ALIGNMENT SYSTEMS

FOR CHECKING AND SETTING STRAIGHTNESS, ALIGNMENT, VERTICALITY, PARALLELISM, SQUARENESS AND LEVEL
SOLVING PROBLEMS OF ALIGNMENT

The Micro Alignment Telescope

Since the late 1930’s Taylor Hobson has sold thousands of Alignment Telescopes to industries throughout the world. The Micro Alignment Telescope is used to set and check alignment, squareness, straightness, flatness, parallelism, verticality and level. With its wide range of accessories the Micro Alignment Telescope forms a unique and comprehensive system for solving alignment problems in a wide variety of applications. The Micro Alignment Telescope system:

- Is simple and easy to use
- Is versatile and adaptable
- Enables improved product performance
- Enables reliable, accurate installation
- Reduces warranty and maintenance costs
- Is robust and reliable
- Is portable

The Micro-Alignment Telescope has:

- Optical and Mechanical axes aligned to within 3 seconds and concentric within 6µm (0.00025in)
- Achievable accuracy within 0.05mm at 30m (0.002in at 100ft)
- Field of view: 50mm at 2m (2in at 6.5ft) 600mm at 30m (24in at 100ft)
**PRINCIPLES OF ALIGNMENT**

The basic measurement principles available with the Micro Alignment Telescope System are Alignment, Squareness, Flatness, Autocollimation and Autoreflection. The Micro Alignment Telescope generates a straight line of sight from zero to infinity. This forms the basic reference from which all measurements are taken.

To measure squareness a penta prism is used to deviate the straight line through exactly 90 degrees. A similar rotating penta prism is used to generate a plane for flatness measurement.

The Telescope is designed to allow Autocollimation and Autoreflection, providing for squareness and angular measurement using reflective Mirror Targets.

There is a comprehensive range of accessories enabling the Telescope, Targets and Prisms to be mounted to the work concerned.

**Principle 1 - Alignment**

**Principle 2 - Squareness**
 Typical applications for which the Micro Alignment Telescope is being successfully used are:

- Bore alignment checks
- Machine tool straightness and alignment checks
- Turbine installation and maintenance
- Flatness checking and setting of bed plates
- Shipbuilding repair and maintenance
- Weapon systems alignment and harmonisation
- Alignment of rollers of process machinery
- Aircraft jig setting and control
- Tool alignment of large boring machines
- Compressor installation and maintenance
- Main bearing alignment of large engines
- Railway equipment assembly and set-up
- Earthmoving machinery and general equipment alignment
- Portable machining system set-up and monitoring.

* A Talyvel Electronic Level can be used in place of a Stride Level if greater accuracy is required.
SOME TYPICAL APPLICATION AREAS

- Aircraft assembly jigs
- Satellite testing
- Steam and gas turbines
- Marine propulsion machinery
- Printing presses
- Air compressors
- Cranes
- Diesel engines
- Nuclear reactors
- Coal conveyors
- Shipbuilding and repair (Civil and Military vessels)
- Rolling mills (steel, paper, sugar etc.)
- Rod and wire mills
- Extruder barrels
- Civil engineering projects

Aligning diesel engine bearings using CCTV and Micro Alignment Telescope

Squareness with plumblines. (Using principle 2)

Alignment - removing twist (Using principle 1)

Micro Alignment Telescope (112/2582),
4-in Offset Square (112/1130), Unimount
(137/1916), Trivet Stands (137/1904 or 1905).

Mounting Sphere (112/376),
Sphere Clamp (112/657),
Flange Cup (112/471), Target.

Micro Alignment Telescope (112/2582),
Horizontal Base (112/656),
Adjusting Bracket (112/645),
Flange Cup (112/471),
Mounting Sphere (112/376),
Talyvel 4 (S112/2584),
Stride Base (112/2315).
HOW TO SELECT THE RIGHT MICRO ALIGNMENT TELESCOPE

MICRO ALIGNMENT TELESCOPE
(Code 112/2582 Metric, 112/2583 British)

The Micro Alignment Telescope focuses from zero to infinity and incorporates an optical micrometer to measure deviations from an optical line of sight in two directions at right angles to each other.

Specification:

<table>
<thead>
<tr>
<th>Micrometer range:</th>
<th>± 1.2mm (+0.05in) with 0.02mm (0.001in) graduations</th>
</tr>
</thead>
<tbody>
<tr>
<td>Barrel diameter:</td>
<td>57.137-57.147mm (2.2495-2.2499in)</td>
</tr>
<tr>
<td>Optical axis:</td>
<td>Parallel to mechanical axis within 3 arc seconds and concentric within 6µm (0.00025in)</td>
</tr>
<tr>
<td>Field of view:</td>
<td>From 50mm (2in) at 2m (65ft) to 600mm (24in) at 30m (100ft)</td>
</tr>
<tr>
<td>Magnification:</td>
<td>X34</td>
</tr>
<tr>
<td>Image:</td>
<td>Erect</td>
</tr>
<tr>
<td>Accuracy:</td>
<td>Within 0.05mm (0.002in) at 30m (100ft) and proportionally for longer or shorter distances down to about 3m (10ft). Below this distance the errors are less than the precision to which the micrometers can be read.</td>
</tr>
</tbody>
</table>

ALIGMENT TELESCOPE
(Code 112/850)

Similar to 112/2582 but without micrometer measuring system.
COPE SYSTEM

Select your alignment kit from these accessory items:
To use the Micro Alignment Telescope you will need to select from a range of accessories. Should you need any advice on the precise accessories and components necessary, contact Spectrum Metrology or your local Taylor Hobson outlet.

Application Reports
Many applications which have utilised the Taylor Hobson range of Micro Alignment Telescopes are the subject of application reports – contact Spectrum Metrology or your local Taylor Hobson outlet for further details.
DIGITAL CCD SYSTEM
(connects to any of the Alignment Telescopes)
(Code 137/2160-01)

Available as a complete system when ordered with a Telescope, or an accessory upgrade for existing Micro Alignment Telescopes in the field.

- Clear digital output of X and Y minimises operator error
- Graphical output for professional reporting of results and storage of measurements.
- Repeatability of measurement provided by CCD
- Rapid calculation of results for quick and easy assessment of measurement.
- Ideal for automatic remote monitoring with measurement time interval input from operator.
- Typical accuracies: 5µm over 3m proportionally increasing with distance, ie 50µm over 30m

A new high resolution CCD system with software automatically senses the centre position of the targets then calculates the displacement from a set datum to ensure a fast set up time with repeatable readings, as well as digitally outputting the result. This is particularly useful on large alignment projects such as aircraft jigs or large machine tools since a single operator can make measurements and adjustments along the construction or fixture while the target is displayed on the monitor.

Target readings are recorded along the component and can then be output as a graph/results table or saved for further analysis. Analysis of the results can give advice on the required precise adjustment of the component under construction to bring it in line quickly. Distance measurements can also be made to an accuracy of a few millimetres. The system can be connected to PC, laptop or a tablet PC.

**Specification:**

<table>
<thead>
<tr>
<th>Specification</th>
<th>Details</th>
</tr>
</thead>
<tbody>
<tr>
<td>Operating range:</td>
<td>between 1m and 30m (less than 1m and greater than 30m available on request)</td>
</tr>
<tr>
<td>Repetition:</td>
<td>better than 2µm</td>
</tr>
<tr>
<td>Accuracy:</td>
<td>Displacement using one target better than 2% of displacement or 5µm, whichever is the greater. Displacement using two targets better than 4% of displacement or 10µm, whichever is the greater.</td>
</tr>
<tr>
<td>Typical accuracies:</td>
<td>5µm over 3m and proportionally increasing with distance, ie 50µm over 30m</td>
</tr>
<tr>
<td>Distance measurement accuracy:</td>
<td>20mm from 0 to 10m, 25mm from 10 to 20m, 30mm from 20 to 30m</td>
</tr>
<tr>
<td>Targets:</td>
<td>Standard, short, long range and virtual (see through) targets available</td>
</tr>
</tbody>
</table>

* Windows is a registered trademark of Microsoft Corporation
MICRO ALIGNMENT TELESCOPE ACCESSORIES

CCTV Camera
(Code 137/2161-01)
- Minimises eye fatigue
- Eliminates parallax
- Easier/more practical setting and adjustment of work by viewing from a monitor
- More comfortable viewing position of awkward measurement locations through the monitor
- High magnification lens available to improve setting resolution

A miniature CCTV camera can be fitted to the telescope eyepiece to remotely view the target when working for example in difficult locations. By viewing the target image on the monitor, parallax problems are eliminated and set-up made quicker, allowing the operator to adjust the machine tool, targets or fixtures that require setting, without having to return to the Telescope each time or rely on a second operator for directions. It also allows a number of operators to observe the target image at the same time, or alternatively one operator can view a series of Telescopes.

Right-Angle Eyepiece Adaptor
(Code 112/568)
Enables the Telescope to be viewed at right angles to the line of sight. Especially useful where space is cramped or the sighting position inconvenient.

Customised cases
Customised cases are available. These are padded and reinforced to absorb shocks. The case contains compartments to accommodate the Telescope and its accessories.

MOUNTING THE TELESCOPE

Adjusting Bracket
(Code 112/645)
Provides a fine azimuth and elevation adjustment for sighting the Telescope, used with a Horizontal Base or Bore Fixture.

Horizontal Base
(Code 112/656)
Used for mounting the Adjusting Bracket onto either the Plain, Flange or Adjustable Cup. When used on flat surfaces (plain cup), two fence pins provide a sideways location.

Plain Cup
(Code 112/472)
Locates the Mounting Sphere on the Horizontal Base with its centre 76mm (3in) from the base of the Cup.

Flange Cup
(Code 112/471)
Locates the Mounting Sphere on the Horizontal Base with its centre 110mm (4.33in) from the base of the Cup.

Adjustable Height Cup
(Code 112/849)
Similar to code 112/471, but adjustable to height 110mm +/-5mm (4.33in +/-0.188in).

Left to right: Flange Cup, Plain Cup, Adjustable Height Cup
**Mounting Sphere**
(Code 112/376)
The Mounting Sphere accepts either the Telescope or Target. Used on the Telescope it serves to provide a pivot when sighting the Telescope. The line of sight always passes through the Sphere centre. A Collet Clamp key (code 116/27) serves any number of spheres. A shoulder ring (code 112/465) positions the pattern side of the Target at the centre of the sphere and is threaded to take the Target Illuminator (code 112/642).

**Bore Fixture**
(Code 112/1168)
Used in conjunction with the Adjusting Bracket and Mounting Sphere to mount the Telescope in bores. The mounting diameter of 120.625-120.637mm (4.7490-4.7495in) is concentric with the Sphere.

**Trivet Stands**
(Code 137/1904 & 1905)
Used to mount the Telescope remotely from the work. Trivet stands are either 185mm (7.3in) or 85mm (3.3in) high and provide an extremely rigid mounting up to approximately 2 metres (78in) high. A battery operated version is also available.

**Unimount**
(Code 137/1916)
This lightweight universal mounting system is used when using the Telescope remotely from the component to be measured. It is normally mounted on Trivet Stands to the required height and provides all the facilities for moving the Telescope through +/-2.5° elevation, +/-2° fine (360° coarse) azimuth, 100mm (3.9in) vertical, 76mm (3in) horizontal and 40mm (1.6in) sideways.

**Sphere Clamp**
(Code 112/657)
Retains the sphere onto its Mounting Cup when the Sphere is used to hold a Target.

**Target Illuminator**
(Power Supply included)
(Code 112/642)
With a diffusing screen and colour filter, this accessory provides glare-free background illumination for ideal viewing of the Target pattern. The illuminator fits the sphere, shoulder ring, adjustable target holder and spider fixture. A battery operated version is also available.

**Adjustable Target Holder**
(Code 112/837)
Normal height from base to centre of target 76mm (3in) and a range of vertical and horizontal adjustment of approximately +/-3mm (0.125in). It has magnetic feet, can be located against fence pins and incorporates vertical and horizontal adjustment screws. Takes 2.25in targets and is threaded to accept the target illuminator.

**Spider Fixture**
(Code 137/1943)
Enables a target to be positioned in the centre of bores from 200mm to 1m (8-40in). Larger diameter fittings to special request. Target centring is shown by a rotating dial indicator. The spider fixture is threaded to take the illuminator. Uses 1.5in targets.
### SETTING A HORIZONTAL LINE

**Talyvel 4 Electronic Level**  
(Code M112/2584-01)  
**with Stride Base**  
(Code 112/2315)

By means of the stride base, Talyvel is mounted on the Telescope barrel for setting horizontal lines of sight.

Talyvel is a pendulum type, Electronic Level, which provides a digital reading in angular measure or gradient. Typical accuracy setting is 0.2 arc second; ie 1µm per metre.

For further details please refer to our Talyvel brochure.

### Stride Level  
(Code 112/2315 & 112/2318)

Used for establishing horizontal lines of sight, this is a precision bubble level that is mounted directly on the Telescope barrel. Accuracies of 5 seconds are obtainable.

Other types of level are available on request, including methods to set truly vertical.

### OPTICAL SQUARES

These are used to deviate the Telescope’s line of sight precisely 90° within 1 arc second; ie 5µm per metre.

The 4in offset square is mounted on the barrel of the Telescope. Rotated with the Telescope, it is used to sweep out planes perpendicular to the Telescope reference line of sight.

**4in Offset Square**  
(Code 112/1130)

Has its 90° line of sight 4in (102mm) forward of its mounting sphere and is used to sweep the full 360°. It has a through sighting facility, enabling the reference target to be viewed at all times.

### Optical Square  
(Code 142/77)

This optical square enables a 90° line of sight to be set up vertically or horizontally from the Telescope.

The height of the sighting aperture is normally 76mm (3in) corresponding to the Plain Cup mounting height for the Telescope.

Other accessories and types of squares are available on request such as devices for sweeping a plane.

### AUTOREFLECTION AND AUTOCOLLIMATION

When fitted with a lamphouse, the Micro Alignment Telescope can be used for setting or checking squareness, and measuring small gradients of tilt, by autoreflection or autocollimation.

**Telescope Lamphouse (power supply included)**  
(Code 112/1365)

Inserted into the Telescope to illuminate the integral cover glass target, it has a partially reflecting mirror that does not obscure the line of sight.

**Adjustable Mirror Target Holder**  
(Code 112/729)

For mounting a Mirror Target on the end of a rotating spindle or shaft. The two adjusting screws enable the mirror target to be tilted so that the spindle axis can be aligned with the Telescope line of sight, using Autoreflection. Has a 95.25mm (3.75in) diameter locating spigot concentric with the Target pattern.

**Squaring-On Reflector**  
(Code 112/722)

Assists in preliminary lining up of the workpiece when the Autoreflection image is initially outside the Telescope field of view. Two images are seen through the viewing aperture and these converge as the workpiece is brought square to the line of sight.
TARGETS

The targets listed below are available for various applications. Alignment targets parallel to within 20 arc seconds are normally used, but targets having a parallelism within 2 arc seconds are available as intermediate targets for through sighting, minimising possible refraction errors.

Mirror targets are used when both alignment and squareness are checked concurrently using autoreflection or autocollimation. Other targets are available on request.

<table>
<thead>
<tr>
<th>Nominal Diameter</th>
<th>Type</th>
<th>Pattern</th>
<th>Parallelism</th>
<th>Use</th>
<th>Code</th>
</tr>
</thead>
<tbody>
<tr>
<td>2.25in (57mm)</td>
<td>target</td>
<td>standard circular</td>
<td>20 sec</td>
<td>general</td>
<td>112/1053</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>112/1059</td>
</tr>
<tr>
<td>2.25in (57mm)</td>
<td>target</td>
<td>standard circular</td>
<td>2 sec</td>
<td>intermediate target</td>
<td>112/1052</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>112/1058</td>
</tr>
<tr>
<td>1.5in (38mm)</td>
<td>target</td>
<td>standard circular</td>
<td>20 sec</td>
<td>general</td>
<td>112/1051</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>112/1057</td>
</tr>
<tr>
<td>1.5in (38mm)</td>
<td>target</td>
<td>standard circular</td>
<td>2 sec</td>
<td>intermediate target</td>
<td>112/1050</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>112/1056</td>
</tr>
<tr>
<td>2.25in (57mm)</td>
<td>long</td>
<td>long distance circular</td>
<td>20 sec</td>
<td>25-75m (80ft-250ft)</td>
<td>112/856</td>
</tr>
<tr>
<td>2.25in (57mm)</td>
<td>mirror</td>
<td>standard circular</td>
<td>2 sec</td>
<td>back face location</td>
<td>112/1054</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>112/1060</td>
</tr>
</tbody>
</table>

1.5in target Diameter: 38.075-38.087mm (1.4990-1.4995in)
Thickness: 9.27-9.78mm (0.365-0.385in)
2.25in target Diameter: 57.132-57.148mm (2.2493-2.2498in)
Thickness: 12.45-12.95mm (0.490-0.510in)
Pattern concentric with outside circumference of target:-
Long distance targets: within 0.0127mm (0.0005in). All other targets: within 0.0064mm (0.00025in)
Special targets are available on request.

TRAINING AND CALIBRATION

Optical Alignment Handbook (Code 303-60)

A comprehensive manual covering all the Taylor Hobson Micro Alignment Telescope mechanical equipment. It combines a complete technical description of the Telescope and its accessories, with detailed operating instructions. The theory of Optical Alignment is discussed in detail, making the book a valuable reference work on the subject.

Training

Detailed training courses are available either on-site or at Spectrum Metrology’s facility in Leicester, UK. Price on application.

Telescope Calibration Equipment

Intended for users who wish to carry out their own calibration check on their Telescopes, including variable focus collimator (code 137/583), rotating Test Wedge (code 137/829) and Micro Alignment Telescope bench (code 137/1917).

Parallelism of the Telescope line of sight with respect to the barrel of the Telescope is checked by sighting into the Variable Focus Collimator and revolving the Telescope through 180°.

The variable focus of the collimator simulates all focal distances, enabling the straightness of the Telescope line of sight to be checked. The graduated scale target on the front of the collimator is used for checking concentricity of the Telescope line of sight to its barrel, and also linearity of the Telescope micrometers. The test wedge is used to measure the angle of parallelism.

In addition to the range of standard accessories shown in this brochure, equipment can be designed or manufactured to special order to meet specific applications, for example to set the Micro Alignment Telescope truly vertical.

Contact our technical support agent, Spectrum Metrology, or your local Taylor Hobson outlet for details.

UKAS Certification

Micro Alignment Telescopes can be supplied with a United Kingdom Accreditation Service (UKAS) certificate which gives an independent and authoritative traceable guarantee of instrument performance and accuracy. Regular servicing and UKAS calibration will guarantee that the performance specification is maintained.
MICRO ALIGNMENT LASER ALIGNMENT SYSTEM

Available to enhance the Taylor Hobson electro optical metrology range, the laser alignment system offers versatility and high accuracy to increase the range of applications offered by both the Micro Alignment Telescope and autocollimator ranges offered by Taylor Hobson.

- Ideal for dynamic measurement
- Simple and compact design
- Easy, icon-driven software
- Digital output with clear graphical output and report writing facilities
- Battery operated

Micro Alignment Laser is a laser measuring instrument equipped with the latest optical and electronic components for precise measuring of straightness, flatness, parallelism, perpendicularity, alignment and much more. It comprises a highly stable laser transmitter with integrated micro-adjustment for fine alignment of the laser beam, a high-precision position sensitive device (PSD) receiver with a complete electronic processing system and software for use on a laptop, notebook or desktop PC. The software provides users with comprehensive support for extensive geometrical measuring including recording of data in reports.

Typical applications include:
- Dynamic checking of assembled machine slideways for straightness and squareness
- Parallelism measurements and adjustment of tracks and guides
- Monitoring of movement, deformation and deflection of structures

The Micro Alignment Laser system comprises the following components:

**Laser Transmitter:** a highly stable semi-conductor laser which incorporates a sophisticated adjustment technique for fast setup.

**Laser Receiver:** highly precise optoelectronic position recognition. State of the art technology ensures optimal processing of measuring signals, eliminating external disturbances such as oscillation of buildings, etc.

**IR-Remote Control:** can be used almost anywhere to trigger operations such as individual measurements, adjustments or determining measuring point.

**Software:** data can be transferred to PC using either fiber optics or radio signals to an RS232 serial interface. This user-friendly software allows real-time measurements in graphical or numeric form.

**Cableless radio link:** included as standard with the system.

A wide range of accessories is available to suit individual applications.

### SPECIFICATION

#### Transmitter

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Specification</th>
</tr>
</thead>
<tbody>
<tr>
<td>Laser Power</td>
<td>≤1 mW</td>
</tr>
<tr>
<td>Laser Class</td>
<td>2</td>
</tr>
<tr>
<td>Laser Wave Length</td>
<td>630-670nm (red)</td>
</tr>
<tr>
<td>Power Supply</td>
<td>Li-Ion battery 7.2V</td>
</tr>
<tr>
<td>Dimensions (LxRxH)</td>
<td>137x50x50mm</td>
</tr>
<tr>
<td>Weight</td>
<td>0.73kg inc battery</td>
</tr>
</tbody>
</table>

#### Receiver

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Specification</th>
</tr>
</thead>
<tbody>
<tr>
<td>Measuring Range (X/Y)</td>
<td>5x5mm*</td>
</tr>
<tr>
<td>Measuring Resolution</td>
<td>0.1µm</td>
</tr>
<tr>
<td>Linearity y1 y2</td>
<td>0.4%</td>
</tr>
<tr>
<td>Reproducibility y1 y2</td>
<td>±0.25µm</td>
</tr>
<tr>
<td>Power supply</td>
<td>7.2V</td>
</tr>
<tr>
<td>Dimensions (LxRxH)</td>
<td>156x50x50mm</td>
</tr>
<tr>
<td>Weight</td>
<td>0.63kg inc battery</td>
</tr>
</tbody>
</table>

* wider measuring range option available on request

#### System

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Specification</th>
</tr>
</thead>
<tbody>
<tr>
<td>Measuring Distance</td>
<td>0.1-10m (longer distances may be available on request</td>
</tr>
<tr>
<td>Temperature Range</td>
<td>10-35°C</td>
</tr>
<tr>
<td>Case (LxRxH)</td>
<td>460x350x110mm</td>
</tr>
<tr>
<td>Weight of Case &amp; Contents</td>
<td>4.0kg</td>
</tr>
</tbody>
</table>

#### Processing

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Specification</th>
</tr>
</thead>
<tbody>
<tr>
<td>Software</td>
<td>Straightness, parallelism, rectangularity, alignment (Windows 95/98/XP/2000/NT4.0)</td>
</tr>
</tbody>
</table>

1) Data measured at 20°C
2) Within 80% of range
3) With li-ion battery or mains adapter
4) depend on environmental conditions
ELECTRO OPTICAL METROLOGY

Taylor Hobson has been selling electro-optical metrology products since the late 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 metrology 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.

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Micro Alignment Telescope 1E SM 11/02