



XV Monitor for ProEx and X3M with Ethernet communication

Operating manual

Version 1.5



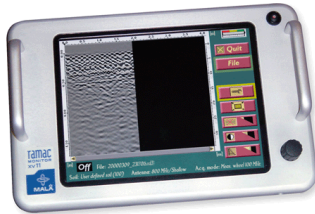
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1 Introduction

Thank you for purchasing the MALÅ XV Monitor. The XV is an easily operated data acquisition unit for quick and reliable gathering of GPR data. The unit is compatible with both the ProEx and the X3M control units with Ethernet communication. XV10 gives you a High Brightness type of screen, while XV11 is equipped with a transreflective screen for best performance in bright sunlight.

This manual is used for XV versions starting with version number 4.6.042



We at MALÅ Geoscience welcome comments from you concerning your experiences in using this equipment, as well as your impressions of this manual. Please take the time to read through the assembly instructions carefully and address any questions or suggestions to the following:

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1.1 Unpacking and Inspection

Great care should be taken when unpacking the equipment. Be sure to check the contents against those shown on the packing list and inspect the equipment for any loose parts or other damage. All packing material should be preserved in the event of damage occurring during shipping. Any claims for shipping damage should be filed with the carrier. Any claims for missing equipment or parts should be filed with MALÅ Geoscience.

1.2 Repacking and Shipping

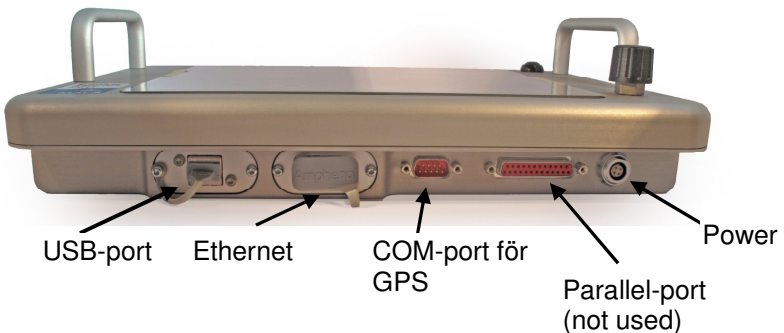
If the original packing materials are not available, the equipment should be packed in at least 80 mm of absorbing material. Do not use shredded fibres, paper wood, or wool, as these materials tend to get compacted during shipping, thus permitting the instruments to move around inside the package.

2 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 system the following have to be connected:

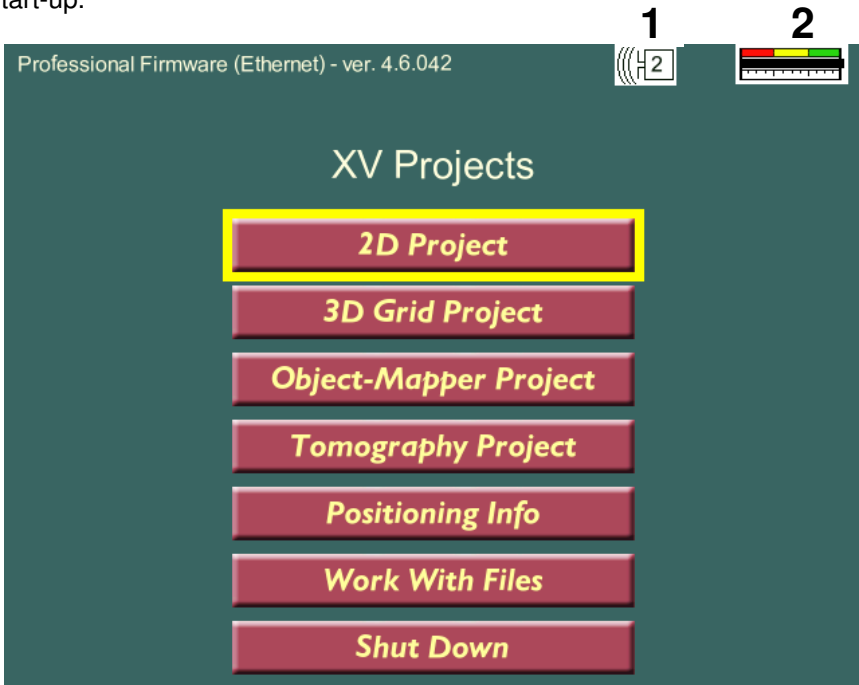
- The MALÅ ProEx or MALÅ X3M with Ethernet connection to the chosen antenna/antennas
- The XV Monitor to the X3M or ProEx control unit with a Ethernet communication cable
- If using a positioning system, the encoder to the ProEx or X3M control unit with an encoder cable (serial port) and/or GPS to the Monitor.
- Battery to both the XV and the X3M with battery cables. If a ProEx is used, also its internal battery.





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

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

When the XV 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, it shows 1 if X3M is connected). It looks like this:  if Control Unit is OFF or if it is bad connection between Control Unit and Monitor;
- 2: Battery Status Indicator. It shows 2 black lines for 2 batteries. It can look like this:  The lower line is for battery level in the Control Unit and the upper line is for battery level in the Monitor.

2.1 The Main Menu and Project Types

You can select 4 different project types from this main menu.

If you select “2D Project” you can create profiles with radar data (scans). These profiles can be limited only by disc size in Monitor. They can be tagged with GPS Positions, data from EM sensors. You can create surface and object markers under measurement. Trig sources can be: wheel, time and keyboard. See also section “2D Project” for more information.

Selection of the “3D Grid Project” button brings possibility to measure limited rectangular areas to create 3D display. The data can be investigated then by 2 Views: Top View and Side View. Any of X or Y cross sections can be selected for the Side View and Top View shows Z slice on any depth. See also section “3D Grid Project” for more information.

“Object Mapper Project” consists of several 2D profiles that are positioned by GPS or by connecting to the Base Line. This kind of project can be opened in the ObjectMapper PC software. See also section “Object Mapper Project” for more information.

“Tomography Project” let us measure separated transmitter and receiver antennas. This kind of measurement is used usually under boreholes investigations. This project can be opened on PC in WinTomo software.

“Position Info” is the mode where you can measure distances by wheel and work with GPS: see GPS coordinates, create a file with GPS coordinates trigged by time.

By pressing “Work With Files” previously measured files and screenshots can be opened. See also section “File manager”.

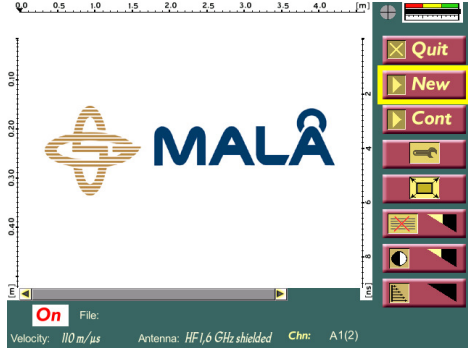
3 2D Project

3.1 2D Measurement

By selecting New and pressing the turn-push button, a measurement can be started immediately.

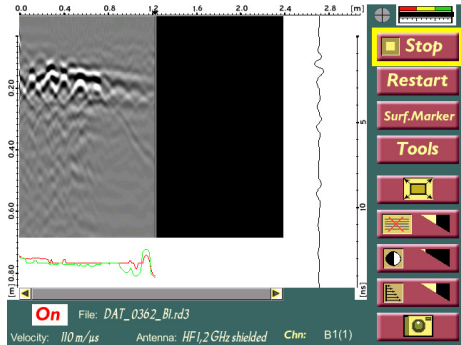
The XV offers you a fast way of parameter choices through factory default settings and automatic identification of the antenna used.


Press  to enter Measurement Settings.

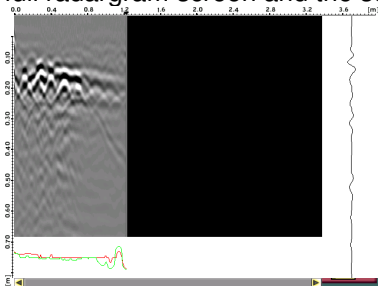


If a High Frequency (HF) antenna with EM-option is used the EM data will be displayed directly underneath the radargram. More can be read in the Operating Manual for ProEx or CX control units.

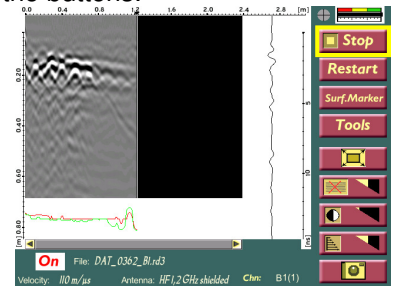
Please note that the HF antennas can not be operated with the X3M control unit.




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

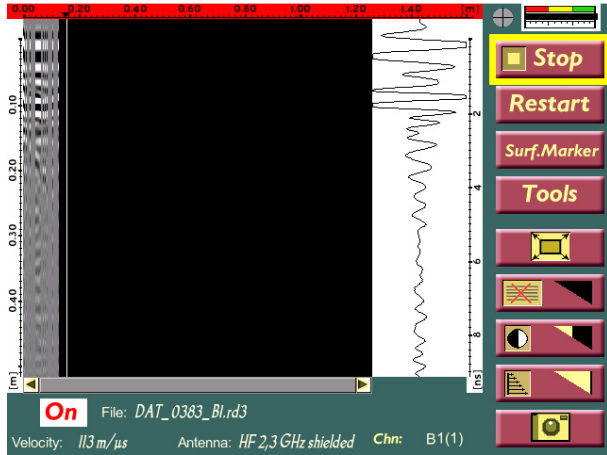


or



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 horizontal scale begin to blink red, but the length measurement will continue to be correct. Horizontal scale is blinking red with over speeding to make clear for user that he has to slow down.




Note! Missed trace appears when the measurement is carried out with a high speed 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 2.

If a GPS device is connected to the Com or USB port of the XV the coordinates are displayed below the radargram and stored in a *.cor file, with a coordinates connected to trace number. See also Section 3.5 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 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.

Error mounting disk for data files

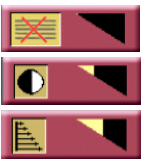
All data files will be erased

When the QUIT-option is used, but then the power is not turned off immediately, with the on/off switch on the unit, 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 Chapter System Settings. This type of format can also be carried out prior every measurement round to guarantee best possible disk operation.

3.2 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 turn-push 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 3.7.

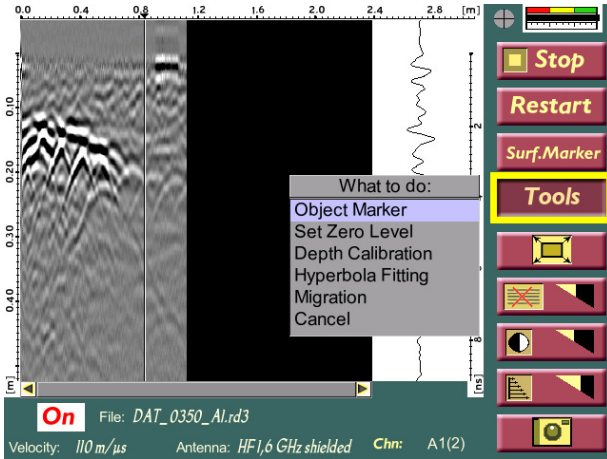
A FIR filter can also be applied on the data, see Section 3.7.

3.3 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 via button "Tools".

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 turn-push-button on the XV or with the red button on HF antennas. See Appendix 1 for further information.

3.4 Button “Tools”



It is important to set correct Zero Level for correct Depth Scale, Hyperbola Fitting and Migration. Zero Level has to be in the beginning of the first big wave in the trace.

Depth Calibration can be done if you have some object underground on the known depth. The result will be a correct depth scale for this ground.

Hyperbola Fitting can be used to define wave velocity in the ground.

Migration allows you to see reflections as points instead of hyperbolas.

Correct wave velocity in the ground is very important for Migration.

3.5 Connection to a GPS

A GPS can easily be connected to the XV Monitor via the serial port (Com port) or the USB port (See Section “System Settings” to change between Com or USB port). If using a USB GPS, this have to be connected to the Monitor when the system is running and not before.

When the communication settings, the baud rate, is correctly applied (see section “Parameter menus”), 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. Monitor can receive GPS coordinates with maximum rate 4 times per second. GPS Devices can send coordinates more often, in this case some coordinates can be lost.


The Malå GPS standard GPS 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 is expressed in Greenwich Time zone. The GPS data is saved automatically in a *.cor file, when a GPS is connected and running. An excerpt from a data file is seen below:

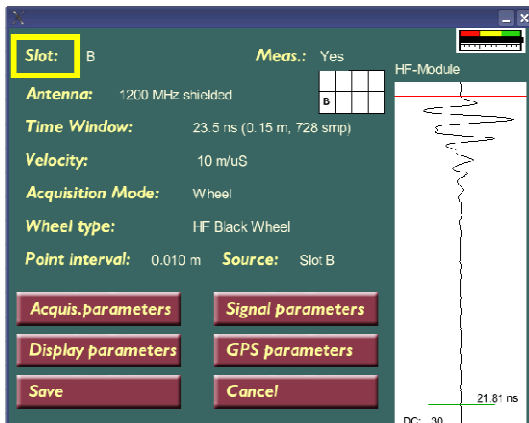
Trace	date	time	latitude N	longitude E	"height above MSL" M	HDOP
1	2008-05-14	08:52:44	59.368000 N	18.248722 E	15.9 M	2.4
2	2008-05-14	08:52:49	59.368000 N	18.248722 E	15.4 M	2.7
16	2008-05-14	08:52:51	59.368008 N	18.248701 E	15.1 M	2.7

Note! We can guarantee proper functionality of USB GPS Devices only if they are bought from us. COM port GPS Devices are not limited like this.

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

3.6 Measurement settings

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

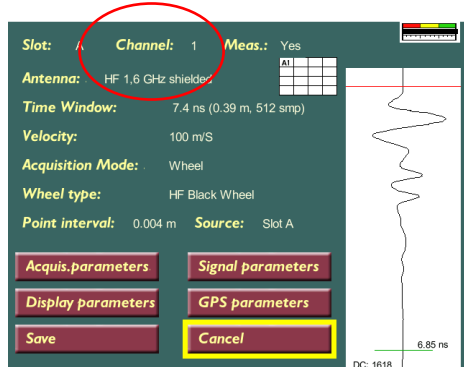


In this menu the options for changing Antennas, Time window, Velocity, Acquisition mode and Point interval are found.

When the ProEx control unit is used the settings for each slot can of course be changed individually in the menu **Slot: A**. The options for Slot are 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 System Settings.

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



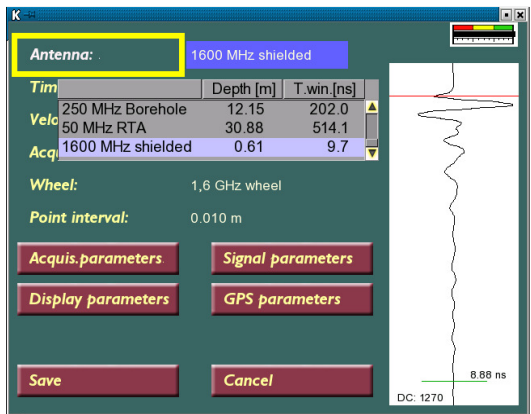
To toggle between the channels in use while measuring is done with the option **Chn: A1(1)** on the main menu.

If the slot A to H is to be used under measurements or not is changed with **Meas.: Yes**.

If an X3M is connected to an un-identified older antenna it's possible to choose between all the different antennas in the antenna list.

When the X3M 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 turn-push 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 this menu. The turn-push 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.

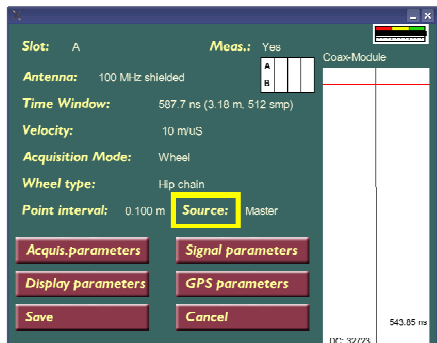
The **velocity** given is the moving speed of the electromagnetic wave in the ground/soil measured.

The option **acquisition mode** and **wheel** is 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 below.

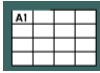
Point interval (or time in seconds) gives the distance between the measured points / traces in the radargram.

Note! When measuring by time, check and make sure that the time interval is appropriate. For instance, for a RTA a time of 0.15-0.5 seconds is 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, which is connected to one of the slots. Then the correct **Slot** (A to H) is chosen.



A1			

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 **Meas.: Yes** 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.

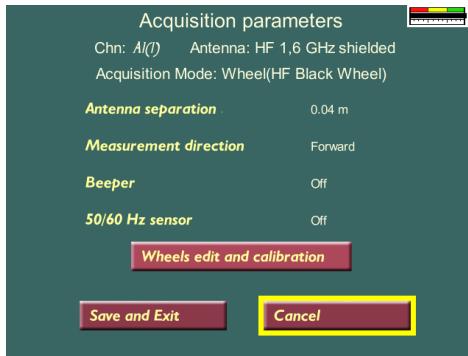
See also System settings, for activation of the cross-channel mode.

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3.7 Parameters menus

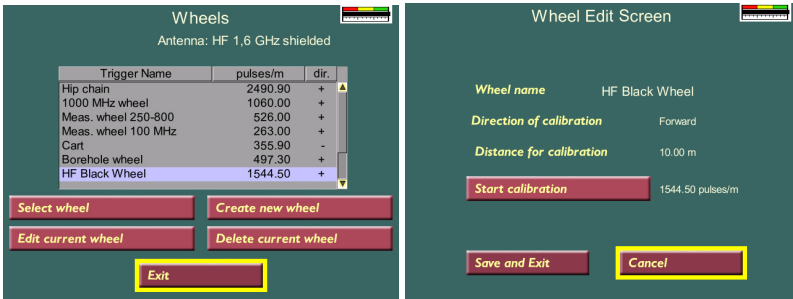
The different parameter menus found in the Tools menu contain the following:

Acquisition parameters screen: Antenna separation, Measurement Direction, Wheels Edit and Calibration.

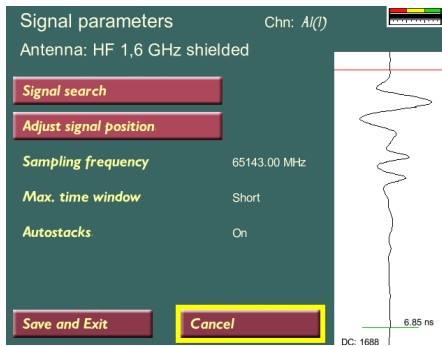


The antenna separation cannot be changed for predefined antennas (it can be changed only for the last 4 custom antennas, even Antenna Name can be changed for custom antennas on this screen). If unshielded antennas are used and the user wants to change standard antenna separation then the user can select custom antenna to do it. 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 is pressed. After that the measuring wheel is moved the correct distance, to make the calibration.



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

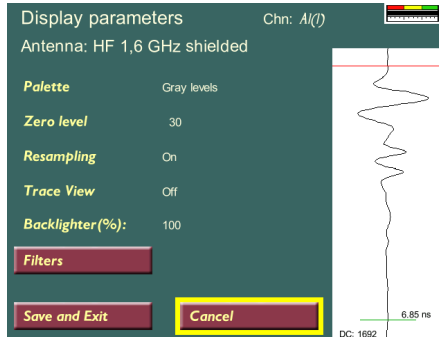


Signal search carries out an automatic finding of the zero level. There are two different algorithms for this search: MAX or Threshold. The type is selected in the System Menu. This level is depending on the antenna together with the surrounding environment and ground conditions. This level can be adjusted by choosing Adjust Signal position and then change the location of the red horizontal line in the trace view, with the turn-push 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 Auto-stack is activated, the systems stacks each measured trace as many time as possible according to your measurement speed. Otherwise the number of stack 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.

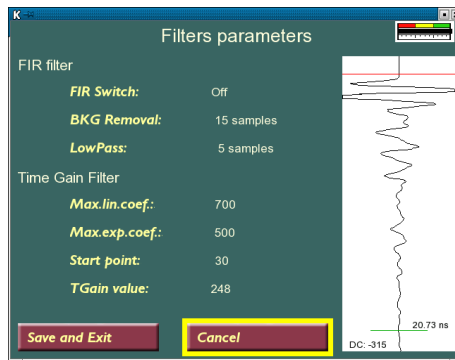
Zero level is expressed in nanoseconds as the location of the ground surface; from where the depth scale is begin.

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 Filter the following screen is seen:



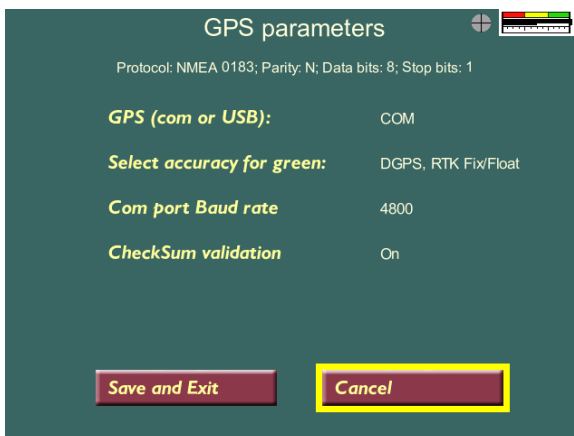
Here it is possible to change the parameters for the two different filters, the FIR filter and the Time Gain filter. If one of the buttons are pressed then the Trace View will show how the choice of filter parameters affects the trace otherwise the Trace View will show the trace only with DC removal filter.

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 (Finite Impulse Response 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 (see Chapter 2.1).

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 (see Chapter 2.1) 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 window. Instead an Automatic Gain will be applied.

GPS Parameters Screen:



The needed GPS parameters are seen in the first line. The NMEA should be of GGA sentence type.

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

Parameters “Select accuracy for green” is needed for the round GPS indicator that is placed on the start screen, on 2D measurement screen and some other screens also. If you need highest accuracy select “High (RTK Fix only)”. In this case this indicator will be green if you have RTK Fix, it will be yellow if you have coordinates but not RTK Fix, it will be red if you have GPS connected but no coordinates yet and it will be grey if you have no GPS connected.

The CheckSum validation is used only in some cases like for instance for a Leica 1200 Robotic Totalstation, 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 GPS:

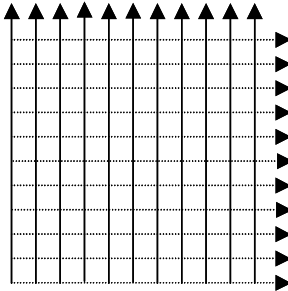
If a GPS is connected to the USB port these two parameters are not in use. The baud rate is fixed to 4800. **Note!** The only GPS with USB communication tested and functioning today are:

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

See also Appendix 2.

4 3D Grid Project

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



A typical 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 Grid Project option in the XV 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.

4.1 Creating a Grid Project

First of all do the correct measurement settings in the Tools menu (see chapters above) and then start working with Grid Project by selecting “3D Grid Project” on the Start Screen. The following screen appears:

The “New Grid Project” screen appears, the user has here the opportunity to select proper parameters, before data collection begins. The parameters are: size of the grid, spacing between lines (profiles) and point interval. 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 that the "Line spacing" has to be evenly divided with the set "Point interval" distance.

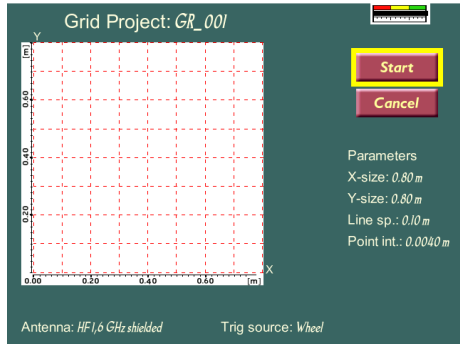
How to edit the project definitions:

- 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 big triangle at the end of the string and press the button to finish editing the parameter.



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

By choosing Start, the Grid Project is activated.



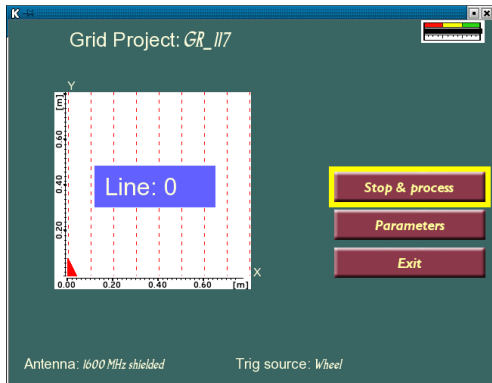
When using an antenna from the High Frequency series the two buttons on the antenna or on the extension handle are used as remote controls, for choosing the next profile and start profile. See Operating Manual High Frequency Antennas.

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 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 Monitor, then move the antenna to the end of the line. The button has to be released during movement.

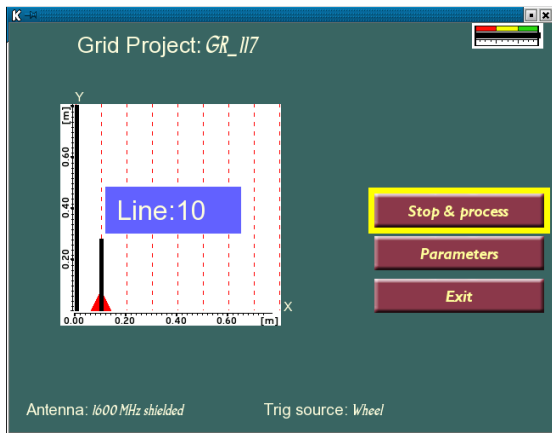
If measurements are carried out with a too high speed horizontal scale begin to blink red to make clear for user that he has to slow down. If measurement will be continued with this too high speed then there will be lot of missed trace in the profiles, it leads to poor quality of the 3D View. You can 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 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.

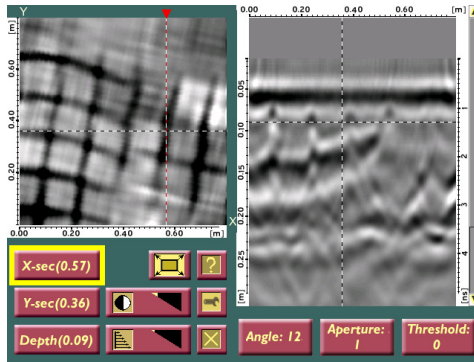
Place the antenna correctly on the second line, align it well and choose Start line or press Button 1 (black) to continue the gathering of Grid data.

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 slice, to the left.

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

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

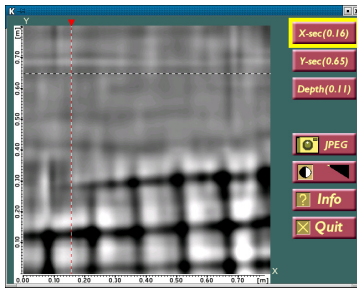
Angle – The space between the single lines of data is being filled with the help of an interpolation scheme. This interpolation can be performed in different directions where the angle parameter determines this direction as -45 to +45. A value of 0 indicates orthogonal interpolation, the normal case. 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.

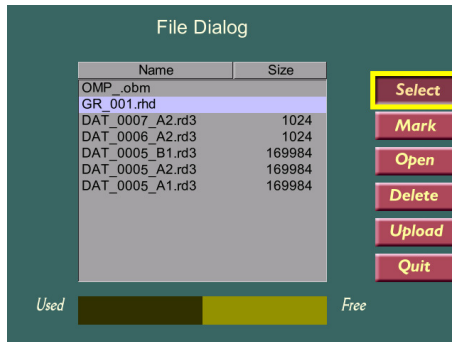
The screen can be expanded by  and displayed as:



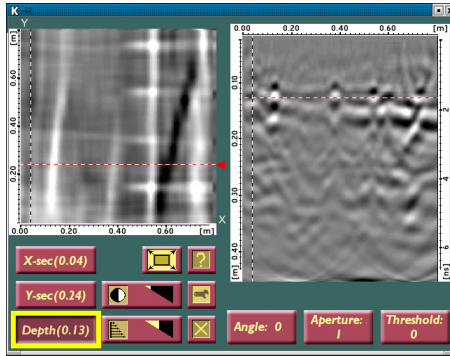
Here the user has the choice to save a jpg-image of the current view, by selecting  **JPEG**. These files are automatically named according to the Grid Project they belong to and an increasing number.


4.2 View and Process recorded Grid Project

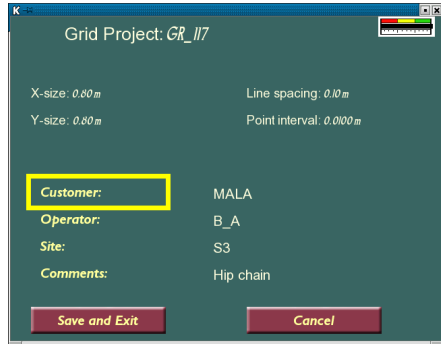
As with other types of radar files acquired with the XV, Grid Projects can again be viewed and processed within the “Work With Files” option on the Start Screen.




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 the Customer name or other comments on the measurement.



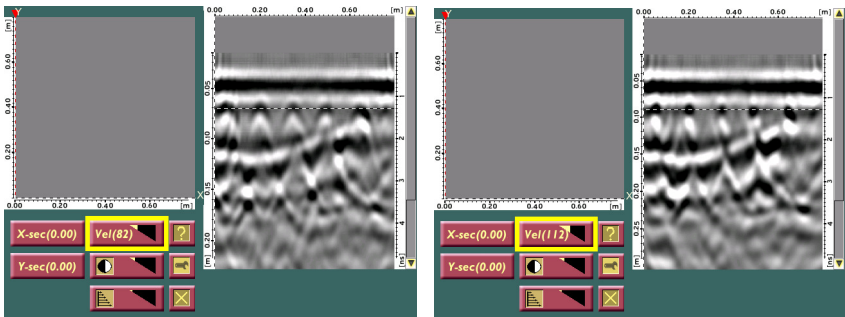
By pressing the  button, it is possible to change each of the settings, for example the screen and processing parameters.



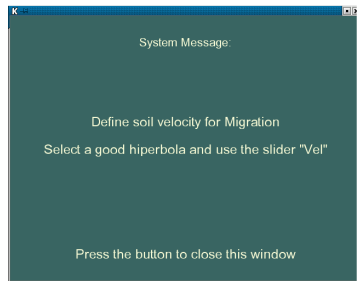
If the parameters important for migration (BKGR (background) removal, Auto first arrival or parameters within the Migration wizard) are changed, then all calculations to create the horizontal and vertical slices are carried out once more. This can take from 30 sec to 3 min (depends on the data size). 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 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 **Vel(128)** 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.

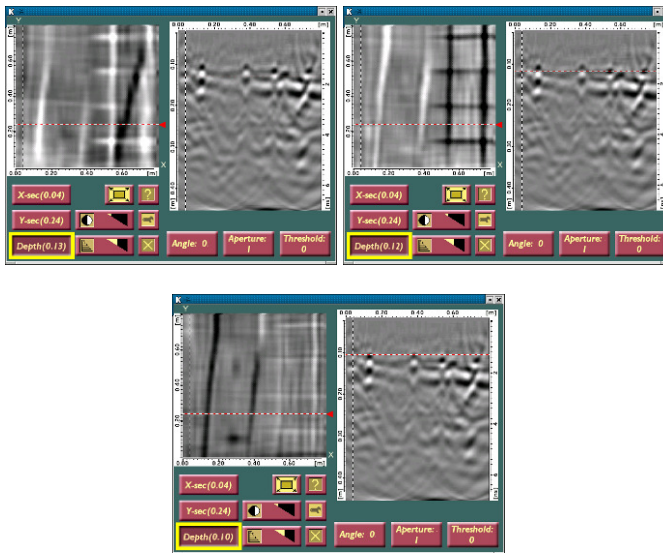


And the **?** gives the following screen, where some of the display settings can be changed.

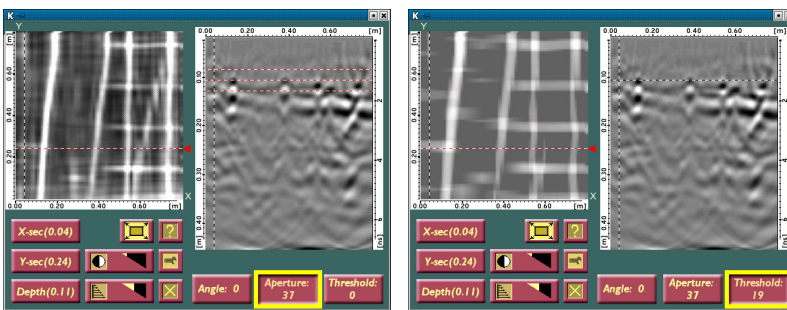


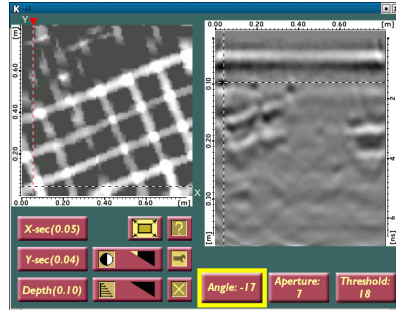
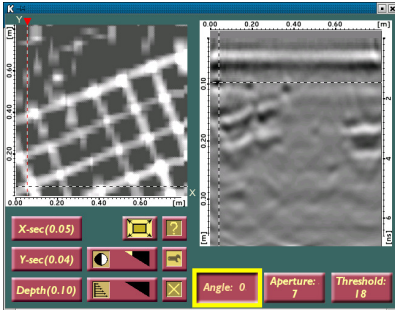
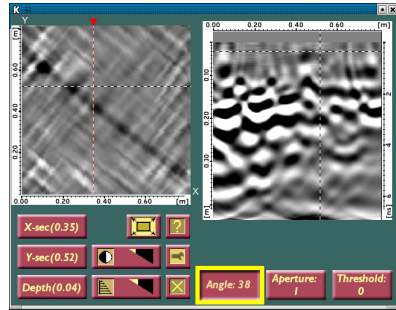
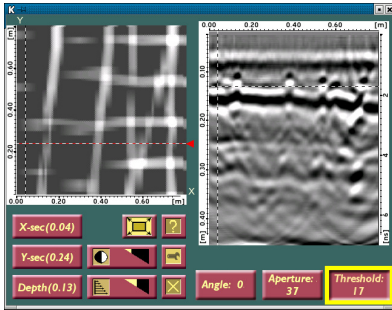
By pressing **X** the new settings of velocity is calculated for the whole data set.

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 rather easy to identify in the different depth slices.



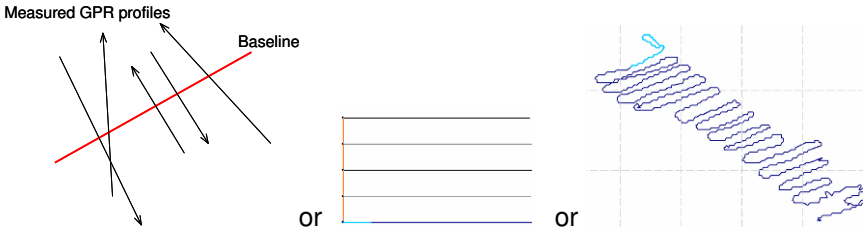
In the following six pictures the effects of changing Angle, Aperture and Threshold is displayed:





5 Object Mapper Project

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



Once an Object Mapper Project is created within the XV Monitor, it can be directly opened in ObjectMapper, a Windows based interpretation software for quick mapping of underground features. For further information, see the ObjectMapper Operating Manual.

Note! More information on measurements with GPS is seen in Appendix 2.

5.1 Creating an Object Mapper Project

Start working with Object Mapper Projects by selecting “Object-Mapper Project” on the Start Screen. The following screen appears:

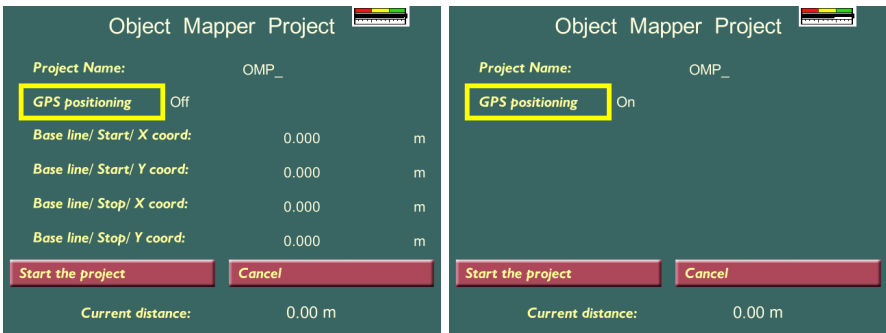


Select “Settings” do the correct measurement settings (remember that OM Project can be done only with one channel and wheel based triggering). Do not forget set GPS parameters and connect GPS for GPS OM Project. See sections 3.6 and 3.7 to learn more about settings.

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 option is ON no baseline is needed.

To change the settings use the turn-push 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 turn-push button. The characters available include A to W, 0 to 9 and underscore.

To edit the project name and coordinates:

1. 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.
2. By pressing and rotating the button without releasing, the operator can add or delete characters.
3. Set the lower triangle under the big 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.

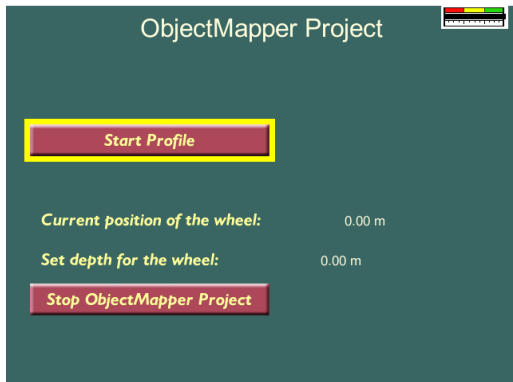
When the baseline is defined or GPS option is ON press, "Start the Project" to collect the Object Mapper files.

In this mode, before pressing "Start the Project", the XV System 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 turn-push button once.

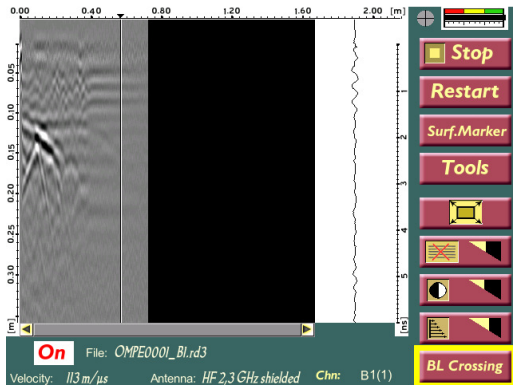
5.2 Taking Object Mapper measurements with baseline

When user press "Start the project" a new "Start Profile" screen appears:

All Profiles that has to be taken in this OM Project will be started from this screen.



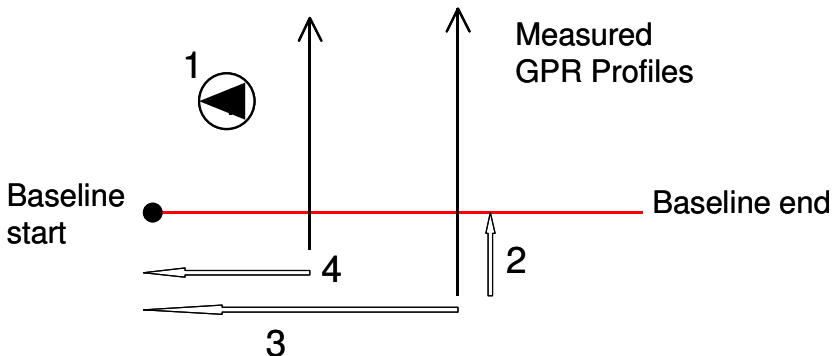
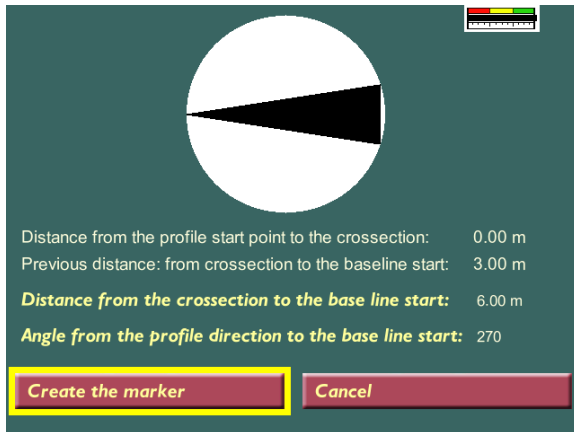
Once "Start Profile" is pressed, the user returns to the ordinary measurement screen, with one new option (BLMarker, BL for Base Line) among the menus, on bottom right.



When passing the baseline, go to the menu option BLMarker 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 BLMarker immediately after pressing “Start Profile”, in other words, before moving the antenna.

After pressing BLMarker 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 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 , then you are again in the “Start Profile” Screen and a new profile can be started as usual, again applying the BLMarker option when passing 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 ObjrctMapper Project” to close and save the Object Mapper Project.

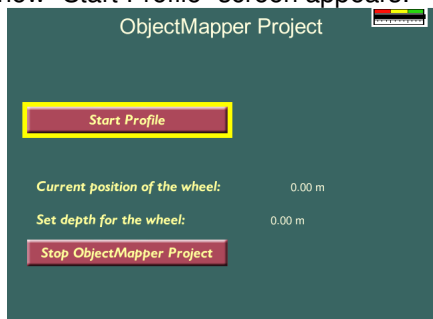
This project is then easily uploaded to a computer (See the Section “Transferring Data”) where it can be opened in the Object Mapper software, for simple interpretation of underground features. For further information, see the Object Mapper Operating Manual. One can also open or upload separate files from the Project.

5.3 Taking Object Mapper measurements with GPS

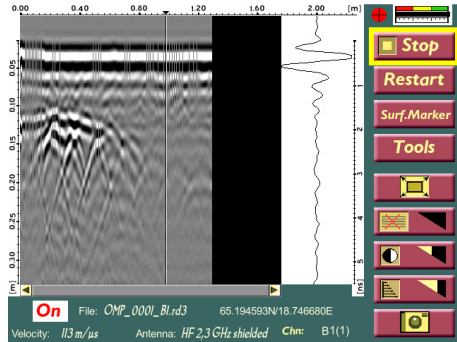
Note!

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

When user press “Start the project” a new “Start Profile” screen appears: All Profiles that has to be taken in this OM Project will be started from this screen.



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

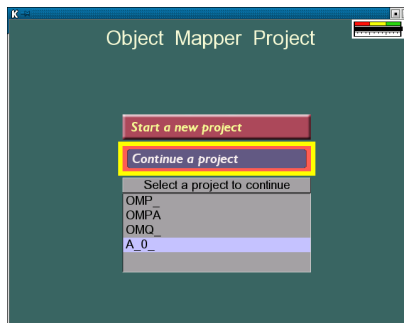


When all the Object Mapper profiles are measured, press “Stop ObjectMapper Project” to close and save the Object Mapper Project.

This project is then easily uploaded to a computer (See the Section “Transferring Data”) where it can be opened in the Object Mapper software, for simple interpretation of underground features. For further information, see the Object Mapper Operating Manual. One can also open or upload separate files from the Project (GPS files will be uploaded as usual .cor files in this case).

5.4 Continuing an Object Mapper Project

To continue a previously started Object Mapper Project press Continue OM 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.

Object Mapper Project

Project Name: A_0_

Base line/ Start/ X coord: 0.000 m

Base line/ Start/ Y coord: -90.000 m

Base line/ Stop/ X coord: 0.000 m

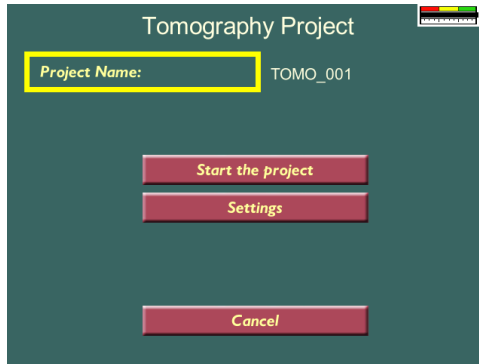
Base line/ Stop/ Y coord: 0.000 m

Continue the project Cancel

Current distance: 0.00 m

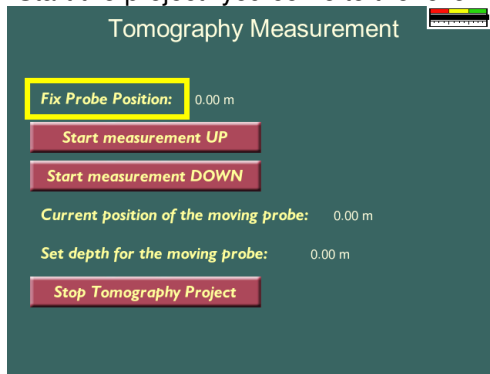
6 Tomography Project

After selecting “Tomography Project” on the Start Screen following screen appears:



On this screen you have to set project name and you may change measurement settings (see sections 3.6 and 3.7 to learn about settings). Tomography Project is possible only with one channel. You can use cross-channel, in this case transmitter will be taken from one channel and receiver from other or you can use usual channel, in this case transmitter and receiver have to be 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 other as moving probe (moving probe has to have encoder wheel).

Place Fix Probe on its start position and enter this position on the screen. Place Moving Probe on its start position and enter this position on the screen also.

Press “Start Measurement” button (UP or DOWN) and move Moving Probe in this selected direction. During the measurement Monitor shows the same screen as if you are in 2D measurement.

After you press “Stop” on the measurement screen, you are back on the “Tomography Measurement” screen.

Place Fix Probe on a new position, enter this new position on the screen. Current position of the moving probe has to be real, if it is not (because of some wheel error) you can correct it on the screen.

Then you can start measurement again.

Press “Stop Tomography Project” when you have done all measurements.

The result project can be uploaded to PC as any other project and it can be opened on PC by Windows program WinTOMO.

It can be opened in XV also but only as a long 2D profile.

7 Positioning Info

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



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”.

There are current GPS coordinates in this window if GPS is connected.

It is also possible to create a file with GPS coordinates, time interval for coordinates gathering can be edited on this screen. File extension is “.crn”, it is a text file, and it can be uploaded to PC from File Manager like any other project.

8 File Manager

As a measurement is started the data is automatically saved and named as to the following files:

Files types seen in the File Manager View:

- DAT_0001_A1.rd3 - Ordinary 2D Project Data files;
- 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.

File types seen after uploading the data:

Examples for the ProEx control unit:

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

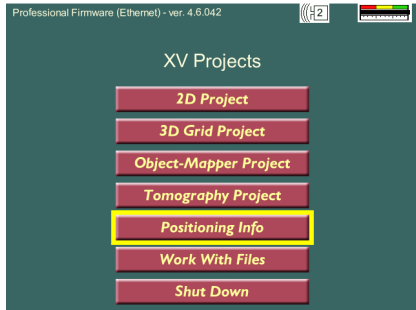
Screen Shots:

- 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.

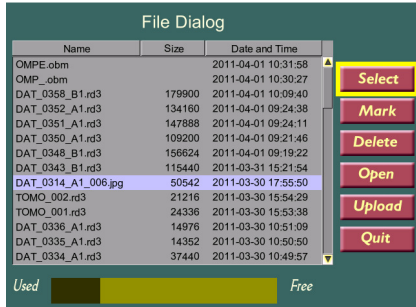
Each file type is given a unique name corresponding to the data file.

Measured files can again be viewed and deleted within the XV, when choosing the File option in the Main View or when closing down the control unit.

Select "Work With Files" on the Start Screen.



You see list of all data files sorted by date. Every project you see like one string in the table, but it can be lot of files included and when you do some operations with a project (delete, upload, mark) it concerns all files of the project.



To select a file turn the turn-push 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 the operator can choose to open them, delete them or upload them to a PC (see also the Section "Transferring Data").

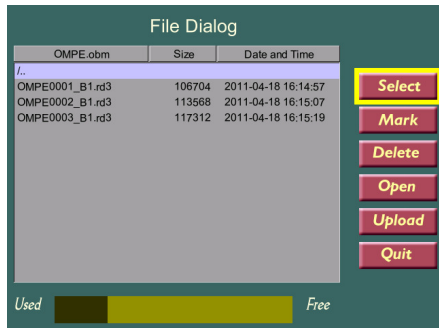
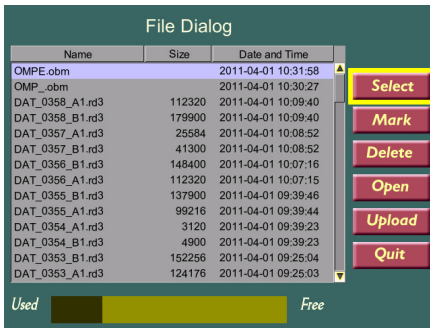
When viewing 2D projects or profiles from OM Project the operator can select and press horizontal and vertical scrolling (Vertical scrolling is possible only if Resampling is OFF). When one of the scroll bars is selected it turns blue and scrolling the data is carried out by turning the turn-push button.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

8.1 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 turn-push button again.

The Object Mapper Project contains *.rd3, *.rad and *.obm files (and *.em files if HF antennas with EM option is used). GPS OM Project contains *.cor files with coordinates also. For further information see Operating Manuals for Object Mapper.

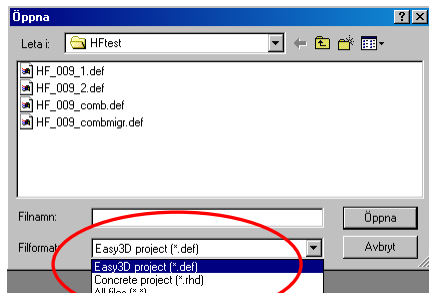
8.2 Grid Project files

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.

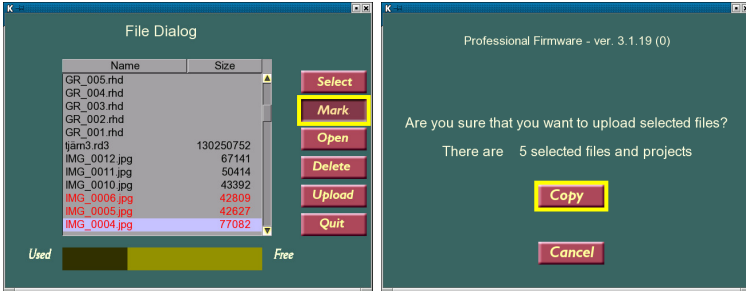
These separate *.rd3-files is extracted when the project is imported to the MALÅ Easy3D software.

To open a Grid Project in Easy3D or 3D Quick just choose “Open” in the File Menu, and change the file type to *.rhd in the File format list.



8.3 Transferring data

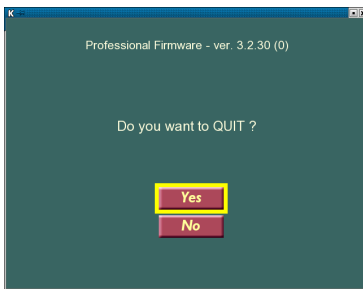
By connecting a flashcard (USB storage media) to the USB port on the XV Monitor (to the left of the serial port), the measured data can be easily transferred by pressing **Upload** in the File dialog (See the section “File Manager”). All marked files will then be copied or moved to the storage medium,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



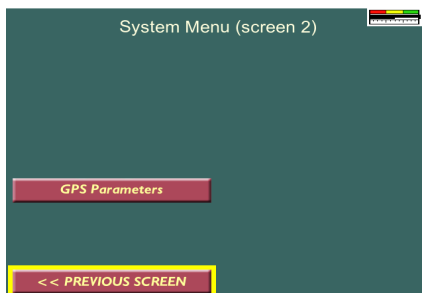
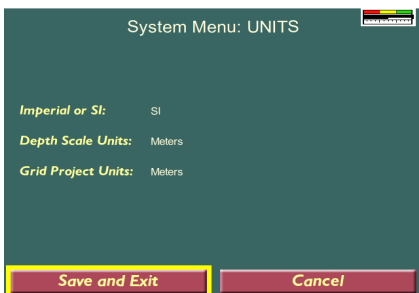
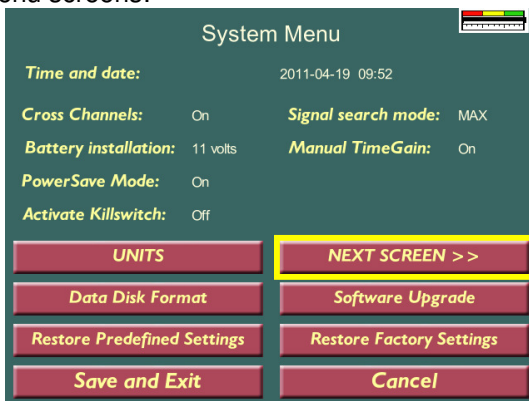
For Object Mapper and Grid Project it is necessary to only mark the project file (*.obm or *.rhd) and all connected radar files will automatically follow.

9 System settings

When starting a project without a connected Control Unit or before closing down the MALÅ XV system, the System menu can be reached. This is done by turning the turn-push button 3 clicks right, 3 clicks left and 3 clicks right at either on 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 GPS: 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 it is no big difference what mode to use.
- Cross-channel, 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: This 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 Monitor is turned OFF without using the Quit option.
- Restoration of predefined settings (CU has to be ON);
- Software 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 electro-magnetic waves when the switch is released. The 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** (CU has to be ON) the parameters in the XV restores to the following:

- System settings are read from the Initial Parameters Files;

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- 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 is restored from the defaults values. This is useful if the Initial Parameters Files has been damaged in some way.

Note! Run the “Restore Predefined Settings” if default antenna settings or distance calibrations are missing from the XV.

10 Upgrade

The instructions below describe how to upgrade the application software of the MALÅ 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 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 FAT16, which is suitable.

Note! You can upgrade only parameters in XV by using files "eeprom_1" and "eeprom_2" without "ram10img.gz". "eeprom_1" contains default antenna parameters for ProEx and wheel parameters, it can be edited by ProEx_Par_Editor. "eeprom_2" contains default antenna parameters for X3M, it can be edited by X3M_Service.

11 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

Note! Before charging it is important to reset the internal memory of the charger by reconnecting it to the mains supply and wait until the indicator lamp turns off.

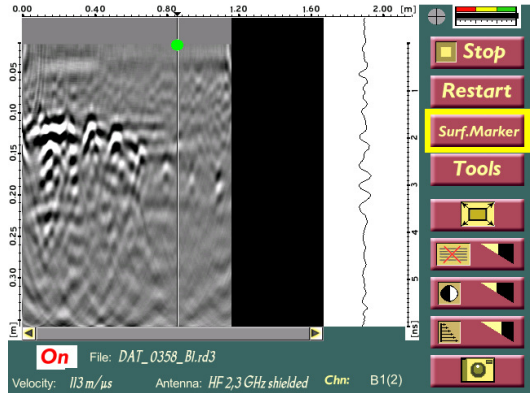
12 MALÅ XV specifications

Display	High Brightness (XV10) or transreflective (XV11), 10.4" weather resistant (IP65)
Memory capacity	1GB – Flash disk; 256MB – RAM;
Power supply	Li-ion or other (9-18 V)
Operating time	Depending on battery capacity
Communication interface	Ethernet
Dimensions	325.8 x 215 x 52 mm (with protruding details 86 mm)
Weight	2.6 kg
Operating temperature	-20 to + 50 °C
Control Unit	ProEx control unit or X3M with Ethernet communication
Antennas	All
Data memory	900MB

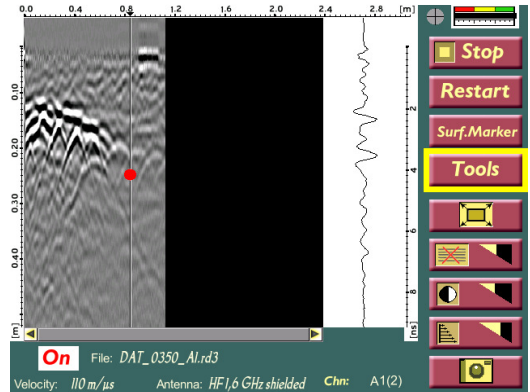
13 Appendix 1 Markers and Tools

A surface marker is applied by pressing **Surf.Marker**, when passing the object to be marked. Or by pressing the red button on a HF antenna.

A green dot indicates the location of the marker.

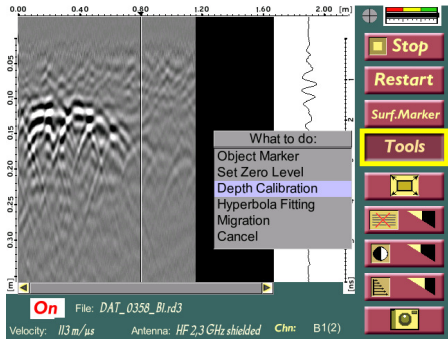


To mark an object underground, or to calibrate the depth scale, press “Tools” button and the select “Object Marker” from the list. A cross will appear on the screen which can be moved up or down with the turn-push button and backwards or forwards by moving the antenna.

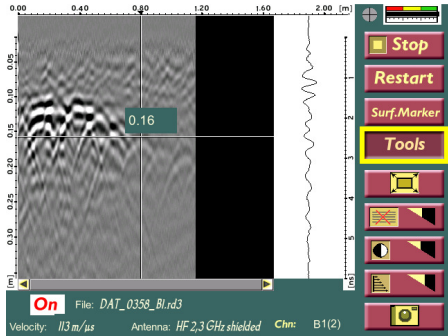


When the correct location is found press turn-push button again and object marker appears as a red dot.

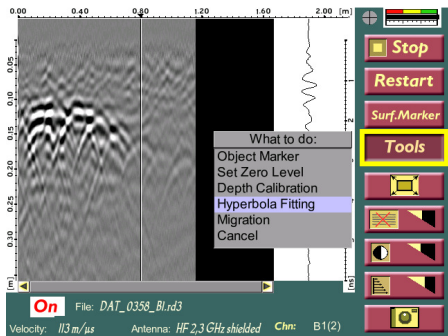
To calibrate the depth and ground velocity to a marked object, choose the option “**Depth Calibration**” instead. It can be done both under measurement and later when you open existing project.



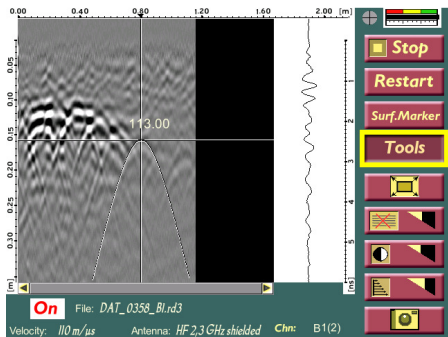
You select the place by moving vertical and horizontal lines by turn-push button (under measurement vertical line is moved by wheel) and then you set depth for known object underground. It gives you right depth scale and right soil velocity.



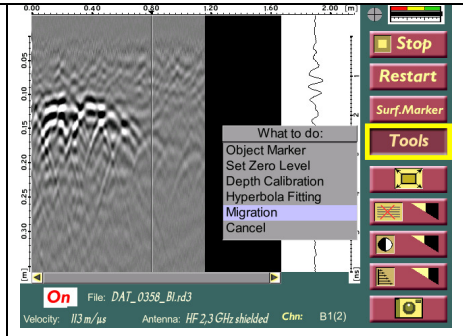
Hyperbola Fitting is necessary when you have good hyperbolas in radagram and you want to estimate soil velocity.



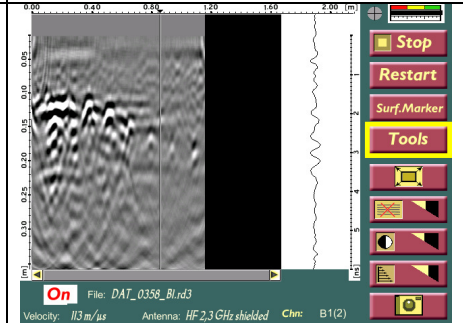
After placing vertical and horizontal lines so that cross section comes on the top of the hyperbola, press turn-push button and fit the hyperbola by rotating turn-push button. Press the button one more time and the new value of soil velocity will be stored.



For good **Migration** it is necessary that Zero Level is installed correctly (on the beginning of the first big wave in the first arrival) and soil velocity also has to be correct (it can be adjusted by Depth Calibration and Hyperbola Fitting).



The result of the correct migration is that all hyperbolas are gathered into points.



It should be noted that hyperbola fitting and migration would not work if using time triggering for measurements.

14 Appendix 2 GPS Measurements

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

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

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

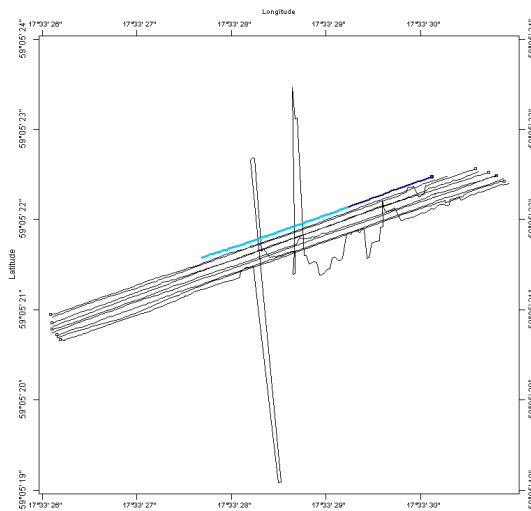
GPS: Relatively inexpensive, the GPS is using only satellites for positioning, accuracy around ± 4 m. Suitable for large scaled layer mapping etc.

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 GPS: Real Time Kinematic GPS, expensive, uses two GPS receivers (one stationary base and one rover) and correction signal from the base antenna, accuracy around ± 1 cm. Network RTK also available in many locations, where the correction is received via GSM. RTK GPS accuracy is recommended for utility mapping.

For all the three different GPS 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 GPS in motion, the GPS 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 GPS 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.