GUIDELINEGEO | MALÅ

MALÅ XV Monitor

User Manual

Our Thanks...

Thank you for choosing Guideline Geo and MALÅ! The very core of our philosophy is to provide our users with great products, support, and services. Our team is committed to providing you with the most efficient and easy-to-use solutions with the capability to meet your needs for efficiency and productivity.

Whether this is your first MALÅ product, or addition to the MALÅ collection, we believe that small investment of your time to familiarize yourself with the product by reading this manual will be rewarded with a significant increase in productivity and satisfaction.

Please let us know about your use and experience of our products as well as the contents and usefulness of this manual. We're excited to be part of your journey!

MALÅ

Guideline Geo AB

www.guidelinegeo.com

GUIDELINEGEO | MALÅ

Table of Contents

Preface

About this Manual

This manual is written for the end user of the product and explains how to set up and configure the product, as well as providing detailed instruction on its use.

Additional Resources

Training: www.guidelinegeo.com/training-gpr-resistivity-seismics-tem/

Downloads: www.guidelinegeo.com/support-service-advice-training/resource-center/

Applications: www.guidelinegeo.com/application-areas/

Feedback

Feedback regarding the contents of this manual or the product may be sent using any of the contact details found at www.guidelinegeo.com

About XV Monitor

Thank you for purchasing the MALÅ XV Monitor. The XV Monitor is an easily operated data acquisition unit for quick and reliable gathering of GPR data. The unit is compatible with the ProEx control unit with Ethernet communication. The XV Monitor is equipped with a transreflective screen for best performance in bright sunlight.

More information, such as technical specifications can be found at www.guidelinegeo.com.

Unpack. Inspect. Register

Great care should be taken when unpacking the equipment. Be sure to verify the contents shown in the packing list and inspect the equipment and accessories for any loose parts or other damage.

Note: The packing list that is included with the shipment should be read careful and any discrepancy should be reported to our sales department at www.guidelinegeo.com

Note: All packing material should be kept in the event that any damage occurred during shipping.

File any claim for shipping damage with the carrier immediately after discovery of the damage and before the equipment is put into use. Any claims for missing equipment or parts should be filed with Guideline Geo within fourteen (14) business days from the receipt of the equipment.

Repacking and Shipping

The Guideline Geo packing kit is specially designed for shipping the MALÅ XV Monitor. The packing kit should be used whenever shipping is necessary. If original packing materials are unavailable, pack the instrument in a box that is large enough to allow at least 80 mm of shock absorbing material to be placed all around the instrument. This includes top, bottom and all sides.

Warning: Never use shredded fibres, paper or wood wool, as these materials tend to pack down and permit the instrument to move inside its packing box.

Please read our shipping instructions before returning instruments to Guideline Geo. These instructions can be found on our website at www.guidelinegeo.com.

Registering MALÅ XV Monitor

By registering your equipment, you ensure that you will receive important information, such as manual updates, software upgrades and other product information, which all helps to optimize the utilization of the equipment and realize the maximum return on your investment.

To register your equipment, simply visit – www.guidelinegeo.com.

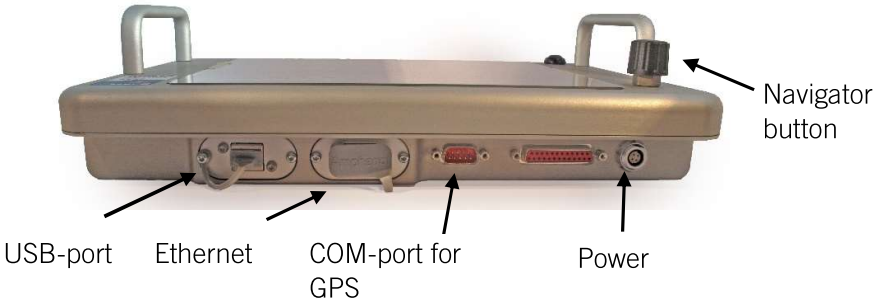
Note: The serial number is found on the underside of the XV monitor.

XV Monitor Tutorial

This XV tutorial will act as a guide through the main steps of carrying out measurements with GPR systems from MALÅ Geoscience.

Before starting up the XV Monitor, do the following connections:

- The MALÅ ProEx control unit to the chosen antenna/antennas.
- The XV Monitor to the ProEx control unit with an Ethernet communication cable.
- If using a positioning system, the encoder to the ProEx control unit with an encoder cable (serial port) and/or GNSS to the XV Monitor (USB or COM-port).
- Battery to the XV Monitor with battery cable. The ProEx control unit is powered by its internal battery or by external battery and battery cable.

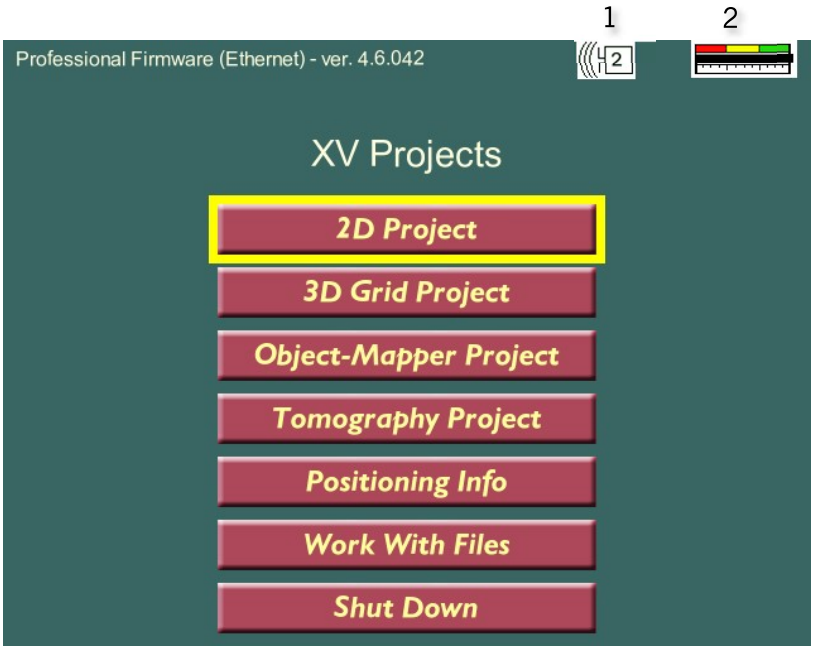


Note: The number of ports on the XV Monitor may differ depending on generation of hardware.

When all connections are made, the control unit and the XV Monitor can be turned on. Pressing the On/Off button at top right-hand corner activates the XV Monitor.

Once active, the XV Monitor is operated using a dual function turn-push button, the navigator button (bottom right on the monitor) to control the measurements. By turning the navigator button right or left, a selection of a specific menu can be highlighted. By pushing the navigator, the selection is activated.

When the XV Monitor is connected to a control unit the following screen is shown at start-up.



1. Control unit status indicator. The number indicates number of connected modules to ProEx. If the control unit is off or if the connection is bad the indicator is red 

2. Battery Status Indicator. It shows two black lines for two batteries.  The lower line is for battery level in the control unit and the upper line is for battery level in the XV monitor.

The Main Menu and Project Types

You can select four different project types from the main menu.

In 2D Project you can create profiles with radar data (so called B-scans). The profiles can be tagged with GNSS positions, and data from EM sensors (if this type of antenna is used). You can create surface and object markers under measurement. Wheel, time and keyboard can be used as trig sources. See section *2D Project* for more information.

With 3D Grid Projects you can measure rectangular areas to create a 3D volume of radar data and display the same. The data can be visualized in two views: Top View and Side View. Any X or Y cross sections can be selected for the Side View and Top View shows the Z slice for any depth. 3D Grid projects can directly be imported to the cloud based MALÅ Vision software. See section *3D Grid Project* for more information.

The Object Mapper Project consists of several 2D profiles that are positioned by GNSS or connected to a base line. Object Mapper Projects can directly be imported to MALÅ Vision. See section *Object Mapper Project* for more information.

Tomography Project is used when you measure with separate transmitter and receiver antennas. This type of measurement is mainly done for borehole investigations. Tomography Projects can be opened in the WinTomo software or other third-party software's. See section *Tomography Project* for more information.

In the Positioning Info you can use the wheel to measure distances and also see the GNSS coordinates. See section *Positioning Info* for more information.

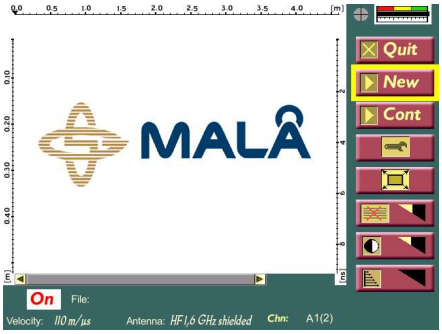
In Work With Files previously measured files and screenshots can be opened, uploaded or deleted. See section *File manager* for more information.

2D Project

2D Measurement

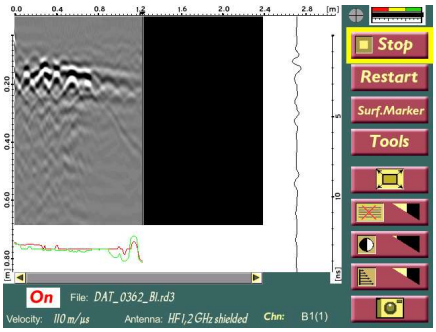
By selecting **New** and pressing the navigator button, a measurement can be started immediately.

The XV offers you a fast way of parameter choices through factory default settings and automatic identification of the antenna used.

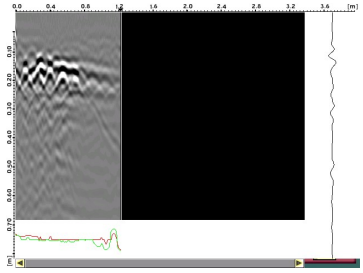


Press  to enter Measurement Settings. See section *Measurement Settings* below.

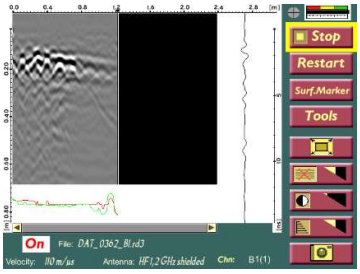
If a High Frequency (HF) antenna with EM-option is used the EM data will be displayed directly underneath the radargram. More can be read in the User Manuals for *ProEx* or *CX control units*.



By pressing  the operator has the possibility to toggle between a full radargram screen and the screen with the menu options.



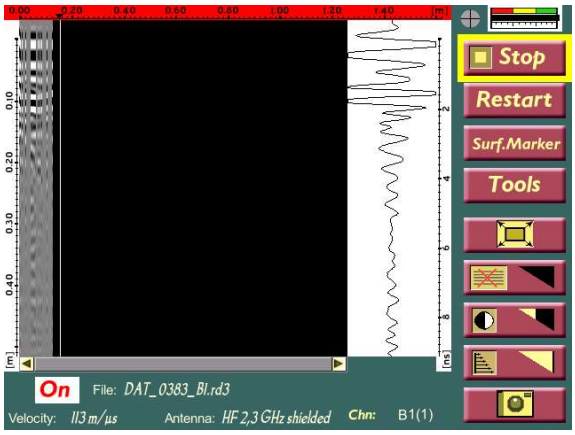
or



By pressing  the last measured radar profile can be continued. The measurement will always be continued from the last trace.

If measurements are carried out with a too high speed, the traces collected will appear grey (containing no data) in the radargram window and the horizontal scale will blink in red, to make the operator aware of the over speeding and need to slow down.

The length measurement will continue to be correct.



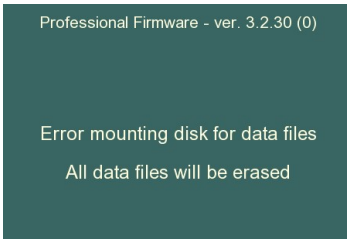
Note: Missed trace appears when the measurement is carried out with a high speed, with dense trace interval and in combination with too many samples or stacks.

Note: When working with the ProEx control unit and in cross-channels mode, this also affects the maximum measurements speed. The maximum speed is reduced with a factor of 2.

If a GNSS device is connected to the COM or USB-port of the XV Monitor the coordinates are displayed below the radargram and stored in a *.cor file, where the coordinate is connected to radar data by trace number. See section *Connection to a GNSS* below.

As each profile is completed, just press Stop to stop the measurement and save the data. The data can be moved from the XV Monitor to another computer for further interpretation work, see section *Transferring data.*

To turn off the unit once the work is completed, use the QUIT button on the screen and then the on/off switch on the unit. If the unit is switched off using only on/off switch, the file system in the unit can be corrupted and all the data can be lost. If this happens the following message will be shown the next time the unit is switched on.



Screenshots can be taken under measurement by pressing  button.

Note: When the QUIT option is used, but then the power is not turned off immediately, with the on/off switch on the XV Monitor, the unit has to be powered off before start again by pressing the on/off switch and then wait for 5-10 seconds before pressing the on/off switch again. Otherwise, the unit will not turn on.

Note: If the unit has been turned off without using the QUIT button, a data disk format should be carried out. See section *System Settings*. This type of format can also be carried out prior every measurement round to guarantee best possible disk operation.

Filter, contrast and gain

To improve the visualization of radar data the XV Monitor provides the operator with different filter and contrast options. For each option the navigator button is rotated to increase or decrease the effect.

Applies a background removal filter.

Changes the contrast of the radargram.

Applies time gain on the measured traces. The settings for this filter can be changed, see section *Parameters menus*.

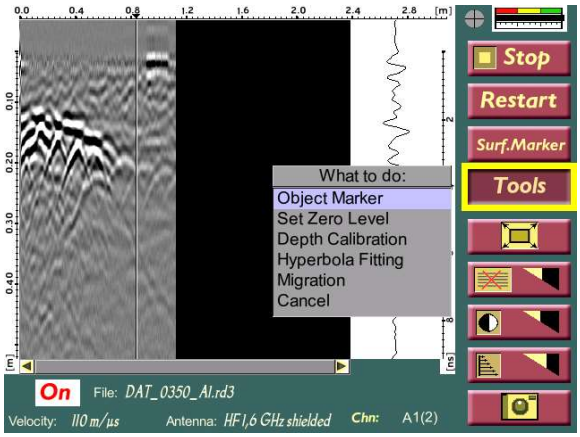
A FIR filter can also be applied on the data, see section *Parameters menus*.

Markers

During measurement surface markers can be used to identify surface features on the investigation site, such as manholes, cables, trees etc. Object markers can be used for underground objects. Object markers can be selected by pressing the option Tools. See section *Tools* below.

All the associated markers are saved in a *.mrk-file and are automatically connected to the associated radar data file. Markers can be set with the navigator button on the XV Monitor or with the red button on HF antennas. See Appendix 1 for further information.

Tools



To obtain a correct depth reading, it is important to set a correct zero level and signal velocity. If not correctly set the depth reading will be incorrect. The zero level in your data should

correspond to where the media (usually the ground surface) begins. This can be the beginning of the maximum peak of the first arrival. The velocity should be set to the average velocity between the zero level and the object to which we need to know the depth. The XV Monitor have three different tools to estimate the average velocity:

- Depth Calibration can be used if you have some object underground on a known depth. The result will be a corrected depth scale according to your object and set depth.
- Hyperbola Fitting can be used to define the velocity of the radar wave in the ground. The angle of the hyperbola arms is directly related to the velocity of the GPR signal.
- Migration allows you to see reflections as points instead of hyperbolas. When the hyperbola is turned to a point, the correct velocity is used.

For more information, see Appendix 1 Tools and Markers.

Connection to a GNSS

A GNSS (Global Navigation Satellite System, as GPS or GLOSASS) can easily be connected to the XV Monitor via the COM or USB-port. See section *2D Project – GPS Parameters* for settings of COM or USB-port connected GNSS.

Note! If using a USB GPS, this have to be connected to the XV Monitor when the system is running and not before.

When the communication settings for the GNSS, is correctly applied (see section *GPS Parameters*), the received coordinates are displayed below the radargram and saved in a *.cor file.

In the *.cor-file the coordinates are found together with the trace number. The coordinates will only be saved when the position is changed. The XV Monitor will check for updated coordinates at a maximum rate of four times per second.

The MALÅ standard GNSS format contains the following information: trace number, date, latitude, longitude, height above mean sea level, and HDOP. The HDOP value is a theoretical measure of the accuracy in the horizontal coordinates based on the positions of the available GPS satellites. A lower value indicates better accuracy. The date and time are expressed in Greenwich Time zone. The GPS data is saved automatically in a *.cor file, when a GNSS is connected and running. An excerpt from a data file is seen below:

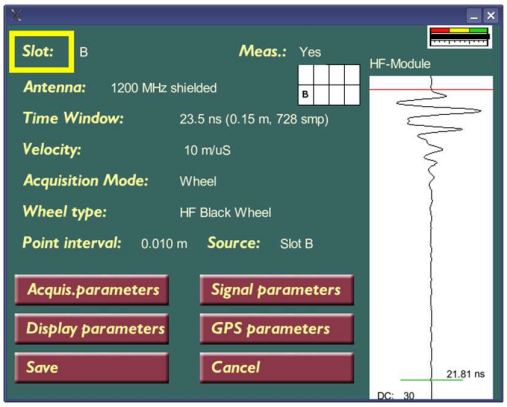
```
Trace   Date     Time     Latitude N Longitude E  "height above MSL" M  HDOP

1    2008-05-14 08:52:44  59.368000 N  18.248722 E   15.9  M  2.4
2    2008-05-14 08:52:49  59.368000 N  18.248722 E   15.4  M  2.7
16   2008-05-14 08:52:51  59.368008 N  18.248701 E   15.1  M  2.7
```

Note: We can only guarantee proper functionality of a USB GPS devices purchased directly from us.

See also Appendix 2 for more information on measurements with GPS.

Measurement settings

If the measurement settings need to be changed before a measurement is started, they can be altered within the Tools menu  .

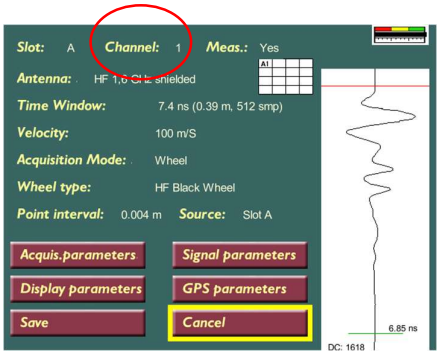


In this menu the options for changing Antennas, Time window, Velocity, Acquisition mode and Point interval are found.

The settings for each slot used on the ProEx control unit can be changed individually by changing the slot  . You can choose between Slot A to H.

To activate the cross-channel mode, when one antenna communicates between Slot A and B, C and D, E and F and G and H, see section *System Settings*.

When this mode is activated, the settings for Channel 1 and 2 can be changed by changing channel.



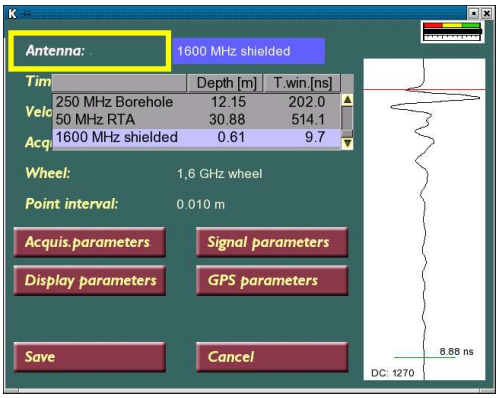
To toggle between the channels in use, while measuring, is done with the option  on the main menu.

If the slot A to H is to be used for the measurements or not is changed with  .

If the ProEx is connected to an un-identified older antenna it's possible to choose between all the different antennas in the antenna list.

When the ProEx is connected to a new known antenna, the operator sees only the current antenna and can select the required investigation depth.

	Depth [m]	T.win.[ns]
Shallow	0.99	15.4
Medium	3.10	50.5
Deep	4.55	74.6



In the Tools menu the different parameter menus are also reached, see next section.

Using the navigator button, the setting to be changed is chosen and the button pressed to activate it. As this is done, the different options are displayed and can be changed. The changes have to be saved before leaving the menu. The navigator button is turned to increase or decrease the displayed values.

Time window defines the total trace length in time; in other words, the total length of time the electromagnetic wave is transmitted. It is the result of the number of samples and sampling frequency (see below). A sample is a part of the trace and defined as the digital amplitude value of the electromagnetic waveform at a specific time. Adjusting the sampling frequency and/or the number of samples controls the time window. The time window can be recalculated to a depth value if the ground velocity is known.

The velocity given is the moving speed of the electromagnetic wave in the ground/soil measured.

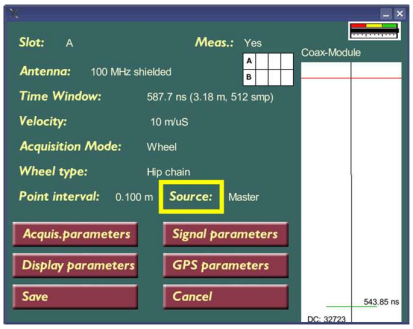
The option acquisition mode and wheel are changed depending on how the measurements are to be gathered, by time or by distance. If distance is chosen, the correct encoder is selected. The standard MALÅ wheels and hip-chain are found in the list, and these default settings are often most convenient.

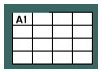
Note: The precision of the encoder wheel is not infinite and depending on several factors as, the measurement surface, the pressure applied on the wheel and possible wear. If you are unsure of the encoder wheel precision a re-calibration should be made, see section *Acquisition Parameters* below.

Point interval (or time in seconds) gives the distance between the measured points / traces in the radargram.

Note: When measuring by time, check and make sure that the time interval is appropriate. For instance, for an RTA a time of 0.15-0.5 seconds can be enough, giving 2-4 traces per second.

Source gives the choice where the encoder wheel will be connected. It can be as Master connector (on the ProEx unit) or the wheel can be integrated in an antenna (for e.g., a HF antenna), which is connected to one of the slots. Then the correct Slot (A to H) is chosen.



The table in the Tools menu 

gives information when working with several antennas with the ProEx control unit, in other words with several slots. In this table all the different channels and slots is seen which will be active and measure. In other words, when the option 

is set on Yes.

The different options are:

- A or A1 stands for T1R1, Transmitter and Receiver in the same slot, Slot A.
- A2 stands for T2R1, Transmitter in slot B and Receiver in slot A.
- B or B1 stands for T2R2, Transmitter and Receiver in the same slot, Slot B.
- B2 stands for T1R2, Transmitter in slot A and Receiver in slot B.
- And so on with C to H for the expansion slots on the ProEx control unit.

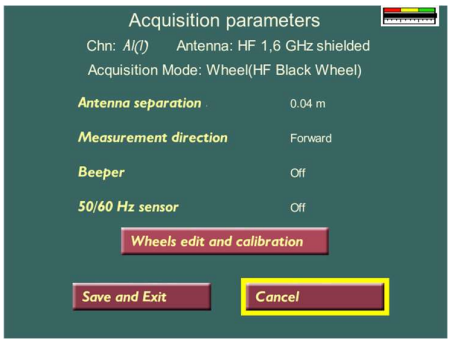
See also section *System settings*, for activation of the cross-channel mode.

Parameter menus

The different parameter menus found in the Tools menu contain the following:

Acquisition parameters

Antenna separation, Measurement Direction, Wheels Edit and Calibration.

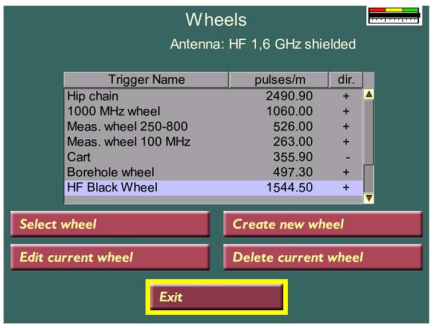


The antenna separation cannot be changed for predefined antennas but can be changed for the last four custom antennas. This is convenient if you work with separate antennas or combine Tx and Rx from different antennas. The antenna name of custom antennas can also be changed on this screen.

Measurement direction can be set as forward or backward if a wheel is used (not the hip chain) indicating in which direction the measurement wheel should roll.

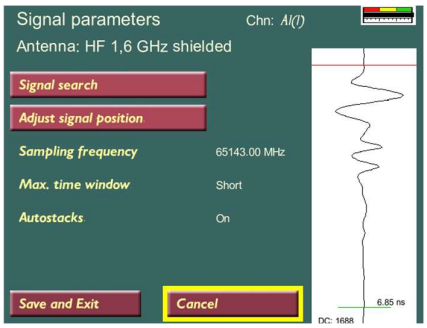
With the option Wheel edit and calibration the setting for the measuring wheel can be changed. It should be noted that the precision of the encoder wheel is not infinite and depending on several factors as; the measurement surface, the pressure applied on the wheel and possible wear. If you are unsure of the encoder wheel precision a re-calibration should be made.

First the wheel to edit is chosen and then edited, or press Create new wheel and then edit. In the Wheel Edit Screen the name for the wheel / hip chain can be given, and then the correct distance for calibration is set before Start calibration is pressed. When the measuring wheel has moved the correct distance, press Stop to make the calibration.



Signal parameters

Signal Search, Adjust Signal Position, Sampling Frequency, Max. Time window and Stacking Mode.



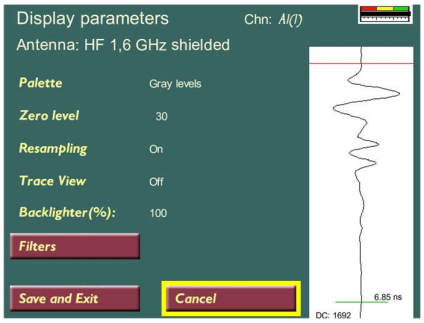
Signal search carries out an automatic finding of the zero level. There are two different algorithms for this search: MAX or Threshold. The type is selected in the *System Menu*. This level is depending on the antenna together with the surrounding environment and ground conditions. This level can be adjusted by choosing Adjust Signal position and then change the location of the red horizontal line in the trace view, with the navigator button.

The sampling frequency should be set to approximately 10 times the antenna frequency. Sampling frequency is defined as the interval in which samples is taken over the trace length. A higher sampling frequency gives a shorter time window.

If Autostacks is activated, the system stacks each measured trace as many times as possible according to your measurement speed. Otherwise, the number of stacks can be chosen between 1 and 512.

Display parameters

Palette, Zero level, Resampling, Trace view and Filter Settings.



The palette refers to the display of the radargram, in grey scale or in colour.

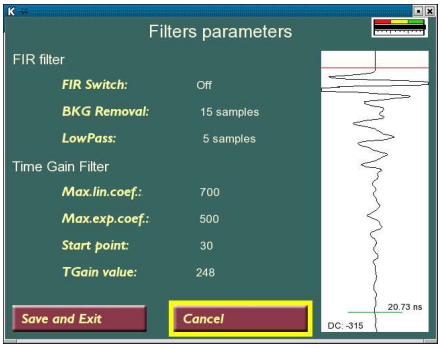
Zero level is expressed in nanoseconds as the location of the ground surface; from where the depth scale is begins.

If the option resampling is OFF the radargram view will show a sample per pixel. If the option is ON the entire measured time window is showed on the screen and a scrollbar appears on the right hand side of the screen.

If Trace view is ON a small window will appear during measurements, showing the actual measured trace.

The intensity of the screen light can be changed with the Backlighter option. When this value is decreased the light of the screen decreases, which affects the battery capacity positively.

When pressing Filters the following screen is seen:



Here you can change the parameters for the two different filters, the FIR (Finite Impulse Response) filter and the Time Gain filter. When settings are changed the Trace View will show how the choice of filter parameters affects the trace. The trace view will always have DC removal activated.

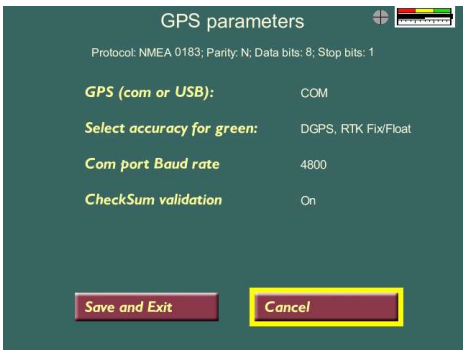
If the FIR switch is OFF then DC Removal filter is ON for all displayed data. If the FIR switch is ON this filter will be applied on all displayed data according to the settings made. The FIR filter is essentially a band-pass, time domain filter, removing unwanted noise from the signal.

As a rule of thumb: If the sampling frequency is set to 10 times the antenna centre frequency, the default parameters 25 and 5 will be appropriate. If higher sampling rates are used, the parameters (especially the BKG removal) should be changed accordingly, by increasing the number of samples.

Observe that the setting of the option BKG Removal only affects the FIR filter and works on a trace level as a high-pass filter. It will not affect the background removal option in the main menu.

The time gain filter is applied to compensate for the geometrical and conductive attenuation of the signal in matter. The intensity of the filter is set in the main menu while the settings are changed here. The maximum linear coefficient can be set to max 3000 and the maximum exponential coefficient to max 1000. The time gain filter can be turned off in the *System setting* menu. Instead, an Automatic Gain will be applied.

GPS Parameters



The needed GNSS parameters are displayed in the first line of the GPS parameters screen. The NMEA should be of GPGGA sentence type. x

Coordinates will only be saved in *.cor file during measurements (together with the correct trace number) when there is a change in the position.

Select accuracy for green is used for the GNSS indicator, seen top right on some screens, as the 2D Project. If you need highest accuracy select High (RTK Fix only). The indicator is:

- Green if you have RTK Fix.
- Yellow if you have coordinates but not RTK Fix.
- Red if you have GPS connected but no coordinates yet.
- Grey if you have no GPS connected.

The CheckSum validation is used only in some cases like for instance for a Leica 1200 Robotic Total station, which delivers a NMEA protocol without check sum, so then the **CheckSum** should be turned OFF.

Com Port Baud Rate and CheckSum validation can be changed only for COM-port based GNSS devices. If a GPS is connected to the USB-port these two parameters are not in use. The baud rate is then fixed to 4800.

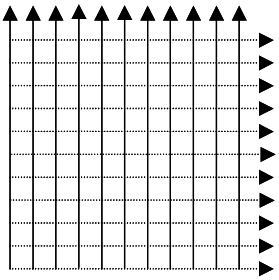
Note! The only GPS with USB communication tested and functioning today are:

- GM-158-USB (from San Jose Navigation Inc.)
- Globalsat BU-353
- Globalsat GPS-105

For more information, see Appendix 2.

3D Grid Project

Grid Project is a tool that makes the visualization of radar data measured in two perpendicular directions easier.



A typical 3D Grid project is the investigation of re-bars in concrete, acquiring data with a high frequency antenna, the ProEx and the XV Monitor. It can also be used to map a larger area where the direction and location of utilities for instance is unknown. The 3D Grid Project option in the XV Monitor will guide you through all steps involved in the data collection to the final processed 2.5D view of the investigated area.

The measurement for smaller investigations sites (0.8 x 0.8 m) can be carried out using a MALÅ grid-mat, for fast and easy data collection.

Creating a Grid Project

First of all, do the correct measurement settings in the *Tools menu* (see sections above) and then start working with Grid Project by selecting 3D Grid Project on the Start Screen.

On the New Grid Project screen, you can set the proper parameters for grid size, spacing between lines (profiles) and point interval before data collection begins. These parameters are not changeable afterwards. The text fields with information on site, customer, name etc. can be changed afterwards, though.

The grid size is limited not by the actual size but by the number of data points (traces) along a profile. Currently the limit is set to 280 by 280 points. The MALÅ Geoscience grid-mat is 0.8 x 0.8 m and preferably measured with a point interval of 1 cm and a line spacing of 10 cm.

Note: The Line spacing must be evenly divided with the set Point interval distance.

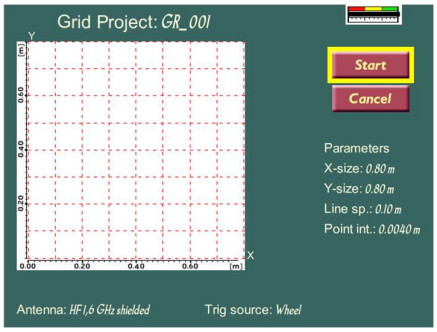
How to edit the project definitions:

- Choose the parameter to be edited and press the button to select. A blue box will appear over the parameter value, and a triangle under the character currently being edited.
- Press and release the button on a character, causing a second triangle to appear above the character. The character can now be changed by turning the button. Pressing the button again will allow the user to move on to the next character.
- By pressing and rotating the button without releasing, the operator can add or delete characters.
- Set the lower triangle under the large triangle at the end of the string and press the button to finish editing the parameter.

Press 

to reach the Control Screen where you can do a final check of your project parameters.

By choosing Start, the Grid Project is activated.

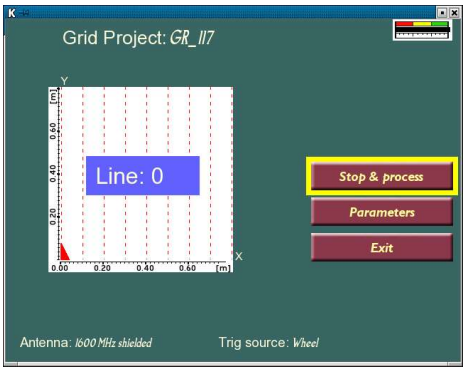


When using an antenna from the High Frequency series the two buttons on the antenna or on the extension handle are used as remote controls, for choosing the next profile and start profile. See User Manual *High Frequency Antennas*.

If other antennas are used, two new menu choices will be found on the screen, Start Line and Next Line, see figure below.

The number in the blue rectangle refers to the line number on the grid carpet.

Lines are gathered by placing the antenna over the start position. The red triangle shows the start point and direction.



Note: Good alignment of the antenna on the start position is vital for good results.

Press Button 1 (black) and wait for a beep on the HF antenna or choose the menu option Start Line on the XV Monitor, then move the antenna to the end of the line. The button must be released during movement.

If measurements are carried out with a too high speed, the horizontal scale will start to blink red to make clear you need to slow down. If measurement continues with a too high speed, this will result in missed trace in the profiles, and by that poor data quality of the 3D view. You can decrease number of samples or stacks to make higher measurement speed possible.

When the end of the line is reached a new beep is sounding, indicating that the line is ready. Another beep will sound shortly after, indicating that it is ok to change measurement line. This is done by pressing the Button 2 (red) on the HF antenna or choose menu option Next Line on the XV Monitor.

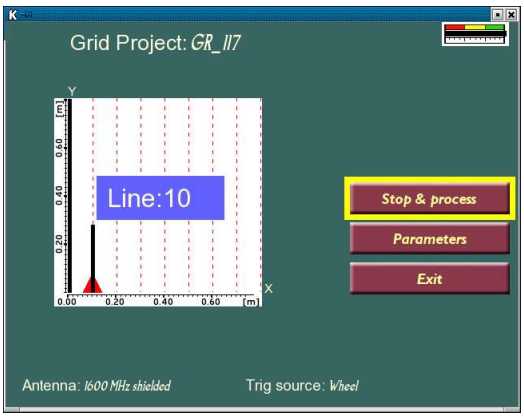
If button 1 on the HF antenna is pressed again, after the line is finished, the software assumes that the operator wants to re-measure the current line. The same can be made by selecting the menu option Previous line, and then lines measured before can be re-made.

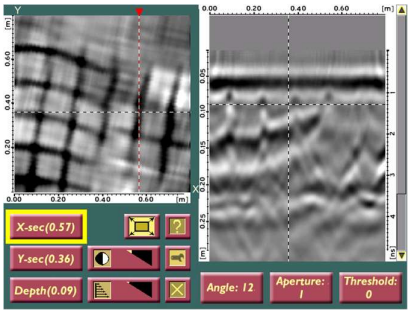
Place the antenna correctly on the second line, align it well and choose Start line or press Button 1 (black) to continue the gathering of grid data.

In the picture to the right, 28 cm of the second line has been measured.

Continue in the same manner until the whole grid is filled, in both directions.

Once the last line (profile) is filled, the Stop & Process button is selected, which leads to the following screen after some minutes of processing:





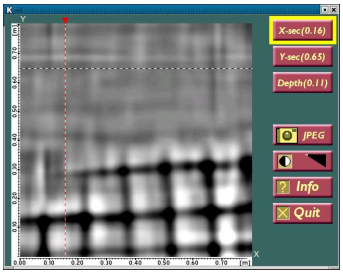
This screen shows the result of the calculations made to create vertical and horizontal slices of the measurements done. You see the horizontal slice (X or Y) to the right and the Top View, the vertical time slice, to the left.

For explanation of the three function-buttons,  ,  and  see next section in this manual.

The options Angle, Aperture and Threshold are settings for the Top View and stands for:

- Angle – The space between the single lines of data is being filled with the help of an interpolation scheme. This interpolation can be performed in different directions where the angle parameter determines this direction as -45 to +45. A value of 0 indicates orthogonal interpolation, the normal case. This filter should mainly be used when the target directions are not parallel with any of the profile sets.
- Aperture – When targets are not exactly horizontal, it helps a lot if one can view a depth/time interval instead of an instant time slice. This parameter determines the thickness of the merged time slices. It should be altered in order to better follow a dipping target or to view several targets, on different depths, in the same top view. When the parameter is altered, the time/depth span is shown interactively on the side view.
- Threshold – this is composed filter. It mainly sets a threshold on the top view data. Levels below the threshold are zeroed and levels above are presented. The parameter is expressed in percent of maximum amplitudes found the dataset. Increase the value to highlight white elements on the Top View, decrease (to negative values) to distinguish dark elements on the Top View.

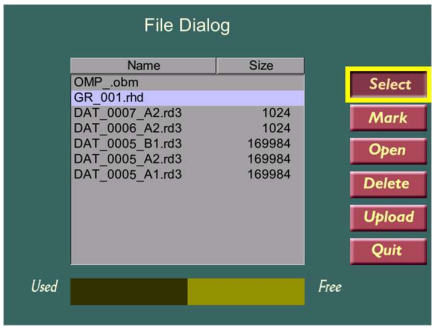
See also section below for pictures of these filter settings.

The screen can be expanded by  and displayed as: 

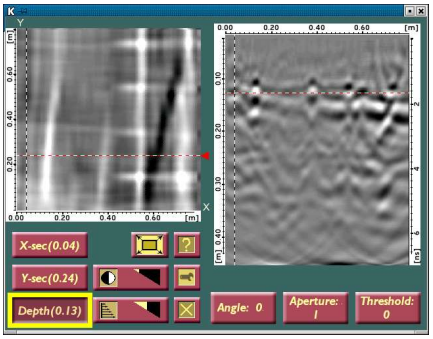
Here the user has the choice to save a jpg-image of the current view, by selecting  . These files are automatically named according to the 3D Grid Project they belong to and will be given an increasing number.

View and process recorded 3D Grid Projects

As with other types of radar files acquired with the XV, 3D Grid Projects can again be viewed and processed within the Work With Files option on the Start Screen.

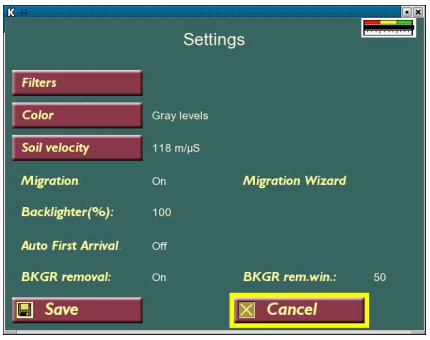


Choose the project to view in the File Dialog and press Open to view it.



By pressing  , the user can view the settings of the project and change the text information, such as customer name or other comments on the measurement.

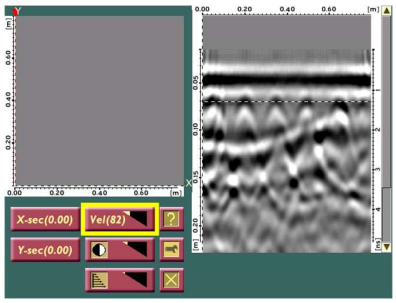
By pressing the  button, it is possible to change each of the settings, for example the screen and processing parameters.

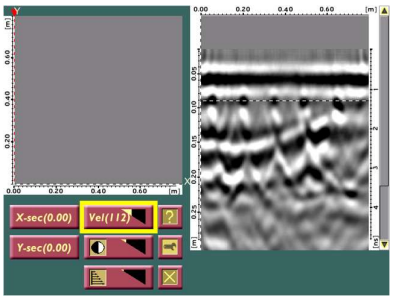


If the parameters important for migration (BKGR (background) removal, Auto First Arrival or parameters within the Migration wizard) are changed, then all calculations to create the horizontal and vertical slices are carried out once more. This can take from 30 sec to 3 min (depends on the data size). The calculations carried out in each of the directions include FIR filters, interpolation of the data and combining the two directional data sets. BKGR Removal, Migration, and Auto first arrival also are calculated if chosen by the user.

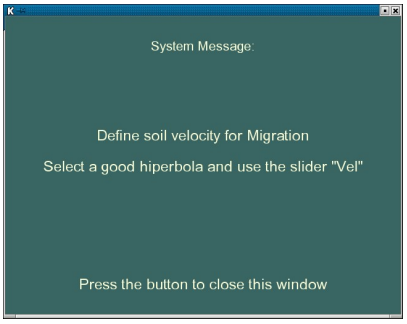
By selecting Migration Wizard, the option Migration Wizard is reached. In this option it is possible to select an appropriate soil velocity for the migration. First, select a slice (X or Y) with a well-defined hyperbola. Choosing the X or Y Slice buttons views the data before migration, and when releasing them views the data with migration. The soil velocity may be changed, with the Velocity option 

to be correctly set to give a point shape result of the chosen hyperbola and the result of the migration with that particular velocity can be viewed, without spending the time of migrating the whole dataset.



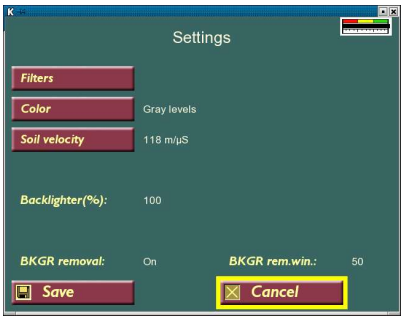


In the Migration Wizard mode, the  button gives the following screen. Closing the window returns the user to the measured data.

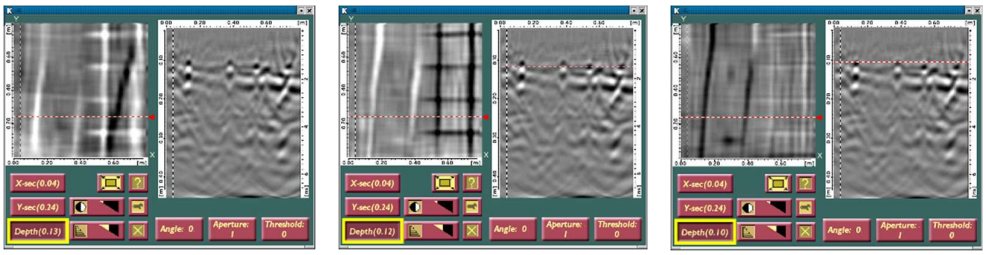


And the  gives the following screen, where some of the display settings can be changed.

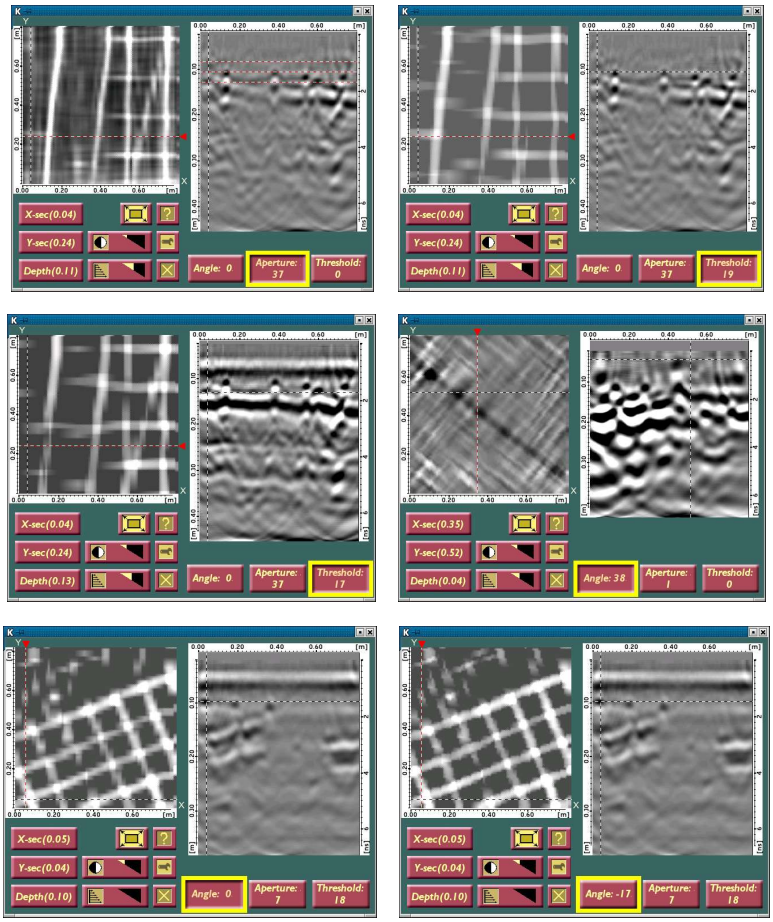
By pressing  the new settings of velocity is calculated for the whole data set.



The results of the migration can look like the following pictures, showing three different depth slices of the same data set. The re-bars are easy to identify in the different depth slices.

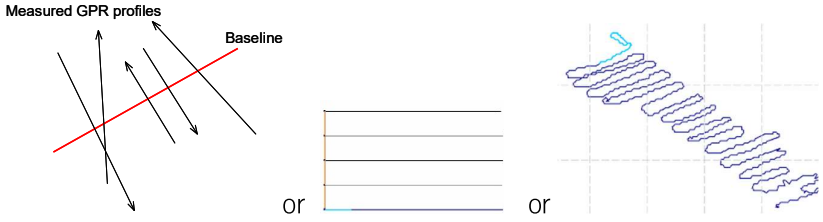


In the following six pictures the effects of changing Angle, Aperture and Threshold is displayed:



Object Mapper Project

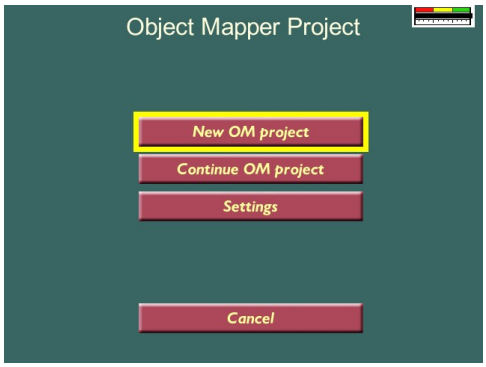
An Object Mapper Project is a tool to easily handle and interpret radar profiles acquired with the XV Monitor, where a number of radar profiles are linked to a common baseline or positioned with GNSS. See the examples below.



Once an Object Mapper Project is created within the XV Monitor, it can be directly opened in MALÅ Vision or MALÅ Object Mapper. For further information, see the *MALÅ Vision* and *MALÅ Object Mapper* user manuals.

Creating an Object Mapper Project

Start working with Object Mapper Projects by selecting **Object Mapper Project** on the start screen. The following screen appears:

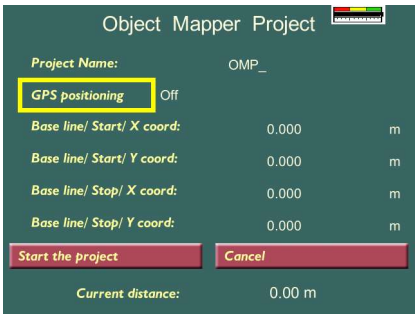


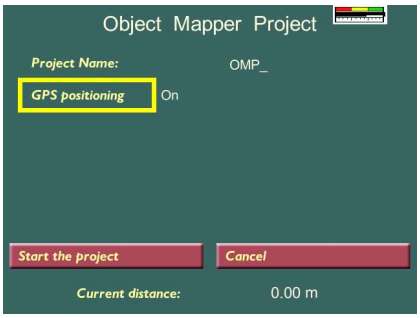
Select **Settings** do the correct measurement settings (remember that OM Project can be done only with one channel and wheel-based triggering). Do not forget to set GNSS parameters and connect a GNSS for a GPS OM Project. See sections *Measurement Settings* and *GPS Parameters* to learn more about settings.

A new Object Mapper Project is created by pressing New OM Project. Give the project name and choose between baseline project and GPS project. If the GPS positioning is ON no baseline is needed.

To change the settings, use the navigator button to choose between the settings and press the button to activate that choice.

Note: An Object Mapper Project can only be started if the trigger is set to wheel and not time or keyboard.





The name of the project can be chosen, and each letter individually changed, with help of the navigator button. The characters available include A to W, 0 to 9 and underscore.

To edit the project name and coordinates:

- Press and release the button on a character, causing a second triangle to appear above the character. The character can now be changed by turning the button.
- By pressing and rotating the button without releasing, the operator can add or delete characters.
- Set the lower triangle under the large triangle at the end of the string and press the button to finish the editing.

The location of the baseline is given by setting the x and y-coordinates of the start and stop positions of the line. If no coordinates are available, the baseline is most often defined as 0 m for x- and y-start position and then the length of the line for x- or y-stop position.

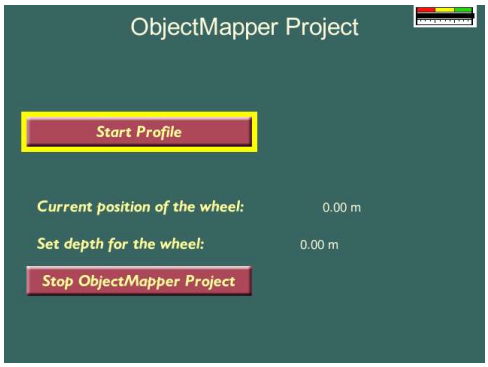
When the baseline is defined or GPS positioning is ON press, press Start the Project to collect the Object Mapper files.

In this mode, before pressing Start the Project, the measuring wheel can also be used as a measuring tape, showing the travelled distance at the bottom of the screen. To set the measuring tape function to zero, just select this option and press the navigator button once.

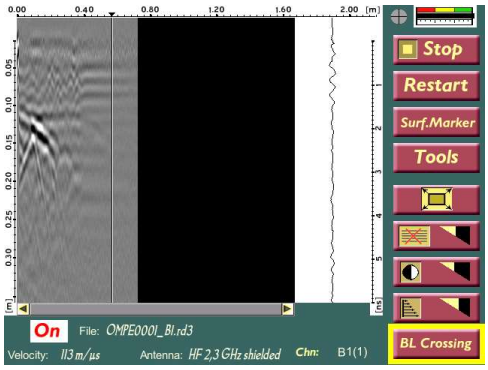
Object Mapper measurements with baseline

When you press Start the project a new Start Profile screen appears.

All Profiles that are included in this OM Project will be started from this screen.



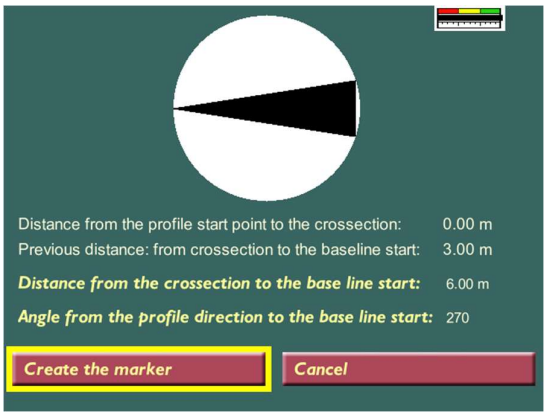
Once Start Profile is pressed, the user returns to the ordinary measurement screen, with one new option (BL Crossing, where BL stands for Base Line) among the menus, on bottom right.

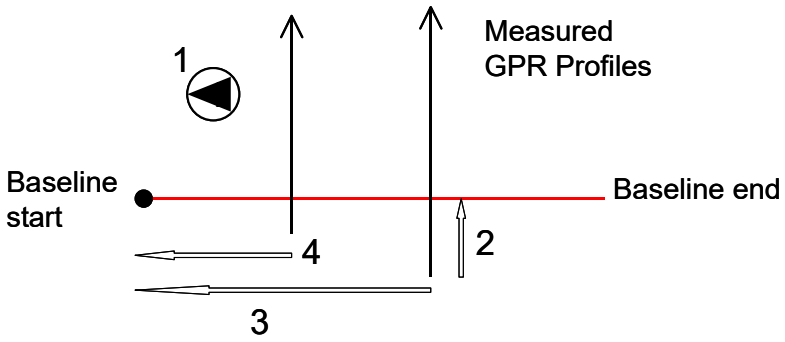


When reaching the baseline, stand still with the antenna measurement point on the baseline, choose the menu option BL Crossing to place a marker on the GPR profile. This marker will be used to connect the current profile to the defined baseline.

Note: If starting the profile directly on the baseline, press BL Crossing immediately after pressing Start Profile, in other words, before moving the antenna.

After pressing BL Crossing the following screen is seen. Here the current profile is defined, in terms of distance from the baseline start point and the direction of the profile in relation to the baseline. See the picture below.





1: Orientation to baseline start point. In this case it is 270 degrees.
2: Distance from the start of the current profile to the baseline
3: Distance from baseline start to the current profile
4: Previous distance

Finally, press Create the Marker, and a blue marker dot is seen on the GPR profile. Now it's possible to continue the measurement along the current profile.

Once a profile is completed, it is stopped by 

, and you are back on the Start Profile Screen and a new profile can be started as usual, again applying the BL Crossing option when reaching the baseline.

The XV Monitor and the Object Mapper project will after three measured profiles automatically suggest the distance and the angle to the baseline start.

If measuring every second profile in the opposite direction and at a right angle to the baseline the angle from the profile direction to the baseline start will be 270, 90, 270, 90 and so on.

When all the Object Mapper profiles are measured, press **Stop ObjectMapper** Project to close and save the Object Mapper Project.

This project is then easily uploaded to a computer (See the section *Transferring Data*) where it can be opened in MALÅ Vision or in MALÅ Object Mapper, for simple interpretation of underground features. For further information, see the *MALÅ Vision* or *MALÅ Object Mapper* user manuals.

You can also open or upload separate files from the Object Mapper project.

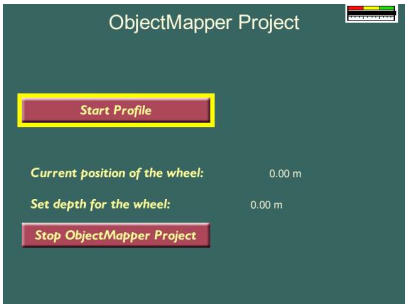
Object Mapper projects with GNSS

Note! More information on GPS measurements can be found in Appendix 2.

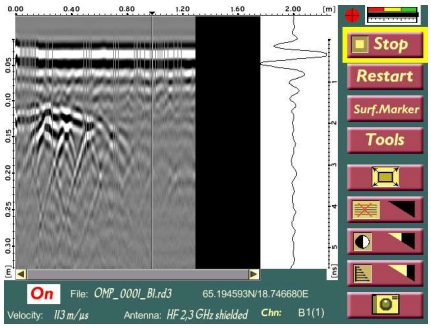
Start an Object Mapper Project from the main menu and select **GPS positioning** ON.

When user press **Start the project** the Start Profile screen appears.

All profiles collected within the present Object mapper project are started from this screen.



Once Start Profile is pressed, the user returns to the ordinary 2D measurement screen.

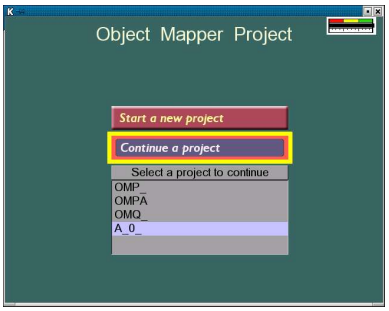


When all the Object Mapper profiles are measured, press Stop ObjectMapper Project to close and save the Object Mapper project.

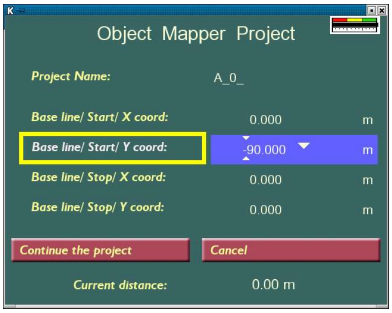
This project is then easily uploaded to a computer (See the section *Transferring Data*) where it can be opened in the MALÅ Vision or MALÅ Object Mapper software, for simple interpretation of underground features. For further information, see the *MALÅ Vision* and *MALÅ Object Mapper* user manuals. One can also open or upload separate files from the project. GNSS files will be uploaded as usual .cor files in this case.

Continuing an Object Mapper project

To continue a previously started Object Mapper project press Continue a project in the Project main screen. Use the turn-push button to choose between the Object Mapper projects and press the button to continue the selected project.

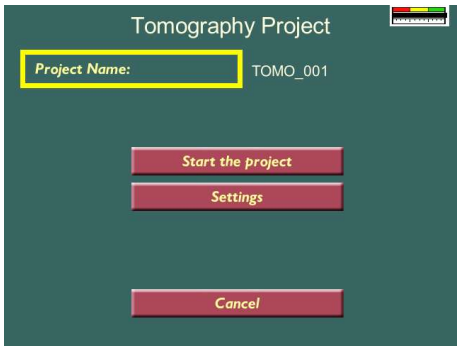


The baseline coordinates can also be changed.



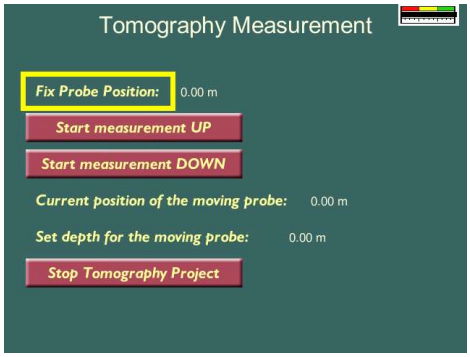
Tomography Project

After selecting Tomography Project on the main start screen following screen appears:



On this screen you have to set project name and you may change measurement settings (see sections *Measurement settings* and *Parameters menus* to learn about settings). For Tomography Projects you can only use one channel. However, you can use cross-channel, in this case the transmitter can be connected to one channel and the receiver to another channel. If you use the same channel for both Tx and Rx, you need to have separate antennas.

When you press Start the project you come to the following screen:



Let's define one of the antennas (it does not matter which, transmitter or receiver) as fixed probe and the other as moving probe. The moving probe need to have an encoder / measurement wheel.

- Place Fix Probe on its start position and enter this this depth on Fix Probe Position.
- Place the Moving Probe on its start position and enter this depth on Set depth for the moving probe.
- Press Start measurement UP or Start measurement DOWN (depending on if you are logging downwards or upwards in the borehole) and move the moving antenna in this selected direction. During the measurement the XV Monitor shows the same screen as if you are in 2D project measurement.
- After you press Stop on the measurement screen, you are back on the Tomography Measurement screen.
- Place the Fix Probe on a new position in the borehole and enter this new depth on the screen.

- Current position of the moving probe must be real, if it is not (because of some encoder error) you can correct it on the screen.
- Then you can start measurement again by pressing Start measurement UP or Start measurement DOWN, depending on your logging direction.
- Press Stop Tomography Project when you have done all measurements (e.g. fixed antenna at every meter down the borehole).

The result project can be uploaded to PC as any other project, and it can be opened with WinTomo or other third-party software's.

A tomography project can also be opened in the XV Monitor but only as a 2D profile, with all runs displayed one after the other.

Positioning Info

Select Positioning Info on the Start Screen. The following screen appears:

The current GNSS coordinates are displayed if a GNSS is connected, with the correct settings. See section *GPS Parameters*.

The measuring wheel can be used as a measuring tape on this screen, showing the travelled distance. To set the measuring tape function to zero, just press the button Reset Wheel.

You can set the time interval for the collection of GNSS coordinates and create a file with coordinates. This text file will have the file extension *.crn, and can be uploaded from the File Dialog, see section *Work with Files*.

Files and File Manager

As a measurement is started the data is automatically and continuously saved. The following6 file types are found in the File Dialog view:

- DAT_0001_A1.rd3 - 2D Project Data file.
- OBM_.obm – Object Mapper Project Header file.
- GR_0001.rhd - Grid Project Header file.
- G001_001.jpg – an image file of a selected view. If several images are saved the second file name will be G001_002 and so on. G001 refers to the Grid Project they belong to.
- DAT_0001_A1.crn - text file containing date, time and coordinates.

Choose Work with Files, on the start screen to open, view, upload or delete already collected data.

File types seen after uploading the data depends on project type and number of channels. Examples are given below.

2D project, slot A and channel 1

- DAT_0002_A1.cor
- DAT_0002_A1.mrk
- DAT_0002_A1.em
- DAT_0002_A1.rad
- DAT_0002_A1.rd3

Multi-channel, for example if slot A and B is used

- DAT_0002_A1.cor
- DAT_0002_A1.mrk
- DAT_0002_A1.em
- DAT_0002_A1.rad
- DAT_0002_A1.rd3
- DAT_0002_A2.cor
- DAT_0002_A2.mrk
- DAT_0002_A2.em
- DAT_0002_A2.rad
- DAT_0002_A2.rd3
- DAT_0002_B1.cor
- DAT_0002_B1.mrk
- DAT_0002_B1.em
- DAT_0002_B1.rad
- DAT_0002_B1.rd3
- DAT_0002_B2.cor
- DAT_0002_B2.mrk
- DAT_0002_B2.em
- DAT_0002_B2.rad
- DAT_0002_B2.rd3

Object Mapper files (example with 2 profiles)

- OMP_.obm, object mapper project header file
- OMP_0001_A1.cor
- OMP_0001_A1.mrk
- OMP_0001_A1.em
- OMP_0001_A1.rad
- OMP_0001_A1.rd3
- OMP_0002_A1.cor
- OMP_0002_A1.mrk
- OMP_0002_A1.em
- OMP_0002_A1.rad
- OMP_0002_A1.rd3

Grid Project Files

- GR_008.add, additional parameters
- GR_008.rad, measurement parameters
- GR_008.rhd, Grid Project header file
- GR_008_1.rd6, vertical profiles
- GR_008_2.rd6, horizontal profiles

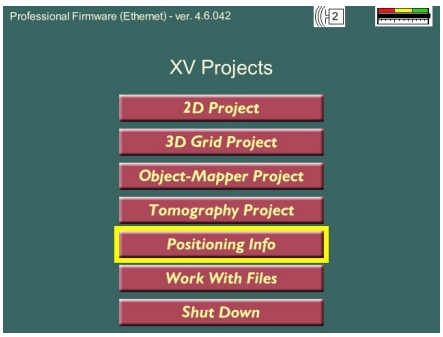
Screen Shots

G001_001.jpg – an image file of a selected view. If several images are saved the second file name will be G001_002 and so on. G001 refers to the Grid Project they belong to.

Each file type is given a unique name corresponding to the data file.

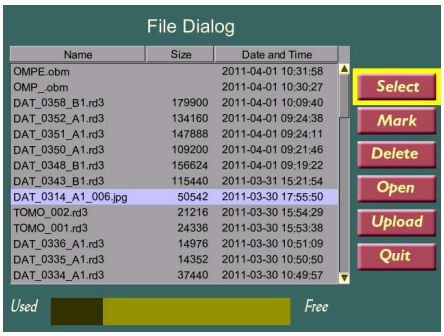
Work with files

Select Work With Files on the Start Screen.



You see the list of all data files sorted by date.

Every Object Mapper and 3D Grid project is displayed as a single line in the table but contains several files. When choosing this single line, you can open, upload or delete the complete project. See section *Object Mapper files* and *Grid project files* below.



To select a file, turn the navigator button to the correct file name and press to **Select.**

To mark and select several files at the same time, use the **Mark** option. Now, you can choose to open them, delete them or upload them to a PC (see section *Transferring Data)*.

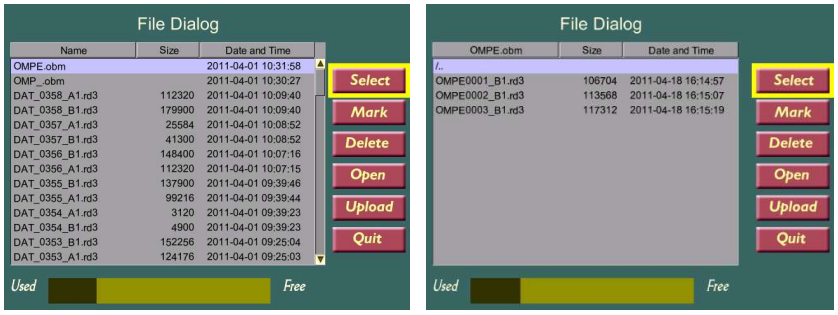
When viewing 2D projects or profiles from OM Project the operator can select and press horizontal and vertical scrolling (Vertical scrolling is possible only if Resampling is OFF). When one of the scroll bars is selected it turns blue and scrolling the data is carried out by turning the navigator button. If the file is very large the operator can press the navigator button and rotate it without releasing it, so the profile is scrolled quickly horizontally and redrawn after releasing the button.

The Background removal filter, contrast, time gain, hyperbola fitting, depth calibration, zero level and Migration function are also applicable for the 2D View.

If Trace View is ON it shows the first trace on the display screen or the current trace under hyperbola fitting or depth calibration.

Object Mapper files

The viewed Object Mapper Project files in the file dialog are actually directories. These directories can be marked and deleted like files. If an Object Mapper Project is deleted it is deleted along with all profiles which belong to it.



By selecting a Project and pressing **Open**, the operator will see all the profiles linked to the current Project. To go back to the "root directory" press **Select**, then select the first line in the list (/..) and press the navigator button again.

The Object Mapper Project contains *.rd3, *.rad and *.obm files (and *.em files if HF antennas with EM option is used). Object Mapper projects with GPS also contains .cor files with coordinates.

Grid Project files

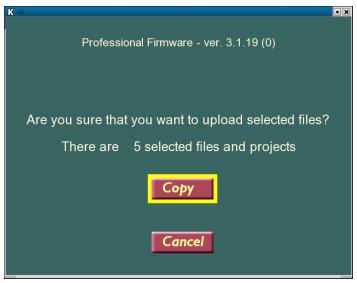
The viewed Grid project files (*.rhd) in the file dialog are actually directories for the different created Grid Projects. These directories can be marked, deleted and uploaded like files. Deleting a grid project removes all files belonging to the project.

The Grid Project file *.rhd contains two different *.rd6 files which holds all the separate measured profiles (in standard MALÅ *.rd3-format) in the two different grid directions.

These separate *.rd3-files are extracted when the project is imported to e.g. MALÅ Vision.

Transferring data

By connecting a flashcard (USB storage media) to the USB port on the XV Monitor (to the left of the serial port), the measured data can be easily transferred by pressing Upload in the File dialog (See the section *Files and File Manager*). All marked files will then be copied or moved to the storage medium, which can be connected to any desired computer.

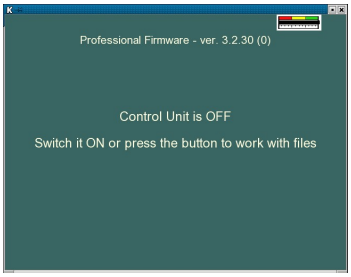


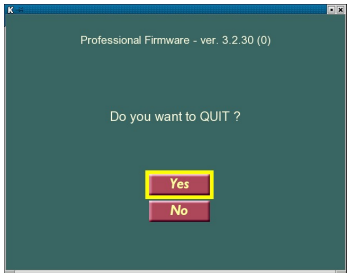
Note: For Object Mapper and Grid Project it is necessary to only mark the project file (*.obm or *.rhd) and all connected radar files will automatically follow.

Note: The number of ports on the XV Monitor may differ depending on generation of hardware.

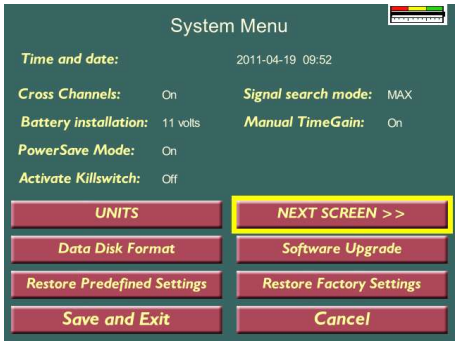
System settings

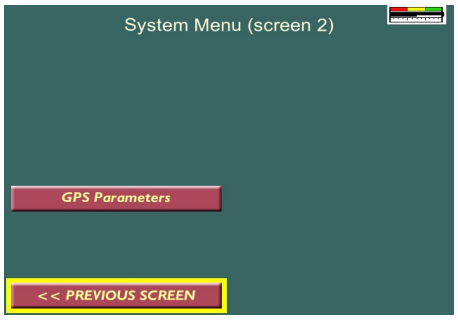
When starting a project without a connected control unit or before closing down the XV Monitor, the System menu can be reached. This is done by turning the navigator button 3 clicks right, 3 clicks left and 3 clicks right at either one of the following screens.





The System Menu screens:





In the System Menu screens the following changes are possible:

- Time and date.
- Measurement unit (feet or meters).
- Battery installation to set battery indicator level.
- Manual time gain. If turned off, Automatic Gain will be applied.
- Power save mode: If the Power Save mode is on, the screen will “turn-off” when in-active, and by that save power.
- GPS port: USB or COM-port. For COM-port based GNSS: Baud rate, checksum validation.
- Activate Kill-switch.

- Signal Search Mode: MAX or Threshold. MAX mode is recommended for HF antennas. Threshold mode is recommended for RTA antenna. For other antennas you can choose any mode.
- Cross-channel is by default OFF. This mode enables two different antennas in the Slot-pairs AB, CD, EF and GH to communicate with each other.
- Data disk format carries out a formatting of the data disk in the Monitor which can be needed if files cannot be erased, the disk seems full etc. These types of problems may arise if the XV Monitor is turned OFF without using the Quit option.
- Restoration of predefined settings (control unit has to be ON).
- Software upgrade. The lates software for the XV Monitor is found on www.guidelinegeo.com. See section *Upgrade*.
- Restoration of predefined or factory settings.

By activating the Kill-switch (mandatory under certain conditions, due to FCC regulations, see FCC Part 15). The use of a kill switch function makes the antenna stop emitting electromagnetic waves when the switch is released. The ProEx and XV system will work in the following manner:

- By default the Kill-switch is always OFF and transmitting is always enabled.
- If Kill-switch is ON and a High Frequency antenna connected, the button 1 on the antenna has to be held down to enable measurements. When realizing this button, the transmitting will stop within 9 seconds.
- When pressing button 1 on the antenna again, the measurement can continue, and the antenna is transmitting. It should be noted that if the antenna has been off for a longer time period, it can be necessary to let the antenna get warm, especially when working with high frequency antennas, (by pressing button 1 for a time) before starting the measurements.

By pressing Restore Predefined Settings (control unit has to be ON) the parameters in the XV Monitor restores to the following:

- System settings are read from the Initial Parameters Files.
- Battery level is set to 11 V.
- Meter is chosen.
- Time interval is set to 0,1 sec.

By pressing Restore Factory Settings the initial parameters files in the XV Monitor are restored from the default values. This is useful if the initial parameters files have been damaged in some way.

Note: Run the Restore Predefined Settings if default antenna settings or distance calibrations are missing from the XV Monitor.

Upgrade

The instructions below describe how to upgrade the application software of the XV Monitor.

1. Copy the file ram10img.gz (and parameter files: eeprom_1, eeprom_2 if they exists) to the root of the USB data storage device shipped with the Monitor XV at delivery.
2. Connect the XV to a fully charged 12V power source and start up the XV. NOTE! It's important that the battery is fully charged to avoid power loss during the upgrade that can cause damage of the internal memory.
3. Select the "Shut Down" button on the Start Screen and go to the system menu by turning the turn-push key three turns clockwise, three turns counter clockwise and three turns clockwise again. A more detailed description on this can be found in the operating manual and the section on system settings.
4. Insert the USB memory device in the USB slot of the XV. The USB slot can be found under the rubber cap at the front left side of the XV.
5. Select the option "Software upgrade" in the system menu. The upgrade starts and can take up to several minutes.
6. When the upgrade is done, a message is shown that the upgrade was successful. Then press the turn-push key once to reboot.
7. Remove the USB memory from the XV and close the rubber cap onto the USB connectors.

Use a proper USB Flash Disk or USB Flash Reader that is Linux compatible. This is often described as: Operation System Compatibility: .., Linux, ... or Compatible: Linux (kernel 2.6.22.1 or higher).

Usually when buying a USB Flash device, it is formatted as FAT32, which is suitable.

Batteries

Note: Before use, open the battery pack and connect the battery to the outside connectors. See figure below.

The Li-Ion battery pack is the standard power supply for the XV Monitor. The capacity of the battery is 12V/13.2 Ah. This gives an operation time of 4-6 hours depending on the settings and configuration of the system. The battery should always be stored fully charged to maximize the lifetime of the battery. The XV Monitor can also be supplied by any other external 12V DC power source.

Internal of the battery pack (left) and the connectors on the outside (right)

Quit the system and disconnect the battery before charging.

The battery charger is an automatic quick charger designed for Li-Ion batteries. The recharge up to about 80% of the full capacity goes very quickly. However, it is recommended to keep the battery charging until it is fully charged. The battery charger can be left on after the battery has been fully charged. It then automatically turns into maintenance charging.

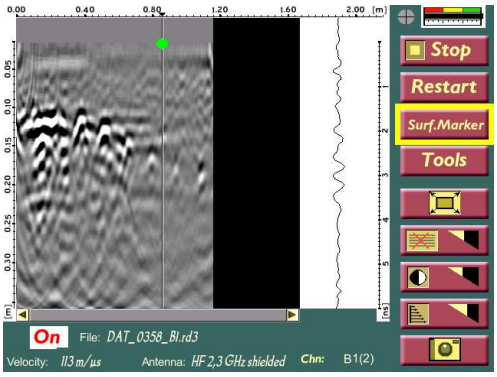
The indicator lamp on the charger gives you the following information:

- Red = Charged < 80%
- Yellow = Charged 80-100%
- Green = Maintenance charging

Appendix 1 Markers and Tools

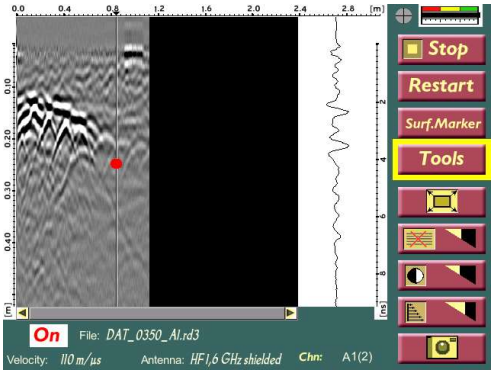
A surface marker is applied by pressing Surf.Marker, when passing the object to be marked. On a HF antenna you can also press the red button.

The green dot indicates the location of the surface marker.

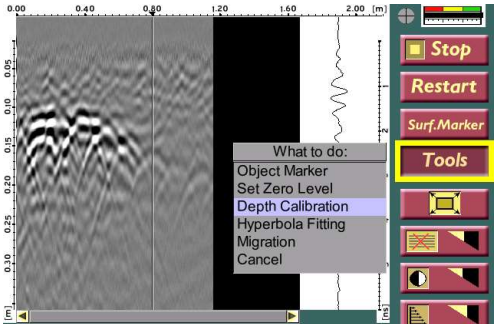


To mark an object underground, or to calibrate the depth scale, press **Tools** button and the select **Object Marker** from the list. A cross will appear on the screen which can be moved up or down with the navigator button and backwards or forwards by moving the antenna.

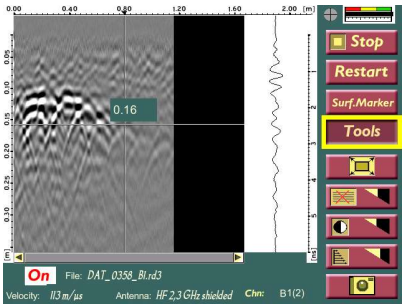
When the correct location is found press turn-push button again and object marker appears as a red dot.



To calibrate the depth and ground velocity to a marked object, choose the option **Depth Calibration** instead. It can be done both during a measurement but also later when you open an existing project.

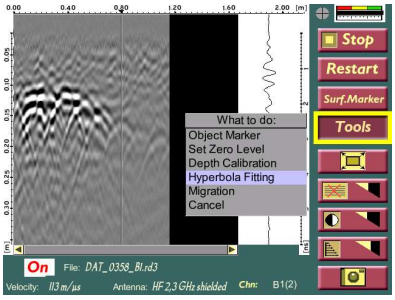


You select the correct location (most often on the top part of the hyperbola) by moving the vertical and horizontal lines by the navigator button. Note that during measurement the vertical line is moved by the wheel. When the marker is positioned, set the depth for this known underground object. This will adjust the depth scale and soil velocity, accordingly.

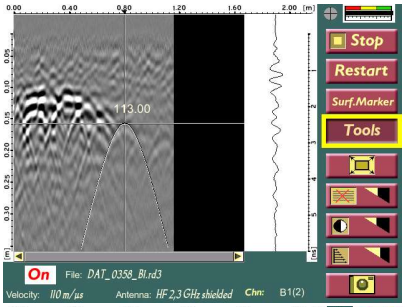


Hyperbola Fitting is useful when you want to estimate the soil velocity and have clear hyperbolas in the radargram.

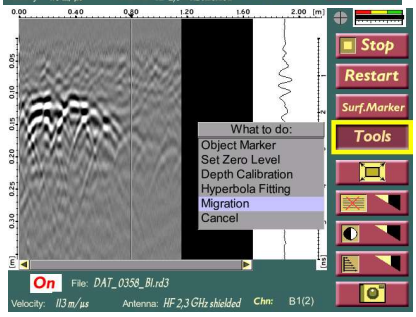
Place the vertical and horizontal guidelines, so the cross is positioned on top of the hyperbolas. Press the navigator button to confirm the location.



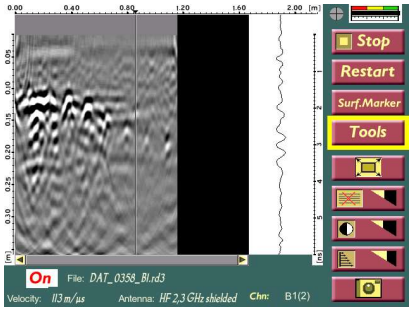
Now you can fit the hyperbola by rotating button button. This will change the shape of the hyperbola. When the fit is good, press the button once more. The new value of soil velocity will be stored, and depth scale adjusted.



For a successful Migration process, it is necessary that the Zero Level is positioned correctly. This should be on the on the beginning of the first maximum peak of the first arrival.



When the result shows hyperbolas collected into single points, the correct velocity is used and can be applied for the collected radargram.



Note: You can also use Depth Calibration and Hyperbola Fitting first, to get good starting velocity.

Note: Hyperbola fitting and Migration will not work if using time trigging for measurements.

Appendix 2 GNSS Measurements

This appendix covers some important issues when using a GNSS to position the GPR measurements.

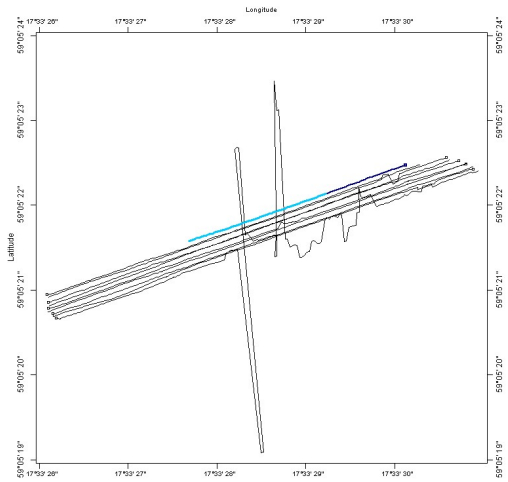
The XV Monotir or GroundVision2 software can be used together with GNSS equipment which communicates via a 9-pin series connector. The GNSS must communicate with NMEA 0183 protocol with GPGGA sentence. For the XV Monitor there is also one type of USB GPS available.

The GNSS equipment available today can be divided into three different types:

- GPS: Inexpensive, the GPS is using only satellites for positioning, accuracy around ±4 m. Suitable for large scale layer mapping etc.
- DGPS: Differential GPS, uses satellites and a correction from a reference station, accuracy around ± 0.5 m. Similar systems are EGNOS (Europe), WAAS (USA) and MSAS (Japan).
- RTK GNSS: Real Time Kinematic GNSS, uses two GNSS receivers (one stationary base and one rover) and correction signal from the base antenna, accuracy around ± 1 cm. Network RTK is also available in many locations, where the correction is received via GSM. RTK GNSS accuracy is recommended for utility mapping.

For all the three different GNSS systems the following is very important to remember:

1) Regardless the system used; GPS, DGPS or RTK, the positioning data gathered will be of bad quality if the measurements are made under bridges, in dense forest, close to high buildings etc. In the example below the lowermost line is measured 1 m from a building, resulting in incorrect positioning of that measurement line.



2) When using a GNSS in motion, the GNSS system is updated more or less seldom. Inexpensive systems may update 1 time/second while RTK systems can update 10 or more times/second.

3) The GNSS antenna should be placed on the middle of the GPS antenna to give the most correct position of the GPR traces. This will be a problem when measuring with the MALÅ Geoscience RT antennas and should be corrected afterwards.

4) It should be observed that during the day the connection to satellites can change, giving better or worse positioning possibilities.