

## **User Manual**







# ExpoM - RF

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## **1** Description

ExpoM - RF is a personal radio frequency exposure meter. Band selective measurements allow for a detailed differentiation of the different electromagnetic field sources. The 16 bands covered by this device include all major wireless communication and broadcasting services, including LTE. ExpoM - RF stands out due to its true-RMS detection method. This approach ensures modulation insensitive measurements, allowing for meaningful cross-standard field value comparisons.

Additional features include GPS based outdoor localization and Bluetooth connectivity. The integrated Bluetooth module allows to stream the measurement data to any Android based device for real-time display.



*Important notice:* The accuracy and reliability of the GPS localization depends on the environmental conditions. Inside buildings and homes GPS localization may not be possible.

**Important notice:** After switching on the device it may take several minutes for the GPS receiver to search for satellites. No position data will be logged during this time. The first few measurement points may be quite inaccurate.

## 2 Case and interfaces

The standard enclosure of ExpoM - RF provides basic water (IP 64) and shock protection of the exposure meter. The case includes following control elements and interfaces (Figure 1):



Figure 1: ExpoM – RF control elements: Marker button (1), Multi-color LED (2), Micro-USB interface (3), ON/OFF switch (4)





#### 2.1. Multi-color LED

Status information about the operation of the device is given via the multi-color LED. The following table shows an overview about the color code and its corresponding behavior.

Situation	Multi-color LED
	1. White flash immediately after switch is turned on;
Device initialization (after nower on)	2. Bluetooth init: Blue light for 2 sec; only if Bluetooth is enabled
Device initialization (arter power on)	3. Successful initialization is signalized by a quick color sweep
	After initialization ExpoM - RF switches over to measurement mode.
Moasurement mode	Short red flash after each measurement. If GPS is enabled, an additional
	green flash signalizes a successful GPS position fix.
Charging the battery	Continuous red light. Turns off as soon as the battery is fully charged.
Connection to PC	Continuous yellow light.
Rustaath connection	Single blue flash: Bluetooth connection established
Bluetooth connection	Double blue flash: Bluetooth has been disconnected
Marker button pressed	Blue light lights up for about one second
Initialization error at newer on	Series of fast red flashes shortly after power-on. Device has to be restarted
initialization error at power on	using the ON/OFF switch.

## 3 Using ExpoM - RF

#### 3.1. Starting a measurement

As soon as the device is turned on by means of the ON/OFF switch it starts to measure and log the data using the last device settings (described in paragraph 5). The device can be turned on and off at any time. When ExpoM - RF is powered on, the new measurements are appended to the existing log file preserving all previously recorded data. The internal memory can only be cleared using the ExpoM - RF Utility on the PC (see paragraph 5).

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**Important notice:** During the measurement the device should not be hold in the hand and not be placed on a metallic surface. Both can influence the receiving characteristics of the built-in antennas and therefore influence the measurement. If it is required to use it as a handheld device, please contact the distributor for an additional calibration (additional calibration will cause additional costs).

**Important notice:** The measured data is saved to the internal memory every 6 samples. Before each memory access it is temporarily held in a volatile memory that is erased when the device is turned off. It is therefore recommended not to switch off the device for at least 6 additional measurements after the required time end point.



#### 3.2. Setting a marker

The Marker button on the top of the device can be used to flag single measurement samples. The flagged samples are highlighted by means of an ascending marker number visible in the measurement results after download. The marker number can be reset with ExpoM - RF utility on the PC (see paragraph 5).

## 4 Battery management

#### 4.1. Charging the battery

The USB interface is used to recharge the internal battery or power the device from an external power source. Unless it is already fully charged, the battery is recharged as soon as the device is connected to a powered USB source (Wall adapter, PC, laptop etc.). Any compliant USB port and chargers providing at least 1000 mA can be used for this purpose.

While ExpoM - RF is charging the battery, the multi-color LED lights solid red. At the end of the charging cycle the red light turns off.

 $\triangle$ 

**Important Notice:** Using USB chargers that do not fulfill the USB dedicated charger port specification can lead to incomplete and slow charging process of the batteries. **It is strongly recommended to use an USB charger with a current rating of at least 1A (1000mA)**. More information about suitable USB charger types for ExpoM - RF can be obtained from the distributor.



**Important Notice:** Although it is possible to perform measurements while charging ExpoM - RF it is inadvisable to do so. The charging cable falsifies the antenna characteristics, reducing the measurement accuracy. Frequency bands below 1 GHz are particularly susceptible to this effect.



*Important Notice:* At environmental temperatures above 45°C ExpoM - RF should not be charged. Direct exposure to sunlight during the charging process should be avoided.

 $\underline{\wedge}$ 

**Note:** The actual charging time depends on the charger model and the type of USB cable used. Long and / or thin USB cables can significantly increase the required charging time regardless of which type of charger is used. It is recommended to use the USB cable provided with the device.



## 4.2. Over-discharge protection (automatic shutdown)

In order to preserve its capacity as long as possible, the internal battery must be prevented from being discharged below a critical level. ExpoM - RF includes a battery monitoring circuit that powers the device down when a critically low battery level (below 3% remaining capacity) is detected. After such an automatic power down it is recommended to switch ExpoM - RF off using the ON/OFF switch and charge it for at least 10 minutes before switching it on again.

## 5 ExpoM - RF Utility (PC Software)

The ExpoM - RF Utility software is required for transferring and displaying the measurement data from the ExpoM - RF to a PC and for changing the various device settings. This software is currently only available for Windows operating systems.



Figure 2: Main window of the ExpoM - RF Utility Software

In the following the functions of the different buttons in the menu bar are explained:



"Load file": When selecting the 'Open file' button any measurement file previously saved on the PC can be selected and loaded into the Utility. When loading is completed the data is displayed in the large window (see Figure 3). The procedure of selecting the file to be opened corresponds to the one of all common Windows software.





Figure 3: Main window with displayed data set after loading



"Save data": All data loaded to the software is saved at the selected location on the PC. This function corresponds to the 'Save As' functionality of all common Windows software.



"KML GPS export": The data is exported in a file format that can be directly loaded into Google Earth.



"ExpoM": Connecting to an ExpoM - RF device and change the device settings. Please make sure to turn on your ExpoM - RF and connect it to the PC using an USB cable. When this button is pressed, following window will appear:



A Connect to ExpoM		
Conr	ect to ExpoM	
USB Port Search COM80	•	Connect to ExpoM
ExpoM Connection status: no connection	Download data	Device settings
Battery charge: n/a	Delete data	Firmware update Device firmware: n.a.

Figure 4: Dialog window for connecting to an ExpoM - RF via USB

The USB Port control element on the top left lists all serial ports found on the computer. If your device has been successfully recognized, there will be at least one entry in the USB port drop-down menu. If more than one port was found on your computer, it is possible that a wrong one is chosen by the application. In that case it is necessary to select the right port number manually using the drop-down menu. If the Utility it is not able to recognize any COM port or no connection to your device is possible even after several attempts, please refer to chapter 5.1.

Turn on ExpoM RF. Wait 3-5 seconds for the device to switch into measurement mode and select *Connect to ExpoM*. As soon as a connection to the device has been successfully established the command window will change and the data information of the device is displayed (Figure 5).

A Connect to ExpoM		
Conne	ect to ExpoM	
USB Port Search COM80 🗸		Disconnect
ExpoM Connection status: Connected to ExpoM (ID = 49)	Download data 3864 samples	Device settings
Battery charge:	Delete data	Firmware update Device firmware: 3.4.2

Figure 5: Dialog window after selecting the device

Using the *Download data* button the data stored on the device is downloaded and displayed in the Main window. Depending on the number of measurement samples stored on the device this operation can take several minutes. The *Delete data* button erases all the data saved on the device. Selecting the *Device settings…* button brings you to the Device Settings window shown in Figure 6.



A Device Settings	
ExpoM Se	ettings
1. Connectivity Bluetooth GPS	2. Date and Time Get Time ExpoM Clock: Sync with PC 11.12.2014 13:06:26
3. Sampling Interval (seconds) 3 •	4. Marker counter Reset 11 markers set
Cancel	Save Settings

Figure 6: Device settings dialog window of the Expom - RF

In this window the connectivity options (Bluetooth and GPS) can be switched on and off. This will improve runtime of the device. The date and time of the real time clock in the device is displayed and can be synchronized with the computer clock that the device is connected to. The sampling interval (in seconds) can be either selected in a pull-down menu or entered in the corresponding text field. Values between 3 and 3000 seconds in steps of 0.1 second are accepted. The device's marker number counter is reset to 0 using the *Reset* button in the *Marker counter* section.



"Print chart": Printing of the curves displayed in the main window. If the monitor window is open, the monitor data is also printed.



"Settings": This button directs you to the application settings dialog window displayed in the following:

eneral Settings	8
Application Settings	
Band Names	
FM Radio • edit Default Names	
Band Colors	
FM Radio  Click to modify Default Colors	
Export Format	
Google Earth Export	
V Discard inaccurate GPS samples Threshold:	
Google Earth Bar Size: 0	
Bar base width         Bar height scaling:          50 x 50 m        1 V/m = 100 m	

Figure 7: Application Settings Window



The application settings allow to modify the band names and the corresponding color. These settings are stored locally and will be automatically activated every time ExpoM - RF utility is started.

The Google Earth export options allow to customize the appearance of the 3D bar graph of the exported KML files. Please note that a new KML file has to be exported for changes to take effect. The accuracy slider allows to set a filter on the quality of the GPS positioning accuracy. When this option is enabled, GPS data captured in bad reception conditions is discarded in the KML export.

**Caution**: setting the filter too strict can lead to no GPS data being exported at all.



Figure 8: Main window with displayed data set and monitor window displaying the field strengths

#### 5.1. Installing the USB driver

The USB driver required for ExpoM RF is included with most Windows versions and is automatically installed the first time ExpoM - RF is connected to the PC. If the automatic driver installation fails, however, it is necessary to install the driver manually. The driver can be found on our homepage (www.fieldsatwork.ch/downloads).

#### 5.2. Data format

ExpoM - RF PC utility can store the measurement data in two different file formats, Excel (xlsx) and CSV. All field strengths are given in Volts per meter (V/m).

Being a simple and universal text based file format, a CSV file can be imported into virtually any spreadsheet application (Excel, Open-/LibreOffice etc.). In both formats the measurements are stored chronologically row by row in a table. Following information is contained in each row:



Date and	Sequence	Field strengths	Overload	GPS: Fix, lat, lon, altitude, HDOP,	Marker
Time	number	Band #1 Band #16, Total	Overioau	number of sat, speed	(number)
Figure 9: Contents of one row of the CSV file generated by the ExpoM - RE Litility					

Date and Time: Contains the date and time at which the corresponding sample was taken.

**Sequence number:** Each measurement is labeled with a sequence number. Every time ExpoM - RF is switched on the sequence number starts at 1. If not interrupted by a power cycle, the sequence number counts up to 65535 after which it restarts at 1.

**Field strength:** The measured field strength of the 16 frequency bands are stored in the same order as listed in 7.1. . The last field contains the resulting total field strength computed from all band measurements. All field values are expressed in Volts per meter (V/m).

**Overload:** An exclamation mark (!) in this field signalizes that ExpoM - RF measured a signal exceeding its specified measurement range. The affected sample is likely to be inaccurate due to overload effects and should be discarded. Otherwise this entry is empty.

**GPS:** The recorded GPS data consists of the following 7 parameters:

- 1. GPS fix 0: invalid; 1: 2D only (no accurate altitude information) 2: full GPS localization
- 2. Latitude NMEA format: degrees minutes.decimal\_minutes
- 3. Longitude NMEA format: degrees minutes.decimal\_minutes
- 4. Altitude Meters above mean sea level. Caution: accuracy is strongly signal dependent
- 5. HDOP GPS fix quality (lower = better). < 2: very good; 2-5: OK; >5: limited accuracy
- 6. Nsat Number of satellites in view; higher numbers mean higher GPS reliability
- 7. Speed in km/h determined by GPS. In bad reception conditions, speeds up to several km/h are sometimes measured even in stationary conditions.

**Marker:** Tracks the number of marker button activations. The measurement that was active at the time the marker button was pressed contains the corresponding marker number. Otherwise this entry is empty.

## 6 Smartphone App

The Bluetooth capability of ExpoM - RF allows to transmit the measurements to a smartphone in order to visualize the data in in real time. Following requirements have to be fulfilled:

- 1. Android based smartphone running Android 4.0 or higher.
- 2. The ExpoM RF App (available on <u>www.fieldsatwork.ch/downloads</u>) is installed on the smartphone.
- 3. Bluetooth is enabled on ExpoM RF (using the PC Utility).

#### 6.1. Establishing the Bluetooth connection

When the app is started, the default screen is displayed (Figure 10 on the left). In order to connect to an ExpoM - RF device, press the Bluetooth icon on the top bar. This will open the Bluetooth



connection dialog (2nd picture from the left). If you are connecting a device for the first time select "Scan for devices". A list of the available devices will appear. If ExpoM - RF is turned on and Bluetooth is enabled, it will be found and appear in the list after several seconds (3<sup>rd</sup> picture). Select the desired ExpoM - RF device. A pairing dialog will appear. The code for all ExpoM - RF devices is "0000". As soon as a device is paired to your smartphone this last step is not required any more.

Screenshot wird gespeichert	EAA 0 🗘 🛪 🗎 18:29	🖬 E 🛦 🛦 🛛 🕴 🐔 🛪 📋 18:29	🗉 🗛 🖳 🕰 🖞 🐱 🕺 🕄 🖉 🖬 11:19
LIVE VIEW 🛛 😽 🌣 🗙	LIVE VIEW 🛛 🔻 🕸 🗡	LIVE VIEW 🛛 🕸 🗡	LIVE VIEW 🛛 😽 🌣 🗙
Total:	Total:	Total:	Total: 0.399 V/m
FM-Radio:	FM-Radio:	FM-Radio:	FM-Radio: 0.142 V/m
DVB-T:	DVB-T:	DVB-T:	DVB-T: 0.363 V/m
LTE800-DL:	LTE800-DL:	LTE800-DL:	LTE800-DL: 0.006 V/m
LTE800-UL:	LTE800-UL:	LTE800-UL:	LTE800-UL: 0.004 V/m
GSM900-UL:	GSM900-UL:	GSM900-UL:	GSM900-UL: 0.003 V/m
GSM900-DL:	GSM900-DL:	est soloot a device to connect	GSM900-DL: 0.050 V/m
GSM1800-UL:	select a device to connect	<sup>GSI</sup> No devices have been paired	GSM1800-UL: 0.003 V/m
GSM1800-DL:	GS No devices have been paired	GS Other Available Devices	GSM1800-DL: 0.031 V/m
DECT:	DEC Scan for devices	DEC ExpoM - Device 55	DECT: 0.014 V/m
UMTS-UL:	UMTS-UL:	00:18:DA:02:48:F3	UMTS-UL: 0.002 V/m
UMTS-DL:	UMTS-DL:	UMTS-DL:	UMTS-DL: 0.051 V/m
ISM-2.4GHz:	ISM-2.4GHz:	ISM-2.4GHz:	ISM-2.4GHz: 0.023 V/m
LTE2600-UL:	LTE2600-UL:	LTE2600-UL:	LTE2600-UL: 0.002 V/m
LTE2600-DL:	LTE2600-DL:	LTE2600-DL:	LTE2600-DL: 0.002 V/m
WiMax-3.5:	WiMax-3.5:	WiMax-3.5:	WiMax-3.5: 0.003 V/m
ISM-5.8GHz:	ISM-5.8GHz:	ISM-5.8GHz:	ISM-5.8GHz: 0.025 V/m

Figure 10: from left: Default view (not connected); Bluetooth connection dialog; Device is found and can be paired (code: 0000); ExpoM - RF is successfully connected and streams the measurements.

After this step, the Bluetooth icon turns green and ExpoM - RF starts to stream the measurements (last picture). In order to improve readability, all measurement values below ExpoM - RF's detection limit are greyed out. The device's current battery status is displayed by means of the bar left to the Bluetooth icon. Tapping on it displays the exact remaining battery charge in %.

#### 6.2. Disconnecting from a device

The Bluetooth connection can be terminated by means of the Bluetooth icon on the top bar. This will allow to connect to a different ExpoM RF.

When the phone switches to another app, the ExpoM RF app and any existing Bluetooth connection are kept alive in the background. The app can be terminated by pressing the cross in the upper right corner. This will also terminate all Bluetooth connections.



## 7 Technical Specifications

#### 7.1. Frequency bands and measurement range

Band name	E-UTRA Band	Frequency range	Typical dyna	amic range
FM Radio		87.5 – 108 MHz	0.02 V/m	5 V/m
DVB-T		470–790 MHz	0.005 V/m	5 V/m
Mobile 800 MHz downlink	Band XX	791–821 MHz	0.005 V/m	5 V/m
Mobile 800 MHz uplink	Band XX	832 – 862 MHz	0.005 V/m	5 V/m
Mobile 900 MHz uplink	Band VIII	880–915 MHz	0.005 V/m	5 V/m
Mobile 900 MHz downlink	Band VIII	925 – 960 MHz	0.005 V/m	5 V/m
Mobile 1800 MHz uplink	Band II	1710–1785 MHz	0.005 V/m	5 V/m
Mobile 1800 MHz downlink	Band II	1805 – 1880 MHz	0.005 V/m	5 V/m
DECT		1880 – 1900 MHz	0.005 V/m	5 V/m
Mobile 2.1 GHz uplink	Band I	1920 – 1980 MHz	0.003 V/m	5 V/m
Mobile 2.1 GHz downlink	Band I	2110 – 2170 MHz	0.003 V/m	5 V/m
ISM 2.4 GHz		2400 – 2485 MHz	0.005 V/m	5 V/m
Mobile 2.6 GHz uplink	Band VII	2500 – 2570 MHz	0.003 V/m	5 V/m
Mobile 2.6 GHz downlink	Band VII	2620 – 2690 MHz	0.003 V/m	5 V/m
Mobile 3.5 GHz	Band 42	3400 – 3600 MHz	0.003 V/m	3 V/m
ISM 5.8 GHz / U-NII 1-2e		5150 – 5875 MHz	0.05 V/m	5 V/m

#### 7.2. RF Measurement

Detection method	True-RMS, 0.3 seconds integration time for each band
Sample interval	User-selectable; from 3 to 6000 seconds in steps of 0.5 second
Antenna	Tree axis isotropic antenna
Crosstalk	Typically between -40 and -60 dB

#### 7.3. Size / Conditions

Size and weight	16 cm x 8 cm x 3-5 cm (L x W x H) Weight: approx. 320g
Device Calibration	15 field levels, three axes (for each frequency band)
Conformity	CE-marking
Operation Conditions	Temperature -5 to +50 Degrees Celsius
	0 to 90% rel. humidity

### 7.4. Connectivity / Storage

Time	Integrated precision (± 2 ppm) real time clock
Connectivity	USB, Bluetooth, GPS
Marker	Built-in marker button to highlight specific events
Storage	Internal 4 GB memory / 50 million measurement samples



## 7.5. Battery Management

Battery	Built-in rechargeable Li-ion battery
Typical operating time with 3 sec sample interval	>12h (GPS and Bluetooth ON)
Typical operating time 3 sec sample interval	>16h (GPS and Bluetooth OFF)
Typical Operating time 10 sec sample interval	>55h (GPS and Bluetooth OFF)
Typical Operating time 1 minute sample interval	>7 days (GPS and Bluetooth OFF)
Charging	USB compliant charger ports are supported (min. current rating 1000 mA)

## 7.6. ExpoM-RF Utility Software

Hardware requirements	Dual core processor recommended
Operating System	Windows (XP, 7, 8) with installed .NET environment (Version 4 or newer)
Storage usage	5 MB
Installation	No installation required – ExpoM RF Utility can be started from the downloaded folder
Download	www.fieldsatwork.ch

#### 7.7. ExpoM-RF Android Software

Processor	No limitations
Operating System	Android 4.0 or newer
Storage usage	Less than 5 MB
Download	www.fieldsatwork.ch

Size and weight	16 cm x 8 cm x 3-5 cm (L x W x H) weight: approx. 320g
Time	Integrated precision (± 2 ppm) real time clock
Connectivity	USB, Bluetooth, GPS
Battery	Integrated rechargeable Li-ion battery
Operation time	>10h operation using a sample interval of 3 seconds, GPS and Bluetooth on. Lifetime is extended by longer sample intervals and disabled GPS/Bluetooth
Charging	USB interface; Generic USB chargers are supported (1A minimum current rating)
Marker	Built-in marker button to highlight specific events
Storage	Non-volatile internal memory; Capacity: 50 million measurement samples
Device Calibration	15 field levels, three axes (for each frequency band)
Case	IP64 protected; Material: ABS



