

# InSituTec

## Precision In-process Solutions



InSituTec manufactures high-end nanometer dimensional measurement and motion products for nano precision quality control for OEM companies as well as stand alone custom tools and services.

**Nanopositioning  
Stages**



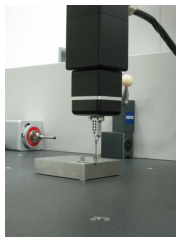
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**Nanopositioning  
Digital Controllers**



**Page 9**

**InSituTec Metrology  
Technology & Services**



**Page 12**

## InSituTec Precision Stages

InSituTec's nano-motion stages are designed to provide extremely precise and robust performance that is insensitive to temperature and is best in class in terms of noise and stiffness. Each stage is crafted using precision engineering principles to achieve the highest precision and repeatability.

InSituTec's core strength is designing custom piezo-driven stages to meet challenging demands for OEMs and machine builders. InSituTec is able to rapidly deliver custom stage designs at competitive pricing.

**Nanopositioning Stage  
X-25 / XY-25**



**Nanopositioning Stage  
X-50 / XY-50**



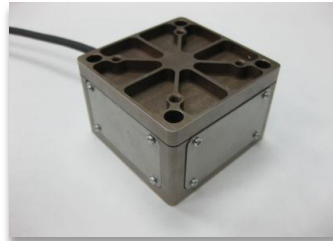
**Nanopositioning Stage  
X-100 / XY-100**



**Nanopositioning Stage  
XYZ-50 / XYZ-100**



**Nanopositioning Stage  
Z-100-B**



**Nanopositioning Stage  
High Force ST-500**



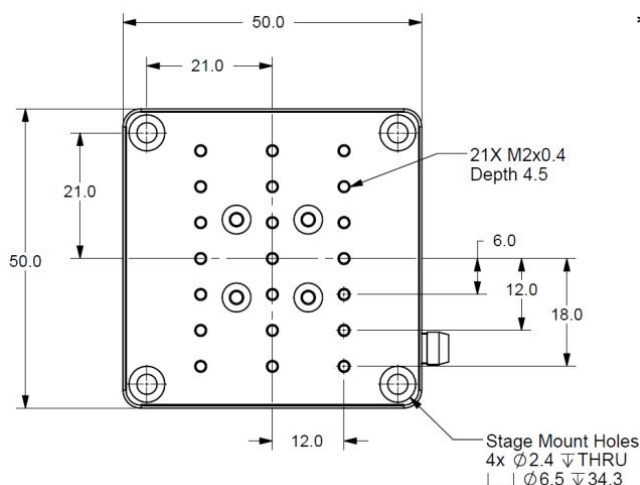
## Precision X-25 and XY-25 Stages

The X25 and XY25 stages are designed to seamlessly integrate into picoscale metrology, nanomagnetic research, nano-motion machines, optical alignment, laser measurement systems, x-ray metrology, nano-automation, and research applications. The unique internal flexure design provides wear free highly planar motion.



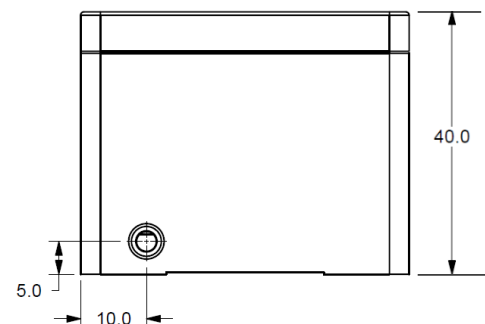
**High Speed, High Stiffness, Low Noise, Fast Settling Time, Highly Planar Precision Stage**

Stage Parameters	Specifications	Motion Parameters	Specifications	Units
Stage Size (mm)	50 (D) x 50 (W) x 40 (H)*	Axis	X   Y	
Sample mounting holes	M2 and M3 tapped holes	Range of Motion	50   50	μm
Material	Aluminum	Positioning Noise	12 (@ 10 Hz)	picometer
Weight (X axis)   (XY axis)	196 gram   200 gram	Linearity	0.01	%
Maximum Payload	5 kg	Natural Frequency**	1500   2000	Hz
Sensor Feedback	Capacitance	Settling Time	1   1	ms
Cable Lengths	Up to 10 meter			



\*X-25 is 30mm (H)

\*\*Natural frequency higher for X-25



Dimensions are in mm

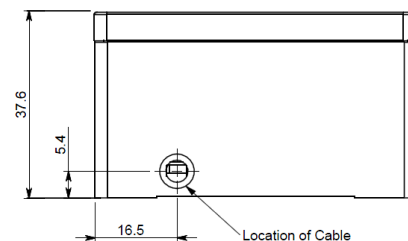
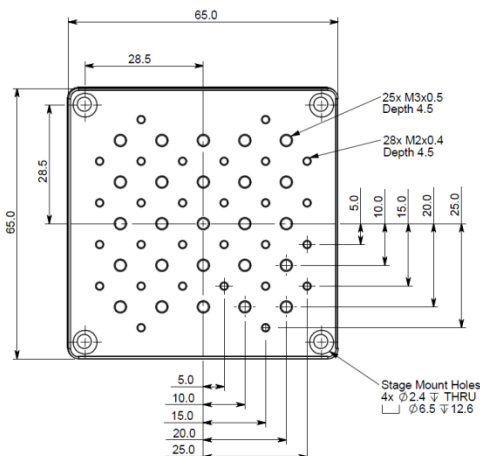
## Precision X-50 and XY-50 Stages

The X50 and XY50 stages are designed to seamlessly integrate into metrology applications, nano-motion machines, optical alignment, laser measurement systems, x-ray metrology, nano-automation, and research applications. The unique internal flexure design provides wear free highly planar motion.



**Low Noise, Fast Settling Time, Highly Planar Precision Stage**

Stage Parameters	Specifications	Motion Parameters	Specifications	Units
Stage Size (mm)	65 (D) x 65 (W) x 38 (H)	Axis	X      Y	
Sample mounting holes	M2 and M3 tapped holes	Range of Motion	50      50	µm
Material	Aluminum	Positioning Noise	19 (@ 10 Hz)	picometer
Weight (X axis)   (XY axis)	261 gram         323 gram	Linearity	0.01	%
Maximum Payload	2 kg	Natural Frequency	360      450	Hz
Sensor Feedback	Capacitance	Settling Time	5      8	ms
Cable Lengths	Up to 10 meter			



Dimensions are in mm

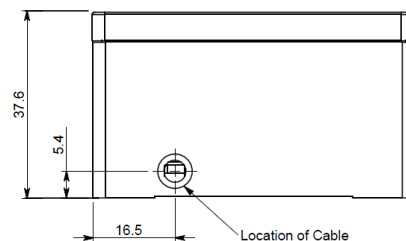
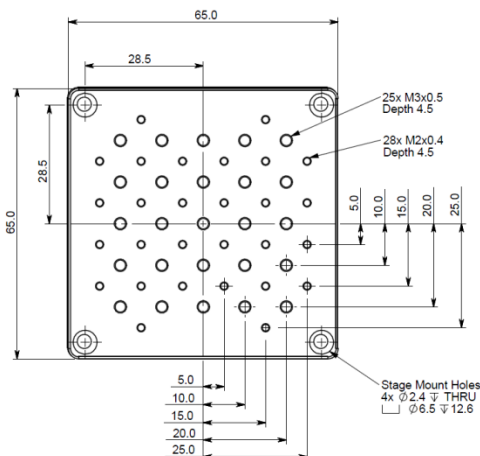
## Precision X-100 and XY-100 Stages

The X100 and XY100 stages are designed to seamlessly integrate into metrology applications, nano-motion machines, optical alignment, laser measurement systems, x-ray metrology, nano-automation, and research applications. The unique internal flexure design provides wear free highly planar motion.



**Low Noise, Fast Settling Time**

Stage Parameters	Specifications	Motion Parameters	Specifications	Units
Stage Size (mm)	65 (D) x 65 (W) x 38 (H)	Axis	X      Y	
Sample mounting holes	M2 and M3 tapped holes	Range of Motion	100      100	μm
Material	Aluminum	Positioning Noise	19 (@ 10 Hz)	picometer
Weight (X axis)   (XY axis)	261 gram             323 gram	Linearity	0.01	%
Maximum Payload	2 kg	Natural Frequency*	360      450	Hz
Sensor Feedback	Capacitance	Settling Time	5      8	ms
Cable Lengths	Up to 10 meter	*natural frequency is 500Hz for X-100		

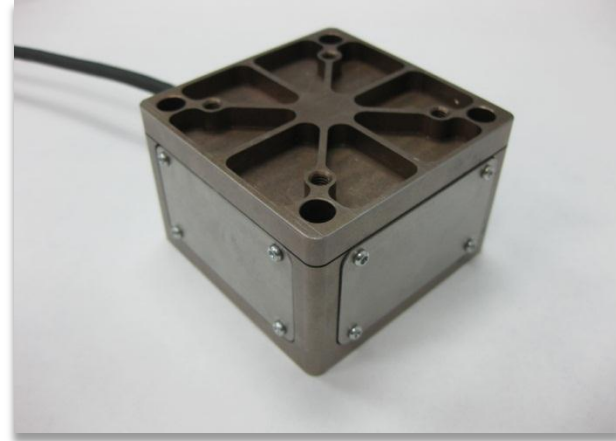


Dimensions are in mm

## Nanopositioning Stage Z-100-B

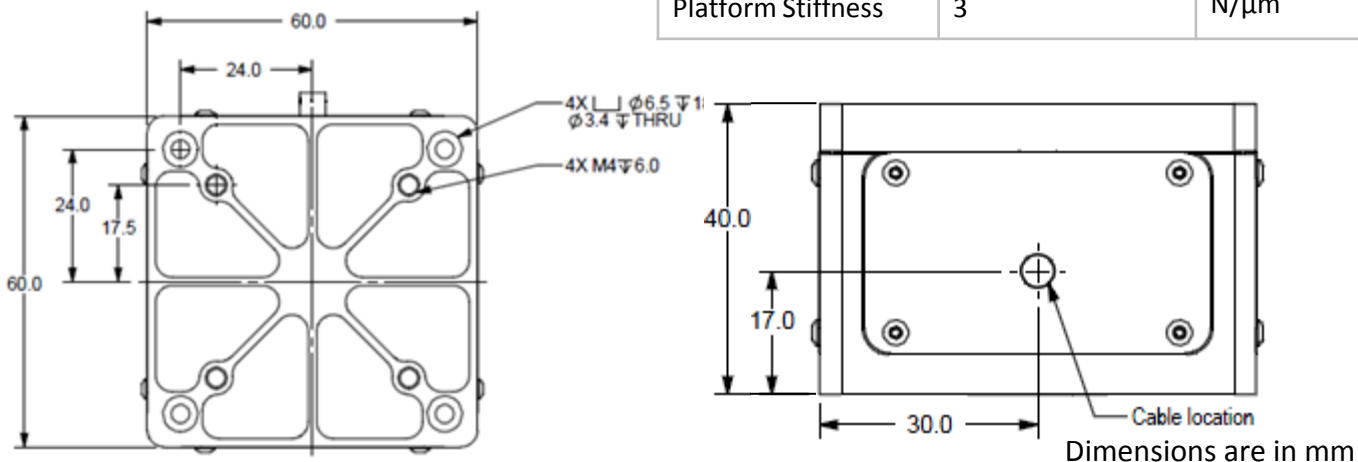
### Precision Vertical Lift Stage Z-100-B

The Z-100-B stage is a high stiffness vertical lift stage designed to carry payloads up to 10 kg in a compact package. This is an ideal stage when rapid step and settle times are required for high payloads. The Z-100-B is combined with our RDC-1-180 digital controller. The RDC-1-180 is equipped with input shaping, feed forward controls, and control loop rates up to 20 us.



**High Speed Vertical Lift , High Stiffness,  
Low Noise, Fast Settling Time**

Stage Parameters	Specifications	Motion Parameters	Specifications	Units
Stage Size (mm)	60 (D) x 60 (W) x 40 (H)	Axis	Z	
Sample mounting holes	M4 tapped holes	Range of Motion	100	μm
Material	Stainless Steel	Positioning Noise	19 (@ 10 Hz)	picometer
Weight	660 gram	Linearity	0.01	%
Maximum Payload	10 kg	Natural Frequency	850	Hz
Sensor Feedback	Capacitance	Settling Time	5	ms
Cable Lengths	Up to 10 meter	Platform Stiffness	3	N/μm



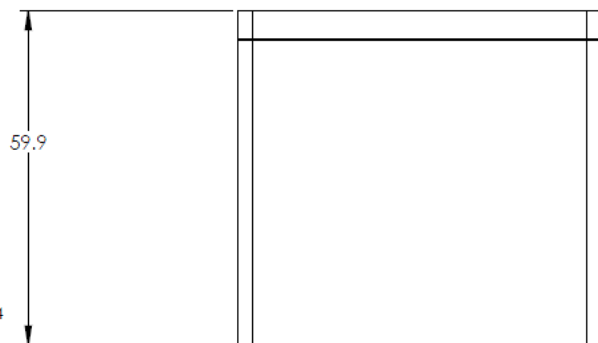
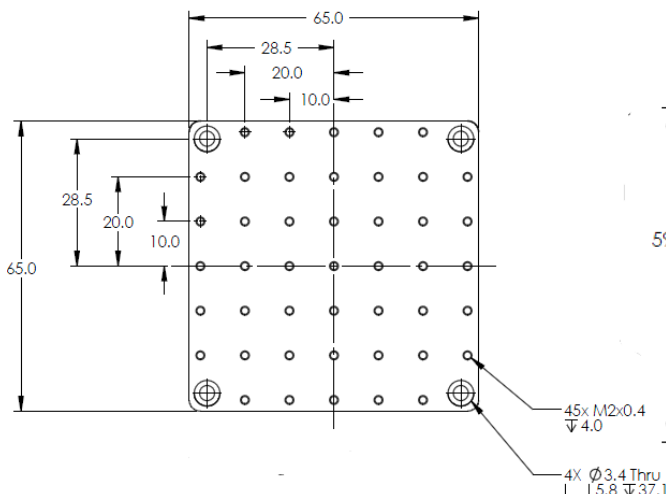
## Precision XYZ-50 and XYZ-100 Stages

The XYZ50 and XYZ100 stages are compact 3 axis stages designed to seamlessly integrate into metrology applications, nano-motion machines, optical alignment, laser measurement systems, x-ray metrology, nano-automation, and research applications.



**Compact XYZ stage, Low Noise,  
Fast Settling Time**

Stage Parameters	Specifications	Motion Parameters	Specifications			Units
Stage Size (mm)	50 (D) x 50 (W) x 59.9 (H)	Axis	X	Y	Z	
Sample mounting holes	M2 and M3 tapped holes	Range of Motion	50/100	50/ 100	50/ 100	μm
Material	Aluminum	Positioning Noise	20 (@ 10Hz)			picometer
Weight	250 gram	Linearity	0.01			%
Maximum Payload	1 kg	Natural Frequency	320	450	500	Hz
Sensor Feedback	Capacitance	Settling Time	10	8	6	ms
Cable Lengths	Up to 10 meter					



Dimensions are in mm



## High Force ST-500-AL/ST\* Stages

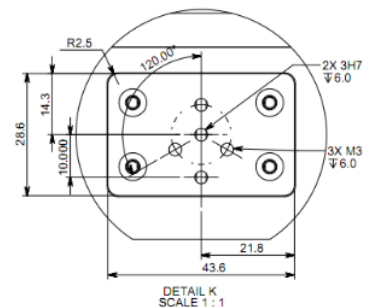
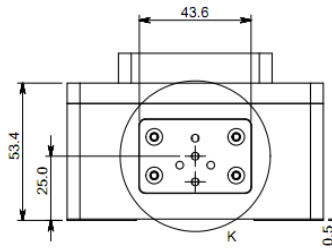
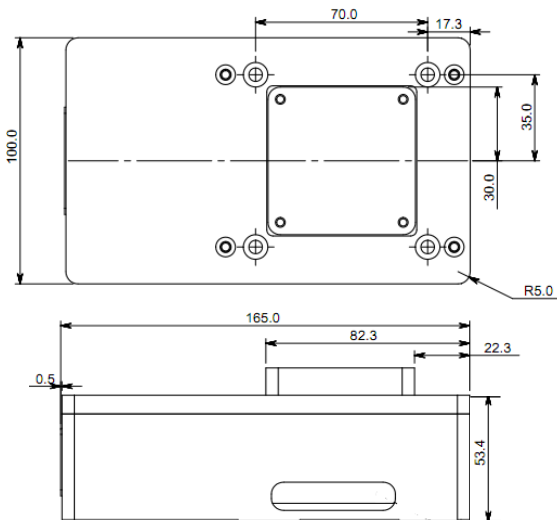
This stage is designed for manufacturing applications that require high stroke, high stiffness and high force. Example applications include servo tools, miniature presses and load testing. Both aluminum and steel stages are available for higher force.



\*ST = Steel  
AL = Aluminum

**High Force, High Stiffness, Long  
Stroke, Low Noise**

Stage Parameters	Specifications	Motion Parameters	Specifications		Units
Stage Size (mm)	165 (D) x 100 (W) x 60 (H)	Motion Along x-Axis	Steel	Aluminum	
Sample mounting holes	M3 tapped holes	Range of Motion	490	470	μm
Material	Aluminum / Steel	Platform Stiffness	1.5	1.1	N/μm
Weight	2 kg	Maximum Force Output	735	500	N
PZT Drive Voltage	0 to 1000 volts	Natural Frequency	400	500	Hz
Maximum Payload	1 kg	Sensor RMS Noise	95		picometer (at 10Hz)
Sensor Feedback	Capacitance	Sensor RMS Noise	30		picometer /root Hertz
Cable Lengths	Up to 5 meter	Linearity	0.01		%
		Settling Time	5		ms
		Max Power Consumption	300		W



Dimensions are in mm



## InSituTec Digital Controllers

Our digital controllers are designed with an easy to use key pad and display. We provide USB connections to a host computer as well as voltage input and output functions to control the stage. The controller runs on a high speed 40 MHz processor and allows the user to control and read the stage to better than 10 picometers.

### Digital Controller RDC-1-180



### Digital Controller RDC-1-1000



## RDC-1-180 Digital Controller

The RDC-1-180 digital controller is based on a high speed precision digital architecture. The chassis encompasses high speed precision converters with capability of achieving displacement precision > 1:400,000 at 2 kHz sampling rates and controller loop rates up to 33 micro-seconds.

The RDC-1-180 enables input shaping, feedforward and standard PID controls for fast settling time capability with a user friendly display and keypad. In particular, the input shaping is designed to enable the user to easily tune the nano-positioning stage system and minimize unnecessary vibrations.



Parameters	Specifications	Units
Number of Channels	1	
Processor Type	FPGA with 40 MHz clock	
Converter Sampling Rates	1.0	MSPS
Displacement Precision @ 2 kHz bandwidth	1:400,000	
Output voltage to PZT	-30 to + 150	V
PZT Amplifier Noise (RMS)	< 100	uV
PZT Current per channel	120	mA
User control input signal	-10 to + 10	V
User output sensor signal	-10 to + 10	V
Controller Capability	PID, Input Shaping Feedforward Algorithms	

### Features include:

- Precision at 1:400,000 at 2 kHz sampling rates.
- 33 microseconds control loop rates.
- Less than 100 micro-volt RMS PZT amplifier noise over a 180 volt range.
- Digitally tune your input signal using input shaping to suppress unwanted vibration.
- Adjustable feedforward gain terms to improve closed-loop performance.
- User friendly keypad and display to program settings.
- Settings automatically stored when unit is powered off and on.

## InSituTec Digital Controllers

The RDC-1-1000 digital controller is a single axis controller equipped with high speed precision digital architecture and 1000 volt amplifier. The chassis encompasses high speed precision converters with capability of achieving displacement precision > 1:400,000 at 2 kHz sampling rates and controller loop rates up to 33 micro-seconds.

The RDC-1-1000 enables input shaping, feedforward and standard PID controls for fast settling time capability with a user friendly display and keypad. In particular, the input shaping is designed to enable the user to easily tune the nano-positioning stage system and achieve fast settling times



Parameters	Specifications	Units
Number of Channels	1	
Processor Type	FPGA with 40 Mhz clock	
Converter Sampling Rates	1.0	MSPS
Displacement Precision @ 2 kHz bandwidth	1:400,000	
Output voltage to PZT	10 to 990	V
PZT Amplifier Noise (RMS)	< 1000	uV
PZT Current per channel	300	mA
User control input signal	-10 to + 10	V
User output sensor signal	-10 to + 10	V
Controller Capability	PID, Input Shaping Feedforward AlgorithmMs	

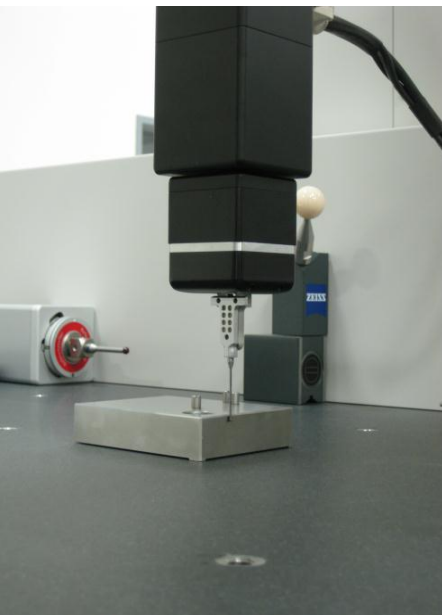
### Features include:

- Precision at 1:400,000 at 2 kHz sampling rates.
- 33 microseconds control loop rates.
- 1000 volt amplifier with 300mA current capability.
- Digitally tune your input signal using input shaping to suppress unwanted vibration.
- Adjustable feedforward gain terms to improve closed-loop performance.
- User friendly keypad and display to program settings.
- Settings automatically stored when unit is powered off and on.

### AccuSurf Gauge Head (Page 13)

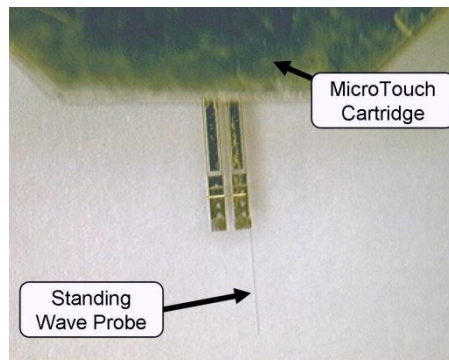
InSituTec offers a precision gauge head called the AccuSurf that can be added to metrology systems such as CMMs. The AccuSurf is combined with either a precision probe or the MicroTouch sensor.

The AccuSurf consists of a precision nano-positioning x-y stage and a precision spindle for high-speed nanometer repeatability.

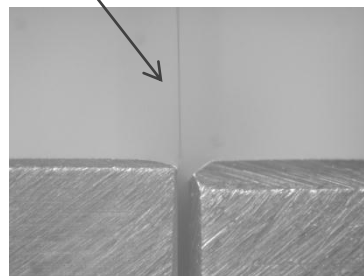


### MicroTouch Metrology and Profilometry Probe (Page 14)

Born out of over a decade of R&D, the MicroTouch is a 7 micron fiber probe that is capable of measuring micro features in either contact or non-contact mode. When combined with the AccuSurf, the MicroTouch becomes a high-aspect ratio micro-measurement device for both form and finish.



Below: Probe measuring  
Micro-Feature



### PreCess 2D Passive Gauge Head (Page 15)

The PreCess 2D is a 2 axis measurement head with scanning speeds up to 300 mm/s with 50 nm of accuracy that can seamlessly integrate into existing measurement machines.



### Metrology Services (Page 16)

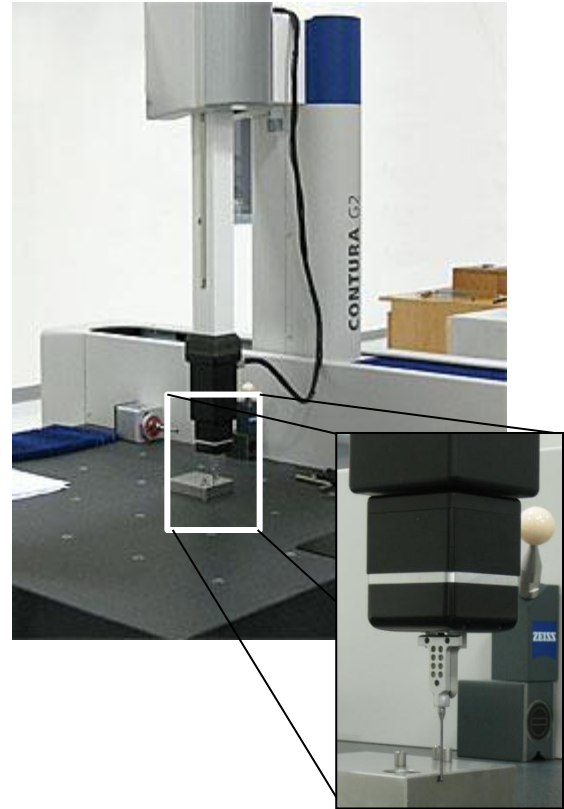
InSituTec offers advanced measurement services for extremely small and difficult to measure parts.



## AccuSurf Gauge Head

The AccuSurf Gauging System incorporates a state-of-the-art nanometer repeatable rotary axis with a multi-axis active scanning head. This advanced gauging system provides the ability to measure complex 3D surface profiles with < 20 nm repeatability, is capable of high scanning speeds with 1000's of data points collected per second, has scanning forces less than 100 nN.

The AccuSurf gauge when accompanied with the MicroTouch Sensor System will extend, the functionality of a CMM to enable microscale form measurements, nanoscale surface metrology, and roundness, tasks that would otherwise require 3 different machines. This provides ability to measure shapes and parts that were otherwise difficult to measure such as freeform optics, inside channels and cavities of MEMS and soft exotic materials such as aerogels and roots of miniature threads.



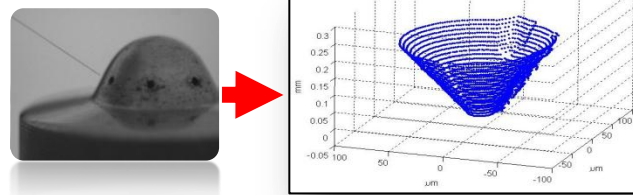
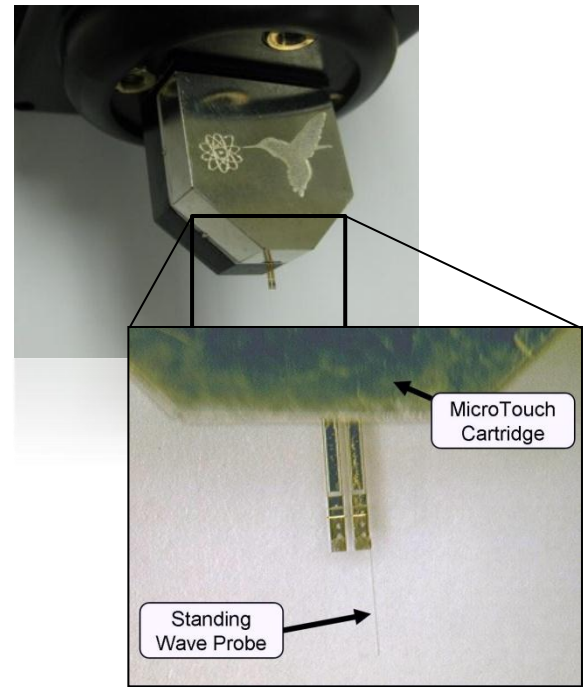
Spindle Information	Typical Specifications	Units
Synchronous error	Up to $\pm 1$	micrometers
Asynchronous error	< 10	nanometers
Rotational Resolution/Control	0.08	Arc-seconds
Maximum speed	10	RPM
Radial Scanner Information		
Displacement noise	< 0.5	nanometers
Repeatability	10	nanometers
Accuracy	25	nanometers
Range	100	micrometers
Mechanical Bandwidth	300	Hertz
General Information		
Gauge head weight	2	kilograms



## AccuSurf Gauge Head

InSituTec's MicroTouch sensor is a metrology sensor with the capability of providing cost effective measurement of microscale parts and features that currently cannot be measured. This technology overcomes the shortcoming of existing techniques because it can measure high aspect ratio features, is highly repeatable because it does not stick to the surface, and provides high data rate scanning capability. In addition it provides the ability to combine three traditionally separate measurement capabilities, surface finish, form, and roundness into one instrument.

The MicroTouch sensor is a revolutionary new tactile probe designed for quality control of microscale manufacturing. The probes are typically 7  $\mu\text{m}$  in diameter, 3.5 mm in length, and contact parts with < 100 nN forces. The probes are capable of measuring with 10 nm repeatability in contact and 50 nm out-of-contact scanning modes. As a result, the MicroTouch sensors are applicable to wide range of parts from silicon MEMS structures to exotic materials such as aerogel foams to more traditional materials such as steels for medical implant parts. Optical components with free form shapes will also benefit from this quality control device. We have provided a few specifications below related to the probes size and scanning ability. Contact us to discuss in more detail our capabilities and how they can meet your requirements and learn how the MicroTouch will add significant value to your micromanufacturing processes.



### Measurement Applications:

- Measure high aspect ratio microstructures
- Inspect Surface Wear on Thread Gauges
- Measure Very Delicate Surfaces
- Scan microscale optics
- Inspect microscale holes

Electrical Parameters	Specifications	Units	Mechanical Parameters	Specifications
Output Signal	-10 to + 10	Volts	Tip Diameter	7 micrometers
Repeatability	< 10	nm	Fiber Length	~3.5 mm
Data Collection Bandwidth	100	Hz	Contact Forces	< 50 nano-Newtons
Signal Sensitivity (Typ)	1	V/ $\mu\text{m}$	Cartridge Casing	Custom Sizing Available
Scanning Capability	Contact and Near Field		Tip Velocity with wave on	~ 1 m/s
Tip Overtravel Capability	~ 1	mm		

## PreCess 2D Gauge Head

The PreCess differentiates among competing technologies in “Dynamic Precision” or the inherent ability to reproduce highly accurate measurements at rapid speeds. This is important when considering high quality control measurements and high throughput demands on the manufacturing floor. Using highly precise movers or measuring machines with the gauge, the probe’s fast and precise scanning response is unparalleled in the metrology industry. Mounting the gauge head with a highly precise mover or measuring machine is of course critically important. However, many vendors provide precision movers but few provide precision gauging products with less than 50 nm accuracies while maintaining fast scanning speeds.

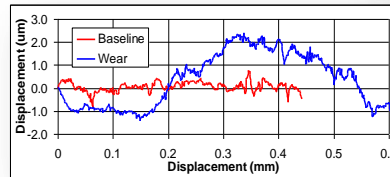
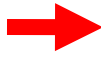
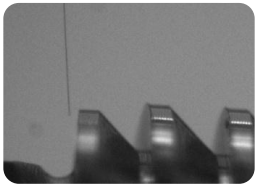
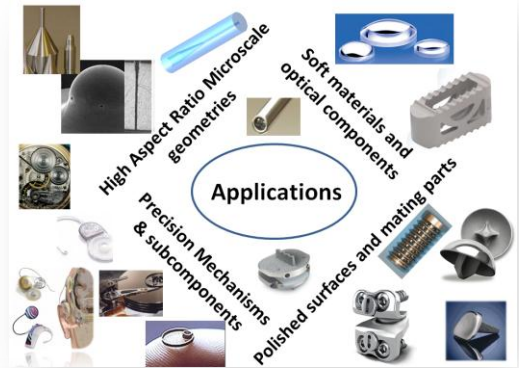


Typical Specifications				Units	Typical Specifications				Units
Parameters	<i>R-axis</i>	<i>Z-axis</i>			Parameters	<i>R-axis</i>	<i>Z-axis</i>		
Max Travel	± 0.30	± 0.30	mm		Frequency Response	170 (125)	102 (108)		Hz
Sensing Range	± 0.30	± 0.30	mm		Kinematic mount breakaway force	720 (380)	> 2,200		grams
Stiffness	14,100	13,800	N m <sup>-1</sup>		Offset Drift	N/A	0.84		µm/°C
Inertial Mass	~48	~73	grams		Linearity (over ± 0.05 mm)	< 50	< 100		nm
Noise Level	34	35	nm		Max Hysteresis	< 10	< 10		nm
Offset Drift	0.04	0.13	µm/°C		Lateral Compliance (normal to R-Z plane)	5000 (1985)	5000 (1985)		N m-1
					Rotational Error about Y-axis	0.40 (0.95)	0.40 (0.95)		ArcSec / µm



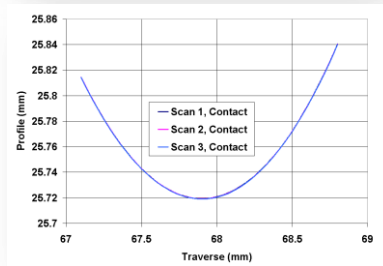
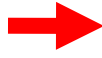
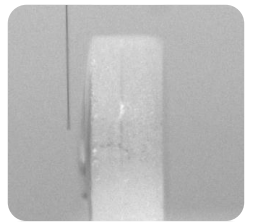
## Custom Metrology Services

InSituTec uses the AccuSurf combined with the MicroTouch to perform high aspect ratio profilometry and form measurements for parts that are difficult or impossible to measure by other means. Please contact us for more information.



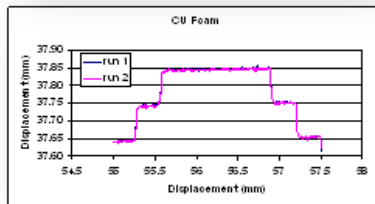
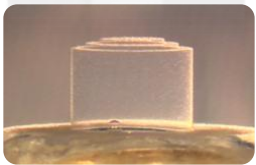
### Threads & Gears

Wear measurement of negative angle thread. Baseline represents unused thread and wear represents used part.



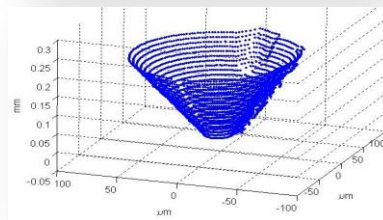
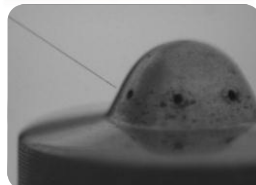
### Micro Lens & Optics

Measurement of optical curvature with 3.4 mm radius and 2 mm diameter.



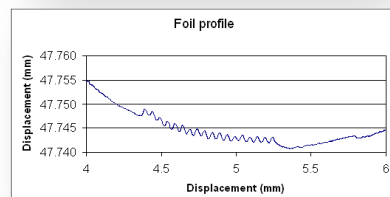
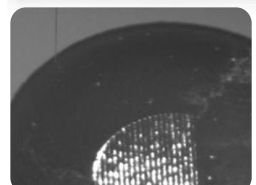
### Ultra Fragile Material

Measurement of aerogel cylinder with 100  $\mu$ m steps. Extremely delicate material.



### Small Holes

Measurement of 130  $\mu$ m hole entrance. Data includes surface texture, form and dimensions of the part.



### Thin Foils

Thickness measurement of 60  $\mu$ m foil with 2  $\mu$ m of amplitude sinusoidal feature on top.

# InSituTec



## Precision In-process Solutions

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