Leica PaveSmart 3D for Milling Machines

Technical Reference Manual

Version 2.0
English

- when it has to be **right**

Leica Geosystems

Introduction

Purchase

Congratulations on your purchase of the Leica PaveSmart 3D Machine Control System. Leica PaveSmart 3D is an ideal tool for increasing productivity in milling applications.

☞ To use the product in a permitted manner, please refer to the detailed safety directions in the User Manual.

Product identification

The type and serial number of your product are indicated on the label on the base of the product.

Enter the model and serial number in your manual and always refer to this information when you need to contact your agency or Leica Geosystems authorized service workshop.

Type: MPC1310 Machine Computer	Serial No.:	___________
Type: MSS1201 Dual-Axis Slope Sensor	Serial No.:	___________
Type: TCPS27S Ruggedised Radio Modem	Serial No.:	___________
Type: TCPS27S Ruggedised Radio Modem	Serial No.:	___________

Symbols

The symbols used in this manual have the following meanings:

Type	Description
☞	Important paragraphs which must be adhered to in practice as they enable the product to be used in a technically correct and efficient manner.

Trademarks

- Windows is a registered trademark of Microsoft Corporation
- Wirtgen is a registered trademark of Wirtgen Group, Germany

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Applicability of this manual

This Technical Reference Manual is for **Leica PaveSmart 3D**, for use to control **milling machines**.

Introduction to Leica PaveSmart 3D

Conventionally, milling machines are controlled for elevation and steering by a wire rope or sonic sensor. Sometimes by a laser. The wire rope is connected with the side blade and performs like a ski. Sonic and side blade will be used to mill a copy from the existing surface with a constant milling depth. By changing depth and cross slope the surveyor has to assign this at the surface. The ground operator can then change the height and cross slope on the controller manually. Milling with laser makes sense to design a surface with a constant slope. To mill a design for roads and surfaces with changing slopes the rational method is 3D.

With **Leica**'s **PaveSmart 3D** control system, the machine is controlled from a design on the PC. One Leica Geosystems robotic total station (TPS) or GNSS (GPS / GLONASS) sensor measures the position of a prism or an antenna at a rate of 10/20 Hz. These measurements are transmitted by radio to the Leica Machine Computer (MPC1310), mounted on the machine. A high-accuracy machine-mounted slope sensor provides additional information and cross slope (cross fall) of the machine's milling drum. From this pool of position, height and slope information, **Leica PaveSmart 3D** continuously calculates the current or **Actual** position, elevation and slope of the drum and the heading (or direction of travel) of the machine. These **Actual** position, elevation and slope values are compared to the computed 3D **Design** model of the project. The results of this **Design-vs-Actual** comparison are called **Corrections**. These represent the amount of **Correction** (in position, elevation and slope) required to bring the machine **ongrade**. **Leica PaveSmart 3D** transmits these **Corrections** to the machine controller, which regulates the hydraulics, in a similar way to controlling the machine with conventional sensors.

Contents of this manual

The Leica PaveSmart 3D Technical Reference Manual has been designed to match the layout of the Software. The individual chapters are based on the options available within the software and have been arranged to mimic the workflow setup of a new project and installation.

Path

Work: Offset**Steer** describes the working sequence:
From the **Work** dialog select **Offset** and then select **Steer**.
Leica PaveSmart 3D paths always start either in the **Work** dialog or in the **Menu** dialog.

Screen

Work**Elevation Offsets****Steer Offsets** describes the name of the screen.

Fields and options

Fields displayed on the screen are described such as **<Speed:>** or **<Speed: ft/min>**, if "ft/min" is the selected speed unit.

Index

The index is at the end of the manual.

☞ Keys, fields and options on the screens, which are considered as self-explanatory, are not explained.

Available documentation

Name of documentation	Description
Leica PaveSmart 3D User Manual	All instructions required in order to operate the system to a basic level are contained in this User Manual. It provides an overview of the system together with technical data and safety directions.
Leica PaveSmart 3D Technical Reference Manual for Milling Machines	Overall comprehensive guide to the system functions. Included are detailed descriptions of special system settings and functions intended for technical specialists.
TPS1200+ User Manual	Contains important safety directions as well as instructions for setting up the TPS1200+ product and operating it.

Name of documentation	Description
MNS1200 User Manual	Contains important safety directions as well as instructions for setting up the MNS1200 product and operating it.
TPS1200+ Technical Reference Manual	Contains detailed technical instructions for setting up the TPS1200+ product and operating it.
MNS1200 Technical Reference Manual	Contains detailed technical instructions for setting up the MNS1200 product and operating it.
MGuide User Manual	Contains instructions for setting up the MGuide onboard application for TPS1200+ and operating it.
TCPS27 User Manual	Contains important safety directions as well as technical instructions for setting up the TCPS27 product and operating it. (optional)
FreeWave Radio Manual	Contains important safety directions as well as technical instructions for setting up the FreeWave radio modems and operating them. (optional)
MPC1310 User Manual	Contains important safety directions as well as a general description of technical processes and instructions for using and operating the MPC1310.

☞ All documents must be read before commencing working on the machine.

Format of the documentation

The Leica PaveSmart 3D CD contains the entire system documentation in electronic format. The user manuals are also available in printed form.

Software Architecture

Leica PaveSmart 3D is divided into three operator levels accessed via two software paths.

The **Work** dialog displays all of the information required for daily production and is designed for use by the machine operator. There is unrestricted access for all users in the **Work** dialogs. Upon making a change to any field within the work dialog the result is effective immediately. This is why there is no **<CONT>** or confirmation buttons are present in the **Work** dialogs.

The **Menu** dialog is where all system configuration and data preparation is carried out. The **Menu** dialog is divided into two access levels. The first level contains the **configuration** dialogs, access via the password 007. All configuration tasks must be carried out before production commences.
The second access level in the **Menu** dialog is the **service** level and is intended for service personal to install the system and for rapid trouble shooting if any problems arise.

2 Projects

2.1 The Projects Dialog

Introduction

The Projects dialog contains all the information necessary to manage and create the data required to operate Leica PaveSmart 3D.
Refer to the Leica PaveSmart 3D user manual "Quick Start" chapter for details on creating a new project.

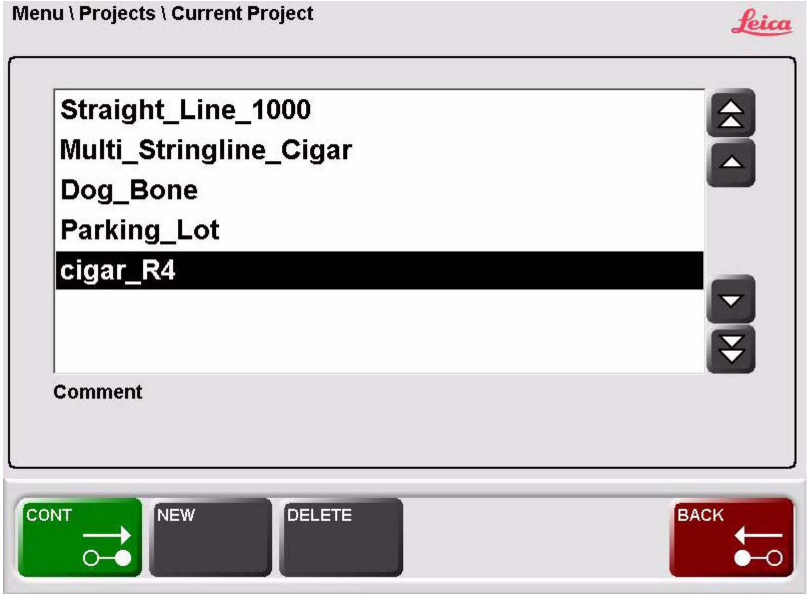
Project preparation steps

Before a new Project can be created a DBX file for the project must be available. Refer to chapter "2.4 Converting Data With the Design to Field Tool".
A project within Leica PaveSmart 3D contains the design data necessary to control the milling machine. This must contain at least 1, 3-dimensional stringline on a specific layer. A project may consist of many stringlines on many layers but only one stringline can be active as reference line at any given time. A second line can be chosen as slope line. The Leica PaveSmart 3D calculates the actual cross slope between the reference line and the slope line at any position.
After the data has been converted in to the DBX Road format the following files need to be transferred to Leica PaveSmart 3D.

Stringline_Indoor02_120706_0712_163640.X15
Stringline_Indoor02_120706_0712_163640.X16
Stringline_Indoor02_120706_0712_163640.X22
Stringline_Indoor02_120706_0712_163640.X23
Stringline_Indoor02_120706_0712_163640.X24
Stringline_Indoor02_120706_0712_163640.X30
Stringline_Indoor02_120706_0712_163640.XCF

These files must be stored on the USB storage device under the Folder **D:\DBX**.

New or existing PaveSmart 3D Projects are managed in the **Menu\Projects\Current** dialog.



In this dialog it is possible to create a new project or delete an existing project.

☞
- If the Project is deleted the folder will be completely removed from the MPC1310 hard drive.
- Leica Geosystems recommends that the project defined at installation by the Leica support engineer be used to create (for example copy to a new project name) any subsequent projects for the specific machine it was installed on. This project will contain the machine dimensions and all settings.

Stringlines

The main element used in Leica PaveSmart 3D projects is a Stringline. A stringline is defined as a System 1200 road DBX job.
Refer to chapter "2.4 Converting Data With the Design to Field Tool" for details on converting data to the DBX format.

A stringline contains all of the design information necessary to control the machine. It must be in a 3-dimensional format and may contain:
- Straights
- Arcs
- Clothoids, entry and exit as well as partial
- Cubic parabolas
- Full/Partial Bloss curves (parabola of degree five)
- Multipoints, are all elements that cannot be described by one of the previous types, and are represented by discrete points along the curve. For example, a line parallel to a clothoid.

Long Slope (mainfall)

The long slope describes a height change on the long-section of a stringline. The long slope is the angle between a horizontal line and the stringline.
This is also referred to as mainfall and is the element used in describing a machine's draft.
The longslope is set automatically by the change in height along a Stringline.

Cross Slope

Cross Slope describes the height change on the cross section of a stringline between elements.
In Leica PaveSmart 3D a single stringline can be given an orthogonal cross slope by projecting a plane through the stringline at a given angle in the **Work: offsets/slope offset** dialog.

Cross Slope may also be defined in Leica PaveSmart 3D by selecting an additional stringline to calculate the cross slope. The cross slope is then calculated by the height difference between the Reference StringLine and the Slope Stringline. If using a slope line additional cross slope may be added or subtracted from the design in the **Work: offsets/slope offset**.

The working slope is defined by the design cross slope (a single stringline always has 0% cross slope) plus the working slope offset.
Positive cross slope is defined as a clockwise rotation about the axis of the stringline in the direction of travel.
Negative cross slope is defined as a anti-clockwise rotation about the axis of the stringline in the direction of travel.
Depending on the milling drum used this will form a catch or spill curb.

Creating Stringlines for production

When creating designs only one stringline can be selected at any given time. All calculations are then relative to this stringline. Multiple stinglines can be created on a single layer and all stringlines on one layer will be displayed in the graphic. The active stringline is then graphically selected in the **Work: design** dialog.
Multiple layers can be imported into Leica PaveSmart 3D but only one layer can be displayed at a time.

2.2 Recommendations and Rules for Designs

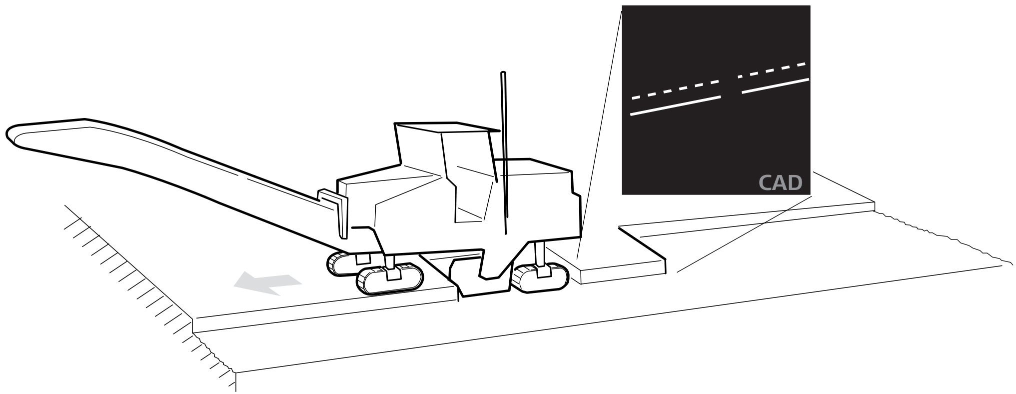
Introduction

Leica PaveSmart 3D works with DBX data. DBX is a Leica proprietary file format that is based on LandXML. A number of CAD software packages support the DBX file format, and PaveSmart 3D designs can be created directly within these packages. It is also possible, using Leica Geomatics Office (LGO) or Leica SiteSmart Translator (late 2006 onwards) to convert DXF (or other supported CAD format) files into the DBX format.
Independent of the data source or the method used to convert the data into the DBX format, there are several important aspects to be aware of in the design creation to assure good production results. The following recommendations are not restrictions by the software but more by the machine geometry and behaviour or the general production workflow and machine.
Refer to the LGO User Manual for further details of data file formats supported.

CAD Layers

CAD design layers with multiple stringlines are handled in Leica Geo Office and Leica PaveSmart 3D, the same as they are in conventional CAD packages. In Leica PaveSmart 3D only one layer is visible at a time. The operator can only select a single Stringline from this layer for calculation and machine control. All Stringlines that are in relation to each other should be on one layer.

Gap



If there is a gap in a CAD StringLine line, it may be converted as two separate StringLines. If this occurs it is only possible to select one stringline or the other. For production this means that the machine cannot mill the whole length continuously. Therefore a very small gap in the stringline file can lead to a large gap in production (at least the length of the milling drum). Due to this stringlines must be checked in the CAD software for gaps before and after they are converted.

☞ Leica PaveSmart 3D will attempt to automatically fill very small gaps if present, however we recommend inspecting and joining stringlines at design-time to prevent unwanted stoppages in production.

2.3 Rules for Defining Projects

Overview

Leica PaveSmart 3D requires accurate design data to be able to control the machines movements. The machine is only capable of following the information contained within the design data, therefore the quality of the final product is directly influenced by the quality of the data used.

The control process is also influenced by the design data. **The greater the number of segments contained within the design the greater the processing power required to run the system.** A balance must be found between the number of segments required to define the design and the processing power it will take.

The recommendations detailed below must be followed when creating designs.
Without following these rules Leica Geosystems cannot guarantee good quality milling performance.

Angle change between segments

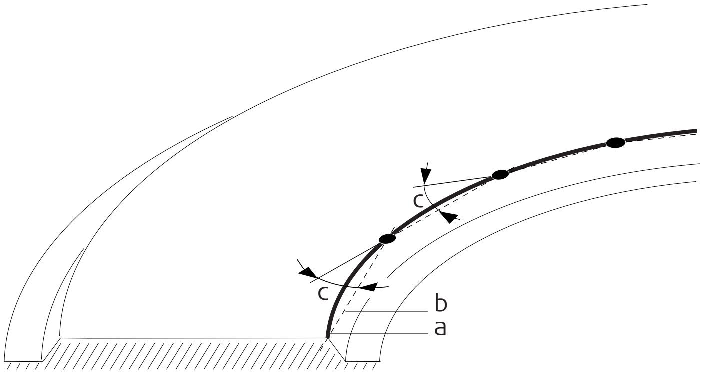
Leica PaveSmart 3D is capable of using designs in a 3 dimensional format which may contain:

- Straights
- Arcs
- Clothoids, entry and exit as well as partial
- Cubic parabolas
- Full/Partial Bloss curves (parabola of degree five)

Using these shapes only a small number of segments are required to define any 3 dimensional shapes.

Not all CAD packages are capable of producing curved 3 dimensional polylines. To overcome this curved line segment are broken up into a number of individual straight-line segments. The closer these straight segments are together the more accurate the original design data is approximated.

- When approximating curved 3 dimensional line segments the angle change between two connected line segments must never be greater than 1 degree.
- When defining a straight line it is not necessary to add more points in the middle of a line.



a) Reference line
b) Line segments
c) Angle change ≤ 1°

Number of Segments

The number of segments contained within a single stringline must not exceed 2000 individual elements. It is possible to have multiple stringlines on the same layer but each individual stringline must not exceed 2000 elements.
If a single stringline requires more than 2000 elements it must be broken into more than one stringline, which must be milled separately.

2.4 Converting Data With the Design to Field Tool

Introduction

Design to Field is the name of a software component contained within the Leica Geo Office (LGO) application that allows data to be imported into Leica PaveSmart 3D, and used onboard Leica System 1200 sensors. **Design to Field** allows many different data types to be imported.

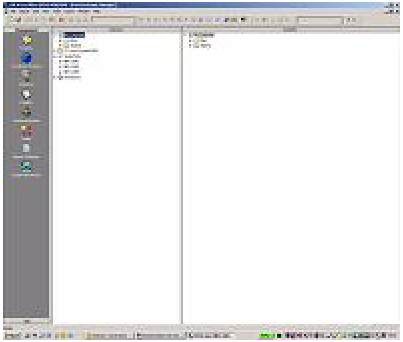
Data may be imported using industry standard data formats such as LandXML, DXF and GSI or from a number of additional formats using converters that are available in the downloads area of the Leica Geosystems website.

In this Technical Reference Manual the focus is set on how to prepare DXF data. However there are many more available import formats. Details on how to convert these are described in the Design to Field User Manual.

For further information on how to use the Design to Field Tool, refer to the Design to Field User Manual.

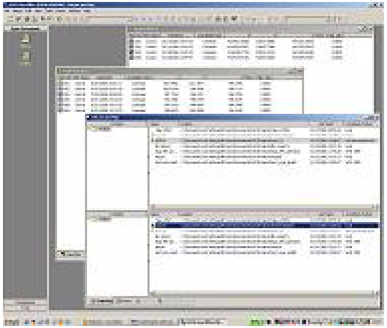
☞ In the Design to Field Tool terminology DBX jobs, used for Leica PaveSmart 3D, are called RoadRunner jobs.

Opening the Design to Field Tool in LGO



In the **Leica Geo Office** software package select **<Design to Field>** from the **<Tools>** menu.

Selecting the Import Type



Select **<Import Type: Road Data>**. This is the only **<import type>** supported by Leica PaveSmart 3D.
If you work with DXF data, then choose **<Importer: DXF-Importer road>**. If working with an alternative file type select the appropriate importer.

In the Manage dialog additional import formats can be added.

Confirms the selections and continues.

Choosing the DFX Elements

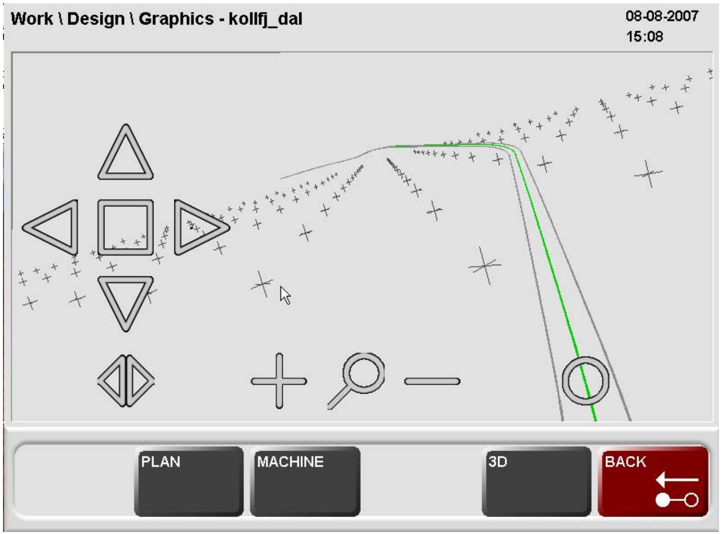
After selecting the DXF file to be imported, a list of the layers containing polylines is displayed. Take care to select the correct Units - usually either Metric (Metres) or English (US Feet) before importing data!

Leica PaveSmart 3D requires **3D polylines** to enable elevation control.

Converting the DXF

<Select the layers to import> to the Leica PaveSmart 3D software. A layer will be created in the DBX job with the same name as the dxf layer and will contain all of the polylines that correspond to that layer.
The majority of DXF files do not contain information regarding the linear units of the file, the user must select the unit in **<DXF File Linear Units>**.
Lines imported from the DXF file do not have identifiers. During the import the lines are numbered sequentially starting with the number 1 and incrementing each line by 1. In addition, a prefix may be added to each line number in **<Line ID prefix>**.

Checking the Design graphically



In the Design to Field Viewer all the data can be checked before exporting. Single layers can be selected to be viewed or exported. New layers can also be created and lines can be moved from one layer to another.

When all of the layer information is ready, press the Export button and enter a folder and file name for the DBX to be saved to.

☞ To import the DBX to Leica PaveSmart 3D the DBX files must be stored on the **\DBX\...** folder on the USB flashdrive.

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3 Machine Configuration

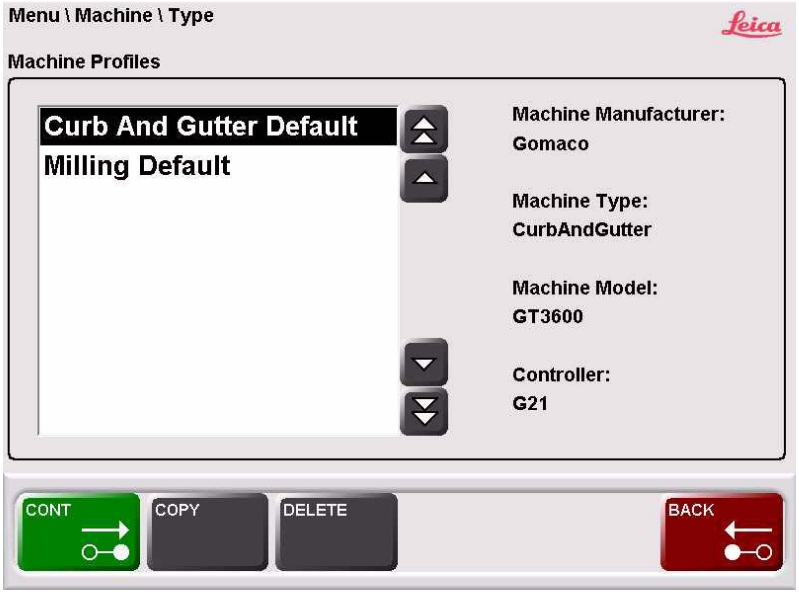
3.1 Machine Profiles

Introduction

PaveSmart 3D is designed to be used on a variety of different construction machines, from different manufacturers and different models with different machine controllers. To define all of these machines a **<Machine Profiles>** function is used.

Select a Profile

Open the following dialog: **Menu: Machine \ Profile**.



On the left side of the screen the available Profiles are listed. The currently selected Profile is shown with a black background colour. It can be changed by selecting a different machine type.

On the right side the detailed information from the highlighted Profile is listed.

confirm the selected Profile. PaveSmart 3D now automatically restarts to set the new Profile.

delete the highlighted Profile.

create a new Profile by copying the highlighted Profile and changing the required settings. See the following dialog "Create a new Profile".

Create a new Profile

Open the following dialog: **Menu: Machine \ Profile \ Copy**.

Enter a **<New Profile Name>** which will show up in the selection list.

Select a **<Machine Manufacturer>**.

The **<Machine Type>** is selected by default, depending on the Profile you have chosen to copy previously.

In **<Machine Model>** all of the supported models of the selected manufacturer are available.

The **<Controller>** depends on the Machine Model and can be selected in the last field.

- The new machine has to be set up in the same way as a new installation is carried out. All the machine relevant settings are stored in the Profile, so after a Profile change all machine specific settings are re-activated. An easy switch of the PaveSmart 3D system between different machines is possible.
- Depending on the Machine Type, the user interface of PaveSmart 3D changes slightly as not every function is useful for all the different machines.

3.2 Measuring the Machine Dimensions

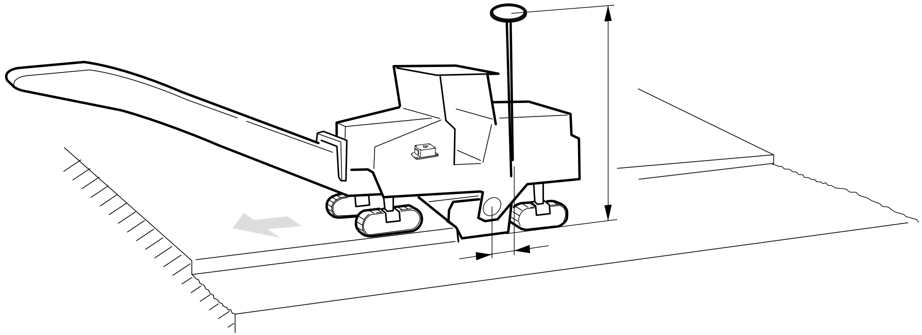
General

The Machine Dimension procedure is the process of linking all of the measuring components into one system to control the machine including the milling drum, Sensor Masts and Slope Sensor.
A change of the machine dimensions is needed whenever the relative position **changes** between the drum and the machine masts. This includes moving the mast up/down or moving the mast positions.
If the position of the slope sensor changes, the sensor needs a new calibration.

☞ It is recommended this procedure is repeated before each new project is commenced, and when a milling drum is changed.

Mast and slope sensor position

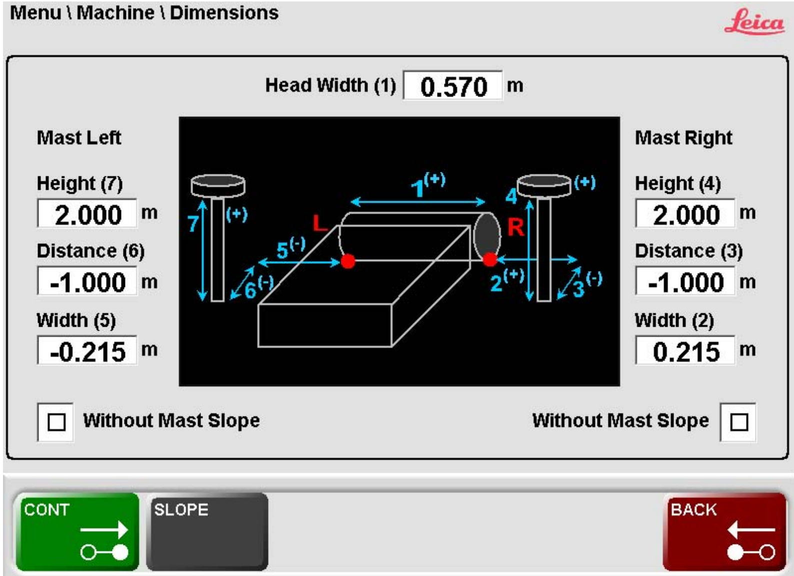
The mast position is important for a stable performance. To minimise the effects from abrupt machine driving starts and stops to the 3D elevation it is best to mount the masts vertical to the drum centre, no more than 20 cm in front or behind the centre.
In the horizontal direction the masts should not be mounted more than 20 cm from the drum edge.
The best option for the placement of the masts, is to have one mast on each side of the machine. This will enable you to choose the best side for TPS or GPS.



☞ The 3D slope sensor can be mounted anywhere on the machine frame because the drum is constantly connected to the frame.

Machine dimension and 3D slope calibration Step by Step

Step	Description
☞	Leica PaveSmart 3D must be running and the sensors must have radio communication with the MPC1310.
1.	Before setting up the machine dimensions, the frame must be leveled with an accurate spirit level. Start the engine and level the machine with manual hydraulic control.
2.	Additionally level the cross slope in parallel with the machine slope sensor.
3.	**Menu/Sensor/Slope**: press the Zero button to set both slope directions to 0.00%. In some cases a slope can be typed in and stored with **Set**.

Step	Description
4.	**Menu/Machine/Dimension:** 
☞	To measure the dimensions the machine should be leveled in both directions.
5.	The drum dimension (1) is given from the machine data.
6.	The mast heights (4) and (7) will be measured from the working height of the drum to the antenna or prism. We recommend holding a 3 - 4 m batten underneath the drum. Measure from the prism centre or from the bottom of the GPS antenna.

Step	Description
7.	The prism or antenna positions (2), (3), (5), (6) must be plumbed down and measured with a tape or meter to the drum centre. This will do for both directions and both masts. We recommend using a TPS to do this.
8.	It is possible to work without a mast slope sensor. That means, that there is no compensation of the mast long and cross slope. This means that the position which is interpolated from the antenna or prism to the design, is less exact. If the surface has a slope of >3% the influence could be as much as 4 mm.

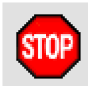
3.3 Defining Production Tolerances and Stop Rules

Purpose

Leica PaveSmart 3D has integrated safety features, designed to send a **3D ERROR** to the controller if a system, measurement or tolerance error is detected. These are defined when setting up the Project.
All Tolerance and Stop rule settings are set in the Configuration level of Leica PaveSmart 3D and should be turned on when milling.

Production Tolerance

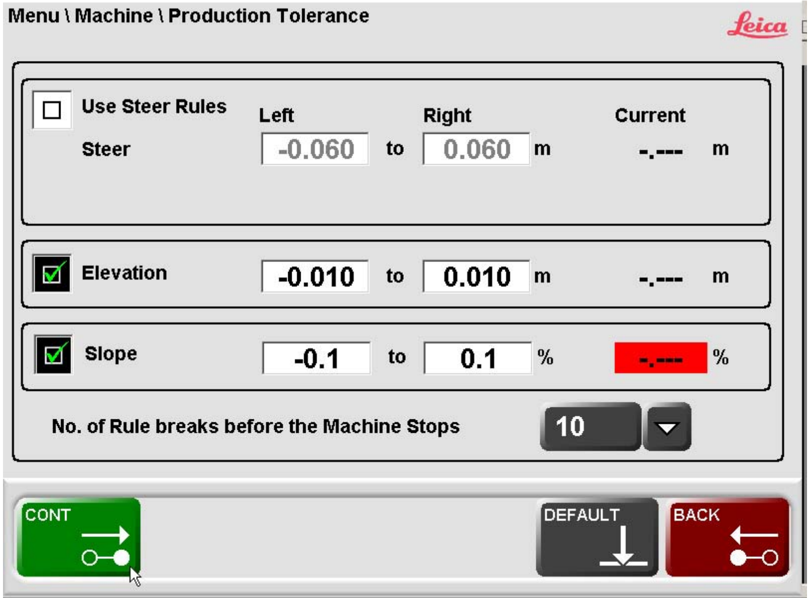
The Production Tolerance function allows the user to define a set of rules to send a **3D ERROR** message to the hydraulic controller if it is too far away from the reference line (if the deviations are outside the predefined tolerances). These rules, when switched on, can prevent incorrect milling if, for example, the operator forgets to switch on Automatic control for on the machine's control console (auto steer is not implemented in V1.10).

Separate tolerances are available for the steering*, elevation and slope controls. When the detected deviation exceeds the value set in the dialog **3D ERROR** will be indicated at the controller and the 

at the PaveSmart 3D screen.

* The steering option is not availeble at milling machines at the moment.

<No. of Rule breaks before 3D ERROR sent> sets the number of continuous measurements which must break this rule before the machine will stop (default 10).



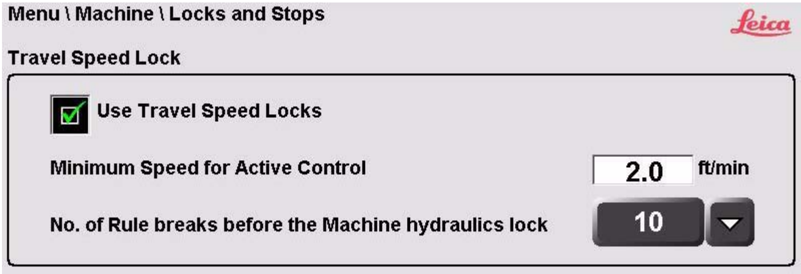
All Stop Rules depend on accurate instrument setup and orientation, and react to an apparent error condition **instantly**. They should not be switched on until the machine is inside the project area, and within the **<Production Tolerance>** (for example on or around zero deviations). Also, the **<No. of Rule breaks before Machine Stops>** should usually be set to 10, to prevent, for example, an erroneous measurement from a total station or GNSS causing an unwanted 3D ERROR.

Travel Speed Locks

<Travel Speed Locks> are used to freeze the hydraulic cylinders while the machine is stationary. This is to prevent small fluctuations in the hydraulics due to measurement noise while the machine is not moving.

The Travel Speed Locks send an Actual value = the current Set value. This results in no movement in the hydraulics. The machine will not move up or down.

The speed at which this rule is activated is set in the **<Menu\Machine\Locks and Stops>** dialog.
<No. of Rule breaks before Machine Stops> sets the number of continuous measurements which must break this rule before the machine will stop (default 10). The default Travel Speed Lock is set to 0.3 m/min (0.5 ft/min).

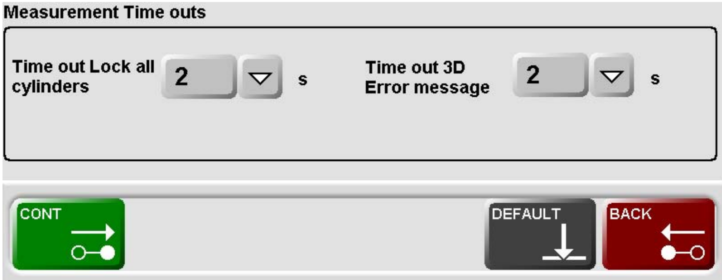


Measurement Timeouts

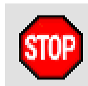
Timeout Lock all Cylinders:
If no valid measurements are received from the TPS(s), GNSS (GPS / GLONASS) or slope sensor after a predefined period, then Leica PaveSmart 3D freezes the elevation (send an Actual value = the current Set value).
The **<Time out Lock all Cylinders>** default value is 2 seconds.

Timeout Stop Machine:
If no valid measurements are received for a longer period of time a **3D Error message** is sent to the machine controller. This will put the machine controller and Leica PaveSmart 3D out of control and into standby.
The **<Time out Stop Machine>** default value is 5 seconds.

For causes and remedies of timeouts, refer to the Troubleshooting Chart.



Machine controller communication timeout

The machine controller communication timeout ensures that, in the event of communications failure between MPC and Controller (for example CANBus fault) the machine should stop. Leica PaveSmart 3D indicates no deviation values and the 

icon.

The machine controller will indicate **No Sensor**.

Activating & deactivating stop rules

Stop rules can be activated or deactivated by selecting the appropriate check box.

The measurement timeout Stop rules can not be deactivated.

☞ It is recommended that no milling operations should be undertaken without all of the Lock and Stop Rules turned on.

3.4 Tuning the Machine

General

The hydraulic behaviour of every machine is different due to the type of the machine, the machines hydraulics, or the tolerances required etc. Although the biggest influence comes from the different sensors, because of this, every machine needs a different tuning if the sensors are changed. For this - different tuning settings like, sensitivity and dead band are stored in the controller. With the identification of the sensor the controller automatically chooses the proper tuning set.
For special solutions, Leica PaveSmart 3D has additional tuning features.
Especially for milling applications with GNSS (GPS/GLONASS) sensors the tuning is necessary because the controller has no distinction between TPS and GNSS.

☞

- With standard milling machines using TPS there is no need to use this feature.
- The tuning has to be done by Leica support.

The tuning parameters dialog **Menu/Machine/ Tune Elevation** can be changed while the machine is in control and moving.

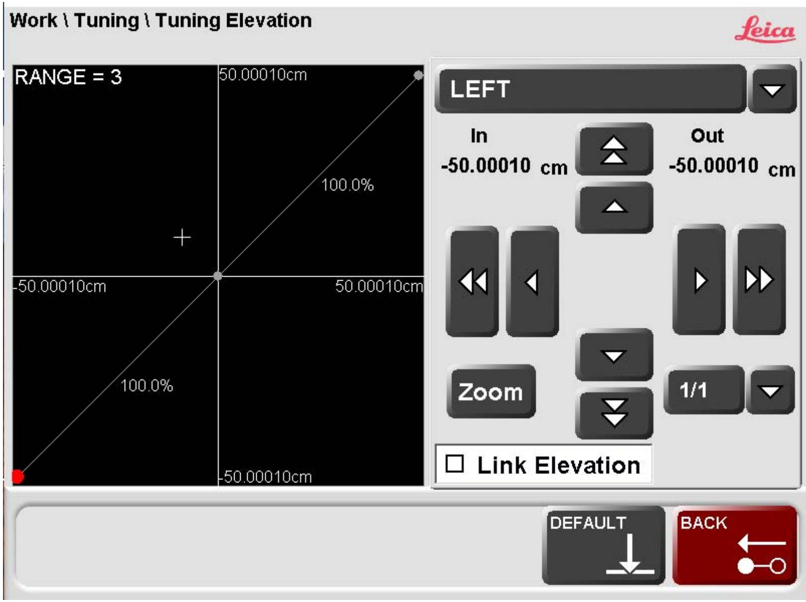
Because there is no automatic steering at standard milling machines, the tuning for steering is not relevant.

☞

The tuning parameters dialog **Menu/Machine/ Tune Elevation** or **Tune steer** can be changed while the machine is in control and moving.
The tuning process is a key procedure for a good quality concrete milling.

Tuning the Elevation

The tuning affects a change at the measured deviation, to get a faster or slower reaction at the hydraulic. This option is additional to the machine tuning at the controller. Wirtgen DLS and Mobamatic controller have defined values form Leica PaveSmart 3D. By using these controllers it is not normally necessary to tune additionally with PaveSmart 3D.



Tuning is an iterative and intuitive process, which must be repeated until a desirable hydraulic performance is achieved.
Initially start the tuning procedure with the default tuning settings from the configuration created during the installation.

If the machine is reacting much too fast or too slow, and an extremely undesirable behaviour is seen, roughly tune the machine using the Link Elevation tick box. When this button is selected the tuning parameters for all of the ranges will change simultaneously (i.e. Left Front, Right Front).

There are five tuning parameters, which can be altered to achieve the desired hydraulic response. The default values are:

Left Big	Left small	Dead band	Right small	Right big
-500 mm to -50 mm	-50 mm to -3 mm	±3 mm	+3 mm to +50 mm	+50 mm to +500 mm
-1.64 ft to -0.164 ft	-0.164 ft to -0.10 ft	±0.10 ft	+0.10 ft to +0.164 ft	+0.164 ft to -1.64 ft

The zoom button may be used to view each of the ranges. **<Range=3>** shows all of the parameters at the same time, **<Range = 2>** show the details of the first two ranges and **<Range = 1>** shows the smallest range which is generally set as a dead band (for example 0 gradient).

Each cylinder must now be tuned independently. Make sure that the Link Elevation tick box is **not** selected and then select each height cylinder individually making small changes to the tuning parameters.

- Left Front
- Right Front

4 Radio Modem Configuration

TCPS27 radios (worldwide)

The radio modem is delivered with an operational frequency band between 2401 - 2471 MHz, which is approved world wide. Changes to the standard frequency band are only possible with the external radio modems TCPS27S/B/R, and not with the radio handle. Changes can only be carried out at a Leica service centre if required.

Default values	TCPS27S/R	Radio handle, TCPS27B
Baud rate	115kbit/s	115kbit/s
Transceiver mode	Remote	Base
Link number	0	0

Further information refer to the "TCPS27" User manual

Checking TCPS radio modem settings

To check the TCPS27 radio settings open the TCPS configuration tool in **Menu/Tools/Tcps Conf**. Choose the port number your radio modem is attached to and press "Connect". Disconnect and reconnect the radio as prompted from the port. The configuration tool displays the currently stored settings.

Storing new TCPS radio modem settings

To change the TCPS configuration repeat the procedure detailed in chapter "Checking TCPS radio modem settings". Set all values back to the factory settings by pressing **<Default>**. Change the appropriate parameter and press **<Save>**.
Repeat the procedure to check the new parameters have been stored.
Suggested parameters:

- Baud rate: 115200 baud
- Link number: 1 - 15 (do not use 0)
- TCPS27S: Remote (link information on machine radio)
- Radio Handle: Base

Free Wave radios, applicable in U.S.A

Free Wave Radios may be used as an alternative to TCPS27 radios in the USA and have a maximum transmitted output of 500 mW (I-series). The radios are delivered as pairs and must be set up in Point to Point Network configuration. Each pair of radio must have unique matching parameters.

Checking Free Wave radio modem settings

To check the Free Wave radio settings open the Free Wave configuration tool in **Menu/Tools/Fwave Conf**. Choose the port number your radio modem is attached to and press "Read From Radio". The configuration tool will displays the currently stored settings.

Storing new Free Wave radio modem settings

Refer to the Free Wave Radio Manual chapter "Quick Start on a Point-to-Point Network".

5 Defining Measurement Sensors

5.1 Sensor Arrangement

Definition of the Measurement Sensors

The Leica PaveSmart 3D Curb & Gutter application can be used with two different sensor combinations. The appropriate sensor combination will depend on the application the system is being used for. A sensor combination is possible in the case for a parallel running as build check and leapfrogs.

- **TPS Solution**
  Is the standard solution for exact 3D milling. Depending on the instrument distance a milling accuracy of ± 1-2 mm is possible. The limitation is given from the measurement distance and from frequently occurring leapfrogs. This can slow down the milling process.
  The solution is useful for accurate design milling.
  A secondary TPS can be used for as build checks and take over control after the distance is exceeded.
- **GNSS (GPS / GLONASS) Solution**
  Ideal for design milling with decreased tolerances.

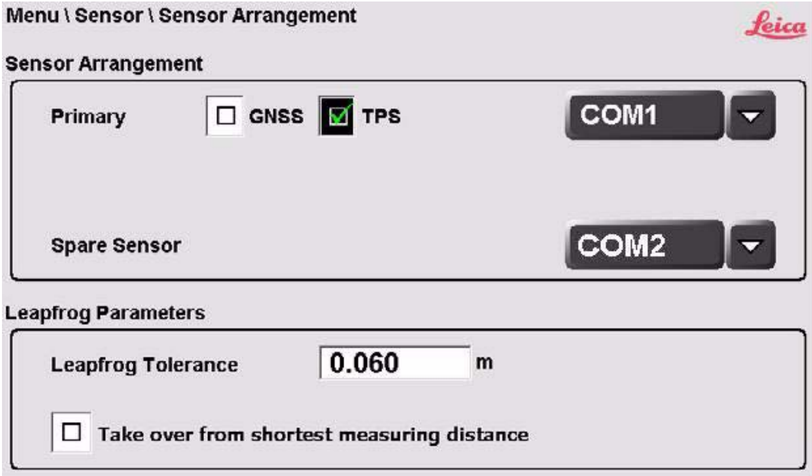
  ☞ This option is not appropriate if the GNSS availability is not guaranteed such as in urban canyons, heavily built up areas, heavily vegetated areas or where milling needs to be placed near or under existing structures.

  A TPS can lock on to use for as build checks right away behind the machine. Therewith the absolute height of the milled surface can be monitored.

Definition of the serial COM ports

It is essential that the correct sensor combination be defined before milling commences. TPS and GNSS (GPS / GLONASS) sensors communicate with the MPC1310 via radios (TCPS27S, or FreeWave) or cable (MNS1200). After defining the point-to-point communication, each radio pair or the MNS must be set to operate on a separate communication channels. Refer to chapter "4 Radio Modem Configuration" for setting radio-pair frequencies.

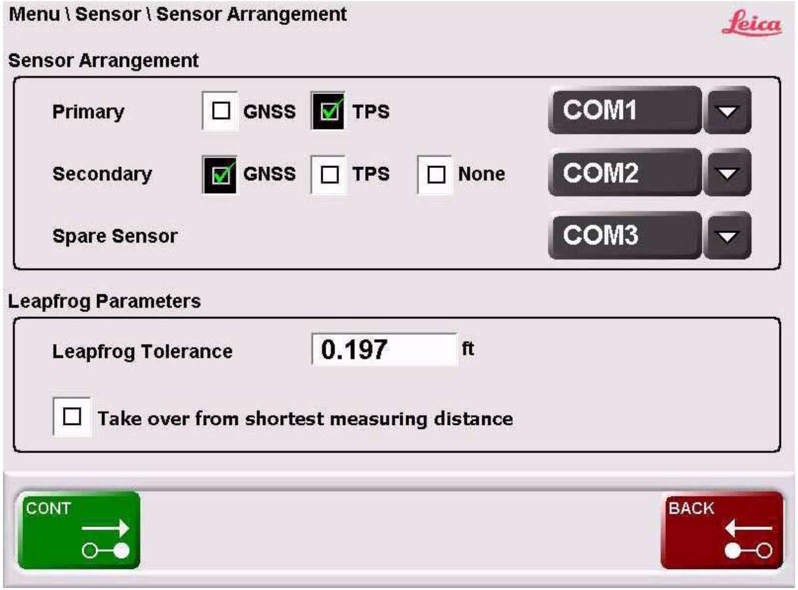
After Leica PaveSmart 3D is installed on the MPC1310, four Communication or COM ports (1, 2, 3 and 4) are available.
The COM port combination can be altered in **Menu\Sensors\Arrange** dialog or via the short cut **Work\Sensors\Arrange** dialog.



- If using a TPS solution, connect and select the **<Primary Sensor>** at COM1 and the second as **<Spare Sensor>** at COM2.
- If using the GNSS solution, connect and select the MNS1200 as **<Primary Sensor>** at COM1 and the TPS as **<Spare Sensor>** at COM2.
  The Spare sensor at COM4 can be chosen also if no TPS is connected.

Selecting the Sensor Arrangement

It is essential that the correct sensor arrangement is defined before paving commences. The Sensor Arrangement dialog is available in **Menu\Sensors\Arrange** or via the short cut **Work\Sensors\Arrange**.
If using a One TPS solution select the **<Secondary Sensor>** to **<None>**.
The orientation of the machine will be calculated parallel to the design.
The secondary communication port is not used in this application.



If using a Two TPS solution select the **<Secondary Sensor>** as the **<TPS>**. If using the GNSS (GPS / GLONASS) assist solution select the **<Secondary Sensor>** as the **<GNSS>**.
The GNSS sensor is automatically allocated to the secondary communication port.

5.2 Sending a Start Tracking Command

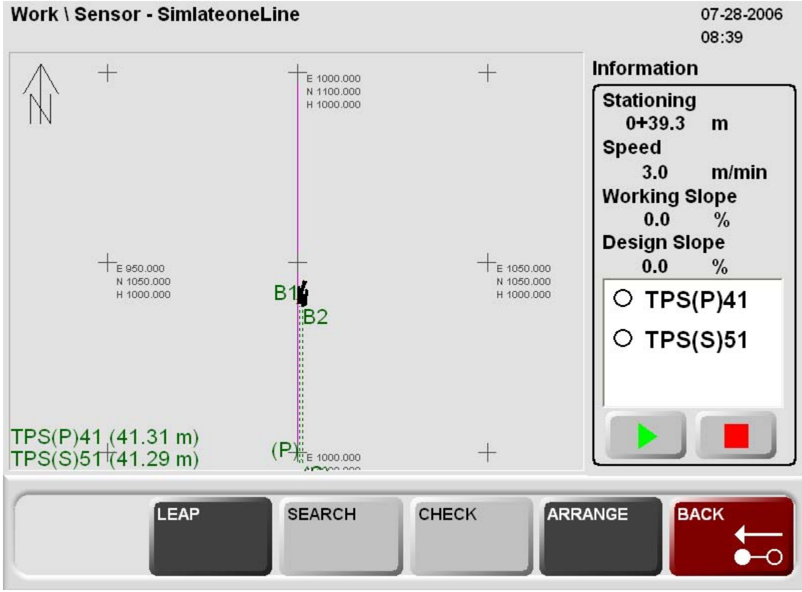
Sending a start tracking command

After defining the sensor arrangement, the TPS and GNSS (GPS / GLONASS) sensors are ready to send 3D Position data to Leica PaveSmart 3D.

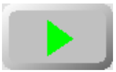
All sensors, which have been correctly configured will appear in the **Work/Sensors** dialog, labelled as:

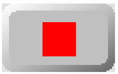
- **TPS(P)1** or **GPS(S)1** - Primary Sensor
- **TPS(Sp)2** - Spare Sensor

If all of the sensors do not appear check the radios are correctly connected to the MPC1310 and the Sensors, the Sensors are switched on and in MGuide (TPS only) and the **sensor arrangement** have been configured correctly.



To send a **Start Tracking** command highlight the desired sensor by pressing the circle next to the sensor name and press the Start button. When the **<START>** button is pressed in the **Work** dialog a start tracking command is sent to the primary or spare sensors.

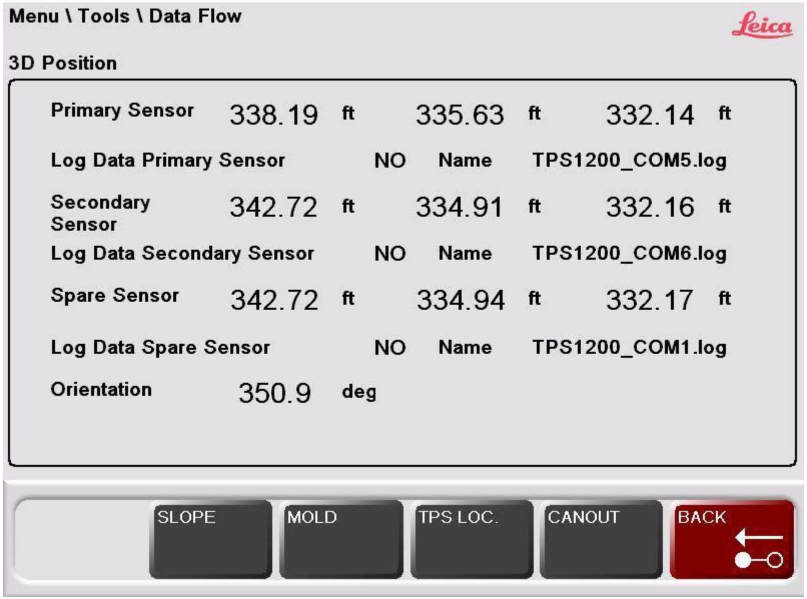

Start button


You can stop tracking by pressing the stop button.

5.3 Checking the Data Flow

Purpose

The **<Menu \ Tools \ Data Flow>** dialog is used predominantly for trouble-shooting/support purposes. Measurements from each of the sensors are displayed in real time.



Other details available include:

Displays the current slope sensor measurements.

Displays the current drum correction.

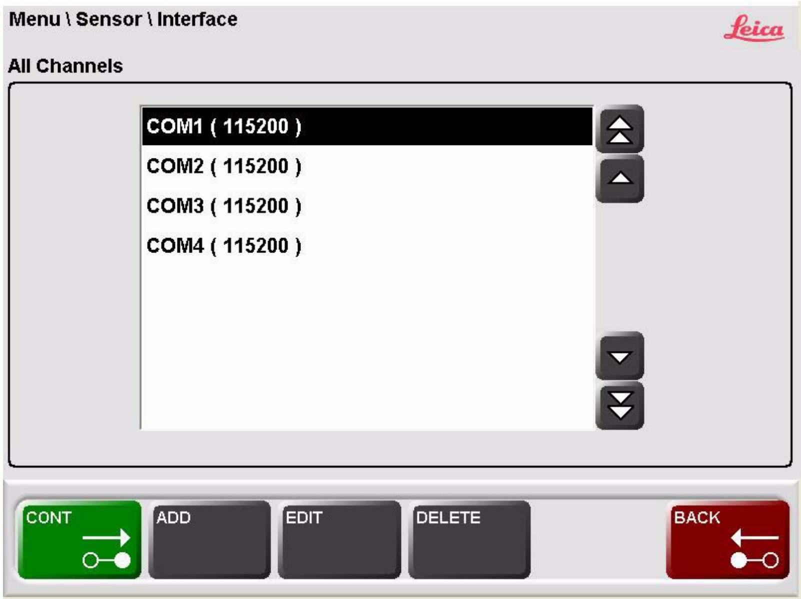
Displays each of the TPS location (set-up) coordinates.

Displays the CAN messages being sent to the machine controller.

5.4 Adding Serial Interfaces (COM Ports)

Definition of the Serial COM ports

The Default Communication port numbers are 1, 2, 3 and 4, which correspond to the settings on the MPC1310. These four ports cannot be altered.
If the software is installed on a laptop or a PC for a training or a demonstration purposes additional Communication ports can be defined or deleted in the **Menu\Sensors\Interface** dialog.
Select **<ADD>** and follow the instructions to add an additional serial port.



6 Setting up the Measurement Sensors

General

PaveSmart 3D can be used with two different sensors. The appropriate sensor will depend on the application the system is being used for. A sensor combination is possible in the case for a parallel running as build check and leapfrogs.

TPS solution

- Is the standard solution for precise 3D milling. Depending on the instrument distance a milling accuracy of ±1 - 2 mm is possible. The limitation is given from the measurement distance and from frequently occurring leapfrogs. This can slow down the milling process.
- **The solution is useful for accurate design milling.**
- A secondary TPS can be used for as build checks and take over control after the distance is exceeded.

GNSS (GPS / GLONASS) solution

- Ideal for design milling with decreased tolerances.
- This option is not appropriate if the GNSS availability is not guaranteed such as in urban canyons, heavily built up areas, heavily vegetated areas or where milling needs to be placed near or under existing structures.
- A TPS can lock on to use for as build checks right away behind the machine. Therewith the absolute height of the milled surface can be monitored.

6.1 Instrument (TPS) Setup

Overview

The overall accuracy of milling using Leica PaveSmart 3D is greatly influenced by the instrument set-up procedure.
The procedure uses a known fixed points (reference points) file to establish the position and orientation of each TPS relative to the design (local coordinate system). It is important that this information is accurate, as this will influence the set-up quality of the TPS(s), and in turn the overall milling quality.

☞ The TPS(s) must be setup in a stable location and leveled.
Refer to TPS1200+ User Manual, chapter "Instrument Setup" for more information on instrument setup.

The instrument should be protected from direct sunlight in order to avoid thermal warming.

☞ Additional information is provided in the TPS1200+ Technical Reference Manual and MGuide User Manual.

Description

When using Leica PaveSmart 3D the MGuide application onboard system 1200 TPS(s) will begin automatically in the **<Start>** dialog.
This dialog displays general information required to carry out the Setup procedure.
The **<Fixpoint Job>** selected must contain the coordinates of the fixed points which are to be used to set-up the instruments.
The **<Reflector>** type can also be selected in this menu or by pressing F9 (with the standard Hot Key definition).

The instruments can now be set up and orientated using the **SETUP** application **F3** on the instrument. Various methods are available:

- Set Azimuth (set up by azimuth)
- Known BS Point (set up by a known backsight point)

- Ori & Ht Transfr (set up by orientation and height transfer)
- Resection (set up by resection)
- Resection Helmert (set up by resection Helmert)
- Local Resection (set up by local resection)

Each setup method has specific requirements for input data and each setup method requires a different number of target points.

Recommended Methods

For Leica PaveSmart 3D we recommend using:

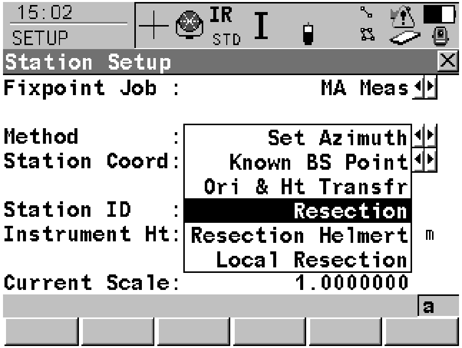
- Resection (with a minimum of 2, preferably 3 fixed points) or
- Known Backsight Point

☞

The Tiepoint Check function in Leica PaveSmart 3D, will use the first point of a Resection or the orientation point from a Known BS Point setup (by default). Other points may be selected in the **<CONF>** settings in MGuide.
The Tiepoint Check function will only work automatically if you are using either Resection or Known Backsight Point method.
Refer to MGuide 1200 User Manual chapter "Tie point check" for more information on tie point check.

6.2 Setting the Instrument (TPS) Orientation

Station Setup



Press **SETUP (F3)** in the MGuide Start screen. The Fixpoint job is automatically set to the file selected in the start screen.

Description

Choose the method for the instrument setup and press **F1 CONT**.
For the Tiepoint check function to work correctly the **<Fixpoint Job>** name must be set in the **<Start>** screen.

Method: Resection Description

If setting up the TPS by Resection, the station coordinates of the TPS and the orientation of the system are determined by measuring angles, or angles and distances to known target points.
The instrument may be set up on an unknown point.
A least squares or robust calculation is used to determine the system orientation when performing a resection.

Resection step-by-step

The following table explains the most common settings.

Step	Description
1.	Check settings for the Fixpoint job in the start screen.
2.	**SETUP (F3)** from MGuide start screen to access Station Setup.
3.	**SETUP Station Setup** Choose a method: **<Method: Resection>** Type in a station ID and the instrument height.
4.	**CONT (F1)** to access **SETUP Measure Target XX**.
5.	**SETUP Measure Target XX** Choose a target, type in a reflector height and choose reflector type with the F9 key. Aim the TPS at the reflector.
6.	**ALL (F1)**.
7.	Repeat steps 5. and 6. until all target points are measured. ☞ A minimum of 3 fixpoints should be used to introduce redundancy into the calculation.
8.	**CALC (F5)** to access **SETUP Results XX**.
9.	**SETUP Results XX**, **Stn Coords** page. **<Set:>** select the information to be set in the system.
10.	**SET (F1)** to store the selected setup data and exit the application program.

☞ Refer to TPS1200+ Technical Reference Manual, chapter "Setup Methods" for more information on instrument setup.

Method: Known Backsight Point Description

If the coordinates of the instrument station are known, Known Backsight Point allows setting the position and orientation of the instrument by taking a single measurement to a known backsight point.

Access step-by-step

Step	Description
1.	Check the settings for the Fixpoint job in the start screen.
2.	**SETUP (F3)** from the MGuide start screen to access **Station Setup**.
3.	**SETUP Station Setup** **<Method: Known BS Point>**
4.	Is **<Station Coord: Frm Fixpoint Job>**? • If yes, continue with step 5. • If no, continue with step 6.
5.	**CONT (F1)** to access **SETUP Select Station**.
6.	**CONT (F1)** to access **SETUP Set Stn & Ori - Known BS Point**. Following survey best practice always check the orientation of the system by turning the instrument onto a reference object with a known orientation after performing the Known Backsight set-up.

☞ Refer to TPS1200+ Technical Reference Manual, chapter "Setup Methods" for more information on instrument setup.

6.3 Calculation Results

Description

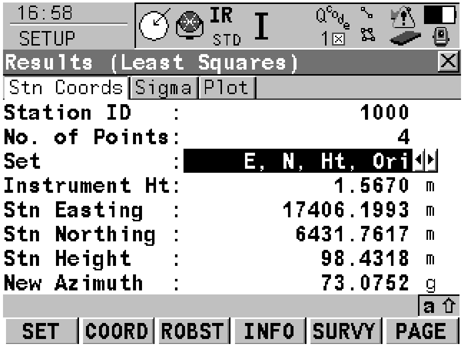
The results of the TPS set-up are displayed after a Resection or Known Back-sight Point calculation have been carried out.

Access

Press **CALC (F5)** in the **SETUP Measure Target XX** screen. This button is only available after the minimum number of fixpoints are measured.

SETUP Results XX, Stn Coords page

The calc **Results** screen consists of the **Stn Coords**, **Sigma**, **Stn Code** and **Plot** page. The explanations for the softkeys given below are valid for the **Stn Coord** and **Sigma** page. Refer to TPS1200+ Technical Reference Manual, chapter "Creating a New Point" for information on the keys on the **Stn Code** page, to chapter "Plot Mode - MapView Screen Area" for information on the keys on the **Plot** page.



SET (F1)
To set data selected in **<Set:>**, to set new geometric ppm if **<Use Scale: Yes>** and to store all setup data and exit the application program.

COORD (F2)
To view other coordinate types.

ROBST (F3) or **LSQRS (F3)**
To display the results for the robust or the least squares calculation method.

INFO (F4)
To display additional information about the accuracy of the measured target points and to delete inconsistent measurements in the **SETUP Additional Information** screen.

SURVY (F5)
To access **SETUP Measure Target XX** and tomeasure more target points.

PAGE (F6)
To change to another page on this screen.

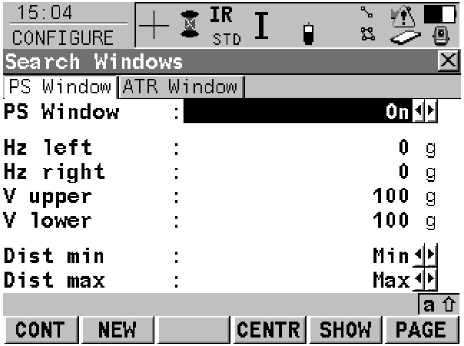
SHIFT ELL H (F2) or **SHIFT ORTH (F2)**
Changes between the ellipsoidal and the orthometric height.

SHIFT OTHER (F5)
Available if two solutions were calculated. Changes between these solutions.

☞ Refer to TPS1200+ Technical Reference Manual, chapter "Least Square and Robust Calculation" for more information on calculation results.

Power Search Instruments

After the Setup procedure is complete the Power Search Window screen is opened.



CONT (F1)
To accept changes and return to MGuide Main Menu.

NEW (F2)
To define your working area and pointing two corners of the desired search window.

CENTR (F4)
To centre the PowerSearch window to current position of the telescope.

SHOW (F5)
To position the telescope to corners of Search window.

PAGE (F6)
To change the ATR search window.

Additional Reading

Refer to Leica TPS1200+ Technical Reference Manual chapter "Setup" for more information.

6.4 GNSS (GPS / GLONASS) Solution

Overview

If using a GNSS system, a GNSS reference station is also required to enable differential positioning coordinates to be computed.
Prior to milling the GNSS coordinate system and the local TPS coordinate system must be linked to ensure the orientation is calculated correctly. If this is not carried out correctly the machine may not track as expected.

Further Reading

Refer to Leica GPS1200 Technical Reference Manual for further details.

6.5 Real Time Reference Operations

Description

To enable differential positioning, a GNSS (GPS / GLONASS) base station must first be established.

Requirements

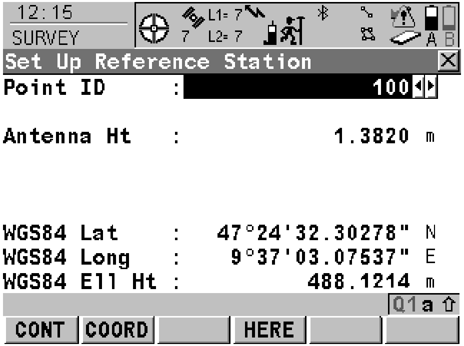
- A typical configuration set for real-time reference operations.
- A real-time interface configured correctly.
- The real-time device must be attached to the receiver and working properly.

Station Access step-by-step

Step	Description
1.	In the **SURVEY** application, on **Survey Begin** screen, select an existing job if an appropriate one exists or create a new job.
2.	Select a typical configuration set with **<R-Time Mode: Reference>**.
3.	Select an antenna
4.	**CONT (F1)** to access **SURVEY Set Up Reference Station**.

SURVEY Set-up Reference Station

The settings on this screen set the reference station and its coordinates.



CONT (F1)
To accept changes and access the subsequent-screen. The chosen settings become active.

COORD (F2)
To view other coordinate types. Local coordi-natesare available when a local coordinate-system is active.

LAST (F3)
To use the same coordinates as when the receiver was last used as reference station. Available when the receiver has previously been used as reference station and if no point in the active job has the same point ID as the one last used as reference station.

HERE (F4)
To use the coordinates of the current naviga-tion position as reference station coordinates.

SHIFT ELL H (F2) or **SHIFT ORTH (F2)**
To change between the ellipsoidal and theo-rthometric height. Available for local coordi-nates.

Field	Option	Description
<Point ID:>	**Choicelist**	The point selected as reference station.Opening the choicelist opens **SURVEY Data: Job Name** which is similar to **MANAGE Data: Job Name**.

Field	Option	Description
<Antenna Ht:>	**User input**	The default antenna height as defined in the active configuration set is suggested. Changing the antenna height here does not update the default antenna height as defined in the active configuration set. The changed antenna height is used until the application program is exited.

Enter GNSS (GPS / GLONASS) base station coordinates

The reference station coordinates can be entered in four different ways.

IF the coordinates of the reference station
are known
are those from the last used reference station
are those of the current navigation position
using a known point stored in the active job
☞ Refer to Leica GPS1200 Technical Reference Manual for further details.

Using a known point stored in the active job

Step	Description
1.	From the **SURVEY Set Up Reference Station** menu.

Step	Description
2.	**SURVEY Set Up Reference Station** Select the point to be used as reference station. ☞ A point may already be stored in the active job either by manual entry, by measuring or by transfer from LGO. Select the required point with known WGS 84 coordinates. ☞ If a new point is to be created, with known coordinates open the choicelist for **<Point ID:>** and **NEW (F2)**. Enter the new point number and the known WGS 84 coordinates of the point. ☞ If an existing point is to be edited, open the choicelist for **<Point ID:>** and **EDIT (F3)**. The coordinates and the point number of the existing point can be edited. ☞ If a new point with unknown coordinates is to be used refer to paragraph "Using the coordinates from the last used reference station".
3.	Check the antenna height.
4.	**CONT (F1)** to access **SURVEY Survey: Job Name**.

Using the coordinates from the last used reference station

Step	Description
☞	The receiver must have previously been used as reference station. After turning off, the reference station coordinates are stored in the System RAM. They can be used again the next time the receiver is used as a reference station. This means that even if the Compact-Flash card that previously contained the reference station coordinates is formatted, the last used coordinates can still be used.
1.	From the **SURVEY Set Up Reference Station** menu.
2.	**LAST (F3)**

Step	Description
☞	The point ID and coordinates of the last used reference station are displayed in grid. When no local coordinate system is active, WGS 1984 coordinates are displayed.
3.	Check the antenna height.
4.	**CONT (F1)** to access **SURVEY Survey: Job Name**.

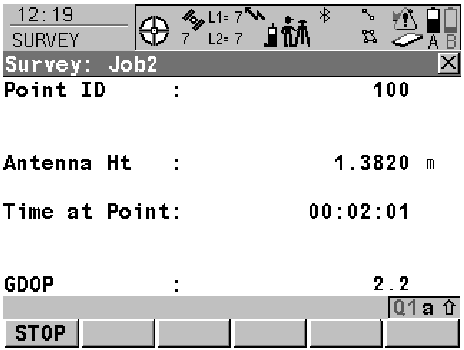
Using the coordinates of the current navigation position

Step	Description
1.	From the **SURVEY Set Up Reference Station** menu.
2.	**HERE (F4)** to access **SURVEY New Reference Point**.
3.	**SURVEY New Reference Point**, **Coords** page. The current navigation position in grid is displayed. When no local coordinate system is active, WGS 1984 coordinates are displayed. Type in a point ID for this new point.
☞	**COORD (F2)** views other coordinate types. Local coordinates are available when a local coordinate system is active.
☞	**SHIFT ELL H (F2)** and **SHIFT ORTH (F2)**. Available for local geodetic coordinates. Changes between the ellipsoidal and the orthometric height.
4.	**PAGE (F6)** changes to the **Code** page.

Step	Description
5.	**STORE (F1)** stores the new point and all associated information and returns to **SURVEY Set Up Reference Station**. The properties stored with the point are: • Class: **NAV** • Sub class: **GPS Code Only** • Source: **Survey (Static)** • Instrument source: **GPS**
6.	**SURVEY Set Up Reference Station** The coordinates of the new point are displayed. Check the antenna height.
7.	**CONT (F1)** to access **SURVEY Survey: Job Name**.

SURVEY
Survey: Job Name

The appearance and functionality of the screen is identical for all real-time reference configuration sets. Display masks cannot be used for real-time reference configuration sets.



STOP (F1)
To end the point occupation, store the point and to return to **GPS1200 Main Menu**.

Description of fields

Field	Option	Description
<Point ID:>	**Output**	The identifier for the reference station point.
<Antenna Ht:>	**Output**	The antenna height as entered in **SURVEY Set Up Reference Station** is displayed.
<Time atPoint:>	**Output**	The time from when the point is occupied until point occupation is stopped.
<GDOP:>	**Output**	The current GDOP of the computed position.

Next step

STOP (F1) to end the point occupation, store the point and to return to **GPS1200 Main Menu.**

6.6 Real Time Rover Operations

Recording points to be used in the transformation

The system is now ready to record WGS 84 coordinates of the local fixed points to be used in the transformation.
This process will link the local TPS coordinate system with the GNSS (GPS / GLONASS) coordinate system.

☞

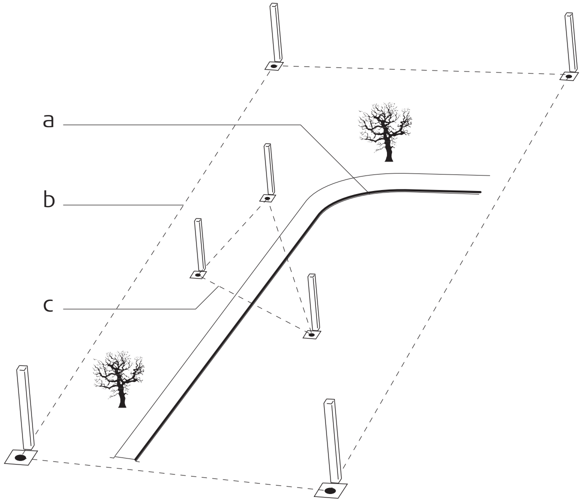
- Ensure that the same fixpoints used in the local coordinate system are occupied during the GNSS measurement procedure.
- Ensure that the fixpoints recorded in both the local coordinate system and the WGS84 coordinate system are distributed around the extents of the working area. If they are not incorrect orientation may result and the milling machine may not steer as desired.

Requirements

- A typical configuration set for real-time rover operations.
- A real-time interface configured correctly.
- The real-time device must be attached to the receiver and working properly.

Refer to the GPS1200 Technical Reference Manual.

Diagram of distribution required and possible errors



a) Reference Line
b) Control points in Local and WGS coordinate system with good distribution
c) Control points in Local and WGS coordinate systems with unable distribution

Real time Rover operations
Access step-by-step

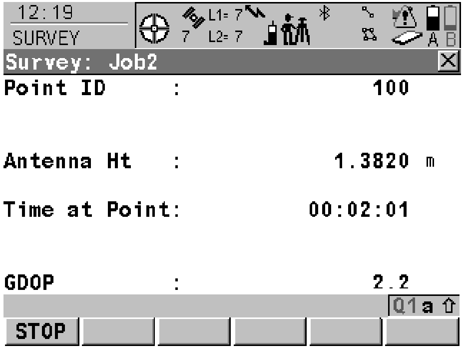
Step	Description
1.	In **SURVEY Survey Begin** select a job or create a new job.
2.	Select a typical configuration set with **<R-Time Mode: Rover>**.
3.	Select an antenna.
4.	**CONT (F1)** to access **SURVEY Survey: Job Name**.
☞	The arrow at the real-time device and real-time status icon flashes when real-time messages are being received.
☞	Fixing ambiguity begins. The current position status is indicated by the position status icon. When working with code only corrections, an ambiguity solution is not attempted.
☞	The position mode icon is the moving icon. This indicates that the antenna can be moved around and that no static observations are being recorded.

Ocupy points

In the **SURVEY Survey Begin** menu occupy all fixpoints to be used in the transformation. It is recommended that a minimum of 3 fixpoints are occupied with coordinates in the local system to perform the transformation.

SURVEY
Survey: Job Name, Survey page

The fields shown are those from a typical configuration set for real-time rover operations. The screen described consists of the **Survey** page and the **Map** page. The explanations for the softkeys given below are valid for the **Survey** page.



OCUPY (F1)
To start recording positions. The position mode icon changes to the static icon. **(F1)** changes to **STOP**.

STOP (F1)
To end recording of positions when enough data is collected.

STORE (F1)
To store the point information.

H PNT(F5)
To measure a hidden point.

PAGE (F6)
To change to another page on this screen.

SHIFT CONF (F2)
To configure auto points and hidden point measurements. Accesses **SURVEY Configuration**.
Refer to the GPS1200 Technical Reference Manual.

Acess Step by Step

Field	Option	Description
<Point ID:>	**Userinput**	The identifier for manually occupied points. The configured point ID template is used. The ID can be changed: • To start a new sequence of point ID's overtype the point ID.
<Antenna Ht:>	**Userinput**	The default antenna height as defined in the active configuration set is suggested.
<3D CQ:>	**Output**	The current 3D coordinate quality of the computed position.

Step	Description
1.	Position the GNSS (GPS / GLONASS) antenna over the fixpoints to be used in the transformation.
2.	**OCCUPY (F1)** all fixpoints to be used in the transformation.
3.	**STOP (F1)** to end the point occupation.
4.	Repeat the procedure for all fixpoints.

6.7 Determining a New Coordinate System (Transformation)

Description

GNSS (GPS / GLONASS) measured points are always stored based on the global geocentric datum known as WGS 1984. Most surveys require coordinates in a local grid system, for example, based on a country's official mapping datum or an arbitrary grid system used in a particular area such as a construction site. To convert the WGS 1984 coordinates into local coordinates a coordinate system needs to be created. Part of the coordinate system is the transformation used to convert coordinates from the WGS 1984 datum to the local datum. This can be carried out on board the MNS1200 sensor (with a Survey Licence) or in Leica Geo Office (LGO).

Transformation

A transformation is the process of converting coordinates from one geodetic datum to another.
Requirements:

- Transformation parameters.
- In some cases a local ellipsoid.
- In some cases a map projection.
- In some cases a geoid model.

Transformation parameters

A transformation consists of a number of shifts, rotations and scale factors, depending on the type of transformation used. Not all of these parameters are always required. These parameters may already be known, or may need to be computed.

Three different transformations are provided onboard the MNS sensor:

- Classic 3D, also called Helmert transformation
- Onestep
- Twostep

Further methods are also available in LGO.

☞ The details of a Onestep transformation is provided in this manual.
For more information about other transformation types refer to GPS1200 Technical Reference Manual, and LGO help files.

Transformation: Onestep

Characteristics	Description
Principle	Transforms coordinates directly from WGS 1984 to local grid and vice versa without knowledge about the local ellipsoid or the map projection. Procedure: 1. The WGS 1984 coordinates are projected onto a temporary Transverse Mercator projection. The central meridian of this projection passes through the centre of gravity of the common control points. 2. The results of 1. are preliminary grid coordinates for the WGS 1984 points. 3. These preliminary grid coordinates are matched with the local grid control points in order to compute the Easting and Northing shifts, the rotation and the scale factor between these two sets of points. This is known as a classic 2D transformation. 4. The height transformation is a single dimension height approximation.
Positions and Heights	The position and height transformations are separated.
Use	When measurements are to be forced to tie in with local existing control. For example: A site where the coordinates of the control points are based on a purely local grid. The coordinate values within this grid are totally arbitrary and are in no way connected with any ellipsoid or map projection.

Characteristics	Description
Requirements	• The position is known in WGS 1984 and in the local system for at least one point. Three or more points are recommended in order to obtain redundancy. • Additional height information for one point enables the transformation of heights. • Parameters of the local geoid model. This is not compulsory. • No parameters of the local ellipsoid. • No parameters of the local map projection.
Area	• Limited to 10 x 10 km because no projection scale factor is applied and a standard Transverse Mercator projection is used to compute the preliminary WGS 1984 grid coordinates. • For areas without large height differences.
Points and transformation parameters	The transformation parameters determined depend on the number of available points with position information. • One point: Classic 2D with shift in X and Y. • Two points: Classic 2D with shift in X and Y, rotation about Z and scale. • More than two points: Classic 2D with shift in X and Y, rotation about Z, scale and residuals.

Characteristics	Description
Points and height transformation	The type of height transformation performed depends on the number of available points with height information. • No point: No height transformation. • One point: Heights are shifted to fit to the height control point. • Two points: Average height shift between the two height control points. • Three points: Tilted plane through the three height control points to approximate the local heights. • More than three points: Best fitting average plane.
Advantage	• Errors in height do not propagate into errors in position since the height and position transformations are separated. • The height points and position points do not have to be the same points. • No parameters of the local ellipsoid and map projection is required. • Parameters may be computed with a minimum of points. Care should be taken when computing parameters using just one or two local points as the parameters calculated are valid in the vicinity of the points used for the transformation.
Disadvantage	Restriction in the area over which the transformation can be applied. This is mainly due to the fact that there is no provision for scale factor in the projection. • The accuracy in height depends on the undulation of the geoid. The bigger the geoid variations the less accurate the results are.

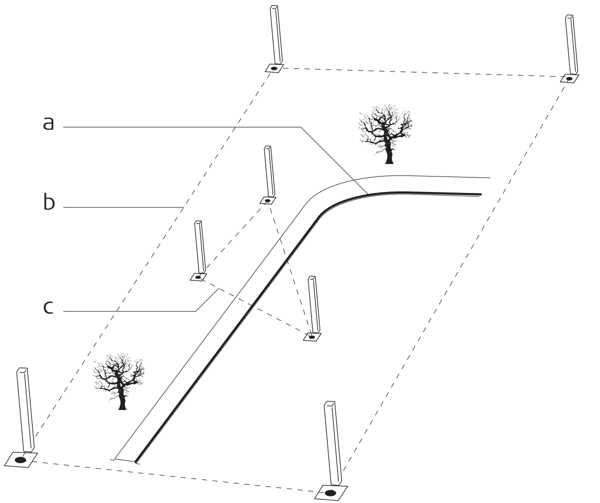
Requirements to determine a transformation

To determine a transformation it is necessary to have common control points whose positions are known in both WGS 1984 coordinates and local coordinates. The more points that are common between datums the more accurately the transformation parameters can be calculated. Depending on the type of transformation used, details about the map projection, the local ellipsoid and a local geoidal model program may also be needed.

Requirements forcontrol points

The control points used for the transformation should surround the area for which the transformation is to be applied. It is not good practice to survey or convert coordinates outside of the area covered by the control points as extrapolation errors may be introduced. **Milling must not be carried out outside the area enclosed by the control points.**

Diagram of control point distribution



a) Reference Line
b) Control points in Local and WGS coordinate system with good distribution
c) Control points in Local and WGS coordinate systems with unable distribution

6.8 Determining a New Coordinate System (Transformation) Onboard the MNS1200 Sensor

Description

Before a transformation can take place onboard the MNS1200 sensor it is necessary to have both the local coordinate system information and the corresponding WGS 84 coordinates on the sensor.

☞ MNS sensor must have the survey option enabled.

Manually entering local coordinates

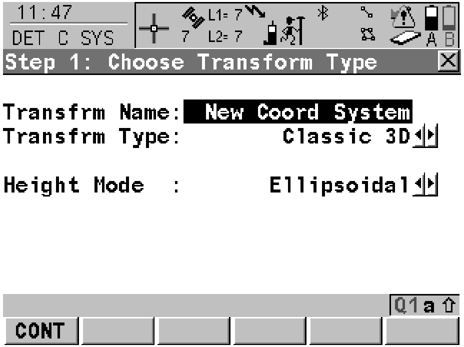
If a limited number of reference points are being used local coordinates should be manually entered onto the sensor before carrying out the transformation.
Care should be taken not to introduce transcription errors when entering the fixpoint coordinates manually.
Refer to GPS1200 Technical Reference Manual for more information.

Uploading local coordinates from LGO

If a large number of coordinates are being used to perform the transformation they may be uploaded directly from LGO.
Refer to GPS1200 Technical Reference Manual and LGO help files for more information.

Determine a New Coordinate system
Access step by step

Step	Description
1.	Select **<Method: Normal>**.
2.	**CONT (F1)** to access **DET C SYS Step 1: Choose Transform Type**.



CONT (F1)
To confirm the selections and to continue withthe subsequent screen.

Description of Fields

Field	Option	Description
<Transfrm-Name:>	**Userinput**	A unique name for the transformation. The name may be up to 16 characters in length and may include spaces. If a coordinate system is being updated then its name is displayed.
<Transfrm-Name:>	**Onestep**, **Twostep** or **Classic 3D** Output	The type of transformation to be used when determining a coordinate system. Available when determining a new coordinate system. Available when updating a coordinate system. The transformation type shown is the same as the transformation used in the existing system.
<Height-Mode:>	**Orthometric** or **Ellipsoidal** Output	The height mode to be used in the determination of a coordinate system

Next Step

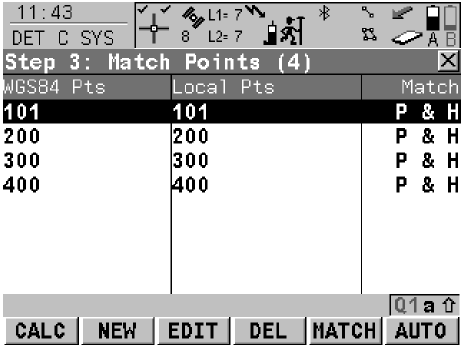
CONT (F1) continues to **DET C SYS Step 2: Choose Parameters**.

Next Step

The geoid model to be used in the transformation. Geoid models from **MANAGE Geoid Models** can be selected.
CONT (F1) continues to **DET C SYS Step 3: Match Points (n**), not required for One Step transformations.

DET C SYS Step 3: Match Points (n)

This screen provides a list of points chosen from **<WGS84 Pts Job:>** and **<Local Pts Job:>**. The number of control points matched between both jobs is indicated in the title, for example **DET C SYS Step 3: Match Points (4)**. Unless there is no pair of matching points in the list all softkeys are available.



CALC (F1)
To confirm the selections, compute the transformation and continue with the subsequent screen.

NEW (F2)
To match a new pair of points. This pair is added to the list. A new point can be manually occupied.

EDIT (F3)
To edit the highlighted pair of matched points.

DEL (F4)
To delete the highlighted pair of matched points from the list.

MATCH (F5)
To change the type of match for a highlighted pair of matched points. Refer to "Description of columns".

AUTO (F6)
To scan both jobs for points that have the same point ID. Points with matching point ID's are added to the list.

Description of columns

Column	Description
WGS84 Pts	The point ID of the points chosen from <WGS84 Pts Job:>.
Local Pts	The point ID of the points chosen from <Local Pts Job:>.
Match	The type of match to be made between the points. This information is used in the transformation calculation. **P**osition **&** **H**eight, **P**osition **only**, **H**eight **only** or **None**. • For **<Transfrm Type: Onestep>** or **<Transfrm Type: Twostep>** possible options are **P & H**, **P only**, **H only** or **None**. • For **<Transfrm Type: Classic 3D>** possible options are **P & H** or **None**. **None** removes matched common points from the transformation calculation but does not delete them from the list. This can be used to try and improve the residuals that are obtained when calculating the transformation, when the point that is the problem is not known.

For more information on matching points refer to GPS1200 User Manual.

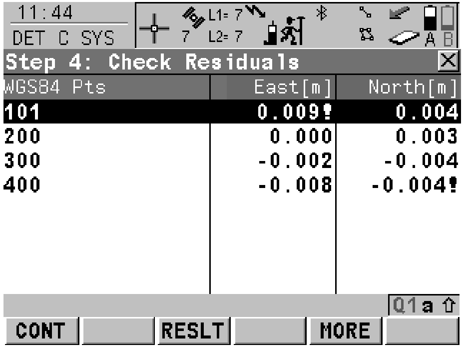
Next step

CALC (F1) computes the transformation and continues to **DET C SYS Step 4: Check Residuals**.

Refer to paragraph "DET C SYS Step 4: Check Residuals".

DET C SYS Step 4: Check Residuals

Displays a list of the matched points used in the transformation calculation and their associated residuals.



CONT (F1)
To accept the residuals and to continue with the subsequent screen.

RESLT (F3)
To view results of the transformation. Accesses **DET C SYS TransformationResults**.

MORE (F5)
To display information about height residuals.

Description of columns

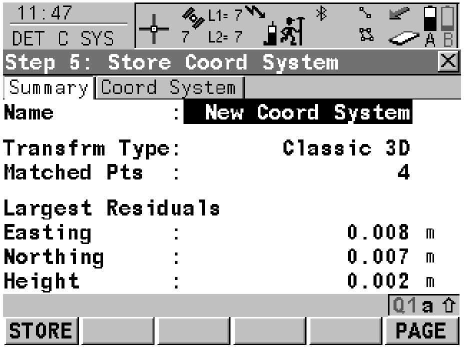
Column	Description
WGS84 Pts	The point ID of the points chosen from **<WGS84 Pts Job:>**.
East	The Easting residual. If positions were not used in the transformation calculation then ----- will be displayed.
North	The Northing residual. If positions were not used in the transformation calculation then ----- will be displayed.
Height	The Height residual. If heights were not used in the transformation calculation then ----- will be displayed.
!	Indicates residuals that exceed the residual limit defined in **DET C SYS Configuration**, **Residuals** page.
!	Indicates the largest residual in **East**, **North** and **Height**.

Next Step

IF the residuals are	THEN
unacceptable	**ESC** returns to **DET C SYS Step 3: Match Points (n)**. Matched points can be edited, deleted or temporarily removed from the list and the transformation recalculated.
acceptable	**CONT (F1)** continues to **DET C SYS Step 5: Store Coord System**.

DET C SYS Step 5: Store Coord System, Summary page

This screen consists of the **Summary** page and the **Coord System** page. The **Coord System** page contains different fields, depending on what transformation type was chosen in **DET C SYS Step 1: Choose Transform Type**. The explanations for the softkeys given below are valid for all pages.



Store (F1)
To store the coordinate system to the DB-X and return to **GPS1200 Main Menu**.

PAGE (F6)
To change to another page on this screen.

Description of Fields

Field	Option	Description
<Name:>	User input	The name of the coordinate system can be changed. The name may be up to 16 characters in length and may include spaces.

Field	Option	Description
<Transfrm-Type:>	Output	The type of transformation used, as defined in **DET C SYS Step 1: Choose Transform Type**.
<MatchedPts:>	Output	Number of matched points, as defined in **DET C SYS Step 3: Match Points (n)**.
<Easting:>	Output	Largest Easting residual from the transformation calculation.
<Northing:>	Output	Largest Northing residual from the transformation calculation.
<Height:>	Output	Largest Height residual from the transformation calculation.

Next Step

PAGE (F6) changes to the **Coord System** page. Refer to paragraph "DET C SYS Step 5: Store CordSystem, Coord System page".

DET C SYS Step 5: Store CordSystem, Coord System page

For **<Transfrm Type: Onestep>** Description of fields.

Field	Option	Description
<Residuals:>	None, 1/DistanceXX or Multiquadratic	The method by which the residuals of the control points will be distributed throughout the transformation area.
<GeoidModel:>	Output	Name of geoid model used, as defined in **DET C SYS Step 2: Choose Parameters**.

Next Step

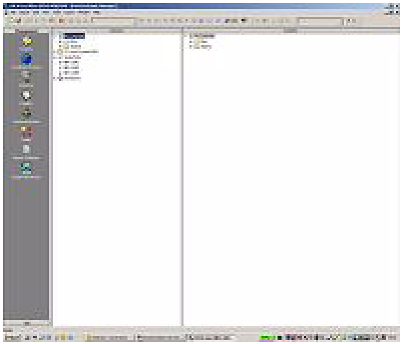
STORE (F1) stores the coordinate system to the DB-X and attaches it to the **<WGS84 Pts Job:>** selected in **DET C SYS Determine Coord System Begin**, replacing any coordinate system attached to this job. **<WGS84 Pts Job:>** becomes the active job.

6.9 Downloading Files to/from the Instrument in LGO

Downloading files from the sensor

The Data Exchange Manager component of LGO can be used for transferring files to / from the Sensor to the hard disk of your PC (Download) using **Serial communication**.

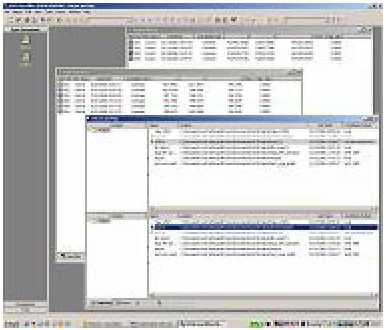
Access Step by Step

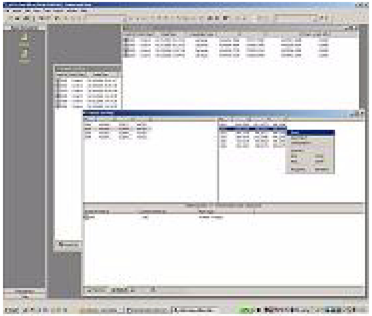
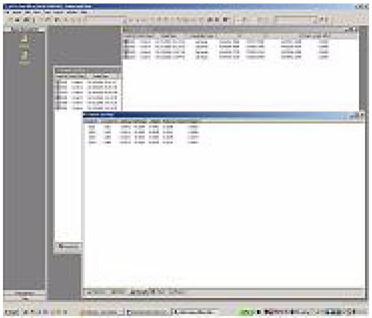
Step	Description
1.	Connect the MNS1200 to the serial port of your computer using the datatransfer cable.
☞	With MNS1200 instruments ensure that the serial cable is attached to a port which is not configured to any other interface (such as Real-Time or NMEA).
☞	To configure a port on the MNS1200 sensor, refer to the MNS1200 Technical Reference Manual.
2.	From the **tools** menu select the **Data Exchange Manager**.
3.	 In the left-hand side of the tree-view, open the **COM port** node to which your instrument is connected. Select the file you want to transfer. Files can only be copied from a directory in the **Files** directory of either the PC-Card or Internal memory device.
4.	In the right-hand side tree-view of the Data Exchange Manager open the Files folder of the My Computer location and select the sub-directory where the files will be transferred to.

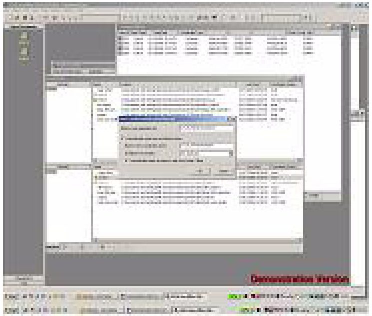
Step	Description
5.	Drag and Drop (Copy and Paste) the file to the selected sub-directory on your hard disk.
	The same procedure is used for copying file back onto the sensor.
	Select the file with coordinate details of the WGS 84 control points and copy it to the projects folder on the hard drive of the computer. The LGO software can now be used to perform a transformation on the GNSS (GPS / GLONASS) data.
	If the local fixpoints coordinate file has not been created in LGO then another project must be created containing details of the local coordinate system. This is carried out by: • Connecting the TPS instrument and downloading the details from the TPS; • Transferring data from the memory card held in the TPS via a memory card port; • By importing an ASCII file into a new job in LGO. For more details refer to the TPS1200+ User Manual and the LGO help files

6.10 Determining a New Coordinate System (Transformation) in LGO

Performing a transformation in LGO
Access step by step

<table>
<tr><th>Step</th><th>Description</th></tr>
<tr><td>1.</td><td>To perform a transformation in LGO open the Tool / Datum/Map tool.
In order to determine transformation parameters two sets of coordinates must be selected.
These two coordinate sets are always stored in the Projects directory. Upon starting Datum/Map the Selection View lists all available Projects in an upper and a lower Explorer-View.
System A, the upper view represents the points to be transformed.
System B, the lower view represents the control or pass points into which System A is to be transformed.

To select two sets of coordinates:
From the upper View select a Project as the system A. This will contain the WGS 84 coordinates
From the lower View select a Project as the system B. This will contain the local coordinates.</td></tr>
<tr><td>2.</td><td>The transformation type is displayed in the status bar between the upper and the lower window. The default transformation type is the last used.
Configure the transformation type and parameters.
Refer to the LGO help files for more information on transformation types.</td></tr>
</table>

Step	Description
3.	The Match tab at the bottom of the view will be active once the two coordinate sets have been selected. Click on this tab to continue.
	The Match View enables you to select the common points of system A and system B, which are used to determine the transformation parameters.
4.	 After selecting the Match icon a screen will appear with the System A (WGS 84) coordinates on the left hand side and System B (Local coordinates) on the right hand side. Match the corresponding data points by selecting the two points and pressing the left hand mouse button. A drop down screen will then appear. Press **Match**. Repeat this process until all corresponding data points are matched.  Tab to the Results page at the bottom of the window and view the residuals. These should all be under 25 mm. If they are not the measurement process should be repeated.

Step	Description
5.	 Save the transformation parameters. Enter a file name for the transformation and save it onto the hard drive.
6.	In the manage dialog copy the transformation file "*.DAT" back onto the sensor.

6.11 Uploading a Trafoset to a GNSS (GPS / GLONASS) Sensor with PaveSmart 3D

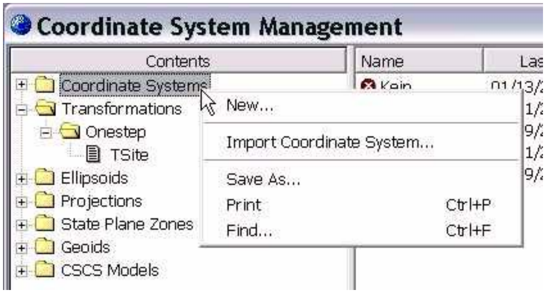
Existing Trafoset

For construction projects a lot of surveying work is done in advance. It's quite likely, that for this tasks a GNSS (GPS / GLONASS) sensor was used and therefore a Coordinate System or Trafoset already exists.

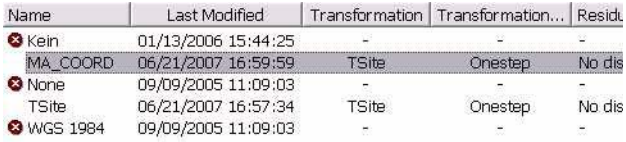
Preparing the Trafoset in LGO

In LGO (Leica Geo Office) open the **<Coordinate System>** window:

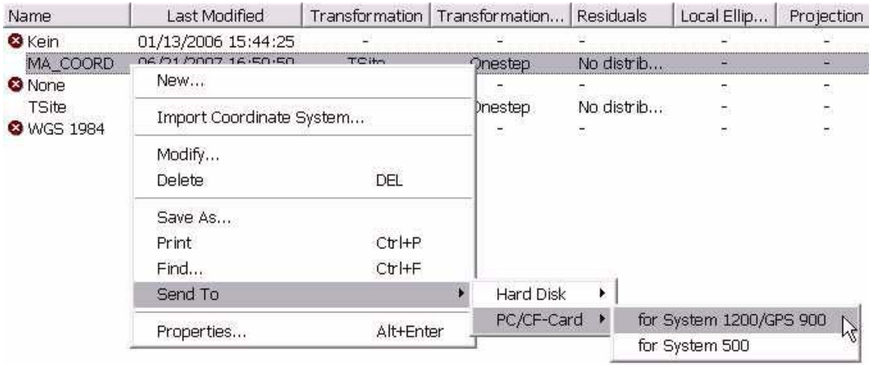
<Import Coordinate System...> by right clicking on the Coordinate Systems folder:



Once the Coordinate System is in LGO, it has to be renamed to **<MA_COORD>**. The correct name is very important for the whole successful transfer process to the GNSS (GPS / GLONASS) sensor.



After renaming the Coordinate System it is sent to the USB storage device by right clicking on the name:



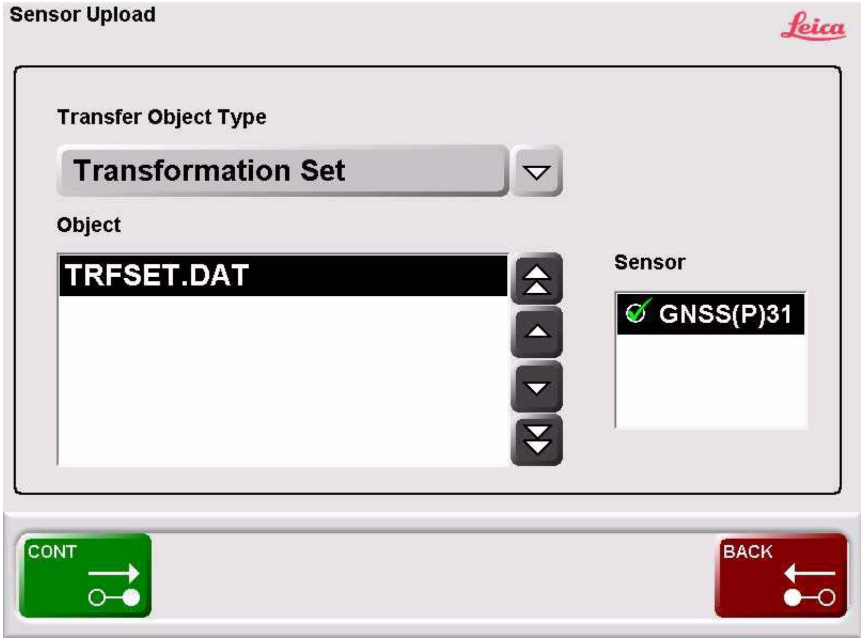
Finally you have the file **<TRFSET.DAT>** in the **\ DBX folder** of the USB storage device.

☞

- If you don't have a Leica Coordinate System available but all the transformation parameters, it's possible to create a new Coordinate System by entering all the parameters. Please refer to the LGO help function.
- A new Coordinate System can also be calculated in LGO from previous GNSS (GPS / GLONASS) measurements taken on site. Please refer to "6.10 Determining a New Coordinate System (Transformation) in LGO".
- It's very important to check with an RX1200 terminal on the MNS1200 sensor if the correct Coordinate System is selected. Furthermore it's recommended to verify your Coordinate System on the job site by measuring some control points, before commencing milling.

Uploading the Trafoset with PaveSmart 3D

Open the following dialog: **Menu: Projects \ Exchange**.



The **<Transfer Object Type: Transformation Set>** is set by default and can't be changed.

In **<Object>** the Transformation Set **<TRFSET.DAT>** is shown. It has to be selected, so the background colour is displayed in black.

On the right side in **<Sensor>** the currently connected sensors are listed. You have to tick the GNSS (GPS / GLONASS) sensor on which you want to upload the Transformation Set.

The Transformation Set is uploaded automatically by PaveSmart 3D. On the GNSS (GPS / GLONASS) sensor the uploaded Transformation Set with the name **<MA_COORD>** is set as the currently used transformation. No further settings have to be made on the GNSS sensor.

☞ It's very important to check with an RX1200 terminal on the MNS1200 sensor if the correct Coordinate System is selected. Furthermore it's recommended to verify your Coordinate System on the job site by measuring some control points, before commencing milling.

6.12 Preparing the GNSS (GPS / GLONASS) Rover on the Machine for Milling

Mounting the GGNSS (GPS / GLONASS) on the milling machine

Once the transformation parameters have been established the GNSS (GPS / GLONASS) can be mounted onto the milling machine.

1. The antenna must be mounted on the left or right Mast position and connected to the antenna cable.
2. The MNS1200 sensor must be mounted on the milling machine and all cables connected. See diagram in chapter "13 System Installation and Components".
3. Connect the RX1200 terminal and ensure the correct transformation is selected.

Step	Description
1.	In **SURVEY Survey Begin** select the job containing the transformation parameters for the site.
	The transformation parameters will be set in the **Coord System** field.
2.	Select a typical configuration set with **<R-Time Mode: Rover>**. The GNSS (GPS / GLONASS) on the milling machine must always be the rover.
3.	Select the appropriate antenna type.
4.	**CONT (F1)** to access **SURVEY Survey:** .
	The arrow of the real-time device and real-time status icon flashes when real-time messages are being received.
	Fixing ambiguity begins. The current position status is indicated by the position status icon. When working with code only corrections, an ambiguity solution is not attempted.
	The position mode icon is the moving icon. This indicates that the antenna can be moved around and that no static observations are being recorded.
5.	Coordinates of the milling machines position are now being calculated. Ensure that the 3D quality is under 0.02 m before starting to mill.

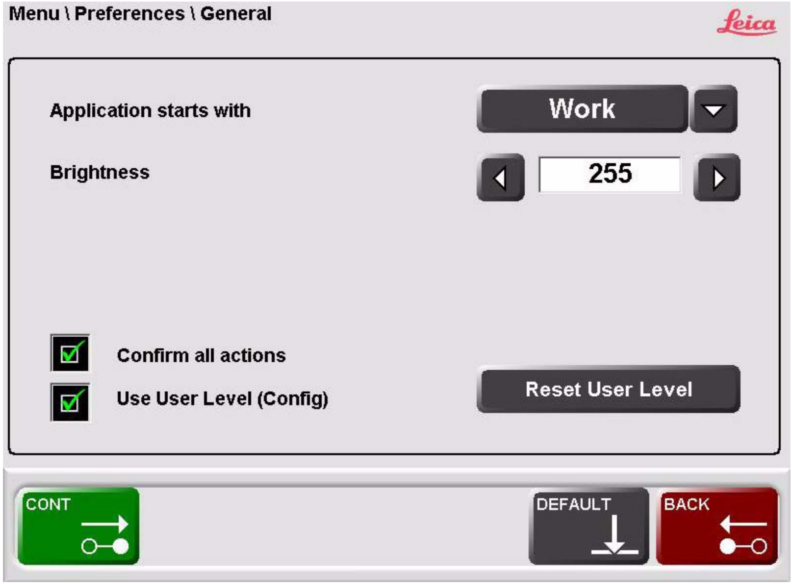
Step	Description
6.	The GNSS (GPS / GLONASS) should be left in this state while milling.
☞	**Do not** press the **OCUPY** button.
☞	Refer to the GPS1200 Technical Reference Manual for more information.

7 Setting the Operators Preferences

Introduction

Leica PaveSmart 3D gives the operator the ability to change a number of user preferences to customise the system to their individual needs. Below is a description of the most common parameters which may be changed.

Setting general



<Application Starts with> Selects the application Leica PaveSmart 3D will start in. The Work dialog (default), Main dialog, Projects dialog or the Job dialog can be selected.

<Brightness> Choose a value in between 2 (dullest) and 255 (brightest).

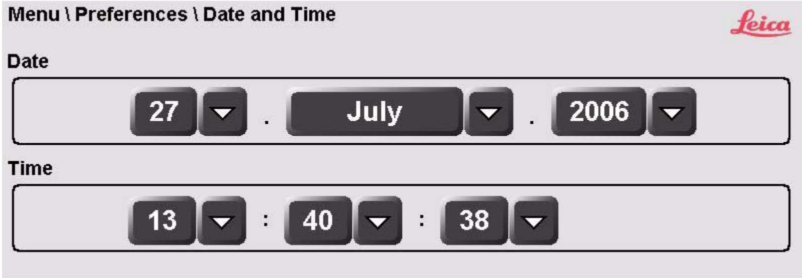
<Confirm all actions> If not activated, all changes are immediately rejected when pressing **DEFAULT** or **RESET**. If activated, an additional message box will ask if you are sure you want to reject any changes made after pressing **DEFAULT** or **RESET**.

<Use User Level (Config)> Leica PaveSmart 3D is divided into three access levels.

- Level 1 - Operator level:
  This allows for all daily operations to be carried required for production. All configuration and Service tools are deactivated to the user.
- Level 2 - Configuration level:
  This allows configuration of the system. Access to this user level is required to adjust the tuning, set the stop rules, and change the user preferences. The Config. user level is deactivated by selecting, not to use the **<Use User Level (Config)>**. All configuration tasks will be accessible in the operator level. The configuration level password is 007.
- Level 3 - Service level:
  This is intended for service personal to install the system and for rapid trouble shooting if any problems arise.

Enter the current Date and time zone

Menu/Preferences/Date and Time



The Day, Month, Year and current time can be set in the **Menu/Preferences/Date and Time** dialog

☞ Changing the date and time settings in Leica PaveSmart 3D also changes the windows date and time settings. All logfiles are timestamped relative to this clock.

Choosing the appropriate Units

The **Menu/Preferences/Units** dialog allows the unit settings to be customised to your needs. The unit options are:

- **<Distance>** US Feet (ft)(default), International Feet (fi) , Meter(m)
- **<Angles>** 360 dec. (deg) (default), 400 gon (gon)
- **<Slope>** Percent (%), 360 dec. (deg) (default), 400 gon (gon)
- **<Speed>** US Feet/min (ft/min)(default), Meter/min (m/min)
- **<Time>** Seconds (s)(default)
- **<Stationing>** +1234+56.7

8 Quality Control

8.1 Taking and Recording As-Built Measurements

Description

To check elevation and position during production, Leica PaveSmart 3D has an integrated as-built **<Control>** function to replace the manual **dipping** method used when milling on stringline.

☞ The tool is very helpful to check and compare the design height and the projected milling depth at the start points. It will recommend to calibrate the system using the set value at the controller or the here function at Leica PaveSmart 3D.

Before taking as built measurements

- Ensure the client (project owner) accepts this method of as-built check before production starts.
- For the integrated as-built control function to operate correctly, the instrument must be turned on, running MGuide and in radio-contact with the MPC.
- Measurements are only possible if the instrument is correctly positioned and orientated within the project coordinate system (Resection or Known Point set-up).
- As Builts checks can only be performed with the spare TPS sensor while the system is in active control.

Taking As built (control) measurements

- All **<Control>** measurements are relative to the actively selected reference line.
- When using single stringline design files the elevation deviation between the design and the as-built measurement is given to the top back of kerb.

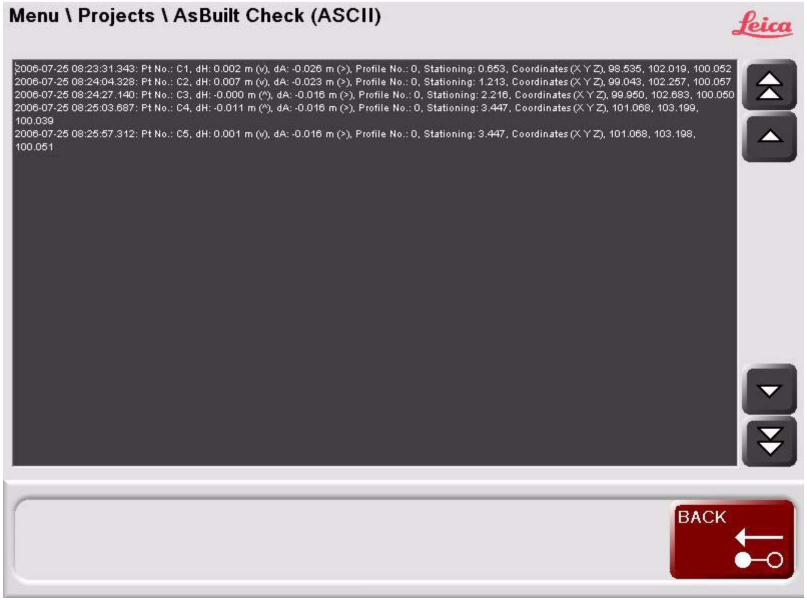
  ☞ Cross slope is not taken into consideration.
- If a slope line is selected the elevation deviation is calculated relative to the slope calculated from the slope line.

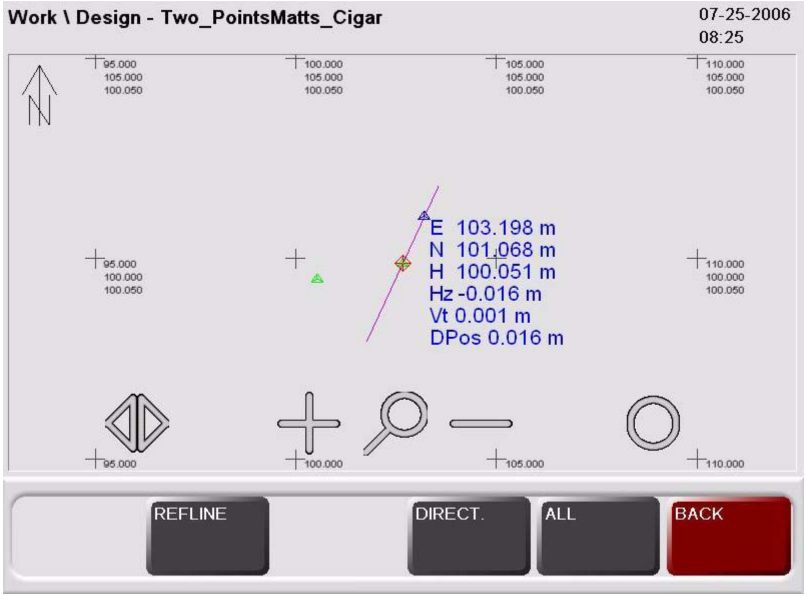
☞ Any Slope offsets entered into the **<Work \ Offsets \ Slope Offsets>** dialog are not taken into consideration when performing as-built checks.

☞ Refer to the MGuide User Manual for your instrument type for detailed instructions on making as-built measurements

Viewing As-built results

The as-built results are seen in the as-built logfile in the **Menu\Projects\As-Built** dialog. The coordinates of the as built point and the offsets to the design are also displayed in the **Work\Design** dialog immediately after being recorded.
The results are also displayed on the TPS screen used to make the **<control>** measurement.




Work \ Design - Two_PointsMatts_Cigar
07-25-2006
08:25
95.000
105.000
100.050
100.000
105.000
100.050
105.000
105.000
100.050
110.000
105.000
100.050
N
E 103.198 m
N 101.068 m
H 100.051 m
Hz -0.016 m
Vt 0.001 m
DPos 0.016 m
95.000
100.000
100.050
110.000
100.000
100.050
95.000
100.000
105.000
110.000
REFLINE
DIRECT.
ALL
BACK

As-Built (Control) Measurements Log-files

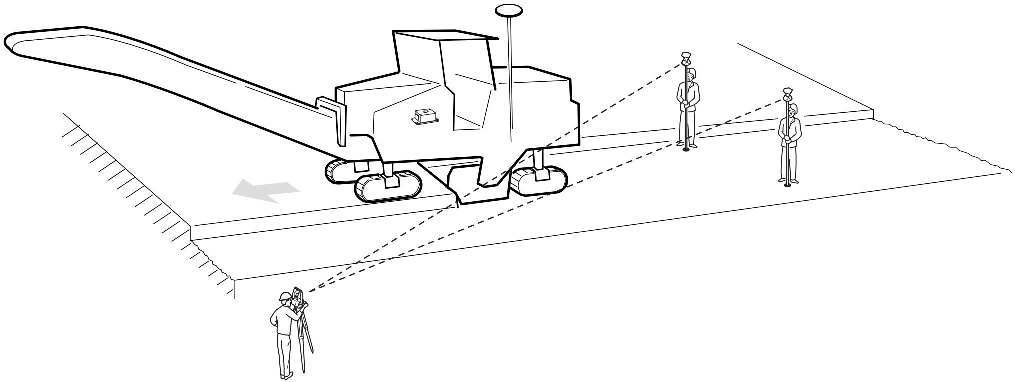
A comma-separated As-Built log file, able to be imported into Excel or CAD systems for 3D plotting of as-built results is recorded. Data recorded in this file includes:

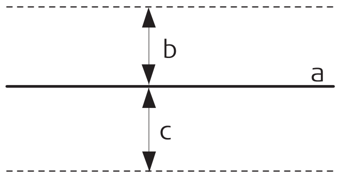
Field	Description
Date and Time	Date and Time of measurement
Pt	Point number
dH	Height deviation from Design-value (not including Working Offsets)
dA	Position deviation from Current RefLine (not including Working Offsets)
Prof no.	Selected Reference line
Ch	Stationing (Chainage)
XYZ	As-built Control point coordinates
ReflHt	Reflector (prism) height used to take measurement

Description of correction and deviation conventions

The diagrams below detail the arrow conventions used in the as built **<control>** function in Leica PaveSmart 3D and MGuide.

UP and Down arrow





a) Design

b) Positive Offset from design or Negative Correction.
⇩ Down arrow diesplayed in correction dialog and in the as-build file.

a) Negative Offset from design or Positive Correction.
⇧ Up arrow diesplayed in correction dialog and in the as-build file.

Additional Data Validation options

Leica's RoadRunner Application for TPS1200+ instruments can also be used for data validation. RoadRunner supports the same DBX file format as Leica PaveSmart 3D and has additional road stakeout functionality.

☞ Refer to the RoadRunner Technical Reference Manual for more information

8.2 Recording and Managing Logfiles

Purpose

Leica PaveSmart 3D can generate various logfiles, to record system actions/events. Most are used only for trouble shooting / support purposes, but some, such as the **<As-Built logfile>** are very useful for Quality Assurance purposes, and can be used to generate as-built drawings.

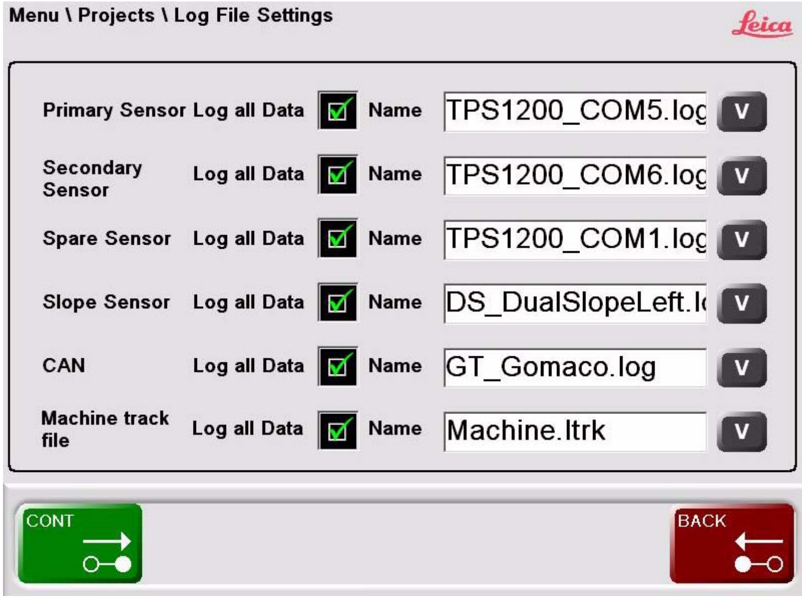
- As-built logfiles are accessed in the **<Menu\Projects\AsBuilt>**
- Senor logfiles are accessed in the **<Menu\Projects\Logfiles>**

☞ Logfiles can grow very large very quickly, and may fill up the MPC1310 hard disk, leading to unexpected system behavior or a Windows XP problem. The user must remember to delete or export the contents of the log files and delete the original on a daily basis.
If the log file is too large the system may stop recording data. A warning message will first appear in the dashboard informing the operator that the disk drive is reaching capacity.

☞ If experiencing difficulties with Leica PaveSmart 3D system, a Leica-authorised Support Engineer may request that one or more of these files are recorded and the results sent to Leica for detailed analysis.

Sensor Logfiles (for system supporters only)

Sensor log files are only accessible through the password protected Service Mode.
Senor log files are stored in the **<Menu\Projects\Logfiles>** dialog.
All sensor components are listed, as well as a machine track file, which incorporates information from all of the sensors. If a log file is to be generated, tick the appropriate checkbox.
To **View** the logfile press the **<v>** button
Measurements of each of the sensors are continuously recorded if selected.



Recording and Exporting Logfiles

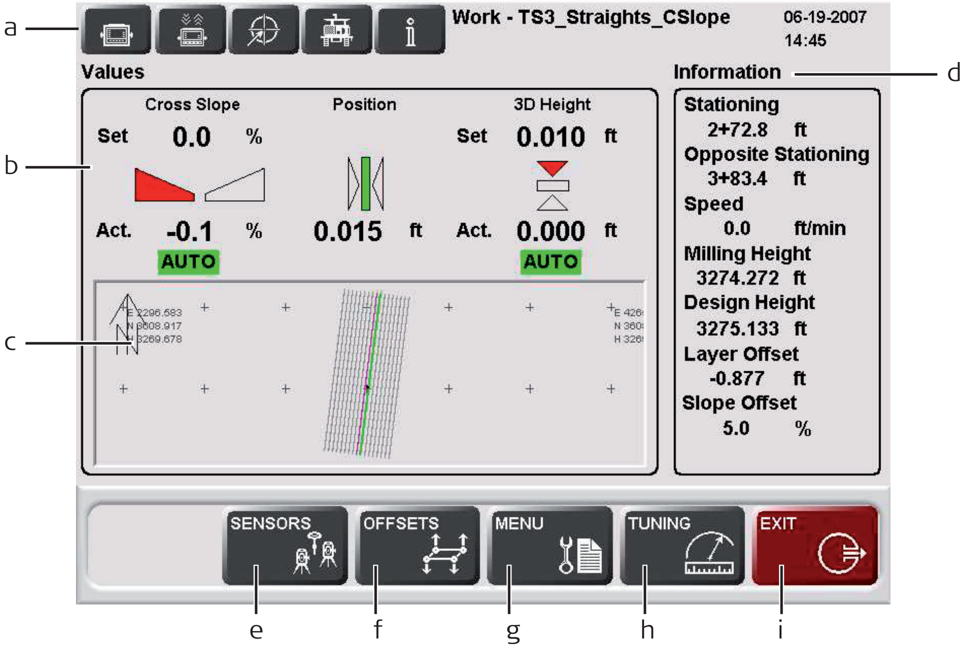
All logfiles are saved in the **C:\Program Files\Leica Geosystems\Leica PaveSmart 3D\Projects\....** directory of the MPC1310.

9 System Operation

9.1 Software and Calculation Description

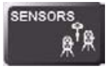
Work dialog

The Software is divided into two different areas. All production tasks are carried out in the **Work** dialog.



The Work dialog screen shows all the information needed while the machine is in operation.

a) **Dash-board / Error messages**: the specific icon flashes yellow if a warning is detected or flashes red if an error occurres. By pressing on the specific button additional information and troubleshooting tips will be displayed.
   1.) MPC1310 messages
   2.) Communication messages
   3.) Sensor messages
   4.) Machine messages
   5.) Software messages
b) **Corrections**: indicates the required corrections for the elevation and cross slope of the milling head and the position of the milling head. For example, if the height correction shows 0.010 (in m or ft), the machine has to lower the milling head by 0.010 (in m or ft). The values and settings are exactly the same as those displayed on the machine controller and can be changed manually on the controller or automatically through PaveSmart 3D.
c) **Information**: provides information about the work progress.
   - Stationing is calculated at the reference line.
   - Opposite Stationing is calculated from the project data end.
   - Speed is the actual machine calculated from the measurement data.
   - Milling Height is the actual drum height at the ground (at the bottom of the drum).
   - Design Height is the project height at the actual drum centre position.
   - Layer offset is the cutting depth.
   - Slope offset is the offset between design slope or the independent calibration value to the machine slope sensor.
d) **Stationing**: shows current Stationing or Chainage (in m or ft).
e) **Opposite Stationing**: shows the inverted Stationing or Chainage, the difference to the end (in m or ft).
f) **Speed**: indicates current Speed of the machine (in m/min or ft/min).
g) **Design display**: shows the whole project and the current machine position.

h) 

open the Sensor dialog to manage the TPS and GNSS (GPS / GLONASS) sensors.

i) 

open the Offset dialog to set the working offsets relative to the stringline.

j) 

open the Menu dialog to configure the Leica PaveSmart 3D software.

k) 

open the Tuning dialog to set the hydraulics parameters for the machine.

l) 

press and hold for more than 1 second to stop Active Control and in a second step to close the software and shut down the MPC1310.

☞ **Do not power off the MPC1310 by holding down the Power Key!** Always shut down the MPC1310 by using the Exit button to ensure all important project data are saved.

9.2 Leapfrogging (Swapping Total Stations)

Purpose

Leapfrogging refers to the method of swapping measurement from a machine prism from a TPS (primary) in active control to the spare TPS. This is usually required when the machine has reached a predetermined distance away from the total station, for example 100 m (300'), or an obstacle blocks the line of sight to the prism.
A Leapfrog is a fully automatic process, but the user may choose to adjust the Working Offsets to accommodate any change in Deviations due to inbuilt errors in the Fixpoint (Reference Point) network, or where instruments have been allowed to stand for a long period of time at one location, and the quality of the TPS setup and orientation has deteriorated due to, factor such as vibration, high wind, thermal expansion/contraction effects etc.

Adjusting the working Offsets

In Leica PaveSmart 3D, the **Work\Sensors\Leapfrog** is able to automatically adjusts the Working Offsets to produce new Deviations, which are inside the **deadband** of the machine. This will prevent **steps** in the surface of the material when the machine moves again. The user can choose to override this feature and make manual adjustments to the Working Offsets if desired.

☞

The maximum operating distance between instrument and machine will vary according to:
- Temperature
- Humidity
- Weather Conditions
- Air Quality

Leica Geosystems recommends a **maximum distance** from instrument to machine of 200 m (600'), however this is **often not achievable** due to the above influences. It is the **customer's responsibility** to ensure that construction tolerances and required surface smoothness are being achieved, and to regulate the maximum measurement distance accordingly.

Setting the leapfrog method

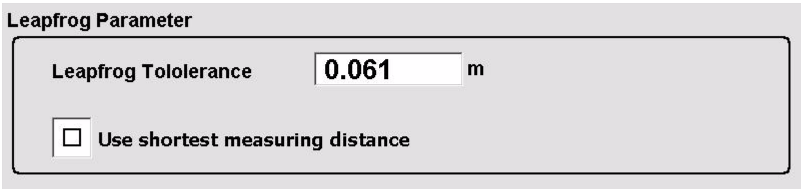
The leapfrog command will automatically take the nearest or furthest TPS measuring out of active control of the milling machine and replace it with the spare TPS. This is set in the **<Work\Sensors\Arrange>** dialog.

If the **<Take over from shortest measuring distance>** check box is selected the TPS with the shortest measuring distance will be removed from active control of the milling machine and replaced with the spare TPS.

If the **<Take over from shortest measuring distance>** check box is **not** selected the TPS with the longest measuring distance will be removed from active control of the milling machine and replaced with the spare TPS (this is the default setting).

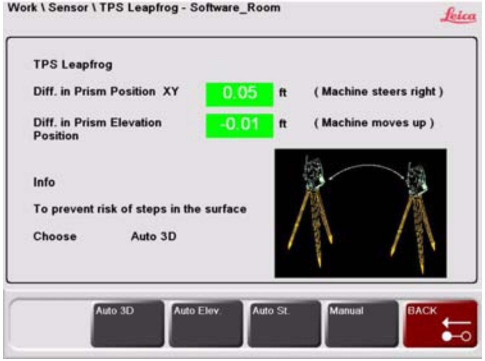
The maximum allowable deviation between the existing TPS coordinates and the new TPS coordinates is set in the **<Work\Sensors\Arrange\Leapfrog tolerance>**. If this deviation is exceeded a warning message will be displayed informing the operator. This may occur if the set-up quality of either the TPS in active control of the milling machine or the spare TPS is not acceptable.

If using a Hybrid GNSS (GPS / GLONASS)\TPS solution the leapfrog will always swap the Spare TPS to the Primary position sensor.



Swapping TPS -Making a leapfrog step by step

Step	Description
1.	Set-up the Spare TPS and ensure that it is communication with Leica PaveSmart 3D, and they are in the MGuide **<Tracking>** Screen.
2.	Before swapping a TPS the machine must be stationary and out of active control. If the machine is moving the spare instrument will not be able to lock onto the prism and erroneous measurements may result.
3.	Enter the **<Work\Sensors\Leapfrog>** dialog. The leapfrog will automatically take place and the spare TPS will turn to the Primary or Secondary prism depending on the settings in the **<Leapfrog parameters>**. The TPS which has just been swapped will start tracking automatically.
4.	A calculation between the coordinates of the old sensor measurement and the new sensor measurement is carried out. If the deviation is less than the specified in the **<Leapfrog parameters>** Leica PaveSmart 3D will prompt the user to select a method for dealing with the deviations between the two measurments.
☞	Auto 3D is the recommended method to prevent steps appearing in the finished product.

<table>
<tr><th>Step</th><th>Description</th></tr>
<tr><td>5.</td><td>


<Auto 3D> The difference in elevation between the active measurement and the new measurement will be applied to the elevation offset at the milling drum.
The difference is position to the reference line between the active measurement and the new measurement will be applied to the steer offsets.
<Auto Ht> The difference in elevation between the active measurement and the new measurement will be applied to the elevation offset of the milling drum.

The steering offsets will remain as they were before the leapfrog. This may result in the machine moving left or right when put into active control.

<Auto St.> The difference in position between the active measurement and the new measurement will be applied to the steer offsets.

The elevation offsets will remain as they were before the leapfrog. This may result in the machine moving up or down when put into active control.
</td></tr>
</table>

Step	Description
	<Manual> The elevation and steering offsets will remain as they were before the leapfrog. This may result in the machine moving left or right and up or down when put into active control. **<Back>** Takes the user back to the last screen and the leapfrog is not carried out.

9.3 Search

Introduction

The **search** function in Leica PaveSmart 3D is used to find a reflector when a TPS losses lock. This may be useful if the line of sight to the reflector is temporarily obstructed during the course of milling.

From the **Work/Sensor** dialog select the sensor which is to search for the prism and press the search button. The search button is deactivated while the system is in control and if no sensor has been selected.
A command is sent to the TPS to perform a search based on the settings in the MGuide application. For more information refer to the MGuide User Manual.

☞ The search function is not required with a GNSS (GPS / GLONASS) sensor.

9.4 Check

Introduction

Observing survey best practice is the key to maximum milling accuracy with Leica PaveSmart 3D. Poorly positioned or orientated instruments may have a serious effect on milling quality. The **Check** procedure should be carried out regularly, ideally during breaks in milling operations, for example while waiting for trucks, to ensure no undetected movement of the total stations has occurred which may be due to excessive vibrations, bad sub ground of the tripod, high wind, temperature cycling effects etc. This is also very important when the instrument has been standing for a long time (> 2 hr) at the same setup.
For more information on performing check measurements refer to the Leica PaveSmart 3D User Manual.

10 Offsets

10.1 Offset Conventions

Introduction

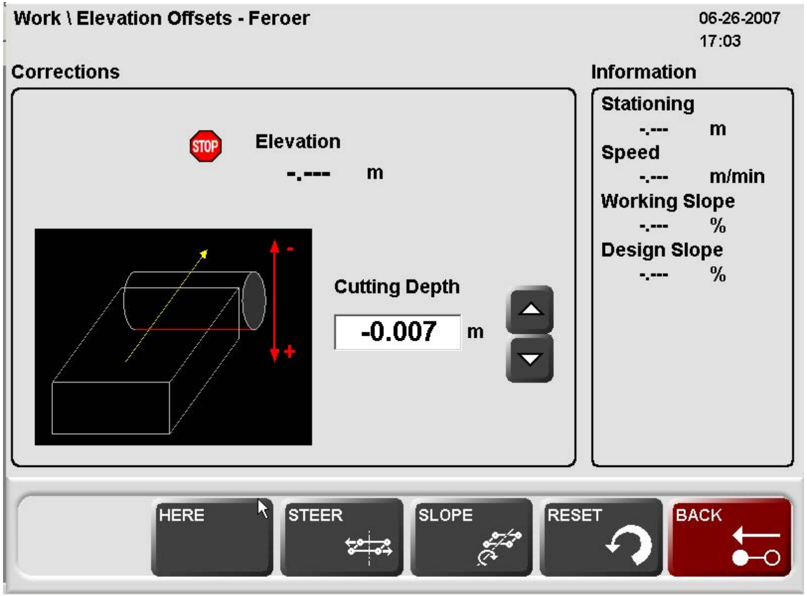
When using Leica PaveSmart 3D the machine will always be controlled to the active stringline selected in elevation and slope, and always relative to the current working direction of the machine.

On occasion it may be necessary to control the machine at a constant, additional offset to the design in order to match into existing features not detected when the design was made, adjust small errors which may have be introduced due to imperceptible movements of TPS instruments, alter the amount of milling depth and slope sensor fine calibration.

In Leica PaveSmart 3D it is possible to change the elevation, steer and slope offsets relative to the selected reference line.

Elevation Offsets

Elevation offsets are entered in the **Work/Offsets/Elevation** dialog.



If a positive **Cutting Depth** is entered, the machine will be controlled below the design, and if a negative offset is entered, the machine will be controlled higher than the design.

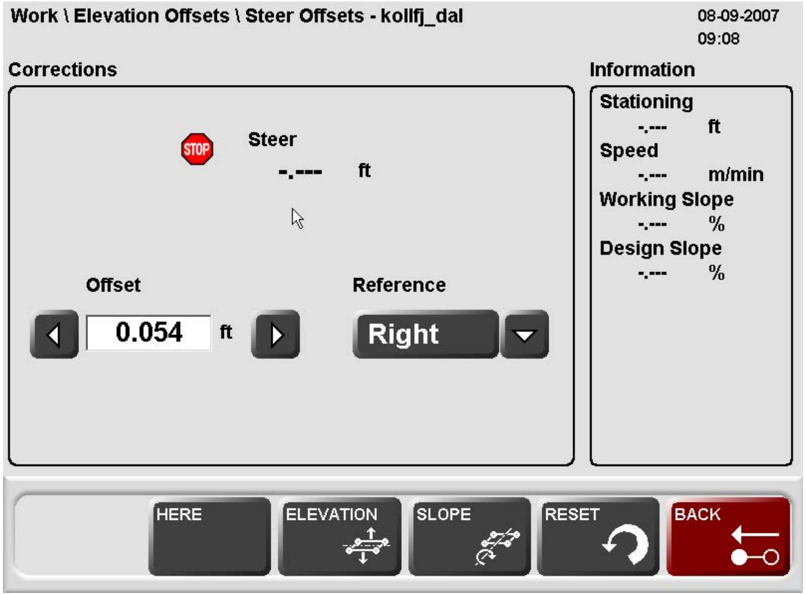
The Cutting Depth works similar to a **Set** value at the controller but the Cutting Depth is regarded at the milling height.

☞ Changes made to Working Offsets are instantaneous! Ensure the milling drum will not strike the ground.

Steering Offsets

Steer offsets are entered in the **Work/Offsets/Elevation Offsets/ Steer Offsets** dialog. If a positive offset is entered the steering value will be indicated to the right of the design, and if a negative offset is entered, to the left of the design.

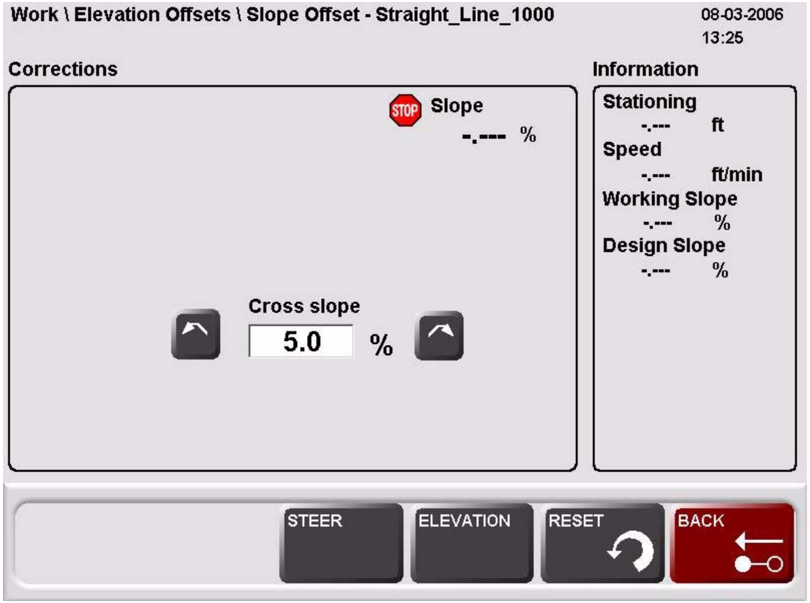
A reference at the machine can be chosen for Left, Right or centre. The indication is along this parallel line to the reference line.



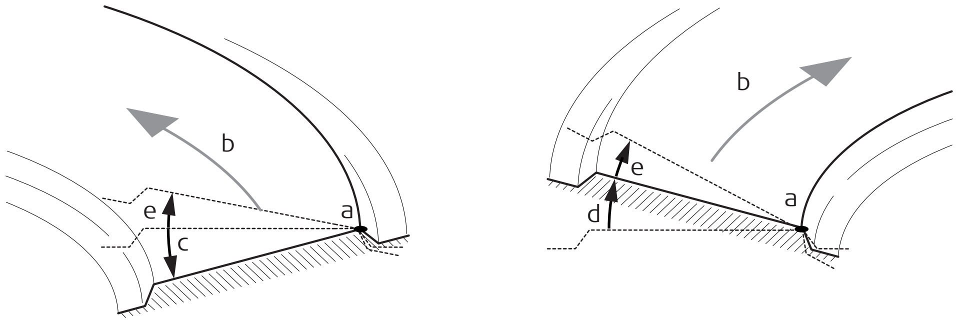
☞ The steering value is just a indication. An automatic steering is not implimented at the current milling machines.

Cross Slope offsets

Cross Slope offsets are entered in the **Work/Offsets/Elevation Offsets/ Slope Offsets** dialog. If a positive cross slope offset is entered a clockwise rotation will be applied. If a negative cross slope offset is entered an anti-clockwise rotation will be applied.
Regularly the cross slope is given from the design but in the case of a cross slope deviation of the machine slope, the offset can be used instead of a sensor calibration.
The Cross Slope offset values may be adjusted with the arrow buttons or with the number pad by clicking inside the field.



Cross slope convention



a) Controlpoint
b) Direktion of Travel

	Rotation	Cross Slope	Slope Offset	Water
c)	anti clockwise	negative		catch
d)	clockwise	positive		spill
e)			positive	

11 Maintenance Tasks

11.1 Weekly Maintenance Tasks

Required maintenance tasks

The following steps will help minimize problems during production and should be carried out on a weekly basis or if disturbance to any of the equipment is detected.

- **Check & Adjust** all instruments
  Refer to TPS1200+ Technical Reference Manual for further details.
  If the required adjustments are excessive, contact Leica Geosystems Support to arrange for return-to-base adjustment of the instrument. Instruments should be returned to Leica Geosystems once every six months for a factory check and adjustment.
- Check the MPC1310 has sufficient flash disk space. A warning message on the Leica PaveSmart 3D dashboard will flash when the disc space has reach 75% capacity.
- Remove all old Logfiles, AsBuilt files and delete old Projects. All these files should be backed up to an external data storage location first.
- **Check & Adjust** slope sensor and ensure machine mast(s) have not **shifted** excessively. Repeat Machine Dimension procedure.

11.2 Disk Check on MPC1310 Machine Computer

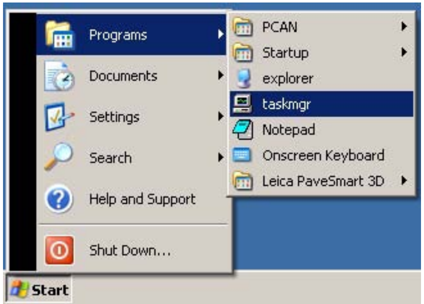
Introduction

This is a short description on how to check the disk of an MPC1310 machine computer. The procedure can be very helpful if you get messages about corrupted files on your MPC1310.

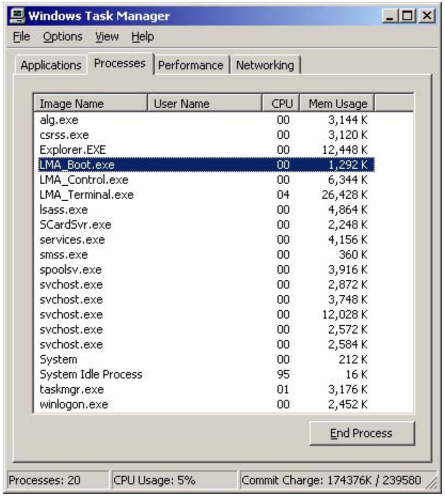
Shut down PaveSmart 3D

PaveSmart is in the Autostart folder and will therefore always start automatically. If there are corrupted files on the MPC1310, PaveSmart can't start up completely and there will always be a system crash.

To prevent from a crash, the operator needs to shut down PaveSmart 3D before it can read the corrupted files.

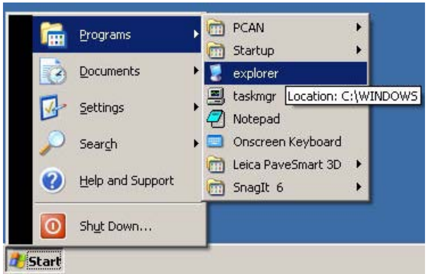


In the Processes tab you have to end LMA_Boot.exe, LMA_Control.exe and LMA_Terminal.exe. This has to be done very fast, as PaveSmart tries to start up in the mean time.



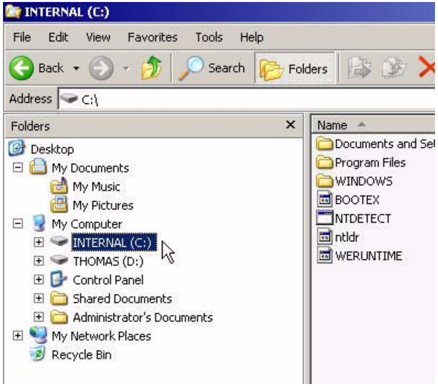
Windows Explorer

Start the Windows Explorer:

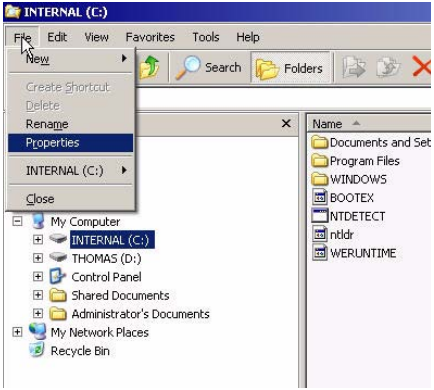


Prepare Check Disk

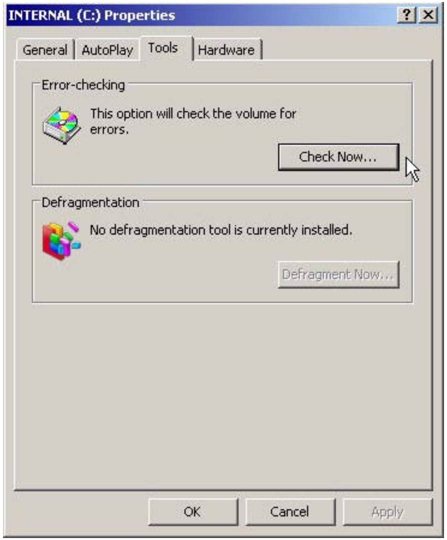
Select the drive c:



Open File / Properties:



Select Tools and press **Check Now...**



Set the two ticks as shown below and press **Start**

Confirm the message by clicking **Yes**

Restart MPC1310

The disk check can only take place during a start up of the MPC1310 machine computer. Therefore you have to restart your computer before the procedure can be finished.

As soon as the computer starts up again, you will see a blue screen with some percentage numbers counting up. This may take a few minutes.

Further Steps

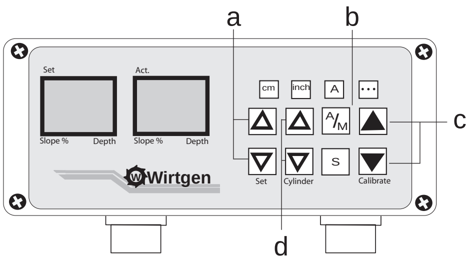
During the disk check some files on your drive c: may be deleted automatically if they are corrupted. If this happens, one or more of the following steps may be necessairy:

- Upload the PaveSmart design project again
- Delete projects you don't need anymore
- Reinstall PaveSmart 3D

12 DLS Controller and Mobamatic

12.1 Operating the DLS Controller

Function keys



a) Set Design-values
b) Automatic mode on/off
c) Set current working offset as Zero (Press both keys simultaneously)
d) Raise / lower cylinder (machine)

Meaning of the functional lamps

cm — The unit for the numerical data in the **displays is centimetre** (cm).

inch — The unit for the numerical data in the **displays is Inch** (inch).

A — Lamp to indicate **manual** or **automatic mode**
- Lamp on: automatic mode
- Lamp off: manual mode
- Lamp flashes: external automatic locking (valve control locked);

... — This lamp has only a meaning when **operating the multiplex unities**.
- Lamp on: Multiplex operation with multiple evaluation
- Lamp off: Single evaluation of the middle sensor

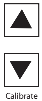
Meaning of the keys

UP/DOWN - keys - Set
Use these keys to set the rated value, independent of connected sensor.

UP/DOWN - keys - Cylinder
In manual mode use these keys to shift the cylinders (by hand).

Automatic/Manual - key
Use this key to toggle between manual and automatic mode.

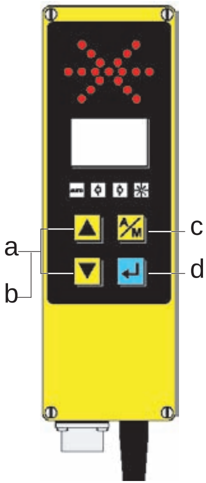
Setup - key
Use this key to call the user menu.
Use the Automatic/Manual - key to exit the Setup menu.



UP/DOWN - keys - Calibrate
When in manual mode and with a distance sensor connected, use this key to set the actual value (simultaneously pressing both keys causes zero position).
In automatic mode a "rated value / actual value" reading correction can be carried out, i.e. while shifting the actual value, for example to the physically actual value, the rated value is corrected accordingly.

12.2 Operating the Mobamatic Controller

MOBA-matic Controller



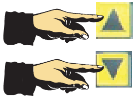
a) Set to zero and set design values; Raise / lower cylinder
b) Switch profile reference string / ground
c) Automatic on/ off
d) Sensor alignment (Set current working position to Zero by pressing for 1 second)

Basic settings

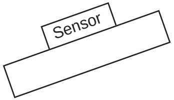
Basic settings are always to be made in manual mode!

Functions lamp off

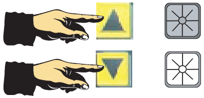
Grade sensors



1. **Set screed/ drum** to initial position. Preset project data to about 1.5x the thickness of layer, depending on the type of machine used.



2. **Sonic-Ski Sensor**
   Align the sensor. With the Sonic-Ski sensor the string / ground scan is set by simultaneously pressing the UP/DOWN keys.



String
Ground

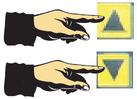
3. **3D-sensor**
   MPC has been started and the mast sensor has been connected to enable the selection of **3dSEn** control.

Press enter key.

The UP/DOWN keys changes the Design-values.

4. **Height setting**
   - Is-value setting:
     Press the enter or UP/DOWN keys until **SEt** is displayed. The Is-value is set as Design-value.
   - Setting to zero:
     Press the enter or UP/DOWN keys until **SEt** is displayed and then 0.0. Is and Design-values are set to zero.

Slope sensors



1. **Set screed/ drum** to initial position. Preset project data to about 1.5x the thickness of layer, depending on the type of machine used.

2. **Manually preset Design-values**
   With 3D sensor connected, the **SP** control parameter must manually be set to **Hd**. Without 3D sensor it is automatically set to **Hand**.

The UP/DOWN keys changes the Design-values.

3. **Automatically preset Design-value**
   With 3D sensor connected, the **SP** control parameter must manually be set to **A**. The steering automatically adjusts to any changes in Design-value.

☞ To make the distinction, the Design-value flashes on the control display. The Design-value cannot be chaged with the arrow keys.

12.3 Error Messages Controller

Error messages

Error message	Error diagnoses	Controller line-out	Countermeasures
no SEn	Controller does not recognize any sensor.	Line-out blocked in automatic mode.	• Connect sensor • Check and replace connecting cable. • Replace sensor • Connect mast sensor/ machine computer • Update controller SW
Err 3d	Tracking does not work, error message on machine computer.	Line-out blocked in automatic mode.	• Correct machine computer error message • Start tracking
I--.-	Measured value overrun on controller display.	Line-out blocked in automatic mode.	• Define layer • Check position / TCA
SLo out **Pot out** **LAS out** **-23- out**	Measured value of active sensor outside permissable measuring area.	Line-out blocked in automatic mode.	• Check sensor alignment resp. position • Replace sensor
--- **-** **---**	Measured value of active sensor outside of the set controller window.	Line-out blocked in automatic mode.	• Check sensor alignment resp. position • Set up sensor again

Error message	Error diagnoses	Controller line-out	Countermeasures
Son dEF **Slo DEF**	Controller recognizes faulty sensor.	Line-out blocked in automatic mode.	• Check and replace connecting cable. • Replace sensor
Err 2	Battery buffered memory looses data.	Line-out blocked in automatic mode.	• Acknowledge error message with any key • Reset work position (zero point and Design-value)
Err 3 **Err 4** **Err 5**	Data loss of saved parameters in battery independent memory.	Line-out blocked in automatic mode.	• Acknowledge error message with any key. The machine parameters are set to default values. • Reset work position (zero point and Design-value)

13 System Installation and Components

13.1 General

Warning

Unauthorized modification of machines by mounting the 3D Control System may alter the function and safety of the machine.
Always follow the instructions of the machine manufacturer. If no appropriate instruction is available, ask the machine manufacturer for instructions before mounting the 3D Control System.
Even though the hardware components are designed for rough conditions, the components have to be treated and transported in a careful manner. Therefore always use the designated packaging for transport and study the relevant documentation for cleaning and maintenance work.
The installed components on the machine comprise a **Machine Computer** with attached **Radio Modem**(s) to communicate with the **Total Station**(s), **Dual Slope Sensor**, mast with attached prism or optional **GNSS (GPS / GLONASS) Sensor**.
As well as the installed components on the machine, TPS(s) with radio modem(s) need to be set up. In case of a Hybrid GNSS (GPS / GLONASS) / TPS System a combination of this two different measurement techniques is needed.

13.2 Machine Preparation Tasks

General System Installation Steps

- Check the Leica compatible machine controller software DLS 207-3 or higher and Mobamatic V 3.28.
- Check the power availability independent from the engine.
- Mount Mast(s) with the Prism(s) or GNSS (GPS / GLONASS) Antenna, ensure both bayonet and locking-collar on the prism are being used.
- Mount Dual-Slope Sensor.
  Use the machine-manufacturer-supplied slope sensor mounting bracket wherever possible.
- Mount Radio Modems for TPS/GNSS (GPS / GLONASS).
- Mount Machine Computer (MPC1310).
- Setup Total Stations (with a GNSS (GPS / GLONASS) Combination also the Reference and Rover Receiver).
- Test radio communications between all devices.
- Test Slope Sensor communications.
- Test Installation and Leica-to-machine communications (In the dataflow).
- **Check & Adjust** instruments (refer to instrument User Manual)
- Tune the machine hydraulics in both elevation and steer.

Refer to the Leica PaveSmart 3D User Manual for a detailed cabling description.

13.3 Hardware Descriptions

General information

All hardware components used in Leica PaveSmart 3D have been designed for rough conditions. To ensure longevity of the components they must be treated and transported correctly. Always use the designated packaging for transport and study all relevant documentation for cleaning and maintenance procedures.

System Hardware

The installed components on the machine comprise a Machine Computer with attached radio modem(s) to communicate with the Total Station(s), dual slope sensor, and optional GNSS (GPS / GLONASS) rover and GNSS antenna. One or two prism/antenna masts are mounted on the machine. In addition to the components mounted on the machine two TPS instruments are required and/or a GNSS (GPS / GLONASS) reference station (if using the GNSS assist option without an available correction signal).

☞ Details on each component are listed below. Refer to component specific manuals for further details.

Machine Computer

The MPC1310 is a ruggedised computer with Windows XP Embedded, touchscreen, milspec connectors for power, CAN, four serial (RS232) and USB interfaces. Bracket to mount Machine Computer for easy installation and removal at the end of the day, a power supply for office preparation, a carry-case and a USB CF-Card adapter are all supplied as part of the MPC1310 package.
For further information refer to the MPC1310 user manual.

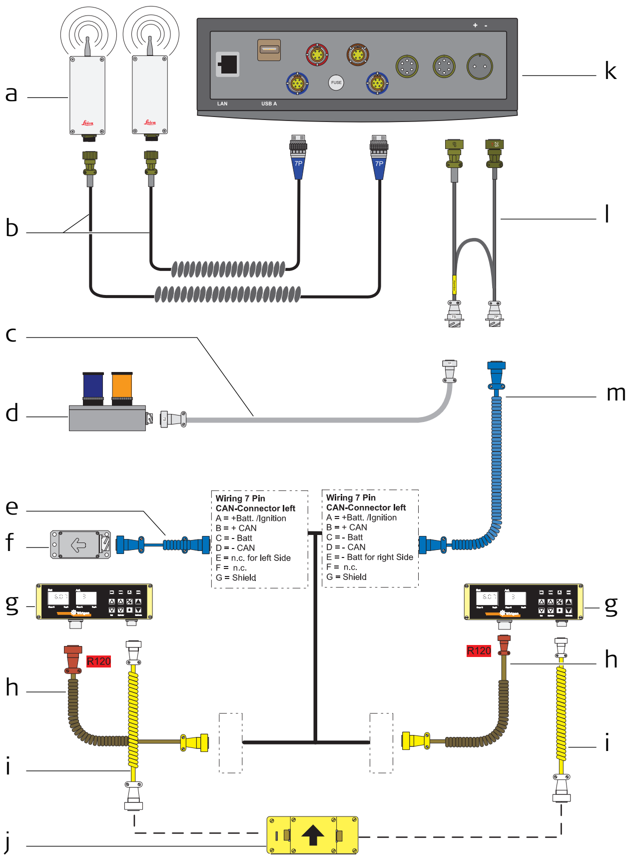
USB Data Stick

(Art. no. 777172)	USB Data Storage device for exchanging Projects, Jobs Logfiles etc. between office and machine(s)

Cabling

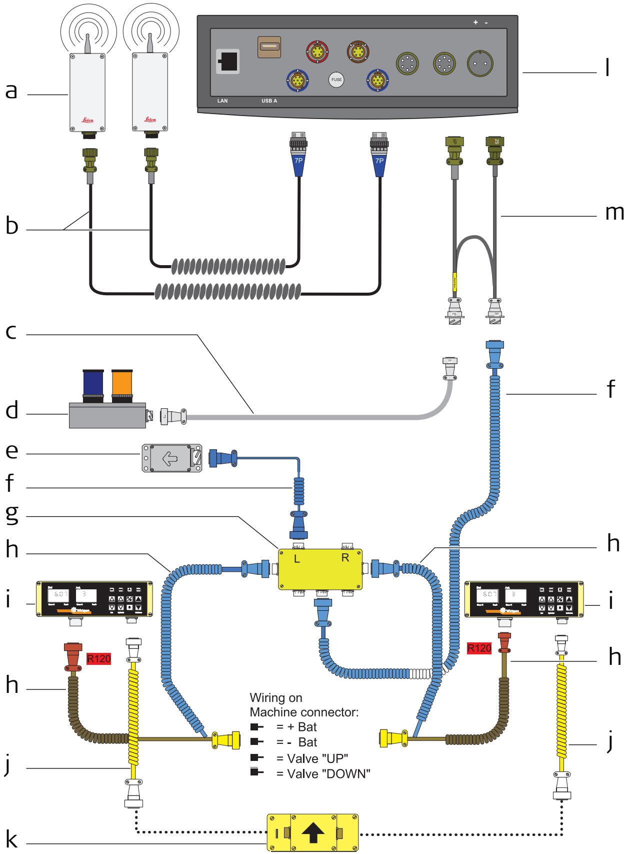
(Art. no. 767518)	MSC1328 Kabel MPC1310-PWRBox no PWR,7m
(Art. no. 776873)	MYC1304 H-Cable, MPC1310-CAN to Alarmbox, 35cm
(Art. no. 776874)	MCC1301 Coiled Cable, MPC1310 COM1&2 to TCPS27S (Cannon), 6m
(Art. no. 776875)	MCC1302 Coiled Cable, MPC1310 COM1&2 to Freewave (Fischer), 6m
(Art. no. 776877)	MCC1304 Coiled Cable, MPC COM3-TCPS27S (Cannon), 6m
(Art. no. 777179)	MCC1303 Coiled Cable MPC1310 COM3-Freewave (Fisher), 6m
(Art. no. 667345)	MCC1201 Coiled Cable CAN 7P, bayonet 6m
(Art. no. 726089)	Straight Cable, 7pol, bayonet, 3m
(Art. no. 762356)	MSC1258, 11m cable PowerBox to Ma-Batt.
(Art. no. 746616)	MYC1204, 1.8m Y-Cabel, Fw-TPS1200-Batt.

Cabeling Wirtgen Milling Machine - 3D prepared



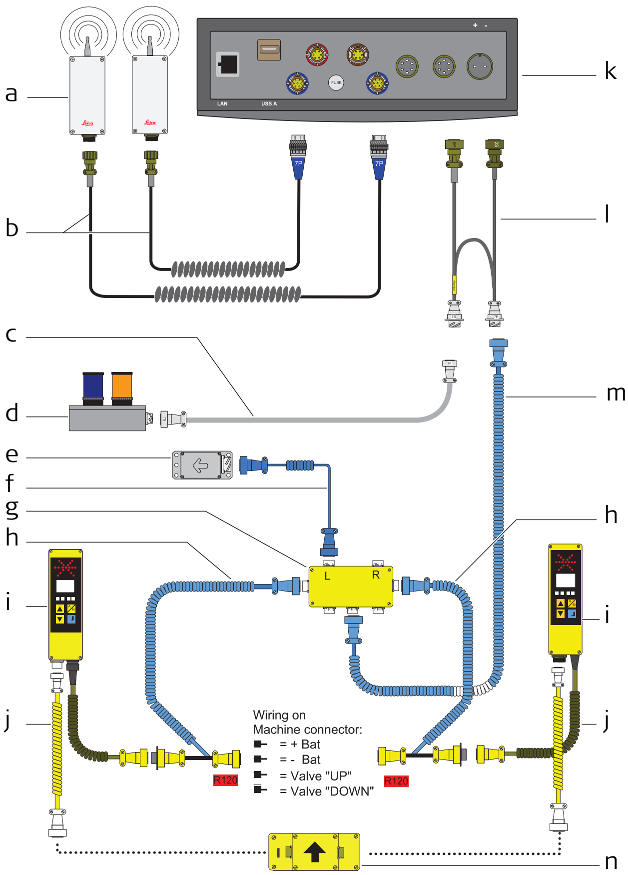
a) TCPS27S radio modems, Art. no. 737909
b) PWM cable for serial connection to TCPS27S, Art. no. 776874
c) Straight Cable 7pol, Art. no. 726089
d) Alarm box, Art. no. 734166
e) Coiled Cable CAN 7P, Art. no. 667345
f) Dual-axis slope sensor, Art. no. 667344
g) Wirtgen DLS controller
h) Wirtgen machine cable
i) PWM sensor cable, Art. no. 726320
j) Machine cross slope sensor
k) MPC1310, Art. no. 776882
l) H-cable Power / CAN connection, Art. no. 776873
m) Cable to machine, Art. no. 667345

Cabeling Wirtgen Milling Machine - 3D Hang on



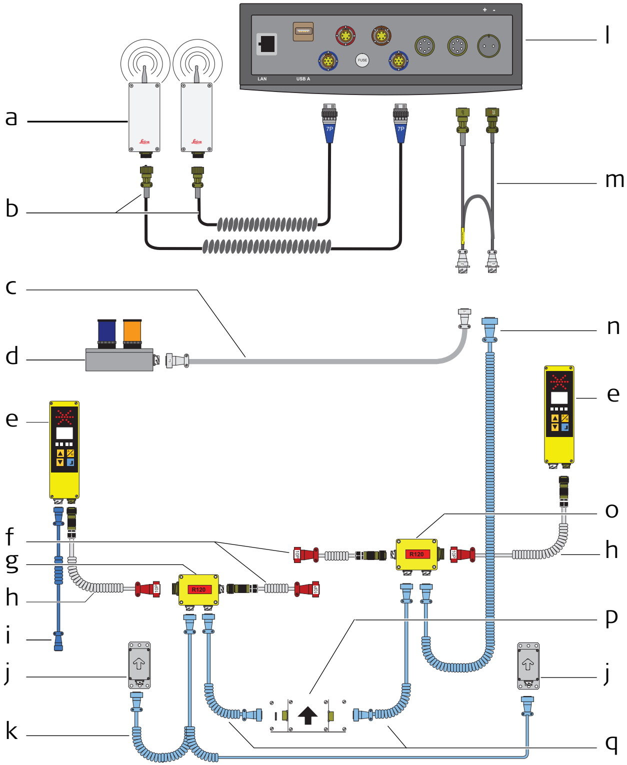
a) TCPS27S radio modems, Art. no. 737909
b) PWM cable for serial connection to TCPS27S, Art. no. 776874
c) Straight Cable 7pol, Art. no. 726089
d) Alarm box, Art. no. 734166
e) Dual-axis slope sensor, Art. no. 667344
f) Coiled Cable CAN 7P, Art. no. 667345
g) Junction box, Art. no. 726314
h) Cable, Art. no. 732682
i) Wirtgen DLS controller
j) PWM sensor cable, Art. no. 726320
k) Machine cross slope sensor
l) MPC1310, Art. no. 776882
m) H-cable Power / CAN connection, Art. no. 776873

Cabeling PWM MOBA-matic Hang on - 3D



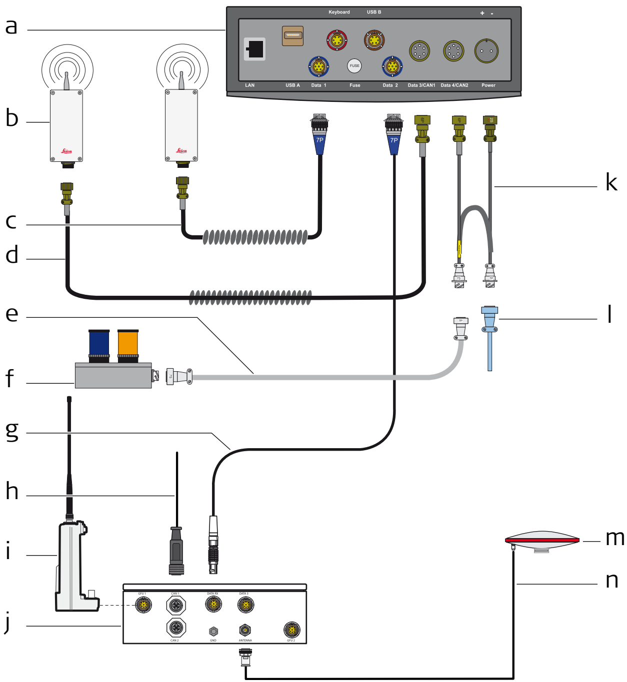
a) TCPS27S radio modems, Art. no. 737909
b) PWM cable for serial connection to TCPS27S, Art. no. 776874
c) Straight Cable 7pol, Art. no. 726089
d) Alarm box, Art. no. 734166
e) Dual-axis slope sensor, Art. no. 667344
f) Cable slope sensor to junction box, Art. no. 667345
g) Junction box, Art. no. 726314
h) Cable, Art. no. 731977
i) MOBAmatic Controller, Art. no. 726312
j) Coiled cable PWM, Art. no. 726320
k) MPC1310, Art. no. 776882
l) H-cable Power / CAN connection, Art. no. 776873
m) Cable to machine, Art. no. 667345
n) Slope sensor PWM, Art. no. 726313; only R or L connectable

Cabeling CAN MOBA-matic Junctionbox - 3D



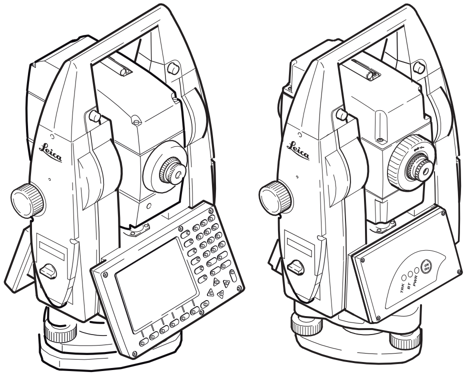
a) TCPS27S radio modems, Art. no. 737909
b) PWM cable for serial connection to TCPS27S, Art. no. 776874
c) Straight Cable 7pol, Art. no. 726089
d) Alarm box, Art. no. 734166
e) MOBAmatic Controller, Art. no. 732659
f) Cable 10pol, Art. no. 732676
g) Junction box Left, Art. no. 766976
h) Cable, Art. no. 732675
i) Coiled Cable CAN 7P, Art. no. 667345
j) Dual-axis slope sensor, Art. no. 667344
k) Y-Cable for Dual-axis slope sensor, Art. no. 722428
l) MPC1310, Art. no. 776882
m) H-cable Power / CAN connection, Art. no. 776873
n) Cable to machine, Art. no. 667345
o) Junction box Right, Art. no. 766977
p) Slope sensor CAN, Art. no. 732660
q) Coiled cable, Art. no. 667345

Cabeling one TPS and GPS Satel



a) MPC1310, Art. no. 776882
b) TCPS27S radio modems, Art. no. 737909
c) PWM cable for serial connection to TCPS27S, Art. no. 776874
d) PWM cable for serial connection (COM3) to TCPS27S, Art. no. 776877
e) Straight Cable 7pol, Art. no. 726089
f) Alarm box, Art. no. 734166
g) Cable MPC1310 to PowerBox, Art. no. 767518
h) Cable PowerBox to machine battery, Art. no. 762356
i) SATELLine or Freewave radio
j) PowerBox GNSS sensor, Art. no. 761677
k) H-cable Power / CAN connection, machine specific
l) Cable to machine, usually supplied by machine manufacturer as part of 3D Kit
m) GNSS antenna, Art. no. 753221
n) Antenna cable, Art. no. 632372

Total Station(s)



The system supports TPS1200+ Total Stations with the OnBoard software application MGuide. The radio modem is integrated into the handle of the instrument. Only fully robotic ATR-equipped instruments can be used with PaveSmart 3D (i.e. TCP, TCA, TCRP verions), angular accuracy recommended is 1 arc-second.
For further information refer to the TPS1200+ User Manual.

(Art. no. 737451, 737455, 737463)

CF-Card

(Art. no. 733256)	CF-Card storage device to up- and download data to -and from the Total Station.

Power Cable

(Art. no. 734697)	Power cable to connect the Total Station with a GEB171 Long Life Battery.

Battery

(Art. no. 727367)	GEB171, External universal battery, NiMH, 12V/9Ah, rechargeable.

Battery Charger

(Art. no. 733271) Universal charger for external- and internal batteries.
For further information refer to the GKL221 User Manual.

Tripod

(Art. no. 667301) Tripods for the TPS1200+ total stations.

Tribrach

(Art. no. 667304) GDF121 Pro Tribrach for TPS1200+ total stations.

TCPS27S Radio Modems

(Art. no. 737909) TCPS27S radio modems with robust connectors are used on the machine, and communicate with the TPS1200+ radio handle mounted onto the instrument.
For further information refer to the TCP27S User Manual.

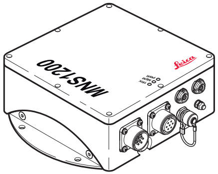
FreeWave Radio Modems

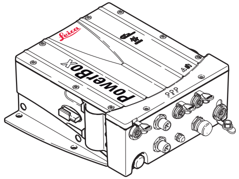
(Art. no. 8214737) FreeWave radio modems can be used as an alternative to the TCP27 and Radio handle for communication between the MPC1310 and the measurement sensors. Freewave radios require either removable Flexible Antenna (Art. no. 8218706) or permanently-mounted Whip Antenna (Art. no. 8205634).

Reflector (Prism)

(Art. no. 756637) MPR122, 360° Reflector PRO

GNSS (GPS / GLONASS)





(Art. no. 748105)

The GNSS option uses the MNS1230 machine navigation sensor (GPS and GLONASS) with power protection and milconnectors.
For further information refer to the MNS1200 User Manual.

Antenna

(Art. no. 753221) The MNA1202 GG antenna mounted on the mast.

Sateline radio modem GNSS (GPS / GLONASS) Assist option works with the Satelline radio modem. FreeWave radios or other 3rd party products may be used as an alternative.

Cabling

(Art. no. 667399)	Antenna spiral cable, 6m
(Art. no. 744686 or 639968)	Radio modem cable, 6m

Further Reading

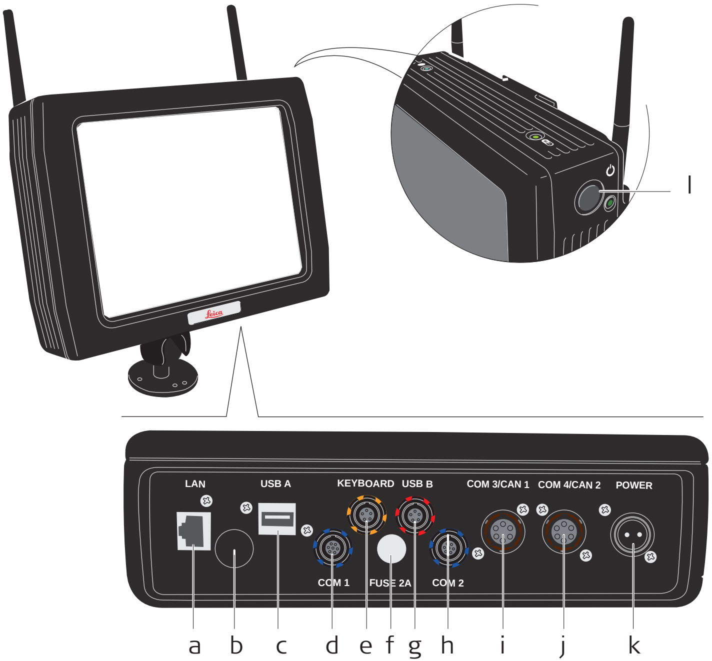
For further details on each component listed below, refer to the specific component manual mentioned in each section.

Wiring Diagrams

For system wiring diagrams refer to the Leica PaveSmart 3D User Manual

13.4 Machine Personal Computer MPC1310

MPC1310



a) LAN connector
b) Ventilation cap
c) USB A Host connector
d) COM 1 port
e) Keyboard connector
f) 2A fuse for outgoing power
g) USB B Device connector
h) COM 2 port
i) COM 3/CAN 1 port
j) COM 4/CAN 2 port
k) Power connector
l) Power key

USB

USB connection, Leica Geosystems USB storage device or standard USB keyboards recommended only.

☞ Never remove the USB storage device until file read/write/copy operations are completed, as this may cause file loss or corruption.

☞	**Do not attach** any USB device which needs additional driver installation, as this may cause configuration corruption or installation **problems**.
COM 1, 2, 3, 4	Serial Ports for Radio Modem connection to Total Station and connection to GNSS sensor. Power output voltage: regulated +13.6 V
CAN 1, 2	CAN bus connection.
POWER	Power in, 10-36 volt DC, reverse polarity protected.
Power key	To turn On and Off the Machine Computer.
⚠ **Caution**	Never turn Off the Machine Computer without shutting down all running applications. This could result in unexpected data loss!
	Precautions: Black screen must be displayed after pressing the Shutdown button in Leica PaveSmart 3D software before switching the power off to the MPC1310.
KEYBOARD	Permits connection of external keyboards with compatible LEMO connectors. Contact Leica Geosystems for further information.

14 Glossary Leica PaveSmart 3D

System1200

System1200 includes the current Leica TPS, GNSS (GPS / GLONASS) and office software products. Leica PaveSmart 3D is closely integrated with System1200. For example the data structure and files (DBX) is same format and the user interface looks similar. As there are these dependencies, Leica PaveSmart 3D uses the same terms as in System1200 where possible.

RoadRunner

RoadRunner is an application program for GPS1200 and TPS1200+ for staking out and checking all types of alignments: highways, railways, pipelines, canals, airport runways, earthworks etc. RoadRunner also includes support software that converts data from many design packages, prepares the data, and uploads data to GPS1200 and TPS1200+.

RoadRunner Project

A project consists of different kinds of jobs that belong together. By selecting a project automatically all referenced jobs are selected as well. A project can reference:

- one fixpoint job
- one measurement job
- one road job
- one DTM job.

As jobs are just referenced by a project, they can be used in more than one RoadRunner project, as well as in other applications. For example the same collection of control points may be used in two different projects.

Leica PaveSmart 3D uses the same DBX format as a RoadRunner Road job.

Fixpoint job

The fixpoint job holds all control point information needed in the field. Control points are, for example, points with known coordinates used for a TPS set-up or points used to determine a GNSS (GPS / GLONASS) coordinate system. The fixpoint job is a source of information.

Road job

All road design information, either typed in manually or exported from a design package is stored in the road job.

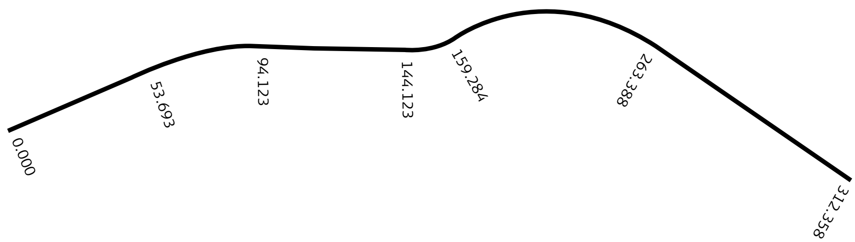
Alignment

The alignment defines the geometry of a road. Therefore a plan view (horizontal alignment) and a long section (vertical alignment) is needed.

Horizontal Alignment

The horizontal alignment is a design of the horizontal geometry of a road.
Leica PaveSmart 3D supports the following elements in the horizontal component of alignments:

- Straights
- Arcs
- Clothoids, entry and exit as well as partial
- Multipoints, all elements that cannot be described by one of the previous types are represented by discrete points along the curve. For example, a line parallel to a clothoid.

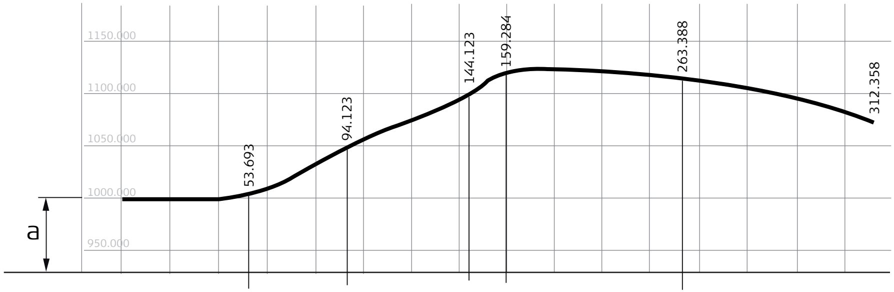


Vertical Alignment

The vertical alignment is a design of the vertical geometry of a road.

Leica PaveSmart 3D supports the following elements in the vertical component of alignments:

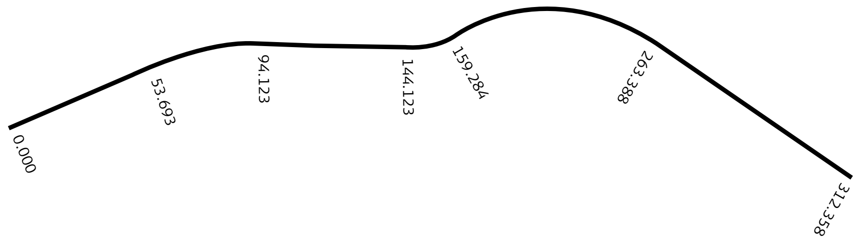
- Straights
- Arcs
- Quadratic parabolas
- Multipoints, all elements that cannot be described by one of the previous types are represented by discrete points along the curve.



a) elevation

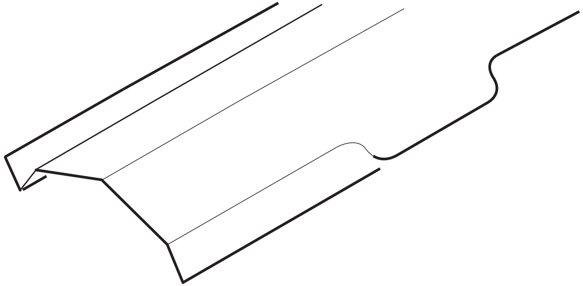
Chainage, Stationing or Station

The cumulative distance along the centre line, in general but not always starting at zero.



Stringlines

In conventional milling work the stringline is physically staked out with pins. Between this pins a chord or a string is mounted, where the machine drives along.
In Leica PaveSmart 3D a StringLine is a part of a StringLine Job. In the System1200 definition a DBX Road Job consists of several StringLines. One of them may be defined as the Reference Line, the others are only used for height information. The different StringLines in one StringLine Job may have different functions and are then named with a different term.
During definition of a stringline, alignments and cross sections are used. Alignments are defined by geometric elements, for example straights and arcs, and the cross sections by vertices. Furthermore, one defines at which chainage a certain cross section is used. By doing this the vertices are connected to create a series of lines representing the three dimensional design of the road.

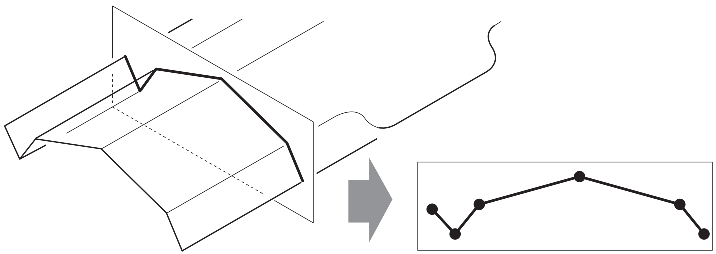


Stringline representation of a road design

In Leica PaveSmart 3D such lines, defining the design, are called stringlines. Stringlines are the base elements used for machine control calculations. Stringlines have a project unique name by which they are identified and selected. Whenever a new design is typed in or imported from a design package these stringlines are generated automatically in the background.

Cross section

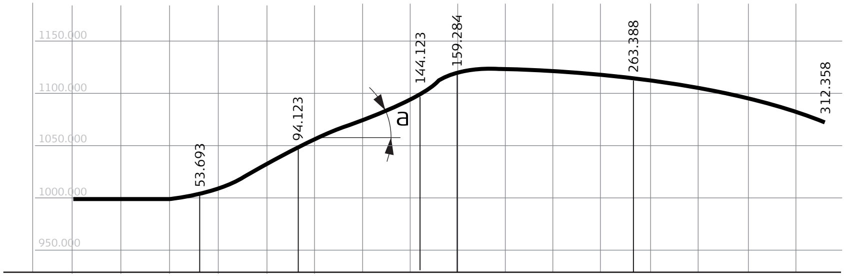
A cross section may be derived from the stringline model by slicing a group of stringlines with a vertical plane orthogonal to the centre line.



Stringline representation of a road design

Long slope

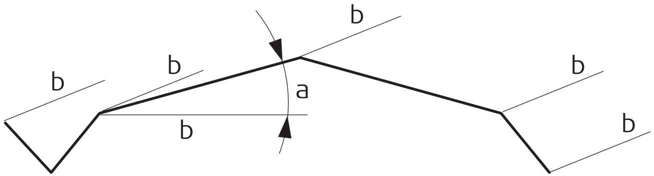
The long slope describes a height change on the long section of a stringline. The long slope is the angle between a horizontal line and the stringline. This is also called mainfall and is the element describing draft.



a) Long slope

Cross slope

Cross Slope describes the height change on the cross section of a stringline between elements. In PaveSmart 3D a single stringline can be given a cross slope by projecting a plane through the stringline at a given angle.
Positive cross slope is defined as a clockwise rotation about the axis of the stringline in the direction of travel.
Negative cross slope is defined as a anti-clockwise rotation about the axis of the stringline in the direction of travel.
Depending on the milling drum used this will form a catch or spill curb.



a) Cross slope between two stringlines
b) Stringlines

Leica PaveSmart 3D	Leica PaveSmart 3D terms are the same as System1200 where possible. Some terms have a slightly different meaning and have been described as such. Others terms come from Leica Machine Guidance System (LMGS) or from the different applications.
Leica PaveSmart 3D Project	A Leica PaveSmart 3D Project contains all of the Stringline data needed to carry out production in a DBX Road job format (System1200). There may be multiple stringlines on multiple layers.
Leica PaveSmart 3D Job	The Leica PaveSmart 3D Job contains the current StringLine in a DBX Road job format (System1200). For an easier handling in Leica PaveSmart 3D there are several restrictions to a Leica PaveSmart 3D StringLine job.
Leica PaveSmart 3D Layer	A Leica PaveSmart 3D layer is the same as a System1200 DBX Layer. In Leica PaveSmart 3D one Layer represents one curb&gutter object. In a Leica PaveSmart 3D Layer we always need a Reference Line selected from the stringlines contained in the layer. The current selected Layer defines with its Reference Line to which object the relative position of the machine is calculated to. A slope line may also be selected to calculate cross slope.
Leica PaveSmart 3D Object	A Leica PaveSmart 3D object is a single 3D Stringline.
Reference Line (Center Line in RoadRunner/System1200)	The Reference Line is the line which the machine drives along in position and in height. The long slope and cross slope of the machine is calculated to the Reference Line. If there is no default Reference Line in a StringLine Job, it must be selected before paving commences.

SlopeLine	The SlopeLine is used for the height calculation and regulation of the cross slope. If there is no default SlopeLine in a StringLine Job, the machine operator has to choose it before he starts paving. It is possible to work without slopelines and use manually selected cross slopes. Without a SlopeLine supplied in the design, only manual slope setting and adjustment is possible, via the Slope Offset dialog.
DXF file	A DXF file is the most common way to exchange CAD data. It is based on the AutoCAD software, although is supported by almost all CAD systems. The file contains different layers (not the same as DBX layers). In one layer are different entities. The DXF format is graphical (for example points, lines, shapes,...) and stores no additional information (for example no stationing, no cross slope for a single line, unit information).
DXF Layer (not the same as a DBX layer)	A DXF layer includes all the objects related to one topic (for example houses, roads, electrical wires, gas pipelines). The objects are formed by entities.
Entity	An entity is a geometrical object in a DXF file. Common entities are: • Point • Line • Polyline • Block & 3Dface

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Total Quality Management: Our commitment to total customer satisfaction.

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).

Ask your local Leica Geosystems dealer for more information about our TQM program.

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Original text

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- when it has to be **right**