ENAC
CALIBRACIÓN
Nº 184/LC10.132

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

CERTIFICATE OF CALIBRATION

Number 19/04911

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: WPF40
IDENTIFICATION	Meter: 19SN1219 Probe: 19WP140136
APPLICANT	Wavecontrol C/ Pallars 65-71 08018 Barcelona
DATE/S OF CALIBRATION	27/11/2019, 28/11/2019

Authorized Signatories:

Date of issue: 28/11/2019

Signature Not Verified
Digitally signed by ALEJANDRO CLUSA MORENO
Date: 2019.11.28 14:52:14 CET
Reason: Wavecontrol
Location: Barcelona

Álvaro Granero
Laboratory Technician

Laboratory 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 field strength monitors involves the generation of a known linearly polarised electromagnetic field, approximating to a plane wave, into which the probe or sensor is placed.

Over the frequency range of 20 – 800 MHz, an absorber loaded TEM cell is used to generate the known field. The probe under test is positioned parallel to the electric field and perpendicular to the direction of propagation.

Over the frequency range of 800 MHz – 40 GHz the probe is positioned on a low reflectivity mount inside a microwave anechoic chamber on the bore sight of a linearly polarised horn antenna. The probe under test is always perpendicular to the direction of propagation and parallel to 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:

DARE Calibrations
NPL (National Physical Laboratory)
Applus Metrología

Reference standards:

IEEE Std 1309:2013 “Standard for Calibration of Electromagnetic Field Sensors and Probes, Excluding Antennas, from 9 kHz to 40 GHz”.

Uncertainties:

The uncertainty of calibration for this device is as follows:

20 MHz - 10 MHz:	**± 1.19 dB**
10 MHz - 300 MHz:	**± 1.33 dB**
300 MHz – 500 MHz:	**± 1.08 dB**
500 MHz - 800 MHz:	**± 1.46 dB**
800 MHz - 1 GHz:	**± 1.52 dB**
1 GHz - 2.5 GHz:	**± 1.50 dB**
2.5 GHz - 8 GHz:	**± 1.51 dB**
8 GHz - 18 GHz:	**± 1.82 dB**
18 GHz - 40 GHz:	**± 2.05 dB**

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
(48.7 ± 1.7) % rH	(22.8 ± 0.6) ºC

The uncertainties refer to the measured devices only. They relate to the on-the-day values and make no allowance for drift or operation under other environmental conditions.

Procedure:

PC-1205 – Calibration of electric field probes in the range 100 kHz – 800 MHz
PC-1206 – Calibration of electric field probes in the range 800 MHz – 18 GHz

Both methods follow the *Standard probe method*. A reference probe is used to measure and calibrate the field used for calibrating the probe under calibration.

Calibration engineer: Álvaro Granero

Calibration set-up:

Figure 1: Calibration set-up in the absorber loaded TEM cell

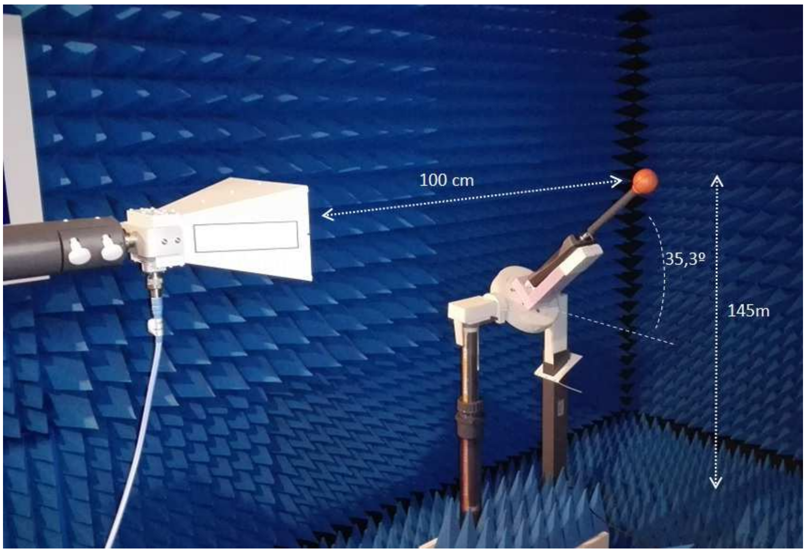

Figure 2: Calibration set-up in the anechoic chamber

The position of the probe inside the TEM cell is specified in Figure 1. The main axis of the probe is parallel to the cell walls.

The probe is positioned on the bore sight of the horn antenna inside the anechoic chamber, at the distance and height specified in Figure 2.

The position and orientation of the probe relative to the applied field to calibrate the 3 axis is specified in Figure 3.

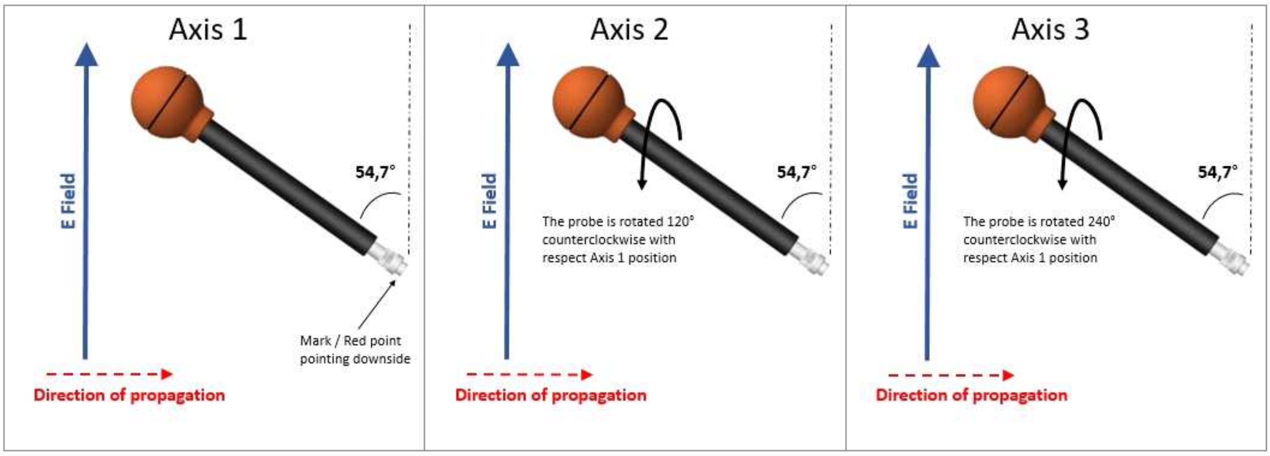

Figure 3: Position and orientation of the probe

Results:

The correction factors (CF) for the requested calibration points are shown below.

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:

Linearity						
Freq. (MHz)	Actual Field (V/m)		CF			
			Axis 1	Axis 2	Axis 3	Mean
100	2		0.86	0.86	0.86	0.86
100	5		0.86	0.86	0.87	0.86
100	10		0.86	0.87	0.87	0.87
100	20		0.88	0.88	0.86	0.87
100	30		0.90	0.90	0.90	0.90
100	40		0.92	0.92	0.91	0.91
100	50		0.89	0.89	0.88	0.89
100	60		0.86	0.86	0.85	0.86
100	80		0.88	0.88	0.87	0.88
100	100		0.89	0.88	0.88	0.88

Frequency response						
Freq. (MHz)	Actual Field (V/m)		CF			
			Axis 1	Axis 2	Axis 3	Mean
20	10		0.89	0.89	0.91	0.90
30	10		0.92	0.90	0.94	0.92
100	10		0.87	0.87	0.87	0.87
200	10		0.84	0.86	0.85	0.85
400	10		0.81	0.81	0.79	0.80
600	10		0.87	0.95	0.94	0.92
700	10		0.84	0.82	0.80	0.82
800	10		0.84	0.87	0.81	0.84
1000	10		0.87	0.86	0.85	0.86
1200	10		0.84	0.87	0.88	0.86
1400	10		0.87	0.86	0.90	0.88
1600	10		0.83	0.87	0.86	0.85
1800	10		0.92	0.96	0.90	0.93
2000	10		0.96	1.00	0.94	0.97
2200	10		0.92	0.94	0.88	0.91
2400	10		0.91	0.94	0.93	0.93
2600	10		0.88	0.88	0.89	0.88
2800	10		0.91	0.93	0.97	0.94
3000	10		0.95	0.99	0.98	0.97
3200	10		0.94	0.98	0.94	0.95
3400	10		0.92	0.96	0.90	0.93
3600	10		0.99	1.00	0.99	0.99
3800	10		1.03	1.07	1.06	1.05
4000	10		0.94	0.97	0.96	0.96
4250	10		0.87	0.88	0.91	0.89
4500	10		0.86	0.88	0.89	0.88
4750	10		1.00	1.06	1.03	1.03
5000	10		0.95	0.99	0.96	0.97
5250	10		0.87	0.84	0.86	0.86
5500	10		0.92	0.92	0.94	0.93
5750	10		0.90	0.96	0.94	0.93
6000	10		0.84	0.87	0.83	0.85
6250	10		0.88	0.87	0.85	0.87
6500	10		1.09	1.13	1.17	1.13
6750	10		0.99	0.99	1.00	0.99
7000	10		0.84	0.85	0.83	0.84
7250	10		0.89	0.95	0.86	0.90
7500	10		1.08	1.12	1.11	1.10
7750	10		0.97	0.96	0.98	0.97
8000	10		0.85	0.85	0.85	0.85
10000	10		0.86	0.92	0.88	0.89
12000	10		0.88	0.93	0.93	0.91
14000	10		0.95	0.91	0.87	0.91
16000	10		0.80	0.83	0.92	0.85
18000	10		0.84	0.86	0.85	0.85
26500	10	($)	1.06	1.03	1.04	1.04
40000	10	($)	2.13	2.02	2.19	2.11

($): 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.

The following values summarise the Linearity and Frequency response uncertainties of the calibrated device. These values can be used to calculate the total uncertainty of the measurements realised with the calibrated device:

	Linearity error	
±	0.29	dB (2 – 100 V/m)

Frequency response					
+	1.91	/	-	0.44	dB (1 MHz – 5 GHz)
+	1.50	/	-	1.06	dB (5 – 18 GHz)