CERTIFICATE OF CALIBRATION

Number **17/XXXXX**

Nº 184/LC10.132

Measurements marked with this symbol ($) are not covered by the scope of the Laboratory's accreditation.

LabCal - Wavecontrol
Radio-electric Calibration Laboratory
C/ Pallars 65-71
08018 Barcelona (Spain)

WAVECONTROL

ITEM	EM Field Meter + Isotropic EM Field Probe
BRAND	Wavecontrol
MODEL	Meter: SMP2 Probe: WP400
IDENTIFICATION	Meter: xxxxxx Probe: xxxxxx
APPLICANT	Wavecontrol C/ Pallars 65-71 08018 Barcelona
DATE/S OF CALIBRATION	DD/MM/YYYY

Authorized Signatories:

Date of issue: DD/MM/YYYY

Àlex Clusa
Laboratory Manager

Laurent Derousseau
Technical Director

This certificate is issued in accordance with the conditions of accreditation granted by ENAC, according to standard ISO 17025, which has assessed the measurement capability of the laboratory and its traceability to national and international standards.
ENAC is one of the signatories of the Multilateral Agreement of the European Cooperation for Accreditation (EA) and the International Laboratories Accreditation Cooperation (ILAC).

Measurement:

The calibration of a magnetic or electric field meter is done by introducing the probe into a nearly uniform magnetic or electric field of known magnitude and direction.

To calibrate the magnetic field sensor a Helmholtz coil system is used to generate the low frequency nearly uniform magnetic field needed.

To calibrate the electric field sensor a parallel plates system, energized with a centre-tapped transformer, is used.

In both cases, the probe is positioned on a low reflectivity mount inside the nearly uniform field area. The probe axis under test is placed perpendicular to the direction of the magnetic field when calibrating the magnetic field, and parallel to the electric field when calibrating the electric field.

Three calibration parameters are obtained:

1- Correction factor (CF)

For each measurement, the input power to the test facility is adjusted so that the actual field strength is set to a specific value. The field strength indicated by the probe under calibration is then read and the correction factor calculated using the following definition:

$$CF = \frac{Actual\ Field\ Strength}{Indicated\ Field\ Strength} \qquad CF^2 = \frac{Actual\ Power\ Density}{Indicated\ Power\ Density}$$

The indicated field strength must be multiplied by the appropriate correction factor to give the actual field strength.

2- Linearity

The linearity can be calculated as the variation of the Correction Factor as a function of the field strength applied to the probe for a frequency value.

3- Frequency response

The frequency response can be calculated as the variation of the Correction Factor as a function of the frequency for a fixed field value applied to the probe.

Traceability:

Swarzbeck Mess – Elektronik
PTB (Physikalisch-Technische Bundesanstalt)
Metaltest
LME – CIRCE
AT4 Wireless
Siemsa-Trescal

Reference standards:

IEC 61786-2013 "Measurement of low-frequency magnetic and electric fields with regard to exposure of human beings – Special requirements for instruments and guidance for measurements".

Uncertainties:

The uncertainty of calibration for this device is as follows:

Electric field:	**10 Hz – 100 kHz:**	**± 2.71 %**
	100 – 400 kHz:	**± 3.33 %**
Magnetic field:	**10 Hz – 3 kHz:**	**± 2.53 %**
	3 – 100 kHz:	**± 2.53 %**

The measurement uncertainties above apply only when the probe is supported in a low reflectivity mount. The user should be aware of the effects of reflections from nearby objects, including human body, and should allow additional measurement uncertainties accordingly.

The reported expanded uncertainty is based on a standard uncertainty multiplied by a coverage factor $k = 2$, providing a level of confidence of approximately 95 %. The uncertainty evaluation has been carried out in accordance with the EA-4/02 document.

Environmental conditions:

Humidity	Temperature
(56.9 ± 0.5) % rH	(23.1 ± 0.6) ºC

The results and uncertainties relate to the on-the-day values and make no allowance for drift or operation under other environmental conditions.

Procedure:

PC-1104 – Calibration of ELF electric field probes in the range 1 Hz – 400 kHz.
PC-1207 – Calibration of ELF magnetic field probes in the range 10 Hz – 200 kHz.

Calibration engineer: Álvaro Granero

Calibration set-up:

The position of the probe inside the electric and magnetic field calibration systems is specified in Figure 1 and Figure 2 respectively.

The axis under test is placed perpendicular to the direction of the magnetic field when calibrating the magnetic field, and parallel to the electric field when calibrating the electric field. The probe is placed in the 1% field uniformity zone of the field generator.

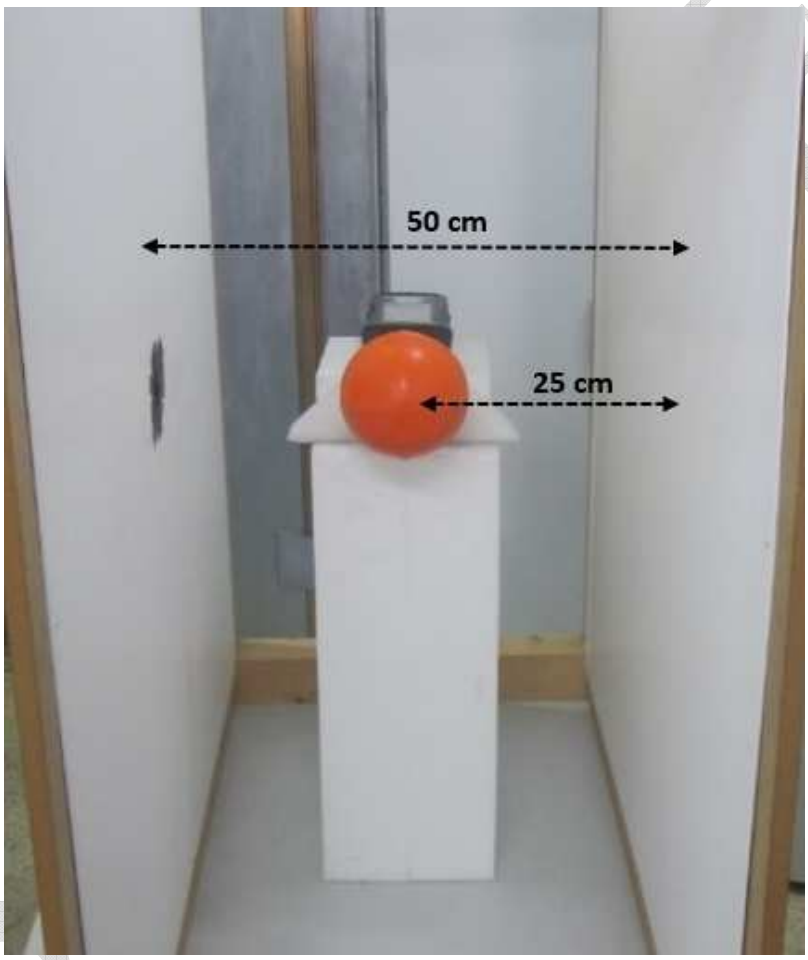

Figure 1: Calibration set-up in the parallel plates system – E field

Figure 2: Calibration set-up in the Helmholtz coils system – B field

Results:

The correction factors (CF) for the electric and magnetic field calibrations.

The correction factors for each axis and the average correction factor are given. This average correction factor must be applied to the measured value for the total field. The average correction factor is the arithmetic mean of the correction factors for the three axes.

The correction factors given below must be multiplied by the measured value for the field in order to obtain the actual field value:

1. Electric field

Linearity - 50 Hz					
E field (V/m)		X axis CF	Y axis CF	Z axis CF	Mean CF
800		1.00	1.00	1.00	1.00
750		1.00	1.00	1.00	1.00
500		1.00	1.00	1.00	1.00
250		1.00	1.00	1.00	1.00
100		1.00	1.00	1.00	1.00
50		1.00	1.00	1.00	1.00
10		1.00	1.00	0.99	1.00

Frequency response 10Hz-100kHz: 750V/m / 200-400kHz: 300V/m					
Frequency (Hz)		X axis CF	Y axis CF	Z axis CF	Mean CF
10		1.00	1.00	1.00	1.00
25		1.00	1.00	1.00	1.00
50		1.00	1.00	1.00	1.00
100		1.00	1.00	1.00	1.00
500		1.00	1.00	1.00	1.00
1 000		1.00	1.00	1.00	1.00
2 000		1.00	1.00	1.00	1.00
10 000		1.00	1.00	1.00	1.00
100 000		1.02	1.02	1.02	1.02
200 000		1.04	1.05	1.04	1.04
300 000		1.08	1.09	1.08	1.08
400 000		1.13	1.14	1.14	1.14

2. Magnetic field

Linearity - 50 Hz					
B field (uT)		X axis CF	Y axis CF	Z axis CF	Mean CF
2 000		1.00	1.00	1.00	1.00
1 500		1.00	1.00	1.00	1.00
1 000		1.00	1.00	1.00	1.00
750		1.00	1.00	1.00	1.00
500		1.00	1.00	1.00	1.00
250		1.00	1.01	1.00	1.00
100		1.00	1.00	1.00	1.00
50		1.00	1.00	1.00	1.00
10		1.00	1.00	1.00	1.00
5		1.00	1.01	1.00	1.00

Frequency response 10Hz-2kHz: 100uT / 10-200kHz: 25uT					
Frequency (Hz)		X axis CF	Y axis CF	Z axis CF	Mean CF
10		1.00	1.00	1.00	1.00
30		1.00	1.00	0.99	1.00
50		1.00	1.00	1.00	1.00
100		1.01	1.00	1.00	1.00
500		1.00	1.00	1.01	1.00
1 000		1.00	1.01	1.00	1.00
2 000		1.01	1.00	0.99	1.00
10 000		1.00	1.01	1.00	1.00
100 000		1.03	1.04	1.03	1.03
200 000	($)	1.08	1.09	1.08	1.08

($): Measurements marked with this symbol are not covered by the scope of the Laboratory's accreditation. Nevertheless, these measurements are covered by LabCal´s traceability.