GPS System 500

Getting Started with Static and Kinematic Surveys

Version 2.0
English

Leica
MADE TO MEASURE

Congratulations on your purchase of a new Leica System GPS500.

View of chapters

Introduction 6

Equipment checklist for static and rapid static measurements using system 500 7

Setting up System 500 for a static survey 8

Using the TR500 terminal 9

Taking Static / Rapid-Static measurements 13

Exploring the sensor status during operation 23

Changing the system configuration parameters 29

Creating new configuration sets 33

Programming wake-up sessions 34

Kinematic and Stop & Go surveying - using static initialization 37

Kinematic "on the fly" 43

Practical hints for kinematic, Stop & Go and 45

Miscellaneous 46

Appendix: Summary of status icons 47

Appendix: Measuring antenna heigths 49

Contents

Introduction 6

Equipment checklist for Static and Rapid-Static measurements using System 500 7

Setting up System 500 for a static survey ... 8

Using the TR500 terminal 9
- Menus 9
- Entering information 10
- Listboxes 11
- Hardkeys 12

Taking Static / Rapid-Static measurements 13
- Step 1: Power on 13
- Step 2: Study the icons 13
- Step 3 (optional): Format your memory card 15
- Step 4: Begin a survey 16
- Step 5: Logging raw data 19
- Step 6: Ending a survey 21
- Suggested exercise: Measure a very short baseline 22

Exploring the sensor status during operation 23
- Satellite status 24
- Stop & Go indicator 25
- Battery and memory status 26
- Display current navigated position 27
- Suggested exercise: Get familiar with system status 28

Changing the system configuration parameters 29
- Turning on the illumination of the terminal 30
- Changing the observation rate 30
- Setting local time zone 31
- Changing distance units from meter to feet 32

Creating new configuration sets 33

Programming Wake-up Sessions 34

Kinematic and Stop & Go surveying - using static initialization 37
Introduction and general comments 37
Equipment setup for Kinematic and Stop & Go surveys 38
Carrying out Kinematic and Stop & Go measurements . 39
Initialization on a known point 42

Kinematic "on the fly" 43

Practical hints for Kinematic, Stop & Go and Kinematic on the fly measurements 45

Miscellaneous 46

Appendix: Summary of status icons 47

Appendix: Measuring antenna heights 49

Introduction

The purpose of this short manual is to give guidelines and useful hints on how to perform static, rapid static and kinematic surveys using SR510, SR520 or SR530 GPS receivers without utilizing Realtime techniques.

Realtime applications, based on the use of radio modems - in particular RTK (Real-Time-Kinematic) operation with SR530 receivers - are described in the booklet *"Getting Started with Real-Time Surveys"*.

Full description of all features and functions of System 500 can be found in the *"Technical Reference"* Manual which is available as an electronic PDF document only. This manual can be found on the SKI-Pro installation CD. For more information please refer to the file \MANUALS\README.TXT on the SKI-Pro installation CD.

It is assumed that the reader of this manual is familiar with the principles of GPS Surveying, i.e. he knows the concept of differential measurements, the need for a reference receiver, etc. A basic introduction of these principles is given in the booklet *"General Guide to Static and Rapid Static"*.

After studying these guidelines a user will know the basic concepts and principles of how to operate System 500 and carry out static, rapid static and kinematic GPS surveys.

Equipment checklist for Static and Rapid-Static measurements using System 500

If you want to use System 500 for Static or Rapid-Static survey then the minimum equipment you need is a pair of System 500 units.

Each unit comprises a SR510 or SR520 or SR530 **sensor**.

A single frequency SR510 sensor requires an AT501 single frequency **antenna**; SR520 and SR530 sensors need to be connected to a dual-frequency **antenna**, normally the AT502 standard antenna or - for utmost accuracy - high precision chokering antennas: either a AT503 or AT504.

An **antenna cable** is needed to connect the sensor and the antenna.

A TR500 **terminal** - a keyboard & display device - is needed to easily start the operation, check system status and manipulate sensor parameters.

Batteries are needed to power the sensor. Standard are two camcorder batteries which are plugged into the backside of the sensor and power the unit for about 6 hours.

Warning

Brand new camcorder batteries need about 5 charging cycles before reaching the full capacity. It is highly recommended to fully charge and decharge camcorder batteries for 4 to 5 times before start-ing using them for practical fieldwork. This is easily accomplished by plugging them into the sensor and having the sensor turned on until the sensor switches off automatically once the batteries get flat. Then simply recharge them and repeat this exercise.

Setting up System 500 for a static survey

Successful GPS surveys require undisturbed satellite signal reception. This means that GPS sensors should be set up in locations which are free of obstructions. No obstacles like trees, buildings, mountains, etc. should block the line between the GPS antenna and GPS satellites. This holds true in particular for the sensor which serves as the reference.

For static and rapid static surveys, the antenna must be kept perfectly steady throughout the whole occupation of a point. This means that the AT501 or AT502 antenna will usually be put on a tripod.

Center and level the tripod precisely above the survey marker. Place and lock the carrier in the tribrach. Mount the antenna onto the carrier.

Connect the antenna to the sensor using the antenna cable.

Plug two camcorder batteries into the backside of the sensor. Alternatively or in addition you might want to power the sensor externally. In this case connect a GEB71 battery to one of the PWR- ports of the sensor.

Attach the TR500 terminal to the sensor, either directly or via a connection cable by plugging it into the TERMINAL-port on the sensor.

Insert a PC-card into the sensor.

Warning

Lock the lid carefully after insertion of the card in order to prevent water and dust from getting inside the sensor.

Use the hook on the backside of the sensor to hang it on one of the tri-pod legs. Alternatively you may want to leave the sensor inside the shipping case.

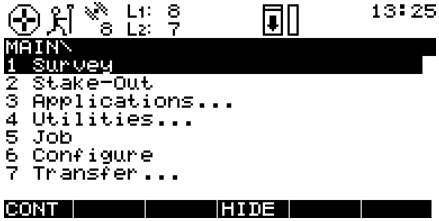
Your System 500 sensor is now fully ready for operation.

In order to operate System 500 some interactions between the user and the TR500 terminal are usually required. You will find the operating concept of the onboard software intuitive and easy to use. All screens and panels are steered in the same way which makes the software very userfriendly and easy to learn.

This chapter explains by use of some examples how to operate the terminal. These operational guidelines apply to all parts of the System 500 onboard software.

We basically distinguish between menus and screens which require a certain input.

A typical example can be found in the main menu:



You can see 7 different choices. Line "1 Survey" is highlighted which means that this is the currently selected choice.

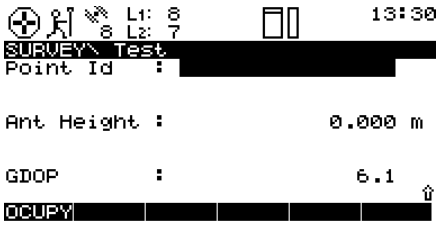
You can navigate up and down the screen using the cursor up / down keys on the terminal. The highlighted bar will follow accordingly. For instance press the "cursor down key"

twice to highlight "3 Applications": The function keys at the bottom of the screen describe certain commands. If for instance you want to enter the "Applications" part of the software you press **F1** CONT (to continue).

A shortcut is to press the numbers which are associated with each choice directly. For instance if you press "**6**" you will get straight into "Configure"

Entering information

A typical example can be found in the main Survey panel:



Two inputs have to be made here, the Point Id and the Antenna Height. Use the cursor down / up keys to move to the desired input field. In the current example the Point Id can be entered.

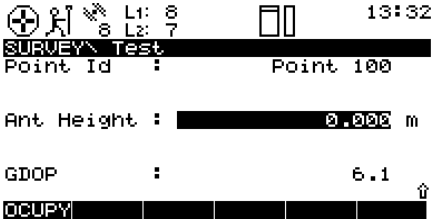
Use the **alphanumeric** keys on the terminal to enter the information.

Use the **CE** key to correct any typing error.

Use the **ENTER** key to conclude the input.

Listboxes

When ENTER is pressed the focus is moved to the next input field:



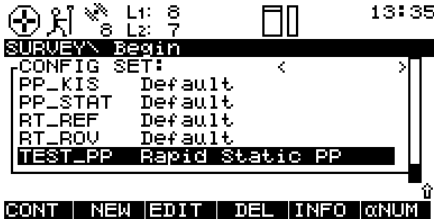
Use **numeric** keys to enter the antenna height.

Some input fields expect a predefined input. The choices are available in a list which is kept behind the input field.

Input fields based on a listbox are identified by a small triangle which appear on the right side of the field. The following example shows 3 such input fields in one screen:

The input for Configuration Set, Job and Antenna has to be made based on a list.

Press ENTER to open the highlighted listbox. A list pops up from which a choice has to be made:



Use the cursor down / up keys to move the selection bar down or up the list. Select your input by highlighting the particular line.

Press **F1** CONT to confirm the selection. This will then also close the listbox

You can speed up the selection by entering the name of your choice. If in this particular example "**T**" is entered, the focus will automatically move to "TEST_PP Rapid Static PP".

On the right side of the screen you see a vertical "scroll bar" which indicates the current positio n within the list. In this particular example the current focus is about 20 % below the top of the list. Such a scrollbar becomes useful when the listbox is very long.

If the listbox is very long it might become cumbersome to navigate by pressing cursor down / up to move down and up the list. In such cases press the **SHIFT** key to get access to page down / up, home and end keys:

Another way to make a selection from a listbox is by using the cursor left / cursor right keys. Instead of opening a list box press the cursor left or cursor right keys to toggle between different choices.

The terminal supports some additional useful hardkeys:

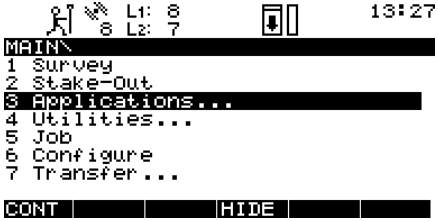
The **ESC** key allows you to "escape" from a screen. Instead of executing a command you get back to the previous screen.

The **STATUS** key provides direct access to all system status information, based on a certain menu structure

The **CONFIG** key allows to change configuration parameters during operation.

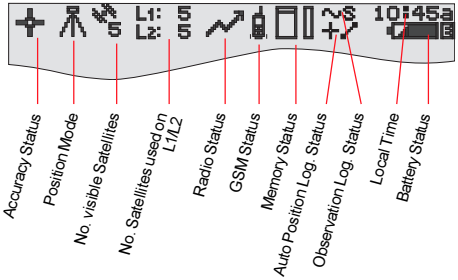
Step 1: Power on

Turn on the sensor by pressing the ON-button on the terminal. One of the following two screens will appear on the display:



Step 2: Study the icons

Most important at this stage is the top part of the screen which contains several symbols (icons) which indicate the current system status.



Upon power on you will first recognize the "Number of visible Satellites" icon, indicating the number of satellites which are theoretically visible at the current location and time. Usually this number varies between 4 and 10, depending on the satellite geometry.

Next to this symbol you find the "Number of Satellites used on L1 / L2" icon, indicating the number of satellites currently tracked either on L1 or on L2.

Upon power on you will read L1: 0, L2: 0. It will take about 30 seconds until these number will start changing and very soon reach the number of visible satellites.

Both "Number of visible satellites" and "Number of satellites used" icons will change from time to time, reflecting changes in the satellite geometry due to either the rise of new satellites or the setting of descending satellites.

Once a minimum of 3 satellites is tracked the sensor can start computing a position. As soon as a position is available it will be indicated by an icon on the far left of the status line. Since for post-processing surveys no realtime link will be used, the icon will always indicate the availability of an autonomous position ("navigated position") with an accuracy of about 100 meters.

As soon as the position icon becomes visible the sensor is in a stage where practical operation can commence.

If the position icon does not become visible even after one or two minutes then the sensor is still not tracking satellites. If the "number of satellites used" is still zero please check whether the antenna cable is connected properly to both sensor and antenna.

If the "number of satellites used" differs from the "number of visible satellites" make sure you place the antenna in an open area without obstructions, since any obstacle will block the view of satellites.

When you switch on the unit for the very first time it might take a maximum of 5 minutes until all satellites are tracked. This can happen in case your current location differs significantly (i.e. > 1000 km) from the initial position which is the position where your sensor has been used before. Once you are tracking satellites, the position memory in the sensor will be updated.

The battery status icon at the right side of the icon line shows from which source the sensor is currently powered. A and B indicate the internal batteries, E an external battery source. The symbol also indicates the voltage level of the currently used battery in 4 different stages from "full" (fully black) to 2/3 to 1/3 and "almost flat" (white color).

The memory status icon gives several information: whether memory for logging data is available or not. Options are either a PC-card or internal memory. If a PC card is available and configured for use then at this stage an arrow indicates the fact that it is safe to remove the PC-card from the sensor. The little bar on the right side indicates the available memory on either the PC-card or the internal memory.

Warning

You cannot proceed from here if no memory device is avail-able. Insert a PC-card other-wise no GPS survey can be carried out.

All status symbols which are relevant for static and kinematic measurements are listed in the appendix.

Step 3 (optional): Format your memory card

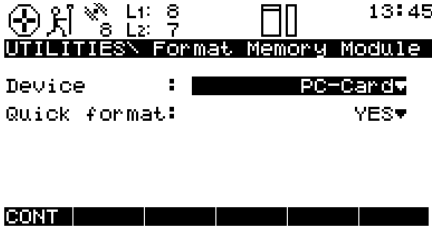
Before you start logging data you may want to (re-)format your PC-card or your internal memory.

This step is only necessary if a completely new PC-card is used or all existing data should be deleted !

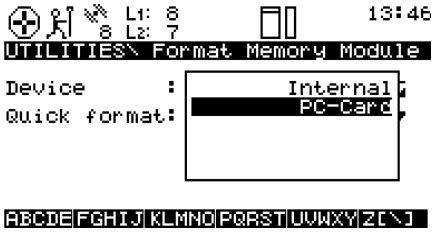
Press **4** on the terminal or use the cursor down key to highlight the line "4 Utilities", then press **ENTER**; alternatively press **F1** CONT.
(If only lines 1 to 3 are visible at this stage press **F4** SHOW first).

Then press **2** to get access to the "Format Memory Module" panel, or alternatively use the cursor key to navigate to "2 Format Memory Module" and press **ENTER**; again alternatively press **F1** CONT.

You are now in the Utilities \ Format Memory Module panel:



If you want to format the PC-card just press **F1** CONT to format the card. If you want to format the internal memory press **ENTER**. A listbox opens which allows you to select the internal memory.



Step 3 (optional): Format your memory card, continued

Use the cursor key to highlight Internal, then press **ENTER**. Then press **F1** CONT in order to start the formatting process of the internal memory.

Warning

By activating the format command all data will be lost! Make sure that all important data which resides on the PC-card is properly backed-up before reformatting the card. If you want to reformat the internal memory make sure that all important data is first transferred to the PC.

If you realize that you do not want to format the memory device, simply press **ESC** instead of **F1** CONT. This keystroke brings you always a step back into the previous panel without execution of any command.

Once the formatting of the card is completed the MAIN\ panel will reappear.

Step 4: Begin a survey

Enter the Survey operation by either pressing **1** in the Main\ panel or by first navigating to "1 Survey" via cursor keys and then pressing **ENTER** or **F1** CONT.

The following panel will appear:

Some basic decisions have to be made in this panel:
Which configuration set should be activated, in which job the raw data should be stored and which antenna setup should be used.

A Configuration Set (Config Set) is a collection of certain sensor parameters needed to perform a certain operation, like data recording rates, point id templates, data formats, antenna types, coding methods, etc.

Several default configuration sets exist which cover standard survey scenarios. How to create new configuration sets is described in a later chapter as well as in the Technical Reference Manual.

For static survey you should select the PP_STAT configuration set. You can make this selection either by using the cursor left key to toggle between all available configuration sets until PP_STAT appears or you can highlight the input field and press **ENTER**.

Then a list box showing all available sets becomes available:

Now use the cursor up or cursor down key on the terminal to highlight the **PP_STAT** line. Then press **ENTER** or **F1** CONT.

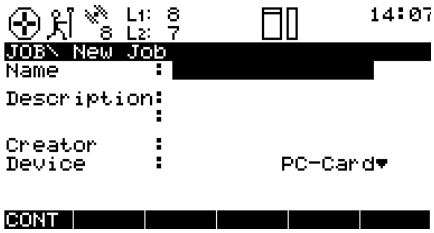
Jobs are used to organize and structure the data you collect in the field. Jobs can comprise an unlimited number of points together with all related information (raw measurements, codes, point annotation, etc.).

It is suggested to create a new job whenever you start a new project.

Upon formatting the memory device (i.e. PC-card or internal memory) a default job is automatically created. You can either use this job straight away or you can create your own job by doing the following:

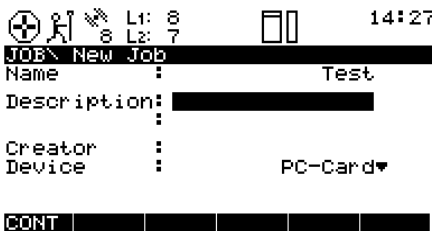
Move the cursor up or cursor down key of the terminal into the input field for jobs. Then press **ENTER**. The following lisbox will appear:

Now press **F2** NEW. The following panel appears:



You can now enter a name for a new job; press **ENTER** upon completing the input of the name. Input fields for description and creator are optional and can be left blank.

As an example we can create a new job called "Test":



By default the new job will be assigned to the PC-card. If needed this can be changed to internal by toggling this input field to "Internal".

Pressing **F1** CONT which confirms the creation of a new job name and its location. Press **ESC** if you want to leave this field without creating a new job. Pressing **F6** QUIT has the same effect.

After pressing **F1** CONT the list of available jobs is updated and now also shows the job "Test":

Now press **F1** CONT to confirm the selection of the newly created job.

Finally you have to select the antenna type and antenna setup which you are using. Normally this will be AT502 on tripod (or AT501 on tripod in case of a SR510 sensor).

See Technical Reference Manual "Measuring Antenna Heights" for further details.

Step 4: Begin a survey, contd.

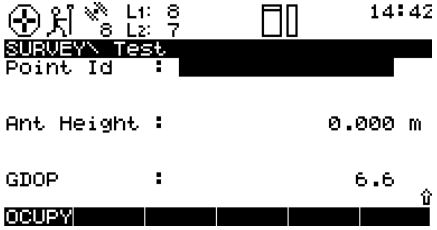
This selection is made in the usual way: first use the cursor down key to get this input field highlighted. Then use the cursor left key to toggle among the several options until the right one appears. Alternatively you can press the **ENTER** key to get a listbox from which the choice can be made.

Now all required settings for a static survey are made. The Survey \ Begin panel looks as follows:

Pressing **F1** CONT finishes this startup sequence.

Step 5: Logging raw data

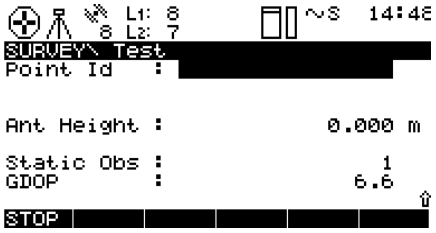
We are now within the main Survey panel. The way the sensor is currently configured, the panel will look as follows:



It is time to check again the icons on the top of the display: The position icon should be available, the position mode icon still indicates "moving" , the "number of satellites visible" icon should display a number greater or at least 4, and the number of used satellites should be identical to the number of visible satellites.

As soon as you are tracking a minimum of 4 satellites, the position icon is visible and the antenna is placed correctly above the survey marker, you should press **F1** OCUPY.

This activates logging of raw data and the screen changes accordingly:



The position mode icon has changed to static, indicated by a symbol of a tripod.

A new icon is now displayed which indicates that raw data is logged.

Raw data (containing pseudorange and phase measurements to each tracked satellite) is logged at predefined intervals (by default every 10 seconds, which is the "observation recording rate" set in the default PP_STAT configuration set): Enter a Point Id by filling in the input field. If you make a typing error correct the mistake by pressing the **CE** key (Clear Entry). Complete the input by pressing **ENTER**.

Now use the height hook to determine the height of the antenna above the survey marker. Insert the height hook into the carrier and measure the height between the white mark at the bottom of the height hook and the survey marker.

Enter this reading into the antenna height field. Since the antenna you have selected is "AT502 Tripod" (AT501 Tripod in case of a SR510 sensor) the offset from the height hook to the phase center of the anten-na is automatically taken care of.

These are the only two inputs needed for surveying a point.
The Static observation counter (Static obs) will now go up every 10 sec-onds (because this is the default logging interval).

The displayed GDOP value indicates the current satellite geometry; the lower the value the better.

Warning

The antenna must not be moved while data is logged, other-wise the quality of post-processed coordinates will be impaired !

Warning

The PC-card must not be removed while in the Survey panel. If the card is taken out of the sensor all stored data might get corrupted, preventing SKI-Pro from successfully reading the data on the card.

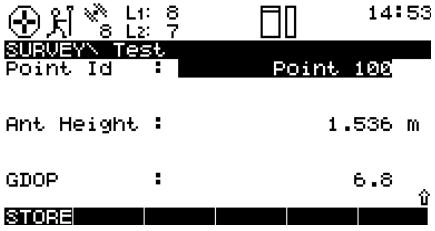
The TR500 terminal may now be disconnected. This will have no effect on the survey ! Datalogging will continue. When reconnecting the ter-minal the same panel will reappear.

Datalogging should continue depending on your observation plan: a sensor used as reference has to run permanently until all rover site occupa-tions are completed. If a unit is operated as a roving receiver the site occupation time depends mainly on the baseline length and your accuracy requirements. See "General Guide to Static and Rapid Static" for details.

Step 5: Logging raw data, continued

Once sufficient amount of raw data has been collected the survey of the point can be completed by pressing **F1** STOP.

The screen is altered as follows:



The STORE key has become active, and you have still the chance to check and correct entered point id and antenna height.

Conclude the survey sequence by again pressing **F1** STORE.

After pressing the STORE key all related information will be stored in the currently used job (point id, antenna heights, etc.)

Step 6: Ending a survey

You can now quit the survey operation panel by pressing **SHIFT F6** QUIT. This brings you back to the main menu.

Pressing **SHIFT F6** will always allow you to terminate the survey operation, even during a site occupation. In this case you will loose all data collected since pressing OCUPY.

As soon as you are back to the main menu the PC-card may be removed. This is indicated by the PC-card icon in the status line which contains an arrow:

Step 6: Ending a survey, conts.

You can now switch off the sensor. Once power is off, put the equipment back into the shipping case.

You might now move to another site and repeat the procedure outlined in this chapter. Once your fieldwork is finished you can proceed by processing the collected data in SKI-Pro in order to get accurate baseline results.

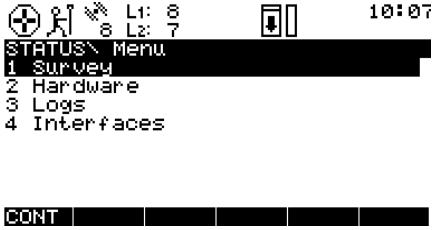
Suggested exercise: Measure a very short baseline

It might be a useful exercise to start with a very simple static baseline.

- Choose a location which is free of obstructions.
- Mark two points on the ground which are a few meters apart and measure the distance by tape (for comparison later on)
- Set up two System 500 sensors on tripod as explained in chapter 2.
- Log raw data simultaneously on each unit for about 10 minutes, using the PP_STAT configuration and newly created jobs.
- Measure and record the height of the antennas correctly using the height hook.
- Enter Point Id's of your choice
- Transfer the data of both sensors into SKI-Pro and post-process the collected raw data.
- Compare the GPS results with your initial tape reading. The resulting slope distance should not differ by more than a few millimeters.

Exploring the sensor status during operation

The terminal gives direct access to all relevant status information via a dedicated **STATUS** key. This key - located in the center of the terminal - is accessible at any time and regardless of the current system operation. By pressing **STATUS** the following menu appears:



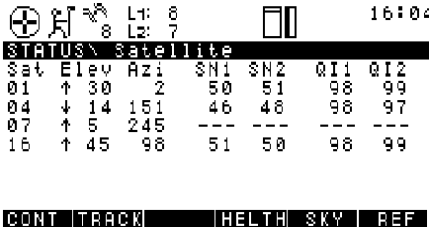
It is now very simple to navigate further through all available status screens. Either use the cursor up / cursor down key to highlight the various options, then press either **F1** CONT or **ENTER**. A quicker way is to press numbers **1** , **2, 3** or **4** to get direct access to the next level of status menus.

A detailed description of all status screens can be found in the Technical Reference Manual.

This short guideline will only concentrate on the screens which are important for Static and Rapid-Static measurements.

Satellite status

Select "1 Survey" \ "5 Satellite". The following display appears:



For each satellite the following information is provided:

- SV number
- Elevation and azimuth
- Signal strength on L1 and L2
- Quality indicator for L1 and L2 measurements

This panel provides valuable information on the current performance of your sensor:

All satellites above the default minimum elevation of 15 degree should be tracked.

Tracked satellites will show signal strength values between 32 and 51 (SN1 and SN2 - Signal / Noise values on L1 and L2). High elevation satellites should have values between 45 and 51. Low elevation satel-lites (elevations below 20 degree) will show values between 32 and 40.
Not tracked satellites are shown with a dash line instead S/N values.

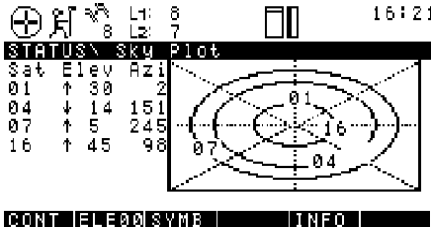
The measurement quality is indicated with numbers of up to 99 in the QI1 and QI2 column. Values will usually vary between 80 and 99. Lower values indicate disturbed signal reception, for instance caused by trees, leaves, or very active atmospheric conditions.

If you find satellites above 15 degree which are not tracked then the line of sight between the antenna and the satellite is most likely blocked by obstructions.

If more than 6 satellites are in view you have to use the cursor down / up keys to scroll up and down the screen and get the information on those satellites which do not fit onto the same screen.

Satellite status, continued

Press **F5** SKY to get a skyplot representing the position of each satellite with respect to the Zenith and North:



The center of the graph represents the Zenith, the circles represent lines of equal elevation: 15 degree - 30 degree - 60 degree (from outside to inside).

Press **F1** CONT to get back to the STATUS \ Satellite screen.

Press **F1** again to exit the STATUS menu and return directly to the screen from where STATUS was called. The same can be achieved by pressing **ESC** several times; this brings you back step by step until you will also end up at the screen from which STATUS was initially called.

Stop & Go indicator

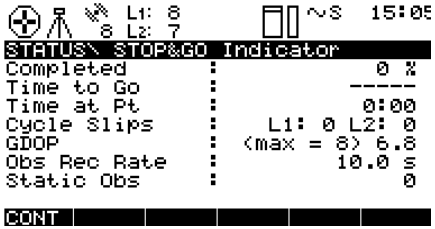
The Stop & Go indicator helps users to judge the necessary site occupation time for rapid static measurements for sensors used as rovers.

A minimum site occupation time is calculated depending on various parameters such as:

- The number of currently tracked satellites
- The current satellite geometry (represented as GDOP)
- Number of cycle slips
- The assumed baseline length between the reference site.
- The current rover position.

Stop & Go indicator, contd.

Once a point is occupied a percentage counter becomes active which informs the user on the site occupation status:



It is recommended to continue data logging until the completion counter indicates at least 100 %.

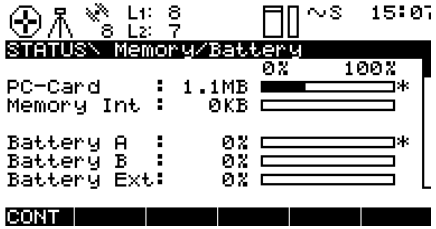
Additional information provided in this panel is the time already spent on the point, the estimated time to go (until 100% completion is achieved), number of cycle slips which occurred since the start of this site occupation, current GDOP as well as the number of recorded static observations.

The way the completion counter is programmed is based on years of practical experience. Although the settings are on the conservative side there is no guarantee that baseline results will meet the accuracy specifications of System 500 after the post-processing of the data.

Press **F1** CONT to return to the previous operation.

Battery and memory status

This quite useful screen is found under "3 General" \ "1 Memory / Battery".



The numbers given represent the still available amount of capacity.

For instance in this particular example there is still 1.1 MB memory left on the PC-card.

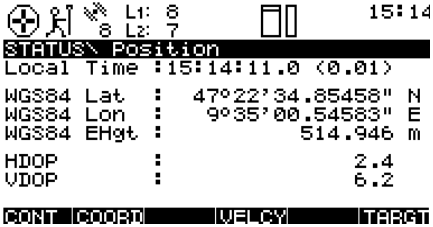
The graphics indicate the level of consumption for each device.
For instance in this particular example about 35 % of the PC-card is already used up.

Currently active devices (for both data recording and power consumption) are indicated by an asterisk

Pressing **F1** CONT gets you back to your previous operation. Pressing ESC brings you back one level only (in this particular case to the "STATUS \ General" Menu.

Display current navigated position

The current position can be found under STATUS in submenu "1 Survey / 3 Position". The following screen is displayed:



Suggested exercise: Get familiar with system status

- Start up a sensor and begin a Survey.
- Start measuring a point (by pressing F1 OCUPY in the main Survey panel)
- Explore various status screens:
  - Satellite Status
  - Skyplot
  - Watch the Stop & Go indicator
  - Check battery level
  - Current (navigated) position
- Finish the site occupation (by pressing STOP and STORE after entering a Point Id and an Antenna Height).

Changing the system configuration

The user has direct access to all configuration parameters via the **CONFIG** key.

Almost all currently used configuration parameters can be altered any time. Access to these parameters is via the **CONFIG** button. Upon pressing it, the following menu appears:

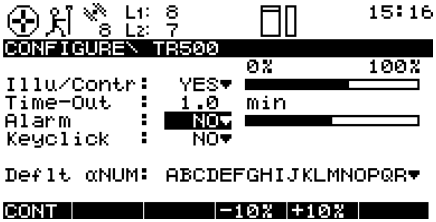
It is again very easy to navigate further and get access to individual parameters: Either by pressing numbers (e.g. **2** for Operation) or by using the cursor down / up keys and to highlight the line of interest and then pressing **F1** CONT.

A detailed description of all configuration parameters can be found in the Technical Reference Manual. This guideline will focus on those which are of importance to Static and Rapid-Static measurements only.

In the five following subchapters we describe 5 different configuration examples which are of relevance for static and kinematic surveys.

Turning on the illumination of the terminal

Certain parameters of the Terminal can be configured under "3 General\ 6 TR500" :



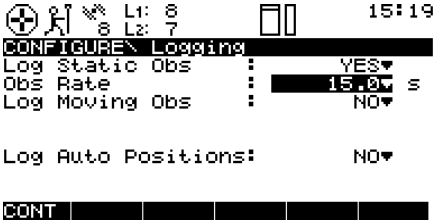
Illumination and contrast of the display of the terminal can be turned on or off. Use the "Cursor left" key to toggle between yes and no. If you select yes you should specify a time-out: once this set time is expired, the illumination is switched off again.

In the same panel you can also activate or deactivate an audible alarm and keyclick.

The requested changes are activated upon pressing **F1** CONT. This key-stroke brings you then straight back to the screen from which the Configuration program was activated.

Changing the observation rate

You might want to change the rate at which observations are recorded. This parameter can be found under "2 Operation \ 3 Logging":



Move the focus to the next line by pressing the cursor down key. Then either press **ENTER** to get access to a list box with all possible rates (from 0.1 sec to 60 sec) or use the cursor left / right keys to toggle among these options one by one.

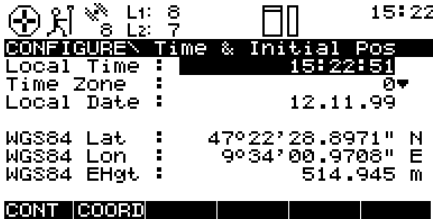
Warning

- If "Log Static Obs" is switched to NO then no raw data will be logged anymore. No data will then be available for post-processing !

- If you change the recording rate please keep in mind that only those observations can be post-processed for which data for both reference and rover sensors is available. If for instance one unit is recording every 10 seconds, and the other unit is recording every 15 seconds then only data every 30 seconds is common and can be post-processed !

- It is not recommended to switch "Log Moving Obs" to YES ! This parameter is only of interest in case kinematic observations should be post-processed.

The local time zone can easily be set under "3 General \ 4 Time & Initial position":



Move the highlighted bar down to "Time Zone" by using the cursor down key. Then either toggle with the cursor left / right keys until the right zone appears or press **ENTER** to open the listbox with all possible options.

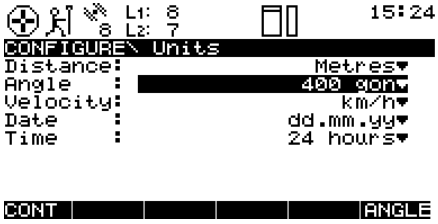
Setting local time zone, contd.

Afterwards press **F1** CONT to activate the selection. You will then see the correct local time being displayed in the upper right corner of the status line.

There is usually no need to modify initial time or the initial position, even if the current settings are completely wrong. The sensor will automatically enter a "search the sky" mode and as soon as satellites are tracked time and position will be updated automatically.

Changing distance units from meter to feet

This can be done in panel CONFIG "3 General / "1 Units". The following screen becomes accessible:



To change units for distances move the focus to this input field. Then use either **ENTER** to get access to a listbox from which the preferred choice can be made; or alternatively use the cursor left / right keys to toggle to the units of your choice (meters, US feet, etc.).

Also other unit parameters can be changed here, for instance the format in which dates should be displayed.

Confirm changes by pressing **F1** CONT. If you want to exit this panel without making any changes simply press **ESC** to get one level back.

Creating new configuration sets

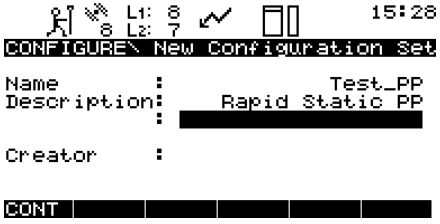
In case the factory default configuration sets do not fully meet your requirements you can easily create new ones by carrying out the following procedure:

Select "6 Configure" from the Main menu. The main menu is the first one to appear after power on. In case only menu items 1 to 3 are visible press **F3** SHOW first.

The following display appears:

Highlight the configuration set which you want to copy to a new one. The parameters of this set will be copied across to the new one you will create by pressing **F2** NEW.

The following display appears:



Type in a new name. Input of a description and a creator's name is optional. Finish this step by pressing **F1** CONT.

If you press **ESC** instead, then you return to the previous screen without having created a new configuration set.

A new configuration set under the name "Test_PP" has been created. The parameters are equivalent to the one of "PP_STAT".

Now we are ready to edit the parameters of this new configuration set. Just press **F3** EDIT to get into a sequence of several screens which contain all relevant configuration parameters.

Programming Wake-up Sessions

The Auto-Wake-up functionality allows you to preprogram the operation of a sensor. By defining start and end times and a configuration set the sensor will automatically start up at the predefined time and take measurements according to the configured parameters and again stop at the predefined time.

This function is useful if a sensor has to be left unattended and the GPS survey campaign is still hours ahead. This way battery power and memory is saved.

Wake-up sessions are programmed in the following way:

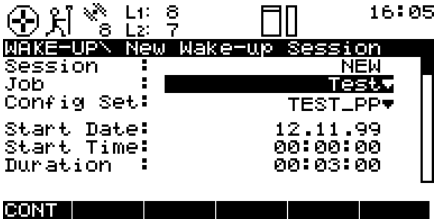
Navigate to the Wake-up session menu. This menu can be found under "3 Applications / 04 Wake-up Sessions":

Press **F1** CONT.

The following display appears:

In this screen it is now possible to create new sessions, edit and delete existing sessions:
Press **F2** NEW to create a new Wake-up Session.

The following display appears:



Define the job in which the data should be stored. Highlight this input line and press **ENTER**. This gives you the opportunity to select from the list of existing jobs or to create a new job.

Programming Wake-up Sessions, contd.

Define the configuration set you want to use. Highlight this input field and press **ENTER**. A listbox will appear from which you can choose the appropriate configuration set. Make sure that this set is configured such that observations will be logged - otherwise there will be no data available for subsequent postprocessing in SKI-Pro.

Define Start Date by typing in the date when the session should be executed.

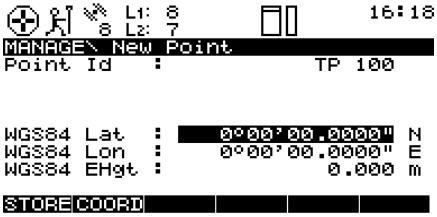
Define Start Time by typing in the time the session should start.

Define the duration of the session. The format is hours: minutes: seconds (hh:mm:ss).

Then press the cursor down key to get access to additional input fields:

You have to enter a Point Id. Navigate to this input field and press **ENTER** in order to get access to the point management:

If the point list is empty or the point you want to occupy is not contained in the list you have to create a new point by pressing **F2** NEW:



Enter a Point Id. You can leave the coordinates blank (the correct input of these coordinates is only of importance for points which should be used as realtime reference sites): Press **F1** STORE to create the new point and get back to the previous display.

Programming Wake-up Sessions, contd.

Press **F1** CONT to get back to the "New Wake-up Session" display. The Point Id of your choice is selected.

Now enter the antenna height. It is recommended to measure the antenna height while you prepare the wake-up session.

Last but not least it is possible to define repetitions of one and the same session. Enter a number for " # of execut's" different from one if you want this particular session to be carried out more than once. In this case you also have to enter a interval (hh:mm:ss format). The maximum interval to be entered is 23:59:59

All necessary input is now given. Please verify the input for correctness by using the cursor up / down keys. Then press **F1** CONT. This leads to the following display:

The session which has just been programmed appears on the list and is highlighted. Session number, start date and time as well as duration is displayed.

Press **F1** CONT to confirm the newly created wake-up session. It is then safe to turn off the sensor. The sensor will then automatically execute the operation as defined in the session parameters.

Alternatively press **F4** DEL to delete an already programmed session, or press **F3** EDIT to modify an existing session, or press **F2** NEW to create another new Wake-up Session.

Kinematic and Stop & Go surveying - using static initialization

Introduction and general comments

Kinematic measurements will provide the trajectory of a moving antenna. If for instance raw data is logged every second, the result will be 3 dimensional coordinates for every second the antenna was moved.

While kinematic measurements are only time related but not point related, Stop & Go measurements deliver coordinates for discrete points which are occupied for a short period of time, usually a few seconds.

In order to achieve position accuracy's on the centimeter level in a moving environment the so called "ambiguities" must be resolved. The safest way is to start Kinematic and Stop & Go surveys with a static initialization. Usually about 5 minutes of dualfrequency static observations on a baseline not longer than 3 - 5 km will be sufficient to resolve ambiguities in post-processing. Once this static initialization is accomplished the GPS antenna can be moved and other points of interest can be occupied with only a few seconds of measurements. High accuracy's will be maintained as long as satellite signal reception is not interrupted, for instance by obstructions.

As soon as a complete loss of signal lock occurs - this means that the signal of satellites is interrupted such that less than 4 satellites remain unaffected - the high accuracy of results is lost and ambiguities must be reestablished first. This means that in such a case another static initialization is required.

Kinematic and Stop & Go surveying is an efficient way of measuring many points quickly and efficiently, provided the following criteria are met:

- Distances between the reference receiver and the rover is fairly short, ideally less than 3 km. Baselines above 5 km should be avoided if possible.

- The surveying area is fairly open with not many obstructions between points. Obstructions will cause satellite signal interruptions which can cause complete losses of lock. In such cases static re-initializations become necessary which slow down the field operation.

- The rover is kept perfectly steady during the static initialization. Movements of even a few centimeters only can cause difficulties in post-processing of such data, leading to unresolved ambiguities and therefore poor accuracy of the starting point as well as all subsequently measured points.

- A static re-initialization is always carried out after a complete loss of lock.

- Satellite geometry is strong. This means that a minimum of 5 satellites should be visible throughout the whole operation, preferably 6 or more satellites.

On the reference site static measurements have to be taken. Follow the instructions given in chapters 1 to 4 with regard to conducting static survey operations.

The roving sensor however might be configured differently in order to allow efficient operation while moving from point to point.

The GPS antenna can be mounted on a rangepole, and the sensor can be stored in the System 500 Minipac; alternatively the whole sensor can be kept on the rangepole itself.

The System 500 rangepole is designed such that either the terminal or the sensor itself can be attached easily. The length of the rangepole is such that the total instrument height of an AT501 or AT502 antenna equals exactly 2 meters. All vertical antenna offsets are taken care of.

See the Technical Reference Manual for details on how to setup a System 500 sensor for kinematic and stop & go surveys.

Step 1:
Setting up the reference site

Follow the instructions given in the previous chapters on running a static survey.

Make sure the "observation rate" is the same as the one you choose for the roving sensor and that logging of static data is turned on. Normally a rate of 2, 3 or 5 seconds is chosen for Kinematic and Stop & Go surveys.

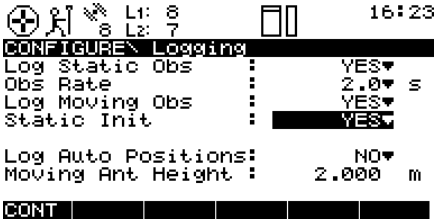
Make sure that the reference receiver is operated in an environment which is suitable for GPS measurements; it should be free of obstructions in order to avoid missing satellites or poor satellite signal reception.

Step 2:
Starting the rover sensor

Kinematic and Stop & Go surveys are part of the "Survey" operation of System 500, to be found under "1 Survey" in the Main menu.

- Select a suitable configuration set, preferably the factory default set "PP_KIS".

Of importance is that the data logging parameters are set correctly for Kinematic and Stop & Go surveys. Logging for both static and moving observations must be turned on. Also the parameter "Static Initialization" has to be set to "YES" :



- Select a job of your choice.
- Select the antenna setup you use, most likely AT502 Pole (or AT501 Pole in case a SR510 sensor is used):

Press **F1** CONT to proceed.

Step 3:
Taking kinematic and Stop & Go measurements

After **F1** CONT has been pressed the survey panel appears:

Start with a static point measurement. Measure a point for a few minutes. Make sure you keep the antenna steady:

- Use a tripod on the starting point
- Use supporting legs (quickstand) in case the GPS antenna is mounted on a rangepole
- Hold the rangepole against a fencepole or another stable object

Take the measurements of the starting point by pressing **F1** OCUPY to start logging static observations, followed by pressing **F1** STOP after a few minutes and **F1** STORE to store the point related information like Point Id and Antenna Height.

You are now ready to move your antenna. You can expect coordinates with centimeter accuracy as long as lock to a minimum of 4 to 5 satellites is maintained.

Observations are logged while moving, which is indicated by a switch in the status symbol from "Static" to "Moving":

If you are only interested in the trajectory of your antenna, then just get moving. Postprocessing will provide you with time tagged coordinates for every epoch at which observations are logged (normally every 2, 3 or 5 seconds).

If you want to pick up subsequent discrete points then just move to the next point you want to measure. Then press **F1** OCUPY, and hold your antenna steady for a few seconds. You have to remain on the point until at least one epoch of "Static observations" has been recorded. You can then again press **F1** STOP and **F1** STORE to complete the point measurement. A Point Id and antenna height must be entered for such Stop & Go points. Post-processing will provide results with point id's and associated coordinates.

Make sure you avoid obstructions when you move from point to point. Severe obstructions might cause a complete loss of lock which in turn will cause a loss of accuracy in post-processing. A static reinitialization will become mandatory in such a case. A warning message will be displayed to inform the user to start another "chain" of measurements:

"Another static initialization is necessary"

In this case logging of raw data stops automatically. Thus you now must carry out another static initialization (see above).

Step 4:
Ending a kinematic and stop & go operation.

End a kinematic or stop & go survey by pressing **SHIFT F6** QUIT. This will of course also end logging of raw data.

Static initializations can be speeded up by occupying a point with known coordinates.

If the coordinates of a point are known in the WGS84 system to within 5 - 10 cm, the static initialization can be accomplished with about 20 to 30 seconds of measurements (10 to 15 epochs).

- Get into the main Survey panel
- Start measuring by pressing **F1** OCUPY in order to log observations on that point. Keep the rangepole steady !
- After about 20 to 30 seconds press **F1** STOP.
- Make sure you enter the correct point id and antenna height. Then press **F1** STORE.
- You can now start moving and occupy subsequent points with few seconds of measurements. The need for another static initialization arises only in case of a complete loss of lock, although it is recommended to keep such a "track" of measurements short (e.g. maximum of 20 points).

When you post-process the data in SKI-Pro you have to mark such tracks as "Init (track)"; this ensures that SKI-Pro relies on the already existing coordinates for this point to fix ambiguities. Again, it is important that the coordinates of the starting points are accurate to within 5 to 10 cm within the WGS84 system.

This method of initialization is of particular interest for SR510 sensors because static initializations on unknown points are very time consuming with single-frequency receivers.

Kinematic "on the fly"

Kinematic on the fly measurements provide the trajectory of a moving sensor without the necessity of a static initialization. The sensor can be moved from the first observation epoch onwards.

Accurate results on the centimeter level can only be obtained if dual-frequency phase measurements are available. Thus this method is restricted to SR520 and SR530 sensors. Single-frequency receivers like the SR510 sensor cannot be used for precise kinematic on the fly measurements.

The advantage of this measurement method is that the sometimes time-consuming static initialization is avoided, thus the productivity in the field will be higher.

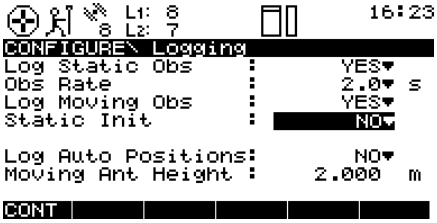
The disadvantage of this method is that an absolute minimum of 5 satellites on L1 and L2 is needed to allow a fixing of ambiguities "on the fly" in post-processing.

Discrete points can also be measured within a "kinematic on the fly" measurement chain.

Thus the operation procedure is very similar to standard Kinematic and Stop & Go surveying as described in the previous chapter.

Configuration parameters for kinematic on fly:

It is important that the logging parameters are set correctly. The parameter "Static Init" must be set to "NO", while logging of static observations and moving observations must be set to "YES".



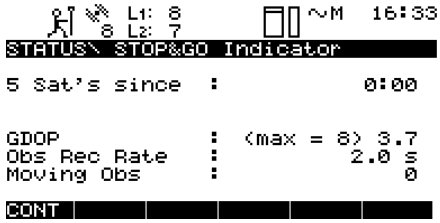
Make sure that the recording rate at the rover sensor is the same as on the reference site.

Taking measurements

As soon as the main Survey panel is accessed, data logging commences according to the configured logging parameters. You will see the status icons changing from moving to static in case you press **F1** OCUPY. After finishing a point occupation by pressing **F1** STOP and **F1** STORE the measurement mode will switch back to "moving".

SKI-Pro will process such data and resolve ambiguities "on the fly". It is recommended to collect about 2 minutes of cycle slip free data before you start occupying points. Otherwise you take the risk that ambiguities cannot be resolved and the accuracy of such points will certainly not meet the specification of 1 - 2 cm + 1 ppm.

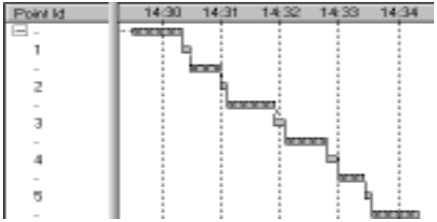
The Stop & Go indicator will provide useful information for this kind of operation (while you are moving):



"5 Sat's since mm:ss" tells the operator the time elapsed since tracking started or since the last complete loss of lock. It is recommended to start occupying points only once this counter exceeds 2 minutes. In case of a complete loss of lock (i.e. the number of satellites tracked on both L1 and L2 falls below 5, the counter is reset to zero.

Post-processing of Kinematic-on-the-fly measurements

SKI-Pro will treat the data as so called "Mixed Tracks". Both static and moving data is contained in one and the same chain of measurements:



In the example above points 1 to 5 are static points. Data-processing will compute and provide a position for each static point by averaging the results of each epoch of data which was taken during the static occupation.

Practical hints for Kinematic, Stop & Go and Kinematic on the fly measurements

- It is very important to use a period of time where the satellite constellation is strong; a window with more than 6 satellites is ideal.
- Distances between reference and rover should be kept short. Ideally this distance does not exceed 3 to 5 km
- It is recommended to keep a "track" (consisting of the observations taken during static initialization as well as during moving and occupying subsequently measured Stop & Go points) short. It is suggested to end a track after e.g. a maximum of 20 points and then reinitialize again. You can force the system to do so by just blocking the GPS antenna by hand for some seconds until the message "Complete loss of lock" appears.
- Include independent checks in your measurements. Either measure a point twice based on different initializations, or include known points into your survey.

Miscellaneous

These guidelines cover only a small subset of the functionality which is available on System 500 sensors. Most of the functionality is used only in realtime applications.

This chapter lists additional features which might be of use also for static or kinematic surveys. Detailed descriptions can be found in the Hardware User Manual.

- System 500 sensors can be used without any terminal at all. Sensors can be preprogrammed in a way that only the "On"-button has to be pressed, then everything else is done automatically, even the switch-off of the sensor.
- System 500 sensors are equipped with 3 LED's which provide status information on power, tracking, and memory. The LED's are visible when the terminal is not attached to the sensor.
- System 500 supports two levels of operation modes. Standard and advanced. Certain parameters are de-activated in standard mode for simplicity reasons and therefore can only be accessed if the sensor is previously configured to "Advanced" mode.
- System 500 supports a comprehensive coding system. By default coding is deactivated for simplicity reasons. Point related thematical coding is possible as well as free sequential coding.
- In Status all measured points of a job can be viewed.
- It is possible to automatically increment point id's, based on user- definable templates.
- System 500 is equipped with a calculator function. This can be found under "3 Applications \ 03 Calculator".
- The System 500 sensor firmware supports a multilanguage concept. English is the master language and permanently loaded. Several local language versions exist which can be loaded and activated in parallel. Talk to your local Leica dealer for details.

Appendix: Summary of status icons

The following Status Icons are supported by the sensor during static and kinematic measurements.

Position / accuracy status

Navigation (<100m)

When no icon is shown no position is available. This usually means that no (or not enough satellites) are tracked.

Other accuracy levels are not supported unless realtime corrections are received through a radio.

Position mode

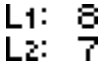
Static - the GPS Antenna should be held stationary.

Moving - The GPS Antenna may move.

Number of visible satellites

The number of theoretically visible number of satellites according to the currently used almanac is displayed.

Number of satellites used on L1 and L2



The number of currently tracked satellites are shown.

If a SR510 single frequency sensor is used only the L1 line is active.

Appendix: Summary of status icons, contd.

Memory status


Internal Memory selected


PC-Card selected


Safe to remove PC-Card


Memory level Indicator. Has 12 levels between:


Memory Empty and


Memory Full

Observation recording status


The Receiver is recording raw GPS observations in Stationary mode. The Receiver should be held stationary.


The Receiver is recording raw GPS observations in Moving mode. The Receiver may move.

Battery status


Battery Voltage OK


Battery supplying 2/3 peak voltage

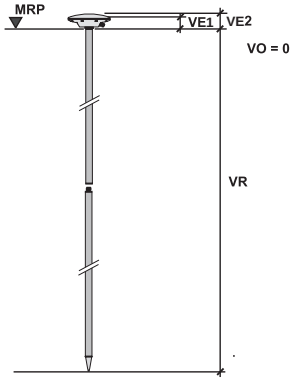

Battery supplying 1/3 peak voltage


Battery empty

The battery being used is denoted by a letter next to it. A and B are the plugin camcorder batteries, E indicates a connected external 12 V battery.

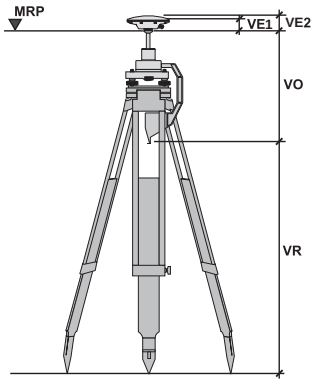
Local time

Local time can be displayed in either an 12 hour format or an 24 hour format. The time appears in the upper right corner of the status line.



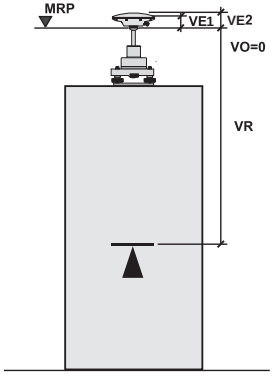
AT502 Pole

If you are using the antenna on a pole select the antenna type AT502 Pole (or AT501 Pole) during the begin of a survey. The Vertical Height Reading (VR) per default is 2m. Normally you do not have to change this value. The Vertical Offset (VO) is 0m and is applied automatically.



AT502 Tripod

If you are using the antenna on a tripod together with the height hook select the antenna type AT502 Tripod (or AT501 Tripod) during the begin of a survey. Measure and enter the Vertical Height Reading (VR). The Vertical Offset (VO) is 0.360m and is applied automatically.



AT502 Pillar

If you are using the antenna on a pillar or a tripod without height hook select the antenna type AT502 Pillar (or AT501 Pillar) during the begin of a survey. Measure and enter the Vertical Height Reading (VR) from the pillar benchmark to the Mechanical Reference Plane (MRP). The MRP is the underside of the threaded metal insert at the bottom of the antenna housing.

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

Total Quality Management-
Our commitment to total customer satisfaction

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

712172en-2.0.0

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