CERTIFICATE OF CALIBRATION

Number 18/0XXXX

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)

ITEM	EM Field Meter + Isotropic EM Field Probe
BRAND	Wavecontrol
MODEL	Meter: SMP2 Probe: WPF18
IDENTIFICATION	Meter: 17SN0XXX Probe: 18WP090XXX
APPLICANT	Wavecontrol C/ Pallars 65-71 08018 Barcelona
DATE/S OF CALIBRATION	09/01/2018

Authorized Signatories:

Date of issue: 10/01/2018

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 0.3 – 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 – 18 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:

0.3 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**

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
(45.4 ± 1.1) % rH	(22.4 ± 0.7) 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

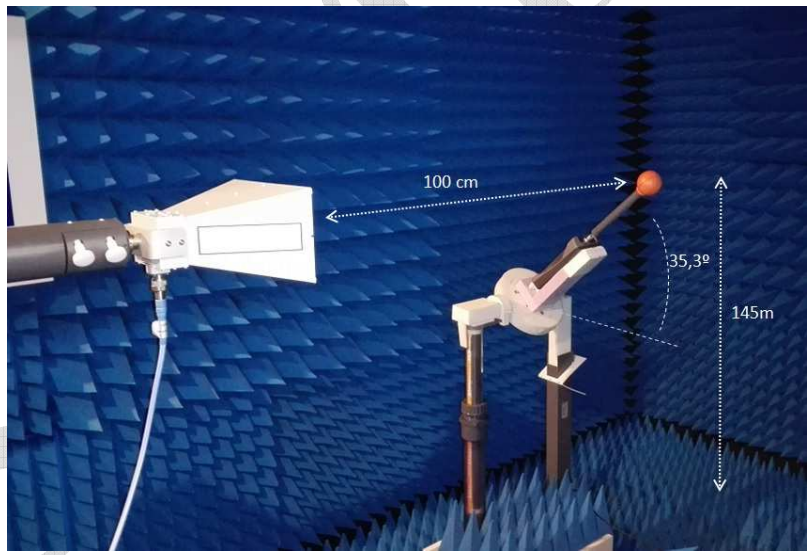

Figure 2: Calibration set-up in the anechoic chamber

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.

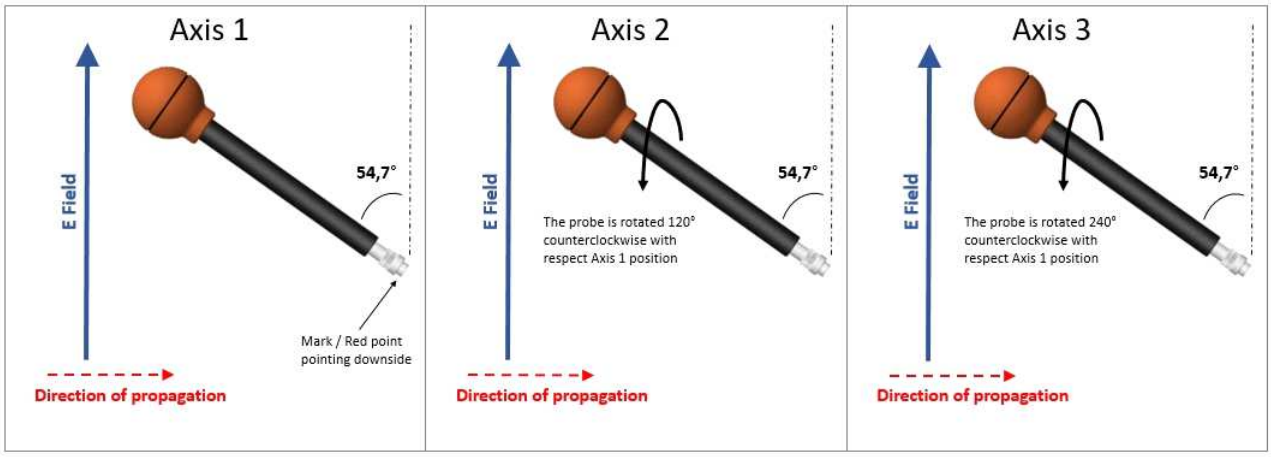

Figure 3: Position and orientation of the probe

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 - 100 MHz				
E field (V/m)	Axis 1	Axis 2	Axis 3	Mean
	CF	CF	CF	CF
1	0.98	0.95	0.97	**0.97**
2.5	0.95	0.94	0.95	**0.95**
5	0.96	0.96	0.96	**0.96**
10	0.96	0.96	0.95	**0.96**
20	0.97	0.97	0.96	**0.96**
30	0.99	0.99	0.98	**0.98**
40	0.95	0.95	0.95	**0.95**
50	0.97	0.97	0.97	**0.97**
60	0.98	0.99	0.98	**0.98**
80	0.98	0.98	0.97	**0.97**
100	0.96	0.96	0.95	**0.96**

Frequency response - 10 V/m				
Freq. (MHz)	Axis 1	Axis 2	Axis 3	Mean
	CF	CF	CF	CF
0.3	1.65	1.80	1.82	**1.76**
0.5	1.37	1.45	1.45	**1.42**
1	1.18	1.21	1.20	**1.20**
10	0.96	0.96	0.96	**0.96**
30	0.96	0.96	0.95	**0.96**
100	0.96	0.96	0.95	**0.96**
200	0.93	0.94	0.94	**0.93**
400	0.84	0.82	0.82	**0.83**
600	0.90	0.95	0.95	**0.94**
700	0.85	0.85	0.84	**0.84**
800	0.87	0.88	0.83	**0.86**
1000	0.93	0.90	0.91	**0.91**
1200	0.90	0.89	0.91	**0.90**
1400	0.99	0.95	1.01	**0.98**
1600	0.94	0.95	0.95	**0.95**
1800	1.06	1.08	1.03	**1.06**
2000	1.06	1.06	1.00	**1.04**
2200	1.08	1.08	1.04	**1.06**
2400	1.05	1.04	1.04	**1.04**
2600	1.11	1.07	1.08	**1.09**
2800	1.15	1.10	1.15	**1.13**
3000	1.14	1.14	1.17	**1.15**
3200	1.22	1.22	1.21	**1.22**
3400	1.18	1.17	1.15	**1.17**
3600	1.24	1.26	1.21	**1.24**
3800	1.33	1.32	1.28	**1.31**
4000	1.23	1.17	1.20	**1.20**
4250	1.26	1.22	1.23	**1.24**
4500	1.24	1.21	1.23	**1.23**
4750	1.29	1.28	1.27	**1.28**
5000	1.32	1.35	1.32	**1.33**
5250	1.30	1.27	1.26	**1.28**
5500	1.33	1.26	1.27	**1.29**
5750	1.34	1.30	1.27	**1.31**
6000	1.22	1.24	1.22	**1.23**
6250	1.30	1.28	1.25	**1.28**
6500	1.57	1.55	1.58	**1.57**
6750	1.61	1.55	1.47	**1.54**
7000	1.31	1.27	1.29	**1.29**
7250	1.39	1.31	1.29	**1.33**
7500	1.58	1.64	1.58	**1.60**
7750	1.52	1.50	1.41	**1.48**
8000	1.40	1.20	1.23	**1.28**
10000	1.32	1.38	1.35	**1.35**
12000	1.83	1.74	1.76	**1.78**
14000	1.22	1.24	1.22	**1.23**
16000	1.40	1.48	1.54	**1.47**
18000	1.79	1.56	1.74	**1.70**

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 at 100 MHz		
±	0.16	dB (1 - 100 V/m)

Frequency response at 10 V/m				
+	1.66	/ -	2.49	dB (1 MHz - 5 GHz)
+	0.00	/ -	4.99	dB (5 - 18 GHz)