7I

Agilent 10717A Wavelength Tracker

Description

The Agilent 10717A Wavelength Tracker (see Figure 7I-1) uses one axis of a laser measurement system to report wavelength-of-light changes, not changes in position (displacement). The Agilent 10717A Wavelength Tracker's output can be used to correct displacement values reported via other measurement axes in the system. Since the wavelength of the laser light is the length standard used in Agilent laser measurement systems, being able to track these changes helps to make more-accurate measurements.

The Agilent 10717A Wavelength Tracker consists of an optical reference cavity (called an etalon) and an Agilent 10715A Differential Interferometer. Both components are mounted on a common metal baseplate and prealigned at the factory. Built-in baseplate adjustments simplify installation and alignment to the laser system.

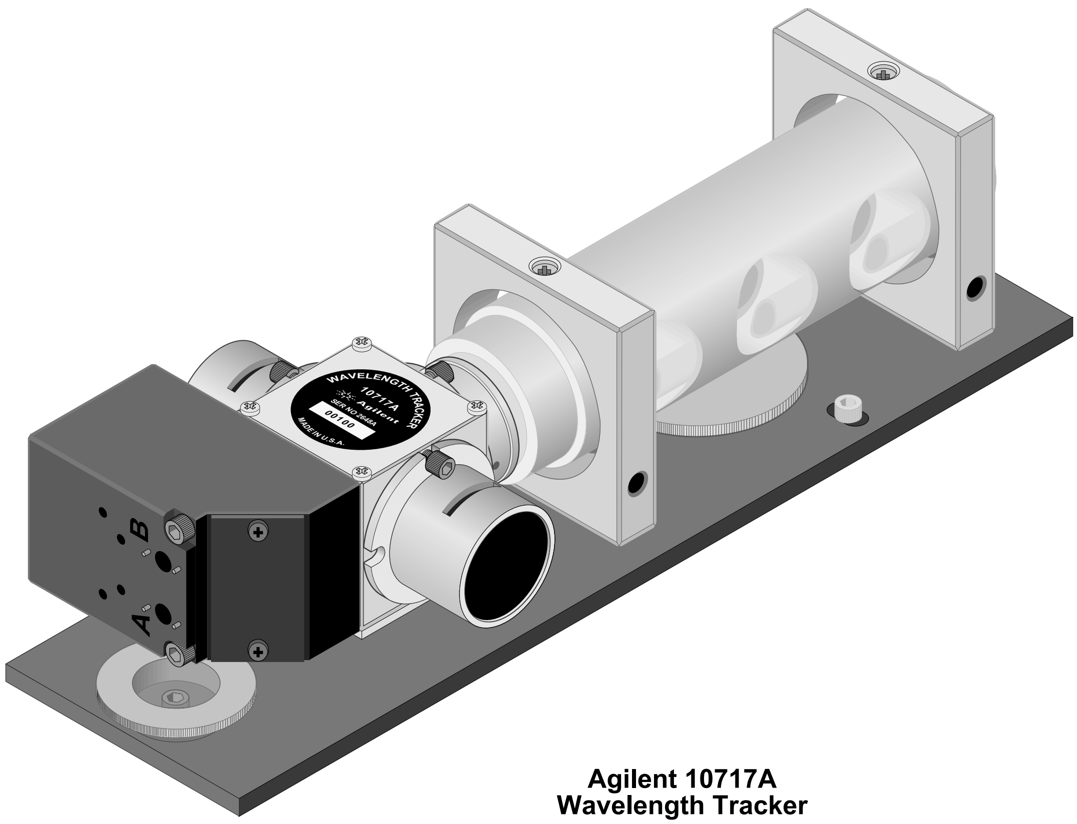

Figure 7I-1. Agilent 10717A Wavelength Tracker

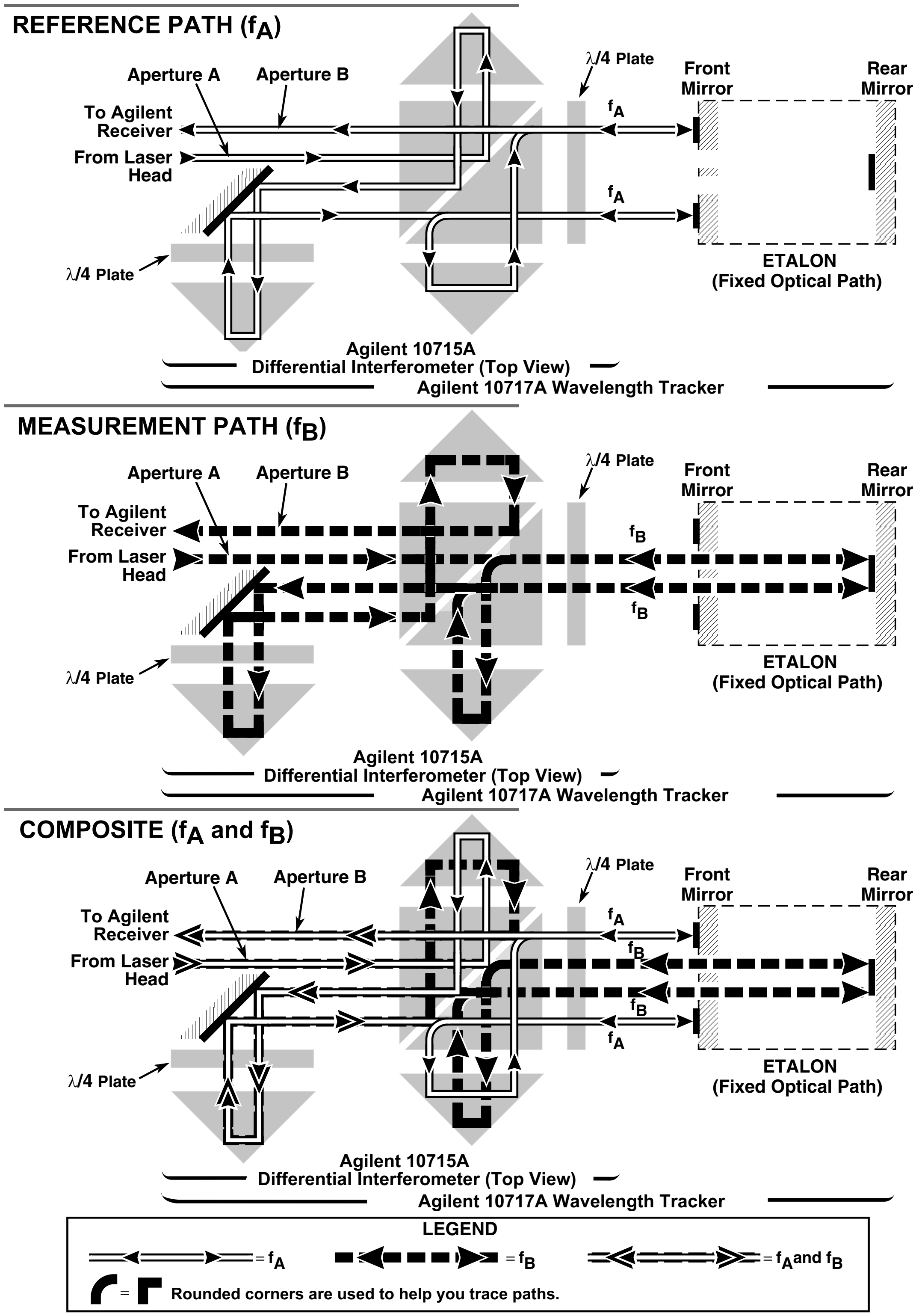

Figure 7I-2. Agilent 10717A Wavelength Tracker laser beam path

The Agilent 10717A Wavelength Tracker provides a higher degree of accuracy than environmental sensors such as the Agilent 10751C or Agilent 10751D Air Sensor, thereby improving the laser system measurement performance. For a more detailed comparison of compensation methods, see “WOL Compensation Method Comparison” in Chapter 15, “Accuracy and Repeatability,” of this manual.

The Agilent 10717A Wavelength Tracker’s output must be directed to an Agilent 10780C, Agilent 10780F, Agilent E1708A, or Agilent E1709A receiver where a measurement signal is generated. The laser measurement system electronics use this signal and the laser head’s reference signal to monitor changes in the wavelength of light. For maximum accuracy, the etalon’s length (the number written on the end of the etalon) must be used in the electronics.

Operation is straightforward. The etalon, consisting of two mirrors separated by a thermally stable spacer, presents a fixed distance to the differential interferometer. The interferometer monitors the optical path length between these two mirrors. Any change in the wavelength-of-light (that is, changes in the air density or index of refraction within the etalon cavity) causes an optical path length change, which is detected as a phase shift in the measurement frequency. The Agilent compensation electronics uses this phase information to update the compensation number for use by the rest of the system.

Maintaining the ± 0.20 ppm accuracy typical of this compensation technique requires that air within the etalon’s cavity have the same temperature, pressure, and humidity as the air in the measurement paths. To accomplish this, the Agilent 10717A Wavelength Tracker should be mounted as close to the measurement area as possible.

Figure 7I-3 shows an X-Y stage application using a Wavelength Tracking Compensation system. The components that comprise the Wavelength Tracking Compensation system are:

- Agilent 10717A Wavelength Tracker
- Beam Bender or Beam Splitter
- Agilent 10710B Adjustable Mounts (for mounting beam bender or beam splitter)
- Agilent 10780C or Agilent 10780F receiver
- Receiver Cable (the cable used depends on the measurement system electronics used, see Chapter 9, “Accessories,” in this manual for a listing and description of the cables available.)

- Automatic Compensation Board for the system electronics you are using. (Recommended; see “Automatic Compensation” paragraphs in your electronics documentation for installation procedures.)

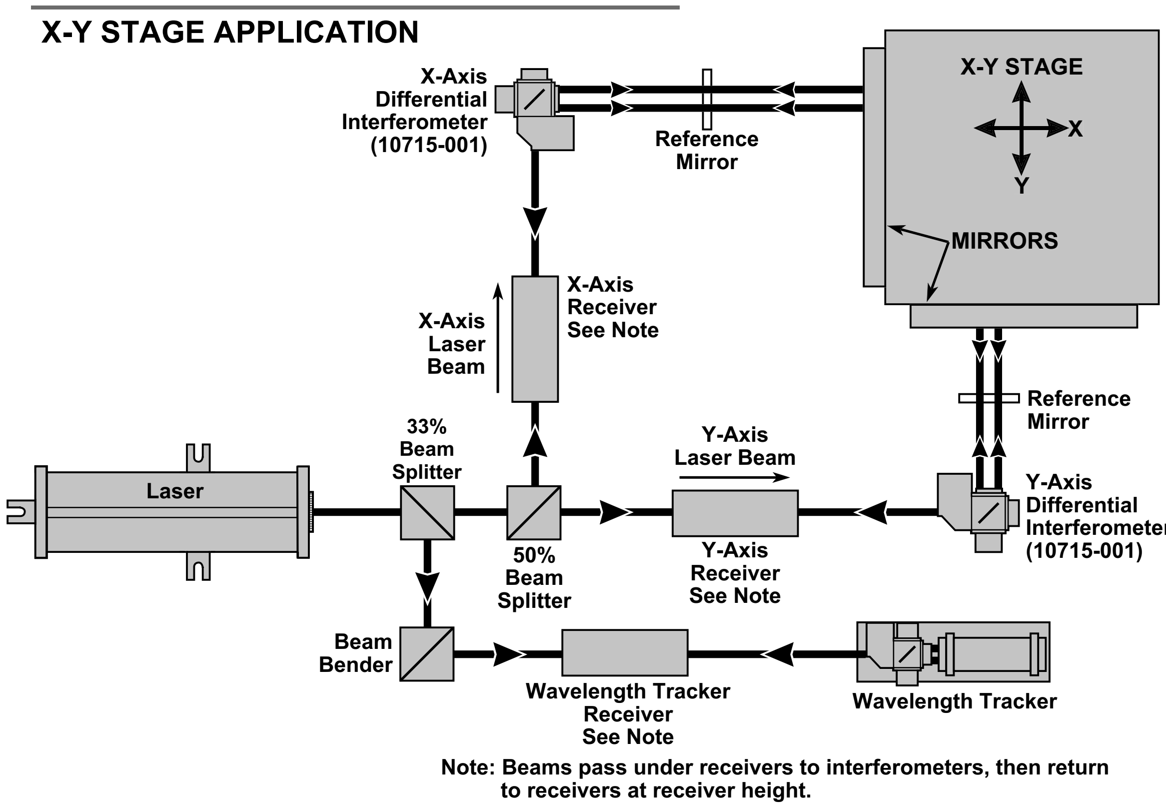

Figure 7I-3. Two-axis differential interferometer with wavelength tracker

Special Considerations

The orientation of the laser head with respect to the Agilent 10717A Wavelength Tracker, and the selection of the input aperture on the wavelength tracker's differential interferometer, affect the direction sense of the compensation output. The correct direction sense of the wavelength tracker signal occurs when the compensation number gets larger as the wavelength-of-light increases. Refer to Chapter 15, "Accuracy and Repeatability," in this manual for a discussion on atmospheric compensation.

The direction sense of the wavelength tracker signal may be changed on the Agilent 10896A VME Compensation Board by modifying the sign of the *WRL value. Refer to the appropriate electronics Users Manual for details. Table 7I-1 gives the correct sign of the *WRL value for various system configurations.

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Table 7I-1. Agilent 10717A direction sense

Laser Head	Laser Head Orientation Horizontal or Rolled 90° About Beam	Agilent 10717A Input Aperture A or B	Agilent 10717A Orientation Horizontal or Rotated 90° About Etalon Axis	Sign of *WRL Value
Agilent 5517A/B/C/D F1 Horizontal F2 Vertical	Horizontal	A	Horizontal	+
Agilent 5517A/B/C/D F1 Horizontal F2 Vertical	Horizontal	A	Rotated 90°	–
Agilent 5517A/B/C/D F1 Horizontal F2 Vertical	Horizontal	B	Horizontal	–
Agilent 5517A/B/C/D F1 Horizontal F2 Vertical	Horizontal	B	Rotated 90°	+
Agilent 5517A/B/C/D F1 Horizontal F2 Vertical	Rotated 90°	A	Horizontal	–
Agilent 5517A/B/C/D F1 Horizontal F2 Vertical	Rotated 90°	A	Rotated 90°	+
Agilent 5517A/B/C/D F1 Horizontal F2 Vertical	Rotated 90°	B	Horizontal	+
Agilent 5517A/B/C/D F1 Horizontal F2 Vertical	Rotated 90°	B	Rotated 90°	–

Installation and Alignment

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).
- ☐ 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 "Agilent 10717A Wavelength Tracker Specifications and Characteristics" section at the end of this subchapter.)

Alignment aid

To help in aligning the Agilent 10717A Wavelength Tracker, an Alignment Aid (Agilent Part Number 10706-60001) is included. This is the same alignment aid used on the Agilent 10706A Plane Mirror Interferometer and Agilent 10715A Differential Interferometer.

Procedure

This procedure describes the installation and alignment of the wavelength tracker axis. The two units that require alignment are the Agilent 10717A Wavelength Tracker and the Agilent 10780C or Agilent 10780F Receiver. The wavelength tracker unit itself is prealigned at the factory and requires no internal alignment. The Wavelength Tracking Compensation system should be installed and aligned with the following considerations in mind:

- The wavelength tracker should be installed so that the air it samples is the same air through which the measurement axis beam passes.
- The wavelength tracker should be aligned to obtain maximum laser beam signal at the receiver. (See multiaxis applications information in Chapter 3, "System Design Considerations," and elsewhere in this manual.)
- The Agilent 10780C, 10780F, E1708A, or E1709A receiver should be mounted in such a way that its LED indicator and gain adjustment potentiometer are accessible.

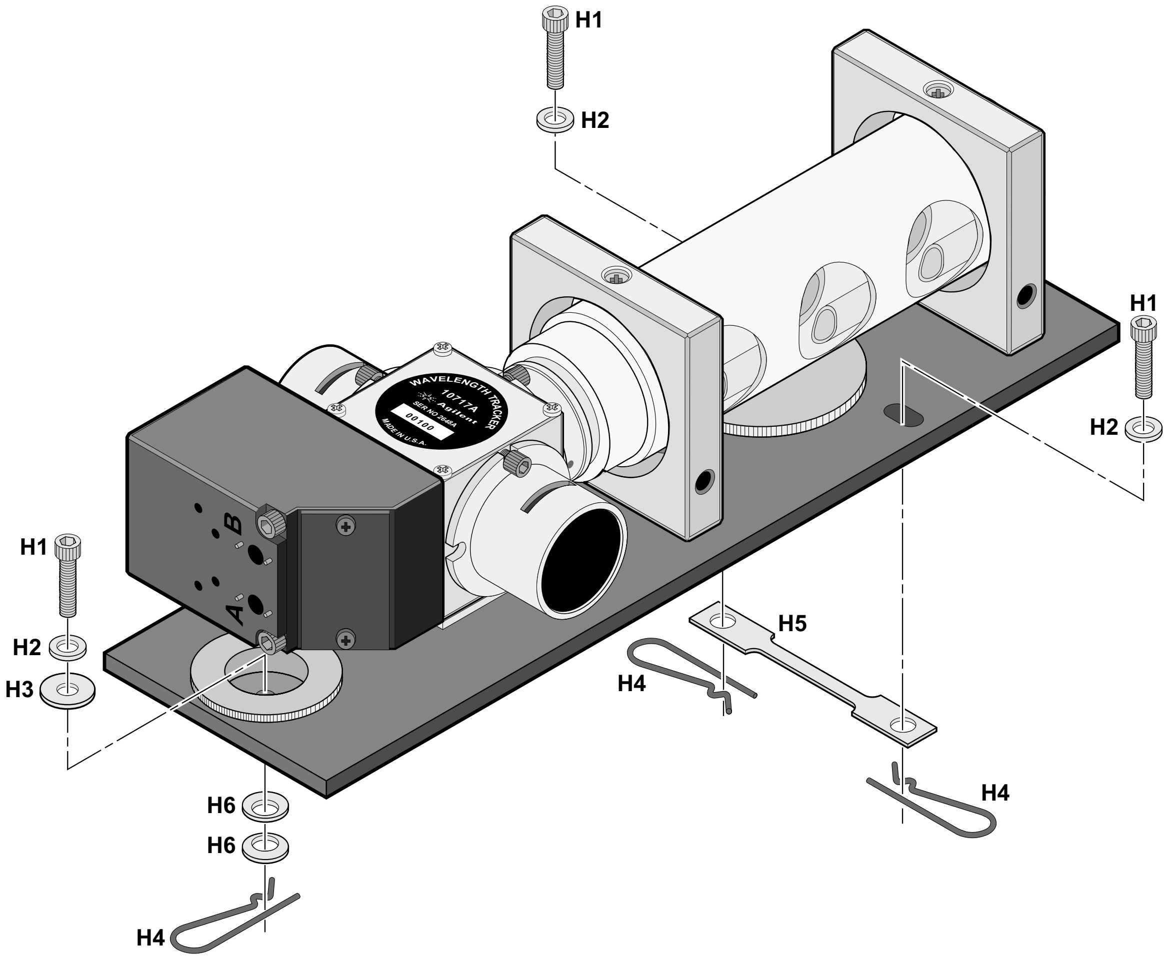
- The Agilent 10780C, 10780F, E1708A, or E1709A receiver is properly aligned when: 1) the laser beam is centered on its input aperture, 2) the LED indicator on top is lighted, and 3) the voltage at the its test point is greater than +0.7 Vdc. A receiver alignment procedure is provided in Chapter 8, “Receiver,” of this manual.
- No more than six measurement axes are installed in addition to the wavelength tracker.

Alignment starts at the laser head and moves out one component at a time (laser head, beam bending and beam-splitting optics, wavelength tracker, and then receiver) until the last component of the Wavelength Tracking Compensation system is aligned and the laser beam is centered on the receiver’s aperture. This alignment procedure has the laser beam entering the Agilent 10717A’s differential interferometer through aperture A.

NOTE

Do not remove the red tape and three hitch-pin clips until instructed to do so in this procedure. The “clips” make installation of the wavelength tracker easier. The red tape and clips (see Figure 7I-4, item H4) keep the three mounting screws in place during installation, and allow installation of the unit at any angle without having to physically hold the three mounting screws in place. After installation is complete, the clips are removed by pulling on the red tape. If the red tape and mounting hardware are removed or lost prior to the wavelength tracker’s installation, refer to Figure 7I-4 for an exploded view of the tracker’s hardware and a listing of their respective Agilent part numbers.

WAVELENGTH TRACKER MOUNTING HARDWARE



Reference Designator	Description	Agilent Part Number
H1	Screw - HD cap 10-32 0.75 in-lg	3030-0182
H2	Washer - spring	3050-1274
H3	Washer - flat 1/4 in. 0.281 in-lg	3050-0583
H4	Hitch-pin clip	1480-0694
H5	Subplate	10717-20209
H6	Washer - 2 part spherical	3050-1272

Figure 7I-4. Wavelength tracker mounting hardware

1 Set the wavelength tracker over the tapped holes on your equipment.

NOTE Do not remove red tape and hitch-pin clips at this time.

2 Engage three to four threads of the three mounting screws (see Figure 7I-4) by rotating each screw three to four revolutions using the hex-ball driver supplied.

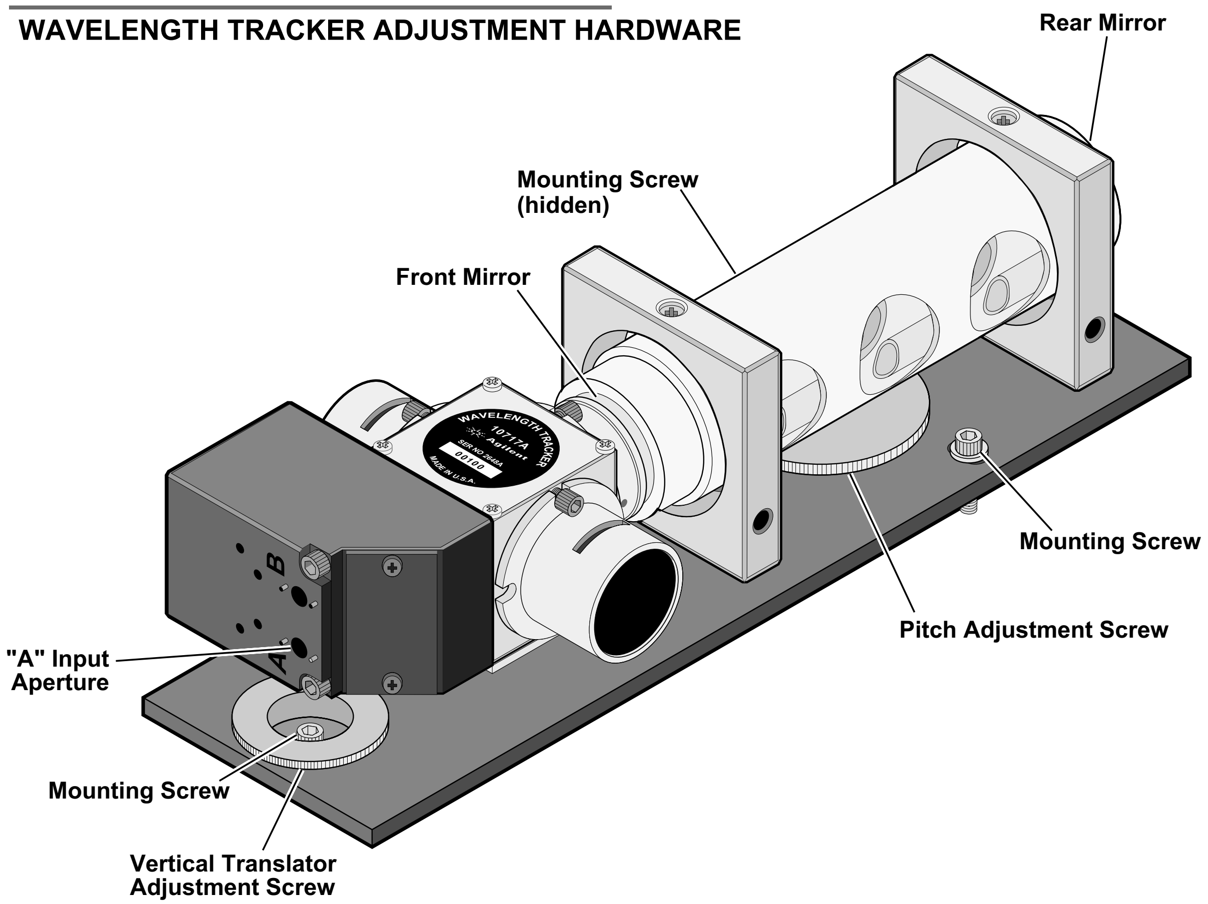


Figure 7I-5. Agilent 10717A Wavelength Tracker adjustment hardware

3 Remove the three hitch-pin clips by pulling on the red tape.

4 Tighten the front mounting screw (Figure 7I-5) until slight resistance is sensed.

5 Place a piece of translucent tape over the differential interferometer's "A" input aperture (see Figure 7I-4). Flatten the tape tightly against the input "A" aperture to produce a high-resolution outline of the input aperture. You should see a well-defined laser pattern on the tape.

6 Rotate the vertical translator adjustment screw (see Figure 7I-5) until the input beam is vertically centered about the input aperture. At the same time, move the tracker horizontally to center the laser beam horizontally.

7 Tighten the front mounting screw (see Figure 7I-5) finger-tight when the laser beam is centered on the input aperture.

8 Remove the translucent tape from the differential interferometer input aperture.

9 Install the quarter-waveplate alignment aid so the primary measurement beam passes through the hole in it (see Figure 7I-6).

NOTE Standard input aperture for the wavelength tracker is “A” (positive sense). If the input beam goes to aperture “B”, the direction sense changes (negative sense). See “Special Considerations” section in this subchapter and Table 7I-1 for wavelenght tracker direction sense change details.

10 Select the small aperture of the laser head.

11 Rotate the pitch adjustment screw (see Figure 7I-5) until the laser beam autoreflected back to the laser head is centered vertically about the output beam. Yaw the baseplate back and forth until the autoreflected beam is concentric with the laser head aperture.

12 Tighten all three mounting screws alternately (see Figure 7I-5) until finger-tight. Now tighten the screws by applying a torque of 0.9 Newton-meter (8 inch-pounds). Maintain proper autoreflection as the screws are tightened. Correct for any change by readjusting the wavelength tracker in pitch and yaw until the laser beam is autoreflected back into the laser head. This insures proper angular alignment.

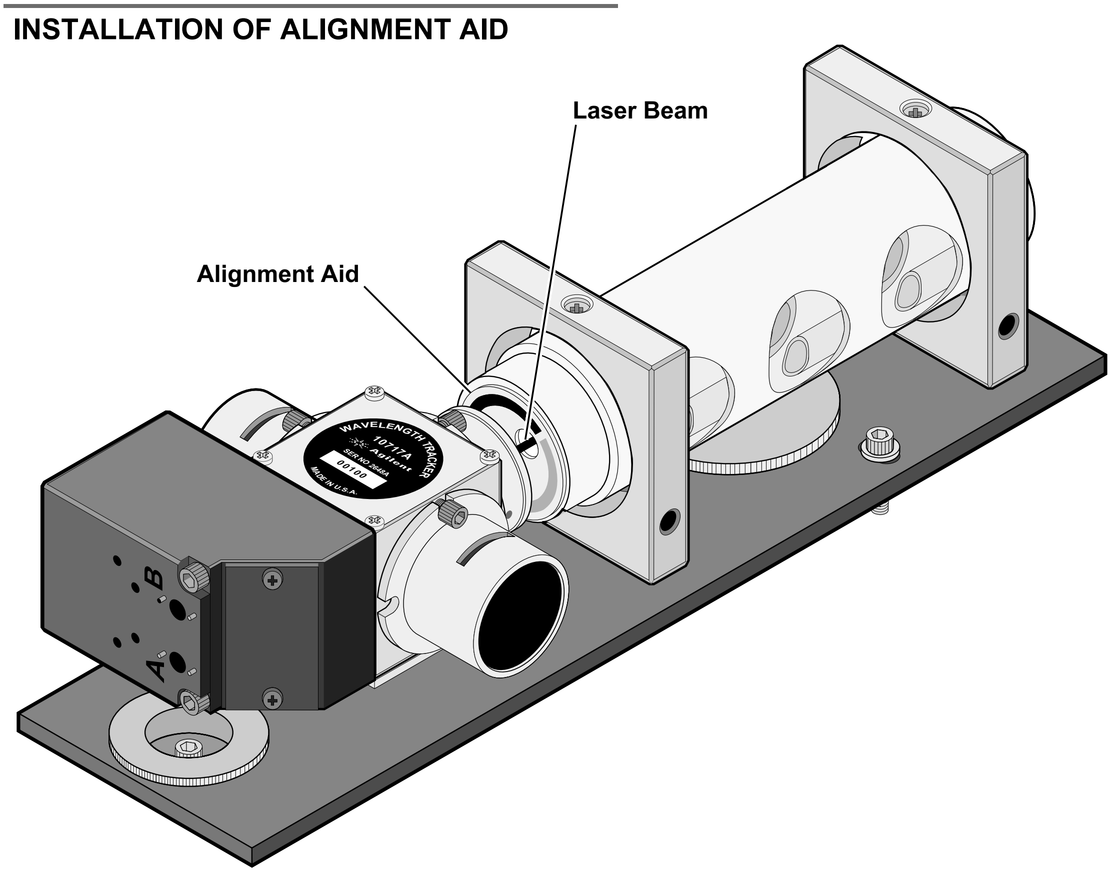


Figure 7I-6. Installation of alignment aid

NOTE

Tightening the mounting screws unevenly or exceeding the specified torque specification will disrupt alignment and degrade overall system performance.

13 Remove the alignment aid.

14 Return the laser head turret to its larger aperture. Two parallel unclipped beams should now exit the differential interferometer.

15 Check for a circular, unclipped laser beam. As long as the two beams are not clipped, the wavelength tracker alignment is adequate.

16 Alignment of the receiver is accomplished by moving it (or its sensor head) from side to side, and pitching and yawing it to center the beam on its lens. Coarse beam alignment is performed using the snap-on Alignment Target fixture (Agilent Part Number 10780-40003 or Agilent Part Number 10780-40009) supplied with the receiver (see Chapter 8, “Receivers,” in this manual.) For the wavelength tracker, this target is used only to align the receiver (or its sensor head) to the incident beam.

17 To check the final optical alignment of the Wavelength Tracking Compensation system, place a rectangular gage block over the lens of the receiver (and pressed against the receiver’s case, or its sensor head’s input face) and autoreflect the beam back toward the differential interferometer of the wavelength tracker. When the receiver (or its sensor head) is mounted properly (which occurs when the beam enters the receiver’s or sensor head’s input aperture parallel to its housing), the autoreflected beam will be coincident on itself back to the laser head. Refer to the receiver alignment procedures in Chapter 8, “Receivers,” in this manual for more receiver alignment information.

After optical alignment of the receiver, the gain of the receiver is adjusted. This procedure ensures that the leakage signal from one of the beams isn’t sufficient to turn on the receiver. The following procedure sets the gain just below the optical leakage threshold.

18 Connect a fast-responding voltmeter to the test pin on the receiver.

19 Block one of the two beams incident on the **front** etalon mirror (see Figure 7I-5) with a piece of paper. Be sure to block only one beam at this time. Observe the voltmeter reading. If the reading is greater than +0.1 Vdc, turn the gain adjustment screw counterclockwise until the voltage reads +0.1 Vdc.

20 Block one of the two beams incident on the **rear** etalon mirror (see Figure 7I-5) with a piece of paper. Again, be sure to block only one beam at this time. If the measured voltage is greater than +0.1 Vdc, turn the gain adjustment screw clockwise until the reads +0.1 Vdc.

21 Remove the beam-blocking device. The voltmeter should now read at least +0.7 Vdc. If the measured voltage is below +0.7 Vdc, the wavelength tracker, or the receiver, or both, is not properly aligned. If, after repeating the receiver alignment (steps 16 through 20), the voltage measured at the test point is still below +0.7 Vdc, the entire alignment procedure must be repeated until the misalignment is corrected.

22 Disconnect the voltmeter from the receiver's test point.

All alignment and adjustment procedures are now complete.

NOTE

After the wavelength tracker and receiver have been properly aligned in the measurement system, you should lock the vertical translator adjustment screw (see Figure 7I-5) in place. This will prevent possible cosine error in the wavelength tracker due to thread clearance between the adjustment screw and the baseplate. A suitable low strength, wicking adhesive (Locktite #425) is recommended. In vibration-free environments, this precaution may not be necessary.

Agilent 10717A Wavelength Tracker Specifications and Characteristics

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.

Dimensions: see figure below

Weight: 1.7 kg (3.7 pounds)

Etalon Length: 127mm (5 inches) nominal

Optical Efficiency:

Typical: 36%
Worst Case: 25%

Angular Adjustment Range (at nominal position):

Pitch: I°

Yaw: I°

Translational Adjustment Range (at nominal position):

Vertical: ± 3 mm (0. 12 inch)

Horizontal: ± 3 mm (0.12 inch)

Mounting:

Three 10-32 UNF2A tapped holes (hardware supplied).

See drawings below

Mounting Screw Torque: 0.9 Newton-meter (8 inch-pounds)

Minimum Mounting Clearance Required:

3 mm (0.12 inch) around perimeter

Calibration: none required

NOTE: If an Agilent Automatic Compensation Board is not used, system measurement repeatability may be calculated as follows:

[(R/127+0.028) ppm +AT(0.06 ppm/° C) +
AP(0.002 ppm/mm Hg)]
where
R = electronics resolution in nm (5 nm for
Agilent Automatic Compensation Boards)

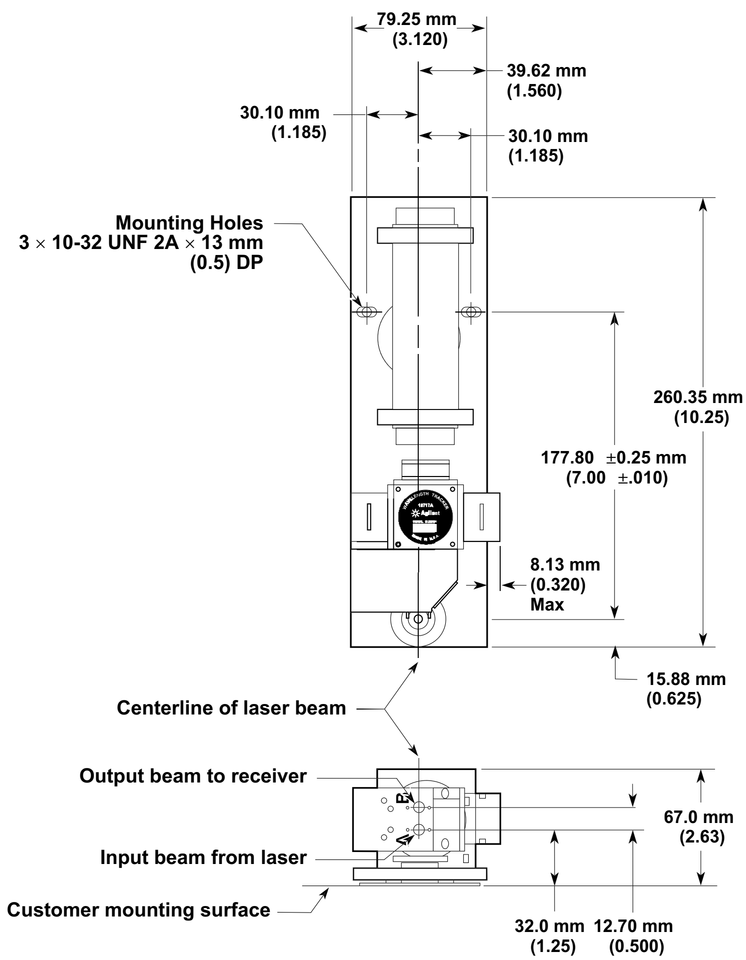


Figure 7I-7. Agilent 10717A Wavelength Tracker — dimensions

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Laser and Optics User's Manual
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Paper version: p/n 05517-90045
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This chapter is p/n 05517-90116