

# PEM200 PHOTOELASTIC MODULATOR

## USER MANUAL



**Hinds Instruments, Inc.**  
P/N: 010-0000-095 UM Rev C

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In all respects, the English version of this manual is controlling.

The PEM200 and PEM-200 are covered by the following US patents: (1) 7,800,845, (2) 7,495,205, (3) 6,970,278, (4) 6,906,844, (5) 6,867,863, (6) 5,886,810, (7) 5,744,721, (8) 5,652,673.

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# Operators' Safety Summary

The general safety information in this summary is for operators of the PEM200 Photoelastic Modulator System. Specific warnings and cautions may be found throughout the manual where they apply, but may not appear in this summary.

If the user sees the exclamation point symbol, they need to consult this section of the user manual.

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## Terms

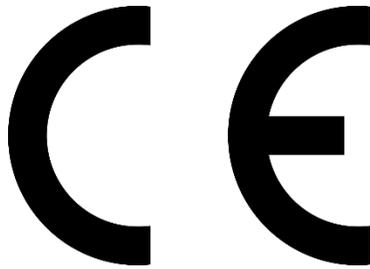
**WARNING** statements identify conditions or practices that could result in personal injury or loss of life.

**CAUTION** statements identify conditions or practices that could result in damage to the equipment or other property.

**NOTICE** statements identify conditions or practices that are important in proper use of the equipment to get the expected results.

---

## PEM-200 Controller Labels



**CE:** The CE certification label is located at the top right corner on the PEM-200 Controller rear panel as shown in figure S.1 below.

The power supply input is labeled with "24V" as well as the DC connection label. See DC Power Source below for details and safety with the power supply.



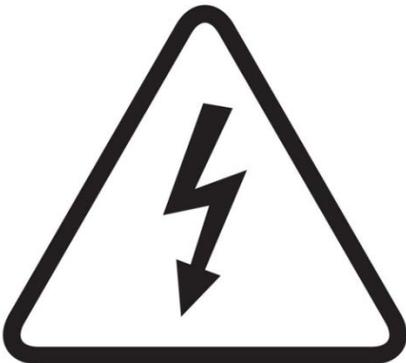


**USB:** The USB label is located above the input of the USB2.0 port for communication with any Windows 7 or newer computer.

**ON/OFF:** The ON/OFF engraving is above the power switch. Ensure the power is off before connecting or disconnecting SMA cables from HV outputs to optical head. More details below.



**WARNING: HARZARDOUS VOLTAGE:**



High Voltage (HV) SMA connectors support hazardous electrical levels, up to 138Vrms. Contact with High Voltage (HV) SMA outputs may cause severe shock or burn. Power off the unit before connecting or disconnecting SMA cables to connectors and optical head.

Avoid contact with SMA cable-ends or connectors other than to connect or disconnect controller to optical head. Always connect or disconnect SMA cables with power off. Do not turn on power until all cables are connected properly.

**WARNING:** Hazardous Voltage



---

## DC Power Supply

This product is intended to operate from a DC power source at 24 VDC. The main power input is 90-264VAC, 47-63 Hz, 1.7A. A protective ground connection by way of the grounding connector in the power cord is required for safe operation. Power line requirements are listed in the specifications section.

The power cord provided with this instrument is less than 3 meters in length. Use only the power cord and connector specified for your product to work with your local power outlets. Use only a power cord that is in good condition.

The appliance inlet or plug on cord should always be positioned to be accessible by the operator. To disconnect all power from the instrument, pull the power cord from the wall outlet or from the appliance inlet. See Operating Space below for detail.

---

## Covers

To avoid personal injury, do not operate the PEM-200 Controller without the cover. There are no user-serviceable parts inside the PEM-200 Controller. High voltages are present within the controller.

With the cover properly installed, impact rating for the PEM200 is 5J.

Only remove the optical head cover as instructed in the unpacking instructions below. Do not remove the cover of optical head for any other reason. Ensure the optical head is disconnected from any SMA cables before removing cover. High voltages can be present otherwise.

Do not remove the cover from the PEM-200 Controller or optical head unless you are being actively supported by Hinds Instruments personnel.

---

## Operating Space

Hinds Instruments suggests leaving 2-3 inches (5-8cm) minimum of space around the PEM-200 controller to allow for safe connection and disconnection of all cables.

Keep liquids of all types away from PEM200, especially if flammable.

---

## Integration & Special Conditions

The integration of the PEM into a measurement system by a customer doesn't involve any change or modification to the PEM's operating electronics. Therefore, the PEM doesn't create any additional safety issues in integration.

Out of range ambient conditions may cause slight degradation in the performance of a PEM including slight frequency shift and reduced stability. Mounting the optical head by any means other than the mount holes described in Section 3 may also lead to these shifts.

---

**Any use of the PEM200 outside of the manufacturer intended use, as specified in this manual, could result in safety impairment.**

---

## **Not Required**

To operate the PEM200, there no requirements for:

- Safety Equipment Accessories
- Pollution Degree
- Ventilation
- Flow of air or cooling liquid
- Permanently connected equipment
- Sound level

# *Unpacking the PEM200*

---

## **Shipping Damage Check**

Inspect all system components for obvious shipping damage. The PEM200 is a precision instrument that can be damaged by rough handling. The units are packaged to minimize the possibility of damage in transit. Therefore, it is recommended that the user save the specially designed shipping container for any future shipment of a modulator unit.

In the event an order arrives in damaged condition, it is important that the following steps be taken immediately. The title transfers automatically to the customer, once the material is entrusted to the transport company.

1. DO NOT RETURN THE INSTRUMENT TO HINDS INSTRUMENTS, INC. until the following steps are completed. Failure to follow this request will jeopardize user claim with the insurance company.
2. If a “Shock Watch” is present on the outer shipping container or anywhere inside, note the location and the condition of the shock watch. If the shipment receives handling rough enough to trigger the shock watch, the watch will turn red.
3. Open the container and inspect the contents. Do not throw away the container or any damaged parts. Try to keep all items in the same condition as originally received.
4. Notify the Transport Company immediately in writing, preferably by facsimile or email, about the shipping damage.
5. Wait for the transport company’s representative to inspect the shipment personally.
6. After inspection, request Hinds Instruments’ permission to return the damaged instrument by calling the service department at (503) 690-2000 or email to [support@hindsinstruments.com](mailto:support@hindsinstruments.com). A return authorization number (RMA) will be assigned to you. See Overview of the PEM200 Help System on page 52 for further contact information.
7. Return approved items to Hinds Instruments Inc. at the following address:  

Hinds Instruments, Inc.  
7245 NE Evergreen Pkwy, Suite 150  
Hillsboro, OR 97124-5850
8. After return permission is given and Hinds Instruments receives the instrument, an estimate of the cost of repair will be sent to you in the event you choose to submit a claim to the transport company.

---

## Packaging Overview

The PEM200 packaging is separated into four sections:

- **Power Supply Unit**
- **Optical Head**
- **SMA Cable Assembly, Power Cable**
- **PEM-200 Controller**



*Figure S.1 PEM200 Photoelastic Modulator in Shipping Case*

---

## Unpacking the PEM Optical Head

### **CAUTION**

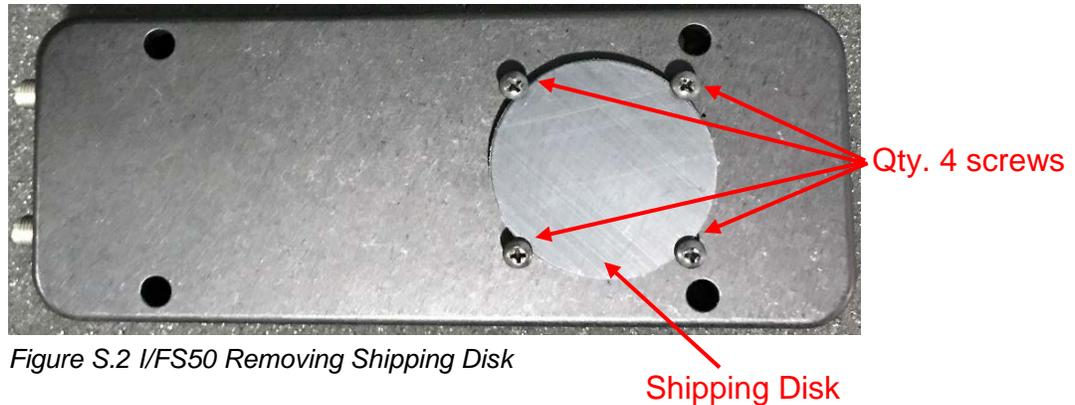
PLEASE USE CARE when unpacking the PEM optical head, for this assembly is very fragile. Please follow the unpacking instructions carefully. Unless this is done, the PEM system will not operate and the optical head may be irreversibly damaged.

---

## Special Instructions for I/FS50 Optical Head

The following unpacking instructions are for an I/FS50 PEM optical head.

- Ensure the work surface is clean and free of dust
- Using a #1 Phillips screwdriver, remove the shipping disk



*Figure S.2 I/FS50 Removing Shipping Disk*

- The alternate side of the Optical Head is covered by tape to prevent dust and other particles from entering the enclosure. This can be easily removed by hand.



*Figure S.3 Removal of White Cover on Optical Enclosure*

- Please save the shipping disk, screws and white cover in the event the PEM needs to be transported.

---

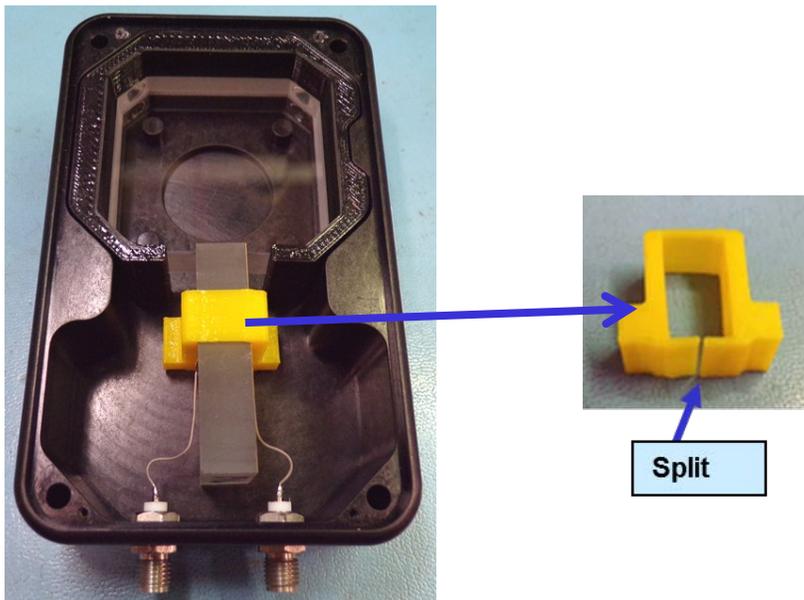
## Special Instructions for Series II Optical Heads

Included in all orders for Series II Optical Heads is a packet outlining instructions for removing the Transducer Safety Clip.

- A Phillips screwdriver has been included in the packet for removal of the outer lid of the optical enclosure
- Please follow the provided instructions carefully to avoid damaging the optical assembly

---

## Series II FS Optical Heads



*Figure S.4 Unpacking II/FSXX Optical Head*

1. Remove the 4 lid screws using the provided screwdriver.
2. Gently pull the yellow clip out. Grab the provided tabs on the lower half of the clip. There is a split in the clip under the transducer. Separate the clip and lift it out from around the transducer. Take care when removing a clip near transducer wires. Save clips for future return or transportation of unit.

**NOTE: DO NOT TURN OPTICAL HEAD OVER WHILE LID IS OFF – OPTICS WILL FALL OUT**

3. Replace lid. Extra screws are provided.

---

## Series II ZS50 & ZS42 Optical Heads

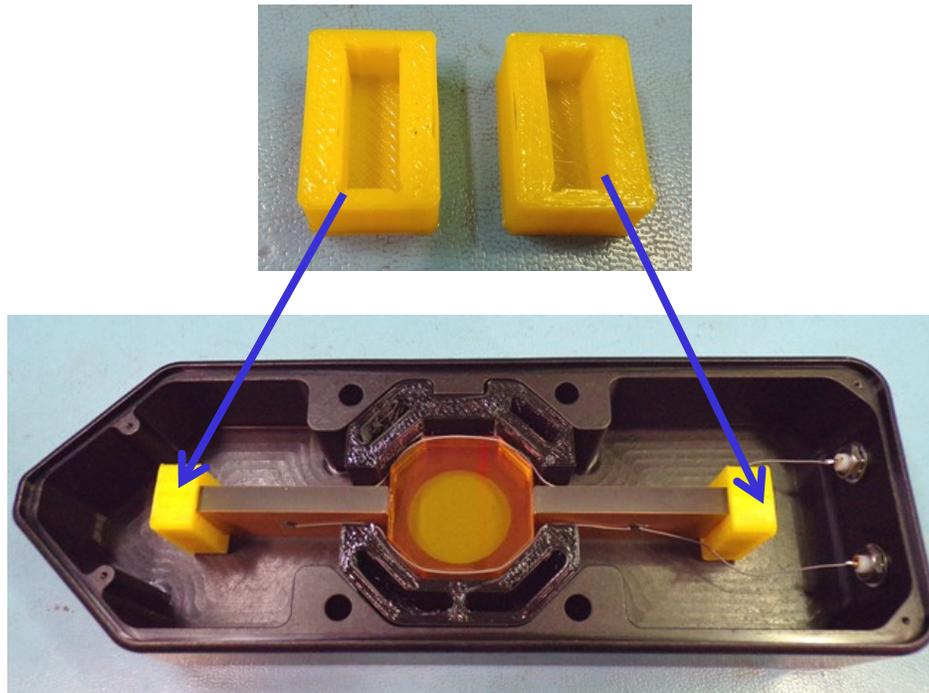


Figure S.5 Unpacking II/ZS50 or II/ZS42 Optical Head

1. Remove the 4 lid screws using the provided screwdriver.
2. Gently pull the yellow clip out. Grab the provided tabs on the lower half of the clip. There is a split in the clip under the transducer. Separate the clip and lift it out from around the transducer. Take care when removing a clip near transducer wires. Save clips for future return or transportation of unit.

**NOTE: DO NOT TURN OPTICAL HEAD OVER WHILE LID IS OFF – OPTICS WILL FALL OUT**

3. Replace lid. Extra screws are provided.

---

## Series II ZS37 Optical Heads

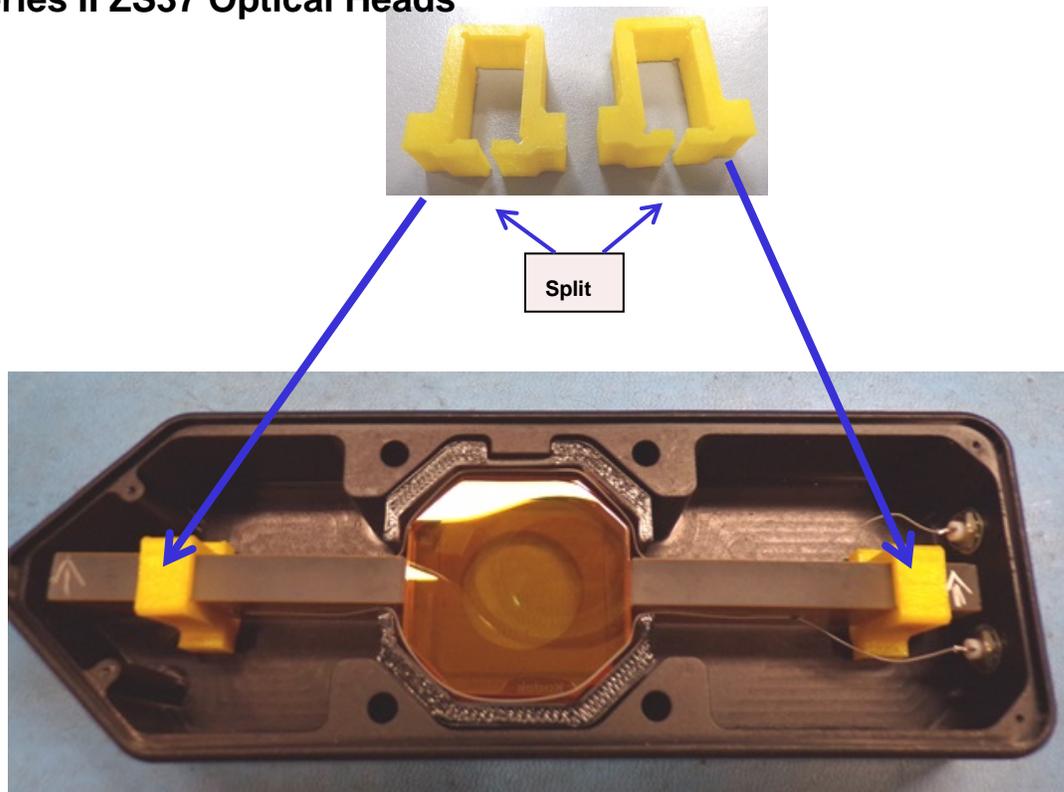


Figure S.6 Unpacking II/ZS37 Optical Head

1. Remove the 4 lidsscrews using the provided screwdriver.
2. Gently pull the yellow clip out. Grab the provided tabs on the lower half of the clip. There is a split in the clip under the transducer. Separate the clip and lift it out from around the transducer. Take care when removing the clip near transducer wires. Save clips for future return or transportation of unit.

**NOTE: DO NOT TURN OPTICAL HEAD OVER WHILE LID IS OFF – OPTICS WILL FALL OUT**

3. Replace lid. Extra screws are provided.

# 1

## Introduction

---

### Overview

The PEM200 Photoelastic Modulator is an instrument used for modulating or varying (at a fixed frequency) the polarization of a light beam. Hinds Photoelastic Modulators are used for measurement of circular and linear dichroism, birefringence, optical rotation, ellipsometry, polarimetry, reflection difference spectroscopy and FTIR double modulation.

The PEM200 principle of operation is based on the photoelastic effect, in which a mechanically stressed sample exhibits birefringence proportional to the resulting strain. Photoelastic modulators are resonant devices, each producing oscillating birefringence at a fixed frequency in the low frequency ultrasound range (20 kHz to 82 kHz). These factors result in a number of very useful advantages, which are unique to the PEM including wide acceptance angle, large aperture and high modulation “purity.”

Figure 1.1 provides an overview of the PEM200 photoelastic modulator system which includes the PEM-200 Controller, Optical Head, and the Head-to-Controller cables.



Figure 1.1 PEM200 Photoelastic Modulator

# PEM-200 Controller

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## PEM-200 Controller Front Panel

The PEM-200 Controller front panel consists of six separate SMA connections:

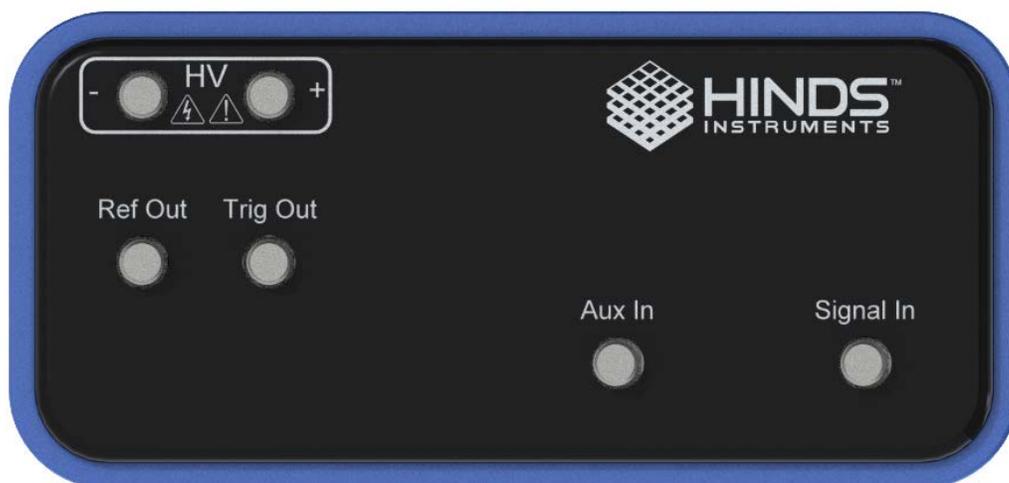


Figure 2.1 PEM-200 Controller Front Panel

**HV:** Two SMAs enclosed in the high voltage (“HV”) box are for interface between optical head and controller. These connections are necessary to drive the PEM optical head. These are the high voltage SMA connections. Please ensure that the PEM200 controller is off or disconnected from power when making any connection with these SMA ports. Order (+/-) does not matter when connecting SMAs from HV output to optical head inputs. See Operators Safety Summary for more detail.

**Ref Out:** The “Ref Out” SMA will give a 3.3V TTL signal at the PEM's selected harmonic frequency for any triggering needs.

**Trig Out:** Trig Out is a second reference SMA reserved for future expansion or custom customer triggering needs upon request.

**Signal In & Aux In:** Additional connections required for synchronous detection options.

---

## PEM-200 Controller Rear Panel

All electrical/electronic connections to the controller are made on the rear panel.

---

### PEM-200 Controller Rear Panel Buttons

- **Power Switch:** The PEM-200 powers using the I/O switch. Push the selector to the “I” position to power ON and “O” to power OFF

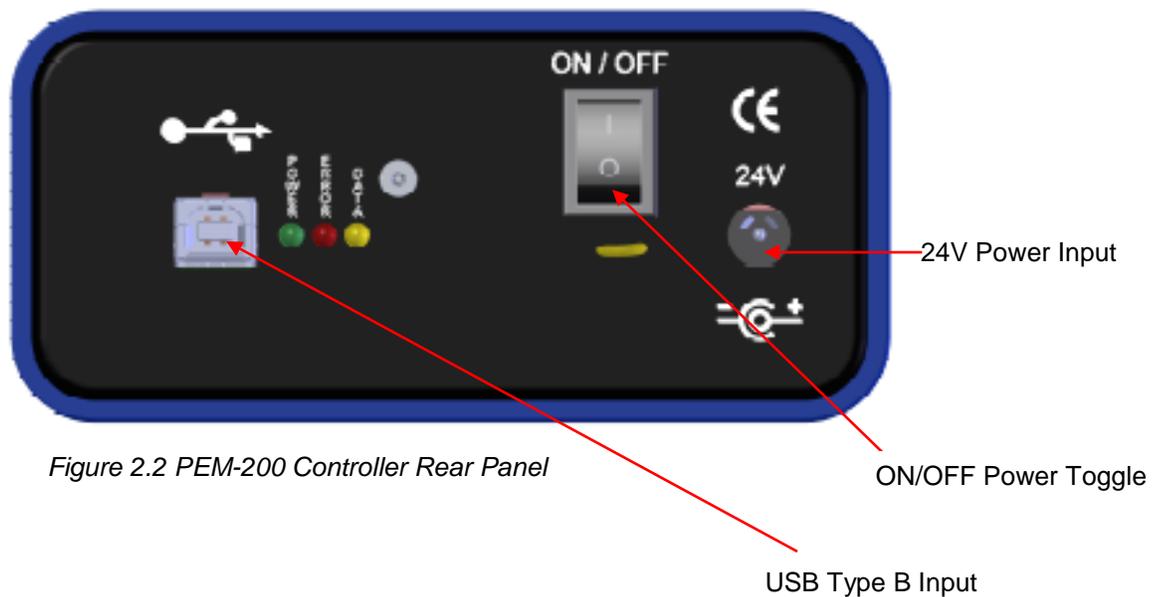


Figure 2.2 PEM-200 Controller Rear Panel

---

### PEM-200 Controller Rear Panel Connections

- **USB Type B Connection:** The USB 2.0 Type B connector interface allows communication to a PC. PEM200 software runs on Windows 7 or 10.
- **24V Barrel Input:** The barrel connection is the input for a 24VDC power brick.

---

## PEM-200 Controller Rear Panel LEDs

- **Power:** Power will illuminate green whenever the PEM200 controller has power and is on.
- **Data:** The yellow data LED will flash anytime there is communication between the PC and PEM-200 controller. It will illuminate if the controller is attempting to detect connection with the PEM optical head, or if the optical head connected is inappropriate match for the controller hardware.
- **Error:** Error (red) will illuminate when the PEM controller reaches a limit of drive voltage. PEM will go into idle state if connected and error occurs. To recover the PEM from an error state, cycle the power on the PEM-200 controller and set the PEM to a lower modulation amplitude.

---

## PEM-200 Controller Dimensions

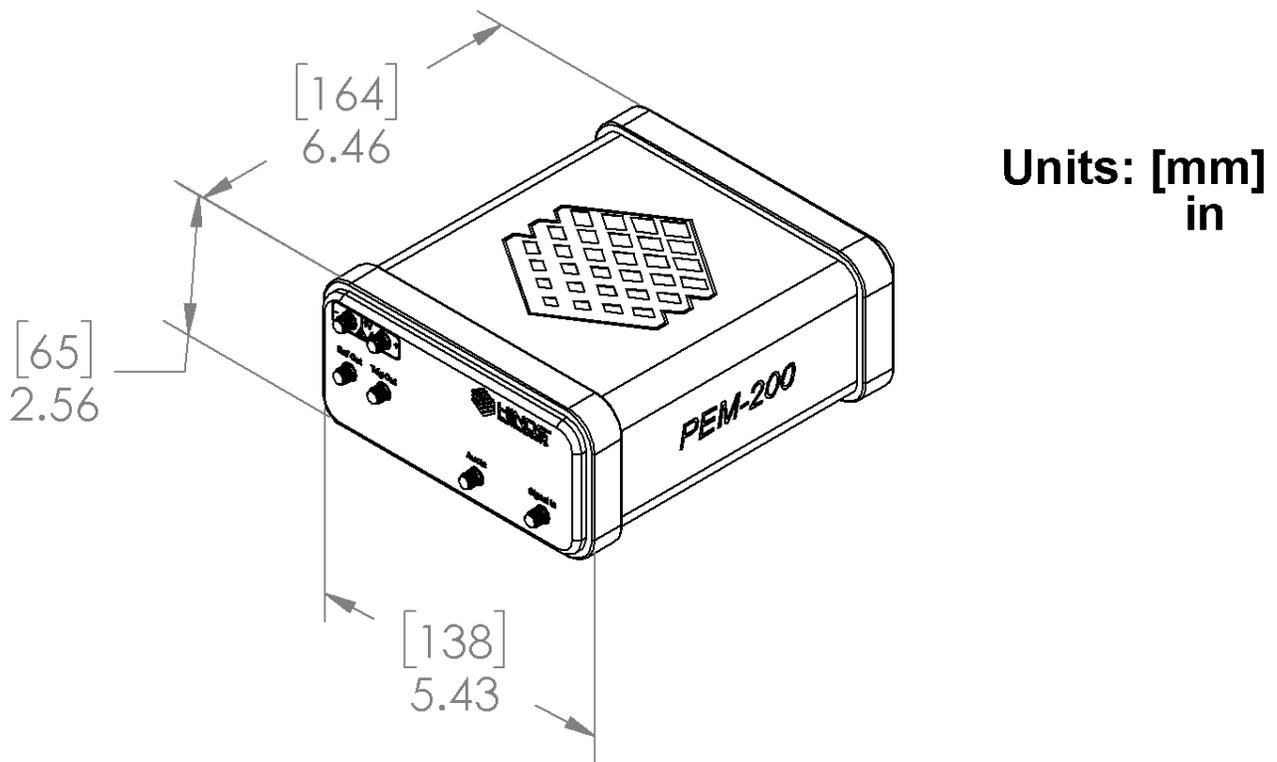


Figure 2.3 PEM-200 Controller

# 3

## Modulator Head Assembly

The transducer-optical element assembly (called the “optical assembly”) is the heart of a PEM200 photoelastic modulator. It consists of a rectangular or octagonal “window” of optical material bonded to a quartz piezoelectric transducer. Both optical element and transducer are tuned to the same frequency. This assembly oscillates and produces the time-varying birefringence which is the basis of operation of the PEM.

This assembly, consisting of the optical head, controller and the cables which connects them, is a single circuit. It is not intended to operate unless all three elements are together.

### CAUTION

Operation of the controller without the optical head attached may result in damage to the controller.

### Optical Head

The Optical assembly is housed in an enclosure called the “optical head.” Figures 3.1 through 3.5 provide dimensions for various optical head types.

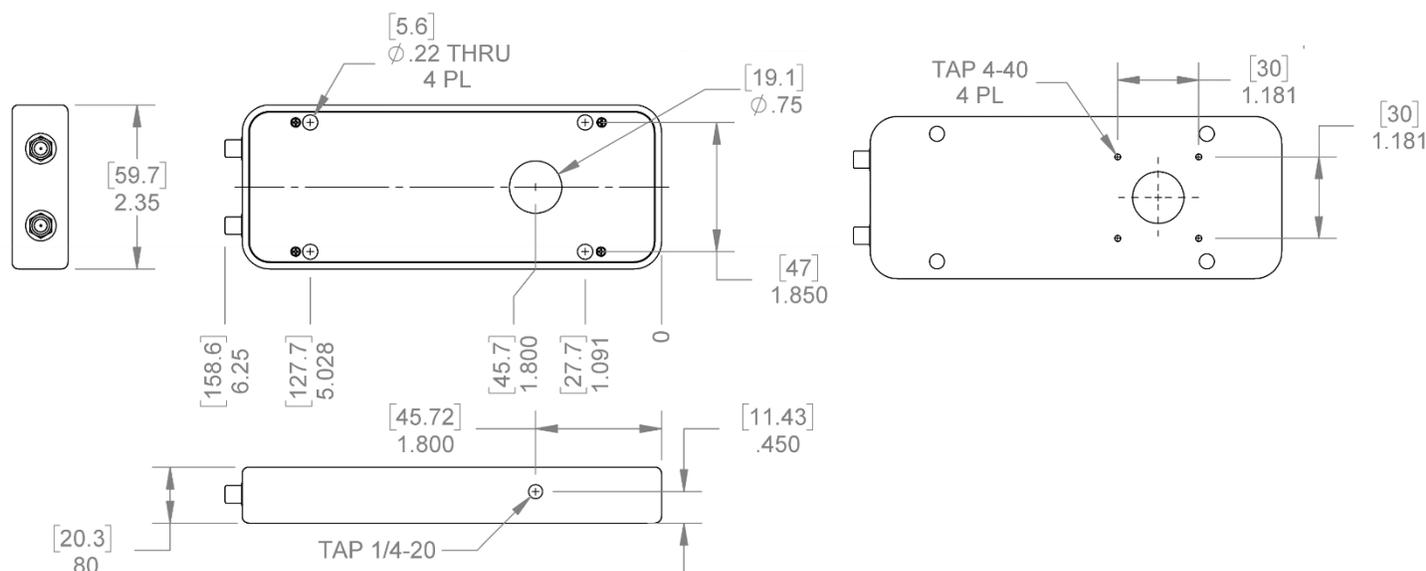


Figure 3.1 Model I/FS40, I/FS50, I/FS60, I/CF50 Optical Head

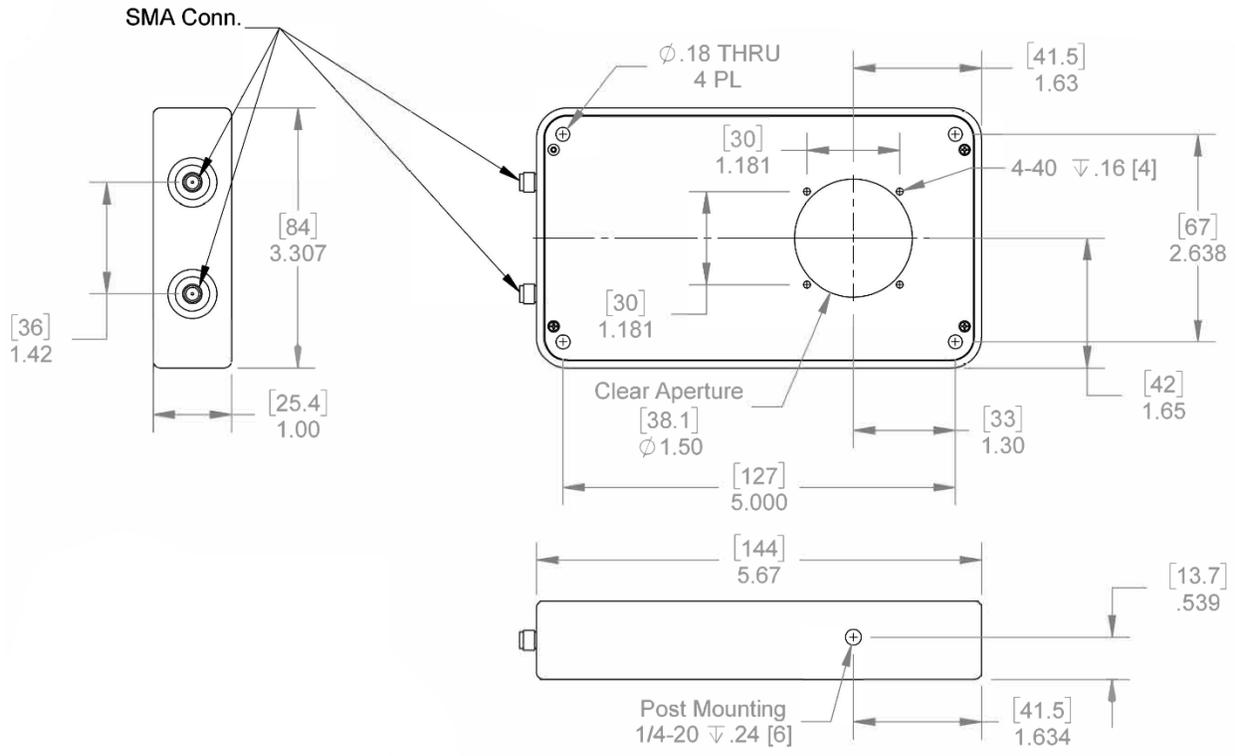


Figure 3.2 Model II/FS42, II/FS47, II/FS50 Optical Head

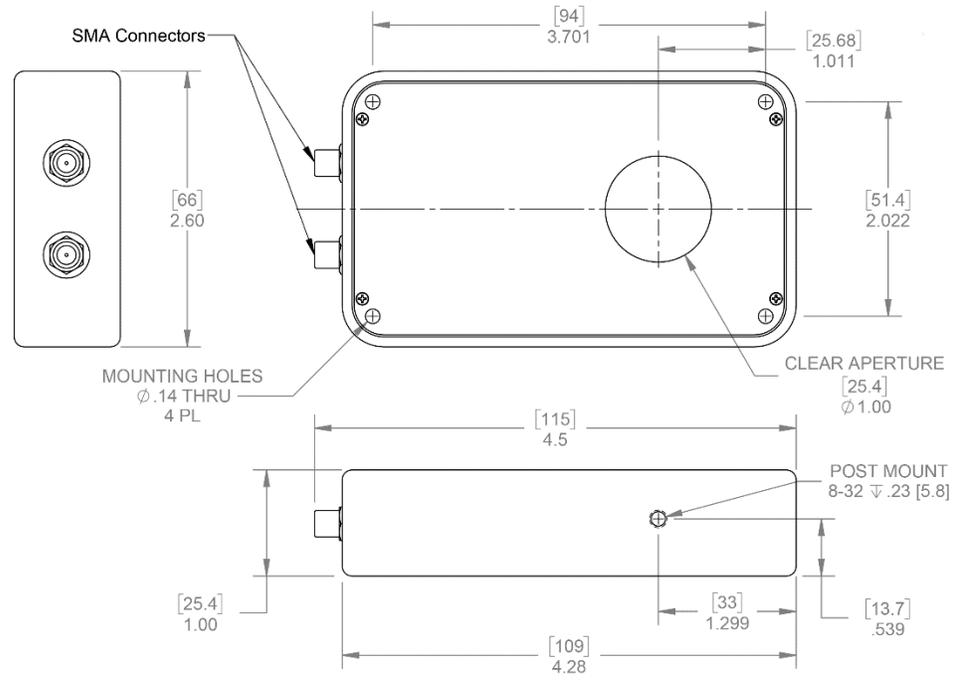


Figure 3.3 Model II/FS55, II/FS60 Optical Head

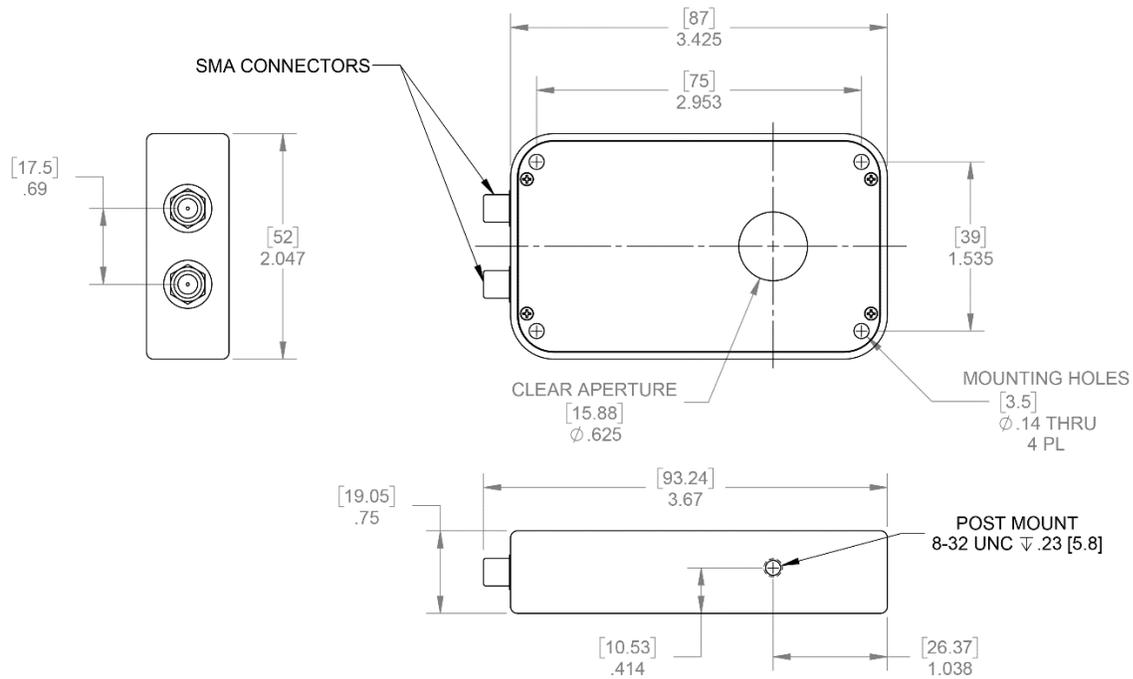


Figure 3.4 Model II/FS74, II/FS84 Optical Head

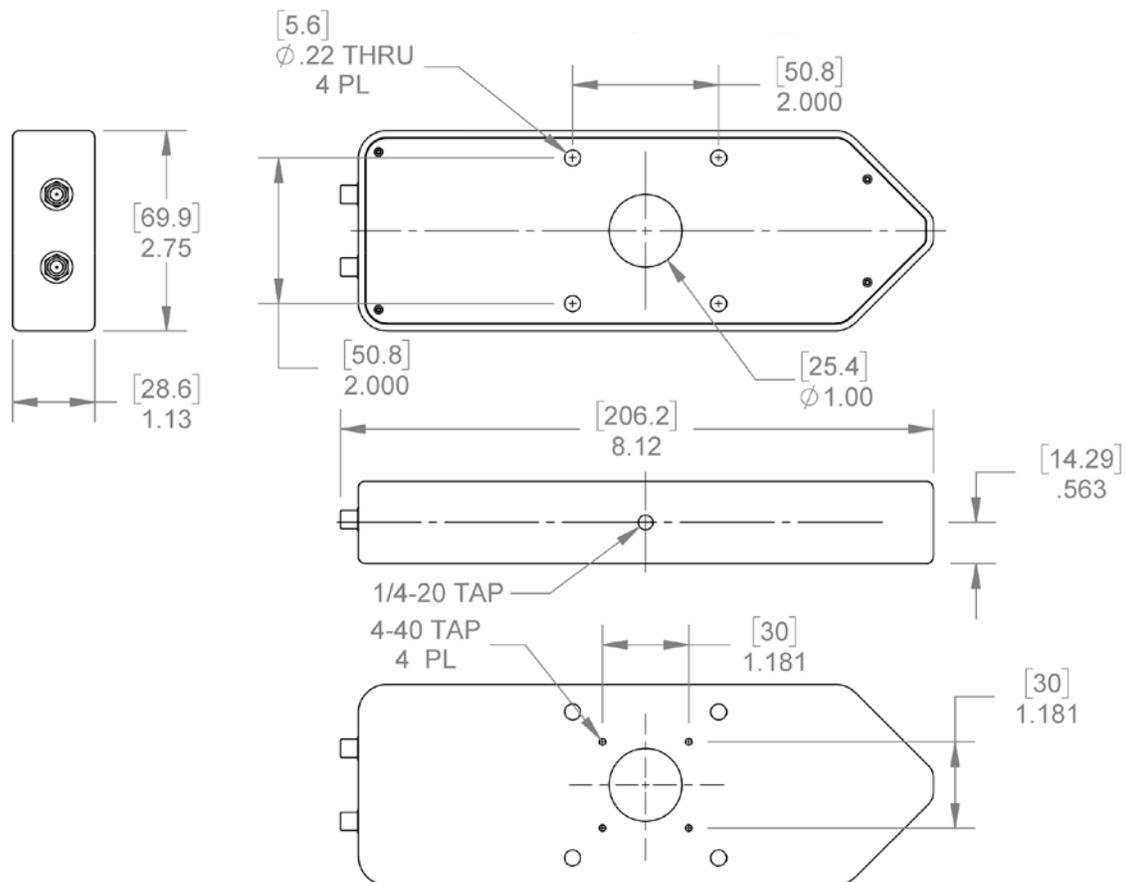


Figure 3.5 Model II/ZS37, II/ZS42, II/ZS50 Optical Head

# 4

## Initial Set-Up

Before the initial set-up, the PEM optical head should be unpackaged as described on page 6- [Unpacking the PEM200](#).

---

### Connecting the PEM Optical Head and Controller

Use the two (2) supplied female to female SMA cables to run a connection between the optical heads' SMA connectors and the high voltage (HV) output of the PEM-200 controller. Order does not matter on which controller output goes to which optical head input. Ensure the SMA cables are securely hand-tightened on both ends.

---

### Optical Bench Set-up

The optical bench and electronic configuration depend on the particular application required for the modulator. More detailed set-up information can be found at our website's [applications](#) menu.

The most common optical and electronic setup for checkout and calibration of the modulator is shown in figure 4.1. This shows a monochromatic light source (such as a laser) or multi wavelength source with a wavelength selection device (e.g. monochromator).

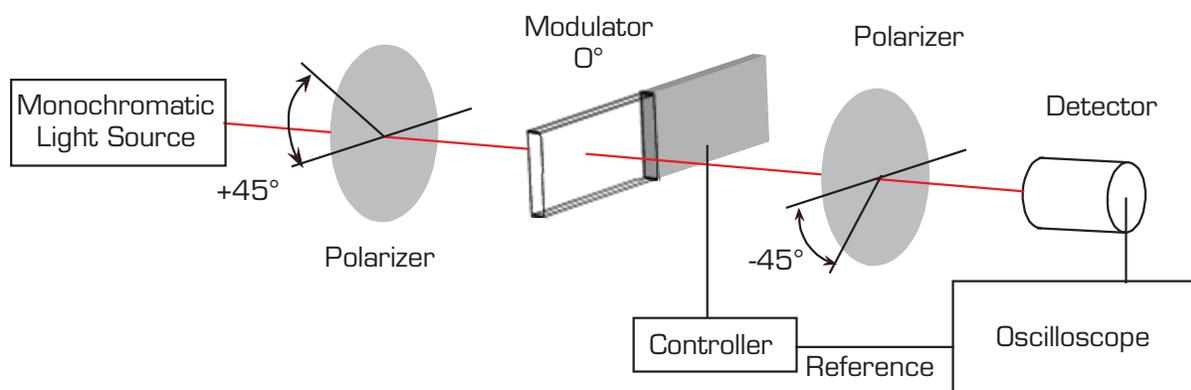


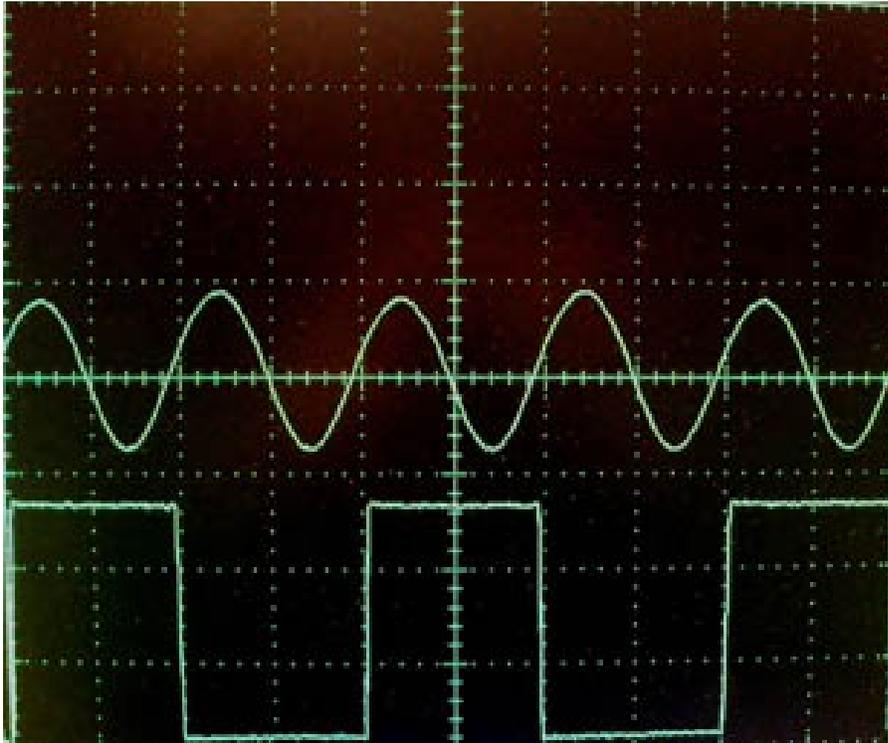
Figure 4.1 Block Diagram for Oscilloscope Calibration Method

The light source, if unpolarized, is followed by a polarizer at 45 degrees with respect to the horizontal, the modulator with its axis horizontal (0 degrees), a second polarizer (often called the analyzer) at -45 degrees, and a detector.

---

## Functional Check

Figure 4.1 shows the basic electronic requirements. Most light sources will require an electrical power supply, not discussed here. The detector is shown supplying a signal to the oscilloscope, with the controller reference signal connected to the oscilloscope trigger input.



*Figure 4.2 Oscilloscope Waveform for PEM Set to 0.25 Wave Retardation Between Crossed Polarizers and PEM 1f Reference Signal*

The detector circuitry deserves some special comment. Care must be taken to ensure adequate frequency response, typically several times the PEM operating frequency. Pre-amplified photo detectors are available from Hinds Instruments that fit this need. See [page 65](#) for contacting Hinds Instruments, Inc.

# 5

## *PEM200 Software Setup*

### Installation

To begin installation, first download the software installer from <https://www.hindsinstruments.com/products/photoelastic-modulators/pem-200/>.

Download the software package (.zip) on the computer that will control the PEM200. After the download has completed, be sure to unzip the software package before installing.

The Graphical User Interface (GUI) is downloaded with a provided Windows Installer (.msi) file. Click on the 'Pem200ControllerSetup.msi' file. After running the file, a destination folder prompt will appear. This is where the software will be saved on the computer.

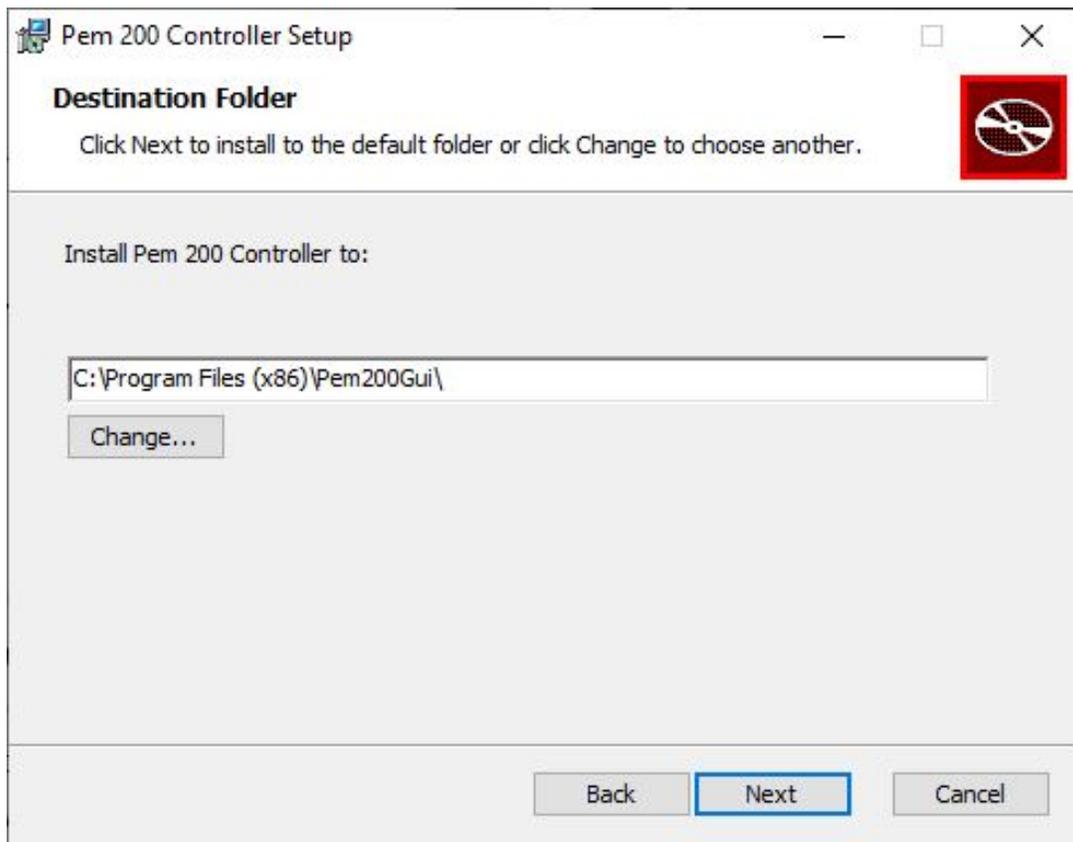


Figure 5.1 PEM200 Software Installer, Install Location

---

## Setup Running

After selecting 'Next', the setup installs the necessary files onto the computer. The progress is shown through a green status bar.

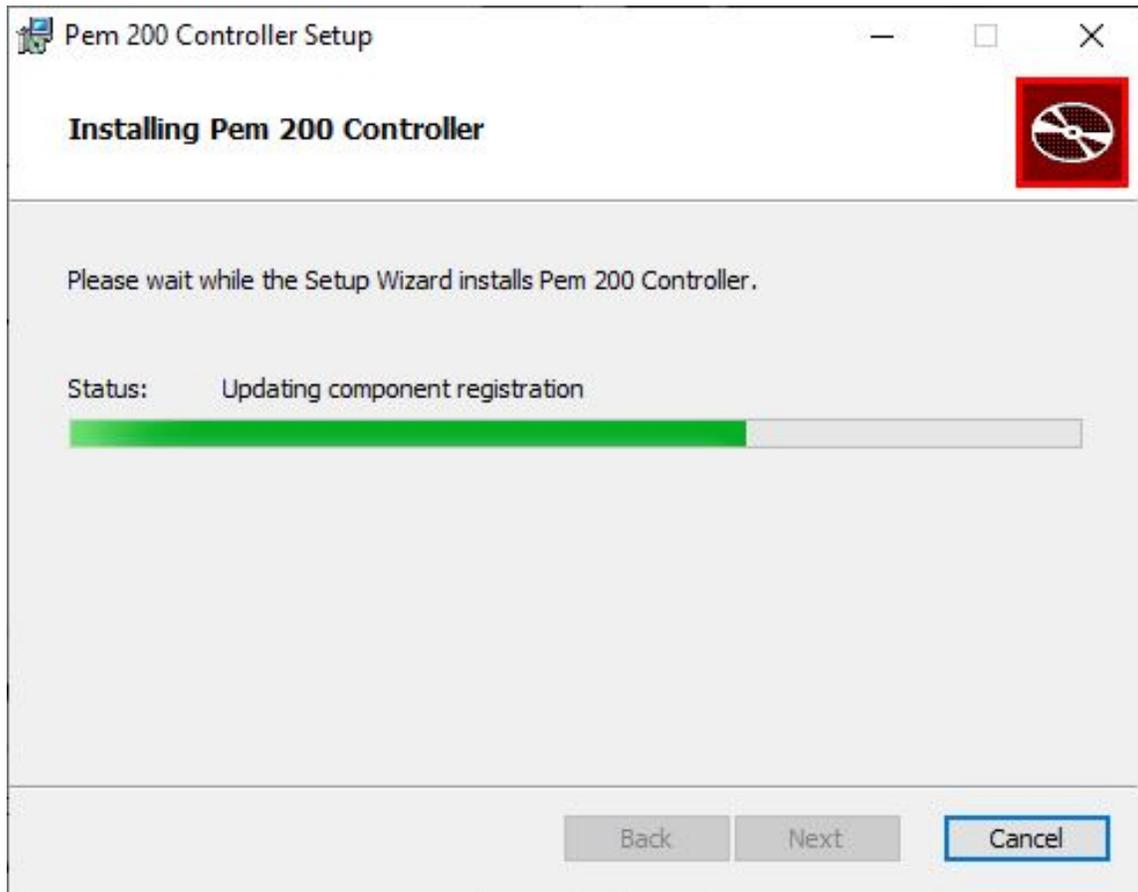


Figure 5.2 PEM-200 Software Installer, Loading

---

## Setup Complete

Once complete, the setup will prompt you to select 'Finish', indicating the software has been successfully installed on the computer.

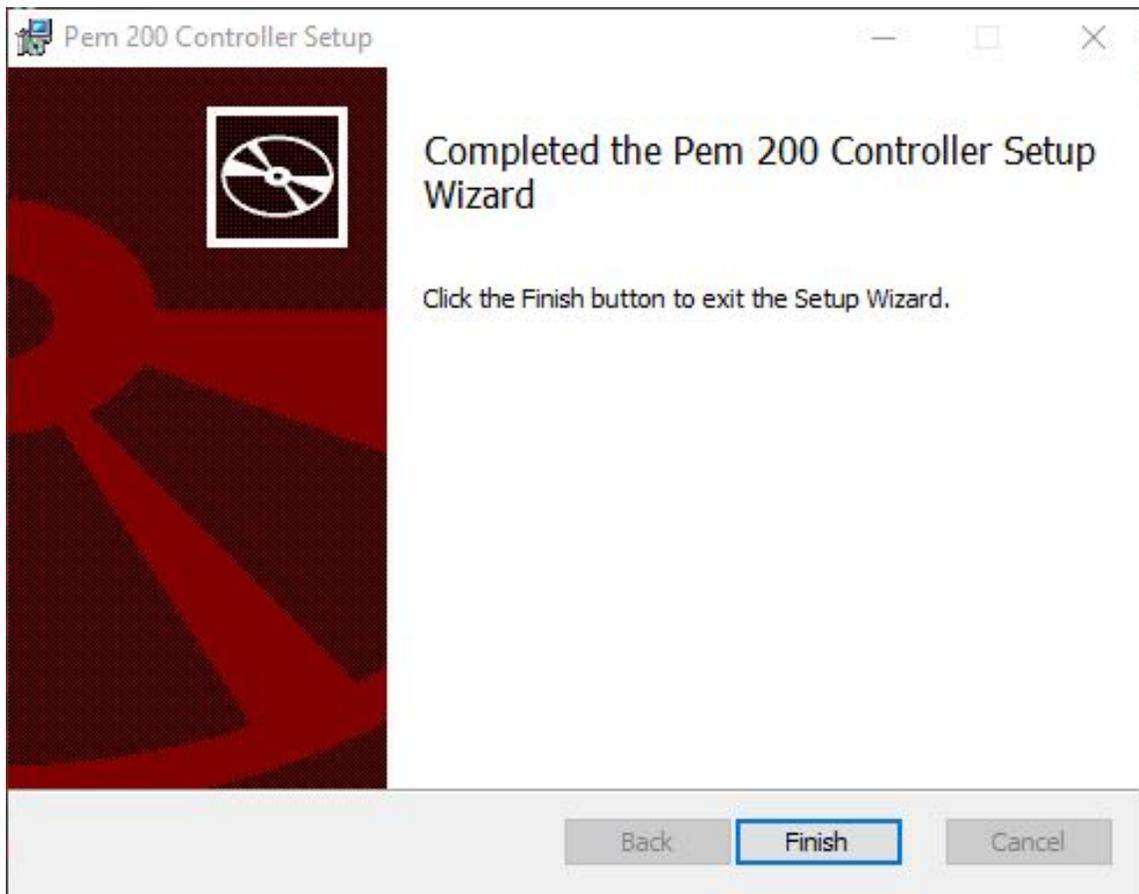


Figure 5.3 PEM-200 Software Installer, Finish

The PEM Control Software is now installed. There will be a shortcut placed on your desktop with the following icon:



# 6

## ***PEM200 Control Software***

The VPEM Control Software allows the user to remotely operate the PEM-200 controller from a PC. This section provides an overview of PEM Control Software installation and the remote operation of the PEM-200 Controller.

---

### **Setup of the PEM-200 Controller for Use with PEM Control**

Ensure the PEM-200 Controller is set up as follows before attempting to use the PEM Control Software:

1. Make sure the PEM-200 has power.
2. Connect the USB 2.0 B cable to the PEM-200 controller and to the PC.
3. Once connected, the PEM-200 should connect to a COM port on the target computer. View this on the computers 'Device Manager'.
4. In the 'Device Manager', select the 'Ports (COM & LPT)' dropdown. If there are multiple ports open, you can disconnect and reconnect the PEM-200 to see the COM port disappear and reappear.
5. Note the COM port number.
6. Make sure a PEM optical head is connected to the PEM-200 with both SMA cables.

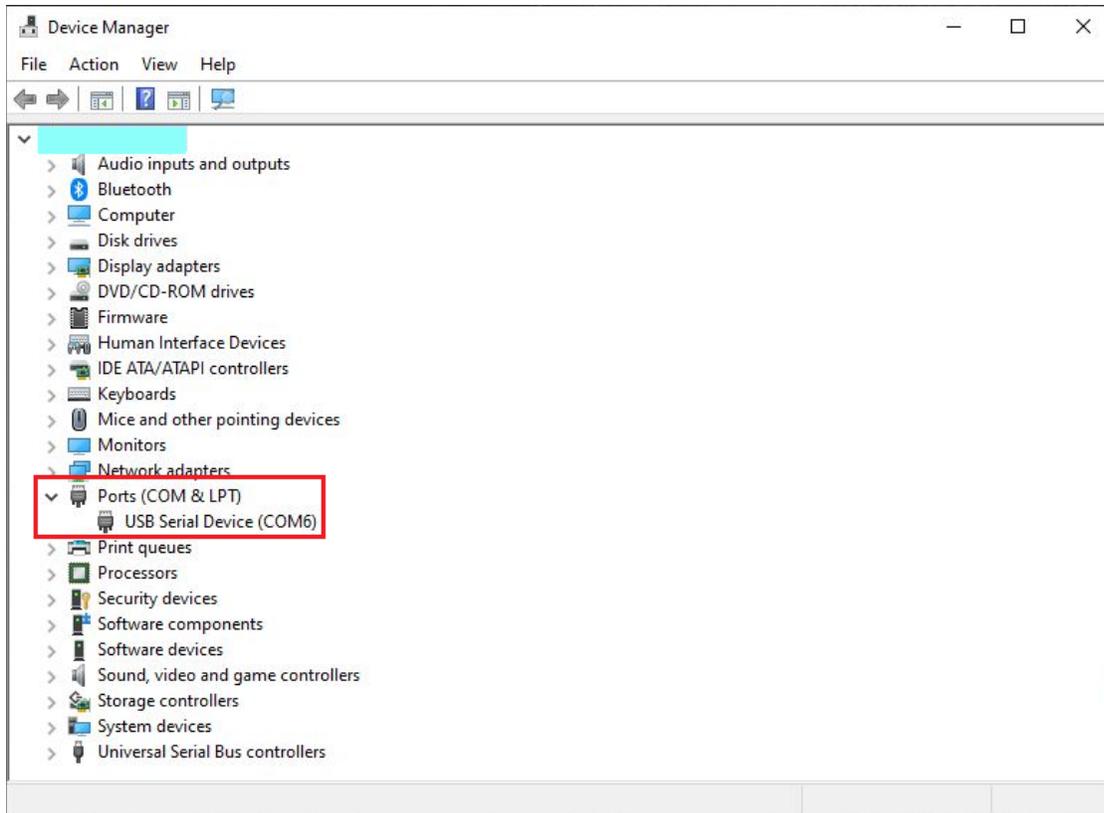


Figure 6.1 Device Manager Ports Screen

---

## Launching the PEM Control Software and Verifying Communication with the PEM-200 Controller

1. Open the 'PEM Control Software' icon from the computer desktop. Upon opening, the following COM port dialog box will appear:

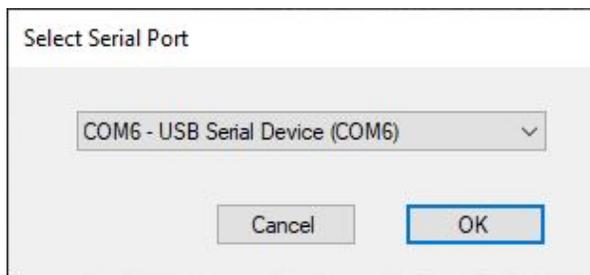


Figure 6.2 COM port dialog box

2. Use the dropdown to select the computer COM port number used by the PEM200 Controller, then press 'OK' to open the main window.

---

## Main Interface

When launching the PEM Control Software, the main display screen will appear with the default settings as shown. This screen allows for adjustments to wavelength and retardation settings as well as provides an update for the resonant frequency.

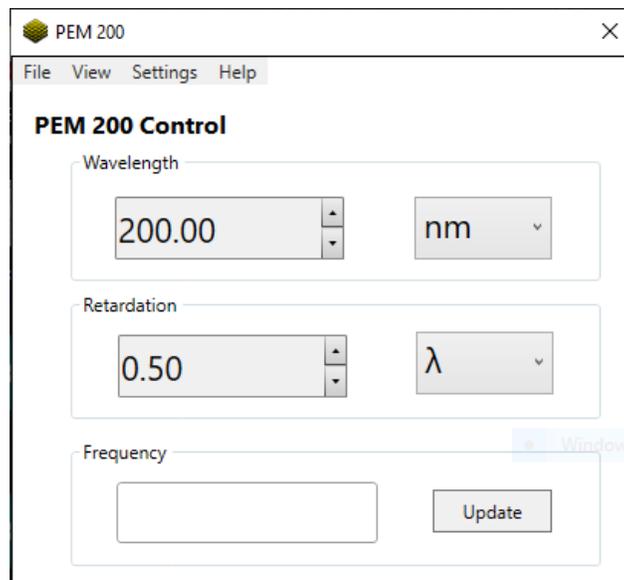


Figure 6.3 PEM200 Control Software Main Interface

**Wavelength:** The wavelength field displays the wavelength setting. Entering a different wavelength can be accomplished two ways:

1. Double click the wavelength displayed to highlight the setting and then enter a new wavelength using the keyboard.
2. Click on the up ▲ or down ▼ arrow to the right of the wavelength display to adjust the wavelength setting by single digits.

**Wavelength Units:** The wavelength units field displays the selected wavelength unit. Wavelength units can be set to display in nanometers (nm), micrometers (μm) and wavenumbers (1/cm).

To change the wavelength unit, click on the arrow to the right of the wavelength units field and click on the desired wavelength unit. The wavelength displayed will adjust accordingly.

**Retardation:** The retardation field displays the retardation setting. Entering a different retardation can be accomplished two ways:

1. Double click the displayed retardation to highlight the setting and then enter a new retardation using the keyboard.
2. Click on the up ▲ or down ▼ arrow to the right of the retardation display to adjust the retardation setting by single digits.

**Retardation Units:** The retardation units field displays the selected retardation unit. Retardation units can be set to display in fraction of wavelength ( $\lambda$ ) radian (rad) or degrees ( $^{\circ}$ ). To change the retardation unit, click on the arrow to the right of the retardation units field and click on the desired retardation unit. The retardation displayed will adjust accordingly.

**Frequency:** The frequency field displays the first (1f) harmonic operating frequency of the head-set being used.

**Update Frequency:** Press the “Update” button.

---

## Scan Panel

The scan panel will display additional fields to set up a wavelength scan. The panel will display the ending wavelength and retardation. The retardation and beginning wavelength is set in the main window as described above.

Select the **View** tab and select **Show Scan Panel** to open the scan panel on the window.

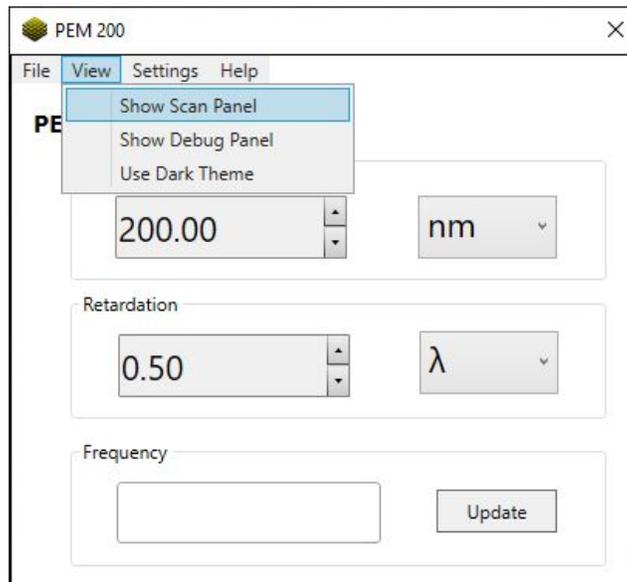


Figure 6.4 Accessing Scan Panel

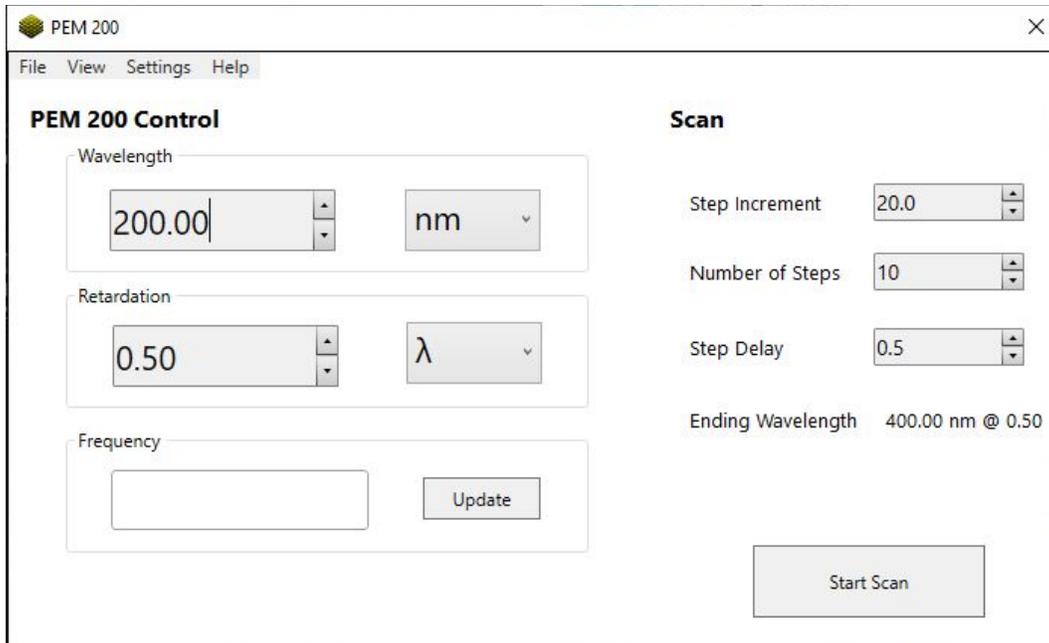


Figure 6.5 PEM200 Control and Scan Panel

**Step Increment:** Step increment describes the step size of a wavelength sweep. Entering a different step increment can be accomplished two ways:

1. Double click the step increment displayed to highlight the setting and then enter a new step increment using the keyboard.
2. Click on the up ▲ or down ▼ arrow to the right of the step increment display to adjust the step increment setting by single digits.

**Number of Steps:** The number of steps taken in the wavelength sweep. Entering a different number of steps can be accomplished two ways:

1. Double click the number of steps displayed to highlight the setting and then enter a new number of steps using the keyboard.
2. Click on the up ▲ or down ▼ arrow to the right of the number of steps display to adjust the number of steps setting by single digits.

**Step Delay:** The delay in seconds taken between each step in the wavelength sweep. Entering a different step delay can be accomplished two ways:

1. Double click the step delay displayed to highlight the setting and then enter a new step delay using the keyboard.
2. Click on the up ▲ or down ▼ arrow to the right of the step delay display to adjust the step delay setting by single digits.

Set all parameters and select 'Start Scan' to begin wavelength sweep.

## Debug Panel

The 'Debug Panel' displays the console input and output between the PC and the PEM. This is used to check that the PEM and PC are correctly interacting. It also serves as a tool to see what commands are being used to properly set up the PEM for unique experiments or software where the user will communicate through the serial port.

Select the **View** tab and select **Show Debug Panel** to open the debug panel on the window.

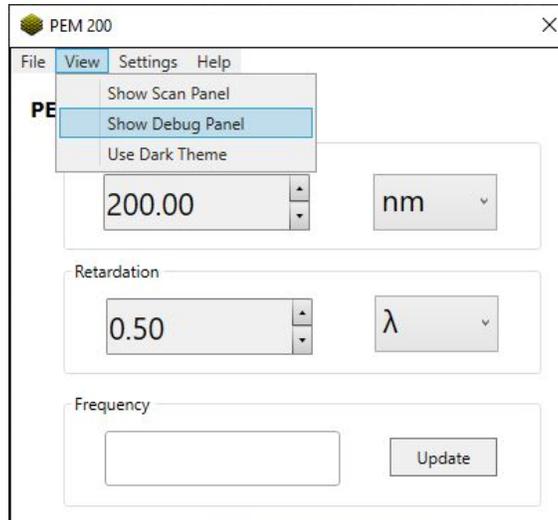


Figure 6.6 Accessing PEM200 Control Debug Panel

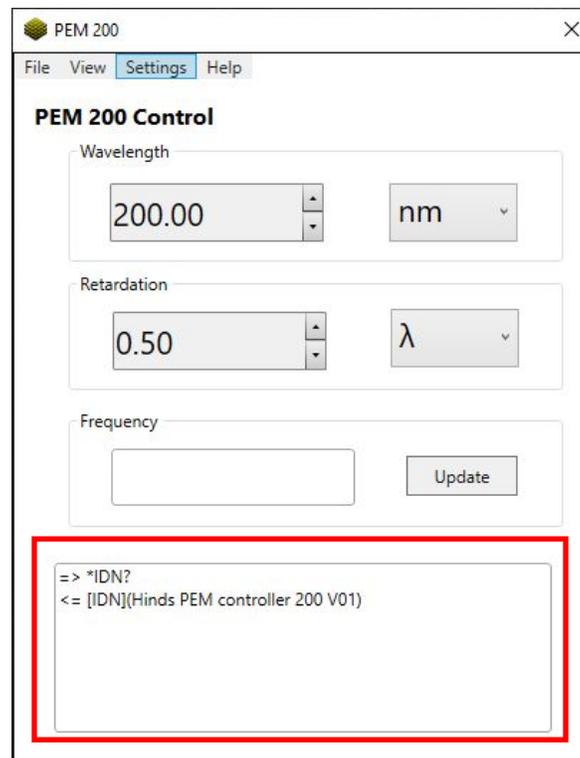


Figure 6.7 PEM200 Control Debug Panel

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## Themes

The PEM Control Software offers both a light and dark theme.

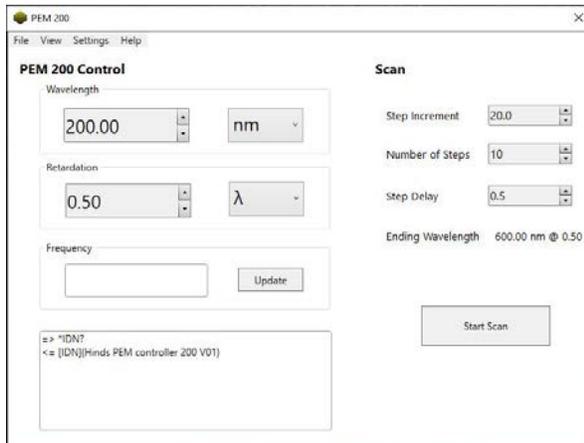


Figure 6.8 PEM200 Control Light Theme

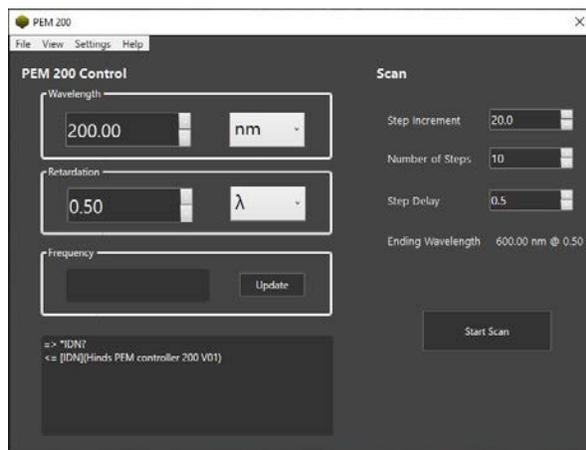


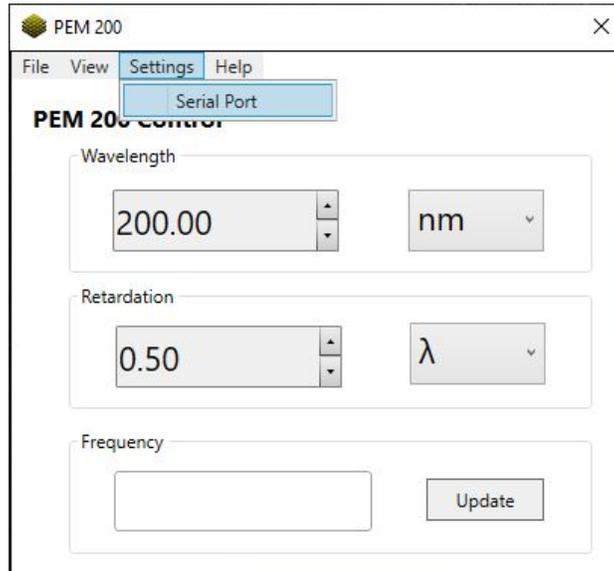
Figure 6.9 PEM200 Control Dark Theme

Select the **View** tab and select **Use Light/Dark Theme** to switch themes.

---

## Change COM port

Select the **Settings** tab and select **Serial Port** to change the COM port number to the PEM200 Controller. The serial port dialog box will appear. Use the dropdown to select the appropriate COM port.



*Figure 6.10 PEM200 Control Serial COM Port Access*



*Figure 6.11 PEM200 Control COM Port Selection*

# *Communication Protocol*

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The Hinds PEM200 controller drives a single PEM at a user selectable amplitude of modulation. The PEM200 communicates over USB as a simple SerialCOM device. The communication protocol is a derivative of the SCPI protocol common to many instruments. In this document, the basic SCPI protocol is outlined. From there, the specific connection requirements are outlined. Finally, the full command list and explanation for each command is given.

---

## **Port Settings**

PEM-200 connects to the computer as a USB serial COM port. The connection baud rate is 250,000 bytes per second. As this is a USB serial port, the software defined baud rate can be set anywhere from 9,600 to 250,000 and the PEM-200 should still communicate.

---

## **Standard Commands for Programmable Instruments (SCPI) protocol**

SCPI protocol is a standard syntax for controlling programmable devices. The protocol outlines a common syntax, command structure and data format. Commands are text strings sent to the device as either set operations (eg “:MODulator:VOLTage 0.25”) or get operations (“:MODulator:VOLTage?”). Set operations are often followed by a text string containing numerical or string data (eg. “:MODulator:VOLTage 0.1”). Get operations end with a ‘?’ and return data. Similar commands are grouped with similar leading strings in a tree structure.

Commands can be abbreviated by sending only the capitalized portion of the command text. Such as “:MODulator:VOLTage 0.1” can be abbreviated as “:MOD:VOLT 0.1”. Commands are terminated with a new line character (also known as line feed, ‘\n’, ASCII DEC 10, ASCII HEX A) or a semicolon (;). Carriage returns are ignored as many terminal applications send a full new line and carriage return by default. All commands are case sensitive.

Set commands are usually but not always followed by arguments. Arguments can be single values (eg. "0.1"), text (eg. "ON" or "OFF"), or vectors (eg. "0.1, 10, 100.3"). The expected argument is defined by the specific command. If the command is not known, the unit will return an error (eg. sending ":BOD:VOX" will return "<SCPINOP>(:BOD:VOX)" as this is an unknown command). Returns are categorized by type with each type using a different bracket set to ease parsing with regular expressions. All returns are ended with a new line ('\n').

Type	Bracket format	Notes
Error	<IDENTIFIER>(Message)	Sent on unknown commands and general errors. May be transmitted by the unit at any time or in response to a command.
Command return	[IDENTIFIER](Return arguments)	Sent upon successfully parsing and applying the command. Some returns are instant. Others may take a moment to return as the unit is setting internal systems.

## Argument format

Arguments usually consist of a single floating point number. These are parsed by the device as standard floats (eg. 0.01) or as scientific notation (eg. 1e-2 for 0.01). Arguments can also be a simple integer (eg 1). Arguments may take a vector format of more than one argument. For these cases, individual values are separated by a comma,','.

Please allow 300ms for PEM-200 to return after a command is sent.

Command structure overview. **NOTE: All Detector commands other than Harmonic Trigger are only available with the Synchronous Detector (SD) option.**

Command	Type	Note
*IDN?	Get	Identify the unit
:MODulator	Root	Modulator related command root
:DRiVe	Set	Set modulator drive voltage as range 0 to 1
:DRiVe?	Get	Get modulator drive voltage as range 0 to 1

:AMPlitude	Set	Set modulator amplitude in nanometers or retardance
:AMPlitude?	Get	Get modulator amplitude in nanometers of retardance
:AMPRange?	Get	Get modulator retardation amplitude range from lowest to highest in nanometers
:FREQUENCY?	Get	Get modulation frequency in Hz
:STABLE?	Get	Get modulator stability
:DETECTOR	Root	Synchronous detector command root
:SampleFREQUENCY	Set	Set the sampling frequency
:SampleFREQUENCY?	Get	Get the sampling frequency
:Gain	Set	Set the gain
:Gain?	Get	Get the gain
:HARMONICS	Set	Set the harmonics measured by the synchronous detection system
:INTEGRATION	Set	Set the integration time of the synchronous detector
:INTEGRATION?	Get	Get the integration time of the synchronous detector
:FORMAT	Set	Set the XY or magnitude angle format
:FORMAT?	Get	Get the XY or magnitude format
:MEASURE?	Get	Take a measurement and return data as set by :FORMAT
:MEASUREDC?	Get	Take a measurement of the DC voltage
:MEASUREAUX?	Get	Take a measurement of the AUX input voltage
:HARMTRIG	Set	Set Harmonic Trigger
:DETACTIVE	Set	Set Detector Active
:DDEBUG	Get	Get Detector Readings
:SYSTEM	Root	Internal device controls
:PEMOUTPUT	Set	Set PEM Active or Inactive
:IDLE	Set	Set PEM to Idle
:CPEERROR?	Get	Get Current/Phase Error

## Command explanation

Commands are listed below. The input command is listed in full with the symbol # denoting a numerical input. All commands are terminated with '\n' or ';'.

Command	*IDN?
Short command	*IDN?
Type	Get
Purpose	Identify the unit. Reports the firmware version.
Input example	*IDN?
Output example	[IDN](Hinds PEM 200 controller V01)

Command	:MODulator:DRiVe #
Short command	:MOD:DRV #
Type	Get/Set
Purpose	Sets the voltage to the modulator on an arbitrary range of 0.0 (lowest modulation amplitude) to 1.0 (highest modulation amplitude)
Input example	:MOD:DRV 0.1325
Output example	[DRIVE](1.325000E-1)

Command	:MODulator:AMPlitude #
Short command	:MOD:AMP #

Type	Get/Set
Purpose	Sets the voltage of the modulator in nanometers. For instance, if half wave retardance at 633nm is desired, the argument should be 316.5
Input example	:MOD:AMP 316.5
Output example	[AMP](3.165000E+2)

Command	:MODulator:AMPRange?
Short command	:MOD:AMPR?
Type	Get
Purpose	Reports the modulation amplitude range in nanometers
Input example	:MOD:AMPR?
Output example	[AMPR](1.000000E+1,5.50000E+2)

Command	:MODulator:FREQuency?
Short command	:MOD:FREQ?
Type	Get
Purpose	Reports the frequency of modulation in Hz
Input example	:MOD:FREQ?
Output example	[FREQUENCY](5.01930899E+4)

Command	:MODulator:STABLE?
Short command	:MOD:STABLE?
Type	Get
Purpose	Returns if the PEM is stable (binary)
Input example	:MOD:STABLE?
Output example	[STABLE](1)

Command	:DETector:SampleFREQuency #
Short command	:DET:SFREQ #
Type	Get/Set
Purpose	Sets the sampling frequency of the synchronous detector in Hz. The valid range is 1MHz (1e6) to 10MHz (1e7). Suggested and default sample frequency is the suggested 10MHz.
Input example	:DET:SFREQ 1e6
Output example	[SCLOCK](1.000000E+6)

Command	:DETECTOR:Gain #
Short command	:DET:G #
Type	Get/Set
Purpose	Sets the gain level of the synchronous detector. The gain range is 0.25 to 40000 . The gain circuitry only has 8 selectable gain levels and the closest option will be chosen and returned.
Input example	:DET:G 20
Output example	[GAIN](4.000000E+2)

Command	:DETECTOR:HARMONICS #, #
Short command	:DET:HARM #, #
Type	Get/Set
Purpose	Select the channel and harmonic of interest to measure when the synchronous detector is activated. The range of the harmonic is 1 to 5.
Input example	:DET:HARM 1, 2 (Channel 1, 2f)
Output example	[HARMONIC](1,2)

Command	:DETECTOR:INTEGRATION #
Short command	:DET:INT #
Type	Get/Set
Purpose	Set or get the integration time in seconds. The range is 1e-3 (1ms) to 1e2 (10s).
Input example	:DET:INT 0.25
Output example	[ITIME](2.500000E+1)

Command	:DETECTOR:MEASURE?
Short command	:DET:M?
Type	Get
Purpose	Starts the synchronous detection system and returns the magnitude of the harmonic components as set by :DET:FORM
Input example	:DET:M
Output example	[MXY](1.314652E0, 3.623624E-1, 2.1465E-1, 1.02436E-4, -9.21565E-5)

Command	:DETECTOR:MEASUREDC?
Short command	:DET:MDC?
Type	Get
Purpose	Quickly measure the DC amplitude of the input optical signal. Returns mean and standard deviation.
Input example	:DET:MDC?
Output example	[DC](1.314652E2, 0.244652E0)

Command	:DETECTOR:MEASUREAUX?
Short command	:DET:MAUX?
Type	Get
Purpose	Measure the AUX input amplitude.
Input example	:DET:MAUX?
Output example	[AUX](1.314652E0)

Command	:DETECTOR:HARMTRIG #
Short command	:DET:HARMT #
Type	Set
Purpose	Set the trigger out signal to different harmonics 1f (enter 0) to 4f (enter 3)
Input example	:DET:HARMT 1
Output example	[HARMT](1)

Command	:DETECTOR:DETAActive
Short command	:DET:DETA #, #
Type	Set
Purpose	Set channel, detector active: 0 off, 1 on
Input example	:DET:DETA 1, 0 (Channel 1, off)
Output example	[DETA](1, 0)

Command	:DETECTOR:DDeBuG
Short command	:DET:DDBG
Type	Set
Purpose	Get debug reading on selected channel. Returns (Sin/Abs(Sin),Cos/Abs(cos), Sin, Cos, Abs(Sin), Abs(Cos), Phase[0], Phase[1], Phase[2], Phase[3])
Input example	:DET:DDBG 1
Output example	[DDBG](0.13546,0.321654,0.212384,0.874654,0.32158,0.386546,0.87951,0.36547,0.9874160,0.3658745)

Command	:SYStem:PEMOutput #
Short command	:SYS:PEMO #
Type	Set
Purpose	Sets modulator active/inactive (on/off)
Input example	:SYS:PEMO 1
Output example	[PEMOUT](1)

Command	:SYStem:IDLE #
Short command	:SYS:IDLE #
Type	Set
Purpose	Set the PEM to an idle mode, where PEM will stop dynamically stabilizing.
Input example	:SYS:IDLE 0
Output example	[PIDLE](0)

Command	:SYStem:CPEError?
Short command	:SYS:CPE?
Type	Get
Purpose	Get current error and phase error as a percentage (0-1 scale)
Input example	:SYS:CPE
Output example	[CPE](2.500000E-4,1.670000E-3)

# 8

## *Troubleshooting*

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Should you run into any issues with the PEM200 controller, first check that all necessary connections are made: SMA's between optical head and PEM, 24V power input. Cycle the power and try to communicate with the PEM200. Should power cycling with all connections in place still result in no communication, please contact [sales@hindsinstruments.com](mailto:sales@hindsinstruments.com) or call +1-503-690-2000 for assistance.

Only remove optical head cover as instructed in unpacking instructions below and when initially unpacking. Do not remove cover of optical head for any other reason. Ensure the optical head is disconnected from any SMA cables before removing cover. High voltages can be present otherwise.

Do not remove cover from PEM-200 Controller or optical enclosure unless instructed to do so and while being supported by Hinds Instruments personnel.



# 9

## Maintenance

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### Calibration

PEM200 modulators are calibrated at the factory before shipment. For most applications, recalibration is neither necessary nor appropriate. For a few applications, however, an *on-site* calibration procedure will be necessary if optimum performance is to be achieved. Hinds' engineers will be glad to advise users on whether on site calibration is appropriate in a particular case.

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### Adjustment of Peak Retardation Calibration

The most common reference point used for calibration is half-wave peak retardation or an integral multiple of half-wave. This condition may be easily observed using an oscilloscope, as described in the Calibration appendix. Even when other reference points are used, this method should be regarded as the “coarse adjustment” on the modulator calibration.

The peak retardation calibration of the modulator is adjusted by adjusting modulation drive (:MOD:DRV #) and fitting appropriate firmware points. Please contact Hinds Instruments for assistance with these commands. With the appropriate optical bench setup and detection system, the modulation amplitude can be adjusted until the calibration condition is obtained. For example, in the case of the half-wave calibration, the appropriate flat topped (or flat-bottomed) characteristic waveform is observed on the oscilloscope.

---

### Maintenance

The optical head contains an optical element and requires the same care in use as other components such as lenses and mirrors. The unit should not be operated in a dusty, corrosive, or otherwise contaminating environment. Small amounts of dust may be removed from the optical element with a soft brush such as an artist's camel-hair brush. If more serious contamination occurs, contact Hinds' engineers.

The PEM units are rugged and reliable and normally require no additional maintenance. If trouble occurs, please consult the troubleshooting section and then contact Hinds' engineers for assistance.

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## Cleaning

When the PEM was shipped, the surface was clean and defect free; however, the rigors of packing and shipping may leave some residue on the optical surface(s). A final cleaning of the optical surfaces may be required before using them in your system.

As with all optics, dirt, fingerprints, oils and other materials lower the effectiveness and shorten the lifetime of dielectric coatings.

Handle all optics with care to prevent unusual wear, breakage or surface scratches.

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## Recommended Optics Cleaning Solutions

It is important to use the proper cleaning solution for specific optic materials. Failure to use the proper cleaning solution may scratch or damage the optical surface.

### Coated/Uncoated Non-ZnSe Optics

The non-ZnSe optics are coated with a hard, durable dielectric material and may be cleaned like an uncoated optical surface. The optic may be cleaned with *uncontaminated acetone*.

### Coated/Uncoated ZnSe Optics

The ZnSe optics may be cleaned with lighter fluid/butane.

Avoid exposing the junction between the optical element and the transducer with the solvent.

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## Cleaning the Optics

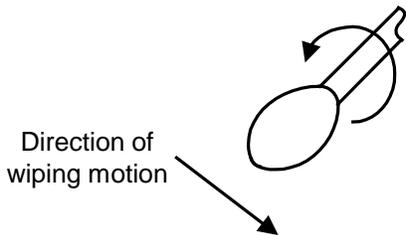
Two cleaning methods recommended are the cotton swab method and the lens tissue method. These “wet drag” techniques of cleaning are effective methods for removing dust and light residue from most hard-coated optical surfaces.

### Warning

To guard against electrical shock or instrument damage, never allow water to get inside the case. Unplug the unit before cleaning the optics.

## Cotton Swab Method

Using a 100% cotton swab moistened with solvent, wipe the surface gently while rotating the swab slowly. This action ensures that the contaminants are lifted away from the surface of the optic.

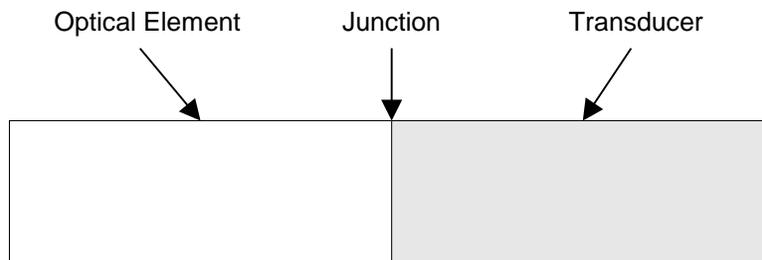


*Figure 9.1 Direction of cotton swab wiping motion*

## Lens Tissue Method

In order to clean the optics using the lens tissue method, the cover to the optics must first be removed.

When applying the solvent, avoid exposing the junction between the optical element and the transducer.



*Figure 9.2 Junction between Optical Element and Transducer*

1. Take a single piece of lint-free lens tissue (do not use Kimwipes) and place it on the surface to be cleaned, so it covers the entire surface.
2. Using the recommended cleaning agent, soak the lens tissue until the entire surface is damp (not wet).
3. Grasp two free corners of the lens tissue and drag the tissue across the surface away from the junction in a smooth, even manner so the alcohol dries immediately as the rear edge of the tissue moves over the optical surface.

This cleaning method leaves no residue or moisture on the coated surface and assures a clean and long lasting coating. This technique may be used regularly to keep residue from building up, preventing damage and degradation to the optical surface.

When replacing the cover to the optics, tighten screws (Qty 4) until snug.

# A

## *Specifications*

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### **General- Controller**

Model Number	Controller, PEM-200, P/N 020-2651-093-R
Size	5.31" W x 2.44" H x 6.86" D (135mm W x 62mm H x 174mm D)
Weight	6 Lbs (2.75 Kg) (without head assembly)
Power	100-240 VAC (no switching required), 50-60 Hz, 13 Watts maximum
Power Supply	Output: 24DC Input: 90-264VAC 47-63 Hz, 1.7A

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### **Parameter Specifications**

#### **Frequency**

'f' Display Range/Resolution	37 kHz – 74 kHz, 1 dHz
Display Accuracy	4 dHz

#### **Retardation**

Retardation Range	See head set ratings in Appendix C.
Retardation Units	Wavelength ( $\lambda$ ), radian (rad) or degree ( $^{\circ}$ )

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### **Input / Output Specifications**

#### **'Head' Connection**

Connector Style	SMA Female – RP-SMA Female
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## Reference Outputs

Connector Style	SMA Female - Female
Output Waveform	5 VDC square wave
Output Frequency	See 'Optical Head Specifications'
Phase Stability Duty Cycle	'f', 50% +/- 0.001%

## USB Connection

Connector Style	USB 2.0 Type B (Male – Male)
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## Environmental

Designed for indoor use only.

Operating Temperature	2 to +50 degrees C (36 to 122 degrees F)
Storage Temperature	-40 to +65 degrees C (-40 to 150 degrees F)
Humidity	95% RH non-condensing
Operating Altitude	3000 meters
Oversvoltage Category	40V oversvoltage limit
Wet Location	NA
Pollution Degree	NA

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## Approvals

CE	Approved for connection cables not exceeding 3 meters in length.
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## EMC & Safety Standards

EN 61326; FCC Class A  
EN 61010-1

# B

## Optical Head Specifications

### PEM200 OPTICAL HEAD SPECIFICATIONS<sup>1</sup>

Model	Optical Material	Frequency, nominal	Retardation Wavelength Range		Useful Aperture <sup>2</sup>
			Quarter Wave	Half Wave	
I/FS50	Fused Silica	50 kHz	170 nm - 2 µm	170 nm - 1 µm	16 mm
I/FS20 <sup>4</sup>	Fused Silica	20 kHz	170 nm - 2 µm	170 nm - 1 µm	22 mm
I/CF50	Calcium Fluoride	50 kHz	130 nm - 1 µm	130 nm - 500 nm	16 mm
II/FS20 <sup>3, 4</sup>	Fused Silica	20 kHz	170 nm - 2 µm	170 nm - 1 µm	56 mm
II/FS42 <sup>3</sup>	Fused Silica	42 kHz	170 nm - 2.6 µm	170 nm - 2.5 µm	27 mm
II/FS47 <sup>3</sup>	Fused Silica	47 kHz	170 nm - 2.6 µm	170 nm - 2.5 µm	24 mm
II/FS50 <sup>3</sup>	Fused Silica	50 kHz	170 nm - 2.6 µm	170 nm - 2.5 µm	22 mm
II/FS84 <sup>3, 4</sup>	Fused Silica	84 kHz	200 nm - 2.5 µm	200 nm - 2.5 µm	13 mm
II/IS42 <sup>3</sup>	Infrasil	42 kHz	300 nm - 3.5 µm	300 nm - 3 µm	27 mm
II/IS84 <sup>3, 4</sup>	Infrasil	84 kHz	300 nm - 3.5 µm	300 nm - 3 µm	13 mm
II/CF57	Calcium Fluoride	57 kHz	2 µm - 8.5 µm	1 µm - 5.5 µm	23 mm
II/ZS37	Zinc Selenide	37 kHz	2 µm - 18 µm	1 µm - 9 µm	19 mm
II/ZS42	Zinc Selenide	42 kHz	2 µm - 18 µm	1 µm - 10 µm	17 mm
II/ZS50	Zinc Selenide	50 kHz	2 µm - 18 µm	1 µm - 10 µm	14 mm
II/SI40 <sup>4</sup>	Silicon	40 kHz	28 µm - 57 µm		36 mm
II/SI50 <sup>4</sup>	Silicon	50 kHz	28 µm - 57 µm		29 mm

<sup>1</sup> Specifications for models purchased after February 1, 2020

<sup>2</sup> For a full discussion, consult the Useful Aperture Technical Note

<sup>3</sup> Please contact Hinds Instruments with your wavelength range for optical calibration

<sup>4</sup> Models only available with PEM-100 controller, electronics, and enclosures

# *User Support Information*

Hinds Instruments makes every attempt to ensure that the instruments we provide are products of superior quality and workmanship. We also aim to provide superior technical user support. If you have any questions, or if you encounter problems in the operation of your PEM instrument or system, please contact us. Our customer service staff is available to assist you from 8:00AM to 4:00PM, Pacific Standard Time, Monday through Friday. The telephone number is (503) 690-2000 or toll free, in the United States, (800) 688-4463.

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## **PEM 200 Limited Warranty**

Hinds Instruments, Inc. warrants the PEM 200 Photoelastic Modulator and systems to be free from defects in materials and/or workmanship when operated in accordance with the manufacturer's operating instructions for one (1) year from the date of purchase, subject to the provisions contained herein. Our warranty shall extend to the original purchaser only and shall be limited to factory repair or replacement of defective parts.

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## **Exclusions**

This warranty does not cover normal maintenance, damage resulting from improper use or repair, or abuse by the user. This warranty extends only to repair or replacement, and shall in no event extend to consequential damages. In the event of user repair or replacement, this warranty shall cover neither the advisability of the repair undertaken, nor the sufficiency of the repair itself.

THIS DOCUMENT REFLECTS THE ENTIRE AND EXCLUSIVE UNDERSTANDING OF THE PARTIES, AND EXCEPT AS OTHERWISE PROVIDED HEREIN, ALL OTHER WARRANTIES, EXPRESS OR IMPLIED, PARTICULARLY THE WARRANTIES OF MERCHANTABILITY AND/OR FITNESS FOR A PARTICULAR PURPOSE, ARE EXCLUDED.

This warranty gives you specific legal rights, and you may also have other rights that vary from state to state.

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## Overview of the PEM 200 Help System

As shown in Table D.1, you can contact Hinds Instruments, Inc. Technical Support in several ways.

Method	Information
Telephone	Monday - Friday 8:00 AM to 4:00 PM PST (503) 690-2000
FAX	(503) 690-3000
Email	<a href="mailto:sales@hindsinstruments.com">sales@hindsinstruments.com</a>
Website	<a href="http://www.hindsinstruments.com">www.hindsinstruments.com</a> for general information about Hinds Instruments, Inc. and the Hinds PEM <a href="http://www.hindsinstruments.com/PEM">http://www.hindsinstruments.com/PEM</a> for information specific to the PEM-200 Photoelastic Modulator
U.S. Mail	Hinds Instruments, Inc. 7245 NE Evergreen Pkwy Hillsboro, Oregon 97124-5850

Table D.1 Contacting Technical Support

When contacting Hinds Instruments for technical support, have the following PEM information available:

- Model name
- Serial number of the optical and electronic heads, and the controller.

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## Return For Repair Procedure

If your unit ever does need repair, please contact Hinds Instruments, Inc. before attempting repairs yourself or returning it to us. We may be able to provide additional troubleshooting suggestions to help diagnose the problem. In the event it is necessary to return the unit to us, we will give it our prompt and professional attention. In most cases, we can repair and return your instrument to you faster than you could diagnose and repair it yourself.

To arrange for service: In the event of defects or damage to your unit, first contact Hinds Instruments, Inc. by telephone at 1(503) 690-2000 or via email at [sales@hindsinstruments.com](mailto:sales@hindsinstruments.com). Give us a brief description of the problem. We will then advise whether factory repair is necessary. If factory service is required, we will give you a Return Material Authorization (RMA) number. You should return your instrument as follows:

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## Packaging

Consider the following guidelines when preparing the instrument for return:

- Wrap the unit in a plastic bag
- Pack the unit in the original shipping carton or in a sturdy oversized carton
- Use plenty of packing materials

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## Items To Include

- PEM Packing List (you will receive this from Hinds)
- The RMA number
- A brief description of the problem with all known symptoms
- Information on how to contact you
- Your return shipping address (UPS will not deliver to a post office box)

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## Shipping Arrangements

- Send freight prepaid (UPS recommended)
- Insurance is strongly recommended (we can advise you on the current replacement value of the unit being shipped)
- We are unable to accept COD shipments.

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## Return Shipping Address

Customer Service

Hinds Instruments, Inc.

7245 NE Evergreen Pkwy

Hillsboro, OR 97124-5850 U.S.A.

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## Shipping Costs

**If the unit is under warranty**, after repair or replacement has been completed, we will pay the shipping costs to return the instrument to you via a carrier we choose to any destination within the continental United States. If you desire some other specific form of conveyance, or if you are located outside the continental United States, then you must bear the additional cost of return shipment.

**If the unit is not under warranty**, we will contact you with an estimate of the charges. If you approve of the indicated repairs and cost, Hinds Instruments, Inc. will return your repaired unit after all charges (including parts, labor and return shipping and handling)

have been paid. If you do not approve of our proceeding with the repair, then your unit will be returned as is via UPS COD for the amount of the UPS COD freight charges.



**HINDS INSTRUMENTS, INC.**  
7245 NE EVERGREEN PKWY  
HILLSBORO, OR 97124 USA

PHONE: 503.690.2000  
FAX: 503.690.3000  
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