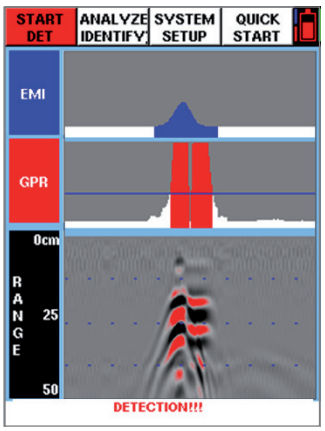
Mine Detector MTD-3

Capable to Measure Shape or Explosive Content in Addition to Metal Content

MBI SAVUNMA VE ALANI ARAMA TEKNOLOJİLERİ SANAYİ A.Ş.

MBI Defence Corp.

Owners Operators Manual / Workshop Repair Manual



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HAND-HELD MINE DETECTION SYSTEM (MTD-3) IS A DUAL-SENSOR DEVICE DESIGNED IN ORDER TO DETECT AND IDENTIFY METALLIC (FERROMAGNETIC) AND NON-METALLIC MINES.

THE SYSTEM POSSESSES ALL THE PROPERTIES OF TRADITIONAL METAL DETECTORS; ADDITIONALLY IT HAS THE CAPABILITY OF DETECTING NON-METALLIC OBJECTS AND PROVIDING THEIR UNDERGROUND VISUALIZATION DATA TO THE USER.

THE AUTOMATED DATA THAT THE SYSTEM GENERATE CONTAINS INFORMATION ASSISTING THE OPERATOR TO DECIDE, AND THE FINAL DECISION OF DETECTION & IDENTIFICATION IS SUPPOSED TO BE MADE BY THE OPERATOR HIMSELF.

THE DETECTION AND IDENTIFICATION PERFORMANCE OF THE DEVICE MAY VARY ACCORDING TO THE ENVIRONMENTAL CONDITIONS AND THE USAGE OF THE OPERATOR.

WHILE THE SYSTEM IS RUNNING, IT SHOULD NOT BE KEPT OVER HIGH METAL CONTAINING OBJECTS FOR A LONG PERIOD OF TIME.

THE SENSITIVITY SETUP OF THE METAL DETECTOR SHOULD BE REMADE WHENEVER THE SOIL PROPERTIES OF THE SCANNING AREA CHANGE.

THE MANUFACTURING INSTITUTION CANNOT BE HELD RESPONSIBLE FOR THE INAPPROPRIATE USAGE OF THE DEVICE.

MTD-3 BASIC FEATURES

1. MTD-3 is a device designed for detecting buried objects, providing underground vision and obtaining a prediction about identification, i.e. whether a buried object is a mine or not.
2. MTD-3 device is capable of detecting metallic (ferromagnetic) objects by the metal detector (EMI sensor).
3. MTD-3 device can detect non-metallic objects by the GPR sensor.
4. MTD-3 device runs on two main modes being **DETECTION** and **IDENTIFICATION**.
5. In MTD-3, EMI and GPR sensors can work together, or one by one; and in necessary conditions they can both be turned off.
6. After MTD-3 device is prepared to be ready for usage:
   a. In the **DETECTION** mode, the user travels the search head in the territory to be scanned, and he determines the points where detection occurs.
      i. While the user is locating the center of the object, in addition to the data flowing in EMI, GPR and underground cross-section parts, he also uses his subjective evaluation and personal opinion.
      ii. Detection result may differ according to regional properties.
   b. Over the points of detection, **IDENTIFICATION** mode can be selected, and a prediction about the buried object type can be retrieved. For this purpose, an identification scan is carried out over a linear trajectory of 1m provided that the object is in the middle of that line.
      i. By the algorithms running on MTD-3, the predictive identification result about the type of the buried object is conveyed to the user by such written message: MINE or OTHER OBJECT.
      ii. The identification result created automatically by the system is just a prediction, based on a dataset previously collected from a controlled test site and it should be considered as an assistant for the final decision of the operator.

c. Identification result may differ according to the variations in soil properties. The user should remember that the identification result is an estimation and he should take his personal assessment and experience into account while taking the final decision.

7. It has to be considered that there may be cases of missing the detection of some targets, especially if small objects are relevant.
8. GPR detection rate may decrease in humid and electromagnetically lossy environments.
9. Detection and identification performance may vary with respect to the scanning speed and the variation of height from the ground. Scanning speed is expected to be around 40cm/s. The search head should be moved parallel to the ground and of 5cm height above the ground level.
10. The batteries reach their optimum performance after a couple of full discharges and recharges.
11. The connectors on the electronic hardware unit must be covered with the plugs on them, when they are not being used.
12. MTD-3 should be turned off from the on-off switch on the electronic hardware unit.
13. In case of any problems related with the battery block or if it becomes unusable, battery block shall not be disposed. It is expected to be returned to the manufacturing institution.
14. According to MILSTD-810G Method 512.5, Procedure I, search head is capable of operating underwater up to 80cm depth during 30 minutes.
15. When two MTD-3 devices are being used in the same location, they should be kept at least 6m apart.

VERSION TRACKING FORM

Version	Explanation	Chapter / Page No	Date of Change

CONTENT

LIST OF APPENDICES

There are no appendices included in this document.

LIST OF FIGURES

LIST OF TABLES

There are no tables included in this document.

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1 INTRODUCTION

1.1 PURPOSE

The purpose of this document is to provide the necessary information for the usage and the maintenance of Hand-Held Mine Detection System (MTD-3).

1.2 SCOPE

The user-level knowledge required for the appropriate utilization of MTD-3, system operation steps, settings and maintenance information for long-term usage can be found in this manual.

1.3 DEFINITIONS

Buzzer is the component which transforms electricity signal into sound.

Detection calibration part is a cylindrically shaped piece, made of dielectric (plastic) material outside, containing a metal part inside. It has a diameter of 5.6cm and a height of 6cm. It is used to test the sensitivity of the two sensors which are GPR (Ground Penetrating Radar) and EMI (Electromagnetic Induction).

Scanning arc is the trajectory that the search head follows during the scanning of the area.

1.4 ABBREVIATIONS

BIT Built-In Test

EMI Electromagnetic Induction (Metal Detector)

MTD-3 Hand-Held Mine Detection System
(In Turkish: Elde Taşınabilir Mayın Tespit Sistemi)

GPR Ground Penetrating Radar

LCD Liquid Crystal Display

2 PRESENTATION OF THE SYSTEM

MTD-3 is a portable system developed for the purpose of detection and identification of landmines, which can detect and identify metallic or non-metallic landmines by operating EMI and GPR sensors synchronously.

While the system is running, as well as EMI and GPR sensors can be used together at the same time; they can also be used separately, one at a time. In separate usage, when the EMI sensor is selected, only buried metallic objects are detectable. When the GPR sensor is selected, the objects (both metallic and non-metallic) which create an electromagnetic discontinuity are detectable.

MTD-3 user interface is comprised of an LCD screen, 3 (three) pushbuttons positioned on the handle and a headphone/buzzer. The user can navigate through the menu by the left and right pushbuttons and select the relevant action by pressing the middle button.

The system has two running modes being **DETECTION** and **IDENTIFICATION**. Signals obtained from the sensors are processed and when detection occurs, the user is alerted by audiovisual warnings.

In the **DETECTION** mode, the signals produced by the sensors are shown to the user via the LCD screen. In case of detection of a buried object, a written message is displayed on the screen, and a beep sound is heard from the headphone/buzzer; those are the audiovisual warnings for the operator. There are two distinctive beep sounds, each for one of the two sensors: GPR and EMI. Detection beep sounds are generated according to the detections of the currently active sensor(s).

User might proceed to the **IDENTIFICATION** mode, pursuant to a reception of a clear detection signal. A sensitive scan is made along a scanning curve of 1m length, while coinciding the probable location of object center with the medium point of the scanning curve. Making

sure that the scanning speed to be around 40cm/s and the height of the search head from the ground level to be around 5cm will increase the accuracy of identification. At the end of this procedure, user would make his final decision about the buried object with the assistance of the identification result guessed by the device.

EMI and GPR sensors must both be operating in order to create a reliable identification prediction. The appearance of identification results for landmines appears as MINE on the screen, for objects other than mines appear as OTHER OBJECT . Identification prediction result is reported to the user by a written message on the LCD.

MTD-3 detection and identification algorithms were developed according to the analysis of a series of datasets collected from a controlled test site located in TÜBİTAK BİLGEM campus. These datasets consist of data belonging to different objects (mine & other) buried in several depths in various soil types. During data collection, search head was driven by a robotic system 5cm above ground level, while completing 1m scan in 2.5 seconds (i.e. 40cm/s).

MTD-3 user is supposed to be observing the results created automatically by the system; and while gaining experience by interpreting the data with his subjective evaluation he should form an opinion about the type of the buried object.

3 SYSTEM UNITS AND ACCESSORIES

MTD-3 consists of a scanning arm, an armrest, an interaction unit, a search head, an electronic hardware unit, a battery block and a headphone. For the remaining part of this document, scanning arm, armrest, search head and interaction unit will be referred as “hand unit”. The accessories provided with MTD-3 are; detection calibration part, battery charger, spare parts catalog, operation and maintenance manual, hanger belt, weight reducing belt, carrying and storage box, carrying case and carrying bag.

Interaction unit and headphone unit are connected to the electronic hardware unit by waterproof connections.

3.1 SCANNING ARM

Scanning arm is a telescopic structure including non-rotating pipes of different radii. Scanning arm contains the armrest, the handle and the search head. Electronic hardware unit cables pass through the scanning arm and connect to the search head.

3.2 ARMREST

Armrest is a non-rotating part on the scanning arm. MTD-3 user puts his elbow on it for carrying the hand unit comfortably. Armrest position could be changed to the desired position by loosening the fixing nut.

3.3 INTERACTION UNIT

Interaction unit provides the communication between the user and the device. User could select different modes and view the menu using pushbuttons located on the handle. Selections of the user and scanning results are displayed on the LCD screen. User could make his

detection and identification decision according to the audio warning and the graphics displayed on the screen.

3.4 SEARCH HEAD

Search head is the sub-unit including GPR antenna and EMI coils. It has an elliptical structure which has 30cm of long axis and 19cm of short axis.

3.5 ELECTRONIC HARDWARE UNIT

Electronic boards operating the system are inside the electronic hardware unit. Hard case of this unit is waterproof. On the body of electronic hardware unit, there are two connectors reserved to the interaction unit and the headphone unit. In addition, battery block and on-off switch are located on the electronic hardware unit body.

3.6 BATTERY BLOCK

A battery block is produced of two rechargeable Li-Ion cells and has a duration of at least 4.5 hours of operation. According to the environmental conditions battery can last up to 4.5 hours. Operating temperature interval is from -10°C to +55°C. Full charge of a dead battery takes 4 to 5 hours fed with 220V AC or 24/12V DC car charger. While the system is on, the level of battery is shown on the top right corner of the LCD screen.

3.7 HEADPHONE/BUZZER

There are two channels of hearing the sounds from the device: one from the buzzer (out loud), and the other from the headphone (for the user's personal hearing). User can hear the audio warnings from one or the other. When headphone connector is attached to the hardware unit, the sound is heard from the headphone and it can no longer be

heard from the buzzer. Once the headphone is unplugged, audio warnings are given from the buzzer.

3.8 DETECTION CALIBRATION PART

Detection calibration part enables the test of functionality of the system in the **DETECTION** mode. To calibrate the system:

1- MTD-3 is positioned on a suitable platform horizontally i.e. parallel to the ground.
2- Calibration part should be located 5cm in front of the search head.
3- It is connected to a non-metallic rope or band, and it is waved sideways.
4- While swinging the detection calibration part, there should be nothing else in front of the search head.
5- Detection mode is functional if both of the sensors respond to the movement of calibration part.

3.9 BATTERY CHARGER

To charge the MTD-3 battery block, battery charger is used, which could run on 220V AC or 24V/12V DC car charger.

3.10 SPARE PARTS CATALOG AND OPERATION & MAINTENANCE MANUAL

Spare parts catalog is a document describing system accessories, units and sub-components in detail.

Operation and maintenance manual gives information about the installation and the usage of the system.

3.11 HANGER BELT

Hanger belt is an accessory that helps carrying the electronic hardware unit over the shoulder.

3.12 CARRYING CASE

Device units and accessories are placed in their unique holes on the supportive sponge inside the carrying case. Carrying case is waterproof.

3.13 CARRYING BAG

Carrying case could be put inside the carrying bag and the bag could be carried as a backpack.

3.14 CARRYING AND STORAGE BOX

Carrying bag could be put inside the carrying and storage box. Handles are located on two sides and wheels are located on one side of the box.

3.15 WEIGHT REDUCING BELT

Weight reducing belt is an assistant material to decrease the load on the user's arm.

4 CARRYING THE SYSTEM

When not used, MTD-3 is kept inside the carrying and storage box, and while transferring it from one place to another, carrying and storage box is utilized. There are wheels on one side of the box. It can be held by the handle on the short side and dragged like a suitcase on its wheels; or it can be carried by holding the handle on the long side. In Figure 1, the usage of the carrying and storage box is presented.

a) Dragging the carrying and storage box

b) Holding the carrying and storage box by hand

Figure 1 Usage of carrying and storage box

5 INSTALLING THE SYSTEM

MTD-3 user is required to make the necessary connections regarding the system, before proceeding to the scanning operation. In that context, after taking the system out of the carrying and storage bag and/or carrying case, he should connect the components by their connectors as described below, and make necessary physical adjustments for his own usage. Appearance of the carrying and storage box is shown in Figure 2.

Figure 2 General view of MTD-3 carrying and storage box

The buttons of latches on the sides of MTD-3 carrying and storage box are pushed and by turning the latches upwards, the box is opened. Opening steps of the box are shown in Figure 3.

a) Pushing the buttons on the latches

b) Turning the latches upwards

Figure 3 Opening the carrying and storage box

Inside the carrying and storage box, carrying bag is present; and inside the carrying bag, carrying case can be found. MTD-3 units and accessories are all put in their own place carved in supportive sponge block inside the carrying case, shown in Figure 4.

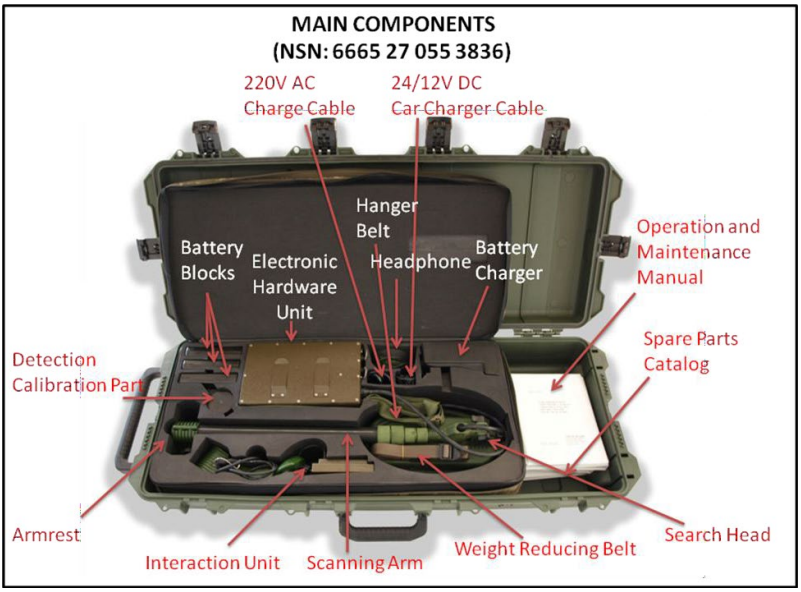


Figure 4 Components and accessories in carrying and storage box

MTD-3 components are taken out of the carrying case and mounted in the following order:

1. From holding the joint of the search head and the scanning arm, the hand unit is gently pulled upwards with one hand; the armrest is also pulled upwards with the other hand. Displacement of the hand unit is shown in Figure 5.

Figure 5 Displacement of the hand unit

2. In order to take the electronic hardware unit out, it is pulled up a little by holding from the hanger belt. Then the unit is grabbed with both hands and taken out. The picture of dislocating the electronic hardware unit is given Figure 6.

a) Pulling hanger belt

b) Holding electronic hardware unit

Figure 6 Dislocating hardware unit

3. Interaction unit is taken out by holding from the handle part. Figure 7 demonstrates the action.

Figure 7 Taking the interaction unit out

4. Handle handcuff is unlocked by twisting and loosening up the handle bolt. Interaction unit is placed on the scanning arm at an appropriate level for comfortable usage. Then the handle bolt is tightened and fixed. Attachment of the handle unit to the scanning arm is shown in Figure 8.

a) Loosening up the handle bolt

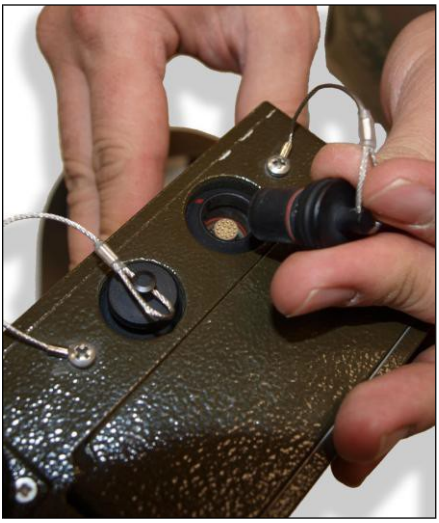
b) Unlocking the handcuff

c) Attaching the handle to the scanning arm

d) Attaching the handle bolt

Figure 8 Placement of the handle on the scanning arm

5. The connector plugs on the electronic hardware unit and the interaction unit cable are released. The red dots on the ends of the connectors are aligned with each other, and they are connected afterwards. The connector of the interaction unit is mounted to the hardware case as in Figure 9.



a) Releasing connector plug

b) Plugging the connector while aligning the red dots

Figure 9 Connecting interaction unit connector to the hardware unit

6. Headphone connector plug is taken out. The red dots on the connectors are aligned. The connection between the headphone connector and the electronic hardware unit is demonstrated in Figure 10.

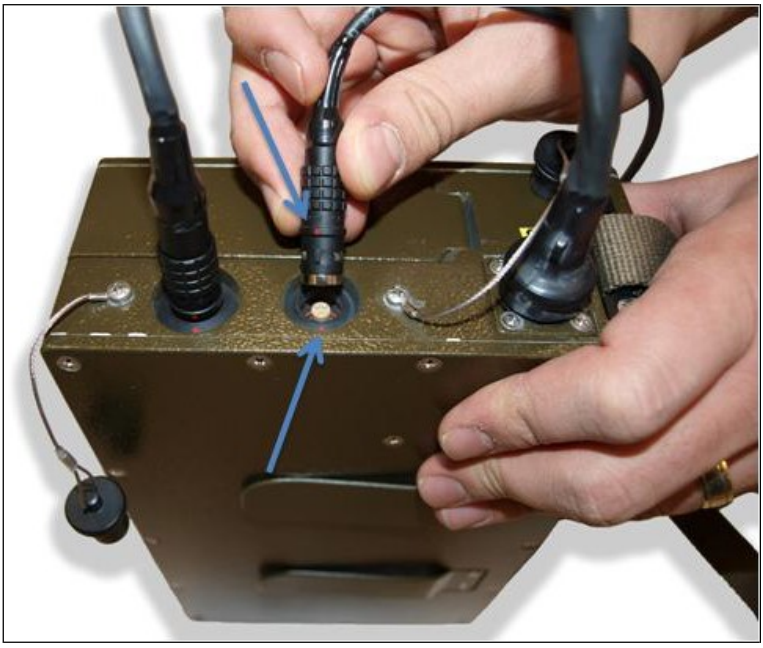


Figure 10 Plugging the headphone connector

7. Electronic hardware unit can be carried using the hanger belt. This action is shown in Figure 11.

Figure 11 Carrying electronic hardware unit via the hanger belt

8. If desired, electronic hardware unit might also be carried by fastening to a bandolier using the bandolier latches. This type of carrying is demonstrated in Figure 12.

a)

b)

Figure 12 Fastening electronic hardware unit to bandolier

9. Scanning arm is extended and adjusted according to the height of the user, and the length of the arm is fixed by tightening the nuts. The adjustment of scanning arm length is shown in Figure 13.

a) Loosening up pipe nuts

b) Extending the scanning arm

c) Scanning arm is ready to use.

Figure 13 Extending scanning arm and adjusting its length

10. By changing the angle between the scanning arm and the search head, search head is positioned parallel to the ground, as in Figure 14.

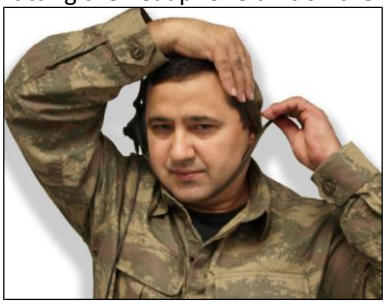
a) Initial state of search head

b) Search head is ready to use.

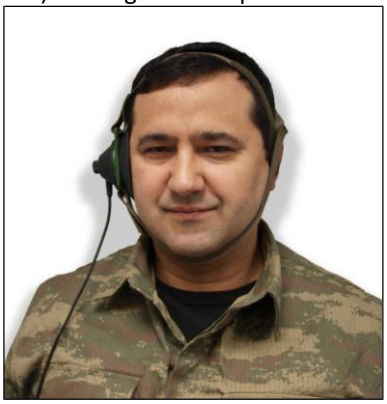
Figure 14 Positioning the search head parallel to the ground

11. Headphone unit is put on the head by its belt and fixed as shown in Figure 15.

a) Putting the headphone unit on the head



b) Fixing the headphone unit



c) Headphone is ready to use.

Figure 15 Putting the headphone set on

12. Weight reducing belt could be utilized for decreasing the load on the user's arm. The attachment steps are pictured in Figure 16.

a) Attaching weight reducing belt to the lower pipe

b) Fastening weight reducing belt

c) Appearance of weight reducing belt after fastening

d) Fastening weight reducing belt to the bandolier

e) System is ready to use.

Figure 16 The usage of the weight reducing belt

13. When the system's detection functionality is desired to be tested, detection calibration part is used. Detection calibration part is tied with a band, hung down in front of MTD-3 head and waved sideways as in Figure 17. It is required to check whether the system is detecting the calibration test part with both of the sensors.

a) Fastening the band

b) Tightening the band

c) Testing

Figure 17 Utilization of the detection calibration part

5.1 USAGE OF THE CARRYING BAG

Carrying bag is designed to be carried on the back of the user during military transition. There is a waterproof carrying case inside the carrying bag. The external and internal appearance of the carrying bag is given in Figure 18, and its usage is given in Figure 19.

a) Top view of the carrying bag

b) Carrying case inside the carrying bag

Figure 18 Carrying case and the carrying bag

a) Carrying bag on the shoulder

b) Carrying bag on the back

c) Carrying bag lower belt is fastened.

d) Carrying bag upper belt is fastened to the chest.

Figure 19 Usage of the carrying bag

5.2 INTERFACE AND MENU STRUCTURE

MTD-3 user interface includes LCD screen, pushbuttons and headphone/buzzer. User can navigate through the tabs and select the desired function. The navigation through the tabs is realized by clicking the right/left pushbuttons; selecting the relevant action is done by clicking the middle button. The pushbuttons and their functions are shown in Figure 20.

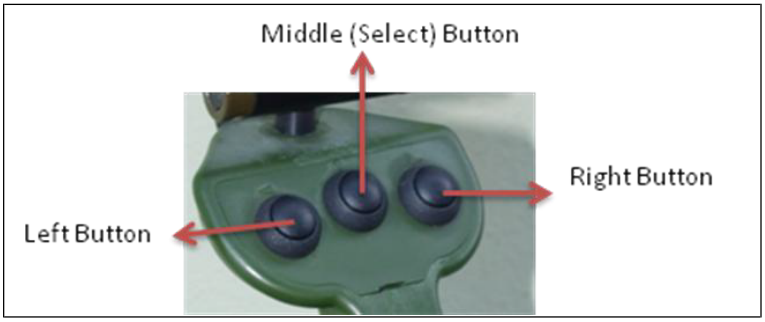


Figure 20 Functions of the pushbuttons

6 USAGE OF THE SYSTEM

Tab-based menu hierarchy of MTD-3 is given in Figure 21. By using right/left buttons, relevant tab is found, and then that function is chosen by the select button.

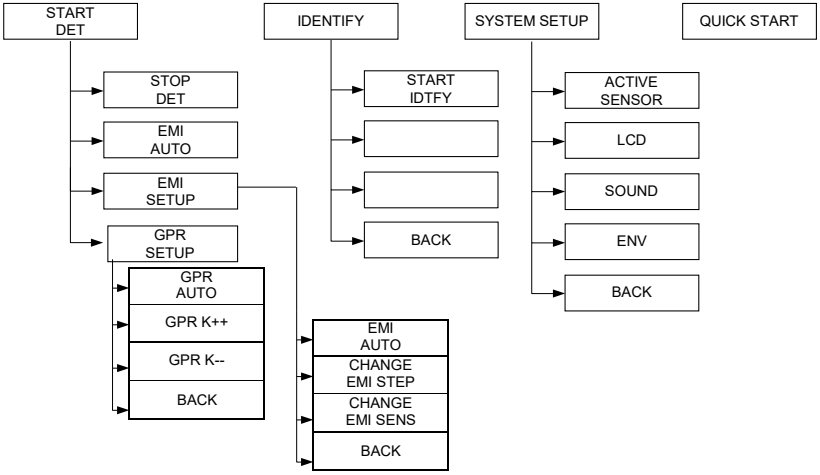


Figure 21 General menu structure

MTD-3 menu design is based on the graphical user interface shown in Figure 22.

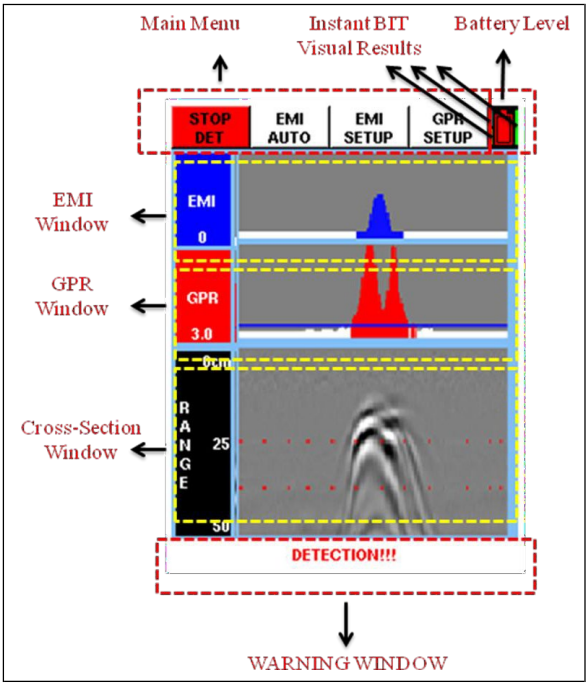


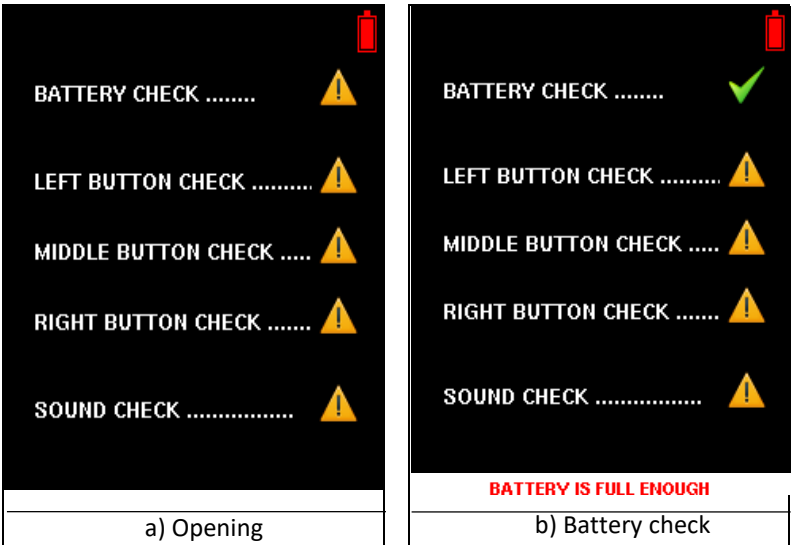
Figure 22 MTD-3 graphical user interface

System operation steps are given below.

1. MTD-3 device is turned on by switching it from KAPALI (off) to AÇIK (on) from the on-off switch on the electronic hardware unit. Figure 23 shows how to turn the system on.

Figure 23 Switching the system from off to on

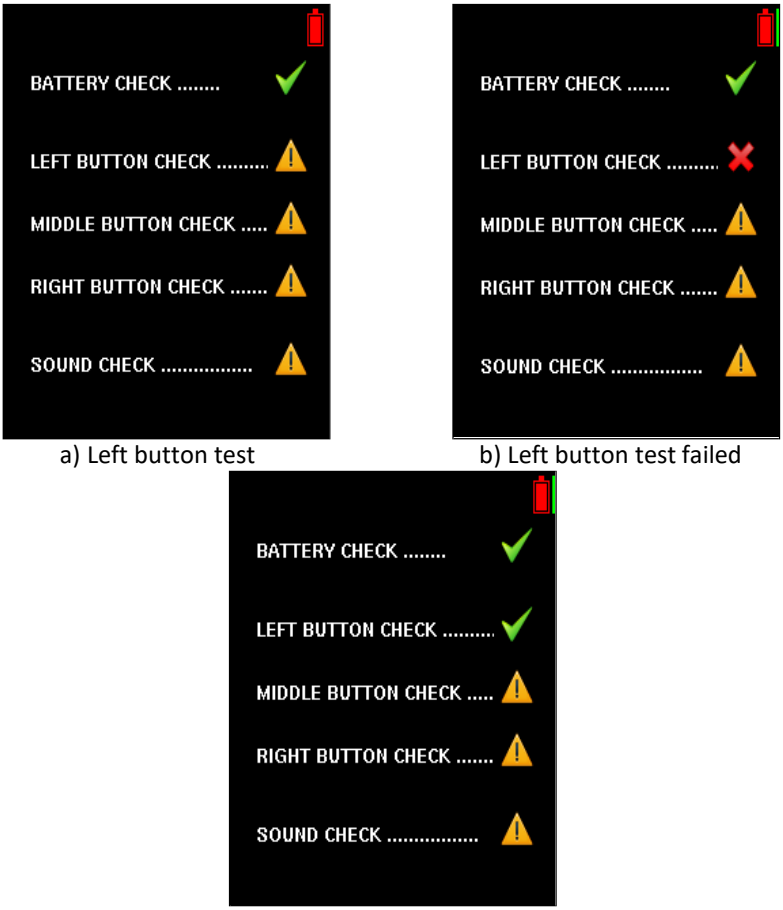
2. When turned on, the system runs an internal battery check. If the energy level of the battery is enough to operate the system, " ⚠ " symbol changes to " ✓ " symbol. Figure 24 shows battery testing steps.



a) Opening b) Battery check

Figure 24 Battery test steps

3. After that, the system checks the functionality of the pushbuttons; during the test of every button, " " symbol flashes in the related line. When that sign is observed, the user is expected to push the desired button, otherwise the test fails. If the test is successful, " "symbol changes to " " symbol, if the test fails " "symbol turns into " " symbol. Regarding the left button check, success and failure cases are given in Figure 25.



a) Left button test

b) Left button test failed

c) Approval of left button functionality

Figure 25 Pushbutton checks

If the user waits more than 10 seconds to push the button, or if a problem occurred regarding the button, the system warns the user with a message appearing on the warning window below. After 15 seconds, the built-in test (BIT) starts for the second time. If BIT fails again, the warning message in Figure 26 appears on the screen. The system needs to be shut down from the on-off switch on the electronic hardware unit. On the next restarts if the error still exists, there is a problem with the related pushbutton. In that case, the device should be sent to the authorized technical service of the manufacturing institution.

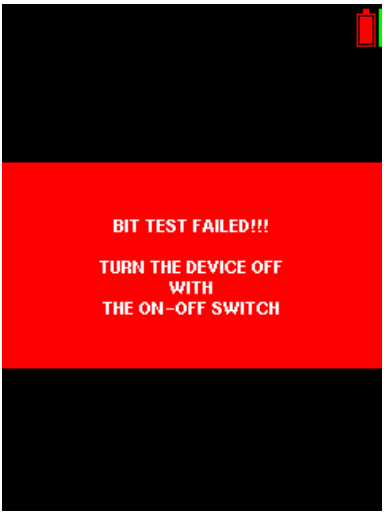


Figure 26 Failure of built-in test for the second time

4. The system proceeds to the sound check part and the related " symbol flashes, if the pushbuttons are working properly. When a beep sound is heard from the system, it is required to push any button within 10 seconds. If the user waits more than 10 seconds or if any problem occurs with the button pushed, the system warns the user with a warning, and then restarts the tests after 15 seconds. The system needs to be shut down from the on-off switch on the hardware unit if the test fails again. In case of the problem persistence, there is a technical difficulty with the sound/headphone/buzzer. The device should be transferred to the technical service. When sound check is done successfully, the interface will be as demonstrated in Figure 27.

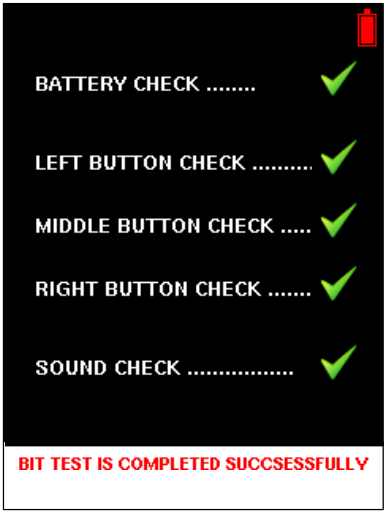


Figure 27 BIT completed

Then the system proceeds to the main menu screen seen in Figure 28.

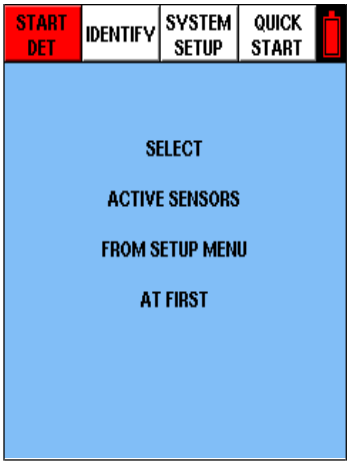


Figure 28 Main menu

5. In the mair menu shown in Figure 28, middle button is pushed when START DET tab is selected, then the screen in Figure 29 appears.

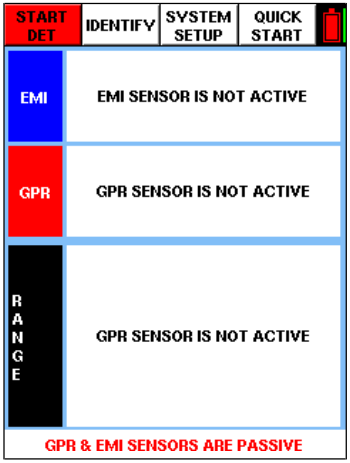
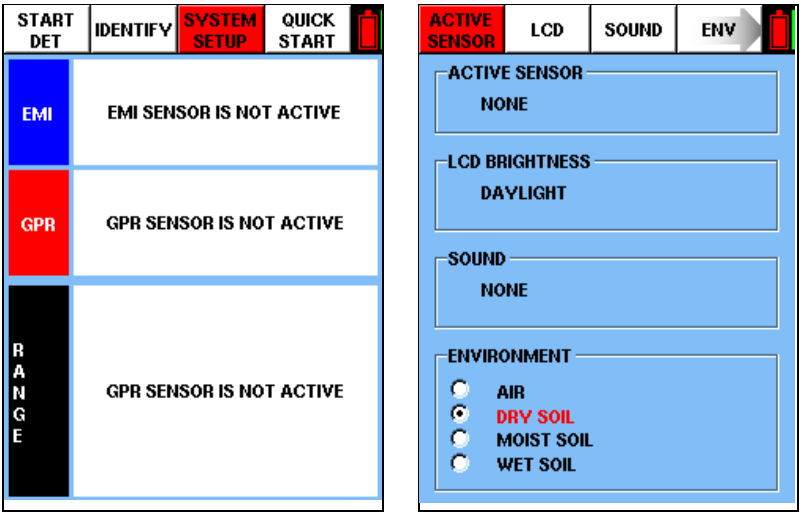


Figure 29 Initial detection screen when the sensors are not activated

In that case, the desired sensor(s) should be selected from ACTIVE SENSOR tab in SYSTEM SETUP menu, and the selection should be done by the middle button. The navigation through SYSTEM SETUP menu is realized as shown in Figure 30.



a) Navigation to SYSTEM SETUP menu

b) SYSTEM SETUP menu appearance

Figure 30 The selection of "SYSTEM SETUP" tab

Every time ACTIVE SENSOR tab is clicked, the sensors could be selected as one of the following configurations:

"GPR & EMI" (both GPR and EMI are active)
"GPR" (only GPR sensor is active)
"EMI" (only EMI sensor is active)
"NONE" (none of the sensors are active)

Then, the user proceeds to the right side of ENV tab, BACK tab is selected by the middle button. A transparent right arrow on the tab menu indicates that the menu continues to the right side. When proceeded to the right, the transparent left arrow appears which indicates that there are tabs on the left side. When navigated

continuously to the right, ACTIVE SENSOR tab is reached again. User interface menu has this circular property.

When BACK tab is clicked and returned to the main menu, the system automatically activates the chosen sensor(s) and returns to the START DET tab. At this point, when START DET tab is clicked by the middle button; the system is ready to be used in the detection mode with the sensors selected before (Figure 31).

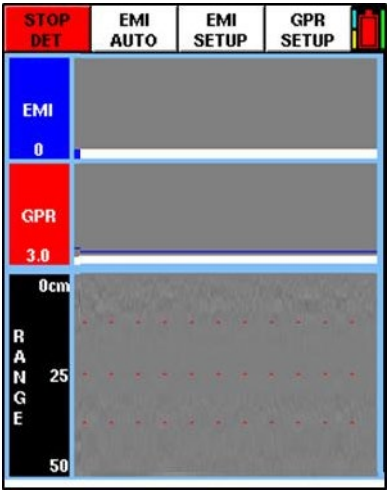


Figure 31 The sensors are active, detection mode is on.

Two vertical flashing bars to left of the battery indicator (Figure 32) show which of the sensor(s) is functioning. The turquoise vertical bar on the top indicates the metal detector (EMI) is operating; and the yellow vertical bar shows that the GPR sensor is running. The green vertical flashing bar on the right of the battery indicator shows that the processor inside the electronic hardware unit is operating. In case of any problem, related bar stops flashing, this means the system has a technical difficulty.

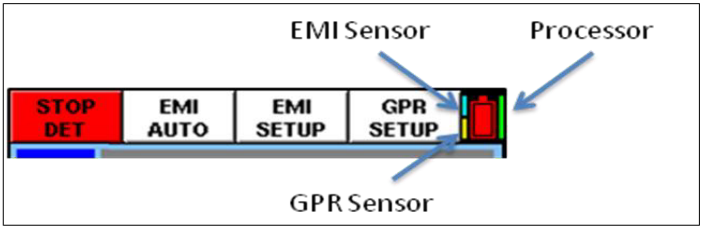
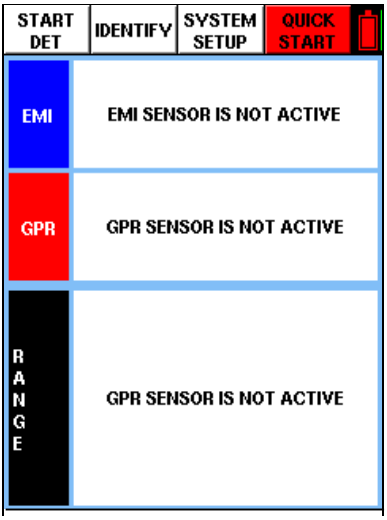


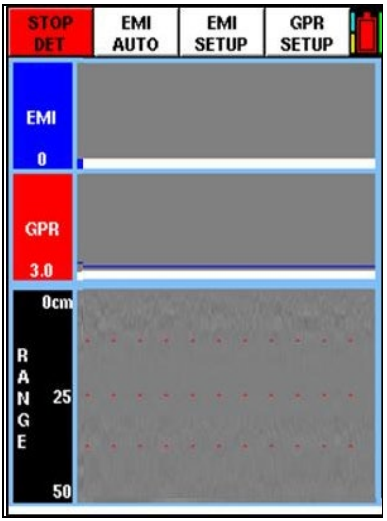
Figure 32 Bars indicating the functionality of the sensors and the processor

The user begins detection scanning after the selection of START DET tab. Approximately in 0.5 second, the system calculates a detection threshold for the GPR sensor, according to the type of the terrain. It is crucial to begin the scanning process just after START DET tab is clicked, in terms of determining an accurate threshold. Threshold level is displayed as a thin blue line on GPR detection window. Automatic GPR thresholding is executed every time START DET tab is chosen. There is a critical point to be paid attention to; when in START DET mode, the search head should begin its scanning over a clean and a target-free area, i.e. there shouldn't be any buried object at the starting point. If the scan starts on an area where an object is present or the search head undergoes unstable movements; it would be difficult to obtain detection warnings with GPR, because of automatic thresholding -which would have high values- due to these unexpected variations.

Another way of starting detection mode is selecting QUICK START tab. Both the sensors are automatically activated when quick start is chosen. Other system configurations are made as shown in Figure 33.



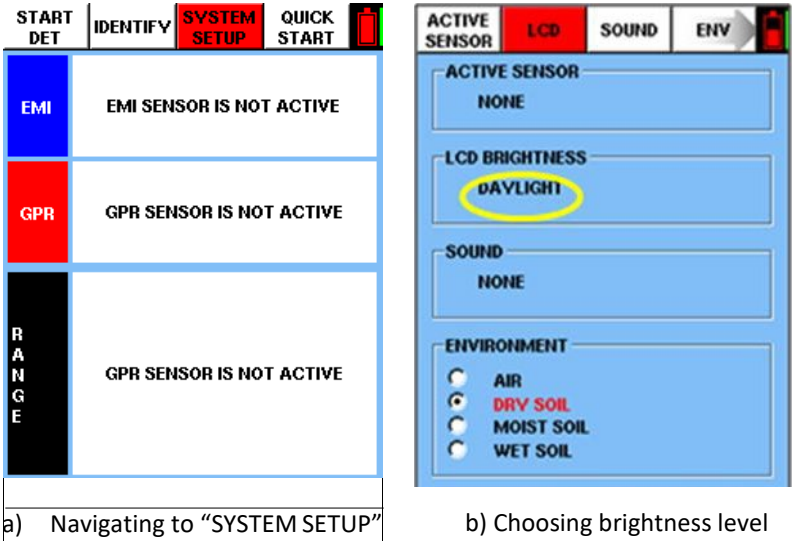
a) Navigating to ”QUICK START”



b) The system is running

Figure 33 Activating the sensors using quick start

6. The brightness of the LCD screen can be selected as one of the following: Daylight, night, disabled. For the adjustment, SYSTEM SETUP tab is found by the right pushbutton and clicked with middle button. LCD tab is chosen by the right button. After that, for every click on the middle button, "DAYLIGHT" (LCD brightness is the highest), "NIGHT" (LCD brightness is the lowest), "DISABLED" (LCD is completely dark) modes can be chosen. This choice is demonstrated in Figure 34. When "DISABLED" mode is selected from SYSTEM SETUP menu and then advanced to the main menu, the system switches to "NIGHT" mode. As soon as the detection mode starts, the screen is blacked out. To exit from the "DISABLED" mode, the user is required to push LEFT, MIDDLE and RIGHT pushbuttons, respectively.



a) Navigating to "SYSTEM SETUP" b) Choosing brightness level

Figure 34 LCD brightness setup

7. If the detection is started by using QUICK START, the sounds of GPR and EMI sensors are on. Turning the operating sensors' sounds off or turning the sound on again can be realized from entering SYSTEM SETUP menu. Every time SOUND tab is clicked, the sound can be customized as one of the following:

"GPR&EMI" (Both GPR and EMI sounds are active)
"GPR" (only GPR sound is active)
"EMI" (only EMI sound is active)
"NONE" (no sound)
When the option "NONE" is active, detection must be carried out by analyzing the screen carefully. Using the system in this mode is not recommended. The sound adjustment is shown in Figure 35.

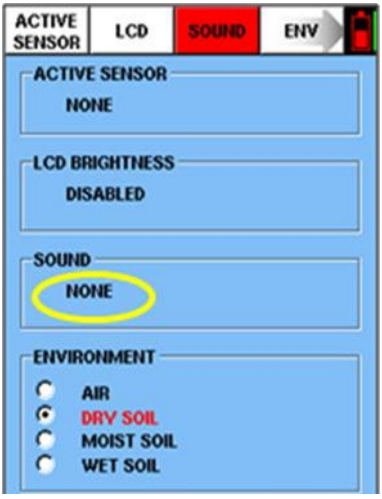


Figure 35 Sound setup of sensors

8. Through ENV tab (stands for environment), the terrain type to be scanned could be selected as one of these modes: "AIR", "DRY SOIL", "MOIST SOIL" or "WET SOIL".
   If the user is going to test the system with detection calibration part (as in Figure 17), he should choose "AIR" mode. After the calibration test, he should reselect soil type according to the scanning area. With respect to the soil type, the depth values on the left of the bottom window -which shows the underground cross-section- changes too. These depth values are intended to give approximate information to the user, and they are not accurate. The system default for the ENV parameter is the "DRY SOIL" mode. Environment selection is pictured in Figure 36.

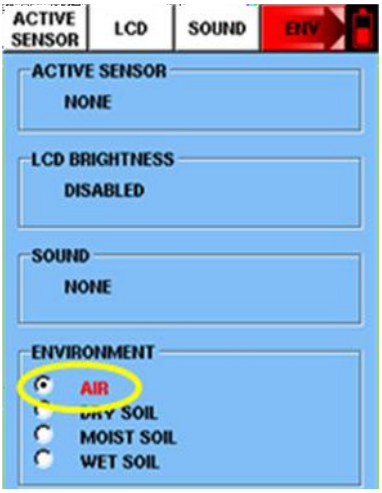


Figure 36 Choosing the environment

9. After the system setup, START DET tab is selected from the main menu and detection procedure begins.

10. For a safe scanning, EMI sensitivity adjustment should be made periodically. For that purpose, EMI AUTO tab is selected from the main menu and the adjustment is done automatically by the system as in Figure 37. So the system adapts itself to the environment in terms of metal density in the soil (for example mineral soil). If the user's opinion is towards that there is a change in the environment, EMI AUTO should be carried out.

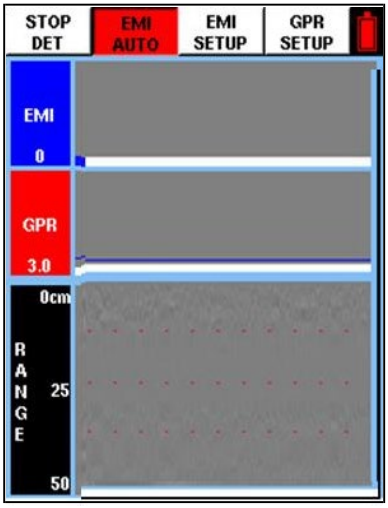
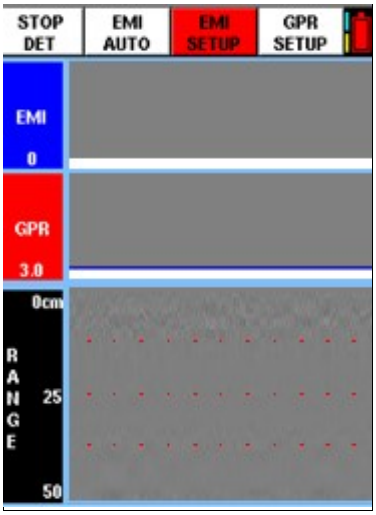
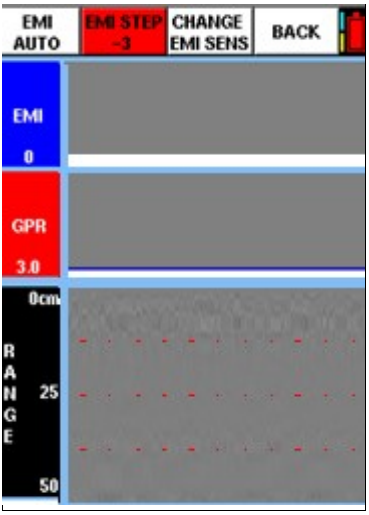


Figure 37 Automatic sensitivity setup of the metal detector

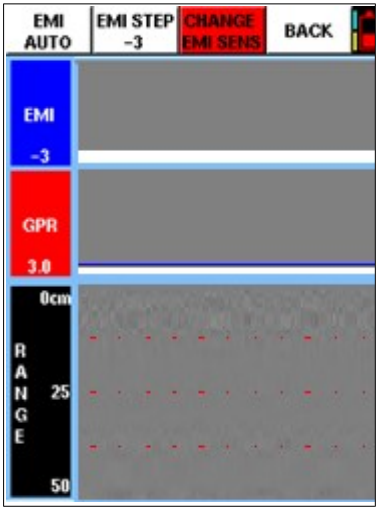
If EMI sensitivity is intended to be done manually, EMI SETUP tab is selected from the main menu (Figure 38-a). EMI step size can be determined as 3, -3, -10 or 10 by pushing CHANGE EMI STEP (Figure 38-b). Negative values mean lower sensitivity, and positive values stand for larger sensitivity. EMI sensitivity level is adjusted by adding EMI step size to the previous EMI sensitivity level for each time CHANGE EMI SENS tab is pushed; that means if EMI step size is positive, it is added up to the previous sensitivity level, but if EMI step size is negative, its value is subtracted from the previous sensitivity level. Updated EMI sensitivity level is shown in white fonts on the blue EMI window. EMI sensitivity can take values from -500 up to +200.



a)



b)



c)

Figure 38 Setting up EMI sensitivity

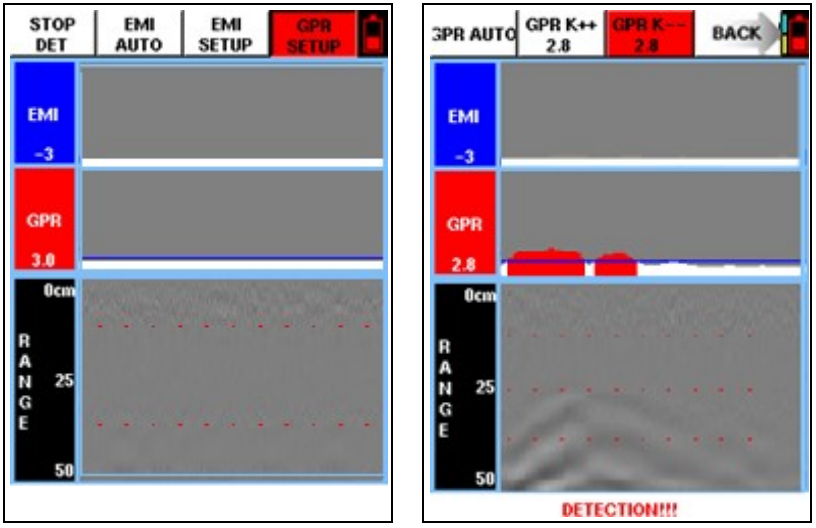
11. When the scanning is to be carried out near a tank, or parallel to a railroad or near any kind of high metallic locations, EMI automatic sensitivity setup is made in the beginning. Later, according to the size of the object being hunted, sensitivity setup is done manually to be more precise. If the object looked for is a low-metallic one, sensitivity should be increased.

12. The detection sensitivity of the object to be found with GPR can be adjusted from GPR SETUP tab. GPR detection threshold value can be changed through GPR K++ and GPR K-- tabs. The "K" value in "GPR K" expression indicates that it is a coefficient. The coefficient value can be changed as in Figure 39. This value is also displayed in red GPR window under "GPR" writing.

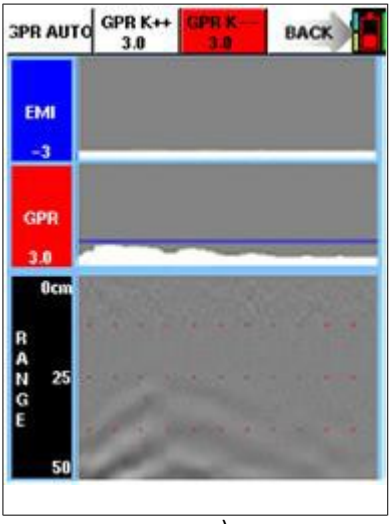
    After START DET tab is clicked, the search head is moved over the area where there is no buried object. Meanwhile the system determines the GPR detection threshold automatically. This value is multiplied by the “GPR K” value chosen and the updated detection threshold is found this way.

    As long as the automatic GPR detection threshold increases, the threshold line shifts to a higher level in the window; and vice versa. While high threshold values decrease false alarms in the territories where the underground cross-section view is bad/noisy; it may cause missing the buried object. On the other hand; keeping the threshold value low increases buried object detection rate, but it also increases false alarm rate. In this context, to be able to interpret the GPR cross-section view and the self-training of the operator is extremely crucial.

    The user scans and advances by scanning 1m linear trajectories. It is important to move the search head 2 or 3cm forward after each scanning act and continue scanning like that, in order not to miss small objects.



a) b)



c)

Figure 39 Changing GPR detection threshold

13. A typical detection screen is captured and given in Figure 40. While a metal containing object is being detected, the graphics flowing from EMI and GPR windows are colored into blue and red.

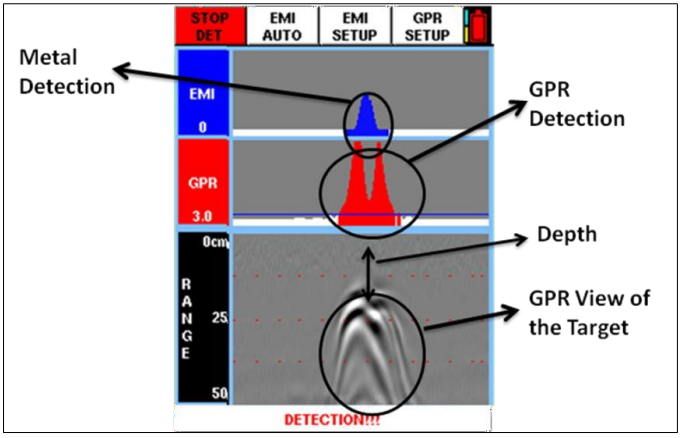


Figure 40 Metal detection (EMI) and discontinuity detection (GPR)

14. When an object is detected, identification prediction could be looked into by selecting IDENTIFY tab. The location of the search head is adjusted so that the detected object would be in the middle of 1m long scanning arc, as in Figure 41.

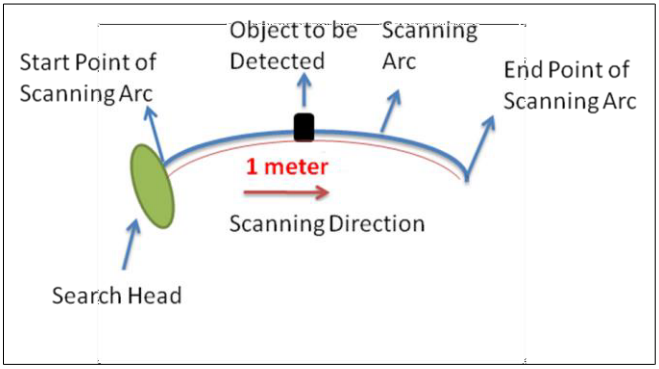


Figure 41 An identification scan

START IDTFY tab is clicked when starting to the scan. Identification result is displayed on the screen after the scanning action is completed. The warning "MINE" is shown on the display if the identification result is a mine; the warning "OTHER OBJECT" is shown if the buried object is not identified as mine. The case is portrayed in Figure 42.

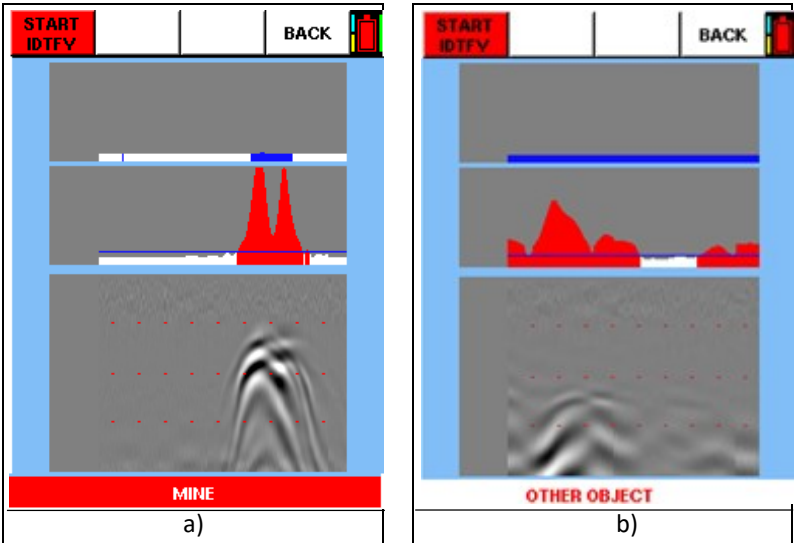


Figure 42 Two samples of identification result

15. When the battery is low, a low battery warning pops out. After this warning message is seen, the system keeps operating at least three more minutes.

7 SYSTEM ERROR AND WARNING MESSAGES

While using MTD-3, the user will come across some warning and error messages. Some of these messages inform the user about system and there is no need for the user to take any action. However, in some cases depending on the content of the message the user is required to perform some action. MTD-3 error and warning messages, on which screen these messages will be encountered and what needs to be done are listed below.

7.1 WARNING-1: BATTERY IS EMPTY!!!

Screen: BIT screen

Reason: It is the message when the battery level is insufficient.

Solution: Insert a full battery.

7.2 WARNING-2: BATTERY IS FULL ENOUGH

Screen: BIT screen

Reason: Indicates the system can operate with the battery present.

7.3 WARNING-3: PRESS THE LEFT BUTTON

Screen: BIT screen

Reason: In order to check whether the left button is working or not.

Solution: Press the left button.

7.4 ERROR-1: LEFT BUTTON IS NOT WORKING!!!

Screen: BIT screen

Reason: If the left button is not pushed on time or left button is dysfunctional, this message appears.

Solution: The system is turned on again, press the left button within 10 seconds. If the same warning occurs, send the device to the maintenance service.

7.5 WARNING-4: PRESS THE MIDDLE BUTTON

Screen: BIT screen

Reason: In order to check whether the middle button is working or not.

Solution: Press the middle button.

7.6 ERROR-2: MIDDLE BUTTON IS NOT WORKING!!!

Screen: BIT screen

Reason: If the middle button is not pushed on time or middle button is dysfunctional, this message appears.

Solution: The system is turned on again, press the middle button within 10 seconds. If the same warning occurs, send the device to the maintenance service.

7.7 WARNING-5: PRESS THE RIGHT BUTTON

Screen: BIT screen

Reason: In order to check whether the right button is working or not.

Solution: Press the right button.

7.8 ERROR-3: RIGHT BUTTON IS NOT WORKING!!!

Screen: BIT screen

Reason: If the right button is not pushed on time or right button is dysfunctional, this message appears.

Solution: The system is turned on again, press the right button within 10 seconds. If the same warning occurs again, send the device to the maintenance service.

7.9 WARNING-6: ALL BUTTONS ARE WORKING

Screen: BIT screen

Reason: If all the buttons are functional, the user is informed by the system through this message.

7.10 WARNING-7: PRESS ANY KEY IF YOU HEAR SOUND

Screen: BIT screen

Reason: This message appears for the sound check of the system.

Solution: Press any button.

7.11 ERROR-4: BUZZER IS NOT WORKING

Screen: BIT screen

Reason: This message appears when the BIT sound check failed.

Solution: Send system to the maintenance service.

7.12 WARNING-8: "LOW BATTERY LEVEL!!! TURN OFF THE SYSTEM THEN CHANGE BATTERY PRESS ANY KEY IF YOU WANT TO CONTINUE"

Screen: Battery warning screen

Reason: When battery level is below the critical level, this message appears on the screen.

Solution: Change the battery of the system.

7.13 ERROR-5: AN ERROR HAS OCCURRED RESTART THE SYSTEM

Screen: Error window

Reason: This error message appears if there is a problem related to one of the following: EMI sensor, GPR sensor, electronic hardware unit.

Solution: Restart the system. If the same error occurs again, send the device to the maintenance service.

7.14 WARNING-9:"EMI SENSOR IS NOT ACTIVE"

Screen: Main screen

Reason: This warning message appears on EMI Window when EMI sensor is not active.

7.15 WARNING-10:"GPR SENSOR IS NOT ACTIVE"

Screen: Main screen

Reason: This warning message appears on GPR window and underground cross-section window, when the GPR sensor is not active.

7.16 WARNING-11:"ONLY EMI SENSOR IS ACTIVE"

Screen: Main screen

Reason: In detection mode, this warning message informs the user that only EMI sensor is active (GPR sensor is inactive).

7.17 WARNING-12:"ONLY GPR SENSOR IS ACTIVE"

Screen: Main screen

Reason: In detection mode, this warning message informs the user that only GPR sensor is active (EMI sensor is inactive).

7.18 WARNING-13:"GPR&EMI SENSORS ARE ACTIVE"

Screen: Main screen

Reason: In detection mode, this warning message informs the user that both GPR&EMI sensors are active.

7.19 WARNING-14:"GPR&EMI SENSORS ARE PASSIVE"

Screen: Main screen

Reason: In detection mode, this warning message informs the user about neither GPR nor EMI sensors are active.

7.20 WARNING-15:"DETECTION!!!"

Screen: Main screen

Reason: This warning message appears when detection occurs on either EMI or GPR sensor.

7.21 WARNING-16: "SELECT ACTIVE SENSORS FROM SETUP MENU AT FIRST"

Screen: Main screen

Reason: This warning message appears on main screen after passing built-in test successfully.

Solution: The user activates the desired sensor by clicking "SYSTEM SETUP" tab of the main menu. Or the user clicks the "QUICK START" tab to active both of GPR&EMI sensors.

7.22 WARNING-17:"COLLECTING DATA"

Screen: Identification screen

Reason: This message is received while collecting data for identification.

7.23 WARNING-18:"MINE"

Screen: Identification screen

Reason: It is a warning message that indicates the result of identification is a mine.

7.24 WARNING-19:"OTHER OBJECT"

Screen: Identification screen

Reason: It is a warning message that indicates the result of identification is another object than mine.

7.25 WARNING-20: "ACTIVATE BOTH GPR & EMI SENSORS"

Screen: Identification screen

Reason: When "START IDTFY" tab is clicked, if both GPR&EMI sensors are not active at the same time, this message appears.

7.26 ERROR-6 : "BIT TEST FAILED!!! TURN THE DEVICE OFF WITH THE ON-OFF SWITCH"

Screen: BIT screen

Reason: This message is received when BIT failed for the second time.

Solution: Switch the system off from on-off switch located on the electronic hardware unit, and then switch it on again.

8 USAGE OF BATTERY CHARGER

MTD-3 battery blocks should be charged by the battery charger shown in Figure 43. Battery charging process is given below. Charging time for an empty battery lasts approximately 4 to 5 hours.

Figure 43 View of the battery charger

Battery charging steps:

a) One side of the battery charger cable is connected to the charger as in Figure 44 ; other side of cable is plugged to 220V AC socket. As battery charger cable is plugged in the socket, "GÜÇ" (Power) and "BOŞ" (Empty) LEDs are on.

Figure 44 Connecting 220V AC battery charger cable to the charger

b) User could charge the battery blocks using 24V/12V car charger cable as shown in Figure 45.

Figure 45 Connecting 24V/12V car charger cable to the charger

c) To start charging the battery; battery contact points and charger contact points are held face to face, then the battery is pushed downwards from the opposite side of the battery block and the spring makes its position fixed. Placing the battery in the charger is pictured in Figure 46.

Figure 46 Placing the battery in the charger

d) When the charger is supplied with energy, "GÜÇ" (Power) and "BOŞ" (Empty) LEDs on the charger are constantly on, as in Figure 47. When charging is complete "DOLU" (Full) LED will be on and it

is going to inform the user. If any problem related to the battery occurs, "HATA" (Error) LED will warn the user. In that case, the battery should be replaced.

Figure 47 The LEDs on the battery charger

e) Once charging is complete, the battery is taken out by pulling it up, as in Figure 48.

Figure 48 Taking the battery out

9 SYSTEM MAINTENANCE AND PROTECTION RECOMMENDATIONS

MTD-3 and its accessories do not often require maintenance, but the concerns below have to be taken into account to increase the lifetime of the system.

- Nothing should be put on the LCD screen of MTD-3 hand unit.
- None of the parts of MTD-3 should be dismantled except for authorized MBI personnel.
- MTD-3 should be kept inside the carrying and storage box when it's not used.
- The system should be cleaned with a soft and wet cloth when needed. Make sure that LCD screen is not damaged during the cleaning process.
- When the temperature is too low, keeping the battery in a warm place would be beneficial.
- Under normal circumstances, minimum running time of MTD-3 with a fully charged battery is 4.5 hours.
- EMI sensitivity setup should be redone periodically for a sensitive and trustworthy detection.
- If there is a twist on the cable of the interface unit, fixing nuts on the scanning arm should be loosened and the search head should be rotated in order to make the cable flat.
- If the search head is not stable (if its tightening component is loosened), the plastic screw between the scanning arm and the search head should be tightened.

SENSOR SYSTEMS

MTD-3

MINE DETECTOR

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