

move3

**How To
Levelling**
Version 4.6



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1. Introduction

This document describes how measurement data from levelling can be imported into MOVE3 and how the data can be adjusted as a 1D network.

Levelling height differences from the Leica NA/DNA, Topcon DL, Sokkia SDL and Trimble/Zeiss DINI(Rec500 and RecE) format can be added to a MOVE3 project. All raw observations will be reduced to height differences and will be added to current project. Stations are only added if they are not yet present in the current project.

Please note that this is a sample. The actual settings may differ depending on your local requirements.

2. Field Coding

For the import of levelling files it is important to specify which points should be defined as turning points and which points should be included in the adjustment as a station. Therefore following conventions apply:

Leica (NA3000 and DNA3/DNA10), Topcon DL and Sokkia SDL

To determine the turning points, a lower and upper limit for the point numbers should be defined. Point numbers between the lower (including) and the upper limit are considered as turning points. A unique numbering for turning points is not required for MOVE3. The side shots will always be included as a station in the adjustment, irrespective of their point code. A unique numbering of points is required in this case.

Zeiss DINI(Rec500 and RecE)

The points with point code 0 are considered as turning points, if the point code is present. If no point code is specified in the DINI-file, a lower and upper limit for the point numbers can be entered to define the turning points. Point numbers between the lower (including) and the upper limit will be regarded as turning points. A unique numbering for turning points is not required for MOVE3. The side shots will always be included as a station in the adjustment, irrespective of their point code. A unique numbering of points is required in this case.

3. New MOVE3 Project

Create a new MOVE3 project by specifying the project name. A template project (option file) can be selected to use previously defined project settings.

4. Options

Starting with a new project without using a template will set all options to the MOVE3 defaults. In this case you must set some of the options to meet the 1D adjustment requirement. Set the *Project* options to terrestrial only.

The screenshot shows the 'General options' dialog box with the 'Project' tab selected. The 'Network name' field contains 'Level'. The 'Terrestrial' section has 'Observations' and 'Coordinates' checked. The 'GNSS/GPS' section has both 'Observations' and 'Coordinates' unchecked. The 'Feature code' dropdown is set to 'None'. The 'Project type' dropdown is set to 'Default'. The 'Project Height' is set to '0 m'. The 'Geoid model' dropdown is set to 'None'. The 'Geoid precision' is set to '0.0000 m' and '0.0000 ppm'. The projection is set to 'Terr -> Local (stereographic)'. The 'OK', 'Cancel', and 'Help' buttons are visible at the bottom.

Project tab sheet.

In the *Geometry* tab the Dimension must be set to 1D and it is best to select a projection, in case also approximate coordinates are entered for the levelled stations. If the projection type and parameters are not known, select the Local (stereographic) option.

General options

Project Geometry Adjustment MOVE3 output selection Units Datasnooping

Dimension 1D

Projection Local (stereographic) More...

Projection name Local (stereographic)

Longitude of origin/CM 0 00 00.00000

Latitude of origin 0 00 00.00000

Standard parallel 1

Standard parallel 2

Scalefactor 1.000000000

False Easting 0.0000 m

False Northing 0.0000 m

Ellipsoid Bessel 1841

Semi major axis 6377397.1550 m

Inverse flattening 299.152812800

Transformation None

GPS coordinate type XYZ

OK Cancel Help

Geometry tab sheet.

5. Default standard deviations

Before importing the data it is important to properly set the defaults for the standard deviations of the Height Differences. The standard deviation for the Height Differences consists of three parts, the absolute part, a relative part per square root kilometre and a relative part per kilometre. The default values are added to each imported Height difference.

The image shows a software dialog box titled "Standard Deviations" with two tabs: "Standard deviations for observations" (selected) and "Standard deviations for stations".

Standard deviations for observations:

Terrestrial Observations:

Direction	0.00100 gon	0.00000 gon.km
Distance	0.0100 m	0.0 ppm
Zenith Angle	0.00100 gon	0.00000 gon.km
Azimuth	0.00100 gon	0.00000 gon.km
Height Difference	0.00 mm	1.00 mm/sqrt(km)
		0.00 mm/km
Shift Vector EN	0.0100 m	H 0.0100 m
Local Coordinate EN	0.0100 m	H 0.0100 m

GNSS/GPS Observations:

GNSS/GPS Baseline	0.0100 m	1.0 ppm
GNSS/GPS Coordinate	0.0100 m	

Geometrical Relations:

Angle	0.10000 gon
Distance / collinearity	0.0150 m

Offsets:

Steel Tape measurement	0.0100 m
Auxiliary point	0.0100 m

Update Observations:

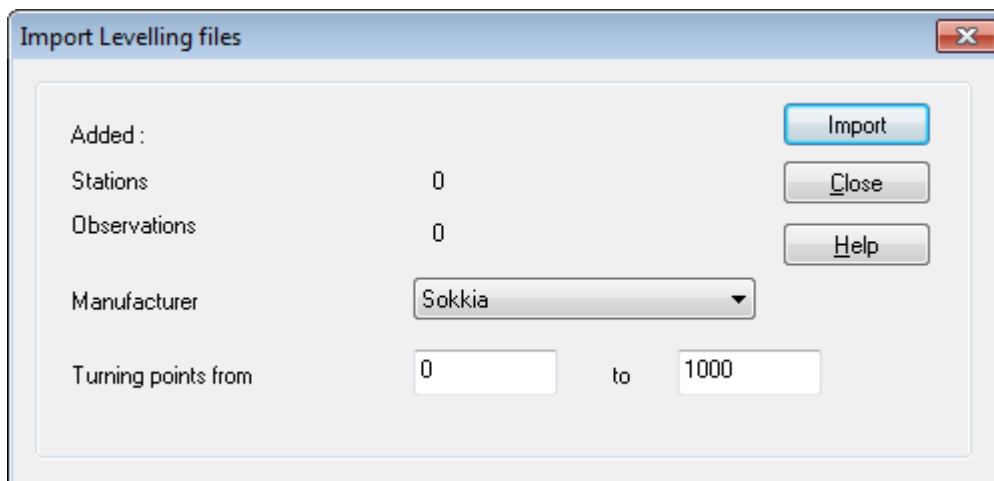
- All
- All types with changed defaults
- All with old defaults
- None

Buttons: OK, Cancel, Help

Standard Deviations.

6. Import raw levelling data

Select the menu option Import/export | Levelling and specify the manufacturer and the range for the turning points. Then click Import and select the raw level data file(s).

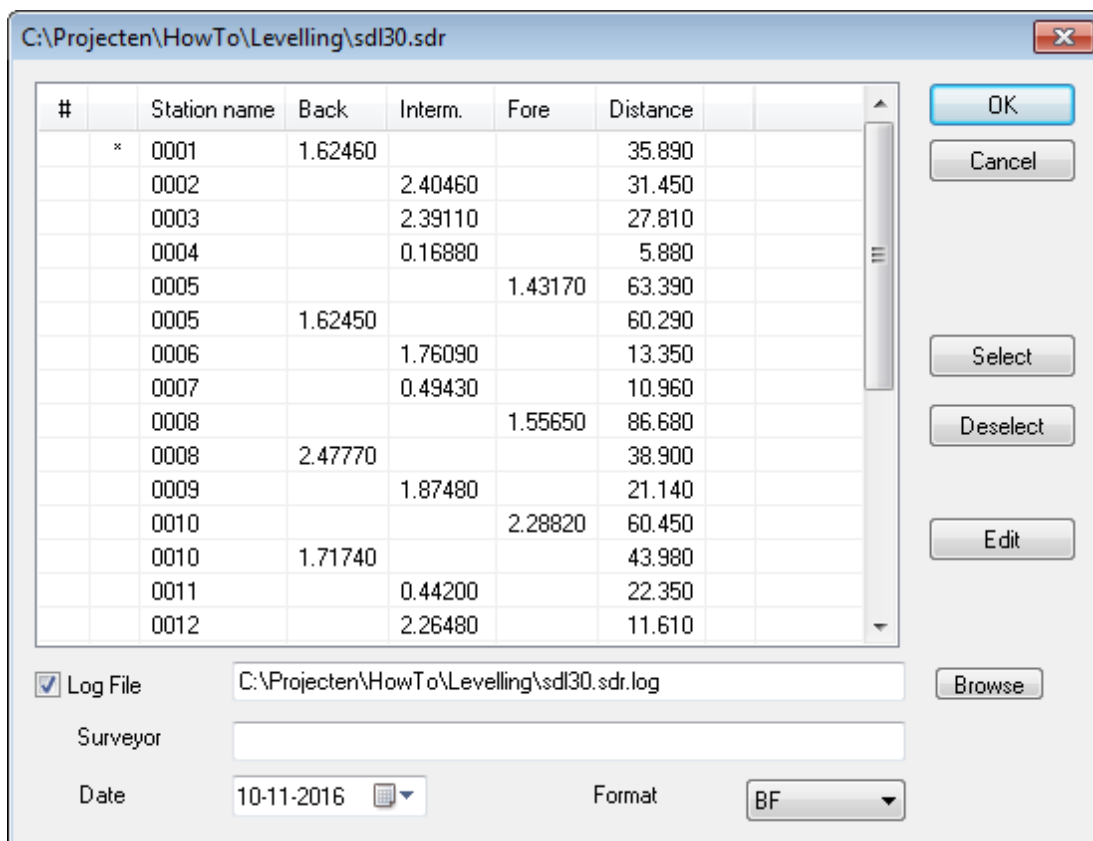


Import Levelling files dialog box. The dialog contains the following fields and controls:

- Added : 0
- Stations : 0
- Observations : 0
- Manufacturer : Sokkia (dropdown menu)
- Turning points from : 0 to 1000 (text input fields)
- Buttons: Import, Close, Help

Import dialog.

For each file the results of the imported raw readings will be shown in a dialog. At this stage the imported raw reading can be deselected in case a problem is suspected in the reading.



Raw reading dialog box showing a table of readings and control options.

#	Station name	Back	Intern.	Fore	Distance
*	0001	1.62460			35.890
	0002		2.40460		31.450
	0003		2.39110		27.810
	0004		0.16880		5.880
	0005			1.43170	63.390
	0005	1.62450			60.290
	0006		1.76090		13.350
	0007		0.49430		10.960
	0008			1.55650	86.680
	0008	2.47770			38.900
	0009		1.87480		21.140
	0010			2.28820	60.450
	0010	1.71740			43.980
	0011		0.44200		22.350
	0012		2.26480		11.610

Buttons: OK, Cancel, Select, Deselect, Edit, Browse

Log File: C:\Projecten\HowTo\Levelling\sdl30.sdr.log

Surveyor:

Date: 10-11-2016 Format: BF

The raw reading dialog

After pressing the OK-button the raw readings are converted to Height Difference observations and added to the current MOVE3 project. The import summary is written to a log file that contains both the raw readings and the aggregated Height Differences.

7. Adding known heights

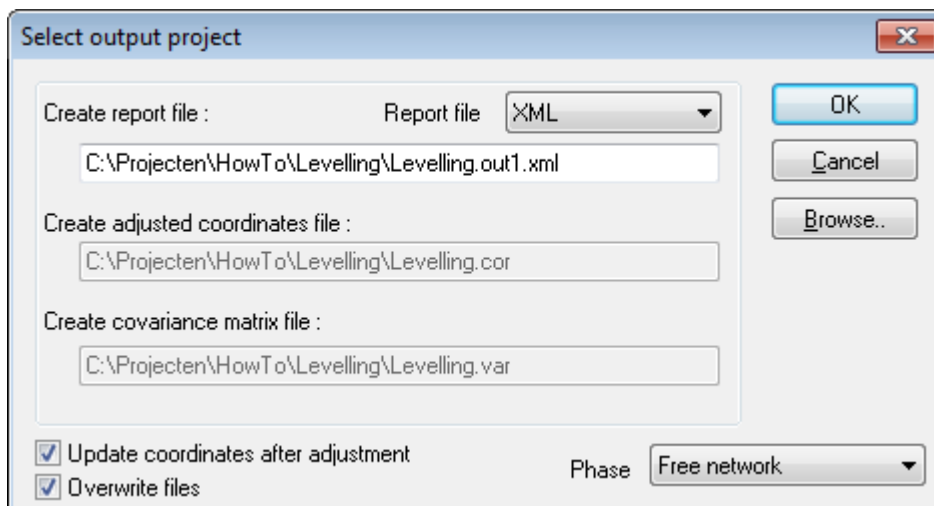
A proper adjustment requires that all control heights are added as known heights. Go to the View | Station and edit the control stations. Enter the proper station height and check the Known Height check box.

Adding Known Heights

8. Adjustment in Phases

You are now ready to adjust the network. It is best to do a free network first to perform testing on the observations and find outliers.

Go to Compute| MOVE3 and set the phase to Free network.



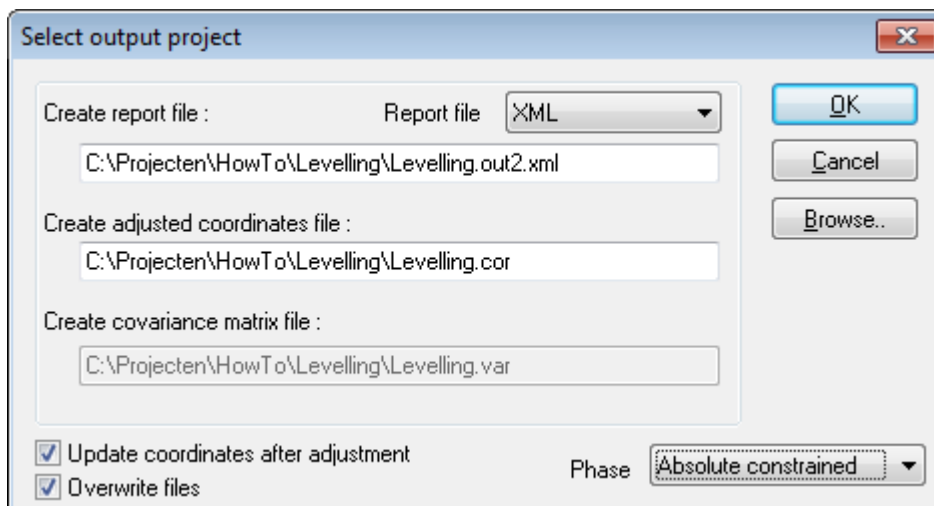
Compute Free network

The MOVE3 report will give the testing results of the adjustment, allowing to identify errors when sufficient redundancy is available.

In case one does not meet the predefined quality of the observations the global F-test will be rejected. This may be caused by either a too optimistic set of standard deviations of the observations or by observation errors. Usually a rejection is caused by errors in the observations. To identify the observation errors one can use the W-test. The observation with the largest W-test is the most suspect observation. One should try to solve the cause of the error, maybe there was a problem during import of the raw observations that can be corrected. The estimated error can be used for this purpose because it gives an estimate of the size of the observational error. If the error cannot be repaired, the observation can be deselected (not used in the adjustment). This will however affect the reliability of the network. In some cases rejected observations may have to be re-measured to maintain proper reliability.

Please note that for levelling the W-tests of several observation may have equal size. In this case this whole set is suspect. The error cannot be uniquely appointed to one of the observations.

After an acceptable free network adjustment the levelling network can be constrained to all available control heights in the Absolute constrained adjustment. This phase will result in testing of the available control heights and the final adjusted height computation.



Compute Absolute constrained network

If there is more than one control height in the levelling network the control heights can be tested. The quality of the control points (the standard deviation of the known height) is taken into account for testing. If the level network does not fit to the control points there may be rejected heights. If the F-test is rejected, the largest W-test value can be used to identify the errors. If a control height is rejected this may have been caused by a mistake in entering the known heights or by entering a wrong control point. It is best to check this out first. There may be a deformation in the control points as well causing the error. If the problem cannot be solved the control point can be removed as a control point for the adjustment. The point will then be re-adjusted, getting new adjusted coordinates.

Please note that it will not be possible to uniquely identify the error in the control heights if there are just two control heights in the network. There will be rejections, but both control heights will have identical W-test values.

The final results are stored in the MOVE3 report file, but they are also written to the MOVE3 COR file.

9. Loop detection and loop closing errors

If levelling loops are available in the network LOOPS3 from the Compute menu can be used to automatically detect loops and compute and test the closing errors in the loops. This will also give an idea of the quality of the network.