Form Talysurf
Intra

Taylor Hobson
PRECISION

Form Talysurf Intra

For simultaneous measurement of dimension, form and surface roughness. Curvature, inclination, roughness and waviness all affect the way surfaces interact with other surfaces. Form Talysurf Intra detects and evaluates all elements with just a single traverse across the component.

Impressive pedigree

The original Form Talysurf was developed in 1984 for the precision bearing industry.

As the first instrument ever to measure dimension, form and texture on curved surfaces, it demonstrated the ability of Taylor Hobson engineers to lead instead of follow surface measurment industry trends.

Since then the basic premise has been refined, improved and expanded to suit other industries but like many truly groundbreaking ideas it has never been surpassed.

Form Talysurf Intra is surface finish metrology engineered for the way you work...wherever you work.

It can be used with the Processor Control Module for completely portable operation or with a PC to function as a dedicated inspection station...or both.

Best of all, Intra moves easily from clean room to shop floor and back again. Even casual operators will be able to maintain high throughput with reliable results.

Now, for the first time, you can have surface finish inspection that controls your manufacturing process without disrupting your manufacturing schedule.

Choosing the right product

Simple roughness parameters like Ra can be checked with our Surtronic series instruments. If you need advanced analysis, higher levels of accuracy or greater flexibility, Form Talysurf Intra is the perfect choice. It combines industry leading specifications with simplicity of operation for unbeatable practicality and value.

Analysis fundamentals

The measurable elements of a surface are dimension, form, roughness and waviness. Many high specification components require analysis of all four.

Dimension - the functional shape of a surface as defined by radius, angle, distance, and the linear relationship between features.

Form - deviations from the intended shape of a surface (flat, spherical, tapered, etc.); often caused by machine tool inaccuracies.

Roughness - a deliberate, controllable element of the component design produced by the action of the cutting tool or machining process.

Waviness - an undesireable machine tool effect resulting from vibration, lack of stiffness or other instabilities in the machining process.

Skidless measuring system

Many roughness checkers use skidded pick-ups to guide the stylus over the workpiece, with the workpiece itself forming the datum for measurement.

Because the skid also acts as a mechanical filter, removing or altering general form and waviness characteristics, the collected data is not suitable for advanced analysis.

Intra is the right choice

For correct data collection the gauge must pass over the component in a straight line such that only the stylus tip comes in contact with the surface under test.

Vertical stylus movement is relative to the traverse datum, a reference bar that has been lapped or precision ground to an extremely high flatness and straightness tolerance.

Form Talysurf Intra is skidless and can be used for waviness, profile and other parameters such as Material Ratio with absolute confidence in the measurement results.

For your industry

Form Talysurf Intra offers exceptional productivity for a wide range of industries and applications.

For your budget

For general purpose or for solving a specific application problem, Form Talysurf Intra can be configured to perform within your budget.
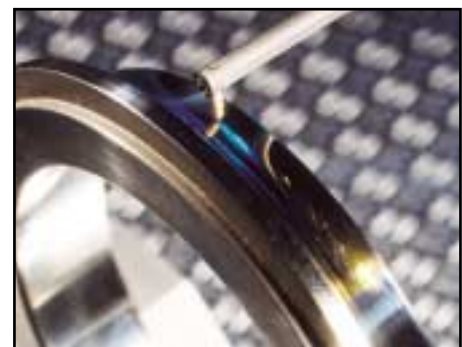
For your future

Unlike closed end systems that will be obsolete when your requirements change, Form Talysurf Intra can be expanded to meet whatever the future brings.

skidless tracing arms provide access to internal features such as ball tracks and ring grooves

high resolution skidless pick-up is necessary for straightness and waviness measurements

measureable form features may be spherical, aspherical, concave, convex, internal or external

Calibration of the system

Just as the three elements of surface texture function as one, each element of a measuring system is designed to complement the others. The specification of one component - no matter how outstanding - is meaningless out of context with the system. Form Talysurf Intra optimizes system performance by means of calibration over a ball.

The calibration procedure

Like most instruments of this type, the Form Talysurf stylus moves in an arcuate manner. A method to linearize data measured in this way was pioneered by Taylor Hobson.

With this method a polynomial is applied to the readings from the gauge. The coefficients of the polynomial are determined by means of calibration.

The accuracy of this calibration directly affects the accuracy of radius, form and surface texture measurement.

To obtain these coefficients, Form Talysurf instruments are typically calibrated through the measurement of a high precision spherical artifact - a method of calibration patented by Taylor Hobson.

Verify processor functions

Form Talysurf uses powerful software to combine the data generated by vertical movement of the stylus with data collected from the linear scale and reading head in the horizontal traverse unit. The result is a grid array of as many as 120,000 data points, each with unique spatial characteristics.

Compensate correctly for arcuate stylus motion error

Patented algorithms are applied that compensate for arcuate stylus motion error. This error occurs because data is collected in X-Z coordinates even though the stylus arm is moving in an arc.

Automatic and powerful

Calibration is programmable and essentially automatic. A positioning stage is used to manually locate the crest of the ball in the 'Y' axis. Cresting in the 'X' axis, positioning of the traverse to its start location and the actual measurement are all automatic.

The result is a true system calibration; all elements that may influence the measurement have been checked:

- Arcuate stylus motion error
- Gauge non-linearity
- Stylus tip geometry
- Instrument stability
- Traverse datum and data logging
- Gauge / stylus mechanical stiffness
- Processor functions

Calibration frequency

Calibration is recommended whenever the stylus arm is changed. To simplify this process all stylus arm configuration dimensions are stored for easy recall.

Calibration history regarding operator, artifact and date is automatically stored and artifacts used for calibration can be identified and referenced to certification date.

Distance

Radius

Angle
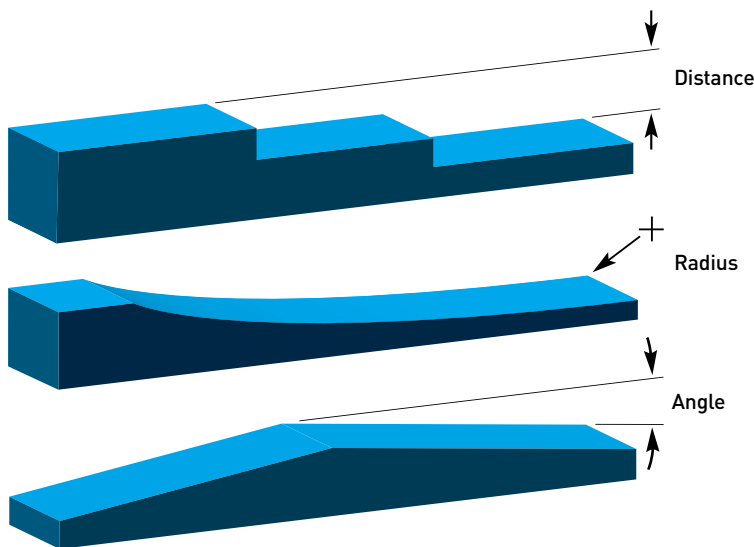
Linearity and wide range assure accurate measurement of dimension, form and texture

Correlation of results

Manufacturers who outsource expect their suppliers to deliver parts that meet specification. You know the parts are good but the instrument your customer uses to inspect them says they are bad. Lack of correlation can occur even when the instruments are configured the same way as to filter, cut-off and length of trace.

Different suppliers, different results

In the case of mating pieces, one supplier makes part A, another makes B. Both say the roughness is acceptable but the end user may find that neither part meets the spec.

Some of the lack of correlation between different brands of instruments or even between instruments of the same brand can be partially attributed to three factors:

• speed of traverse
• condition of the stylus
• gauge linearity

Speed of traverse

Most roughness checkers are time based, collecting data for a fixed period of time instead of a precise, constant distance.

Anything that affects speed of traverse - wear, dirt, slippage, etc. - affects the quantity and spacing of the collected data points which in turn affect the measurement results.

Form Talysurf Intra utilizes a glass scale and reading head to assure that data collection is accurate and consistent. Every measurement on every instrument is calculated from the exact same quantity of identically spaced data points.

Stylus condition

With many surface measuring systems, the size, shape and condition of the stylus tip are assumed to be constant in terms of data processing. In practice the stylus tip may vary due to manufacturing tolerance, routine wear or physical damage.

During calibration with a Form Talysurf, the stylus is traversed over the spherical artifact to make contact at all points along the radius of the conisphere tip in the measurement direction. By this method, the user can detect effects due to stylus damage or deviations of size and shape.

Gauge linearity

Intra is calibrated over a ball to check linearity of the entire 1mm gauge range. Most other systems use a step master or an Ra patch that calibrates only over a very narrow band. The assumption is that if the gauge is linear over that band it is linear over the full range.

Unless your measurements are all taken within the same vertical position of the gauge range and never exceed the amplitude of the step height master, the data you collect may be non-linear which will cause incorrect results.

calibration over a ball checks stylus condition, gauge range, linearity and processor functions

form errors cause assembly problems, inefficient operation and premature failure of the component
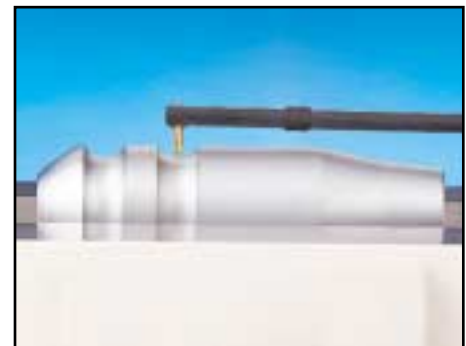
measure dimension, form and texture at once with a single traverse over curved or straight surfaces
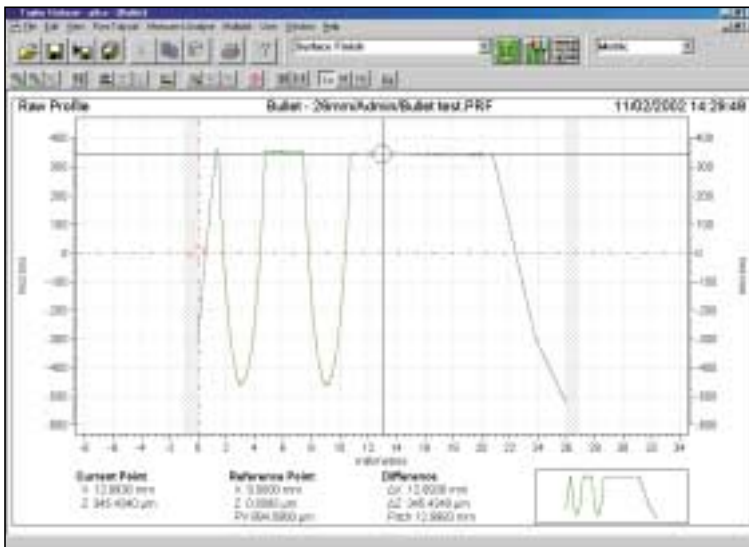
µltra software

When Form Talysurf Intra is used with a PC, our industry leading software takes control of all mechanical, administrative, analysis and display functions. µltra is network ready for central data storage and output to network printers. Users will benefit from ease of use as well as advanced analysis techniques.


µltra takes full advantage of Intra's wide gauge range and its ability to measure curved straight and inclined features with a single traverse. This powerful software uses exclusion, removal and zoom tools to let you identify and isolate component features for detailed analysis of dimension, form and texture without re-measuring the part.

In this example, the zoom tool is used to isolate an arcuate feature. Next, the radius and, significantly, deviation from true radius will be analyzed via removal of the LS Arc. After removal of the LS Arc, conventional filters can be applied to determine roughness, waviness, material ratio and more than 95 different surface finish parameters.

measuring path for raw profile
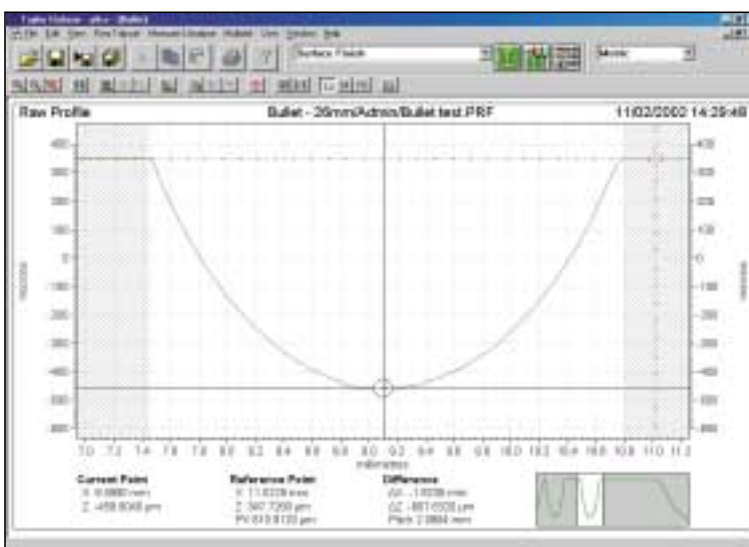
detail of radius shown in zoom section
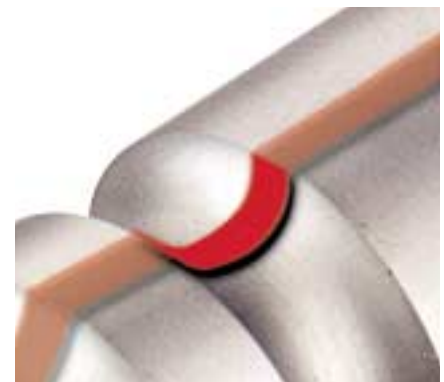
µltra software options

Form Analysis Software - code 112/2843

Form error is determined with reference to a best fit concave or convex circular arc or straight line, with all surface roughness detail included. Radius, angle and pitch can be calculated and the linear relationship of surface features can be determined based on calculated X and Z co-ordinate positions.

Aspheric Form Software - code 112/2845

Assessments of form error, surface slope error and tilt in comparison with operator defined design data. An aspheric, defined in the form of a polynomial expression, is best fitted to the measured profile.

After form removal the residuals are calculated and the following parameters can be determined:
Fig, Ra, Rt, Smn, Smx, Tilt, Xp, Xt and Xv.

Conic Form Software - code 112/2844

Assessment of residual errors after removal of best fit elliptical or hyperbolic forms to provide major and minor axis values, tilt, and residual surface texture analysis.

Contour Analysis - code 112/3170

Provides dimensional analysis of geometric features such as radii, angles, length and height. Includes user programmed measurement macros, individual feature tolerancing, comparison of DXF files to contour and fitting of geometric elements to unknown contour.

Dual Profile - code 112/2846

Enables two sets of measurement data to be displayed at once with one set being used as the datum against which the other set is tested. Comparison can be of one measured profile to another or to a master profile which has been saved as a template. A "difference" profile can be displayed at the touch of a button and used for further analysis.

**Gothic Arch Analysis -** code 112/3121

Of particular benefit to bearing producers, the Gothic Arch tool electronically fits the nominal bearing diameter into the raceway profile and the parameters (radius, radius offset, vertex angle and ball clearance) are automatically calculated for on-screen display or color printout.
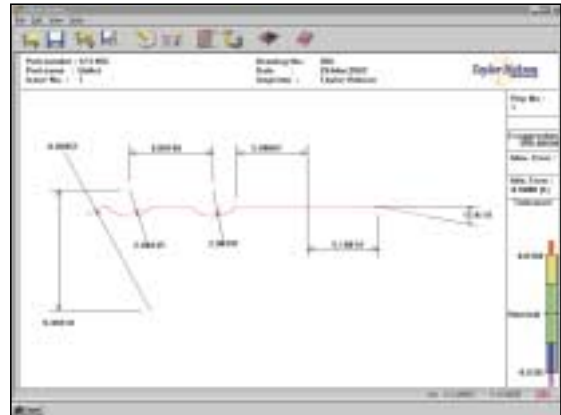
contour analysis software
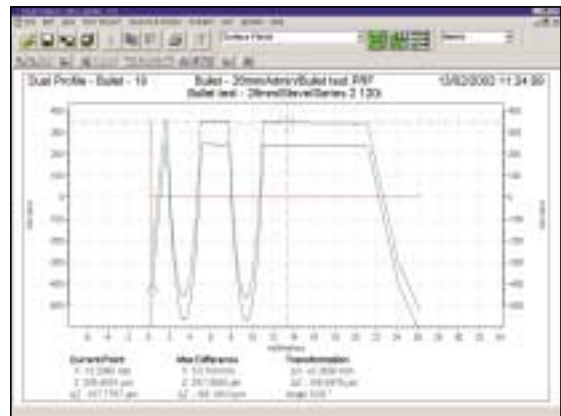
dual profile software
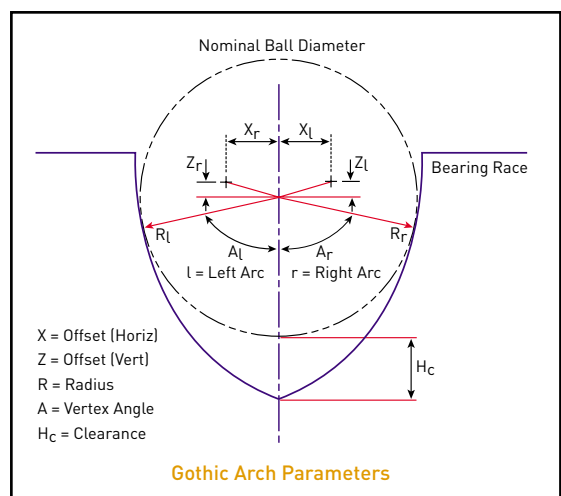
gothic arch software

Processor Control Module

Component inspection shouldn't be more complex than manufacturing. With the Intra Processor Control Module it isn't. A color VGA touch screen panel with simple "one touch" icons will be familiar to anyone who has ever operated a machine tool. Commands are in plain English and arranged in a logical, task oriented sequence. With little or no training required, the Intra PCM enables every machine operator to inspect parts correctly and efficiently.

Intuitive operation improves productivity

Designed for simple set up and instant results, this dedicated control and analysis processor minimizes errors and maximizes inspection throughput.

No cables required

The Processor Control Module (PCM) includes an infra red link (IrDA) to communicate with the traverse unit. This eliminates the nuisance of connecting cables when the Intra is used in portable mode.

Mains or battery power

Both the PCM and the traverse unit operate on mains power supply via low voltage power adapter. Also available are rechargeable, high capacity metal hybride batteries for operation in remote locations.

No installation

Intra with the PCM requires no installation or special set-up considerations. The system will fit on any available table or workbench anywhere in the shop. Intra will be ready to work immediately without disrupting normal workflow.

Instant results

All measurement results are displayed instantly on the high resolution control panel screen and also stored internally in the event that future re-analysis or documentation is desired.

Smart media data transfer

The PCM has a PCMICA type II slot for use with an optional PC Smart Media card. This allows for the transfer of measurement results to personal computers for storage or extended analysis.

An optional printer completes the package whenever a hard copy of results is necessary.

Shop floor approved

Thoroughly tested in hostile environments, the Intra PCM is designed and intended to be used on the production floor.

Expanding capability

Form Talysurf Intra includes an inductive gauge which is suitable for most tasks. For contour measuring applications we also offer a wide range pick-up.

Inductive Gauge

This traditional gauge head leads the industry with a full 1mm (0.04in) of range and an outstanding range to resolution ratio of 65,536:1. It has a pivoted and balanced beam to allow measurement in any attitude. (standard - code 112/2564)

Range / Resolution

1.0mm / 16nm   (0.04in / 0.64µin)
0.2mm / 3.0nm   (0.008in / 0.12µin)

Right angle attachment -

Code 112/2022 (Skidless applications)
Code 112/2040 (Skid applications)

Stylus stop attachment - code 112/2098

Wide range pick-up

Available as a plug-in accessory, the wide range pick-up provides 28mm (1.1in) of range with 426nm (17µin) resolution. Suitable for form and contour measurements.

Wide range pick-up - code 112/2628

Includes three interchangeable stylus arms

• Conical tip with 30° included angle
• Ball tip with 0.5mm (0.02in) radius
• Chisel tip with 15° included angle


wide range pick-up for contour applications

Note: All stylus arms have 90° conisphere diamond styli with 2µm nominal radius tips unless otherwise stated.
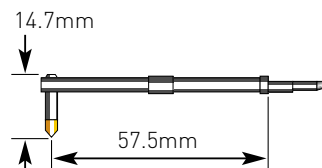
Additional stylus arms
The stylus arms shown on these pages represent just some of the standard configurations. In addition, Taylor Hobson can provide customized stylus arms for specific applications.

Inductive Pick-up Stylus Arms

Standard Stylus Arm - code 112/2009

8.3mm

57.5
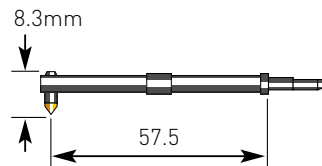
Recess Stylus Arm - code 112/2011

14.7mm

57.5mm

Small Bore Stylus Arm - code 112/2012

1.2mm

57.5mm
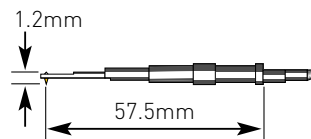
Chisel Edge Stylus Arm - 2µm x 750µm chisel diamond stylus - code 112/2013

9.0mm

57.5mm
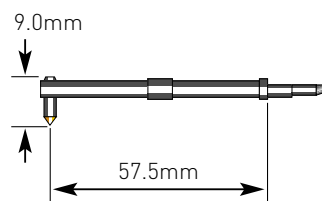
Ball Stylus Arm, nominal range 2mm (0.078in) 500µm radius sapphire ball stylus - code 112/2010

16.5mm

117.5mm
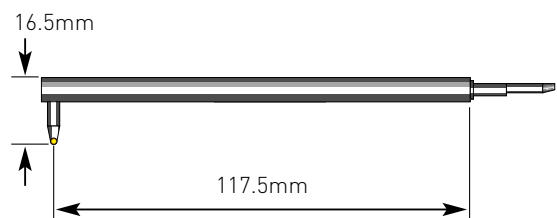
Accessories

All the accessories you need to begin using Form Talysurf Intra are supplied as standard. However, for more demanding measuring requirements, we have a range of accessories which may be ordered separately.

❶ **Universal Worktable**
Complete stage assembly to provide X, Y, Z, rotary and tilting positioning moves. Includes vee block and location plate for mounting to the T slot in the granite base.
code 112/3064

X axis Stage Assembly
Simple stage assembly with X axis positioning, vee block and location plate for mounting to the granite base.
code 112/3067

Manual Column and Base
Granite base 800x400mm (32x16in) with Tee slot and manual granite column with hand wheel for 350mm (14in) height adjustment.
code 112/3116 (cradle mount)
code 112/3117 (fixed mount)

Leveling Foot
Used on granite base 112/3117 for leveling the traverse unit
code 137/2157

❷ **Ball Joint Vise**
Provides universal positioning via 360° rotation and 180° tilt; especially for lightweight or small components
code 112/2695-01

❸ **Adjustable Worktable**
Provides fine adjustment for rotational [+/- 3°] and lateral [+/-10mm (0.4in)] positioning of the workpiece. Work surface with T-slot = 120mm x 120mm (4.7in x 4.7in)
code 112/1644

❹ **Vee Blocks (Pair)**
For the support of large, cylindrical components
code 112/1645

Ra and 3 Line Standard
An Ra verification patch with step height standard can be supplied with a Form Talysurf unit for calibration when surface texture only is to be analysed.
code 112/557.

Radius Calibration Standard
For systems using form software, spherical calibration artifacts are a requirement.

80mm (3.15in) Radius
A glass artifact for systems using a wide range pick-up.
code 112/2028

22mm (0.86in) Radius
A mounted precision ball for systems using long stylus arms.
code 112/1844

12.5mm (0.49in) Radius
A mounted precision ball for standard Intra systems.
code 112/2062 (standard)

❺ **Ball and Roller Unit**
Special fixture rotates ball or roller over stationary stylus for circumferential inspection of surface finish. Includes set of (4) plates for ball diameters 1 - 25mm (0.04 - 0.98in)
code 112/3219

Roller Plates
Set of (3) for 1 - 16mm (0.04 - 0.63in) diameter rollers
code 112/3248

Specification

Horizontal Performance	
Traverse length - X Min / Max	0.1mm to 50mm (0.004in to 1.97in)
Traverse / measuring speeds	10mm/s (0.39in/s) max - 1mm/s (0.039in/s)
Data sampling interval in X	0.5µm (20µin)
Straightness error (Pt) [1]	0.4µm over 50mm (16µin over 1.96in) 0.2µm over any 20mm (8µin over any 0.78in)
Vertical Performance	
Nominal measuring range (Z) [2]	1mm (0.04in)
Resolution (Z) [2]	16nm @ 1mm range (0.63µin @ 0.04in) 3nm @ 0.2mm range (0.12µin @ 0.008in)
Range to resolution ratio	65,536 : 1
Stylus arm length, tip size, force	60mm arm, 2µm radius conisphere diamond stylus, 1mN force
System Performance [2]	
Spherical calibration artifact	12.5mm (0.49in) nominal radius
Calibration uncertainty - Pt [3]	< 0.25µm (10µin)
Radius measurement uncertainty [4]	0.1 - 12.5mm (0.004 - 0.5in) = 2% to 0.04% of nominal 12.5 - 25mm (0.5 - 1in) = 0.04% of nominal 25 - 1000mm (1 - 39.4in) = 0.04% to 0.2% of nominal
Angle measurement uncertainty [5]	within 1% of measured angle (+ / - 35º maximum range)
Parameter height uncertainty	within 2% + 6nm (0.24µin) (peak parameters only)
Dimensions L x D x H	Traverse unit - 343 x 116 x 160mm (13.5 x 4.6 x 6.3in) Control module - 285 x 200 x 80mm (11.2 x .9 x 3.2in)
Weight	Traverse unit - 4.9Kg (10.8lbs) Control module - 1.9Kg (4.2lbs)
Analysis	
Primary parameters	Pa, Pc, Pda, Pdc*, Pdq, PHSC*, Pku, Pln, Plo, Plq, **Pmr(c)***, Pmr* Pp, PPc*, Pq, PS, Psk, Psm, Pt, Pv, Pvo*, Pz, Pz(JIS)
Roughness parameters	R3y, R3z, Ra, Rc, Rda, Rdc*, Rdq, RHSC*, Rku, Rln, Rlo, Rlq **Rmr(c)***, Rmr*, Rp, **Rp1max**, Rpc*, Rq, RS, Rsk, RSm, Rt, Rv Rvo*, **Rv1max**, Rz, Rz(DIN), Rz(JIS), Rz1max
Waviness parameters	Wa, Wc, Wda, Wdc*, Wdq, WHSC*, Wku, Wln, Wlo, Wlq, **Wmr(c)*** Wmr*, Wp, WPc*, Wq, WS, Wsk, Wsm, Wt, Wv, Wvo*, Wz
Rk Parameters	A1, A2, Mr1, Mr2, Rk, Rpk, Rvk
R + W Parameters	AR, AW, Pt, R, **Rke**, **Rpke**, **Rvke**, Rx, Sar, Saw, Sr, Sw, W, Wte, Wx
Dimension parameters	Slope, Datum slope, Delta slope, Intercept X / Intercept Z
Filters / bandwidths	Gaussian, ISO 2CR, 2CR PC / 30:1, 100:1, 300:1
Cut-offs	0.08, 0.25, 0.8, 2.5 and 8mm (0.003, 0.010, 0.03, 0.1 and 0.3in)

Environment notes

Storage temperature
5ºC to 40ºC (41ºF to 104ºF)

Storage humidity
10% to 80% Relative, non condensing

Operating temperature
15ºC to 30ºC (59ºF to 86ºF)

Temperature gradient
< 2ºC (< 3.6ºF) per hour

Operating humidity
45% to 75% Relative, non condensing

Maximum RMS floor vibration
2.5µm/s (100µin/s) at < 50Hz
5.0µm/s (200µin/s) at > 50Hz

Electrical supply
110 / 220 / 240V - 50 / 60 Hz

Power consumption
10VA traverse unit / 18VA processor

Safety
EN 61010 - 1 : 2001

EMC
EN 61000 - 6 - 4 : 2001
EN 61000 - 6 - 1 : 2001

Note:
Taylor Hobson pursues a policy of continual improvement due to technical developments. We therefore reserve the right to deviate from catalog specifications.

Analysis and parameter notes:

Pass / Fail tolerances
All parameters can be assigned nominal, minimum and maximum values.

* Qualifiers
All parameters marked with an asterisk are suitable for user assigned single or multiple qualifiers. For example, material ratio (mr) may be assessed at one or more slice levels within a single measurement.

Ultra software parameters
Parameters highlighted in bold are available only with PC / Ultra based systems.

ISO standards
Where applicable, parameters conform to and are named as per ISO standards, 4287-1997, 13565-1-2 and 12085.

1   Measured over a glass flat nominally parallel to the traverse datum using a 60mm arm with a diamond stylus (speed = 1mm/s, LS Line analysis, primary filter λs = 2.5mm).

2   Using a 60mm arm with a diamond stylus.

3   Analysis using a primary filter λs = 0.025mm (PDA) 0.25mm (Ultra).

4   Assumes a calibration artifact of perfect radius.

5   Measurements up and down a 35º angled slope over 80% of the gauge range, using a 60mm arm with a diamond stylus.

The above technical data is for measurements taken in a metrology laboratory controlled environment: 20ºC ± 1ºC (68ºF ± 1.8ºF), draft free, and isolated from low frequency floor borne vibration.

Uncertainties and maximum permissible errors (MPE's) are at 95% confidence in accordance with recommendations in the ISO Guide to the expression of uncertainty in measurement (GUM:1993). All errors are expressed as MPE's.

At Taylor Hobson we don't sell products - we provide solutions. Whatever our customers' measuring needs, we will find a solution to meet them.

Our reputation for excellence is based on more than 100 years of metrology design and manufacturing experience. Add to this our worldwide coverage, our after sales support and our commitment to customer care and you have a company which provides its customers with total peace of mind.

The Taylor Hobson service:

Special applications
We have a team of engineers who provide a design service for dedicated metrology solutions. This can involve customising standard Taylor Hobson instruments to meet specific requirements or designing unique products.

For details of your local support center phone
+44 116 246 3034 or e-mail sales@taylor-hobson.com

Centers of Excellence
Our Centers of Excellence, offer:

- product and theory training either at our local training centers or at our customers' premises

- instrument and metrology advice

- a trial measurement service to help you decide which product to buy

- lectures and presentations

For details of your local Center of Excellence phone
+44 116 276 3779 or email cofe@taylor-hobson.com

After sales support
To ensure that all our products are maintained to the standards you require, we offer a range of after sales service packages. They include an on-site calibration service, field service and a refit and upgrade service.

We also offer an instrument calibration service at our UKAS laboratory in Leicester.

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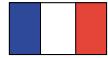
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QUALITY
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