

GUIDELINEGEO | MALÅ

MALÅ MIRA Compact
User Guide

Our Thanks...

Thank you for choosing Guideline Geo and MALÅ as your Ground Penetrating Radar solution provider. The very core of our corporate philosophy is to provide our users with the very best products, support and services. Our development team is committed to providing you with the most technologically advanced and easy-to-use GPR products with the capability to meet your needs for efficiency and productivity now, and into the future.

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.

At Guideline Geo, we welcome comments concerning the use and experience with our products, as well as the contents and usefulness of this manual.

Guideline Geo team



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Table of Contents

Preface	5
Safety and Compliance User Notices	6
About MIRA Compact	8
Unpack. Inspect. Register	9
Overview MIRA Compact	10
System set-up	11
System components.....	12
Antenna box.....	12
Antennas.....	12
Connector panel	12
Built in GNSS	12
Batteries	13
Skid plate	14
Straps.....	15
Carrier frame.....	15
Antenna assembly	15
Encoders	15
Pivot wheel	15
Handle.....	15
GNSS and prism pole mount.....	15
Data acquisition software	16
Post-processing software.....	16
Positioning	17
Accessories.....	17
GNSS pole support.....	17

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 and Support

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

For technical support please contact support@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 1m 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 and FCC RF exposure compliance requirements, a separation distance of at least 20 cm should be maintained between the EUT and all persons during normal operation.

French translation

Pour se conformer aux exigences de conformité d'exposition ISDE et FCC 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 Compact

The MIRA Compact, together with the data acquisition software MIRA Controller is a very efficient and easy to use multi-channel system for 3D GPR measurements.

The MIRA Compact system enables measurement combinations between any of the individual receiver and transmitter antennas used in the array and all antennas are using the MALÅ HDR technology (High Dynamic Range).

As long as careful attention is given to accurate positioning and data collection, the MALÅ MIRA Compact 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 carefully 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 MALÅ MIRA Compact. 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 at www.guidelinegeo.com.

Registering MALÅ MIRA Compact

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 rear right-hand side of the antenna box.

Overview MIRA Compact

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

- **MIRA Compact antenna box.** Special antenna box for deployment of the MIRA Compact system, holding 6 receiver (Rx) and 5 transmitter (Tx) antennas with a central frequency of 500 MHz. The default set-up provides a 10-channel swath, however it is possible to program any Tx-Rx combination giving up to 30 data channels. The antenna box is powered by four hot-swappable internal batteries.
- **MIRA Compact carrier frame.** The carrier is equipped with three wheels, a handle, a computer holder, a GNSS mount and two integrated encoders on the rear wheels. The encoders are used to trig data collection and keep track of the distances.

To make the system complete and ready for measurement, the following are also needed:

- Field computer or tablet (Windows 10 or later with Ethernet port) with the MIRA Controller software installed, to collect, save and view multi-channel data. We strongly recommend the use of a rugged field computer.
- Positioning system e.g., RTK-GNSS or Robotic Total station.



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

System set-up

1. Connect the Ethernet cable between the computer or tablet with MIRA Controller installed and the connector marked Ethernet on the connector panel of the antenna box. See section *Antenna box*.
2. Mount the GNSS antenna and if using a RS-232 cable for your GNSS, connect this to your computer. See section *Positioning*.
3. If you need to power your computer or tablet, connect the same to the Power Out connector (USB-C) on the connector panel. See section *Antenna box*.
4. Power up the MIRA Compact and wait for the light on the On/Off button to change from blinking to solid (this means that the hardware is ready for connecting to MIRA Controller). See section *Antenna box*.
5. Start MIRA Controller. The system will automatically connect, and the software will guide you through any steps necessary. See section *Data acquisition software*.
6. See the *MIRA Controller User guide* for details on how to operate the software.

Note: Please use the dust caps for the connectors whenever cables are not connected. This prevents dirt and moisture ingress in the connectors.

System components

Antenna box

Antennas

The MALÅ MIRA Compact antenna box is available with a centre frequency of 500 MHz. This frequency will cover investigations depths down to approximately 4 meters. The maximum measurement depth will vary and depends for example on the soil conductivity locally.

The MIRA Compact antenna box houses 5 transmitters and 6 receivers.

Connector panel

All connectors are placed at the rear side of the antenna box. Here, from left to right, you find the connection to the encoders, antenna connector to the internal GNSS*, Power In for charging, charge indicator, On/Off button, Power Out (USB-C) and Ethernet connection. Also see *System set-up* section.

When powered, the On/Off button diode blinks while the MIRA Compact system is booting; it becomes solid once the system is ready to connect to MIRA Controller.



Note: When cables are not connected, the protective caps of the connectors MUST be attached. This prevents dirt and moisture ingress in the connectors.

Built in GNSS

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

A GNSS antenna is located inside the antenna box. If the system is covered or placed in a surrounding where satellite view is blocked the GNSS reception can be too poor for the system to get time lock. Move the system to a position with better satellite reception to get time lock before beginning your measurements.

Batteries

The MIRA Compact is powered by four 14.4V Li-Ion batteries. The batteries are located in the battery compartment behind the two black lids. Make sure the lids are securely closed to prevent water and dust from entering.

The batteries are hot-swappable, meaning that batteries can be exchanged while the system is running as long as at least one charged battery is kept in the system. The system can be used with a single battery if needed, however we recommend always using four batteries when possible for optimal survey time and performance.

All four batteries can be charged in the system using the provided charger. Connect the charger to the Power In connector on the antenna box connector panel. The system does not have to be powered on for the batteries to charge. The charge indicator LED on the system will be lit while the batteries are charging and shuts off when charging is complete.



When the charger is connected to the system the USB-C connector will also provide power, enabling you to e.g. charge a laptop at the same time.

Note: The charge indicator LED on the system only indicates charging of the internal batteries and not of devices being charged via the USB-C connector. Always check charge and power status on your peripheral devices separately.

The batteries can also be charged in the external smart battery charger, where two batteries can be charged at the same time.



Powering the MIRA Compact batteries with the external charger are done as follows.

Powering the charger:

1. Connect the cable from the mains adapter to the battery charger.

2. Connect the power cable to the mains adapter and plug it into the mains socket.
3. The LED will turn off after the self-test of the battery charger. The battery charger is then ready for use.
4. If the red control lamp remains on and no battery is in the charger, the battery charger is defective.

Charging batteries:

1. Connect the battery charger as described above.
2. Place a discharged Smart Battery into the battery charger.
3. The battery charger makes a battery recognition and initialisation.
4. The battery will be charged, leave the battery until the green LED lights.
5. Remove the battery for use.

The LED light on the external charger indicates the follow cycles.

One time Red/Orange/Green	Self-test: Charger is ready for use
Red/Green blinking	The battery is not recognised as a Smart Battery. Either a conventional battery is inserted or an extremely discharged Smart Battery. If it is a Smart Battery, it will be reactivated within 15 minutes and recharged. If this is not the case, the LED will light red – see below.
Orange blinking	The battery is currently being calibrated.
Orange light	The inserted battery is the correct type and is currently being charged.
Green light	The battery is charged and can be removed for use.
Red blinking	The battery is too hot or too cold to be charged without damage. If the battery is too cold, it will be charged as soon as it has warmed up sufficiently. If the battery is too hot it should be removed to cool down.
Red light	Either - the battery is damaged and must be replaced, or it is a conventional battery which cannot be recharged.

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

Skid plate

The skid plate is attached directly to the antenna box. It is intended to protect the bottom of the antenna box and is sealed to the antenna box to prevent water from collecting under the antenna box, potentially affecting the data. The skid plate is expected to be worn out and changed when needed. How often it needs to be replaced depends on how the system is used, including factors such as ground conditions. We recommend inspecting the skid plate before and after each use. New skid plates can be purchased directly from Guideline Geo or through your local MALÅ partner.

How to replace the MIRA Compact skid plate:

1. TBD

Straps

TBD

Carrier frame

Antenna assembly

The antenna is mounted in the carrier frame using four straps and two stabilizer arms. The floating antenna solution makes it possible to operate MIRA Compact over uneven surfaces. The ground clearance is easily adjusted using the straps.

Encoders

The system has two encoders, one on each rear wheel. A single cable and connector is used to transfer the signals from both encoders to the antenna box. Should there be any issues with an encoder it is possible to configure the system to use either right or left encoder instead of both. This is done in MIRA Controller.

MIRA Controller includes default encoder values ('Compact Frame'). For accurate triggering we recommend calibrating the wheels on a regular basis.

Pivot wheel

For easy manoeuvring the carrier frame has a pivot wheel in the front. This can be locked to a straight position.

Handle

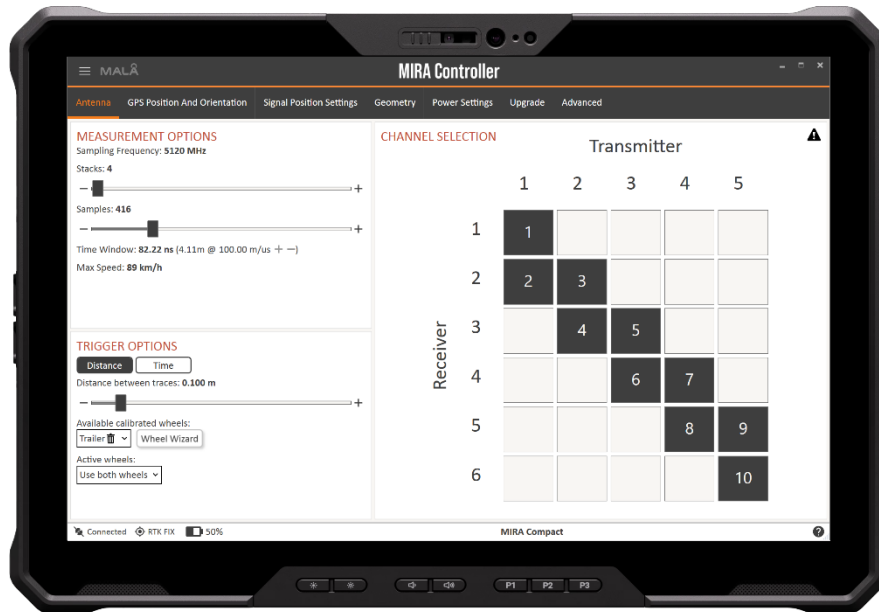
TBD

GNSS and prism pole mount

The carrier frame has a quick-release GNSS and prism pole connection for 25 mm diameter poles. An adapter (5/8 UNC threading) for thicker poles is included.

Data acquisition software

The MIRA Controller data acquisition software is used to collect, view, and save data from the MIRA Compact. The software is an easy to use and straight forward application, 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 the measurement progress whilst carrying out the investigation. An Ethernet cable is used to transfer the measured data from the system to the data acquisition computer or tablet for storage and display in MIRA Controller.

Note: The system has a rugged Ethernet connector requiring a specific MIRA Compact Ethernet cable for data transfer.

Note: It is strongly recommended to use a laptop or tablet with a native Ethernet port. The use of Ethernet adapters may cause unexpected issues during data collection.

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

Post-processing software

Data from MIRA Compact and MIRA Controller measurements can efficiently be post-processed in the MALÅ Vision Desktop software. For more information see the *MALÅ Vision Desktop User Guide*.

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 Compact can be positioned by using an RTK GNSS or Total station solution.

The system can be used as a rover-base set up or without a base station if a suitable rover unit is used and a correction subscription service is available.

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

It is recommended that you use a GNSS update rate of 5 Hz for hand-pushed measurements.

The GNSS antenna or the Total Station prism can be attached to the MIRA Compact Carrier solution, supplemented with the MALÅ GNSS support, see section *Accessories*.

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.
- However, on open ground with lower vegetation and/or fewer overhead obstacles, an 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.

Note: 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: Measurements can be carried out without any positioning system but is not generally recommended unless absolutely necessary. The measurement lines should be straight and with an even spacing so coordinate files for post-processing software can be created afterwards.

Accessories

GNSS pole support

When delivered the MIRA Compact has a GNSS mount attached on the carrier solution, and a 150 mm GNSS pole is supplied.

When a longer pole is needed, we highly recommend using the MALÅ GNSS support kit which includes a 800 mm pole.



Note: The MALÅ GNSS support is only compatible with 25 mm diameter poles.