



**Multi rod geophysics, magnetometer and metal detector imaging system**

ELECTRONICS COMPANY

Dear customer, thank you for your purchase of the MAGNARADAR geophysics imaging system that is upgradeable to use various portable heads, for more information please contact your dealer. It is strongly suggested to study this manual carefully in order to understand the operation of your unit and then to practice in order to gain a level of experience. This is a scientific instrument and every detail in that manual has to be followed. We wish to you the best in your survey.



## **ATTENTION! READ BEFORE OPERATING THE INSTRUMENT**

### **Note**

All information on this manual can be altered without prior notice.

Avoid strong electromagnetic fields that may exist close to electronic equipment.

This instrument and its accessories is used to locate either buried structures or geological variations in the soil. These variations and structures are located using the electrodes or sensors provided with your instrument.

The calculated soil data are send through an RS232 cable to a PC for a graphical display, all notes on the manual have to followed for that reason. There are many listed factors below that affect the detection, therefore no warrantees are given that the instrument in all cases will give the desirable result.

### **General notes**

Like an electronic device the MAGNARADAR must be handled with care necessary when operating such devices. Special care has to be taken with the electrode cables, these must be handled gently, avoid bending, avoid moisture, avoid any excessive force on the alligator connectors.

The MAGNARADAR includes an in build data logger for the field co-ordinates, and an electromagnetic transmitter / receiver and digital processor.

Every fail to attend the security precautions given, or usage of the instrument for other purposes than those it was designed may result to malfunction or destruction of the main unit or its accessories and connected parts.

#### **Health injury**

The MAGNARADAR normally cannot make health injury when operated normally, The frequency signals of the MAGNARADAR spectrum do not pose threat to human body, mainly because of their low power.

Like an electronic device the MAGNARADAR must be handled away from children.

#### **Surrounding environment**

If you have transport the instrument from a cold to a warm environment, it is not suggested to operate it right after. Any contention that may occur may result to failure.

#### **Power supply**

Use only the supplied battery charger, the unit operates on 12v / 2,6 Ah rechargeable battery.

**Avoid connecting the MAGNARADAR to a 110 / 220 volt socket! That will destroy the unit!**

**If the survey field is vast and the inbuilt rechargeable battery does not last to cover it, connect an external battery on the battery recharge socket (12V and up to 7,5 Ah) to support the in built battery, contact your dealer for details.**

#### **Repairs**

All repairs come free of charge within the first year of your purchase. Contact your dealer when the instrument needs service or for questions or problems.

A qualified technician will inspect the unit and will initiate any repair if necessary.

After the first year you will receive a calculation of repair charges.

If you destroy the unit, or if you open its case, the warranty will expire. The MAGNARADAR is equipped with an internal mechanism that will stop operating if you remove the case. The instrument then must be bring back to working condition by an experienced service technician.

# 1. CONTROLS

## 1.1 Front Panel



**1. GROUND:** This is the Power on switch. It is also used to adjust the electronics to the ground conditions as a rotary knob.

When you first plug rods in the ground, turn unit on and typically use a setting that will result on a processed value (see LCD) closest to 250, this initial calibration must be away from metals / voids, the average setting of 250 will permit the processed value to swing low (minerals / metals) or high (cavities) on whatever the ground condition, canceling the effects of minerals / moisture.

**ⓘ Always keep the same GROUND setting during your field survey**

It is worth noting however that surveying on different days on the same site may require a different GROUND setting due to soil moisture that may have changed -due to a rain perhaps-, to maintain a close to "250" value.

The back lighted LCD main indications are :

**2. TOP / BOTTOM values:** These are the lowest/highest signal retrieved during your current measurement from each of receiving electrodes. Only the MAGNARADAR twin receiver / transmitter can produce that unique feature.

**3. PROCESSED VALUE #:** This is the "target" value, generated from the top / bottom values, for your current survey block. That number will indicate the presence of an underground structure. Although significant changes are desirable to suppose that a target was found, small variations are due to physical soil geology. This is also the value that can be stored at MAGNARADAR internal memory using the "**SAVE**" key. "LIM" (limit – this is the highest value due to soil conditions, indicating a poor signal transmittance due to a low conductive ground). If "LIM" is displayed few times during a survey it is acceptable as this is the indication of large voids or cavities. If "LIM" is indicated throughout the field then it is suggested to adjust the GROUND knob to a lower setting and restart.

**4. "H" / horizontal & "V" / vertical:** These are the co-ordinate settings of your survey. When data need to be recorded for creating images these values need to be set. This is different dependant to the mode / head that is used. See chapter 2.

**5. SAVE:** Stores the current processed value on MAGNARADAR internal memory, so that it can be recalled later to be viewed on the LCD using the arrow keys, or to be downloaded to a PC.

(See chapter 4. ). When you press **“SAVE”** the value is saved on its **“V”** & **“H”** positions. It is stored in other words at the current co-ordinate settings. After if you wish to view the stored values use the arrow keys to change between **“H”** / **“V”** locations, the stored values are indicated automatically on screen.

For the next survey block, remember to change co-ordinates to ensure not to overwrite the previous value! ( see chapter 2 )

**❗ Do not use “SAVE” on automatic mode (22 rod strings). When “AUTO” key is pressed the MAGNARADAR goes to automatic mode and values are automatically stored. Use “SAVE” only on manual mode (4 rods / 2 spools), to store the value for each survey block. See chapter 2**

**6. AUTO:** It is sometimes time consuming to work manually with 4 rods (Twin transmitter/receiver), therefore an in build automatic program exists. Using the **“AUTO”** function the MAGNARADAR automatically collects underground data from 2 strings (transmitter / receiver string) and 22 electrodes in total. The switching between different rod blocks, data collection, save of values in memory, and **“V”** alteration is operated by the instrument. This is a great advantage over conventional geophysical systems on the market that use only 4 electrodes which make the field work time consuming – with poor images. See chapter 2

**7. DELETE:** If you wish to clean MAGNARADAR internal memory from all the stored values, turn unit **“OFF”**, press **“DELETE”**, MAGNARADAR will turn on automatically, with no backlight on the LCD screen for battery consuming reasons. A measuring process starts on the LCD indicating which memory point is now deleted. All stored values are cleared if you press **“DELETE”**, that means all co-ordinates **“V”** & **“H”** from 0 to 127, will read again **“0”**.

**❗ As a safety for an operator fault, the MAGNARADAR must be in the “OFF” position to delete.**

In 20 seconds after the memory delete operation ends the MAGNARADAR shuts down automatically.

**8. LOAD:** Press to download data to a PC. ( See chapter 4.)

**9. BATT:** LED to remind low battery condition. Recharge battery using the external battery charger that comes with your MAGNARADAR. You can charge during operation also.

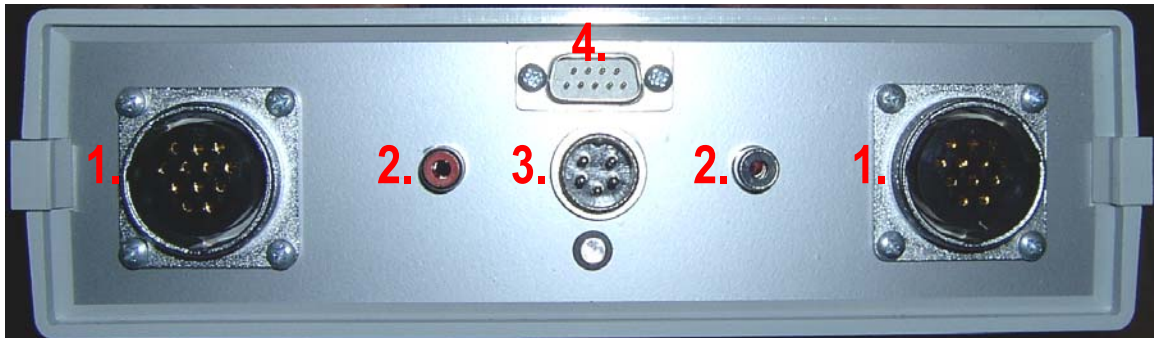
**❗ Use only the supplied battery charger, avoid using non-original accessories, may damage the unit and void any warranty / guarantee option.**

**10. DATA:** LED that flashes when the **“AUTO”** function is collecting underground data. During that time the unit sets everything automatically.

**❗ Wait the DATA LED to go off. It is not permitted to alter any controls during the time it flashes.**

**11. ARROW KEYS:** Use the **< >** key to select between **“H”** horizontal and **“V”** vertical. Use the **∨** and **∧** keys, either to set the co-ordinate value ( for taking a measurement on that co-ordinate, or view stored values -if any- on that co-ordinate position)

## 1.2 Rear Panel



**1. 2 X 12 PIN FEMALE CONNECTORS** (*automatic mode*): These 2 rugged 12 pin female connectors are used to connect the multi cable strings to work with the 22 rods using the “**AUTO**” automatic mode facility – see chapter 2.  
Insert the male connectors (shown) gently, insuring they fit the correct way around, then screw it tight, pay attention not to push too much the rear panel and damage the unit.

**ⓘ** Ensure that no other connectors are fitted in, when you plug the 12 pin male connectors, and will stay in that state during the automatic survey.

**2. RED / BLACK JACKS** (*manual mode*): Are used to fit in the 2 spool male jacks, for surveying on manual mode – see chapter 2.

**ⓘ** Ensure that no other connectors are fitted in, when you plug the 2 spool male connectors, and stay in that state during the manual survey.

**3. RECHARGE / PORTABLE HEADS CONNECTOR:** When is needed to recharge the battery, connect carefully the charger. The LED lights during charging.  
Portable heads like the magnetometer are connected on the same socket – see chapter 2.

**4. RS232 female:** connect via the supplied software MAGNARADAR to a PC to download all stored values. Then the graphical representation of the underground structures is possible, as an aid for the operator to determine their size / shape - see chapter 4.

**ⓘ** Protect connectors from getting dirt or oxidized from water, rain or moisture, using the supplied leather case. Always check for dirt in the connectors, it must be cleaned immediately using approved electrical contact cleaner spray. The performance and reliability of your instrument depends on the good connector condition.

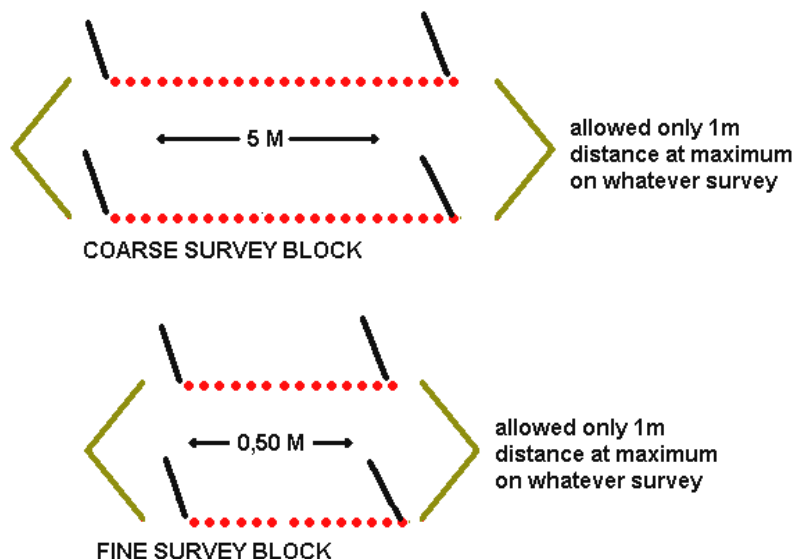
## 2. OPERATION MODES

### 2.1 Manual mode without data recording ( 2 wire spools / 4 ground rods )

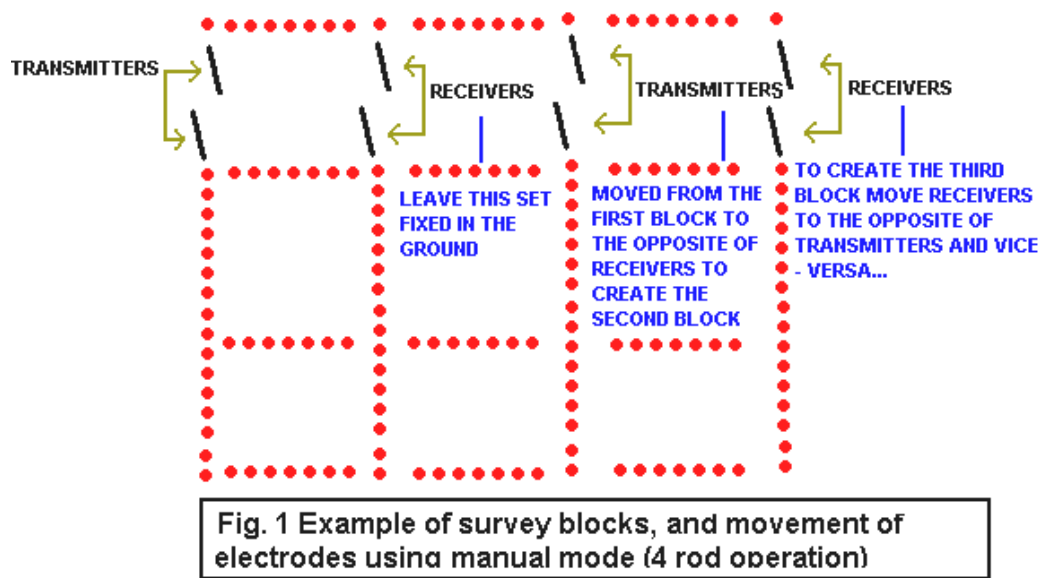
Using this mode, the operator will be informed of the presence of underground structures only by the processed value. These values are not recorded therefore the PC software will not be used to interpret data. Keys are not used also.

Connect the 2 wire spools to the 2 manual mode connectors ( red / black). Extend as much cable necessary. Take 4 rods and place them in the ground but not above a cavity or buried metals, connect them with the wire clips to create your first survey block . The distance between the 2 rod sets depends upon many factors that will be described.

**i** The same distance between transmitters / receivers must be retained, as on your first survey block. If you start your survey at a distance of 1m between transmitters / receivers that distance must be retained up to the last survey block for that field.



Adjust GROUND to maintain a "250" value. This is the initial setting, the variations of it will determine possible targets. For this continue as on the figure 1.



Observe the processed value at every survey block to find significant variations.

The length of the survey blocks relates to the length of the first survey block, for example if the distance between the 2 electrode pairs on the first block was 5m. Then this distance must be kept for all survey blocks in your pattern. This is called a “coarse” survey.

If the distance for the first block between the 2 electrode pairs was 50 cm, then this distance must be kept for all survey blocks in your pattern. This is called a “fine” survey.

**ⓘ Attention, the distance between the receivers / transmitters is permitted to vary from 50cm to 15m. The distance from one transmitter to the other, and the one receiver to the other can be up to 1m. Or 1,5m at maximum.**

The larger the distance between rod sets, the deeper the results, and information from deeper structures affect the processed value (see chapter 3 Signal characteristics).

It is therefore suggested that if results are needed for structures laying at depths of 20 – 40 m. a distance between receivers / transmitters of 15-30 m is adequate. But only large sized targets can be located. Like tunnels, voids, minerals. Small artifacts are lost.

Information from a shallower soil level 0 –20 m can obtained with “fine” surveys and distances between receivers / transmitters of up to 15 m. Small man made artifacts like a concealed box are located using a “fine” survey.

Both the “coarse” and the “fine” survey’s can be effective in recovering an underground structure, although the “fine” method will provide much detailed images using the software later, ( see paragraphs 2.2, 2.3 ) regarding the size / shape of the underground structures.

What is the use of the “coarse” survey then? Sometimes quick results are needed from a field, an operator can make some experimental measurements using the manual mode 4-rod operation, in large distances between pairs.

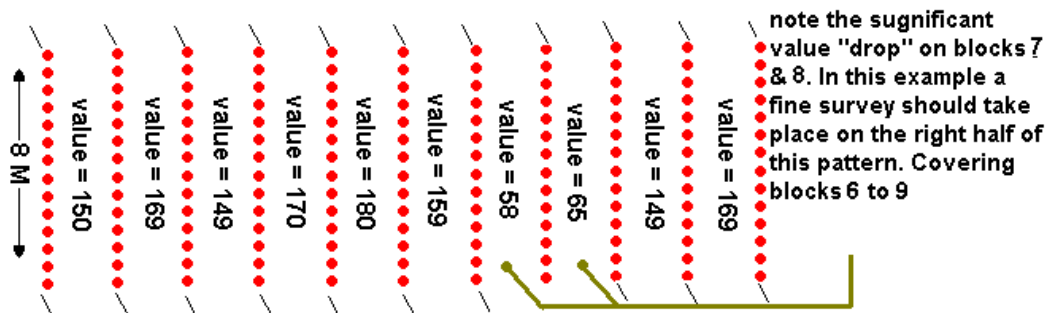


Fig.2: Example of a 4 rod coarse survey. The area is divided in long parallel survey blocks. A significant change of the processed value will determine if, and where a fine survey will take place.

As the example of Figure 2. lay out the 4 rod strings at distances between receivers / transmitters 8m, then make several measurements covering the whole field in less time, using the pattern on fig. 2, if a significant change is observed on the LCD at the processed value, then a "fine" survey can take place at that area (probably using "SAVE" or the "AUTO" facility as described on the next paragraphs to record data) by dividing the area of blocks 6 – 9 in many smaller blocks, to observe better the target size and determine the center.

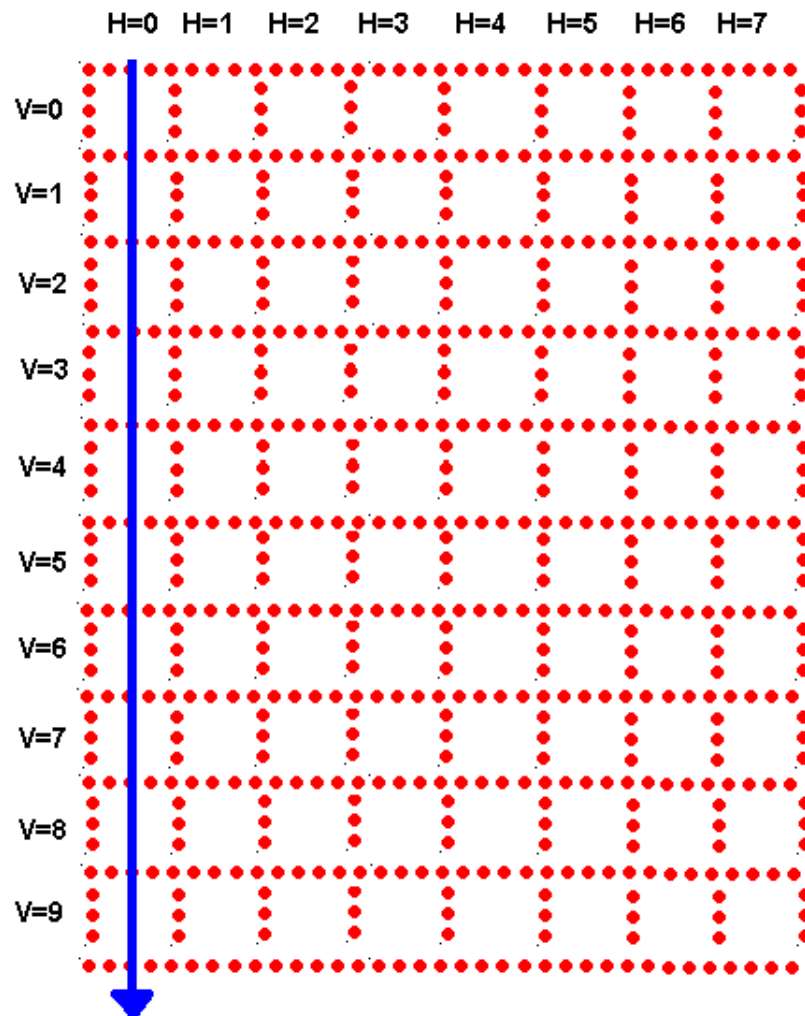


## 2.2 Manual mode with data recording ( 2 wire spools / 4 ground rods )

All Advices of paragraph 2.1 apply for this mode. Although the keys “**SAVE**” and the arrow keys need now to be operated to record the value of every survey block in memory on a specific co-ordinate, in order for the PC software to produce accurate images.

Let us create a grid of survey blocks to cover our area of investigation that is 8 survey blocks in horizontal by 10 survey blocks vertical. The Grid pattern will look like that on Figure 3.

The starting point for this survey is block  $V=0, H=0$  and the last to be covered is the  $V=9, H=7$ .



After completing measurements on the first line  $H=0$ , go back and start again with the same direction (left to right) for measuring the next line  $H=1$

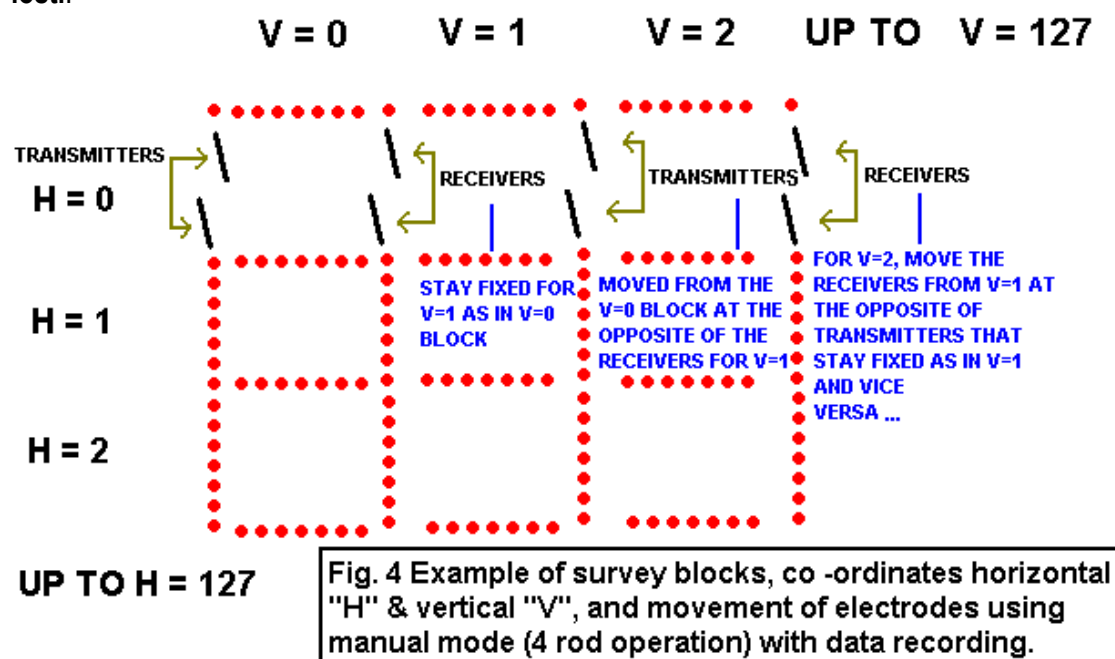
**Fig. 3:** Example of a survey pattern 8 lines (H) by 10 verticals (V). The survey should always performed starting left and ending at right for every line for the computer software to produce accurate images.

A typically investigated area will be like that on Fig.3. However the operator can extend the survey for up to 127 horizontal or vertical blocks. Always start moving from left to right, on a survey line, and work on the same direction, covering all the horizontal lines as on the first line.

As an example to start set the "H" & "V" at "0", using the <> key to select between "H" / "V" and then the √∧ keys to set their values at "0". Then place the one pair of electrodes (transmitters) in the ground, at say 50 cm apart, and place the other pair of electrodes (receivers) at a distance of 1m, 50 cm apart each other, see also Fig. 4. Choose a value close to "250" for the processed value indicator using the **GROUND**, wait for the number to stabilize, then press "**SAVE**" the value is now stored on memory and can be viewed again on location "V" = "0" & "H" = "0", anytime using the <> / √∧ keys.

For the next survey block, retain the receiver electrodes plugged in, and move the transmitters at 1m on the opposite, as on the sketch. Then leave "H" value at "0" because we continue on the same horizontal line, and change the "V" to "1" using the ∧ key, as we moved to the next block, again wait the processed value to stabilize, Then push "**SAVE**", the value is now stored on memory and can be viewed again on location "V" = "1" & "H" = "0", anytime using the arrow keys. On next survey block move the receiving pair opposite 1m, 50 cm apart, and change the "V" to "2", and push "**SAVE**" the value is now stored on memory and can be viewed again on location "V" = "2" & "H" = "0", anytime using the arrow keys ...you can continue up to "V" = "127", that means 128 survey blocks for the first survey line. If you wish to change to move on the second survey line, simply change the "H" value to "1", and start again with the "V" value at "0" and so on. All values stored to co-ordinates can be viewed again using the arrow keys.

❗ The user must not overwrite on already stored co-ordinate value, the value will be lost..



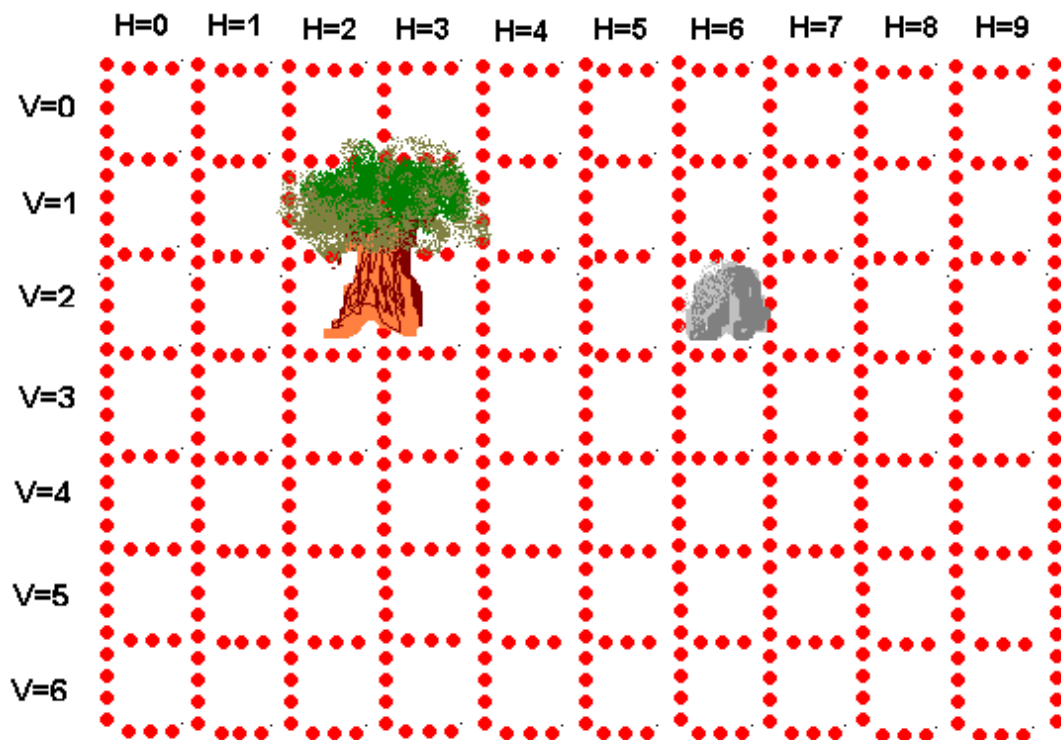
Remember that both a "fine" and a "coarse" survey will be accomplished using the same grid pattern.

Every change to the pattern will bring erratic results and lead in extra fieldwork.

That means the operator must be precise and leave no "empty spaces", keep the horizontal / vertical lines firmly straight, keep the same distances between blocks.

If an object like a rock, or a tree is blocking your grid, then leave "empty" some blocks on your pattern, (and at the MAGNARADAR memory bank) to accommodate for the tree / rock.

Then start again at the other side of the rock, again using the same grid pattern



**Notice that a tree is blocking co-ordinates  
V1,H2 V1,H3 V2,H2 V2,H3 and a rock blocking V2,H6. These  
co-ordinates should stay empty on memory (no storing)**

A useful tool to practice, on how to create “fine” investigations, is an old fishing or volley net. It has been proved effective especially on “fine” surveys, low cost and time saving. Another idea of a grid pattern is to fit small sticks in the ground and pass a thin thread through them.

Although these are practical tips, the use of the automatic mode (“**AUTO**” function) and 22-rod strings is the best solution for a professional “fine” survey.

### 2.3 Automatic mode ( 2 multi cable strings with 22 rods )

The automatic MAGNARADAR data collection will speed up your fieldwork, but is not only accelerated is also enhanced and provides much-detailed pictures.

In order for the automatic mode to operate the 2 multi cable strings have to be connected tightly and the ground rods to be fitted. Observe the alligator clips to make a good contact with every rod.

The data recording and V value manipulation is performed automatically by the unit.

10 survey blocks in total are stored in memory every time after pressing the **AUTO** key.

The string itself ensures that the survey line remains correct, as it is often possible when working manually with 4 electrodes to go “off” the correct straight survey horizontal line, or go “off” the vertical line, also the string helps not to loose the repeatability of survey blocks, we do not have to remember which pair to move, and we rest assured that each block will go right next to the other, or exactly beneath the others on our next horizontal line. Remember that only good detailed fieldwork will produce an accurate image on the computer software.

The MAGNARADAR microprocessor will automatically check if both the 22-rod strings are connected, when you press the **AUTO** key and start collecting data. At the same time DATA LED flashes for every new survey block that is recorded in memory.

If the string is not connected however it immediately returns to manual 4-rod mode, and nothing happens.

The **AUTO** function is not only an automatic switch for 22 rods (11 transmitters / 11 receivers). It has 9 functions build in, Lets inspect a real survey situation:

1. Lay out both the multi rod strings parallel and plug in all rods, at the first survey horizontal line, and ensure that V and H are in 0.

**i** Leave the arrow next to V value on the LCD screen every time before **AUTO** key is pressed

2. When you press the **AUTO** for the first time, the system will check if both the 22 rod strings are connected firmly, if not the MAGNARADAR will remain in manual mode and no automatic measurement occur

3. If the strings are connected however will open the first 4 rods, on the first survey block and wait for the processed value to stabilize

4. Will not change the “V” to “1” ( for the first survey block ) because location  $V = 0 / H = 0$  will remain empty in memory if that happened

5. Will **SAVE** automatically the processed value on memory at co-ordinates  $V = 0 / H = 0$

6. It will then open the rods on the second survey block

7. Where it will now change automatically the V to 1

8. Then **SAVE** again ( on  $V = 1 / H = 0$  ) and so on, up to the last survey block on the string (10<sup>th</sup> block), it will automatically change V values 1,2,3,4,5,6,7,8,9 and **SAVE** right after

9. For the last survey block  $V = 9$ , after **SAVE** the V goes to 10, but no **SAVE** happens the user now has 2 ways to continue covering the field:

1. The first option, is to move the left string parallel to the right, without having to unscrew the connector, by overlapping the cables. Set H to 1 and V to 0 and press **AUTO**. When the new 10 blocks are stored, move the left string again parallel to the right, set H to 2 and V back to 0 and press **AUTO** again...continue until the whole field is covered. Figure 5a.

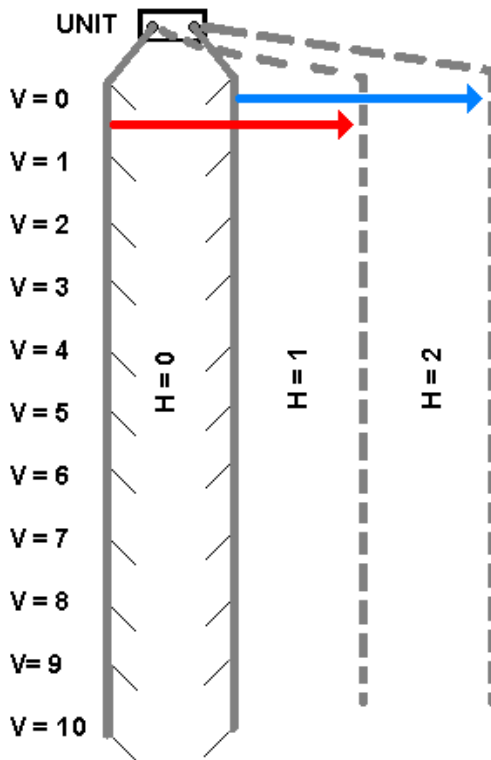


Fig. 5a

For the first line  $H = 0$ , plug in the rods, set  $H = 0$ ,  $V = 0$ , leave LCD arrow at 'V' and press "AUTO".

When unit finish recording of the first line 'V' will read "10".

For the second line  $H = 1$ , move the left multi cable at right (see red arrow), plug in the rods, set  $H = 1$ ,  $V = 0$ , leave LCD arrow at 'V' and press "AUTO".

When unit finish recording of the second line 'V' will read "10".

For the third line  $H = 2$ , move the left multi cable at right (see blue arrow), plug rods, set  $H = 2$ ,  $V = 0$ , leave LCD arrow at 'V' and press "AUTO".

When unit finish recording of the third line 'V' will read "10". Continue for as many lines needed to cover the field.

2. The second option is to move both strings / rods so that the first new survey block starts where the previous last ended and press **AUTO**, to collect new data. You select to do this if the field is very extended therefore long survey lines are needed. After ending measurements of the first line  $H = 0$  proceed as on figure 5b.

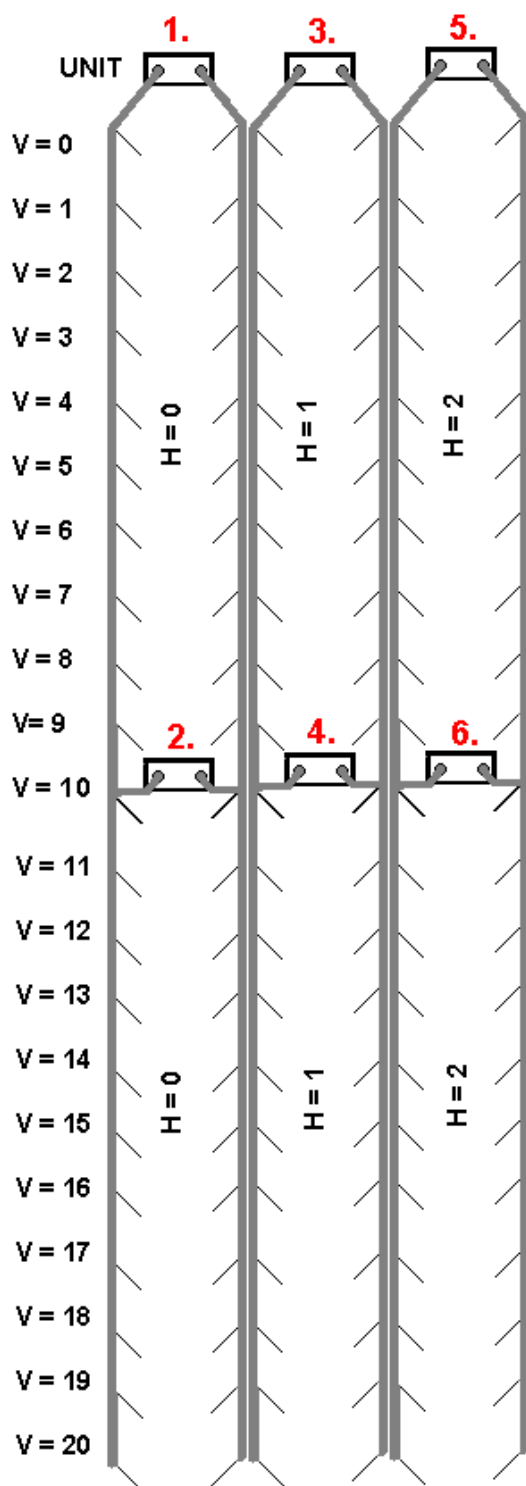


Fig. 5b

1. To start, plug the rods, set  $V = 0$ ,  $H = 0$ , leave LCD arrow at 'V' and press "AUTO". The unit will indicate  $V = 10$  when it will record all blocks
2. To continue on the same line, move the instrument and plug the rods, so that the first survey block starts exactly where the last ended. Press "AUTO". The unit will indicate  $V = 20$  when it will record all blocks. The user can continue for as many blocks needed
3. To move on the second line, move the instrument parallel to the first position, set  $V = 0$ ,  $H = 1$ , leave LCD arrow at 'V' and press "AUTO". The unit will indicate  $V = 10$  when it will record all blocks.
4. See step 2. The user can continue for as many blocks needed for the second line ( $H = 1$ )
5. To move on the third line, move the instrument parallel to the initial position of the second line. set  $V = 0$ ,  $H = 2$ . Work like step 3.
6. See step 2. Continue until the entire field is covered

Select the option that best suits the field area and your needs and continue the same way.

AS a summary for the auto mode, Imagine the operator that has to maintain a straight line between survey blocks, plug the rods, loose time to come back and alter the co-ordinate settings, then save the value and go back to rods, unplug them, have to remember which pair to move and where, then go back to the instrument to operate the co-ordinates and push **SAVE**, also in the risk of a human error, and time waist – these things do not happen on the **AUTO** automatic mode.

## 2.4 Magnetometer mode ( gradiometer sensor )

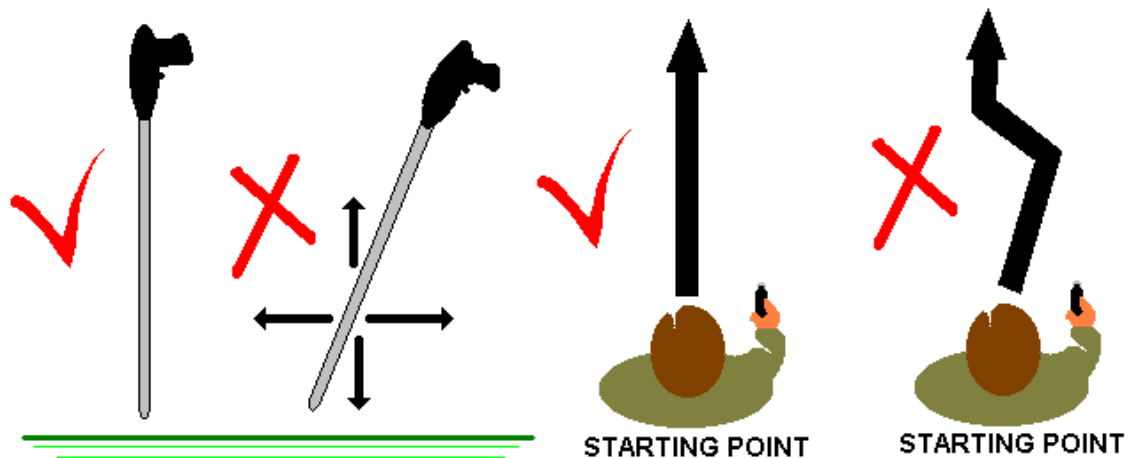
Magnetometry requires no ground probes. Measurements can be done while walking at a slow steady pace and holding the sensor vertically to the ground with tip constantly close to surface during the survey. Voids, ferrous metals, and structures like ditches and pits are recovered. The operator must not carry steel, nickel or iron objects during magnetometry.

Connect the magnetometer at the RECHARGE / PORTABLE HEADS CONNECTOR. Then turn on main unit. Also when you finish the survey turn off main unit and then disconnect the magnetometer. The same applies for the metal detector.

**❗ Ensure that the rods strings and spools are not connected when operating the magnetometer**

To calibrate the sensor stand at the start of the first survey line. Take care not to be close or above steel, nickel, iron objects or standing above a void. Hold the sensor vertically with tip close to ground surface. Turn unit on by setting **GROUND** knob fully clockwise. Hold the sensor motionless and wait for approximately 10 seconds for the electronics to calibrate to the ground conditions.

Magnetometers are sensitive to earth magnetic field. Therefore the sensor when rotated far away to the left / right of the initial calibration direction will produce readings. Hold it steady to face the same direction (of the original calibration) when surveying, and always walk in straight lines. Fig 6. Hold the sensor with the right hand, while the unit must be far away at your left side.



**Fig. 6: Position of the magnetometer during operation**

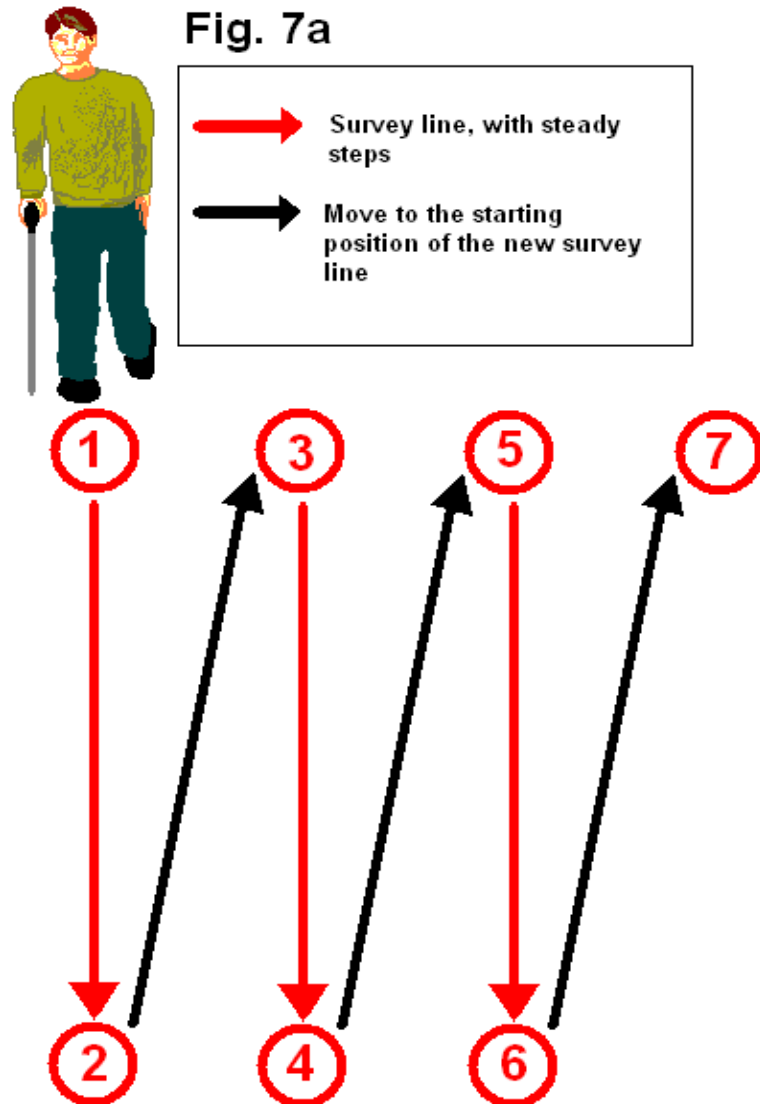
There are 2 ways to survey with the sensor



### 2.4.1 Magnetometer survey without data recording

After calibrating the sensor, work like Fig. 7a. Divide the area in parallel lines (red). Distance between them from 30 cm for a fine survey, or up to 1m for a coarse survey. Do not squeeze the gradiometer trigger. Start at position 1. walk with slow & steady steps of 1 sec each and observe the variations of the processed value on every step. Stop at position 2.

Move to position 3. and again walk to position 4. to cover the second line observing simultaneously the value while you walk. The user can walk as many lines needed to cover that area.

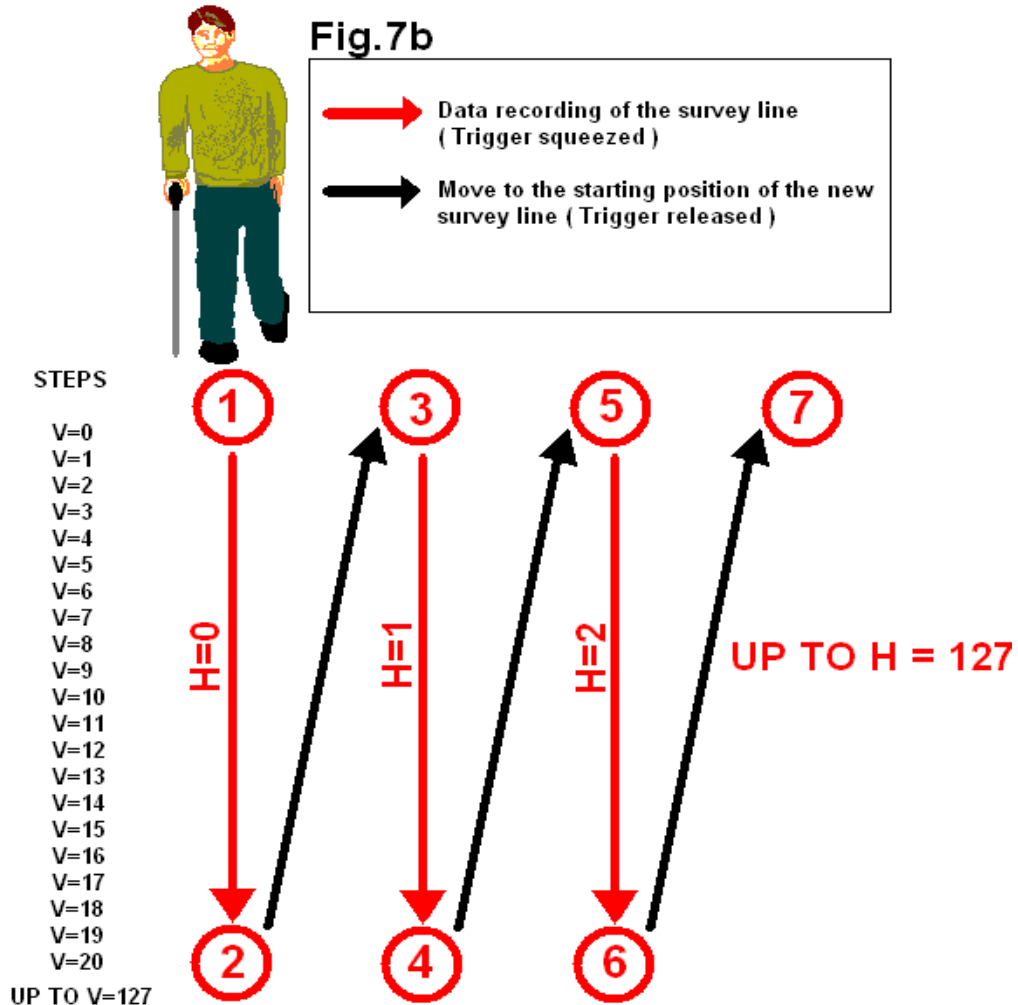


## 2.4.2 Magnetometer survey with data recording

Data recording is performed by holding the trigger.

After calibrating the sensor, work like Fig. 7b. Divide the area in parallel lines. Distance between them from 30 cm for a fine survey, or up to 1m for a coarse survey. Set V=0, H=0 and Leave the LCD arrow at V.

Start at position 1 and hold the trigger squeezed. The unit will store the value for the first survey block. Walk the next step, and observe the V value change and the automatic storing of the new processed value on the new V co-ordinate.



**①** DATA led lights after “storing” a value on the LCD, walk the next step, observe the new processed value, then the V changes and again the new processed value is “stored”, then step again, and so on for every step. These automatic functions on the LCD will determine your steps speed and timing.

It is very important to keep your stepping synchronized to these automatic functions, by observing the LCD during your survey. Alternatively DATA led may be used to prompt every next step.

To stop recording your first line H=0 at position 2. release the trigger, observe the V value, if for example you ended with V = 20 ( 20 steps for the first line) every new line must be the same.

Move to position 3. Set V back to "0" and H to "1", leave the LCD arrow at V, and again walk towards to position 4. having the trigger squeezed for all the way, to cover the second line observing simultaneously the V while you walk.

If the correct step speed and timing with the LCD functions is maintained, V=20 will come at position 4.

Then release the trigger, walk to position 5, set V back to "0" and H to "2", leave LCD arrow at V and work the same by walking to position 6 in the same stepping method while holding the trigger . at V=20 you will be in position 6, release the trigger and move to position 7. Set V back to "0" and H to "3"...

The user can record as many lines ( H up to 127 ) needed to cover that area.

Steps should be small (30 cm) for a fine survey to reveal either small magnetic object, or produce detailed images. Large steps ( 50 - 80 cm ) will often miss small magnetic objects, and produce rough images.

For uneven surfaces where a constant step speed is difficult to maintain, do only squeeze and release immediately the trigger after every step. This will store the soil value and increase the V. Take your time to make the next step and squeeze / release the trigger right after.

Ferromagnetic objects result in increasing the processed value, depth depends on the shape, iron percentage and the way they lay in the soil.

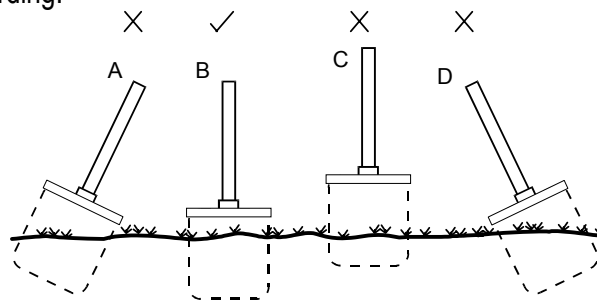
Avoid recording of zero "0" processed value data, or empty spaces will be created on the computer graph.

## 2.5 Metal detector

Use the metal detector to recover only metal targets, like coins and small valuables. Connect the metal detector at the RECHARGE / PORTABLE HEADS CONNECTOR. Stand at the start of the first survey line, position the detector head to the ground - ensuring not to be close or above metal objects, buried or not. Turn on by rotating **GROUND** fully clockwise, set **SENSITIVITY** slowly at around "150" by pressing simultaneously the red button. The calibration is now finished, release the red button and maintain head constantly close to the ground during operation. Worthless items are rejected by the **DISCRIMINATION** control, iron 1 – 4, thin foils 4 – 7, coins and small valuables 7 – 8.

The **Red pushbutton** is the detector "reset". When readings due to minerals occur, press it momentarily to ignore the minerals, having head close to ground & away from metals.

When a calibration has been made to **SENSITIVITY / DISCRIMINATION** press it momentarily to adopt to the new conditions. Also At the start of a new survey line press momentarily to reset, and then start data recording.



### 2.5.1 Metal detector survey without data recording

Headphones can be connected to have also an audio signal. Move head right to left in an arc affront of you. The speed you "sweep" the ground is not critical, but remember that you are likely to loose a target if you move very fast. Move slowly forward, enabling the area you scan to overlap in part, the area you scanned at the previous sweep, avoiding loosing targets, by creating "empty spaces" in the ground, in the which the head didn't swept. Fig. 8

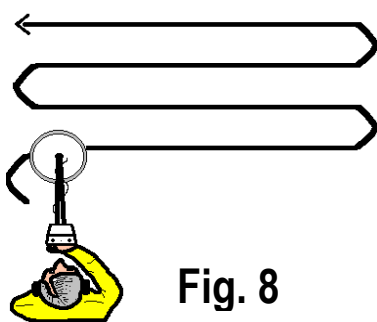


Fig. 8

**LOCK POSITION:** ←  
For flat areas when constant steps are possible, push to lock, then when DATA led glows make the next step. When the survey line finishes restore it to the center position ( no record )

**MOMENTARY POSITION:** →  
For uneven surfaces that is difficult to maintain constant steps, after every step press it and release it when the DATA led glows. This will record the soil value for the current step and increase the V.

Fig. 9

### 2.5.2 Metal detector survey with data recording

Hold the record trigger squeezed backwards ( momentary position ) and investigate the area like on Fig. 7a. having every survey line in distance equal to the half of the detector head. Do not to adjust the knobs while recording data. DATA led defines your steps speed. For good images and recovery of small targets, short steps are required. All suggestions of paragraph 2.4.2 apply also for metal detector data recording. Push the trigger outwards, to set "lock" position of data record. Fig. 9.

## 3. SIGNAL CHARACTERISTICS

### 3.1 About geophysics resistivity

#### FERF (FREE ELECTRON RADIATION FIELDS)

To begin all matter is made of atoms and molecules. Atoms differ in structure based on what type of molecules they make.

The simplest molecule is that of the hydrogen atom. It consists of one proton and one electron. Hydrogen has only one electron and other atoms easily take it away. As an example: oxygen steals two atoms of hydrogen to form a molecule of what we know as water.

This new combination "water", as a molecule spins at a given molecular frequency. We can disrupt this new "water" by exciting the molecules by hitting the frequency with power. This result is best known as "micro wave cooking". That is why anything with water in it can be cooked, and very quickly, in a microwave oven.

By now, you probably are asking yourself how talk of atoms, molecules and microwave cooking could have anything to do with underground location of metals.

The important thing for you to understand is the principal...that all matter has a molecular "spin" to it and that if any type of atomic structure is excited...it produces energy!

This energy can manifest itself in many ways, heat in a microwave cup of coffee, a glow, vapor like steam or even a smell. In our particular area of interest, this energy produces FERF...Free electron radiation fields

All FERF are detectable. Some are very weak but with the right equipment they can be detected.

In order to detect a FERF you need to know what to look for. The field of a FERF is very similar to a radio station transmission, which starts out a perfect circle of radio waves but soon varies in shape and size due to power and other obstacles in its way. The same can be said of a FERF.

#### HOW IT WORKS

The MAGNARADAR has a variable power consumption circuit and uses very little power when the ground is inert or poor in conductivity. It has a maximum power more than enough to allow the strongest conductor of precious metals to show its presence. When a strong, low frequency signal is transmitted through the ground from one set of rods to another, the wave is used as a "radio carrier". The DC wave generated by a 12-volt battery is capable of traveling only a few inches through the ground. Changing the DC wave to an AC wave (also called a carrier wave "CW") allows it to travel much further at low frequency.

The wave will take the path of least resistance to travel through the ground. That means the CW easily travels through precious metals. If metal is in the wave's trajectory, the wave encounters resistance along its path. In this case, a "stronger" CW hits the receiving probe. This is how the MAGNARADAR LCD value drops, when a highly conductive (and therefore less resistant) target is located.

All precious metals suffer a slight deterioration due to acid rain, snow, and other chemicals. When acid and ultra-high radiation contact metals, free electron radiation fields (FERFs) are created. The longer the object is buried, the stronger the field.

## **❗ Therefore freshly buried targets do not indicate true readings**

Carrier waves are attracted to FERFs. As the CW sinks into the ground it has to disperse. By creating a strong charge that sinks into the ground, the CW will find the FERF, tune automatically to it and follow it.

This instrument works on underground resistivity, measuring the total ground resistance.

If it tells you of a high resistivity underground, you can bet, that there is nothing worth digging for. If, in the contrary, the instrument shows a low value resistance on the LCD, it means that a good conductor is absorbing the power due to a strong battery charge of the metal, producing the FERF.

Imagine if you will, the kitchen light that dims, when the starting motor of the refrigerator kicks in and takes a big portion of the power available in the circuit.

The MAGNARADAR has a special variable power circuit that activates the LCD value at varying degrees: the more power the target is stealing, the lower the value.

Those of us who look for precious metal have tried many methods over the years but none have been perfected to the level of the MAGNARADAR.

### **LIMITATIONS**

Freshly buried targets do not indicate true readings, due to their weak FERF's, oxidation will build it after at least a year or two.

Targets must be buried deeper than 1ft to be detected.

Objects in a glass container can be detected only if contents make a good connection with containers metallic lid.

Mineralised soil is a must for carrier wave transmittance.

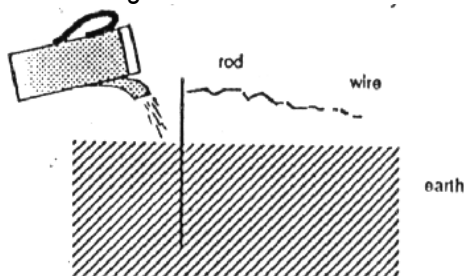
Locator does not operate accurately in sand, dunes, very loose ground, gravel, and hot or rainy days. If gold or silver exist in an iron box carrier wave detects box not the container. Gold/silver can be detected inside tunnels, but readings will indicate higher values than other places.

Practicing will permit operator to evaluate readings of good targets.

### **ATTENTION**

Ensure that there is a good connection between rods and wire clips, also between ground and rods. Clip the rods near the ground. The rods must have a stable contact to the ground, deep enough to penetrate the top first dry soil layer, and make contact to soil moistness.

In some cases when soil is completely dry, the operator should water slightly every rod, before take readings.



Bad connections give bad indications, unstable or high values. Copper rods can be used when searching in loose ground.

In areas with a volcanic surface or high conductivity surface layers (for example intent agricultural chemical works) put rods deeper to achieve accuracy or remove surface soil and then place rods.

When operate in hot environment cover locator panel with a white towel.

Sand dunes, due to the lack of minerals, cannot be scanned effectively. The MAGNARADAR relies on ground minerals to conduct its “carrier wave”.

### FRAME OF REFERENCE

The earth is composed of many layers, first the top dry layer, then the alluvial deposits, sediments, clay, sand, organic plant life. Rocks of all kinds etc., all this in combination will produce various readings. You should make a FRAME OF REFERENCE of the ground you are planning to scan. Check what readings produce that specific soil. From this you will be able to determine when you are encountering “true” lower readings on one or more set of “rods”.

For example, Beaches, due to salt, are low in resistivity values, farm lands with fertilizers (acid ground due to agricultural works) will produce lower readings than average but you will be still able to recognize solid metals.

Other example, some inert grounds will produce very high readings, i.e. 300-400, as your frame of reference, cavities may read even higher 400 or more. If the reading drops to 120 it is usually a water deposit and if it is significantly below that, (90-80) it is metal probably iron, any lower readings (75-60) it is a precious metal.

Please do not take these values as a guide. Target size, shape, depth, its oxidation or not, soil type, distance between rods can produce readings a lot different than those given, with much less target value difference from the soil values.

Again every target reading depends from the soil value,. If soil reads an average “80” a void would be “150” and a target “20”...

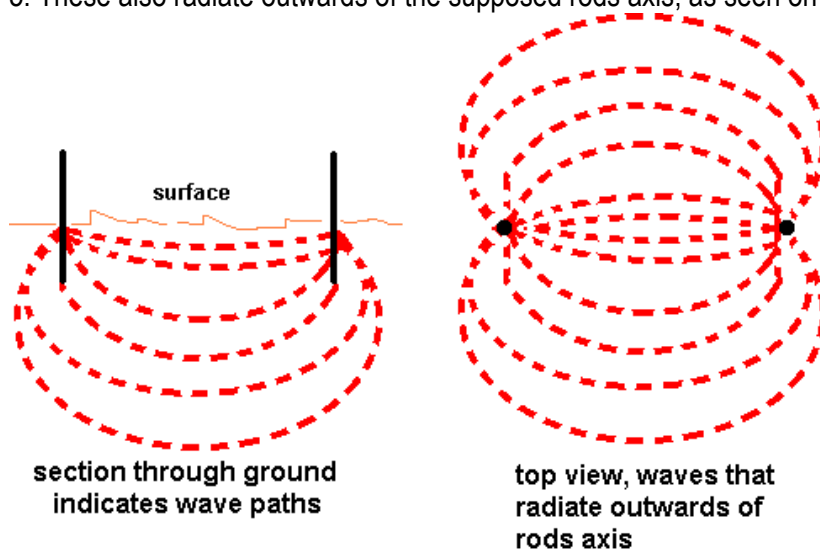
The software will help determine man made structures.

Sometimes large mineral concentrations will produce even lower readings than those on the metal spectrum, again the software by the use of “filters” can overcome that problem.

Sand dunes, due to the lack of mineralization, cannot be scanned effectively. MAGNARADAR relies on ground minerals to conduct its “carrier wave”.

### WAVE PATHS

When a set of rods (receiver – transmitter) is placed in a moist soil, the Carrier wave current flows between them, not just like a small path, but as many three dimensional paths, seen in Fig 5. These also radiate outwards of the supposed rods axis, as seen on top view.



**Fig. 5: Wave Paths**

The amount of carrier wave that flows depends on factors discussed previously, moisture, minerals, soil type, and objects in between.

The measured value indicated on the LCD depends on not just the resistivity of only one of these paths, but the total resistance of all these paths on that specific volume of soil.

On Figure 5. *One receiving and one transmitting rod* are shown.

The MAGNARADAR has its carrier wave conducted through soil *by twin receiver / transmitter rods*. This is an advanced geo - scientific layout. Unique for the MAGNARADAR. Its advantages are increased stability of readings, (as the processed target value on the LCD comes from the procession of 2 values the top value "T" of the one receiving rod, and the bottom "B" value of the other receiving rod) and carrier wave that is forced to penetrate deeper.

As for depth regulation it is in harmony with the distance between transmitters / receivers. View again the Fig. 5. and its "section through ground" sketch. Imagine the distance increasing between the transmitters / receivers. If so, the waves are making a deeper curve and more depth is achieved. Again, think the distance between them decreasing, the carrier waves are making a shorter journey, and the curve is much shallower, so depth is decreased also.

**DEPTH MEASUREMENT:** Depth is determined by placing rods (receivers & transmitters) even closer to each other, as long as readings getting lower. When reaching a point where by placing rods closer, readings no longer go low or they increase, move to previous point, where lowest reading occurred. This is the best point to estimate target depth. Generally half the distance between rods is approximate target depth. For example if by making a vertical measurement you found a lower reading in smaller rod distance, then maybe you are off target center or 2 targets exist. It is worth to shift all 4 rods by 45 degrees having the same centre and measure again. Practice on known targets buried for some years will help before searching of unknown objects.

**NECESSARY TOOLS:** Rubber gloves, water, wire pliers, screwdriver, white towel, hammer, notebook, pencil.

**HOW TO IMPROVE DETECTION:** All rods are made of sweet iron. Have to be polished regularly using steel wool, never to be oiled etc. Some large electronics retail stores offer rods 3/8" or 1/2" approximate 50" long, copper coated. These are the best rods for instrument operation, as can be put deeper in the ground making stronger CW transmittance.

**STORAGE:** When not in use your MAGNARADAR should be stored in a dry warm environment. If it is not to be used for a length of time it is advisable to recharge the batteries every 2 months to avoid shortening the battery life. The working life of your detector will be shortened by careless use or neglect of the unit. Think of your detector as a scientific instrument. Your detector is designed to withstand rugged handling on any terrain, but misuse or lack of due attention will tell in the end. After using your detector in a hostile environment (salt water, sand, etc.) The exterior parts should be wiped clean with a damp cloth, paying particular attention to rods and rear panel connectors.

**❗ Avoid oxidation of the rods! Erratic signals occur!**

Then carefully wipe dry. DO NOT use solvents or detergents on any part of the detector specially the rods. Always check for dirt in the connectors, it must be cleaned immediately using approved electrical contact cleaner spray



## 4. MAGNARADAR SOFTWARE

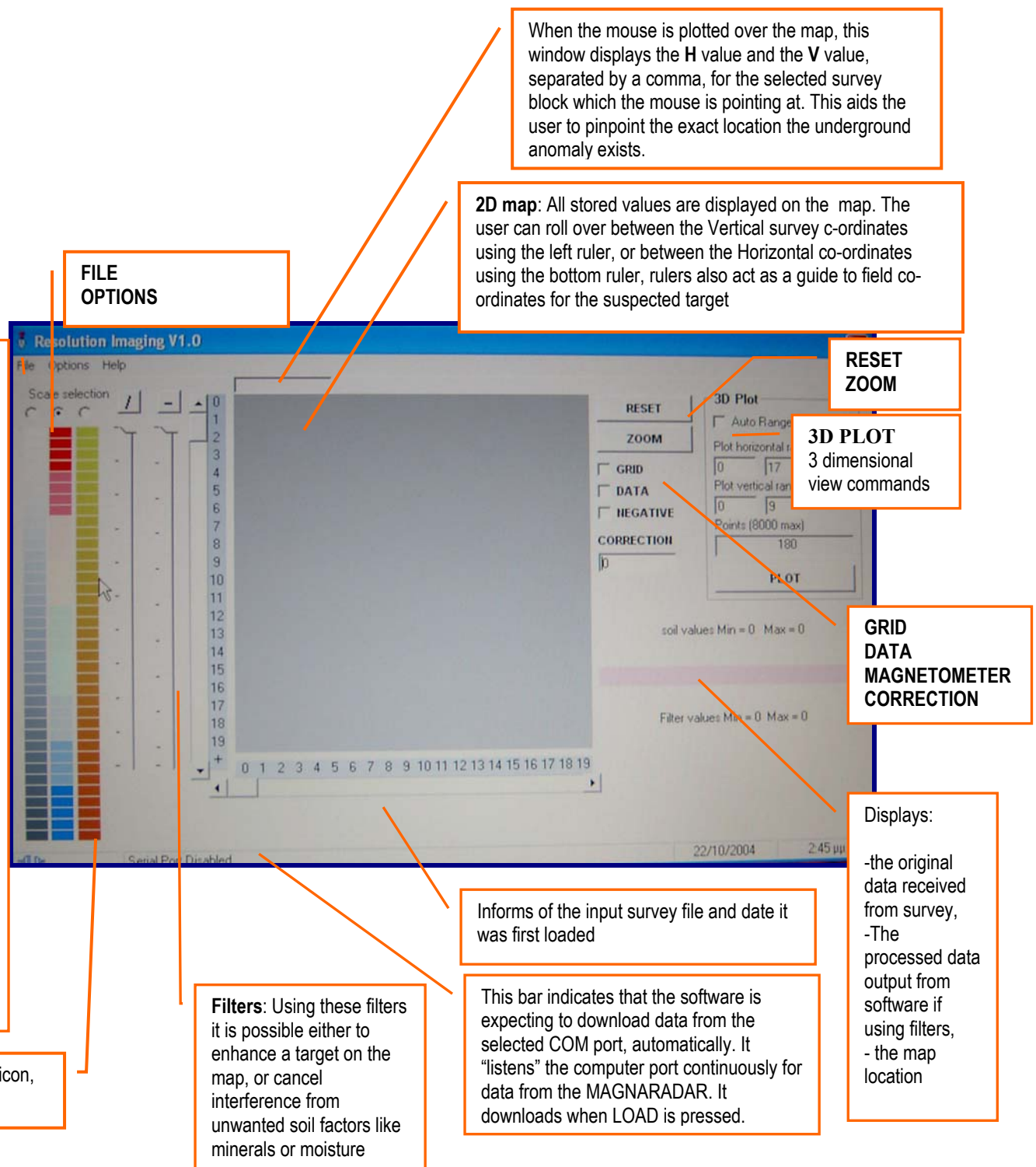
### 4.1 PC INSTALLATION WIN 98 / XP

1. Place the cd on your cd rom drive
2. "C" is the only hard drive name the software accepts. You are required to change the name of your hard drive to "C" in order to operate the MAGNARADAR software
3. The winzip program must be installed on your PC
4. Click on the **RI II2.0.4 install.zip** icon. The installation process starts, follow the instructions, select the "unzip & install" option. **For windows XP**, by clicking on the RI II.2.0.5 install.zip, may open many icons, for installing click the "setup.exe" icon
5. The software will be installed at C:/Program files/MAGNARADAR
6. The "MAGNARADAR" shortcut icon is now also displayed on your screen. Click on the "MAGNARADAR" icon and see the software main screen, which will be described next.

### 4.2 DOWNLOAD STORED DATA

1. Connect the **RS232 male / female cable** tight between your **PC RS 232 input** and the **MAGNARADAR RS232 data output, (rear panel)**
2. Start the MAGNARADAR software on your PC. Turn on the power on the MAGNARADAR system.
3. Notice at bottom left of the main screen the **connection icon**, if it is disabled and the message is "Serial port disabled" click at the "options" at top of main screen and select the appropriate com port from which you plug in the RS232 input, and you expect to download data from unit. Then if the connection icon is still on disabled, click at "File" and then "Enable port" to see the connection icon establishing a connection and the message to indicate "Serial port ready"  
Press the "**LOAD**" key on the MAGNARADAR main unit, A message appears, informing that data are inputted and will be saved automatically as a file which you can open again, having the name "Imaging +date&time you are downloading . txt". This file will be stored in your computer hard disk within the MAGNARADAR program directory folder.
4. If you connected the **RS232 cable** on a faulty COM port address than that on which the software is expecting data, you will fail to see the input message and the download is terminated, you must try to download on the other COM port address, until you find the correct one - by clicking on the "options" and setting up another COM port address from those that are available. If this time data are received the valid COM port address will be stored for the next download. The **connection icon** is a proof that the selected COM port is available in your PC.
5. In rare situations a fault during download may be experienced. The user can restart the download
6. When the download box disappears drag the right filter slider (see Definition of main screen below for details) in order to make the map visible. Drag it enough to make all survey blocks visible, and the majority of them to be in soft tones that represent the ground (yellow / light green) then you can evaluate the solid targets to be blue and red (cave / metal), their size interacts with the size of the number of survey blocks they cover, that means the distance between the receivers / transmitters when operating on the field  
The user can download many field maps at once, to view on the computer software, (as long the user had placed those survey's on separate co-ordinates at memory bank) the download procedure will retrieve all stored values.
7. If still no download, try check the COM Port settings - under XP in Start>Settings>Control Panel>Performance>System>Hardware>Device manager>Ports Com & LPT, select your com port and right click properties, Port Settings, set bits per second to 115200, 8-N-1 and flow control to NONE. Try again and if no results, try the advanced button switch on the FIFO buffers for the port, or try other PC.

## 4.3 DEFINITION OF THE MAIN SCREEN



**File (on top left of main screen):**

- *Open* - File finder screen where older survey files held in your computer can be imported again to be viewed on the MAGNARADAR program.

The files are held within your hard disk having the "Imaging+date that were first downloaded.txt" form. They are included on the MAGNARADAR program folder.

- *Enable Port* - Disables or enables the connection between the imaging software and the PC communication port (see the port connection icon on bottom left of screen), the communication port **is selected from the options selection next to the File.**

**Options (on top left of main screen:** Notice at bottom left of the main screen the connection icon, if it is disabled and the message is "Serial port disabled" click at the "options" at top of main screen and select the appropriate com port from which you plug in the RS232 input, and you expect to download data from unit. Then if the connection icon is still on disabled, click at "File" and then "Enable port" to see the connection icon establishing a connection and the message to indicate "Serial port ready"- now you are able to download from the MAGNARADAR unit.

By clicking on the options you also check which ports are available to use with the software. To find the correct COM port is accomplished by trial and error. Select COM ports and press the LOAD key, when you find the correct one, it will stored and it is not necessary to set it again.

COM port addresses of number 5 and higher can work with USB adaptors better.

Instructions of using a USB adaptor to download from the MAGNARADAR can be obtained from your local computer store. If your PC does not provide an RS232 port but only USB, then a USB adaptor is necessary to operate.

**RESET:** It needs to be clicked occasionally if a change has been made, either to settings or the imported survey file, so that an "update" occurs on screen.

**ZOOM:** Opens a new screen where the map can be zoomed, in or out, useful for surveys for Horizontal or Vertical values larger than 20, as the whole survey map can be viewed at once.

**GRID:** Divides the map with a "net" to display all the survey blocks on screen, accordingly to the survey on the field. This is sometimes useful for the user to understand in which co-ordinate the target exists, to pinpoint it later on the field. – Or to make a fine survey to cover the target and the surrounding area for a better imaging.

**DATA:** Every survey block on the map will have a visible number, according to the processed value data stored in the MAGNARADAR. Helping identify small variations produced by targets, that color scales may miss.

**MAGNETOMETER:** Depending on the color scale used will give a negative color effect, helping identify soil structures that would otherwise be missed. Data from the magnetometer and metal detector are better viewed using this.

**CORRECTION:** This by entering a number either darkens or lights the map. Depending of the filters position. Experienced user may find this way a number which is presenting much better the target itself, this "**CORRECTION**" key is a "fine" adjust for the filters used.

**FILTERS:** Sometimes soil variations, mineralization, moistures, etc may "mask" a target, using filters it is possible to smooth out the interference so that all underground structures can stand out clearly visible.

Click on the first filter icon to change between "X" (multiply map data at every time the filter is used) to "/" (divide map data at every time the filter is used), also click on the second filter icon to change between "add" (add to map data at every time the filter is used) and "minus" (subtract from map data at every time the filter is used)

*Example:* import a survey file on the map, then leave the first filter on “/”, second on “add” slightly drag the second filter to bottom, be careful to drag it in small steps until the image is smoothed, so the targets are start to appear in tones of red, while the majority of the map has the yellow/light green tones that represent the soil. Dependant on the survey, different settings of the filters may required to produce a smoothly detailed image, or a rough one to indicate only the strong variations.

**❗ As soon the image has been smoothed examination must take place for locating solid shapes outlining man made structures like buried metals, cavities, tombs.**

Other forms belong to physical soil geology variations.

The Imaging software is a great tool for determining the size / shape and composition of the buried target, and also for canceling natural interference from minerals.

**❗ Click on “RESET” if a change has been made, either to settings or the imported survey file, so that an “update” occurs.**

### **3D PLOT**

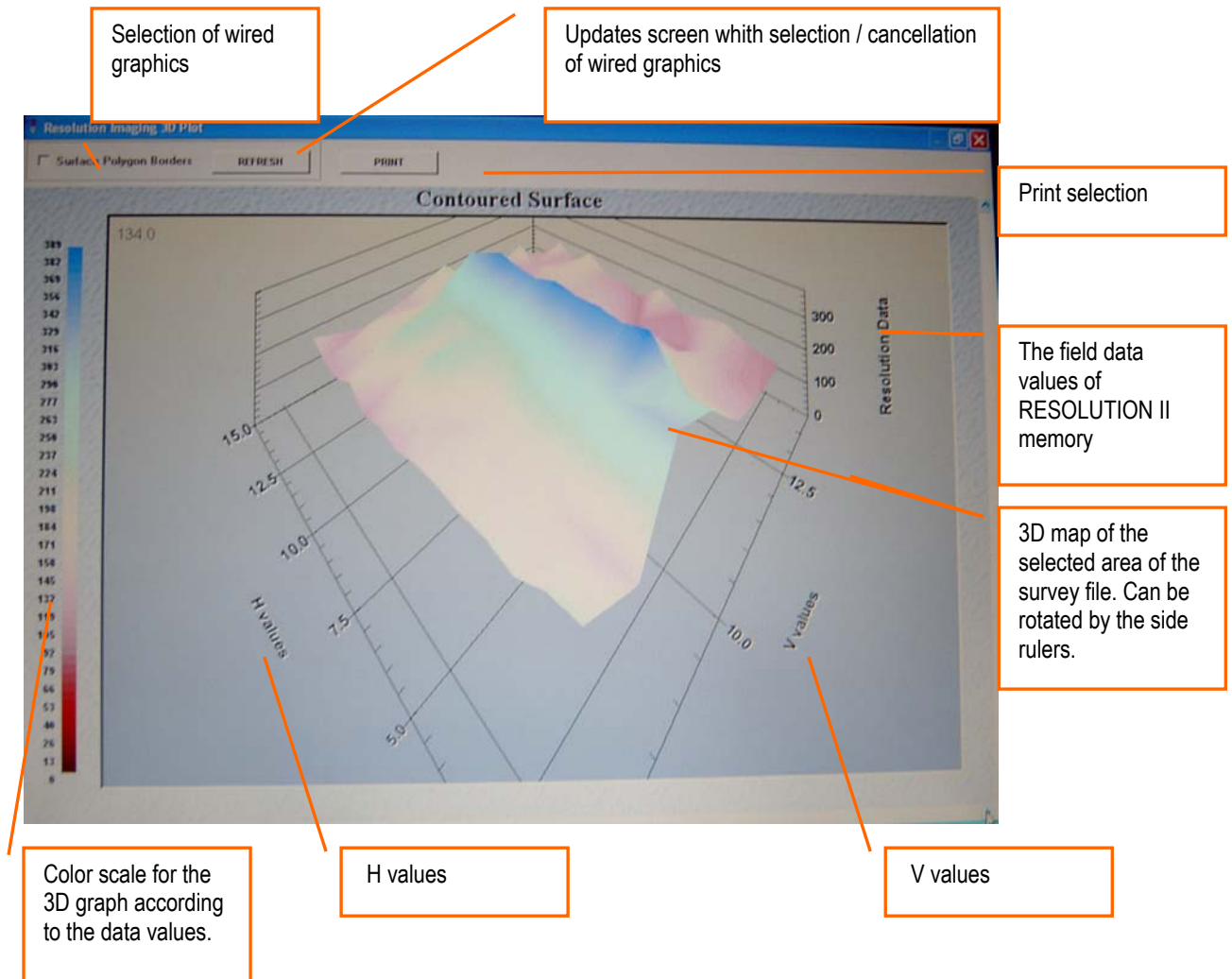
The 3D PLOT area contains the settings that lead to the 3Dview screen for the current survey data file, these settings are:

**AUTO RANGE:** In 3D representation shows the area of the 2D map, which is currently viewed from the main screen. This means in whatever co – ordinates of the 2D map the user has been moved, via the left / bottom ruler, that specific area will be viewed in 3d. Also auto range cancels from view areas of empty memory (no data), in other words it is a magnification for the 3D window.

**PLOT HORIZONTAL RANGE & PLOT VERTICAL RANGE:** Sometimes it is desirable for the operator to view in 3D only a part of the map, specifically the one that contains anomalies that need a careful study because they could represent a target. Unlike AUTO RANGE that leaves out areas of no measurement, these settings select specific measurement areas for magnification. The operator has to type the horizontal (H) co-ordinates from the which starts and ends the area of interest, and then the vertical (V) co-ordinates that also cover the area of interest. These co-ordinates are determined by moving the mouse over the area of suspected target and observing the “V,H window ” over the 2D map. For better target view set 2-3 more co-ordinates horizontal and vertical than those the target is actually covering, on its perimeter. The 3D view has a limit of 8000 memory points, those are presented at the “points window” if these you exceed them, the 3D is not functioning.

**PLOT:** It opens the 3D view screen that will be analyzed below, according with the settings you defined on the 3D PLOT window.

#### 4.4 DEFINITION OF THE 3D SCREEN



**i** 3D view works better with “square” data files. For example the survey lines (H) must have the same numbers of vertical measurements (V). In general if there are empty co-ordinates inside or at the edges of the data file the graphs are not accurate.

Set the mouse over the graph, and right click, then a number of visual enhancing tools appear to enable better viewing of the structures. The “export” tool will then save to disk the image as it is viewed on the screen, in whatever file format desirable. The “2D” provides a much detailed 2D graph on top or bottom of the 3D for accurate target examination and localization.

The 3D produces variations of colors to interpret data and visualize possible targets. The software occasionally when there are no targets will still produce color variations because data always are different in every survey block, there always be a low value and a high value, therefore software has to color them accordingly, but these not necessarily belong to targets.

The color scale, is a great tool to estimate a true target from a false. Having the value of “green” as an average - a target in “red” should have at least the half “green” value to be considered as a true one. Values also depend on target depth.



Using “**ZOOM**” this is an example of a 2D MAGNARADAR (120 x 120 block) survey of a buried monument. The entrance and relics are shown inside.

The user can apply color using the color scales, where metals presented in red and soil in variations of yellow and light green.

The above gray scaling is used to reveal underground structures like buildings; the Color scaling is preferred for geological investigations, caves and metals.

**i** For the best image quality of buried structures, work on fine survey, making small distances between receivers / transmitters, and take many readings on the field.

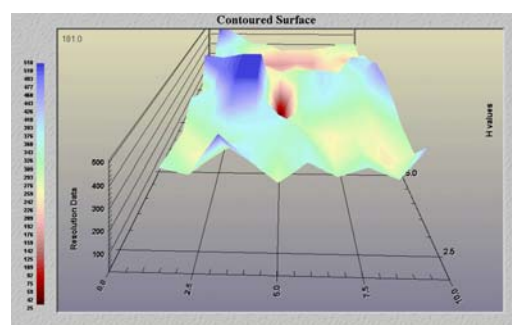
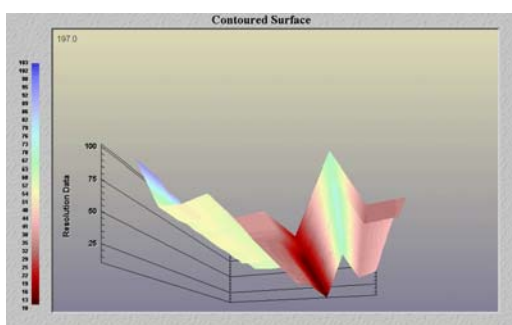
If the above survey consisted of 80 x 80 blocks, the image quality would be reduced, but still the outlined shape of a buried monument would stand visible as a solid structure, regarding to the background geology variations that change in random.

3D image of a metal pipe, its track is easily identifiable with the deep red color, and a void in blue. Surrounding soil has lighter tones of yellow and green.

Also visible are the grid lines that represent the survey co-ordinates of the field, helping to pinpoint the target with precision and identify the dimensions.

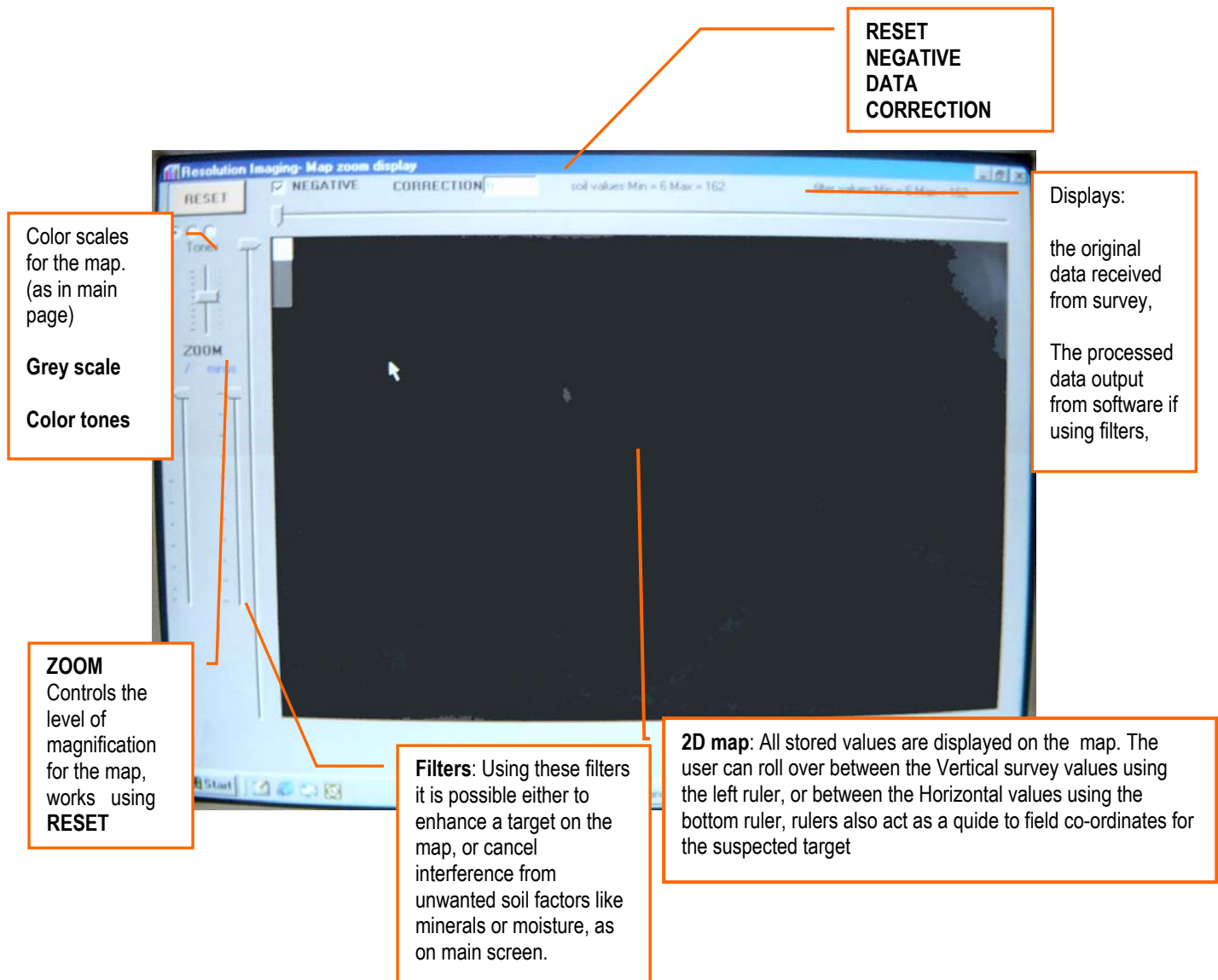
Both these survey files are included within the program directory as examples.

( at Program files / magnaradar / Imagingpipe.txt or Imagingvoid.txt )



#### 4.5 DEFINITION OF THE ZOOM SCREEN

By clicking on the “**ZOOM**” opens a new screen where the map can be zoomed, in or out, useful for surveys for Horizontal or Vertical values larger than 20, as the whole survey map can be viewed at once.



**Using Filters on the ZOOM screen:** leave the first filter on “/”, second on “add” slightly drag the first filter to bottom, be careful to drag it in small steps, and keep clicking on the “**RESET**” after every step, until the image is smoothed, so the targets start to appear in tones of red, and soil in smooth variations of green/yellow, dependant on the survey, different settings of the filters may required to produce a smoothly detailed image, or a rough one to indicate only the strong variations.



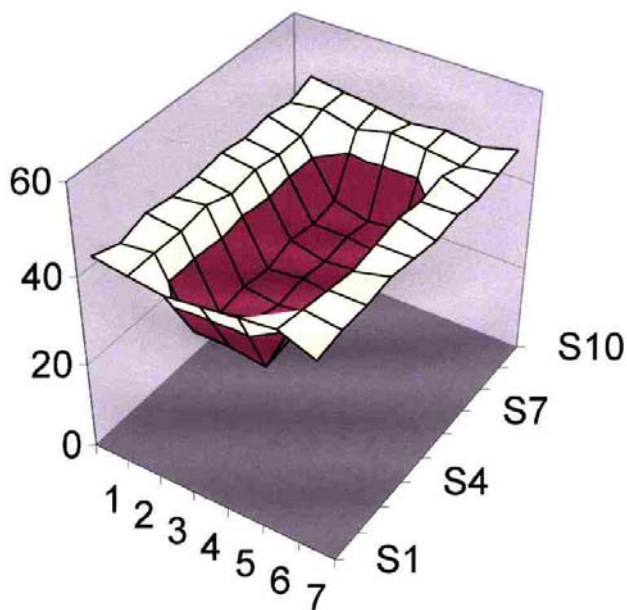
#### 4.6 USING WINDOWS EXCEL

("Windows", and "windows excel" are registered trademark of MICROSOFT corporation)

There has been the possibility to open a MAGNARADAR survey file on windows excel which has many functions for data processing, using windows excel the survey data can be viewed in 3D, to be rotated to your preferred position etc.

Also the user can cut the survey to view only the preferred part of the field, or to view the data for each Vertical or horizontal survey line he prefers, via a 1D representation. Creating a "side scan view" radar through the soil.

Start windows excel, and search from its import menu on the MAGNARADAR directory, select the "all files" import, click on the "Imaging....txt" file you wish to open, then follow the instructions, but click on the "comma" option, the survey values will appear on screen filling the "boxes", then click on the first value, hold the mouse button and drag your mouse to include all survey values. Go at the "graph" choose whatever data pattern you wish, the best for geological investigation is the 3D map shown below.



A 3D windows excel graphical representation of a MAGNARADAR investigation.

The graph rotates for better viewing, the vertical and horizontal values are indicated with numbers, in this case this is a 7 x 10 survey block investigation, indicating a rough image of the ancient grave, a fine survey could reveal more structures and objects possibly lying in it.



## 4.7 SPECIFICATIONS

### **detection depth**

geophysics : caves 40 m. metals 18 m.

magnetometry : caves 5m metals 2m.

metal detector : under development! Please contact your dealer

**Memory capacity** 16384 measurements

**Frequency of operation** 137 hz

**Back lighted graphic lcd**

**Battery 12v 2,6 Ah** with low battery alert

**Dimensions** 26,8 cm X 21,6 cm X 6,3 cm

**Weight 4kg** (main unit)

Program to present data in 2D or 3D using variations of gray, or colors different for the target type. Data files are compatible with windows excel.

### **Modes of operation**

#### **1.Geophysical**

**Automatic - using the 'AUTO' function**, from 2 multi-cable strings of 11 electrodes each (transmitting string / receiving string).

automatic co-ordinates setting for every measurement, automatic target / soil value storage.

**Manual - with only 4 electrodes and 4 cables**, Setting of field co-ordinates and storage of target value in memory by the operator.

**3. Magnetometry**, using a twin sensor gradiometer probe with a trigger for data recording

**4. Metal detector**, with variable metal rejection

In standard kit includes: **watertight case, PC connection cable, imaging software, 22 electrodes, 2 multi cable strings (auto mode) , 4 single cables (manual mode), charger .**