# SMART RFID SYSTEM

# Manual for Smart Marker Locator



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Thank you for buying our Smart Marker Locator!

Policy of Ing. Štefan Sivák – KOMPLEX (further only "Komplex") is continuous development, therefore it reserves right to change and improve product (Smart Marker Locator, further only "SML") described in this document without former notice. Likewise, Komplex reserves right to modify or recall from circulation anytime without former notice.

Komplex is not responsible in any circumstances for loss of data or for particular, accidental, consecutive or indirect damages caused anyhow.

Before you start operate with SML, read carefully following cautions and safety precautions.

## CAUTIONS AND SAFETY PRECAUTIONS

! Changes or modifications not expressly approved by the party responsible for compliance could void the user's authority to operate the equipment!
! Before using SML, acquaint yourself properly with this Manual!
! Use SML only as determined in Manual!
! Use only primary batteries recommended by manufacturer in SML (p. 4, chapter "Technical specification")!
! Used batteries can contain materials contaminating environment, so treat them according to sewage legislation!

SML is sensitive electronic equipment, so it is needed to treat it as well as its parts carefully when using, handling, and transporting it. Following recommendations will help you keep all guarantee conditions and ensure long-term using of this product.

- Keep SML in dryness and in temperature ranges recommended by manufacturer (p. 3, chapter "Technical specification").
- Extremely high or low temperatures can damage SML, so do not leave it behind windowpane or hot engine of car, etc.
- SML or any of its part must not be dipped into water or other liquid, because it could be damaged. If such case happens, do not switch on the device and dry it for several days in standard temperature. If problems remain, contact your supplier or manufacturer.
- Short-term impact of moderate rainfalls and moisture does not damage SML.
- Do not try to open SML or any of its parts. Inexpert manipulation with SML can lead to its damage.
- Rough treatment can damage SML. Big vibrations, hits, or bumps can damage it, so do not leave it e.g. on sleight of trucks during transportation.
- To clean SML, use soft shred damp in water or industrial alcohol.
- Manufacturer is not responsible for defects caused by incorrect using of SML.
- In case of some problems, contact your supplier or manufacturer.

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## INTRODUCTION

Smart Marker Locator and Smart marker is a Radio Frequency Identification (RFID) System, which represents effective way of tracking underground utilities.

Marker is a passive electrical mark intended for permanent marking of selected point under the earth. KOMPLEX offers 2 types of markers: 1st type – analog marker – is a passive electrical circuit of a known frequency and 2nd type – smart marker – complements existing analog (passive) marker by providing more information using its own unique 10 digits identification number.

Smart Marker Locator is a portable device designed for localization and identification of both analog and smart markers. Smart Marker Locator is able to find a marker and define the place and depth of marker imposition and also enables to save marker to Smart Marker Locator memory (smart markers are saved also with their identification number ID).

Moreover, there is GPS module inbuilt in Smart Marker Locator, which improves properties of Smart RFID System. It enables to assign GPS coordinates to each marker (selected point) and back navigation.

An accessory included in Smart RFID System is the software for computer "LOCATOR" and a serial cable for data transfer to and from PC. Software LOCATOR is designed for creation and editing of marker database, such as editing name of marker and its record number, adding advanced text to marker record (some of which can be transferred back to locator to be used in terrain), sorting markers by different attributes, exporting database to Excel files, sending database to Smart Marker Locator and more.

## TECHNICAL SPECIFICATION

| | |
|---|---|
| Operating temperature | - 20 ℃ to + 60 ℃ |
| Storage temperature | - 20 ℃ to + 60 ℃ |
| Guaranteed depth of reading of marker ID | 150 cm |
| Marker depth measurement accuracy | +/- 10 % up to marker specification |
| GPS system error | less than 15 m |
| Operating frequency | According to type of underground facilities (see table at the end) |
| Size  (height x width x depth) | 225 x 240 x 210 mm |
| Weight of device with antenna | Max. 4 kg |
| Memory capacity | 8000 marker records |
| Display type | Backlight LCD screen, 4 x 20 digits |
| Serial port | Standard RS 232 serial port with DB9 connector |

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| Battery life | 45 hours typically |
| --- | --- |
| Device power supply: <br> Primary battery cells, voltage 1,5 V <br> Dimension according to IEC R 14 <br> We recommend alkaline battery cells (due to big capacity, <br> e.g. VARTA 1041). | 10 pcs. |

**CAUTION! Do not use chargeable batteries – accumulators, or primary lithium batteries!**

NOTE 1:      Battery life depends on GPS activity (GPS module On/Off).

## CONTROLS OF DEVICE AND THEIR FUNCTION

**Front Panel**
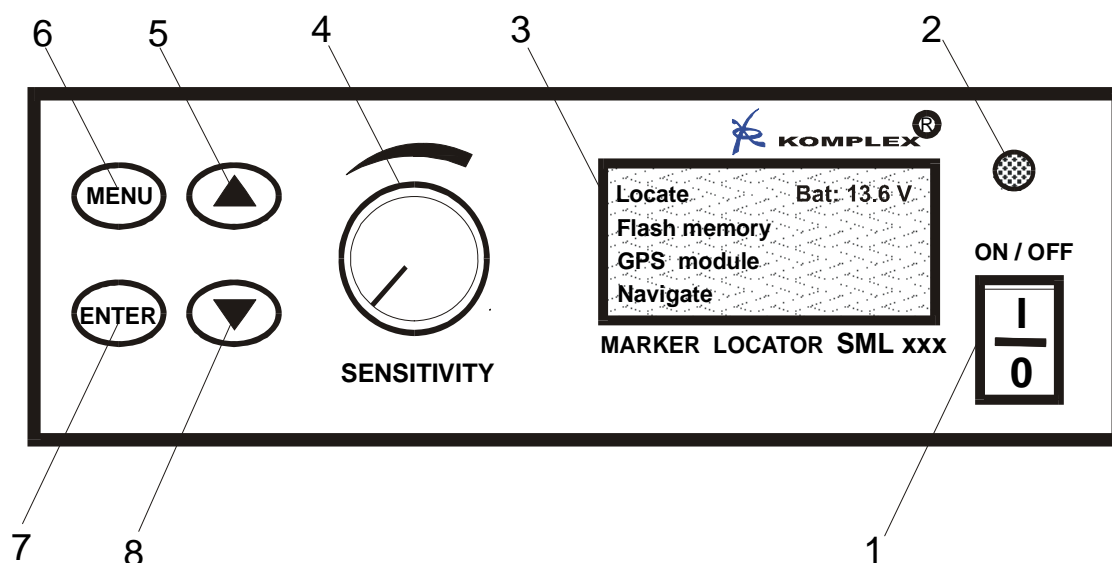


Fig. 1

| 1 | power switch | switching the device on and off |
| --- | --- | --- |
| 2 | acoustic converter | signalizing received echo from marker |
| 3 | display | showing menu of device |
| 4 | sensitivity controller | changing sensitivity |
| 5 | UP button | multifunctional button |
| 6 | MENU button | multifunctional button |
| 7 | ENTER button | multifunctional button |
| 8 | DOWN button | multifunctional button |

**Function of the Front Panel buttons: MENU, ENTER, UP, DOWN**

| MENU | • move down<br>• back<br>• recall menu |
|---|---|
| ENTER | • confirm<br>• recall menu |
| △ | • move up<br>• recall menu |
| ▽ | • display backlight<br>• move down |

**Function of Smart Marker Locator Menu**

After switching the device on, it displays Main Menu (Fig. 2).

```
Locate            Bat: 13.6 V
Flash memory
GPS  module
Navigate
```
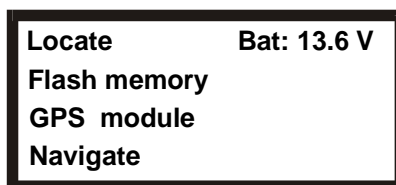
Fig. 2

| Locate | this function enables to locate marker, read smart marker ID, store marker with its record number and GPS coordinates to database, determine marker distance from antenna probe (marker depth) |
|---|---|
| Flash memory | this function enables to send, receive, or erase data in memory |
| GPS module | this function enables to activate/deactivate GPS module |
| Navigate | this function enables navigation to selected marker |
| Bat. 13.6 V | status of battery cells |

**Locate**

Activate function Locate by using MENU button and ENTER button, and device is able to locate markers (Fig. 3).

Smart mode of determining marker depth

Marker depth imposition in meters

```
Locating  Smt       Gps:Off
Dp:0.98m
              I
■ ■ ■ ■ ■ ■
       ENTER to read
```

Depth reference point
Accuracy indicator

Fig. 3

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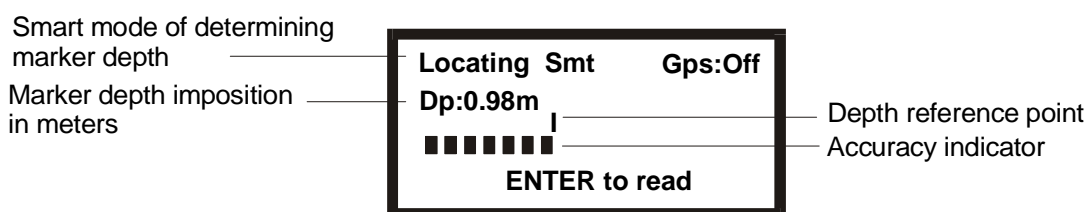*tel: +421 41 5651 497, fax: +421 41 5652 302, komplex@komplex.sk, www.komplex.sk*

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- How to determine marker depth is described in "Determining the Marker Depth" chapter (p. 13).
- How to save marker to Smart Maker Locator memory is described in "Recording the Marker to Smart Marker Locator Memory" chapter (p. 11).

**Flash Memory**

Flash memory menu (Fig. 4) contains possibilities:

**Receive data**
**Send data**
**Erase data**
**Main menu**

Fig. 4

| Receive data | receiving data from PC |
|---|---|
| Send data | sending data to PC |
| Erase data | erasing data in Smart Maker Locator memory |
| • Last record | • erasing last record |
| • All records | • erasing all records (all memory) |
| • Back | • back to Flash memory menu (Fig. 4) |
| Main menu | back to main menu (Fig. 2) |

- How to receive data from PC to Smart Maker Locator memory is described in "Receiving Data from PC into Smart Marker Locator" chapter (p. 14).
- How to send data from Smart Maker Locator memory to PC is described in "Sending Data from Smart Marker Locator into PC" chapter (p. 14).
- How to erase data in Smart Maker Locator memory is described in "Erasing Data from Smart Marker Locator Memory" chapter (p. 15).

**GPS Module**

GPS module menu (Fig. 5) possibilities:

**Gps module      Gps:Off** ⎯⎯ GPS module status
  **On**
  **Off**
  **Main menu**
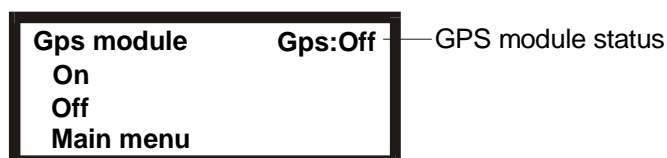
Fig. 5

| On | GPS module activating |
|---|---|
| Off | GPS module deactivating |
| Main menu | back to main menu (Fig. 2) |

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- How to activate or deactivate GPS module in Smart Maker Locator is described in "GPS Module Activating/Deactivating" chapter (p. 15).

**Navigate**

Navigate menu (Fig. 6) possibilities:

```
Navigate              Gps:On
  Enter record number
  Search record
  Main menu
```
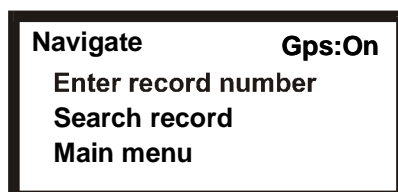
Fig. 6

| Enter record number | inserting record number of marker |
|---------------------|-----------------------------------|
| Search record | searching record number of marker |
| Main menu | back to main menu (Fig. 2) |

**Rear Panel**



9                                    10

Fig. 7

| 9 | connector RS 232 | device to PC connection with serial cable |
|----|------------------|-------------------------------------------|
| 10 | antenna connector | connection of antenna probe with Smart Maker Locator |

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## INITIAL SETUP

### Installing the Batteries

1. Remove the metal battery cover on the underside of device (Fig. 8).
2. Put the new batteries according to figured polarity in device.
3. Fix metal battery cover.
4. Put the device in bag.

Fig. 8

### Antenna Probe Connection

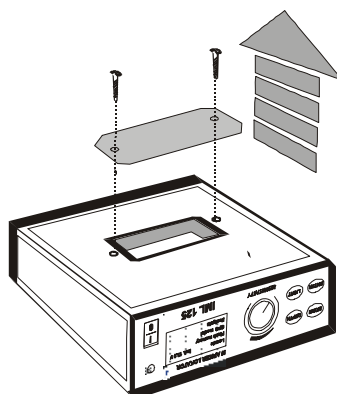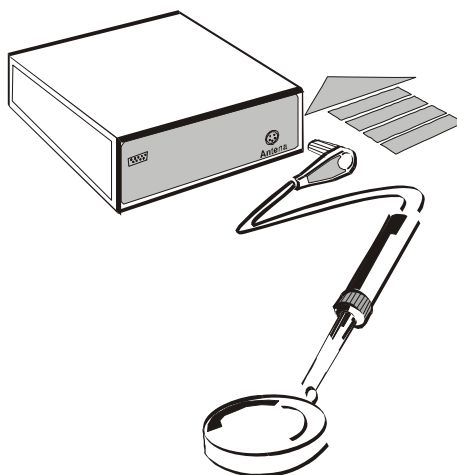Connect antenna by plugging antenna probe cable (Fig. 9) into the connector 10 Fig. 7.

Fig. 9

### Setting the Length of Antenna Telescope

It is possible to set the length of antenna telescope according to service demand in different scale.

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Release telescope female screw of one – two turns. Set the suitable telescope length and fix the female screw (Fig. 10).
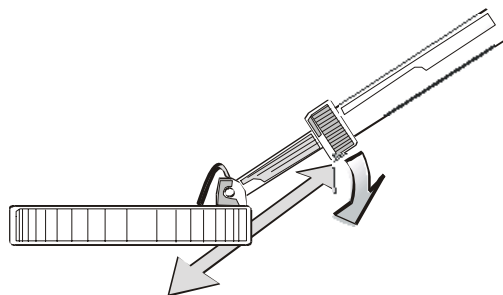
Fig. 10

## Antenna Probe Positions

You can set the antenna probe position by simple turning into operating or transporting position (Fig. 11). Correct operating position of antenna probe is when the probe is horizontally above the ground.

Fig. 11

## Using Ergonomic Crutch

Using ergonomic crutch increases working comfort with antenna probe. The crutch can be fixed on antenna telescope by hooked screw (Fig. 12a, 12b).
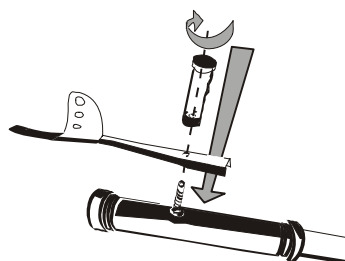
Fig. 12a                                    Fig. 12b

## OPERATION WITH DEVICE

### Searching Markers

1. Switch the device on with a power switch (1, Fig. 1) – display shows main menu (Fig. 2)
2. Press button ENTER and turn the sensitivity controller (4, Fig. 1) to the position with the highest sensitivity.
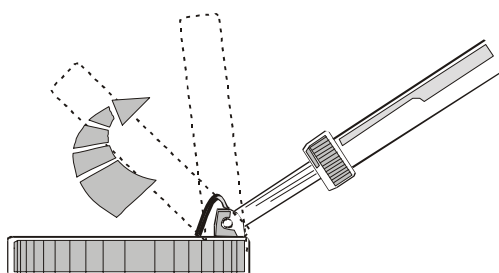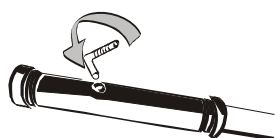3. Move with antenna horizontally above the ground in chosen direction of the walk (Fig. 13).
4. When the marker is in Smart Maker Locator range, device signalizes it by acoustic intermittent tone (7 and 8, Fig. 1) and by accuracy indicator (Fig. 3). Signal intensity rises up toward the marker.
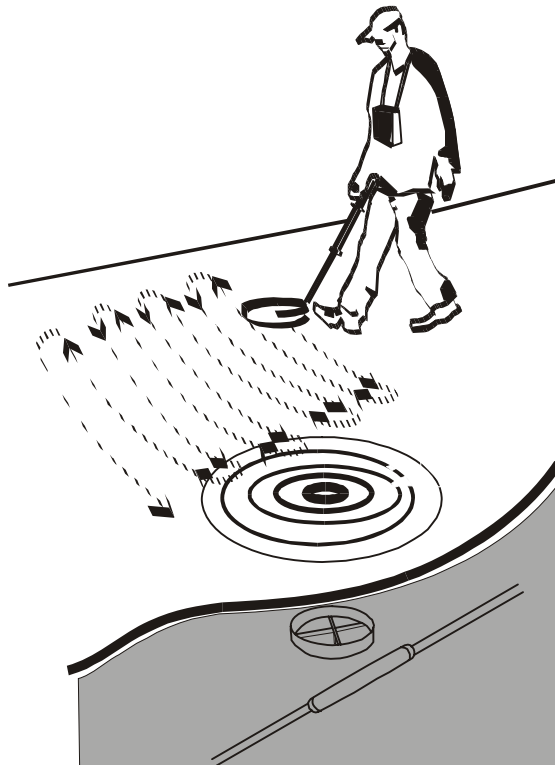


Fig. 13

### Locating Markers

Marker imposition place is equal to maximum signal area. To determine the precise marker imposition place, act according to following instruction:

1. Find the marker according to previous chapter.
2. Move with antenna probe horizontally in several directions above terrain in order to border the area, where device signalizes presence of the marker.

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3. By reducing sensitivity and by repeating procedure according to previous point 2 you will make this area smaller.
4. By multiple repeating of the procedures according to previous points 2 and 3, the area will be reduced to diameter of antenna probe. This is the area of maximum signal and it is equivalent to the place of marker imposition (Fig. 14).



Fig. 14

## Recording the Marker to Smart Marker Locator Memory

After marker localization you can store marker to Smart Maker Locator memory (smart marker is stored with 10 digits unique identification number).
Three alternatives can happen during marker storing to Smart Maker Locator memory:

1. Press button ENTER in Locate menu (Fig. 3) and device will be in reading mode. If device does not recognize any smart marker till 10 seconds, display will show you: Smt. marker not found. Press ENTER. (Fig. 15). Press button ENTER and device will be back in Locate menu (Fig. 3).



```
No:- - - -            Gps:Off


    Smt. marker not found
       Press ENTER.
```

Fig.15

2. If you want to store GPS coordinates of an analog marker, press button ENTER in Locate menu (Fig. 3), and then press button MENU. Then you can select (Fig. 16a): Store analog marker, Main menu, Back. Make required selection by using buttons MENU and ENTER. After storing the marker you will see information of the stored analog marker record. (Fig. 18). Press button ENTER and device will be back in Locate menu (Fig. 3).

   After marker storing you will see stored marker record information (Fig. 16b): record number of stored marker, stored marker name, GPS coordinates of the stored marker. Analog marker does not have 10 digits unique ID. Instead of this number there is shown: FF-FF-FF-FF-FF and "Analog" is displayed as its Stored marker name.
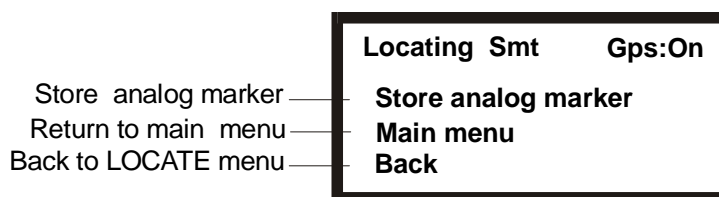
Store analog marker ———
Return to main menu ———
Back to LOCATE menu ———

```
┌──────────────────────────────┐
│ Locating  Smt        Gps:On  │
│                              │
│ Store analog marker          │
│ Main menu                    │
│ Back                         │
└──────────────────────────────┘
```

Fig. 16a

Marker record number ———
Name of the Marker ———

Marker coordinates ———

```
┌──────────────────────────────┐
│ No:0001            GPS :On   │
│ Analog                       │
│ FF-FF-FF-FF-FF               │
│ N2145.420    E04125.324      │
└──────────────────────────────┘
```
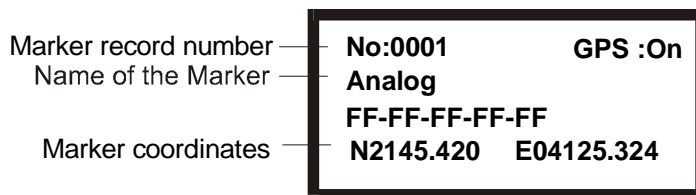
Fig. 16b

3. If device recognizes smart marker, you can store smart marker together with 10 digits unique identification number ID to Smart Maker Locator memory (Fig. 17).

Store smart marker ———

Don't store smart marker ———
and return to reading mode

```
┌──────────────────────────────┐
│                   Gps:On     │
│ Store ?                      │
│ Yes      01-01-7B-E4-A0      │
│ No         Unknow            │
└──────────────────────────────┘
```

——— 10 digits unique ID
——— Smart marker is uknown
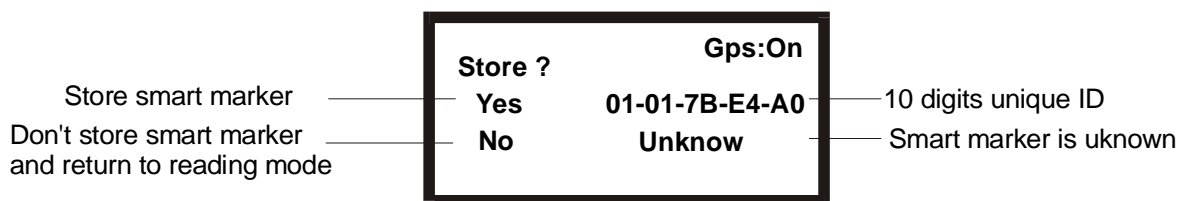
Fig. 17

When you store the smart marker you will then see (Fig. 18): record number of the marker, ID of the smart marker, name of the marker, GPS coordinates of the marker.

Record number of stored marker ———
Stored marker name ———
10 digits unique ID of saved ———
smart marker
GPS coordinate of stored marker ———

```
┌──────────────────────────────┐
│ No:0001            GPS :On   │
│ New                          │
│ 01-01-7B-E4-A0               │
│ N2145.420    E04125.324      │
└──────────────────────────────┘
```

Fig. 18

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Press button ENTER after storing the marker information (Fig. 18) and device will be in Locate menu.
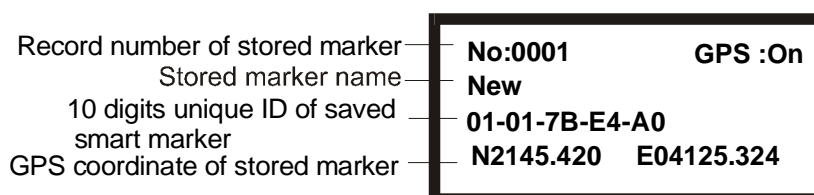Press button MENU after storing the marker information (Fig. 18) and device will offer you more choices (Fig. 19): Locate, Update GPS data, Main menu.

Marker record number ——————— | **No:0004               Gps:On**
Return to Locate menu (Fig.3) ——————— | **Locate**
Update GPS data ——————— | **Update Gps data**
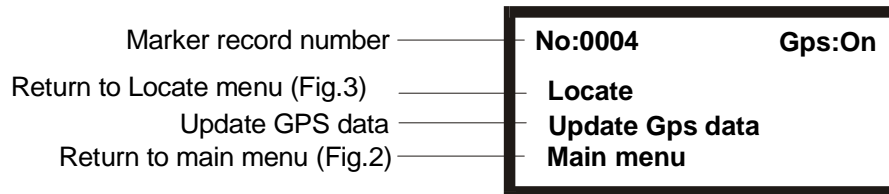Return to main menu (Fig.2) ——————— | **Main menu**

Fig. 19

If device recognizes smart marker and you don't want to store the smart marker, device will offer you choices, which were already described and displayed on Fig. 19.

Device will also ask you if you want to store marker when error of system GPS (Fig. 22, 23) is bigger than 30 meters (Fig. 20).
If you still choose to store marker, then by using MENU button select Yes and press ENTER button. Device will store marker with GPS coordinates and will display stored marker information (Fig. 18).
If you don't want to store marker with GPS error bigger then 30 meters, then by using MENU button select No and press button ENTER. Device will be in Locate menu.

Store marker with GPS error bigger then 30 meters ——— | **Gps  err. > 30m   Store?**
| **Yes**
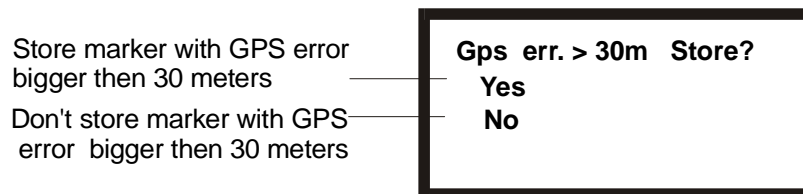Don't store marker with GPS error  bigger then 30 meters ——— | **No**

Fig. 20

NOTE 2:     You can upgrade GPS coordinates of smart marker only.
NOTE 3:     If device has not active GPS module, or fixated GPS satellites, or if antenna is damaged, device displays "GPS data unavailable" instead of GPS coordinate   message.
NOTE 4:     For analog marker storing, display shows "Analog".
            For digital marker storing, display shows "New".
            You can change these names with software LOCATOR.
NOTE 5:     If the error of GPS system is bigger than 30 meters, KOMPLEX recommends waiting 5 minutes and then store marker again.

## Determining the Marker Depth

It is possible to define the depth of marker imposition by measuring the level of received signal from marker. To determine the marker depth, act according following instructions:

1. Locate the marker according to "Locating the Marker" chapter (p. 10).
2. Hold antenna horizontally above the ground in the place having been bordered as maximum signal (point 4 in "Locating the Marker" chapter).
3. Press button UP in Locate menu (Fig. 3) and in displayed offer (Fig. 21), by using MENU or ENTER buttons, select type of marker, which depth you want to determine.

```
Depth
  Analog marker
  Smart marker
```

**Fig. 21**

4. Turn the sensitivity controller (4, Fig. 1) anticlockwise.
5. Turn sensitivity controller slowly clockwise to the maximum and watch accuracy indicator (Fig. 3)
6. When the end of accuracy indicator is exactly under the depth reference point (Fig. 3) stop turning with sensitivity controller.
7. Depth of marker imposition is shown on display (Fig. 3).

NOTE 6: Depth measuring is respectable only in case, when the accuracy indicator reaches reference point with slowly turning the sensitivity controller clockwise.

NOTE 7: Analog marker depth measuring is displayed (Fig.3): "Locating Anl"
Smart marker depth measuring is displayed (Fig.3): "Locating Smt"

## Receiving Data from PC into Smart Marker Locator

Connect Smart Maker Locator with PC using serial cable and follow instructions:
1. Plug one female DB9 connector of serial cable to RS232 connector on the Smart Maker Locator rear panel (9, Fig. 7) and second female DB9 connector plug to COM port on PC.
2. Select Receive data in Flash memory menu (Fig. 4) and press button ENTER.
3. Select SEND DATA in TOOLS in software LOCATOR and press OK

NOTE 8: If the connection of Smart Marker Locator and PC is not correct during the data transmission, device will display: Error, Check cable. Press Enter.

## Sending Data from Smart Marker Locator into PC

Connect Smart Maker Locator with PC using serial cable and follow instructions:

1. Plug one female DB9 connector of serial cable to RS232 connector on the Smart Maker Locator rear panel (9, Fig. 7) and second female DB9 connector plug to COM port on PC.
2. Select RECEIVE DATA in TOOLS in software LOCATOR and press OK
3. Select Send data in Flash memory menu (Fig. 4) and press button ENTER.

NOTE 9:    If the connection of Smart Marker Locator and PC is not correct during the data transmission, device will display: Error, Check cable. Press Enter

## Erasing Data from Smart Marker Locator Memory

Select Erase data in Flash memory menu (Fig. 4) using button MENU and press button ENTER.
If you want to erase just the <u>last record in Smart Marker Locator memory</u>, use button MENU to select Last record in Erase data menu and press button ENTER. If you are sure with this decision, select Yes in next menu and press button ENTER. Otherwise select No and press button ENTER.

If you want to erase <u>all records in Smart Marker Locator memory</u>, use button MENU to select All records in Erase data menu and press button ENTER. If you are sure with this decision, select Yes in next menu and press button ENTER. Otherwise select No and press button ENTER.

## GPS Module Activating/Deactivating

If you want to activate GPS module, use button MENU to select ON in GPS module menu (Fig. 5) and press button ENTER. After initialization time device will display current Smart Marker Locator position (Fig. 22): geographic longitude and latitude, Greenwich Time, number of satellites, which GPS works at the moment with, and current error of GPS system position, which depends on number of fixated satellites.
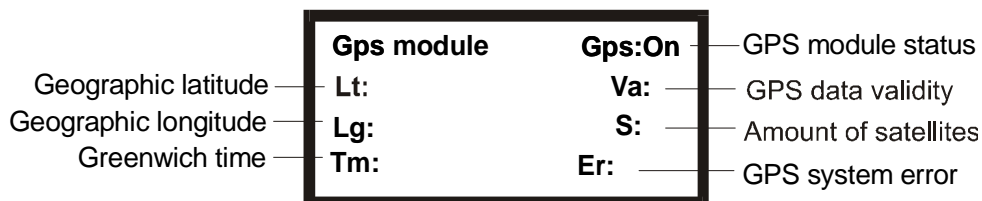


Fig. 22

If you want to deactivate GPS module, use button MENU to select Off in GPS module menu (Fig. 4) and press button ENTER.

NOTE 10:    Greenwich Time is measured in place of zero meridians.
NOTE 11:    GPS data validity has 2 values:
    1. valid data:      Va: G or DG if differential Va
    2. invalid data:    Va: N

NOTE 12:     KOMPLEX recommends turning off GPS module, unless it is used, to save batteries.

## Navigation to Selected Marker using Smart Marker Locator

You can navigate Smart Marker Locator only to marker, which coordinates are stored in Smart Marker Locator memory (in marker database). Marker record number can be selected in 2 ways, which are described in following subchapters.

1. After selecting marker record, device displays marker information (Fig. 18). Press button ENTER to start navigation
2. During navigation follow information on display and acoustic signalization.
3. When distance between device and selected marker is less than 10 meters, device signalizes it by intensive acoustic intermittent tone.

### Inserting Marker Record Number

1. Use button MENU to select ENTER record number in Navigate menu (Fig. 6), and press button ENTER.
2. Use UP – ascending sequence of numbers and button DOWN – descending sequence of numbers to select required number and press ENTER after each selection.

### Searching Marker Record Number

1  Use button MODE to select Search record in Navigate menu (Fig. 6) and press button ENTER.
2. Use button UP – ascending selection of marker records number and button DOWN – descending selection of marker record number to find required marker record number and press ENTER.

### Acoustic Signalization of Navigation

Type of acoustic signalization depends on direction of Smart Marker Locator user movement:
1. When you decrease distance from selected marker, device signalizes it with double beep.
2. When you increase distance from selected marker, device signalizes it with one longer beep.
3. When distance between device and selected marker is less than 10 meters, device signalizes it by intensive acoustic intermittent tone.

### Display Information of Navigation

Information of navigation to selected marker is displayed on Fig. 23.

Marker record number

ID number of smart marker

GPS system error

Distance from selected marker

```
┌─────────────────────────────────┐
│ No:0004    Dr: NW   S: 00        │
│ 01-01-7B-E4-A0                   │
│ Er:  004m          N4910.670     │
│ D:00021m           E01045.702    │
└─────────────────────────────────┘
```

Recommended direction

Amount of satellites

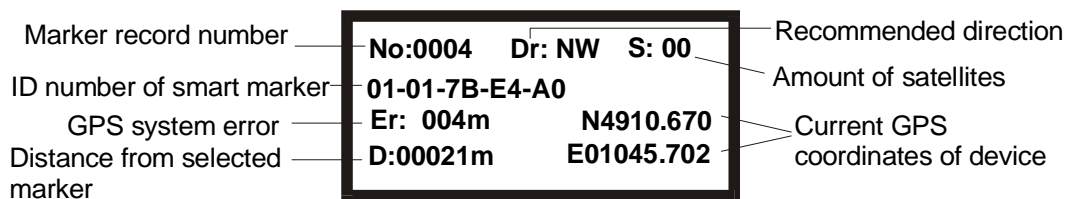Current GPS coordinates of device

Fig. 23

Recommended direction D (Fig. 23):
1. NW:  North-West
2. NE:  North-East
3. SW:  South-Wes
4. SE:  South-East

When GPS module has not contact with satellites, message: Tracking satellites (Fig. 24) is displayed instead of current coordinate.
By holding button MENU min. 1 sec. you will return to Navigate menu (Fig. 6).

```
┌─────────────────────────────────┐
│ No:0001    Dr:      S: 00        │
│                                  │
│ xx-xx-xx-xx-xx                   │
│ Tracking satellites              │
└─────────────────────────────────┘
```
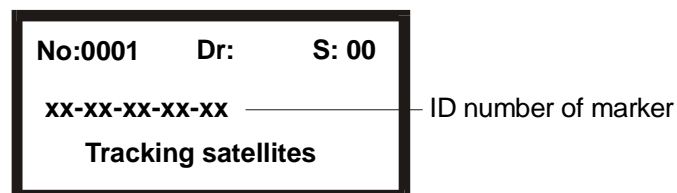
ID number of marker

Fig. 24

NOTE 13: When inserting marker record number which doesn't exist, device displays message: EMPTY RECORD. Then press button MENU.

NOTE 14: After selecting marker record number which position you want to find, the GPS module will activate automatically.

**Characteristics of GPS and necessity to know them in navigation**

CAUTION:
The Global Positioning System (GPS) is operated by the government of the United States, which is solely responsible for its accuracy and maintenance. The system is subject to changes which could affect the accuracy and performance of all GPS equipment.

Following information describe characteristics of GPS system and it is advisable to know them for successful use of GPS system so eventual errors are not attributed to Smart Marker Locator function.

1. GPS module in Smart RFID Locator uses satellite signals and quality of their receiving is essentially influenced by GPS antenna view to sky. The best results are achieved with better view to sky.
2. Near or high objects decrease view to sky. Operator of devise can also decrease view to sky – GPS antenna is located on the right under buttons.

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3. Accuracy of actual place determining by GPS depends on atmospheric state (atmospheric discharges, ozone state, etc.). Fog, dense clouds, snowfall, or rain deteriorate receiving of signal from satellites.

4. Accuracy of determining of location (actual GPS coordinates) and so also navigation accuracy is determined by number of satellites, which GPS module works currently with. This should be kept in mind when storing coordinates into Smart Marker Locator memory and also in navigation. When the number of satellites is 4 or less, worse accuracy or loss of satellites can be expected. To achieve more satellites it is then enough to change place, increase view of antenna or to wait for different satellites position.

5. It is necessary to realize that actual error, which GPS works at the moment with, influences accuracy of actual coordinates, i.e. also accuracy of stored coordinates and accuracy, which system navigates us with.

## MAINTENANCE

### Replacing the Batteries

If the voltage of primary battery cells (status of primary battery cells, Fig. 2) is lower then 12.0 V, KOMPLEX recommends replacing all of them. Instruction how to replace battery cells is described in "Installing the Batteries" chapter (p. 8).

## COMPLETE SET-UP DELIVERY

- Device                                        1  pc
- Antenna with telescope                        1  pc
- Bag                                           1  pc
- Auxiliary crutch                              1  pc
- Primary cells 1.5 V                           10 pcs
- Serial cable                                  1  pc
- Software LOCATOR – CD                         1  pc
- Manual for Smart Marker Locator               1  pc

NOTE 16:    Device is delivered standard with primary cells.
NOTE 17:    KOMPLEX recommends using recommended types of primary battery cells for device power supply.

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## TYPES OF OPERATING FREQUENCIES

| Operating frequency | Type of facility | Color of Smart Marker SM 1500 | Type of Smart Marker Locator |
|---|---|---|---|
| 83.0 kHz | Gas pipelines | Yellow/Black | SML G1 |
| 101.4 kHz | Telecommunication cables | Orange/Black | SML T1 |
| 121.6 kHz | Sewage pipelines | Green/Black | SML S1 |
| 134.0 kHz | Energy cables | Red/Black | SML E1 |
| 145.7 kHz | Water pipelines | Blue/Black | SML W1 |