N5991 Test Automation Software Platform - Getting Started Guide

KEYSIGHT

GETTING STARTED GUIDE

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Manual Part Number

N5991-91011

Edition

Edition 5.0, October 2024

Published by:

Keysight Technologies Deutschland GmbH
Herrenberger Str. 130
71034 Böblingen, Germany
Phone +49 7031 464-1
Fax +49 7031 464-2020

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1 Introduction

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 ValiFrame software, run the procedures with the desired hardware configurations, and obtain results. It concentrates on things that are common to N5991 ValiFrame software for nearly all the standards.

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. 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 Appendix A: Acronyms and Abbreviations.

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.

Fifth Edition (October 2024)

The fifth edition of this user guide describes the functionality of the N5991 Test Automation Software Platform based on Framework versions up to August 2024.

2 Software Prerequisites

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:

- Windows 10 or Windows 11 Operating System
- Microsoft .NET Framework
- 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 at https://www.bitifeye.com.

During the installation process of the Test Automation Software, the installer setup program will check for the required software (see Figure 3-7). If any is missing, a link to the specific download page will be available.

3 Installing the Software

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

The N5991 installers can be found on the BitifEye Download Hub (Figure 3-1).

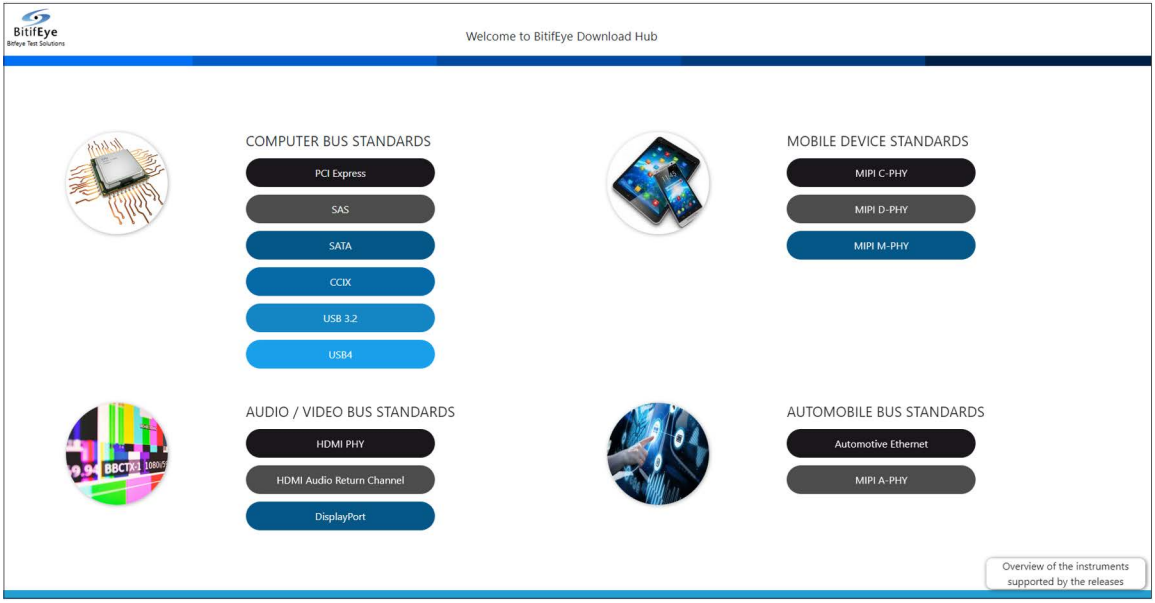

Figure 3-1 Start page of the BitifEye Download Hub

This can be reached either directly at https://downloads.bitifeye.com or from the BitifEye homepage (Figure 3-2).

Figure 3-2 BitifEye homepage banner with button to access the Download Hub

The first time you access the Download Hub you will be asked to register. Once you have an account, click on the standard you are interested in to see the software that is available to download. Figure 3-3 shows an example for PCI Express.

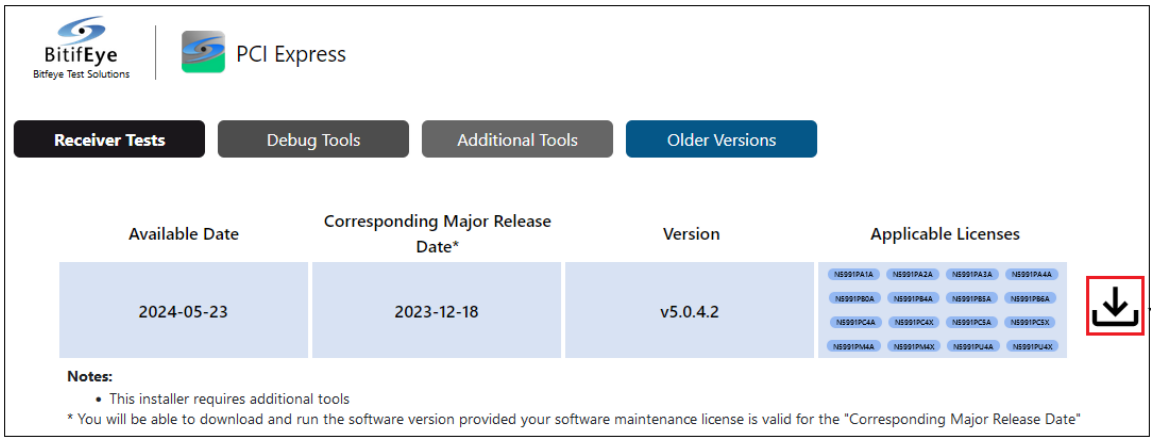

Figure 3-3 Example download page (for PCI Express Receiver Tests)

Various types of software can be downloaded:

- Receiver Tests: The N5991 ValiFrame receiver test automation software.
- Debug Tools: For some standards, debugging tools are available, for example, the Link Training Suite for PCI Express and the Frame Generator for MIPI® standards.
- 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.
- Older Versions: In some cases, it may be necessary to install an older version of software. Older versions of installers can be found here.

Click the download icon (red frame in Figure 3-3) to download the installer or the corresponding changelog.

Downloading 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 > Digital Test Solutions > “Standard”. The page for the standard PCI Express is shown in Figure 3-4.

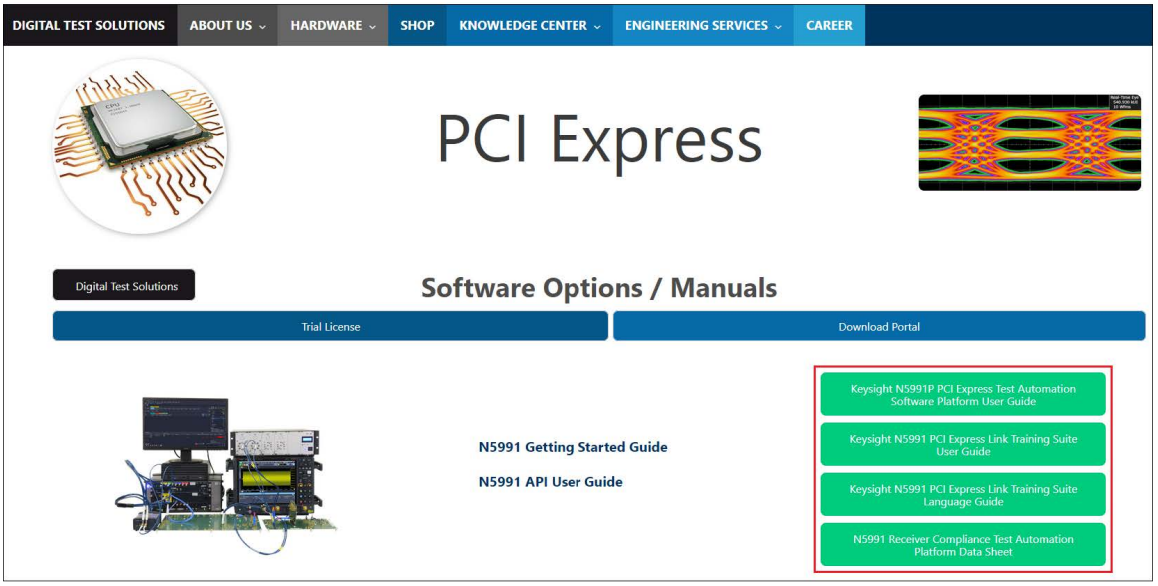

Figure 3-4 Part of the PCI Express page of the BitifEye web portal

The colored buttons on the right (outlined in red in Figure 3-4) 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, the following figures (Figure 3-5 to Figure 3-8) show the installation of the PCI Express N5991 ValiFrame software.

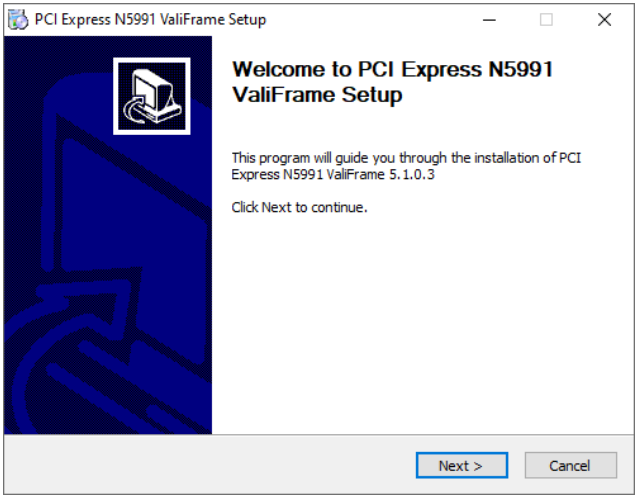

Figure 3-5 Installer 'Welcome to Setup' window

The second page of the installer wizard will show the software license agreement (see Figure 3-6). Read it carefully and select **I accept the terms of the License Agreement** option. Then, click **Next** to continue.

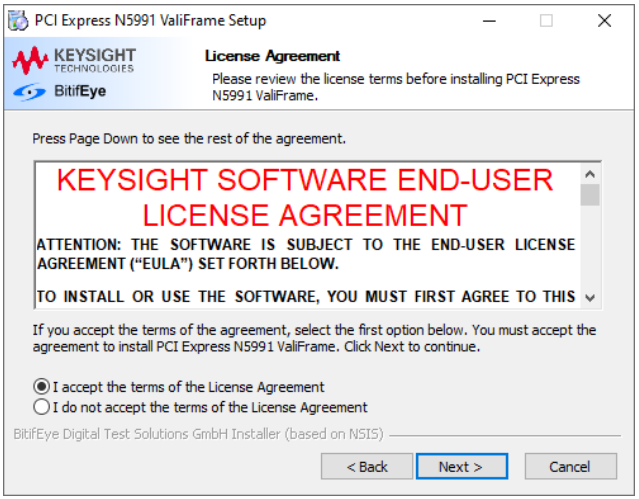

Figure 3-6 Installer 'License Agreement' window

A list of additional software required by the N5991 software and also the status of individual software is then shown (Figure 3-7). If any required software is not yet installed, the N5991 Required Software window shows that the missing software needs to be installed.

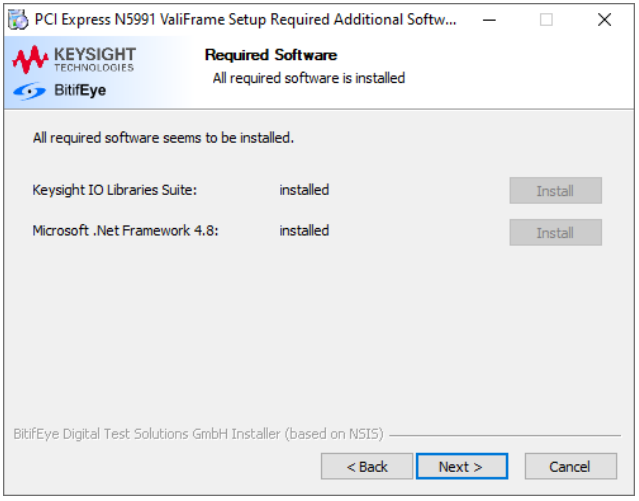

Figure 3-7 Installer 'Required Software' window

When all the required software has been installed, click **Next** to go to the next step.

The **Choose Install Location** window is displayed as shown in Figure 3-8. 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.

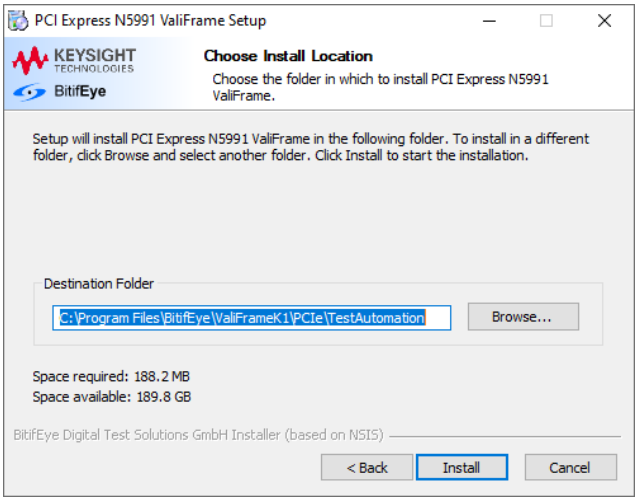

Figure 3-8 Installer 'Choose Location' window

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 3-9). Click 'No' to exit and update the license(s). Alternatively, click 'No' to exit and install a version of the ValiFrame software that is supported by the licenses available on the host computer. See Chapter 4: Licenses.

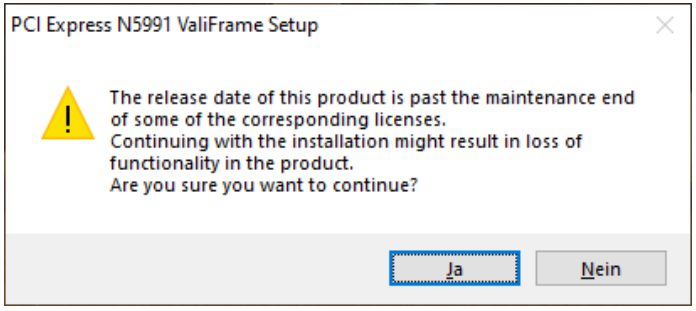

Figure 3-9 'Past end of license maintenance' warning

Once the software has been successfully installed, a shortcut icon will appear on the desktop (Figure 3-10).

Figure 3-10 Desktop ValiFrame icon (example for PCI Express)

NOTE For older versions of ValiFrame, two desktop icons appear, one for the Station Configurator and one for ValiFrame.

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 correct license for the N5991 Software is already activated, it will start automatically. In that case, proceed to Chapter 5: Using the Software.

NOTE If you are using a version of ValiFrame with a separate Configurator icon, you need to open the Configurator first (before clicking on the ValiFrame icon) if you are starting ValiFrame for the first time.

Updating the Software

To keep your software settings when upgrading to a new version of N5991 ValiFrame for a particular standard, see N5991 Data Structure on page 73.

Then download the software (see Downloading the Software on page 16) and install it (see Installing the Software on page 19).

At the beginning of the installation you will be asked if you want to uninstall the currently installed version of ValiFrame from the PC. You must do this in order to install the new version. Click 'Yes' and the Uninstaller will open.

NOTE **Ensure that NO versions of ValiFrame are running before beginning to uninstall it for one standard.**

In the 'Choose Components' window of the Uninstaller (Figure 3-11), 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**.

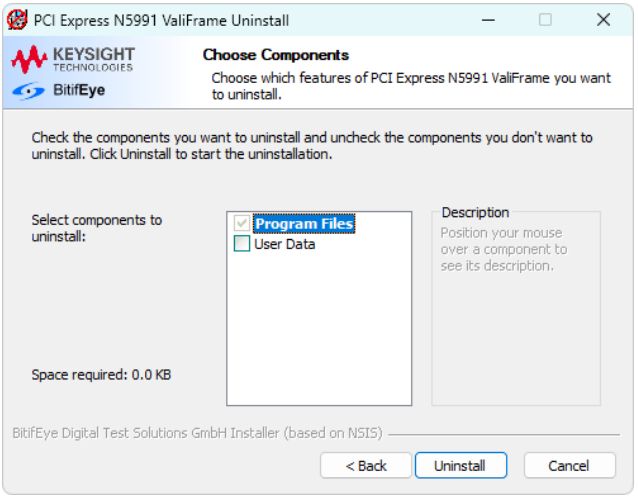

Figure 3-11 Uninstaller 'Choose Components' window

4 Licenses

This chapter explains how to obtain the licenses that you require to run the Test Automation Software.

Licenses for the Software

N5991 software is protected by licenses. If the software is started without a valid license, the following panel (Figure 4-1) will open.

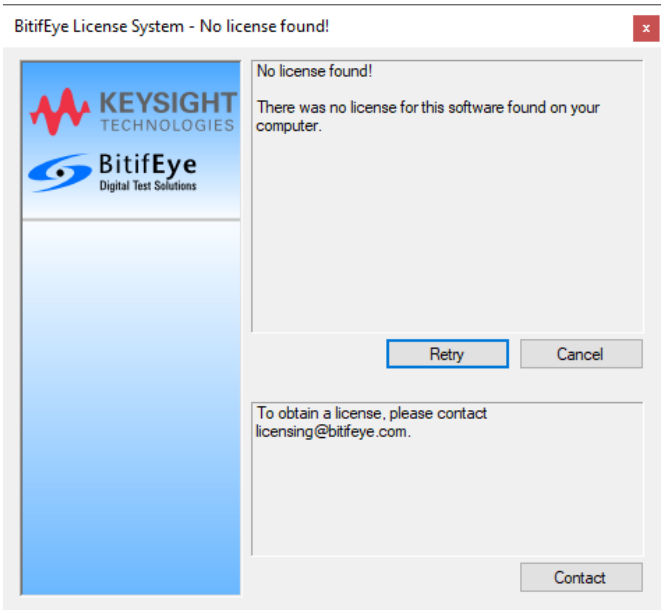

Figure 4-1 'No license found' dialog window

If you do not have a license, contact your Keysight representative.

Once you have the license certificate, you can add the license to your PC and activate it. You can do this on the BitifEye License Manager (BLM) portal: https://licensing.bitifeye.com/. The first time you access the BLM, you will need to create an account.

For detailed instructions on how to use the BLM, refer to the BitifEye License Manager User Guide. There are also tutorial videos on the BitfiEye web portal.

When the N5991 Software is open, license information can be reviewed by clicking **About** in the taskbar (orange frame in Figure 4-2).

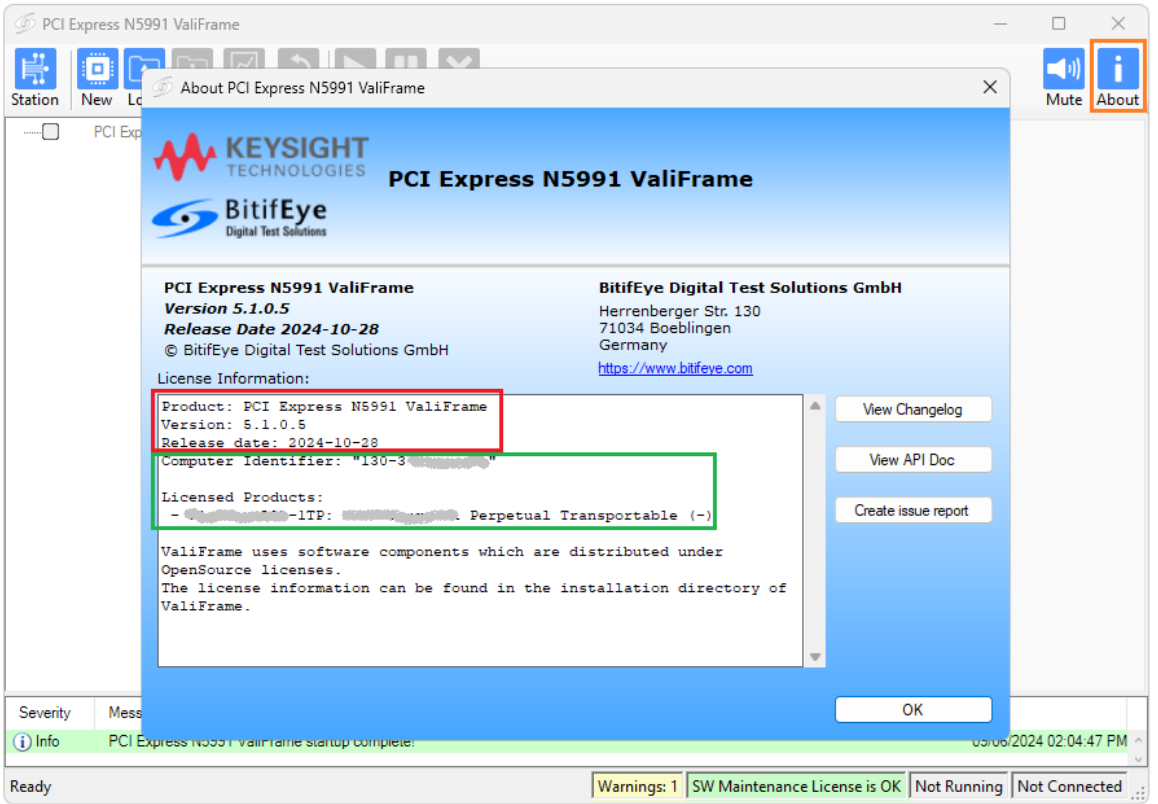

Figure 4-2 How to view N5991 license and software information

Information about the software is listed, such as the product name, the version number and the release date of the corresponding major version (red frame in Figure 4-2). The computer identifier and details of the licensed products are also listed (green frame). This information is useful if you ever have to seek help from BitifEye licensing support.

Software Maintenance

Software maintenance ensures that new releases of the software can be installed as long as the maintenance is valid. Ninety days before the software maintenance expires, a warning will be shown in the ValiFrame main window. See the yellow areas in Figure 4-3.

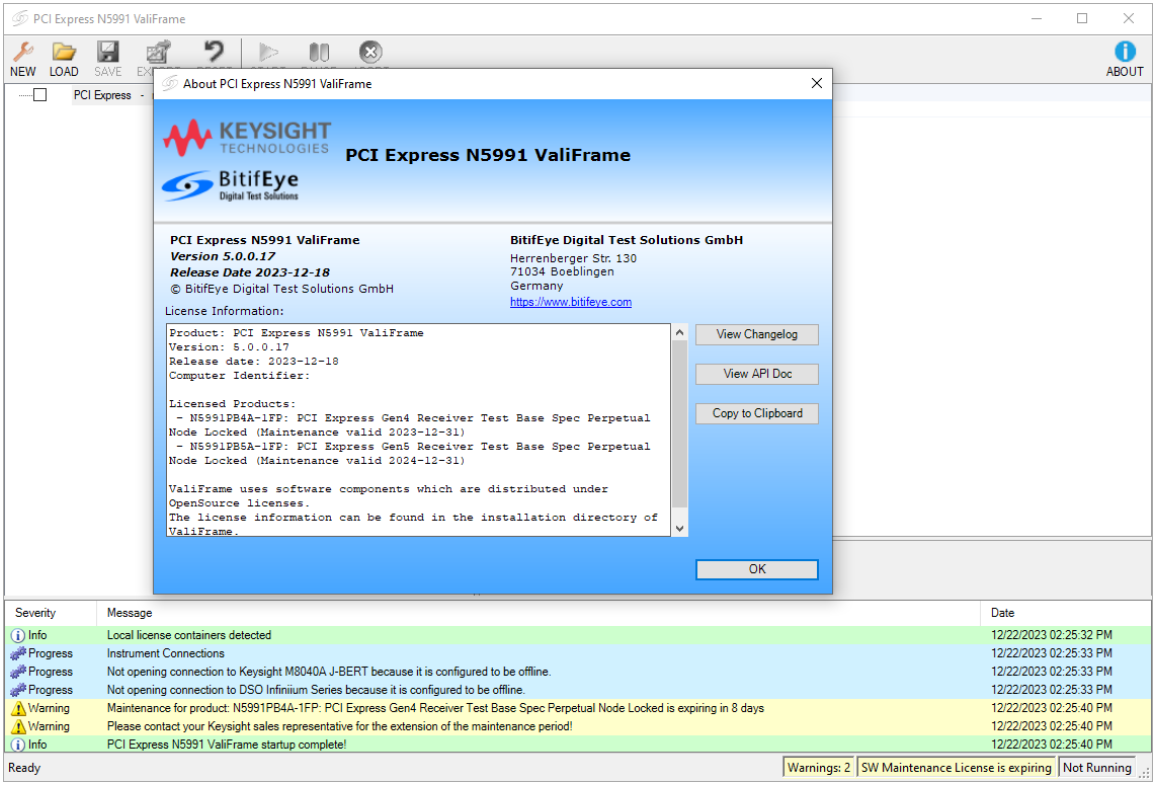

Figure 4-3 Warning that the software maintenance will expire shortly

Once the software maintenance has expired, a warning will be shown in red in the ValiFrame main window (Figure 4-4).

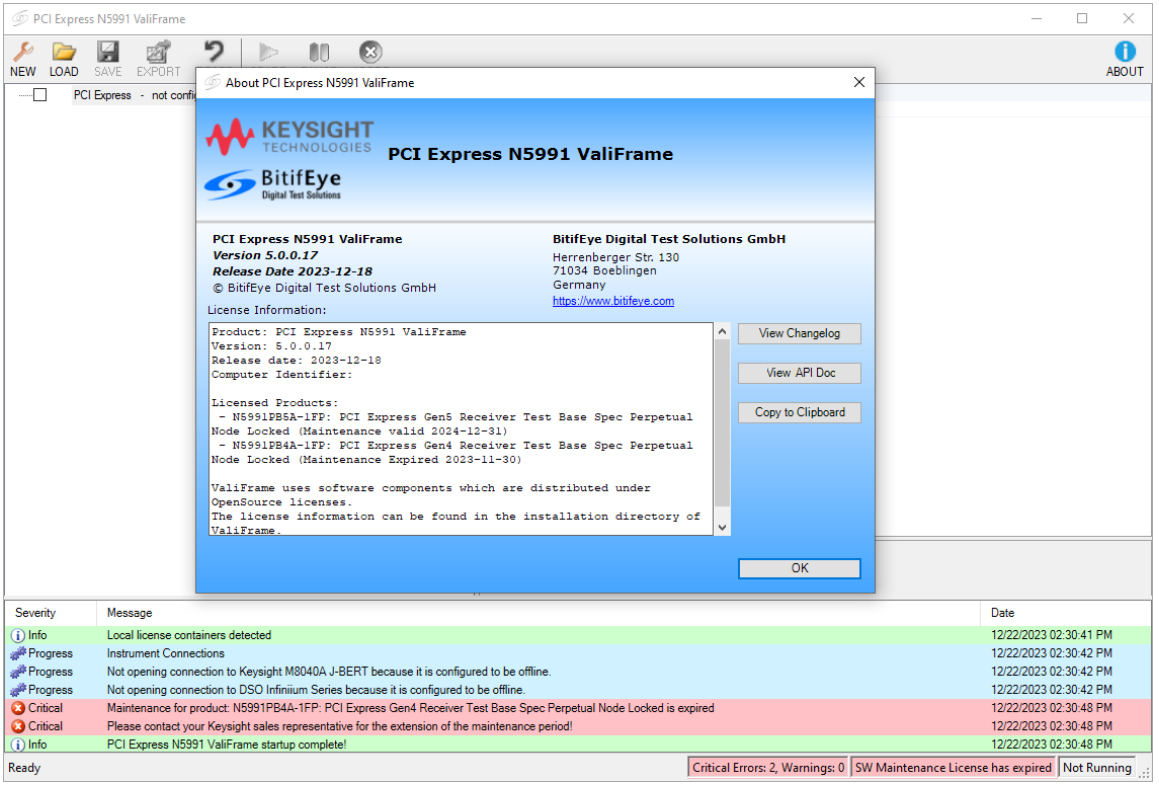

Figure 4-4 Warning that the software maintenance has expired

Contact your Keysight representative to extend the software maintenance.

NOTE When the software maintenance expires, you can continue to use the software versions that you have been using. It simply means that you cannot download and use newer versions where the corresponding major release date is outside of the software maintenance period. For that, you need to extend the software maintenance.

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5 Using the Software

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.

- **Configure the station** (see Configuring the Test Station on page 33)
  - Station selection (only for a separate Station Configurator, “two icons”)
  - Station configuration
  - Instrument configuration
- **Configure the DUT** (see Configuring the DUT on page 42)
- **Calibrate the system**
  - Select calibration procedure(s) (see Selecting Procedures on page 49)
  - Modify parameters (see Modifying Parameters on page 49)
  - View connection diagram and connect setup (see Connection Diagrams on page 57)
  - Run calibration procedure(s) (see Running Procedures on page 55)
  - Save/export calibration results (see Exporting Results on page 67)
- **Run test procedures**
  - Select test procedure(s) (see Selecting Procedures on page 49)
  - Modify parameters (see Modifying Parameters on page 49)
  - View connection diagram and connect setup (see Connection Diagrams on page 57)
  - Run test procedure(s) (see Running Procedures on page 55)
  - Save/export test results (see Exporting Results on page 67)

Configuring the Test Station

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.

ValiFrame Versions with Just One Desktop Icon

NOTE If your version of N5991 ValiFrame has two desktop icons, see ValiFrame Versions with Two Desktop Icons on page 36.

If there is only one desktop icon, the Configurator is integrated into the N5991 ValiFrame software. In this case, double-click the ValiFrame icon to launch the software. Alternatively, to launch ValiFrame in Windows 10, click

Start > BitifEye "Application" N5991 > "Application" ValiFrame (N5991)

where "Application" is PCIe, USB4, SATA, etc., as required.

In the main N5991 ValiFrame window that opens, click ‘Station’ (red frame in Figure 5-1) to open the Station Configuration window (Figure 5-2).

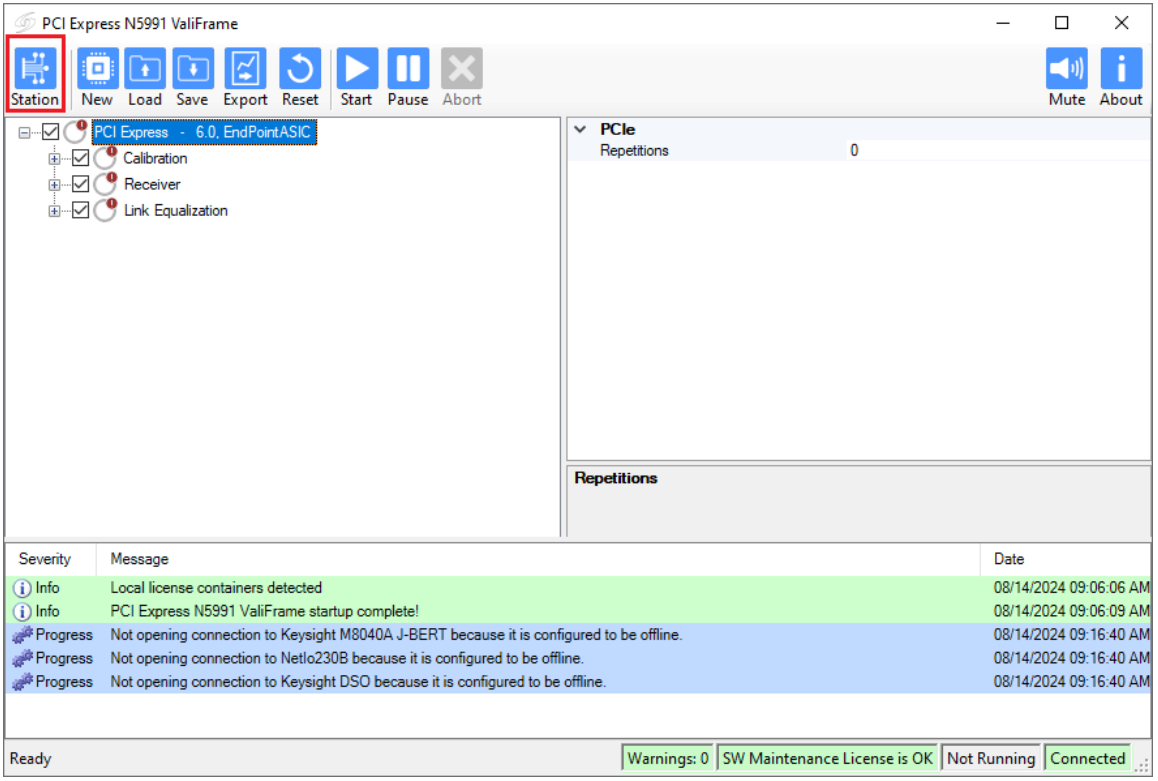


Figure 5-1 Example N5991 ValiFrame main window

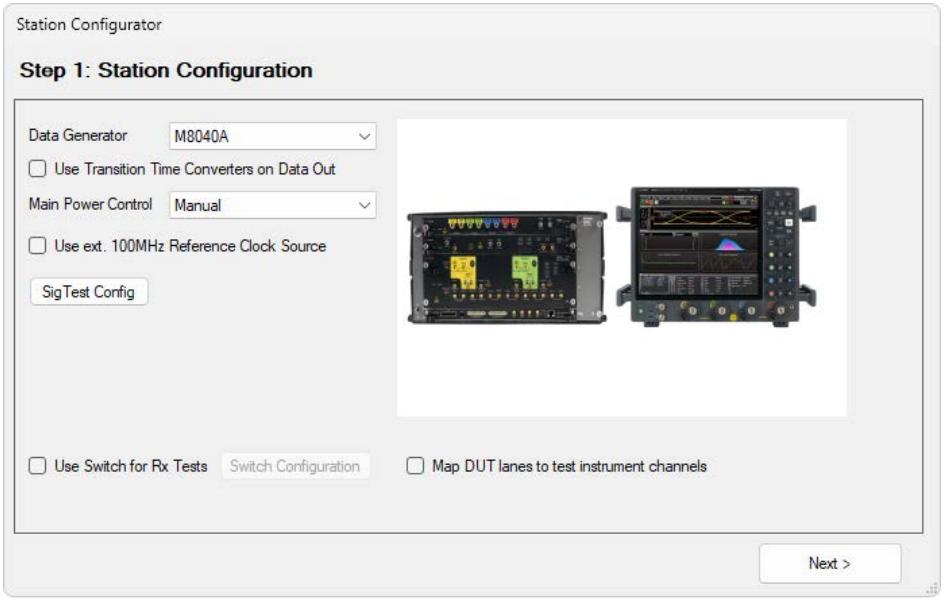


Figure 5-2 Example Station Configuration window

This shows the various options for instruments that can be used for testing, which vary according to the station in use.

Once the instruments have been selected, click 'Next' to see them listed in the Instrument Configuration window. See Instrument Configuration on page 38.

ValiFrame Versions with Two Desktop Icons

If there are two desktop icons, 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 “Standard” N5991 > “Standard” Station Configurator (N5991)

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

When the ValiFrame Station Configurator is launched, the ValiFrame Station Selection window appears as shown in Figure 5-3. The station (standard) is already selected.

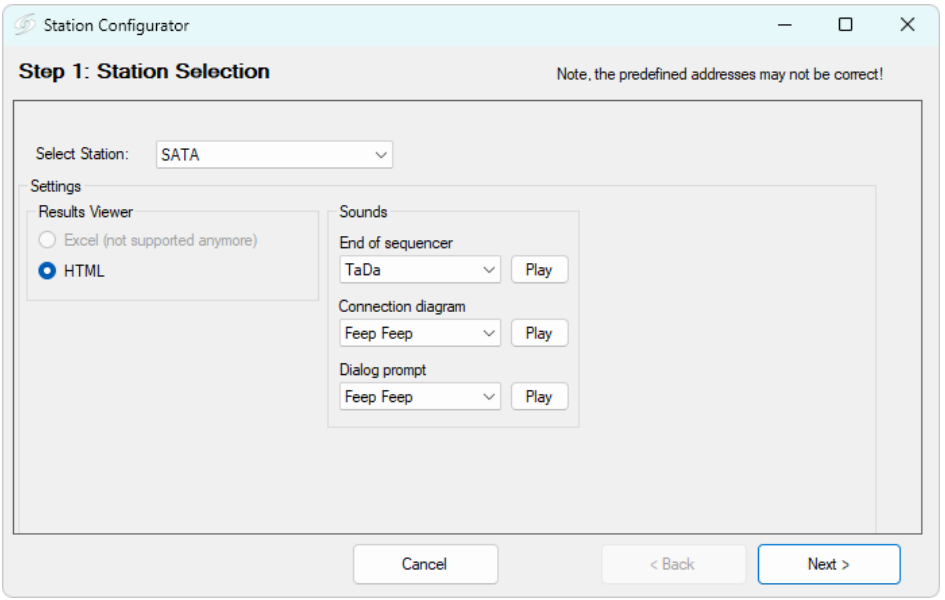


Figure 5-3 Example Station Selection window

Here 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.

NOTE **In some N5991 applications (standards), this first step of the Station Configurator is skipped. Default sounds are used for all three notification types.**

The next window to open is the Station Configuration, which looks and acts similar to that shown in Figure 5-2. It shows the various options for instruments that can be used for testing, which vary according to the station in use.

Once the instruments have been selected, click 'Next' to see them listed in the Instrument Configuration window. See Instrument Configuration on page 38.

Instrument Configuration

Once all required instruments have been selected, these are listed in the Instrument Configuration window (Figure 5-4).

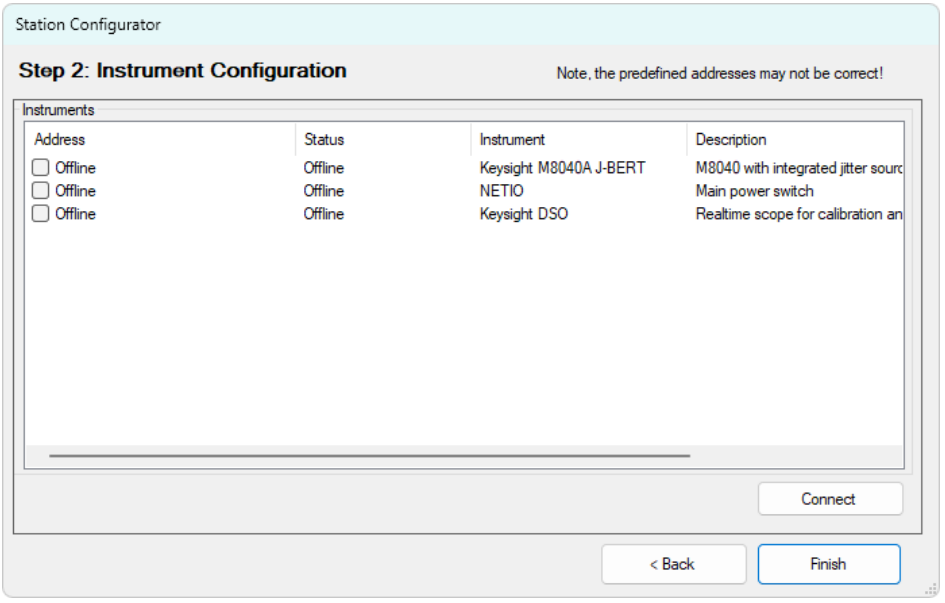


Figure 5-4 Example Instrument Configuration window

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 40). 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 ValiFrame.

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 those 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 pops up with a message describing the problem.

Finally, click **Finish** to save the changes, close the Instrument Configuration window and return to the N5991 ValiFrame main window.

NOTE **If you are using a version of N5991 ValiFrame with two desktop icons, you will need to click the ValiFrame (N5991) desktop icon to open the N5991 ValiFrame main window.**

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 5-5 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**.

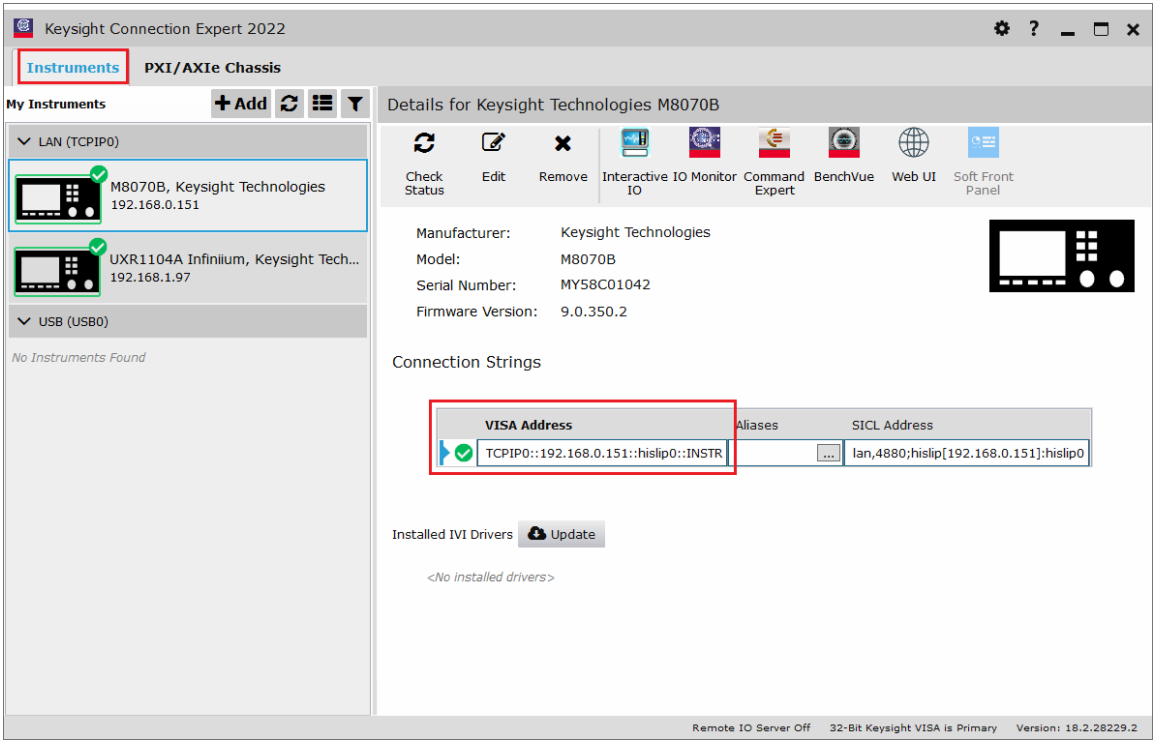


Figure 5-5 Keysight Connection Expert

4. Select one of the instruments you want to connect and verify that its **VISA Address** appears as shown (larger red frame in Figure 5-5) with a tick beside it.
5. Repeat for all required instruments that use VISA addresses.
6. Use these addresses (connection strings) in the Station Configuration as follows:
   a. Copy one of the VISA addresses from the Connection Expert.
   b. Select the same instrument in the Instrument Configuration window (Figure 5-4) and paste the address in the corresponding Address text field.
   c. Repeat this procedure for all the required instruments that use VISA addresses.

Configuring the DUT

After the test station has been configured, N5991 ValiFrame connects automatically to the instruments that are set to “Online” mode in the Instrument Configuration window (Figure 5-4). Once all the connections have been initialized successfully, you will see the N5991 ValiFrame main window.

For versions of N5991 ValiFrame with just one desktop icon, the top of the main window looks similar to that in Figure 5-6, while for versions of N5991 ValiFrame with two desktop icons (Configurator and ValiFrame), the top of the main window looks similar to that in Figure 5-7.

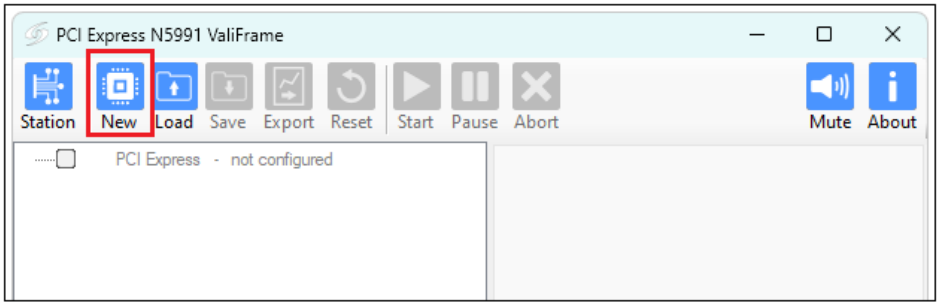


Figure 5-6 Example N5991 ValiFrame main window (top) with integrated station configuration

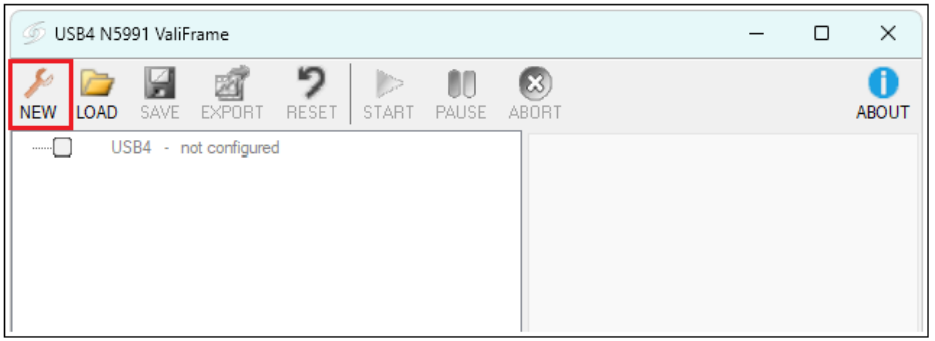


Figure 5-7 Example N5991 ValiFrame main window (top) with separate station configurator

The next step is to configure the test parameters. Click New (red box in Figure 5-6 or Figure 5-7) to open the Configure DUT or Configure Product dialog. The name depends on the standard.

Configure DUT Panel

The parameter selections available in the **Configure DUT** panel depend on the specific application. An example is shown in Figure 5-8. 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.

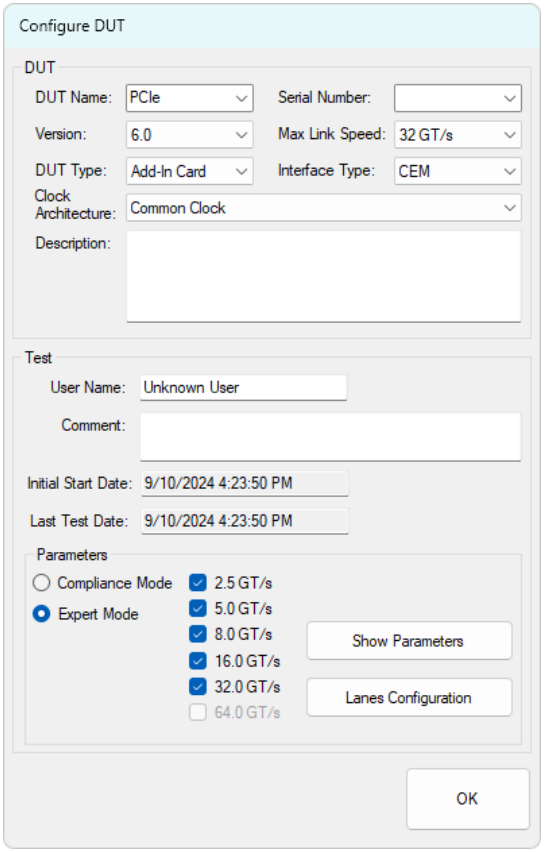


Figure 5-8 Example configure DUT panel

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 **OK** in the **Configure DUT** panel. The N5991 ValiFrame main window is displayed with the procedure tree on the left, as shown in Figure 5-9. It contains the list of calibration and test procedures, the top-level groups typically being

- Calibration
- Receiver

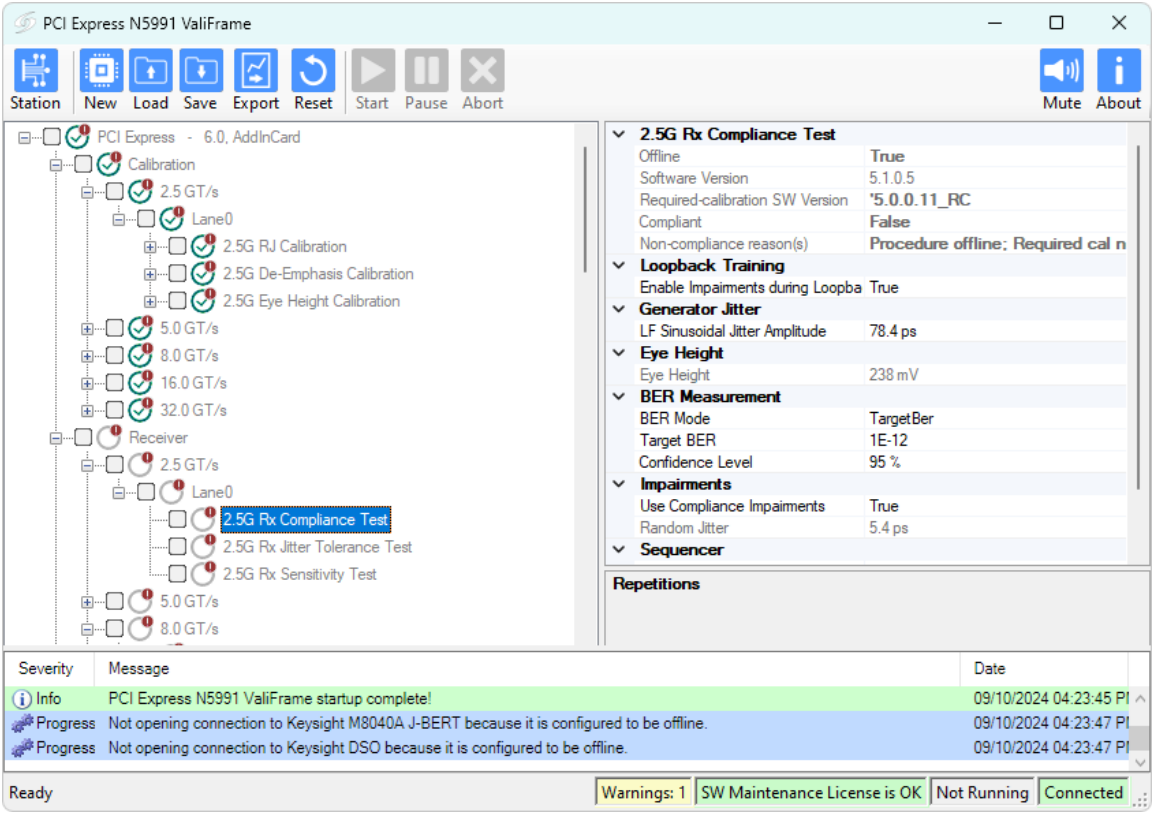


Figure 5-9 Example main window for N5991 ValiFrame

Menu Buttons

The menu buttons control the main actions.

- **Station**: This exists only for versions of N5991 ValiFrame with just one desktop icon. It replaces the separate Configurator. See Configuring the Test Station on page 33.
- **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 ValiFrame 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" (configuration) file using the Save button. Similarly, once some procedures have been run, Save can be used to save a ".vfp" (project) file. See Running Procedures on page 55 for more details.
- **Export**: Use the Export button to save calibration and test data results. See Exporting Results on page 67.
- **Reset**: The Reset button sets all properties/parameters to their default values.
- **Start**: When the Start button is enabled (blue), clicking it starts the next marked procedure. In older versions of N5991 ValiFrame, the button is green when enabled.
- **Pause**: Click Pause to stop the current procedure.See Running Procedures on page 55 for more details.
- **Abort**: Click Abort to abandon the current procedure.
- **Mute**: Click to mute the sounds that N5991 ValiFrame makes when a particular status of the program is reached.

– **About**: Clicking on ‘About’ opens a window that provides information about the N5991 ValiFrame software version in use and the corresponding license. If you have a problem with your N5991 ValiFrame license but can still access the About window, send a screenshot of this to licensing@bitifeye.com.

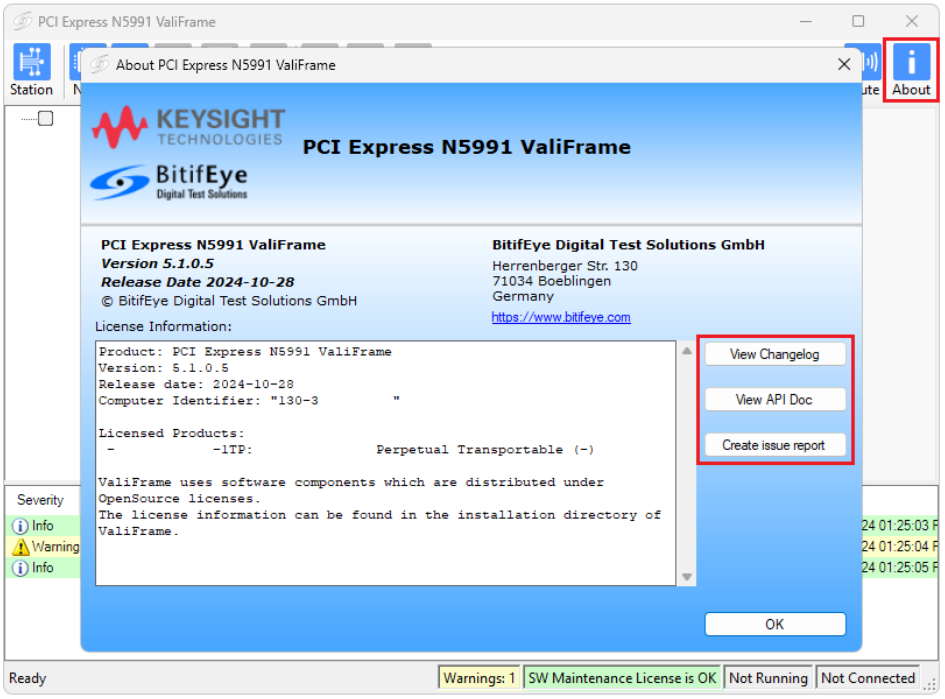


Figure 5-10 Example ‘About’ window

On this page (Figure 5-10) you can also

– View the corresponding changelog

– View the ValiFrameAPI documentation

– Create an issue report zip file to send to your support contact

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 5-11).

- 'Show Log File' is required for troubleshooting (see Troubleshooting on page 80).
- 'Export Log to JSON...' is useful if you want to analyze or filter the log with another program.
- Enabling 'Only Severe Messages' removes many routine messages, leaving just those that are important if something goes wrong.
- 'Clear Log List' deletes the current log list.
- If 'Show Icons' is ticked, icons appear at the left of the log list that depend on the function of each message (examples in the red frame in Figure 5-11).
- Enable 'Use Severity Color' to add a colored background for each type of message. For example, error messages are shown on a red background if it is checked.
- Check 'Group Logs' to add headings to the log list that describe the stage that has been reached, for example, 'ValiFrame Startup'.

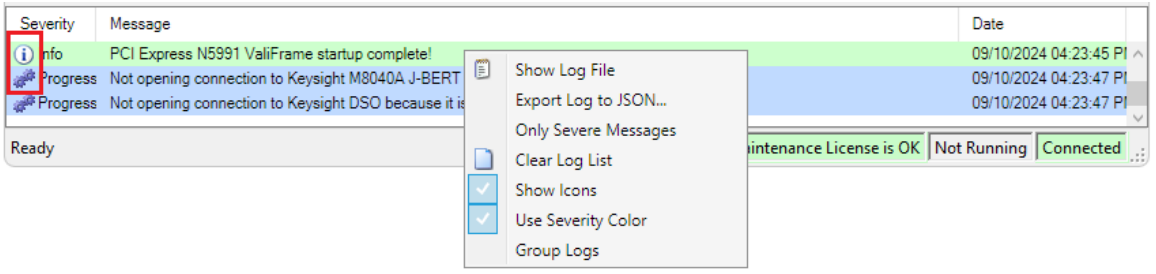


Figure 5-11 Customizing the log list

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 maintenance 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 (no significant temperature changes), 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

Groups of calibration or test procedures 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 blue (green in older versions of N5991 ValiFrame). 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, click a specific calibration or test procedure or one of the groups contained in the N5991 ValiFrame procedure tree. The corresponding parameters are displayed in a property list (parameter grid) on the right-hand side of the screen (see Figure 5-12).

In the parameter grid, 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.

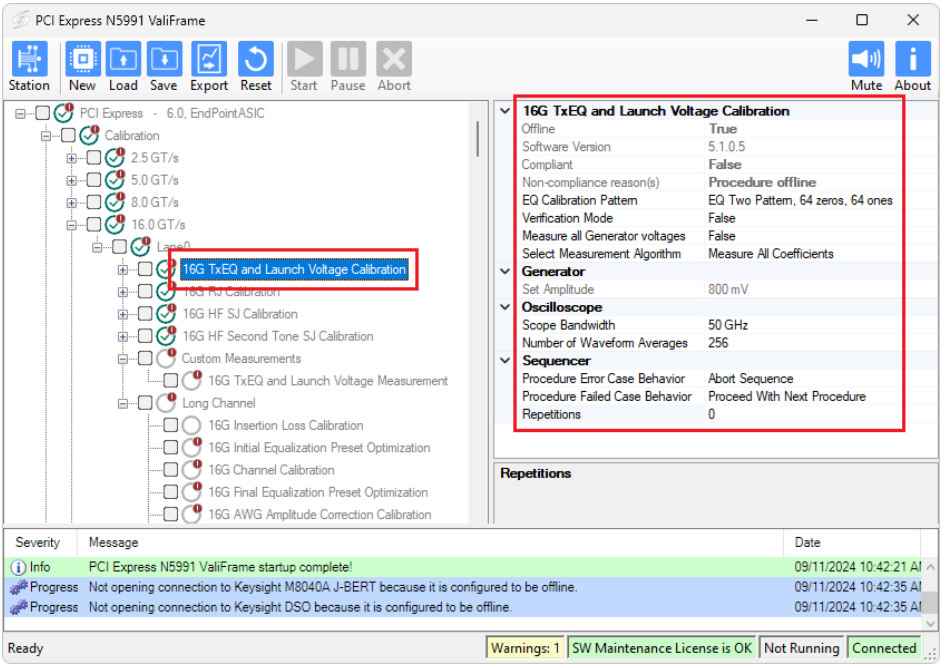


Figure 5-12 Modifying parameters

There are different types of parameters:

- sequencer parameters
- common parameters
- procedure parameters

These are explained in more detail below.

Sequencer Parameters

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 available only for procedures.

Like all other parameters, the sequencer parameters are shown on the right side of the ValiFrame user interface (Figure 5-12) and they can be changed by the user.

The sequencer parameters are listed and described in Table 5-1.

Table 5-1 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 the parameters that do not fall into one of the previous two 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.

Procedure Parameters for All Individual Parameters

The values of several parameters are displayed, read-only, in the parameter grid for (nearly) all individual procedures. They are defined in Table 5-2. Keep an eye on these parameters to ensure that you produce valid data.

Table 5-2 Parameters for (Nearly) All Individual Procedures

Parameter	Description
Offline	– 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.
Required-calibration SW 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	Read-only in the parameter grid. It indicates whether the procedure you are running is compliant with the corresponding standard specification. – 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. The mode can be selected in the Configure DUT panel. False is also shown if you are working offline or if any of the prerequisite calibrations were not performed in compliant conditions. If the value is False, an additional property (Non-compliance reason(s)) is shown to indicate why the data is not compliant.
Non-compliance reason(s)	Possible reasons for non-compliance include: the required calibrations were run offline, with unreleased software, with old firmware.

Procedure Context Menu

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 (Table 5-13), which depend on the state of the procedure.

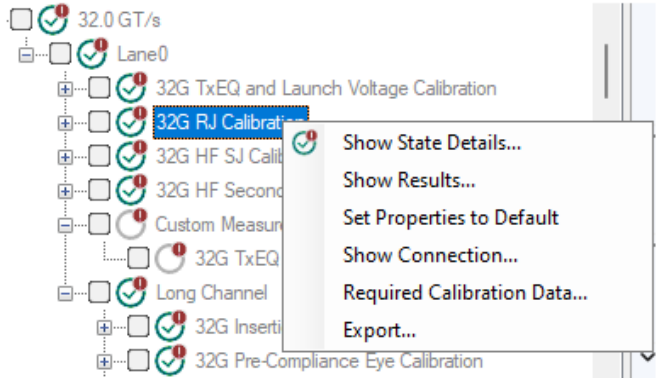


Figure 5-13 Example context menu for procedures

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 5-3 on page 71.

Show Results...

After the procedure has been run, click here to open the results viewer. For more details see the section Results on page 63.

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 57.

Required Calibration Data...

Click here to open the list of calibrations that must be performed before the current procedure can be run (Table 5-14).

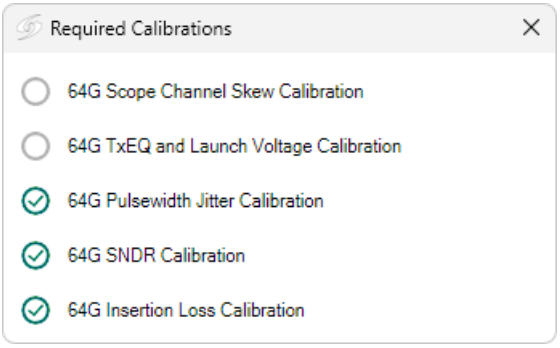


Figure 5-14 Example list of required calibrations

The icon next to the name of a calibration procedure in the list indicates whether the calibration has been run successfully (green), is incomplete (yellow), failed (red) or has not yet been run (gray).

Export...

You can export the results of all or just selected procedures by clicking here. The process is described in Exporting Results on page 67.

Running Procedures

To run the selected procedures, click the **Start** button. The procedures are run in the order shown in the procedure selection tree.

Some 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 when it is required.

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.**

When a test is running, use the **Pause** button to pause the test at the next step of the procedure sequence. When the test is paused, the Start button is relabeled Step (Figure 5-15).

You have two options when a procedure is paused.

- Click **Step** to continue the procedure and pause at the next step.
- Click **Pause** again to toggle the state of the Start/Step button. Then click **Start** to continue running the test until the end of the procedure.

The Step feature is useful for debugging purposes, for example to analyze the signal on the oscilloscope at each step. When a procedure is paused, a message at the bottom of the main window (lower red frame in Figure 5-15) indicates which step has been reached.

To force the sequencer to stop running the tests, click **Abort**. This will stop the procedure in progress and will prevent the remaining tests from running.

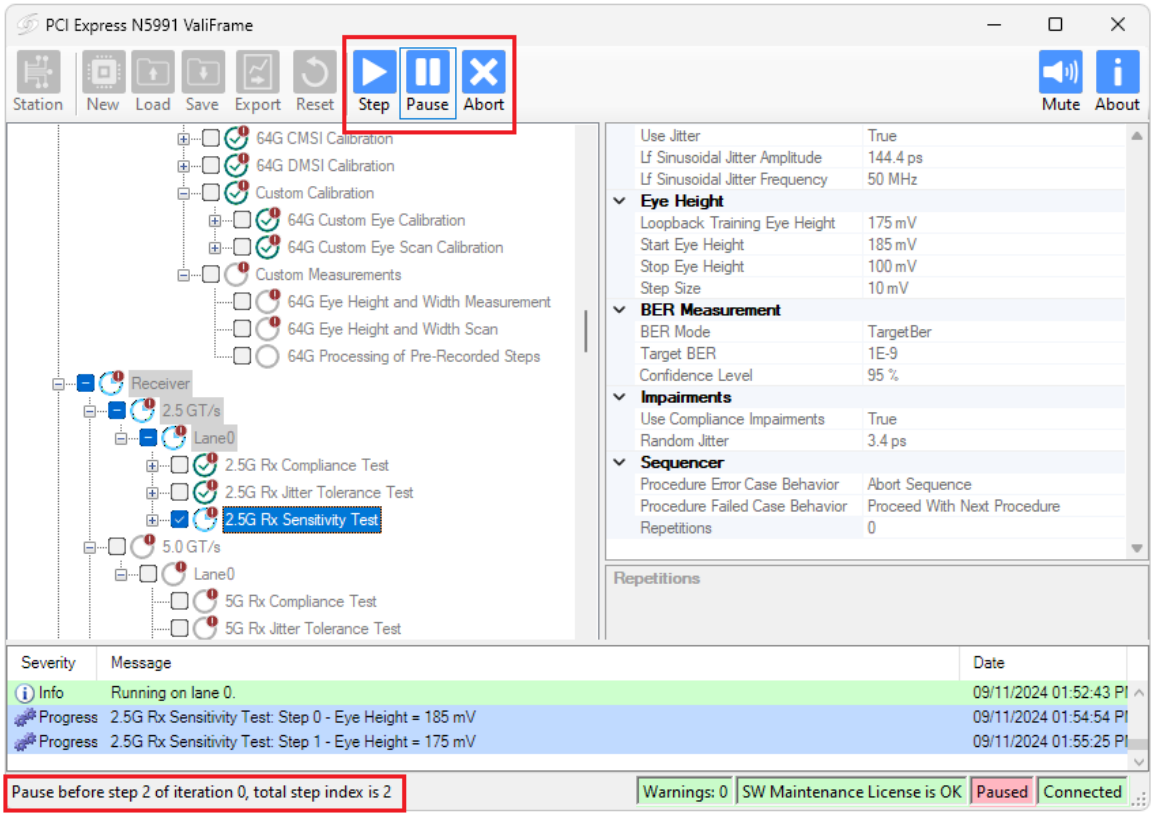


Figure 5-15 Main window when a procedure is paused

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 '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.

Connection Diagrams

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 running, 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 5-16.

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 5-17).
3. **Instruments and Accessories**: Toggle to 'on' to view the list of required instruments and accessories (Figure 5-18).
4. **Export Mode**: Click here to change the layout of the connection diagram before exporting it (Figure 5-19).
5. **OK**: Click here to close the connection diagram window.

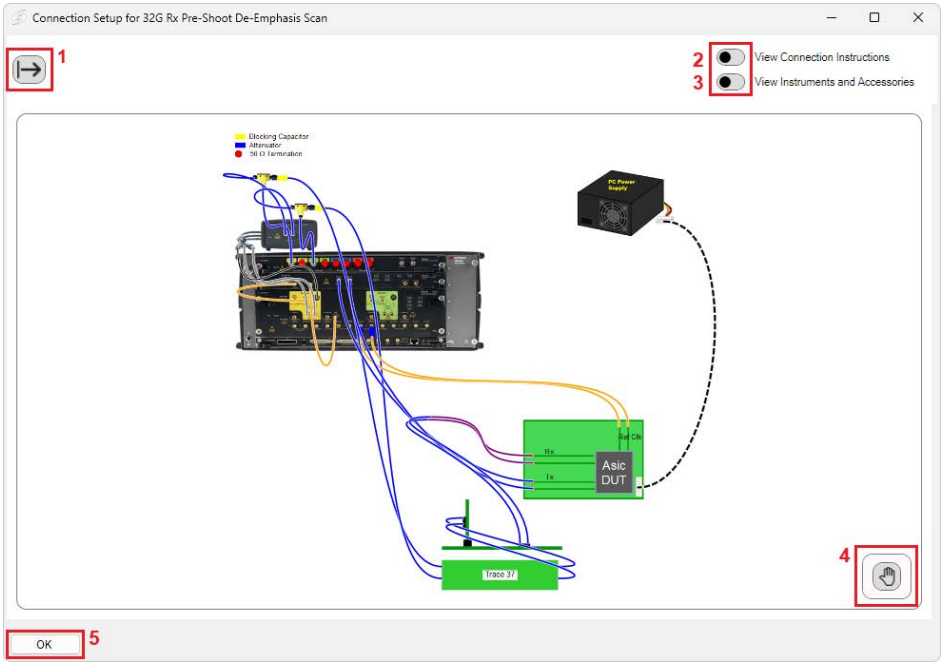


Figure 5-16 Example connection diagram dialog – default view

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 5-17.

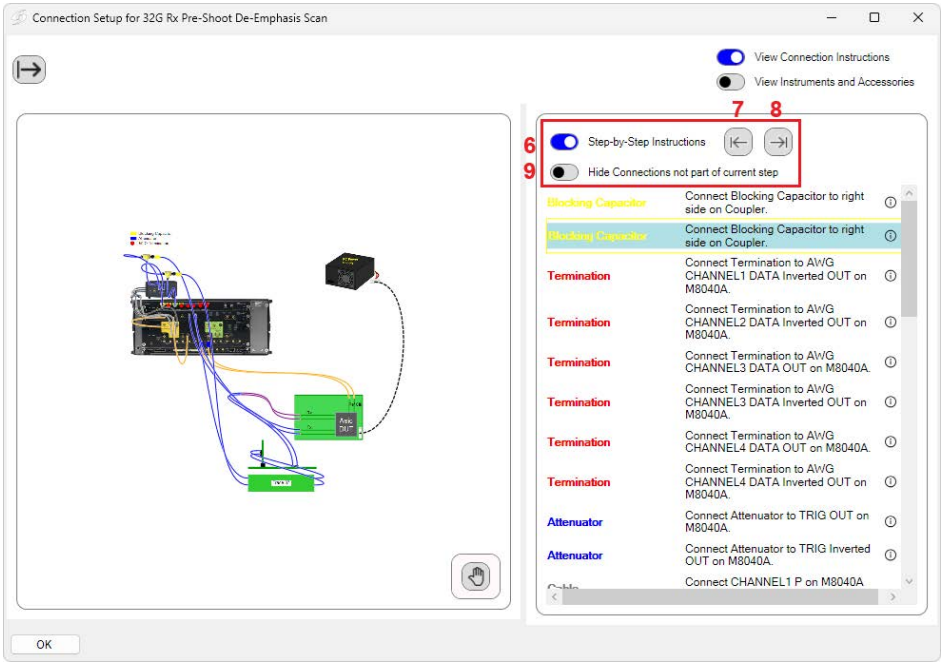


Figure 5-17 Example connection diagram dialog – with Connection Instructions pane

This view helps avoid any connections being overlooked.

Functions of buttons 6–9:

6 Toggle button for step-by-step instructions.

7 Return to previous step. Only visible if step-by-step instructions are activated.

8 Go on to next step. Only visible if step-by-step instructions are activated.

9 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, a lower pane opens that contains a list of instruments and accessories. This can also be viewed in combination with the Connection Instructions pane, as in Figure 5-18.

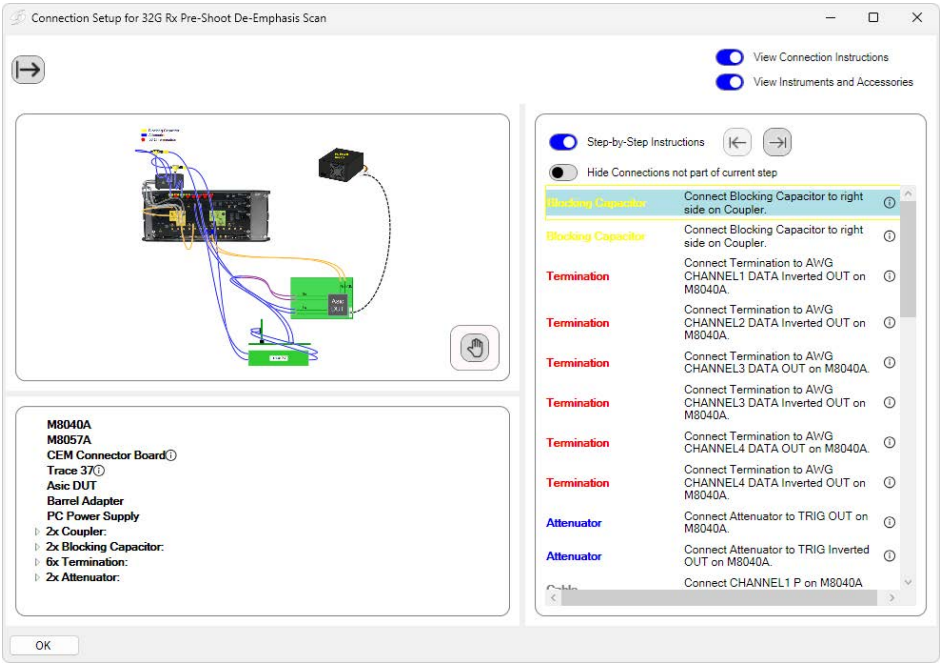


Figure 5-18 Example connection diagram dialog – all panes

Export Mode View

In the Export Mode view (Figure 5-19) you can change the layout of the connection diagram before exporting it.

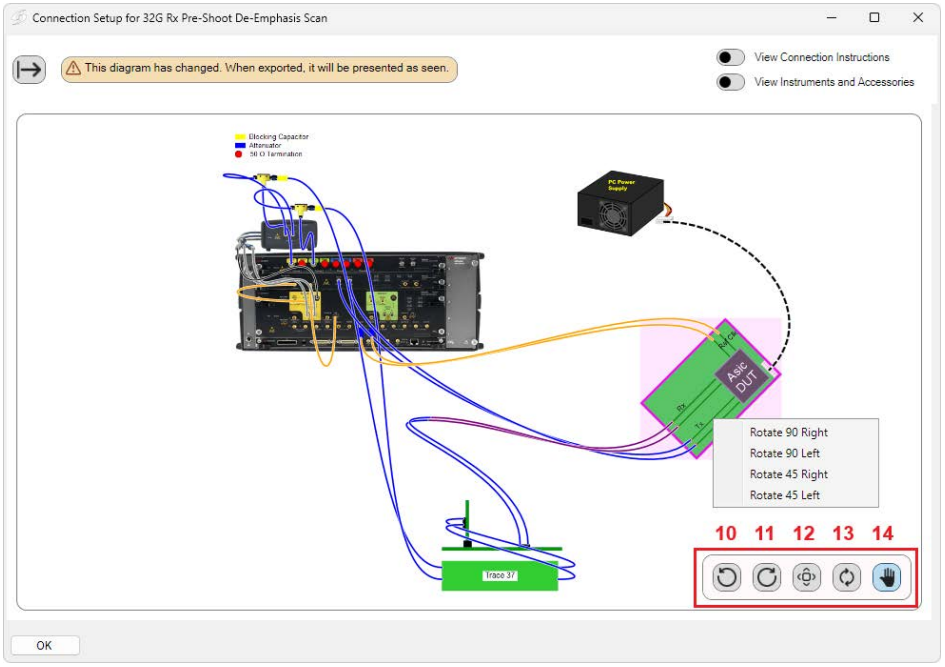


Figure 5-19 Example connection diagram dialog – Export Mode view

Functions of buttons 10–14.

10 Undo

11 Redo

12 Resize, to show the whole diagram

13 Reinstate the original diagram layout

14 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 5-19).
- 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

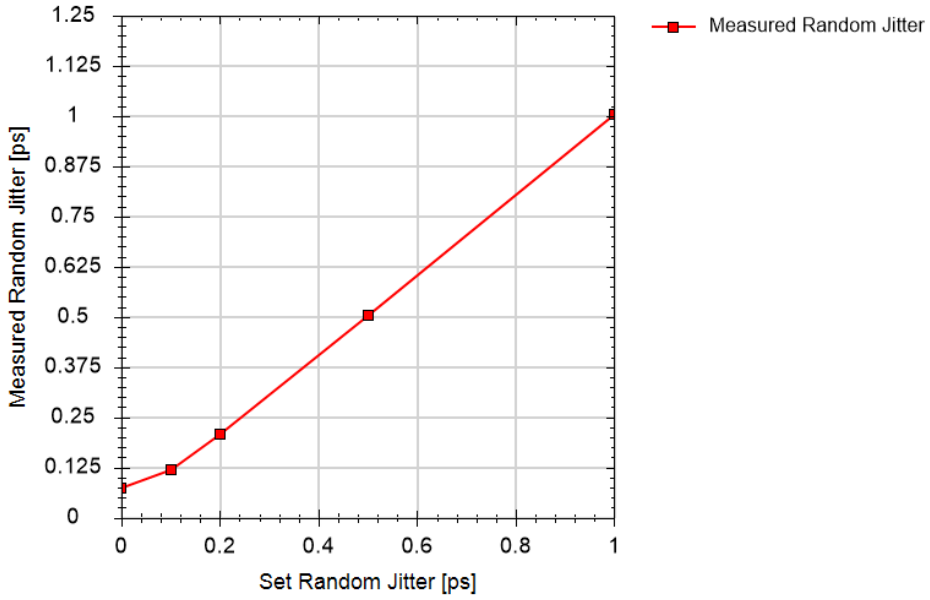
Viewing Results

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 5-20.

L0_Cal_64GTps_RJ

[Not Compliant]

for PCIe 6.0 EndPoint ASIC



----General----	
Offline	True
Software Version	5.0.0.11_RC
Required-calibration SW Version	5.0.0.11_RC
Compliant	False
Non-compliance reason(s)	Procedure offline; Software status unreleased; Required cal not compliant: 64G TxEQ and Launch Voltage Calibration; Required cal offline: 64G TxEQ and Launch Voltage Calibration; Required cal unknown/unreleased: 64G TxEQ and Launch Voltage Calibration
Verification Mode	False

----Oscilloscope----	
Scope Bandwidth	50 GHz
Use Bessel Filter	True
Remove Scope Noise	True
Scope RJ	78 fs
Number of Averages	7
Number of UIs	2 MUI
Scope Connection for Calibration	Chan 1 3 Direct Connect
----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]
0.00	0.075
0.10	0.119
0.20	0.208
0.50	0.505
1.00	1.003

Figure 5-20 Example procedure result

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 drop-down menu under ‘File’ (Figure 5-21).

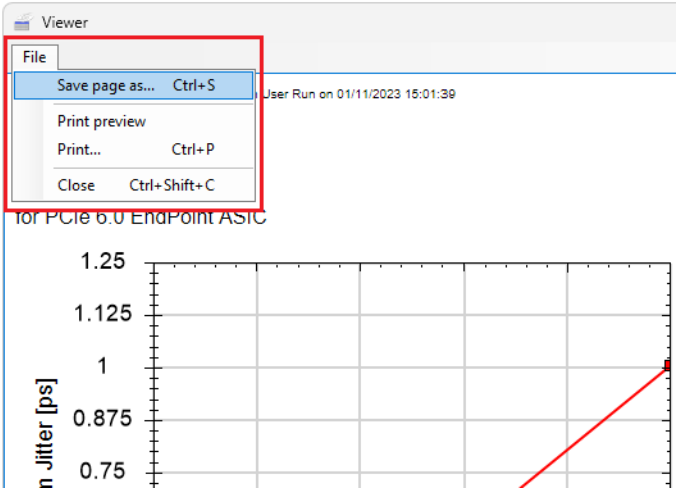


Figure 5-21 Exporting a single result from the results viewer

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. You can view a particular set of results in two ways:

- Left-click the timestamp of the results you want to see. The results will be displayed in the right-hand pane of the main window (Figure 5-22).
- Right-click the timestamp of a particular result and select 'Show Results...' to open it in the Results Viewer.

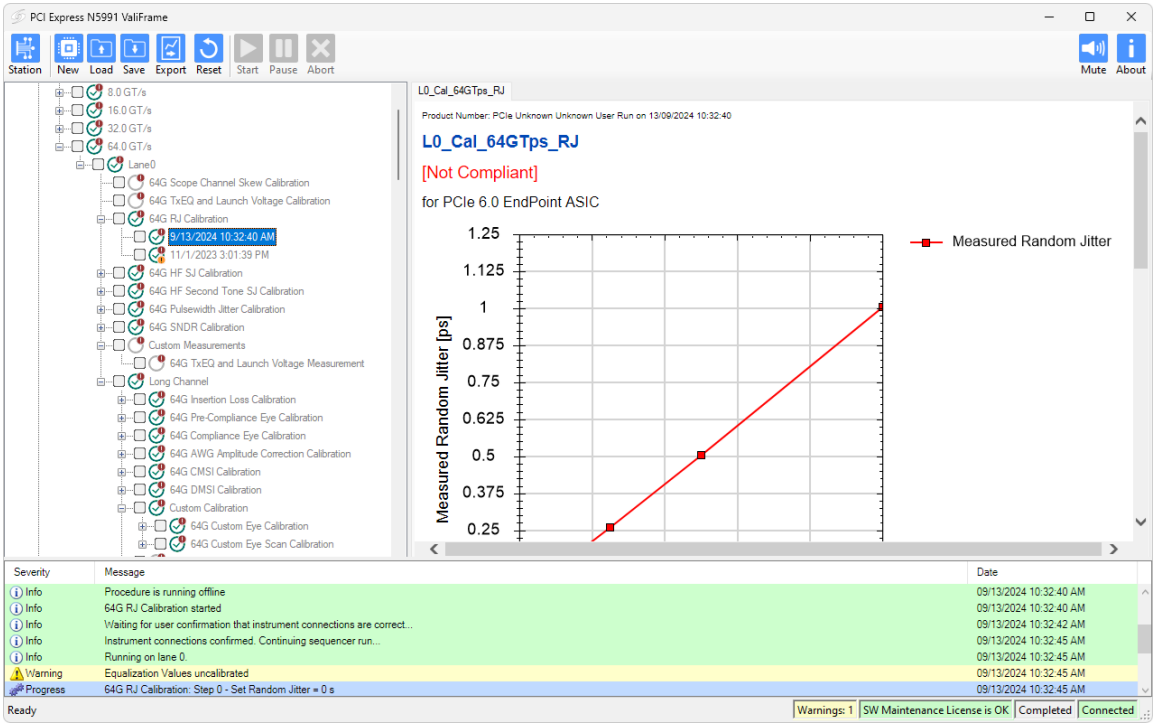


Figure 5-22 Displaying a particular set of results

Exporting Results

All calibration and test data results from one N5991 ValiFrame 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 ValiFrame run.

The Export Procedure Results window opens (Figure 5-23).

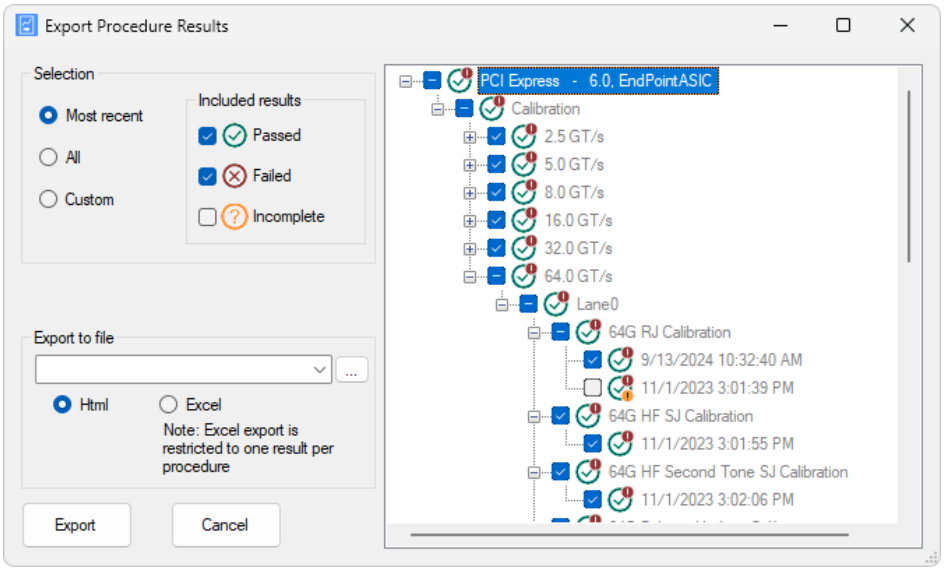


Figure 5-23 Example Export Procedure Results window

Make the following selections:

- The results to be exported: Most recent, All or Custom
- The type(s) of results to be included (for 'Most recent' and 'All'): Passed, Failed, Incomplete
- Path and file to which the results should be exported
- HTML or Excel format

NOTE An Excel report is restricted to one result per procedure.

N5991 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 36 shows an example Test Result Summary, and Figure 5-25 an example Instrument Summary.

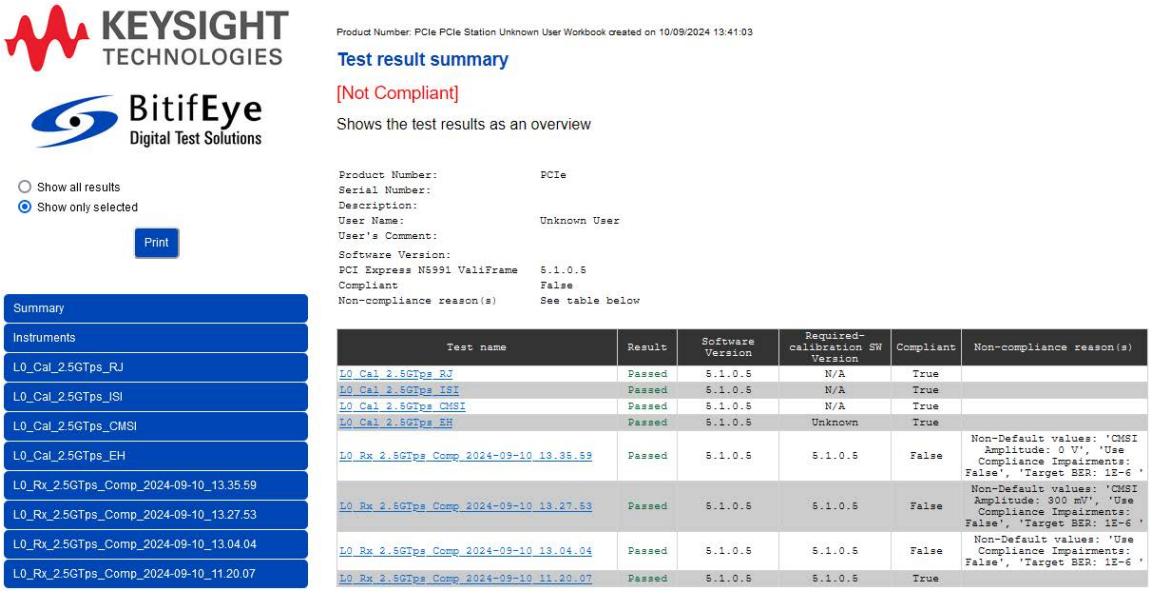


Figure 5-24 Example test result summary in an N5991 ValiFrame HTML workbook

- **Test Name**: The name of the procedure (test or calibration).
- **Result**: Whether the test was passed or failed.
- **Software Version**: The version number of the N5991 ValiFrame software used to perform the procedure.
- **Required-calibration SW Version**: Tests, and some calibrations, rely on data obtained in calibrations. The Required-calibration SW Version gives the version number of the N5991 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. 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: The procedure relies on calibrations, and the software version used to obtain the calibration(s) listed here is unknown.
  - Non-default values: If one (or more) parameter does not have its default value, the procedure is no longer being conducted according to the specification. This is often the case when investigating the limits of a DUT.

Instrument Summary

[Not Compliant]

This table lists the instruments used to run these tests

Compliant	False
Non-compliance reason(s)	See table on summary page

Company	Instrument Name	Serial	Instrument Revision	Description
Keysight Technologies	M8070B	MY	11.0.150.12	M8040 with integrated jitter sources for BER tests
Keysight Technologies	M8045A,M8057B	MY ,MY	11.0.150.12	M8040 with integrated jitter sources for BER tests
Keysight Technologies	M8054A	MY	1.0.23.0	M8040 with integrated jitter sources for BER tests
Keysight Technologies	M8054A	MY	1.0.23.0	M8040 with integrated jitter sources for BER tests
KEYSIGHT TECHNOLOGIES	UXR1102A	US	11.60.00115	Realtime scope for calibration and transmitter tests
Keysight Technologies	M8046A	MY	11.0.150.12	M8040 with integrated jitter sources for BER tests

Figure 5-25 Example list of instruments in an N5991 ValiFrame HTML workbook

- **Company**: The manufacturer of the instrument.
- **Instrument Name**: The model number or name of the instrument.
- **Serial**: The serial number of the instrument.

- **Instrument Revision**: The revision number or version of the software running on the instrument.
- **Description**: The type of instrument, e.g., real-time oscilloscope.

Icon Representation of Results

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...”. The pop-up window displays the meaning of the icons (Figure 5-26). The meanings of all result or state icons are listed in Table 3.

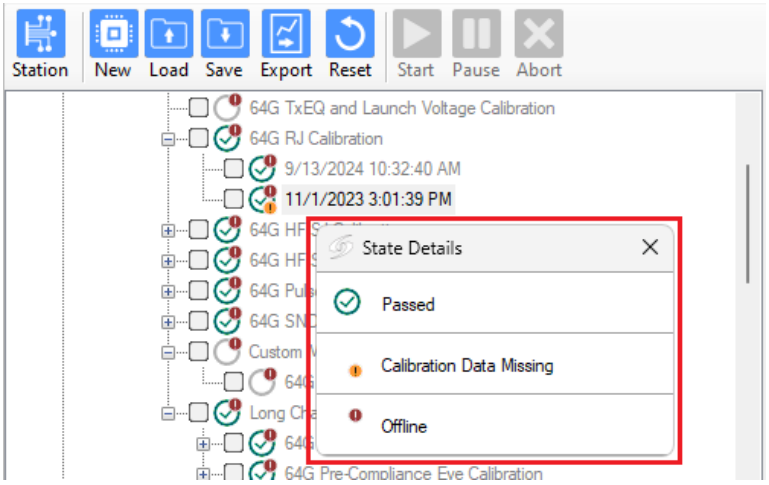


Figure 5-26 Icon representation of results

Table 5-3 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.
	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.
	Incomplete – Iterative. The procedure was run for several repetitions and they were incomplete.

Table 5-3 List of All State Icons (cont.)

Icon	Description
Additional States	
	CalMissing. This icon appears on the lower right portion of the main icon. For example:  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.
	Offline. This icon appears on the upper right portion of the main icon. For example:  It indicates that the procedure was run (or will be run) in offline mode.
 	Both states can occur at the same time. For example:  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**: 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 that are required for some applications.

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6 Additional Tools

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

ValiFrame API

The ValiFrame Application Programming Interface allows N5991 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 N5991 ValiFrame by external software. In typical use, a top-level external test sequencer makes use of N5991 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 6-1), which opens when you click the “About” button at the right-hand end of the ValiFrame menu bar.

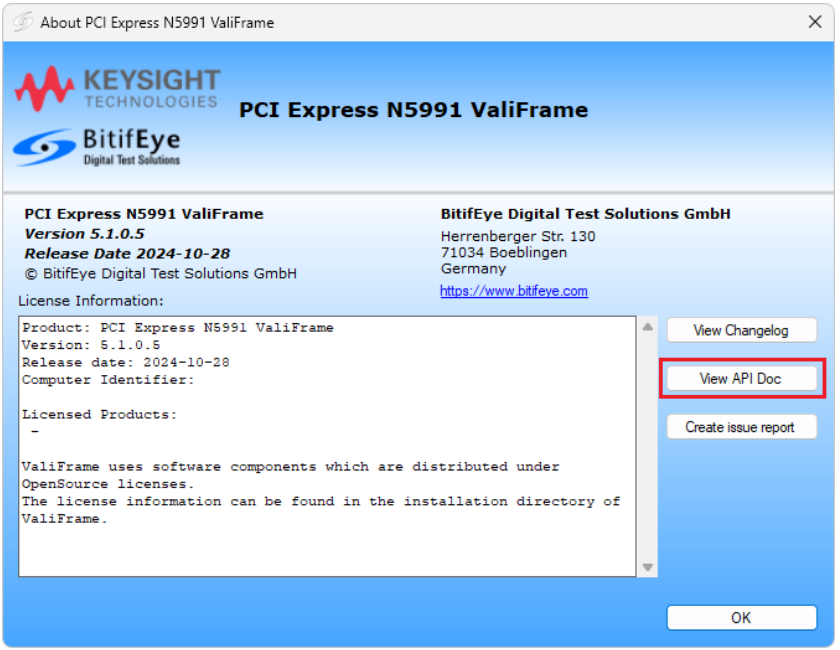

Figure 6-1 Example ValiFrame ‘About’ window, showing the ‘View API Doc’ button

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).

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 N5991 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.

Contact your Keysight representative if you wish to purchase a license. To activate a license, use the BitifEye License Manager (BLM): https://licensing.bitifeye.com/. See also Chapter 4: Licenses.

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7 Troubleshooting and Support

This chapter describes what to do if you run into a problem with the N5991 Test Automation Software.

Troubleshooting

If you encounter problems when running the software, check the log list at the bottom of the main window. The log file can be viewed by right-clicking within the log list section (see red frame in Figure 7-1). The log file is temporarily saved at C:\ProgramData\BitifEye\ValiFrameK1\Tmp. Note that all log information will be lost when the N5991 application is terminated unless you save the log file elsewhere.

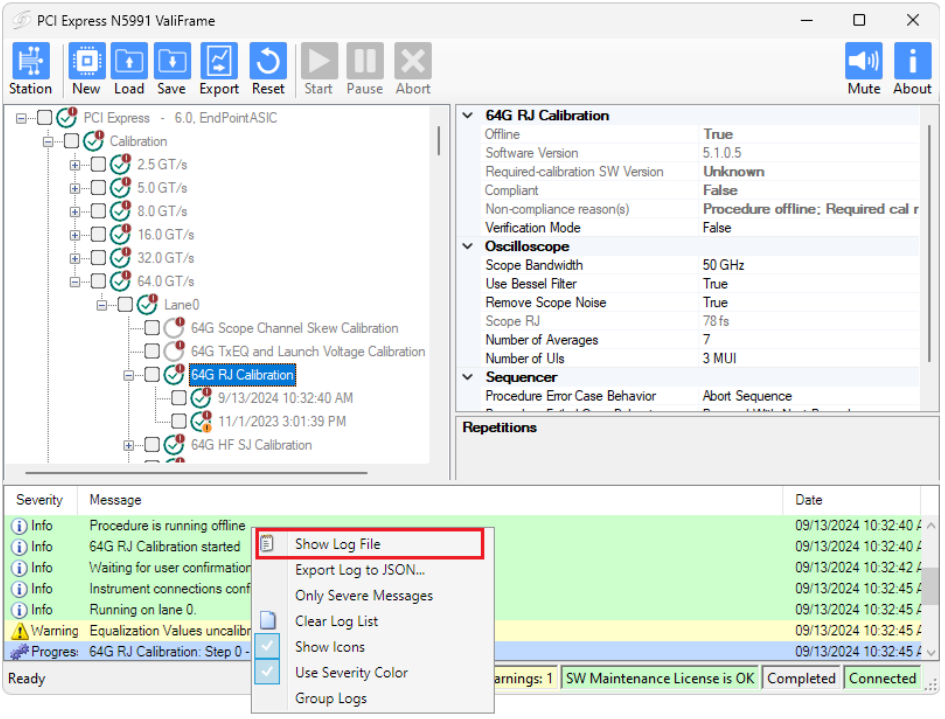

Figure 7-1 Accessing the log file

Support

If a problem with the application persists, send the log file 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.

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A Acronyms and Abbreviations

This Appendix contains a list of acronyms and abbreviations used in this Getting Started Guide.

List of Acronyms

Acronym	Definition
A	
API	Application Programming Interface
AWG	Arbitrary Waveform Generator
B	
BER	Bit Error Ratio
BERT	Bit Error Ratio Tester
D	
DLL	Dynamic Link Library
DUT	Device Under Test
G	
GUI	Graphical User Interface
H	
HDMI	High-Definition Multimedia Interface
HTML	HyperText Markup Language
J	
JSON	JavaScript Object Notation
M	
MIPI	Mobile Industry Processor Interface
P	
PC	Personal Computer
PCIe	Peripheral Component Interconnect Express
U	
USB	Universal Serial Bus
V	
vfc	ValiFrame Configuration

Acronym	Definition
vfp	ValiFrame Project
VISA	Virtual Instrument System Architecture

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Edition 5.0, October 2024

N5991-91011
www.keysight.com

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