



Laser and Optics

User's Manual



Agilent Technologies

User's Manual

Agilent 5517A/5517B/5517C/5517D Laser Head
Agilent 5519A/B Laser Head
Agilent 5529A Dynamic Calibrator
Agilent 10567A Dual Beam Beam-Splitter
Agilent 10700A 33% Beam Splitter
Agilent 10701A 50% Beam Splitter
Agilent 10702A Linear Interferometer (and 10702A-001 with Windows)
Agilent 10703A Retroreflector
Agilent 10704A Retroreflector
Agilent 10705A Single Beam Interferometer
Agilent 10706A Plane Mirror Interferometer
Agilent 10706B High Stability Plane Mirror Interferometer
Agilent 10707A Beam Bender
Agilent 10710B Adjustable Mount
Agilent 10711A Adjustable Mount
Agilent 10713B/C/D Cube Corner
Agilent 10715A Differential Interferometer (and 10715A-001 Turned Configuration)
Agilent 10716A High Resolution Interferometer (and 10716A-001 Turned Configuration)
Agilent 10717A Wavelength Tracker
Agilent 10719A One-axis Differential Interferometer
Agilent 10721A Two-axis Differential Interferometer
Agilent 10722A Plane Mirror Converter
Agilent 10723A High Stability Adapter
Agilent 10724A Plane Mirror Reflector
Agilent 10725A 50% Beam Splitter
Agilent 10726A Beam Bender
Agilent 10728A Plane Mirror
Agilent 10735A Three-axis Interferometer
Agilent 10736A Three-Axis Interferometer
Agilent 10736A-001 Three-Axis Interferometer with Beam Bender
Agilent 10737L, R Compact Three-axis Interferometers
Agilent 10753B Laser Tripod
Agilent 10759A Footspacing Kit
Agilent 10766A Linear Interferometer
Agilent 10767A Linear Interferometer
Agilent 10767B Lightweight Retroreflector
Agilent 10768A Diagonal Measurement Kit
Agilent 10769A Beam Steering Mirror
Agilent 10770A Angular Interferometer
Agilent 10771A Angular Retroreflector
Agilent 10772A Turning Mirror
Agilent 10773A Flatness Mirror
Agilent 10774A Short Range Straightness Optics
Agilent 10776A Straightness Accessory Kit
Agilent 10777A Optical Square
Agilent 10780C Receiver
Agilent 10780F Remote Receiver
Agilent 10790A/B/C Receiver Cable
Agilent 10880A/B/C Receiver Cable
Agilent 10881A/B/C Laser Head Cable
Agilent 10882A/B/C Laser Head Cable
Agilent 10884A Power Supply
Agilent E1705A Fiber-Optic Cable
Agilent E1706A Remote Sensor
Agilent E1708A Remote Dynamic Receiver
Agilent E1709A Remote High-Performance Receiver
Agilent N1203C Precision Beam Translator
Agilent N1204C Precision Horizontal Beam Bender
Agilent N1207C Precision Vertical Beam Bender
Agilent N1250A/B High Performance Receiver Cable
Agilent N1251A/B High Performance Laser Head Cable

PROPRIETARY INFORMATION

This manual contains proprietary information of Agilent Technologies, Inc. This information may not be used or reproduced without the express written permission of Agilent Technologies.

© Copyright AGILENT TECHNOLOGIES, INC. 1992, 1996, 2000, 2002
5301 Stevens Creek Boulevard Santa Clara, California 95052-8059

All rights reserved.

No part of this publication may be reproduced, stored in a retrieval system, or transmitted, in any form or by any means, electronic, mechanical, photocopying, recording, or otherwise without prior written permission of Agilent Technologies.

MANUAL PART NUMBER: 05517-90045

PRINTED: July 2002

Laser and Optics

Certification and Warranty

Certification

Agilent Technologies certifies that this product met its published specification at the time of shipment from the factory. Agilent further certifies that its calibration measurements are traceable to the United States National Institute of Standards and Technology (formerly National Bureau of Standards), to the extent allowed by the Institute's calibration facility, and to the calibration facilities of other International Standards Organization members.

Warranty

Agilent warrants Agilent hardware, accessories and supplies against defects in materials and workmanship for a period specified by each product from date of shipment. If Agilent receives notice of such defects during the warranty period, Agilent will, at its option, either repair or replace products which prove to be defective. Replacement products may be either new or like-new.

Agilent warrants that Agilent software will not fail to execute its programming instructions, for the period specified above, due to defects in material and workmanship when properly installed and used. If Agilent receives notice of such defects during the warranty period, Agilent will replace software media which does not execute its programming instructions due to such defects.

For detailed warranty information, see back matter.

Safety Considerations General

This product and related documentation must be reviewed for familiarization with this safety markings and instructions before operation.

This product is a safety Class I instrument (provided with a protective earth terminal).

Before Applying Power

Verify that the product is set to match the available line voltage and the correct fuse is installed.

Before Cleaning

Disconnect the product from operating power before cleaning.

Safety Earth Ground

An uninterruptible safety earth ground must be provided from the mains power source to the product input wiring terminals or supplied power cable.

Warning Symbols That May Be Used In This Book



Instruction manual symbol; the product will be marked with this symbol when it is necessary for the user to refer to the instruction manual.



Indicates hazardous voltages.



Indicates earth (ground) terminal.

Safety Considerations (contd)



or



Indicates terminal is connected to chassis when such connection is not apparent.



Indicates Alternating current.



Indicates Direct current.

WARNING

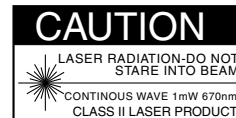
BODILY INJURY OR DEATH MAY RESULT FROM FAILURE TO HEED A WARNING. DO NOT PROCEED BEYOND A WARNING UNTIL THE INDICATED CONDITIONS ARE FULLY UNDERSTOOD AND MET.

CAUTION

Damage to equipment, or incorrect measurement data, may result from failure to heed a caution. Do not proceed beyond a *CAUTION* until the indicated conditions are fully understood and met.

These CAUTION labels are required by the United States Center for Devices and Radiological Health. Failure to follow their instructions may result in personal injury.

This symbol indicates laser radiation.



CAUTION: Laser radiation when open. DO NOT STARE INTO THE BEAM

For additional safety and acoustic noise information, see back matter.

Contents

1 About This Manual

- Introduction 1-2**
- How to Locate Information 1-2**
- Manual Organization 1-2**
- Manuals Available 1-6**
- How to Order Manuals 1-7**

2 Familiarization and Initial Operation

- Introduction 2-2**
 - A one-axis example is used for simplicity 2-2
 - Basic steps apply to all laser systems 2-2
 - Agilent laser interferometer positioning systems at a glance 2-2
 - All Agilent laser systems share a similar configuration 2-3
 - A controller is required for all laser positioning systems 2-4
 - What follows? 2-4
- Setting Up the System Electronics 2-5**
 - To Install the Laser Electronics in the PC 2-5
 - To Connect the Electronics Cables 2-5
 - To Start the System 2-6
- Aligning the Optics 2-6**
- Making a Measurement 2-7**
- Solving Problems 2-8**

3 System Design Considerations

- Introduction 3-2**
- Accuracy Considerations 3-4**
- Determining What Equipment is Needed 3-4**
- Electronic Components 3-9**
 - Transducer Systems 3-9
 - PC-Based Electronics 3-9
 - VME Compatible Electronics 3-9
 - PC-Based PCI Electronics 3-9
 - Calibrator System Electronics 3-10
 - Agilent 5529A Dynamic Calibrator 3-10
- Adjustment Considerations 3-11**
 - Laser beam and optics protection 3-11
- System Grounding 3-14**
- Laser Head 3-15**
 - Orientation 3-15

Mounting plane tolerance	3-15
Pointing stability	3-16
Thermal isolation	3-16
Vibration isolation	3-16
Magnetic shielding	3-17
Mounting	3-17
Optics	3-17
Plane of orientation with respect to laser head	3-17
Effect of optics on measurement direction sense	3-17
Configuration effects	3-18
Vibration isolation for optics	3-19
Adjustable mounts for optics	3-19
Fasteners for optics	3-20
Vacuum applications	3-20
Differential measurements with interferometers	3-21
Moving interferometer instead of reflector	3-22
Introducing an offset into the laser beam	3-22
Beam Path Loss Computation	3-23
Considerations	3-23
Calculation of signal loss	3-25
Axis component efficiencies (worst case)	3-26
Axis component efficiencies (typical)	3-27
Receivers	3-28
General	3-28
Clearance for laser beam	3-28
Alignment adjustment required	3-28
Example Configurations	3-29
Single-axis system for servo-track writing	3-29
Multiaxis configurations	3-30
Multiaxis system for a precision x-y stage	3-31
Four-axis linear configuration	3-32
Two-axis plane mirror	3-33
Two-axis plane mirror in a vacuum	3-33
Two-axis measurement system using two Agilent 10715A differential interferometers	3-35
Three-axis measurement system using discrete plane mirror interferometers (X, Y, YAW)	3-35
Multiaxis systems using Agilent 10719A and Agilent 10721A inteferometers	3-39
Multiaxis systems using Agilent 10735A and Agilent 10736A three-axis inteferometers	3-39

Optical Device Troubleshooting 3-39

Site Preparation 3-40

Site preparation for laser head 3-40

Site preparation for optical devices 3-40

Site preparation for referenced interferometers 3-41

4 System Installation and Alignment

Introduction 4-2

Pre-Installation Checklist 4-2

System Grounding 4-3

External Cabling 4-3

Laser head cables 4-3

For use with Agilent 10895A VME, 10889B PC, 10896B VME, 10897B VME, 10898A VME, or N1231A PCI axis board 4-3

Receiver cables 4-4

For use with Agilent 10895A VME Axis Board 4-4

For use with Agilent 10895A VME, 10889B PC, 10896B VME, 10897B VME, 10898A VME, or N1231A PCI axis board 4-5

Mounting Optics 4-6

Adjustable mounts 4-6

Typical mounting of optics which use adjustable mounts 4-6

Fasteners 4-7

Aligning Optics 4-10

General 4-10

Alignment principles 4-12

Receiver Alignment and Gain Adjustment 4-14

Autoreflexion Method Summary 4-14

Overlapping Dots Method Summary 4-16

Aligning the Agilent 10702A Linear, Agilent 10766A Linear, and Agilent 10705A Single Beam Interferometers 4-18

Alignment aids (for Agilent 10702A, Agilent 10766A, Agilent 10705A) 4-19

Autoreflexion alignment procedure (for Agilent 10702A, Agilent 10766A, Agilent 10705A) 4-20

Overlapping dot alignment procedure (for Agilent 10702A, Agilent 10766A, Agilent 10705A) 4-24

5 Laser Heads

General	5-2
Frequencies and Polarizations	5-3
Number of Measurement Axes	5-4
Measurement Range	5-4
Heat Generation	5-4
Accuracy Considerations	5-5
Vibration Isolation	5-6
Automatic Tuning and Warmup Period	5-6
Beam Shutters	5-6
Orientation	5-7
Magnetic Shielding	5-7
Pointing Stability	5-8
Maintenance Requirements	5-9
Laser Head Descriptions	5-9
Comparison of Laser Heads	5-9
Agilent 5517A Laser Head	5-10
Description	5-10
Mounting and Clearance	5-11
Agilent 5517A Laser Head Specification	5-13
Agilent 5517B Laser Head	5-14
Description	5-14
Mounting and Clearance	5-14
Agilent 5517B Laser Head Specifications	5-17
Agilent 5517C Laser Head	5-18
Description	5-18
Mounting and Clearance	5-19
Agilent 5517C Laser Head Specifications (Standard and 5517C-003)	5-21
Agilent 5517C-009 Laser Head Specifications	5-22
Agilent 5517D Laser Head	5-23
Description	5-23
Mounting and Clearance	5-24
Agilent 5517D Laser Head Specifications (Standard and 5517D-003)	5-26
Agilent 5519A/B Laser Head and Receiver	5-27
Description	5-27
Functional Description	5-29
Mounting and Clearance	5-32
Agilent 5519A/B Laser Head Specifications	5-33

6 Beam-Directing Optics

Introduction 6-2

Use of the Adjustable Mounts 6-4

Vacuum Applications 6-4

Agilent 10567A Dual Beam Beam-Splitter 6-5

Agilent 10567A Dual Beam Beam-Splitter Specifications 6-6

Agilent 10700A 33% Beam Splitter and 10701A 50% Beam Splitter 6-7

Agilent 10700A 33% Beam Splitter Specifications 6-8

Agilent 10701A 50% Beam Splitter Specifications 6-9

Agilent 10707A Beam Bender 6-10

Agilent 10707A Beam Bender Specifications 6-11

Agilent 10725A 50% Beam Splitter and 10726A Beam Bender 6-12

Agilent 10725A Beam Splitter Specifications 6-12

Agilent 10726A Beam Bender Specifications 6-13

Agilent N1203C, N1204C, and N1207C Beam Manipulators 6-14

Overview 6-14

Application simplified 6-14

Stability 6-15

Thermal 6-15

Mechanical 6-15

Optical Input/Output ports and adjustment access 6-167

Agilent N1203C Precision Beam Translator Specifications and Characteristics 6-17

Agilent N1204C Precision Horizontal Beam Bender Specifications and Characteristics 6-19

Agilent N1207C Precision Vertical Beam Bender Specifications and Characteristics 6-21

7 Measurement Optics

- General 7-2**
- Resolution 7-6**
- Range 7-6**
- Measurement Direction Sense 7-6**
- Vibration Isolation 7-9**
- Fasteners 7-9**
- Vacuum Applications 7-10**
- Use Through Window 7-10**
- Differential Measurements with Interferometers 7-10**
- Moving Interferometer Instead of Reflector 7-12**

7A Agilent 10702A and 10766A Linear Interferometers, and Agilent 10703A and 10767A Retroreflectors

- Introduction 7A-2**
- Description 7A-3**
- Laser Beam Path 7A-8**
 - Differential measurements 7A-9
- Special Considerations 7A-10**
 - Effect of optics on measurement direction sense 7A-10
 - Configuration effects 7A-10
 - Moving interferometer instead of reflector 7A-10
- Mounting 7A-11**
 - Vibration considerations 7A-11
 - Adjustable mounts 7A-11
 - Fasteners 7A-11
- Installation 7A-12**
 - Pre-installation checklist 7A-12
 - Alignment 7A-13
 - Alignment aids 7A-13
 - Procedure 7A-13
- Specifications and Characteristics 7A-13**
 - Agilent 10702A Linear Interferometer Specifications 7A-14
 - Agilent 10702A-001 Linear Interferometer with Windows Specifications 7A-15
 - Agilent 10703A Retroreflector Specifications 7A-16
 - Agilent 10713B Cube Corner Specifications 7A-16
 - Agilent 10766A Linear Interferometer Specifications 7A-17
 - Agilent 10767A Retroreflector Specifications 7A-18

7B Agilent 10705A Single Beam Interferometer and Agilent 10704 Retroreflector

Agilent 10705A Single Beam Interferometer and Agilent 10704A Retroreflector

Description 7B-2

- Laser beam path 7B-3
- Differential measurements 7B-4
- Plane mirror measurements 7B-4

Special Considerations 7B-5

- Effect of optics on measurement direction sense 7B-5
- Configuration effects 7B-5

Mounting 7B-5

- Adjustable mounts 7B-5
- Fasteners 7B-5

Installation 7B-6

- Pre-installation checklist 7B-6
- Alignment 7B-7
 - Alignment aids 7B-7
 - Procedure 7B-7

Specifications and Characteristics 7B-7

- Agilent 10705A Single Beam Interferometer Specifications 7B-8
- Agilent 10704A Retroreflector Specifications 7B-9
- Agilent 10713C Cube Corner Specifications 7B-9
- Agilent 10713D Cube Corner Specifications 7B-10

7C Agilent 10706A Plane Mirror Interferometer

Description 7C-2

- Laser beam paths 7C-4

Special Considerations 7C-6

- Differential measurements 7C-6
- Turned configuration 7C-6

Mounting 7C-8

- Adjustable mounts 7C-8
- Fasteners 7C-8

Installation 7C-9

- Pre-installation check 7C-9

Alignment	7C-10
General	7C-10
Alignment aids	7C-10
Alignment procedure	7C-11
Specifications and Characteristics	7C-16
Agilent 10706A Plane Mirror Interferometer Specifications	7C-17
Agilent 10722A Plane Mirror Converter Specifications	7C-18
Agilent 10723A High Stability Adapter Specifications	7C-18
Agilent 10724A Plane Mirror Reflector Specifications	7C-19
Converting to High-Stability Plane Mirror Interferometer	7C-20
General	7C-20
To convert an Agilent 10706A Plane Mirror Interferometer to the Agilent 10706B configuration	7C-20

7D Agilent 10706B High Stability Plane Mirror Interferometer

Description	7D-2
Laser beam paths	7D-2
Special Considerations	7D-5
Mounting	7D-5
Adjustable mounts	7D-5
Fasteners	7D-5
Installation	7D-5
Alignment	7D-5
Straight-Through Configuration	7D-6
Turned Configuration	7D-6
Alignment aids	7D-8
Alignment Procedures	7D-9
Straight-Through Configuration (Signal-Axis Alignment)	7D-9
Turned Configuration (X-Y Stage Example) Alignment	7D-12
Specifications and Characteristics	7D-19
Agilent 10706B Plane Mirror Interferometer Specifications	7D-20

7E Reserved for later user 7E-1

7F Reserved for later user 7F-1

7G Agilent 10715A Differential Interferometer

Description 7G-2

Special Considerations (Configuration Effects) 7G-5

Configurations with the same direction sense 7G-5

Standard configuration Agilent 10715A 7G-5

Turned configuration Agilent 10715A-001 7G-5

Agilent 10715A upside down 7G-5

Configurations that change the direction sense 7G-5

Agilent 10715A Input and Output Apertures 7G-5

Agilent 10715A orientation (horizontal or vertical) 7G-7

Mounting 7G-7

Adjustable mounts 7G-7

Fasteners 7G-7

Installation and Alignment 7G-8

Configurations 7G-8

Reference mirror mounting 7G-9

Alignment aid 7G-10

Alignment procedure 7G-10

Specifications and Characteristics 7G-15

Agilent 10715A Differential Interferometer (and 10715A-001
Turned Configuration) Specifications 7G-16

7H Agilent 10716A High-Resolution Interferometer

Description 7H-2

Special Considerations 7H-5

Mounting 7H-5

Adjustable mounts 7H-5

Fasteners 7H-5

Installation 7H-5

Pre-installation checklist 7H-5

Alignment 7H-6

Configurations 7H-6

Alignment Aids 7H-7

Alignment Overview 7H-8

Alignment Procedure 7H-9

Specifications and Characteristics 7H-13

Agilent 10716A High Resolution Interferometer (and
10716A-001 Turned Configuration) Specifications 7H-14

7I Agilent 10717A Wavelength Tracker

Description 7I-2

Special Considerations 7I-6

Installation and Alignment 7I-7

Pre-installation checklist 7I-7

Alignment aid 7I-7

Procedure 7I-7

Agilent 10717A Wavelength Tracker Specifications and
Characteristics 7I-15

**7J Agilent 10719A One-Axis Differential
Interferometer**

Description 7J-2

General 7J-2

Applications 7J-2

Differential measurements 7J-2

Angular measurements 7J-3

Multiaxis configurations 7J-4

Three-Axis System 7J-5

**Five-Axis System Using Agilent 10719A and Agilent 10721A
Interferometers 7J-7**

Optical schematic 7J-7

Special Considerations 7J-10

Configuration and beam locations 7J-10

Beam diameter 7J-10

Receiver considerations 7J-10

Spacing to beam-directing optic 7J-11

Input and output apertures 7J-12

Direction sense 7J-12

Deadpath 7J-12

Reference and measurement mirror requirements 7J-13

Mounting 7J-14

Vibration considerations 7J-14

Interferometer mounting system (user-supplied) 7J-14

- Designing the mounting system 7J-14
- Installation 7J-17**
 - Pre-installation checklist 7J-17
 - Receivers 7J-17
- Alignment 7J-18**
 - Alignment aid 7J-18
 - Alignment procedure 7J-18
- Operation 7J-21**
 - Reset considerations 7J-21
 - Deadpath compensation considerations 7J-21
- Specifications and Characteristics 7J-21**
 - Agilent 10719A One-Axis Differential Interferometer Specifications 7J-22

7K Agilent 10721A Two-Axis Differential Interferometer

- Description 7K-2**
 - General 7K-2
 - Applications 7K-2
 - Differential measurements 7K-2
 - Angular measurements 7K-3
 - Multiaxis configurations 7K-4
 - Optical schematic 7K-5
- Special Considerations 7K-7**
 - Laser beam power consideration 7K-7
 - Configuration and beam locations 7K-7
 - Beam diameter 7K-7
 - Receiver considerations 7K-7
 - Spacing to beam-directing optic 7K-9
 - Input and output apertures 7K-9
 - Direction sense 7K-9
 - Deadpath 7K-10
 - Reference and measurement mirror requirements 7K-10
- Mounting 7K-11**
 - Vibration isolation 7K-11
 - Interferometer mounting system (user-supplied) 7K-11
 - Designing the mounting system 7K-12
- Installation 7K-14**
 - Pre-installation checklist 7K-14
 - Receivers 7K-14

Alignment 7K-15

Alignment aid 7K-15

Alignment procedure 7K-15

Operation 7K-18

Reset considerations 7K-18

Deadpath compensation considerations 7K-18

Specifications and Characteristics 7K-19

Agilent 10721A Two-Axis Differential Interferometer
Specifications 7K-19

7L Reserved for later user 7L-1

7M Reserved for later user 7M-1

7N Agilent 10735A, 10736A, and 10736A-001 Three-Axis Interferometers

Description 7N-2

Applications 7N-5

General 7N-5

X-Y stage 7N-6

Optical Schematics 7N-8

Special Considerations 7N-9

Laser beam power consideration 7N-9

9-mm laser beam considerations 7N-9

Orientation 7N-9

Mounting 7N-10

General 7N-10

Installation 7N-15

Pre-installation checklist 7N-15

Procedure 7N-16

Alignment 7N-16

Laser beam alignment 7N-17

Objective 7N-17

Procedure 7N-17

Operation 7N-20

Measurements 7N-20

Displacement 7N-20

Pitch 7N-20

Yaw 7N-21

Error 7N-21

- General 7N-21
- Agilent 10736A-001 Interferometer — Bent Axis 7N-21
- Specifications and Characteristics 7N-22**
 - Agilent 10735A Three-Axis Interferometer Specifications 7N-22
 - Agilent 10736A Three-Axis Interferometer and Agilent 10736A-001 Three-axis Interferometer with Beam Bender Specifications 7N-24

70 Agilent 10737L and 10737R Compact Three-Axis Intefereometers

- Description 70-2**
 - Applications 70-6
 - General 70-6
 - X-Y Stage 70-6
 - Optical Schematics 70-7
- Special Considerations 70-9**
 - Laser beam power consideration 70-9
 - Orientation 70-9
- Mounting 70-12**
 - Adjustable mounts 70-12
 - Fasteners 70-12
- Installation and Alignment 70-13**
 - Summary 70-13
 - General 70-13
 - Tools and Equipment Required or Recommended 70-13
- Procedure 70-16**
 - Planning the measurement setup 70-16
 - Initial installation and setup 70-16
 - Installing and aligning an interferometer 70-17
 - Removing the receiver assembly 70-17
 - Removing the high stability adapter (reference mirror) 70-18
 - Aligning the measurement beam path 70-19
 - Aligning the reference beam path 70-21
 - Comparing beam path alignments 70-22
- Operation 70-23**
 - Measurements 70-23
 - Displacement 23
 - Pitch 70-23
 - Yaw 70-23

	Error	7O-23
	Specifications and Characteristics	7O-24
	Agilent 10737L/R Compact Three-Axis Interferometer Specifications	7O-25
7P	Reserved for later user	7P-1
7Q	Reserved for later user	7Q-1
7R	Reserved for later user	7R-1
7S	Reserved for later user	7S-1
7T	Reserved for later user	7T-1
7U	Reserved for later user	7U-1
7V	Agilent 10770A Angular Interferometer with Agilent 10771A Angular Reflector	
	Description	7V-2
	Optical schematic	7V-2
	Installation and Alignment	7V-4
	General considerations	7V-4
	Alignment target	7V-4
	Alignment procedure	7V-4
	Autoreflexion Method	7V-5
	Moving Dot Method	7V-6
	Operation	7V-8
	Specifications	7V-8
	Agilent 10770A Angular Interferometer Specifications	7V-9
	Agilent 10771A Angular Reflector Specifications	7V-10
7W	Reserved for later user	7W-1
7X	Reserved for later user	7X-1
7Y	Agilent 10774A Short Range Straightness Optics and Agilent 10775A Long Range Straightness Optics	

Introduction	7Y-2
Squareness and Parallelism	7Y-3
Principles of Operation	7Y-4
Installation and Alignment	7Y-6
Pre-installation checklist	7Y-6
Alignment targets	7Y-6
General considerations	7Y-6
Principal alignment steps	7Y-9
Alignment procedures	7Y-10
Autoreflexion method	7Y-12
Gunsight method	7Y-13
Slope removal	7Y-15
Operation	7Y-17
Accuracy considerations	7Y-17
Specifications	7Y-17
Agilent 10774A Short Range Straightness Optics and	
Agilent 10775A Long Range Straightness Optics Specifications	
	7Y-18

8 Receivers

General	8-2
Comparison of Agilent Laser Receiver Families	8-2
Agilent 10780C and Agilent 10780F Receivers	8-5
Description	8-5
General	8-5
Lens and polarizer	8-5
Photodiode	8-6
Agilent 5519A/B Laser Head Receiver	8-7
Special considerations	8-7
Cables	8-7
Effects of motion and orientation	8-8
Mounting	8-9
Offset aperture	8-9
Agilent 10780F Remote Receiver sensor head	8-9
Installation	8-9
Cable connection	8-9
Fasteners	8-10
Clearance for laser beam	8-10
Alignment	8-12
General	8-12
Alignment target	8-12
Principle	8-12
Receiver alignment and gain adjustment procedure	8-14

Operation	8-16
Specifications and characteristics	8-16
Sensitivity	8-16
Agilent 10780C Receiver Specifications	8-17
Agilent 10780F Remote Receiver Specifications	8-18
Agilent E1708A Remote Dynamic Receiver	8-19
Description	8-19
Principles of operation	8-20
Installation	8-21
Cables for electronics	8-22
Agilent E1705A Fiber-Optic Cable considerations	8-23
Alignment and adjustments	8-25
Operation	8-26
Specifications and characteristics	8-26
Agilent E1708A Remote Dynamic Receiver Specifications	8-27
Agilent E1709A Remote High-Performance Receiver	8-28
Description	8-28
Key definitions and concepts	8-29
Features	8-33
Agilent E1706A Remote Sensor	8-33
Application characteristics	8-33
Agilent E1709A relationship to Agilent E1708A	8-34
Technical enhancements	8-34
Adjustment and additional alignment requirements	8-34
Retrofit issues	8-34
Specifications and characteristics	8-35
Agilent E1709A Remote High-Performance Receiver Specifications	8-36

9 Accessories

General 9-2

Adjustable Mounting Hardware 9-2

Adjustable mounts 9-2

Height adjuster and post, and base 9-4

Specifications 9-4

Agilent 10710B/10711A Adjustable Mount Specifications 9-5

Agilent 10785A Height Adjuster/Post and the Agilent 10784A Base Specifications 9-7

Cables 9-8

Agilent 10790A/B/C Receiver Cable 9-11

Agilent 10880A/B/C Receiver Cable 9-12

Agilent 10881A/B/C Laser Head Cable 9-13
 Agilent 10881D/E/F Laser Head Cable 9-14
 Agilent 10882A/B/C Laser Head Cable 9-15
 Agilent N1250A/B High Performance Receiver Cable 9-16
 Agilent N1251A/B High Performance Laser Head Cable 9-17

Alignment Targets and Aids 9-18

Agilent 10753B Laser Tripod 9-20

Agilent 10759A Footspacing Kit 9-20

Optics 9-20

Vacuum applications 9-21

Agilent 10724A Plane Mirror Reflector 9-21

Agilent 10724A Plane Mirror Reflector Mounting 9-22

Agilent 10724A Plane Mirror Specifications 9-24

Agilent 10728A Plane Mirror 9-25

Agilent 10728A Plane Mirror Specifications 9-25

Agilent 10772A Turning Mirror 9-26

Agilent 10772A Turning Mirror Specifications 9-27

Agilent 10773A Flatness Mirror 9-27

Agilent 10773A Flatness Mirror Specifications 9-28

Agilent 10776A Straightness Accessory Kit 9-29

Agilent 10776-67001 Straightness Retroreflector
 Specifications 9-30

Agilent 10777A Optical Square 9-31

Agilent 10777A Optical Square Specifications 9-32

**Agilent N1203C/04C/07C Beam Manipulator Accessories
 9-33**

Adjustment tools 9-33

Adjustment tool kit (Agilent N1206T) 9-33

Customer-supplied hardware 9-33

Agilent 10884A Power Supply 9-34

Agilent 10881A/B/C Laser Head Cable 9-34

Agilent 10884A and Agilent 10881A/B/C Installation and
 Use 9-35

Agilent 10884A Power Supply Specifications and
 Characteristics 9-36

10 Maintenance

General 10-2

Procedures for Cleaning Optics 10-2

Agilent Receivers 10-3

Measurement optics and beam-directing optics 10-3

Lens tissue 10-4

	Alcohol	10-7
	Maintenance Procedures	10-7
	Before and After Service Product Safety Check	10-7
11	Troubleshooting	
	Introduction	11-2
	Troubleshooting Assumptions	11-3
	Electrostatic Discharge (ESD)	11-4
	Required Test Equipment	11-4
	Troubleshooting Information	11-5
	Laser Head troubleshooting	11-6
	Agilent 5517A/B/C/D Laser Head	11-6
	Agilent 5519A/B Laser Head	11-8
	Receiver troubleshooting	11-8
	Agilent 10780C, 10780F, E1708A, E1709A Receiver	11-8
	Agilent 5519A/B Laser Head internal receiver	11-12
	Optical device troubleshooting	11-12
	Agilent 10717A Wavelength Tracker troubleshooting	11-12
	Before and After Service Product Safety Check	11-15
12	Unpacking and Incoming Inspection	
	Introduction	12-2
	Unpacking and Incoming Inspection	12-2
	Warranty Claims	12-2
13	Packaging for Storage or Shipment	
	Laser Tube	13-2
	Tagging for Service	13-2
	Original Packaging	13-2
	Other Packaging	13-2
14	Principles of Operation	
	Introduction	14-2
	Measurement Technique	14-3
	Introduction	14-3
	Creating the two-frequency laser beam	14-4
	Using the two-frequency laser beam at the interferometer	14-4
	Doppler frequency shifting	14-5

Basic Measurement System 14-5

Basic Agilent Laser Measurement System Components 14-6

- Laser head 14-7
- System optics 14-7
- Receiver 14-8
- Environment sensors 14-8

15 Accuracy and Repeatability

Introduction 15-2

The Components of System Accuracy and Repeatability 15-2

- Laser wavelength 15-4
- Electronics error 15-4
- Optics nonlinearity 15-7
- Atmospheric compensation 15-8
- Material thermal expansion 15-11
- Optics thermal drift 15-12
- Deadpath error 15-16
- Abbé error 15-22
- Cosine error 15-24

Determining System Accuracy and Repeatability 15-25

Examples — Determining System Accuracy and Repeatability 15-26

- Precision Coordinate Measuring Machine (CMM) example 15-27
 - Laser wavelength error 15-29
 - Atmospheric compensation 15-29
 - Material thermal expansion 15-30
 - Deadpath error 15-31
 - Electronics error 15-31
 - Optics nonlinearity 15-31
 - Optics thermal drift 15-31
 - Abbé error 15-31
 - Cosine error 15-32
 - CMM system accuracy calculation 15-32
 - CMM system repeatability calculation 15-34
- IC Wafer Stepper example 15-35
 - Laser wavelength error 15-37
 - Atmospheric compensation 15-37
 - Material thermal expansion 15-38
 - Deadpath error 15-38
 - Electronics error 15-38

Optics nonlinearity	15-38
Optics thermal drift	15-38
Abbé error	15-39
Cosine error	15-39
IC Stepper System accuracy calculation	15-39
IC Stepper system repeatability calculations	15-42
Achieving Optimum System Accuracy and Repeatability	15-44
Minimizing environmental effects	15-44
Laser compensation capability	15-46
Manual compensation	15-47
Automatic compensation	15-47
Sensor placement	15-48
Agilent 10717A Wavelength Tracker	15-48
Agilent 10751C/D Air Sensor	15-48
Agilent 10757D/E/F Material Temperature Sensor	15-49
WOL compensation method comparison	15-49
Non-Uniform Environments	15-50
Changing temperature conditions	15-50
Air turbulence	15-50
Reducing air turbulence	15-51
Avoiding thermal gradients	15-51
Optics installation effects	15-51
Minimizing deadpath errors	15-52
Compensation for deadpath errors	15-54
Minimizing Abbé error	15-56
References	15-58

16 Wavelength-of-Light Compensation

Introduction	16-2
“Absolute” Pressure Versus “Barometric” Pressure	16-2
Calculation of Exact Wavelength-of-Light (WOL) Compensation Factor	16-3
Wavelength-of-Light (WOL) Compensation Tables	16-5

17 Material Expansion Coefficients

Linear Thermal Expansion Coefficients of Metals and Alloys 17-2

18 Glossary

18-2

Index

Contents

List of Figures

- Figure 2-1. Typical single-axis Agilent Laser Interferometer Positioning System 2-3
- Figure 3-1. Possible component motions 3-3
- Figure 3-2. Protective covers for optics and laser beam 3-12
- Figure 3-3. Collapsible spiral cover for movable retroreflector 3-13
- Figure 3-4. Laser position transducer mounting 3-16
- Figure 3-5. Direction sense - fringe counts increase as optics move apart 18
- Figure 3-6. Introducing an offset into the laser beam 3-24
- Figure 3-7. Single-axis system for servo-track writing 3-30
- Figure 3-8. Multiaxis system for a precision x-y stage 3-31
- Figure 3-9. Four-axis configuration 3-33
- Figure 3-10. Two-axis plane mirror interferometer configuration 3-34
- Figure 3-11. X-Y stage installed in a vacuum chamber 3-34
- Figure 3-12. Two-axis system using two Agilent 10715A differential interferometers 3-36
- Figure 3-13. Yaw measurement of x-y stage using discrete plane mirror interferometers 3-36
- Figure 3-14. Optical Method for Yaw Measurement 3-38
- Figure 3-15. Optical Method for Yaw Measurement 3-38
- Figure 3-16. Agilent 5517C-009 Mounting Location - Dimensions 3-41
- Figure 4-1. Agilent 10710B and Agilent 10711A adjustable mounts 4-6
- Figure 4-2. Horizontal plane mounting using the Agilent 10710B adjustable mount 4-7
- Figure 4-3. Vertical plane mounting using the Agilent 10710B adjustable mount 4-8
- Figure 4-4. Horizontal plane mounting using the Agilent 10711A adjustable mount 4-9
- Figure 4-5. Vertical Plane Mounting Using the Agilent 10711A Adjustable Mount 4-9
- Figure 4-6. Optimum alignment 4-10
- Figure 4-7. Effect of optics misalignment 4-11
- Figure 4-8. Effects of angular misalignment to the direction of travel 4-12
- Figure 4-9. Using reference surfaces to align mirror 4-15
- Figure 4-10. Measurement beam dot movement 4-17
- Figure 4-11. Results of reflector movement 4-18

- Figure 4-12. Linear and single-beam interferometer alignment aids 4-19
- Figure 4-13. Autoreflexion alignment 4-20
- Figure 4-14. Overlapping dot alignment 4-25
- Figure 5-1. Laser position Transducer mounting 5-8
- Figure 5-2. Agilent 5517A Laser Head 5-11
- Figure 5-3. Agilent 5517A Laser Head dimensions 5-13
- Figure 5-4. Agilent 5517B Laser Head 5-15
- Figure 5-5. Agilent 5517B Laser Head dimensions 5-17
- Figure 5-6. Agilent 5517C Laser Head 5-20
- Figure 5-7A. Agilent 5517C Laser Head, (Standard and 5517C-003) dimensions 5-21
- Figure 5-7B. Agilent 5517C-009 Laser Head dimensions 5-22
- Figure 5-8. Agilent 5517D Laser Head 5-25
- Figure 5-9. Agilent 5517D Laser Head dimensions 5-26
- Figure 5-10. Agilent 5519A/B Laser Head 5-27
- Figure 5-11. Agilent 5519A/B Laser Head Block Diagram 5-31
- Figure 5-12. Agilent 5519A/B Laser Head dimensions 5-33
- Figure 6-1. Agilent 10567A Dual Beam Beam-Splitter 6-5
- Figure 6-2. Agilent 10567A Dual Beam Beam-Splitter — laser beam path 6-5
- Figure 6-3. Agilent 10567A Dual Beam Beam-Splitter — dimensions 6-6
- Figure 6-4. Agilent 10700A 33% Beam Splitter and Agilent 10701A 50% Beam Splitter 6-7
- Figure 6-5. Agilent 10700A 33% Beam Splitter — dimensions 6-8
- Figure 6-6. Agilent 10701A 50% Beam Splitter — dimensions 6-9
- Figure 6-7. Agilent 10707A Beam Bender 6-10
- Figure 6-8. Agilent 10707A Beam Bender — dimensions 6-11
- Figure 6-9. Agilent 10725A 9mm Laser Beam Splitter — dimensions 6-13
- Figure 6-10. Agilent 10726A 9mm Laser Beam Bender — dimensions 6-13
- Figure 6-11. Agilent precision beam manipulators 6-15
- Figure 6-12. Agilent N1203C/N1204C/N1207C beam manipulator dimensions 6-23
- Figure 7-1. Effect of beam-directing optics on laser beam polarization orientations 7-8
- Figure 7A-1. Agilent 10702A Linear Interferometer
Agilent 10702A-001 Linear Interferometer with Windows 7A-3
- Figure 7A-2. Agilent 10702A-001 Linear Interferometer with Windows 7A-5

- Figure 7A-3. Three-axis machine tool Installation 7A-6
- Figure 7A-4. Agilent 10766A Linear Interferometer and Agilent 10767A Linear Retroreflector 7A-7
- Figure 7A-5. Agilent 10722A Plane Mirror Converter 7A-7
- Figure 7A-6. Linear interferometer laser beam path 7A-8
- Figure 7A-7. Differential measurements with the Agilent 10702A 7A-9
- Figure 7A-8. Agilent 10702A Linear Interferometer — dimensions 7A-14
- Figure 7A-9. Agilent 10702A-001 Linear Interferometer with Windows — dimensions 7A-15
- Figure 7A-10. Agilent 10703A Retroreflector — dimensions 7A-16
- Figure 7A-11. Agilent 10713B 1-Inch Cube Corner, no housing — dimensions 7A-16
- Figure 7A-12. Agilent 10766A Linear Interferometer — dimensions 7A-17
- Figure 7A-13. Agilent 10767A Linear Retroreflector — dimensions 7A-18
- Figure 7B-1. Agilent 10705A Single Beam Interferometer and Agilent 10704A Retroreflector 7B-2
- Figure 7B-2. Single Beam Interferometer — laser beam path 7B-3
- Figure 7B-3. Agilent 10705A Single Beam Interferometer — dimensions 7B-8
- Figure 7B-4. Agilent 10704A Retroreflector — dimensions 7B-9
- Figure 7B-5. Agilent 10713C 1/2-Inch Cube Corner, no housing — dimensions 7B-9
- Figure 7B-6. Agilent 10713D 1/4-Inch Cube Corner, no housing — dimensions 7B-10
- Figure 7C-1. Agilent 10706A Plane Mirror Interferometer 7C-3
- Figure 7C-2. X-Y Stage measurement with Agilent 10706A Plane Mirror Interferometer 7C-3
- Figure 7C-3. Plane mirror interferometer laser beam path 7C-5
- Figure 7C-4. Differential measurements with the Agilent 10706A 7C-7
- Figure 7C-5. Differential measurements with the Agilent 10706A 7C-7
- Figure 7C-6. Agilent 10706A Plane Mirror Interferometer— alignment 7C-8
- Figure 7C-7. Agilent 10706A Interferometer — alignment aids 7C-11
- Figure 7C-8. Receiver and receiver alignment target 7C-12
- Figure 7C-9. Agilent 10706A Plane Mirror Interferometer — dimensions 7C-17

- Figure 7C-10. Agilent 10722A Plane Mirror Converter — dimensions 7C-18
- Figure 7C-11. Agilent 10723A High Stability Adapter — dimensions 7C-18
- Figure 7C-12. Agilent 10724A Plane Mirror Reflector — dimensions 7C-19
- Figure 7C-13. Agilent 10723A High Stability Adapter 7C-21
- Figure 7C-14. Agilent 10706A Conversion Using the Agilent 10723A 7C-21
- Figure 7D-1. Agilent 10706B High Stability Plane Mirror Interferometer 7D-3
- Figure 7D-2. Agilent 10706B High Stability Plane Mirror Interferometer, optical schematic 7D-4
- Figure 7D-3. Agilent 10706B Interferometer — configurations 7D-7
- Figure 7D-4. Agilent 10706B Interferometer — alignment aids 7D-8
- Figure 7D-5. Using the Agilent 10706-60202 Alignment Aid 7D-9
- Figure 7D-6. Agilent 10706B High Stability Plane Mirror Interferometer in an X-Y Stage Application 7D-13
- Figure 7D-7. Agilent 10706B Plane Mirror Interferometer — dimensions 7D-20
- Figure 7G-1. Agilent 10715A Differential Interferometer 7G-3
- Figure 7G-2. Agilent 10715A Differential Interferometer — laser beam path 7G-4
- Figure 7G-3. Agilent 10715A Standard Configuration 7G-6
- Figure 7G-4. Agilent 10715A-001 Turned Configuration 7G-6
- Figure 7G-5. Beam locations for standard Agilent 10715A Differential Interferometer 7G-8
- Figure 7G-6. Beam locations for Agilent 10715A-001 Turned Configuration 7G-9
- Figure 7G-7. Agilent 10715A Interferometer (reference mirror) 7G-10
- Figure 7G-8. Agilent 10715A with gage block in position 7G-11
- Figure 7G-9. Differential interferometer as viewed from plane mirrors 7G-12
- Figure 7G-10. Agilent 10715A with alignment aid attached over measurement beam 7G-13
- Figure 7G-11. Differential interferometer as viewed from plane mirrors with measurement beams aligned 7G-13
- Figure 7G-12. Alignment aid attached over reference beam 7G-14
- Figure 7G-13. Differential interferometer as viewed from plane mirrors with proper alignment 7G-15
- Figure 7H-1. Agilent 10716A High Resolution Interferometer 7H-3

- Figure 7H-2. Agilent 10716A High Resolution Interferometer, optical schematic 7H-4
- Figure 7H-3. Beam Locations for standard Agilent 10716A Interferometer 7H-6
- Figure 7H-4. Beam Locations for Agilent 10716A-001 Turned Configuration 7H-7
- Figure 7H-5. Alignment Aids for the Agilent 10716A Interferometer 7H-8
- Figure 7H-6. Agilent 10716A with gage block attached 7H-10
- Figure 7H-7. Agilent 10716A with alignment aid attached over measurement beam 7H-10
- Figure 7H-8. Using the Agilent 10706-60202 Alignment Aid 7H-12
- Figure 7H-9. Agilent 10716A High Resolution Interferometer (and Agilent 10716A-001 Turned Configuration) 7H-14
- Figure 7I-1. Agilent 10717A Wavelength Tracker 7I-2
- Figure 7I-2. Agilent 10717A Wavelength Tracker laser beam path 7I-3
- Figure 7I-3. Two-axis differential interferometer with wavelength tracker 7I-5
- Figure 7I-4. Wavelength tracker mounting hardware 7I-9
- Figure 7I-5. Agilent 10717A Wavelength Tracker adjustment hardware 7I-10
- Figure 7I-6. Installation of alignment aid 7I-12
- Figure 7I-7. Agilent 10717A Wavelength Tracker — dimensions 7I-15
- Figure 7J-1. Agilent 10719A One-axis Differential Interferometer 7J-3
- Figure 7J-2. Agilent 10719A Interferometer - Measurements 7J-4
- Figure 7J-3. Three axes with Agilent 10719A and Agilent 10721A interferometers 7J-6
- Figure 7J-4. Five-axis system with Agilent 10719A and Agilent 10721A interferometers 7J-8
- Figure 7J-5. Agilent 10719A One-Axis Differential Interferometer — optical schematic 7J-9
- Figure 7J-6. Agilent 10719A Interferometer - Reference and Measurement beams 7J-11
- Figure 7J-7. Agilent 10719 One-Axis Differential Interferometer — dimensions 7J-23
- Figure 7K-1. Agilent 10721A Two-Axis Differential Interferometer 7K-3
- Figure 7K-2. Agilent 10721A Two-Axis Differential Interferometer — measurements 7K-4
- Figure 7K-3. Agilent 10721A Two-Axis Differential Interferometer — laser beam path 7K-6

- Figure 7K-4. Agilent 10721A Two-Axis Differential Interferometer Reference and Measurement beams 7K-8
- Figure 7K-5. Agilent 10721A Two-Axis Differential Interferometer — dimensions 7K-20
- Figure 7N-1. Agilent 10735A Three-Axis Interferometer 7N-3
- Figure 7N-2. Agilent 10736A Three-Axis Interferometer 7N-4
- Figure 7N-3. Agilent 10736A-001 Three-Axis Interferometer 7N-5
- Figure 7N-4. Measuring Using Agilent 10735A and Agilent 10736A-001 Interferometers 7N-6
- Figure 7N-5A. Agilent Three-Axis interferometers — beam paths 7N-7
- Figure 7N-5B. Agilent Three-Axis Interferometers — beam paths (continued) 7N-8
- Figure 7N-6. Three-Axis interferometers — beam patterns 7N-11
- Figure 7N-7. Three-Axis interferometer — mounting 7N-12
- Figure 7N-8. Agilent 10735A Three-Axis Interferometer — dimensions 7N-23
- Figure 7N-9. Agilent 10736A Three-Axis Interferometer — dimensions 7N-25
- Figure 7N-10. Agilent 10736A Three-Axis Interferometer with Beam Bender — dimensions 7N-26
- Figure 7O-1. Agilent 10737L Compact Three-axis Interferometer 7O-3
- Figure 7O-2. Agilent 10737L Compact Three-Axis Interferometer 7O-4
- Figure 7O-3. Agilent 10737R Compact Three-Axis Interferometer 7O-5
- Figure 7O-4. Measurement using two Agilent 10737R interferometers 7O-7
- Figure 7O-5. Agilent 10737L/R Compact Three-Axis interferometers — beam paths 7O-8
- Figure 7O-6A. Agilent 10737L Interferometer — beam patterns 7O-10
- Figure 7O-6B. Agilent 10737R Interferometer—beam patterns 7O-11
- Figure 7O-7. Agilent 10737L/R interferometers—alignment aids 7O-15
- Figure 7O-8. Agilent 10737L Compact Three-Axis Interferometer with Agilent 10706-60001 Alignment Aid 7O-18
- Figure 7O-9. Agilent 10737L Compact Three-Axis Interferometer — return beam pattern 7O-20
- Figure 7O-10. Agilent 10737L Compact Three-Axis Interferometer with 10706-60202 Alignment Aid 7O-21
- Figure 7O-11. Agilent 10737L/R Compact Three-Axis Interferometer — dimensions 7O-26

- Figure 7V-1. Agilent 10770A Angular Interferometer and Agilent 10771A Angular Reflector 7V-2
- Figure 7V-2. Angular optics — laser beam paths 7V-3
- Figure 7V-3. Measurement beam dots movement 7V-7
- Figure 7V-4. Agilent 10770A Angular Interferometer 7V-9
- Figure 7V-5. Agilent 10771A Angular Reflector 7V-10
- Figure 7Y-1. Straightness optics 7Y-2
- Figure 7Y-2. Straightness optics — beam paths 7Y-5
- Figure 7Y-3. Alignment Targets for use with straightness interferometers 7Y-6
- Figure 7Y-4. Single axis system 7Y-7
- Figure 7Y-5. One linear and one straightness axis 7Y-8
- Figure 7Y-6. One linear and one straightness axis 7Y-9
- Figure 7Y-7. Reflected semicircular beams 7Y-11
- Figure 7Y-8. Agilent 10774A or Agilent 10775A Interferometer scribe line 7Y-13
- Figure 7Y-9. Initial Positioning of Reflector 7Y-14
- Figure 7Y-10. Slope Error 7Y-15
- Figure 7Y-11. Manual Slope Reduction 7Y-16
- Figure 7Y-12. Agilent 10774A Short Range Straightness optics and Agilent 10775A Long Range Straightness optics 7Y-19
- Figure 8-1. Agilent 10780C Receiver and Agilent 10780F Remote Receiver 8-6
- Figure 8-2. Agilent 10780C and Agilent 10780F Receiver beam clearances and alignment targets 8-11
- Figure 8-3. Effect of optics misalignment 8-13
- Figure 8-4. Effects of Angular Misalignment to the Direction of Travel 8-14
- Figure 8-5. Agilent 10780C Receiver — dimensions 8-17
- Figure 8-6. Agilent 10780F Remote Receiver — dimensions 8-18
- Figure 8-7. Agilent E1708A Remote Dynamic Receiver 8-20
- Figure 8-8. Agilent E1708A Receiver—block diagram 8-21
- Figure 8-9. Grip and fiber-optic cable connector 8-23
- Figure 8-10. Agilent E1708A receiver — dimensions 8-27
- Figure 8-11. Agilent E1709A Remote High-Performance Receiver 8-28
- Figure 8-12. AC/DC light power relationship 8-29
- Figure 8-13. Agilent E1709A Receiver block diagram 8-31
- Figure 8-14. Agilent E1709A with fiber and lens assembly 8-32
- Figure 8-15. Agilent E1709A receiver — dimensions 8-37
- Figure 9-1. Agilent 10710B and Agilent 10711A adjustable mounts 9-3

- Figure 9-2. Agilent 10785A Height Adjuster and Post and Agilent 10784A Base 9-4
- Figure 9-3. Agilent 10710B Adjustable Mount — dimensions 9-5
- Figure 9-4. Agilent 10711A Adjustable Mount — dimensions 9-6
- Figure 9-5. Agilent 10785A Height Adjuster and Post and Agilent 10784A Base — dimensions 9-7
- Figure 9-6. Agilent 10790A/B/C Cable 9-11
- Figure 9-7. Agilent 10880A/B/C Cable 9-12
- Figure 9-8A. Agilent 10881A/B/C Laser Head Cable 9-13
- Figure 9-8B. Agilent 10881D/E/F Laser Head Cable 9-14
- Figure 9-9. Agilent 10882A/B/C Laser Head Cable 9-15
- Figure 9-10. Agilent N1250A/B High Performance Receiver Cable 9-16
- Figure 9-11. Agilent N1251A/B High Performance Laser Head Cable 9-17
- Figure 9-12. Alignment targets and aids 9-18
- Figure 9-13. Agilent 10724A Plane Mirror Reflector 9-22
- Figure 9-14. Agilent 10724A Plane Mirror Reflector — mounting requirements and installation 9-23
- Figure 9-15. Agilent 10724A Plane Mirror — dimensions 9-24
- Figure 9-16. Agilent 10728A Plane Mirror — specifications 9-25
- Figure 9-17. Agilent 10772A Turning Mirror 9-26
- Figure 9-18. Agilent 10772A Turning Mirror — dimensions 9-27
- Figure 9-19. Agilent 10773A Flatness Mirror 9-28
- Figure 9-20. Agilent 10773A Flatness Mirror — dimensions 9-28
- Figure 9-21. Agilent 10776A Straightness Accessory Kit 9-29
- Figure 9-22. Agilent 10776-67001 Straightness Retroreflector — dimensions 9-30
- Figure 9-23. Agilent 10777A Optical Square 9-31
- Figure 9-24. Agilent 10777A Optical Square — dimensions 9-32
- Figure 9-25. Agilent N1206T Adjustment Tool Kit 9-33
- Figure 9-26. Agilent 10884A and Agilent 10881A,B,C installation and use 9-35
- Figure 9-27. Agilent 10884A Power Supply — dimensions 9-36
- Figure 11-1. Agilent 5517A/B/C/D Laser Head—troubleshooting tree 11-7
- Figure 11-2. Agilent Receiver troubleshooting tree 11-11
- Figure 11-3. Agilent 10717A Wavelength Tracker troubleshooting tree 11-14
- Figure 14-1. Typical Agilent Laser Position Transducer block diagram 14-6
- Figure 15-1. Worst-case error resulting from imperfect separation of two beam components 15-8

- Figure 15-2. Conventional plane mirror interferometer with unequal path lengths that result in optics thermal drift 15-12
- Figure 15-3. Agilent 10706B High Stability Plane Mirror Interferometer Beam Paths 15-14
- Figure 15-4. Comparison of optics thermal drift between Interferometers 15-15
- Figure 15-5. Deadpath caused by unequal lengths from initial point 15-17
- Figure 15-6. Optical configuration with and without deadpath 15-20
- Figure 15-7. Abbé error 15-23
- Figure 15-8. Cosine error 15-24
- Figure 15-9. Laser system configuration for a precision Coordinate Measuring Machine (CMM) 15-28
- Figure 15-10. Worst-case System Accuracy with and without Atmospheric Compensation for the CMM example 15-33
- Figure 15-11. Worst-case System Accuracy with Atmospheric Compensation for the CMM example 15-33
- Figure 15-12. Worst-case System Repeatability with and without Atmospheric Compensation for the CMM example 15-34
- Figure 15-13. Worst-case System Repeatability with Atmospheric Compensation for the CMM example 15-35
- Figure 15-14. Laser System Configuration for an Integrated Circuit Wafer Stepper 15-36
- Figure 15-15. Worst-case System Accuracy with and without Atmospheric Compensation for the Wafer Stepper example 15-40
- Figure 15-16. Worst-case System Accuracy with Atmospheric Compensation for the Wafer Stepper example 15-41
- Figure 15-17. Worst-case System Long-term Repeatability with and without Atmospheric Compensation for the Wafer Stepper example 15-42
- Figure 15-18. Worst-case System Long-term Repeatability with Atmospheric Compensation for the Wafer Stepper example 15-43
- Figure 15-19. Relative effect of errors in atmospheric and material temperature 15-45
- Figure 15-20. Air sensor orientation 15-48
- Figure 15-21. Equal path length correction 15-53
- Figure 15-22. Positioning of measurement axis to minimize Abbé error 15-57
- Figure 15-23. X-Y Stage measurement with Agilent 10706A Plane Mirror Interferometer 15-58

List of Figures

Figure 18-1. Degrees of freedom (for X-Axis) 18-3

List of Tables

Table 1-1.	Laser Head and Receiver Manuals	1-6
Table 3-1.	Equipment choices	3-5
Table 5-1.	Laser Heads Summary	5-2
Table 5-2.	Comparison of Agilent 5517A/B/C/D Laser Heads (Summary)	5-9
Table 6-1.	Beam-direction optics	6-3
Table 7-1.	Measurement Optics Summary	7-3
Table 7-2.	Interferometer Resolutions	7-6
Table 7G-1.	Agilent 10715A direction sense	7G-7
Table 7I-1.	Agilent 10717A direction sense	7I-6
Table 7O-1.	Tools and Equipment Required or Recommended	7O-14
Table 8-1.	Comparison of Agilent Laser Receiver families	8-3
Table 8-2.	Cables for use with an E1708A receiver	8-22
Table 8-3.	Fiber optic cable considerations	8-23
Table 9-1.	Adjustable mounting hardware	9-2
Table 9-2.	Summary of available laser system cables	9-8
Table 9-3.	Cables	9-9
Table 9-4.	Alignment targets and aids	9-19
Table 9-5.	Optics	9-21
Table 10-1.	Optics Shipped with or without lens tissue	10-6
Table 11-1.	Chapter content summary	11-2
Table 11-2.	Recommended test equipment	11-5
Table 11-3.	Agilent 10780C or Agilent 10780F Receiver signal chart	11-9
Table 15-1.	Error components for accuracy and long- and short-term repeatability error budgets	15-3
Table 15-2.	System measurement resolution for each interferometer	15-6
Table 15-3.	Deadpath mirror positions and values for Agilent interferometers	15-18
Table 15-4.	Laser interferometer system accuracy and repeatability error	15-25
Table 15-5.	Parameters needed to calculate each error component	15-27
Table 15-6.	System accuracy with and without atmospheric compensation	15-32
Table 15-7.	IC Stepper System Accuracy with and without Atmospheric Compensation	15-39
Table 15-8.	Laser system measurement accuracy comparison	15-49

- Table 16-1. Metric—Wide-Range
(Temp = 2 to 50° C, Press = 525 to 800 mm, 50% Humidity)
16-6
- Table 16-2. Metric—Low Alt, Low Temp, Low Humidity
(Temp = 5 to 13° C, Press = 720 to 800 mm, 20% Humidity)
16-7
- Table 16-3. Metric—Low Alt, Low-Mid Temp, Low Humidity
(Temp = 13.5 to 21.5° C, Press = 720 to 800 mm, 20% Humidity) 16-8
- Table 16-4. Metric—Low Alt, Mid Temp, Low Humidity
(Temp = 22 to 30° C, Press = 720 to 800 mm, 20% Humidity) 16-9
- Table 16-5. Metric—Low Alt, High-Mid Temp, Low Humidity
(Temp = 30.5 to 38.5° C, Press = 720 to 800 mm, 20% Humidity) 16-10
- Table 16-6. Metric—High Alt, Low Temp, Low Humidity
(Temp = 5 to 13° C, Press = 640 to 720 mm, 20% Humidity)
16-11
- Table 16-7. Metric—High Alt, Low-Mid Temp, Low Humidity
(Temp = 13.5 to 21.5° C, Press = 640 to 720 mm, 20% Humidity) 16-12
- Table 16-8. Metric—High Alt, Mid Temp, Low Humidity
(Temp = 22 to 30° C, Press = 640 to 720 mm, 20% Humidity) 16-13
- Table 16-9. Metric—High Alt, High-Mid Temp, Low Humidity
(Temp = 30.5 to 38.5° C, Press = 640 to 720 mm, 20% Humidity) 16-14
- Table 16-10. Metric—Low Alt, Low Temp, Med Humidity
(Temp = 5 to 13° C, Press = 720 to 800 mm, 50% Humidity)
15
- Table 16-11. Metric—Low Alt, Low-Mid Temp, Med Humidity
(Temp = 13.5 to 21.5° C, Press = 720 to 800 mm, 50% Humidity) 16-16
- Table 16-12. Metric—Low Alt, Mid Temp, Med Humidity
(Temp = 22 to 30° C, Press = 720 to 800 mm, 50% Humidity) 16-17
- Table 16-13. Metric—Low Alt, High-Mid Temp, Med Humidity
(Temp = 30.5 to 38.5° C, Press = 720 to 800 mm, 50% Humidity) 16-18
- Table 16-14. Metric—High Alt, Low Temp, Med Humidity
(Temp = 5 to 13° C, Press = 640 to 720 mm, 50% Humidity)
16-19
- Table 16-15. Metric—High Alt, Low-Mid Temp, Med Humidity
(Temp = 13.5 to 21.5° C, Press = 640 to 720 mm, 50% Humidity) 16-20

- Table 16-16.Metric—High Alt, Mid Temp, Med Humidity
(Temp = 22 to 30° C, Press = 640 to 720 mm, 50% Humidity) 16-21
- Table 16-17.Metric—High Alt, High-Mid Temp, Med Humidity
(Temp = 30.5 to 38.5° C, Press = 640 to 720 mm, 50% Humidity) 16-22
- Table 16-18.Metric—Low Alt, Low Temp, High Humidity
(Temp = 5 to 13° C, Press = 720 to 800 mm, 80% Humidity) 16-23
- Table 16-19.Metric—Low Alt, Low-Mid Temp, High Humidity
(Temp = 13.5 to 21.5° C, Press = 720 to 800 mm, 80% Humidity) 16-24
- Table 16-20.Metric—Low Alt, Mid Temp, High Humidity
(Temp = 22 to 30° C, Press = 720 to 800 mm, 80% Humidity) 16-25
- Table 16-21.Metric—Low Alt, High-Mid Temp, High Humidity
(Temp = 30.5 to 38.5° C, Press = 720 to 800 mm, 80% Humidity) 16-26
- Table 16-22.Metric—High Alt, Low Temp, High Humidity
(Temp = 5 to 13° C, Press = 640 to 720 mm, 80% Humidity) 16-27
- Table 16-23.Metric—High Alt, Low-Mid Temp, High Humidity
(Temp = 13.5 to 21.5° C, Press = 640 to 720 mm, 80% Humidity) 16-28
- Table 16-24.Metric—High Alt, Mid Temp, High Humidity
(Temp = 22 to 30° C, Press = 640 to 720 mm, 80% Humidity) 16-29
- Table 16-25.Metric—High Alt, High-Mid Temp, High Humidity
(Temp = 30.5 to 38.5° C, Press = 640 to 720 mm, 80% Humidity) 16-30
- Table 16-26.English—Wide Range
(Temp = 40 to 120° F, Press = 20 to 31 inches, 50% Humidity) 16-31
- Table 16-27.English—Low Alt, Low Temp, Low Humidity
(Temp = 40 to 56° F, Press = 27 to 31 inches, 20% Humidity) 16-32
- Table 16-28.English—Low Alt, Low-Mid Temp, Low Humidity
(Temp = 57 to 73° F, Press = 27 to 31 inches, 20% Humidity) 16-33
- Table 16-29.English—Low Alt, Mid Temp, Low Humidity
(Temp = 74 to 90° F, Press = 27 to 31 inches, 20% Humidity) 16-34
- Table 16-30.English—Low Alt, High-Mid Temp, Low Humidity
(Temp = 91 to 107° F, Press = 27 to 31 inches, 20% Humidity) 16-35

- Table 16-31. English—High Alt, Low Temp, Low Humidity
(Temp = 40 to 56° F, Press = 23 to 27 inches, 20% Humidity) 16-36
- Table 16-32. English—High Alt, Low-Mid Temp, Low Humidity
(Temp = 57 to 73° F, Press = 23 to 27 inches, 20% Humidity) 16-37
- Table 16-33. English—High Alt, Mid Temp, Low Humidity
(Temp = 74 to 90° F, Press = 23 to 27 inches, 20% Humidity) 16-38
- Table 16-34. English—High Alt, High-Mid Temp, Low Humidity
(Temp = 91 to 107° F, Press = 23 to 27 inches, 20% Humidity) 16-39
- Table 16-35. English—Low Alt, Low Temp, Med Humidity
(Temp = 40 to 56° F, Press = 27 to 31 inches, 50% Humidity) 16-40
- Table 16-36. English—Low Alt, Low-Mid Temp, Med Humidity
(Temp = 57 to 73° F, Press = 27 to 31 inches, 50% Humidity) 16-41
- Table 16-37. English—Low Alt, Mid Temp, Med Humidity
(Temp = 74 to 90° F, Press = 27 to 31 inches, 50% Humidity) 16-42
- Table 16-38. English—Low Alt, High-Mid Temp, Med Humidity
(Temp = 91 to 107° F, Press = 27 to 31 inches, 50% Humidity) 16-43
- Table 16-39. English—High Alt, Low Temp, Med Humidity
(Temp = 40 to 56° F, Press = 23 to 27 inches, 50% Humidity) 16-44
- Table 16-40. English—High Alt, Low-Mid Temp, Med Humidity
(Temp = 57 to 73° F, Press = 23 to 27 inches, 50% Humidity) 16-45
- Table 16-41. English—High Alt, Mid Temp, Med Humidity
(Temp = 74 to 90° F, Press = 23 to 27 inches, 50% Humidity) 16-46
- Table 16-42. English—High Alt, High-Mid Temp, Med Humidity
(Temp = 91 to 107° F, Press = 23 to 27 inches, 50% Humidity) 16-47
- Table 16-43. English—Low Alt, Low Temp, High Humidity
(Temp = 40 to 56° F, Press = 27 to 31 inches, 80% Humidity) 16-48
- Table 16-44. English—Low Alt, Low-Mid Temp, High Humidity
(Temp = 57 to 73° F, Press = 27 to 31 inches, 80% Humidity) 16-49
- Table 16-45. English—Low Alt, Mid Temp, High Humidity
(Temp = 74 to 90° F, Press = 27 to 31 inches, 80% Humidity) 16-50

List of Tables

- Table 16-46. English—Low Alt, High-Mid Temp, High Humidity
(Temp = 91 to 107° F, Press = 27 to 31 inches, 80%
Humidity) 16-51
- Table 16-47. English—High Alt, Low Temp, High Humidity
(Temp = 40 to 56° F, Press = 23 to 27 inches, 80%
Humidity) 16-52
- Table 16-48. English—High Alt, Low-Mid Temp, High Humidity
(Temp = 57 to 73° F, Press = 23 to 27 inches, 80%
Humidity) 16-53
- Table 16-49. English—High Alt, Mid Temp, High Humidity
(Temp = 74 to 90° F, Press = 23 to 27 inches, 80%
Humidity) 16-54
- Table 16-50. English—High Alt, High-Mid Temp, High Humidity
(Temp = 91 to 107° F, Press = 23 to 27 inches, 80%
Humidity) 16-55
- Table 17-1. Linear thermal expansion coefficients of metals and
alloys 17-2
- Table 18-1. Number systems 18-5

List of Tables

Product specifications and descriptions in this document subject to change without notice.
Copyright (C) 2002 Agilent Technologies
Printed in U.S.A. 07/02
This is a chapter from the manual titled:
Laser and Optics User's Manual
For complete manual, order:
Paper version: p/n 05517-90045
CD version: p/n 05517-90063
This chapter is p/n 05517-90100