# 7J

# Agilent 10719A One-Axis Differential Interferometer

# Description

## General

The Agilent 10719A One-Axis Differential Interferometer (see Figure 7J-1) is a plane mirror type of interferometer that allows differential measurements to be made between a measurement mirror and a reference mirror. Both mirrors are usually provided by the user.

The Agilent 10719A interferometer has the same fundamental optical resolution as the Agilent 10706B High Stability Plane Mirror Interferometer $\lambda/4$, before electronic resolution extension).

The Agilent 10719A interferometer is designed to use a 3-mm diameter laser beam, available from an Agilent 5517C-003 Laser Head. This beam is smaller than the standard 6 mm beam and allows the measurement plane (centerline of the beams) to be closer to the upper edge of the X-Y stage measurement mirror, thereby reducing Abbé offset.

The measurement and reference beam paths are parallel and are spaced 19.05 mm (0.750 inch) apart.

The Agilent 10719A interferometer is designed primarily for use with the Agilent 10780F Remote Receiver, which can be attached directly to the housing; however, any other Agilent receiver may be used.

## Applications

### *Differential measurements*

A differential measurement is one in which both the reference beam and the measurement beam travel to external mirrors outside the interferometer housing. This allows measurement of the relative positions of the two external mirrors, either or both of which may move.

One useful example of a differential measurement in a lithography application is for measuring the motion of the X-Y stage relative to the optical column. The Agilent 10719A One-Axis Differential Interferometer and the Agilent 10721A Two-Axis Differential Interferometer (described in subchapter 7K) are ideally suited to this type of measurement, because they provide parallel reference and measurement paths which are offset vertically by 19 mm (0.750 inch). For such an application, a user-supplied reference plane mirror is required in addition to the measurement reflector on the X-Y stage.

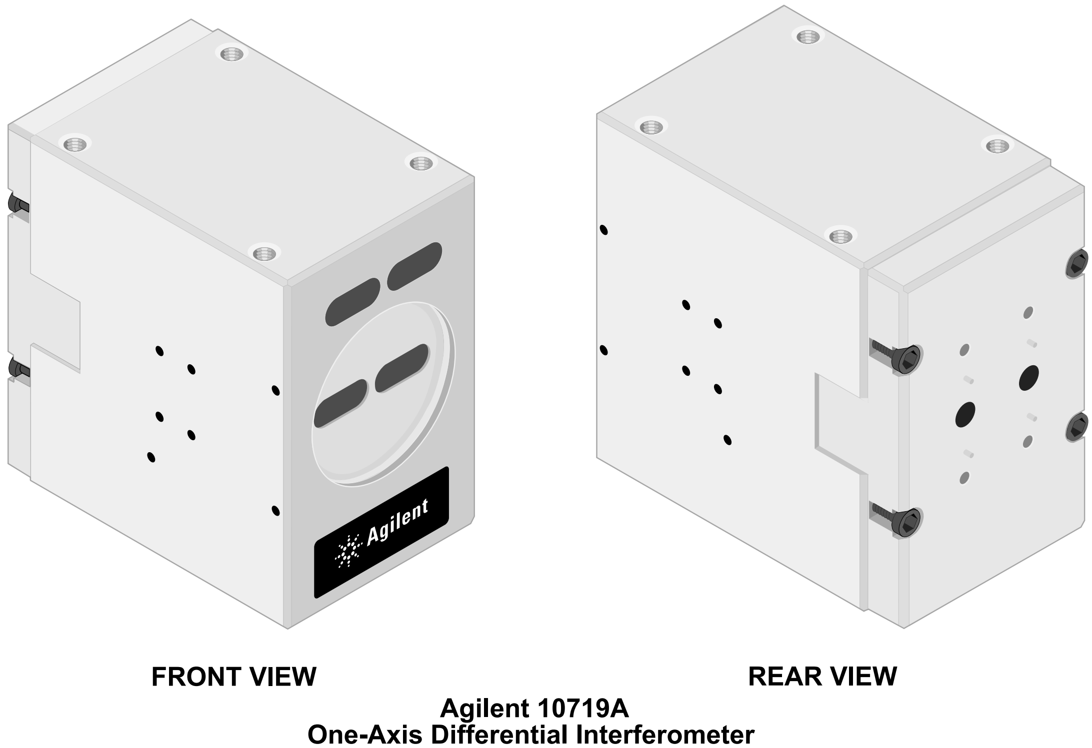


**Figure 7J-1. Agilent 10719A One-axis Differential Interferometer**

### *Angular measurements*

The Agilent 10719A interferometer can measure angular displacement instead of linear displacement, by directing its reference and measurement beams to the same plane mirror. This creates an optically subtracted angular measurement with a fundamental optical resolution of 1.73 arc-seconds, which can be extended electronically by 32X to give 0.05 arc-second resolution. The concept of optical subtraction and a method to calibrate the angle measurement with high accuracy are described in Chapter 4, “System Installation and Alignment,” of this manual.

Both types of measurements using the Agilent 10719A interferometer are illustrated in Figure 7J-2.

**LINEAR/ANGULAR MEASUREMENT FOR AGILENT 10719A**

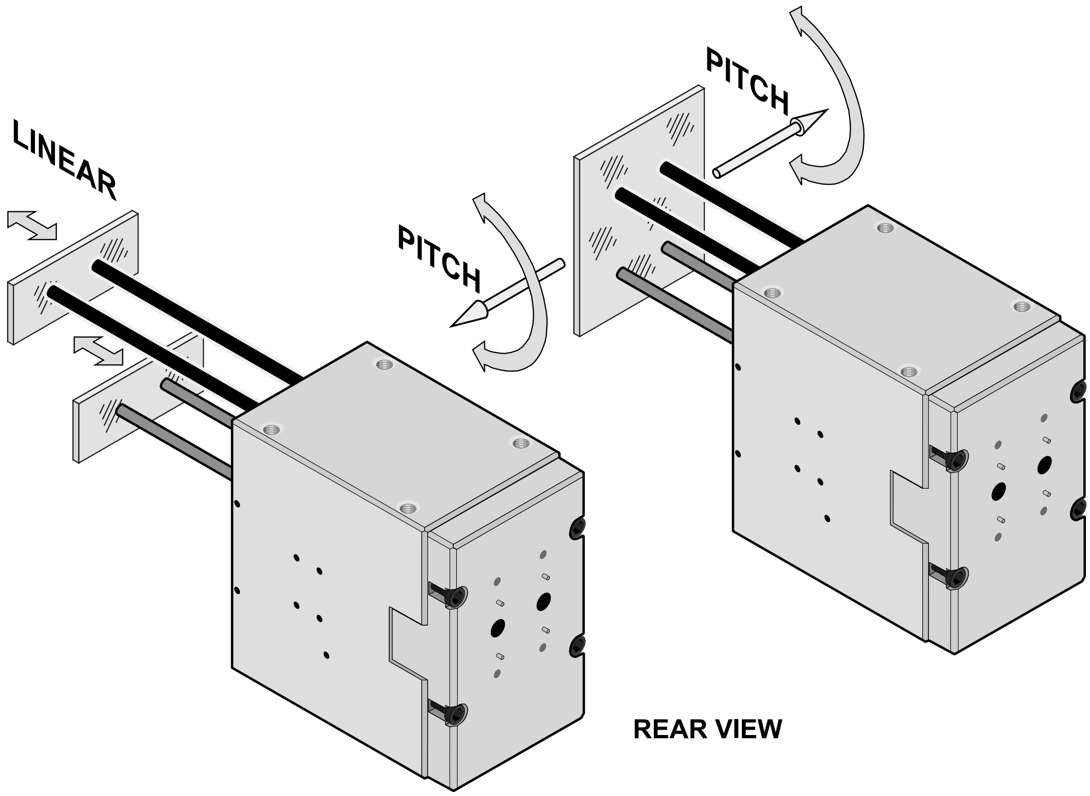


**Figure 7J-2. Agilent 10719A Interferometer - Measurements**

## Multiaxis configurations

The maximum number of independent axes of displacement that can be measured using one laser head depends on: 1) the measurement system electronics, 2) the strength of the beam from the laser head, 3) the sensitivity of the receivers used, 4) linear and angular range to be measured, and 5) the reflectivity and wavefront of the plane mirrors used for the reference and measurement mirrors.

By using the proper combination of beam splitters, beam benders, and interferometers, the measurement axes can be established with a minimum number of components. The following paragraphs provide examples of routing the laser beam for multiaxis measurement configurations.

Agilent 10719A and Agilent 10721A interferometers can be used in combination to create multiaxis stage measurements of one to six axes. Some of these applications are described the following sections.

# Three-Axis System

The three-axis system described here consists of:

- an Agilent 10719A One-Axis Differential Interferometer
- an Agilent 10721A Two-Axis Differential Interferometer

The Agilent 10719A One-Axis Differential Interferometer and the Agilent 10721A Two-Axis Differential Interferometer (described in subchapter 7K) are well suited for X-Y stage applications, such as lithography equipment. With these interferometers, the measurement mirror is attached to the X-Y stage, and the reference mirror is attached to the exposure column, allowing positioning of the stage relative to the column itself (see Figure 7J-3).

**THREE-AXIS SYSTEM CONFIGURATION**

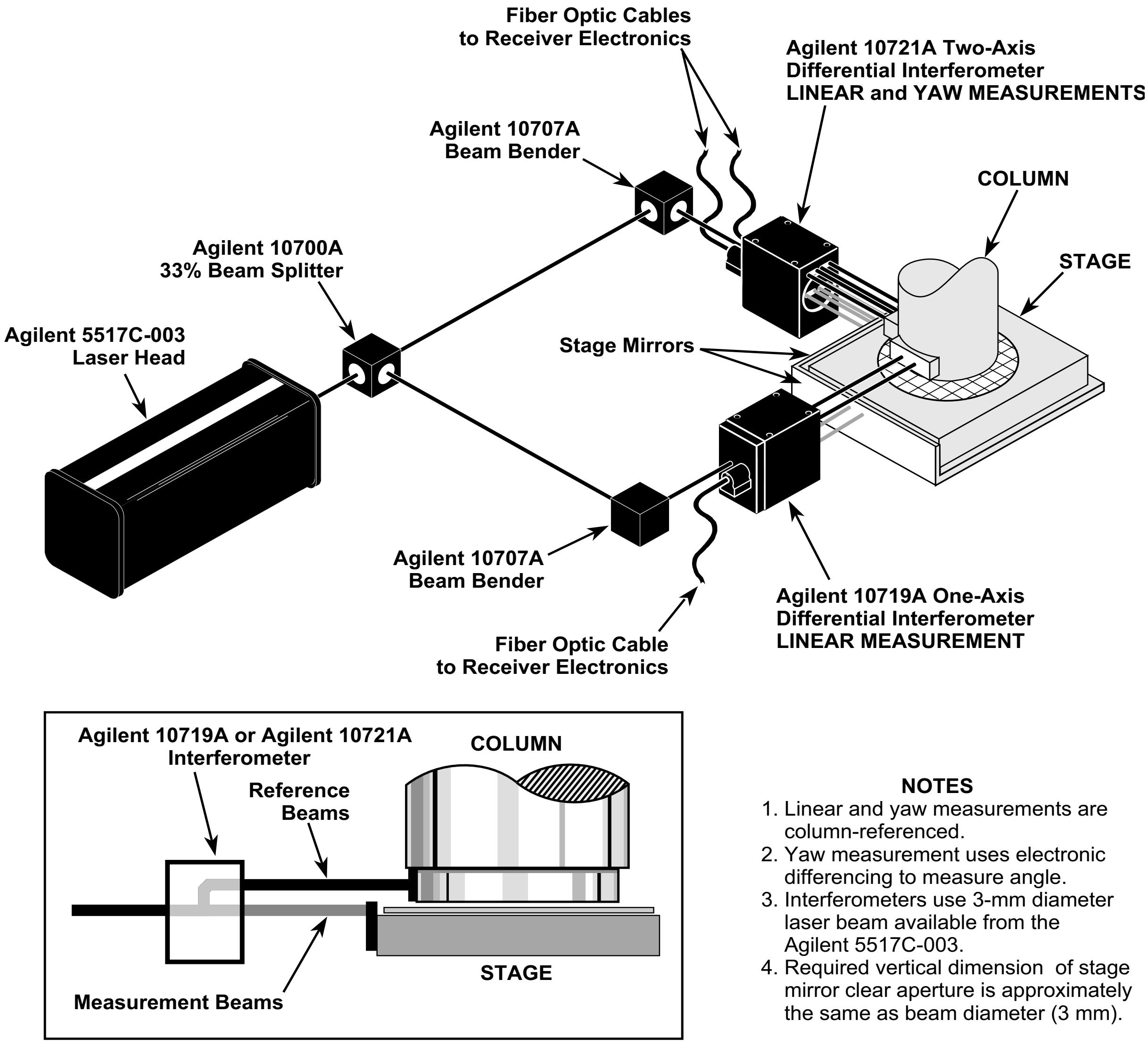


**Figure 7J-3. Three axes with Agilent 10719A and Agilent 10721A interferometers**

This configuration also allows yaw measurements of the X-Y stage. The Agilent 10721A interferometer combines the capabilities of two discrete linear interferometers into a single package. It makes two linear measurements with built-in parallelism, spaced 12.7 mm (0.5 inch) apart. The angular measurement can be calculated by taking the arctangent of the difference between these linear measurements divided by their separation:

$$\text{THETA} = \arctan \frac{Y - Y'}{D}$$

# Five-Axis System Using Agilent 10719A and Agilent 10721A Interferometers

The five-axis system described here consists of:

- three Agilent 10719A One-Axis Differential Interferometers
- an Agilent 10721A Two-Axis Differential Interferometer

The Agilent 10719A One-Axis Differential Interferometers and the Agilent 10721A Two-Axis Differential Interferometer may be used in a multiaxis configuration to measure X, Y, Yaw, Pitch, and Roll of an X-Y stage. As in the earlier three-axis system, the first three degrees of motion are column-referenced, and the yaw measurement is electronically subtracted.

Pitch and roll are measured by adding two more Agilent 10719A interferometers to the three-axis setup. Inverting the Agilent 10719A interferometers so the measurement beams and the reference beams both reflect off the stage mirror, creates an optically-subtracted angle measurement. Inverting the Agilent 10719A interferometers instead of just shifting them vertically, keeps the input beams for all interferometers in the same plane, which significantly simplifies installation and alignment. However, this also causes the inverted interferometers to be mounted with a 3.18 mm (0.125 inch) offset relative to the non-inverted ones as described in Figure 7J-4.

## Optical schematic

Figure 7J-5 shows the optical schematic of the Agilent 10719A One-Axis Differential Interferometer.

After entering the input aperture, the laser beam is split into its separate components. The measurement beam continues straight through the interferometer to the measurement mirror. The reference path includes two 90-degree bends, causing the reference beam to be parallel to the measurement beam, but offset from it by 19.05 mm (0.750 inch).

To reduce thermal drift errors, the measurement and reference beam paths have the same optical path length in glass. This reduces measurement errors due to temperature changes in the interferometer.

## Five-Axis System Using Agilent 10719A and Agilent 10721A Interferometers

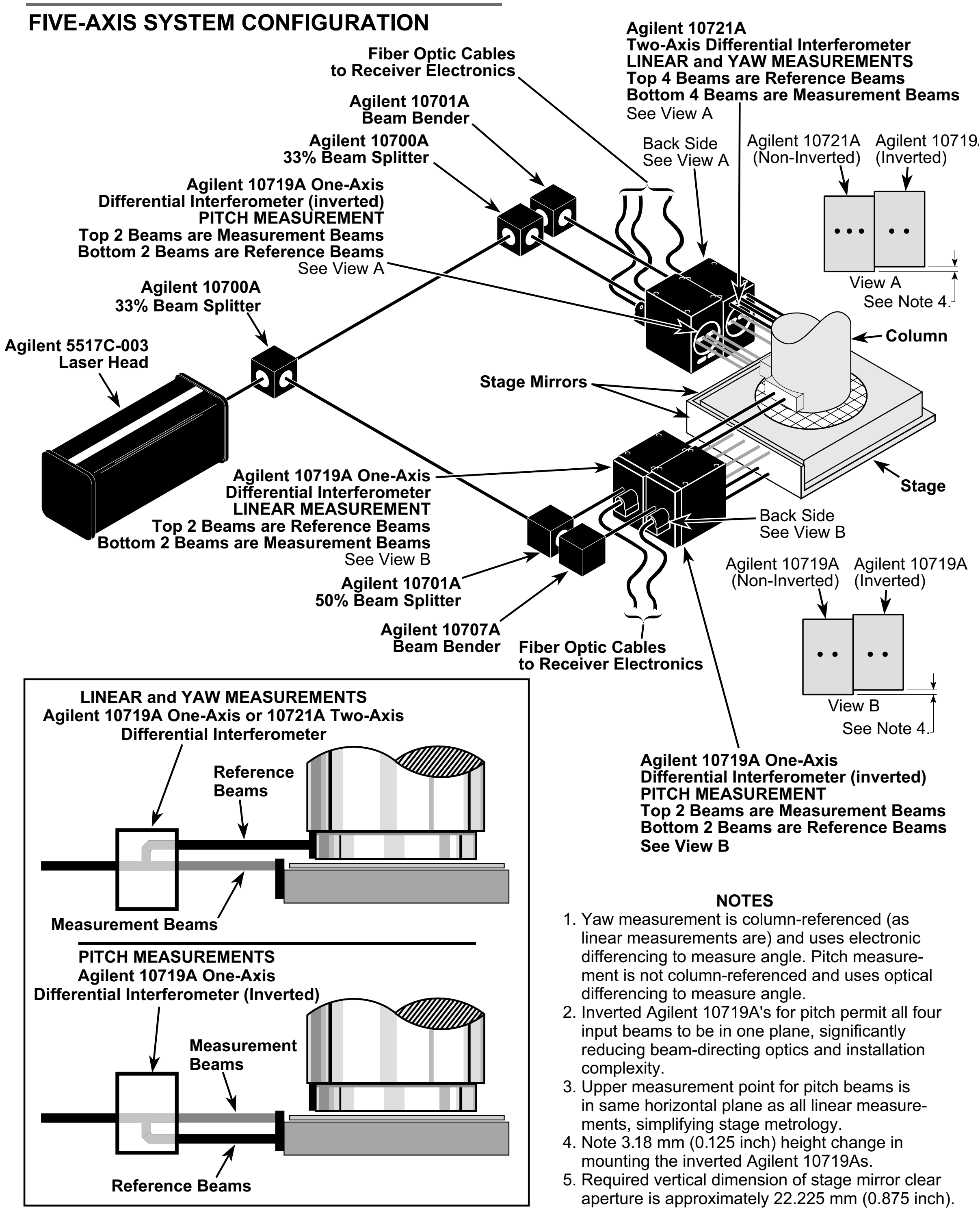


**Figure 7J-4. Five-axis system with Agilent 10719A and Agilent 10721A interferometers**

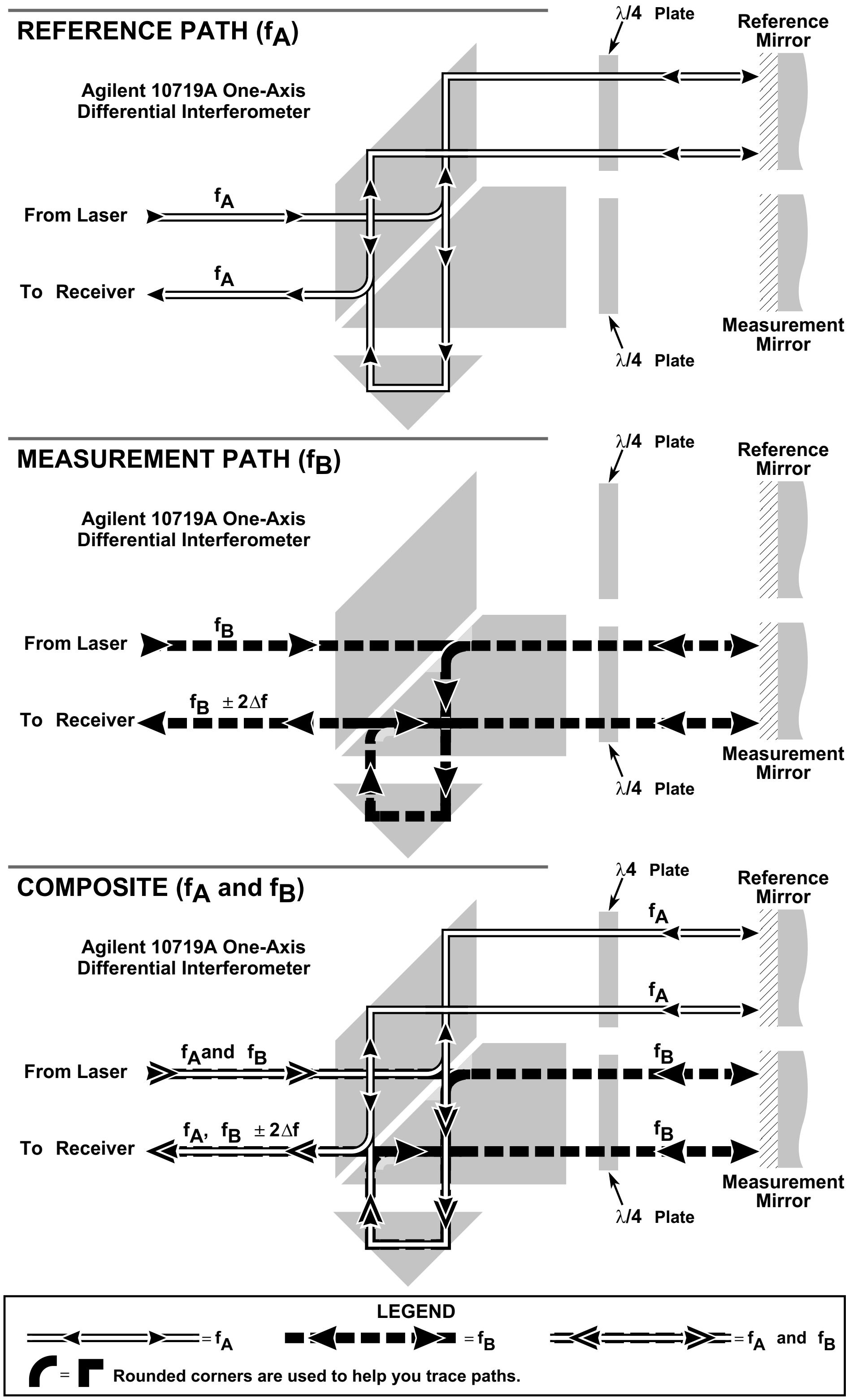


**Figure 7J-5. Agilent 10719A One-Axis Differential Interferometer — optical schematic**

# Special Considerations

## Configuration and beam locations

The Agilent 10719A interferometer is designed to be used in a "straight-through" configuration only.

Its input face and measurement face are parallel to each other, on opposite sides of the housing.

The locations of the reference and measurement beams, with inputs and outputs identified, are shown in Figure 7J-6.

The Agilent 10719A interferometer is similar to other plane mirror interferometers except that its reference path is redirected to be parallel to the measurement path outside the interferometer. Thus, the reference path also requires a plane mirror for its reflector.

## Beam diameter

The Agilent 10719A inteferometer requires the 3 mm diameter beam, available from an Agilent 5517C-003 Laser Head. The smaller diameter beam enables the beam positions on the stage mirror to be closer to the lithographic image plane, reducing Abbé offset errors.

## Receiver considerations

The Agilent 10719A interferometer is designed primarily for use with the Agilent 10780F Remote Receiver; however, any other Agilent receiver may be used.

The advantage of using the remote receiver is that the fiber-optic sensor head can be directly attached to the interferometer, eliminating the need for separate mounting brackets.

When laying out an application, be sure to allow enough clearance for the fiber-optic cable without bending it tighter than its minimum bend radius of 35 mm (1.4 inches). Also avoid any kinking where the fiber connects to the sensor head. Kinking or excessive bending of this cable can cause signal attenuation.

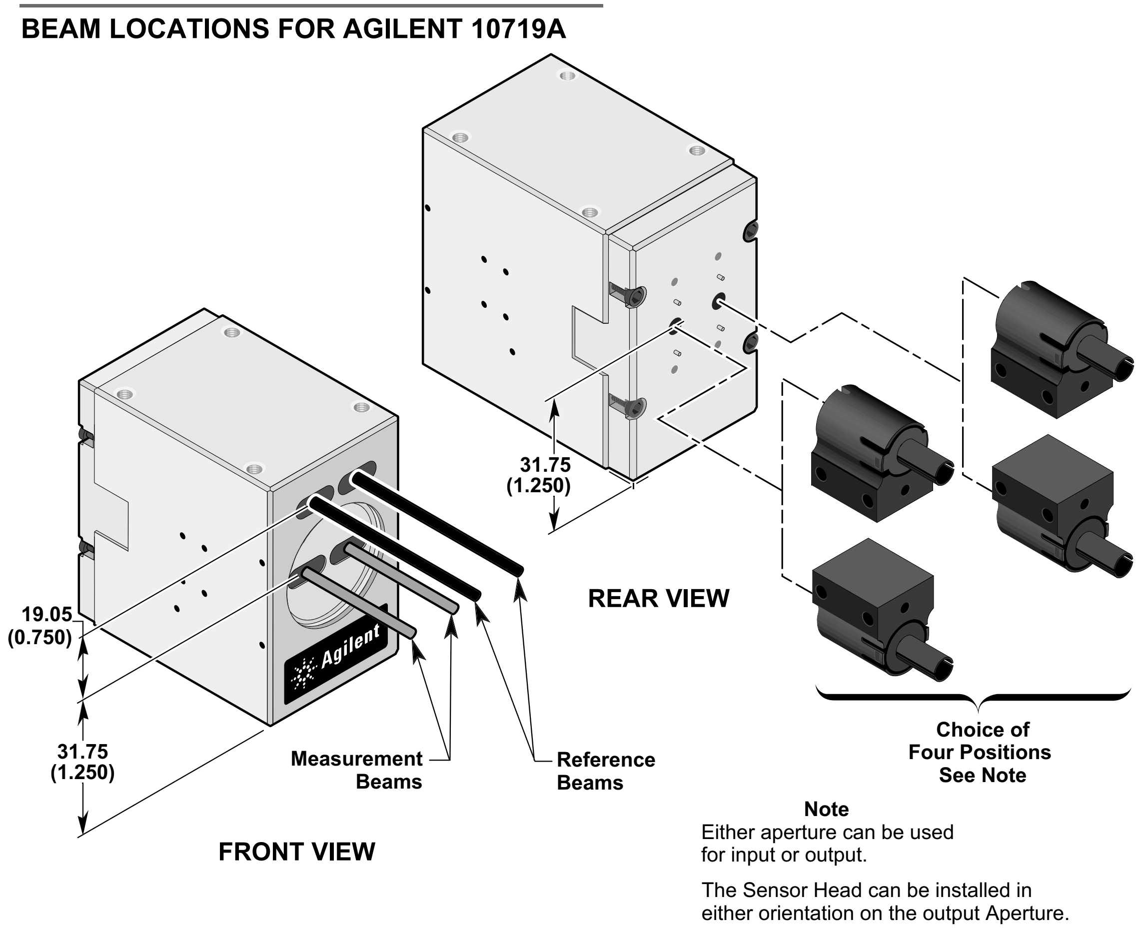


**Figure 7J-6. Agilent 10719A Interferometer - Reference and Measurement beams**

Mounting pins on the interferometer eliminate the need for any user alignment of the sensor head. The sensor head may be installed on the mounting pins either right-side up or upside-down, whichever is best for your measurement situation.

Use 4-40 × 1-inch screws to fasten the sensor head to the interferometer.

## Spacing to beam-directing optic

The recommended minimum spacing between the interferometer and its beam-directing optic is 63.5 mm (2.50 inches). This spacing will provide the minimum clearance for the fiber optic cable when the Agilent 10780F Remote Receiver is used.

## Input and output apertures

The Agilent 10719A interferometer has two apertures, which may be used interchangeably as the input or output apertures. Each aperture is equipped with mounting pins for the Agilent 10780F receiver's fiber-optic sensor head; therefore, either aperture can be used for the output beam.

## Direction sense

The Agilent 10719A interferometer direction sense depends fundamentally on which laser frequency is in its measurement path. This is affected by the mounting orientations of both the interferometer and the laser head.

In most cases, the Agilent 10719A interferometer will be oriented "upright", that is, with its top and bottom mounting surfaces horizontal. In this orientation, the internal polarizing beam splitter will send the vertical polarization into the measurement beam path and the horizontal polarization into the reference beam path. As mentioned in Chapter 5, "Laser Heads," of this manual, the Agilent 5517C-003 Laser Head produces $f_1$ (its lower frequency) with horizontal polarization and $f_2$ (its higher frequency) with vertical polarization.

Thus, an Agilent 5517C-003 with its mounting plane horizontal will direct $f_1$ into the reference path and $f_2$ into the measurement path. This configuration will result in the fringe counts DECREASING when the measurement mirror moves AWAY from the interferometer.

The direction sense will change sign for any configuration which rotates either the laser head or the interferometer by 90 degrees. The configuration of the beam-directing optics between the laser head and the interferometer may effectively rotate the laser beam, changing which laser frequency (polarization) is in which interferometer path, and thus the direction sense of the interferometer.

## Deadpath

For the Agilent 10719A interferometer, "zero-deadpath", the condition in which the measurement beam path length and the reference beam path length are equal, does not occur when the reference and measurement mirrors are coplanar.

Because the reference beam travels 19.05 mm (0.750 inch) further through air inside the interferometer than the measurement beam does, the zero-deadpath condition for the Agilent 10719A interferometer occurs when the measurement mirror is 19.0 mm (0.750 inch) farther from the interferometer housing than the reference mirror is. The consequences of this are discussed in more detail under the “Operation” section, later in this subchapter.

## Reference and measurement mirror requirements

A key feature of the Agilent 10719A interferometer is its ability to make relative measurements between a measurement plane mirror and a reference plane mirror. Since mirror size requirements depend on the application, both plane mirrors must be supplied by the user. Recommended optical specifications for these reflectors can be found under the “Specifications and Characteristics” section at the end of this subchapter.

The mounting system for the mirrors must also be provided by the user. An important consideration in designing the mountings is to provide the means to ensure the mirrors are aligned substantially parallel to each other during system reset (even though they are not, in general, coplanar). Initial parallelism at reset is important for keeping the permitted angle range symmetrical about the initial “zero angle” position. For example, a parallelism error of 10 seconds during reset will effectively reduce the angle range in one direction by 10 seconds and increase it in the other direction by the same amount.

The general solution is to provide a way to adjust at least one, and possibly both, mirrors. As explained below, the alignment procedure requires that the reference and measurement mirrors both be made initially perpendicular to the input laser beam. Thus, with three items to adjust (2 mirrors and 1 input beam), at least two of them should be adjustable. The input beam itself usually allows the first adjustment; so one of the two mirrors must provide the second.

In a typical lithography application, the reference mirror will usually be stationary (that is, mounted to the optical column); hence, it is often the convenient choice for attaching to an adjustable mount.

Whether mounted with adjustment capability or not, the mirrors must be held rigidly and stable after installation. Choose the mounting method with care to avoid the introduction of mounting stresses which deform the surface flatness of the mirrors. Adhesives can be used successfully, but beware of any stresses which may be introduced during curing. The mounting method should also be designed to minimize thermal expansion effects which could displace the mirrors and give “false” displacement or rotation measurements.

Many methods exist for mounting optics with low stress and high thermal stability. For additional information, a useful introductory article is “The Optic As A Free Body”, Photonics Spectra, Aug. 1985, pp. 49-59. Also, textbooks on opto-mechanical design can provide more information.

# Mounting

## Vibration considerations

Agilent 10719A interferometers are inherently less susceptible to vibration effects than some other interferometers. The stability of these interferometers is due to the fact that both their reference beams and their measurement beams travel to external mirrors. Any motion of the interferometer itself that is common to both beams will not appear as a measurement. Of course, any vibration between the reference and measurement mirrors will constitute real, measurable, displacements.

## Interferometer mounting system (user-supplied)

Since the mounting system requirements depend on the application, the mounting system must be designed and provided by the user. Here are some guidelines and recommendations for designing the mounting system.

The Agilent 10719A interferometer is designed for easy mounting and alignment. It may be mounted in any orientation, using the mounting hole patterns on either the top or bottom surface of the housing (see “Specifications and Characteristics” at the end of this subchapter). Mounting screw thread is 6-32.

The Agilent 10719A interferometer is a “referenced” interferometer. This means that the relationships of its internal optical components and laser beam paths to reference surfaces on its housing are specified. This information is shown in Figure 7J-7. This allows the possibility of a mounting scheme which eliminates the need for aligning or adjusting the interferometer.

## Designing the mounting system

The first step in designing the mounting system is to choose the nominal position of the interferometer in the application. This is primarily dictated by the desired location of the measurement beams on the measurement mirror.

Next, the mounting system for the interferometer should be designed to restrict each of the six-degrees-of-freedom (three translational, three rotational). The recommended positional tolerances for mounting the interferometer are given below. Consider an ideal case in which the input laser beam is perfectly aligned to its desired axis:

1. There is no recommended tolerance for locating the Agilent 10719A interferometer along the X-axis, since this has no influence on the measurement.
2. The recommended tolerances for locating along the Y-axis and Z-axis are ± 0.15 mm (± 0.006 inch). Positional errors here will displace the effective measurement points on the mirrors by an equal amount. Also, mislocation can offset the beam centering in the input and output apertures.
3. The recommended tolerances for pitch, roll, and yaw of the interferometer are ± 15 arc-minutes each, relative to the input beam. Here again, mislocation chiefly affects beam centering (although gross errors in roll, that is, over ±1 degree, can start to induce non-linearity error due to polarization misalignment.)

The primary reason for these tolerances is to control the measurement points on the mirrors and to ensure that the laser beams will reach the receivers properly aligned, with no clipping or signal loss. Small positional errors do not impair the measurement accuracy, provided they are fixed and do not change during the measurement.

With these positional accuracy goals in mind, there are two recommended approaches to designing the mounting system:

- Create an accurate, fixed mounting platform which predetermines the location of each interferometer using reference surfaces, or
- Create an adjustable mount with adjustments to “dial in” the positional accuracy after each interferometer is installed.

**Fixed Mounting Platform:** If you use the first approach, the best design for a mounting platform is to make it kinematic. Kinematic means that all six-degrees-of-freedom are singly and unambiguously restricted. It is best to use a locating plane, a locating line, and a locating point. The locating plane will be the surface to which the top or the bottom of the interferometer is bolted. The locating line should be a 2-point contact (or rail) which aligns the front face of the interferometer. The locating point should be a 1-point contact (or pad) which constrains side-to-side translations of the interferometer. To install the interferometer, it should be firmly pressed against its locating plane, line, and point while the mounting screws are torqued down. If the platform is made with the above-mentioned accuracy, this mounting method can completely eliminate the need to adjust or align the interferometers during installation. Then only the laser beam itself will need to be aligned to its proper position.

**Adjustable Mount:** The “adjustable mount” approach is recommended when the mechanical tolerances within the application do not permit the use of a predetermined (non-adjustable) platform. Coarse adjustments may be provided in a variety of ways, such as using slotted holes for the mounting screws. For fine adjustments, micro-positioning stages are available from a variety of vendors. When using adjustable mounts, ensure that the adjustment capability does not introduce creep or instability into the mounting system.

In some applications, a combined approach may be best. For example, perhaps a platform having an accurate, fixed height can be used in conjunction with an adjustment for yaw and side-to-side motion.

Whatever approach is used, the Agilent 10719A interferometer should always be held rigidly and stably once it has been installed.

# Installation

## Pre-installation checklist

In addition to reading chapters 2 through 4, and Chapter 15, “Accuracy and Repeatability,” complete the following items before installing a laser positioning system into any application.

- ☐ Complete Beam Path Loss Calculation (see “Calculation of signal loss” in Chapter 3, “System Design Considerations,” of this manual).
- ☐ Supply plane mirror reflectors. See Chapter 15, “Accuracy and Repeatability,” or “Specifications and Characteristics” section at the end of this subchapter for mirror specifications.
- ☐ Determine the direction sense for each axis, based on the orientation of the laser head, beam-directing optic, and interferometer. Enter the direction sense for each axis into the measurement system electronics. (See Chapter 5, “Laser Heads,” Chapter 14, “Principles of Operation,” and Chapter 15, “Accuracy and Repeatability,” in this manual.)
- ☐ Supply suitable mounting means for all components of the laser measurement system, based on the recommendations given earlier in this subchapter and elsewhere in this manual.
- ☐ Provide for aligning the optics, laser head, and receiver(s) on the machine.
- ☐ Be sure to allow for transmitted beam offset of beam splitters (Agilent 10700A and Agilent 10701A) in your design. (See the offset specifications under the “Specifications” section at the end of this subchapter.)

## Receivers

1. Agilent 10780F, E1708A, or E1709A receiver’s fiber optic sensor heads may be mounted directly to the Agilent 10719A interferometer’s output aperture. Alignment pins are provided for easy installation and alignment. This eliminates the need for any other user-supplied mount for the sensor head.
2. Maintain a bend radius not less than 35 mm (1.4 inches) to prevent signal attenuation in the Agilent 10780F receiver’s fiber optic cable.

# Alignment

## Alignment aid

To help in aligning the Agilent 10719A interferometer, an alignment aid (Agilent Part Number 10706-60202) is included with the interferometer.

## Alignment procedure

The objectives of the alignment procedure are:

1. to locate the measurement point accurately on the measurement mirror,
2. to minimize cosine error,
3. to maximize signal strength at the receiver, and
4. to ensure a symmetrical range of rotation about the “zero angle” point.

To accomplish these goals:

1. the measurement mirror must be aligned perpendicular to its axis of linear motion, and
2. the reference mirror must be aligned parallel to the measurement mirror, before proceeding with the steps below.

***NOTE*** When using the Agilent 10719A interferometer for angle measurements, comments in the procedure below regarding reference mirror alignment may be disregarded since they are inherently satisfied by the use of a single mirror for these measurements.

For a system having more than one measurement axis, choose a practical sequence in which to align the axes before beginning the interferometer alignment. Be aware that the laser head and certain beam-directing optics may be adjusted for the first axis, but then must not be readjusted while aligning any other axis. (In fact, the convenience of being able to make independent adjustments may suggest the use of additional beam-directing optics in certain cases.)

**1** Begin by installing the laser head and the optics in their desired locations and roughly aligning the laser beam so it is centered on the input aperture of each interferometer. Do not install the receivers yet.

**2** If the interferometers are mounted on adjustable mounts, instead of fixed platforms which predetermine their locations, position them to within the translational and rotational tolerances described in

"Mounting" section, above. This determines the locations of the measurement points on the mirrors.

3 With the interferometers and mirrors properly positioned, finish the alignment by adjusting the input laser beam's angle and position for each interferometer individually:

**a.** First, adjust the angle of the input beam using the autoreflection technique.

1 Start by selecting the small aperture on the front turret of the laser head.

2 Insert the alignment aid (Agilent Part Number 10706-60202) into the measurement beam between the interferometer and the measurement mirror. (This may be held in position temporarily by affixing a piece of tape to its yellow label.) This will cause the beam reflecting off the mirror to reflect back out through the input aperture toward the laser head.

3 Angularly adjust the input beam using the beam-directing optics or the laser head or both until the reflected beam re-enters the small aperture of the laser head.

***NOTE*** Careful, accurate autoreflection at this step is essential to minimizing cosine errors, assuming the mirror is perpendicular to the linear axis of travel.

***NOTE*** For higher accuracy alignment, the "Autoreflection" information in Chapter 4, "System Installation and Alignment," of this manual for additional methods to optimize the autoreflection alignment.

**b.** Second, adjust the centering of the input beam on the input aperture by visual alignment.

1 Start by switching back to the large aperture on the turret of the laser head (because the small aperture is only roughly aligned to the beam center).

2 Place a piece of translucent tape across the input aperture of the interferometer to make the input beam easily visible.

***NOTE*** Be careful not to stick the tape to any glass surface.

3 Translate the beam-directing optics or the laser head or both to center the input beam on the aperture. Do not disturb the angular alignments already made. With care, you can center the beam visually to within ±0.15 mm (±0.006 inch) of its ideal position.

**c.** Go back to steps 3.a and 3.b and alternately recheek and readjust the input beam angle and centering until both are simultaneously optimized. Then remove the tape from the input aperture and remove the alignment aid.

**d.** As a further alignment check, place a piece of translucent tape across the output aperture(s) to make the output beam(s) easily visible. Each output beam should now be approximately centered in its aperture without clipping.

***NOTE*** Any clipping observed here indicates a centering problem at the input aperture or an autoreflection problem.

**e.** Clamp down the laser and the beam directing optics without changing their alignment.

**4** At this point, the reference beam has also been automatically aligned, assuming the reference mirror is parallel to the measurement mirror. If any parallelism error exists, the beam overlap in the output aperture(s) will be degraded, which may be visible. You can check beam overlap qualitatively by alternately blocking the reference and measurement beams and observing their respective positions on the tape across the output aperture(s). Remove the tape when done.

***NOTE*** If a beam overlap problem exists, recheck the parallelism of the reference mirror, relative to the measurement mirror. Adjust as needed.

**5** Attach the Agilent 10780F receiver’s fiber-optic sensor heads, using 4-40 screws. Avoid kinking or excessive bending of the cable as explained under the “Receivers” subsection, earlier in this subchapter.

**6** Repeat the above steps for all other interferometers in the application, being careful to adjust only beam-directing optics which do not disturb the alignments already completed.

# Operation

## Reset considerations

If the reflectors you use with the interferometer are not at their zero deadpath positions when you reset the system, you should enter a zero-deadpath compensation value, as described in the “Deadpath compensation considerations” subsection, which follows.

## Deadpath compensation considerations

Proper use of deadpath compensation is essential to achieving maximum accuracy.

“Zero-deadpath” is the condition in which the measurement beam path length and the reference beam path length are equal. For the Agilent 10719A interferometer, this does NOT occur when the measurement and reference mirrors are coplanar, as a cursory look might imply. Because the reference beam travels an additional 19.05 mm (0.750 inch) through air inside the interferometer itself, the zero-deadpath condition occurs when the measurement mirror is 19.05 mm farther from the interferometer housing than the reference mirror.

Deadpath compensation for the Agilent 10719A interferometer can be performed in one of two ways:

- move the measurement mirror to the zero-deadpath position before each system reset, or
- use a deadpath compensation number in software. If you use this method, be aware that the compensation number can be either positive or negative, depending on the relative position of the mirrors at reset. Be sure to use the correct sign for your application.

When the Agilent 10719A interferometer is used in its angle-measuring configuration, you must use the second (software) method, since the measurement and reference path lengths are inherently unequal by 19.05 mm (0.750 inch).

# Specifications and Characteristics

Agilent 10719A interferometer specifications are presented in this section.

# Agilent 10719A One-Axis Differential Interferometer Specifications

**USE:** Single- and multiple-axis applications such as precise positioning of a multiaxis stage, where the stage must be linearly positioned with respect to an external object such as a column or inspection tool. Alternatively, an angle is measured when both reference and measurement beams measure distance to the same mirror. The interferometer can be made vacuum compatible.

## SPECIFICATIONS

**Operating Temperature:** 17 to 23°C
**Weight:** 300 grams (11 ounces)

**Dimensions:** see Figure 7J-7 on next page

**Materials Used:**

Housing: Aluminum

Optics: Optical grade glass

Adhesives: Vacuum grade

**Axis:** Linear or pitch or roll
**Available Beam Size:** 3 mm

**Thermal Drift Coefficient (Average):** 150 nm (5.9 µin.)/°C

**Non-linearity Error:** <2.2 nm (0.09 µin)

**Resolution:***

Optical: λ /4

Linear: 5 nm (using 32 × resolution extension)
0.62 nm (using 256 × resolution extension)

Angular (pitch or roll): 0.7 µrad (0.14 arc-sec)-using X32 electronics
0.1 µrad (0.02 arc-sec)-using X256 electronics

**Range:****

Linear: 10m (33 ft).

Angular (pitch or roll):

| at distance = 150 mm | at distance = 300 mm |
|---|---|
| ± 0.88 mrad<br>(± 3 arc-min) | ± 0.44 mrad<br>(± 1.5 arc-min) |

*Linear and angular resolutions are dependent on the electronics used. Optical resolution is dependent only on the interferometer, and can be used to determine linear and angular resolutions when the electronic resolution extension is known. The linear and angular specifications in this section are for interferometer use with the X32 resolution extension electronics (10885A, 10895A) or X256 resolution extension electronics (10897B, 10898A).

** Linear range here is the sum of the ranges for all axes. Angular range is the maximum measurement mirror angle due to all components (i.e., yaw and pitch, or yaw and roll) between the measurement mirror and the interferometer for a 6-axis system. Range will be reduced when the reference mirror is misaligned.

**Parallelism (Input to output beams):** 0.1 mrad (20 arc-sec).

**Optical Efficiency (output beam/input beam):**

Average: 60%

Worst Case: 40%

**INSTALLATION RECOMMENDATIONS**

**Installation and alignment:** Kinematic installation requires a referenced surface.

**Receivers:** Agilent 10780F fiber-optic remote receivers or Agilent 10780C receivers.

**Receiver Alignment:** Self-aligning when mounted to interferometer.

**MEASUREMENT AND REFERENCE (Plane) MIRROR RECOMMENDATIONS**

**Reflectance:** 98% at 633 nm, normal incidence.

**Flatness:** Depending on accuracy requirements of the application, mirror flatness may range from λ /4 to λ /20 (0.16 to 0.03 µmeters, 6 to 1.2 µinches).

**Optical Surface Quality:** 60—40 per Mil-0-13830.

**NOTE:** Flatness deviations will appear as measurement errors when the mirror is translated across the beam. Mirror mount should be kinematic so as not to bend mirror. If accuracy requirements demand it, mirror flatness might be calibrated (scanned and stored in the system controller) to be used as a correction factor.

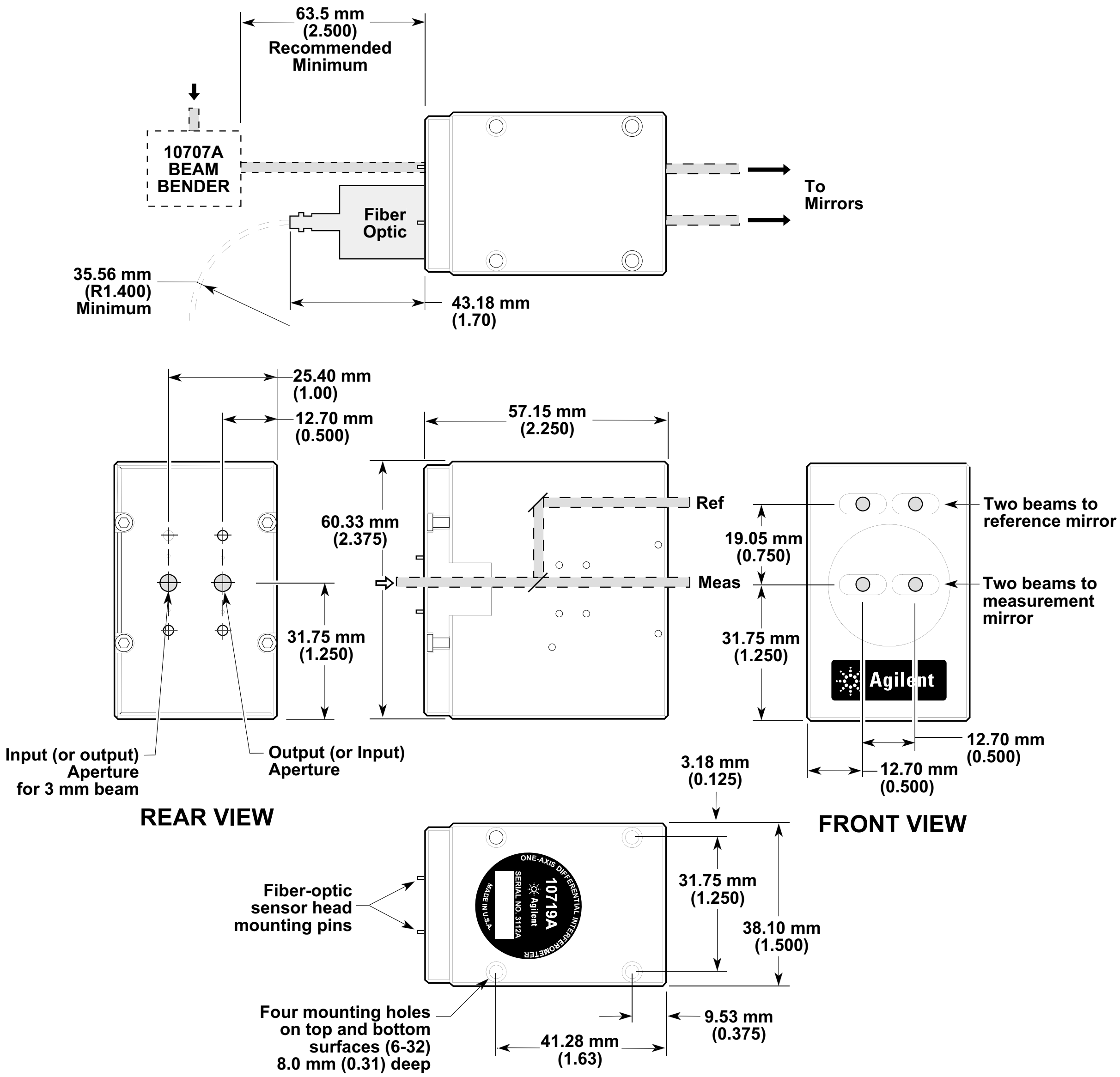


**Figure 7J-7. Agilent 10719 One-Axis Differential Interferometer — dimensions**

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