

Agilent N1203/4/7C Beam Manipulators and N1206T Adjustment Tool Kit

Product Overview

N1203C, N1204C, N1207C, N1206T



N1203C



N1204C

Introduction

The Agilent beam manipulator family of products (N1203C, N1204C, N1207C and N1206T) precisely bend or translate a laser beam to achieve sub-nanometer measurements. They align laser beams quickly and easily in order to reduce measurement errors.

These products are usually used in combination to provide precise, independent, stable control over beam translation and angle. The precise bending and translating results in a properly aligned laser beam, minimizes Abbé and cosine errors and ensures maximum angular measurement range. Maximum angular measurement range is achieved by translating the laser beam to the center of the remote sensor aperture when the measurement mirror is normal to the measurement laser beam.

Product Description

The N1203C Precision Beam Translator contains a refracting window at the center of a metal ball inside a precision optical mount. The translator precisely moves the outgoing beam parallel to the incoming beam *without changing the angle*. It is the component used primarily to reduce Abbé errors.

The N1204C and N1207C Precision Beam Benders contain a mirror at the center of a metal ball inside a precision optical mount. The benders precisely angle the beam, with a large degree of freedom around 90 degrees, *without translating the beam*. The N1204C bends the beam horizontally and the N1207C bends the beam vertically. These components are used primarily to reduce cosine errors.

Removable tooling (Agilent N1206T Tool Kit) allows fast and easy alignment. Once the adjustment is completed and tools removed, the precision mounts provides long-term stability of the setting over specified temperature, shock and vibration.



Features

Thermal Stability

The Agilent N1203C, N1204C, and N1207C beam manipulators exhibit excellent thermal stability since all mounting components of the manipulator are of the same material. The optic (refracting window or mirror) is placed at the center of a ball which is suspended symmetrically in a spring nest. The symmetry of this design enables the contact points between the ball and the springs to remain precisely the same as the temperature changes. Hence, as the temperature changes, there is no rotation imparted to the ball.

Mechanical Stability

The beam manipulator feet are designed not to slip due to differential thermal expansion between the stainless steel housing and an Invar mounting plate in the presence of an environmental temperature change of up to 20°C. Thus, there will be no unrecoverable beam displacement due to foot slippage when mounted to many materials.

Optical Input/Output Ports and Adjustment Access

The Agilent N1203C, N1204C, and N1207C manipulators have six input and output (I/O) ports. There is only one mounting face. From this one mounting, either horizontal or vertical bends in any direction may be accomplished. Adjustment tools may be attached at any of ten access ports, allowing two of the I/O ports for entrance and exit of the laser beam.

Adjustment Tool Kit (Agilent N1206T)

This kit contains a set of adjustment levers and an adapter that are designed to make user-desired beam alignment (by rotating the

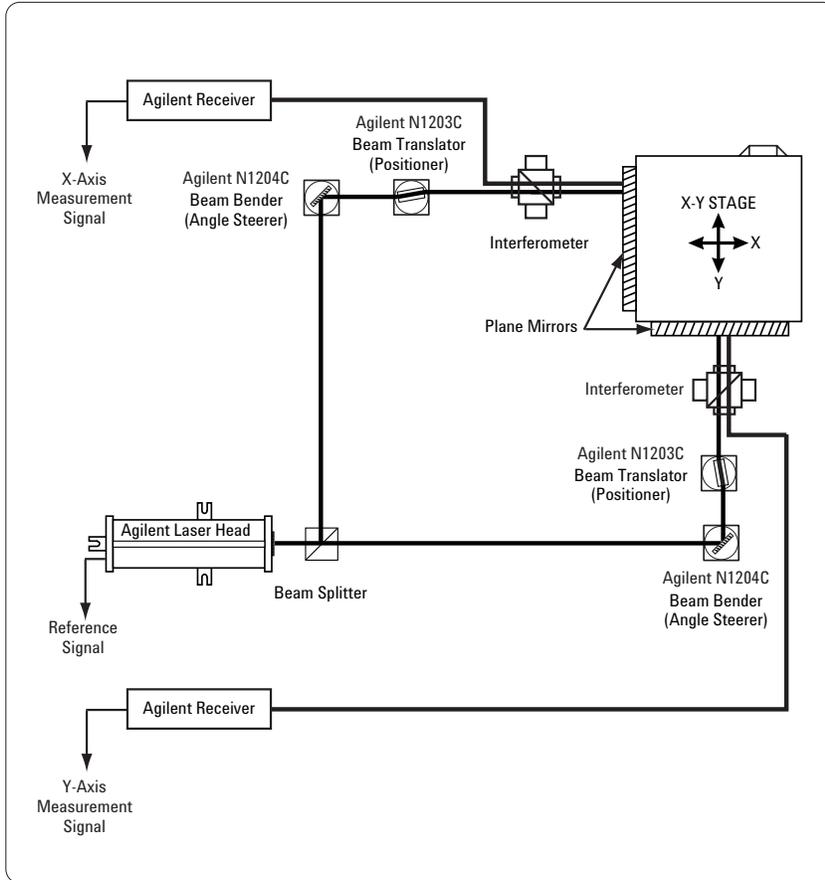
ball/mirror inside the manipulator) accessible from many different positions.

The tools contained in the kit are:

- **Agilent N1206A**
Ball Adjustment Lever – long (176 mm)
- **Agilent N1206B**
Adjustment Lever Adapter
- **Agilent N1206F**
Ball Adjustment Lever – short (123 mm)
- **Agilent N1206G**
Ball Adjustment Lever – bent (173 mm with 45° angle)

Applications: Cosine and Abbé Error

Misalignment of the measurement axis (the laser beam) to the mechanical axis of motion results in an error between the measured distance and the actual distance traveled. This error is called cosine error because its magnitude is proportional to the cosine of the angle of misalignment. Cosine error is common to all position transducers. If the laser alignment is unchanged over time, the cosine error will not change. Therefore, cosine error is part of the accuracy budget, but not part of the repeatability budget.



Abbé error occurs when the measuring point of interest is displaced from the actual measuring scale location and unwanted angular motion occurs in the positioning system. Abbé error makes the indicated position either shorter or longer than the actual position, depending on the angular offset.

The figure above shows a typical system that uses the principles of aligning each axis using the beam manipulators. In this type of multi-axis interferometric measurements, you can only align the laser head to one of the axes, but you still must have some means of angularly steering the beam for each axis of measurement, translating the beam (up/down, left/right) for each axis so that you can position the beam to enter the input port of a fixed interferometer, and reducing Abbé error.

In multi-axis systems, the laser beam manipulators allow you to pick up the beam and move it around to accommodate each individual axis of measurement. Alignment of a multi-axis system would be impossible if we didn't have precision angle adjustments on bending mirrors and precision beam translation capability.

N1203C Precision Beam Translator Specifications

Weight: 920 grams

Materials Used: Martensitic stainless steel, Optical grade glass

Optical Efficiency: 99% typical, 98.7% Worst case

Input/Output Clear Aperture: ϕ 19.0 mm

Input Beam Position Tolerance: \pm 5 mm

(Note: input beam de-centering may limit translation range.
See range specification below.)

Beam Translation Range (from input at normal incidence on center of clear aperture):

\pm 3 mm with ϕ 9 mm beam

\pm 4 mm with ϕ 6 mm beam

\pm 4.4 mm with ϕ 3 mm beam

Transmitted Beam Deviation: \pm 10 microradian maximum

Beam Translation Sensitivity/Resolution: 1.0 micrometer

Thermal Drift: 100 nm per $^{\circ}$ C

Resonant Frequencies: The natural resonance of the spring-mass system (350 Hz) is completely suppressed. The first FFT measured resonance in the assembly is at 3.5 kHz. Thus, there is no resonance which could disturb laser beam alignment or position in the operating environment.

N1204C Precision Horizontal Beam Bender and N1207C Precision Vertical Beam Bender Specifications

Weight: 920 grams

Materials Used: Martensitic stainless steel, Optical grade glass

Optical Efficiency: 99% typical, 97.5% Worst case

Input/Output Clear Aperture: ϕ 13.0 mm

Input Beam Position Tolerance: \pm 1.6 mm for ϕ 9 mm beam

N1204C Angular Beam Steering Range

(from nominal 90° , ϕ 9 mm beam centered on ϕ 13.0 mm Aperture):

Yaw: \pm 6 $^{\circ}$ (using Adjustment Lever and adapter at ϕ 25 mm port)

Pitch: \pm 3 $^{\circ}$ (using Adjustment Lever and adapter at ϕ 25 mm port)

Yaw: \pm 1 $^{\circ}$ (using Adjustment Lever only, at ϕ 9 mm port)

Pitch: \pm 0.7 $^{\circ}$ (using Adjustment Lever only, at ϕ 9 mm port)

N1207C Angular Beam Steering Range

(from nominal 90° , ϕ 9 mm beam centered on ϕ 13 mm Aperture):

Yaw: \pm 6 $^{\circ}$ (using Adjustment Lever and adapter at ϕ 25 mm port)

Pitch: \pm 3 $^{\circ}$ (using Adjustment Lever and adapter at ϕ 25 mm port)

Yaw: \pm 0.7 $^{\circ}$ (using Adjustment Lever only, at ϕ 9 mm port)

Pitch: \pm 1 $^{\circ}$ (using Adjustment Lever only, at ϕ 9 mm port)

Angular Adjustment Sensitivity and Beam Steering

Resolution: 10 – 15 μ radians (better with operator patience)

Thermal Drift:

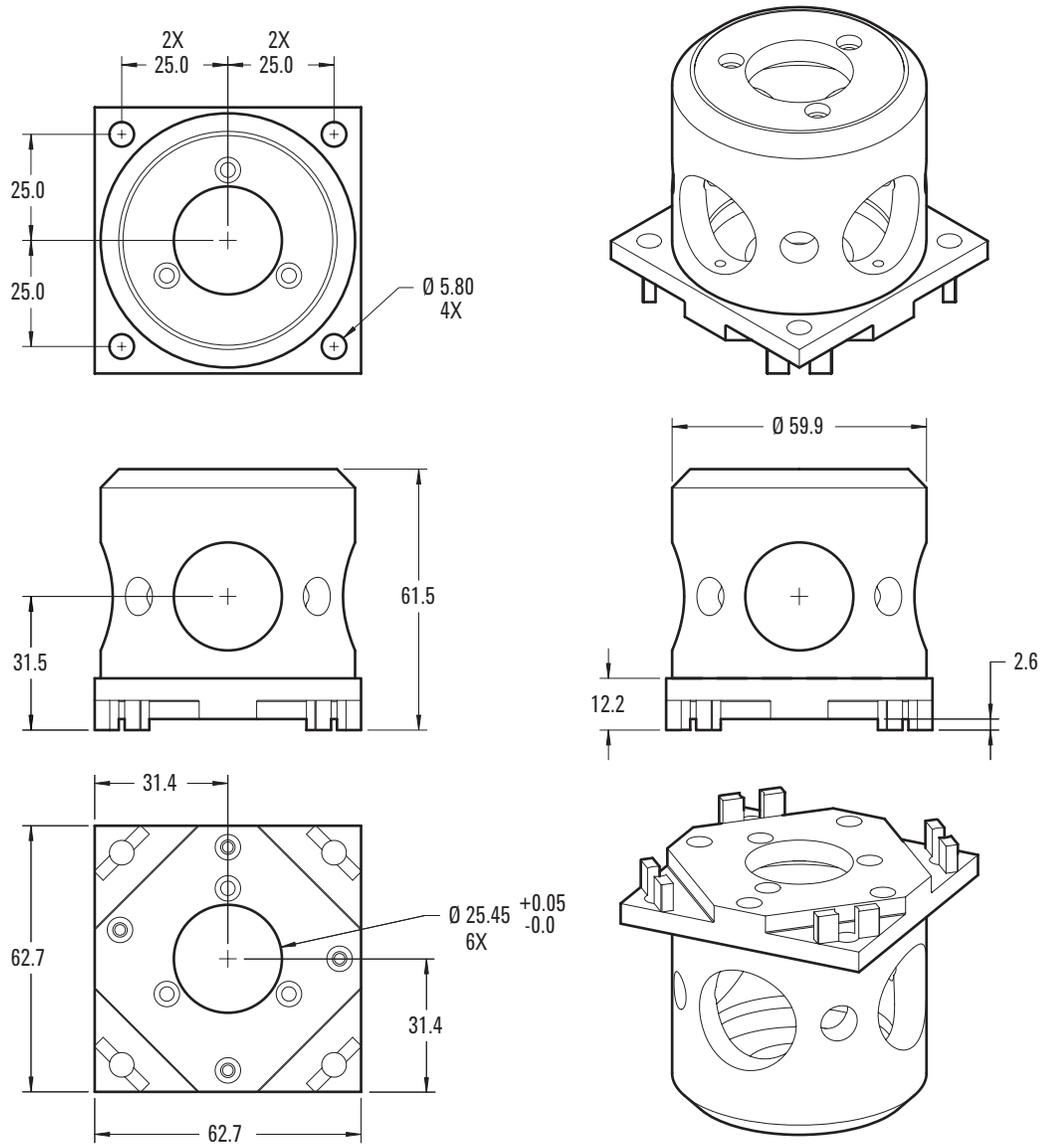
Pitch: 5 μ rad per $^{\circ}$ C

Yaw: 0.5 μ rad per $^{\circ}$ C

Resonant Frequencies: The natural resonance of the spring-mass system (350 Hz) is completely suppressed. The first FFT measured resonance in the assembly is at 3.5 kHz. Thus, there is no resonance which could disturb laser beam alignment or position in the operating environment.

Angular Adjustment Tool Leverage: Lever rotation : ball rotation = 2.9 : 1

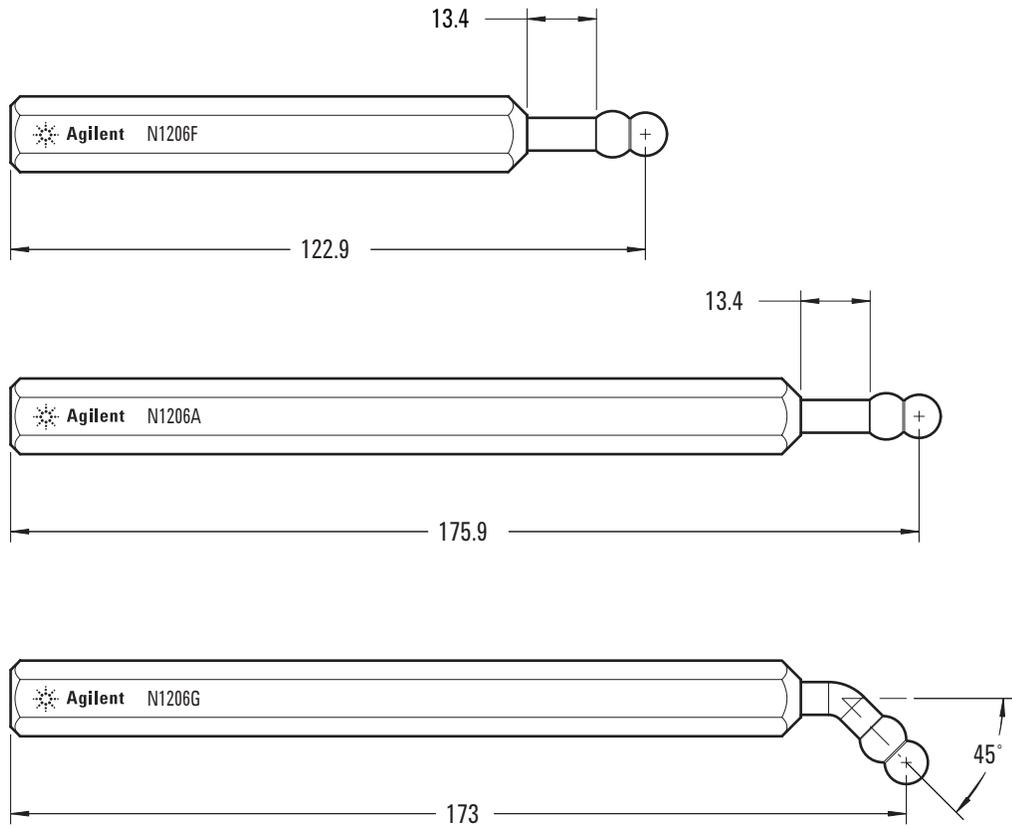
N1203C/N1204C/N1207C Beam Manipulator Dimensions



Unless otherwise specified, dimensions are in millimeters (mm).

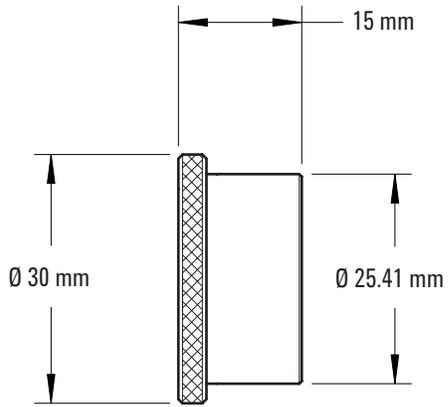
\varnothing = Diameter

N1206A/F/G: Ball Adjustment Levers

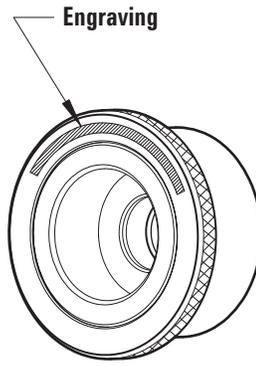


Unless otherwise specified, dimensions are in millimeters (mm).

N1206B: Adjustment Lever Adapter



∅ = Diameter



Ordering information

- **N1203C**
Precision Beam Translator
- **N1204C**
Precision Horizontal Beam Bender
- **N1207C**
Precision Vertical Beam Bender
- **N1206T**
Adjustment Tool Kit.
Individual tools can be bought separately:
 - **N1206A**
Ball Adjustment Lever - long
 - **N1206B**
Adjustment Lever Adapter
 - **N1206F**
Ball Adjustment Lever - short
 - **N1206G**
Ball Adjustment Lever - bent

Related Literature

Lasers and Optics
Users Manual
(PN 05517-90045)

Agilent N1203C
Precision Beam Translator,
and Agilent N1204C
and N1207C Precision
Beam Benders
(PN N1203-90012)

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