Autodesk® Topobase™ Survey User Guide

Autodesk®

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Topobase Survey User Guide

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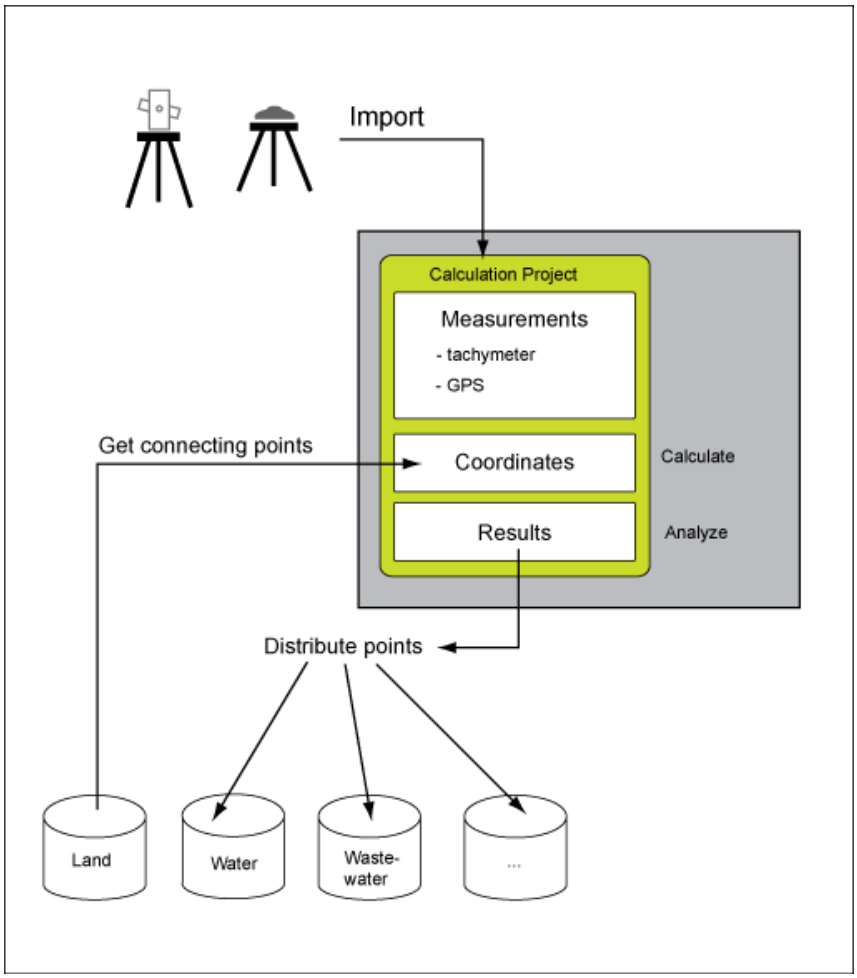
Survey Introduction

Use Autodesk® Topobase™ Survey to import and process field measurements. The module provides tools to import terrestrial and GPS survey data. You import the field data, and calculate the coordinates in a survey database schema. Then, you use statistical quantities to analyze the results, and distribute the coordinates to the appropriate documents, such as Water, or Wastewater.



Topobase Survey is available for desktop Clients, and can be used without AutoCAD Map 3D as standalone version. Using Topobase Survey without Map 3D, you cannot display the network plan. However you can run the adjustment calculation, and create the network plan offline. For example, use the standalone version when you come back to the office from the field, you want to save your measurements on the computer to free the memory of the instrument. Generally you can calculate the adjustment and distribute the points in standalone mode, however if errors and warnings occur, it is easier to find errors using the display of the results in the drawing.

Survey Database

Topobase Survey stores measurements, calculation settings, and results in a separate database schema. You use Topobase Administrator to create the Survey database. See Creating the Survey Database (page 109).

Adjustment Calculation

Topobase Survey calculates point coordinates using an adjustment process that is based on least squares. Up to now network adjustment has mainly been used for high precision networks. However, using adjustment calculation for detail points has the following advantages.

- You integrate all observations in one adjustment calculation.
- You apply statistical testing to detect measurement errors.

For each point the precision and reliability is stored in the database.

The adjustment calculation consists of two steps:

- Calculation of approximate coordinates.
- Adjustment calculation (least squares adjustment).

The calculation consists of a 2D adjustment for the plane coordinates (easting/northing), and a 1D adjustment for the height.

The adjustment results are displayed graphically in a network plan, and in reports.

Survey - Observations and Unknowns

For the adjustment calculation you introduce the measurements (angles, distances, coordinates) as observation. Also, you can include existing points as observation.

The adjustment calculation processes base points and detail points. See Base Points and Detail Points (page 99).

Survey Project Management

Topobase Survey provides the following tools to manage survey projects.

- **Project Manager**—To create and manage projects, project groups, and calculation projects. See also Project Groups (page 4), Projects (page 5), and Calculation Projects (page 8).
- **Instrument Manager**—To set up instruments for different measurement types and accuracy. See also Instrument Manager (page 9).
- **Operator Manager**—To manage operators. See also Operator Manager (page 13).
- **Field Code List Manager**—To manage field codes. See also Field Code List Manager (page 14).

Project Groups

You use project groups to administer projects and observations that belong together. A project group consists of one or more projects. For example, you group all measurements of a municipal district area in one project.

To start the Project Manager

1. Start Topobase Survey.
2. Click Project ➤ Manage.
3. In the Manage Projects dialog box, you edit the project group settings.

Project Group option	Description
Project Group area	Specifies the project group settings. Click  to display all options.
Select A Project Group	Selects a project group.
 Create	Creates a project group. Enter name and description.

Project Group option	Description
 Delete	Deletes the selected project group and all projects and calculation projects.
 Edit	Edits the selected project group name and description.

Projects

You use projects to process measurements that are performed in one area of interest to determine specific real world objects. Each project can use its own field code list that maps the field codes to the database feature classes. A project consists of one or more calculation projects. Also, if you work with different field code lists, you must create a project for each field code list. For example, if you process data from different contractors that use different field codes, you create a project for each contractor.

To start the Project Manager

1. Start Topobase Survey.
2. Click Project ➤ Manage.
3. In the Manage Projects dialog box, select a project group, and edit the project settings.

Project option	Description
Project area	Specifies project settings. Click  to display all options.
Select A Project	Selects a project of the selected project group.
 Create	Creates a project. Enter name and description.

Project option	Description
 Delete	Deletes the selected project and all calculation projects.
 Edit	Edits the selected project name and description.
Field Code List area	Click  to display all options. See also Understanding Field Codes (page 84).
Select A Field Code List	Selects the field code list that is used in the current project.
 Manage Field Code List	Opens the field code list manager. See also Field Code List Manager (page 14).
Description	Describes the field code list.
Calculation tab	Displays the main field code attributes that are used for calculation. See also Field Code Settings for Calculation (page 84)
Distribution tab	Displays the main field code attributes that are used for the distribution of the calculated coordinates to the target documents. See also Field Code Settings for Distribution (page 86)
Fill Document	If the Document Name on the Calculation or Distribution tab is empty: Starts the replacement of the placeholder for the document name. See Fill Document (page 7).

NOTE On the Calculation tab, and on the Distribution tab, you can modify the Document Name. Click the input field, and enter a new name.

Fill Document

Use the Fill Document function to replace the placeholder in the field code list with a valid document name. The placeholder is written in braces, such as {LAND}, or {WATER}.

NOTE To replace the placeholders, you can select any document that is available in the current workspace.

Using placeholders you can use the same field code list in multiple projects, or you can use a field code list that has been exported from another system. When assigning a field code list to the project, you replace the placeholders by appropriate document names. This replacement is only valid in the current project.

NOTE The Manage Projects dialog box displays the document names. In the Manage Field Code List dialog box, when you edit the field code list, you see the document placeholders.

You replace the document placeholders, when you create a project.

To replace the document placeholders

1. In the Manage Projects dialog box, select project, and the field code list.
2. In the Field Code List area, click Fill Document.
3. In the Fill Documents dialog box, select the placeholder.
4. Select the document, and click Fill.

Repeat this step for each placeholder in the field code list.

Fill Document dialog box	Description
Document Placeholder	Specifies a placeholder. The dialog box displays all placeholders that are used in the selected field code list.
Document	Selects a document to replace the placeholder. The list displays all documents that are available in the current workspace.

See also:

- Understanding Field Codes (page 84)
- Field Code List Manager (page 14)

Calculation Projects

You import all observations that shall be processed in one adjustment process into one calculation project. You can combine multiple measurements and measurements from different instruments in one calculation project.

To start the Project Manager

1. Start Topobase Survey.
2. Click Project ➤ Manage.
3. In the Manage Projects dialog box, select a project group and a project, and edit the calculation project.

Calculation Project option	Description
Calculation Project area	Provides tools to manage calculation projects. Click  to display all options.
Select A Calculation Project	Selects a calculation project.
 Create	Creates a calculation project. Enter name and description.
 Delete	Deletes the selected calculation project.
 Edit	Edits the calculation project name and description.

Calculation Project option	Description
 Copy	Copies the calculation project. For example, use this function to create a backup of a particular calculation stage such as a adjustment calculation without detail points.

See also:

- Calculation Project Settings (page 23)

Instrument Manager

You use the Instrument Manager to define instrument properties.

Topobase Survey administers different instruments, and you can import measurement files from different instruments into one calculation project.

Basically you use different types of instruments, such as tachymeters that provide distance and angle observations, and instruments that provide coordinates (GPS). Instrument properties such as the precision influence the calculation of the coordinates and their reliability indicators.

For example, for polar mapping you use an instrument of type Tachymeter, for coordinate observations you use an instrument of type GPS. When you import a measurement into the database, you select the instrument that has been used. Then, the instrument properties are used for the calculation.

To start the Instrument Manager

1. Start Topobase Survey.
2. Click Settings ➤ Instrument Manager.
3. In the Instrument Manager dialog box, you edit the instrument settings as shown in the following table.

Instrument Manager option	Description
Instrument area	Administers the instruments. Select an instrument, and use the icons.
Select An Instrument	Selects an instrument.

Instrument Manager option	Description
 Create	Creates an instrument. Opens the Create Instrument dialog box. Enter name, description, and type.
 Delete	Deletes the selected instrument. You can only delete instruments that are not used in any calculation projects.
 Edit	Edits the selected instrument name, description, and type. When you modify the instrument type, all settings are lost and reset to the default values.
Description	Describes the instrument.
Instrument Type	For new instruments, specifies the instrument type you want to import the field data from. Select one of the following: ■ Tachymeter—To import distance and angle observations. ■ GPS—To import coordinates.
Settings area	Specifies the instrument settings.
Transformation/GPS	Specifies settings for instruments of type GPS. Click  to display all options. See also Instrument Settings - Transformation and GPS (page 11).
Tachymeter	Specifies settings for instruments of type Tachymeter. Click  to display all options. See also Instrument Settings - Tachymeter (page 11).

Use the Global Settings to specify default instrument settings, and units for length, angles, temperature, pressure. See also Global Survey Settings (page 15) and Unit Format Settings (page 18).

Instrument Settings - Transformation and GPS

When you import coordinate files into a calculation project, you use an instrument of the type GPS. During the import, instrument settings are used to determine the a priori standard deviation for each coordinate value. Under Settings, Transformation/GPS, the following settings can be specified.

GPS/Transformation settings	Description
Standard Deviation Position	Specifies the standard deviation in position.
Standard Deviation Height	Specifies the standard deviation in height.
Measurement Unit	Specifies the unit of the observation. See also Working With Units (page 19).

Default values for the GPS instrument settings are defined in the Global Settings. See Global Survey Settings (page 15).

Instrument Settings - Tachymeter

When you import tachymeter measurement files into a calculation project, you use an instrument of type Tachymeter. During the import, instrument settings are used to determine the a priori standard deviation for each observation. For distance observations, the standard deviation is calculated using the distance parameters that are specified in the Instrument settings.

Tachymeter settings	Description
Standard Horizontal Angle	Specifies the standard deviation for horizontal angle observations. The display unit is set to the Angle Unit.
Standard Vertical Angle	Specifies the standard deviation for vertical angle observations. The display unit is set to the Angle Unit.

Tachymeter settings	Description
Standard Height Difference	Specifies the standard deviation for height difference observations. The display unit is set to the Distance Unit.
Distance Type	Specifies the default value for the type of distance measurement, such as Slope, or Horizontal. This value can be overwritten by values from the imported files. See also Measurement - Distance Types (page 29).
Vertical Angle Type	Specifies the default value for the type of vertical angle measurement. This value can be overwritten by values from the imported file. See also Measurement - Vertical Angle Types (page 30)
Default Centring Error	Specifies the default value for the centring error. In the Global Settings, use the Category 2 for small units to specify the display unit. See also Unit Settings (page 17).
Distance Parameter A Distance Parameter B [ppm] Distance Parameter C [ppm2]	Specifies the parameters that are used to calculate the standard deviation for distance measurement. *m0 = A + B/1000 * d + C /1000* SQRT (d)* The display unit is set to the Distance Unit.
Distance Unit	Specifies the unit of the distance observation. Notice that this setting also applies to the display of the Distance Parameters, and the Standard Height Difference. See also Working With Units (page 19) and Unit Format Settings (page 18).
Angle Unit	Specifies the unit of the angle observation. Notice that this setting also applies to the display of the Standard Horizontal Angle, and the Standard Vertical Angle. See also Working With Units (page 19) and Unit Format Settings (page 18).

Tachymeter settings	Description
Meteo corrected	Specifies whether the meteorological reduction has already been applied by the instrument.

Default values for the Tachymeter instrument settings are defined in the Global Settings. See also Global Survey Settings (page 15).

Operator Manager

When you import measurements, for each set of files you specify an operator. Use the Operator Manager to create and administer operators.

To start the Operator Manager

1. Start Topobase Survey.
2. Click Settings ➤ Operator Manager.
3. In the Manage Operator dialog box, you edit the operators.

Operator option	Description
Select An Operator	Selects an operator.
 Create	Creates an operator.
 Delete	Deletes the selected operator.
 Edit	Edits the selected operator name and description.
Shortcut	Specifies a short name for the operator.
Remark	Remark.

Field Code List Manager

You use the field code list manager to create, delete, import or export field code lists. For different projects you can use different field code lists. For example, to process measurements of different surveyor teams that use different codes.

NOTE The field code list manager displays the document placeholders instead of the document names. See also Fill Document (page 7).

- Use the Field Code Manager to create a field code list that contains placeholders for the document names.
- Use the Manage Projects dialog box to assign the field code list to a project, and to replace the document placeholders.

To start the Field Code List Manager

1. Start Topobase Survey.
2. Click Settings ➤ Field Code List Manager.
3. In the Manage Field Code List dialog box, you administer and edit the field code list.

Manage Field Code List dialog box	Description
Select A Field Code List	Selects a field code list.
 Create	Creates a field code list. Enter name and description.
 Delete	Deletes the selected field code list.
 Edit	Edits the selected field code list name and description.
Export	Exports the selected field code list into an XML file.

Manage Field Code List dialog box	Description
Import	Imports a field code list from an XML file.
Field Code area	Displays the field code list.
Calculation tab	Displays the field code attributes that are needed during the calculation process. See Field Code Settings (page 84).
Distribution tab	Displays the field code attributes that are needed during the distribution of the coordinates. See Field Code Settings (page 84).
Add	Adds a new definition to the current field code list, either for Calculation or for Distribution. For example, click the Distribution tab, and click Add to add a new distribution rule.
Delete	Removes the selected field code definition from the list, either for Calculation or for Distribution.
Save	Saves the modifications.
Close	Closes the dialog box without saving the modifications.

See also:

- Understanding Field Codes (page 84)
- Projects (page 5)

Global Survey Settings

When you set up the Survey database, you define global settings. For example, Global Settings specify default values, such as for instrument settings.

To specify the Global Settings

1. Start Topobase Survey.
2. Click Settings ➤ Global Settings.
3. In the Global Settings dialog box, you edit the settings as shown in the following table.

Global Settings	Description
Default Calculation Settings tab	Specifies the default values for the Calculation Project Settings. See Calculation Project Settings (page 23).
Use Step 6, Find Existing Points	Specifies whether the search of existing detail points is added to the default workflow. If not selected, the Calculation wizard skips this step. Find Existing Points (page 40)
Default Project Settings tab	Specifies the default values for the Advanced project settings. See Calculation Project Settings (page 23).
Default Tachymeter Settings tab	Specifies the default values for the tachymeter instrument settings. See Instrument Settings - Tachymeter (page 11).
Default Control Distance Settings tab	Specifies the fault section threshold (FS) for processing of control distance measurements. Default is 0.05 m. In the Global Settings, use the Category 2 for small units to specify the display unit. See also Unit Settings (page 17).
Default GPS Settings tab	Specifies the default values for the GPS instrument settings. See Instrument Settings - Transformation and GPS (page 11).
Boolean Values tab	Specifies the boolean values in the database. For example, boolean values are used to store the reliability of a point.

Global Settings	Description
	See Storing the Adjustment Results (page 82).
Use As True	Specifies the value that indicates TRUE. Default is 1.
Use As False	Specifies the value that indicates FALSE. Default is 0.
Unit Format Settings tab	Specifies unit and format settings.
Unit Settings tab	Specifies display units and format. These settings apply to all units, except those which are displayed in the data grid. For example, you specify the display units of the instrument settings.
Length area	Specifies the length unit and format for two categories. See also Unit Settings (page 17).
Angle area	Specifies the angle unit and format for two categories. See also Unit Settings (page 17). **NOTE** 1 Grade or Gon is 1/400 of a full circle.
Temperature area	Specifies the temperature unit and format.
Pressure area	Specifies the pressure unit and format.
Unit Format tab	Displays length and angle unit and format settings that can be used to set up the instruments in the Instrument Manager. See also Unit Format Settings (page 18).

Unit Settings

In the Global Settings, on the Unit Settings tab, you specify length and angle units in two categories. One category is for normal use, such as for distance

or angle measurement. The second category is for small values, such as residuals or standard deviations. These values are more clearly to read, if they are displayed in a smaller unit.

For example specify meter as distance measurement unit, and mm as unit for the distance standard deviation.

Large units, category 1, apply to

- Instrument Height that is displayed in the Measurement dialog box, on the Tachymeter tab, under Station Parameter.
- Height For Reduction, displayed in the Calculation Project Settings.

Small units, category 2, apply to

- Default Centring Error that is displayed in the Instrument Manager.
- Centring Error that is displayed in the Measurement dialog box, on the Tachymeter tab, under Station Parameter.
- Distance Parameter A that is displayed under Global Settings, in the Default Control Distance Settings tab.

Unit Format Settings

In the Global Settings, on the Unit Format tab, you specify the distance units and angle units that can be used to set up the instruments in the Instrument Manager.

- Distance Unit
- Angle Unit

NOTE In the Instrument Manager, when you select a unit that is not specified explicitly in the Unit Format settings, the unit will be displayed with 3 decimals.

To add a unit to the Unit Format list

1. Open the Global Settings, and click the Unit Format Settings tab.
2. Click the Unit Format tab, and click Add.
3. In the Format dialog box, under Unit Format, select a category, such as Length.

4 Select a unit, such as Kilometer.

5 Specify the format, such as 1.

6 Click OK.

To modify a a format value, in the data grid, click the Format field, and enter a new value. In the Instrument Manager, when you set the Distance Unit to Kilometer, the values will be displayed with 1 decimal.

See also:

- Instrument Manager (page 9)

Working With Units

Topobase Survey supports the following unit settings.

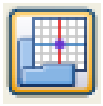
- **Document units**—Specify the document units for the values that are stored in the database. For example, you use metric or imperial units to store the length, and you use degree to store angles. The document units are specified when you create a document, and cannot be modified later. See also *Topobase Administrator*.
- **Measurement**—Your surveying instrument records the measurements in a specific unit, such as meter or inch, degree or grade. Topobase Survey supports multiple measurement units. For example, you jointly process data that has been measured with instruments that record different units. You specify the measurement unit in the Instrument Settings. See Instrument Manager (page 9).
- **Display**—At any time when you analyze the results in the data grid, you can modify the display unit. For example, when you analyze the results in the Result dialog box, you display the residuals in meter, and in grade. The display unit setting is stored in the Survey database, and applies to all calculation projects. See also Working With the Data Grid (page 105).

See also:

- Unit Settings (page 17)
- Unit Format Settings (page 18)

Styling the Network Plan

After the adjustment calculation, you optionally create a network plan that displays the adjusted network, including error ellipses and reliability rectangles. The components of the network plan are stored in the Survey database. Use Display Manager to style the components, as shown in the following table. Use the attribute FID_PROJECT to set a filter on the calculation project.

Network Plan feature class	Description
TB_SUR_FIELD_POINT	Stores all points that have been imported from the field data. This feature class stores all points that are displayed in the Coordinate dialog box. 
TB_SUR_CALC_POINT	Stores all points that have been calculated, including coordinate, precision, and reliability. After the completion of step 7, Calculate Adjustment, this feature class stores all points that are displayed in the Results dialog box, on the Calculated Coordinates tab. 
TB_SUR_V_FIELD_POINT	This view provides the points that have been imported from the field data. Use FID_PROJECT to style the points.
TB_SUR_V_RELIABILITY_RECT	This view provides the reliability parameters, and the calculation project of the calculated points. Use NA, NB, and FID_PROJECT to style the reliability rectangles.
TB_SUR_V_ACCURACY_ELL	This view provides the precision, and the calculation project of the calculated points.

Network Plan feature class	Description
	Use EMA, EMB, and FID_PROJECT to style the error ellipse.
TB_SUR_V_NETPLAN_POINT	This view stores the points of the network plan that indicate the type of measurement, or the session of a point. Use the TYPE_ attributes to style the points.
TB_SUR_V_NETPLAN_LINE	This view stores the network lines that indicate the measurements between the points, the type of measurement, and the calculation project. Use TYPE_HZ_MEASURE, and TYPE_LINE to style the lines.

Network lines

A network line consists of line segments and network points. For example, a tachymeter network line consists of a two line segments, and three network points at the start, middle, and end.

- The start segment runs from the start point to the middle of the line. Normally it is styled as a continuous line. The end line runs from the middle of the line to the end point. Normally it is styled as dashed line.
- TYPE_LINE—Describes the route of the line. 0=start segment; 1=end segment.
- TYPE_HZ_MEASURE—Describes the type of horizontal angle measurement. 0 = Single measurement, one direction; 1 = Double measurement, both directions; 2 = Single return measurement; 3 or NULL = No direction measurement.
- Network lines are stored in the Survey database in a feature class of type Compound.

Network points

A network point describes the session, and observations that have been made to determine the point. Network points are located either on the point or in the middle of a network line.

- TYPE_POINT—Describes the location on the network line. 0 = at start point; 1 = at the end/target point; 2 = in the middle of the line.

- TYPE_HZ_MEASURE—Describes the type of horizontal angle measurement. 0 = Single measurement, one direction; 1 = Double measurement, both directions; 2 = Single return measurement; 3 or NULL = No direction measurement.
- TYPE_V_MEASURE—Describes the number of vertical angle observations. 0 = Single measurement, one direction; 1 = Double measurement, both directions; 2 = Single return measurement; 3 or NULL = No direction measurement.
- TYPE_DISTANCE—Describes the number of distance observations. 0 = Single measurement, one direction; 1 = Double measurement, both directions; 2 = Single return measurement; 3 or NULL = No direction measurement.
- TYPE_HEIGHTDIF—Describes the number of height difference measurements. 0 = Single measurement, one direction; 1 = Double measurement, both directions; 2 = Single return measurement; 3 or NULL = No direction measurement.
- TYPE_SESSION—Describes the type of the measurement. For example, 1 = Tachymeter, 2 = GPS; 5= Control Distance.

Survey Calculation Wizard

The Topobase Survey calculation wizard guides you through all steps of the calculation. The survey calculation process is a multiple step task. The calculation wizard controls the sequence of the steps, and validates your input.

You import all observations that shall be processed in one adjustment calculation, in one calculation project. When you have selected the calculation project, the Calculation Wizard is ready to use.

In the Calculation Wizard, use the links on the Navigation Pane, or click the navigation buttons to proceed. The links, or the buttons are only available, if all necessary entries have been entered, and if the command is appropriate. For example, if you have just created a calculation project, only the Calculation Project Settings links is available.

- Click Next to browse to the next step.
- Click Back to browse to the previous step.

- Click Finish to start all remaining steps. For example, if you modify any measurement data or settings, the wizard steps back to step 3, Find Reference Points.

At any time you can modify the settings and the measurement data. Then the Calculation Wizard steps back to the appropriate step that has to be performed to apply the modifications.

Calculation Project Settings

In the first calculation step, you specify the calculation parameters as shown in the following table.

NOTE You can modify the settings at any stage of the calculation. However, then you must start again with calculation step 3, Find Reference Points.

Calculation Project settings	Description
Calculation Project Name	Specifies the unique name.
Calculation Project Description	Describes the calculation project.
Options	To set the adjustment type and distance reduction. Click  to display all options.
Reduce Distance	Selects whether distance reduction is applied.
Height For Reduction	For distance reduction, and if no heights are calculated, specifies the average height of the survey area. In the Global Settings, use the Category 1 for large units to specify the display unit. See also Unit Settings (page 17).

Calculation Project settings	Description
Reduction	Mandatory. Specifies the reference system, and the reduction algorithm. Click  to display all options.
Module	For distance reduction, selects the reduction algorithm. Select Universal Reduction, to use one of the coordinate systems that are supported by Map 3D. Select Specific Reduction, to use a specific algorithm. Then, the system will check whether the spatial area of the document matches the selected reference frame.
Reference Frame	Selects the reference frame for the distance reduction. If Universal Reduction is selected, the list displays the default coordinate systems of Map 3D. If Specific Reduction is selected, the list displays reference frames that have been modified to meet local requirements.
Description	Displays a description of the selected reference frame. For the universal reference frames, also displays the well-known text description (WKT).
Advanced Options	Advanced options control the adjustment calculation process. Click  to display all options. When you click Next, the system checks for invalid and missing input.
Maximal Norm. Residual (Wi) Threshold	Specifies the maximal value for the normalized residuals Wi. Enter a value from 0-20. See also Normalized Residual Error Wi (page 74).

Calculation Project settings	Description
Maximal Numbers Of Iterations	Specifies the number of iterations that will be performed to improve the approximate coordinates in step 7, Calculate Adjustment. Enter a value between 0 and 20. Normally the results of the first approximation calculation is sufficient.
Maximal Coordinate Increase	For coordinate transformation, that means to process coordinate observations. Specifies the maximum coordinate increase between two iterations. Enter a value between 0 and 1. The unit corresponds to the length unit that is used in the database.
Error Second Type	Specifies the probability of an error of second type in [%]. The value is used to calculate the Nabla values. Enter a value between 0 and 100. Nabla is the largest undetectable error of an observation.
Minimum Chi Square Test Threshold	Specifies the minimum value that determines a successful Chi Square test. See Chi-Square Test (page 71).
Refraction Coefficient	Specifies the refraction coefficient.
Standard Refraction Coefficient	Specifies the standard deviation (0-0.5).
Approximate Orientation Threshold	For tachymeter processing, specifies the upper limit for the standard deviation of a station orientation. If this limit is exceeded, no approximate coordinates can be determined for the station in step 4, Calculate Approximation.
One Side Vertical Factor	Specifies a factor that is used to calculate the a priori standard deviation of one-sided vertical angle observations. Enter a value between 0 and 5.

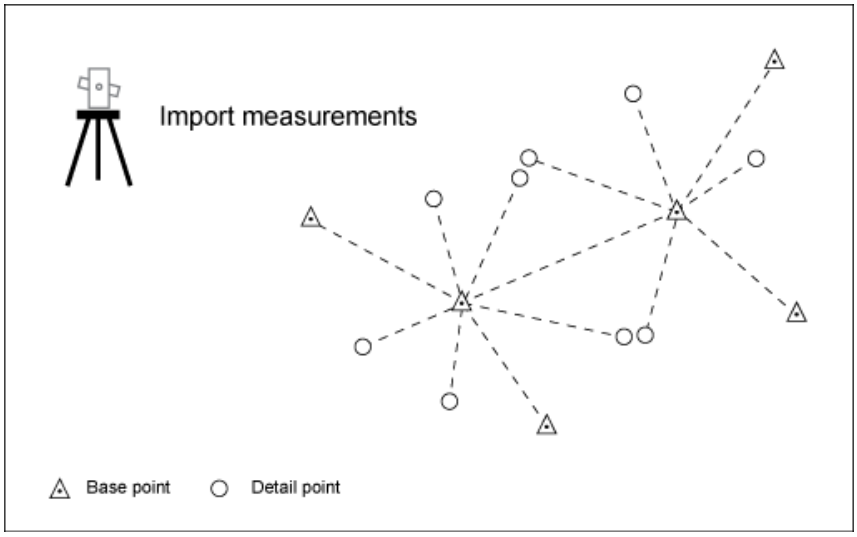
Calculation Project settings	Description
Minimum Reliability (Zi) Threshold	Specifies the minimum value for the local reliability. See Local Reliability Zi (page 75).

Import Measurements

The second calculation step loads the measurements to the Survey database. You can import measurement groups, that means multiple files, each of which has been measured by one operator, using one instrument.

For example, in one measurement group you import multiple tachymeter files containing a polar mapping, and in another measurement group you import several GPS sessions.

For each set of import files, you specify the instrument. The import function reads the records of the import file, stores the measurements in the Survey database, and applies the a priori standard deviations, as specified in the instrument settings.



In the Survey database, you can edit the measurements, for example to correct any errors.

NOTE If you want to edit the import files using the Edit button, you must assign an editor. For example, in Windows explorer, open the File Properties, and under Opens With, select an editor.

Import Measurement	Description
File Data Source area	Specifies the files to import.
File Format	Selects a file format. See also Supported File Formats (page 93)
Files To Import	Displays the files to be imported into the current calculation project. ■ Click Add to open the Windows file selector, and select one or more files to import. ■ Select a file name in the Files To Import list, and click Remove, to remove the file from the list. ■ Select a file name in the Files To Import list, and click Edit to open the file in a text editor.
Attributes area	Specifies the properties for the measurement group.
Field Date	Specifies the date of measurement.
Instrument	Mandatory. Specifies the instrument that has been used. The instrument settings are used to determine the standard deviation of the measurements. Click Manage to open the Instrument Manager. See also Instrument Manager (page 9). To import control distance measurements, select Default Tape. See Importing Control Distance Files (page 31).
Operator	Mandatory. Specifies the surveyor. Click Manage to open the Operator Manager. See also Operator Manager (page 13).

Import Measurement	Description
Remarks	Specifies a remark. For example, enter an appropriate description of the file content. After the import, the remark is displayed in the list of imported files.
Import button	Imports the selected files. The Import button is deactivated in the following cases. ■ Mandatory information is missing. ■ Files have already been imported. Click Show Imported Files to check. The import loads the measurements into the database.
Show Measurement	Shows the imported data in a separate Measurement dialog box. For example, check the standard deviations. See also Measurement - Tachymeter (page 50) and Measurement - Transformation (page 54) and Measurement - Control Distance (page 60).
Show Imported Files	Opens the Imported Files dialog. See Imported Files (page 28).

Imported Files

The Imported Files dialog box displays the files that have been imported in the current calculation project. In the data grid, click a heading to sort the items.

You cannot edit the files after they have been imported. To edit a file, under File Data Source, select the file, and click Edit. Then import the file again to load your modifications.

NOTE When you import the file again, the existing measurement will not be deleted. A message alerts you that the files has already been imported. To delete a station: In the Measurement dialog box, select the station, and click the Delete Station icon.

Measurement - Point Types

During the import of the measurements, points are classified either as Base Point or as Detail Point.

Base point—Geodetic point, such as station, control point, or geodetic network point. Base points are either existing points with known coordinates that are stored in the data base, or they are determined during the adjustment calculation. When you import a file, each target point (tachymeter), or point (GPS) is classified either as detail point, or as base point (Point Type attribute). For any adjustment calculation, a minimum number of known base points is required.

Fix point—Base point with known coordinates that is stored in the data base.

Detail points—Measured point, that determines the location of real world features, such as building corners, manholes, border points. Other than base points they are not used as station, and they are not part of the geodetic network.

For each observation, the sub type specifies whether the point has been measured in face 1 = Normal Measurement, or face 2 = Second Face Measurement.

See also:

- Storing the Measurements (page 32)

Measurement - Distance Types

For tachymeter measurements, distance types describe how a distance has been measured.

Distance type	Description
Slope	Distance that has been measured along the slope between the center of the instrument and the center of the prism target. This distance will be reduced to horizontal distance.
Horizontal	Distance that has been measured horizontally.

You specify a default distance type in the Instrument settings. See Instrument Manager (page 9).

If available, the distance type is imported from the field data. For example, in a (**.RO*) file, points with the key dc:2 are of type Slope. For detailed information see description of input formats.

See also:

- Measurement - Tachymeter (page 50)

Measurement - Vertical Angle Types

For tachymeter measurements, vertical angle types describe how an angle has been measured.

Vertical Angle type	Description
Nadir	Angle that is measured from the nadir of a plumb line to the foresight point.
Vertical	Angle that is measured from the horizon to the foresight point.
Zenith	Angle that is measured from the zenith of a plumb line to the foresight point.

You specify a default vertical angle type in the Instrument settings. See Instrument Manager (page 9).

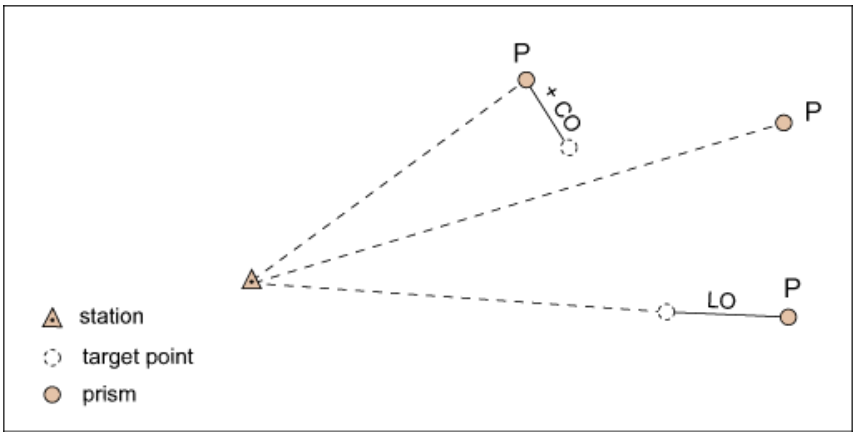
If available, the vertical angle type is imported from the field data. For example, in a (**.RO*) file, points with the key hc:2 are of type Zenith. For detailed information see description of input formats.

See also:

- Measurement - Tachymeter (page 50)

Measurement - Offset Types

For tachymeter measurements, length offset and cross offset are used if the target point cannot be measured directly.



See also:

- Measurement - Tachymeter (page 50)

Measurement - Coordinates

Coordinate observations, such as GPS measurements are being processed in a coordinate transformation. When you have imported the coordinates into the calculation project, you specify the transformation type in the Measurement dialog box.

See also:

- Measurement - Transformation (page 54)
- Transformation Parameters (page 58)

Importing Control Distance Files

Use the Calculation Wizard, to import control distance files. The control distance calculation is part of the calculation workflow, and will be performed during step 7, Calculate Adjustment. See also Processing Control Distance Measurements (page 122).

NOTE When you import control distance files, the calculation workflow resets to step 3, Find Reference Points.

To import control distances

1. Start Topobase Survey.
2. Select the Project Group, the Project, and the Calculation Project.
3. Under File Data Source, File Format, select the file format, for example, Cplan RO.
4. Under Files To Import, click Add, and browse for the file (*.RO).
5. Select the instrument Default Tape.
6. Click Import.

Storing the Measurements

The import stores the measurements in the Survey database, and processes the data for the calculation.

- **Standard Deviation**—The import function determines the standard deviation for each observation, according to the instrument settings.
- **Point Type**—The import function determines the Point Type of each measured point, according to the key in the import file. For example, in a (*.*RO*) file, points with the key AP, or ST are of type Base Point, and points with the key NP are of type Detail Point. For detailed information see description of input formats (page 93).
  For example, in a GPS session, or in a coordinate (*.*RO*) file, points with the key K, and C=1-2, are of type Base Point. Points with key K, and C = 3-9 are of type Detail Point.
- The measurements are stored in the system table TB_SUR_MEASURE.

See also:

- Measurement - Point Types (page 29)

Session

In the Survey database the measurements are stored session-wise. A session is a set of observations that has been imported into a calculation project. A session can be of type GPS, Tachymeter, or Control Distance.

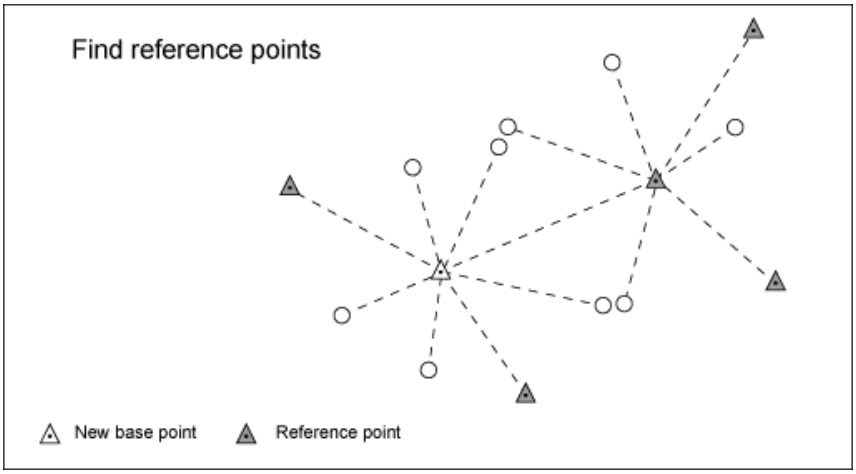
- For coordinates, each import file is assigned to a GPS session.

- For tachymeter files, each station is assigned to a Tachymeter session.

In the Results dialog box, on the Measurement Results tab, you can view the session of the observations. See also Result (page 65).

Find Reference Points

For each point that has been classified as Base Point, you search for a reference point. You use the field code list to define search rules. For example, reference points are searched by identifier, or location.



Reference points are existing base points that are stored in the database. They can be stored in any document, that is part of the workspace. The reference points will be used for the approximate calculation, and the adjustment calculation. If a Base Point has no reference in the database, and if the required measurements are available, it can be determined in the adjustment calculation.

To reference points that are stored in documents that are not part of the workspace, see Managing additional basepoints (page 110).

For any calculation a minimum number of reference points is required. For example, if you import coordinate files, reference points for the transformation are required. For example, if you measured free stations, reference points for the connecting points are required.

NOTE The search only comprises the base points. Base point feature classes must have the default attribute <point feature classe>.TB_POINTNUMBER. See also Topobase Administrator Guide, section Feature Class Type: Point.

To find reference points

1. In step 3, Find Reference Points, click Find.
2. For points that have no reference points stored, a message box lists the point numbers. Click the Show Message link.
3. To continue, do one of the following:
   - In case of a free station, no messages are displayed, and no reference point is available. Click Close and continue with the calculation process. The point will be determined in the calculation.
   - Read the messages, and open the Measurement dialog box. Check the measurement data. Is the point of type Base Point? Check the field code.
   - Check the search rules in the field code list. Do you search in the right document? Are the tolerances appropriate?
   - In job enabled documents, check whether the reference points are either live or in the current job.
   - Check the additional base points. Click the Manage Additional Base Points link.
4. In the Information area, click the Show Coordinates link.
5. Click the Planimetry Fix Points tab to display the existing base points.
6. Click the Planimetry New Points tab to display the new base points, such as a free station.

To define or check the search rules

1. Under Configuration, click the Manage Field Code List link.
2. In the Manage Field Code List dialog box, select the field code list.
3. Under Field Code, click the Calculation tab, and define the search rules. See also Field Code Settings for Calculation (page 84).

If all reference points are found, click Next to continue with step 4, Calculate Approximation.

Detail Points Configuration

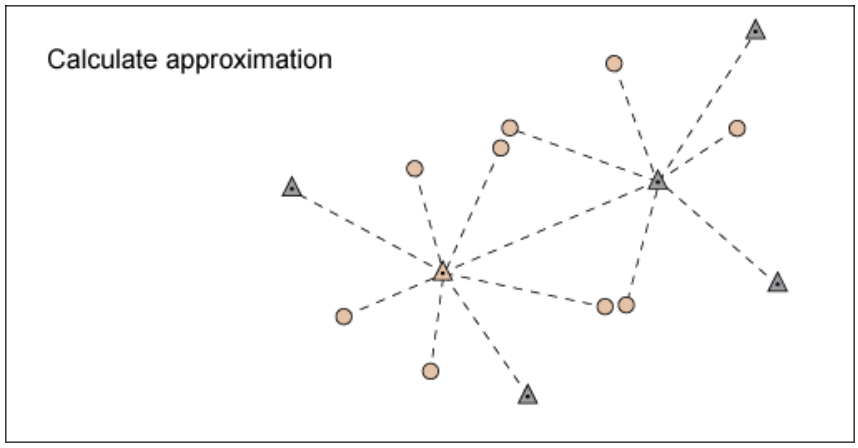
Before you start the search, you optionally include or exclude the detail points from the adjustment calculation. However, this action only applies to the steps that come after the search of the reference points. For larger geodetic network adjustments, you can calculate the adjustment using only the station points. You deactivate all detail points. See also Calculating Base Points and Detail Points in one Calculation Project (page 122).

NOTE You can also activate or deactivate single detail points, using the check boxes and the icons in the Measurement dialog box.

NOTE Detail points must be activated or deactivated before you start step 3, Find Reference Points, because in the calculation workflow this is a modification of the calculation parameters, and whenever you modify something, the system resets to step 3.

Calculate Approximation

In the fourth calculation step, you calculate approximate coordinates for the every unknown point. For GPS sessions, the calculation determines the transformation parameters. For tachymeter sessions, the calculation determines the orientation for each station.



The approximate coordinates are used to find identical points, and as input for the adjustment calculation.

If you have generated graphic, the approximate coordinates are displayed on the feature layer TB_SUR_V_FIELD_POINT. See also Styling the Network Plan (page 20).

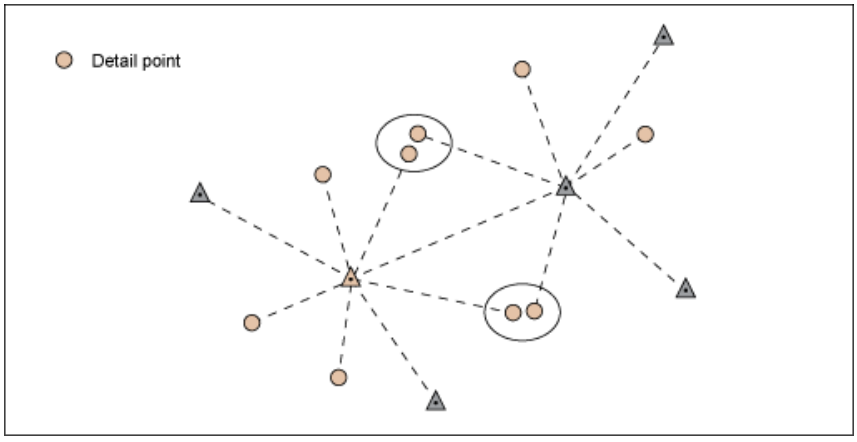
Click Calculate to start the calculation. After the calculation, use the links in the Information area to analyze the results.

If the results are all right, click Next to continue with step 5, Find Identical Points.

Information area	Description
Show Message	Opens the messages dialog box that displays the related notes, warnings, and errors. See also Calculation Wizard Messages (page 43).
Show Coordinate	Opens the Coordinate dialog box that displays the approximate coordinates.
Show Measurement	Opens the Measurement dialog box.

Find Identical Points

In the fifth calculation step, you identify points that have been measured more than once. The approximation in the previous calculation step results in coordinates for each point. Usually, for identical points, these coordinates are slightly different.



For the adjustment, identical points have to be merged and introduced as one unknown.

The Find Identical Points function detects identical points by identifier, field code and location, as specified in the field code list. For points that exceed the tolerances, you are prompted to analyze the search results manually.

For example, if two points with different field codes lie within the tolerance, you would keep both points, if they represented two different real world objects. Then, they were both included in the adjustment calculation.

To find identical points

1. In step 5, Find Identical Points, click Find.
2. The identical points are merged. However, the following cases require that you decide how to proceed.
   - Two points seem to be identical, but have different field codes. See Different Field Code (page 38)
   - Two points seem to be identical but do not lie within the tolerance. See Critical Identical Point (page 39)
3. After the search has finished, click the Show Coordinates link to analyze the search result. In the Coordinates dialog box, the Planimetry New Point tab, displays the new points that will be determined in the adjustment calculation in the next step.

To define or check the search rules for identical points

1. In step 5, Find Identical Points, under Configuration, click the Manage Field Code list.
2. In the Manage Field Code List dialog box, select the field code list.
3. Under Field Code, click the Calculation tab. See also Settings to Find Identical Points (page 92).

If the results are all right, click Next to continue with step 7, Calculate Adjustment.

NOTE After step 5, Find Identical Points has been completed, you can introduce existing base points (fix points) as unknowns. See Moveable Points (page 64).

NOTE Step 6, Find Existing Points, is not part of the default workflow. Explicitly click the link on the Navigation pane to start this step optionally. Also, in the Global Settings, under Default Calculation Settings, you can add step 6 to the default workflow. See Global Survey Settings (page 15).

Calculation step 5, Find Identical Points, helps to detect measurement errors. For example, if you use unique identifiers for the points, the distance FS between two points that have the same identifier is calculated. If the distance exceeds the tolerance, the points are listed. See also Critical Identical Point (page 39).

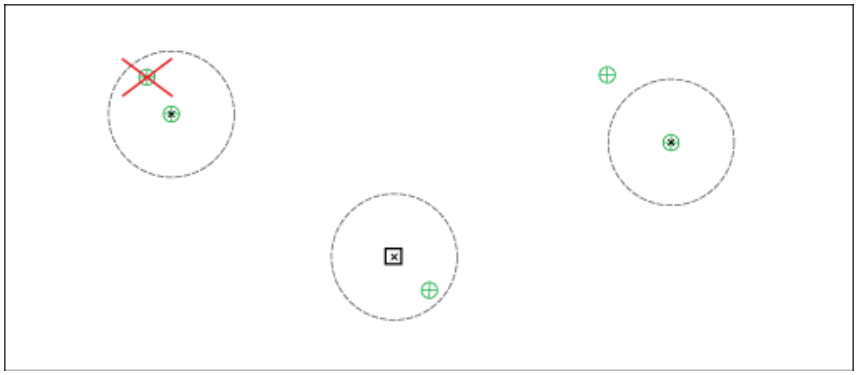
See also:

- Find Existing Points (page 40)

Different Field Code

When you search identical points by position, points that lie within the tolerance are treated as identical.

When you search identical points by identifier, points that have the same point number are treated as identical.



However, it can happen, that points that are identical by position or by point number, have different field codes. Then, the Different Field Code dialog box is displayed. For example, two points that lie closely together and have different field codes. In the Different Field Code dialog box, you decide whether the

points are identical or not. The dialog box displays identifier and field code of the two points, and provides the options as shown in the following table:

Different Field Code dialog box	Description
Show Points In Graphic	Displays the points in the map.
Treat Points As Not Identical	Adds both points to the adjustment.
Points Are Identical With Field Code Of First Point.	Merges the points, and uses the field code of the first point.
Points Are Identical With Field Code Of Second Point.	Merges the points, and uses the field code of the second point.

See also:

- Understanding Field Codes (page 84)

Critical Identical Point

The Critical Identical Point dialog box is displayed during calculation step 5, Find Identical Points. When you search by identifier, such as the point number, it can happen that the position of the two identical points exceeds the tolerance.

Critical points can be caused by the following.

- Measuring error.
- Point number mismatch.
- Sign error of the cross offset value.
- Any measure inaccuracy.
- Configuration error (field code list).

For example, points that have been measured twice from different stations are listed, if the difference is bigger than the tolerance. The tolerance is specified in the field code list.

Critical Identical Points	Description
Main Ident Child Ident	Display the unique identifier of the two points.
Main E Child E	Displays the easting value.
Main N Child N	Displays the northing value.
Main H Child H	Displays the height.
FS	Displays the difference in position.

In the data grid, right-click the row to view the related measurements.

To analyze critical identical points

1. In the data grid, select the row, right-click, and click one of the following:
   - Show Station of Main Point
   - Show Station of Child Point
2. In the Measurement dialog box, check the observation for possible errors. If you correct any errors, you must restart the calculation at step 3.

See also:

- Measurement - Tachymeter (page 50)
- Measurement - Transformation (page 54)

Find Existing Points

This calculation step is optional. You can include existing detail points to the adjustment process. For example, to improve the reliability of detail points that are already stored in the database.

To reference points that are stored in documents that are not part of the workspace, see Managing additional detailpoints (page 110).

NOTE The existing point feature classes must have the following default attributes: TB_POINTNUMBER, TB_ACCURACY_POSITION, TB_ACCURACY_HEIGHT, TB_RELIABILITY_POSITION, TB_POSITION_RELIABLE, TB_RELIABILITY_HEIGHT, TB_HEIGHT_RELIABLE. See also Storing the Adjustment Results (page 82).

Step 6, Find Existing Points, searches existing detail points, and adds them to the adjustment process, depending on its reliability. A point is reliable, if the attributes <point feature class>.TB_POSITION_RELIABLE or <point feature class>.TB_HEIGHT_RELIABLE are set to True.

NOTE The reliability attribute can either be 1 or 0. In the Global Settings, you specify which value indicates True or False. For example, 1 = True, and 0 = False. See also Global Survey Settings (page 15).

- Reliable detail points are added as fix points.
- Non-reliable detail points are added as moveable points, that means that they are added as coordinate observation with a standard deviation. The standard deviation is stored in the attributes <point feature class>.TB_ACCURACY_POSITION, and <point feature class>.TB_ACCURACY_HEIGHT.

To define the search rules

1. Under Configuration, click the Manage Field Code List link.
2. In the Manage Field Code List dialog box, select the field code list.
3. Under Field Code, click the Calculation tab.
4. On the Calculation tab, define the search rules. See also Settings to Find Existing Points (page 91).

To find existing detail points

1. In step 6, Find Existing Points, click Find.
2. After the search has finished, click the Show Coordinates link to analyze the search result. In the Coordinates dialog box, the Planimetry Moveable Point tab, displays the existing detail points that will be included in the adjustment calculation.

NOTE In the Coordinate dialog box, you can add moveable points manually. See Moveable Points (page 64).

If the results are all right, click Next to continue with step 7, Calculate Adjustment.

Calculate Adjustment

In the seventh calculation step, you start the adjustment calculation. You calculate the adjusted coordinates of the new points, and statistical information about precision and reliability.

After the calculation, the Information area displays the test statistics, and you can analyze the results.

To calculate the adjustment

1. In step 7, Calculate Adjustment, click Calculate.
2. After the calculation, under Information click the Calculate Indicators link. See Analyzing Precision and Reliability (page 70).

If the adjustment calculation fails, in the Warning area, click the Show Message link. See Calculation Wizard Messages (page 43).

To calculate the adjustment without detail points, under Configuration, click the Show Measurement link. In the Measurement dialog box, deactivate the detail points. See also Measurement - Tachymeter (page 50) and Find Reference Points (page 33).

NOTE When you deactivate or activate detail points, you must restart the calculation process at step 3, Find Reference Points.

When the calculation results are OK, continue with the following steps.

- Create Network Plan. See Create The Network Plan (page 43).
- Distribute Points. See Distributing Coordinates (page 79).
- Generate Report. See Generate Survey Reports (page 43).

Create The Network Plan

After the adjustment calculation, and before you distribute the new points to their target documents, you can create the network plan that displays the measurements, error ellipses, and reliability rectangles in the map. All elements are stored in the Survey database. Use the Display Manager to stylize the features of the network plan.

See also:

- Styling the Network Plan (page 20)

Generate Survey Reports

After the adjustment calculation you can generate reports to document the calculation results. You use report templates that have been defined using the Topobase Report Designer.

You use Topobase Report Designer to customize the reports, and to create your own templates. For more information see *Topobase Administrator, section Report Designer*.

To generate a report

1. In the Navigation pane, under step 7, Calculate Adjustment, select Generate Report.
2. On the right pane, select a report template, such as Coordinates.
3. Click Generate.

Calculation Wizard Messages

Three types of messages inform you about the execution of the calculation steps.

Notice—Information to log the completion of the calculation steps.

Warning—Information about any issues that did not stop the calculation step.

Error—Errors that made the calculation step fail.

At any stage of the calculation process, when you click the Show Messages link, the Message dialog box displays all messages that have been issued so far.

NOTE A number in () indicates that the messages include warnings and errors that need further investigation.

To resolve the issues, right-click the message, and start one of the commands to further explore the issue. For example, you see the point number, or the station of the measurement that probably caused the issue.

Survey Warnings

To resolve the issues, right-click the message, and start one of the commands to further explore the issue.

Warning	Description
No Topobase Document With The Name <name> Defined For Used Field Code <field code> Exists In The Workspace.	Step 3, Find Reference Points. The measurement contains a base point with a field code that points to a document that is not in the current workspace. Under Project ➤ Manage, check the field code list. If the document name is displayed in {}, use Fill Documents to replace the placeholder. See Fill Document (page 7).
No Field Code Definition For Used Code <field code>.	Step 3, Find Reference Points. The measurement contains a base point with a field code that is not specified in the field code list. Under Find Reference Points, click the Manage Field Code List link, and check the field code list.
No Approximate Coordinate Available For The Point.	Step 4, Calculate Approximation. The approximate coordinate could not be determined. Check the measurements and coordinates. For example, add missing measurements.
Measurement In Session With The Maximum Difference To Expected Orientation.	Step 7, Calculate Adjustment.

Warning	Description
	Indicates a possible error on the horizontal angle measurement. Check the measurements. Check for Critical Identical Points.

Survey Error Messages

To resolve the issues, right-click the message, and start one of the commands to further explore the issue.

Error message	Description
Calculated Standard Orientation Exceeded The Threshold In Approximation.	The orientation could not be determined with the required precision. Check the station measurements. Check the coordinates of the reference points. If you have included the detail points, make sure that you have resolved all Critical Identical Points. See Critical Identical Point (page 39).
The Transformation Parameter <name> Is Set To Previous But There Is No Previous Session.	The transformation parameters could not be taken from the previous session. In the Measurement dialog box, check the session number. For example, if a parameter is set to Previous, the session number cannot be 1.
Planimetry Approximation Calculation For Session Is Not Possible.	Right-click the message line and click a command to display the critical station or session.

Control Distance Measurements

You can incorporate control distance measurements into the adjustment calculation workflow. Use control distance measurements, if a point could not be measured with the necessary quality. For example, if a point could not be measured from two stations, if a point has been measured only once, or if for any other reasons you need to check the reliability of the measurement.

If the calculation project is set up to apply distance reduction, these will also be applied to the control distances.

You can enter the control distance measurements manually, or you import a file.

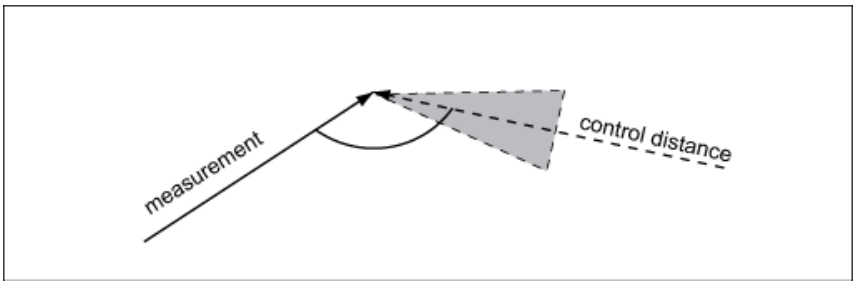
- To enter the control distance measurements manually, see Processing Control Distance Measurements (page 122).
- To import control distance files, see Importing Control Distance Files (page 31).

The results of the control measurement are documented with each control distance, with each measurement, and with each coordinate. See Control distance results (page 61), Measurement Results (page 65) and Calculated Coordinates (page 68).

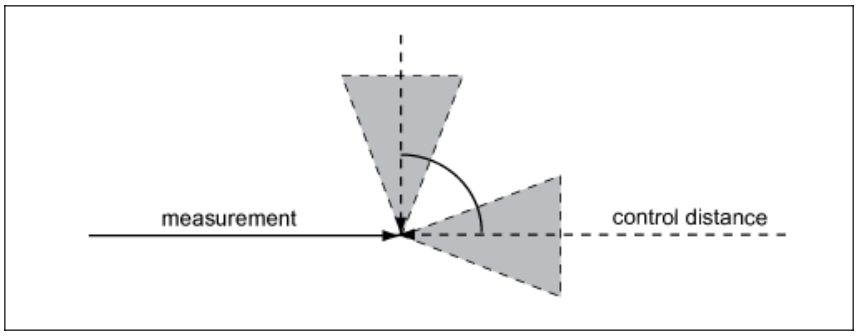
Control Distance Checks

Control distances are measured between new detail points of the current calculation project, and one or more existing points. The control distance analysis performs the following steps.

- **FS**—Calculation of the fault section. FS is the difference between the distance that is calculated from the point coordinates, and the measured distance. FS must not exceed the fault section threshold.
  If FS is within the threshold, the system continues to check whether the measuring direction is appropriate to provide a valid check.
- **Geometry check - case 1**—Checks the angle between the control distance and the measurement line. The angle must be an odd modulo of an eighth circle (45 degrees) +-13.57 degrees. The check is successful, if the angle is either 45 +-13.5, 135 +-13.5, 225 +-13.5, or 315 +-13.5 degrees.
  If case 1 is not successful, the system continues to check case 2.



- **Geometry check - case 2**—Checks the angle between two control distances. The angle must be an odd modulo of a quarter circle (90 degrees) +- 13.5 degrees, that means if the angle is either 90 +-13.5, or 270 +-13.5 degrees, the check is successful.



To control a GPS point, you must measure two control distances according to case 2.

NOTE You can change the default threshold of +-13.5 degrees system table TB_SUR_SETTING, key CONTROLDISTANCE_GEOM_CHECK_THRESHOLD. The unit is the document angle unit.

Control Distance check results

The result of the control distance analysis is documented. The result can either be:

-  Successful: FS is within the threshold, and the measurement setup is appropriate.
-  Not Successful: Geometry. FS is within the threshold, but the measurement setup does not provide appropriate control.
-  Not successful: FS exceeds the threshold. Measurement setup has not been checked.

Successful control distance measurements influence the calculation results: Normalized Residuals (Wi), Local Reliability (Zi), and Coordinates Reliability (NA). Control distance have no influence on Coordinate Precision (EMA), and the Chi Square Test, and they have no impact on the altimetry results.

In step 7, Calculate Adjustment, the measurements to points that have a successful control distance measurement will not be listed in the following summaries: Analyze Normalized Residual (Wi) (page 74), and Analyze Local Reliability (Zi) (page 75).

In step 7, Calculate Adjustment, the calculated points that have a successful control distance measurement will not be listed under Coordinates Reliability (NA) (page 78).

Analyzing Measurement and Results

At any stage of the calculation process you can view and analyze the survey data and -if available- the calculation results. Use the buttons on the Navigation Pane, or use the links in the Calculation Wizard, or use the Calculation Project menu commands.

Measurement

The Measurement dialog box displays the original field data that has been imported in the current calculation project, and -after the calculation- the adjustment parameters and indicators of reliability. For example, after step 4, Calculate Approximation, the orientation of the stations is displayed.

NOTE When you modify the measurements, you must restart the calculation at step 4, Calculate Approximation.

Click  Measurement to open the Measurement dialog box. The Measurement dialog box displays the following.

Tachymeter tab - for each station

- Parameter section, see Measurement - Tachymeter (page 50).
- Measurement Data tab, see Measurement - Tachymeter (page 50)
- Results tab

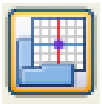
Transformation tab - for each session

- Transformation parameter - planimetry/altimetry, see Measurement - Transformation (page 54).
- Measurement Data tab
- Results tab

Control Distance tab

- Measurement Data tab, see Measurement - Control Distance (page 60).
- Results tab

Coordinate

Click  Coordinate to open the Coordinate dialog box. The Coordinate dialog box displays the following, both for planimetry and altimetry.

- Fix Point tab
- New Points tab
- Moveable Point tab

Result

Click  Result to open the Result dialog box. The Result dialog box displays the following.

- Measurement Results tab
- Moveable Point Results tab
- Calculated Coordinates tab
- Distributed Coordinates tab

Measurement - Tachymeter

On the Tachymeter tab, select a station to view or edit the tachymeter measurement. The Tachymeter tab displays polar mapping data that has been imported from an instrument of type Tachymeter.

Tachymeter tab	Description
Select Station/Identifier	Selects the station to view. The list displays the identifier of the stations that have been imported.
 Create Station	Creates a station. Use this function to add measurements manually. See also Measurement - Adding a Station (page 54)
 Delete Selected Station	Deletes the selected station. For example, if you want to import a station once more, using different instrument settings.
Detail Points area	To exclude or include detail points from the adjustment calculation. The command applies to the selected station. These commands can also be started for the whole calculation project. See also Detail Points Configuration (page 35)
 Activate All	Includes all detail points of the selected station by setting the Active attribute in the Measurement Data tab.
 Deactivate All	Excludes all detail points of the selected station by clearing the Active attribute in the Measurement Data tab.
Station area	Displays the station data.
Parameter	Click  to display all options.
Identifier	Specifies the station identifier.

Tachymeter tab	Description
Field Code	Specifies the field code of the station.
Instrument	Specifies the instrument.
Operator	Specifies the operator.
Instrument height	Specifies the instrument height, as imported from the field data. In the Global Settings, use the Category 2 for small units to specify the display unit. See also Unit Settings (page 17).
Pressure	Specifies the pressure. This value is used to calculate the distance reduction.
Centring Error	Specifies the centring error, as defined in the instrument settings. In the Global Settings, use the Category 2 for small units to specify the display unit. See also Unit Settings (page 17).
Temperature	Specifies the temperature.
Orientation	Displays the calculated station orientation.
Standard Orientation	Displays the standard deviation of the orientation.

The measurement is displayed on two tabs, Measurement Data tab, and Results tab.

Measurement Data Tab

Measurement Data tab	Description
Identifier	Unique identifier, such as a point number. Imported from the field data.
FC	Field Code that specifies the feature class of the point. Imported from the field data.
Point Type	Specifies whether the point is a

Measurement Data tab	Description
	■ Base Point ■ Detail Point. See also Measurement - Point Types (page 29).
Sub Type	Specifies whether the point is measured ■ Face 1 = Normal ■ Face 2 = Second Face See also Measurement - Point Types (page 29).
Active	Specifies, whether a point is used for approximation or adjustment calculation.
Target H	Height of the reflector on the target point. Imported from the field data. For example in RO files the target height is stored with the zh code.
Dist	Measured distance. Observation.
Dist Type	Indicates whether the distance has been measured horizontally, or as a slope. See also Measurement - Distance Types (page 29).
Std Dist	Standard deviation of distance. This value is calculated using the instrument settings.
LO	Length offset. Imported from the field data. Indicates the distance between the target point and prism. See also Measurement - Offset Types (page 30).
Hz	Measured horizontal angle to the target point. Imported from the field data.
Std.Hz	Standard deviation of horizontal angle. Imported from the instrument settings.

Measurement Data tab	Description
CO	Cross offset of the measurement. Imported from the field data. See also Measurement - Offset Types (page 30).
V Type	Indicates whether the vertical angle is a zenith, a vertical or a nadir angle See also Measurement - Vertical Angle Types (page 30).
V	Measured vertical angle. Imported from the field data.
Std. V	Standard deviation of vertical angle. Imported from the instrument settings.
H.Diff	Measured height difference. Imported from field data.
Std. H.Diff	Standard deviation of height difference. Imported from the instrument settings.

Results Tab

The Results tab displays the residuals and indicators for each observation, such as distance, horizontal angle, vertical angle, and measurement of height difference.

Results tab	Description
Identifier	Unique identifier, such as a point number. Imported from the field data.
FC	Field Code that specifies the feature class of the point. Imported from the field data.
Vi	Specifies the residual error of the observation.
Zi	Specifies the local reliability. See also Local Reliability Zi (page 75).

Results tab	Description
Nabla	Specifies the largest undetectable error of the observation.
Wi	Displays the normalized residual error of the observation. See also Normalized Residual Error Wi (page 74).
Gi	Specifies the estimated size of an error in the observation. See also Normalized Residual Error Wi (page 74).

Measurement - Adding a Station

You can add measurements manually. Use the Create Station icon to add a tachymeter station to the calculation project.

To add a station

1. Select the calculation project.
2. On the Navigation Pane, click the Measurement icon.
3. Click the Tachymeter tab.
4. Under Select Station/Identifier, click Create Station.
5. Under Station, enter the station parameters, such as Identifier, Field Code, and Instrument.
6. On the Measurement Data tab, enter the measurements.
7. Click Save to store the values.

Measurement - Transformation

On the Transformation tab, select a session

- To view the coordinate observations.
- To set up the transformation type.

The Transformation tab displays the coordinates that have been imported from an instrument of type GPS.

Transformation tab	Description
Select Session/Name	Selects the session to view. By default the session name is GPS <number>.
 Create Session	Creates a session. Use this function to manually add a session to the current calculation project.
 Delete Selected Session	Deletes the selected session.
Detail Points area	To exclude or include detail points from the adjustment calculation. The command applies to the selected session. These commands can also be started for the whole calculation project. See also Detail Points Configuration (page 35)
 Activate All	Includes all detail points of the selected session by setting the Active attribute in the Measurement Data tab.
 Deactivate All	Excludes all detail points of the selected session by clearing the Active attribute in the Measurement Data tab.
Session area	Displays the session measurement.
Name	Displays the session name. If you use the default name, this field is empty. The default name is GPS <number>, and it is displayed under Select Session / Name. To modify the name, enter a new name.
Number	Displays the session number. The session number is created automatically. It indicates the order in which the GPS files have been imported.

Transformation tab	Description
	IMPORTANT The session number can be used to control the determination of the transformation parameters. For example, if you want to use one particular session to determine the transformation parameters, you use the session number to address the session. See Transformation Parameters (page 58)
Instrument	Specifies the instrument.
Operator	Specifies the operator.
Parameter	Displays the transformation parameters: translation, rotation, and scaling. Click  to display all options. See Transformation Parameters (page 58)

The measurement is displayed on two tabs, Measurement Data tab, and Results tab.

Transformation Measurement Data Tab

Measurement Data tab	Description
identifier	Unique identifier, such as a point number. Imported from the field data.
FC	Field Code that specifies the feature class of the point. Imported from the field data.
Point Type	Specifies whether the point is a ■ Base Point ■ Detail Point. See also Measurement - Point Types (page 29).

Measurement Data tab	Description
Active	Specifies, whether a point is used for approximation or adjustment calculation.
E	Easting. Displays the measured coordinate in east-west direction.
Std. E	Displays the standard deviation for easting. Imported from the instrument settings.
N	Displays the measured coordinate in north-south direction.
Std. N	Displays the standard deviation for northing. Imported from the instrument settings.
H	Displays the measured height.
Std. H	Displays the standard deviation of the height. Imported from the instrument settings.

Transformation Results Tab

The Results tab displays the residuals and indicators for each observation.

Results tab	Description
Identifier	Unique identifier, such as a point number. Imported from the field data.
FC	Field Code that specifies the feature class of the point. Imported from the field data.
Vi	Specifies the residual error of the observation.
Zi	Specifies the local reliability. See also Local Reliability Zi (page 75).
Nabla	Specifies the largest undetectable error of the observation

Results tab	Description
Wi	Displays the normalized residual error of the observation. See also Normalized Residual Error Wi (page 74).
Gi	Specifies the estimated size of an error in the observation. See also Normalized Residual Error Wi (page 74).

Transformation Parameters

Depending on various conditions, such as number of observations, over determination, quality of the geodetic network, or desired accuracy you can specify the number of parameters that will be determined for the transformation. Transformation parameters are:

- **Translation**—Delta Easting, Delta Northing.
- **Rotation**—Rotation 1, Rotation 2. Use Rotation 1 to rotate both axes at the same value.
- **Scaling**—Scale Easting, Scale Northing. Use Scale Easting to scale both Easting and Northing using the same value.

Also you can specify that for each session the transformation parameters will be determined independently, or you can select a session that will be used to determine the parameters, and some or all other sessions will use the same values.

To specify the transformation

1. Open the Measurement dialog box.
2. Select a session.
3. Under Session, click  to display the Parameter area. The parameters for planimetry and altimetry are displayed on separate tabs.

4 For each transformation parameter, select one of the options, as shown in the following table.

Transformation tab Parameter area	Description
No	Specifies that the transformation parameter will not be determined for the transformation.
New	Specifies that the parameter will be determined, and will be used for the transformation.
Previous	Specifies that the value of the previous session will be used for the transformation. For the selected session, the value will not be determined, and the transformation will be calculated using the value of the previous session. The previous session is recognized by the session number. For example, session number 4 is previous to session number 5.

The default settings specify a Helmert transformation.

- Delta Easting: New.
- Delta Northing: New.
- Rotation 1: New. With Rotation 2 set to No, this parameter will be applied to both axes. Both axes will be rotated at the same value.
- Rotation 2: No.
- Scale Easting: New. With Scale Northing set to No, this parameter will be applied to both Easting and Northing.
- Scale Northing: No.

To specify an affine transformation, set all parameters to New.

For each parameter, the Transformation Planimetry tab and the Transformation Altimetry tab displays the option, value and standard deviation.

Measurement - Control Distance

The Control Distance tab displays distances that have been measured between two points.

Requirements: Either the start or the end point must be part of the current calculation project. One of the points must be either new planimetry points, or new moveable detail points, including GPS points. You cannot control points that are stored in other documents.

To enter the measurements, do one of the following.

- Enter the values manually in the Measurement data grid. If you are working with Topobase Client, you can select the points in the map. See also Processing Control Distance Measurements (page 122).
- Import control distance measurement files. See Importing Control Distance Files (page 31).

Control Distance tab	Description
Fault Section (FS) Threshold	Specifies the fault section FS that must not be exceeded. FS is the difference between the calculated distance, and the measured distance.
Operator	Selects the operator.
Detail Points area	To exclude or include detail points from the adjustment calculation. These commands can also be started for the whole calculation project. See also Detail Points Configuration (page 35)
 Activate All	Includes all detail points of the selected session by setting the Active attribute in the Measurement Data tab.
 Deactivate All	Excludes all detail points of the selected session by clearing the Active attribute in the Measurement Data tab.

Control Distance tab	Description
Add From Map	Adds the points from the map. Click the button, and select the points in the drawing.
Save	Saves the modifications.

The Add From Map command is not activated, if you are working with the Standalone Topobase Client. To use this command, generate graphic. We recommend, that you use a display model that has a project filter (FID_PROJECT) to only display the points of the selected calculation project.

TIP Using Add From Map you can also select a line feature in the map. Then, the start point, or end point next to where you clicked, will be selected.

The measurement is displayed on two tabs, Measure Data tab, and Results tab.

Measure Data Tab

Measure Data tab	Description
From Ident.	Displays the identifier of the first point.
FC	Displays the field code.
To Ident.	Displays the identifier of the second point.
FC	Displays the field code.
Active	Specifies whether the measurement is used in the calculation. Clear this option to exclude the measurement.
Distance	Specifies the distance that has been measured.

Results Tab

The Results tab displays the residuals and indicators for each observation.

Results tab	Description
From Ident.	Displays the identifier of the start point.

Results tab	Description
FC	Displays the field code of the start point.
To Ident.	Displays the identifier of the end point.
FC	Displays the field code of the end point.
Fs	Displays the fault section FS.
Result	Displays an icon that indicates the result. Hover over the icon, and read the tooltip for more details. If one control distance controls two points, and if the result type is not the same, the worse result is shown. See also Control Distance Measurements (page 45).

A result is available for the start point, and for the endpoint. If the result type is not equal, the worse one is displayed in the UI.

Coordinate

The Coordinate dialog box displays the approximate and final coordinates that are available after each calculation step. The coordinates are grouped according to their status in the adjustment process.

- **Fix Point tab**—Displays control points with known coordinates that are stored in the database. A fix point is a control point that is not subject to adjustment, and whose coordinates are fixed.
- **New Point tab**—Displays control points, and detail points with unknown coordinates.
- **Moveable Point tab**—Displays control points, and detail points that have been introduced as unknowns in the adjustment process. See also Working With the Data Grid (page 105)

In the Coordinate data grid, use the following shortcut menus to move a point to another point group. These commands are available after calculation step

5, Find Identical Points has been completed, and before step 7, Calculate Adjustment has been executed.

Coordinate shortcut menus	Description
Set As Fix Point	Moves the point to the Fix Point tab. Use this command to introduce a reliable existing point to the adjustment calculation. You can only set a new point as fix point, if it has a a feature class and a source document defined.
Set As Moveable Point	Moves the point to the Moveable Point tab. For example, if you are not sure about the quality of a fix point, you introduce the point as moveable point.
Set As New Point	Moves the point the New Points tab.

The Coordinate dialog box displays the point attributes as shown in the following table.

NOTE When you modify the coordinates, or move the point to another tab, you must restart the calculation at step 5, Find Identical Points.

Coordinate dialog box	Description
Identifier	Unique identifier, such as a point number. Imported from the field data.
FC	Field Code that specifies the feature class of the point. Imported from the field data.
E N H	Displays the coordinates. Easting-Coordinate in east-west direction. Northing-Coordinate in north-south direction. Height.
Std. E	For moveable points: Displays the standard deviation for easting.
Std. N	For moveable points: Displays the standard deviation for northing. This value is stored

Coordinate dialog box	Description
	in the database: <point feature class>.TB_ACCURACY
Source Document	For existing points: Displays the document that stores the point.
Source FC	For existing points: Displays the feature class that stores the point.

NOTE For moveable altimetry points the easting and northing values remain empty. For moveable planimetry points, the height value must be empty.

Moveable Points

Moveable points are either detail points or fix points that are already stored in the database. Moveable points have known coordinates, and a standard deviation that are introduced to the adjustment process as observation. Introducing moveable points will fit the new points well into the local situation.

You introduce moveable points either automatically or manually.

To automatically introduce moveable detail points

➤ Start the Calculation wizard, and execute the optional step 6, Find Existing Points. See Find Existing Points (page 40)

This step adds existing detail points to the adjustment process.

To manually introduce a fix point as moveable point

- In the Coordinate dialog box, click the Planimetry Fix Points tab.
- Select the coordinate row.
- Right-click, and click Set As Moveable Point.

See also:

- Find Existing Points (page 40)
- Moveable Point Results (page 67)

Result

The measurement results are grouped by session or station. In the Result dialog box, you access all measurements of the current calculation project.

The Result dialog box displays the calculation results and adjustment parameters and indicators of reliability in a data grid, ordered by the following categories. The results are updated after each calculation step. At any stage of the calculation process this dialog box displays the available values.

- Measurement Results
- Moveable Point Results
- Calculated Coordinates
- Distributed Coordinates

Measurement Results

Measurement Results tab	Description
From Point	Displays the identifier of the station of the measurement. For coordinate observations, this column is empty.
To Point	Displays the identifier of the target point of the observation.
Session	Displays the session of the observation. For tachymeter measurements, each station corresponds to a session. The session number is created automatically during the import of the files.
Session Type	Describes the type of measurements. GPS = Coordinates. Tachymeter = Polar mapping; Control Distance.
Meas. Elem. Type	Describes the type of observation. For example: ■ Horizontal angle ■ Bearing (azimuth)

Measurement Results tab	Description
	■ Slope distance ■ Horizontal distance ■ Zenith angle ■ Vertical angle ■ Nadir angle ■ Easting (GPS) ■ Northing (GPS) ■ Height (GPS) ■ Easting ■ Northing ■ Height ■ Height difference ■ Horizontal distance at height of the target point
Plani	Specifies
Base	Specifies
Vi	Specifies the residual error of the observation.
Zi	Specifies the local reliability. See also Local Reliability Zi (page 75).
NABLA	Specifies the largest undetectable error of the observation.
Wi	Displays the normalized residual error of the observation. A large value indicates a possible gross error. See also Normalized Residual Error Wi (page 74).
Gi	Specifies the estimated size of an error in the observation. See also Normalized Residual Error Wi (page 74).

Measurement Results tab	Description
CD	Displays the result of the control distance measurement (result of the target point of the measure element). See also Control Distance Measurements (page 45).

Moveable Point Results

Moveable Point Results tab	Description
Identifier	Displays the identifier.
Wi	Displays the normalized residual of the observation. A large value indicates a possible gross error. See also Normalized Residual Error Wi (page 74).
Gi	Specifies the estimated size of an error in the observation. See also Normalized Residual Error Wi (page 74).
Vi	Specifies the residual error of the observation.
Zi	Specifies the local reliability. See also Local Reliability Zi (page 75).
Nabla	Specifies the largest undetectable error of the observation

See also:

- Working With the Data Grid (page 105)

Calculated Coordinates

Calculated Coordinates tab	Description
Identifier	Displays the unique identifier, such as a point number.
FC	Displays the field code that specifies the feature class of the point.
E N H	Easting, northing, and height.
EMA	Major axis of the error ellipse. When distributed to the target document, this value is stored in <feature class>. TB_ACCURACY_POSITION.
EMB	Minor axis of the error ellipse.
EMH	Standard deviation of the adjusted height. When distributed to the target document, this value is stored in <feature class>. TB_ACCURACY_HEIGHT.
EM Bearing	Azimuth of the large shaft section of the error ellipse.
NA	Maximum value for the external reliability, long side of the reliability rectangle. See also Coordinate Reliability (page 78). When distributed to the target document, this value is stored in <feature class>. TB_RELIABILITY_POSITION.
NB	Short side of the reliability rectangle.
NH	Maximum value of the external reliability for the height. When distributed to the target document, this value is stored in <feature class>. TB_RELIABILITY_HEIGHT.

Calculated Coordinates tab	Description
N Bearing	Azimuth of the long side of the reliability rectangle.
CD	For detail points, displays the result of the control distance measurement. If several control distance measurements apply, the best result is shown. For example, with one control distance measurement successful, and one not successful, the overall result is successful. See also Control Distance Measurements (page 45).

See also:

- Distributing Coordinates (page 79)

Distributed Coordinates

The Distributed Coordinates tab displays the points that have been distributed to their target documents, along with their distribution status, as shown in the following table.

Distributed Coordinates tab	Description
Identifier	Displays the unique identifier, as it is specified in the measurement file, and in the Survey database <point feature class>.TB_POINTNUMBER.
Point Number	Displays the point number in the target feature class, after the distribution. For example, if you use rules for automatic point numbering, the Point Number would be is different from the Identifier.
E N H	Easting, northing, and height.

Distributed Coordinates tab	Description
Plani	Indicates that the planimetry (X,Y/Easting, Northing) has been distributed.
Height	Indicates that the height has been distributed.
New	Indicates that the point has been inserted into the target document. If the check box is cleared, the point has been updated.
Document	Displays the target document.
Feature Class	Displays the target feature class.
Date	Displays the distribution date.
Topobase User	Displays the login user who executed the distribution.
Success	Indicates whether the distribution has been successful.
Failed Message	Displays the message that explains why the point could not be distributed.

See also:

- Distributing Coordinates (page 79)

Analyzing Precision and Reliability

When you have calculated the adjustment, the precision and reliability of the measurements can be analyzed. In the Information group box, click the Calculate Indicators link to see the details.

Information group box	Description
General Information	Displays the number of observations and unknowns, the number of iterations, and the standard deviation a posteriori.

Information group box	Description
Number Of Iterations	Displays the number of iterations. In most cases 1 iteration provides the coordinates.

Click the Calculate Indicators link to calculate and display the reliability indicators. The analysis results are categorized as follows.

-  Green light indicates that the test has been successful.
-  Yellow light indicates that the test has not been passed for all observations. Read the message to find possible reasons.
-  Red light indicates that the test has not been passed.

Chi-Square Test

The Chi-square test is a global statistical test that checks the quality of the calculation model. For example, it indicates whether the residuals correspond to the a priori standard deviation. The Chi-square test result should not be < 20%. A value of 0% indicates, that the standard deviations do not represent the actual measurement precision.

NOTE A successful CHI-square test is most important for the calculation of base points. However, you can modify the threshold for the Chi-square test. For example, when you calculate detail points. See Calculation Project Settings (page 23).

-  Green light indicates a Chi-Square value that is greater than the threshold.

-  Red light indicates a Chi-Square value that is below the threshold, that means that not all possible errors have been detected.

Click the Show Measurement link to open the Measurement dialog box. In the Measurement dialog box, select the station or session, In the Measurement Data tab, check the standard deviation values.

By default, the a priori values are specified in the instrument settings. However you can update these values separately for each calculation project. Click the Update A Priori Standard Deviation (page 72) link to adjust the values. Then, start the adjustment calculation again.

Update A Priori Standard Deviation

After the adjustment calculation the Chi-square test (page 71) indicates a possible mismatch between the a priori standard deviation, and the a posteriori mean error. To get a suitable calculation model, you can adjust the standard deviation for the current calculation project.

The Update A Priori Standard Deviation dialog box displays normalized values for the a priori standard deviation, and compares the a priori with the a posteriori values.

To adjust the a priori standard deviation

1. In the Calculation Wizard, step 7, Calculate Adjustment, under Chi Square Test, click the Update A Priori Standard Deviation link.
2. In the Update A Priori Standard Deviation dialog box, specify new a priori values for each measurement group, as shown in the following table.

   Note that the dialog box displays all measurement groups of the current calculation project. There can be multiple measurement groups of the same type.
3. Click Update. Then, the Calculation Wizard steps back to the beginning of step 7, Calculate Adjustment.

NOTE This update only modifies the values that are stored in the calculation project, under Measurement. It does not affect the instrument settings.

4 Click Calculate to restart the process.

Update A Priori Standard Deviation	Description
Measurement group	A measurement group summarizes observations that have been observed under the same external conditions, such as instrument. For each measurement group, you can adjust the values.
New Value	Specifies the new value. For example, enter the A-Posteriori value as new value, or enter a value that is close to the A-Posteriori value.
Tachymeter <instrument name>	Compares the values for Tachymeter measurement groups.
Distance	Values for A-Priori and A-Posteriori contain the impact of the centring error, and are based on a distance of 1000 meter (1km).
Distance Param. A Distance Param. B	The distance parameters do not contain the impact of the centring error, however you can enter a new value for the centring error separately.
Horizontal Angle	Values for A-Priori and A-Posteriori contain the impact of the centring error, and are based on a distance of 1000 meter (1km). The new value does not contain the impact of the centring error, however you can enter a new value for the centring error separately.
Vertical Angle Height Difference	A-Priori, A-Posteriori, and New Value do not contain the centring error.
Centring Error	The Centring Error impacts distance measurements, and horizontal angles.
Transformation/GPS <instrument name>	Compares the values for Transformation / GPS measurement groups.

Update A Priori Standard Deviation	Description
Coordinate	Compares the values for moveable points.

BEST PRACTICE Use different instruments (page 9), if you have measurements with different levels of accuracy.

See also:

- Instrument Settings - Transformation and GPS (page 11)
- Instrument Settings - Tachymeter (page 11)

Normalized Residual Error Wi

The Normalized Residual Wi is a local test statistic that is used to detect **gross errors**.

They are calculated for each observation, and they are not affected by the weight of the measurement. A large value indicates that a large residual is possibly caused by a measurement error. For example, significant values are:

- Wi > 4 = gross error is likely
- Wi < 2.5 = measurements are of good quality.

According to local regulations, other limits may apply for geodetic networks, or polar mappings. You specify a maximum value for Wi in the Advanced Options of the Calculation Project Settings. See also Calculation Project Settings (page 23).

Estimated size of a gross error Gi

If Wi exceeds the maximum value, the system calculates estimates for the size of the gross error Gi. A gross error of this size would explain the calculated Wi. Gi indicates the size and algebraic sign of a possible gross error.

Click the Analyze Normalized Residual link to open the Result dialog box. On the Measurement Results tab, click the header of the Wi column to sort for the Wi values.

-  Green light indicates that no measurement errors have been detected, and that Wi < Wi max for all values.
-  Yellow light alerts you that for some observations no Wi value could be determined. For example, for points that have no over determination. Continue, if you want to include detail points that are only measured once.
  If your measurements do not contain single measurements, check the configuration, or the tolerances.

  If you want to allow single measurements for some points, modify the field code list, and select the Single option. See Field Code Settings for Calculation (page 84).
-  Red light indicates that measurement errors have been detected. The list displays the 5 observations that have the largest Wi > Wi max. Click the Show link, to open the Result dialog box, and to check the measurements.

To resolve the measurement errors, you can do the following:

- In the Measurement dialog box, on the Measurement Data tab, deactivate the measurement.
- Use the Gi value to modify the measurement accordingly.
- In the Measurement dialog box, on the Measurement Data tab, modify the standard deviation accordingly.

Local Reliability Zi

The local reliability describes how controlled a measurement is, and how likely it is that a gross error will be detected. Zi is dependent on the network design.

The local reliability Zi [%] is a reliability factor that represents the distribution of the over determination of the network on the individual observation (redundancy number).

NOTE Use the Calculation Project settings to modify the threshold for the Local Reliability. See Calculation Project Settings (page 23).

- A value of 100% indicates that the observation is totally controlled.
- A value of 0% indicates an observation that is not controlled, that means, a possible gross error can not be detected, and Nabla is infinite. For example, for points that have been measured only once, Zi is 0%.
- For example, if an observation has a local reliability of 10%, only 10% of a possible measurement error would be visible in its residual, that means the error could not be detected.
- A value of 20% indicates a measurement that is well controlled.
- Values between 25% and 60% indicate a well designed network.

Click the Analyze Local Reliability link to open the Result dialog box. In the Result dialog box, on the Measurement Results tab, click the header of the Zi column to sort for the Zi values.

Select the row of the measurement, right-click and click Show Station to open the Measurement dialog box for the station on which the point has been measured.

-  Green light indicates that all measurements are controlled, and all Zi are > the defined threshold for the Local Reliability.
-  Yellow light alerts you that for some observations no Zi value could be determined. For example, for points that have no over determination. Continue, if you want to include detail points that are only measured once.
  If your measurements do not contain single measurements, check the configuration, or the tolerances.
  If you want to allow single measurements for some points, modify the field code list, and select the Single option. See Field Code Settings for Calculation (page 84).

-  Red light indicates that the some measurements are not controlled, and have a Zi < the defined threshold for the Local Reliability. The list displays the 5 observations with the smallest Zi values. Click the Show link to open the Result dialog box.

Coordinate Precision

The precision of a calculated coordinate is indicated by its error ellipse. Click the Analyze Main Error Ellipse Axis link to display the Calculated Coordinates tab in the Result dialog box. Click the EMA column title to sort the coordinates.

The precision tolerance is specified in the field code list. Click the Manage Field Code List link to open the Manage Field Code List dialog box. Click the Distribution tab. See also Reliability and Precision Tolerance Statement (page 88).

-  Green light indicates that the precision of all points is within the tolerance. When you distribute the point, EMA will be stored in the attribute TB_ACCURACY_POSITION, and EMH will be stored in TB_ACCURACY_HEIGHT.
-  Yellow light alerts you that for some points no precision tolerance is specified, so that the analysis could not be completed.
-  Red light indicates that some points are not within the tolerance. The list displays the 5 points that have the largest EMA values.

Error Ellipse

For each point, the error ellipse represents the result of the least squares adjustment, that means it indicates the maximum and minimum values of the standard deviation along with their direction.

For example, if all directions are about the same, this could indicate a general network defect.

Coordinate Reliability

The external reliability is an indicator for coordinate reliability. The external reliability of a point describes the effect of an undetected gross error on the coordinate. In the network plan, the external reliability of a point is represented by a rectangle in which its coordinate is located with a probability of 99%. Otherwise the gross error would have been detected.

The reliability tolerance is specified in the field code list. Click the Manage Field Code List link to open the Manage Field Code List dialog box. Click the Distribution tab. See also Reliability and Precision Tolerance Statement (page 88).

Click the Analyze Length Reliability Rectangle link to display the Calculated Coordinates tab in the Result dialog box. Examine the values NA, NB, NH, and N Bearing.

-  Green light indicates that the reliability of all points is within the tolerance. When you distribute the point, NA will be stored in the attribute TB_RELIABILITY_POSITION, and NH will be stored in TB_RELIABILITY_HEIGHT.
-  Yellow light alerts you that for some points no reliability tolerance is specified, so that the analysis could not be completed. Or some of the single measurement points do not have over determination (NA = Infinite).
-  Red light indicates that some points are not within the tolerance. The list displays the 5 points that have the largest NA values.

Reliability Rectangle

For each new point, the reliability rectangle describes the effect of an undetected gross error on the coordinate and on the height. The size and orientation of the rectangle are: NA (long side) NB (short side), and N Bearing (bearing of the long side).

Distributing Coordinates

After the adjustment calculation, the coordinates of the new point features are stored in the Survey document.

You use the Distribute Points function to distribute the coordinates to their target documents, and to the appropriate feature class. The distribution rules and tolerances are defined in the field code list. You either distribute the plane coordinates (easting and northing), the height, or both.

In one distribution process, you can distribute the new points to several feature classes and target documents.

NOTE The target documents must be included in the current workspace. See also Workspaces for Survey (page 109).

To define the distribution rules in the field code list

1. Start the Field Code List Manager. For example, in the Calculation wizard - Distribute Points, under Configuration, click the Manage Field Code List link.
2. Select the Field Code List.
3. In the Manage Field Code List dialog box, in the Field Code group box, click the Distribution tab.
4. For each field code, define the distribution rules. See Field Code Settings for Distribution (page 86).

To distribute points

1. In the Navigation pane, under 7, Calculate Adjustment, select Distribute Points.
2. On the right pane, click Distribute.
3. In the Distribute Coordinate dialog box, configure the distribution. For example, select the points that you want to distribute. See Configuring the Distribution (page 80).
4. Click Distribute.

After the distribution, in the Information group box, the distribution report is displayed.

Information group box	Description
Insert Points Failed Insert Points	Displays the number of new points that have been distributed, and how many points could not be inserted. For example, if the target feature class does not exist, or if a feature class is read-only, the point cannot be inserted.
Update Points Failed Update Points	Displays the number of existing points that have been updated, and how many points could not be updated. For example, if the target feature class does not exist, or if a feature class is read-only, the point cannot be updated.
Total	Displays the total number of distributed points.
Show Distributed Coordinates	Opens the Distributed Coordinates tab in the Result dialog box. Click this link to view the status of the distribution, and to view the messages that inform you about any failure. See also Distributed Coordinates (page 69).

See also:

- Understanding Field Codes (page 84)

Configuring the Distribution

The Distribute Coordinate dialog box displays all points that have been calculated, along with their precision and reliability indicators. Use the check boxes to control the distribution as shown in the following table.

NOTE By default, all points that meet the accuracy requirements, are selected for distribution. In the data grid, missing or unsuitable values are highlighted.

Distributed Coordinate dialog box	Description
Point Number	Counts the points that you have selected for distribution.
Point Number Selected For Planimetry Distribution	Counts the points that you have selected for planimetry distribution.
Point Number Selected For Altimetry Distribution	Counts of points that you have selected for distribution of the height.
Distr	Selects the point for distribution.
Plani	Selects the planimetry (easting, northing) for distribution. By default, only planimetry is distributed.
Height	Selects the height for distribution. Only available, if a height coordinates has been calculated.
Identifier	Displays the unique identifier, such as a point number.
FC	Displays the field code.
Document	Displays the document where the point will be stored. Mandatory. If the document is not specified, you cannot select the point for distribution.
Feature Class	Displays the feature class of the point.
Distributed	Indicates whether the point has already been distributed previously.
New	Indicates that this point has been determined in the current calculation project, and is not yet stored in the database. New

Distributed Coordinate dialog box	Description
	points will be inserted into the target document. If not selected, this option indicates an existing point in the database, whose coordinates have been calculated once again. Existing points will be updated in the target database.
Easting, Northing, Height	Displays the coordinates of the point.
EMA, EMB	Displays the length of the major and minor axis of the error ellipse. Indicates the coordinate precision.
NA, NB	Displays the maximum and minimum value for the external reliability (side length of the reliability rectangle).

NOTE You can temporarily change the field code, the document, and the feature class of the distributed points. However the target must be available in your current workspace.

Storing the Adjustment Results

When you distribute points, for each point the calculation results are stored as shown in the following table.

Point feature class attribute	Description
TB_POINTNUMBER	Stores the point number, if the option Keep Identifier has been selected.
TB_ACCURACY_POSITION	Stores EMA. See also Coordinate Precision (page 77).
TB_ACCURACY_HEIGHT	Stores EMH.
TB_RELIABILITY_POSITION	Stores NA. See also Coordinate Reliability (page 78).
TB_RELIABILITY_HEIGHT	Stores NH.

Point feature class attribute	Description
TB_POSITION_RELIABLE TB_HEIGHT_RELIABLE	Stores whether the position coordinates or the height are reliable. For example, 1 = Yes = Reliable. 0 = No = Not reliable. The coordinates are reliable, if they meet the tolerances that are specified in the field code list. See also Reliability and Precision Tolerance Statement (page 88).

NOTE The reliability and precision attributes are default attributes, that can optionally be added to point feature classes. See Topobase Administrator - Feature Class Type: Point.

NOTE The reliability values can either be 1 or 0. In the Global Settings, you can specify which value will be interpreted as true and which value as false. For example in the INTERLIS format, 0 = True and 1 = False. See also Global Survey Settings (page 15).

Distribution Job Selection

When you distribute points to a document that is job enabled, the Distribution Job Selection dialog box is displayed.

Distribution Job Selection	Description
Job Selection	Displays the job for each feature class in the distribution list that distributes into a job enabled document. Select a row to edit the values.
Document	Displays the document.
Feature Class	Displays the feature class.
Job	Selects the job. The list displays all open jobs that contain the target feature class.
Distribute button	Distributes the features.

Understanding Field Codes

In the field, you use field codes to distinguish the points that you measure. For example, field code B10 represents a control point, field code LM21 represents a building corner, and field code WW41 represents a manhole. The field code is an alphanumeric value with a maximum of 64 characters.

You use field code lists to map the measured points to Topobase feature classes. You assign the field code list to a project, so that several calculation projects can use the same field code list.

The field codes connect the field measurements to the database. The field code controls how the measured points are introduced into the calculation process, how reference points are searched, and into which document/feature class a new point will be distributed.

- Existing points are base points and reference points that already exist in the database. For each field code, you specify search rules and tolerances.
- Identical points are points that have been measured more then once. For each field code, you specify search rules and tolerances.
- New points can be distributed to multiple target documents. For each field code, you specify the document, the feature class, distribution rules, and optionally up to 10 pairs of attribute/value combinations.

Topobase Survey provides a Field Code Manager to manage multiple field code lists. See also Field Code List Manager (page 14).

Field Code Settings

In the Manage Field Code List dialog box, under Field Code, you edit and view the field code definition using two tabs, as shown in the following tables.

Field Code Settings for Calculation

On the Calculation tab, you specify the search rules that apply during the adjustment calculation in step 3, Find Reference Points, step 5, Find Identical Points, and step 6, Find Existing Points.

See also Field Code List Manager (page 14).

Field Code settings in the Calculation tab	Description
FC	Specifies the field code.
Document Placeholder	Specifies a placeholder for the name of the document where the point is stored. See Fill Document (page 7).
Feature Class	Specifies the feature class.
Identical	Specifies whether the search for identical points uses points with this field code. See also Find Identical Points (page 36).
Identifier	Specifies whether the identifier is used to find identical points.
Pos.	Specifies whether the position is used to find identical points. If you select this option, you must enter a tolerance.
Tol.	Specifies the tolerance. Points that lie within the tolerance are treated as identical points.
Existing	Specifies whether the search for existing detail points uses points with this field code. See also Find Existing Points (page 40).
Identifier	Specifies whether the identifier is used to find existing points.
Pos.	Specifies whether the position is used to find existing points.
Tol.	Specifies the tolerance. Points that lie within the tolerance are treated as existing points.

Field Code settings in the Calculation tab	Description
Single	Specifies that the points are allowed to be determined from a single measurement, without over determination. For example, for house corners, for points with lower accuracy requirements. Select Single, if you do not want the point to be considered as not well controlled. See step 7, Calculate Adjustment, Normalized Residual Error Wi (page 74).

Field Code Settings for Distribution

On the Distribution tab, you specify the rules that apply during the distribution of the calculated points to their target documents. See also Distributing Coordinates (page 79).

NOTE You can distribute one new point to multiple feature classes and target documents.

Each distribution rule distributes the point once, that means that for each document and feature class, a separate distribution rule is required. For each field code you can define no, one or more distribution rules.

When you distribute a point, you can either update the coordinates and move the point, or you can update the precision, and keep the location of the existing point.

Field Code settings in the Distribution tab	Description
FC	Specifies the field code.
Tolerance Statement	Specifies a query that returns the maximum tolerance values for reliable and precise points. The unit for the tolerances is the document length unit. See also Reliability and Precision Tolerance Statement (page 88).

Field Code settings in the Distribution tab	Description
Rule Name	Specifies a name for the distribution rule. Enter a name that describes the distribution.
Document Placeholder	Specifies a placeholder for the name of the document where the point is stored. See Fill Document (page 7).
Feature Class	Specifies the feature class.
Keep Identifier	Specifies whether the identifier of the Survey document is stored in the point number attribute of the target feature class TB_POINTNUMBER. Default is Yes. Clear this option, if you do not want to store the Identifier in the point number attribute. For example, if you use other methods of point numbering.
Update Position	Specifies whether the position of the point shall be updated. Only for existing and moveable points. Clear this option, if you do not want to update the coordinates of the point. Then only the reliability attributes will be updated. For example, if a point lies on a straight line, or if a dimensioning has been applied.
Attr.1 Value 1	Specifies a feature class attribute and a value to be stored in the database. You can specify up to 10 pairs of attribute/value to be stored. For example, you specify that a point with field code 41 is a manhole (feature class = WW_MANHOLE) with the following properties: Attribute 1 = ID_FUNCTION Value 1 = 2 (Control Manhole) Attribute 2 = ID_OWNERSHIP Value 2 = 3 (Public)

Field Code settings in the Distribution tab	Description
	Attribute 3 = ID_LAYING_TYPE Value 3 = 4 (Underground).

Reliability and Precision Tolerance Statement

As a part of the adjustment calculation, and of the distribution, the system analyzes the precision and the reliability. When you distribute a point, the system analyzes and stores the reliability. Reliability is stored separately for position and height.

Reliability attributes in point feature classes

- TB_POSITION_RELIABLE—Stores the reliability of the position (easting, northing). The reliability of the position is indicated by the value NA.
- TB_HEIGHT_RELIABLE—Stores the reliability of height. The reliability of the height is indicated by the value NH.

NOTE The reliability attribute can either be 1 or 0. In the Global Settings, you specify which value indicates True or False. For example, 1 = True, and 0 = False. See also Global Survey Settings (page 15).

In the field code list, you specify Tolerance Statements to set the precision and reliability tolerances for reliable points. See also Field Code Settings for Distribution (page 86)

NOTE You can only have one Tolerance Statement per field code. However you can define multiple distribution rules for one field code.

You specify the tolerances in the document length unit.

If all tolerances are met, the distribution function sets the reliability attributes to true, otherwise to false.

The Tolerance Statement is either a short expression, or you define your own SQL select statement. You can define multiple tolerance statements to distribute the points to several documents. For example, in the Land document, the reliability tolerances are lower than in a Water document.

NOTE After the adjustment calculation, when you calculate the reliability indicators, the tolerances are checked. Green light in the Coordinate Precision area, and in Coordinate Reliability area indicate that all tolerances have been met. See also Coordinate Precision (page 77) and Coordinate Reliability (page 78).

Tolerance Statement - Short

The short expression for the Tolerance Statement contains the tolerances explicitly.

```
Tolerance/<tolerance EMA>/<tolerance EH>/<tolerance NA>/<tolerance
 NH>
```

All values are separated by a slash. For example, a point is reliable in position, if EMA < 0.15, and NA < 0.15. The point is reliable in height, if EH < 0.25, and NH < 0.25.

IMPORTANT You specify the tolerances in the document length unit.

```
Tolerance/0.15/0.25/0.15/0.25
```

For indicators that you do not want to be checked, set the tolerance = NULL. For example, if you do not want to check for the height reliability.

```
Tolerance/0.15/NULL/0.15/NULL
```

Tolerance Statement - SQL Select Statement

Optionally you define your own select statements to set the reliability tolerances. For example, if you want to distinguish between different tolerance zones, such as an inner area with high requirements, and an outer area with lower tolerances.

The tolerance statement must return the following values:

- TB_TOLERANCE_ACCURACY_POSITION—Maximum EMA value for points that lie within the position tolerance.
- TB_TOLERANCE_ACCURACY_HEIGHT—Maximum EMH value for points that lie within the height tolerance.
- TB_TOLERANCE_RELIABILITY_POSITION—Maximum NA value for points that lie within the position tolerance.
- TB_TOLERANCE_RELIABILITY_HEIGHT—Maximum NH value for points that lie within the height tolerance.

If you want to set tolerances that are dependent on the position of the point, you use the following placeholders.

- for easting: {0}
- for northing: {1}
- for height: {2}

Example - Select statement to set all maximum values to 0.15.

```
select 0.15, 0.25, 0.15, 0.25 from dual
```

Example - Select statement

```
SELECT
t.ACCURACY_POSITION, t.ACCURACY_HEIGHT, t.RELIABILLITY_POSITION,
t.RELIABILITY_HEIGHT
FROM TOLERANCE t
WHERE t.LAYER_NAME = 'LFP3' AND t.TOLERANCELEVEL =
(select tl.ART from Toleranzlevel tl where SDO_RELATE(tl.geom,
MDSYS.SDO_GEOMETRY(2001, NULL, MDSYS.SDO_POINT_TYPE({0},{1},NULL),
 NULL, NULL), 'mask=ANYINTERACT')= 'TRUE'
```

This select statement uses a table that defines the tolerances for field codes (LAYER_NAME) and tolerance level (TOLERANCELEVEL). The inner select is a spatial intersection to find out the tolerance level of the position. To simplify the select statement, replace the inner select with a static tolerance level.

Adding Field Codes

You use the Field Code List Manager to a add field code and its rules for calculation and distribution.

NOTE For each field code, you can add one definition in the Calculation tab. However, in the Distribution tab, you can add multiple definitions rows. For example, for field code 1 you add one row in the Calculation tab, and you add three rows in the Distribution tab, to distribute the point to multiple documents.

To add a field code

1. Start the Field Code List Manager.
2. Select the field code list.
3. In the Field Code group box, click the Calculation tab.

4 Click Add.

5 Enter the properties and rules for the calculation. See Field Code Settings for Calculation (page 84).

6 In the Field Code group box, click the Distribution tab.

7 Click Add.

8 Enter the properties for the distribution. See Field Code Settings for Distribution (page 86).

Settings to Find Existing Points

During calculation, you search for base points and detail points that are already stored in the database. The Field Code List specifies the search rules for existing points. You can either find existing points by identifier, such as the point number, or by position. You configure the search using the options on the Calculation tab.

NOTE The existing point feature classes must have the following default attributes: TB_POINTNUMBER, TB_ACCURACY_POSITION, TB_ACCURACY_HEIGHT, TB_RELIABILITY_POSITION, TB_POSITION_RELIABLE, TB_RELIABILITY_HEIGHT, TB_HEIGHT_RELIABLE. See also Storing the Adjustment Results (page 82).

To define the search rules for reference points, or detail points

1 In the Manage Field Code List dialog box, click the Calculation tab.

2 Select the field code. For each field code that you want to include in the search, select one or more of the following:

- **Existing**—Select Existing, if you want to include the feature class into the search.
- **Identifier**—Select Identifier, if you want to find existing points by point number.
- **Position**—Select Position, if you want to find existing points by position.
  Tolerance—Enter a tolerance that specifies the search radius.

For example, if a field code has multiple definition rows, you can select the one that is stored in your land management database.

See also:

- Find Reference Points (page 33)
- Find Existing Points (page 40)

Settings to Find Identical Points

During calculation, you identify points that have been measured more then once, for example from different stations. The Field Code List specifies the search rules for identical points. You can either find identical points by identifier, such as the point number, or by position. You configure the search using the options on the Calculation tab. For each field code you can specify whether to include the point in the search.

To define the search rules for identical points

1. In the Manage Field Code List dialog box, click the Calculation tab.
2. Select the field code. For each field code that you want to include in the search, select one or more of the following:
   - **Identical**—Select Identical, if you want to include the feature class into the search.
   - **Identifier**—Select Identifier, if you want to find identical points by point number.
   - **Position**—Select Position, if you want to find identical points by position.
     Tolerance—Enter a tolerance that specifies the search radius.

For example, when you search by point number, and two points with the same point number are found with the tolerance exceeded, a dialog box alerts you. See Critical Identical Point (page 39). When two points with the same point number are found, that lie within the tolerance, one of the points will be removed from the Coordinate - New Points tab. That means, only the remaining point will be introduced as unknown point to the adjustment. However the adjustment calculation will use all measurements to determine the final coordinates.

See also:

- Different Field Code (page 38)

- Find Identical Points (page 36)

Supported File Formats

You can import field measurements from the following file formats. See Import Measurements (page 26)

- CPlan RO: File format used by previous Topobase versions, supports polar mapping, coordinate transformation, and control distances.
- GSI 8 / GSI 16: File format used by previous Topobase versions.

IMPORTANT Any other input formats can be added by PlugIns (see Topobase API documentation).

Survey File Formats - Examples

Leica GSI formats

The supported GSI file formats are based on the Leica GSI specification, and contain user defined parameters. The code lines must follow the measurement lines.

Leica GSI 16

```
*410000+0000000000070403 42....+0000000000001400
43....+0000000000000001 44....+0000000000000011
45....+0000000000001600 <EOL>
*410000+0000000000003432 42....+0000000000002238
43....+0000000000000002 44....+0000000000000015
45....+0000000000000950 <EOL>
```

Leica GSI 8

```
410001+00130027 42....+00001810 43....+00000010 44....+00000019
45....+00000000 <EOL>
110002+00130021 21.102+19723700 22.102+10000000 31..00+00045179
51....+0000+000 <EOL>
410003+00000012 42....+00001810 43....+00000013 <EOL>
```

CPlan RO format

```
*234567890123456789012345678901234567890123456789012345678901234567890123456789
***=-----------------------------------------------------------------
------=-------- <EOL>
*   Tachymet
er                                                              !
 <EOL>
***>---------=---------=-----=----------=----------=--------=--
------+         <EOL>
*  !  ST/AP  !    NP   ! FC  !  zh/lv/qv !  Distance! Hz-Angle! V-
Angle!         <EOL>
*  >---------+---------+-----+----------+----------+--------+--
------<         <EOL>
 ST:23340015 !        :12   !  ih:1.5   !     dc:2 !       !   hc:2 !
 <EOL>
 AP:23340030 !        !12   !          :300.027    :.242    :99.2955 !
 <EOL>
 AP:23340034 !        !12   !          :183.928    :80.054  :99.5431 !
 <EOL>
 NP!         : 2234323 :10   !           :17.305     :137.625 :101.655
 !          <EOL>
 NP!        : 2225327 :10   !          :79.41      :84.444  :98.14   !
 <EOL>
 NP!          : 2223458 :10   !  lv -
.85  :112.032    :69.669  :99.818  !         <EOL>
***>---------=---------=---=-=----------=----------=--------=--
------+-------- <EOL>
*  ! GPS / Transforma
tion                                                          ! <EOL>
***>---------=---------=----------------=----------=----------
------+         <EOL>
*  !         ! Ident   ! FC! ! Easting   ! North
ing  !        ! Height !         <EOL>
***>---------+---------+---+-+----------+----------+--------+--
------!         <EOL>
 K
!        !   423107! 10!3! 495462.812! 391220.658!       !       !
 <EOL>
 K
!        !   583028! 10!3! 495439.080! 391229.600!       !       !
 <EOL>
 K
!        !   583029! 10!3! 495459.861! 391235.422!       !       !
 <EOL>
```

```
***=------------------------------------------------------------
-------=         <EOL>
*  ! Control Dis
tance                                                        !
<EOL>
***>---------=---------=-----------------=-----------=-----------
------+         <EOL>
*  ! Ident A ! Ident B !                  !  dis
tance ! FC A! FC B!     !          <EOL>
***>---------+---------+-----------------+-----------+-----+-----
+-----!         <EOL>
 KO:  5001   !  5003   :              !  27.34    !  1  !  1  !    !
 <EOL>
 KO:  5002   !  5011   :              !  123.56   !  1  !  1  !    !
 <EOL>
```

key (position)	description
* (1)	Indicates a comment line.
	Lines have 80 characters.
ST (2-3)	station, base point
FS (2-3)	free station, new base point
AP (2-3)	connecting point (base point, face 1)
A2 (2-3)	connecting point (base point, face 2)
NP (2-3)	new detail point, face 1
N2 (2-3)	new detail point, face 2
K (2-3)	point coordinates (transformation, GPS)
	See also Storing the Measurements (page 32).
KO (2-3)	Indicates a control distance measurement.

Getting Started: Introducing Topobase Survey

2

Understanding the Topobase Survey Concept

This section introduces the key concepts and features of the Topobase survey module.

Import - Calculate - Analyze - Distribute

Topobase Survey provides tools to process field measurements. The basic workflow comprises:

- Import of the field measurements
- Calculation of the coordinates, based on Least Squares Adjustment. The coordinates are stored in a separate Survey database.
- Analysis of the results.
- Distribution of the coordinates, that means transfer from the Survey database to the appropriate GIS databases.

Field Code

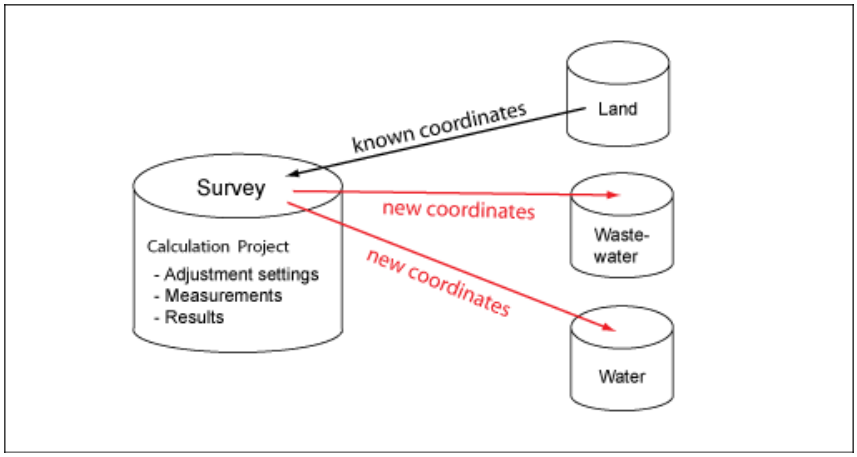
In the field, you use field codes to distinguish the points that you measure. The field code specifies how the point is integrated into the calculation process, and in what database schema and feature class the calculated point will be stored. For example, field code 10 represents a control point, field code 21 represents

a building corner, and field code 41 represents a manhole. The field code is an alphanumeric value with a maximum of 64 characters.

Field Code List

You use field code lists to map the measured points to Topobase feature classes. For example, you map field code 41 to the manhole feature class (WW_MANHOLE) in the wastewater database. Topobase supports multiple field code lists. You can define different global field code lists, such as one for Basic Survey, and one for Topographic Survey. When you create a project, you select the appropriate field code list.

Survey Database



Topobase Survey stores measurements, calculation settings, and results in a separate database schema. Control points that are needed for the adjustment calculation can be stored in any document on the server. Also, you can distribute the new coordinates to any document on the server.

Survey Workspace

When you use Topobase Survey, you need a workspace that contains the Survey database, the documents that store the connecting points, and the documents where the new points will be distributed to.

Calculation Project

A Calculation Project stores measurements and settings for one adjustment calculation. You import all measurements that shall be processed in one

adjustment into one calculation project. You can combine measurements from different instruments in one calculation project, such as GPS and tachymeter measurements.

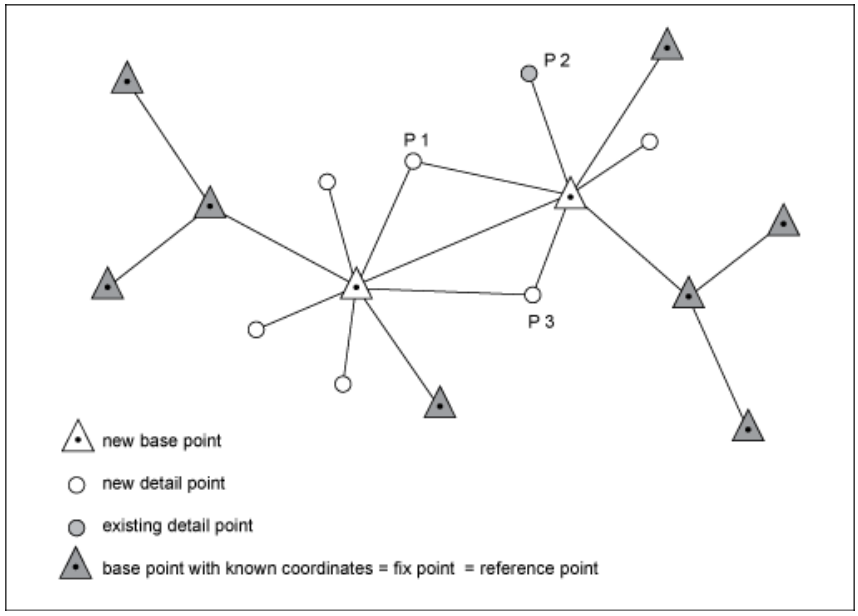
Session

A session is a set of measurements that has been imported into a calculation project. A session can be of type GPS, or of type Tachymeter. For coordinates, each import file is assigned to a GPS session. For coordinate transformation, for each session you can determine the transformation parameters separately.

For tachymeter files, each station is assigned to a Tachymeter session. A session groups observations that have been made under the same conditions, such as a GPS session, or a tachymeter station.

Base Points and Detail Points

In field measurements, you distinguish between two types of points, base points and detail points. In the measurement files, the points are either classified as base point or as detail point.



Base point—Geodetic point such as control station, connecting point, or geodetic network point. Base points are either points with known coordinates that are stored in the database (fix point), or they are new points, such as a free station.

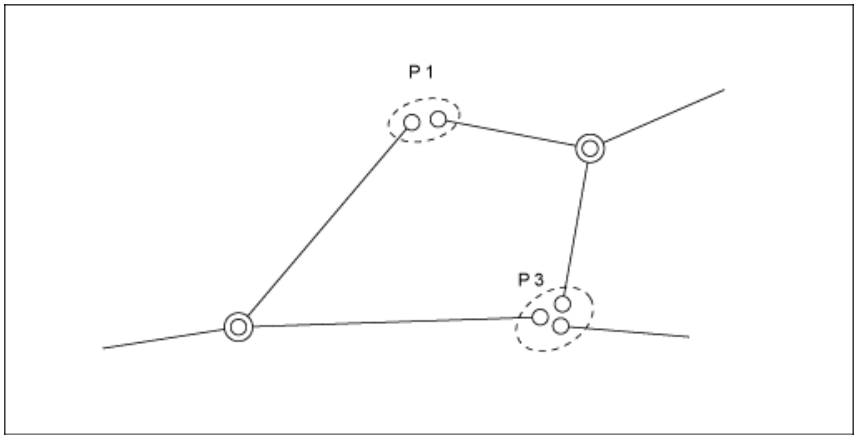
Detail point—Measured point, that determines the location of a real world object, such as building corner, manhole, or border point. Other than base points they are not used as station, and they are not part of the geodetic network.

Reference Points and Existing Detail Points

Reference point—Fix point that is stored in the database. Before you start the adjustment calculation, for each base point, you search a reference point in the database. Base points that have no reference in the database are introduced as new points in the adjustment process.

Existing detail point—Detail point that is stored in the database. Before you start the adjustment calculation, you optionally search existing detail points. For example, if you have measured a detail point once again to improve or validate the coordinates, and you want to add the existing point to the adjustment process.

Identical Points



You normally measure detail points more then once. For example, you measure a detail point from different stations, so that the measurement is well controlled (over determination). Identical points are detail points that have been measured several times. For the adjustment process, identical points are merged, and introduced as one unknown new detail point.

Moveable Points

Moveable points are either detail points or fix points that are already stored in the database. Moveable points have known coordinates that are introduced

to the adjustment process as observation. Introducing moveable points will fit the new points well into the local situation.

Distributed Points

After the calculation, you distribute the new points that are stored in the Survey database to their target documents. You can distribute one point to multiple documents, and to multiple feature classes, according to the distribution rules that are specified in the field code list.

Starting Topobase Survey

To start Topobase Survey you must have a workspace with access to an Oracle® database containing the Survey database. Also, make sure that the documents that contain the connecting points, and the target documents for the new points are included in the workspace.

To start Topobase Survey

1. Start Topobase Client.
2. Open the workspace, such as Topobase Survey.
3. Click Tools tab ➤ Survey panel ➤ Survey.
4. Click Project ➤ Manage.
5. In the Manage Projects dialog box, select the calculation project.
6. In Topobase Client, click Home tab ➤ Display panel ➤ Open Display Model. Select a Survey display model. Click Generate Graphic.

Alternatively, start Topobase Survey from the Map 3D command line. Command entry: TBSURVEY.

To start Topobase Survey (Standalone Topobase Client)

1. Start Standalone Topobase Client.
2. In the Topobase Login dialog box, enter a user name and password.
3. Open the workspace.
4. On the document main toolbar, click Topobase Survey  .

Topobase Survey runs in a separate window. See Basic Handling (page 102).

Using the Survey Demo Data Set

You can start with the Survey demo data set to get an overview. See also Exploring the Sample Calculation Project (page 103).

Basic Handling

The Topobase Survey main window consists of the following components.

- **Task Overview pane**—Provides the links that are available/appropriate at the current stage of the workflow. If you are in a calculation project, it provides access to the measurements, coordinates, and results.
- **Navigation bar**—At the bottom of the window, provides buttons to start the steps of the default workflow, Back, Next, Finish. When the current step is done, the Next button is activated. Press <RETURN>, or click Next to continue.
- **Task area**—Task related area containing information and input for the current step. Changes appropriately depending on the stage of workflow. For each calculation step, the task area provides a start button, and optionally more areas, such as Configuration, Options, Attributes, Information.

To get familiar with the Survey UI

1. Start Topobase Survey.
2. On the Task Overview, click  or  to show or hide the Task Overview.
3. On the Task Overview, click the Project Group link, and in the task area, select a project group.
4. On the navigation bar, click Next. Select a project.
5. On the navigation bar, click Next. Select a calculation project.
6. When the Calculation Project is selected, the Calculation Wizard is active.

   For new calculation projects, only the first link to start the first step is activated.

For existing calculation projects, the links to all steps that have already been executed, are activated.

7 Click Next. The task area displays information and options for the first calculation step.

8 Use the buttons  , and  , to display or hide more options.

Exploring the Sample Calculation Project

You can start with the Survey demo data set to get an overview. The demo data set provides a calculation project where step 7, Calculate Adjustment has been finished. The calculation project combines tachymeter and GPS measurements. To learn about the calculation steps, you can copy the calculation project, and restart at step 3, Find Existing Points.

To use the Survey demo data set

1 Create a workspace, such as Topobase Survey, and import the demo data set <topobase_administrator>\Template\Modules\Survey\Dump.

2 Copy the Display Model files from the <default display model repository>\Modules\Survey* to your display model repository.

3 Start Topobase Survey, and copy the sample calculation project.

To copy the sample calculation project

If you have imported the Survey demo data set, you can create a copy of the sample calculation project.

1 Start Topobase Survey.

2 In the Survey main window, click Project ➤ Manage.

3 Select Project Group LM City, and Project Job 1 City.

4 Under Calculation Project, select Calculation 1. Click  Copy.

5 Select Copy Of Calculation 1, and click  Edit. Edit the name, and enter a new name such as Example Tachymeter And GPS.

6 Click Close.

7 In Topobase Client, click Home tab ➤ Display panel ➤ Open Display Model.

8 Select the Survey display model. Click Generate Graphic.

To view the field code list

1 In the Survey main window, click Project ➤ Manage.

2 In the Manage Projects dialog box, click  to expand the Field Code List area.

3 In the Field Code List area, on the Calculation tab, the field codes 11, 12, 15, and 19 specify the fix points.

4 Click Close.

To view the imported files, and the measurements

1 In the Survey main window, on the Task Overview, click the Import Measurements link.

2 In the task area, click the Show Imported Files link. Click Close.

3 On the Task Overview, click  Measurement.

4 In the Measurement dialog box, click the Tachymeter tab, and select a station. Notice, that 3 stations have been measured.

5 On the Measurement Data tab, notice the Point Type. The point type has been determined during the import. Be aware of the difference between Base Points and Fix Points, see Measurement - Point Types (page 29).

6 Click the Transformation tab, and select a GPS session. Notice, that 4 GPS sessions have been measured.

7 On the Measurement Data tab, notice the Point Type. There are points with field code 11 = fix point, that have been measured as Detail Point. These are new base points that are being determined in the current adjustment calculation. Be aware of the difference between Base Points and Fix Points, see Measurement - Point Types (page 29).

8 Click Close.

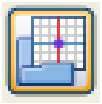
See also Calculation Wizard, Import Measurements (page 26).

To restart the calculation

1 In the Survey main window, on the Task Overview, click the Find Reference Points link. Click Find.

2 The No Reference Point Found dialog box lists three base points without reference. Click the Show Message link.

3 No messages, this indicates that the 3 points are to be determined during the calculation. Click Close.

4 On the Task Overview, click  Coordinate. The Planimetry Fix Point tab displays the base points that have a reference point. The Planimetry New Points tab displays the points that will be determined in the adjustment calculation, amongst them the base points without reference points. Click Close.

5 Click Next. In the Calculate Approximation area, click Calculate. Click the Show Message link. Click Close.

6 Click Next. In the Find Identical Points area, click Find. If points exceed the tolerance. close the message box.

7 Click Next. In the Calculate Adjustment area, click Calculate.

Working With the Data Grid

Topobase Survey displays measurements, coordinates, results, and messages in a data grid.

To view the measurement data grid

Use the icons in the Task Overview, or the links in the Calculation wizard. Or use the Calculation Project menu.

To sort the data

Click the column heading to sort the rows.

To copy a value

To copy a value (not a complete row), select the value, right-click, and click Copy.

To adjust the column width

Click the separator between the column headings, and drag to adjust the column width.

To process the data

You use shortcut menus to process the data. In the data grid, select a row, right-click and click the command. See also Detecting Measurement Errors (page 107) and Moveable Points (page 64).

For administrators

To format the display unit

At any time you can modify the display unit. This change applies to all users, and is stored per document, in the Survey database. It does not affect the document units, or the measurement units.

1. Right-click the column heading.
2. Click Format Column.
3. Select the number of decimals.
4. Select the unit, and click OK.

See also Working With Units (page 19).

Modifying Measurements

After the import, the measurements are stored in the Survey database. At any stage of the calculation process, you can modify the measurements. For example, you remove an incorrect observation from the calculation.

To edit the measurements

1. Open the Measurement dialog box. For example, on the Task Overview, click the Measurement icon.
2. Select the station or the session.
3. Click the value to modify. A messages alerts you that after the modification you must restart the calculation.
4. Click Yes, and edit the value.

When you edit the measurements, the calculation project is no longer consistent, and you must calculate the project again, starting with calculation step 3, Find Reference Points. The Calculation wizard automatically steps back to this step. See also Find Reference Points (page 33)

Checking Messages

At any stage of the calculation process you can check messages.

To check messages

1. In the Survey main window, click Calculation Project menu ➤ Messages.
2. In the Messages dialog box, right-click a row, and select a command.

See also:

- Calculation Wizard Messages (page 43)

Detecting Measurement Errors

After the adjustment calculation, the measurement results are stored in the Survey database. For each observation, you can display the station, or display the point in the map.

To analyze the measurement results

1. Open the Result dialog box. For example, on the Task Overview, click the Result icon.
2. Click the Measurement Results tab.
3. For example, to find a possible gross error, click the Wi heading to sort by the measurements with the greatest Wi values. See also Normalized Residual Error Wi (page 74).
4. Right-click a measurement row, and click Show In Graphic. The point is highlighted in the map.
5. Right-click a measurement row, and click Show Station. The Measurement dialog box opens, and displays the station where the measurement has been taken.

Measurement results shortcut menus	Description
Show Station	Opens the Measurement dialog box, and shows the station or the session of the selected observation.
Show Graphic	Highlights the selected measurement in the drawing. This command is active only if you have created the network plan.
New Selection	Creates a filter. For example, select multiple rows, and click New Selection to display the selected rows.
Selected Measures Filter Active	Indicates that a filter is being used. Clear this option to display all records again.

See also:

- Result (page 65)

Administrator Tasks

This section for Topobase administrators shows how to setup up and configure the Survey database, so that Topobase Client users can start importing and processing the field data.

Creating the Survey Database

Topobase Survey stores measurements, calculation settings, and results in a separate database schema. You use Topobase Administrator to create the Survey database.

Survey Database

We recommend that you use one separate Survey database to store the all your survey projects and measurements. After the calculation and analysis of the results you will transfer the new points to their target documents. See also Survey Database (page 98).

Workspaces for Survey

We recommend that you create workspaces that contain both the Survey database and the target documents. For example, the Land document stores the basic data, such as connecting points and parcels. The Wastewater document stores the wastewater network. To process measurements, create a workspace that contains the Survey database, and the Land and Wastewater document.

Also, in the field code list, if you use placeholders, you can only replace the placeholders with the documents that are available in the current workspace. See Fill Document (page 7).

To create a Survey Database

1. Start Topobase Administrator.
2. Click Workspace ➤ New.
3. Enter a workspace name, such as Topobase Survey. Click Create.
4. Under Documents, click New.
5. In the Create Document dialog box, on the General tab, enter the document name, and the Database settings.
6. Click the Units tab, and enter the document units for length, angle, temperature, and pressure. See also Working With Units (page 19).
7. Click the Modules tab, and select Survey Module.
8. Click OK.

Managing additional base points and detail points

As an exception, you can use reference points from documents that are not part of your current workspace. For example, if you administer your documents by municipality, but want to reference points from other municipalities that are not part of your current workspace. We recommend that you only use additional points, if you need to reference a small number of points from separate documents. Keep in mind that these points are just a copy of the current state, and that the points are maintained in their own documents.

To use additional base points and detail points

You store the additional points in the survey database, in the system tables Basepoint (TB_SUR_BASEPOINT), and Detailpoint (TB_SUR_DETAILPOINT).

- Use the Topobase Coordinate Export to export additional points.
- Use the Topobase Coordinate Import to import the points into your survey database.
- To view the additional points, click Calculation Project menu ➤ Manage Additional Basepoints, and Project menu ➤ Manage Additional Detailpoints.

Configuring Survey Projects

After the creation of the Survey database, you use Topobase Survey to configure the database.

To configure the Survey database

Use Global Settings to define default values, display units and formats.

1. Start Topobase Survey.
2. Click Settings ➤ Global Settings.
3. On each tab, check the predefined values. See also Global Survey Settings (page 15).

To set up instruments

Use the Instrument Manager to set up the instruments that are used by your field crew to collect the measurement data. For example, set up several

tachymeters with different precision. To process GPS data, or coordinates, set up an instrument of type GPS.

1 Start Topobase Survey.

2 Click Settings ➤ Instrument Manager.

3 Under Instrument, click Create Instrument  .

4 In the Create Instrument dialog box, enter a name, such as Tachymeter TM1200.

5 Under Instrument Type, select Tachymeter.

6 Click Create.

7 Under Settings, define the Tachymeter Settings.

8 See also Instrument Manager (page 9)

To process control distances, specify the Default Control Distance Settings in the Global Survey Settings (page 15).

To set up an operator

Use the Operator Manager to set up at least one operator.

1 Start Topobase Survey.

2 Click Settings ➤ Operator Manager.

3 See Operator Manager (page 13)

To create the field code list

Use the Field Code List Manager to create a list that lists all field codes that are used in the measurements. For each field code, you specify the document and the feature class that stores the point as well as search rules to find existing points in the database.

The following steps add a field code for a control manhole that has been measured with field code 41.

1 Start Topobase Survey.

2 Click Settings ➤ Field Code List Manager.

3 In the Manager Field Code List dialog box, under Field Code List, click Create Field Code List  .

4 In the Create Field Code List dialog box, enter a name, such as Topographic Survey.

5 Under Field Code, click the Calculation tab, and click Add.

6 In the New Field Code Calculation dialog box, enter the following values, for example:

- Field Code: 41.
- Document Placeholder: Enter the placeholder for the document, such as {WASTEWATER}.
- Feature Class: WW_MANHOLE
- Identical Point Search: Select this option to enable the search for points that have been measured more than once. Configure the search by selecting one of the following. If you use point numbers to identify a point, select Identifier. Select Position, and enter a tolerance, to find identical points by location.
- Existing Point Search: Select this option to enable the search for existing points.

7 Click Add.

8 Under Field Code, click the Distribution tab, and click Add.

9 In the New Field Code Distribution dialog box, enter the following values, for example:

- Field Code: For example 41.
- Tolerances: Enter the limit values for precision and reliability that must not be exceeded for points in order to be stored as reliable points (TB_POSITION_RELIABLE is True). *Tolerance/0.15/0.25/0.15/0.25*
- Rule Name: Enter a descriptive name such as Manhole.
- Document Placeholder: Enter the placeholder for the target document, such as {WASTEWATER}.
- Feature Class: WW_MANHOLE.

- Keep Identifier: Select this option to store the identifier in the point number attribute of the target feature class.
- Update Position: For existing and for moveable points, select this option to replace the existing coordinates.
- Attribute 1: Select the feature class attribute to be stored, such as ID_FUNCTION.
- Value 1: Select the value to be stored, such as 2 for a control manhole.

10 Add another definition, if you want to distribute the point to another document.

11 Click Save.

See also Field Code Settings for Calculation (page 84) and Field Code Settings for Distribution (page 86).

To set up a project

Use the Project Manager to create at least one project group and one project, and to assign the field code list to the project.

1 Start Topobase Survey.

2 Click Project ➤ Manage.

3 In the Manage Projects dialog box, under Project Group, click Create  .

4 In the Create Project Group dialog box, enter a name, such as Survey Projects, and click Create.

5 In the Manage Projects dialog box, under Project, click Create  .

6 In the Create Project dialog box, enter the Project Name, such as Wastewater.

7 Under Field Code List, select the field code list to e be used in the project.

8 Click the Calculation tab, and click Fill Document.

9 In the Fill Document dialog box, for each row, click the Document input field, and select the document.

10 Click Fill, and click Close.

Now the Survey database is ready for your calculation projects. In one project, you can create multiple Calculation Projects, where each calculation project contains the measurements that are processed in one adjustment calculation. You use the Calculation Wizard to process your field measurements. See Survey Calculation Wizard (page 22).

Processing Field Data

This section for surveyors shows how to process field measurements.

Processing Polar Mapping

For this task you use the Calculation wizard to process polar mapping data. You import tachymeter measurements of 4 stations, one of which is a free station. The import files are Cplan Ro files.

Requirements

- The Survey database is configured, see Configuring Survey Projects (page 110)
- The coordinates of the connecting points/base points are stored in the database.
- Instrument of type Tachymeter, representing the precision and type of the measurements.
- Field code list containing the field codes of all target points that have been shot in the measurements.

Creating the Calculation Project

1 Start Topobase Survey.

2 Select the Project Group, and the Project that has the field code list assigned.

3 Under Select A Calculation Project, click  Manage Calculation Project.

4 Under Calculation Project, click  Create.

5 In the Create Calculation Project dialog box, enter a name, such as Polar Mapping Example 1, and enter a description, such as Polar Mapping and Free Station.

6 Click Create, and click Close.

7 In the Survey main window, click Next.

Step 1, Calculation Project Settings

1 Under Options, select Calculate, and select Reduce Distance.

2 Under Reduction, Module, select Specific Reduction. Under Reference Frame, select CH1903.

3 Click  to display the Advanced Options. Do not modify the default values.

4 Click Next.

See Calculation Project Settings (page 23)

Step 2, Import Measurements

1 Under File Data Source, File Format, select Cplan RO.

2 Under Files To Import, click Add, and browse for the file (*.*RO*).

3 In the file list, select the file, and click Edit to display the measurement data in your default editor. Close the editor.

4 Under Attributes, enter a field date, and an operator.

5 Select the instrument, such as <tachymeter name>.

6 Click Import.

7 Click the Show Measurement link to open the Measurement dialog box.

8 In the Measurement dialog box, on the Tachymeter tab, select a station, such as <station number>. Under Station, Parameter, the instrument properties are displayed. The Measurement Data tab displays the measurements as stored in the Survey database. For example, for each measurement, check the standard deviation that have been determined from the instrument settings. See also Measurement - Tachymeter (page 50)

9 In the Measurement dialog box, click Close.

10 In the Survey main window, click the Show Imported Files link. The Imported Filed dialog box displays all files that have been imported into the calculation project. Click Close.

11 In the Survey main window, click Next.

See also Import Measurements (page 26).

Step 3, Find Reference Points

Step 3, Find Reference Points, provides information that helps you to detect possible errors, such as missing base points, field coding errors, or point number typos.

1 Under Find Reference Points, click Find.

2 A message alerts about the base points that have no reference point. For example, if your measurements include a free station, no reference point can be found. In this case, you can continue, because the coordinates will be determined in the adjustment calculation.

3 In the No Reference Point Found dialog box, click the Show Message link. If no messages are listed, the point that is listed is a free station. Click Close.

4 Click Close.

5 Under Information, click the Show Coordinate link. The Coordinate dialog box displays the reference points. The Planimetry Fix Point tab displays the existing base points. The Planimetry New Point tab displays the new detail points, including the base point of the free station.

6 In the Coordinate dialog box, click Close.

7 Click Next.

See also Find Reference Points (page 33).

Step 4, Calculate Approximation

In step 4, you can detect measurement errors, such as missing observations.

1. Under Calculate Approximation, click Calculate.
2. Under Information, click the Show Message link. See also Calculation Wizard Messages (page 43). Close the Messages dialog box.
3. Under Information, click the Show Coordinate link to open the Coordinate dialog box.
4. Click the Planimetry New Points tab. The tab displays the approximate coordinates of the each measured point.
5. In the data grid, click the Identifier heading to sort the points by their point number. Note, that some points have been measured twice, and that approximate coordinates have been calculated for each point.
6. Click Close.
7. Click Next.

Step 5, Find Identical Points

1. Under Find Identical Points, click Find.
2. Under Information, click the Show Coordinate link.
3. Click the Planimetry New Points tab. The tab displays the approximate coordinates of the new points.
4. In the data grid, click the Identifier heading to sort the points by their point number. All point numbers are unique. Double measurements have been merged. Click Close.
5. Click Next.

At this stage of the calculation process, the unknowns of the adjustment calculation are specified.

Notice that by default, step 6, Find Existing Points is skipped, and the Calculation wizard continues with step 7, Calculate Adjustment.

See also Find Identical Points (page 36)

Step 7, Calculate Adjustment

1. Under Calculate Adjustment, click Calculate.

2 Under Information, click the Calculate Indicators link.

See also Analyzing Precision and Reliability (page 70).

Create Network Plan

1 On the Task Overview, click Create Network Plan.

2 In the task area, click Create.

See also Create The Network Plan (page 43).

Distribute Coordinates

1 On the Task Overview, click Distribute Coordinates.

2 In the task area, click Distribute.

3 In the Distribute Coordinate dialog box, you configure the distribution.

See also Configuring the Distribution (page 80).

Create Reports

1 On the Task Overview, click Generate Reports.

2 In the task area, select a report, and click Generate.

See also Generate Survey Reports (page 43).

Processing GPS Measurements

For this task you use the Calculation wizard to process coordinates measurements. You import the GPS sessions to the Survey database, and transform the new coordinates to the existing network.

Requirements

- The Survey database is configured, see Configuring Survey Projects (page 110)
- The coordinates of the connecting points/base points are stored in the database.
- Instrument of type GPS, representing the coordinate precision.

- Field code list containing the field codes of all points that have been measured.

Creating the Calculation Project

1. Start Topobase Survey.
2. Select the Project Group, and the Project.
3. Under Select A Calculation Project, click  Manage Calculation Project.
4. Under Calculation Project, click  Create.
5. In the Create Calculation Project dialog box, enter a name, such as GPS Example 1, and enter a description, such as GPS Measurements.
6. Click Create, and click Close.
7. In the Survey main window, click Next.

Step 1, Calculation Project Settings

1. Click  to display the Advanced Options. Do not modify the default values.
2. Click Next.

Step 2, Import Measurements

1. Under File Data Source, File Format, select Cplan RO.
2. Under Files To Import, click Add, and browse for the files (*.*RO*).
3. In the file list, select the GPS coordinate files.
4. Under Attributes, enter a field date, and an operator.
5. Select the instrument, such as <GPS name>.
6. Click Import.

7 Click the Show Measurement link to open the Measurement dialog box.

8 In the Measurement dialog box, on the Transformation tab, select a session, such as <GPS 1>. Click  to show the transformation parameters.

9 On the Transformation Planimetry tab, you select the transformation parameters to be used. See also Transformation Parameters (page 58). The default settings are for a Helmert transformation, as shown in the following list.

- Delta Easting: New.
- Delta Northing: New.
- Rotation 1: New.
- Rotation 2: No.
- Scale Easting: New.
- Scale Northing: No.

10 In the Measurement dialog box, click Close.

11 In the Survey main window, click the Show Imported Files link. The Imported Filed dialog box displays all files that have been imported into the calculation project. Click Close.

12 In the Survey main window, click Next.

Step 3, Find Reference Points

Step 3, Find Reference Points, provides information that helps you to detect possible errors, such as missing base points, field coding errors, or point number typos.

1 Under Find Reference Points, click Find.

2 Under Information, click the Show Coordinate link. The Coordinate dialog box displays the reference points. The Planimetry Fix Point tab displays the existing base points. The Planimetry New Point tab displays the detail points that will be transformed.

3 In the Coordinate dialog box, click Close.

4 Click Next.

Step 4, Calculate Approximation

1. Under Calculate Approximation, click Calculate.
2. Under Information, click the Show Message link. Close the Messages dialog box.
3. Under Information, click the Show Coordinate link to open the Coordinate dialog box.
4. Click the Planimetry New Points tab. The tab displays the approximate coordinates of the each measured point.
5. In the data grid, click the Identifier heading to sort the points by their point number. Note, that some points have been measured several times, and that approximate coordinates have been calculated for each point.
6. Click Close.
7. Click Next.

Step 5, Find Identical Points

1. Under Find Identical Points, click Find.
2. Under Information, click the Show Coordinate link.
3. Click the Planimetry New Points tab. The tab displays the approximate coordinates of the new points.
4. In the data grid, click the Identifier heading to sort the points by their point number. All point numbers are unique. Double measurements have been merged. Click Close.
5. Click Next.

Notice that by default, step 6, Find Existing Points is skipped, and the Calculation wizard continues with step 7, Calculate Adjustment.

See also Find Identical Points (page 36)

Step 7, Calculate Adjustment

1. Under Calculate Adjustment, click Calculate.
2. Under Information, click the Calculate Indicators link.

See also Analyzing Precision and Reliability (page 70).

Calculating Base Points and Detail Points in one Calculation Project

In some cases your field measurements contain both new detail points and new base points. You can import all measurements into one calculation project, however you can calculate both types of points separately. Doing this, you make sure that the detail point measurements do not impact base point calculation.

To calculate detail points and base points separately

- Import all measurements into one calculation project (page 8).
- In the Calculation Wizard, before starting step 3, Find Reference Points (page 33), deactivate the detail points.
- Continue with the calculation process: calculate, review results, apply corrections, recalculate, and distribute the base points.
- Copy the calculation project and continue to calculate the detail points.
  - Select the copy of the project.
  - In the Calculation Wizard, on the Task Overview, click step 3, Find Reference Points.
  - Activate the detail points. Your new base points will now be used as fix points.
- Continue the process: calculate, review results, apply corrections, recalculate, and distribute the detail points.

Processing Control Distance Measurements

You use the Calculation wizard to process control distance measurements. The control distance calculation is part of the calculation workflow, and will be performed during step 7, Calculate Adjustment.

Requirements

- The Survey database is configured, see Configuring Survey Projects (page 110).

- If you want to select the points in the map: Generate Graphic has been performed.

To process control distance measurements (Enter control distances manually)

After you have completed calculation step 5, Find Identical Points, you enter the control distance measurements.

1. On the Task Overview, click  Measurement.
2. In the Measurement dialog box, click the Control Distance tab.
3. Enter the fault section (FS) threshold.
4. Select the Operator.
5. In the data grid, on the Measure Data tab, for each control distance, enter the identifiers, the field codes, and the measured distance.

   You can change the order of the start point and the end point as you like.

   Alternatively, click Add From Map, to select the points in the map.
6. Click Save, and continue with step 7, Calculate Adjustment.
7. To review the results, on the Task Overview, click Result.
8. In the Result dialog box, click the Measurement Results tab. For each measurement, the CD column displays the result of the control distance calculation.
9. Click the Calculated Coordinates tab. For each point, the CD column displays the result of the control distance calculation.

See also Control Distance Measurements (page 45)

When you enter the control distances, the system validates your input. Notice that some validations takes place immediately, and other validations will be performed when you finish your entries by clicking another row. Either case, a warning icon appears. Hover over the icon, and read the tooltip for more details.

- You can only enter new detail points of the current calculation project.
- You cannot enter two fix point numbers.

Glossary

area topology Description of spatial relationship between geographic area features. Area topologies contain line strings and centroids. In Topobase™, the polygons are generated automatically from the surrounding line strings. Examples of area topologies are parcels, land use, land cover and political boundaries. See also Topology.

centroid A point that indicates a polygon (approximately in the center). In Topobase, centroids are part of area topologies and belong to the surrounding edges (line string feature class). The centroid normally holds the polygon's attribute data. See also Area Topology.

COGO Abbreviation for Coordinate Geometry. COGO functionality provides calculation routines, such as for intersection, projection, orthogonal survey, offset lines, and right angle course.

Display Manager For stylization in Autodesk Map 3D, applies custom styles to selected features and objects. To view the Display Manager task, select Display Manager in the list at the top of the Task Pane. Also used for stylization of Topobase features.

display model In Topobase, you use display models to administer thematic views. A display model definition specifies which set of layer files (feature layers) is loaded into the Display Manager. Also, the display model defines multi map windows and autoload layers.

display model repository Central location on your file system or on a shared network to store the display model files (**.tbdm, *.tbdmmap, *.LAYER, *.DWG*).

Autodesk provides a default display model repository <default display model repository> containing the display models for the demo data sets, and the extensions.

document In Topobase, a document is an Oracle® database schema with additional settings in the Topobase System user (database server schema TBSYS). A document is an Oracle database user plus settings for menu bars, toolbars and forms. A document must be assigned to a workspace to be accessible by

Topobase Client or Topobase Web. You can create, edit, and configure the documents using the Topobase Administrator.

document explorer Control element in the Topobase Client task pane and in the Topobase Web layout. Use the tree view to show the objects that are stored in the database. For different requirements and more clarity these objects can be grouped into explorer groups. Provides a document-specific view to process the following objects: Topics (and feature classes), domains, topologies, intersections, system tables, and workflows. You can define a different document explorers for each document. Also called Topobase explorer.

domain Sets of values. For example, a domain defines the values that are allowed for a feature attribute. Topobase data models store domains in domain tables (*****_*TBD*). Domain tables are created using the Topobase data model administrator.

explorer group In Topobase Administrator, a configuration that specifies which objects are to be shown in the document explorer. These settings are saved as Explorer Groups.

feature In Topobase, an entity of a feature class. Each feature in a feature class represents a row or record in the feature class table.

feature class In Topobase, the basic class for objects. For example, a parcel is a feature class. In a database, each feature class corresponds to one Oracle table. A feature class can have any number of attributes (Oracle columns), one of which can be of type "geometry". There are general types of feature classes, such as the following:

- Attribute (feature class without geometry)
- Line String
- Polygon
- Point
- Centroid
- Label
- Compound Polygon
- Compound Linestring

You can group several feature classes for each topic. Each feature class contains many entities/instances or records, which are called features.

feature class form Database form to view and edit attribute data stored in Topobase. Forms can be customized with the Topobase form designer.

feature explorer Control element used to display a set of features in a tree view, resulting from a selection, a validation, or a tracing.

Feature Search Finds the location of a certain object, such as a building, a parcel, or any other type of feature that has geometry. The geometry found will be the center of a graphic generation or a zoom GoTo. There are several types of search such as Sequential search and Flat search.

graphic connection A connection between Topobase and Autodesk Map or Autodesk MapGuide to display the features. Topobase Client has a graphic connection to Autodesk Map. Topobase Web has a graphic connection to Autodesk MapGuide.

job perimeter Spatial area where a job can be processed. You can use job perimeters to control where the modifications of the current job is allowed. Features outside the job perimeter cannot be processed. Also, you can define feature rules to be applied on the objects within the perimeter.

label In Topobase, any attribute data of a feature can be displayed as text, using label features. Label features are generated by arbitrary select statements that can be defined by the customer and therefore are a flexible way to add inscriptions to the objects. Label definitions (select statements and other settings) are stored in the system table TB_LABEL_DEF. Label definitions can be created or edited using the Topobase data model administrator. Label features can be stylized with the Display Manager by displaying the LABEL_TEXT property.

label definition Select statements that create labels. The label definition 1) queries data from the database and 2) specifies positioning and text orientation. This information is used in the Display Manager for stylization.

label feature class Feature class type used to store label features in the database <feature class name>_TBL. Each feature class (parent feature class) can have exactly one label feature class. The label feature class contains default attributes only, and contains no other specific attributes. It stores a relation to the parent feature class.

label placer Places a label to generate a label feature, to write information into the drawing or the map.

logical topology Description of the relationship of features of any feature classes, both attribute or geometry feature classes. The features need not to be spatially connected. For example, a logical topology connects points with points, lines with lines,lines to points, or attribute features to attriute features.

Utility networks are based on logical topologies that connect points (nodes) and lines (edges).

For example, a logical topology can represent a waste water network or electrical transmission lines.

master-detail form Type of feature class form where related records are shown in an embedded sub-form on one or more tabs.

network topology See logical topology.

Polygon Object built of line segments that form an enclosed area. In Topobase, polygons are stored in a polygon feature class.

profile In Topobase, a longitudinal section of line features. A profile is created by projecting features on an axis.

profile data model Data model consisting of a set of profile system tables and an arbitrary set of profile feature classes. Profile system tables store the basic configuration and settings. Profile feature classes store the components of each profile drawing.

prototype drawing Drawing that stores all used blocks, symbols, regular and other lines, text styles and dimensioning styles.

schema plan A schematic diagram that represents real world features by transforming the original feature geometry to an alternative location, for example by applying a coordinate offset. The schema plan represents the real world features in a clear structure, and preserves topology. A schema plan can either be displayed as overlay to the original features, or in a secondary window. You use Topobase Administrator to define schema plans.

schematic feature In Topobase, schematic features are derived from real world features. They are stored in the database and are used to draw the schema plan. Each schematic feature is associated to its real world feature.

TBMAIN Topobase Main User, which is a Topobase System User with restricted rights. The default name for the Topobase Main User is TBMAIN. To start the application, non-administrator users can optionally connect to the Topobase Main User.

TBSYS Topobase System User. Topobase system database schema. Topobase server component that stores application settings and server-side stored procedures. The default name for the Topobase System user is TBSYS. Application users must be connected to the Topobase System user or to the Topobase Main User TBMAIN to start the application.

template In Topobase, a template is an arrangement of recurrent features. The arrangement includes feature attributes, geometry and connectivity. In Topobase Client, you use templates to place a feature arrangement in one single step.

topic In Topobase, a group of several feature classes. A topic is a collection of feature class tables. Topics can be thought of as containers used to organize feature classes. Considering a data transfer, topics are fully independent of one another. Each topic may have sub-topics.

To build a clear and transparent data structure, you can group feature classes into topics, group several topics into main topics, and define feature classes with sub-feature classes. These relations between topics and feature classes serve only as an illustration of the data structure. There is not necessarily an actual relation between the tables.

Topobase Administrator A Topobase basic module, used for Topobase administration. Topobase Administrator contains several components, such as:

- Topobase data model administrator
- Topobase form designer
- Topobase report designer
- Topobase job administrator

Topobase Client A component of Topobase Administrator, used for registering and processing data stored in Topobase through forms and using Autodesk Map for graphic processing.

Topobase data model administrator A Topobase module used to process and establish data structures (topics, tables, attributes, topologies, and intersections) in Topobase. Also, you can define label definitions and dimensioning.

Topobase job All changes in the Topobase data pool can be controlled and performed by exact reports on appropriate processing steps, if they are performed inside a job. Using jobs allows you to control the version. A job includes various processing states (live, pending, project). For each processing state, an application exactly defines which actions are allowed.

Topobase System User Database schema that stores application settings and server-side stored procedures. Default name is TBSYS. Application users must be connected to the Topobase System User to start the application. They can either connect directly to the Topobase System User or use a Topobase Main User which has restricted rights. See also TBSYS and TBMAIN.

Topobase Web The web version of Topobase applications.

topology A geometric shape property in which metrical relations play no role. Topology describes how lines, nodes, and polygons connect and relate to each other, and it forms the basis for spatial analysis as network tracing. In Topobase, topologies can be administered within individual groups of feature classes. They can be defined with the Topobase data model administrator.

topology checker Tool to check topologies. The results are displayed in a tree view, displaying all feature errors.

user A person who works with any Topobase application. Each application user belongs to a group called a user group, with certain tasks and rights. Examples of users: Mr. MILLER, Mr. SMITH, Ms. BAKER; BILLY, TONY, LARRY.

user group A group of users having certain task and rights. Examples of user groups: ADMIN, VIEWER, EDITOR, and so on. A member of a user group can access workspaces only if he has a permission. He may use certain tools and functions and he has certain rights to edit or view the data.

utility model Topobase data model component for utility applications, which provides feature classes and rules for utility networks.

viewport Area of interest for the generate graphic process. A Topobase viewport is a spatial filter on the map.

workflow In Topobase applications, a guide for the user through tasks like acquisition, analysis, and reports.

workspace The central workflow unit in Topobase. For different user groups, such as EDITOR, VIEWER or ADMIN, you can define the appropriate workspaces, with respective roles and rights. A workspace comprises one or more documents.

From the user's point of view, a workspace is the starting point of his work. He must open a workspace to work with any Topobase application. By selecting a workspace, he will load all necessary objects, including the appropriate menus and toolbars, with a single mouse-click. Therefore, he can even access data from different applications, such as land management and wastewater, in arbitrary combinations.

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