7V

Agilent 10770A Angular Interferometer with Agilent 10771A Angular Reflector

Description

The Agilent 10770A Angular Interferometer and the Agilent 10771A Angular Reflector are normally supplied as part of the Agilent 55281A Angular Optics Kit. They are shown in Figure 7V-1. These Angular Measurement optics are designed for use in a calibrator system such as the Agilent 5529A/55292A. More detailed information about the use of these optics can be found in Agilent calibrator system user's documentation.

With these optics the angular rotation of the Agilent 10771A Angular Reflector can be measured over a range of ±10 degrees.

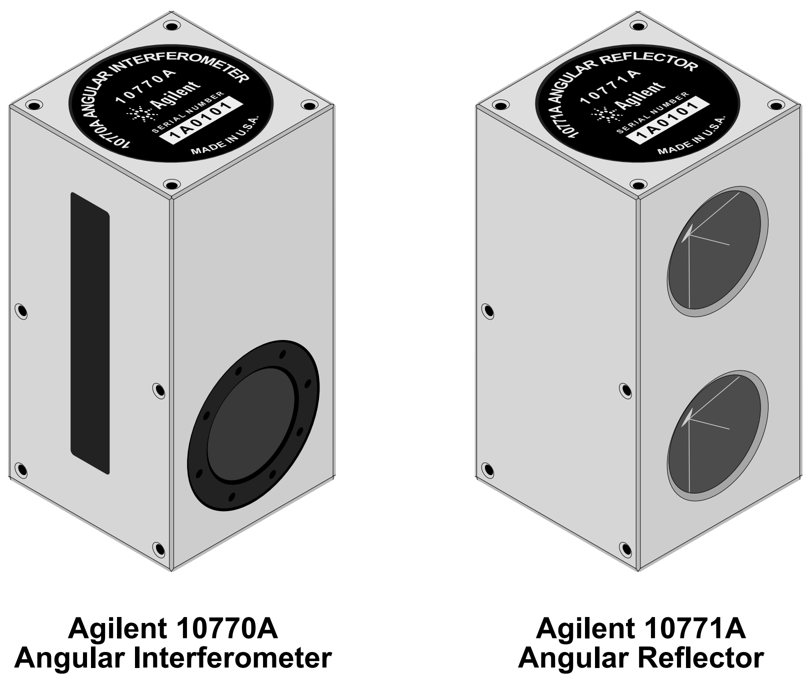

Figure 7V-1. Agilent 10770A Angular Interferometer and Agilent 10771A Angular Reflector

Optical schematic

Figure 7V-2 shows the laser beam path through the optics.

The angular optics create two parallel beam paths between the angular interferometer and the angular reflector. The spacing between the two paths (32.61 mm, or 1.28 inches) is precisely known because it is set by the optics and the retroreflectors within the angular reflector. Both components are positioned 32.61 mm apart at their centerlines. The optics are initially set parallel to each other and the system is initialized.

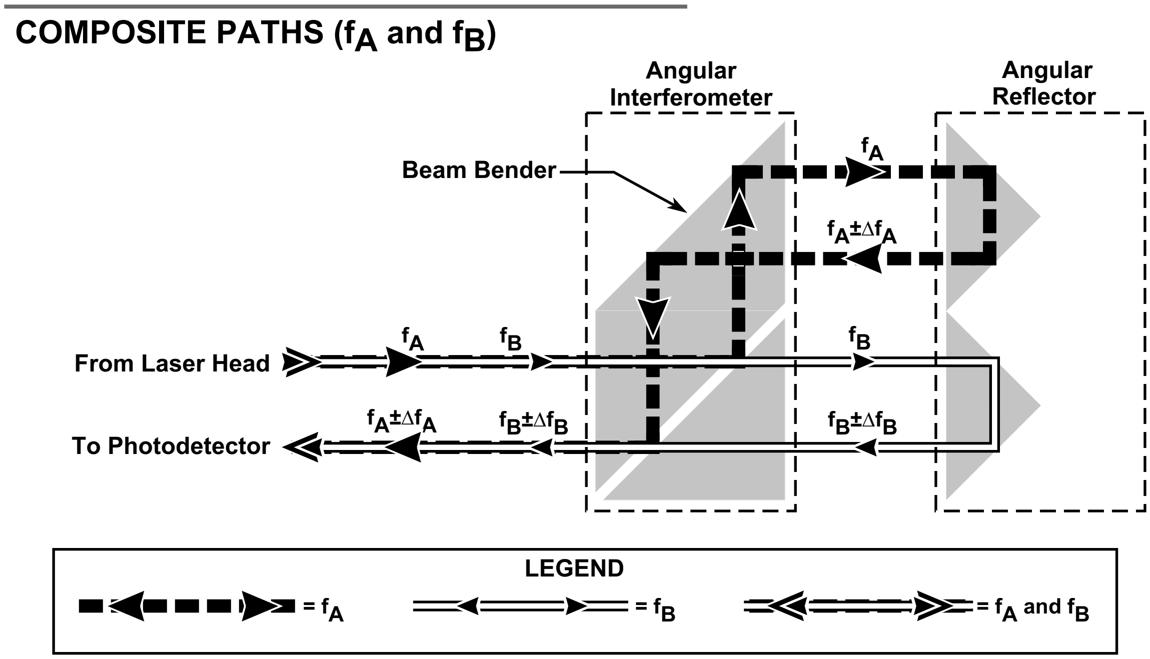

Figure 7V-2. Angular optics — laser beam paths

The two beam paths are initially the same length. If either optic is rotated, the relative path lengths will change. This change will cause a Doppler-shifted frequency change in the beam returned from the interferometer to the receiver. The change will result in an indicated change in path length. From geometry, the angle of rotation is related to the change in relative path length by:

$\sin\theta$	=	D/32.61 mm
so θ	=	arcsin (D/32.61 mm),
where θ	=	the angle of rotation, and
D	=	the indicated change in relative path length in mm, and 32.61 mm is the spacing of the retroreflectors in the angular reflector, and also the spacing between the parallel beam paths from the angular interferometer to the angular reflector.

Installation and Alignment

General considerations

1. Carefully read chapters 2 through 4, and Chapter 15, "Accuracy and Repeatability," and complete the following items before installing a laser positioning system into any application.
2. Alignment of the angular optics is similar to alignment of a Linear Interferometer. Read the alignment procedure for the Linear Interferometer given in subchapter 7A of this manual.
3. The angular interferometer must be located between the laser head and the angular reflector. The beam from the laser head must enter the angular interferometer either through the single opening on one side for an in-line measurement, or through the opening in the bottom for a measurement along an axis perpendicular to the laser beam. The side of the angular interferometer with two openings should always face the angular reflector.
4. When initializing the laser measurement system, the angular optics must be parallel to within 20 arc-minutes to achieve the specified accuracy (corresponds to 40 arc-minutes misalignment by autoreflection).
5. Supply a rigid mounting surface for both optics. The mounts should be adjustable for alignment. The adjustable mounts available from Agilent for these optics include the Agilent 10785A Height Adjuster and Post. The Agilent 10784A Base may be used as a support for the post. Dimension drawings for these items are provided in Chapter 9, "Accessories," of this manual.
6. The Angular Interferometer's apertures are 18.0 mm in diameter. With this aperture, the beam spacing will be 11.0 mm. This beam spacing (11.0 mm) differs from that used for other interferometers. This difference means that you cannot use the receiver's alignment aid to establish proper spacing between the receiver and the beam from the laser head to the interferometer.

Alignment target

To help in aligning the Agilent 10770A Interferometer, an alignment target (Agilent Part Number 10767-67001) is included.

Alignment procedure

There are two techniques for aligning the angular optics. They are:

- Autoreflection Method, and
- Moving Dot Method.

Autoreflection Method

The principal alignment procedure for the angular optics is the same as that for the linear interferometer and retroreflector. The following is the step-by-step procedure that corresponds to the example in Chapter 4, "System Installation and Alignment," of this manual. In this case, however, the angular optics, instead of the linear interferometer and retroreflector, will be used on the X-axis.

1. With all optical components in place, visually align the laser beam parallel to the axis of travel. Do this by blocking the laser beam with a piece of paper and moving the paper along the axis of travel.
2. With the laser beam passing through the 50% beam splitter, coarsely adjust optical components so the measurement beams strike the center of the receiver aperture. Use the "Moving Dot" method (described in the following subsection) to do this.
3. Place a referenced mirror between the interferometer and the reflector so the measurement beams from the interferometer strike this mirror. Align the referenced mirror with a precision indicator until the mirror's reflective surface is perpendicular to the direction of travel.
4. Select the small aperture on the laser head by rotating the front turret.
5. Adjust the laser head angularly until the beam reflects back on itself from the referenced mirror and is centered on the small aperture of the laser head.
6. Lock down the laser head and interferometer securely. Make sure the alignment is not disturbed.
7. Reposition the reflector until the return measurement beams are centered on the receiver. Select the large aperture on the laser head.

NOTE Placing a piece of translucent tape over the receiver lens will help in observing the impinging beams.

CAUTION Do not let the tape adhesive touch any optical surface.

8. Verify that the receiver's LED is ON and that the voltage at the receiver test point is between 0.6 and 1.3 Vdc (for 10780C/F), or 1.5 and 8.0 Vdc (for E1708A), or 1.8 and 10.0 Vdc (for E1709A).

Moving Dot Method

The principal steps used for the “moving dot” method of alignment are:

1. The laser head and optics are mounted in their desired locations.
2. Select the small beam aperture on the laser head.
3. With the reflector as close as possible to the interferometer, adjust any component (laser head, interferometer, or reflector) to center the measurement beams on the receiver aperture.

NOTE Placing a piece of translucent tape over the receiver lens will help in observing the impinging beams.

CAUTION Take care that you do not let the tape stick to any optical surface.

4. Move the reflector away from the interferometer. If the laser beam is not parallel to the axis of travel, the measurement beams will begin to move away from their original position on the receiver aperture. The impinging beams will move until the beam is cut off by the edge of the interferometer’s aperture. Stop moving the reflector before the beam is blocked, or when the end of travel is reached. Figure 7V-3 illustrates this situation.
5. Adjust the laser beam by angularly moving the beam until the dots again overlap at the receiver. This adjustment of the laser beam is accomplished by moving the laser head, beam bender, or interferometer depending on the optical layout.

NOTE Some translations of either the laser head or interferometer may also be necessary to achieve alignment.

6. Select the large aperture on the laser head. Verify that the receiver’s LED is ON and that the voltage at the receiver test point is between 0.6 and 1.3 Vdc (for 10780C/F), or 1.5 and 8.0 Vdc (for E1708A), or 1.8 and 10.0 Vdc (for E1709A).

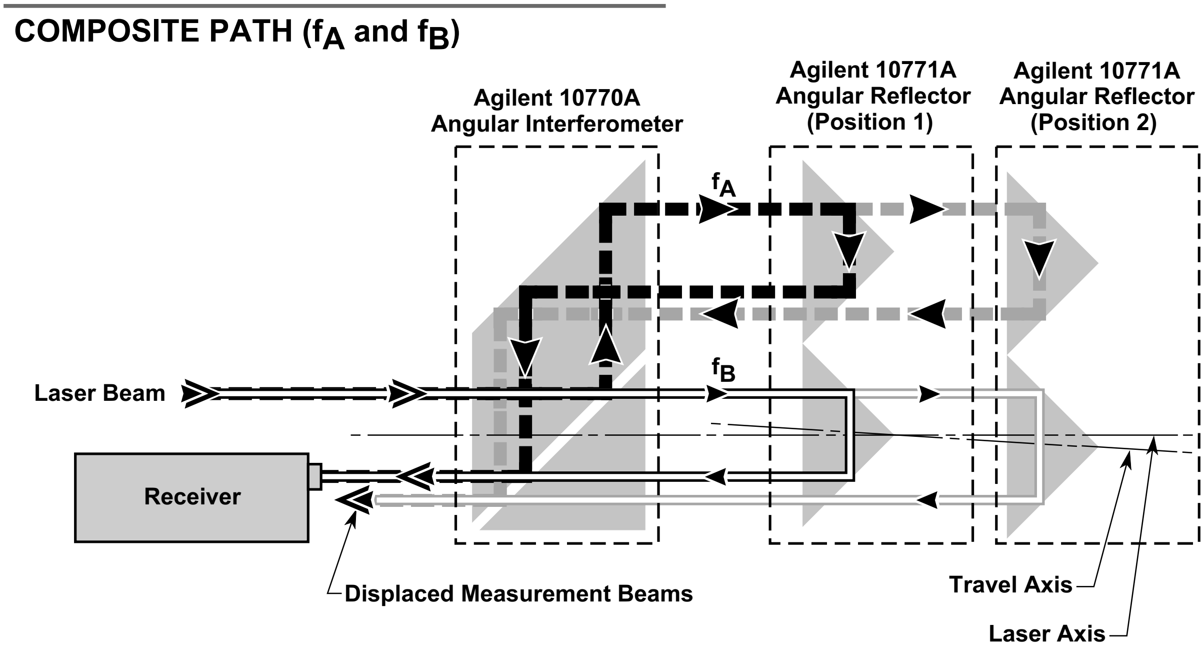

Figure 7V-3. Measurement beam dots movement

Operation

Accuracy considerations

There are three error sources that are controlled by the operator:

1. The accuracy depends on the nodal point spacing. The optics must be temperature-stabilized in the 15-to-25 degree C range or thermal expansion will change the nodal point spacing, causing excessive error.
2. Misalignment in roll effectively reduces the nodal point spacing in the plane of the measurement. The accuracy specification includes allowance for 1 degree of roll misalignment by the operator.
3. The initial angle must be near zero when the system is initialized or the measured change in angle will have an error. The accuracy specification includes allowance for 20 arc-minutes of initial angle. The error in measured path length due to an initial angle error is given by:

$$Dt = Dm\{\sin\theta t/[\sin(\theta t - \theta i) + \sin\theta i]\}$$

Where Dt	=	the true change in path for the true angle of rotation,
θt	=	the true angle of rotation,
Dm	=	the measured change in path length caused by an initial angle error, and
θi		the initial angle error.

Specifications

Specifications describe the device’s warranted performance. Supplemental characteristics (indicated by TYPICAL or NOMINAL) are intended to provide nonwarranted performance information useful in applying the device.

Accuracy: Angle measurements are accurate to ±0.2% of calculated value ±0.05 arc-second per meter of distance traveled by the moving optic. This assumes that the Agilent 10771A Reflector is aligned within 40 arc-minutes using retroreflection techniques, roll alignment by the operator is within l° relative to the measurement plane, and the temperature of all optics is stabilized in the range 15-25° C.

Resolution: 0.06 arc-second

Range: ± 36000 arc-seconds (± 10°)

Axial Separation: (Typical, with proper alignment, 15-25° C, distance between the laser head and the reflector): 15 meters (50 feet).

Agilent 10770A Angular Inteferometer Specifications

Dimensions: see figure below

Weight: 553 grams (19.5 ounces)

Materials Used:

Housing: Stainless Steel (416)
Apertures: Plastic (Nylon)
Optics: Optical Grade Glass
Adhesives: Low Volatility (Vacuum Grade)

Maximum Transmitted Beam Deviation: ± 30 arc-seconds

Optical Efficiency:

Typical: 75%
Worst Case: 71%

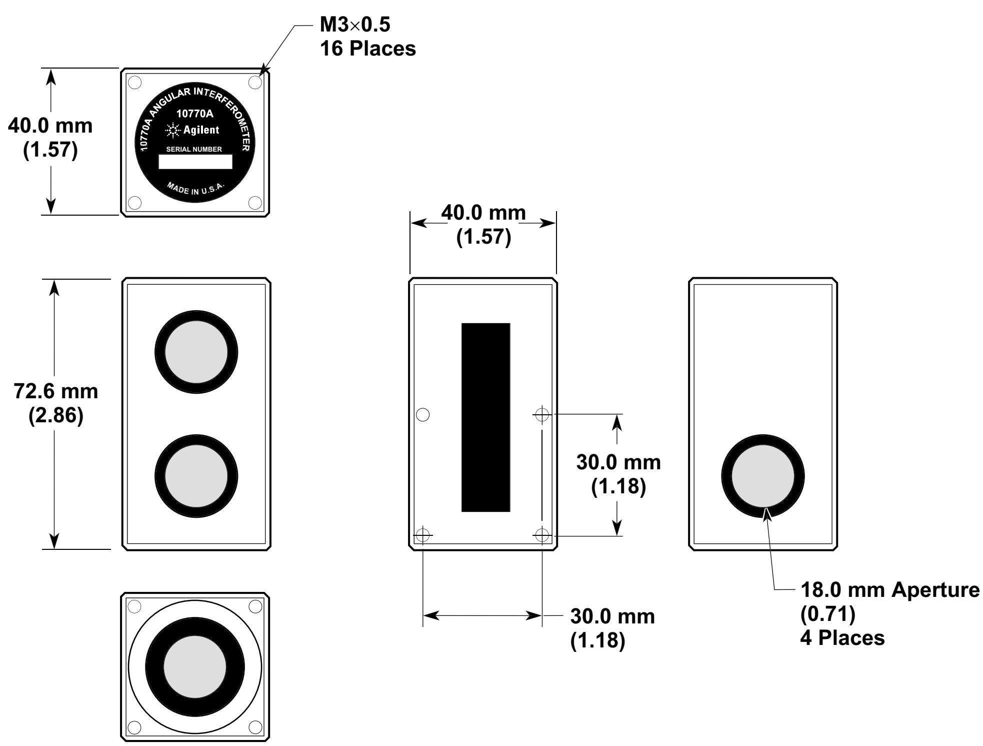

Figure 7V-4. Agilent 10770A Angular Interferometer

Agilent 10771A Angular Reflector Specifications

Dimensions: see figure below

Weight: 650 grams (23 ounces)

Materials Used:

Housing: Stainless Steel (416)
Apertures: Plastic (Nylon)
Optics: Optical Grade Glass
Adhesives: Low Volatility (Vacuum Grade)

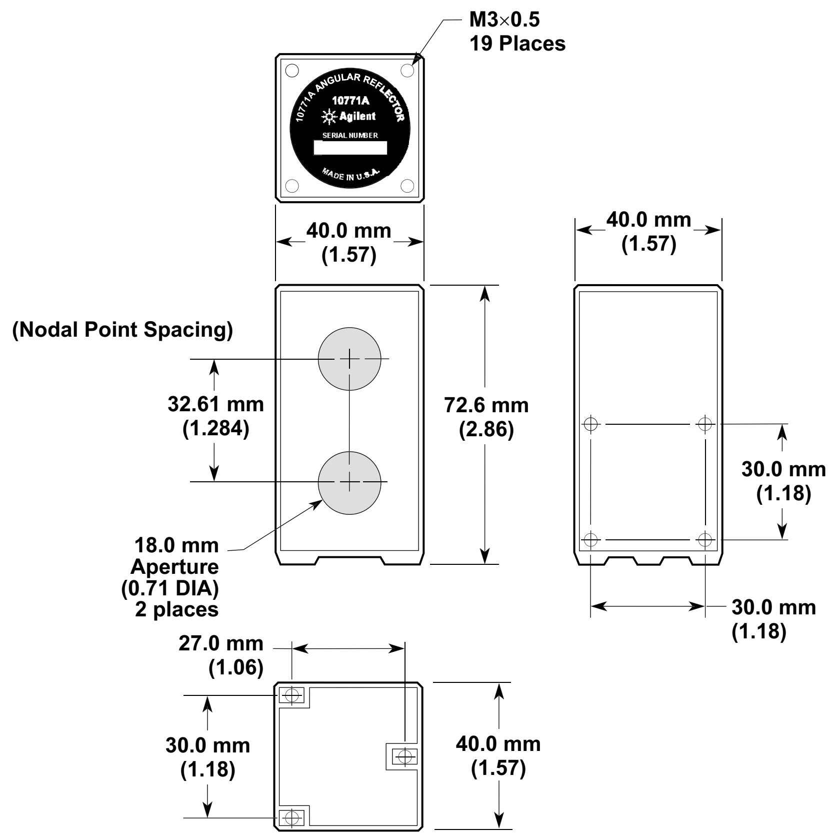

Figure 7V-5. Agilent 10771A Angular Reflector

This is a chapter from the manual titled:
Laser and Optics User's Manual
For complete manual, order:
Paper version: p/n 05517-90045
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This chapter is p/n 05517-90129