful for debugging purposes, for example to analyze the signal on the oscilloscope at each step.

To force the sequencer to stop running the tests, press the **ABORT** button. This action will stop the current test in progress and prevent the remaining tests from running.

The **SAVE** button has two purposes. First, it can be used to save the current N5991 configuration as a '.vfc' (ValiFrame configuration) file. This will include the selections made in the 'NEW'/'Configure DUT' panel and the parameters on the right side of the main window (in the parameter grid). Second, once some procedures have been run, it can be used to save the results of these procedures along with the current configuration in a single '.vfp' (ValiFrame project) file.

Use the **LOAD** button to recall a saved configuration — or a saved configuration plus the corresponding results — to avoid having to configure the DUT again.

CAUTION

Before executing the calibration or test procedures, ensure that the Station Configuration is conducted properly with all necessary instruments such as the Infiniium oscilloscope set to 'online'. All calibrations can be run in offline mode, that is, without any instrument connected. The offline mode is intended for product demonstrations with simulated data. CALIBRATIONS RUN IN OFFLINE MODE DO NOT GENERATE VALID CALIBRATION DATA.

Connection Diagrams

NOTE

The interactive connection diagrams described here are gradually being introduced to all ValiFrame test applications. Currently, they are available only for a few applications.

Connection diagrams can be accessed in two ways:

- Right-click the name of the procedure in the procedure tree and select “Show connection...” from the menu.
- When a procedure is run, the connection diagram appears in a pop-up dialog box prior to execution. In some apps this function can be turned off.

Default View

The default view consists of a connection diagram surrounded by five buttons, which are outlined in red and numbered in [Figure 26](#).

- 1 **Export:** Export the diagram as an HTML file. If the list of instruments and accessories is expanded, that will be included in the HTML report as well.
- 2 **Connection Instructions:** Toggle to ‘on’ to view the connection instructions and further information ([Figure 27](#)).
- 3 **Instruments and Accessories:** Toggle to ‘on’ to view the list of required instruments and accessories. If a description of how to connect the setup is available, this will be displayed as well ([Figure 28](#)).
- 4 **Export Mode:** Click here to change the layout of the connection diagram before exporting it ([Figure 29](#)).
- 5 **OK:** Click here to close the connection diagram window.

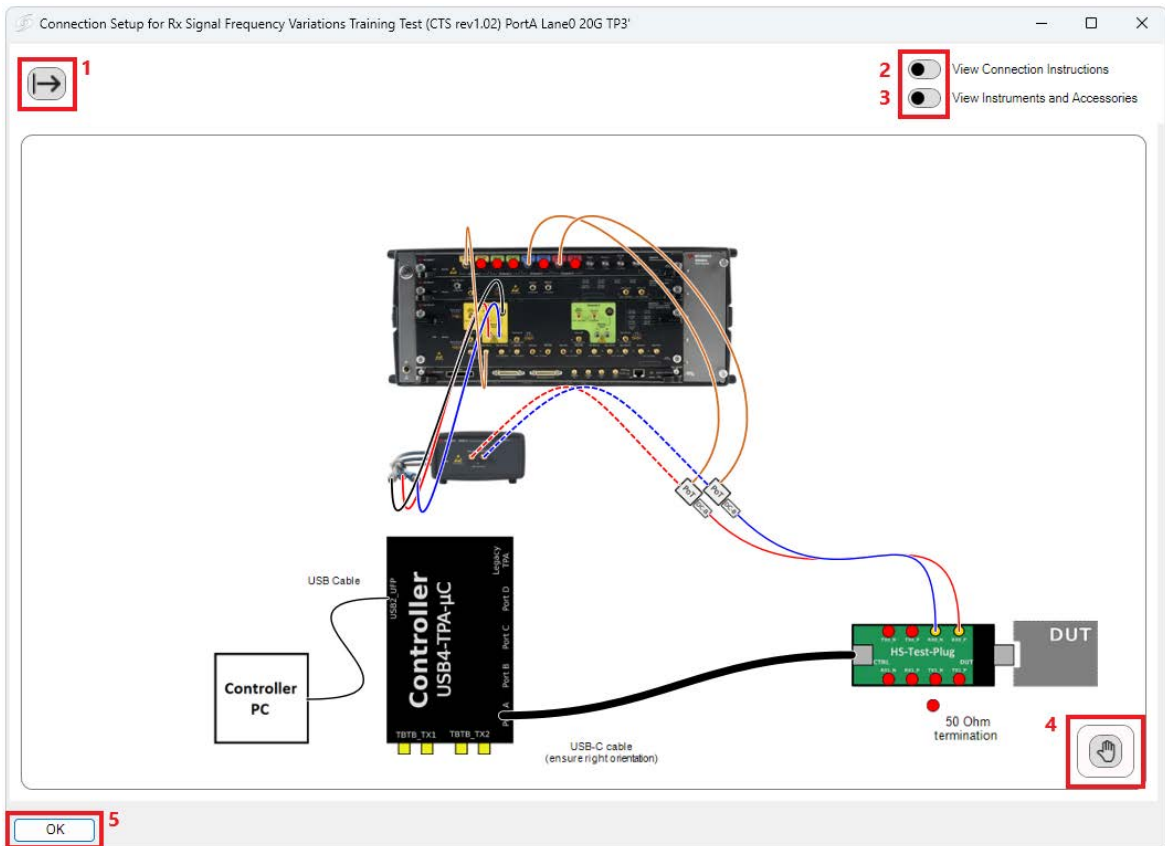


Figure 26 Connection diagram dialog – default view (example for USB4)

Connection Instructions View

If “View Connection Instructions” is toggled to ‘on’, a second pane listing instructions in order appears.

- Click the eye symbol next to each step for further information, such as the color used for the cable in the diagram.
- If there is extra information or a warning about a particular step, this is indicated by icons. Reveal the information or warning by clicking the eye symbol.

Toggling “Step-by-Step Instructions” within the Connection Instructions pane leads to a view such as in [Figure 27](#).

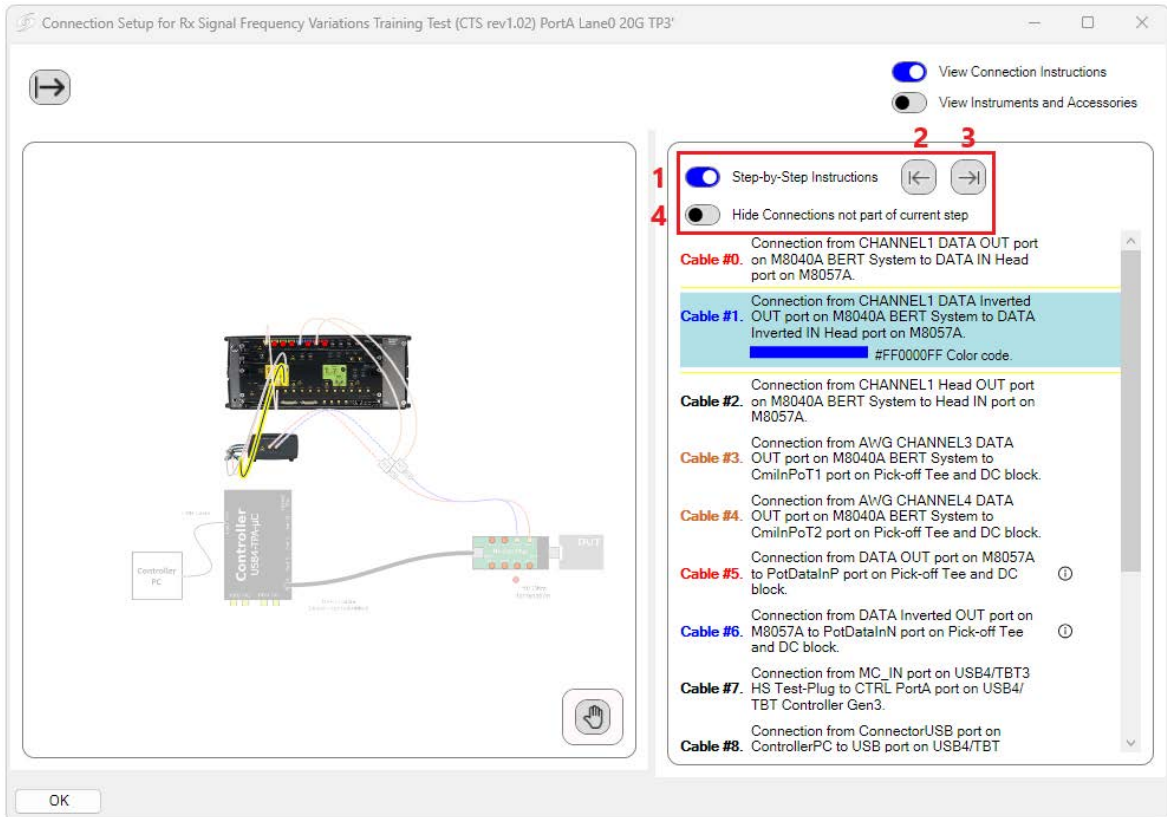


Figure 27 Connection diagram dialog – with Connection Instructions pane (example for USB4)

This view helps avoid any connections being overlooked.

Functions of buttons 1–4:

- 1 Toggle button for step-by-step instructions.
- 2 Return to previous step. Only visible if step-by-step instructions are activated.
- 3 Go on to next step. Only visible if step-by-step instructions are activated.
- 4 If “Hide Connections” is activated, all connections that are not part of the step are hidden, instead of just being grayed out. A warning appears that what can be seen is not the complete setup.

For activated step-by-step instructions, the current connection (in the highlighted step) is highlighted in the diagram and all others are grayed out.

Instruments and Accessories View

In the Instruments and Accessories view (Figure 28), the lower pane contains

- A list of instruments and accessories (on the right here)
- A description of how to make the connections (on the left). This is not available in all applications.

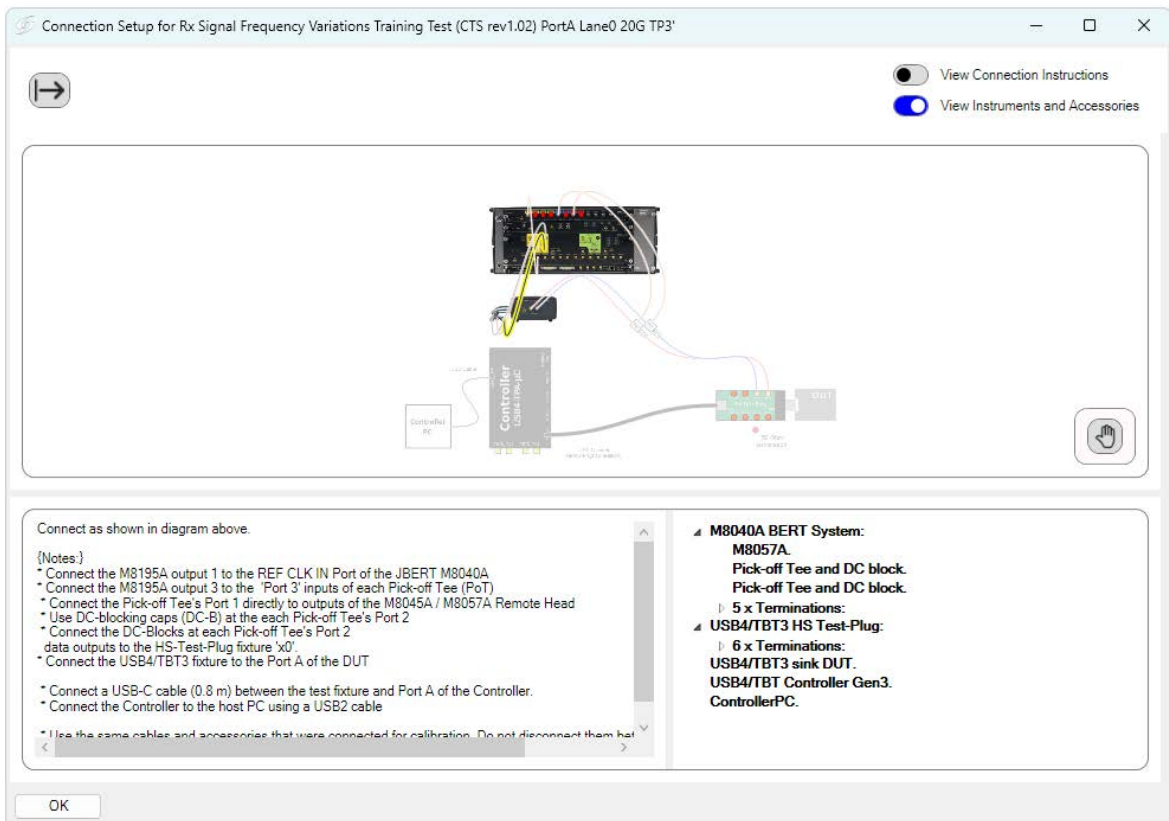


Figure 28 Connection diagram dialog – with Instruments and Accessories pane (example for USB4)

Export Mode View

In the Export Mode view (Figure 29) you can change the layout of the connection diagram before exporting it.

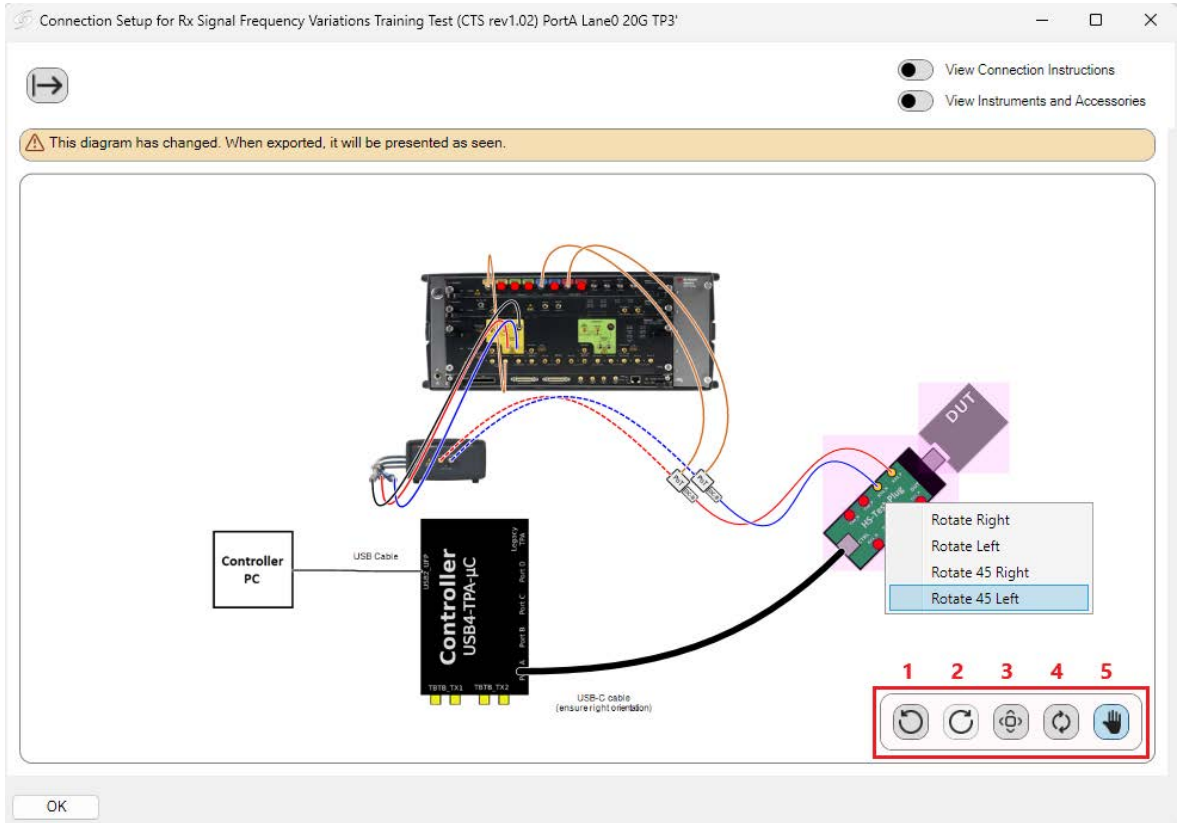


Figure 29 Connection diagram dialog – Export Mode view

Functions of buttons 1–5:

- 1 Undo
- 2 Redo
- 3 Resize, to show the whole diagram
- 4 Reinstates the original diagram layout
- 5 Exit Export Mode (this reinstates the original diagram layout)

Other possibilities:

- To **move** an instrument or accessory: Double click the instrument and then drag-and-drop it to the required position.
- To **rotate** an instrument: Double left click to select an instrument, then right click. Select the required rotation from the pop-up menu (see [Figure 29](#)).
- To **zoom** in on or out from an instrument: Double left click to select an instrument, then use the mouse wheel.
- To **alter the angle** of cables: Single click on a node (where the cable enters or exits an instrument). The cable will be highlighted. Right click and select either “Tightest curvature” or “Slackest Curvature” from the pop-up menu.

Results

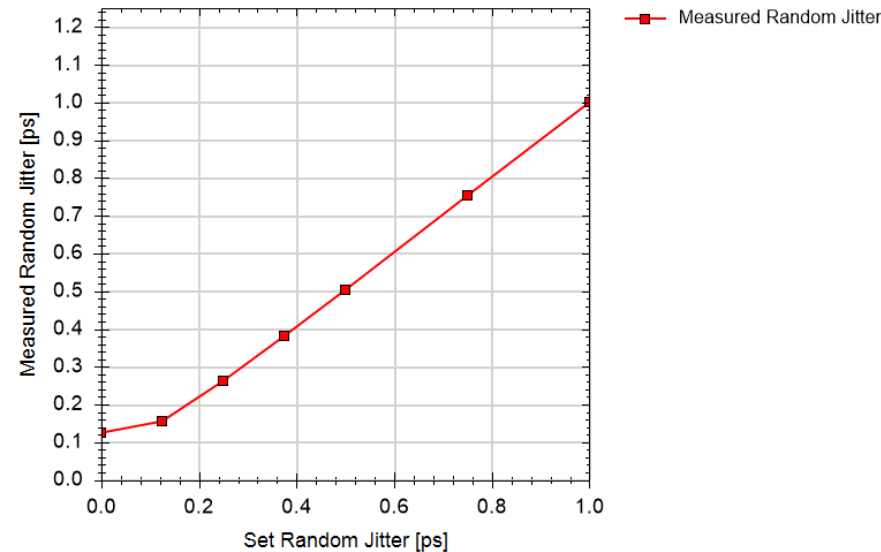
Run-Time Data Display

Most procedures generate data output. While the procedure is running, the data is displayed in a **Results Viewer** window, which opens automatically for each individual procedure. An example is given in [Figure 30](#).

L0_Cal_32Gtps_RJ

[Not Compliant]

for PCIe 6.0 EndPoint ASIC



```
-----General-----
Offline                               True
Software Version                      5.0.0.17
Calibration Data Version              5.0.0.11
Compliant                             False
Non-compliance reason(s)              Procedure offline; Required cal not compliant: 32G TxEQ and
                                       Launch Voltage Calibration; Required cal offline: 32G TxEQ
                                       and Launch Voltage Calibration; Required cal
                                       unknown/unreleased: 32G TxEQ and Launch Voltage Calibration
Verification Mode                     False
Gen5 Fixture                          PCIe 5.0 FR4 Base Fixture
Gen5 Asic Eye Calibration Method       Seasim
```

```

----Oscilloscope----
Scope Bandwidth           33 GHz
Number of Averages         3
Number of UIs              2 MUI
----Generator----
Pre-Shoot                  0 dB
De-Emphasis                0 dB
Differential Voltage        800 mV
----Instruments----

Calibrated Instrument 1    Name: Keysight M8040A J-BERT ; Company: Keysight
                           Technologies ; Model: Keysight M8040A J-BERT ; SN: Unknown ;
                           FW rev.: Unknown ; Description: M8040 with integrated jitter
                           sources for BER tests ; Calibrated Instrument

Calibrated Instrument 2    Name: DataOut1 ; Company: Keysight Technologies ; Model:
                           M8045A,M8057A ; SN: DE5250000002,DE12345678 ; FW rev.:
                           7.5.700.8 ; Description: M8040 with integrated jitter
                           sources for BER tests ; Calibrated Instrument

Calibrated Instrument 3    Name: DataOut1 ; Company: Keysight Technologies ; Model:
                           M8195A ; SN: DE5250000004 ; FW rev.: 4.0.0.0 ; Description:
                           M8040 with integrated jitter sources for BER tests ;
                           Calibrated Instrument

Calibrated Instrument 4    Name: DataOut2 ; Company: Keysight Technologies ; Model:
                           M8195A ; SN: DE5250000004 ; FW rev.: 4.0.0.0 ; Description:
                           M8040 with integrated jitter sources for BER tests ;
                           Calibrated Instrument

Measurement Instrument 1   Name: Keysight DSO ; Company: Keysight Technologies ; Model:
                           DSO Infiniium Series ; SN: Unknown ; FW rev.: Unknown ;
                           Description: Realtime scope for calibration and transmitter
                           tests ; Measurement Instrument

```

Set Random Jitter [ps]	Measured Random Jitter [ps]
0.000	0.125
0.125	0.156
0.250	0.264
0.375	0.383
0.500	0.505
0.750	0.753
1.000	1.003

Figure 30 Example procedure result (for PCI Express)

The results viewer window that is opened during the procedure run closes once the specific procedure is finished. As long as the N5991 software is running, the results window for each procedure can be reopened with a double-click on the respective procedure. However, the individual results of a test procedure will be lost when the N5991 main window is closed, unless you have saved them.

While the results viewer is open, that page of results can be exported as an HTML file or printed using the dropdown menu under 'File' (Figure 31).

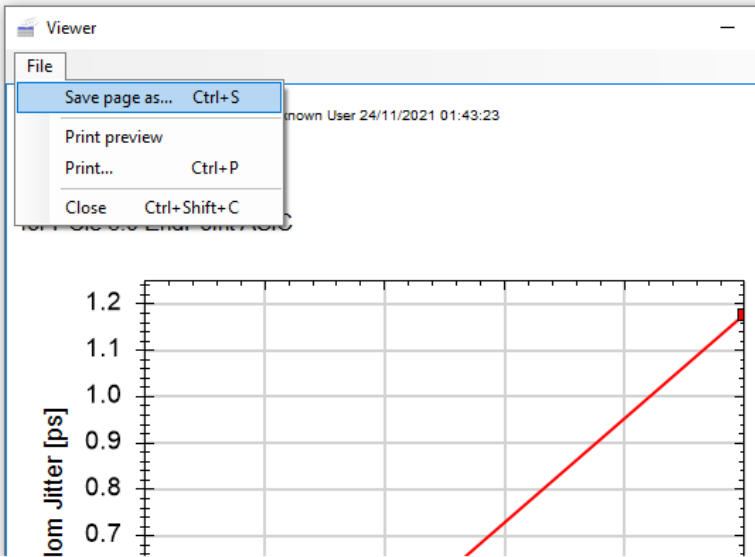


Figure 31 Exporting a single result from the results viewer

If a test or calibration procedure was run more than once, a list of the results with their timestamps is visible in the main ValiFrame window below the particular procedure after expanding the procedure tree below this procedure (see Figure 32). Right-click on a particular result and select 'Show Results...' to open it in the Results Viewer.

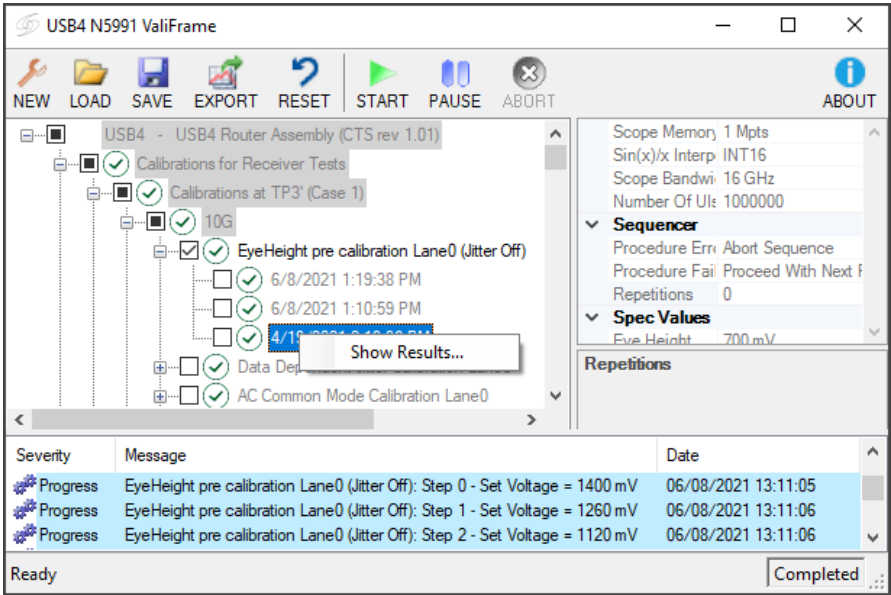


Figure 32 Selecting test results

Exporting Results

All calibration and test data results from one N5991 run can be saved together by clicking the **EXPORT** button at the top at any time. It is recommended that this step is carried out at least at the end of each N5991 run.

Clicking the **EXPORT** button opens the Export Procedure Results window (Figure 33).

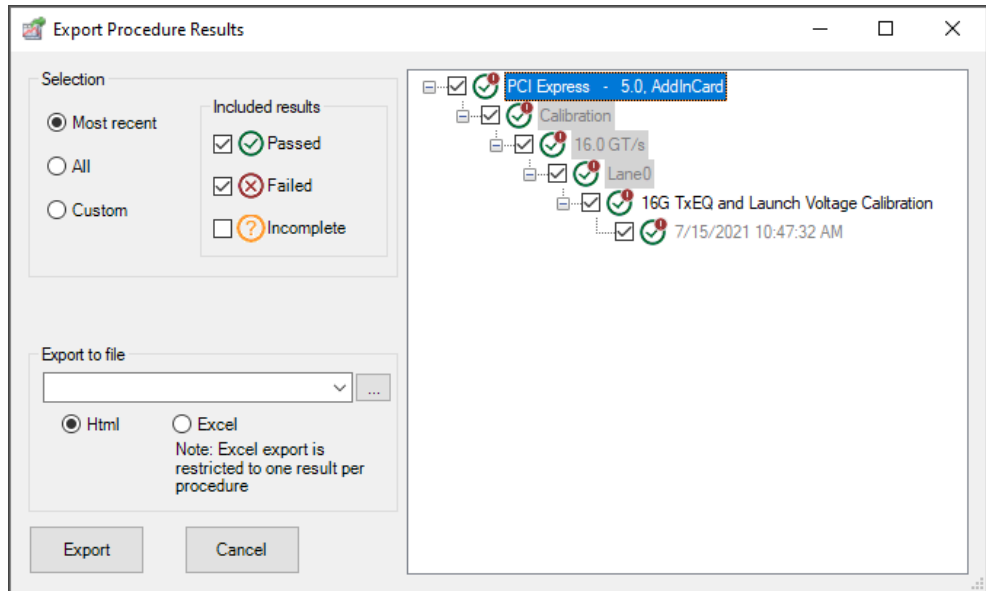


Figure 33 Export Procedure Results window (example for PCI Express)

Here the results to be exported can be selected. These can be:

- Most recent
- All
- Custom (the results of particular runs can be selected)

For the first two of these options, it is then possible to specify which type or types of results should be included:

- Passed
- Failed
- Incomplete

The file to which the results should be exported needs to be specified and whether the export should be in HTML or Excel format.

NOTE

An Excel report is restricted to one result per procedure.

ValiFrame HTML Workbook

A workbook consists of a summary of the procedures performed, details of the instruments used and the results of the individual procedures carried out. On the left you can select a test to view, whose results are then displayed on the right. Figure 34 shows an example Test Result Summary.

The screenshot displays the ValiFrame HTML Workbook interface. On the left, there is a sidebar with the Keysight Technologies and BitifEye Digital Test Solutions logos. Below the logos, there are radio buttons for 'Show all results' and 'Show only selected', and a 'Print' button. The main content area shows a 'Test result summary' for a PCIe device. It includes a table with columns: Test name, Result, Software Version, Calibration Data Version, Compliant, and Non-compliance reason(s). The table lists several tests, including '10_Cal_16GTps_PS', '10_Cal_16GTps_DE', '10_Cal_16GTps_Vdiff', '10_Cal_16GTps_RJ', '10_Cal_16GTps_HFSJ', and '10_Cal_16GTps_HF2ndSJ'. The results for these tests are 'Passed'. The 'Compliant' column shows 'False' for all tests. The 'Non-compliance reason(s)' column provides details for each test, such as 'Software status unreleased' or 'Required cal not compliant: 16G TMSQ and Launch Voltage Calibration'.

Product Number: PCIe Station PCIe-1 Workbook created on 20/10/2023 16:49:05

Test result summary
[Not Compliant]

Shows the test results as an overview

Product Number: PCIe
Serial Number:
Description: PCIe-1
User Name:
User's Comment:
Software Version: PCI Express N5991 ValiFrame 5.0.0.9

Test name	Result	Software Version	Calibration Data Version	Compliant	Non-compliance reason(s)
10_Cal_16GTps_PS	Passed	5.0.0.9		False	Software status unreleased
10_Cal_16GTps_DE	Passed	5.0.0.9		False	Software status unreleased
10_Cal_16GTps_Vdiff	Passed	5.0.0.9		False	Software status unreleased
10_Cal_16GTps_RJ	Passed	5.0.0.9	5.0.0.9	False	Software status unreleased; Required cal not compliant: 16G TMSQ and Launch Voltage Calibration; Required cal unknown/unreleased: 16G TMSQ and Launch Voltage Calibration
10_Cal_16GTps_HFSJ	Passed	5.0.0.9	5.0.0.9	False	Software status unreleased; Required cal not compliant: 16G TMSQ and Launch Voltage Calibration; Required cal unknown/unreleased: 16G TMSQ and Launch Voltage Calibration
10_Cal_16GTps_HF2ndSJ	Passed	5.0.0.9	5.0.0.9	False	Software status unreleased; Required cal not compliant: 16G TMSQ and Launch Voltage Calibration; Required cal unknown/unreleased: 16G TMSQ and Launch Voltage Calibration

Figure 34 Example test result summary in a ValiFrame HTML Workbook

- **Test Name:** The name of the procedure (test or calibration).
- **Result:** Whether the test was passed or failed.
- **Software Version:** The version of the ValiFrame software used to perform the procedure.
- **Calibration Data Version:** Tests, and some calibrations, rely on data obtained in calibrations. The Calibration Data Version gives the version number of the ValiFrame software used to obtain the calibration data.
- **Compliant:** If True, the procedure was carried out in a way that met all the requirements of the specification. If False, this was not the case.

- **Non-Compliance Reason(s):** Here the reasons for non-compliance are listed. There may be just one, a few or a large number. In the example in [Figure 34](#), the procedures are never compliant because the software status is “unreleased”. Other possible reasons include
 - Procedure offline: The procedure was performed in “demonstration mode” without instruments connected.
 - Required cal not compliant: The procedure relies on calibrations, and the calibrations listed here are themselves not compliant and have to be repeated.
 - Required cal unknown/unreleased: The procedure relies on calibrations, and the software version used to obtain the calibration(s) listed here is either unknown or unreleased.

Icon Representation

Once the selected procedures have been run, the icons that appear for individual procedures in the procedure tree indicate the result (Pass / Fail / Incomplete) and provide further information.

For an explanation of the icon beside a particular procedure, right-click the name of the procedure and select “Show State Details...”. A small window displaying the meaning of the icon will open (see Figure 35). The meanings of all result or state icons are given in Table 3.

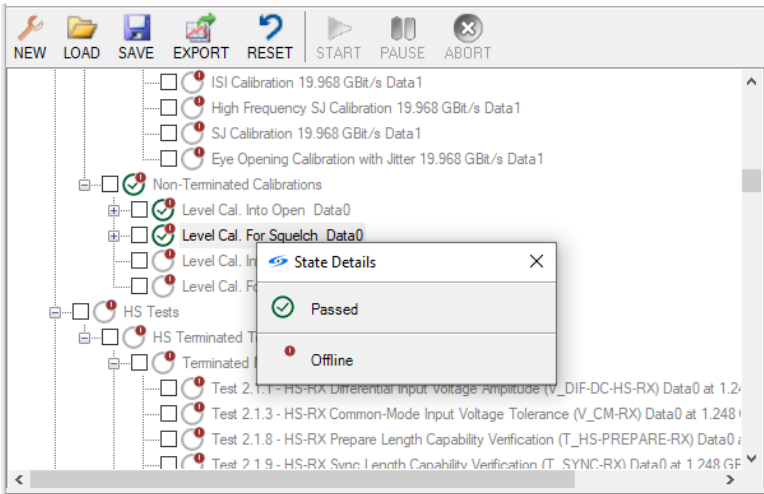





















Figure 35 Icon representation

Table 3 List of all state icons

Icon	Description
	NotRun. The procedure has not been run yet.
	NotRun – Iterative. The procedure is going to be run more than once.

Icon	Description
	Running. The procedure is running. Note: This icon is animated.
	Running – Iterative. The procedure is running with several repetitions. Note: This icon is animated.
	Pass. The procedure passed successfully.
	Pass – Imported. The procedure (result “pass”) has been imported.
	Pass – Iterative. The procedure was run for several repetitions and passed successfully.
	Fail. The procedure failed.
	Fail – Imported. The procedure (result “fail”) has been imported.
	Fail – Iterative. The procedure was run for several repetitions and failed.
	Incomplete. The procedure was aborted/interrupted.
	Incomplete – Imported. The imported procedure was aborted/interrupted.

Icon	Description
	Incomplete – Iterative. The procedure was run for several repetitions and they were incomplete.
Additional States	
	<p>CalMissing. This icon appears on the lower right portion of the main icon. For example:</p> 
It is specific to calibration procedures. It indicates that the calibration data is missing, and therefore is not available to be used in the Rx tests.	
	<p>Offline. This icon appears on the upper right portion of the main icon. For example:</p> 
It indicates that the procedure was run (or will be run) in offline mode.	
	<p>Both states can occur at the same time. For example:</p> 
It indicates that the calibration was run offline and that the offline calibration data is not available.	

N5991 Data Structure

All the N5991 internal data is saved on the PC's local disk in the application data folder ProgramData\BitifEye\ValiFrameK1\“Application”, where “Application” is PCIe, USB4, SATA, etc., as required.

NOTE

Windows hides the system folders by default. To make the application data folder visible, check ‘Hidden items’ in the Windows file explorer > View > Show/hide.

The ValiFrame application data folder contains the following folders:

- Calibrations
- CalibrationsOffline
- Data
- Pattern
- Settings
- SParameter

Calibrations

The calibration data is stored in the Calibrations or CalibrationsOffline folder, depending on whether the calibration was run in online or offline mode. For each calibration procedure run, at least one calibration file is saved. Offline calibrations are for demonstration purposes only. They do not give valid data.

Pattern

The Pattern folder contains the test pattern/sequence files. These are text files that contain the patterns in hexadecimal format. Patterns can also be defined with macros.

Settings

The Settings folder contains various settings files. These files include, for example, the instrument connection setup. Details depend on the specific application.

SParameter

The SParameter folder contains the S-parameter files which are required for some applications.

6 Additional Tools

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[IBerReader Interface](#) / 69

Additional tools are available to increase the usefulness of the N5991 Test Automation Software Platform.

ValiFrame API

The ValiFrame Application Programming Interface allows ValiFrame functionality to be accessed from external programming environments, for example Python scripts. Accessible functionality includes test setup information, calibration and test procedures, and results. The ValiFrame API can thus be used to control ValiFrame by external software. In typical use, a top-level external test sequencer makes use of ValiFrame functionality, for example to run a series of tests at different temperatures.

The ValiFrame API Documentation can be accessed via the “View API Doc” button in the “About” window of ValiFrame (Figure 36), which opens when you click the “About” button at the right-hand end of the ValiFrame menu bar.

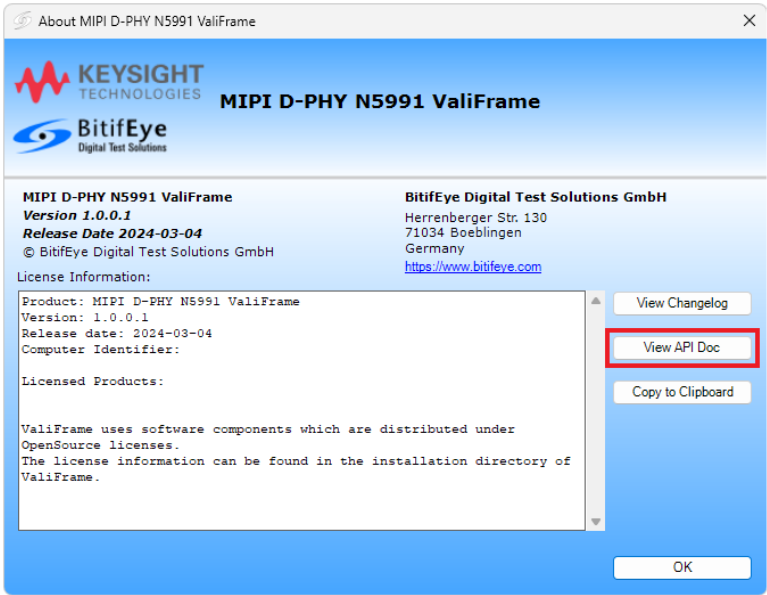


Figure 36 Example ValiFrame “About” window showing the “View API Doc” button

For more details about the ValiFrame API, download the [Application Programming Interface for the Keysight N5991 Test Automation Software Platform User Guide](#) (“N5991 API User Guide” for short) from www.bitifeye.com. Click **Digital Test Solutions** then one of the standards.

IBerReader Interface

For some DUTs, proprietary tools exist to control the device (e.g., set it to loopback mode) as well as for reading internal checksum error counters, burst counters, or other indicators. These indicators make it possible to determine whether the receiver was able to receive the data properly. The integration of such proprietary tools into the Test Automation Software can be achieved with the IBERReader software interface.

The C# .NET software interface acts as a wrapper for the proprietary tools. It contains methods that will be called by ValiFrame during test execution to configure the DUT and request the pass/fail information from the DUT. A DLL will be loaded at run time and a class will be instantiated that supports the IBERReader interface.

The IBERReader interface is part of the N5991 ValiFrame installers, so no additional software needs to be installed. However, an additional license is required for each standard (e.g., PCI Express, MIPI C-PHY®, USB) you want to use it for. The licenses are available as “Integrated BER Counter Interface Add-on” options. To get a license, use the BitifEye License Manager (BLM) portal: <https://licensing.bitifeye.com/>. See also [Registering the Software](#) on page 22 of this guide.

7 Troubleshooting and Support

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What to do if you run into a problem with the N5991 Test Automation Software.

Troubleshooting

In the case of problems, check the log list at the bottom of the main window. Note that all log information will be lost when the N5991 application is terminated unless you save the log file. The log file can be accessed by right-clicking within the log list section and selecting 'Show Log File' from the drop-down menu (see red box in Figure 37).

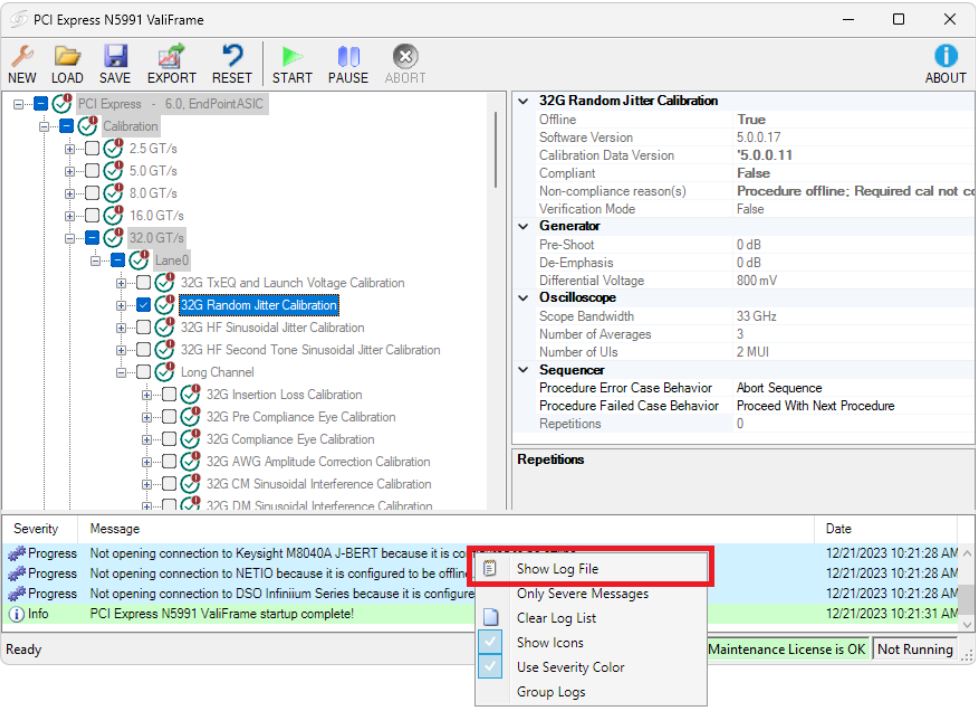


Figure 37 Accessing the log file

Support

If a problem with an application persists, send the log file (see previous page) with the problem to Keysight support.

The Keysight support team is also happy to help you should you require further information about a particular application.

For support options, visit www.keysight.com/find/contactus.

8 Appendix: Acronyms and Abbreviations

List of Acronyms / 76

This chapter contains a list of acronyms and abbreviations used in the Keysight N5991 Test Automation Software Platform Getting Started Guide.

List of Acronyms

Acronym	Definition
API	Application Programming Interface
AWG	Arbitrary Waveform Generator
BERT	Bit Error Ratio Tester
CTS	Compliance Test Specification
DLL	Dynamic Link Library
DUT	Device Under Test
GUI	Graphical User Interface
HDMI	High-Definition Multimedia Interface
JSON	JavaScript Object Notation
MIPI	Mobile Industry Processor Interface
PC	Personal Computer
PCIe	Peripheral Component Interconnect Express
UI	User Interface
USB	Universal Serial Bus
vfc	ValiFrame Configuration
vfp	ValiFrame Project
VISA	Virtual Instrument System Architecture

