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1. **Introduction:**

The geophysical reconnaissance method developed by EMFAD® – GmbH (EMFAD® = ElectroMagnetic Field Anomaly Detection) is based on the measurement of abnormal variations in conductivity of the subsoil. The anomalies measured using the **EMFAD® – UG12 PRO** are caused by

- conductive metallic materials such as tubing, piping, barrels, waste of metal, reinforced concrete, etc.
- variations in the subsoil caused by hollow spaces, chasms, shafts, fillings, intercalation, electrolytes (e.g. emission trailing of dumps) etc.

By means of area mapping, zones or individual objects are explicitly highlighted.

The EMFAD® technology has been successfully deployed in practice under various different climatic and geological environmental conditions. Fields of application predominantly are archaeology, subsoil test, and geology.

The EMFAD® measuring method uses electromagnetic fields (primary fields) which are sent by different types of broadcasting equipment (e.g. radio station). If materials with different conductivity are located in the subsoil within the effective radius of the ‘primary field’, different ‘secondary fields’ are produced according to the respective different materials by means of induction. Primary and secondary fields interfere at the earth’s surface forming the basis for the EMFAD® measurement. Measuring technology serves to filter out and display the magnetic field components of the secondary electromagnetic field. Measurements are taken by a person at pedestrian speed.

The EMFAD® – UG12 PRO is a highly sensitive sensor system which does not disturb other equipment. However, measurements may be disturbed by other electrical / electronic equipment in the near circumference of the unit. The following technical equipment shows particular disturbance: TV set, computer, AC-powered equipment with electronic control. Metal detectors should not been operated closer than 20 m to the EMFAD® – UG12 PRO.

Also natural effects can cause falsification of the measuring results. Hence, no measurements should be carried out within the effective radius / area of a thunderstorm.
2. Description of the Unit:

2.1 Operating elements of Front panel
2.1.1 OFF / ON

By using the switch Off/On the device will be switched on resp. switched off.

2.1.2 AUT / MAN

The switch serves the selection between automatical and manual measuring recording.

Remark: The selection has to be done before you switch on the device.

2.1.3 FREQUENCY

The switch helps to shift between the 4 frequencies 130 kHz, 77 kHz, 23.4 kHz and (optional) 33 kHz.

2.1.4 SENSITIVITY

The adjustment of the levels is the fine control of signal power of the receiver signal. The signal strength will be shown on the LC Display at the lower bar in percentage. The level should be adjusted after preadjustment under the switch „amplification (see 2.1.6)” and before you start measuring by approx. 30-40%. Should you reach an overl during measuring the measuring has to be executed under lower level and/or reduced adjustment of the amplification.

Remark:
- In order to get an optimal adjustment you should check before measuring by logger recording the measuring surface by means of various adjustments like „sensitivity“, „gain“, „amplification“ and „smooth“.

- To make sure that radio signals in the frequency ranges 130 kHz, 77 kHz and 23.4 kHz are present hold the unit horizontally and turn around 360 degree. You should notice a change in the signal strength on the display. If there are no changes either the station does not broadcast at that time or the distance to the station is too big. If this is the case, you will not get a real signal and with a to high setting of SENSITIVITY and AMPLIFICATION you will only amplify the electronic noise. The measurement is not useable.

2.1.5 GAIN

In the normal measuring operation the GAIN potentiometer is set to min. In case the received signals are week, you may turn the gain in direction max to compensate the signal strength (SENSITIVITY). The signal strength bar will then
drop down. After that turn the SENSITIVITY in direction max back again to reach
the old bar setting there.
The advantage of using the GAIN is that a change in the signal strength will be
indicated at the display with a higher resolution.

**Example:**
- GAIN is min and the signal strength is 60%.
- after turning the GAIN to 50% the signal strength drops down to 25%-30%
- then turn the SENSITIVITY back to 50%.

### 2.1.6 AMPLIFICATION

The amplification switch of the receiver signal helps the preadjustment of the
amplificator in 10 steps. It should be adjusted that if you use a lower adjustment of
sensitivity the bar of the signalpower gets visible on the display. A further
adjustment of sensitivity will take place then as described under 2.1.4.

### 2.1.7 SMOOTH

There can be impetus amplitudes come visible on the display if you set the switch
on 2 of the frequency adjustment (see 2.1.3). The impetus is sender specific and
might fall off by potentiometer smooth if you switch to 2 and 3.
You have to consider that reactions of the sending signal might be dampened
resp. get slower.

Because of the impetus amplitudes are getting filtered out as far as possible if you
are recording by data logger of the micro processor we recommend to check by a
test measuring if the adjustment of switch makes it necessary to put the switcher
on 2 or 3.

**Please note:**
If you use the automatical measuring recording (AUT) you should lower the
rate. If you use the manual measuring recording (MAN) you should wait on
each breakpoint approx. 1-2 seconds for recording the measuring before
pressing the red button.

### 2.1.8 VOLUME

You can adjust by potentiometer the volume of the headphone connected by plug
socket.

### 2.1.9 SIGNAL EXT

The measuring signal can be found additionally at the cinch plug socket by means
of a appropriate measuring device (for instance multimeter) and brought for
display.
2.1.10 HEADPHONE

The 3,5 mm audio plug socket connects the stereo headphone. By altering the pitch you can check out very well the conductivity of bottom.

2.2 Operating elements of handle

2.2.1 LC-Display

The views of the LC-Display are described in detail in Chapter 4.2.

2.2.2 Start / Stop button (red)

- In automatic mode the red start / stop button is used / pushed to start the measuring at the beginning of each profile and to stop the end of each profile. The probe recording is done automatically in a “one second” interval. (See also Chapter 4.4)

- In manual mode the red button is used / pushed to make a probe recording on every measuring point.

2.2.3 Profile end / erase Logger (green)

- In manual mode the green button is used to end every profile (see also chapter 4.3). Another function is described in chapter 5.1.

2.2.4 LC-Display light / selection of language (blue)
After switching the unit on and run through the start phase the background light of the LC-Display can be switched on with the blue button. Another function of the blue button is described in chapter 5.2.

2.3 Contents of the side compartment

2.3.1 Battery compartments

Left side: 10 rechargeable AA-cells as block for the datalogger. Right side: 10 rechargeable AA-cells as block for the receiver. To recharge the blocks a special charger is delivered with the unit.

2.3.2 Interface RS 232

To connect the EMFAD-UG12 PRO with an computer you may use either an serial (RS 232) interface cable or the special RS 232 / USB adapter which is delivered with the unit. The software EMFAD-ScanPRO will recognize the type of cable used automatically.

2.3.3 Fuse

To protect the receiver in case of improper battery handling, the unit is equipped with an 200 mW fuse.
3. Preparations:

The EMFAD® – UG 12 PRO requires 2 Packs, 2 x 10 AA accumulator-cells. The cells will be sufficient enough to operate the EMFAD® – UG12 PRO for approximately 12 hours. If the accu-warning message (R and/or L) appears on the LC-Display, the corresponding pack should be changed. Because both packs use approximately the same amount of current, they should be changed both at the same time. For more details refer also to 4.2 und 5.3. While changing the accu-cells the logger data will be kept in the memory.

3.1 Software Installation

The EMFAD® – UG12 PRO can only be properly operated using the EMFAD® – ScanPRO data processing software which is specially designed for the EMFAD® – UG12 PRO. This software is a program serving to process and display measurements of abnormal variations in conductivity in the subsoil. The installation procedure of the software is described in detail in the EMFAD® – SCAN operating manual.

3.2 Preparing the data logger

Before you turn the <ON/OFF> switch to the “ON” position you must decide whether the survey shall be made in the automatic <AUT> or manual <MAN> mode. To achieve the necessary sensitivity and performance of the equipment, you need to make adjustments to find Radio Stations in the search area.

4. Measuring operation

4.1 General

You may decide yourself for an automatical or a manual recording of the reading point. In general you will chose the automatical recording of the reading point for diagrams if there is clear ground. In case the ground is difficult to access you should go for the manual recording of the reading point.

The reading point density is dependent on step length, rate and profile distance when using the manual reading point. By using the manual recording of the reading point the density of the reading point depends from the chosen distance of the reading point and from the profile distance. The profile distance can average by every distance divided by 0.5. The distance at least has to be 0.5 m.
The programme runs by micro processor. The display will be carried out on LCD on 4 lines each containing 20 characters. 3 buttons (red, green, blue) serve the operation system.

4.2 Start phase

The display appears after having switched on

..........................................................
 ....E.M.F.A.D.......                      
 ....Vers:..200a.....                      
 ..........................................................

It will be followed by display of the accu voltage

Receiver.Akku . .....  
 ■■■■■■■■■■■■■■13,0  
 Controller.Akku.....  
 ■■■■■■■■■■■■■■13,0

The version display may diverge.

Then the present chosen mode “manual” or “automatic” appears

..........................................................
 ...Mode = manual ...                         
 ..........................................................
 resp..  
 ..........................................................
 ..Mode.=.automatic..                         
 ..........................................................

If there is existing memory data another query starts

clear logger?  
Key red = yes  
Key green = no

You have to answer the query; if not there is no measuring mode possible

4.3 Manual probe recording

If you start the device by switching on “MAN” (manual), you will see the display
This is replaced by clear by

**I-Ant 2..norm ......**
Start Taste rot...M.
■■■■■■■■■ ......70%
■■■■■■■■■■■ ....82%

The 1\textsuperscript{st} line shows the SMOOTH-Part (1or2or 3), followed by display norm = normal or over=overloaded.

The 2\textsuperscript{nd} line starts the actual measuring operation. The M (or A) at last place refers once more to the regulated manual (automatical) operation.

The 3\textsuperscript{rd} line shows the compensation display (GAIN) and the 4\textsuperscript{th} line indicates the signal power as bar and in percent.

### 4.3.1 Measuring profile 1

After using the red start button the display changes to the following

**I-Ant 2..norm ......**
Profil..1....MP.1.
■■■■■■■■■ ......70%
■■■■■■■■■■■ ....82%

The 2\textsuperscript{nd} line will now be shown. Profile 1 + measuring point.

Any further keypress on the red button rises the digit behind “MP”, i.e., the following display

**I-Ant 2..norm ......**
Profil.1....MP..5..
■■■■■■■■■ ......70%
■■■■■■■■■■■ ....82%

If you press the green button this will end the profile and gives you the display of

**I-Ant 2..norm ......**
End of Profile......
The 2nd line shows you the already measured amount of each profile.

4.3.2 Measuring Profile 2....X

Pressing the red button again starts the next profile.

I-Ant 2..norm ......
Profil..2.....MP..1..

Pressing the green button will end the next profile.

After measuring the last measuring point on the last profile with pressing the red button and following pressing the green button the display may be

I-Ant 2..norm ......
End of Profile 10...MP..25..

4.3.3 To quit the measuring

A further pressing on the green button ends the measuring, you will see in the display

I-Ant 2..norm......
end of data acqu......

In the 2nd line shows the end of data acquisition .

Thereafter you can switch off the device (non mandatory).

Remark: If one forgets to finish the data acquisition by pressing the green button at the end of the measurement, the data can not be transferred to the computer.

4.3.4 Stand by

If you did not switch off the device before or after the transfer of the reading point recording another pressing on the green button will bring you back to start, i.e.,
you will see the accu tension and the device has the condition like after having it switched on.

### 4.3.5 Manual probe recording

![Diagram showing manual probe recording]

### 4.4 Automatic probe recording

Starting the device by switching the button on “AUT” (automatical) you will see the following display

```
...Mode.=.automatic...
```

It will be cleared by

I-Ant 2..norm ......
Start key red...A.

- Repeat pattern: 70%
- Repeat pattern: 82%

### 4.4.1 Measuring profile 1
Pressing the red button (start) starts the automatical reading point recording by display

I-Ant 2..norm ......
Profile..1...MP...1..
■■■■■■■■■■......70%
■■■■■■■■■■■■■■■■■......82%

Within approx. 1 second the cycle will change the display behind “MP”

If you press then the red button (stop) the automatically reading point recording will be stopped by display.

I-Ant 2..norm ......
end of Profile 1......
■■■■■■■■■■......70%
■■■■■■■■■■■■■■■■■......82%
This allows already the reading of already measured profiles.

4.4.2 measuring profiles 2….X

Another pressing on the red button (Start) continues the measuring in new profile

I-Ant 2..norm ......
Profile..2...MP...1..
■■■■■■■■■■......70%
■■■■■■■■■■■■■■■■■......82%

After you have measured the last point of the last profile and pressing the red button you will see on display

I-Ant 2..norm......
end of profile 10.......
■■■■■■■■■■......70%
■■■■■■■■■■■■■■■■■......82%

4.4.3 Ending the measuring

Press the green button and you will see that the measuring has finally ended, the display shows

I-Ant 2..norm......
end of data acqu....... 
■■■■■■■■■■......70%
■■■■■■■■■■■■■■■■■......82%

The 2nd line indicates End of Recording, i.e., the reading point recording is terminated.
Now you are allowed to switch off the device (non mandatory).

**Remark:** If one forgets to finish the data acquisition by pressing the green button at the end of the measurement, the data can not be transferred to the computer.

### 4.4.4 Stand by

If you did not switch off the device after transfer of the reading point data into your PC you can start again by using the green button the device again into the start process, that means you will see the accu tension and the device condition will be the same like after you have it switched on.

### 4.4.5 Automatical probe recording

4.4.6 Pause

If it is necessary to interrupt the reading point recording on one profile you have to press the green button to get a pause in the measuring process, the following display will be shown

```
I-Ant 2..norm ...... end Pause=key red
 ■■■■■■■■■■ ......70%
```
The 2nd line will show then end pause = key red. You are ending the pause by pressing the red button the measuring will be continued on respective profile. The display could shows

I-Ant 2..norm ......
Profil..1...MP...4..

If you did not switch off the device after transfer of the reading point data into your PC you can start again by using the green button the device again into the start process, that means you will see the battery power and the device condition will be the same like after you have it switched on.

5. Additional functions

5.1 Delete logger (memory)

In order to delete the memory of the logger safely you have to switch on the device under pressing the green button. The green button has to be pressed so long till the following display will appear

Clear logger.?....
release key.....

After release the key the display will change to

Clear logger?.....
key red = yes......
key green = no..

By pressing the red button (delete) the logger will be deleted, pressing the green button (no deletion) the measuring data remain in the logger. This function should be kept always if you want absolutely safety for storing a new measuring in your logger.

5.2 Change language

The messages of your LC displays can be indicated in german or english. If you want to fix the language version you have to switch on the device by pressing the
blue button. You have to press the blue button so long in order to receive the following message on your display

Change language..
red key = german.
key green = english..

....................

5.2.1 German language

By pressing the red button you will fix the English language, the display changes as follows

Change language..
red key = german.
key green = english
Sprache ist deutsch

Thereafter the measuring process is automatically started. The fixed language will be stored in your device. The next start transports in your display the language fixed.

5.2.2 English language

By pressing the button the german language will be fixed, the display will change as follows by pressing the red button:

Change language..
red key = german.
key green = english
Language is English

Thereafter the measuring process is automatically started. The fixed language will be stored in your device. The next start transports in your display the language fixed.

5.3 Supervision of battery-packs

There is a permanent control of the both accu units internally. The running time of the units – which both have almost the same power requirement – will last approx. 12-16 hrs. The power requirement of the receiver will be increased by frequent use of the headphones.

5.3.1 Battery – Warning (Alarm)
If one of both tensions go down under a limiting value of 10,5 Volt there will appear in the first line right one or 2 additional signs as R for receiver and/or L for Logger. The reaction time for this display will last approx. 2 minutes.

I-Ant 2..norm...E.L.  
Start key red...M.  
■ ■ ■ ■ ■ ■ ■ ....6,0  
■ ■ ■ ■ ■ ■ ■ ■ ....9,1  

This means enough time in order to end the measuring operation accordingly.

If one of both tensions is going down under the limiting value of 10,0 Volt the display will show

Accu exhausted...  
Receiver...9,0....  
Logger......8,9....  
.................  

The reaction time on this display will be 1 minute.

**There is no proper measuring possible in this case**

5.4 Supervision of the logger (memory)

The logger offers storing place for approx. 32.000 reading points. If this figure should be reached actually the follow display will appear

Logger full........  
...............  
...............  
...............  

In this case you still can measure by receiver; a storing will be not possible.

6. Operation of EMFAD-UG12 TRX1

The transmitter should be operated at least 150 m away of the area to be searched. A less distance could cause an overload (overl) in the receiver.

- To build up the antenna, you have to connect the 4 antenna cable and form them to a square.
- Plug 2 yellow plugs into the rear side of the transmitter casing into the yellow sockets

- Switch the 0/1-switch to the 1 -position and press the red start button.

- The Volt meter should show the battery power and the Ampere meter should show the current flow (power which is transferred into the ground.

- Start with a power of about 200-400 mA and increase if necessary with the potentiometer. Make sure, that the transferred power is not too big and the Receiver shows an overload (overl.) in the display.

- To turn the unit off you have to switch the 0/1 switch to 0-position.

- If the voltage drops below 10 Volts the unit switches off automatically and can not be restarted before the battery has been recharged.

- To avoid damage of the Battery because of an improper connection of the charger plugs the unit has a Fuse 1.25 mA slow.
- There special battery charger with a red and a black plug have to be connected with the accompanying sockets of the transmitter. The reloading stops automatically when the recharging has been finished. (See also the manual of the charger)

- Do not expose the transmitter to bright sunlight because the casing warms up to much.