

EMF Measurement of Ovens

APPLICATION NOTE



AN_SMP2_OVENS_V1.00

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Application note

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1. INTRODUCTION

Numerous sources of electromagnetic fields can be found in the home. One of these sources is household appliances.

As a result, manufacturers of electrical household appliances have to certify that their appliances are compliant with the **IEC 62233** standard. This means ensuring that these appliances do not exceed the permitted limits in the regions where they are to be used.

In this application note, we will look at the EMF safety assessment of an electrical oven with a pyrolytic self-cleaning function. The Assessment is completed in line with the following standard [1]:

- **IEC/EN 62233** – “Measurement methods for electromagnetic fields of household appliances and similar apparatus with regard to human exposure”

The application note is addressed to:

- Manufacturers of electric ovens
- Test labs and test engineers
- Anyone interested in EMF safety of household appliances (EMF safety officers and inspectors)

PLEASE NOTE: *Wavecontrol* will not be held 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 guidance, but under no circumstance does it serve as a replacement for the standards mentioned herein. We recommend that you review those standards carefully.

2. EMF MEASUREMENT OF OVENS

IEC 62233 specifies the measurement procedures for different types of household appliances. For ovens, the measurements should be taken in front and on top of the appliance at a distance of 30 cm. During testing, the oven should be empty with the door closed and the thermostat at the highest setting. If the oven has a self-cleaning mode, then it should also be tested in this mode.

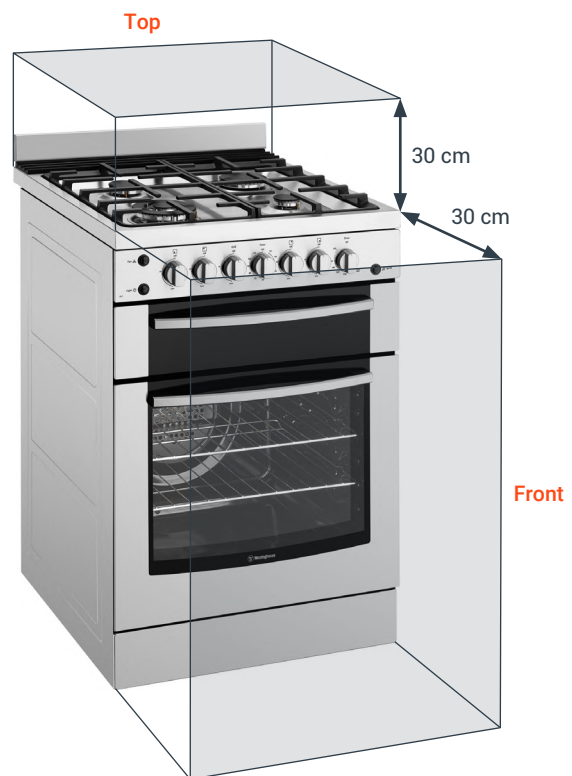


Figure 1: Top and Front measurement of the oven.

The back of the appliance does not need to be measured if it is installed against the wall. The oven should be tested in all possible operating modes one at a time and at maximum power.

3. PRACTICAL APPLICATION

In this example, an oven destined for commercial use is tested by the manufacturer to determine compliance with **IEC 62233** Standard and the **ICNIRP 98** EMF limits [2]. The equipment under test (EUT) is an electronically controlled built-in oven (Rated voltage and frequency, 220–240 V and 50/60 Hz) with pyrolytic self-cleaning function and a connection for a cooktop with 4 electronically controlled hob elements.

The relevant EMF sources of this EUT are the heating elements (maximum of 3.6 kW), the cooling fan (28.5 W), hot air fan (35 W), the user interface (at the front of the EUT) and the control power module.

Any EUT with an integrated Wi-Fi module that has already been assessed by its manufacturer under the **European Council Directive 2014/53/EU**, the **Radio Equipment Directive (RED)**, and will not be covered in this application note.



Figure 2: (on the left) Equipment under Test (Commercial Oven with Pyrolytic self-cleaning function), (top right) The top view with cover removed containing cooling fan, user interface and COM2 module; (bottom right) Rear view with cover removed containing hot air fan and control power module.

3.1 Measurement Instrument

The measurement equipment used for this test is the **SMP2** electromagnetic field (EMF) meter from **Wavecontrol** and an **ISO 17025** calibrated **WP400** E and H field probe (from 1 Hz to 400 kHz). The measurement instrument fully complies with the **IEC 61786-1** [3] and **IEC 62233** standards.

The **SMP2** uses the Weighted Peak Method (WPM) as the recommended assessment method by the standards, and limits are set to **ICNIRP 98** public reference levels as the EUT will be commercially sold in many countries around the world.

The measurement can be done following the steps below:

- Select H field.
- Choose the desired limit (depending on the country).
- If the user is interested in frequency information, set 'Mode' to 'FFT', 'HOLD' to 'Max' and 'FILTER' to 10 Hz.
- Place the **SMP2** at measurement distance as required by the standard.
- Press 'LOG' to save measurement results. The user should wait a certain amount of time to make sure all the operation modes have been covered and the maximum value is no longer increasing before saving the measurement. If the measured RMS value is below 100 %, no extra action needs to be done and the EUT is considered safe for use.

NOTE 1: Remember to account for measurement uncertainty. For more information on how to calculate measurement uncertainty, please refer to **IEC 62233** and **Wavecontrol** application note [4].

NOTE 2: As seen in figure 3, once a limit (**ICNIRP 98 Public**) is selected, %H represents the H-field level in % with respect to that limit. On the graph, the '0.05/50 Hz' in the top-right corner represents the %H value (0.05 %) at the marker position (50 Hz frequency). The user can also easily scroll between frequencies.

It is important to note that the **SMP2** has a long list of limits to choose from. The user can easily compare between limits, which is a very important feature for manufacturers that sell their appliances globally.

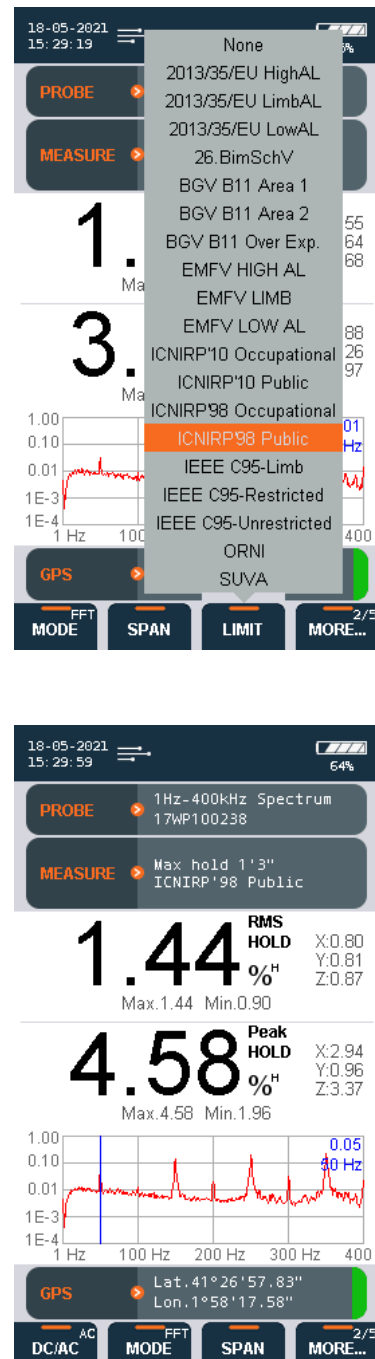


Figure 3: (Screenshots) EMF measurement using the SMP2 + WP400.

3.2 Test conditions and Measurement Procedures

A. Test conditions

- The measurement was performed in a full anechoic chamber (with FAR3 specification) to avoid interference from the surrounding area. Note that this is not a requirement of the standard but allows the user to eliminate background noise and obtain more accurate measurement results from the actual EUT.
- The test room had atmospheric conditions as follows:
 - **Atmospheric pressure:** 942 hPa
 - **Temperature:** 22°C
 - **Relative humidity:** 40 %
- The test voltage and frequency were 230 V \pm 0.1 V and 50 Hz, respectively. The main field sources are the motors (fans) and the heating elements.
- As required by the standard, the oven was empty with the doors closed and the thermostat at the highest setting. The oven was in pyrolytic self-cleaning mode. In the full anechoic room, the EUT was operated on an 80 cm high non-metallic support (Figure 4).

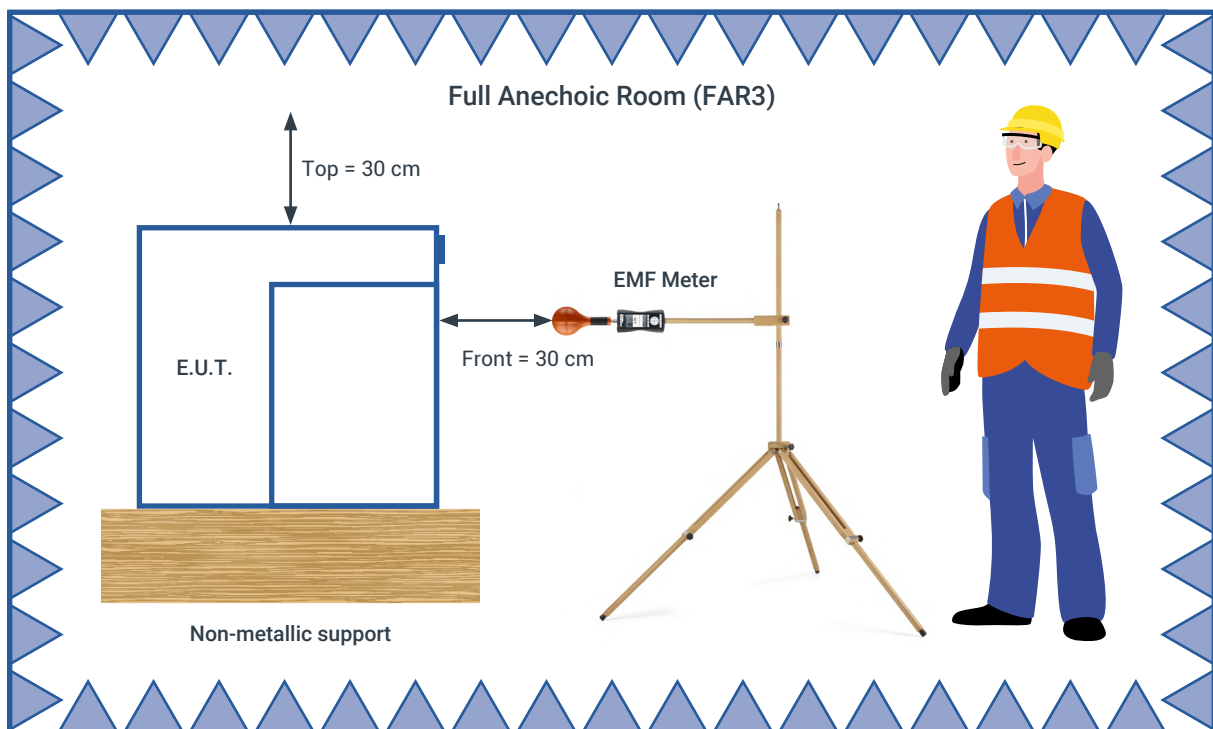


Figure 4: Test in the Anechoic chamber.

B. Measurement procedure

- The first step was carrying out a pre-scan of the appliance, in order to define areas with increased EMF levels. This preassessment is useful to familiarize yourself with the appliance, for example, the position of motors, electronics, power supplies and their different operating modes such as the motor speed, direction and load conditions.
- The **IEC 62233** standard specifies carrying out measurement at 30 cm on the top and in front of the EUT. The measurement in % of the **ICNIRP** limit was done at the points with the highest EMF levels at these specified locations and distance. The measurement distance was ensured by a 30 cm wooden spacer. A meter rule or any other 30 cm spacer can also be used. Optionally, the **SMP2** could be placed on a wooden tripod at the defined distance to ensure the device is not moved during measurements.



Figure 5: EMF assessment of EUT using the SMP2 in an anechoic chamber.

- Additionally, measurement values were also taken with the probe touching the surface of the appliance (0 cm) for both the top and front of the appliance as a precautionary condition for unforeseeable use of the appliance.

3.3 Measurement Results

The result of the measurement for the test are summarized in Table 1. The results were taken in two operation modes:

1. The hot air motor operating at 200°C.
2. The cooling fan at full speed with the oven in pyrolytic self-cleaning mode for 3 hours.

Operation mode	Measurement point	Measurement result in % of ICNIRP limits at the following measurement distances:		
		Precautionary condition (0 cm)	EN 62233 (30 cm)	Comments
Hot air @ 200°C	Front (Max.)	1.1 %	0.31 %	Hot air motor operating
	Top (Max.)	2.5 %	0.79 %	
Pyrolytic self-cleaning mode	Front (Max.)	3.6 %	0.83 %	Cooling fan at full speed
	Top (Max.)	7.5 %	0.85 %	

Table 1: Measurement results at 0 cm (precautionary distance) and 30 cm (normative specified distance).

Using the precautionary distance (0 cm) and the measuring distance specified by the standard, the maximum magnetic field values measured were 7.5 % and 0.85 % of the **ICNIRP public** reference levels. If the measured value exceeds 100 %, coupling factor is applied as described in Annex C of the **IEC 62233** [1, 5], which requires using a probe with a $3 \text{ cm}^2 \pm 0.6 \text{ cm}^2$ sensor area. The **WP400-3** field probe perfectly meets this requirement.

In the present example, no coupling factor is used as the EMF exposure is far below 100 %.

APPENDIX 1. References

- [1] **IEC 62233:2005** – Measurement methods for electromagnetic fields of household appliances and similar apparatus with regard to human exposure.
- [2] **ICNIRP 1998 Guideline** for limiting exposure to time varying E, H and Electromagnetic fields (up to 300 GHz), **HEALTH PHYSICS 74(4):494-522; 1998.**
- [3] **IEC 61786-1:2013** – Measurement of DC magnetic, AC magnetic and AC electric fields from 1 Hz to 100 kHz with regard to exposure of human beings - Part 1: Requirements for measuring instruments.
- [4] **Wavecontrol Application Note** on *Calculation of the total measurement uncertainty of a field strength meter.*
- [5] **Wavecontrol Application Note** on *Assessment of household and similar electrical appliances.*

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