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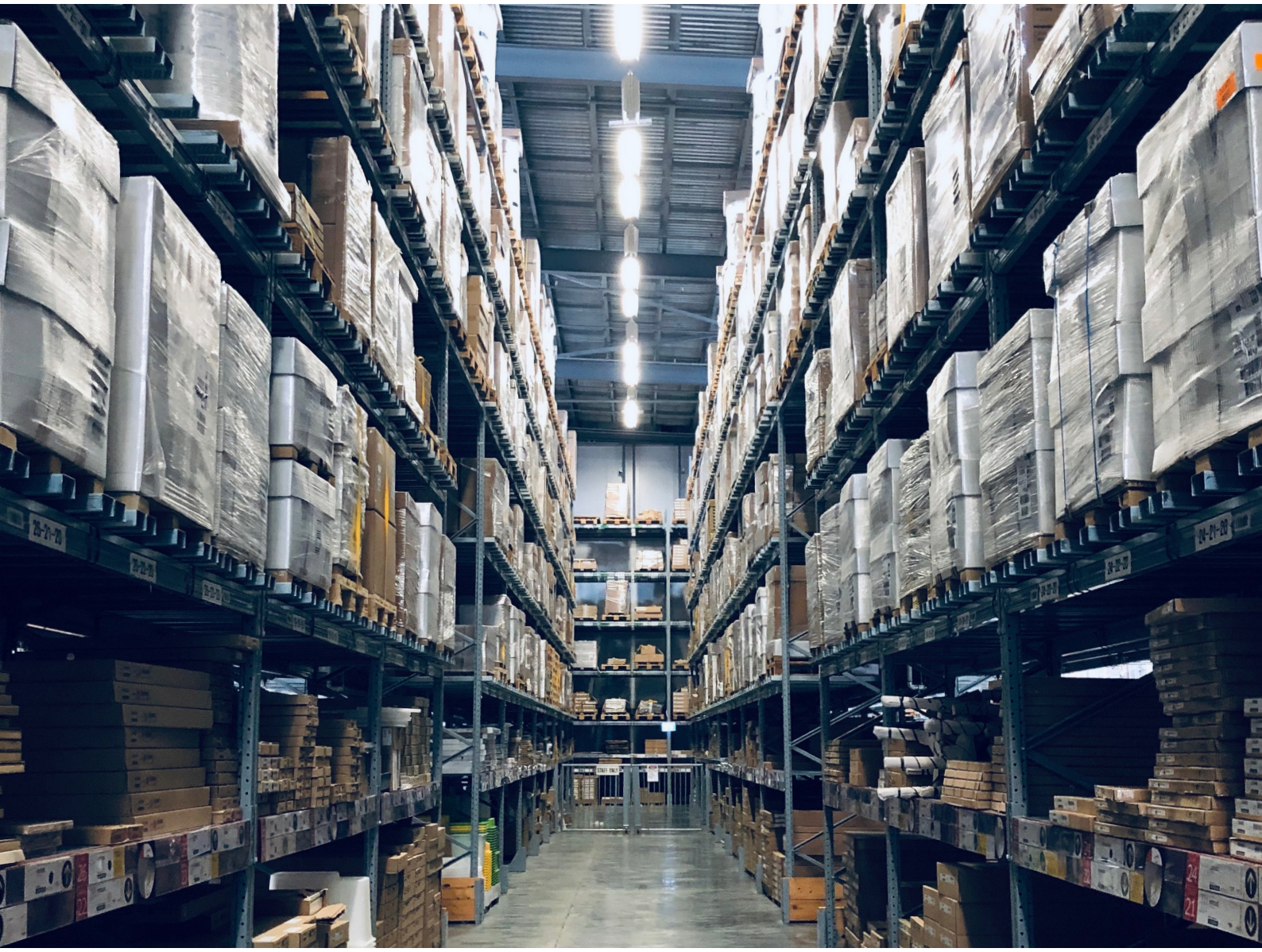
Evaluation of exposure to an RFID system of workers bearing active implanted medical devices (AIMDs)

APPLICATION NOTE



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WAVECONTROL
Safety, Quality, Service

+34 93 320 80 55
www.wavecontrol.com
info@wavecontrol.com

Index

Evaluation of exposure to an RFID system of workers bearing AIMDs

Addressed to

- Manufacturers of RFID antennas and systems.
- Anyone responsible for the workers' safety (employers, safety officers, safety managers, safety departments, etc.) of companies or organizations using RFID systems in their facilities.

Scope

This application note provides an example of evaluation of exposure to electromagnetic fields produced by an RFID system of workers bearing AIMDs. It shows two different measurement methods: spectrum analyser and broadband meter, discussing the advantages and disadvantages of each.

PLEASE NOTE: *Wavecontrol will not be responsible for any errors that may be found in this document or for the results of any faulty application of regulations. This application note is meant to be used for assistance, but under any circumstance as a replacement for the standards that it mentions. We recommend that you study those standards carefully.*

1. INTRODUCTION

In Europe, the general public and workers are protected against exposure to electromagnetic fields (EMF) under **Recommendation 1999/519/EC** and **Directive 2013/35/EU** (*). Those texts establish the exposure limits based upon **ICNIRP guidelines**.

(*) Member States may enact stricter legislation.

Those limits are meant to guard against the direct effects of EMFs, specifically electric stimulation or heating of human tissues, depending upon the frequency range, from 0 Hz to 300 GHz.

The Directive also obliges employers to protect workers against indirect effects, such as interference with **active implantable medical devices (AIMDs)**, e.g. pacemakers or defibrillators.

The levels defined in those texts are not necessarily sufficient to protect individuals at particular risks, such as those bearing medical devices mentioned above. Standard EN 50527-1:2016 describes how to evaluate such risks.

2. Evaluation procedure

The first step comprises a simplified risk analysis, followed, if necessary, by a detailed evaluation.

The risk evaluation set out in EN 50527- 1 is based upon the assumption that the AIMDs will operate in accordance with their product regulations, provided that the reference levels for the general public specified in Recommendation 1999/51/EC are not exceeded (excepting static magnetic fields and not including any average level, particularly at high frequencies).

That approach is valid where the AIMD holder has not received any specific warning by his/her medical team about incompatibility with general public exposure limits (e.g. due to the technology used by the device, especially sensitive configurations or clinical effect consequences). Such warnings are given in addition to the general warnings given to all individuals with AIMDs, such as keeping a mobile telephone at certain distance from the area where the device is implanted.

In any event, the recommendations for use supplied with the device must be observed. Where they cannot be taken into account, a specific evaluation must be made.

Table 1 in **EN 50527- 1** lists the equipment and uses that produce fields that do not exceed exposure limits for the general public.

The evaluation must therefore be made in keeping with the limits applicable to the general public and with no averaging of the EMF being measured, i.e. taking the instantaneous value into account (not averaging the measurement over any given 6-minute period for frequencies between 100 kHz and 6 GHz).

3. Measurements

The electric field may be measured with a spectrum analyser connected to an isotropic probe (triaxial antenna) or with a field meter.

A spectrum analyser allows selective measurements (narrow band). It is sophisticated to use due to the need to adjust many parameters (RBW, detector, and so on) and measurement needs time. The measured power must also be converted into electric field thanks to the antenna factor.

On the other hand, a field meter allows overall direct measurements. Its use requires less

technical preparation. The measurement is fast, because the 3 axes are read simultaneously and the device directly displays the field level in V/m or the exposure index, as a percentage of the selected exposure limit. This method is particularly preferable where measurements must be taken at many points.

In both cases, operating precautions must be taken (distance from the operator, objects in the surrounding area…). Evaluation using a spectrum analyser as a rule is more precise than evaluation using a field meter.

In the example below, evaluation of the **RFID in the UHF band (866 MHz)** allows comparison of these two measurement techniques.

RFID is a contactless identification technology. A reader feeds an antenna that broadcasts an EMF to electronic tags. The most commonly used tags are considered passive because they have no energy source. They must therefore capture the radiant energy to run and send a signal back to the reader (the technique for returning the signal is known as backscattering). The tag needs to be within an electric field of at least approximately 1 V/m in order to respond to the reader.

Four channels with a maximum broadcast power of 2 W are assigned to the RFID UHF in Europe (ETSI regulation). They are centred on 866.6 MHz.

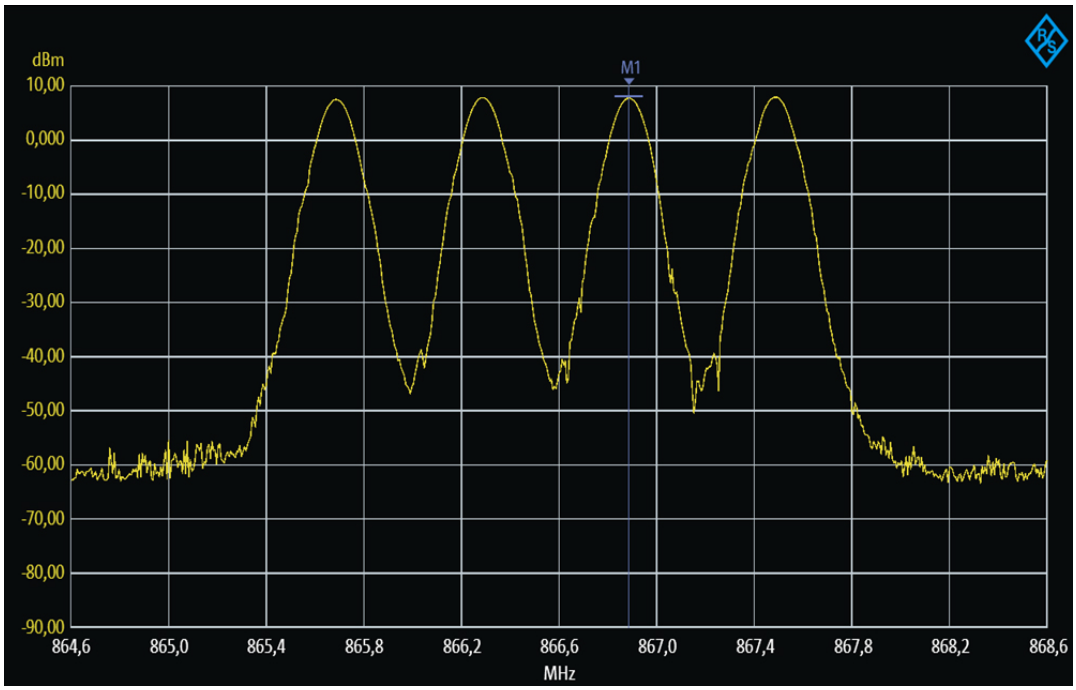

Figure 1. **Frequency spectrum of an RFID UHF broadcast**

3.1 Spectrum analyser

The spectrum analyser must be equipped with an isotropic probe (triaxial antenna). Picture 1 allows to determine the maximum power of the signal (6.8 dBm) and the average power (-6.08 dBm) along one measurement axis. A measurement of several seconds is sufficient because the radiation parameters are stable.

The SPAN ZERO mode displays the RF signal over time. The rms detector is selected. The resolution bandwidth (RBW) of 3 MHz allows the 4 RFID broadcast channels to be spanned.

The signal is a transmission sequence of a few tens milliseconds every 230 ms.

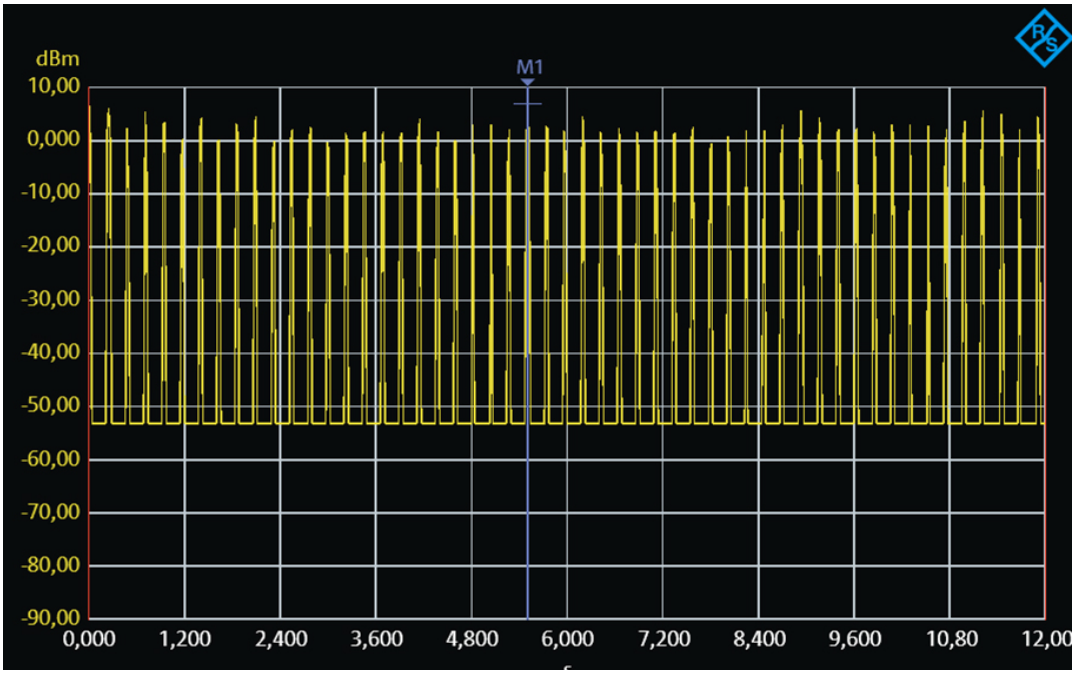

Figure 2. **RFID broadcast in the 866 MHz band**

These readings can be used to calculate the average electric field and the maximum electric field, adding the values for the other two axes and applying the antenna factors available in the calibration certificate for the probe.

The field obtained at the measurement point is:

- Average electric field: 2.3 V/m
- Maximum electric field: 10.1 V/m

The average exposure is in line with the reference level applicable to the general public (according to European Directive 2013/35/EU), which is 40 V/m at the broadcast frequency.

At this distance, use of the RFID system by a person with an AIMD complies with the requisites of Standard EN 50527-1 (maximum level lower than reference level without 6 min averaging).

3.2 Field meter

The measurements were taken with the **Wavecontrol SMP2** field meter, equipped with the WPF18 probe. This probe covers the 300 kHz to 18 GHz band. **It features a fast detector** that allows measurement of the maximum value of short signals, from 4 ms up.

The following screen shots show both measurements: average electric field and maximum electric field.

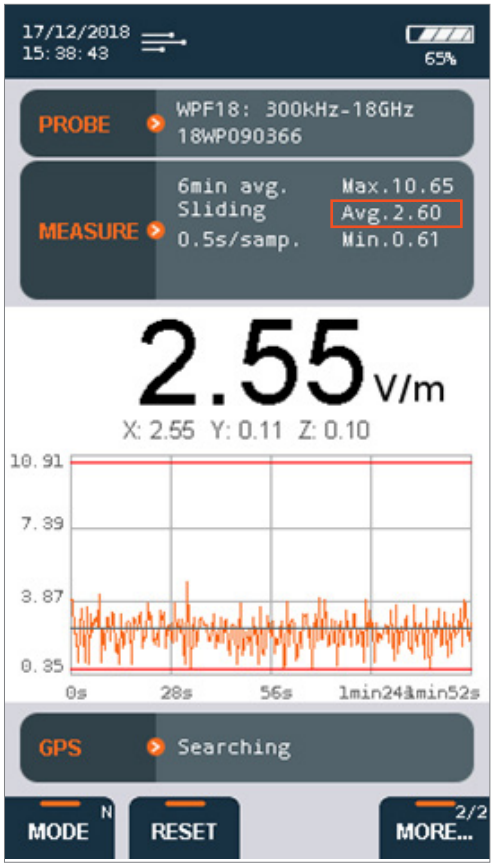

Figure 3a. **Direct measurement of average field (Avg.)**

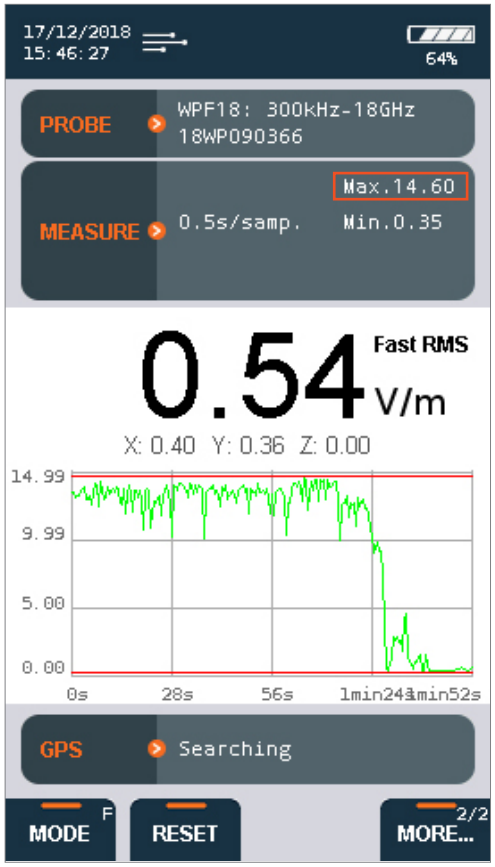

Figure 3b. **Direct measurement of maximum field (Max.)**

Direct reading of the screens gives the following results:

- Average electric field (Avg.): 2.60 V/m
- Maximum electric field (Max.): 14.60 V/m

The conclusion reached above is valid here as well.

The exposure is in line with the reference level applicable to the general public (and to European Directive 2013/35/EU). The reference level to be taken into account in this case, considering the frequency is not known, is the lowest in the measurement bandwidth of the field probe (28 V/m).

3.3 Conclusion

The results obtained for the measurements with the analyser and the field meter are similar.

The overall uncertainty associated with the results for a field meter is, as a rule, around 4 dB (+60%, -37%), while it tends to be lower with an analyser (1.5 dB max., 1 dB typ.).

The field meter allows quick measurements and remains the preferred solution where there are many measurement points. Its use does not require radio frequencies or metrology skills. However, it is necessary to know how to use the device and to use it meticulously with the suitable methodology.

Patrick Staebler

Expert in human exposure to EMF
www.exposition-cem.com

WAVECONTROL
Safety, Quality, Service

+34 93 320 80 55
www.wavecontrol.com
info@wavecontrol.com