CALIBRATION SYSTEM

IQS-12002B

R&D AND MANUFACTURING

USER GUIDE

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EXPERTISE REACHING OUT

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Units of Measurement

Units of measurement in this publication conform to SI standards and practices.

Version number: 1.0.1.4

Contents

1 Introducing the IQS-12002B Calibration System

The IQS-12002B Calibration System has been designed to calibrate, verify, and adjust several types of devices. Some concept pertaining to the system are described here:

- Calibration is a set of operations that establish, under specified conditions, the relationship between values of quantities indicated by a measuring instrument (DUT) and the corresponding values realized by standards.
- Verification consists in comparing calibration results with established limits. It is the confirmation that, through the explanation of a given item and a provision of objective evidence, it fulfils specified requirements.
- Adjustment is the operation of bringing a measuring instrument into a state of performance suitable for its use.
- Uncertainty is the parameter that quantitatively characterizes the dispersion of values that could be attributed to the measures. Uncertainty is given with a specific level of confidence.

Note: *Accuracy is the qualitative expression of the capacity of an instrument to give results close to the true value.*

Note: *Precision is the closeness of agreement between quantity values obtained by replicate measurements of a quantity under specified conditions.*

Some units (DUT) cannot be adjusted using the IQS-12002B. Depending on the DUT model, adjustment will or will not be possible. When adjustment is not possible, you can only perform calibration and verification of the unit. If adjustment is possible, you will be asked to perform calibration and verification of the DUT before and after adjustment.

The provided application helps you to comply to the ISO/IEC 17025 standard with the use of the following features:

➤ The application keeps (in the database) the complete history of the operations performed by a user on a DUT.

➤ You can report all DUTs that have been verified or adjusted using a specific standard.

➤ For some procedures, the system allows taking uncertainties into account when judging on compliance.

Calibration and Verification: Assessing Conformity

The latest international standards require that calibration uncertainties be evaluated and taken into account when a declaration of conformity is given for a specification. Our uncertainty evaluations are carried out in accordance with the guidelines stated in the *Guide to the Expression of Uncertainty in Measurement* by ISO, IEC, BIPM (Bureau International des Poids et Mesures) and other international organizations.

In order to ensure coherence, EXFO makes every effort to establish correspondence between calibration uncertainties, guaranteed specifications, allowed deviation between the unit and the standard, as well as the conformance assessment of the power meter status upon reception of the unit.

Calibration Uncertainties

Calibration uncertainties are expressed in the certificate. It states the combined uncertainties of the following factors:

- Reference standard calibration uncertainty
- Dependence of the reference standard on measurement conditions
- Dependence of the tested meter on measurement conditions
- Other uncertainties due to the setup and measurement method

As an example, for power meter absolute power calibration, the dependence of the detector response at each point is evaluated for the wavelength uncertainty of the source, output stability and output bandwidth of the light, temperature uncertainty, connector-adapter combination, fiber type, repeatability of the measurement, power meter linearity, and other factors.

Guaranteed Specifications

Guaranteed specifications are EXFO's published specifications for the unit. In fact, the calibration process foresees the possibility of making some adjustments to ensure compliance. Written proof is given in the "As left" section of the calibration certificate when the **Within specifications** box is selected.

Allowed Deviation

The allowed deviation is the difference between the measurement of the power meter under test and the reference standard; this is a key factor in the determination of whether or not a unit conforms to its specifications.

The Concepts behind the IQS-12002B Calibration System

The IQS-12002B Calibration System is used to verify and/or adjust a DUT (device under test) of a certain type (e.g., FPM-300) and of a certain model (e.g., FPM-302X). The application keeps a history of each tested device.

To test a device, the system needs various instruments such as sources, power meters, fiber spools, etc. In the system, there may be several instruments of a given type and model. By default, the system uses the first instrument available, unless you specify one.

Some of the instruments are considered as “standards”, for which the system keeps an history. Since the system relies on the accuracy of these standards, you must respect the recommended calibration frequency. The system does not allow tests with a standard that is due for calibration.

To test a device, the application will need a test sequence. This test sequence consists in several substeps identified as “scenarios”. A scenario is based on a general procedure (e.g., insertion loss) that it adapts with particular specifications for a particular DUT model (e.g., variable attenuator insertion loss at 1310 nm).

The specifications are the different values the application uses to determine the compliance of a DUT. For certainties compliant with ISO 17025, there are four possible collections when assessing conformity:

- Inside specifications
- Inside specifications*
- Outside specifications*
- Outside specifications

Note: *Please refer to the section Conformance Assessment of the Unit Status for a Certificate Compliant with ISO 17025 for further details on verification of a device when taking into account measurement uncertainties.*

Conformance Assessment of the Unit Status for a Certificate Compliant with ISO 17025

The conformance assessment of the power unit status, upon reception, requires a judgement on the compliance or non-compliance with specifications. The result of this judgement depends on the allowed deviation and on the gray zone introduced by calibration uncertainties. As a consequence of this gray zone, it is not always possible to draw a firm conclusion regarding the unit status when it is received from the customer.

Following the indications given by ISO/IEC 17025, EXFO provides, in the "As found" section of the certificates, four conclusions depending on deviation, guaranteed specifications (Spec), and calibration uncertainty (Ucal):

- Inside specifications

  When measured deviation is within the following limits, the unit is said to be within specifications with a level of confidence of 95 %:

  $$|\text{deviation}| \leq \text{spec}(-0.825 \bullet \text{Ucal})$$

- Inside specifications

  When all results are within specification limits. In conformance with ISO/IEC 17025, full compliance cannot be achieved because of measurement uncertainties. Nevertheless, results indicate that the instrument is likely to perform according to specifications. Results are bound by the following limits:

  $$\text{spec} - 0.825 \cdot \text{Ucal} < |\text{deviation}| \leq \text{spec}$$

➤ Outside specifications

When some results are outside specification limits. Nevertheless, non compliance cannot be established because of measurement uncertainties. Results are bound by the following limits:

$$\text{spec} < |\text{deviation}| \leq \text{spec} + 0.825 \cdot \text{Ucal}$$

When one of the two first conclusions applies to the unit under test, it is up to you to determine if measurements taken with that unit, before verification, are considered valid. This depends on the following:

Whether a deviation outside published specifications can be tolerated for these measurements.

The proximity of the measurements, taken with the unit, to the maximum allowed deviation.

➤ Outside specifications

The unit is definitely not within specifications. The deviation is larger than the sum of the specification and the calibration uncertainty.

$$|\text{deviation}| > \text{spec} + 0.825 \cdot \text{Ucal}$$

For example, for power meter models whose specification and calibration uncertainties are respectively ±5 % and ±3.1 % (at 1550 nm), the deviation will allow us to conclude the following:

Inside specifications

$$|\text{deviation}| \leq 2.5\ \%$$

Inside specifications*

$$2.5\ \% < |\text{deviation}| \leq 5\ \%$$

- Outside specifications*

$$5\ \% < |\text{deviation}| \leq 7.5\ \%$$

Outside specifications |deviation| > 9 %

$$|\text{deviation}| > 7.5\ \%$$

IMPORTANT

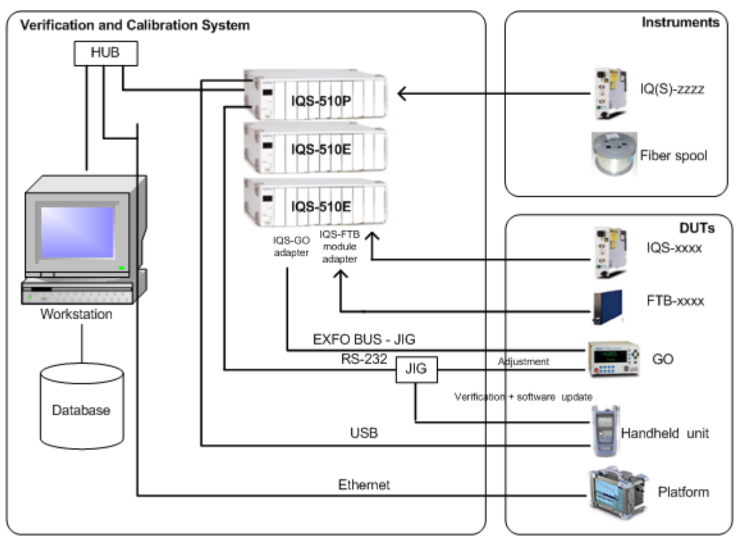
For a pass/fail certificate (not compliant with ISO 17025), uncertainties are not taken into account for conformance assessment, therefore, there are only two zones: pass or fail.

System Overview

The system includes:

- a computer, on which the application and database are located
- an IQS-500 controller unit that contains the instruments requiring a warmup period
- one or several IQS-500 expansion units that could contain both instruments that do not require a warmup period and DUTs.

  Both instruments and DUTs can be inserted in the same IQS-500 expansion unit (in specific areas, refer to *Configuring Areas Specific for Instruments* on page 19). You may find useful to insert only instruments that do not require a warmup period in an expansion unit that also houses DUTs. This way, turning off the expansion unit to insert your DUTs, will not affect the instruments warmup.



The required instruments vary according to the DUTs and the type of verification and adjustment you want to perform.

Conventions

Before using the product described in this manual, you should understand the following conventions:

WARNING

Indicates a potentially hazardous situation which, if not avoided, could result in *death or serious injury*. Do not proceed unless you understand and meet the required conditions.

CAUTION

Indicates a potentially hazardous situation which, if not avoided, may result in *minor or moderate injury*. Do not proceed unless you understand and meet the required conditions.

CAUTION

Indicates a potentially hazardous situation which, if not avoided, may result in *component damage*. Do not proceed unless you understand and meet the required conditions.

IMPORTANT

Refers to information about this product you should not overlook.

2 Getting Started with Your Calibration System

Inserting and Removing Test Modules

CAUTION

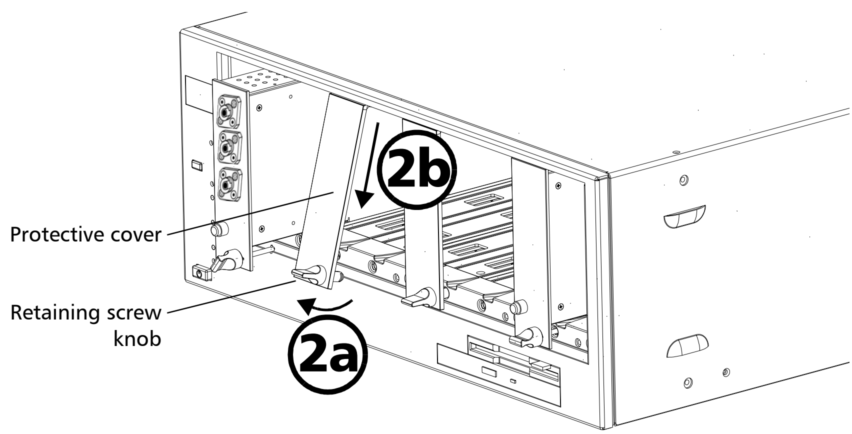
Never insert or remove a module while the controller unit and its expansion units are turned on. This will result in immediate and irreparable damage to both the module and unit.

To insert a module into the controller or expansion unit:

1. Exit IQS Manager and turn off all your units.

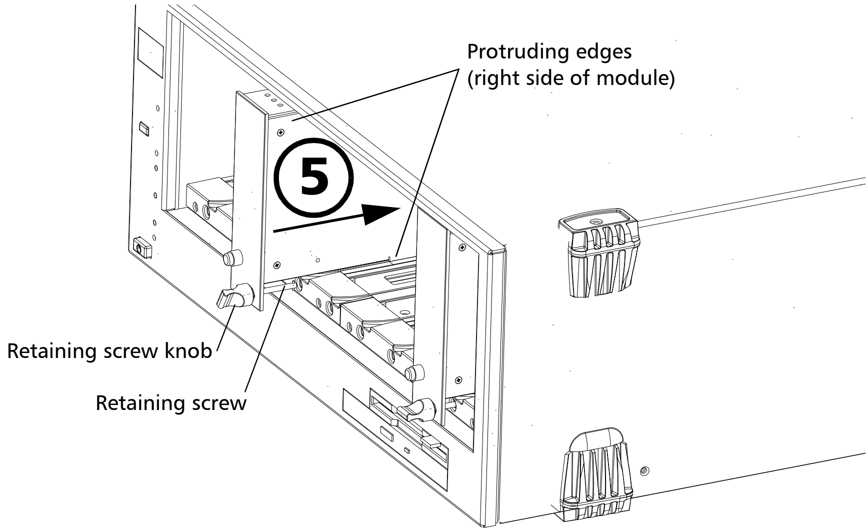
2. Remove the protective cover from the desired unused module slot.

- ***2a.*** Pull the retaining screw knob firmly towards you and release the bottom of the cover.
- ***2b.*** Gently pull the top of the protective cover downwards, to remove it from the unit grooves.

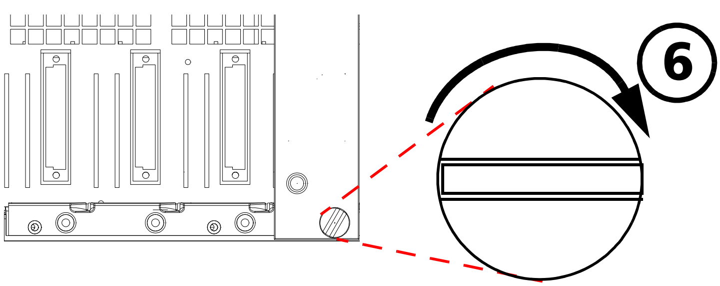


3. Position the module so that its front panel is facing you and the top and bottom protruding edges are to your right.

4. Insert the protruding edges of the module into the grooves of the unit's module slot.



5. Push the module all the way to the back of the slot, until the retaining screw makes contact with the unit casing.
6. While applying slight pressure to the module, turn the retaining screw knob (located at the bottom of the panel) clockwise until the knob is horizontal. This will secure the module into its "seated" position.



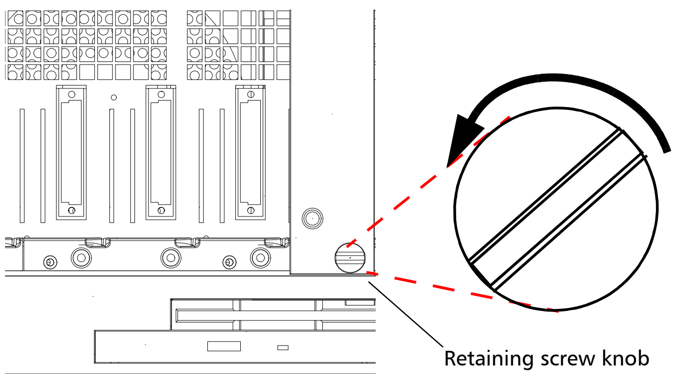
The module is correctly inserted when its front panel is flush with the front panel of the controller or expansion unit.

When you turn on the controller unit, the startup sequence will automatically detect your module.

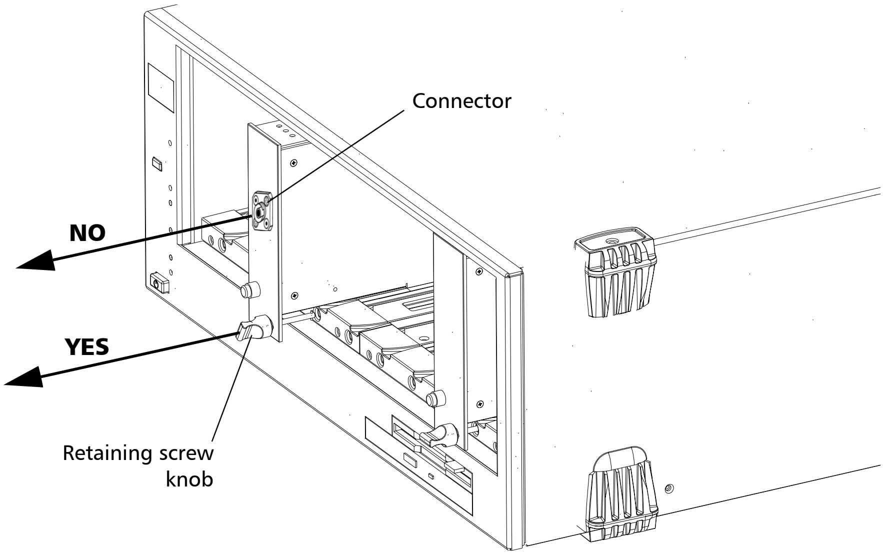
Note: *You can insert IQ modules into your controller or expansion unit; the IQS Manager software will recognize them. However, the IQS-500 locking mechanism (retaining screw) will not work for IQ modules.*

To remove a module from your controller or expansion unit:

1. While pulling gently on the knob, turn it counterclockwise until it stops. The module will slowly be released from the slot.



2. Place your fingers underneath the module or hold it by the retaining screw knob *(NOT by the connector)* and pull it out.



> **CAUTION**
>
> **Pulling out a module by a connector could seriously damage both the module and connector. Always pull out a module by the retaining screw knob.**

3. Cover empty slots with the supplied protective covers. Simply slide the top of the protective cover into the upper grooves of the unit, and then snap into place by pushing the retaining screw knob.

> **CAUTION**
>
> **Failure to reinstall protective covers over empty slots will result in ventilation problems.**

Installing Hardware Components

Both instruments and DUTs can be inserted in the same IQS-500 expansion unit (in specific areas). You may find useful to insert only instruments that do not require a warmup period in an expansion unit that also houses DUTs. This way, turning off the expansion unit to insert your DUTs, will not affect the instruments warmup. For more information on how to define the area reserved to instruments, see *Configuring Areas Specific for Instruments* on page 19.

To avoid multiple warmup periods, you can consult the list of required instruments for the test you want to perform.

Instrument	Warmup period
Source	60 minutes
EDFA	60 minutes
Power meter	15 minutes
Others	no warmup

The application will show you the required connections, step by step, during the test.

Starting and Exiting the Calibration System Application

To start the Calibration System application:

1. Turn on the IQS-500 controller and expansion units.

> **IMPORTANT**
>
> **Wait until the LED push button of all the modules (except the polarization or mode scrambler) light up before starting the application. Otherwise, the application will not be able to link to the hardware.**

2. Turn on the computer on which the application is installed and log on as “operator” or “manager” and enter the password.

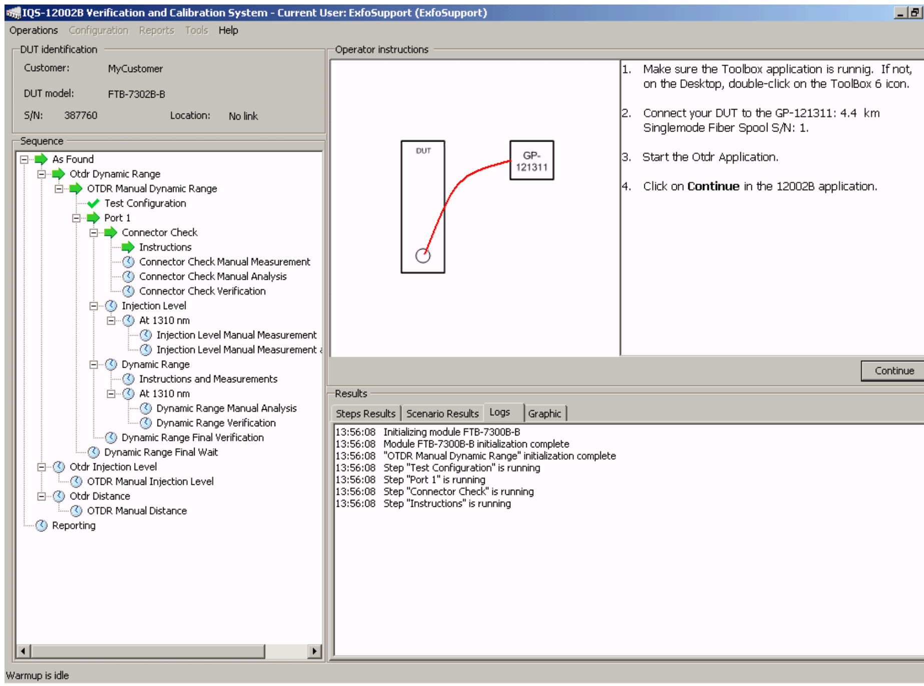
3. From the computer, on the Windows taskbar, click the **Start** button and select **Programs** > **EXFO** > **IQS-12002B**.

   OR

   Double-click the IQS-12002B Calibration System icon.

4. When the application prompts you, log on to the system.

The main window (shown below) contains all the commands required to control your system.



To exit the Calibration System application:

1. From the **File** menu, click **Exit**.

2. Turn off the controller and expansion units.

Reinstalling or Upgrading the IQS-12002B Calibration System Application

Please be careful before uninstalling the application. When processed, all data saved in the database will be lost. This include the DUT results, DUT creation, standards creation, standard traceability, DUT traceability, certificates, all users modifications, etc.

Normally you would not have to install the Calibration System application, except in particular circumstances (such as after having reinstalled Microsoft Windows).

Please contact the customer’s service to proceed with the installation/upgrade of the system.

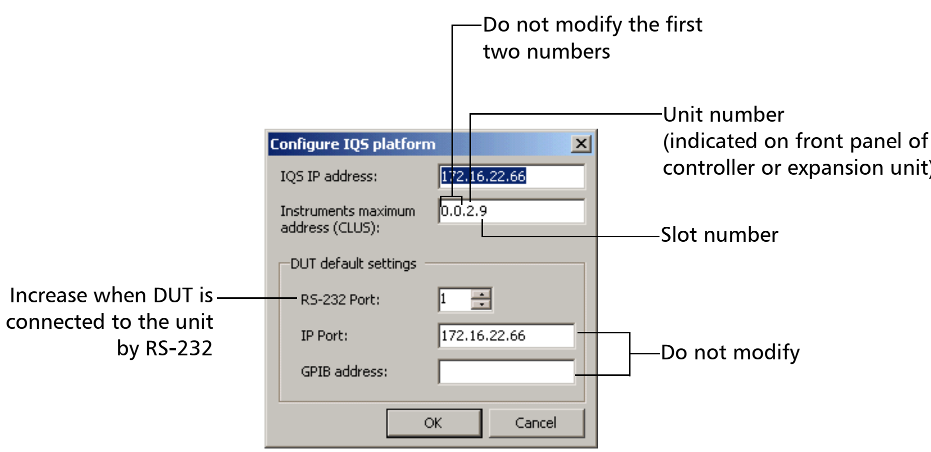
3 Setting Up Your Calibration System

Configuring Areas Specific for Instruments

Since the system can house instruments and DUTs in the same expansion unit, you must specify which area is dedicated to the instruments. The application will then be able to identify which modules must be considered as instruments and which as DUTs.

To configure the area for instruments:

1. From the **Tools** menu, select **System** > **Configure IQS Platform**.
2. In the **Instruments maximum address (CLUS)** box, enter the address of the last slot you want to use for instruments. The application will assign the next slots to DUTs.



3. Click **OK** to confirm.

Configuring Access Levels and Passwords

To comply with standard ISO 17025, you must be able to identify who (which user) verified and/or adjusted a particular DUT.

There are three types of users:

➤ Operator: verifies and adjusts DUTs, and generates certificates.

➤ Manager: has the same rights as the operator and can also configure the system.

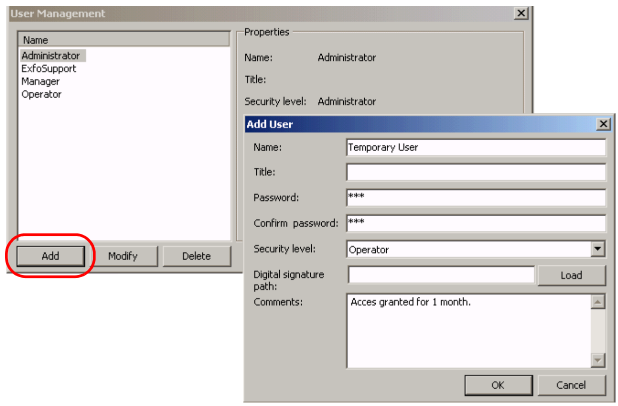
➤ Administrator: has the same rights as the manager and can also install components and complete the initial system configuration.

Each system user must have a password.

Only users with administrator rights can create, modify, and delete user profiles in the system. A user profile contains a user name, a password, a permitted access level, etc.

To create a user profile:

1. From the **Tools** menu, select **System** > **User Management.**
2. Click **Add** to create a user.



3. In the **Add User** box, fill in the information and click **OK** to confirm.

   Clicking **Cancel** takes you back to the main window.

To modify a user profile:

1. From the **Tools** menu, select **System** > **User Management.**
2. From the **Name** list, select the user profile you want to modify.
3. Click **Modify**.
4. Modify the information and click **OK** to confirm.

   Clicking **Cancel** takes you back to the main window.

To delete a user profile:

1. From the **Tools** menu, select **System** > **User Management**.
2. From the **Name** list, select the user profile you want to delete.
3. Click **Delete** and confirm deletion.

   Clicking **Cancel** takes you back to the main window.

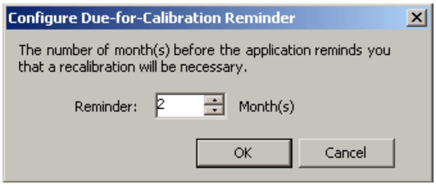
Configuring the Due-for-Calibration Reminder

Since the system relies on the accuracy of standards, the application will warn you before a standard is due for recalibration (by default, 2 months ahead). You can set the number of months before the application reminds you that a recalibration will be necessary. For information on how to proceed when a standard is back from calibration, see *Using a Standard after Recalibration* on page 54.

To configure the due-for-calibration reminder:

1. From the **Tools** menu, select **System** > **Configure Due-for-Calibration Reminder**.

2. Enter the desired number of months and click **OK**.



Activating or Deactivating the Warmup Confirmation

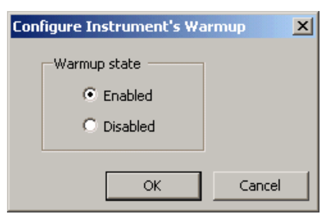
By default, the application prompts you to select the instruments and DUT for which a warmup is wanted. You can deactivate the warmup confirmation. It is always possible to perform a warmup manually afterwards (see *Launching a Manual Warmup* on page 28).

IMPORTANT

To ensure accurate results, EXFO recommends to always perform warmup.

To activate or deactivate the automatic warmup confirmation:

1. From the **Tools** menu, select **System** > **Configure Instrument's Warmup**.
2. Select the desired option and click **OK** to confirm.



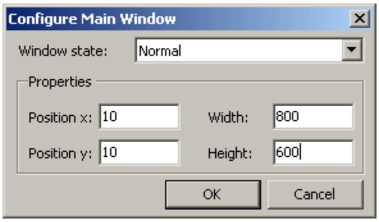
The application will take the new setting into account the next time you start the application or turn on the expansion unit.

Configuring Main Window Appearance

By default, the main window is maximized. However, you can configure its size and position.

To configure main window appearance:

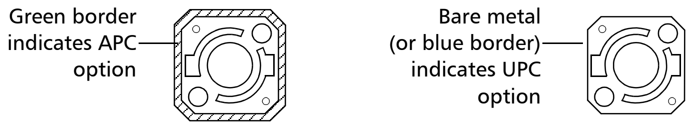
1. From the **Tools** menu, select **System** > **Configure Main Window**.
2. From the **Window state** list, select the desired appearance. If you select **Normal**, you can also specify the size and position.



4 Operating Your Calibration System

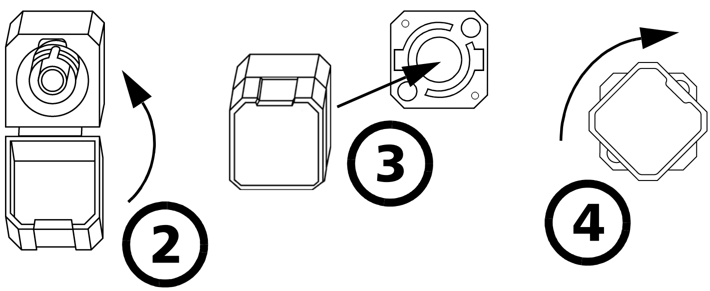
Installing the EXFO Universal Interface (EUI)

The EUI fixed baseplate is available for connectors with angled (APC) or non-angled (UPC) polishing. A green border around the baseplate indicates that it is for APC-type connectors, as shown below:



To install an EUI connector adapter onto the EUI baseplate:

1. Hold the EUI connector adapter so the dust cap opens downwards.



2. Close the dust cap in order to hold the connector adapter more firmly.
3. Insert the connector adapter into the baseplate.
4. While pushing firmly, turn the connector adapter clockwise on the baseplate to lock it in place.

Cleaning and Connecting Optical Fibers

IMPORTANT

To ensure maximum power and to avoid erroneous readings:

- **Always clean fiber ends as explained below before inserting them into the port. EXFO is not responsible for damage or errors caused by bad fiber cleaning or handling.**
- **Ensure that your patchcord has appropriate connectors. Joining mismatched connectors will damage the ferrules.**

To connect the fiber-optic cable to the port:

1. Clean the fiber ends as follows:

   1a. Gently wipe the fiber end with a lint-free swab dipped in isopropyl alcohol.

   1b. Use compressed air to dry completely.

   1c. Visually inspect the fiber end to ensure its cleanliness.

2. Carefully align the connector and port to prevent the fiber end from touching the outside of the port or rubbing against other surfaces. If your connector features a key, ensure that it is fully fitted into the port's corresponding notch.

3. Push the connector in so that the fiber-optic cable is firmly in place, thus ensuring adequate contact.

   If your connector features a screwsleeve, tighten the connector enough to firmly maintain the fiber in place. Do not overtighten, as this will damage the fiber and the port.

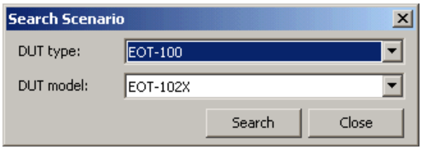
Note: *If your fiber-optic cable is not properly aligned and/or connected, you will notice heavy loss and reflection.*

Viewing the Required Instruments

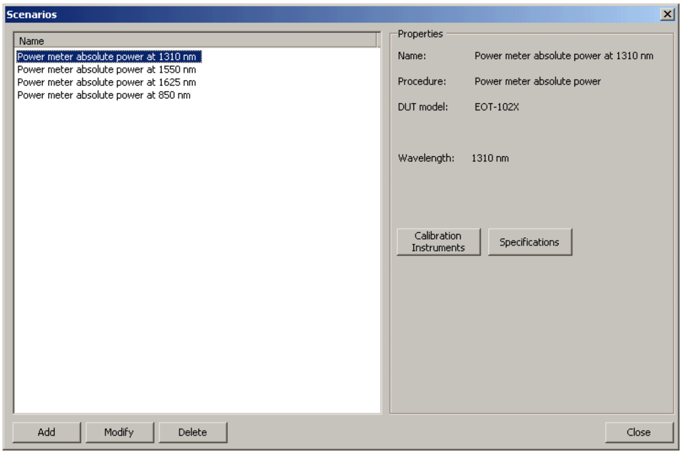
Before launching a test sequence, you can view the instruments that are required. This way, you will not have to turn off the controller or expansion units to insert the instruments and wait for the warmup period.

To view the required instruments:

1. From the **Configuration** menu, click **Scenario**.
2. Select the desired DUT type and model, and click **Search**.



3. From the **Scenarios** box, select a test scenario.



4. Click **Calibration Instruments** to view the list of instruments required for the selected scenario.
5. Repeat steps 3 and 4 for every scenario to be included in the sequence.
6. Close the windows to return to the application main window.

Launching a Manual Warmup

By default, the application prompts you at startup to select the instruments for which a warmup is wanted. If you have deactivated the warmup confirmation or if you have cancelled the warmup at the application startup, you can still launch it manually.

To launch a manual warmup:

From the **Tools** menu, select **System** > **Start Warmup**.

Note: *If the **Warmup** window does not appear, the warmup has already been completed.*

Locating IQS Modules

You can access the list of all IQS modules inserted in the system. The list includes instruments and DUTs, and their position in the system (unit and slot number). This allows you to retrieve the model and serial number of the modules without having to turn off the IQS-500 controller or expansion units.

To locate IQS modules:

From the **Tools** menu, select **System** > **Detect IQS Modules**.

Performing a Test

The test sequence you have built can be used immediately or saved it for future use. Once a test is underway, you can stop it and resume it later from the point it was stopped.

The application will guide you through the necessary steps from DUT creation to printing results. You can generate reports that are ISO/IEC 17025 compliant. They can take into account measurement uncertainties or not (i.e. pass or fail status without considering uncertainties). You can also export results to a PDF file.

Note: *It is also possible to perform several tasks, such as adding a new DUT or a new customer, directly from the application menus.*

Note: *When creating a new sequence, the system verifies that all necessary connected standards are present in the platform. If there are more connected standards of a particular kind than needed, the system reserves them in the detection order (unit 1 and slot 1, unit 1 and slot 2, and so on). If you would like to use other connected standards than the reserved ones, you must remove the undesired standards from the platform.*

WARNING

Do not install or terminate fibers while a light source is active. Never look directly into a live fiber and ensure that your eyes are protected at all times.

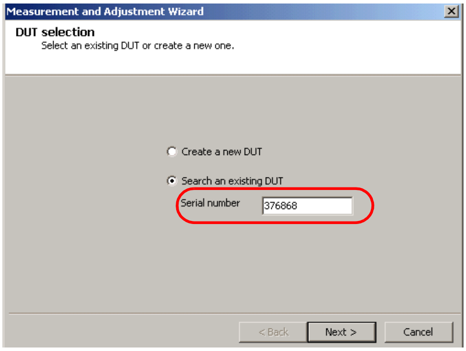
WARNING

Use of controls, adjustments and procedures for operation and maintenance other than those specified herein may result in hazardous radiation exposure.

To launch a test sequence:

1. From the **Operations** menu, click **Create Sequence**.
2. Select **Search an existing DUT** and enter the DUT serial number.

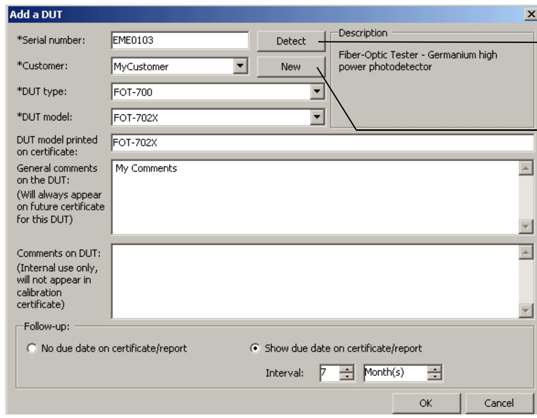
   If the DUT already exists in the database, the application will retrieve it. If it does not exist, the application will create it.

   If necessary, confirm the creation of the DUT.

Note: *If you click* ***Next*** *without entering a serial number, the application displays the list of created DUTs.*

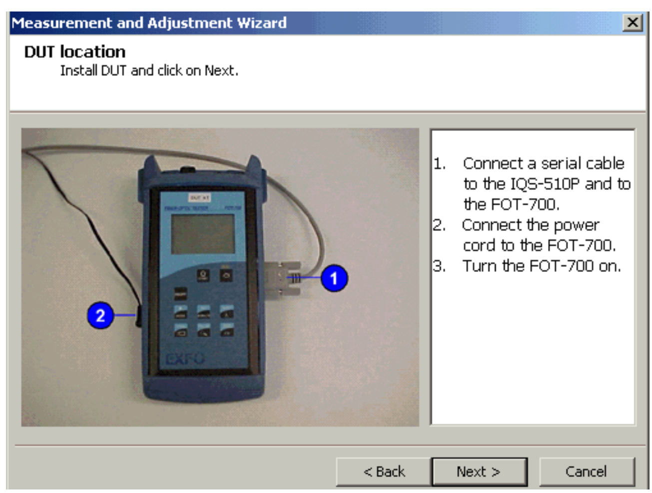
3. Enter the information in the appropriate boxes. Mandatory information is indicated by a “*”.



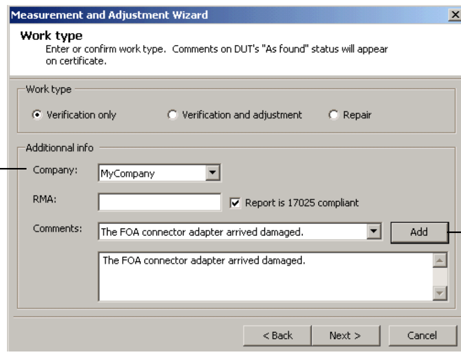
4. Click **OK** to confirm.

5. The application displays DUT information; click **Next**.

6. Prepare your DUT as shown on screen and click **Next**.



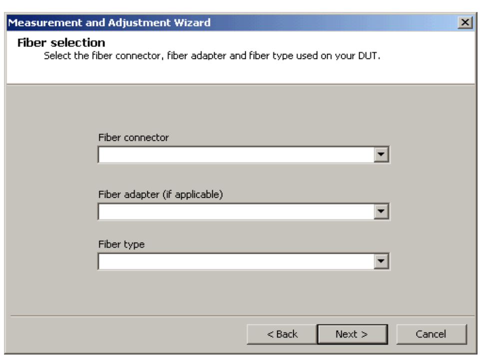
7. Under **Work type**, select the operation you want to perform. The available choices depend on the type of device you are testing and on available instruments.



8. Under **Additional info**, enter the information that will appear in the report.

9. Click **Next**.

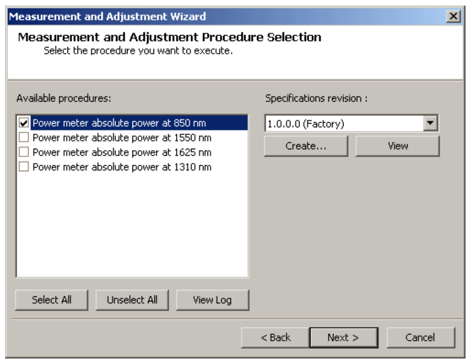
10. In the **Fiber selection** box, specify the fiber connector, the fiber adapter, and the fiber type you are using.



11. Click **Next**

12. From the **Measurement and Adjustment Procedure Selection** box, select the scenarios you want to include in your test sequence.

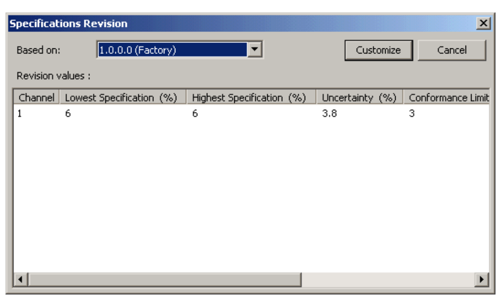
Note: *Some scenarios cannot be cleared from the list. These are mandatory scenarios and must be performed for the selected DUT.*



13. To create custom specifications for a scenario, proceed as follows:

13a. Select the scenario you want to customize and click **Create**.

13b. From the **Based on** list, select a set of specifications to be used as a template.



13c. Click **Customize** to create the new set of specifications and values.

13d. Click **OK**.

14. Back in the **Measurement and Adjustment Procedure Selection** box, make sure **Custom Specifications** appears in the **Specification revision** list.

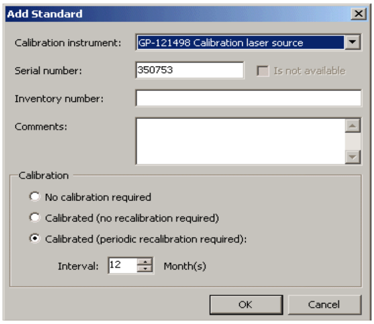
15. Click **Next** and click **Complete** to close the wizard.

The application will prompt you to confirm if you want to perform the acquisition now or later.

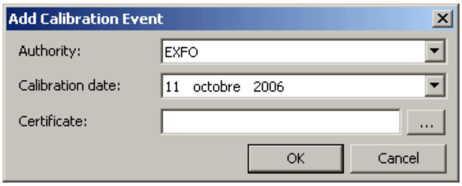
16. If the required standards have not been added to the database yet, the application will prompt you to add them; proceed as follows:

16a. Click **OK**.

16b. Enter the required information and click **OK**.



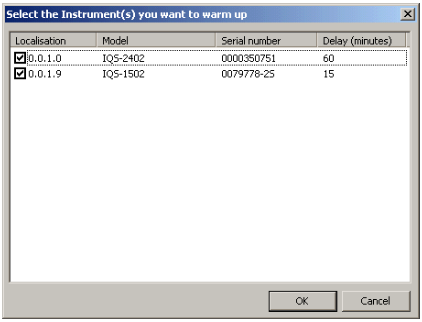
16c. Confirm the authority name and calibration date.



16d. Click [...] and link the calibration certificate file provided by the calibration authority.

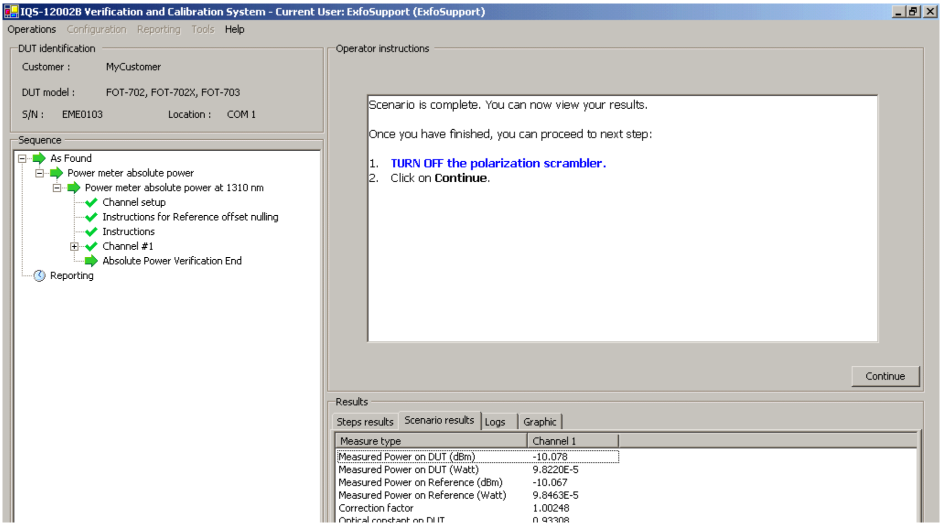
16e. Click **OK**.

17. When the application prompts you, select the instruments that must have a warmup period and click **OK**.



18. Follow the instructions appearing on screen.

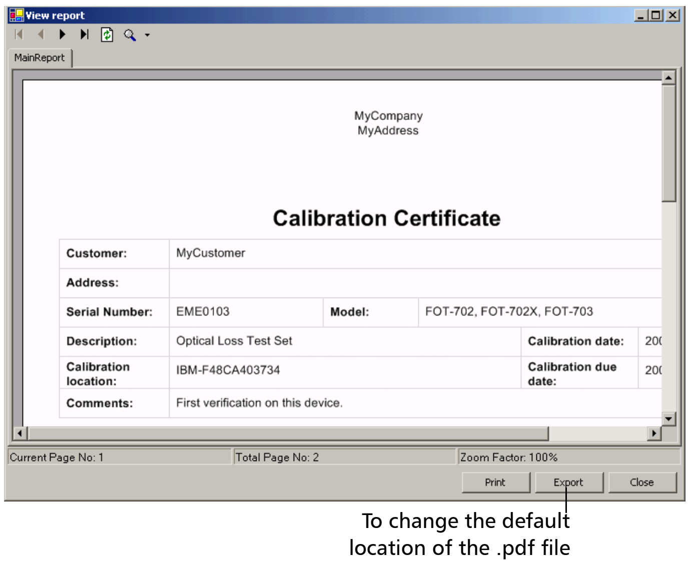
At the end of a scenario, the application displays the results.



Note: *Before printing the report, you can still modify the information it contains, but you cannot modify the measures.*

19. The application displays a preview of the report. It will also be possible to print or export results afterwards (see *Printing or Exporting Results* on page 37).

Note: *To let the application consider the test sequence completed, you must perform a print or export of the report. As long as this is not done, the sequence will remains in the Open Sequence dialog windows and the results will not be accessible in the DUT history or traceability reports.*



When you have finished, click **Close**.

To launch an existing test sequence:

1. From the **Operations** menu, click **Open Sequence**.

2. Follow the instructions appearing on screen.

To resume a test sequence:

From the **Operations** menu, click **Run Sequence**.

The application will resume the test from where it stopped.

Printing or Exporting Results

You can print or export results of the DUTs for previous test sequences.

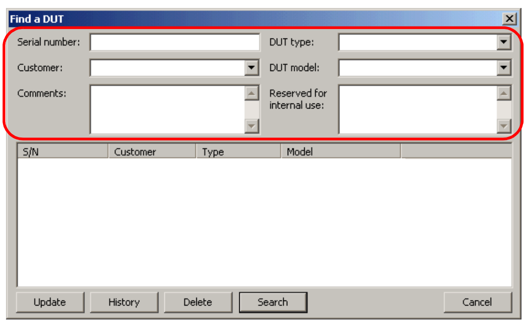
To print or export results:

1. From the **Configuration** menu, select **DUT** > **Search**.

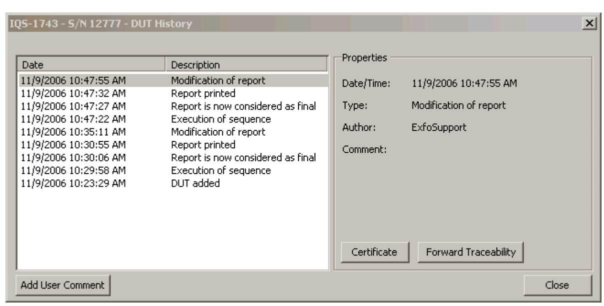
2. Enter criteria to retrieve the DUT information and click **Search**.

IMPORTANT

If you leave the Serial number box empty, the system will retrieve all DUTs matching the information entered in the other boxes and lists.



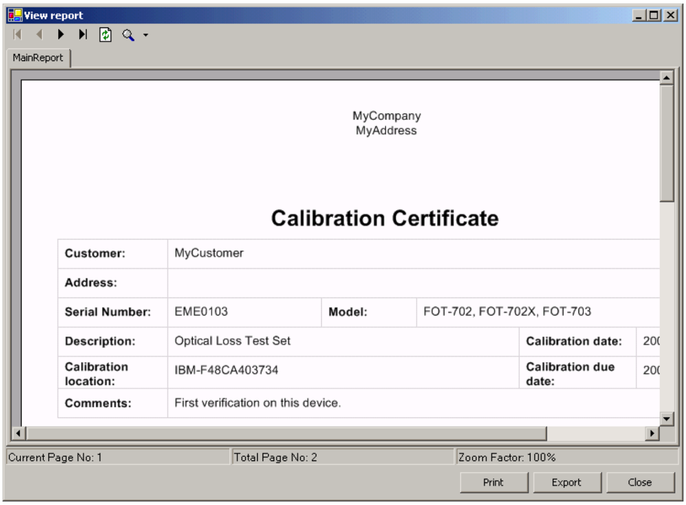
3. Click **History**.



4. From the **DUT History** box, select the row indicating that the report has been printed and click **Certificate**.

Note: *Upon clicking **Certificate**, the systems offers you the possibility to make modifications before printing the report. If you choose to do so, a box opens to let you make the changes and a note is automatically added in the “As found” and “As left” fields of the report.*

5. In the **View Report** box, click **Print**, or click **Export** to save the report in the PDF format.



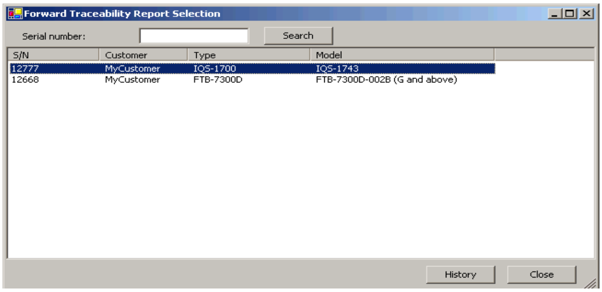
6. Click **Close**.

Printing Reports

You can view or print traceability results of the DUTs or Standards you have tested or used in previous test sequences.

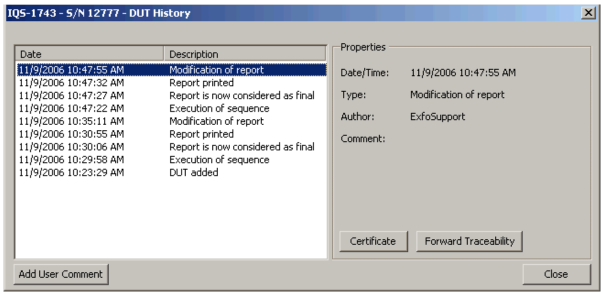
To view or print Forward Traceability results:

1. From the **Report** menu, click **Forward Traceability**.
2. In the **Serial number** box, type the DUT serial number (leave the box empty to get all tested DUTs) and click **Search**.



3. Select the desired DUT in the list.
4. Click **History**.

5. From the **DUT History** box, select the event for which you want to view the traceability information.

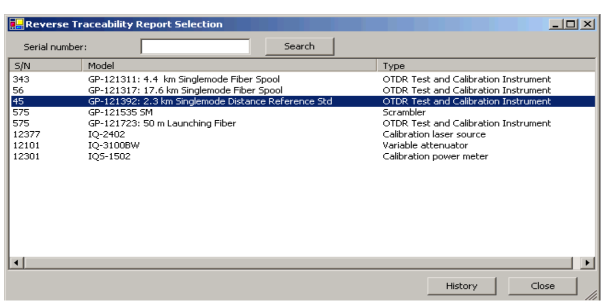


Note: *The information depends on the date of the selected event. On the Forward Traceability Report, the information starts with the date the DUT was added and ends with the date of the selected event. To see all the information, you must select the event with the most recent date.*

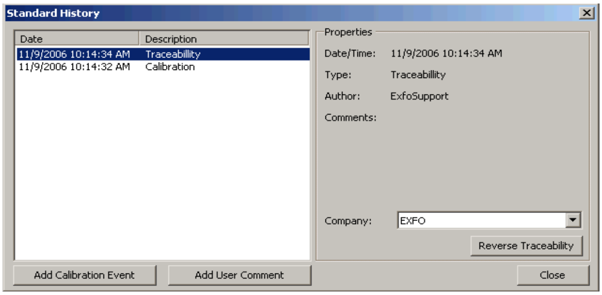
6. When the event is selected, click **Forward Traceability** to see the results.

To view or print Reverse Traceability results:

1. From the **Report** menu, click **Reverse Traceability**.
2. In the **Serial number** box, type the Standard serial number (leave the box empty to get all Standards) and click **Search**.



3. Select the desired Standard in the list.
4. Click **History**.
5. From the **Standard History** box, select the event for which you want to view the traceability information.



Note: *The information depends on the date of the selected event. On the Reverse Traceability Report, the information starts with the date of the last calibration and ends with the current date. To see all the information, you must select the event with the most recent date.To see all the information, you must select the date the Standard was first calibrated.*

6. Click **Reverse Traceability** to see the results.

5 Troubleshooting

This chapter presents a list of common problems and their solution, the technical support offered on the web and at EXFO facilities, and product shipping information.

Solving Common Problems

Problem	Possible cause	Solution
Communication loss between PC and IQS system	You have logged yourself out.	Logging out closes the communication port. Make sure that all operations of the IQS system are completed before you log out.
	The computer has gone into the stand-by mode.	Change the stand-by mode settings as follows: on the computer desktop, make a right-click and, on the contextual menu, click **Properties**. On the **Screen Saver** tab, click **Power** and, under **Settings for Home/Office Desk power scheme**, select **Never** in the three lists.
Instruments do not warm up properly		Try installing all your instruments (sources and calibration power meter) in the controller unit instead of the expansion units.
Error message “Warm-up has encountered an error.”		Restart the warm-up period as follows: From the **Tools** menu, select **System** > **Start Warmup**. If the instruments still do not warm-up properly, restart the system.
Getting a French message while calibrating the FTB-100B power meter.		It means that the serial link is available for calibration.

Problem	Possible cause	Solution
Error message “Catastrophic failure”	Incorrect connections for the FOT-10A or FOT-10A unit.	Disconnect the unit, close all applications, and restart the system. Make sure the connection procedure is properly done.
Calibration has a Fail in Distance result.	The automatic positioning of events for an FTB-7000B-B OTDR is incorrect.	Positioning must be done manually. Set marker A right before the reflective event at 50 m and marker B right before the end of fiber event.
Interruption of the dead zone calibration	The automatic positioning of the events is incorrect.	Make sure that the standard distance information include the 3-m patchcord as described in *Configuring the FTB-7000D OTDR on the IQS-12002B* on page 79.
Impossible to print information on a specific DUT.	This DUT has never been tested.	Test the DUT and try again.

Finding Information on the EXFO Web Site

The EXFO Web site provides answers to frequently asked questions (FAQs) regarding the use of your IQS-12002B Calibration System.

To access FAQs:

1. Type http://www.exfo.com in your Internet browser.
2. Click on the **Support** tab.
3. Click on **FAQs** and follow the on-screen instructions. You will be given a list of questions pertaining to your subject.

The EXFO Web site also provides the product’s most recent technical specifications.

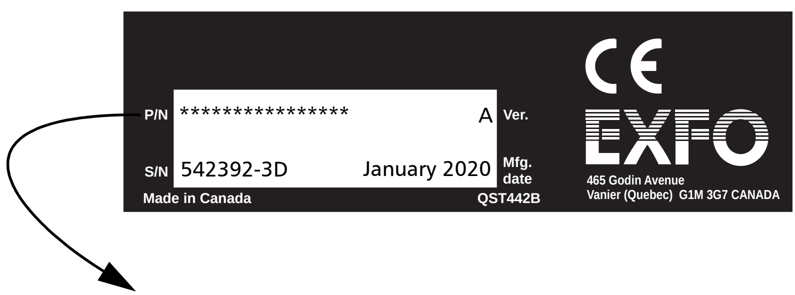
Contacting the Technical Support Group

To obtain after-sales service or technical support for this product, contact EXFO at one of the following numbers. The Technical Support Group is available to take your calls from Monday to Friday, 7:30 a.m. to 8:00 p.m. (Eastern Time in North America).

Technical Support Group
400 Godin Avenue
Quebec (Quebec) G1M 2K2
CANADA

1 866 683-0155 (USA and Canada)
Tel.: 1 418 683-5498
Fax: 1 418 683-9224
support@exfo.com

To accelerate the process, please have information such as the name and the serial number (see the product identification label—an example is shown below), as well as a description of your problem, close at hand.



IQS-12002B

Transportation

Maintain a temperature range within specifications when transporting the unit. Transportation damage can occur from improper handling. The following steps are recommended to minimize the possibility of damage:

- Pack the unit in its original packing material when shipping.
- Avoid high humidity or large temperature fluctuations.
- Keep the unit out of direct sunlight.
- Avoid unnecessary shock and vibration.

6 Maintenance

To help ensure long, trouble-free operation:

- Always clean fiber-optic connectors before using them.
- Keep the unit free of dust.
- Clean the unit casing and front panel with a cloth slightly dampened with water.
- Store unit at room temperature in a clean and dry area. Keep the unit out of direct sunlight.
- Avoid high humidity or significant temperature fluctuations.
- Avoid unnecessary shocks and vibrations.
- If any liquids are spilled on or into the unit, turn off the power immediately and let the unit dry completely.

WARNING

Use of controls, adjustments and procedures for operation and maintenance other than those specified herein may result in hazardous radiation exposure.

Cleaning EUI Connectors

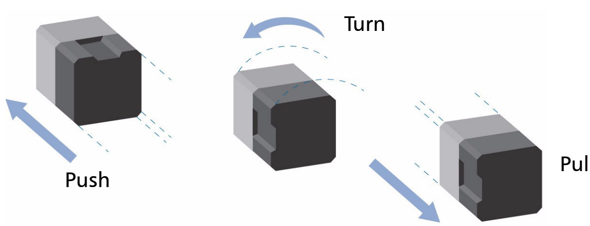
Regular cleaning of EUI connectors will help maintain optimum performance. There is no need to disassemble the unit.

IMPORTANT

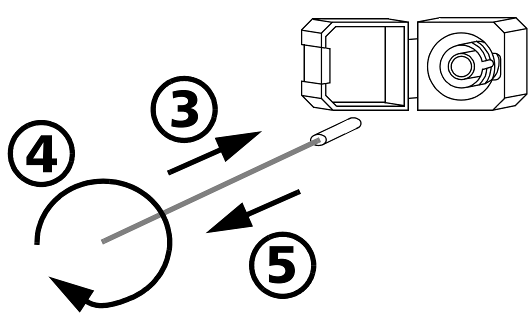
If any damage occurs to internal connectors, the module casing will have to be opened and a new calibration will be required.

To clean EUI connectors:

1. Remove the EUI from the instrument to expose the connector baseplate and ferrule.



2. Moisten a 2.5 mm cleaning tip with *one drop* of isopropyl alcohol (alcohol may leave traces if used abundantly).
3. Slowly insert the cleaning tip into the EUI adapter until it comes out on the other side (a slow clockwise rotating movement may help).



4. Gently turn the cleaning tip one full turn, then continue to turn as you withdraw it.
5. Repeat steps 3 to 4 with a dry cleaning tip.

Note: *Make sure you don't touch the soft end of the cleaning tip.*

6. Clean the ferrule in the connector port as follows:

   6a. Deposit *one drop* of isopropyl alcohol on a lint-free wiping cloth.

IMPORTANT

Isopropyl alcohol may leave residues if used abundantly or left to evaporate (about 10 seconds).

Avoid contact between the tip of the bottle and the wiping cloth, and dry the surface quickly.

   6b. Gently wipe the connector and ferrule.

   6c. With a dry lint-free wiping cloth, gently wipe the same surfaces to ensure that the connector and ferrule are perfectly dry.

   6d. Verify connector surface with a portable fiber-optic microscope (e.g., EXFO's FOMS) or fiber inspection probe (e.g., EXFO's FIP).

WARNING

Verifying the surface of the connector WHILE THE UNIT IS ACTIVE WILL result in permanent eye damage.

7. Put the EUI back onto the instrument (push and turn clockwise).
8. Throw out cleaning tips and wiping cloths after one use.

Cleaning Fixed Connectors

Regular cleaning of connectors will help maintain optimum performance. *Do not try to disassemble the unit. Doing so would break the connector.*

To clean fixed connectors:

1. Fold a lint-free wiping cloth in four to form a square.
2. Moisten the center of the lint-free wiping cloth with *only one drop* of isopropyl alcohol.

IMPORTANT

Alcohol may leave traces if used abundantly. Avoid contact between the tip of the bottle and the wiping cloth, and do not use bottles that distribute too much alcohol at a time.

3. Gently wipe the connector threads three times with the folded and moistened section of the wiping cloth.

IMPORTANT

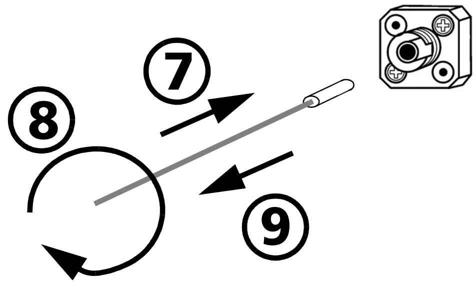
Isopropyl alcohol takes approximately ten seconds to evaporate. Since isopropyl alcohol is not absolutely pure, evaporation will leave microscopic residue. Make sure you dry the surfaces before evaporation occurs.

4. With a dry lint-free wiping cloth, gently wipe the same surfaces three times with a rotating movement.
5. Throw out the wiping cloths after one use.
6. Moisten a cleaning tip (2.5 mm tip) with *only one drop* of isopropyl alcohol.

IMPORTANT

Alcohol may leave traces if used abundantly. Avoid contact between the tip of the bottle and the cleaning tip, and do not use bottles that distribute too much alcohol at a time.

7. Slowly insert the cleaning tip into the connector until it reaches the ferrule inside (a slow clockwise rotating movement may help).



8. Gently turn the cleaning tip one full turn.
9. Continue to turn as you withdraw the cleaning tip.
10. Repeat steps 7 to 9, but this time with a dry cleaning tip (2.5 mm tip provided by EXFO).

Note: *Make sure you don't touch the soft end of the cleaning tip and verify the cleanliness of the cotton tip.*

11. Throw out the cleaning tips after one use.

Cleaning Detector Ports

Regular cleaning of detectors will help maintain measurement accuracy.

IMPORTANT
Always cover detectors with protective caps when unit is not in use.

To clean detector ports:

1. Remove the protective cap and adapter (FOA) from the detector.
2. If the detector is dusty, blow dry with compressed air.
3. Being careful not to touch the soft end of the swab, moisten a cleaning tip with *only one drop* of isopropyl alcohol.

IMPORTANT
Alcohol may leave traces if used abundantly. Do not use bottles that distribute too much alcohol at a time.

4. While applying light pressure (to avoid breaking the detector window), gently rotate the cleaning tip on the detector window.
5. Repeat step 4 with a dry cleaning tip or blow dry with compressed air.
6. Discard the cleaning tips after one use.

Cleaning the FOA Connector Adapter

Make sure that the FOA connector adapter is properly cleaned to assure its accuracy during calibration.

To clean your FOA connector adapter:

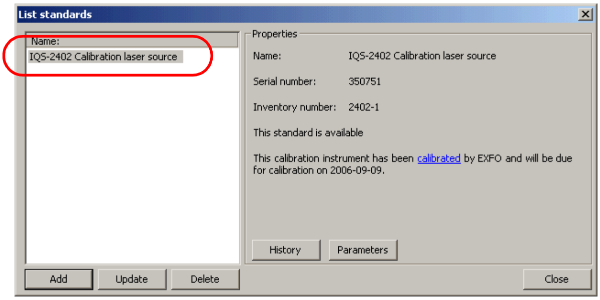
1. Remove the FOA from the instrument.
2. Slowly insert and gently rotate a cleaning tip that has been dipped in isopropyl alcohol into the FOA.
3. Insert a dry cleaning tip to dry.
4. Blow away any remaining lint with clean compressed air.
5. Use a metal wire (diameter smaller than 150 μm) and carefully insert it through the sleeve until it comes the other way through the pin-hole (200 μm).
6. Gently rotate the FOA around the wire to ensure that no particle remains.
7. Finally, whenever the proper instrumentation is available, a visual camera with enough magnification might allow to inspect the cleanliness of the FOA pin-hole.

Using a Standard after Recalibration

When a standard is back from recalibration, you must add its calibration information and certificate to the application's database. Otherwise, you will not be able to use the module.

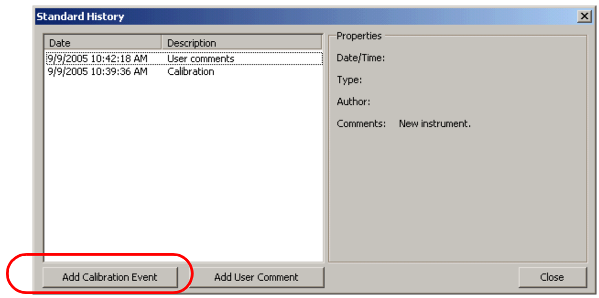
To use a standard after recalibration:

1. From the **Configuration** menu, click **Calibration Instruments**> **Standards**.
2. Select the appropriate standard from the list.

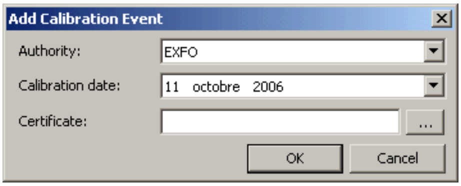


3. Click **History**.

4. Click **Add Calibration Event**.



5. The authority name and calibration date are automatically set.



Click ... and add the calibration certificate file.

6. When you have finished, click **OK**. Close all windows to return to the main window.

The newly calibrated standard is now available.

A Calibration Methods

This chapter presents the methods, on which are based the procedures of the IQS-12002B Calibration System., for the calibration of power meters and OTDRs.

Power Meter

The calibration of a power meter includes the calibration of its absolute power and, for a high-end unit (e.g., IQS power meter), the calibration of its linearity.

Absolute Power Calibration

Power meter calibration is performed by comparing it with an IQS-1502 Calibration Power Meter (working standard). Comparison between the two is done by measuring the output power of a laser source, such as the IQS-2400 (usually a DFB laser), having excellent wavelength and power stability.

In order to improve accuracy, the system can integrate a polarization scrambler, which reduces the uncertainty due to the polarization dependant response (PDR) of photo detectors.

For calibration at the 850-nm wavelength, the IQS-2400 uses a stabilized FP laser with the mandatory mode scrambler in order to obtain a stable laser source.

At all wavelengths, the output power of the laser sources is measured several times alternating between the calibration power meter and the power meter under test (DUT). A minimum of five responsivity constants are calculated for the DUT and are statistically analyzed to ensure that they are within appropriate limits (e.g. the calculated values must all be inside a certain range of values). Whenever one or more responsivity constants are outside the acceptable range, the measured values are considered invalid and the measurements have to be redone.

The number of measurements taken with the calibration power meter and the DUT, and the number of comparisons between the two units are set so as to reduce uncertainties of Type A. These uncertainties include connection uncertainty and interference due to reflections.

The system uses expanded uncertainty (U) values that are included in the report. The following tables present the method used to establish the uncertainty for calibration made at four wavelengths.

Power meter calibration at 850 nm @ 23 °C ± 1 °C

i	influence *Xi*	uncertainty		probability distribution	divisor	standard uncertainty $u(x_i)$	sensitivity coefficient c_i	Unit	uncertainty contribution $u_i(y)$ (dB)
1	**Factors related to the reference standard**			rectangular	1.73205	0.000	1	N/A	0.000
2	Incertitude d'étalonnage	3.00	%	normal	2	1.500	1	N/A	1.500
3	Ref non-linearity	0.25	%	rectangular	1.73205	0.144	1		0.144
4	Ageing	0.00	%	rectangular	1.73205	0.000	1		0.000
5	Ref temperature dependance	1.00	%/°C	rectangular	1.73205	0.577	0.01	°C (variation)	0.006
6	Ref PDR (½ (max-min))	0.64	%	rectangular	1.73205	0.370	1		0.370
7	Ref Dependance on spectral bandwith	0.00	%	rectangular	1.73205	0.000	1	ratio applicability	0.000
8	1/2 Ref's Resolution	0.01	%	rectangular	1.73205	0.006	1		0.006
9	**Factors related to the DUT**			rectangular	1.73205	0.000	1		0.000
10	DUT temperature dependance	1.00	%/°C	rectangular	1.73205	0.577	1	°C (variation)	0.577
11	DUT's Dependance on spectral bandwith	0.00	%	rectangular	1.73205	0.000	1		0.000
12	DUT's PDR (½ (max-min))	0.35	%	rectangular	1.73205	0.202	1	ratio applicability	0.202
13	1/2 DUT's Resolution	0.120	%	rectangular	1.73205	0.069	1		0.069
14				rectangular	1.73205	0.000	1		0.000
15				rectangular	1.73205	0.000	1		0.000
16	**Combined effects**			rectangular	1.73205	0.000	1		0.000
17	Wavelength dependance DUT versus reference std	1.500	%/nm	rectangular	1.73205	0.866	0.5	nm	0.433
18	Source stability	0.48	%	rectangular	1.73205	0.277	1		0.277
19				rectangular	1.73205	0.000	1		0.000
20				rectangular	1.73205	0.000	1		0.000
21				U-shaped	1.41421	0.000	1		0.000
22				rectangular	1.73205	0.000	1		0.000
23				rectangular	1.73205	0.000	1		0.000
24	TYPE A UNCERTAINTY (includes interferance and FOA)	1.50	%	3 measures	1.73205	0.866	1		0.866
y									1.950

coverage facto	k =	2
expanded uncertainty	U =	3.9

S=	5.0
Limit 1=	1.8
Limit 3=	8.2

Power meter calibration at 1310 nm and 1550 nm @ 23 °C ± 1 °C

i	influence *Xi*	uncertainty	Unit	probability distribution	divisor	standard uncertainty *u*(*xi*)	sensitivity coefficient *ci*	Unit	uncertainty contribution *ui*(*y*) (dB)
1	**Factors related to the reference standard**			rectangular	1.73205	0.000	1		0.000
2	Incertitude d'étalonnage	2.00	%	normal	2	1.000	1		1.000
3	Ref non-linearity	0.25	%	rectangular	1.73205	0.144	1		0.144
4	Ageing	0.00	%	rectangular	1.73205	0.000	1		0.000
5	Ref temperature dependance	1.00	%/°C	rectangular	1.73205	0.577	0.01	°C (variation)	0.006
6	Ref PDR (½ (max-min))	0.64	%	rectangular	1.73205	0.370	0.1	ratio applicability	0.037
7	Ref Dependance on spectral bandwith	0.00	%	rectangular	1.73205	0.000	1		0.000
8	1/2 Ref's Resolution	0.01	%	rectangular	1.73205	0.006	1		0.006
9	**Factors related to the DUT**			rectangular	1.73205	0.000	1		0.000
10	DUT temperature dependance	1.00	%/°C	rectangular	1.73205	0.577	1	°C (variation)	0.577
11	DUT's Dependance on spectral bandwith	0.00	%	rectangular	1.73205	0.000	1		0.000
12	DUT's PDR (½ (max-min))	0.35	%	rectangular	1.73205	0.202	0.1	ratio applicability	0.020
13	1/2 DUT's Resolution	0.120	%	rectangular	1.73205	0.069	1		0.069
14				rectangular	1.73205	0.000	1		0.000
15				rectangular	1.73205	0.000	1		0.000
16	**Combined effects**			rectangular	1.73205	0.000	1		0.000
17	Wavelength dependance DUT versus reference std	1.000	%/nm	rectangular	1.73205	0.577	0.5	nm	0.289
18	Source stability	0.12	%	rectangular	1.73205	0.069	1		0.069
19				rectangular	1.73205	0.000	1		0.000
20				rectangular	1.73205	0.000	1		0.000
21				U-shaped	1.41421	0.000	1		0.000
22				rectangular	1.73205	0.000	1		0.000
23				rectangular	1.73205	0.000	1		0.000
24	TYPE A UNCERTAINTY (includes interferance and FOA)	1.50	%	3 measures	1.73205	0.866	1		0.866
y									1.483

coverage factor	k =	2
expanded uncertainty	U =	3.0

Note 1: If there is a polarisation scrambler, the Detector's PDR can be neglected

S=	5.0
Limit 1=	2.6
Limit 3=	7.4

Power meter calibration at 1625 nm @ 23 °C ± 1 °C

i	influence Xi	uncertainty	Unit	probability distribution	divisor	standard uncertainty u(xi)	sensitivity coefficient ci	Unit	uncertainty contribution ui(y) (dB)
1	**Factors related to the reference standard**			rectangular	1.73205	0.000	1		0.000
2	Incertitude d'étalonnage	3.00	%	normal	2	1.500	1		1.500
3	Ref non-linearity	0.25	%	rectangular	1.73205	0.144	1		0.144
4	Ageing	0.00	%	rectangular	1.73205	0.000	1		0.000
5	Ref temperature dependance	1.00	%/°C	rectangular	1.73205	0.577	0.01	°C (variation)	0.006
6	Ref PDR (½ (max-min))	0.90	%	rectangular	1.73205	0.520	0.1		0.052
7	Ref Dependance on spectral bandwith	0.00	%	rectangular	1.73205	0.000	1	ratio applicability	0.000
8	1/2 Ref's Resolution	0.01	%	rectangular	1.73205	0.006	1		0.006
9	**Factors related to the DUT**			rectangular	1.73205	0.000	1		0.000
10	DUT temperature dependance	1.00	%/°C	rectangular	1.73205	0.577	1	°C (variation)	0.577
11	DUT's Dependance on spectral bandwith	0.00	%	rectangular	1.73205	0.000	1		0.000
12	DUT's PDR (½ (max-min))	0.90	%	rectangular	1.73205	0.520	0.1	ratio applicability	0.052
13	1/2 DUT's Resolution	0.120	%	rectangular	1.73205	0.069	1		0.069
14				rectangular	1.73205	0.000	1		0.000
15				rectangular	1.73205	0.000	1		0.000
16	**Combined effects**			rectangular	1.73205	0.000	1		0.000
17	Wavelength dependance DUT versus reference std	-1.250	%/nm	rectangular	1.73205	-0.722	0.5	nm	-0.361
18	Source stability	0.12	%	rectangular	1.73205	0.069	1		0.069
19				rectangular	1.73205	0.000	1		0.000
20				rectangular	1.73205	0.000	1		0.000
21				U-shaped	1.41421	0.000	1		0.000
22				rectangular	1.73205	0.000	1		0.000
23				rectangular	1.73205	0.000	1		0.000
24	TYPE A UNCERTAINTY (includes interferance and FOA)	1.50	%	3 measures	1.73205	0.866	1		0.866
y									1.871

coverage factor	k =	2
expanded uncertainty	U =	3.7

Note 1: If there is a polarisation scrambler, the Detector's PDR can be neglected

S=	5.0
Limit 1=	1.9
Limit 3=	8.1

Linearity Calibration

The nonlinearity of the power meter should be calibrated to ensure accurate measurements at power levels different from the calibration level and for relative measurements such as loss and gain measurements. Nonlinearity is the relative difference between the response at a given power (P) and the reference power (P_0):

$$NL = \frac{\Re(P)}{\Re(P_0)} - 1$$

The calibration should be made by increasing and decreasing the power level to detect nonlinearities over each amplifier range and, whenever possible, at both sides of each amplifier boundary in order to include nonlinearities at the switching between scales. Detector nonlinearity is dependent on the wavelength. For example, an InGaAs detector linear at 1310 nm and 1550 nm may be nonlinear at 850 nm.

The method privileged by the international standard on power meter calibration (IEC 61315 Ed. 2.0 b:2005) is the superposition method. It is the most accurate and does not require a reference standard as it is a self-calibrating (ratio-type) method. It consists in verifying that the sum of the power read in each branch of a 1 × 2 coupler is equal to the total power read when measuring the two branches simultaneously. This is performed over the useful dynamic range of the DUT.

However, before performing the linearity calibration, both branch of the coupler have to be balanced (i.e. have the same output power). Balancing the linearity setup is the basis of this method. It requires a subscript coupler to split the power in two and a shutter on both branches in order to block light or let it through. Power is then recombined using a second coupler before sending the light to the power meter under test. A variable attenuator on each path is very useful in order to match the output power of each branch of the coupler. Finally, the power coming from each individual branch (P_a and P_b) and also from both branches (P_{total}) is measured on the photo detector. The deviation of P_{total} from $P_a + P_b$ is the local nonlinearity (NLL).

By using an attenuator between the source and the first splitter, the total power is attenuated by a factor of 2 (~3 dB) with respect to the previous step. Adding the local nonlinearities and referencing to the reference power, we obtain the total linearity error (NLglobal), starting from the reference power level where the nonlinearity is zero. This process is repeated throughout the desired range.

The following is the procedure to measure nonlinearity using the superposition method.

To measure nonlinearity:

1. Set the attenuators in the two paths so that the power measured on the meter is the same whether the light is coming from branch a or from branch b.
2. Open both shutters and measure the total power from both branches simultaneously: $P_{total,i}$.
3. Close the shutter on branch b and measure the power on branch a: $P_{a,i}$.
4. Close the shutter on branch a, open the shutter on branch b, and measure the power on branch b: $P_{b,i}$.
5. Add the individual power measurements.

   If the sum is not equal to the total power measurement, the DUT presents nonlinearity.

$$NL_{\mathrm{i}} = 10 \times \log_{10} \frac{P_{\mathrm{total,i}}}{P_{\mathrm{a,i}} + P_{\mathrm{b,i}}} (\mathrm{dB})$$

6. Using the first attenuator, attenuate the total power by the following factor to the level of the sum of the individual power measurements calculated in step 5.

$$10 \log 2 \cong 3{,}01 \text{ dB}$$

7. Repeat steps 2 through 6 to cover the desired range.

8. At the end, the global nonlinearity is the sum of all the local nonlinearities expressed in decibels (dB), starting calculations from the reference power level where the nonlinearity is zero (higher order terms are negligible).

The equations to use are as follows:

For n < 0

$$NL_{\text{global}}(P_{\text{n}}) = -\sum_{i=0}^{n+1} NL_{\text{i}}$$

For n = 0

$$NL_{\text{global}}(P_0) = 0$$

For n > 0

$$NL_{\text{global}}(P_{\text{n}}) = +\sum_{i=1}^{n} NL_{\text{i}}$$

where:

n < 0 indicates power levels lower than the reference power.

n > 0 indicates power levels higher than the reference power.

NL_i is the local nonlinearity for the step (i = 0 for the step where P_{ab} is the reference power).

The result is a list of global nonlinearities for the whole power range in steps of 3,01 dB.

The largest nonlinearity relative to the reference power is:

$$NL_{max} = \pm \max(|NLglobal|)(dB)$$

This procedure can be performed with decreasing and/or increasing the power sent to the DUT.

To cover a bigger area of the power meter range, once the test done by *decreasing* the power is completed, shift the first attenuator by 1.5 dB and then start the test at increasing power levels.

Typical uncertainties of this method include:

➤ All possible power fluctuations while measuring P_a, P_b, and P_{total} such as fluctuations of the source due to drifts.

➤ Improper balancing of the output powers of each coupler branch (P_a and P_b). If balancing is not correctly done, the global linearity cannot be easily inferred).

➤ Sensitivity to changing reflections.

➤ Instabilities due to interference if the coherence length of the laser is too large.

➤ Polarization sensitivity of the power meter and attenuators (when applicable).

➤ Resolution of the power meter.

➤ Difference between the individual powers of each step ($P_{a,i}$ and $P_{b,i}$) compared to the total power of the next step ($P_{total,i+1}$) (for calculating global linearity).

The errors for each step are cumulative and will add to the errors of the preceding steps.

The system uses an expanded uncertainty (U) value that is included in the report. The following table presents the method used to establish the uncertainty for the linearity calibration.

Power meter nonlinearity calibration uncertainty

i	influence *Xi*	uncertainty	Unit	probability distribution	divisor	standard uncertainty *u*(*xi*)	sensitivity coefficient *ci*	Unit	uncertainty contribution *ui*(*y*) (dB)
1	Source stability ans sensitivity to reflections)	0.004	dB	rectangular	1.73205	0.002	0.5	N/A	0.001
2	Detector PDR	0.025	dB	rectangular	1.73205	0.014	0	N/A	0.000
3	Attenuator PDR	0.300	dB	rectangular	1.73205	0.173	0	N/A	0.000
4	Instabilities due to Mach-Zender interf	0.000	dB	rectangular	1.73205	0.000	1	N/A	0.000
5	Improper balancing	0.000	dB	rectangular	1.73205	0.000	1	N/A	0.000
6	½ resolution	0.0005	dB	rectangular	1.73205	0.000	1	N/A	0.000
7			dB	rectangular	1.73205	0.000	1	N/A	0.000
y									0.0012

coverage factor	k =	2
expanded uncertainty	U =	0.0024

Note 1: If there is a polarisation scrambler, the PDL of the detector and the attenuator can be ignored

FTB-7000D and FTB-7000B-B OTDR Modules

Calibration of the FTB-7000D OTDR includes the event and attenuation dead zones, dynamic range, injection levels, linearity, front connector position, and distance. Calibration of the FTB-7000B-B family, includes test or verification of event and attenuation dead zones, dynamic range, injection level, and distance.

The verification of the technical specifications such as dead zones, linearity, and dynamic range are more a validation of the expected instrument performance. However, for an OTDR to produce accurate distance measurements, a calibration is required and may include some adjustments.

For any test or calibration, make sure that the front connector of the OTDR is clean and does not present scratches. If the connector is damaged, it must be replaced, and Repair must be selected in the Work type box (refer to step 7 on page 32) of the IQS-12002B application: no measurements, for which the results would appear in the “As found” section of the report, will be performed.

Note: *All measurements performed on the FTB-7000B-B are to be manually done and entered as per the instructions given in the IQS-12002B system.*

Dynamic Range Test

The dynamic range is verified using various combinations of pulse duration and distance range with the averaging time set at 45 s. Only one pulse duration is included in the calibration report, usually 10 μs for singlemode and 1 μs for multimode. The dynamic range is the difference (in dB) between the launch level (backscatter trace extrapolated at distance zero) and the noise floor. The noise floor has many definitions, but the one mostly accepted in the fiber-optic industry is when the signal-to-noise ratio equals 1 (SNR = 1). For EXFO OTDRs, we use custom software that measures the noise floor on the raw data (before conversion in dB), which is the only way to properly evaluate the standard deviation at the noise floor level.

When trying to measure the dynamic range, the main difficulty is to determine the proper noise floor. In general, alternative noise floor definitions are used (e.g. peak noise level or 98 % noise level) and are then converted to SNR = 1. Because the interpretation of noise is difficult and the correct evaluation of the noise floor, when the raw data is not available, is hard to make, and also because noise has different definitions, it is not uncommon to find deviations of up to 2 dB between measurements done with EXFO's IQS-12002B software and done manually without raw data.

The software indicator of the injection level at each pulse is also verified when measuring the dynamic range. The results might indicate that an adjustment is required for one or more pulses. Note that a failure on an injection level test does not imply a failure on the dynamic range; these are separate parameters. Moreover, the injection level being only a visual indicator, its result is not shown on the calibration certificate.

Note: *There is no uncertainty value associated with this measurement.*

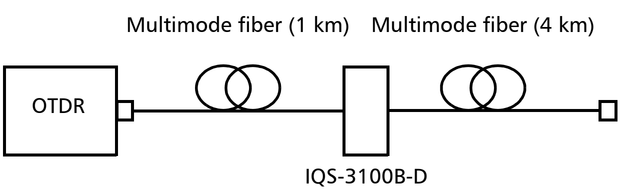
Linearity Test

Linearity is verified by looking at variations in loss measurements made over a same portion of fiber at different levels of attenuation (a variable optical attenuator (VOA) is included in the IQS-12002B Calibration System). This is performed at the shortest wavelength present in the unit both each multimode and singlemode ports. The pulse used for multimode wavelengths is 1 μs and, for singlemode wavelengths, it is 10 μs. In both cases, the averaging time is set at 45 s.

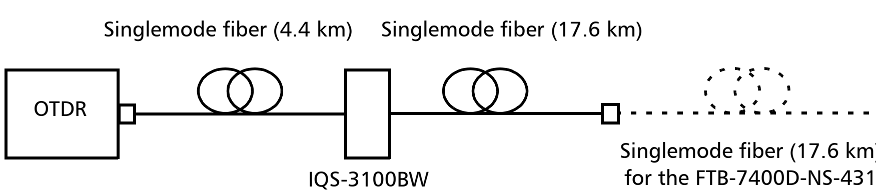
IMPORTANT

Linearity is not tested on FTB-7000B-B OTDR modules.

The setup for linearity measurements of multimode OTDRs (7000D series) is as follows:



The setup for linearity measurements of singlemode OTDRs (7000D series) is as follows:



Note: *For the FTB-7400D-NS-431, a second fiber length of 17.6 km is required.*

The fiber section chosen for the loss measurement must be as far as possible from the VOA to reduce errors due to recovery on the OTDR. Usually, the fiber section is chosen to roughly emulate a 0.5-dB loss.

The initial measurement, performed at the minimum attenuation of the VOA, is considered as the reference loss (A_{ref}). Following measurements are done at higher attenuation. The OTDR loss measurements (A_{otdr}) must meet the linearity criteria where nonlinearity (NL) is calculated this way:

$$NL = \pm \max \left| \frac{A_{otdr}}{A_{ref}} - 1 \right|$$

The linearity specification must be met for a given attenuation range. This range depends on the OTDR type, the pulse, and the wavelength. The attenuation range is limited by noise on the trace or recovery after the VOA.

Note: *There is no uncertainty value associated with this measurement.*

Distance Calibration

An OTDR calculates the length of a fiber section by measuring the time of flight of a light pulse between its launch point and the detection of a fraction of its reflection. Using the time of flight, the speed of light, and the index of refraction of the fiber, one can calculate the length of a fiber link.

Before starting the distance calibration procedure, the position of the front connector must be verified and adjusted if necessary.

Front Connector Position

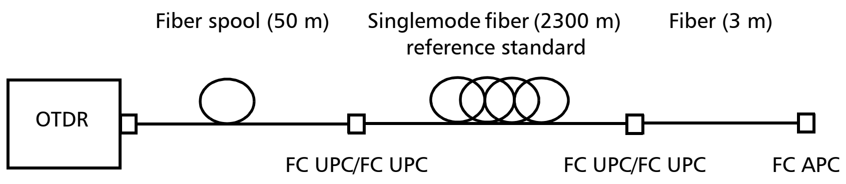
To determine the position of the front connector, a section of fiber of a known length is installed at the output of the OTDR. Its length, usually around 15 m, is measured using a calibrated measurement ribbon. The front connector position is determined by using the calibrated length of this 15-m fiber as determined by the OTDR. The position of the front connector is recorded in the OTDR permanent memory and will be used to correctly locate any event measured with the OTDR.

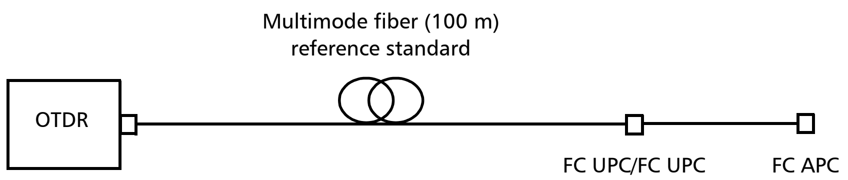
Note: *This calibration is not performed for an FTB-7000B-B OTDR module.*

Distance Calibration Method

Distance is calibrated with the use of a reference fiber that is traceable to a national metrology institute (e.g. METAS, NPL, NIST, NRC).

The following diagram shows the setup used by EXFO for distance calibration.





For multimode OTDRs, calibration is performed on the same fiber for both 50/125 and 62/125 OTDRs (the difference in dispersion in the fiber has a negligible impact). A 3-meter test Jumper is connected at the far end of the reference fiber in order to have a similar reflection at both ends.

For singlemode calibration, since the OTDR could be equipped with an output APC connector, the setup requires a short fiber spool (about 50 m ±1 m) to be installed before the reference fiber. This is done so that you can set markers at each end of a known reflection of similar level (as that given by FC UPC to FC UPC connectors: about 55 dB). This also has the great advantage of allowing the use of an uncalibrated test jumper to connect an OTDR, equipped with an APC connector at the output, to the short fiber spool of 50 m.

Distance Measurement Specification

Distance specification depends on the location offset, distance scale deviation, and sampling resolution.

$$S = \pm(\text{location offset} + \text{scale deviation} \times \text{distance} + \text{sampling resolution})$$

For example, for an OTDR of the FTB-7000D family, the distance specification is:

$$S = \pm(0.75 + 0.0025\ \% \times \text{distance} + 0{,}04)\ \text{m}$$

Note: *For FTB-7000B-B, displayed resolution is 1 m for a distance between markers greater than 1 km. Therefore, specification is to be evaluated according to S = ±(1 + 0.0025 % x distance + 1) m.*

The OTDR specification for distance depends on the range and pulse duration used, as they will determine the sampling resolution on the trace.

Also, as the optical path changes with wavelength (because of the fiber effective index dependence on wavelength) and due to the fact that fiber calibration is performed using a normalized index of refraction of 1.46, the optical distance of the reference fiber changes with the OTDR wavelength. The equation which describes the difference in the optical length due to the difference between the calibration wavelength and the actual wavelength of the OTDR is:

$$\delta L_{\lambda} := \text{Lcal} \cdot \frac{S0}{8} \cdot \left[\lambda^2 - \lambda\text{cal}^2 + \lambda 0^4 \cdot \left(\lambda^{-2} - \lambda\text{cal}^{-2} \right) \right] \cdot \frac{c}{N}$$

where:

S0 is the zero dispersion slope in ps/(nm^2 * km), as given by the fiber manufacturer.

For example, Corning gives as a typical value, for the SMF-28 fiber, an S0 coefficient of 0.086 ps/(nm^2 * km), with a maximum value of 0.092 ps/(nm^2 * km), at a λ0 of 1311.5 nm ±10 nm.

EXFO determines the true central wavelength and distribution for the type of lasers used in an OTDR family (e.g., FTB-7000D, AXS-100). The reference distance used in the OTDR calibration takes into account the true central wavelength of the OTDR family. The following table is an example for an OTDR of the FTB-7000D family.

Calibration conditions for fiber reference standard					
Calibration wavelength in vacuum	1308.65		1552.72		nm
Calibrated length	2531.61		2532.72		m
Uncertainty of calibrated length	0.04		0.04		m
Calibration temperature	23	°C	±	1	°C

Calibrations conditions for the FTB-7000D					
Nominal wavelength (nm)	1310	1383	1490	1550	1625
OTDR central wavelength (nm)	1309	1383	1491.4	1548.2	1622.7
Uncertainty on OTDR central wavelength (nm)	24.3	20	4.4	24	11
Factors for evaluating OTDR specifications					
Offset (±0.75 m or ±1 m)	0.75	0.75	0.75	0.75	0.75
Scale factor (0.0025 % or 0.005 %)	0.000025	0.000025	0.000025	0.000025	0.000025
Resolution_DUT-OTDR (m)	0.04	0.04	0.04	0.04	0.04
Calibration temperature	23	°C	±	2	°C

Results for IQS-12002B					
Nominal wavelength (nm)	1310	1383	1490	1550	1625
Optical length at central wavelength (m)	2531.610	2531.714	2532.255	2532.682	2533.381
Uncertainty (m)	0.071	0.104	0.089	0.242	0.160

Uncertainties

The uncertainties for distance calibration are as follows:

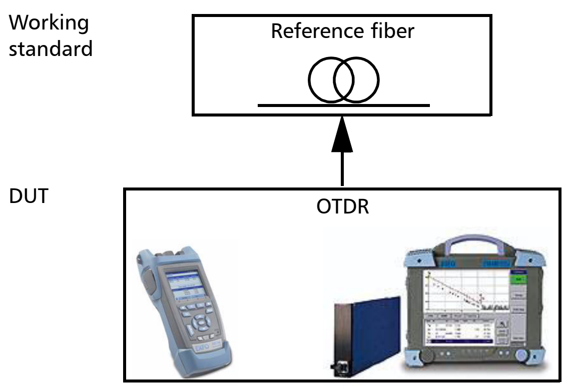
- Reference fiber (as per the calibration certificate issued by the national laboratory where the fiber was calibrated).
- Environment temperatures.
- Chromatic dispersion.
- Wavelength differences: calibration wavelength for the reference fiber versus OTDR wavelength, and OTDR wavelength uncertainties.
- OTDR resolution.

Traceability

Distance calibration is performed by comparing the length of a reference fiber (traceable to a national metrology institute) as measured by the OTDR under test with the reference fiber length given by the specification.

Reference fibers are calibrated at NPL (National Physical Laboratory in the UK) or METAS (Swiss Federal Office for Metrology).

EXFO traceability of OTDRs



Reference fiber calibration is traceable to the national metrology of Switzerland, named METAS or Swiss Federal Office for Metrology.

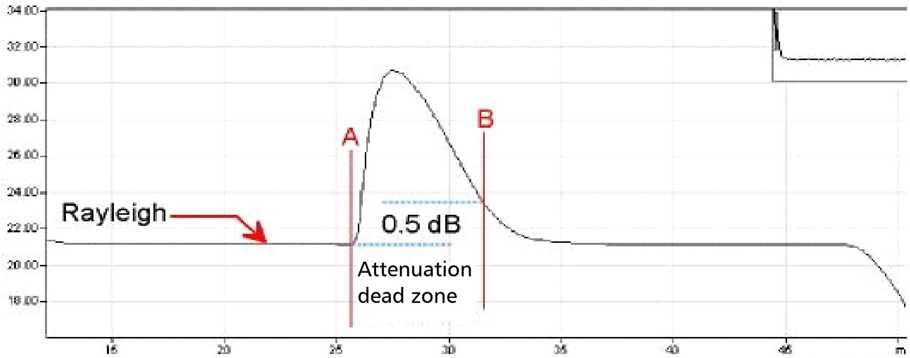
Dead Zone Calibration

The dead zone depends on the intensity of the reflectance. Compliance to the specification must be done for a reflectance of –35 dB in multimode and –45 dB in singlemode.

Note: *There is no uncertainty value associated with this calibration.*

Attenuation Dead Zone

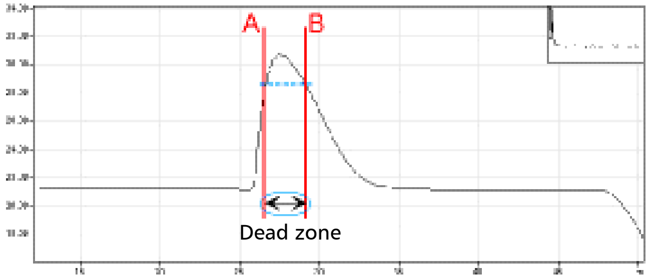
The attenuation dead zone is the distance between markers A and B on the OTDR trace presented below.



Marker A is positioned at the rising edge of the reflective event. Marker B is positioned within the falling edge, 0.5 dB above the backscatter level.

Event Dead Zone

The event dead zone is the distance between markers A and B on the OTDR trace presented below.



Markers are positioned on both side of the peak, 1.5 dB below the maximum peak value.

B Configuring the FTB-7000D OTDR on the IQS-12002B

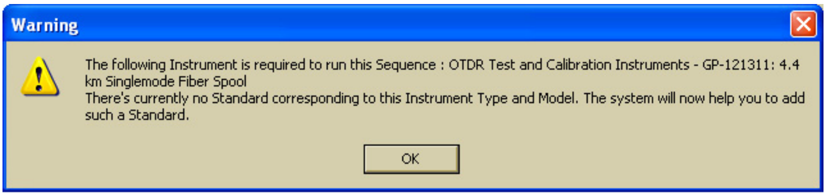
Test equipment is configured at the factory before shipping. The procedures presented in this document address the case when the IQS-12002B detects a new instrument or when a particular instrument has not been configured.

Note: *The given instructions are for the singlemode FTB-7000D OTDR; however, you can use the same procedures for the multimode model (lengths, tolerances, and uncertainties can differ).*

The following table shows the list of calibration instruments and standards for the singlemode and the multimode OTDRs.

Calibration Instruments and Standards for Singlemode OTDR	Calibration Instruments and Standards for Multimode OTDR
GP-121311: 4.4-km fiber spool	GP-121492: 1-km multimode fiber spool
GP-121317: 17.6-km fiber spool	GP-121490: 4-km multimode fiber spool
IQS-3100BW Variable Attenuator	IQS-3100B-D Variable Attenuator
GP-121723: 50-m launch fiber	Useless for multimode calibration
GP-121392: distance reference standard	GP-121489: multimode distance reference standard
GP-121310: singlemode front-connector position (for UPC connectors)	GP-121487: multimode front-connector position (for UPC connectors)
GP-120963: singlemode dead zone	GP-121200: multimode dead zone
GP-121310: singlemode front-connector position (for APC connectors)	GP-121487: multimode front-connector position (for APC connectors)

When you create a test sequence for an FTB-7000D, you may receive the following message:



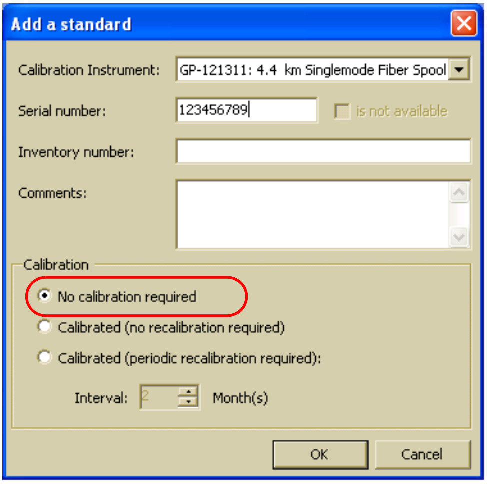
Click **OK** to proceed with the creation of a calibration instrument.

Creating the GP-121311: 4.4-km Fiber Spool as a Calibration Instrument

This section presents the procedure to create the 4.4-km fiber spool as a calibration instrument.

To create the calibration instrument:

1. From the **Add a standard window**, enter the relevant information:



1a. Match the calibration instrument appearing in the **Calibration Instrument** list to the instrument you intend to create.

The calibration name will be displayed in the **Calibration Instrument** list.

1b. Enter the instrument serial number.

1c. Enter the inventory number and comments if necessary.

Note: *When the basic model of the calibration instrument is configured to appear in the Calibration Certificate produced by the IQS-12002B, the information that you enter in the Inventory number text box will appear in the Calibration Certificate in the section entitled Standards used to establish traceability.*

1d. Select **No calibration required.**

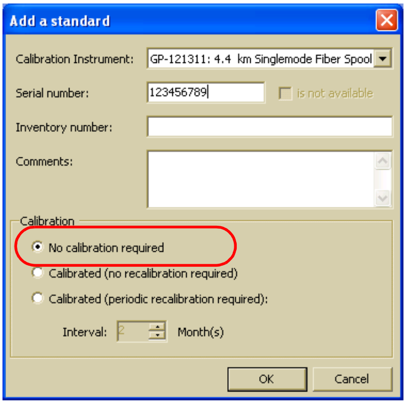
2. Click **OK**.

Creating the GP-121317: 17.6-km Fiber Spool as a Calibration Instrument

This section presents the procedure to create the 17.6-km fiber spool as a calibration instrument.

To create the calibration instrument:

1. From the **Add a standard** window, enter the relevant information:



1a. Match the calibration instrument appearing in the **Calibration Instrument** list to the instrument you intend to create.

The calibration name will be displayed in the **Calibration Instrument** list.

1b. Enter the instrument serial number.

1c. Enter the inventory number and comments if necessary.

Note: *When the basic model of the calibration instrument is configured to appear in the Calibration Certificate produced by the IQS-12002B, the information that you enter in the **Inventory number** text box will appear in the section entitled Standards used to establish traceability.*

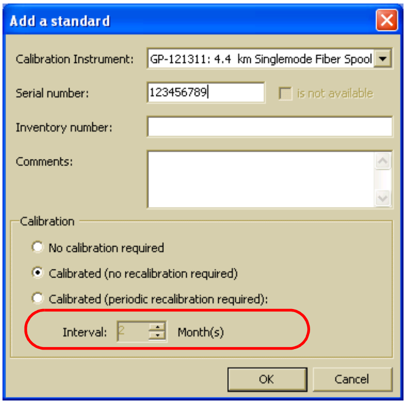
1d. Select **No calibration required** and click **OK**.

Creating the IQS-3100BW Variable Attenuator as a Calibration Instrument

This section presents the procedure to create the IQS-3100BW Variable Attenuator as a calibration instrument.

To create the calibration instrument:

1. From the **Add a standard window**, enter the relevant information:



1a. Match the calibration instrument appearing in the **Calibration Instrument** list to the instrument you intend to create.

The calibration name will be displayed in the **Calibration Instrument** list.

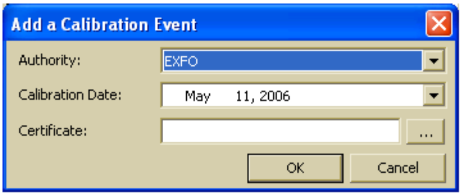
1b. Enter the instrument serial number.

1c. Enter the inventory number and comments if necessary.

Note: *When the basic model of the calibration instrument is configured to appear in the Calibration Certificate produced by the IQS-12002B, the information that you enter in the* ***Inventory number*** *text box will appear in the section entitled Standards used to establish traceability.*

1d. Select **Calibrated (no recalibration required)** and click **OK**.

2. From the **Add a Calibration Event** window, enter the date as written on the instrument calibration certificate, and click **OK**.

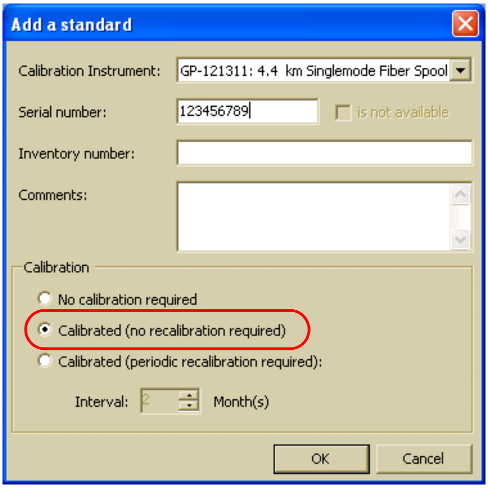


Creating the GP-121723: 50-m Launch Fiber as a Calibration Instrument

This section presents the procedure to create the 50-m launch fiber as a calibration instrument.

To create the calibration instrument:

1. From the **Add a standard window**, enter the relevant information:



1a. Match the calibration instrument appearing in the **Calibration Instrument** list to the instrument you intend to create.

The calibration name will be displayed in the **Calibration Instrument** list.

1b. Enter the instrument serial number.

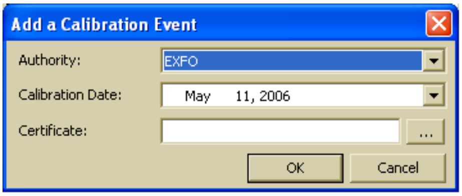
1c. Enter the inventory number and comments if necessary.

Note: *When the basic model of the calibration instrument is configured to appear in the Calibration Certificate produced by the IQS-12002B, the information that you enter in the Inventory number text box will appear in the Calibration Certificate in the section entitled Standards used to establish traceability.*

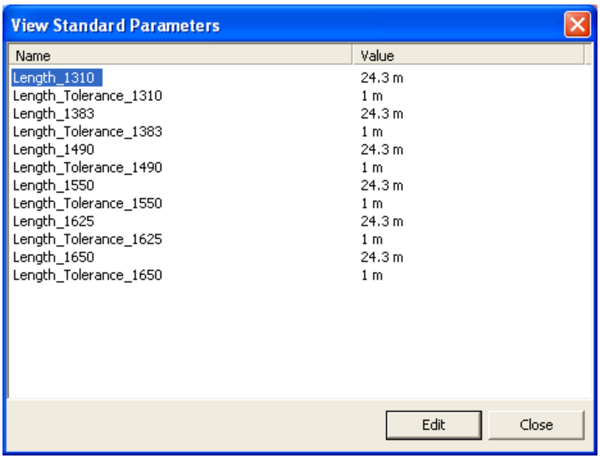
1d. Select **Calibrated (no recalibration required)**.

2. Click **OK**.

3. From the **Add a Calibration Event** window, enter the manufacturing date (if the day of manufacturing is not available, enter the first day of the manufacturing month), and click **OK**.



4. From the **View Standard Parameters** window, click **Edit** to enter the length of the reference standard given on the acceptance test plan for all requested wavelengths (e.g., 56.1 m).



IMPORTANT

Ensure that the Length Tolerance parameter is set to 5 m.

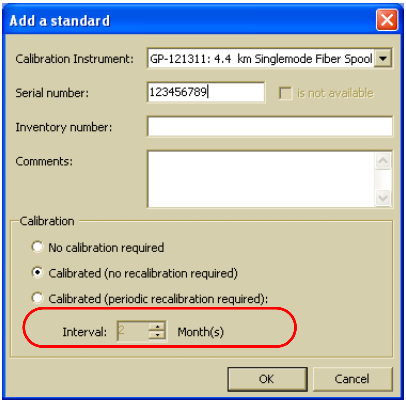
5. Click **Close**.

Creating the GP-121392: Distance Reference Standard

This section presents the procedure to create a distance reference standard.

To create the reference standard:

1. From the **Add a standard** window, enter the relevant information:



1a. Match the calibration instrument appearing in the **Calibration Instrument** list to the instrument you intend to create.

The calibration name will be displayed in the **Calibration Instrument** list.

1b. Enter the instrument serial number.

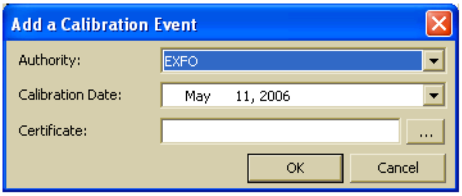
1c. Enter the inventory number and comments if necessary.

Note: *When the basic model of the calibration instrument is configured to appear in the Calibration Certificate produced by the IQS-12002B, the information that you enter in the Inventory number text box will appear in the section entitled Standards used to establish traceability.*

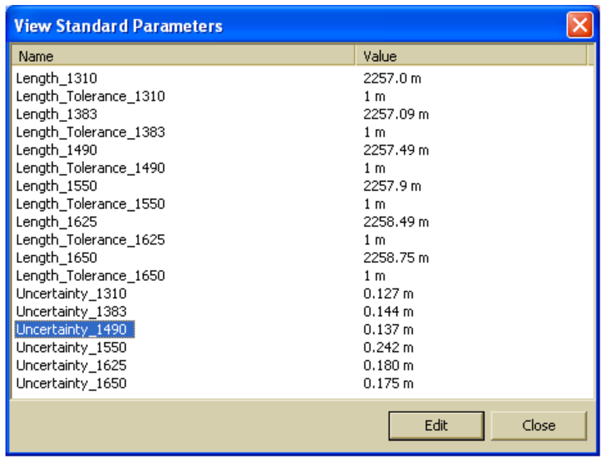
1d. Select **Calibrated (no recalibration required).**

2. Click **OK**.

3. From the **Add a Calibration Event** window, enter the date as written on the instrument calibration certificate, and click **OK**.



4. From the **View Standard Parameters** window, click **Edit** to enter the length of the reference standard given on the acceptance test plan for each wavelength (**Optical length at central wavelength (m)**) along with its uncertainty (**Uncertainty (m)**).



Note: *If the IQS-12002B requests information on a wavelength not given in the acceptance test plan (e.g., 1650 nm), enter "0" for both **Length_XXXX** and **Uncertainty_XXXX**.*

IMPORTANT

The Calibration Certificate issued by a national calibration laboratory is the *official traceability document for OTDR calibration*. Please make sure that you keep it in an appropriate location in your files.

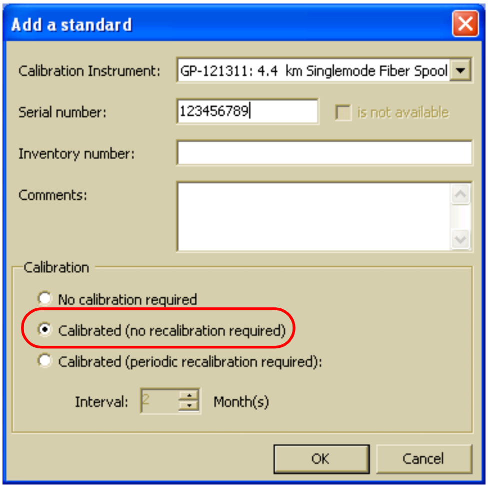
5. Click **Close**.

Creating the GP-121310: Calibration Instrument for Singlemode, Front-Connector Position (UPC Connectors)

This section presents the procedure to create the calibration instrument for the singlemode, front-connector position for UPC connectors.

To create the calibration instrument:

1. From the **Add a standard** window, enter the relevant information:



1a. Match the calibration instrument appearing in the **Calibration Instrument** list to the instrument you intend to create.

The calibration name will be displayed in the **Calibration Instrument** list.

1b. Enter the instrument serial number followed by “(UPC)” (e.g., 123456 (UPC)).

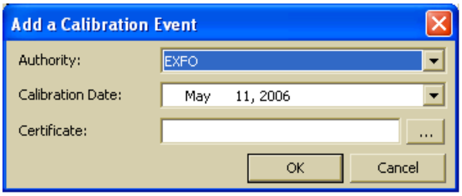
1c. Enter the inventory number and comments if necessary.

Note: *When the basic model of the calibration instrument is configured to appear in the Calibration Certificate produced by the IQS-12002B, the information that you enter in the **Inventory number** text box will appear in the section entitled Standards used to establish traceability.*

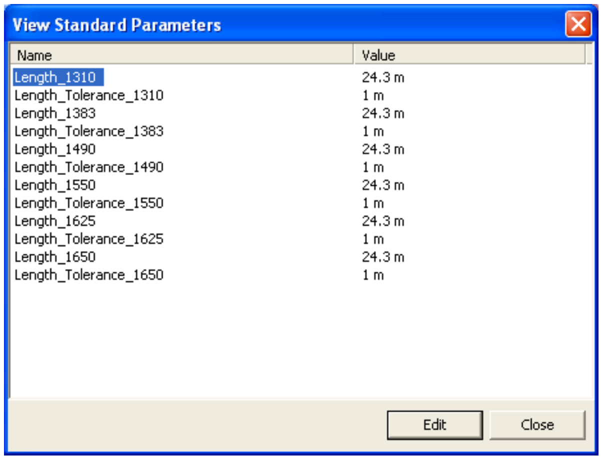
1d. Select **Calibrated (no recalibration required).**

2. Click **OK**.

3. From the **Add a Calibration Event** window, enter the date as written on the instrument calibration certificate, and click **OK**.



4. From the **View Standard Parameters** window, click **Edit** to enter the length given on the acceptance test plan for all requested wavelengths.



IMPORTANT

Do not change the Length_Tolerance parameter.

5. Click **Close**.

IMPORTANT

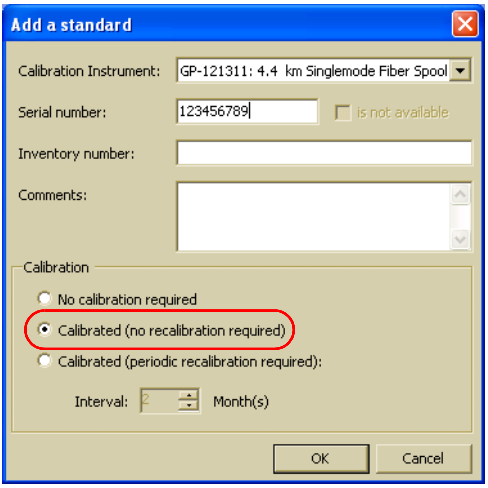
Now that you have created a calibration instrument for UPC connectors, you must manually create a calibration instrument for APC connectors. For more information, see *Creating the GP-121310: Calibration Instrument for Singlemode, Front-Connector Position (APC Connectors)* on page 98.

Creating the GP-120963: Singlemode Dead-Zone Calibration Instrument

This section presents the procedure to create the dead-zone calibration instrument. This calibration instrument is created using the length given on the acceptance test plan.

To create the calibration instrument:

1. From the **Add a standard** window, enter the relevant information:



1a. Match the calibration instrument appearing in the **Calibration Instrument** list to the instrument you intend to create.

The calibration name will be displayed in the **Calibration Instrument** list.

1b. Enter the instrument serial number.

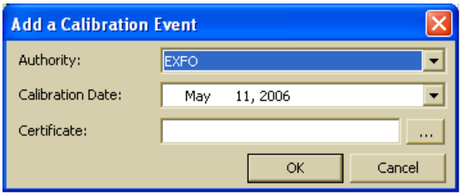
1c. Enter the inventory number and comments if necessary.

Note: *When the basic model of the calibration instrument is configured to appear in the Calibration Certificate produced by the IQS-12002B, the information that you enter in the **Inventory number** text box will appear in the section entitled Standards used to establish traceability.*

1d. Select **Calibrated (no recalibration required).**

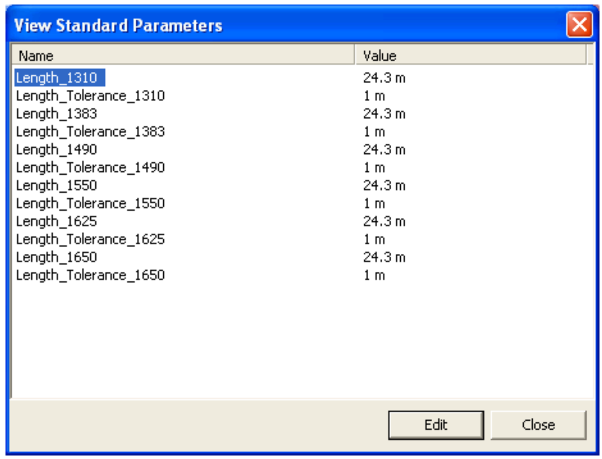
2. Click **OK**.

3. From the **Add a Calibration Event** window, enter the date as written on the instrument calibration certificate, and click **OK**.



4. Use the length of the reference standard given on the acceptance test and add *3 meters* to it (new length = 3 m + given length).

5. From the **View Standard Parameters** window, click **Edit** to enter the resulting length for all requested wavelengths.



IMPORTANT

Do not change the Length_Tolerance parameter.

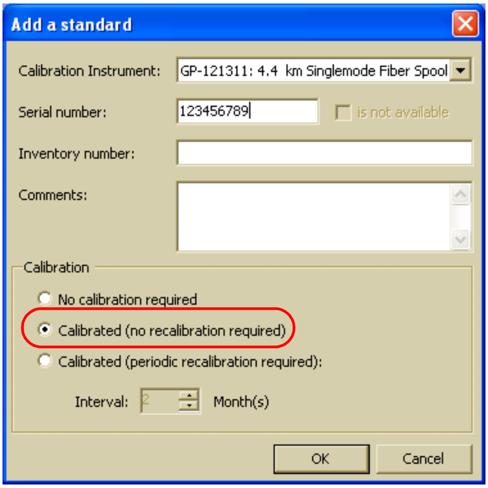
6. Click **Close**.

Creating the GP-121310: Calibration Instrument for Singlemode, Front-Connector Position (APC Connectors)

This section presents the procedure to create the calibration instrument for the singlemode, front-connector position for APC connectors.

To create the calibration instrument:

1. From the **Configuration** menu, select **Calibration Instruments** > **Standards** and click **Add**.
2. From the **Add a standard** window, enter the relevant information:



2a. Match the calibration instrument appearing in the **Calibration Instrument** list to the instrument you intend to create.

The calibration name will be displayed in the **Calibration Instrument** list.

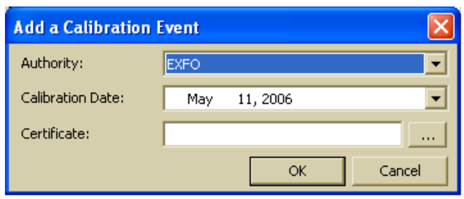
2b. Enter the instrument serial number followed by "(APC)" (e.g., 123456 (APC)).

2c. Enter the inventory number and comments if necessary.

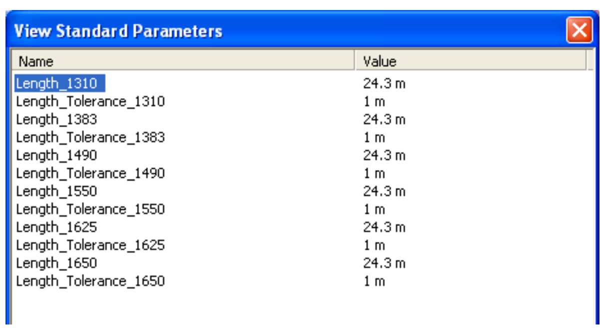
Note: *When the basic model of the calibration instrument is configured to appear in the Calibration Certificate produced by the IQS-12002B, the information you enter in the* ***Inventory number*** *box will appear in the Calibration Certificate in the section entitled “Standards used to establish traceability”.*

2d. Select **Calibrated (no recalibration required)** and click **OK**.

3. From the **Add a Calibration Event** window, enter the date as written on the instrument calibration certificate, and click **OK**.



4. From the **View Standard Parameters** window, click **Edit** to enter the length given on the acceptance test plan for all requested wavelengths.



IMPORTANT

Do not change the Length_Tolerance parameter.

5. Click **Close**.

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