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LCIE

Rapport d'essai / Test report

N° 275423-R3-E

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DELIVRE A / ISSUED TO

: SOLEM
ZAE LA PLAINE
5 rue Georges Besse
34830 CLAPIERS - FRANCE

Objet / Subject

: Essais de compatibilité électromagnétique conformément aux normes
FCC CFR 47 Part 15, Subpart B et C.
*Electromagnetic compatibility tests according to the standards
FCC CFR 47 Part 15, Subpart B and C*

Matériel testé / Apparatus under test

- Produit / Product : **RF WATERING SYSTEM**
- Marque / Trade mark : **RAIN BIRD**
- Constructeur / Manufacturer : **SOLEM**
- Type / Model : **TBOSII-RADIO ADAPTATOR**
- N° de série / serial number : **302**
- FCCID : **YWW-TBOS2ADUS1**

Date des essais / Test date

: Du 1er au 14 Décembre 2011 / *From December 01st to 14th, 2011*

Lieu d'essai / Test location

: **LCIE SUD-EST**
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38430 MOIRANS - FRANCE

Test réalisé par / Test performed by

: Anthony MERLIN / Nicolas BILLAUD

Ce document comporte / Composition of document : 23 pages.

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MOIRANS, LE 9 JANVIER 2012 / *JANUARY 9th, 2012*

Approuvé par / *Approved by*,
Jacques LORQUIN

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1. TEST PROGRAM

Standard: - FCC Part 15, Subpart C 15.247
- ANSI C63.4 (2003)

EMISSION TEST	LIMITS			RESULTS (Comments)
Limits for conducted disturbance at mains ports 150kHz-30MHz	Frequency	Quasi-peak value (dBμV)	Average value (dBμV)	NA
	150-500kHz	66 to 56	56 to 46	
	0.5-5MHz	56	46	
	5-30MHz	60	50	
Radiated emissions 9kHz-30MHz	Measure at 300m 9kHz-490kHz : 67.6dBμV/m /F(kHz) Measure at 30m 490kHz-1.705MHz : 87.6dBμV/m /F(kHz) 1.705MHz-30MHz : 29.5 dBμV/m			PASS
Radiated emissions 30MHz-10GHz*	Measure at 3m 30MHz-88MHz : 40 dBμV/m 88MHz-216MHz : 43.5 dBμV/m 216MHz-960MHz : 46.0 dBμV/m Above 960MHz : 54.0 dBμV/m			PASS
Bandwidth 6dB 15.247 (a) (2)	At least 500kHz			PASS
Maximum Peak Output Power 15.247 (b)	Limit: 30dBm Conducted or Radiated measurement			PASS
Band Edge Measurement 15.247 (d)	Limit: -20dBc or Radiated emissions limits in restricted bands			PASS
Power spectral Density 15.247 (e)	Limit: 8dBm/3kHz			PASS

***§15.33:** The highest internal source of a testing device is defined like more the highest frequency generated or used in the testing device or on which the testing device works or agrees.

- If the highest frequency of the internal sources of the testing device is lower than 108 MHz, measurement must be only performed until 1GHz.
- If the highest frequency of the internal sources of the testing device ranges between 108 MHz and 500 MHz, measurement must be only performed until 2GHz.
- If the highest frequency of the internal sources of the testing device ranges between 500 MHz and 1 GHz, measurement must be only performed until 5GHz.

If the highest frequency of the internal sources of the testing device is above 1 GHz, measurement must be only performed until 5 times the highest frequency or 40 GHz, while taking smallest of both.



2. SYSTEM TEST CONFIGURATION

2.1. JUSTIFICATION

The system was configured for testing in a typical fashion (as a customer would normally use it).

2.2. HARDWARE IDENTIFICATION

- **Equipment under test (EUT):**

TBOSII-RADIO ADAPTATOR

Internal max frequencies: 32MHz

Serial number: 302

- **Input/output:**

- Alkaline Battery 9VDC

- **Auxiliaries used for testing:**

- None

- **I/O cables used for testing:**

- None

- **Equipment information:**

- External antenna connector: NO, special EUT with connector for conducted tests.
- Radiated fundamental frequency band: [915.5-926.5]MHz, 12 channels
- Antenna type: Integral
- Stand By mode: Yes
- Normal power source: battery 9VDC.
- Modulation Type: FSK +/- 140kHz
- Modulation Technology: DSSS
- Transfer rate: 38400 bps
- Maximum Antenna Gain: 0 dBi



2.3. EUT CONFIGURATION

A special configuration of the EUT permits:

- | | |
|--|----------------|
| - Permanent emission of the carrier frequency with modulation | – TX mode |
| - Permanent emission of the carrier frequency without modulation | – TX mode |
| - Permanent reception of the carrier frequency | – RX mode |
| - Carrier frequency OFF | – Standby mode |

2.4. EQUIPMENT MODIFICATIONS

None

2.5. SPECIAL ACCESSORIES

None

3. RADIATED EMISSION DATA

3.1. CLIMATIC CONDITIONS

Test performed by	: A.MERLIN / N.BILLAUD	
Date of test	: December 01 st , 2011 and	December 06 th , 2011
Ambient temperature	: 24.1C	21.9°C
Relative humidity	: 30%	33%

3.2. TEST SETUP

The installation of EUT is identical for pre-characterization measurement in a 3 meters semi anechoic chamber and for measures on a 10 meters Open site.



**3.3. DIVERGENCE, ADDITION OR SUPPRESSION ON THE TEST SPECIFICATION**

None

3.4. TEST SEQUENCE AND RESULTS**3.4.1. Pre-characterization at 3 meters [9kHz-30MHz]**

A pre-scan of all the setup has been performed in a 3 meters semi anechoic chamber. The distance between EUT and antenna is 3 meters. For Pre-characterization, the loop antenna was rotated during the test for maximized the emission measurement. Measurement performed on 3 axis of EUT. Frequency band investigated is 9kHz to 30MHz.

The pre-characterization graphs are obtained in PEAK detection.

See graph for 9kHz-30MHz band: **Emr#1** (See annex 1)

3.4.2. Pre-characterization [30MHz-12GHz]

For frequency band 30MHz to 1GHz, a pre-scan of all the setup has been performed in a 3 meters semi anechoic chamber.

The distance between EUT and antenna is 3 meters. Test is performed in horizontal (H) and vertical (V) polarization with a log-periodic antenna. The EUT is being rotated on 360° and on 3 axis during the measurement. The pre-characterization graphs are obtained in PEAK detection.

For frequency band 1GHz to 12GHz, a search is performed in the semi-anechoic chamber in order to determine frequencies radiated by the EUT.

See graphs for 30MHz-1GHz:

H polarization **Emr#2** (See annex 1)
V polarization **Emr#3** (See annex 1)

3.4.3. Characterization on 10 meters open site below 30 MHz

The product has been tested according to ANSI C63.4 (2003), FCC part 15 subpart C. Radiated Emissions were measured on an open area test site. A description of the facility is on file with the FCC.

The product has been tested at a distance of **10 meters** from the antenna and compared to the FCC part 15 subpart C §15.109 limits and C §15.209.

Antenna height was 1m for both horizontal and vertical polarization.

Antenna was rotated around its vertical axis.

Continuous linear turntable azimuth search was performed with 360 degrees range. Measurement performed on 3 axis of EUT. A summary of the worst case emissions found in all test configurations and modes is shown in following tables.

Frequency (MHz)	QPeak Limit (dBµV/m) @ 30m	Qpeak (dBµV/m)	Qpeak-Limit (Margin dB)	Turntable Angle (deg)	Ant. Pol./ Angle (deg)	Tot Corr (dB)
No frequency observed						

*: Measure have been done at 10m distance and corrected according to requirements of 15.209.e) ($M@30m = M@10m - 19.1dB$)



3.4.4. Characterization on 10 meters open site from 30MHz to 12GHz

The product has been tested at a distance of **10 meters** from the antenna and compared to the FCC part 15 subpart B §15.109 limits and C §15.209 limits. Measurement bandwidth was 120kHz from 30 MHz to 1GHz and 1MHz from 1GHz to 12GHz.

Antenna height search was performed from 1m to 4m for both horizontal and vertical polarization. Continuous linear turntable azimuth search was performed with 360 degrees range. Measurement performed on 3 axis of EUT.

A summary of the worst case emissions found in all test configurations and modes is shown on clause 3.2

Worst case final data result:

No	Frequency (MHz)	QPeak Limit (dBµV/m)	Qpeak * (dBµV/m)	Qpeak-Limit (Margin, dB)	Angle (deg)	Pol	Hgt (cm)	Tot Corr (dB)	Comments
No frequency observed									

*: Measure have been done at 10m distance and corrected according to requirements of 15.209.e)
(M@3m = M@10m+10.5dB)

Frequency band 1GHz to 12GHz

Measurements are performed using a PEAK and Average detection. (RBW = 1MHz)

Carrier frequency: 915.5MHz

N°	Frequency (GHz)	Limite Peak (dBµV/m)	Mesure Peak (dBµV/m)	Margin (Mes-Lim) (dB)	Limite Average (dBµV/m)	Mesure Average (dBµV/m)	Margin (Mes-Lim) (dB)	Angle Table (deg)	Pol Ant.	Ht Ant. (cm)	Correc. Factor (dB)	AXIS
1	1831.00	74.00	61.93	-12.07	54.00	OORB	OORB	0	V	100	-3.50	Z
2	2746.50	74.00	57.58	-16.42	54.00	49.66	-4.34	0	V	100	-0.90	Z
3	3662.00	74.00	51.25	-22.75	54.00	45.33	-8.67	0	V	100	1.10	Z
4	4577.50	74.00	51.70	-22.30	54.00	39.74	-14.26	0	H	100	2.50	Z
5	5493.00	74.00	56.20	-17.80	54.00	OORB	OORB	0	V	100	5.40	Z
6	6408.50	74.00	54.91	-19.09	54.00	OORB	OORB	0	V	100	5.80	Z

OORB: Out Of Restricted Band

Carrier frequency: 921.5MHz

N°	Frequency (GHz)	Limite Peak (dBµV/m)	Mesure Peak (dBµV/m)	Margin (Mes-Lim) (dB)	Limite Average (dBµV/m)	Mesure Average (dBµV/m)	Margin (Mes-Lim) (dB)	Angle Table (deg)	Pol Ant.	Ht Ant. (cm)	Correc. Factor (dB)	AXIS
1	1843.00	74.00	62.46	-11.54	54.00	OORB	OORB	0	V	100	-3.40	Z
2	2764.50	74.00	56.00	-18.00	54.00	49.99	-4.01	10	V	100	-0.80	Z
3	3686.00	74.00	50.51	-23.49	54.00	46.62	-7.38	10	V	100	1.60	Z
4	4607.50	74.00	51.05	-22.95	54.00	42.22	-11.78	10	H	100	2.50	Z
5	5529.00	74.00	55.00	-19.00	54.00	OORB	OORB	0	H	100	5.40	Z
6	6450.50	74.00	54.83	-19.17	54.00	OORB	OORB	0	V	100	5.80	Z

OORB: Out Of Restricted Band



Carrier frequency: 926.5MHz

N°	Frequency (GHz)	Limite Peak (dBμV/m)	Mesure Peak (dBμV/m)	Margin (Mes-Lim) (dB)	Limite Average (dBμV/m)	Mesure Average (dBμV/m)	Margin (Mes-Lim) (dB)	Angle Table (deg)	Pol Ant.	Ht Ant. (cm)	Correc. Factor (dB)	AXIS
1	1853.00	74.00	61.98	-12.02	54.00	OORB	OORB	10	V	100	-3.30	Z
2	2779.50	74.00	55.31	-18.69	54.00	51.12	-2.88	10	V	100	-0.80	Z
3	3706.00	74.00	49.77	-24.23	54.00	47.67	-6.33	10	V	100	1.60	Z
4	4632.50	74.00	50.99	-23.01	54.00	42.69	-11.31	10	H	100	2.50	Z
5	5559.00	74.00	54.79	-19.21	54.00	OORB	OORB	10	H	100	5.40	Z
6	6485.50	74.00	56.57	-17.43	54.00	OORB	OORB	30	V	100	5.80	Z

OORB: Out Of Restricted Band

Note: Measures have been done at 3m distance.

RESULTS: PASS

3.5. FIELD STRENGTH CALCULATION

The field strength is calculated by adding the Antenna Factor and Cable Factor, and subtracting the Amplifier Gain (if any) from the measured reading. The basic equation with a sample calculation is as follow:

$$FS = RA + AF + CF - AG$$

Where
 FS = Field Strength
 RA = Receiver Amplitude
 AF = Antenna Factor
 CF = Cable Factor
 AG = Amplifier Gain

Assume a receiver reading of 52.5dBμV is obtained. The antenna factor of 7.4 and a cable factor of 1.1 are added. The amplifier gain of 29dB is subtracted, giving a field strength of 32 dBμV/m.

$$FS = 52.5 + 7.4 + 1.1 - 29 = 32 \text{ dB}\mu\text{V/m}$$

The 32 dBμV/m value can be mathematically converted to its corresponding level in μV/m.

$$\text{Level in } \mu\text{V/m} = \text{Common Antilogarithm } [(32\text{dB}\mu\text{V/m})/20] = 39.8 \mu\text{V/m}.$$



4. BANDWIDTH (15.247)

4.1. TEST CONDITIONS

Test performed by : A.MERLIN / N.BILLAUD
Date of test : December 09th, 2011
Ambient temperature : 24.0°C
Relative humidity : 32%
Atmospheric pressure : 996mb

4.2. LIMIT

The 6 dB bandwidth must be greater than 500 kHz.

4.3. SETUP

Conducted measurement:

The EUT is turned ON and connected to measurement instrument; the center frequency of the spectrum analyzer is set to the fundamental frequency and using 100kHz RBW and VBW>RBW, the span greater than RBW.

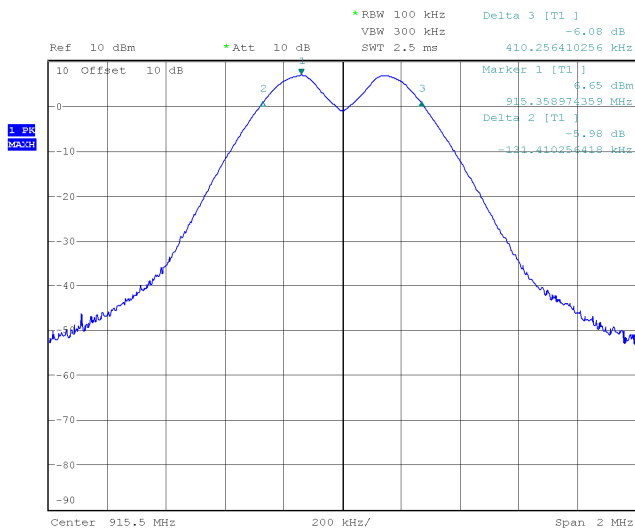
The captured power is measured and recorded; the measurement is repeated until all frequencies required were complete.

4.4. DIVERGENCE, ADDITION OR SUPPRESSION ON THE TEST SPECIFICATION

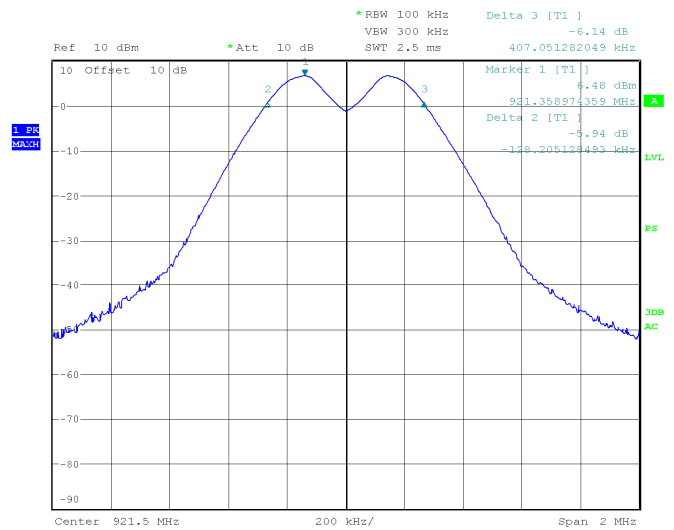
None

4.5. RESULTS

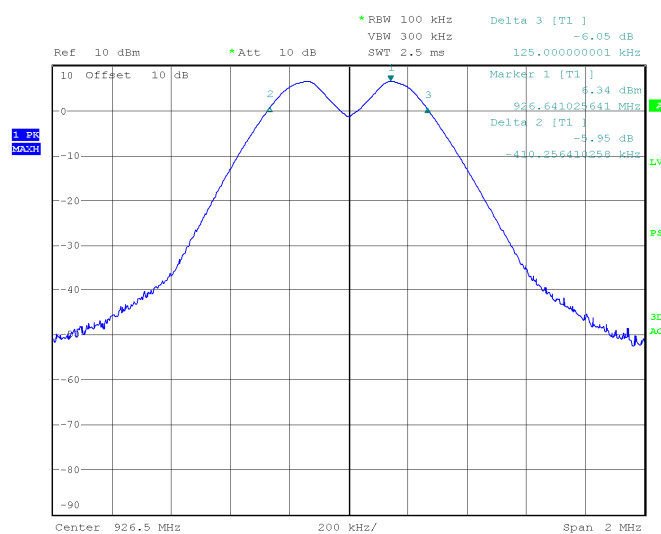
Channel Frequency (MHz)	6dB Bandwidth (kHz)	PASS / FAIL
915.500	541	PASS
921.500	535	PASS
926.500	536	PASS



Lower frequency



Middle frequency



Upper frequency



5. MAXIMUM PEAK OUTPUT POWER (15.247)

5.1. TEST CONDITIONS

Test performed by : A.MERLIN / N.BILLAUD
Date of test : December 09th, 2011
Ambient temperature : 24.0°C
Relative humidity : 32%
Atmospheric pressure : 996mb

5.2. EQUIPMENT CONFIGURATION

Modulation: FSK

5.3. SETUP

Conducted measurement:

The EUT is turned ON and connected to measurement instrument; the center frequency of the spectrum analyzer is set to the fundamental frequency and using 1MHz RBW and 3MHz VBW (greater than 6dB bandwidth)

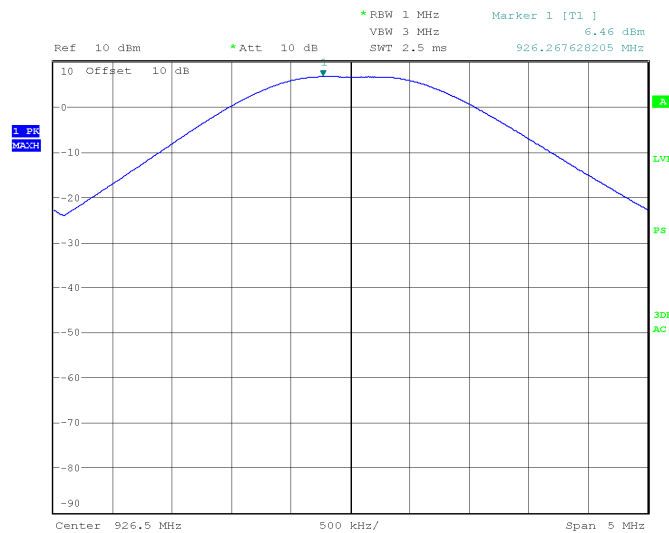
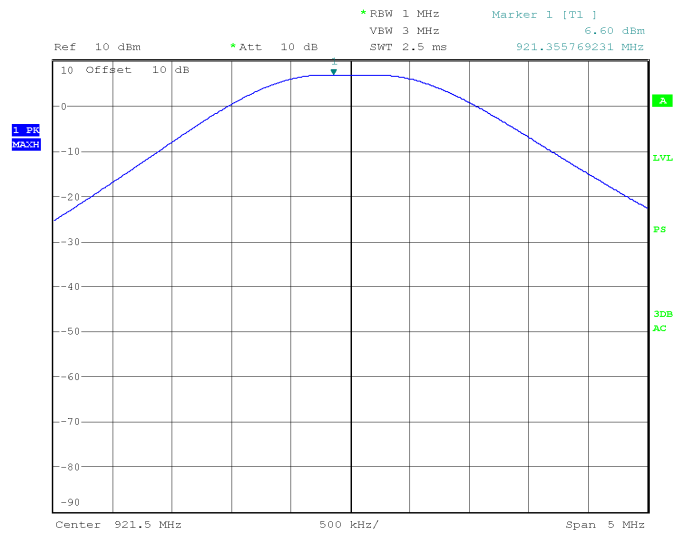
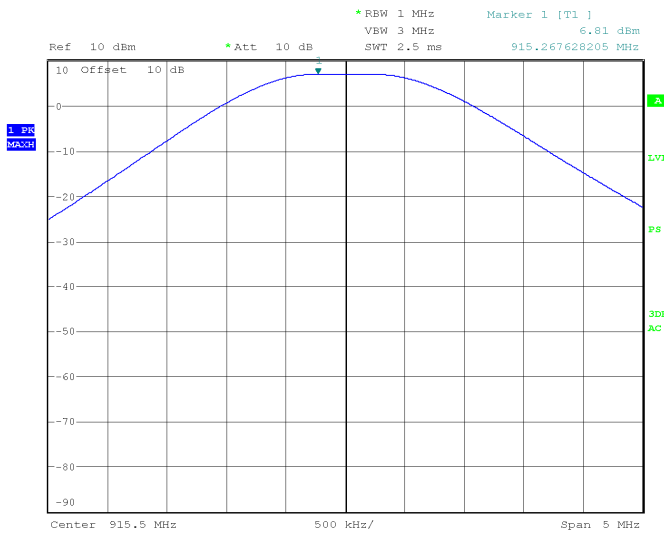
The captured power is measured and recorded; the measurement is repeated until all frequencies required were complete.

5.4. DIVERGENCE, ADDITION OR SUPPRESSION ON THE TEST SPECIFICATION

None

Channel Frequency (MHz)	Peak Output Power (dBm)	Power Limit (dBm)	PASS / FAIL
915.500	6.8	30	PASS
921.500	6.6	30	PASS
926.500	6.5	30	PASS

Antenna Gain: 0dBi



**6. BAND EDGE MEASUREMENT (15.247)****6.1. TEST CONDITIONS**

Test performed by : A.MERLIN / N.BILLAUD
Date of test : December 14th, 2011
Ambient temperature : 24.5°C
Relative humidity : 31%

6.2. LIMIT***RF antenna conducted test:***

Set RBW = 100 kHz, Video bandwidth (VBW) > RBW, scan up through 10th harmonic. All harmonics/spurs must be at least 20 dB down from the highest emission level within the authorized band as measured with a 100 kHz RBW. Note: If the device complies with the use of power option 2 the attenuation under this paragraph shall be 30 dB instead of 20 dB.

Radiated emission test:

Applies to harmonics/spurs that fall in the restricted bands listed in Section 15.205. The maximum permitted average field strength is listed in Section 15.209. For measurements above 1 GHz, set RBW = 1MHz, VBW = 10 Hz, Sweep: Auto. If the emission is pulsed, modify the unit for continuous operation; use the settings shown above, then correct the reading by subtracting the peak-average correction factor, derived from the appropriate duty cycle calculation. See results in Radiated emissions section before.

6.3. EQUIPMENT CONFIGURATION

Modulation: FSK
Channel frequency: [915.5MHz-926.5]MHz

6.4. SETUP

The EUT is connected to measurement instrument; levels have been corrected to be in compliant with Peak Output Power measurement. The EUT is turn ON; the graphs of the restrict frequency band are recorded with a display line indicating the highest level and other the 20dB offset below to show compliance with 15.247 (d) and 15.205. The emissions in restricted bands are compared to 15.209 limits.

RBW: 100kHz

VBW: 300kHz

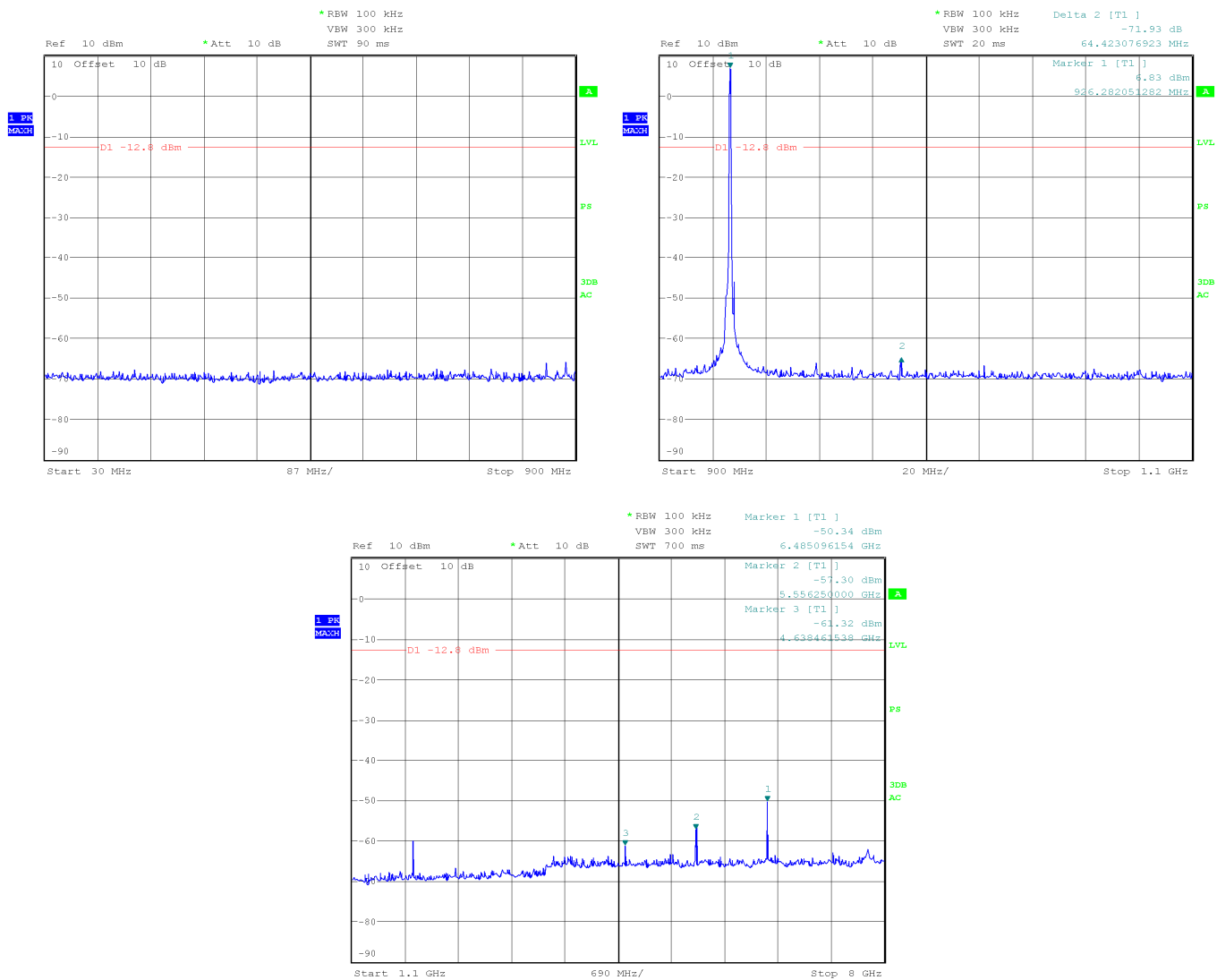
For measurements below 900MHz the carrier is set on 915.5MHz and for measurements upper than 1.1GHz to 10GHz the carrier is set on 926.5MHz.

Frequency range measured from 30MHz to 10GHz, no frequency observed above 8GHz.

6.5. DIVERGENCE, ADDITION OR SUPPRESSION ON THE TEST SPECIFICATION

None

6.6. RESULTS



**6.7. MEASUREMENT IN RESTRICTED BAND**

No	Frequency (MHz)	Peak Limit (dB μ V/m)	Peak (dB μ V/m)	Peak-Limit (Margin, dB)	Average Limit (dB μ V/m)	Average (dB μ V/m)	Average-Limit (Margin, dB)	Angle (deg)	Pol	Hgt (cm)	Tot Corr (dB)
1	4632.50	74.0	50.99	-23.0	54.0	42.69	-11.3	10	H	100	2.5

Measure has been done at 3m distance.



7. POWER SPECTRAL DENSITY (15.247)

7.1. TEST CONDITIONS

Test performed by : A.MERLIN / N.BILLAUD
Date of test : December 12th, 2011
Ambient temperature : 22.5°C
Relative humidity : 32%
Atmospheric pressure : 990mb

7.2. SETUP

Conducted measurement:

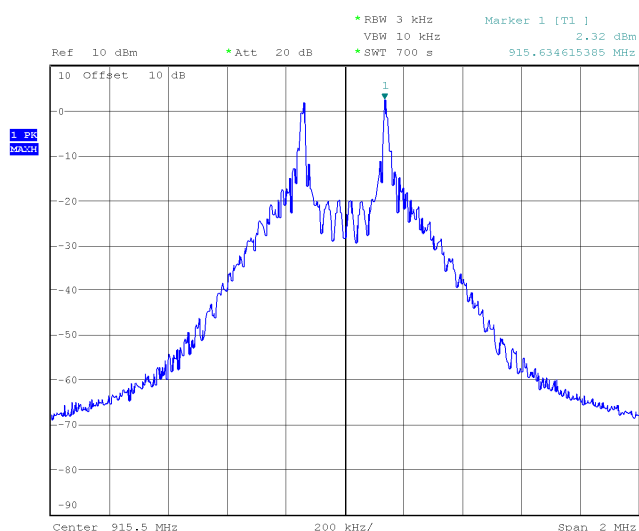
The EUT is turned ON and connected to measurement instrument; the center frequency of the spectrum analyzer is set to the fundamental frequency and using 3kHz RBW and VBW>RBW.

The captured power is measured and recorded; the measurement is repeated until all frequencies required were complete.

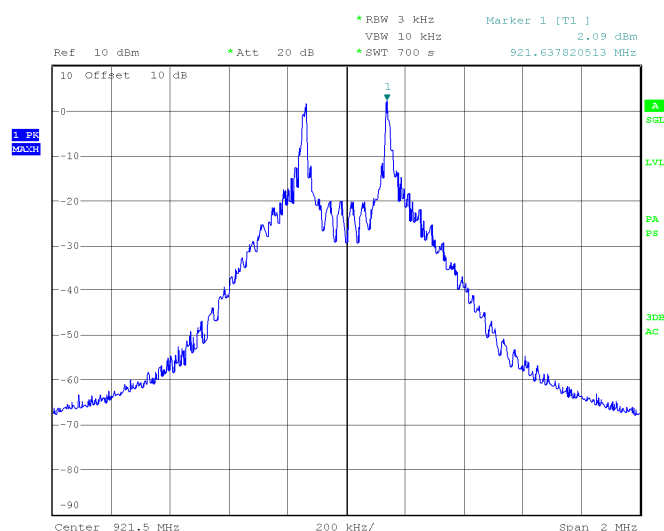
7.3. DIVERGENCE, ADDITION OR SUPPRESSION ON THE TEST SPECIFICATION

None

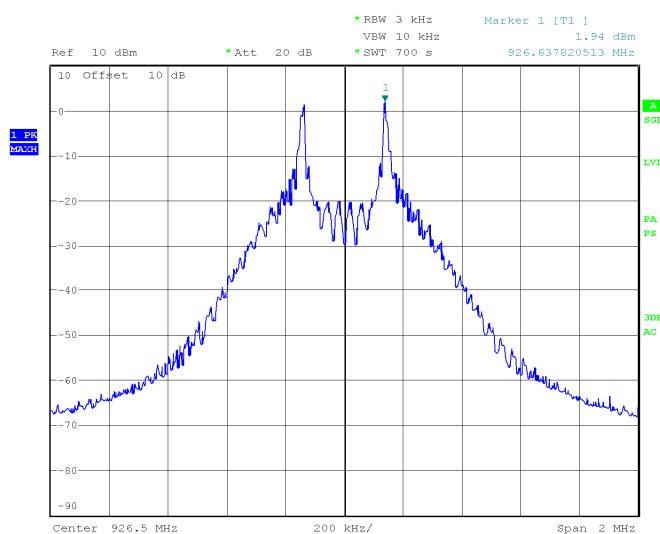
Channel Frequency (MHz)	Power Spectral Density (dBm)	PSD Limit (dBm)	PASS / FAIL
915.500	2.3	8	PASS
921.500	2.1	8	PASS
926.500	1.9	8	PASS



Lower frequency



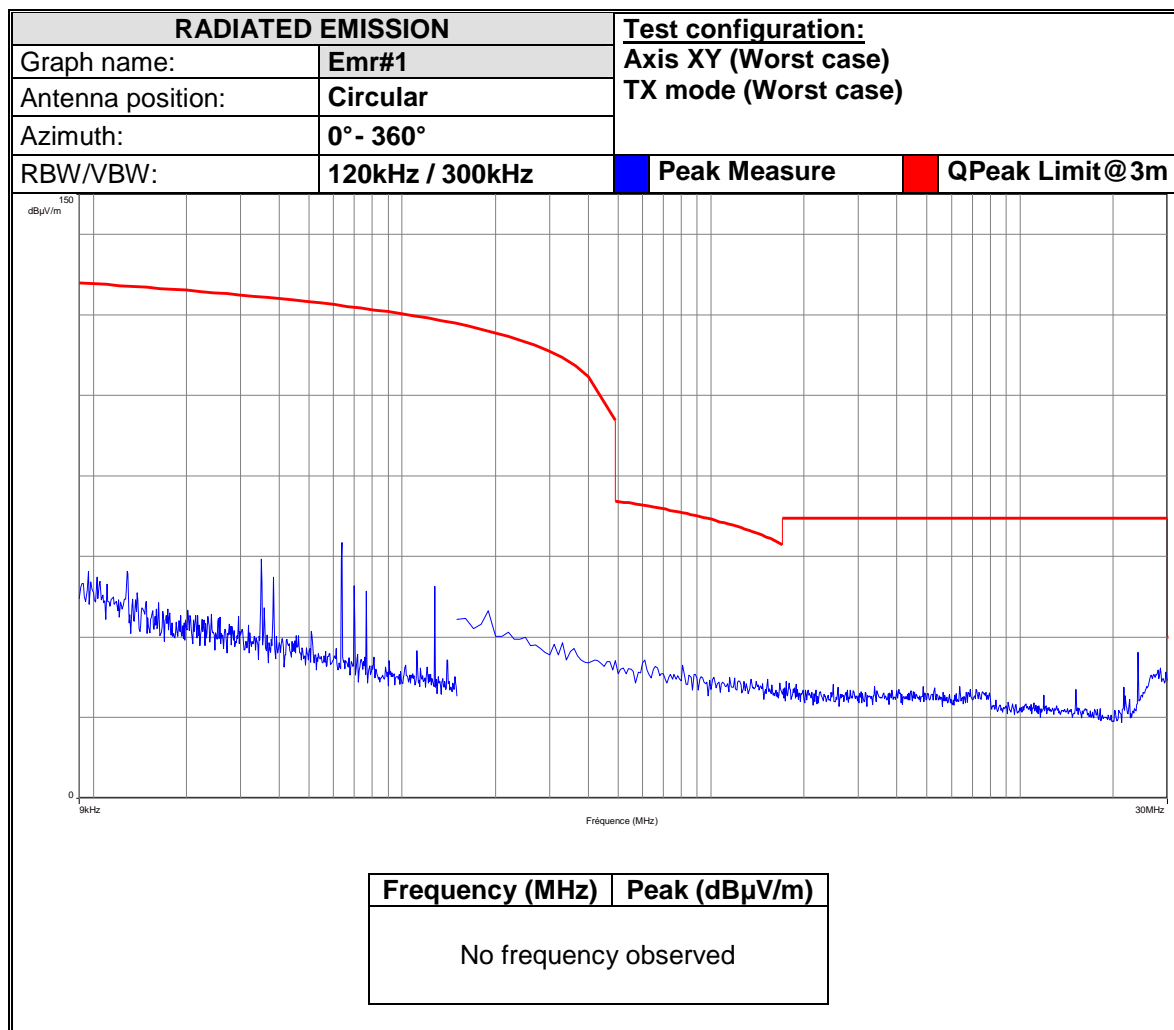
Middle frequency

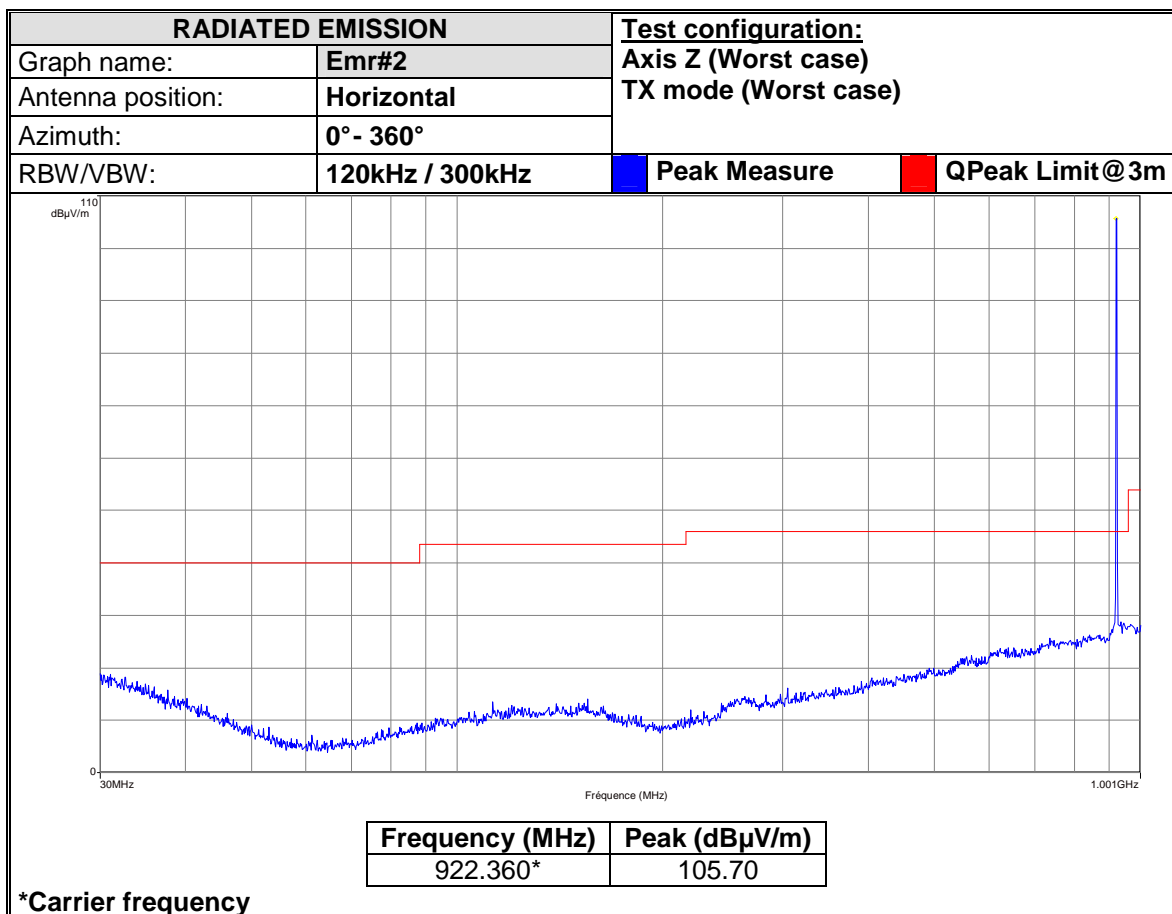


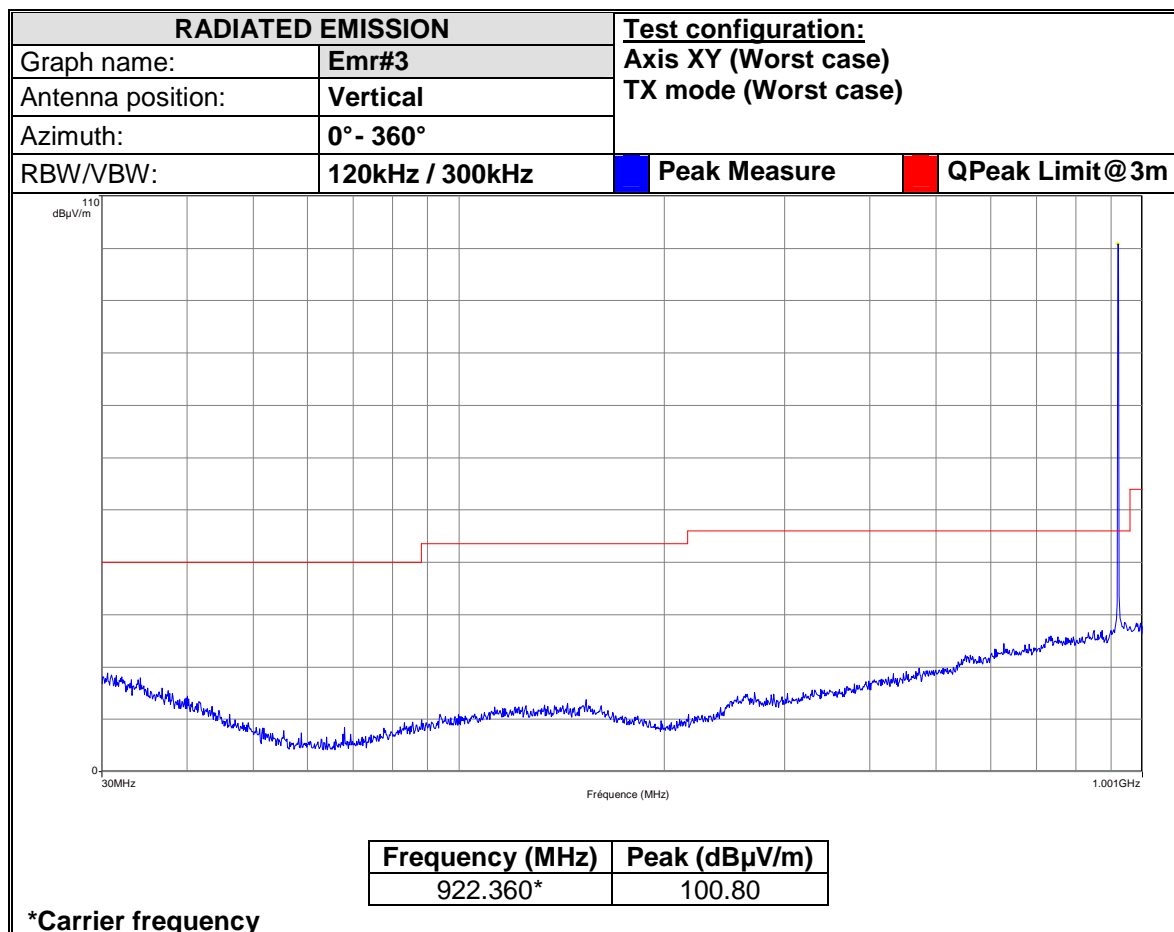
Upper frequency



8. ANNEX 1 (GRAPHS)









9. TEST EQUIPMENT LIST

USED	N° LCIE	TYPE	COMPANY	REF
CONDUCTED EMISSION DATA				
x	A5329198	Cable	-	-
x	D3044010	Faraday Cage	RAY PROOF	-
x	A3169049	Conducted emission comb generator	BARDET	-
x	C2320123	LISN	RHODE & SCHWARZ	ENV216
x	A2642019	Receiver 20Hz – 8GHz	ROHDE & SCHWARZ	ESU8
x	A4049061	Transient limiter	HEWLETT PACKARD	11947A
RADIATED EMISSION DATA				
x	A7085008	Amplifier 0.1MHz – 1300 MHz	HEWLETT PACKARD	8447D
x	A7102024	Amplifier 8 GHz	HEROTEK	A1080304A
x	A7102026	Amplifier 8-26GHz	ALDETEC	ALS01452
x	C2040051	Antenna Bi-log	CHASE	CBL6111A
x	C2040052	Antenna Loop	ELECTRO-METRICS	EM-6879
x	C2040146	Antenna Bi-Log XWing	TESEQ	CBL6144
x	C2042027	Antenna horn	EMCO	3115
x	A7122167	Attenuator 10dB 18GHz 2W	JFW	-
x	A5329038	Cable N/N	-	-
x	A5329061	Cable	SUCOFLEX	106G
x	A5329188	Cable OATS (Mast at 10m)	UTIFLEX	-
x	A5329199	Cable OATS (Mast at 10m)	UTIFLEX	-
x	A5329207	Cable	UTIFLEX	-
x	D3044015	Semi-Anechoic chamber #2	SIEPEL	-
x	D3044016	Semi-Anechoic chamber #1	SIEPEL	-
x	D3044017	Semi-Anechoic chamber #3	SIEPEL	-
x	A3169050	Radiated emission comb generator	BARDET	-
x	A7484035	High Pass (1-15GHz)	WAINRIGHT	WHKX 1.03/15G-10SS
x	F2000409	OATS	-	-
x	A7044055	Power supply DC	TDK	-
x	A2642019	Receiver 20Hz – 8GHz	ROHDE & SCHWARZ	ESU8
x	A4060018	Spectrum Analyzer 9KHz – 26.5GHz	HEWLETT PACKARD	8593E
x	B4204052	Thermo-hygrometer	HUGER	-
x	F2000371	Turntable chamber (Cage#3)	ETS Lingren	Model 2165
x	F2000372	Turntable / Mast controller (OATS)	ETS Lindgren	Model 2066
x	F2000392	Antenna mast (OATS)	ETS Lindgren	2071-2
x	F2000393	Turntable controller (Cage#2-3)	ETS Lingren	Model 2066
x	F2000403	Turntable (OATS)	ETS Lindgren	Model 2187
x	F2000404	Turntable chamber (Cage#2)	ETS Lingren	Model 2165
x	F2000406	Turntable chamber (Cage#1)	MATURO Gmbh	TT 2.0 SI
x	F2000407	Antenna mast (Cage#1)	MATURO Gmbh	AM 4.0
x	F2000408	Turntable controller (Cage#1)	MATURO Gmbh	Control Unit
BANDWIDTH				
x	A7122167	Attenuator 10dB 18GHz 2W	JFW	-
x	A5329041	Cable SMA/SMA	-	-
x	A2642019	Receiver 20Hz – 8GHz	ROHDE & SCHWARZ	ESU8
MAXIMUM PEAK OUTPUT POWER				
x	A7122167	Attenuator 10dB 18GHz 2W	JFW	-
x	A5329041	Cable SMA/SMA	-	-
x	A2642019	Receiver 20Hz – 8GHz	ROHDE & SCHWARZ	ESU8
BANDEDGE MEASUREMENT				
x	A7122167	Attenuator 10dB 18GHz 2W	JFW	-
x	A5329041	Cable SMA/SMA	-	-
x	A2642019	Receiver 20Hz – 8GHz	ROHDE & SCHWARZ	ESU8
POWER SPECTRAL DENSITY				
x	A7122167	Attenuator 10dB 18GHz 2W	JFW	-
x	A5329041	Cable SMA/SMA	-	-
x	A2642019	Receiver 20Hz – 8GHz	ROHDE & SCHWARZ	ESU8



10. UNCERTAINTIES CHART

Type de mesure / Kind of measurement	Incertitude élargie laboratoire / Wide uncertainty laboratory (k=2) $\pm x$	Incertitude limite du CISPR / CISPR uncertainty limit $\pm y$
Mesure des perturbations conduites en tension sur le réseau d'énergie <i>Measurement of conducted disturbances in voltage on the power port</i>	3.57 dB	3.6 dB
Mesure des perturbations conduites en tension sur le réseau de télécommunication <i>Measurement of conducted disturbances in voltage on the telecommunication port.</i>	3.28 dB	A l'étude / Under consid.
Mesure des perturbations discontinues conduites en tension <i>Measurement of discontinuous conducted disturbances in voltage</i>	3.47 dB	3.6 dB
Mesure des perturbations conduites en courant <i>Measurement of conducted disturbances in current</i>	2.90 dB	A l'étude / Under consid.
Mesure du champ électrique rayonné sur le site en espace libre de Moirans <i>Measurement of radiated electric field on the Moirans open area test site</i>	5.07 dB	5.2 dB

Les valeurs d'incertitudes calculées du laboratoire étant inférieures aux valeurs d'incertitudes limites établies par la norme, la conformité de l'échantillon est établie directement par les niveaux limites applicables. / The uncertainty values calculated by the laboratory are lower than limit uncertainty values defined by the standard. The conformity of the sample is directly established by the applicable limits values.