LASER MEASUREMENT SYSTEM
5526A

OPERATOR'S HANDBOOK SUPPLEMENT
FOR
LINEAR AND ANGULAR/FLATNESS INTERFEROMETER
5526A OPTION 020
AND
ANGULAR/FLATNESS ADD-ON
5526A OPTION 021

5301 STEVENS CREEK BLVD., SANTA CLARA, CALIF. 95050

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HEWLETT hp PACKARD

SAFETY PRECAUTIONS

WARNING

LASER BEAM

This instrument emits laser light. The power output of the HP laser is low in comparison to most other lasers, either continuous wave or pulsed, but due to the high brilliance factor, the output beam of any laser should never be allowed to strike the eye directly. It is the considered opinion of Hewlett-Packard Company that the light beam from this device presents NO hazard to health and safety. However, the existence of newly enacted federal regulations with respect to laser devices together with the lack of any widely accepted standards of laser power safety thresholds requires the insertion of this cautionary statement.

GENERAL INFORMATION

INTRODUCTION

This publication is a supplement to the basic Laser Measurement System 5526A Operator's Handbook. Place this supplement in the Operator's Handbook three-ring binder. This supplement contains information on Option 020 and Option 021 and will present the components of these options separately.

CAUTION

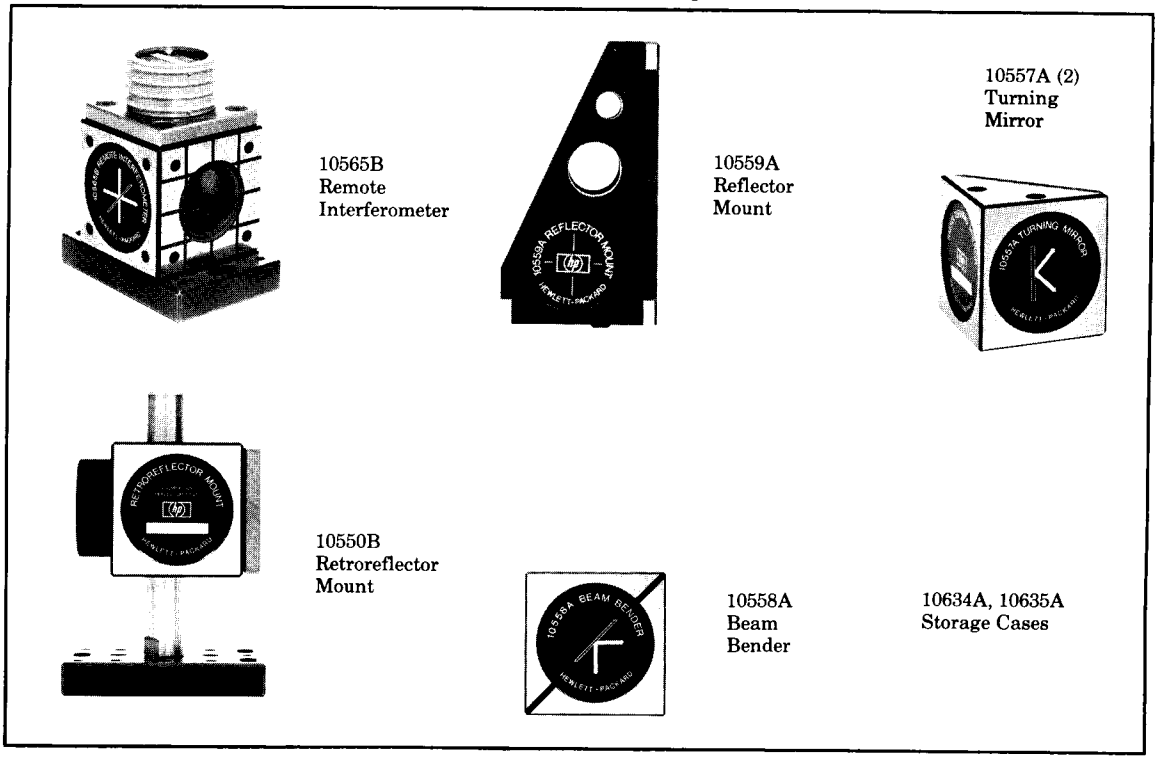
The Remote Interferometer and Beam Bender have precision ground and lapped external surfaces. DO NOT scratch, dent, or, in any way, damage these surfaces. Even small burrs can cause measurement errors. Keep these surfaces as clean as possible.

OPTION 020, LINEAR AND ANGULAR/FLATNESS INTERFEROMETER

Option 020 combines with the 5526A Laser/Display to make linear and angular measurements. Surface plate flatness measurements can also be made; the calibration techniques for this measurement are described in Application Note 156-2, *Calibration of a Surface Plate.* The separate components of Option 020 are shown in Figure 1.

Linear measurements are made with the 10565B Remote Interferometer and the 10550B Retroreflector Mount. Only CHANGES in distance from the 10550B to the 10565B are measured.

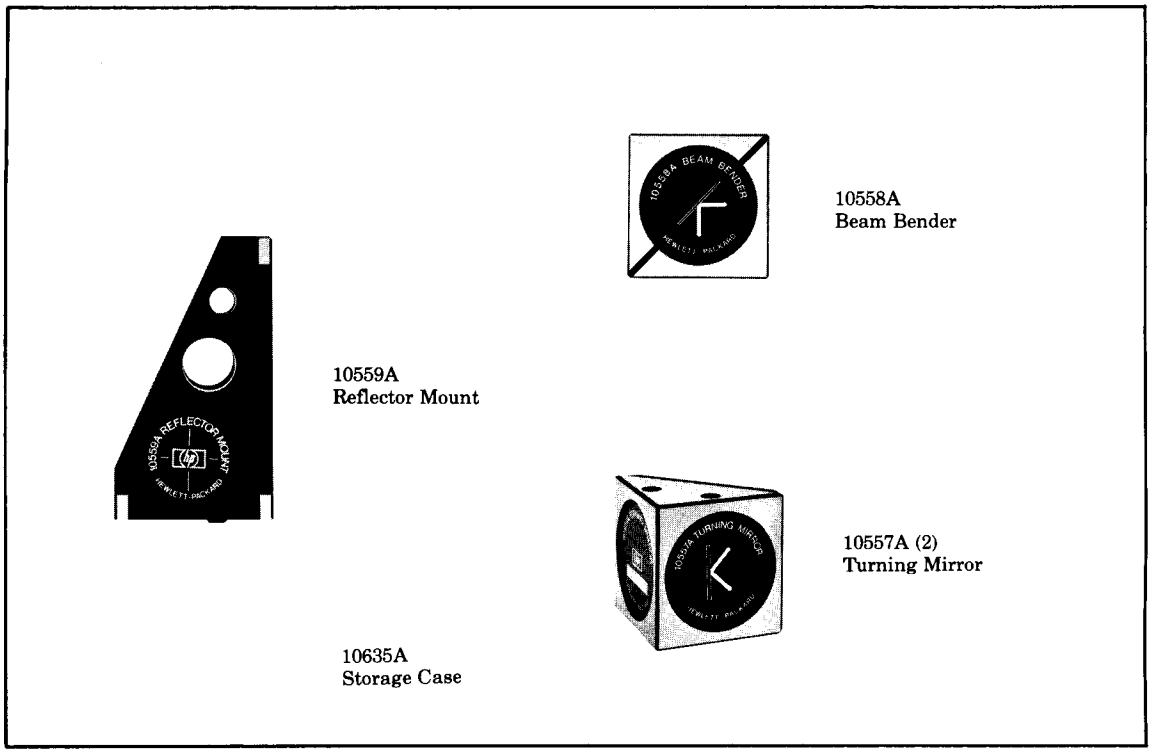
Figure 1. Components of Option 020



OPTION 021, ANGULAR/FLATNESS ADD-ON

This option must be combined with the Linear Interferometer (Option 010) to make angular and flatness measurements. The separate components of Option 021 are shown in Figure 2. Assuming the user has Option 010, all components in this supplement are pertinent to the system.

Figure 2. Components of Option 021



5526A LASER MEASUREMENT SYSTEM AND ITS PUBLICATIONS

The 5526A Laser Measurement System is described in the 5526A Operator's Handbook. A listing of all publications about the Laser Measurement System is available from:

HEWLETT-PACKARD
5301 Stevens Creek Boulevard
Santa Clara, California 95050
United States of America
Attention: Laser Publications

10557A TURNING MIRROR
Serial Prefix: 1216A

DESCRIPTION

The Hewlett-Packard Model 10557A Turning Mirror is a high-quality front-surface mirror for use as an accessory to the Laser Measurement System. The mirror is housed in a ground block of magnetic stainless steel.

PURPOSE

SURFACE PLATE FLATNESS. With two turning mirrors, a granite surface plate may be rapidly calibrated with only one preliminary alignment of the laser head required. Application Note 156-2, *Calibration of a Surface Plate*, explains the setup procedures of the angular measurement system. This publication is available upon request.

ALIGNMENT PROCEDURES

Autoreflection

This method ensures that the laser beam is parallel to the measured surface.

a. Place 10557A Turning Mirror at far end of travel and along the line of measurement.

b. Place 10565-80004 Magnetic Alignment Template on face of turning mirror (see Figure 3).

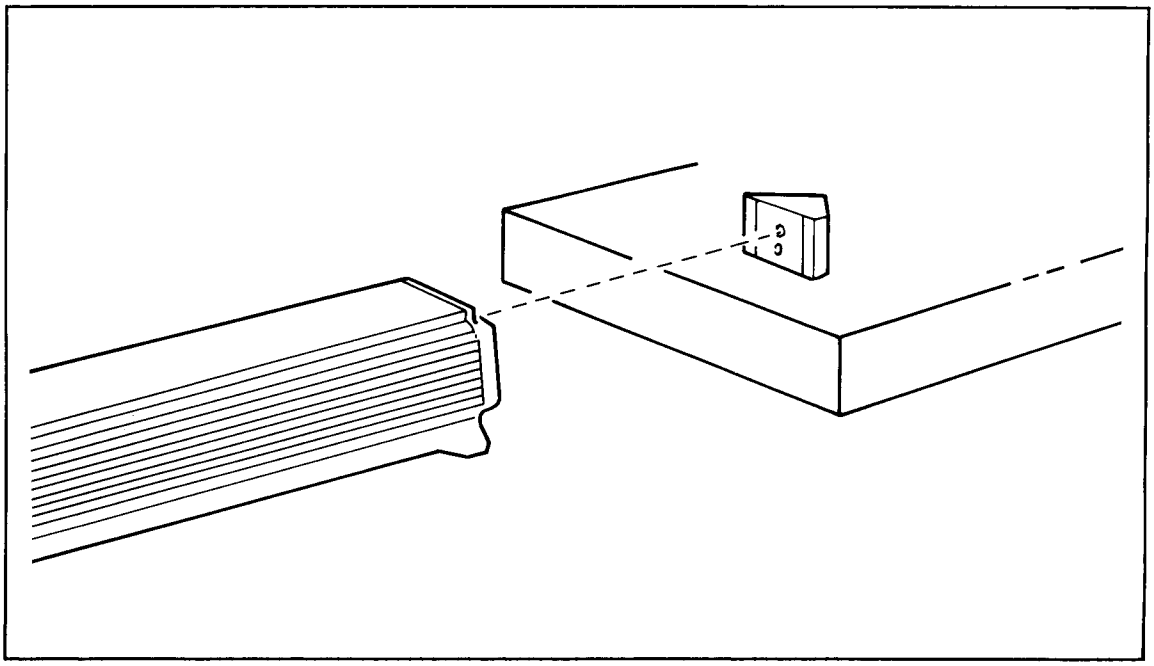
c. Set source hole on laser to the small aperture. This is not necessary for surface plate measurements.

d. Adjust laser so beam strikes template in top opening.

e. Observe reflected beam at small aperture on laser.

f. Adjust laser head until maximum amount of reflected beam is returned into the aperture or until the return beam "halo" is symmetrical around the aperture.

Figure 3. Autoreflection Alignment



10558A BEAM BENDER
Serial Prefix: 1208A

DESCRIPTION

The Model 10558A Beam Bender is a magnetic stainless steel two-inch cube with a first-surface mirror mounted inside. The mirror is visible through two holes and sits at an extremely precise 45° angle to the surfaces of the cube.

PURPOSE

The 10558A bends the laser beam at a 90° angle. The 10558A should be placed on a flat surface while the laser beam is directed at the mirror and parallel to the flat surface. The Beam Bender can be used with the 5526A Laser/Display and other accessories to measure precision surface flatness, pitch and yaw, and small angles. For measurement details, refer to description of 10559A Reflector Mount.

PRECISION MOUNTING OF BEAM BENDER AND REMOTE INTERFEROMETER

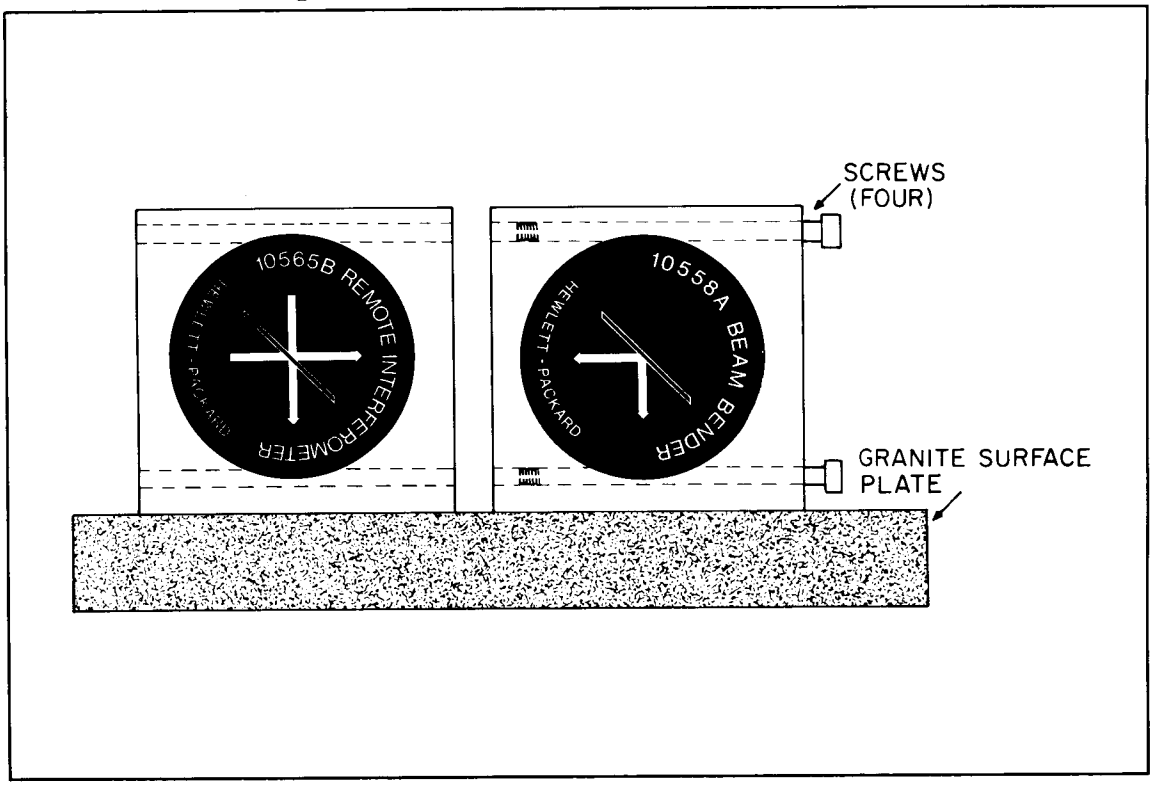
The 10558A Beam Bender and 10565B Remote Interferometer must be fastened together for angular and flatness measurements. For accurate measurements, the two parts must be properly aligned. To fasten the Beam Bender and Remote Interferometer together properly, perform the following steps:

a. Clean the mating surfaces of the 10558A and the 10565B.

b. Lay the 10558A and 10565B on a clean surface plate. See Figure 4. Labels on 10565B and 10558A are shown in correct position.

c. Using proper wringing techniques, wipe the two cubes around on the surface plate, and then wring them against each other. Keep the cubes on the plate. Screw the two cubes together.

Figure 4. Correct Positioning of 10565B and 10558A



10559A REFLECTOR MOUNT
Serial Prefix: 1208A

DESCRIPTION

The 10559A Reflector Mount is a small, precision, magnetic stainless steel frame designed to hold two 10556A Retroreflectors (cube corners) in precise alignment.

PURPOSE

The 10559A can be used with the 5526A Laser Measurement System and other accessories to measure precision surface flatness, pitch and yaw, and small angles (see Figure 7 for measurement configurations).

MOUNTING 10556A REFLECTORS IN THE 10559A

Two 10556A Reflectors must be mounted in the 10559A Reflector Mount for angular measurements. For accurate measurements, the reflectors must be installed carefully. To install the reflectors properly, perform the following steps:

a. Remove 10556A Retroreflector from 10565B Remote Interferometer by removing the four hex head screws.

b. Remove 10556A Retroreflector from 10550B Reflector/Mount by removing the four hex head screws.

c. Properly clean the reflector mount and the two retroreflectors.

d. Insert the two retroreflectors gently in the mount.

NOTE

Turn the retroreflectors so that none of the edge lines of the trihedral prisms cut across the ingoing laser beam. (See the Laser Interferometer instructions.)

e. Gently screw the retroreflectors in place with four screws each.

CAUTION

DO NOT tighten the screws more than finger tight.

PRECISION MOUNTING OF BEAM BENDER AND REMOTE INTERFEROMETER

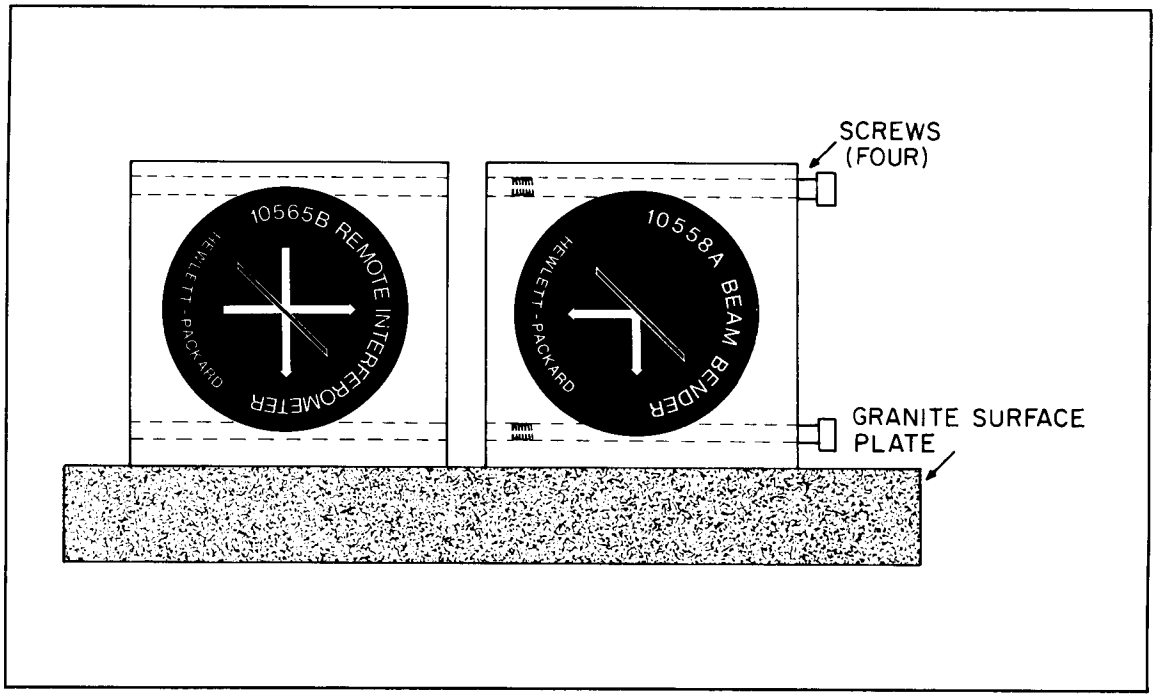
The 10558A Beam Bender and 10565B Remote Interferometer must be fastened together for certain measurements. For accurate measurements, the two parts must be properly aligned. To fasten the Beam Bender and Remote Interferometer together, properly perform the following steps:

a. Clean the precision surfaces of the 10558A and the 10565B.

b. Lay the 10558A and 10565B on a clean surface plate. See Figure 5. Labels on 10565B and 10558A are shown in correct position.

c. Using proper wringing techniques, wipe the two cubes around on the surface plate, and then wipe them against each other. Keep the cubes on the plate. Screw the two cubes together.

Figure 5. Correct Positioning of 10565B and 10558A



ALIGNMENT PROCEDURES

Autoreflection

This method ensures that the laser beam is parallel to the measured surface.

a. Place 10557A Turning Mirror at far end of travel and along the line of measurement.

b. Place 10565-80004 Magnetic Alignment Template on face of turning mirror.

c. Set source hole on laser to the small aperture.

d. Adjust laser so beam strikes template in top opening.

e. Observe reflected beam at small aperture on laser.

f. Adjust laser head until a maximum amount of the reflected beam is returned into the aperture or until the return beam "halo" is symmetrical around the aperture.

Angular Measurement System Alignment

a. Perform the autoreflection alignment, described above.

b. Set up angular measurement system as shown in Figure 6.

c. Place 10559A at end of travel and against straight edge.

d. Press RESET button on 5505A Display unit.

e. While maintaining front foot against straight edge, slowly rotate rear foot 1/10 inch (2.54 mm) away from edge. Measure this distance for accuracy with feeler gage or similar device.

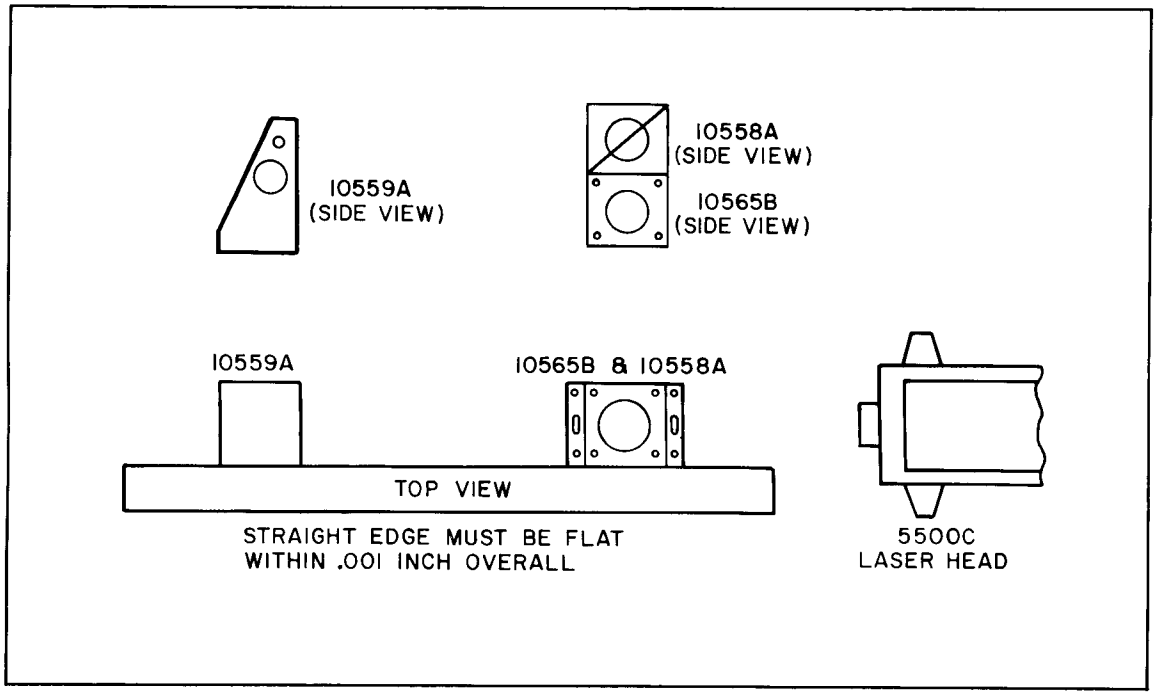
f. 5505A Display should accumulate <100μ inches (2.54 μm). This procedure checks the centering of retroreflectors in 10559A mount.

g. Remove gage and place 10559A flush against straight edge.

h. Press RESET button on 5505A Display unit.

i. Slowly move both ends of the 10559A away from the straight edge by a distance of 1/10 inch (2.54 mm). The laser display should accumulate <10μ inch (.254 μm). This procedure checks the parallel alignment of the two beams from the 10565B and 10558A. If this test fails, disassemble 10565B and 10558A, reclean precision surfaces, and reassemble.

Figure 6. Angular Measurement Setup



LARGE ANGLE CORRECTIONS

For small angles (±3,000 arc seconds from the starting point) the readout on the display unit is linear and correct. Larger readouts must be corrected. A large angle (>3,000 arc sec) correction chart may be calculated by using the following formula:

$$\theta a = \text{arc sin}\left(\frac{\text{reading in inches}}{2.0625}\right)$$

where θa is the "true" angle

MEASUREMENT READINGS

Angular Measurements

When the 10559A and the 5526A Laser Measurement System are used to measure small angles, the indications on the Laser Display unit in the NORMAL mode and with the UNITS switch set to **in** (inches) are direct in arc seconds of angle. Ten microinches equal one arc second. In the X10 mode, the resolution is 1/10 arc second of angle.

Flatness Measurements

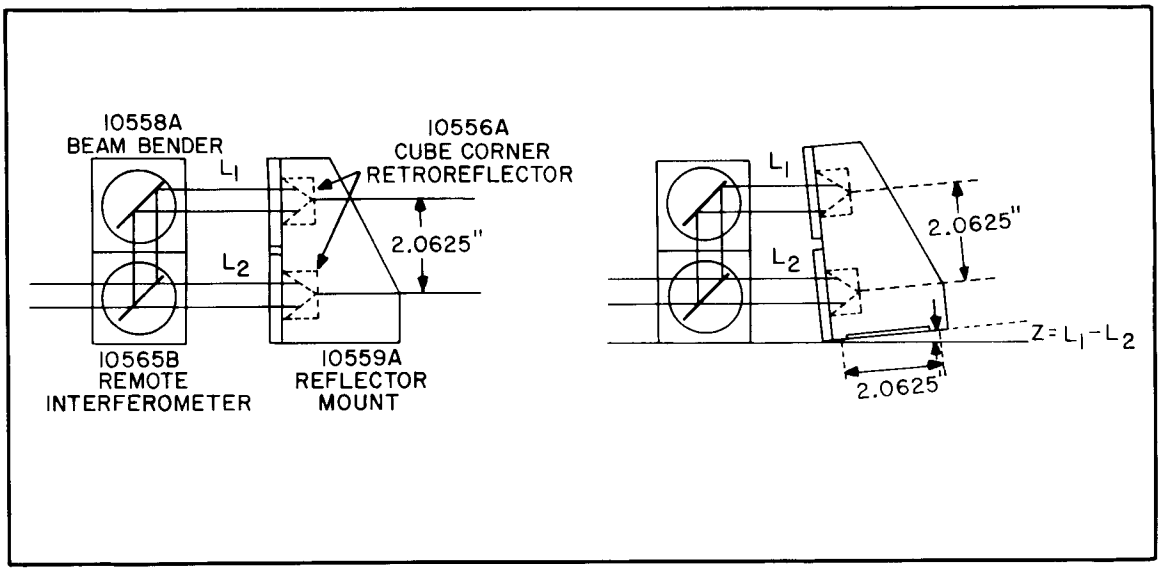
When the 10559A and the 5526A Laser Measurement System are used to measure surface flatness, the readout of the Laser Display unit indicates elevation changes directly to the same resolution as in linear measurements.

APPLICATIONS

Application Note 156-2, *Calibration of a Surface Plate,* explains the setup procedures of the angular measurement system. This publication is available upon request.

PRINCIPLE OF OPERATION

The Model 5526A Laser Measurement System measures the difference in the length of two laser beam paths (L_1 and L_2, as illustrated below) emerging from the Model 10565B Remote Interferometer.



In order to use this difference for angular measurement, the Model 10558A Beam Bender first deflects beam path L_1 to become parallel to path L_2. The two beams are then reflected by two Model 10556A Cube-Corner Retroreflectors mounted in the Model 10559A Reflector Mount and directed back to the interferometer for detection.

Pitch/Yaw

When the Reflector Mount rotates in a clockwise direction, L_1 becomes longer than L_2. The angle of rotation θ is expressed

$$\sin \theta = \frac{L_1 - L_2}{2.0625 \text{ in.}}$$

since the two Cube-Corner Retroreflectors are spaced 2.0625 inches apart. If $L_1 - L_2$ is 0.000,01 inch (the resolution of the NORMAL mode of operation of the laser interferomter), then θ is equal to one arc-second. Thus, a measure of 0.000,001 inch difference between L_1 and L_2 (the resolution of the X10 mode) corresponds to an angle of 0.1 arc-second.

Flatness

The spacing of the feet of the Reflector Mount is 2.0625 inches, the same as the Retroreflector spacing. Consequently, when the Reflector Mount tilts due to an elevation difference "Z" between its front and rear feet, the path difference $L_1 - L_2$ is exactly equal to the difference in feet elevation. The resolution of flatness measurements is the same as the interferometer resolution, namely 0.000,001 inch (in the X10 mode of operation).

Figure 7. Measurement Setup