GPS System 500

General Guide to DTM Stakeout

Version 4.0
English

Leica Geosystems

Congratulations on your purchase of a new Leica System GPS500.

Contents

Introduction

This manual describes the application program DTM Stakeout (Digital Terrain Model) for the Leica GPS System 500. With DTM Stakeout you can

- navigate around an entered DTM. When in this mode, the system will display the coordinate values of the point being measured at that time and the cut or fill in relation to the DTM.

- stake points anywhere within an entered DTM, store the coordinate values of the points that have been staked as well as the cut or fill from the point on the actual ground suface to the DTM.

The DTM can be created in AutoCAD DXF or in Leica GSI format by using for example LISCAD. Please refer to chapter „Preparation“ for more information.

Activation of the Application

The application is initially activated by an access code which is provided by Leica. If the application does not appear on your menu or you are otherwise unable to access the application, please contact your Leica representative.

Requirements

You must be familiar with the principles and procedures that are outlined in the manual „Getting Started with Real-Time Surveys“ as well as the “Technical Reference Manual”.
If the material referenced is not thoroughly understood, it is strongly advised that you review them prior to proceeding with this application program.
Within this document, it is assumed that you are familiar with the operation of the system.

DTM data format

Before starting the application program, the DTM must be prepared and stored on the memory card and the appropriate coordinate system relating to the DTM must be selected.

The data for the DTM Stakeout program may be prepared in one of three formats: standard Leica GSI8, standard Leica GSI16 or AutoCAD DXF.
The file may be named any valid DOS name with either .gsi (for Leica GSI format) or .dxf (for AutoCAD DXF format) extension.

Example for a DTM file in Leica GSI8 format

Below is an example of a DTM file in Leica GSI8 format. The top half of the file shows the header and coordinates of the first two triangle vertices. The bottom half of the file shows the coordinate records of the last two triangles. Additionally, in the complete listing of the data file there would also be coordinate records for the triangle vertices for triangles from 3 to 50.

```
41....+00GARWIN 42....+DTMNTWRK 43....+DTMCOORD 44....+00000000 45....+00000000
110002+00000002 71....+TRI00001 81..11+05000000 82..11+01080256 83..11+00109634
110003+00000100 71....+TRI00001 81..11+05006165 82..11+01088405 83..11+00109683
110004+00000102 71....+TRI00001 81..11+05008364 82..11+01083345 83..11+00102435
110005+00000102 71....+TRI00002 81..11+05009823 82..11+01080032 83..11+00104333
110006+00000100 71....+TRI00002 81..11+05003784 82..11+01089022 83..11+00104860
110007+00000104 71....+TRI00002 81..11+05003486 82..11+01083844 83..11+00106943
. . . .
110036+00000133 71....+TRI00051 81..11+05003643 82..11+01083372 83..11+00102484
110037+00000134 71....+TRI00051 81..11+05009743 82..11+01088744 83..11+00105833
110038+00000135 71....+TRI00051 81..11+05002395 82..11+01089364 83..11+00105853
110039+00000137 71....+TRI00052 81..11+05000843 82..11+01081038 83..11+00101257
110040+00000135 71....+TRI00052 81..11+05003467 82..11+01084556 83..11+00102483
110041+00000136 71....+TRI00052 81..11+05003492 82..11+01084553 83..11+00105552
```

Note that each line must end with a blank and that a CR/LF is required after the last data line.

Example for a DTM file in Leica GSI16 format

Below is the same example in Leica GSI16 format.
In contrast to Leica GSI8 format, each line in a GSI16 file starts with a *. And all values (not the word indexes) have 16 digits instead of 8. Values are extended to 16 digits by adding zeros from the left.
Except for these differences, everything else said about GSI8 in the following sections also applies to GSI16, too.

```
*41....+0000000000GARWIN 42....+00000000DTMNTWRK 43....+00000000DTMCOORD 44....+0000000000000000 45....+0000000000000000
*110002+0000000000000002 71....+00000000TRI00001 81..11+0000000000500000 82..11+0000000001080256 83..11+0000000000109634
*110003+0000000000000100 71....+00000000TRI00001 81..11+0000000005006165 82..11+0000000001088405 83..11+0000000000109683
*110004+0000000000000102 71....+00000000TRI00001 81..11+0000000005008364 82..11+0000000001083345 83..11+0000000000102435
*110005+0000000000000102 71....+00000000TRI00002 81..11+0000000005009823 82..11+0000000001080032 83..11+0000000000104333
*110006+0000000000000100 71....+00000000TRI00002 81..11+0000000005003784 82..11+0000000001089022 83..11+0000000000104860
*110007+0000000000000104 71....+00000000TRI00002 81..11+0000000005003486 82..11+0000000001083844 83..11+0000000000106943
. . . .
*110036+0000000000000133 71....+00000000TRI00051 81..11+0000000005003643 82..11+0000000001083372 83..11+0000000000102484
*110037+0000000000000134 71....+00000000TRI00051 81..11+0000000005009743 82..11+0000000001088744 83..11+0000000000105833
*110038+0000000000000135 71....+00000000TRI00051 81..11+0000000005002395 82..11+0000000001089364 83..11+0000000000105853
*110039+0000000000000136 71....+00000000TRI00052 81..11+0000000005000843 82..11+0000000001081038 83..11+0000000000101257
*110040+0000000000000137 71....+00000000TRI00052 81..11+0000000005003467 82..11+0000000001084556 83..11+0000000000102483
*110041+0000000000000138 71....+00000000TRI00052 81..11+0000000005003492 82..11+0000000001084553 83..11+0000000000105552
```

Note that each line must end with a blank and that a CR/LF is required after the last data line.

The header is the first line in the GSI file. There is only one header line per file.
The header line takes the following form:

41….+000JOBID 42….+DTMNTWRK 43….+DTMCOORD 44….+00000000 45….+00000000

The word indexes are:

WI 41	Job identification, maximum 8 characters, may be defined by user.
WI 42	Identification of DTM file, may not be changed by user. This entry must be +DTMNTWRK.
WI 43	Identification of principal point type, may not be changed by user. This entry must be +DTMCOORD.
WI 44	Optional easting offset. May be defined by user.
WI 45	Optional northing offset. May be defined by user.

Note that the values for easting and northing offset have no digits to the right of the decimal place. For example, +001000000 means that 1000000 will be added to the coordinates of the triangle vertices.

In a DTM GSI file, the data line records for the triangle vertices follow the header line. One line describes one vertex of one triangle by its coordinates. One triangle is fully described by three lines - one for each vertex.
The coordinates should be sorted by triangles. It is therefore obvious that three coordinate lines with the same triangle number should be found together in the file. There is however no need to sort the vertices itself for one triangle.

A data line for one triangle vertex is shown below:

110002+00000002 71….+TRI00001 81..11+05000000 82..11+01080263 83..11+00109688

The word indexes are:

WI 11	Point identification, ignored by the application.
WI 71	Triangle number, indicates to which triangle the coordinate belongs.
WI 81	Easting of the triangle vertex.
WI 82	Northing of the triangle vertex.
WI 83	Elevation of the triangle vertex.

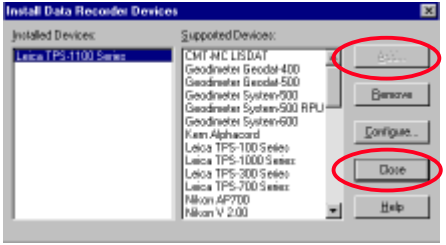
It is assumed that LISCAD Plus S.E.E. is running with the drawing file (*.see) open and a Digital Terrain Model has already been created for this file.

➢From the menu bar select **Task, Field Transfer**.

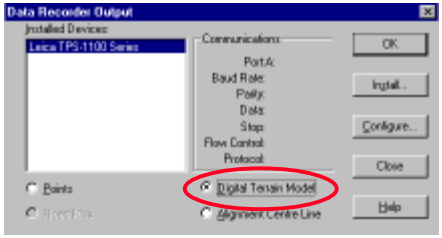
➢Also from the menu bar select **Output, Data Recorder**.

➢A dialogue called **Data Recorder Output** appears. Click the **Install ...** button. This leads to a new dialogue **Install Data Recorder Devices**.

➢In the box **Supported Devices** either highlight **Leica TPS - 1100 Series** or **Leica TPS - 1000 Series** and click **Add...**. The selected instrument will appear in the box **Installed Devices**. Click **Close**.

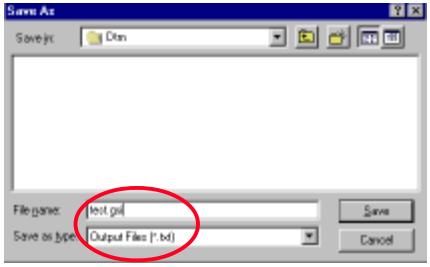


➢In the dialogue **Data Recorder Output** tick **Digital Terrain Model**. Click **OK**.



➢In the new window **Output Digital Terrain Model** tick the option **Output to file**. Click **OK**.

➢The next screen gives all necessary input options for Save As. Select a **directory** and a **file name**. Note that the file requires the **extension .gsi**. Even though the Save as type box only shows the option text file (*.txt), it is possible to type the file name plus the .gsi extension in the box File name. Click **Save**.



Example for a DTM file in AutoCAD DXF format

DTM triangles are imported to DTM Stakeout as 3DFACE entities from a DXF file. The format is as follows:

DXF Format	Explanation
0	Start of record
3DFACE	Record is a 3D face entity
TRIANGLE	3D face type
10	X coordinate, first point
5000.000	X value
20	Y coordinate, first point
1080.263	Y value
30	Z coordinate, first point
109.688	Z value
11	X coordinate, second point
5006.165	X value
21	Y coordinate, second point
1074.519	Y value
31	Z coordinate, second point
109.772	Z value
12	X coordinate, third point
5010.000	X value
22	Y coordinate, third point
1090.000	Y value
32	Z coordinate, third point
109.800	Z value
0	End of record

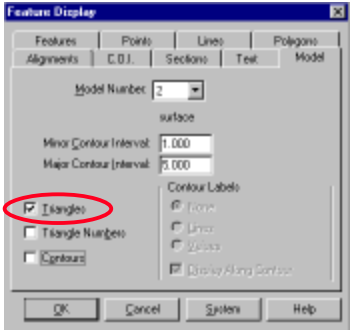
Properties, Layers, etc. may be in the DXF file, but are ignored by the DTM Stakeout application. The completion of the polygon by repeating the first point is required by AutoCAD, but is not required by the DTM Stakeout application. There will be a record like the one outlined above for each triangle in the DXF file.

It is assumed that LISCAD Plus S.E.E. is running with the drawing file (*.see) open and a Digital Terrain Model has already been created for this file.

➢From the menu bar select **Task, Terrain Modelling**.

➢Then also on the menu bar, go to **Display, Features…**.

➢In the dialogue **Feature Display** select the tab view **Model**. Ensure **Triangles** is checked and Triangle numbers and Contours is not checked. Click **OK**.



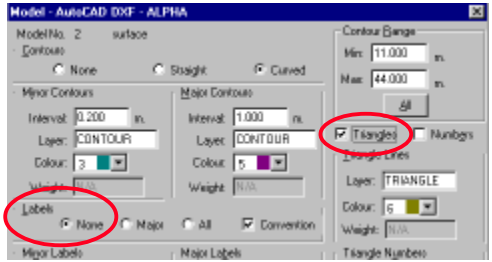
➢On the menu bar, go to **Display, Groups…** Turn off all Groups but **DEFAULT**. Click **OK**.

➢From the menu bar select **Task, CAD Output**.

➢Under **Settings, CAD System** tick **AutoCAD DXF**.

➢Go to **Settings, Codes…** next. Only in the tab view **General** turn off all options .

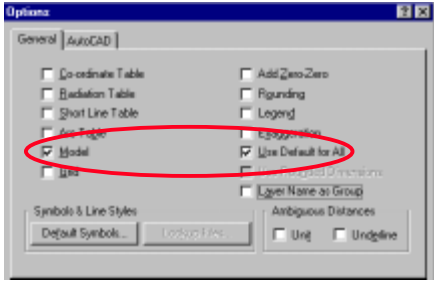
➢Under **Settings, Model…** set **Labels** to **none** and check the **Triangles** check box.



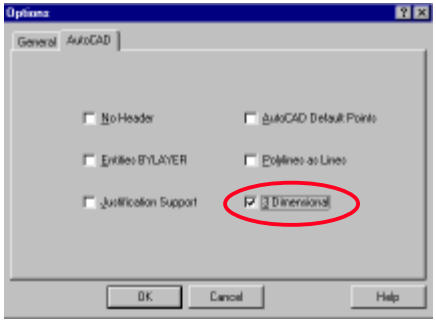
➢Click **Output!** on the menu bar to access the **AutoCAD DXF** dialogue.

➢Click the **Options** button. A new dialogue **Options** appears.

➢On the tab view **General** tick **Model** and **Use Default for All**. Untick all other option check boxes.



➢In the same dialogue on the tab view **AutoCAD** tick **3 Dimensional**. Click **OK**.



➢Back in the dialogue **AUTOCAD DXF** for **Save as type:** select **AutoCAD (*.dxf)**, define a **file name** and select a **directory** for storing the file. Clicking **OK** creates the DXF file.

You may also create a CAD Output Parameter File of these settings which will make the creation of DXF files easier for further outputs. Refer to LISCAD on-line help on how to create a CAD Output Parameter File.

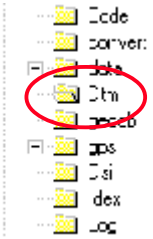
Once the DTM file has been created, it needs to be copied to the PCMCIA card.
If your computer has a PC card reader, you can transfer the data files directly from the PC to the card. Use the sensor transfer option in SKI-Pro if no PC card reader is available on the PC being used.

Transferring a DTM file directly from the PC to the card

➢Format the PCMCIA card in the sensor.

➢Insert the card into the PC.

➢By using the Explorer, copy the data files from the hard drive of the PC into the directory GSI on the memory card.



➢Switch the **Sensor off**.

➢**Remove** the TR500 terminal from the sensor.

➢**Connect** the data transfer cable to the serial port of your computer and to the TERMINAL port on the Sensor.

➢Start SKI-Pro. Go to **Sensor Transfer** under Tools.

➢Right-click on **Sensor**, go to **Settings...** and check the serial port and the baud rate settings.

➢Right-click on **Sensor** and choose **Turn GPS Sensor on**.

➢Right-click on **Sensor** and select **Transfer Any File**.

➢Under **Look in:** select the directory where your GSI or DXF file is kept.

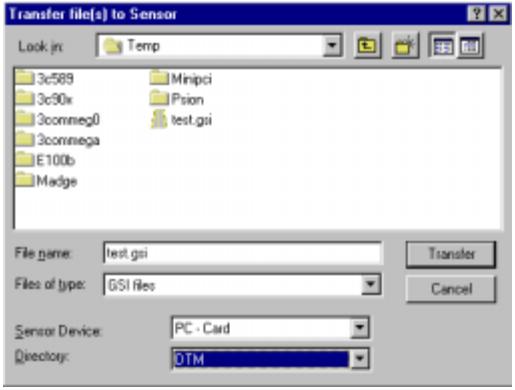
➢Under **Files of Type:** select **GSI or DXF** depending on the file you wish to transfer.

➢Under **Sensor device:** select **PC-card**.

➢Under **Directory:** select **DTM**.

➢Highlight the file to be transferred and click the **Transfer** button.

➢Once the transfer is finished, right-click on **Sensor** and choose **Turn GPS Sensor off**.



The Coordinate System

In order to get the correct result when surveying or staking out with a DTM, the GPS jobs must be orientated to the same local grid coordinate system as the DTM. This is accomplished by attaching an appropriate coordinate system to the job consisting of the three components transformation, ellipsoid and projection.

Depending on the coordinate system, you will either use pre-defined parameters or determine the required transformation parameters either on the sensor or in SKI-Pro.

On how to set up a coordinate system and on how to calculate transformation parameters please refer to „Getting Started with Real-Time Surveys“ as well as the "Technical Reference Manual" for assistance.

Receiver set-up

DTM Stakeout is a real-time application.

Therefore, a properly initialised real-time configuration set is required. This means, reference and rover must be set-up properly running a suitable configuration set and the data transfer from the reference to the rover must be working.

For detailed information please refer to „Getting Started with Real-Time Surveys“ and the "Technical Reference Manual".

Setting the units

The GPS sensors must be configured in the same coordinate units as those of the generated DTM.

Check the sensor settings in panel **CONFIGURE \ Units**.

The units must not be changed while surveying the DTM.

Starting the application

This section explains who to use the DTM application to verify an existing surface with a design surface.

Switch the receiver **ON** > Main Menu
Select **3 Applications** ...
CONT (F1)

Remember to ensure that the icon for the accuracy status shows the symbol for high precision navigation.

Panel APPLICATION \ Menu
08 DTM Stakeout
CONT (F1)

Panel DTMSO \ SET DTM FILE

This is where a job, the DTM file and a DXF layer may be selected.

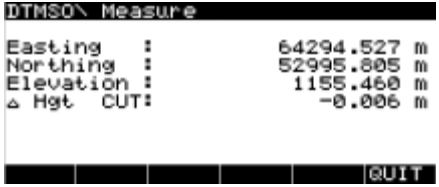
Job - Press ENTER to open listbox (and create a new job) or use right/left arrow key to toggle between jobs.
DTM File - If only one DTM file is kept in the DTM folder on the PC card, it is selected automatically. With several files in the folder press ENTER to make a selection.
DXF Layer - For a DXF file, the layer in which the triangles for the DTM have been stored can be selected here. TRIANGLE is the default layer name setting. If your DXF file uses a different layer, overtype here. For files in Leica GSI format, this line is irrelevant.

CONT (F1)

Briefly, a **panel DTMSO \ Initializing DTM** appears while the selected DTM is being read, verified and formatted for use by the program.

Once the DTM has been initialized you will automatically be taken to the **panel DTMSO \ Measure**.

Panel DTMSO \ Measure.



The position, existing elevation and delta height in relation to the DTM will be updated automatically as you move around the area where the DTM is valid. Moving outside the area enclosing the triangle network calls an error message every 10 seconds saying that no height difference can be calculated.

This panel is simply for verifying position and cut/fill of an area. **Cut** means, the point is below the original ground.

Fill means, the point is above the original ground.

There is no further need for action in this panel.
For staking a DTM and saving staked points proceed to the next chapter.

The following section of this guide explains how to use the DTM application to stakeout points in relation to a DTM which is the design surface.

Before starting staking a DTM, make sure that all instructions mentioned in the chapter "Preparations" are read and carried out.

Prior to staking out, the **coordinates** of the points to be staked need to be transferred **from an ASCII file** on the PC card in the subdirectory \ Data **to a job** on the sensor. For this, use **7 TRANSFER** from the main menu and then **06 ASCII/GSI to Job** (see also the "Technical Reference Manual").

Configuring Stakeout to use a DTM file

Normally, the Stakeout application on the System 500 compares the height actual being measured with the one to be staked and gives cut or fill values relative to the point being staked.

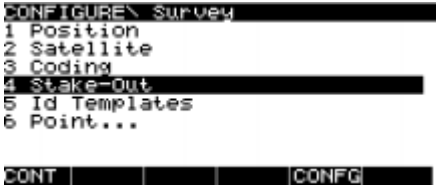
With the DTM Stakeout option however, the normal Stakeout application can use a DTM as the height datum and will show cut and fill values relative to the DTM.

Since it is possible that a user may sometimes wish to use the DTM model and sometimes stake points, the option whether or not to use a DTM with the Stakeout application is user configurable.
The procedure required is as follows:

Switch **ON** > Main Menu
Press the **CONFIG** key.
Panel CONFIGURE \ Rt_rov.cnf (where Rt_rov.cnf is the name of the currently active configuration set).

1 Survey
CONT (F1)

Panel CONFIGURE \ Survey



4 Stake-Out
CONT (F1)

Panel CONFIGURE \ Stake-Out
Use the up/down arrow key to highlight the line **Use DTM**. Initially, on entering the panle this line is invisible until you scroll down twice after the line Diff Check.

Use the right/left arrow key to toggle to YES.

CONT (F1) returns to the main menu.

In the main menu screen select **2 Stake-Out ...**.
CONT (F1)

Remember to ensure that the icon for the accuracy status shows the symbol for high precision navigation.

Panel STAKE-OUT \ Begin

Config Set - Select a real-time rover configuration, e.g. Rt_rov.
Stake Pts - The job where the points to be staked are kept. Select the job.
Store Pts - The job where the staked points will be stored. Either select an existing job from the listbox or press **NEW (F2)** to create a new job.
Stake Type - Select Point.
Antenna - Select your antenna setup, e.g. AT502 Pole.
Ant Height - Enter the antenna height, when using the Leica standard pole setup it is 2.000 m.

Once all information is entered:
DTM (F5)

Panel DTMSO \ SET DTM FILE

You now have to select a job, the DTM file and a DXF layer.

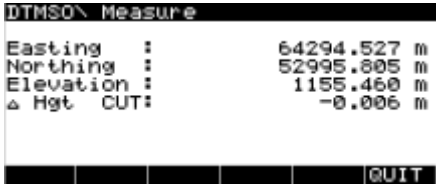
Job - Press ENTER to open listbox (and create a new job) or use right/left arrow key to toggle between jobs.
DTM File - If only one DTM file is kept in the DTM folder on the PC card, it is selected automatically. With several files in the folder press ENTER to make a selection.
DXF Layer - For a DXF file, the layer in which the triangles for the DTM have been stored can be selected here. TRIANGLE is the default layer name setting. If your DXF file uses a different layer, overtype here. For files in Leica GSI format, this line is irrelevant.

CONT (F1)

Briefly, a **panel DTMSO \ Initializing DTM** appears while the selected DTM is being read, verified and formatted for use by the program.

Once the DTM has been initialized you will automatically be taken to the **panel DTMSO \ Measure**.

Panel DTMSO \ Measure.



This panel is simply for verifying position and cut/fill of an area. **Cut** means, the point is below the original ground. **Fill** means, the point is above the original ground. There is no further need for action in this panel.

The values for position, existing elevation and delta height in relation to the DTM are updated automatically as you move around the area where the DTM is valid. Moving outside the area enclosing the triangle network calls an error message saying that height differences cannot be calculated.

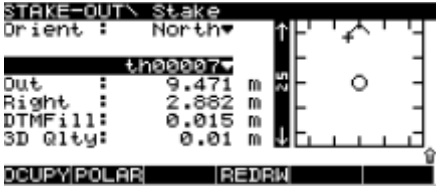
For staking a DTM and saving staked points press **QUIT (F6)** to return to the **STAKEOUT \ Begin** screen.

Panel STAKEOUT \ Begin

Make sure all the settings are correct.

CSYS (F6) to check that the appropriate local coordinate system is selected.
CONT (F1)

Panel STAKEOUT \ Stake



Orient - Select a method of orientation as reference direction.
Select a point to be staked.

Out/In and **Right/Left -** This is the range to the selected point and is updated as the antenna pole is moved.
DTMCut/Fill - Indicates the cut/fill to the DTM surface.

Place the antenna pole at the location to be staked within the DTM. Be sure that the antenna is levelled. Once the desired point is located: **OCUPY (F1)**.

Panel STAKE-OUT \ Occupy Point

The current point ID may be accepted or changed.
3D Quality - Keep an eye on this position quality indicator. Data should not be recorded until you are satisfied with this value.
When you are satisfied:
STOP (F1)

When surveying outside of the area enclosing the triangle network, no height can be calculated. A warning will then appear every 10 seconds.

DIFF (F2)

Pressing this key gives the difference between the designed coordinates and staked coordinates of the point.

STORE (F1)

The system returns to **panel STAKEOUT \ Stake** and the next point to be staked can be selected.
No heights can be calculated for points lying outside of the area enclosing the triangle network. A warning will appear when storing such points.

For complete information on how to use STAKE-OUT please refer to chapter "Real-Time Rover, Staking Out" in the "Technical Reference Manual".

Leica Geosystems AG, Heerbrugg, Switzerland, has been certified as being equipped with a quality system which meets the International Standards of Quality Management and Quality Systems (ISO standard 9001) and Environmental Management Systems (ISO standard 14001).

Total Quality Management-
Our commitment to total customer satisfaction

Ask your local Leica agent for more information about our TQM program

725973 - 4.0.0en

Leica Geosystems

Leica Geosystems AG
CH-9435 Heerbrugg
(Switzerland)
Phone +41 71 727 31 31
Fax +41 71 727 46 73
www.leica-geosystems.com