# WAVECONTROL

# Electromagnetic Field Meter
# SMP2

USER'S MANUAL

# Index

Congratulations for your acquisition

of a Wavecontrol **SMP2**.

This Manual provides you with instructions

for using and handling your **SMP2**.

Please read this Manual carefully before using

your **SMP2**.

# 1. WARNINGS AND PRECAUTIONS

⚠ Review this manual and become familiar with all the instructions for using and handling your **SMP2**.

⚠ Your **SMP2** is a portable apparatus with a rechargeable battery. Before taking any measurement, make sure that the battery is sufficiently charged for the time that you need for the measurement. If it is not, recharge the battery before.

⚠ Your **SMP2** is not watertight and it should be protected from moisture, such as rain.

⚠ Adjustment, maintenance, or repair of the equipment must be performed only by qualified personnel. Please get in touch with **Wavecontrol** or your sales contact.

⚠ Never overtighten when screwing the **SMP2** on the tripod since the thread engagement could break down.

**Environmental information**
Disposal of your old product:

Your product is designed and manufactured with high quality materials and components, which can be recycled and reused.

When this crossed-out wheeled bin symbol is attached to a product it means the product is covered by the European Directive 2002/96/EC.

Please get informed about the local separate collection system for electrical and electronic products.

Please act according to your local rules and do not dispose of your old products with your normal household waste. The correct disposal of your old product will help prevent potential negative consequences for the environment and human health.

# 2. INTRODUCTION

The **SMP2** Portable Electromagnetic Field Monitoring System can measure electromagnetic field levels generated by any source within the frequency range of the probe attached to the system.

It combines 2 instruments in 1: broadband measurements and selective measurements (FFT), including % direct EMF exposure assessments to limit lines by using the weighted peak exposure (WPE) technique.

The **SMP2** has been developed to meet demanding customer requirements in the RF safety measurements domain. Its versatility makes it a perfect measurement tool for many different sectors and industries such as Railway, Power, Manufacturing, Chemical, Medical, Defence, RFID and EAS, Telecommunications, etc.

Those measurements can be made quickly and easily anywhere because the **SMP2** is portable and simple to handle and use.

The **SMP2** can sample the field level continuously and store that data automatically in its built-in memory at user-configured intervals with a capacity of up to 1 000 000 samples.

The data stored in the memory can be easily downloaded to a computer via a USB or fiber optics port for later processing.

The **SMP2** is also available with a built-in GPS receiver (optional) to allow each measurement to be associated automatically with the geographic location where it was taken.

# **3.** FIRST STEPS

This section contains instructions for unpacking and checking the equipment when you receive it.

1) When you receive the equipment, check the packaging to see if it has been damaged in any way. Make a description of any damage on the delivery note before you sign it.

2) Check that all the components of the **SMP2** are there. The **SMP2** is delivered in a compact briefcase that should contain the following components:

- **SMP2.**
- 1 or more electromagnetic field probes.
- Battery charger.
- USB key containing the User's Manual and **SMP2** software.
- USB – mini USB cable.
- Fibre optic link (optional).

If any of those components is missing, please contact **Wavecontrol**.



Field Probe

SMP2 and USB cable below

Flash drive

Field Probe

Battery charger
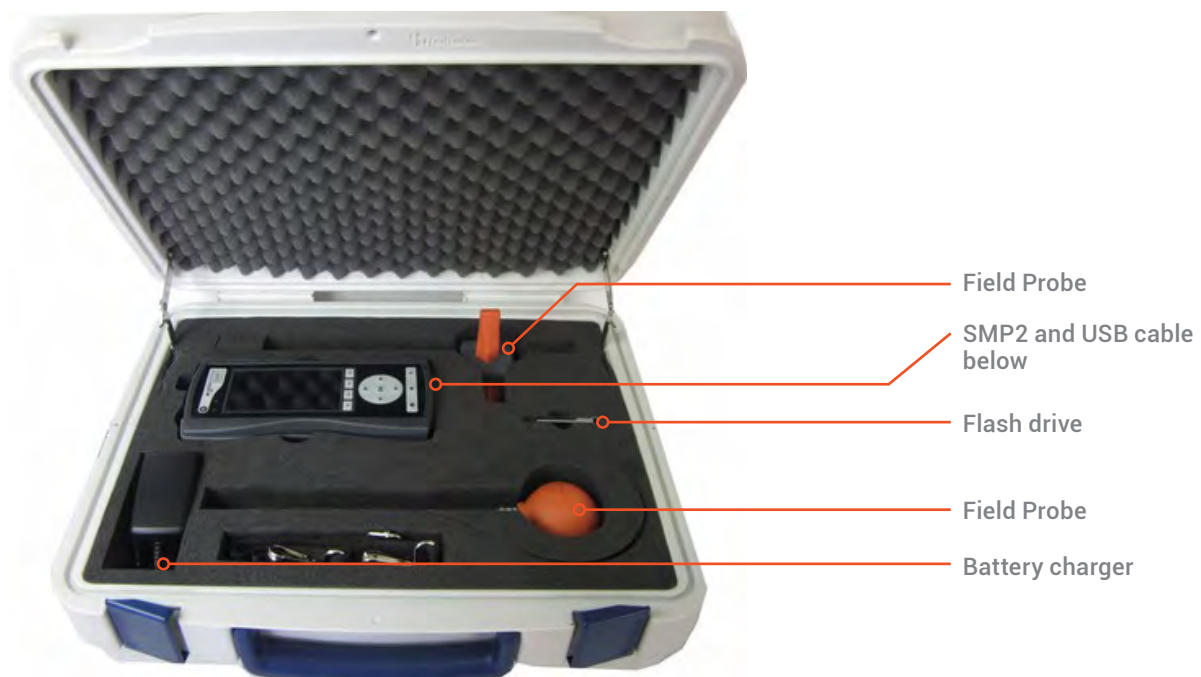
**Figure 1:** Case

# **4.** GETTING STARTED

### 4.1 Overview

The front panel of the **SMP2** contains the user interface, made up of the screen and keypad.

The keyboard presents 8 standard buttons, 4 virtual buttons (below the screen) and 1 ON/OFF button.

- ◀ ▶ ▲ ▼: These arrows allow you to move through the menu options and the data stored in memory.
- OK : allows to validate an option or enter in a menu.
- 🏠 : always allows to come back to the main screen (measuring screen).
- � : allows to get back to an earlier menu or to cancel a selection.
- 📷 : allows to take print-screens anywhere in the program.

The top of the **SMP2** holds the field probe connector.

**Figure 2:** Front

Probe connector

On/Off button

Integrated GPS patch antenna

Light sensor

Status LED

**Figure 3:** Top

- **Probe connector:** (see 4.2).
- **On / Off button:** switches the equipment on and off.
- **Status LED:** when the unit is off, red means charging, green charged. When the unit is on, green LED should be always on.
- **Light sensor:** allows to control the automatic screen back-light intensity depending on ambient light.

The bottom of the **SMP2** holds the other connections of the equipment.



Mini USB connector

Charger connector

Tripod ¼' screw

Fibre optic connector
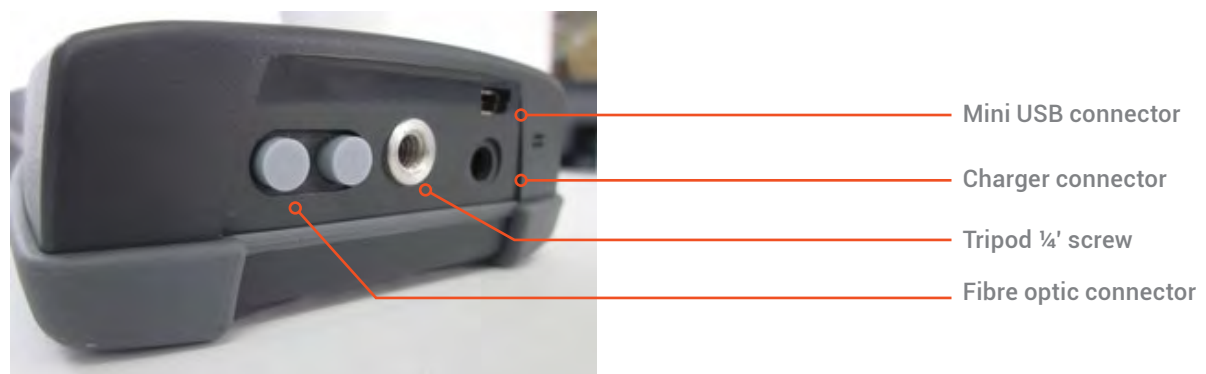
**Figure 4:** Bottom

- **Mini USB connector and fibre optics:** allows connection to a PC in order to:
  - Download data stored in the **SMP2** memory.
  - Update firmware for the equipment.
  - Control the unit remotely.

- **Battery charger connector:** allows the **SMP2** battery to be recharged using the charger supplied with the equipment.
- **¼' screw connector:** takes a ¼' screw, the standard screw used for most tripods, allowing the **SMP2** to be mounted on a tripod.

## 4.2 Field probes

The **SMP2** is a highly versatile EMF measurement device that requires connection of the proper field probe to obtain the best results for each application. Only **Wavecontrol** field probes will work with the device.

If the device is switched on with no field probe attached, it will not show any field value and therefore no measurement will be saved to memory. However, saved data and GPS positioning functions will be available.

The **SMP2** automatically detects the type of field probe and its calibration parameters.

### 4.2.1 Connector type

There are two types of connector: push-pull and screw.



**Figure 5:** Push-pull connector



**Figure 6:** Screw connector

### 4.2.2 Screw connector
### 4.2.2.1 How to connect the field probe
Connect the field probe by inserting the male connector into the female connector with the tab aligned. Once fully inserted, screw the connector until it is snug, without forcing it.



Sleeve to screw on after inserting the probe

Tab
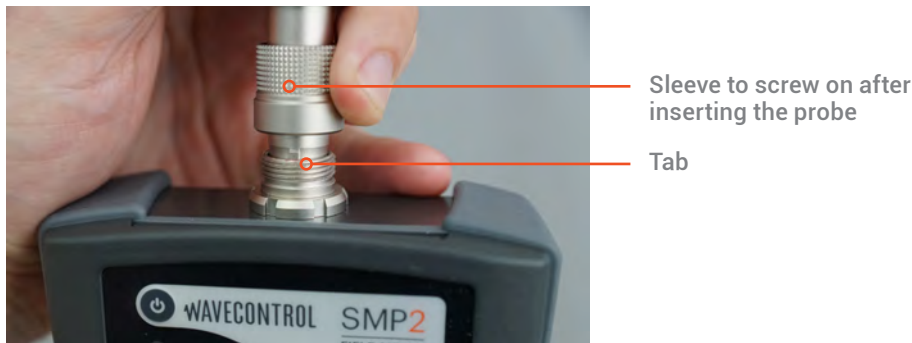
Figure 7: How to connect the field probe

### 4.2.2.2 How to disconnect the field probe
First unscrew the probe connector, then pull the connector to remove it.

⚠ **Important:** pull the connector.
Do not try to twist or turn the probe tube.

### 4.2.3 Push-pull connector
### 4.2.3.1 How to connect the push-pull probe
With a push-pull connector, the field probe is connected by inserting the male connector into the female connector of the **SMP2** until it stops. The polarity of the connector must be observed and so the red marks on the male and female. connectors must line up.



Figure 8: How to connect the field probe

### 4.2.3.2 How to disconnect the field probe
You do not need to switch the device off before you disconnect the field probe. Pull the connector of the probe firmly with one hand (pulling with the thumb) while you hold the **SMP2** with your other hand as shown in the pictures below:



Figure 9: How to disconnect the field probe

⚠ **Important:** pull the connector. Don't pull any other part of the probe!
Don't try to twist or unscrew the probe.

## 4.3 External connections

### 4.3.1 USB

A USB to mini USB cable is delivered with the **SMP2**. After installing the **SMP2** software (first install the software see 8.1) just plug the cable to the **SMP2** and to the computer. You will be able to download stored measurements to the computer or update the **SMP2** firmware.

**Note:** *it is not recommended to perform measurements while the USB is connected, it could affect the quality of the readings.*

### 4.3.2 Fibre optic



Breakable part see Note2

A fibre optic link is available as an option in order to remotely control and see live readings of the instrument from a PC without interfering with the measurements. To connect the fibre optic link:

- Plug the fibre to the **SMP2** (respect the colour code, grey side is looking up).
- Plug the fibre to the USB to fibre converter (respect the colour code).
- Plug the USB of the converter to the PC.

**Note:** *no need to install additional software, everything has been already installed with the main software.*

**Note2:** *in case the connector does not fit into a small waveguide, you can break the connector in 2 parts.*

# 5. SMP2 – initial use

The **SMP2** is designed for simple and intuitive operation with 2 basic functions:

• Time or frequency domain field measurement.
• Storage of results in memory.

Several additional functions make the **SMP2** a very complete field measurement system.

The **SMP2** is controlled via the keypad and easy access to data is available through the different screens.

### 5.1 Switching the apparatus on and off
The apparatus is switched on and off with the On / Off button located on the upper part of the keyboard.

To power on the unit, click on the On/Off button. The status LED will stay in red for some milliseconds before turning green. A welcome screen is displayed until the software completely boots and shows the main screen.

To power off the unit, click once on the On/Off button. A pop-up will appear on the screen to confirm the command. F1 and F2 buttons will confirm the action, F3 and F4 buttons will cancel it. You can also select the option with the right and left arrows and click on OK to confirm.

**Note:** *All device's configurations (alarm level, units, type of measurement, measurement interval, etc.) are saved when it is switched off and recovered automatically when it is switched on.*

### 5.2 Main screen
The main screen provides instantaneous and continuous information on the electromagnetic field being measured.

• **Date and time:** date and time of the apparatus.
• **Icons:** several icons give some information on the state of the unit.

| | | | |
|---|---|---|---|
| | Alarm is activated | | USB is connected |
| | Fibre connection available | | Schedule measure is activated |

• **Battery :** battery charge level.

| | |
|---|---|
| | Battery discharged |
| | Battery fully charged |

• **Probe information:** serial number of the field probe attached to the apparatus and its frequency information.
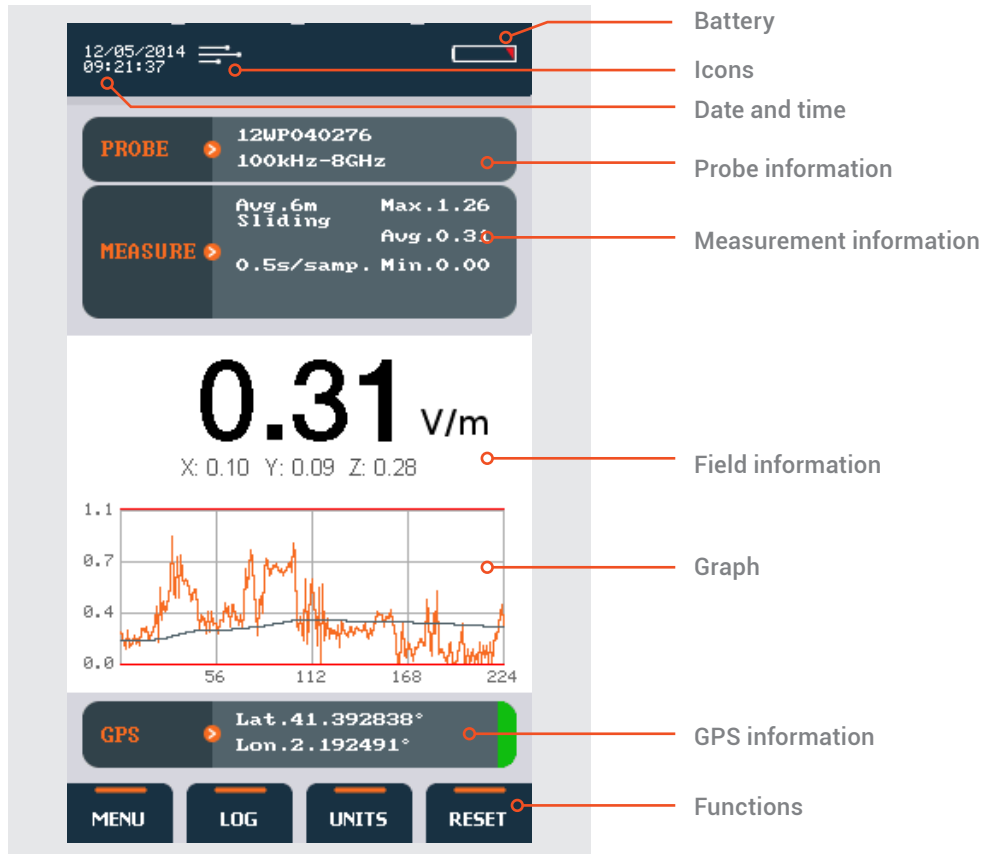
Figure 10: Main screen

**Measurement information:**

- **Maximum, minimum and average values:** these values are initialized when beginning a new log or can also be initialized with the virtual button "Reset". Average value is updated depending on the type of averaging and interval chosen in the Measurement Options.
- **Logging and average parameters:**
    1. Average window time.
    2. Type of interval (sliding or arithmetic).
    3. Logging time.

**Field information:** (updated twice per second)

- **Total field:** instantaneous total field level. Obtained, for three-axis probes as:
- The quadratic sum of each axis field (for field intensity units):

$$E_{Tot} = \sqrt{E_X^2 + E_Y^2 + E_Z^2}$$

- The sum of each axis field (for power density units):

$$S_{Tot} = S_X + S_Y + S_Z$$

- **Field unit:** unit of measurement of the field value shown on the display. This unit applies to the total field, the field on each axis and the maximum, minimum and average values.
- **Field on each axis:** the field measured on each axis for isotropic three-axis probes. Updated twice per second.

**Graph:**

In the time domain: It shows a graphical view of the temporal evolution of the field. It represents the last measurements. This time scale can be modified in the settings menu (graph timespan).

In the frequency domain: it shows the frequency information of the signal (horizontal axies value depend on the span). Also a vertical line represents the position of the cursor (with the associated information on the right top side of the graph).

**GPS information:**

Positioning information provided by the GPS receiver. This information is only displayed when the GPS is switched on.

- Lat: latitude.
- Lon: longitude.

On the right side a colour indicates the quality of the position:

- **Red:** bad.
- **Orange:** average.
- **Green:** good.

**Functions:**

These menus depend on the probe connected but general functions are as follows:

- **Menu:** access to the menu screen.
- **Log:** start a new measurement.
- **Units:** change the current units (this will reset the min, max, average and graph). With the up and down arrow you can select the unit. By pressing OK the highlighted unit will be selected.
- **Reset:** it resets the min, max, average and graph.
- **Keypad Arrows in frequency mode:**
  - Right-left arrows shift the cursor by one step.
  - Up-down arrows shift the cursor to the next right or left peak found in the FFT:

**Note:** *When there are more than 4 functions available, the button on the right allows to show more functions available.*

## 5.3 Menu screen

This is the main screen to access sub menus.
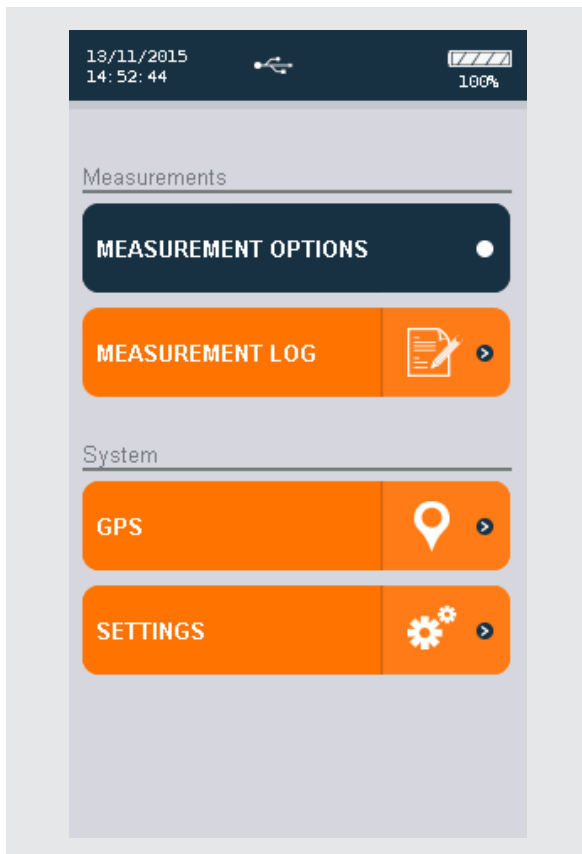


- **Configuration measurement** (allows to change all the parameters related to measurement).
- **Measurement log** (allows to see the stored measurements).
- **GPS** (allows to change GPS parameters).
- **Settings** (allows to change general parameters of the unit).
- **Messages.** (in case some events are available this menu will appear).

## 5.4 Measurement Options screen

This screen is used to configure different parameters related to measurement behaviour. It appears as a menu with a scrolling bar. The parameters to be configured are shown on the left and the different options for each parameter are shown on the right.

The keypad is used to move along the menu. The process for changing the value of a parameter is:

- Run through the different parameters using the arrows ▲▼.
- To change a parameter, press Enter when the cursor is on that parameter. A pop-up will appear showing all the possible values.
- Run through the different values using the arrows ▲▼ and click on OK to select the desired value. (you can cancel with the back button).
- When finished you can either press again back to return to the menu screen or press the home button to come back to the main screen.

The following parameters can be configured:
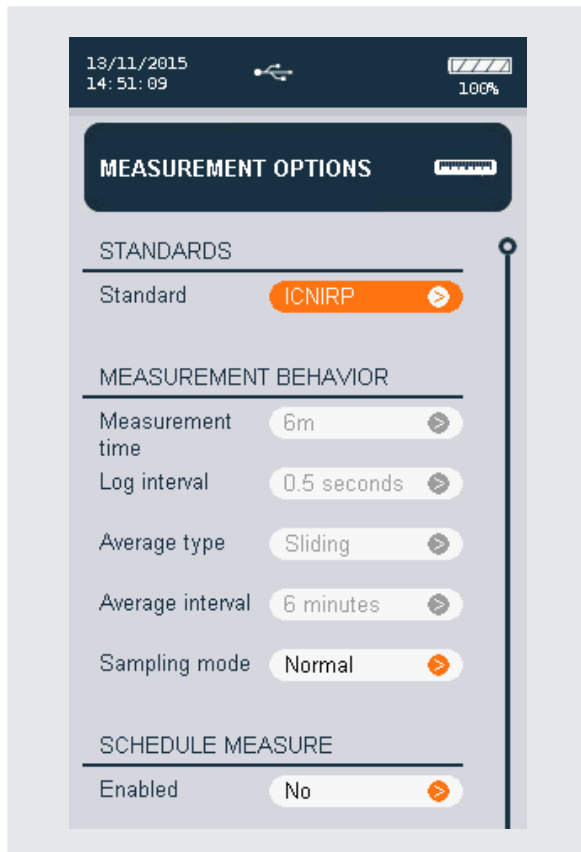


- **Standard:** List of preselected standards. This will affect other parameters that will not be editable. For example: if you choose ICNIRP standard then all the parameters in "Measurement behaviour" will not be editable as they are defined by the standard.
- **Measurement time:** allows to define a maximum time for the measurement. Available values are: not limited, 1min, 5min, 6min, 10min, 15min, 30min, 1h, 2h, or custom from 1sec to 100 hours.
- **Log interval:** used to select the time interval for storage of data in memory (see section 6.1.1). A datum will be stored every 'Log interval' seconds (or minutes). The available intervals are 0.5s, 1s, 5s, 10s, 15s, 30s, 1min and 6min.

- **Average type:** two types of average are available: arithmetic (a new average is calculated every average interval) , sliding (a new average is calculated every new sample).
- **Average interval:** used to select the time interval for calculation of the average. The available intervals are 10s, 15s, 30s, 1min, 2min, 5min, 6min, 10min, 15min and 30min.
- **Sampling mode:** choice between a single temporal log or several spatial measurements that will be represented in a column graphical chart.
- **PostProcessing:** this menu is only available with broadband probes that have correction factors in memory. It has 3 parameters:
  - **Enable correction:** allows correction of the value measured at a given frequency (Working frequency defined below) using the factors measured during the latest laboratory calibration.
  - **Limit value for results in %:** allows direct reading of the field as a % of a limit defined on the main measurement screen. This is a software calculation taking the limit value in V/m and comparing it with the reading from the probe. You can select the lower limit (minimum value) of the regulation (within the band width of the probe) or a specified frequency (Working frequency defined below).

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**Note:** *If the minimum value is selected, no working frequency can be defined and therefore the correction factors cannot be activated.*

- **Working frequency:** allows definition of the working frequency for correction factors or for calculation of the value as %. Where the lower limit of the regulation is selected, this parameter will show as "Not available", since it is not compatible with that selected mode.

- **Schedule measurement:** allows to program a scheduled measurement. A delay up to 24 hours can be set. Even with the unit is powered off, this feature works.
- **Wait time before start:** delay before the measurement really starts (it allows the technician to separate himself from the equipment. Available values are No delay, 5s, 10s, 15s, 20s, 30s, 1min.
- **Shut down after measurement:** useful option to power off the unit when measurement is done. It avoids having to wait to power off the unit manually.
- **Screenshot on last sample:** when this is activated it will allow to take a screenshot on the last measurement. When using for example the ICNIRP standard it will allow to have an image with the 6 min average results. This image will be available to be exported directly into the report with the **SMP2** software.
- **Save measurement name:** permits to save a name for each measurement. In case it is activated, a pop-up will appear before the measurement starts in order to indicate a name.
- **Delete all measurement:** will delete all measurements as well as all the screenshots related to these measurements. Depending on the number of data in memory this operation may last some time. It is recommended to use this function from time to time in order to free space for new measurements.

## 5.5 Measurement Log screen

This screen shows all the available measurements. The ▲▼ arrows are used to select the next measurement or the preceding measurement. The ◄ ► arrows are used to select the next page or the preceding page.

From this menu you can use the "SHOW" virtual button to show a specific measurement (by pressing OK), "ERASE" to erase a single measurement, or "ERASE ALL" to erase all the memorised data (this is the same as "erase all measurements" on the measurement configuration screen).

When a measurement is entered, you can view a measurement summary screen. To view the data, use the "Show data" virtual button.

On the data screen, each rectangle represents a measurement point. You can use the up or left arrows to go to directly to the latest point. Where a screenshot exists, you can display that image by pressing OK on the selected point.

## 5.6 GPS screen

This screen has the same layout and behavior as the Measurement Options screen. It allows to modify the GPS parameters. Those parameters are:

- **Format:** allows to select 3 standard format for the latitude and longitude. You can choose between:
  - Degrees minutes seconds: example: 40° 26' 46" N  79° 58' 56" W.
  - Degrees decimal minutes: example: 40° 26.7671' N  79° 58.9331' W.
  - Decimal degrees: example: +40.446  -79.982°.
- **Turn on at start up:** defines the GPS state when the unit starts up.
- **Turn on for current session:** defines the GPS state only for this session. That means that next time you switch on the unit the GPS will be in the state defined by "Turn on at start up" parameter.

## 5.7 Settings screen

This screen has the same layout and behavior as the Measurement Options screen. It allows to modify the general parameters of the **SMP2**.

The following parameters can be configured:

- **Alarm:** allows to activate or deactivate the alarm. When activated, you can define the alarm threshold and unit for electric and magnetic field. (the ◄ ► arrows are used to select the figure to be changed and the ▲▼ arrows are used to change the figure value.).
- **Date:** allows to change the date of the system.
- **Time:** allows to change the time of the system.
- **Zero based time plots:** allow to scale the graph between 0 and the maximum of the measurement or between the minimum and maximum to have a precise view of the time variation of the field.
- **Graph timespan:** sets the duration of the representation of the graph up to 12 min.

- **Language:** sets the desired language.
- **Adjust backlight automatically:** if enabled the **SMP2** will adjust backlight depending on ambient light.
- **Backlight level:** if automatic adjustment is disabled, manual level can be selected from 1 to 4 (4 is the brightest).
- **Screensaver delay:** defines the time before screen power off. When the screensaver is active the instrument will not stop measuring. To exit the screensaver just click any button.
- **Sound:** enable or disables sound.
- **Turn off after inactivity period:** The instrument turns off after the specified period of inactivity. (Activity may be communication with PC, keyboard pressing key). When log is activated, automatic turn off is disabled.
- System info: indicates the version of the **SMP2** software. By clicking on OK, you will have more information about the unit like disk space available.

# 6. Functions

This section describes the main functions of the **SMP2**, in addition to instantaneous measurement of the electromagnetic field.

## 6.1 Measurement modes
There are several working modes for the **SMP2**. All probes have the temporal mode with spatial average. Only the WP400 has the FFT mode and the Frequency Log mode. For this last probe, in the main screen you can see the "Mode" function that allows to switch between modes.

Modes are:

- Temporal: it records the evolution of the total field value. For more details see 6.1.1
- FFT (only available for the WP400): it records the frequency information of the field. For more details see 6.1.2
- Frequency Log: it records the evolution of the field but only at one frequency of interest. For more details see 6.1.3

### 6.1.1 Temporal mode - time domain measurements
One of the functions of the **SMP2** is the storage of measurements in memory for later study or processing. Measurements in time domain contain field samples, one sample every "log interval" as defined in 5.4. For example, a 6 minutes measurement at 0.5s log interval will create a 720 samples measurement.

Measurements are stored in a SQL database. The memory of the **SMP2** allows storage of up to 1,000,000 samples. The maximum number of measurements is 1000.

Before starting the measurement, the parameters for the measurement time, type of average and average interval should be configured via the Measurement Options menu (see 5.4). The field and average field values will be stored in the unit selected in the main screen.

To start logging samples, go to the main screen (direct access is always available by pressing the home button) and press the "log" function. When logging starts, the device automatically creates a new measurement with its starting date.

To stop logging samples, press the "stop function".

**Note:** *if the storage limit of the memory is reached, the logging of samples will be automatically stopped. During logging, parameters of the **SMP2** can not be changed.*
*In order to store positioning information along with the field values, the GPS receiver should be enabled before logging is started.*

### 6.1.1.1 Measurements according to ICNIRP procedures
The ICNIRP procedure set-up is the most widely referenced by international standards.

That measurement allows an average to be taken of the field values measured over 6 minutes at a given place without the presence of the technician affecting the result.

To perform this type of measurement select ICNIRP in the Measurement Options screen → Standard. All the parameters will be forced to the pre-defined value:

1. The apparatus will wait 10 s before starting the measurement to allow the technician to move away. After the 10 s, a beep will indicate the start of the measurement.
2. It will log samples for six minutes.
3. At the end of the 6 minutes, the measurement will be stopped automatically and the alarm will sound. The apparatus will calculate the average, display it on the screen and store it in the memory.

This measurement can be cancelled at any time by pressing the STOP function.

### 6.1.1.2 Low frequency time domain measurement with WP50 or WP400

When using these probes, additional functions are available other than those explained in 5.4.

- **Mode:** select frequency or time domain mode (only available for WP400)
- **Field:** select electric (E) or magnetic (H) field
- **Limit:** (see 6.2) select the standard to apply
  - None: no weighting will be applied and the measurement will be displayed in the desired units.
  - Other choice: measurements will be weighted in % compared to the chosen limit. When using WP400 and a limit is activated the main value becomes peak instead of RMS. Note that some standards require both peak and RMS values to be below 100% of the limit.

### 6.1.2 FFT mode - frequency domain measurements

This function is only available with a selective probe like WP400.

Measurements in frequency domain contain frequency information of the measured field. One measurement contains 401 frequency points so the memory of the **SMP2** allows storage of up to 1000 frequency measurement.

***

**Note:** *in this mode you can see the FFT on the graph and use the cursor to select a frequency. The total RMS and peak field values are shown above the graph. Those values represent the whole field across the full bandwidth of the probe. The SPAN only affects the FFT.*

In frequency mode the parameters in "measurement configuration" have no effect. All parameters have to be chosen from the functions in the main screen:

- **Mode:** select the FFT mode
- **Field:** select electric (E) or magnetic (H) field
- **Span:** select the frequency range (only affects the FFT):
  - 0 - 400 Hz (1 Hz resolution)
  - 0 - 4 kHz (10 Hz resolution)
  - 0 - 40 kHz (100 Hz resolution)
  - 0 - 400 kHz (1 kHz resolution)

- **Limit:** (see 6.2) select the standard to apply
  - None: no weighting will be applied and the measurement will be displayed in the desired units.
  - Other choice: measurement will be weighted in % compared to the chosen limit.

Total values (span independent)

FFT graph (span dependent)
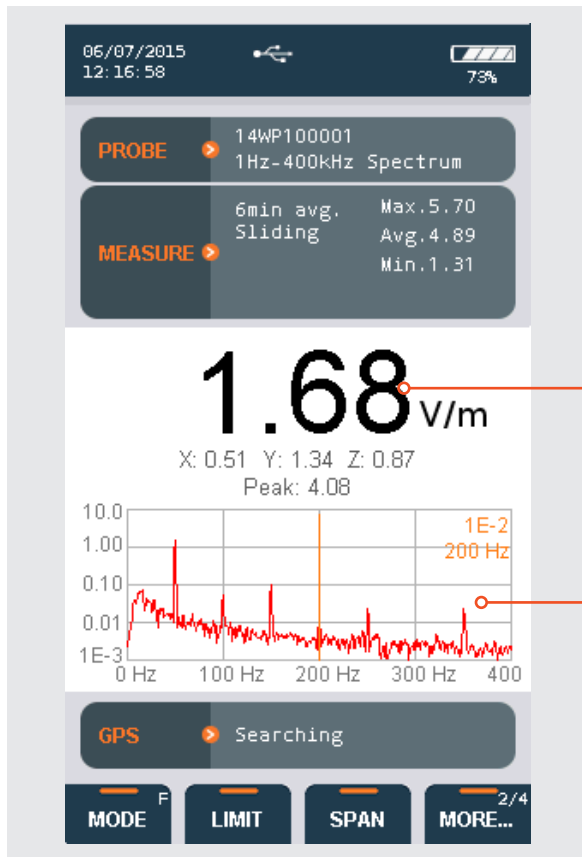
- **Hold:**
  - Off: no Maxhold is applied. Real-time value is displayed on the screen and FFT is updated with new values every half second.
  - Max.: Maxhold is applied. Peak value, RMS value and FTT will keep only the max. value. This option is the best when you want to perform a single measurement for compliance with a limit. Activate the MaxHold, wait the desired time and press log to save the maximum Peak value, RMS value and FTT in a single register.
- **Axis:** (useful for direction finding application)
  - T. Total value of the FFT
  - X axis of the FTT
  - Y axis of the FFT
  - Z axis of the FFT

**Note:** *When downloaded to the PC, all axis of FFT measurements can be seen on the graph.*

To save a FFT, go to the main screen (direct access is always available by pressing the home button) and press the "log" function. The device will save the current FFT.

### 6.1.2.1 Scenarios
This paragraph intents to give some recommendations on how to use this selective system for several situations:

- **Checking power lines harmonic content:**
  - Select mode: frequency domain
  - Span: 400 Hz
  - Filter: 10 Hz

You will get an FFT showing the 50 Hz and its main harmonics in the frequency domain (from 1 to 400 Hz). Repeat this for electric and magnetic field.

- Power line exposure measurement:
- Select mode: temporal
- Filter: 10 Hz.

In this mode you will get a temporal recording of the total broadband value (from 1 Hz to 400 kHz when using WP400). Repeat this for electric and magnetic field.

- **Measurements where the field type is unknown:**
  - If only assessing the compliance to a standard is needed, temporal mode is the right one. It will provide a direct and instantaneous result as a % of the limit.
  - If checking the frequency content of the field is needed, then  frequency mode should be used. We recommend to start using  the 10 Hz filter  because below 10 Hz any non desired movement around the unit may affect the measurement. If you are not sure if there is field below 10 Hz, then change the filter to 1 Hz. In this case always measure with the **SMP2** on a tripod and the fibre link in order to avoid any external perturbation.
  - We also recommend start using the higher span. If no field is detected above 40 kHz then change span to 40 kHz. If no field is detected above 4 kHz then change span to 4 kHz. If no field is detected above 400 Hz, change to the lowest span that is 400 Hz. Once you have the desired span you can save the FFT by pressing the log function.

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**Note:** *even in frequency mode, total field value, axies values, max, min and peak value are updated every 0.5 seconds and represents the field value in all the frequency range.*

### 6.1.3 Log Frequency Log mode
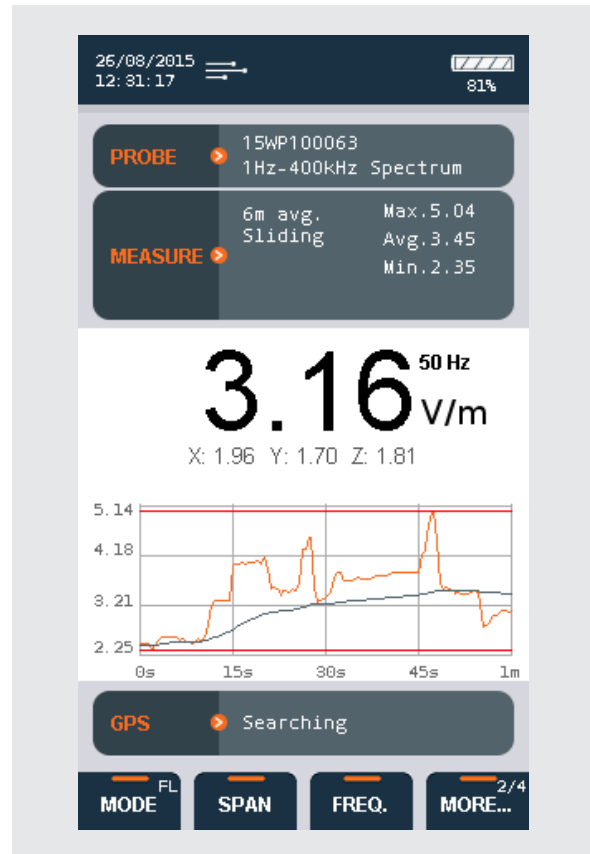


In this mode, the unit will display the temporal evolution of a single pre-selected frequency of the measured field. To select a frequency, 2 ways are available:

a) In the FFT mode, place the cursor on the desired frequency (change the SPAN if needed). Then switch to Frequency Log mode.

b) In the Frequency Log mode, using the function SPAN and FREQ. depending on the SPAN, different frequency resolutions will be available: SPAN 400 Hz, resolution 1 Hz; SPAN 4 kHz, resolution 10 Hz; SPAN 40 kHz, resolution 100 Hz; SPAN 400 kHz, resolution 1 kHz.

Please note that in this mode, if a limit is selected, the measurement value is always a RMS value. Peak values are not compatible with this mode.

### 6.1.4 Spatial average
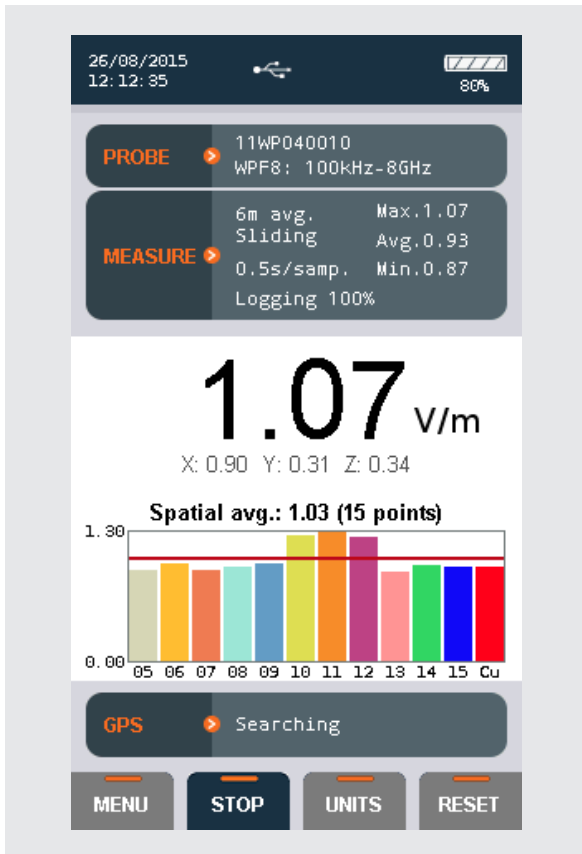


This option can be activated from Menu →
Measurement Options → sampling mode.

This mode can be used in conjunction with the
temporal mode and the Frequency Log mode.

This mode allows to automate several
measurements made in different spatial positions
as required in some standards. The levels and the
resulting average of the different positions will be
displayed in a column graph.

When launching a log, it will start by measuring
the first point. At the end of each measurement,
a pop-up will ask whether you want to do a new
point, repeat the last point or finalize the spatial
average.

The actual spatial average value and the number
of points are displayed above the column graph.

Note:  *The "Measurement time" parameter should be
configured as desired before launching a measurement
(see  5.4).*

### 6.2 Time domain weighting
Some probes like WP50 and WP400 can assess
the RF exposure by directly comparing the field
to a reference limit. It uses the Weighting Peak
Exposure technique that weights the field with
a filter function which is related to the reference
level.

The result is a number in % where 100%
represents the reference limit line. More than
100% will mean that the present field is exceeding
the limit specified by the chosen standard.

Note: *this function is available for time and frequency
domain measurements and the results will be
displayed in % instead of the electric or magnetic
corresponding units.*

### 6.3 Alarm

The alarm function is very useful for the person performing the measurements because it allows the apparatus to produce an audible warning when the field exceeds a threshold value defined on the settings screen. The alarm will only sound if the alarm function has been activated and if the sound is enabled in the settings screen.

### 6.4 GPS

The **SMP2** is available with a built-in latest-generation GPS ublox engine 7 allowing you to display and memorise the position of the device when taking measurements. The incorporation of ublox functions makes the receiver extremely sensitive and precise, allowing exact positioning even in built-up areas with poor satellite visibility.

The GPS is enabled/disabled through the configuration menu as explained in section 5.6.

When the position obtained by the GPS is not valid, the main screen displays 'Searching for satellites'. When the position obtained by the receiver is valid, the data for latitude and longitude are displayed on the screen with a colour indicator representing the quality of the position.

**Note:** *enabling the GPS increases power consumption and reduces its autonomy. It is important to keep it switched off when it is not in use to avoid unnecessary drain on the battery.*

# 7. BATTERY information

### 7.1 General information

The **SMP2** contains a rechargeable Li-ion battery allowing the apparatus to run for over 15 hours with broadband probes and over 5h for selective probe like WP400. The level of battery charge can be checked at any time on the main screen of the apparatus, in the battery field.

Li-ion batteries have no "memory effect", so there is no need to fully discharge the battery. It is recommended to charge completely the battery before the first use.

- Always switch the apparatus off when it is not in use.
- Recharge the battery regularly (for example, once every 2 months) if the apparatus goes for long periods without being used.

The battery of the **SMP2** should be recharged when the battery indicator shows that it is at its minimum level: 

⚠ Although the apparatus can be fully used while the battery is being charged we do not recommend to measure with the charger connected as mains perturbation may alter measurement. In general measurement has to be done **without** the charger or USB connected.

The battery will function normally at temperatures ranging from -20ºC to +45ºC. However, we recommend avoiding low temperatures to prevent its useful life from being shortened.

⚠ Only the battery charger supplied by **Wavecontrol** should be used to recharge the battery of the **SMP2**.

### 7.2 Recharging

**The battery charge time is 4–5 hours.** We recommend to turn off the **SMP2** for charging the battery. The procedure for charging the battery is:

- Plug the charger into an electrical outlet (110-240 V AC).
- Insert the connector of the battery charger into the connector of the **SMP2**. The recharge red LED will light up. If it does not light up, it means that the charger is not properly connected.
- The charge is complete when the recharge LED is green. Disconnect the charger from the **SMP2** and unplug it from the mains.

The **SMP2** has a Li-ion battery charge controller so you can leave the apparatus charging for more than the specified 5 hours with no danger of damaging the battery.

**Note:** *it is recommended to do a complete charge from time to time for* **SMP2** *to recalibrate the battery capacity.*

**Note2:** *if during the charging, the red light blinks this means the battery is too hot or is not charging properly. Disconnect the charger and wait at least 1 hour, connect the charger back: in case this happens again battery may be broken.*

# **8.** Software

## 8.1 Installing the software

Before connecting the **SMP2** to the PC, launch the setup file (available in the USB flash key).

During the process the setup file will install the software and all the necessary drivers.

When the installation is finished you can connect the **SMP2**, Windows will install the driver automatically.

**Images below show the complete process:**
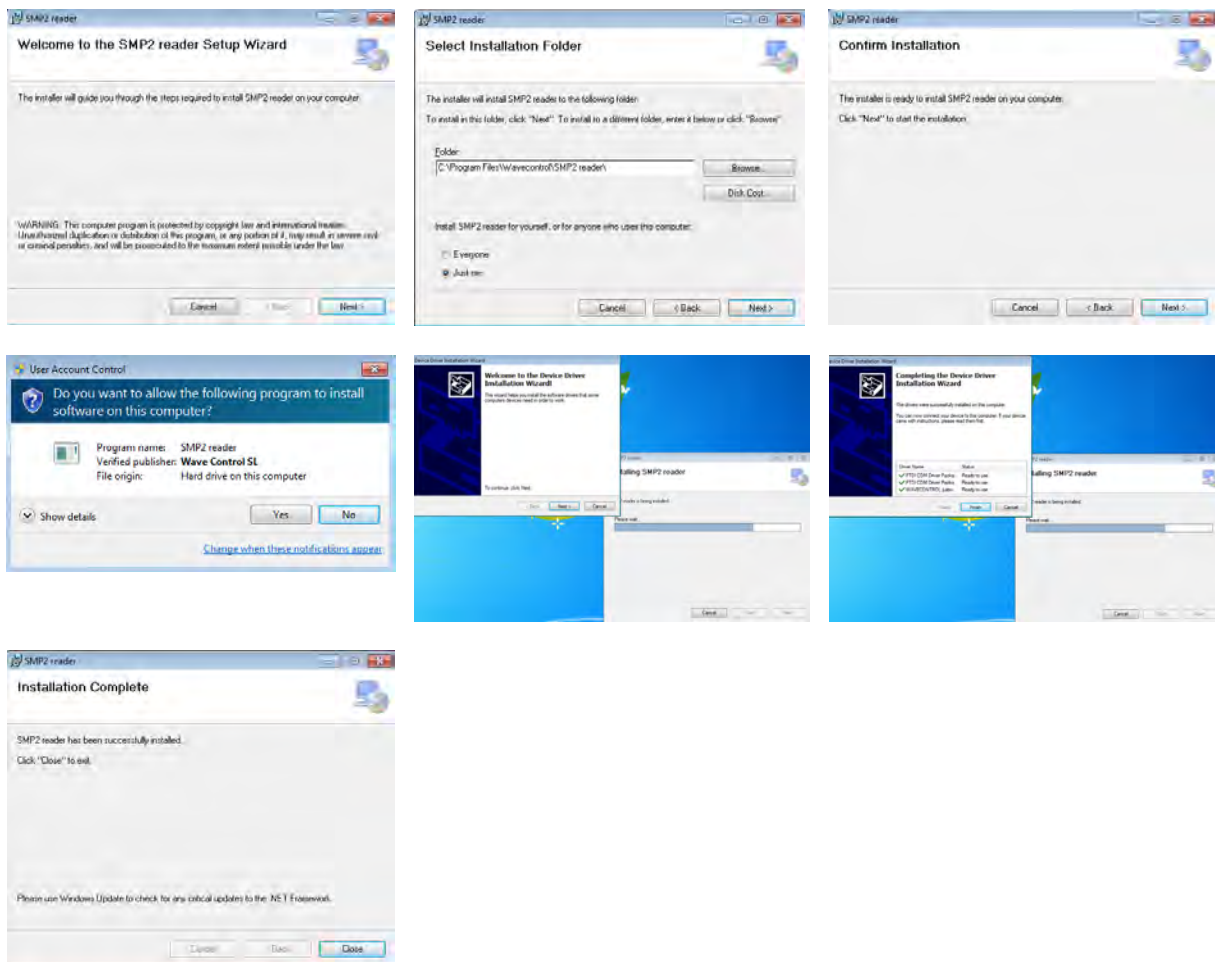


**Figures 11:** Installation of the software

## 8.2 System requirements

- Operating system: Minimum Windows 7.
- RAM: 2 GB.
- Net Framework 4.5 (4.0 may work on most system)

## 8.3 Using the PC software

The **SMP2** software presents several features:

- Downloading stored measurements.
- Displaying measurements in graph and table format.
- Displaying stored screenshots.
  - Exporting measurements and screenshots to excel files.
  - Displaying **SMP2** information.
  - Sending measurements directly to a web server.

### 8.3.1 Measurements screen

The first tab relates to measurements. Measurements are automatically loaded when the **SMP2** is connected by USB. A list on the left will appear with all the current measurements. When clicking on a measurement, a table and a graph will appear on the right hand side of the screen showing all field samples contained in the measurement. On the left side of the table some information about the measurement can be found like frequency, minimum and maximum field. Data will be positioned on a map if internet connection and GPS position data is available.

When clicking on a sample in the table, this point will be showed in the graph with a vertical red line. In the same way, when clicking on the graph, the vertical red line will shift to your cursor position and the corresponding sample will be selected in the table. This can be useful to find for example the maximum values as you can sort the table by clicking on the "field" column header of the table.

**Note:** *if GPS was activated, GPS information would also appear in this table.*
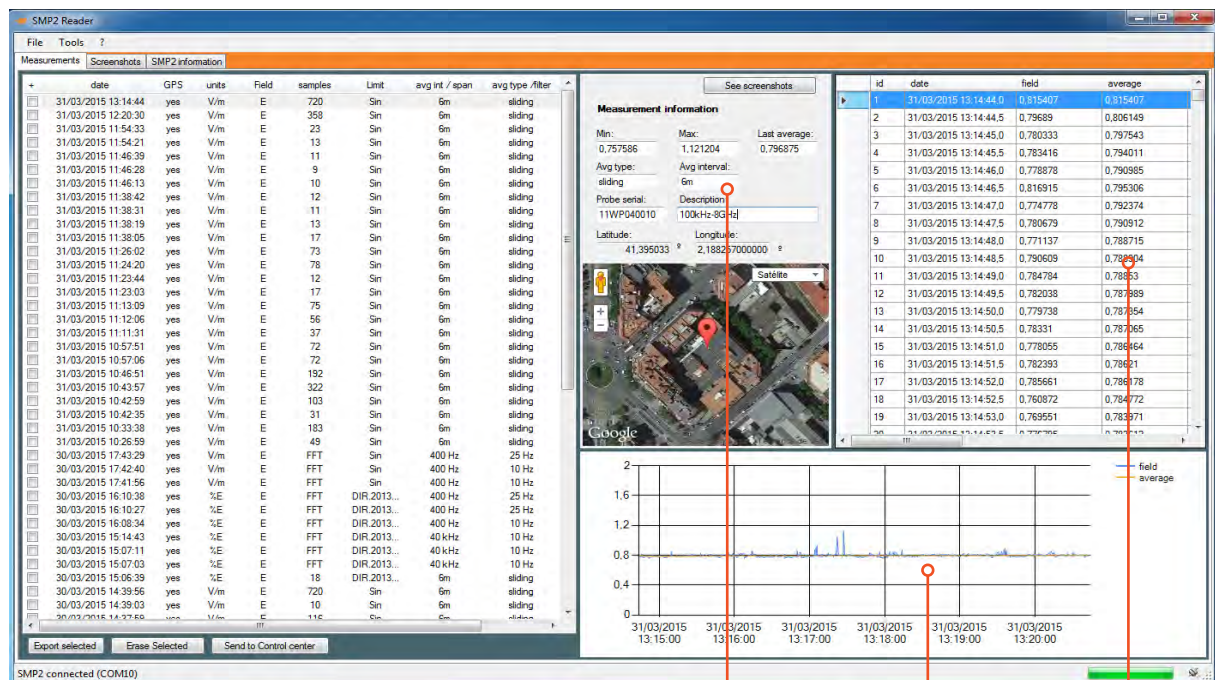


Figure 12: SMP2 software measurement screen

Measurement info with map  •  Graph  •  Samples table

At the bottom of the measurements tab you may:

- Export measurements: this will export all measurement that have the check-box ticked.
- Erase selected: this will erase all measurements that have the check-box ticked.
- Send to control centre: click on a measurement (check-box has no effect here). This will open a new tab with the information to upload to the control centre. See paragraph 8.3.5 for more details.

**Note:** *only 6 minutes measurements are compatible with this control center feature.*

### 8.3.2 Screenshots screen
This tab allows to download and display **SMP2** screenshots. Click one line to be able to see the screenshot.

Each line contains a selection box to select it, a date of creation and a sample reference. This last parameter represents the internal database identification of the sample. This is used to know which measurement this screenshot belongs to (in case logging was activated). If you click on this number and if it's different from 0, the software will download the associated measurement and show it in the measurement screen.

In the bottom, you have 2 buttons:
- Save selected.
- Delete selected.

Before using these buttons, you must select one or several boxes from the list.

### 8.3.3 Information screen
This tab shows **SMP2** internal information like the firmware version, the disk usage or the measurements and samples currently stored in the internal memory.
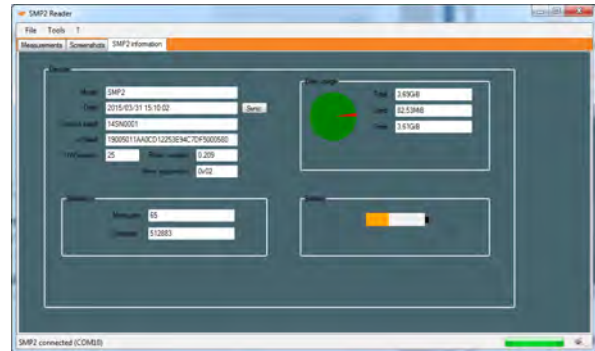


Figure 13: SMP2 information screen

### 8.3.4 Spreadsheet exporting
In the measurements screen you can select the measurements to be downloaded by clicking on the selection box to the left of each measurement or you can select all measurements by clicking on the + sign above all the selection boxes.

When pressing the "Export selected" button the download starts to the folder defined by the user. A file is created for each measurement. The file name is "date_of_measurement.xlsx".

The downloaded files use the open XML format so they can be opened by Microsoft Office (2007 and above), LibreOffice or OpenOffice (version 3.3 and above) for example.

From the Tools →Parameters menu on the export tab, you can select the options for exporting reports. You can first choose the type of report: A4 format or no format.
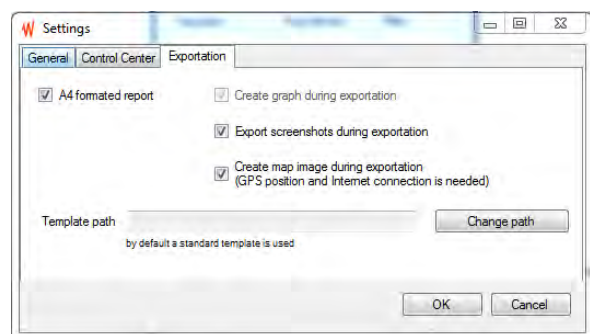


Figure 14: SMP2 Export parameters

The A4 report format is a report that fits on an A4 page, showing the main figures for the measurement with the corresponding diagram and a screenshot from the device where available. The figures for all the measured points are not shown on the same page, but rather on another tab of the report.

The template for this report is located in the program installation file, in the template directory (e.g. C:\Program Files (x86)\Wavecontrol\SMP2 reader\template). It can be copied to another file and modified, for example the logo. In that case, the program will have to be told where to find it



Figure 15: Example of export in A4 format

The no format report is simpler, the first lines comprise the heading, with information on the software, the device, the probe and the measurement parameters.

Depending on the settings, these files may also contain a graph of the measurement and all the screenshots made during the measurement.

**Note 1:** *graph generation can be very time consuming, so it is not recommended if the measurement contains lots of samples.*

**Note 2:** *screenshots are saved in a second worksheet called "Screenshots".*

### 8.3.5 Control centre screen
If you have access to a **Wavecontrol** Control Center for the management of **MonitEM** and **SMP2** units, then you can upload your **SMP2** measurements directly to the Control Center by using **SMP2** software.

**Note:** *you can only upload a measurement at a time. Internet connection is needed to use this feature.*

To do so please make sure that you have a valid URL, user and password in the settings menu (see figure 16).
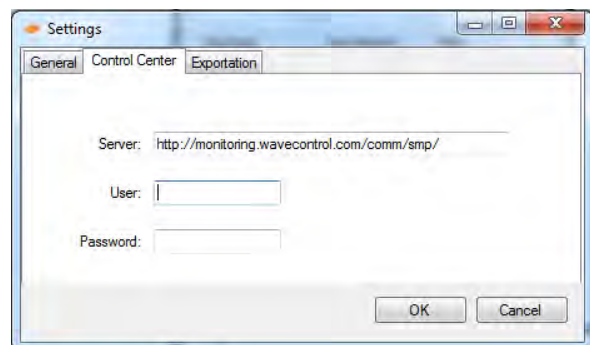


Figure 16: SMP2 setting menu

To upload the data from the measurement screen, first click on a measurement to see its graph and then click on "Send to control centre". It will show you a new tab (fig 16), where you can:

- Adjust the GPS position or enter an address to set the location of your measurement.
  - Find an address from the GPS position.
  - Fine tune the position by dragging the marker on the map.
  - Select a picture to upload with the measurement.

When this is done, click on "Send to control centre".
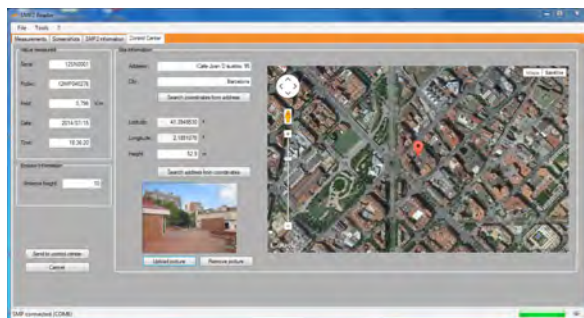


Figure 17: Settings screen to upload data to a control centre

## 8.4 Live screen

This screen is only available with the fibre optic link (see 4.3.2). It provides a real time display of the data being measured by the **SMP2** and allows to modify some of its parameters.



Figure 18: live screen

On the top left side, the instant total field value along with each axis value can be found. The right buttons allow to modify some parameters of the unit depending on the field probe being used.

To start and stop logging (and take screenshots) is possible by pressing the Start logging button.

In FFT mode, a graph is showed with the FFT information. By clicking on a point the cursor is placed on the desired frequency (this cursor is shared with the **SMP2** display graph).

When GPS is on and has a fix position, a map will show the **SMP2** position. (Internet connection is needed for this feature).

**Note:** *this live view is not compatible with the spatial average mode. You will not be able to launch a measurement in this mode from the PC.*

# 9. Firmware updating

**SMP2** firmware can be updated from the **SMP2** software.

To update it connect the **SMP2** to the PC via USB and to the **charger** and launch the software. Go to menu Tools → update → update firmware.

Click on update and locate the firmware to update. The software will update the firmware in 3 steps:

• Download the firmware to the **SMP2.**
• Checking the firmware integrity.
• Writing the firmware in the **SMP2.**

**Note1:** *this is quite a long process (from 10 to 20 minutes).*

**Note2:** *be sure that the* **SMP2** *has enough battery.*

**Note3:** *it is recommended to update the firmware without any probe connected.*

# **10.** MAINTENANCE

This section explains the maintenance of the apparatus that can be carried out by the user. If you have any questions about how to maintain the **SMP2**, please contact **Wavecontrol**.

Maintenance by the user is limited to the outside of the apparatus and its connections. Any calibration or maintenance that requires the apparatus to be disassembled should be performed by **Wavecontrol** or their representatives.

### 10.1 Cleaning the apparatus and the screen
To avoid damaging the surface, use soft antistatic wipes to clean the apparatus and the screen. Use extra care when cleaning the screen, to avoid scratching it.

### 10.2 Handling the equipment
The **SMP2** and its field probes are not watertight. When using them outdoors be sure to protect the apparatus from rain.

The apparatus and the probes should also be protected from any strong blows or vibrations.

### 10.3 Periodic recalibrations
**Wavecontrol** recommends that the **SMP2** and field probe/s are recalibrated every 2 years.

**Wavecontrol** can recalibrate your equipment in a timely and efficient way.

Please contact **Wavecontrol** (www.wavecontrol.com) for additional information and recalibration scheduling.

# 11. TECHNICAL SPECIFICATIONS

| Measurement Functions | | |
|---|---|---|
| Measurement field probes | Interchangeable; automatic probe detection and recognition system | |
| Measurement units | V/m, kV/m, uW/cm2, mW/cm2, W/m2, A/m, nT, uT, mT, T, mG, % | |
| Acquisition time | 2 samples per second | |
| Measurement display | Total field and axis field value (X, Y, Z), maximum, minimum and average | |
| Average type | Sliding average (continuous), arithmetic average, normative average | |
| Averaging time | 10s, 15s, 30s, 1min, 2min, 5min, 6min, 10min, 15min, 30min | |
| Alarm | audible signal, 2800 Hz; adjustable threshold | |
| **Memory** | | |
| Sample acquisition adjustable period | 0,5s, 1s, 5s, 10s, 15s, 30s, 1min, 6min | |
| Capacity | 1 000 000 samples | Up to 1000 measurements |
| **Interfaces** | | |
| Probe | Automatic detection and recognition | |
| Data download | Mini USB connector / Fiber optic | |
| Firmware update | Mini USB connector | |
| Battery charger | coaxial jack connector + LED | |
| **Display** | | |
| Display type | TFT 4,3'' | |
| Display size | 60 x 78 mm (272 x 480 pixels) | |
| Backlight | White LED | |
| **GPS (optional)** | | |
| Chip set | 56-channel u-blox 7 engine, embedded | |
| Position accuracy | Position 2.5 m CEP / 4.0 m | |
| Sensitivity | Tracking: −162 dBm / −158 dBm | |
| SBAS (Satellite Based Augmentation System) | WAAS/EGNOS/MSAS support | |
| Geodetic system | WGS 84 | |
| **General Specifications** | | |
| Battery | rechargeable Li-ion battery | |
| Operation time | > 15 hours broadband probe    >5 hours 30 minutes for WP400 probes | |
| Standby time | > 3 years | |
| Recharge time | 4 – 5 hours (at 20ºC) | |
| Temperature range | -10 ºC a +50 ºC | |
| Size (without field probe) | 100 x 215 x 40 mm | |
| Weight (without probe) | 610 g (including the internal GPS receiver) | |
| Accessories | Hardcase, battery charger, USB-mini USB cable, **SMP2** Reader software, user manual, probe calibration certificate | |

# **12.** WARRANTY

**Wavecontrol** warrants that this product is free from defects in materials and workmanship for a period of two years from the date of shipment. If any such product proves defective during this warranty period, **Wavecontrol**, at its discretion, will either repair the defective product without charge for parts and labour, or provide a replacement in exchange for the defective product.

In order to obtain service under this warranty, the customer must notify **Wavecontrol** (or one of its distributors) of the defect before the expiration of the warranty period, by sending a Failure Report including:

- Defect Report.
- Equipment data (model, serial number, purchase date).
- Contact data (company name and complete contact details).

This warranty shall not apply to any defect, failure or damage caused by improper use, or improper or inadequate maintenance and care. **Wavecontrol** shall not be obligated to provide service under warranty to repair damage resulting from attempts by personnel other than **Wavecontrol** personnel to repair or service the product.

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# Annex 1. WP400 probe special functions

With this probe several special functions are available.

**Range:** select the way the probe will adapt its range of measurement.

- Automatic: range will increase and decrease depending on the field to be measured.

- Auto-increasing: range will only increase. This is important when measuring sporadic peaks because even when field is low, **SMP2** will be ready for the next peak to be measured. This option should be used when single peaks occur at more than 1 second separation. To reset range, press the reset button.

**Filter:** select the high pass filter. This high pass filter affects all values (FFT, peak, RMS) because it is an analog filter inside the probe that affects signal before any digital treatment.

- 1 Hz (No filter applied, in this mode all the operations are slower because of the integration time).

- 10 Hz (-3dB at 10 Hz) Recommended if you are sure that no signal below 10Hz is present (most of the cases).

- 25 Hz (-3dB at 25 Hz).

- 100 Hz (-3dB at 100 Hz, <-18dB at 50Hz). Useful when 50Hz signal needs to be attenuated. This can help for example to gain better SNR (signal noise ratio) at high frequency.

Below you can find 2 images with this filter response.
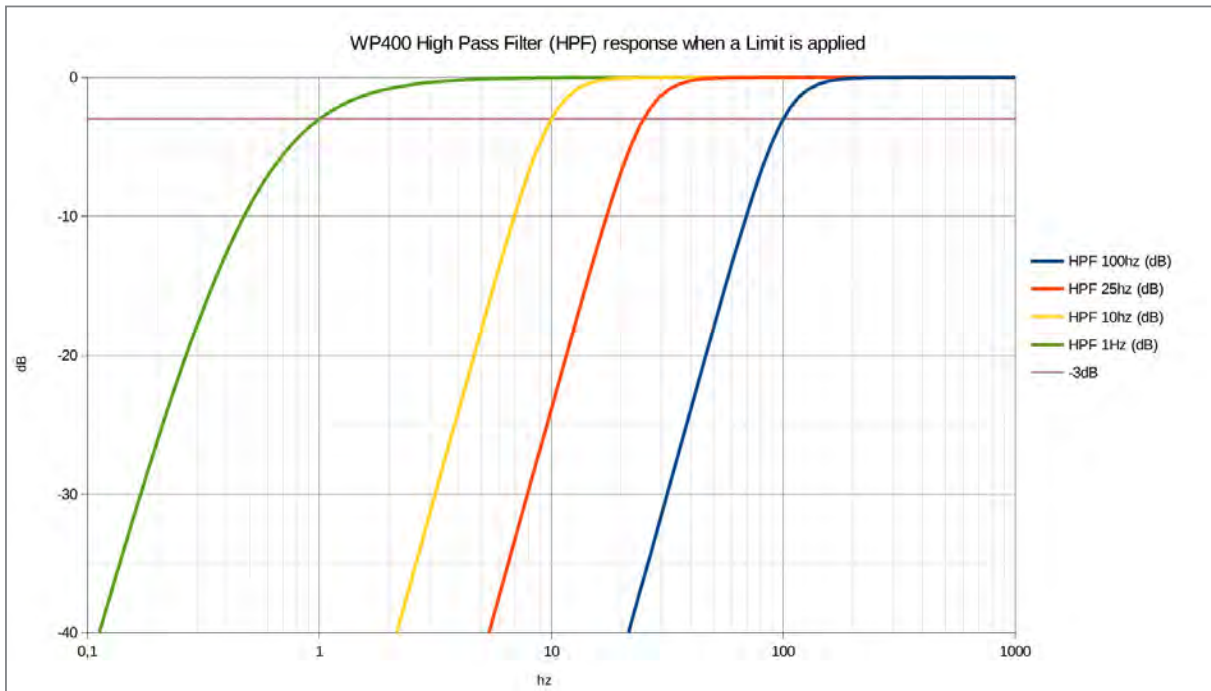


**Figure 19**: Filter response when a limit is applied (For limit see 6.2)
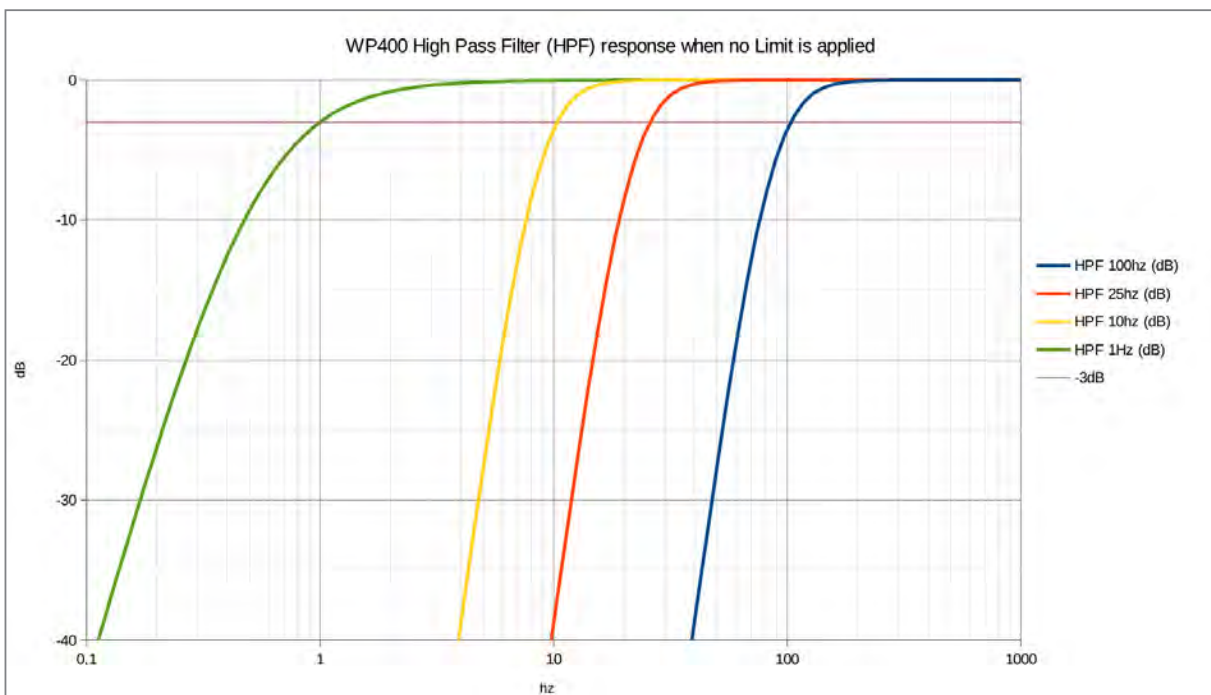


**Figure 20**: Filter response when no limit is applied (For limit see 6.2)

# Annex 2. WPF18 probe special functions

These probes (the ones produced since April 2016) have a special function: Max fast RMS. It is activated on the measurement screen with the "MODE" button.

**MODE:** selects the sampling mode for the probe

- **Normal RMS:** allows standard measurement of the total RMS field
- **Max fast RMS:** allows measurement of the maximum RMS field over a very short integration time (4 ms). The maximum measured RMS value is displayed every 0.5s.

**Note:** *This Max fast RMS mode is very useful, e.g. to allow measurement of a rotating radar antenna, to determine its radiated power by detecting its maximum radiation.*

**Note 2:** *Max fast RMS does not allow averaging, since the value obtained every 0.5s is a maximum.*

# Annex 3. Communication Protocol

This communication protocol is valid for USB or fibre. The main difference between the two is the port settings.

### Ports
**USB:** it emulates a serial port service with CDC, automatically negotiated rate, 8 bits, no parity,1 bit stop. The Vendor ID and Product 0x1FC9 ID 0x807B of the USB may be used to find the port number opened by the driver.

**Fibre:** 230400 bps, 8 bits, no parity, 1 bit stop. The 0x0403 Vendor ID and Product ID 0x6001 may be used to find the number of communication port opened by the FTDI driver.

### Format of commands and responses
Communication is done through the exchange of strings with the XML format. The **SMP2** checks the frames received and rejects them if not well formed.

The XML format accepted by the **SMP2** parser is as follows :

| Command:<br><br>PC ➜ SMP2 | General format of commands |
|---|---|

```
<?xml version="1.0" encoding="ISO-8859-1"?>
    <cmd>
        <instruction>[String to identify the command]</instruction>
        <params>
            [Settings needed by the command]
        </params>
        <timeout_msec>[optional; max time to run the command]</timeout_msec>
        <md5>
            [MD5 of string from "<?xml" to the character previous to tag "<md5>", in ASCII hex]
        </md5>
    </cmd>
```

There are 5 characters that can not be used in the XML content and must be replaced by the following syntax.

| Character | Syntax |
|-----------|--------|
| " | &quot; |
| & | &amp; |
| ' | &apos; |
| < | &lt; |

The XML format used by **SMP2** is as follows:

| Response:<br>PC ➔ SMP2 | OK | General format of the correct reply |
|---|---|---|

```
<?xml version="1.0" encoding="ISO-8859-1"?>
<reply>
        <result>
        <instruction>[String that identifies the command]</instruction>
        [Specific results of the command]
        </result>
        <md5>
                [MD5 of the string from "<?xml" to the previous character of  the "<md5>", tag in ASCII hex]
        </md5>
</reply>
```

| Response:<br>PC ➔ SMP2 | ERROR | General format of the error reply |
|---|---|---|

```
<?xml version="1.0" encoding="ISO-8859-1"?>
<reply>
        <error>
                <code>[Numeric code of error]</code>
                <msg>[Error description]</msg>
        </error>
        <md5>
                [MD5 of the string from "<?xml" to the previous character of  the "<md5>", tag in ASCII hex]
        </md5>
</reply>
```

## Commands and Responses

| Instruction | Parameters | Response |
|---|---|---|
| GET_SAMPLE<br><br>get the field measured | | **field_type**: 0 electric, 1 magnetic<br>**value**: field in V/m or uT<br>**unit**: units displayed on the screen (see Units section)<br>**x, y, z**: field in axis<br>**avg**: average field<br>**peak**: peak value of WP400 probe<br>**gps_lat_deg**: latitude in decimal degrees<br>**gps_lon_deg**: longitude in decimal degrees<br>**gps_height**: height in meters |
| GET_TIME<br><br>get time | | **local_time**: time in format YYYY-MM-DD HH:mm:ss |
| SET_TIME<br><br>set time | **new_date_time**: time in format YYYY-MM-DD HH:mm:ss | **local_time**: time in format YYYY-MM-DD HH:mm:ss |
| INFO_SYSTEM<br><br>get info about device | | **device**: identify device **SMP2**<br>**serial_micro**: unique ID of micro crontoler<br>**firmware_version**: firmware version<br>**serial_device**: device serial number<br>**hardware_version**: hardware version |
| MEASURE_START<br><br>start measurement | | |
| MEASURE_STOP<br><br>stop measurement | | |
| SET_DATA_TYPE<br><br>to select time or frequency measurement mode | **data**: time or freq | **data**: time or freq |
| KEY<br><br>take a screenshot | **key**: PRINTSCREEN | |
| BATTERY_INFO<br><br>get battery level | | **capacity_mAh**: capacity in mA/h<br>**charge_mAh**: current charge in mA/h |

## Units

Below it is described in c# the units of **SMP2**
with the identification number that the command
GET_SAMPLE returns.

```csharp
enum E_FieldUnits
{
E_FIELD_V_m       = 0,    // E - V/m
E_FIELD_kV_m      = 1,    // E - kV/m
E_FIELD_uW_cm2    = 2,    // E - uW/cm2
E_FIELD_mW_cm2    = 3,    // E - mW/cm2
E_FIELD_W_m2      = 4,    // E - W/m2
E_FIELD_A_m       = 5,    // E - A/m
E_FIELD_PERCENT   = 6,    // E - %
} ;
enum H_FieldUnits
{
H_FIELD_A_m       = 7,    // H - A/m
H_FIELD_uT        = 8,    // H - uT
H_FIELD_nT        = 9,    // H - nT
H_FIELD_mT        = 10,   // H - mT
H_FIELD_T         = 11,   // H - T
H_FIELD_PERCENT   = 12,   // H - %
H_FIELD_mG        = 13,
} ;
```

## Limitations and Timeout

The XML commands from the PC to the **SMP2**
can be up to 32768 bytes. The **SMP2** expects
to receive complete commands in less than 3
seconds (counting from the time of receipt of the
first byte); If after this time it does not have a full
and valid response, an error message is sent and
discards the information received so far. If you
send a message without the initial " < " XML tag,
the **SMP2** will not send any response.

When connecting the USB to the computer, the
**SMP2** will interrupt listening the fibre port.

## Example of Commands

These examples have been automatically generated by the software **SMP2** and should be sent unformatted (ie no spaces and line breaks between tags).

### System info

<?xml version="1.0" encoding="ISO-8859-1"?> <cmd><instruction>INFO_SYSTEM</md5>c1c0060ec77a5b477c8e164012df8e4f
</md5></cmd>

### SMP2 time

<?xml version="1.0" encoding="ISO-8859-1"?> <cmd><instruction>GET_TIME</on><md5>81c73f231ba30eca41b76577ad6f7f9f
</md5></cmd>

### Field level

<?xml version="1.0" encoding="ISO-8859-1"?> <cmd><instruction>GET_SAMPLE</md5>d8dd6be74a3df920ca20b397a0f49bc0
</ md5></cmd>

**Example c# code to generate the MD5**

```csharp
using System;
using System.text;
using System.Security.Cryptography;

private string AddMd5(string cmd)
        {
            String   formatted_xml  = cmd;
            String   result         = string.Empty;
            string[] string_parts;
            /* Add a <md5>MD5_VALUE</md5> tag before the closing </cmd> tag. */
            if (!formatted_xml.Contains("<md5>"))
            {
                /* Split result: before "</cmd>" and after "</cmd>": */
                string[] tokenizer = new string[1];
                tokenizer[0] = "</cmd>";
                string_parts = formatted_xml.Split(tokenizer, 3,
StringSplitOptions.None);
                if (string_parts.Length == 2)
                {
                    //Calculate MD5 of the chunk before "</cmd>
                    using (var md5 = MD5.Create())
                    {
                        string md5_str = BitConverter.ToString(md5.
ComputeHash(Encoding.UTF8.GetBytes(string_parts[0]))).Replace("-", "").ToLower();
                        //Add it to the result
                        result = string_parts[0] + "<md5>" + md5_str + "</md5></
cmd>";
                    }
                }
            }
            return result;
        }
```

# DECLARATION OF CONFORMITY (DoC)

**Manufacturer:** Wavecontrol, S.L.          C/ Pallars, 65-71
                                            08018 Barcelona (Spain)

**Object of the declaration:**          SMP2 Electromagnetic Field Meter

The above mentioned product complies with the essential requirements, which are specified in the 2004/108/EC Directive on the approximation of the laws of the Member States relating to electromagnetic compatibility.
The product of the declaration described above is in conformity with the requirements of the following specifications:

**Documents-No. and description:**

**IEC-EN 61326-1:2013**

Electrical equipment for measurement, control and laboratory use.

**EN 55011:2011 + A1:2011**

Industrial, scientific and medical equipment - Radio-frequency disturbance characteristics - Limits and methods of measurement.

**IEC-EN 61000-3-2:2006 + A1:2010 + A2:2010**

Electromagnetic compatibility (EMC) -- Part 3-2: Limits - Limits for harmonic current emissions (equipment input current <= 16 A per phase).

**IEC-EN 61000-3-3:2009**

Limitation of voltage changes, voltage fluctuations and flicker in public low-voltage supply systems, for equipment with rated current <= 16 A per phase and not subject to conditional connection.

**IEC-EN 61000-4-2:2010**

Testing and measurement techniques - Electrostatic discharge immunity test.

**IEC-EN 61000-4-3:2007 + A1:2008 + A2:2011**

Testing and measurement techniques- Radiated, radio-frequency, electromagnetic field immunity test.

**IEC-EN 61000-4-4:2005 + CORR:2010 + A1:2010**

Testing and measurement techniques - Electrical fast transient/burst immunity test.

**IEC-EN 61000-4-5:2007 + CORR:2010**

Testing and measurement techniques - Surge immunity test.

**IEC-EN 61000-4-6:2009**

Electromagnetic compatibility (EMC) -- Part 4-6: Testing and measurement techniques - Immunity to conducted disturbances, induced by radio-frequency fields.

**IEC-EN 61000-4-8:2011**

Electromagnetic compatibility (EMC) -- Part 4-8: Testing and measurement techniques - Power frequency magnetic field immunity test.

Barcelona 18th of June 2014          Ernest Cid - CEO

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