

# NHT-310

## User Manual



*Design development and manufacturing*

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# 1 SAFETY INSTRUCTIONS

## 1.1 Foreword

The following general safety precautions must be observed during all phases of operation, service, and repair of this instrument.

**Read the entire manual carefully before using the instrument.**

Always keep a copy of the manual with the instrument, available to anyone who uses it, even if it is transferred to a third party.

## 1.2 Correct use

The NHT310 has been designed and built to provide the operator with an instrument for the measurement of electromagnetic fields. Use the instrument only for the purpose and under conditions for which it is designed.

In particular, follow the technical specifications of use, shown in paragraph 2.7, "NHT310 technical specifications".



Make sure that the instrument is used by qualified and adequately trained operators.

## 1.3 Improper use

The NHT310 is not an alarm device. Its purpose is not to alert the operator for the presence of a dangerous field by means of an audio or visual signal.



Remember that the NHT310 instrument is a measuring device and not an alarm device. The operator must be careful, continuously checking the field value indicated by the instrument, when it is in areas with an unknown field.

## 1.4 Dangers for electromagnetic fields



- *Pay attention to high fields*

Fields with particularly high values may be present near some sources. Do not cross barriers or safety warnings. Persons particularly at risk, as carriers of active implanted medical devices (eg pacemakers), must avoid dangerous electromagnetic field situations.



- *Check the operation of the probe*

Before starting the measurement, check that the probe connected to the instrument is working properly. This will prevent the operator from being in high field areas without the instrument having detected the level. Therefore carry out a preventive measure under known conditions.



- *Possible measurement errors*

Do not apply metal labels or other on the probe, since metal parts in contact with the part of the probe suitable for the measurement of the electromagnetic field can influence the value detected by the instrument.



- *High static magnetic fields*

In the presence of high static magnetic fields, pay attention to the effect of attraction caused by the field on the instrument itself.

## 1.5 Dangers for electric sources



- *DO NOT use the instrument near electric sources*

Since the instrument shell is made of metallic material, always keep the instrument away from electrical sources in order to avoid the risk of electric shock.

## 1.6 Dangers due to batteries

NHT310 operates both with NiMh rechargeable batteries (supplied) and with alkaline dry batteries (4 x AA stylus). The battery charger delivered with the instrument can be used to charge the rechargeable batteries supplied.

- **WARNING**



**Never connect the battery charger if dry batteries are installed!**

**This procedure can cause significant damage to the instrument!**

**Failure to do so will cause the warranty being declined!**

Batteries can break, ignite or explode when handled incorrectly.



- *Battery replacement*

Do not replace only part of the batteries; always replace the complete set of four batteries. Always use identical batteries.



- *Battery polarity*

Make sure you have placed the batteries with the correct polarity, as indicated inside the battery compartment.



- *Closing the battery compartment*

Close the battery compartment as soon as the replacement is complete. Do not use the instrument if the battery compartment is open.

**WARNING**

Do not touch the battery terminals with a metal object.

## 1.7 Dangers due to the battery charger

Electrical shock events may occur due to improper use of the battery charger.



- *Check the battery charger*

The battery charger, provided with the instrument, must be used to recharge the rechargeable batteries.

Do not use the charger if it is damaged.

Do not use the charger if it is moved from a cold to a warmer environment, as this may cause condensation on the device.



- *Conditions for recharging*

Recharge only indoor, with ambient temperature and humidity within the operating limits of the device. Keep away from flammable and explosive sources.



- *Verification of the AC line*

Check that the specifications of the electric network used for recharging are exactly those for the battery charger. If the mains voltage is different, it can cause damage to the charger.

## 1.8 Additional risks



- *DO NOT substitute parts or modify the instrument*

To avoid the danger of introducing additional hazards, do not open the NHT310 meter, do not install or substitute parts, or perform unauthorized modifications to the instrument. Return the instrument to *Microrad* Service Center for service and repair to ensure that safety features are maintained in operational condition.

## 2 GENERAL INFORMATION

### 2.1 Application

Human exposure to electromagnetic fields (not ionizing radiation) is nowadays a very critical subject with which almost all countries must deal. Technical and normative bodies work alongside government institutions to enact new guidelines and decrees regarding maximum permitted exposure levels for populations and workers.

The measurement equipment for this type of analysis must suit the technical requirements from the guidelines and must provide the user with qualified physical parameters for compliance with legally required thresholds.

### 2.2 About the instrument

NHT310 is the new *Microrad* solution for the measurement of electromagnetic fields. Besides being handy and compact, the instrument operates in the widest frequency band possible for a handheld instrument.

It is user-friendly and provides extremely reliable measurements; it also provides the operator with local temperature and GPS coordinates of the site being measured for inclusion in a final report.

### 2.3 Operating modes

#### 2.3.1 Single EMF measurement

The main application of NHT310 is to perform wideband electromagnetic field measurements allowing the user to make evaluations in relation to established protective safeguards. The system uses a variety of probes to measure specific physical parameters (magnetic induction, magnetic field and electric field) according to the frequency band of interest.

On the instrument LCD display, are always displayed:

- Instantaneous isotropic value **ISO** of measured field.
- Time average isotropic value (**AVG**) of measured field.
- Spatial average value **SPT** of measured field.
- Maximum isotropic value **MAX** of measured field.
- Alarm threshold **ALM**.
- Geographic coordinates **GPS**.
- Ambient temperature.
- Date and time.

The instrument can be used in direct operating mode via the front keyboard panel and the measurements can be viewed on the LCD display. The user can store single measurement data by pressing the **[STORE SINGLE]** command. Each measured value is stored in a specific memory portion for single



measurements (for a total of 432 measurements) along with the information regarding date and time, GPS coordinates, and ambient temperature.

### 2.3.2 Long-term Monitoring

NHT310 can perform up to 8 data acquisition sequences for long-term monitoring of broadband electromagnetic fields. This mode is particularly useful for low frequency magnetic induction measurements, since it is possible to follow the possible fluctuation of field values depending on the daily variation of the current flow in the electric lines or in the transformation cabins (field source).

The user can initiate the acquisition sequence by simply pressing the **[SHIFT]** key and then the **[STORE MONIT]** key.

Each monitoring can extend to full memory space (over 21'500 acquisitions) or until the user wishes to interrupt the process by pressing any key on the instrument.

### 2.3.3 NHT310 remote control through MicroLink software

This operation mode is recommended in order to avoid where possible the influence of the user's presence on the environment being measured (mainly for low and high frequency electric field analysis) or when there is a requirement to install the measurement system in a screened and controlled space (anechoic chamber for EMC testing). In such a situation it is strongly recommended that a wooden tripod with variable height (optional) is used.

NHT310 can be remotely managed through a fiber optic connection to an external PC. This operation is possible with the MicroLink software. MicroLink allows the total remote control of the NHT310 unit by displaying on PC screen the same keys of the instrument keyboard, making the system easy to use.

The software displays the measured data in real time and simultaneously displays the amplitude / time graph of the field being analyzed.

In remote mode, it is possible to store single data or to start and stop monitoring sequences.

### 2.3.4 Downloading data to PC

All measured values, recorded both as single acquisition or continuous monitoring, can be downloaded to an external PC through the fiber optic cable using MicroLink software.

Once the values have been transferred, they can be viewed and analyzed within the MicroLink software and saved on a hard disk or other mass storage units for later reference.

The software allows the numeric and tabular display of the field values as well as the display of amplitude / time diagram with zoom function in the time window of interest.

Data export in tabular format (Excel compatible) and graphics, jpeg or bitmap format, is also possible.

Using MicroLink software, the user can send configuration data to the device in order to set the threshold for a high field acoustic alarm, set the sampling interval between an acquisition and the next in long-term monitoring, set the time interval to calculate the moving average with high frequency probes (default value is 6 minutes as per international regulations), set the date and time.

MicroLink is also able to calculate the 24-hour moving average on monitoring sequences that exceed that duration.

## 2.4 Measurement probes

Various measurement probes are available for use in conjunction with NHT310 for both magnetic and electric field measurements, with frequency bands ranging from dc up to 40 GHz.

The NHT310 automatically recognizes each probe when it is inserted.

A detailed list of available probes is given in section 1.7.2.

## 2.5 GPS module and temperature sensor

NHT310 integrates a **GPS module** to acquire geographic coordinates as reference to the area in which the measurements were carried out.

In case of outdoor activities, it is always recommended to add the GPS data related to the measurement site in order to mention them in the final report. GPS associates not only geographic information but also the exact time (UTC time).

No other external device is required to perform these operations as the NHT310 performs the measurement and automatically provides field values together with GPS coordinates of the site. The MicroLink software can directly show them on **Google Maps™**.

In addition NHT310 integrates a **temperature sensor** acquiring the temperature value during measurement activity.

Since the sensor is integrated into the front of the instrument, it is necessary to consider that, as the meter shell is a good thermal conductor, the measurement may be influenced by the operator's hand temperature. In order to have exact temperature values, the instrument must be used with a tripod support.

## 2.6 Equipment configuration

The basic unit NHT310 is delivered in the standard configuration including:

- NHT310 basic unit for measuring, storing and display field data
- Fiber optic cable (10 meters length)
- Fiber-USB adapter to link fiber optic to PC
- USB A/B adapter cable
- Battery charger
- Rechargeable batteries
- Sturdy carrying case with IP67 protection class
- MicroLink software and user manual (available on [www.microrad.it](http://www.microrad.it))
- ISO 9001:2008 calibration certificates

In order to work correctly, the NHT310 meter must be connected to a measurement probe from those available for this model.

## 2.7 NHT310 technical specifications

### 2.7.1 NHT310 base unit

<b>PROBE TYPE</b>	
<i>Frequency range</i>	From DC to 18GHz using several B, E, H probes
<b>DISPLAY</b>	
<i>Type</i>	Transflective LCD monochrome COG (chip on glass)
<i>Size</i>	7 cm , 128x64 dots
<i>Backlight</i>	Electroluminescent screen 10s/continuous selectable
<b>MEASUREMENT FUNCTIONS</b>	
<i>Measurement units</i>	mW/cm <sup>2</sup> , W/m <sup>2</sup> , V/m, A/m, Tesla
<i>Display range</i>	from 0.0001 to 999999 (depending on probe and measurement unit)
<i>Result type (isotropic, RSS)</i>	Instantaneous (ACT), Maximum (MAX), Average (AVG), Median
<i>Time average</i>	6min std, from 4s to 30 min (step 2s ), software selectable
<i>Moving average</i>	24h calculated by MicroLink
<b>STORAGE MEMORY</b>	
<i>Samples</i>	21.504 (8 monitoring sequences) / 432 (snapshot)
<b>INTERFACES</b>	
<i>Optical interfaces</i>	Serial, full duplex
<i>Probe input</i>	Plug-and-play auto detection, connector LEMO™
<b>GPS</b>	
<i>Receiver</i>	Sensitivity -163dBm, 48 channels, L1 C/A code, update rate 4Hz
<i>Time to first position (TTFF)</i>	typical < 60 seconds
<b>GENERAL SPECIFICATIONS</b>	
<i>Recommended calibration interval</i>	24 months
<i>Battery</i>	Alkaline or rechargeable NiMH, 4 x AA size (Mignon), 2800 mAh
<i>Battery operation time</i>	> 72 ore (backlight and GPS off)
<i>Charging time</i>	4 hours
<i>Battery level indication</i>	100%, 66%, 33%, < 10%
<i>Operative Temperature range</i>	-10 °C to +50 °C
<i>Storage Temperature range</i>	-20 °C to +70°C
<i>Humidity</i>	5 to 95%, non-condensing
<i>Size (h x w x d)</i>	160 x 98 x 30 mm (without probe)
<i>Weight</i>	Approx 400 g (including batteries without probe)
<i>Accessories (included)</i>	Rechargeable batteries, AC charger, fiber optic cable (10mt), USB-Optical Converter, User manual, MicroLink software, probes calibration certificate

*Note: technical specifications are subject to change without any prior notice.*

## 2.7.2 Measurement probes

### Radio-frequency probes

P/N Probe	01E	02E	02H	03E	04E
Frequency range	100 kHz - 6.5 GHz	400 kHz - 30 MHz	300 kHz - 30MHz	100k Hz - 18GHz	3 MHz - 40GHz
Frequency Response	Flat	Flat	Flat	Flat	Flat
Measurement range	0.2 - 350 V/m	2 - 800 V/m	0.016 - 16 A/m	0.8 - 340 V/m	0.5 - 350 V/m
Directivity	Isotropic	Isotropic	Isotropic	Isotropic	Isotropic
Calibration interval	24 months	24 months	24 months	24 months	24 months
Operative temperature	0°C - 50°C	0°C - 50°C	0°C - 50°C	0°C - 50°C	0°C - 50°C

### Low-frequency probes

P/N Probe	11E e 33E	10B	20B (100 cm <sup>2</sup> )	30B 33B (100cm <sup>2</sup> )
Frequency range	5Hz - 400 kHz	5 Hz - 400 kHz	5 Hz - 20 kHz	5 Hz - 400 kHz
Frequency Response	Flat	Flat	Flat	Flat
Measurement range	1 V/m - 20KV/m	0.1 $\mu$ T - 1 mT	0.3 $\mu$ T - 16 mT	0.3 $\mu$ T - 16 mT
Directivity	Isotropic	Isotropic	Isotropic	Isotropic
Calibration interval	24 months	24 months	24 months	24 months
Operative temperature	0°C - 50°C	0°C - 50°C	0°C - 50°C	0°C - 50°C

### Static probes

P/N Probe	10H e 33H	20H	30H
Frequency range	DC	DC - 1 kHz	DC - 1 kHz
Frequency Response	n/a	Flat	Flat
Measurement range	150 nT – 2.5 mT	1 mT – 5 T	200 $\mu$ T - 600 mT
Directivity	Isotropic	Isotropic	Isotropic
Calibration interval	24 months	24 months	24 months
Operative temperature	0°C - 50°C	0°C - 50°C	0°C - 50°C

*Note: technical specifications are subject to change without any prior notice.*

## 2.8 Standard compliance

<b>ESD e EMC</b>	Electrical equipment for measurement, control and laboratory use. EMC requirements: radiating emission, radiating immunity in radio frequency, electrostatic discharge.	<b>CEI EN 61326</b>
<b>SAFETY</b>	Safety requirements for electrical equipment for measurement, control and laboratory use – General requirements.	<b>CEI EN 61010</b>
<b>CE MARK</b>	European Union	<b>OK</b>
	Country of origin	<b>ITALY</b>

## 3 CERTIFICATION AND WARRANTY

### 3.1 Certification

*Microrad* certifies that this product met its published specifications at the time of shipment from the factory. *Microrad* also certifies that each probe for the NHT310 instrument has been calibrated according to DIN EN ISO 9001: 2008. On request, SIT certification is available, covering magnetic and electric field strength and high frequency electromagnetic power density, and OKD certification for magnetic induction intensity and low frequency electric field.

### 3.2 Warranty

This *Microrad* product is warranted against defects in material and workmanship for a period of 24 months. Accessories are warranted for a period of 6 months. During the warranty period, *Microrad* will, at its option, either repair or replace products that prove to be defective.

For warranty service or repair, this product must be returned to *Microrad*.

*Microrad* warrants that its software and firmware, designated by *Microrad* for use with an instrument, will execute its programming instruction when properly installed on that instrument.

### 3.3 Limitation of warranty

The foregoing warranty shall not apply to defects resulting from: improper use or inadequate maintenance by User, User-supplied software or interfacing, unauthorized modification or misuse, operation outside the environmental specifications for the product, or improper site preparation or maintenance.

# 4 UNIT DESCRIPTION

## 4.1 Front panel legend

The following table refers to Figure 4.1 which shows the keyboard and the main parts on the NHT310 base unit front panel.

Some keys have a second function, indicated in blue, which can be enabled by pushing the middle button **SHIFT** in advance.

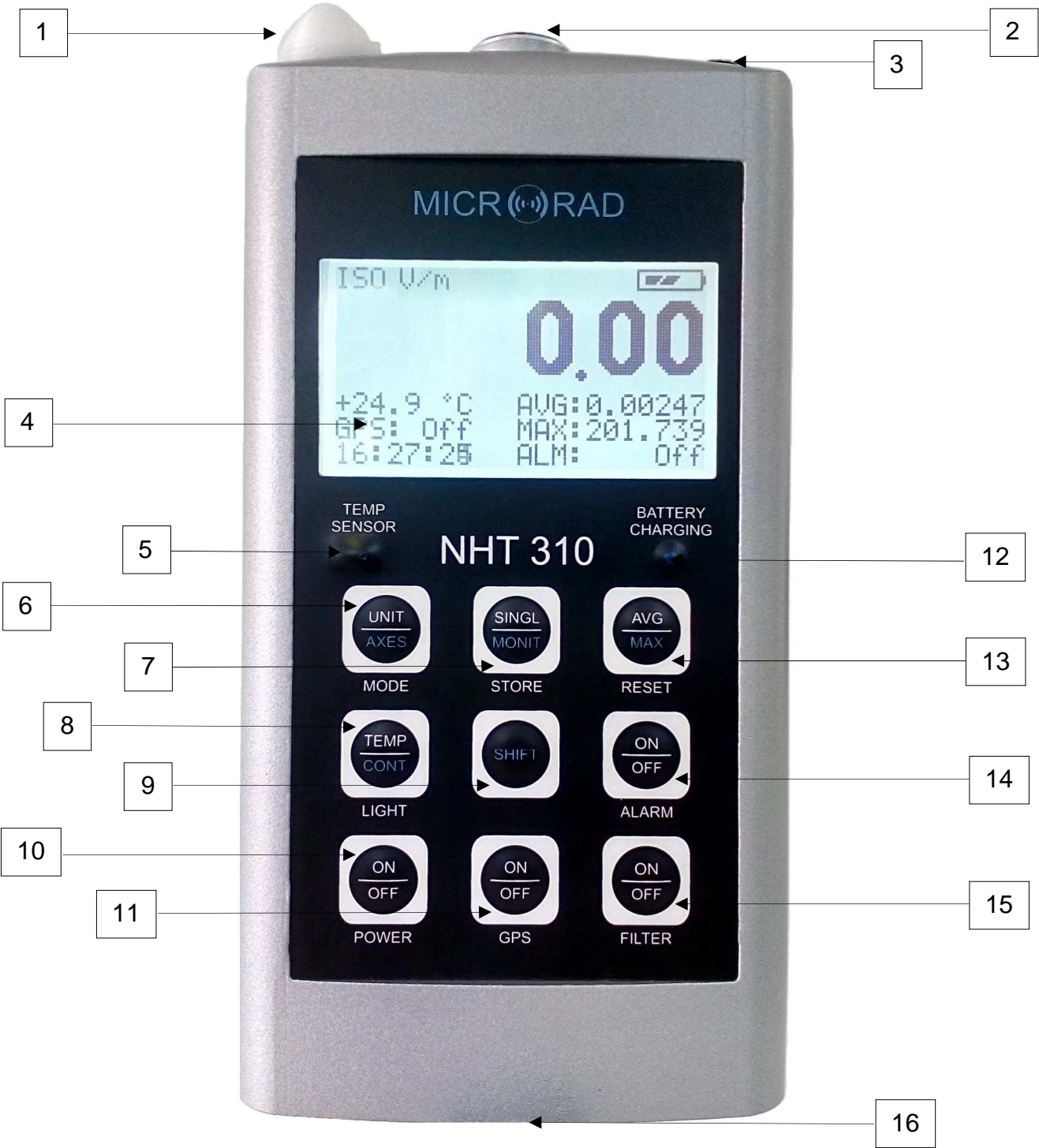












Fig. 4.1 – Front view



<b>Item</b>	<b>Name</b>	<b>Function</b>
<b>1</b>		GPS Antenna
<b>2</b>		Probes Input connector
<b>3</b>		Battery charge input
<b>4</b>		Backlit display
<b>5</b>		Temperature sensor
<b>6</b>		<p><b><u>MODE key</u></b></p> <p><b>UNIT:</b> changes the field measurement unit. Pressing the button for 10 seconds it is possible to change the temperature unit from °C to °F and vice versa.</p> <p><b>AXES:</b> visualizza i singoli assi X, Y, Z.</p>
<b>7</b>		<p><b><u>STORE key</u></b></p> <p><b>SINGL:</b> storing a single measuring value. If pressed for more than 2 seconds, initiates a countdown sequence before starting the store. If pressed for more than 4 seconds enables/disables the spatial average mode.</p> <p><b>MONIT:</b> start a monitoring sequence.</p>
<b>8</b>		<p><b><u>LIGHT key</u></b></p> <p><b>TEMP:</b> Temporary backlight of 10 s.</p> <p><b>CONT:</b> Continuous backlight.</p>
<b>9</b>		<p><b><u>SHIFT key</u></b></p> <p><b>SHIFT:</b> Enables all blue defined functions.</p>

10		<b><u>POWER key</u></b> <b>ON / OFF:</b> Switching the device on / off.
11		<b><u>GPS key</u></b> <b>ON / OFF:</b> enables / disables the GPS receiver.
12		Blue LED indicating battery recharge.
13		<b><u>RESET key</u></b> <b>AVG:</b> reset of time average value. If pressed for more than 10 seconds performs a reset of the instrument, reinitializing all parameters and deleting all stored data. <b>MAX:</b> reset of the MAX measured value.
14		<b><u>ALARM key</u></b> <b>ON / OFF:</b> enables / disables the acoustic alarm of exposure threshold exceeded.
15		<b><u>FILTER key</u></b> <b>ON / OFF:</b> Enables / disables a filter for low frequency probes. With the magneto-static probes 10H or 33H, if the 3 axis display mode (X,Y,Z) is activated, the field direction, positive or negative are also displayed.
16		¼-inch threaded hole for tripods or brackets mounts

Tab. 4.1 – Front panel and keyboard legend

## 4.2 Connectors and interfaces legend

The tables below refer to connectors and interfaces available on the back and at the top of the base unit.



Fig. 4.2 – Rear View

<i>Item</i>	<i>Name</i>	<i>Function</i>
1	FIBER	Fiber optic cable interface for connection to a remote PC/Tablet

Tab. 4.2 – Rear interfaces



Fig. 4.3 – Top view

<i><b>Item</b></i>	<i><b>Name</b></i>	<i><b>Function</b></i>
1	BARREL JACK	Battery charge input
2	LEMO	Probes Input connector
3	GPS	GPS Antenna

Tab. 4.3 – Top interfaces

## 5 PREPARATION FOR USE

### 5.1 Unpacking

As soon as the instrument arrives at its destination, please carefully check the packages to verify possible damages caused by shipment. If any damage is found, inform *Microrad* immediately. It is recommended to keep the original packages for a future return shipment due to, for instance, repairing or resetting.

### 5.2 Storage

After the material contained in the packages has been inspected and it has been verified for damages, it should be stored in its original packing until the time of use. The storage deposit must be well protected and free from humidity. If the instrument should be kept in storage for a long time, it is advisable to insert hygroscopic substances (such as silicon gel salts) in the package.

### 5.3 Connecting the probes

The probe is equipped with a LEMO “Push/Pull” connector. To connect it to the NHT310 unit, push the probe plug straight down into the probe socket until it clicks into place (the red mark on the probe plug must point towards the red mark on the unit socket).

To disconnect the probe, slide the sleeve on the probe plug upwards and pull the probe upwards to remove it.



Fig. 5.1



**WARNING: TO REMOVE DO NOT TURN THE PROBE !  
SLIDE THE SLEEVE ON THE PROBE PLUG UPWARDS AND PULL THE PROBE  
UPWARDS TO REMOVE IT.**

## 5.4 Power supply

NHT310 operates both with NiMh rechargeable batteries (supplied) and with alkaline dry batteries (4 x AA stylus). The battery charger delivered with the instrument can be used to charge the rechargeable batteries supplied.

**During the battery recharge cycle, the instrument can not be used for measurements.**

The batteries are usually delivered pre-charged, but they need a complete charge before the first use. The full recharging time, very close to 100%, is about 4 hours.

### WARNING



**Never connect the battery charger if dry batteries are installed!**

**This procedure can cause significant damage to the instrument!**

**Failure to do so will cause the warranty being declined!**

During normal operation, the battery charge status is always displayed at the top right of the screen.

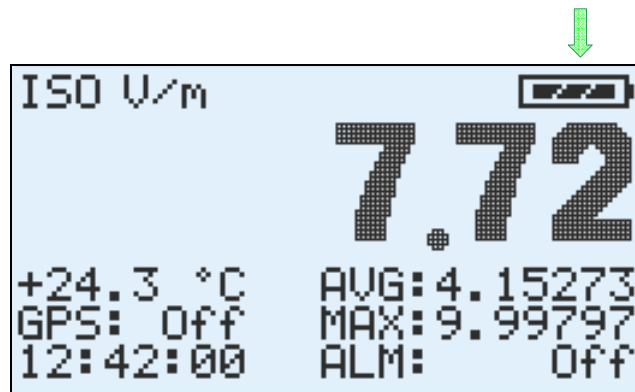


Fig. 5.2

During the batteries charging cycle, the blue LED lights up.



Fig. 5.3

### 5.4.1 Battery autonomy

The battery discharge time is longer than 72 hours of continuous operation (with backlight turned off and no active GPS).

The discharge time of alkaline dry batteries may also be longer than that of rechargeable batteries.

### 5.4.2 Battery replacement

The battery compartment is located on the instrument back (see Fig. 5.4). The replacement procedure is described below.



Fig. 5.4

1. Switch the instrument off and disconnect it from the battery charger.
2. Open the battery compartment on the back of the instrument using an appropriate screwdriver.
3. Remove old batteries and dispose of them in accordance with the waste regulations in force in the country.
4. Insert the new batteries paying attention to the direction indicated in the compartment.
5. Close the compartment.

## 6 OPERATION

### 6.1 Base unit switching on

Press **[POWER ON]** key (Tab. 4.1).

The instrument starts an auto test tool and simultaneously displays instrument information.

Fig. 6.1 shows the first screen displayed at power up and reports the identification data of the instrument for a few seconds.

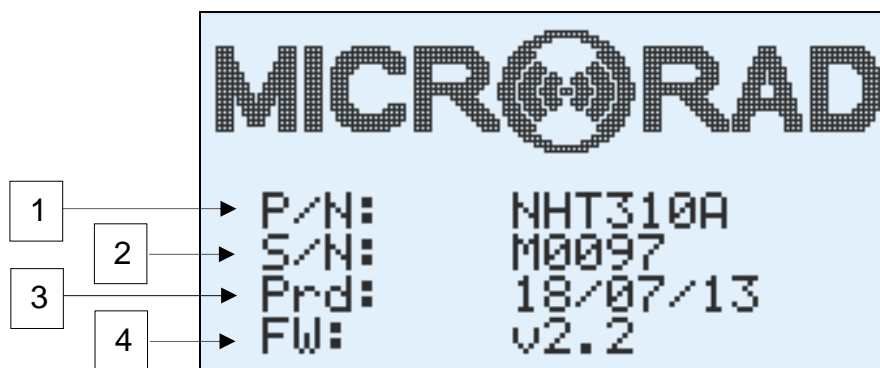


Fig. 6.1

1 – **P/N**: instrument identification code.

2 – **S/N** : instrument serial number

3 – **Prd** : instrument production date

4 – **Fw** : instrument firmware version

Fig. 6.2 shows the second screen displayed after the power up, reporting memory status information and the setting of some parameters.

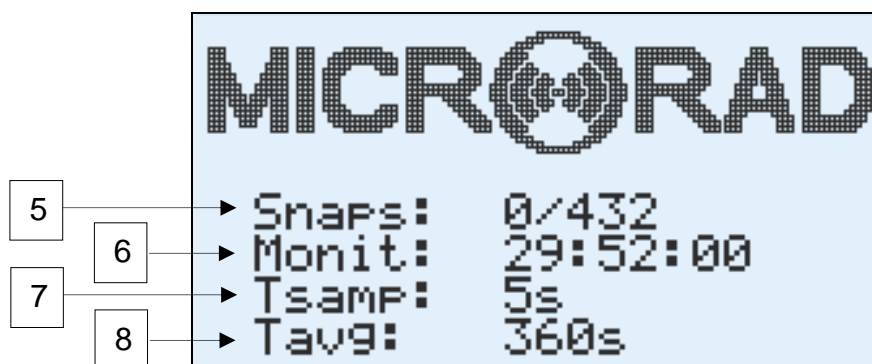


Fig. 6.2



- 5 – Snaps.** number of single measurements stored in the NHT310 memory.
- 6 – Monit.** Residual recording time for the monitoring function, calculated taking into account the current sampling interval set (Tsamp).
- .
- 7 – Tsamp.** sampling interval used during monitoring.
- 8 – Tavg.** time window width for moving average (AVG).

After the power up information sequence, if a probe is already connected to the instrument, the following information are displayed (see fig 6.3).

The same information is also displayed for a few seconds whenever a probe is inserted in the instrument.

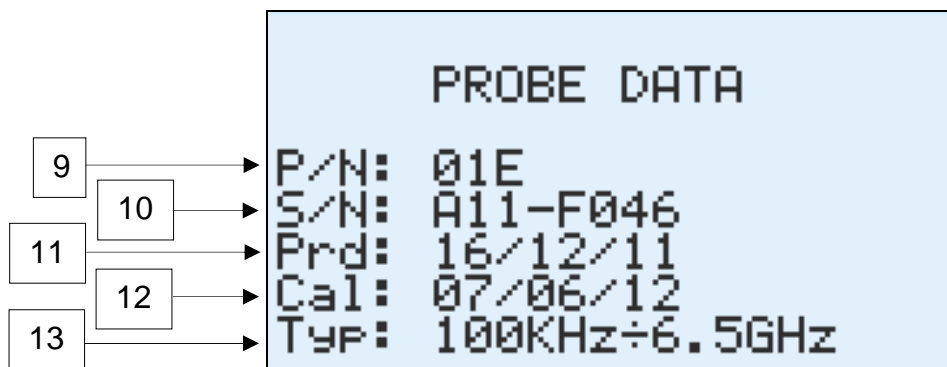


Fig. 6.3

- 9 – P/N:** probe identification code.
- 10 – S/N:** probe serial number.
- 11 – Prd:** probe production date.
- 12 – Cal.** Probe calibration date.
- 13 – Typ.** Probe frequency range.

If no probe is inserted or if the probe is removed, the typical screen shown in Fig. 6.4 is displayed.

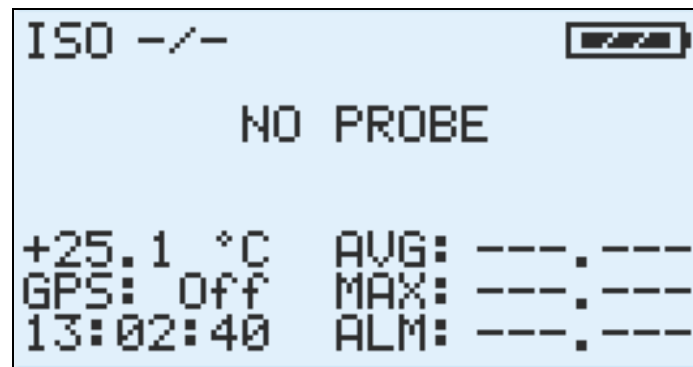


Fig. 6.4

## 6.2 Main measuring display screen

After the power on operation and probe detection and calibration is completed, the main measure screen appears together with all the other report elements which are also highlighted as shown in figure 6.5.

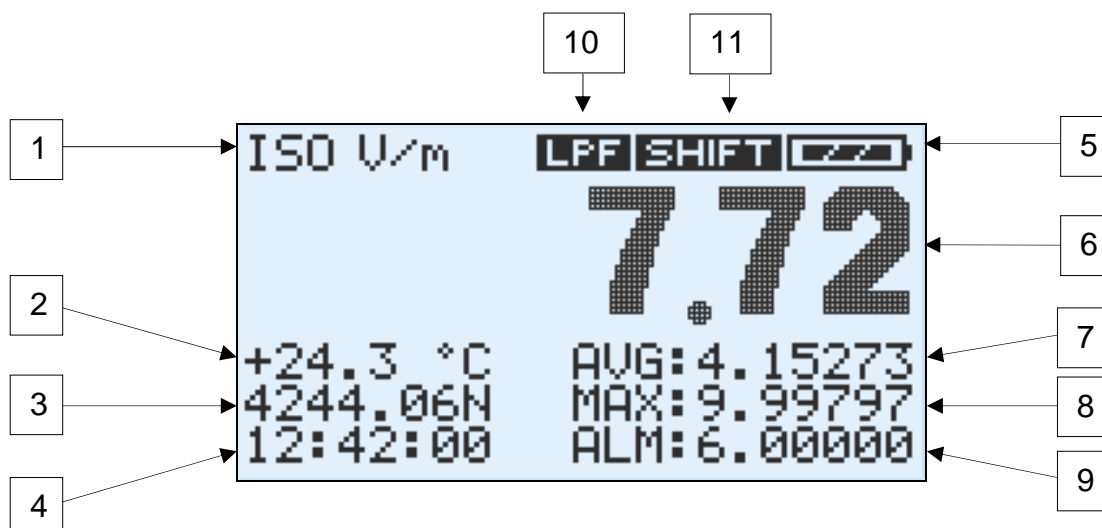


Fig. 6.5

**1 – Measurement unit.** As a default, the instrument indicates the typical measurement unit of the connected probe (V/m for E probes,  $\mu\text{T}$  for B probes, A/m for radiofrequency H probes and mT for static H probes). Pressing the **[MODE UNIT]** key the measurement unit can assume one of the following value: V/m, A/m, W/m<sup>2</sup>, mW/cm<sup>2</sup>. The instrument automatically calculates conversion by applying specific algorithms.

This feature is particularly useful when measuring a plane wave (far field, ie when the distance from the source is greater that  $2d^2/\lambda$ , where  $\lambda$  is the measured signal wave length and d is the largest linear dimension of the source antenna), it is possible to calculate the magnetic field value (H) using an electric field probe (E) or vice versa.

**2 – Environmental temperature** measured by the integrated sensor on the front part of the unit. The temperature value shown is surely reliable when the unit is working on a tripod and not in the user's hand.

**3 – GPS Coordinates.** Localization information from the built-in GPS sensor. Press the **[GPS ON]** key in order to activate the GPS sensor; at this point, if the tool is outdoor, within a couple of minutes, geographic location coordinates are displayed. Longitude and latitude coordinates, in the format defined in the NMEA standard, alternate in displaying:

$$\text{Latitude / Longitude} = \text{DDMM.FFC}$$

Where the 2 digits *DD* are used for degrees (digits can be 3 for longitude), the 2 digits *MM* for minutes, and the 2 digits *FF* for cents of minute. *C* is the cardinal direction: N (North) or S (South) for latitude, E (East) or W (West) for longitude.

**4 – Date and clock** alternates on the display.

**5 – Battery charge level.** The residual autonomy is proportional to the battery icon fill. When the battery is running low, the battery icon blinks.

**6 – Instantaneous isotropic measured field value (ISO).**

**7 – AVG Value.** The root mean square value on a moving time window is displayed. Press **[RESET AVG]** in order to reset the value. The time window width is factory set to 6 minutes, but the value is configurable via MicroLink application. The AVG value is evaluated only after a period of time equal to the length of the moving window has been completed (starting from power on, from insertion of the probe or from the average reset).

The AVG value is continually updated (mobile media) by adding the latest samples and removing the oldest. The average is dynamically updated maintaining the same number of samples.

**8 –MAX Value.** is equal to the maximum ISO value; it displays the maximum value measured from insertion of the probe or from last reset. This value is updated only when a new higher amplitude value is reached. A reset from the keyboard can be performed pressing **[RESET MAX]** key.

**9 – ALM Level and SPT value.** When the **[ALARM ON]** key is pressed, the field threshold value above which an acoustic warning alarm is activated will appear. This threshold can be set using the MicroLink software. In the same region, the spatial average value, indicated as **SPT**, is also alternately displayed.

**10 – Filter.** If the **[FILTER ON]** key is pressed and a low frequency probe (ie probe 10B, probe 11E) is connected, the **LPF** indicator is displayed and a

second order **low pass filter** (40 dB / decade) with 1kHz cutting frequency is enabled. Its use is useful for analyzing 50Hz sources with their main harmonics, cutting off the influence of higher frequency sources. Figure 6.6 shows the typical filter response diagram.

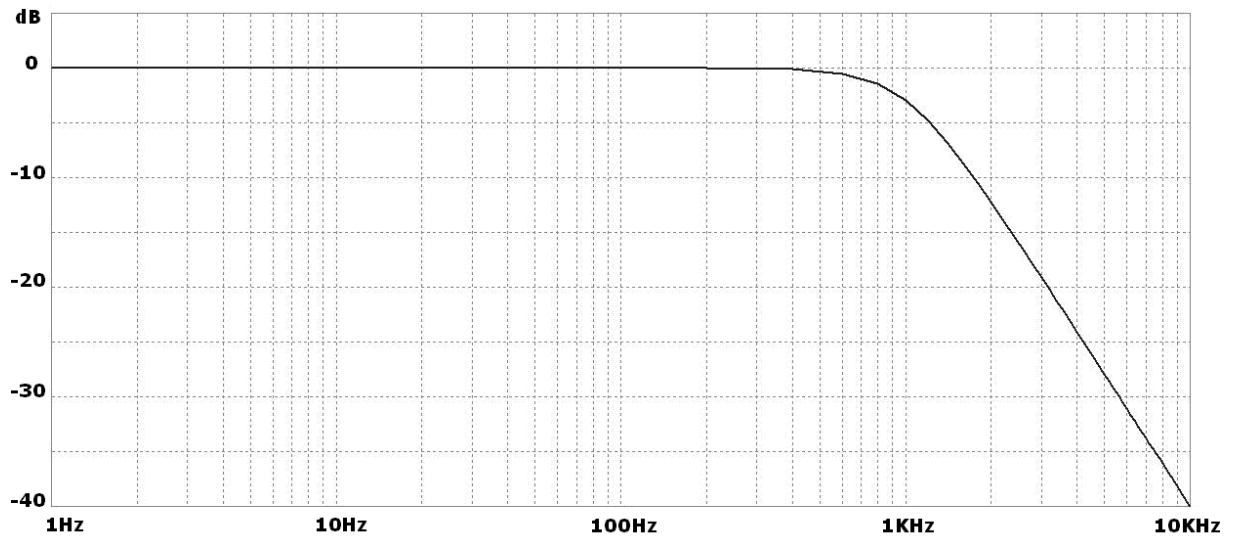


Fig. 6.6

In the particular case of static field probes (eg 20H, 30H), the filter is a first-order **high pass filter** (20 dB / decade) with a cutting frequency of about 1.5Hz. In this case, the **HPF** indicator appears on the screen of the NHT310. This filter cuts the continuous component of the field and can be useful in order to discriminate only static components from the others at higher frequencies.

**11 – SHIFT** state indicator: for the ability to activate a blue function on the keyboard; it is activated or deactivated via the SHIFT key.

**12 – X, Y, Z.** Figure 6.7 shows a screen display of the 3 orthogonal components of the ISO field which has been selected. These values take the place of AVG, MAX and ALM indicators when the **[MODE AXES]** key is pressed.

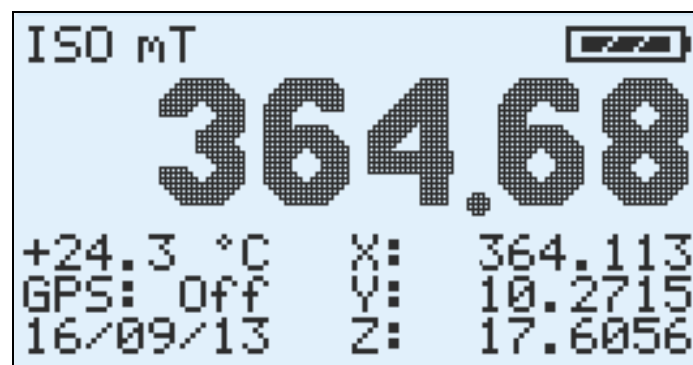


Fig. 6.7

12

## 6.3 Recording measured value

The user can record the measured values using two different methods:

- Manual storing of the single measured value (single storing)
- Automatic storing of a measurement sequence (monitoring).

The instrument reserves two different memory spaces for the two recording modes.

**Space available in the memory for single storing: 432 measurements**

**Space available for monitoring sequences: 21'504 measurements.**

### 6.3.1 Single storing

Each time the user makes preliminary measurements or he wants to store data displayed on the screen, he has to simply press the **[STORE SINGLE]** key.

Every time the key is pressed, a measured value with relevant data displayed on the screen (ISO value, X, Y, Z, time, date, GPS coordinates and time if activated, temperature, MAX value, AVG value if available, connected probe data) is stored in the memory.

During data storing the display shows the message as in Fig. 6.8; it informs the user about number of stored values vs total available (432 single stores).



Fig. 6.8

A delay can be introduced when storing data: depress the **[STORE SINGLE]** key for at least 2 seconds before releasing it and the countdown starts. This feature is useful in order to allow the operator to move away from the device and avoid disturbing the electromagnetic field before storing takes place. The delay can be set via the MicroLink software and is the same parameter that sets the delay for monitoring.

### 6.3.2 Monitoring

The instrument is able to carry out continuous tracking activity over time: practically it performs a sequence of single stores, all spaced from the same time delay.

The time interval between a sample storing and the next (sampling step) is by default 5 seconds but it can be reconfigured by the user using the MicroLink software.

A sample corresponds to the three values X, Y, Z. Additionally, the temperature and the initial GPS position are also stored if available.

GPS sensor and display backlight are switched off during monitoring to increase the batteries autonomy.

The instrument can store in up to 8 different data acquisition sequences for electromagnetic fields long-term monitoring. The maximum limit of samples for all sequences is 21,504 samples.

The operator can start the monitoring sequence by simply pressing the **[STORE MONIT]** key.

The instrument will start a countdown of 15 seconds (it's a default value that can be reconfigured using the MicroLink software) before the acquisitions start, to allow the user to move away from the instrument installed on a tripod and thus avoid any possible disturbance of the measurement.

During countdown (Fig. 6.9), the current tracking number, from 1 to 8, is displayed.

During countdown the sequence can be aborted simply by pressing any key.

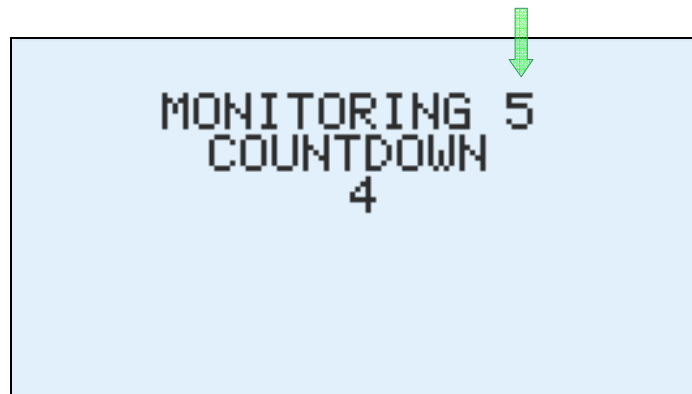


Fig. 6.9

Once the monitoring sequence has started, the display will show a screen indicating battery life, in-progress monitoring number from 1 to 8, sampling rate, time since the monitoring start and total monitoring memory fill bar (Fig. 6.10).

An empty bar indicates that the memory available for the 21,504 samples is completely free (no monitoring is present in memory).

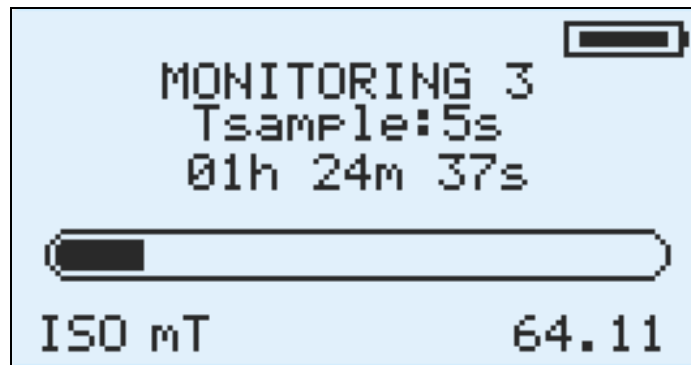


Fig. 6.10

The measurement unit and the instantaneous isotropic value of the field (ISO) are always displayed underneath the bar.

To stop the monitoring before the memory space is exhausted, simply press any key on the instrument.

When there are 8 monitoring sequences or 21'504 samples already stored in the NHT310, if a new acquisition sequence is attempted, the display shows a full memory warning (**MEMORY FULL**) and the monitoring is aborted.

In order to continue monitoring activity, data must be downloaded and delete from the device.

Monitoring start and stop can be also set from remote through MicroLink software, by setting start time and stop time. When a monitoring activity has been set, the \* symbol blinks on instantaneous value left. Once the start time is reached, the symbol disappears and the monitoring starts automatically for the expected duration.

## 6.4 Measurement download and display

All measured values, stored in NHT310 memory, can be downloaded to an external PC/Tablet via fiber optic connection and USB adapter. This data can then be viewed, processed and analyzed using the MicroLink software.

## 6.5 Spatial Average Mode

Depressing the **[STORE SINGLE]** key for more than 4 seconds, the instrument enters into the spatial average mode. The same procedure is also applicable to exit spatial average mode and return to standard mode.

This mode is signalled by the **MODE SPATIAL AVERAGE** text that replaces the section normally reserved for temperature, GPS, date and time on the display (Fig.6.11).

In this mode, user can save single values by pressing **[STORE SINGLE]** (as described in Section 6.3.1) and can visualize on the display a **SPT** window showing the root mean square value calculated on the **N** captured samples.

This function can be useful to quickly obtain an average value in space when two or more values are captured in different spatial points.

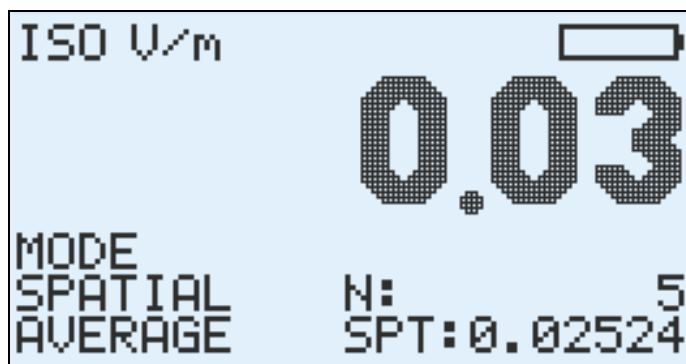


Fig. 6.11

Note that the **SPT** value is also displayed in the standard operating mode, alternating with the ALM alarm threshold display. Additionally, the SPT average value is maintained even after the instrument is switched off, and it is reset only when the instrument enters into spatial average mode.

## 6.6 Alert levels

The NHT310 features a function which alerts the user by means of an acoustic signal which indicates that the measured field exceeds a user configurable threshold inserted via the MicroLink application; this function is enabled by pressing the **[ALARM ON]** key.

As well as having this user configurable function, the instrument also alerts the operator when the maximum field value measured by the probe has been exceeded by 95%. This warning is provided by the letter **E** which appears beside the ISO field (Fig. 6.12) accompanied by an acoustic signal. The letter **E** appears near the isotropic value and near axis which has surpassed this threshold, as long as the display of the single components has been selected.

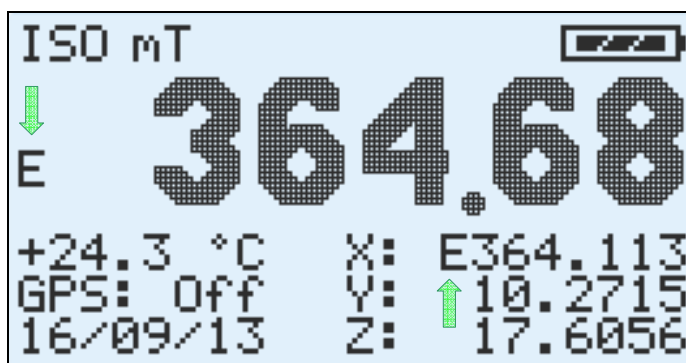


Fig. 6.12



In the case where the field is so strong that it surpassed the probe range, then the message **OVER-RANGE** (Fig. 6.13) appears on the screen in place of the isotropic value; the message is always coupled with an acoustic signal.

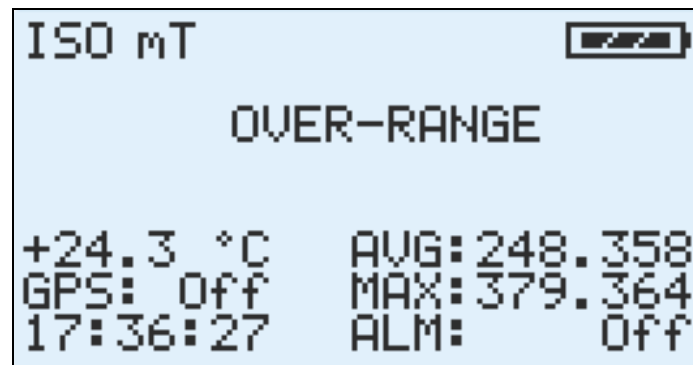


Fig. 6.13

## 6.7 Factory reset

To perform a reset on NHT310 unit, press the **[RESET AVG]** key and hold it for 10 seconds. The system restarts by performing a general reset.

**This action will erase all measurement data and will restore all NHT310 parameters to factory default.**

## 7 MICROLINK SOFTWARE

### 7.1 Description

The MicroLink software, supplied with the NHT310, has mainly three functions.

The first is to allow the setting of the instrument parameters, relating to the moving average, the monitors, the alarm thresholds and the clock.

The second is to allow download on a PC of all data stored in the NHT310 memory and its graphical and tabular display on PC screen, in order to include in a measurement report. Data can also be exported in Microsoft Excel™ compatible format.

The third function is to manage the NHT310 from a remote PC using the fiber optic cable. This mode is indicated for measurements with the instrument installed on a tripod, in order to constantly monitor the field but avoiding the influence of the user's presence. In this mode, user can also change the setting of the NHT310 parameters.

### 7.2 Software installation

MicroLink software is compatible with Windows XP, Vista, 7, 8, 10 operating systems, both 32 and 64 bits. The installation file can be downloaded from the *Microrad* website ([www.microrad.it](http://www.microrad.it)) within the software download page.

Together with the application, the Optical / USB adapter driver is also installed, enabling automatic adapter recognition each time it is connected to the PC.

### 7.3 Software main screen

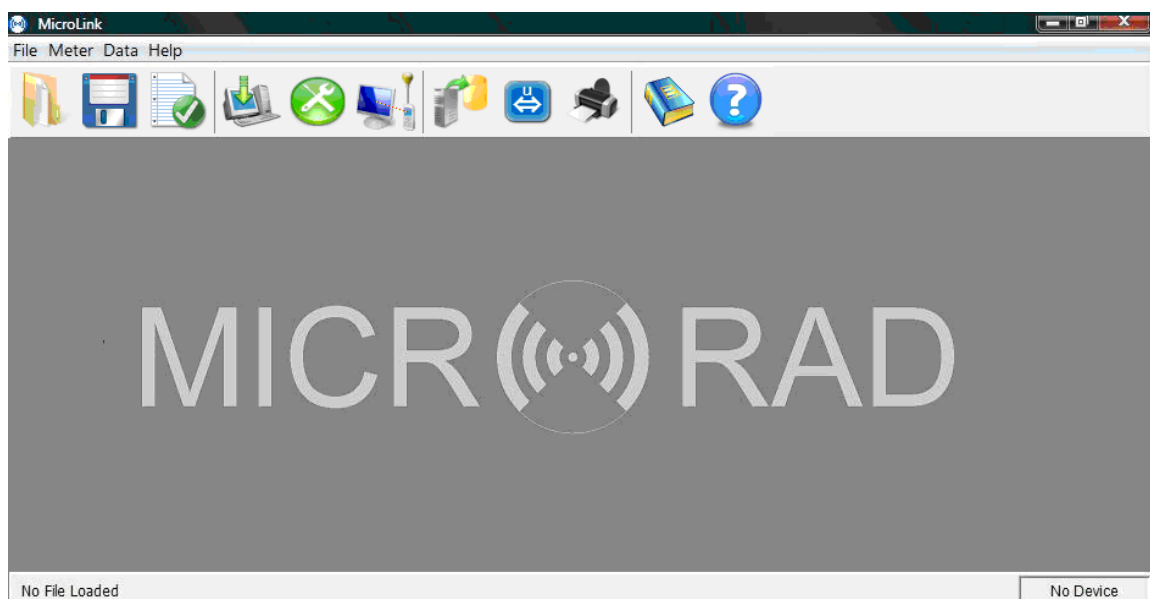


Fig. 7.1

The program functions can be opened from the upper toolbar menu as follows:

**File** - [Open] [Save] [*Properties*] [*Exit*]  
**Meter** - [Download] [Settings] [*Remoting*] [*Fw Update*]  
**Data** - [Export] [Units] [Print]  
**Help** - [Contents] [*About*]

For simplicity, all the functions listed above can be accessed directly via the icons located immediately under the menu bar (except the *Fw Update* and *Exit* functions).

When the NHT310 is not connected to the PC, a **No Device** message appears in the right bottom of the screen.

Once the instrument is connected, as soon as the user interacts with it with some command or opens the MicroLink application, the name **NHT310** appears in the same window, meaning that the instrument has been identified and communicates.

As long as user do not recall a file that has already been saved on the PC, the **No File Loaded** message appears in the lower left of the screen.

When a measurement file is selected and opened, its name and path appear in the same window.

## 7.4 Functions



**Open** – Searching and opening a measurement file previously saved in the PC.



**Save** – Saves a new measurement file on a PC's mass unit.



**Properties** – Displaying data of the NHT310 instrument connected.



**Download** – Transfers data stored on the NHT310 to the PC.



**Settings** – Allows the user to set configuration parameters of the NHT310.



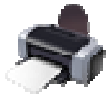
**Remoting** – Remote management of the NHT310 from PC via fiber optic connection.



**Export** – Exports in tabular format (Excel compatible) all the acquisition data.



**Units** – Selecting the default measurement unit for the electric and magnetic fields, and for temperature.



**Print** – Prints the acquisition data.



**Contents** – Link to the user's manual via Internet



**About** – Information regarding the software version installed.

## 7.5 NHT310 parameters setting (Settings)



By clicking on the **[Settings]** icon, user can access the configuration screen (Fig.7.2) for some parameters of the NHT310. These parameters are:

- **RMS Average** : time interval for AVG average calculation
- **Monitoring** : start / stop time and sampling interval
- **Alarm Level**: threshold level for acoustic alarm
- **Date & Clock**: Date and time of NHT310



Fig. 7.2

The possible settings from this panel are illustrated below.

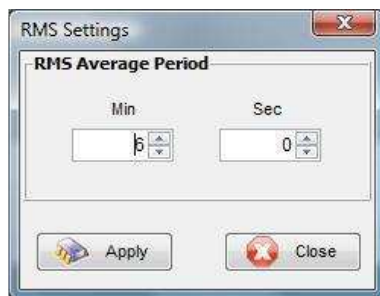


Fig. 7.3

#### ***RMS Settings***

User can set the time interval to calculate the AVG (time average) value in the range from 1 second to 192 minutes. Default value is 6 minutes as per international regulations.

This configuration is useful for high frequency measurements.

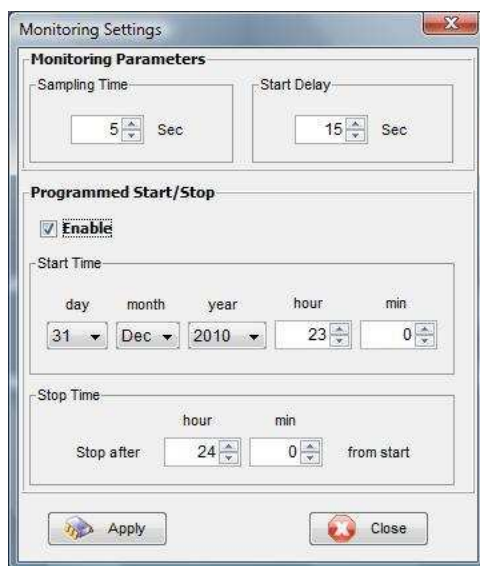


Fig. 7.4

#### ***Monitoring Settings***

User can configure:

- time interval between a sample and the next (Sampling Time, from 1 to 30 seconds);
- start delay time (Start Delay);
- enable or disable the scheduled monitoring (Enable);
- date and time for monitoring start (Start Time);
- date and time for monitoring stop (Stop Time).

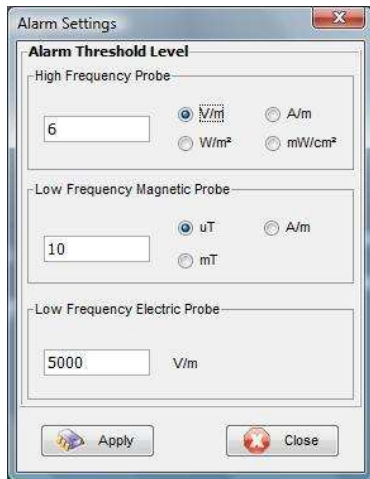


Fig. 7.5

### Alarm Settings

Allows the user to configure the alarm threshold for high field.

- *High Frequency Probe*: level and measurement unit for use with high frequency electric (E) or magnetic (H) probe;
- *Low Frequency Magnetic Probe*: level and measurement unit for use with static or low frequency magnetic probe;
- *Low Frequency Electric Probe*: level and measurement unit for use with low frequency electric probe.

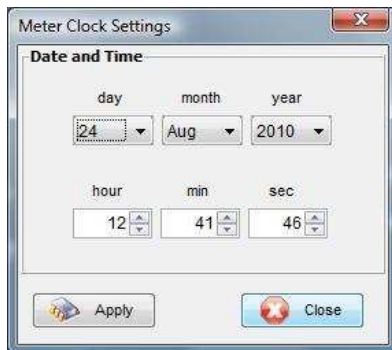


Fig. 7.6

### Meter Clock Settings

Allows the user to configure the date and time of the NHT310.

## 7.6 Download data from NHT310 (Download)



After connecting the NHT310 to the PC through the supplied optical cable and converter, click on the **[Download]** icon.

Data transfer starts and a progress bar appears during the process (Fig.7.7).

When download is complete, user can to save measurements on the PC. This action is not necessary at this stage and can also be done at a later time by clicking on the **[Save]** command.

It is also required if user wants to delete the data from the NHT310.

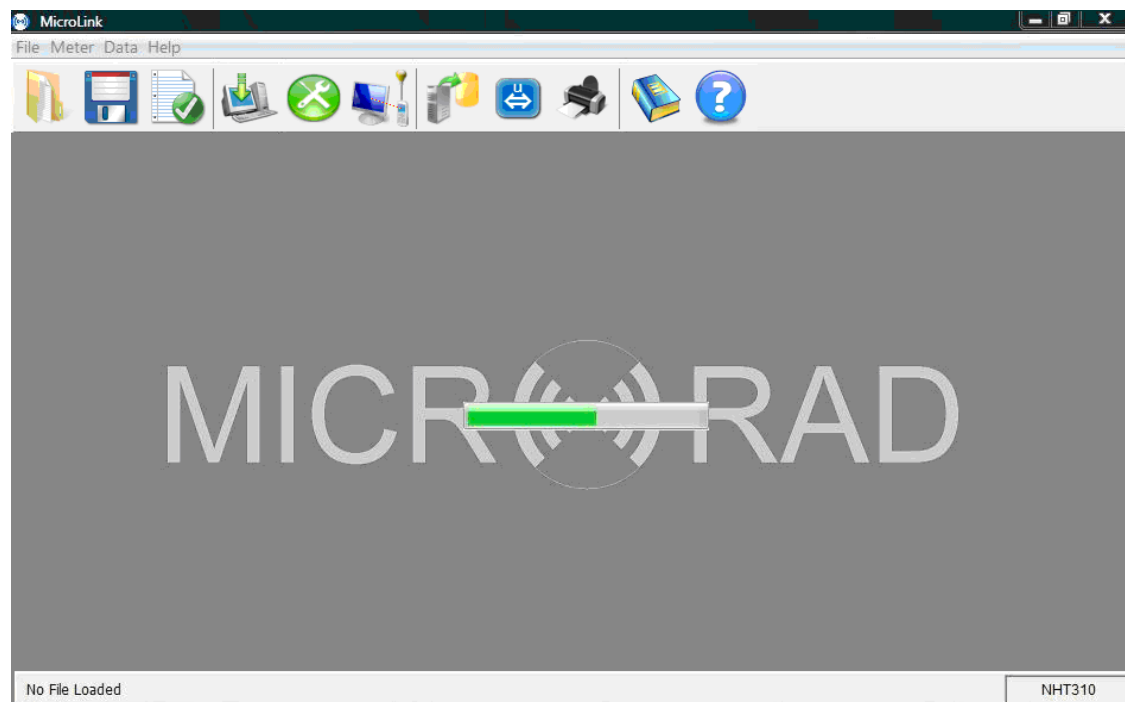


Fig. 7.7

Data saved to files (.uR extension) can also be recalled via the **[Open]** command.

After download or after opening a file, a screen is displayed that allows selection between *SnapShots*, *Monitoring*, *Plot*.

### 7.6.1 SnapShots panel

SnapShots are measures taken in punctual mode.

Nr	Time	X	Y	Z	Iso	Avg	Max	T (°C)	Filter	Probe	Gps
1	09/01/00, 5:33:46	0.00 V/m	0.00 V/m	0.00 V/m	0.00 V/m	1801.003 V/m @Tavg=360s	2147.484 V/m @5:25:...	27.0	Off	01E	Off
2	06/02/00, 0:11:18	0.07 V/m	0.00 V/m	0.05 V/m	0.08 V/m	0.17 V/m @Tavg=360s	1.42 V/m @0:08:53, 0...	28.1	Off	01E	Off
3	06/02/00, 0:34:25	0.07 V/m	0.00 V/m	0.04 V/m	0.08 V/m	0.35 V/m @Tavg=360s	1.42 V/m @0:08:53, 0...	28.3	Off	01E	Off
4	06/02/00, 0:34:33	0.06 V/m	0.01 V/m	0.05 V/m	0.08 V/m	0.35 V/m @Tavg=360s	1.42 V/m @0:08:53, 0...	28.3	Off	01E	Off
5	06/02/00, 0:34:39	0.07 V/m	0.00 V/m	0.04 V/m	0.08 V/m	0.35 V/m @Tavg=360s	1.42 V/m @0:08:53, 0...	28.4	Off	01E	Off
6	06/02/00, 0:34:47	0.06 V/m	0.00 V/m	0.04 V/m	0.08 V/m	0.35 V/m @Tavg=360s	1.42 V/m @0:08:53, 0...	28.4	Off	01E	Off
7	06/02/00, 0:34:59	0.06 V/m	0.01 V/m	0.05 V/m	0.08 V/m	0.35 V/m @Tavg=360s	1.42 V/m @0:08:53, 0...	28.4	Off	01E	Off
8	24/08/10, 16:48:06	0.04 V/m	0.01 V/m	0.06 V/m	0.07 V/m		n/a 0.25 V/m @5:00:04, 0...	30.7	Off	01E	Lock
9	24/08/10, 16:48:13	0.05 V/m	0.01 V/m	0.06 V/m	0.08 V/m		n/a 0.25 V/m @5:00:04, 0...	30.8	Off	01E	Lock
10	24/08/10, 16:48:18	0.04 V/m	0.00 V/m	0.06 V/m	0.08 V/m		n/a 0.25 V/m @5:00:04, 0...	30.8	Off	01E	Lock
11	24/08/10, 16:48:27	0.05 V/m	0.00 V/m	0.07 V/m	0.08 V/m		n/a 0.25 V/m @5:00:04, 0...	30.8	Off	01E	Lock
12	24/08/10, 16:48:32	0.05 V/m	0.00 V/m	0.06 V/m	0.08 V/m		n/a 0.25 V/m @5:00:04, 0...	30.9	Off	01E	Lock

Fig. 7.8

Each single measurement (snapshot) is represented by a line in a table which contains the following information:

- Progressive number (from 1 to 432).
- Date and time.
- X, Y, Z instantaneous component values for the field.
- Instantaneous isotropic values of the field (ISO).
- r.m.s. moving average value (AVG) and time window width.
- Maximum isotropic value (MAX) with associated date and time.
- Temperature
- Filter on/off status (only for low-frequency probes).
- The model of the probe with which the measurement was taken (with a click above this field a window will appear with all the details of the probe).
- GPS status: if the GPS is active and locked on to a satellite during the measurement activity, a *Lock* message appears. By clicking on it the user can access to the GPS coordinates and time and to the map view as explained in paragraph 7.9.

From this screen user can also get a Spatial AVG value by simply pointing two or more of the available AVG values.

This is very useful, for example, when measurements have been made with a tripod mounted NHT310 unit at different heights as suggested by some guidelines. Obviously, user can highlight non-consecutive measurements by clicking on the mouse while depressing **[CTRL]** key on PC. The value is displayed in the *Spatial Avg* field.

Note that, unlike the spatial average that NHT310 calculates in space mode (par.6.5), which is a quadratic average on instantaneous values, this is a quadratic average that MicroLink software calculates considering the values already mediated over time by the instrument (AVG).

### 7.6.2 Monitoring panel

Table below (fig.7.9) lists all samples acquired in monitoring mode. Each row corresponds to a stored sample.



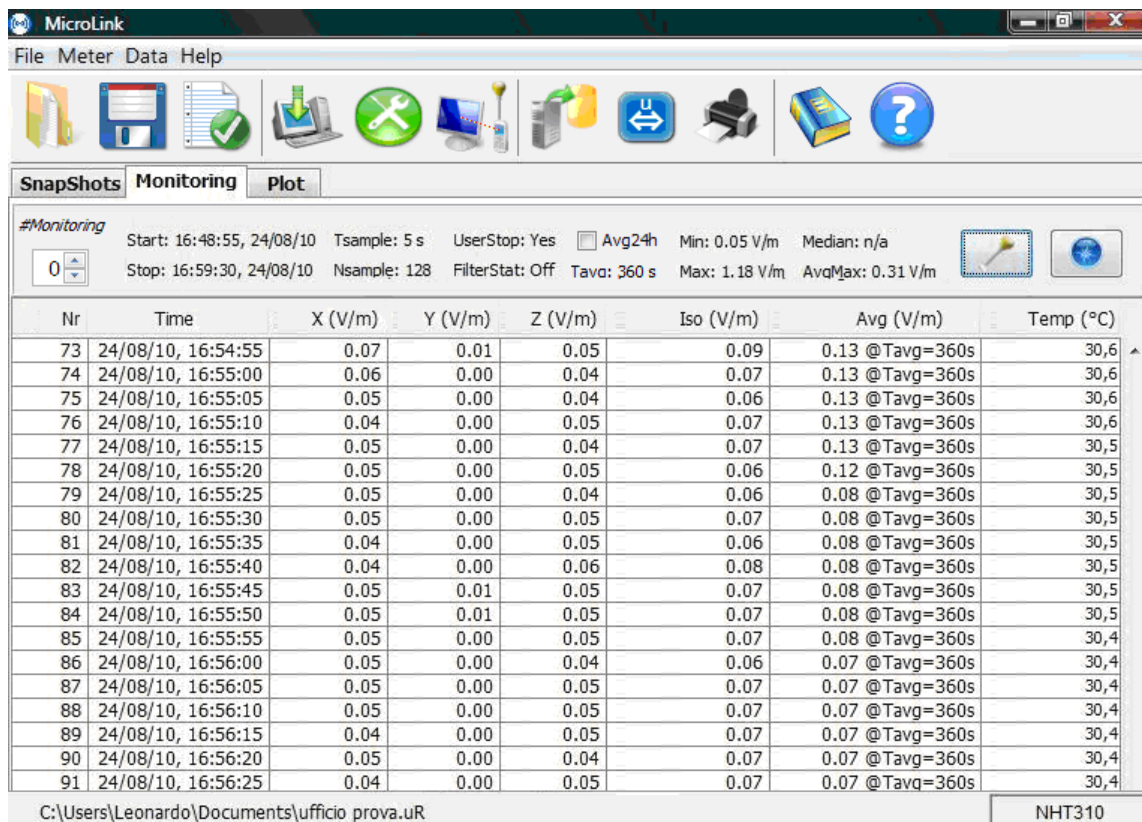


Fig. 7.9

Eight separate monitoring sequences can be stored, that can be selected by control on top left corner, under the *#Monitoring* tag.

The maximum number of measurements and then lines in the table is 21'504. For each one the following information are displayed:

- Progressive number (from 1 to 21'504 if a single monitoring filled all the NHT310 memory).
- Date and time.
- X, Y, Z instantaneous component values for the field.
- Instantaneous isotropic values of the field (ISO).
- r.m.s. moving average value (AVG) calculated using the Tavg parameter that was selected at the time of the monitoring start, or calculated on 24h when the function Avg24h is selected.
- Temperature.

On the table top, many important information about the monitoring are displayed:

- Date and time of start (*Start*) and stop (*Stop*).
- Sampling step used (*Tsample*).
- Number of samples acquired (*Nsample*).
- *UserStop* indicator, if Yes is displayed the monitoring has been stopped manually (by tapping the instrument or pulling out the probe) and then

the last data may be disturbed by the operator proximity. As an alternative to manual shutdown, it is possible to stop monitoring by remote control, setting a scheduled stop, or stop for memory depletion.

- *FilterStart* indicator, returns the On / Off status of the instrument low frequency filter during monitoring.
- The *Avg24h* control enables a 24 hours calculation of the moving average in the Avg column, by forcing a 24-hour *Tavg*. This calculation is useful only in case of monitoring sequences lasting more than 24 hours.
- Time interval for moving average calculation set during acquisition (*Tavg*).
- Minimum (*Min*) and maximum (*Max*) instantaneous isotropic value measured.
- Moving average maximum value (*AvgMax*).
- Median index or middle value (*Median*).

Note that the *AvgMax* average value index is calculated only for monitoring carried out using radio frequency probes; while the *Median* index is calculated only for static or low-frequency probes.

Finally, through 2 dedicated buttons, operator can access the probe data used for monitoring and GPS information (Fig.7.10). Coordinates and GPS time refer to the location and time at the monitoring start.

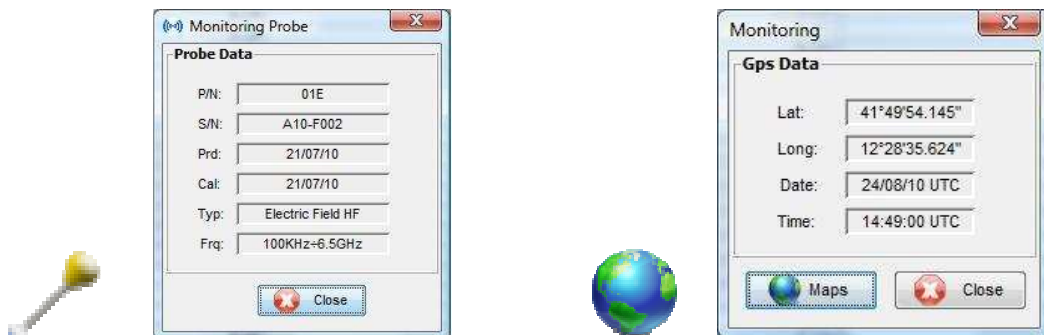


Fig. 7.10

### 7.6.3 Monitoring data graphic format

In this section, operator accesses the time diagram (Fig. 7.11) of the monitoring sequence selected in the numerical display panel pressing the control *#Monitoring*.

Controls displayed in the bar on the left are described below.

- *Y Scale*: allows to switch from the linear view [**Lin**] of the field values to the logarithmic [**Log**] (except temperature and weighted indexes that are always displayed on a linear scale); in the case of logarithmic display, the

value of 0 dB is assigned to the maximum value of the isometric field; then each point assumes a decibel value according to the relation:

$$E(\text{dB}) = 20 \text{ Log}_{10} ( E / E_{\text{isomax}} )$$

- **Tracks:** allows the viewing of the **[ISO]** instant field values, of the individual axes **[X]**, **[Y]**, **[Z]**, of the r.m.s. value **[AVG]**, of temperature **[T]**.
- **Marker:** indicators (horizontal lines) for the maximum **[Max]** and minimum **[min]** value of each plot displayed.
- **Tools :** functions to zoom time dimension and to export the diagram to bitmap or jpeg files **[Export image]** .

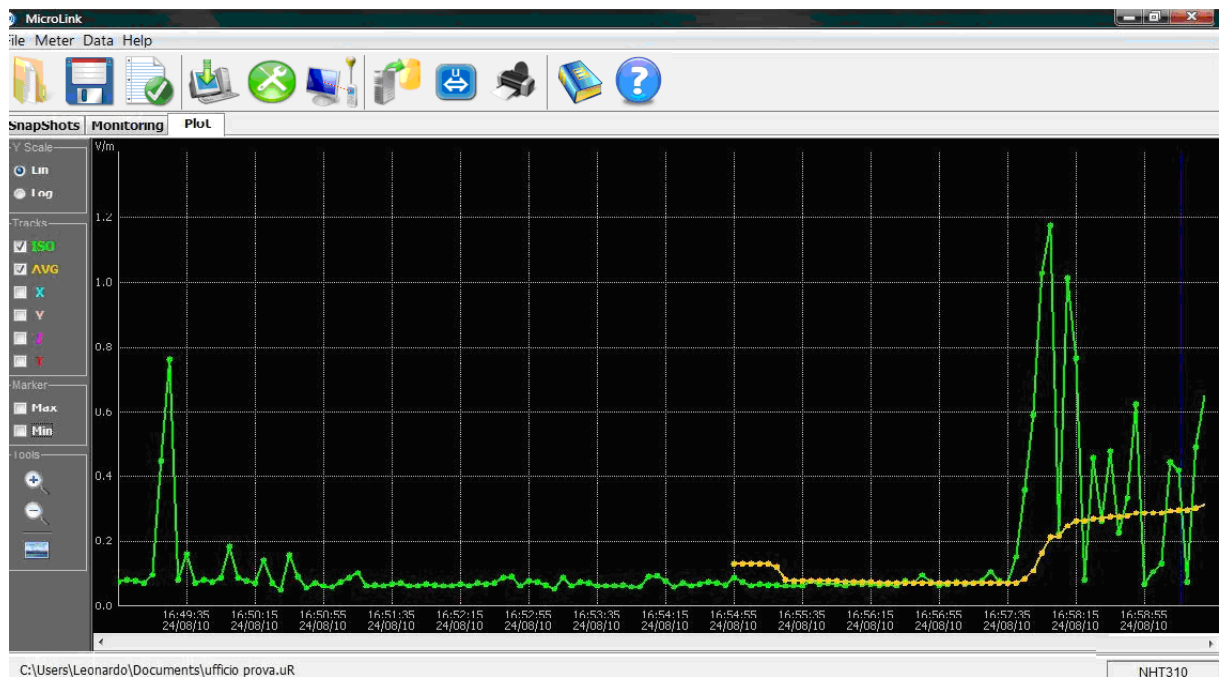


Fig. 7.11

Moving the mouse pointer over the graph values are displayed.

By highlighting (dragging the mouse with the left key depressed) parts of the table, the corresponding portions of the diagram automatically highlight (Fig. 7.12) and vice versa.

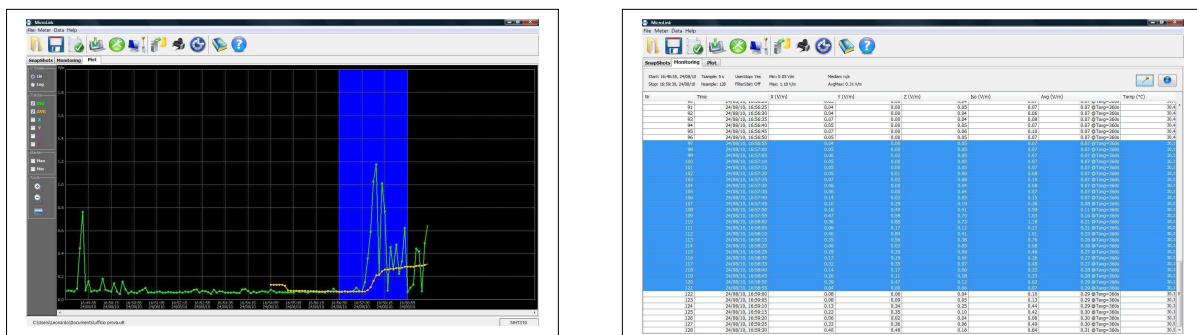


Fig. 7.12

As far as exporting graphics images is concerned, by clicking on the specific icon user can access the image save window as illustrated in Fig.7.13.

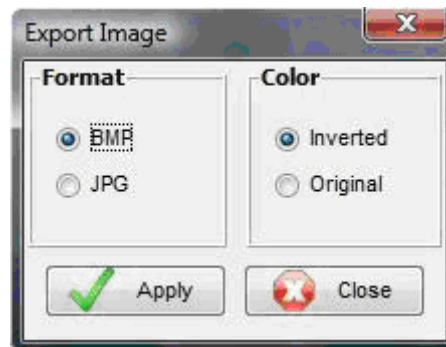


Fig. 7.13

User can select the .BMP or .JPG file type and choose inverted colors in order to save with a white background for a better print economy.

## 7.7 Microsoft Excel™ data export



After data download, in addition to saving them on a PC using the **[Save]** button, user can export them automatically to Excel by clicking on **[Export]**.

The window illustrated in Fig.7.14 will open, there user can select the data he wants to export, both for SnapShot and Monitoring. The choice is between all data, no data, only the selected data.

User can then choose to name and save a new .xls file with the selected measurements.

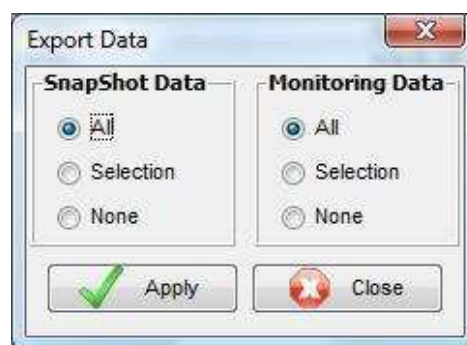


Fig. 7.14

## 7.8 NHT310 remote control



After switching on the NHT310 and connecting it to the PC, user can remotely control it by clicking on the **[Remoting]** command.

A double window on the PC monitor will be displayed: on the left the frontal image of the instrument is faithfully reproduced; on the right, the real-time measure graph is displayed.

User can manage the NHT310 instrument, simply clicking on the virtual keyboard on the PC.

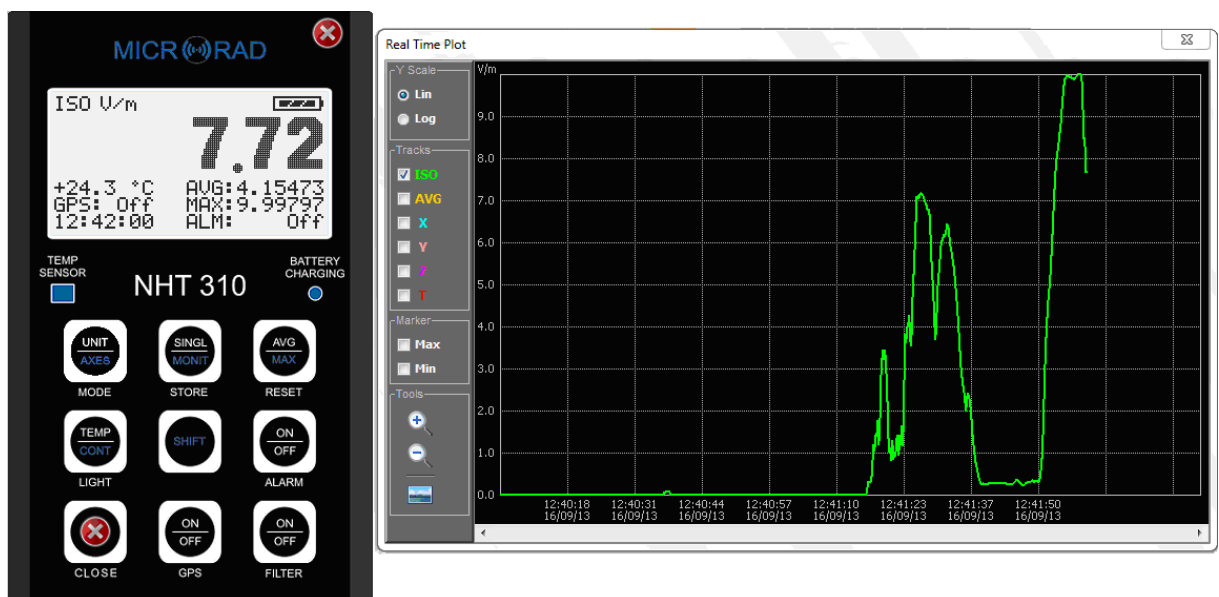


Fig. 7.15

The graph displayed on the PC screen is not saved in the PC memory. To perform any single or monitoring data acquisition, user must press the **[STORE SINGLE]** or **[STORE MONIT]** virtual keys.

## 7.9 GPS and Google Maps

Localization information (latitude and longitude) from the GPS sensor are always displayed on the instrument screen, as well as inside the virtual instrument on the MicroLink screen.

In addition, as already seen, GPS location and UTC time are saved in the instrument both with single acquisitions and with monitoring.

In this case, after data download to the PC, not only the GPS coordinates and the time are recorded, but the user also has the facility to view them using



Google Maps which indicates the positions from which the measurements were taken.

This is done by establishing a connection between the PC and the internet and then clicking on the **[Maps]** button which appears in the window as shown in Fig. 7.16.

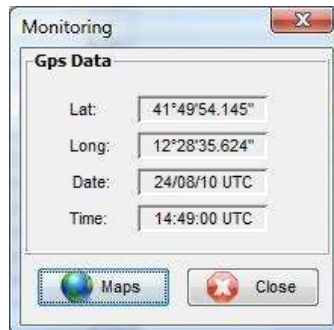


Fig. 7.16

This command automatically opens Google Maps in the predefined browser of the system and shows the position from which the measurement was taken on the map (Fig. 7.17).

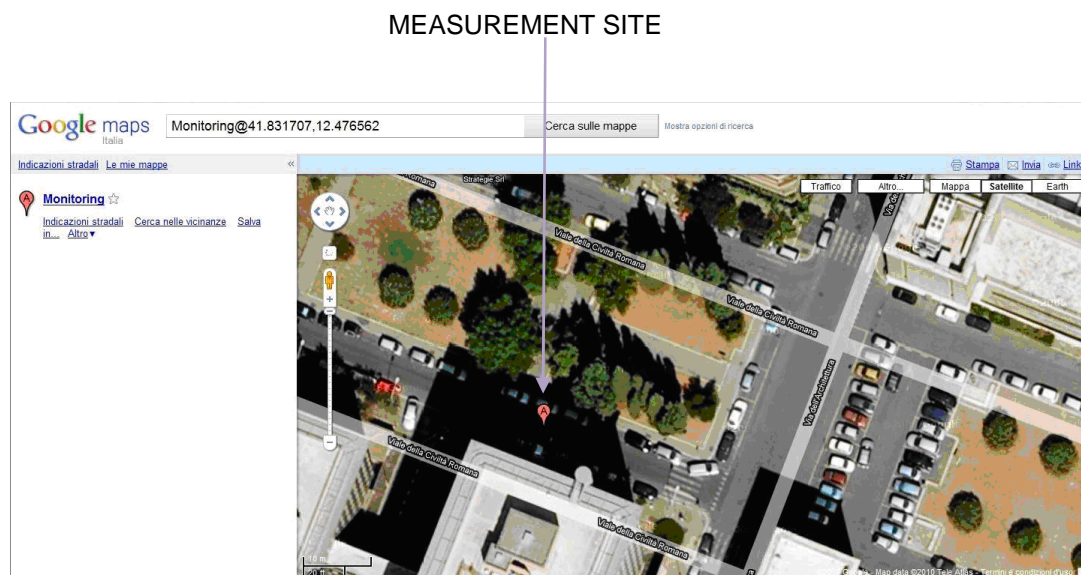


Fig. 7.17

## 7.10 NHT310 firmware update



The MicroLink software is designed to allow eventual updates to the firmware located inside the NHT310 device when they are released by the manufacturer.

The file containing the new firmware version is recognizable through the extension **.rom** and may be downloaded from the manufacturer website: [www.microrad.it](http://www.microrad.it).

To carry out an update the following procedure is used:

- Make sure the NHT310 device is switched off before connecting it to the PC via the optical cable supplied with the kit.
- Press the **[RESET AVG]** key on NHT310 keyboard and, keeping this key pressed, contemporarily press the instrument **[POWER ON]**.
- Release **[POWER ON]** key but keep the **[RESET AVG]** key pressed until the following message appears on the screen:

### ***“FIRMWARE UPDATE MODE”***

- Release the **[RESET AVG]** key.
- After the start of MicroLink software, click *Meter* menu and then **[Fw Update]** menu.
- A window will open that allows to select **.rom** files on the PC's hard disk. Select and open the file (double-click or *Open* key).
- The update automatically started, and It can take about 30 seconds.

At the end of the update procedure the MicroLink software sends a message that the update procedure has been successful. The NHT310 will then reboot automatically.

## APPENDIX A COMMUNICATION PROTOCOL

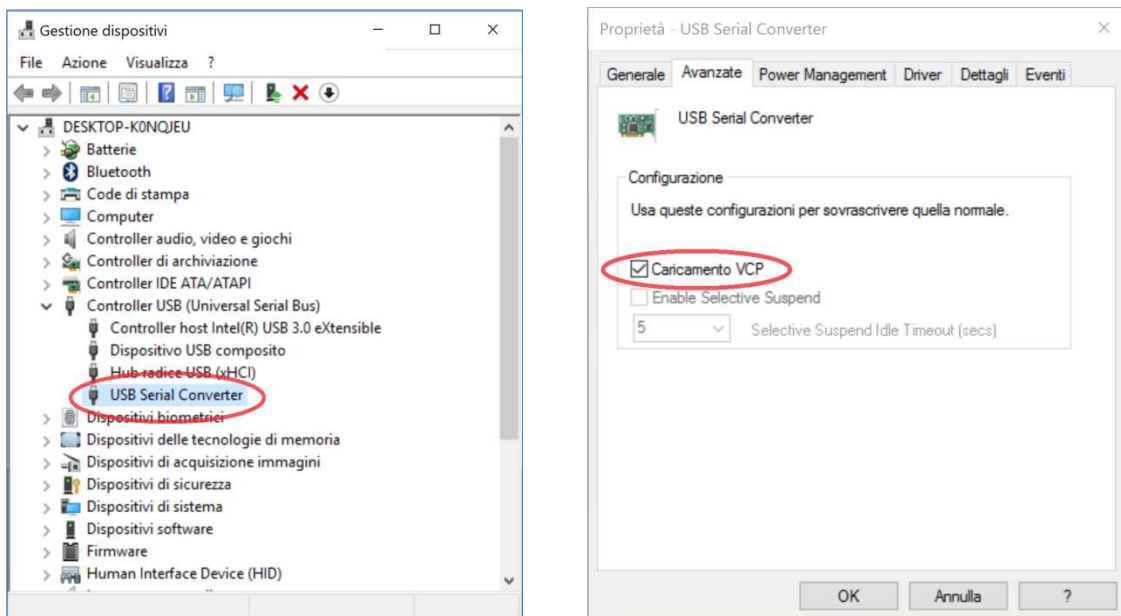
The measurements made by the instrument can also be accessed through proprietary applications, using the fiber optic communication line and the USB adapter.

To enable communication between the PC and the instrument USB line, operator must first install the Virtual COM Port (VCP) driver provided by FTDIChip; the driver allows the software to see the USB line as a normal serial port and establish communication with UART protocol.

Driver installation is not required if a PC where *Microrad Waves* software is already present is used.

In any case, operator should verify that the VCP option is enabled:

*Device Manager (Gestione dispositivi) → Controller USB → USB Serial Converter → Properties → Advanced*



**Fig. A.1 - Virtual COM Port enable**

To this end, the communication port must be configured by the user application to work with 8 data bits, no parity bit, 1 stop bit (8n1) and a 9600 baud rate.

It is then necessary to enable the serial data communication mode in the instrument, keeping the SHIFT key pressed for about 10s until a blinking 'R' appears to the left of the ISO value. This mode remains active permanently, even after the instrument is switched off / on again. Deactivation takes place with the same procedure.

When the serial data communication mode is active, the instrument continues to operate normally, and it is able to send measurement data to the optical fiber when required.



However, it is no longer possible to perform memorization operations (single acquisitions and monitoring) on the instrument. Furthermore, it is no longer possible to interface it with the application software, first disable the serial data communication mode and the driver's VCP option.

The communication protocol is based on the exchange of ASCII messages between the user's custom application (master) and the instrument (slave).

The commands consist of single characters sent by the master.

The responses of the slave consist of strings with common characteristics: they all start with the character '\$' (24h) and end with the sequence **\*checksum<CR><LF>**.

**\$ campo1, campo2, ... , campoN \*checksum<CR><LF>**

- the first character of the string is always '\$' (24h)
- '\*' (2Ah) is the character used as checksum delimiter
- the fields are always delimited by the character ',' (2Ch)
- characters carriage return and new line, '<CR>' (0Dh) and '<LF>' (0Ah) always end the string
- the checksum consists of 2 hexadecimal characters corresponding to the XOR of all the bytes between '\$' and '\*' ('\$' and '\*' excluded).

The calculation methods are the same as those foreseen in the NMEA protocol ([https://en.wikipedia.org/wiki/NMEA\\_0183](https://en.wikipedia.org/wiki/NMEA_0183)).

The command of the measurement data request consists in sending to the instrument the uppercase character 'A'.

Il comando di richiesta dei dati di misura consiste nell'invio allo strumento carattere 'A' maiuscolo. The instrument responds with the string:

**\$Eiso,Ex,Ey,Ez,T\*checksum<CR><LF>**

where the 5 fields shown are:

- **Eiso** : total value of the isotropic field
- **Ex** : value of the field component along the X direction
- **Ey** : value of the field component along the Y direction
- **Ez** : value of the field component along the Z direction
- **T** : temperature (°C)

The measurement unit of the field is the default one adopted by the probe in use (V/m for all the electric probes, µT for the magnetic low field probes, A/m for the magnetic radiofrequency probes, mT for the static high field).

*Example with probe 01E:*

**\$103.94,10.42,103.4,1.83,19.9\*1B<CR><LF>**

- *Eiso*= 103.94 V/m
- *Ex*= 10.42 V/m
- *Ey*= 103.4 V/m
- *Ez*= 1.83 V/m
- *T*= 19.9°C