

REPRESENTANTE EXCLUSIVO  
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## ELECTRO OPTICAL METROLOGY

Taylor Hobson has been selling electro-optical metrology products since the last 1930s and the range includes Micro Alignment Telescopes (used for checking and setting straightness and alignment) Autocollimators (for accurate measurement of small angular displacements), clinometers and "Talyvel" electronic levels. Used in a range of applications in industries such as machine tools, aerospace, marine and steel rolling, the Taylor Hobson range combines high accuracy and repeatability with fast response and operational convenience.

To provide focused technical support to all its electro-optical metrology customers, Taylor Hobson has a dedicated technical support centre:

### Spectrum Metrology

Customers with electro-optical measurement needs often require not only equipment but also advice on solving a specific manufacturing or calibration problem. With many years experience in electro-optical metrology, Spectrum Metrology provides rapid technical and application support via phone, fax, e-mail or on-site visits. A full demonstration and training facility is available either on-site or in Spectrum Metrology's demonstration room.

Spectrum Metrology is also the authorised repair agent to Taylor Hobson for the electro optical metrology range and holds a wide stock of ex-demonstration equipment for hire or sale.

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Autocollimator 1E SM 11/04



# AUTOCOLLIMATORS AND ACCESSORIES RANGE

MEASURING ANGLE, STRAIGHTNESS, FLATNESS, SQUARENESS, PARALLELISM



a division of

**AMETEK**

# THE AUTOCOLLIMATOR RANGE

## FOR MEASURING ANGLE, STRAIGHTNESS, FLATNESS, SQUARENESS, PARALLELISM

Used extensively in workshop, tool rooms, inspection departments and quality control laboratories throughout the world, Taylor Hobson Autocollimators - developments of the renowned Hilger and Watts products - are sensitive optical instruments designed for the accurate measurement of small angular displacements. There are five models in this comprehensive range, from the simple Minidekkor to the ultra precision DA20, each produced as a result of the company's commitment to quality optics and backed by a dedicated staff with considerable experience.

### THE PRINCIPLES OF AUTOCOLLIMATION

Figures A and B illustrate the basic principles of Autocollimation.

Light from an origin point O is collimated (made parallel) by a high quality objective lens. If the collimated beam falls perpendicularly onto a plane reflecting surface, the light is reflected back along its original path and is brought to a focus at a point coincident with the origin point (as Figure A). If the reflector is tilted through an angle  $\theta$ , the reflected beam is deflected through an angle  $2\theta$ , and the image I is displaced laterally from the origin O.

The amount of displacement is given by  $d=2\theta f$  where  $f$  is the focal length of the lens, and  $\theta$  is in radians.

Given that  $f$  is a known constant for the Autocollimator, measurement of the displacement  $d$  enables the tilt  $\theta$  to be ascertained.

A practical Autocollimator is illustrated in Figure C.

Light from an illuminated target graticule at the focus of an objective lens is directed towards the lens by a beam splitter. After reflection by a mirror on the workpiece, the light returns through the Autocollimator and passes through the beam splitter, forming an image of the target graticule in the plane of an eyepiece graticule.

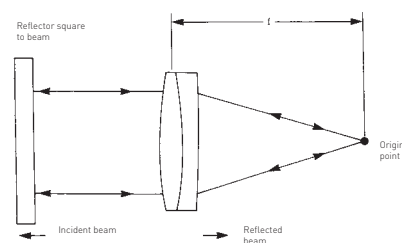


Figure A

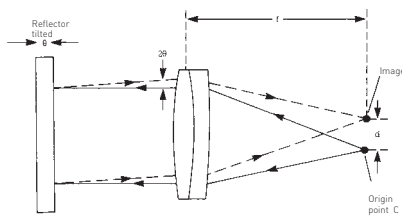


Figure B

The eyepiece graticule and the reflected image of the target graticule are viewed simultaneously through the eyepiece.

The image of the target graticule is always seen in focus and at constant magnification in the eyepiece, regardless of the distance between the Autocollimator and the reflecting surface.

However, at long working distances only a portion of the reflected target graticule may appear in the eyepiece, owing to the failure of obliquely returning rays to enter the Autocollimator. This will result in a restricted measuring range.

Displacement of the image is measured by various means, as detailed in the descriptions of individual auto-collimators within this brochure.

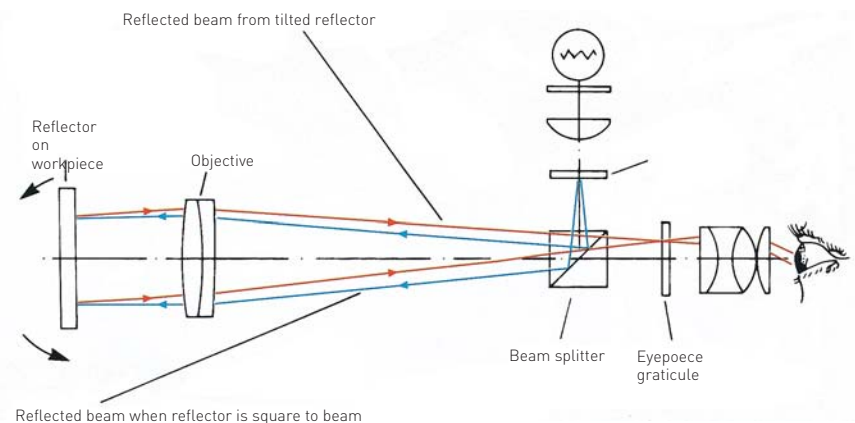


Figure C

# AUTOCOLLIMATION IN PRACTICE

## CHECKING, MEASURING, INDEXING & MONITORING

Taylor Hobson Autocollimators are used in conjunction with reflecting mirrors or surfaces for the accurate measurement of small angular deviations from a datum angle.

The main advantages of Taylor Hobson Autocollimators are:

- High accuracy angle measurement
- Easy to set up and operate
- Non contact measurement
- Calibration traceable to international standards
- High performance and repeatable measurement
- Choice of visual or photo electronic systems



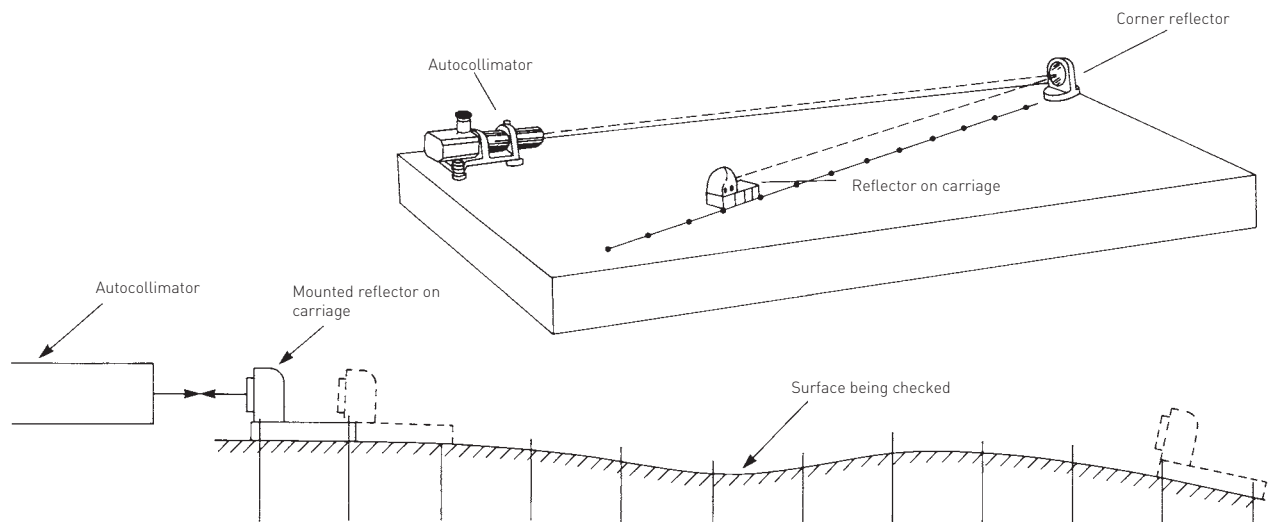
DA20 Autocollimator with reference index table used to calibrate a polygon



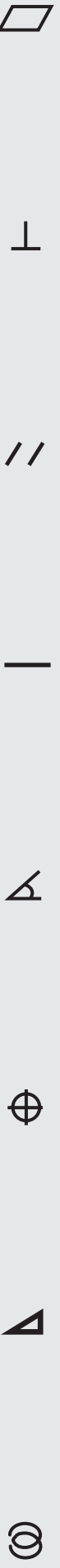
Precision Machine Tool alignment using DA20 Autocollimator

Their main applications include:

- Checking straightness of machine tool slideways
- Setting the angle of machine tool heads
- Checking dividing heads for their angular displacements
- Measuring very small angles
- Indexing small angles precisely
- Measuring small linear displacements
- Checking flatness of bed plates and surface tables



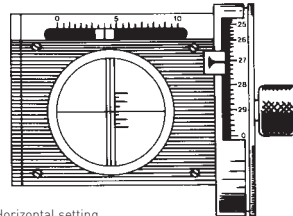
Measuring straightness using a reflector and carriage



# VISUAL AUTOCOLLIMATORS. EASY TO USE AND READ

The visual Autocollimators are extremely accurate instruments with a wide variety of applications, particularly for checking straightness and flatness and for angular indexing.

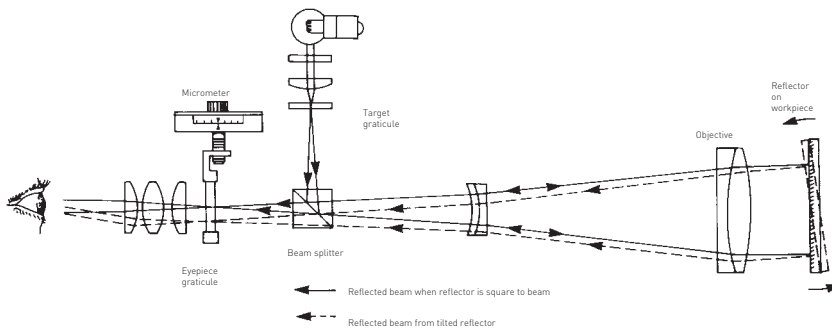
They are normally supplied with the eyepiece positioned for straight through viewing, although the TA51 is available with the eyepiece positioned for right angle viewing if required. All models have a long eyepoint - convenient for spectacle wearers. Measurements are made using a graticule in the eyepiece system with or without micrometers.



Example : Horizontal setting  
 Micrometer = 27.1 seconds  
 Turn counter = 4 minutes 30 seconds  
 Reading = 4 minutes 57.1 seconds  
 Each graduation equals 0.5 minute (Scale)  
 Each graduation = 0.2 second (Micrometer)  
 Double setting lines straddle reflected image  
 Field of view through eyepiece



Checking a TB100 Clinometer with the TA51 Autocollimator



The Taylor Hobson VA900 and TA51 Autocollimators incorporate a micrometer in the eyepiece viewing system for the precise measurements of angular displacement. The TA51 has two micrometers, one in each axis of measurement.

On single axis types, the instrument is rotated through 90 degrees to measure in a second plane perpendicular to the first.

The micrometer is used to move the eyepiece graticule across the field of view until it coincides with the reflected target graticule image. The angular displacement of the reflector can then be read directly from the micrometer scale.

The field of view as observed through the Autocollimator eyepiece is shown above.

For measuring horizontal displacement in a single axis instrument, the micrometer drum is rotated to move the twin setting lines across the field of view until they straddle the vertical line of the reflected image.

The instrument reading is then the sum of the indicated positions of micrometer and turn counter scale.

The TA51 Autocollimator is normally supplied with a light field graticule. Only one setting line is used in instruments fitted with dark field graticules.

## GRATICULES TO SUIT YOUR REQUIREMENTS

The VA900 and Minidekkor Autocollimators are normally fitted with dark field graticules as standard for a better visual contrast from low reflectivity surfaces or a small cross section reflector. However, light field graticule variants can be supplied on request.

## TA60 DUAL AXIS MINIDEKKOR Code 142/10

- Lightweight and portable
- Wide range of measurement
- Can measure X and Y Axes at the same time
- Can measure components of low reflectivity or with small surface area

The TA60 Minidekkor is an inexpensive visual Autocollimator using a two axes graticule for general measuring duties in workshop and tool room.

Only 152mm (6in) long for straight through viewing or 203mm (8in) long for right angle viewing, it is an ideal instrument for inclusion in a fitters tool kit for use outside the factory.

The standard Minidekkor is provided with a dark field graticule, forming an illuminated cross line image on a dark background. This offers the advantage of clear images being obtained from low reflectivity surfaces such as unsilvered glass, and from surfaces as small as 3mm (0.125in) in diameter.

With the addition of a microscope objective and linear measuring device, the Minidekkor can be used for measuring radius of curvature of a lens or mirror and, for example, the spacing of electrodes enclosed in a glass envelope.

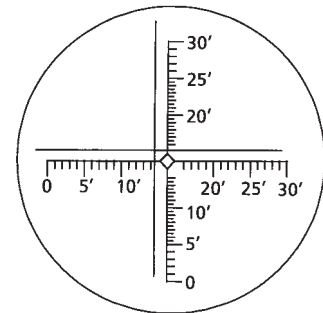
This Autocollimator is supplied as standard without mounting fixtures. Therefore, when ordering it is important to consider the applications and select the appropriate mounting accessories.

**TA51 MICROPTIC DUAL AXIS AUTOCOLLIMATOR**  
Code 142/13

- Ideal for checking machine slides for straightness and squareness
- Checking flatness of surface tables
- Checking angular indexing tables and polygons
- Low reflectivity surfaces



TA51 Autocollimator



VA900 Graticule



The TA60 Minidekkor

**VA900 MICROPTIC DUAL AXIS AUTOCOLLIMATOR**  
Code 112/2208

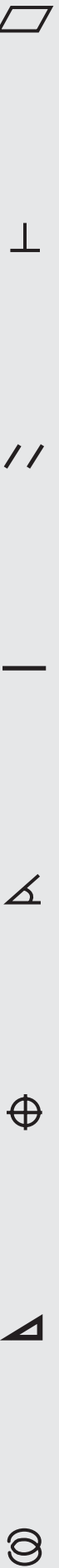
- Lightweight high accuracy instrument
- Ideal for precise measurement of angle of components such as prisms and for checking straightness, flatness and angular indexing
- Wide range using combination of graticule and micrometer

The VA900 Microptic Autocollimator is a dual axis, lightweight, highly accurate instrument. It is ideally suited for the precise measurement of angles or components such as prisms, for checking straightness, flatness or angular indexing. Measurement of the two axes is made using a combination of the instrument's two axes graticule and single micrometer.

This Autocollimator is supplied as standard without mounting fixtures. Therefore, when ordering, it is important to consider the application and select the appropriate mounting accessories.



The VA900 Microptic Dual Axis Autocollimator



# PHOTOELECTRONIC AUTOCOLLIMATORS

## DUAL AXIS MEASUREMENT

### WITH DIGITAL DISPLAY

The DA instruments are highly versatile Autocollimators which use the latest light source and detector technology to provide dual axis operation with digital display.

Whereas the wide range DA400 is used for a variety of applications, typically in the machine tool industry, the ultra high precision DA20 is used primarily under strict environmental conditions in laboratories.

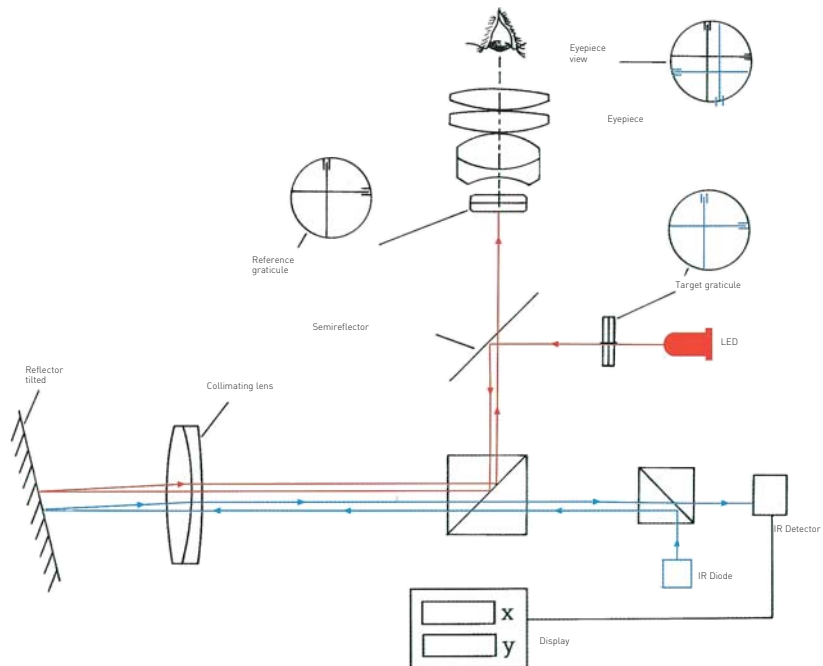
Each Autocollimator has an eyepiece with an independent visual channel to assist initial setting up procedures.

The electronic unit display is readable from several metres. Also incorporated is a signal strength display to ensure correct set up and results.

Measured values of angular displacement are displayed in digital form.

An RS232 interface is provided for connection to various types of accessory computer. Among other applications, this allows computer processing of straightness, flatness, angle and polygon (rotary devices) measurement. A remote control switch is available, enabling the Autocollimator and Electronic Unit to be positioned remotely from the operator.

The DA20 and DA400 dual axis Autocollimators can be provided software which includes a straightness (squareness and twist) program, a flatness (Union Jack or Moody) program and a polygon or rotary analysis package.



#### DA20 DIGITAL DUAL AXIS AUTOCOLLIMATOR Code 137/1939

- High accuracy dual axis operation with digital display
- Independent visual channel to assist in setting up
- Direct analogue display, readable from several metres
- RS232 interface provided
- Software programs for flatness, straightness and rotary analysis
- Ideal for ultra-precision measurement and indexing of small angles
- Suitable for calibration of polygons, rotary tables and encoders

DA20 Photoelectronic Autocollimator





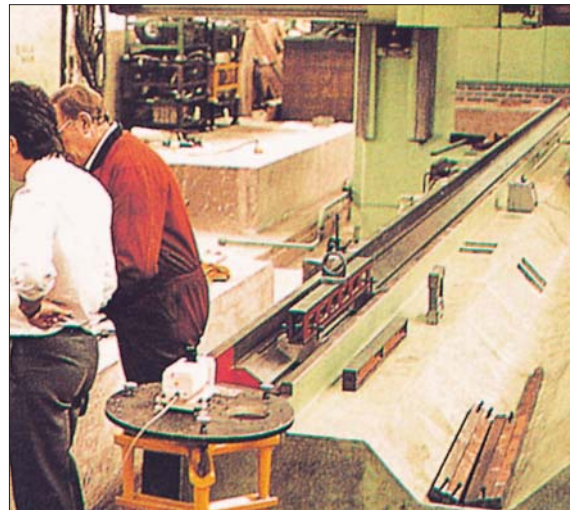
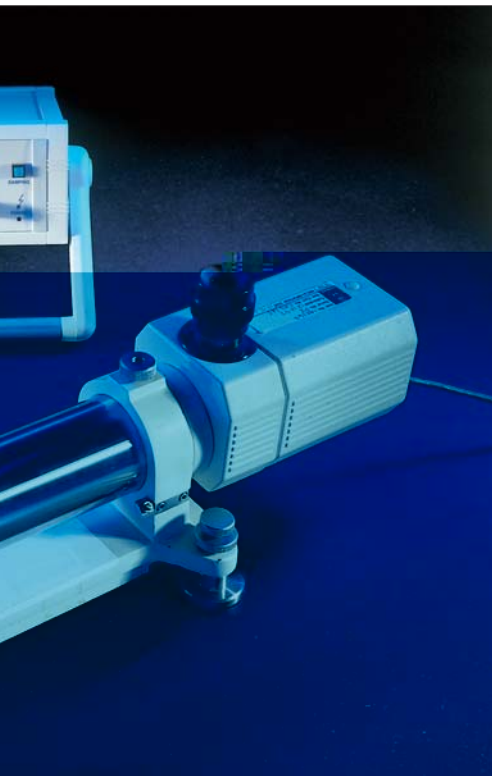
DA400 Autocollimator

**DA400 DIGITAL DUAL AXIS AUTOCOLLIMATOR**  
Code 142/78

- Wide measurement range
- Dual axis operation and display
- Independent visual channel to assist in setting up
- RS232 and analogue outputs (IEEE option available)
- Full software package
- Wide range of applications



Checking surface table flatness with a DA400 Autocollimator



Checking a machine tool slideway using a DA400 Autocollimator

Using a computer allows automatic calculation using the selected program, with results on the screen display and printout of measurement results. This enables a more efficient method of measurement, speeding up measuring times and minimising the risk of human error in taking the reading.

Communication between microcomputer and operator is in simple interactive Windows™ based program, enabling inexperienced personnel to carry out measurements. Each stage of measurement to be carried out is prompted by the screen display which also indicates when any error of operation has occurred.





# ACCESSORIES

## LEVELLING BASES AND STANDS



### LEVELLING BASE Code 142/76

Normally included as standard with Autocollimators TA51, DA20 and DA400.

The levelling base provides support for the Autocollimator, enabling the unit to be levelled and to bring its axis parallel to the surface being measured. It incorporates clamps to securely hold the Autocollimator without damage.

Three pads are included for use under the foot screws. There is no necessity to remove the Autocollimator from the base after use, as the Autocollimator carrying case is constructed to accommodate both items.

Spacing between front and back foot screws: 205mm (8in)  
 Spacing between the two back foot screws: 130mm (5in)  
 Height of Autocollimator axis when base is resting on the pads: 76mm (3in)  
 without pads: 67mm (2.5in)  
 Range of angular adjustments: approx  $\pm 3^\circ$   
 Approximate weight: 3.4kg (7.5lb)

### ADAPTOR BUSHES, Code 112/2257

A set of two bushes to convert standard levelling bases to 38mm (1.5in) diameter for use with VA900.

### VERTICAL BASE WITH ADJUSTING BRACKET Code 112/3451-01 for TA60, 25.4mm (1in) dia clamp Code 112/3450-01 for VA900, 38mm (1.5in) dia clamp

A multipurpose stand of sturdy construction for general bench use, comprising epoxy granite surface plate, and ground cast iron column and bracket. The Autocollimator clamping bracket has independent clamping and rotational adjustments, enabling the bracket to be turned without disturbing the height adjustment.

Available for use with 25.4mm (1in), 38mm (1.5in) and 67mm (2.5in) diameter autocollimators.

Surface Plate Area: 220x150mm (8.7x5.9in)  
 Maximum Height Adjustment above Surface Plate: 200mm (8in)  
 Flatness of Surface: 5 $\mu$ m (0.0002in)  
 Approx Weight: 7.6kg (16.8lb)

## REFLECTORS AND OTHER ACCESSORIES

### STANDARD GLASS REFLECTOR 50mm (2 inch) Code 142/24 mounted

A reflector is an integral part of any Autocollimator system. Successful autocollimation requires a reflector of adequate flatness, reflectivity and diameter; this reflector meets all of these requirements. The parallelism of the faces is such that negligible error is introduced when the unmounted reflector is back mounted. The mounted version can be used horizontally or vertically. Steel reflectors can be supplied to special order.

Diameter: 50mm (2.0in) nominal  
 Faces Parallel to Within: 5 secs  
 Faces Flat to Within: 0.08 $\mu$ m (3 $\mu$ in)  
 Centre height of Mounted Reflector: 37mm (1.5in)  
 Weight Unmounted: 130g (9oz)  
 Mounted: 1.1kg (2.5lb)



### LARGE GLASS REFLECTOR MOUNTED 100mm (4 inch) Code 142/26

Offering a large reflective surface, this is normally used in conjunction with a reflector carriage and mounted reflector for calibrating a surface plate. It enables several calibration lines to be traversed without the Autocollimator being moved, thereby saving setting up time.

## ADJUSTABLE BASE

Code 112/2316

This accessory has a 200mm (8in) range of adjustment and can be set to the appropriate step interval length for flatness and straightness measurement.

It provides a base for the Autocollimator reflector, with self aligning seating pads adjustable to a graduated scale. This base can also be used for mounting a Talyvel level unit.



Reflector mounted on adjustable base with side feet, for two axis straightness measurement

## SIDE FEET

Code 137/1947

For use with the Adjustable Base when measuring in two axes.

## POLYGONS

Code 142/35 : 12 sided glass,  
nominal face angle 30°

The angle between the 0° datum face and any other face is within 5 seconds of the nominal values. A calibration chart is provided with each polygon, giving the actual angles to 0.1 second of arc to an accuracy of determination of 1 second.

Other polygons up to 72 sides and in steel or chrome carbide can be supplied to special order.



## ANGLE GAUGES (Set of 8)

Code 142/32

Gauge Angles : 90°/60°/30°, 14°, 9°, 3°, 1°,  
30 min, 15 min, 5 min  
Accuracy of Angle: ±2 seconds  
Face Length: 50mm  
Face Width: 13mm  
Working faces flat to within:  
0.13µm (5µin)

These gauges can be wrung together additively or subtractively to form any angle from 0° to 90° in 5 minute steps as a comparison standard. The faces themselves can be used as a reflector.



## CUBE REFLECTOR

Code 142/25

Can be used as general purpose reflector and for providing a 90° angle standard in three planes, for setting or checking perpendiculars.

Size of Faces: 38mm (1.5in) square  
Polished Faces: Three (two adjacent faces perpendicular to the base and one parallel to the base)  
Accuracy of 90° Angle: ±3 secs  
Weight: 0.43kg (1lb)

Other cubes can be supplied to required specifications to special order. For example, as above but with an accuracy of 90° ±1 sec or with four or five polished faces.

## OPTICAL SQUARE

Code 142/77

Aperture: 38mm (1.5in) 90° angle  
accurate to within ±1 sec

This square comprises a mounted pentagonal prism and is used to deviate the autocollimator beam through 90°. It may be used when checking the straightness of two surfaces which are at right angles to one another or when checking parallelism.

## TA48 SMALL ANGLE GENERATOR

Code 137/1918

Autocollimators require periodic calibration to verify their capability for precise measurement. Users can calibrate their own Autocollimators using the Small Angle Generator. This device is also suitable for testing angle gauges, electronic levels, level vials used in block levels etc.

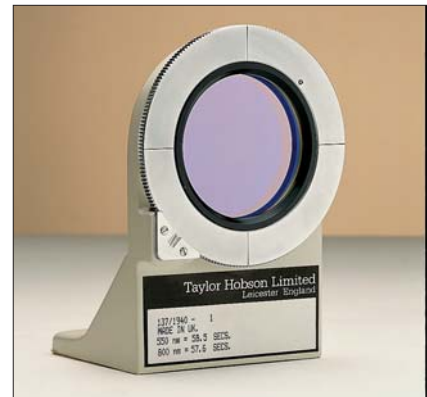
Total Measuring Range: 200 mins of arc  
One Revolution of Micrometer Drum:  
0.635mm (0.025in) moving the Auto-  
collimator beam through 5 minutes of arc  
Drum Graduations: 1 second of arc  
Vernier Readings to: 0.1 second of arc

## FIXED TEST WEDGE

Code 137/1940

The fixed wedge can be used to quickly check the accuracy of any Autocollimator. It introduces a fixed angle of deviation nominally of 60 seconds by rotating the wedge from minimum to maximum deviation and comparing this with the readings on the Autocollimator. A UKAS certificate is optionally available.

Centre Height: 75mm (3in)  
Weight: 1kg (2.25lb)  
Working Diameter: 50mm (2in)



# COMPUTER BACKED AUTOCOLLIMATION ELECTRO-OPTICS SOFTWARE FOR WINDOWS™

## SOFTWARE PROGRAM 112/2337

A full software package is available to support the DA series of Autocollimators. The package includes flatness measurement (Union Jack or Moody) straightness measurement (including twist and squareness) and the polygon angular indexing program. All programs benefit from the ability to interface to Talyvel 3 and 4 levels and the DA series autocollimators. Statistical filtering and edit facilities add to user confidence and flexibility of approach (Grid pattern flatness is also applicable to Talyvel systems).

## FLATNESS PROGRAM

The rectangle and diagonal (Union Jack or Moody) method for flatness measurement offers simple, interactive, menu driven software which displays or prints out an initial diagram of the surface to be measured, together with surface generator lines and instructions on the method of entering surface data. Multiple measuring steps can be taken along each generator line.

After the selected number of measuring steps have been entered, the program calculates and displays the shape of each generator line and the flatness of the surface.

During measurement, readings can be automatically entered into the computer, using the remote data entry lead. This is particularly useful when measuring large surfaces. Alternatively readings can be entered manually via the computer keyboard, as would be necessary when using a Visual Autocollimator.

Values are displayed/printed out initially as arc seconds and then converted to micrometers or millionths of an inch units ( $\mu\text{m}$  or 0.00001in units).

Measurement results of flatness are displayed/printed out as an isometric diagram or certificate. In addition, the display/printout gives the maximum deviation from flatness over the entire surface. To comply with international standards a minimum zone calculation is used to generate flatness errors.

## STRAIGHTNESS PROGRAM

The straightness program will permit straightness measurement on components such as machine tool slideways, shafting and rolls.

The methods and procedure for use are similar to those described for flatness measuring.

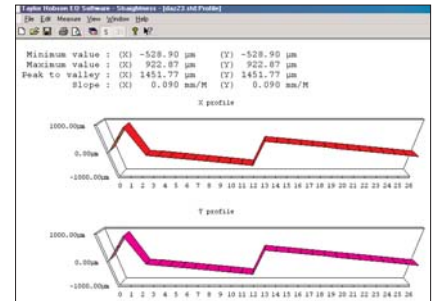
Multiple measurements can be taken for straightness measurement in a single axis or two axes, results being presented in both tabular form and also as a straightness graph. Twist and squareness measurement is also available in this package. Analysis is to LSL or ENDS ZERO, with appropriate graphical representation of results.

## POLYGON PROGRAM

A software package for the calibration of rotary devices and polygons with up to 72 faces allows single or bi-directional calibration of rotary devices, with results in both angular index accuracy and pyramidal error. The operator has a choice of single or multiple runs with the computation of mean values. Measurements can also be performed automatically using various auto-measure functions.

## TWIST PROGRAM

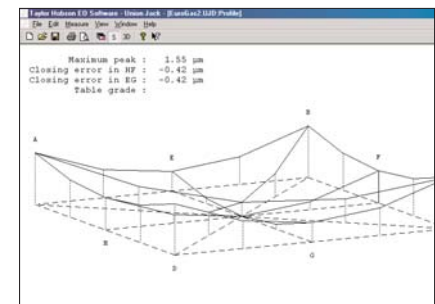
The twist program allows straightness measurements to be carried out on one guideway and then compared to the straightness of a second guideway (for this option a Talyvel levelling system is required-see separate brochure).



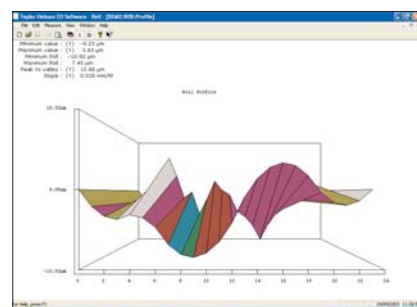
*Straightness measurement*

Station	Angle	Height	Station	Angle	Height	Station	Angle	Height
AR1 (0)	0.00	7.68	RC1 (0)	0.00	7.68	MP1 (0)	0.00	4.85
AR1 (1)	1.00	5.56	RC1 (1)	-9.00	5.56	MP1 (1)	3.00	2.79
AR1 (2)	2.00	4.05	RC1 (2)	-79.00	4.05	MP1 (2)	2.00	3.12
AR1 (3)	3.00	3.14	RC1 (3)	+8.00	3.14	MP1 (3)	3.00	0.30
AR1 (4)	4.00	2.84	RC1 (4)	-9.00	2.84	MP1 (4)	4.00	0.00
AR1 (5)	5.00	3.14	RC1 (5)	+8.00	3.14	MP1 (5)	3.00	0.30
AR1 (6)	6.00	4.05	RC1 (6)	-9.00	4.05	MP1 (6)	4.00	0.00
AR1 (7)	7.00	5.56	RC1 (7)	-9.00	5.56	MP1 (7)	3.00	2.79
AR1 (8)	8.00	7.68	RC1 (8)	-9.00	7.68	MP1 (8)	3.00	4.85

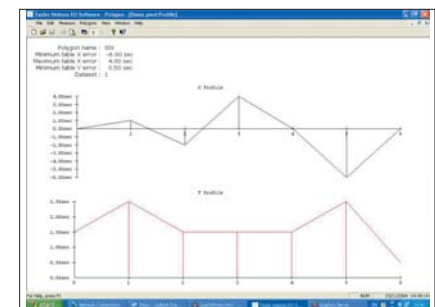
*Union Jack results*



*Union Jack plot*



*Twist measurement*



*Polygon measurement*

# THE AUTOCOLLIMATOR RANGE

TECHNICAL DATA						
TYPE CODE		TA60 142/10	VA900 112/2208	TA51 142/13	DA20 137/1939	DA400 142/78
Accuracy over 1 min of arc ++	sec	6	1	0.5	0.1+++	0.2+++
Accuracy over total range	sec	30	1	2	0.2	4
Range of measurement	min	60x60	-	10		
	sec	-	± 900 (±1500ext)	-	±20	±400
Range in eyepiece	sec	10,800	2,800	1,140	1,800	12,600
Direct reading to	sec	60	0.5	0.2	0.01	0.1
Working distance* for full measuring range	m	0.5	1	9	5	5
	ft	1.5	3	30	15	15
Maximum working distance	m	3	5	20	10	20
	ft	9	15	60	30	60
Readout means		Graticule	Micrometer & Graticule	Micrometer	Digital Display	Digital Display
Measurement axes		2	2	2	2	2
Light source for measurement **		6V 2 Watts Lamp	6V 2 Watts Lamp	6V 2 Watts Lamp	Infra-red LED	Infra-red LED
Light source for viewing		-	-	-	Yellow LED	Yellow LED
Barrel diameter approx	mm	25	38	57	57	57
	in	1	1.5	2.25	2.25	2.25
Approximate overall length	mm	150+	330	420	490	245
	in	6.2	13	16.5	19.5	10
Approximate weight	kg	0.5	1.7	4.8	5	2
	lb	1.1	3.8	10.5	11	4.4
Computer interface		No	No	No	RS232 analogue	RS232 analogue
Mains supply		90-26V with selector 50-60 Hz			90-260 V with selector for 100, 120, 200, 240 V 48-63 Hz	

\* Longer distances may be possible at proportionally reduced range

+ Straight through viewing. For right angle viewing length is 200mm (8in)

++ For the DA instruments the accuracy is over a central range of 20 seconds for DA400 and 10 seconds for DA20.

+++ Note: the best accuracy that can be certified and traceable to international standards is 0.2 seconds.

NB : All autocollimators are affected by the condition of the air path between the instrument and the reflector. To obtain maximum accuracy, this must be as short as possible and may need to be shielded from draughts and convection currents.

## UKAS CERTIFICATE

Autocollimators and certain accessories can be supplied with a National Accreditation of Measurement and Sampling (UKAS) certificate which gives an independent and authoritative traceable guarantee of instrument performance and accuracy. Regular service and UKAS calibration will guarantee that the performance specification is traceable to International Standards.

