

**DVD-400
Interferometer System
Operation Manual
OMP-0444**



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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
Original	February 2000		

MANUAL NOTATIONS



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

Note: Provides helpful information.

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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 Corporation. 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.

In addition, being committed to providing our customers with superior service, Zygo will support all standard products for a period of five years after the sale of the last newly-manufactured unit. Beyond this five-year period, we will continue to support these products on a "best-effort" basis.

WARRANTY SERVICE

Zygo's responsibility under this warranty shall be limited to the repair or replacement (at Zygo's option) of defective equipment at no cost to the buyer, except for transportation, cleaning, and recalibration charges.

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. This number 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.

RETURNS

Unused and undamaged products, in their original shipping containers, may be returned for credit within 30 days of receipt. All such products will be subject to a restocking fee equal to 20 percent of the purchase price. Custom products are not returnable.

EXCLUSIONS

The above warranty and product support statement applies only to equipment that is an integral part of a Zygo manufactured product. It does not apply to peripheral equipment manufactured by others, such as: computers, printers, vibration isolation tables, etc. In such cases, the warranty and the support that the original manufacturer supplies will apply.

In addition, warranty service does not include or apply to any product or part which, in Zygo's judgment:

- a. Has been repaired by others, improperly installed, altered, modified, or damaged in any way.
- b. Malfunctions because the customer has failed to perform maintenance, calibration checks or good operating procedures.
- c. Is expendable or consumable (such as panel lights, fuses, batteries, windows, and filters) if such items were operable at the time of initial use.
- d. Requires replacement because of decomposition due to chemical action.
- e. 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 or accident; or repaired or altered by other than service representatives qualified by Zygo.

01/96

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1

System Overview

Introduction

Zygo MetroPro Software

Principles of Operation

System Specifications

Computer Components

Laser Safety

Electrical Safety

Introduction

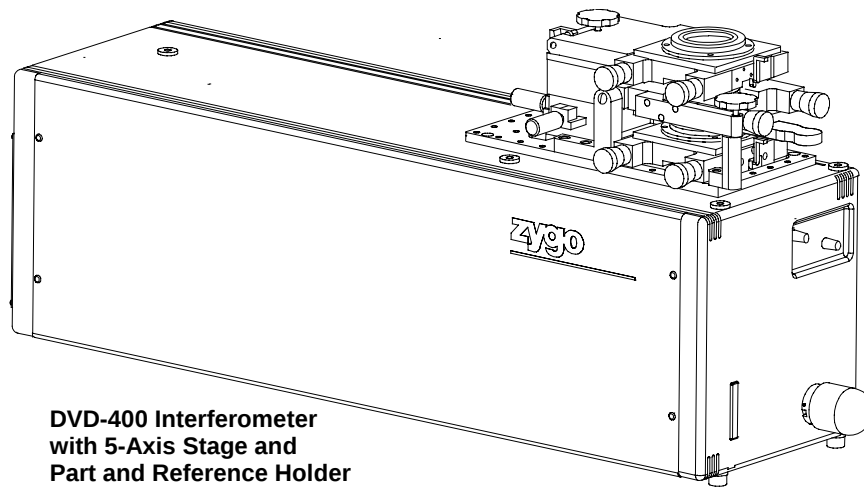
The DVD-400 provides complete measurement and analysis for measuring the transmitted wavefront quality of small, DVD lenses. The compact footprint of the interferometer enables easy positioning, and it may be used in both the upward-looking or horizontal configurations.

The interferometer includes three discrete magnifications as listed below, and the measurement beam has three polarization settings: circular, horizontal, or vertical. The specially designed 5-Axis Stage, along with the Reference and Part Holder Mounts, allow for adjustment in the X, Y, and Z axes as well as providing tip and tilt controls. A hand-held remote makes it possible to easily switch between view and align modes.

DVD-400 Magnifications

<i>Resolution</i>	<i>Field</i>	<i>Magnification</i>
512x480	6 mm	1x
512x480	3 mm	2x
512x480	1.5 mm	4x

The DVD-400 Interferometer assembled in the upward-looking configuration is shown below.



**DVD-400 Interferometer
with 5-Axis Stage and
Part and Reference Holder
Mounts**

Zygo MetroPro Software

MetroPro software provides acquisition and data analysis control of information obtained by the interferometer. Measurement and analysis functions may be automated or initiated individually as desired. Some of the analysis functions available are: Peak-to-Valley, Root-Mean-Square, Zernike computation, Point Spread and Modulation Transfer Functions, Encircled Energy, subtraction of third order aberrations, generation of filled plots and oblique plots, plots of surface slope, and many other additional graphs.

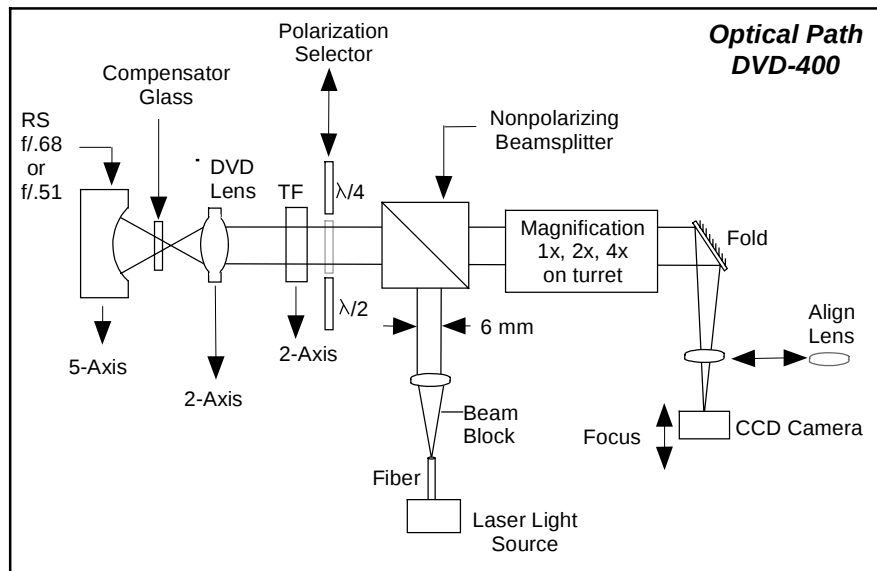
Refer to *Getting Started with MetroPro*, OMP-0398, and the *MetroPro Reference Guide*, OMP-0347, for a complete explanation of MetroPro software.

Principles of Operation

The DVD-400 Interferometer is a Fizeau-type interferometer. In comparison with other types of interferometers, such as Twyman-Green and Mach-Zehnder, a Fizeau interferometer has the advantages of having fewer optical components, greater accuracy, and is easier to use.

The light source is a low power, violet diode laser. The laser beam is expanded to a 6-millimeter diameter and exits the interferometer through 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.

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



When performing transmitted wavefront quality tests, the measurement wavefront passes through the component and is reflected back by a reference mirror of known quality. The wavefront passes through the component a second time and then enters the interferometer. In either case, the phase of the wavefront returning to the interferometer has been influenced by the component being tested.

Inside the interferometer, the returning wavefront is recombined with the reference wavefront, 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 solid-state video camera, and is sent to the video monitor.

Basic Principles of Phase Measuring Interferometry

The Phase Modulating Receptacle (PMR) on the DVD-400 interferometer 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 90-degree 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 90-degree 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.

Double-Pass Interferometry

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. The MetroPro 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.

DVD-400 System Specifications

Specifications for the DVD-400 Interferometer and the Power Kit are described on the following pages.

Specifications for all other components are provided in the corresponding manufacturers' manuals.

DVD-400 Interferometer

Physical Characteristics:

Dimensions: See figure on next page.

Electrical:

Interferometer
90 VAC, 50/60 Hz
240 VAC, 50 Hz
100 VAC, 50/60 Hz
75 watts, single phase

Operating Environment:

Temperature: 15° to 30° C (59° to 86° F)
Rate of Temperature Change: <1.0° C/15 minutes
Humidity: 5 to 95% relative, noncondensing
Vibration: Frequency Isolation - 1Hz <freq.< 120Hz

Laser:

Type: Diode laser in tunable, external Cavity
Wavelength: 405 ±5nm
Maximum Output Power: ≤2 milliwatt
Output Power at Instrument Aperture: (≤1milliwatt)
Test Beam Diameter: 6 mm at 1X
Beam Polarization: Circular, horizontal, vertical
Coherence Length: (≥1 meter)

Performance Specifications:

Accuracy¹: $\lambda/100$ PV
Instrument Precision²: $\lambda/1000$ rms (2σ)
Repeatability of PV³: $\lambda/300$ (2σ)
Repeatability of rms³: $\lambda/2000$ (2σ)
Spatial Sampling: 512x480 pixels
(6 mm clear aperture at 1X zoom)
Resolution: $\lambda/6000$ (low resolution, double pass)
Data Acquisition Time:
230 ms low resolution (7 frames of data)
Digitization: 8 bits
Averaging Modes: Phase and intensity

Optical:

Discrete Magnifications: 1X, 2X, 4X
Aperture Focus: 20-80mm @ 1X
Optical Centerline: 4.25 in. (108 mm)
Alignment System:
Twin Spot, retroreflector assist, no reticle.

Alignment Viewing: Nine-inch video monitor

Controls:

Interferometer: Power On/Off, Beam Attenuator,
Tip/Tilt, Polarization modes, Magnification
Remote: Align/View Toggle, Focus, Measure,
Print

System Quality:*

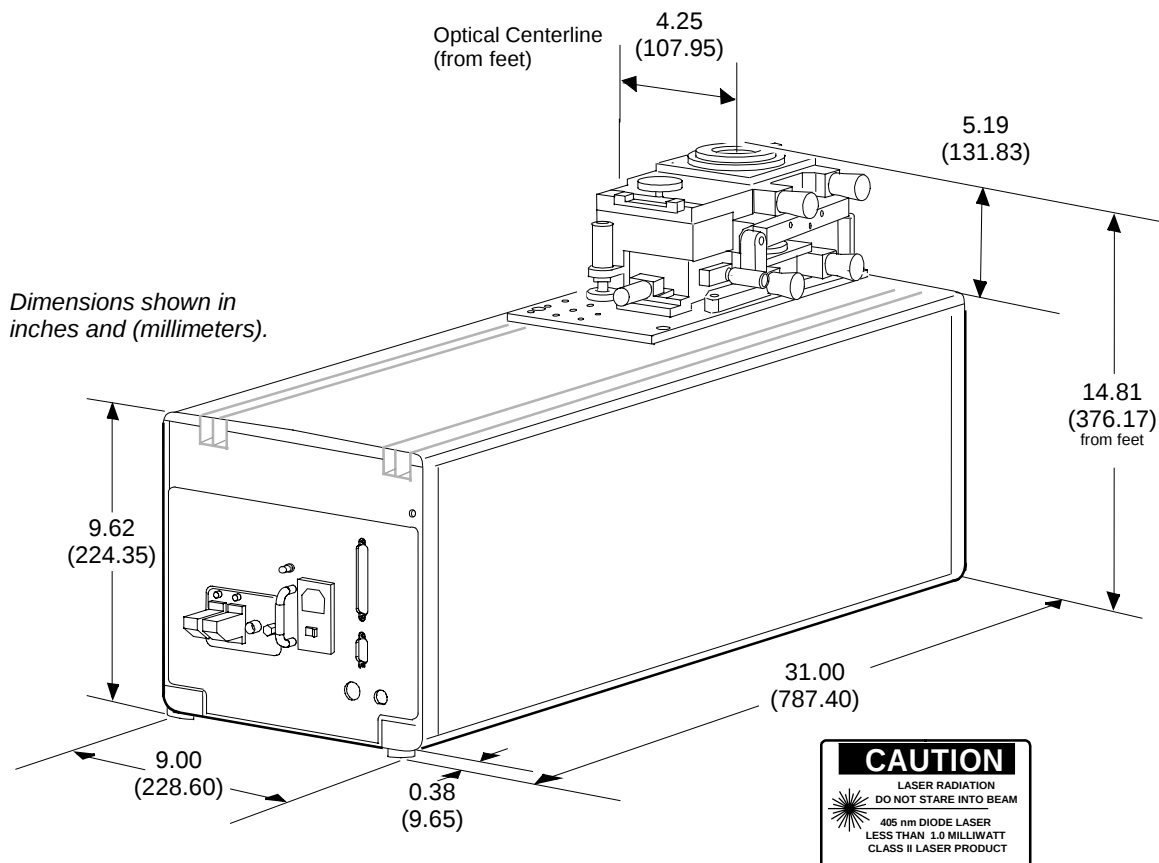
$\lambda/10$ -plano testing
 $\lambda/10$ -transmitted wavefront testing

* System quality depends upon the accuracy of the transmission element, geometric distortion of the optical/video system used for imaging and the number of fringes used in the evaluation. The DVD-400 is designed to provide better than $\lambda/10$ performance when using 7 or fewer fringes for evaluation.

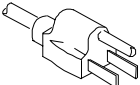
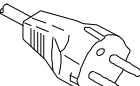
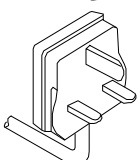
Footnotes:

- 1 The overall system accuracy for absolute testing (e.g. 3-Flat test). System accuracy for relative testing is dependent on the quality of the reference optic.
- 2 Precision is the residual rms error of the difference of two consecutive measurements, each with 16 phase averages. This specification is derived from 100 measurements and represents the mean value plus 2σ .
- 3 Repeatability of the quoted statistic is for 100 measurements of the same part; with 16 phase averages per data set. The specification represents the mean value plus 2σ .

DVD-400 Interferometer (continued)



Power Kit

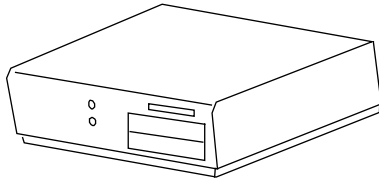
AC Voltage	Country	Zygo Part No.	Plug Type
100V	Japan	6194-0153-03	Same as 120V, but with 3-prong to 2-prong plug adapters.   
120V	United States/ Canada	6194-0153-01	
220V	France/ Germany	6194-0153-02	
240V	United Kingdom	6194-0153-04	

Computer Components

Typical computer components are shown below. For descriptions and specifications refer to the manuals from the original equipment manufacturer.

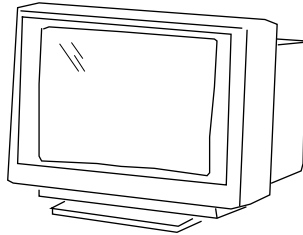
Typical Computer Components

*Typical components shown;
actual equipment may vary.*



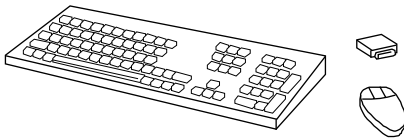
Computer

For system control and data storage.
Includes: internal hard drive, floppy drive, and CD-ROM.



Color Monitor

Displays graphics and data.



Keyboard

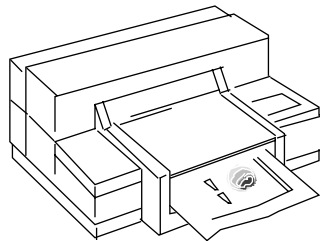
For data entry.

Mouse

For software control and selecting menus.

Hardware Key

Key enables MetroPro software and options.



Printer (Optional)

Outputs color copies of MetroPro displays.
Connects directly to the computer.

Laser Safety

The DVD-400 emits deep blue or violet 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 DVD-400 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. The beam will not appear very bright because the human eye has only 1/1000th the sensitivity at 405 nm as compared to 550 nm (green).

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. The user and personnel responsible for the safe use of the DVD-400 in the user's organization should consult this ANSI standard. It is available from:

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

The DVD-400 conforms to the National Center for Devices and Radiological Health (NCDRH) of the Food and Drug Administration and to international laser safety regulations.

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.

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: Semiconductor diode
Emission Duration: more than 0.25 second
Radiant Power: <1 milliwatt
Wavelength: 405 ±5 nanometers

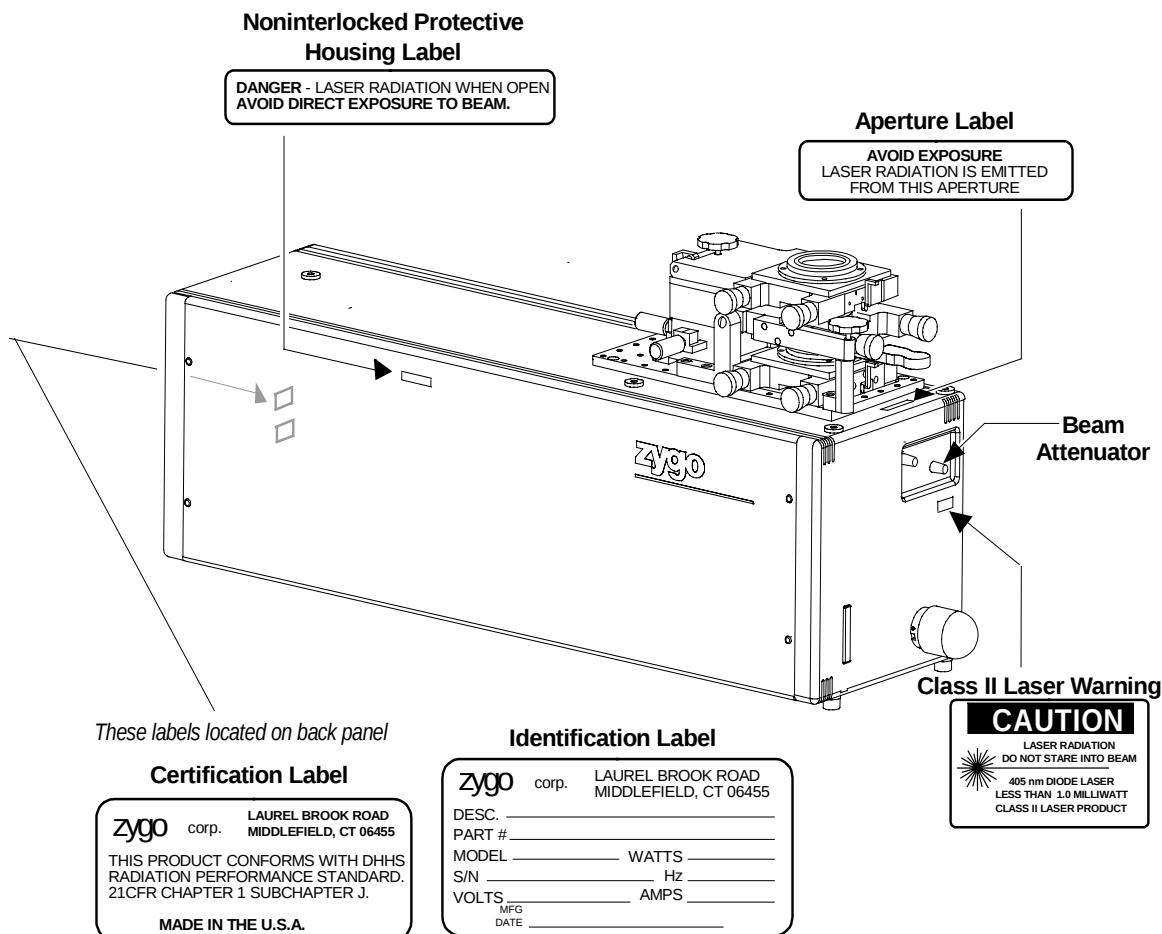
Laser Emission Control Devices

<i>Device</i>	<i>Function</i>
Emission Indicator (located on back panel of interferometer)	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 <i>turned clockwise</i> , blocks the laser beam from being emitted from the instrument.
Power Switch (located on front panel of Laser Controller)	In the off position, the laser interlock turns off the separate external power supply. The laser is powered by a separate, external power supply and controller.

Laser Safety Labels

<i>Label</i>	<i>Purpose</i>
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 IIIa laser radiation is accessible.
Certification	Shows that Zygo Corporation has conformed to the DHHS standard.
Identification	Provides information about the instrument - serial number, manufacture date, model number, etc.

Laser Safety Controls and Labels



Electrical Safety



The DVD-400 system 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 DVD-400 system with power applied.

DO ensure that the instrument power supply has been set to match available line voltage, and that the correct fuse is installed, before applying power to the system.

DO replace blown fuses only with identical fuses of the same current rating and type (slo-blo) to avoid fire hazards and damage to the DVD-400.

DO turn off the DVD-400 before disconnecting and reconnecting cables.

2

Assembly and Setup

Installation Overview

Operating Environment Considerations

Assembling the System

Connecting Cables

System Power Up Procedure

System Shut Down Procedure

Installation Overview

This chapter describes important procedures that should be done before you set up your system, and provides detailed installation instructions. If you are performing your own installation, please first read over the entire chapter to get an overview of the process. Do not attempt to use the system until you are familiar with its operation.

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

Unpacking and Installation Checklist

This checklist is provided to assist you in unpacking your DVD-400 system and in preparing for installation in any one of the configurations covered in this chapter.

- ☐ Inspect all packages for signs of shipping damage. Report any damage to the freight carrier.
- ☐ Be sure the shipment is complete. If not, contact your Zygo Corp. representative.
- ☐ Place the shipping containers near where the system will be installed.
- ☐ Several components, including the DVD-400 Interferometer, are heavy. Have two persons available when removing these components from the shipping containers as well as for assembly procedures.
- ☐ Place components on a secure, flat, dry surface.
- ☐ Save the shipping containers in case any items must be returned to Zygo Corp.
- ☐ Ensure that necessary utility requirements are available in the area in which you are installing the equipment.

Checking the Operating Environment

Vibration, Temperature, Air Turbulence, and Air Impurities can effect overall performance of the DVD-400 system. Review the following information when selecting a location for the interferometer.

Vibration - Any of several sources can introduce vibration: floors with insufficient support or rigidity, acoustic noise, other equipment (fans, etc.) human activity, and so on. Vibration is the most significant environmental concern and is the most difficult to control.

Ideally, the floor of the installation site should be a poured concrete slab at ground level. This greatly reduces large-amplitude vibrations. Small amplitude vibrations transmitted through the ground, such as those caused by human activity, can be eliminated by using a vibration isolation system.

Acoustic vibration (sound) of sufficient amplitude can cause vibration of the items under test, the interferometer, and even the top of a vibration isolation table. This is especially true of low-frequency vibrations, which may not be audible, even at relatively high amplitude. Uninsulated walls made with plasterboard are prone to retransmitting acoustic vibration from adjoining areas and suspended ceilings can couple roof mounted air conditioning noise.

Vibration can also be transmitted to the interferometer and support table through connecting cables. Be careful not to run cables where they would be touching sources of vibration or are likely to be jarred or kicked. Don't place the keyboard, mouse, or anything that has moving parts, on the vibration isolation table.

Temperature- Rapid temperature changes will degrade system performance because different materials absorb and release heat at different rates, resulting in uneven expansion and contraction of the interferometer and components under test. The maximum acceptable rate of temperature change is approximately 1°C (1.8°F) per 15-minute interval.

Wide concurrent temperature differences in the operating environment can also degrade performance because they create air turbulence, which can disturb the measurement beam. Air conditioning and/or heating devices or vents can cause such temperature differences.

Air Turbulence - Fans or blowers help to even out temperature differences in the operating area. However, if positioned improperly, they can cause air turbulence and vibration problems. Air turbulence causes uneven air density within small areas, which may refract parts of the measurement beam and alter the wavefront.

Airborne Impurities - Smoke, dust, and grease or oil globules can accumulate on optical components, degrading their performance, and eventually ruining sensitive optical coatings.

Utility Availability

Electrical - Incoming voltage can be 100, 120, 220, or 240. The system requires an isolated 15-Amp power circuit (6-Amp for 220/240 volt power) with at least three separate outlets and an earth ground.

Air Supply - The vibration isolation system accessory requires a compressed air supply or bottled nitrogen. Operation at maximum load requires a supply line pressure of approximately 75 PSI (5.3 kg/cm²), although typical operation pressure is less. The flow rate is negligible once the isolator has been pressurized. The air supply should be filtered and free of oil and water. Bottled nitrogen normally does not require filtering.

Installing Computer Components

Refer to the product documentation for specific information on the computer, monitors, and peripherals. A cable connection diagram is provided showing interconnection between the DVD-400 Interferometer and computer components. Observe the following guidelines when performing any cable connection procedure.

- Ensure that all power is off.
- 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 such that they do not introduce vibration into the system.

Cable Connections



Warning!

Ensure that all power is off when connecting cables.

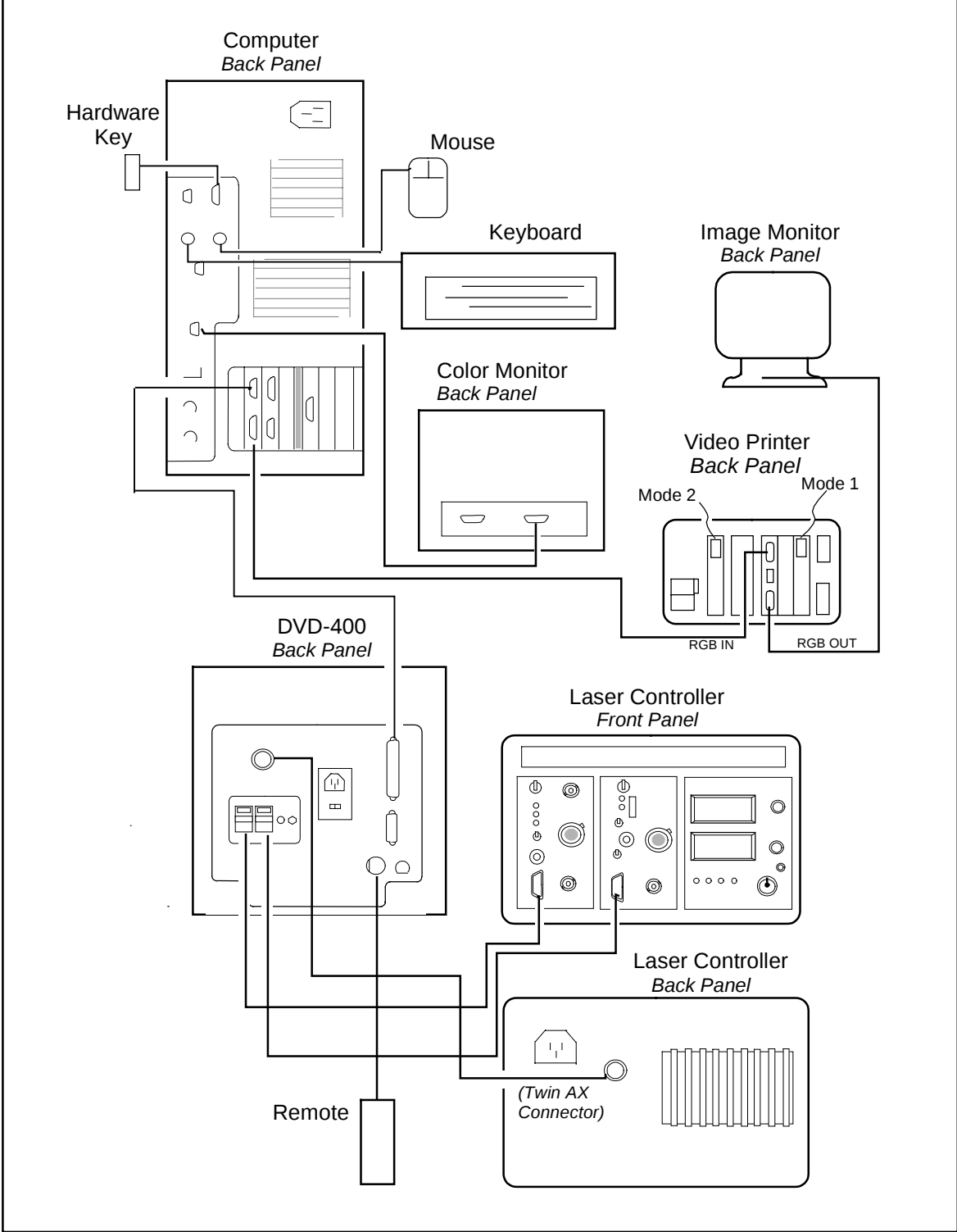
Video Printer Setup

After connecting the Video Printer to the system, the printer must be set to VGA mode. Use the Mode 1 and Mode 2 Selectors on the back panel of the printer. Set these switches using the following table. In addition, set the Contrast selector to Light; set the Scan selector to Frame; and set the Direction selector to normal. Refer to the product manufacturer's manual for additional information.

Video Printer Mode Selector Settings for VGA

DIP Switch	Mode 2 Selector	Mode 1 Selector
8	On	Off
7	On	Off
6	Off	Off
5	Off	Off
4	Off	Off
3	Off	Off
2	Off	Off
1	On	Off

Cable Connections



Power Distribution

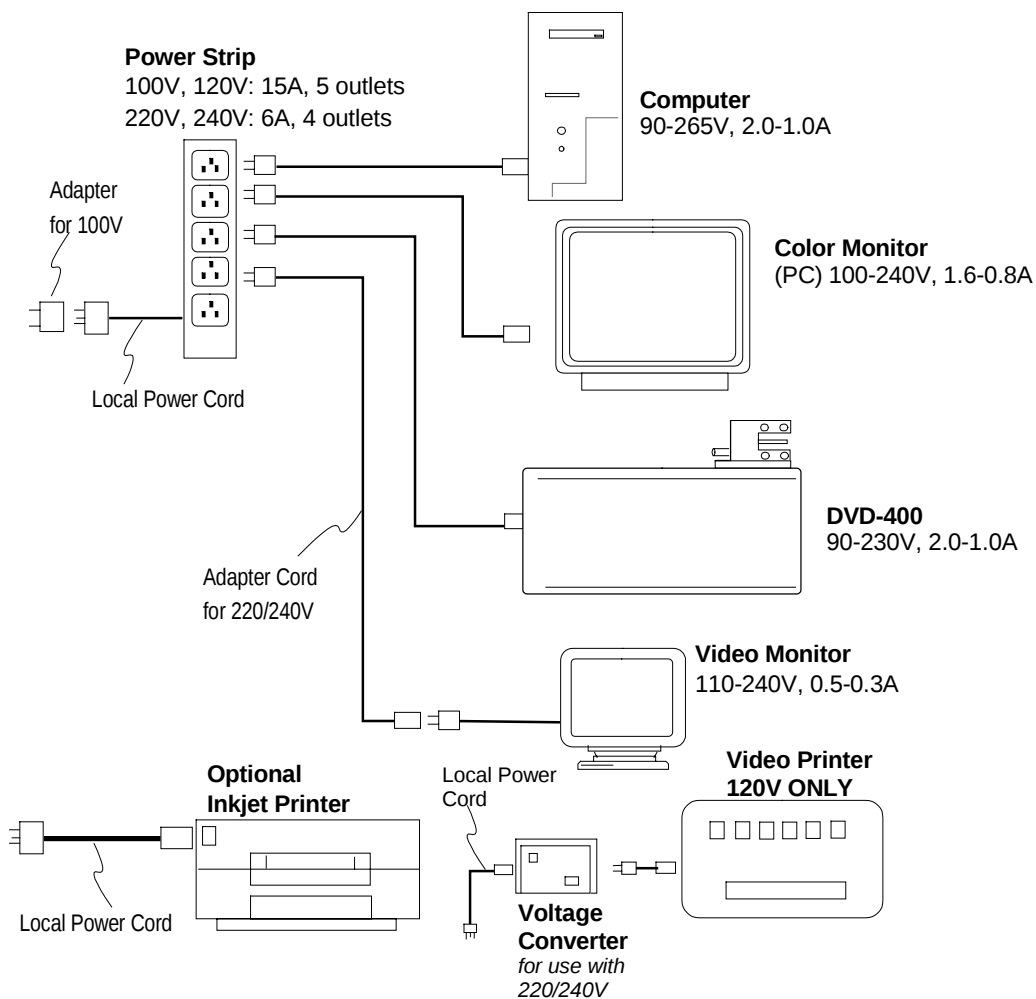


Warning!

Ensure that all power is off when connecting cables. The equipment is intended to be electrically grounded. It is equipped with a grounding plug to fit a grounding-type outlet. Ensure that the components are properly grounded through the outlet.

110 or 120V: A 120V, 15 amp, 5 outlet power strip is used for distribution.

100V, 200V, and 240V: A universal 6 amp, 4 outlet power strip is used for power distribution; it accepts 100, 120, 220, or 240 VAC. A local power cord is supplied for the universal power strip.



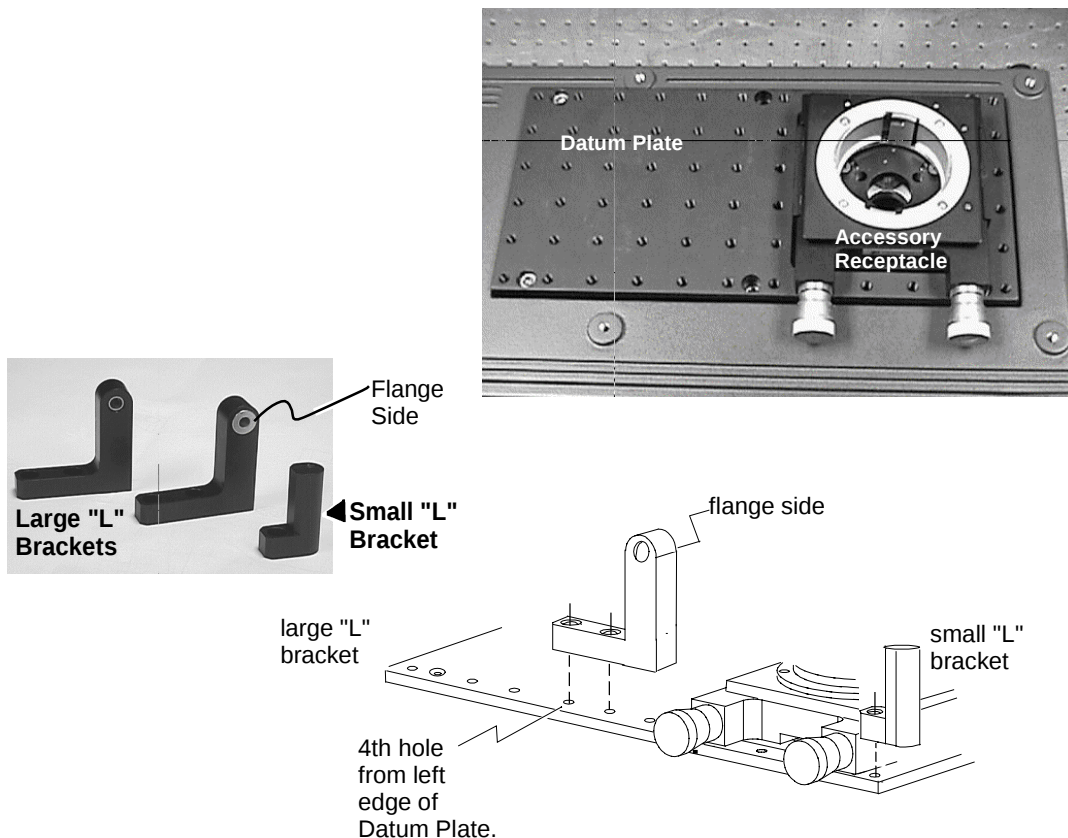
System Setup in the Upward-Looking Configuration

The interferometer is designed to hold a special 5-Axis Stage and mounts on its integral worktable in the upward-looking configuration. For shipping purposes, the 5-Axis Stage and mounts are located in a separate container and must be attached to the interferometer.

Attaching the “L” Brackets to the Datum Plate

The Datum Plate and Accessory Receptacle are already attached to the interferometer. Refer to the following illustration when attaching the three “L” brackets to the plate. You will need a 5 millimeter(mm) hex wrench for this procedure.

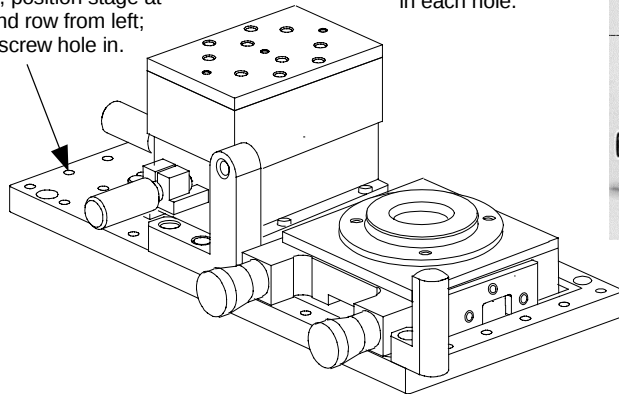
1. Place one of the large “L” brackets as shown on the Datum Plate. The flange on the bracket should face away from you and toward the opposite side of the interferometer.
2. Align the screws with the threads in each hole. Loosely secure the bracket in place with the 6 mm screws. Do not completely tighten yet.
3. Place the small “L” bracket on the Datum Plate as shown, and secure it in place with one 6 mm screw.



Attaching the 5-Axis Stage to the Datum Plate

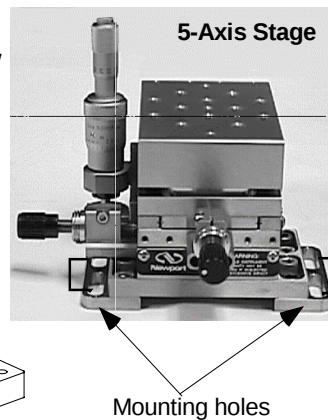
Step 1.

From the edge of the Datum Plate, position stage at second row from left; third screw hole in.

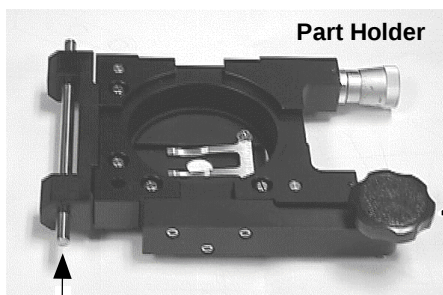


Step 2.

Secure stage to plate using one 6mm screw in each hole.

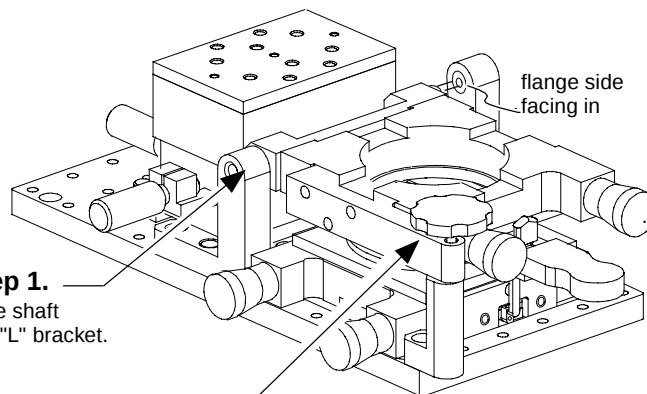


Attaching the Part Holder



Step 1.

Slide shaft into "L" bracket.



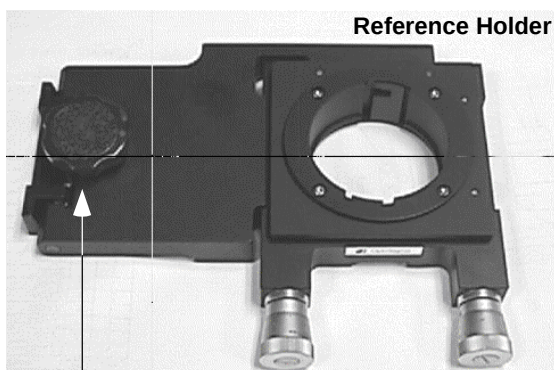
Step 2.

Slide shaft of Part Holder Mount into the flange side of the second "L" bracket. Secure the bracket to the datum datum plate using two 6 mm screws.

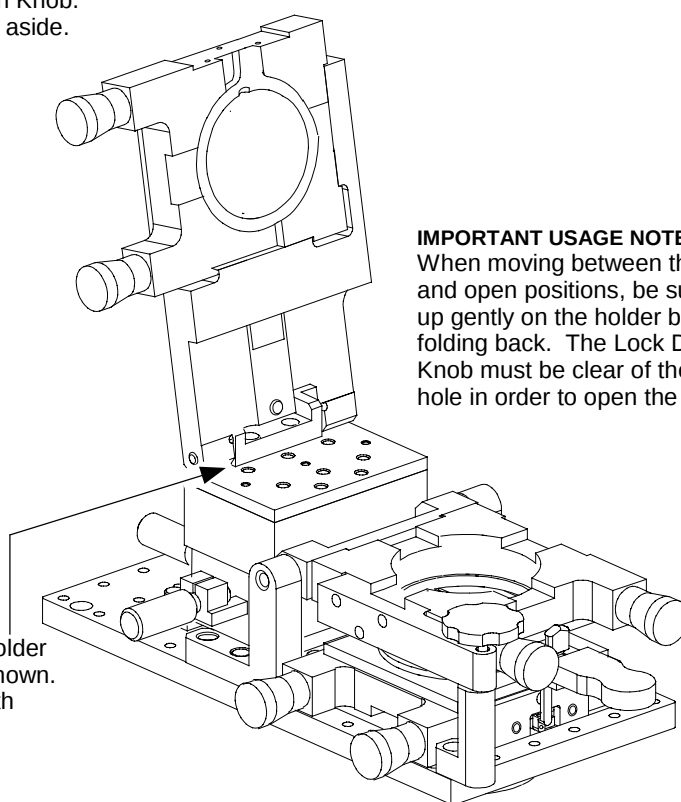
Step 3.

Align the Lock Down Knob with the small "L" bracket seating it so that you can tighten it, turning clockwise. After securing the Lock Down Knob, tighten the screws holding the "L" bracket (located as shown in Step 1).

Attaching the Reference Holder to the Stage



Step 1.
Loosen Lock Down Knob.
Remove it and set aside.



IMPORTANT USAGE NOTE!
When moving between the closed and open positions, be sure to lift up gently on the holder before folding back. The Lock Down Knob must be clear of the screw hole in order to open the holder.

Step 2.
Position the Reference Holder aligning screw holes as shown. Secure holder in place with 2-6mm screws. After returning the holder to the closed position, reinstall the Lock Down Knob.

System Power Up

1. Turn power on to the interferometer.
2. Review the specifications' sheet that accompanies the laser. It contains the correct settings for this laser.
3. On the front panel of the Laser Controller, there are controls for Temperature and Operating Current.. These settings ensure proper grating stabilization. Be sure they are set to the values listed on the specifications' sheet.
4. Turn power on to the computer components.
5. Allow a warm up time of 5 minutes.

System Shut Down

1. On the Laser Controller, turn the Current control to Off. Then turn the key switch Off.
2. Turn power off to the DVD-400 Interferometer.
3. Shut down the computer components.

3

Operation

DVD-400 Interferometer Controls

Opening the DVD Application

Installing the Transmission & Reference
Elements

Aligning the Elements to the System

Creating a System Error File

Installing the Lens in the Part Holder

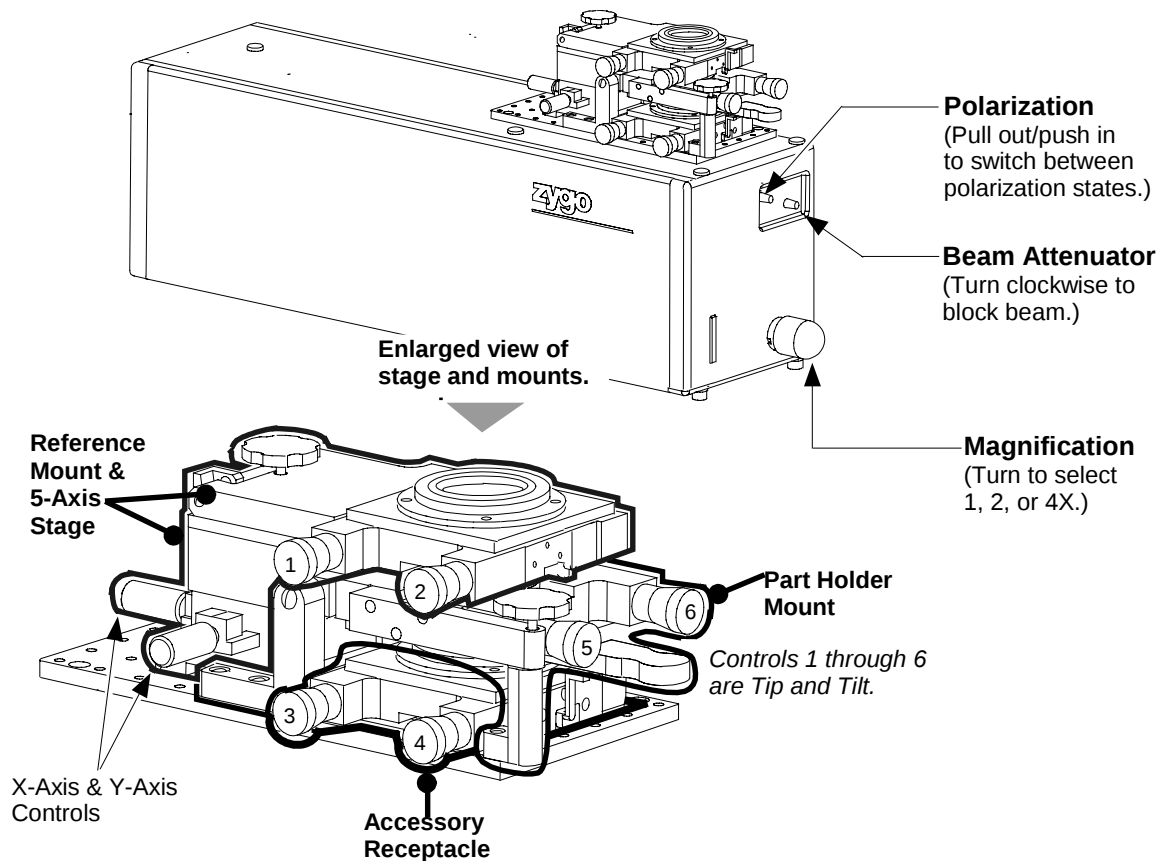
Aligning the Lens to the System

Setting Software Measurement & Analysis
Controls

Making Measurements

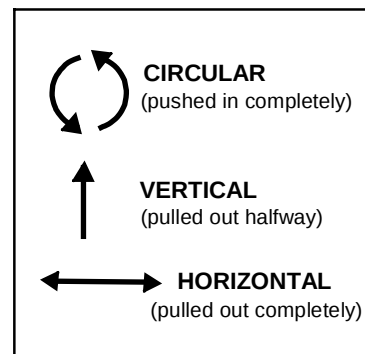
DVD-400 Interferometer Controls

The illustration below identifies controls for the interferometer, 5-Axis Stage, and Reference and Part Holder Mounts. These controls are referred to in subsequent operation procedures.



Setting Polarization Mode

Prior to making a measurement, be sure that the Polarization control is set to the desired setting. There are three polarization modes: circular, vertical, and horizontal.



Setting Magnification

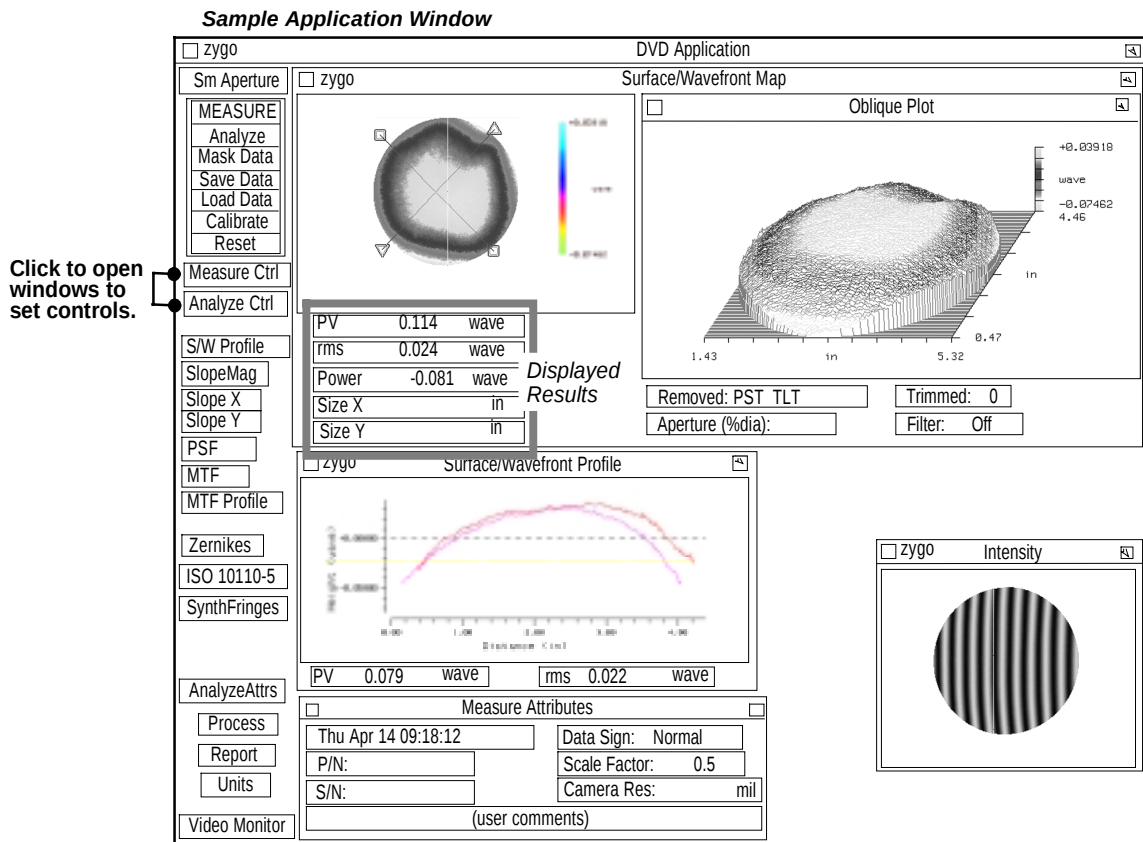
Select the appropriate magnification (1, 2, or 4X) by turning the control to the desired setting. At 1X, the field of view is 6-mm diameter. At 2X, it is 3 mm, and at 4X it is 1.5 mm.

The DVD-400 Application

This application supports the DVD-400 System; it includes controls that enable you to set up the measurement specifically for your part type. It also includes results that provide information about the transmitted wavefront quality of a lens. Graphic displays and numeric results are available for three-dimensional areas, as well as two-dimensional cross sections or slices. The application is licensed with standard MetroPro. For information on licensing, refer to the *Getting Started with MetroPro* manual, OMP-0398. The information provided in this section is a quick reference. Detailed MetroPro information is located in the *MetroPro Reference Guide*, OMP-0347.

To open the DVD-400 application, click the DVD.app icon. If this icon is not on the MetroPro window, then use the Load Application command from the MetroPro window menu to first load the application icon.

The Application Screen



Installing the Transmission Flat

If the Reference and Part Holder Mounts are closed, you must loosen the Lock Down Knob for each mount and place each mount in the open position to gain access to the Accessory Receptacle.

Reminder: For the Reference Mount (topmost mount), be sure to loosen the Lock Down Knob completely so that it clears the screw hole. Then lift up gently on the mount before folding it back to the open position.

Loosen the Lock Down Knob (screws into the small “L” bracket) completely for the Part Holder Mount, and move the mount to the open position.

1. The Accessory Receptacle is a bayonet type mount. When handling the optics, do not touch the surfaces. Hold the flat by the edges. Align the red dot on the Transmission Flat with the red dot on the Accessory.
2. Turn the Transmission Flat clockwise until you hear it click (lock) into place.
3. Carefully close the Part Holder and Reference Holder Mounts. Secure the Lock Down Knobs.

Note: The Transmission Flat should remain installed on the interferometer at all times. This will protect the fragile components inside the interferometer including the thin waveplates and the pellicle beamsplitter located directly beneath the flat.

Aligning the Transmission Flat

1. Use the Remote Control to switch to view mode.
2. Install the retro reflector (corner cube) in the Reference Holder (topmost) Mount.
3. Use the X and Y controls on the 5-Axis Stage to roughly adjust Transmission Flat so that the aperture is filled with an image of the retro reflector. (Tip and tilt of the 5-Axis Stage is not important.)
4. Adjust the tip and tilt controls on the Accessory Receptacle until the fringes between it and the retro reflector are nulled. This makes the Transmission Flat normal to the test beam.
5. Remove the retro reflector and set aside.
6. Switch from view to align mode. There will be a bright spot visible. This is from the Transmission Flat.
7. Using the Mask Editor function in MetroPro (refer to OMP-0347), place a fiducial at this location. This alignment spot will be in slightly different locations for each of the 1X, 2X, and 4X imaging lenses. This is normal and does not interfere with the function of these alignment spots.
8. Do not make anymore adjustments to the tip and tilt of the Transmission Flat. The retro reflector should always be used when determining the proper tip and tilt of the Transmission Flat.

Aligning the Part Holder Mount and Focusing the Interferometer

These steps ensure that the Part Holder is perpendicular to the interferometer test beam, which provides a reasonable starting point for DVD lens testing.

1. Measure the opening diameter of an empty Part Holder.
2. Slide the empty Part Holder into the Part Holder Mount.
3. Using tweezers, place a window on top of the Part Holder.
4. Switch to align mode. There will be a bright spot from the Transmission Flat and another from the window. *Reminder: DO NOT* adjust the tip and tilt of the Transmission Flat.
5. Adjust the tip and tilt controls on the Part Holder Mount to superimpose the spot from the window over the spot from the flat.
6. Switch to view mode and null the fringes.
7. Focus the beam on the edge of the opening in the Part Holder. Because the window is so close to the Part Holder, there will be a little Fresnel diffraction at the edge of the Part Holder opening. It should be possible to come to sharp focus.

Note: It is important to focus on the plane of the Part Holder when making transmitted wavefront measurements of the aspheric DVD lenses. This is the pupil plane of these lenses. Do not focus on the Reference Sphere surface.

Performing Lateral Calibration

Refer to OMP-0347 for instructions on how to perform lateral calibration.

1. Drag a calibration fiducial across the diameter of the empty Part Holder, which is sharply focused in the field of view.
2. Resolution should be roughly equal to one of the following values:

1X	12.7 $\mu\text{m}/\text{pix}$
2X	6.3 $\mu\text{m}/\text{pix}$
4X	3.2 $\mu\text{m}/\text{pix}$
3. Lateral calibration will have to be repeated when switching between the 1X, 2X, and 4X imaging lenses. It may also be necessary to recalibrate when focus is changed since magnification varies slowly with focus.

Installing and Aligning the Reference Flat

1. Install the Reference Flat on the Reference Holder Mount.
2. Switch to align mode. There will be a bright spot from the Transmission Flat, and a spot from the Reference Flat. *Reminder:* DO NOT adjust the tip and tilt of the Transmission Flat.
3. Using the tip and tilt controls on the Reference Holder Mount, superimpose the spot from the Reference Flat over the spot from the Transmission Flat.
4. Switch to view mode. Null the fringes.

Creating a System Reference File

System error files are used to subtract the systematic errors associated with the interferometer's optics. This improves measurement accuracy. Zygo Corp. recommends that you use system error files for optimum measurement performance. Create a system error file measuring a component of known high quality, such as the DVD-400 Reference Flat.

Make a new system error file if:

- the magnification or focus change;
- Phase Res software setting changes;
- there are changes in the operating environment, especially temperature fluctuations.

Procedure

1. Make sure that the software Zoom button, and Phase Res control are set to the desired settings.

Note: The systematic errors mapped out by the system error file are specific to the above settings. *Reminder!* Make a new system error file whenever one of these settings changes.
2. If the Transmission Flat is not installed in the Accessory Receptacle, do so now.
3. Install the retro reflector in the Reference Holder Mount (topmost mount).
4. There will be a spot from the Transmission Flat and one from the retro reflector displayed on the monitor. Using the tip and tilt controls on the Accessory Receptacle, position the spot from the Transmission Flat over the spot from the retro reflector.
5. Remove the retro reflector from the mount.
6. Install the Reference Flat in the Reference Holder Mount.
7. Using the tip and tilt controls on the Reference Holder Mount, align the Reference Flat to the Transmission Flat.

8. If you have not opened the DVD application, do so now. In the Measure Control window, locate the Phase Avgs control and enter the number of averages. A general guideline is to use 3X the same number of averages as used during typical measurements, or a minimum of 8.
9. Set the Subtract Sys Error control to Off.
10. Press F1 or click the Measure button to measure.
11. Click the Save Data button. In the File Handler, click the “Current Selection” box, enter a name for the reference error file, ending with “.dat” (SysErr.dat is recommended.) and press Enter, then click the Done button to close the File Handler.

Using System Error Files

1. Open the Measure Cntrl icon.
2. Click the Subtract Sys Err control to set it to On.
3. Click the Sys Err file control and enter the name of the system error file that matches your software and instrument settings, and then press Enter.
4. Make one more measurement to ensure that the result is nearly zero.

Installing the Reference Sphere

The Reference Sphere has a Compensator window attached to it. This window simulates the thickness of the DVD substrate.

1. If the Reference Flat is installed in the Reference Mount, remove it.
2. Be sure the mount is closed and secured with the Lock Down Knob. Install the Reference Sphere, aligning the red dot on the sphere with the red dot on Reference Mount.
3. Turn the Reference Sphere clockwise to lock it in place.

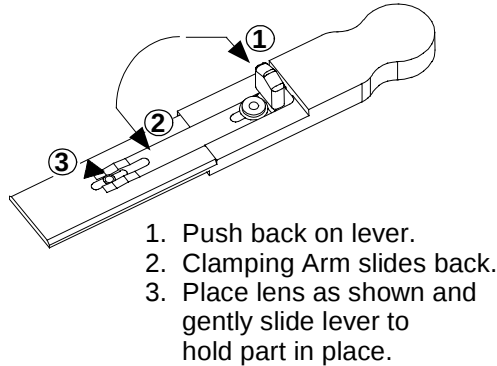
Aligning the Compensator and Reference Sphere

1. If the Part Holder is in the Part Holder Mount, remove it.
2. Switch to align mode. There will be a bright spot from the Transmission Flat, one from the spherical surface of the sphere (which may or may not be in focus), and one from the Compensator window. It is important that the Compensator window be perpendicular to the beam to minimize coma.
3. *Reminder:* DO NOT adjust the tip and tilt of the Transmission Flat. Use the tip and tilt controls on the Reference Mount to superimpose the spot from the Compensator window over the spot from the Transmission Flat. Use the X and Y Axis Controls on the 5-Axis Stage to superimpose the spot from the Reference Sphere over the other spots. You may have to adjust the Z-Axis if the Reference Sphere spot is too big.
4. Switch to view mode. Use the tip and tilt controls on the Reference Holder to null the fringes.

Note: The Compensator window is up close to the Part Holder. This window can form a cavity with the Transmission Flat that is nearly as good for performing focus and lateral calibration as the previously outlined procedures. This may be more convenient to use than a loose window on top of the empty Part Holder. The closer the Compensator is to the empty Part Holder, the lower the Fresnel diffraction artifacts that make it difficult to focus and calibrate carefully.

Installing the Lens in the Part Holder

This specially designed part holder holds the lens perpendicular to the beam. Use tweezers to place the lens in the holder. The strong curve of the aspheric single will typically face down (toward the Transmission Flat).



Aligning the Lens to the System

Alignment of high NA aspheres takes practice. With the Part Holder and Compensator window perpendicular to the test beam, gross tilt errors should be minimized. It will still require fine-tuning of these adjustments.

Reminder: DO NOT adjust the tip and tilt of the Transmission Flat without using the retro reflector.

1. The Reference Sphere should be adjusted first, making changes only to X, Y, and Z controls. Tip and tilt are not adjusted until the fine-tuning stage.
2. If the spot from the Reference Sphere is not visible, temporarily switch to 4X magnification since it has the largest angular field of view in align mode. It may be necessary to unlock the sphere and manually search for the spot. Iterate the spot into the field of view in align mode and then switch back to the magnification of interest.
3. Superimpose the Reference Sphere spot over the Transmission Flat spot. Switch to view mode and null the fringes. The differential micrometers are useful for high NA lenses.

4. Click on the Analyze Cntrl icon and click on Remove PST, TLT, and PWR.. This will remove test artifacts. Press F1 to make a measurement.
5. Note the coma magnitude. Coma develops rapidly when slightly off-axis to an asphere. If coma is present, it is likely that the test is being conducted at a small field angle. Iterate to a better tip/tilt setting of the Part Holder by minimizing coma. It will be possible to get within some tolerance of zero coma and then mathematically remove the remaining residual coma. This will yield the result that would be seen if enough time were spent iterating to a zero-coma tip/tilt adjustment.

Making Measurements

Guidelines for transmitted wavefront measurements follow. This information is intended to be a framework from which to begin when setting up the software to make measurements. Individual test parts may require different settings. Other subjects not covered in the following sections are masks and calibration. Consult the *MetroPro Reference Guide* for a detailed discussion of both functions. This manual is also available on CD-ROM.

Setting Software Measurement Controls

Click on the Measure Cntrl icon to access the following set of controls. Clicking on them with the left mouse button changes most controls. Some controls may require a keyboard entry, which is completed by pressing the Enter key.

Control	Function
Comment	User comments. May be up to 81 characters.
Data Sign	Determines the sign of the data. The settings are normal or inverted. Change the data sign if the measurement data appears reversed in the results.
Discon Filter	Specifies the degree to which discontinuities are removed from the data. Raise the value to increase filtering, but be aware that data may also be removed as well. The default setting is 60.
Intf Scale Factor	Specifies the number of wavelengths per fringe in the analysis. It scales the measurement data so it properly represents the measured parameter desired by the user. The default setting is 0.5. A setting of 1.0 corresponds to a single-pass transmitted wavefront setup, such as a Mach-Zender interferometer.
Intens Avgs	Specifies the number of intensity averages to perform during measurements to improve repeatability. Intensity averaging is more sensitive to drift and vibration than phase averaging. The default is 0.
Min Area Size	Specifies the minimum number of data points in a valid region. Decrease for smaller areas; increase for larger areas. The default is 20.

Measurement Controls-continued

Min Mod (%)	Specifies the minimum modulation necessary for a valid data point. Increase to exclude unwanted data; decrease to accept areas with poor fringe contrast or low reflectivity. Enter a number from 0 to 100; the default setting is from 7 to 10.
Part Number & Serial Number	User entry for part identification. Serial Number has special operation modes. Enter up to 39 characters.
Phase Avgs	Specifies the number of phase averages to perform during measurements to improve repeatability. The default setting is 0.
Subtract Sys Err	Click ON to activate. This subtracts system errors from the data.
Sys Err File	Identifies the file to use when subtracting system errors. The file should contain measurement data from a high quality test part.
Wavelength-In	Specifies the wavelength of the instrument laser.
Wavelength-Out	Specifies the wavelength of the data displayed within an application

Click on the Analyze Cntrl icon to access the following set of controls. Clicking on them with the left mouse button changes most controls. Some controls may require a keyboard entry, which is completed by pressing the Enter key.

Control	Function
Aperture ID (%)	Specifies the inner diameter of an automatic round aperture mask; the size is specified as a percentage of the data set. Data inside this mask is excluded from the analysis. Auto Aperture must be on.
Aperture OD (%)	Specifies the outside diameter of an automatic round aperture mask; the size is specified as a percentage of the data set. Data outside this mask is excluded from the analysis. Auto Aperture must be on.
Auto Aperture	When on, it activates automatic circular mask creation based on the setting of the Aperture ID (%) and Aperture OD(%) controls.
Filter	Selects filtering options for data. The settings are: Off, High Pass, Low Pass, Band Pass, or Band Reject. High pass allows the short wavelength (high frequency) components to pass. The filter control is used in conjunction with the Filter Type, Filter Window Size, and Filter Trim controls. Use of the Band Pass or Band Reject filter settings require the use of additional controls that are not displayed in the Analyze window.
Filter Freq	The filter cutoff frequency in cycles per lateral unit. This is the cutoff point between shape and roughness data when the Filter Type control is set to FFT Fixed, and Filter control is set to Low Pass, Band Pass, or Band Reject. When a value is entered, a corresponding value is displayed in the Filter Wavelen control.

Analyze Controls-continued

Filter Type	Selects the algorithm used during filtering: Average, Median, 2 Sigma, FFT Fixed, or FFT Auto. Average uses all valid data points in each filter window and averages them. Median uses the middle value of all valid data points in each filter window. 2 Sigma uses data points that are within two times the rms value in each filter window and disregards values outside this range. FFT Auto and FFT Fixed use a Fast Fourier Transform algorithm, and the Window Size control is ignored. FFT Fixed sets filter cutoffs based on the entries in the Filter Waven or Filter Freq control.
Filter Waven	Specifies filter cutoff wavelength. This is the cutoff point between shape and roughness data when the Filter Type control is set to FFT Fixed, and Filter control is set to Low Pass, Band Pass, or Band Reject. When a value is entered, a corresponding value is displayed in the Filter Freq control.
Filter Window Size	Selects the number of data points used to generate a new, filtered data point when the Filter Type control is set to Average, Median, or 2 Sigma. Settings are odd numbers from 3 to 49.
Remove	Specifies the overall shape(s) to subtract from the data during analysis. It contains six buttons: PST(piston), TLT (tilt), PWR (power), AST (astigmatism), CMA (coma), or SA3 (spherical aberration). More than one shape can be selected. Remove uses a least-squares technique.
Trim	Specifies the number of pixel layers to remove from data edges or obstructions. The Trim Mode control specifies where trim is performed.

Measurement Results

Result	Function
Power	A measure of the curvature of the surface or wavefront without distinguishing between the X and Y dimensions.
PV	Peak-to-Valley is the distance between the highest and lowest points within the sample.
rms	Root-Mean-Square or rms is the deviation from the best-fit shape specified with the Remove control. In other terms, it is the transmitted error relative to a reference surface.
Size X	Size X is the dimension of the data set in the x-axis.
Size Y	Size Y is the dimension of the data set in the y-axis. The instrument must be calibrated for the Size X and Y results to display.

Other Software Functions

Operation	How To
Save data	Click the Save Data button. In the File Handler, click the Current Selection box, enter a name for the file, ending with “.dat” and press [Enter], then click the Done button.
Print	Click the word "zygo" in the window you want to print, or select the Print command from the window's menu. In the Print Panel, click the Print button.
Saving changes made to controls, plots, results and windows	You must save the application under a new name. Select the Save Application command from the Application Window menu. In the File Handler, click the Current Selection box, enter a name for the file, ending with “.app” and press [Enter], then click the Done button.
Use masks	Click on the Mask Data button. Use the Mask Editor to define areas to include or exclude from the test part measurement. See the <i>MetroPro Reference Guide</i> .
Turn off the system	Warning! <i>Improper shutdown may damage the instrument.</i> For instruments running under Windows, select the Quit command from the MetroPro menu; turn off power after you have shut down from within Windows.

Troubleshooting

Symptom	Possible Cause and Correction
Application not functional.	MetroPro is not licensed. The application is licensed as part of standard MetroPro; contact Zygo for licensing information. The hardware key or ID Module is not installed. Install the hardware key and restart the computer.
No data error, or graphic displays appear incomplete.	The instrument is not properly focused or the fringes are not nulled.. Focus the instrument and null the fringes. The Min Mod (%) control is set too high; decrease the value.
Poor repeatability of results.	Noisy environment. Look at the video monitor for fringe drift or vibration. These signs indicate a noisy environment. Check for air drafts; ensure that the computer is not contributing noise to the vibration isolation system.

4

Maintenance & Troubleshooting

Maintenance Guidelines

Maintenance and Service for Computer Components

Troubleshooting

Maintenance Guidelines

DVD-400 Interferometer

The DVD-400 Interferometer is virtually maintenance free. However, it is important to operate the equipment in a relatively clean environment. Should you need to clean the exterior surfaces of the Interferometer, use the following steps.

1. Use a commercially available, mild furniture polish and a soft cloth to remove dust and fingerprints from the side and front panel of the unit.
2. Wipe dust or dirt off the unit with a clean, dry cloth. Do not use furniture polish or cleaning sprays near the optics.

Video Monitor

Except for routine cleaning of the case and screen, this unit is maintenance free. There are no user serviceable parts in the video monitor. Contact the Zygo Service Department if the monitor requires service.

To clean the sides and top of the unit, use a clean, damp cloth, or commercially available, mild spray cleaner.

Maintenance and Service for Computer Components

Refer to the original manufacturer's documentation for maintenance information for the computer components, which includes the computer, color monitor, mouse, keyboard, and any accessories, such as a printer.

If you are experiencing problems, but are not sure what is at fault, contact Zygo.

Troubleshooting

If you should encounter any difficulty while operating your DVD-400 System, 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.

Problem	Possible Cause and Correction
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.
Interferogram not displayed on video monitor.	Power Switch on Interferometer is in OFF position. Move to ON position. Video monitor cable is disconnected from Interferometer. Check connector panels on Interferometer and monitor. 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 Service Department.
Interferogram not focused.	Check the focus adjustment control on the remote. The part may be outside of the focus range. Check the position of the part. Interferometer camera may need replacement. Contact Zygo Service Department.
Laser ON/OFF Lamp is not lit.	The interferometer is off, or the interlock cable is not connected. Check power and cable connections.

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 cord and power outlet, and power switch. Check the settings on the Laser Controller. They may be set incorrectly.
Interferometer on/off indicator not lit.	Interferometer ON/OFF switch is in OFF position. Flip to ON position. There is no power to the system. Check power cord and power outlet.
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.