SI-10
Interferometer System
Operation Manual
OMP-0315B

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MANUAL REVISION INFORMATION

The document number and latest publication date for this manual appear on the title page. Any revision letter following the document number indicates that the manual has been revised and shows its current revision level. An appropriate revision letter also appears at the bottom of each revised page.

Manual revision status and printing history appear below.

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(There is no revision tracking of Preliminary Issues.)

NOTICE

This manual contains descriptions, drawings, and specifications for a Zygo product. Equipment or products made prior to or subsequent to the publication date of this manual may have parts, features, options, or configurations that are not covered by this manual.

Specifications contained herein are subject to change by Zygo Corporation without prior notice. Zygo is not responsible for errors or omissions that may be contained herein or for incidental or consequential damages in connection with the furnishing or use of this information.

Comments or suggestions for possible improvements to the manual are appreciated and may be sent to the following address:

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Attention: Technical Publications Department
Or telephone (203) 347-8506

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. In the case of new systems, the warranty period is 12 months. 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.

USING THIS MANUAL

MANUAL ORGANIZATION

The information in this manual is organized to help you locate the information you need as easily as possible. It begins with general information to familiarize you with the system and how it works, then progresses through system installation, basic operation procedures, maintenance, and so on.

Tab separators identify major topics and will help you quickly locate information. A brief explanation of what appears after each tab is shown on the back of this page.

Use the table of contents and index when you want to locate a specific topic. Also, on the first page of each chapter there is a brief outline of the subjects covered in the chapter. A glossary is provided to define some of the specialized terms used in this manual.

MANUAL NOTATIONS

At various points in this manual, a paragraph or two will be separated from the normal text and labeled as a Warning, Caution, or Note. The significance of each of these headings is explained here:

WARNING!

Denotes a hazard that could cause personal injury to yourself and/or others in the area, or cause severe damage to the equipment.

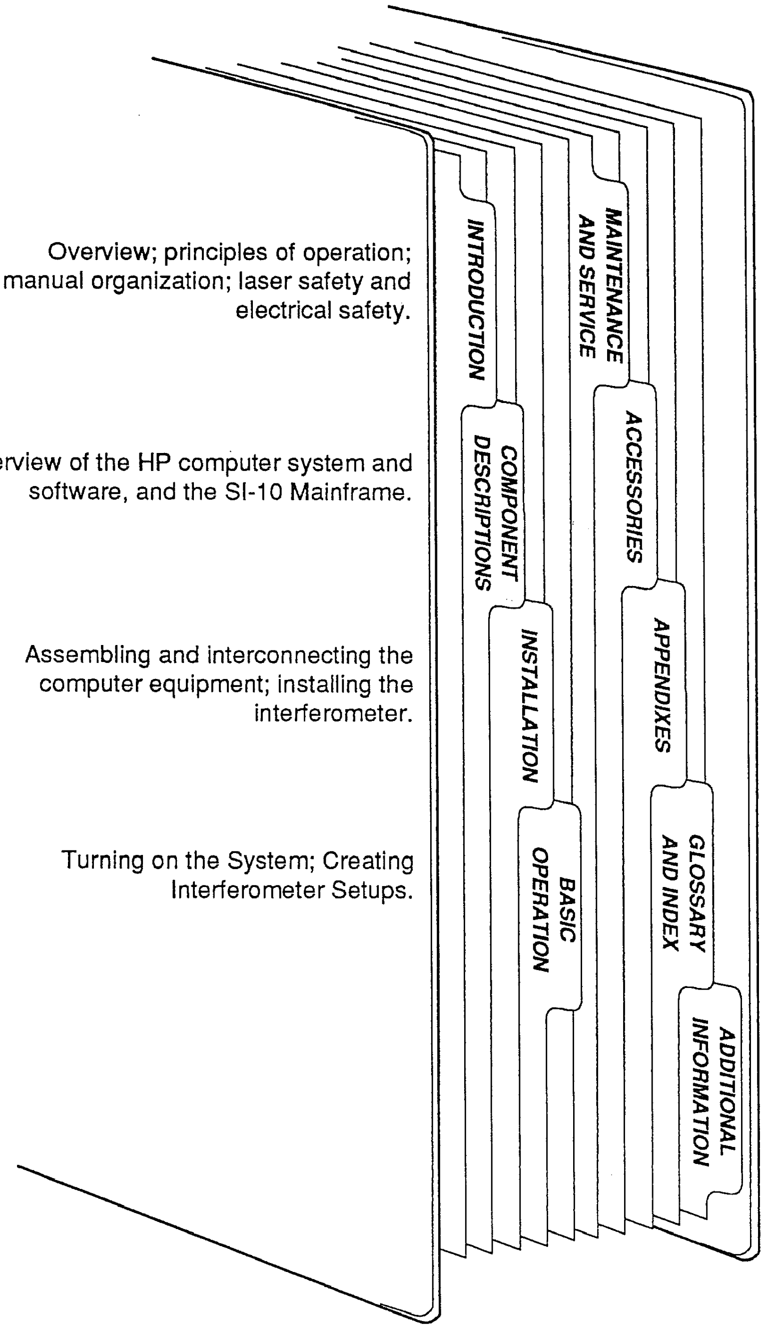
CAUTION:

Indicates a potential problem that could cause damage to the equipment. Less severe than a warning because people will not be injured.

Note:

Provides helpful information or a tip about the topic or procedure under discussion to make it easier to understand or perform.

MANUAL OVERVIEW



Overview; principles of operation; manual organization; laser safety and electrical safety.

Overview of the HP computer system and software, and the SI-10 Mainframe.

Assembling and interconnecting the computer equipment; installing the interferometer.

Turning on the System; Creating Interferometer Setups.

Maintaining the system; cleaning optical components; basic troubleshooting; performing some basic repairs.

Describes accessories that are available for the SI-10 system.

Environmental considerations; PZT linearity calibration.

Glossary defines terms used in the manual. Index helps you locate information quickly.

Provides a space to keep reference information.

CONTENTS

CHAPTER 4 - INSTALLATION (CONTINUED)

CHAPTER 5 - BASIC OPERATION

CHAPTER 6 - MAINTENANCE AND SERVICE

CHAPTER 7 - ACCESSORIES

APPENDIXES

GLOSSARY AND INDEX

FIGURES

Number and Title

Chapter 1

INTRODUCTION

IN THIS CHAPTER

- System Overview
  - Zygo MetroPro Software
- Principles of Operation
  - Phase Measuring Interferometry
  - Double-Pass Interferometry
- Techniques for Testing Optical Components
- Safety
  - Laser Safety
  - Electrical Safety

SYSTEM OVERVIEW

The SI-10 Interferometer System (Figure 1-1) is a precise, high-speed, measurement and analysis system. The Mainframe is based on the design of the industry-standard Zygo Mark IVxp Interferometer*, while the data acquisition and analysis equipment consists of Zygo "MetroPro" software running on a Hewlett Packard 9000-Series computer system. The Zygo Instrument Power Supply provides a power source for the Mainframe, and a Zygo Controller Board, resident in the HP computer, comprises the interface between the Mainframe and the computer system.

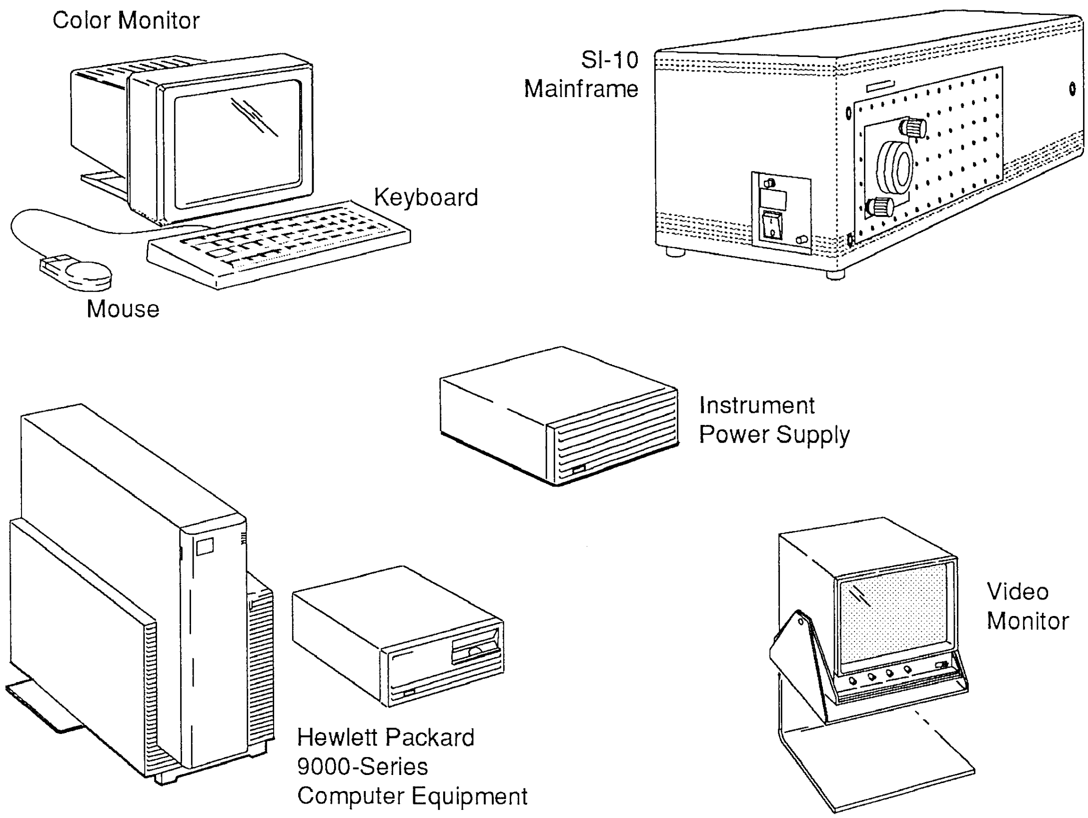
The SI-10 system is designed to measure transmitted wavefront quality of lens systems and surface quality of flat optical components and specular surfaces.

In addition to these basic measurement capabilities are numerous variations including measurements of: parallelism, lens system performance, surface figure of conic sections, surface or transmitted wavefront characteristics of irregularly-shaped or segmented windows, components with obscurations, and more.

*U.S. Patent Numbers: 4,201,473 and 4,577,131

Zygo MetroPro Software

The Zygo MetroPro software analyzes and quantifies measurement information obtained by the interferometer according to parameters you select. Measurement analysis functions can occur automatically or can be 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 contour and isometric plots, plots of surface slope, tables, and graphs.



The SI-10 Interferometer System

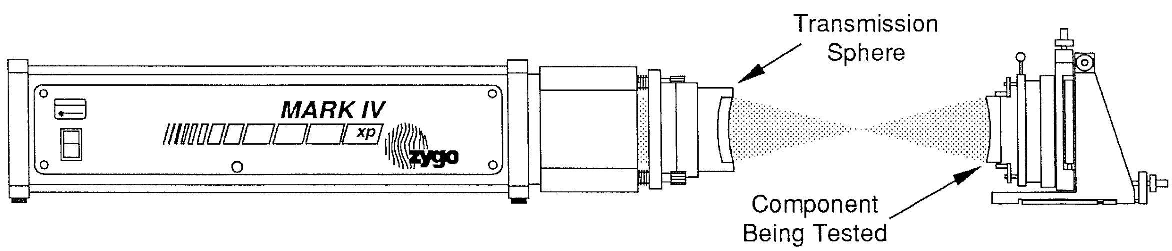
Figure 1-1

PRINCIPLES OF OPERATION

The SI-10 Mainframe is a Fizeau 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 helium-neon laser. The laser beam 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.

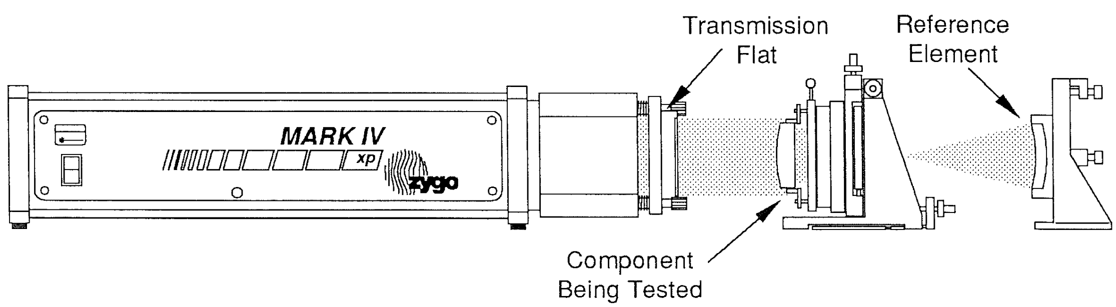
When performing surface quality tests, the measurement wavefront reflects back to the interferometer from the surface of the component being tested (Figure 1-2).



Typical Setup for Surface Quality Tests (Mark IV*xp* Shown)

Figure 1-2

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 (Figure 1-3).

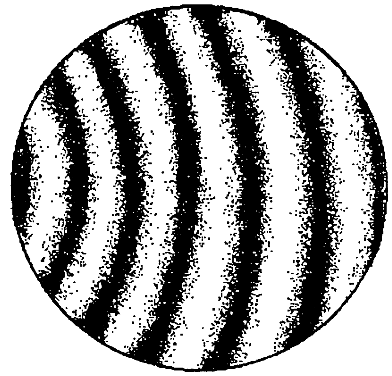


Typical Setup for Transmitted Wavefront Quality Tests (Mark IV*xp* Shown)

Figure 1-3

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 bands (called fringes) that is a direct indication of the quality of the component being tested (Figure 1-4). This image, known as an interference pattern, is converted to electrical signals by a solid-state video camera, sent to the computer, and analyzed.



Interference Pattern
Figure 1-4

Basic Principles of Phase Measuring Interferometry

The Phase Measuring Receptacle (PMR) on the SI-10 Mainframe uses piezoelectric crystals 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 of the interference pattern. 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.

TECHNIQUES FOR TESTING OPTICAL COMPONENTS

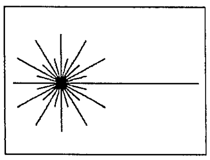
Chapter 5 of this manual explains how to test components for both surface quality and transmitted wavefront quality. Once you understand the basic principles of these test setups, you should be able to develop setups for testing more complex components.

For assistance with specific testing needs, contact your Zygo Sales Engineer or Zygo's Marketing Applications Engineering Group.

SAFETY

Before operating the SI-10 system, please read the following material to become familiar with safety controls, markings, and warnings. Safety concerns cover two areas: laser safety and electrical safety.

Laser Safety



The SI-10 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 SI-10 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.

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 SI-10 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 SI-10 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 Figures 1-5 and 1-6 to locate the controls and the labels listed on the next page.

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

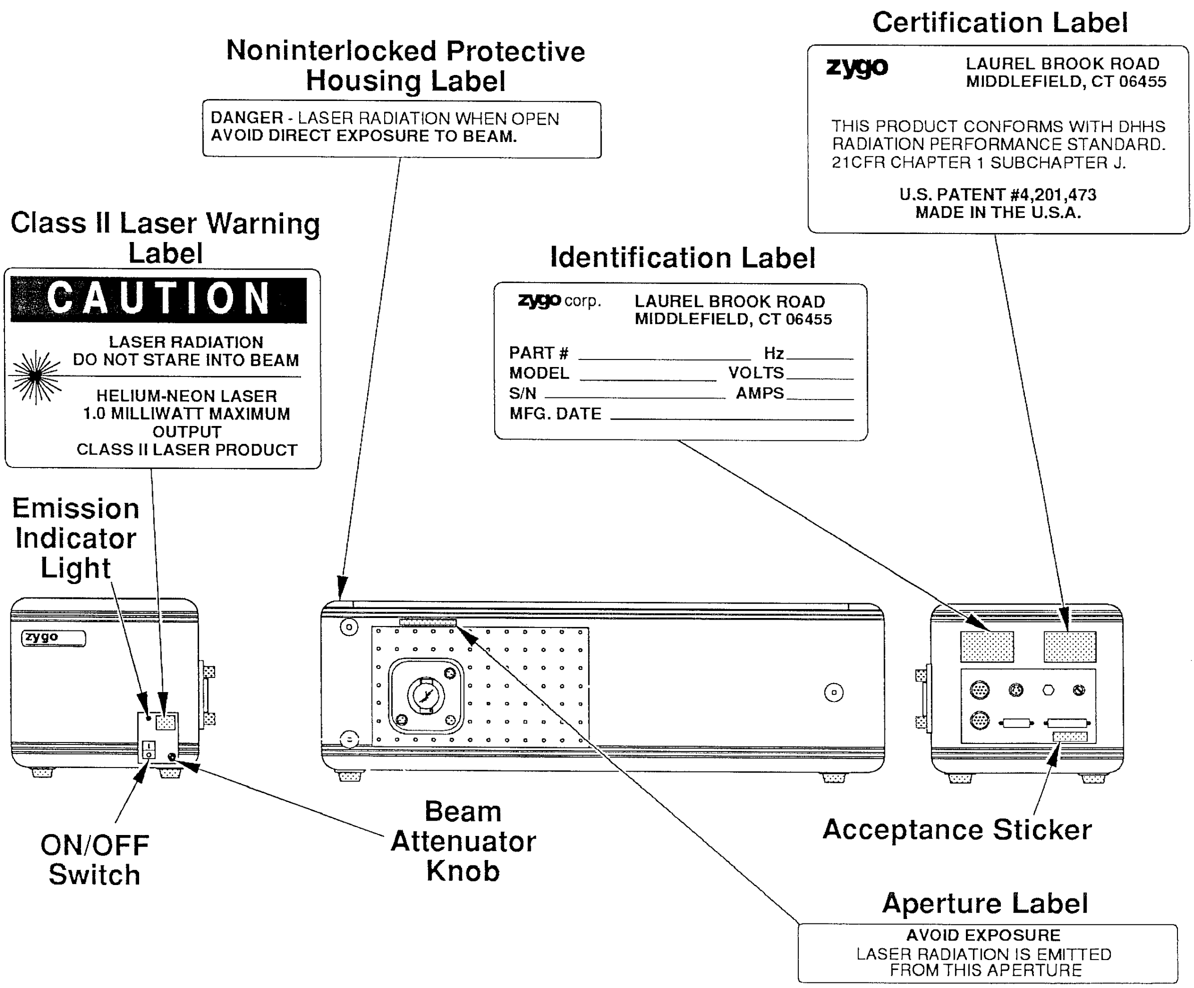
Wavelength: 632.8 nanometers

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 rotated to the left, blocks the laser beam from being emitted from the instrument.
Power Switch	In the off position, the laser is not energized and laser radiation is not emitted from the instrument.

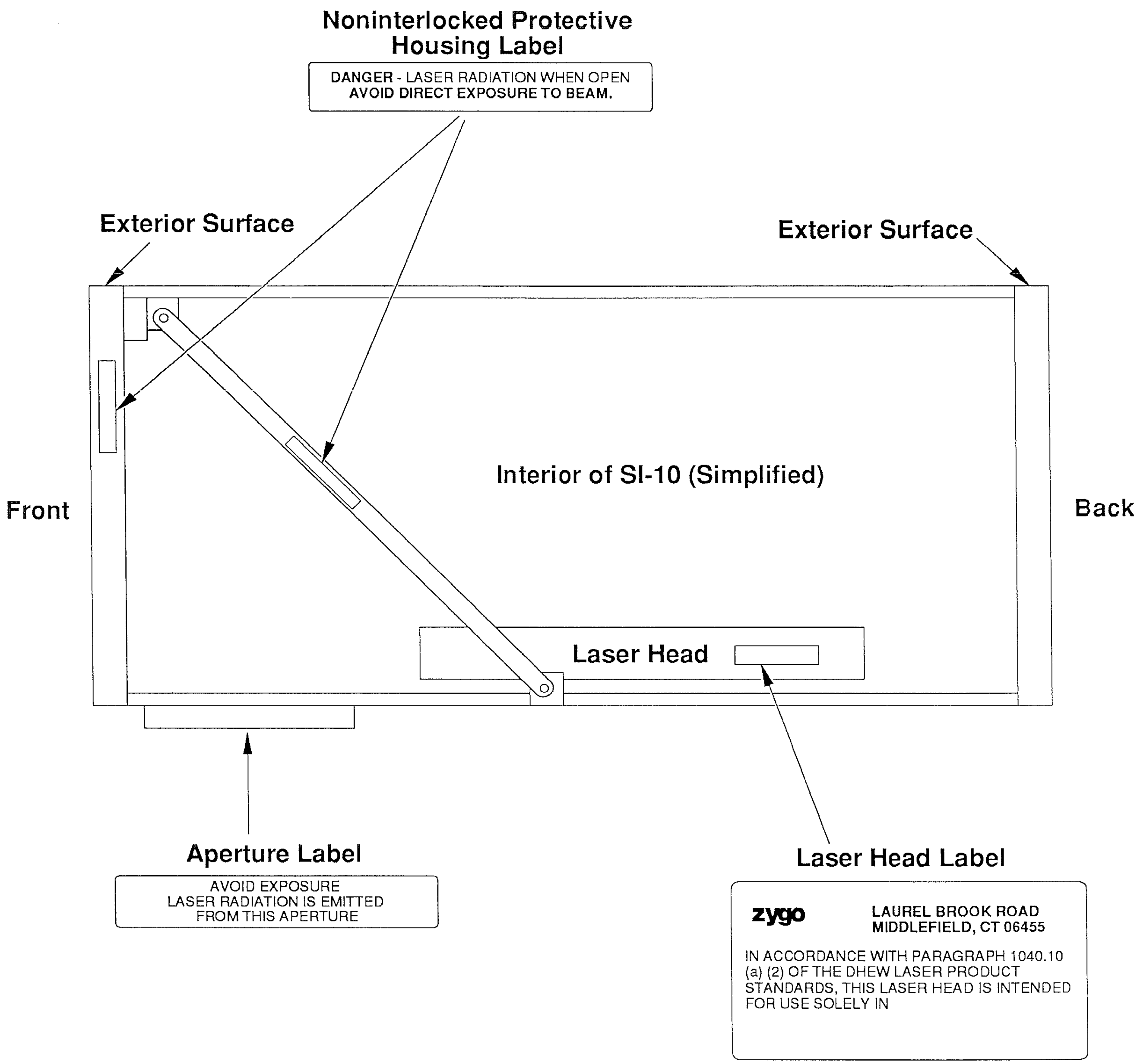
Laser Safety Labels

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 certifies conformance to the DHHS standard.
Identification	Provides information about the instrument - serial number, manufacture date, model number, etc...



SI-10 Laser Safety Controls and Labels

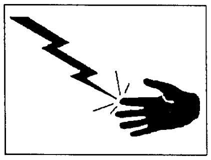
Figure 1-5



Interior (Top) View of the SI-10 Interferometer

Figure 1-6

Electrical Safety



The SI-10 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 SI-10 system with power applied.

CAUTION:

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 SI-10.

DO turn off the SI-10 before disconnecting and reconnecting cables.

Chapter 2

COMPUTER

IN THIS CHAPTER

- The Computer System
- System Software

THE COMPUTER SYSTEM

The computer is a Hewlett-Packard* 9000 Series workstation and controls the instrument, performs calculations, and displays the measurement results numerically and as graphic representations on a color monitor. Figure 2-1 shows the computer components and their function.

Figure 2-1 shows the computer components and briefly explains the function of each component.

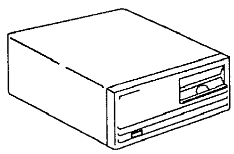
Figure 2-2 illustrates a complete typical computer system.

Note:

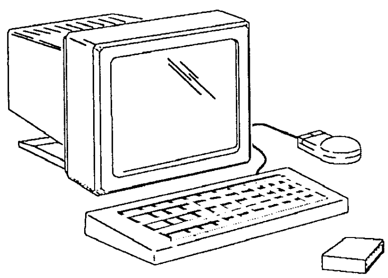
For general information on the available computer accessories, refer to Chapter 7 of this manual.

For detailed information and specifications on any of the Hewlett-Packard computer components, refer to the HP documentation packaged with it.

* Hewlett-Packard is abbreviated as HP in this manual.



HP 1/4-inch Tape Drive
Program loading and data backup

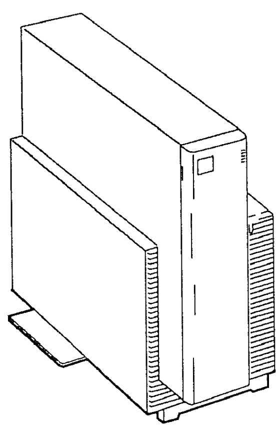


HP 16-inch Color Monitor
Display graphics and data

HP Mouse
Getting around the program

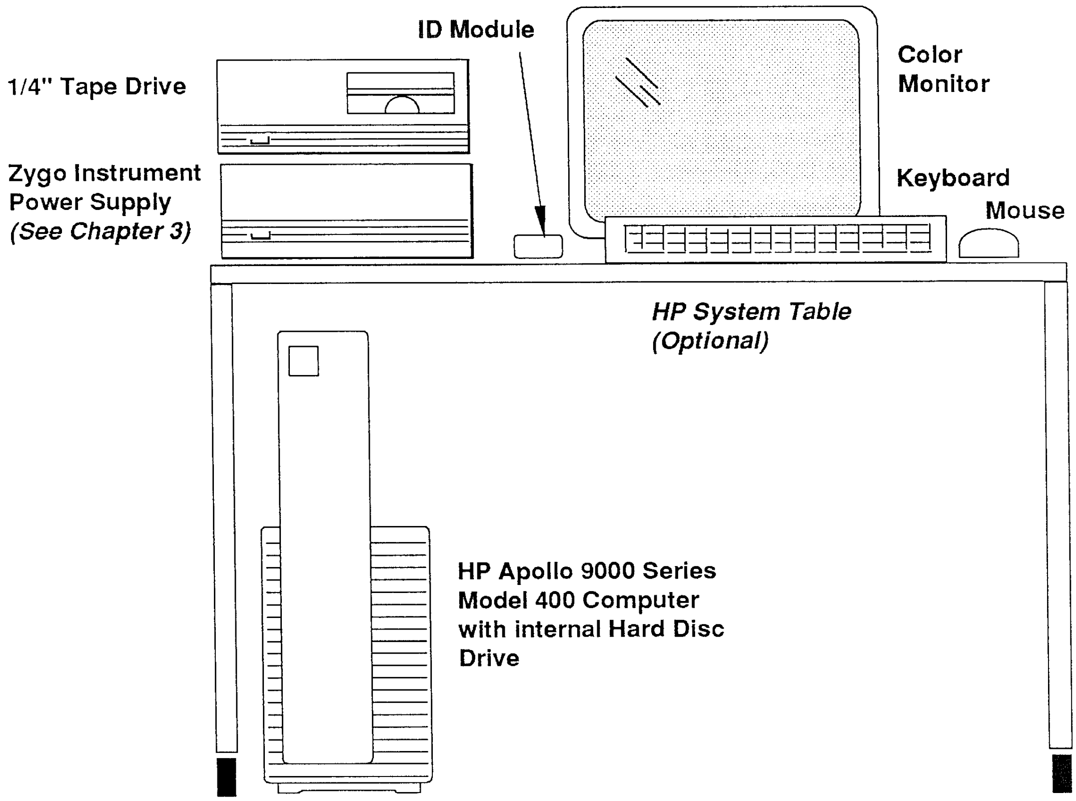
HP Keyboard
Data entry

HP ID Module
Hardware "key" for software options



HP 9000 Series
Model 400 Computer
System control and data storage

The Computer Components
Figure 2-1



HP Component	*HP Part #*	*Description*
HP Apollo 9000 Series Model 400 Computer	HPA1421A	MC68030 Processor, 50 Mhz; 8 MB RAM; with internal SCSI Hard Disk Drive, 330 MB. (HPAD8) Graphics Board. (HPAL5) IEEE-488 Interface Board.
1/4-Inch Tape Drive	HP9144A	Data storage; 67 MB per cartridge.
Color Monitor	HPADH	16-Inch, 1280 x 1024 pixel resolution.
HIL Keyboard HIL Mouse	HPA1099A	Command and data entry. Three-button; activates processing.
HIL ID Module	HPAL5	Hardware "key" necessary to operate MetroPro software options.
System Table (optional)	HP92214*x*	Workstation table. Model suffix A is 29.5 inches wide, Model suffix B is 44.3 inches wide.

Typical Computer System

Figure 2-2

System Interfaces

The HP Apollo 9000 Series Computer includes a set of basic interfaces. They are briefly described below:

The **HP-HIL** interface is used to connect the keyboard, mouse, and the ID Module.

The **HP-IB** (IEEE-488) interface can be used to connect up to 14 printers, disc drives, or other standard speed HP-IB devices to the system. The HP PaintJet Printer uses this interface.

The **SCSI** (Small Computer System Interface) interface is used for high-speed access to as many as seven peripheral devices. The SCSI connector requires a termination plug when only the internal drive is used.

The **RS-232C** interface can be used to connect a terminal, printer, plotter, or other serial device to the system.

The **Parallel** interface is used for connection to other parallel peripheral devices.

The **LAN** interface can be used to connect multiple instruments over a network.

SYSTEM SOFTWARE

There are two software options, as shown below.

Standard	Programming
HP-UX Operating System	HP-UX Operating System
Zygo MetroPro	Zygo MetroPro
	Zygo MetroBASIC
	HP BASIC/UX

HP-UX Operating System

The computer workstations use HP-UX, Hewlett-Packard's implementation of a standard UNIX* operating system. HP-UX is factory-installed on the internal hard disc drive, and provides a powerful, interactive, multi-tasking, and multi-user operating system for the SI-10 System. For details regarding the HP-UX Operating System, refer to the HP documentation included with your computer.

Zygo MetroPro

You don't have to be a UNIX expert to operate the System. Zygo has designed the MetroPro (**Metro**logy **Pro**fessional) software to take advantage of the power of HP-UX without passing on its complexity to the user.

The MetroPro software is arranged in a "window" environment that uses menus, buttons, and control devices accessed by the mouse and the keyboard. The mouse is used to access menus and to activate certain functions, such as defining measurement areas (masks) and controlling the graphic displays. Commands are executed from menus activated by the mouse or by selectable "push buttons".

MetroPro is a very versatile program. A sample measurement application is included, where measurements can be made, results printed, and data saved, all with a click of the mouse. Though easy to use, the program has great capabilities; it can display data as a filled plot, solid model plot, slice (2D) plot, or in a three dimensional (3D) representation. It can also perform complex analyses on the surface data, such as Point Spread Function (PSF) and Modulation Transfer Function (MTF).

Starting either from scratch or with the sample application, you can easily create custom measurement applications to analyze and display data the way you want by selecting various plot types and measurement results and placing them together in a window. Applications you create can be saved and recalled for later use.

Refer to the MetroPro User's Guide, OMP-0289, for detailed information about using MetroPro.

Zygo MetroBASIC

MetroBASIC provides the same analysis features as MetroPro software but, with additional programming capability. If you need features for test conditions not handled by the MetroPro software, you can write your own test and analysis software using HP BASIC/UX and the Zygo Interferometric Software Library (ISL). The ISL is a storehouse of routines that can be accessed from HP BASIC/UX.

MetroBASIC is purchased separately and is completely described in its own Operation Manual, OMP-0282.

HP BASIC/UX

HP BASIC/UX is an extended BASIC language which was designed primarily for engineers and scientists who desire a simple yet powerful language that can both manipulate data as well as interface with a wide variety of instruments. Using BASIC/UX along with the Zygo ISL (Interferometric Software Library) will provide you with almost limitless measurement capabilities.

For more information on HP BASIC/UX, refer to the HP documentation included with it.

Chapter 3

INSTRUMENT

IN THIS CHAPTER

- General Description
- Mainframe
- Instrument Power Supply
- Zygo Controller Board
- Video Monitor
- Power Kit
- Specifications

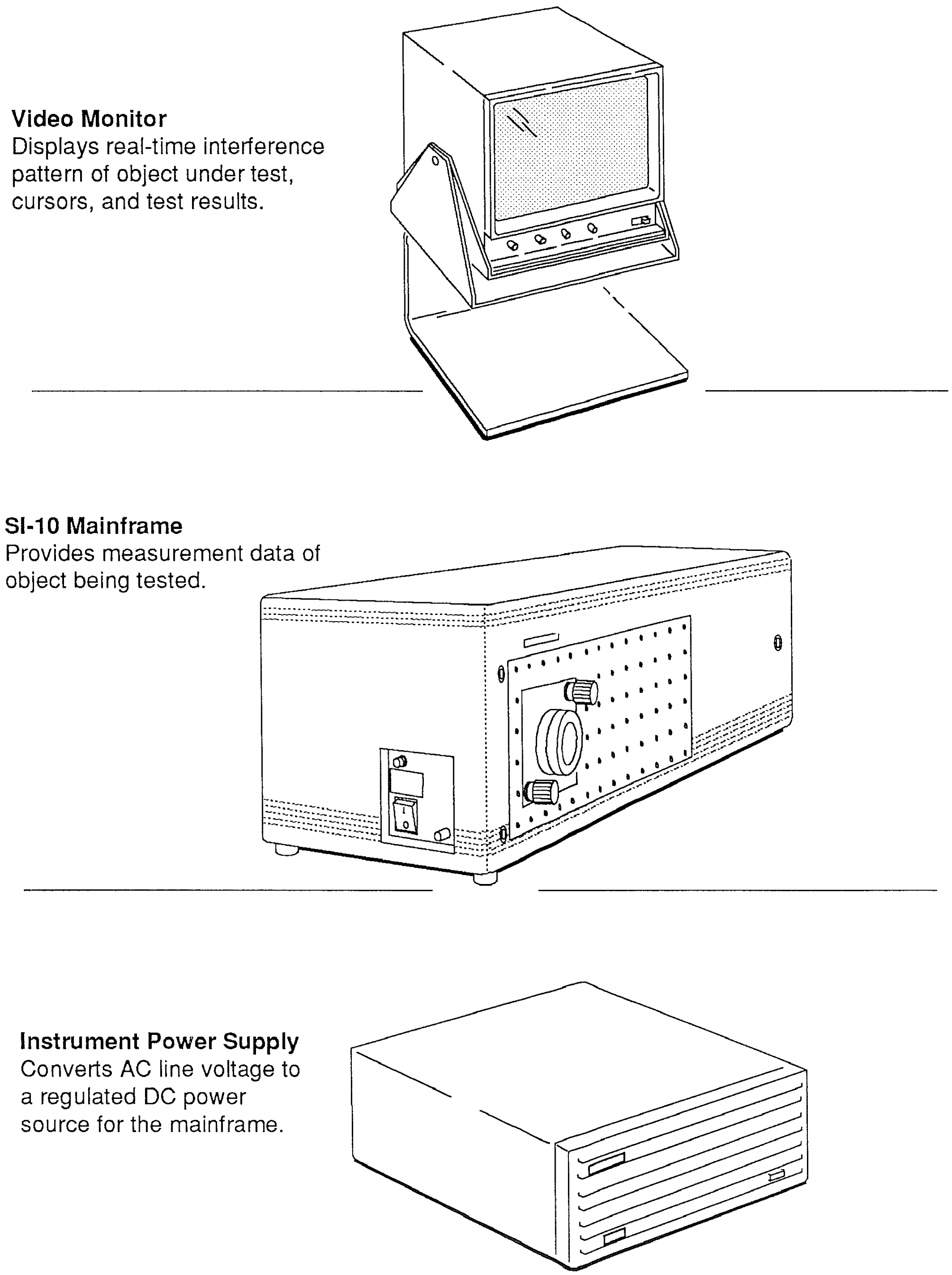
GENERAL DESCRIPTION

The instrument portion of the SI-10 Interferometer System consists of the SI-10 Mainframe, a video monitor, and an instrument power supply.

Figure 3-1 identifies the major components and some of the features of the instrument.

MAINFRAME

The SI-10 Mainframe is a Fizeau interferometer. It emits a 12-millimeter diameter beam of collimated laser light at a wavelength of 632.8 nanometers. The beam reflects off the surface under test or, when testing transmitted wavefront quality, passes through the lens system under test and is reflected back to the Interferometer by a reference mirror. The Mainframe provides raw intensity data to the computer for wavefront analysis.



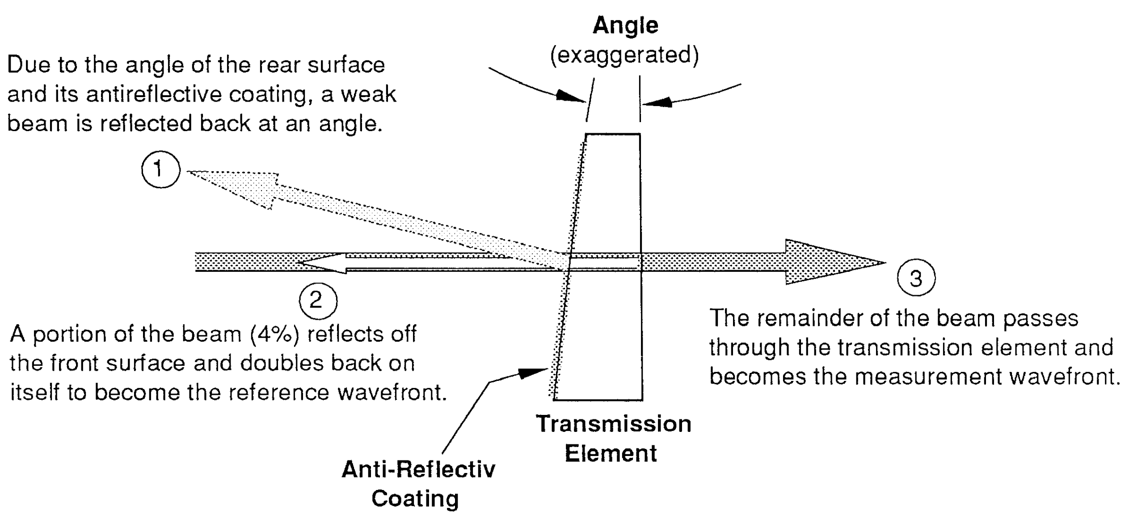
Major Components of the Instrument Portion of the System

Figure 3-1

Transmission Elements

The SI-10 works with 33 millimeter 4% elements or Dynaflect™ flats. These attach to the Mainframe's aperture with a two-pin bayonet mount.

The transmission element's reference surface forms the reference wavefront to which the surface (or the transmitted wavefront) of the item under test is compared. As the laser light leaves the Mainframe, most of the light passes through the transmission element to become the measurement wavefront; however, some of the light reflects back into the Mainframe off the element's front surface and becomes the reference wavefront (Figure 3-2).



Representation of Laser Light Encountering the Transmission Element
Figure 3-2

Some laser light also reflects back into the Mainframe off the transmission element's *rear* surface. To prevent this rear-surface reflection from interfering with the reference or measurement wavefronts, the rear surface of the transmission element is manufactured with a slight angle in relation to the front surface so that reflections from it will be at a slight angle to the Mainframe's optical axis. The rear surface also has an antireflective coating to reduce the intensity of the reflection and help differentiate it from the reference wavefront.

In the Align mode, the rear surface reflection is visible as the second (dimmer) dot of light on the video monitor's screen.

Size of Test Items

The diameter of the Mainframe's measurement beam is 12 millimeters. Therefore, the largest plano component that may be tested is also 12 millimeters. Plano components less than 12 millimeters, as small as 2 millimeters, can be made to fill the measurement aperture using the Mainframe's 6x continuous zoom capability.

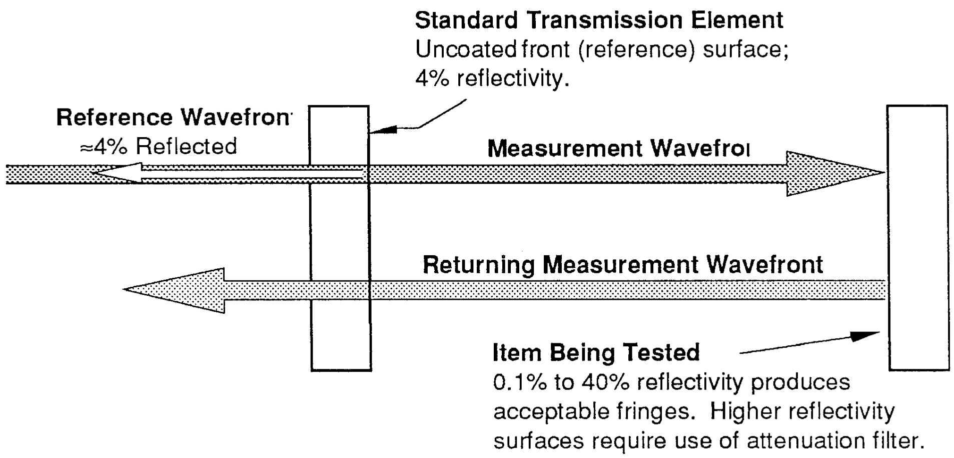
The size limits given here assume that you want to fill the measurement aperture with the interference pattern. Useful measurements can still be made if it does not; however, to obtain the best measurement resolution, the interference pattern should fill as much of the measurement aperture as possible.

Reflectivity of Test Items

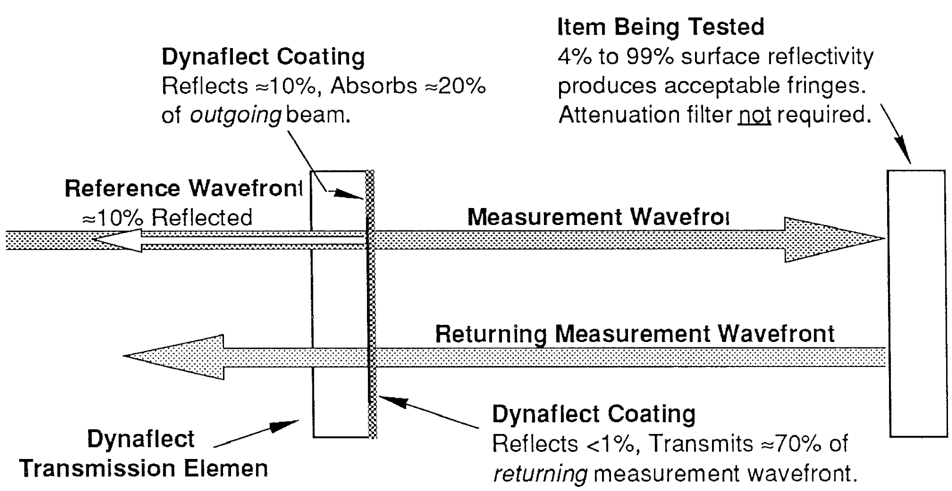
When measuring the surface quality of optical or specular components, the test surface's reflectivity must be within a certain range to produce fringes that will yield good data for phase measurements.

If using a standard transmission element, the intensity of the reference wavefront amounts to about 4% of the original beam intensity, which means that the surface being tested can have a surface reflectivity of approximately 0.1% to 40% (Figure 3-3). (The reflectivity of uncoated glass is approximately 4%.)

For surface reflectivities greater than 40%, either an attenuation filter must be used to reduce the intensity of the beam returning to the Mainframe, or, if measuring plano components, a Dynaflect transmission element may be used. A Dynaflect transmission element can accommodate test surfaces ranging from 4% to 99% reflectivity *without* an attenuation filter (Figure 3-4).



Standard Transmission Element
Figure 3-3



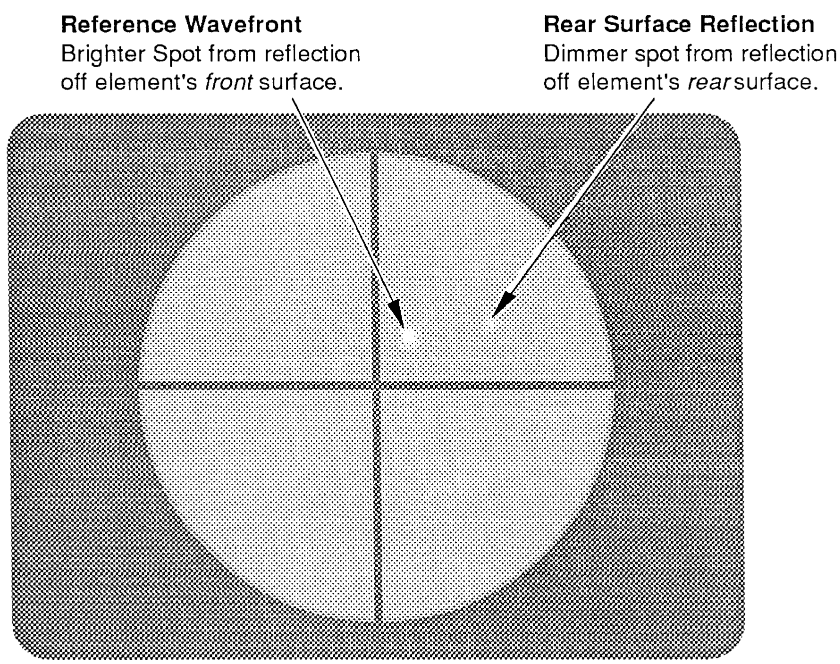
Dynaflect Transmission Element
Figure 3-4

Quick Fringe Acquisition System

Alignment of the transmission element, and of the item being tested, to the optical axis is accomplished quickly and easily with the Quick Fringe Acquisition System, or "Q-FAS".

Q-FAS has two modes: Align and View.

In the Align mode, alignment crosshairs are displayed on the Video Monitor's screen. With the transmission element in place, the reference wavefront appears as the brighter of two dots of light (Figure 3-5). The second (dimmer) dot of light is the attenuated off-axis reflection from the transmission element's rear surface. Aligning the transmission element to the Mainframe's optical axis consists of adjusting the tip and tilt knobs on the Mainframe's element holder until the brighter dot is superimposed on the intersection of the crosshairs.



Video Monitor Screen Showing the Align Mode
Figure 3-5

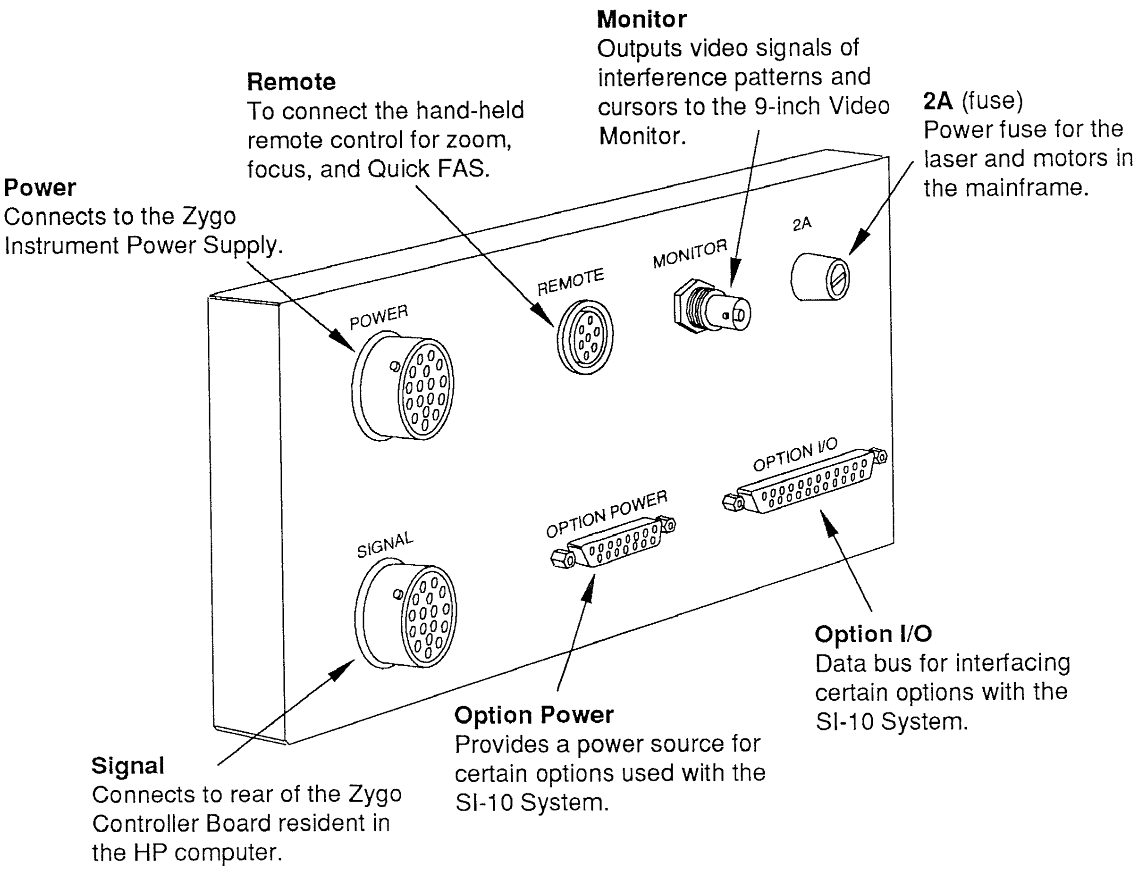
The measurement wavefront, reflected back from (or through) the test component in the interferometer's cavity, also appears as a bright dot on the screen. The test and, if applicable, reference components in the cavity are adjusted until the bright dot is at the appropriate position (dependent on the type of test being performed).

Once alignment is complete, switching back to the View mode shows the interference pattern of the test item on the Video Monitor. At this point, only minor fine-tuning of the component(s) in the cavity is required to produce an optimum interference pattern.

This explanation of Q-FAS is just an overview; actual setup and alignment procedures are explained in detail in Appendix A.

Connector Panel

Figure 3-6 shows and explains the various connectors found on the Mainframe's connector panel.

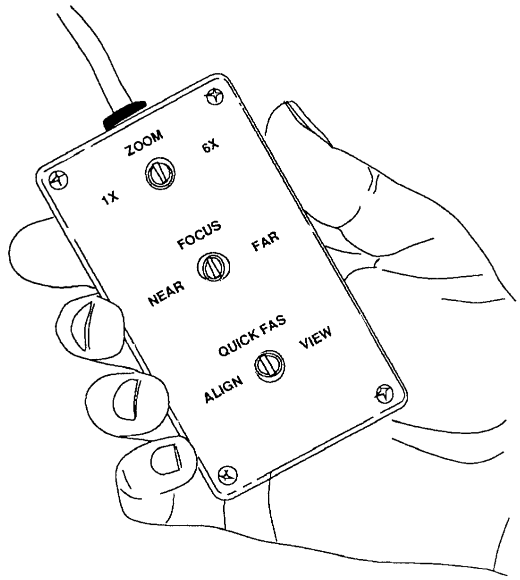


SI-10 Mainframe's Connector Panel

Figure 3-6

Hand-Held Remote

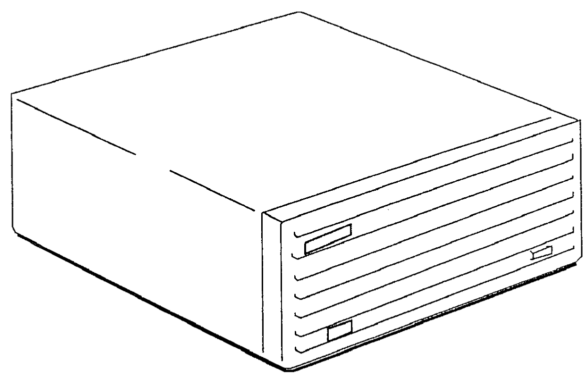
Included with the Mainframe is a hand-held wired remote unit (Figure 3-7) which provides sole access to the Mainframe's Quick-Fringe Acquisition System, aperture focus, and 6:1 zoom capability. The remote not only makes it more convenient to operate the Mainframe, but is necessary to prevent vibration from being introduced into the test setup.



Hand Held Remote Unit
Figure 3-7

INSTRUMENT POWER SUPPLY

The Zygo Instrument Power Supply (Figure 3-8) is the sole power source for the Mainframe. Voltages output to the Mainframe are +12 Volts DC for the laser and solid state camera, and +5 Volts DC and ±15 Volts DC for its internal electronics. All the voltages are sent to the Mainframe via a single connecting cable.



Instrument Power Supply
Figure 3-8

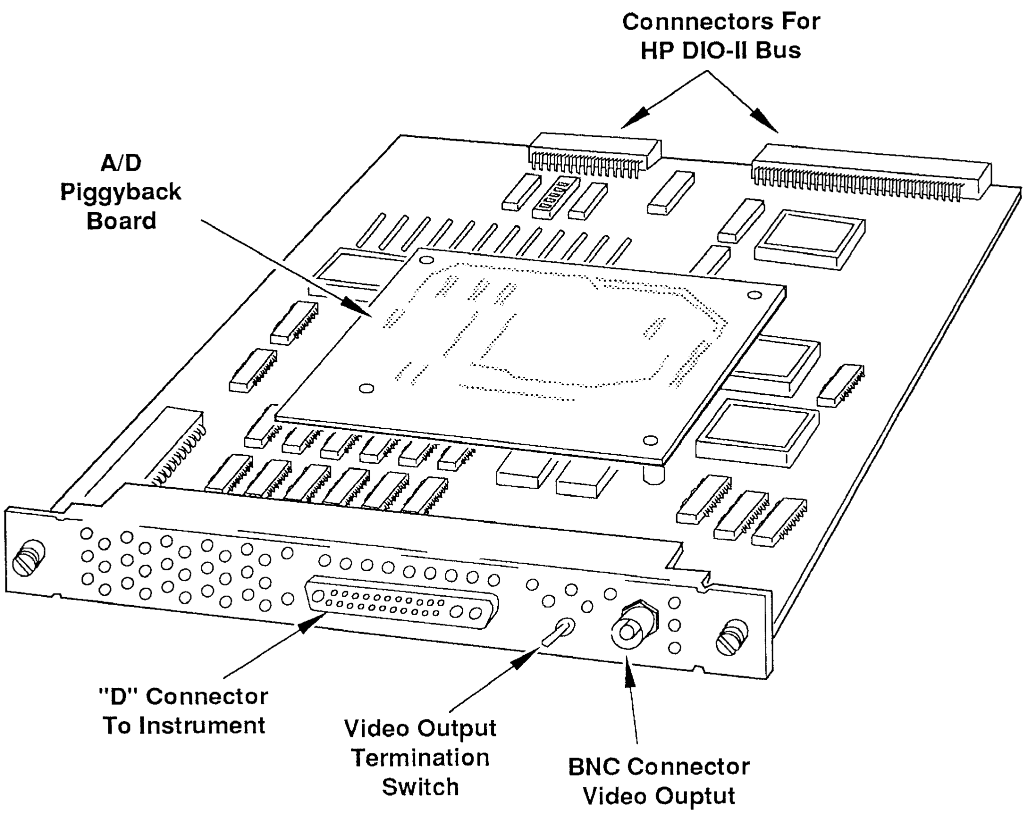
The Power Supply can be set to operate on 100, 120, 220, or 240 volt AC power by properly configuring the power connector module on its back panel.

Cosmetically, the Power Supply matches the appearance of the HP computer equipment and can be mounted in the HP mini-rack, if space permits.

ZYGO CONTROLLER BOARD

The Controller Board (Figure 3-9) is the link between the computer and the Mainframe. It connects directly to the HP computer's DIO II bus, and handles data acquisition, averaging, and masking, digitizes the output of the solid state camera, and transfers data to the HP computer. It consists of a main board with a piggy-back Analog-to-Digital Video Board.

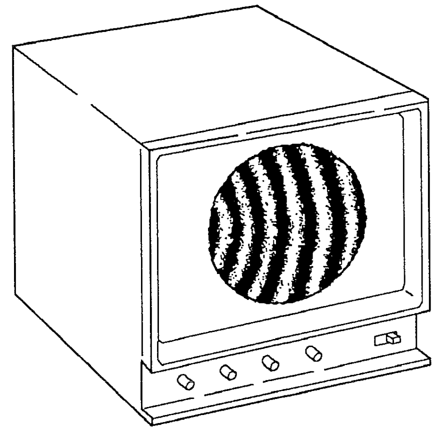
The Controller Board has a D-style connector for sending/receiving data signals to/from the Mainframe, and a BNC connector to output video signals to a Video Monitor.



Zygo Controller Board
Figure 3-9

VIDEO MONITOR

The Video Monitor, Model 8005, has a 9-inch (22.9 centimeter) diagonal monochrome screen and displays the alignment screen, a real-time image of the interference pattern of the item under test, cursors, and some measurement results. The Video Monitor is also referred to as a "fringe monitor" because the interference patterns it displays are also called fringe patterns.



Video Monitor
Figure 3-10

The Video Monitor receives its signals from the Zygo Controller Board resident in the HP computer. It can also be plugged directly into the video output on the Mainframe's connector panel.

POWER KIT

The SI-10 Interferometer System includes a Power Kit consisting of power strips and the necessary power cords. There are four Power Kit options, one for each of the following incoming voltage: 100, 120, 220, and 240.

When the system is to be used where the available power is 100, 220, or 240 Volts, a voltage converter is included with the Power Kit to supply 120-volt power to the Video Monitor. The voltage converter does not alter the line frequency.

More information on the Power Kits and Voltage Converter is located in the Specifications section in this chapter and in Chapter 4, the section entitled "Power Distribution."

SPECIFICATIONS

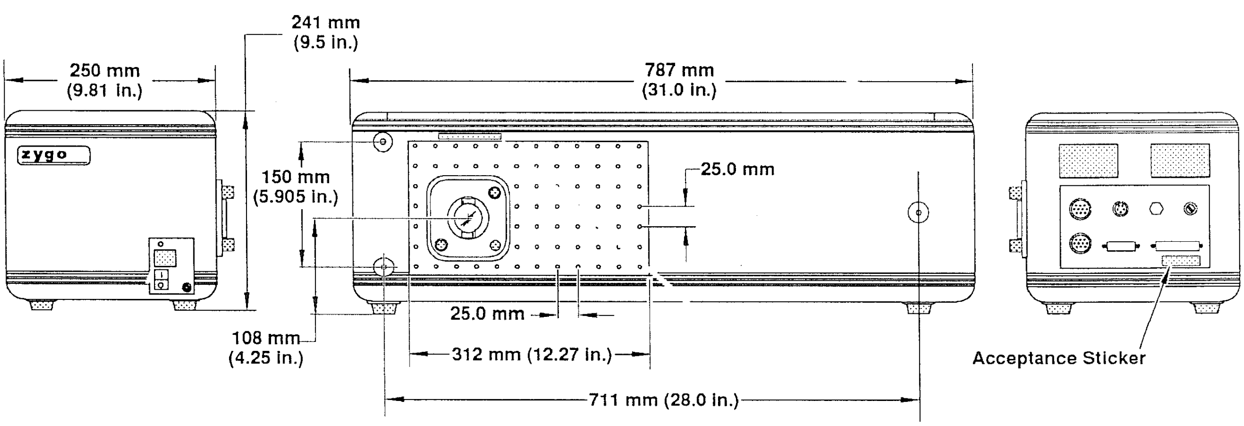
The remainder of this chapter contains individual specification pages for each of the major components that comprise the instrument portion of the SI-10 Interferometer System. Each page lists general specifications and other pertinent reference information about the component, and also provides a dimensioned illustration of it.

The specification pages are listed in the order shown here:

- SI-10 Mainframe
- Video Monitor
- Instrument Power Supply
- Voltage Converter (foreign applications)

SI-10 Interferometer System

Aperture:	10 mm
Operation configuration:	horizontal/upward/downward
Focus range, measured from TF, reference surface lateral resolution:	20 mm - 140 mm
Fringes defocus limit at 1x (full aperture):	10
Fringes defocus limit at 6x (full aperture):	10
Waves SA3 (at best focus) limit at 1x (full aperture):	10
Waves SA3 (at best focus) limit at 6x(full aperture):	10
Number of tilt fringes when spots aligned (10mm part, 1x):	50
Accessory receptacle:	Zygo 33 mm bayonet
Output beam (with TF) to datum plane perpendicularity:	0.1°
Mounting face threaded hole pattern:	M6 threaded holes on 25 mm centers
Mounting bosses:	M6 threaded holes, 3 sides



INSTALLING THE SOFTWARE

The operating system, HP-UX, is installed on the hard disc drive (inside the computer) at the factory. The Zygo MetroPro software is stored on a 1/4-inch tape cartridge for shipment and must be installed onto the hard disc drive. At this point, refer to the MetroPro User's Guide (OMP-0289) for instructions on how to intall the MetroPro software.

WHERE TO GO FROM HERE

After installing the hardware and software of the SI-10 System, the next step is to learn how to use the software and make it do what *your* application requires. As mentioned at the beginning of this chapter, the Zygo installer will show you some of the basics of using the System during the one-day installation and training session. When that session is over, the MetroPro User's Guide (OMP-0289) will be your main source of information for operating the MetroPro software and tailoring it to your application.

The next chapter of this manual explains how to power up the SI-10 System, and provides detailed procedures for creating test setups for plano and spherical components.

Video Monitor - Model 8005

Physical Characteristics:
- Dimensions: See Figure below
- Picture Tube: Monochrome 9-inch (23 cm) diagonal
- Weight: 12.4 lb (5.6 kg)

Power Requirements:
- Voltage: 105-130 AC
- Line Frequency: 50/60 Hz
- Power Consumption: 30 watts

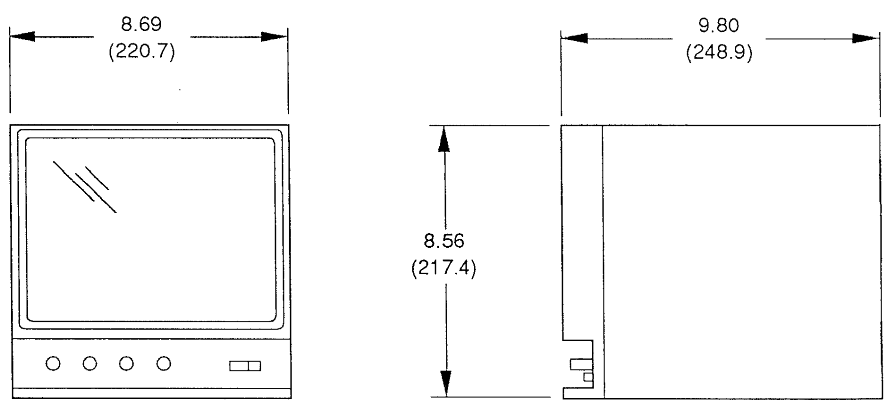
Video Signals:
- Input: 0.5 to 2.0 Volt peak-to-peak composite video, sync negative
- Termination: Selectable, 75 ohm or Hi-Z (for loop-through operation)
- Connectors: Two BNC (on rear panel); one input, one loop-through output
- Sync: Internal

Operating Environment:
- Temperature: 10° to 55° C (50° to 131° F)
- Humidity: 10 to 80% relative, non-condensing
- Altitude: Sea level to 10,000 ft (3,040 m)

Performance:
- Scanning: 60 fields/second, 525 lines/field
- Resolution Capability: Better than 700 lines (horizontal)
- Sweep Linearity: 2% or better

Controls:
- Rotary Knobs (4): Vertical hold, Horizontal hold, Brightness, Contrast
- Power Switch: Two-position front panel slide switch (On/Off)
- Termination: Two-position rear panel slide switch (75 ohm/Hi-Z)

Indicator:
- Power: Red LED near power switch



Dimensions are shown in inches and (millimeters).

Zygo Instrument Power Supply

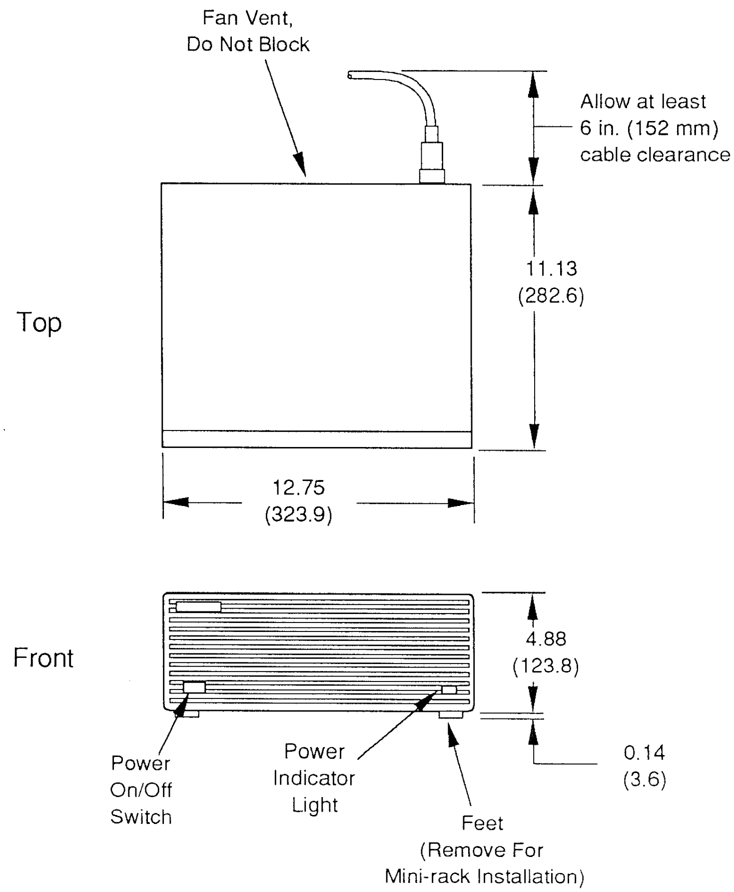
Physical Characteristics:
- Dimensions: See Figure Below
- Weight: 12.5 lb (5.7 kg)
- Clearance required for cables: 6.0 in. (152 mm)
- Cooling: 1 fan

Power Requirements:
- Voltage: 100, 120, 220, or 240 AC ± 10%
- Line Frequency: 47-63 Hz
- Power Consumption: 50 watts maximum

Fuse Ratings (supply module):
- 100 and 120 Volt settings - 250V 3A (slo-blo)
- 220 and 240 Volt settings - 250V 1.5A (slo-blo)

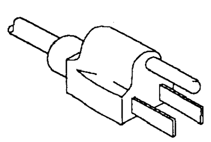
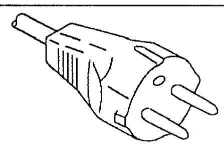
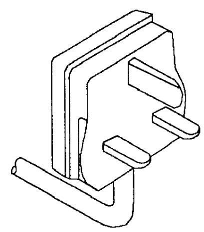
Output Voltages:
- + 5 VDC at 2A
- − 5 VDC at 2A
- + 12 VDC at 5A
- + 15 VDC at 0.4A
- − 15 VDC at 0.4A

Mounting:
- Table top or HP Mini-rack



Dimensions are shown in inches and (millimeters).

Power Kit

Plug Type	AC Voltage	Country	Zygo Part No.
	100V*	Japan	6202-160-03
	120V	United States Canada	6202-160-01
	220V*	France Germany	6202-160-02
	240V*	United Kingdom	6202-160-04

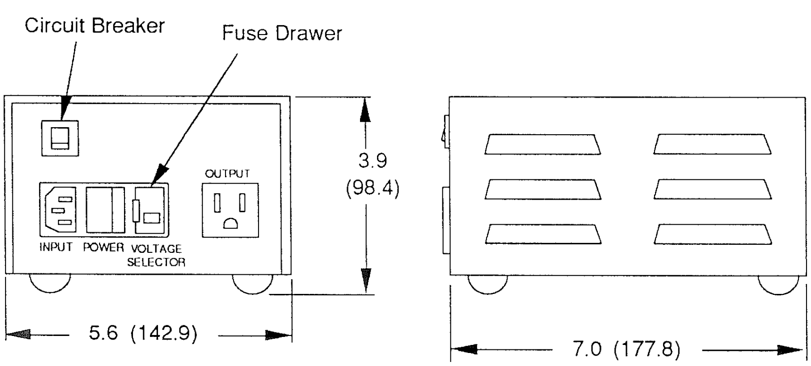
* Includes Voltage Converter for use with the 120V Power Strip.

Voltage Converter Model 250 VA

Physical Characteristics:
- Dimensions: See Figure Below
- Weight: 9.9 lb (4.5 kg)

Power Requirements (source):
- Voltage: 100, 120, 220, or 240 AC
- Line Frequency: 50 - 60 Hz
- Fuse Rating: 250V 5A

Power Output:
- Voltage: 120 AC
- Line Frequency: Same as power source.
- Load Capacity: 2.08A (100 watts)
- Circuit Breaker: 2A



SELECTING INCOMING VOLTAGE
1. Remove fuse drawer.
2. Pull out bottom fuse holder.
3. Position holder so incoming voltage is visible through window in fuse drawer.
4. Insert fuse drawer.

Dimensions are shown in inches and (millimeters)

Chapter 4

INSTALLATION

IN THIS CHAPTER

- Installation Considerations
- Installation Checklists
- Installing the Zygo Controller Board
- Installing the HP Computer
- Installing the Instrument Power Supply
- Setting Up the Video Monitor
- Installing the Mainframe
- Power Distribution

OVERVIEW

Only the instrument components are shipped directly from Zygo. The HP computer workstation is shipped from Hewlett-Packard, and the vibration isolation system, if purchased, is shipped from its manufacturer.

One day of on-site installation and training by a Zygo installer is included with the purchase of the SI-10 System. To make the most of this one-day session, Zygo recommends that you install as much of the System as possible beforehand. (You should at least set up the computer components and the vibration isolation system, and have all the SI-10 instrument components at the installation site.) This will allow you and the installer to spend more time on actual hands-on training and less time on installation. It can take from 4 to 6 hours to completely install the system.

CAUTION:

Do not operate the system prior to the Product Specialist's training. Damage to the system caused by untrained personnel is not covered under the Zygo warranty.

For detailed information about any of the Hewlett-Packard components, refer to the HP documentation packaged with it.

INSTALLATION CONSIDERATIONS

Before installing the SI-10 Interferometer System, you should carefully consider the following aspects of the installation:

- Operating Environment
- Utility Availability
- Component Positioning

Operating Environment

Because the System is capable of measuring to less than $\lambda/20$, the environment in which it is installed is significant and will have an effect on its overall performance. There are several aspects of the operating environment to be considered:

Vibration - The most significant environmental concern for the System, and the most difficult to control, vibration can be introduced by any of several sources: floors with insufficient support or rigidity, acoustic noise, other equipment (fans, etc.), human activity, and so on.

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 heavy trucks and traffic, can be eliminated by using a vibration isolation support table.

Acoustic vibration (sound) of sufficient amplitude can cause vibration in the Mainframe, optical components, and items under test. This is especially true of low-frequency vibrations, which may not be audible even at relatively high amplitude. Uninsulated walls made with gypsum board (sheetrock) tend to to retransmit acoustic vibration from adjoining areas.

Vibration can also be transmitted to the Mainframe 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 same table as the Mainframe. Even a cooling fan produces too much vibration.

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 Mainframe and components under test. The maximum acceptable rate of temperature change is approximately 1.8 °F (1 °C) 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. Within the measurement cavity, wide temperature differences can disturb the measurement beam due to the difference in densities between warm and cold air. Such temperature differences can be caused by air conditioning and/or heating devices or vents.

Air Turbulence - Fans or blowers help to even out temperature differences in the operating area but, if improperly positioned, can cause air turbulence problems. Air turbulence causes uneven air density within small areas, thus refracting parts of the measurement beam and altering the wavefront.

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

Utility Availability

Electrical - The SI-10 system can operate on 100, 120, 220, or 240-Volt power. The system requires an isolated 20-Amp power circuit (10-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/cm^2), although typical operation pressure is less. The flow rate is negligible once the isolator has been pressurized. The air supply should be filtered and oil and water free. Bottled nitrogen normally does not require filtering.

SI-10 COMPONENT POSITIONING

After considering the previously-mentioned concerns about vibration, the only limitation as to where components can be positioned is the length of the interconnecting cables. The SI-10 Mainframe may be oriented in any of three directions; one suggested layout is shown in Figure 4-1.

Horizontal Configuration

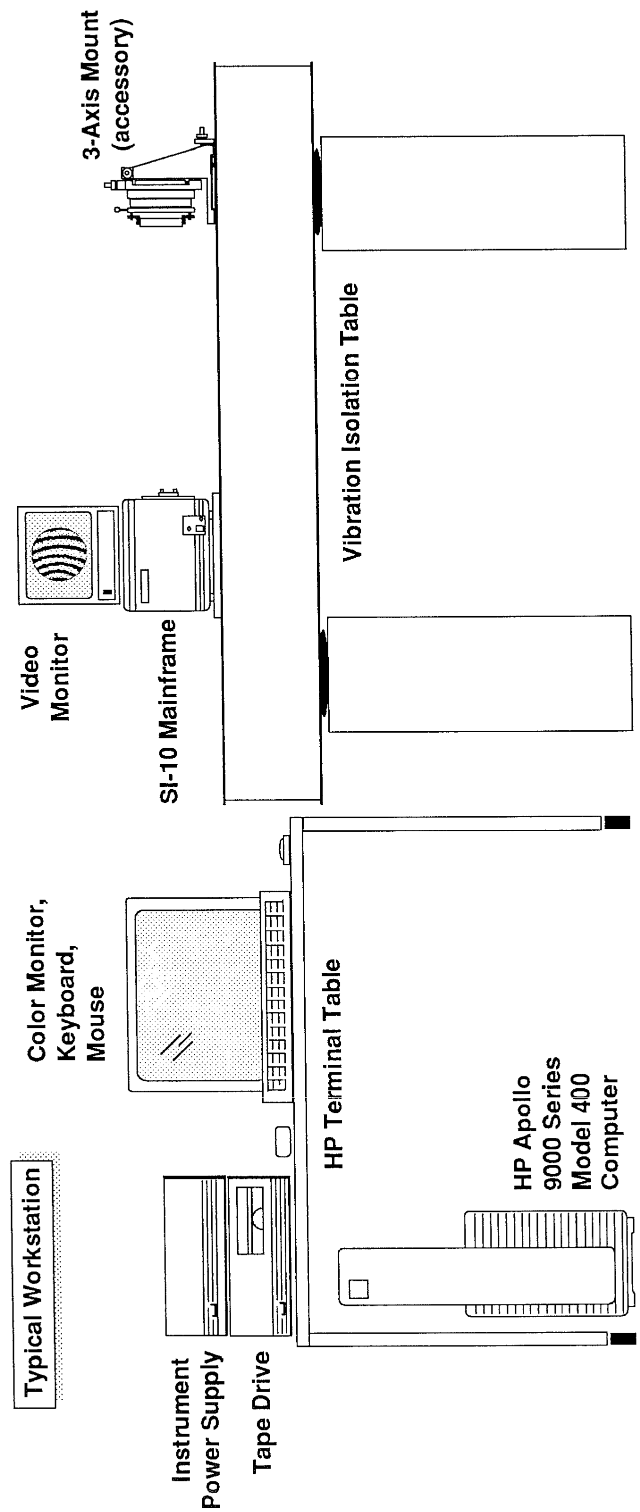
In the horizontal configuration, the feet are mounted on the bottom of the unit (Figure 4-1), with the datum plate facing to the right of the operator. In this configuration, the SI-10 is compatible with the centerline height of all Zygo accessories. Air isolation must be used in this configuration.

Upward Looking Configuration

In the upward looking configuration, the feet are mounted on the side of the unit, opposite the datum plate. The datum plate is therefore horizontal, with the beam aimed up toward the ceiling. In this configuration, the datum plate may be used to support a variety of standard optical breadboarding components, such as stages, mounts, or manipulators, and the measured part can be dropped into a holder. Zygo recommends use of the air isolation accessory in this configuration.

Downward Looking

In the downward looking configuration, the unit is bolted to three customer-furnished vertical supports, which must be fixed to a substantial base. In this configuration, the user has the choice of bolting to the pair of mounting holes nearest the front face, or the pair six inches aft of them, in conjunction with the third point toward the rear.



Dimensions:	(HWD) inches
HP Terminal Table	28.4 x 44.3 x 28.0
HP Apollo Computer	24.0 x 8.7 x 23.4
Z-38 Newport Research Table (vibration isolation)	32 x 96 x 36

Recommended Component Layout

Figure 4-1

INSTALLATION CHECKLISTS

A series of checklists are provided to assist you in installing your system. Use the checklists as a summary of the installation procedure.

Note:
The [HP] check box indicates that the step is covered in HP documentation, included with the HP components. Other steps are covered in later sections of this chapter, and are noted by page numbers in brackets.

PreInstallation Checklist

- ☐ Inspect all shipping containers for signs of shipping damage. Report any damage to the carrier.
- ☐ Check that the shipment is complete.
- ☐ Ensure that the installation site has the necessary utilities and environmental control. *[page 4-2 and 4-3]*
- ☐ Move all shipping containers to the worksite. Allow the equipment to acclimate for at least 24 hours.
- ☐ Unpack the electronic equipment from the shipping boxes and place it in the approximate working location. *Do not unpack the Mainframe yet.*

Computer Installation Checklist

- ☐ Install the Zygo Controller Board in the HP Computer. *[pages 4-7 and 4-8]*
- [HP] Ensure that the Tape Drive is set to the proper voltage setting.
- [HP] Assemble the HP System Table (if purchased).
- [HP] Connect the Tape Drive, Color Monitor, Keyboard, Mouse, and the ID Module to the Computer. *[page 4-10 and 4-11]*

Instrument Installation Checklist

- ☐ Check the voltage setting of the Instrument Power Supply and change it if necessary. *[pages 4-12 and 4-13]*
- ☐ Assemble the Video Monitor Stand and mount the Monitor on it. *[page 4-14]*
- ☐ Carefully unpack the SI-10 Mainframe. *[page 4-15]*
- ☐ Position the Mainframe and Video Monitor on a vibration isolation table, and interconnect the components. *[pages 4-15 and 4-16]*

Power Distribution Checklist

- ☐ Position the Universal Power Strips near your computer work table.
- ☐ Connect the computer and instrument components to incoming power. *[pages 4-17 through 4-19]*

Software Installation Checklist

- ☐ Turn on the computer system.
- ☐ Load the Zygo MetroPro software. *[Refer to the MetroPro User's Guide]*

You are now ready to use the system.

INSTALLING THE ZYGO CONTROLLER BOARD

The procedure for installing the Zygo Controller Board is similar for all HP 9000 Series Computers. Note that the position of the open slot may vary according to the model of the computer. Refer to Figure 4-2.

1. Ensure that the computer system is turned off.
2. On the computer, locate a blank slot cover, then remove it by loosening the two thumbscrews and pulling the cover straight out.

CAUTION:

When handling the Zygo Controller Board, use measures to prevent the board from being damaged by electrostatic discharge (ESD). The board should be stored in a static shield bag and handled only by individuals using the disposable wrist strap (included).

3. Peel off the backing and adhere the copper foil end of the disposable wrist strap to an unpainted metal surface on the computer and wrap the other end around your wrist.

WARNING!

The electrical ground on the computer must be connected to earth ground during the following part of the procedure. This can be done by plugging the computer into a grounded outlet. However, do not turn on the computer.

4. Ensure that the computer's power switch is off; then, plug the computer's power cord into a grounded outlet.

5. Remove the Controller Board from the static shield bag.

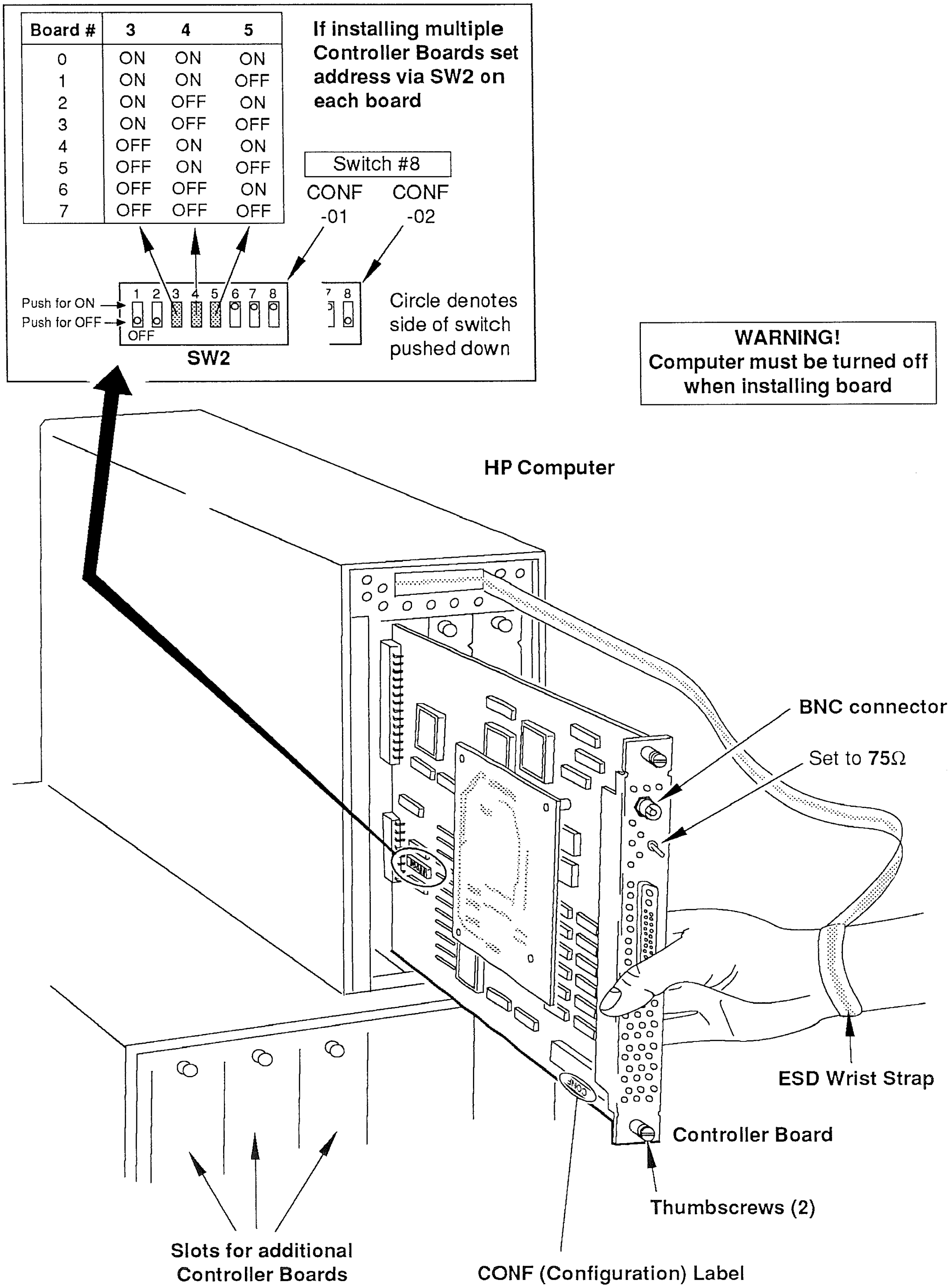
6. If installing a single controller board, check that switches 3, 4, and 5 of DIP switch SW2 are set to an address of 0 (zero). If installing more than one controller board in the computer, each board must be set to a unique address, starting with 0. Set additional boards to addresses 1, 2, and so on, in sequence. Refer to Figure 4-2 to set SW2 for various addresses.

7. Make sure that switch 8 of DIP switch SW2 is set to match the CONF label on the board. Refer to Figure 4-2.

8. Insert the Controller Board into the computer, oriented as shown in Figure 4-2. Ensure that the board slides in the card guides. Push the board in firmly to seat it in its connector. Tighten the thumbscrews.

9. Set the BNC termination switch on the Controller Board to "75Ω".

10. Remove the wrist strap.



Installing the Controller Board in the Computer

Figure 4-2

INSTALLING THE HP COMPUTER

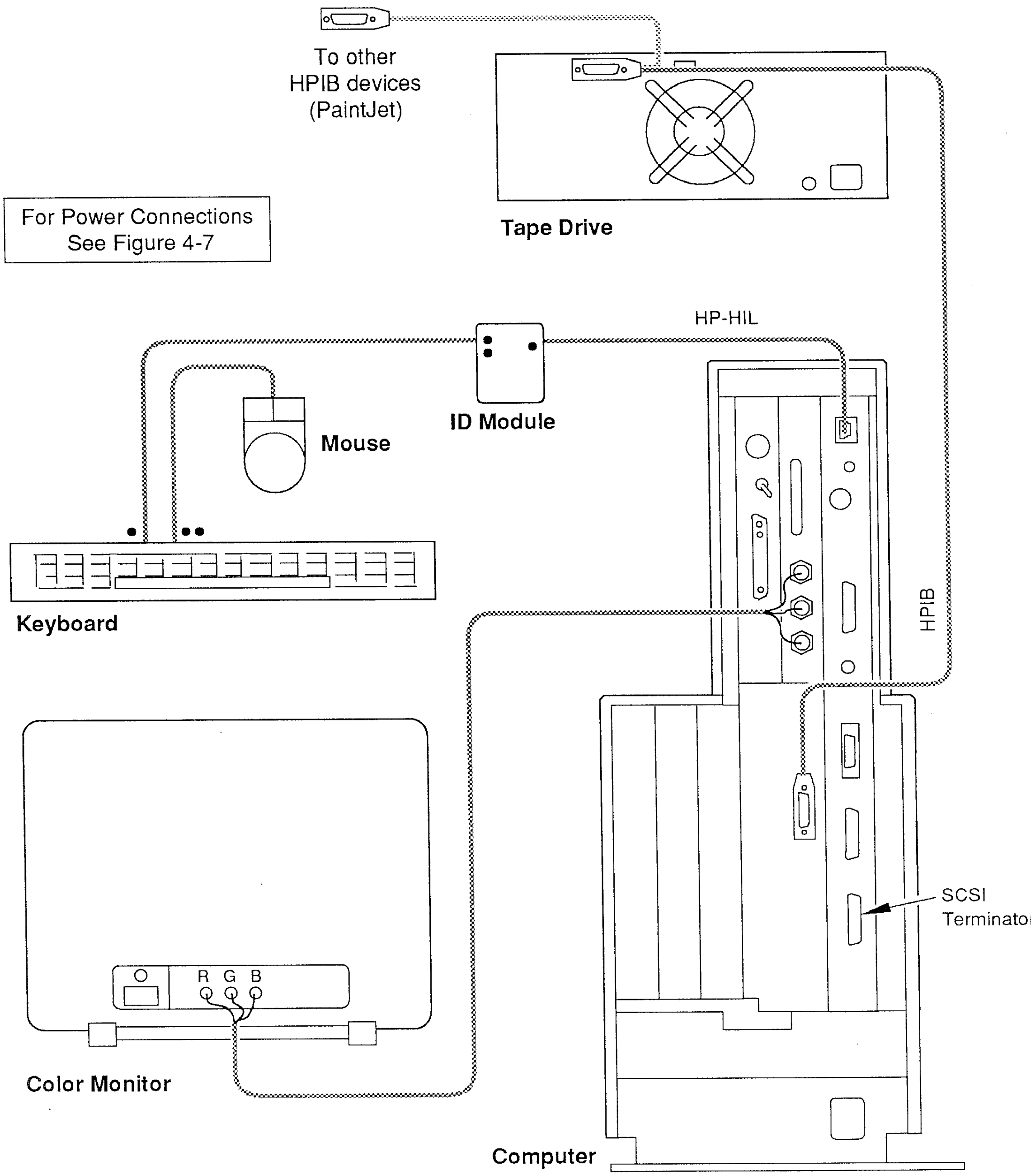
Refer to the manuals included with the HP components for installation instructions. In particular, you should refer to:

- HP Apollo 9000 Series Installation Guide (shipped with the computer)
- Assembly Instructions for the HP Workstation table (shipped with the table)

Computer Interconnection

Computer component cables should be connected following the procedures in the HP documentation. Always disconnect power from the components before connecting the cables. As an aid, refer to Figure 4-3.

For power connections, refer to the "Power Distribution" section later in this chapter.



Computer Interconnection
Figure 4-3

INSTALLING THE INSTRUMENT POWER SUPPLY

The power cable of the Instrument Power supply is 15 feet (4.6 meters) long; therefore, the Power Supply and the Mainframe must be located close enough to one another so that this interconnection cable is not stressed.

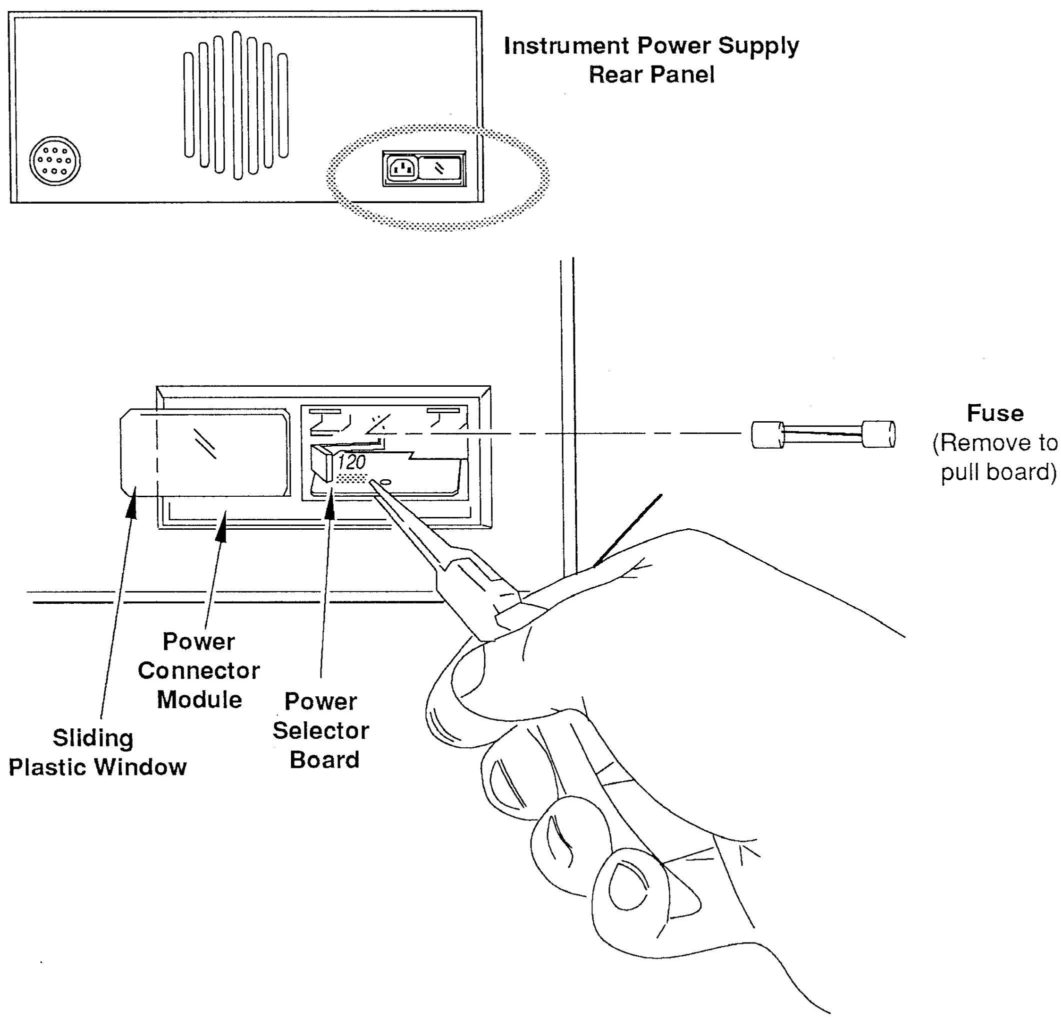
Setting the Line Voltage for the Instrument Power Supply

The Power Supply is factory-set for the line voltage in your area; however, before using the Power Supply, check that the power connector module on the rear of the supply is set for the proper input voltage. The following procedure explains how to check and, if necessary, alter the voltage setting. It can be set to operate at 100, 120, 220, or 240 VAC

CAUTION:

Configuration of the power connector module determines the line voltage on which the Supply will operate. If incorrectly configured when power is applied, electronic components may be severely damaged.

1. Locate the power connector module at the lower right side of the Power Supply's rear panel (Figure 4-4).
2. Unplug the power cord from the module; then slide the plastic window all the way to the left.
3. Make sure that the fuse in the power module is rated for 3A if the line voltage is 100/120 VAC, or 1.5A if the line voltage is 220/240 VAC.
4. Look just below the fuse in the power connector module; you will see a small thin circuit board with a number printed on the left side. This number must match the line voltage to which the Power Supply will be connected. If the number shown is correct, slide the plastic window all the way to the right, and proceed to Step 9. If the voltage shown is not correct, proceed to Step 5.
5. Remove the line fuse by pulling out the black plastic tab labeled "FUSE PULL".
6. Pull the small circuit board from its slot with a pair of long-nosed pliers as shown in Figure 4-4, or with a paper clip formed into a hook inserted through the small hole in the board.



Setting up the Power Supply for Incoming Voltage
Figure 4-4

7. Orient the board so that the desired voltage can be read right side up, and is at the left side of the board.

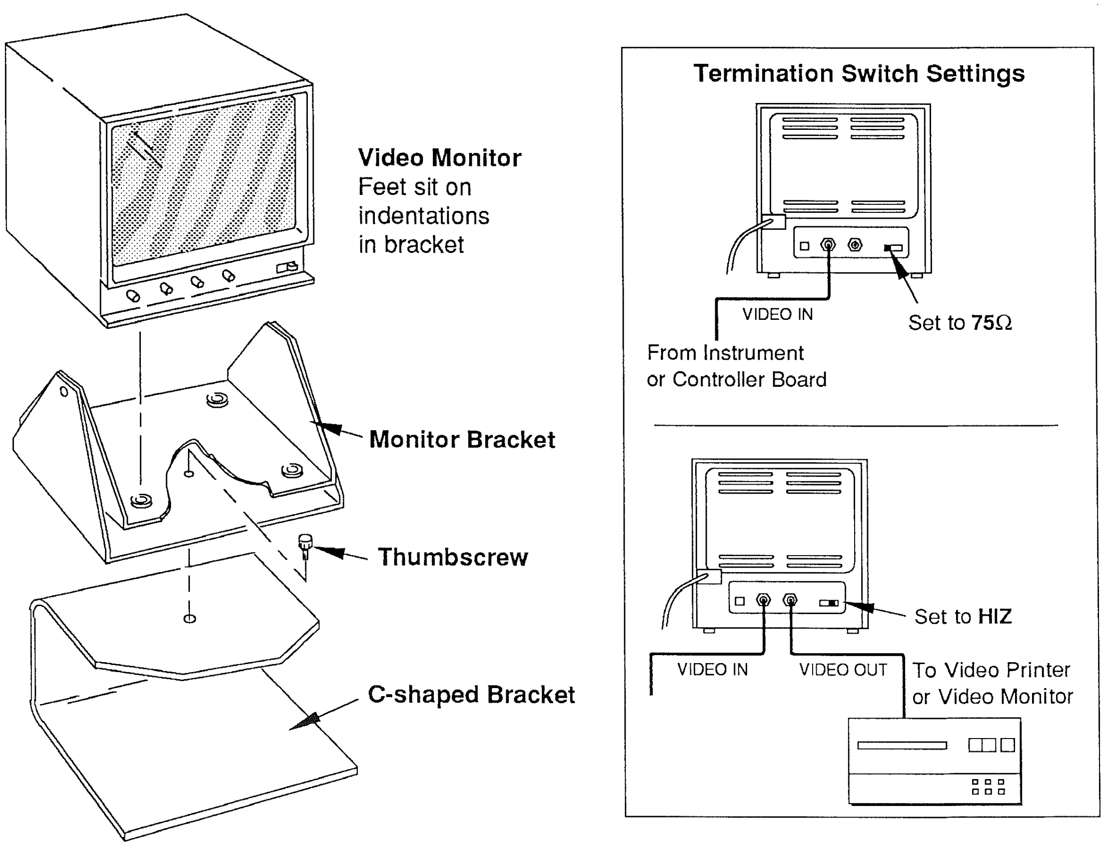
8. Replace the board in the slot from where it was pulled. Be sure to push it in all the way.

9. Install the correct fuse for the selected line voltage (as explained in step 3). Slide the plastic window all the way to the right, and plug the power cord into the module.

SETTING UP THE VIDEO MONITOR

The Video Monitor stand must be assembled and a termination switch on the rear of the monitor must be set to the correct position. Refer to Figure 4-5 and proceed as follows:

1. Place the monitor bracket on top of the C-shaped bracket. Secure the brackets together using the thumbscrew.
2. Place the Video Monitor on the stand, aligning the feet to the indentations on the stand. Adjust the position of the monitor for comfortable viewing.
3. When the monitor is located at the end of a cable run (such as when one Video Monitor is used), set the termination switch to "75Ω". When the cable is "looped through" the monitor to other video equipment, set the termination switch to "HI-Z" and set the termination of the last piece of video equipment in the series to 75Ω.



Video Monitor Installation
Figure 4-5

INSTALLING THE MAINFRAME

Carefully lift the Mainframe out of its shipping box and place it on the vibration isolation table. Use two people for this job as the Mainframe is an awkward size and weight for one person to lift and position.

CAUTION:

Do not, under any circumstances, lift the Mainframe by the Phase Measuring Receptacle.

The Mainframe does not need to be bolted or otherwise secured to the vibration isolation table. However, if your installation requires special mounting arrangement, drilled and tapped holes are provided on both the side and bottom of the Mainframe. (Remove the feet to use the bottom mounting holes.) The Mainframe can operate in any orientation, but do not mount it such that access to the power switch/laser emission indicator or the laser attenuator knob is blocked.

Connecting the Instrument Components

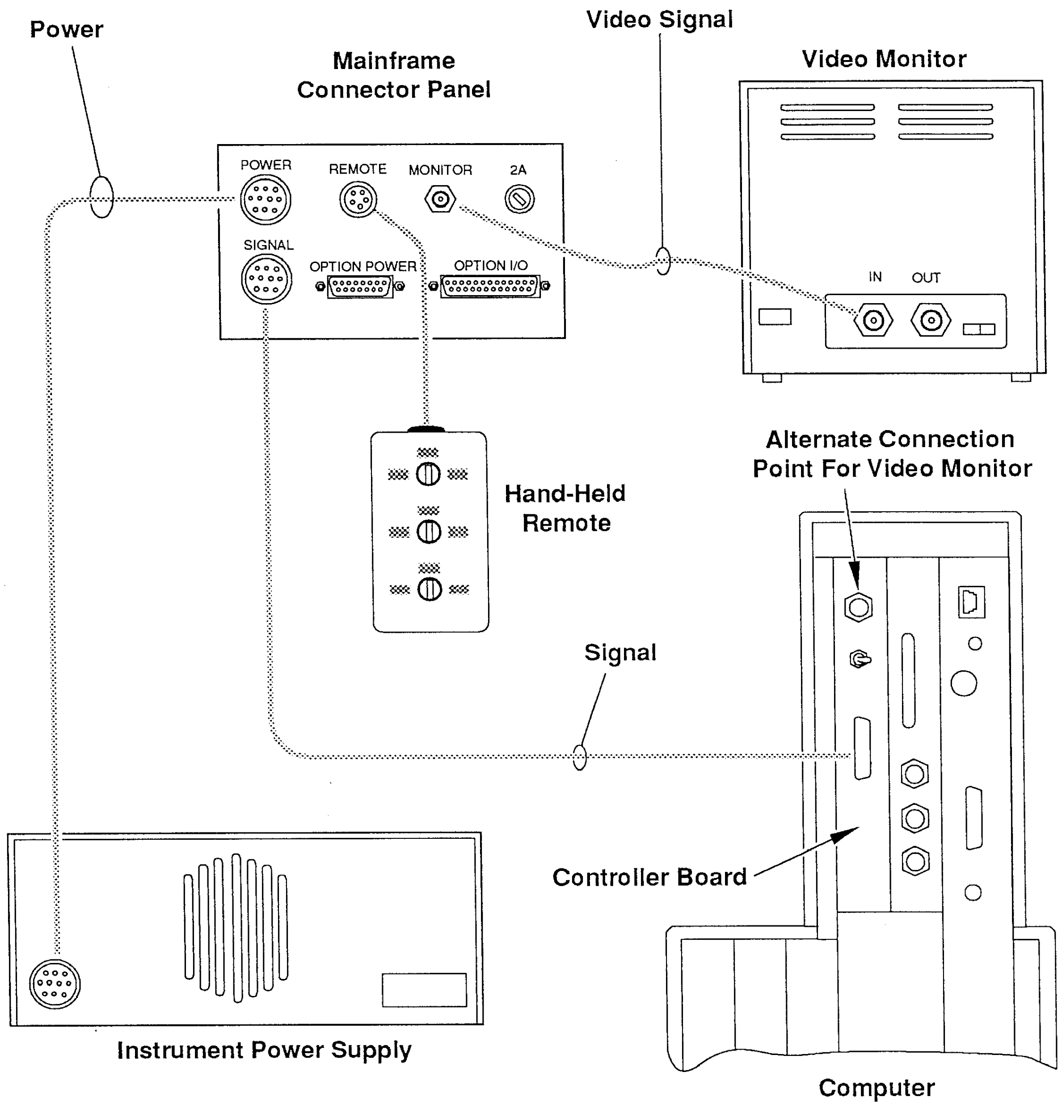
Figure 4-6 shows how to connect the Mainframe, Remote Control, Video Monitor, and Instrument Power Supply. (Remove protective caps from connectors before attaching cables.) Cables entering and leaving the Mini-rack should be routed through the recess at the bottom of the rear cover. To connect power to the computer and the instrument components, refer to the "Power Distribution" section, located later in this chapter.

CAUTION:

Align keyed connectors before attempting to join them together. Failure to align mating connectors may cause damage to the pins or the connector.

When routing power and signal cables to the Mainframe, be sure they are not touching sources of vibration or are in a location where they are likely to be kicked or jarred.

The Video Monitor may be connected to either the BNC connector on the Mainframe or the BNC connector on the Zygo Controller Board (in the HP computer), whichever is more convenient.



Instrument Interconnection

Figure 4-6

POWER DISTRIBUTION

The HP computer and Color Monitor automatically adjust for line voltages from 100 to 240 volts. The HP Tape Drive and the Zygo Instrument Power Supply can be configured to operate on 100, 120, 220, or 240 volts AC. Setting the voltage for the Instrument Power Supply is described previously in this chapter; setting the voltage for the Tape Drive is explained in the HP documentation.

CAUTION:

Do not connect power to any of the equipment until all other connections are made (low-voltage power, signal, video, etc.). Failure to observe this precaution may damage the equipment.

120-Volt Power

Zygo provides two, 120-volt, power strips to supply power to each of the computer components. The power cords included with the HP components plug into the power strips. You may plug the power strips into any receptacle supplying an adequate amount of 120-volt power. Power strips may be placed or mounted wherever convenient.

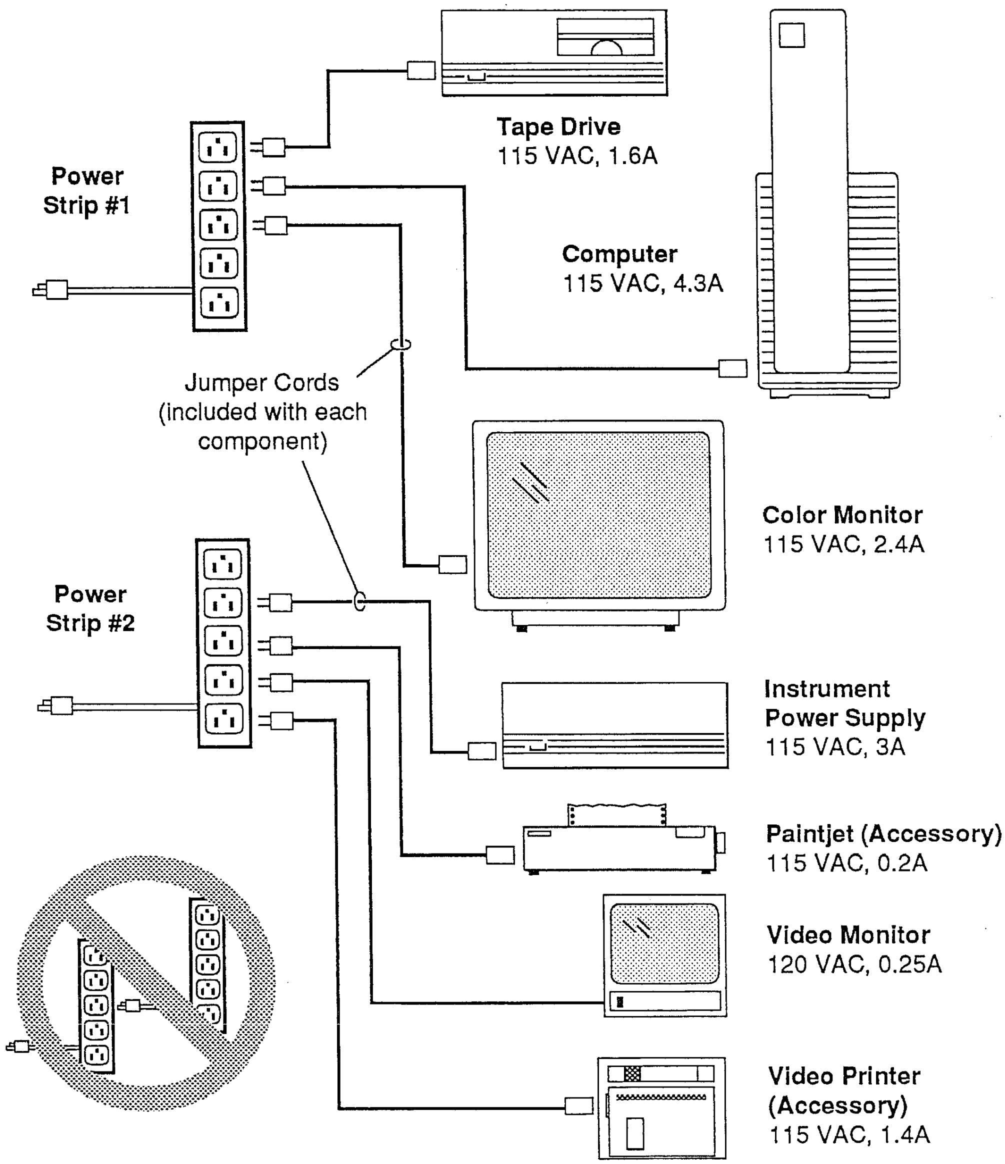
Figure 4-7 illustrates power distribution when using 120-volt power. Do not exceed the 15-Amp rating of either power strip.

100, 220, or 240-Volt Power

Zygo provides two Universal Power Strips, with special power cords, to supply power to the computer components. (The power cords that come with the HP components are not used.) A power cord, with a plug appropriate for the available power source, brings power into each Universal Power Strip. The power strips may be placed or mounted wherever convenient.

Figure 4-8 illustrates power distribution for 100, 220, or 240-volt Power. Which components are plugged into each Universal Power Strip is unimportant, providing that the 6-Amp rating of each strip is not exceeded.

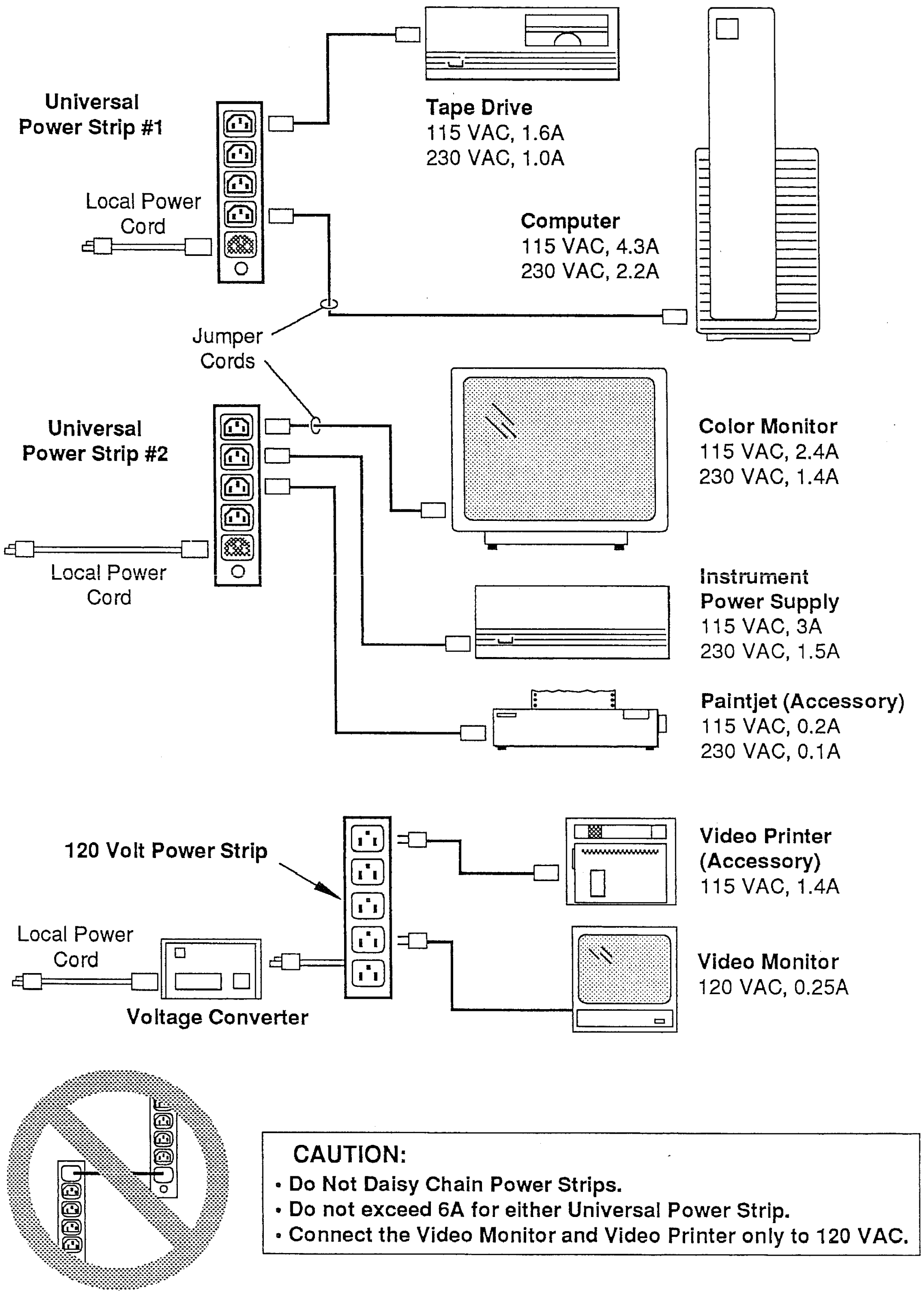
A Voltage Converter is supplied to convert power to 120 volts for the Video Monitor and, if purchased, the Video Printer Accessory. A standard, 120-volt, power strip distributes power to these components.



CAUTION:
- **Do Not Daisy Chain Power Strips.**
- **Do not exceed 15A for either Power Strip.**
- **Connect the Video Monitor and Video Printer only to 120 VAC.**

SI-10 System Power Distribution - 120 Volts

Figure 4-7



SI-10 System Power Distribution - 100, 220, or 240 Volts

Figure 4-8

Chapter 5

BASIC OPERATION

IN THIS CHAPTER

- For The New User...
- Quickstart Procedure
- Transmission Elements
- Testing Plano Surfaces
- Testing Spherical Surfaces
- Transmitted Wavefront Quality Tests

FOR THE NEW USER...

The beginning of this chapter briefly explains how to power up the SI-10 System and take a measurement. The remainder of the chapter provides detailed procedures for mounting and aligning transmission elements on the Mainframe and for creating test setups for plano and spherical components.

To learn more about how the Mainframe works and what controls it has, take advantage of the information in the following chapters:

Chapter 1 provides an easy-to-follow overview of the system and the principles of interferometry. Be sure to read the laser safety information to ensure your personal safety while using the Mainframe.

Chapter 3 goes into more detail about the various parts of the Mainframe and explains how transmission elements work.

Also, remember to use the **Index** and the **Table of Contents** to quickly locate whatever information you may need.

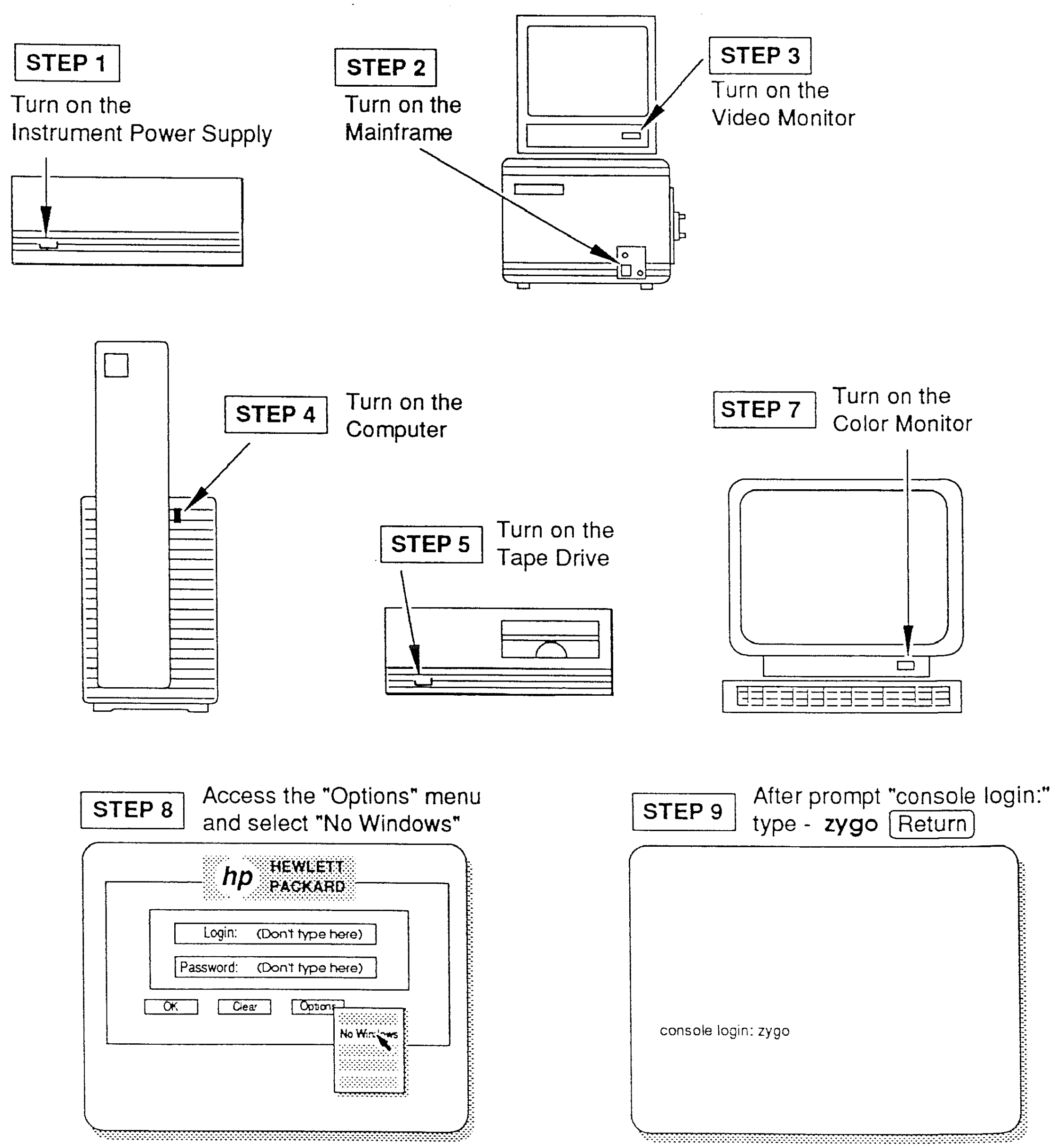
MetroPro Software Operation

To learn how to use the MetroPro software, consult the MetroPro User's Guide, OMP-0289.

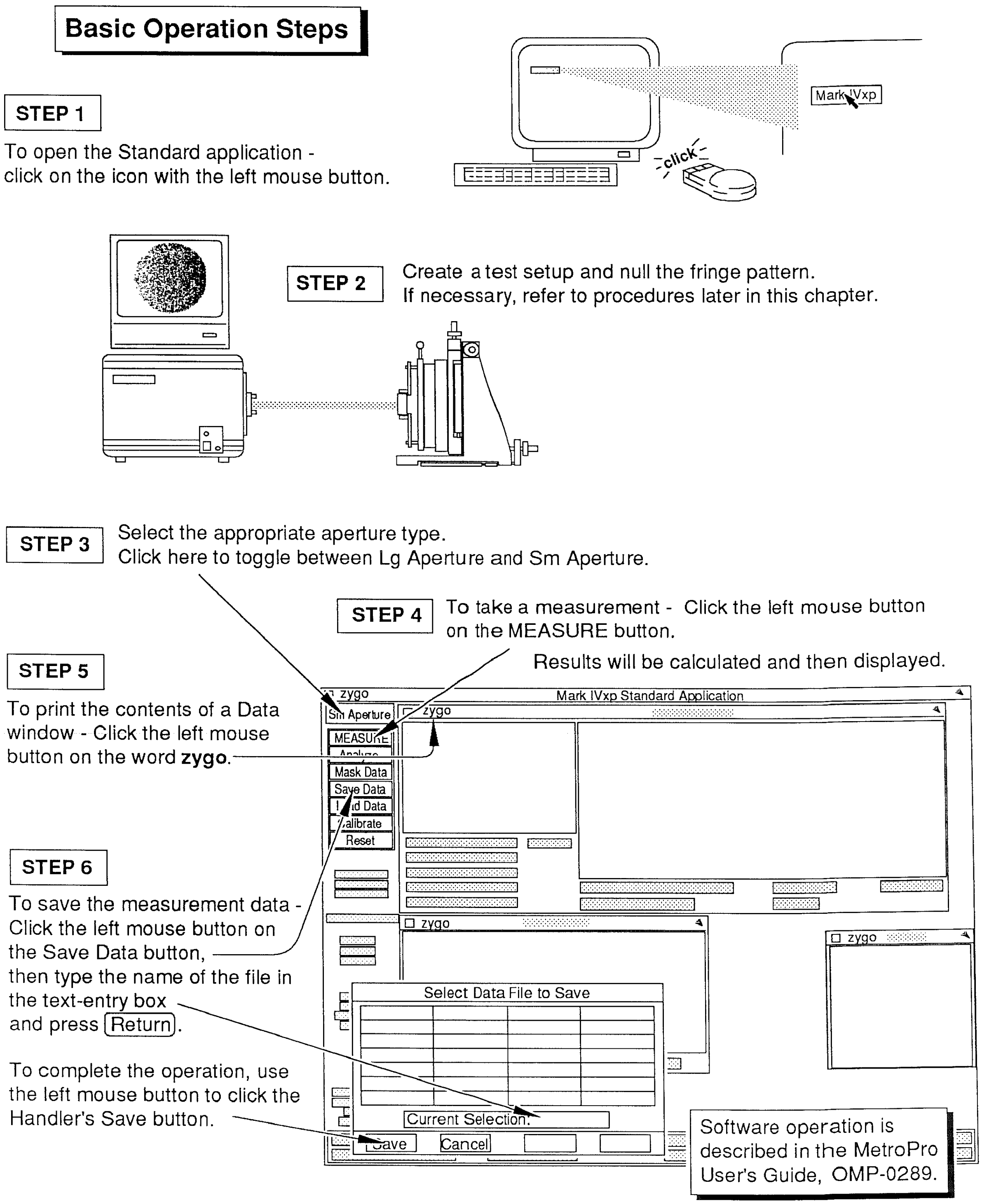
QUICKSTART PROCEDURE

The following illustration shows the order in which the SI-10 System components should be turned on, and shows how to start up the MetroPro software on the HP computer.

Note:
Correct SHUTDOWN procedures are provided at the end of this chapter.



The following illustration shows the basic steps of acquiring and analyzing data, and displaying, printing, and saving measurement results.



Basic Operation Steps

Figure 5-2

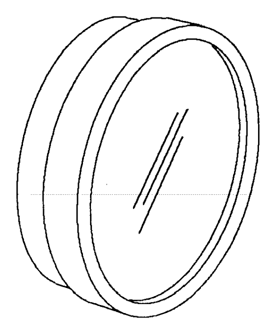
INTERFEROMETER SETUPS

This remainder of this chapter contains procedural information you will need to create setups for testing both surface quality and transmitted wavefront quality of plano and spherical components. These procedures are explained as clearly and completely as possible; however, as with any procedure, there is no substitute for actual hands-on practice and experimentation. Therefore, it is suggested that you read through a given procedure completely, then perform it several times to become proficient with it.

> Note:
> The procedures in the remainder of this chapter show various test setups for a Zygo Mark IV*xp* Interferometer. Test setups for an SI-10 System are very similar to these; however, some may not be possible with the SI-10.

TRANSMISSION ELEMENTS

The transmission element (Figure 5-3) used in the test setup is very important. The element's front (reference) surface forms the reference wavefront to which the surface (or the transmitted wavefront) of the item under test 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 and specular components.

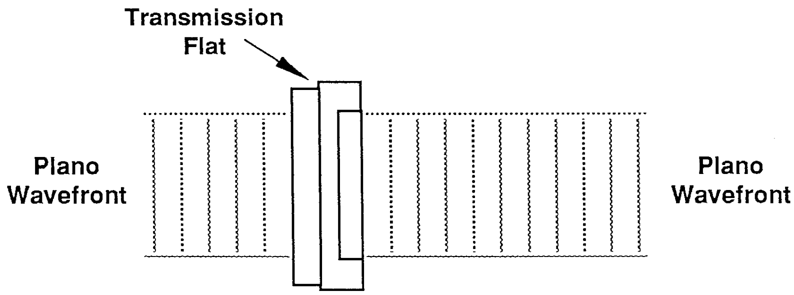


Transmission Flat
Figure 5-3

Transmission elements mount in the aperture of the Mainframe's Phase Measuring Receptacle (PMR) using a two-pin bayonet mounting system.

The Measurement Wavefront

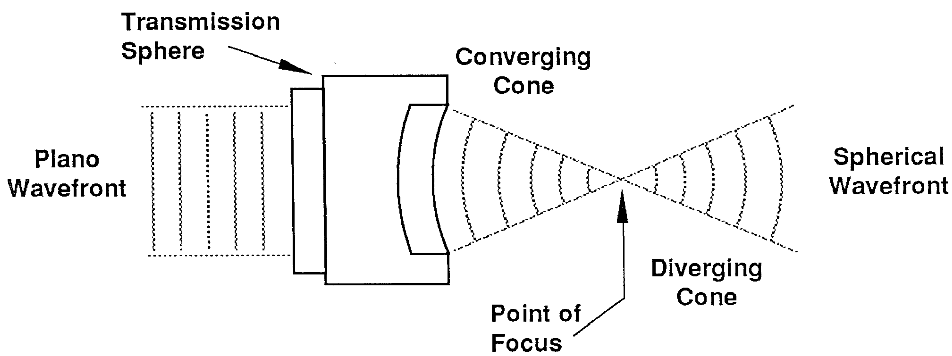
Laser light passing through the transmission element becomes the measurement wavefront. A transmission **flat** allows the collimated laser light to pass through unaltered, resulting in a plano measurement wavefront traveling in a straight shaft of light (Figure 5-4).



Transmission Flat and Resulting Measurement Wavefront

Figure 5-4

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 (Figure 5-5).



Transmission Sphere and Resulting Measurement Wavefront

Figure 5-5

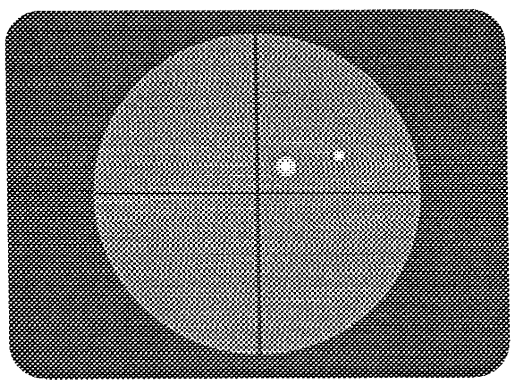
Installing and Aligning Transmission Elements

The procedure for installing and aligning a transmission element is the same regardless of whether you are using a transmission flat or a transmission sphere. The object of the procedure is to align the axis of the reference and measurement wavefronts to the optical axis of the interferometer.

When handling the transmission element, hold it by the metal rim without touching the glass. When not in use, return the element to its protective box.

The procedure begins on the following page.

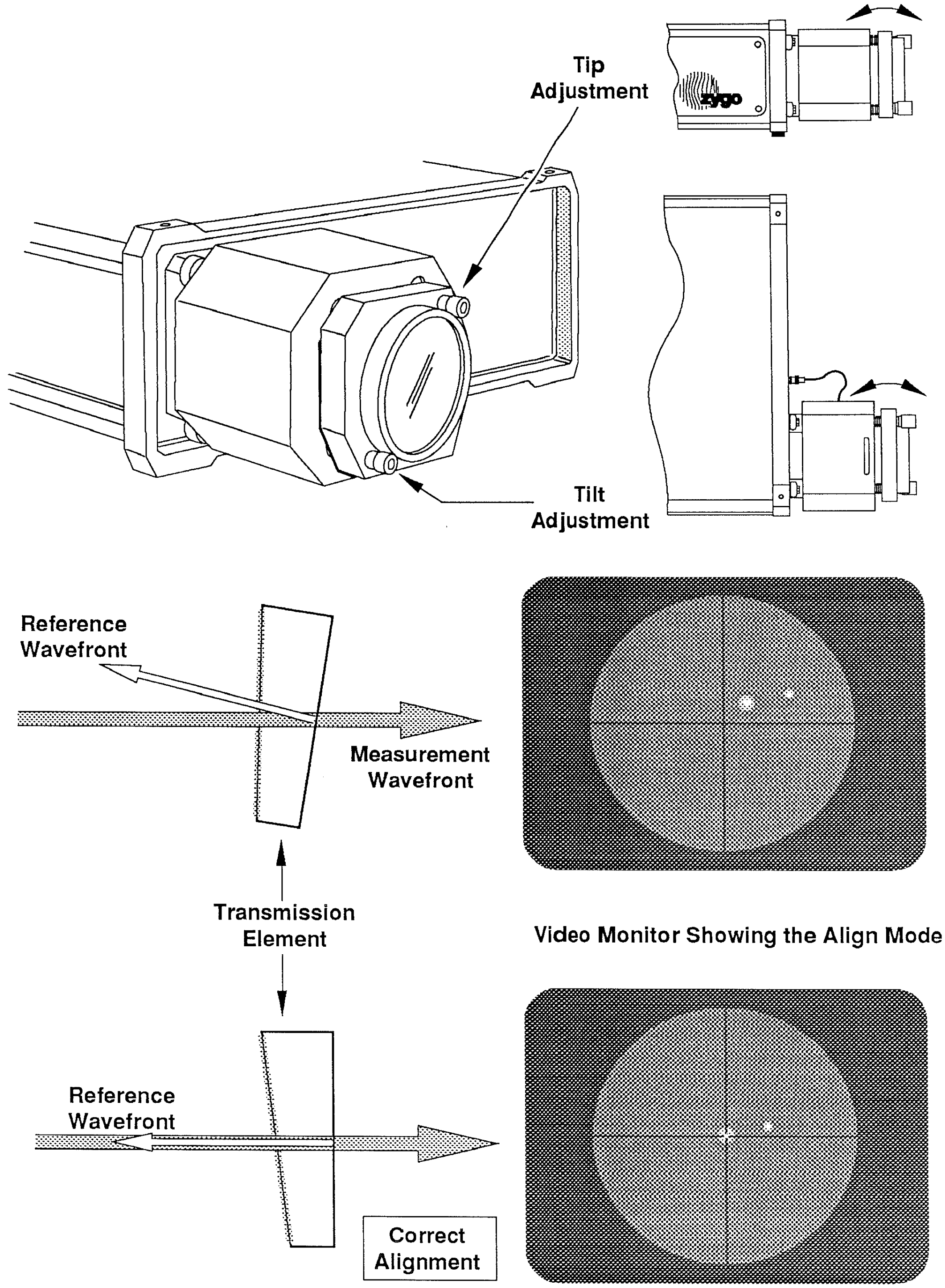
1. Loosen the screw on each of the two bayonet spring clips on the Mainframe's Phase Measuring Receptacle (PMR).
2. Align the two metal pins on the transmission element's mounting ring with the two slots in the PMR.
3. Slide the transmission element straight in; then turn it clockwise until it clicks into place. If the element becomes difficult to turn before it clicks into place, loosen the screws on the spring clips more.
4. If it isn't already on, turn on the Mark IV*xp* system following the standard procedures outlined at the beginning of this chapter.
5. Tighten the screw on each of the two bayonet spring clips to secure the element in the PMR.
6. Make sure the Mainframe's beam attenuator knob is pushed in.
7. Hold the **QUICK FAS** switch on the Mark IV*xp* Remote Control at the **ALIGN** position until the alignment screen (crosshairs) is visible on the Video Monitor (Figure 5-6).



Alignment Screen
Figure 5-6

The reference wavefront, reflected from the front surface of the transmission sphere, appears as a bright dot of light on the alignment screen. Transmission flats will also have a second, dimmer, dot of light off to the side of the bright dot. This is the attenuated reflection off the transmission flat's *rear* surface.

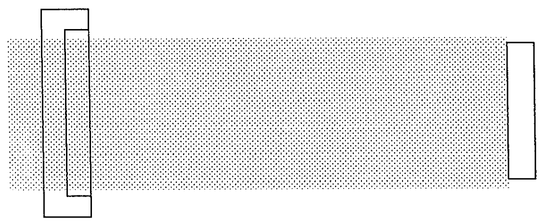
8. Use the tip and tilt knobs on the PMR to superimpose the bright dot of light on the intersection of the crosshairs (Figure 5-7).



Aligning the Transmission Element
Figure 5-7

TESTING PLANO SURFACES

Probably the simplest of all tests that you can perform with the Mark IV*xp*, the plano surface quality test setup consists only of a transmission flat and the surface that you want to test (Figure 5-8).



Plano Surface Quality Test Setup
Figure 5-8

Setup Procedure

1. Align the transmission flat as described previously. Leave the Mainframe in the ALIGN mode.

3. Place the item having the surface to be tested in a mount that allows tip and tilt adjustments. Such mounts are available from Zygo.

4. Position the test surface in the measurement beam such that it is within the Mainframe's measurement beam. Also, position the test surface as close as practicable to the transmission flat. This reduces the effects of any air turbulence that may be present.

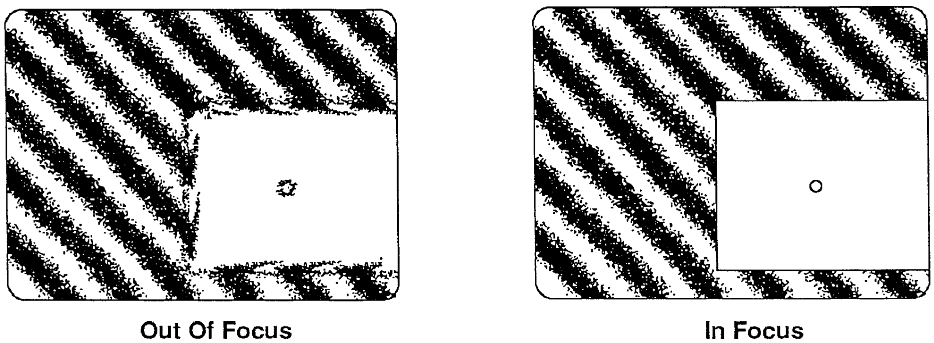
5. Adjust the tip and tilt of the test item until its corresponding bright spot on the alignment screen is superimposed on the intersection of the crosshairs.

6. Switch the Mainframe to the VIEW mode. You should be able to see an interference pattern on the screen.

7. If necessary, adjust the zoom function (using the **ZOOM** switch on the remote control) until the section of the test surface that you want to examine fills as much of the Video Monitor's screen as possible.

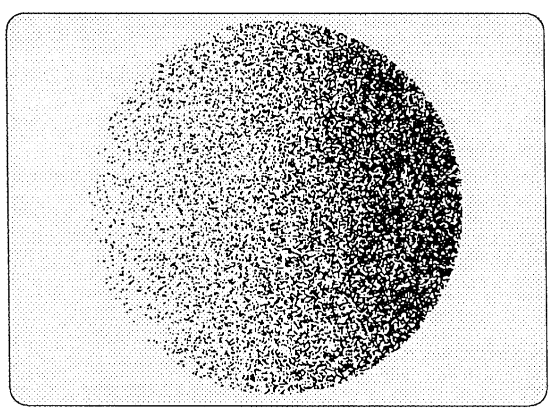
8. Position the Alignment Flag (or a piece of paper) in the field of view, as shown in Figure 5-9, close to the surface being tested. This provides a clean edge on which you can focus.

9. Using the **FOCUS** switch on the remote control, adjust the focus so that the edges of the Alignment Flag (viewed on the monitor) are as sharp as possible.



Adjusting Focus Using The Alignment Flag
Figure 5-9

10. Fine tune the tip and tilt of the test surface to obtain the best possible interference pattern. The best pattern is a "null" pattern where no distinct fringes are visible. The screen is either all light, all dark, or halfway in between (all gray). If a null pattern is not obtainable, come as close to it as you can, and make the fringes as straight as possible. Figure 5-10 shows a fringe pattern approaching null.



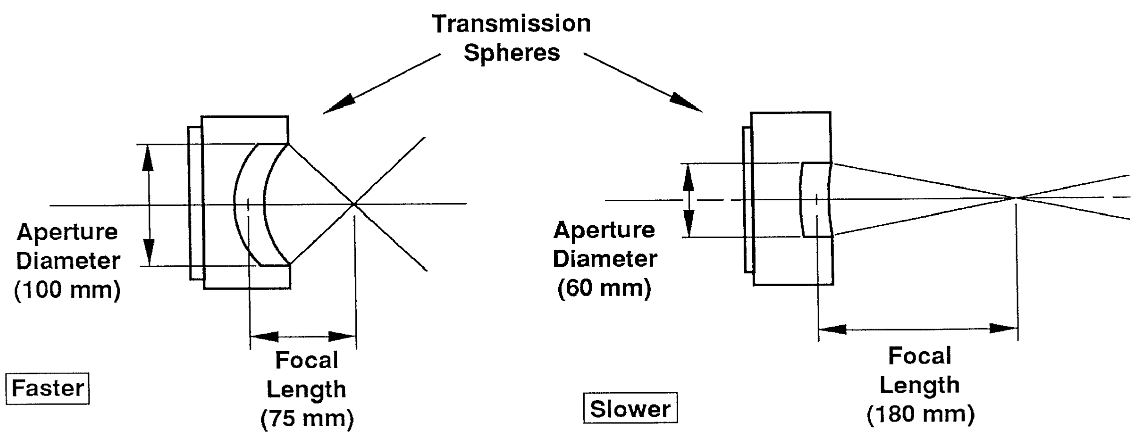
Near-Null Pattern
Figure 5-10

TESTING SPHERICAL SURFACES

Describing Transmission Spheres and Spherical Surfaces

Transmission spheres are described using the conventional lens terminology of **f/numbers**. The f/number of a lens is the ratio of its focal length to the diameter of its aperture.

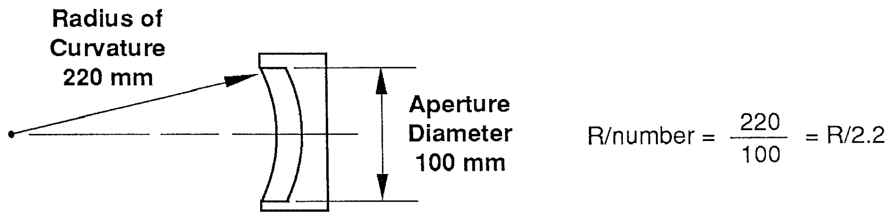
Smaller f/numbers denote "faster" transmission spheres. The smaller the f/number, the faster the light comes to focus after leaving the front surface, and the shorter and broader the resulting cone of light. A transmission sphere with larger f/number is considered slower, and produces a longer, narrower, cone of light. Figure 5-11 illustrates the differences between faster and slower Transmission Spheres.



$$\text{f/number} = \frac{75}{100} = \text{f/.75} \qquad \text{f/number} = \frac{180}{60} = \text{f/3}$$

F/numbers of Transmission Spheres
Figure 5-11

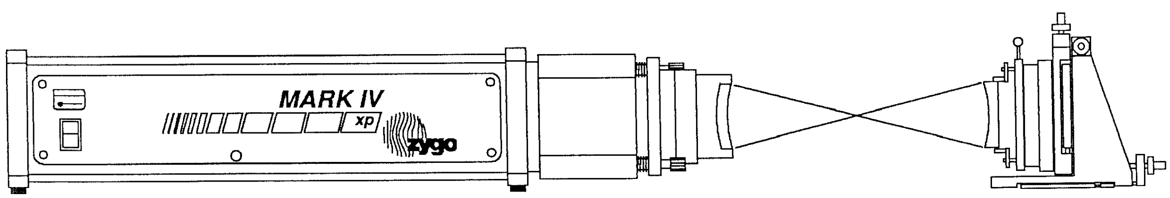
The spherical surface being tested is described by an R/number instead of an f/number. The R/number of a spherical surface is the ratio of the radius of curvature to its diameter (Figure 5-12). An R/number is analogous to an f/number, but relates only to the *surface* of a spherical component.



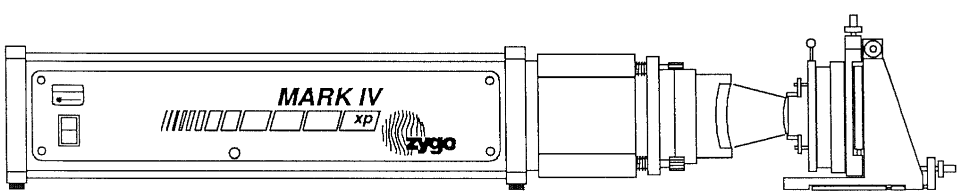
R/Numbers of Spherical Surfaces
Figure 5-12

Spherical Surface Testing Overview

Spherical surface testing is accomplished by positioning the spherical surface to be tested within the measurement beam. Concave surfaces are tested in the *diverging* portion of the measurement beam (Figure 5-13), whereas convex surfaces are tested in the *converging* portion of the beam (Figure 5-14). Special care must be taken to ensure that the optical axis of the spherical surface is aligned with optical axis of the Mainframe.



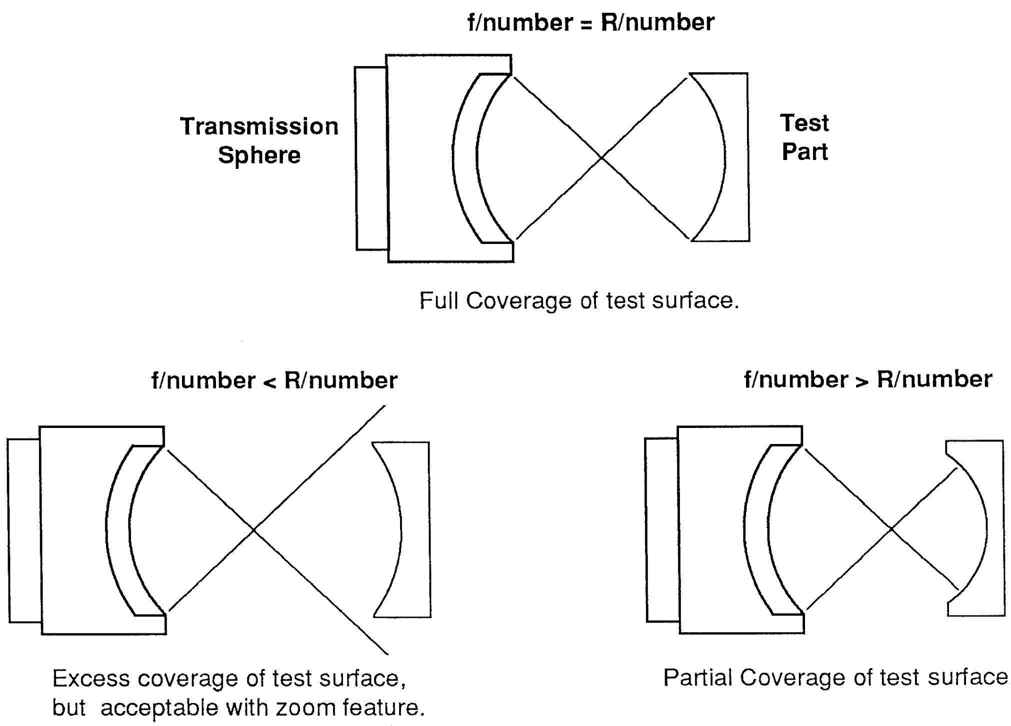
Concave Surface Test Setup
Figure 5-13



Convex Surface Test Setup
Figure 5-14

Selecting a Transmission Sphere

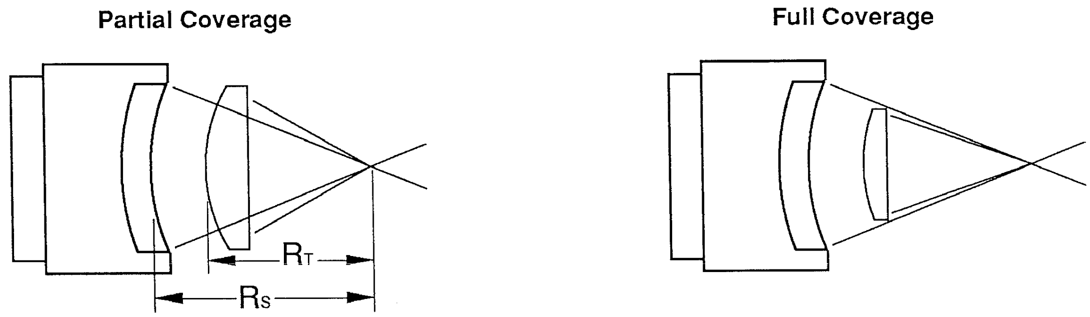
Concave Surfaces - To measure the entire surface of a test part, the cone of light from the Transmission Sphere must be large enough to completely cover the surface being tested. To accomplish this, the f/number of the Transmission Sphere must be equal to, or less than, the R/number of the test part (Figure 5-15). The zoom feature of the Mark IV*xp* is very useful in compensating for mismatch between f/numbers and R/numbers, but only if the f/number of the Transmission Sphere is *smaller* (faster) than the R/number of the test part.



Measuring Concave Surfaces
Figure 5-15

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 (Figure 5-16). 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.

For some elements, the only solution is to use an aperture converter and a larger aperture transmission sphere to increase the coverage of the measurement beam. These items are available from Zygo.



Radius of convex test surface (RT) must be less than distance between Reference Sphere surface and 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 entire surface, f/number must be less than R/number also.

Measuring Convex Surfaces
Figure 5-16

Setup Procedure - Concave Surface Test

In this procedure, you will be creating a test setup similar to the one shown in Figure 5-17. To test a concave surface, it must be positioned so that its center of curvature is at the point of focus of the transmission sphere. Creating this setup is greatly simplified by using an Alignment Flag.

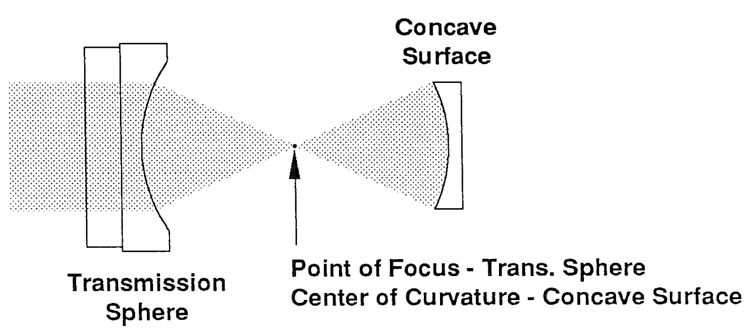
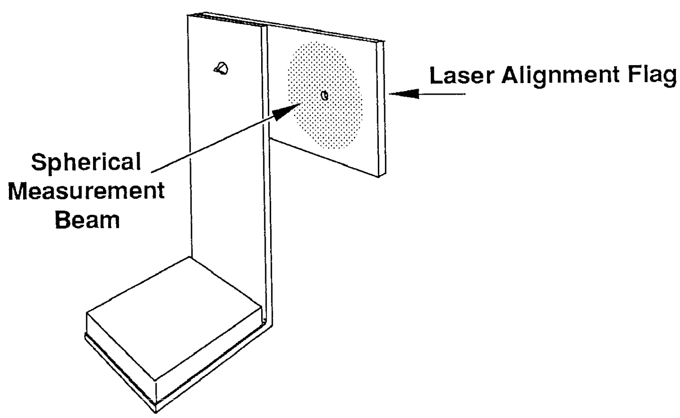


Diagram Of Test Setup For Concave Surface Testing
Figure 5-17

Before performing this procedure, make sure you have selected the appropriate transmission sphere for the surface you will be testing. Refer to the subsection entitled: "Selecting a Transmission Sphere" on page 5-12.

1. Align the transmission sphere as described in the subsection entitled "Installing and Aligning Transmission Elements" on page 5-5. Leave the Mainframe in the ALIGN mode.

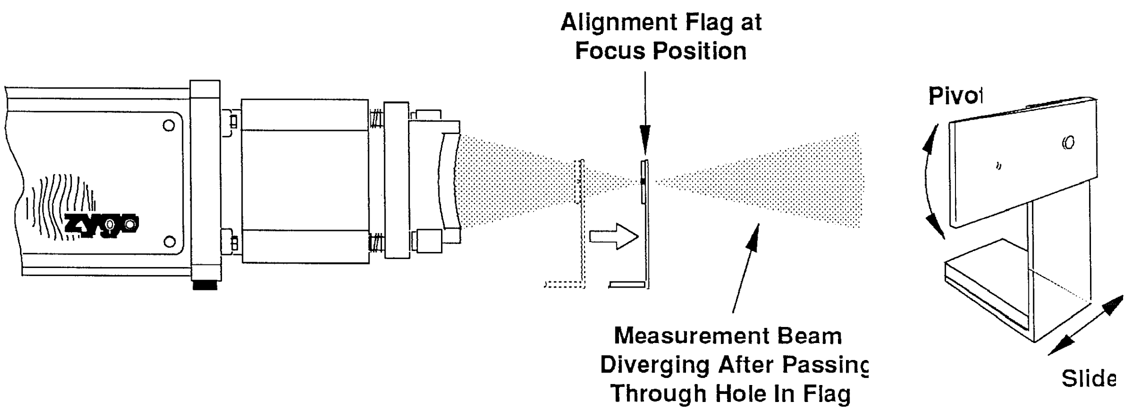
2. Position an alignment flag in the beam just in front of the transmission sphere. You can get an idea of the shape of the beam by slowly moving the alignment flag away from the Mainframe. Notice that the beam appears as a disk of red light as you near the point of focus (Figure 5-18). As you continue to move the flag away from the Mainframe, the beam comes to focus, and then diverges after passing the point of focus.



Laser Alignment Flag
Figure 5-18

3. 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.)

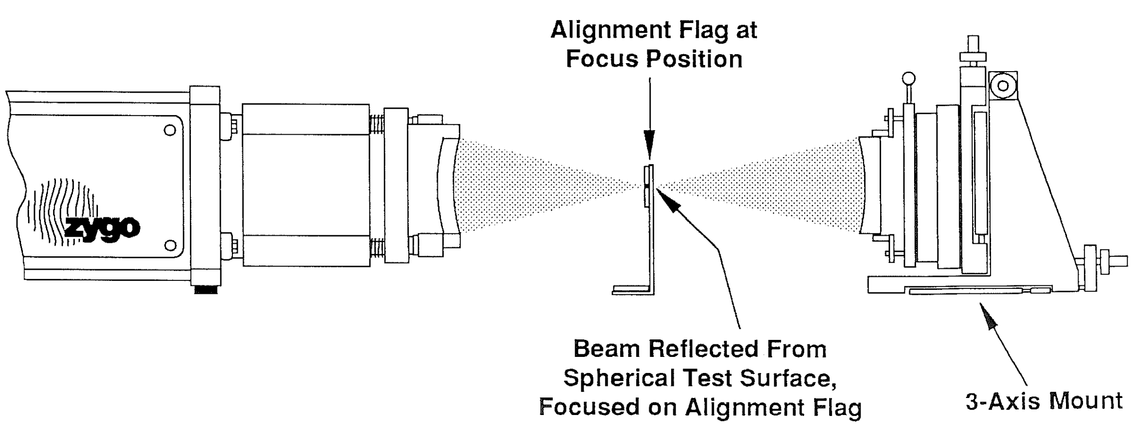
4. Without changing the flag's distance from the Mainframe, slide the flag's stand to one side or the other and/or pivot the flag up or down until the point of light passes through the hole in the flag (Figure 5-19).



Positioning the Alignment Flag at the Point of Focus
Figure 5-19

5. Place the item with the spherical surface to be tested in a mount that allows fine adjustments in the X, Y, and Z axes. Such 3-Axis mounts are available from Zygo.

6. Position the mounted surface just behind the Alignment Flag, then slowly pull it straight away from the Mainframe until the measurement beam reflected from it comes to focus (becomes a point of light) on the back of the Alignment Flag (Figure 5-20).



Positioning Test Surface's Focus Point on Alignment Flag
Figure 5-20

7. Nudge the 3-Axis mount from side-to-side on the table until the point of light from the test surface is as close as possible to the hole in the Alignment Flag.

8. Adjust the mount's **X axis** and **Y axis** controls until the point of light passes through the hole in the Alignment Flag. The beam reflected from the test surface should now appear as a bright dot on the alignment screen on the Video Monitor. Remove the Alignment Flag from the test area.

9. Adjust the mount's **Z axis** control until the dot of light on the Monitor is as small as possible.

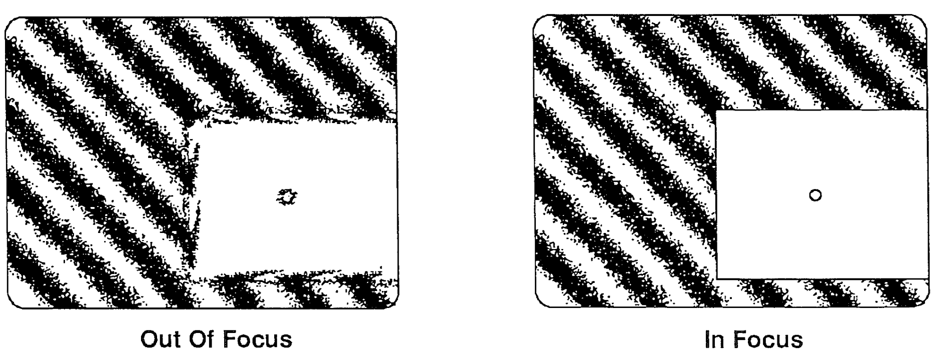
10. Fine tune the mount's **X axis** and **Y axis** controls until the dot of light is superimposed on the crosshairs on the Monitor.

11. Switch the Mainframe to the VIEW mode by holding the **QUICK FAS** switch in the **VIEW** position for approximately four seconds. A fringe pattern should now be visible on the Video Monitor.

12. If the fringe pattern consists of concentric rings, turn the **Z axis** control in the direction that makes the fringe rings appear to move toward the center of the screen. Fine tune the the **Z axis** control until the fringes are as straight as possible.

13. If necessary, adjust the zoom function (using the **ZOOM** switch on the remote control) until the section of the test surface that you want to examine fills as much of the Video Monitor's screen as possible.

14. Position the Alignment Flag (or a piece of paper) in the field of view, as shown in Figure 5-21, close to the surface being tested. This provides a clean edge on which you can focus.



Adjusting Focus Using The Alignment Flag

Figure 5-21

15. Using the **FOCUS** switch on the remote control, adjust the focus so that the edges of the Alignment Flag are as sharp as possible (as viewed on the monitor).

16. Fine tune the mount's **X axis** and **Y axis** controls to adjust the number of fringes on the Video Monitor. You may also have to fine tune the **Z axis** control to keep the fringes straight. The best pattern is a "null" pattern where no distinct fringes are visible. The screen is either all light, all dark, or halfway in between (all gray). If a null pattern is not obtainable, come as close to it as you can, and make the fringes as straight as possible.

Setup Procedure - Convex Surface Test

In this procedure, you will be creating a test setup similar to the one shown in Figure 5-22. To test a convex surface, the surface must be positioned so that its center of curvature is at the point of focus of the transmission sphere.

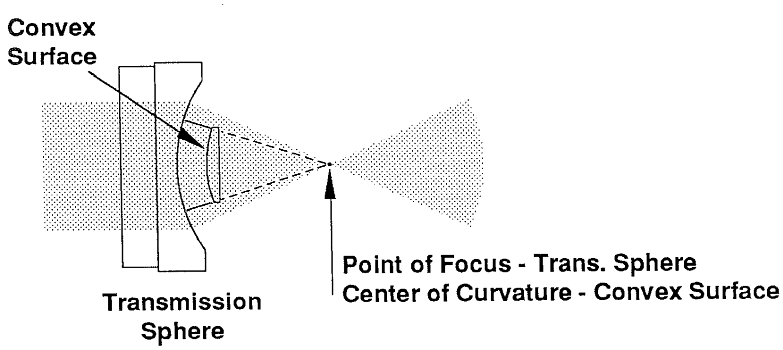


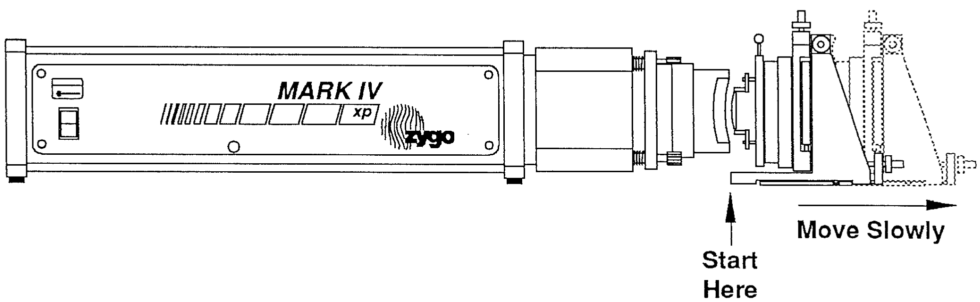
Diagram Of Test Setup for Convex Surface Testing
Figure 5-22

Before performing this procedure, make sure you have selected the appropriate transmission sphere for the surface you will be testing. Refer to the subsection entitled: "Selecting a Transmission Sphere" on page 5-12.

1. Align the transmission sphere as described in the subsection entitled "Installing and Aligning Transmission Elements" on page 5-5. Leave the Mainframe in the ALIGN mode.

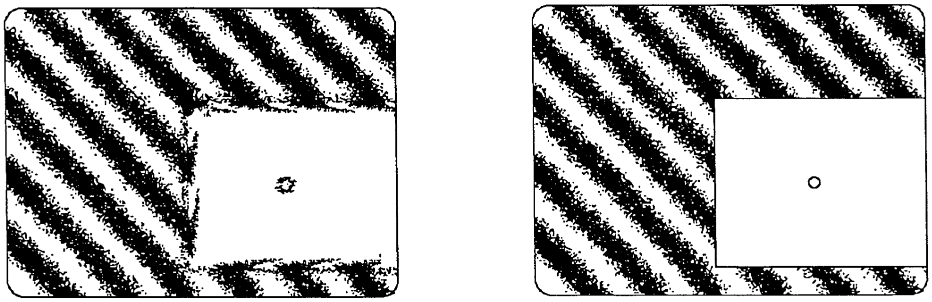
2. Place the item with the convex spherical surface to be tested in a mount that allows fine adjustments in the X, Y, and Z axes. Such 3-Axis mounts are available from Zygo.

3. Position the mounted surface as close as possible to the transmission sphere; then *slowly* pull the mounted surface straight away from the Mainframe (Figure 5-23) until you see a spot of light appear on the Video Monitor. This spot of light is the wavefront reflecting off of the convex surface.



Convex Surface Test - Positioning the Mount
Figure 5-23

4. Adjust the mount's **Z axis** control until the dot of light on the Monitor is as small as possible.
5. Fine tune the mount's **X axis** and **Y axis** controls until the dot of light is superimposed on the crosshairs on the Monitor.
6. Switch the Mainframe to the VIEW mode by holding the **QUICK FAS** switch in the **VIEW** position for approximately four seconds. A fringe pattern should now be visible on the Video Monitor.
7. Fine tune the the **Z axis** control until the fringes are as straight as possible.
8. If necessary, adjust the zoom function (using the **ZOOM** switch on the remote control) until the section of the test surface that you want to examine fills as much of the Video Monitor's screen as possible.
9. Position the Alignment Flag (or a piece of paper) in the field of view, as shown in Figure 5-24, close to the surface being tested. This provides a clean edge on which you can focus.
10. Using the **FOCUS** switch on the remote control, adjust the focus so that the edges of the Alignment Flag are as sharp as possible (as viewed on the monitor).



Out Of Focus In Focus

Adjusting Focus Using the Alignment Flag
Figure 5-24

11. Fine tune the mount's **X axis** and **Y axis** controls to adjust the number of fringes on the Video Monitor. You may also have to fine tune the **Z axis** control to keep the fringes straight. The best pattern is a "null" pattern where no distinct fringes are visible. The screen is either all light, all dark, or halfway in between (all gray). If a null pattern is not obtainable, come as close to it as you can, and make the fringes as straight as possible.

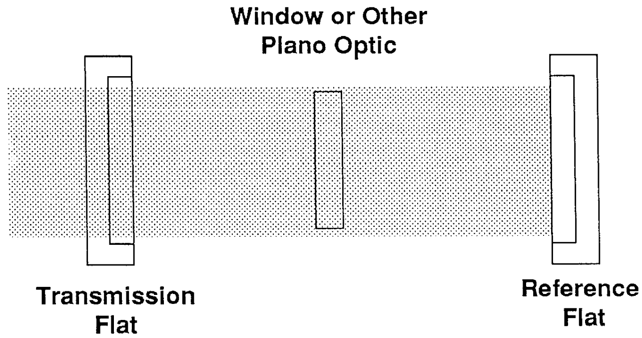
TRANSMITTED WAVEFRONT QUALITY

In addition to a transmission element, you will also need a reference surface to reflect the measurement beam back to the Mainframe. The reference surface may be either a flat or a sphere depending on the type of test being performed.

Two basic setup procedures are provided: one for plano optics and one for lens systems. The purpose of each procedure is to create a setup in which the measurement beam will pass through the component under test, reflect off the reference surface, pass through the component under test in the reverse direction, and then reenter the Mainframe.

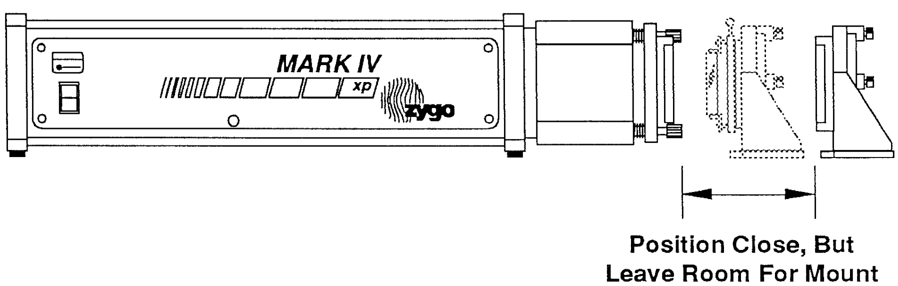
Setup Procedure - Plano Optics

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 (Figure 5-25).



Measuring Transmitted Wavefront Quality of a Plano Optic
Figure 5-25

1. Align the transmission flat as described in the subsection entitled "Installing and Aligning Transmission Elements" on page 5-5. Leave the Mainframe in the ALIGN mode.
2. Place the reference flat in a mount that allows tip and tilt adjustments. Such mounts are available from Zygo.
3. Position the reference flat such that it is within the Mainframe'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 (Figure 5-26). This close positioning reduces the effects of any air turbulence that may be present.



Positioning Mounts
Figure 5-26

4. 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.
5. Place the plano optic to be tested in a mount that allows tip and tilt adjustments. Such mounts are available from Zygo.

6. Position the mounted plano optic between the transmission flat and the reference flat.

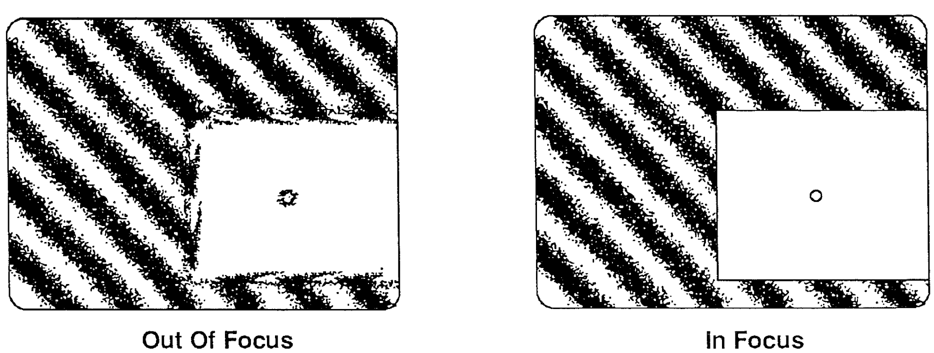
7. Adjust the tip and tilt of the plano optic so that its corresponding bright spot on the alignment screen is near, but *not* superimposed on, the intersection of the alignment crosshairs.

8. Switch the Mainframe to the VIEW mode. You should be able to see an interference pattern on the screen. 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 Mainframe's measurement aperture. Watch the video monitor 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 (using the **ZOOM** switch on the remote control) until the section of the test surface that you want to examine fills as much of the Video Monitor's screen as possible.

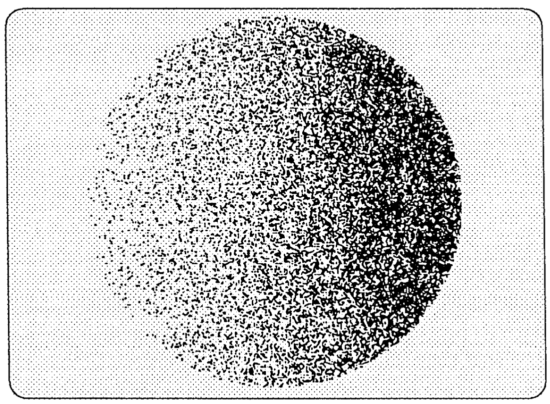
11. Position the Alignment Flag (or a piece of paper) in the field of view, as shown in Figure 5-27, close to the plano optic being tested. This provides a clean edge on which you can focus.



Adjusting Focus Using the Alignment Flag
Figure 5-27

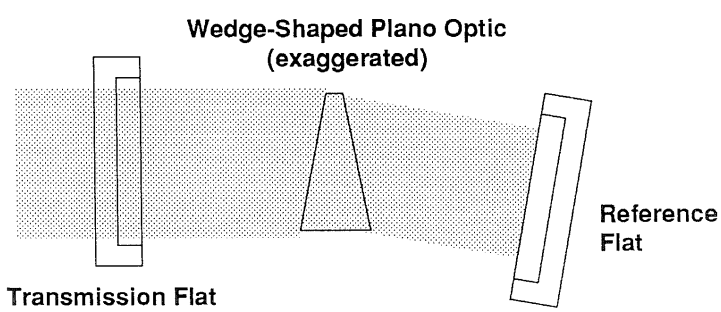
12. Using the **FOCUS** switch on the remote control, adjust the focus so that the edges of the Alignment Flag are as sharp as possible (as viewed on the monitor).

13. Fine tune the tip and tilt of the test surface to obtain the best possible interference pattern. The best pattern is a "null" pattern where no distinct fringes are visible. The screen is either all light, all dark, or halfway in between (all gray). If a null pattern is not obtainable, come as close to it as you can, and make the fringes as straight as possible. Figure 5-28 shows a fringe pattern approaching null.



Near-Null Pattern
Figure 5-28

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 (Figure 5-29).



Setup for Testing Wedge-Shaped Plano Optics
Figure 5-29

Steps 6 and 7 of the Plano Optic Set Up procedure should be amended with the following information:

Watch the video monitor as you place the test optic between the Mainframe 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 screen. This new dot is the reflection off of the reference flat; it will remain stationary as you adjust the position of the wedge optic.

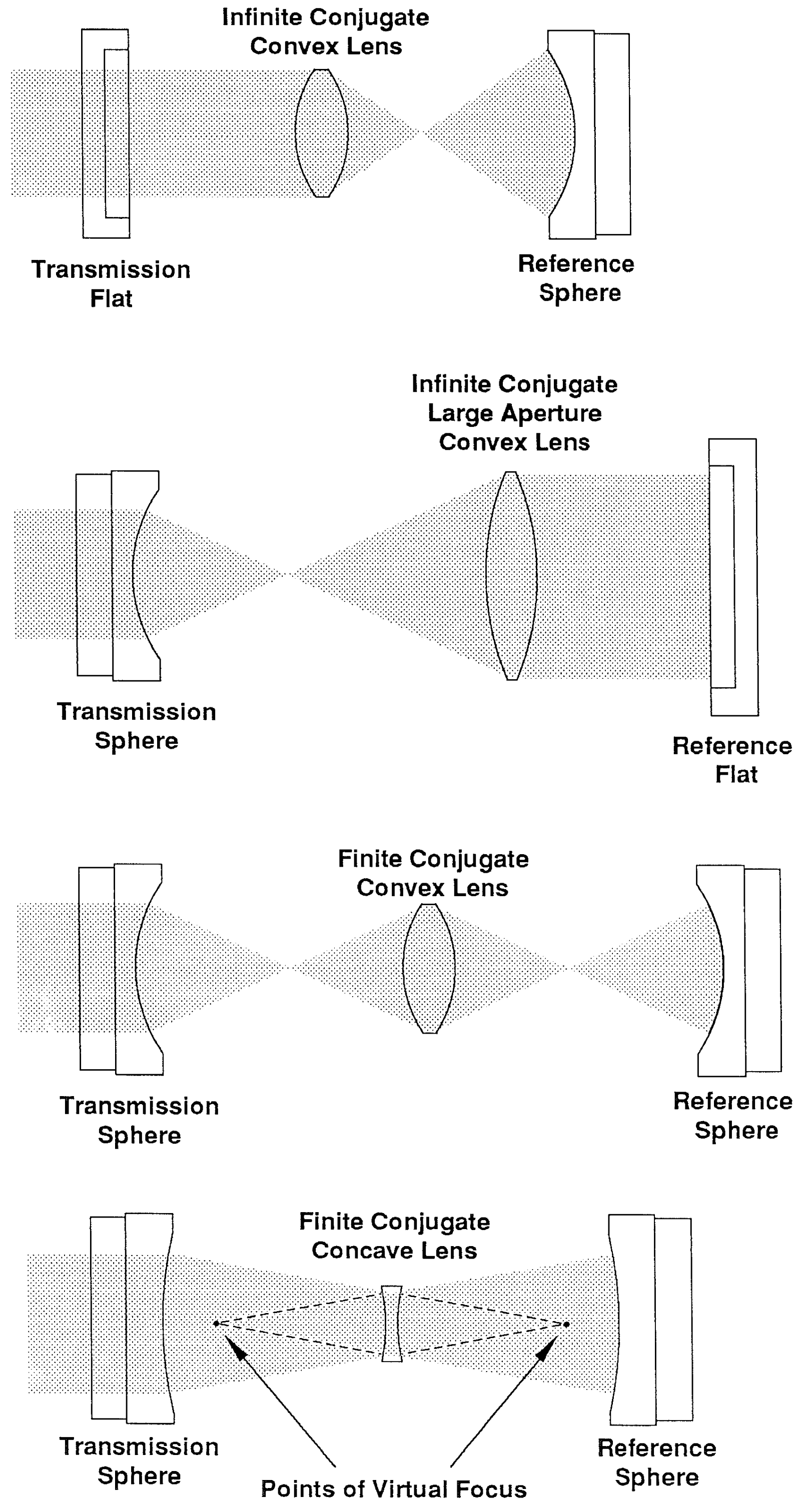
Adjust the tip and tilt of the wedge optic such that the two bright dots are equidistant from the intersection of the crosshairs. Adjust the tip and tilt of the reference flat until the *new* bright dot is superimposed on the alignment crosshairs.

At this point, switch to the VIEW mode and continue with the existing procedure.

Testing Lens Systems

For the purposes of this text, 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 a group of elements.

Creating a test setup for a lens system requires a knowledge of its design and intended usage. Selecting the proper transmission element and reference surface and aligning the optical axes of the lens system, Mainframe, 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 here are several diagrams illustrating some of the tests that may be performed (Figure 5-30). For assistance with specific testing needs, contact your Zygo Sales Engineer or Zygo's Marketing Applications Engineering Group.



Examples of Transmitted Wavefront Quality Tests of Lens Systems

Figure 5-30

TURNING OFF THE SYSTEM

The specific shutdown procedure is determined by which software you are using at the time. Select one of the procedures described below.

CAUTION:

Always turn off system power using one of the following procedures. Failure to do so may damage the file system. If the file system becomes severely corrupted the system may become unusable.

Shutdown from MetroPro

To turn off the system, when working in MetroPro, perform the following steps:

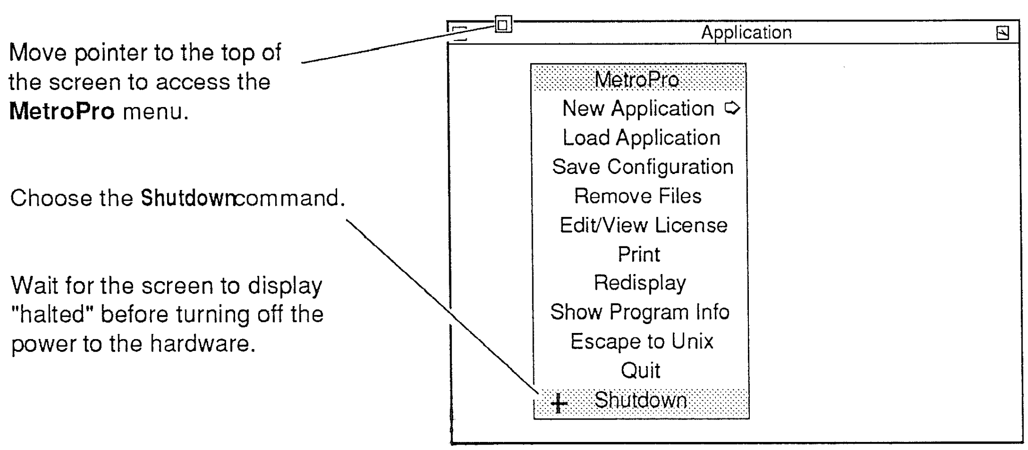
1. Before turning off the system, save important data, application, and mask files. It is not necessary to close windows.

   CAUTION:

   Use the Shutdown command to properly exit the software, so power can be turned off. Do not use the Quit command, as it quits MetroPro only and does not properly halt HP-UX.

2. Move the pointer to the outside of the Application window to access the MetroPro menu, then select the **Shutdown** command. The **Shutdown** command properly closes the software and parks the hard drive.

3. When the "halted" message is displayed, it is safe to turn off system power.



Shutdown from HP-UX

To turn off the system, when working in HP-UX, perform the following steps:

1. After the HP-UX prompt, type:

   shutdown [Return]

2. When the "halted" message is displayed, it is safe to turn off system power.

Shutdown from MetroBASIC

To turn off the system, from MetroBASIC, perform the following steps:

1. If you are working in the editor mode, with line numbers displayed, press the **Insert line** key and [Return], so you get a clear line. If you are working in the command mode, proceed to the next step.

CAUTION:

Do not use the RMB/UX quit command and then turn off power, as this may cause damage to the file system.

2. On a clear line, type:

   `quit` [Return]

3. Then type:

   `/usr/local/zygo/bin/shutdown` [Return]

4. When the "halted" message is displayed, it is safe to turn off system power.

Chapter 6

MAINTENANCE AND SERVICE

IN THIS CHAPTER

GENERAL MAINTENANCE

The SI-10 System is almost maintenance-free and will provide many years of quality service if used and cared for as described in this manual.

HP Components

Refer to the HP documentation for maintenance information for the HP components which include the Computer, 1/4-inch Tape Drive, Color Monitor, Mouse, Keyboard, Audio Extension, and PaintJet Printer accessory.

If you require assistance with any of the HP components, contact Hewlett-Packard directly. In the United States, you can telephone HP, toll-free, at this number: 1-800-835-4747. In other countries, refer to the service directory packaged with the HP products.

Zygo Instrument

Use the following guidelines for general maintenance for the components that comprise the Zygo Instrument (Mainframe, Video Monitor, and Instrument Power Supply).

- Operate and store the Instrument only in a clean and dry environment.
- Occasionally clean the exterior of the components with a damp (not wet) cloth. If necessary, use a mild detergent solution on the cloth. Do not allow the cleaning cloth to contact any optical component. If an optical component needs to be cleaned, refer to the subsection entitled "Cleaning Optical Components" later in this chapter.
- Use only Zygo recommended or supplied accessories and replacement parts.

BASIC TROUBLESHOOTING

This section presents some of the more common symptoms and solutions associated with operational problems of the SI-10 System. If you cannot find and fix the problem using this section, Zygo's Service Department is available to assist you. A Service Engineer may be able to talk you through the problem over the telephone or, at the very least, will be able to tell you if the equipment needs to be returned to Zygo for repair. Refer to the subsection entitled "Technical Support" near the end of this chapter.

Symptom: **Nothing Works**

Things to Check:

1. Make sure the components are plugged in to working power receptacles. If power strips are used, make sure the switch on the power strip (if it has one) is turned on, and that the circuit breaker hasn't tripped.
2. Check the component's fuse to make sure it hasn't blown.
3. Verify that all interconnections have been made properly. Refer to the interconnection diagrams in Chapter 4 of this manual.

Symptom: **No Laser Light Emitted from Mainframe**

Things to Check:

1. Check all the things listed under the "Nothing Works" symptom.
2. Make sure the Laser Attenuator knob on the side of the Mainframe is pushed in all the way.
3. Check the fuse on the rear panel of the Mainframe and the fuse on the Instrument Power Supply.
4. Either the laser or the laser power supply may have stopped working. Without proper test equipment, you will not be able to determine which component has failed. Contact the Zygo Service Department to order both components; then return the component that was not at fault.

Symptom: **Fringe Patterns on the Video Monitor Look Very "Grainy"**

Things to Check:

1. The Diffuser Disk Motor has probably stopped working. Contact the Zygo Service Department to order a replacement part. Refer to the appropriate procedure in this chapter to replace it.

Symptom: **Align or View Mode Doesn't Work Properly**

Things to Check:

1. The Mainframe may be in between the Align and View modes. When changing from one mode to the other, hold the switch (on the remote control) in appropriate position until the image on the Video Monitor stops changing. This usually takes approximately four seconds.

Symptom: **The MetroPro Software Doesn't Seem to Work Properly**

Things to Check:

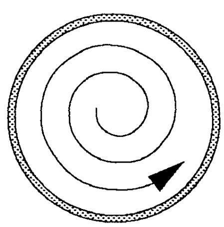
1. By it's very nature, software doesn't usually stop working by itself. Problems are usually due to either a hardware malfunction or a misunderstanding of how the software is *supposed* to work. In either case, contact the Zygo Service Department to help you determine where the problem lies.

CLEANING OPTICAL COMPONENTS

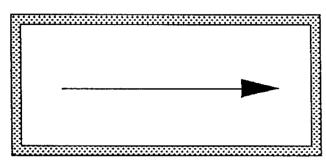
Before You Begin...

Here are some items you should know about cleaning optical components:

- Don't do it unless you have to. Optical components, especially ones with delicate coatings, can be permanently damaged by improper cleaning. Also, it may be less risky to clean one small area (such as a fingerprint) rather than the entire surface of the component.
- Fingerprints should be removed as soon as possible because the acids contained in skin oils will attack both coated and uncoated surfaces.
- If any special cleaning instructions accompany the component you want to clean, use them instead of the procedure in this manual.
- Use only the materials recommended in the cleaning procedure. Pay particular attention to the lens tissue that you use. It must be of high quality and intended for use with precision optics. Do not use cloth or tissue intended for use with eyeglasses. Some such materials are purposely made to be slightly abrasive to polish out minute scratches in eyeglasses.
- When wiping the surface of the component with a solvent, use the appropriate wiping method, as shown in Figure 6-1.



Circular Optics:
Wipe from center out toward edge in a circular motion.



Rectangular Optics:
Wipe from one edge straight across to opposite edge.

Recommended Wiping Motions
Figure 6-1

- Don't use a lens tissue for more than one cleaning stroke. Repeated wiping with the same tissue may scratch the component with grit picked up by a previous stroke. Do not, under any circumstances, *scrub* the surface with anything.

Materials You Will Need

For the cleaning procedure, you will need some or all of the following materials (depending on the type of cleaning required):

- Polyethylene Lab Gloves - To prevent fingerprints on the surfaces being cleaned, and to protect your skin from cleaning solvents.
- Dust-Free Lens Tissue - *Not* eyeglass tissue.
- Clean, Dry, Compressed Air - Should also be fitted with an antistatic nozzle to help remove dust attracted by static electricity. Bulb-type blowers and brushes may be used; however, they must be very clean to prevent redistribution of dirt.
- Isopropyl Alcohol - Spectroscopic Grade
- Acetone - Spectroscopic Grade
- Distilled Water - Use best quality available
- Mild, Neutral Soap - 1% in distilled water. Several drops of green soap (available at any pharmacy) per 100 cc of distilled water is appropriate. (Or use Orvus WA paste.)

Many of these items are available from:

Edmund Scientific Company
101 East Gloucester Pike
Barrington, New Jersey, USA 08007
Telephone: (609) 573-6250

Procedure

1. Remove rings and other jewelry from your hands and wrists.

2. Wash your hands thoroughly to remove excess skin oils.

3. Put on the Polyethylene gloves.

4. Use the compressed air to blow loose particulate matter from the surface of the component. Position the nozzle so that the air blows across the surface, not directly at it.

5. Form a couple of pieces of lens tissue into a wad. Moisten the lens tissue with the soap/water solution and shake off any excess. The wad of tissue should be wet but not be dripping.

6. *Gently* wipe the surface of the component with a motion appropriate for its shape. (Refer to "Before You Begin" subheading.) Remember to use a new wad of lens tissue for each stroke.

7. Form another wad of lens tissue and moisten it with distilled water. Again, it should be wet but not dripping. Rinse the surface with this wad. Remember - a new wad for each stroke.

WARNING!
Be careful when using isopropyl alcohol and acetone; both are flammable and toxic.

8. Use another wad of lens tissue, moistened with isopropyl alcohol, to wipe the surface of the component. (Remember - a new wad for each stroke.) The anhydrous property of alcohol will draw residual water into the lens tissue.

9. Moisten another wad of lens tissue with acetone. Wipe the surface of the component again. (Remember - a new wad for each stroke.) The acetone will remove the residual alcohol from the surface. When using the acetone, wipe with a single, slow moving, light stroke ending with a "pick-up" motion. Too fast a stroke may leave a gritty trail of acetone on the surface. Repeat this step, using a new wad each time, until all traces of acetone are gone.

REPLACING MAINFRAME COMPONENTS

The next several pages of this chapter contain procedures for replacing the following components of the SI-10 Mainframe:

- Laser
- Laser Power Supply
- Diffuser Disk Motor Assembly

Each procedure may be performed by the average user; however, it is possible that some users may not be comfortable with a particular procedure. For this reason, we recommend that you read through the entire procedure before performing any of the steps, as this will help you to determine if it's within your skill range. If you need help or clarification on any of the steps, call the Zygo Service Department for assistance.

CAUTION:

Should it be necessary to remove the cover of the SI-10 Mainframe, make sure your working environment is very clean and free from dust and other airborne contaminants. It is very important that the cover remain securely in place except when absolutely necessary.

Replacing the Laser

This procedure explains how to replace the laser in a SI-10 Mainframe.

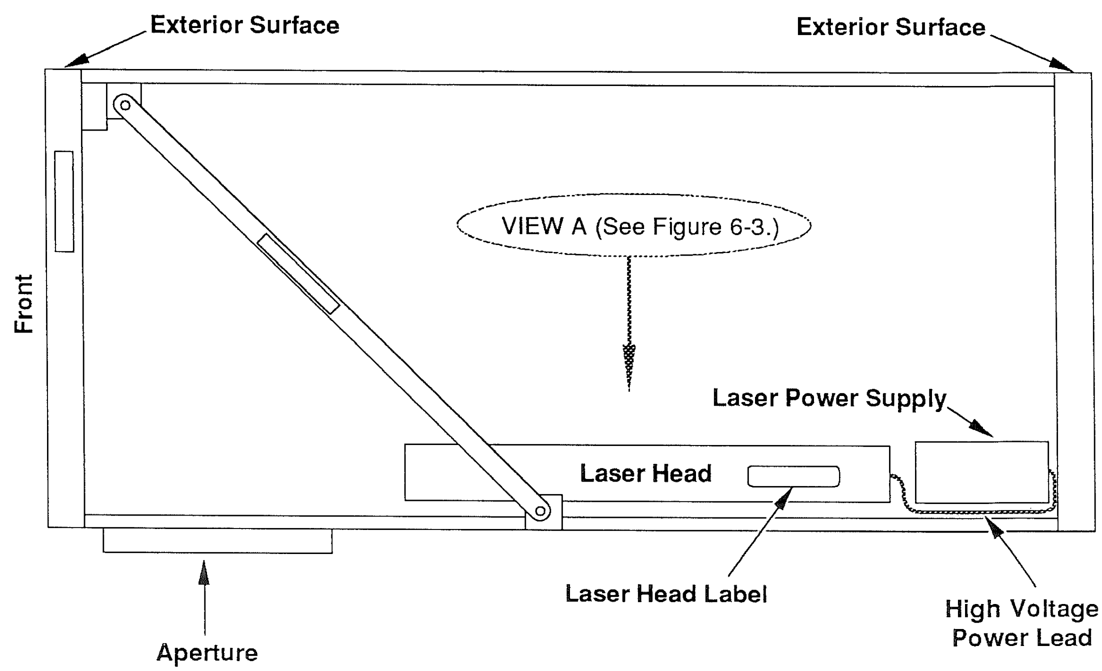
Tools Needed: Wire Cutters, Needle-Nose pliers, Phillips Screwdriver, Allen Wrenches.

1. Turn off the Mainframe and disconnect it from the Instrument Power Supply. Remove the seven Phillips head screws that secure the Mainframe's top cover; then lift off the top cover.

CAUTION:
When handling the electronics board, use measures to prevent it from being damaged by electrostatic discharge (ESD). Do not touch the board unless you are using the special, grounded, disposable ESD wrist strap.

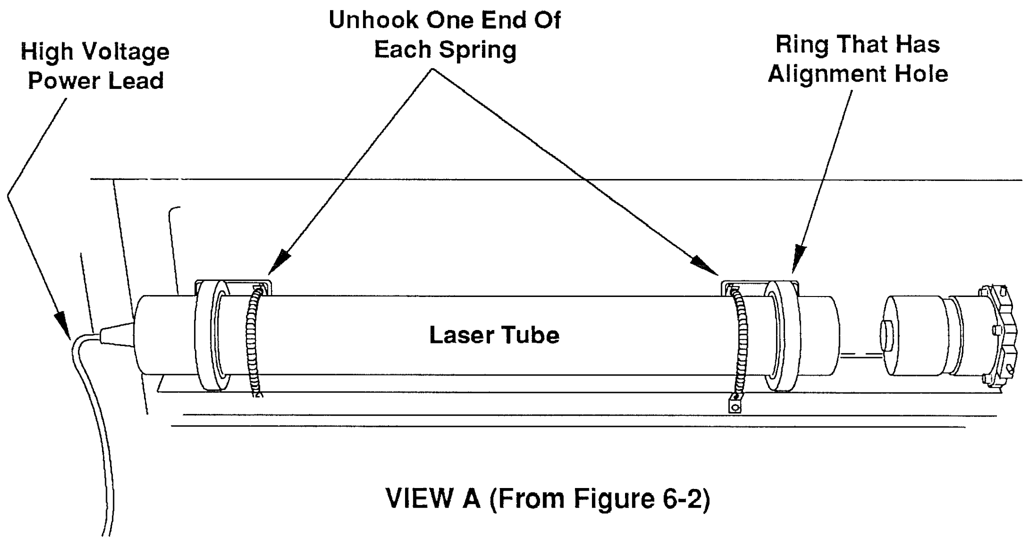
2. Remove the two Phillips head screws that hold the electronics board, and temporarily set them aside. Carefully swing the board out of the way.

3. Locate the laser tube inside the Mainframe. (The interior of the Mainframe is shown in Figure 6-2.) Note that the laser is held in place by two springs that loop around the laser.



Interior of the SI-10 Mainframe (Top View)
Figure 6-2

4. Using a pair of needle-nose pliers, unhook one end of each spring from its corresponding bracket on the inner wall of the Mainframe (Figure 6-3).



Laser Tube and Hold-Down Springs
Figure 6-3

5. The alignment ring on the output-end of the laser has a small hole that fits over an alignment stud on the inner wall of the Mainframe. Pull the laser away from the inner wall until it clears the alignment stud, then lift the laser out of the Mainframe.

WARNING!

When cutting the cable ties on the high voltage leads, be careful not to cut into the leads themselves. You could receive an uncomfortable shock from the electrical potential stored in the laser.

6. Cut the cable ties that bundle the high voltage leads from the laser and laser power supply.

WARNING!

As you unplug the laser's leads from the laser power supply, do not let your skin contact the exposed metal tips of the laser's connectors. You could receive an uncomfortable shock from the electrical potential stored in the laser.

7. Unplug the red and black laser leads from the molded high voltage connector of the laser power supply. Touch the metal ends of the laser's leads together to discharge any electrical potential stored in the laser.
8. Plug the leads of the replacement laser into the high voltage connector of the laser power supply.
9. Place the replacement laser in the Mainframe. Make sure that the hole in the laser's mounting ring fits over the alignment stud on the inner wall of the Mainframe.
10. Reconnect each of the two springs that hold the laser in place.
11. Use new cable ties to bundle the high voltage leads from the laser and laser power supply. Make sure the laser's high voltage leads are routed such that they will not be pinched when the Mainframe's cover is replaced.

CAUTION:

When handling the electronics board, use measures to prevent it from being damaged by electrostatic discharge (ESD). Do not touch the board unless you are using the special, grounded, disposable ESD wrist strap.

12. Swing the electronics board back to its normal position and secure it with the two Phillips head screws. Replace the top cover of the Mainframe.
13. Reconnect the Mainframe to the Instrument Power Supply; then, turn on the Mainframe and allow it to warm up for approximately one-half hour.
14. Install and align a transmission flat. (If you need to, refer to Chapter 5 of this manual for instructions.)

15. Use the **ZOOM** function on the Remote Control to zoom all the way out to the 1X position.

16. Adjust the contrast and brightness controls on the Video Monitor to their maximum setting.

17. Slowly turn down the brightness control while watching the the circular aperture on the video monitor. If the edges of the aperture fade to black first, and the center region of the aperture fades to black last, no further alignment is necessary and you may skip ahead to Step 26. If the circular aperture fades to black from one edge to the another, the Beam Diverger - Spatial Filter (BDSF) must be adjusted.

WARNING!

The remainder of this procedure requires that the Mainframe be operating while you are making adjustments inside of it. While performing this procedure, do not touch any components, either deliberately or accidently, other than those indicated in this procedure.

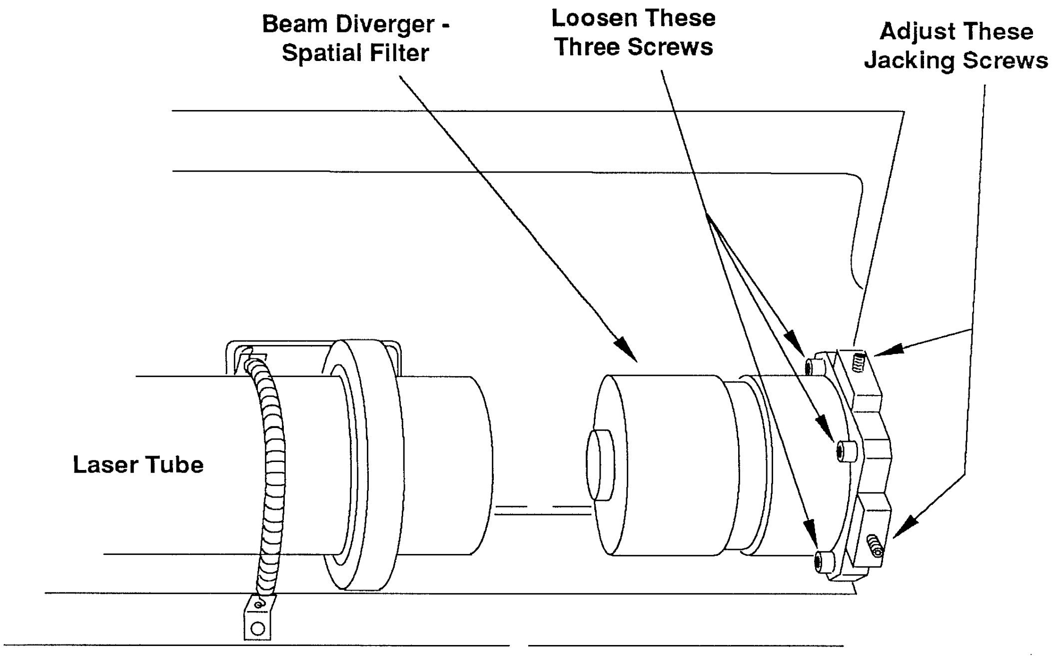
18. Lift off the top cover of the Mainframe.

CAUTION:

When handling the electronics board, use measures to prevent it from being damaged by electrostatic discharge (ESD). Do not touch the board unless you are using the special, grounded, disposable ESD wrist strap.

19. Remove the two Phillips head screws that secure the electronics board and carefully swing the board out of the way.

20. Locate the Beam Diverger Spatial Filter (Figure 6-4).



Adjusting the Beam Diverger - Spatial Filter
Figure 6-4

21. Loosen the three socket head screws that hold the BDSF to the inner wall of the Mainframe. Do not back out the screws. The head of the screw should still be in light contact with the Bellville washers, and the washers should still be in light contact with the BDSF.

22. Adjust either or both of the socket head "jacking" screws shown in Figure 6-4 until the test described in Step 17 is successful.

Note:
The BDSF is spring loaded against the jacking screws, and therefore, it should "follow" the jacking screws if they are loosened. However, if the three screws that hold the BDSF against the wall are too snug, the BDSF may not follow the jacking screws properly. If this is the case, either loosen the three screws a bit more, or hold the BDSF against the jacking screws while adjusting them.

23. Tighten the three socket head screws that secure the BDSF to the inner wall of the Mainframe.

24. Recheck the test described in Step 17 to make sure the BDSF did not move when the screws were tightened.

CAUTION:

When handling the electronics board, use measures to prevent it from being damaged by electrostatic discharge (ESD). Do not touch the board unless you are using the special, grounded, disposable ESD wrist strap.

25. Swing the electronics board back to its proper position and secure it with the two Phillips head screws.

26. Replace the top cover of the Mainframe and the screws that secure it.

Replacing the Laser Power Supply

This procedure explains how to replace the laser power supply in an SI-10 Mainframe. Tools needed: wire cutters, Phillips head screwdriver, Allen wrenches.

1. Turn off the Mainframe and disconnect it from the Instrument Power Supply.

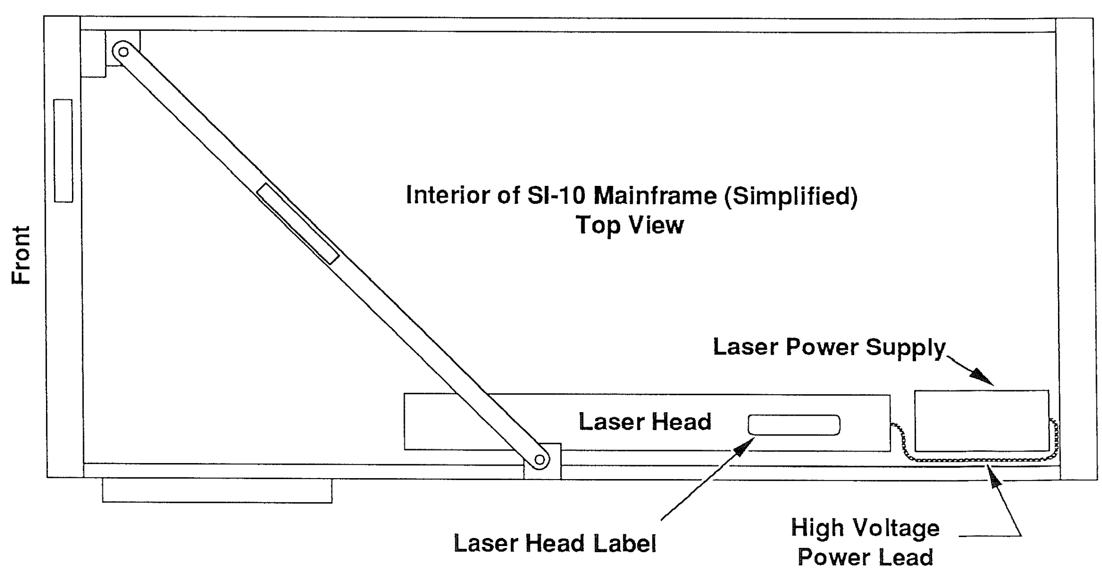
2. Remove the seven Phillips-head screws that secure the Mainframe's top cover; then lift off the top cover.

CAUTION:

When handling the electronics board, use measures to prevent it from being damaged by electrostatic discharge (ESD). Do not touch the board unless you are using the special, grounded, disposable ESD wrist strap.

3. Remove the two Phillips head screws that hold the electronics board, and temporarily set them aside. Carefully swing the board back out of the way.

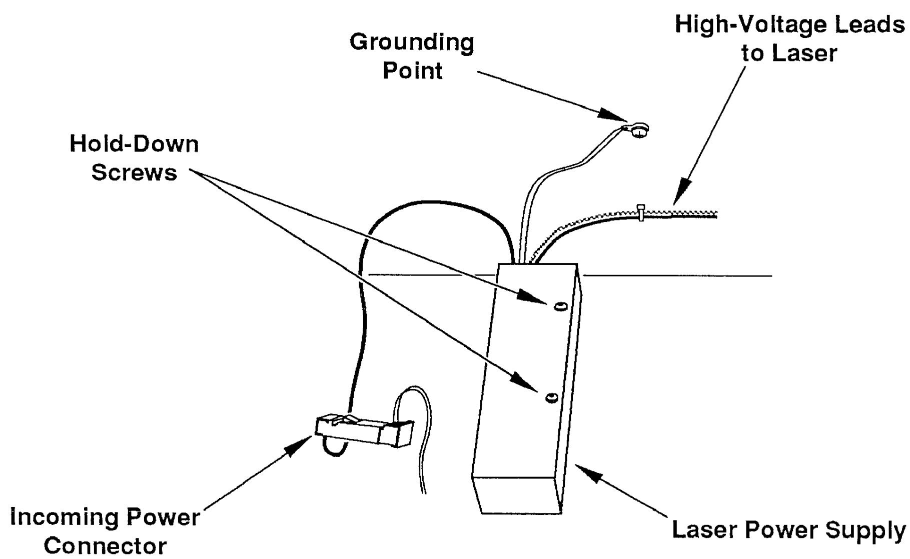
4. Locate the laser power supply inside the Mainframe. (Figure 6-5.) Before removing or disconnecting anything, study the routing and connection points of the three sets of wires coming from the power supply.



Interior of the SI-10 Mainframe

Figure 6-5

5. Disconnect the power supply's incoming power cable by pulling apart the connector (Figure 6-6).



Laser Power Supply and Wires
Figure 6-6

6. Disconnect the power supply's grounding lug by removing the screw that secures it to the grounding point.

WARNING!
When cutting the cable ties on the high voltage leads, be careful not to cut into the leads themselves.

7. Cut the cable ties that bundle the high voltage leads from the laser and laser power supply.

WARNING!
As you unplug the laser's leads from the laser power supply, do not let your skin contact the exposed metal tips of the laser's connectors. You could receive an uncomfortable shock from the electrical potential stored in the laser.

8. Unplug the red and black laser leads from the molded high voltage connector of the laser power supply. Touch the metal ends of the laser's leads together to discharge any electrical potential stored in the laser.

9. Remove the two socket-head screws that secure the laser power supply to the floor of the Mainframe. Remove the power supply.
10. Position the new power supply in the Mainframe.
11. Install and tighten the two screws that secure the power supply to the floor of the Mainframe.
12. Fasten the ground lug to the grounding point.
13. Plug the power supply's incoming power connector to its mating connector.
14. Plug the red and black leads from the laser into the molded connector of the laser power supply. Make sure you match red to red and black to black when plugging in the leads.
15. Use new cable ties to bundle the high voltage leads from the laser and laser power supply. Make sure the laser's high voltage leads are routed such that they will not be pinched when the Mainframe's cover is replaced.

CAUTION:

When handling the circuit board, use measures to prevent the board from being damaged by electrostatic discharge (ESD). Do not touch the board unless you are using the special, grounded, disposable ESD wrist strap.

16. Swing the electronics board back into its normal position and secure with the two Phillips head screws. Then replace the top cover of the Mainframe and secure it with the screws.
17. Reconnect the Mainframe to the Instrument Power Supply.

Replacing the Diffuser Disk Motor Assembly

This procedure explains how to replace the Diffuser Disk Motor Assembly in an SI-10 Mainframe. Tools needed: Phillips head screwdriver, Allen wrenches, Reference Flat and Mount.

CAUTION:

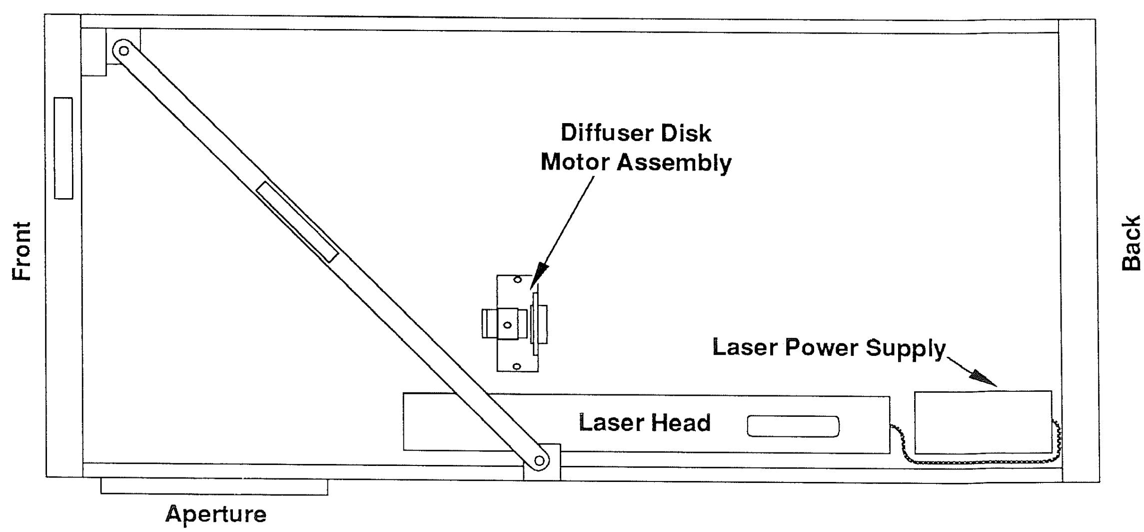
Before starting this procedure, make sure your working environment is very clean and is free from dust and other airborne contaminants. Do *not* leave the SI-10 Mainframe uncovered for any more time than is absolutely necessary.

1. Turn off the Mainframe and the Instrument Power Supply.
2. Remove the Phillips-head screws that secure the Mainframe's top cover; then lift off the top cover.

CAUTION:

When handling the circuit board, use measures to prevent the board from being damaged by electrostatic discharge (ESD). Do not touch the board unless you are using the special, grounded, disposable ESD wrist strap.

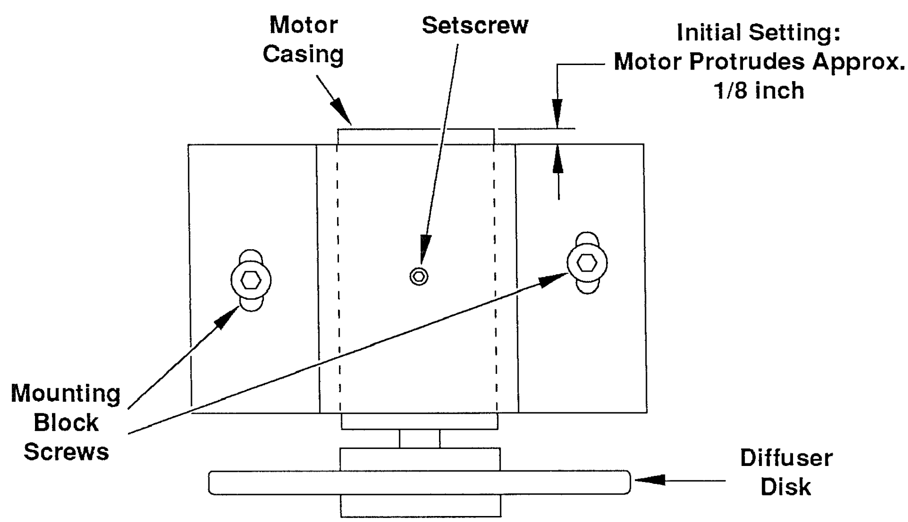
3. Remove the two Phillips-head screws that hold the electronics board, and temporarily set them aside. Carefully swing the board out of the way.
4. Refer to Figure 6-7 to locate the Diffuser Disk Motor Assembly.



Location of Diffuser Disk Motor in the SI-10 Mainframe (Top View)
Figure 6-7

5. Unplug the Diffuser Disk Motor's cable from the motor drive board.

6. Remove the two socket-head screws that secure the motor's mounting block to the Mainframe base casting (Figure 6-8).



Diffuser Disk Motor Assembly and Mounting Block
Figure 6-8

7. Lift the Diffuser Disk Motor Assembly out of the Mainframe.

8. Loosen the setscrew in the top center of the mounting block. Slide the motor out of the mounting block.

9. Slide the replacement motor into the mounting block. The back of the new motor should protrude approximately 1/8 inch from the mounting block (Figure 6-8).

10. Reinstall the Diffuser Disk Motor Assembly, mounting block, and screws in the Mainframe, making sure that the block bears against the machined edge of the laser assembly. Snug up the mounting screws, but do not tighten them. Do not tighten the setscrew yet.

11. Plug the connector on the motor's cable onto the appropriate pins on the motor drive board.

WARNING!

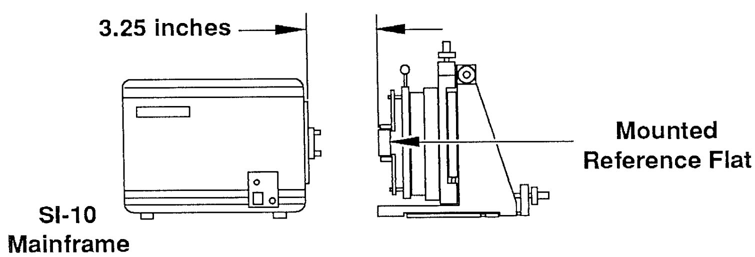
The remainder of this procedure requires that the Mainframe be operating while you are making adjustments inside of it. While performing this procedure, do not touch any components, either deliberately or accidently, other that those indicated in this procedure.

12. Turn on the Instrument Power Supply and the Mainframe.

13. Use the Remote Control to adjust the Focus to its midpoint. At focus midpoint, the top and bottom halves of the focus slide will be even at the ends.

14. Install a 4% reflectance Reference Flat in a mount that allows tip and tilt adjustments. (If there is a Transmission Flat in the Mainframe's Phase Measuring Receptacle, remove it.)

15. Place the mounted Reference Flat approximately 3.25 inches away from the surface of the Mainframe's datum plate (Figure 6-9).

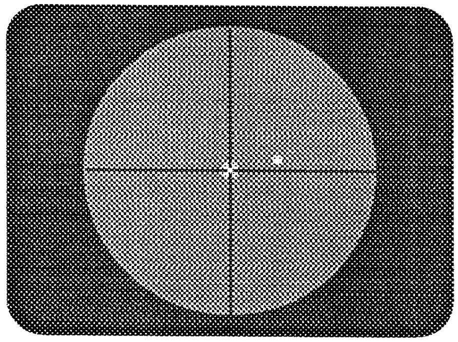


Positioning the Reference Flat

Figure 6-9

16. Put the Mainframe in the ALIGN mode.

17. Adjust the tip and tilt of the mounted Reference Flat so that its bright dot is superimposed on the crosshairs (Figure 6-10).

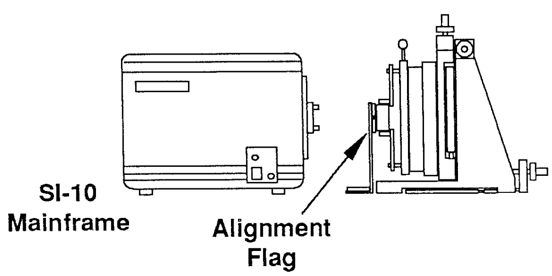


Alignment Screen - Bright Dot Superimposed on Crosshairs
Figure 6-10

18. Put the Mainframe in the VIEW mode.

19. Use the ZOOM function on the Remote Control to zoom in all the way to 6X.

20. Place the Alignment Flag or the edge of a piece of paper as close as possible to the surface of the Reference Flat that faces the Mainframe (Figure 6-11).



Positioning the Alignment Flag
Figure 6-11

21. While watching the video monitor, slide the motor's mounting block back and forth until best focus is achieved. If there is insufficient travel in the mounting block's slotted mounting holes, slide the motor body in the mounting block.

22. Zoom out to 1X and recheck the focus.

23. When best focus is achieved at both zoom settings, tighten the setscrew that holds the motor in the mounting block and the two screws that secure the mounting block to the Mainframe.

CAUTION:

When handling the circuit board, use measures to prevent the board from being damaged by electrostatic discharge (ESD). Do not touch the board unless you are using the special, grounded, disposable ESD wrist strap.

24. Swing the electronics board back into its normal position and secure it with the two Phillips head screws.

25. Replace the top cover of the Mainframe and the screws that secure it.

TECHNICAL SUPPORT

If you have been unable to resolve a problem with your system and need more help, call us at (203) 347-8506, between the hours of 8:00 and 4:30 (EST), Monday through Friday. You should make the call from a telephone close to the System in case the Service Engineer needs you to perform certain operations or requests additional information.

Before you call, have the following information ready:

1. The product's **name** or **model number**.
2. The product's **serial number** and, if applicable, software **version number**.
3. The **sequence of events** that led up to your discovering the problem.
4. **What you have done** (so far) to correct the problem.

After dialing Zygo's number, press **2 2 6** when prompted (if calling from a touch-tone phone), or stay on the line and ask the Zygo Operator for the Service Department. When the Service Department answers, explain that you would like to talk to a Service Engineer about your SI-10 System.

(Zygo can also be contacted by **TELEX** at 64-3006, or by **FAX** at (203) 347-8372.)

Returning Equipment to Zygo for Repair

If it is necessary to send equipment to Zygo for repair, you must first contact our Service Department (as explained above) to obtain a **Return Authorization** (RA) number. Equipment returned without an RA number cannot be accepted; Zygo assumes no responsibility for unauthorized returns.

When calling for an RA number, have the following information handy:

1. The system's model number, serial number, and if applicable, software version number.
2. A description of the problem, and the sequence of events that led up to your discovering the problem.
3. Your name and telephone number.
4. Your company's name and complete shipping address.
5. Your company's billing address and a purchase order number (if the SI-10 System is out of warranty).

Use the space provided here to write down information about the SI-10 so it will be conveniently available if you need it.

Model Number ________________ Date Installed ________________

Serial Number ________________ Software Version ________________

Packaging the Equipment for Shipping

When packing the equipment for shipping, use the original Zygo shipping containers, if you still have them. If you don't have the original containers, make sure the equipment is well-protected to prevent shipping damage. Also, mark the RA number on the shipping container and include the number on any correspondence.

Ship to:

Zygo Service Department
Laurel Brook Road
Middlefield, Connecticut 06455-0448

Chapter 7

ACCESSORIES

IN THIS CHAPTER

- Overview
- Computer Accessories
- Instrument Accessories

OVERVIEW

This chapter briefly describes the available accessories for both the computer and the SI-10 instrument. Operation instructions for the computer accessories are supplied by the original equipment manufacturer. Operation instructions for the instrument accessories are covered in separate accessory manuals, supplied by Zygo.

When you purchase a Zygo Accessory, insert the manual that accompanies it at the end of this chapter.

COMPUTER ACCESSORIES

Support equipment for the HP computer workstation includes:

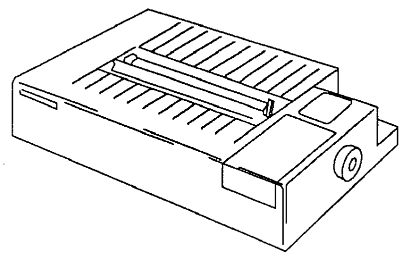
HP PaintJet Printer
HP Mobile Terminal Table
Mitsubishi Video Printer

Note:

For specific information regarding any of the computer accessories, refer to the documentation from the original manufacturer. However, this chapter provides some hints to help you integrate these components into your system.

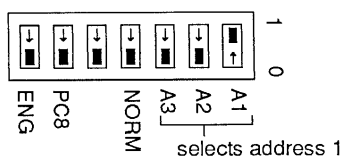
HP PaintJet Printer

The PaintJet Printer makes full color copies of the color video monitor display with a resolution of 180 dots per inch. The PaintJet includes the necessary cables, paper, and ink cartridges.



HP PaintJet
Prints color copies of the color monitor display.

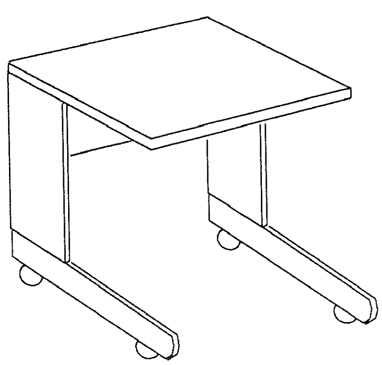
The PaintJet connects to the computer through the HP-IB (Hewlett-Packard Interface Bus). Set the switches of your printer as shown below.



HP Mobile Terminal Table

The Mobile Terminal Table is used as a movable table with the HP 9000 Series computer to support the HP Color Monitor, mouse, and keyboard. It comes with a cable tray and locking casters. The HP Apollo computer fits underneath.

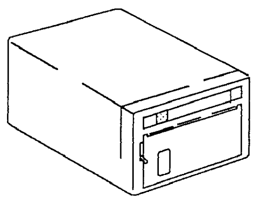
The Terminal Table comes in two sizes... both are 28.4 inches (720 mm) high and 28.0 inches (711 mm) deep. One model is 29.5 inches (750 mm) wide and the other is 44.3 inches (1125 mm) wide.



HP Mobile Terminal Table
Computer workstation table.

Video Printer

The Video Printer makes monochrome copies of the Video Monitor display, which may include interference patterns, cursors, and surface detail. The Video Printer outputs a 3 x 4-inch image with a resolution of 640 (horizontal) dots x 500 (vertical) lines. Images are reproduced with a grey scale of 256 gradations. The Video Printer is 4.9 x 6.0 x 12.4 inches (124 x 152 x 315 millimeters) (HWD). The Video Printer is manufactured by Mitsubishi. The Video Printer connects directly to a BNC connector on the Video Monitor.



Video Printer
Prints black & white copies of the Video Monitor display.

INSTRUMENT ACCESSORIES

Support equipment for your SI-10 System includes:

- Transmission Flats
- Reference Flats
- Adjustable 2-, 3-, and 5-Axis Mounts
- Vibration Isolation Table
- Aperture Converters
- Element Holders

The "Interferometer Accessories" brochure following this page explains each of these accessories.

Appendix A
ENVIRONMENTAL CONSIDERATIONS

INTRODUCTION

This Appendix provides additional information about environmental considerations for the operation of the SI-10 Interferometer System. Basic information on this subject is located in Chapter 4 of this manual.

TEMPERATURE

The optimum temperature range for operating the SI-10 Mainframe is 60° to 85° Fahrenheit (15° to 30° Celsius). At temperatures above or below this range, the calibration of the reference optics is not specified. If the Mainframe must be used at temperatures outside of the optimum range, the reference optics should be qualified at the operating temperature.

The temperature of the facility where the Mainframe is used should be maintained at ±0.56°C (±1°F). While this is not critical for surface testing "zero expansion" materials such as Zerodur™ and Fused Silica, it is critical when testing materials with high coefficients of thermal expansion. It is also critical when testing transmitted wavefront quality of materials where the index of refraction changes with temperature.

Active temperature control is not necessarily the best method of controlling the operating environment of the Mainframe. An active system can create a temperature ripple in the room that, although maintaining the ±1° specification, will prevent the materials being tested from reaching thermal equilibrium. The maximum acceptable rate of temperature change is approximately 1°C (1.8°F) per 15-minute interval.

The recommended approach is to construct a "room within a room" with the outer room having the active temperature control and the inner room having no temperature control. The temperature set point of the outer room should be set to the desired nominal ambient temperature of the inner room. The outer room will serve as a thermal "shock absorber" and should prevent rapid temperature changes in the inner room.

VIBRATION

Vibration can be minimized by using a top-quality vibration isolation system such as Newport Corporation's Research Series™ vibration isolation table. This table will isolate the Mainframe and test setup from floor vibration in the 10 Hz to 200 Hz frequency range. As you might expect, the effectiveness of the vibration isolation table much greater if the test area is located away from sources of noise and vibration.

AIR TURBULENCE

The "room within a room" recommendation, described previously, will greatly reduce air turbulence in the test area. Turbulence can be further reduced by using a test tunnel to cover the interferometric cavity. The tunnel must enclose the reference optic and the surface or lens system under test, and should be constructed from a material that is not resonant in the frequency range of 5 Hz to 200 Hz. Newport Corporation manufactures enclosures for their vibration isolation tables that meet these requirements. The area enclosed by the tunnel should not include the SI-10 Mainframe or any other equipment that generates heat, as this can result in air stratification in the cavity. The enclosure should also provide easy access to the cavity through hinged or sliding doors.

OPTICAL PATH LENGTH

The longer the optical path length in the interferometric cavity, the more vulnerable the cavity will be to noise and air turbulence. Therefore, the length of the optical path should always be kept as short as practicable. If a long optical path is unavoidable, use an enclosure around the cavity as described under the previous heading.

ACOUSTIC NOISE

The difficulties with acoustic noise are that the source is sometimes difficult to locate, and usually difficult to eliminate. Since interferometric applications vary, there are no specifications for specific frequencies and sound pressure levels. It is known that noise in the 10 Hz to 30 Hz range seems to have the greatest effect on measurements. This is partially due to the fact that some of the components in the test setup are likely to resonate in this frequency range.

The best solution for the acoustic noise problem is to install some type of noise damping material for the wall of the test area. There are several types of foam materials available that are designed specifically to damp acoustic noise. The recommended material has the trade name SONEX™, and is manufactured by Illbruck Incorporated, 3800 Washington Avenue North, Minneapolis, Minnesota 55412. This material effectively reduces the level of acoustic noise in the 10 Hz to 100 Hz range.

Additionally, care should be taken in how a component or lens system is mounted for testing. Mounts of fixtures that are resonant over the 10 Hz to 30 Hz range should be avoided. Also, test components should be securely mounted using a method that does not distort them. Finally, the area should be kept as clean as possible. The stability of a component mount can be dramatically affected if there is dirt or debris on the table top, under the base of the mount.

SHIELDING

Electromagnetic or radiation shielding is not required if the system is used in a normal laboratory or production environment. Shielding may be required if the system is subject to intense electromagnetic radiation. The type of shielding required will depend on the strength of the radiation, but it must enclose the Mainframe and interconnecting cables, and should be sufficient to reduce radiation levels to normal levels. The computer system uses magnetic media to store data which could be affected by electromagnetic radiation.

HUMIDITY

The upper limit for humidity in the operation or storage environment for the SI-10 is 95%, noncondensing. The humidity limit for a particular test setup is dependent on the material being tested. Some materials are hygroscopic and the maximum allowable humidity specification for the material will dictate the humidity level for the environment.

BAROMETRIC PRESSURE

The SI-10 System will operate to specification over the normal ambient range of barometric pressure. If testing at low or extremely low pressures (vacuum or near-vacuum), contact a Zygo Product Specialist for assistance.

Appendix B

PZT LINEARITY CALIBRATION

INTRODUCTION

If the Phase Measuring Recptacle (PMR) on your SI-10 Mainframe is replaced, the following procedure should be performed to check and, if necessary, adjust, the calibration of the PZT ramp linearity correction factor.

This procedure requires no tools except for a 4% transmission flat and reference flat, and will not harm the system if performed incorrectly. However, since it can affect the accuracy of measurements, it should be performed only when the PMR is replaced, or if you are asked to do so by a Zygo Service Engineer or Sales Representative.

PROCEDURE

1. This procedure is performed at the HP-UX level. If MetroPro is running, move the pointer to any edge of the screen, press the right mouse button to access the MetroPro menu, and select **Escape to Unix**.

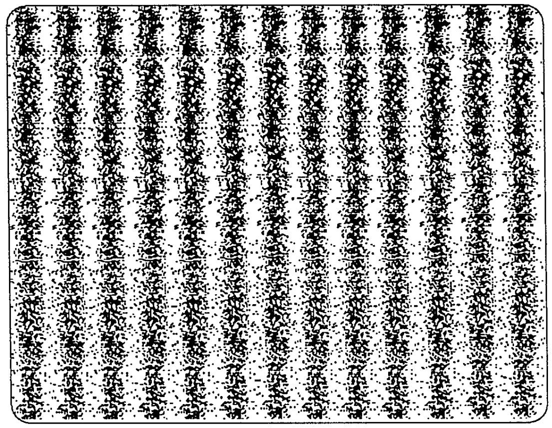
2. Type: `cd /usr/local/zygo/diag` [Return]

   Type: `d2bug` [Return]

   When you see the prompt: `d2bug>`

   Type the following: `do init` [Return]

3. Install and align a 4% Transmission Flat in the PMR and set up a 4% Reference Flat as the test surface. (Refer to Appendix A for set up and alignment information.) Adjust the Reference Flat to obtain 10 to 15 vertical fringes as shown in the Figure B-1. Use the Zoom function so that the fringes fill the entire screeen of the video monitor.



Thirteen Vertical Fringes
Figure B-1

4. To run the PZT linearity *diagnostic* program, type: `do pztlin` Return

   The values displayed by the diagnostic program are explained below:

   Fit RMS - Indicates the cleanliness of the surface of the Reference Flat and the quality and stability of the measurement environment. Values less than 2.0 are good. If the value is higher than 2.0, make sure the reference surface is clean, and evaluate the operating environment according to the guidelines provided in Chapter 4 and Appendix C of this manual. Unless this value can be brought to 2.0 or less, PZT linearity calibration cannot be performed reliably.

   Ramp Gain Error - This value should be less than ±1%. If it is not within this range, run the test again to see if the value is repeatably high. If so, contact the Zygo Service Department for assistance.

   Nonlinearity and **Trim** - Both of these values should be less than ±0.5 and will typically be about ±0.1. If they are less than ±0.5, you do not need to recalibrate the PZT linearity, and you may skip ahead to Step 7. If the values are repeatably higher than ±0.5, proceed to Step 5.

5. To run the PZT linearity *adjusting* program, type: `do pztlin_adj` Return

6. When the final values are displayed, compare them to the acceptable limits explained in Step 4 of this procedure. If the values are within the acceptable limits, proceed to Step 7. If the values are still too high, contact the Zygo Service Department for assistance.

7. Save the PZT Calibration data. Type: `write cal` [Return]

8. To leave the d2bug program, type: `quit` [Return]

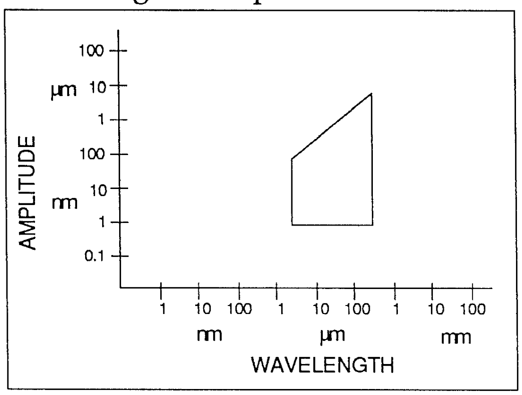
9. To return to the home directory, type: `cd` [Return]

10. To return to MetroPro, type:

    `exit` [Return]

GLOSSARY OF TERMS

A/W Space: The amplitude/ wavelength response of a surface measuring instrument as defined by the M. Stedman Amplitude/ Wavelength Graphs.



accuracy: The amount by which a measured value adheres to a standard.

Angstrom (Å): Equal to 10^{-10} meters, or 0.1 nanometers.

beamsplitter: An optical device for dividing a beam into two or more separate beams.

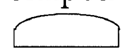
cartridge: 1) A housing containing magnetic tape wound between two spools and which has a write-protect switch. 2) An ink bladder for the Paintjet Printer.

coherence length: The distance over which interference will occur. Coherence length of an optical source is affected by the size of the source, spatial coherence, the phase purity of the source, temporal coherence, and the spectral bandwidth of the light.

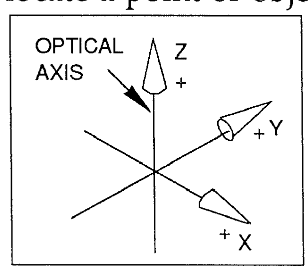
coherent light source: A light source that is capable of producing radiation with all the waves vibrating in phase.

concave: Denotes a spherically shaped surface, curved inward.

convex: Denotes a spherically shaped surface, curved outward.



coordinate system: A method of locating points or positions by assigning numbers to them. A three dimensional coordinate system has 3 axes and is used to locate a point or object in space.



Datum Plate: An aluminum plate mounted to the Maxim•3D microscope base which holds test samples and provides a mounting surface for translation stages and application fixtures.

Fizeau interferometer: An interferometer that incorporates a reference and test light path of unequal distance. See *interference*.

form: The general shape of a surface or low frequency surface characteristics.

fringe: The light and dark band caused by interference. Each cycle from light to dark to light is equal to $\lambda/2$ or 316 nm in a Fizeau double-pass setup with the interferometer operating at 633 nm in wavelength.

HP-IB: The Hewlett-Packard Interface Bus. A cable with standard connectors for transfer of data between the computer and peripherals. Also known as IEEE-488.

HP-UX: An extension of AT&T's UNIX System V developed by Hewlett-Packard for its super-minicomputers and workstations.

incoherent: Denotes the lack of a fixed phase relation between two waves.

index of refraction: The ratio of the velocity of light in air to the velocity of light in a refractive material for a given wavelength.

interference: The constructive and destructive superposition of two wavefronts that have different phases. In an interferometer the two wavefronts are produced by the reference surface and the test sample surface.

interferometer: An instrument that employs the interference of light waves to measure the wavefront.

interferometric objective: An optical component attached to the Maxim•3D microscope that gathers light from the object, forms a real image of it, and creates an interference pattern.

laser: An acronym of "Light Amplification by Stimulated Emission of Radiation." A laser is a cavity, with mirrors at the ends, that is filled with a lasable material, such as Helium-Neon gas.

lateral resolution: The smallest linear separable and measurable feature on the imaged surface. Lateral resolution of an interferometric microscope objective is a function of the N.A. and the Spatial Sampling Interval. See *Vertical Resolution, Rayleigh, and Sparrow.*

lay: The direction of predominant surface features.

magnification: The amount of lateral enlarging produced by an interferometric microscope objective.

MB: Short for MegaByte; a unit of data approximately equal to one million bytes (1,048,576 bytes).

memory: The area of a computer where programs and data are stored.

micro: The prefix meaning one-millionth (10^{-6}).

microinch (µin)**:** Equal to 10^{-6} inch, or 0.0254 µm.

micrometer (µm)**:** Equal to 10^{-6} meters (formerly micron), or 39.3701 min.

micron: See *micrometer.*

microroughness: Fine irregularities of a surface.

milli: The prefix meaning one-thousandth (10^{-3}).

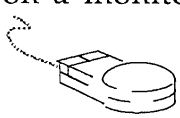
millimeter: Equal to 10^{-3} meters, or 39.3701 mils.

millimicron: See *nanometer*.

Mirau interferometer: An interferometer where interference occurs only when the reference and test light paths are equal.
See *interference*.

Motion Control: A control device for the Maxim•3D microscope comprised of a joystick and a motor drive. It is used to drive the microscope head up and down and operate motorized translation stage accessories.

mouse: The small mechanical device whose movement corresponds to pointer movements on a monitor.

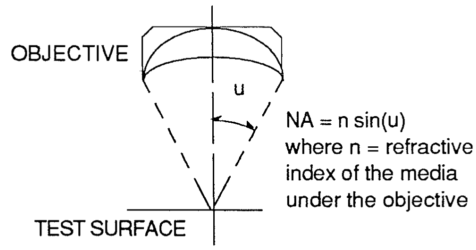


nanometer (nm): Equal to 10^{-9} meters (formerly millimicron), or 0.03937 µin.

noise: Any random or periodic non-data signal in the measurement.

nominal surface: The intended surface contour, exclusive of any intended surface roughness.

numeric aperture (N.A.): The sine of the vertex angle of the largest cone of meridional rays that can enter or leave an objective, multiplied by the refractive index of the medium in which the vertex is located. In air the N.A. must be <1.



phase discontinuity: A phase discontinuity occurs when the software algorithm for connecting the adjacent pixel phases in a continuous manner cannot determine the direction and height of a step. This is typically caused by steep surface slopes. This slope limitation in the Maxim•3D is objective dependent.

pixel: Short for picture element. The smallest element of the CID detector used for imaging and data acquisition.

points: The number of detector pixels in a particular data set. The number varies due to the use of the masks and zoom features which can alter the definable measurement area. The maximum number of points is approximately 256^2 or 65,536 for a system with a standard camera, or 512^2 for a high resolution system.

profile: The contour of the surface in a plane perpendicular to the surface. It is a two dimensional plot of the data.

PZT: Abbreviation for piezoelectric transducer. This component modulates the phase of the interference pattern across the detector by moving the objective and hence the reference surface.

radian: A unit of angular measurement equal to the angle at the center of a circle subtended by an arc equal in length to th radius. There are 2π radians in a circle.

RAM: Abbreviation for Random Access Memory. It is erasable program memory; programs and data are usually copied into RAM from a disk drive. Data in RAM is lost when power is removed.

Rayleigh resolution: Describes the resolving power of an objective as $1.22\lambda/N.A.$

refractive index: See *index of refraction.*

repeatability: The precision with which repeat measurements of the same sample give the same value with all conditions unchanged between measurements, except time.

resolution: The smallest quantity that can be measured.

roughness: The finer irregularities of the surface texture; usually including irregularities resulting from the production process.

SCSI: An acronym for Small Computer System Interface, an industry standard interface that provides high-speed access to peripheral devices.

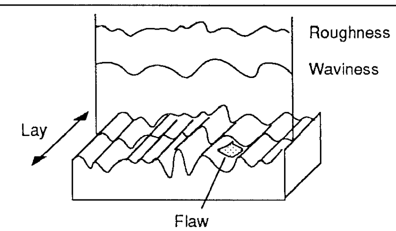
Sparrow resolution: Describes the resolving power of an objective as $\lambda/N.A.$

spatial sampling interval: The apparent size of a camera pixel (see *points*) that is projected on the test sample. Spatial Sampling Interval is a function of the interferometric microscope magnification.
$SSI = {}^{\text{Field of view}}/_{256}$

specular: 1) an object that reflects light. 2) In the direction in which a mirror reflects incident light.

surface texture: The repetitive or random deviation from the nominal surface that forms the three dimensional surface topography. Includes lay, waviness, roughness, and flaws. Any manufactured surface has irregularities due partly to the nature of the material but to a greater extent to the finishing operation used.

Surface Texture



Lay: predominant surface pattern.
Waviness: irregularities in the form of waves.
Roughness: irregularities finer than waves; roughness may be superimposed on a wavy surface.
Flaw: random irregularities - holes, cracks, etc.

turret: A rotating plate on the microscope that contains up to five objectives to provide for a rapid change of magnification.

UNIX™: An interactive, multi-tasking, and multi-user computer operating system that controls the communications, data storage, and information process capabilities of the computer hardware. It is comprised of three main parts: kernel, shell, and file system.

vertical resolution: The smallest measurable increment normal to the plane of measurement. A function of the resolution of measurement of interferometric phase.

Video Monitor: A television-like component which displays the image under view and is used for focusing and other measurement control.

wavefront: A surface connecting all field points (of electromagnetic energy) that are equidistant from the source.

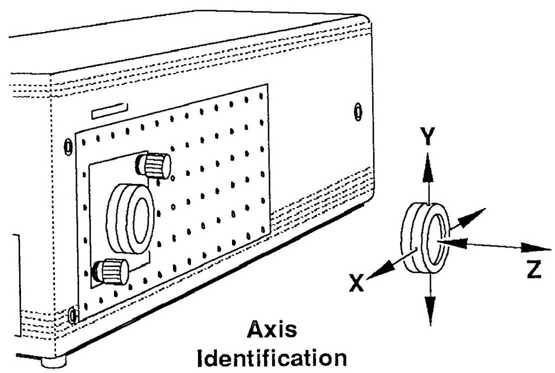
waviness: The component of surface texture upon which roughness is superimposed. See *form*.

X, Y, Z axes: See below.

X: Horizontal or side-to-side direction. Can refer to left-to-right movement of a 3-axis mount or to the left-to-right direction on the video monitor. Orthogonal to Y and Z axes.

Y: Vertical or up-down direction. Can refer to the up-down motion of a 3-axis mount or to the up-down direction on the video monitor. Orthogonal to X and Z.

Z: Parallel to the optical axis of the Mainframe. Refers to the closer-to, away-from motion of a 3-axis mount. Perpendicular to the X-Y plane.



Axis Identification

INDEX

To use this index, look for the major heading of the topic in question. Related topics are listed following the major heading.

Topics associated with MetroPro software are described in a separate manual, the MetroPro User's Guide, OMP-0289.

- Because of space limitations, only the *starting page* reference is given for each index entry. Information relevant to the subject may be confined to the identified page, or may continue for several more pages.
- Pages with numbers preceded by a single letter, such as A-1, are located behind the APPENDIXES tab.
- Individual Zygo accessories are not included in this index.