GPI XP/D™
GPI FlashPhase™
Interferometer Operating Manual

OMP-0502C

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For help within North America, please use the contacts listed below. For help in other countries, please contact your local Zygo representative. Be sure to supply the instrument model and serial number, and the software version.

PHONE Monday - Friday, 8 a.m. - 8 p.m. (Eastern Standard Time)
(800) ZYGO NOW (800) 994-6669
or (860) 704-5191

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Attn: Customer Support

MANUAL REVISION INFORMATION

The document (OMP) number and the applicable revision letter for this manual appear on the title page. The publication date appears below.

Revision	*Publication Date*	*Revision*	*Publication Date*
A	March 2005		
B	February 2006		
C	July 2006		

MANUAL NOTATIONS

Warning!
Denotes a hazard that could cause injury to personnel, and can also cause damage to the equipment.

Note, provides helpful information.

NOTICE: The descriptions, drawings, and specifications contained herein are subject to change. Zygo is not responsible for errors or omissions herein or for incidental damages in connection with the furnishing or use of this information. This document shall not be reproduced, photocopied, or duplicated, in whole or in part, without prior written approval of Zygo Corporation.

ZYGO Statement of Warranty and Product Support

ZYGO Corporation provides this warranty to protect its customers from defects in product workmanship or product materials. This warranty covers all products manufactured by ZYGO.

A. STANDARD PRODUCTS.

WARRANTY PERIOD ZYGO warrants that the equipment purchased will be free from any defects in material and/or workmanship under normal operating conditions for a period of one year from the date of shipment.

POST WARRANTY TO 5 YEARS ZYGO will support all standard products for a period of five years after the sale of the last newly manufactured unit. As vendor supplied material components become unavailable during this period, ZYGO will create upgrade paths to replace obsolete components with more current replacements. These upgrades can include internal components, computers, and software.

5 TO 10 YEARS ZYGO will continue to support older products. Service methods may include modifying units when parts become available, upgrading a unit to allow peripherals in a more supportable configuration, or providing a current product that meets or exceeds the original units functionality.

GREATER THAN 10 YEARS Product is obsolete. Service and support will be performed on a best-efforts basis.

B. NON-STANDARD / CUSTOM PRODUCTS.

WARRANTY PERIOD ZYGO warrants that the products purchased will be free from any defects in material and/or workmanship under normal operating conditions for a period of one year from the date of shipment. In cases of customer supplied materials, ZYGO warrants only the workmanship.

POST WARRANTY ZYGO will continue to support non-standard / custom products on a best effort basis after the new product warranty expires.

C. WARRANTY SERVICE.

ZYGO will provide service to return malfunctioning products to as shipped condition by repair or replacement (at ZYGO's option) of defective equipment at no cost to the Buyer. ZYGO will perform warranty service by: (1) sending replacement parts with appropriate installation instructions to the Buyer, the Buyer returning his defective part to ZYGO or: (2) repairing the product at a ZYGO repair facility after it has been returned freight prepaid, or: (3) at the Buyer's request, dispatching a service representative to the Buyer's facility. The Buyer shall pay ZYGO's travel and living expenses as well as travel time.

Defective products or parts will be repaired or replaced with new or like-new parts. These replacement parts will be warranted for a period of 90 days after they are shipped, or for the remainder of the original warranty period, whichever is longer. Warranty service will be performed only if the Buyer notifies ZYGO within 14 days of discovering any defects. Equipment or parts that are to be returned to ZYGO must be issued a Return Authorization number that can be obtained by contacting the ZYGO Service Department. Should ZYGO's subsequent inspection reveal that the parts were not defective, all expenses incurred by ZYGO shall be charged back to the Buyer. Defective equipment that is replaced shall become the property of ZYGO.

Warranty period begins when the product is shipped from ZYGO. Replacement parts, service workmanship, used equipment and refurbished equipment are warranted for a period of 90 days.

D. RETURNS.

Unused and undamaged products, in their original shipping containers, may be returned for credit within 30 days of receipt. All such returned products will be subject to a restocking fee equal to 35% of the purchase price. Custom products are not returnable.

E. EXCLUSIONS.

Warranty service does not include or apply to any product or part which, in ZYGO's judgment:

i. Has been repaired by others, improperly installed, altered, modified or damaged in any way.
ii. Malfunctions because the Buyer has failed to perform maintenance, calibration checks or use good operating procedures.
iii. Is expendable or consumable (such as panel lights, fuses, batteries, windows and filters) if such items were operable at the time of initial use.
iv. Requires replacement because of decomposition due to chemical action.
v. Fails because of poor facility, operating conditions or utilities.

OTHER THAN EXPRESSLY DESCRIBED ABOVE, ZYGO MAKES NO EXPRESS OR IMPLIED WARRANTIES, INCLUDING ANY REGARDING MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE RELATING TO THE USE OR PERFORMANCE OF THE EQUIPMENT. ZYGO WILL NOT BE LIABLE FOR PERSONAL INJURY OR PROPERTY DAMAGE (UNLESS CAUSED SOLELY BY ITS OWN NEGLIGENCE). LOSS OF PROFIT OR OTHER INCIDENTAL OR CONSEQUENTIAL DAMAGES ARISING OUT OF THE USE OR INABILITY TO USE THE EQUIPMENT, NOR DOES THIS WARRANTY APPLY TO ANY EQUIPMENT WHICH HAS BEEN SUBJECT TO MISUSE, NEGLECT, ACCIDENT, REPAIRED OR ALTERED BY OTHER THAN SERVICE REPRESENTATIVES QUALIFIED BY ZYGO.

11/2002

CE Notice

Marking by the CE symbol indicates compliance of this Zygo Corp. instrument to EMC (electromagnetic compatibility) Directive and the Low Voltage Directive of the European Union. Such marking indicates that this system meets the following technical standards:

- EN 55011 – “Limits and methods of measurements or radio disturbance characteristics of ISM (Industrial Scientific & Medical) radio frequency equipment.” Class A, for use in typical commercial environments.
- EN 55022 – “Limits and methods of measurements of radio disturbance characteristics of ITE (Information Technology Equipment).” Class A, for use in typical commercial environments.
- EN50082-1 1992 – “Electromagnetic compatibility generic immunity standard for the residential, commercial and light industrial environments.”
- EN 61010-1 1993/A2: 1995 – “Safety requirements for electrical equipment for measurement, control and laboratory use – Part 1: General requirements.”
- EN60825-1:1994/IEC825-1 :1993 – “Safety of laser products—Part 1. Equipment classification, requirements and user’s guide. Part 2. Safety of optical fiber communication systems.”

A Declaration of Conformity in accordance with the preceding directives and standards has been made and is on file at Zygo Corporation, Middlefield, Connecticut, USA.

Introduction

Chapter 1

Safety Precautions

Failure to follow safety precautions could result in damage to personnel and the instrument, and may void the warranty.

⚠ WARNINGS!

- **Disconnect Power During Installation.** Ensure that all power is off, that the Power On/Off switch is off (0), and that the power cable is disconnected during installation, when connecting cables, or when servicing equipment.
- **Ground the Instrument.** To minimize shock hazard, the equipment must be properly connected to an electrical ground through the power outlet.
- **Use Care When Moving Equipment.** It is recommended that several helpers work together when lifting or moving the instrument. Contact the appropriate agencies in your country for proper lifting recommendations.
- **Follow Laser Safety Precautions.** The instrument emits Class II laser radiation. It will not damage skin or the eyes, but it is recommended not to look into the instrument aperture. Follow the laser safety recommendations in this manual.
- **Do Not Touch Optical Surfaces.** Handle the transmission elements carefully. Do not touch exposed glass surfaces on the instrument or on the transmission element.
- **Clean Optics Only When Necessary.** Do not clean optical surfaces unless necessary. Improper and unnecessary cleaning may damage optical coatings.
- **Do Not Modify Equipment.** Do not install substitute parts or perform any unauthorized modification of the equipment.

Safety Labels

The following list identifies the meaning of safety labels found on the instrument. Specific warnings are covered in the applicable section within this manual. Failure to follow the safety labels and the recommendations in this manual could result in damage to personnel and the instrument, and may void the warranty.

Label	Meaning
	General Hazard. Proceed with caution. Refer to the manual for instructions.
	Electrical Shock. Proceed with caution; there is a risk of electrical shock.
	Disconnect power before performing the specified procedure.
	Refer to the manual for complete instructions on performing a specified procedure.

Laser Safety

The interferometer emits visible red light only; no invisible radiation is emitted. The radiant output power of the internal laser and of the instrument is low. The radiation emitted cannot burn or drill holes, even if a lens is used to focus the light. However, the laser light emitted by the interferometer should be treated with caution and common sense. It will not damage skin, but to protect your eyes, do not look directly into the laser beam or stare at its bright reflections.

To encourage proper laser safety and to abide by the above laser safety regulations, ZYGO supplies the information listed on the next page. Refer to the following tables and figure to locate the controls and the labels listed.

Laser Safety Standards

The American National Standard for the Safe Use of Lasers (ANSI Z136.1-1986) classifies this laser product as Low Power - Class II (per Table A1), and provides reasonable and adequate guidelines for its safe use. This laser also complies with the Low Voltage Directive EN 60825 and IEC 825. The user and personnel responsible for the safe use of the Interferometer in the user's organization should consult the ANSI standard. It is available from:

American National Standards Institute
1430 Broadway
New York, New York 10018

The interferometer conforms to the Center for Devices and Radiological Health (CDRH) of the Food and Drug Administration and to international laser safety regulations.

Product Use Warning

Warning!
Use of controls or adjustments or performance of procedures other than those specified herein may result in hazardous radiation exposure.

Output Beam Data

Laser medium: Helium-Neon

Emission Duration: more than 0.25 second

Radiant Power: <1 milliwatt

Wavelength: 632.8 nanometers

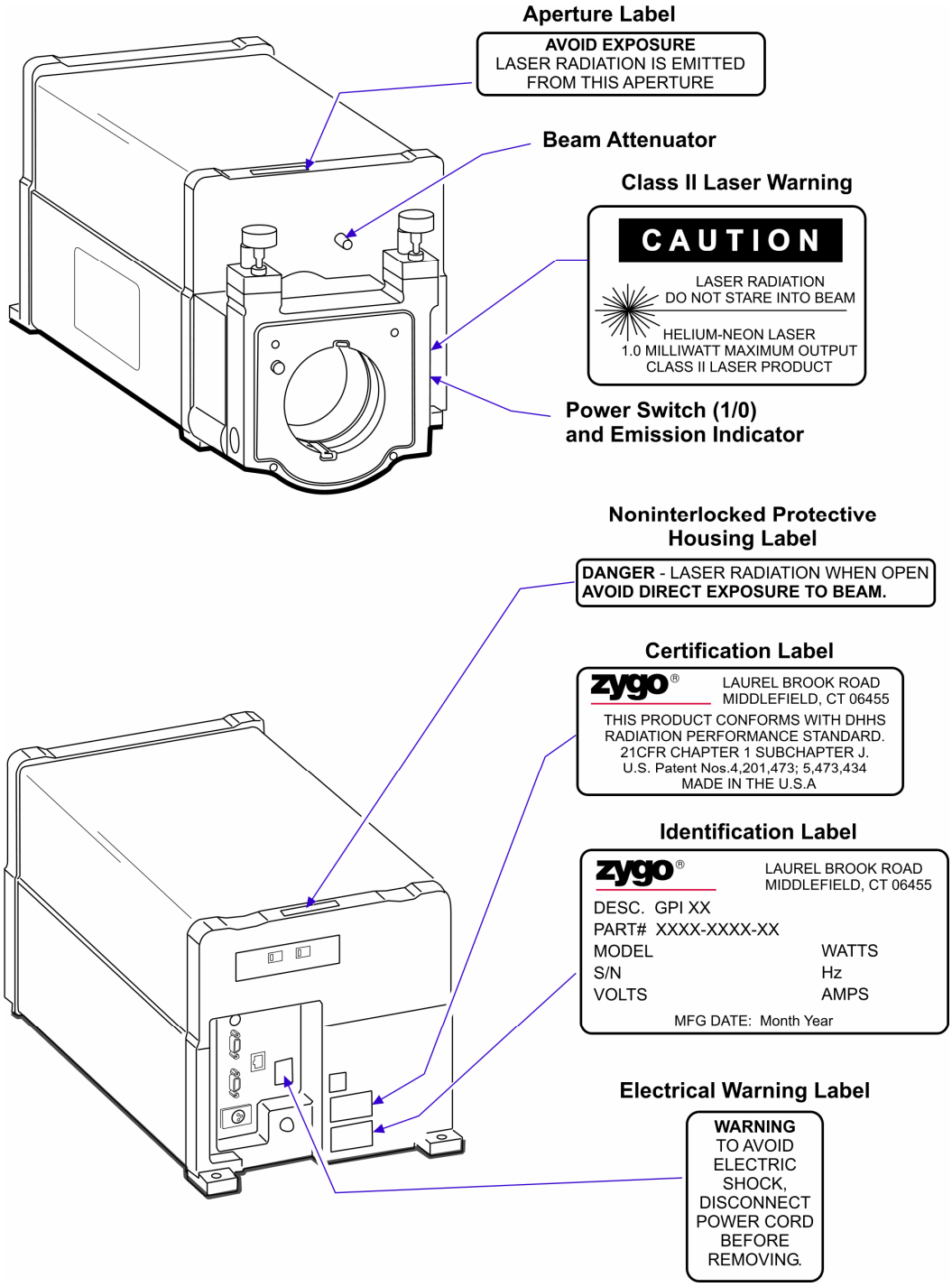
Laser Emission Control Devices

Device	Function
Emission Indicator	When lit, indicates that power is being supplied to the laser, and that Class II laser radiation may be emitted from the instrument's aperture.
Beam Attenuator	When *pulled out*, blocks the laser beam from being emitted from the instrument.
Power Switch (1/0)	In the off position (0), the laser is not energized and laser radiation is not emitted from the instrument.

Laser Safety Labels

Label	Purpose
Class II Laser Warning	Federal requirement for Class II lasers.
Aperture	Labels the instrument's aperture through which laser radiation is emitted.
Noninterlocked Protective Housing	Reminds you that when the covers are removed, and the system is turned on, Class II laser radiation is being emitted.
Certification	Shows that Zygo Corporation has conformed to the DHHS standard.
Identification	Provides information about the instrument, including serial number, manufacture date, model number, etc.

Laser Safety Controls and Labels



Electrical Safety

The interferometer is provided with a protective grounded terminal through the grounding connectors on the supplied AC power cords. An uninterrupted safety ground must be provided from the AC power source to the power cords.

Warning!

DO NOT disconnect the protective ground terminal on the incoming AC power cord. Any interruption of the protective grounding conductor inside or outside of the instrument can cause potential shock hazard and could result in personal injury. Do not rely on the neutral conductor in a two-terminal power outlet for grounding.

DO NOT connect cables, install, or repair the interferometer with power applied.

DO turn off the interferometer before disconnecting and reconnecting cables.

The GPI[(1)] Interferometer

The GPI family of interferometers provides non-contact measurement of flat or spherical surfaces, and transmitted wavefront measurement of optical components and assemblies. A wide range of operational features, data analysis capabilities, and accessories are available. The GPI XP/D model is a phase-shifting interferometer, as the phase differences between two wavefronts are used to derive measurement data. The GPI FlashPhase model is non-phase-shifting and uses quick data acquisition and Fourier analysis to derive measurement data.

GPI Configuration Options

Option	Description
Aperture	4 in. (102 mm) or 6 in. (152 mm)
Horizontal Mounting	Basic tabletop orientation. Requires optional vibration isolation system. An optional table mounting kit is available.
Vertical Mounting	The GPI can be downward looking or upward looking with the optional vertical kit. A vertical kit consists of three support rods, two “L” brackets, and a base plate. Support rods are available in 1, 1.5, or 2 meter lengths. The GPI is also available in vertical configurations with specially designed enclosures and built-in vibration isolation systems. Contact your ZYGO representative and ask for information on the MPT and MetroCell systems.

Accessories are described in the *GPI & VeriFire Accessories* booklet, OMP-0463.

(1) U.S. Patent Numbers 4,820,049, 5,054,925, 5,473,434, 6,359,692, 6,717,680, 6,788,422 and 6,804,011; U.S. and foreign patents pending.

Model Descriptions

Model	Description
GPI FlashPhase	FlashPhase enabled Fizeau interferometer system with a shuttering digital camera providing 640 x 480 acquisition.
GPI XP/D	Base model phase-shifting interferometer with digital camera providing 640 x 480 acquisition (1K x 1K camera optional).

Technical Differences

Model	Configuration	Pixels(1)	Fringe Resolution(2)
GPI FlashPhase	Non-phase-shifting system	640 x 480	180 fringes
GPI XP/D	Phase-shifting system	640 x 480 1K x 1K	180 fringes 380 fringes

(1) Maximum numbers of pixels or data points in the measurement.
(2) The approximate number of tilt fringes in the part image that can be resolved by the interferometer at 1X.

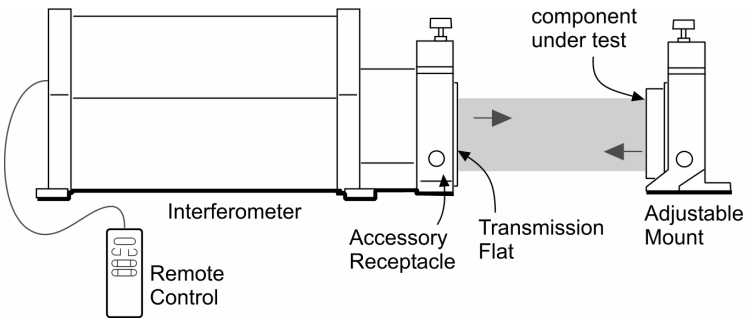
Principle of Operation

The GPI is a Fizeau type-interferometer. In comparison with other types of interferometers, such as Twyman-Green and Mach-Zehnder, a Fizeau interferometer has the advantage of fewer optical components, greater accuracy, and ease of use.

The light source is a low-power, helium-neon laser. The laser beam is expanded to a four inch (or six inch) diameter and exits the interferometer though the aperture. A transmission element, mounted in front of the aperture, reflects some of the laser light back into the interferometer, thus creating a reference wavefront. The remainder of the laser light passes through the transmission element to the component being tested and is referred to as the measurement wavefront.

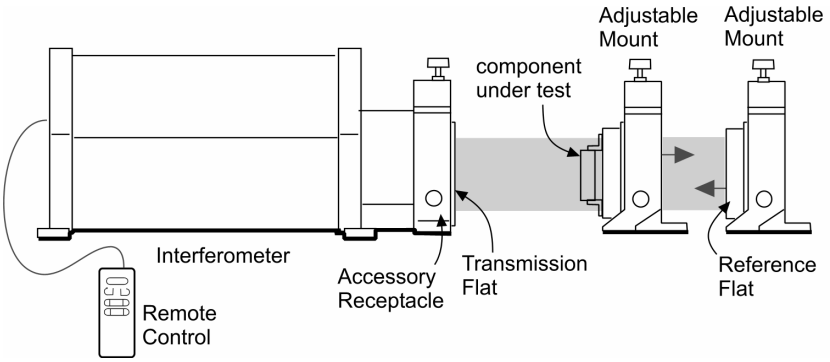
When performing surface quality tests, the measurement wavefront reflects back to the interferometer from the surface of the component being tested.

Typical Surface Quality Test



When performing transmitted wavefront tests, the measurement wavefront passes through the optic under test, reflects back from a reference optic traveling through the optic under test a second time and into the interferometer.

Typical Transmitted Wavefront Quality Test



For both the surface quality test and the transmitted wavefront test, the returning wavefront is recombined with the reference wavefront inside the interferometer, and the two wavefronts interfere with each other. The phase differences between the two wavefronts result in an image of light and dark fringes that is a direct indication of the quality of the component being tested. The interference pattern is converted to electrical signals by a video camera.

When performing either transmitted wavefront or surface quality tests, the measurement wavefront is affected by the optical component twice, thus the name "double-pass interferometry." In the interference pattern, defects in the component being tested appear to be twice as severe as they really are. ZYGO software compensates for this and, as a result, measurements have twice the resolution of measurements that would have resulted from a comparable single-pass interferometer.

Basic Principles of Phase Measuring Interferometry

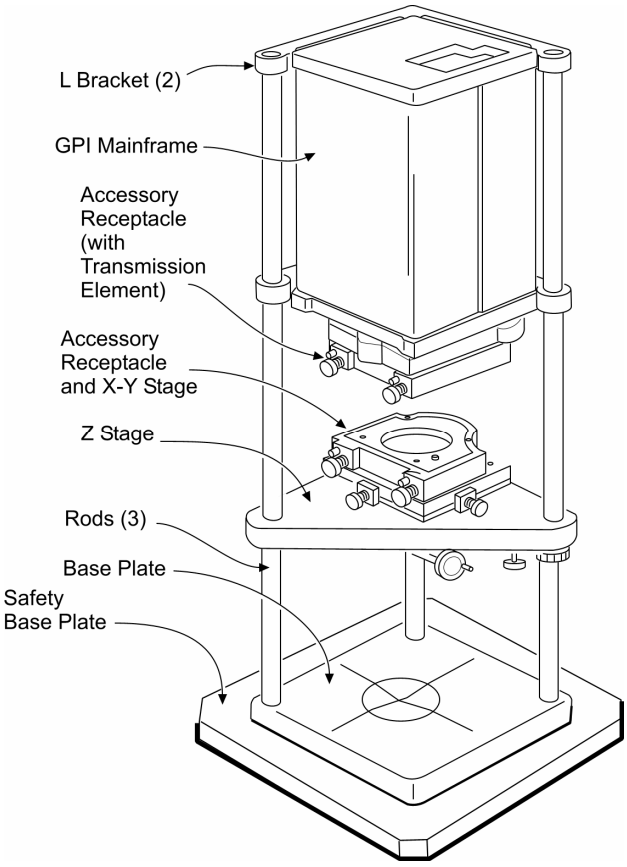
The Phase Measuring Receptacle (PMR) on the GPI XP/D model uses piezoelectric transducers to move the transmission element forward and backward, causing constant phase variations between the reference wavefront and the measurement wavefront.

The motion of the transmission element is precisely controlled and is synchronized with the frame rate of the solid-state video camera. During a data acquisition sequence, the computer takes several "snapshots" of the interference pattern (via the video camera), each at a point when the interfering wavefronts have undergone a predetermined phase shift in relation to one another.

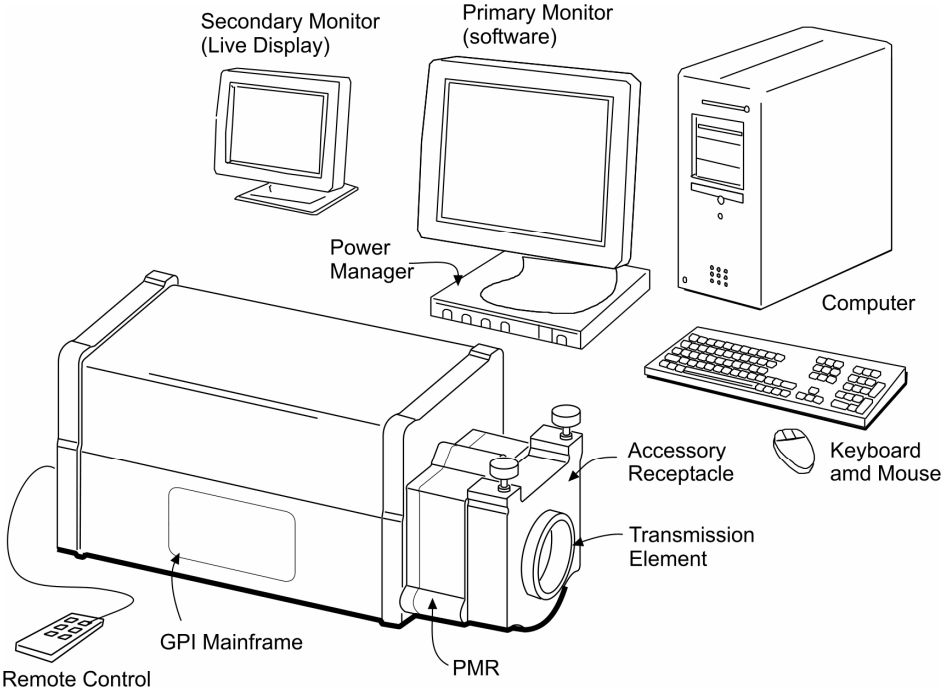
These snapshots are processed by the computer to determine the phase of the wavefront at each point when the interfering wavefronts have undergone a predetermined phase shift in relation to one another. The result is a very accurate map of the wavefront and, therefore, of the quality of the component being tested.

GPI Components

Vertical Configuration



Horizontal Configuration

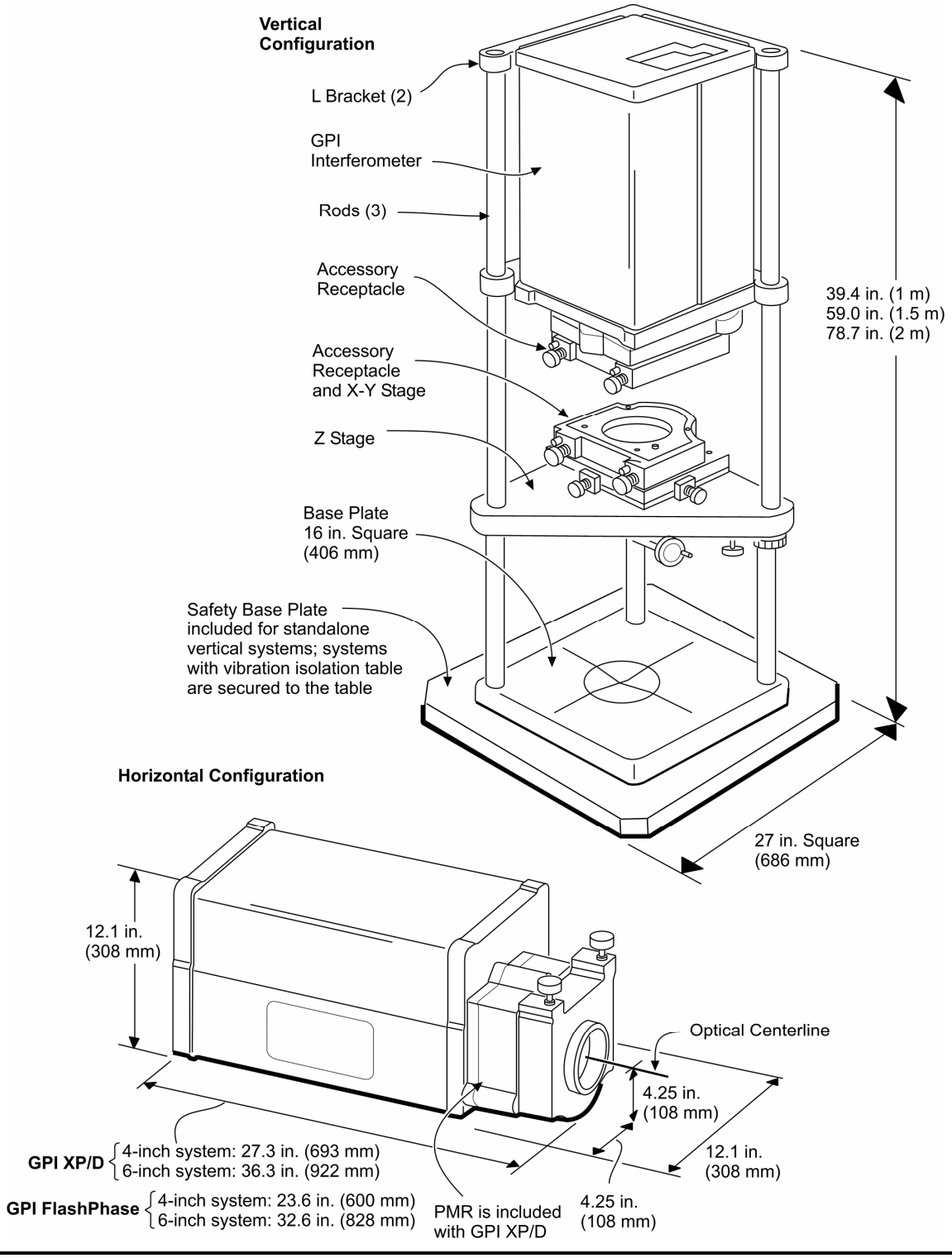


GPI Components (shown on previous page)

Component	Description
GPI Mainframe	Mainframe is a term used for the main interferometer body. The GPI is a high-quality Fizeau interferometer with a low-power, helium-neon laser light source.
PMR	The Phase Measuring Receptacle precisely moves the transmission element as measurements are made to provide phase shifting data. GPI XP/D model only.
Accessory Receptacle	Holds and provides for adjustment of the transmission element mounted in the interferometer aperture.
Transmission Element (optional)	A high quality optical lens that forms the reference wavefront for the GPI. They may be Transmission Flats for measuring flat surfaces or Transmission Spheres for measuring convex or concave surfaces.
Remote Control	Controls settings of the GPI, such as zoom, operation mode, and focus.
Primary Monitor	Flat panel display shows MetroPro graphics and data.
Secondary Monitor (Live Display)	Displays a live image of the part under test. It is used as visual feedback when adjusting the interferometer.
Computer	For system control, data storage, and running MetroPro software.
Keyboard and Mouse	For data entry and software operation.
Power Manager	Distributes power to the system components, provides surge protection, and serves as the system disconnecting device.
Z Stage (vertical configuration)	Positions the test part distance relative to the GPI and the operator.
Accessory Receptacle and X-Y Stage (vertical configuration)	Adjustable stages that provide for part adjustment necessary for testing.  When the Accessory Receptacle is combined with the X-Y Stage and the Z Stage, it is collectively referred to as a 5-Axis Stage.
L Brackets, Rods, and Base Plates (vertical configuration)	The support system for holding the GPI components in an upward or downward orientation. A safety base plate is included for standalone vertical systems; vertical rod systems with a vibration isolation table are secured to the table.

 Detailed specifications for the GPI models are provided at the end of this manual.

GPI Dimensional Information



Computer Components

For descriptions and specifications, refer to the manuals from the original equipment manufacturer.

Replacement of any non-ZYGO components (e.g. monitor, printer, etc.) must be done with CE compliant components.

Installation

Chapter 2

A Note About Installation

This chapter describes the appropriate operating environment, which should be considered before the system is set up. It also provides installation instructions.

Installation instructions for computer equipment are covered separately in documentation provided by the original manufacturers.

Warning!
Installation must be performed by ZYGO trained personnel.

Site Requirements

Consideration	Comment
Floor	The floor should be as stable as possible to avoid transmission of vibrations into the system. A ground level, poured concrete slab is recommended. An optional vibration isolation system is recommended for the GPI XP/D model to minimize vibration effects from other equipment and human activity. The GPI FlashPhase model is not as susceptible to vibrations and normally does not require a vibration isolation system.
Temperature	The temperature should be in the range of 20 to 23°C (68 to 73°F) and remain relatively constant. Rapid temperature changes degrade performance by causing uneven expansion and contraction of the instrument and parts under test. Air conditioning, heating devices, or vents, in the nearby area, can cause temperature differences.
Air Turbulence	The site should be free of air movement. Air turbulence causes uneven air density within small areas, which can refract portions of the measurement beam and alter the measurement. Fans, heaters, and air conditioners should not blow air onto the instrument.
Cleanliness	Keep the work environment clean. Over time, dust, smoke, and oil can accumulate on the optics and degrade performance. Keeping the site clean and periodically cleaning the instrument will minimize this concern.

Utility Requirements

Requirement	Comment
Electrical	100/120/220/240 VAC at 50/60 Hz Isolated 15 amp circuit with an earth ground.
Compressed Air	For optional vibration isolation table 75 PSI (5.2 bar) dry and filtered source (bottled nitrogen acceptable)

Warning!
The equipment must be electrically grounded through the supply outlet. Any interruption in the ground circuit can cause a shock hazard and could result in personal injury.

The Power Manager plug is used as the disconnecting device. Ensure that the outlet is accessible.

Installation and Assembly Checklist

- Inspect all packages for signs of shipping damage. Report any damage to the carrier.
- Check that the shipment is complete.
- Ensure that the worksite has the required operating environment and utilities.
- Contact your ZYGO representative to make arrangements for installation and training.
- Move all shipping containers to the worksite. Allow the equipment to acclimate for at least 24 hours. ZYGO recommends that you save the shipping containers for future transport of the equipment.

Warning!
When lifting or moving equipment or pallets, contact the appropriate local and national agencies in your country for proper lifting recommendations.

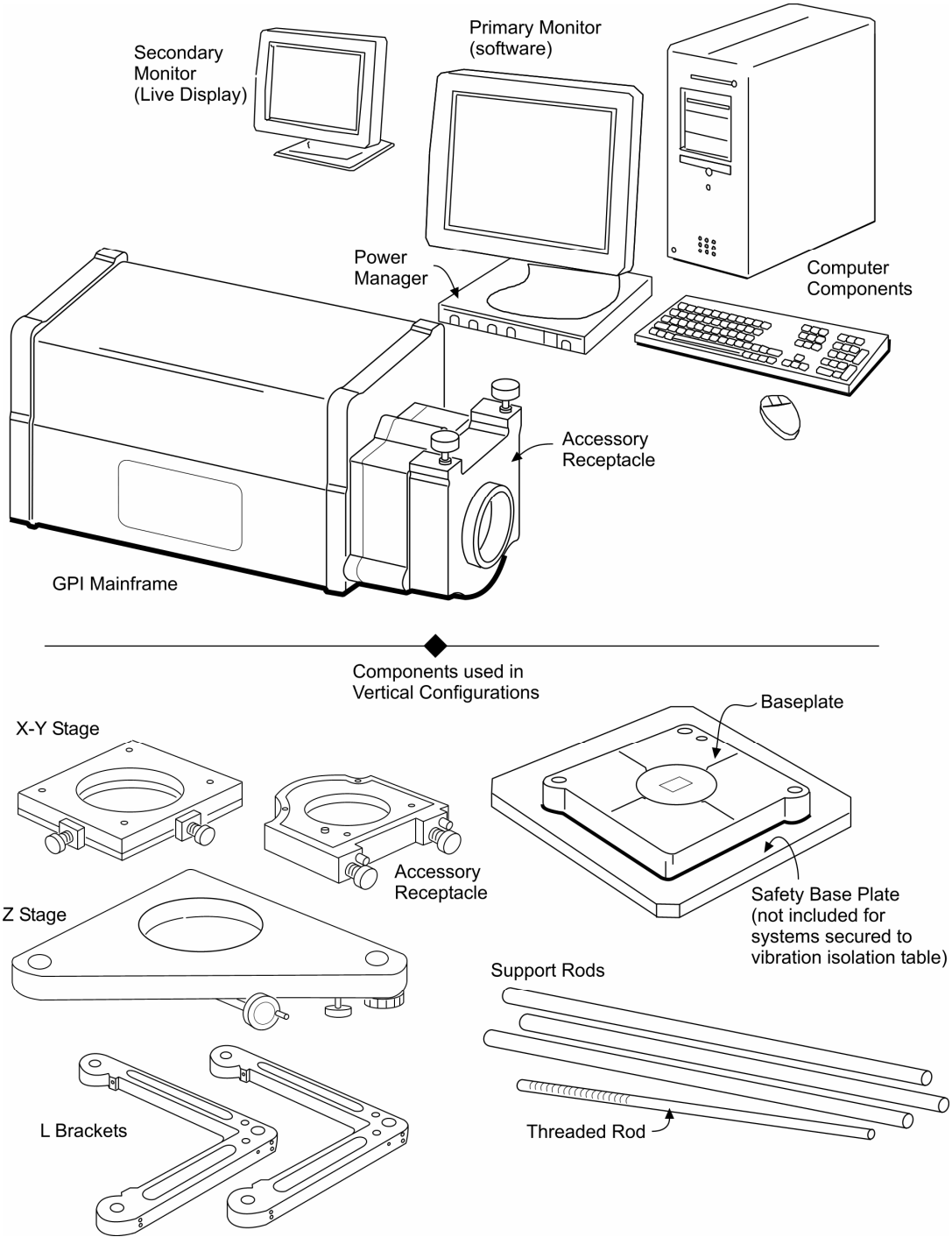
Installing the Computer

Most of the computer components are simply unpacked, set in position, and then interconnected with cables. For reference purposes, a cable interconnection diagram is included later in this chapter.

Using the Assembly Instructions In This Chapter

The GPI can be used in Upward or Downward-Looking configurations, or in the horizontal orientation. The various parts mentioned in these procedures are shown in the following illustration. Assembly instructions for each configuration are included in this chapter.

Assembly Parts

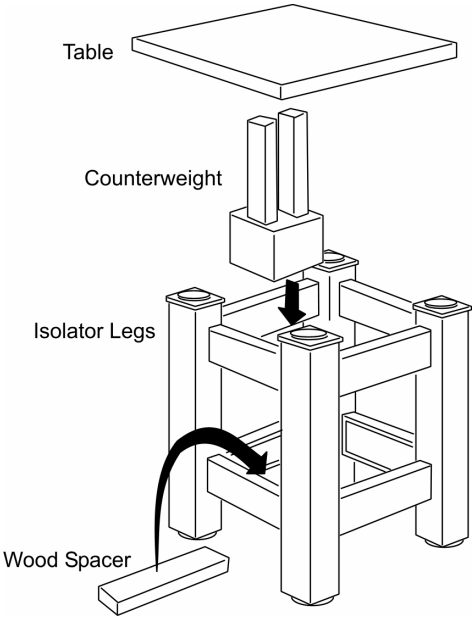


Installing a Vibration Isolation System for a Vertical Configuration

When moving and installing a vibration isolation system have several helpers and/or use a forklift or hoist with lifting straps. Contact the appropriate agencies in your country for proper lifting recommendations. Weights listed in the following steps are approximate.

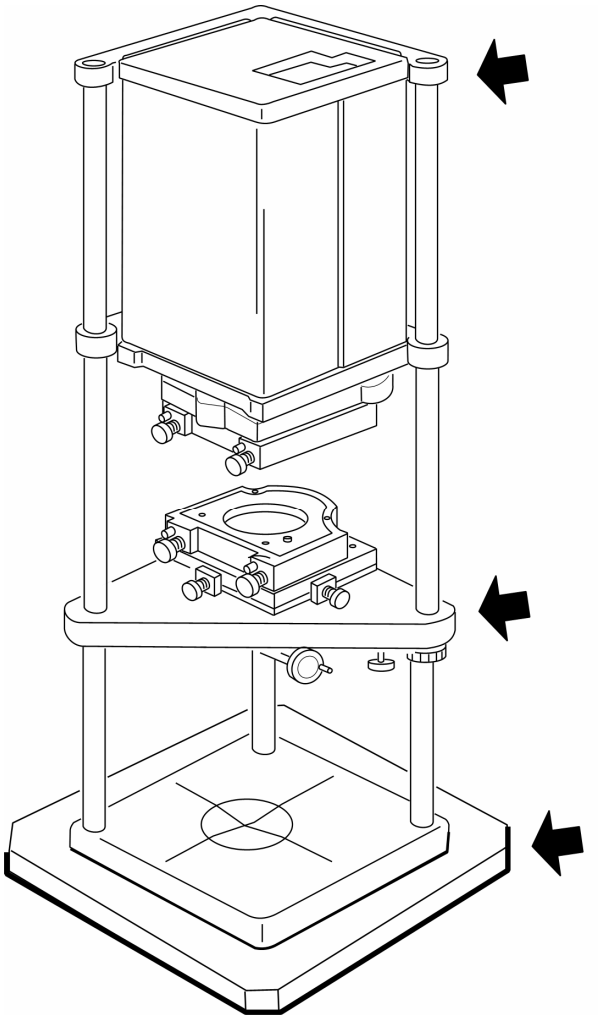
1. Open the box containing the vibration isolation system.
2. Move the isolator legs into position at the installation site. Weight: 200 lb (90 kg).
3. Place the wood spacer inside the lower leg brackets.
4. Place the counterweight on top of the wood spacer. Weight: 90 lb (41 kg)
5. Place the table top on top of the legs. Weight: 300 lb (136 kg)
6. Attach the counterweight to the bottom of the table with the supplied bolts.
7. Follow the instruction included with the vibration isolation system for connecting an air supply to the isolators.

Optional Vibration Isolation System for Vertical Configurations



Assembling the Downward Looking Configuration

Handling Locations for the GPI in Downward-Looking Configuration



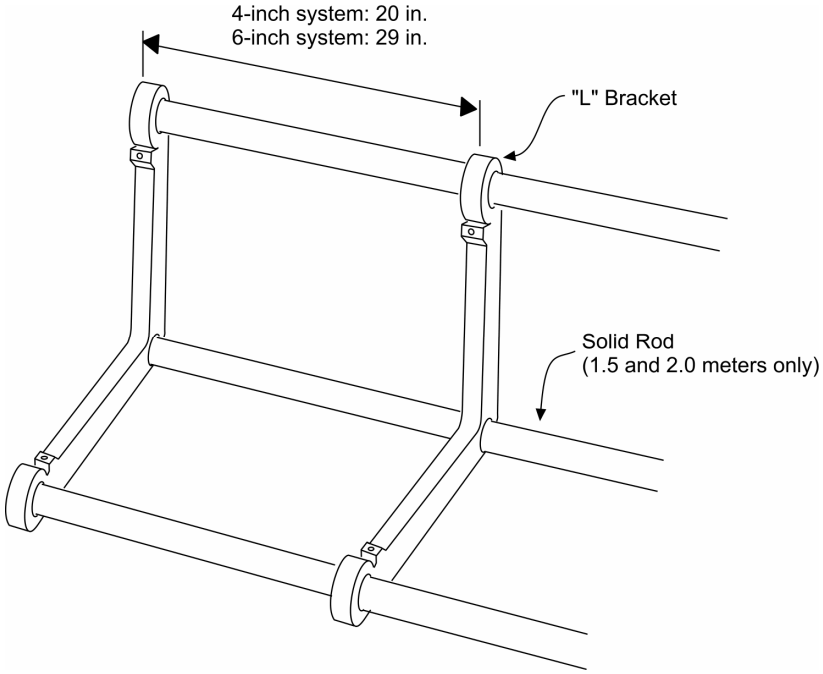
Warning!
A typical GPI 4-inch system weighs more than 160 lb (73 kg) with the baseplate and rods. The 6-inch system weighs more than 170 lb (77 kg) with the baseplate and rods. Have at least 3 or 4 people available to assemble and move this system. Arrows in the above diagram show optimal locations for handling. Contact the appropriate agencies in your country for proper lifting recommendations.

Attaching the “L” Brackets to the Support Rods

The 1.5 and 2.0 meter rod kits contain two hollow rods and one solid rod. The solid rod must be positioned in the center hole of the “L” bracket assembly as shown below.

1. Place one “L” bracket on the rods approximately 20 inches (29 inches for a 6-inch system) from the end of the rods. (This is the amount of clearance required for proper seating of the interferometer. See the illustration below.) Do not tighten the 10-32 set screws yet, as you may need to adjust the position of the brackets on the rods.
2. If you are using the monitor bracket, slide it onto one of the hollow rods. Do not secure the bracket in place yet. You may want to adjust its position after you place the interferometer on the rod assembly.
3. Place the second “L” bracket on the rods. Place this bracket so that it is flush with the ends of the rods. Slightly tighten the 10-32 set screws only on the solid rod at this time.
4. Slide the threaded rod through the smaller opening in the “L” brackets.

Attaching the “L” Brackets to the Support Rods

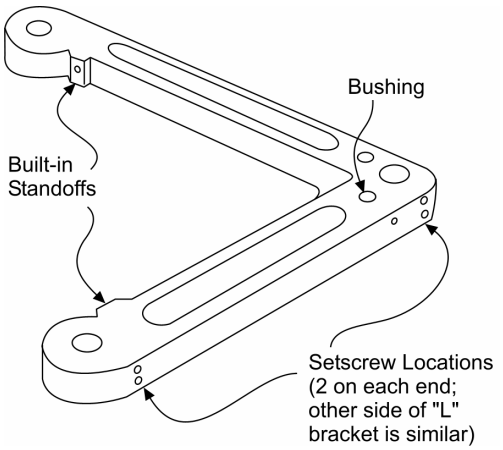


Attaching the Interferometer to the Rods

Warning!
The next sequence of steps involves attaching the interferometer to the rod assembly. Have some assistance (3 or 4 people) available for lifting the interferometer.

1. Check the rod assembly to ensure that the built-in standoffs are facing up.
2. Lift the interferometer and place it on the rods. Seat the interferometer in the recessed channels and stand-offs in the upper and lower "L" brackets. It may be helpful to have someone hold the interferometer in place while you tighten the screws that secure it to the "L" brackets.
3. Each "L" bracket has four 1/4-20 socket head screws that secure the interferometer in place. Tighten the four exposed screws.

Standoffs Facing Up

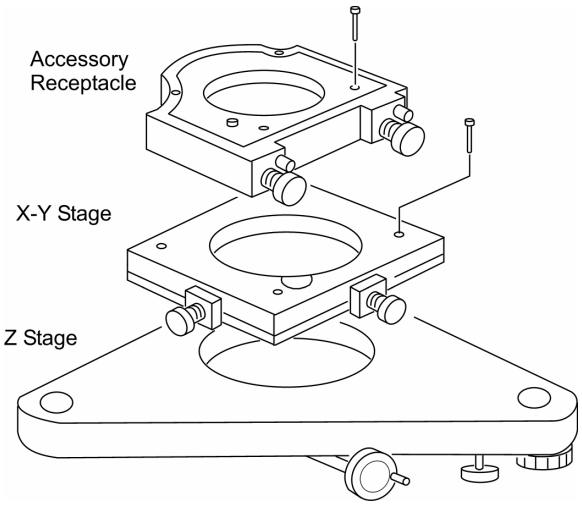


4. Move the entire assembly to the upright position.
5. Insert and tighten the remaining interferometer screws.
6. Tighten the set screws on the "L" bracket.

Attaching the X-Y Stage to the Z Stage

1. Place the X-Y Stage on the Z Stage aligning the screw holes. Attach the X-Y Stage to the Z Stage using the four 10/32 low head setscrews provided.
2. Position the Accessory Receptacle on the X-Y Stage and tighten the four setscrews.

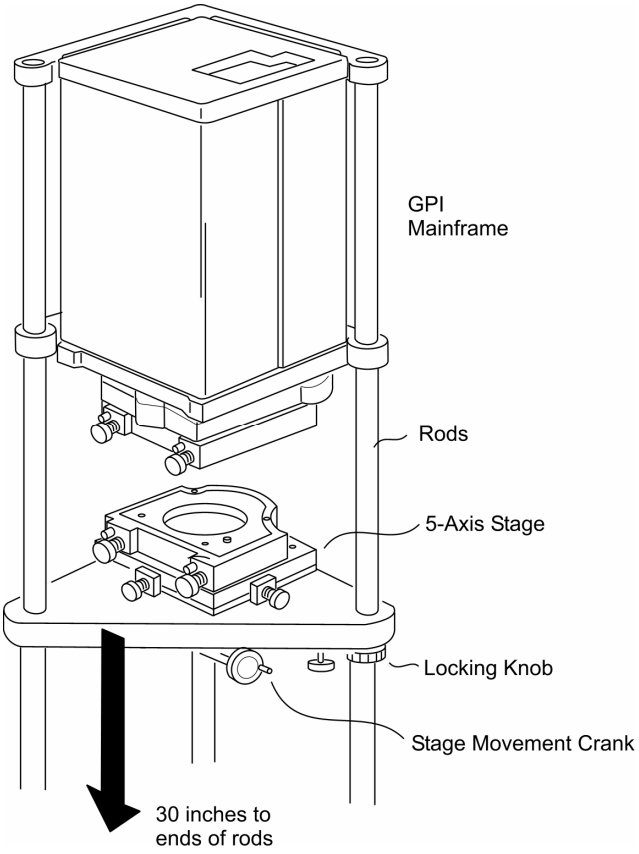
Assembling the 5-Axis Stage



Installing the 5-Axis Stage on the Rods

1. Rotate the Locking Knob on the Stage one half turn counter clockwise.
2. Place the 5-Axis Stage on the rods as shown.
3. Using the Crank on the stage, move the stage along the rods so that it is at least 30 inches from the ends of the rods.

Placing the Stage on the Rods (Downward Configuration)

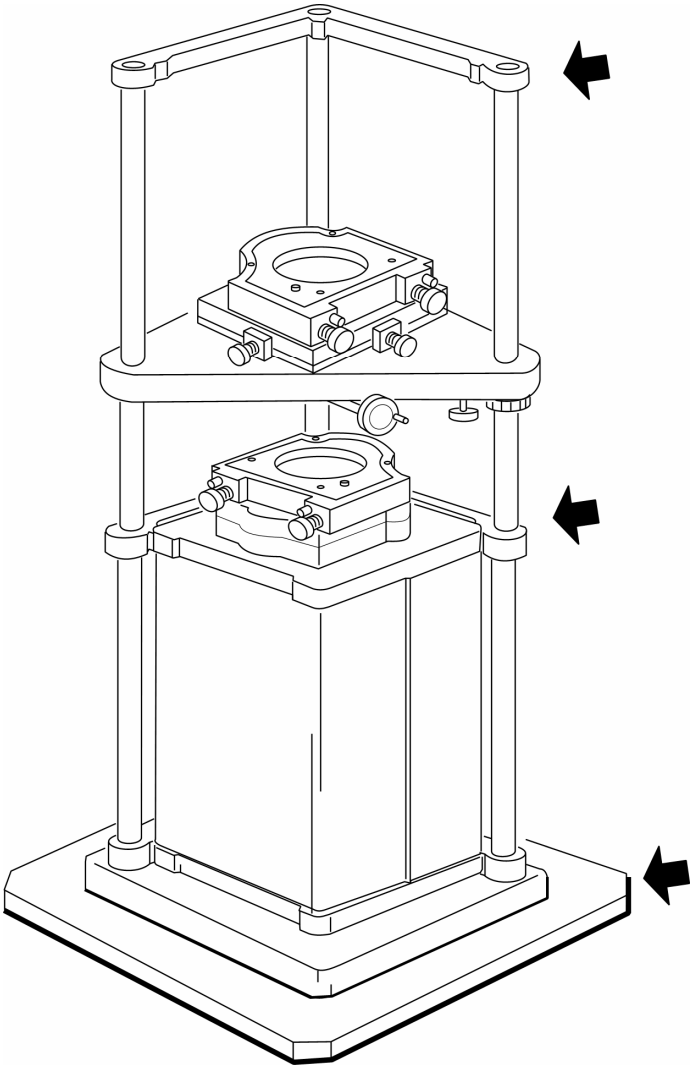


Attaching the Base Plate

1. Insert the small brass bushing (for the threaded rod) into the base plate opening.
2. Place the base plate on the rods. Ensure that the base plate is seated on the rods.
3. Tighten the setscrew, located in the base plate, for each rod.
4. With the proper assistance, lay the system down.
5. If the safety base plate is included, attach the safety plate to the bottom of the base plate with the four capscrews provided.
6. With proper assistance, lift the system to the downward-looking vertical position.

Assembling the Upward Looking Configuration

Handling Locations for the GPI in the Upward-Looking Configuration



Warning!
A typical GPI 4-inch system weighs more than 160 lb (73 kg) with the baseplate and rods. The 6-inch system weighs more than 170 lb (77 kg) with the baseplate and rods. Have at least 3 or 4 people available to assemble and move this system. Arrows in the above diagram show optimal locations for handling. Contact the appropriate agencies in your country for proper lifting recommendations.

Attaching the “L” Brackets to the Support Rods

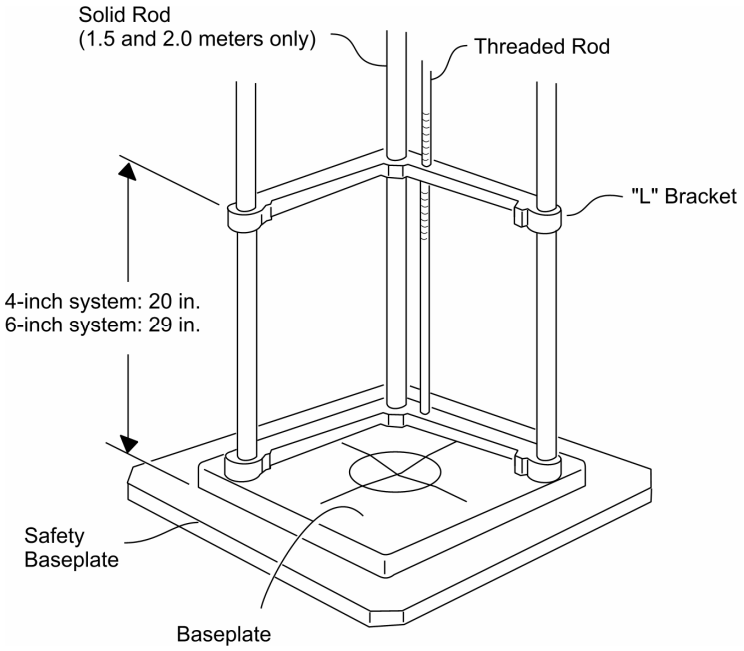
The 1.5 and 2.0 meter rod kits contain two hollow rods and one solid rod. The solid rod must be positioned in center hole in the “L” bracket assembly.

1. Place one “L” bracket on the rods approximately 20 inches (29 inches for a 6-inch system) from the end of the rods. This is the amount of clearance required for proper seating of the interferometer. Do not tighten the 10-32 set screws yet, as you may need to adjust the position of the brackets on the rods.
2. If you are using the video monitor bracket, slide it onto one of the hollow rods. Do not secure the bracket in place yet. You may want to adjust its position after you place the interferometer on the rod assembly.
3. Place the second “L” bracket on the rods. Place this bracket approximately 3 inches from the ends of the rods. This leaves space for installing the base plate. Slightly tighten the 10-32 set screws only on the solid rod at this time.
4. Slide the threaded rod through the smaller opening in the “L” brackets. This rod should be flush with the bracket.

Attaching the “L” Bracket Assembly to the Base Plate

1. Place the small brass bushing in the remaining small opening on the base plate.
2. Place the assembly on the base plate as shown below.
3. Secure the assembly in place by tightening the setscrews in the base plate.
4. If the safety base plate is included, attach the safety base plate to the bottom of the base plate with the four capscrews provided.

Installing the Rods in the “L” Bracket and Base Plate



Attaching the Interferometer to the Rods

Warning!
The next several steps involve moving the interferometer from the horizontal to vertical position. Have at least 3 or 4 people available to move the system.

1. Check the rod assembly to ensure that the built-in standoffs are facing up. (Refer to the illustration entitled “Standoffs Facing Up.”)
2. Lift the interferometer and place it on the rods. Seat the interferometer in the recessed channels and stand-offs in the upper and lower “L” brackets. It may be helpful to have someone hold the interferometer in place while you tighten the screws that secure it to the “L” brackets.
3. Each “L” bracket has four 1/4-20 socket head screws that secure the interferometer in place. Tighten the four exposed screws.
4. For easy cable connection, it is a good idea to connect the interferometer power cord, the video monitor cable, and the Remote Control cable to the appropriate connectors on the conector panel of the interferometer (refer to the “Cable Connection” section of this chapter).
5. Move the entire assembly to the upright position.
6. Insert and tighten the remaining interferometer screws.
7. Tighten the setscrews on the “L” bracket.

Attaching the X-Y Stage to the Z Stage

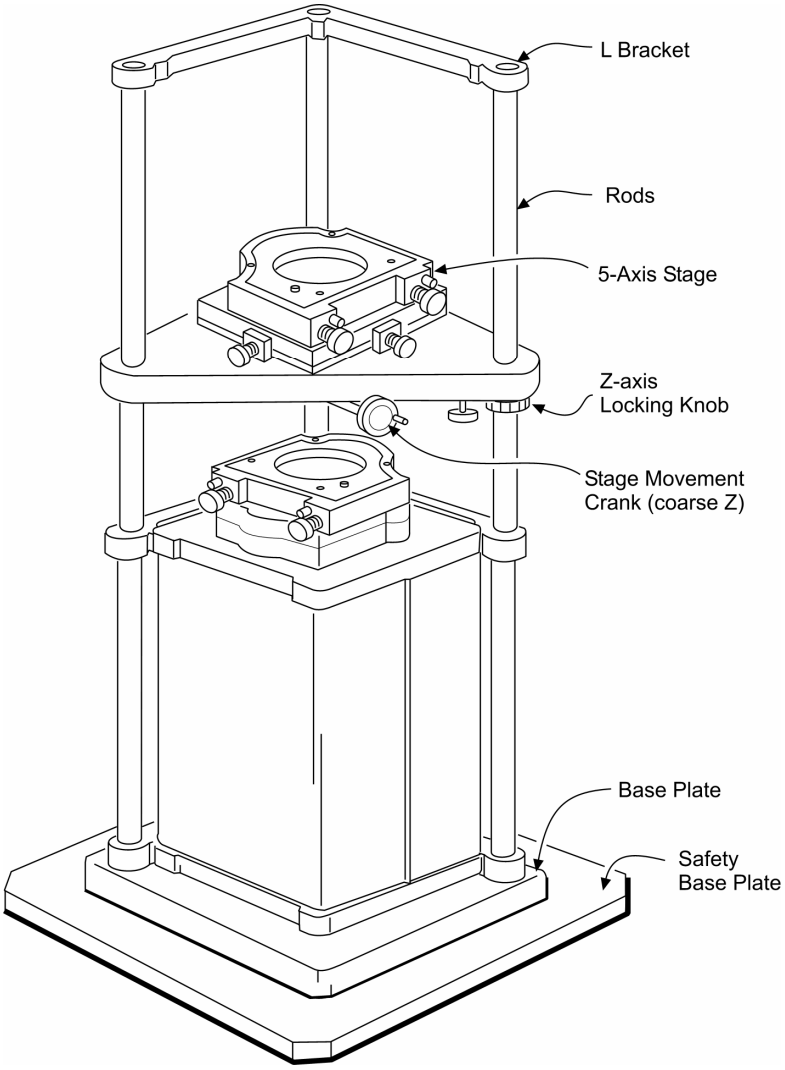
Refer to the illustration entitled “Assembling the 5-Axis Stage.”

1. Place the X-Y Stage on the Z Stage aligning the screw holes. Attach the X-Y Stage to the Z Stage using the four 10/32 low head screws provided.
2. Position the Accessory Receptacle on the X-Y Stage and tighten the four screws.

Installing the 5-Axis Stage on the Rods

1. Rotate the Locking Knob on the Stage one-half turn counter clockwise.
2. Place the 5-Axis Stage on the rods as shown.
3. Using the crank on the stage, move the stage down on the rods so that it is at least 30 inches from the ends of the rods.
4. Place the third "L" Bracket on the top of the rods. Tighten the setscrews to secure the bracket in place on the rods.

Placing the Stage on the Rods (Upward-Configuration)



System Setup in the Horizontal Configuration

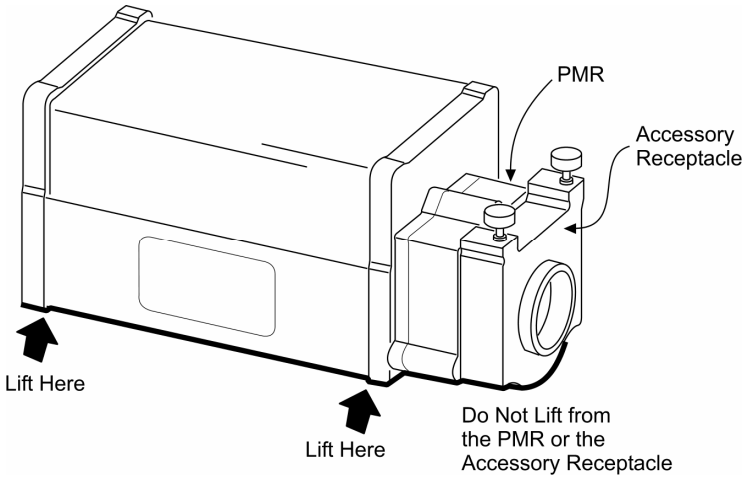
This configuration requires the use of a vibration isolation table, a 2-Axis or 5-Axis mount, and self-centering element holder.

Consult with your ZYGO representative for the selection of the most suitable table and accessories for your measurement application.

Warning!
When moving and installing the vibration isolation system, have several people available and use a forklift or hoist with lifting straps. Contact the appropriate agencies in your country for proper lifting recommendations.

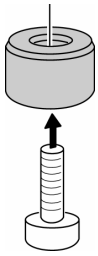
A typical GPI 4-inch system weighs 80 lb (36 kg). The 6-inch system weighs 90 lb (41 kg). Have at least 2 people available to move this system. Arrows in the following diagram show optimal locations for handling.

Handling Locations for the Horizontal Configuration



Attaching Interferometer Feet

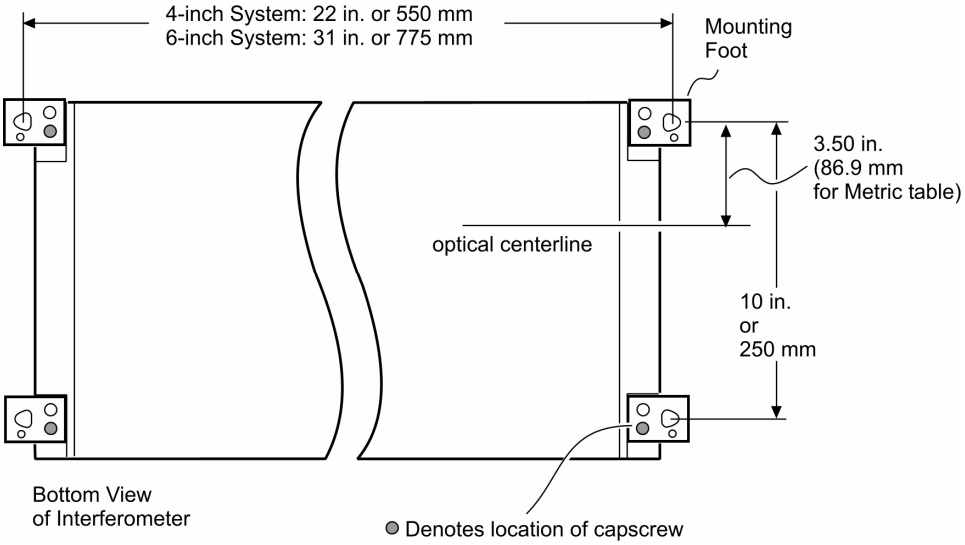
1. Lay the interferometer on its side so that you can access the bottom on the unit.
2. Attach the feet using the screws provided to the four recessed areas on the bottom of the interferometer. Be sure that the flat surface of each foot is placed against the interferometer. The cap screw fits inside of the foot.
3. Return the interferometer to the upright position.



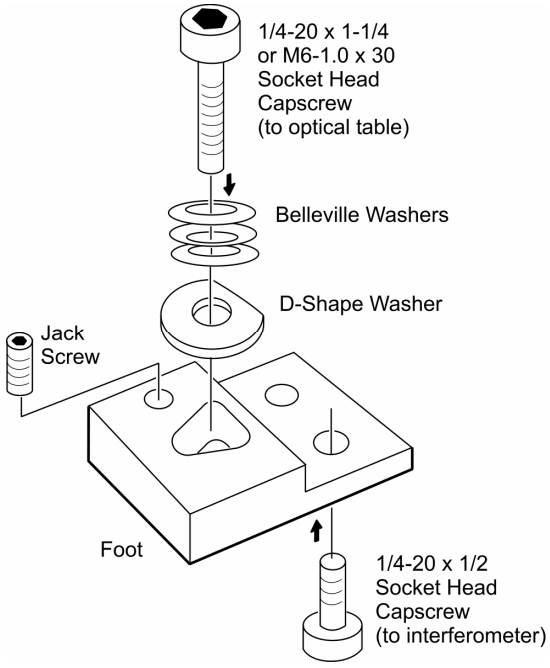
Mounting the Interferometer to an Optical Table

With an optional mounting kit (ZYGO P/N 6500-0179-02) the interferometer can be mounted to either 1/4-20 holes on 1-inch grid table or M6-1.0 holes on 25 mm grid table. The kit contains all necessary hardware.

Mounting Dimensions Using the Optical Table Mounting Kit



Optical Table Foot shown with Hardware



Connecting Cables

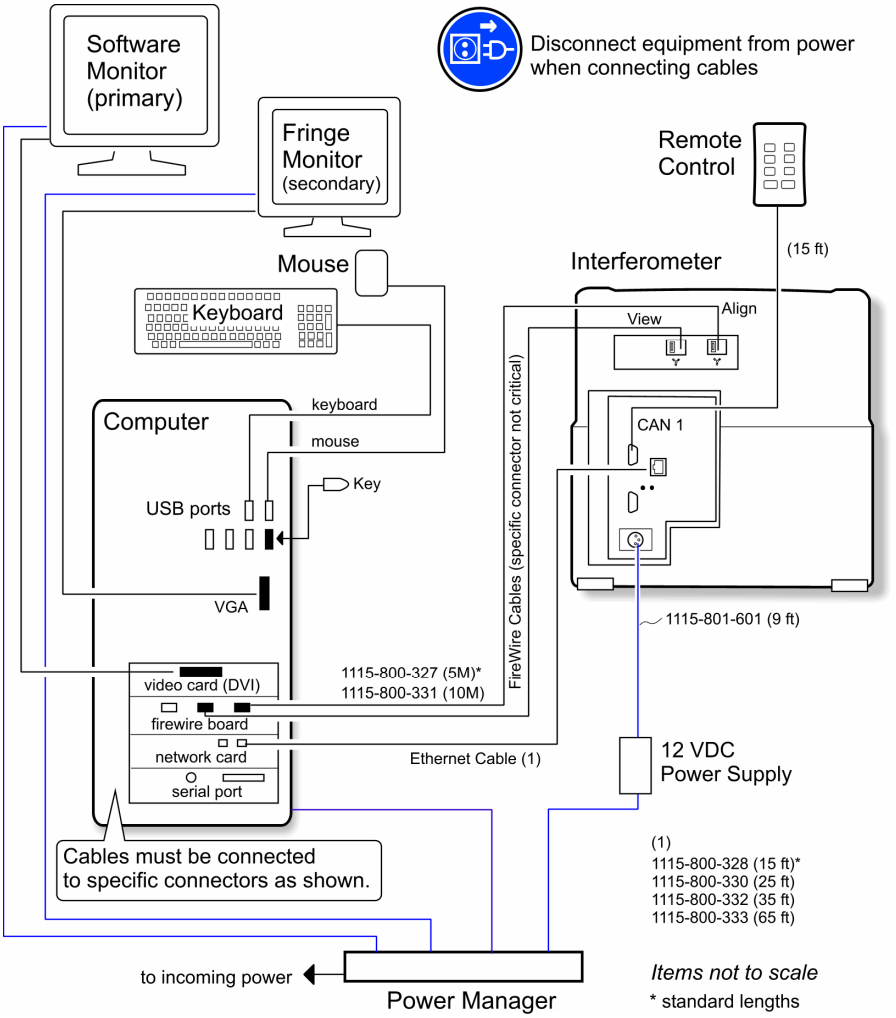
General Cable Guidelines

- Remove protective caps from connectors before attaching cables.
- Some connectors have alignment keys. Align keyed connectors before attempting to join them together.
- Ensure that cables are located so they do not introduce vibration into the system.

Warning!
Disconnect equipment from power when connecting cables.

The equipment must be electrically grounded through the supply outlet. The Power Manager is for power distribution for the system. Non-system equipment should not be connected to the Power Manager.

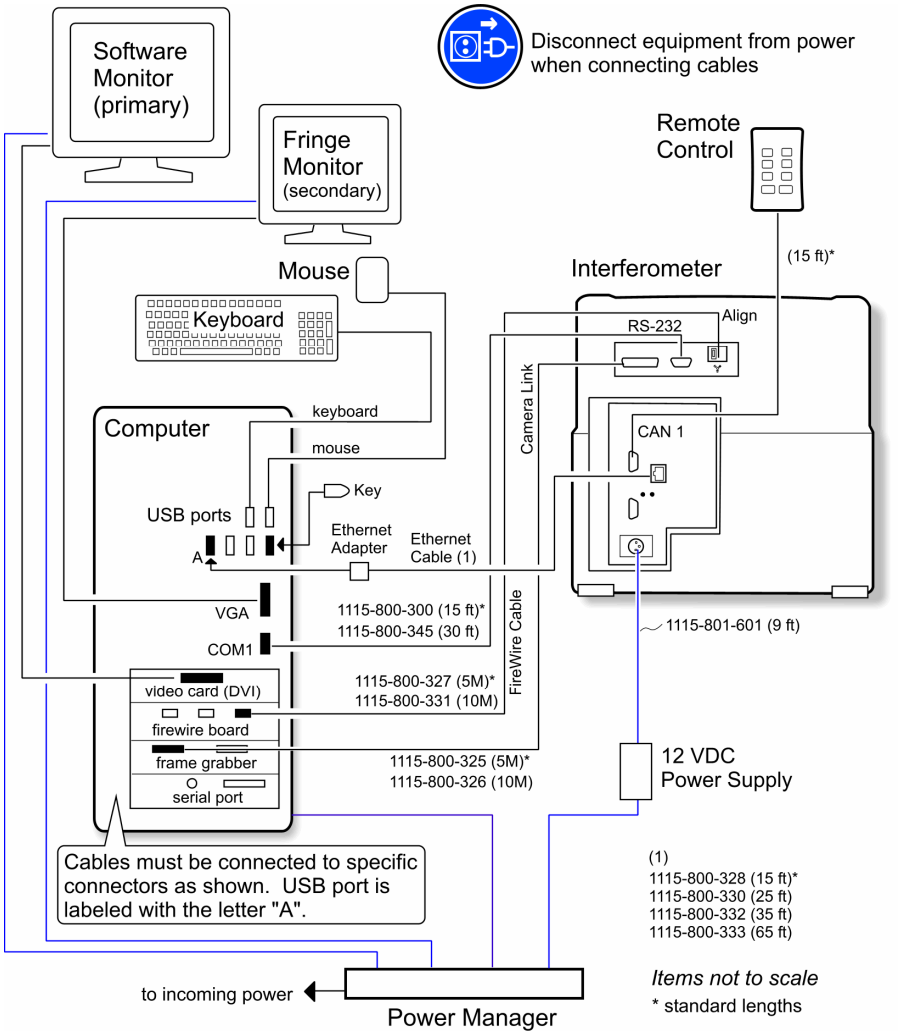
Cable Connections- GPI FlashPhase, and GPI XP/D



Standard Long Cable Kit (30 ft) Option (P/N 6500-0747-30)

Quantity	ZYGO P/N	Description
1	1115-800-345	Remote control extension
2	1115-800-331	FireWire Align and View cameras
1	1115-800-332	Ethernet

Cable Connections- GPI XP/D with Optional 1K x 1K Camera



1K Long Cable Kit (30 ft) Option (P/N 6500-0744-30)

Quantity	ZYGO P/N	Description
2	1115-800-345	Camera and Remote Control extension
1	1115-800-331	FireWire Align camera
1	1115-800-332	Ethernet
1	1115-800-326	Camera Link data camera

Operation

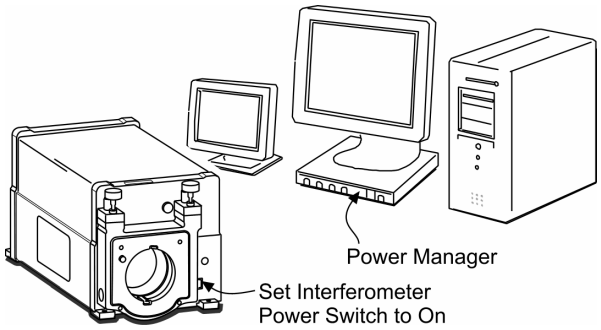
Chapter 3

A Note About Operation

Warning!
The operator must be trained before operating the system. Read all operation instructions before starting the equipment. The equipment should only be used in the manner for which it is intended.

Starting the Interferometer

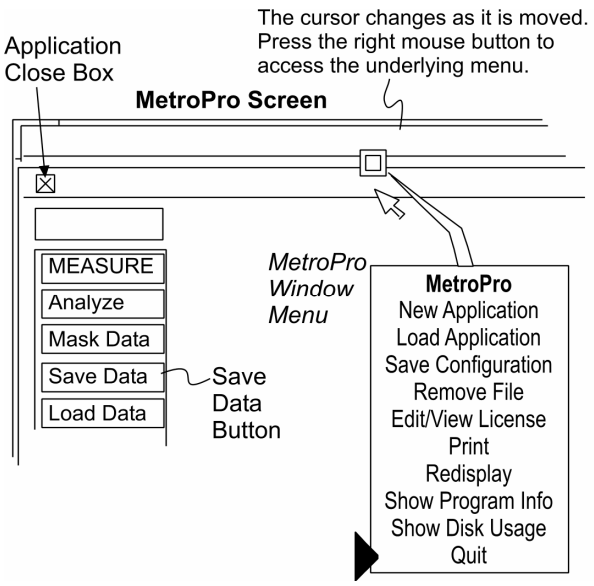
1. Push the Beam Attenuator in. Turn on all components with the master switch on the Power Manager.
2. After the Log On to Windows message appears, press Ctrl-Alt-Del to log on. Type a username and password. If you do not have a username, enter "zygo" and press [Enter].
3. Locate the MetroPro program icon and double click it.



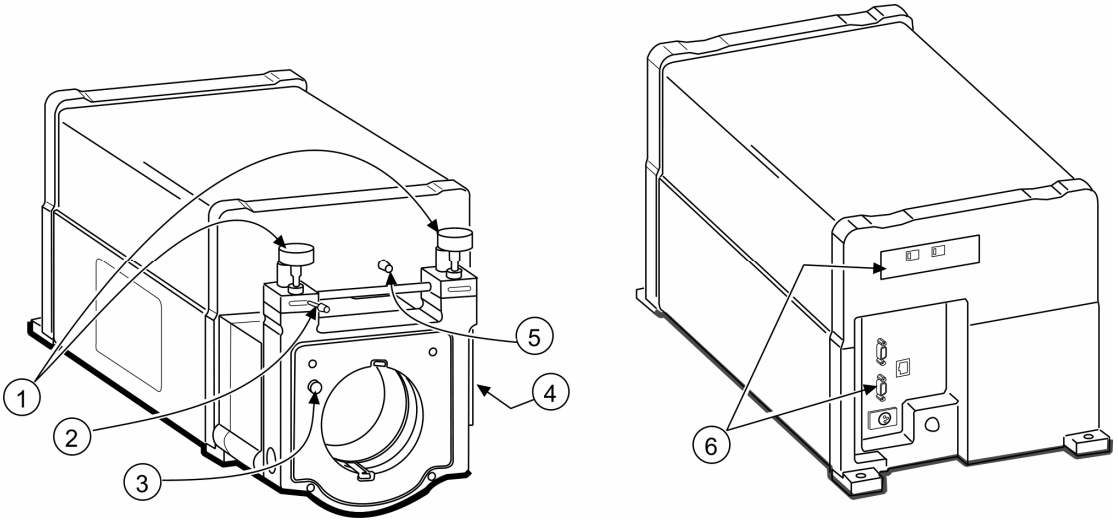
Turning Off the Interferometer

1. Save data and other files.
2. Close open applications by clicking the close box in the upper left corner.
   Press and hold the right mouse button; choose Quit from the MetroPro Window menu.
   Select the Windows Shutdown command.
3. Turn off all components using the master switch on the Power Manager.

Sample MetroPro Screen

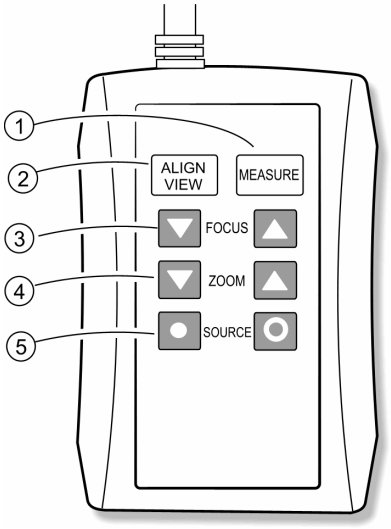


GPI Controls



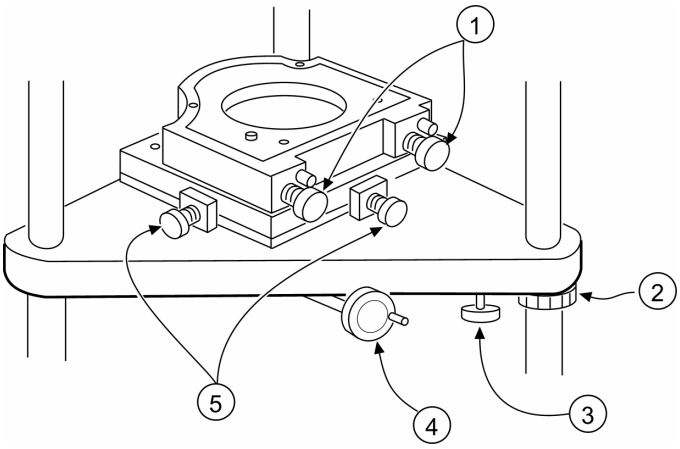
Ref	Control	Description
1	Accessory Receptacle Tip/Tilt Knobs	Adjusts the tip and tilt of a transmission element mounted in the Accessory Receptacle. Used to align the element to the interferometer.
2	Accessory Receptacle FlashPhase Lever	Adds the required tilt before making a FlashPhase measurement. Standard with GPI FlashPhase.
3	Accessory Receptacle Locking Knob	Turn clockwise to lock the installed transmission element in place in the Accessory Receptacle.
4	Power Switch (1/0) and Emission Indicator (hidden in view above)	In the Off position (0), the laser is not energized and laser radiation is not emitted from the instrument. In the On position (1), the indicator light in the switch is lit and laser radiation may be emitted from the instrument's aperture.
5	Beam Attenuator Knob	When *pulled out*, blocks the laser beam from being emitted from the instrument.
6	Connector Panels	Provides connections to the computer, remote control, and power.

Remote Control



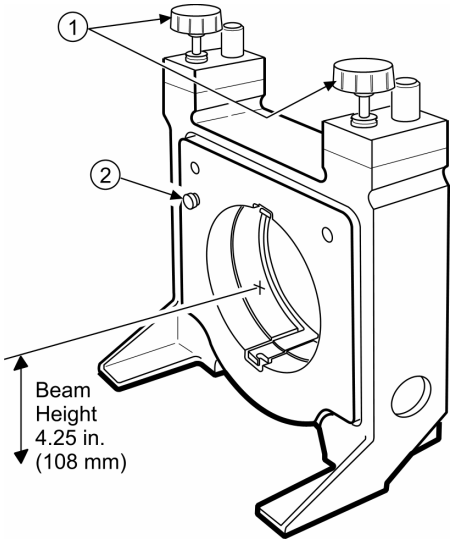
Ref	Button	Description
1	Measure	Begins a measurement; same as pressing F1 on the keyboard.
2	Align/View	Toggles the operation mode. In View mode the light level is 10%. In Align mode the light level is 100%.
3	Focus	Focuses the interferometer in the indicated direction.
4	Zoom	Selects the relative size of the image area in the indicated direction. The zoom range is 6:1.
5	Source	Selects the light source as spot or ring. Functional for VeriFire interferometers only.

5-Axis Stage Controls (vertical configuration)



Ref	Control	Description
1	Accessory Receptacle Tip/Tilt Knobs	Adjusts the tip and tilt of a test part. Used to align the test part to the interferometer.
2	Z-axis Locking Knob	When tightened the 5-Axis Stage is secured to the rods.
3	Fine Z Control	Moves the 5-Axis Stage in the Z axis along the rods in fine increments.
4	Stage Movement Crank	When turned it moves the 5-Axis Stage in the Z axis along the rods in coarse increments.
5	X and Y Knobs	Adjusts the lateral location of the Accessory Receptacle in X and Y axes. Used when measuring spherical parts.

2-Axis Adjustable Mount (option)



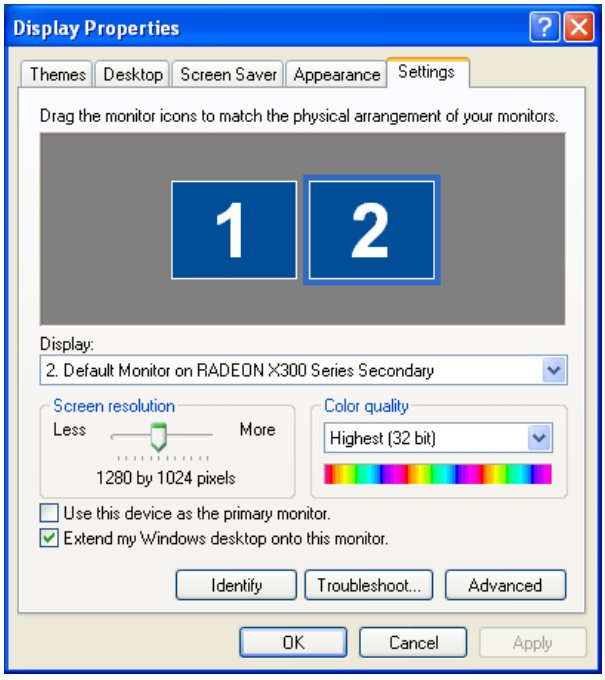
Ref	Control	Description
1	Tip/Tilt Knobs	Adjusts the tip and tilt of a test part. Used to align the test part to the interferometer.
2	Locking Knob	Turn clockwise to lock the installed accessory, such as a Self Centering Element Holder, in place in the Adjustable Mount.

Using the Secondary Monitor as the Live Display

It may be necessary to perform these steps if the software is not configured for dual monitors. The primary monitor serves as the main software screen and the secondary monitor serves as the Live Display. This secondary monitor is also called the fringe monitor or video monitor.

Extending the Desktop to Two Monitors

1. Right-click the desktop, and then click Properties.
2. In the Display Properties dialog box, click the Settings tab.
3. Click the Display list and select the secondary external monitor.
4. Select the Extend my Windows desktop onto this monitor option. Click Apply or OK. Now two monitors are connected to the computer. This allows you to drag items across your screen onto alternate monitors.

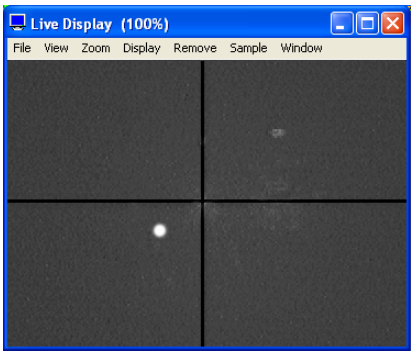


Configuring the Live Display

1. Open the MetroPro Live Display window and drag it onto the secondary monitor.

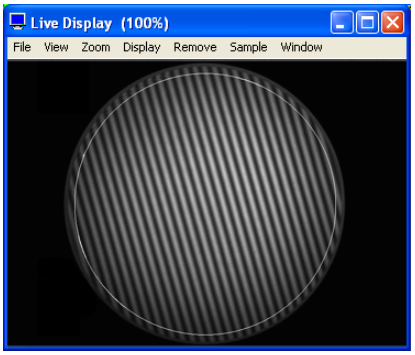
The Live Display

The Live Display window shows a live image of the part under test. It typically is displayed in the secondary monitor. Some uses of the Live Display are shown below.



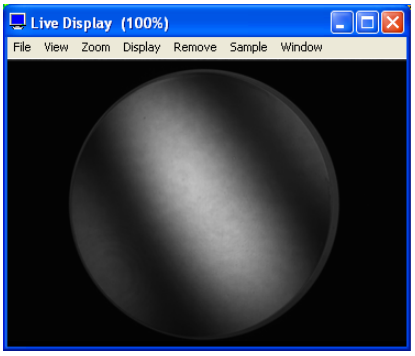
Test Part Tilt Feedback

The Live Display provides feedback on the tilt of the test part when the system is in align mode. Adjust the tip and tilt knobs on the Adjustable mount to move the brightest dot into the center of the crosshairs.



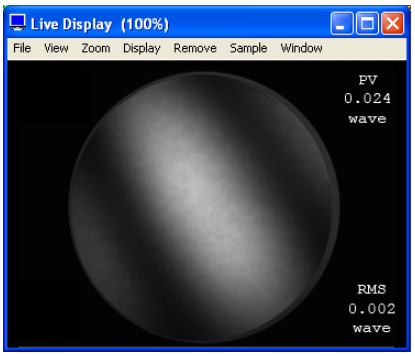
Display Fringe Pattern and Zoom Aid

The Live Display shows a fringe pattern image of the test part and a mask. The fringe pattern is the light and dark bands caused by interference of light reflected from the part surface. The mask was created with the Mask Editor and defines the outer border of the analyzed data. Push the Remote's Zoom buttons (1X and 6X) to fill the mask with the fringe pattern.



Nulled Part Aid

The Live Display shows a nulled fringe pattern. The term "null" means to minimize the number of fringes. This means the tilt of the test part is adjusted so the light striking the part reflects back into the instrument.



Display and Print Results

The Live Display can show results and notations. The items displayed in the Live Display window are determined by the Video Monitor Output window in MetroPro. The Live Display can be printed to an optional printer with the File → Print menu.

To include the results in the printout, check Include Overlay in the Print dialog box.

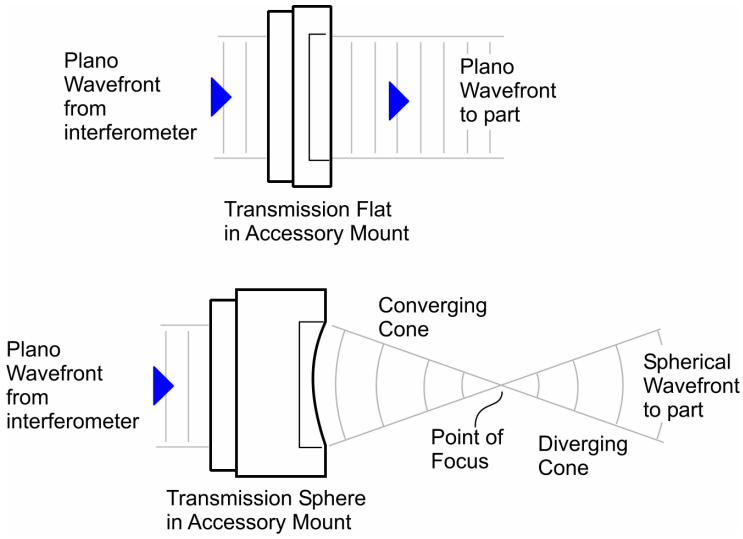
Selecting Transmission Elements

The term "Transmission Element" refers to a Transmission Flat or Transmission Sphere. The quality of the transmission element selected for testing is important to the accuracy of the measurement. The element's front surface (reference) forms the reference wavefront to which the surface (or transmitted wavefront) is compared. Therefore, the accuracy of the measurement is directly related to the quality of the transmission element used. ZYGO offers a wide variety of transmission elements, both plano and spherical for testing flat, spherical, and near spherical optical components.

The Measurement Wavefront

Laser light passing through the transmission element becomes the measurement wavefront. A Transmission *Flat* allows the collimated laser light to pass through unaltered, resulting in a plano measurement wavefront traveling in a straight shaft of light. A Transmission *Sphere* converts the collimated laser beam to a spherical wavefront, which is a converging cone of light as it leaves the Transmission Sphere and becomes a diverging cone of light after passing the point of focus.

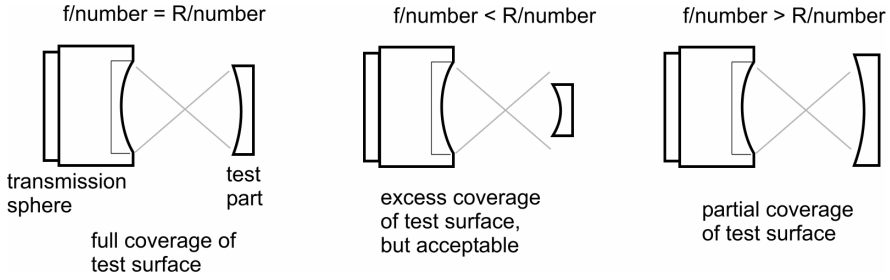
Measurement Wavefronts



Selecting Transmission Spheres for Concave Surfaces

To measure the entire surface of a test part, the cone of light from the Transmission Sphere must be large enough to completely cover the surface being tested. To achieve this, the f/number of the Transmission Sphere must be equal to, or less than, the R/number of the test part.

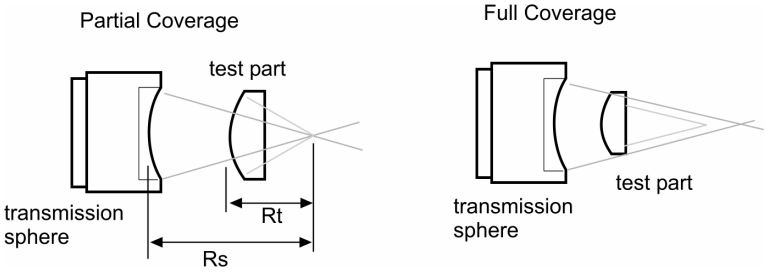
Selecting Transmission Spheres for Measuring Concave Surfaces



Selecting Transmission Spheres for Convex Surfaces

To measure at least a portion of a convex surface, the radius of curvature of the surface must be shorter than the distance from the front surface of the Transmission Sphere to its focal point. To measure the entire surface of a convex element, the f/number of the Transmission Sphere must also be less than the R/number of the convex element.

Selecting Transmission Spheres for Measuring Convex Surfaces



Radius of convex test surface (Rt) must be less than the distance between the Reference Sphere surface and the focal point (Rs).

In this diagram, the f/number is higher than the R/number, resulting in only partial coverage of the test surface.

To test the entire surface, the f/number must be less than the R/number.

Installing Transmission Elements

Warning!
In the steps that follow, do not touch the surface of the transmission element. Fingerprints can permanently damage the optical coating and surface.

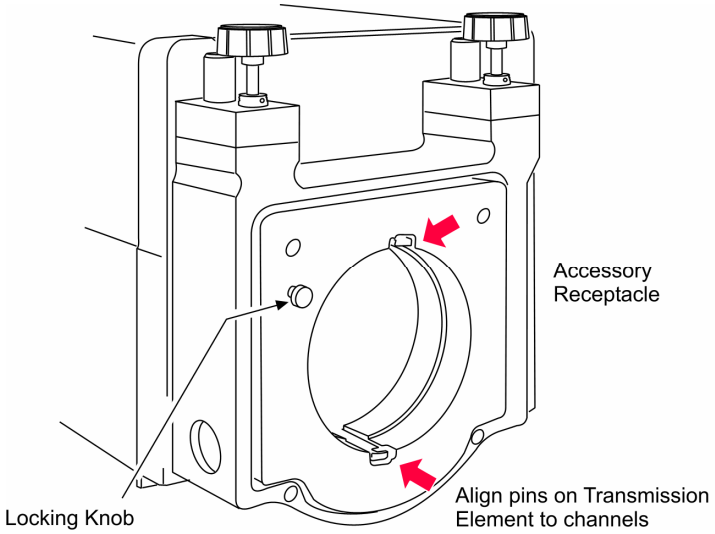
1. Grasp the element by the metal edges and remove it from the protective container.
2. Align the two small metal pins on the edges of the element with the two slots on the Interferometer Accessory Receptacle.

Warning!
When the system is assembled in the downward looking configuration, *do not remove* your hand from the transmission element until you have locked it in place in the Accessory Receptacle as described in the next step.

3. Gently push the element into the interferometer Accessory Receptacle and continue to hold the element in place touching only the metal edges. Turn the black locking screw clockwise. This locks the element into the accessory receptacle.

To remove the element from the Accessory Receptacle, support the element by holding it on the metal rim and then turn the black locking screw counter clockwise.

Installing a Transmission Element



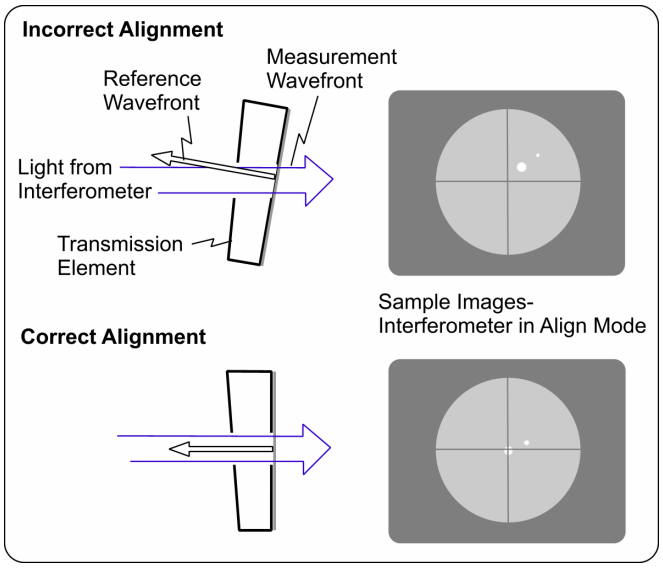
Aligning the Transmission Element

Before you can make measurements, you must align the transmission element to the interferometer and then align the test part to the element. Aligning either transmission flats or transmission spheres is covered below.

Aligning the test part is covered in the "Measuring Surface Quality" and "Measuring Transmitted Wavefront Quality" sections.

1. Ensure that the Beam Attenuator knob is in the ON position (pushed in).
2. Press the ALIGN/VIEW button on the Remote Control. The alignment target (crosshairs) and one or more bright spots will appear on the monitor. The brightest spot represents the reflection off the outermost surface of the transmission element.
3. Turn the tip and tilt knobs on the *interferometer's* Accessory Receptacle until the brightest spot is superimposed on the crosshairs center.

Aligning a Transmission Element



Measuring Surface Quality

Testing a Plano Surface

Required Equipment:

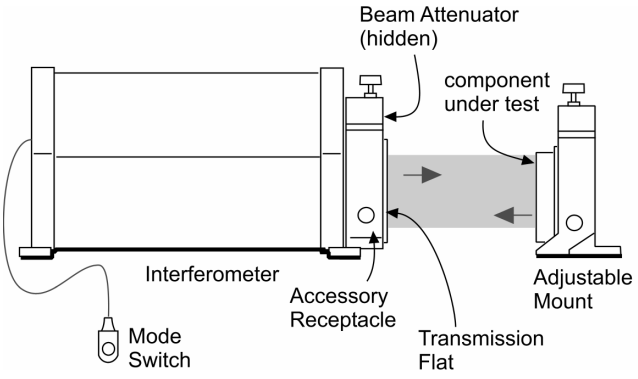
- Transmission Flat
- 5-axis Stage (for vertical configuration)
- Adjustable Mount, 2-axis (stage) (for horizontal configuration)

1. Press the Remote Control Align/View button to put the interferometer into the Align mode.
2. Align transmission element to interferometer (described in a previous section).
3. Place test part in the interferometer test beam.

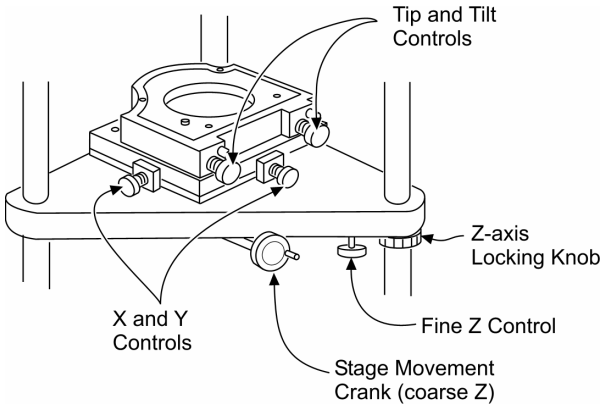
   Minimize the space between the interferometer and the part being tested to reduce the impact of air turbulence.
4. If a spot from the test part is not visible on the Live Display slowly move the part around until it appears.
5. Align test part to the transmission flat by turning the tip and tilt knobs to move the second spot over the top of the first spot. When the two spots are perfectly superimposed they disappear.

   For a vertical configuration use the 5-axis Stage's tip and tilt knobs. For the horizontal configuration use the Adjustable Mount's tip and tilt knobs.
6. Press the Remote Control Align/View button to put the interferometer into the View mode.

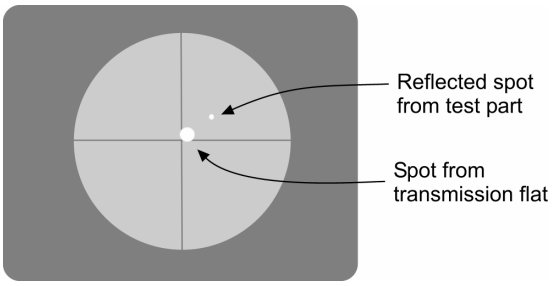
Plano Surface Measurement (Horizontal)



5-Axis Stage (Vertical)

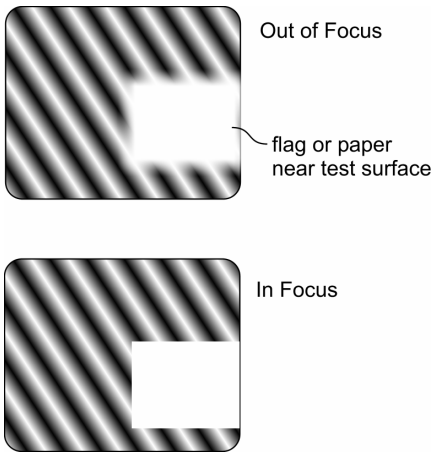


Aligning the Test Part to the Interferometer
Example Live Display Image

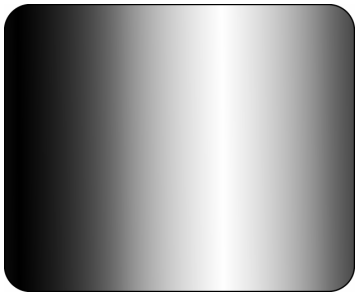


7. If necessary, adjust the zoom function using the ZOOM buttons (1X and 6X) on the Remote Control until the section of the test surface that you want to examine fills as much of the Live Display's screen as possible.
8. Position the Alignment Flag (or a piece of paper) in the field of view, close to the surface being tested. This provides a clean edge on which you can focus.
9. Fine-tune the test part tip and tilt to minimize (null) the number of fringes.
10. If measuring in the Phase mode, continue to step 11. If measuring in the FlashPhase mode, introduce tilt into the test cavity by moving the Accessory Receptacle FlashPhase lever.
11. Click the MetroPro Measure button to make a measurement.

Using the Flag as a Focus Aid



Example Nulled Fringe Pattern



Testing a Concave Surface

Required Equipment:

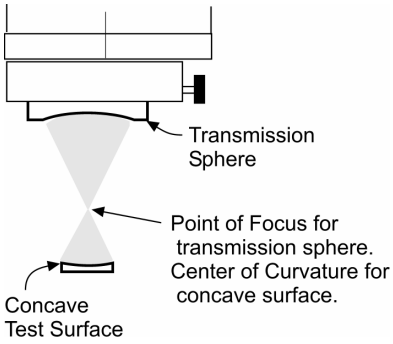
- Transmission Sphere (selected for coverage of test surface)
- 5-axis Stage (for vertical configuration)
- High Accuracy Mount (stage) (for horizontal configuration)
- Alignment Flag

1. Press the Remote Control Align/View button to put the interferometer into the Align mode.
2. Align transmission element to interferometer (described in a previous section).
3. Position an Alignment Flag in the beam just in front of the transmission sphere. Slowly move the Alignment Flag away from the interferometer to get an idea of the shape of the beam. As the beam leaves the interferometer it comes to focus and then diverges.
4. Position the Flag such that the measurement beam appears as a point of light on the flag. This is the beam's point of focus.
5. Adjust the Alignment Flag so the point of light passes through the hole in the flag.
6. Place the spherical test part on the stage just behind the Alignment Flag in the diverging portion of the test beam.
7. Move the part stage straight away from the interferometer until the measurement beam reflected from it comes to a point of light on the back of the Alignment Flag.
8. Adjust the lateral positioning of the spherical test part so the point of light passes through the hole in the Alignment Flag. The beam reflected from the test surface should appear as a bright dot on the Live Display. Remove the Alignment Flag from the test area.

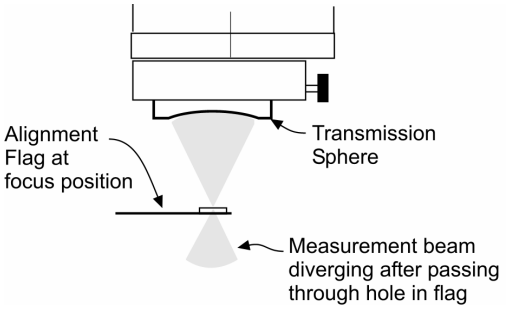
   For a vertical configuration use the 5-axis Stage's X and Y knobs. For the horizontal configuration use the High Accuracy Mount's X and Y knobs.
9. Carefully adjust the Z position of the part stage until the dot of light on the Live Display align screen is as small as possible.

   For a vertical configuration use the 5-axis Stage's Fine Z control. For the horizontal configuration use the High Accuracy Mount's Z knob.

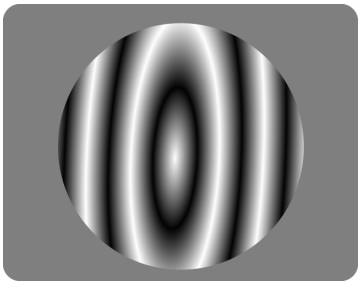
Positioning a Concave Test Part



Positioning the Alignment Flag



Example Concave Fringe Pattern



10. Fine-tune the stage's X and Y axis controls until the dot of light is superimposed on the crosshairs.
11. Press the Remote Control Align/View button to put the interferometer into the View mode. A fringe pattern should be visible on the Live Display.
12. If the fringe pattern consists of concentric rings, turn the Z control in the direction that makes the fringe rings appear to move toward the center of the screen. Continue to adjust the z axis until the fringes are as straight as possible.
13. Fine-tune the stage's X and Y axis controls to minimize (null) the number of fringes. You may also have to fine-tune the Z axis control to keep the fringes straight.
14. If measuring in the Phase mode, continue to step 15. If measuring in the FlashPhase mode, introduce tilt into the test cavity by moving the Accessory Receptacle FlashPhase lever.
15. Click the MetroPro Measure button to make a measurement.

Testing a Convex Surface

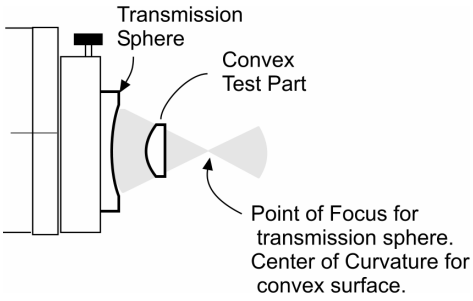
Required Equipment:

- Transmission Sphere (selected for coverage of test surface)
- 5-axis Stage (for vertical configuration)
- High Accuracy Mount (stage) (for horizontal configuration)

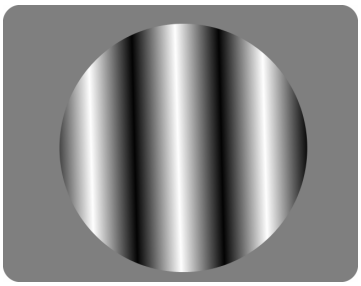
1. Press the Remote Control Align/View button to put the interferometer into the Align mode.
2. Align transmission element to interferometer (described in a previous section).
3. Place the convex test part on the part stage.
4. Position the test surface as close as possible to the transmission sphere; then *slowly* pull the convex part straight away from the interferometer until you see a spot of light appear on the Live Display. This spot of light is the wavefront reflecting from the convex surface.
5. Adjust the location of the part stage in the Z axis until the dot of light on the Live Display is as small as possible.

For a vertical configuration use the 5-axis Stage's Coarse Z Crank. For the horizontal configuration move the entire High Accuracy Mount.

Positioning a Convex Test Part



Example Convex Fringe Pattern



6. Fine-tune the X and Y axis controls on the part stage until the dot of light is superimposed on the crosshairs on the Live Display.

   For a vertical configuration use the 5-axis Stage's X and Y knobs. For the horizontal configuration use the High Accuracy Mount's X and Y knobs.

7. Press the Remote Control Align/View button to put the interferometer into the View mode. A fringe pattern should be visible on the Live Display.
8. Fine-tune the z axis position of the part stage until the fringes are as straight as possible.

   For a vertical configuration use the 5-axis Stage's Fine Z knob. For the horizontal configuration use the High Accuracy Mount's Z axis knob.

9. Fine-tune the stage's X and Y axis controls to minimize (null) the number of fringes. You may also have to fine-tune the Z axis control to keep the fringes straight.
10. If measuring in the Phase mode, continue to step 11. If measuring in the FlashPhase mode, introduce tilt into the test cavity by moving the Accessory Receptacle FlashPhase lever.
11. Click the MetroPro Measure button to make a measurement.

Measuring Transmitted Wavefront Quality

Testing Transmitted Plano Wavefront (horizontal configuration)

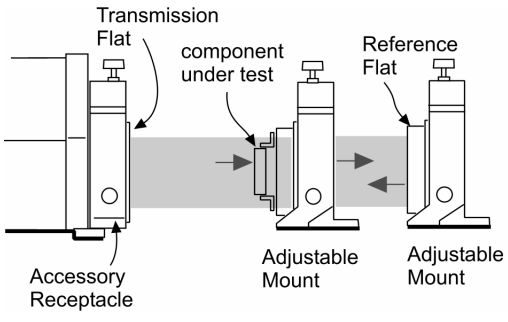
The simplest transmitted wavefront quality test is one involving a single plano element that has little or no wedge, typically a window of some type.

Required Equipment:

- Transmission Flat
- Reference Flat
- Two Adjustable Mounts
- Self Centering Element Holder (to hold plano optic)
- Alignment Flag

1. Press the Remote Control Align/View button to put the interferometer into the Align mode.
2. Align transmission element to interferometer (described in a previous section).
3. Place the Reference Flat in an Adjustable Mount.
4. Position the Reference Flat so that it is within the interferometer's measurement beam and is as close as practicable to the Transmission Flat while leaving enough room to position the plano optic and its mount between them.

Typical Transmitted Wavefront Setup

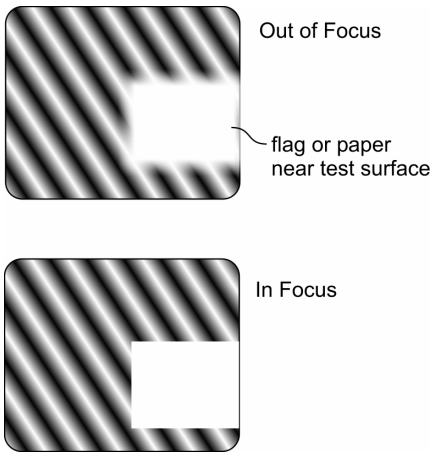


5. Adjust the tip and tilt of the reference flat until its corresponding bright spot on the alignment screen is superimposed on the intersection of the crosshairs.
6. Place the plano optic to be tested in a mount that allows tip and tilt adjustment. Position the mounted plano optic between the transmission flat and the reference flat.
7. Adjust the tip and tilt of the plano optic so that its corresponding bright spot on the alignment screen is near, but *not* superimposed on the intersection of the alignment crosshairs.
8. Press the Remote Control Align/View button to put the interferometer into the View mode. You should be able to see an interference pattern on the Live Display.

   To be sure the interference pattern is the result of transmitted wavefront and not the surface of the plano optic, place a piece of paper between the plano optic and the reference flat. If the paper blocks the interference pattern, the pattern is a result of transmitted wavefront.
9. If necessary, adjust the x-axis (side-to-side) position of the plano optic such that it (or the portion of it that you need to test) falls within the interferometer's measurement aperture. Watch the Live Display while making position adjustments.

   You may want to temporarily switch back to the Align mode to make sure the bright dot from the test optic is still near the intersection of the crosshairs.
10. If necessary, adjust the zoom function until the section of the test surface that you want to examine fills as much of the Live Display's screen as possible.
11. Position the Alignment Flag or a piece of paper in the field of view, close to the reference flat being tested. This provides a clean edge on which you can focus.
12. Using the FOCUS button on the remote control, adjust the focus so that the edges of the Alignment Flag are as sharp as possible.
13. Fine-tune the tip and tilt of the test surface to minimize (null) the number of fringes.

Focusing With an Alignment Flag

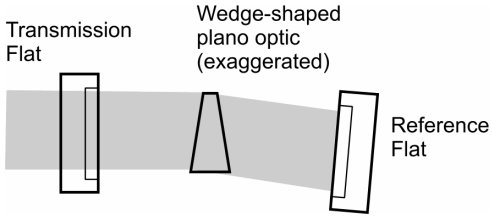


14. If measuring in the Phase mode, continue to step 15. If measuring in the FlashPhase mode, introduce tilt into the test cavity by moving the Accessory Receptacle FlashPhase lever.
15. Click the MetroPro Measure button to make a measurement.

Testing Plano Optics with Wedge

Testing a wedge-shaped plano optic (one having sides that are not parallel to one another) is similar to testing one that is not wedge-shaped, except for a few special adjustments noted in the following paragraphs. The adjustments are necessary because the measurement beam changes direction slightly as it passes through the wedge-shaped optic.

Beam Passing Through Wedge Optic



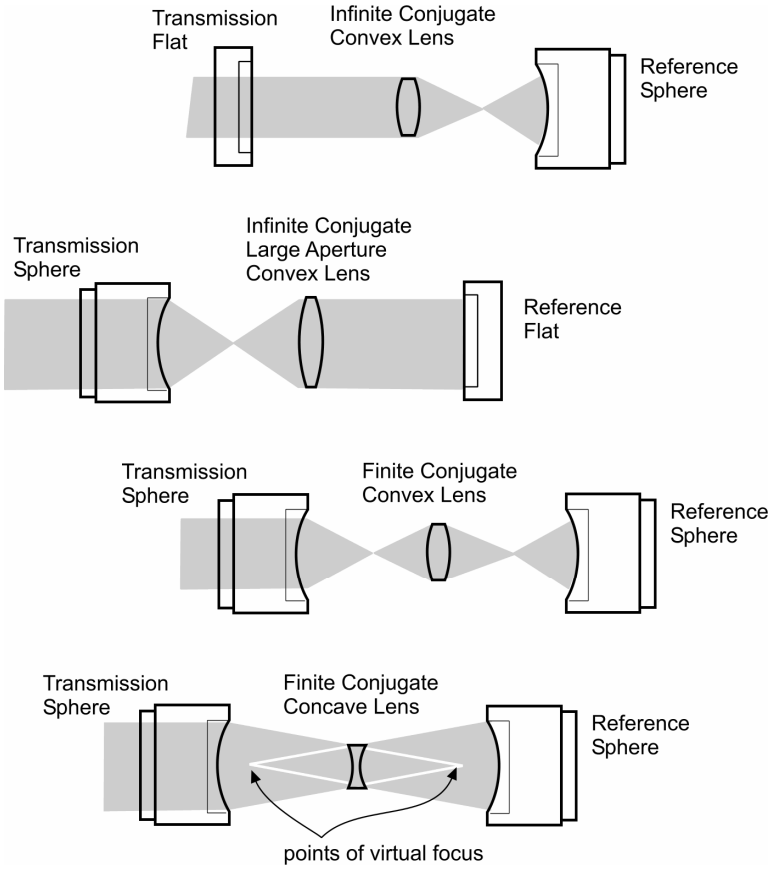
1. Perform steps 1 through 4 of the previous procedure.
2. Watch the Live Display as you place the test optic between the interferometer and the reference flat. Notice that the wavefronts reflected from the surfaces of the wedge optic show up as two bright dots on the alignment screen. (The distance between the dots depends on the amount of wedge in the optic.) Also, as you insert the test optic in the measurement beam, watch for the appearance of an additional bright dot on the Live Display. This new dot is the reflection off of the reference flat; it will remain stationary as you adjust the position of the wedge optic.
3. Adjust the tip and tilt of the wedge optic such that the two bright dots are equidistant from the intersection of the crosshairs. Adjust the tip and tilt of the reference flat until the *new* bright dot is superimposed on the alignment crosshairs.
4. Continue with step 7 of the previous procedure.

Testing Lens Systems

Spot mode should be used for all lens system testing. In this section, any component tested for transmitted wavefront quality will be referred to as a "lens system," regardless of whether it is comprised of a single spherical element or group of elements.

Creating a test setup for a lens system requires knowledge of its design and intended usage. Selecting the proper transmission element and reference surface and aligning the optical axes of the lens system, interferometer, and reference sphere are crucial to the success of the test. The method for doing these things is almost entirely dependent on the lens system being tested, and is therefore beyond the scope of this manual. Instead, what is provided are several diagrams (next page) illustrating other test setups. For assistance with specific testing needs, contact ZYGO.

Typical Transmitted Wavefront of Lens Systems



Maintenance & Troubleshooting

Chapter 4

Maintenance for the GPI

The GPI is virtually maintenance free. However, it is important to operate the equipment in a relatively clean environment.

To clean the exterior of the interferometer use a commercially available, mild cleanser and a soft cloth to remove dust and fingerprints from the side and front panel of the unit.

Do not clean the front lens of the interferometer with general cleaning solution.

Maintenance for Peripheral Components

Refer to the original manufacturer's documentation for maintenance information for the computer components, and any accessories, such as a printer.

Cleaning Optics

Cleaning of any precision optic risks degrading the surface. Many of the optics used with the interferometer are coated. Coated optics are easily damaged by improper or unnecessary cleaning. The need for cleaning can be minimized by proper handling techniques; return transmission elements to their protective boxes when not in use, and keep the environment clean.

Do not attempt to clean optics within the instrument since system performance may be impaired.

Precautions When Cleaning Optics

Warning!
Be careful when using isopropyl alcohol and methanol; both are flammable and toxic.

Do not reuse any cleaning tissue or pads, reusing tissues can cause contamination and damage to the optic.

Before cleaning optics, remove all rings and jewelry from your hands and wrists; wash you hands thoroughly to remove excess skin oils; and wear lab gloves.

Consult the local agency in your area for requirements concerning proper disposal of cleaning waste.

Recommended Cleaning Materials

Item	Comments
Polyethylene lab gloves	Wear to prevent contamination of surfaces and to protect the skin against harsh chemicals.
Compressed gas with blower nozzle	Use to blow off dust and lint from the optic.
Lens tissue	Use when it is necessary to clean an optical surface. The lens tissue must be optics grade.
Cotton swabs	Use to clean difficult to reach surfaces. The swabs should have wood or paper stems; plastic stems can dissolve in acetone.
Solvents	Use spectroscopic grade isopropyl alcohol and methanol to remove contaminants fixed to the optical surface. Use a mild, neutral 1% soap solution or lens cleaner to remove oily contaminants.

Recommended Cleaning Procedures

Contaminant	Procedure
Dust or light dirt.	1. Blow off loose particles. 2. If any dust remains, twist two sheets of lens tissue around a swab or fold a lens tissue so it is just wider than the area you are cleaning. 3. Dampen the tissue with alcohol or methanol. 4. Wipe the lens straight across once. If it needs additional wiping, use a new swab or tissue.
Fingerprints, oil, and water spots. *Note: Clean surface immediately; skin acids attack lens coatings.*	1. Blow off loose particles. 2. Twist two sheets of lens tissue around a swab or fold a lens tissue so it is just wider than the area you are cleaning. 3. Dampen it with 1% soap solution. 4. Wipe the lens straight across once. If it needs additional wiping, use a new swab or tissue. 5. Repeat steps 2 and 4 with tissue dampened with distilled water to remove soap residue. 6. Repeat steps 2 and 4 with tissue dampened with alcohol or methanol.

Troubleshooting

If you should encounter any difficulty while operating your interferometer, refer to the chart below. Quite often it is a simple problem and can be fixed quickly. If you cannot resolve a problem using this chart, contact ZYGO Customer Support.

Problem	Possible Cause & Correction
Alignment target not displayed on monitor.	Interferometer power switch is in the Off position. Move to the On (1) position. Check the Power Manager. Interferometer Remote Control is in incorrect mode. Press button on the remote to go to align mode. Remote Control is not connected. Check interferometer connector panel. Monitor on/off switch is in off position. Move it to on position. Check the Power Manager. Video monitor cable is disconnected from the interferometer. Check monitor and interferometer connector panels.
Hardware error message.	Computer equipment was reset, but the instrument was not. Restart both the computer and the instrument. If this does not correct the problem, contact the ZYGO service department for additional information.
Interference pattern irregularity— a circular pattern (or more than one) does not seem to be a feature of the test part.	This is a diffraction pattern that is imaged as an Airy Disk pattern. If the diffraction pattern is not in focus, the resulting pattern will not appear as a true Airy Disk. In either situation, the pattern does not represent any defect or feature of the part being measured. It is the result of two interrelated factors. The first is the nature of coherent laser light; the second is the inherent inconsistencies present in some of the system optics. This pattern, or artifact, may be present at the time of manufacture and is specified at $\leq$4 nm peak-to-valley. Please note that the presence of such patterns should not adversely affect the system's ability to meet the stated accuracy specifications of the instrument.
Interferogram not focused.	X, Y, or Z Axis knobs on stage may need adjustment. Adjust for fine-tuning. Interferometer camera may need replacement. Contact ZYGO.
Loss of laser light.	Beam Attenuator knob on interferometer is pulled out. Push in for laser emission. There is no power to the system. Check Power Manager and power switch (1/0) on interferometer.

Problem	Possible Cause & Correction
Interferogram not displayed on video monitor.	Interferometer power switch is in the 0 (off) position. Move to the 1 (on) position. Check Power Manager. Monitor power switch is in the off position. Move it to the on position. Check Power Manager power cord. Secondary display not plugged into dual monitor video adapter or desktop not properly extended to secondary display. Video monitor power cord is disconnected. Check interferometer connector panel. Video monitor contrast and brightness controls are not adjusted correctly. Try adjusting both controls. Interferometer ALIGN/VIEW Remote Control is in wrong mode. Press button. Interferometer camera may need servicing. Contact ZYGO Customer Support.
Interferometer 1/0 (on/off) indicator not lit.	Interferometer power switch is Off. Turn to the On (1) position. There is no power to the system. Check power cord and Power Manager.
Non-uniform image field on monitor.	Transmission element may not be aligned properly. Refer to the "Aligning the Transmission Element" section of Chapter 3. The Beam Attenuator Control is only pulled out part way. Check the position of the control.

Service

Warning!
The equipment does not have any user-serviceable components. Service must be performed by ZYGO trained service personnel. Any attempt to service or repair equipment may void the warranty.

For service on any peripherals, refer to the original manufacturer's documentation.

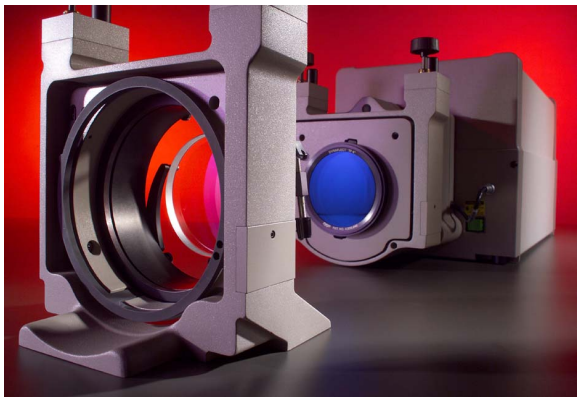
Returning Equipment for Service

To return equipment to ZYGO, it is necessary to have a RA (return authorization) number. Contact ZYGO for a RA Number and instructions on packing and shipping equipment.

Do not return equipment to ZYGO without a RA Number. Equipment returned without a RA number is not accepted.

Telephone numbers for contacting ZYGO are located in the *Customer Support* section of this manual.

GPI XP/D™ Specifications



Model Description

GPI XP/D	Phase-shifting interferometer with digital camera providing 640 x 480 acquisition

System

Measurement Technique	Laser-based, three-dimensional, optical phase-shifting interferometry
Measurement Capability	Measure overall form of reflective surfaces and optics, and transmitted wavefront of optics
Test Beam Diameter Options	4 inch: 4 in. (102 mm) 6 inch: 6 in. (152 mm)
Mounting Options	Horizontal and Vertical, upward and downward-looking
Optical Centerline	4.25 in. (108 mm)
Alignment System	Quick Fringe Acquisition System (QFAS) with twin spot reticle
Zoom Range	6:1 Low distortion discrete zooms optional
Alignment Field of View	4 inch: ±3 degrees 6 inch: ±2 degrees
Pupil Focus Range	-800 mm/ +1600 mm from 4 in. output aperture
Part Viewing	Live Display on computer monitor; separate monitor optional
Computer	High-performance Dell PC with hard drive, CD-R/W, floppy drive, two network interface cards, and 17-inch flat panel monitor; printer optional
Software	ZYGO MetroPro™ software running under Microsoft® Windows XP Professional

Physical

Dimensions (H x W x D)	Horizontal, 4 inch: 12.1 x 27.3 x 12.1 in. (308 x 694 x 308 mm) Horizontal, 6 inch: 12.1 x 36.3 x 12.1 in. (308 x 992 x 308 mm) Vertical: H x 27 x 27 in. (H x 686 x 686 mm) 1 meter H = 39.4 in (1000 mm) 1.5 meter H = 59 in. (1500 mm) 2 meter H = 78.7 in. (2000 mm)
Weight (approximate)	Horizontal, 4 inch: 80 lb (36 kg) Horizontal, 6 inch: 90 lb (41 kg) Vertical, 4-inch: 160 lb (73 kg) Vertical, 6-inch: 170 lb (77 kg)

Performance

Repeatability of Three-Flat Test (1)	$\lambda/300$ (2σ)
Repeatability of rms (2)	$\lambda/10{,}000$ (2σ)
Spatial Sampling	640 x 480 pixels; 1K x 1K pixel camera optional
Resolution	Better than $\lambda/8{,}000$ (double-pass)
Fringe Resolution (3)	640 x 480: 180 fringes 1K x 1K: 380 fringes
Data Acquisition Time	Low Res (7 frames): 93 ms High Res (13 data frames): 173 ms
Digitization	8 bits

Utility Requirements

Input Voltage	100 to 240 VAC, 50/60 Hz
Compressed Air	80 psi (5.5 bar); dry and filtered source (required for optional vibration isolation system)

Environmental Requirements

Temperature	15 to 30°C (59 to 86°F)
Rate of Temp. Change	<1.0°C per 15 min
Humidity	5 to 95% relative, noncondensing
Vibration Isolation	Required for vibration frequencies in the range of 1 Hz to 120 Hz

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Website: www.zygo.com

SS-0031 07/06

GPI XP/D™ Specifications

LASER SPECIFICATIONS

Type	Helium-Neon, Class II
Wavelength	632.8 nm
Output Power at Aperture	≤1 milliwatt
Beam Polarization	Quasi-circular for light efficiency; switchable linear polarization optional
Coherence Length	Greater than 328 ft (100 m)

TEST PART CHARACTERISTICS

Material	Various; glass, super-finished metals, ceramics, and plastics
Preparation	None (typically); measurements are noncontact and nondestructive and performed under ambient conditions
Size (H x W x D) (approximate)	10 x 8 x 8 in. (254 x 203 x 203 mm) with 2-Axis Adjustable Mount
Weight	≤ 50 lb (22.7 kg) with 2-Axis Adjustable Mount
Reflectivity	0.1% to 100% (based on transmission element)

ZYGO offers a wide variety of accessories, including transmission and reference flats, transmission and reference spheres, part mounting options, large aperture components, and radius of curvature measurement options. For information on these accessories, refer to the GPI and VeriFire Accessories booklet, OMP-0463.

NOTATIONS

1 Repeatability of the three-flat test is a practical example of the in-use performance of this instrument. Flat 'A' is tested six times using the three-flat test, using the six available pairs of flats B, C, D, and E to complete six three-flat combinations, with 16 phase averages per data set. The specification represents the 2σ value from these six three-flat tests. System accuracy for relative testing is dependent on the quality of the reference optic.

2 Repeatability of the quoted statistic is for 100 measurements of the same cavity, with 16 phase averages per data set. The specification represents the 2σ value of each statistic.

3 The approximate number of tilt fringes in the part image that can be resolved by the interferometer at 1X.

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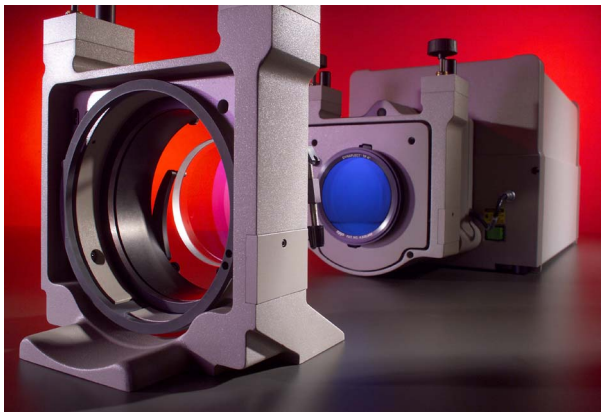
SS-0031 07/06

GPI FlashPhase™ Specifications



MODEL

GPI FlashPhase	FlashPhase™ enabled Fizeau interferometer system with a shuttered digital camera providing 640 x 480 acquisition

GENERAL SPECIFICATIONS

Measurement Technique	Laser-based, three-dimensional, carrier fringe interferometry with proprietary analysis and algorithms
Measurement Capability	Measure overall form of reflective surfaces and optics, and transmitted wavefront of optics
Test Beam Diameter Options	4 inch: 4 in. (102 mm) 6 inch: 6 in. (152 mm)
Mounting Options	Horizontal and Vertical, upward and downward-looking
Optical Centerline	4.25 in. (108 mm)
Alignment System	Quick Fringe Acquisition System (QFAS) with twin spot reticule
Zoom Range	6:1 Low distortion discrete zooms optional
Alignment Field of View	4 inch: ±3 degrees 6 inch: ±2 degrees
Pupil Focus Range	-800 mm/ +1600 mm from 4 in. output aperture
Part Viewing	Live Display on computer monitor; separate monitor optional
Computer	High-performance Dell PC with hard drive, CD-R/W, floppy drive, two network interface cards, and 17-inch flat panel monitor; printers optional
Software	ZYGO MetroPro™ software running under Microsoft® Windows XP Professional

PHYSICAL

Dimensions (H x W x D)	Horizontal, 4 inch: 12.1 x 23.6 x 12.1 in. (308 x 600 x 308 mm) Horizontal, 6 inch: 12.1 x 32.6 x 12.1 in. (308 x 828 x 308 mm) Vertical: H x 27 x 27 in. (H x 686 x 686 mm) 1 meter H = 39.4 in (1000 mm) 1.5 meter H = 59 in. (1500 mm) 2 meter H = 78.7 in. (2000 mm)
Weight (approximate)	Horizontal, 4 inch: 80 lb (36 kg) Horizontal, 6 inch: 90 lb (41 kg) Vertical, 4-inch: 160 lb (73 kg) Vertical, 6-inch: 170 lb (77 kg)

PERFORMANCE

Repeatability of rms (1)	λ/6,000 (2σ)
Wavefront Measurement Uncertainty(2)	λ/10 Uncorrected λ/50 Self corrected
Data Density	640 x 480 pixels 1K x 1K pixels, optional
Resolution	Better than λ/8,000 (double-pass)
Fringe Resolution (3)	180 fringes
Acquisition Rate	75 frames per second
Minimum settable Exposure Time (4)	20 microseconds
Digitization	8 bits

UTILITY REQUIREMENTS

Input Voltage	100 to 240 VAC, 50/60 Hz
Compressed Air	80 psi (5.5 bar); dry and filtered source (required for optional vibration isolation system)

ENVIRONMENTAL REQUIREMENTS

Temperature	15 to 30°C (59 to 86°F)
Rate of Temp. Change	<1.0°C per 15 min
Humidity	5 to 95% relative, noncondensing
Vibration Isolation	Unnecessary, but optional

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SS-0030 06/06

GPI FlashPhase™ Specifications

LASER SPECIFICATIONS

Type	Helium-Neon, Class II
Wavelength	632.8 nm
Output Power at Aperture	≤1 milliwatt
Beam Polarization	Elliptical, linear switch optional
Coherence Length	Greater than 328 ft (100 m)

TEST PART CHARACTERISTICS

Material	Various; glass, super-finished metals, ceramics, and plastics
Preparation	None (typically); measurements are noncontact and nondestructive and performed under ambient conditions
Size (H x W x D) (approximate)	10 x 8 x 8 in. (254 x 203 x 203 mm) with 2-Axis Adjustable Mount
Weight	≤ 50 lb (22.7 kg) with 2-Axis Adjustable Mount
Reflectivity	0.1% to 100% (based on transmission element)

ZYGO offers a wide variety of accessories, including transmission and reference flats, transmission and reference spheres, part mounting options, large aperture components, and radius of curvature measurement options. For information on these accessories, refer to the GPI and VeriFire Accessories booklet, OMP-0463.

NOTATIONS

1 Repeatability of the quoted statistic is for 100 measurements of the same cavity in a stable environment, with 16 phase averages per data set. The specification represents the 2σ value of the statistic.

2 Quoted wavefront measurement uncertainty is based on comparison to mechanical phase shifting interferometry with less than 7 fringes of tilt across the aperture. Zygo's patent pending self correction removes the errors induced by the tilt required to spatially separate the phase information for carrier fringe analysis and involves a series of measurements to characterize the specific interferometer system and measurement setup.

3 The approximate number of tilt fringes in the part image that can be resolved by the interferometer at 1X.

4 Parameter is the minimum settable exposure time allowed by the camera. The minimum usable exposure time is cavity reflectivity dependent with higher reflectivity parts allowing shorter exposure times than low reflectivity parts.

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