RAMAC/GPR

Operating manual

Version 1.0

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1 Introduction

Thank you for purchasing the RAMAC/GPR system. We at Malå GeoScience welcome comments from you concerning the use and experience of this equipment, as well as the contents and usefulness of this manual. Please take the time to read through the assembling instructions carefully and address any questions or suggestions to the following:

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Technical support issues can be sent to: support@malags.se

Information about MALÅ GeoSciences products is also available on Internet: http://www.malags.com

1.1 Unpacking and Inspection

Great care should be taken when unpacking the equipment. Be sure to verify the contents 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 that any damage occurred during shipping. Any claims for shipping damage should be filed to the carrier. Any claims for missing equipment or parts should be filed with Mala GeoScience.

1.2 Repacking and Shipping

If original packing materials are unavailable, the equipment should be packed with at least 80 mm of absorbing material. Do not use shredded fibers, paper wood, or wool, as these materials tend to get compacted during shipment and permit the instruments to move around inside the package.

2 General

2.1 General description of the GPR Technique

In its simplest form the RAMAC/GPR system consists of an external PC, a Radar Control Unit, a transmitter antenna and a receiver antenna. The Radar Control Unit is connected to the transmitter and the receiver antenna with optical fibres and to the computer with a parallel communication cable.

Figure 2.1 shows a schematic diagram of the system when connected. Note that this picture refers to the case where the transmitter and receiver are located in different modules. The general principle is still the same also for shielded antennas.

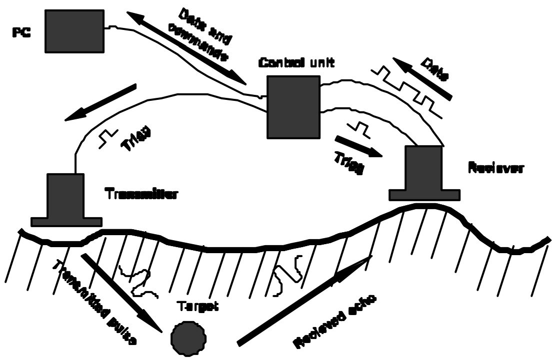


Figure 2.1 General description of the principle

In GPR context the following terminology is often used:

Sample:
In a digital system, the incoming signal (to the receiving antenna) is measured a certain number of times per unit of time. The result of every such measurement is a numeral, a sample. A defined number of samples are used to construct a trace.

Trace:
At each point of measurement along the profile, a specific number of samples are collected. Together, these samples make up a trace, an envelope of the received waveform.

Profile:
A collection of traces along a line or transect.

Direct wave:
This is the part of the energy that travels the shortest distance between the transmitter and the receiver. When collecting a sample, the CUII sends a timing signal (a control signal) to the transmitter and receiver antenna respectively. After the transmitter has received the signal, it generates and transmits radar pulses through the antenna. The pulse then propagates through the medium. Reflections occur from underground objects, structures and other materials where there are changes in subsurface electrical properties.

Once the receiver has detected the control signal, it collects a sample and passes it to the CUII. By repeating this process at very finely controlled intervals, the CUII can collect all the samples in a trace. The CUII places each incoming sample in its correct position in the current trace. When the trace is complete, it is sent to the computer where it is saved on the hard disk and displayed on the computer monitor.

During data collection, the whole system is transported along the line to be investigated, while collecting and recording traces at defined distance or time intervals. The result is a continuous profile record of subsurface conditions along that line (see Fig 2.2), a so-called radargram.

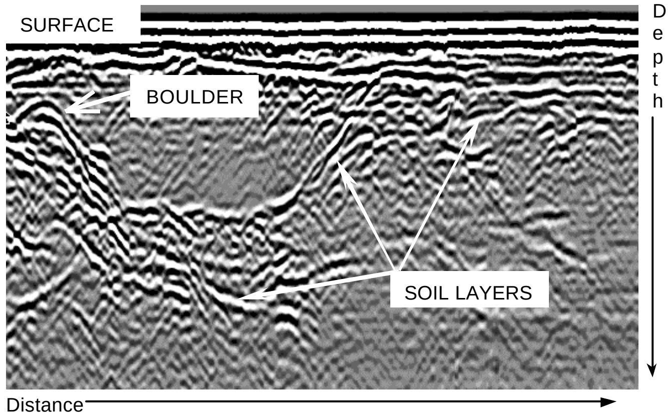


Figure 2.2 An example of a continuous record of radar traces.

2.2 Basic information in investigation depths and velocities

The problem of range (depth) vs. resolution is well known for the type of investigations that GPR represents. Sufficient penetration depth may be achieved but it may require a low frequency that reduces the resolution. Range is defined as the distance at which a target can be detected. Resolution on the other hand is defined as the smallest size an object or thinnest layer that may be detected. There often is a compromise regarding the choice of antenna frequency for a particular application at a specific site.

The depth penetration with different frequency antennas varies greatly depending on local soil conditions. Primarily the depth/resolution requirements and the soil conditions at the site determine the choice of antenna frequency. The table below is hoped to be of assistance when selecting antenna frequency based on the depth interval of interest.

Table 2.1. Approximate depth ranges for different antenna frequencies.

Antenna frequency (MHz)	**Lower limit of object target size (m)**	**Approximate depth range * (m)**	**Approximate penetration depth (m)**
100	0.1 - 1	2 - 15	15 - 25
250	0.05 - 0.5	1 - 10	5 - 15
500	0.04	1 - 5	3 - 10
800	0.02	0.4 - 2	1 - 6

* In normal geological environment absent of low resistive layers

For the interpretation part the velocity of different geological environment is needed for the best possible depth interpretation. The following velocities can then be used (Table 2.2). It has to be remembered that the values given are only approximate, and can vary greatly with the water content in the medium. The larger value given for velocity applies to unsaturated media.

Table 2.2. Approximate values of $?_r$ (relative permittivity) and the corresponding velocity. e_r varies greatly with the water content in the medium. The larger value given for velocity applies to unsaturated media.

Medium	e_r	**Velocity [m/µs]**
Air	1	300
Fresh water	81	33
Limestone	7 - 16	75 - 113
Granite	5 - 7	113 - 134
Schist	5 - 15	77 - 134
Concrete	4 - 10	95 - 150
Clay	4 - 16	74 - 150
Silt	9 - 23	63 - 100
Sand	4 - 30	55 - 150
Moraine	9 - 25	60 - 100
Ice	3 - 4	150 - 173
Permafrost	4 - 8	106 - 150

3 Radar Control Unit CUII

The Radar Control Unit CUII is the main part of the RAMAC/GPR system. As seen in Fig. 3.1, the CUII is compatible with all current RAMAC antennas, both unshielded, shielded and borehole antennas.

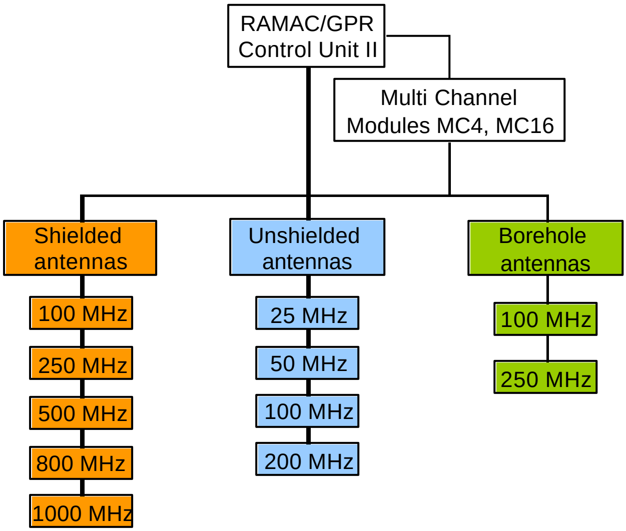


Figure 3.1 An overview of all antennas that can be used together with the CUII.

The CUII is the administrator for data collection. It consists of a power supply, an analogue section that generates the crucial control signals and an internal computer. A 32-bit processor controls transmitter and receiver timing, sampling and trace intervals, stores raw radar data in a temporary buffer and data transfer to the PC interface.

For quick and easy operation, calibration and set up defaults parameters are stored in the internal memory.

The unit has (see Fig. 3.2 below):

?? a parallel port for PC communication, see Chapter 7

?? connectors for an external trigger (distance-measuring devices), see Chapter 9

?? input power, see Chapter 7

?? fibre optic links to the transmitter and receiver antennas respectively, See Chapter 7.

The CUII requires no warm up time and is ready for immediate data acquisition.

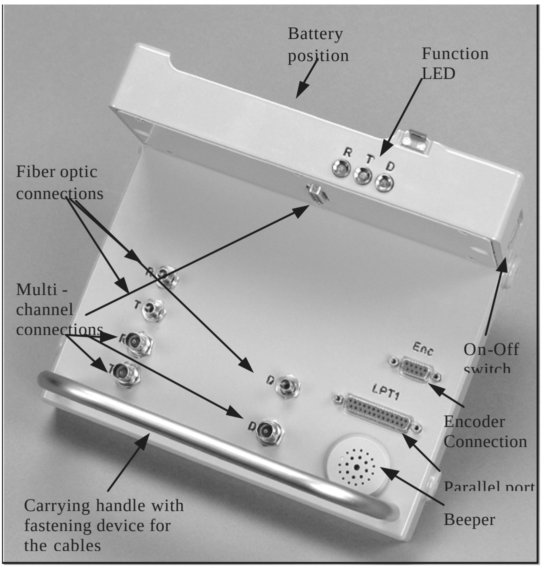


Figure 3.2 The Radar Control Unit CUII

During operation the CUII is mounted on a specially designed back-pack holder or put in to the CUII back-pack:

?? **Mounting the CUII to the back-pack holder**: The CUII is attached to the backpack with the 4 screws that have black plastic grips. Once the battery is mounted on the control unit there is a strap on the soft backpack that should be attached below the battery and firmly tightened. The shoulder straps can be adjusted for maximum comfort for the operator. This holder is easily combined with a PC holder to give you a convenient working surrounding.

?? **CUII in the RAMAC back-pack**:

For assembling the CUII to the rest of the RAMAC/GPR system, see Chapter 4, 5, 6 and 11.

4 Unshielded antennas

The unshielded antennas consist of separate transmitter and receiver electronics to which the antenna elements are attached. The antennas can then be used with antenna handles, a skid box or an antenna sledge (see Chapter 10). The complete RAMAC/GPR system is shown in Fig. 4.1, where the antenna electronics are mounted to the antenna elements together with wooden handles.

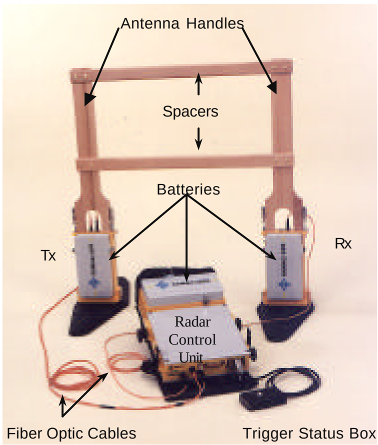


Figure 4.1 Unshielded system connected with the 200 MHz antennas and handles with 0.6 separators.

4.1 Antenna electronics

The unshielded antenna electronic unit for the transmitter generates electromagnetic energy and transmits it to the attached antenna elements every time a trigger signal is received from the CUII through the optical fibre (labelled **T**). These high amplitude pulses (typically 370V) are fed to the antenna elements at a repetition rate of 100 kHz. The antenna element transforms these pulses into radar impulses at a centre frequency, which is dependent on the antenna dimensions. The unit has one optical connector for the transmitter trigger, a connector for a battery pack, a power switch and a LED.

See Figure 4.2.

When flashing, the LED on the transmitter electronic indicates trigger pulses are being received from the Radar Control Unit. No light indicates no power is being received by the electronics. A steady light indicates that no Trigger pulses are received from the Radar Control Unit.

NOTE: As soon as the power switch is turned on with a battery connected the transmitter starts firing pulses. There is a short "warm-up" sequence of the antenna whereby it is recommended to turn the electronics on a few minutes before data collection starts. A good rule of thumb is to turn on the transmitter first when preparing for a survey.

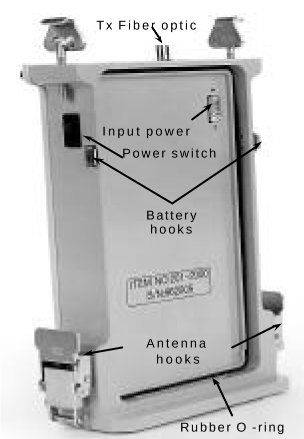


Figure 4.2 Unshielded Transmitter **Figure 4.3** Unshielded Receiver

The receiver electronic (Fig. 4.3) digitises the received signals from the antenna to a 16-bit numerical integer value (0-32768 and +32767). These numerical values represent the amplitudes of the received radar signals. This digital collected data is transmitted to the CUII via the fibre optic cable labeled **D**). A second fibre optic cable labeled **R** is used to receive the trigger signals from the Radar Control Unit. There are also a connector for a battery pack, a power switch and two LEDs.

4.2 Antenna elements

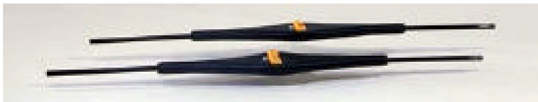
Each unshielded antenna frequency consists of a pair of transmitter and receiver antenna elements. These elements are connected to their respective unshielded electronic units via a D-sub connector. The connectors are different genders for the transmitter and receiver antenna elements to eliminate the possibility of incorrect connections.

A rubber O-ring is fitted to the connecting metal plate for water resistance and should be inspected periodically. The antenna elements must be fitted to the electronics by properly locking the metal clips.

The antenna elements are also sealed to be water-resistant, however, they are not guaranteed to be water-proof and should never be submerged in water.

25 MHz

50 MHz



100 MHz

200 MHz

Figure 4.4 Unshielded antennas

The 25 and 50 MHz antenna elements consist of a central element with detachable end pieces. When mounting these pieces it is important that they are properly fitted so that the double O-rings at their ends seal properly against moisture and that the electrical connection is proper. The 100 and 200 MHz antenna elements are in one piece. See Figure 4.4 above.

Antenna Handles are used when profiling without the use of Skid Box or Antenna Sledge. Use of the handles is recommended mainly for the low frequency antennas where the station separation is comparably great. For more information see Chapter 10.

4.3 Operation modes

The unshielded antennas can be operated in a variety of modes for different survey techniques. They are:

- ?? **Reflection profiling**: This is the most common type of operation. The antennas are mounted at a fixed separation and moved along a line. Measurements are taken at even distance or time intervals.

- ?? **Velocity profiling** (common midpoint (CMP) or wide angle reflection and refraction (WARR) type of profiling): In order to calculate an accurate depth scale the measured reflection times must be converted to velocities of the radar signals. This conversion can be made empirically by assuming a velocity based on experience or existing data such as the relative dielectric permittivity of the medium being surveyed. Otherwise, the radar velocity can be calculated by measuring time delays of the reflected signals as various transmitting and receiving antenna offsets.

- ?? **Cross-scanning** (tomographic type of profiling): Cross-scanning is a technique used to investigate e.g. the integrity of an area located scanning between the antennas. This can be e.g. concrete constructions or a rock mass between two tunnels. RAMAC/GPR allows you to collect cross-scanning data that needs to be processed in external software in order to produce images of the area between the antennas. For further information about such software the user is recommended to contact MALÅ GeoScience directly.

5 Shielded antennas

Presently, Malå GeoScience manufactures 100, 250, 500, 800 MHz and 1 GHz shielded antennas. The 100, 250, 500 and 800 MHz antenna's interface with the Shielded Electronics Unit is described below (see also Fig. 5.1 to 5.4). The 1 GHz antenna contains its own built-in transmitter and receiver electronics and is described in Chapter 6.

A shielded type of antenna means that the energy is only transmitted in one direction. It is also insensitive to radiation from all directions except from the bottom part of the antenna where the receiving antenna element is located. The shielded antenna element comprise both transmitter and receiver antenna elements in a single housing. These consist of a modified bow-tie antenna construction with the receiver element at the front end and the transmitter element at the back of the housing.

The front of the antenna is equipped with a hook for attaching a tow handle or strap. A fastening device at the back of the housing accommodates the distance-measuring wheel This wheel operates as a triggering device instructing the RAMAC/GPR system to collect traces at operator pre-set distant intervals (see Chapter 9). Detachable wear plates to help insure long antenna life are also provided. See Figures 5.1 and 5.2.

Figure 5.1 From left to right: Shielded 250, 500 and 800 MHz antennas. In front: electronics unit and survey wheel.

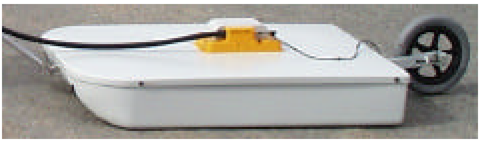


Figure 5.2 Shielded 100 MHz antennas, electronics unit and survey wheel

The Shielded Electronics Unit is used to operate the RAMAC/GPR shielded antennas (see Fig. 5.3 and 5.4). The Shielded Electronics Unit contains both the transmitter and the receiver electronics. Power to the electronics is provided by a standard RAMAC/GPR battery pack. Communication with the CUII is managed via three optical fibres and a cable for a distance-measuring wheel. These cables provided are in a protective housing.

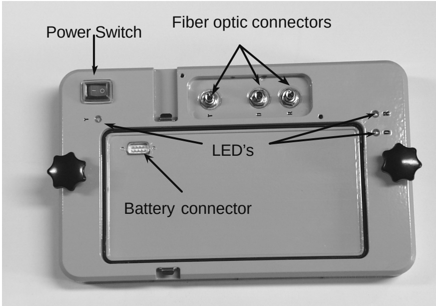


Figure 5.3 Shielded electronic unit without the optical fibre cable.

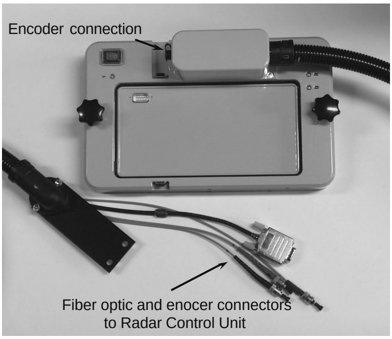


Figure 5.4 Shielded electronic unit with connected cable hose.

As in the unshielded electronics LED-indicators show the status of communications between the Shielded Electronics Unit and the Radar Control Unit.

When flashing, the **T** and **R** trigger pulses are being received from the CUII. No light indicates no power is being received by the electronics. A steady light indicates that no trigger pulses are received from the CUII.

When flashing, the LED labeled **D** indicates that data are sent to the CUII. No light indicates no power is being received by the electronics. A steady light indicates that no data are being transmitted to the CUII.

As seen a steady light on a LED indicates an interruption in the optical communication. This means either a fibre optic cable has failed or, the fibre optic connectors need to be cleaned with the compressed air can provided with the system. When none of the LED's is blinking a power failure to the electronics unit has occurred. Replace or recharge the battery. If the electronics still do not function with a fresh battery then there is an internal failure in the Shielded Electronics Unit.

To mount the shielded electronic on a shielded antenna, perform as follows;

?? Place the Shielded Electronics Unit on the antenna with facing the cable hose towards the antenna front.

NOTE: DO NOT TRY TO MOUNT THE ELECTRONICS IN THE REVERSE DIRECTION. THIS WILL DAMAGE THE ELECTRONIC UNIT.

?? See to that the unit is firmly attached to the antenna before you fasten the two black mounting screws.
?? Mount a battery pack to the electronic unit.
?? When appropriate mount the survey wheel at the antenna rear and connect the signal cable to the electronics unit.
?? Attach the cable hose to the backpack as a strain relief.
?? Connect the optical fibers labeled **T**, **D** and **R** to the CUII.
?? Connect the signal cable from the survey wheel to the CUII.

6 1 GHz shielded antenna

The 1 GHz shielded antenna (Fig. 6.1) for RAMAC/GPR has been designed for surveys on shallow environments such as roadbeds, concrete constructions, archaeological sites etc. With the antenna a survey depth in these materials of roughly 1 m (two way travel time of 15-25 ns) can be expected. Local conditions may however affect this value in both directions.

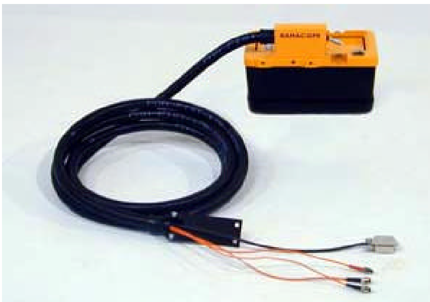


Figure 6.1 Shielded 1 GHz antenna together with cable hose.

Power is fed through the standard RAMAC/GPR battery pack that attaches to the top of the antenna. Alternative power supplies are either to use of the alkaline power pack available as an extra item or to feed the required power through an external power cable to the 9-pin connector on the top of the antenna. The power requirement for the 1 GHz shielded antenna is 6-14 V DC and a minimum of 1.5 Ah.

Preparing the antenna for survey includes:

?? Connecting the optical fibres to the three connectors. It is important to connect the fibres as they are marked or to connect the corresponding colours to the right connector at the control unit.

NOTE: Take care when bending the fibres under the metal cover that attaches to the connectors with the two screws. The fibres should form a soft bend in order to obtain good light conditions. A too hard bend may result in loss of trig pulses to either Tx or Rx or the loss of data from the Rx to the control unit.

- If the measuring wheel is used then the connecting cable should be connected to the cable from the plastic hose.
- At the control unit the optical fibres should be attached firmly as well as the electric cable for the measuring wheel. The latter attaches to the 9-pin connector marked **ENC**.
- The metal plate at the end of the plastic hose may be attached to the control unit using one of the screws for the backpack. This gives a firm attachment and avoids fibre problems.

When the antenna is connected properly and the charged battery pack is connected properly we recommend you turn on the antenna and let it ”warm up” for about 3-5 minutes before performing any measurements. The ”warm up” period reduces the vertical signal deflection of data.

A red LED light on the antenna indicates that the power is switched on. At this stage the transmitting element starts transmitting pulses at the normal rate of 100 kHz. Now the control unit and external PC can be connected and turned on.

7 Power supply, Optical fibres and Communication cables

7.1 Power supply

Each electronic component in the RAMAC/GPR system is powered by specially designed battery packs. These packs are interchangeable between system components.

Rechargeable Ni-Cd or Pb-acid battery packs are available. The capacity of the Ni-Cd packs is approximately 5.7 Ah. The Pb-acid battery packs have an approximate 8 Ah capacity.

The operating time of the system is dependent on the charge cycle history of the batteries. Normally, maximum operating time is not reached until the batteries have been fully charged and discharged 3-5 times. Optimum performance is achieved through fully discharging and recharging the battery packs.

Note that batteries lose efficiency in cold temperatures. So insulating the electronics and battery packs in cold climates will prolong the battery life as the electronic units generate internal heat during operation.

The batteries are mounted by simply placing the battery compartment with the lid on the rear short side under the corresponding groove in the electronic units. The front end or the battery pack has a locking tab on the plastic housing. Gently press on the front end of the battery until the lid is released from the groove before removal.

A special empty battery pack for the CUII and unshielded antennas is also available. It can hold six standard D-size-cells. These can easily be replaced and are suitable when operating in areas where recharging of the batteries is not possible.

NOTE: Alkaline batteries will NOT operate the Shielded Electronics Unit.

7.2 Optical fibres

The RAMAC/GPR Radar Control Unit communicates with the transmitter and receiver electronics through fibre optic cables. The data transfer rate through the fibres is up to 4 Mbytes/sec and they operate:

- Trig signals to the transmitter element from the CUII
- Trig signals to the receiver element from the CUII
- Data from the receiver element to the CUII.

The antennas can be operated through the standard set of optical fibres for RAMAC/GPR. These optical fibres come in a standard length of 4 m. They are also available in lengths up to 100 meters or more for applications such as CMP measurements or cross scanning where the two antennas have to be separated from each other.

For the shielded antennas Malå GeoScience have designed a special set of fibres housed in a plastic hose for convenience (Fig. 5.4 and 6.1). This is to protect the fibres from damage when operating the antenna in e.g. rough environments. The attachment of the optical fibres to the antenna includes a metal cover over the optical connectors. This is in order to protect the connectors and the fibres at their attachment on the antenna. When sampling at high sampling frequencies as e.g. 100 000 MHz the bending of a trig fibre can play an important role for the time displacement of the pulse in the time window. This is due to the short time interval that each sample represents at these frequencies.

For using the shielded antennas at longer distances from the CUII than 4 m there is also a plastic hose of 20 m length available. Alternatively the standard optical fibres with lengths up to 100 m can be used.

All the fiber optic cables provided with the RAMAC/GPR are reinforced with Kevlar? and feature stainless steel and ceramic tip connectors. However, care should always be exercised when handling this type of cable. The light carrying fibre core is only 50 micrometer in diameter, which is less than the thickness of hair.

?? Avoid excessive bending
?? Keep cables protected against physical damage
?? Keep connectors clean

7.3 Communication cable

Parallel data transfer between the RAMAC/GPR CUII and the external PC is used as a standard.

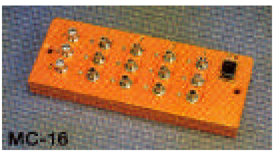
It should be noted that data transfer is more secure with shorter cables. For best performance use an IEEE 1284 (ECP) compatible parallel cable that is less than or equal to three meters long.

For configuration of external PC communication ports, see the RAMAC GroundVision Software manual.

8 Multi-channel modules

The RAMAC/GPR Multi-channel unit (MC-4 and MC-16) is an optional add-on module to the CUII (See Fig. 8.1 and 8.2). The Multi-channel comes in two versions, MC-4 with up to 4 recording channels or the MC-16 with up to 16 recording channels. The MC-16 connects 4 transmitter and 4 receiver antennas.

The Multi-Channel unit has the capability to operate any of the optional receiver inputs to any transmitter (controlled through software). The repetition rate of the CUII is shared among the defined channels, i.e. the effective repetition rate equals 100 kHz (standard) over the number o f channels defined. For more information see RAMAC GroundVsion Software manual, version 1.3.



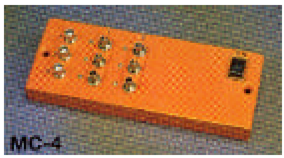


Figure 8.1 Multi-channel units, MC-16 and MC-4.

The multi-channel unit is connected to the D-sub connector on the CUII (see Fig 3.2) and the fixed firmly with two skrews. The multi-channel unit is provided with three short fibre optical cables for connection between the add-on unit and the CUII. The lower T, D and R connectors on the CUII are used to connect the multi-channel unit (see Figure 8.2 and 3.2).

Figure 8.2 The Multichannel MC-4 add-on mounted on the CUIl.

9 Trigger devices

The most efficient method of data acquisition is to use a distance-measuring wheel or profile encoder (hip chain) to control the collection of radar data. Data is acquired at user defined distance intervals so that the position of each trace along a survey line is given by the position of a radar trace in the data file. This simplifies data acquisition procedures and locating the position of reflections.

The **hip chain** can be used when scanning from a sled or when the transmitter and receiver are mounted on the carrying handles. The hip chain comes with cotton string of a length of 2800 meters in a roll. The string is made of pure cotton that decomposes in nature. Its greatest advantage is in trackless and undulating terrain where it would be impractical to use a measuring wheel.

The **measuring wheel** may be more appropriate to use for distance control for surveys on flat terrain or in urban areas (on Skid Box or shielded antennas). The measuring wheel is attached to the tow handle of the skid box or directly on the shielded antennas. The measuring wheel for Skid boxes operates through a rubber band (models 9610-) that circles the pulse encoder. In wet or snowy terrain it is important that the rubber band and the wheels are kept clean in order to let the band run free.

All distance-measuring devices for the RAMAC/GPR use an optical encoder that transmits electrical pulses to the CUII. A distance calibration file is used to convert the number of pulses to the correct distances. The operator can create calibration files or use those supplied with the installation diskette.

These calibration files for different length encoders contain information about both the numbers of pulses that are counted per meter and the rotation direction in which it will calculate the optical pulses correctly. The triggering of readings from the GPR will ONLY be done in the positive direction of rotation. This, so you should be able to move the wheel back-wards without any readings made. However, if the wheel needs to be rotated constantly in the opposite direction this can be accomplished by changing acquisition direction in the GPR software.

NOTE: When using both devices you should keep accurate record of your calibration files for the devices so the right one is selected for the device used at each measurement occasion.

NOTE: The distance interval when using a measuring wheel should be set to a greater value than 0.003 m. The measuring wheel counts about 427 pulses/m, which is less than one pulse/ 2mm. A distance < 0.003 m will correspond to zero pulses and cause the antenna to start collecting data immediately at full speed.

10 Other accessories

10.1 Antenna handles

The wooden antenna handles (see Fig. 4.1) are used for carrying the unshielded antennas and stabilizing the antennas during measurements (when not using a skid box).

The handles are mounted together using the set of 8 screws and nuts. Mounting both horizontal bars for maximum stability is strongly recommended. The bars come in 0.6, 1.0 and 2.0 meters lengths for use with the 200, 100, 50 MHz antennas respectively. These are only recommended antenna separations. The operator is however free to select other transmitter/receiver offsets as desired.

The handles attach to the antenna electronics using the metal locks on each side. It may be necessary to adjust the metal hooks on the electronics for firm attachment. The handle tops are intended for use when the antennas are moved individually without the horizontal bars. This is the case when performing e.g. CMP or WARR type of surveys.

NOTE: If antenna separations other than the standard ones mentioned are used it will be necessary to edit the header file for correct depth scales to be displayed by the software.

Wooden separators or the 25 MHz antennas are not practical because the recommended antenna separation for this frequency is 4 meters. MALÅ GeoScience provides 4 m long strapping for this purpose.

10.2 Skid box

The glass fibre skid boxes come in two sizes, one for the 100 MHz and one for 200 MHz antennas. The robust design of the skid boxes make them well suited for operations in rugged terrain as well as on flat terrain where smooth operation and movement at constant speed are required.

The mounting of the antennas in the Skid Box is seen in Figure 10.1.

It is important that the antenna elements are firmly attached to the bottom using the rubber ties. The optical fibres pass through the pulling handle. A stress relief arrangement inside the handle prevents the optical fibres from being pulled out of the handle. The following procedures should be followed:

- ?? Connect the short plastic tube to the handle firmly with a screwdriver fastening the 10-cm black rubber tube
- ?? Thread the bottom ends of the optical fibres through the front hole in the Skid Box into it.
- ?? Mount the short plastic tube through the same hole making sure that the optical fibres are not damaged.
- ?? Fasten the plastic tube in the Skid Box using the metal clamp.
- ?? Place the Antenna electronics with its antenna element inside the Skid Box.
- ?? Fasten the antenna elements using the rubber ties.
- ?? Attach the optical fibres to respectively antenna.
- ?? Attach the corresponding ends of the fibres to the CUII.
- ?? Attach the stress relief to the backpack.
- ?? If necessary mount the Skid Box cover using the rubber ties.

NOTE: If this is done, remember to turn on the Power switches on the antennas before survey start.

- If the Hip Chain is used it can be mounted on the pulling handle.
- If the Measuring Wheel is used it is mounted on the metal clamp on the pulling handle.
- If the Wheel set is used it should be attached using the rubber ties fastened to the plastic clamps on each side of the Skid Box.

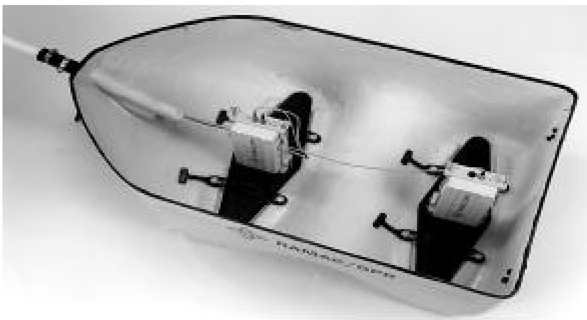


Figure 10.1 Skid Box with unshielded 200 MHz antennas mounted

10.3 Antenna Sled

An alternative to a skid box is the Antenna Sled. It consists of a tough plastic mat with fastening devices for 100 and 200 MHz antenna elements and stabilising tubes for the edges. This sled can be towed by hand on flat surfaces. The Hip Chain can be used as measuring device when attached to the operator's belt.

11 Start up of your RAMAC/GPR CUII

In order to operate the system, the following items are required:

- ?? RAMAC/GPR CUII
- ?? Transmitter and Receiver antenna electronics, if unshielded antennas are used
- ?? Transmitter and Receiver antenna elements, unshielded or shielded
- ?? Optical fibers:
  - One transmit (single) and one receiver (dual) fiber optic cable for unshielded configuration or
  - Cable-hose assembly for shielded configurations
- ?? A rechargeable power supply for each electronics unit
- ?? Parallel data cable for ECP communication
- ?? External PC. Minimum requirements:
  - Windows 95, 98, ME, 2000, NT or XP
  - Processor: 100 MHz Pentium
  - RAM Memory: 32 MB
  - Disk capacity: Minimum 100 MB recommended
  - Graphics: 800x600
  - Communication: ECP Parallel port (IEEE 1284)
- ?? Data collection software installed (GroundVision)

In addition the above mentioned there exists different length measuring devices, pulling and carrying handles as well as skid boxes which are regarded as accessories, as seen in Chapter 7.

11.1 Connecting the system components

- Mount the antenna electronics to the antenna element according to Chapter 4 - 6.
- Connect the CUII (labeled **LPT 1**) to the external PC parallel port with the parallel data cable provided with the system.
- Connect appropriate fibre optic cables between the CUII and the antenna electronics as follows:
  - For unshielded systems: Single fibre optic cable from the fibre optic connector labeled **T** on the CUII to the Transmitter Electronics. Dual fibre optic cable from the fibre optic connectors labeled **D** and **R** to their respective connectors on the Receiver Electronics
  - For shielded systems: Fibres labeled T, D and R should be attached to their respective fiber optic connectors on the CUII.

NOTE: It is essential to attach the strain relief to the CUII in order to protect the optical fibers and connectors. Failure to do so will likely result in damaged cables.

- Attach the appropriate Measuring Device (if any purchased) and connect to the port labeled **ENC**.
- Turn on the power on the antenna electronics and the CUII. Turn on the PC and start the data acquisition program GroundVision. Your RAMAC/GPR system is now ready for operation.

11.2 Running a survey

When starting out for a survey you should always have an idea about the depth/time section you are about to survey. This not only determines your depth/time section to be recorded but also your choice of antenna frequency for the survey. One antenna can be used for a wide range of depth surveys but it might not possess the maximum depth resolution required for your survey.

Starting a survey routine is a simple task with RAMAC/GPR CUII. CUII offers you a fast way of parameter choice through the "Pre-set" parameter settings. Factory default and user selected parameters can be saved for later use. First-time GPR users will find the default settings to be helpful in setting up their system parameters.

During data collection the radar data and other information are displayed on the computer screen. Once data collection is in progress modifications to display functions, screen colors, gain settings can be performed without affecting the start parameters or the recorded data. The data collection can be interrupted and resumed at any time. This feature facilitates the entry of field notes and comments. For more information see RAMAC GroundVision software manual, version 1.3.

RAMAC/GPR CUII offers you four different ways of acquiring data. They are:

?? By the use of a distance measuring device (distance triggered)
?? Through the external PC keyboard (by pressing the SPACE button)
?? By taking readings at fixed time intervals

We recommend measurements be performed using some kind of distance measuring control. This way you can relate the results to a fixed geographic location. Using time triggering is as an alternative for lake, river and wetlands surveys where the equipment may be setup in a boat or raft or, for studies where a Global Positioning System may be deployed for positioning control.

?? The selection of triggering method depends on a number of factors such as:
?? The purpose of the survey
?? The type of antenna
?? The need for post-processing of data
?? Positioning control
?? Type of terrain
?? The accessories for your equipment

Trouble shooting

As with all electronic equipment it is important to handle the CUII and the antennas with great care and to avoid harsh handling and bumps against the electronics. During transport of the equipment the CUII and antennas should be packed properly and firmly in a transport box.

Care should also be taken for the optical fibres so they are protected against dust and dirt. When finishing a survey the equipment should be checked and packed properly in the transport case. Batteries should be kept charged if possible and if stored away for longer time they should be charged now and then.

The most common types of problems you will find listed below together with our recommended actions. If you do not succeed following these actions we recommend you please contact your closest MALÅ GeoScience sales representative.

An error messages appear on the computer screen when taking a reading, Communication problem:

Cause	Action
Communication problem between the PC and the CUII	Check the data cable
	Check that control unit is on
	Check battery for control unit
	Check communication set up in the data acquisition programme

Only a straight line appears on screen when taking a reading:

Cause	Action
The transmitter is not turned on	Turn the transmitter on
Signal search has not not been performed	Perform signal search
The transmitter is not triggered by the CUII	Check the LED located on the transmitter unit. If it blinks the electronics receives a correct trig signal from the CUII If the LED does not blink: Check for dirt in the optical connector in the Transmitter
The ground is too conductive for a GPR survey	Check the system by collecting a trace with the antenna above the ground.

No traces are collected when survey starts:

Action

Check Trig setup and calibration with measuring wheel file.
Move the antenna in the correct direction.

Traces disappear during survey and only a straight line appears intermittently:

Action

Check Tx fibre connection at the antenna.

12 How to assemble the RAMAC/GPR Cart

1.

When receiving the CART you will have to mount it before use. You'll find four pieces in the case, one handle, one frame with the skid plate attached, 4 wheels and a plastic bag with smaller accessories inside. The first piece that you must start the assemble with is the frame with the attached skid plate.

2.

The first step in the mounting process is to attach the wheels. To be able to fasten the wheel on the frame you will first have to loosen the small plastic clips. By doing that the wheel will fit properly and to fix it, just replace the plastic clip.

The left back wheel is equipped with an encoder. One of the wheels are different from the others and will only have the possibility to mount the needed o-ring. The o-ring can be found in the small plastic bag with the other accessories. This o-ring attached on the wheel must then be mounted on the frame of the cart as well. The picture will show how it will look like.

3.

After the wheel has been mounted it's time to prepare the handle piece. First you have to unfold it and put the tray in its right position. This is done by removing the lower plastic clips on the legs. Press the fortress for the tray upwards and then restore the plastic clips.

4.

Now it's time to mount all the pieces together into one RAMAC/GPR Cart. Start by assembling the inner legs of the handle piece to the frame. Secure the mounting with the locks. When the inner legs are fasten, mount the outer legs at the front of the frame.

Now we have a mounted cart in front of us and the only thing left to do is to fasten the safety leg, if you have a 250MHz Cart. This leg does not exist for the 500MHz cart.

5.

The final part is to mount the equipment onto the CART. Attach the antenna into the skid plate and adjust the straps accordingly, the skid plate should drag lightly on the ground. Use the velcro to attach the PC or RAMAC Monitor onto the upper plate of the CART. Place the PC or the RAMAC Monitor on the upper plate and place the X3M Unit or X3M Corder unit directly on the antenna. (See RAMAC X3M Hardware Manual for additional assembly). If you are using the Control Unit II, mount the unit on the two hooks placed under the tray.

Have a nice survey!