Guideline Geo

MALÅ MIRA HDR

User Guide

Our Thanks...

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

Whether this is your first MALÅ product or an addition to the MALÅ collection, we believe that a 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 and the contents and usefulness of this manual. We are excited to be part of your journey!

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Guideline Geo AB

www.guidelinegeo.com

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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

Safety and Compliance User Notices

This GPR device is certified according to FCC, subpart 15, IC RSS-220 and ETSI EN 302 066-1&2.

You are cautioned that changes or modifications not expressly approved by the party responsible for compliance could void the user's authority to operate the equipment.

Note: This equipment has been tested and found to comply with the limits for a Class B digital device, pursuant to part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference in a residential installation. This equipment generates, uses and can radiate radio frequency energy and, if not installed and used in accordance with the instructions, may cause harmful interference to radio communications. However, there is no guarantee that interference will not occur in a particular installation. If this equipment does cause harmful interference to radio or television reception, which can be determined by turning the equipment off and on, the user is encouraged to try to correct the interference by one or more of the following measures: —Reorient or relocate the receiving antenna. —Increase the separation between the equipment and receiver. —Connect the equipment into an outlet on a circuit different from that to which the receiver is connected. —Consult the dealer or an experienced radio/TV technician for help.

According to the regulations stated in ETSI EN 302 066-1 (European Telecommunication Standards Institute):

The control unit should not be left ON when leaving the system unattended. It should always be turned OFF when not in use.

The antennas should point towards the ground, walls etc. during measurement and not towards the air.

The antennas should be kept in close proximity to the media under investigation.

Canadian and US regulations state that whenever GPR antennas are in use the following notes apply:

This Ground Penetrating Radar device shall be operated only when in contact with or within 1 meter of the ground.

Only law enforcement agencies, scientific research institutes, commercial mining companies, construction companies and emergency rescue or firefighting organizations shall use this Ground Penetrating Radar Device.

This device complies with Industry Canada license-exempt RSS standards. Operation is subject to the following two conditions: (1) This device may not cause interference and (2) this device must accept any interference, including interference that may cause undesired operation of the device.

French translation:

Cet instrument de Géoradar se devra d'être opéré seulement en contact à même le sol ou en deça d'un mètre du sol.

Cet instrument de Géoradar se devra d'être utilisé seulement par les agences chargées de l'application de la loi, les instituts de recherches scientifiques, les compagnies minières à buts lucratifs, les compagnies de construction et les organisations responsables pour le sauvetage et la lutte contre les incendies.

Cet instrument répond aux exigences de la licence avec Industrie Canada- exempt des standards RSS. L 'opération est sujette aux deux conditions suivantes: (1) Cet instrument ne peut pas causer une interférence et (2) cet instrument se doit d'accepter quelque interférence que ce soit, incluant une interférence qui pourrait causer une opération non-souhaitable de l'instrument.

Radiation Exposure Statement

To comply with ISED RF exposure compliance requirements, a separation distance of at least 20cm should be maintained between the EUT and all persons during normal operation.

French translation:

Pour se conformer aux exigences de conformité d'exposition ISDE RF, une distance de séparation d'au moins 20 cm doit être maintenue entre l'EST et toutes les personnes pendant le fonctionnement normal.

About MIRA HDR

Together with the data acquisition software MIRA Controller, MALÅ MIRA HDR is a multi-channel antenna array for large scale 3D GPR measurements. The MIRA HDR system enables measurement combinations between any of the individual receiver and transmitter antennas used in the array; all antennas are using MALÅ HDR technology (High Dynamic Range).

As long as careful attention is given to accurate positioning and data collection, the MALÅ MIRA HDR array produces extremely high-resolution output.

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 if 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 MALÅ MIRA HDR. 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 80mm 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 www.guidelinegeo.com

Registering MALÅ MIRA HDR

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 numbers are found on the antennas, one on the Tx and two on each Rx unit.

Overview MIRA HDR

In short, the MIRA HDR system comprises the following parts:

- HDR antennas. Separate transmitter (Tx) and receiver (Rx) antennas with a central frequency of 500MHz.
- MIRA antenna box. Special antenna box for deployment of the MIRA system. The antenna box is set-up for a regular 22-channel swath, with 12 Rx and 11 Tx antennas, but it is possible to program any Tx-Rx combination resulting in, if all are selected, 132 data channels.
- Measurement wheel. Used to trigger data collection and keep track of the distances.

To make the system complete and running, the following parts are also needed:

- Power supply for the antenna box.
- Field computer or tablet (with Windows 10x64) with MIRA Controller software installed, to collect, save and view multi-channel data. We highly recommend the use of a rugged field computer.
- Positioning system e.g. RTK-GNSS or Robotic Total station.
- Suitable carrier solution (see www.guidelinegeo.com for different options).

To connect the parts, see *System set-up* section. Instructions and information for carrying out a multi-channel MIRA measurement can be found in the *MIRA Controller User Guide*.

System components

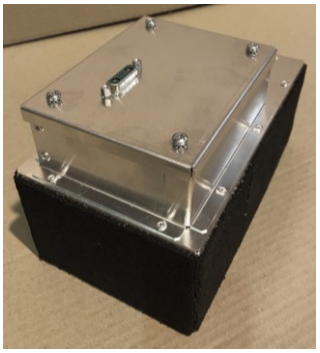
Antennas and antenna box

Note: The antenna box should NOT be opened, when the system works as it should. If opened, make sure to close it properly, to make the system IP65 compliant.

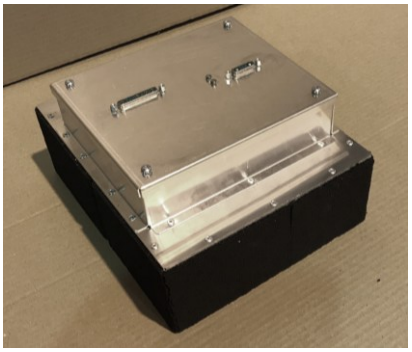
Antennas

The MIRA HDR system is designed to handle shielded separable antennas only. No other antennas can be used with the MIRA HDR system. The MALÅ HDR antennas are designed and built to very tight tolerances to achieve a 'near-identical' response (signature) from each data channel.

The MALÅ HDR shielded antennas are available with a centre frequency of 500MHz. This frequency will cover investigations ranging from 0m to approximately 5m depth. The maximum measurement depth may vary and is dependent on the soil conductivity locally.



Tx



Rx

Each antenna element is 128 x 222 mm in size. The Tx is contained in one box, while the Rx consists of two connected boxes. In the Rx antenna the antenna elements are placed 130 mm apart giving a channel separation of 6.5 cm.

The Tx has one connector providing both power and trig signal. The Rx has two connectors. One provides power and communication, the other provides the trig signal. The status of the Rx antennas can be seen when connected to the laptop with MIRA Controller installed.

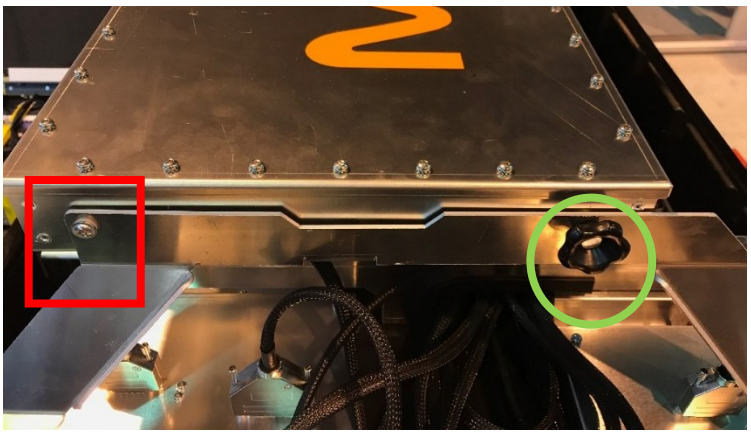
Blockmaster

The blockmaster contains the electronics for generating the trig signals and their timing. It is situated above the antennas and can be raised for disconnecting and reconnecting the units:

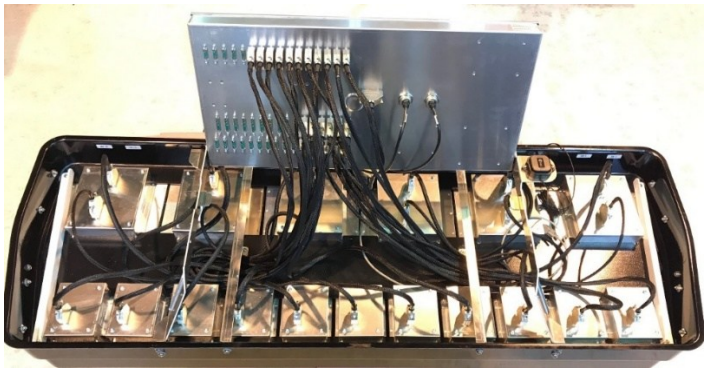
To access the blockmaster connectors:

- Remove the two screws on each side of the blockmaster (marked with circles in the picture below)
- If needed, loosen but do not remove the remaining two screws (marked with squares in the picture below)
- Lift up the blockmaster
- Tighten the screws (marked with square), if needed, to hold the blockmaster in place.
- Connect or disconnect antennas
- Lower the blockmaster
- Insert and tighten the two screws on each side of the blockmaster (marked with circles)
- Tighten the remaining screws (marked with squares)

Blockmaster on top of antennas



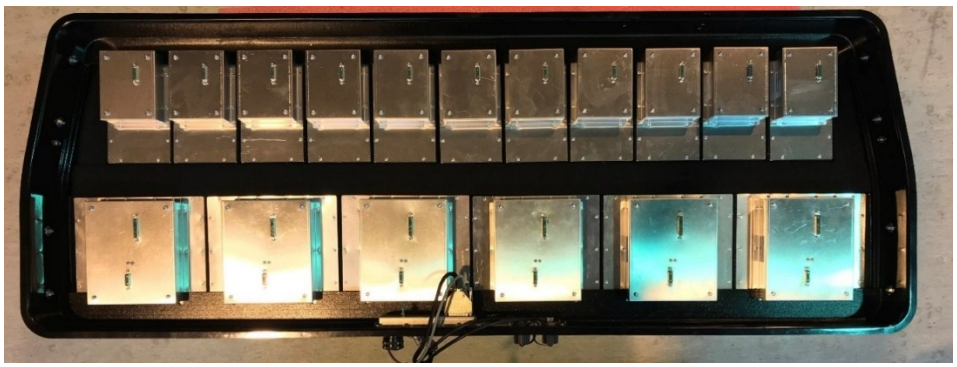
Screws that hold the blockmaster in place



Blockmaster in upright position

Antenna box

The antenna box houses 11 transmitters and 12 receivers placed in two rows.



Tx on top and Rx on bottom

Each antenna element has its own secured slot and is connected via communication cables to the Blockmaster.

A connector panel can be found at the (long) side of the antenna box. Here power, GNSS, Ethernet etc. are connected. Also see *System set up* section.

The System diode blinks while the MIRA HDR system is booting; it becomes constant once the system is ready to connect to the MIRA Controller software. The GPS diode will blink until the internal GPS clock is ready to sync with the external GNSS clock (to pair the GNSS coordinates with GPR traces).

Note: When no connectors are connected, the protective caps of all the connectors MUST be attached. This prevents dirt and moisture entering the antenna box and makes the system IP65 compliant.

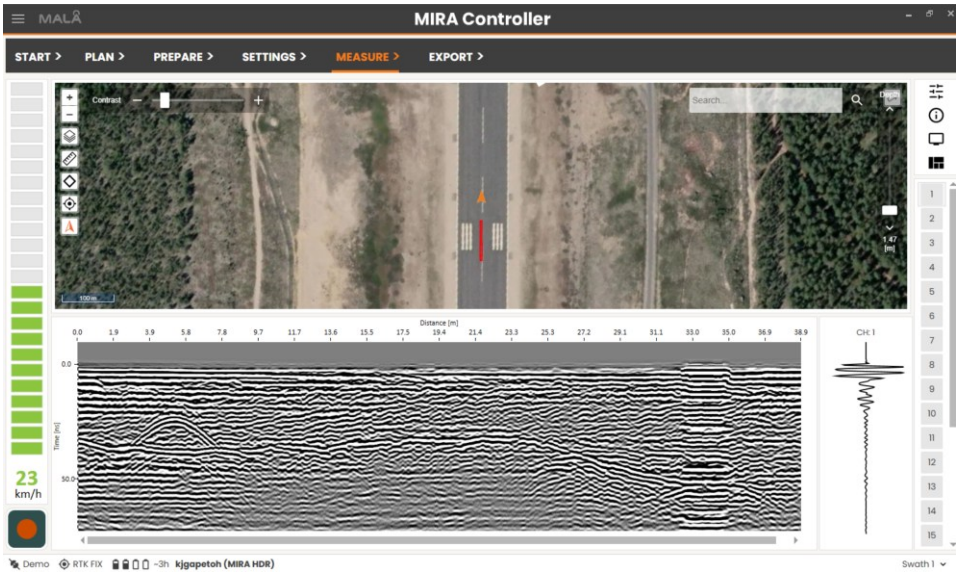
Built in GPS

The MIRA HDR has a built in GPS module that utilises the Pulses Per Second (PPS) output for synchronisation of the recorded traces to the external RTK-GNSS measurement input. This aid improved positioning and alignment of each recorded trace due to potential latency between the external GNSS and the MIRA HDR.

The built in GPS module can be found to the top right side of the Blockmaster

Data acquisition software

The data acquisition software for the MIRA HDR system is called MIRA Controller, a simple and straight forward application designed to collect, view and save MIRA HDR data. For more information, see the *MIRA Controller User Guide*.



The computer or tablet used for measurements should be placed in a convenient position for the operator to monitor progress whilst carrying out the measurements. An Ethernet cable is used to transfer the measured data from the antenna box to the data acquisition computer or tablet for storage and display in MIRA Controller.

Note: It is highly recommended to use the provided Ethernet cable with IP-classed connector housing to protect the connection from water and dirt ingress.

MIRA Controller aids collection of data with a satisfactory overlap between swaths and will provide information on coverage of your investigation area.

Positioning

The antenna array must be positioned with a high level of accuracy throughout the survey. A precise control of the geometry is an absolute prerequisite to make the resulting 3D radar picture correct and reliable. Centimetre accuracy is needed over the whole investigation site. The MIRA HDR system can be positioned by using an RTK-GNSS system and with a Total Station solution. The system can be used without a base station if a suitable rover unit is used and a correction subscription service is available.

The positioning system has to be set to export the positioning data in NMEA 0183 GGA format for the GPS option, so that the MIRA Controller data acquisition software can record it and assign it correctly to the measured GPR swaths.

The GPS antenna or the Total Station prism can be connected to Guideline Geo carrier solutions or can be mounted on the survey vehicle:

Note: The placement and recording of the GNSS antenna or Total Station prism's position must be thorough; this is described in the *MIRA Controller User Guide*.

The best choice of positioning method will depend upon the conditions at the investigation site. Some points to consider:

- If working in an environment with a number of trees, high buildings or other infrastructure that might disturb the communication with GNSS satellites, a Total Station is preferred. In these types of environments, it can also be hard to define lines and point features with the GPS.
- However, on open ground with lower vegetation and/or fewer overhead obstacles, the RTK-GNSS solution is most often a faster and easier method of positioning.
- The Total Station needs line of sight and possibly an extra operator for the Total Station if the tracking fails.
- If the investigation area is large, the Total Station may need to be moved and new Total Station positions defined, which can be more time consuming. However, every type of investigation area can be covered by a Total Station which is not the case with a GNSS.

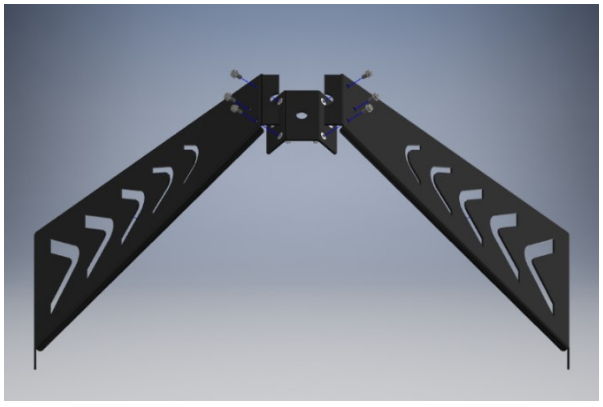
It should also be mentioned that temporary loss of tracking will not cause the data to be useless, provided the start and end points of each swath are well defined.

Note: RTK-GNSS is an effective solution when applicable. In some circumstances a Total Station might be required to obtain real-time positioning.

Note: Measurements without any positioning system should only be made for testing.

Assembly of Extension pole support

- Assemble the GPS/prism support using the 6 provided M6 screws (picture below).
- Attach the extension pole to the GPS/prism mounting plate.
- Remove 6 screws on the GPS/prism mounting plate, 3 on each side.
- Place the support over the extension pole and the antenna/prism mounting plate. The holes on the support should match the screws on the GPS/prism mounting plate, 2 on each side.
- Attach the 6 screws removed in step 3.



Power

Depending on your system the power supply can be customized.

Preferably, a connection to the alternator of the carrying vehicle can be made but, if this is not an option, arrangements with portable power sources may be considered and solutions are provided by Guideline Geo with suitable cables and boxes.

It is recommended to use a LiFe-battery for longer power supply. An ordinary car battery requires exchanges during a working day as the battery will last approximately 4-5 hours. The MIRA HDR system operates at 10-14V.

If the battery is connected using the wrong polarity, a buzzer tone will sound. If power consumption is unexpectedly increasing, the internal fuse may blow. The fuse is situated behind the connector panel and is an easily replaceable, standard vehicle accessory fuse.

On the hand-pushed solution, the battery is placed at the rear side of the antenna, towards the user. If using the Guideline Geo Road-trailer the battery has a ready-made shelf. With other carrier solutions the battery can be placed in the vehicle.

Note: It is important to turn the power off when the antenna array is not in use, otherwise it will drain the power supply.

Accessories

Carrier

The prime applications for the MIRA systems usually involve GPR surveys over larger areas and, practically, it may not be feasible or particularly efficient to move the array manually over thousands of square meters. To gain the maximum coverage and efficiency, a motorised vehicle is highly recommended. Customized carrier solutions are possible. Please contact Guideline Geo for more information.

For example, lawn-mower type vehicles or small utility vehicles are usually suitable for carrying the MIRA HDR array. For uneven, grass covered, surfaces the MALÅ Field Trailer is recommended or a front-loaded vehicle. For very small area MIRA HDR scanning on concrete, asphalt or other hard surfaces, the antenna box can be attached to a special hand-pushed carrier, but in all other cases a vehicle mounted solution is preferred.

Whatever solution is chosen to carry the MIRA HDR antenna box, some adoption for the radar system has to be done, these can include:

- Fastening arrangement for the array box.
- Power supply, typically the vehicle alternator must be exchanged to one with higher current specifications. Cables, fuses, and switches must also be installed.
- Attachment for laptop mounting.

If the carrier is part of the purchase, these details will be taken care of by Guideline Geo. However, the client may find it more suitable to source the vehicle locally, in which case they must arrange the mounting details themselves with help from Guideline Geo. It is most highly recommended to use the power from the carrier as the antenna array box has a reasonably high-power consumption. The vehicle must be able to support 12A@12V for the 22 channel MIRA HDR.

Encoders

For positioning along the measurement swaths and to control the data collection, the MIRA HDR system is compatible (together with an adapter) with all MALÅ measuring wheels.

- The 300 mm wheel is recommended when using the hand-pushed carrier solution.
- If the system is used front loaded, an encoder kit is available to mount on the survey vehicle.
- If the Guideline Geo trailer solutions is used, the encoder is built in.

Vehicle mounted encoder and the 300mm measuring wheel

System set up (how to connect)

1. Connect the battery cable using the provided power cable to the Power connector on the antenna box connector panel.

Note: Make sure to connect to the battery with the correct polarity (Red = "+" positive, Black = "-" negative). If the wrong polarity is used, there will be warning sound and the system will not start.

2. Connect your GNSS or TS. There are two 12V output connectors at the system's connector panel. Contact Guideline Geo for adapters for your brand of GNSS.

Note: The 12V connectors are secured with a 2A e-fuse. The fuse will be restored after a power-cycle.

3. Connect the measuring wheel/encoder to the connector marked Wheel on the antenna connector panel.
4. Connect the Ethernet cable between the computer or tablet with MIRA Controller installed and the connector marked MIRA Controller on the connector panel.
5. Power up the MIRA HDR system and wait for the System diode on the connector panel to change from blinking to solid (this means that the hardware is ready for connecting to MIRA Controller).
6. Start MIRA Controller, the system automatically connects, and the software will report Ready.
7. See the *MIRA Controller User Guide* for a detailed guide on how to operate the software.

Note: The System diode will be blinking while the MIRA HDR system is booting. When the light is steady, the system is ready to be connected to MIRA Controller. The GPS diode will be blinking until the internal GPS clock is ready to sync with the external GNSS clock.

Note: Make sure the lid is firmly closed. Please use the dust caps for the connectors when there is no plug inserted. This prevents dirt and moisture entering the antenna box and makes the system IP65 compatible.