

Laser Interferometry Tools for Precision Measurement

Excel Precision... a world leader in the field of laser interferometry since 1987.

Whether your application is on a production line, a laboratory, or in the field, Excel Precision can help with your precision measurement requirements.

Excel Precision provides applications engineering support to give you a superior, effective, and efficient solution to your precision measurement needs.

- Semiconductor exposure stage positioning
- Hard drive servowriting
- Semiconductor test equipment
- Machine tool calibration
- Laboratory measurement

APPLICATIONS

Linear Displacement

- Linear
- Plane Mirror
- High Resolution

Calibration

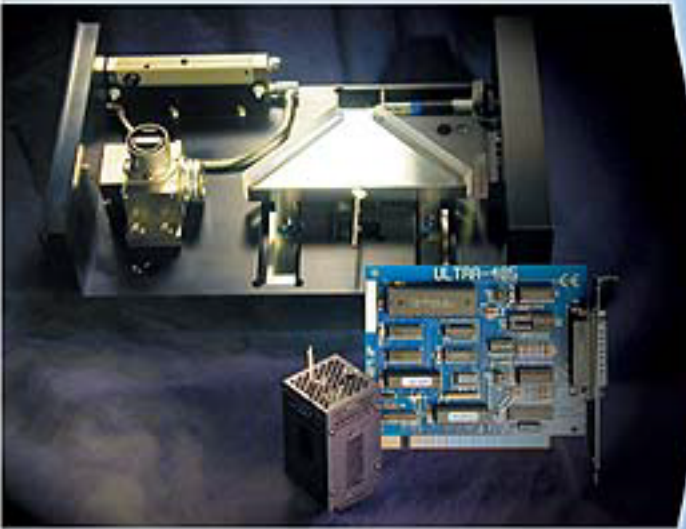
- Linear
- Angular
- Flatness
- Parallelism
- Straightness
- Squareness
- Velocity

FEATURES

- Traceable wavelength standard
- Fast measuring speed
- Wide product range
- PC based measurement boards
- Refractometer & Weather Station
- Applications engineering assistance

BENEFITS

- High measurement accuracy
- Improved throughput
- Flexibility
- Easy to use in your PC
- Precision in any environment
- The right solution...on time



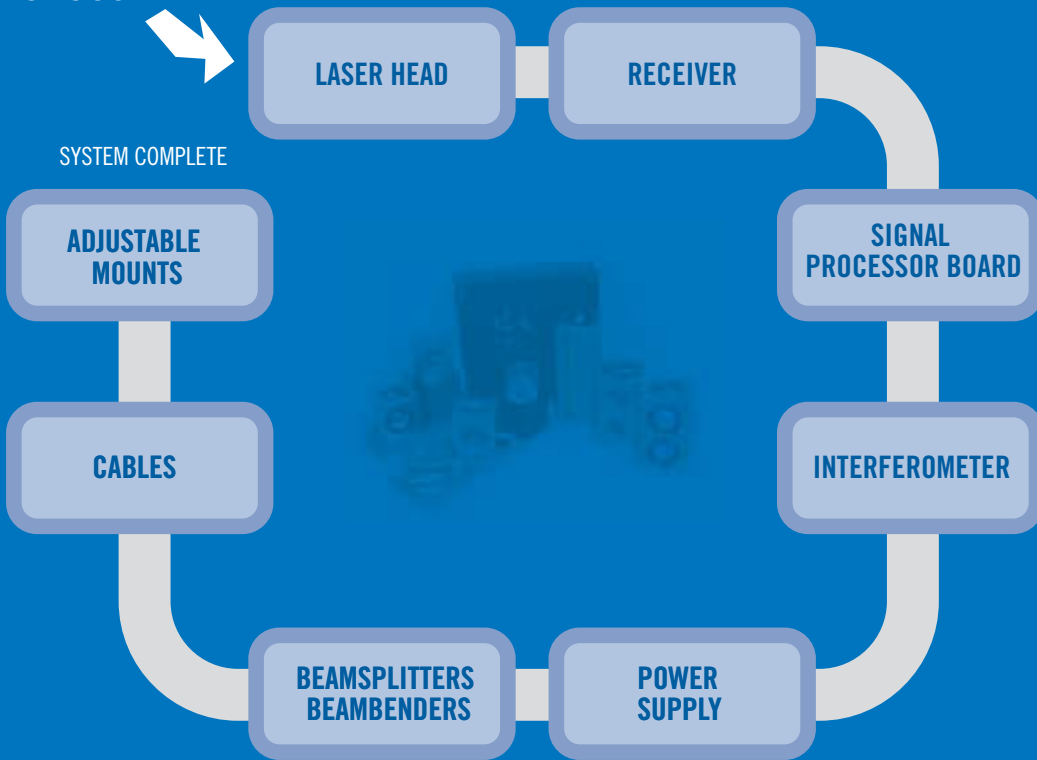
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DESIGN YOUR OWN MEASURING SOLUTION

CHOOSE



EXAMPLE:

ONE AXIS LINEAR MEASUREMENT CONFIGURATION

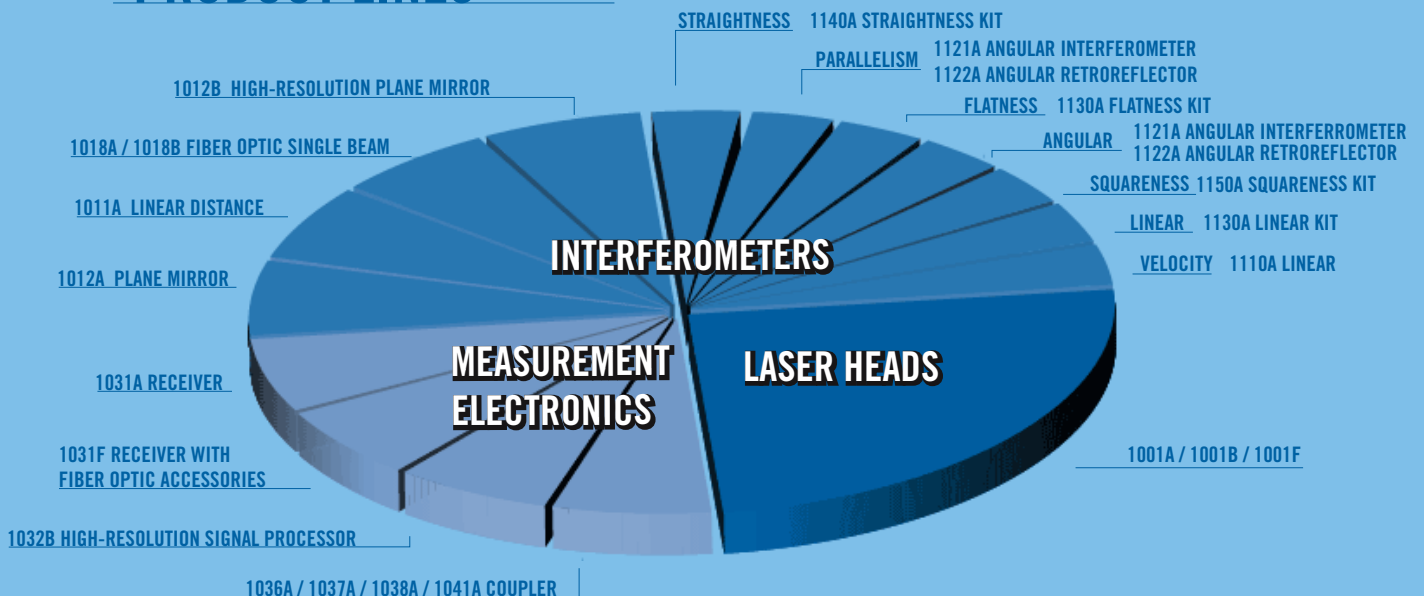
10 NM RESOLUTION:
 MAX MEASUREMENT SPEED = 0.5 M/S
 PC INTERFACE REQUIRED
 NO WAVELENGTH COMPENSATION REQUIRED

REQUIREMENTS:

- 1001F LASER HEAD
- 1031A RECEIVER
- 1032A SIGNAL PROCESSOR BOARD *
- 1011A LINEAR INTERFEROMETER
- 1040B POWER SUPPLY
- 1059A LASER HEAD CABLE
- 1058A MEASUREMENT CABLE
- 1022A ADJUSTABLE MOUNT (OPTIONAL)

* PC COMPATIBLE

PRODUCT LINES





LASERS

Excel Precision manufactures laser heads of two sizes. Models **1001A** and **1001F** are the same size and are smaller than the model **1001B**. Mechanical variations of these are available on special order.

The heart of Excel's laser is the high-performance Zeeman laser tube that is specially designed and fabricated at Excel to achieve excellent reliability and maximum measurement accuracy. Zeeman laser technology is used for state-of-the-art accuracy and frequency stability.

All Excel's laser heads are calibrated against a frequency standard that is traceable to the National Institute of Standards and Technology of the US Department of Commerce.

Each Excel Precision laser head is capable of six simultaneous measurements. Special products are available for applications that require more than six axes.

LASER HEAD SPECIFICATIONS:

OPERATING TEMPERATURE	0-40 C (32-104°F)
POWER REQUIREMENTS	2.5 @ 15V DC (start up), 1.1A @ 15V DC (operating)
SPLIT FREQUENCY	1.5 - 3.0 MHz
VACUUM WAVELENGTH	632.99137 nm (nominal)
FREQUENCY STABILITY	2×10^{-8} (nominal)
POINTING STABILITY	$< 0.1 \times 10^{-3}$ after full warm up
BEAM DIAMETER	5 mm typical
LASER POWER OUTPUT	> 0.2 mW; < 1 mW
WARM-UP TIME	< 15 min
DIMENSIONS	35 X 13 X 11.5 cm
SIGNAL OUTPUT	differential square wave
MEASURING RANGE	0-20 m
MEASURING SPEED	0.6 m/s



INTERFEROMETERS & OPTICS

Excel Precision designs and manufactures its own interferometers and optics to exacting standards. These interferometers are typically used in linear displacement measurements or for calibration.

INTERFEROMETERS:

The **1011A** Linear Interferometer and the **1013A** Retroreflector form the simplest configuration for linear displacement measurements.

The **1018A** Single Beam Interferometer and **1019A** Retroreflector are designed for measurements where space is a constraint. Excel Precision also offers **1018F** Fiber Optic Single Beam Interferometer, which connects to **1031F** Fiber Optic Receiver with an fiber optic cable.

The **1012A** Plane Mirror Interferometer, **1012B** High Resolution Plane Mirror Interferometer, **1012C** Differential Plane Mirror Interferometer, **1012D** High Stability Plane Mirror Interferometer, and **1012F** Fiber Optic Plane Mirror Interferometer are available for meeting the highest precision requirements. Plane Mirror Interferometers cause the measurement beam to traverse the measurement path two times, doubling the resolution achievable by the **1011A** or **1018A** interferometers.

OPTICS:

The **1014A** (50/50) and **1015A** (33/67) Beam Splitters are designed for measurements that require more than one axis. In the **1014A** 50/50 Beam Splitter, the laser beam is divided into two equal intensity beams, one in the original propagation direction, and the other perpendicular to this direction.

The **1015A** reflects 33% of incident intensity perpendicular to the original laser beam direction, and transmits 67% in the original direction. Beam reflection of 50% can be accomplished with the **1017A** (small) or the **1017B** (large) Beam Bender.

Two types of adjustable mounts are available to facilitate the installation of the above interferometers and beam splitters. The **1021A** Adjustable Mount is smaller and is used with **1014A**, **1015A**, and **1018A**. The larger **1022A** is used with **1011A**, **1012A**, **1012B**, **1012C**, **1012D**, and **1012F** interferometers.



WAVELENGTH COMPENSATION

The changes in laser wavelength as a function of changes in air temperature, pressure and humidity are:

Temperature:	$\pm 1^{\circ}\text{C}$	= ± 1 PPM
Pressure:	± 2.5 mm Hg	= ± 1 PPM
Humidity:	$\pm 30\%$ Change	= ± 1 PPM

Excel Precision offers two approaches to improve your measurement accuracy: the **1160A** Sensor-based Weather Station and the **1024B** Refractometer which provides an absolute vacuum reference.

WEATHER STATION:

The **1160A** Weather Station measures temperature, relative humidity, and barometric pressure on a real-time basis and feeds this information to the measurement electronics for atmospheric compensation.

REFRACTOMETER:

The **1024B** Refractometer provides a corrective signal, based on your measurement environment compared to an internal vacuum reference, which eliminates the environmental effects of temperature, pressure, humidity, and composition. The **1024B** uses one **1032B** Signal Processor Card (included).

MATERIAL SENSOR:

The **1163A** Material Sensor provides corrective feedback to compensate for thermal expansion or contraction of materials in or around the measurement on a real-time basis. During measurement, the physical dimensions of an object change due to temperature variation. These changes significantly affect the measurement accuracy. To ensure your position measurement is most accurate, this temperature effect to the object needs to be included in data correction.

1160A WEATHER STATION

	TEMP	PRESSURE	HUMIDITY
ACCURACY	$\pm 0.06^{\circ}\text{C}$	± 1.2 mm Hg	$\pm 2\%$ relative humidity
RANGE	$0-40^{\circ}\text{C}$	$0-775$ mm Hg	$0-100\%$ relative humidity

1024B REFRACTOMETER

ACCURACY	$\pm 5 \times 10^{-8}$ @ I/128	$\pm 6 \times 10^{-9}$ @ I/1024
REPEATABILITY	± 0.020 ppm @ I/128	± 0.025 ppm @ I/1024



MEASUREMENT ELECTRONICS

PERSONAL COMPUTER-BASED INTERFACE:

The **1032B** Signal Processor Card achieves a resolution of $0.01 \mu\text{m}$ when used with the 1011A or 1018A interferometers and a resolution of $0.0025 \mu\text{m}$ with the 1012B High Res Plane Mirror Interferometer.

COUPLER BASED INTERFACE:

The Coupler Based electronics consists of the **1036A** Fast Pulse Converter, **1037A** Binary Interface Card, **1038A** Fast Comparator, and **1041A** Card Cage.

The **1036A** Fast Pulse Converter extends the resolution from the raw interference fringes of $0.16 \mu\text{m}$ to as high as $0.001 \mu\text{m}$ (when used with 1012B). The 1036A produces very fast signal output (up to 22.5 MHz) in real time mode. The 1036A can be used as stand alone circuitry for direct servo applications, or can be used in conjunction with a 1037A and 1038A. Each 1036A can serve two axes of measurement.

The **1037A** Binary Interface Card carries input/output signals between the computer and the 1041A Card Cage. One 1037A is required for each card cage, which can support up to six axes of measurement (three each of 1036A, six each of 1038A).

The **1038A** Fast Comparator is used for comparing the target position and the instantaneous position of the moving stage. Difference between these two positions is the "position error", which becomes the servo signal for the servo electronics. The target position can be manually input through a computer, or automatically input through an external sensor.

A-QUAD-B, UP/DOWN PULSE INTERFACE UNIT:

The **1060A** Interface can work as a stand-alone unit to produce $0.16 \mu\text{m}$ resolution in A-QUAD-B, or Up/Down Pulse format, or accept signals from 1036A to generate A-Quad-B, or Up/Down pulses at very high resolutions.

1032B PC AXIS CARD

	LINEAR	PLANE	HI-RES
ACCURACY	10 nm	5 nm	24 nm
MAX MEAS RANGE	5.3+ nm	2.65+ nm	1.33+ nm

1036A FAST PULSE CONVERTER

(USED WITH COMPARATOR AND BINARY INTERFACE CARDS)

ACCURACY	5 nm
VELOCITY	8.1 cm/s (max)

1100A SYSTEM SETUP CONFIGURATIONS



1100A CALIBRATION SYSTEM

The **1100A** Measurement System is designed specifically to provide a variety of real-time, extremely accurate measurements for machine tool calibration and metrology applications.

FEATURES:

- ONE TOOL KIT PERFORMS ALL MEASUREMENTS
- NIST TRACEABLE STANDARD
- EXCEL APPLICATIONS ASSISTANCE IS READY

Excel offers calibration kits for these applications:

- Distance
- Flatness
- Straightness
- Squareness
- Angular Displacement
- Velocity
- Parallelism
- Vibration

All calibration systems are based on the Excel **1001** Laser. This laser's wavelength is traceable to NIST, via an in-house standard at Excel, to ensure the most accurate measurements.

The **1100A** is a complete set which can make all measurements, comprised of 1 Laser head, 1 **1031A** Receiver, 1 **1032B** Signal Processor, various optics, as well as optional wavelength compensation products. However, individual kits can be purchased to make only the desired measurements.

1110A Linear Measurement Kit is designed to measure the distance with extremely high accuracy and repeatability from a reference position.

1120A Angular Measurement Kit is used for measuring small angles to very high resolution and accuracy.

Flatness measurement is carried out by using **1120A** Angular Optics standard plates equipped with accurate footspacers, and moving these plates on the surfaces that need to be measured.

1140A Straightness Measurement Kit consists of a straightness interferometer, matching reflector, and optical/mechanical accessories. To make a straightness measurement, the straightness interferometer separates the incoming laser beam into two polarizations perpendicular to the other. These two laser beams shine on the matching reflector, which is mounted on the moving object to measure its straightness.

APPLICATION

Distance
Velocity
Vibration



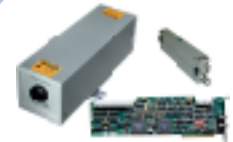
Angular
Parallelism
Squareness
Flatness



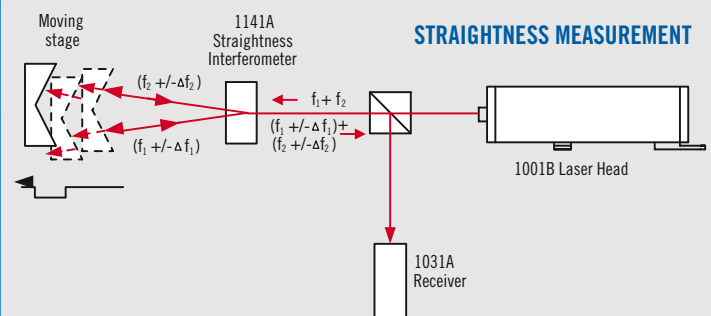
Straightness



EQUIPMENT REQUIRED FOR ALL APPLICATIONS



OPTIONAL Wavelength Compensation

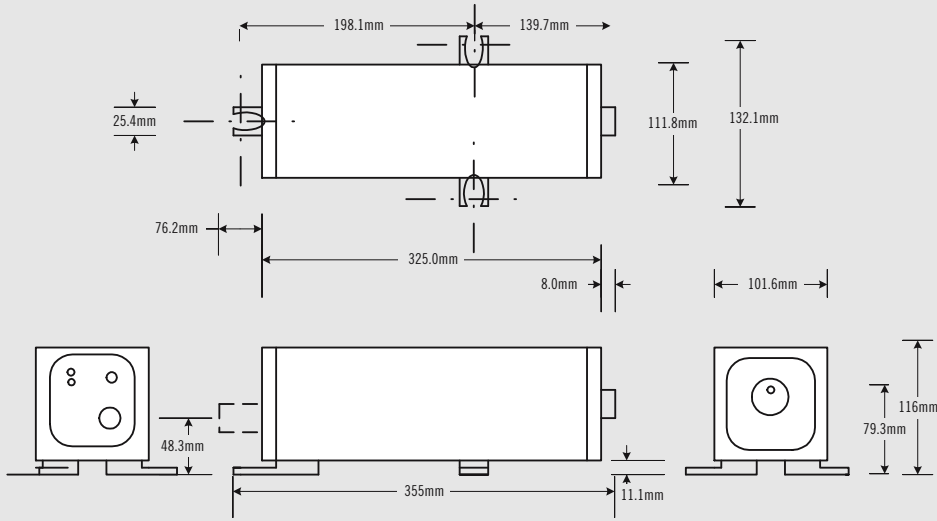


1100A SPECIFICATIONS:

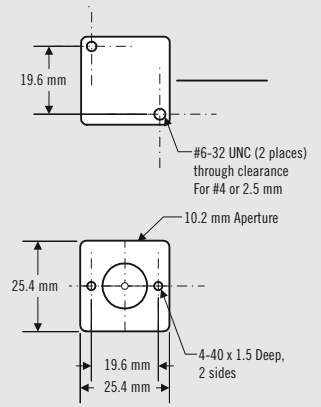
PRODUCT NUMBER	1110A	1120A	1130A	1140A
RESOLUTION	10 nm	0.05 ARCSECONDS	30 nm W/50 mm footspacing	0.55 μm
ACCURACY	±1 x 10 ⁻⁷	±0.2%	±0.2%	0.4 PPM
RANGE	up to 20 m			±1.5 mm with 0.1-3 m optics spacing

* - (in vacuum), (±5 x 10⁻⁷ in air without air refractive index correction, ±1.4 x 10⁻⁶ in air with air refractive index correction)

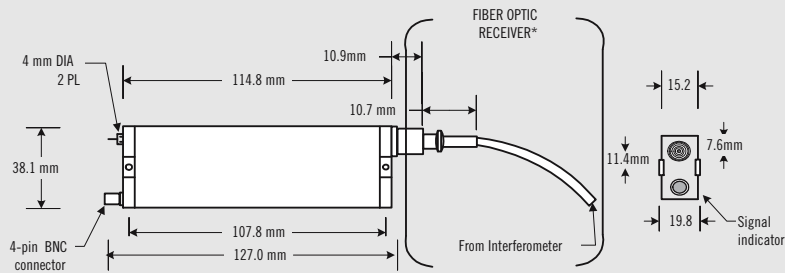
1001F LASER HEAD



1014A / 1015A BEAMSPLITTER 1017A BEAMBENDER

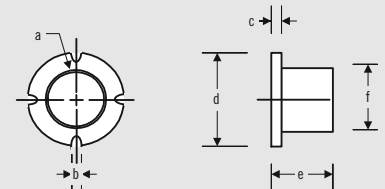


1031A RECEIVER / 1031F FIBER OPTIC RECEIVER*



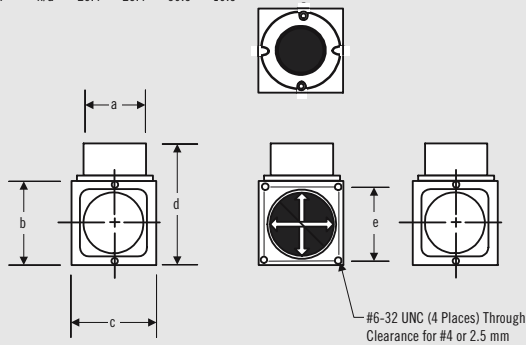
1013A RETROREFLECTOR 1019A SMALL RETROREFLECTOR

	a	b	c	d	e	f
1013A	22.5	3	2.5	37.6	23.9	28.4
1019A	10.2	2.5	2.5	20.5	14.3	15.2

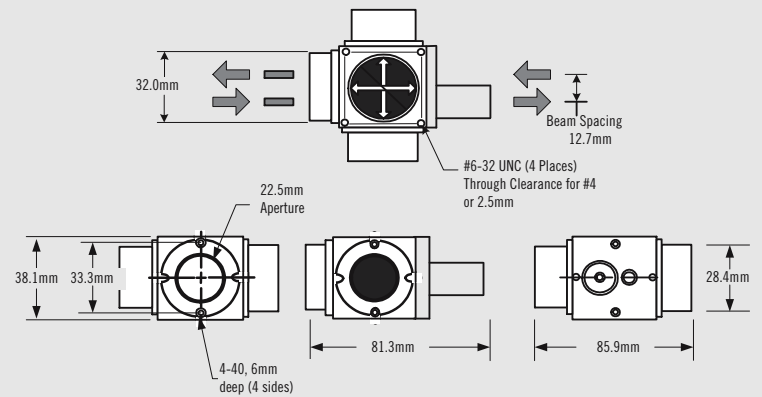


1011A LINEAR INTERFEROMETER / 1018A SINGLE BEAM INTERFEROMETER

	a	b	c	d	e
1011A	28.4	38.1	38.2	62.0	32.0
1018A	n/a	25.4	25.4	39.6	19.6



1012A PLANE MIRROR INTERFEROMETER / 1012F WITH FIBER OPTIC ACCESSORIES



NOTE: DRAWINGS NOT TO SCALE

ALL DIMENSIONS IN MILLIMETERS

For more information, please contact

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