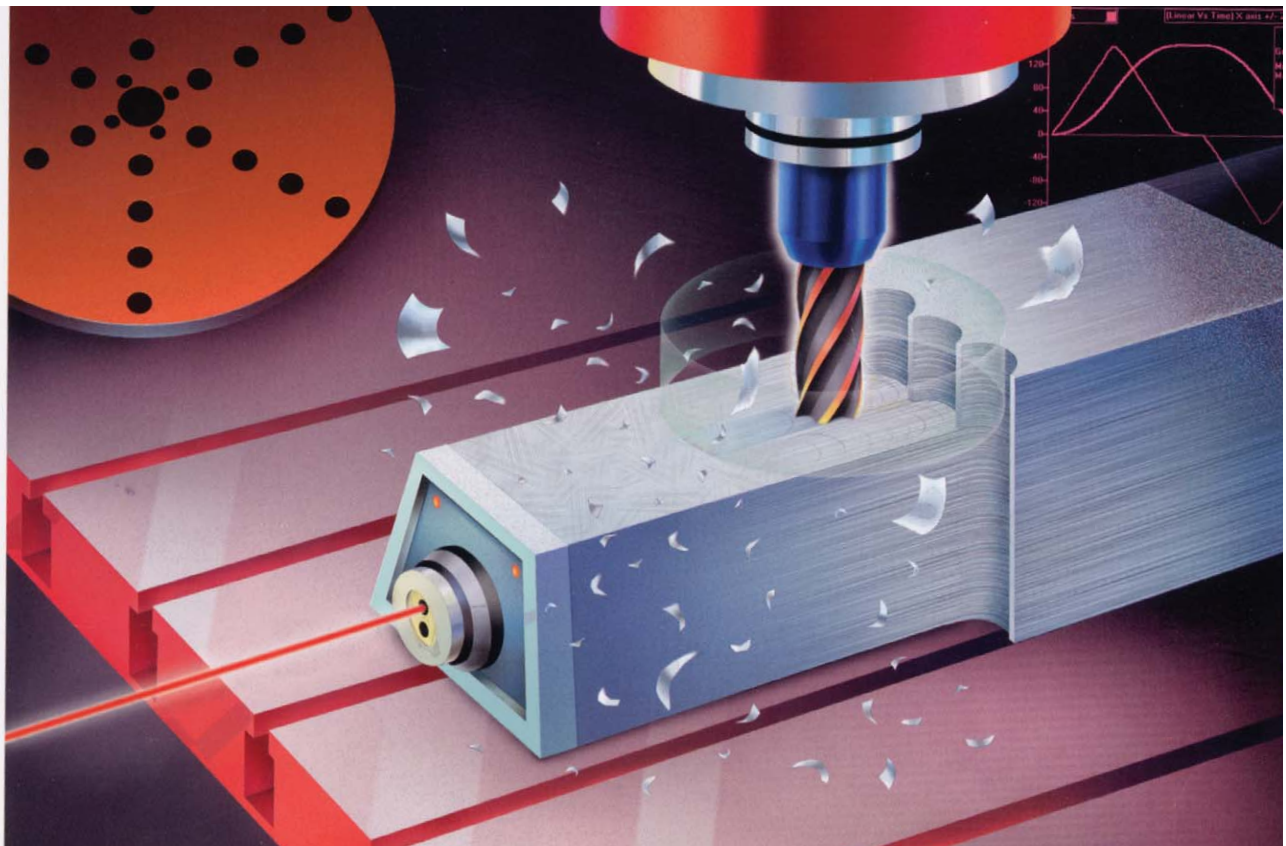


Agilent 5529A Dynamic Calibrator

Verify Machine Performance
with the World Standard for Laser Metrology



Agilent Technologies

Agilent 5529A – A Powerful Analysis System

The Agilent 5529A Dynamic Calibrator is a powerful analysis system that:

- measures machine tool positioning accuracy;
- provides compensation data used to correct machine positioning error;
- aids in diagnosing geometry problems;
- documents machine performance in seven international standards.

Used to help control the manufacturing process, the laser-based calibrator provides production managers with known performance for each machine.

Users first establish the machine's basic geometry and positioning, then use the 5529A to identify the source and degree of error in the machine tool's positioning.

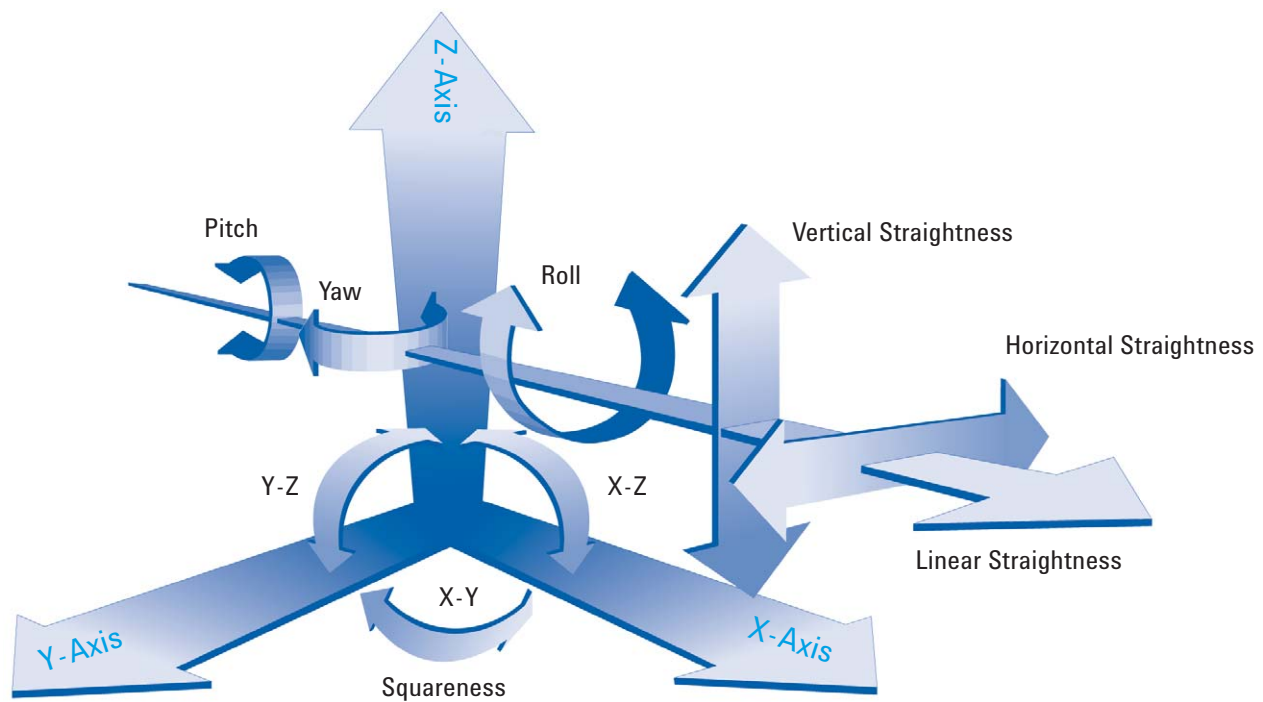
Agilent Technologies is one of the largest manufacturers of laser interferometers. The company invented the two-frequency, heterodyne laser interferometer that made laser calibration practical in a shop environment and pioneered the use of software to simplify calibration and analysis.

Agilent Technologies is committed to maintaining leadership by continuously providing new measurement capabilities; new, easier-to-use software; and hardware enhancements including easier calibration setups.



- *Are you reducing the life of your expensive machine tools because geometry errors are causing excessive wear?*
- *Do you spend too much time customizing your part programs and not enough time making parts?*
- *Are you afraid to trust laser measurements because your harsh shop environment decreases their repeatability?*
- *Are you being passed over for contracts by manufacturers who aren't convinced you can produce the quality they need?*

If you have these concerns, you'll want to know how the 5529A Dynamic Calibrator helps verify performance and improve process control ...



To fully analyze a machine's positioning accuracy, the six possible positioning errors on each of three axes and squareness between axes must be measured.

Verify Performance and Improve Process Control

Customers continue to make demands on machine shops for more precise parts, manufactured to tighter specs. In order to maintain low inventories and trim cash flow, manufacturers want quick turnaround on parts. Short part runs, often using expensive materials, have become more common.

To help machine shops succeed in this increasingly competitive environment, Agilent Technologies designs and manufactures the 5529A Dynamic Calibrator with unmatched repeatability and reliability, making it the most cost-effective laser calibrator available.

Regular calibration with the 5529A:

- provides verification of your machine tool's performance for manufacturers who want proof of quality;
- helps you achieve process control by giving you a complete understanding of each of your machine's capabilities;
- improves your shop's productivity by saving hours of CNC programmer time that would otherwise be spent adjusting the program to bring parts into spec.

Measurement Integrity – Results You Can Trust

Agilent Technologies uses two-frequency interferometry because of its inherent repeatability. You can trust the results because you know you can repeat your measurements, even in a shop environment.

• Two-Frequency Laser

At Agilent Technologies, we know that an incorrect measurement is worse than no measurement at all. That's why we make a two-frequency laser calibrator that is far less sensitive to air turbulence noise than single-frequency systems. Because the Dynamic Calibrator is less sensitive to thermal gradients in the air, you can have complete confidence in the repeatability of your measurements. Even when temperatures in your shop are unstable and air quality is poor, you'll be able to repeat your measurements and get consistent results.

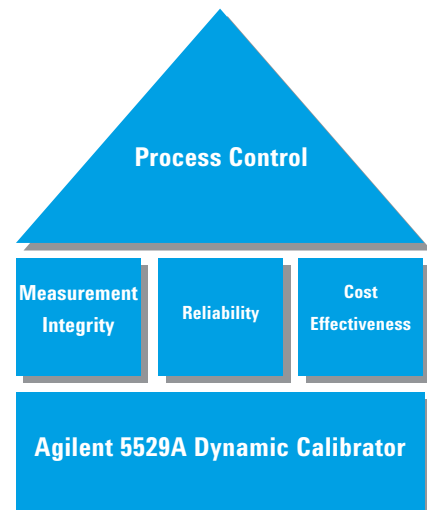
• Stainless Steel Optics

Further enhancing the integrity and believability of measurements, Agilent Technologies manufactures rugged, thermally stable optics. Agilent Technologies optics are encased in stainless steel housings to reduce the effects of temperature changes that cause other metals to contract and expand at a higher rate. As a result, measurements made with stainless steel optics are more accurate and more repeatable. The rugged qualities of stainless steel also work to increase the optics' lifetime, even when they are subjected to abuse.

Reliability – A Laser Tube that Won't Quit

To achieve reliability that is unmatched in the industry, Agilent Technologies designs and manufactures a laser tube specifically for the Dynamic Calibrator. We know that you want as little downtime as possible. You want a laser tube that won't quit in the middle of calibration.

Agilent Technologies' laser tube lasts 2½ times longer than other laser tubes. Our proprietary design provides reliability of greater than 50,000 hours mean time between failures (MTBF), exceeding the dimensional metrology industry standard of 20,000 hours.



The 5529A Dynamic Calibrator, which comes with a three-year warranty and has an optional five-year warranty, provides the building blocks needed to improve process control.

Cost Effectiveness – Get the Most from Your Investment

The Agilent 5529A provides the lowest cost of ownership in the industry. Because you will replace the Agilent Technologies laser tube – which is approximately 20 percent of the cost of the calibrator – less than half as often as would be required for other lasers on the market, it actually costs less to own an 5529A than other laser interferometers. And that's before you consider the productivity cost savings that result from less laser downtime.

Machine Tool Manufacturers

Machine tool manufacturers can use the 5529A Dynamic Calibrator to:

- Respond to customer requests for acceptance testing at installation.
- Avoid expensive troubleshooting at the customer site by ensuring all of your machines meet specifications before they leave your factory.
- Give customers documented performance of their equipment as it leaves the factory by merely hitting a button on the screen. In any of eight languages. To any of seven international standards.
- Monitor and control your building process by recording the capability of every machine you produce.
- Identify performance errors and make improvements in machine tool design.
- Reassure customers that their machine has passed the test of the toughest laser calibrator – the 5529A heterodyne laser interferometer that is the most rugged and accurate calibration method available.

Agilent Technologies responds to the needs of machine tool manufacturers who provide their customers with regular calibration services by designing the 5529A to fit into two transit cases. The two cases and a PC are easy to transport from one customer site to another.

When Should You Calibrate?

The 5529A Dynamic Calibrator helps you control quality and maximize productivity from the day your machine tool is delivered:

1. Acceptance Testing:

Even though machine tool manufacturers carefully test your equipment for accuracy before it leaves the factory, most equipment loses its accuracy during shipment and installation. By calibrating with the 5529A Dynamic Calibrator, you prevent costly performance problems and ensure that your new investment begins paying its way immediately.

2. Scheduled Calibration:

Just as regular maintenance increases the life of your automobile, periodic calibration increases the life of your machine tool.

Agilent Technologies recommends that new machine tools be calibrated every six months during the first year-and-a-half of operation and then annually, unless calibration results warrant more frequent calibration. If environmental factors are extreme or if the machine tool is subjected to high stress or a crash, users should calibrate at shorter intervals.

Scheduled calibration with the 5529A provides a complete picture of your machine tool performance so that you can efficiently schedule work flow. You can schedule the most demanding work on the most accurate machines. And by identifying machines that cannot meet the accuracy requirements for a given job, the 5529A helps you control your processes so you avoid costly scrap and schedule slips.

3. Quick Check:

Measuring diagonals is a quick way to verify machine tool volumetric performance and check a machine's signature (see page 19). If the diagonal measurements are acceptable, a full calibration and its associated downtime may be avoided.

4. Diagnosis of problems:

When a crisis occurs and your machine begins producing scrap, the 5529A can minimize the time it takes to get your process back on track. Data collected during this troubleshooting process can be compared with data that is collected and saved during regular, scheduled calibration to help pinpoint most problems.

5. ISO 9000 documentation:

The Agilent Technologies laser is an important tool to help you verify and document your manufacturing process as may be required for ISO 9000 certification. Plots showing machine performance can be used for documented proof of performance.

Contents



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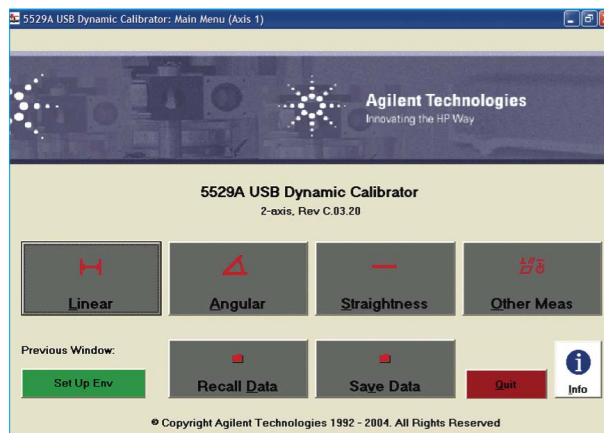
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Windows* - Based Software Makes a Difficult Task Easier

Prior PC experience is not needed to use the 5529A. The Windows-based software is easy to navigate, showing you everything you need – and only what you need – at each step in the calibration process.

Six Steps to Calibrate

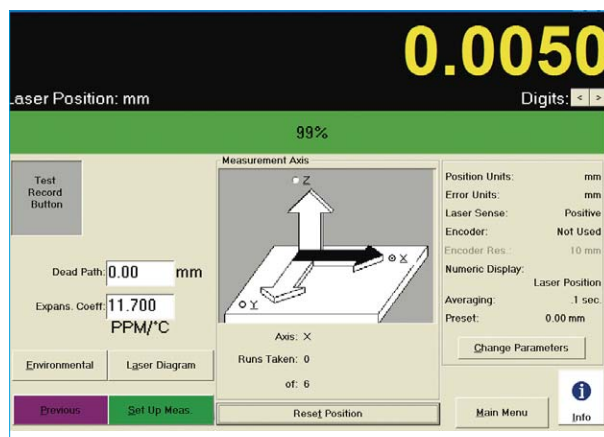
After you have made a machine measurement, powerful PC software collects, analyzes and plots data so you can build a machine history and gain a solid understanding of your processes. Logical graphics guide the user through the five steps to make a measurement to the sixth step that calculates error compensation for input to the CNC.



1. Select a measurement

- Select a measurement from the main menu or...
- Recall previously saved data and setup information.

1



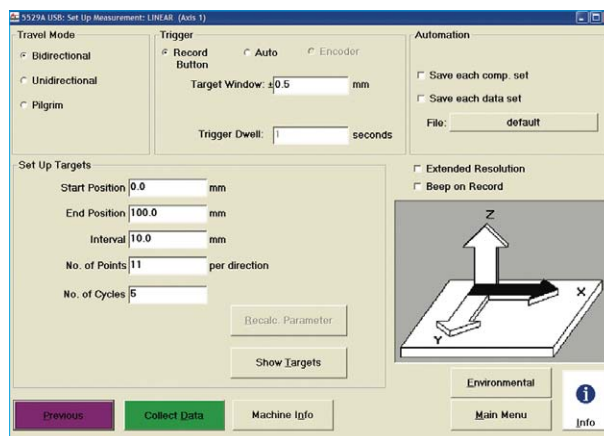
2. Set up the laser

- Select the measurement axis.
- **Laser Diagram** shows user how to set up laser.
- Align the optics. (Large beam strength display gives instant feedback on alignment.)
- Use the green

2

Set Up Meas.

button to go to the next step.



3. Set up the measurement

- Enter target list and trigger mode or...
- Recall setup from a previous calibration (from Step 1).
- Use the green **Collect Data** button to go to the next step.

3

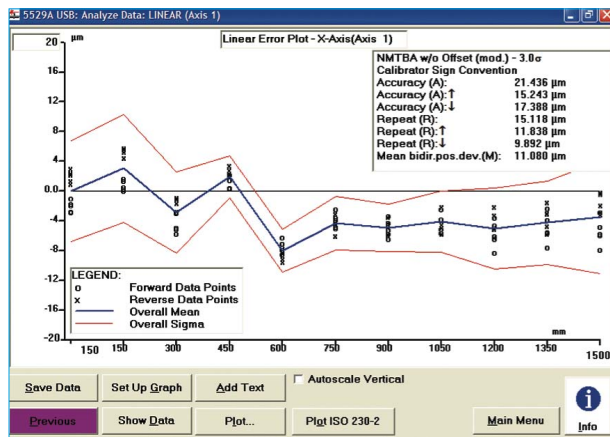
* Windows is a U.S. trademark of Microsoft Corporation



4. Collect the Data

- Collect data manually, automatically or by encoder.
- Small tabular and graphical displays show measurement progress.
- Use the green **Analyze Data** button to go to the next step.

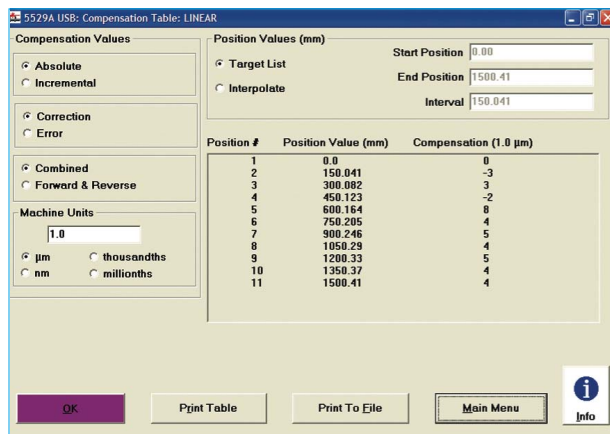
4



5. Analyze the Data

- Analyze data to your choice of seven international calibration standards.
- Use **Show Data** button to view data in tabular format.
- Use **Comp Table** button on **5529A USB: Show Data Set:** screen to create compensation table.

5



6. Compensation table

- Error compensation tables are calculated and printed, ready for input to the CNC.

6

Windows* - Based Software Makes a Difficult Task Easier

Online »Help« Windows

Technicians and engineers of all skill levels value the online »help« sources, available at every step in the calibration process to provide fast answers about a specific screen or subject. Online measurement checklists and setup graphics help new users avoid mistakes and omissions.

Additional help is available in the manuals described on page 31. Help windows as well as manuals are translated into eight different languages.

Laserdiagramm

Laser Diagrams, on the »Set up Laser« screen, display the measurement setup.

5529A USB: Set Up Laser: STRAIGHTNESS (Axis 1)

-0.32
Digits: 4

Laser Position: mm

100%

Optics
☒ Short Range
☐ Long Range

Optics Calibration Factor
 Interferometer: 1.000000

Environment **Laser Diagram**

Previous Set Up Meas.

Runs Taken: 10 of 6

Reset Position

Metrology Software

Straitness optics setup: Vertical for X

The following illustrations show two typical hardware setups to check the X-axis for vertical straightness. These setups check the X-axis for motion in the Z-axis. Use one setup or the other.

X-axis hardware setup for a vertical spindle

1 Straitness reflector (Agilent 10774A or Agilent 10775A) 2 Straitness interferometer (Agilent 10774A or Agilent 10775A) 3 Laser beam 4 Laser head (Agilent 5519A/B)

X-axis hardware setup for a horizontal spindle

5529A USB: Show Data Set: LINEAR

Machine Zero Pt. 1 Limit Lines 25.0000 µm

Position Units
☒ mm
☐ inches

Error Units
☐ millimeters
☐ micrometers
☐ nanometers

Error Sign Convention
☐ algebraic
☒ calibrator

Custom Print

F1

Error values: Sign Conventions

For the reference, target value, the mean error value is set to zero and all other error values are referenced to it.

Notes: The information below applies to the following situations only: 1) Measurement is Linear (non-Timebase) and, 2) Target Value Change Sign box is selected. select this text.

For target values more positive than the reference target value, the machine moved farther than it reported it did; and did not move as far as it reported it did. For negative sign convention you prefer, as described below.

When Algebraic is chosen, error values for target value are handled as described above. For target value value, however, the sign convention becomes reverse: the machine did not move as far as it reported it did; machine moved farther than it reported it did.

When Calibrator is chosen, the error value sign has regardless of the target value sign. That is: 1) a positive farther than it reported it did, and 2) a negative error as it reported it did.

Related topics:
[Explanation](#)
[Examples](#)

Error values: Sign Conventions -- examples

The examples below are all taken from the same data. The only differences are in the reference point and the error sign convention. Note that the Algebraic graph line is the same in all four examples, the only difference is where it meets the horizontal line marking 0 on the vertical axis. The Calibrator line behaves differently, as described in more detail in the descriptions below.

In the first two examples, the reference point is at target value = 0, in the middle of the graph. The graph from 0 to +50 is the same for both. The graph from 0 to -50 is inverted in the Calibrator example.

Algebraic

Calibrator

F1 context-sensitive help files

provide online information regarding a specific subject.

5529A USB: Analyze Data: FLATNESS (Axis 1)

2.00 patches = AZ Scale

Flatness

© Isometric Plot ○ Numeric Graph

Save Data Add Text Autoscale

Previous Show Data Plot... Next Line Main Menu Info

Metrology Software

Analyze Data window (for flatness measurements)

This window displays the data you recorded on the Collect Data: Flatness window. It displays the data in either isometric or numeric format.

- The isometric format displays a three-dimensional plot of the measurement values obtained while moving the reflector along the measurement grid lines. When in isometric format, the window displays three axes in the upper left corner of the window. These axes show you how the plot is oriented, and the scale (AZ) of the vertical (Z) axis data.
- The numeric format displays a two-dimensional measurement grid and the measurement values recorded at each point. The locations of the measurement values represent the locations of the measurement points.

To show the data in a table, select Show Data.

Note: For instructions on displaying help, see Using Agilent 5529A/55292A Help.

Related topic:
[Display option](#)
[AZ Scale box](#)

Info

Information button provides online help for an entire screen or step being performed.



Documented Performance

The 5529A provides documentation that:

- verifies your machine tool and
- proves to your customers that they can count on getting quality from your company.

ISO 9000

The Agilent laser is an important tool to help you verify and document your manufacturing process as may be required for ISO 9000 certification. Plots showing machine performance (see samples in »Measurement« section, pages 16-28) can be used for documented proof of performance.

Proof of Agilent Technologies' manufacturing process is also documented. The Agilent Technologies laser system has been manufactured in an ISO 9002 certified environment.

For Your Customers

Reassure your customers that they can count on getting quality from your shop by handing them plots generated using the 5529A.

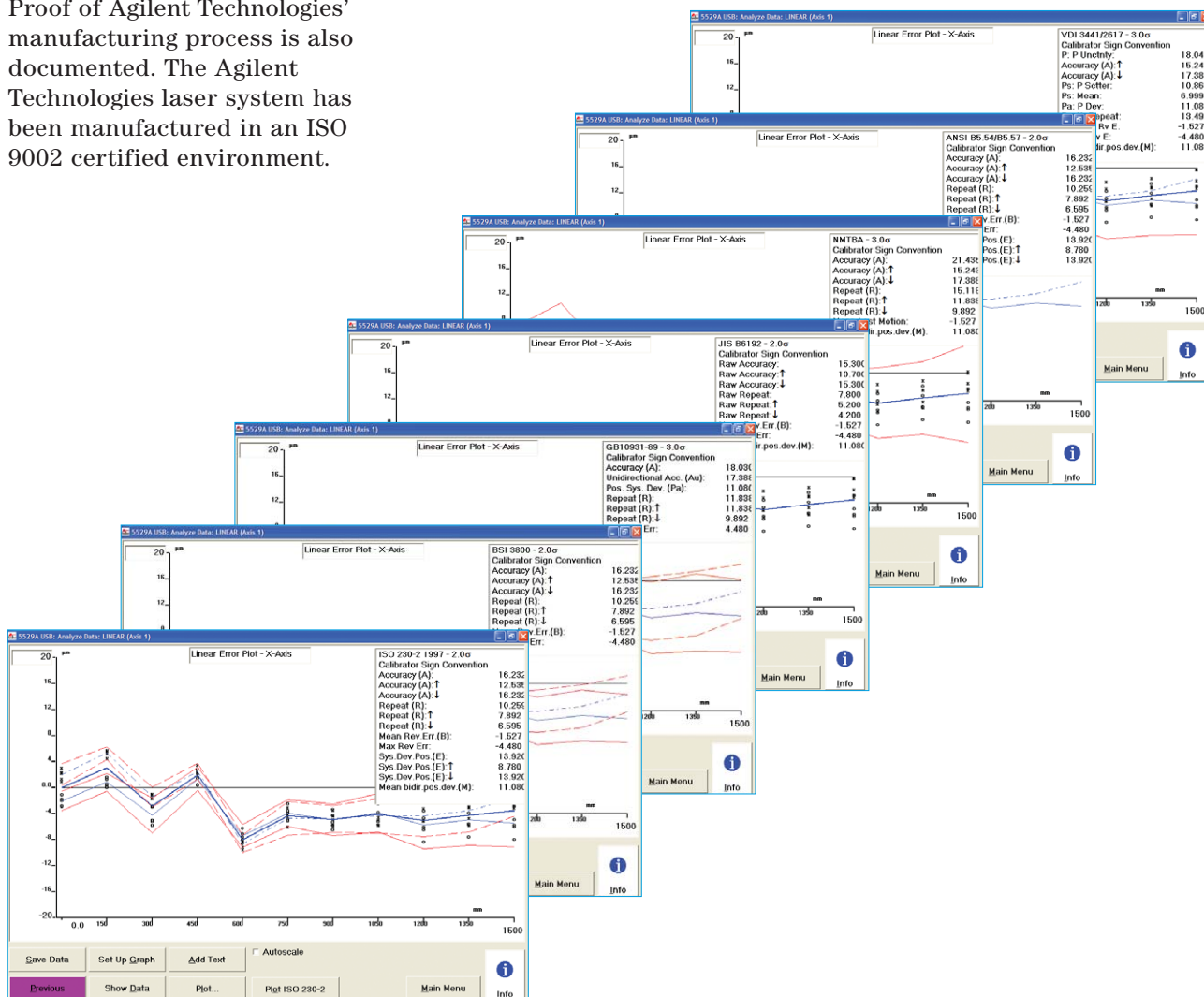
• Seven International Standards

Show conformance to any of seven international standards:

NMTBA
VDI 3441/2617
ANSI B5.54/B5.57
BSI 3800
ISO 230-2 1997
JIS 136192
GB 10931-89

• Eight Languages - Provide documented performance in any of eight languages:

- English
- French
- Spanish
- German
- Italian
- Japanese
- Chinese (PRC)
- Chinese (ROC)



Special Capabilities Make Calibration More Efficient

To help you get your expensive machine tools back into production as quickly as possible, Agilent has designed important, timesaving features into the dynamic calibrator and its software.

Flexible Data Presentation

After measurements are taken, the 5529A software simplifies the analysis of calibration results by converting the data into usable information:

• Standards Comparison

Calibration software is compatible with seven international calibration standards. Data can be taken once and then plotted in any or all standards.

Standards

☐ NMTBA w/o Offset ☐ User
☐ NMTBA ☐ BSI 3800
☐ ANSI B5.54/B5.57 ☐ JIS B6192
☐ VDI 3441/2617 ☐ ISO 230-2 1997
☐ GB10931-89

Sigma

• Customized Plots

Report and plot the data that is important to you. To track your process well, you may need more or different information than is shown on the standards plots. The 5529A gives you the ability to customize graphical and numerical analyses.

• English or Metric Units

Convert data between millimeters and inches with no loss of integrity.

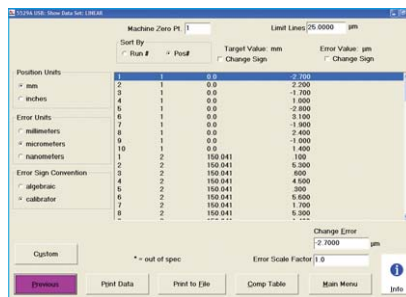
• Programmable »Custom« Button

Using the programmable »custom« button, you can automatically integrate calibration data with other applications. Data can be transferred to applications such as spreadsheets and databases, or to a software application that you custom design such as a downloading routine.

• Calibrator Mode versus Algebraic Mode

When you look at a performance plot, have you ever been confused about whether your machine will make a part longer or shorter?

The 5529A software can automatically convert algebraic computation tables to calibrator mode (as shown on the help screen on page 10) so that error polarity is always correct. Regardless of the machine's 0 point, your plot can show a positive error if your machine produces long parts and a negative error if your machine produces short parts.



The screenshot shows a Microsoft Excel spreadsheet with the following data:

Run #	Position	Target Value	Error Value	Out of spec.
1	1	0.00E+00	-2.70E+00	
2	2	0.00E+00	2.20E+00	
3	3	0.00E+00	-1.30E+00	
4	4	0.00E+00	1.00E+00	
5	5	0.00E+00	-2.80E+00	
6	6	0.00E+00	3.10E+00	
7	7	0.00E+00	-1.30E+00	
8	8	0.00E+00	2.40E+00	

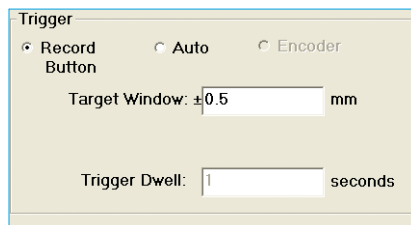


Tools to Simplify the Measurement Task

Whether you are performing a quick assessment of a machine's performance or a detailed analysis of the machine's geometry, Agilent Technologies has designed tools that make the job easier:

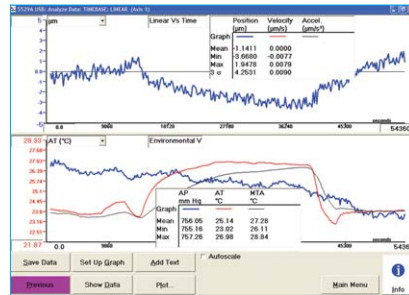
• *Trigger Modes*

Select from a variety of methods to trigger measurements. Use the mouse, keyboard or remote control to trigger manually. Use the software to trigger automatically («Auto») when the machine tool is within a specified distance («Target Window»). Or use A-Quad-B output from the encoder («Encoder») to trigger measurements either automatically or on-the-fly.



• *Thermal Drift Test*

If you think you're having temperature problems at different periods of time, you can perform a thermal drift test over very long time periods to diagnose intermittent temperature issues.



• *Deadpath Compensation*

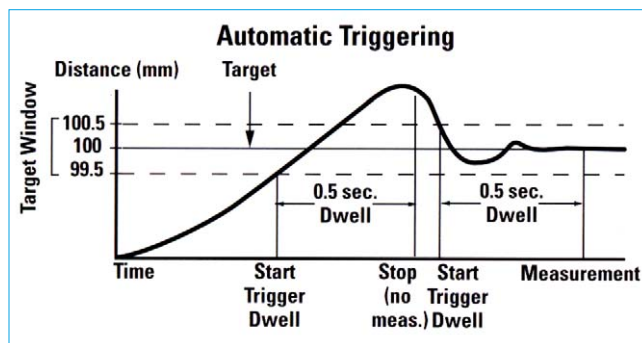
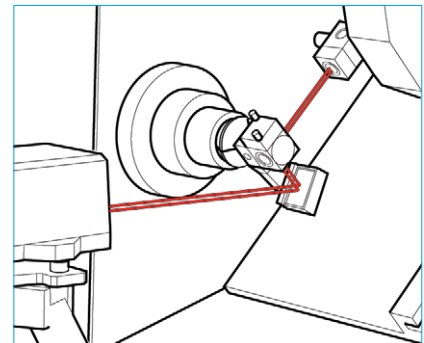
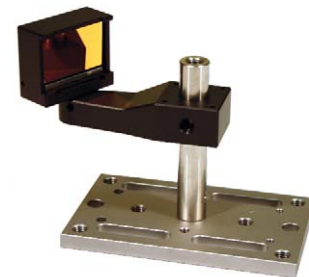
increases accuracy when you cannot bring the retroreflector and interferometer together. The system compensates for wavelength of light changes over the deadpath distance. (Deadpath is the part of the measurement path through which the retroreflector never moves.)

• *For Machining Centers with Indexing Tables*

Use the Angular Position Measurement Kit (55290A) to keep the beam on indexing tables that require a great deal of lift – up to 15 mm.

• *For Slant-Bed Turning Centers*

The Turning Mirror (10769A) makes calibrator setup easy by eliminating the need to tilt the laser when you are calibrating slant-bed lathes.



Modular System Starts with the Basics

The 5529A Dynamic Calibrator is a laser system used to ensure the accuracy of a machine's motion and positioning. Controlled through your PC, the system is able to collect and analyze measurement data for a number of measurements, including those shown on the following pages.

After you have made a machine measurement, the system generates plots and reports as shown throughout this brochure, including environment and machine data.

The 5529A provides high accuracy over long distances – up to 80 meters (260 feet) with long-range option.

The 5529A offers even greater reliability than other lasers because it uses Agilent's two-frequency laser technique that virtually eliminates problems resulting from changes in beam intensity.

Basic System

The 5529B Basic Laser System includes most basic components needed to make machine tool calibrations. Users will add a PC to the basic laser system, plus the Agilent Technologies optics kit needed to make specific measurements (see »Equipment Needed« table on this page).

Portability

- The dynamic calibrator system fits into two transit cases (10786S and 10787S) and is easily transported with the computer from one location to another.
- A heavy duty carrier (10786S, Option 001) is designed specifically for the laser system.



Transit Cases (10786S and 10787S) with laser system components



Heavy Duty Carrier (10786S, Option 001)

Equipment Needed to Make Measurements

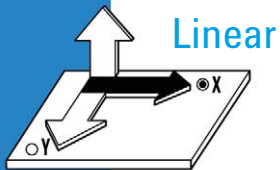
Measurement	Basic Laser System Plus...	Page No.
Linear	Linear Measurement Kit (55280B)	16-17
Diagonal	Diagonal Measurement Kit (10768A) Linear Measurement Kit (55280B)	18-19
Angular	Angular Optics Kit (55281A)	20-21
Rotary/Indexing Table Calibration	Angular Position Measurement Kit (55290A) Supplemental Fixturing Kit (Opt. 774) Angular Optics Kit (55281A)	22-23
Flatness and Way Straightness	Flatness Accessory Kit (55282A) Angular Optics Kit (55281A)	24-25
Straightness and Parallelism	Straightness Measurement Kit (55283A)	26-27
Squareness	Optical Square (10777A) Straightness Measurement Kit (55283A)	28

Note: A personal computer (PC) is also needed to control the laser system.



Components included in the 5529B Basic Laser System are:

A	Laser Head (0.7 m/s)	5519A
B	PC Calibrator Board with Software and Encoder Input Cable	10887B
C	PC Material Compensation/WOL Board (Compensates for wavelength of light and material)	10886A
D	Remote Control	10888A
E	Air Sensor with 5m Cable	10751C
F	Material Temperature Sensor with 15m Cable	10757E
G	Laser Head Cable (7 m)	10882B
H	Tripod	10753B
I	Case for Laser Head and Optics	10786S
Options		
J	Option 19B Laser Head (1 m/s) (replaces 5519A)	5519B



Linear measurements are made at multiple points along a machine's travel path to measure linear displacement and velocity.

Purpose of Measurement:

To document capability and, when possible, improve positioning accuracy along an axis for any machine that requires positioning accuracy and velocity control.

Basic Equipment:

- Basic Laser System (5529B)
- [Linear Measurement Kit \(55280B\)](#)

Also Recommended:

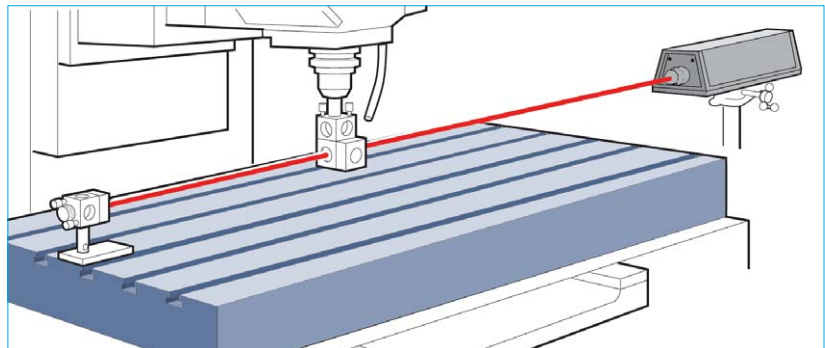
- Second Material Temperature Sensor (10757D, E, or F)
- Tripod and Sensors Case and Cart (10787S and 10786S-001)
- Fixturning Kit (10744A)

Items Included in the 55280A Linear Measurement Kit:

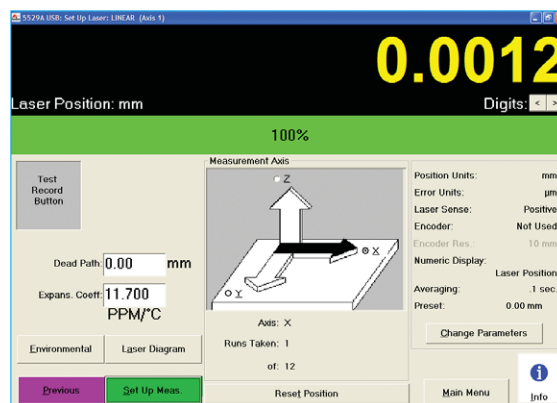
- 1 Linear Interferometer 10766A
- 2 Linear Retroreflector 10767A
- 2 Base 10784A
- 3 Height Adjuster and Post (~4") 10785A



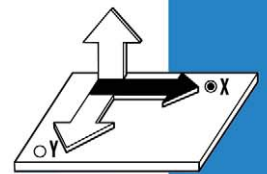
Linear Measurement Kit (55280B)



Optical setup for linear measurements

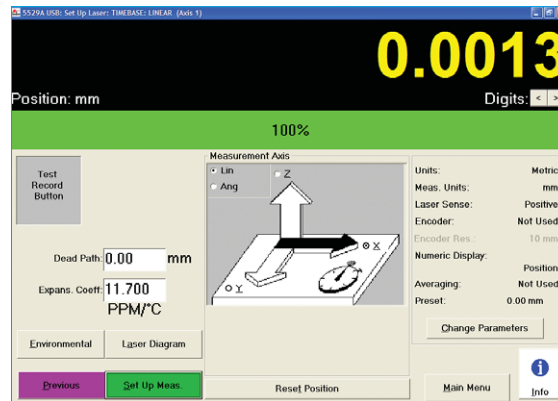


Initial »Set Up« screen for linear measurements

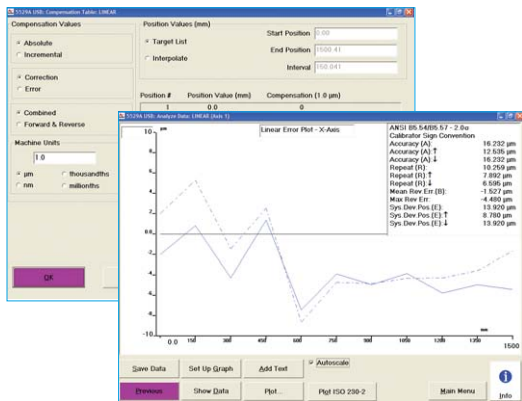


Additional Capabilities:

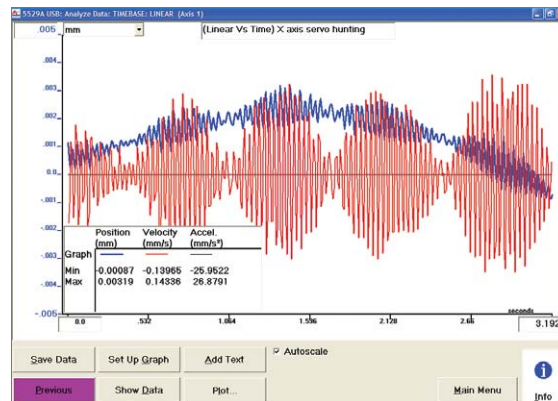
- Long-range option doubles measurement range to 80 m (Option C01 for 5519A).
- For 1 m/s axis velocity, replace 5519A with 5519B.
- Resolution is easily increased to 1 nm with averaging.
- Perform surface (2-D) diagonal measurements.
- High data rate/fast data collection is useful for relative vibration analysis or for measurements made »on-the-fly«.
- Long-term thermal drift test can be performed over hours or days, showing possible effects of temperature on geometry.



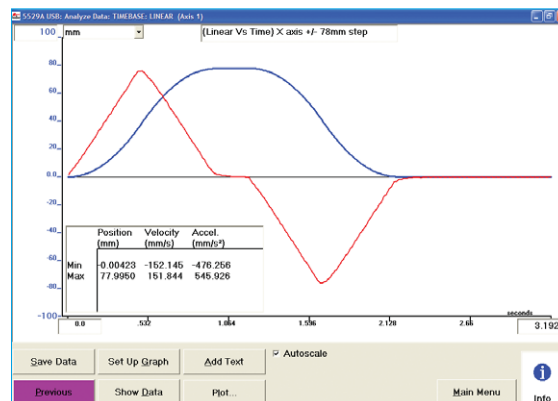
Initial Timebase »Set Up« screen



Compensation table (above) and linear plot verify machine performance in ANSI B5.54



Servo hunting with position data



Velocity profile with position data

Diagonal

Diagonal measurements are linear measurements made on the four body diagonals of a machine's working volume to check for volumetric positioning performance.

- If the machine tool is within specification, full calibration and its associated downtime may be unnecessary.
- Diagonal measurements are used to determine compliance with the ANSI B5.54 standard that defines volumetric performance of machine tools over the working volume.

Purpose of Measurement:

To document machine tool capability and quickly perform a complete check of volumetric positioning performance.

Basic Equipment:

- Basic Laser System (5529B)
- Linear Measurement Kit (55280B)
- **Diagonal Measurement Kit (10768A)**

Also Recommended:

- Second Material Temperature Sensor (10757D, E or F)
- Turning Mirror (10769B)
- Lightweight Reflector (10767B)
- Tripod and Sensors Case and Cart (10787S and 10786S-001)
- Fixturing Kit (10744A)

In optical setup for diagonal measurement, place the bending mirror in front of the interferometer

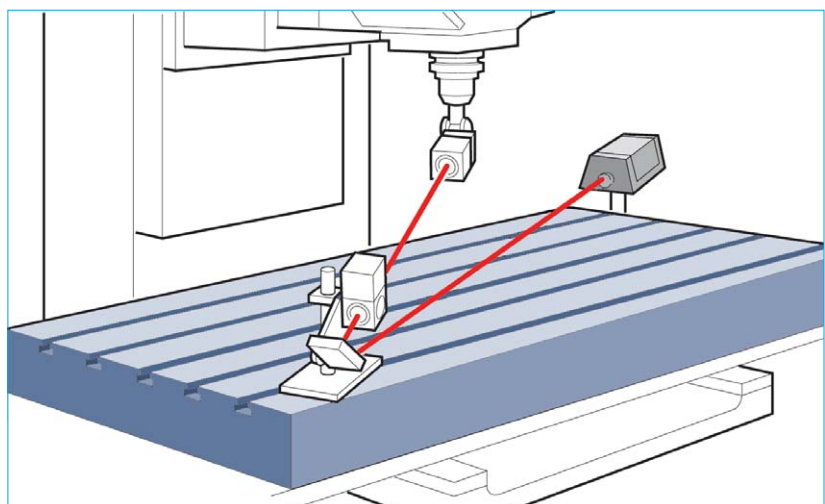
Items Included in the 10768A Diagonal Measurement Kit:

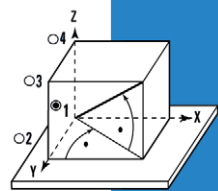
- 1 Target
- 1 Magnet
- 1 Post (~1")
- 2 Post (~2")
- 1 Post (~4")
- 1 Base (Large)
- 2 Adaptor Plate
- 1 Flexible Ball Joint
- 2 Right Angle Clamp
- 1 Adjustable Triangle
- 1 Beam Stearing Assembly
- 1 Hardware Kit (includes hex keys)
- 1 M10x1.5x20 mm Hex Skt Hd Set Screw



Lightweight Reflector (10767B) weighs 41 grams (1.4 oz.) for applications that are weight sensitive, such as CMM calibration

Diagonal Measurement Kit (10768A)



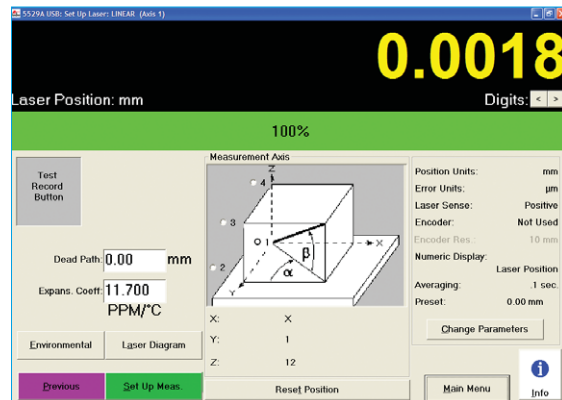


Additional Capabilities:

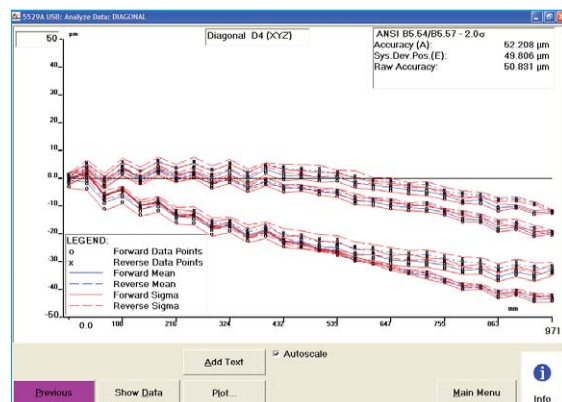
Long-term drift tests can be performed over hours or days, showing possible effects of temperature on geometry.

Repeatable Signature:

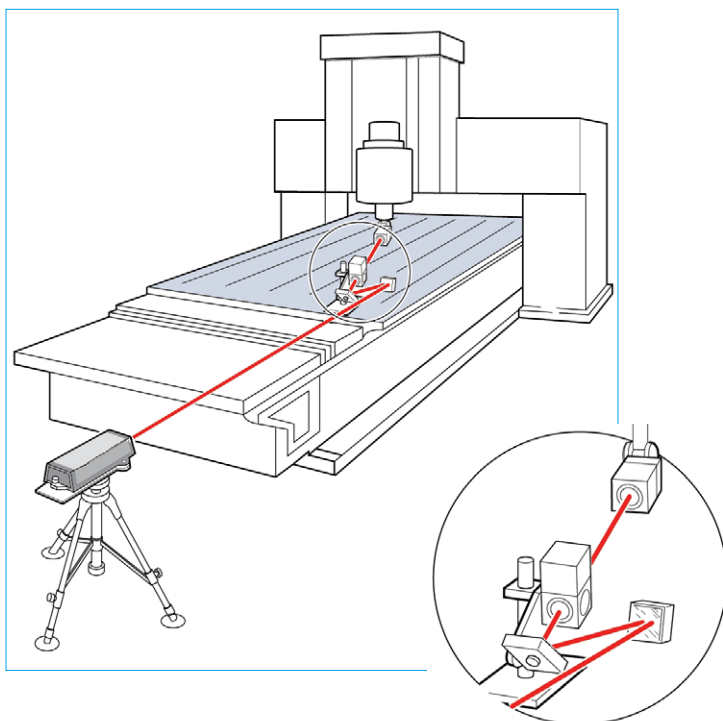
To achieve a signature for each of your machine tools, make diagonal measurements with the 5529A and the Diagonal Measurement Kit. The repeatability of diagonal measurements is optimized because the laser beam is aligned to the machine rather than the machine to the laser by changing the machine program. By using the identical machine movement for each set of measurement, you learn if the machine meets spec and you can predict change in performance even when volumetric performance is adequate.



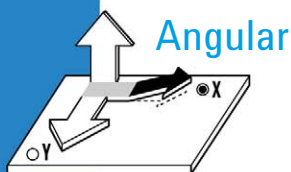
Initial »Set Up« screen for diagonal measurements



Agilent diagonal measurements provide a signature that tells if your machine performance has changed



Turning Mirror (10769B) for diagonal measurements on certain gantry machines with moving beds.



Angular measurements are made at multiple points along a machine's travel path to test for rotation about an axis perpendicular to the axis of motion (pitch and yaw).

- A common cause of machining errors, geometry errors are as critical as linear positioning errors.
- Unwanted angular motion in a machine tool causes positioning errors that reduce the overall accuracy of your machine.

Purpose of Measurement:

To document, analyze and diagnose machine tool geometry.

Basic Equipment:

- Basic Laser System (5529B)
- [Angular Optics Kit \(55281A\)](#)

Also Recommended:

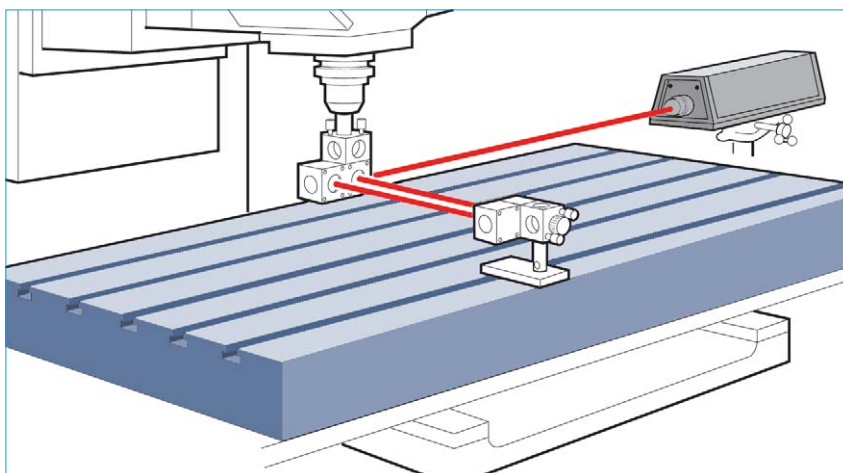
- Tripod and Sensors Case and Cart (10787S and 10786S-001)
- Fixturing Kit (10744A)

Items Included in the 55281A Angular Optics Kit:

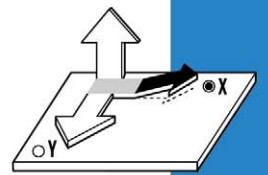
- 1 Angular Interferometer 10770A
- 1 Angular Reflector 10771A



Angular Optics Kit (55281A)

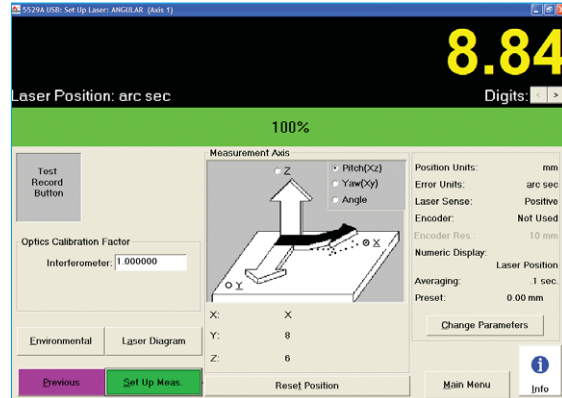


Optical setup for a yaw measurement on Y-axis

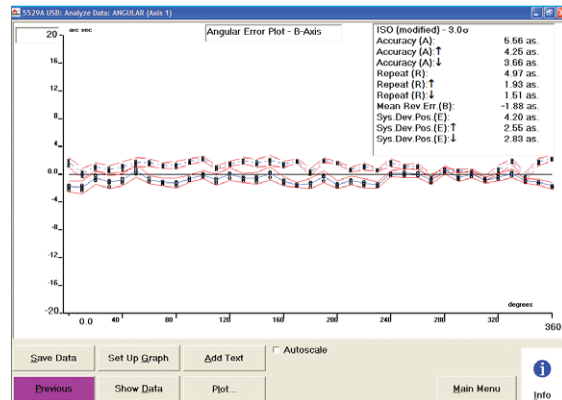


Additional Capabilities:

- Positioning errors over the work zone can be estimated from the angular and linear measurements.
- The condition of ways and the range of squareness and parallelism in the work zone can be indicated by angular measurements.
- Angular measurements help find the causes of linear positioning errors and can be useful in making decisions about whether to replace or rebuild older machines.
- Long-term drift tests can be performed over hours or days, showing possible effects of temperature on geometry.



Initial Angular setup screen for pitch on X-axis



ISO 230-2 angular plot

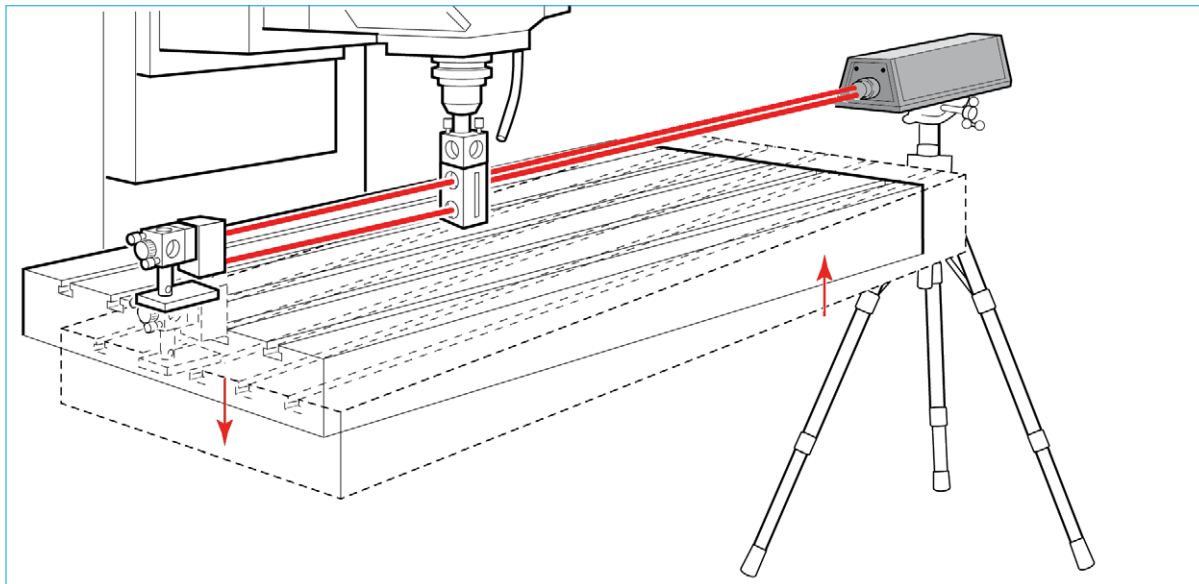
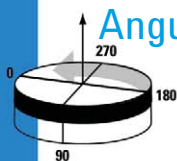


Table pitch along X-axis



Angular Position

Angular position measurements are made on full, multiple or partial rotation of *rotary tables, indexing tables and other angular positioning devices.*

Purpose of Measurement:

To document machine tool capability and even improve angular positioning accuracy when possible.

Basic Equipment:

- Basic Laser System (5529B)
- Angular Optics Kit (55281A)
- [Angular Position Measurement \(APM\) Kit \(55290A\)](#)
- Supplemental Fixturing Kit (55290A, Option 744)

Also Recommended:

- Fixturing Kit (10744A)
(can replace Supplemental Fixturing Kit [55290A, Option 744])
- Tripod and Sensors Case and Cart (10787S and 10786S-001)

Items Included in the 55290A

Angular Position Measurement Kit:

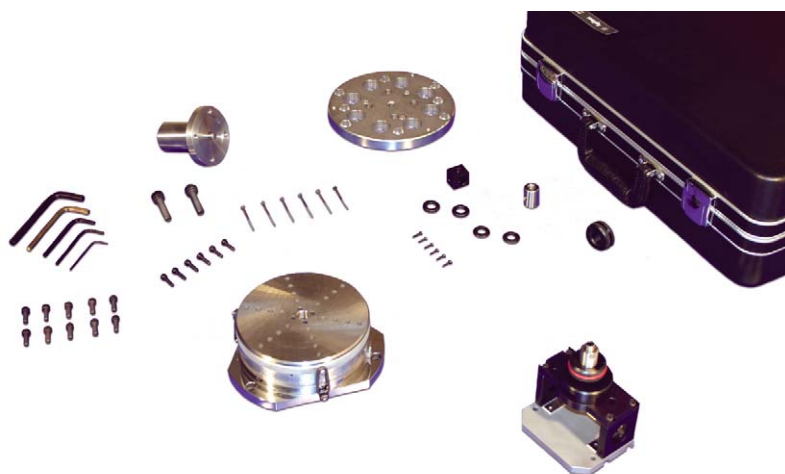
- 1 Adaptor
- 1 Post (~1")
- 1 Carrying Case
- 1 Flanged Shaft
- 2 Split Nut with O-Ring
- 1 Circular Adapter Plate
- 1 Precision Angular Indexing Table
- * Mounting Hardware and Hex Keys
- 1 Angular Optics Mounting Fixture and Clutch Assembly

Items Included in the 55290A-744 Supplemental Fixturing Kit:

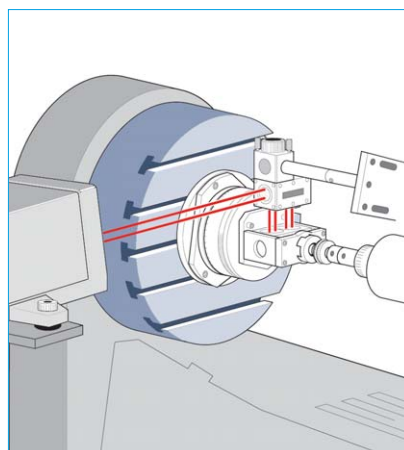
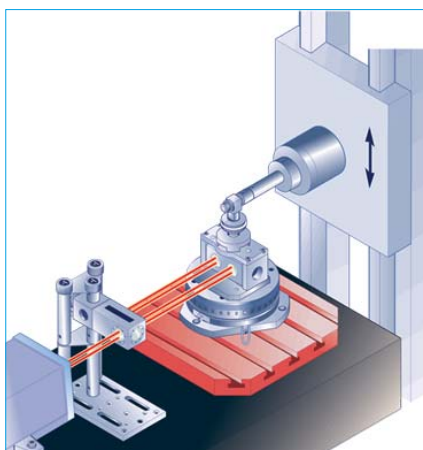
- 2 Gusset
- 3 Post (~2")
- 4 Post (~4")
- 1 Base (large)
- 1 Flexible Ball Joint
- 1 Height Adjuster with Knob and Thumb Screws



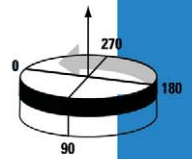
Supplemental Fixturing Kit (55290A, Option 744)



Angular Position Measurement Kit (55290A)

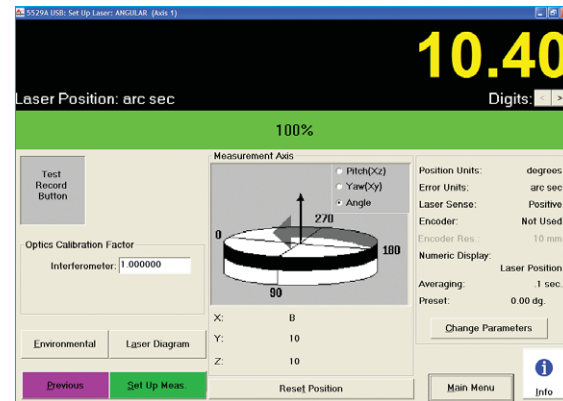


Optical setup on horizontal machining center with vertical table (right) and with horizontal table (left)



Additional Capabilities

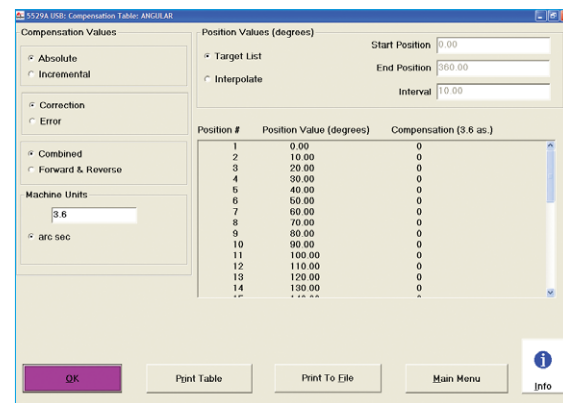
- Angular Position Measurement Kit enables users to keep the laser beam on indexing tables, even those that require a great deal of lift – up to 15 mm.
- Long-term drift tests can be performed over hours or days.
- Agilent Technologies' equipment can calibrate tools that cannot rotate 360°. The Agilent APM Kit comes calibrated for any arc.
- Can perform multiple revolutions when used on turning centers with »C« axis spindles that are programmed to index to specific angles as well as continuous revolutions.



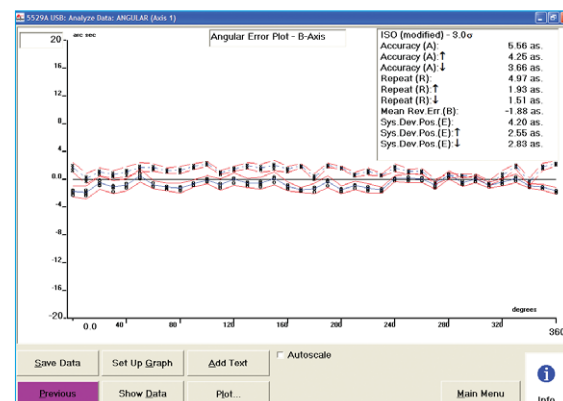
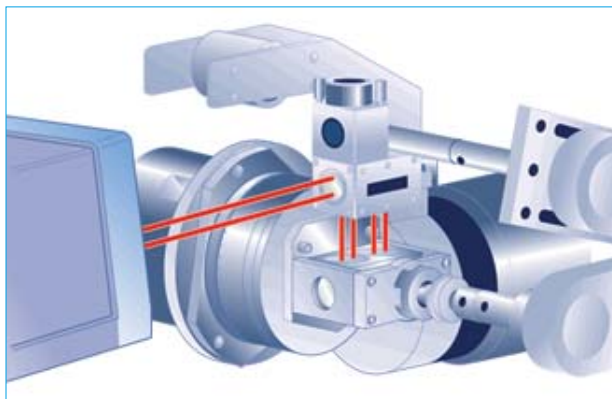
Initial »Set Up« screen for angular measurement



Turning center with adapter plate and post used for mounting

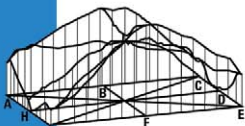


Compensation table for rotary table



ISO 230-2 angular plot for 10-degree steps

Flatness and Way Straightness



Flatness measurements are a series of angular measurements made along a pattern of lines combined to evaluate the flatness of a surface in three dimensions.

Way straightness measurements are a series of angular measurements made in a single line along a machine's ways to evaluate the straightness of those ways in two dimensions.

Purpose of Flatness Measurement:

To document and analyze in 3-D any flat surface such as a surface plate or machine bed.

Purpose of Way Straightness Measurement:

To document and analyze straightness of a line along a solid object such as machine tool ways and master straight edges. (See »Straightness« on page 26 for analysis of the motion of a machine tool's travel.) This measurement is very useful when you are setting up or rebuilding machines.

Basic Equipment:

- Basic Laser System (5529B)
- Angular Optics Kit (55281A)
- Flatness Accessory Kit (55282A)

Also Recommended:

- Tripod and Sensors Case and Cart (10787S and 10786S-001)

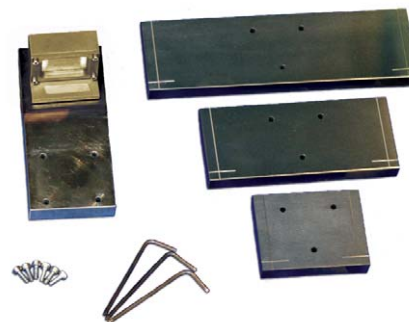
Items Included in the 10759A Footspacing Kit:

- 1 50.8 mm (2 in) Base
- 1 101.6 mm (4 in) Base
- 1 152.2 mm (6 in) Base
- 1 Hardware Kit (includes hex keys)

Items Included in the 55282A

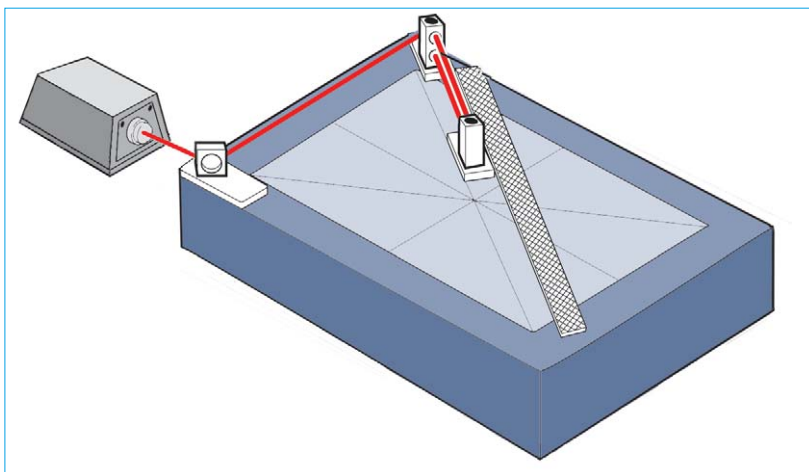
Flatness Accessory Kit:

- 1 Footspacing Kit 10759A
- 2 Flatness Mirror 10773A

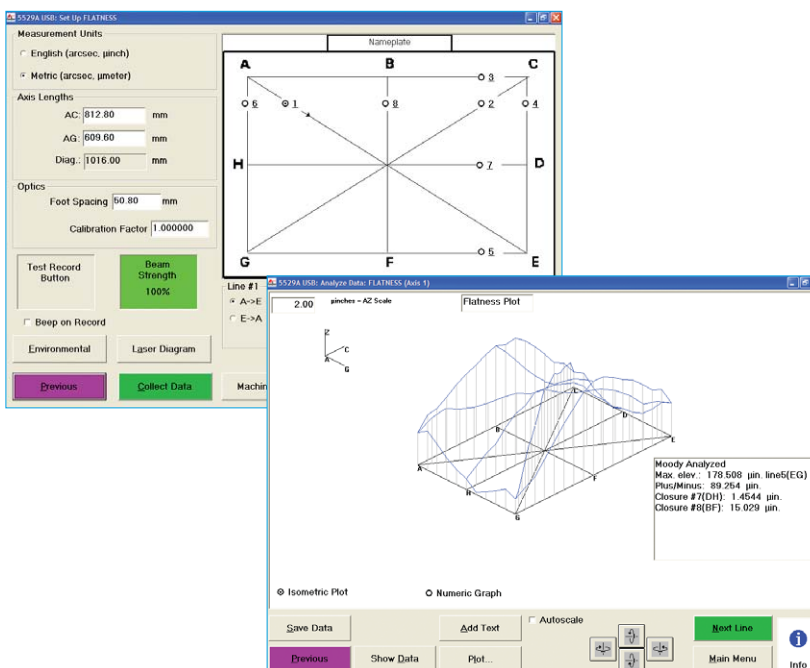


Flatness Accessory Kit (55282A)

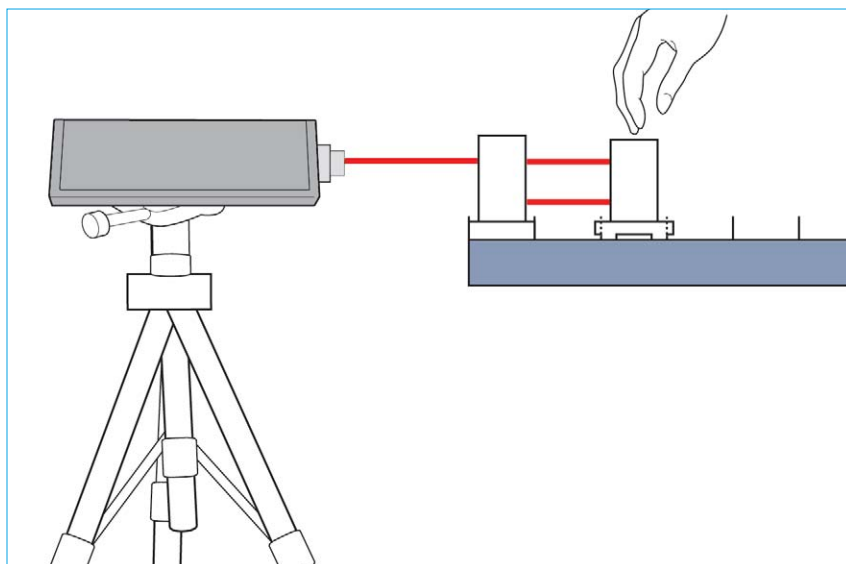
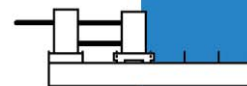
Optical setup to measure line number one



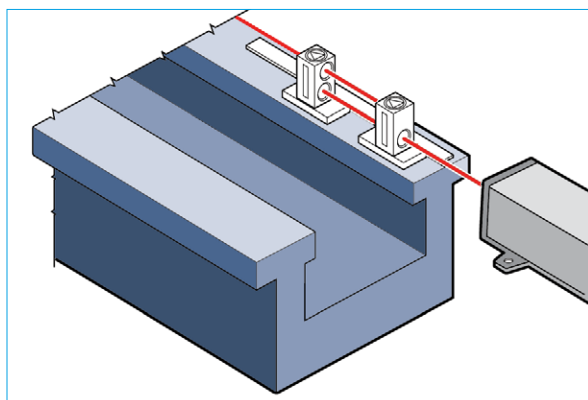
Initial »Set Up« screen for flatness



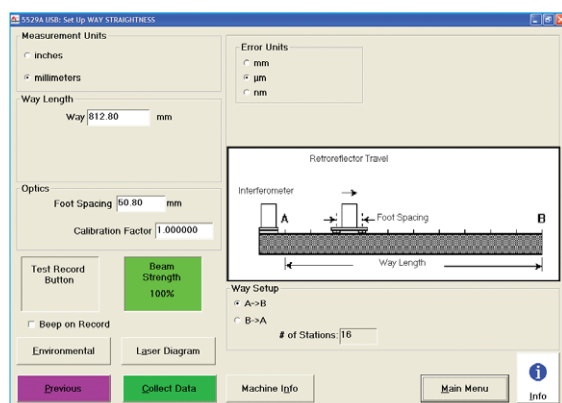
Isometric output for Moody analyzed surface plate



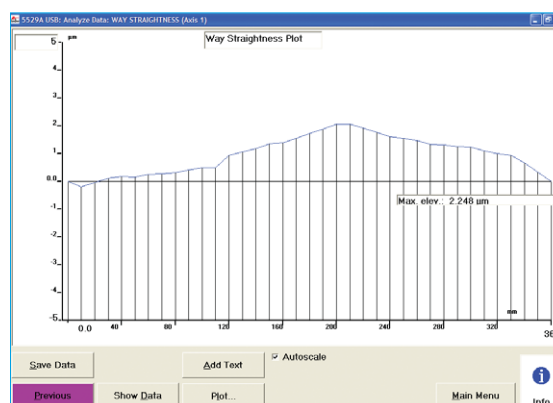
Optical setup to measure straightness of way



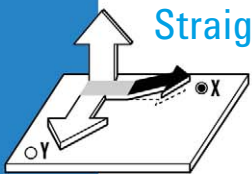
Machine way straightness measurement



Initial Set Up screen for way straightness



Output plot of way straightness



Straightness and Parallelism

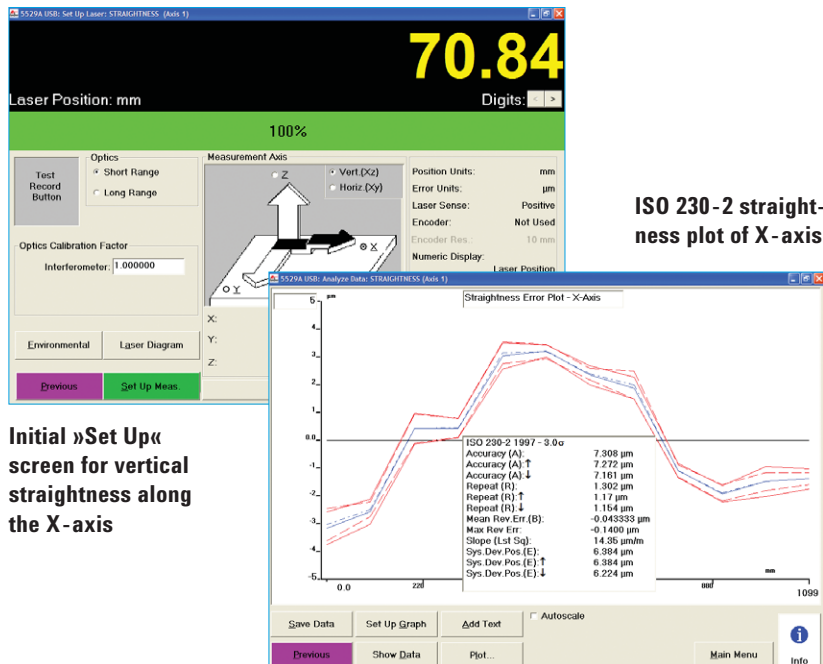
Straightness and parallelism measurements identify geometry errors that seriously degrade machine tool performance including straightness of travel and parallelism of co-linear axes...

- **Straightness measurements** evaluate the unwanted side-to-side or up-and-down motion of a machine tool's travel in a specified direction. (See »Way Straightness« on page 24 for analysis of the straightness of an object such as a machine tool way.)
- **Linear parallelism measurements** evaluate the misalignment between two co-linear axes such as a w-axis and z-axis on a horizontal machining center.
- **Rotational parallelism measurements** evaluate the misalignment between a rotational axis and a linear axis such as spindle parallelism of a turning center.

Straightness of travel, a measurement that is particularly sensitive to air turbulence, is accurately measured using Agilent's two frequency laser optical »straight edge« that is less sensitive to air turbulence than other laser technologies.

Items Included in the 10776A Straightness Accessory Kit:

- 1 Post (~2")
- 2 Post (~4")
- 1 Adapter Plate
- 1 Adjustment Screw
- 1 Straightness Base
- 1 Reflector Mount Assembly
- 1 Large Cube Corner Assembly
- 1 Turning Mirror Mount Assembly
- 1 Hardware Kit (includes hex key)



ISO 230-2 straightness plot of X-axis

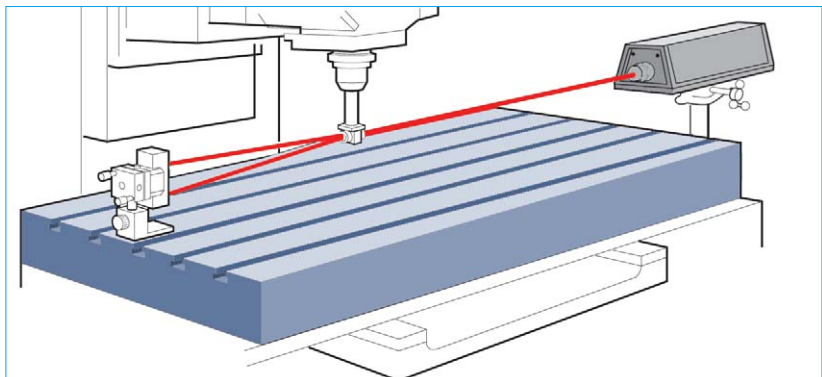
Initial »Set Up« screen for vertical straightness along the X-axis

Purpose of Measurement:

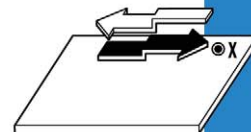
To document, analyze and diagnose machine tool travel and parallel axes of motion.

Basic Equipment:

- Basic Laser System (5529B)
- [Straightness Measurement Kit \(55283A\)](#)
(includes 10774A Short Range Straightness Optics to measure distances up to 3 meters [120 inches])



Optical setup for vertical straightness along the X-axis



Also Recommended:

- Long Range Straightness Optics (10775A measures distances up to 30m [100 feet])
- Tripod and Sensors Case and Cart (10787S and 10786S-001)

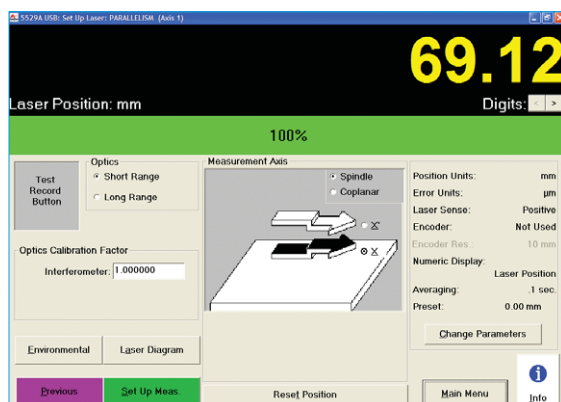
Additional Capabilities:

- Long-term drift tests can be performed over hours or days to diagnose machine problems.

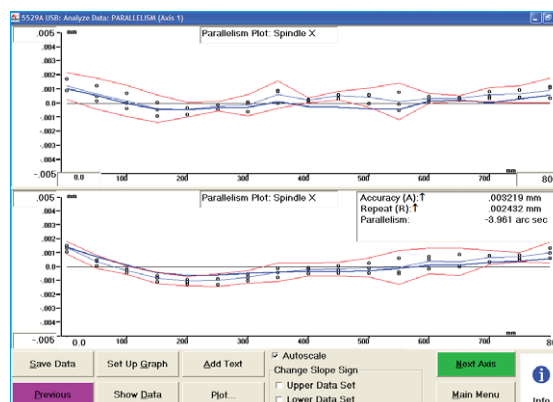
Items Included in the 55283A

Straightness Measurement Kit:

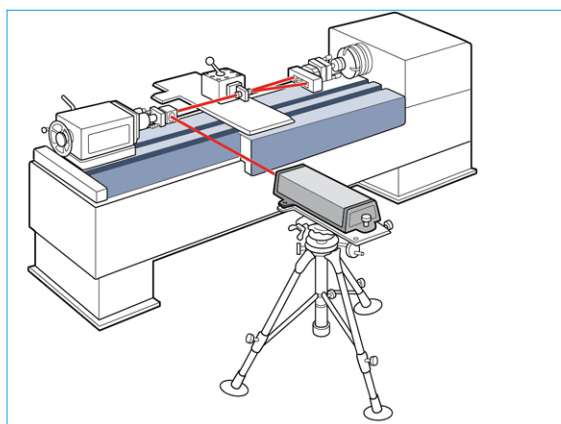
- 1 Turning Mirror 10772A
 - 1 Straightness 10776A Accessory Kit
 - 1 Straightness/ Squareness Case 10787A
 - 1* Short Range 10774A Standard Straightness Optics
 - 0* Long Range 10775A OPT-C01 Straightness Optics
- * Only one set of optics is included. Short Range is Standard. Long Range is Opt C01



Initial »Set Up« screen for parallelism



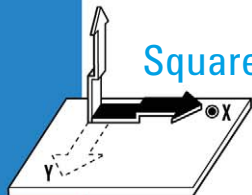
NMTBA parallelism plot of X and X'



Optical setup on lathe for parallelism

Straightness Measurement Kit (55283A)





Squareness

Squareness measurements are made in a horizontal or vertical plane to determine if two machine axes are oriented and move perpendicular to each other.

Out-of-squareness between axes, a machine tool geometry error, can seriously degrade machine tool performance.

Summary of Purpose:

To document, analyze and diagnose out-of-squareness of orthogonal machine axes.

Equipment Needed:

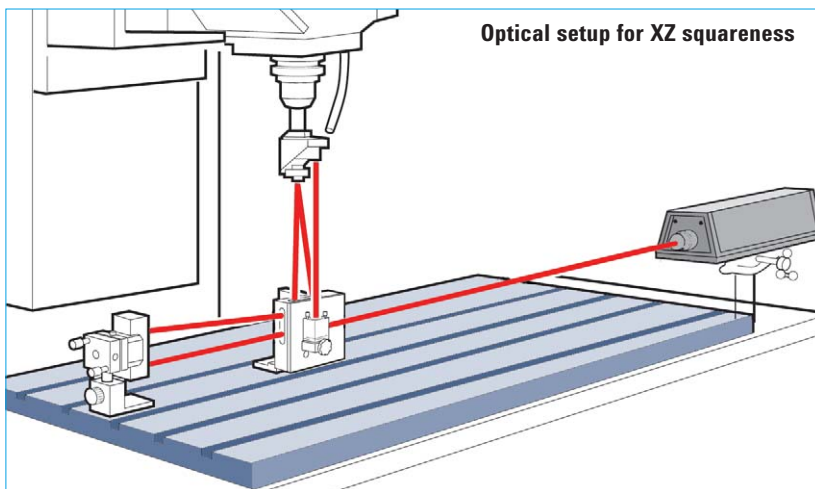
- Basic Laser System (5529B)
- Straightness Measurement Kit (55283A)
(includes 10774A Short Range Straightness Optics to measure distances up to 3 m [120 inches])
- Optical Square (10777A)

Also Recommended:

- Tripod and Sensors Case and Cart (10787S and 10786S-001)
- Long Range Straightness Optics (10775A measures distances up to 30m [100 feet])

Additional Capabilities:

- Long-term drift tests can be performed over hours or days showing possible geometry problems caused by changing thermal gradients.
- Perform straightness and squareness measurements of two orthogonal axes with one optical setup.



ANSI B5.54 squareness plot for XZ axes



Optical Square (10777A)

Special Equipment

Simultaneous Measurements for Dual Drive Machines:

When you calibrate dual drive machines, you can tie two systems together to simultaneously measure linear position on both sides by using 10887C to replace 10887B and 10888B to replace 10888A when ordering the 2nd system. Calibration time is cut in half because both sides are measured at the same time.

Calibration in Center of Work Zone:

The Fixturing Kit (10744A) is a rigid structure that helps you calibrate in the center of your work zone to avoid Abbe´ errors. The rigidity eliminates vibration related to fixturing.

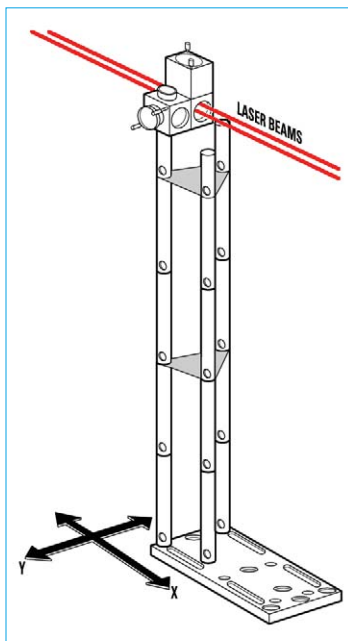
Long-range Option (5519A Option C01) extends your range to 80 m for linear measurements.

Items Included in the 10744A Supplemental Fixturing Kit:

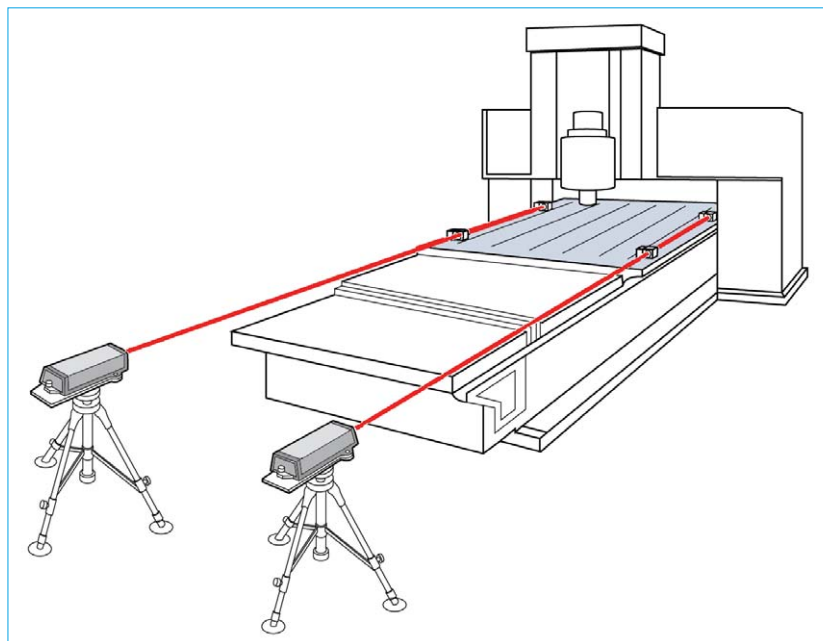
- 3 Gusset
- 2 Post (~1")
- 2 Post (~2")
- 5 Post (~4")
- 1 Base (large)
- 1 Adapter Plate
- 1 Flexible Ball Joint
- 3 Right Angle Clamp
- 1 Hardware Kit (includes hex keys)



Fixturing Kit (10744A) parts for calibration in center of work zone.



Example linear setup using 10744A Fixturing Kit



Two-axis setup for split-servo profiler



Other Equipment

USB Expansion Modul 55292A

Application:

Universal Serial Bus (USB) Expansion Module is designed for the Agilent 5529A Dynamic Calibrator, the world standard in laser based machine tool metrology. The USB Expansion Module is an ideal portable solution for laser-based calibrations when combined with a laptop computer. IRQ and memory conflicts are no longer an issue with the USB Expansion Module. Up to 5 modules can be used simultaneously with the USB hub. New metrology software with seven of the latest international machine tool standards are also included.

Features:

- Serves as host for one 10887B calibration board and one 10886A compensation board in each module
- Five modules may be used simultaneously with the addition of the USB hub
- A portable solution when used with laptop computer
- Includes new metrology software that meets latest known revisions of seven international machine tool standards
- Portable around the shop floor or around the world.

Minimum requirements:

- IBM compatible Computer with Windows 98, 2000, or XP installed
- 64MB ram, CD-ROM drive
- 1 internal USB port

Note: add on adapters are not supported

All 10887B and 10886A boards must be reset to factory defaults: 10887B to addr 512, IRQ5 and 10886A to addr 288

Shipping weight: 2.1 Kgs

Envelope: 387 x 184 x 127 mm





Upgrade Kit (5529U),

used to upgrade the 5528A system, includes adapter cables, software and PC boards. Uses the 5518A Laser Head and any Agilent calibrator optics (5526A, 5528A or 5529A).

Items Included in the 5529U Upgrade Kit:

- 1 Laser Power Supply 10884A (with power cord)
- 1 PC Compensation Board 10886A
- 1 PC Calibrator Board 10887B and Software
- 1 Laser Head Cable (7m) 10883-60202
- 1 Remote Adaptor Cable 05508-60212
- 1 Air Sensor Adaptor Cable 10751-60209
- 3 Material Sensor Adaptor Cable 10757-60306
- 1 Manual (language specific)



Combination Linear/Angular Kit, (55281B)

reduces cost by using the angular interferometer to make linear measurements.

Items Included in the 55281B

Combination Linear/Angular Kit:

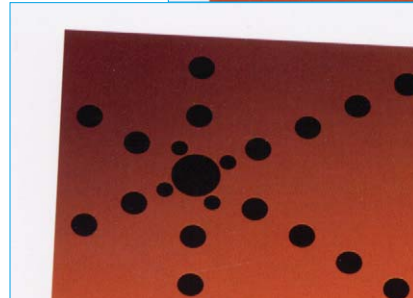
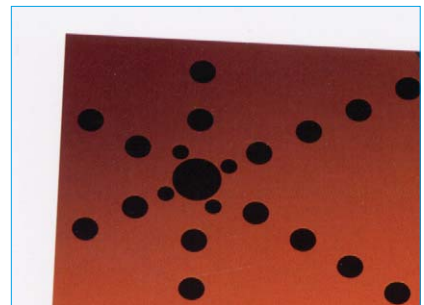
- 1 Linear Retroreflector 10767A
- 1 Angular Interferometer 10770A
- 1 Angular Reflector 10771A
- 2 Base 10784A
- 2 Height Adjuster and Post (~4") 10785A



55291A-010 CNC

Upload/Download Software

A compensation table created during machine performance verification, and used to improve the machine's performance, can be downloaded directly to the CNC controller using the 55291A Software. The software directly supports transfers of tables and programs to or from FANUC 0M, 6M, 10M, 11M, 12M, 15M, 16M, 18M, 20M, 21M, and any controllers with compatible compensation table programming codes. Both a manual and a serial cable are included with the software CD.





Unmatched Service & Support

Training

Whether your technicians are novices or highly skilled, product specific instruction will give your people the skill and confidence they need. Training is provided at your site by an Agilent authorized distributor.

Warrenty

The 5529A Dynamic Calibrator comes with a three-year warranty. An optional five-year warranty for major components is available at a nominal cost.

Manuals

Comprehensive documentation – available in eight languages including PRC and ROC Chinese, English, French, German, Italian, Japanese and Spanish – helps operators quickly learn how to install and use the 5529A system.

- **Installation Guide**
explains how to install the compensation and calibrator boards and the software.
- **Getting Started Guide**
explains to first-time users how to set up and use the 5529A to perform a simple linear measurement on your desktop before you actually make a machine measurement. The guide also provides an overview of the metrology software, guidelines for ensuring consistent accuracy and troubleshooting/maintenance procedures.
- **Measurements Reference Guide**
explains how to plan measurements and use the 5529A to make machine calibrations.

Screen-by-screen help, including instructions on completing each field, is available using the online help features presented on page 10 of this brochure.



Manuals are available in eight languages. A set of manuals in one language is included with the system. Manuals in other languages are available as options.



5529A Calibration

Agilent Technologies provides calibration of the laser head in a factory-based metrology lab equipped with an iodine stabilized laser that is directly traceable to the National Institute of Science and Technology (NIST).

Customers can also send air pressure and material temperature sensors for calibration annually to a local Agilent service center.

What to do Next?

To talk with a sales engineer or to purchase the 5529A Dynamic Calibrator System, contact your nearest Agilent sales office or an Agilent authorized distributor.

Worldwide Service and Support

Agilent service and support is provided at local Agilent service centers throughout the world.

 Agilent Technologies	Agilent Technologies 3501 Stevens Creek Blvd Santa Clara, California 95051-8059 USA Telephone: (408) 553-2051	5962-0476
--	---	-----------

Certificate Of Calibration
ANSI/NCSL Z540-1-1994

Certificate No: XXXXX

Manufacturer: Agilent Technologies Description: Laser Head
Model No: 5519B Serial No: USXXXXXXXXXX
Options Installed With Specifications: none

Date of Calibration: 20 OCT 2005 Humidity: 15-60% RH
Temperature: 23 °C +/- 0.5 °C
Procedure: LASER 100

This certifies that the above product was calibrated in compliance with ANSI/NCSL Z540-1-1994 and a quality system registered to ISO 9001:2000 using applicable Agilent Technologies' procedures.

As Received: Factory tested - No incoming data available.

As Shipped Conditions: At the completion of the calibration, measured values were IN SPECIFICATION at the points tested.

This Laser Head was checked by measuring the frequency difference between it and a reference iodine stabilized laser, which is an intrinsic standard. This Laser Head was within specifications when received and no adjustments were made.

The measured wavelength was 632.9913709 nanometers. The nominal wavelength for this laser head is 632.9913540 nanometers. The error is 2.67E-8, which is well within the specifications.

Measurement uncertainty is accounted for in the determination of the test limits for compliance to specifications. The measurement uncertainty is 1E-9.

Remarks or special requirements:

Traceability Information: Traceability is to national standards administered by the U. S. NIST, NRC Canada, Euramet members (NPL, PTB, BNM, etc.) or other recognized standards laboratories. Some measurements are traceable to natural physical constants, consensus standards or ratio type measurements. Supporting documentation relative to traceability is available for review by appointment.

Calibration Equipment Used:			
Model Number	Model Description	Trace Number	Cal Due Date
53181A	Frequency Counter	90361	31 August 06
100	Stabilized HeNe Laser	90394	Intrinsic Standard, Metrologia vol. 30 pp. 523-41, 1993/4

This report shall not be reproduced, except in full, without prior written approval of the calibration facility.

Print Date: 27 October 2005


Lynn Vanderhof
Measurement Standards

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The 5519B-A6J option provides ANSI/NCSL Z540 compliant calibration of the laser head.

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