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LUMETRICS

OptiGauge™

Precision Thickness Measurement System

User Manual

Revision B

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QUICK START INSTRUCTIONS

The following are the basic steps for installing and using the OptiGauge thickness measurement system. These steps are intended to help you efficiently set up the equipment for basic measurements. More detailed information may be required for advanced functions or procedures. The specified page numbers located after each step indicate the pages in this manual where more detailed explanations can be found.

1. **Unpack and set up the equipment** (Page 3)
   - Check package contents against packing list (Page 3)
   - Choose a location to setup the OptiGauge System (Page 3)
2. **Connect the electronic cables** (Page 3)
   - Connect data cables first (Page 6)
   - Connect monitor, keyboard, and mouse (Page 6)
   - Connect power cables and plug system into surge protector (Page 7)
3. **Connect the fiber optic cables** (Page 7)
   - Carefully clean each fiber optic tip before making connections (Page 7)
   - Gently insert connector tip into coupler, and then slowly rotate to align key notch (Page 7)
   - Gently hand-tighten the knurled plug assembly (Page 7)
4. **Power-up the equipment.** (Page 8)
   - Power up the OptiGauge using front panel switch (Page 8)
   - Open Controller front panel using key, then power up using front toggle switch (Page 8)
   - Start the OptiGauge Control Center software on desktop (Page 8)
5. **Align the probe** (Page 19)
   - If possible, use a thin glass sample such as a microscope slide. (Page 19)
   - Align probe angle and distance according to probe specifications. (Page 19)
6. **Adjust software settings and locate signal** (Page 21)
   - Find signal and optimize light level (Page 21)
   - Maximize measurement window and light level (Page 21)
7. **Take Measurements** (Page 22)
   - Adjust layer detection and data output settings (Page 22)
   - View numeric or graphic results on measurement data window. (Page 14)

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Certificate Of Conformity

Diversified T.E.S.T. Technologies, Inc. has tested the product to the current appropriate standards and finds that the product is in compliance with those requirements.

EMC Directive:	**89/336/EEC**	
Generic Emissions Standard:	EN 61000-6-3: 2001	
Product Specific Emissions:	EN 55022 Class A	
Generic Immunity Standard:	EN 61000-6-1: 2001	
Immunity:	EN 61000-4-2	Electrostatic Discharge
	EN 61000-4-3	Radiated Susceptibility
	EN 61000-4-4	Electrical Fast Transient/Burst
	EN 61000-4-5	Surge
	EN 61000-4-6	Conducted Susceptibility
	EN 61000-4-11	Voltage Dips & Interruptions
	EN 61000-3-2	Harmonic Current
	EN 61000-3-3	Voltage Fluctuations & Flicker

Manufacturer's Name:	**Lumetrics**
Manufacturer's Address:	150 Lucius Gordon Drive W. Henrietta, NY 14586
Product:	Optigauge Controller
Model Number:	DI-340

This Certificate of Compliance issued October 2, 2006 is valid for the test sample of the product specified above and that it conforms to the Directive(s) and Standard(s).

Signature: _____

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1.0 OVERVIEW

The OptiGauge system provides precision thickness measurement capability for a diverse range of clear and translucent materials, including tubing, sheet, and packaging components. It has numerous applications in medical, food processing, scientific, and manufacturing operations, and may be used in both production line and static laboratory environments.

The OptiGauge system combines optical technology with the processing power of a specialized PC to measure and display thickness results in an easy-to-use format with high precision, and in a non-contact, non-destructive manner.

1.1 Features and Benefits

The Lumetrics, Inc. OptiGauge has an array of advanced features that give users a new level of speed, accuracy, flexibility, and cost effectiveness for all measurement needs. The key benefits of the OptiGauge include:

- Non-contact thickness measurement
- Wide measurement range - 12 microns to 8 millimeters
- Extreme accuracy – to 100 nanometers/.000004"
- Self-calibrating electronics
- Real-time, fast 50 Hz scan rate (50 measurements per second); custom versions are available up to 200 Hz for 2mm material thickness
- No underside sensor or reflector needed for probe readings
- Modular - Up to eight probes can be multiplexed to the OptiGauge for remote and multi-point measurements
- Compatible with many common logic control systems and languages, supervisory control systems, Ethernet protocols, and data collection schemes; customizable software packages are available for nearly every inspection and measurement application
- IR light from probes is unaffected by ambient lighting conditions and is intrinsically safe; the system operates safely in any environment
- Precise gauging of extruded, flat stock, and injection molded parts, including plastic, glass, liquid, air gaps, etc.

1.2 Custom Applications

Lumetrics, Inc. can create custom software applications that will fit most users' needs, from QA inspection packages to automated tubing and flat stock monitoring software, to sophisticated packages that integrate the OptiGauge into plant logic control and SCADA systems, including customized operator interfaces, data collection and report generation tools, accept/reject decision trees, tolerance alarms, and advanced machine controls. Contact Lumetrics, Inc. for further information.

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1.3 How the OptiGauge System Works

The OptiGauge system is comprised of a low-coherence interferometer, a computer (OptiGauge Controller) with specialized hardware and software, fiber optic cable(s), optical probe(s), and mounting hardware. Standard optical probes are available to meet a wide range of application requirements. Custom optical probes or mounting hardware can be provided on a per-system basis to accommodate unique applications.

The OptiGauge and OptiGauge Controller can be remotely located from the optical probes and measurement point. The controller runs the OptiGauge Control Center software and provides a graphical user interface to display current measurement data. The OptiGauge Control Center allows the user to adjust hardware and data collection settings, including LED intensity and measurement range to accommodate measurement of complex materials and layer configurations. Figure 1 provides a basic block diagram of the system.

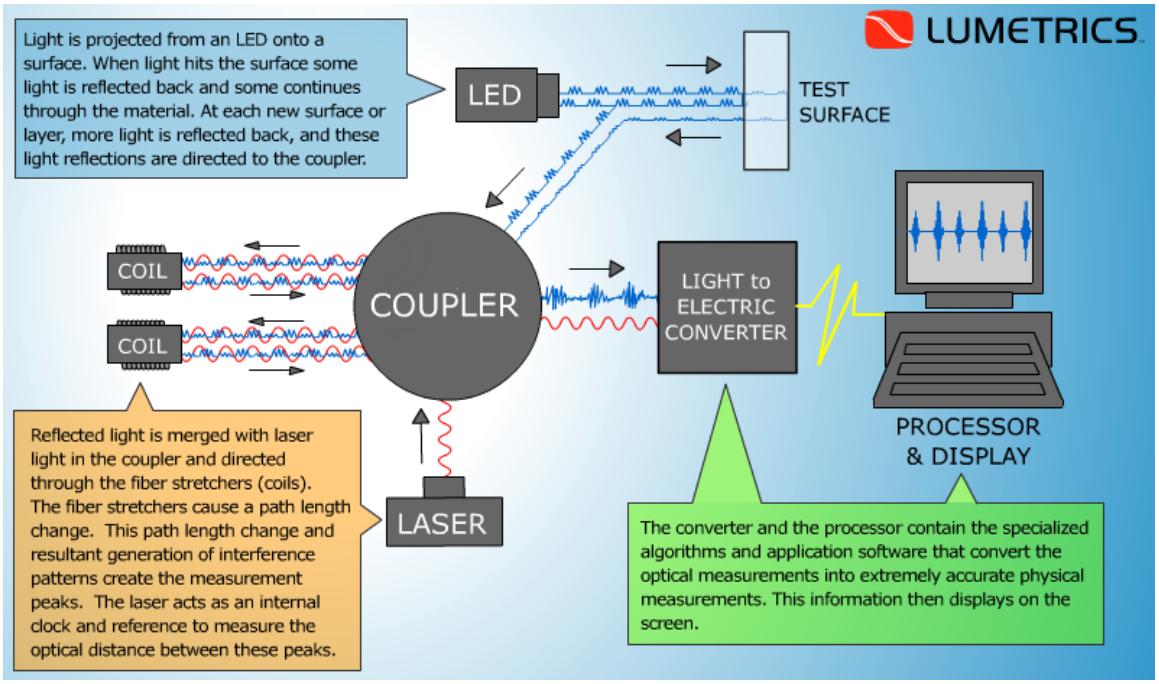


Figure 1 - OptiGauge System Block Diagram

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2.0 SETTING UP THE HARDWARE

This section explains how to prepare the OPTIGAUGE system for operation. It includes information on making cable connections, mounting the equipment, and applying power for the first time, and shutdown procedures.

2.1 System Contents

The OPTIGAUGE system includes the following components:

- User's Guide
- Lumetrics OPTIGAUGE Unit
- Lumetrics Controller Unit
- LCD Monitor, Keyboard, and Mouse
- Optical Probe and Fiber Optic Cable
- Fiber Tip & Connector Cleaners
- 68-Pin Data Cable
- OPTIGAUGE Control Center Software (pre-installed)
- Software Installation CDs
- Certificate of Calibration
- Optical Switch (optional)

Carefully unpack all system components and check the contents against the packing list secured to the outside of the container. Inspect all items for signs of damage, and save all shipping materials for possible re-shipment.

2.2 Mounting Options

The OPTIGAUGE Controller and Interferometer units may be set up on a sturdy tabletop or bench, or optionally, they may be mounted in a standard 19" rack cabinet. If the equipment was ordered for optional rack mounting, the appropriate brackets will be supplied and can be attached directly to the rack cabinet with screws.

2.3 Cable Connections

This section explains the connection of cables between the OPTIGAUGE components. Refer to Figure 2 (Single-Probe System) or Figure 3 (Multiple-Probe System) when making these connections. Table 1 includes a description of the Controller motherboard connectors.

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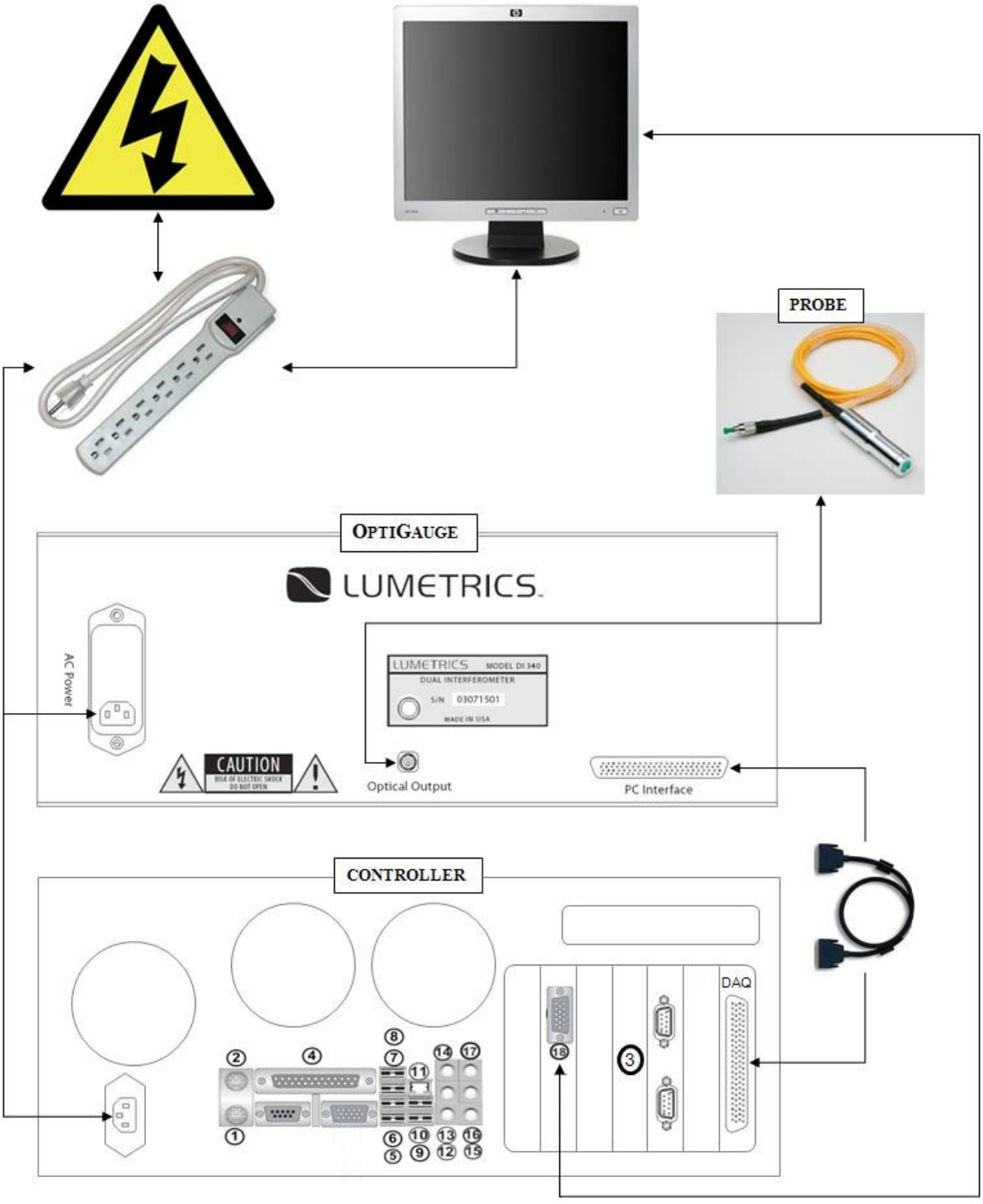


Figure 2 - Installation Diagram—Single-Probe System

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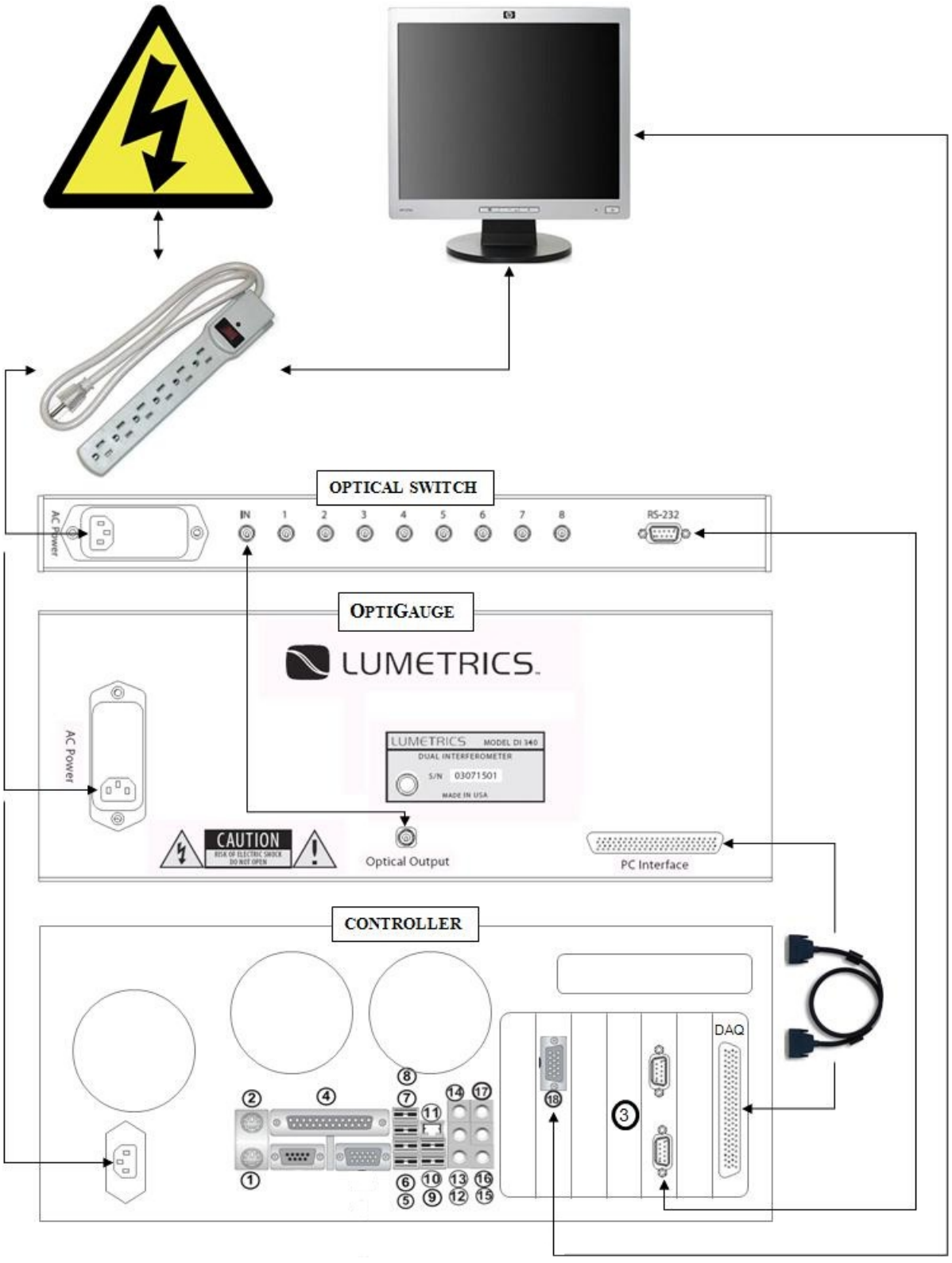


Figure 3 - Installation Diagram—Multiple-Probe System

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(Refer to Figures 2 & 3 as applicable)

Table 1 Controller Motherboard - Rear Panel Connectors

Key Number	Rear Panel Connector
1	Keyboard (Purple)
2	PS/2 Mouse (Green)
3	COM Port 1(top) COM Port 2 (bottom)
4	Parallel Port (Printer)
5	Back Panel USB Port 3
6	Back Panel USB Port 4
7	Back Panel USB Port 5
8	Back Panel USB Port 6
9	Back Panel USB Port 1
10	Back Panel USB Port 2
11	Gigabit LAN 1
12	Side Surround (Grey)
13	Back Surround (Black)
14	CEN/LFE (Orange)
15	Microphone-In (Pink)
16	Front (Green)
17	Line-In (Blue)
18	VGA

2.3.1 Electronic Cables

Follow the steps below to connect the electronic cables between system components.

CAUTION

Do not connect A/C power cords until all other electronic cables are connected. In addition, the use of a surge protector is highly recommended on all AC lines powering the OptiGauge system to protect against potentially damaging spikes that may occur on AC power lines.

1. Set up the OptiGauge Controller and connect the keyboard and mouse.
2. Connect the LCD monitor to the OptiGauge Controller.
3. The OptiGauge Controller includes pre-installed data acquisition (DAQ) hardware and software. The DAQ card has a 68-pin connector and is located in an expansion slot on the rear panel of the OptiGauge Controller. Carefully connect the OptiGauge to the OptiGauge Controller using the 68-pin data cable provided.

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CAUTION

The 68-pin connector on the DAQ card contains delicate pins that may be easily damaged if the data cable is not properly inserted. When connecting the 68-pin data cable hand-tighten only. Do not tighten thumbscrews with screwdriver.

4. If using an Optical Switch, connect the RS-232 input on the switch to the COM port on OptiGauge Controller motherboard. Hand-tighten the cable screws to secure in place.
5. After all data cables have been connected, connect the AC power cables.

2.3.2 Fiber Optic Cables

CAUTION

The Probe is a delicate optical instrument. Handle it with care during mounting and operation. Carefully uncoil fiber optic cables provided, avoiding any kinks or knots. Do not pinch, fold, or sharply bend the fiber optic cable.

NOTE

Standard probes include a 3-meter cable that is permanently attached. Do not attempt to remove the cable. The probe cable may be connected directly to the OptiGauge, or if additional length is required, a single patch-cord and coupler may be used. Standard patch-cord lengths are 5 or 10 meters. Custom lengths are available if necessary.

Follow these steps to connect the fiber optic cable(s) to the system:

1. For each fiber optic cable provided, remove the protective cap from one end of the fiber optic cable, and then clean the fiber tip using the Fiber Tip Cleaner provided. Follow the instructions located on the Fiber Tip Cleaner.
2. Carefully insert the male connector into the coupler. While gently pushing inward, slowly rotate the connector until the key notch on the connector is aligned with key slot on the coupler and gently push in the connector (see Figure 4). Lightly hand-tighten the knurled plug assembly until the connector is secure.
3. If using an Optical Switch, connect the optical output on the back panel of the OptiGauge to the input on the back panel of the switch. Next, connect each probe provided to the numbered connectors on the back panel of the switch.
4. If using a single probe, connect the probe cable or extension patch-cord to the optical output on the back panel of the OptiGauge.

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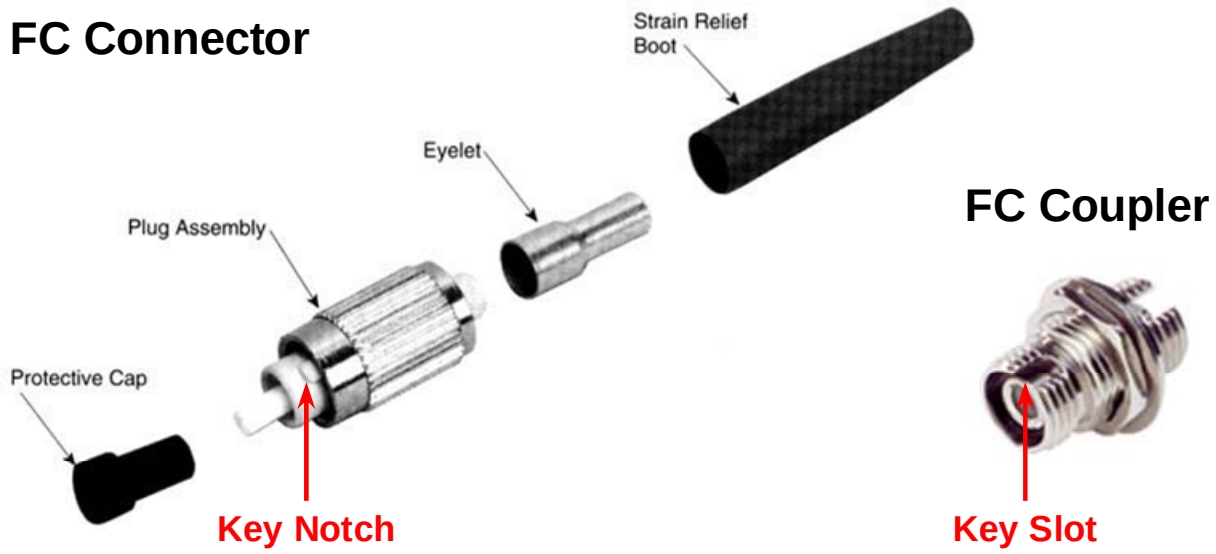


Figure 4 - FC Connector & Coupler

Power-Up Procedure

1. Turn on the OptiGauge using the power switch on the front panel. When the unit is powered up, the green LED indicator next to the power switch will light up.



Figure 5 - Controller Front

2. Turn on the OptiGauge Controller and monitor.
3. Start the OptiGauge Control Center software by double-clicking the desktop icon.
4. **Important:** For optimal performance, allow the OptiGauge system to warm-up for 10 to 15 minutes before making thickness measurements.

Power-Down Procedure

1. Close all applications on the desktop.
2. Once all applications are closed, select Start and Shut Down.
3. Once the computer has fully shut down, turn off the OptiGauge using the power switch on the front panel.

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3.0 OPTIGAUGE CONTROL CENTER SOFTWARE — GETTING STARTED

Once the OptiGauge system hardware is installed and powered-up as described in the previous section, most user interaction with the system takes place using the OptiGauge Control Center software. The software allows the user to set up measurement parameters, view results, collect data, and configure the system for desired operation.

3.1 Control Center Layout

The main OptiGauge Control Center screen is the beginning point for all system functions. It allows you to view measurement data in numerically or graphically, examine waveforms, view and edit control system settings. Descriptions for each component are listed below.



Figure 6 - Control Center Screen

Table 2 Main Elements of OPTIGAUGE Control Center Main Program Screen

Key Number	Component Name	Description
1	Title Bar	Displays the OptiGauge Control Center application title. Includes standard Windows buttons at the top right for **Minimize**, **Maximize**, and **Exit** functions.
2	Main Menu	Provides access to key application features, settings, and display properties. Includes access to searchable help files and information about the OptiGauge unit configuration and current software revision.

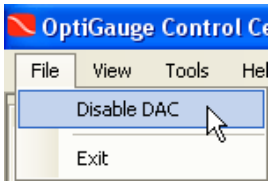
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3	Display Control Buttons	Controls the starting and stopping of the display, and recording of measurement data.
4	Measurement Data Window	Displays numeric or graphic (historic) data from the sample under test.
5	Waveform Window	Provides real-time, graphical interpretation of OptiGauge measurement data. The Waveform window serves as the primary method of alignment and signal quality feedback when using the OptiGauge.
6	Settings Window	Contains controls for key hardware and software settings, data collection, and the Optical Switch (optional).
7	Status Bar	Displays hardware status, data collection status, Calibration Factor and effective measurement rate.

3.2 Main Menu

The main menu bar contains four drop-down selections as described below:

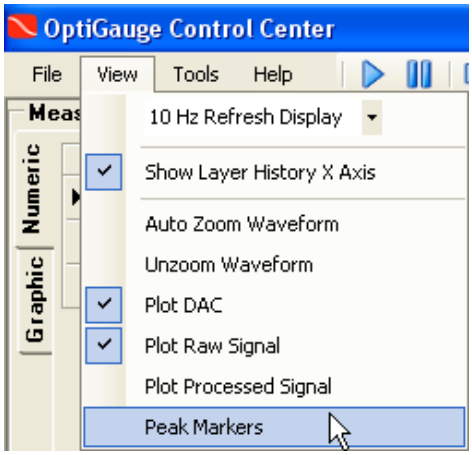
3.2.1 File



Enable/Disable DAC – Turns the Interferometer on and off, enabling and disabling data acquisition.

Exit – Closes the OptiGauge application freeing all system resources.

3.2.2 View



Refresh Display rate – Selects one of 1 Hz, 2 Hz, 5 Hz or 10 Hz.

Show Layer History X Axis – Shows X Axis in the layer history.

Auto Zoom Waveform – Scales the waveform vertically to fit the available plot area and restores the view

Un-zoom Waveform – Sets the vertical scale from 0 to 100%.

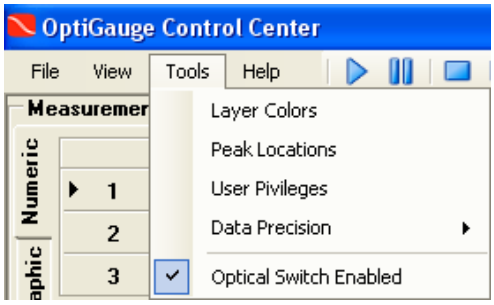
Plot DAC – Sets the visibility of the DAC plotted data.

Plot Raw Signal – Sets the visibility of the Raw Signal plotted data.

Plot Processed Signal – Sets the visibility of the Processed Signal plotted data. The Processed Signal is the result of Noise Reduction.

Peak Markers – Sets the visibility of the Peak Markers. Useful to see where the system found peaks in the material being tested.

3.2.3 Tools



Layer Colors – Shows the Layer Colors Dialog to allow setting of the display color for each layer.

Peak Locations – Shows and hides a table beside the waveform that displays the values of each peak location and amplitude. The average of the selected peak locations is presented at the bottom of the table.

User Privileges – Presents a grid by which user permissions may be customized. This is an admin only feature

Data Precision – field to the right allows the customization of the number of decimal places displayed.

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Optical Switch Enabled – When checked will activate the switch discovery logic and show the Switch Tab in the Settings area. Unchecked will disable any switch processing and hide the switch tab.

Edit Layer Colors Dialog

The **Edit Layers Colors** dialog box shows a button for each allowable layer – up to 20 layers. Clicking the **Layer** button displays a palette for selecting the new color for that layer. Use the **Apply** button to set the colors and see the effects without exiting the dialog.

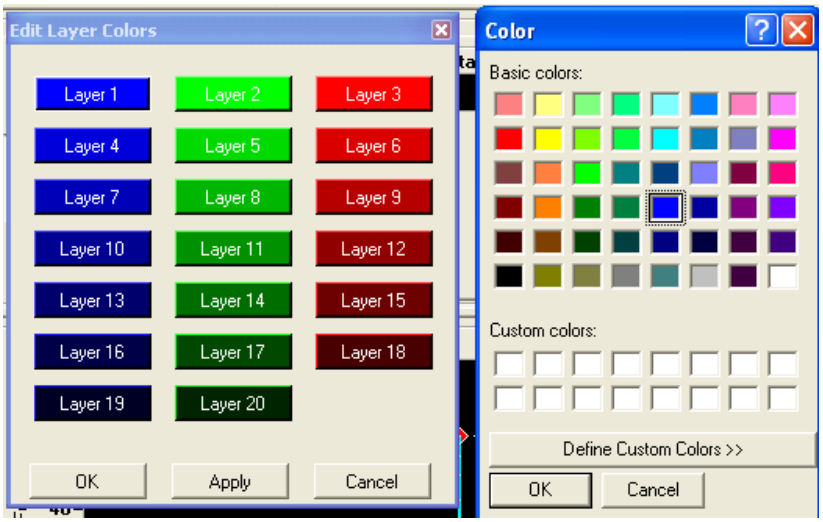


Figure 7 - Edit Layer Colors Dialog

Peak Locations

When the **Peak Locations** option is selection in the tool menu, a data grid will show or hide to the left of the waveform. This grid will display the numerical values for each detected peak. The location average for all selected peaks is displayed below the data grid.

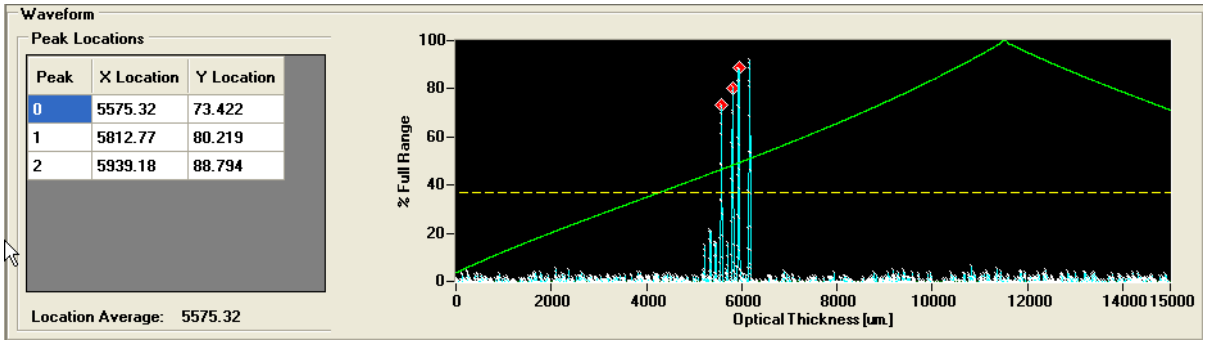
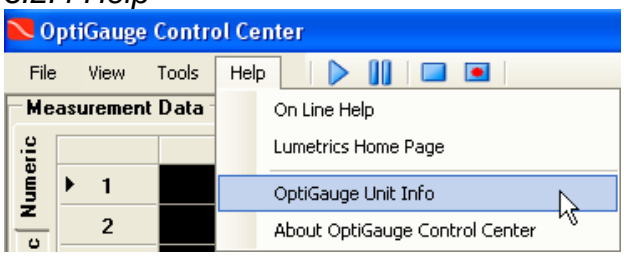


Figure 8 - Waveform with Peak Locations Grid

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3.2.4 Help



On Line Help – Loads a .PDF copy of the Manual

Lumetrics Home Page – Loads the Lumetrics, Inc. Web site in a browser window

OptiGauge Unit Info – Shows a dialog that lists information specific to the configuration of the installed OptiGauge unit

About OptiGauge Control Center– Shows a dialog with information about the application and system

About OptiGauge Screens

These are read-only forms used to verify the system software and hardware configuration. This information may be helpful when calling Lumetrics, Inc. for technical assistance.

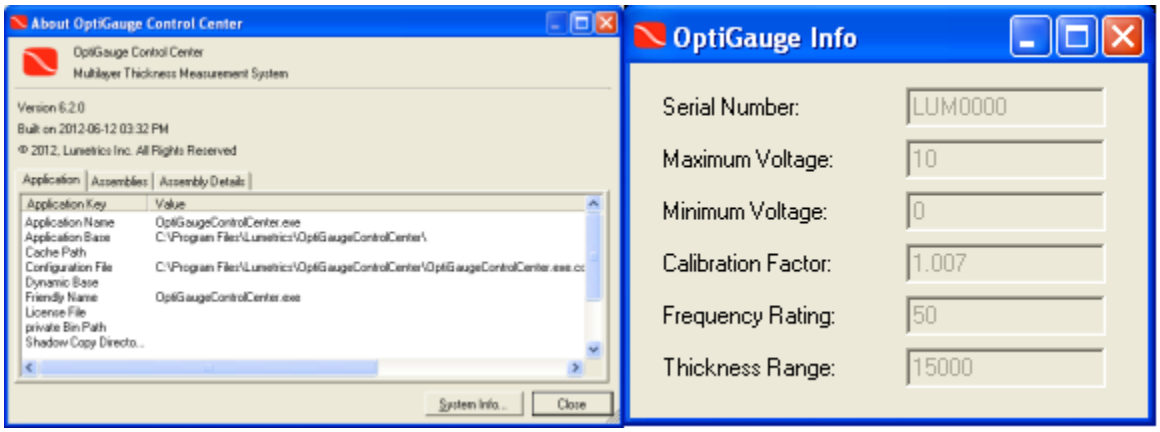


Figure 9 - About OPTIGAUGE Screens

3.3 Display Control Buttons

A set of four tool buttons located near the top of the screen are used for controlling the display refresh and data collection functions. This section of the screen is shown on the next page.

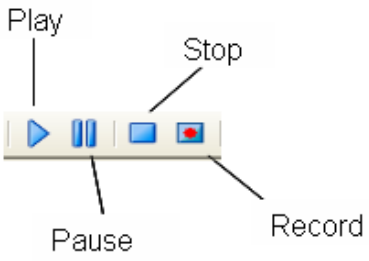


Figure 10 - Display Control Panel

3.3.1 Play Button

Play starts the display refresh. All displays are continuously refreshed.

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3.3.2 Pause Button

Pause will stop the display refresh function. This operation freezes the measurement data and waveform for inspection. System measurement continues when the button is clicked, but the data is not saved in the layer history. Data Collection also continues and Switch advance continues.

3.3.3 Stop Button

Stop discontinues data collection independent of the data collection stop condition. This functions as an abort button for data collection.

3.3.4 Record Button

Record starts data collection when the data collection start condition is set to **Record Button.**

3.4 Measurement Data Window

The Measurement Data window is located at the top of the Control Center screen. It displays numeric or graphic data from the sample under test. There are two tabs located on the left side of the Measurement Data window used to set the desired view of the window.

The default tab selection is **Numeric.** The data columns in the numeric display tab may be resized, and their order may be rearranged to suit the requirements of specific applications.

3.4.1 Numeric Tab

The **Numeric** tab (Figure 12) displays current data from the sample under test. Default columns include: **Material Thickness**, **Total Material Thickness**, **Material Name**, **Refractive Index**, **Optical Thickness**, and the **Standard Deviation** of the measurement (if **Sample Averages** are applied). The columns displayed can be defined by right-clicking on any title column and checking the desired parameter (Figure 13).

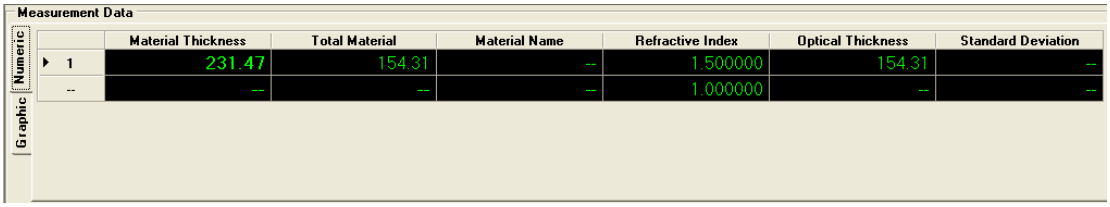


Figure 11 - Numeric Display of Measurement Data

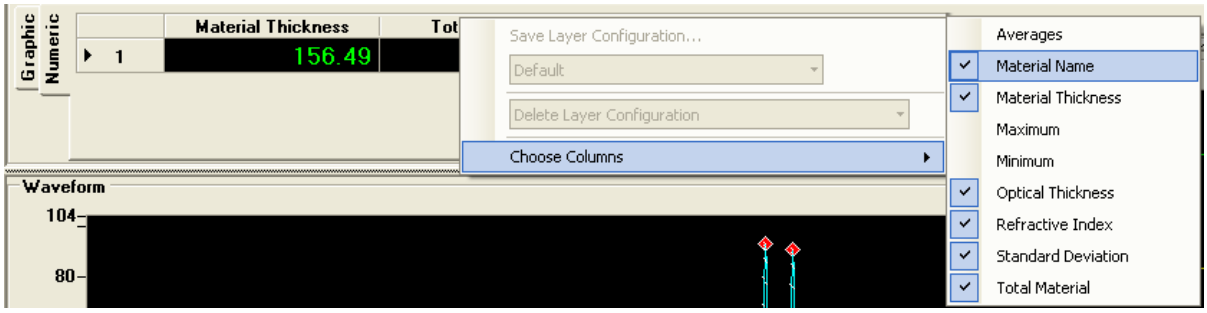


Figure 12 - Save Layer Configuration—Column Selection

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3.4.2 Graphic Tab

The **Graphic** tab contains two areas, **Layer History** and **Layer Thickness**, separated by a slider bar that allows the user to define the size of the panels. The **Layer History** section provides a continuous history of the measurements that are being taken by the OptiGauge. Each layer being measured shows a history plot.

3.4.3 Layer History

The layer history screen (Figure 14) provides a “strip chart” graph that displays the recent measurements. The history of each layer is displayed individually.

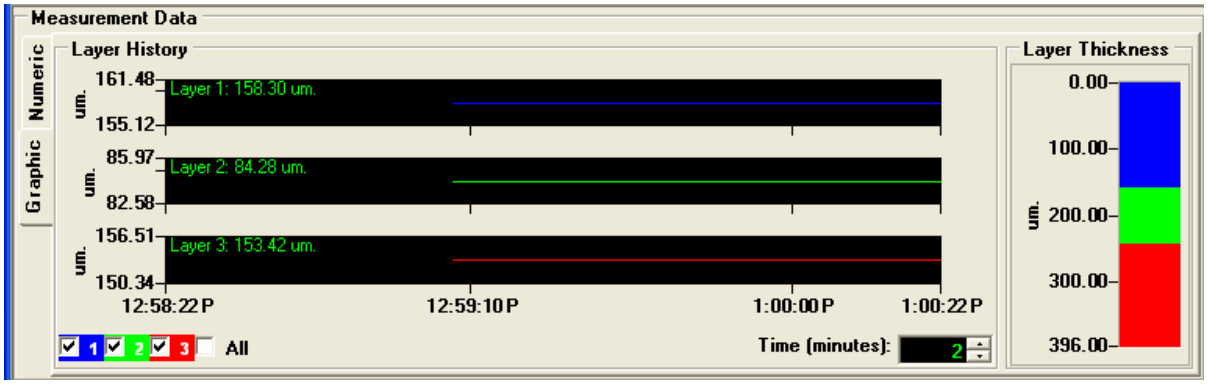
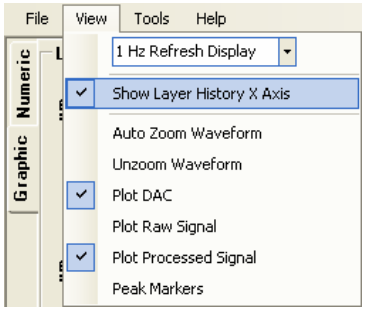


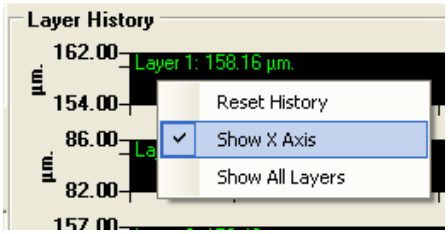
Figure 13 - Layer History Screen

Horizontal Axis

There is a common horizontal axis in “wall clock” time of the measurement. The length of time displayed/stored is settable by the **Time (minutes)** numeric edit box from 1 minute up to several hundred minutes. Displaying the annotation of the horizontal axis is selectable in the context menu or the main menu.



Selecting **Layer History X Axis** visibility via main menu.

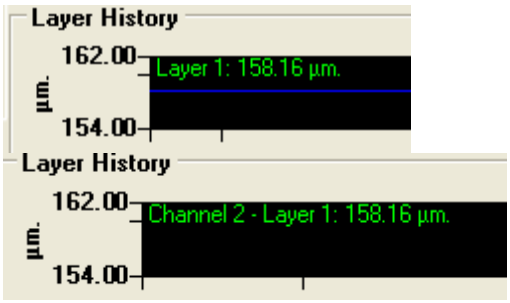


Selecting **Layer History X Axis** visibility via right-click context menu.

Vertical Axis

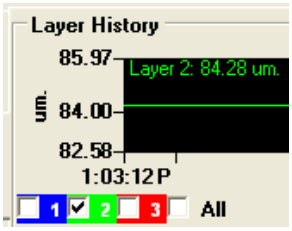
The vertical axis of each layer is ‘auto-scaled’ based upon the data in that layer’s history. The unit of measure is settable via the System Configuration tab.

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The most recent thickness measurement of each layer is displayed in the upper left of the “strip chart” plot area.

If the Optical Switch is enabled, the switch channel number as well as the relative layer number is displayed in the annotation.

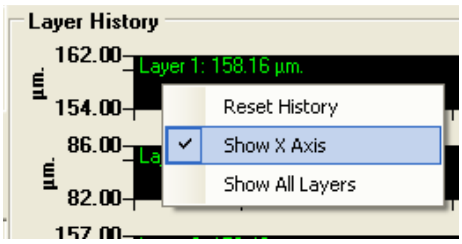


The visibility of individual layers is controlled by check boxes at the bottom left of the Layer History panel. The ‘All’ check box overrides the individual settings as a short cut to select all layers as visible. The layer visibility is switch channel independent, i.e., there is one setting for all switch channels.

Layer Thickness

The layer thickness graphically represents the thickness of each layer of the most recent measurement not dependent on the switch channel selected for display. The thickness is represented by the height of bar with each layer displayed in the layer color. The unit of measure is settable via the System Configuration tab.

Context Menu



Right clicking on the Layer History panel shows the context menu. The menu has three selections:

Reset History – Resets the stored sample history of all layers of all channels. Useful to reset the vertical scaling.

Show X Axis – Selects the visibility of the X Axis annotation.

Show All Layers – Overrides the individual layer selection.

3.5 Waveform Window

The Waveform window at the center of the screen displays a real-time graphical interpretation of the OptiGauge measurement signal (Figure 15). This graph provides the main method of feedback for probe alignment, signal quality, and adjustment of hardware settings.

Each vertical peak represents a surface between two different materials. Each layer is measured as the distance between the centers of two adjacent peaks. The green line rising from left to right shows the system’s scanning signal and is present whenever the DAC (digital-to-analog conversion) line is plotted. The yellow, horizontal dashed line represents the measurement threshold. The threshold is a user-defined value, and peak signals falling below this line are ignored by the software.

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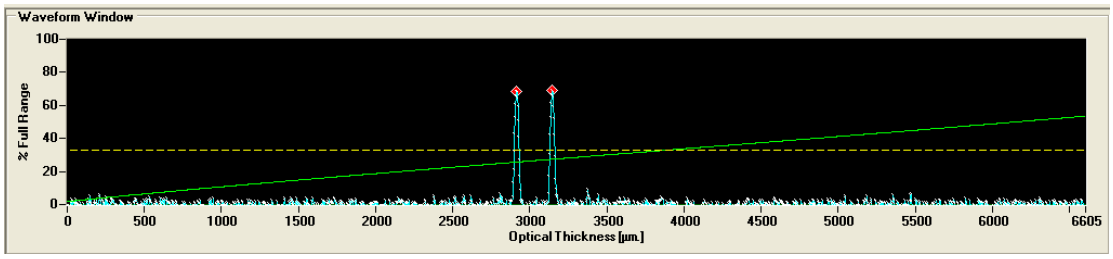


Figure 14 - Waveform Window

3.6 Settings Window

The bottom portion of the OptiGauge Control Center shows the Settings Window. Various hardware and software settings may be viewed and set here, including measurement and output parameters, data collection parameters, and settings for the optical switch (optional). Three tabs are located at the bottom of the Settings window: System Configuration, Data Collection, and Optical Switch.

3.6.1 System Configuration Tab

The System Configuration tab (Figure 16) includes the main hardware and software settings that affect the quality of measurements. These settings will typically be adjusted during optimization of probe alignment, when evaluating or setting up new samples, or when switching between different samples.

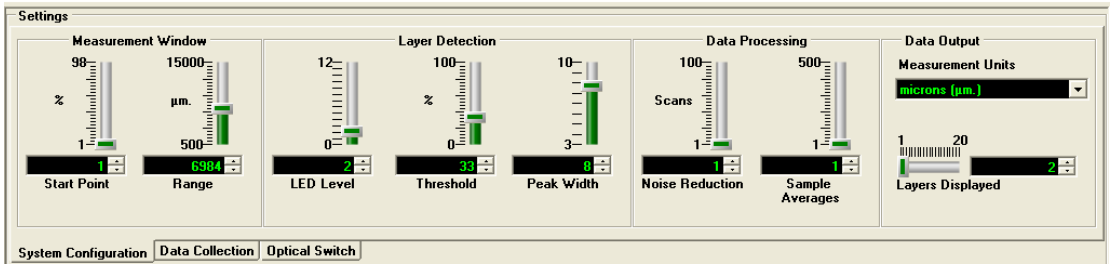


Figure 15 - Settings Screen—System Configuration

3.6.2 Data Collection Tab

The data collection tab (Figure 17) allows the user to choose the method of starting and stopping data collection, and how the data will be stored or output.

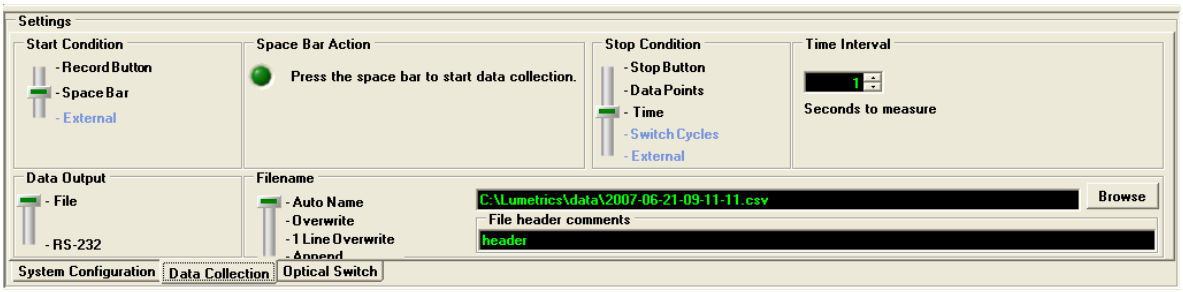


Figure 16 - Settings Screen—Data Collection

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3.6.3 Optical Switch Tab

If using the optical switch to access multiple probes, the Optical Switch tab (Figure 18) allows the user to change probe channels manually or cycle through channels automatically. This tab will only be visible when the Switch is enabled via the Tools menu. Additional features include choosing the method of advancing the switch channels (when cycling automatically) and which channels to display in the graphical layer history.

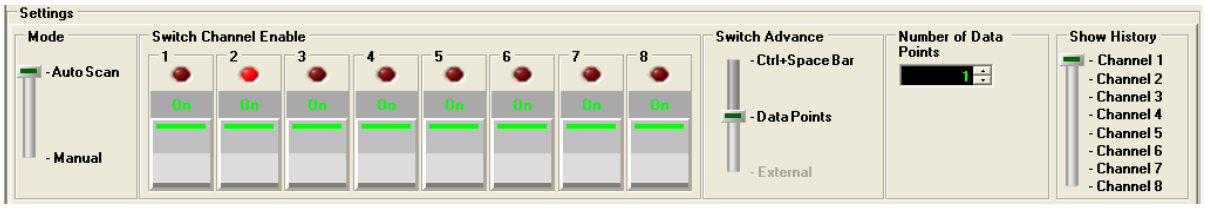


Figure 17 - Settings Screen—Optical Switch

3.7 OptiGauge Control Center Installation

The Control Center software is normally pre-installed on the system. These instructions are provided in the event it becomes necessary to re-install the software, or you are upgrading to a newer version of the program.

After uninstalling any software, use the disk provided to reinstall the drivers and/or application.

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4.0 MAKING MEASUREMENTS

In this section, basic procedures are given for setting up a sample and using the Control Center software to acquire, interpret, and save thickness measurement results.

4.1 Aligning the Probe

The OptiGauge probe functions as both an emitter and receiver. Light emitted from the probe is focused at a fixed working distance, which coincides approximately with the middle of the OptiGauge scan range.

4.1.1 Angular Alignment

In order to measure thickness of a sample, light from the probe must be retro-reflected off the sample and back into the probe, where it is re-coupled into the same optical fiber. Therefore, the sample must be perpendicular to the probe beam. Figure 19 illustrates the angular alignment of the probe.

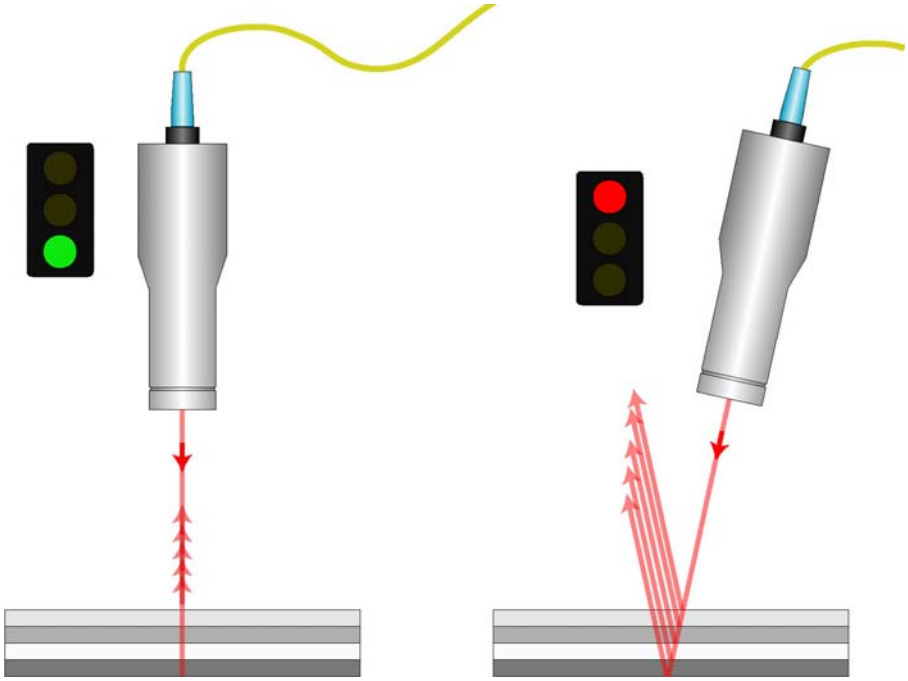


Figure 18 - Angular Alignment of the Probe

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4.1.2 Working Distance

In addition to proper angular alignment, as shown above, the sample must fall within the OptiGauge scan range. Figure 20 illustrates the working distance of the probe relative to the scan range. In general, the strongest signal will occur in the center of the full scan range.

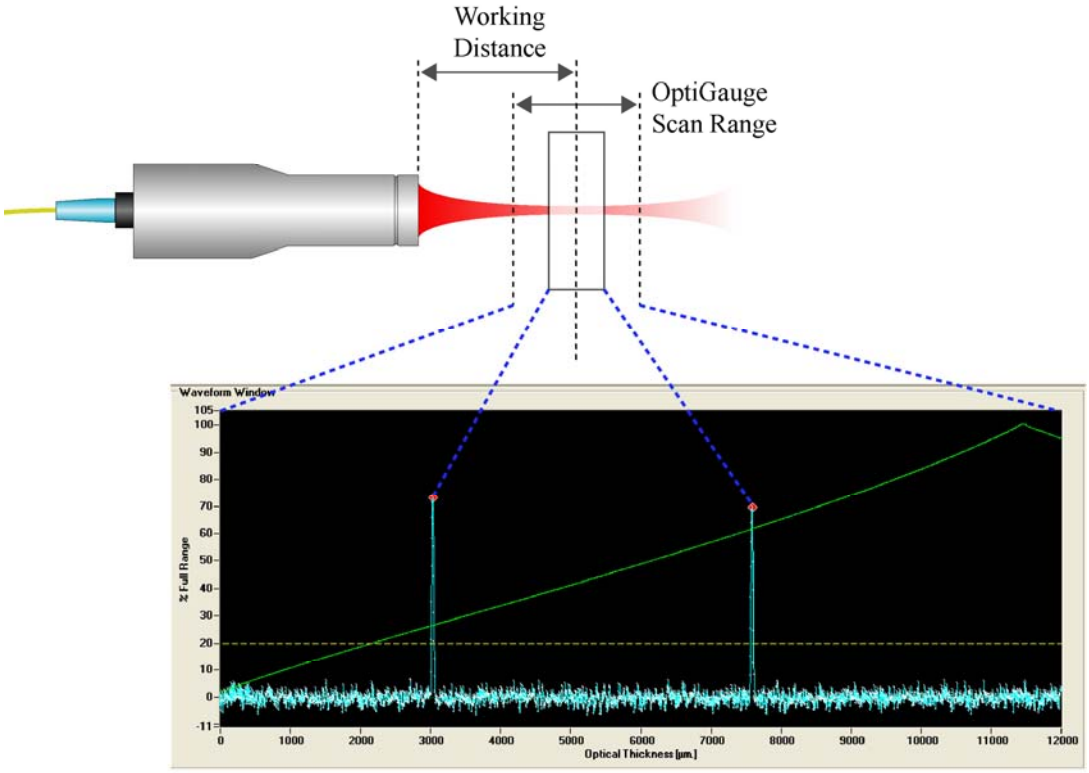


Figure 19 - Working Distance of the Probe

4.1.3 Using the Red Alignment Laser

Standard systems include a low-power red laser that provides a visual indicator of where the invisible infrared measurement light is pointed, to aid in the proper alignment of the sample under test. Once the probe is aligned, the red laser can be turned off. To toggle the red laser on or off, use the switch located on the back panel of the OptiGauge. Leaving the laser on will not have any adverse effects on measurement accuracy.

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4.2 Finding a Signal and Optimizing Probe Alignment

This section provides a quick method of finding a signal and fine-tuning the probe alignment to provide the most accurate sample measurements. Detailed definitions and descriptions of items discussed here will be provided in subsequent sections.

For this procedure, it is recommended that a glass sample be used; ideally a clean, thin glass sample such as a microscope slide. Once the procedure is completed, the probe alignment will be optimized for subsequent sample measurements.

After coarsely aligning the probe according to Figures 16 and 17, follow these steps to quickly find a signal and optimize the probe alignment:

1. In the **System Configuration** tab, apply the following settings:
   - Start Point = 1
   - Range = maximum
   - LED Level = 12
   - Noise Reduction = 1
2. Right-click within the Waveform window and select the following:
   - Plot DAC
   - Auto Zoom
3. At this point, a signal should be visible. If not, re-check coarse alignment of the probe by adjusting the angle and working distance in until a signal is located.
4. If a signal is visible and the Waveform appears red, turn down the **LED Level** one unit at a time until the Waveform signal becomes blue.
5. Slowly adjust the probe angle until the peak heights are maximized. If the Waveform signal becomes red in the process, turn down the **LED Level** one unit at a time as necessary until the Waveform signal becomes blue.
6. Once the probe angle has been maximized, slowly adjust the working distance until the peak heights are maximized. If the Waveform signal becomes red in the process, turn down the **LED Level** one unit at a time as necessary until it turns to blue.

4.3 Setting the Measurement Window

During probe alignment it is recommended to view the full OptiGauge scan range to help find the signal, as described above. This is done using the **Start Point** and **Range** settings.

Start Point - This control sets the start point for a scan (in % of maximum). Setting this value to 1 will start the scan closest to the optical probe. Increasing the value moves the starting point of the scan farther away from the probe.

Range - This control sets the total distance range for a scan (in units of distance). Setting this control to the maximum value allows viewing of the entire OptiGauge scan range. As this value is decreased from the maximum value; the Waveform scales accordingly.

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4.3.1 Windowing the Signal

A balance between the Start Point and Range settings allows the user to “window” the data and simplifies viewing of the waveform (without the need for manual zooming), especially for thin, multi-layer samples.

In addition, as the **Range** setting is decreased, the Controller processes fewer data points, which may increase the effective measurement rate. Maximum measurement rate is obtained by using the smallest **Range** to obtain data. This is accomplished by adjusting the Start Point and Range so that only the peaks of interest are displayed in the Waveform window.

4.4 Layer Detection Settings

These settings, in conjunction with proper probe alignment, are the main factors that determine measurement accuracy of the sample layer(s) under test.

LED Level – Adjust this value to maximize the peak heights (signal amplitude). When the LED Level is too high, the Waveform will appear red, indicating the detector is saturated. Generally, the LED Level should be set to one unit below the saturation point.

Threshold – Adjust this value to determine the minimum height of detected peaks. Threshold is represented in the Waveform window by a horizontal, dashed yellow line. To adjust the Threshold manually, use the mouse cursor to click-and-drag the Threshold line up or down. Generally, this line should be set above the base-line noise level and unwanted peaks, but below peaks of interest. Only peaks above the Threshold line will be detected and measured.

Peak Width – This value controls the number of peak points used to calculate the center location of a peak. Peak points are represented in the Waveform window by the white dots that trace the Waveform graph.

The default value of 8 is optimal for most measurements. When measuring thinner layers (less than approximately 20 microns), it may be necessary to adjust the peak width to a lower number until the software detects the individual peaks.

4.5 Data Output Settings

These settings allow the user to set the number of layers to detect and to set the units of measurement.

Layers Displayed - Number of layers to detect and display (min =1; max = 20).

Units - The units of measure to display and output thickness values: microns (µm), millimeters (mm), microinches (µin), mils (thousandths of an inch), and inches (in).

4.6 Data Processing and Measurements Rate

The OptiGauge control center allows data processing on both the raw waveform signal and the numeric thickness values to provide more accurate measurements.

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4.6.1 Noise Reduction

The Noise Reduction screen (Figure 21) allows the user to increase the waveform signal-to-noise ratio allowing better statistical measurements, or detection of low amplitude peaks. This algorithm uses multiple waveform acquisitions and processes the raw data before peaks are detected and thickness is measured.

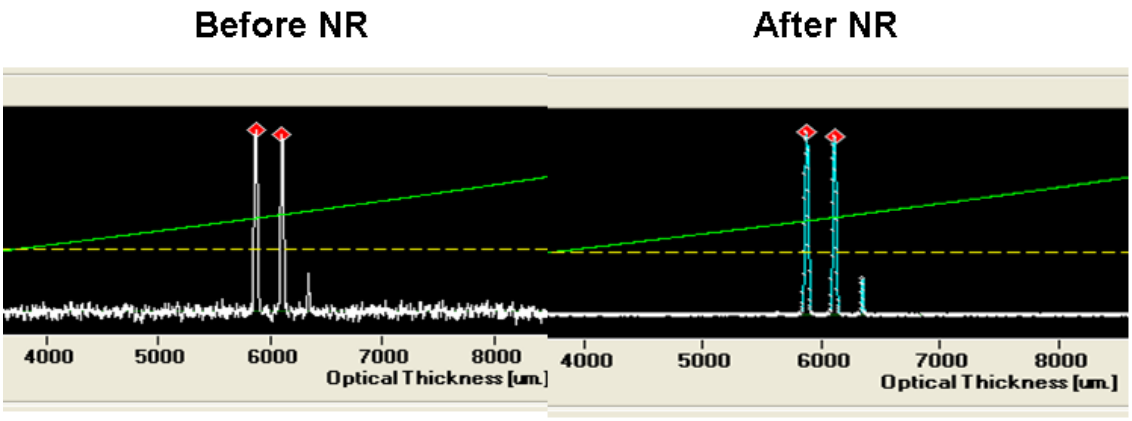


Figure 20 - Noise Reduction; Before and After Views

Since noise reduction is a mathematically intensive algorithm the minimum number to obtain desired results should be used.

4.6.2 Sample Averages

The precision of the OptiGauge can be improved by taking an average of multiple measurements. When **Sample Averages** is set to a number greater than one, the statistics of the data are displayed in the numeric measurement window. Mean, minimum, maximum, and standard deviation values are calculated and can be displayed.

4.6.3 Data Processing Effect on Measurement Rate

Both noise reduction and Sample Averages use multiple scans for calculations; therefore, the final measurement throughput or measurement rate (*i.e.*, measurements/sec) is affected. In general, for a small measurement Range, the final measurement rate is 50 Hz / (Noise Reduction * Sample Averages).

For example, if Noise Reduction is set to 10 scans and Sample Averages is set to 5, then the final measurement is 1 Hz. However, since Noise Reduction is mathematically intensive, large ranges (*i.e.*, thicknesses) may cause slower performance. When using Noise Reduction, the best measurement rate is obtained when the waveform is windowed as described in Section 4.3.2 (Windowing the Signal).

4.7 Waveform Graphical Tools

The Waveform window provides a real-time graph that includes several user tools to allow for customized viewing of the OptiGauge data.

The waveform window view can be quickly changed by zooming and panning, allowing the user to obtain better graphical detail or move the displayed section of the waveform without altering the **Start Point** or **Range** settings.

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In addition, certain graphical elements can be added or removed, such as markers that identify detected peaks, raw & processed signals, and the analog signal that drives the scanning of the OptiGauge interferometer.

4.7.1 Zooming & Panning

With the mouse cursor placed over the Waveform window, the Shift and Ctrl keys provide access to the zoom and pan features, respectively.

To zoom in on a region of the waveform window, press and hold the Shift key. This causes the cursor to change to a magnifying glass. Next, left-click and hold to pinpoint one corner of the desired collection area, and drag the mouse across the area. Release the left-click to select a given rectangular region. Release the Shift key after completing the zoom function.

To pan the current view horizontally or vertically, press and hold the Ctrl key. This changes the cursor to an open hand icon. Click and hold left mouse button to grab the waveform window. The open hand icon will then change to a closed hand icon. Drag the mouse to translate the plot in the window. After the current move is complete release the left button and repeat as necessary. Release the Ctrl key after completing the pan function. This feature is most useful when the current waveform view has already been zoomed.

To show the full waveform selection, use the Auto Zoom feature by performing a Right-click on the waveform and selecting the Auto Zoom option. This adjusts the view to match the **Start Point** and **Range** settings, and automatically scales the vertical axis based on the lowest and highest signals being displayed.

4.7.2 Peak Markers

Peak markers (Figure 22) are displayed to show each surface interface (layer) found by the software. Peak markers are useful in verifying that the software is detecting the correct peaks. If peak markers are not where expected, check the **Threshold** level and **Peak Width** settings.

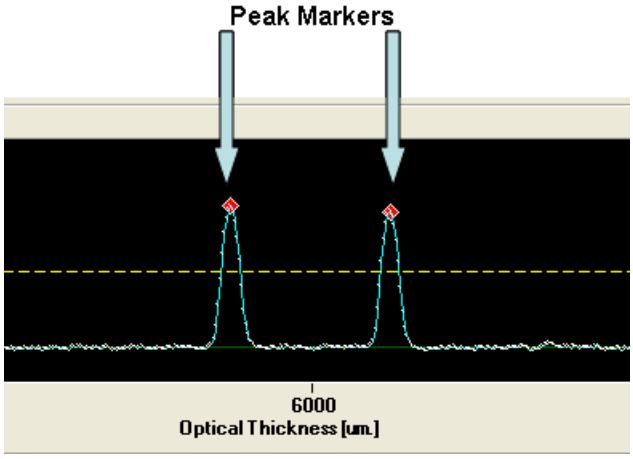


Figure 21 - Peak Markers

Peak Markers can be turned on or off by right-clicking on the Waveform Window and selecting or de-selecting the Peak Markers.

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4.7.3 Raw vs. Processed Signal

The Waveform Window allows the plotting of both the raw and processed waveform signals. The raw signal is the waveform data from each OptiGauge scan at the full 50Hz measurement rate *before* noise reduction is applied. The processed signal is the waveform data after Noise Reduction.

Right-clicking the Waveform Window allows the selection of the waveform plots that can be displayed. Generally only the processed data needs to be displayed.

NOTE:

Since plotting uses system resources, plot only the waveforms of interest. When Noise Reduction is set to 1, the raw and processed signals are identical.

4.7.4 Using the DAC Line

The DAC (Digital to Analog Conversion) line (Figure 23) is the analog waveform driving the OptiGauge interferometer. It is a triangle wave with a rising edge that represents the thickness scanning range. The line is used as a reference to align the peaks within the scan range. The horizontal peak locations are moved relative to the DAC line by adjusting the working distance of the probe. Moving the probe away from the sample moves peaks to the right. Moving the probe toward the sample moves peaks to the left.

The nominal probe working distance (*i.e.*, focal point) coincides with the middle of the DAC full scan. Therefore, the probe should typically be adjusted so that the outermost peaks are centered within the DAC scan line width.

The top of the DAC line represents the end of the scan. It is important to make sure that no peaks on the downward slope of the DAC line are used for measurements. These peaks are mirror images (in reverse order) of the original scan and may produce erroneous thickness measurement values.

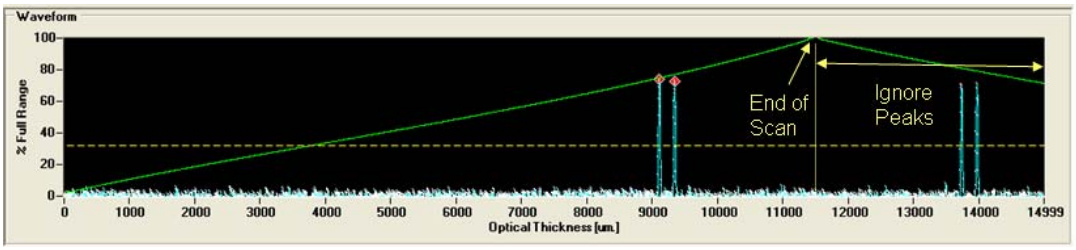


Figure 22 - Waveform Window Showing DAC Line

4.8 Numeric vs. Graphic Data Views

Once peak signals are optimized, accurate thickness values can be read in the Measurement Window. The data is displayed in two modes, numeric and graphic. With the numeric tab selected, thickness values are displayed with digits in the units of measure selected. The number of layers (rows) is controlled by the **Layers Displayed** adjustment in the Data Output section. The material thickness values are presented in a spreadsheet-like table. Other parameters displayed are: **Optical Thickness**, **Total Material**, **Material Name**, **Refractive Index**, and **Standard Deviation**.

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Graphical representation of the data is displayed in the Graphic tab (see Figure 24). A running history of the data is displayed in the **Layer History** section of this screen. This display provides a “chart recorder” view of the data and is useful for monitoring changes in the layer thickness over time. The recorded time span can be adjusted to suit the user’s requirements. To accommodate multiple layers, each layer is displayed in its own graph window.

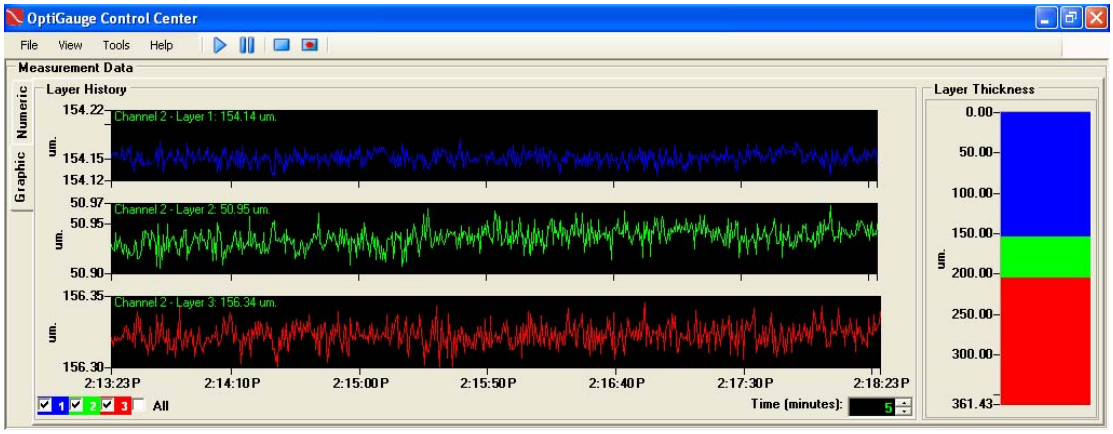


Figure 23 - Graphical Representation of Measurements

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5.0 LAYER CONFIGURATIONS

This section contains information on using the layer configuration feature of the OptiGauge system which is not required, but may enhance measurement procedures.

5.1 Creating Layer Configurations

A layer configuration for a sample contains number of layers, material, and the index of refraction for that material. Layer configurations can be saved and selected for a specific sample type. This allows a library of sample specifications to be saved and easily retrieved.

5.1.1 Naming Materials

A material name can be entered in the Material column of the Data Measurement window. This can be any alpha-numeric descriptor the user wishes to enter. Instructions for entering a material into the database are described in Section 5.1.3.

5.1.2 Saving Layer Configurations

Save Layer Configuration saves frequently used combinations of refractive index, material, layers, and system configuration settings.

Layer Configurations are driven by the number of layers to be displayed. To enter a Layer Configuration, proceed as follows:

1. Set the number of layers that you expect for the material being measured.
2. Configure the settings on the System Configuration panel so that the system is displaying the measurements that you expect to see for the material.
3. Enter refractive indexes and material names for each layer. To save a material configuration, material names are required for each layer.
4. Right-click on the Measurement Data window (except for the **Material Name** cells) and select **Save Configuration**. A dialog box will appear. Select either **New Configuration** or **Overwrite Configuration**. Depending on this selection either enter a name, or select a configuration to overwrite. If an error condition exists when attempting to save a configuration, a pop-up screen appears advising you of this. Errors must be cleared before the system allows you to save a configuration.

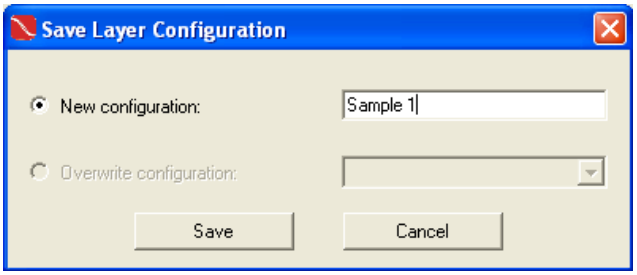


Figure 24 - Save Layer Configuration Screen

You may reload saved configurations by right-clicking anywhere on the **Measurement Data** window (except for the **Material Name** cells), and then selecting the desired layer configuration

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name from the drop-down list. If a layer configuration is currently selected, it is highlighted in the drop-down list as well as indicates on the menu bar. If you have not yet saved a configuration, **Unsaved User Configuration** will appear in the drop-down list. Selecting **Default** will reset all material value pairs to "--", and 1.5.

The **Delete Layer Configuration** option is available to better administer to the layer configuration library by removing unnecessary entries

5.1.3 Materials Database.

The system allows you to define materials with a name and associated refractive index into a built-in database. You may define a layer with these materials by right-clicking on the cell in the **Material Name** column of the desired layer, then clicking a value from the **Select Material** menu item. Beginning to type a selection will bring up a narrowed choice list

The system is not installed with any preloaded materials. Materials are added to the **Select Material** list in one of three ways:

1. Names may be entered in the **Material Name** column of the **Measurement Data** grid. Materials entered in this manner are not added to the **Material Database**. They may be selected from the **Select Material** list for other layers in the current configuration.
2. If the Layer configuration is saved, the materials are added to the **Material Database**. These materials may then be chosen by right-clicking on any cell in the **Material Name** column of the **Measurement Data** grid and proceeding as described above.
3. The materials may be edited with the database editor. This can be viewed by right-clicking on the **Material Name** column of the **Measurement Data** grid and then choosing **Add/Update Material.**

5.1.4 Rules for Material Names

Material names must be unique and may only be associated with one refractive index. The system will generate an error state for duplicate names with contradictory refractive indexes.

5.1.5 Updating Materials

The "Add/Update Material" dialog may be used to add material definitions as well as edit existing materials. To open the Add/Update Material dialog, right-click on the cells in the **Material Name** column and select the Add/Update Material menu item. Any changes to existing materials will be reflected in the layer configurations they are associated with.



Figure 25 - Add/Update Material Screen

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6.0 DATA COLLECTION

This section describes the basic functions of the OptiGauge system and gives procedures for collecting data with the Control Center software.

6.1 How Data Collection works

The flow of measurement data begins with the OptiGauge probe, which emits infrared light and collects the reflected light from the sample. The light signals are converted to electronic signals by detectors in the OptiGauge which are transmitted via data cable to the Controller.

Next, the signals are digitized using an analog-to-digital-converter (ADC), while the OptiGauge is simultaneously controlled using a digital-to-analog-converter (DAC) over the same data cable. Processed data is then displayed, analyzed, and output by the Control Center Software. Figure 27 illustrates the flow of data in the OptiGauge System.

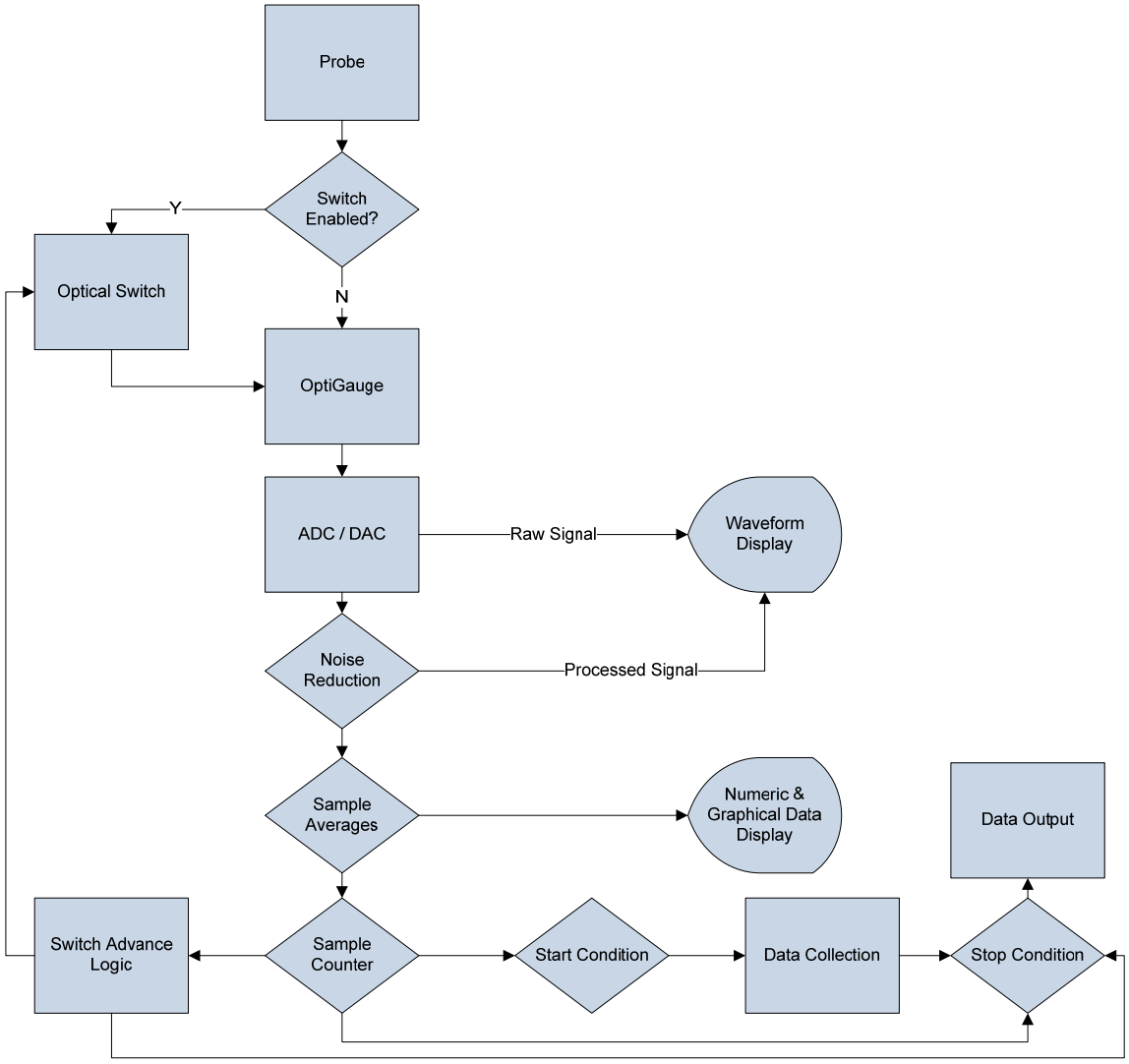


Figure 26 OPTIGAUGE System Data Flow Diagram

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6.2 Data Collection Tab

To access data collection settings, select the **Data Collection** tab on the bottom of the settings screen in the Control Center software. The OptiGauge has the ability to collect and store measured data into files that can be manipulated for data analysis, or stream data to an external source.

To begin collecting data, a start condition must be satisfied. Once data collection has started, data will be continuously stored to a file (on a local or network location), or streamed to the RS-232 port to be interpreted by separate hardware or software. To end data collection, a stop condition must be satisfied. Several options for start/stop conditions are provided to meet different application needs.

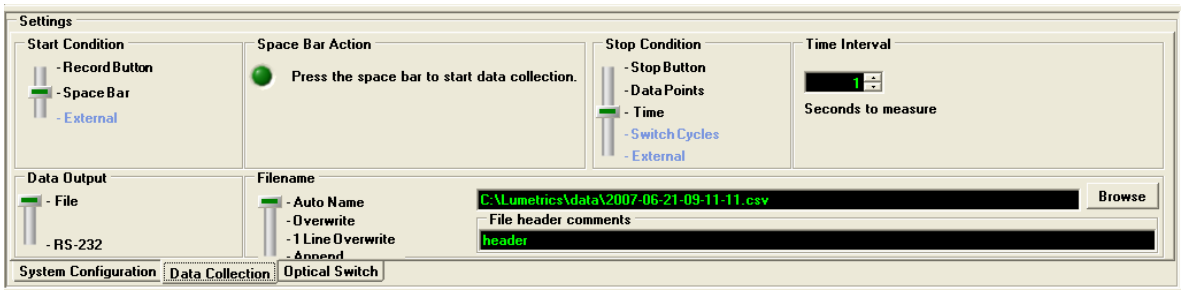


Figure 27 Data Collection

6.3 Starting & Stopping Data Collection

The measurement settings affect how many data points the OptiGauge will output per second. When recording data, there are multiple methods that can be used to collect the data. Data collection is initialized and terminated by start and stop conditions as described below.

6.3.1 Start Conditions

The start condition determines the method used to initiate data collection.

Record Button

Selecting the **Record Button** option in the **Start Condition** box allows the user to click on the record button located in the Main Toolbar to start data collection.

Space Bar

The **Space Bar** option provides the convenience of pressing the Space Bar on the keyboard to start or stop data collection. Note that a green/red LED indicator on the Main toolbar indicates if the Space Bar is active or not.

Since the Space Bar is used for other elements of the Control Center (such as entering Material Names within the Numeric display tab), the Space Bar may become inactive depending on the focus of the mouse cursor. To activate the Space Bar, re-select **Space Bar** under **Start Condition.**

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When the Space Bar is selected as a start condition, it is also automatically available as stop condition, which provides the user with a single button for toggling the data collection on or off.

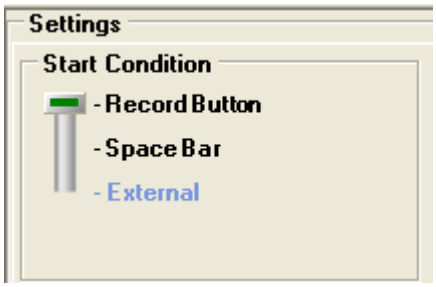


Figure 28 Start Condition

6.3.2 Stop Conditions

Stop Button

The Stop Button option in the Stop Condition box allows the user to click on the Stop Button located in the Main Toolbar to terminate the data collection.

Data Points

The Data Points option in the Stop Condition box allows the user to terminate data collection after a specified number of data points have been collected. The amount of time it takes to acquire a given number of data points depends on the measurement settings.

Switch Cycle

If multiple probes are connected through a switch, the Switch Cycle designates how many times the switches are cycled through before data collection is terminated. Data collection can stop by pressing the stop button (in record button mode) or by pressing the space bar (in space bar mode).

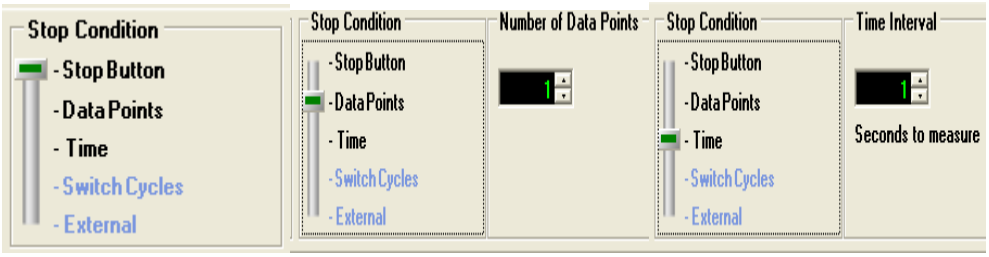


Figure 29 Stop Condition Options

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6.3.3 Data Output

These settings determine whether data will to be stored to a file, or streamed to the RS-232 port.

File

Select File under Data Output to store the recorded data to a local or network file. The default location is C:\Lumetrics\data, which saves files on the local Controller hard drive. Click Browse to search for other locations, or specify a location by typing in the filename text field.

Files will be written in standard comma separated ASCII text format, with .CSV file extension, and will include 4 header rows to indicate the data collection parameters, followed by a row of column headers for the raw data. The following table illustrates a file collected with Displayed Layers set to 1. For each additional displayed layer, four columns will be added to the right, continuing on row 5, with the names: Layer2Value, Layer2MAX, Layer2MIN, Layer2STD, and so on.

% Comments:						
% Data samples averaged per layer:						
% Noise reduction factor:						
% Units:						
DateTimeStamp	LayersDetected	Channel	Layer1Value	Layer1MAX	Layer1MIN	Layer1STD

RS-232

Select RS-232 under Data Output to send the data to the serial port.

Serial Data Output Format

Serial data output is comma-delimited and is in the following format:

ID Number, Channel, Layer 1, Layer 2, Layer 3, Layer X,…

The first field is an ID number that is incremented each time serial data is transmitted. The minimum value for this number is 0; the maximum is 4,294,967,295. The number will roll over to 0 if the maximum value is exceeded.

Subsequent fields are the probe channel and then the layer thickness in microns. If layer averaging is enabled, this value will be the layer mean value.

Serial data is output at 115,200 baud, eight data bits, no parity, and one stop bit. A Null-Modem Cable is required to stream data from the RS-232. A picture is provided below.

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Figure 30 Null Modem Cable

Serial Output Parameters

115200 Baud; 1 Stop Bit; 8 Bit Word Length; No Parity; No Hardware Handshake

Format

The Serial Output is in comma separated value (.csv) format. Thickness values (real data type) are formatted with two decimal digits. All thickness values are in microns as physical thickness – corrected for the refractive index. If no refractive index is specified the default index of 1.5 is used.

Table 3 Serial Output Values

Identifier	Channel	Integer	Incrementing sample identifier. Zero based unsigned 32 bit integer.
		Real	Layer1 physical thickness in units of microns
		Real	Layer2 physical thickness in units of microns.
		Real	Layer3 physical thickness in units of microns.
LineEnding		<carriage return><line feed>	

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Three Layer - 1 channel/probe Example:
Identifier,channel,layer1,layer2,layer3

0, 0,158.16,84.34,158.16<cr><lf>
1, 0,158.16,84.34,158.16<cr><lf>
2, 0,158.16,84.34,158.16<cr><lf>
3, 0,158.16,84.34,158.16<cr><lf>
4, 0,158.16,84.34,158.16<cr><lf>
5, 0,158.16,84.34,158.16<cr><lf>
6, 0,158.16,84.34,158.16<cr><lf>
7, 0,158.16,84.34,158.16<cr><lf>
8, 0,158.16,84.34,158.16<cr><lf>
9, 0,158.16,84.34,158.16<cr><lf>

Three Layer - 2 channel/probe Example:
Identifier,channel,layer1,layer2,layer3

0, 1,158.16,84.34,158.16<cr><lf>
1, 2,158.16,84.34,158.16<cr><lf>
2, 1,158.16,84.34,158.16<cr><lf>
3, 2,158.16,84.34,158.16<cr><lf>
4, 1,158.16,84.34,158.16<cr><lf>
5, 2,158.16,84.34,158.16<cr><lf>
6, 1,158.16,84.34,158.16<cr><lf>
7, 2,158.16,84.34,158.16<cr><lf>
8, 1,158.16,84.34,158.16<cr><lf>
9, 2,158.16,84.34,158.16<cr><lf>

In Hex - Sample 140:

140,158.16,84.34<cr><lf>
31 34 30 2C 31 35 38 2E 31 36 2C 38 34 2E 33 34 0D 0A

Manual Data Collection

File Name

These settings allow the user to specify the name of the file where data is stored.

Auto Name

Automatically assigns a new name for each subsequent file that consists of: Data-year-month-day-hour-minutes-secondsD.csv

Example: data-2006-09-12-14-34-22D.csv

Overwrite

Overwrites the specified file each time data collection is stopped and stores the new recorded data into this file.

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1-Line Overwrite

This option continuously overwrites the current measurement data point to the first line of the specified file until data collection is terminated. This allows a user to create a simple external program for reading data from the OptiGauge.

Files will be written in standard comma separated ASCII text format, with .CSV file extension, and will not include header rows. The following table illustrates a file collected with Displayed Layers set to 1. For each additional displayed layer, four columns will be added to the right, continuing on row 1, with the names: Layer2Value, Layer2MAX, Layer2MIN, Layer2STD, and so on.

DateTimeStamp	LayersDetected	Channel	Layer1Value	Layer1MAX	Layer1MIN	Layer1STD

Append

This option allows the user to record multiple data sets to the same file. While selected, new data will be added to the specified filename each time the data collection is stopped.

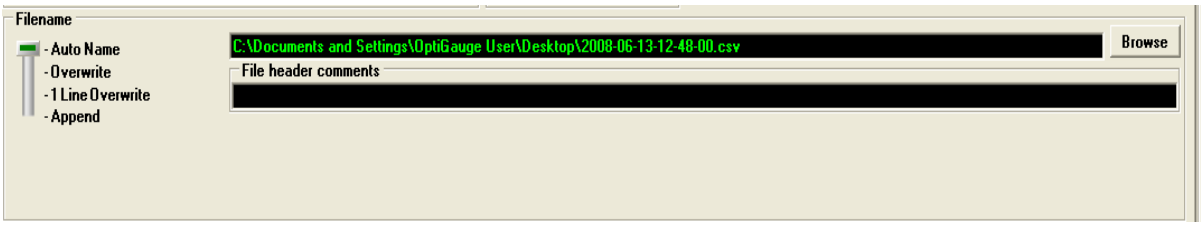


Figure 31 Data File Output Selection

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7.0 OPTICAL SWITCH

The Switch tab is disabled (grayed) if the switch unit is not found or if it has been disabled in the main menu **Tools** selection. There is a “demo” mode which is enabled when the National Instruments (NI) data acquisition hardware is not found and the switch is not discovered. In demo mode the switch performs as though a switch was discovered without sending any commands over the COM1 port.

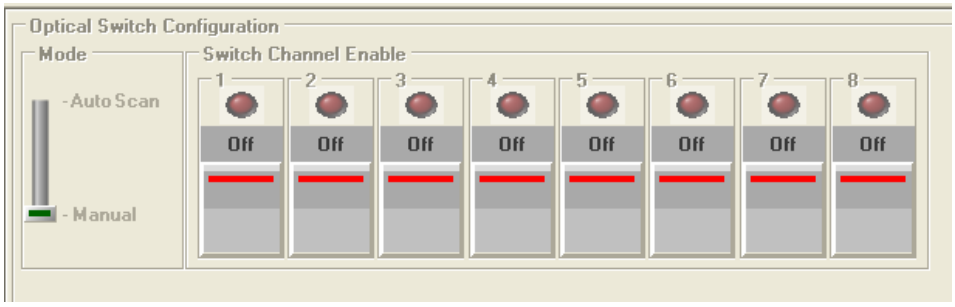


Figure 32 Optical Switch Configurations (Switch Not Found or Disabled)

To enable the switch, select the **Switch enable** selection on the Main Menu **Tools** selection.

Once enabled, the mode of switch operation is selected with a graphical slider. There are two modes available:

Manual – Select a channel by clicking a specific channel number on the screen.

Auto Scan – Scan through the enabled channels based upon the scanning parameters.

7.1 Manual Operation

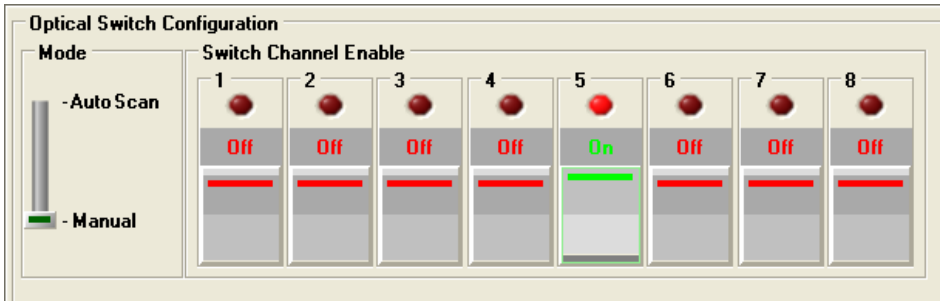


Figure 33 Optical Switch Configurations (Switch Found and Active)

In Manual mode a switch channel is selected by clicking the graphical toggle switch. When selected the toggle label changes from **Off** to **On**, the color is changed from green to red, and the LED is brightened. The current channel is displayed in the status bar. Only one channel can be selected at a time.

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Figure 34 Status bar: switch channel label

7.2 Auto Scan Operation

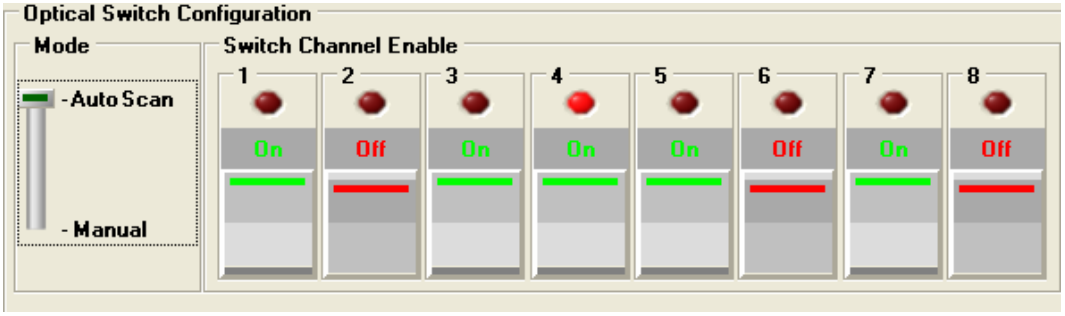
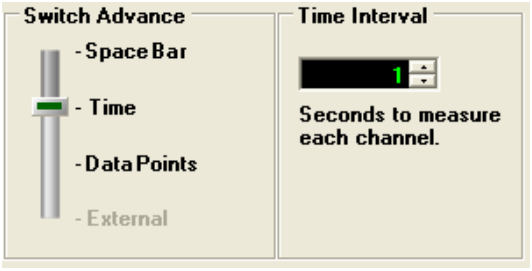
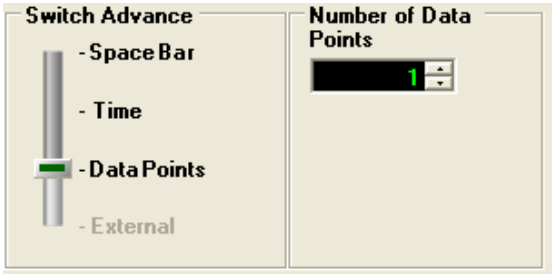


Figure 35 Optical Switch Configurations (Auto Scan)

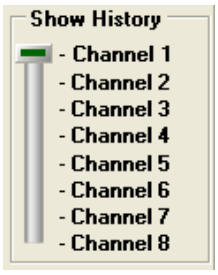
In Auto Scan mode switch channels are enabled for measurement by clicking the graphical toggle switch. An enabled channel is indicated with the text **"On"** displayed in green.





There are three selections for the switch advance:

1. **Ctrl-Space Bar** – Pressing ctrl-space bar advances the switch to the next enabled channel.
2. **Data Points** – The switch advances after the specified number of measurements have been made.



When in Auto Scan mode the Show History slider selects the channel to be displayed by the Layer History panel. Selected a channel that is not enabled will result in the display of a blank panel. After the selection changes, the Layer History panel displays the history. The annotation text is not displayed until a measurement is made on the selected channel.

As with Manual mode, the current channel is displayed in the status bar.

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8.0 REMOTE ACCESS

The OptiGauge has the ability to be remotely accessed through a network by another user. Please follow these steps to set up Remote Access for the OptiGauge Control Center.

8.1 Setup Instructions

1. If a previous version of the OptiGauge Control Center is installed, manually uninstall the version. If not, please skip to step 4.
2. Select Start ->Control Panel -> Add or Remove Programs.
3. Select OptiGauge Control Center and select Remove.
4. Install the OptiGauge Control Center (OCC) package (drivers and software) on the OptiGauge controller and the computer that will be remotely accessing the OptiGauge. The drivers do not need to be installed on the client computer. Please note that both the Host (OptiGauge) and the Client (computer accessing the OptiGauge) must have the same version of the OCC.
5. On the Host Computer (OptiGauge Controller) Select Start -> Control Panel -> Administrative Tools -> Computer Management.
6. Select the plus (+) located next to Local Users and Groups.

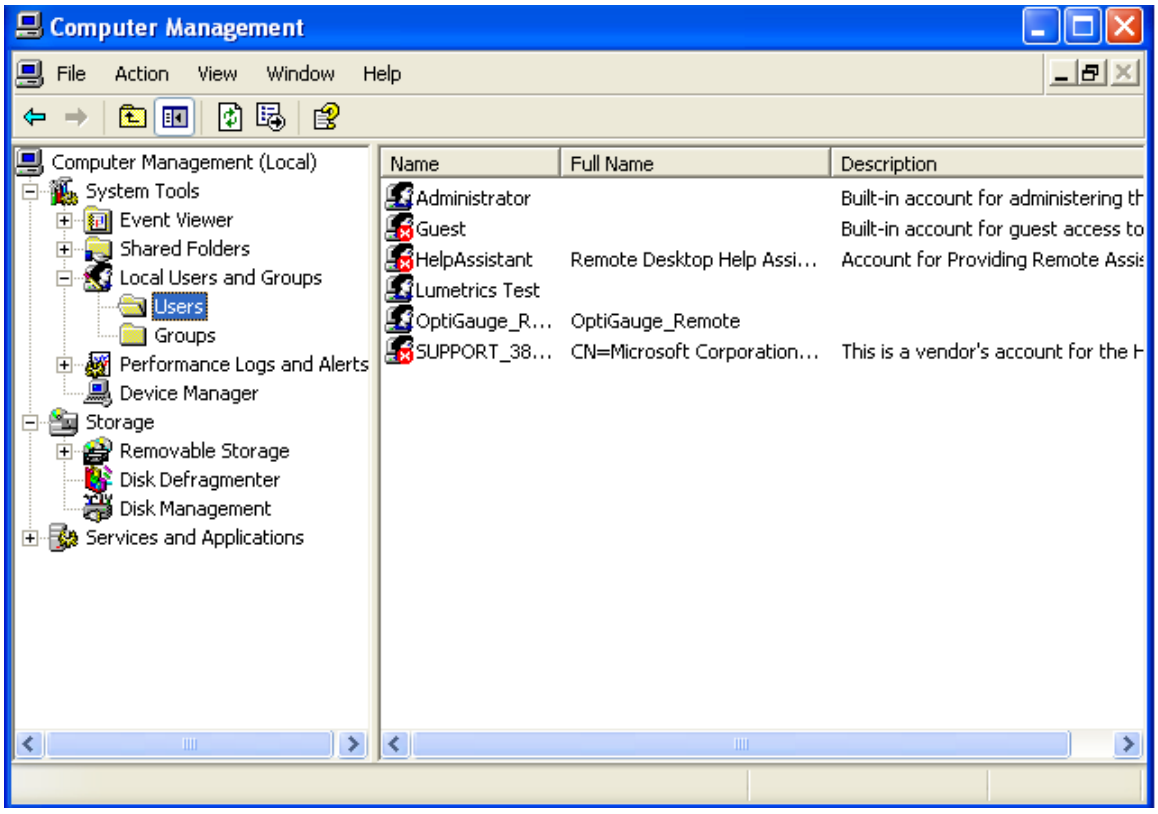


Figure 36 Computer Management Screen

7. Right Click on the Users folder.

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8. Select New User.

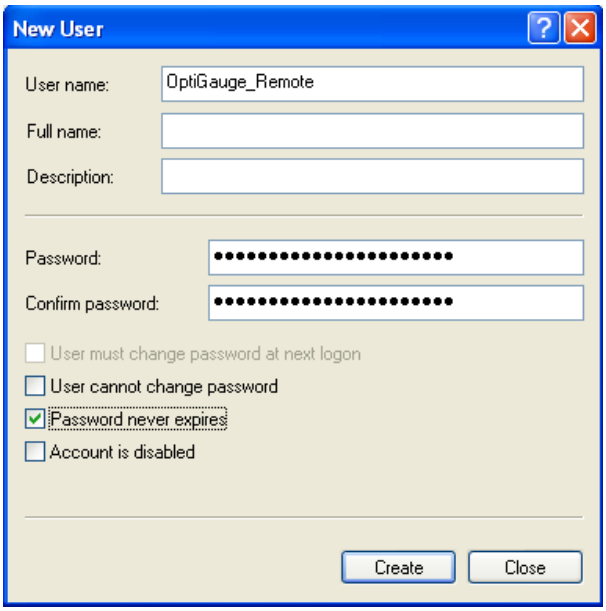


Figure 37 New User Screen

9. Enter ***OptiGauge_Remote*** into User Name. Enter appropriate information into Full Name and description.
10. Enter ***OptiGauge!Remote#User|*** into Password. Enter ***OptiGauge!Remote#User|*** into Confirm Password. Please note that this password can be changed but the password must be the same on both the client and host computer. The password must also match the password in step 35 (OptiGauge Remote Configuration).
11. Ensure that the box for “User must change password at next logon” is unchecked.
12. Ensure that the box for “Password never expires” is checked.
13. Click Create and Close.
14. Right-click on OptiGauge_Remote in the user’s directory and select Properties.
15. Select the “Member Of” tab and click Add.

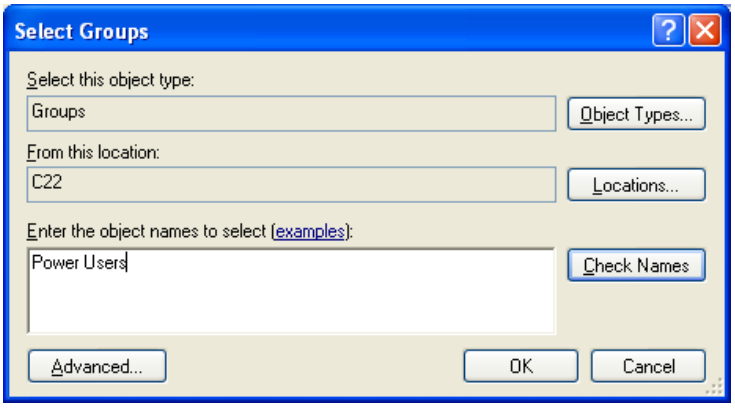


Figure 38 Select Groups

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16. Type “Power Users” and then click “OK”. For security reasons, it is recommended that the account belong only to the “Power Users” group. The same user name and password must exist on both the OptiGauge Controller (Host) and the client computer in order for Remote Accessing to work.

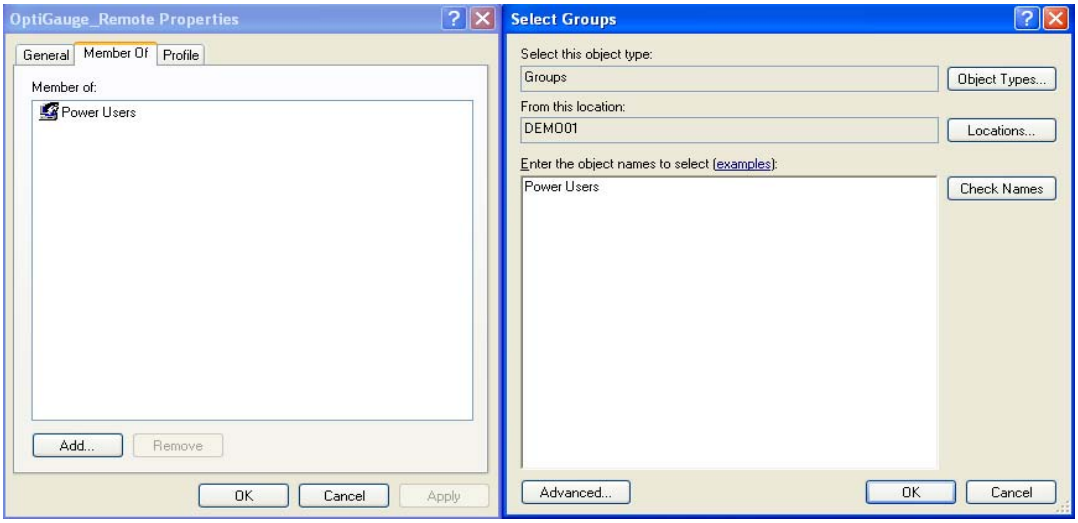


Figure 39 Adding OptiGauge_Remote to Power Users

17. Select Start -> Control Panel -> Administrative Tools -> Local Security Policy.

18. Open Local Policies by clicking the (+) to the left and select “Security Options”.

19. Double Click “Network Access: Sharing and security model for local accounts”.

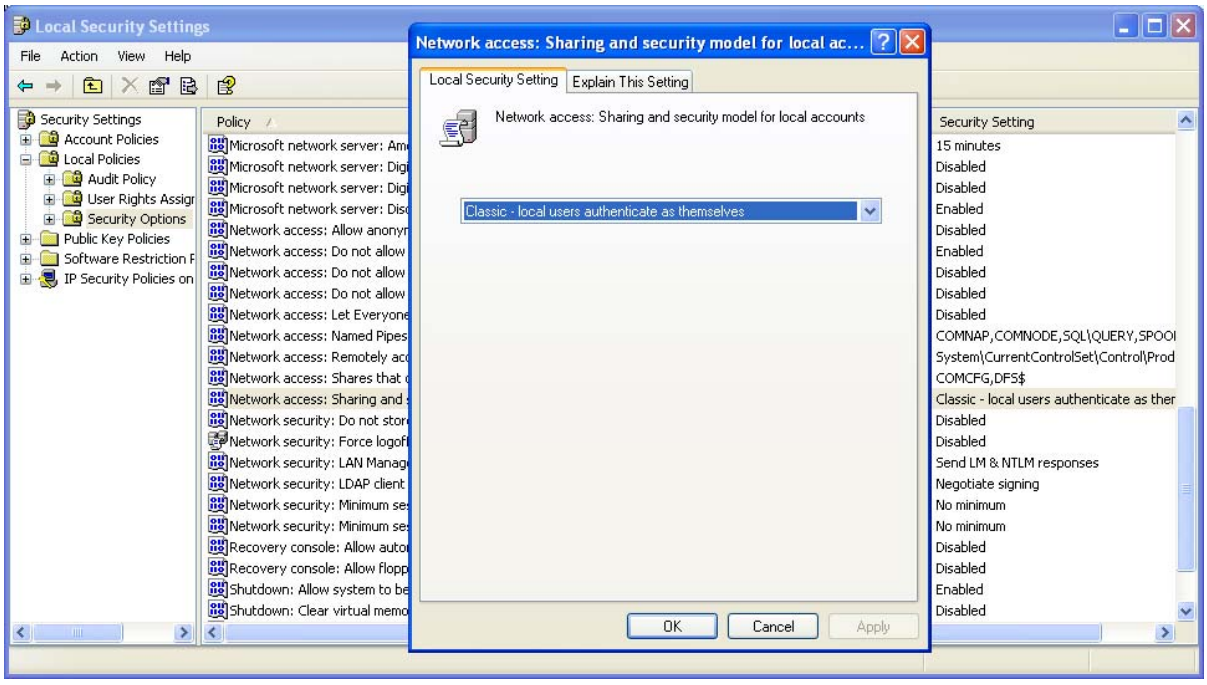


Figure 40 Local Security Settings

20. Change to “Classic - Local Users authenticate as themselves” and click OK.

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21. Close the “Local Security Policy” window.
22. Select Start -> Control Panel -> Windows Firewall.
23. Select the “Exceptions” tab.

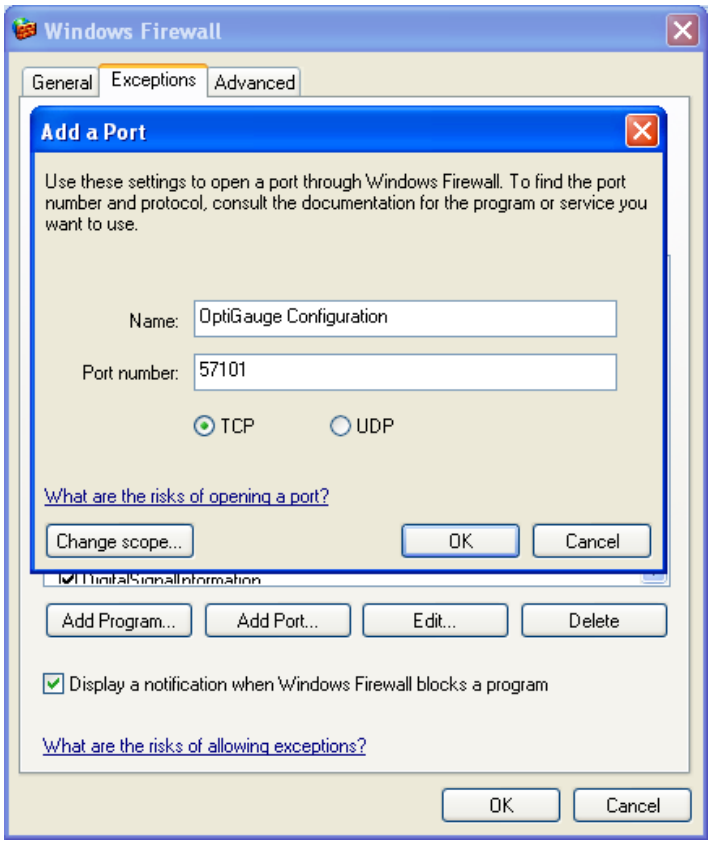


Figure 41 Add Port to Firewall

24. Click “Add Port”.
25. Enter OptiGauge Configuration into “Name” and 57101 into “Port Number”
26. Ensure that TCP is selected and select ok.
27. Repeat steps 26 – 29 for the following items:
    - Name: OptiGauge File Writer, Port: 57103
    - Name: UI, Port: 57105
    - Name: MATH, Port: 57102
    - Name: SWITCH, Port: 57110
    - Name: Serial Port Output, Port: 57108
    - Ensure that the “File Sharing and Printer Sharing” box is checked. This option can be found under programs in services within the exceptions tab.
28. Repeat Steps 1 – 26 for both the OptiGauge controller (Host) and the Client computer.

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29. On the client computer, select My Computer =>C: =>Program Files =>Lumetrics => OptiGauge Control Center =>OptiGaugeRemoteCongifuration.exe.

    Note – Unblock the program if a Firewall box appears.

30. Ensure that the box next to “Remote OptiGauge Controller” is selected.

31. Enter the IP address of the Host.

    - On the Host computer: Select Start -> all programs ->Accessories -> Command Prompt
    - Type in IPConfig. Record the IP address.

32. Ensure that the OptiGauge Network User Name and the Password are the same name and password as entered in step 6 and 7. If the password was changed, please enter the changed password into “OptiGauge Network Password” and “Verify OptiGauge Network Password”.

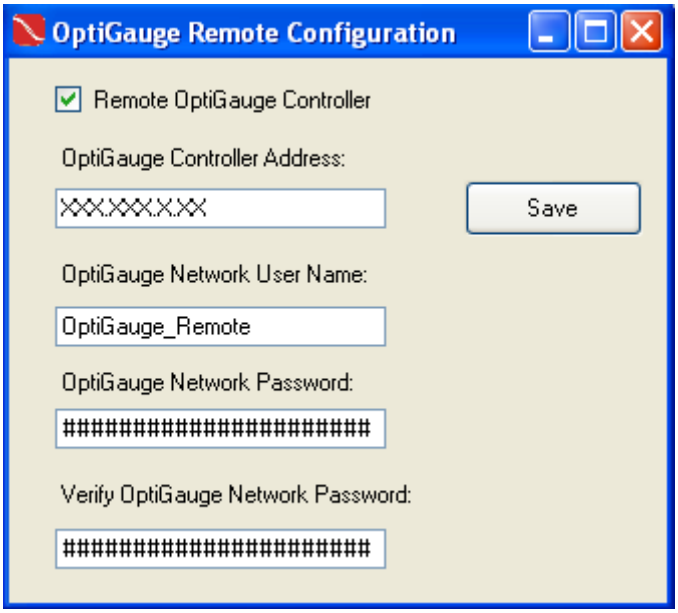


Figure 42 Remote Configurations for Client Computer

33. Click Save.

34. Open the OptiGauge on the Client computer and begin remote accessing the OptiGauge.

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9.0 USER PRIVILEGES

The Windows XP Security Model has been incorporated into the functionality of the OCC Software. This feature allows users who are at a non-administrator level for the PC to use the OptiGauge Control Center. The Security model provides a specific set of functionality to each level of user. These changes also allow the user to manipulate the system within parameters set by administrative users.

9.1 Setup Instructions

The OCC implements a security model that has four roles:

1. Administrators
2. Engineers
3. Operators
4. Users (all others)

Creating Users and Groups

Follow these steps to setup the required Windows Groups:

1. Select Start -> Control Panel -> Administrative Tools -> Computer Management.
2. Open Local Users and Groups by clicking the plus (+) to the left of the directory.

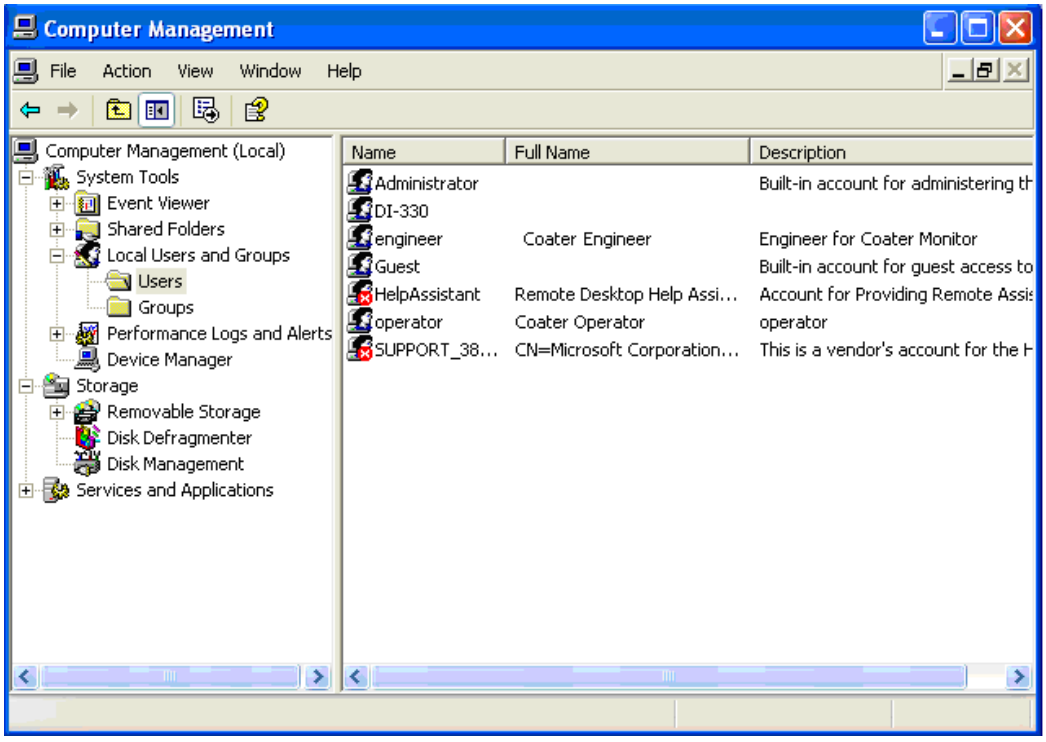


Figure 43 Computer Management Screen

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Create Groups

3. Right Click on the Groups folder.
4. Select New Group.

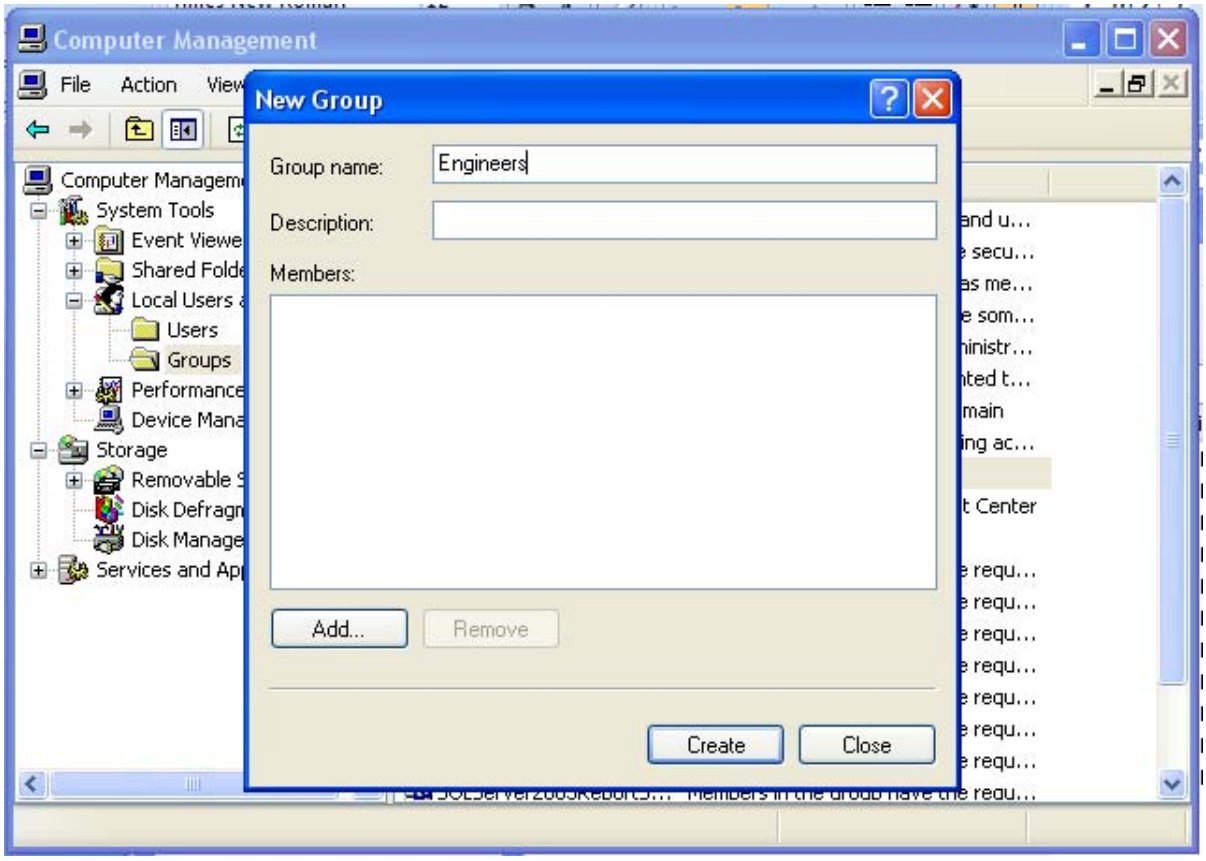


Figure 44 Add new Group

5. Enter **Engineers** into Group Name, provide a description and select Create.
6. Repeat Step 5 entering **Operators** into the Group name field.

Note: The Administrators and Users groups are created by Windows.

7. Click Create and Close.
8. Right Click on the Users folder to either create the new users that belong to the one of the four groups: Administrators, Engineers, Operators, or Users.

Set impersonation rights

1. Select Start -> Control Panel -> Administrative Tools -> Local Security Policy.
2. Open Local Policies by clicking the plus (+) to the left of the directory.
3. Select “User Rights Assignments”
4. Double-click “Impersonate a client after authentication” to open its properties.

Add Engineers, Operators and Users:

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1. Click Add User or Group.
2. Click Object Types.
3. Ensure the Groups checkbox is checked and click OK.

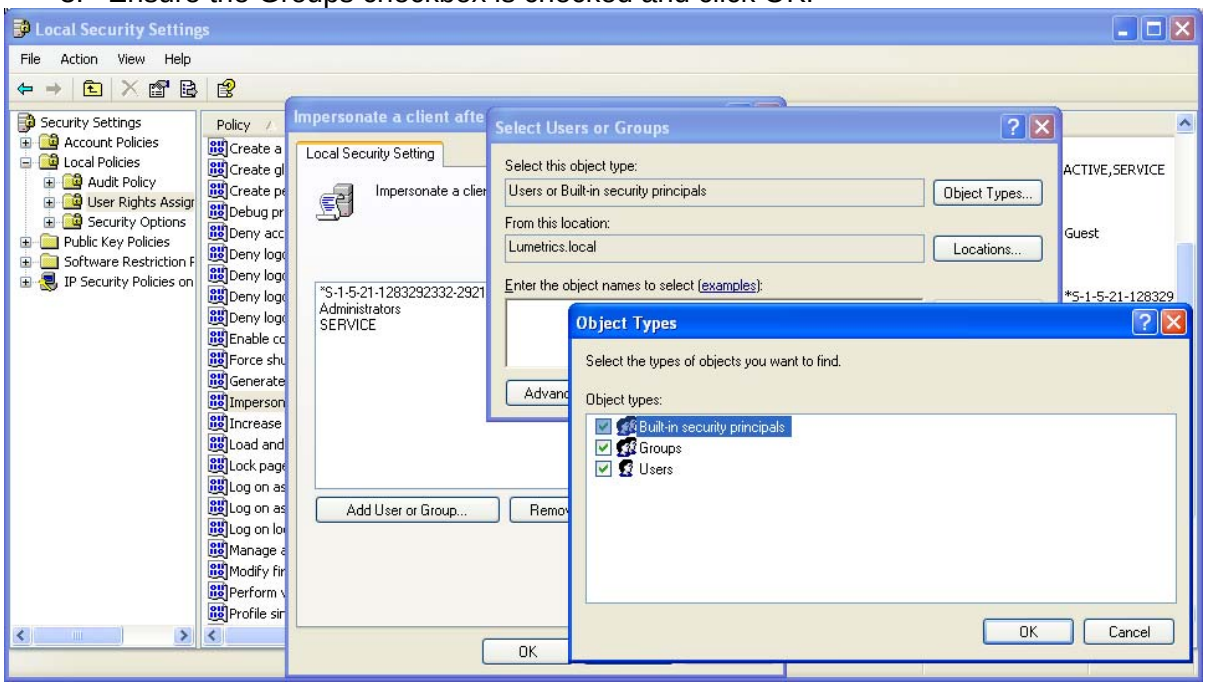


Figure 45 Groups Object Types enabled Screen

4. Enter the group Engineers and click OK
5. Repeat from step 1 to add the groups Operators and Users

9.2 User Permissions

Each type of User has a certain level of functionality that can be accessed with the OptiGauge Control Center. Please refer to the figure below to determine user privileges.

Table 4 User Permissions

Function	Administrator	Engineer	Operator	Viewer
Add Accounts	X			
Add or change access permissions	X			
Set up scan pattern	X	X		
Set up part configurations	X	X		
Change Index of Refraction	X	X		
System Configuration				
Start Point	X	X		
Range	X	X		
LED Level	X	X	X	
Threshold	X	X	X	

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Peak Width	X	X		
Noise Reduction	X	X	X	
Sample Averages	X	X		
Measurement Units	X	X		
Layers Displayed	X	X		
View Section or Right Mouse Click				
Auto Zoom	X	X	X	
Un-zoom	X	X	X	
Plot DAC	X	X		
Plot Raw Signal	X			
Plot Processed Signal	X	X		
Peak Markers	X	X		
Measurement Data Graphic	X	X		
Measurement Data Numeric				
Averages	X	X		
Material Name	X	X		
Material Thickness	X	X		
Maximum	X	X		
Minimum	X	X		
Optical Thickness	X	X		
Refractive Index	X	X		
Standard Deviation	X	X		
Total Material	X	X		
Data Collection				
Start Condition				
Record Button	X	X		
Space Bar	X	X		
Stop Condition				
Stop Button	X	X		
Data Points	X	X		
Number of Data Points	X	X		
Time	X	X		
Data Output				
File	X	X		
RS-232	X	X		
Filename				
Auto-Name	X	X		
Overwrite	X	X		

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1 Line Overwrite	X	X		
Append	X	X		
Browse	X	X		
File Header Comments	X	X		
Switch Control	X	X	X	X

Certain user privileges are customizable by the Administrative users. This form, accessible through the tools menu, allows you to customize the user experience for Engineer and Operator levels.



Figure 46 – User Privileges form

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APPENDIX A: TECHNICAL REFERENCE

This section explains what types of materials can be measured with the OptiGauge, explains the fundamental measurement principles, and discusses the importance of refractive index.

A.1 Types of Materials that Can Be Measured

The OptiGauge is ideally suited to measuring thickness of any materials that transmit infrared light (specifically at a wavelength of 1310nm). Generally speaking, such materials will also be transparent or translucent to visible light. However there are some notable exceptions, including silicon, which appears black in visible light, but has high transmission in the infrared spectrum.

Common materials that can be easily measured by the OptiGauge include many varieties of glass, liquids and gels, polymers, plastics, films, adhesives, and air spaces between materials.

A.1.1 Parallel Surfaces

In order to measure thickness using the OptiGauge, the top and bottom surfaces of a given material must be parallel, but may have a slight wedge angle according to the angular tolerance of the optical probe.

A.2 How Light Interacts with Different Materials

OptiGauge technology relies on a physical process called Fresnel reflection. When light travels from one medium to another (such as from air to glass), a fixed amount will be reflected back from the interface between the two media based on the change of refractive index. The amount of reflected light is governed by the following equation:

$$\% \text{ Reflection} = [(N_1 - N_2)^2 \div (N_1 + N_2)^2] \times 100$$

where N_1 and N_2 are the indices of the two materials.

This process allows the OptiGauge to measure single layer or multi-layer materials. Any multi-layer material can be measured if the individual layers have different refractive indices. Figure A-1 illustrates the process of Fresnel Reflection for a sample with two layers of different refractive index.

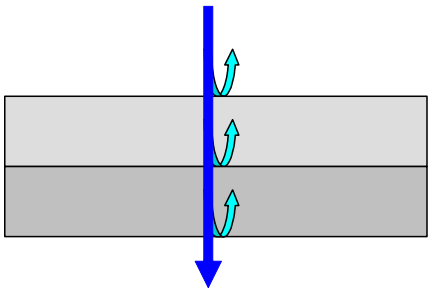


Figure A-1. Fresnel Reflection

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For an interface between air and glass, the index will change from approximately 1.0 to 1.5, and the amount reflected back will be about 4%.

For changes between two similar materials, such as two different types of plastic, the change of refractive index may be small. Therefore, the signal strength will be strongest at the outside surfaces (air interface) of such materials.

A.2.1 Specular vs. Diffuse Reflection

The above equation assumes that the reflecting surface is perfectly smooth, or specular. For specular surfaces, any incident light ray at a given angle will reflect off at the exact same angle. Highly polished, flat glass represents a perfectly specular material. Clear, specular materials are described as transparent.

Any material that is not specular is referred to as diffuse. When an incident light ray at a given angle strikes a diffuse surface, it may be scattered off at a different angle. The more diffuse, the greater the scatter angle may be. Clear, diffuse materials are described as translucent. Figure A-2 illustrates this difference.

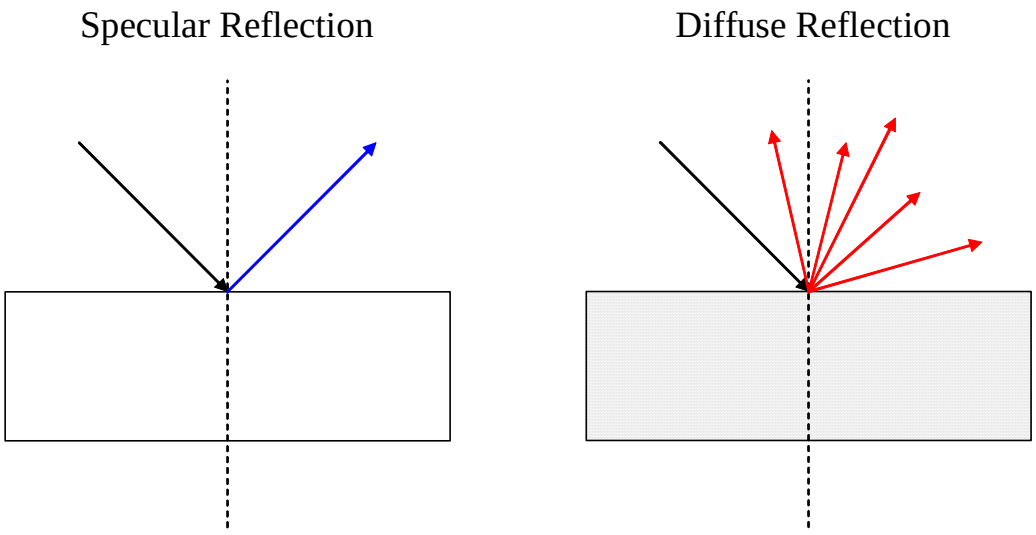


Figure A-2. Specular vs. Diffuse Reflection

A.2.2 Transmission, Absorption, & Internal Scattering

As discussed above, when light strikes a material, some will be reflected or diffused depending on the smoothness of the surface. Once light enters a material, it will be transmitted, absorbed, or scattered internally. Clear materials such as glass have very high transmission, and will absorb or scatter a negligible amount of light. Some dark or colored materials may have lower transmission, and may absorb or scatter a large amount of light.

Common plastics and polymers may have colorants or contaminants that scatter light internally, such as titanium dioxide, barium sulfate, or other agents. Figure A-3 illustrates the process of internal scattering.

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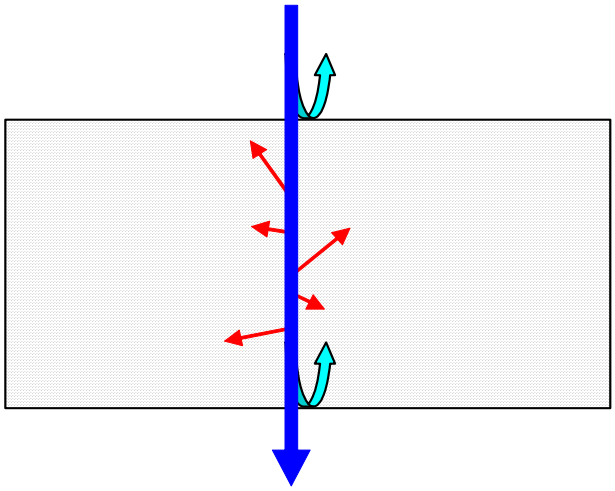


Figure A-3. Internal Scattering from a Single-Layer Material

When using the OptiGauge to measure colored materials, the waveform helps to identify characteristics such as scattering or absorption. Figure A-4 shows a waveform from a single-layer material that exhibits both absorption and internal scattering.

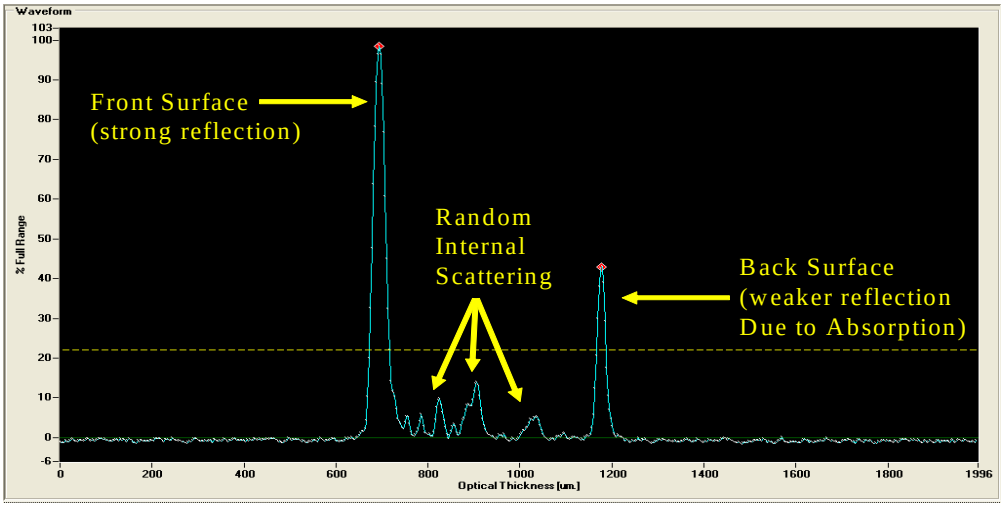


Figure A-4. Example Waveform – Internal Scattering & Absorption

Since light may be diffused from a surface, and then subsequently transmitted, absorbed, or scattered within the material, measurement using the OPTIGAUGE depends on all of the following:

1. Change of refractive index
2. Smoothness of surfaces
3. Transmission within the material
4. Contaminants inside the material

Due to all of these factors, varying light levels, hardware and software settings may be required to measure different materials.

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A.3 Understanding Refractive Index

Since the OPTIGAUGE utilizes a broadband LED, the "refractive index" referred to in the context of this manual is more specifically the group index of refraction at 1310nm over a 50nm bandwidth (FWHM). The following equation can be used to calculate group index of a material:

$$n_g = n_p - \lambda \frac{\partial n_p}{\partial \lambda}$$

where n_p is the phase index as function of wavelength, λ.

A.3.1 Optical Thickness vs. Material Thickness

Generally speaking, refractive index is the ratio of how far light travels in a given medium to how far light travels in a vacuum. The refractive index of a perfect vacuum is exactly 1. Every material has a refractive index higher than 1. Therefore, light travels farther in any material than in a vacuum.

Since air is mostly empty space, its index is only slightly higher than 1; in fact, at standard temperature and pressure, the index of air is about 1.000274. Most clear, solid materials such as glass, plastic, or polymer will have a refractive index near 1.5. Liquids generally have a lower index near 1.3 or 1.4.

Optical thickness is the product of the material's thickness and its index of refraction. The OPTIGAUGE directly measures optical thickness. Material thickness is then calculated as follows:

Material Thickness = Optical Thickness ÷ Refractive Index

NOTE: Optical Thickness will always be greater than Material Thickness.

A.3.2 Refractive Index and Measurement Error

If the assumed refractive index is not correct, the calculated material thickness will have a fixed error. The following equation describes this fixed error:

% Error = [1 – (n ÷ (n + Δn))] × 100

where n is the actual refractive index, and Δn is the deviation (or error) from the actual index.

NOTE:

If the assumed index is too high, the Material Thickness will be less than the actual value, and the error will be negative. If the assumed index is too low, the Material Thickness will be greater than the actual value, and the error will be positive.

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A.3.3 Using OPTIGAUGE to Measure Refractive Index

To accurately measure the actual thickness of a material, the refractive index must be known. Refractive index is known for many clear materials. However, if working with an unknown material, the index may be measured using the OPTIGAUGE.

In order to measure refractive index, it is necessary to measure both optical and material thickness in a single location. This will always be a 2-step process. For liquids, the process is rather trivial. However, measuring index of solids is a more involved process.

Each measurement process below allows direct measurement of both material and optical thickness of the unknown sample; thus, refractive index can be calculated. Custom fixturing and software can be provided to simplify the process of index measurement, especially for solid materials (section 6.2.3.2 below). Contact Lumetrics for details.

A.3.3.1 Measuring Refractive Index of Liquids

This process requires a clear container with parallel surfaces, such as a rectangular glass cuvette. The internal size of the container should be less than 8mm.

1. Set the number of displayed layers to 1, and set the refractive index to 1.00027.
2. Measure the material thickness of the inside of the empty container in one location. Note this value, call it T_1.
3. Without moving the probe or the container, fill the container with the unknown liquid to a line above the measurement location.
4. Measure the optical thickness of the unknown liquid. Note this value, call it T_2.

Calculate the unknown index as follows:

Refractive Index = $T_2 \div T_1$

A.3.3.2 Measuring Refractive Index of Solids

This process requires two glass surfaces, such as polished optical flats. Ideally, wedged glass flats with a wedge angle of 3 to 5 degrees can be used to avoid multiple reflections within the data window. The glass surfaces must be fixed in place horizontally, with the inside surfaces parallel, and separated by less than 8mm. Also required is a flat, single-layer of the unknown sample material, and a spacer with a hole through it, such as a thin washer. It should be possible to balance the sample on the spacer. For best accuracy, thickness of the unknown sample should be between 1 to 2mm.

1. Set the number of displayed layers to 3, and set the refractive index as follows:
    a. Layer 1 = 1.00027
    b. Layer 2 = 1
    c. Layer 3 = 1.00027

    Setup the two fixed surfaces horizontally. Fix the spacer to the bottom surface, and then align the probe to measure the space between the two surfaces such that the probe beam is traveling through the hole in the spacer, and the separation between glass surfaces can be measured with the spacer present.

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2. Measure the material thickness of the inside air space between the two glass surfaces in one location (Layer 1). Note this value, call it T_1.
3. Without moving the probe or the glass surfaces (i.e. the space between glass surfaces remains constant), carefully place the unknown sample on the spacer.
4. If necessary, carefully align the sample so that the following 3 values can be measured simultaneously:
    a. Material thickness of the air space above the sample (Layer 1); Note this value, call it T_2.
    b. Optical thickness of the sample (Layer 2); Note this value, call it T_3.
    c. Material thickness of the air space below the sample (Layer 3); Note this value, call it T_4.

Calculate the refractive index as follows:

Refractive Index = Optical Thickness ÷ Material Thickness

Refractive Index = $T_3 \div [T_1 - (T_2 + T_4)]$

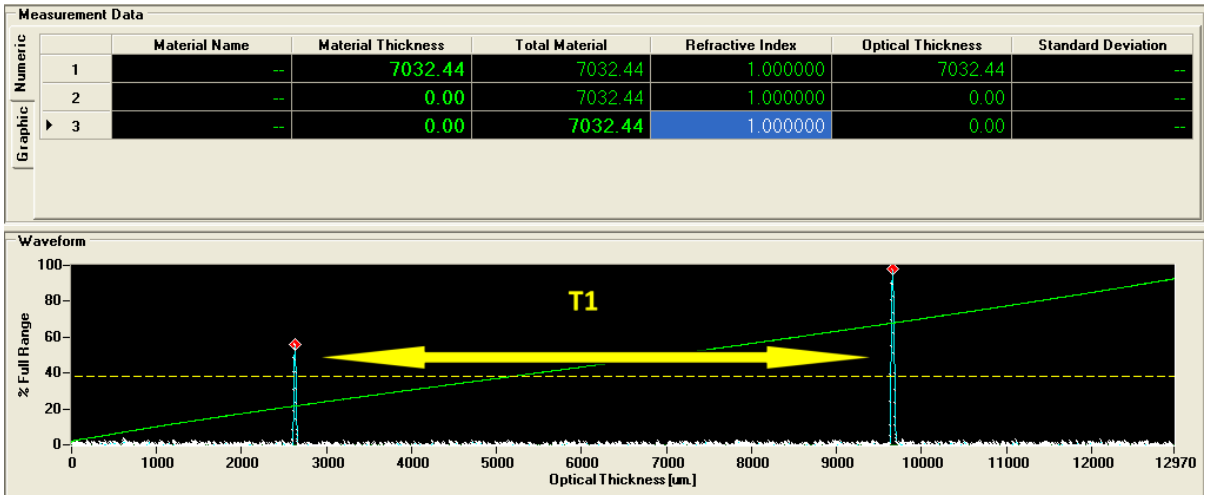


Figure A-5 : T1

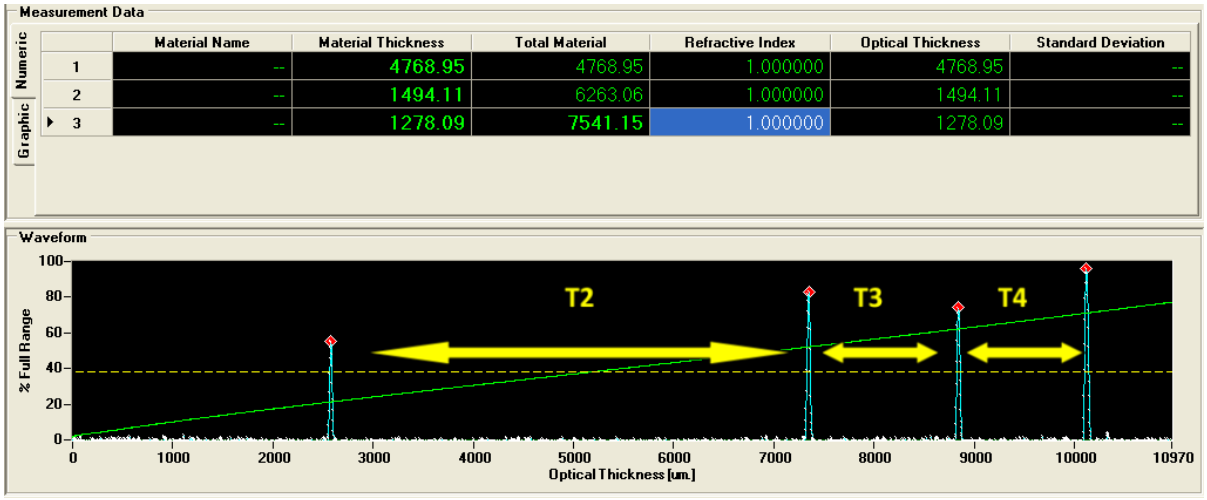
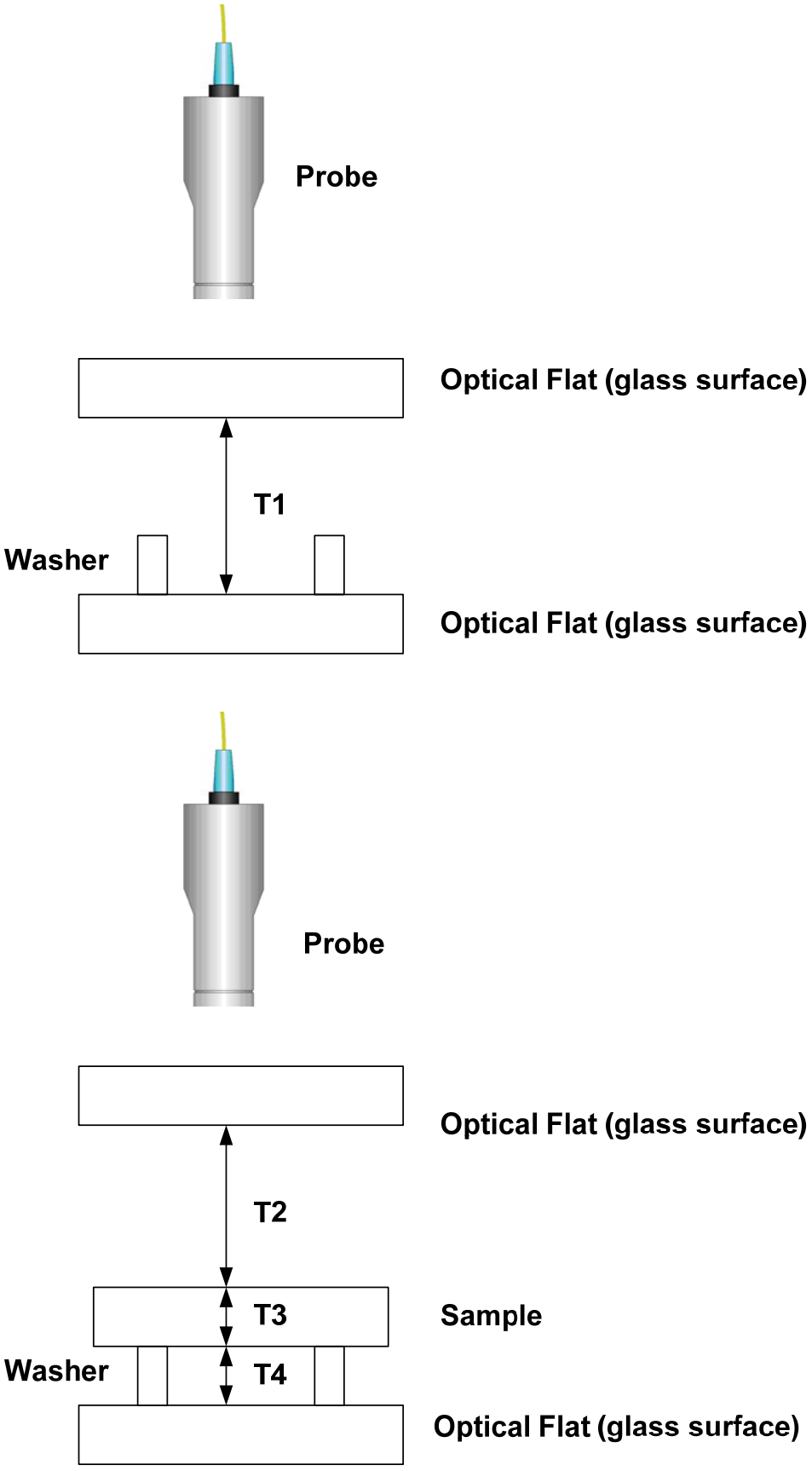


Figure A-6 : T2 – T4

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APPENDIX B—HARDWARE MAINTENANCE

The OptiGauge system is designed to be a reliable and low maintenance thickness measurement system. With proper care the OptiGauge will run continuously for years. This section describes maintenance tasks that you can use to keep your system running smoothly, and to resolve minor difficulties before they become a problem to operation of the machine.

B.1.0 Fiber Cleaning

In order to make accurate measurements it is essential that the fiber optic connectors are clean and dry. It is extremely important to clean the fiber optic connector before each connection. Dirt or other contaminants on the fiber tip can degrade the reliability of the measurements and cause permanent damage to the connector. Protective fiber caps should be placed on unused fibers.

To clean the end of the fiber, use the fiber cleaning tool shipped with the OptiGauge. Follow the directions printed on the cleaning tool:

Fiber Cleaning Instructions:

1. Advance Cloth to expose a clean surface. Tear off Excess material.
2. Move connector end face over the cloth using a figure-8 motion.
3. After three figure-8's, inspect the end face. Repeat if needed.
4. Six connectors may be cleaned before advancing cloth.

It is also important to clean the input fiber female connector on the back of the OptiGauge. This is done using the 2.5mm wrapped foam swabs included with the OptiGauge. These swabs are Q-tip® like swabs that are inserted into the connector to clean the inside. Additional connector swabs and fiber cleaners may be purchased from Lumetrics, Inc.

B.2.0 Probe Care

The Probe is a delicate optical instrument. Please handle it with care during mounting and operation. Carefully uncoil fiber optic cables provided, avoiding any kinks or knots. Do not pinch, fold, or sharply bend the fiber optic cable. Standard probes include a 3-meter cable that is permanently attached. Do not attempt to remove the cable. The probe cable may be connected directly to the OptiGauge, or if additional length is required, a single patch-cord and coupler may be used. Standard patch-cord lengths are 5 or 10 meters. Custom lengths are available if necessary. Please use the following guidelines when handling the probe and optical fiber:

I. Never disassemble the probe. Disassembling the probe will void the warranty.

II. Do not overstretch the Optical Fiber. Overstretching the fiber will cause additional stress and breaks.

III. Do not bend the Optical Fiber less than 2 inches in diameter. Doing so will cause the fiber to break.

IV. Never disconnect the fiber from the back of the probe.

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V. Do not cut the fiber.

VI. Use rubbing alcohol or non-acetone based lens cleaner and a lens cloth to clean the lens with smooth, circular motions

Please contact Lumetrics, Inc. for further details.

B.3.0 System Verification

The OptiGauge system uses an internal laser reference that continuously calibrates the equipment for optimal accuracy. For customers requiring thickness verification checks on their OptiGauge equipment, Lumetrics, Inc. provides a self-contained verification probe (part # 13000-00) to ensure that the system is measuring properly. The verification probe contains a built-in glass sample with a known thickness.

The verification probe includes a certificate documenting its optical thickness value.

To use the verification probe, proceed as follows:

1. Carefully clean & connect the fiber connector of the verification probe to the OptiGauge.
2. Open the OptiGauge Control Center software.
3. On the System Configuration tab:
    a. Start Point = 1
    b. Range = 12000 microns or .472 inches
    c. LED level = 4
    d. Threshold = 30
    e. Peak Width = 8
    f. Noise Reduction = 5
    g. Set Sample Averages to 50.
    h. Set Units to microns or inches
    i. Set Layers Displayed to 1.
4. In the Measurement Data window, select the numeric data tab, set the Refractive Index to 1.
5. Auto Zoom the Waveform Window by right clicking the mouse and selecting Auto Zoom. The Waveform window should look like the diagram below.

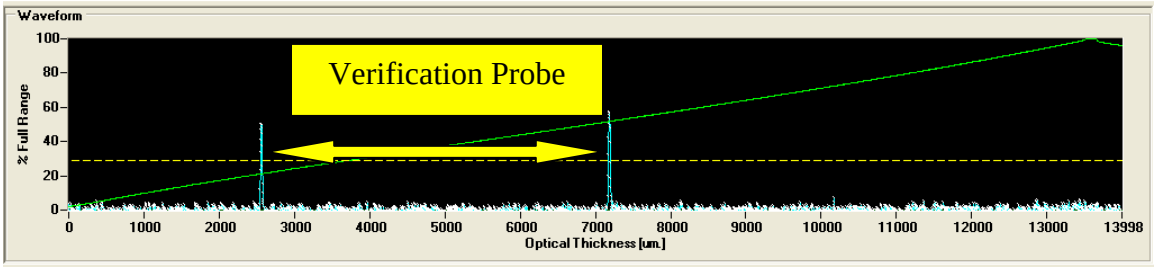


Figure B - 1 Verification Probe

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6. If needed, the LED level should be adjusted such that the standard deviation in the numeric tab is reading its lowest value (less than or equal to 0.1).
7. Compare thickness value to verification probe certificate.

If the LED level is increased beyond the recommended value, erroneous peaks will appear on the waveform graph. Please raise the threshold to only include the two tallest peaks and ignore the erroneous peaks.

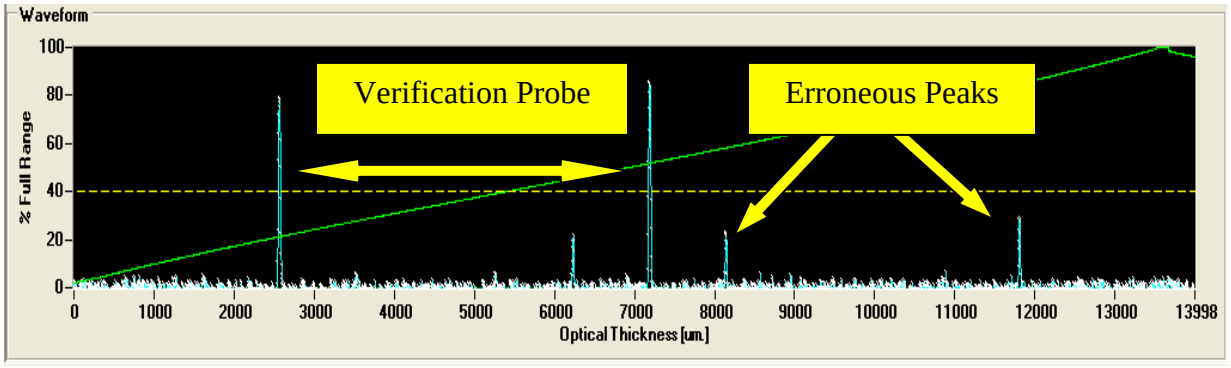


Figure B - 2 Erroneous Peaks

B.4.0 Cleaning Filter on OptiGauge Controller Unit

Contact Lumetrics, Inc. for details.

B.5.0 Fuse Replacement

When a fuse blows, an attempt should be made to find the cause of the failure before replacing it. A surge on AC power lines or nearby lightning activity can cause a fuse to blow, but it may also be caused by a short circuit or over-current condition in the equipment itself. If a fuse continues to blow, contact Lumetrics, Inc. Technical Support for assistance. Fuses should only be replaced with fuses of the same size and rating. Follow these steps below and Figure B-1 to change the fuse:

1. Remove power cord.
2. Pry door open at socket.
3. Lift and swing door into socket.
4. Lift fuse holder out of housing.
5. Install one (1) AG fuse or two (2) metric fuses*.
6. Replace fuse holder into housing.
7. Swing and snap door back in place.

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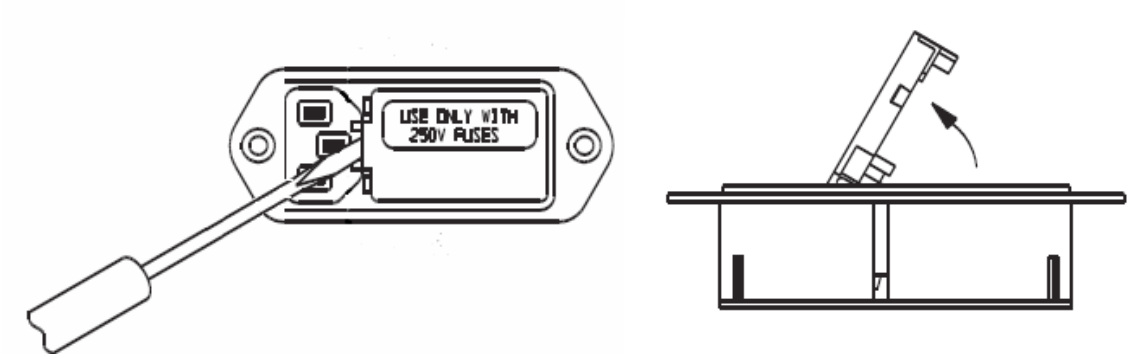


Figure B-3. Fuse Replacement

Fuse Rating: **5A, 250V**

Unit requires One ¼" x 1-¼" fuse OR two 5x20mm fuses

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APPENDIX C—TROUBLESHOOTING

OptiGauge Controller does not turn on

I. Verify that the power cord is plugged into a surge protector and firmly connected to the back of the OptiGauge controller.
II. Locate the black power switch on the back of the controller and confirm that the switch is in the “on” position.

OptiGauge does not turn on

I. Confirm that the power cord is plugged into a surge protector and firmly connected to the back of the OptiGauge.
II. Make sure the front panel mounted power switch is in the “on” position.

Monitor does not turn on

I. Make sure the power cord is plugged into a surge protector and firmly connected into the monitor.
II. Confirm that the monitor cable is plugged firmly into the back of the monitor and hand tighten the screws until firmly seated.
III. Verify that the monitor cable is plugged firmly into the motherboard on the controller.
IV. Press the power button, an orange light will appear if the Controller is off and a green light will appear if the Controller is on.

OptiGauge Control Center software does not start

I. Shut down the “LM” Services and restart the software.
    - Close OCC software
    - Select “Start”
    - Select “Run”
    - Type “services.msc” and click “OK”
    - Find and select “LMConfig”
    - Click the stop button to stop the service. LMConfig should stop all LM services
    - Confirm all LM services have been stopped
    - Wait 60 seconds minimum
    - Open OCC
II. Only one version of the OptiGauge software is allowed to run at a time. If there are two versions open, close both versions and open the desired OptiGauge software.

The red dot does not appear when the OptiGauge is on

I. Depress the red button on the back of the OptiGauge.
II. Disconnect the optical fiber from the rear of the OptiGauge and carefully clean it with fiber cleaner. Reconnect the optical fiber and ensure that the connecter is correctly seated in the OptiGauge.

There is no signal in the waveform graph

I. Carefully clean the optical fiber tip with optical fiber cleaner.
II. Please refer to User Guide sections:
    a. 4.1 Aligning the Probe
    b. 4.2 Finding a Signal and Optimizing Probe Alignment
    c. 4.3 Setting the Measurement Window

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III. Right click on the Waveform window and confirm that the “Plot Processed Signal” is checked.
IV. Shut down the OptiGauge software. Turn off the OptiGauge; disconnect the DAQ cable from the OptiGauge and the controller. Carefully reconnect the DAQ cable to the controller. Ensure that the cable is plugged firmly into the controller and hand tighten the screws until they do not turn. Carefully plug the other end of the DAQ cable into the OptiGauge and ensure that it is firmly connected to the OptiGauge and hand tighten the screws until they do not turn. Turn on the OptiGauge and restart the controller.
V. If the optical cable was sharply bent at any point, it is possible that the internal glass fiber broke and needs to be replaced. Please contact Lumetrics, Inc.

A Saved Data File Cannot Be Located

I. Follow the filename path in the data collection tab to locate the file.

There are two different waves (signals) on the waveform graph

I. Drag the mouse over the waveform graph. Right click to display the drop down menu, verify that processed signal is check marked. Uncheck the unprocessed signal if it is checked

The total thickness is correct, but the individual layers are not being displayed

I. Lower the peak width setting until the layer appears on the waveform graph and data measurement window.
II. Adjust the numbers of layers displayed appropriately.
III. Lower the Threshold to include all visible peaks.

The Measurement Data window is not displaying the desired Column

I. Right click in the Measurement Data window; scroll down to choose columns, select desired column.
II. Select the desired tab and drag to the left or right to change the column position.

The OptiGauge does not collect data when the space bar is selected for Data Collection

I. Select the space bar option in the Data Collection tab. Ensure that a green indicator is displayed on the menu toolbar. If the indicator is red, re-select space bar.

Data is not streaming to the RS-232 port

I. In the data collection tab, ensure that the RS-232 option is selected under “Data Output”.
II. Refer to section 6.3.3. Ensure that the correct cable (Null Modem Cable) and correct settings are being used.
III. Streaming data can also be tested by opening a hyper terminal between the OptiGauge and the system receiving the data. Please follow these steps to test the RS-232:
    1.) Connect the OptiGauge controller to the hardware device that is receiving the data.
    2.) Under data collection, select the RS-232 option under Data Output. Start recording data.
    3.) On the receiving computer, select Start -> All Programs -> Accessories -> Communications -> Hyper Terminal.
    4.) Enter in a name for the connection (ex. Test1, test2, etc). Select ok.
    5.) Ensure that COM1 is selected under “Connect Using:” Select ok.

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6.) Enter in the following settings: Bits per second: 115200, Data bits: 8, Parity: None, Stop Bits: 1, Flow Control: Hardware. Select ok.
7.) The hyper terminal should start receiving thickness measurements from the OptiGauge.

If the information provided in this troubleshooting guide does not resolve the issue, please contact Lumetrics, Inc.
Please email the error log along with a description of the issue. The instructions for obtaining the error log can be found below.
Contact information can also be found below.

To obtain the error log:

1. Select Start -> All Programs -> OptiGauge -> Event Viewer
2. Select OptiGauge Control Center in the left screen.
3. Select Action -> Save File Log As…
4. Select an appropriate name and save.
5. Send the file to **support@lumetrics.com** with a description of the issue.

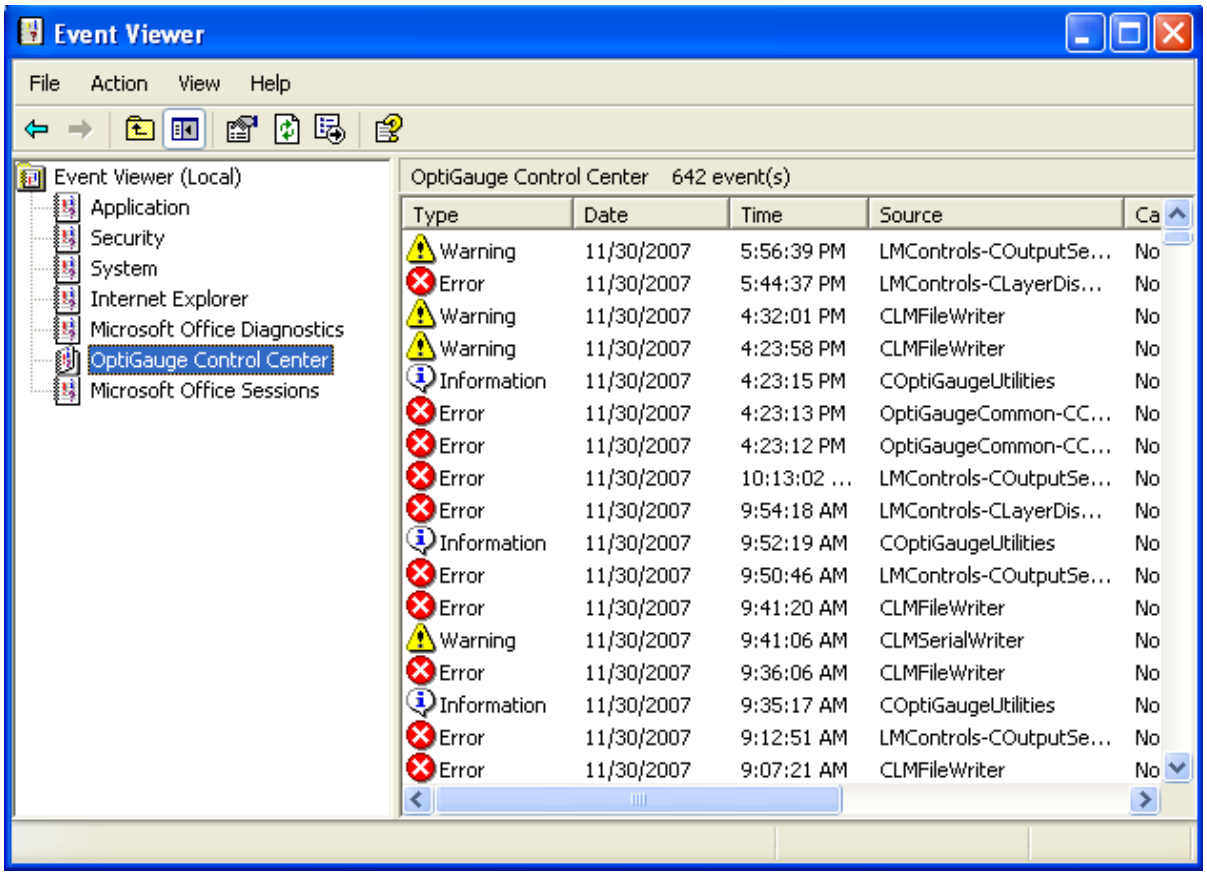


Figure C-1. Event Viewer

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APPENDIX D—TECHNICAL SPECIFICATIONS

OptiGauge Specifications—General

Characteristic	Specification	Explanation
Optical Thickness Range[1]	18µm to 12mm (0.7mils to 0.472")	Total range of optical thickness values that can be measured.
Optical Thickness Accuracy[2]	±0.1µm (±0.004 mils)	Measurement uncertainty of absolute optical thickness value.
Optical Thickness Resolution[3]	0.1µm (0.004 mils)	Minimum optical thickness difference that can be detected.
Measurement Frequency	≤ 50 Hz	Number of measurements (data points) per second.

OptiGauge Environmental Specifications

Operating Temperature:	15º to 30ºC (59º to 86º F)*
Non-Operating Temperature	-15º to 60º C (5º to 140º F)
Operating Relative Humidity	10 to 90% (non-condensing)
Maximum Altitude	2000 meters (6560 Ft.)

* Published accuracy at temperature range 20º to 30ºC

Probe Specifications—50 mm (Part No. 13000-50)

Optical:

Focal Length	50mm (1.97")
Numerical Aperture	0.031
Cone Angle	3.5°
Spot Size	41µm (0.0016")
Angular Tolerance[4]	± 1°

[1] Maximum range may vary from unit to unit.
[2] Under ideal measurement conditions
[3] This value represents one standard deviation for measurements at maximum signal-to-noise ratio.
[4] Angular Tolerance is dependent on sample material and OptiGauge hardware settings

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Mechanical:

Working Distance	48.8mm (1.92”)
Maximum Operating Temperature	85° C (185° F)
Housing Material	Nickel Plated Aluminum
Lens Materials	Corning EC0500, Schott BK7
Maximum Outside Dimensions[5]	Ø21.6mm x 78.2mm (Ø.85” x 3.08”)
Weight	49.8 g (1.76 oz)

Fiber Optic Cable:

Minimum Bend Diameter	50.8mm (2”)
Optical Fiber	Corning SMF-28 Single Mode
Connector	FC/APC
Pigtail Length	3m (118”)
Cable Diameter	3mm (0.12”)
Maximum Cable Length	1000m (3281 ft)

[5] Does not include fiber optic cable

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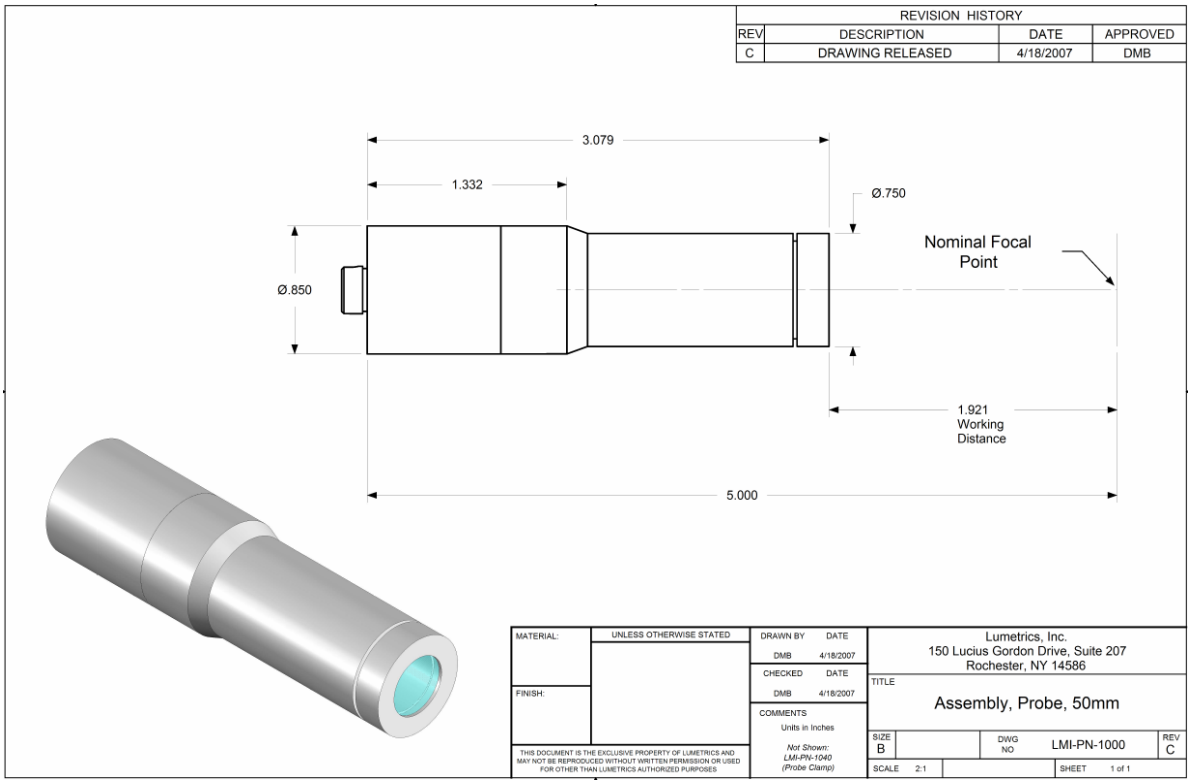


Figure D-1 Probe Assembly, 50 mm, View 1

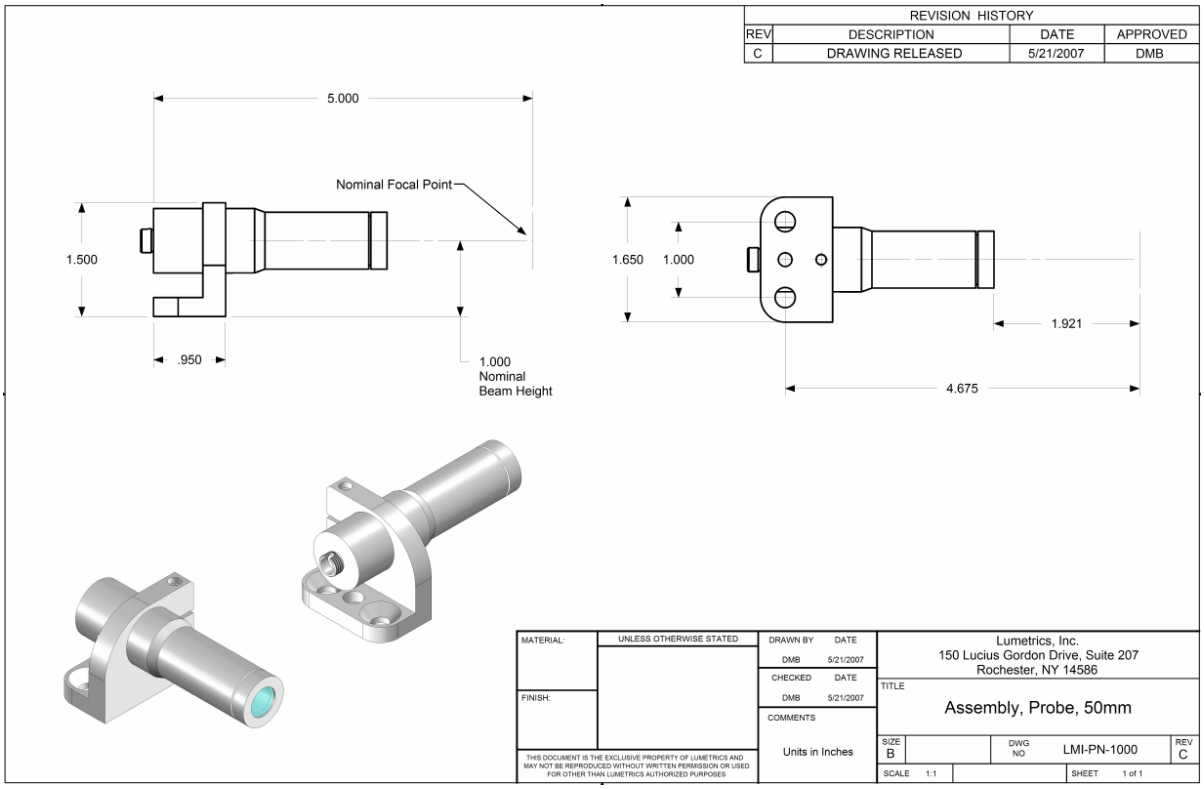


Figure D-2 Probe Assembly, 50 mm, View 2

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Probe Specifications—25 mm (Part No. 13000-25)

Optical:

Focal Length	25mm (0.98”)
Numerical Aperture	0.062
Cone Angle	7.1°
Spot Size	20µm (0.0008”)
Angular Tolerance[6]	± 2°

Mechanical:

Working Distance	19.8mm (0.78”)
Maximum Operating Temperature	85° C (185° F)
Housing Material	Nickel Plated Aluminum
Lens Materials	Corning EC0500, Schott LAKN22 & SFL6
Maximum Outside Dimensions[7]	Ø21.6mm x 104.3mm (Ø.85” x 4.11”)
Weight	62.3 g (2.20 oz)

Fiber Optic Cable:

Minimum Bend Diameter	50.8mm (2”)
Optical Fiber	Corning SMF-28 Single Mode
Connector	FC/APC
Pigtail Length	3m (118”)
Cable Diameter	3mm (0.12”)
Maximum Cable Length	1000m (3281 ft)

[6] Angular Tolerance is dependent on sample material and OptiGauge hardware settings
[7] Does not include fiber optic cable

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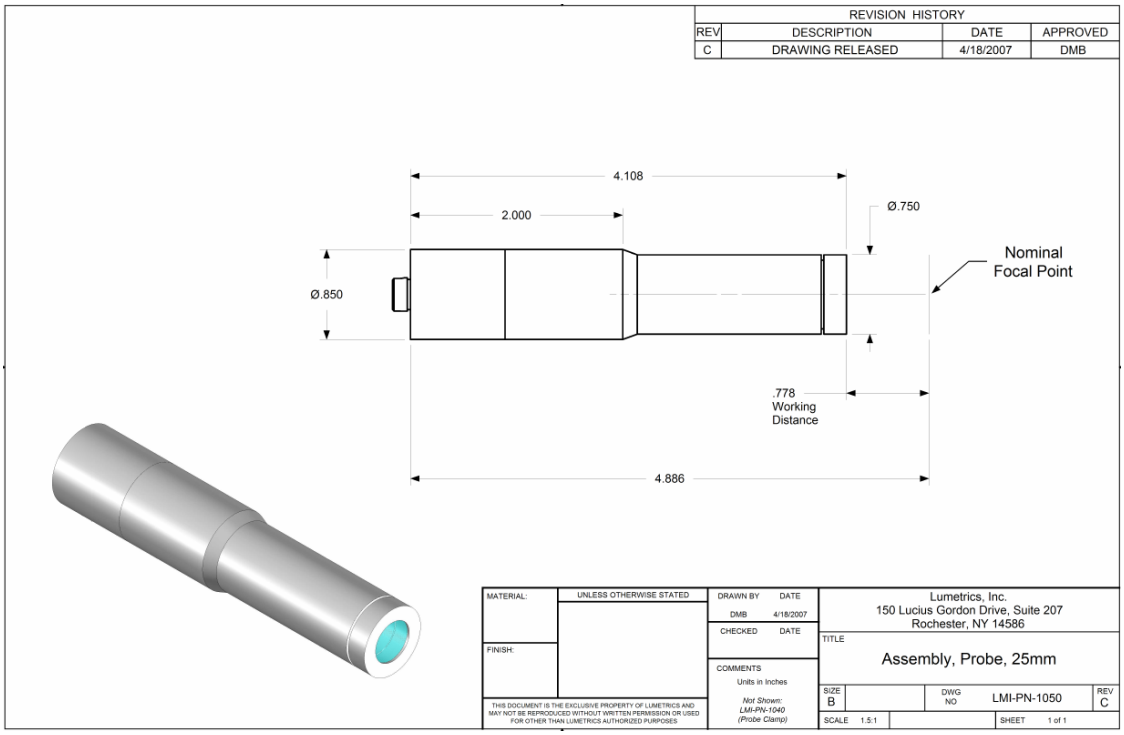


Figure D-3 Probe Assembly, 25 mm, View 1

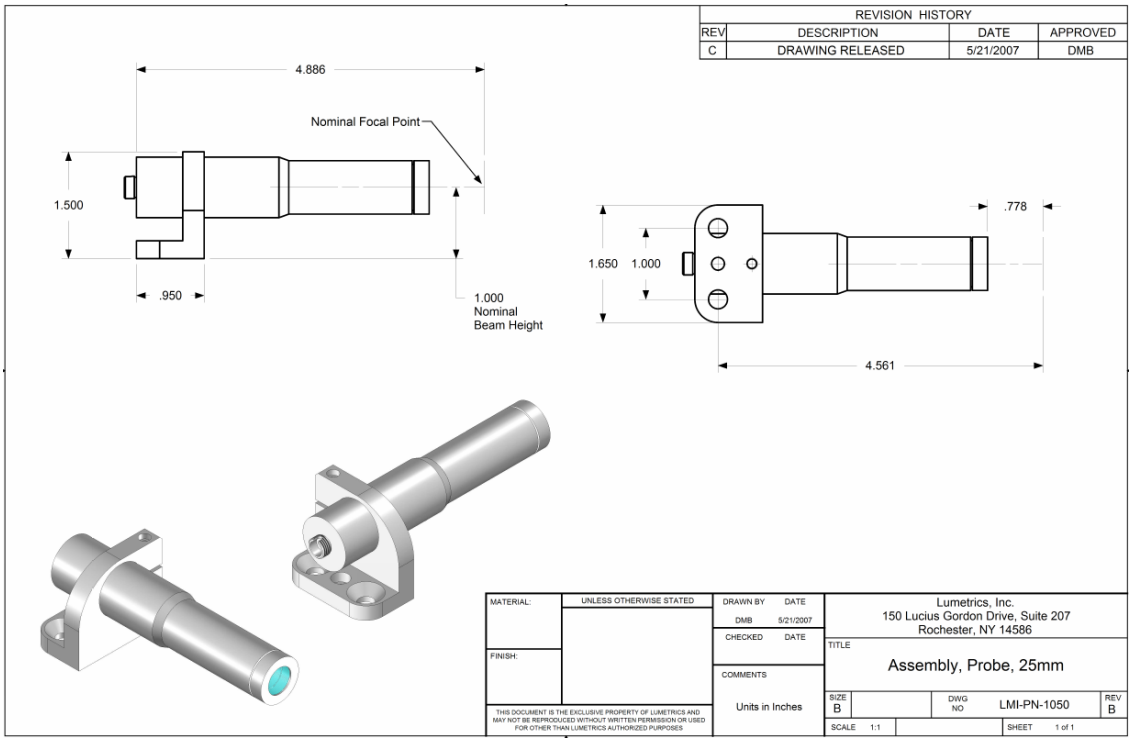


Figure D-4 Probe Assembly, 25 mm, View 2

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Probe Specifications—50 mm Sealed (Part No. 13000-12)

Optical:

Focal Length	50mm (1.97”)
Numerical Aperture	0.031
Cone Angle	3.5°
Spot Size	41µm (0.0016”)
Angular Tolerance[8]	± 1°

Mechanical:

Working Distance	48.8mm (1.92”)
Maximum Operating Temperature	85° C (185° F)
Housing Material	316 Stainless Steel
Lens Materials	Corning EC0500, Schott BK7
Maximum Outside Dimensions[9]	Ø21.6mm x 79.8 mm (Ø.85” x 3.14”)
Weight	49.8 g (1.76 oz)

Fiber Optic Cable:

Minimum Bend Diameter	50.8mm (2”)
Optical Fiber	Corning SMF-28 Single Mode
Connector	FC/APC
Pigtail Length	3m (118”)
Cable Diameter	3mm (0.12”)
Maximum Cable Length	1000m (3281 ft)

[8] Angular Tolerance is dependent on sample material and OptiGauge hardware settings
[9] Does not include fiber optic cable

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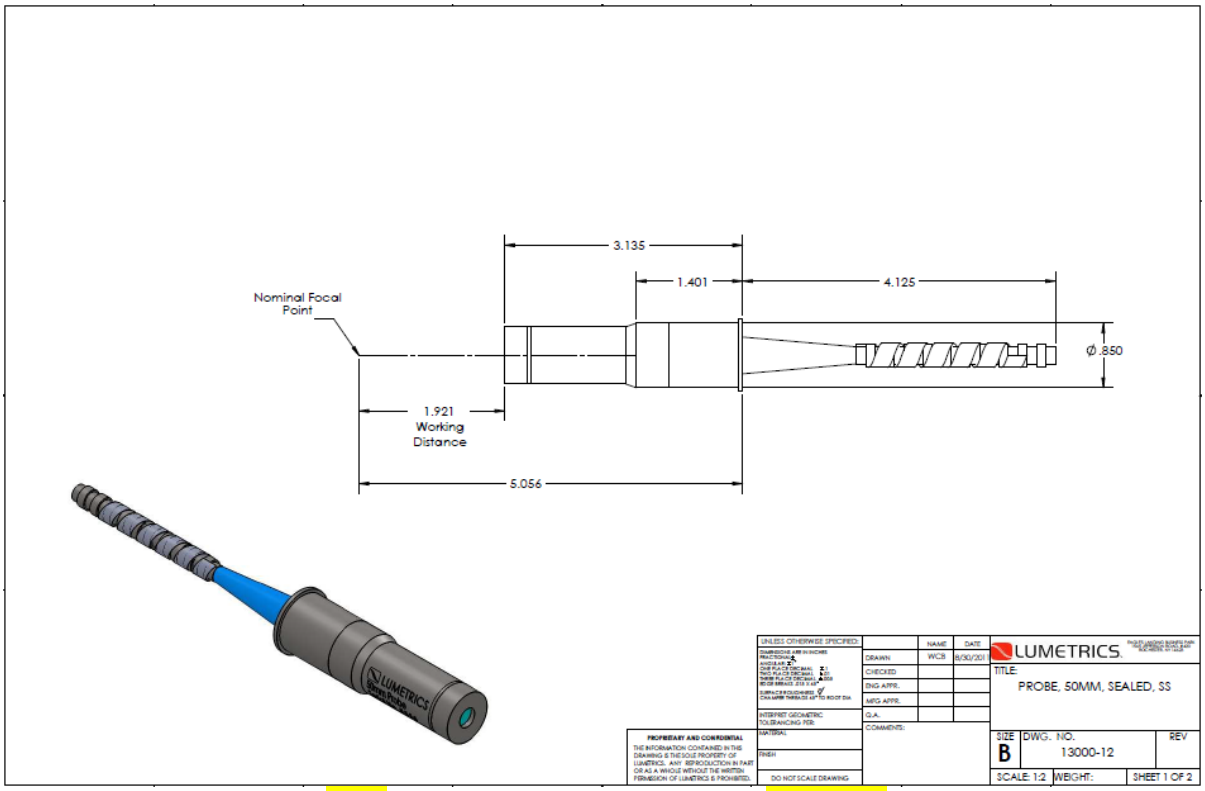


Figure D-5 Probe Assembly, 50 mm Sealed, View 1

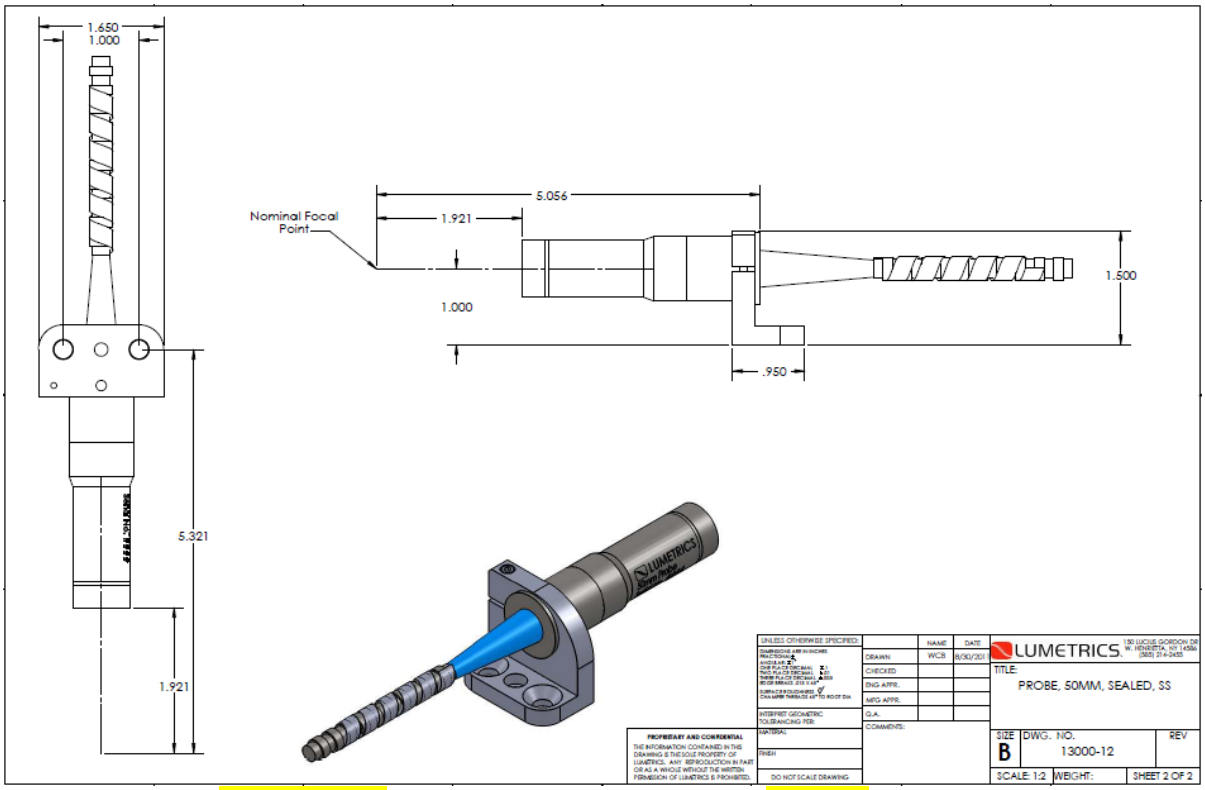


Figure D-6 Probe Assembly, 50 mm Sealed, View 2

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Optical Switch Specifications

Contact Lumetrics, Inc. for details.

APPENDIX E—TERMS & ABBREVIATIONS

If you are new to optical measurement systems, some of the terms used to describe this technology may be unfamiliar to you. Table 2 lists many of these terms and will prove helpful in understanding the operation of the OptiGauge system.

Table E-1 List of Terms, Acronyms, & Abbreviations

Term / Abbreviation	Definition
λ	Wavelength
µm	Micron/micrometer ($1x10^{-6}$ meters or 0.001mm)
ADC	Analog to Digital Conversion
CWL	Center Wavelength
DAC	Digital to Analog Conversion
DAQ	Digital Acquisition
FWHM	Full Width Half Maximum
mil	0.001 inches
mm	Millimeter (0.001 meters)
N	Refractive Index
Nd	Refractive Index @ λ=587.6nm (Sodium d-Line)
Ng	Group Index of Refraction @ CWL=1310nm (FWHM = 50nm)
nm	Nanometer ($1x10^{-9}$ meters or $1x10^{-6}$ millimeters)
SLED	Super-luminescent Light Emitting Diode
WDM	Wavelength Division Multiplexer

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IN CASE OF DIFFICULTY…

If you have difficulties or questions pertaining to the OptiGauge system, please contact Lumetrics, Inc. at the numbers provided below, or write to the following e-mail address: **support@lumetrics.com**

TECHNICAL ASSISTANCE

Technical assistance for Lumetrics, Inc. products is available during business hours (8:00 A.M. to 5:00 P.M. Eastern Time). When contacting us, please include the complete model numbers of the equipment you have, and a description of the trouble symptom(s) you are experiencing. Often, difficulties can be resolved over the telephone, without the need for returning the equipment to Lumetrics, Inc.

The software release notice contains specific information about the development of the system. It is included on the installation CD. To retrieve the file, explore the CD and open the file named ReleaseNotice.doc.

Please use these telephone numbers for product assistance:

(585) 214-2455 ext. 123 (Phone) (585) 214-2458 (FAX)

FACTORY REPAIRS

Component level repair of Lumetrics, Inc. equipment is not recommended in the field. The equipment should be returned to the factory for any PC board repairs. The factory is best equipped to return your equipment to its proper specifications and ensure highly accurate measurement results.

If return of equipment is needed, a Returned Material Authorization (RMA) number will be issued. This number will help expedite the repair and ensure that your equipment is returned to you as soon as possible. Please include the RMA number on all correspondence related to the repair. A statement should accompany the equipment describing the problem(s) experienced, as well as the name of a person who can be contacted if there are further questions.

Equipment being returned for repair must be properly packed for shipping. The original shipping materials should be used when possible, or a durable container capable of supporting the weight of the equipment. All returns should be returned to:

Lumetrics, Inc.
Technical Support Dept.
(RMA No.)
Eagle's Landing Business Park
1565 Jefferson Road #420
Rochester, NY 14623

After repairs have been made, the equipment will be returned to you by the same shipping method used to send it to the factory. Please specify if you wish to make different shipping arrangements.

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Company Name:
Contact Name and Phone:
Contact Name E-Mail:

Thank you for contacting Lumetrics, Inc. customer service. Included is your Return Material Authorization number.

RMA Number: **RMA-**

Return Address:

Lumetrics, Inc.
150 Lucius Gordon Drive
Suite 117
West Henrietta, NY 14586
Attn: **RMA-**

Important Return Instructions:

- Include a copy of this form with your return shipment.
- Ship any returns in proper packaging (if possible, use the original packaging). Please ship UPS Worldwide Expedited.
- Please note this return is for a **repair** and should be notated on all shipping documentation. Please adjust invoice totals accordingly to reflect this.
- Write the RMA number clearly and visibly on the outside of the box.
- All RMA numbers are valid for 30 days only.

If you have any questions or concerns regarding this return, please do not hesitate to contact us. Our phone number is (585) 214-2455. Thank you for your patience and understanding.

Best regards,
Quality Assurance Team
Lumetrics, Inc.

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Eagle's Landing Business Park
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