

OBR 5T-50

Users Guide

Version 1.9.1



OBR Users Guide

**CLASS 1 LASER PRODUCT
IEC 60825-1, 2007
AND 21CFR1040.10**



Many regions prohibit the disposal of WEEE (Waste Electrical and Electronic Equipment) in the normal waste stream, to comply with the Restriction of Hazardous Substances (RoHS) released into the environment. Please contact your local waste authority for instructions on proper recycling of the electronic product(s) described in this *User Guide*.

Optical Backscatter Reflectometer Model OBR 5T-50B
Versions: *User Guide* OBR Software 1.9.1

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Chapter 1 System Overview

Luna Innovations' Optical Backscatter Reflectometer, model (OBR 5T-50), is a high resolution reflectometry device with backscatter-level sensitivity for interrogating optical components or modules. The OBR uses swept-wavelength coherent interferometry to measure minute reflections in

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an optical system. This is reported as reflected amplitude versus time of flight, which scales to distance along the fiber with group index. The OBR quickly and accurately locates and measures return loss (RL) and insertion loss (IL) events inside an optical path. A gas cell is referenced on each scan, ensuring both length and spectral accuracy.



Figure 1-1 OBR measurement system. The OBR is a high resolution reflectometer designed for interrogating optical components and modules.

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Caution



Use of controls or adjustments or performance of procedures other than those specified herein may result in hazardous laser radiation exposure and one or more safety protections may be impaired or rendered ineffective.

The Control Software

The OBR control software includes an intuitive graphical interface. All controls, options, and measurement results are easily accessible from a single window. A table of reflection events including their location, RL, and IL, is automatically generated with each scan. A LabVIEW-based software development kit is included for development of custom applications (refer page 46).

The OBR can also be controlled remotely using TCP/IP commands (refer page 58).

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Assembly and Startup

The Optical Backscatter Reflectometer is shipped with everything needed to conduct device characterizations, including the measurement instrument and all supporting hardware, software, documentation, and cables.

Read and follow all assembly and startup instructions before attempting to operate the OBR.

Warning



The protection provided by the equipment may be impaired if the equipment is used in a manner not specified by the manufacturer, resulting in serious injury or death.

Warning



The power cord is the main disconnect for equipment. If it is necessary to ensure no power to unit, remove power cord

Components List

The OBR is shipped with the following items.



Optical Backscatter Reflectometer instrument.



One PCIe Bus cable to connect the OBR instrument to the PC



Three (3) power cords, one (1) for the OBR instrument and two (2) more for the PC and monitor

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OBR desktop PC



17-inch flat panel monitor



Monitor-PC interface cable

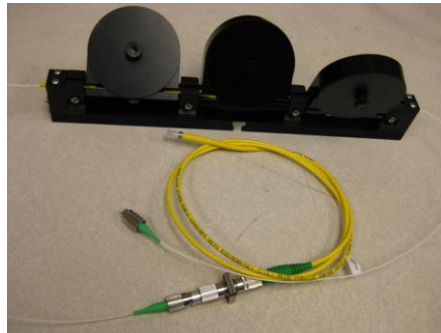
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Keyboard



Mouse



Attenuator, polarization controller, and 10dB gold reflector

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Optical fiber connector cleaner



FC/APC bulkhead



Optical fiber bulkhead connector cleaners

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If components are missing or damaged, contact Luna Innovations toll free at 866-586-2682 or by e-mail at solutions@lunainc.com.

Setting up the OBR

To set up the OBR

- 1 Remove all the OBR components from the shipping containers and verify that no components are missing. (See components list.)
- 2 For best performance, place the OBR on a stable surface, capable of supporting the weight of the entire unit. For the weight and dimensions of the unit, see Appendix A, "Specifications".
- 3 Unpack and set up the desktop PC. Connect the monitor, keyboard, and mouse to the PC, using the cables provided.

Important



Place the OBR away from walls or objects that will restrict the air flow through the fan duct on the back and sides of the unit.

Important



The instrument should always be fully assembled before turning power on to any of its components.

Important



Do not turn on the instrument yet.
Do not connect the instrument to the PC until instructed.

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- 4 Connect the OBR instrument to the PC using the PCIe cable.
- 5 Optional: To connect the OBR to a network, connect a network cable (not provided) to the Ethernet port on the PC.
- 6 Attach the power cords provided to the instrument and to the PC. To ensure safe operation, position the instrument to allow easy access to the power cord. Note that the OBR requires surge-protected, grounded outlets.
- 7 Power on the OBR instrument first, and then the PC.

Chapter 2 Software Guide

The control software is the primary interface between the user and the instrument. It provides all of the necessary tools to perform precise length, RL and IL measurements of fiber-coupled optical devices.

This chapter provides an overview of the location and function of all controls and indicators included in the control software. Chapter 3, "Performing Measurements," provides greater detail on how to use the OBR to perform specific measurements. Chapter 4, "Software Development Kit" assists the user with developing their own software to perform OBR tasks.

Starting the software

Double Click on the OBR icon on the desktop or select OBR 5T-50\OBR from the start menu.

The **OBR Control** main window will open and the instrument will configure.

If the OBR instrument is not powered on or not connected, the software will offer to start in Desktop Analysis Mode. This mode will not allow the user to operate the instrument, but will allow saved measurement files to be loaded and analyzed. To enter this mode, Press OK. Pressing Cancel will cause the software to exit.

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Window Features

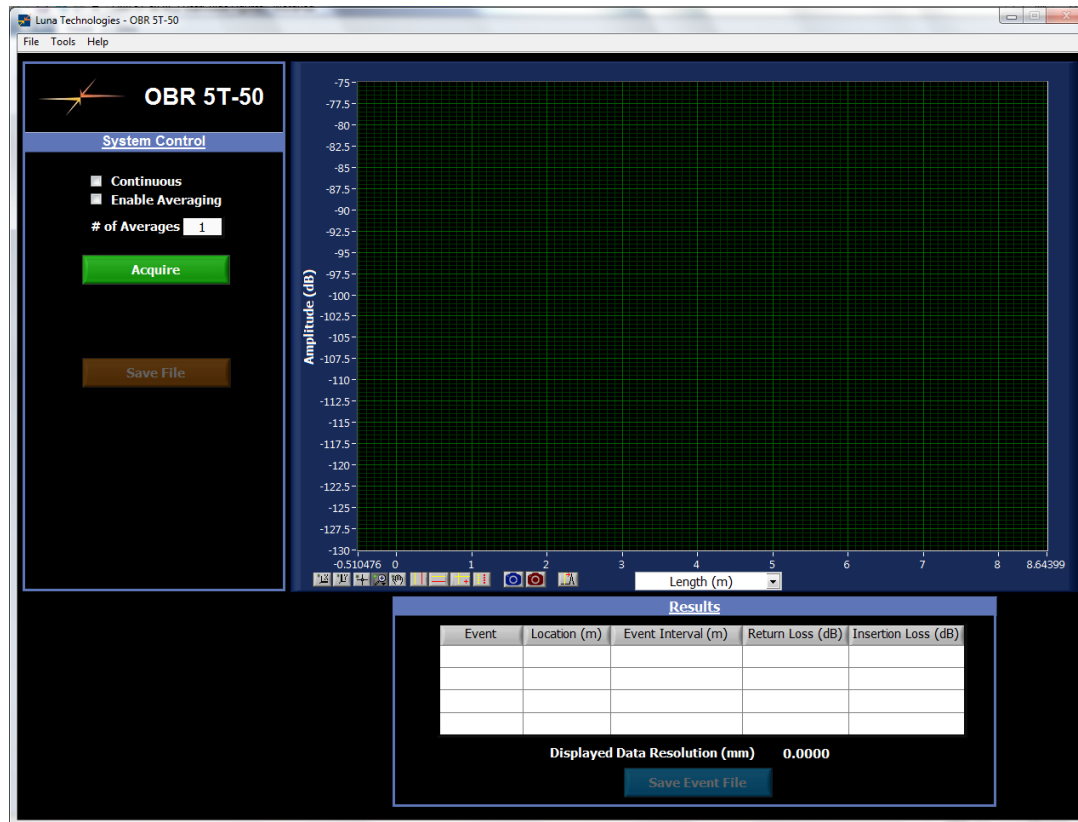


Figure 2-2 OBR Control window is the main user interface

The main OBR Control window is composed of four (4) functional areas:

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- 1 The **System Control** area contains buttons to control the OBR and save files
- 2 The **Graph** area displays time domain data with respect to a length axis as selected from the drop down menu. Buttons to the lower left of the graph adjust plot axes, cursors, and zoom
- 3 The **Results** area displays a table of reflection events and corresponding return loss and insertion loss
- 4 The **Menu Bar** contains commands for loading and saving data and event files, as well as for setting various measurement and display options

System Control

The **System Control** area allows users to control measurement operations.

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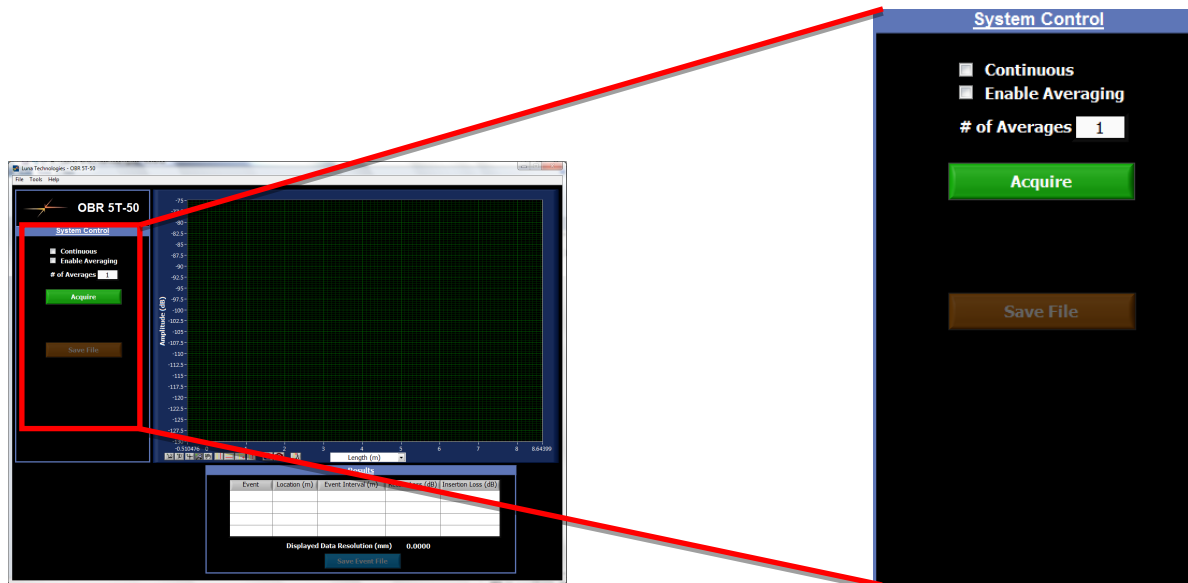


Figure 2-1 System Control area

- 1 **Acquire** – clicking on this results in a single measurement scan being displayed in the **Graph**.
Checking **Continuous** results in a continuously updated display of the attached device.
Checking **Enable Averaging** results in the display of the averaged amplitude over the user-selected number of scans.
- 2 **Save File** – clicking on this saves measurement data in the form of a binary data file (of type “.obr2”). It is not possible to save binary data when **Enable Averaging** is checked, because averaging of amplitude data results in a loss of information regarding S and P components. Thus **Save File** is greyed out.

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Graph

The **Graph** area displays time domain amplitude data in dB. This data is either newly scanned or loaded data.

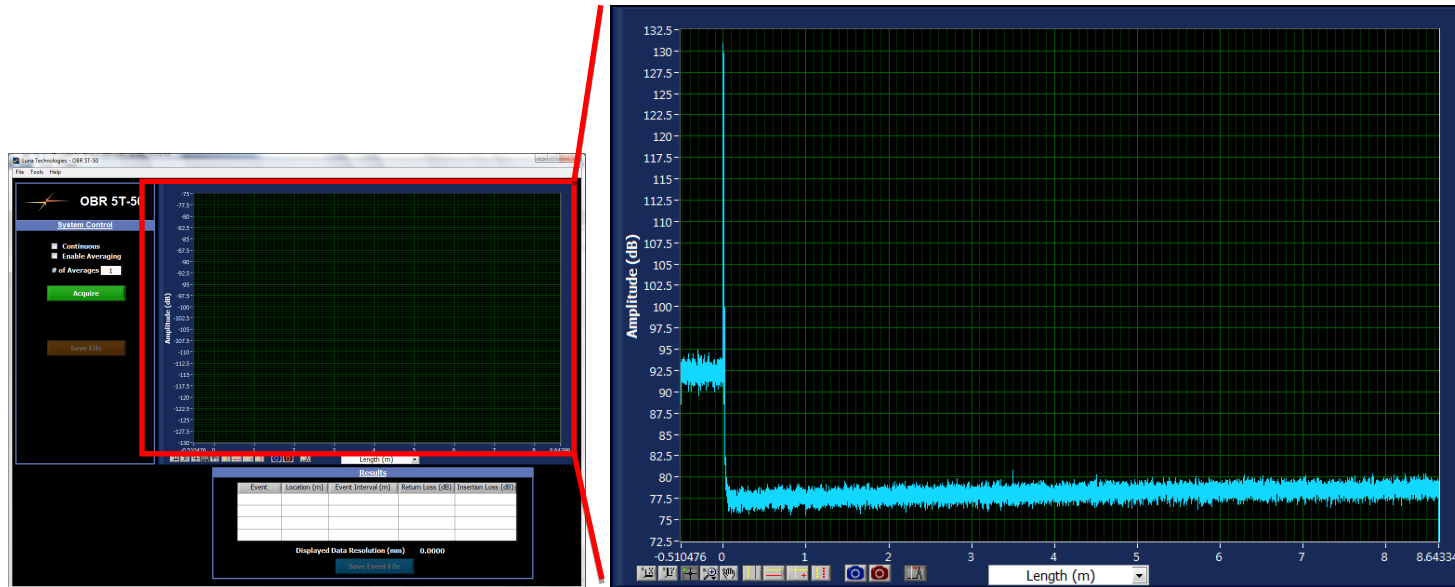


Figure 2-2 Graph area

- 1 Length menu – The pull-down menu at the bottom of the time domain graph allows the user to select the value and units of the X-Axis: **Time (ns)**, **Length (m)**, **Length (ft)**, **Length (in)**, or **Length (mm)**.

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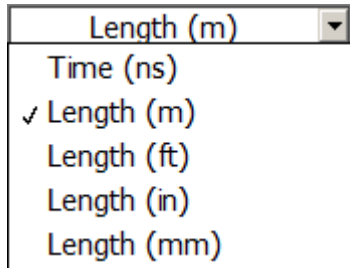




Figure 2-3 Parameters menu

- Buttons to the lower left of the graph allow the user to adjust plot axes, cursors, and zoom, and to save graph or screen.

Scaling Plot Axes

The OBR control software provides several ways for adjusting the scaling of the graph windows.

- **Autoscaling**

The user may rescale each plot axis independently by using the buttons for the X-axis  and the Y-axis .


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- **Manual scaling**

The plot axes may be scaled manually by double-clicking on either the lowest or highest value labeled on the axes and typing in a new value. To accept the new value, press enter or click anywhere in the screen.

Note that by using this method it is possible to flip the graph so that increasing values on the X-axis run from right to left, and increasing values on the Y-axis run from top to bottom.

Cursors

The OBR control software offers three types of cursors. By default, vertical cursors and twin locked cursors appear at 10% and 90% of the X-axis range. Horizontal cursors appear at 10% and 90% of the Y-axis range. To move the cursors, select the cross-hair,  then click, drag, and release the cursor.

- **Vertical Cursors:** 

Clicking this button toggles two vertical cursors on and off. Note that when these cursors are on, the location of these cursors are highlighted in contrasting colors, and the results are displayed in the upper right legend.

- **Horizontal Cursors:** 


Clicking this button toggles two horizontal cursors on or off.

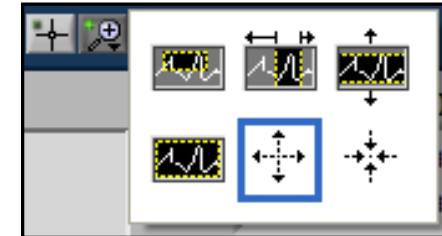
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- **Twin Locked Cursors:** 

Clicking this button toggles twin locked cursors on and off. Regardless of where these cursors are dragged, they will intersect the graph at a data point on the displayed trace.

Using Zoom Tools

There are six available zoom tools, which are accessible by clicking the **zoom menu button** . When this button is clicked, a pop-up window containing the six zoom tools opens. A blue border surrounds the selected tool.



- **The zoom window tool:**



This tool allows the user to zoom in on a rectangular region of the graph window. To use this tool, first select it from the zoom menu button. Then click in the graph window and hold the mouse button to define one corner of the rectangular region. Then drag the mouse cursor and note that a dotted box appears with corners defined by the original click position and the current mouse cursor position. Drag the box around the desired region of the graph window and release the mouse button. Both the X- and Y-axis scales adjust so that the selected region fills the entire graph window.

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- **The X-axis zoom tool:**



This tool allows the user to zoom in on a region of the X-axis only, without adjusting the Y-axis scale. To use this tool, first select it from the zoom menu button. Then click in the graph window and hold the mouse button to define one edge of the desired X-axis region. Drag the mouse cursor to the other edge of the desired region and note that a fixed vertical dotted line appears where the original click occurred, and another follows the mouse cursor. When the cursor is positioned at the other edge of the desired region, release the mouse button. The X-axis scale adjusts to show only the selected region.

- **The Y-axis zoom tool:**



This tool allows the user to zoom in on a region of the Y-axis only, without adjusting the X-axis scale. To use this tool, first select it from the zoom menu button. Then click in the graph window and hold the mouse button to define one edge of the desired Y-axis region. Drag the mouse cursor to the other edge of the desired region, and note that a fixed horizontal dotted line appears where the original click occurred, and another follows the mouse cursor. When the cursor is positioned at the other edge of the desired region, release the mouse button. The Y-axis scale adjusts to show only the selected region.

- **The return to full zoom tool:**



Selecting this button from the zoom menu returns the graph to the full scale of all data.

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- **The zoom in tool:** 

This tool allows the user to zoom in (magnify) the graph from the point where the cursor is clicked. To use this tool, first select it from the zoom menu button. Then click once to magnify once; or click, hold and release to magnify several times at the cursor location.

- **The zoom out tool:** 

This tool allows the user to zoom out from the point where the cursor is clicked. To use this tool, first select it from the zoom menu button. Then click once to zoom out once; or click, hold and release to zoom out several times at the cursor location.

- **The pan tool:** 

This tool allows the user to click in the graph window and drag the data to the left or right. To use this tool, first select it from the zoom menu button. Then click and hold the click in the graph area. Scroll the mouse left or right to move the data.

- **Save Graph Tool:** 

This tool allows use to save the current graph as a .jpg image file.

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- **Save Screen Tool:**



This tool allows use to save the current screen as a .jpg image file.

- **Show/Hide Cursor to Event Buttons Tool:**



Pressing this button will show (or hide) the event buttons in the Results area; the buttons provide user a convenient way to move the vertical cursor to the measurement location relevant to the event.

- **Move Cursor to Peak Tool:**

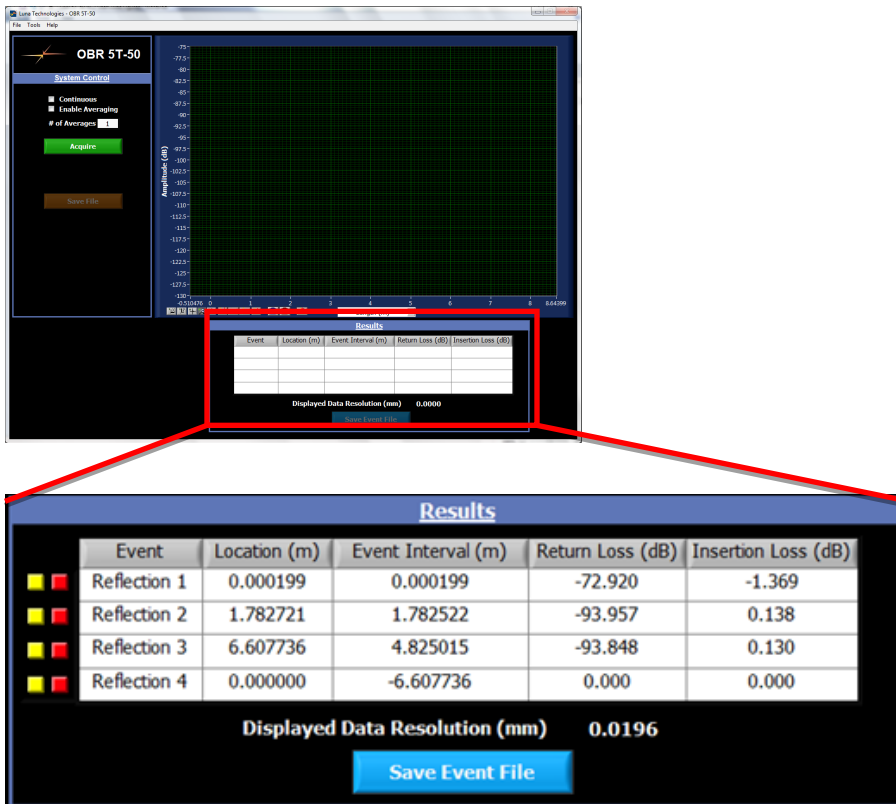


Pressing this button will move the vertical cursor to the highest nearby measurement point.

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Results

The **Results** area displays a table of reflection events and their corresponding location, return loss, and insertion loss values. The area also can display the Cursor to Event Buttons (Buttons can be either shown or hidden via the "Show/Hide Cursor to Event Buttons Tool"); by pressing one of the buttons, vertical cursor will move to the event's relevant measurement location in the graph.



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Figure 2-4 **Results** area

- 1 **Save Event File** – clicking on this saves the results in the table in a tab-delimited .txt file.

Menu Bar

The OBR control menu bar contains three (3) items.

- 1 The **File** menu:

- 1.1 **Load File** loads a binary data file (of type “.obr2”) previously saved by the OBR. A dialog box appears allowing the user to select the file
- 1.2 **Save File** saves measurement data in the form of a binary data file (of type “.obr2”)
- 1.3 **Save Text File** saves measurement data in the form of a tab-delimited data file (of type “.txt”) containing length and amplitude information
- 1.4 **Save Event File** saves the location (units as selected by user from the pull-down menu at the bottom of the time domain graph), return loss (dB), and insertion loss (dB), of the selected number of events as displayed in the **Results** area
- 1.5 **Streaming Data File Settings** allows the user to configure streaming data files. These are tab-delimited text files that are appended with graph or results table data with each measurement that is acquired during Continuous mode.
- 1.6 **Exit** exits the OBR control software

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2 The **Tools** menu:

2.1 **Set Preferences** allows users to control measurement and display options

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Set Preferences

Integration Widths

Units

Return Loss (ns)

Insertion Loss (ns)

Display Options

Autoscale X-Axis

Autoscale Y-Axis

Apply Hanning Window

Show minimum event threshold

Pts in Graph

Decimation Factor

Zero length location (ns)

Events

Maximum # Events

Minimum location (ns)

Maximum location (ns)

Minimum threshold (dB)

Max. IL threshold (dB)

Sort by

Event Search Type

Fiber Settings

Group Index

Software Settings

Align on startup

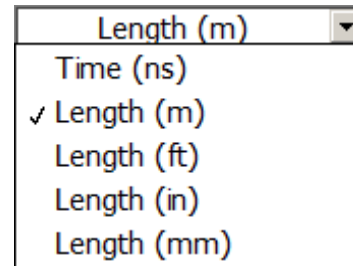
Require password to change preferences

NOTE: Pressing the "Save" button will store the specified settings for use during subsequent executions of the software. If you wish to simply use these settings and not store them, press the "Apply & Close" button.

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Figure 2-5 Set Preferences dialog box

- 2.1.1 **Integration Widths** set the length of segments about each identified reflection event, which are used to calculate the **Return Loss** and **Insertion Loss** of these segments. The units for these widths depend on the units selected by the user from the drop-down menu



- 2.1.2 **Display Options** allows the user to select the following display options:
- Autoscale X-Axis – automatically scales the X-Axis to the maximum measured range when checked
 - Autoscale Y-Axis – automatically scales the Y-Axis to the maximum measured range when checked
 - Apply Hanning Window – turns on the Hanning Window when checked (see “Hanning Windowing” on page 92)

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- # Pts in Graph – allows the user to set the decimation factor for data viewing
- Zero length location – allows the user to shift the x-axis zero location. This applies to the graph, event table and text file however, the binary data file remains unchanged.

2.1.3 **Events** allows the user to select the following event options:

- Maximum # Events (1-4) – number of event to display
- Minimum location – location at which to begin event search
- Maximum location – location at which to stop event search
- Minimum threshold (dB) - locations with amplitude higher than this threshold will be recognized as an event. The user should always view the undecimated data (524288 pts) when determining a suitable event threshold, as decimated data reduces peak maxima.
- Maximum IL threshold (dB) – threshold for identifying insertion loss events
- Sort by – whether events are sorted by location, return loss, or insertion loss

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- Event search type – whether return loss events, insertion loss events, or both should be displayed in the results table

2.1.4 **Fiber Settings** allows the user to enter the **Group Index** appropriate for the device under test

2.1.5 **Software Settings**

- Align on startup - allows the user to check the alignment of the OBR's optics on software startup. Note also that the alignment is automatically checked prior to calibration.
 - Require password to change preferences – allows the user specify a password that must be entered to modify the preferences shown on this screen
- **Save** will store the specified settings for use during subsequent executions of the software
 - **Apply & Close** will use the specified settings without storing them
 - **Cancel** exits the **Set Preferences** window without changing any parameters

2.2 **Align** performs an alignment of the internal optics of the OBR. See "Aligning the Optics" on page 38 for more information about system alignment.

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2.3 **Calibrate** calls up a dialog box which queries the user on a previous alignment of the optics before running a calibration. (See “Calibrating the System” on page 39 for complete calibration instructions.)

- 3** The **Help** menu – provides User Guide, What’s New notes, and general information on the OBR including the software and firmware versions.

Chapter 3 Performing Measurements

Instrument Setup

The front panel of the Optical Backscatter Reflectometer contains the power switch and the optical connectors necessary to perform measurements.




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Figure 3-1 The OBR instrument

Four LEDs indicate the state of the instrument:

- The **Power** LED lights when the power is on.
- **Source** LED lights after the laser has been turned on.
- **Ready** LED lights when the instrument is ready to take a measurement
- **Transmit** LED lights at fixed pulse rate indicating instrument is scanning at all times

Start the control software by double-clicking the desktop icon,  or by selecting **OBR Software** from the programs group in the Windows® Start menu. The **OBR** window will appear. The instrument will take a few moments to initialize before it is ready to use.

Aligning The Optics

In order to perform accurate measurements, the internal optics of the OBR must be properly aligned. The alignment is checked automatically prior to calibration. The two conditions that require an alignment to be performed are listed below.

Alignment must be performed...

- 1 When the instrument is initially set up for the first time
- 2 Whenever the OBR is physically moved from one location to another

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To align the OBR optics

- 1 Ensure that the OBR unit is powered on and that the laser is on and ready
- 2 Select **Tools > Align Optics**

A dialog box appears instructing the user to disconnect devices. The user may opt to **Cancel** or click **OK** to continue.

If **OK** is selected, alignment begins. When the alignment is complete, a dialog box informs the user of the success of alignment. Selecting **OK** returns the user to the software control window.

- 3 The user must next perform a calibration, as described below.

Calibrating the System

The OBR must be calibrated prior to performing measurements. The OBR calibration removes the effects of the measurement network to ensure that the measured data represent only the device under test.

Conditions that Require Calibration

In a typical laboratory or manufacturing environment, calibration should be performed at least once every 24 hours. The need to recalibrate is largely determined by the surrounding environmental conditions. If the temperature is fluctuating rapidly, it may be necessary to calibrate more than every 24 hours. If the surrounding temperature is very stable, a longer interval may suffice.

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Calibration should be performed whenever the surrounding temperature has changed by more than $5\pm$ degrees C. And as previously mentioned, the OBR must be calibrated after an alignment.

The Calibration Procedure

Important



During the calibration procedure, ensure the supplied calibration artifacts are on a stable surface, free from motion and vibration.

- 1 Ensure that the OBR unit is powered on. The **Ready** light on the front of the instrument comes on when the laser is ready.
- 2 Select Tools > Calibrate.
- 3 A prompt appears instructing the user to disconnect all devices from the OBR. This is necessary to allow the instrument to check the alignment prior to calibration.
- 4 When the alignment succeeds, a prompt appears instructing the user to connect the supplied attenuator, polarization controller, and 10dB gold reflector to the instrument.

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Important



Before attaching any fiber, clean the fiber optic connector with the appropriate cleaner to guard against errors or equipment damage. For instructions, see “Cleaning Connectors” in the Maintenance Chapter

- 5 Align the connector key to fit in the groove in the bulkhead adaptor. Turn the screw ring around the connector clockwise until it is just tightened.
- 6 Click **OK**. Adjust the Polarization Controller Paddles per the instructions prompted in the software.
- 7 A prompt appears instructing the user to disconnect the reference fiber and reflector. After doing so, click **OK**.
- 8 Click **OK** in the dialog box indicating that the instrument has been successfully calibrated.

Acquiring Data

The OBR has several options for data acquisition: **Single Scan Mode** and **Continuous Scan Mode**.

Single Scan Mode

To perform a single-scan measurement:

- 1 Ensure that the OBR unit is powered on and that the laser is on and ready. The **Ready** light comes on when the software is launched

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- 2 Be sure that the instrument has been aligned (see "To align the OBR optics" on page 38), and calibrated (see "To calibrate the system" on page 39) within the recommended time period
- 3 Before connecting the device to the OBR, be sure to clean all fiber optic connectors. (See "Cleaning Connectors" on page 95.)
- 4 Connect the device to the **Source** port on the front of the OBR
- 5 Click **Acquire** in the **System Control** area (Fig 3-2)

The instrument performs the measurement and the software displays the test data in the graph.

- 6 The **Results** table will be populated by the **Location** of reflection events as well as **Return Loss** and **Insertion Loss** values. The number of reflection events is a user-defined value (maximum 4) that is set in **Tools > Set Preferences**. The Minimum location that the user wants the software to display reflection events for is also set in this dialog box.

Continuous Scan Mode

Continuous scan mode takes advantage of the fast measurement speed of the OBR to monitor devices whose properties may change over time.

- 1 Perform all but the last step of **the Single Scan** mode above. Before clicking the **Scan** button, check **Continuous** in the **System Control** area of the main window
- 2 Click Scan in the **System Control** area (Fig 3-2)

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- 3 The **Acquire** button will turn gray during continuous scanning
The active graph window(s) will update after each scan.
- 4 The **Results** table will update continuously after each scan
- 5 To stop scanning, either click the grayed **Acquire** button again, or uncheck the **Continuous** box above the **Acquire** button

Saving Data Files

The OBR control software provides two options for saving data files. The first file type (.obr2) is a binary data format that completely captures the measured data and stores it in a format that can be loaded back into the control software at a later time for further analysis. This data file can also be loaded into the OBR 5T-50 Advanced Analysis Software for a more feature rich analysis environment. Contact Luna Innovations for more information on this software package.

The second file type is a text file in a tab-delimited spreadsheet format. Text files contain the amplitude data displayed in the graph at the time of saving. Data saved in the spreadsheet format cannot be loaded back into the control software.

It is highly recommended that the binary data format be chosen over the spreadsheet format for data archives. The binary format stores the complex polarization diverse spectral reflectivity, whereas the spreadsheet format stores only the polarization averaged amplitude (Reflectivity). Furthermore, a spreadsheet file can always be generated from a binary file at a later date, but a binary file cannot be generated from a spreadsheet file. Finally, other data analysis software

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packages available from Luna Innovations accept only the binary data format produced by the OBR control software.

The option to save binary data is available through either the **Save File** button in the **System Control** area, or through **File > Save File**.

The option to save a text file is available through **File > Save Text File**.

If the user is in **Continuous Measurement** mode, the file saved will contain data from the scan taken just before the user clicked **OK**.

Important



When **File > Save File** is selected, or when the **Save File** button is clicked, the OBR software will overwrite any files with the filename specified, without warning the user.

Spreadsheet File Data

The header of a spreadsheet file gives the following information:

- Instrument used
- Date and time (GMT) data was acquired
- Date and time (GMT) of last calibration
- Group Index value used for calculations

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Parameter measured and units are given at the top of each column.

Saving Event Files

Reflection events as displayed in the **Results** area can be saved into a tab-delimited spreadsheet format. The option to save reflection events is available through either the **Save Event File** button in the **Results** area, or through **File > Save Event File**. If the user is in **Continuous Measurement** mode, the file saved will contain data from the scan taken just before the user clicked **OK**.

Event File Data

The header of an event file gives the following information:

- Instrument used
- Date and time (GMT) data was acquired
- Date and time (GMT) of last calibration
- Group Index value used for calculations

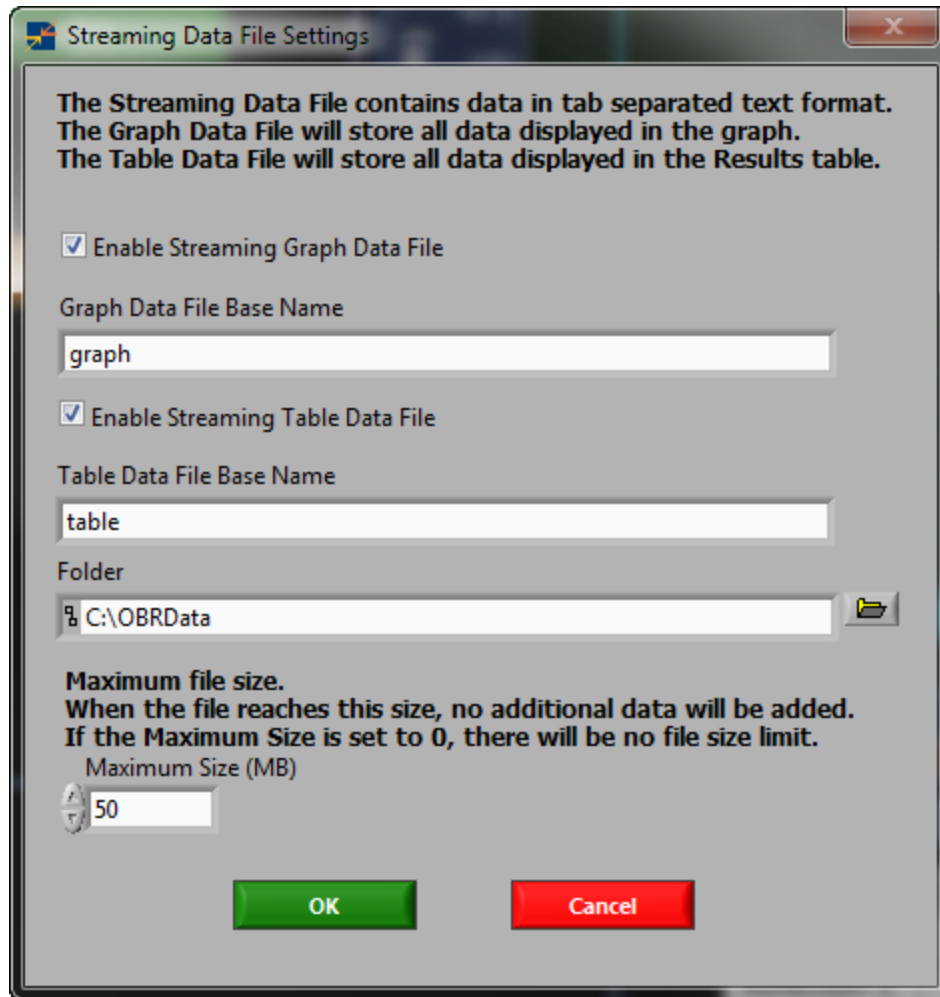
Parameter measured and units are given at the top of each column.

Saving Streaming Data Files

Data from the graph and event table can be streamed into a tab-delimited text file, suitable to be processed by a user-developed program or loaded into a spreadsheet program.

The Steaming Data Files Settings are available from the program menu.

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Separate text files can be enabled to hold the graph data or the event table data. The *Data File Base Name* and *Folder* options control the location and filename of the created files. The actual filename will also be appended with a date and timestamp. The *Maximum File Size* can be set to prevent a file

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from becoming larger than desired. If the size is set to a non-zero number, the data file will stop adding data to the file once that size has been reached.

Once a streaming data file has been configured, data will be added to it each time the graph or event table is updated while the software is operating in Continuous mode. The results of single, non-continuous scans are not appended to the data file.

The format of the graph data text file is shown below.

```
Filename E:\Data\5T50\graph-2015-12-01T15:33;22.947734.txt
First Column is Timestamp
First Row is Time (ns)
Matrix is Amplitude (dB)
-----
0.00000000      0.99999994      1.99999988      2.99999982      3.99999976      4.99999970      5.99999964      6.99999958      →
2015-12-01T15:33:28.580056 -112.06249237 -111.38410950 -111.46731567 -111.81610870 -111.54669189 -111.65595245 -113.19794464 -112.30225372 →
2015-12-01T15:33:28.662061 -112.23053741 -111.18205261 -111.34187317 -111.59674072 -111.74716187 -111.29934692 -113.23500824 -112.45502472 →
2015-12-01T15:33:28.746065 -112.05938721 -111.36673737 -111.34268951 -111.70069885 -111.40075684 -111.63786316 -113.40699768 -112.51171112 →
2015-12-01T15:33:28.830070 -112.21002197 -111.36012268 -111.35425568 -111.70904541 -111.69000244 -111.50759888 -113.46279907 -112.77120972 →
2015-12-01T15:33:28.914075 -111.69178009 -111.36254120 -111.39621735 -111.45168304 -111.51831818 -111.41315460 -113.65799713 -112.47686768 →
2015-12-01T15:33:28.998080 -112.82215881 -111.47729492 -111.54627991 -111.32293701 -111.66784668 -111.42673492 -113.47321320 -112.25273895 →
2015-12-01T15:33:29.083085 -111.60775757 -111.39624786 -111.38804626 -111.42334747 -111.66220093 -111.38461304 -113.58036041 -112.31235504 →
2015-12-01T15:33:29.165089 -111.23599243 -111.30188751 -111.40667725 -111.39796448 -111.70880127 -111.55877686 -113.31449890 -112.58984375 →
2015-12-01T15:33:29.249094 -111.81791687 -111.53514099 -111.38351440 -111.32112122 -111.71149445 -111.55950928 -113.49647522 -112.32756042 →
2015-12-01T15:33:29.333099 -110.58541107 -111.34741211 -111.59960937 -111.57270813 -111.60025787 -111.60243225 -113.33312988 -112.50250244 →
2015-12-01T15:33:29.417104 -110.58147430 -111.37663269 -111.60411072 -111.53534698 -111.58863831 -111.41679382 -113.17093658 -112.58711243 →
2015-12-01T15:33:29.501109 -111.65388489 -111.37070465 -111.46602631 -111.71538544 -111.35394287 -111.25229645 -112.94747162 -112.43156433 →
```

The first row of data contains the x-axis for the graph, using the same units selected in the software. All subsequent rows show a timestamp in the first column, followed by the measurement value for each x-axis point. There will be one measurement row for each scan taken during continuous mode operation. Each row is on a separate line. Columns are separated by tab characters.

The format of the table data file is similar.

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Filename E:\Data\5T50\table-2015-12-01T15;33;22.947734.txt

First Column is Timestamp

First Row is Column Headers

Matrix is Streaming Table Data

-----	Event	Location (m)	Event Interval (m)	Return Loss (dB)	Insertion Loss (dB)
2015-12-01T15:33:28.580056	Reflection 1	0.000225	0.000225	-64.788	-6.914
2015-12-01T15:33:28.580056	Reflection 2	0.000000	-0.000225	0.000	0.000
2015-12-01T15:33:28.580056	Reflection 3	0.000000	0.000000	0.000	0.000
2015-12-01T15:33:28.580056	Reflection 4	0.000000	0.000000	0.000	0.000
2015-12-01T15:33:28.662061	Reflection 1	0.000225	0.000225	-64.788	-6.909
2015-12-01T15:33:28.662061	Reflection 2	0.000000	-0.000225	0.000	0.000
2015-12-01T15:33:28.662061	Reflection 3	0.000000	0.000000	0.000	0.000
2015-12-01T15:33:28.662061	Reflection 4	0.000000	0.000000	0.000	0.000
2015-12-01T15:33:28.746065	Reflection 1	0.000225	0.000225	-64.787	-6.932
2015-12-01T15:33:28.746065	Reflection 2	0.000000	-0.000225	0.000	0.000
2015-12-01T15:33:28.746065	Reflection 3	0.000000	0.000000	0.000	0.000
2015-12-01T15:33:28.746065	Reflection 4	0.000000	0.000000	0.000	0.000

The file contains multiple rows for each measurement taken during continuous mode. Each row contains the details for a single event from the Results table. The maximum number of events can be configured from the *Tools, Set Preferences...* option in the program menu. This also controls the number of event rows per measurement that the table data file contains. The timestamp field can be used to group events as belonging to the same measurement, and also to correlate events in the table data file to measurement data in the data file.

The columns of the event rows show a timestamp followed by the event number, location, interval, return loss, and insertion loss. Columns are all separated by a single tab character. Note that, depending on the tab width settings of your file viewer, the event columns may not align with the column headers. However, the tab delimiters will allow the columns to be correctly parsed and interpreted by a spreadsheet program.

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	A	B	C	D	E	F	G	H	I	J
1	Filename E:\Data\5T50\graph-2015-12-01T15;33;22.947734.txt									
2	First Column is Timestamp									
3	First Row is Time (ns)									
4	Matrix is Amplitude (dB)									
5	-----	0	1	2	3	4	5	6	7	8
6	2015-12-0	-112.062	-111.384	-111.467	-111.816	-111.547	-111.656	-113.198	-112.302	-111.856
7	2015-12-0	-112.231	-111.182	-111.342	-111.597	-111.747	-111.299	-113.235	-112.455	-111.899
8	2015-12-0	-112.059	-111.367	-111.343	-111.701	-111.401	-111.638	-113.407	-112.512	-111.936
9	2015-12-0	-112.21	-111.36	-111.354	-111.709	-111.69	-111.508	-113.463	-112.771	-112.233
10	2015-12-0	-111.692	-111.363	-111.396	-111.452	-111.518	-111.413	-113.658	-112.477	-112.146
11	2015-12-0	-112.822	-111.477	-111.546	-111.323	-111.668	-111.427	-113.473	-112.253	-112.013

Graph data file loaded into a spreadsheet

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	A	B	C	D	E	F
1	Filename E:\Data\5T50\table-2015-12-01T15:33;22.947734.txt					
2	First Column is Timestamp					
3	First Row is Column Headers					
4	Matrix is Streaming Table Data					
5	-----	Event	Location (m)	Event Interval (m)	Return Loss (dB)	Insertion Loss (dB)
6	2015-12-01T15:33:28.580056	Reflection 1	0.000225	0.000225	-64.788	-6.914
7	2015-12-01T15:33:28.580056	Reflection 2	0	-0.000225	0	0
8	2015-12-01T15:33:28.580056	Reflection 3	0	0	0	0
9	2015-12-01T15:33:28.580056	Reflection 4	0	0	0	0
10	2015-12-01T15:33:28.662061	Reflection 1	0.000225	0.000225	-64.788	-6.909
11	2015-12-01T15:33:28.662061	Reflection 2	0	-0.000225	0	0
12	2015-12-01T15:33:28.662061	Reflection 3	0	0	0	0
13	2015-12-01T15:33:28.662061	Reflection 4	0	0	0	0
14	2015-12-01T15:33:28.746065	Reflection 1	0.000225	0.000225	-64.787	-6.932
15	2015-12-01T15:33:28.746065	Reflection 2	0	-0.000225	0	0
16	2015-12-01T15:33:28.746065	Reflection 3	0	0	0	0
17	2015-12-01T15:33:28.746065	Reflection 4	0	0	0	0

Table data file loaded into a spreadsheet

Loading Data Files

Only data saved in the binary format (.obr2) can be loaded into the control software.

- 1 Select **File > Load File** from the pull-down menu
- 2 In the dialog box that appears, choose the desired file and click **OK**

The loaded data will appear in the graph area, and the **Results** table will auto-update to display reflection events identified within the newly loaded data

Chapter 4 Software Development Kit

Overview

The OBR Software Development Kit (SDK) is a collection of software routines that allows users of Luna Innovations' OBR to develop custom software utilities targeted for a specific measurement application. By utilizing the SDK software package, OBR users have the ability to write custom graphical user interfaces and data analysis packages using the same source code used to develop the instrument operational software.

The SDK includes sample code in C++ and LabVIEW. The example programs were written and tested using Visual Studio 2012 and LabVIEW 2012.

The SDK functions are contained in DLLs (primarily Caerus.DLL) to control the OBR and to perform calculation. It may be possible to call these same DLL functions from other programming languages; however C++ and LabVIEW are the only languages currently supported by the SDK.

Getting Started

Copying SDK files

The SDK consists of a set of directories and files, which should be copied to a directory on your PC. For the sake of clarity, it is recommended that the software be copied to the folder `C:\OBR5T50_SDK`. They can be placed in an alternate path if desired, but the remainder of these instructions will assume that you have used the default name.

The SDK contains the following folders:

`bin` – contains the necessary DLLs for linking against the OBR SDK

`C++` – contains a C++ example Visual Studio project demonstrated the key capabilities of the SDK

`LabVIEW` – includes LabVIEW VIs demonstrating the key capabilities of the SDK

`setup` – contains installers for Microsoft runtime components that are required by the SDK DLLs

Note that the C++ and LabVIEW examples are configured to link to the DLLs in the `bin` folder. Any programs created using the SDK should include the files in the `bin` folder as part of their redistribution package.

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Runtime installer

The SDK DLLs require that the Microsoft C++ Runtime Library be installed on your computer. To install this, run the file *finishInstallCaerus.bat* from the *Setup* folder. If the computer running the SDK already has the OBR software installed, this step should be unnecessary.

Using the OBR SDK

The easiest way to begin using the SDK is to run the provided example programs. These programs demonstrate the various operations that can be performed with the SDK, and can serve as starting templates for writing your own programs.

LabVIEW Support

Low Level VIs and Example Programs

The LabVIEW LLB *Caerus.llb* contains low level VIs that call the DLLs in the SDK's *lib* folder. These VIs serve as building blocks for writing more complex programs.

The remaining files in the *LabVIEW* folder are examples that demonstrate how to control the OBR to perform using the SDK.

crssdk_example_singlescan.vi

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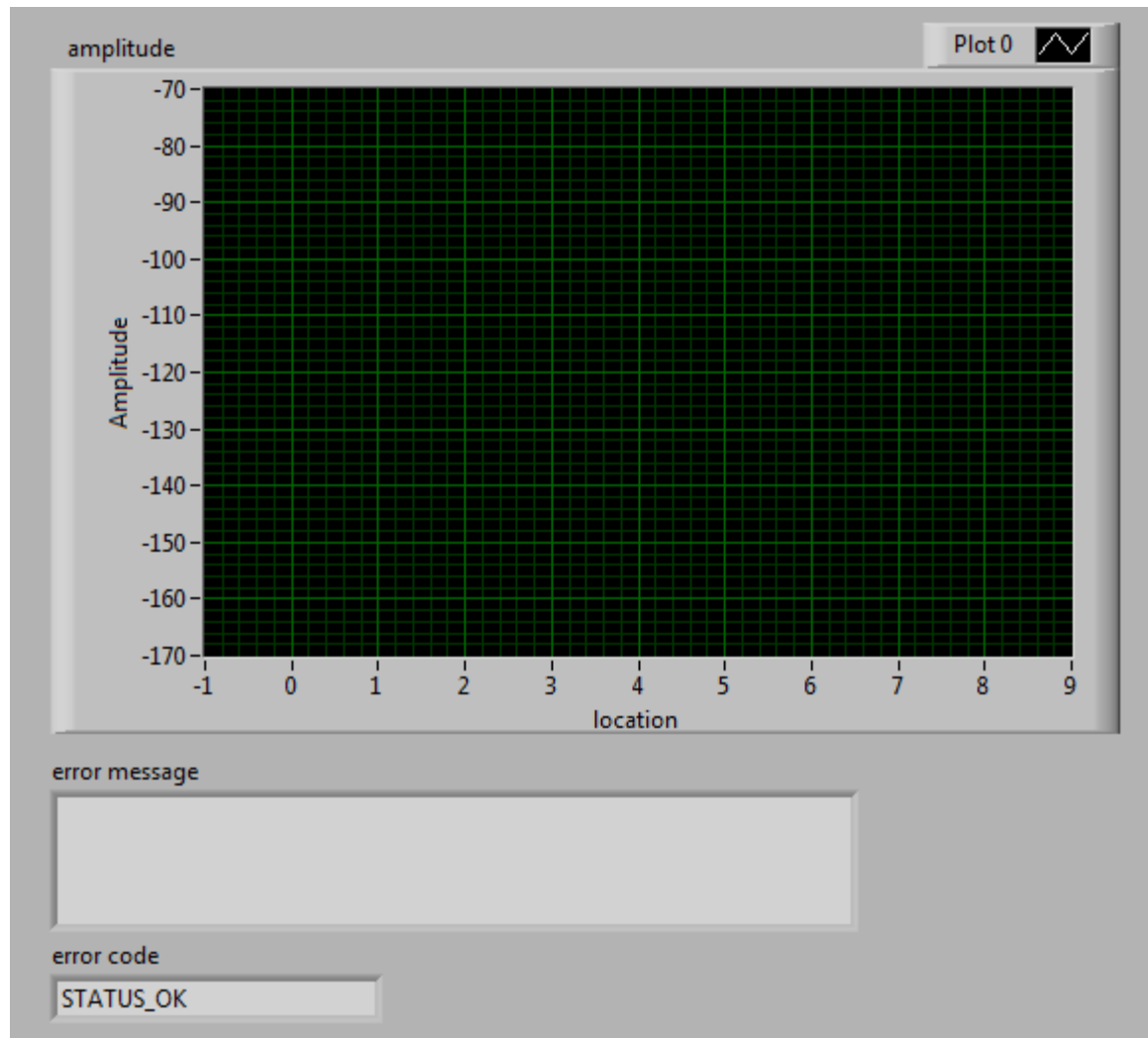


Figure 4-1 *crssdk_example_singlescan.vi* Front Panel

crssdk_example_singlescan.vi demonstrates the minimum steps that must be done to initialize the OBR, acquire a measurement, and display data. If you have an OBR which has been both aligned

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and calibrated using the standard OBR software, *singlescan.vi* is the best place to begin learning the SDK.

When you run *singlescan.vi*, it will initialize the OBR, take a scan, and display graph data. The VI's block diagram shows steps necessary to perform this measurement.

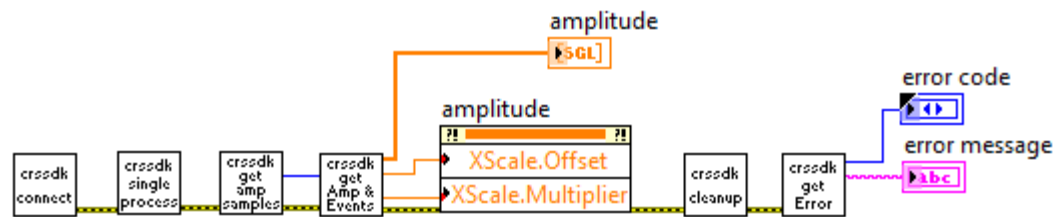


Figure 4-2 *crssdk_example_singlescan.vi*

crssdk_connect.vi connects to the OBR device and initiates scanning. This function must be called first before calling any other SDK function. The calibration status of the instrument is available as an output.

crssdk_getAmpSamples.vi determines how many points will be returned for each measurement, and how much memory needs to be allocated for the data. *crssdk_singleProcess.vi* starts the thread that processes the raw scanned data into amplitude and event form, while actual data processing is carried out in *crssdk_getAmpAndEventData.vi*.

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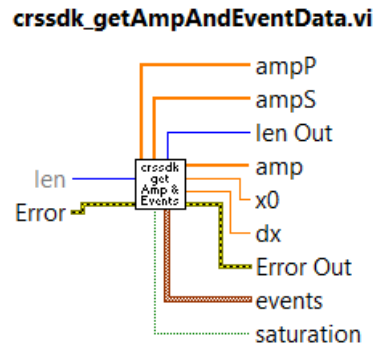


Figure 4-3 `crssdk_getAmpAndEventData.vi` function block

`crssdk_getAmpAndEventData.vi` allows the user to access the amplitude, the S and P polarization components of the amplitude, a scaled x -axis, and a list of event locations and magnitudes. If no parameters are set, the default OBR preferences are used for this VI.

`crssdk_cleanup.vi` closes the connection to the OBR 5T-50 instrument. **Important:** This function must **always** be called before the program exits and after all other calls to OBR SDK functions have been made. Failure to call `crssdk_cleanup.vi` may cause the program to hang when it attempts to exit, and it may be necessary to power cycle of the OBR instrument or the PC before successfully connecting to the OBR again.

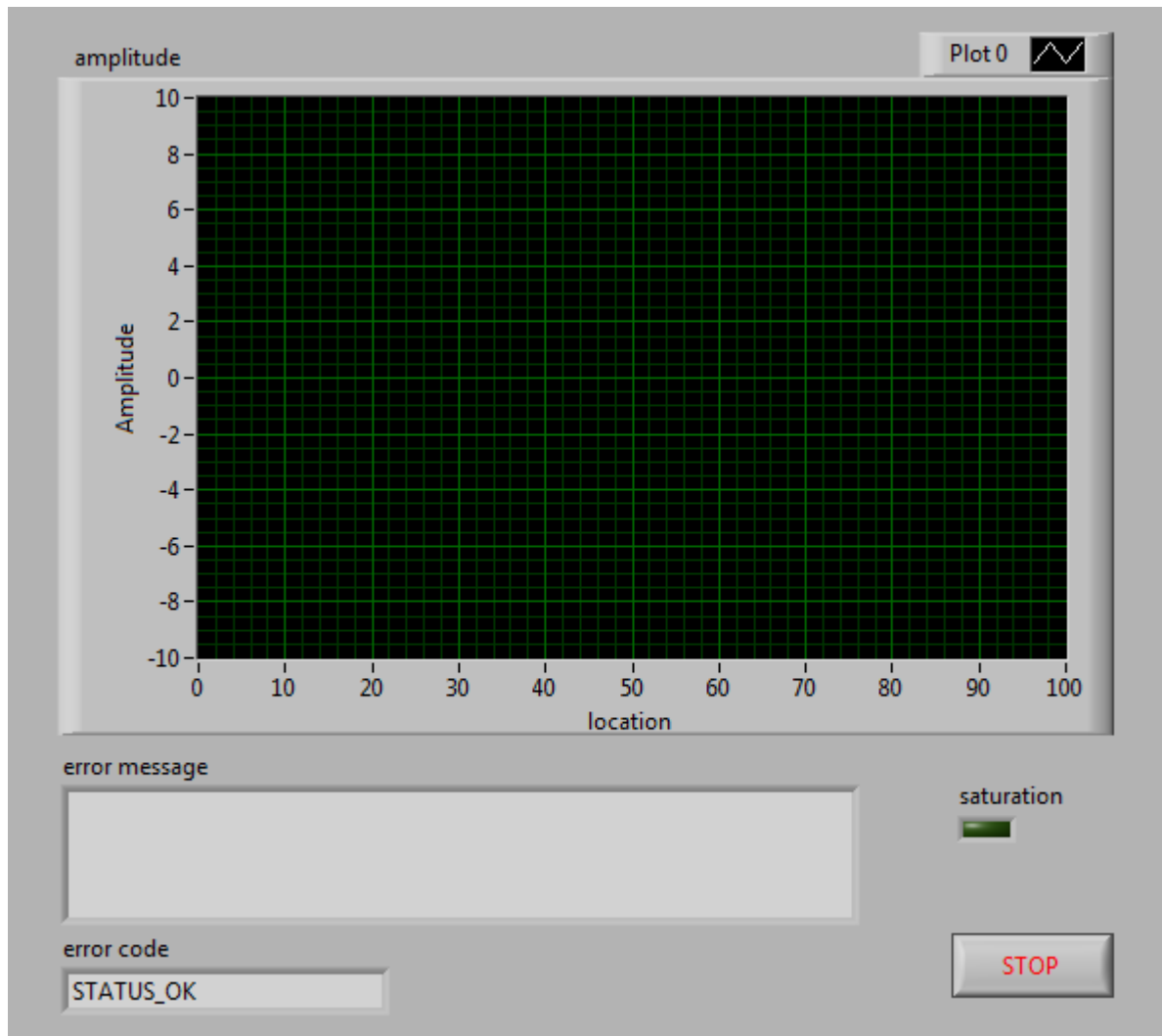
`crssdk_getError.vi` retrieves any error codes and messages from the earlier steps. If no errors occurred, the error code will be `STATUS_OK` and the error message will be blank.

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The SDK VIs are written to propagate any errors that occur. Therefore it is not necessary to check the error status at each step; the program can instead retrieve the error status at the end of a chain of operations as shown here.

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crssdk_example_scanAndDisplay.vi



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Figure 4-4 *crssdk_example_scanAndDisplay.vi* Front Panel

This example demonstrates how to acquire OBR measurements continuously.

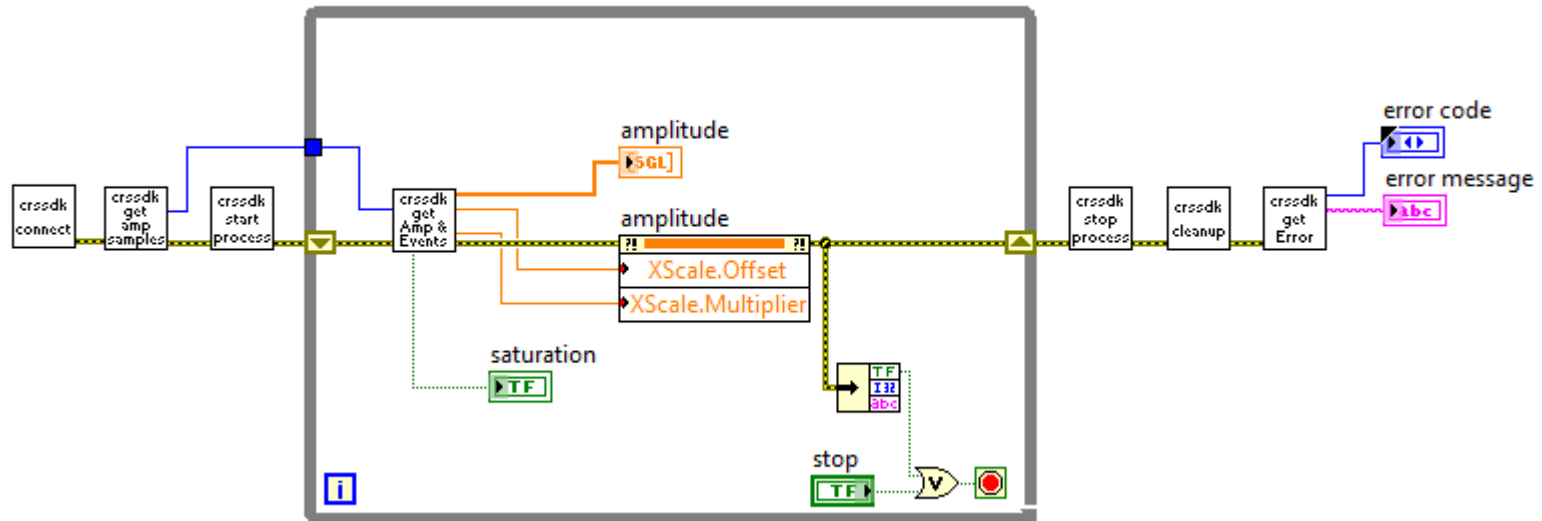


Figure 4-5 *crssdk_example_scanAndDisplay.vi*

The setup and structure is similar to *crssdk_example_singleScan.vi*. First, *crssdk_connect.vi* is called to connect to and initialize the OBR.

crssdk_startProcessing.vi is called instead of *crssdk_singleProcess.vi*, which was used in the previous example. *crssdk_startProcessing.vi* initiates continuous processing of measurement data from the OBR, while *crssdk_stopProcessing.vi* ends the continuous processing.

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crssdk_getAmpAndEventData.vi is again called to retrieve the measurement data. This example displays a detector saturation indicator, using the *saturation* output of *crssdk_getAmpAndEventData.vi*.

As in the previous example, *crssdk_cleanup.vi* is called to shut down the OBR connection, and *crssdk_getError.vi* is called to display any errors that occurred.

crssdk_example_saveFile.vi

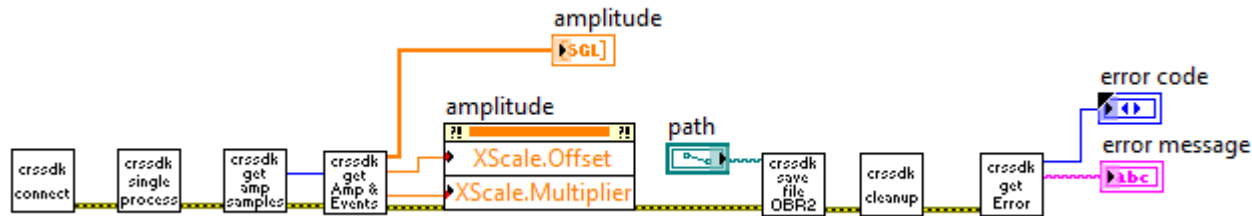


Figure 4-6 *crssdk_example_saveFile.vi*

crssdk_example_saveFile.vi performs the same steps as *crssdk_example_singlescan.vi*, but also calls *crssdk_saveFile_OBR2.vi* to save the binary measurement file. This example tries to save the measurement to the filename *C:\MyData\example.obr2*. This should be changed using the front panel *path* control to a filename and destination folder that can be accessed in the target computer.

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crssdk_example_loadFile.vi

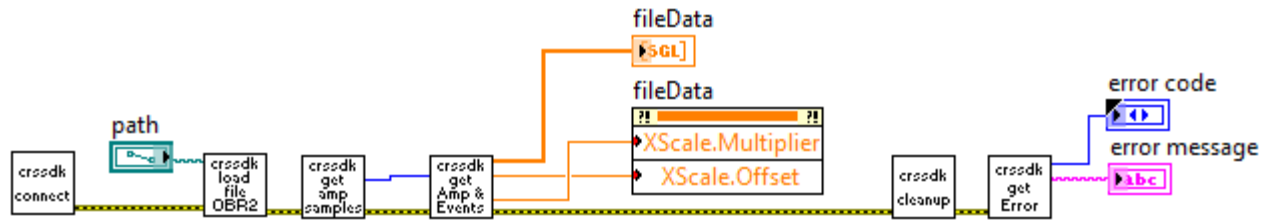


Figure 4-7 crssdk_example_loadFile.vi

This example calls *crssdk_loadFile_OBR2.vi* to load an existing measurement file. As in the file save example, the user should use the path control to select a file that exists on the target computer.

crssdk_example_alignOptics.vi

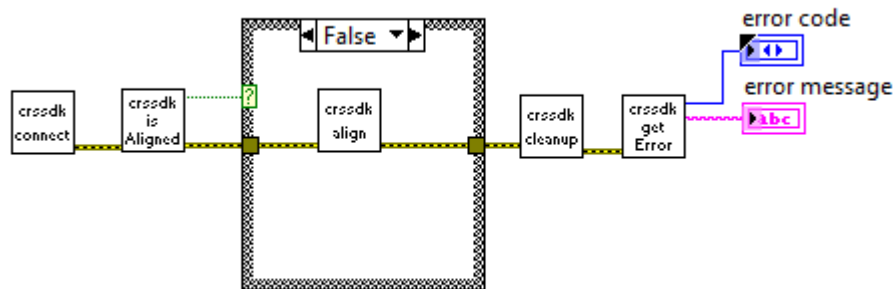


Figure 4-8 crssdk_example_alignOptics.vi

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This example demonstrates how to check the OBR alignment and to perform an alignment. *crssdk_isAligned.vi* checks to see whether the OBR is in alignment. If it is not, *crssdk_align.vi* is called to realign the OBR.

crssdk_example_calibrateInstrument.vi

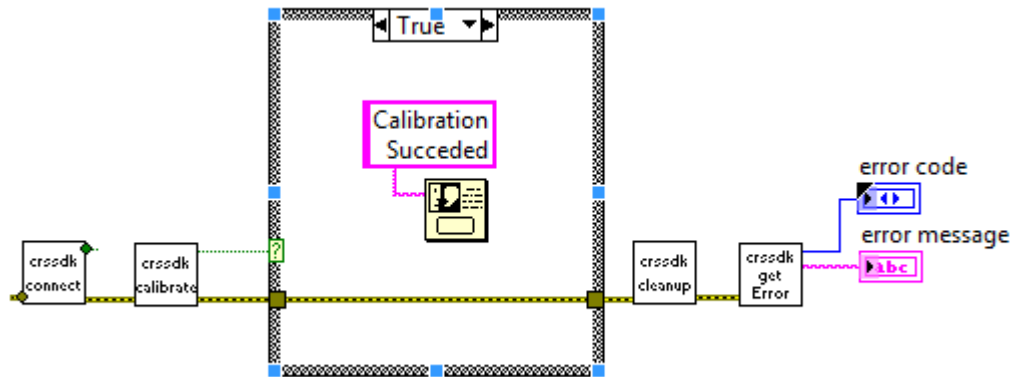


Figure 4-9 *crssdk_example_calibrateInstrument.vi*

This example demonstrates how to calibrate the OBR. *crssdk_calibrate.vi* is called to perform the calibration procedure. This VI will display several dialog boxes instructing the user to attach the calibration instrument and to move its paddles.

crssdk_example_showError.vi

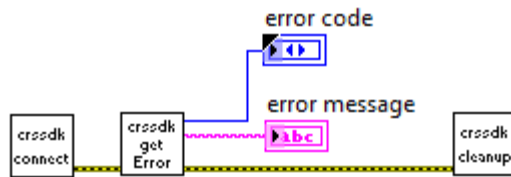


Figure 4-10 `crssdk_example_showError.vi`

This example demonstrates how to retrieve the error status and message from the previous SDK operations. This is also shown at the end of the other SDK examples.

This example tries to connect to the OBR and then shows the any error message that occurs. If there is no error, the error code will be `STATUS_OK` and the error message will be blank. If the SDK cannot connect to the OBR (for example, if this program is when with the OBR turned off or disconnected from the PC) the program will show the error code `STATUS_COMM_ERROR` and error message, "Communication failure. Please ensure the device is properly connected."

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C++ Support

The C++ folder contains an example Visual Studio project that controls the OBR using the SDK.

The file CaerusSDK.h contains prototypes for all of the functions available in the OBR 5T-50 SDK. The file example.cpp demonstrates how to use the SDK functions to connect to the OBR, calibrate the system, acquire measurements, and receive graph and event data.

Chapter 5 Controlling the OBR Remotely

This chapter provides information about controlling the OBR remotely by sending text-based remote commands using either TCP/IP or GPIB. This section assumes that the user already has some familiarity with TCP/IP or GPIB.

Nearly all functions that can be performed using the graphical interface of the control software can also be performed remotely. This includes setting parameters, performing measurements, loading and saving data files, as well as receiving data over the remote interface. However, continuous mode is not available with remote operation.

Note: The x-axis and y-axis measurement data may be retrieved using the remote commands. However, it can take a long time to transfer the maximum number of points (524288) using the remote commands. It is recommended that the number of decimated points be set to 65536 or fewer when using the FETC:MEAS? and FETC:XAXI? commands. For processing larger amounts of data, it is preferable to save files using the SYST:SAVE and SYST:SAVT commands, or to use the Software Development Kit.

Prerequisites for Remote Control Setup

- 1 Be familiar with the use of TCP/IP or GPIB and the OBR control software before attempting to control the OBR remotely.

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- 2 Network cabling must comply with IEEE 802 requirements for TCP/IP operation. GPIB network must be set up correctly.
- 3 Some OBR functions require seconds to complete. Adjust time-outs for your application accordingly.
- 4 Be aware of the IP address of the OBR PC in order to use TCP/IP remote control. If the remote server and client are both on the same PC, the remote client can use the IP address 127.0.0.1 to refer to its own PC

Running the Remote Control Server

The remote server is a separate application from the OBR control software. Exit the main application before running the Remote Control Server application.

When it starts, the Remote Control Server allows the user to select between TCP/IP or GPIB. The default setting is to use TCP/IP over port 5000. The selected settings will be retained and set as the defaults the next time the program is run.

The Remote Control software connects to the OBR and waits for a remote client to connect to it. Once a remote client connects, the Remote System Connected indicator lights up, and the Activity Log shows the commands and responses as they are processed.

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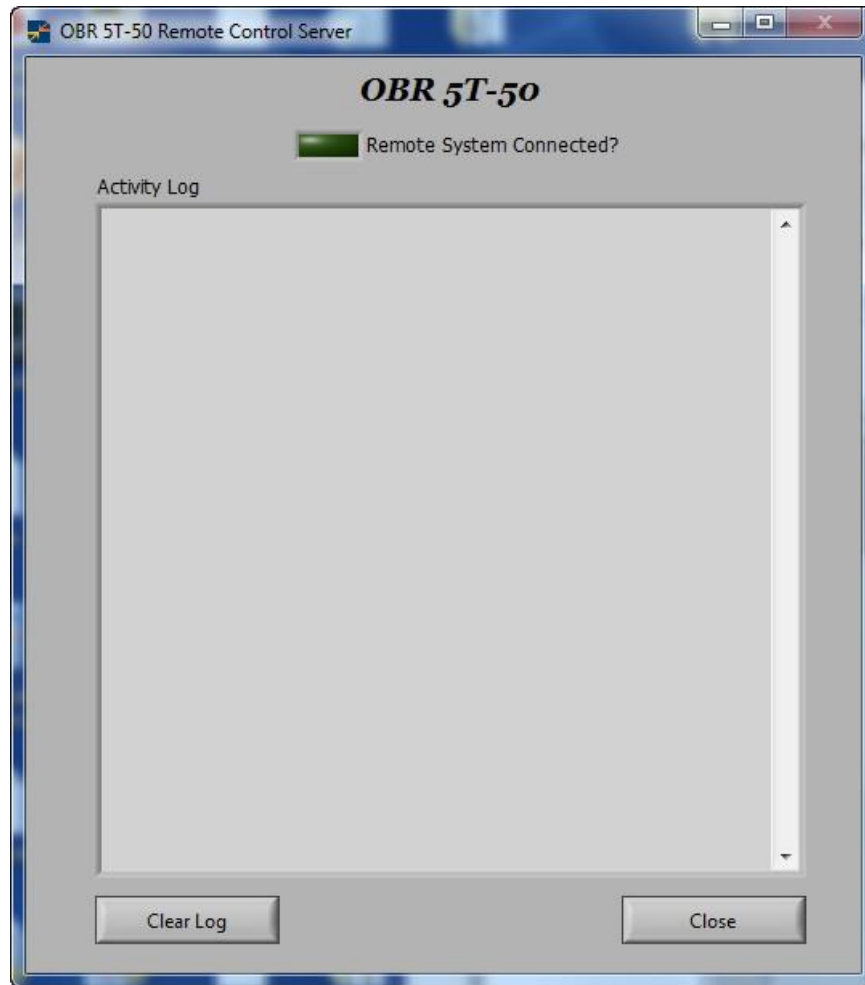


Figure 5-1 The remote control server software.

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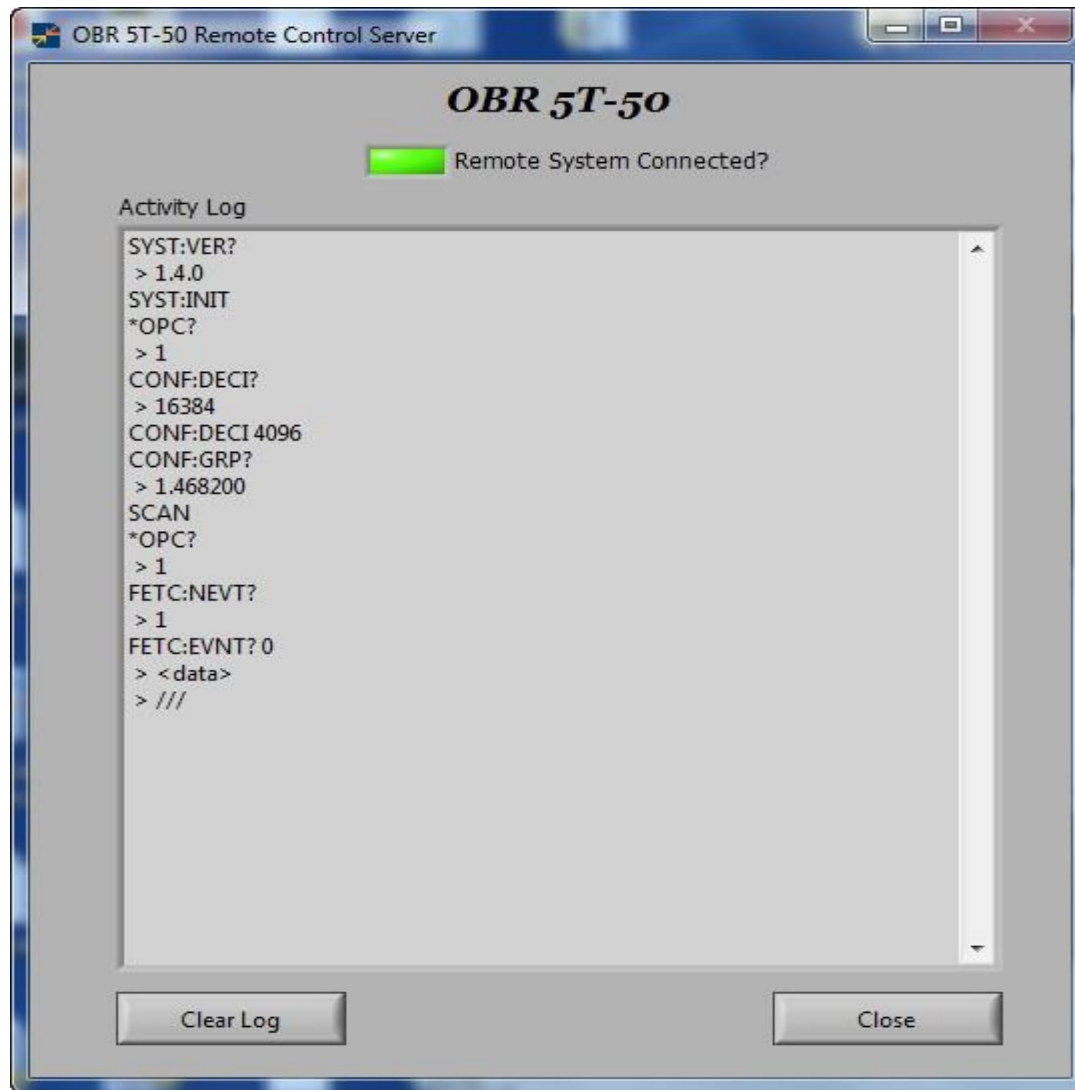


Figure 5-2 The remote control server software with an active connection.

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Once a connection has been established, the Remote Control Server looks for remote commands and processes them sequentially. The results are returned to the remote client and also displayed in the Activity Log. Numerical results, such as event information and x- and y-axis data are not displayed in full in the Activity Log. Instead, the log will simply read, "<data>".

Connecting to the Remote Control Server

A remote control client can be written in any language that can send TCP/IP packets or can communicate over a GPIB connection. The remote client should connect to the selected port on the target (or the correct address on the GPIB network) and then send remote commands to the server.

The OBR software includes two example remote clients (one for TCP/IP and another for GPIB) with LabVIEW 2010 source code. Both executable programs are located in the folder C:\Program Files\Luna Technologies\OBR 5T50\Remote Client. The LabVIEW source code for both is in the src folder in that location.

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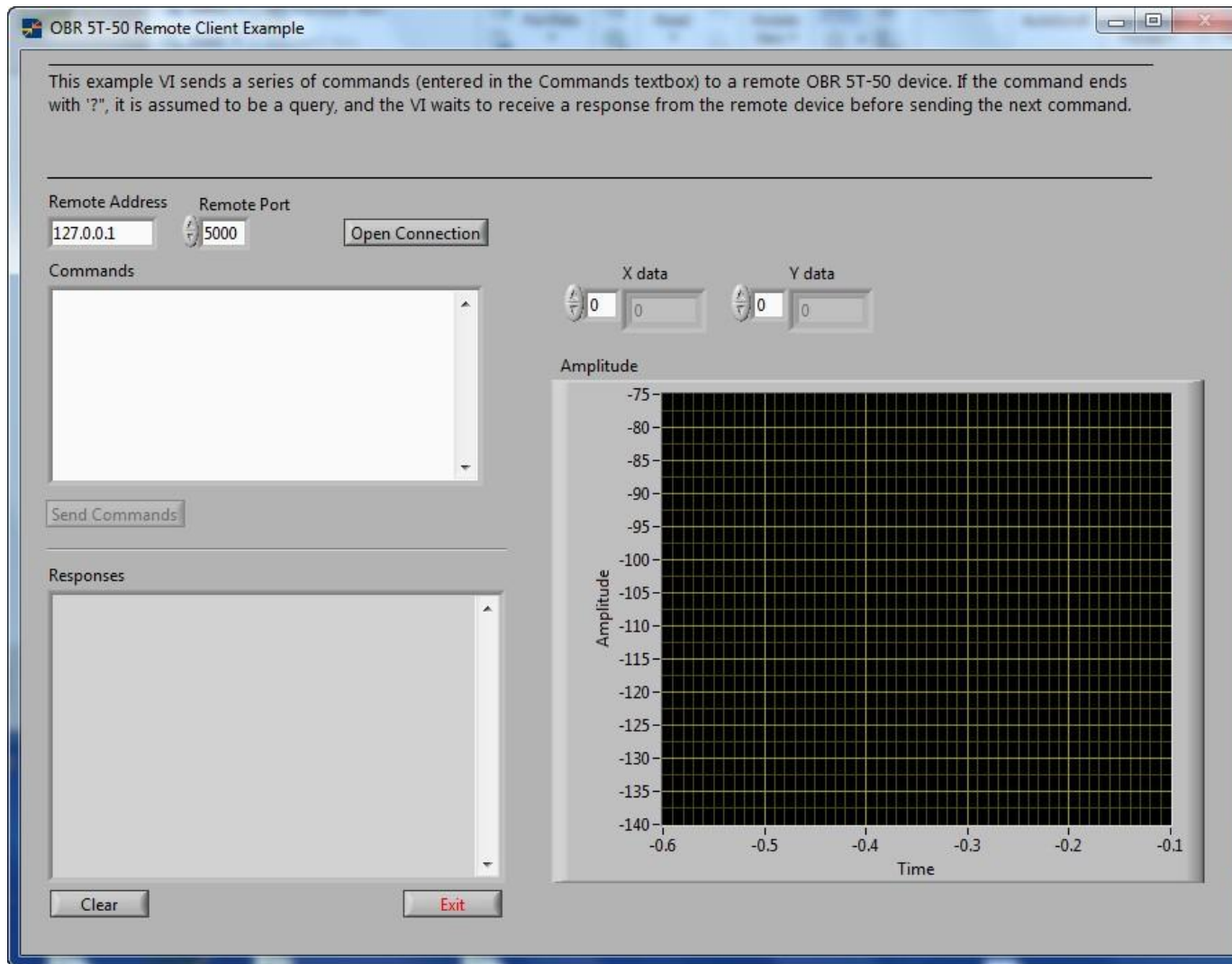


Figure 5-3 Example TCP/IP remote client software.

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To use the example software, press the Open Connection button to connect to the remote server. Then type commands in the Commands box and press the Send Commands button. The commands will be sent to the server one at a time, and the results are displayed in the Responses text box.

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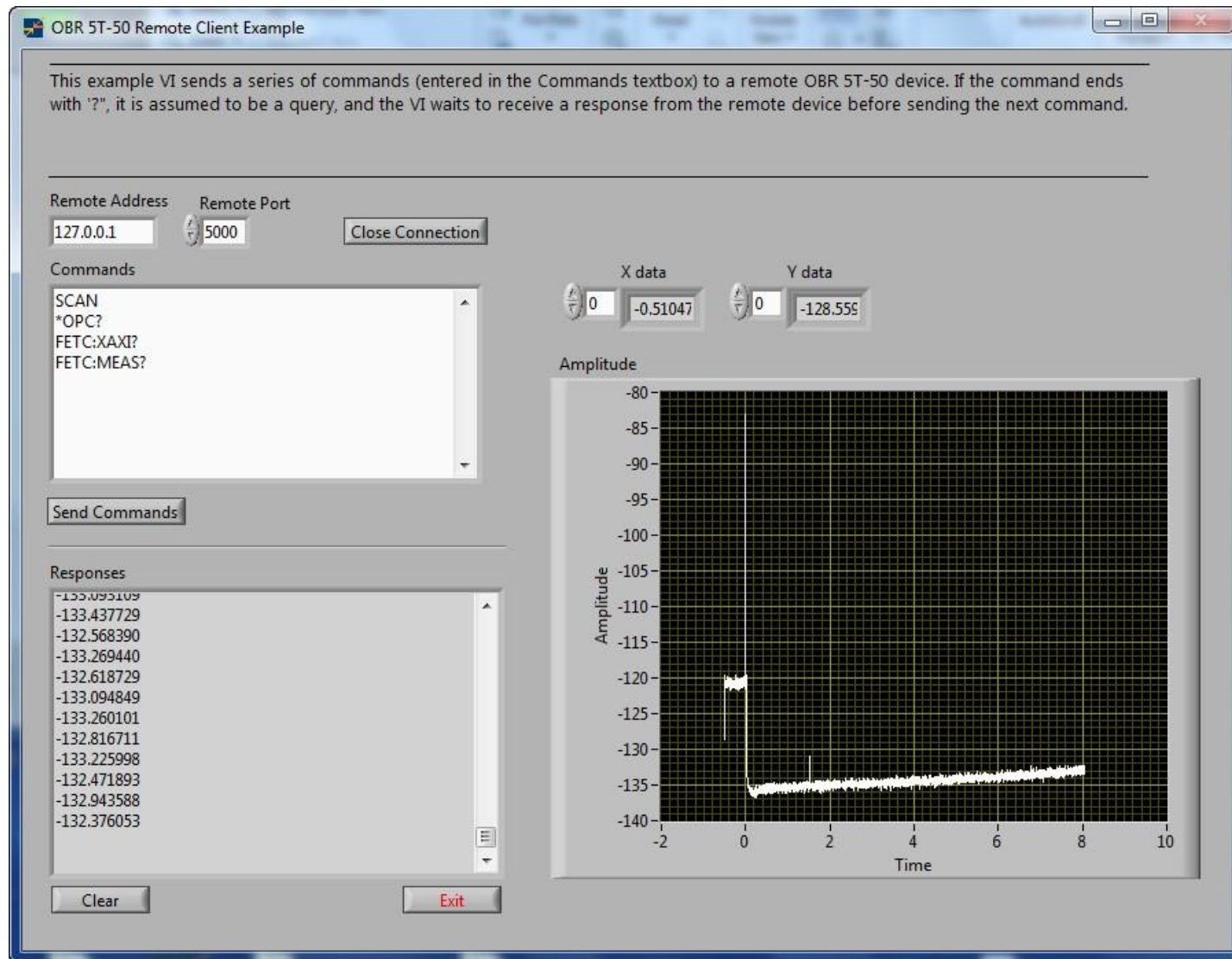


Figure 5-4 Example remote client with active session.

Setting up a GPIB network

A GPIB network consists of at least two GPIB cards (most likely on two separate PCs) connected by a GPIB cable. There can be multiple GPIB cards on a network, and each must have a unique address.

One of the GPIB cards on a network is configured to be the System Controller. For best results, this should be the GPIB card used by the Remote Control Client software, not the Remote Control Server. The assignment of GPIB addresses and System Controller status is done with the GPIB configuration software that comes with the GPIB cards, not the Luna Innovations OBR software. For National Instruments GPIB cards, this is the NI Measurement and Automation software.

The Remote Control Server should specify the GPIB card it is using, along with that card's address. The Remote Control Client should specify the GPIB card it is using, along with the target address – that is, the address being used by the Remote Control Server. Neither piece of software needs to know the Client software's GPIB address.

As an example, say a two-card GPIB is set up with the following options. The Client's GPIB card is set to GPIB0 and address 1. It is set as the System Controller. The Server's GPIB card is set to GPIB1 and address 0. In the NI Measurement and Automation software, this configuration looks like the following:

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Remote Control Client

Name	Value
Interface Information	
GPiB Hardware Model	GPiB-USB-HS
Serial Number	0172509D
IP Address	Not Applicable
General Settings	
GPiB Interface ID	GPiB0
Primary Address	1
Secondary Address	None
System Controller	<input checked="" type="checkbox"/>
I/O Timeout	13 (10 sec)
Autopolling	<input checked="" type="checkbox"/>
Termination Settings	
Send EOI at End of Write	<input checked="" type="checkbox"/>
Terminate Read on EOS	<input type="checkbox"/>
EOS Byte	0
8-bit EOS Compare	<input type="checkbox"/>
Set EOI with EOS on Write	<input type="checkbox"/>
Advanced Settings	
HS488 Cable Length	0 (Disabled)
Parallel Poll Duration	0 (2 usec)
Assert REN when SC	<input type="checkbox"/>
Bus Timing	2 (500 nsec)

Remote Control Server

Name	Value
Interface Information	
GPiB Hardware Model	GPiB-USB-HS
Serial Number	01725198
IP Address	Not Applicable
General Settings	
GPiB Interface ID	GPiB1
Primary Address	2
Secondary Address	None
System Controller	<input type="checkbox"/>
I/O Timeout	13 (10 sec)
Autopolling	<input checked="" type="checkbox"/>
Termination Settings	
Send EOI at End of Write	<input checked="" type="checkbox"/>
Terminate Read on EOS	<input type="checkbox"/>
EOS Byte	0
8-bit EOS Compare	<input type="checkbox"/>
Set EOI with EOS on Write	<input type="checkbox"/>
Advanced Settings	
HS488 Cable Length	0 (Disabled)
Parallel Poll Duration	0 (2 usec)
Assert REN when SC	<input type="checkbox"/>
Bus Timing	2 (500 nsec)

Figure 5-5 Example remote GPIB configuration.

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The Remote Control Server will be set to use GPIB1 and address 2, as shown below:

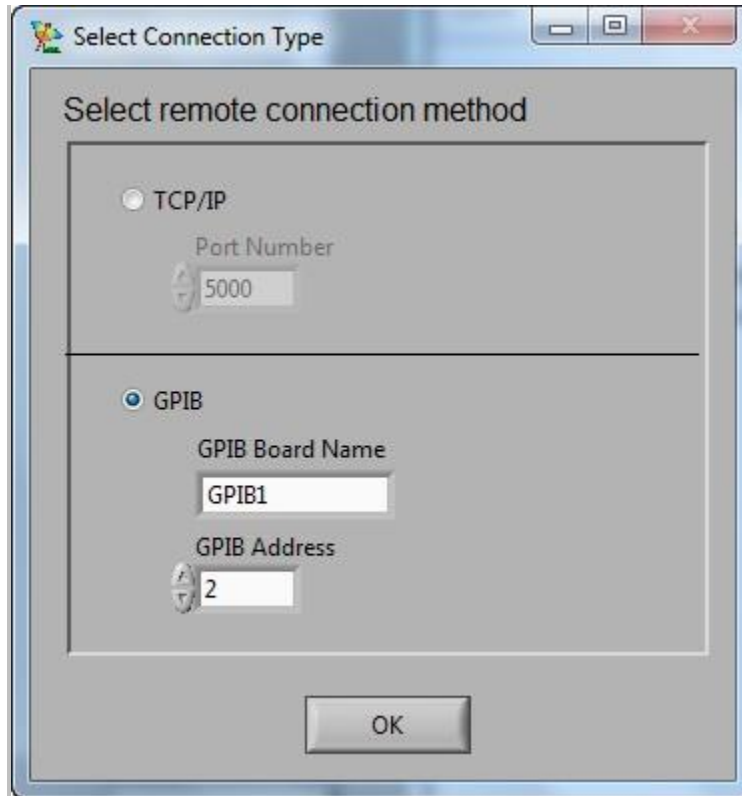


Figure 5-6 Example Remote Server GPIB options.

The Remote Control Client will use GPIB0, and will connect to address 2.

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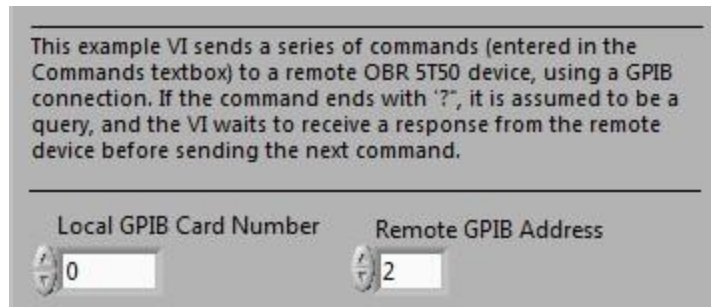


Figure 5-7 Example Remote Server GPIB options.

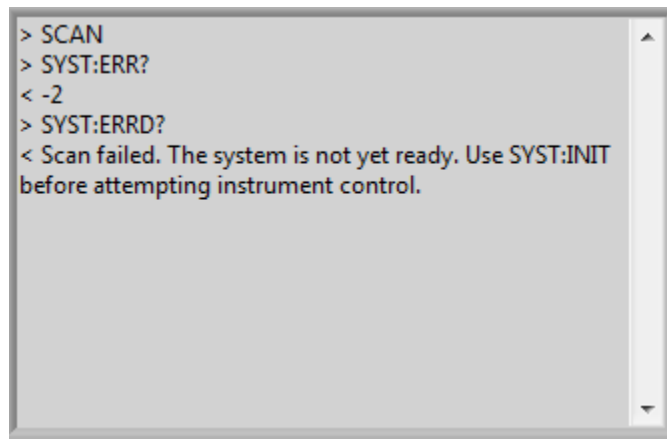
Remote Control Commands for the OBR

This section gives a description of every remote control command available with the OBR remote control software. The commands are organized by function. System level commands begin with "SYST:". (The one exception is the SCAN command, which has no prefix.) Configuration commands begin with "CONF:", and commands that retrieve data begin with "FETC:" (for "fetch").

Commands that end in a question mark are referred to as queries and return responses. Commands without an ending question mark do not retrieve values. The queries SYST:ERR? and SYST:ERRD? can be used to determine whether or not these commands were successful.

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It is important to remember to send the SYST:INIT to initialize the OBR 5T-50 hardware before sending commands like SCAN that use the hardware. If the hardware has not been initialized, the SYST:ERR? command will return a non-zero response to indicate that the scan has failed, and the SYST:ERRD? response will give more information about the error.

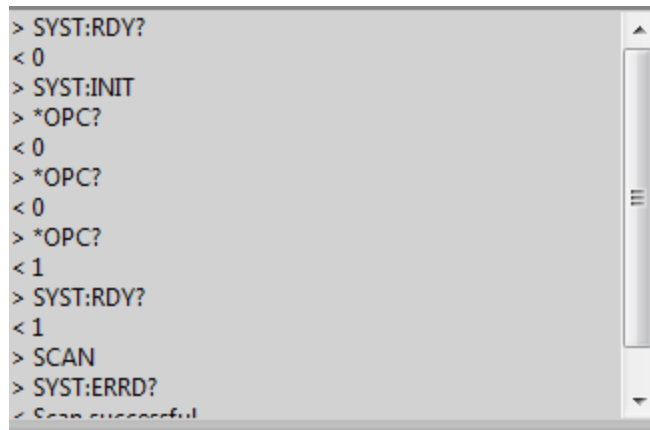


```
> SCAN
> SYST:ERR?
< -2
> SYST:ERRD?
< Scan failed. The system is not yet ready. Use SYST:INIT
before attempting instrument control.
```

Figure 5-8 Error when using SCAN command before SYST:INIT?

The SYST:RDY? command can be used to query whether the system is ready to perform measurements. If this command returns 0, the SYST:INIT command should be sent. If SYST:RDY? returns 1, then the system is ready and SYST:INIT is not necessary.

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```
> SYST:RDY?  
< 0  
> SYST:INIT  
> *OPC?  
< 0  
> *OPC?  
< 0  
> *OPC?  
< 1  
> SYST:RDY?  
< 1  
> SCAN  
> SYST:ERRD?  
< Scan successful
```

Figure 5-9 Checking that the system is initialized before using SCAN command

In the session shown above, SYST:RDY? is used to see if the system is ready for hardware operations. It is not (response is 0), so a SYST:INIT command is sent. The *OPC? command is sent to see if the operation is complete. Once SYST:INIT has completed, SYST:RDY? is checked again. The system is now ready (response is 1), and the SCAN command can be sent and will complete without error.

Some commands have parameters, shown in brackets in this document. Note that for queries, the question mark appears after the command name, not after the parameter and the end of the full command string. For example, the correct format for the FETC:EVNT? query is "FETC:EVNT? 1", not "FETC:EVNT 1?".

Important



The OBR control software does not support multiple commands on a line, separated by semicolons. Enter each command on a separate line.

IEEE 488.2 defines commands as being either *sequential* or *overlapped*. Sequential commands cause the instrument to ignore other remote control commands until each command has completed. Overlapped commands let the device respond to incoming commands before pending commands completely execute. The OBR processes only sequential commands.

All commands are case-sensitive, and must be entered exactly as they appear in this chapter.

Remote control commands are classified by types:

- System Control Commands
- Configuration Commands
- Data Capture and Retrieval Commands

System Level Commands

***IDN?**

Usage: *IDN?

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Description: Queries the identity of the device.

Response: "OBR 5T-50" and the version number. Ex: "OBR 5T-50 v1.0.0".

Note: This command is not displayed in the Remote Server's *Activity Log*.

***OPC?**

Usage: *OPC?

Description: Indicates whether the previous operation has completed.

Response: 1 if the previous operation is complete, or 0 if it is still being processed.

SYST:INIT

Usage: SYST:INIT

Description: Initializes the OBR for acquiring data.

Response: None.

Note: This command should be called before acquiring data or changing scan parameters. The SYST:INIT command should only be called once at the beginning of a remote session.

After calling SYST:INIT, poll the *OPC? command and wait until the response is 1 before sending any other commands.

SYST:VER?

Usage: SYST:VER?

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Description: Returns the software version number.
Response: the software version number. Ex: "1.0"

SYST:ON?

Usage: SYST:ON?
Description: Queries whether the OBR is turned on.
Response: 1 if the OBR is on, or 0 if it is off

SYST:RDY?

Usage: SYST:RDY?
Description: Queries whether the OBR is ready to acquire data.
Response: 1 if the OBR is ready, or 0 if it is not

SYST:ERR?

Usage: SYST:ERR?
Description: Returns the error status of the previous command.
Response: 0 if the previous command was successful, or a non-zero error code if the previous command failed.

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Note: If the response is not 0, the SYST:ERRD? query can be used to retrieve a more detailed error message.

SYST:ERRD?

Usage: SYST:ERRD?

Description: Returns a detailed error status showing the results of the previous command.

Response: A string indicating the results of the previous command.

Examples:

"Set the group index to 1.50"

"Alignment succeeded"

"Failed to write the file C:\My Data\MyFile.txt"

SYST:ALIG

Usage: SYST:ALIG

Description: Aligns the optical network of the OBR

Response: None. Use SYST:ERR? or SYST:ERRD? to determine if the alignment was successful.

Note: This command cannot be used unattended. The Remote Command Server will prompt the user to disconnect any devices from the instrument in order to perform the alignment. This command should not be used if there is no operator to physically attend to the OBR.

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SYST:ALIG?

- Usage: SYST:ALIG?
- Description: Queries whether the OBR optical network is aligned
- Response: 1 if the OBR is aligned, 0 if it is not.
- Note: The alignment check should be performed with no devices connected. For this reason, it is preferable not to use this command unattended.

SYST:SAVE

- Usage: SYST:SAVE { filename }
Ex: SYST:SAVE "C:\My Data\MyFile.OBR2"
- Description: Saves the current measurement as a binary file.
- Response: None. Use SYST:ERR? or SYST:ERRD? to determine if the file was saved successfully.
- Note: Filename which contain spaces should be contained in quote marks. The SYST:SAVE command does not append a file extension, so the ".OBR2" extension should be included in the filename parameter.

SYST:SAVT

- Usage: SYST:SAVT { filename }
Ex: SYST:SAVT "C:\My Data\MyData.txt"

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- Description: Saves the current measurement as a text file.
- Response: None. Use SYST:ERR? or SYST:ERRD? to determine if the file was saved successfully.
- Note: Filename which contain spaces should be contained in quote marks. The SYST:SAVE command does not append a file extension, so the ".txt" extension should be included in the filename parameter.

SYST:SAVN

- Usage: SYST:SAVN { filename }
Ex: SYST:SAVN "C:\My Data\MyEvents.txt"
- Description: Saves the current measurement's event table as a text file.
- Response: None. Use SYST:ERR? or SYST:ERRD? to determine if the file was saved successfully.
- Note: Filename which contain spaces should be contained in quote marks. The SYST:SAVE command does not append a file extension, so the ".txt" extension should be included in the filename parameter.

SCAN

- Usage: SCAN
- Description: Acquires a new measurement

Response: None. Use SYST:ERR? or SYST:ERRD? to determine if the scan was successful.

Configuration Commands

Note: The configuration commands affect the setting that will be used for the next scan. None of these commands will take effect until after sending the next SCAN command.

CONF:GRP?

Usage: CONF:GRP?
Description: Retrieves the current group index.
Response: The current group index.
Ex: 1.468200

CONF:GRP

Usage: CONF:GRP { group index }
Description: Sets the current group index.
Response: None.

CONF:DECI?

Usage: CONF:DECI?

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Description: Retrieves the current number of decimated points.

Response: The current number of decimated points

Ex: 4096, 16384, 524288, etc.

CONF:DECI

Usage: CONF:DECI { number of decimated points }

Description: Sets the number of decimated points.

Response: None.

Note: This command controls the number of points that will be returned by the FETC:XAXI? and FETC:MEAS? commands, as well as the number of points written to the text file using the SYST:SAVT command. It does not affect the amount of data written to the binary file using SYST:SAVE; the binary file always contains the full measurement data.

The number of decimated points is generally a power of two, but this is not strictly necessary. The maximum value is 524288 (the full number of points in the OBR measurement). Any values larger than this will be ignored. The default value when starting the Remote Control Server software is 16384.

Note that retrieving large numbers of points using the FETC:XAXI? and FETC:MEAS? commands may take a long time. For processing large amounts of data, it is preferable to save data files with the SYST:SAVE or SYST:SAVT commands, or to use the Software Development Kit.

CONF:XUNI?

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Usage: CONF:XUNI?
Description: Retrieves the current x-axis units.
Response: 0: nanoseconds, 1: meters, 2: feet, 3: inches, 4: millimeters

CONF:XUNI

Usage: CONF:GRP { units }
Valid values for the units parameter are:
0: nanoseconds, 1: meters, 2: feet, 3: inches, 4: millimeters
Description: Sets the x-axis units.
Response: None.
Note: This sets the units used by the FETC:XAXI? and FETC:EVNT? commands, as well as the text files saved by SYST:SAVT and SYST:SAVN. It also controls the units that should be used by the commands CONF:RLW, CONF:ILW, CONF:MNEV, and CONF:MXEV.

CONF:RLW?

Usage: CONF:RLW?
Description: Retrieves the width used to determine the return loss of events in the event table.
Response: Return loss width, in the units specified by the CONF:XUNI command.

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CONF:RLW

- Usage: CONF:RLW { return loss width }
- Description: Sets the width used to determine the return loss of events in the event table.
- Response: None.
- Note: The return loss width parameter must use the units specified by the CONF:XUNI command.

CONF:ILW?

- Usage: CONF:ILW?
- Description: Retrieves the width used to determine the insertion loss of events in the event table.
- Response: Insertion loss width, in the units specified by the CONF:XUNI command.

CONF:ILW

- Usage: CONF:ILW { insertion loss width }
- Description: Sets the width used to determine the insertion loss of events in the event table.
- Response: None.
- Note: The insertion loss width parameter must use the units specified by the CONF:XUNI command.

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CONF:MXEV?

Usage: CONF:MXEV?
Description: Retrieves the maximum location for which events will be found.
Response: Maximum event location, in the units specified by CONF:XUNI.

CONF:MXEV

Usage: CONF:MXEV { maximum event location }
Description: Sets the maximum location for which events will be found.
Response: None.
Note: The minimum location parameter must use the units specified by the CONF:XUNI command.

CONF:MNEV?

Usage: CONF:MNEV?
Description: Retrieves the minimum location for which events will be found.
Response: Minimum event location, in the units specified by CONF:XUNI.

CONF:MNEV

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Usage: CONF:MNEV { minimum event location }

Description: Sets the minimum location for which events will be found.

Response: None.

Note: The minimum location parameter must use the units specified by the CONF:XUNI command.

CONF:NEVT?

Usage: CONF:NEVT?

Description: Retrieves the maximum number of events that will be calculated in the event table.

Response: Maximum number of events, a value from 0 to 4.

CONF:NEVT

Usage: CONF:NEVT { max number of events }

Description: Sets the maximum number of events that will be calculated in the event table.

Response: None.

Note: Valid values for the max number of events parameter are 0 to 4. Values larger than 4 will be coerced to 4.

CONF:EVTH?

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Usage: CONF:EVTH?
Description: Retrieves the minimum amplitude (in dB) for which events will be found.
Response: Minimum event threshold in dB.

CONF:EVTH

Usage: CONF:EVTH { minimum event threshold }
Description: Sets the minimum amplitude (in dB) for which events will be found.
Response: None.

CONF:FWIN?

Usage: CONF:FWIN?
Description: Queries whether the frequency domain Hanning window will be applied to the measurement data.
Response: 1 if the window will be applied, 0 if not

CONF:FWIN?

Usage: CONF:FWIN { 0 or 1 }
1 to apply the window, 0 not to apply it

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- Description: Sets whether the frequency domain Hanning window will be applied to the measurement data.
- Response: None
- Note: The frequency domain window affects the data returned by the FETC:MEAS command or saved in the text file by SYST:SAVT. It does not affect the data stored in the binary file with SYST:SAVE. The binary file always contains the full, original data.

CONF:ZERO?

- Usage: CONF:ZERO?
- Description: Retrieves the zero length location.
- Response: Zero length location, in the units specified by CONF:XUNI

CONF:ZERO

- Usage: CONF:ZERO { zero length location }
- Description: Sets the zero length location.
- Response: none
- Note: The zero length location parameter must use the units specified by the CONF:XUNI command.

Data Retrieval Commands

FETC:FSIZ?

Usage: FETC:FSIZ?

Description: Retrieves the size of the measurement data.

Response: The size of the measurement data.

Examples: 4096, 16384, etc.

Note: This indicates the number of points that will be returned by the FETC:XAXI and FETC:MEAS commands, as well as the number of points saved in the text file using the SYST:SAVT command.

It should match the number of decimated points returned by the CONF:DECI? query. Note, however, that if CONF:DECI is set to 524288 the number of points returned by FETC:FSIZ? will be slightly smaller because some points at the beginning and end of the measurement are discarded during processing.

FETC:XAXI?

Usage: FETC:XAXI?

Description: Retrieves the x-axis data for the measurement.

Response: A series of x-axis points, separated by newline characters.

Note: The x-axis values will be in the units specified by the CONF:XUNI command. The number of points returned is equal to the response of the FETC:FSIZ? command.

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The points are separated by newline characters and terminated with the string "///".

FETC:MEAS?

- Usage: FETC:MEAS?
- Description: Retrieves the y-axis amplitude data for the measurement.
- Response: A series of y-axis points, separated by newline characters.
- Note: The number of points returned is equal to the response of the FETC:FSIZ? command. The points are separated by newline characters and terminated with the string "///".

FETC:NEVT?

- Usage: FETC:NEVT?
- Description: Retrieves the number of events found in the event table.
- Response: The number of events found.
- Note: This value indicates the number of events that were found using the minimum event threshold. It may be smaller than the maximum number of events set with the CONF:NEVT command.

FETC:EVNT?

- Usage: FETC:EVNT? { event number }

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Description: Retrieves the x-axis location, return loss, and insertion loss for the specified event.

Response: The x-axis location, return loss, and insertion loss.

Note: The event number parameter should be a value between 0 and 3. 0 indicates the first event, 1 the second, and so on.

The x-axis location will be in the units specified by the CONF:XUNI command. Both loss values are in units of dB. The three points are separated by newline characters and terminated with the string "///".

FETC:TIMS?

Usage: FETC:TIMS?

Description: Retrieves the measurement's start time in nanoseconds.

Response: The start time in nanoseconds.

FETC:TIME?

Usage: FETC:TIME?

Description: Retrieves the measurement's end time in nanoseconds.

Response: The end time in nanoseconds.

FETC:TINC?

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Usage: FETC:TINC?
Description: Retrieves the measurement's time increment in nanoseconds.
Response: The time increment in nanoseconds.

Chapter 6 Measurement Theory

The Luna OBR utilizes swept-wavelength interferometry to interrogate the device or system under test. This technique measures the full scalar response, including both phase and amplitude information. The amplitude of the time domain data is equivalent to a traditional optical time domain reflectometry (OTDR) measurement.

Fiber Optic Interferometry

The OBR uses swept-wavelength coherent interferometry) to measure the Rayleigh backscatter as a function of position in the optical fiber. Rayleigh backscatter in optical fibers is caused by random fluctuations in the index profile along the fiber length. Scatter amplitude is a random but static property of a given fiber. This technique is presented at an introductory level. For more information see the references at the end of this section.

The two basic types of fiber interferometers are shown in Figure 7-1.

- (1) A Mach-Zehnder design uses one 3 dB coupler to split the light, and another 3 dB coupler to recombine the light. In general, the two paths between the couplers are of different lengths. A detector is placed at the output of the second coupler.
- (2) A Michelson interferometer uses a single 3 dB coupler to both split and recombine the light. Mirrors are placed at each of the outputs on one side of the coupler, and in general the two paths

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are of different lengths. On the other side of the coupler, one lead is used to inject the light, and the other is directed to a detector.

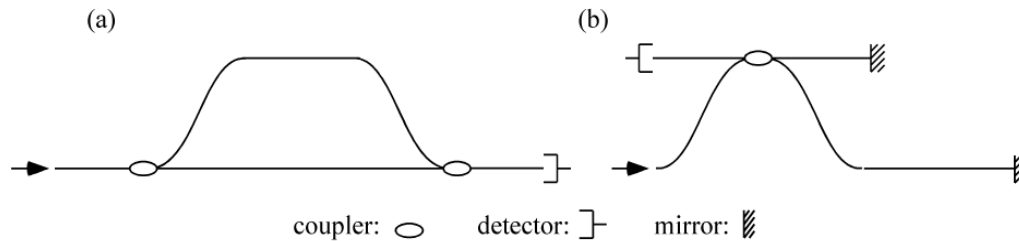


Figure 6-1 Two basic types of fiber interferometers: (a) Mach-Zehnder and (b) Michelson.

Both of these interferometer designs can be treated in a basic way using the same set of mathematics. Consider an input field of the form

$$E_{in} = E_0(t)e^{-i\omega(t)t}$$

where ω is angular optical frequency, and $\omega(t)$ describes the instantaneous frequency of the tunable laser source.

The spatial dependence of the signal may be ignored because the light is detected only at a single point. At the first coupler, the input field is split into two fields, E_1 and E_2 . After propagating through different lengths of fiber, the two fields are recombined, and the resulting field at the detector is

$$E_{out} = E_0(t + \tau_1)e^{-i\omega(t + \tau_1)t} + E_0(t + \tau_2)e^{-i\omega(t + \tau_2)t}$$

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where τ_1 and τ_2 are the delays through the two paths of the interferometer.

The electrical output of the detector is proportional to the optical intensity, I , which is given by the square magnitude of the electric field:

$$I(\omega) = |E_0(t)|^2 + |E_0(t-\tau)|^2 + 2E_0(t)E_0(t-\tau)\cos[\omega(t)\tau]$$

where the time delay difference between the interferometer paths $\tau = \tau_1 - \tau_2$.

Optical Network for OBR

A schematic of Luna's OBR optical network is shown in Figure 7-2. The optical system is comprised of a tunable laser source (TLS), an interferometer (which includes the device under test (DUT)), and a detector.

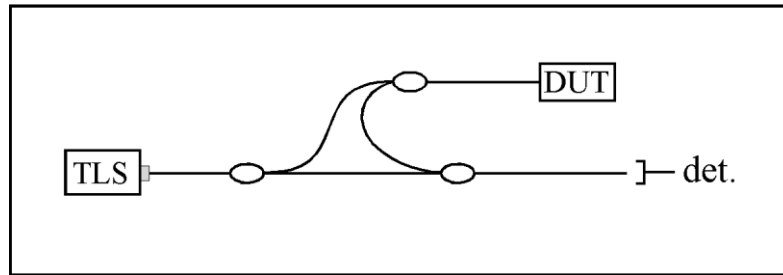


Figure 6-2 OBR optical network

The basic idea from the previous section can be applied to device characterization by including a DUT in one arm of a Mach-Zender interferometer, as shown in Figure 7-2. We can describe the DUT by its frequency domain linear transfer function, $H(\omega)$; the linear transfer function contains

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information about the amplitude, $\rho(\omega)$, and phase, $\phi(\omega)$, response of the DUT and is given by $H(\omega) = \rho(\omega)e^{i\phi(\omega)}$. Given the amplitude and phase response, the detected power is proportional to the intensity, I , given by

$$I = |E_0(t)|^2 + |E_0(t - \tau)|^2 \rho(\omega)^2 + 2\rho(\omega)E_0(t)E_0(t - \tau) \cos[\omega(t)\tau - \phi(\omega)] .$$

Next a Fourier transform is performed allowing the three terms in the above expression to be separated spectrally. Note that the first two terms will have only low frequency characteristics, and thus will appear at or near $t = 0$ in the time-domain. The device information resides in the third term of this expression, called the *interference term*. The interference term oscillates at the frequency $\omega(t)\tau$, while the other terms do not oscillate. Its location in the time-domain will be determined by the delay difference τ between the two arms of the interferometer. Provided that τ is large enough, the device response will be separable from the low frequency terms, and thus measurable. The Luna OBR is designed such that the internal delay path through the device under test is long enough such that the low frequency terms will not influence the measurement, even for very short devices. Thus the OBR operates with no dead zone.

The Fourier transform of reflected optical intensity (I) for a short length of a single-mode fiber is plotted in Figure 7-3 (a). Figure 7-3 (b) shows the selected segment that contains the device information. Because the initial data was acquired as a function of optical frequency, ω , the transformed data is a function of time. For this reason, the transformed data is referred to as *time domain data*.

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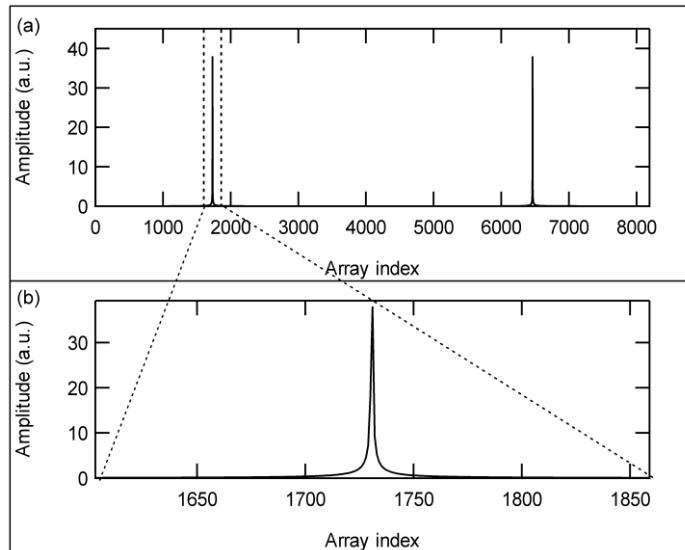


Figure 6-3 (a) The Fourier transform of interference fringes.

(b) The segment of the time domain data that contains device information.

If there are multiple reflecting interfaces within the device under test, each interface will contribute a term to the interference pattern and a peak in the time-domain located at the corresponding delay.

In order to more easily locate the source of reflections within a device, the time-domain data can be scaled in units of length, using the speed of light and the group index of the DUT.

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Fiber Interferometry References

B. Soller, D. Gifford, M. Wolfe and M. Froggatt, "High resolution optical frequency domain reflectometry for characterization of components and assemblies," *Optics Express*, **13:666-674**, Jan. 2005.

B. J. Soller, M. Wolfe, M. E. Froggatt, "Polarization resolved measurement of Rayleigh backscatter in fiber-optic components," paper NWD3, *OFC Technical Digest*, Los Angeles, March 2005.

M. Froggatt, T. Erdogan, J. Moore, S. Shenk, "Optical frequency domain characterization (OFDC) of dispersion in optical fiber Bragg gratings," **FF2**, *Special Meeting on Bragg Gratings, Photosensitivity, and Poling in Glass Waveguides*, Sept. 1999.

M.M. Ohn, S.Y. Huang, S. Sandgren, R. Measures, T. Alavie, "Measurement of fiber grating properties using an interferometric and Fourier-transform-based technique," **WJ2**, *Optical Fiber Communication Conference*, March 1997.

M. Froggatt, J. Moore, and T. Erdogan, "Full complex transmission and reflection characterization of a Bragg grating in a single laser sweep," **WB1**, *Optical Fiber Communication Conference*, March 2000.

M. Froggatt, E. Moore, and M. Wolfe, "Interferometric measurement of dispersion in optical components," **WK1**, *Optical Fiber Communication Conference*, March 2002.

U. Glombitza and E. Brinkmeyer, "Coherent frequency-domain reflectometry for characterization of single-mode integrated-optical waveguides," *J. Lightwave Tech.* **11**, 1377-1384, 1993.

Time Domain Amplitude (dB)

As mentioned above, the OBR uses coherent interferometry to measure the linear transfer function, $H(\omega) = \rho(\omega)e^{i\varphi(\omega)}$, of the DUT. From this, the impulse response is given by the Fourier transform of the transfer function,

$$\tilde{h}_j = FFT\{H(\omega)\}_j ,$$

where $FFT\{H(\omega)\}$ denotes the Fast Fourier Transform of $H(\omega)$. The index j indicates the location in the data array, and corresponds to time.

The Amplitude (dB) curve is the time domain linear amplitude data plotted on a log scale, according to the following relation:

$$Amp[dB]_j = 10\log [|\tilde{h}_j|]$$

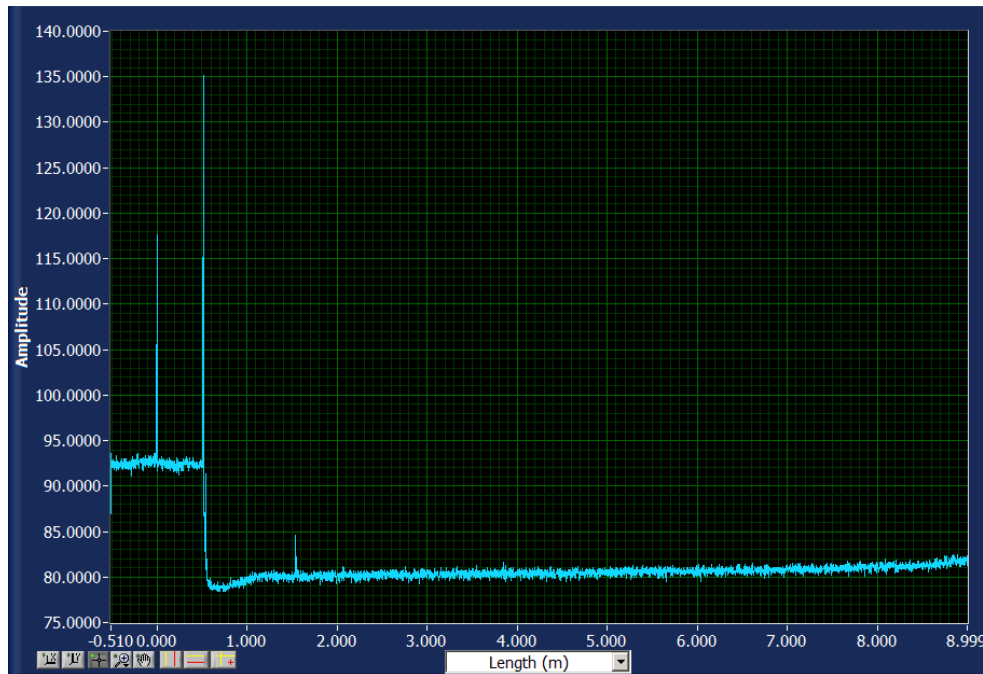


Figure 6-4 Time domain **Amplitude** data for a 0.5m jumper.

Integration Width

The **Integration Widths** area in **Tools > Set Preferences** controls the length of the segments used to calculate the average loss within (**Return Loss**) and between (**Insertion Loss**) segments.

Return Loss and Insertion Loss

The software automatically identifies up to four (4) reflection events starting from a user-specified location along the DUT (**Tools > Set Preferences > Events > Minimum Location**).

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The **Return Loss** as displayed in the **Events** table is calculated over the **Integration Width** set in **Tools > Preferences > Integration Widths > Return Loss**. For example, if the entire time domain axis is given by $t \in [0, T]$ and a reflection peak is bound such that $t \in [t_1, t_2]$, then the average return loss at that cursor is given by

$$RetLoss = 10 \log \frac{\sum_{t_1}^{t_2} |\tilde{h}_j|}{\sum_0^T |\tilde{h}_j|}$$

where \tilde{h}_j is the impulse response, as defined above.

The **Insertion Loss** for any particular reflection, as displayed in the **Events** table, is simply the difference between the return losses on either side of the reflection, divided by two (2). The loss is calculated as five times the log of this ratio because the loss is accumulated twice: once for the light to get to the particular segment, and once for it to return from the segment.

Hanning Window

Some OBR users have noted that the reflectance peaks from strong reflection events (generally with higher than -45 dB return loss) exhibit marked broadening at the base. These side band tails can sometimes obscure the peak of a weak reflector very near a strong reflector peak. They can also overwhelm the nearby Rayleigh scatter level, making insertion loss measurements near the base of the strong reflection peak difficult. Using the **Hanning Window** option (**Tools > Set Preferences > Display Options**) significantly diminishes reflection peak side band tails. There is no significant scan or calculation time penalty associated with selecting this option.

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The effects of the **Hanning Window** are illustrated in Figures 7-5 which show the reflection trace of a LC/PC connector with a clear plastic cap covering the ferrule. In the left trace, the reflections of the end cap surfaces are barely visible above the side band tail of the connector. Applying the **Hanning Window** produces the right trace which suppresses the side band tails and greatly enhances the contrast of the much weaker end cap reflections just a few millimeters away from the connector.

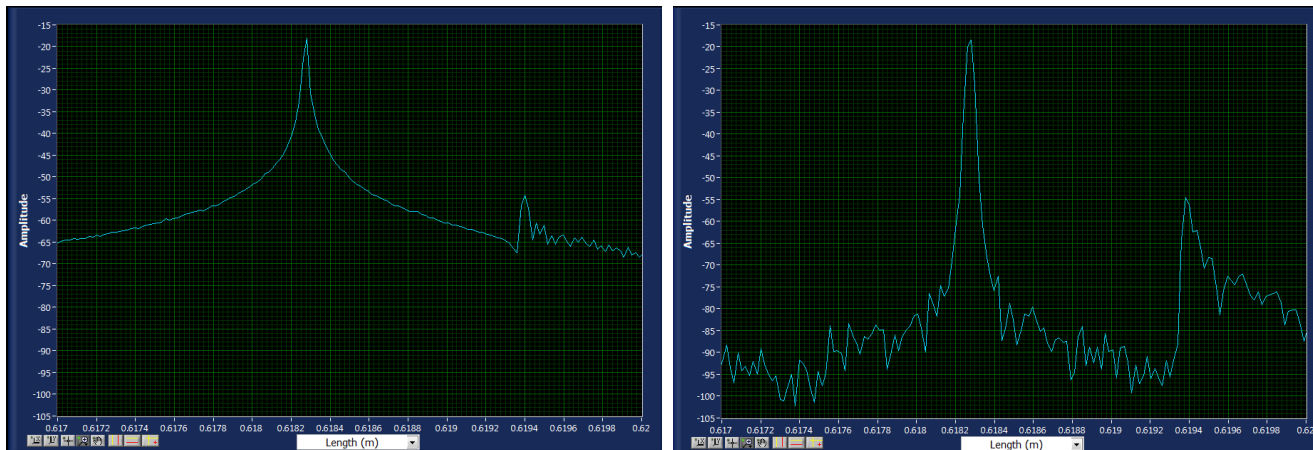


Figure 6-5 Example traces of a LC/PC connector with a clear plastic cap over the ferrule without (left) and with(right) a **Hanning Window** applied.

How Hanning Window Affects Measurements

Return Loss (RL) values may be altered by the **Hanning Window** if the reflection event being measured has significant RL variation in the optical frequency domain. For example, connectors and

splices tend to have spectrally flat RL, but fiber Bragg gratings and thin film filters do not. For this reason, the **Hanning Window** should be left off when measuring the RL of gratings and filters.

Insertion Loss (IL) measurements are made by integrating over the Rayleigh scatter. Since fiber Rayleigh scatter is spectrally uniform, the Hanning Window will not significantly alter the measured Rayleigh scatter amplitude.

Chapter 7 Maintenance

Cleaning Connectors

It is extremely important to clean connectors before attaching optical fibers to the OBR for testing. Failure to do so may result in noisy data or damaged equipment.

Optical fiber connectors on cables should be cleaned before every connection to the OBR. The bulkhead connectors on the front panel of the OBR should be cleaned frequently, roughly once every 25 connections.

The optical fiber connector cleaner is used for cleaning connectors:

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Mini foam swabs are used for cleaning the OBR bulkhead connectors:



The cleaning supplies used with the OBR are:

- CLETOP connector cleaner – P/N F1-6270
- CLETOP connector cleaner replacement reel – P/N F1-6271
- Mini foam swabs (50/package) – P/N F1-0005

These supplies can be ordered from:

FIS Incorporated

161 Clear Road

Oriskany, NY 13424

Web: www.fiberinstrumentsales.com

E-mail: info@fiberinstrumentsales.com

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Important



Use only cleaners approved for use with fiber optic bulkheads and fiber connectors. Do not use any type of cleaning fluid, cotton swabs, or cloths.

Using unapproved cleaning tools or fluids may result in erroneous or noisy data, or may damage the fibers and OBR components.

Cleaning Optical Fiber Connectors

Important



Optical fiber connectors on devices should be cleaned before every connection to the OBR.

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- 1 Expose the cleaning tape by pushing down the cover release lever.

Cleaning tape cover closed



cover release lever tape cover

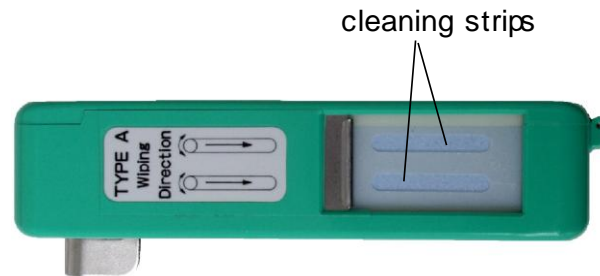
Cleaning tape cover open



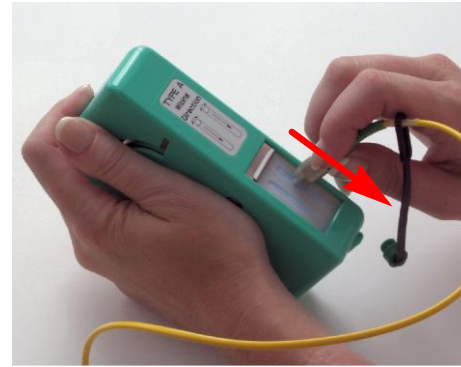
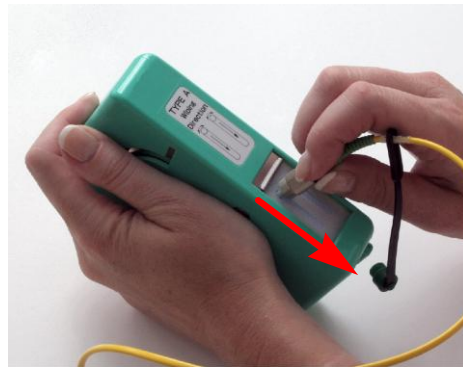
cleaning tape

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The cleaner tape has two cleaning strips:



- 2 Holding the fiber connector perpendicular to the cleaner tape surface, swipe the tip of the connector down the first cleaning strip, then swipe on the second strip.



- 3 Close the cleaning tape cover before swiping another connector. This advances the cleaning tape.

Cleaning Bulkhead Connectors

Important



The bulkhead connector should be cleaned about once every 25 connections.

1. Turn off the OBR.
2. Make sure that no devices are connected to the OBR.
3. Open the protective cover. Gently insert one of the supplied swabs, as shown below. Twist the swab in one direction, and then remove. *Discard swabs after single use.*



Figure 7-1 Remove the protective cap. Gently insert supplied mini swab, rotate in one direction, then remove.

Cleaning the Case

Clean the case by wiping it with a soft cloth dampened with water or a mild, non-abrasive cleaning fluid such as window cleaner.

Caution



Do not spray any fluid directly on case surfaces. It may seep into the interior of the case and damage components.

Replacing Fuses

The fuse drawer is located on the power module on the instrument case back panel:

Warning

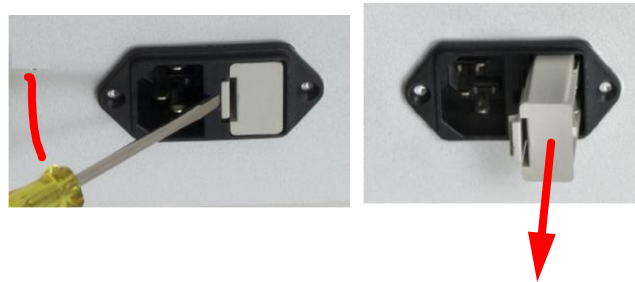


To avoid the risk of serious injury or death, ensure that the power cord is disconnected from the instrument when checking or replacing fuses.

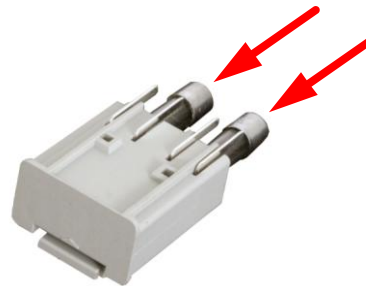
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To replace fuses

- 1 Disconnect the instrument power cord.
- 1 Place the blade of a screwdriver or similar tool in the slot at the bottom of the fuse drawer, then gently pry the drawer out of the power module.



- 3 Replace fuses with Bussmann AGC-2 type 2A @ 250VAC 1 ¼" x ¼" fast acting (FA) fuses, rated FS01008.



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- 4 Push the drawer back into the power module until it snaps into place.
- 5 Reconnect the power cord.

Packing and Shipping the OBR 5T-50

The OBR should only be packed and shipped in its original packing materials. If these have been discarded, contact Luna Innovations for packing material. To minimize physical shock during shipping, the OBR system should always be shipped via air instead of ground, by a reputable shipping service provider.

Required Packing Materials

- OBR Shipping Box(es) (#1)
- Desktop PC Box (#2)
- PC Monitor Box (#3)
- OBR Shipping Foam
- PC Monitor Shipping Foam
- PC Shipping Foam
- OBR Accessory Box
- PC Accessory Box

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- Sturdy packaging tape to seal the boxes

Packing Procedure

- 1 Check that all materials to be shipped are ready to be packed using the "Components List" on page 10-14.
- 2 Place the supplied protective cap over the detector port and turn it clockwise until tightened.
- 3 Obtain an OBR Shipping Box (#1).
- 4 Seal the bottom center and edges of the box.
- 5 Pack the OBR in the OBR Shipping Box using the original Styrofoam insert on each side of the OBR.
- 6 Place the OBR Accessory Box on top of the OBR.
- 7 Seal the top of the box, taping the center and open edges.
- 8 Obtain a Luna Desktop PC Shipping Box (#2), as applicable.
- 9 Seal the bottom center and edges of the box.
- 10 Pack the PC in the PC Shipping Box using the original Styrofoam inserts on each side of the PC.
- 11 Pack the PC software, as well as the mouse, keyboard, and PC Power Cord in the PC Accessory Box.

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- 12 Place the PC Accessory Box on top of the re-packaged PC.
- 13 Seal the top of the box, taping the center and open edges.
- 14 Obtain a Luna Innovations Monitor Shipping Box (#3), if applicable. Otherwise disregard the remaining steps.
- 15 Seal the bottom center and edges of the box.
- 16 Pack the monitor in the Luna Innovations Monitor Box using the original styrofoam inserts on each side of the monitor. The Monitor Box should contain the monitor, the monitor software and manuals, the power supply and the power cord.
- 17 Seal the top of the box, taping the center and open edges.

Chapter 8 Troubleshooting

This chapter describes how to troubleshoot OBR hardware and software errors.

If you have problems or error messages not listed here, or if the solutions provided here do not resolve a problem, please contact Luna Innovations toll free at (1-866-586-2682) or by e-mail at solutions@lunainc.com.

General Troubleshooting

The OBR or PC will not power on

Cause(s)	Solution(s)
The OBR and/or the PC is not plugged in or turned on	The OBR and the PC require separate power cords. Plug in the OBR and/or the PC. Make sure to turn on the OBR power switch on the front of the instrument, and the PC according to its instructions.
Blown fuse.	Replace the fuse. For instructions, see “Replacing Fuses” in Chapter 8

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All software controls are disabled or unavailable

Cause(s)	Solution(s)
The instrument is not properly connected to the PC.	Ensure that the cable connecting the instrument to the PC is securely attached.
The instrument could not be configured properly due to a communication error.	Turn the instrument off and then back on again then reboot the PC. Restart the OBR control software. If the problem persists, reinstall the OBR control software from the OBR software CD.
The OBR has not stabilized to room temperature.	Allow time for the entire system to stabilize at room temperature before trying to operate.
Laser overheated because air flow to the OBR is restricted.	Move the OBR away from objects or surfaces that restrict air flow through the fan duct on the back of the OBR.
Laser overheated because of excessively high ambient temperature.	Move the OBR to a cooler environment or decrease the ambient temperature to within the OBR operating range of 10–35°C.

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Control software will not load

Cause(s)	Solution(s)
Generally this occurs when other software is installed on the PC.	Remove any software not originally installed on the OBR PC, then restart.

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Control software seems to lock up

Cause(s)	Solution(s)
The hardware may have stopped responding to the software.	Exit the software, using the Windows® Task Manger if necessary. [Click Ctrl + Alt + Del, then click the Task Manger button, then select the OBR software, and click End Task.] Turn the instrument off and then back on again. Restart the OBR control software.
Multiple Luna Innovations software applications are running at the same time.	Ensure that you are only running one control software program at a time. Software applications cannot share the OBR instrument, so running more than one at a time will produce undesirable results.
The PC has entered an unusable state.	Turn the instrument off and then back on again then reboot the PC. Restart the OBR control software. If the problem persists, reinstall the OBR control software from the OBR software CD.

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Alignment unsuccessful

Cause(s)	Solution(s)
Normal alignment procedure occasionally fails.	Retry alignment

OBR will not scan

Cause(s)	Solution(s)
Optics not aligned.	Realign
The instrument is not properly connected to the PC.	Ensure that the cable connecting the instrument to the PC is securely attached.

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Excessive noise in data

Cause(s)	Solution(s)
Mechanical vibration.	Move or shut down any sources of vibration. Isolate the OBR from those sources.
Loose fiber connection.	Tighten or reconnect the fiber connections.
Dirty fiber or bulkhead connections.	Clean all connections. For instructions, see “Cleaning Connectors” in Chapter 7
OBR not aligned.	Align the Optics using Tools\Align in the OBR Software.
There is a strong reflection in the optical path.	Check for any breaks in the fiber sensor.
Patch cable too long	Shorten the leads to comply with the length limit of the OBR.
Cracks in bulkhead connector alignment sleeve.	Contact Luna Innovations at 1-866- LUNAOVA or solutions@lunainc.com for service.

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No data after scan

Cause(s)	Solution(s)
Incorrect graph range settings.	Rescale the plot axes.

Instrument drifts out of Alignment

Cause(s)	Solution(s)
Temperature changes will cause the instrument to drift.	Tools\Align

Errors on Software Startup

Cause(s)	Solution(s)
The PCIe cable connections might be loose.	Check the connections to ensure that the cable is connected properly to both the instrument and the PC.
The instrument is not turned on.	Ensure that the instrument is plugged into the proper type of outlet and turn on the power switch.
The software is in an unknown state.	Exit and restart the software.
The hardware is in an unusable state and is not responding to the software.	Exit the software. Turn the instrument off and then back on again. Restart the PC and the control software.
The PCIe cable is faulty.	Replace the cable
Communication Error	Turn off computer. Turn on OBR 5T-50 Restart Computer

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The optics were detected to not be aligned properly

Cause(s)	Solution(s)
This is just a warning letting the user know that the optics are not aligned properly.	Align the optics with Tools\Align

If any error occurs consistently, please contact Luna Innovations toll free at 866-LUNAOVA (866-586-2682) or by e-mail at solutions@lunainc.com

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Technical Support

If you have any problems with or questions about the information contained in this document, please contact our technical support staff by one of the following methods:

Luna Innovations

3155 State Street

Blacksburg, VA 24060

Main Phone: (540) 961-5190

Toll-Free Support: 1.866.LUNA OVA (866.586.2682)

E-mail: solutions@lunainc.com

www.lunainc.com

Appendix A Specifications

Parameter	Specification	Units
Electrical		
Input Voltage Range	100-250	VAC
Input Frequency Range	50-60	Hz
Operating Power	65	VA
Optical Output		
Maximum Rated Output Power	9.0	mW
Internal Laser Module Maximum Rated Output Power	20.0	mW
Emitted Wavelengths	1510-1570	nm

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PC I/O		
Input/Output Devices	<ul style="list-style-type: none">• CD drive• USB ports• Ethernet port• Keyboard/Mouse• Display	

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Environmental		
Operating Temperature Range ¹	10-35	°C
Storage Temperature Range	0-40	°C
Relative Humidity (non-condensing)	< 80	%
Dimensions and Weight (Without PC)		
Weight (PC not included)	7.7	kg
	17	lbs
Case Size	356 X 318 X 171	mm
	14 X 12.5 X 6.75	in

¹ Performance criteria can only be met if the unit is operated within the proper temperature range indicated. Maintenance of an acceptable internal operating temperature depends upon proper equipment ventilation. To ensure proper ventilation, never obstruct enclosure airflow openings.

For current performance specifications, check our website.

Class 1 Laser Product

The Luna Innovations OBR is a **Class 1 Laser Product**, which meets the requirements of Class 1 in standards **IEC 60825-1: 2007**, and complies with **21CFR1040.10**.

Maximum rated output power: 9.0 mW

Internal laser module maximum rated output power: 20.0 mW

Emitted wavelengths: 1510 to 1570 nm