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Agilent 5529A
Dynamic Calibrator



Verify Machine Performance
with the World Standard
for Laser Metrology

Agilent Technologies

The 5529A: A Powerful Analysis System

The 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.

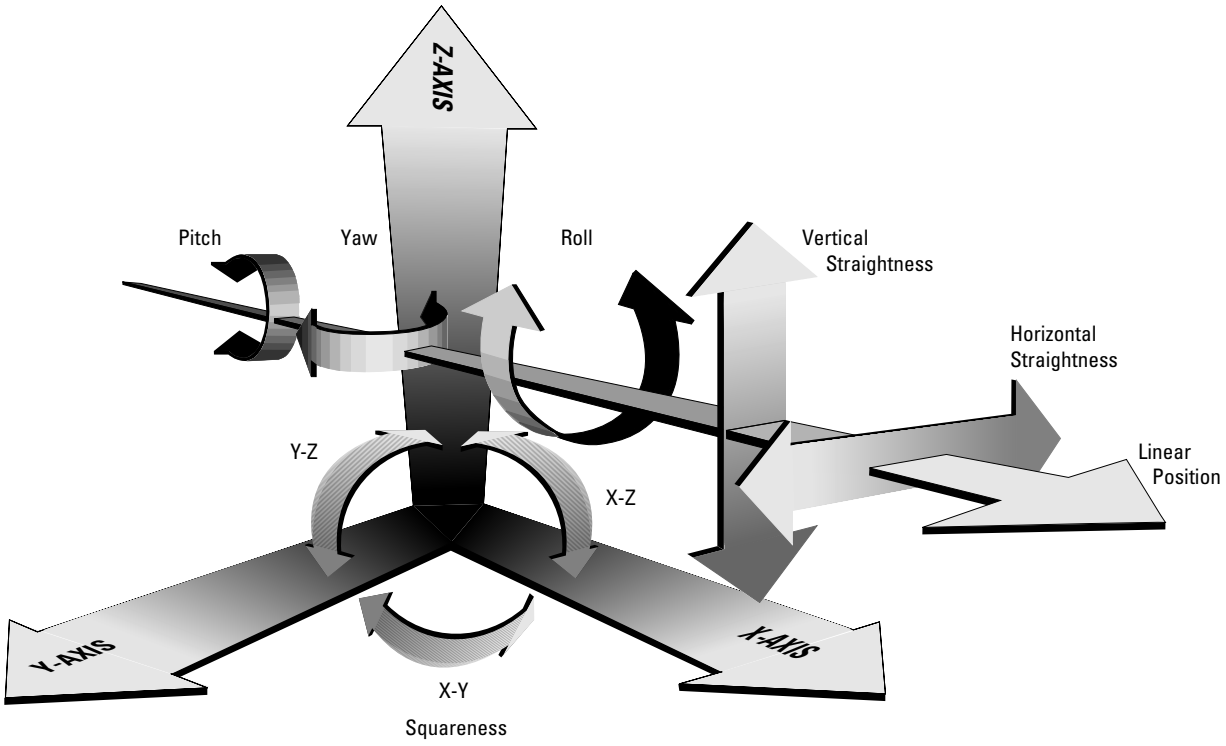
Agilent Technologies is the world's largest manufacturer of laser interferometers. The company invented the two-frequency, heterodyne laser interferometer that made laser calibration practical in a shop environment and pioneered the use of software to simplify calibration and analysis.

Agilent 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 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 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, 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.

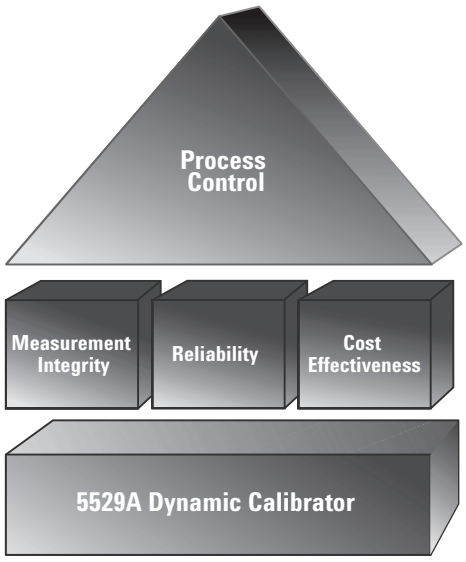
Even when temperatures in your shop are unstable and air quality is poor, you'll be able to repeat your measurements and get consistent results.

- ***Stainless Steel Optics.***

Further enhancing the integrity and believability of measurements, Agilent manufactures rugged, thermally stable optics. Agilent 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 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's laser tube lasts 2-1/2 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 5529A provides the lowest cost of ownership in the industry.

Because you will replace the Agilent 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 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 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 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.

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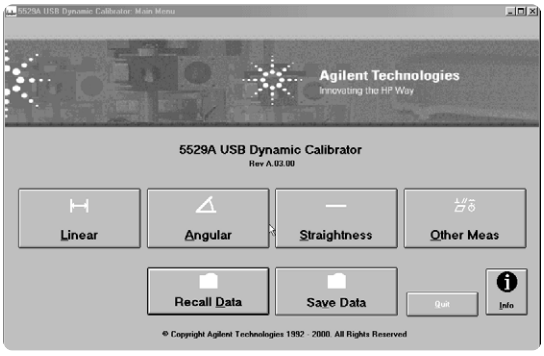
Service & Support 34

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.

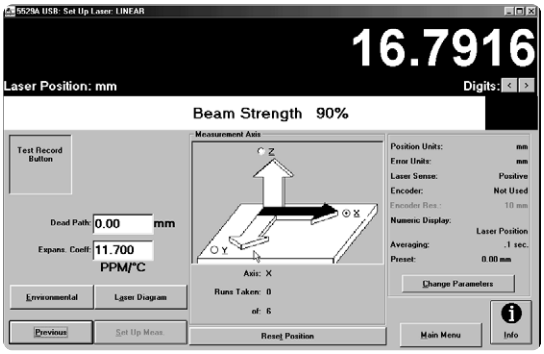
Six Steps to Calibrate

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.



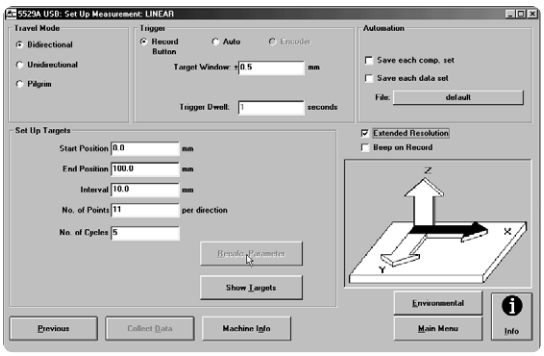
1. Select a measurement

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



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 "Set Up Meas." button to go to the next step.



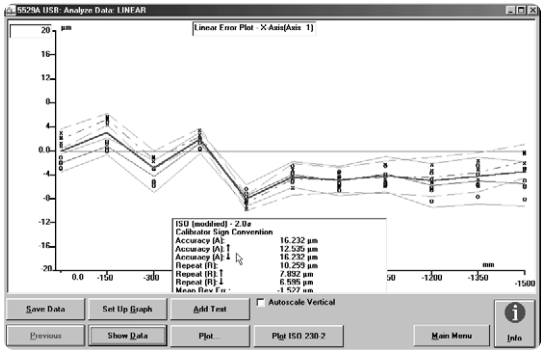
3. Set up the measurement

- 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.



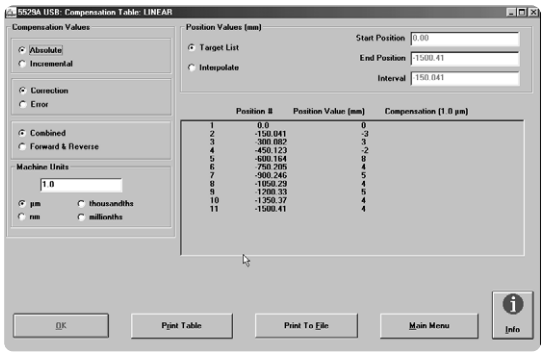
4. Collect the data

- 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.



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 "Show Comp Table" button on "Show Data" screen to create compensation table.



6. Compensation table

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

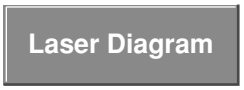
Windows-Based Software Makes a Difficult Task Easier (continued)

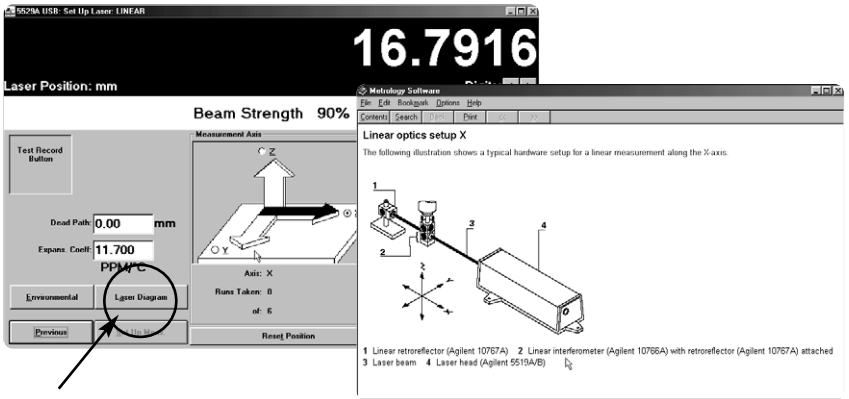
Online "Help" Windows

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 35. Help windows as well as manuals are translated into eight different languages.

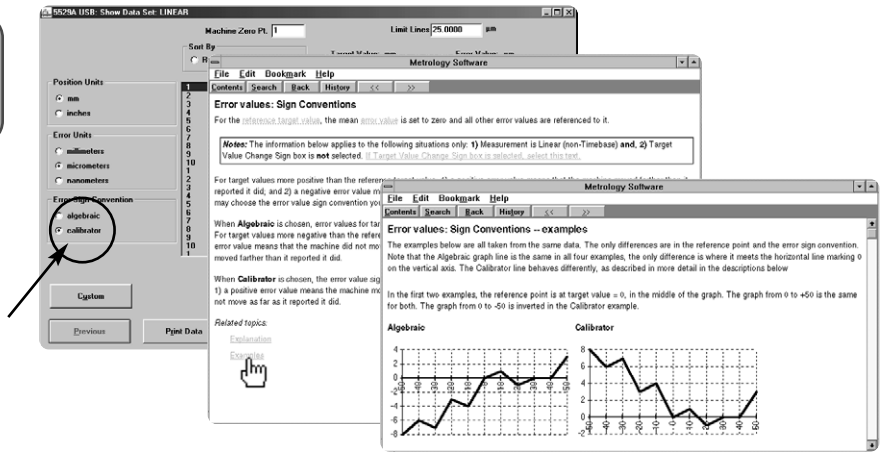
- **Laser Diagrams,** on the "Set up Laser" screen, display the measurement setup.



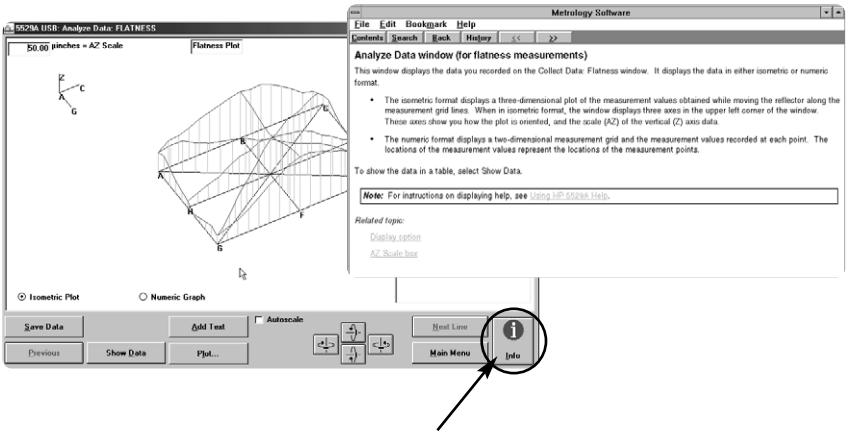


- **F1 context-sensitive help files** provide online information regarding a specific subject.





- **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.

Option UK6 of the Basic Laser System (5529B) provides documentation that verifies conformance for ISO 9001/2 commercial calibration.

Proof of Agilent's manufacturing process is also documented. The Agilent 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.

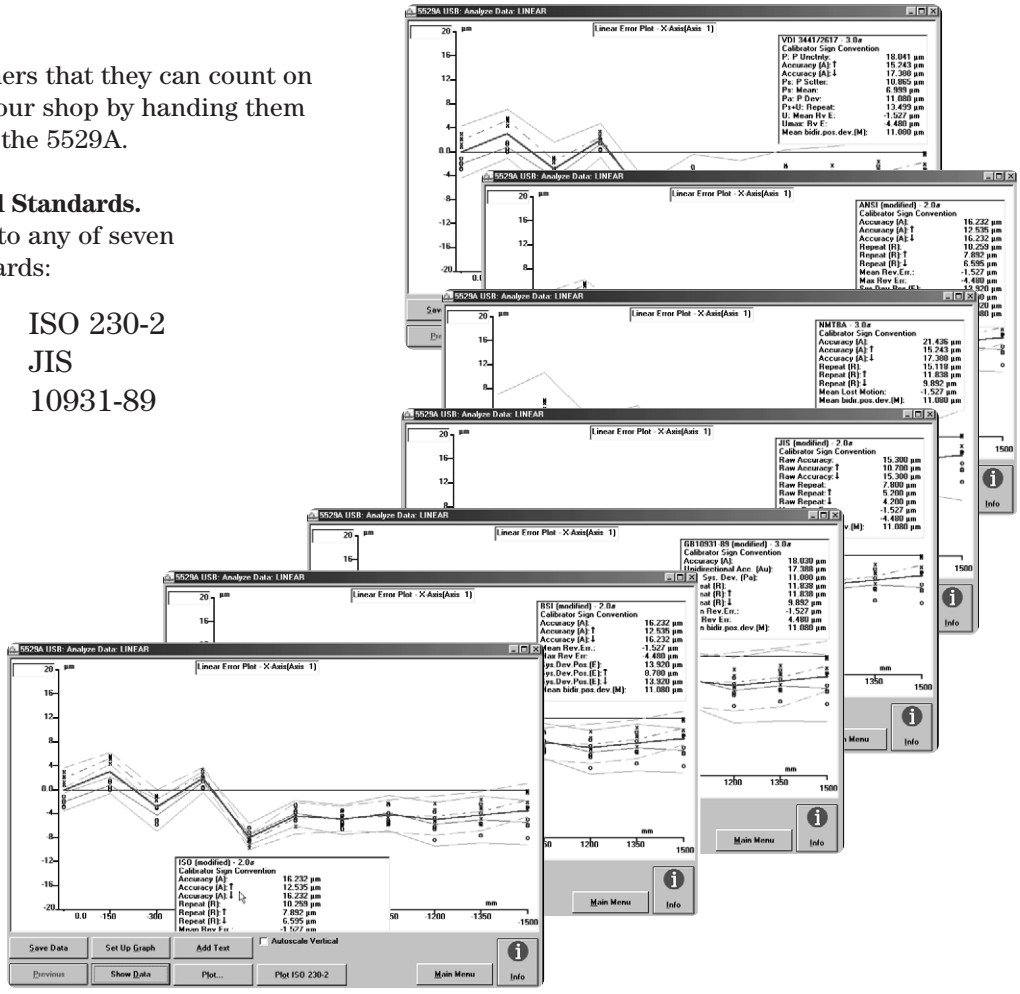
- **Seven International Standards.**
  Show conformance to any of seven international standards:

NMTBA	ISO 230-2
VDI/DGQ 3441	JIS
ANSI B5.54	GB 10931-89
BSI 3800	

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

  - **English**
  - **Français**
  - **Español**
  - **Deutsch**
  - **Italiano**
  - 中文简体
  - 日本語
  - 繁體中文字





Special Capabilities Make Calibration More Efficient

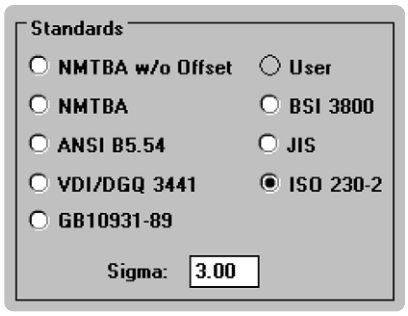
To help you get your expensive machine tools back into production as quickly as possible, Agilent has designed important, time-saving features into the dynamic calibrator and its software.

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.



- **Customized Plots.**

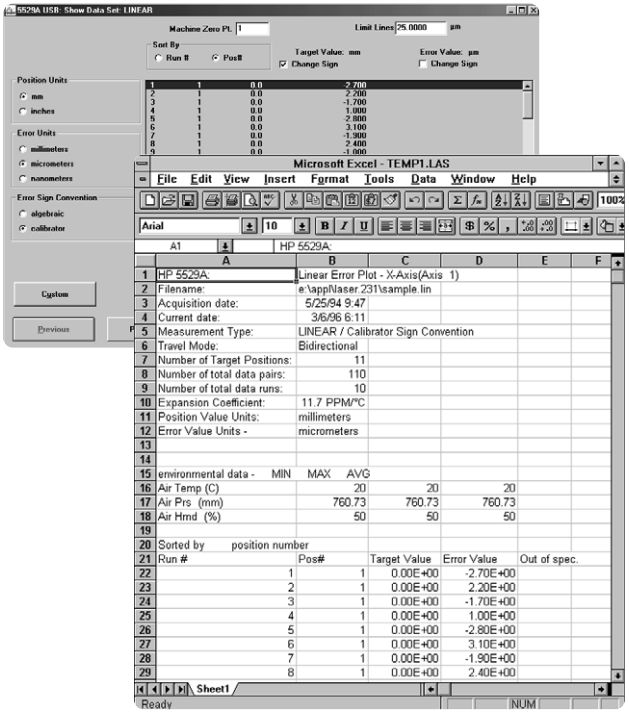
Report and plot the data that is important to you. To track your process well, you may need more or different information than is shown on the standards plots. The 5529A gives you the ability to customize graphical and numerical analysis.

- **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.



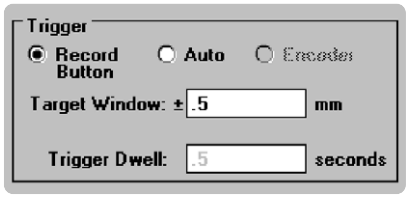
- **Calibrator Mode versus Algebraic Mode.**

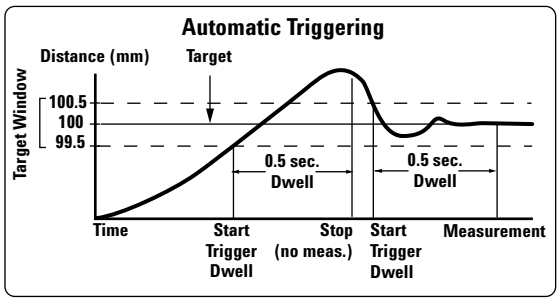
When you look at a performance plot, have you ever been confused about whether your machine will make a part longer or shorter? The 5529A software can automatically convert algebraic computation tables to calibrator mode (as shown on the help screen on page 10) so that error polarity is always correct. 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.

Tools to Simplify the Measurement Task

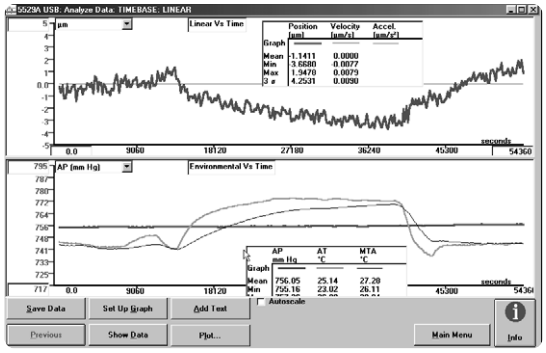
Whether you are performing a quick assessment of a machine's performance or a detailed analysis of the machine's geometry, Agilent has designed tools that make the job easier:

• **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") for a defined period ("Trigger Dwell"). Or use A-Quad-B output from the encoder ("Encoder") to trigger measurements either automatically or on-the-fly.





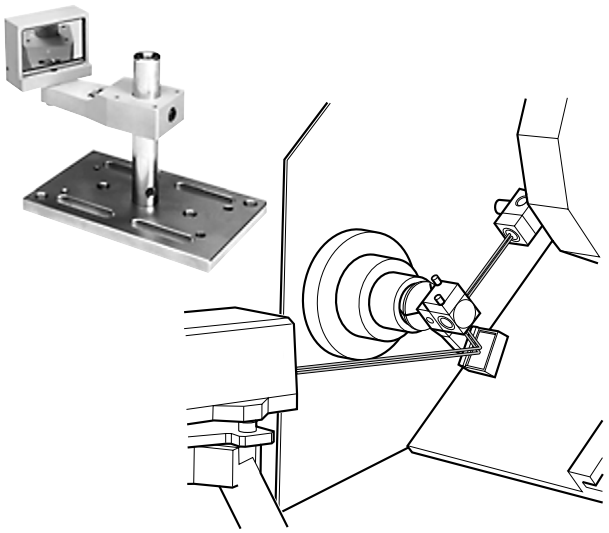
• **Thermal Drift Test.** If you think you're having temperature problems at different periods of time, you can perform a thermal drift test over very long time periods to diagnose intermittent temperature issues.



• **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.



55291A CNC Download/Upload Software

A compensation table ("comp table") created during machine performance verification can be entered to improve performance of many Computer Numerical Controller (CNC) based machine tools.

Purpose of Function
CNC Download/Upload Software allows an 5529A comp table to be converted to a controller-specific format and downloaded to a compatible controller without a tedious, lengthy hand-key operation. The comp table can be downloaded into a CNC by either an RS-232 connection or floppy disk.

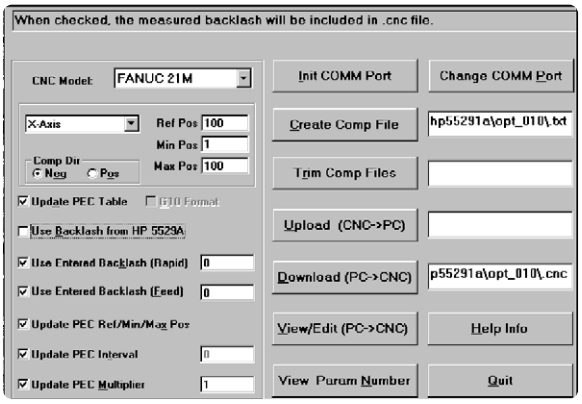
Basic Equipment
- Agilent Dynamic Calibrator System (5529A)
- RS-232 port or floppy drive on selected CNC controller
- CNC Upload/Download Software (55291A, requires Option)
- Selected FANUC M Series Controllers option (55291A Option 010)

Currently Supported Controllers
Option 010: FANUC 0M, 6M, 10M, 11M, 12M, 15M, 16M, 18M, 20M, and 21M

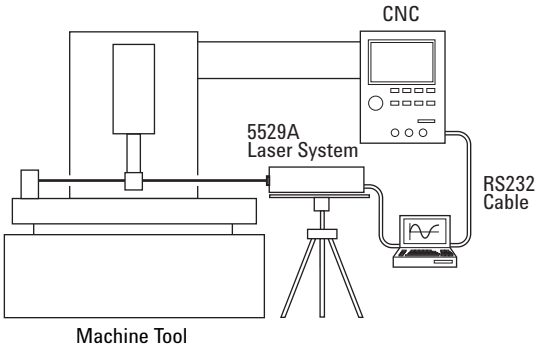
Additional Capabilities
- Download programs used for machine calibration from the PC to the compatible CNC.
- Upload original comp table to maintain a copy of the machine tool's initial state.
- View default parameter numbers quickly without searching through manuals.
- Modify the comp table after initial compensation.
- Upload parts programs from a compatible controller to the PC, freeing space in the CNC.



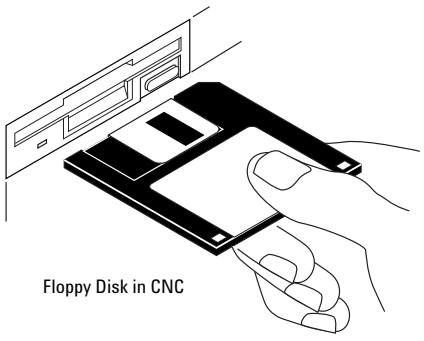
CNC Download/Upload Software product (55291A shown with option 010) includes an RS-232 cable.



The 55291A converts compensation file from the 5529A into a controller-specific comp table. Then the comp table can be sent to a compatible CNC.



The comp table can be downloaded into a CNC by either an RS-232 connection or floppy disk.



Floppy Disk in CNC

Download and Upload require an RS-232 port or floppy drive on the controller.

Option 010:
Format 5529A compensation files for FANUC controllers – 0M, 6M, 10M, 11M, 12M, 15M, 16M, 18M, 20M, and 21M

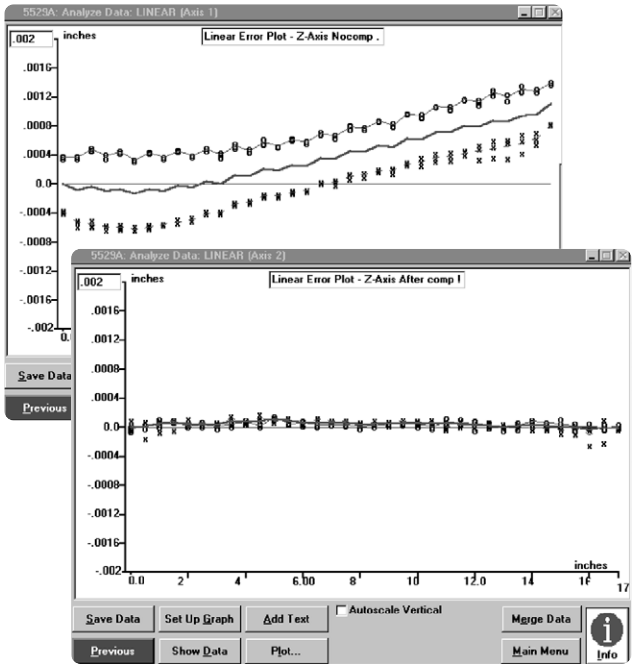
PC requirements:

Minimum:
80486 based 33 MHz PC with 16 MB RAM

Recommendation:
Pentium-based 120-MHz PC with 16 MB RAM

Operating System:
Windows® 3.1
Windows 95

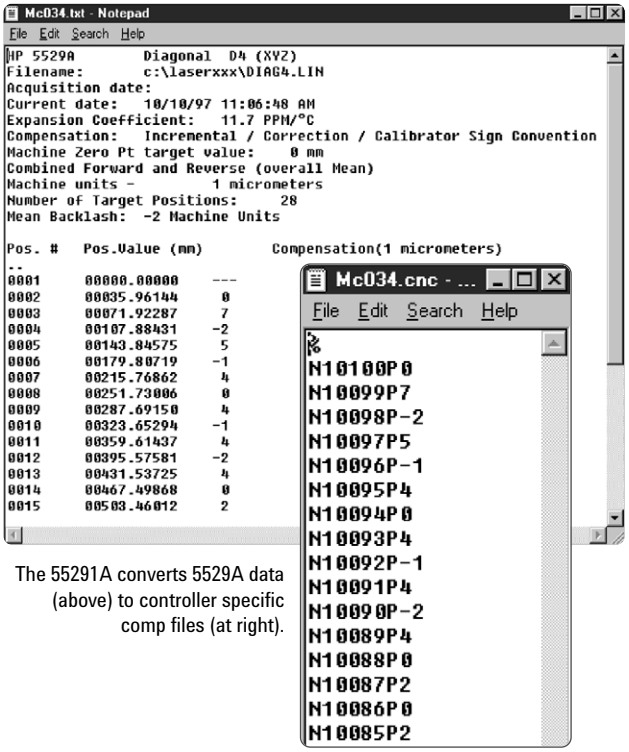
Cable length (nominal):
3 meters



Downloading comp table can dramatically improve performance as seen in these before and after error plots.

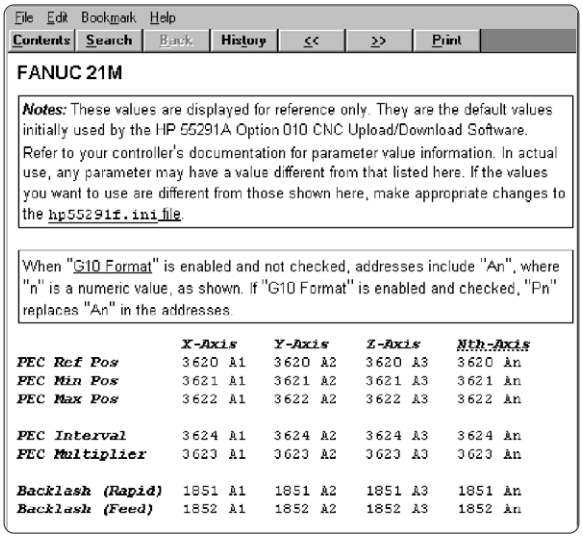
55291A is the download/upload software. The option(s) determine which controllers can be used with the 55291A.

One or more option(s) must be ordered with the 55291A. Contact your Agilent representative for the full list of 55291A options.



The 55291A converts 5529A data (above) to controller specific comp files (at right).

Default parameters can be displayed so that your in-house expertise can confidently check the downloaded comp table without researching a stack of controller manuals.



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.

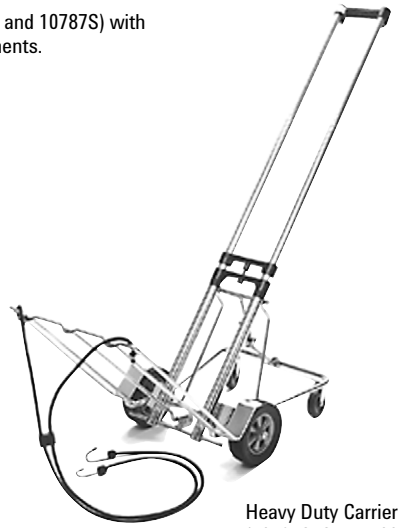
Basic System
The 5529B Basic Laser System includes most basic components needed to make machine tool calibrations. Users will add a PC to the basic laser system, plus the Agilent optics kit needed to make specific measurements (see "Equipment Needed" table on this page).

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 systems components.



Heavy Duty Carrier (10787S, 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	Angular Position Measurement Kit (55290B)	22-23
Table Calibration	Supplemental Fixturing Kit (Opt. 744) Angular Optics Kit (55281A)	
Flatness and Way	Flatness Accessory Kit (55282A)	24-25
Straightness	Angular Optics Kit (55281A)	
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 5-m Cable	10751C
F.	Material Temperature Sensor with 15-m cable	10757E
G.	Laser Head Cable	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

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

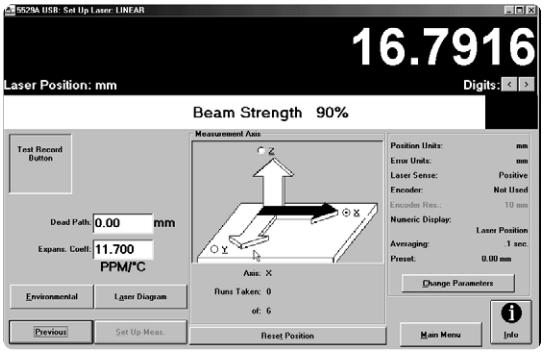
Purpose of Measurement:
To document capability and, when possible, improve positioning accuracy along an axis for any machine that requires positioning accuracy and velocity control.

Basic Equipment:
- Basic Laser System (5529B)
- Linear Measurement Kit (55280B)

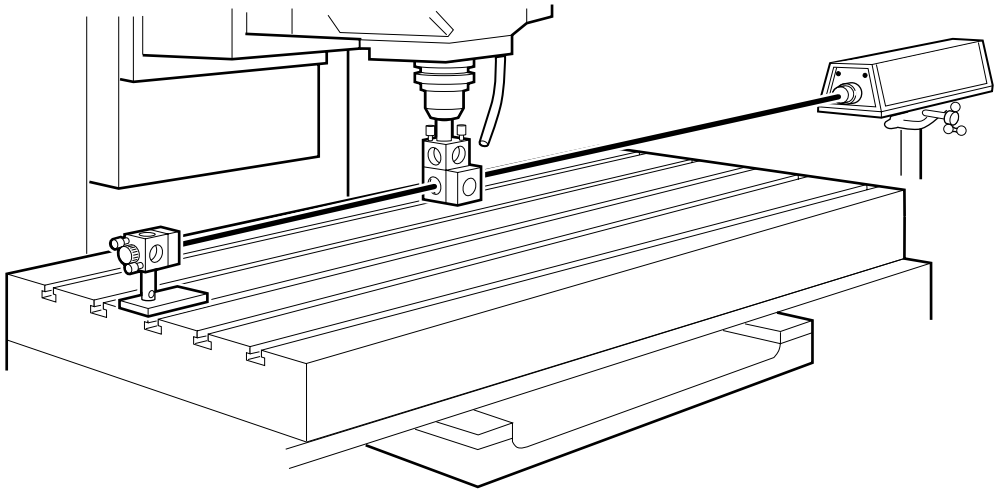
Also Recommended:
- Second Material Temperature Sensor (10757D, E or F)
- Tripod and Sensors Case and Cart (10787S and Opt. 001)
- Fixturing Kit (10744A)



Linear Measurement Kit (55280B).



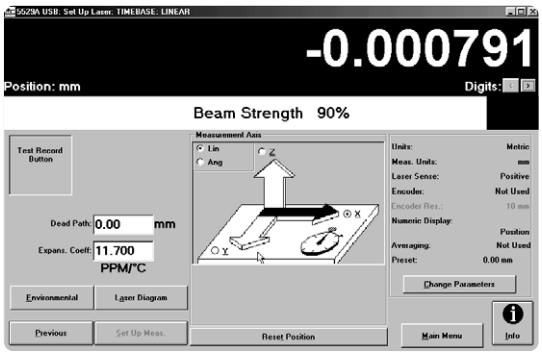
Initial "Set Up" screen for linear measurements.



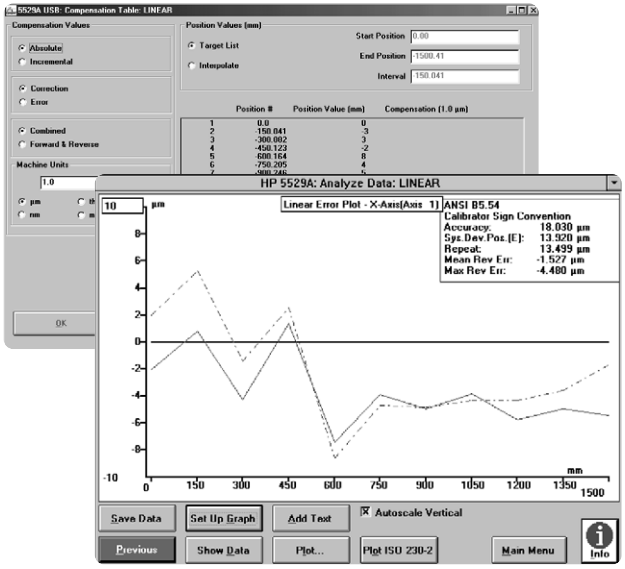
Optical setup for linear measurements.

Additional Capabilities:

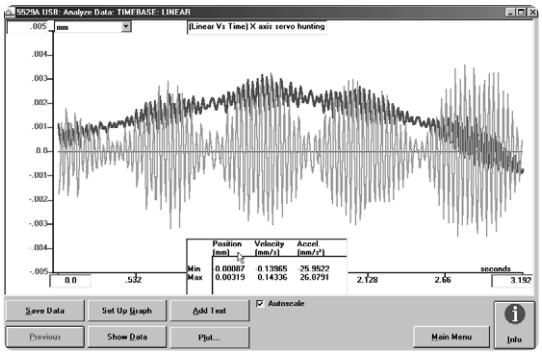
- Long-range option doubles measurement range to 80 meters (Option C01 for 5519A).
- For 1 m/s axis velocity, replace 5519A with 5519B.
- Resolution is easily increased to 1 nm with averaging.
- Perform surface (2-D) diagonal measurements.
- High data rate/fast data collection is useful for relative 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.



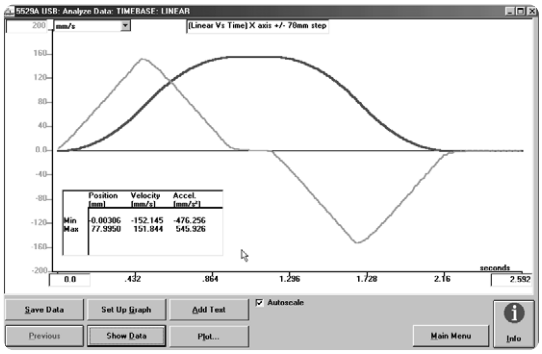
Initial Timebase “Set Up” screen.



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.

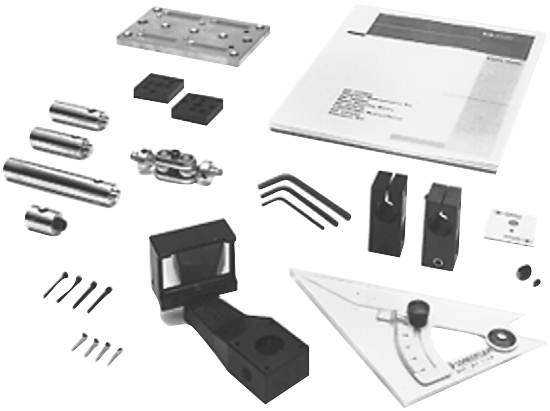
Purpose of Measurement:
To document machine tool capability and quickly perform a complete check of volumetric positioning performance.

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

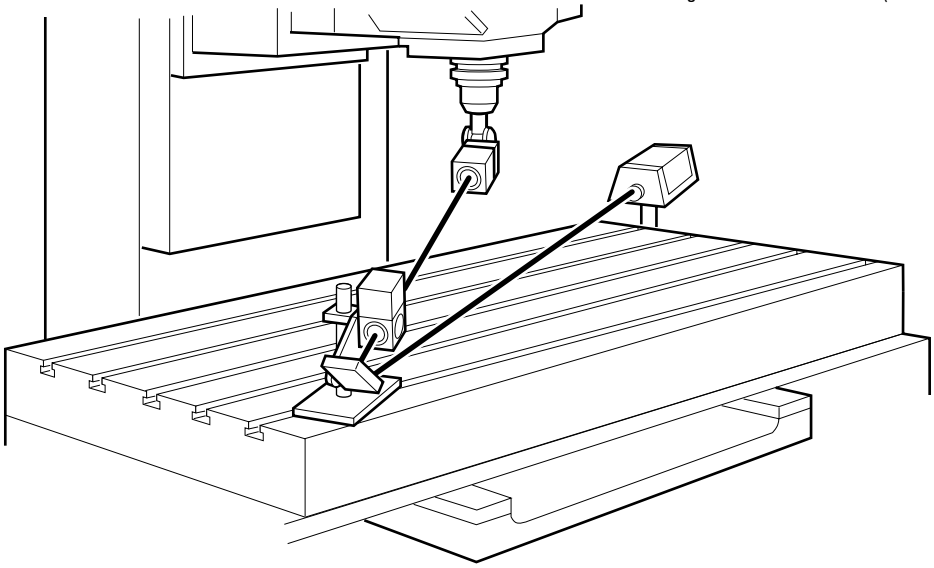
Also Recommended:
- Second Material Temperature Sensor (10757D, E or F)
- Turning Mirror (10769B)
- Lightweight Reflector (10767B)
- Tripod and Sensors Case and Cart (10787S and Opt. 001)
- Fixturing Kit (10744A)



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



Diagonal Measurement Kit (10768A).



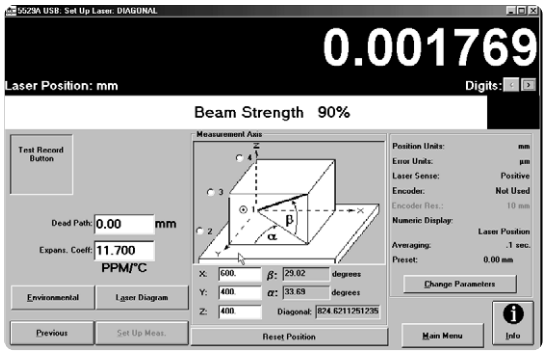
In optical setup for diagonal measurement, place the bending mirror in front of the interferometer.

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

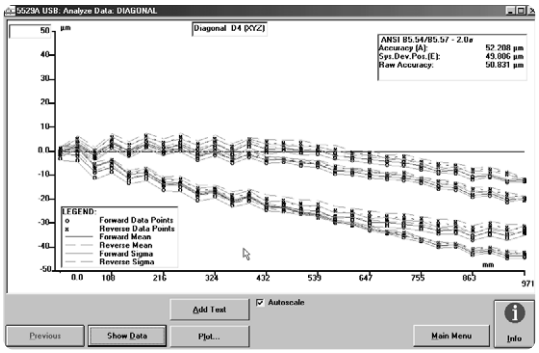
Repeatable Signature:
To achieve a signature for each of your machine tools, make diagonal measurements with the 5529A and the Diagonal Measurement Kit. The repeatability of diagonal measurements is optimized because the laser beam is aligned to the machine rather than the machine to the laser by changing 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.



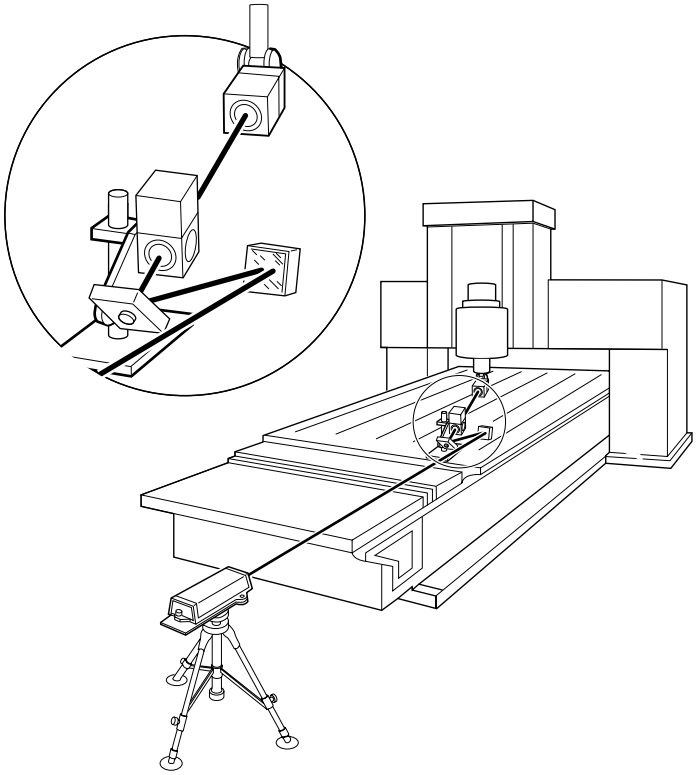
Turning Mirror (10769B) for diagonal measurements on certain gantry machines with moving beds.



Initial "Set Up" screen for diagonal measurements.



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



Angular

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.

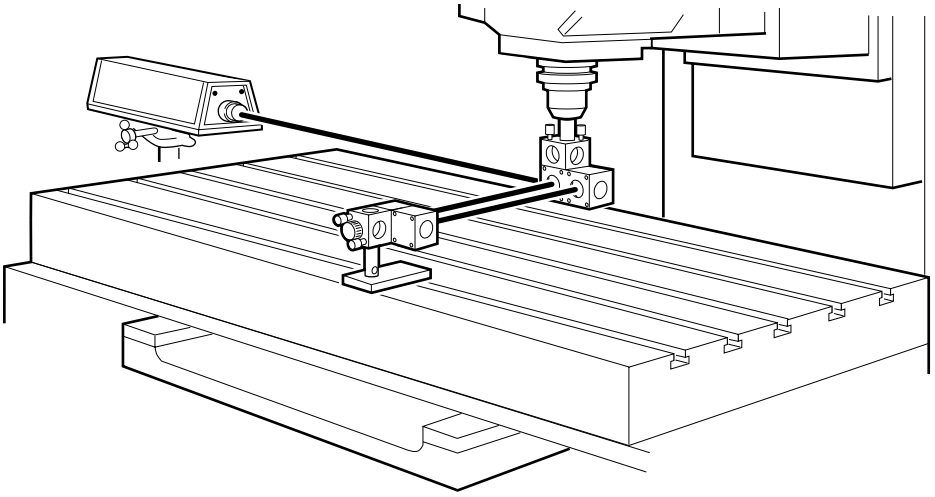
Basic Equipment:
- Basic Laser System (5529B)
- Angular Optics Kit (55281A)

Also Recommended:
- Tripod and Sensors Case and Cart (10787S and 10786S Opt. 001)
- Fixturing Kit (10744A)

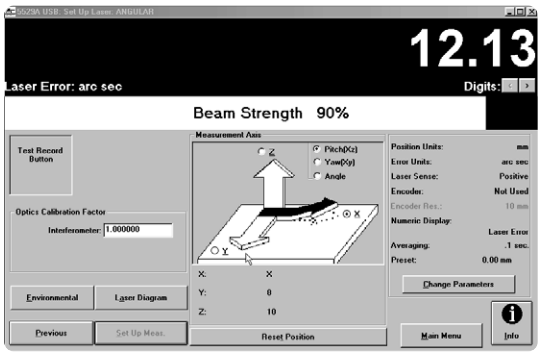
Additional Capabilities:
- Positioning errors over the work zone can be estimated from the angular and linear measurements.
- The condition of ways and the range of squareness and parallelism in the work zone can be indicated by angular measurements.
- Angular measurements help find the causes of linear 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.



Angular Optics Kit (55281A).



Optical setup for a yaw measurement on Y-axis.



Initial Angular setup screen for pitch on X-axis.

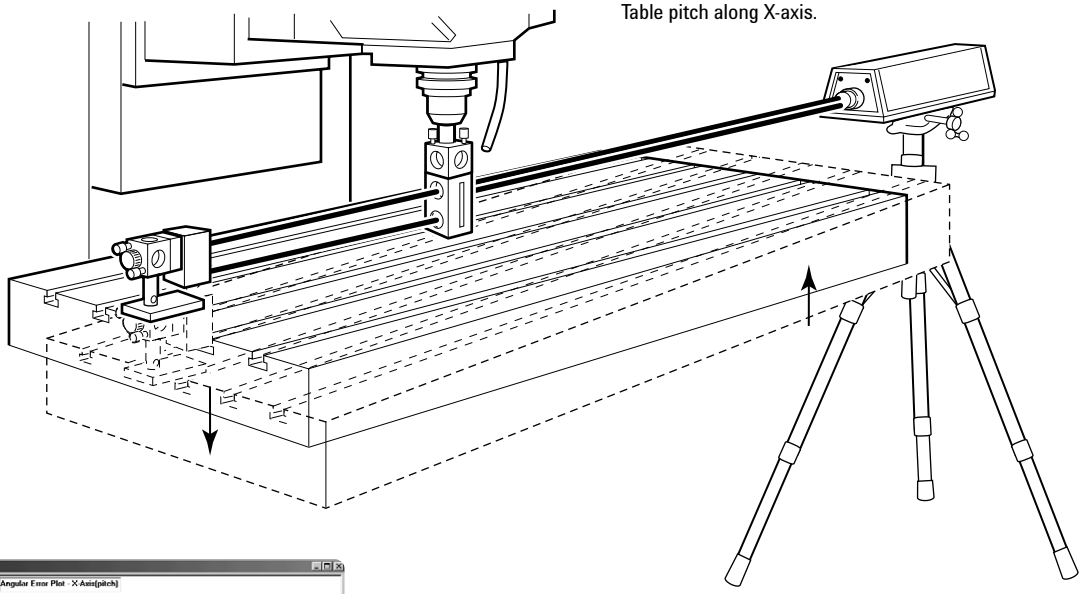
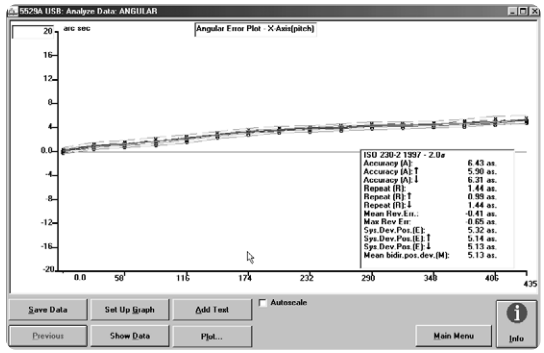


Table pitch along X-axis.



ISO 230-2 angular plot.

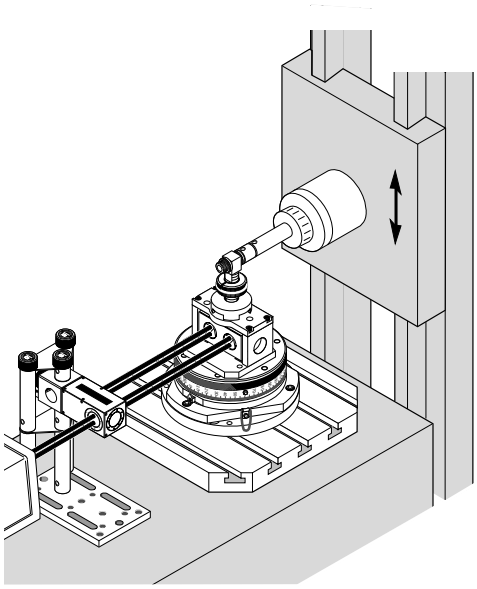
Angular Position

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

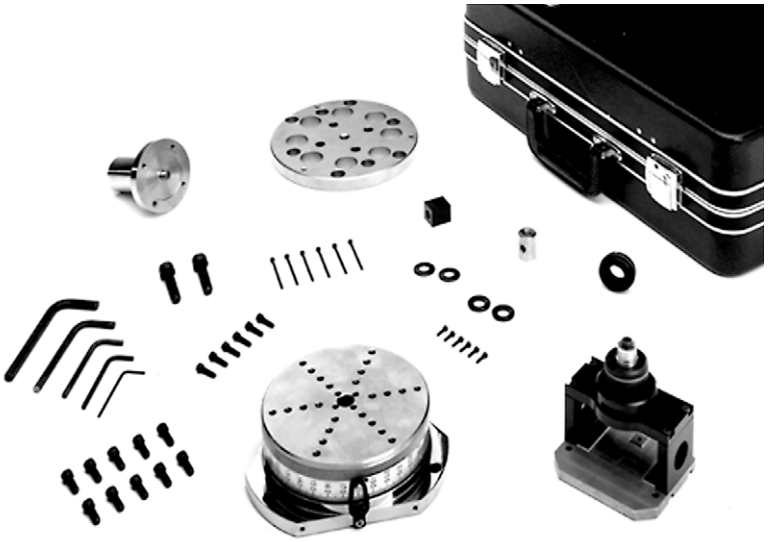
Purpose of Measurement:
To document machine tool capability and even improve angular positioning accuracy when possible.

Basic Equipment:
- Basic Laser System (5529B)
- Angular Optics Kit (55281A)
- Supplemental Fixturing Kit (55290A, Opt. 744)
- Angular Position Measurement (APM) Kit (55290A)

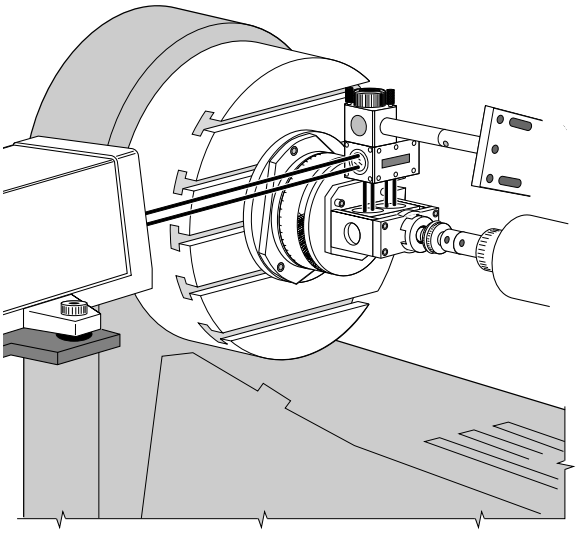
Also Recommended:
- Fixturing Kit (10744A) (can replace Supplemental Fixturing Kit [55290A, Opt. 744])
- Tripod and Sensors Case and Cart (10787S and 10786S Opt. 001)



Optical setup on horizontal machining center with horizontal table (above) and with vertical table (below).



Angular Position Measurement Kit (55290A).

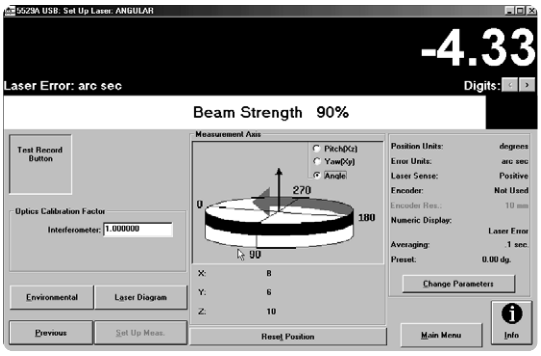




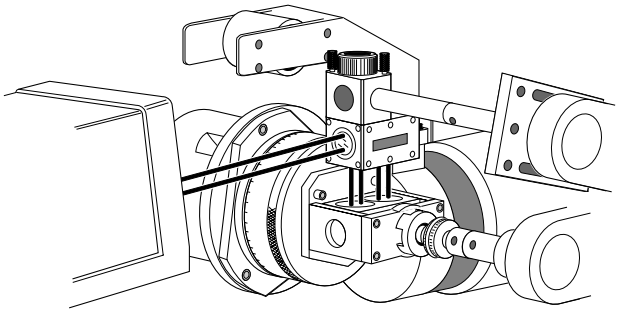
Supplemental Fixturing Kit (55290A, Option 744).

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's equipment can calibrate tools that cannot rotate 360°. The 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.



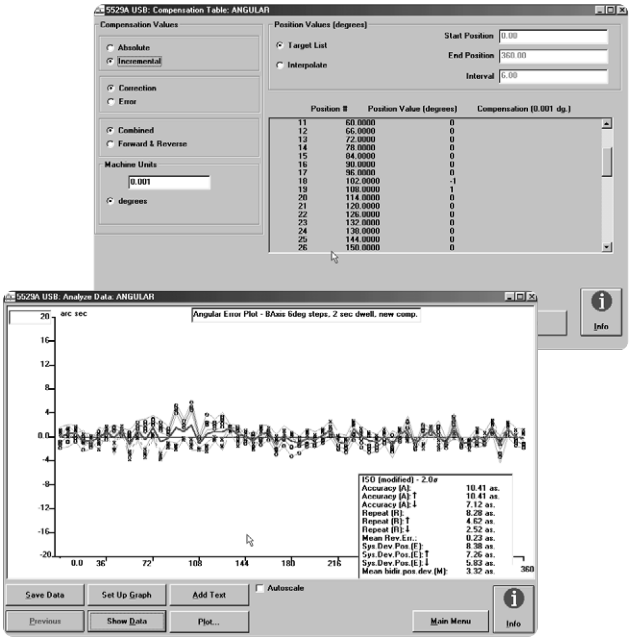
Initial "Set Up" screen for angular measurement.



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.

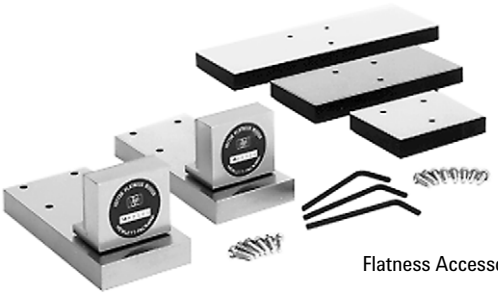
Purpose of Flatness Measurement:
To document and analyze in 3-D any flat surface such as a surface plate or machine bed.

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.)

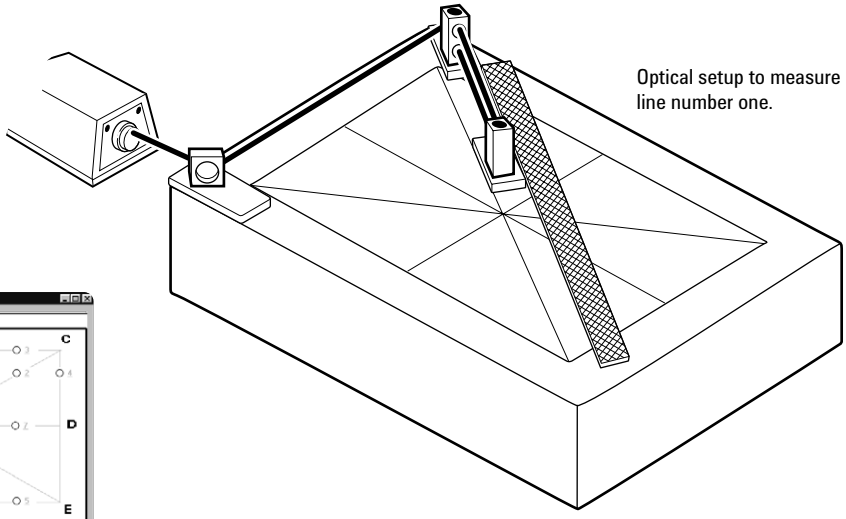
This measurement is very useful when you are setting up or rebuilding machines.

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

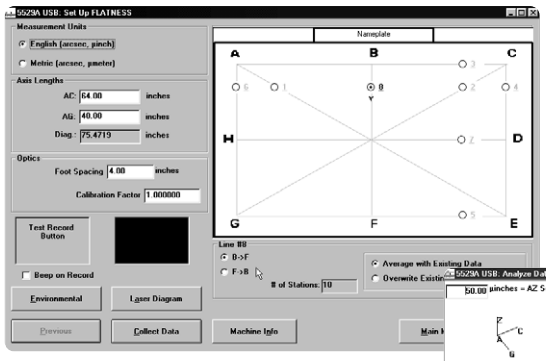
Also Recommended:
- Tripod and Sensors Case and Cart (10787S and 10786S Opt. 001)



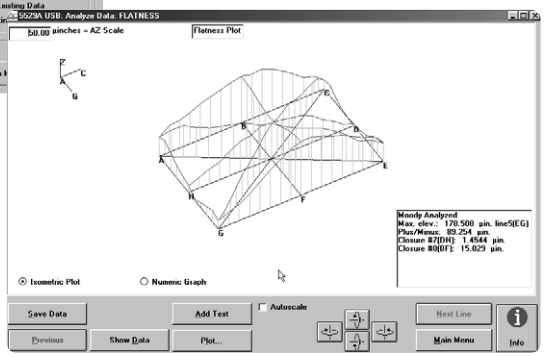
Flatness Accessory Kit (55282A).



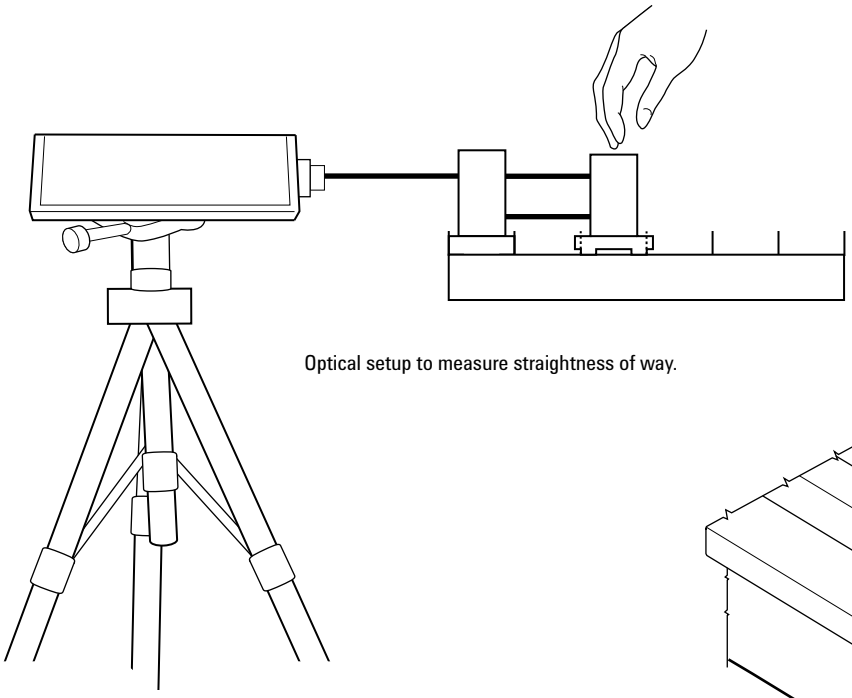
Optical setup to measure line number one.



Initial "Set Up" screen for flatness.

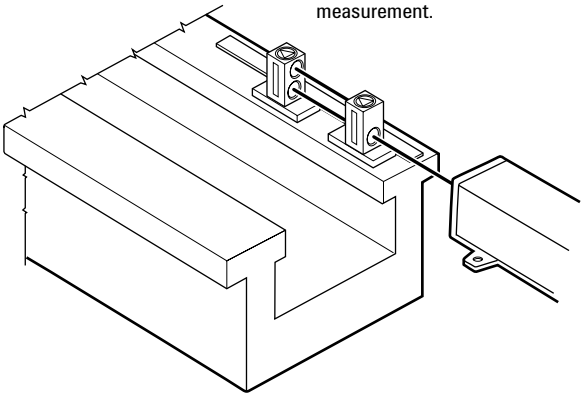


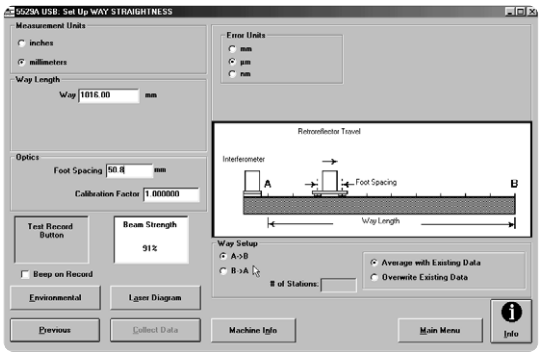
Isometric output for Moody analyzed surface plate.



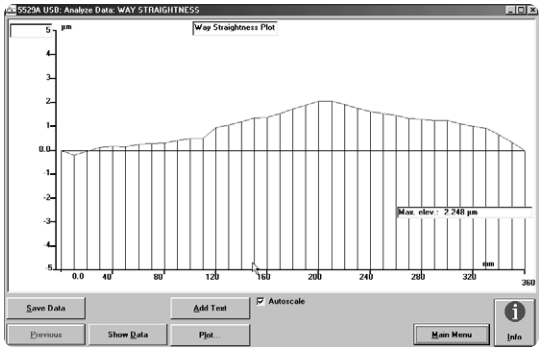
Optical setup to measure straightness of way.

Machine way straightness measurement.





Initial "Set Up" screen for way straightness.



Output plot of way straightness.

Straightness and Parallelism

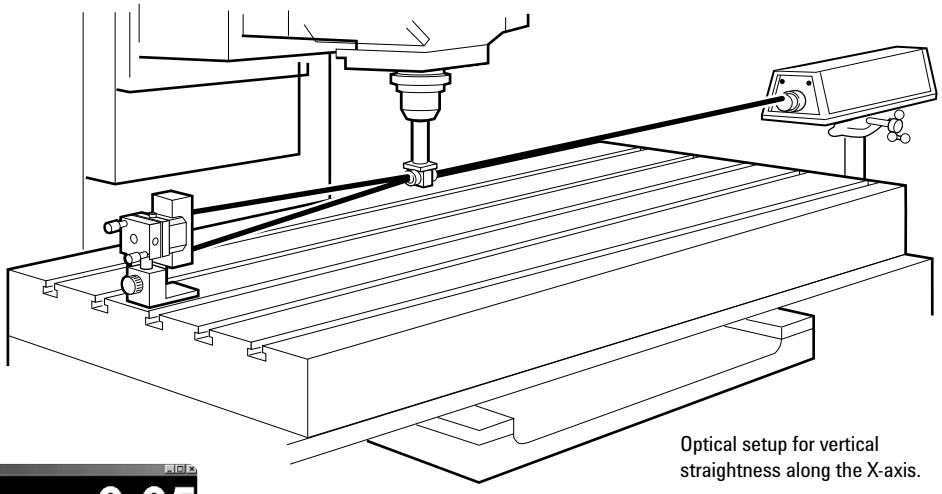
Straightness and parallelism measurements identify geometry errors that seriously degrade machine tool performance including straightness of travel and parallelism of co-linear axes.

- 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 25 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.

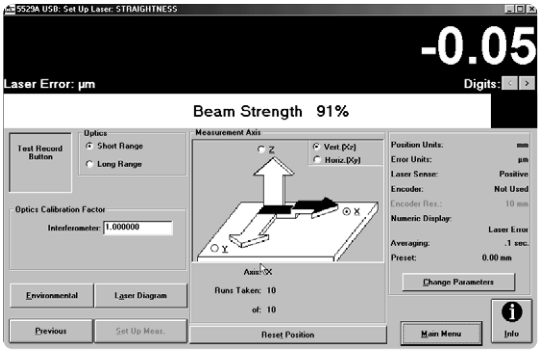
Straightness of travel, a measurement that is particularly sensitive to air turbulence, is accurately measured using Agilent's two-frequency laser optical "straight edge" that is less sensitive to air turbulence than other laser technologies.

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

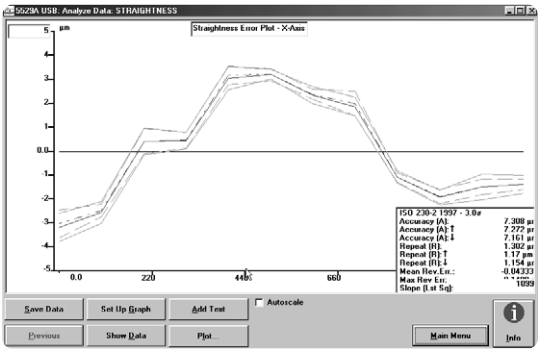
Basic Equipment:
- Basic Laser System (5529B)
- Straightness Measurement Kit (55283A) (includes 10774A Short Range Straightness Optics to measure distances up to 3 meters [120 inches])



Optical setup for vertical straightness along the X-axis.



Initial "Set Up" screen for vertical straightness along the X-axis.



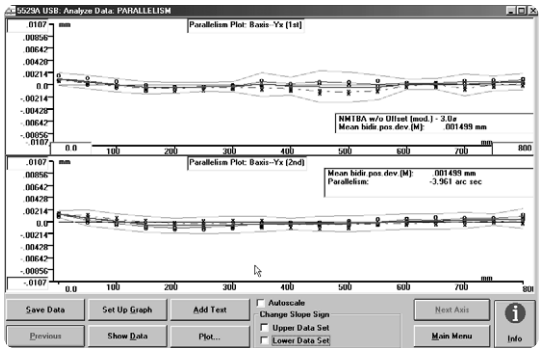
ISO 230-2 straightness plot of X-axis.

Also Recommended:

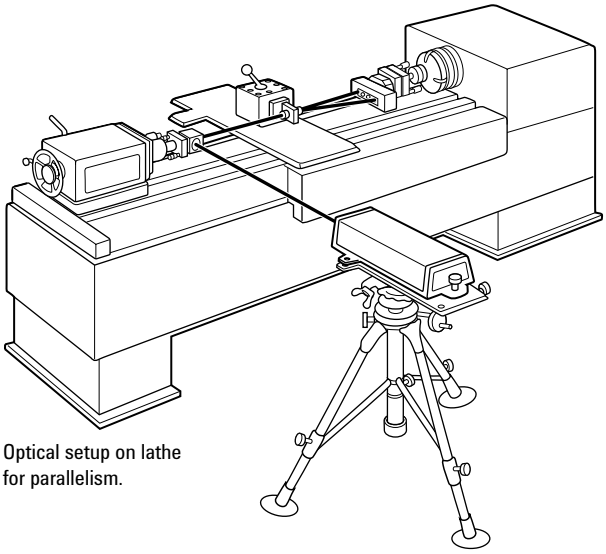
- Long Range Straightness Optics (10775A) (measures distances up to 30 meters [100 feet])
- Tripod and Sensors Case and Cart (10787S and 10786S Opt. 001)

Additional Capabilities:

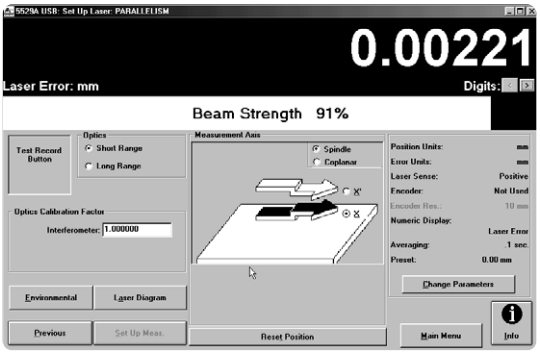
Long-term drift tests can be performed over hours or days to diagnose machine problems.



NMTBA parallelism plot of X and X¢.



Optical setup on lathe for parallelism.



Initial "Set Up" screen 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)
- Vectra Personal Computer (5529B, Opt. 050)
- Straightness Measurement Kit (55283A) (includes 10774A Short Range Straightness Optics to measure distances up to 3 meters [120 inches])
- Optical Square (10777A)

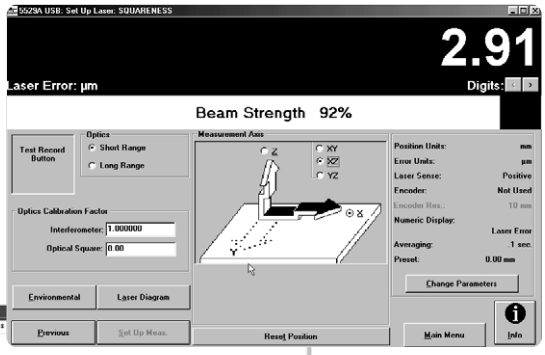
Also Recommended:
- Tripod and Sensors Case and Cart (10787S and 10786S Opt. 001)
- Long Range Straightness Optics (10775A) (measures distances up to 30 meters [100 feet])

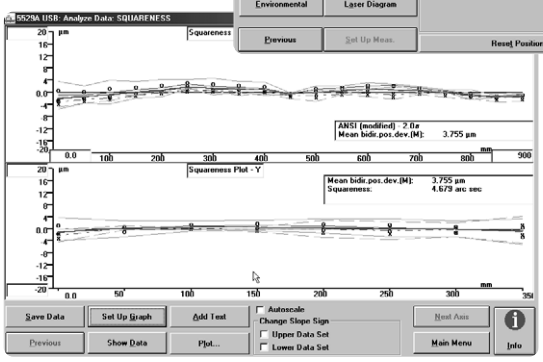
Additional Capabilities:
- Long-term drift tests can be performed over hours or days showing possible geometry problems caused by changing thermal gradients.
- Perform straightness and squareness measurements of two orthogonal axes with one optical setup.

Optical Square (10777A).

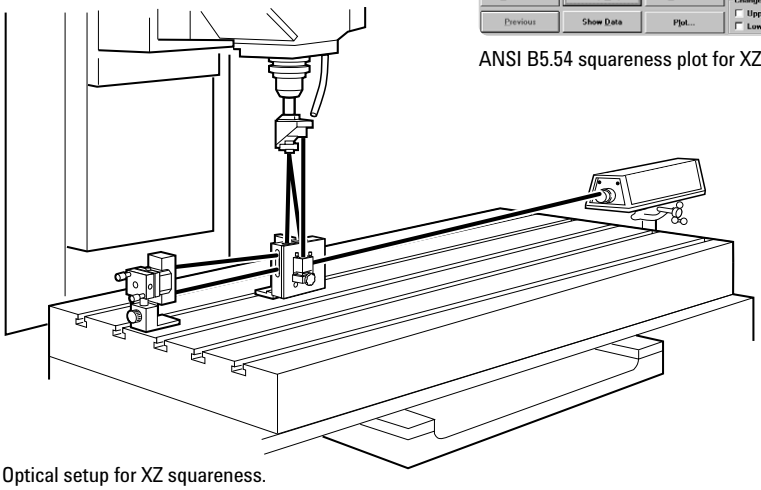


"Set Up" screen for XZ squareness (top).





ANSI B5.54 squareness plot for XZ axes.



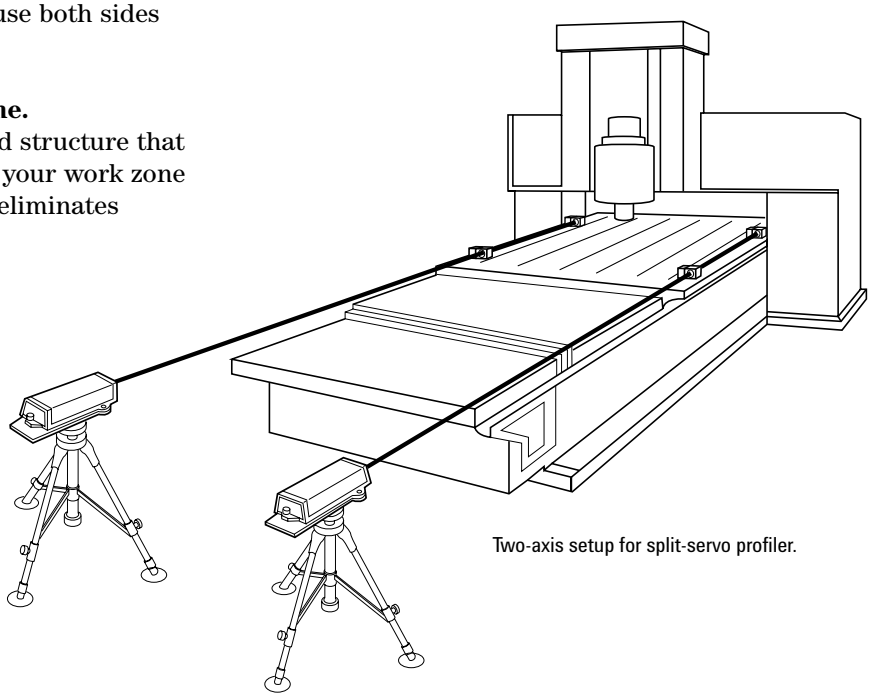
Optical setup for XZ squareness.

Special Equipment

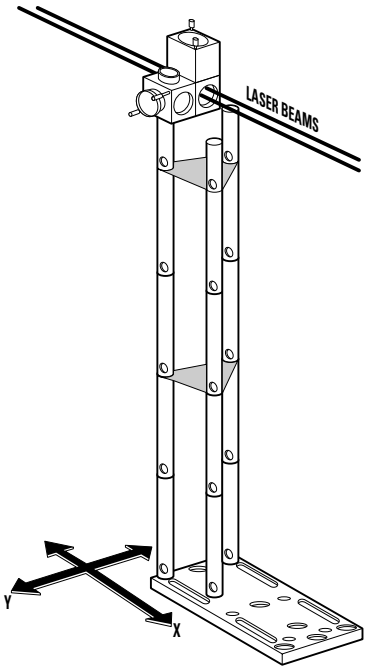
Simultaneous Measurements for Dual Drive Machines.
When you calibrate dual drive machines, you can tie the two systems together to simultaneously measure linear position on both sides by using 10887C to replace 10887B and 10888B to replace 10888A. Calibration time is cut in half because both sides are 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 meters for linear measurements.



Two-axis setup for split-servo profiler.



Example linear setup using 10744A Fixturing Kit.



Fixturing Kit (10744A) parts for calibration in center of work zone. Shown with Opt. 005, five extra posts.

Other Equipment

USB Expansion Module 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 running Windows 98® or Windows 2000®. 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 running Windows 98 or Windows 2000
- 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 or Windows 2000 installed
- 64MB ram, CD-ROM drive
- 1 internal USB port

Note: add on adapters are not supported

All 10887A and 10886A boards must be re-set to factory defaults 10887A to addr 512, IRQ5 and 10886A addr 288

Shipping weight - 2.1 Kgs
Envelope - 387x184x127 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 and 5529A).



Combination Linear/Angular Kit
(55281B) reduces cost by using the angular interferometer to make linear measurements.



Unmatched Service and Support

Training. Whether your technicians are novices or highly skilled, Agilent's classroom instruction will give your people the skill and confidence they need. Training is provided at your site or at the fully equipped HP factory training center. Four-day, hands-on factory training can be ordered as 5529A-T01.

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

The 55291A CNC Download/Upload Software comes with a three-year warranty.

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.

5529A Calibration. Agilent 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 service centers in Mountain View, California, U.S.A.; Sagamihara, Japan; and Boeblingen, Germany.

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.

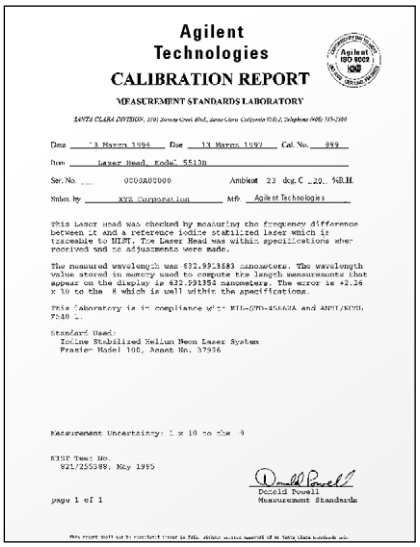
Service & Support (continued)

What to do Next? To talk with a sales engineer or to purchase the 5529A Dynamic Calibrator, contact your nearest Agilent sales office or an Agilent authorized distributor listed on the back of this brochure.

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



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.



Agilent
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CALIBRATION REPORT

MEASUREMENT STANDARDS LABORATORY

SANTA CLARA DIVISION, 3501 Stevens Creek Blvd., Santa Clara, California 95051, Telephone (408) 345-8886

Date 3 March 1994 Due 13 March 1995 Cal. No. 899

Item Laser Head, Kode: 5513B

Ser. No. 0003A02000 Ambient 23 deg.C ±2. %R.H.

Subm. by HYS Corporation Mfr. Agilent Technologies

This Laser Head was checked by measuring the frequency difference between it and a reference iodine stabilized laser which is traceable to NIST. The Laser Head was within specifications when received and no adjustments were made.

The measured wavelength was 632.991383 nanometers. The wavelength value stored in memory used to compute the length measurements that appear on the display is 632.991354 nanometers. The error is +2.26 x 10 to the -8 which is well within the specifications.

This laboratory is in compliance with MIL-STD-45662A and ANSI/NCSL Z540-1.

Standard Used:
Iodine Stabilized Helium Neon Laser System
Spectra-Physics Model 100, Asset No. 37956

Measurement Uncertainty: 1 x 10 to the -8

NIST Test No.
821/255389, May 1995

Donald Powell
Measurement Standards

page 1 of 1

5529B, Opt. 1BP provides MIL-STD-45662A calibration as may be needed for government contracts.

Agilent Technologies' Test and Measurement Support, Services, and Assistance

Agilent Technologies aims to maximize the value you receive, while minimizing your risk and problems. We strive to ensure that you get the test and measurement capabilities you paid for and obtain the support you need. Our extensive support resources and services can help you choose the right Agilent products for your applications and apply them successfully. Every instrument and system we sell has a global warranty. Support is available for at least five years beyond the production life of the product. Two concepts underlie Agilent's overall support policy: "Our Promise" and "Your Advantage."

Our Promise

Our Promise means your Agilent test and measurement equipment will meet its advertised performance and functionality. When you are choosing new equipment, we will help you with product information, including realistic performance specifications and practical recommendations from experienced test engineers. When you use Agilent equipment, we can verify that it works properly, help with product operation, and provide basic measurement assistance for the use of specified capabilities, at no extra cost upon request. Many self-help tools are available.

Your Advantage

Your Advantage means that Agilent offers a wide range of additional expert test and measurement services, which you can purchase according to your unique technical and business needs. Solve problems efficiently and gain a competitive edge by contracting with us for calibration, extra-cost upgrades, out-of-warranty repairs, and on-site education and training, as well as design, system integration, project management, and other professional engineering services. Experienced Agilent engineers and technicians worldwide can help you maximize your productivity, optimize the return on investment of your Agilent instruments and systems, and obtain dependable measurement accuracy for the life of those products.

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(fax) (31 20) 547 2390

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(fax) 64 4 495 8950

Asia Pacific:
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(fax) (852) 2506 9284

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