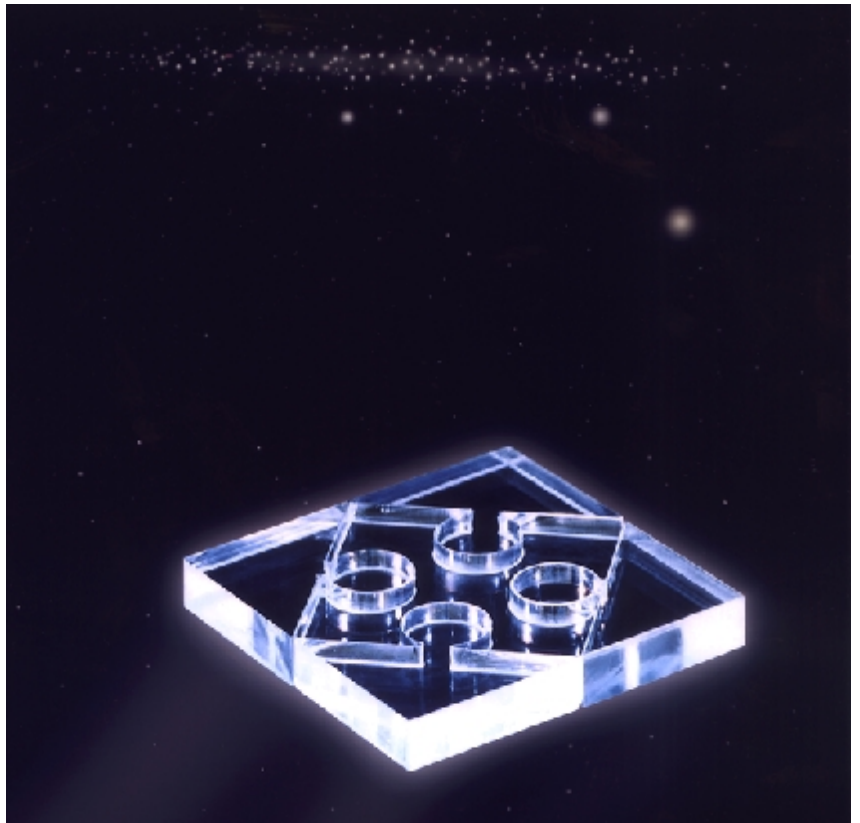# Axyz LTM

Laser Tracker Module

Software Reference Manual

Leica Geosystems AG

Authorship

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Proprietary information

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Contents

1. LTM - the Laser Tracker Module

1.1 About this manual

This is the Software Reference Manual for the *Axyz* Laser Tracker Module (LTM).

The LTM only operates from within the *Axyz* Core Data Module (CDM), which must therefore be installed. The operation of the Core Data Module is explained in the following document

- *Axyz* Core Data Module: Software Reference

The current manual explains in detail how to operate the software interface to the LTM. The manual assumes the reader has an understanding of the measurement task and basic system concepts.

The following documents provide background information:

- *Axyz* "System Concepts" explains the general purpose and structure of the software.
- *Axyz* "Mathematics for Users" provides details of all relevant mathematical techniques.
- MS Visual Basic documentation explains the use of this programming language, except for functions and options specially created for *Axyz*.

1.1.1 CAD users

The *Axyz* system offers an optional graphics module for graphically visualizing measurements and comparing them against imported CAD models.

This module has two configurations:

- *Axyz* View for simple data visualization
- *Axyz* CAD for visualizing data and manipulating CAD models

See "*Axyz* Graphics Module: Software Reference Manual" for more details.

Some features of the Laser Tracker Module only function if *Axyz* CAD is installed. Functions specific to *Axyz* CAD will be indicated by the following label:

CAD only

1.1.2 Remote operation

The LTM is designed to operable from a remote hand-held computer via wireless communication. This does not offer access to all functions and options but enables users to carry out a range of measurement tasks at the measured object. Although the necessary software is part of the LTM package, the hand-held computer and communications hardware must be separately purchased.

1.1.3 Document conventions

The following text formatting conventions are in use:

This	Represents
italic	Italic type is used to indicate new or specialist names and terms. Look for a glossary definition or special section for more details.
ALL CAPITALS	The names of computers, folder names, filenames and acronyms.

1.1.4 Keyboard and menu conventions

Key combinations and key sequences have the following meanings:

Format	Meaning
KEY1+KEY2	A plus sign (+) between key names means to press and hold down the first key while you press the second key.
KEY1, KEY2	A comma (,) between key names means to press and release the keys one after the other.
ENTER or RETURN	The key equivalent to "carriage return" on a typewriter and which causes a new line when typing text. It may be labelled with a bent arrow.
SHIFT, Shift	The key which produces capital letters. It may be labelled with an upward pointing arrow.
CTRL, Ctrl, ALT, Alt	The "control" and "alternate" keys, generally labelled as "CTRL" and "ALT" on your keyboard.

1.1.5 Windows conventions

It is assumed that the user is familiar with the Microsoft WINDOWS™ environment. See MS Windows documentation for use of a mouse, windows features and shortcut keys.

In particular, the following standard buttons will not be further described but enable the user to respond to requested inputs.

OK
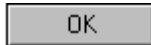
Proceed with actions defined by the settings in the current dialogue box

Cancel
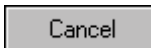
Ignore any changes made in the current dialogue box. Return to the situation which existed before the current box was accessed.

Browse...
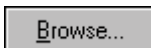
Search folders on disk for the requested information.
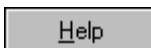
Help

Provide context-sensitive HELP.

1.1.6 On-line HELP

The on-line HELP is derived from this Software Reference Manual using Doc-To-Help ™. HELP and the manual each contain essentially the same information with the exception of menu screens. All menu screens are displayed in the manual. Most menu screens are not displayed in HELP because the screen can be viewed in the actual program when using HELP. However HELP does contain some example screens in order to properly explain the operation of particular features.

1.2 Starting up

The LTM is reached from within the **Axyz** core module (CDM).

Start the **Axyz** CDM by clicking on the **Axyz** icon in the program group or on your desktop.

Then start the LTM by clicking the tracker button on the main toolbar.

2. LTM graphical interface

2.1 Main screen
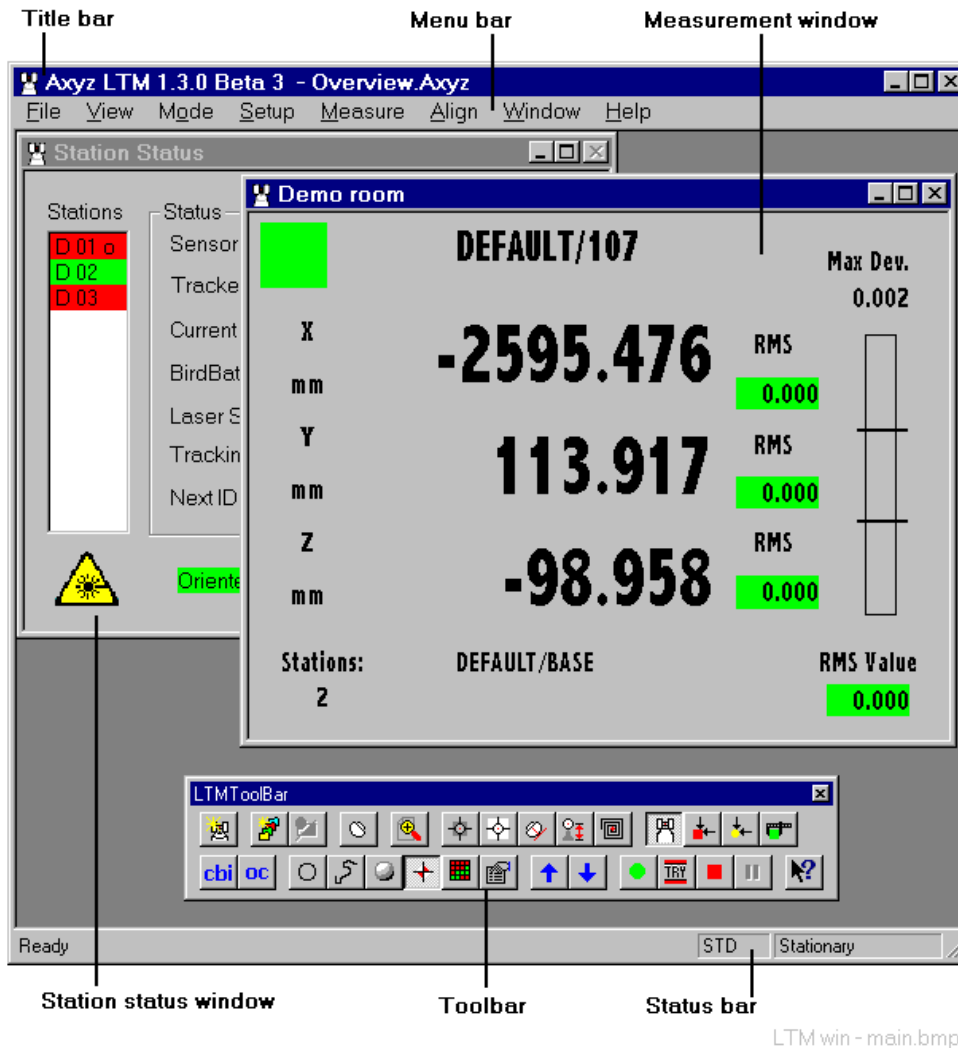
The sample display screen may look different from your own display. It shows the status bar and LTM toolbar, which may be docked or positioned elsewhere on the screen. Simply click on the toolbar's background and drag to a new location. You may have chosen not to display either. This option is available in the View Menu.

Within the display area two further windows are shown. The Station Status window is always present, even if minimized. One or more measurement windows may be open, as in the example.

Data Manager and graphics windows can be opened, and have their own toolbars, but these are not shown in the sample display.

2.2 Summary of toolbar buttons

2.2.1 Configuration buttons

◌	Select a reflector or define its Bird Bath location
🖳	Create a new measurement window. (Multiple windows.)
🗂	Open a new Data Manager window. (Multiple windows.)
📊	Open the graphics window. (Only one window possible.)
🔍	Toggle full/reduced (normal/zoomed) measurement window data
▶?	Provide context sensitive help about selected options

LTM Toolbar - config.bmp

2.2.2 Mode buttons

🖳	Standard mode for single points, continuous and scanned data
↓←	Build (and inspect) mode for single points
↓←	Build (and inspect) mode for standard *Axyz* shapes
🖳	Auto inspect mode to check a sequence of fixed points
cbi	Build/Inspect mode for building to or inspecting a CAD surface
oc	On-line compare mode for checking a surface against CAD

LTM Toolbar - mode.bmp

2.2.3 Recording buttons

●	Start measuring, display and store results
TRY	Start measuring, display only
■	Stop measuring
II	Pause measuring (Auto Inspect only)

LTM Toolbar - recording.bmp

2.2.4 Measurement buttons

Specify point ID and measurement parameters

Increment point ID or go to next Build point

Decrement point ID or go to previous Build point

Lock onto an existing point and re-set the IFM

Lock onto a reflector in the Bird Bath and re-set the IFM

Enable or disable reflector offset correction

Enable or disable target thickness (offset) correction

Manually find a reflector and lock on

LTM Toolbar - measurement.bmp

2.2.5 Standard measurement methods

Measure a stationary point by direct measurement

Measure a fixed point by the circle centre method

Measure a fixed point by the sphere centre method

Continuous point measurement

Continuous point measurement on a 3D grid of planes

LTM Toolbar - methods.bmp

2.3 Status bar

The left area of the status bar provides brief HELP text for buttons and menu items. Place the cursor over a button or highlight a menu item, in order to see the associated text.

Measurement method, e.g Stationary

| Enter Point ID or Other Parameters for Measurement | STD | Stationary |

Operational mode, e.g. STANDARD (STD)

LTM Status Bar. bmp

2.4 Station Status window

This window is always present and cannot be closed although it may be minimized. It lists all stations in the network and provides status information about any trackers which may occupy these stations.

If any stations are occupied by theodolites or Total Stations, status information is not available.

Some information provided in this window is also provided by the **Tracker status** window. Unlike **Tracker status**, station status cannot be regularly updated or used during the warm-up phase.

2.4.1 Station status information

In the **Stations** list:
- Click on a station to see its status information.
- If multiple trackers connected, double click on a station to make the tracker active.

Status information is not available for stations occupied by theodolites or Total Stations.

Example screen: Station status
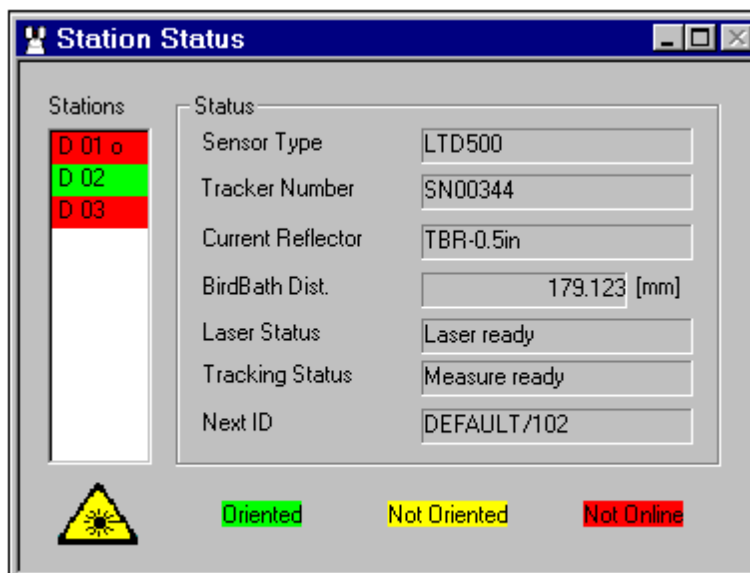
LTM win - Station status.bmp

Stations

A list of all stations in the network. Stations occupied by theodolites and Total Stations will not have any associated data displayed.

Stations are identified by colour-coded station number. Colour coding identifies orientation status. To set colours, see "Tracker Warnings" on page 89. The following labelling is in use:

Oriented (e.g. green background)
This station is oriented and on line.

Not oriented (e.g. red background)
This station is on line but not yet oriented into the network.

Not on line (e.g. yellow background)
This station is not on line, i.e. off line, no longer connected to the network.

"o" suffix
A letter "o" which follows a station displayed as "not on line" indicates that the off-line station is oriented to the network.

"D" prefix
The letter "D" before a station number indicates that it is equipped with an Absolute Distance Meter (ADM) for distance measurement.

Sensor type

Indicates if the tracker is one of the following types:
- LT 500
- LTD 500
- SMART / ADM
- SMART 310

Tracker number

Production serial number of the tracker.

Current reflector

Shows one of the following reflector types in use by the tracker at the highlighted station.
- Cateye
- Corner cube
- TB prism (Tooling ball prism)
- TB corner cube (Tooling ball corner cube) (new, July 97)

Birdbath distance

Distance to the Home Point (also called Birdbath distance). This distance depends on the current reflector.

Laser status

Indicates the laser's operational state which can be one of the following:
- LCP Comm, Failed
  Communication to LCP failed. Implies a broken connection.
- LCP not available
  Typical message if tracker emulation used rather than real instrument
- warm up
  The laser is stabilizing (warming up) and is not yet ready for use
- Laser not ready
  The laser interferometer is not ready for measurement
- Laser ready
  The laser interferometer is ready for measurement
- Laser unable to stablize

Tracking status

This indicates if the reflector is currently being tracked (normal operation) or not. The status can be one of the following:
- Not ready
- Setup not complete
  Some preparations are missing, e.g. tracker not initialized or reflector not specified
- Tracking
  The laser is locked onto the target but the distance is not set
- IFM
  The laser is locked onto the target and a distance is set
- No target
  The laser could measure but a target has not been found

Next ID

This shows the ID of the <u>next</u> point which will be measured at this station.

2.5 Measurement windows: "Traffic lights"

LTM traffic lights.bmp
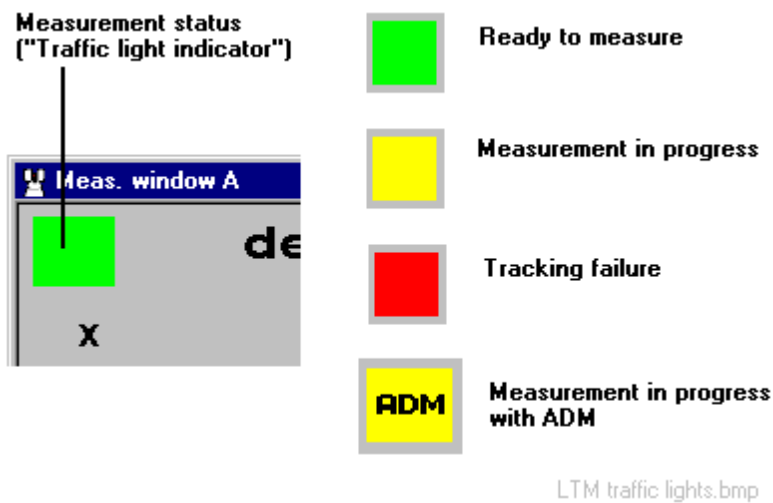
Every measurement window has, in the top left hand corner, an indicator of measurement status resembling a traffic light. The example shows the colour coding, together with the meaning. If the ADM is in use, the letters "ADM" are superimposed on the indicator.

2.5.1 "Big status" display
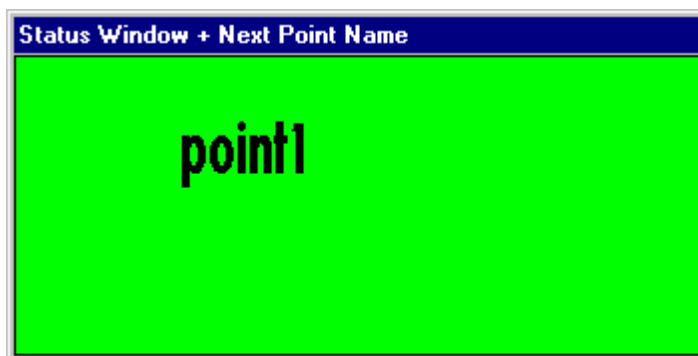
LTM Win - Big status.bmp

If the measurement status indicator is too small for viewing from a distance, another window can be opened to display the "traffic light" colour, together with the name of the next point to be recorded. This window can be re-sized to a more convenient size.

This window can also optionally display the next point name, with or without the workpiece ID. Right click in the window to get a shortcut menu which offers the options.

Big status – shortcut menu on right mouse click

Save Properties
No Display
Show Next Workpiece/ PointId
Show Next PointId
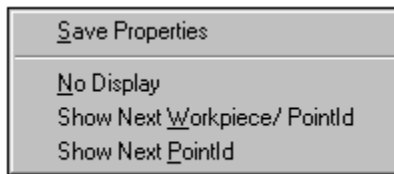
LTM rt click - big status.bmp

Save properties

This saves the current options for the "big" status window.

No display

No point data will be displayed in the window.

Show next workpice/ point ID

The workpiece ID + point ID of the next point to be recorded will be
displayed in the window.

Show next point ID

The point ID only of the next point to be recorded will be displayed in the
window.

2.6 Measurement window: Standard mode

This measurement window shows the 3D coordinates generated for single
static points, for continuously measured points or for grid points as the
reflector moves across defined grid lines. These recording methods are part
of *standard mode*. See "Measure menu" on page 96.

2.6.1 Standard mode: Displayed data and colour-coding

The following items are displayed in a standard measurement window. See
the example screen to locate the items.

To indicate accuracy, several data items use colour-coding according to
defined tolerance levels. To define the colours and warning levels
(tolerance levels), see "Tracker Warnings" on page 89.

It is also possible to zoom in on the coordinates to provide a larger display
for more convenient viewing from a distance. Not all information is then
displayed. Click to toggle between normal and zoomed displays.

Example screen: point data, normal display
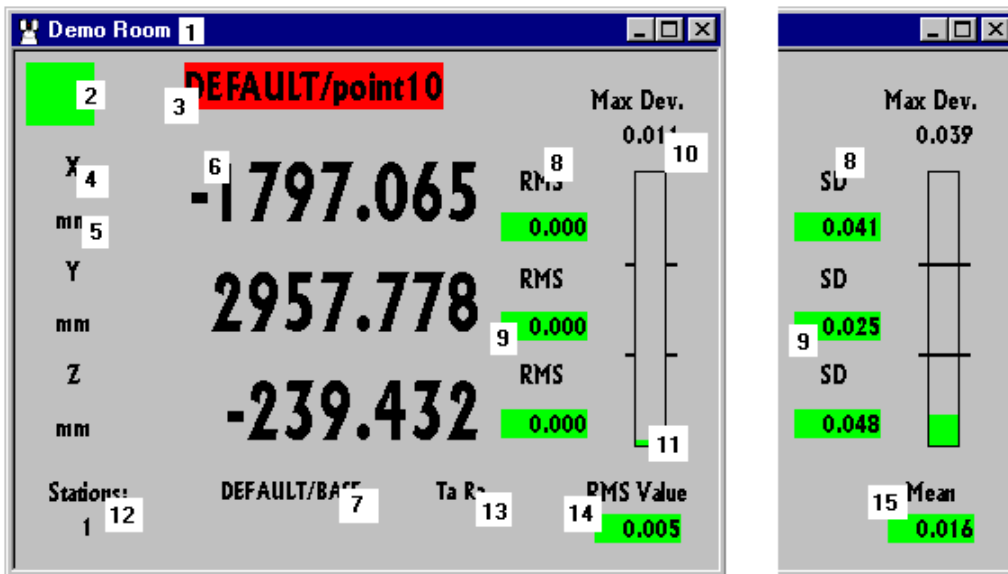
Single fixed point location with RMS display ..   .. and with std. dev. display

LTM win - sgl. pt. full.bmp

Example screen: point data, zoomed display
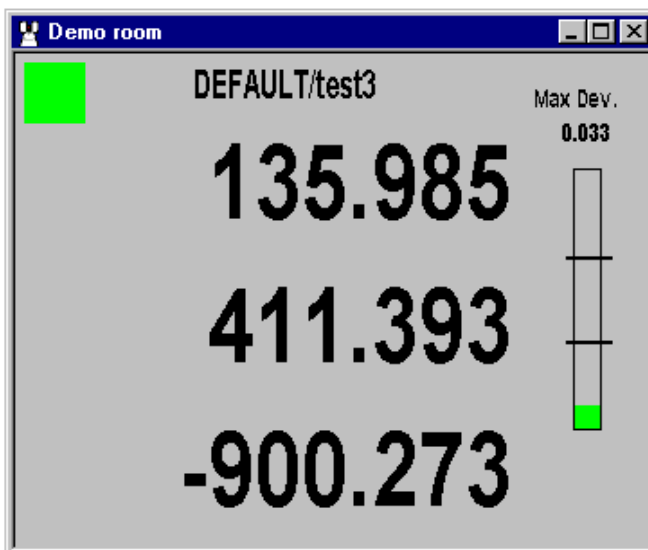
LTM win - sgl. pt. reduced.bmp

Window title (1)

Window title specified when the window is created. See "Measurement window" on page 181.

Status indicator - "Traffic lights" (2)

Measurement status is shown here. See "Measurement windows: "Traffic lights"" on page 10.

Workpiece and target point ID (3)

This is the full identifier for the currently measured point (workpiece ID/ point name).

A red background to the ID means that **Try** measurement is operating. When **REC** or **ALL** are then used to make a measurement, measurement values and 3D coordinates are not stored and the point ID is not incremented.

Coordinate (axis) labels (4)

The current labels in use for the currently active coordinate type are displayed here.

Labels can be changed in the Core Module. See **CDM Settings menu / Axis labels**.

Coordinate units (5)

Units used for the current coordinate type are shown here.

Units can be changed in the Core Module. See **CDM Settings menu / Units**.

Calculated point coordinates (6)

3D point coordinates in the coordinate system assigned to this window are shown here.

Coordinate type (rectangular, cylindrical, etc.) can be changed in the Core Module. See **CDM Coordsys menu/ Coord type**.

Coordinate system name (7)

This is the full ID of the coordinate system used to display coordinates (workpiece ID/coordinate system name).

The coordinate system for this measurement window is chosen when the window is created.

Selected quality statistic (8)

Point coordinates are calculated using the Single Point Solution. This takes into account the pointings from every oriented station, on-line or off-line, which has measured the current point. The calculation can generate figures based either on mathematically derived **standard deviations** or on the current residuals and offsets using root mean square (**RMS**) values. To specify which is displayed, see **CDM Settings menu/General.**

The standard deviation (std.) depends on the user's estimates of the pointing quality of the instruments located at every station involved in the calculation. These estimates can be altered in the **Station setup** menu of the relevant instrument module. If the estimates are altered the calculated point quality will alter. The values are calculated as components along the selected coordinate system axes.

If the target is located from several stations, the RMS value is based on the offsets of the computed 3D location from the pointings or polar locations of every station involved in the calculation. These offsets are split into their axial components using the selected coordinate system axes. An RMS value is then calculated for each group of axial components. The RMS tells you how much the rays miss the target point and does not depend on estimated pointing quality.

If the target is located from a single station, the RMS value (14) is split into its axial components and displayed here.

Statistical values for coordinates (9)

The values of the corresponding statistic are shown here. Their colour coding depends on the level defined by **Coordinate tol. (distance).**

Value of measurement deviation (10)

If a stationary point is measured, a number of individual measurements are always made and the final coordinates calculated as an average position or the centre of a circle or sphere fit.

This calculation takes all the residuals in the relevant calculation and presents the largest as the measurement deviation.

A linear or angular value depends on whether the warning level is set by the value for **Coordinate tol. (distance)** or **Coordinate tol. (angle).**

Note

This statistic is not shown in continuous measurement as each measured point is a single value and a deviation cannot be calculated.

Measurement deviation bar (11)

The value of the measurement deviation, shown as a bar chart.

The bar is colour-coded according to the tolerance level set by either **Coordinate tol. (distance)** or **Coordinate tol. (angle)**, depending on whether a linear or angular display has been specified.

Station assigned to this window (12)

The station assigned to the measurement window is shown here.

Correction for target thickness and reflector offset (13)

If target thickness and reflector offset corrections are active, these are shown at this position as follows:

Ta
Target thickness is applied. The coordinate system which defines the direction of the correction exists and the display shows the corrected values.

T
Target thickness is active but the coordinate system which defines the direction of the correction does not yet exist. The display shows the measured, uncorrected values. The thickness information is stored for later use.

Ra
Reflector offset is applied. The coordinate system which defines the direction of the correction exists and the display shows the corrected values.

R
Reflector offset is active. The coordinate system which defines the direction of the correction does not yet exist and the display shows the measured, uncorrected values. The offset information is stored for later use.

RMS value (14)

For a stationary point located by circle fit, sphere fit or averaged location, this is the RMS value of the corresponding residuals for the current measurement.

> **Note**
> RMS display must be selected in the CDM Settings/General menu option.

Mean (15)

For a stationary point located by circle fit, sphere fit or averaged location, this is the variance factor (mean error) of the corresponding residuals.

> **Note**
> Standard deviation display must be selected in the CDM Settings/General menu option.

2.7 Measurement window: Build/inspect points

The measurement mode *build points* continuously displays the difference between the current reflector position and a reference value. It may therefore be used to place a reflector in a particular location (*build*) or check an existing location against design (*inspect*).

2.7.1 Build/Inspect points: Displayed data in measurement windows

The example windows show the displayed data for **Build/Inspect** points.

To indicate accuracy, several data items use colour-coding according to defined tolerance levels. To define the colours and warning levels, see "Tracker Warnings" on page 89.

A number of data items are described for the **standard** mode window. See "Standard mode: Displayed data and colour-coding" on page 11.

It is possible to zoom in on the difference values to provide a larger display for more convenient viewing from a distance. Not all information is then displayed. Click to toggle between normal and zoomed displays.

The measurement window can show the difference as either 3D components in the coordinate system of the measurement window or as a single vector length offset.

Example screen: build points, 3D display
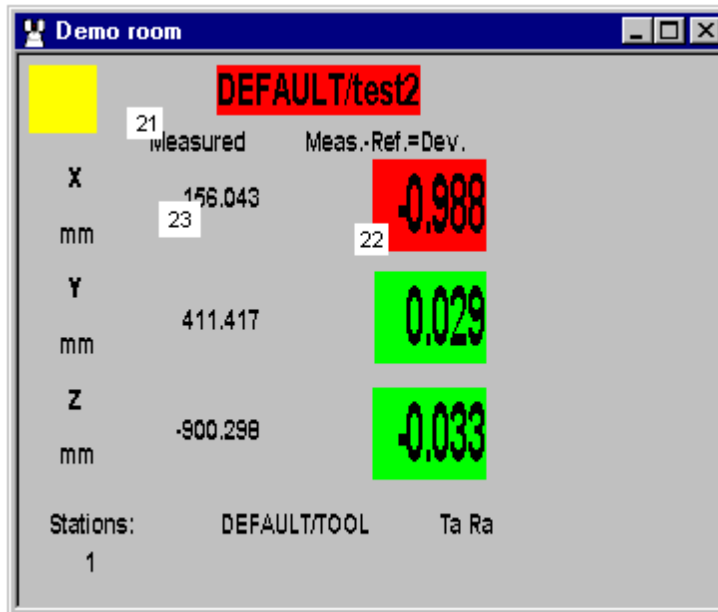
LTM win - Build pts. full.bmp

Build/Inspect labels for 3D display

Build/Inspect idicator (21)
If building points:
Measured - Reference = Difference

If inspecting points:
Reference - Measured = Difference

Difference values (22)
For the current target, the difference between measured and reference coordinate values is displayed in large digits.

Measured coordinates (23)
Measured coordinates appear in smaller characters in front of the differences.

Example screen: build points, 3D zoomed display
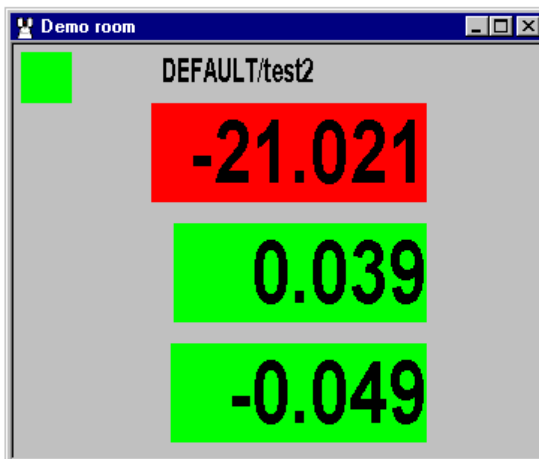
LTM win - build pts reduced.bmp

Example screen: build points, vector display

Right click in measurement window to find **Vector display**.
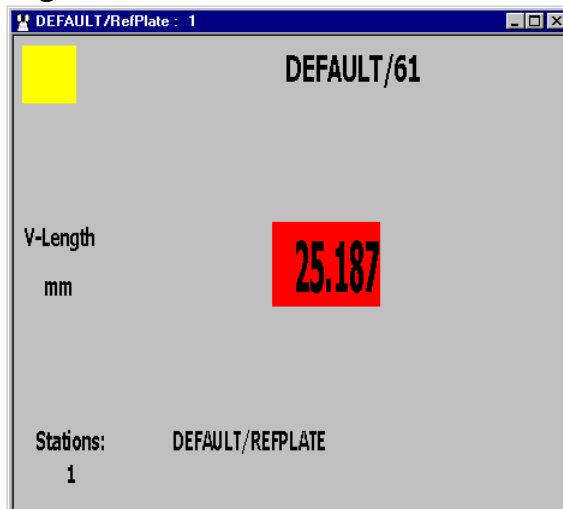
LTM win - build pts. vector display.bmp

Example screen: build points, vector zoomed display
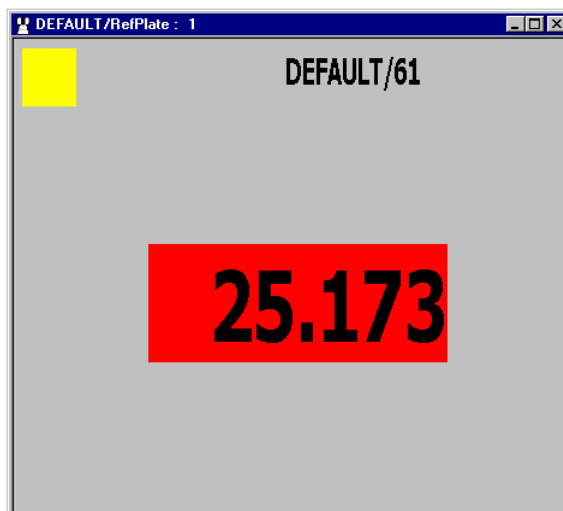
LTM win - build pts. vector zoomed display.bmp

2.8 Measurement window: Vector mode

Vector mode is another method of building or inspecting points in which the target reference point is offset from the true reference point along the normal vector to the corresponding CAD surface.

This difference is displayed in a local coordinate system. For more information see "Vector mode" on page 37.

2.8.1 Vector mode: Displayed data

The following items are displayed in a vector mode window. See the example screen to locate the items.

To indicate accuracy, several data items use colour-coding according to defined tolerance levels. To define the colours and warning levels, see "Tracker Warnings" on page 89.

A number of data items are described for the **standard** mode window. See "Build/Inspect points: Displayed data" on page 16.

It is also possible to zoom in on the difference values to provide a larger display for more convenient viewing from a distance. Not all information is then displayed. Click 🔍 to toggle between normal and zoomed displays.

Example window: Vector mode, normal display
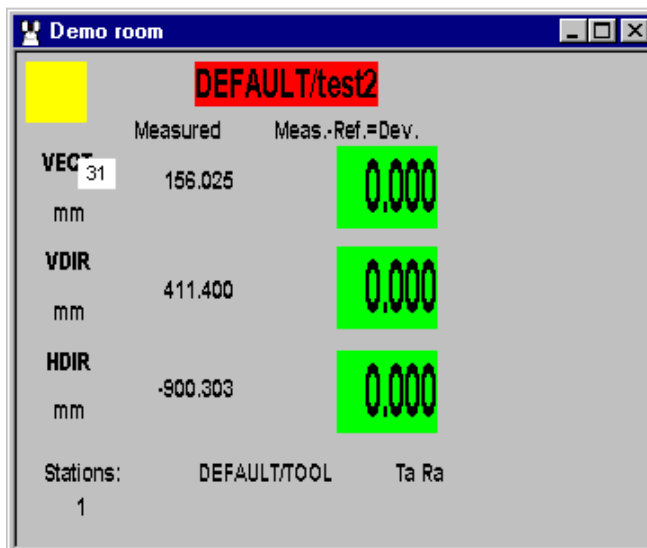
LTM win - vector mode full.bmp

Offset labels (31)

The offsets are shown along the directions **VECT**, **VDIR**, **HDIR** as defined for vector mode.

2.9 Measurement window: Build/inspect shapes

In this mode the perpendicular offset of a measured point from the surface of a standard ***Axyz*** shape is continuously displayed.

The offset is colour-coded to show the error band.

Example screen: Build shapes, normal display
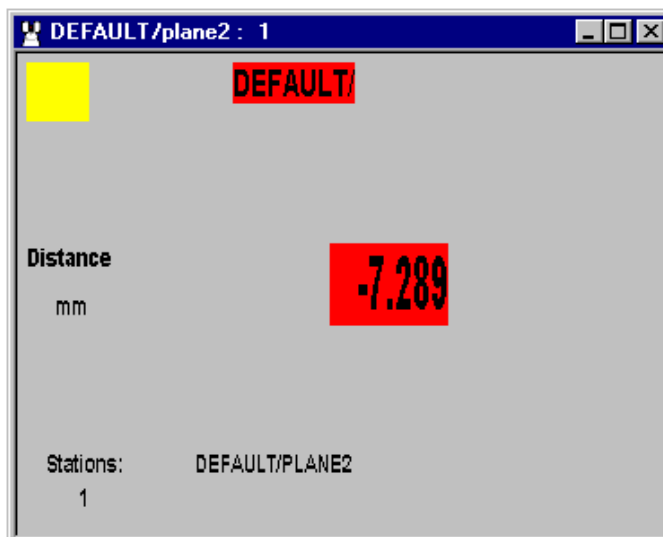
LTM Win - Build shapes.bmp

2.10 Measurement window: CAD Build/Inspect

CAD only

Users of ***Axyz*** CAD can continuously display the perpendicular offset of a measured point from the surface of an imported CAD model.

The offset can be displayed either as 3D components within the coordinate system of the measurement window or as a single vector offset.

The window display options are the same as for **Build/Inspect** points. See "Measurement window: Build/inspect points" on page 16.

At any time the current location can be measured and stored in the job file. This offset will then be displayed in the graphics window.

If build mode is active, only the currently measured offset is graphically displayed. If inspect mode is active, all measured offsets remain displayed. The graphics example is for CAD inspect.

Example graphics: CAD Inspect
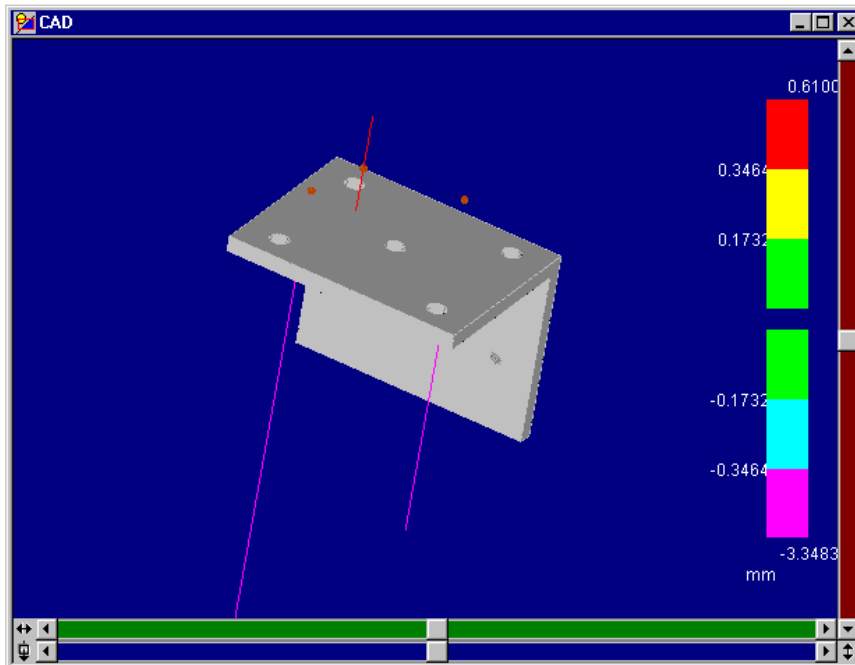
Graph - ex. CAD inspect.bmp

2.11 Measurement window: CAD on-line compare

CAD only

Users of *Axyz* CAD can continuously display the perpendicular offset of a measured point from the surface of an imported CAD model.

The offset is only displayed as 3D components within the coordinate system of the measurement window. The information presented is the same as for the 3D display of Build/Inspect points.

The options specified for the measurement definition will cause a set of points to be recorded at regular time or spatial intervals. As each is recorded the corresponding offset will be displayed in the graphics window.

Example window: CAD on-line compare
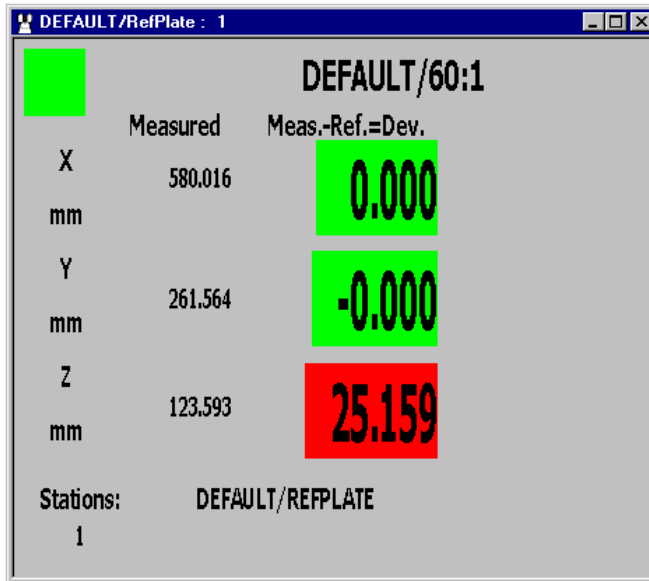
LTM Win - On-line compare.bmp

Example graphics: On-line compare
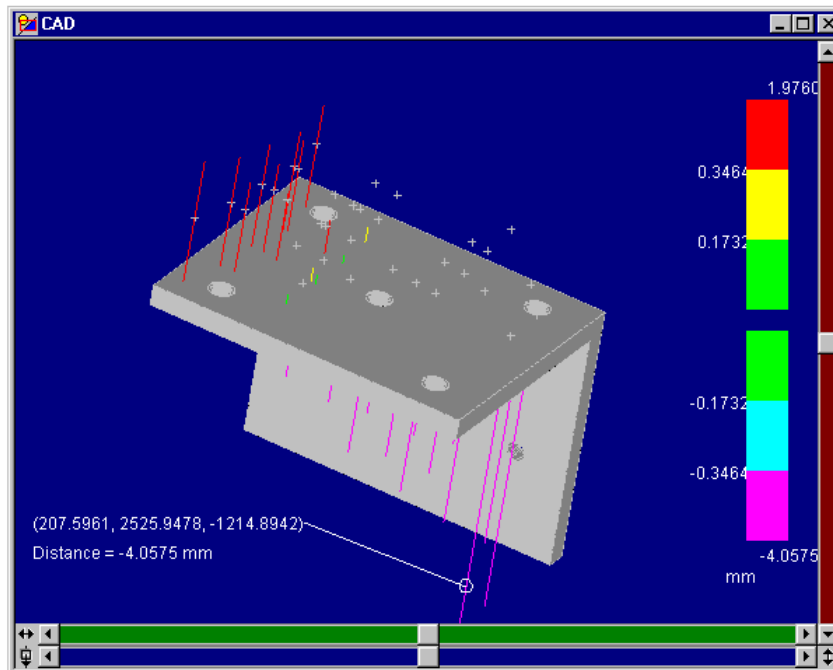
Graph - ex. on-line CAD compare.bmp

2.12 Measurement window: Auto Inspect

Auto Inspect simply provides an automated inspection of a sequence of points. Each individual inspection is therefore equivalent to the manual inspection of a single point.

The window display options are the same as for **Build/Inspect** points. See "Measurement window: Build/inspect points" on page 16.

2.13 Instrument coordinates and active CS

Oriented stations display measured coordinates in the currently active coordinate system. When a new station is added to the network, it is not initially oriented although measurements can immediately be made. Since polar measurements represent 3D values, it is possible to display these measurements in the instrument coordinate system.

These instrument coordinate values apply only to the instrument where the measurements are made. Since the corresponding station is not oriented, these values cannot be related to any other part of the measurement network. and other points measured from a different station cannot be viewed in this coordinate system

As soon as the station is oriented the coordinate display will switch to the active coordinate system.

Note that the instrument coordinate system is a right handed system with positive Y axis pointing away from the Birdbath.

2.13.1 Display of instrument coordinates in measurement window

Either "instrument" or the name of the active coordinate system is shown in the measurement window.
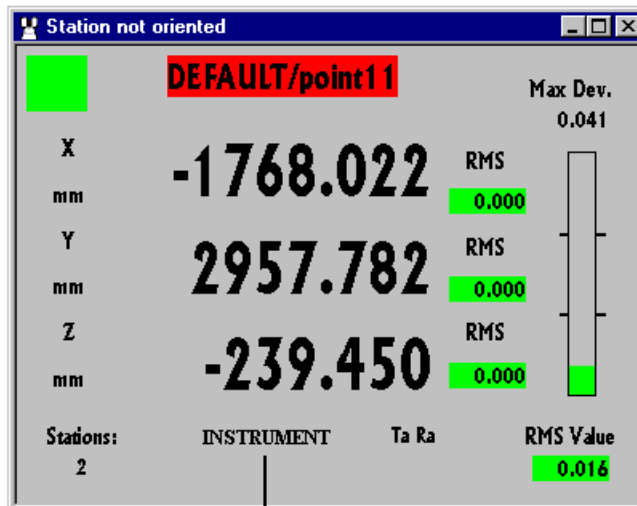
Instrument coordinates indicated here

LTM local coords.bmp

2.13.2 Direction of instrument axes
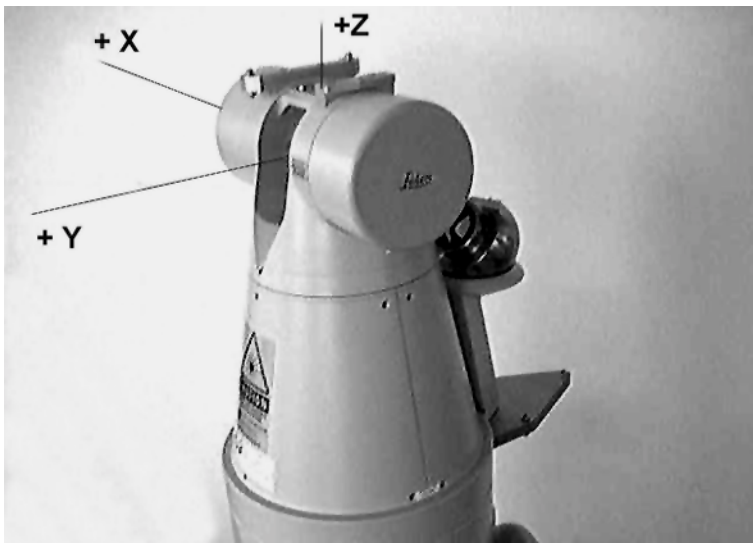
3. LTM main menu summary

3.1 Function key access to commands

A number of commands on the main menu can be directly accessed by a single function key stroke. This is indicated in the summaries of this section, as well as in each menu description. Here is a summary:

Key	Command
F1	HELP (HELP topics)
F2	START (START measurement)
F3	TRY (TRY measurement – measure without recording)
F4	STOP (STOP measurement)
F5	MEASURE/DEFINE (DEFINE measurement parameters)
F6	LOCATION POINT (Enter or check a location)
F7	GO LOCATION (Lock onto an existing point)
F8	GO BIRDBATH (Lock onto the Birdbath [Home point])
F9	NEXT POINT (Go to next point in build list)
F10	PREVIOUS POINT (Go to previous point in build list)
F11	REFLECTOR (Select a reflector or define its Home Point location)
F12	FIND REFLECTOR (Search for and lock onto a reflector)

3.2 File summary

Exit

LTM Table - File menu.bmp

3.3 View summary

	Big status	Show/hide measurement status (Large "traffic light" indicator)
	Tool bar	Show/hide the toolbar
	Status bar	Show/hide the status bar
	Zoomed display	Toggle on "zoomed" display (large coord. digits, minimal extra info.)

LTM Table - View menu.bmp

3.4 Mode summary

	Standard	Measure static points (stationary, sphere, circle methods) or scan sets of points (continuous, grid).
	Build Points	Set out (build) new locations or inspect existing locations.
	Build Shapes	Set out (build) points on a standard shape surface or check offsets from a standard shape surface.
	Auto Inspect	Automatically check a set of fixed reflector locations. Only available if tracker has ADM.
cbi	CAD Build/Inspect	Set out (build) or check (inspect) points on a CAD surface.
oc	CAD On-line compare	Check surfaces against CAD

LTM Table - Mode menu.bmp

3.5 Setup summary

Station...		Create/edit a station definition
Reflectors ...	F11	Select a reflector or define its Home Point location
Tracker init...		Establish external conditions and prepare for measurement
Sensor configuration ...		Set parameters relating to laser and ADM
Orient Network...		"Orient the network"
Orient to gravity...		"Determine the tracker inclination from gravity"
Field check meas: Ball Bars		Set up tracker to record Ball Bar measurements
Two face		Set up tracker to record 2-face measurements
ADM inst.		Set up tracker to record ADM/IFM pairs for checking the ADM instrument offset
ADM refl.		Set up tracker to record ADM/IFM pairs for calculating ADM reflector offsets
Field check calc: Ball Bar		Calculate circle fits for all ball bar measurements currently in the database.
Two face		Compare pointings for all two face measurements currently recorded in the database.
ADM inst.		Check ADM inst. params.
ADM refl.		Check ADM reflector offsets
IFM		"Check interferometer starting point using two point method"
Location point...	F6	Enter or check a location
Tracker warnings...		Define warning levels
General settings		Set auto point and graphics update rate
Laser control		Switch laser tube on or off

LTM Table - Setup menu.bmp

3.6 Measure summary

🖼	Define...	F5	Enter ID of next point and measurement parameters
	Set Point ID		Enter ID of next point.
↑	Next point	F9	Go to next build point or Increment next point ID by 1
↓	Previous point	F10	Go to previous build point or decrease next point ID by 1
●	Start measure	F2	Start measurement and store
TRY	Try measure	F3	Start measure no storage
❚❚	Pause measure	Ctrl+U	Pause Auto Inspection
■	Stop measure	F4	Stop measurement process
∫	Continuous		Continuous measurement
✛	Stationary		Make measurements to stationary reflector centres
◓	Sphere centre		Locate fixed points using a spherical surface adapter.
○	Circle centre		Locate fixed points using a stepped cylindrical adapter.
▦	Grid		Measure points on a 3D grid of surfaces.
⊘	Reflector offset correction...		"Enable or disable reflector offset correction"
⇕	Target thickness...		"Enable or disable the target thickness correction"
	Laser pointer		Use laser beam as a pointer
	Meas. and set ADM dist.		Initialize IFM with ADM
⊕	Go location...	F7	Lock onto existing point
⊕	Go Bird Bath	F8	Lock onto reflector in Bird Bath
▣	Find reflector...	F12	Search for and lock onto reflector

LTM Table - Measure menu.bmp

3.7 Align summary

Ball bars		Sets up the tracker to record Ball Bar measurements
Two face		Sets up the tracker to record 2-face measurements
ADM meas.:	ADM inst.	Sets up tracker to record ADM/IFM pairs for calculating the ADM instrument offset
	ADM refl.	Sets up tracker to record ADM/IFM pairs for calculating ADM reflector offsets
Change face		Switch between faces 1 and 2
IFM dist:	Two point	Uses 2-point method to find IFM datum and Bird Bath distance
	Scale bar	Uses scale bar method to find IFM datum and Bird Bath distance
ADM offsets:	Instrument	Calculates the datum position and scale factor for ADM
	Reflectors	Calculates additive constants for reflectors used with ADM
Align trk.		Calculate the parameters of the tracker model
Align trk. interm.		Update a reduced set of params.
Prev. corrections		Reload previous ADM and tracker model parameters
Video camera		Records offset between video camera pointing and laser pointing

LTM Table - Align menu.bmp

3.8 Windows summary

🗔	Measurement window	Ctrl+N	Opens new meas. window
🗂	Data manager		Open an IDM window
🖼	Graphics		Open a graphics window
	Cascade		Arrange windows, overlapping to show titles.
	Tile horizontal		Arrange windows in non-overlapping horizontal strips
	Tile vertical		Arrange windows in non-overlapping vertical strips
	Open window list		Show currently open windows within LTM. Active window has check mark next to it.

LTM Table - Window menu.bmp

3.9 Help summary

	Help Topics	F1	"Displays the list of help topics"
	Using Help		"Displays general help information on using the help system"
🔎?	Help Mode	Shift+F1	On-screen, context sensitive help
	Tracker status...		Display tracker status
	Diagnostics...		Display diagnostic data
	Hardware cfg...		Show hardware configuration
	About Axyz LTM...		"Display program information, version number and copyright"

LTM Table - Help menu.bmp

4. File menu

4.1 Exit

Exit command **(File menu)**   **Alt,F,X**

"Quit LTM"
Use this command to shut down the LTM. This will not close the ***Axyz***
program.

Shortcuts

Mouse:	Click the application's "Close" button.
Toolbar:	none
Keys:	ALT+F4

5. View menu

5.1 Introduction

The options in this menu change if either the Data Manager or Graphics Module is active. Only options applying to the LTM are explained here.

For DM and graphics options, see the relevant manual or HELP file:
"***Axyz*** DM - Data Manager Software Reference Manual".
"***Axyz*** View/CAD - Graphics Modules Software Reference Manual"

5.2 Big status

Big status command **(View menu)**   **Alt,V,B**
"Show the big status window"

Use this command to display or hide the large display of measurement status ("traffic light" indicator). See "Measurement windows: "Traffic lights"" on page 10.

Shortcuts
  Toolbar: none
  Keys: none

5.3 Toolbar

Toolbar command **(View menu)**   **Alt,V,T**
"Show or hide the toolbar"

Use this command to hide or display the LTM toolbar. See "Summary of toolbar buttons" on page 5.

A check mark appears next to the item when the toolbar is displayed.

Shortcuts
  Toolbar: none
  Keys: none

5.4 Status bar

Status bar command (**View menu**)   **Alt,V,S**
"Show or hide the status bar"

Use this command to display and hide the Status Bar. The Status Bar is displayed at the bottom of the screen. It provides some help text and status information. See "Status bar" on page 6.

A check mark appears next to the menu item when the Status Bar is displayed.

Shortcuts
  Toolbar: none
  Keys: none

5.5 Zoomed display

Zoomed display command (**View menu**)   **Alt,V,Z**
"Toggle between normal or zoomed information display"

This option is only available when a measurement window is open and relates to the information displayed in a particular measurement window. The setting applies to the currently active window so it is an individual setting for every window.

The option switches between a display showing the maximum amount of data about the measurement, and one which zooms in on the critical dimensional information. This gives more space to the coordinate digits which can then be seen from a greater distance.

For examples of normal and zoomed displays, see "Standard mode: Displayed data and colour-coding" on page 11.

Shortcuts
  Toolbar:
  Keys: none

6. Mode menu

6.1 Concepts

A *measurement mode* implies a particular way of making measurements.

A mode can only be selected when a measurement window is open.

Each mode presents its results in a different way in the corresponding measurement window.

The first measurement window opened will correspond to the last mode selected.

6.1.1 Modes in brief

Standard mode offers a number of methods for making 3D static point measurements and 3D dynamic point recording.

Build Points mode is used for manually setting out new points (Build) or manually checking the positions of existing points (Inspect). **Vector mode** is a modified operation of this mode which allows for a difference between the location of an object surface and its CAD representation.

Build Shapes mode is used to manually set out points on a standard *Axyz* shape surface (e.g. cylinder) or check the offsets of existing points from a standard surface.

Auto Inspect mode can automatically check a set of fixed reflector locations. This mode requires ADM.

CAD Build/Inspect
Users of the *Axyz* CAD module can also set out (Build) or check (Inspect) points on an imported **CAD** surface.

On-line compare
Users of the *Axyz* CAD module can also compare the current locations of scanned points on a surface with the corresponding imported CAD model.

6.1.2 Measurement and graphics windows

Measurement windows can display numerical data in different ways:

For **Build points, Auto Inspect, CAD Build/Inspect**
Numerical values can be shown either as 3D components or as vector lengths.

For **Build/Inspect shapes**
Numerical values are shown as vector offsets only

For **On-line compare**
Numerical values are shown as 3D components only

Users of the Graphics Module have access to a wider range of measuring modes. When a graphics window is open, measurements recorded in the database are also immediately displayed in the graphics window.

Build modes will show the offset relating to the current build point.
Inspect modes will show the offsets of all points already measured.

6.1.3 Standard mode and methods of recording

In **Standard mode**, the following methods are available for 3D data acquisition.

- **Stationary**
  Direct measurement to the centre of a reflector at a fixed location.
- **Sphere**
  Measurement of a fixed location using an adapter which puts the reflector on a spherical surface whose centre is the required fixed point.
- **Circle**
  Measurement of a fixed location using an adapter which puts the reflector on a circle whose centre is the required fixed point.
- **Continuous**
  Continuous recording of locations of a freely moving reflector. Various time and spatial criteria can be used to filter the data.
- **Grid**
  Continuous recording of a freely moving reflector as it moves through the surfaces of a spatial grid.

6.1.4 Building points

The dialogue box initiates the process. Once options are specified, further progress is monitored in the relevant measurement windows.

A list of points to be built is selected from the reference points. If a point is input manually, the list only contains the one point. The manually input point is not stored in the reference area but can be stored in the object area by subsequent measurement as a normal measured point.

Sequential point building

Currently only one on-line station is possible. The station works sequentially down the list. By default the starting point is the top of the list but a point within the list can be chosen as the starting point. Points are then measured sequentially down to the bottom and continue again from the top. To change the order of the build points, select them in the required order from the Data Manager using CTRL + left click.

Build to closest point

As the reflector is moved, the system refers to the closest build point and shows the offsets to that point. It is not therefore necessary for the operator to recognize individual points nor to be restricted to a particular build order.

Recording and display

The **Start** button initiates the build process and the **Stop** button ends it.

Whilst the process is active there is a continuous display of the coordinate differences between the current reflector position and the current reference point.

To measure a point the operator clicks again on the **Start** button. The measured point takes the workpiece name and point ID from the corresponding reference point.

After measuring a stationary point the display returns to continuous display.

Since **Build** mode uses both continuous display and stationary point measurement, parameters must be set to cover both forms of operation.
Build to closest point
The points on the build list always remain active. The operator can return to any point at any time to compare reflector and reference coordinates or to measure the current reflector position.

Build sequentially

To move to the next point on the list the operator must make a measurement of the current point. To return to previously measured points the procedure must be re-started.

Build or Inspect?

Build mode is initially assumed. Differences are displayed as (Meas - Ref). If Inspect mode is specified, differences are displayed as (Ref - Meas).

6.1.5 Vector mode

Vector mode is a variation of **Build points** in which the reference point is offset along the vector perpendicular to the CAD surface where the point is located. It is intended to deal with a situation in which a CAD model does not exactly coincide with the actual object surface. In this case it may be more useful to use an alternative reference point which is the closest point on the actual surface to the true reference point. This could, for example, be the best location to drill a reference hole.

Vector mode can only be applied if the reference points have the associated normal vector.

Diagram: Offset reference point in vector mode

Normal vector to CAD surface

Offset ref. point

Object surface

True ref. point

CAD surface

True and offset reference points

Temp. ref. point

Measured point

True ref. point

Temporary reference point
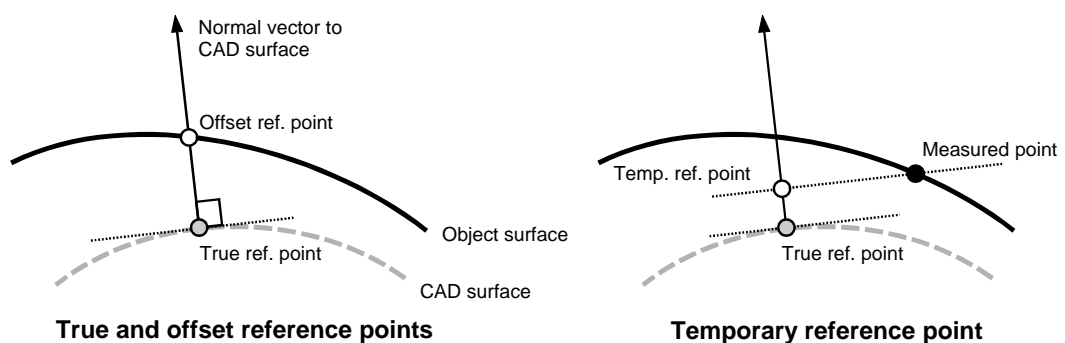
BLDVEC01.WMF

Offset point in vector mode

The simplified diagram shows the true and offset reference points. The current measured point is somewhere nearby on the object surface. It might, for example, be a projected laser spot.

Since the exact tilt of the object surface cannot be determined from the single point measurement, the measured point is projected onto the normal vector to create a temporary reference point as indicated. The temporary point is the foot of the perpendicular from the measured point to the normal vector.

During the build process the measured point will be moved closer and closer to the offset reference point and so the temporary reference point will also become the offset reference point.

Diagram: Local coordinate system for vector mode
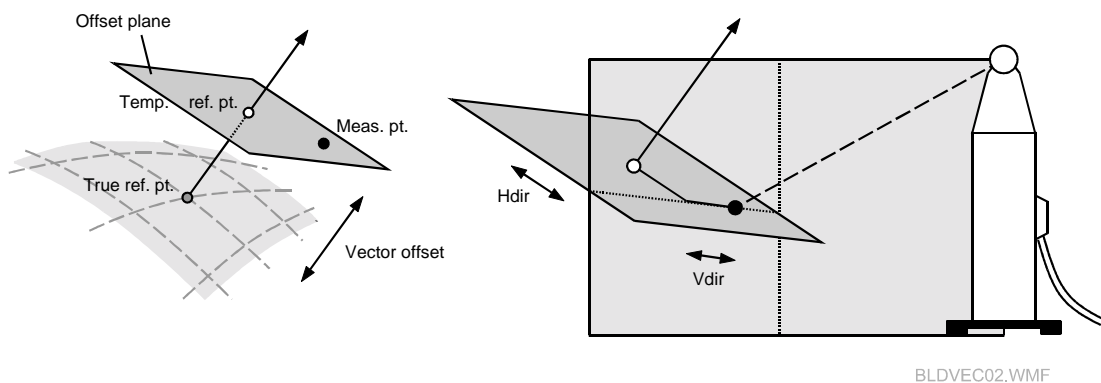
BLDVEC02.WMF

Local coordinate system for vector mode

The measurement window in **Vector mode** shows the current offset of the temporary reference point from the true reference point.

Two other offset components are shown in the offset plane. These are the values Vdir and Hdir. The direction of Vdir is created by intersecting the offset plane with a plane through the measuring point and the measuring instrument. The direction of Hdir is in the offset plane and perpendicular to the direction of Vdir.

If the measuring instrument is levelled, the intersecting plane is a vertical plane through the instrument and measured point.
If the instrument is not levelled, the intersecting plane is through the primary (standing) axis of the instrument and the measured point.

If the measured point is located from more than one station, the instrument at the lowest numbered station defines the intersecting plane.

6.1.6 Building shapes

Build/inspect shapes has two objectives:

1. To check how an existing object surface conforms to one of the standard *Axyz* shapes such as a sphere or cylinder.
2. To set out points on one of these standard surfaces.

When a reference shape has been defined the reflector is tracked and the measurement view shows the perpendicular offset of the current reflector position from the defined surface. A reflector offset may be optionally taken into account. When a zero offset is shown this means:

- If offset <u>not</u> applied: Reflector <u>centre</u> is on the surface of the shape
- If offset <u>is</u> applied: Reflector <u>housing</u> touches the surface of the shape

A shape is defined by the currently active coordinate system and, if necessary, an additional size parameter.

Build to a new shape

1. First create a coordinate system which represents the local origin and axes of the new shape.
2. Make this the currently active coordinate system
3. Specify any size parameter, e.g. radius if a cylinder.

Inspect an existing shape

1. Make the coordinate system of the shape the currently active coordinate system.
2. Manually input any size parameter relating to this shape.

   Note
   It is not possible to directly select an existing shape from the database.

6.1.7 Auto Inspection

1. A list of reference points defines the points to be inspected.
2. At each point a reflector is expected but different reflector types can be used.
3. The tracker cycles through the list, searching for a nearby reflector at the nominal coordinates.
4. If a reflector is found its position is automatically measured and displayed for a short time before moving to the next point.

5. The measured points use the same workpiece ID and point ID as the reference points.
6. Problem points can be skipped.
7. The operator can make repeat measurements of the whole list.

If there are insufficient reflectors for all points, the operator can pause the inspection routine and shift reflectors from previously inspected points to new points.

6.1.8 CAD build and inspect

CAD Build/Inspect is similar to **Build shape**. Where **Build shape** uses the surface of a defined standard *Axyz* shape, **CAD Build/Inspect** uses the surface of an imported CAD model.

The objective is to set out (**Build**) or check (**Inspect**) points on the surface of this model.

Note
CAD Build does not set out specific points on the CAD surface. To do this you must either import points which lie on the CAD surface or create points on the CAD surface. You can then use **Build points** mode to set out these specific locations. Functions are available in *Axyz* CAD to extract points from a CAD model or create points on the surface of a CAD model.

Starting and recording

The **Start** button initiates the build/inspect process and the **Stop** button ends it.

Whilst the process is active there is a continuous display of the coordinate differences between the current reflector position and the CAD surface.

At any time during the build/inspect process the current location can be recorded by clicking again on the **Start** button. Any offset will be displayed as a needle in the graphics window. Only the current offset is shown in **build** mode but all recorded offsets remain displayed in **inspect** mode.

Monitoring the offset

Points are monitored by tracking the reflector. The measurement window shows the perpendicular offset of the current reflector position from the CAD surface, which should be zero. A reflector offset may be optionally taken into account. When a zero offset is shown this means:

- If offset <u>not</u> applied: Reflector <u>centre</u> is on the CAD surface
- If offset <u>is</u> applied: Reflector <u>housing</u> touches the CAD surface

The perpendicular offset can be displayed as a single value or its components in the active coordinate system can be shown.

For **CAD build**, offset = (Measured value minus reference value)
For **CAD inspect**, offset = (Reference value minus measured value)

The reference value is the current foot of the perpendicular from the measured point to the CAD surface and its location changes as the reflector moves.

6.1.9 On-line compare

On-line compare allows users to continuously scan points on a surface and compare these on line with the surface of an imported CAD model.

The measurement procedure is equivalent to **Standard mode/Continuous**. Time and spatial filters can be set accordingly, for example to record a point whenever the X value changes by 10 mm.

As each point is created the offset to a selected CAD surface is computed and displayed as a needle plot in the window of the Graphics Module.

The technique can also be done off line, by first scanning a set of points and then selecting this for comparison with a specified CAD surface. See the CAD Compare option in the Graphics Module documentation.

6.1.10 Offset tolerances

Offset tolerances help the system and the operator recognize if the reference position has been reached. The current offsets are compared with the tolerance values to see how close the reflector is to the reference position. The system recognizes the following conditions:

- Offset within tolerance
- Offset 1 - 2 times tolerance

- Offset 2 - 3 times tolerance
- Offset > 3 times tolerance

The display is colour-coded to indicate the first 3 levels, otherwise there is no colour coding.

If the reference points specified in the build list have associated tolerance values in the database, these are used in the build process.

If the database records zero values, then the tolerances are defined by the value defined for **Coordinate (Distance)** in the "Tracker Warnings" dialogue box. See "Tracker Warnings" on page 90.

6.2 Standard

Standard command **(Mode menu)**   **Alt,O,S**
"Select standard mode"
See "Concepts" on page 34.

Standard measurement mode offers a number of methods for making point measurements. These are:

Measurement of single static points:
- Stationary
- Sphere centre
- Circle centre

Dynamic or scanning methods:
- Continuous
- Grid

The actual method can be chosen in one of two places:
- Directly in the Measurement Menu.
- In the drop-down box used for defining measurement parameters.

For an example of a corresponding measurement window, see "Example screen: point data" on page 12.

Shortcuts

Toolbar:

Keys: none

6.3 Build Points

Build Points command (**Mode menu**)   **Alt,O,B**
"Select Build Points mode"
See "Concepts" on page 34.

This mode is used for manually setting out new points (Build) or manually checking the positions of existing points (Inspect).

Points are set out directly or as offset points on vectors perpendicular to CAD surfaces.

For an example of corresponding measurement windows, see:
- "Example screen: build points, 3D display" on page 17.
- "Example window: Vector mode, normal display" on page 19.

Shortcuts

Toolbar:

Keys: none

6.3.1 Dialogue box: Build Points
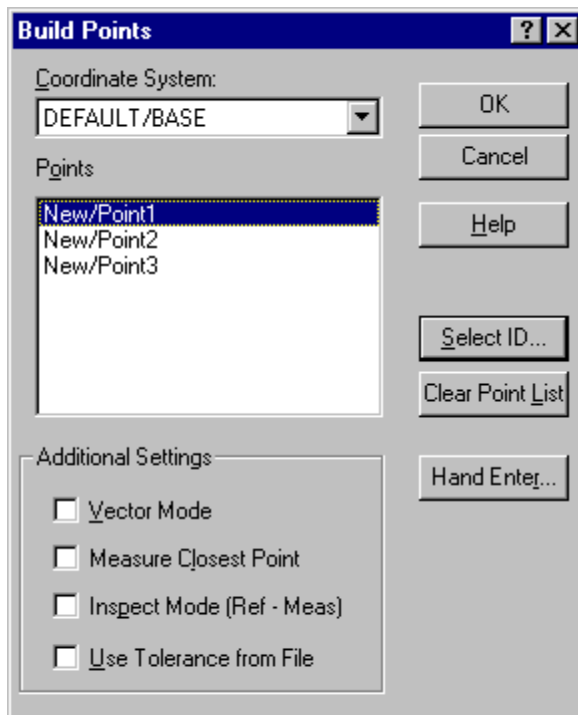
LTM Mode - Bld pts 01 .bmp

Points

This list box shows an ordered list of all reference points chosen for the current build task. These points may be specified in two ways:

- Select from the reference area in the database using **Select ID** (button or right mouse click in "Points" field)
- Enter by hand using the **Hand Enter** button

Coordinate system

From the drop-down list, select the coordinate system of the reference points. It the coordinate system does not exist it must first be created, for example by transformation or axis alignment

Vector mode

Select this option to build/inspect in vector mode. The target point to be built or inspected is not then the reference point itself but a point offset along the normal vector associated with it. The normal vector is a vector perpendicular to the local CAD surface through the reference point. The amount of offset is the separation of the actual object surface from the CAD surface.

When the measurement is on target, the measurement window shows an offset along the vector and two zero offsets perpendicular to the vector.

Measure closest point

Choose this option to automatically build or inspect the point on the list which is closes to the current reflector position.

Inspect mode (Ref minus Meas)

Select this option to display differences as (Ref minus Meas), otherwise differences are displayed as (Meas minus Ref)

Use tolerance from file

If selected, tolerance values stored in the job file will be used to determine the colour-coded display which indicates when you are close to the point.

Otherwise the **Coordinate tol. (distance)** set in the "Tracker Warnings" is used.

Button: Hand enter

You can define a single reference point manually and set this out. Click this button to reach the dialogue box.

Button: Select ID

Click on this button to select the reference points to be built or inspected.

Button: Clear point list

Click on this button to clear the current list of points.

6.3.2 Dialogue box: Hand entered coordinates

LTM Mode - Bld pts 02.BMP

A single reference point can be manually defined here. The point is not entered into the list of reference coordinates.

Workpiece/Point ID

Choose a workpiece name and point identifier for the point. This is the name which will be used if the point is also measured.

Coordinates

Specify the point's coordinates here.

Tolerance

Specify here the estimated tolerances for each coordinate.

Vector

Optionally specify the components (direction cosines) of a unit vector perpendicular to the design surface at the reference point.

6.4 Build Shapes

Build Shapes command **(Mode menu)** **Alt,O,I**
"Select Build Shapes mode"
See "Concepts" on page 34.

Use this mode to manually set out points on a standard **Axyz** shape surface (plane, cylinder, sphere, cone, paraboloid) or check the offsets of existing points from a standard surface.
For an example of a corresponding measurement window, see "Example screen: Build shapes, normal display" on page 20.

Shortcuts

Toolbar:
Keys: none

6.4.1 Dialogue box: Build shapes
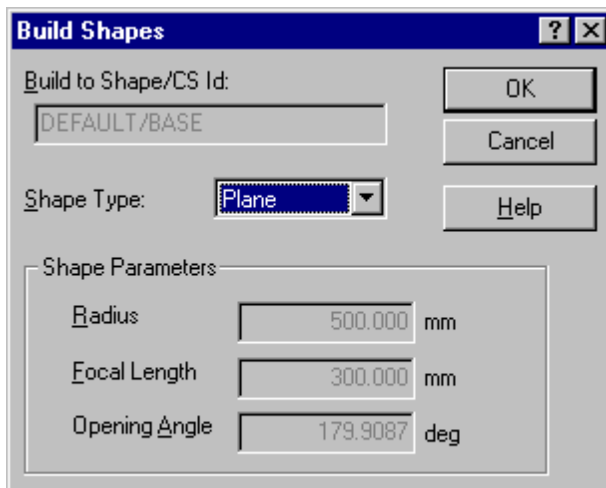
LTM Mode - Bld sh 01.bmp

Build to Shape/CS ID

This box indicates the active coordinate system. Change to the required system in the CDM.

Shape type

Select the standard shape used for building or inspection:

- Cone
- Cylinder
- Paraboloid
- Plane
- Sphere

Lines and circles are not available.

Shape parameters

Some shapes require a size parameter. The availability of an input field depends on the chosen shape type.

Radius

For cylinders and spheres, specify the radius here.

Focal length

For paraboloids, specify the focal length here.

Opening angle

For cones, specify the apex angle here.

6.5 Auto Inspect

Auto Inspect command **(Mode menu)**   **Alt,O,A**
"Select Auto Inspect mode"
See "Concepts" on page 34.

Automatically check a set of fixed reflector locations. Each location is individually measured by ADM and the option is not available if the instrument has IFM only.

For an example of a corresponding measurement window, which is the same as the **Build points** window, see "Example screen: build points, 3D display" on page 17.

Shortcuts

Toolbar:

Keys: none

6.5.1 Dialogue box: Auto inspect
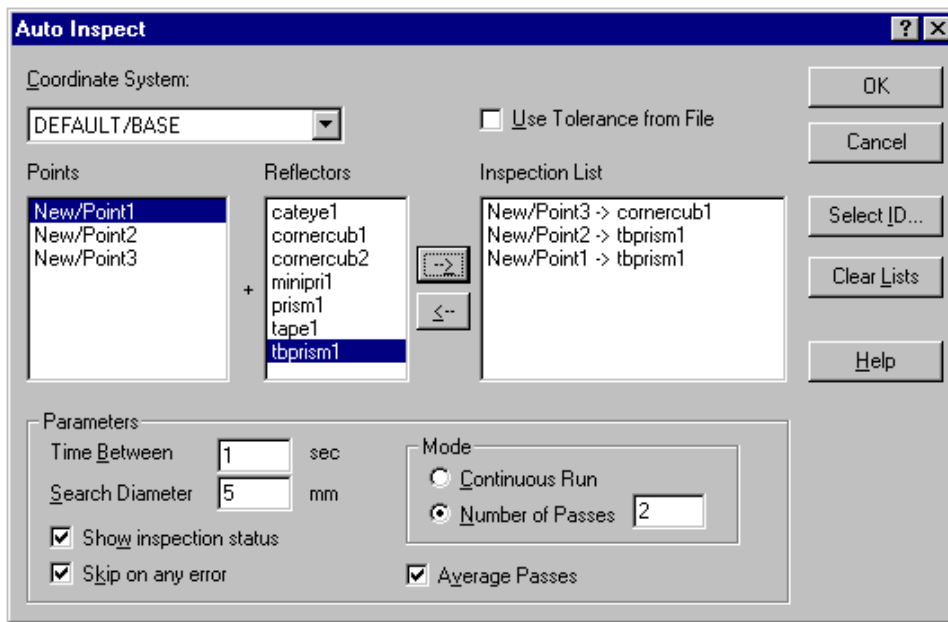
LTM Mode - Auto inspect 01 .bmp

Points

This box shows a list of all reference points chosen for the current build task. Select from the reference area in the database using **Select ID** (button or right mouse click in "Points" box)

Reflectors

This box shows a list of all possible reflector types. The inspected points do not all have to have the same type of reflector.

Inspection list

This list box shows the final ordered list of reference points with reflector types, chosen for the current inspection task.

Build up the inspection list by highlighting a point and an associated reflector type, then use the **Right arrow** button to place the point on the inspection list.

The order on the inspection list determines the order in which the points are measured.

A point can be removed from the inspection list by highlighting it and clicking the **Left arrow** button..

Use tolerance from file

If selected, tolerance values stored in the job file will be used to determine the colour-coded display which indicates when you are close to the point.

Otherwise the **Coordinate tol. (distance)** set in the "Tracker Warnings" is used.

Button: Clear Lists

Click this button to delete all items from the **Points** box and **Inspection list**.

Parameters

Time between
This is an automatic pause between measurements. It is useful if you only have one reflector and do not wish to click the manual pause between points in order to move the reflector to the next point.

Search diameter
This is the maximum diameter of the spiral search routine used to locate a reflector.

Show inspection status
After the inspection is complete a window is displayed which reports on results, e.g. if any point was missed.

Skip on any error
Select this option to automatically move to the next point if the current point cannot be measured. If not selected the inspection process will stop in this case.

Mode
You can choose either to cycle repeatedly through the list using **continuous run** until the **Stop** is activated, or you can define the **number of passes** through the list.

Average passes
Select this option to average the measurements at each inspected point during multiple passes. If not selected, succeeding measurements overwrite previous measurements.

Sample window: Inspection status

	Pass	Point ID	Error Description
	1	OLD/pl-a1	Auto Inspect Position Error
	1	OLD/pl-a3	Auto Inspect Position Error
	2	OLD/pl-a1	Auto Inspect Position Error
	2	OLD/pl-a3	Auto Inspect Position Error

Auto Inspection Error List window with **Close** button.
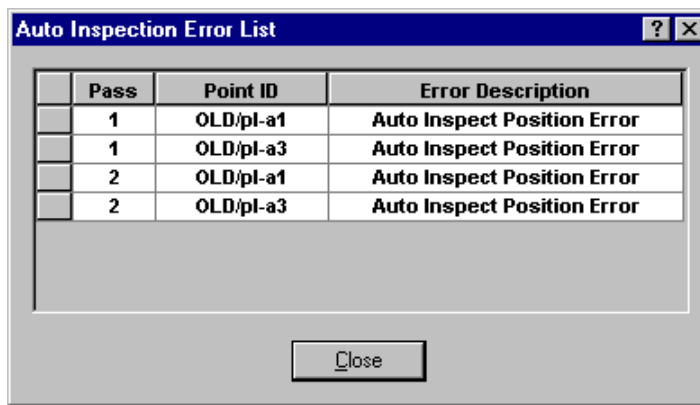
LTM Mode - Auto inspect 02.bmp

If the option to **Show inspection status** was chosen, this window appears after the auto inspect process.

It indicates the point where a fault occurred and during which pass.

Sample window: Position error

Auto Inspect Position Error

(701) Operation Errors
:: Target lost, tracking has failed.

○ Retry Point
◉ Skip Point (Go to next)
○ Skip and Remove from List
○ Quit

[OK]
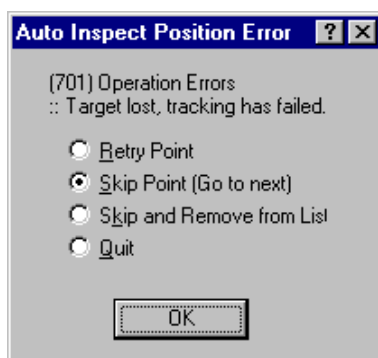
LTM Mode - Auto Insp 03.BMP

If the option **Skip on any error** has not been selected, then this window appears when an error occurs. The operator can take one of the actions.

6.6 CAD build/inspect

CAD build/inspect command (**Mode menu**)   **Alt,O,U**
"Select build or inspect to CAD mode"
 See "Concepts" on page 34.

CAD only

Use this mode to manually set out points on the surface of an imported CAD model or check an existing surface against a CAD model.

For an example of a corresponding measurement window, see "Measurement window: CAD Build/Inspect" on page 20.

Note

This option is only available if the graphics window is open.

Shortcuts

Toolbar: cbi

Keys: none

6.6.1 Dialogue box: Build CAD
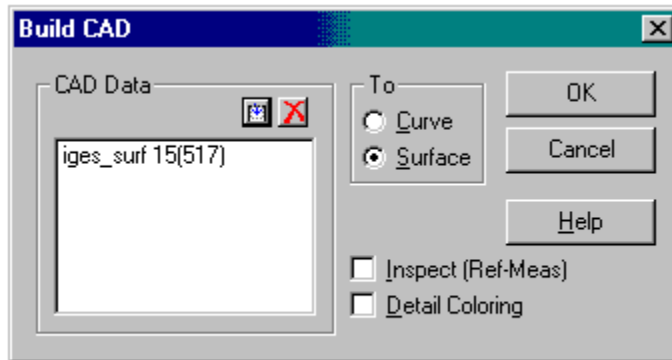
LTM Mode - Build CAD.bmp

CAD data

This list defines the reference CAD data used for building or inspection. Pre-selected CAD data will appear in this list. You may change the listed data at any time before building by clicking in the graphics window and selecting the ones you want. Single or multiple selections can be made.

Selection in the graphics window does not automatically place items on the list. Buttons are available to add or delete from the list, as follows:

Add the current selection to the list.
Delete highlighted items from the list.

To

Specify if **curve** or **surface** data is to be used.

Inspect (Ref-Meas)

Select this option to specify **Inspect** mode. Offsets are then computed as (reference value – measured value).
The reference value is the foot of the perpendicular from the measured point to the CAD curve or surface.

Detail colouring

If **Build** mode is active, this option will apply warning colours to the current build curve or surface. This can provide a sensitive display to indicate how well the current point conforms to the currently defined tolerance thresholds.

6.7 CAD on-line compare

CAD inspect command (**Mode menu**)   **Alt,O,O**
"Select the inspect to CAD mode"
See "Concepts" on page 34.

CAD only

Use this mode to scan a set of points on a surface and display the offset from an imported CAD model as each point is created.

For an example of a corresponding measurement window and graphics display, see "Measurement window: CAD on-line compare" on page 21.

Note
This option is only available if the graphics window is open.

Shortcuts

Toolbar: OC
Keys: none

6.7.1 Dialogue box: On-line compare
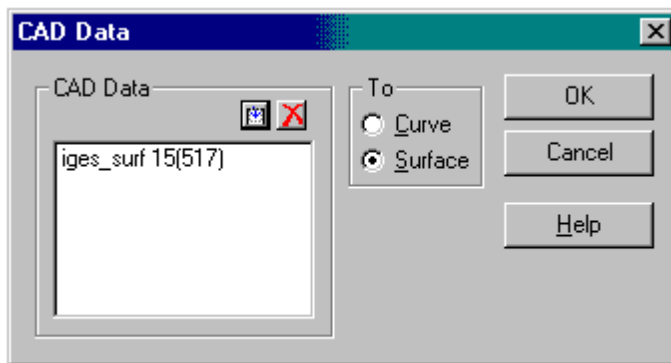
LTM Mode - On-line compare.bmp

CAD data

This list defines the reference CAD data used for comparison. Pre-selected CAD data will appear in this list. You may change the listed data at any

time before comparison by clicking in the graphics window and selecting the ones you want. Single or multiple selections can be made.

Selection in the graphics window does not automatically place items on the list. Buttons are available to add or delete from the list, as follows:

 Add the current selection to the list.
 Delete highlighted items from the list.

To

Specify if **curve** or **surface** data is to be used.

7. Setup menu

7.1 Instrumentation concepts

Multiple trackers can be attached to the LTM, but only one can be the *active tracker* from which measurements can be accepted.

Trackers can be moved from place to place to create a measurement network of up to 99 stations. Dialogue boxes which have counterparts in the theodolite modules may therefore be simpler in the LTM, since the theodolite modules can handle up to 16 instruments connected simultaneously.

The capabilities of a basic tracking laser interferometer can be extended by the addition of extra hardware modules:

- Absolute Distance Meter (ADM)
- Overview video camera
- Internal Nivel tilt sensor

These additional facilities must be manually recorded in the tracker's internal memory as they are not automatically registered after assembly. If this is not done, the additional hardware cannot be used. See "Sensor configuration" on page 64.

If a network is built up only of tracker stations, you may wish to reference this network to gravity. This can be done by orienting the first tracker station in the network to gravity, using a Nivel tilt sensor. It is mathematically sufficient to level the whole network in this way. Any further use of the Nivel at other tracker stations is restricted to simple tilt monitoring for stability checks.

> **Note**
> If you also have a theodolite module (STM, MTM or STM/MTM) the network can also be oriented to gravity by including one or more levelled theodolite stations.

Since the tracker measures and tracks with the interferometer, the absolute distance to the reflector must be established after the beam is broken. There are various methods to do this, some of which require an ADM. Briefly these are:

1. Go to the Birdbath
2. Go to a point where the location is known by:
   Either: an existing point ID
   Or: manually input coordinates
3. Find the reflector after placing it in a stable position, manually or with the aid of the overview camera. Re-set the distance with the ADM
4. Configure the sensor to automatically re-capture the reflector at the last valid position. Then move it to a stable location where the ADM automatically re-sets the distance

7.2 Station

Station command **(Setup menu)**   **Alt,S,S**
"Establish tracker station, type and serial number"

The LTM currently allows a single instrument to be connected on line but the software can accommodate up to 99 stations, including any occupied by theodolites and Total Stations. This command allows you to:
- Create a new station
- Edit the definition of an existing station, e.g. specify a different reflector
- Delete an existing station (and all its measurements!)

This command also prompts the user to select a reflector.

Shortcuts
  Toolbar: none
  Keys: none

7.2.1 Dialogue box: Station setup

	St	LAN Port	Tracker Number	Type	Use	Oriented
	1	1	SN09991	LTD500	YES	YES

Buttons: OK, Cancel, Activate, New, Edit..., Delete, Help
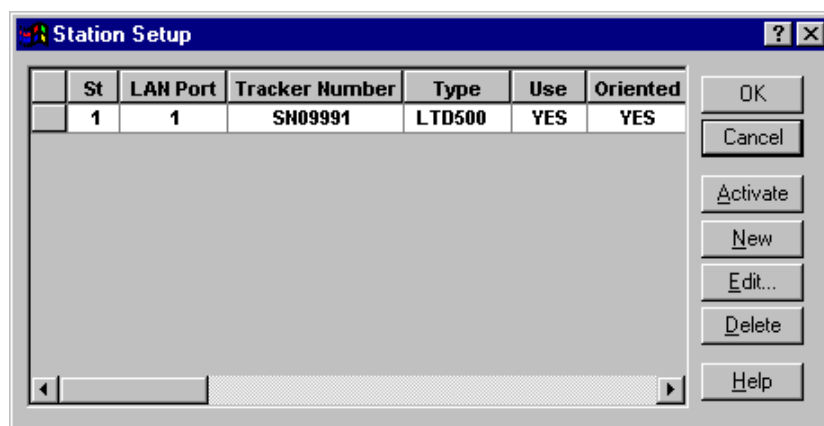
LTM Setup - Station 01.bmp

Summary of data elements (fields) defining each station

Field	Meaning
St	Station number
LAN port	Tracker controller's address (integer) on internal LAN
Tracker number	Manufacturing serial number of tracker sensor
Type	Indicates type of instrument at station, e.g. LTD500
Use	Use station in Orientation Module, YES or NO
Oriented	Orientation status of instrument
Gravity	Indicates if tilt measurement ON or OFF
Status	Indicates laser status. See "Laser status" on page 9.
Operator	Name of operator
Hor SD	Default standard deviation for horizontal angles
Ver SD	Default standard deviation for zenith (vertical) angles
Dist SD	Default standard deviation for distances

Activate button

If several trackers are attached to the LAN, assigned to stations and ready for measurement, one can be chosen as the *active tracker* and its measurements recorded. Highlight the appropriate station and click the **Activate** button. Communication is now established with this tracker.

New button

Activates the Station Editor to create a new station assignment.
See further comments under **Station Editor** dialogue box.

Edit button

If a complete station record or single cell is highlighted, this will bring up the **Station Editor** dialogue box.

Delete button

Deletes a highlighted station assignment. This deletes the station and all measurements made from that station. No warning given.

7.2.2 Dialogue box: Station Editor

The Station Editor is used for creating new station assignments and editing existing station assignments.
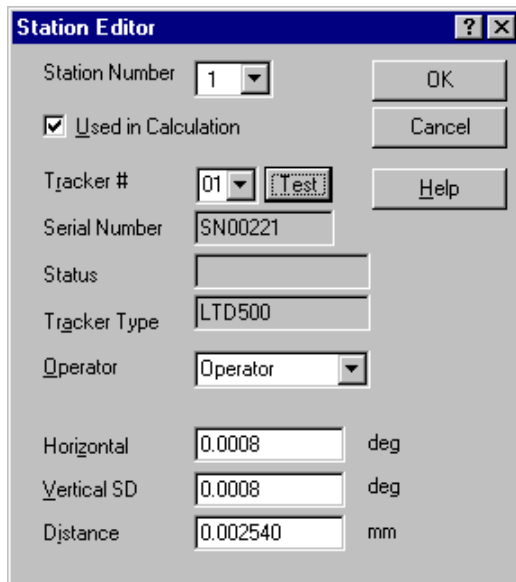
LTM Setup - Station 02.bmp

Station Number

For a new station, choose one of the numbers from the drop-down list. Existing numbers do not appear on the list.

For an existing station, the number cannot be changed.

Used in calculation

If selected, measurements at this station will be used by the Orientation Module and for 3D point measurement.

If not selected, these measurements will not be used and the station will be effectively removed from the measurement network.

LAN port

Up to 9 trackers can be attached to the LAN and controlled by the AP. In order to establish correct communication with a particular instrument, each must have a unique alpha-numeric address on the LAN. Currently the integers 1 – 9 are used as addresses and stored in the TP controller for each tracker head.

From the drop-down list, select the correct address for the TP which controls the tracker head at the currently defined station.

Note

All trackers are delivered from the factor with a default LAN address = 1. If you operate multiple trackers from a single AP you must give each a unique address.

RENAMER.EXE is a utility program which does this. It is located in the ***Axyz*** program folder (e.g. C:/Program Files/Leica/Axyz).

Test button

Click this button to check the tracker and return the following information:

- Tracker type
- Serial number
- Status

Tracker Number

This field reads the manufacturing serial number from the selected tracker.

Status

Status information about the tracker is reported here.

Tracker type

This shows the currently connected tracker, which is one of the following:

- LT500
- LTD500
- SMART
- SMART310

Operator

Optionally enter an operator's name here. Previously used names are available from the drop-down list.

Horizontal, Vertical SD, Distance

Enter the estimated accuracy (standard deviation) of:

- Horizontal angles
- Zenith/Vertical angles
- Distances

These values are used to calculate quality figures for measured point coordinates, which in turn affect the calculated quality figures of derived elements such as shapes fitted to measured points.

This relies on a mathematical technique called *error propagation* which answers questions such as:
"If my angles are good to 1 arc second, how good are point coordinates 5m away when located from 3 stations?"

However this technique assumes the accuracy estimates of the original measurements are good. For example, if you estimate angular accuracy too low then estimated coordinate quality is too low and vice versa.

It is therefore important to make good estimates here if you want good quality estimates of point coordinates and shapes. If in doubt, accept the default values.

7.3 Reflectors

Reflectors command **(Setup menu)** **Alt,S,R**
"Enter or define Birdbath for a reflector"
This option is used to specify which reflector is currently in use at which station.

It is also used to define the Home Point (Birdbath) location for the selected reflector by recording the angle pointings to the reflector in this position and defining the Birdbath distance. This is useful for changing face to the Birdbath.

Note
General reflector information must first be manually input into the database. See "*Axyz* Data Manager: Software Reference Manual".

Shortcuts
Toolbar:
Keys: F11

7.3.1 Dialogue box: Reflectors
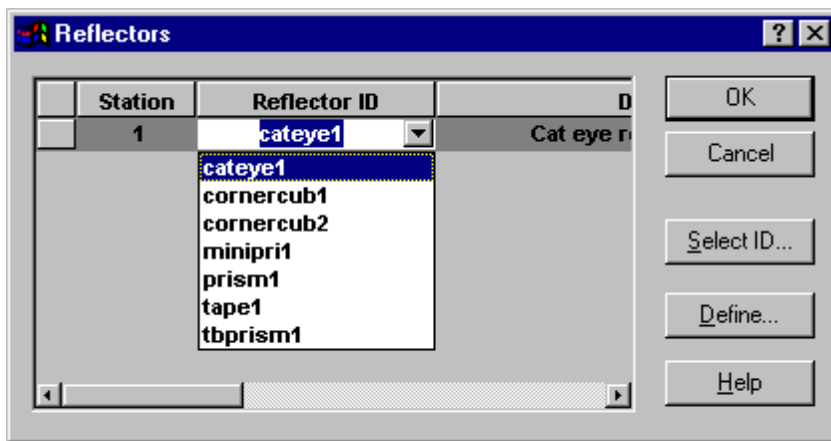
LTM Setup - Reflect 01.bmp

Reflector ID

For the appropriate station select the **Reflector ID** field and chose a reflector type from the drop-down list.

Alternatively, highlight the station row and use the **Select ID** button to chose a reflector type using the Data Manager.

Define button

Click on this button to access a dialogue box to define the Home Point (Birdbath) location for the new reflector.

7.3.2 Dialogue box: Reflector definition
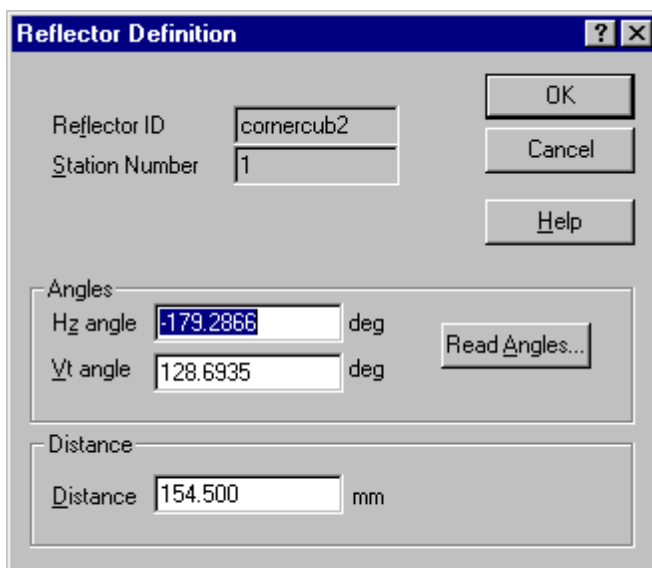
LTM Setup - Reflect 02.BMP

Reflector ID

The identifier of the selected reflector.

Station number

The station at which the reflector's Birdbath location is being defined.

Angles

Define the angular values of the pointing to the reflector.

Hz angle
Horizontal angle value. Can be set manually by overwriting.

Vt angle
Vertical circle reading (zenith angle). Can be set manually by overwriting.

Read angles button
Click this button to read the current angles and enter them into the Hz and Vt fields.

Distance

If the Birdbath distance has been properly calculated using either the "Two point" or "Scale bar" method, the value is shown here and cannot be altered.

If the calculation has not yet been done, you may manually enter an approximate value here. This may be necessary to initiate tracking so that a proper instrument alignment can be made.

Approximate values for corner cube = 154 mm.

> **Note**
> A proper determination of Birdbath distance <u>must</u> be made to ensure accurate 3D results.

7.4 Tracker init

Tracker init command **(Setup menu)** **Alt,S,I**
"Initialize the tracker for measurement"

This function establishes the external environmental conditions of
temperature and pressure. These are used for two purposes:
- Additional information recorded with measurements for general
  monitoring purposes
- Calculation of refractive indices for interferometer and ADM, if
  refractometer measurements not available

If external monitoring devices are connected and their controlling modules
are operating, these may be used to read and set accurate temperature and
pressure readings.

If a refractometer is connected, its values take precedence over other
temperature and pressure readings when calculating refractive indices.

External monitors are configured and run from the CDM "Tools" menu.

The **Tracker init** command also executes several other functions required
to make the tracker operational:
- Initialize encoders and internal components
- Sets index of refraction

Shortcuts
  Toolbar: none
  Keys: none

7.4.1 Dialogue box: Initialize tracker
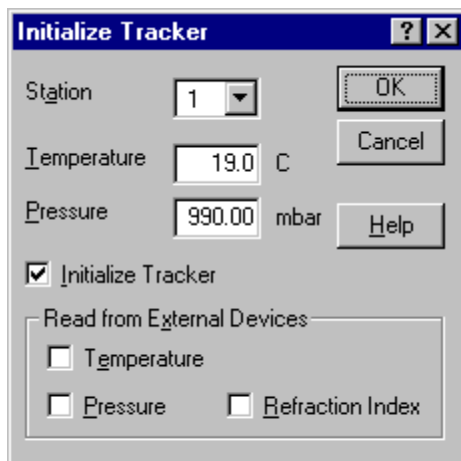
LTM Setup - Trk ini 01.bmp

Station

Shows the current on-line station number at which the tracker is to be initialized

Temperature

Manually enter the external temperature here or read from an external device if connected.

Pressure

Manually enter the external pressure here or read from an external device if connected.

Initialize tracker

Select this option to do the following
- Initialize encoders and internal components
- Sets index of refraction

Read from external device

If environmental data can be read from an external device, select the ones available:

Temperature
Select this option to read the external temperature from the monitor.
Manual input in the temperature field is then blocked.

Pressure
Select this option to read the external pressure from the monitor. Manual input in the pressure field is then blocked.

Refraction index
Select this option to read refractive index from the attached refractometer.

If the external monitor program is not running, a message similar to the following is displayed:

LTM Setup - Trk ini 02.bmp

7.5 Sensor configuration

Sensor configuration command **(Setup menu)**   **Alt,S,C**
"Set operating parameters for tracker"

This option does the following:
- Defines hardware components in current laser tracker
  Absolute Distance Meter (ADM)
  Internal Nivel
  Video camera
- Sets parameters relating to the operation of the interferometer and distance meter
- Shows current refractive indices for interferometer and distance meter

Note
Hardware components <u>must</u> be defined manually or they will not be recognized, but they need only be defined once, when first added to the system.

Shortcuts
Toolbar: none
Keys: none

7.5.1 Dialogue box: Sensor configuration

LTM Setup - Sensor config.bmp

Station number

Select the station number from the drop-down list.

Refractions

IFM
Current value of phase refractive index used for interferometric measurements.

ADM
Current value of group refractive index used for absolute distance measurements.

The above values are calculated internally on the basis of measured temperature and pressure, or refractometer readings.

Configuration

Define the internal tracker configuration here. Any of the following devices which are present but not selected here will not be recognized:
- Video camera (to find reflectors)
- Internal Nivel 20 (to determine tracker tilt)
- ADM (Absolute Distance Meter)

Laser startup mode

The laser's preferred mode of operation depends on external temperature. Select one of the following temperature ranges corresponding to your application:

- +5° to +20° Celsius
- +10° to +30° Celsius
- +20° to +40° Celsius

Parallel output delay

This is the time separation in milliseconds of the data generated by the controller for real time output via the controller's parallel port. A zero value means no data output.

Target stability tolerance for ADM

During ADM measurement the IFM monitors target stability. Target movements should not exceed a maximum value. This maximum must lie within a specified tolerance range.

The stability tolerance range is **0.005 mm to 0.100 mm.**

If you try to enter a value outside the range you get the following message.
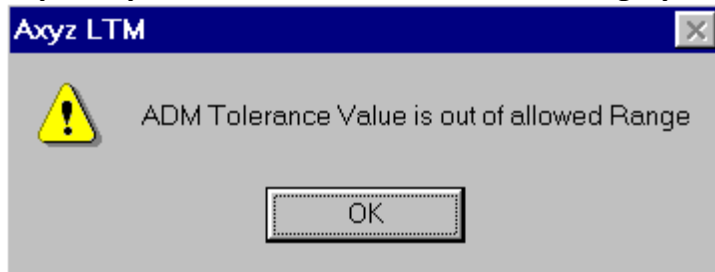
LTM Setup - Sensor config b.bmp

If, during ADM measurement, the target (object) movements are bigger than the specified tolerance then ADM measurement is aborted and you get the following message:
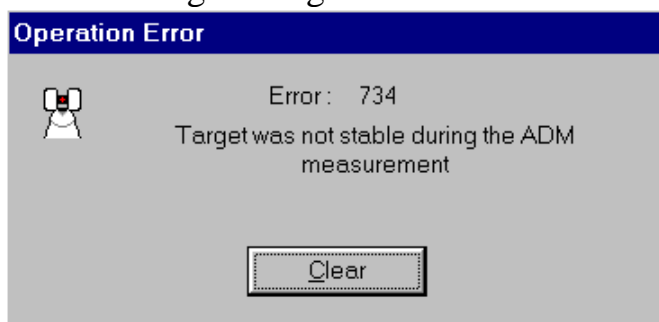
LTM Setup - Sensor config c.bmp

If this happens, try one of the following:

Solution 1
Increase the stability tolerance (within the permitted range)
Solution 2
Stabilize the reflector holder or the object

Time frame for retry

For **Autopoint** using **Keep last position.** For sensors with ADM only.

This specifies the time period taken to test if the reflector has reached a stable location. If the interferometer reading does not change significantly for this length of time, the system assumes the reflector is in a fixed location and an ADM measurement can be made.

Number of retrys

For **Autopoint** using **Keep last position.** For sensors with ADM only.

When a stable location has been detected, this value is the maximum number of attempts which will be made to measure distance by ADM.

7.6 Orient Network

Orient command **(Setup menu)**   **Alt,S,O**
"Orient the network"

Starts up the Orientation Module. See CDM for full information.

Shortcuts
Toolbar: none
Keys: none

7.7 Orient to gravity

Orient to gravity command **(Setup menu)**   **Alt,S,G**
"Determine the tracker inclination from gravity"

This function is used to measure the tilt of the tracker's primary z axis (standing axis) with respect to the vertical. This can be used to orient the measurement network to gravity. The tilt is specified by two angular components about the tracker's internal x and y axes.

This is a guided procedure with automatic measurement.
1. The Nivel is placed in position on the tracker head.
2. The tracker moves to 4 horizontal positions at 90° to one another
3. Average tilt components are calculated

Note 1
This function is only available before this station has made any measurements. The following warning is given if this is not the case:

LTM Setup - Ori to gravity 00.bmp

Note 2
In order to read the Nivel the corresponding monitoring program must be runnning. See:
Axyz Core Data Module: Software Reference
Tools menu / Inclination sensor

Shortcuts
Toolbar: none
Keys: none

7.7.1 Sequence: Orient to gravity

LTM Setup - Ori to gravity 01.bmp

The message box prompts the user to mount the Nivel.

The tracker head then automatically rotates the Nivel into a set of defined positions and records the tilt value. Tilt components are then automatically calculated.

When complete, the following message appears to confirm that the system is oriented to gravity.
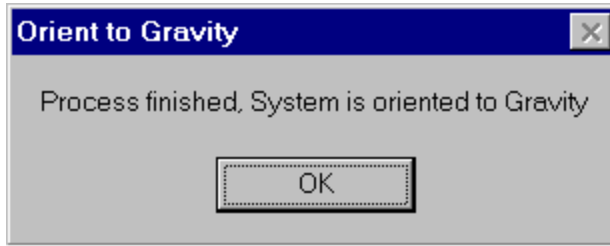
LTM Setup - Ori to gravity 02.bmp

Error messages

The following error messages may appear:
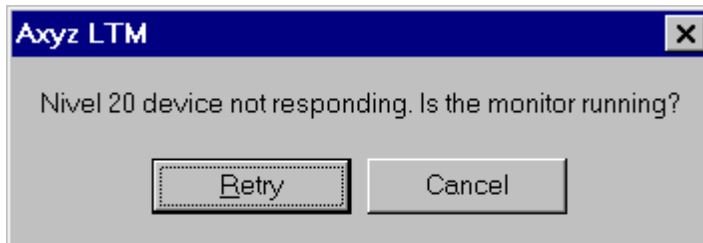
LTM Setup - Ori to gravity 03.bmp

Activate the monitoring program in the Core Data Module (CDM).
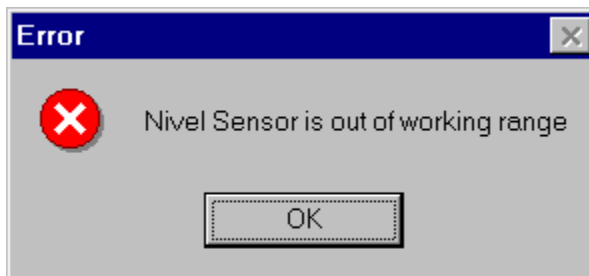
LTM Setup - Ori to gravity 04.bmp
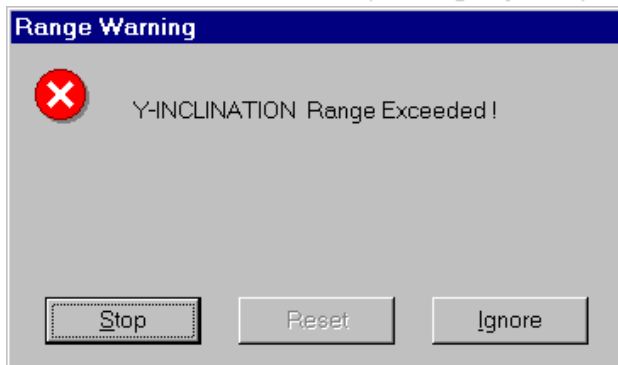
LTM Setup - Ori to gravity 06.bmp

Both these messages indicate that the tracker itself is tilted too far away from the vertical for the Nivel to work. In one case readings cannot be made on either axis, in the other case a reading cannot be made on the axis shown.

Re-adjust the tracker with the footscrews and try again.
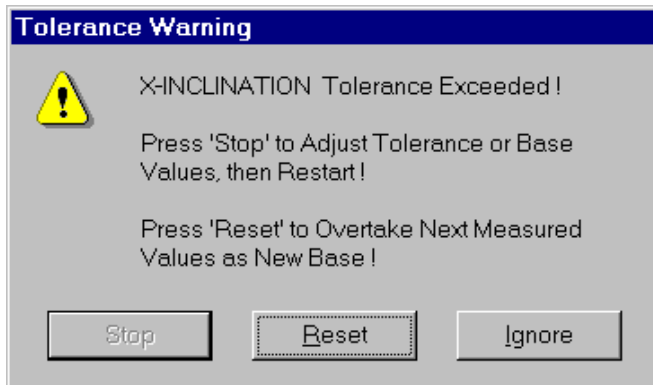
LTM Setup - Ori to gravity 05.bmp

A tolerance can be set which defines how much the current readings can differ from the initial readings before this warning is given. For more information on the settings, see

> **Axyz** Core Data Module: Software Reference
> Tools menu / Inclination sensor
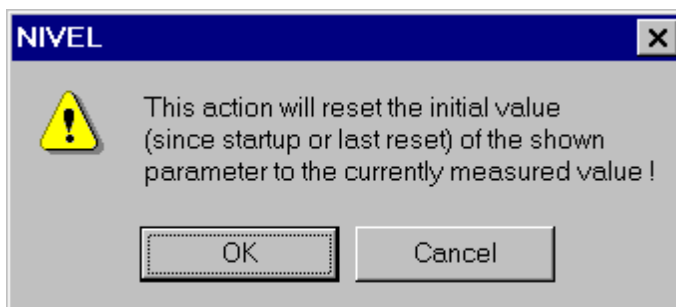
LTM Setup - Ori to gravity 07.bmp

This is a general purpose message which indicates that the current Nivel readings will be used to define parameters currently under review. Choose this option if you want to reduce the number of warning messages appearing.

7.8 Field check meas.: Ball Bars

Field check meas.: Ball Bar command **(Setup menu)**   **Alt,S,F,B**
"Select Ball Bar measurement type"

This sets up the tracker in the correct mode for recording Ball Bar measurements. More information in the "Align" menu. See "Ball Bars" on page 154.

For general guidance on how to make field checks, see "Make a complete field check" on page 197.

Shortcuts
Toolbar: none
Keys: none

7.9 Field check meas.: Two Face

Field check meas.: Two Face command **(Setup menu)**   **Alt,S,F,T**
"Select Two Face measurement type"

This sets up the tracker in the correct mode for recording 2-face
measurements.

More information in the "Align" menu. See "Two face" on page 155.

For general guidance on how to make field checks, see "Make a complete
field check" on page 197.

Shortcuts
Toolbar: none
Keys: none

7.10 Field check meas.: ADM instrument measure

Field check meas.: ADM inst. command **(Setup menu)**   **Alt,S,F,M**
"Select ADM measure instrument check type"

This function is not available if the instrument only has IFM.

This sets up the tracker in the correct mode for recording ADM/IFM
measurement pairs for checking or calculating the ADM instrument offset.

Definition of the measurement parameters is explained in detail in "Filter
tab (ADM measurement)" on page 115.

Note
These measurements will use the IFM values as a reference, so IFM
measurements must be as accurate as possible.

Measurements can only be done with an air-path corner cube reflector.
If this is not the current reflector type a warning will be displayed:

LTM Align - ADM meas inst.bmp

For general guidance on how to make field checks, see "Make a complete field check" on page 197.

Shortcuts
Toolbar:	none
Keys:	none

7.11 Field check meas.: ADM reflector measurement

Field check meas.: ADM reflector command **(Setup menu) Alt,S,F,A**
"Select ADM measure reflector check type"

This function is not available if the instrument only has IFM.

This sets up the tracker in the correct mode for recording ADM/IFM measurement pairs for calculating ADM reflector offsets.

Definition of the measurement parameters is explained in detail in "Filter tab (ADM measurement)" on page 115.

Note
These measurements will use the IFM values as a reference, so IFM measurements must be as accurate as possible.

For general guidance on how to make field checks, see "Make a complete field check" on page 197.

Shortcuts
Toolbar:	none
Keys:	none

7.12 Field check calc: Ball Bar

Field check calc: Ball Bar command (**Setup menu**)   **Alt,S,C,B**
"Ball Bar check method"

Ball Bar measurements should show that all points lie on a circle. This command extracts all Ball Bar measurements from all stations currently in the database and shows the differences from a best-fitting circle for corrected and uncorrected measurements. Corrections can be displayed using the parameters of a current tracker model or a previous model.

To make the Ball Bar measurements you must switch to the appropriate measuring mode and record suitable pointings.

For general guidance on how to make field checks, see "Make a complete field check" on page 197.

Shortcuts
   Toolbar: none
   Keys: none

7.12.1 Dialogue/Results box: Ball Bar calculation
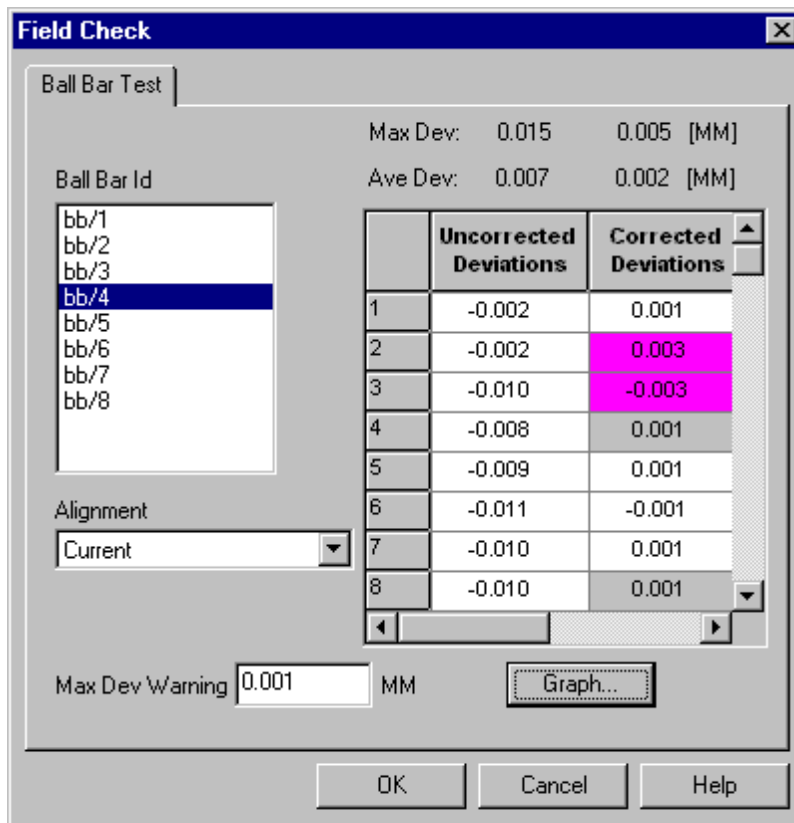
LTM Setup - Check Ball Bar 01.BMP

Ball Bar ID

This is a list of all Ball Bar measurement sets found in the database. Each set is shown with its full ID (workpiece name/point name). Click on a set to highlight it and display the corresponding results.

Deviations

This shows the deviations of individual points from the best-fitting circle. A positive value is outside the circle and a negative value is inside.

In one case the deviations are uncorrected and in the other they are corrected using the selected set of alignment parameters.

Max Dev

This shows the maximum absolute value of the deviations in the corresponding column (uncorrected and corrected).

Ave Dev

This shows the average value of the deviations in the corresponding column (uncorrected and corrected).

Max dev warning

Set a threshold level here to colour-code the results of the corrected deviations. Colours are defined in **Tracker Warnings** and conform to 3 deviation bands:

Result	Colour code
Deviation below threshold	No colour
Deviation 1x - 2x threshold	As defined for this band, e.g. yellow
Deviation > 2x threshold	As defined for this band, e.g. red

Display units

Currently only millimetres can be displayed.

Alignment

A drop-down list shows the existing sets of parameters which define the tracker model. Normally the current set is appropriate but older sets can be applied.

Button: Graph

This button brings up a graphical display of the results.

7.12.2 Dialogue/Results box: Ball Bar graphical display
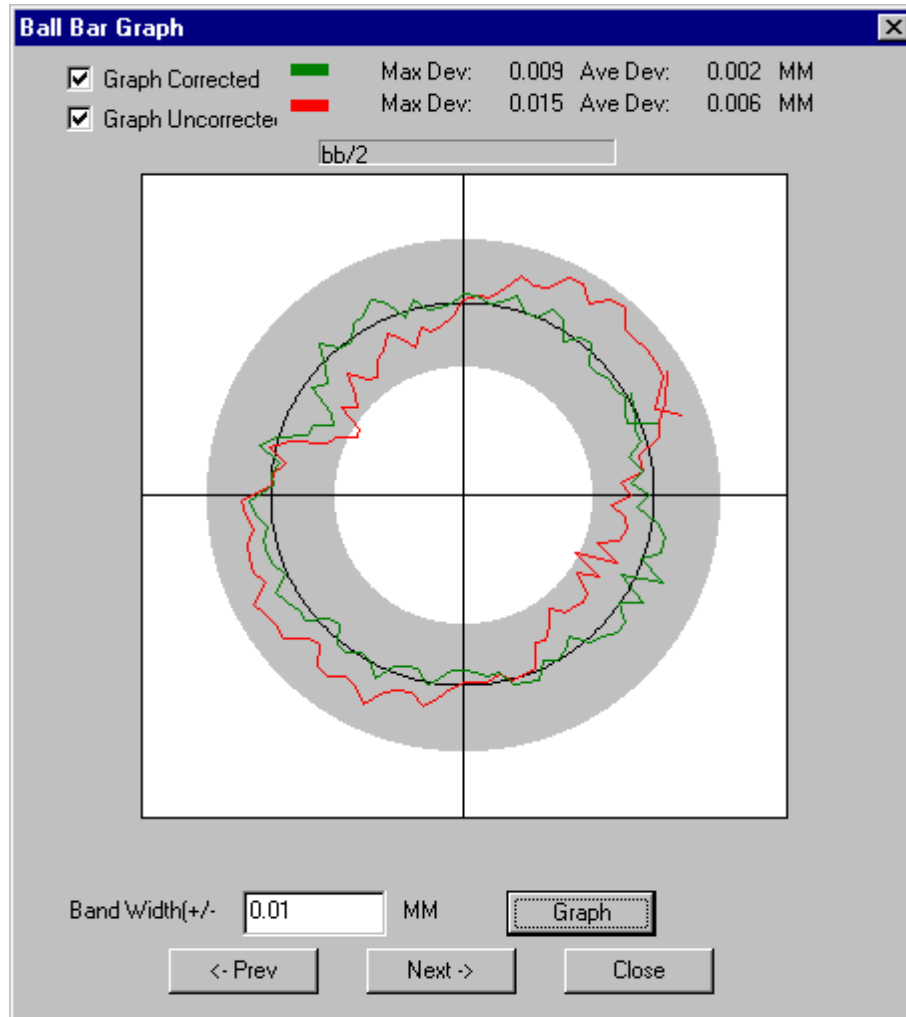
LTM Setup - Check Ball Bar 02.BMP

Graph corrected

Check this box to display corrected values.

Graph uncorrected

Check this box to display uncorrected values.

Max Dev

This shows the maximum absolute value of the deviations of the uncorrected and corrected values.

Ave Dev

This shows the average value of the deviations of the uncorrected and corrected values.

Graph title box

This box shows the name of the current set of Ball Bar measurements being displayed.

Band width

This is the deviation range represented by the width of the grey ring within which the reference circle and the deviations are displayed.

When changed, update the display with the graph button.

Graph button

Update the display with this button.

Prev button

Go back to the previous Ball Bar set on the list.

Next button

Go to the next Ball Bar set on the list.

7.13 Field check calc: Two Face

Field check calc : Two Face command **(Setup menu)**   **Alt,S,C,W**
"Two face check method"

2-face measurements to a fixed location should give the same pointing with only random differences. This command extracts all the two face measurements from all stations currently in the database and compares corresponding pointings. Pointing pairs are shown uncorrected and corrected. Corrections can be displayed using the parameters of a current tracker model or a previous model.

To make the 2-face measurements you must switch to the appropriate measuring mode and record suitable pointings.

For general guidance on how to make field checks, see "Make a complete field check" on page 197.

Shortcuts
Toolbar: none
Keys: none

7.13.1 Dialogue/Results box: Two face calculation
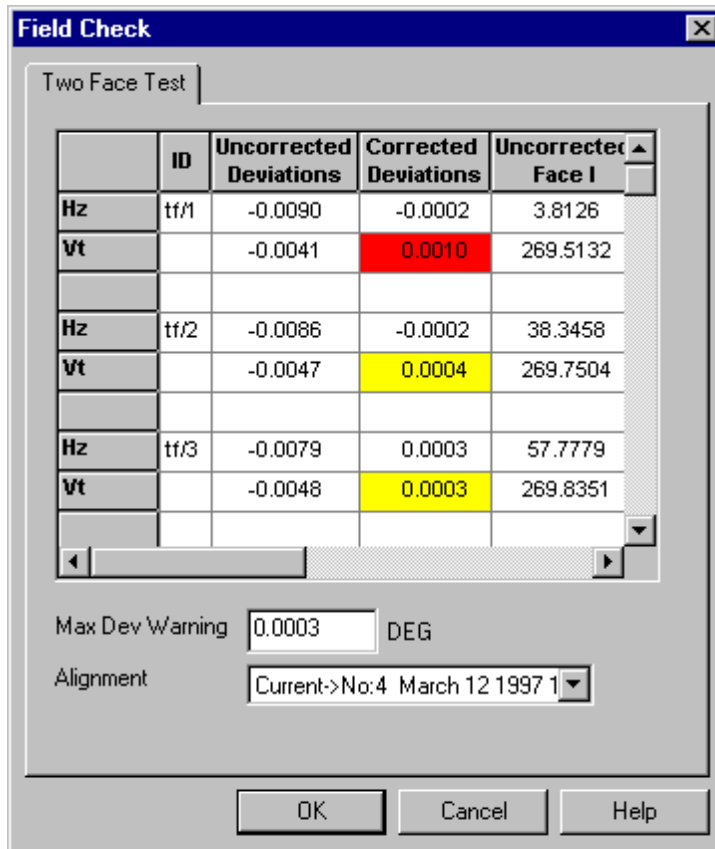
LTM Setup - Check 2-face.BMP

ID

This shows the full ID (workpiece name/point name) of the point to which 2-face measurements were made.

Hz and Vt deviations and values

For each point, deviations indicate the differences between left and right horizontal circle pointings and left and right vertical circle pointings as follows:

(Horiz. angle face left) - (Horiz. angle face right)
(Zenith angle face left) - (Zenith angle face right)

In one case the deviations are uncorrected and in the other they are corrected using the selected set of alignment parameters.

Additional grid elements show the actual corrected and uncorrected horizontal and zenith (vertical) angles for faces I and II.

Max dev warning

Set a threshold level here to colour-code the results of the corrected deviations. Colours are defined in **Tracker Warnings** and conform to 3 deviation bands:

Result	Colour code
Deviation below threshold	No colour
Deviation 1x - 2x threshold	As defined for this band, e.g. yellow
Deviation > 2x threshold	As defined for this band, e.g. red

Display units

Currently only degrees can be displayed.

Alignment

A drop-down list shows the existing sets of parameters which define the tracker model. Normally the current set is appropriate but older sets can be applied.

7.14 Field check calc: ADM instrument

Field check calc: ADM inst. command (**Setup menu**)   **Alt,S,C,A**
"ADM check method"
This function is not available if the instrument only has IFM.

This checks the offset and scale parameters for the Absolute Distance Meter (ADM). These are applied to absolute distance measurements to make them compatible with IFM measurements. The analysis is based on all the IFM/ADM check pairs in the database which were recorded with a corner cube reflector.

To make the necessary ADM/IFM measurement pairs you must switch to the appropriate measuring mode and record suitable pointings with an air-path corner-cube reflector.

If there are significant differences, one of the following problems may exist:

1. The IFM distance is incorrectly initialized. Check the Home Point (Birdbath) distance and, if necessary, re-calibrate it using the 2-point method. See "IFM dist: Two Point" on page 157.
2. The ADM instrument parameters may be incorrect. They can be re-set in the Align menu. See "ADM offsets: Instrument" on page 161.

To review the concept of ADM parameters, see "Calculating the ADM instrument parameter" on page 153.

For general guidance on how to make field checks, see "Make a complete field check" on page 197.

Shortcuts

Toolbar:	none
Keys:	none

7.14.1 Dialogue/Results box: ADM distance

ADM Distance

Max Deviation -0.005 [mm]   Ave Deviation 0.003 [mm]

ID	IFM	ADM Corrected	Deviation	Use	ADM Temp
adm/1	2102.887	2102.892	-0.005	☒	27.9
adm/2	4279.502	4279.501	0.001	☒	27.9
adm/3	8687.051	8687.046	0.004	☒	27.9
adm/4	11530.088	11530.085	0.004	☒	27.9
adm/5	14246.333	14246.333	0.000	☒	27.9
adm/6	17596.235	17596.240	-0.004	☒	27.9

Max Dev Warning 0.002 [mm]		Ave ADM	27.9 [C]
Station Number 1 ▼		ADM Offset	679.332 [mm]
ADM Current ▼		ADM Scale	0.999999860

Close   Save   Graph...   Help

LTM Setup - ADM dist 01.BMP

The ADM measurements are modified with an offset and a scale factor to give a best fit to the corresponding IFM measurements.

Max deviation

The maximum deviation between a corrected ADM value and the corresponding IFM value.

Ave deviation

The average value of the deviations between the corrected ADM values and the corresponding IFM values.

ID

The list of test points where IFM and ADM measurement pairs were made using an <u>air-path corner cube</u> reflector.

IFM

The IFM measurements at the test points.

ADM corrected

The corrected ADM measurements at the test points.

Deviation

The individual deviations between the corrected ADM values and the corresponding IFM values.

Use

If selected, this point is used in the calculation of the offset and scale parameters. A minimum of 2 points is required and a minimum of 5 is recommended.

ADM temp

The internal temperature reading which is used to compensate for material expansion inside the tracker.

Max dev warning

The value here is a threshold value used for colour-coding the list of deviations.

Station number

Select the station from which the test points have been measured.

ADM

This provides a list of calculated parameter sets (offset + scale values). "Current" is the calculation which applies to the currently selected data. This is <u>not</u> the currently active parameter set.

Ave ADM

This is the average internal temperature.

ADM offset

This is the offset calculated to give a best fit between ADM and IFM values.

ADM scale

This is the scale factor calculated to give a best fit between ADM and IFM values.

Graph button

Click this button for a graphical display of the deviations.

Save button

This button is only active when the dialogue box is called from the **Align** menu.

Click the button to save the results of the current calculation as a new set of ADM parameters. The parameters will be stored with a sequential set number and the current date.

This action automatically implements the parameters which immediately affect any future measurements.

7.14.2 Dialogue box: graphical display of ADM check
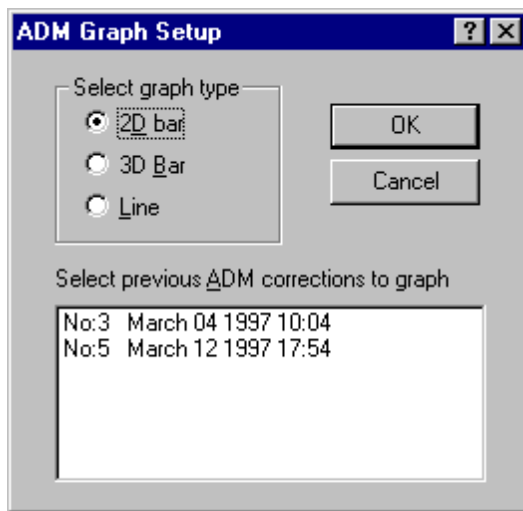
LTM Setup - ADM dist 03.BMP

Select graph type

Select your preferred display format here.

Select previous ADM corrections to graph

Every time ADM corrections are calculated the parameters are stored. You may select previous parameters sets here.

7.15 Field check calc: ADM reflectors

Field check calc: ADM refl. command **(Align menu)   Alt,S,C,R**
"Select ADM measure reflector check type"

This function is not available if the instrument only has IFM.

This checks the internal reflector constant (additive constant) for a particular reflector when used with the Absolute Distance Meter (ADM).

A distance measurement to an air-path corner cube always corresponds to a measurement to the actual corner point, i.e. there is a zero internal offset. However when measuring to a glass prism retro-reflector the effect of the glass is to create an apparent increase in the true distance measurement to the corner point. This depends on the refractive index of the glass and the physical dimensions of the reflector. This additive constant must therefore be calculated for different reflector types.

IFM distances are used as reference values for comparison with ADM distances to the reflector measured at several locations. The reflector

constant is calculated to make the ADM values match the IFM values as closely as possible.

To make the necessary ADM/IFM measurement pairs you must switch to the appropriate measuring mode and record suitable pointings.

To review the concept, see "Calculating internal reflector offsets for the ADM" on page 153.

For general guidance on how to make field checks, see "Make a complete field check" on page 197.

Shortcuts
Toolbar: none
Keys: none

7.15.1 Dialogue box: ADM reflector offset
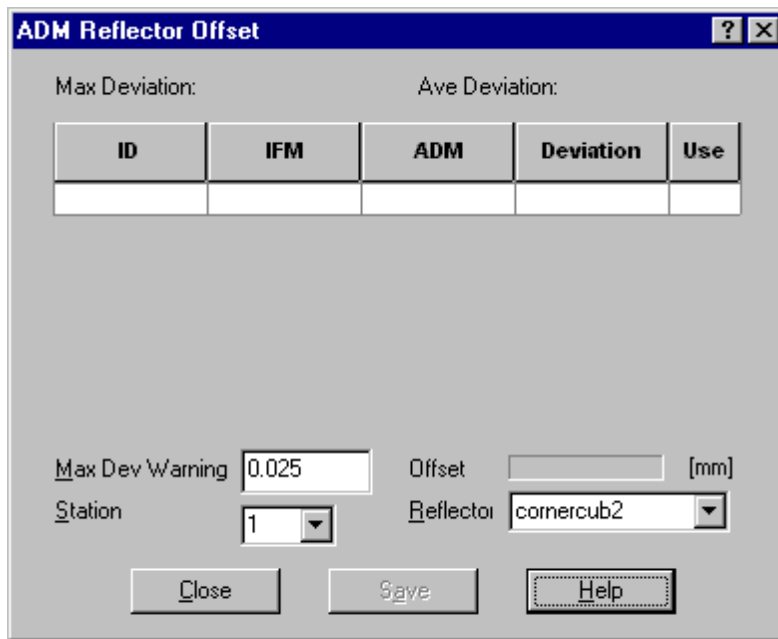
LTM Align - ADM reflector.BMP

Max deviation

The maximum deviation between a corrected ADM value and the corresponding IFM value.

Max dev warning

The value here is a threshold value used for colour-coding the list of deviations.

Ave deviation

The average value of the deviations between the corrected ADM values and the corresponding IFM values.

ID

The list of test points where IFM and ADM measurement pairs were made using a reflector of the selected type from the selected station.

IFM

The IFM measurements at the test points.

ADM

This shows the actual ADM reading, not corrected by a reflector offset.

Deviation

The individual deviations between the ADM values and the corresponding IFM values.

Use

If selected, this point is used in the calculation of the offset. A minimum of 1 point is required and a minimum of 5 is recommended.

Station

Select the station from which the test points have been measured.

Offset

This is the offset which gives a best fit between ADM and IFM values.

Reflector

Select the type from the drop-down list. Only IFM/ADM measurement pairs made with this reflector type will be extracted from the database.

Save button

Click this button to define the calculated offset as the ADM offset for this reflector type.

7.16 Field check calc: IFM

Field check calc: IFM command **(Setup menu)**   **Alt,S,C,I**
"Check interferometer starting point using two point method"

This checks the Home Point (Birdbath) distance for a particular reflector. This is an instrument parameter which can be used to initialize the IFM distance for that reflector.

The analysis is based on the two point method. This involves first measuring the same separation between two points from two stations or measuring the separation from one station with the points in two different orientations.

To review the concept for the Birdbath distance, see "Calculating the Home Point (Birdbath) distance" on page 141.

For general guidance on how to make field checks, see "Make a complete field check" on page 197.

Shortcuts
  Toolbar: none
  Keys: none

7.16.1 Dialogue/Results box: Two point distance
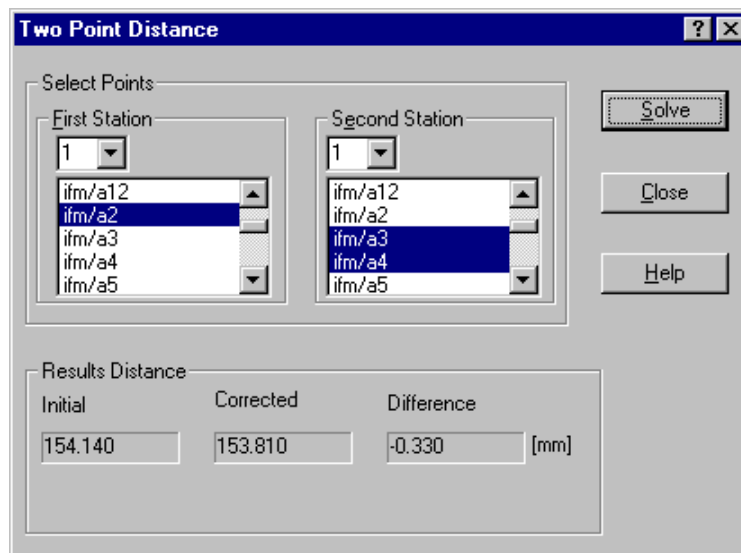
LTM Setup - IFM dist.BMP

Select points

Select a station and a pair of points for each part of the test.

Results distance

The initial value is the current Birdbath distance.
The corrected value is the calculated Birdbath distance.
The difference between these values is displayed.

Solve button

Click this button to calculate the new Birdbath distance. This button is
only active when 2 points are selected at each station.

Accept button

Only active when the dialogue box is called from the **Align** menu. Click
this button to re-set the Birdbath distance to the new calculated value. This
new value then becomes immediately active and the distance to the current
reflector position is re-calculated.

Reject button

Only active when the dialogue box is called from the **Align** menu. Click
this button to reject the results of the calculation.

7.17 Location point

Location point command **(Setup menu)**   **Alt,S,L**
"Enter or check a location point"
This is a dual purpose box which can either be used to lock onto the
reflector at a particular location and/or check the coordinates at that
location. You may specify a location in 3 ways:
• Use the Home Point (Birdbath)
• Use an existing point, defined either by coordinates (x,y,z) or measured
  values (h,v,d)
• Manually define the point by coordinates

If the instrument has an ADM, this is automatically used to measure
distance to the location. However the reflector must be further than the
minimum ADM distance (approx. 2m) for this to work.

Shortcuts
  Toolbar: none
  Keys: F6

7.17.1 Dialogue box: Location point
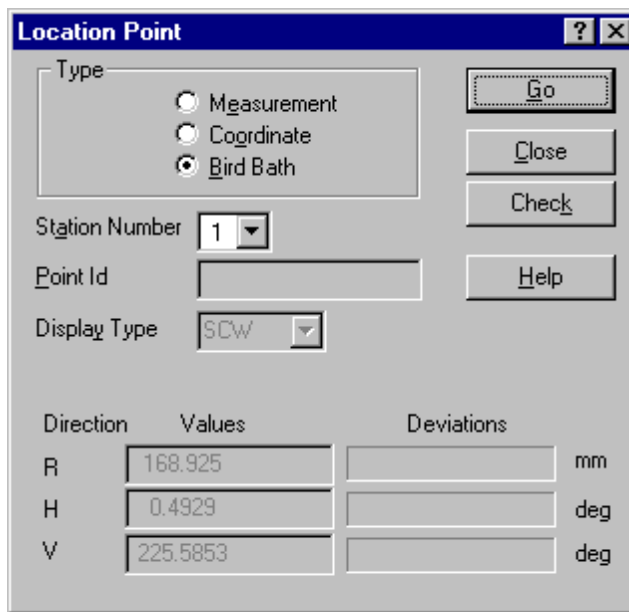
LTM Setup - Loc pt.bmp

Station number

In the drop-down list, highlight the station from where the reflector is to be located.

Type

Measurement
Select this option if the location is to be found using a previous measurement (h,v,d). In this case the tracker will approach the point in the same way as previously. (This may be useful to avoid hitting the mechanical stops.)

Coordinate
Select this option if the location is to be found using its current coordinates (x,y,z). A corresponding pointing (h,v,d) will be computed using these values and the location and tilt of the tracker. This pointing will be used to find the reflector.

Note
The horizontal angle is always computed in the range ±180°. This may mean that the tracker approaches the point from a different direction to the first measurement.

Birdbath
Select this option to lock onto the reflector in the Birdbath.

Point ID

Specify the name of a previously measured location by direct entry or selection from the database. To select from the database use a right mouse click to get a popup menu which offers **Select ID.**

If the selected position is the Birdbath, this field is greyed out.

Display type

Choose the coordinate type for displaying check results or manually specifying the location.

Direction values and deviations

These fields are greyed out if the Birdbath is the chosen location.

If an existing point in the job file is used, the "Values" column shows the position as defined in the database and the "Deviations" column shows the differences with the actual reflector location.

If a point is defined manually, enter coordinates in the "Values" column. The "Deviations" column then shows the differences with the actual reflector location.

Deviation = Existing definition - Actual measurement

If an IFM is used the actual distance to the reflector is set equal to the existing calculated or defined distance.

Go button

After specifying the location procedure, click this button to move to the defined point.

Check button

If tracking enabled this calculates the difference between the specified values and the values measured after the reflector is found.

7.18 Tracker Warnings

Tracker Warnings command **(Setup menu)**   **Alt,S,W**
"Set or change warning displays and colours"

Tracker warnings are used to visually highlight critical conditions or measurements which are above or below error limits defined by the user. Background colours are used as the visual warning cue and the relevant information is displayed in a measurement window.

Note
Colours defined here are independent of warning colours for analysis functions, as defined in the Core Data Module (CDM).

Shortcuts
Toolbar: none
Keys: none

7.18.1 Dialogue box: Tracker warnings
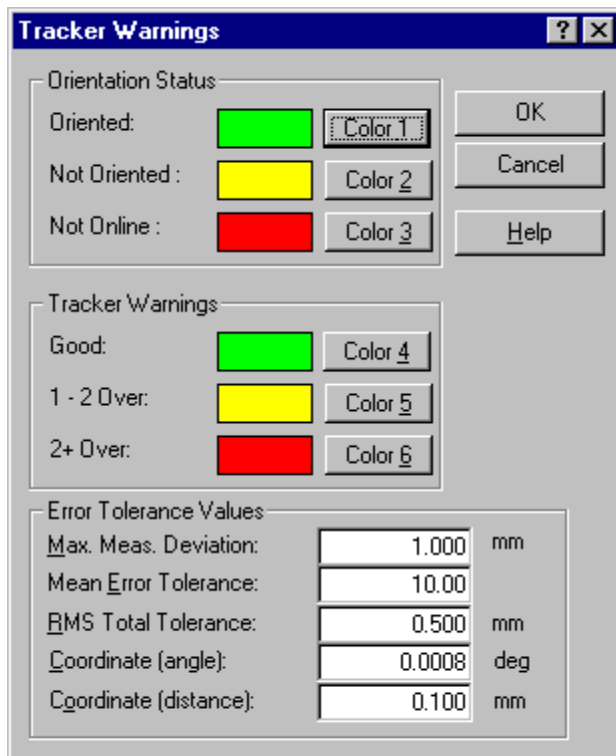
LTM Setup - Trk warn.bmp

Orientation Status

Oriented
The station is oriented

Not oriented
The station has not yet been oriented. It may or may not have sufficient measurements to enable an orientation to be calculated.

Not online
The station is not on line. It may or may not be oriented.

Colour buttons
Colours for each status can individually be set by accessing the colour palette with the colour button.

Tracker Warnings

Colour-coded warnings relate to **error tolerance values** as follows:

Good
The value is less than the warning limit defined as the tolerance.

1 - 2 over
The value is between one and two times the tolerance.

2+ over
The value is more than twice the tolerance.

Colour buttons
Colours for each of the 3 levels can individually be set by accessing the colour palette with the colour button.

Error tolerance values

Max. meas. deviation
For stationary point measurement by direct measurement the averaged location is compared with the individual locations. The lengths of the individual spatial offsets are calculated and the maximum value extracted.

For stationary point measurement by:
- Circle fit
- Sphere fit

The residuals of the best fitting circles or spheres are calculated.

In all 3 cases, this is the error tolerance for the maximum deviation.

Mean error tolerance

For stationary point measurement by:

- Circle fit
- Sphere fit

These use standard circle and sphere fitting routines which can generate a mean error (variance factor). This is the error tolerance for the variance factor.

RMS total tolerance

For stationary point measurement by:

- Direct measurement
- Circle fit
- Sphere fit

The RMS of all the deviations in these 3 cases is calculated. This is the error tolerance for the RMS value.

Coordinate (Angle)

This error tolerance is used for angular standard deviation values when results are displayed in a cylindrical or spherical coordinate system.

Coordinate (Distance)

This error tolerance is used for standard deviation values of linear elements. For example:

- Std. dev. of x coordinate in an orthogonal coordinate system
- Distance coordinate in a spherical coordinate system.

7.19 General settings

General settings command (**Setup menu**)   **Alt,S,G**

Make choices here for the following:

Auto Point

After a beam break it may be helpful to automatically point the beam back to a standard location, e.g. the Home Point (Birdbath). Different options are possible.

On-line update rate for the graphics window

Updating the graphics window can absorb system resources. If performance is a problem, the update rate can be reduced.

Shortcuts
Toolbar: none
Keys: none

7.19.1 Dialogue box: General settings
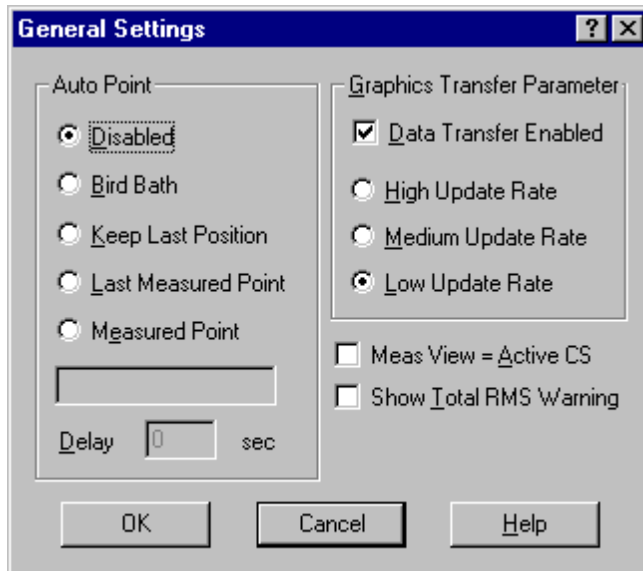
LTM Setup - General.bmp

Auto Point

Select one of the following options for the beam after a beam break.

Disabled
This places the beam in a default position, pointing down.

Birdbath
This points the beam back to the Birdbath.

Keep last position
Only for sensors with ADM (LTD 500).

This maintains the same beam direction when the beam was broken. The reflector can be moved back into the beam to enable tracking. It must then be moved to a stable location to automatically re-set the distance by automatic ADM measurement. This function requires definition of "retry" parameters in the sensor configuration. See "Sensor configuration" on page 64.

Last measured point

This points the beam back to the last measured fixed point. The existing location is used to re-establish distance.

Measured point

This points the beam back to some other point already measured. Enter the point name in the input box. The existing location is used to re-establish distance.

Delay time

This provides a pause between the beam break and re-pointing the beam. This is to gives the operator time to replace the reflector in the recovery position, if required. Relevant for pointing to:

- **Birdbath**
- **Last measured point**
- **Measured point.**

Graphics transfer parameters

Data transfer enabled

If this is not selected, the graphics window will not be updated with new measurements.

The following define how often the graphics window is refreshed with new information:

High update rate

Once every 1/3 second

Medium update rate

Once every 2/3 second

Low update rate

Once every second

Meas view = Active CS

If selected, a new measurement view forces the use of the active coordinate system and no choice is offered, even if other coordinate systems exist in the job file.

If not selected, a new measurement view offers the active coordinate system as the default, but a selection can be made from any others available.

Show total RMS warning

An RMS value is calculated for stationary point measurements. If this option is selected and the tolerance value set under **Tracker Warnings** is exceeded, a warning message is displayed:
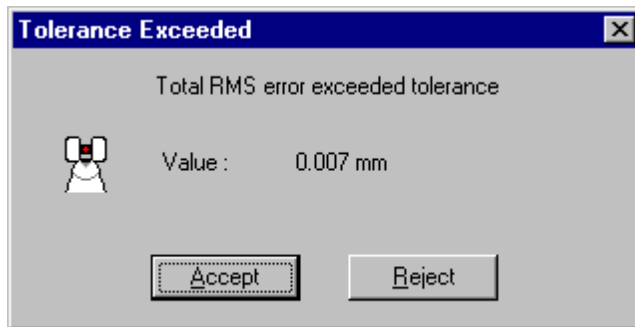
LTM Setup - General - RMS warning.bmp

If **accepted**, the measurement is recorded and the point name incremented for the next measurement. If **rejected** the measurement is not made.

If this option is not selected, then an out-of-tolerance measurement will be automatically recorded. However, if the measurement window is configured for RMS display, the total RMS will be displayed with a warning colour if it is out-of-tolerance. The measurement can then be manually overwritten if required.

7.20 Laser control

Laser control command (**Setup menu**)   **Alt,S,A**

A warm-up phase is required to allow all internal components to stabilize before the tracker can be used for measurement. If the tracker is not in use you may wish to keep it switched on and warm, but this may reduce the life of the laser tube. It is therefore possible to switch the laser independently on or off whilst keeping the rest of the system live.

The warm-up time for the tube itself is only some 15 mins.

The minimum warm-up time of the complete system is 30 minutes but for high precision measurement and tracker alignment, a warm-up time greater than 2 hours is highly recommended. The advantage of the independent switching option is therefore clear.

Shortcuts
Toolbar: none
Keys: none

7.20.1 Dialogue box: Laser control
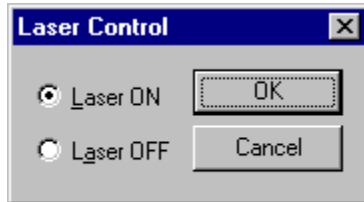
LTM Setup - Laser control.bmp

Select either **ON** or **OFF** and click the **OK** button to implement the selection.

You will be warned about the resultant warm-up time as follows:
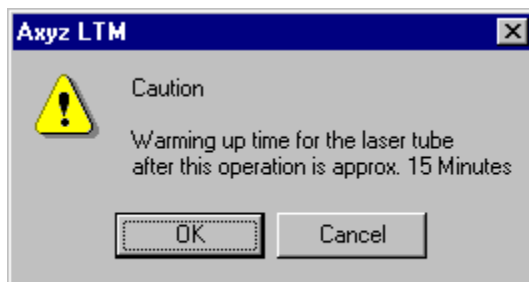
LTM Setup - Laser control caution.bmp

Again select **OK** to implement the action.

8. Measure menu

8.1 Define

Define command (**Measure menu**)   **Alt,M,D**

"Enter point ID or other parameters for measurement"
This is a general purpose menu which is used to set the operational
parameters for all measurement modes. Operational parameters mainly
relate to <u>how</u> a measurement is executed, e.g. how many points per second
are to be averaged to generate a representative value. Mode menus
themselves generally specify <u>what</u> is to be measured, e.g. the list of points
for auto inspection.

This section presents the tab options as they relate to a particular
measurement method.

Note
The measurement method will be defined on entry to this menu option
but can also be changed within the dialogue box.

Shortcuts

Toolbar:

Keys: F5
Right click: in measurement window

8.1.1 Tab restrictions
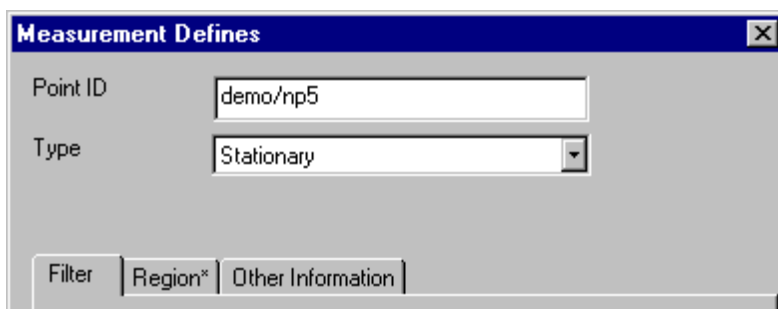
LTM Measure - Tab restrictions.bmp

Some tab options do not apply to certain measurement modes and methods.
The tabs are then marked with an asterisk (*) and are not accessible.

The example shows that stationary point measurement does not have
access to the **Region** tab since the parameters on this tab do not apply to
stationary measurement.

8.1.2 Append to set

A number of recording modes allow you to append measurements to an existing set. The counter identifying individual elements of a set normally increases by 1 for each measured point. If you keep breaking off measurement and then appending new data, this counter will jump by 10 for the start of each new subset. This provides a way of identifying breaks when creating a set

8.1.3 Filter tab (stationary point by direct measurement)

LTM Measure - Def stationary.BMP

For stationary point measurement by IFM, the data stream can be filtered by time interval only, since filtering by a change of distance is not relevant to a fixed reflector. Only a defined number of data items is accepted.

Results are averaged to a single representative measurement.

Point ID

Enter the ID of the point to be measured.
If a workpiece name is not entered, the currently active workpiece will be used.

Time separation

This filters the tracker data according to a time interval. Set the interval between filtered measurements.

Measurement count

For this type of measurement, data can only be recorded for a set number of measurements.

Number
Specify a fixed number of measurements.

Read ADM distance

If ADM is available, select this option to measure the reflector centre by ADM. This re-sets the IFM and then makes the distance measurement.

8.1.4 Filter tab (stationary point by sphere and circle measurement)

LTM Measure - Def. cir,sph.BMP

The following possibilities only apply to stationary measurement using the sphere centre and circle centre methods.

Point ID

Enter the ID of the point to be measured.

If a workpiece name is not entered, the currently active workpiece will be used.

Collection interval

This sets the basic data collection rate from the tracker, which is further filtered by the **Filter specifications.**

Set the interval between measurements.
- For LT500/LTD500 - minimum interval is 0.001 sec.
- For LT300 – minimum interval is 0.002 sec.

This interval cannot be set if a **Time separation** is defined.

Time separation

This filters the tracker data according to a time interval. Set the interval between filtered measurements.
- For LT500/LTD500 - minimum interval is 0.001 sec.
- For LT300 – minimum interval is 0.002 sec.

Individual dist

Data can be filtered by specifying how much the reflector's individual coordinates must change between measurements.

CS Type
Select the type of coordinates used to specify changes.

X,Y,Z (or corresponding axis labels)
Specify the coordinate changes here which will cause another measurement to be taken from the data stream.

Total dist

Data can be filtered by specifying the total (vector) change of distance which will cause another measurement to be taken from the data stream.

Measurement count

For this type of measurement, data can only be recorded for a set number of measurements.
Number
Specify a fixed number of measurements.

Clear button

This re-sets all distance criteria to zero.

Fix radius

When calculating a best-fitting sphere or circle, the corresponding radius may be either calculated (if not already known) or may be held fixed at a particular value (if known).

Select this option to hold the radius fixed. Enter the value in the corresponding box.

8.1.5 Filter tab (continuous measurement)
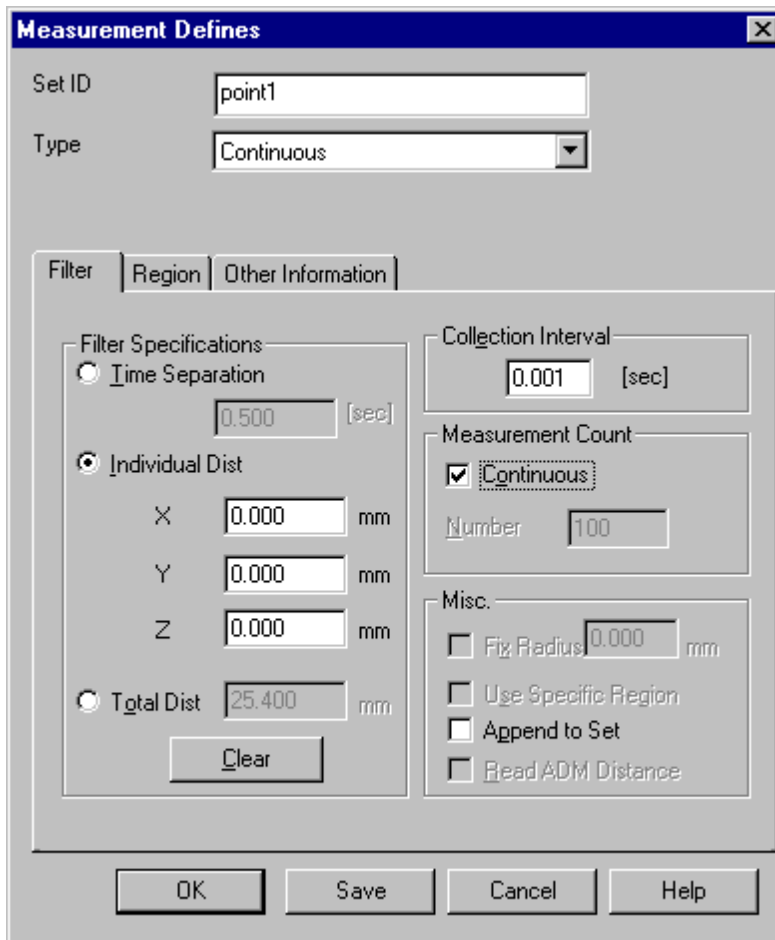
LTM Measure - Def. cont.BMP

The following possibilities only apply to continuous measurement. Continuous measurement generates a **measurement set**.

Set ID

Enter the ID of the set to be measured.

Collection interval

This sets the basic data collection rate from the tracker, which is further filtered by the **Filter specifications.**

Set the interval between measurements.
Set the interval between measurements.
- For LT500/LTD500 - minimum interval is 0.001 sec.
- For LT300 – minimum interval is 0.002 sec.

This interval cannot be set if a **Time separation** is defined.

Time separation

This filters the tracker data according to a time interval. Set the interval between filtered measurements.
- For LT500/LTD500 - minimum interval is 0.001 sec.
- For LT300 – minimum interval is 0.002 sec.

Individual dist

Data recording is triggered by a defined distance change along each axis. A zero value for this distance means that changes in this direction will not cause data recording.

The origin of the coordinate system chosen for the measurement window defines the starting point for measuring change, as well as the axial directions.

Each distance change effectively defines a set of parallel planes, perpendicular to the corresponding axis and separated by the specified value. As the reflector moves through the planes a measurement is triggered.

Total dist

Data can be filtered by specifying the total (vector) change of distance which will cause another measurement to be taken from the data stream.

Measurement count

After initiating data recording, filtered data can be either recorded continuously until explicitly stopped or recording can finish after a set number of measurements have been filtered out of the data stream.

Continuous
Select this option for continuous measurement.

Number
Select this option to record a fixed number of measurements.
When **Continuous** is selected, **Number** is not available. Cancel **Continuous** to select **Number** by entering a number of measurements.

Clear button

This re-sets all distance criteria to zero.

Use specific region

You can define the volume of the workspace where you want measurements to be recorded. This may be a spherical volume or a rectangular box and measurements may be recorded outside or inside this volume.

Select this option if you want to define a specific region for recording data.

The region itself is define on the **Region** tab.

Append to set

If the current data set uses an existing identifier you can either overwrite the existing data or append the new data to it.

Select this option to append the data set to any existing data set with the current identifier.

8.1.6 Filter tab (grid measurement)
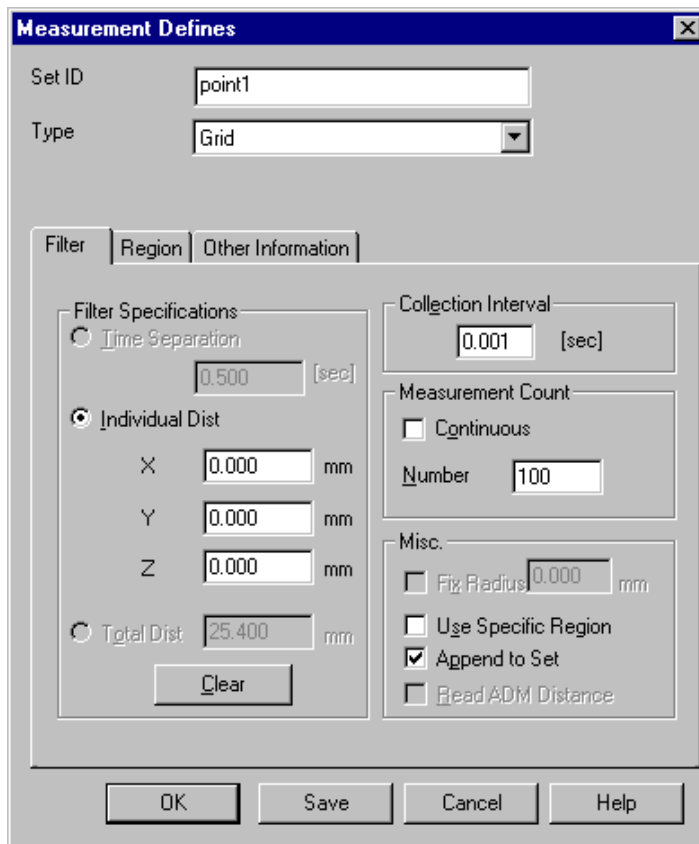
LTM Measure - Def. grid.BMP

In grid measurement a 3D grid of planes is defined. Every time the reflector moves through a surface a point is recorded.

Grid and recording parameters are defined on this tab. Since data is filtered by spatial separation, there is no option to filter data by time separation.

Set ID

Enter the ID of the set to be measured. A default workpiece name "grid" is offered.

Collection interval

This sets the basic data collection rate from the tracker, which is further filtered by the **Filter specifications.**

Set the interval between measurements.
- For LT500/LTD500 - minimum interval is 0.001 sec.
- For LT300 – minimum interval is 0.002 sec.

Individual Dist

Data recording is triggered by a defined distance change along each axis. A zero value for this distance means that changes in this direction will not cause data recording.

The origin of the coordinate system chosen for the measurement window defines the starting point for measuring change, as well as the axial directions.

Each distance change effectively defines a set of parallel planes, perpendicular to the corresponding axis and separated by the specified value. As the reflector moves through the planes a measurement is triggered.

Measurement count

After initiating data recording, filtered data can be either recorded continuously until explicitly stopped or recording can finish after a set number of measurements have been filtered out of the data stream.

Continuous
Select this option for continuous measurement.

Number
Select this option to record a fixed number of measurements.

When **Continuous** is selected, **Number** is not available. Cancel **Continuous** to select **Number** by entering a number of measurements.

Clear button

This re-sets all distance criteria to zero.

Use specific region

You can define the volume of the workspace where you want grid measurements to be recorded. This may be a spherical volume or a rectangular box and measurements may be recorded outside or inside this volume.

Select this option if you want to define a specific region for recording data. The region itself is defined on the **Region** tab.

Append to set

If the current data set uses an existing identifier you can either overwrite the existing data or append the new data to it.

Select this option to append the data set to any existing data set with the current identifier.

8.1.7 Filter tab (build measure)

LTM Measure - Def. build meas.BMP

These settings are required to define how the build points are measured during a build process.

Point ID

Not required. When a build point is measured the recorded point uses the workpiece ID and point ID of the reference point.

Collection interval

This sets the basic data collection rate from the tracker, which is further filtered by the **Filter specifications.**

Set the interval between measurements.
- For LT500/LTD500 - minimum interval is 0.001 sec.
- For LT300 – minimum interval is 0.002 sec.

This interval cannot be set if a **Time separation** is defined.

Time separation

This filters the tracker data according to a time interval. Set the interval between filtered measurements.

- For LT500/LTD500 - minimum interval is 0.001 sec.
- For LT300 – minimum interval is 0.002 sec.

Individual dist

Not relevant here.

Total dist

Not relevant here.

Measurement count

Select **Continuous** for continuous measurement.

8.1.8 Filter tab (build display)
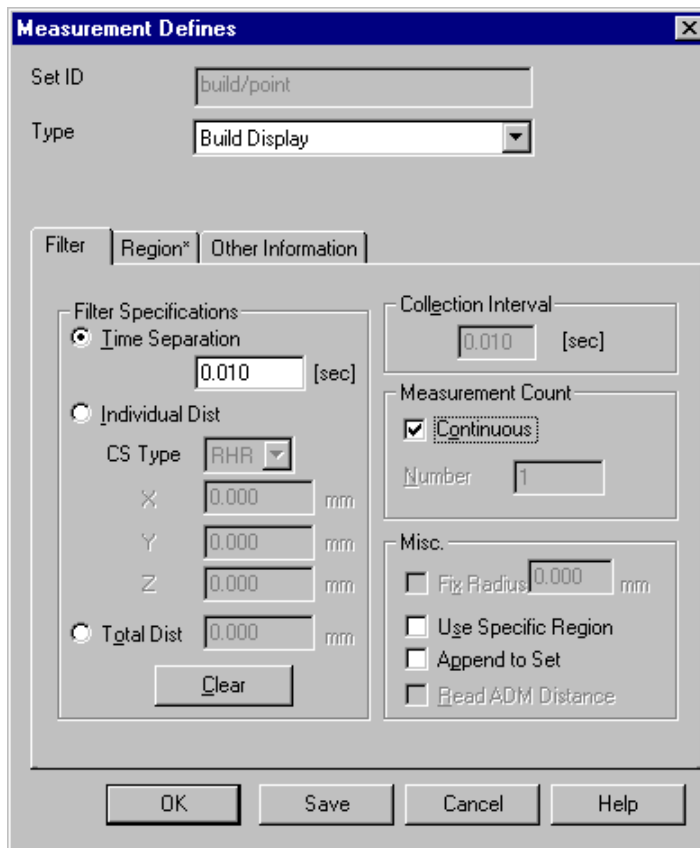
LTM Measure - Def. build disp.BMP

These settings are required to define the continuous display parameters used during a build process.

Set ID

Not relevant here.

Collection interval

This sets the basic data collection rate from the tracker, which is further filtered by the **Filter specifications.**

Set the interval between measurements.
- For LT500/LTD500 - minimum interval is 0.001 sec.
- For LT300 – minimum interval is 0.002 sec.

This interval cannot be set if a **Time separation** is defined.

Time separation

This filters then displayed tracker data according to a time interval. Set the interval between filtered measurements.
- For LT500/LTD500 - minimum interval is 0.001 sec.
- For LT300 – minimum interval is 0.002 sec.

Measurement count

Select **Continuous** for continuous measurement.

Individual dist

Not relevant here.

Total dist

Not relevant here.

Use specific region

Not relevant here.

Append to set

Not relevant here.

8.1.9 Filter tab (on-line comparison)
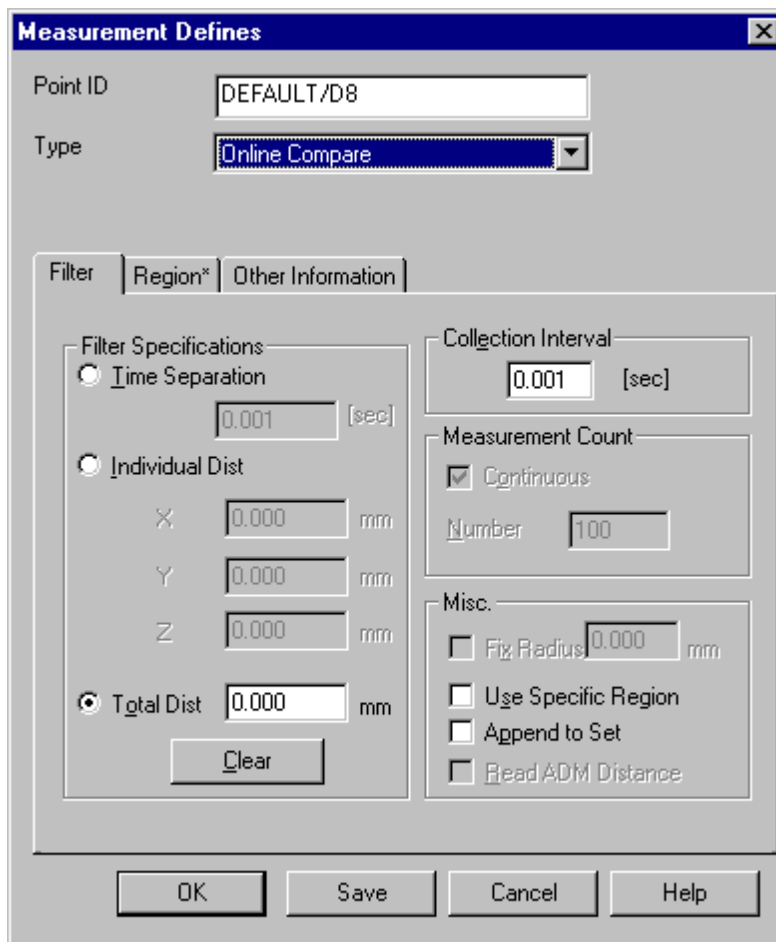
LTM Measure - Def. on-line compare.bmp

On-line comparison is the continuous measurement of a set of points which are automatically compared with a CAD surface as soon as each point is recorded.

Point ID

Enter the ID of the set to be measured.

Collection interval

This sets the basic data collection rate from the tracker, which is further filtered by the **Filter specifications.**

Set the interval between measurements.
- For LT500/LTD500 - minimum interval is 0.001 sec.
- For LT300 – minimum interval is 0.002 sec.

This interval cannot be set if a **Time separation** is defined.

Time separation

This filters the tracker data according to a time interval. Set the interval between filtered measurements.

- For LT500/LTD500 - minimum interval is 0.001 sec.
- For LT300 – minimum interval is 0.002 sec.

Individual dist

Data can be filtered by specifying how much the reflector's individual coordinates must change between measurements.

CS Type
Select the type of coordinates used to specify changes.

X,Y,Z (or corresponding axis labels)
Specify the coordinate changes here which will cause another measurement to be taken from the data stream.

Total dist

Data can be filtered by specifying the total (vector) change of distance which will cause another measurement to be taken from the data stream.

Measurement count

Continuous measurement is automatically specified for this mode of operation and cannot be changed. Recording must be explicitly stopped.

Clear button

This re-sets all distance criteria to zero.

Use specific region

You can define the volume of the workspace where you want measurements to be recorded. This may be a spherical volume or a rectangular box and measurements may be recorded outside or inside this volume.

Select this option if you want to define a specific region for recording data.

The region itself is defined on the **Region** tab.

Append to set

If the current data set uses an existing identifier you can either overwrite the existing data or append the new data to it.

Select this option to append the data set to any existing data set with the current identifier.

8.1.10 Filter tab (ball bar measurement)
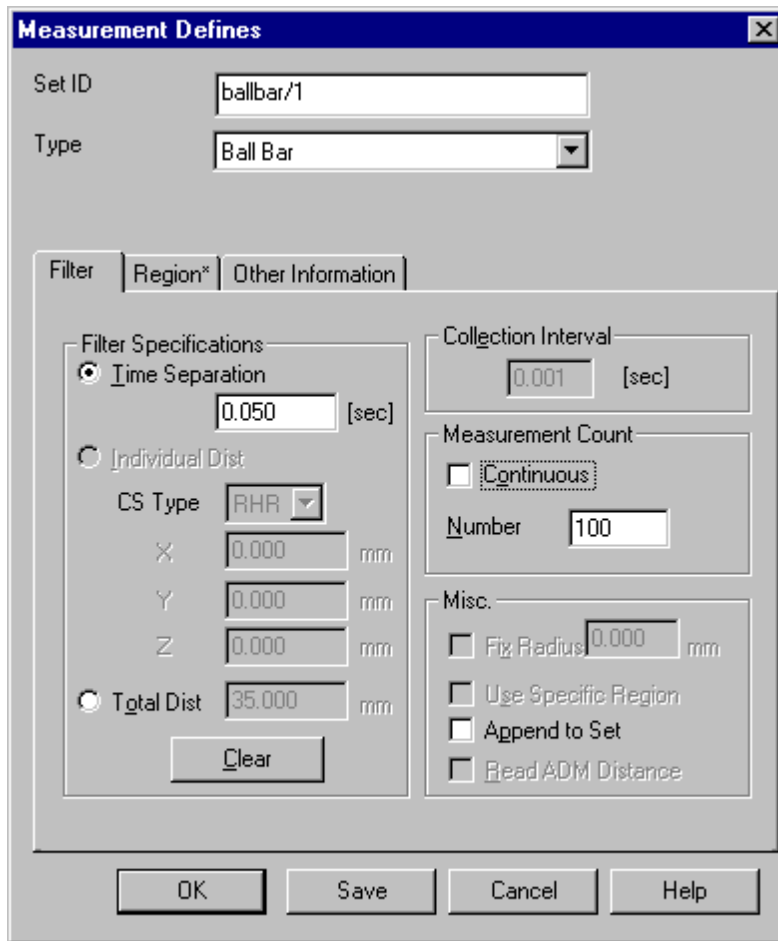
LTM Measure - Def. Ball Bar.BMP

This procedure is designed to record Ball Bar measurements for checking and aligning the tracker.

Set ID

Enter the ID of the set to be measured. A default workpiece name "ballbar" is offered.

Collection interval

This sets the basic data collection rate from the tracker, which is further filtered by the **Filter specifications.**

Set the interval between measurements.
- For LT500/LTD500 - minimum interval is 0.001 sec.
- For LT300 – minimum interval is 0.002 sec.

This interval cannot be set if a **Time separation** is defined.

Time separation

This filters the tracker data according to a time interval. Set the interval between filtered measurements.
- For LT500/LTD500 - minimum interval is 0.001 sec.
- For LT300 – minimum interval is 0.002 sec.

Total dist

Data can be filtered by specifying the total (vector) change of distance which will cause another measurement to be taken from the data stream.

Measurement count

After initiating data recording, filtered data can be either recorded continuously until explicitly stopped or recording can finish after a set number of measurements have been filtered out of the data stream.

Continuous
Select this option for continuous measurement.

Number
Select this option to record a fixed number of measurements.

When **Continuous** is selected, **Number** is not available. Cancel **Continuous** to select **Number** by entering a number of measurements.

Clear button

This re-sets all distance criteria to zero.

Append to set

If the current data set uses an existing identifier you can either overwrite the existing data or append the new data to it.

Select this option to append the data set to any existing data set with the current identifier.

8.1.11 Filter tab (2-face measurement)
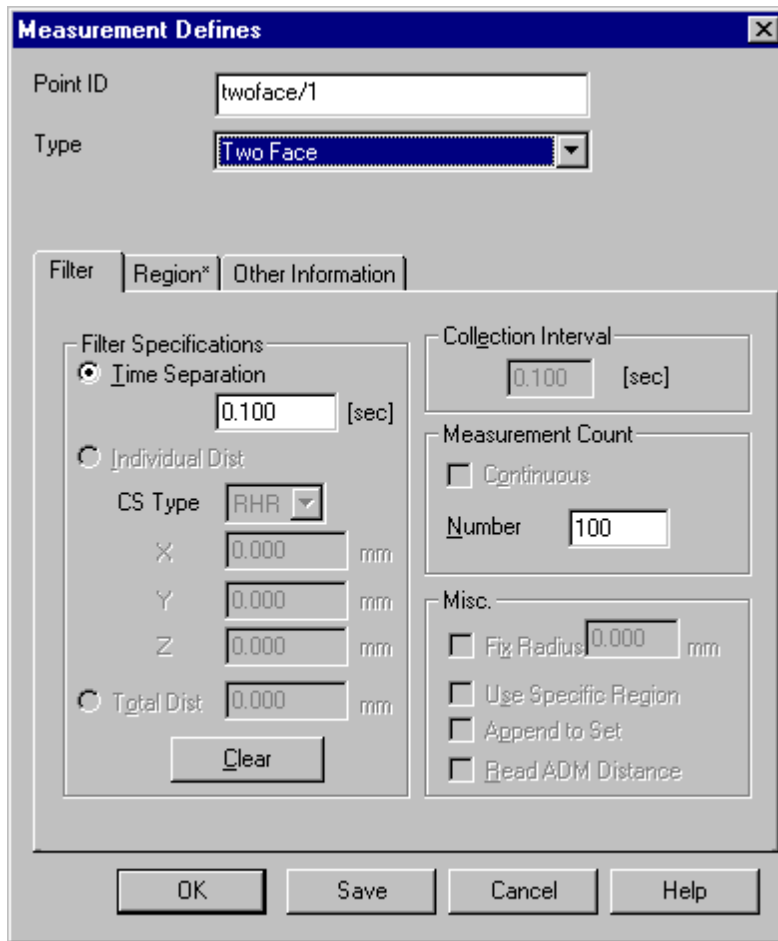
LTM Measure - Def. 2-face.BMP

This procedure is designed to record 2-face measurements in order to compare the angles in each face.

Point ID

Enter the ID of the point to be measured. A default workpiece name "twoface" is offered.

Collection interval

This sets the basic data collection rate from the tracker, which is further filtered by the **Filter specifications.**

Set the interval between measurements.

- For LT500/LTD500 - minimum interval is 0.001 sec.
- For LT300 – minimum interval is 0.002 sec.

This interval cannot be set if a **Time separation** is defined.

Time separation

This filters the tracker data according to a time interval. Set the interval between filtered measurements.

- For LT500/LTD500 - minimum interval is 0.001 sec.
- For LT300 – minimum interval is 0.002 sec.

Measurement count

For this type of measurement, data can only be recorded for a set number of measurements.

Number
Specify a fixed number of measurements.

8.1.12 Filter tab (ADM measurement)

LTM Measure - Def. ADM.BMP

The settings here concern the IFM and angle recording and effectively
specify the number of values which are subsequently averaged to generate
a reading.

However the ADM measurement itself is a single measurement.

Point ID

Enter the ID of the point to be measured. A default workpiece name "adm"
is offered.

Time separation

This filters the tracker data according to a time interval. Set the interval
between filtered measurements. The minimum interval is 0.001 sec.

Measurement count

For this type of measurement, data can only be recorded for a set number
of measurements.

Number

Specify a fixed number of measurements.

Read ADM distance

This option is automatically selected and cannot be altered, since the purpose is to make combined IFM and ADM distance measurements to selected points.

8.1.13 Region tab (continuous and grid measurement)

LTM Measure - Def. region.BMP

All the dynamic scanning methods permit the operator to record data inside a specific volume or region of the working space. This may be a spherical volume or a rectangular box. If a region is not specified, any data within the tracker's reach are potentially relevant.

Type of region

Select either sphere or rectangular box.

Radius

If a spherical region is defined, enter the radius here.

Point

If a spherical region is requested, a single centre point must be defined. Choose an existing measured point by:

- Manual input of name
- Right mouse click in the box for ID 1, then use **Select ID** to choose the point from the database via the Data Manager.

Click the **Query** button to access the coordinates which will be displayed in the X,Y,Z boxes.

Alternatively manually specify the coordinates of a centre point directly in the X,Y,Z boxes.

If a rectangular box is requested, two points defining a diagonal of the box must be defined, e.g. from bottom left to top right. Either point may be specified as an existing point or by manually input coordinate values. Use the same technique as for sphere centre.

If an existing point is chosen from the database but its coordinates altered, then the point name is deleted since the name no longer applies to the specified location.

8.1.14 Other information tab

LTM Measure - Def. other info.BMP

Point

Optionally enter descriptive text to be stored with 3D point data.

Measurement description

Optionally enter descriptive text to be stored with measurement data.

8.1.15 Save button

Saves the settings made on any tab as the default.

8.2 Set point ID

Set point ID command (**Measure menu**)   **Alt,M,I**
"Set the point ID of the next point to be measured"

Here you can re-define the identifier for the next measured point in the
current measurement window.

Shortcuts

    Toolbar: none

    Keys: none

8.2.1 Dialogue box: Set point ID
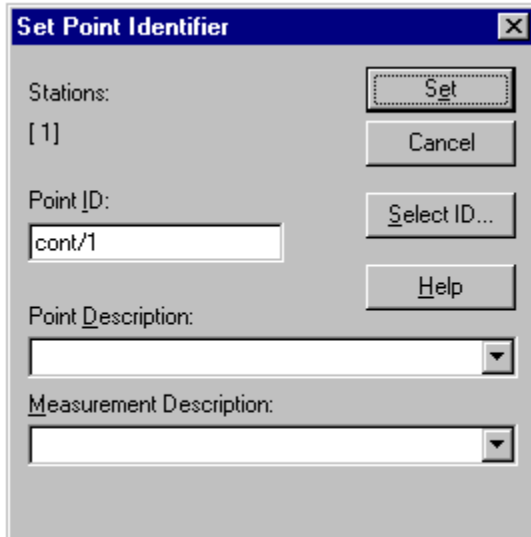
LTM set point ID.BMP

Stations

Indicates the stations assigned to this measurement window.

Point ID

Enter a point ID here or use **Select ID** to choose an existing ID.

Point description

Optionally enter a description for this point.

Measurement description

Optionally enter descriptive text to be stored with the measurements made to this point.

Set button

Click this option to accept the settings.

8.3 Next point

Next point command **(Measure menu)**   **Alt,M,N**
" Next point in Build Points file or next point ID "

Moves to the next point in a Build list, or increments the point ID by 1 for the next point to be measured in normal measurement.

Shortcuts
  Toolbar:
  Keys: F9

8.4 Previous point

Next point command **(Measure menu)**   **Alt,M,P**
" Previous point in Build Points list or next point ID "

Moves to the previous point in a Build list, or decreases the point ID by 1 for the next point to be measured in normal measurement.

Shortcuts
  Toolbar:
  Keys: F10

8.5 Start measure

Start measure command **(Measure menu)**   **Alt,M,M**
"Start measurement and store"

Once a measurement mode or method has been selected and any changes made to the data collection parameters, use this selection to start measurement and record the results in the database.

Shortcuts
  Toolbar:
  Keys: F2

8.6 Try measure

Try measure command **(Measure menu)**   **Alt,M,Y**
"Start measure no storage"

Once a measurement mode or method has been selected and any changes made to the data collection parameters, use this selection to start measurement and display the results.

This is an alternative to **Start** and has the same function <u>except</u> that it does not store any data in the database. It is used simply to make a quick check.

Shortcuts

Toolbar:

Keys: F3

8.7 Pause measure

Pause measure command **(Measure menu)**   **Alt,M,U**
"Pause a measurement process"

This option is only relevant to Auto Inspect in which a set of fixed reflector locations are measured by ADM. If it is not possible to place a reflector at every location the sequence can be paused to permit reflectors from previously measured locations to be moved to the next locations in the sequence.

Shortcuts

Toolbar:

Keys: CTRL+U

8.8 Stop measure

Stop measure command **(Measure menu)**   **Alt,M,P**
"Stop measurement process"

This stops storage or display of any data being continuously recorded.

Shortcuts

Toolbar:

Keys: F4

8.9 Continuous

Continuous command **(Measure menu)**   **Alt,M,N**
"Select continuous type measurement"

This method is used to record a related set of points generated dynamically, such as the sweep of a robot arm or a reflector scanned across the surface of an object.

The method generates a measurement set.

For the corresponding measurement definition see "Filter tab (continuous measurement)" on page 101.

For examples of the measurement window used in this mode, see "Measurement window: " on page 11.

> **Note**
> This option is only available when **Standard mode** is active.

Shortcuts
> Toolbar:
> Keys: none

8.10 Stationary

Stationary command (**Measure menu**)   **Alt,M,A**
"Select stationary type measurement"

This method is used for measuring to a fixed reflector position, either using the IFM or ADM (if available). The pointing is derived by averaging a number of measurements and the averaged measurement is available for use by the Orientation Module and Single Point Solution.

For the corresponding measurement definition see "Filter tab (stationary point by direct measurement)" on page 97.

For examples of the measurement window used in this mode, see "Measurement window: " on page 11.

> **Note**
> This option is only available when **Standard mode** is active.

Shortcuts
> Toolbar:
> Keys: none

8.11 Sphere centre

Sphere centre command (**Measure menu**)   **Alt,M,P**
"Select sphere centre type measurement"

A fixed stationary point such as a hole centre can be measured indirectly with an adapter which has a spherical surface and by scanning a reflector across and in contact with the sphere's surface.

The measured reflector positions also lie on a spherical surface with the same centre as the adapter. This centre is automatically derived from the best-fitting sphere and defines the required point which is assigned the type **entered**.

An equivalent pointing to the sphere centre is not created. A point measured in this way cannot therefore be used by the Orientation Module or Single Point Solution.

For the corresponding measurement definition see "Filter tab (stationary point by sphere and circle measurement)" on page 98.
For examples of the measurement window used in this mode, see "Measurement window: " on page 11.

Note
This option is only available when **Standard mode** is active.

Shortcuts
Toolbar:
Keys: none

8.12 Circle centre

Circle centre command (**Measure menu**)   **Alt,M,C**
"Select circle centre type measurement"

A stepped cylindrical adapter can be used to locate a point indirectly. By scanning a reflector around the step, reflector positions on a circle can be recorded. The centre of the circle lies on the axis of the cylinder. This centre is automatically derived from the best-fitting circle and defines the required point which is assigned the type **entered**.

An equivalent pointing to the circle centre is not created. A point measured in this way cannot therefore be used by the Orientation Module or Single Point Solution.

For the corresponding measurement definition see "Filter tab (stationary point by sphere and circle measurement)" on page 98.

For examples of the measurement window used in this mode, see "Measurement window: " on page 11.

Note
This option is only available when **Standard mode** is active.

Shortcuts
Toolbar:
Keys: none

8.13 Grid

Grid command (**Measure menu**)   **Alt,M,G**
"Select grid type measurement"

In grid measurement a 3D grid of planes or surfaces is defined. Every time the reflector moves through a surface a point is recorded, which means that multiple points can be recorded on the same surface. The technique is similar to continuous measurement by change of coordinate.

This technique creates a **measurement set**.

For the corresponding measurement definition see "Filter tab (grid measurement)" on page 103.

For examples of the measurement window used in this mode, see "Measurement window: " on page 11.

Note
This option is only available when **Standard mode** is active.

Shortcuts
Toolbar:
Keys: none

8.14 Reflector offset correction

Reflector offset correction command (**Measure menu**)   **Alt,M,R**
"Enable or disable reflector offset correction"

The tracker measures to the centre of a reflector but the actual object point of interest may be the contact point between the reflector housing and the object surface or a target adapter on the surface.

This function defines the direction in which the offset must be applied and if it is to be active, i.e. applied to subsequent measurements. Corrections can be applied along the axes of a particular coordinate system or standard shape or perpendicular to the surface of a particular standard shape.

The size of the correction is taken as the radius of the reflector housing, as defined in the database. It is not explicitly entered.

This correction may be combined with target thickness correction.

Shortcuts

Toolbar:

Keys: none

8.14.1 Dialogue box: Reflector offset correction
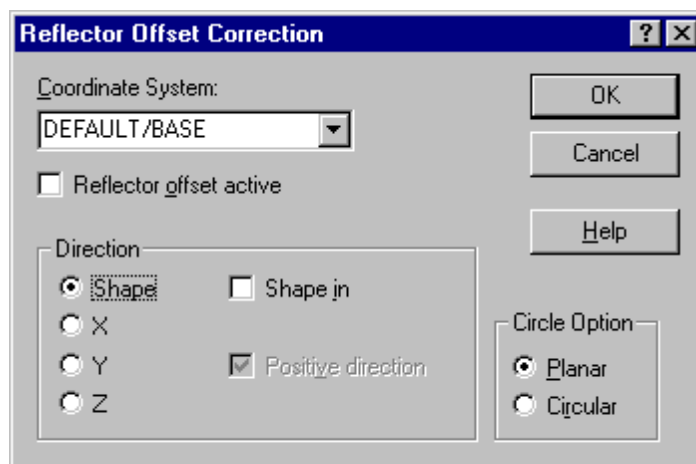
LTM Measure - Refl. offs.BMP

Coordinate system

From the drop-down list, select the name of the coordinate system or shape used for defining the direction of the offset.

Reflector offset active

Select this option to apply the correction to subsequent measurements.

Direction

Choose either:
Shape - perpendicular to the shape surface
X,Y,Z - along the X,Y or Z axis of the selected shape or coordinate system

Shape in
Relevant when correcting to shape surfaces. If the reflector contacts the negative side (inside) of the shape, select this option.

> **Shape surfaces have the following sides:**
> - **Plane, circle**
>   The positive side is the side of the positive local z axis.
> - **Sphere**
>   A point on the positive side is further from the centre than the radius.
>   From the positive side the surface looks convex.
> - **Cylinder**
>   The negative side is on the same side as the axis.
>   From the negative side the surface looks concave. From the positive side it looks convex.
> - **Cone**
>   The negative side is on the same side as the axis.
>   From the negative side the surface looks concave. From the positive side it looks convex.
> - **Paraboloid**
>   The negative side is on the same side as the focus.
>   From the negative side the surface looks concave. From the positive side it looks convex.

Positive direction
Relevant when correcting along axes. Select this option if the reflector is offset in the positive axial direction.

Circle option

If the shape surface is a circle, two directions of correction are possible:

Planar

Select this option to apply the correction perpendicular to the surface of
the circle.

Circular

Select this option to apply the correction along a radius of the circle.

8.15 Target thickness

Target thickness command (**Measure menu**)   **Alt,M,T**
"Enable or disable the target thickness correction"

Object points may be located using target adapters which cause the
reflector centre to be offset from the actual point of interest.
This function defines the direction in which the offset must be applied and
if it is to be active, i.e. applied to subsequent measurements. Corrections
can be applied along the axes of a particular coordinate system or standard
shape or perpendicular to the surface of a particular standard shape.

This correction may be combined with reflector offset correction.

Shortcuts

   Toolbar:
   Keys: none

8.15.1 Dialogue box: Target thickness correction
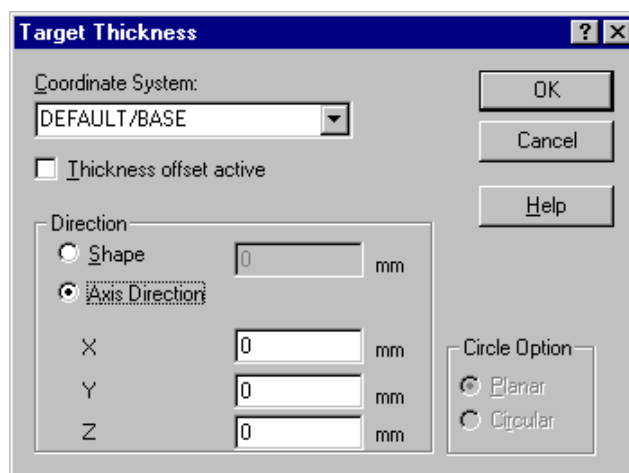
LTM Measure - Targ. thick.BMP

Coordinate system

Select the name of the coordinate system or shape used for defining the
direction of the offset.

Thickness offset active

Select this option to apply the correction to subsequent measurements.

Direction

Choose either:
Shape - perpendicular to the shape surface
Axial direction - along a combination of axial directions defined by the selected shape or coordinate system.

Shape
If shape is selected, specify the amount of correction. The value is positive if the offset is on the outside of the shape.

> **Shape surfaces have the following sides:**
> - **Plane, circle**
>   The positive side is the side of the positive local z axis.
> - **Sphere**
>   A point on the positive side is further from the centre than the radius.
>   From the positive side the surface looks convex.
> - **Cylinder**
>   The negative side is on the same side as the axis.
>   From the negative side the surface looks concave. From the positive side it looks convex.
> - **Cone**
>   The negative side is on the same side as the axis.
>   From the negative side the surface looks concave. From the positive side it looks convex.
> - **Paraboloid**
>   The negative side is on the same side as the focus.
>   From the negative side the surface looks concave. From the positive side it looks convex.

Axis direction
Specify the amount by which the target is offset along each axis. A positive amount means it is offset in the positive direction.

Circle option

If the shape surface is a circle, two directions of correction are possible:

Planar

Select this option to apply the correction perpendicular to the surface of the circle.

Circular

Select this option to apply the correction along a radius of the circle.

8.16 Laser pointer

Laser pointer command (**Measure menu**)   **Alt,M,L**

This command enables the tracker to be used as a simple laser pointer. It can be used to direct the beam at:
- Existing measured single and multiple locations
- Locations defined by manually input coordinates

Unlike commands to find reflectors, this command does not expect a reflector to be present, but if present the tracker can lock onto to it. This requires an ADM measurement to initialize the IFM, since calculating distance from the target coordinates is not guaranteed to be accurate.

Shortcuts

Toolbar: none
Keys: none

8.16.1 Dialogue box: Set and point list tab
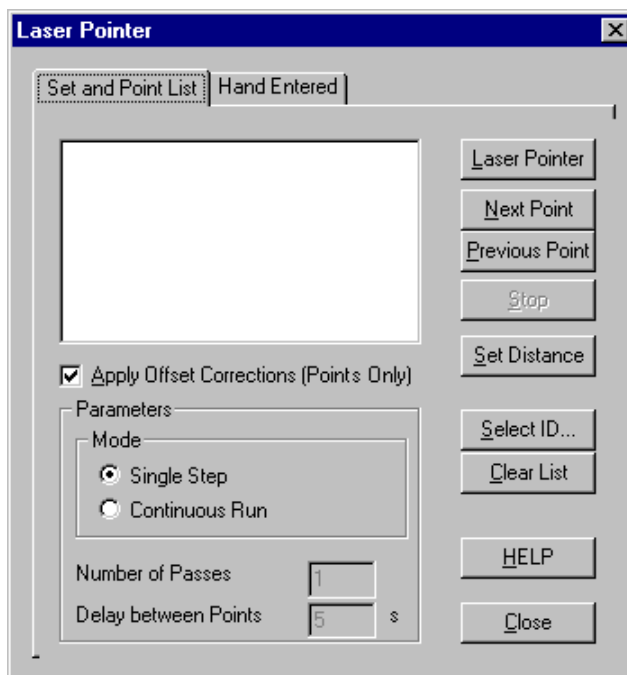
LTM Measure - Laser pointer - Set and point tab.bmp

Use this tab to specify multiple, previously measured locations to be identified by the laser pointer. These locations may be selected from a mixture of single points and sets.

Point list

Click in the list and use either the **Select ID** button or a right click to choose a the points to be identified from the DM. Use CTRL+click to choose a mixture of points from both measured sets and single points.

Use the **Clear List** button to delete the currently listed points.

Select the option to **Apply Offset Corrections** in order to point directly at the feature point of interest, such as a surface point, rather than the original reflector position. (Only applies to single points, not set points.)

Mode

Points in the list can be identified by stepping manually through the specified list, or automatically looping through the list.

Select **Single step** to manually step through the list. The currently identified point can be manually highlighted by directly clicking on the point in the list. Click the **Next point** button to move the pointer to the next point down the list or the **Previous point** button to the next point up the list.

Select **Continous Run** to automatically cycle through the points in the list. This cyclic operation can be stopped at any time by clicking the **Stop** button. A set number of passes through the list can be defined by specifying a positive **Number of passes**. If this value is initially set to zero, the pointer will pass through the list an indefinite number of times, until **Stop** is applied. The pointer will pause at each position for a number of seconds defined in **Time between passes**.

Button: Laser Pointer

Once a target has been defined, click this button to make the beam point at the location.

Button: Set Distance

Only available if ADM present.

Once the laser beam has been pointed, click this button to initialize tracking by setting the IFM distance with the ADM. A reflector must be accurately located at the target position. If this is not the case, the following error is reported:
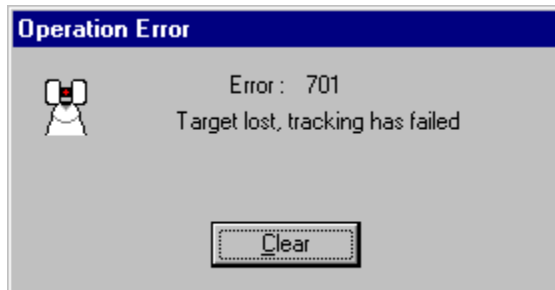
LTM Measure - Laser pointer warning.bmp

8.16.2 Dialogue box: Hand entered tab
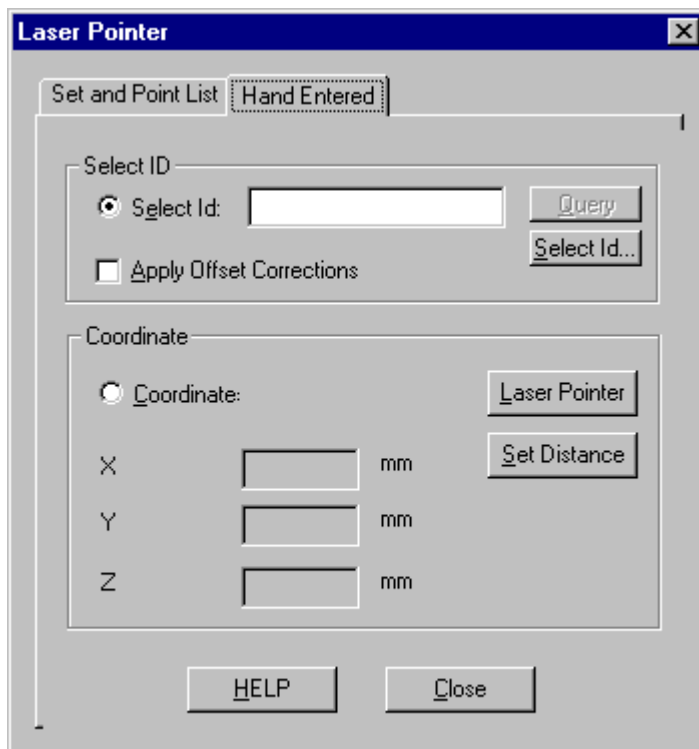
LTM Measure - Laser pointer - Hand enter tab.bmp

Use this tab to specify a single point to be identified by the laser pointer. This may either be a point already recorded or one identified by manually entered coordinates.

Select ID

Select this option to choose a previously measured location already stored in the job file.

Directly type the point name in the input box or use the **Select ID** button or a right-click in the box to select a point from the DM.

When done, optionally click the **Query** button to see the selected point's coordinates displayed in the greyed out X,Y,Z boxes.

Select the option to **Apply Offset Corrections** in order to point directly at the feature point of interest, such as a surface point, rather than the original reflector position.

Coordinate

Select this option to manually define the target coordinates of the point to be located.

Input coordinate values in the X,Y,Z boxes.

Button: Laser Pointer

Once a target has been defined, click this button to make the beam point at the location.

Button: Set Distance

Only available if ADM present.

Once the laser beam has been pointed, click this button to initialize tracking by setting the IFM distance with the ADM. A reflector must be accurately located at the target position. If this is not the case, the following error is reported:
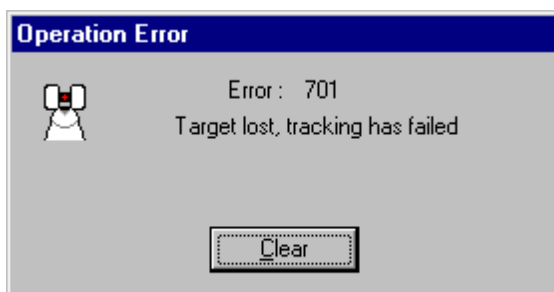
LTM Measure - Laser pointer warning.bmp

8.17 Measure and Set ADM distance

Measure and set ADM distance command (**Measure menu**) Alt,M,S

Only available if ADM present.

Use this command to make an ADM measurement to the current reflector position in order to re-set the IFM. No data is recorded in the job file.

The reflector must be beyond the minimum distance for ADM measurement. If not, the following error message is displayed:
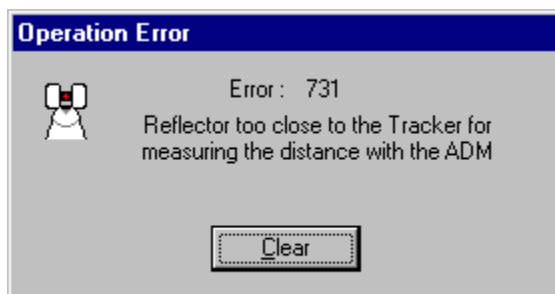
LTM Measure - Set ADM warning.bmp

Shortcuts
   Toolbar: none
   Keys: none

8.18 Go location

Go location command (**Measure menu**)   Alt,M,O
"Lock onto existing point"

This command allows you to place the reflector in a previously measured position and lock onto it. The position may be defined by either coordinate values or a measurement from the appropriate station.

You may explicitly choose the Birdbath as the location.

Note
If the previous position is in error, the tracker will do a spiral search for the reflector. If found it will lock onto the reflector.

Shortcuts
   Toolbar: ⊹
   Keys: F7

8.18.1 Dialogue box: Go location

LTM Measure - Go loc.BMP
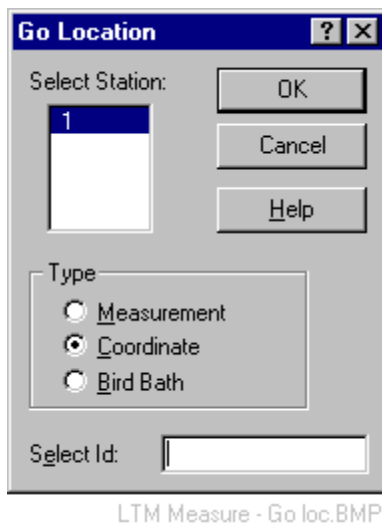
Select station

The list shows the current on-line station.

Type

Measurement
Select this option if the location is to be found using a previous measurement from this station (h,v,d).

Coordinate
Select this option if the location is to be found using its existing coordinates (x,y,z). A corresponding pointing (h,v,d) will be computed using these values and the location and tilt of the tracker. This pointing will be used to find the reflector.

Birdbath
Select this option to lock onto the reflector in the Birdbath.

Select ID

Specify the ID of the corresponding measurement or coordinate values by direct entry or selection from the database. To select from the database use a right mouse click to get a popup menu which offers **Select ID.**

If the selected position is the Birdbath, this field is greyed out.

8.19 Go Birdbath

Go Birdbath command **(Measure menu)**   **Alt,M,B**
"Lock onto reflector in the Birdbath"

This command sets the angular values which define the current location of
the reflector when placed in the Home Point (Birdbath). If the reflector is
in position the beam locks on and the distance is set to the defined
Birdbath value for the current reflector.

Shortcuts
   Toolbar:
   Keys: F8

8.20 Find reflector

Find reflector command **(Measure menu)**   **Alt,M,F**
"Search for and lock onto reflector"

This function is used to set the beam onto a reflector and re-establish the
distance datum for the interferometer (IFM) using the absolute distance
meter (ADM).

The beam is pointed towards the reflector using mouse or key clicks or by
physically moving the mirror. If a video camera is attached this can be
used to help centre on the target.

When close to the reflector a "Find" routine uses a spiral search to detect
and lock onto it. Once the reflector is found the distance is measured by
ADM and used to re-set the IFM.

   Note
   This function is only available to instruments with ADM (LTD 500).

Shortcuts
   Toolbar:
   Keys: F12

8.20.1 Video camera support for Find routine

If a video camera is attached to the system, the mirror will automatically
rotate to provide a camera view when the beam is broken. You must ensure

that the system has been defined with a camera using the sensor configuration. See "Sensor configuration" on page 64.

The camera view is provided either on an external monitor or through an internal video window if the camera is driven by a Coreco Vision "Bandit" video card.

The internal video window offers some additional features as follow:

Left click on video image

This will centre the camera axis on the clicked position. It offers a convenient way to move the camera to a point of interest prior to a fine search for a reflector near that position.

Right click on video image – popup menu

This offers a popup menu.
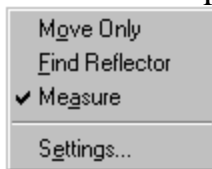
LTM rt click video.bmp

Move only
A left click in the image will centre the camera on the clicked position. No other action.

Find Reflector
A left click in the image will do the following;
- Centre the camera on the clicked position
- Initiate the fine search for a reflector (spiral search)
- Lock onto the reflector
- Set the distance via the ADM

The system is then ready to measure.

Measure
This has the same action as **Find Reflector** but in addition carries out a measurement according to the current settings.

Settings
This option provides a dialogue box for adjusting the internal video window.

8.20.2 Dialogue box: Settings

This dialogue box provides adjustments for the <u>internal</u> video monitor.
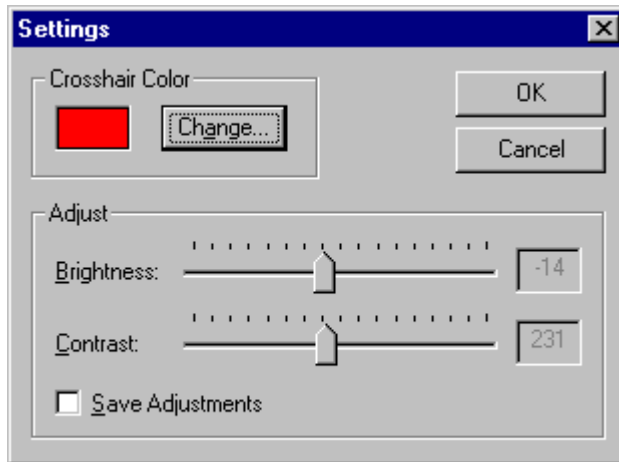
LTM Measure - Video settiings.bmp

Crosshair colour

Click on the **Change** button to obtain the standard Windows colour palette which you can use to change the colour of the crosshairs.
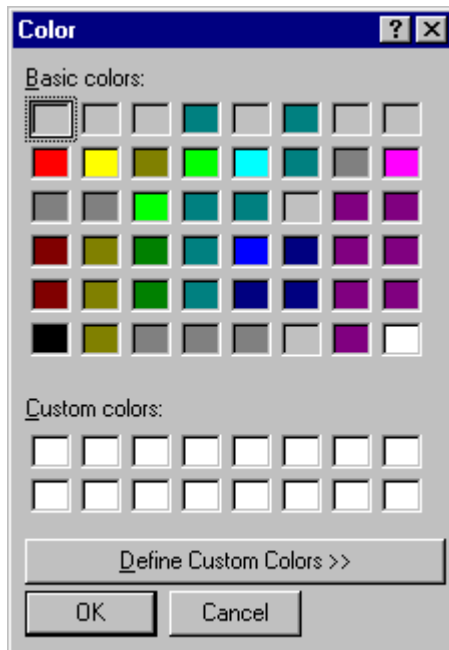
LTM Measure - Video setting colours.bmp

Adjust

There are slider controls to make changes to **brightness** and **contrast**. Make the alterations until the video image is adjusted as you wish.

To save the settings, select the option **Save Adjustments**.

8.20.3 Dialogue box: Find reflector

LTM Measure - Find refl.bmp

Note

You can click and drag the upper or lower edges of this box in order to
hide the lower section **Move Tracker**. The movement commands in this
section are not really required if you have an internal video option
installed.

Station

The number of the current on-line station is shown.

Search diameter

Specify the maximum diameter of the spiral search.

Approx distance in [units]

A rough estimate of distance to reflector is required for the spiral search
mechanism. Click and drag the pointer to a suitable position. Units depend
on the currently active units.

Close on success

Select this option to automatically close the dialogue box when the tracker
is locked onto the reflector.

Button: Release motors

If you want to manually point the mirror, click this button to disengage the head from the motors. You can then turn the head and mirror by hand to point the beam.

Button: Video on/Video off

If you have a video camera connected, click this button to see the camera view down the beam. Any reflectors in the field of view will return a flashing signal from the camera's illumination.

When the button is clicked, the mirror switches position to give the camera a view and the laser beam is no longer reflected out of the instrument.

Move tracker

Click on the arrow keys in the box or use the arrow keys on the keyboard to initiate movement of the tracker. Clicks or key presses increase or decrease the speed of vertical (v) or horizontal (Hz) motion. To stop the motion either click on the red disk or hit the space bar on the keyboard.

Left/right keys affect horizontal motion.
Up/down keys affect vertical motion.

Speed
Select this option to increase the speed steps.

Reverse Hz direction
Select this option to reverse the horizontal direction of movement associated with the left/right keys.

Find button

This button initiates the spiral search. If the video camera has been used, the mirror is switched back into position for the laser beam.

9. Align menu

9.1 Alignment in brief

This menu enables internal tracker parameters to be calculated and set. (Many of these parameters can also be checked, but not set, in the **Setup** menu.)

The tracker is a complex mechanical arrangement of laser beams, mirrors, rotating axes, mixed metal types, etc. Ideally it should conform to a perfect design. For example the primary (standing) axis should intersect the transit axis at right angles. It is impossible to manufacture the tracker exactly according to design and the small deviations from design give rise to systematic errors. These deviations can be calculated by making suitable measurements and their effects eliminated by software compensation. Corrected measurements then only show small random effects.

The tracker can be accurately modelled with 15 parameters which all have a physical meaning. See "Summary of tracker alignment parameters" on page 149. These are known as the parameters of the tracker's error model (alignment parameters) and the **Align** menu provides the functions to calculate them. **Full alignment** is a comprehensive procedure designed to determine all 15 parameters. **Intermediate alignment** provides an updated calculation of just 3 of these parameters which are considered most critical. It is a simpler and faster procedure designed to reduce the number of full alignments required in your maintenance cycle

The tracker's distance measurements are mainly based on an interferometer which can only measure a change of distance. What is required is the absolute distance from the centre of the mirror. Interferometric distance measurements can be converted to absolute distance measurements if tracking is initialized at a point whose absolute distance from the mirror is already known. The tracker is provided with a Home Point or Birdbath to ensure that such a distance is always available, but this distance must be carefully calculated and is different for every type of reflector in use. The calculation can be made here.

Finally an absolute distance measuring device is available which can independently and directly measure the absolute distance to a reflector. However it, too, requires the definition of a number of parameters for its definition, such as the offset of its datum (zero point) from the mirror. This can also be calculated here.

9.1.1 Using the same or different tracker stations

A number of the techniques in this section may involve movement of the tracker to obtain a favourable geometric arrangement for determining the various parameters. The requirement here is merely to place test objects in different relative positions and it does not matter mathematically if the tracker is moved or the object is moved. If the tracker is moved it is therefore possible to assign all measurements to the same station. Operators may therefore find it convenient to use a job only for purposes of checking or calculation of parameters and use only one station within this job.

In contrast, normal object measurement must always be done from fixed stations and if the tracker is moved a new station must be defined. Unlike the reference lengths, Ball Bars or temporary targets used for alignment, the measured object is normally a single entity, not a collection of independent components whose position relative to the other components is irrelevant.

9.1.2 Calculating the Home Point (Birdbath) distance

This procedure is separate from the calculation of the tracker instrument parameters which must, however, be reasonably accurate. It may therefore be advisable to implement the full alignment procedure before calculating this distance. Alternatively any change to alignment parameters should be followed by a re-calculation of Birdbath distance.

Target measurements for calculating the Birdbath distance are normal measurements to stationary reflector locations, i.e. they require **Standard** mode, **Stationary** method.

Note
Measurement of a stationary point with the ADM automatically re-sets the IFM to the current ADM distance. However, this is <u>not</u> a determination of the Home Point (Birdbath) distance and it does not modify this parameter.

Diagram: Concept

TCAL-AD1.WMF
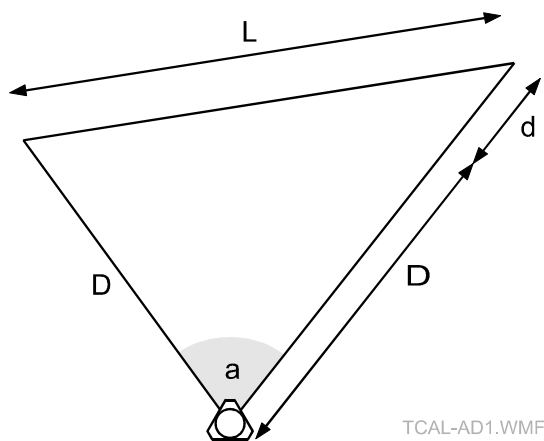
Concept

Distance calibration requires 2 points separated by a known length L and a measured subtended angle a. A reflector is tracked between the points. This provides a measurement of the subtended angle a and range difference d. The value d is the difference between the approximate absolute distances to each point, based on an assumed distance to the Birdbath. (Each distance measurement will be in error by the error in Birdbath distance but their difference correctly gives d.)

The objective is to find the correct absolute distance D to the first point which can then be compared with the provisional measured value and the difference used to correct the Birdbath distance.

Applying the cosine rule:

$$D^2 + (D + d)^2 - 2D(D + d)\cos(a) = L^2$$

Expanding and collecting terms:

$$2D^2(1 - \cos(a)) + 2Dd(1 - \cos(a)) + \frac{d^2 - L^2}{2(1 - \cos(a))} = 0$$

Solution to quadratic equation taking the positive root:

$$D = \frac{-d + \sqrt{d^2 - \frac{2(d^2 - L^2)}{(1 - \cos(a))}}}{2}$$

The interferometric distance d is inherently very accurate. It can be shown that uncertainties in the measured angle a can be eliminated when a = 180°.

At optimal subtended angle:

$$D = \frac{-d + L}{2}$$

Best results

Best results are obtained when a is as close to 180° as possible.

Diagram: 2-point method

TCAL-AD2.WMF
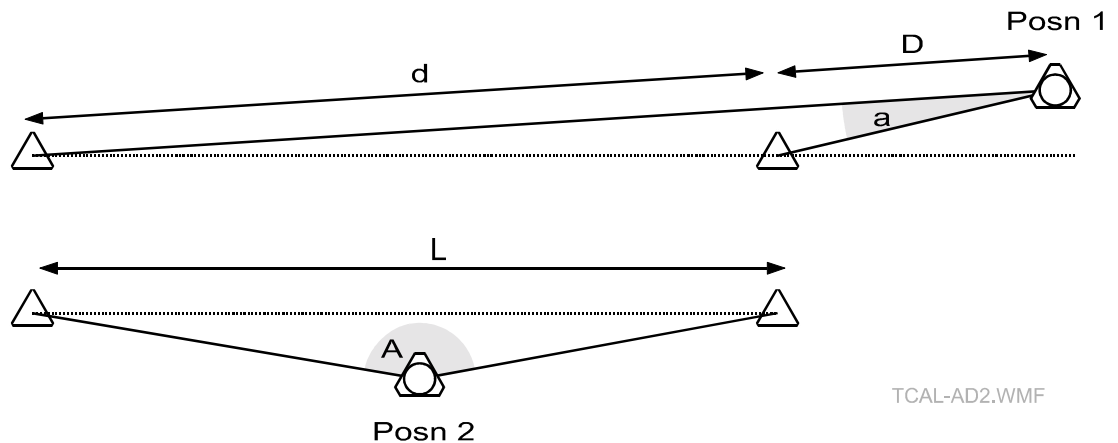
2-point method

The 2-point method implements the concept by using 2 free-standing, unknown points.

The distance L between the points is first measured by placing the tracker close to the extended line of the points and using it almost as a pure interferometer to determine their separation L. The interferometric distance d is then almost equal to the separation L. Any existing errors in the Birdbath distance, or in the subtended angle a, have only a small effect on the calculation of L which is therefore very accurate.

The tracker is then moved between the points such that the subtended angle A is almost 180°. This angle then accurately measured.

With this information the Birdbath distance can be accurately calculated.

To get as close to the ideal geometry as possible, it helps to have the free-standing points at approximately tracker height.

Scale bar method

The scale bar method is a simplified form of the 2-point method and not as accurate. It resembles a direct implementation of the concept in which the known length L is provided by a scale bar with a calibrated length. The scale bar is supported at tracker height and a reflector tracked between its end points.

Unless the scale bar is of a special design which enables the tracker head to be inserted between the end points, it is not normally possible to get close to the ideal subtended angle of 180°. Although the length may accurate, potential loss of accuracy in the subtended makes this method a second choice to the 2-point method.

> **Note**
> Any two fixed points with a known separation can act as a "scale bar".

9.1.3 Calculating the full set of tracker alignment parameters

Two fundamental techniques are used to calculate tracker parameters:

1. Measurement of an accurate reference shape, in this case a reflector attached to a **Ball Bar** which rotates it on a very precise circle in space. Calculated tracker parameters must therefore ensure that the measured points fall on a circle.
2. **2-face** measurement which locates the same fixed target in both mirror positions. This reverses the effects of many parameters which are then easily detected. Calculated tracker parameters must ensure that the pointing is the same in both mirror positions.

In order to calculate all 15 tracker model parameters it is necessary to make a number of such Ball Bar and 2-face measurements. These should be distributed so that the parameters have a significant effect on the measurements, in order that they can be accurately calculated. In practice this means that measurements must be made throughout the tracker's measurement space.

To record suitable Ball Bar measurements, the tracker must switched into the correct recording mode. See "Ball Bars" on page 154.

To record suitable 2-face measurements, the tracker must switched into the correct recording mode. See "Two face" on page 155.

Diagram: Ball Bar measurements
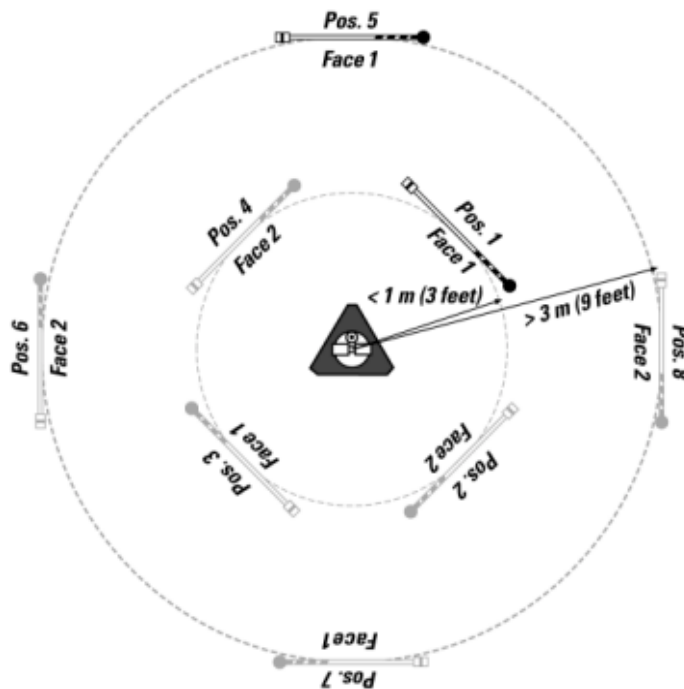
Ball Bar measurements

It is recommended that the Ball Bar be measured in 8 positions. 4 positions should be close to the tracker (1m or less) and 4 positions at between 3m and 5m from the tracker.

The positions should arranged as follows:
- Roughly equally spaced. The Ball Bar centres then appear roughly at 45° intervals in the horizontal plane, as indicated in the diagram
- Ball Bar centre approximately at tracker height
- Plane of the Ball Bar facing the tracker.

The Ball Bar locations should be alternately measured in face 1 and 2, as indicated.

It may be necessary to move both Ball Bar and tracker to obtain a suitable distribution of positions. It is convenient to use the same tracker station each time but different tracker stations may be defined for each position. Since only one tracker can currently be attached to the system there is no confusion about the tracker being calibrated. When the alignment parameters are calculated, the software therefore permits the use of all Ball Bar measurements from all stations.

Diagram: 2-face measurements in the vertical plane

Two face measurements
in the vertical plane

TCAL-V2F.WMF
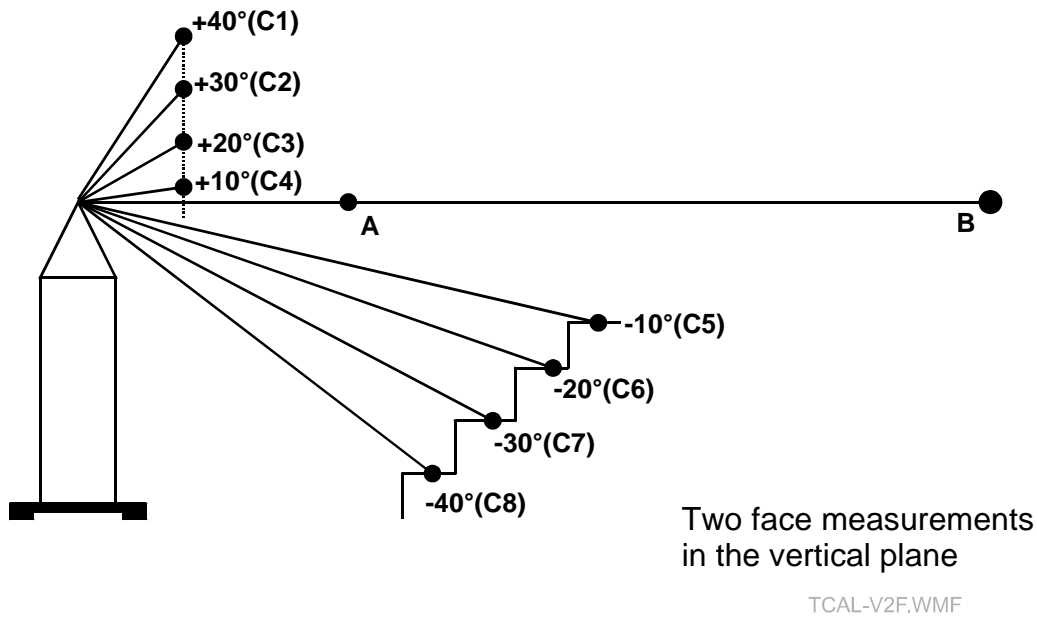
Diagram: Alternative 2-face measurements in the vertical plane

TCALV2Fa.WMF
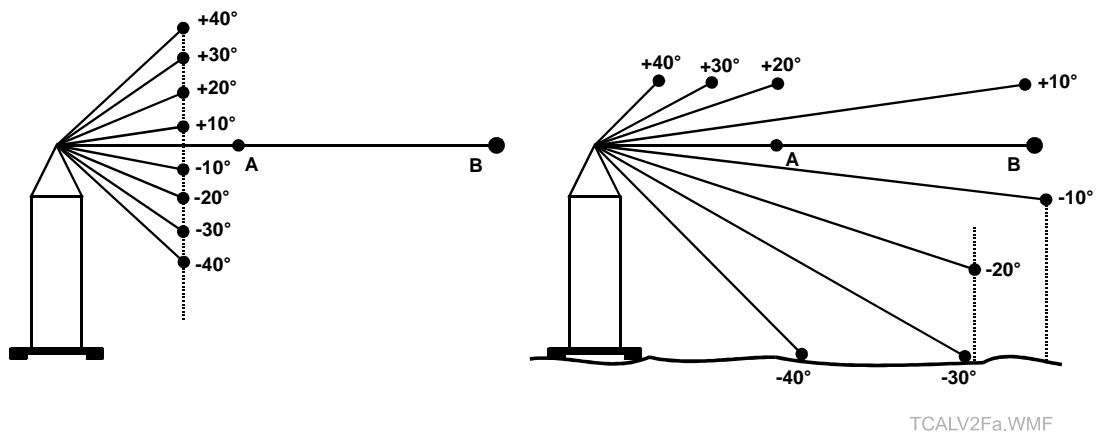
2-face measurements in the vertical plane

2-face measurements in the vertical plane should cover the whole range of
vertical angle measurement and ensure that a range of distances is
incorporated.

It is useful to have a far point and near point close to tracker height and
forming a line with the tracker, as indicated by points A and B.

- Near point A ideally < 0.4m
- Far point B ideally > 5m
- Vertical angles to A and B approx. zero (zenith angles approx. 90°)
- Horizontal angle difference to A and B either zero degrees or 180°.

The remaining points C1 - C8 should provide an even distribution of vertical angles covering the full measurement range. The use of steps, as implied in the main diagram, may offer an easy way of generating a suitable distribution of angles but alternative arrangements are acceptable.

The actual distance to these points is not so important. For example many of the points can lie on a vertical line or be laid out along the ground.

It is also recommended that all the points (A,B,Cx) lie approximately in the same vertical plane.

Diagram: 2-face measurements in the horizontal plane
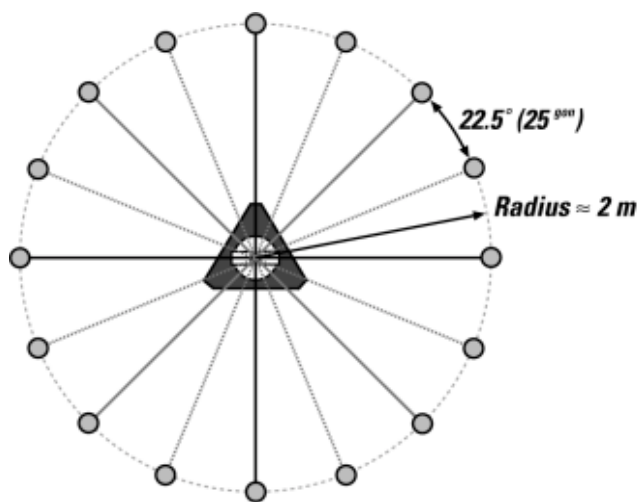
2-face measurements in the horizontal plane

The requirement here is a number of evenly spaced 2-face measurements to roughly equidistant points at approximately tracker height.

For good results, 16 evenly spaced measurements are recommended. They should be at approximately the same horizontal distance, somewhere between 1.5m and 2.5m.

9.1.4 Calculating an intermediate alignment

The intermediate alignment procedure only calculates 3 of the 15 parameters. These are:
- Vertical index error, j
- Transit axis tilt, I
- Mirror tilt, c

These parameters are detectable by 2-face measurements only, and only a small number of these are required. It is therefore a simpler and faster procedure than full alignment. However it is not a substitute for full alignment and its purpose is to reduce the number of full alignments required in a maintenance cycle.

To record suitable 2-face measurements, the tracker must switched into the correct recording mode. See "Two face" on page 155.

Diagram: 2-face measurements for intermediate alignment
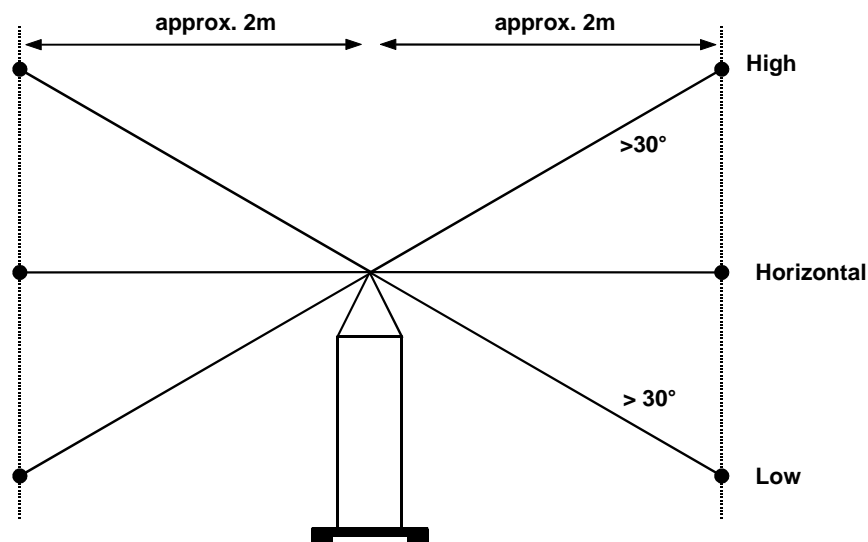
Two face measurements in the vertical plane

TCAL-jic.WMF

2-face measurements for intermediate alignment

The requirement here is for a recommended six 2-face measurements, in two groups of 3. Each set of 3 points is in an approximately vertical line no closer than about 2m to the tracker. The high and low measurements should be more than 30° away from the horizontal.

The groups should have a horizontal angle separation of about 180°, i.e. all measurements should lie approximately in the same vertical plane.

Mathematically only 4 measurements are required but this will not uncover potential measurement errors. In conditions where you feel even more measurements would be advisable, e.g. more vibrations or disturbances than normal, then more measurements can be made. For example:

- 4 pairs of measurements (high and low) separated by approx. 90° (total 8)
- 4 groups of 3 (high, low, horizontal), separated by approx. 90° (total 12)

9.1.5 Summary of tracker alignment parameters

Note

The first 3 parameters listed here are calculated in the procedure of **Intermediate alignment**. These are:

- Vertical index error, j
- Transit axis tilt, i
- Mirror tilt, c

Vertical index error, j
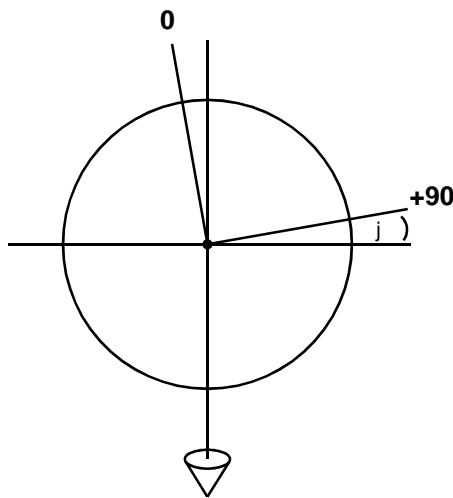
Vertical index error: j

The reading on the vertical circle should be 90º when the beam is pointing horizontally.

"j" is the residual angle error.

TERR-j.WMF

Transit axis tilt, i
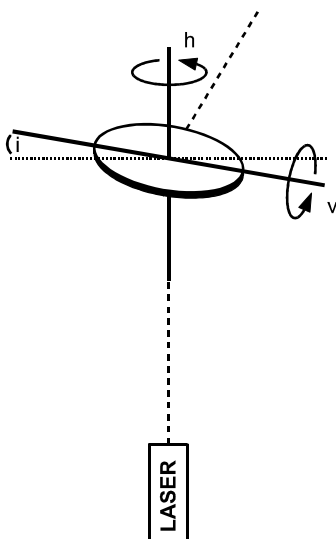
Transit axis tilt: i

The transit axis should be perpendicular to the primary (standing) axis.

"i" is the residual tilt error.

TERR-i.WMF

Mirror tilt, c
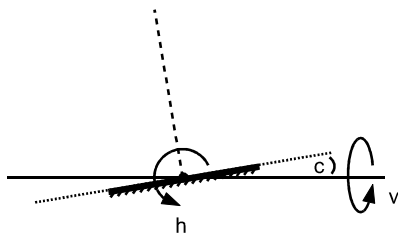
Mirror tilt: c

The plane of the mirror should be parallel to the transit axis.

"c" is the residual tilt error.

TERR-c.WMF

Beam tilt, Ix and Iy

Beam tilt: Ix,Iy
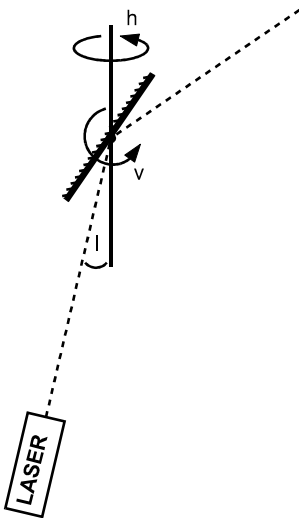
The laser beam should be parallel to the primary (standing) axis.

"Ix,Iy" are the residual tilt components.

TERR-Ixy.WMF

Transit axis offset, e
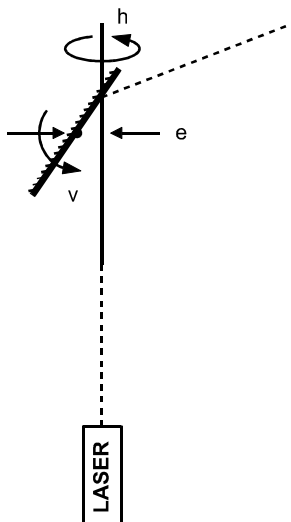
Transit axis offset: e

The transit axis should intersect the primary (standing) axis.

"e" is the residual offset error between the axes.

TERR-e.WMF

Mirror offset, f
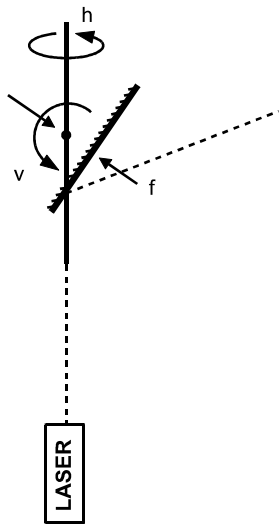
Mirror offset: f

The plane of the mirror should be on the rotation centre where the axes intersect.

"f" is the residual offset error.

TERR-f.WMF

Beam offset, Ox and Oy
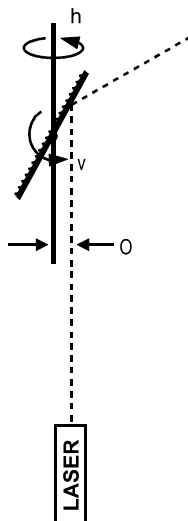
Beam offset: Ox,Oy

The laser beam should lie exactly on the primary (standing) axis.

"Ox,Oy" are the components of the residual offset error.

TERR-O.WMF

Note

Use of the collar reflector ensures that these parameters are always zero and they are not normally used in the error model.

Cover plate offset, O2x and O2y
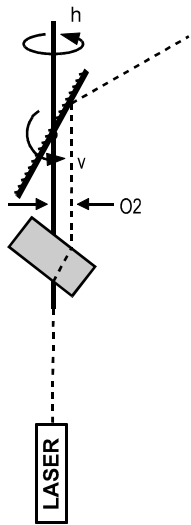
Plate offset: O2x,O2y

Refraction at the cover plate may move the laser beam off the primary (standing) axis.

"O2x,O2y" are the components of the residual offset error.

TERR-O2.WMF

Horizontal encoder eccentricity, Ex and Ey
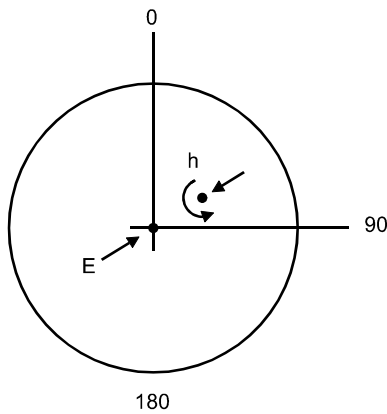
Horizontal encoder eccentricity: Ex,Ey

The encoder centre and its rotation centre should be the same point.

"Ex,Ey" are the components of the error.

TERR-Exy.WMF

Vertical encoder eccentricity, Kx and Ky
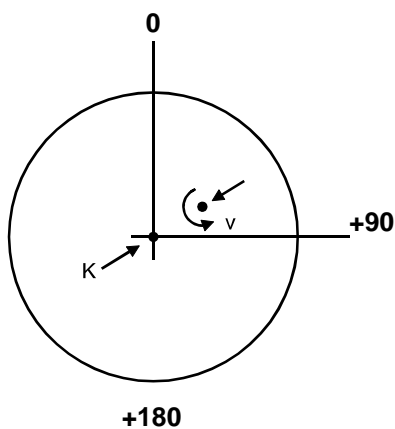
Vertical encoder eccentricity: Kx,Ky

The encoder centre and its rotation centre should be the same point.

"Kx,Ky" are the components of the error.

TERR-Kxy.WMF

9.1.6 Calculating the ADM instrument parameter

Although the ADM can measure absolute distance to a fixed reflector, the datum position for this distance must be established. The measuring unit itself has an unknown position within the tracker housing and the components within the unit have an unknown datum position. What is required is to set a total datum offset so that absolute distance measurement is zero at the tracker's rotation centre.

Because of its higher accuracy the IFM is used as a reference for the ADM. The technique compares ADM distances with IFM distances to the same fixed points and calculates an instrument offset and scale factor to make the ADM values match the IFM values as closely as possible. The technique therefore requires accurate IFM values.

To record suitable measurement pairs, the tracker must be switched into the correct recording mode. See "ADM measurements: ADM instrument measure" on page 156.

Procedure: ADM instrument parameter

The following measurements must use an air-path (hollow) corner cube reflector which has a zero internal reflector offset.

1. Calibrate the Birdbath distance for the hollow corner cube using the 2-point method.
2. Switch to the correct measuring mode for determining the ADM instrument parameter and measure IFM/ADM distance pairs to test points with the hollow corner cube.
3. Calculate the parameters using the option for ADM instrument offset

An absolute minimum of 2 test points is required for a solution and a minimum of 5 is recommended. The points should be equally spaced out approximately on a line at tracker height, starting at a minimum distance of around 3.5m and ideally going up to the maximum range around 30m.

9.1.7 Calculating internal reflector offsets for the ADM

This follows the same procedure as for the ADM instrument offset but the instrument offset must first be accurately measured using an air-path (hollow) corner cube. The only unknown parameter in the procedure is then the reflector offset.

This procedure must be calculated for every type of corner cube except an air-path corner cube. Remember that all reflectors must be individually calibrated for Birdbath distance.

To record suitable measurement pairs, the tracker must be switched into the correct recording mode. See "ADM measurements: ADM reflector measure" on page 156.

> **Note**
> In practice the factory value should be good enough as a special laboratory based on interferometric methods is used. This calculation should therefore only be very occasionally required.

Procedure: ADM reflector offsets

1. Calculate the ADM instrument parameter using a hollow corner cube
2. Calibrate the Birdbath distance for the current reflector using the 2-point method.
3. Switch to the correct measuring mode for determining ADM reflector offsets and measure IFM/ADM distance pairs to test points with the hollow corner cube.
4. Calculate the parameters using the option for ADM reflector offset

An absolute minimum of 1 test point is required for a solution and a minimum of 5 is recommended. The points should be equally spaced out approximately on a line at tracker height, starting at a minimum distance of around 3.5m and ideally going up to the maximum range around 30m.

9.2 Ball Bars

Ball Bars command (**Align menu**)   **Alt,A,B**
"Select Ball Bar measurement type"

This sets up the tracker in the correct mode for recording Ball Bar measurements. These are required for two purposes:

- To check if a circular shape is produced. See "Field check calc: Ball Bar" on page 73.
- As a controlling input to the alignment procedure. See "Align tracker" on page 163.

Definition of the measurement parameters is explained in detail in "Filter tab (ball bar measurement)" on page 111.

Shortcuts
Toolbar: none
Keys: none

9.2.1 Ball Bar: Recommended settings for alignment

The objective is to measure points on a full circle without creating too many points. For each Ball Bar measurement:
Measurement count = 100
Distance criteria: Total point separation = 35mm

9.3 Two face

Two Face command (**Align menu**)   **Alt,A,T**
"Select Two Face measurement type"

This sets up the tracker in the correct mode for recording 2-face measurements. These are required for two purposes:
- To check if each face produces the same pointing to a fixed target. See "Field check calc: Two Face" on page 76.
- As a controlling input to the alignment procedure. See "Align tracker" on page 163.

Definition of the measurement parameters is explained in detail in "Filter tab (2-face measurement)" on page 113.

Shortcuts
Toolbar: none
Keys: none

9.3.1 Two face: Recommended settings for alignment

These apply to the vertical and horizontal plane measurements.

The measurement parameters are intended to reduce the effect of environmental disturbances. For each 2-face measurement:
Measurement count = 100
Time separation = 0.1 sec

This results in a total measurement time of approximately 10 secs per face.

9.4 ADM measurements: ADM instrument measure

ADM measurements: Instrument command **(Align menu)   Alt,A,A,M**
"Select ADM measure instrument check type"

This function is not available if the instrument only has IFM.

This sets up the tracker in the correct mode for recording ADM/IFM
measurement pairs for checking or calculating the ADM instrument offset.

Definition of the measurement parameters is explained in detail in "Filter
tab (ADM measurement)" on page 115.

Notes

These measurements will use the IFM values as a reference, so IFM
measurements must be as accurate as possible.

Measurements can only be done with an air-path corner cube reflector.
If this is not the current reflector type a warning will be displayed:

LTM Align - ADM meas inst.bmp

For general guidance see "Calculate the ADM instrument parameters" on
page 202

Shortcuts

Toolbar: none
Keys: none

9.5 ADM measurements: ADM reflector measure

ADM measurements: Reflector command **(Align menu)   Alt,A,A,A**
"Select ADM measure reflector check type"

This function is not available if the instrument only has IFM.

This sets up the tracker in the correct mode for recording ADM/IFM
measurement pairs for calculating ADM reflector offsets.

Definition of the measurement parameters is explained in detail in "Filter tab (ADM measurement)" on page 115.

Note
These measurements will use the IFM values as a reference, so IFM measurements must be as accurate as possible.

For general guidance, see "Calculate ADM reflector parameters" on page 203.

Shortcuts
Toolbar: none
Keys: none

9.6 Change face

Change face command **(Align menu)**   **Alt,A,C**
"Change the tracker direction"
This action places the mirror in the alternative face position, i.e. it transits the mirror and points it back to the reflector. The distance reading is re-set to the value in the previous pointing.

Shortcuts
Toolbar: none
Keys: none

9.7 IFM dist: Two Point

IFM dist: Two Point command **(Align menu)**   **Alt,A,D,W**
"Establish Birdbath distance using 2 fixed points"

This finds the zero point for <u>interferometric</u> (IFM) distances and computes the Home Point (Birdbath) distance parameter for the current reflector.

This option is identical to menu option **Setup/ Field Check calc/IFM**, except that the Birdbath distance can be stored and implemented.

The analysis is based on the two point method. This involves first measuring the same separation between two points from two stations or measuring the separation from one station with the points in two different orientations.

To review the concept, see "Calculating the Home Point (Birdbath) distance" on page 141.

For general guidance on how to calculate the distance, see "Birdbath distance by 2-Point method" on page 201.

Shortcuts
Toolbar:	none
Keys:	none

See "Dialogue/Results box:" on page 85 for full details of the dialogue box.

9.8 IFM dist: Scale Bar

IFM dist: Scale Bar command **(Align menu)**   **Alt,A,D,C**
"Calculate distance by a known distance method"

This finds the zero point for <u>interferometric</u> (IFM) distances and computes the Home Point (Birdbath) distance parameter for the current reflector. It requires measurements to two points with a known separation. Typically the two end points of a scale bar would be used.

To review the concept, see "Calculating the Home Point (Birdbath) distance" on page 141.

For general guidance on how to calculate the distance, see "Birdbath distance by scale bar method" on page 202.

Shortcuts
Toolbar:	none
Keys:	none

9.8.1 Dialogue/Results box: IFM distance by scale bar

LTM Align - IFM scale.BMP

Scale bar number

If a scale bar stored in the database has been used for the test, select its number from the drop-down list.

Known distance

If the scale length is defined by two points with a known separation, select this option and enter the value of the distance.

Select scale bar points

Station number
From the drop-down list, select the station where the measurements were made.

Points list
This shows all stationary points in the database which were measured by the selected station. Points are listed in the format "workpiece ID/ point name".

Click on the two points in this list which identify the end points of the scale bar or known length. Only two points will allow a solution to be computed.

Note

Points can only be selected once for a particular calculation of Birdbath distance. This is to avoid repeated incremental changes to the Birdbath distance if the calculation is repeated several times.

Solve button

Click on this button to calculate the distance parameter.

Results distance

This shows results for both the Birdbath and the current reflector position.

Birdbath

If selected, the new Birdbath value will be stored in the database and applied the next time the reflector distance is initialized in the Birdbath.

Warning

This <u>does not</u> affect the current distance to the reflector. You must select the **Current** option for this to be effective.

Current

If selected, the current distance to the reflector is immediately changed to agree with the new Birdbath distance.

Warning

This does not record the new Birdbath distance. Once the beam is broken the new Birdbath distance is lost unless saved by selecting the **Birdbath** option.

Initial

The distance to the Birdbath or current reflector position before the new calculation of Birdbath distance.

Corrected

The new Birdbath distance or current reflector position corrected for the new Birdbath distance.

Difference

Difference between initial and corrected values.

9.9 ADM offsets: Instrument

ADM offsets: Instrument command (**Align menu**)   **Alt,A,O,I**
"Calculate instrument ADM distance using 2 fixed points"

This function is not available if the instrument only has IFM.

This calculates the offset and scale parameters for the <u>Absolute Distance Meter</u> (ADM). These are applied to absolute distance measurements to make them compatible with IFM measurements. The analysis is based on all the IFM/ADM instrument check pairs in the database which were recorded with a corner cube reflector.

To make the necessary ADM/IFM measurement pairs you must switch to the appropriate measuring mode and record suitable pointings with an air-path corner-cube reflector.

This option is identical to the menu option **Setup/ Field Check calc/ADM Instrument**, except that the latest parameters can be stored and implemented.

To review the concept, see "Calculating the ADM instrument parameter" on page 153.

For general guidance see "Calculate the ADM instrument parameters" on page 202

Shortcuts
   Toolbar: none
   Keys: none

See "Dialogue/Results box: ADM " on page 79 for full details of the dialogue box.

9.10 ADM offsets: Reflectors

ADM offsets: Reflectors command **(Align menu)**   **Alt,A,O,R**
"Calculate ADM offset in the reflector"

This function is not available if the instrument only has IFM.

This function calculates the internal reflector constant (additive constant)
for a particular reflector when used with the Absolute Distance Meter
(ADM).

A distance measurement to an air-path corner cube always corresponds to a
measurement to the actual corner point, i.e. there is a zero internal offset.
However when measuring to a glass prism retro-reflector the effect of the
glass is to create an apparent increase in the true distance measurement to
the corner point. This depends on the refractive index of the glass and the
physical dimensions of the reflector. This additive constant must therefore
be calculated for different reflector types.

IFM distances are used as reference values for comparison with ADM
distances to the reflector measured at several locations. The reflector
constant is calculated to make the ADM values match the IFM values as
closely as possible.

To make the necessary ADM/IFM measurement pairs you must switch to
the appropriate measuring mode and record suitable pointings.

This option is identical to the menu option **Setup/ Field Check calc/ADM
reflectors**, except that the latest parameters can be stored and
implemented.

To review the concept, see "Calculating internal reflector offsets for the
ADM" on page 153. For general guidance, see "Calculate ADM reflector
parameters" on page 203.

Shortcuts
  Toolbar: none
  Keys: none

See "Dialogue box: ADM reflector offset" on page 83 for full details of the
dialogue box.

9.11 Align tracker

Align tracker command (**Align menu**)   **Alt,A,L**
"Calculate complete alignment parameters"

After making suitable Ball-Bar and 2-face measurements, choose this
option to calculate the full set of 15 tracker parameters.

To review the concept see "Calculating the full set of tracker alignment
parameters" on page 144.

For general guidance on how to align the tracker, see "Align (calibrate) a
tracker and reflectors" on page 204.

Shortcuts
  Toolbar: none
  Keys: none

9.11.1 Initialize solution parameters tab
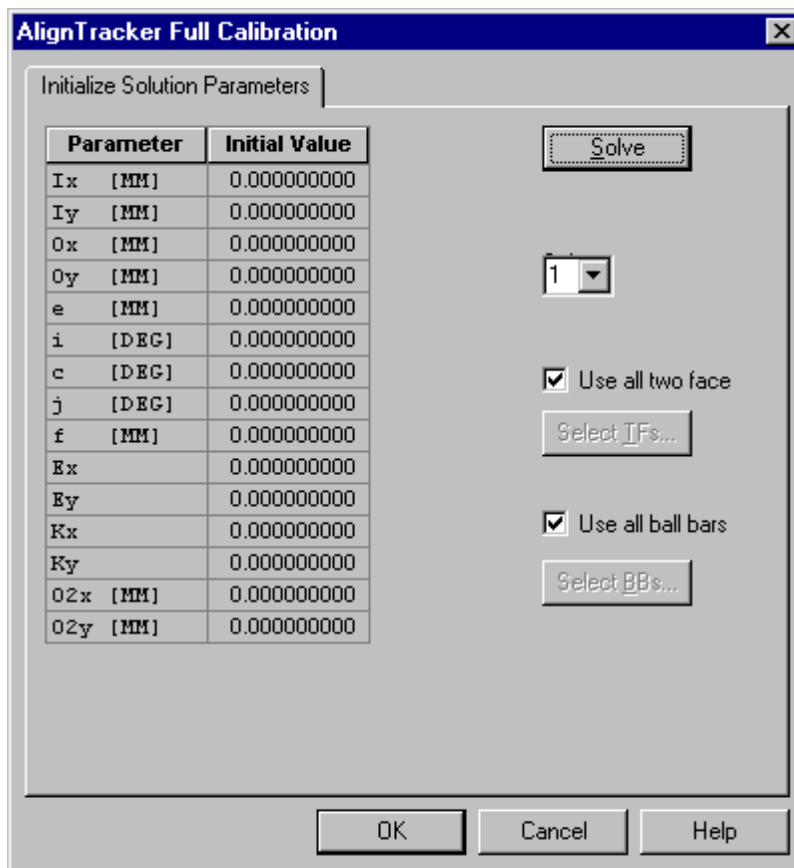
LTM Align - Align T - init tab.BMP

Parameter

This shows a list of all tracker parameters. See "Summary of tracker alignment parameters" on page 149.

Initial value

The value of the parameter prior to calculation of the optimized values. These values should always be zero and should not be changed.

Select measurements

Station
Select the station where the calibrated tracker is located from the drop-down list.

Use all Ball Bars
Select this option to use all Ball Bar measurements recorded at the selected station. Otherwise click the **Select BBs** button to select specific measurements.

Use all Two Face
Select this option to use all Two Face measurements recorded at the selected station. Otherwise click the **Select TFs** button to select specific measurements.

Button: Select BBs
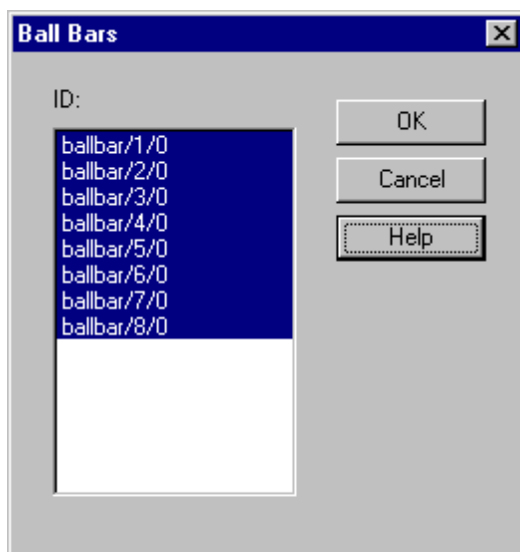
LTM Align - Align - Select Ball Bars.bmp

This provides a list of all Ball Bar measurements at this station. Highlight the required measurements by using standard Windows 95 methods, i.e.

- Click to highlight a single item
- Click + Shift Click to highlight a block
- Ctrl Click to add a single item

Button: Select TFs
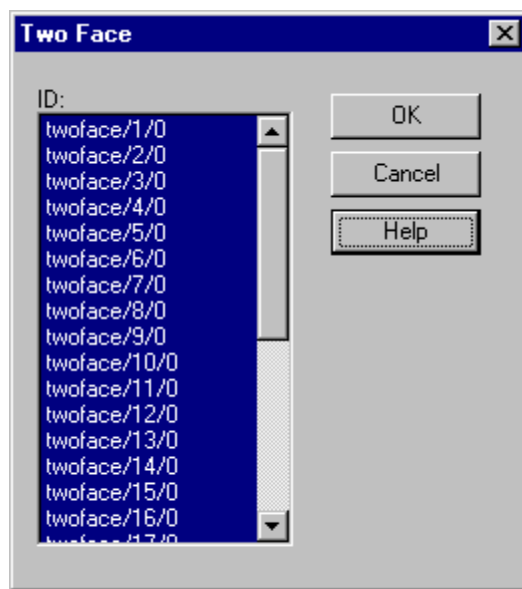
LTM Align - Align - Select 2-face.bmp

This provides a list of all Two Face measurements at this station. Highlight the required measurements by using standard Windows 95 methods, i.e.

- Click to highlight a single item
- Click + Shift Click to highlight a block
- Ctrl Click to add a single item

Solve button

Once the input has been specified, click on this button to calculate the solution. This leads to a display showing tabs for:

- Solution parameters
- Ball Bar test
- Two face test

The Ball Bar test tab is identical to the dialogue box produced for the Ball Bar field check. For a full explanation see "Field check calc: Ball Bar" on page 73.

The Two face test tab is identical to the dialogue box produced for the Two Face field check. For a full explanation see "Field check calc: Two Face" on page 76.

9.11.2 View solution parameters tab

Parameter	Initial	Delta	Corrected
Ix [MM]	0.000000000	-0.012196200	-0.012196200
Iy [MM]	0.000000000	0.011904411	0.011904411
Ox [MM]	0.000000000	-0.000000000	-0.000000000
Oy [MM]	0.000000000	0.000000000	0.000000000
e [MM]	0.000000000	0.005983869	0.005983869
i [DEG]	0.000000000	-0.000563266	-0.000563266
c [DEG]	0.000000000	0.004173006	0.004173006
j [DEG]	0.000000000	-0.007116783	-0.007116783
f [MM]	0.000000000	0.019796024	0.019796024
Ex	0.000000000	-0.000001835	-0.000001835
Ey	0.000000000	-0.000003731	-0.000003731
Kx	0.000000000	-0.000038253	-0.000038253
Ky	0.000000000	0.000006256	0.000006256
O2x [MM]	0.000000000	-0.003497007	-0.003497007
O2y [MM]	0.000000000	-0.010523830	-0.010523830

LTM Align - Align T - View list tab.BMP

Parameter

This shows a list of all tracker parameters. See "Summary of tracker alignment parameters" on page 149.

Initial

The value of the parameter prior to calculation of the optimized values.

Corrected

The value of the parameter after calculation of the optimized values.

Delta

The difference between the initial and corrected values.

Accept button

Click this button to accept and immediately apply the calculated set of parameters. This set will then be stored in the tracker's database, identified by the current date.

Note
The parameter sets for tracker with serial number "nnnn" are stored in the file TRKnnnn.MDB in the folder C:\Program Files\Leica\Axyz\Tracker.

Once the full set of parameters has been modified, a slightly different tracker has thereby been defined. Logically other critical parameters should also be re-defined, in particular the Birdbath distance and ADM parameters. The following warning will appear:

LTM Align - Align T - Birdbath warning.bmp

Details button

Click the **Details** button to see full details of the least squares solution in a format which can be modified and printed.

Graph button

Click the **Graph** button to see the calculated parameters displayed graphically.

9.11.3 View solution details

The details of the solution are recorded in a file and displayed in a simple word processing window. This window provides some facilities for re-arranging the format of the display.

You can also accept or reject the results from this window.
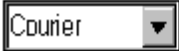
Example screen: Tracker alignment results

```
Jobname:CALIBRATION.AXYZ



   Align Tracker Calculation

   Beginning mean error:        1.659

   Iteration: 1
   Mean error: 0.078
   Percent change 95.293

   Iteration: 2
   Mean error: 0.078
   Percent change 0.000

   Solution successful
```
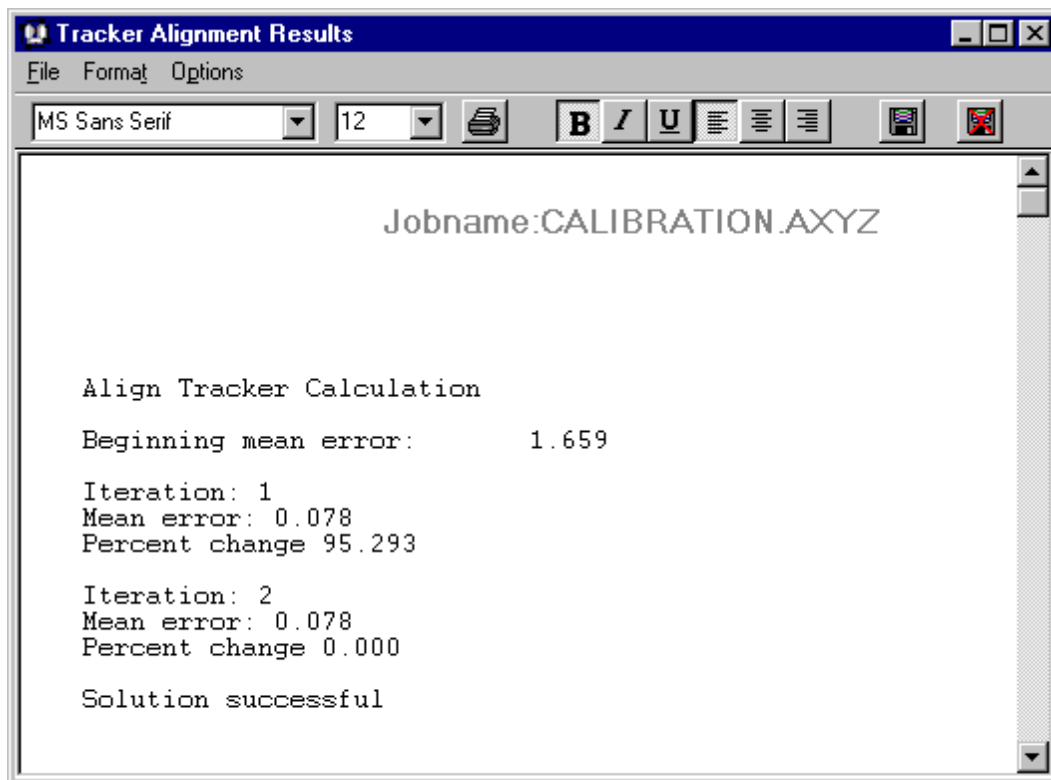
LTM Align - Align T - View detail results.BMP

The sample window shows the first lines of a successful tracker alignment

Toolbar: Solution details

Icon	Description
Courier ▼	Font bar of current selection + drop-down options list
10 ▼	Point size of current selection + drop-down options list
🖶	Print the results file
B	Applies **bold** format to the selection
I	Applies *italic* format to the selection
U	Applies underline to the selection
▤	Right-justify the selected text
▤	Centre the selected text
▤	Left-justify the selected text
🖫	Accept the results and apply them
✖	Reject the results

LTM Align - Align T - res. toolbar.BMP

File menu: Solution details

Print
Corresponds to **Print** button on toolbar. Prints out the results file.

Print setup
Standard windows options for setting up your printing options.

Exit
Leave the results display.

Format menu: Solution details

Select text in the results file by one of these methods:
- Click and drag
- Click in margin to select a line
- Click in margin to select first line of a block, then SHIFT+click to select the last line of a block
- CTRL+click in the margin to select everything

Then apply formatting as follows:

Character
Change font, point size, emphasis and colour of the selected text.

Left
Left-justify the text (also available as a toolbar button).

Centre
Right-justify the text (also available as a toolbar button).

Right
Centre the text (also available as a toolbar button).

Options menu: Solution details

Selection bar
Not yet available.

Show margins
Select this option to show a margin.

Find
Search for specific text in the results.

Sample output: Solution details

```
_____ Solution Parameters _____

Parameter                Initial         Delta         Corrected

Ix [MM]              0.000000000     0.000686949       0.000686949
Iy [MM]              0.000000000    -0.003850360      -0.003850360
Ox [MM]              0.000000000    -0.000000000      -0.000000000
Oy [MM]              0.000000000     0.000000000       0.000000000

Results ball bar:  bb/1
RADIUS     [MM]          550.240        -0.010            550.230
X CENTER   [MM]         -789.231         0.045           -789.186
Y CENTER   [MM]         -340.661        -0.057           -340.718
Z CENTER   [MM]           -4.188        -0.031             -4.219
OMEGA      [DEG]         89.1508         0.0066           89.1574
PHI        [DEG]        293.5960         0.0046          293.6006

                         Face I      Face II     Deviations   Deviations
                      Corrected    Corrected     Corrected    Uncorrected

Result Two Face:tf/1
 Horizontal[DEG]          3.8169    -176.1829      -0.0002       -0.0090
   Vertical[DEG]        269.5159      90.4851       0.0010       -0.0041
   Distance[MM]        1275.640

                                    LTM Align - Align T - Detail output.BMP
```

9.11.4 View solution graph

The alignment parameters can be viewed in 3 different graph formats. For comparison, previous parameter sets can also be viewed.

The 3 graph formats are:
- 2D bar chart
- 3D bar chart
- Line

Graph setup
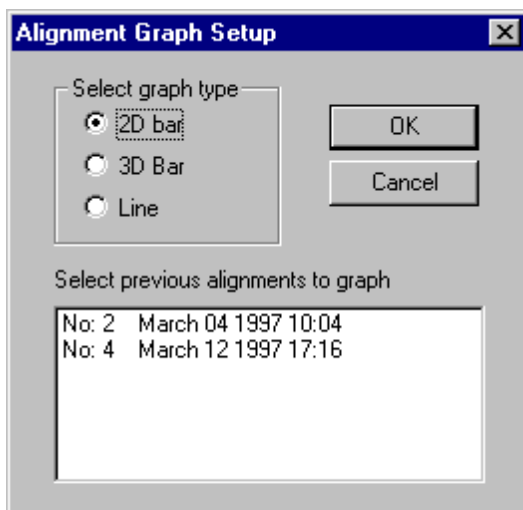
LTM Align - Align T - Graph setup.BMP

Select the required graph format here.

If you wish to view results for a previous parameter set, click on the set's ID. Otherwise the currently calculated set will be displayed.

Graph sample: 2D
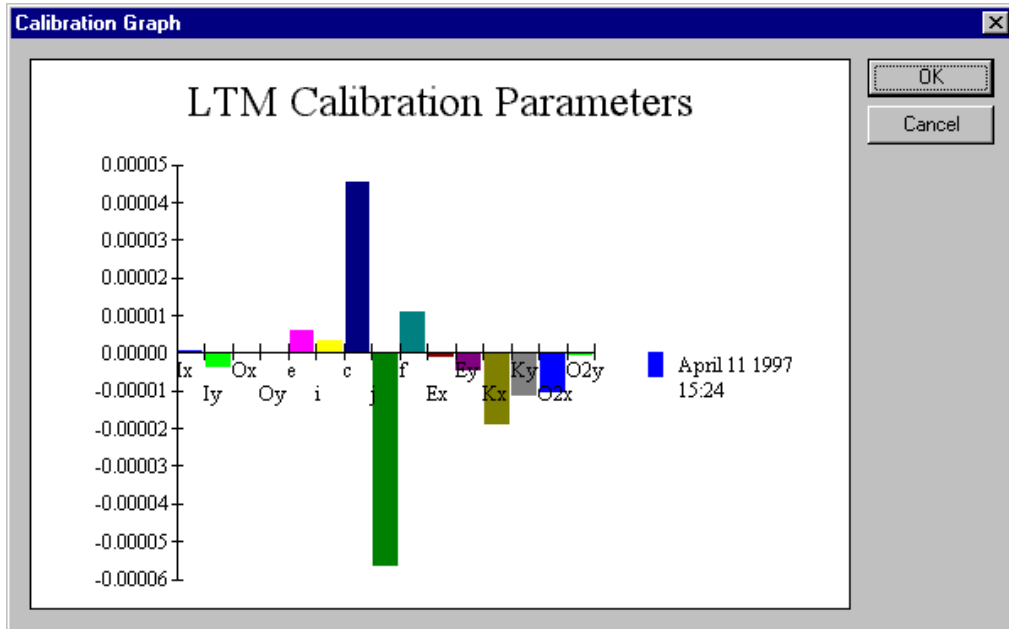
LTM Align - Align T - Graph 2D.BMP

Graph sample: 3D
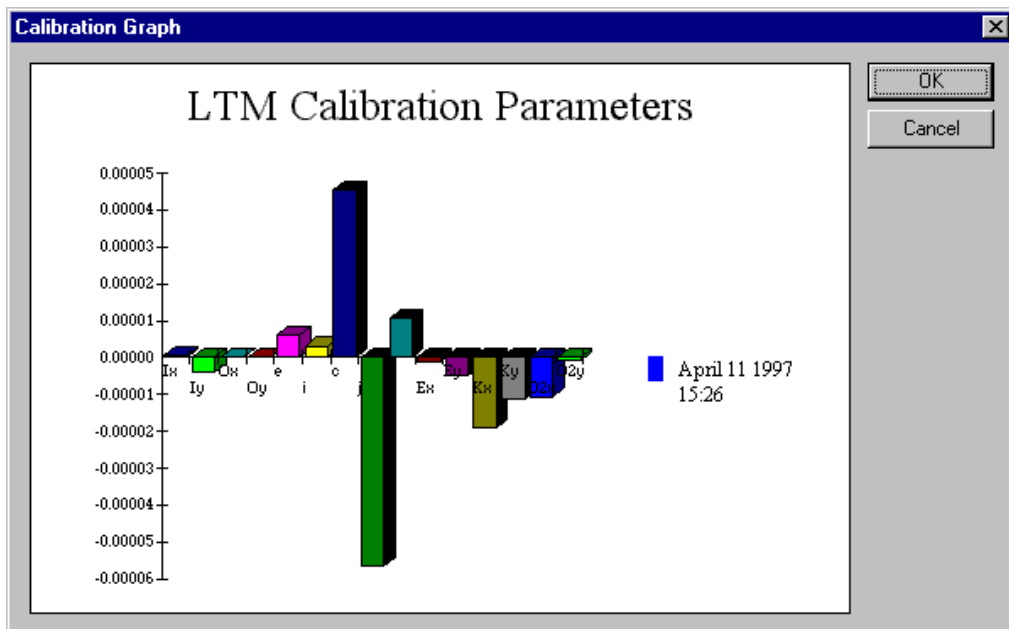
LTM Align - Align T - Graph 3D.BMP

Graph sample: Line
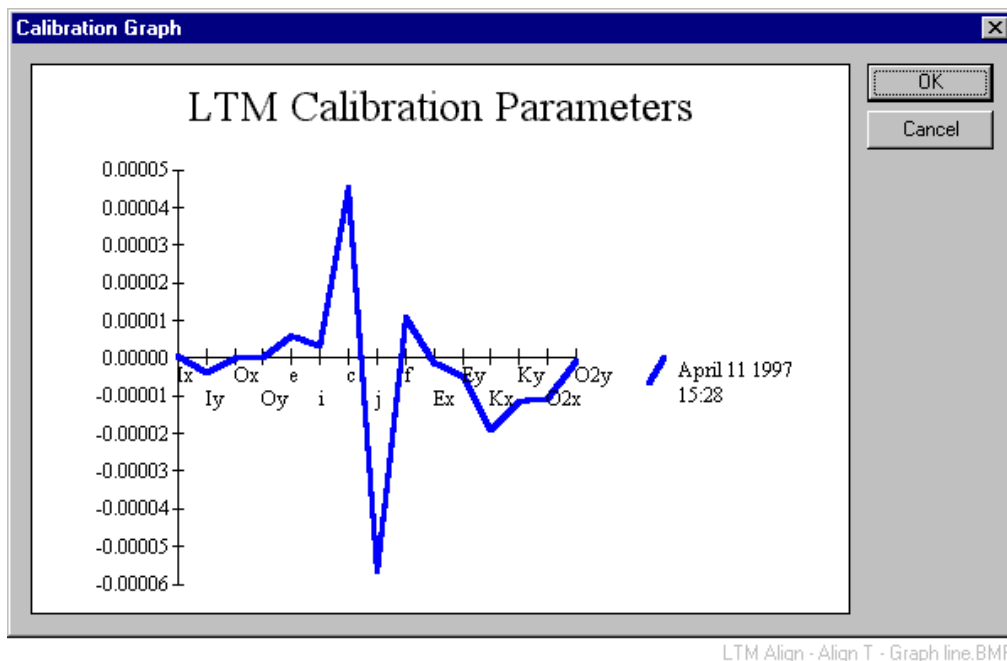
LTM Align - Align T - Graph line.BMP

9.12 Align tracker intermediate

Align tracker intermediate command (**Align menu**)   **Alt,A,L**
"Calculate partial alignment parameters"

After making suitable 2-face measurements, choose this option to calculate the tracker's reduced set of 3 parameters.

To review the concepts see "Calculating the full set of tracker alignment parameters" on page 144 and "Calculating an intermediate alignment" on page 147.

Shortcuts
Toolbar: none
Keys: none

9.12.1 Initialize solution parameters tab (intermediate alignment)

Parameter	Initial Value
Ix [MM]	-0.012196200
Iy [MM]	0.011904411
Ox [MM]	-0.000000000
Oy [MM]	0.000000000
e [MM]	0.005983869
i [DEG]	-0.000563266
c [DEG]	0.004173006
j [DEG]	-0.007116783
f [MM]	0.019796024
Ex	-0.000001835
Ey	-0.000003731
Kx	-0.000038253
Ky	0.000006256
O2x [MM]	-0.003497007
O2y [MM]	-0.010523830

Dialog: AlignTracker Short Calibration — Initialize Solution Parameters. Buttons: Solve, OK, Cancel, Help. Dropdown "1". Checkbox "Use all two face". Button "Select TFs...".

LTM Align - Align Intermed. - Init.bmp

Parameter

This shows a list of all tracker parameters. See "Summary of tracker alignment parameters" on page 149.

Initial value

The value of the parameters as given by the currently applied model.

Select measurements

Station
Select the station where the calibrated tracker is located from the drop-down list.

Use all Two Face
Select this option to use all Two Face measurements recorded at the selected station. Otherwise click the **Select TFs** button to select specific measurements.

Button: Select TFs
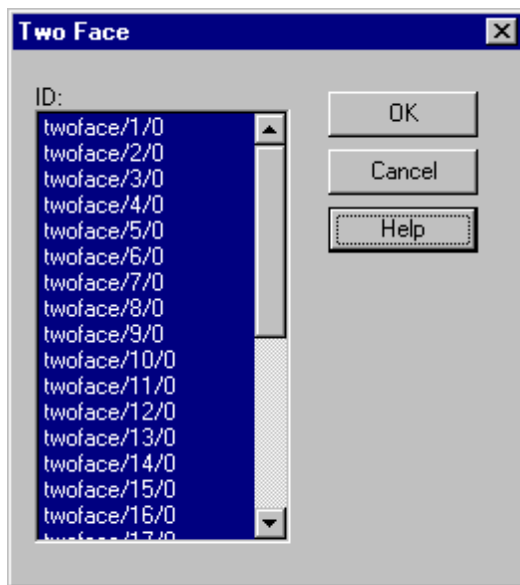
LTM Align - Align - Select 2-face.bmp

This provides a list of all Two Face measurements at this station. Highlight the required measurements by using standard Windows 95 methods, i.e.

- Click to highlight a single item
- Click + Shift Click to highlight a block
- Ctrl Click to add a single item

Solve button

Once the input has been specified, click on this button to calculate the solution. This leads to a display showing tabs for:

- Solution parameters
- Two face test

The Two face test tab is identical to the dialogue box produced for the Two Face field check. For a full explanation see "Field check calc: Two Face" on page 76.

9.12.2 View solution parameters tab (intermediate alignment)

AlignTracker Short Calibration			
Parameter	**Initial**	**Delta**	**Corrected**
Ix [MM]	-0.012196200	0.000000000	-0.012196200
Iy [MM]	0.011904411	0.000000000	0.011904411
Ox [MM]	-0.000000000	0.000000000	-0.000000000
Oy [MM]	0.000000000	0.000000000	0.000000000
e [MM]	0.005983869	0.000000000	0.005983869
i [DEG]	-0.000563266	-0.001052366	-0.001615632
c [DEG]	0.004173006	0.001801400	0.005974406
j [DEG]	-0.007116783	-0.000603270	-0.007720053
f [MM]	0.019796024	0.000000000	0.019796024
Ex	-0.000001835	0.000000000	-0.000001835
Ey	-0.000003731	0.000000000	-0.000003731
Kx	-0.000038253	0.000000000	-0.000038253
Ky	0.000006256	0.000000000	0.000006256
O2x [MM]	-0.003497007	0.000000000	-0.003497007
O2y [MM]	-0.010523830	0.000000000	-0.010523830

Details...   Graph...   Accept

OK   Cancel   Help

LTM Align - Align Intermed - Soln.bmp

Parameter

This shows a list of all tracker parameters. See "Summary of tracker alignment parameters" on page 149.

Initial

The value of the parameter prior to calculation of the optimized values.

Corrected

The value of the parameter after calculation of the optimized values.

Delta

The difference between the initial and corrected values.

Accept button

Click this button to accept and immediately apply the calculated set of parameters. This set will then be stored in the tracker's database, identified by the current date.

> **Note**
> The parameter sets for tracker with serial number "nnnn" are stored in the file TRKnnnn.MDB in the folder C:\Program Files\Leica\Axyz\Tracker.

Details button

Display of details as for full alignment, but showing 2-face results only. See "View solution details" on page 167.

Graph button

Graphical display of results as for full alignment. See "View solution graph" on page 170.

9.13 Previous corrections

Previous corrections command (**Align menu**)   **Alt,A,P**

"Re-load tracker with previous ADM or Align Tracker corrections"
All calculations of ADM and tracker parameters are recorded in an alignment database. You may select and use previous parameter sets. This may be useful if you have a problem with your current set and need to return to a reasonably accurate and working system.

Shortcuts
Toolbar: none
Keys: none

9.13.1 Dialogue box: Previous corrections
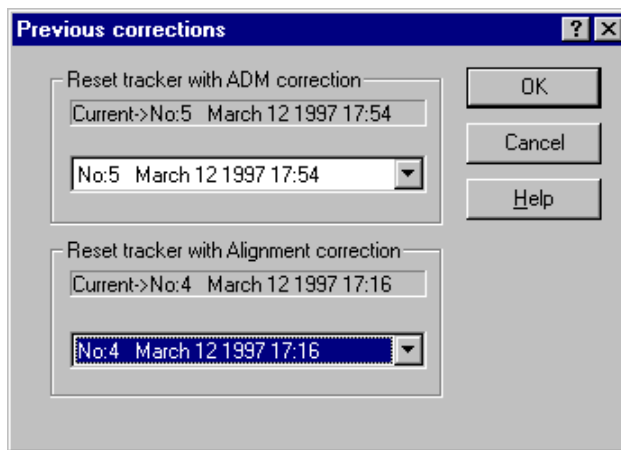
LTM Align - Previous.BMP

Reset tracker with ADM corrections

The currently active parameter set is shown in the top box.
Select an alternative set from the lower drop-down box.

Reset tracker with alignment corrections

The currently active parameter set is shown in the top box.
Select an alternative set from the lower drop-down box.

OK button

Click this button to immediately apply the selected parameter sets.

9.14 Video camera

Video camera command **(Align menu)**   **Alt,A,V**

The video camera is used to point the laser beam by providing a view
down the beam when the mirror is reversed. This view is provided either
on an external monitor or an internal software window if driven by a
Coreco Vision "Bandit" video card.

The camera has a wide field of view and it is convenient to mark a central
position in the image in order to aim the camera at a particular object point.
For this purpose the internal video has crosshairs. An adhesive target can
be attached to an external monitor's screen to achieve the same effect.

This command aligns the pointing defined by the crosshairs in the video
camera to the laser beam direction.

Note
This function is not available to LT300 and LT500.

9.14.1 Concept of video camera alignment

Ideally the aiming direction defined by the video crosshairs should correspond to the laser beam pointing. When the camera is aimed exactly at a target reflector the beam will lock onto the target when the mirror is reversed again.

In practice the aiming direction is offset from the beam direction. It would be possible to correct this by re-setting the crosshairs to another part of the image, corresponding to the true laser beam direction, but this might place the crosshairs well off the centre of the image if the alignment is poor. Alternatively, the difference between the pointing of the crosshairs and the laser beam can be measured. When the camera is set on a target point this difference is applied when switching back to the laser beam, so that the beam also sets on the same target point.

The steps in the alignment are as follows:
* Track the target to some convenient position
* Record the laser pointing
* Switch to the camera
* Adjust the camera pointing to set the crosshairs on target
* Record the camera pointing

9.14.2 Dialogue box: Video camera align

LTM Align - Video.bmp

Laser readings (Step 1)

Lock onto a reflector and place it in a suitable position for viewing with the video camera. Choose this option and click the **Measure** button to record the laser pointing.

The tracker then automatically switches to the video view.

Camera readings (Step 2)

Using the **Move tracker** commands, set the reflector's image onto the crosshairs.

Choose this option and click the **Measure** button to record the camera pointing.

This completes the alignment. The camera pointing can now be corrected to a laser pointing and vice-versa.

Move tracker

These functions permit fine manual positioning of the tracker head.

Click on the arrow keys in the box or use the arrow keys on the keyboard to initiate movement of the tracker. Clicks or key presses increase or

decrease the <u>speed</u> of vertical (v) or horizontal (Hz) motion. To stop the motion either click on the red disk or hit the space bar on the keyboard.

Left/right keys affect horizontal motion.
Up/down keys affect vertical motion.

Speed
Select this option to increase the speed steps.

Reverse Hz direction
Select this option to reverse the horizontal direction of movement associated with the left/right keys.

Button: Video on/off

This button is not normally required as the video switching action is automatic.

10. Window menu

10.1 Measurement window

Measurement window command **(Window menu)**   **Alt,W,M**
"Opens a new measurement window"

Opens a measurement window configured for the current operational
mode.

The window provides on-line 3D results as well as a range of additional
relevant information such as:
- Workpiece name
- Current point ID
- Coordinate system name
- Coordinate (axis) labels
- Error values
- etc

Multiple measurement windows can be opened at the same time.
The various windows may use different coordinate systems.

Shortcuts
  Toolbar:
  Keys: CTRL+N

10.1.1 Dialogue box: Measurement window
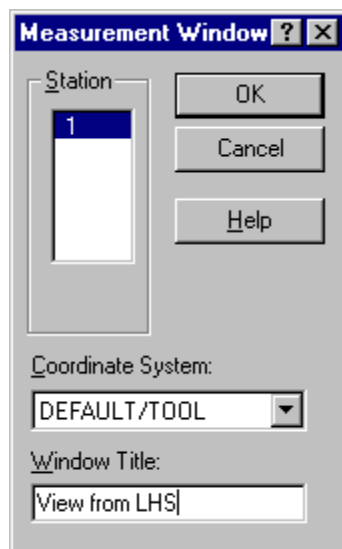
LTM window - meas win.bmp

Station

This shows the current on-line station. This will be assigned to the measurement view.

Coordinate system

Select the coordinate system to apply to this window from the drop-down list of currently defined systems and shapes.

The active system, as chosen in the Core Module, is offered as the default choice. To change the active system, see **CDM Coordsys menu/ Active coordsys**.

It is possible to force the use of <u>only</u> the active coordinate system and prevent the selection of other coordinate systems. To make this setting see "Meas view = Active CS" in "General settings" on page 91.

Window title

Optionally change the window title here.

10.2 Data Manager

Data Manager command **(Window menu)**   **Alt,W,D**
"Open an instance of the Integrated Data Manager"
Opens a Data Manager window.

Shortcuts
   Toolbar:
   Keys: none

10.3 Graphics

Graphics command **(Window menu)**   **Alt,W,G**
"Open an instance of the Integrated Graphics Manager"
If **Axyz** View or **Axyz** CAD installed, this will open a <u>single</u> graphics window.

Shortcuts
   Toolbar:
   Keys: none

10.4 Cascade

Cascade command **(Window menu)**   **Alt,W,C**
"Arrange windows so they overlap"

Any windows inside the LTM main window which are not minimized will be arranged in overlapping "cascade" fashion.

Shortcuts
    Toolbar: none
    Keys: none

10.5 Tile horizontally

Tile command **(Window menu)**   **Alt,W,H**
"Arrange windows as non-overlapping tiles"

Any windows inside the main LTM window which are not minimized will be arranged in non-overlapping horizontal strips.

Shortcuts
    Toolbar icon: none
    Keys: none

10.6 Tile vertically

Tile command **(Window menu)**   **Alt,W,V**
"Arrange windows as non-overlapping tiles"

Any windows inside the main LTM window which are not minimized will be arranged in non-overlapping vertical strips.

Shortcuts
    Toolbar icon: none
    Keys: none

10.7 Open window list

At the bottom of the Window menu is a list of the currently open windows. Click on one of these to make it the active window. If the window has been minimized, it will be automatically restored.

11. Help menu

11.1 Help topics

Help topics command **(Help menu)**   **Alt,H,H**
"Displays the Help index"

This takes you to the **Contents** section of the on-line HELP. From here you also have acess to the **Index** and **Find** tabs.

> **Note**
> The on-line HELP is relevant to the currently active module.
> If an LTM window is active, help on LTM is provided.
> If a Data Manager window is active, help on the DM is provided.
> If a graphics window is active, help on graphics is provided.

Shortcuts
Toolbar: none
Keys: F1

11.2 Using help

Using help command **(Help menu)**   **Alt,H,U**
"Displays general help information on using the help system"

This command displays the standard Windows 95 Help file about using Help systems.

Shortcuts
Toolbar: none
Keys: none

11.3 Help mode

Help mode command **(Help menu)**   **Alt,H,M**
"Starts or stops context sensitive help mode"

This provides an on-screen, context-sensitive HELP. When chosen, the mouse pointer changes to a Help pointer. You can then click on windows, buttons and menu choices to display context-sensitive Help relating to the chosen item.

Shortcuts

Toolbar: ![toolbar icon]
Keys: SHIFT+F1

11.4 Tracker Status

Tracker Status command (**Help menu**)   **Alt,H,S**
"Display tracker status window"

This window displays some information which is also available in the
Station status window. Unlike the **Station status** window it can be
regularly updated and used during the warm-up phase.

Shortcuts

Toolbar: none
Keys: none

11.4.1 Dialogue box: Tracker status
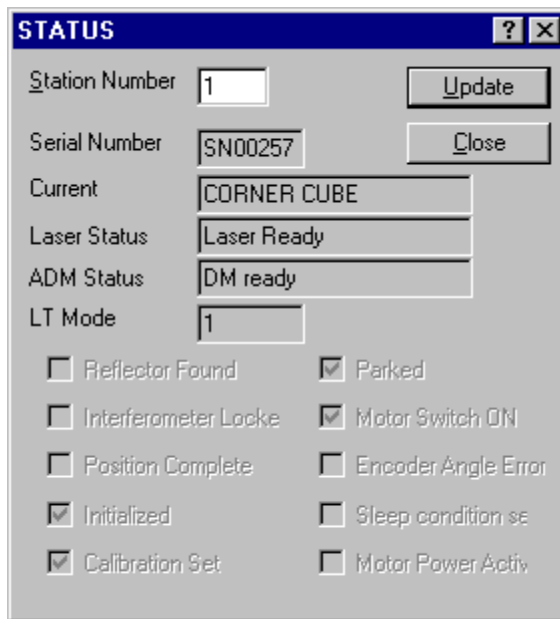
LTM Help - Trk status.bmp

Station number

Choose the station number where status information is required from the
drop-down list.

Serial number

Serial number of tracker at this station.

Current (reflector)

Type of reflector currently in use.

Laser status

The following conditions are shown:
- LCP Comm, Failed
- LCP not available
- Laser not ready
- Laser ready
- Laser unable to stabilize

These conditions are shown in the station status window. Fuller details in "Laser status" on page 9.

ADM status

The following conditions are shown:
- Communication to ADM failed
- No ADM available
- ADM ready
- ADM busy, measurement in progress
- HW error, unable to measure

LT mode

Information relevant for servicing.
0 = LAN communication is "Standard mode"
1 = LAN communication is "Session mode"

Reflector found

If set, IFM is locked onto a reflector but the distance is not set.

Parked

Tracker head has been sent to the "park" position. This is an internal procedure which is achieved during certain initialization routines. It cannot be set by the user.

Interferometer locked

If set, IFM is locked onto a reflector and the starting distance is set.

Motor switch on

If set, power to motors is on.

Position complete

If set, last position command was successful.

Encoder angle error

If set, an encoder angle error (h or v) was detected.

Initialized

If set, the internal check has been made.

Sleep condition set

If set, error messages will not be sent from the controller.

Calibration set

If set, error model values have been sent to the controller.

Motor power active

If set, motor power is maintaining the tracker pointing, e.g. to hold a camera view or make Nivel readings.

Update button

Click this to read the status again.

11.5 Diagnostics

Diagnostics command **(Help menu)**   **Alt,H,D**

"Display diagnostic information"
This menu option may help an operator or Leica service technician to locate a problem if a tracker is not functioning correctly. It provides information on some of the most critical internal components and conditions.

In normal operation it should not be necessary to access this menu.

Shortcuts

Toolbar: none
Keys: none

11.5.1 Dialogue box: Diagnostics information

LTM Help - Diagnostics.bmp

Station number

Choose the station number where diagnostics information is required from
the drop-down list.

Photo sensor

Tracking
These values indicate the return beam position on the tracking PSD. They
are only displayed when the system tracks the reflector.
X,Y - position on PDS relative to servo control point. Internal units used.
Intensity - intensity of beam returned by reflector, which depends on
reflector type.

The intensity depends on reflector type, cleanliness of the optics and the
autmatically selected A/D conversion range. Intensity readings should
correspond to the values below. If not, the options are:
- Clean the optics
- Use another reflector
- Inform the service department

Range	Intensity levels
A/D converter range 5V	<2047
A/D converter range 2.5V	>600

Reference
Older systems have an additional PSD to monitor the outgoing beam.
Newer systems do not have this PSD and zero values are indicated here.

Response as for tracking intensity.

Servo control point

This is the position on the PSD which the return beam should have if the
beam is locked onto a fixed reflector.

This position is influenced by several factors:
- Physical position of PSD in the tracker tube
- Electrical offset of the PDS and its amplifier
- The actual beam offset

Values can be different as the sensor warms up. The reading is updated
after an internal check. If out side the ranges below, the optical adjustment
may have changed due to an impact or fall. Contact the service department.

Parameter	Range
X	± 0.5mm
Y	± 0.5mm

A/D converter range

Range of PDS amplifier in volts.

In normal operation (new laser module) the sensor works in the 5V range.
With ageing the light intensity of the laser can become weaker. The
receiver amplification then automatically switches from the 5V to the 2.5V
range. This can also occur if the optical elements become dirty.

In the 2.5 V range, consider the following options:
- Clean the optics
- Change the reflector
- Monitor the intensity

If laser intensity continues to become weaker the laser will probably soon fail (end of life cycle). Contact the service department.

Laser light mode ratio H:V

This is an internal light quantity which is held at a specific value when the laser status is stable (green LED on sensor is constantly illuminated).

Laser control mode

This is a composite value indicating the internal temperature, heat output and laser control phase.
Example value = 2404703 (composite value). This means:
- 24°C at the interferometer
- 47 - heat output value
- 3 - control phase (3= laser stabilized)

There are no uniquely correct values. They depend on sensor type, laser tube, firmware version, environmental conditions, startup mode, etc.

Sensor inside temperature

This is the air temperature in the sensor housing in °C. It provides an indication of thermal stability with respect to room temperature. However the sensor temperature (determined by the laser heating element) is always higher than room temperature.

Runtime of LCP

Time in minutes since the system was switched on.

Total runtime of laser tube

Total operating time (minutes) of the laser tube since it was installed.

Display	Comment
< 350 hours	Device is new
> 10 000 hours	The tube has reached an average age. The laser light output should be viewed by eye. If it is continually dropping, imminent failuer of the tube is possible. However this also depends on the cleanliness of the optics and the current A/D range.

11.6 Hardware Cfg

Hardware Cfg command **(Help menu)**   **Alt,H,H**
"Display the hardware configuration screen"

Provides information relating to the current hardware and firmware configuration at a particular station.

Shortcuts
  Toolbar: none
  Keys: none

11.6.1 Dialogue box: Hardware Configuration
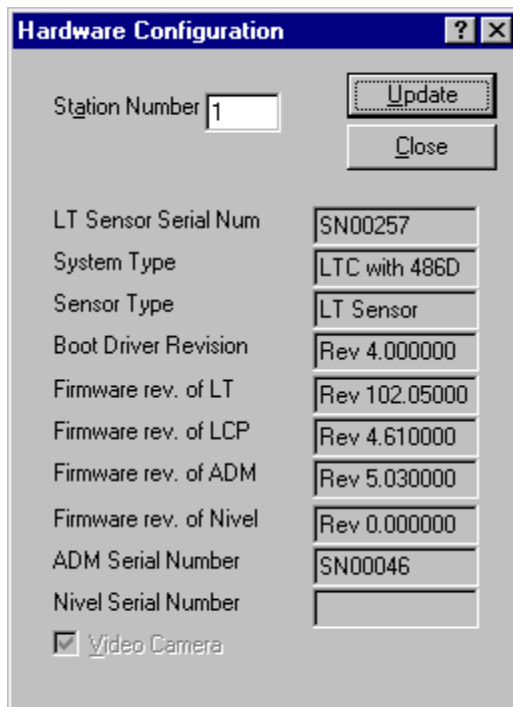
LTM Help - HW.bmp

Station number

Choose the station number where the hardware configuration is required from the drop-down list.

LT sensor serial number

Serial number of the laser tracker connected at the selected station.

System type

Indicates type of processor board installed in the LT controller or on the SMART TP.

Sensor type

Indicates current tracker type:
- SMART 310
- SMART/ADM
- LT 500 (without ADM)
- LTD 500 (with ADM)

Boot driver revision

The revision number of the boot driver installed in the LT controller or on the SMART TP.

Firmware rev. of LT

Revision number of firmware downloaded to the LT controller or the SMART TP.

Firmware rev. of LCP

Revision number of firmware on the Laser Controller Processor (LCP) mounted on the interferometer.

Firmware rev. of ADM

Revision number of ADM firmware.

Firmware rev. of Nivel

Revision number of firmware in Nivel. Only applies to LT500, LTD500.

ADM serial number

Serial number of ADM which is normally different from the system serial number.

Nivel serial number

Serial number of Nivel. Only applies to LT500, LTD500.

Video camera

If set, the video camera is installed.

11.7 About Axyz LTM

About Axyz LTM command **(Help menu)**   **Alt,H,A**
"Display program information, version number and copyright"

Shortcuts
Toolbar: none
Keys: none

12. *Shortcut menus on right mouse click*

12.1 Station status window menu
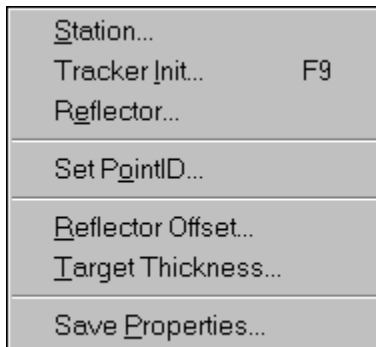
```
Station...
Tracker Init...        F9
Reflector...

Set PointID...

Reflector Offset...
Target Thickness...

Save Properties...
```
LTM rt click stn win.bmp

Right mouse click in the station status window to get this menu.

For **Station, Tracker init, Reflector** see "Setup menu" on page 54.

For **Set point ID, Reflector offset, Target thickness** see "Measure menu" on page 96.

Save properties
This option saves the current display settings for the window.

12.2 Measurement window menu
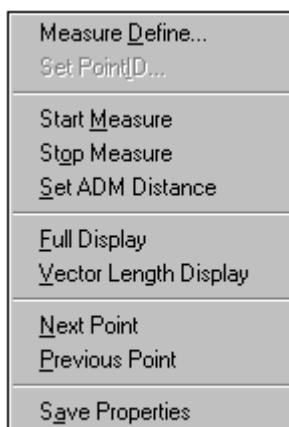
```
Measure Define...
Set PointID...

Start Measure
Stop Measure
Set ADM Distance

Full Display
Vector Length Display

Next Point
Previous Point

Save Properties
```
LTM rt click meas1.bmp

Right mouse click in any measurement window to get this menu.

For **Measure define, Set point ID, Start Measure, Stop measure, Set ADM distance, Next point, Previous point** see "Measure menu" on page 96.

For **Full Display** see "Zoomed display" in "View menu" on page 32.

Vector display
This option is available for **Auto Inspect** and **Build/Inspect** modes and it displays the current offset as a vector length instead of coordinate components.

Save properties
This option saves the current display settings for the window.

13. How to …

13.1 Create the first station in a new job

Move the tracker into position
Define a new station: **Setup/Station**

> **Note**
> For this first station in a network no orientation measurements are
> required.

READY TO GO!

13.2 Add another station to the network (multiple setup)

Before you move the tracker:
- Make sure you have measured at least 3 points on a triangle which can
  be seen from the new station

Move the tracker into the new position
Define a new station: **Setup/Station**

Make orientation measurements to stationary points:
- Select Standard Mode: **Mode menu/Standard**
- Select Stationary measurement method: **Measure menu/Stationary**

Measure at least 3 existing points forming a triangle

Orient the station into the network: **Setup/Orient**

READY TO MEASURE NEW POINTS!

13.3 Measure with a single station network

Create a new job.

Create the first station in the job.

This station is automatically defined as "oriented" and no further action is
needed.

Make further measurements as required.

13.4 Make a complete field check

This section indicates what measurements to make and how to calculate results.

Decide on the type of field check:

Two face
The pointing to a fixed reflector from a fixed station should be the same in both faces.

Ball bar
When a ball bar is measured the resulting points should lie on a circle.

ADM
The purpose here is to check that ADM measurements are consistent with the IFM measurements. Several fixed points can be measured with both the IFM and ADM. The IFM and ADM distances to these points should be the same.

IFM
The Home Point (Birdbath) distance is an instrument parameter which has a current value. One method of setting this value is to make measurements to two fixed points from two fixed stations. This measurement procedure can also be used to check the current value.

13.4.1 Two face

Set up the tracker to make two face measurements:
EITHER Align/Two face
OR Setup/Field check measurements/Two face

Recommended parameters for measurement:
For each 2-face measurement:
Measurement count = 100
Time separation = 0.1 sec

This results in a total measurement time of approximately 10 secs per face.

Make some two face measurements
Choose stable locations for the reflectors

Recommended minimum measurements for check purposes:
    1 near point, low down
    1 far point at tracker height

Calculate results: **Setup/Field check calc/Two face**

Are the 2-face measurements OK?

Ideally the 2σ values in the instrument specification are:

Horizontal angle $\pm 13^{cc}$
Vertical angle $\pm 13^{cc}$

This means that typical values for differences should be not more than twice the above values. If several values are significantly higher you may have to make a full alignment.

13.4.2 Ball bar

Set up the tracker to make Ball Bar measurements:
    EITHER Align/Ball Bar
    OR Setup/Field check measurements/Ball Bar

Recommended parameters for measurement:
    Measurement count = 100
    Distance criteria: Total point separation = 35mm

Make some ball bar measurements
Choose stable locations for the ball bars
Recommended minimum measurements for check purposes:
    1 setup at under 1m range and at tracker height
    1 setup at 3m range and at tracker height

Calculate results: **Setup/Field check calc/Ball Bar**

Are the Ball Bar measurements OK?

Ideally the 2σ values of the offsets from the best fitting circles, as stated in the instrument specification are:

At 1m: $\pm 30\mu$ (± 0.0012 inch)
At 3m: $\pm 90\mu$ (± 0.0035 inch)

The results show the maximum deviation from the best fitting circle which should be not more than twice the above values. If it is significantly higher you may have to make a full alignment.

13.4.3 ADM instrument parameter

Before you can make a reliable ADM instrument check, the IFM must be correctly adjusted, i.e. the Birdbath distance must be correct.

- To <u>check</u> the Birdbath distance, see "IFM (Birdbath check)" on page 199.
- To <u>set</u> the Birdbath distance, see "Calculate the Home Point (Birdbath) distance" on page 200.

Initialize measurements in the Birdbath: **Go Birdbath**
    This ensures that measurements are referenced to the IFM

Set up the tracker to make combined IFM and ADM measurements to stationary points:
    EITHER Align/ADM measurements/ADM instrument measure
    OR Setup/Field check measurements/ADM instrument measure

Record at least 5 points:
    Points at different distances
    Minimum distance of 2m.
    All points near tracker height

Calculate results: **Setup/Field check calc/ADM**

Is the ADM check OK?

Ideally the 2σ value of the difference between an IFM and ADM values, as stated in the instrument specification is $\pm 50\mu$ (± 0.002 inch).

If it is significantly higher you may have to re-calculate the ADM parameters.

13.4.4 IFM (Birdbath check)

Review the concept for this method.

- See "Calculating the Home Point (Birdbath) distance" on page 141.

Select 2 fixed points approximately at tracker height. The points should be chosen so that you can place the tracker conveniently between them. There should also be space to position the tracker on the extended line between the points. Typical point separation would be a minimum of 2m - 3m.

Set up the tracker for stationary point measurement:

Select **Standard Mode: Mode menu/Standard** 🖳
Select Stationary measurement method: **Measure menu/Stationary**

Make stationary point measurements to the 2 points from a position on the extended line between the points.

Move the tracker to a position close to the mid-point between the points. Make stationary point measurements to the 2 points again. (Same measurement parameters.)

If the tracker positions are regarded as the same station, the points must be given different IDs in the second measurement. This is the recommended technique.

(Alternatively, if the tracker positions are regarded as separate stations, the points can be given the same IDs)

Calculate results: **Setup/Field check calc/IFM**

Is the IFM measurement (Birdbath distance) OK?

Ideally the difference between the new value and the existing value should be in the region of 10μ (±0.0004 inch) (2 σ value).

If it is significantly higher you will have to make a new Birdbath calculation.

13.5 Calculate the Home Point (Birdbath) distance

The Birdbath distance is the distance from the centre of the tracker's mirror to the centre of the reflector. This distance depends on the reflector housing and the optical properties of the retro-reflective elements. For this reason there is a different Birdbath distance for every reflector type and the calculation must therefore be made for every reflector type.

To review the concept for this method see "Calculating the Home Point (Birdbath) distance" on page 141.

> **Note**
> The 2-point method is more accurate than the scale bar method.

13.5.1 Birdbath distance by 2-Point method

Select 2 fixed points approximately at tracker height. The points should be chosen so that you can place the tracker conveniently between them. There should also be space to position the tracker on the extended line between the points. Typical point separation would be a minimum of 2m - 3m.

Set up the tracker for stationary point measurement:
> Select **Standard Mode: Mode menu/Standard**
> Select **Stationary measurement method: Measure menu/Stationary**

Make stationary point measurements to the 2 points from a position on the extended line between the points

Move the tracker to a position close to the mid-point between the points. Make stationary point measurements to the 2 points again. (Same measurement parameters.)

If the tracker positions are regarded as the same station, the points must be given different IDs in the second measurement. This is the recommended technique.

(Alternatively, if the tracker positions are regarded as separate stations, the points can be given the same IDs)

Calculate results: **Align/IFM dist/2 point**

Is the Birdbath distance OK?

Ideally the difference between the new value and the existing value should be in the region of 10μ (±0.0004 inch) ($2\,\sigma$ value).

If it is significantly higher you should accept the new value. In this case you must also repeat the test to confirm that this new value is stable.

13.5.2 Birdbath distance by scale bar method

Use 2 fixed points with a known separation. This is easily achieved using a scale bar but a pair of accurately measured existing points, for example from a test field, can also be used.

Ideally the points should be approximately at tracker height. They should also be as close to the tracker as possible so that the subtended angle at the tracker is as close to 180° as possible.

Short distances to the points are acceptable.

Set up the tracker for stationary point measurement:
   Select **Standard Mode: Mode menu/Standard** 🖳
   Select **Stationary measurement method: Measure menu/Stationary**

Make stationary point measurements to the 2 points.

Calculate results: **Align/IFM dist/Scale bar**
Here you can specify the point separation in two ways:
- Manually
- By selection of a scale bar, if measured with a scale bar and the scale bar is defined in the job file

Is the Birdbath distance OK?

Ideally the difference between the new value and the existing value should be in the region of 10μ (±0.0004 inch) (2 σ value).

If it is significantly higher you should accept the new value. In this case you must also repeat the test to confirm that this new value is stable.

13.6 Calculate the ADM instrument parameters

The ADM is compared against the higher accuracy IFM. Two parameters, and offset and a scale factor, are calculated to make ADM values match IFM values.

Before you can calculate ADM parameters, the IFM must therefore be correctly adjusted, i.e. the Birdbath distance must be correct.

- To check the Birdbath distance, see "IFM (Birdbath check)" on page 199.
- To set the Birdbath distance, see "Calculate the Home Point (Birdbath) distance" on page 200.

Since ADM measurements are affected by the material of retro-reflectors, a hollow corner cube reflector must be used in order to avoid an additional offset. (Hollow corner cubes have a zero offset.)

Initialize measurements in the Birdbath: **Go Birdbath**
   This ensures that measurements are referenced to the IFM

Set up the tracker to make combined IFM and ADM measurements: **Align/ADM measurements/ADM instrument measure**

Record at least 5 points:
   Points at different distances
   Minimum distance of 3.5m.
   Maximum distance at tracking limit, around 30m
   All points near tracker height

Calculate and implement results: **Align/ADM offsets/Instrument**

Are the ADM parameters OK?

The offset should be around 670mm.
The scale factor should be around 1.0.

Ideally the 2σ value of the difference between an IFM and ADM values, as stated in the instrument specification is $\pm50\mu$ (±0.002 inch)

13.7 Calculate ADM reflector parameters

Reflectors with glass elements generate a small additional distance offset. Hollow corner cubes do not have this effect.

In practice the factory value should be good enough as a special laboratory procedure based on interferometric methods is used. This calculation should therefore only be required very occasionally.

Check and, if necessary, calculate the ADM instrument parameters.
- See "ADM" on page 199.
- See "Calculate the ADM instrument parameters" on page 202.

Calculate the Birdbath distance for the test reflector using the 2-point method.
- See "Calculate the Home Point (Birdbath) distance" on page 200.

Initialize measurements in the Birdbath: **Go Birdbath**
    This ensures that measurements are referenced to the IFM

Set up the tracker to make combined IFM and ADM measurements:
Align/ADM measurement/ADM reflector measure

Although the minimum is one point, it is recommended to record at least 5 points:
    Points at different distances
    Minimum distance of 3.5m.
    Maximum distance at tracking limit, around 30m
    All points near tracker height

Calculate and implement results: **Align/ADM offsets/Reflectors**

13.8 Align (calibrate) a tracker and reflectors

Do the tests with one reflector type, preferably a corner cube reflector.

Calculate the Birdbath distance for the reflector.
- See "Calculate the Home Point (Birdbath) distance" on page 200.

Make the following groups of measurements (order not important):
- 2-face measurements
  Set the correct measurement mode: **Align/Two face**
- Ball Bar measurements
  Set the correct measurement mode: **Align/Ball Bars**

For recommended geometric arrangements:
- See "Calculating the full set of tracker alignment parameters" on page 144.

Calculate the full tracker model: **Align/Align tracker**

Re-calculate the Birdbath distance because the full tracker model has now changed.
   Make this test for all reflector types!

Calculate the ADM parameters:
- See "Calculate the ADM instrument parameters" on page 202.

Calibrate reflector corrections for ADM, if required.
- See "Calculate ADM reflector parameters" on page 203.

13.9 Calculate an intermediate alignment

Set the correct measurement mode: **Align/Two face**

Make a minimum of 6 2-face measurements as described in "Calculating an intermediate alignment" on page 147.

Calculate the partially updated tracker model: **Align/Align tracker intermediate**

13.10 Digitize a free-form surface

A free form surface can be digitized by scanning a reflector across and in contact with it.

Since the measured reflector centre is not on the surface, the measured points must be corrected by an offset equivalent to the radius of the reflector housing. An offset correction is available to graphics users.

See "*Axyz* Graphics Module: Software Reference Manual"
   Graphics menu/ Surface offset

13.10.1 Simple digitizing by continuous or grid measurement

In the mode menu:
Choose **standard** measurement mode.

In the measurement menu:
EITHER: Choose **continuous** measurement.
   Select recording parameters which will generate a good density of points.

OR: Choose **grid** measurement

    Specify grid parameters which will ensure a good distribution of points

Scan the reflector across the surface and record points.

Note

To ensure full coverage it may help to tape or mark lines on the surface which you can follow with the reflector.

In ***Axyz*** View select the recorded measurement set and calculate an offset correction.

14. Summary of error messages

14.1 System errors - 1xx

Bold+Italic shows new errors for LT/LTD500

Number	Description
101	Program too large from C_BOOT to load.
102	Program failed, reload or reboot.
103	Invalid command.
104	Boot command unable to open file in RAM disk
105	Boot process interrupted by command
110	Calibration not set.
111	Tracker not initialized.
112	reserved
113	Calibration parameters sent to the wrong tracker.
114	Target not defined (target offset for ADM measurement)
121	TP.PGM Software running on a LT Controller
122	LT.PGM Software running on a SMART310 Tracking Processor
...	reserved
130	ADM not available
131	Video Camera not available
132	Beam expander lens for radial searching not available
133	Nivel not available
199	Command not implemented.

14.2 Communication errors - 2xx

Bold+Italic shows new errors for LT/LTD500

Number	Description
201	Overflow of input buffer. (e.g. a message in a session is longer as the receive buffer of the LAN)
202	Communications timeout, the string is not completed within time period.
203	Frame error, the format of the received string is not correct.
205	LAN communication too slow, TP runs out of recources (buffers).
206	LAN name conflict (more than one station with equal names online)
210	Communications between TP and Laser Control Processor (LCP) has failed.
221	Communications between TP and ADM has failed
222	Communications between TP and Nivel20 has failed

14.3 Parameter errors - 3xx

Bold+Italic shows new errors for LT/LTD500

Number	Description
3XX	Invalid value for parameter XX, where XX is the number of the parameter. The number of the parameter depends on the command.
399	Several parameters are invalid.

14.4 LCP hardware errors - 4xx

Bold+Italic shows new errors for LT/LTD500

Number	Description
401	LCP has no firmware loaded.
402	Invalid Tracker Serial Number stored on the LCP
4xx	more error numbers will be defined in the future.

14.5 ADM hardware errors - 5xx

Bold+Italic shows new errors for LT/LTD500

Number	Description
501	ADM has no firmware loaded.
502	Set frequency not locked.
503	Set frequency, illegal state (internal software error)
504	Measurement cycles exceeded
505	reserved
506	Illegal state (internal software error)
507	Minimum lost, unstable measurement conditions
508	reserved
509	Start failed, hardware error
510	reserved
511	Band scanning failed
512	Frequency unstable
513	No RF current
514	Frequency current error
515	Security timeout, maximal measurement time exceeded
516	Security lock, no light from Interferometer
517	Invalid distance
599	unkown ADM error

14.6 Hardware errors in the TP (Service only) - 6xx

Bold+Italic shows new errors for LT/LTD500

Number	Description
600	
..	
610	Beam expander lens not in parking position (moved out of the beam).
611	Beam expander lens not able to move into the beam.
...	
620	IFM fail signal shows always ok (also in cases where the beam is not on a target)
621	IFM count not stable (counting error during servo control point measurement)

14.7 Operation errors - 7xx

Bold+Italic shows new errors for LT/LTD500

Number	Description
701	Target lost, tracking has failed.
702	Interferometer has failed, lost count.
703	Azimuth limit has been reached. The tracker head has attempted to go beyond the ±240 degrees.
704	Elevation limit has been reached.
705	Positioning timeout, positioning of the tracker head could not be completed within the timeout period.
706	Abort command.
707	invalid angle on the azimuth axis.
708	invalid angle on the elevation axis.
710	Radial speed is within bounds. (Sent after a speed warning when the speed has returned to acceptable bounds.)
711	Radial speed warning. This is a warning that the movement of the reflector in the radial direction is approaching the speed limit.
712	Radial speed error. This indicates that the radial speed has exceeded the capacity of the interferometer and there is a likely loss of accurate distance setting.
720	Intensity overflow on photosensor. This error occurs, if the intensity value from the photosensor exceeds the range of the A/D converter. The TP will change the A/D range automatically.
721	Laser light mode has jumped. This means the laser control loop wasn't able to stabilize the laser tube. (This can be caused by a fast and large temperature change). For a proper measuring accuracy the user must wait until the 'laser ready flag' switches again to an active state and then run a new initialization to make sure that the sensor works with a correct servo control point.
722	Laser stabilization in progress, wait until the laser is stable before tracking.
723	Laser unable to stabilize.
731	Reflector too close to the Tracker for measuring the distance with the ADM.
732	ADM gets no signal from the reflector

Operation errors - 7xx (cont.)

Bold+Italic shows new errors for LT/LTD500

733	ADM measuring timeout, the communication with the ADM is working, but there is no completed measurment in a certain time by the ADM.
734	Target was not stable during the ADM measurement
735	Reflector too far from the Tracker to measure the distance with the ADM.
736	Distance measured by the ADM is invalid, out of resonable range
750	reserved

14.8 Hardware configuration errors - 8xx

Bold+Italic shows new errors for LT/LTD500

Number	Description
801	Power switch from the rack is off.
802	Power switch for tracker motor is off.
810	Cables from TP to the rack are not connected.
811	DA-cable from TP to the rack is not connected.
812	Encoder-cable from TP to the rack is not connected.
813	Communication from the TP to the rack is not connected.
820	Cables from the rack to the sensor tube are not connected.
831	Azimuth index offset is not suitable for this measuring head.
832	Elevation index offset is not suitable for this measuring head.
841	Azimuth encoder interpolation rate wrong
842	Elevation encoder interpolation rate wrong
843	An new LT/LTD500 Sensor in use with an old SMART310 Controller/TP, not compatible!
844	An old SMART310 Sensor in use with the new LT Controller, it is not compatible.
845	An old SMART310 Sensor cable is in use, it isn't compatible with the new LT Controller and LT/LTD500 Sensor.

14.9 Hardware errors in the TP (Service only) - 9xx

Bold+Italic shows new errors for LT/LTD500

Number	Description
9XX	This is a hardware error XX to be repaired by service personnel.
901	Azimuth axis is not working.
902	Elevation axis is not working.
903	Azimuth Tacho signal failed.
904	Elevation Tacho signal failed.
905	Azimuth encoder is not working.
906	Elevation encoder is not working.
907	Azimuth index mark does not respond.
908	Elevation index mark does not respond.
909	Azimuth moving range limited (can not move +/- 240 degrees).
910	Photo sensor is not working properly.
911	Photo sensor does not receive enough light.
912	Photo sensor intensity signal failed
913	Photo sensor X signal failed
914	Photo sensor Y signal failed
915	Calculation error while determining the SERVO CONTROL POINT.
916	No collar reflector found for measuring the servo control point. (or the beam intensity is not strong enough to locate the collar reflector.).
917	Laser unable to stabilize, hardware error on the laser detected.
918	Interferometer is not working properly. (eg, at test into the collar reflector did not work)
919	'Lost counts' signal of the interferometer is not working properly.
921	LAN, Command line switch error.
923	No LANtastic hardware detected.
924	LAN, Shared RAM did not pass tests.
925	LAN Coprocessor did not respond to reset.
927	LAN, Interrupt level error.
930	No encoder board detected.
931	Encoder board, Azimuth counter is not working.
932	Encoder board, Elevation counter is not working.
933	Encoder board, Interferometer counter is not working.
934	Encoder board, Azimuth index pulse failed.

Hardware errors in the TP (Service only) - 9xx (cont.)
Bold+Italic shows new errors for LT/LTD500

935	Encoder board, Elevation index pulse failed.
936	Encoder board, Latch signal for counters failed.
937	Encoder board, disabling of index pulses failed.
938	Encoder board, cannot switch on the receiver for index pulses.
939	Encoder potentiometer adjustments, invalid.
940	No A/D board detected.
941	A/D board, Unipolar/Bipolar switch is set wrong.
942	A/D board, 8/16 channel switch is set wrong.
943	A/D board, Analog input multiplexor error.
944	A/D board, A/D converter is not working.
945	A/D board, DMA data transfer is not working.
946	A/D board, onboard clock is not working.
947	A/D board, Pacer clock too slow, switch is set wrong.
948	A/D board, Pacer trigger is not working.
949	A/D board, External trigger is not working.
950	A/D board, A/D voltage range switch is not working.
951	A/D board, A/D input offset is out of tolerance.
952	A/D board, DMA transfer synchronization error.
953	A/D board, Ref. Voltage Jumper for DAC in wrong position
954	D/A board, Address switch is set to a wrong base address.
955	D/A board, both axes not working.
956	D/A board, Azimuth axis not working.
957	D/A board, Elevation axis not working.
958	Azimuth motor amplifier balance not properly adjusted.
959	Elevation motor amplifier balance not properly adjusted.
960	reserved
961	CPU board, DMA controller failed.
962	reserved
963	reserved
964	CPU board, CPU clock too slow.
965	reserved
966	reserved
967	reserved
968	CPU board, not enough memory for dynamic memory allocation.
969	reserved
970	LTC, internal PSD input cable not connected.
971	LTC, internal Motor I/O cable not connected.

cont.

Hardware errors in the TP (Service only) - 9xx (cont.)

Bold+Italic shows new errors for LT/LTD500

972	LTC Digital I/O cable not connected.
973	LTC, COM1 cable not connected
974	LTC, COM2 cable not connected
975	LTC, Az Encoder Cable not connected
976	LTC, El Encoder cable not connected
977	LTC, Cable between PCL and LTC card failed
978	LTC, HW Trigger cable LTC card to Encoder card failed
979	reserved
980	LTC, +5V Power Supply failed
981	LTC, +7V Power Supply failed
982	LTC, +12V Power Supply failed
983	LTC, +28V Power Supply failed
984	LTC, -5V Reference voltage failed
985	LTC, -7V Power Supply failed
986	LTC, -12V Power Supply failed
987	LTC, Inhibit of 28V Power Supply not working
988	LTC, +15V Power Supply failed
989	LTC, -15V Power Supply failed
990	LTC, Tacho Power Supply failed (located in the measuring head)
999	Unknown hardware error.

15. LTM Remote

15.1 Concept of remote operation

The LTM is designed to be operable from a remote hand-held computer via wireless communication. This does not offer access to all functions and options but enables users to carry out a range of measurement tasks at the measured object.

In particular, measurement modes require the definition of recording parameters and may also make use of reference coordinate lists. Modes may be switched remotely and this enables, for example, changing from auto inspection of a set of targets to the measurement of a new single location. However, the relevant parameters for these modes must be set at the controlling PC using the main LTM program.

15.1.1 Hardware and configuration

Although the necessary software is part of the LTM package, the hand-held computer and communications hardware must be separately purchased.

The hand-held computer must have Windows CE (Compact Edition) as its operating system. As part of a complete system package supplied by Leica, only the following computer is available:

- HP Jordana 680

The software will additionally support the following which users must supply themselves:

- Hitachi HPW-600ET e-Plate
- Compaq C-Series 2010c

A Proxim LAN adapter is used for the wireless communications.

Use of the remote facility is established during installation. Apart from a one time recording of addresses during the first startup, further installation procedures are not required.

More details are available in the installation guide.

15.1.2 Running a remote measurement session

1. Start the main LTM module on the controlling PC (Application Controller).

2. Start the LTM Remote module on the hand-held computer.

3. (One-time operation during very first startup:
   Confirm LAN address of controlling computer and port number of the LT controller – see **File menu: TCP/IP**)

4. Connect remote module to main module – see **File menu: Connect**

5. Finish the session by exiting from the Remote module.

15.2 Remote graphical interface

15.2.1 Main screen - remote
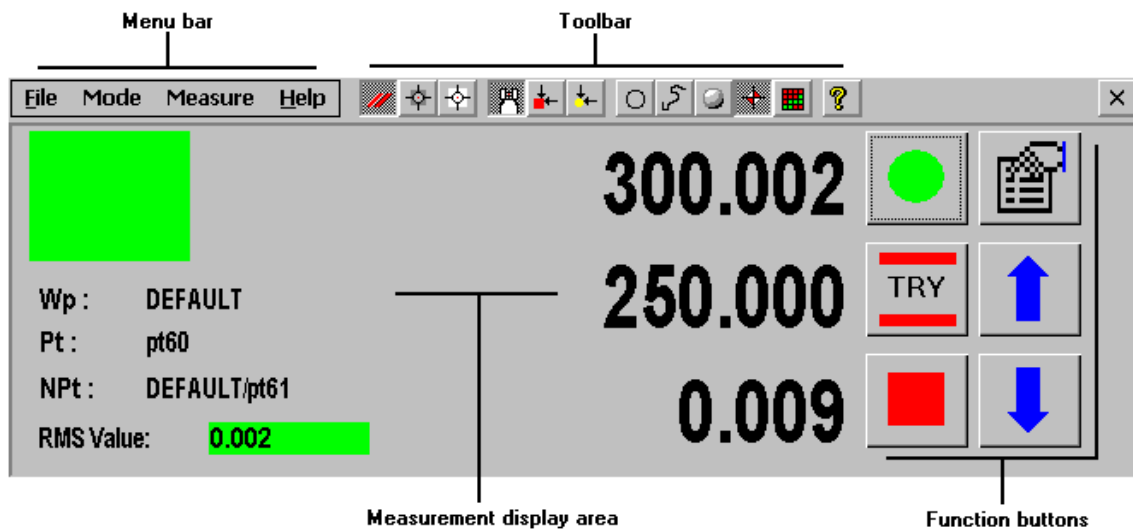
The example screen currently shows the results of a standard single point measurement.

15.2.2 Summary of remote toolbar buttons

Connect hand-held PC to main controlling PC

Lock onto an existing point and re-set the IFM

Lock onto a reflector in the Bird Bath and re-set the IFM

Standard mode for single points, continuous and scanned data

Build (and inspect) mode for single points

Build (and inspect) mode for standard *Axyz* shapes

Measure a fixed point by the circle centre method

Continuous point measurement

Measure a fixed point by the sphere centre method

Measure a stationary point by direct measurement

Continuous point measurement on a 3D grid of planes

Display version information for the Remote LTM program

RLTM - Toolbar.bmp

15.2.3 Summary of remote function buttons

🟢	Start measuring, display and store results
TRY	Start measuring, display only
🟥	Stop measuring
📋	Set point ID
⬆	Increment point ID or go to next Build point
⬇	Decrement point ID or go to previous Build point

RLTM - Function buttons.bmp

15.2.4 Remote display – standard mode
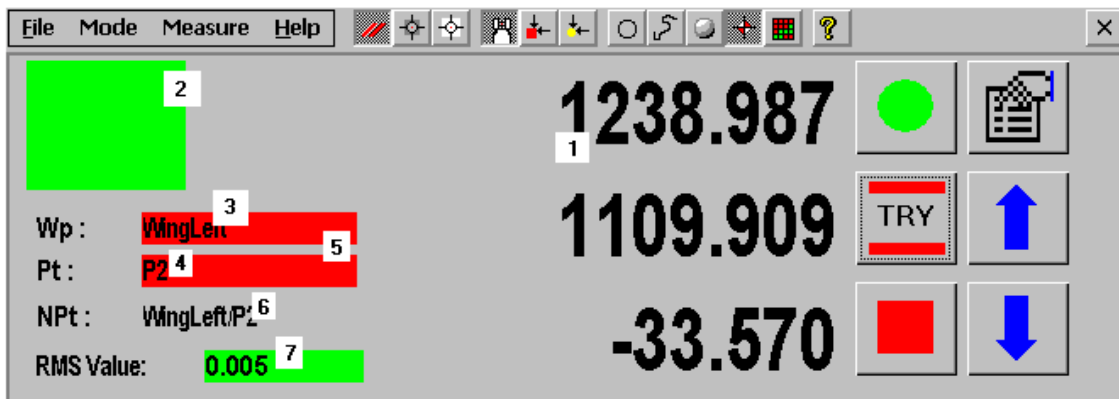
RLTM win - sgl pt.bmp

Current point coordinates (1)
From top to bottom the coordinates are arranged according to the current axis labelling, e.g. (X, Y, Z), (H, V, D), (East, West, Height), etc.

Measurement status "Traffic light" indicator (2)
See also "Measurement windows: "Traffic lights"" on page 10.

Workpiece name (3) and Point name (4)
Workpiece and point ID for the point with the currently displayed coordinates.

"Try" indicator
The background colour here is red if "Try" measurement is active. For normal recorded measurements the dialogue box colour is shown.
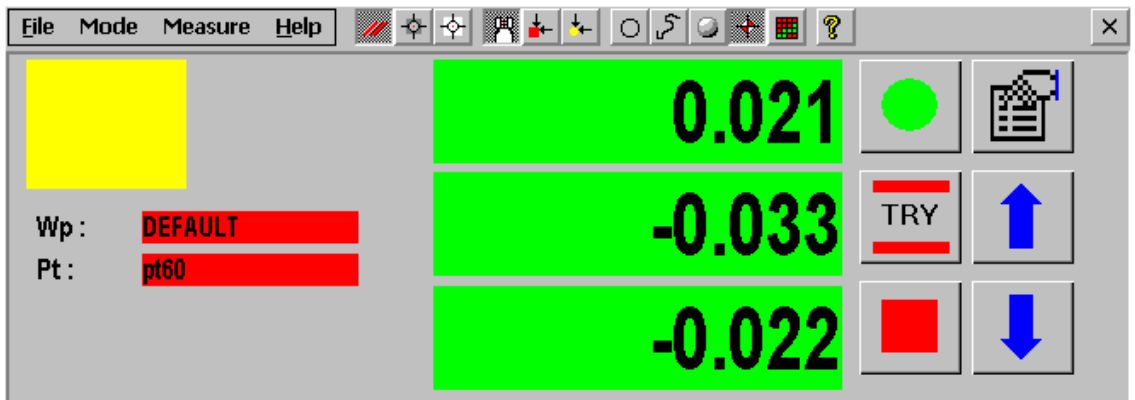
Next point name (6)
Name of the next point which will be measured.

RMS value (7)
For a stationary point located by circle fit, sphere fit or averaged location, this is the RMS value of the corresponding residuals for the current measurement.

15.2.5 Remote display – Build points
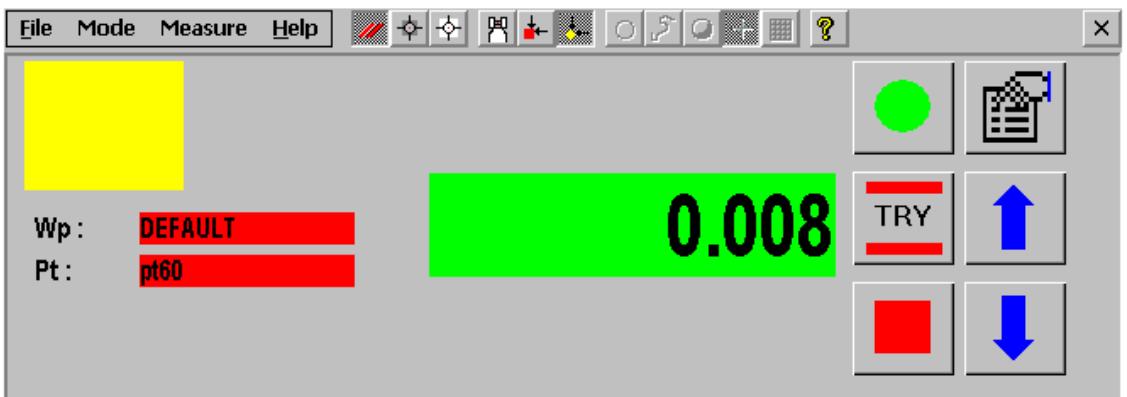

RLTM win - build pts.bmp

Displayed coordinates are differences with reference values. The background is colour coded according to defined tolerance levels. See "Tracker Warnings" on page 89.

The display can also be switched to show the vector length difference. This is available in the **LTM Remote Measure Menu**.

15.2.6 Remote display – Build shapes
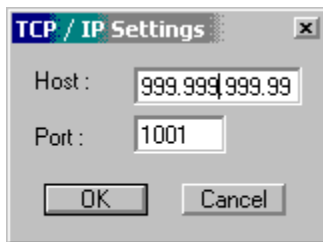

RLTM win - build shapes.bmp

The displayed value is the perpendicular offset from the reference build surface (vector length offset). Its background is colour coded according to defined tolerance levels. See "Tracker Warnings" on page 89.

15.3 File menu – remote

15.3.1 TCP/IP

TCP/IP command (**File menu**)   **Alt,F,T**

This is a one-time operation during the very first setup. During installation of the wireless LAN, the controlling PC (**Host** PC), must be given an address on the LAN. An additional address (**Port** number) is required for the tracker controller. Instruction for locating these values can be found in the installation manual. Enter the values here.

If the addresses are entered incorrectly, a message similar to the following appears:

Shortcuts
    Toolbar: none
    Keys: none

15.3.2 Connect

Connect command (**File menu**)   **Alt,F,C**

To initiate a measurement session using the remote hand-held PC, a connection must be established to the controlling PC (host PC).
An open measurement view is required in the main LTM program.

If the hand-held PC is moved out of the wireless LAN's range, a connection is automatically re-established when it is returned within range.

Shortcuts

Toolbar:

Keys: none

15.3.3 Exit

Exit command **(File menu)**   **Alt,F,X**

Use this command to shut down the LTM Remote program. This will not close the main LTM or *Axyz* programs.

Shortcuts

Mouse: Click the application's "Close" button.

Toolbar: none

Keys: ALT+F4

15.4 Mode menu – remote

15.4.1 Standard

Standard command **(Mode menu)**   **Alt,O,S**

Selects standard measurement mode which offers a number of methods for making measurements of static single points and dynamically recording 3D data sets.

Shortcuts

Toolbar:

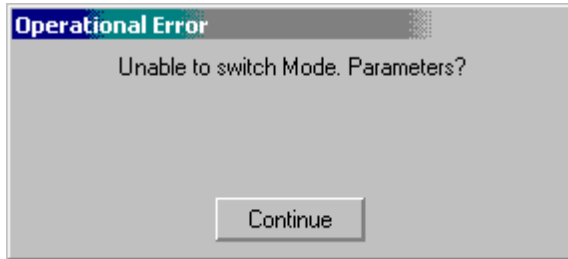Keys: none

15.4.2 Build points

Build Points command **(Mode menu)**   **Alt,O,B**

Selects Build Points mode which is used for manually setting out new points (Build) or manually checking the positions of existing points (Inspect).

Points are set out directly or as offset points on vectors perpendicular to CAD surfaces.

Selection of reference points must be done using the corresponding function in the main LTM program. If this has not been done the following error message is displayed:

RLTM Mode - switch mode error.bmp

Shortcuts

Toolbar:
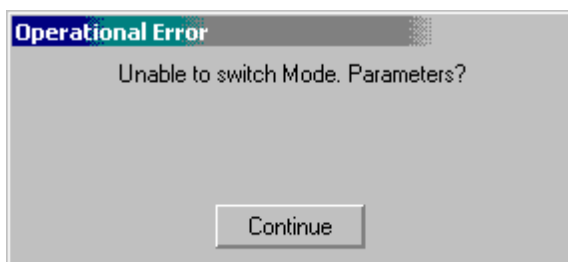
Keys: none

15.4.3 Build shapes

Build shapes command (**Mode menu**)   **Alt,O,I**

Selects Build Shapes mode which is used to manually set out points on a standard ***Axyz*** shape surface (plane, cylinder, sphere, cone, paraboloid) or check the offsets of existing points from a standard surface.

Selection of shape type must be done using the corresponding function in the main LTM program. If this has not been done the following error message is displayed:

RLTM Mode - switch mode error.bmp

Shortcuts

Toolbar:

Keys: none

15.4.4 Stationary

Stationary command (**Mode menu**)   **Alt,O,A**

This measurement method is only available when **Standard mode** is active.

It is used for measuring to a fixed reflector position, either using the IFM or ADM (if available). The pointing is derived by averaging a number of measurements and the averaged measurement is available for use by the Orientation Module and Single Point Solution.

The parameters which control data recording are part of the measurement definition and must be set in the main LTM program (**Measure/Define**).

Shortcuts
   Toolbar:
   Keys: none

15.4.5 Continuous

Continuous command (**Mode menu**)   **Alt,O,N**

This measurement method is only available when **Standard mode** is active.

This method is used to record a related set of points generated dynamically, such as the sweep of a robot arm or a reflector scanned across the surface of an object.

The parameters which control data recording are part of the measurement definition and must be set in the main LTM program (**Measure/Define**).

Shortcuts
   Toolbar:
   Keys: none

15.4.6 Sphere centre

Sphere centre command **(Mode menu)**   **Alt,O,H**

This measurement method is only available when **Standard mode** is active.

A fixed stationary point such as a hole centre can be measured indirectly with an adapter which has a spherical surface and by scanning a reflector across and in contact with the sphere's surface.

The measured reflector positions also lie on a spherical surface with the same centre as the adapter. This centre is automatically derived from the best-fitting sphere and defines the required point which is assigned the type **entered**.

The parameters which control data recording are part of the measurement definition and must be set in the main LTM program (**Measure/Define**).

Shortcuts

Toolbar:

Keys: none

15.4.7 Circle centre

Circle centre command **(Mode menu)**   **Alt,O,C**

This measurement method is only available when **Standard mode** is active.

A stepped cylindrical adapter can be used to locate a point indirectly. By scanning a reflector around the step, reflector positions on a circle can be recorded. The centre of the circle lies on the axis of the cylinder. This centre is automatically derived from the best-fitting circle and defines the required point which is assigned the type **entered**.

The parameters which control data recording are part of the measurement definition and must be set in the main LTM program (**Measure/Define**).

Shortcuts

Toolbar:

Keys: none

15.4.8 Grid

Grid command **(Mode menu)**   **Alt,O,G**

This method is only available when **Standard mode** is active.

In grid measurement a 3D grid of planes or surfaces is defined. Every time the reflector moves through a surface a point is recorded, which means that multiple points can be recorded on the same surface. The technique is similar to continuous measurement by change of coordinate.

The parameters which control data recording are part of the measurement definition and must be set in the main LTM program (**Measure/Define**).

Shortcuts
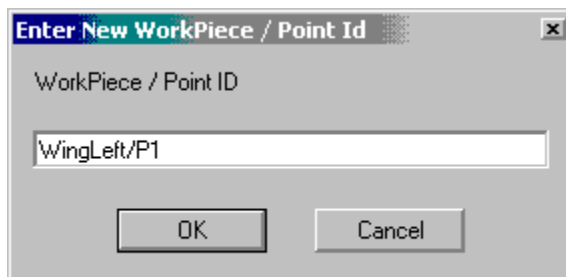Toolbar:
Keys: none

15.5 Measure menu – remote
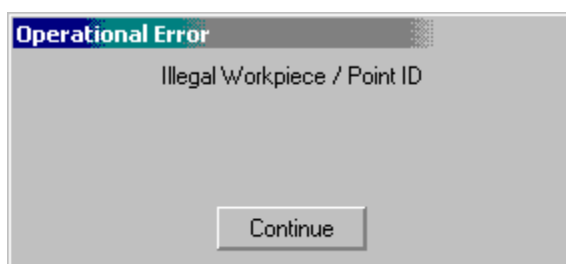
15.5.1 Set point ID

Set point ID command **(Measure menu)**   **Alt,M,I**

RLTM Measure - Set point ID.bmp

Re-set the identifier for the next point in **Standard measurement** mode. Enter workpiece name and point ID as in the example. If the ID is invalid, e.g. has too many characters, the following error message appears:

RLTM Measure - ID error.bmp

Shortcuts

Function button:

Keys: none

15.5.2 Next point

Next point command (**Measure menu**)   **Alt,M,E**

Moves to the next point in a Build list, or increments the point ID by 1 for the next point to be measured in normal measurement.

Shortcuts

Function button:

Keys: none

15.5.3 Previous point

Previous point command (**Measure menu**)   **Alt,M,V**

Moves to the previous point in a Build list, or decreases the point ID by 1 for the next point to be measured in normal measurement.

Shortcuts

Function button:

Keys: none

15.5.4 Start measure

Start measure command (**Measure menu**)   **Alt,M,M**

Once a measurement mode or method has been selected and any changes made to the data collection parameters, use this selection to start measurement and record the results in the database.

Shortcuts

Function button:

Keys: Ctrl+M

15.5.5 Try measure

Try measure command (**Measure menu**)   **Alt,M,Y**

Once a measurement mode or method has been selected and any changes made to the data collection parameters, use this selection to start measurement and display the results.

This is an alternative to **Start** and has the same function <u>except</u> that it does not store any data in the database. It is used simply to make a quick check.

Shortcuts

Function button: [TRY]
Keys: Ctrl+T

15.5.6 Stop measure

Stop measure command (**Measure menu**)   **Alt,M,P**

This stops storage or display of any data being continuously recorded.

Shortcuts

Function button: ■
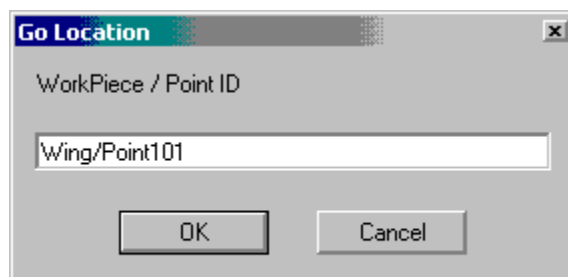Keys: Ctrl+S

15.5.7 Go Location

Go location command (**Measure menu**)   **Alt,M,O**


RLTM Measure - Go location.bmp

This command allows you to place the reflector in a previously measured position and lock onto it. Enter the workpiece name and point ID of this location in the dialogue box. The existing coordinates are used to calculate the tracker pointing.

If the point does not exist in the database, the following message is displayed:

RLTM Measure - Point error.bmp

If an invalid ID is entered, e.g. too many characters, the following message is displayed:
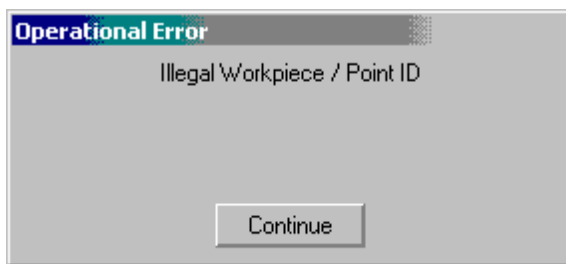
RLTM Measure - ID error.bmp

Shortcuts

Toolbar:

Keys: none

15.5.8 Go Birdbath

Go Birdbath command **(Measure menu)**   **Alt,M,B**

This command allows you to lock onto a reflector placed in the Birdbath.

Shortcuts

Toolbar:

Keys: none

15.5.9 Vector length display

Vector length display command **(Measure menu)**   **Alt,M,L**

Available only in Build Points mode.
This shows the display as a vector length difference between current reflector position and reference position.
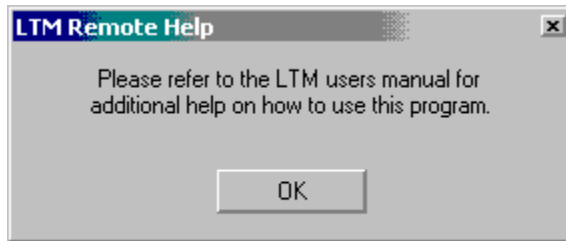
Shortcuts
  Toolbar: none
  Keys: none

15.6 Help menu - remote

15.6.1 Help

Help command **(Help menu)**   **Alt,H,H**

RLTM Help - Help.bmp

It is not possible to provide on-line and context sensitive HELP at the hand-held PC. Instead HELP is provided in the Software Reference Manual and on-line HELP file for the main LTM program. See the final section of both for details of remote operation.

Shortcuts
  Toolbar: none
  Keys: none

15.6.2 About LTM Remote

About LTM Remote command **(Help menu)**   **Alt,H,A**

RLTM Help - About.bmp

This selection displays version information about the Remote LTM program.

Shortcuts
  Toolbar:
  Keys: none