



LCIE

Rapport d'essai / Test report

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: ZODIAC POOL CARE EUROPE
ZA de la balme
31450 BELBERAUD - FRANCE

Objet / Subject

: Essais de compatibilité électromagnétique conformément aux normes
FCC CFR 47 Part 15, Subpart B et C.
RSS-210 Issue 8
Electromagnetic compatibility tests according to the standards
FCC CFR 47 Part 15, Subpart B and C
RSS-210 Issue 8

Matériel testé / Apparatus under test :

- Produit / Product : **RF MODULE**
- Marque / Trade mark : **ZODIAC POOL CARE EUROPE**
- Constructeur / Manufacturer : **ZODIAC POOL CARE EUROPE**
- Type / Model : **ZOD-2.4GHZ-ZTM-V1_00**
- N° de série / serial number : **PROTO**
- FCC ID : **RIR-24ZTM100**
- IC : **10837A-24ZTM100**

Date des essais / Test date

: Du 10 au 13 Décembre 2012 – 12 Juillet 2013/
From December 10th to 13th, 2012 and July 12th, 2013

Lieu d'essai / Test location

: **LCIE SUD-EST**
ZI Centr'Alp – 170 rue de Chatagnon
38430 MOIRANS - FRANCE

Test réalisé par / Test performed by : Anthony MERLIN

Ce document comporte / Composition of document : 57 pages.

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MOIRANS, LE 12 JUILLET 2013 / JULY 12TH, 2013

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Jacques L. CHOUIN

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1. TEST PROGRAM

Standard:

- FCC Part 15, Subpart C 15.247
- RSS-210 Issue 8 – Dec 2010
- RSS-Gen Issue 3 – Dec 2010
- 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)	PASS
	150-500kHz	66 to 56	56 to 46	
	0.5-5MHz	56	46	
	5-30MHz	60	50	
Radiated emissions 9kHz-30MHz CFR 47 §15.209 (a) CFR 47 §15.247 (d) RSS-210 §A8.5	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-25GHz* CFR 47 §15.209 (a) CFR 47 §15.247 (d) RSS-210 §A8.5	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 CFR 47 §15.247 (a) (2) RSS-210 §A8.2	At least 500kHz			PASS
Maximum Peak Output Power CFR 47 §15.247 (b) RSS-210 §A8.4 (4)	Limit: 30dBm Conducted or Radiated measurement			PASS
Band Edge Measurement CFR 47 §15.209 (a) CFR 47 §15.247 (d) RSS-210 §A8.5	Limit: -20dBc or Radiated emissions limits in restricted bands			PASS
Power spectral Density CFR 47 §15.247 (e) RSS-210 §A8.2	Limit: 8dBm/3kHz			PASS
Occupied bandwidth RSS-Gen §4.6.1	No limit			PASS
Receiver Spurious Emission** RSS-Gen §4.10	See RSS-Gen §4.10			NA

***§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.

****Testing covered the receive mode, and receiver spurious emissions are considered to be the same as transmitter.**



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):**

ZOD-2.4GHz-ZTM-V1_00

Serial number: PROTO

FCC ID: RIR-24ZTM100

IC: 10837A-24ZTM100

- Internal max frequencies: 32MHz

- **Power supply:**

- Range: 3.0VDC – 3.3VDC, provide by host equipment.

During all the tests, EUT is supplied by this power: 3.0VDC

- **Input/output:**

- 1 x Antenna, ceramic
- 2 x DC Power supply
- 2 x Data cables, type I2C
- 1 x Data cable

- **Cables:**

- 1 x Data + power supply cable, unshielded, length: 10cm

- **Auxiliaries equipment used during test:**

- 1 x Power supply of laboratory, ELC AL924
- 1 x W2402A control PCBA

- **Equipment information:**

- Frequency band: [2400.0-2483.5] MHz
- Standard: ☐ Wifi ☐ Bluetooth ☒ Zigbee
- Spectrum Modulation: ☐ FHSS ☒ DSSS
- Modulation type: ☒ QPSK ☐ Pi/4 DQPSK ☐ 8DPSK
- Number of channel: 16 channels
- Channel separation: ☒ 5MHz ☐ 2MHz ☐ 1MHz
- Channel tested: Full test on 2405MHz, 2445MHz and 2480MHz
- RF mode: ☒ TX/RX ☐ RX ☐ Standby
- Antenna type: Integral, ceramic Gain: 2 dBi (Declaration of provider)
- Antenna connector: ☐ Permanent external ☐ Permanent internal
- ☒ None ☐ Temporary (only for tests)



2.3. EUT CONFIGURATION

EUT is set in a special mode for all tests. Followings configurations are used to perform tests.

1. Permanent Tx modulated, channel 11.
2. Permanent Tx modulated, channel 19.
3. Permanent Tx modulated, channel 26.

Cable and power comply with EUT will be marketed.

2.4. EQUIPMENT MODIFICATIONS

None

2.5. SPECIAL ACCESSORIES

None

**3. CONDUCTED EMISSION DATA****3.1. CLIMATIC CONDITIONS**

Date of test : December 13th, 2012
Test performed by : A.MERLIN
Atmospheric pressure : 997hPa
Relative humidity : 28%
Ambient temperature : 21°C

3.2. SETUP FOR CONDUCTED EMISSIONS MEASUREMENT

The product has been tested according to ANSI C63.4-(2003) and FCC Part 15 subpart B and C.

The product has been tested with 110V/60Hz power line voltage on power supply of laboratory and compared to the FCC Part 15 subpart B §15.107 and C §15.207 limits. Measurement bandwidth was 9kHz from 150 kHz to 30 MHz.

Measurement is made with a Rohde & Schwarz ESU8 receiver in peak mode. This was followed by a Quasi-Peak, i.e. CISPR measurement for any strong signal. If the average limit is met when using a Quasi-Peak detector, the EUT shall be deemed to meet both limits and measurement with the average detector is unnecessary. The LISN (measure) is 50Ω / 50μH.

The Peak data are shown on plots in annex 1. Quasi-Peak and Average measurements are detailed in a table with frequencies and levels measured.

Interconnecting cables and equipment's were moved to position that maximized emission. A summary of the worst case emissions found in all test configurations and modes is shown on the following page.

3.3. TEST EQUIPMENT LIST

DESCRIPTION	MANUFACTURER	MODEL	N° LCIE
Cable	-	-	A5329578
Conducted emission comb generator	BARDET	-	A3169049
LISN tri-phase ESH2-Z5	RHODE & SCHWARZ	33852.19.53	C2320062
Receiver 20Hz – 8GHz	ROHDE & SCHWARZ	ESU8	A2642019
Thermo-hygrometer (PM2)	OREGON	BAR916HG-G	B4206011
Transient limiter	HEWLETT PACKARD	11947A	A4049061

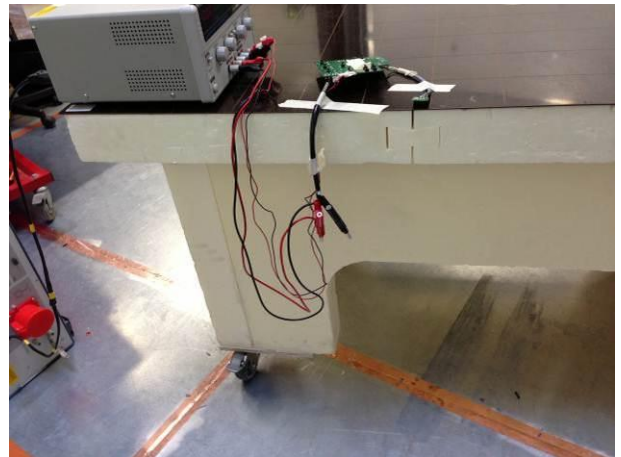
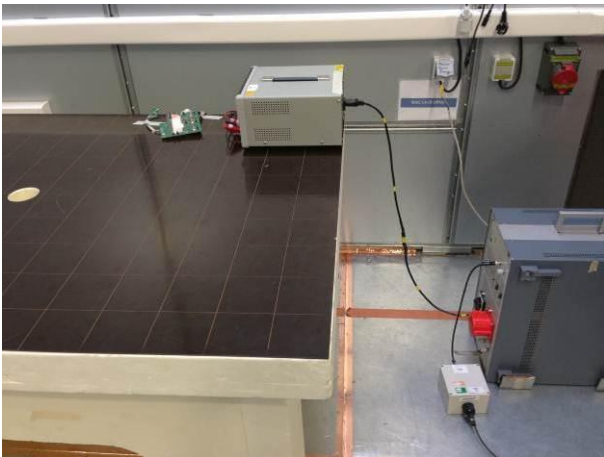
3.4. DIVERGENCE, ADDITION OR SUPPRESSION ON THE TEST SPECIFICATION

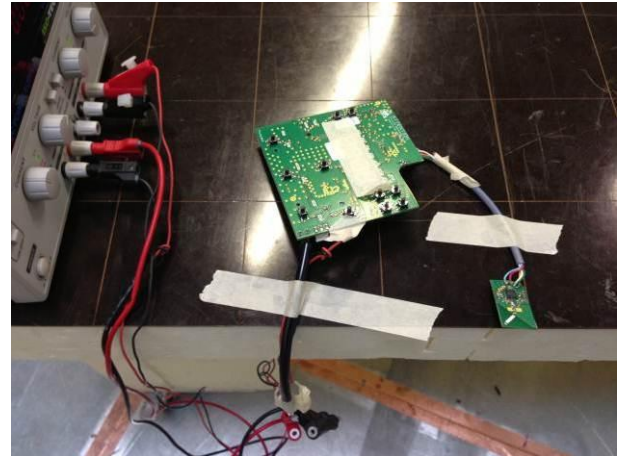
None

3.5. TEST SETUP

The EUT is placed on the ground reference plane, at 80cm from the LISN. The distance between the EUT and the vertical ground plane is 40cm.

The cable has been shorted to 1meter length. The EUT is powered by power supply of laboratory that powered trough the LISN (measure).





Conducted emission test setup

3.6. TEST SEQUENCE AND RESULTS

Measurements are performed on the phase (L1) and neutral (N) of power line voltage.
Graphs are obtained in PEAK detection.
Measures are also performed in Quasi-Peak and Average for any strong signal.

Measure on L1:	graph Emc#1	(see annex 1)
Measure on N:	graph Emc#2	(see annex 1)

RESULT: PASS

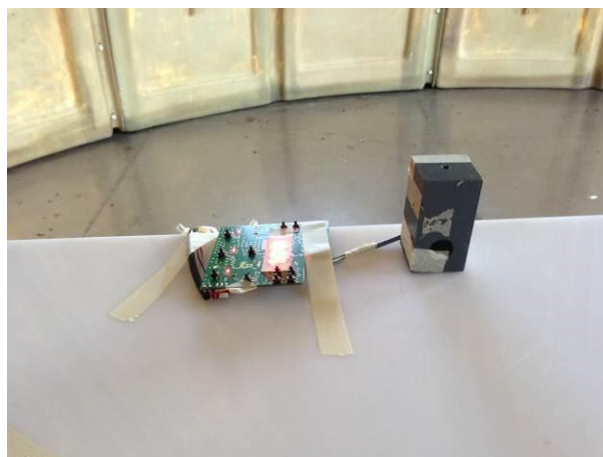
4. RADIATED EMISSION DATA

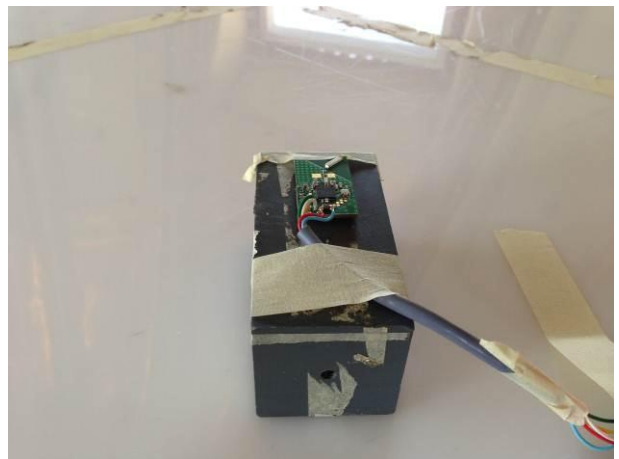
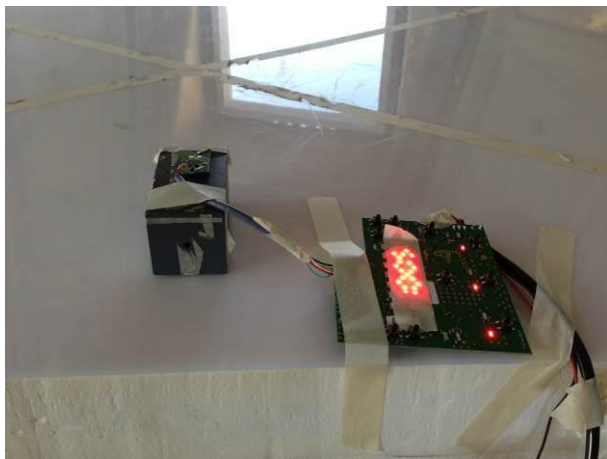
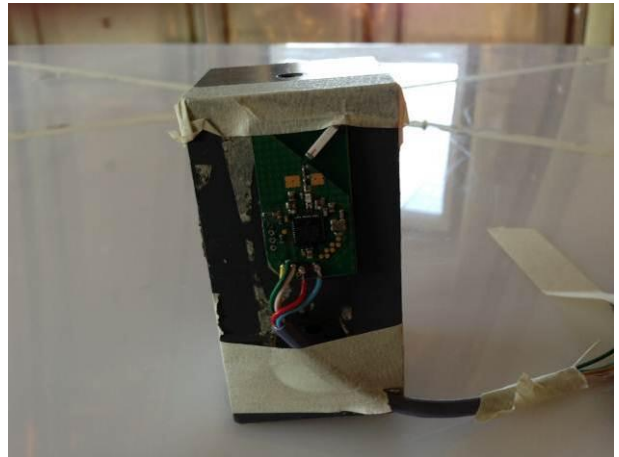
4.1. CLIMATIC CONDITIONS

Date of test	: December 10 th , 2012	December 11 th , 2012	December 12 th , 2012
Test performed by	: A.MERLIN		
Atmospheric pressure	: 994hPa	997hPa	999hPa
Relative humidity	: 29%	32%	23%
Ambient temperature	: 21°C	21°C	21°C

4.2. 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.





Radiated emission test setup



4.3. TEST EQUIPMENT LIST

DESCRIPTION	MANUFACTURER	MODEL	N° LCIE
Amplifier 8 GHz	HEROTEK	A1080304A	A7102024
Amplifier 8-26GHz	ALDETEC	ALS01452	A7102026
Antenna Loop	ELECTRO-METRICS	EM-6879	C2040052
Antenna Bi-Log XWing	TESEQ	CBL6144	C2040145
Antenna Bi-log	CHASE	CBL6111A	C2040172
Antenna horn	EMCO	3115	C2042027
Antenna horn 26GHz	SCHWARZBECK	BBHA 9170	C2042028
Cable N/N	-	-	A5329038
Cable	UTIFLEX	-	A5329192
Cable N/N	-	-	A5329206
Cable	-	-	A5329352
Semi-Anechoic chamber #1	SIEPEL	-	D3044016
Semi-Anechoic chamber #3	SIEPEL	-	D3044017
Radiated emission comb generator	BARDET	-	A3169050
High Pass (4.8-18GHz)	BL Microwave	SH4800-1800	A7484034
Band Rejector (2.4GHz/9kHz-6GHz)	BL Microwave	BR2445-200-7CSJ	A7484043
Receiver 20Hz-26.5GHz	ROHDE & SCHWARZ	ESIB26	A2642021
Receiver 9kHz - 6GHz	ROHDE & SCHWARZ	FSL6	A2642020
Thermo-hygrometer (C3)	OREGON	BAR206	B4204078
Thermo-hygrometer (PM2)	OREGON	BAR916HG-G	B4206011
Turntable chamber (Cage#3)	ETS Lingren	Model 2165	F2000371
Turntable chamber (Cage#1)	MATURO Gmbh	TT 2.0 SI	F2000406
Antenna mast (Cage#1)	MATURO Gmbh	AM 4.0	F2000407
Turntable controller (Cage#1)	MATURO Gmbh	Control Unit	F2000408
Table	MATURO Gmbh	-	F2000437
Turntable controller (Cage#3)	ETS Lingren	Model 2090	F2000444

4.4. DIVERGENCE, ADDITION OR SUPPRESSION ON THE TEST SPECIFICATION

None



4.5. TEST SEQUENCE AND RESULTS

4.5.1. 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:

Circular polarization (0°)	Emr#1	Axis XY – C11	(See annex 1)
Circular polarization (0°)	Emr#2	Axis Z – C11	(See annex 1)
Circular polarization (90°)	Emr#3	Axis XY – C11	(See annex 1)
Circular polarization (90°)	Emr#4	Axis Z – C11	(See annex 1)
Circular polarization (0°)	Emr#9	Axis XY – C26	(See annex 1)
Circular polarization (0°)	Emr#10	Axis Z – C26	(See annex 1)
Circular polarization (90°)	Emr#11	Axis XY – C26	(See annex 1)
Circular polarization (90°)	Emr#12	Axis Z – C26	(See annex 1)

Note: Same results with C19, worst case presented.

4.5.2. Pre-characterization [30MHz-25GHz]

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 25GHz, a search is performed in the semi-anechoic chamber in order to determine frequencies radiated by the EUT (Measuring distance reduced to 1m and 20cm for frequencies from 12GHz to 25GHz).

See graphs for 30MHz-1GHz:

Horizontal polarization	Emr#5	Axis XY – C11	(See annex 1)
Horizontal polarization	Emr#6	Axis Z – C11	(See annex 1)
Vertical polarization	Emr#7	Axis XY – C11	(See annex 1)
Vertical polarization	Emr#8	Axis Z – C11	(See annex 1)
Horizontal polarization	Emr#13	Axis XY – C26	(See annex 1)
Horizontal polarization	Emr#14	Axis Z – C26	(See annex 1)
Vertical polarization	Emr#15	Axis XY – C26	(See annex 1)
Vertical polarization	Emr#16	Axis Z – C26	(See annex 1)

Note: Same results with C19, worst case presented.

**4.5.3. 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)
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No frequency observed, see graphs

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

**4.5.4. Characterization on 10 meters open site from 30MHz to 1GHz**

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. 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 following tables.

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
1	37.963	40.0	34.3	-5.7	300	V	100	16.5	AXIS XY / C11
2	37.963	40.0	34.3	-5.7	300	V	100	16.5	AXIS XY / C26
3	40.857	40.0	34.4	-5.6	270	V	100	15.0	AXIS XY / C11
4	40.857	40.0	34.4	-5.6	270	V	100	15.0	AXIS XY / C26
5	45.371	40.0	34.6	-5.4	310	V	100	12.7	AXIS XY / C11
6	45.371	40.0	34.6	-5.4	310	V	100	12.7	AXIS XY / C26
7	49.019	40.0	34.8	-5.2	100	V	100	11.1	AXIS XY / C11
8	65.313	40.0	34.2	-5.8	25	V	110	8.2	AXIS XY / C26
9	66.738	40.0	34.2	-5.8	45	V	110	8.4	AXIS XY / C11
10	68.131	40.0	33.8	-6.2	0	V	100	8.5	AXIS XY / C26
11	68.496	40.0	34.3	-5.7	305	V	100	8.5	AXIS XY / C11
12	191.999	43.5	26.5	-17.0	215	H	400	11.8	AXIS XY / C11
13	196.520	43.5	26.6	-16.9	250	H	250	11.8	AXIS XY / C26
14	480.010	46.0	36.7	-9.3	0	H	210	20.9	AXIS XY / C26
15	480.010	46.0	37.1	-8.9	0	H	240	20.9	AXIS XY / C11

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

**4.5.5. Characterization on 3 meters anechoic chamber from 1GHz to 25GHz**

The product has been tested at a distance of **3 meters** from the antenna and compared to the FCC part 15 subpart B §15.109 limits and C §15.209 limits. Measurement bandwidth was 1MHz from 1GHz to 25GHz. 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 following tables.

Frequency band 1GHz to 25GHz

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

No	Frequency (MHz)	Limit Average (dBµV/m)	Measure Average (dBµV/m)	Margin (Mes-Lim) (dB)	Angle Table (deg)	Pol Ant.	Ht Ant. (cm)	Correc. factor (dB)	Comments
1	1216	54.0	24.4	-29.6	310	H	110	-5.2	Axis XY - ALL
2	2209	54.0	31.2	-22.8	245	H	110	-2.3	Axis XY - C26
3	2213	54.0	40.4	-13.6	320	V	110	-2.3	Axis XY - C11
4	2220	54.0	39.6	-14.4	320	V	110	-2.3	Axis XY - C19
5	2223	54.0	45.1	-8.9	320	V	110	-2.3	Axis XY - C26
6	2245	54.0	42.7	-11.3	325	V	110	-2.3	Axis XY - C11
7	2253	54.0	40.7	-13.3	320	V	110	-2.3	Axis XY - C19
8	2256	54.0	41.4	-12.6	320	V	110	-2.1	Axis XY - C26
9	2276	54.0	40.2	-13.8	320	V	110	-2.1	Axis XY - C11
10	2285	54.0	42.7	-11.3	320	V	110	-2.3	Axis XY - C19
11	2287	54.0	41.2	-12.8	320	V	110	-2.1	Axis XY - C26
12	2317	54.0	39.9	-14.1	320	V	110	-2.1	Axis XY - C19
13	2320	54.0	43.7	-10.3	325	V	110	-2.1	Axis XY - C26
14	2341	54.0	32.6	-21.4	55	V	110	-2.1	Axis XY - C11
15	2349	54.0	32.1	-21.9	330	V	110	-2.1	Axis XY - C19
16	2352	54.0	40.1	-13.9	320	V	110	-2.1	Axis XY - C26
17	2373	54.0	44.3	-9.7	0	V	110	-2.1	Axis XY - C11
18	2381	54.0	31.8	-22.2	45	V	110	-2.1	Axis XY - C19
19	2384	54.0	31.8	-22.2	325	V	110	-2.1	Axis XY - C26
20	2699	54.0	29.6	-24.4	345	H	110	-0.3	Axis XY - C19
21	2735	54.0	28.1	-25.9	205	V	110	-0.3	Axis XY - C26
22	4810	54.0	50.2	-3.8	300	V	110	5.1	Axis XY - C11
23	4890	54.0	44.4	-9.6	10	V	110	5.3	Axis XY - C19
24	4960	54.0	40.4	-13.6	0	V	110	5.4	Axis XY - C26
15	2483.5	54.0	32.0	-22.0	180	V	110	-2.0	Axis XY - C26



No	Frequency (MHz)	Limit Peak (dBµV/m)	Measure Peak (dBµV/m)	Margin (Mes-Lim) (dB)	Angle Table (deg)	Pol Ant.	Ht Ant. (cm)	Correc. factor (dB)	Comments
1	1216	74.0	43.4	-30.6	310	H	110	-5.2	Axis XY - ALL
2	2209	74.0	50.6	-23.4	245	H	110	-2.3	Axis XY - C26
3	2213	74.0	49.6	-24.4	320	V	110	-2.3	Axis XY - C11
4	2220	74.0	48.0	-26.0	320	V	110	-2.3	Axis XY - C19
5	2223	74.0	45.6	-28.4	320	V	110	-2.3	Axis XY - C26
6	2245	74.0	50.9	-23.1	325	V	110	-2.3	Axis XY - C11
7	2253	74.0	51.7	-22.3	320	V	110	-2.3	Axis XY - C19
8	2256	74.0	47.3	-26.7	320	V	110	-2.1	Axis XY - C26
9	2276	74.0	49.7	-24.3	320	V	110	-2.1	Axis XY - C11
10	2285	74.0	51.0	-23.0	320	V	110	-2.3	Axis XY - C19
11	2287	74.0	50.1	-23.9	320	V	110	-2.1	Axis XY - C26
12	2317	74.0	48.2	-25.8	320	V	110	-2.1	Axis XY - C19
13	2320	74.0	45.0	-29.0	325	V	110	-2.1	Axis XY - C26
14	2341	74.0	43.4	-30.6	55	V	110	-2.1	Axis XY - C11
15	2349	75.0	39.1	-35.9	330	V	110	-2.1	Axis XY - C19
16	2352	74.0	53.1	-20.9	320	V	110	-2.1	Axis XY - C26
17	2373	74.0	51.4	-22.6	0	V	110	-2.1	Axis XY - C11
18	2381	74.0	52.0	-22.0	45	V	110	-2.1	Axis XY - C19
19	2384	74.0	51.4	-22.6	325	V	110	-2.1	Axis XY - C26
20	2699	74.0	51.0	-23.0	345	H	110	-0.3	Axis XY - C19
21	2735	74.0	47.4	-26.6	205	V	110	-0.3	Axis XY - C26
22	4810	74.0	51.9	-22.1	300	V	110	5.1	Axis XY - C11
23	4890	74.0	48.6	-25.4	10	V	110	5.3	Axis XY - C19
24	4960	74.0	46.3	-27.7	0	V	110	5.4	Axis XY - C26
25	2483.5	74.0	43.1	-30.9	180	V	110	-2.0	Axis XY - C26

Note: Measures have been done at 3m distance.

RESULTS: PASS

**4.6. 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 52.5dB μ V 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 dB μ V/m.

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

The 32 dB μ V/m value can be mathematically converted to its corresponding level in μ V/m.

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



5. BANDWIDTH (15.247)

5.1. TEST CONDITIONS

Date of test : December 11th, 2012
Test performed by : A.MERLIN
Atmospheric pressure : 997mb
Relative humidity : 32%
Ambient temperature : 21°C

5.1. EQUIPMENT CONFIGURATION

Modulation: QPSK

5.2. LIMIT

The 6 dB bandwidth must be greater than 500 kHz.

5.3. SETUP

Radiated measurement:

The EUT is placed in an anechoic chamber; 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, a delta marker is used to measure the frequency difference as the emission bandwidth.

**5.4. TEST EQUIPMENT LIST**

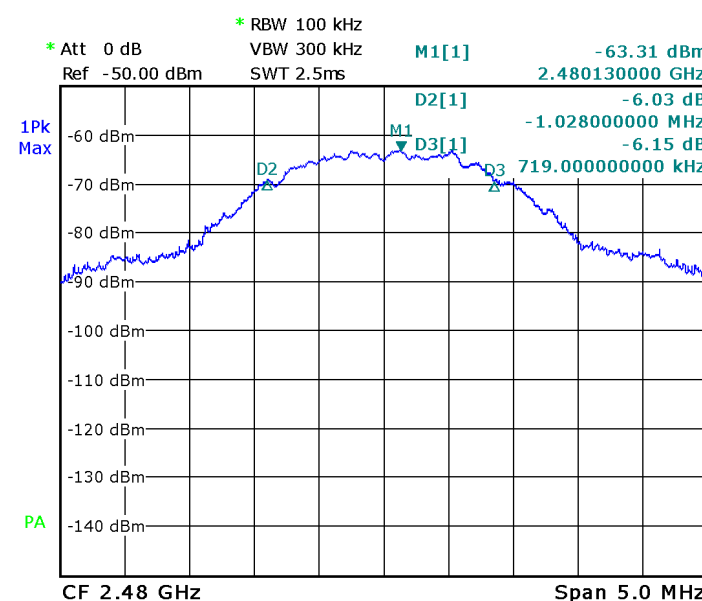
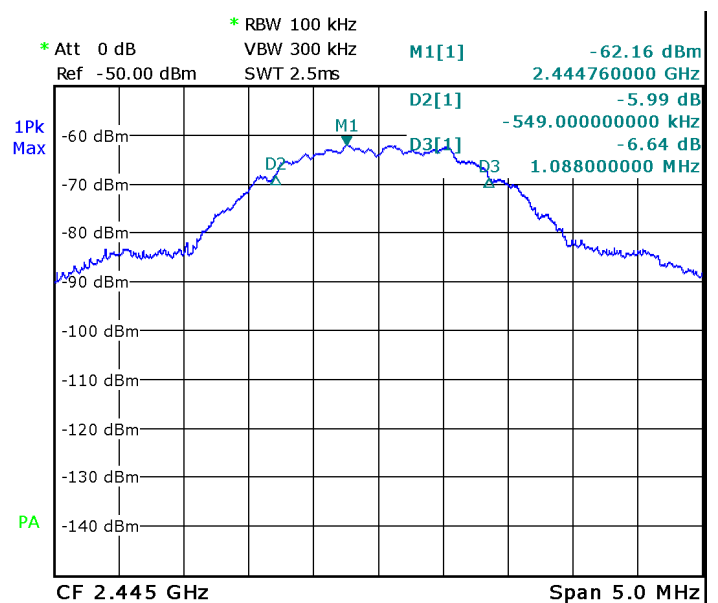
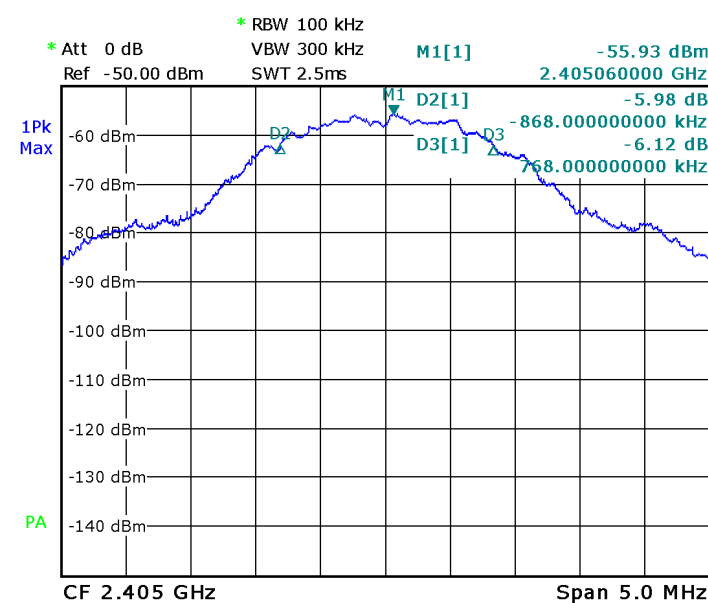
DESCRIPTION	MANUFACTURER	MODEL	N° LCIE
Antenna horn	EMCO	3115	C2042027
Cable N/N	-	-	A5329038
Cable	UTIFLEX	-	A5329192
Cable N/N	-	-	A5329206
Semi-Anechoic chamber #3	SIEPEL	-	D3044017
Receiver 9kHz - 6GHz	ROHDE & SCHWARZ	FSL6	A2642020
Thermo-hygrometer (C3)	OREGON	BAR206	B4204078
Thermo-hygrometer (PM2)	OREGON	BAR916HG-G	B4206011
Turntable chamber (Cage#3)	ETS Lingren	Model 2165	F2000371
Turntable controller (Cage#3)	ETS Lingren	Model 2090	F2000444

5.5. DIVERGENCE, ADDITION OR SUPPRESSION ON THE TEST SPECIFICATION

None

5.6. TEST SEQUENCE AND RESULTS

Channel	Channel Frequency (MHz)	6dB Bandwidth (kHz)	PASS / FAIL
11	2405	1636	PASS
19	2445	1637	PASS
26	2480	1747	PASS



**6. MAXIMUM PEAK OUTPUT POWER (15.247)****6.1. TEST CONDITIONS**

Date of test : December 11th, 2012
Test performed by : A.MERLIN
Atmospheric pressure : 997mb
Relative humidity : 32%
Ambient temperature : 21°C

6.2. EQUIPMENT CONFIGURATION

Modulation: QPSK

6.3. SETUP*Radiated measurement:*

The product has been tested at a distance of 3 meters from the antenna and using 3MHz RBW and 10MHz VBW. 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 following table. The captured power is measured and recorded; the measurement is repeated until all frequencies required were complete.

To demonstrate compliance with peak output power requirement of section 15.247 (b), the transmitter's peak output power is calculated using the following equation:

$$E = \frac{\sqrt{30 P G}}{d}$$

Where:

- E is the measured maximum fundamental field strength in V/m, utilizing a RBW $\geq$ the 20 dB bandwidth of the emission, VBW > RBW, peak detector function. Follow the procedures in C63.4-1992 with respect to maximizing the emission.
- G is the numeric gain of the transmitting antenna with reference to an isotropic radiator.
- d is the distance in meters from which the field strength was measured.
- P is the power in watts for which you are solving:

$$P = \frac{(E d)^2}{30 G}$$

**6.4. TEST EQUIPMENT LIST**

DESCRIPTION	MANUFACTURER	MODEL	N° LCIE
Antenna horn	EMCO	3115	C2042027
Cable	-	-	A5329183
Cable	-	-	A5329191
Cable	-	-	A5329590
Semi-Anechoic chamber #1	SIEPEL	-	D3044016
Receiver 9kHz - 6GHz	ROHDE & SCHWARZ	FSL6	A2642020
Turntable chamber (Cage#1)	MATURO Gmbh	TT 2.0 SI	F2000406
Antenna mast (Cage#1)	MATURO Gmbh	AM 4.0	F2000407
Turntable controller (Cage#1)	MATURO Gmbh	Control Unit	F2000408
Table	MATURO Gmbh	-	F2000437

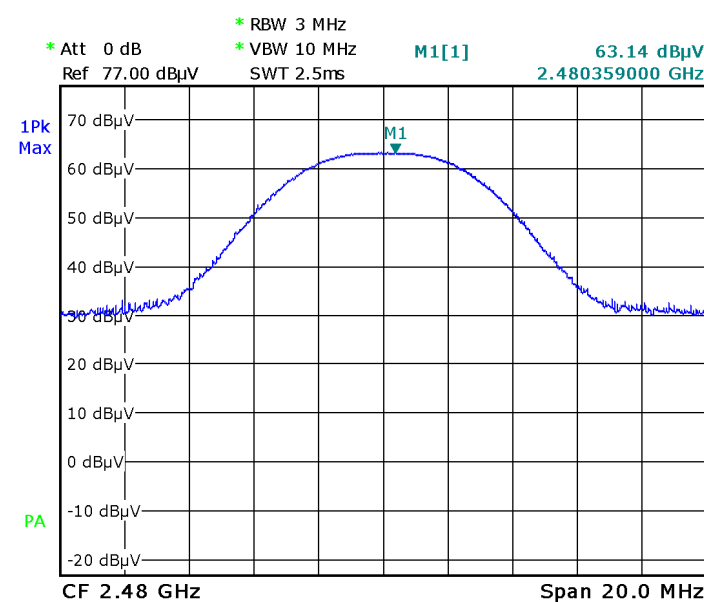
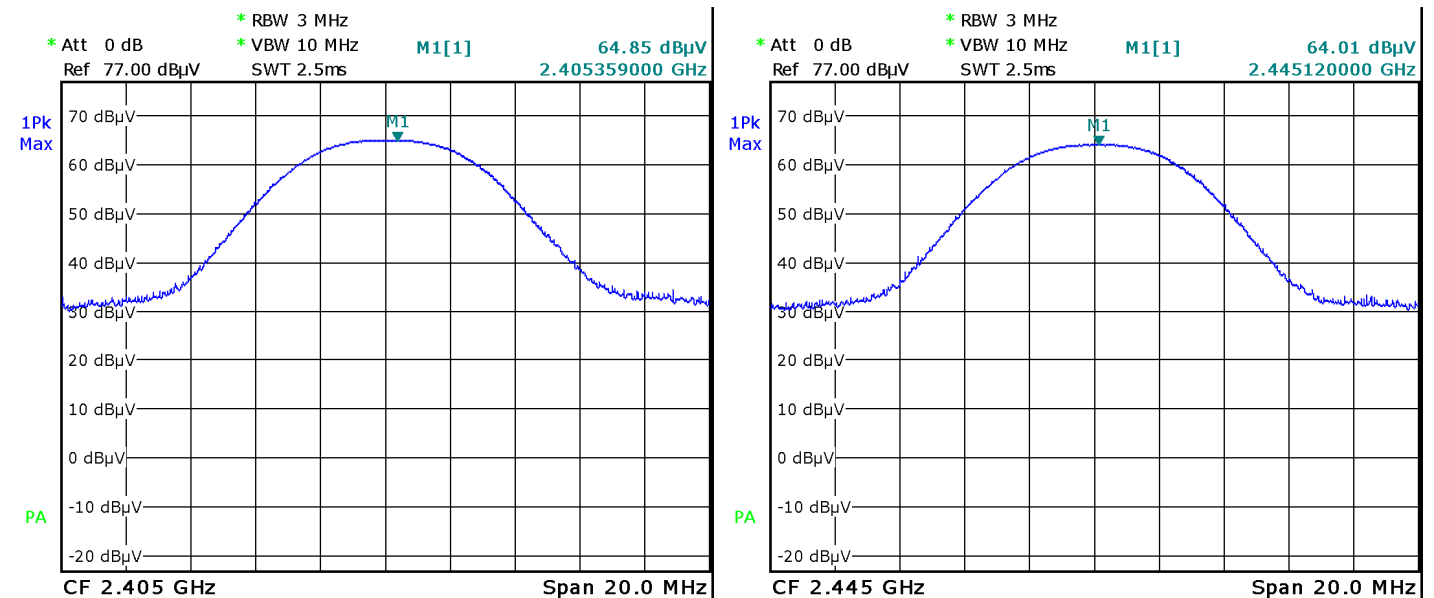
6.5. DIVERGENCE, ADDITION OR SUPPRESSION ON THE TEST SPECIFICATION

None

6.6. TEST SEQUENCE AND RESULTS

Channel	Channel Frequency (MHz)	Maximum Field (dB μ V/m)	Peak Output Power Conducted (dBm)	Power Limit (dBm)	FC (dB)	PASS / FAIL
11	2405	98.0	0.8	30	33.1	PASS
19	2445	97.2	0.0	30	33.1	PASS
26	2480	96.1	-1.1	30	33.1	PASS

Alternative test procedure: Radiated measurements performed, ceramic antenna used with 2dBi gain.



**7. BAND EDGE MEASUREMENT (15.247)****7.1. TEST CONDITIONS**

Date of test : December 11th, 2012
Test performed by : A.MERLIN
Atmospheric pressure : 997mb
Relative humidity : 32%
Ambient temperature : 21°C

7.1. 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.

7.2. EQUIPMENT CONFIGURATION

Modulation: QPSK
Channel frequency: C11 and C26 (Lowest and highest channel)

7.3. SETUP

The EUT is placed in an anechoic chamber; 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

7.4. TEST EQUIPMENT LIST

DESCRIPTION	MANUFACTURER	MODEL	N° LCIE
Attenuator 10dB	JFW	-	A7122166
Receiver 20Hz-26.5GHz	ROHDE & SCHWARZ	ESIB26	A2642021
Receiver 9kHz - 6GHz	ROHDE & SCHWARZ	FSL6	A2642020

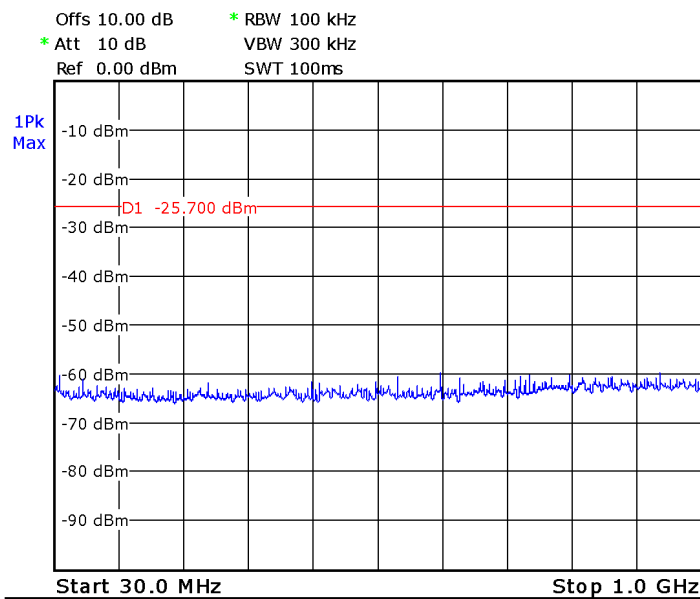
7.5. DIVERGENCE, ADDITION OR SUPPRESSION ON THE TEST SPECIFICATION

None



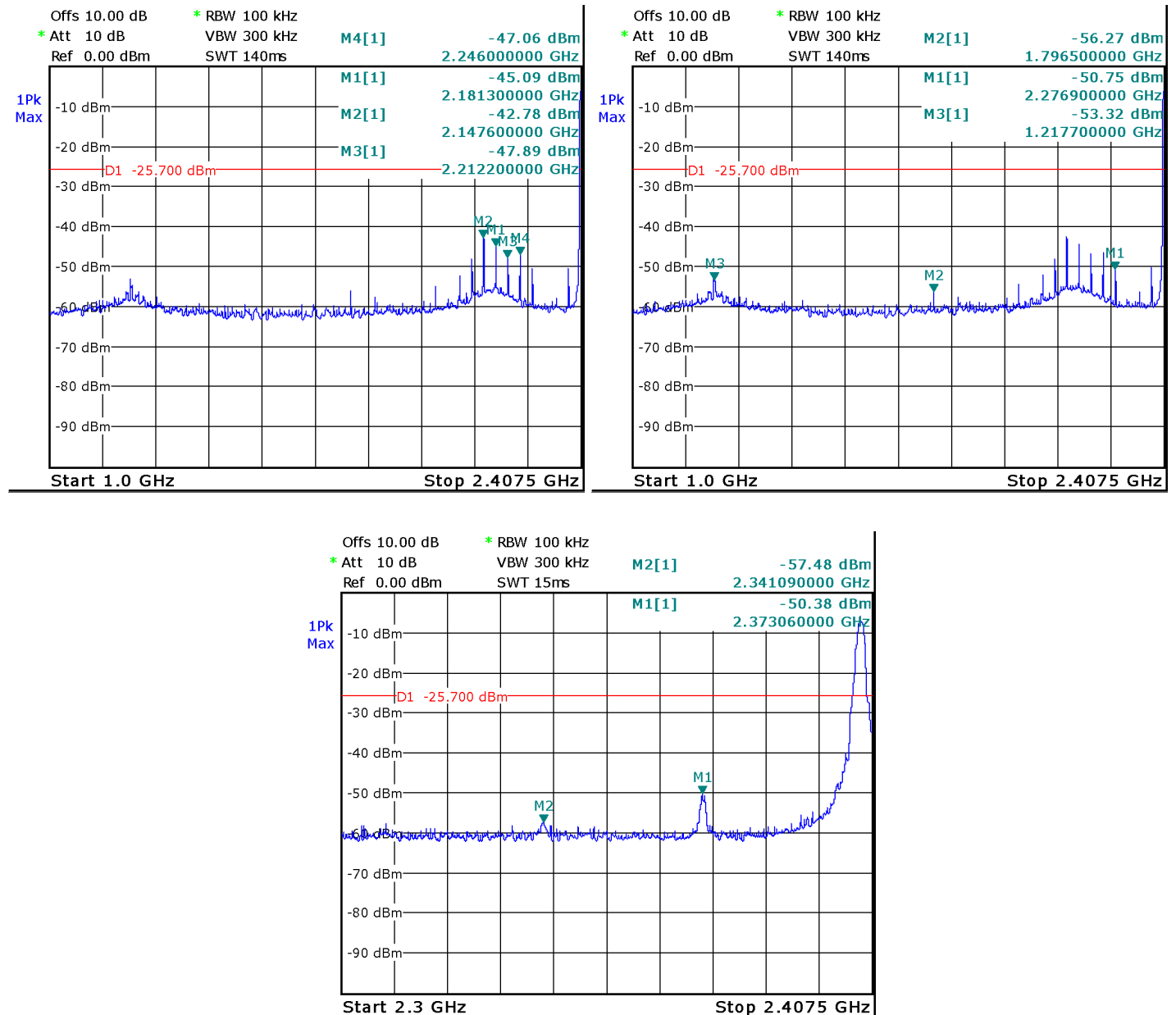
7.6. TEST SEQUENCE AND RESULTS

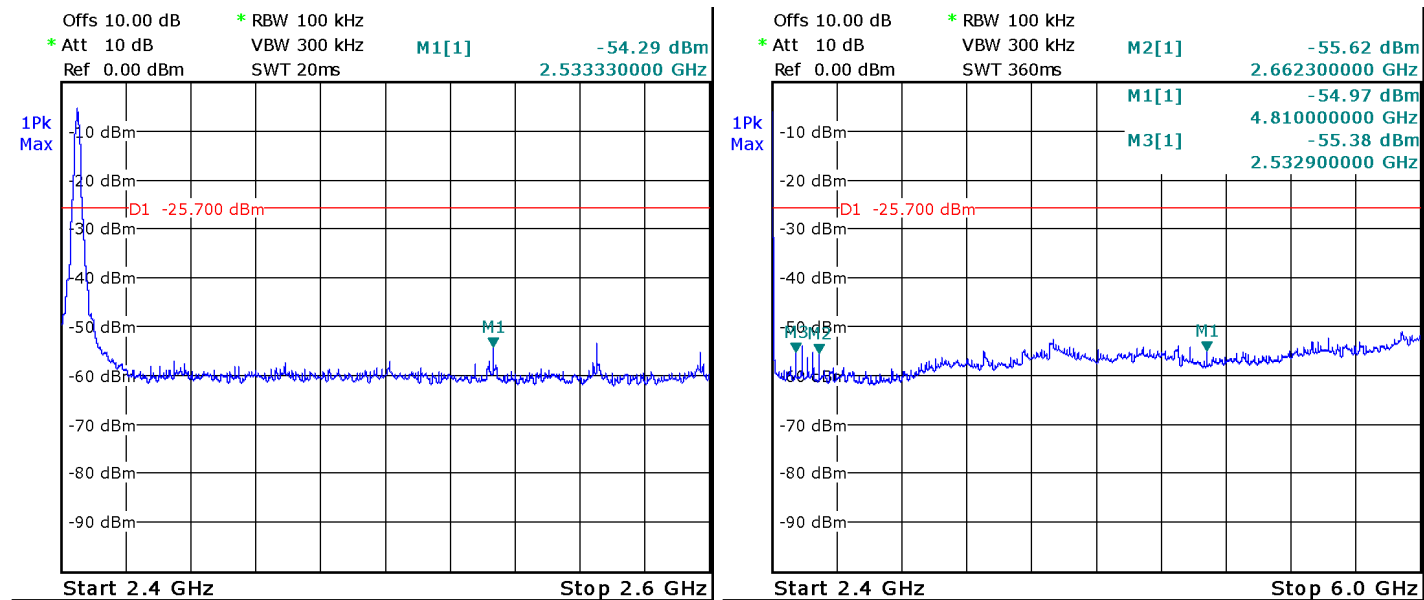
Frequency: 30MHz – 1GHz



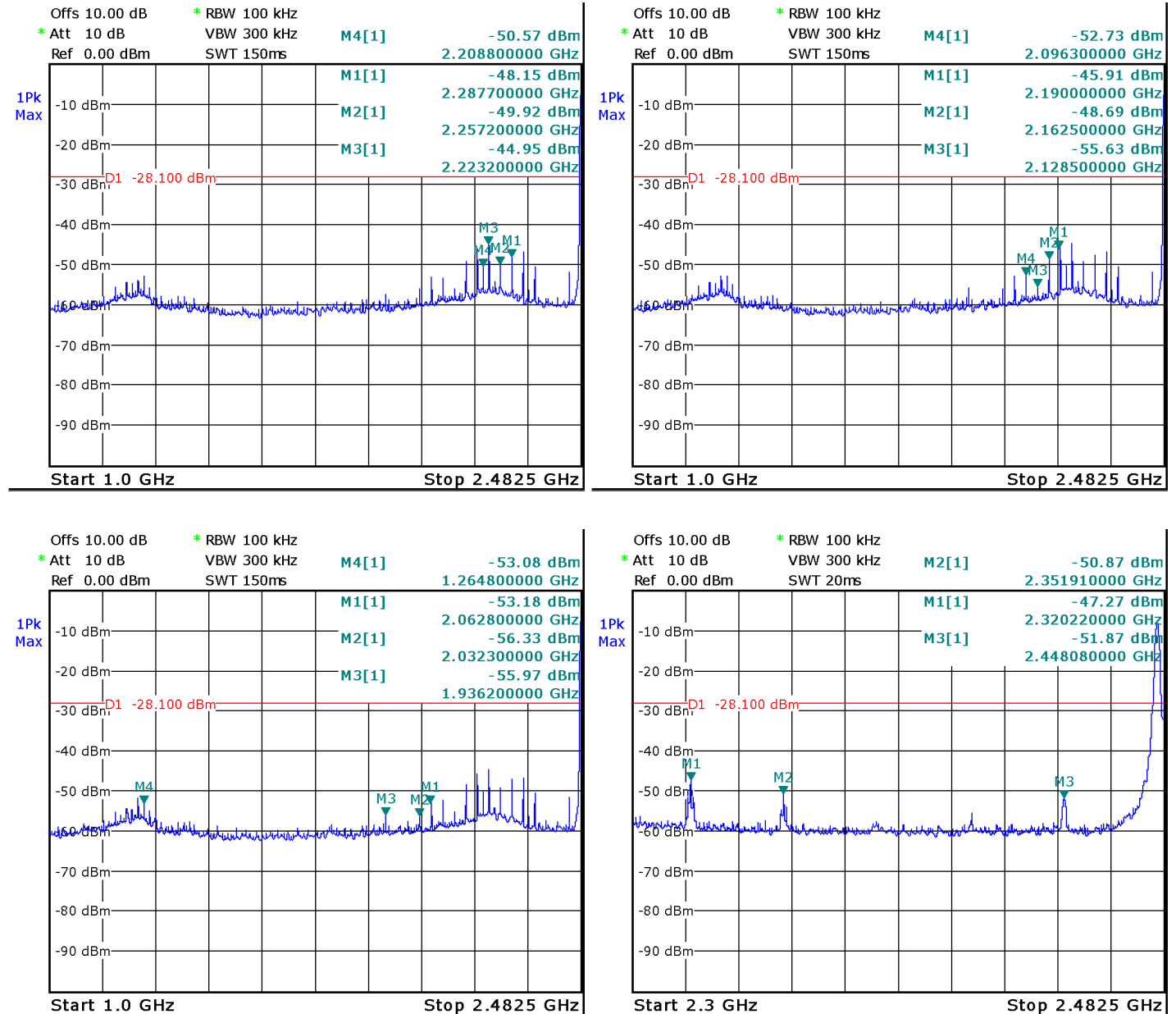
No frequency observed for all channels tested.

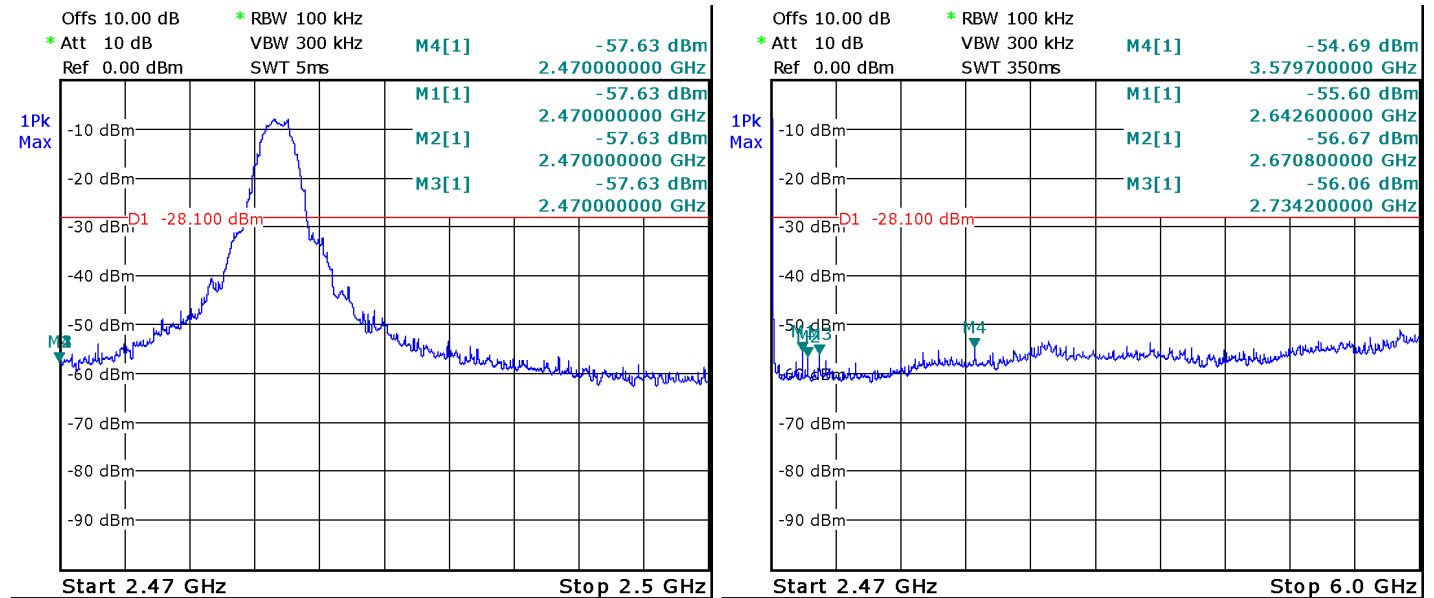
Frequency: 1GHz – 6GHz





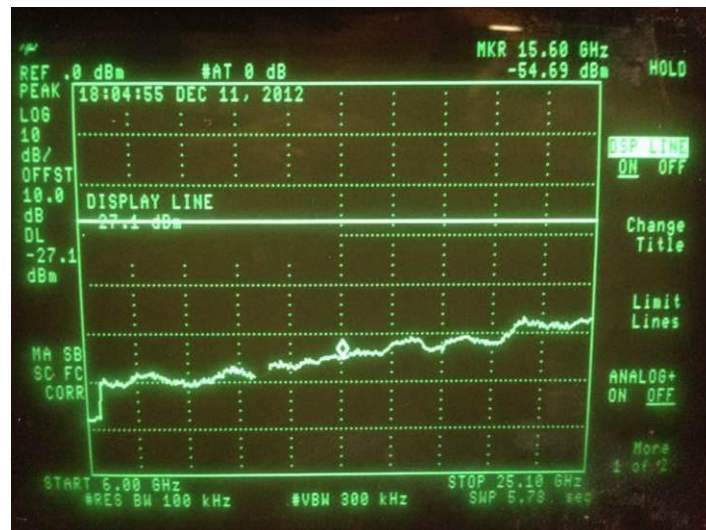
For channel C11, spurious in restricted frequency bands are measured in § 4 (Radiated emission data).





For channel C26, spurious in restricted frequency bands are measured in § 4 (Radiated emission data).

Frequency: 6GHz – 25GHz



No frequency observed for all channels tested.

**8. POWER SPECTRAL DENSITY (15.247)****8.1. TEST CONDITIONS**

Date of test : December 11th, 2012
Test performed by : A.MERLIN
Atmospheric pressure : 997mb
Relative humidity : 32%
Ambient temperature : 21°C

8.2. SETUP*Radiated measurement:*

The product has been tested at a distance of 3 meters from the antenna and using 3kHz RBW and VBW>RBW. 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 following table. The captured power is measured and recorded; the measurement is repeated until all frequencies required were complete. To demonstrate compliance with power spectral density requirement of section 15.247, the PSD is calculated using the following equation:

$$E = \frac{\sqrt{30PG}}{d}$$

Where:

- E is the measured maximum fundamental field strength in V/m, utilizing a RBW $\geq$ the 6dB bandwidth of the emission, VBW > RBW, peak detector function. Follow the procedures in C63.4-1992 with respect to maximizing the emission.
- G is the numeric gain of the transmitting antenna with reference to an isotropic radiator.
- d is the distance in meters from which the field strength was measured.
- P is the power in watts for which you are solving:

$$P = \frac{(Ed)^2}{30G}$$

**8.3. TEST EQUIPMENT LIST**

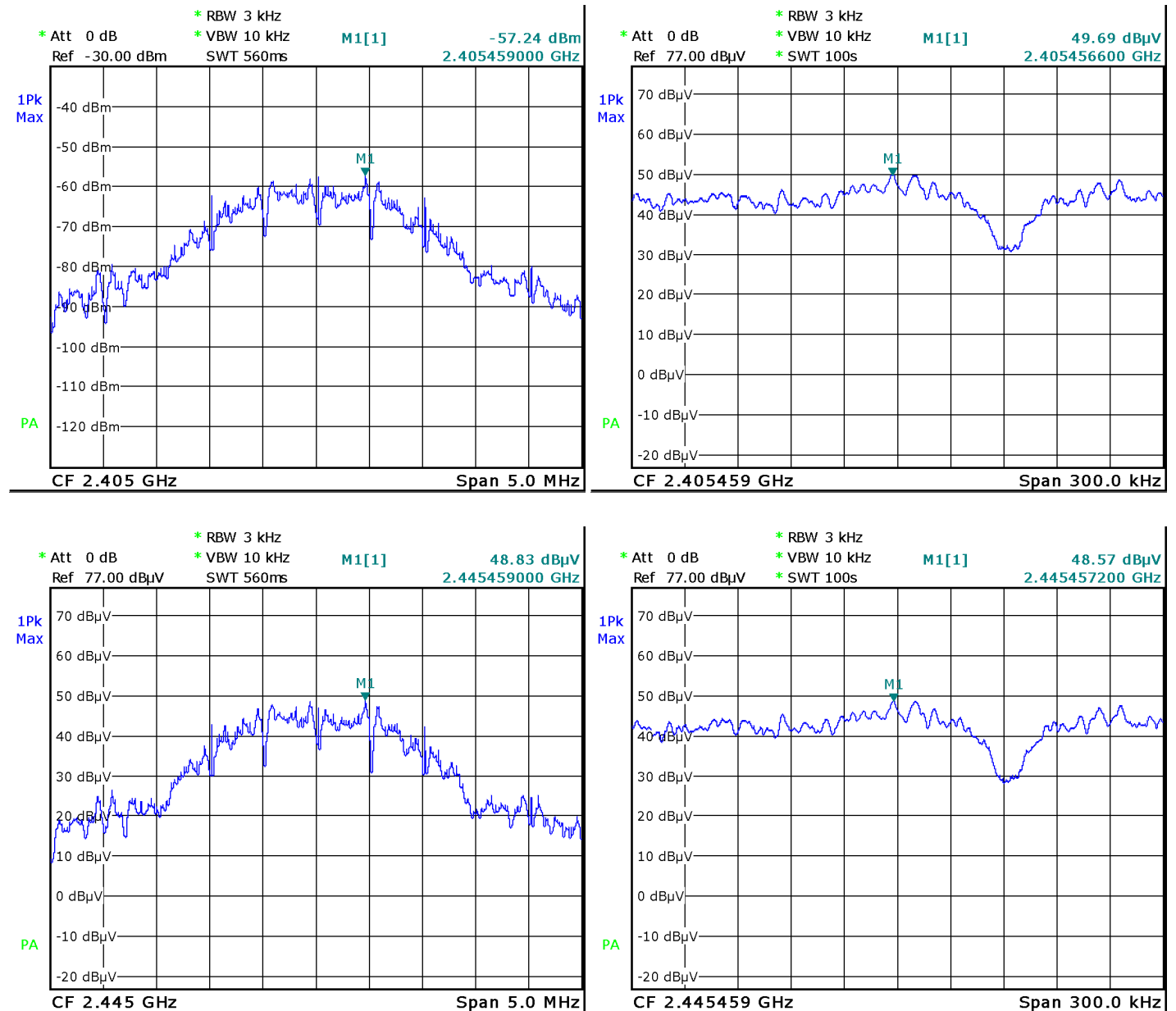
DESCRIPTION	MANUFACTURER	MODEL	N° LCIE
Antenna horn	EMCO	3115	C2042027
Cable	-	-	A5329183
Cable	-	-	A5329191
Cable	-	-	A5329590
Semi-Anechoic chamber #1	SIEPEL	-	D3044016
Receiver 9kHz - 6GHz	ROHDE & SCHWARZ	FSL6	A2642020
Turntable chamber (Cage#1)	MATURO Gmbh	TT 2.0 SI	F2000406
Antenna mast (Cage#1)	MATURO Gmbh	AM 4.0	F2000407
Turntable controller (Cage#1)	MATURO Gmbh	Control Unit	F2000408
Table	MATURO Gmbh	-	F2000437

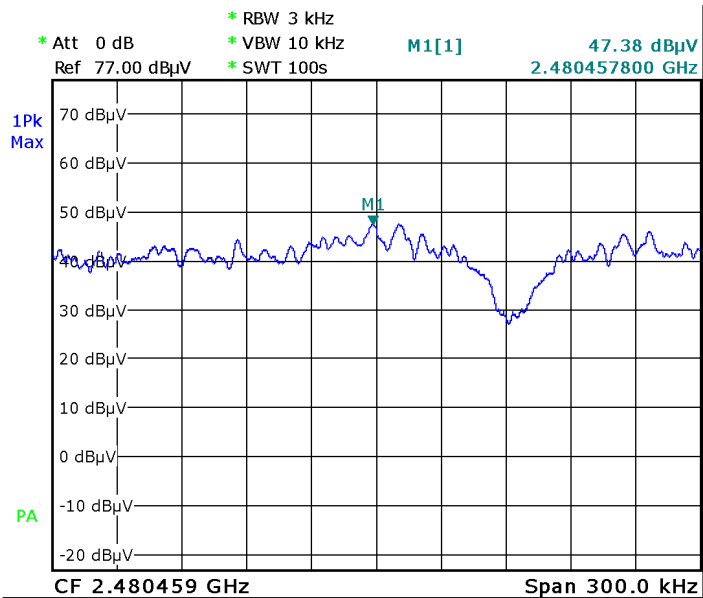
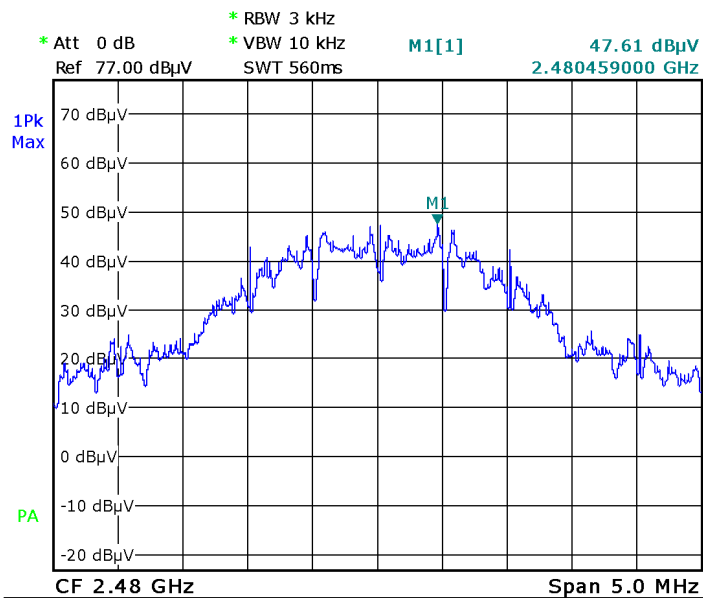
8.4. DIVERGENCE, ADDITION OR SUPPRESSION ON THE TEST SPECIFICATION

None

Channel	Channel Frequency (MHz)	Maximum Field (dBµV/m)	Power Spectral Density conducted (dBm)	PSD Limit (dBm)	FC (dB)	PASS / FAIL
11	2405	82.8	-14.5	8	33.1	PASS
19	2445	81.6	-15.6	8	33.1	PASS
26	2480	80.5	-16.7	8	33.1	PASS

Alternative test procedure: Radiated measurements performed, ceramic antenna used with 2dBi gain.



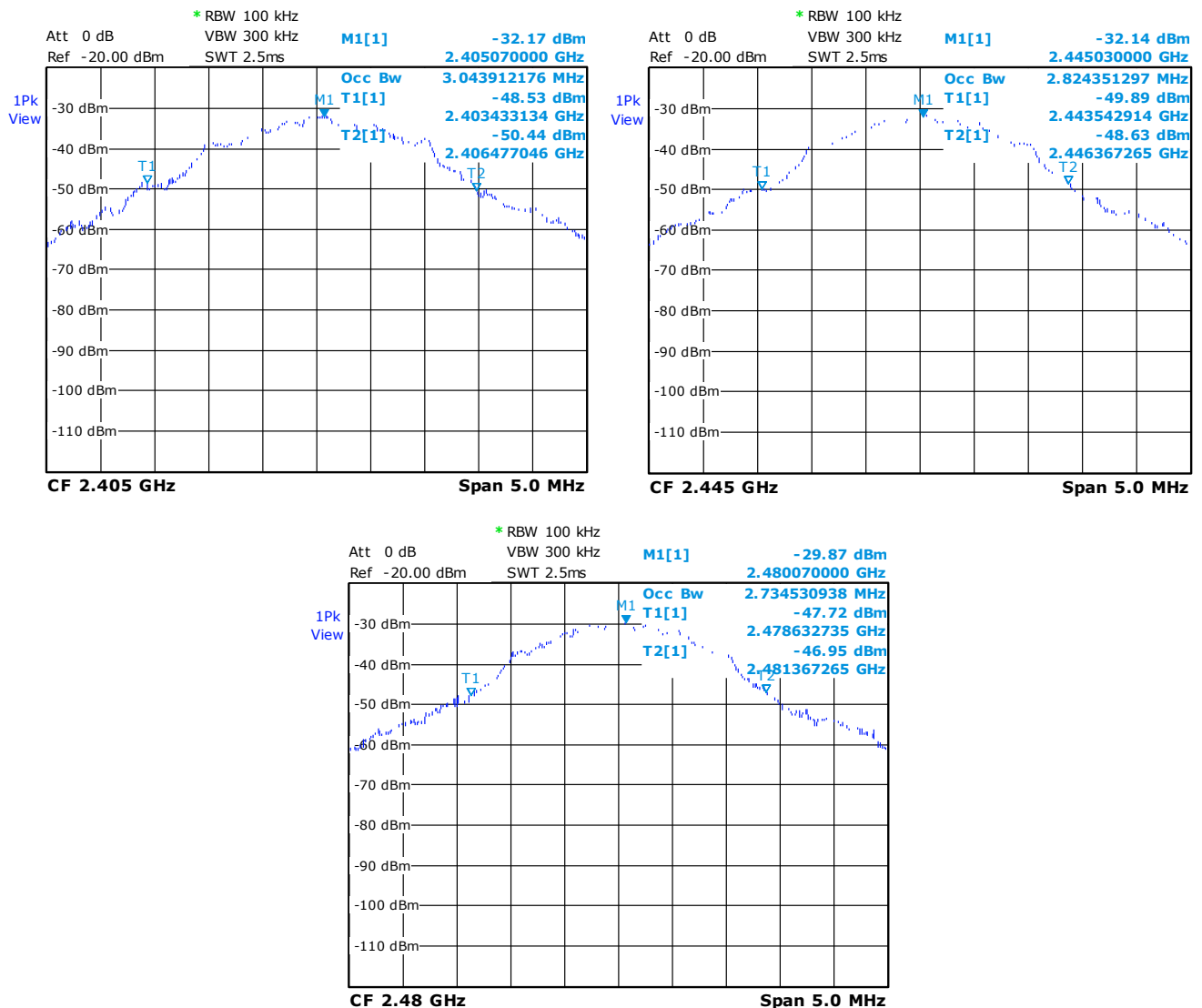


9. OCCUPIED BANDWIDTH

9.1. CLIMATIC CONDITIONS

Date of test : July 12th, 2013
 Test performed by : A.MERLIN
 Atmospheric pressure : 989hPa
 Relative humidity : 45%
 Ambient temperature : 23°C

9.2. TEST RESULTS



Worst measured occupied bandwidth is **3.044MHz**

Measurement settings:

RBW = 30kHz / Video BW = 100kHz / SPAN = 5.0MHz / MaxHold / PEAK

The occupied bandwidth is measured with OBW function of spectrum analyzer.

**9.3. TEST EQUIPMENT LIST**

DESCRIPTION	MANUFACTURER	MODEL	N° LCIE
Antenna horn	EMCO	3115	C2042027
Cable	-	-	A5329183
Cable	-	-	A5329191
Cable	-	-	A5329590
Semi-Anechoic chamber #1	SIEPEL	-	D3044016
Receiver 9kHz - 6GHz	ROHDE & SCHWARZ	FSL6	A2642020

9.4. DIVERGENCE, ADDITION OR SUPPRESSION ON THE TEST SPECIFICATION

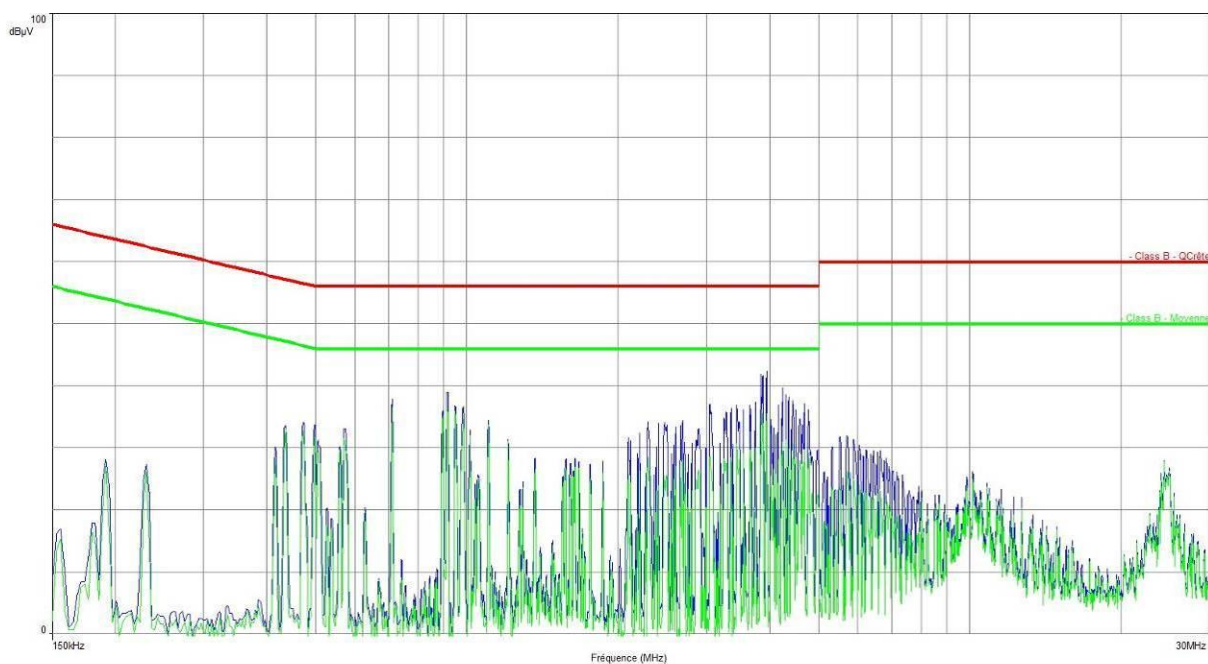
None

**10. ANNEX 1 (GRAPHS)****CONDUCTED EMISSIONS**

Graph name :	Emc#1	Test configuration:
Limit :	EN 55022	
Class :	B	

PARAMETERS

Voltage / Frequency :	110VAC / 60Hz	Legend:	
Line :	Phase	Peak Measure	Average Measure
RBW :	9kHz		
VBW :	30kHz	QPeak Limit	Average Limit
Frequency :	150kHz- 30MHz		



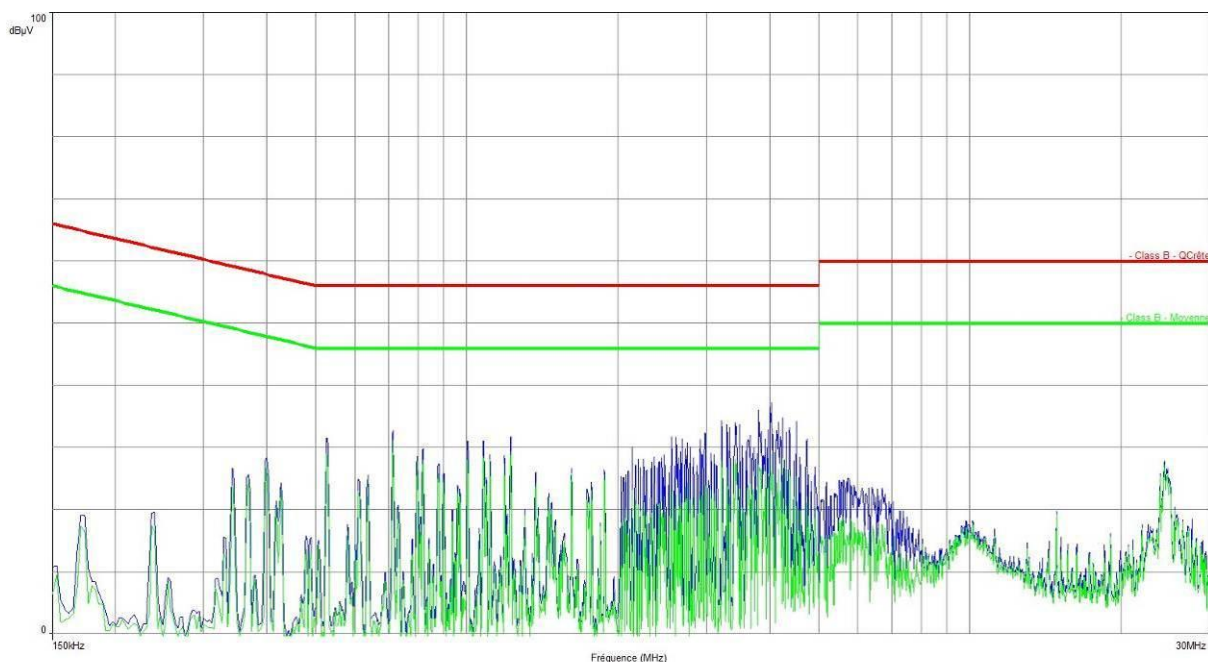
Frequency (MHz)	Avg (dBµV)	Lim Avg (dBµV)	Avg-LimAvg (dBµV)	QPeak (dBµV)	LimQPeak (dBµV)	QPeak-LimQPeak (dBµV)
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No frequency observed



CONDUCTED EMISSIONS		
Graph name :	Emc#2	Test configuration:
Limit :	EN 55022	
Class :	B	

PARAMETERS			
Voltage / Frequency :	110VAC / 60Hz	Legend:	
Line :	Neutral	Peak Measure	Average Measure
RBW :	9kHz		
VBW :	30kHz	QPeak Limit	Average Limit
Frequency :	150kHz- 30MHz		



Frequency (MHz)	Avg (dBµV)	Lim Avg (dBµV)	Avg-LimAvg (dBµV)	QPeak (dBµV)	LimQPeak (dBµV)	QPeak-LimQPeak (dBµV)
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No frequency observed



RADIATED EMISSIONS

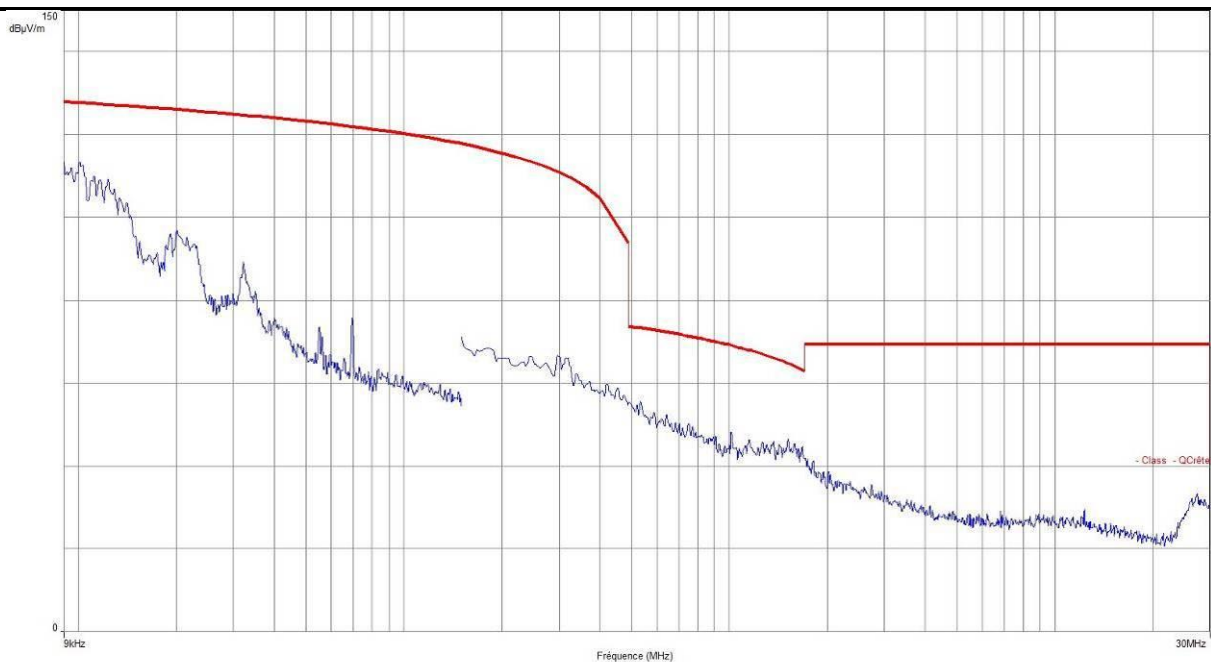
Graph name :	Emr#1	Test configuration:
Limit :	FCC Part15C	(C-0°) - Axis XY - TX C11
Class :	B	

PARAMETERS

Antenna polarization:	0°	Legend:
Azimuth :	0° - 360°	Peak Measure
RBW :	300Hz	QPeak Limit@3m
VBW :	1kHz	
Frequency :	9kHz- 150kHz	

PARAMETERS

Antenna polarization:	0°	Legend:
Azimuth :	0° - 360°	Peak Measure
RBW :	10kHz	QPeak Limit@3m
VBW :	30kHz	
Frequency :	150kHz- 30MHz	





RADIATED EMISSIONS

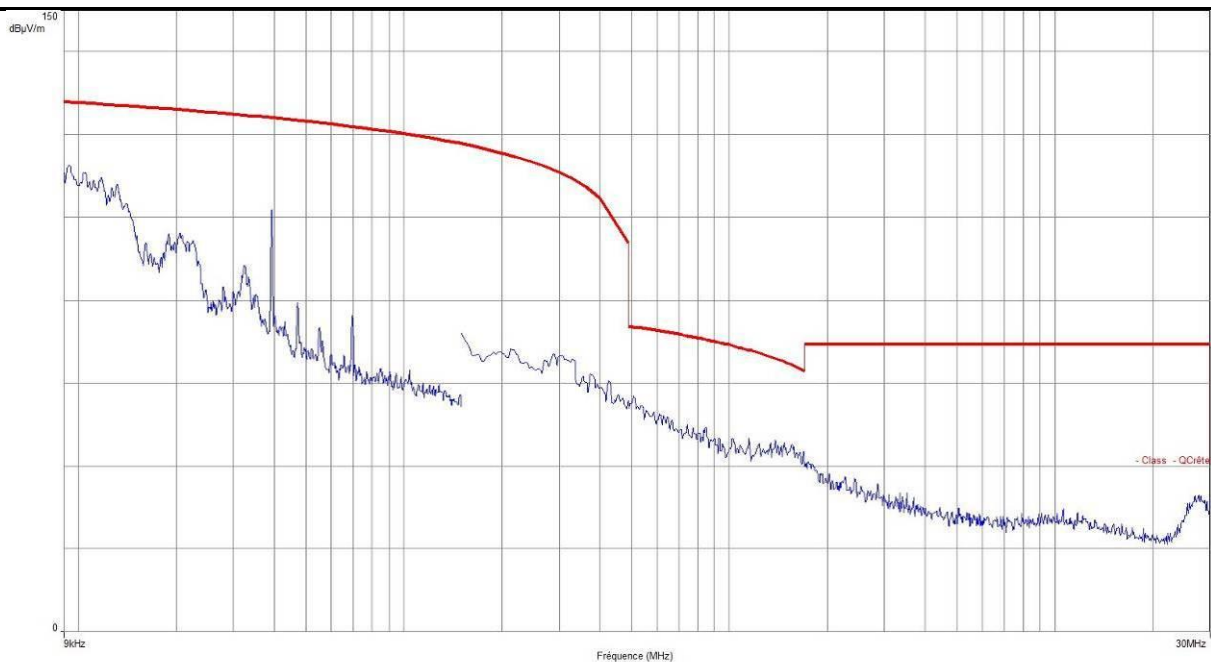
Graph name :	Emr#2	Test configuration:
Limit :	FCC Part15C	(C-0°) - Axis Z - TX C11
Class :	B	

PARAMETERS

Antenna polarization:	0°	Legend:
Azimuth :	0° - 360°	Peak Measure
RBW :	300Hz	QPeak Limit@3m
VBW :	1kHz	
Frequency :	9kHz- 150kHz	

PARAMETERS

Antenna polarization:	0°	Legend:
Azimuth :	0° - 360°	Peak Measure
RBW :	10kHz	QPeak Limit@3m
VBW :	30kHz	
Frequency :	150kHz- 30MHz	





RADIATED EMISSIONS

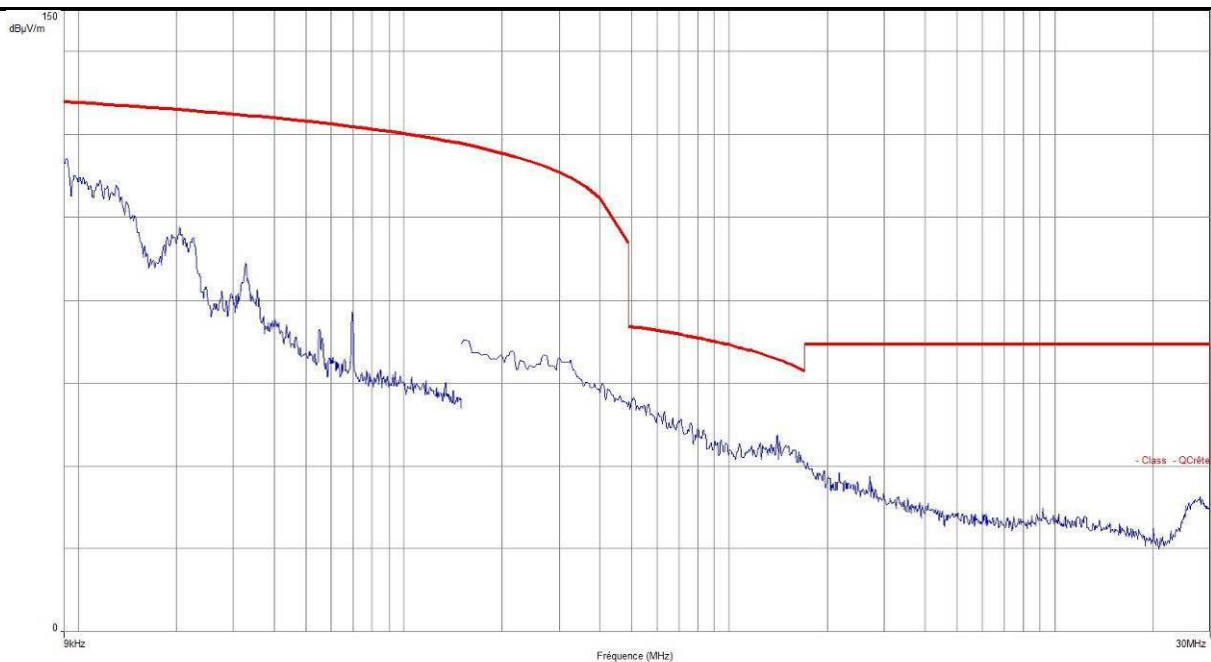
Graph name :	Emr#3	Test configuration:
Limit :	FCC Part15C	(C-90°) - Axis XY - TX C11
Class :	B	

PARAMETERS

Antenna polarization:	90°	Legend:
Azimuth :	0° - 360°	Peak Measure
RBW :	300Hz	QPeak Limit@3m
VBW :	1kHz	
Frequency :	9kHz- 150kHz	

PARAMETERS

Antenna polarization:	90°	Legend:
Azimuth :	0° - 360°	Peak Measure
RBW :	10kHz	QPeak Limit@3m
VBW :	30kHz	
Frequency :	150kHz- 30MHz	





RADIATED EMISSIONS

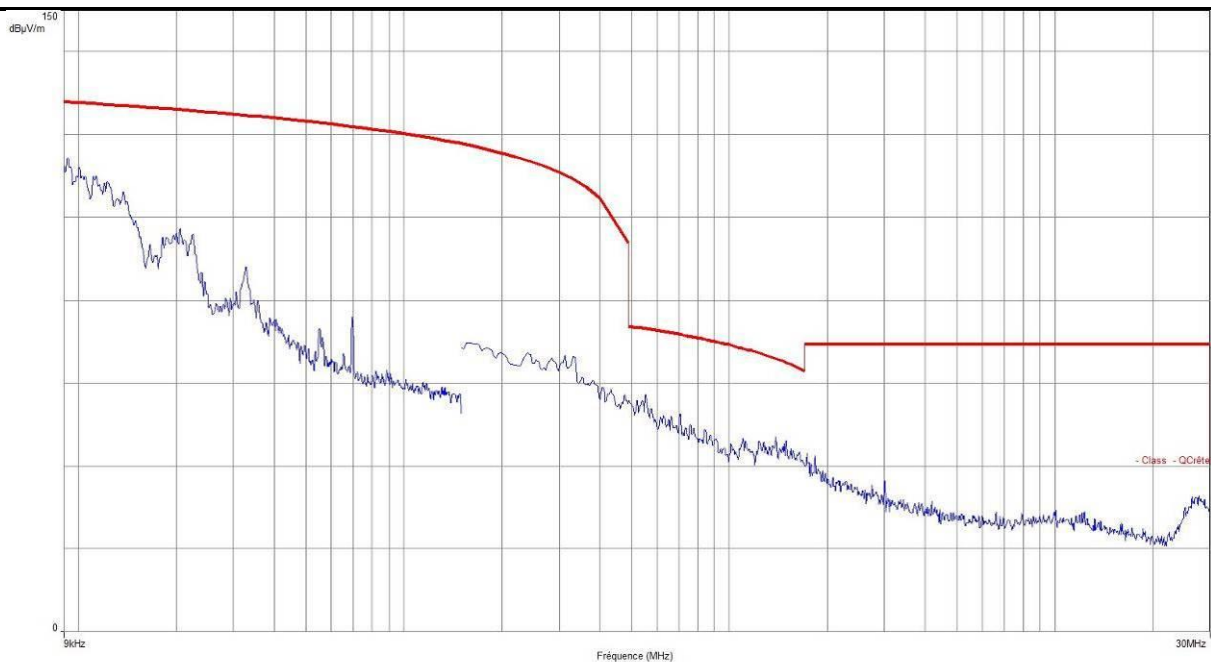
Graph name :	Emr#4	Test configuration:
Limit :	FCC Part15C	(C-90°) - Axis Z - TX C11
Class :	B	

PARAMETERS

Antenna polarization:	90°	Legend:
Azimuth :	0° - 360°	Peak Measure
RBW :	300Hz	QPeak Limit@3m
VBW :	1kHz	
Frequency :	9kHz- 150kHz	

PARAMETERS

Antenna polarization:	90°	Legend:
Azimuth :	0° - 360°	Peak Measure
RBW :	10kHz	QPeak Limit@3m
VBW :	30kHz	
Frequency :	150kHz- 30MHz	



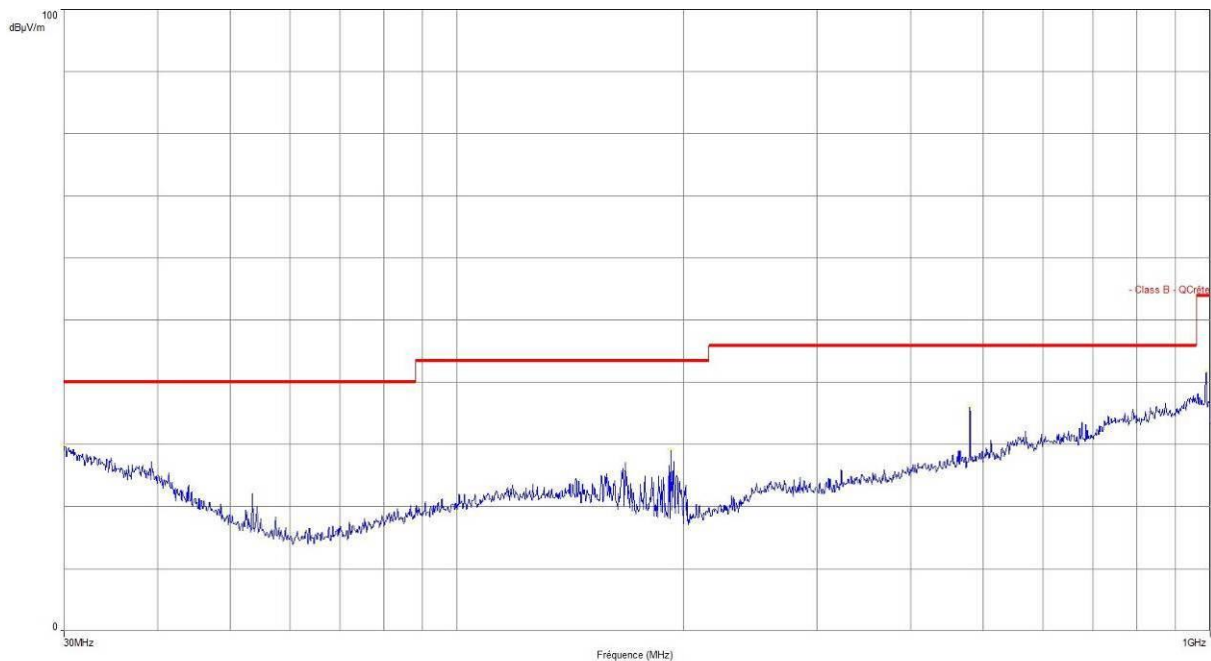


RADIATED EMISSIONS

Graph name :	Emr#5	Test configuration:
Limit :	FCC Part15C	(H) - Axis XY - TX C11
Class :	B	

PARAMETERS

Antenna polarization:	Horizontal	Legend:
Azimuth :	0° - 360°	Peak Measure
RBW :	100kHz	
VBW :	300kHz	QPeak Limit@3m
Frequency :	30MHz- 1GHz	



Frequency (MHz)	Peak (dBµV/m)
30.112	29.7
192.06	29
480.01	36.02
987.52*	41.73

* Frequency due to spectrum analyzer, not EUT.

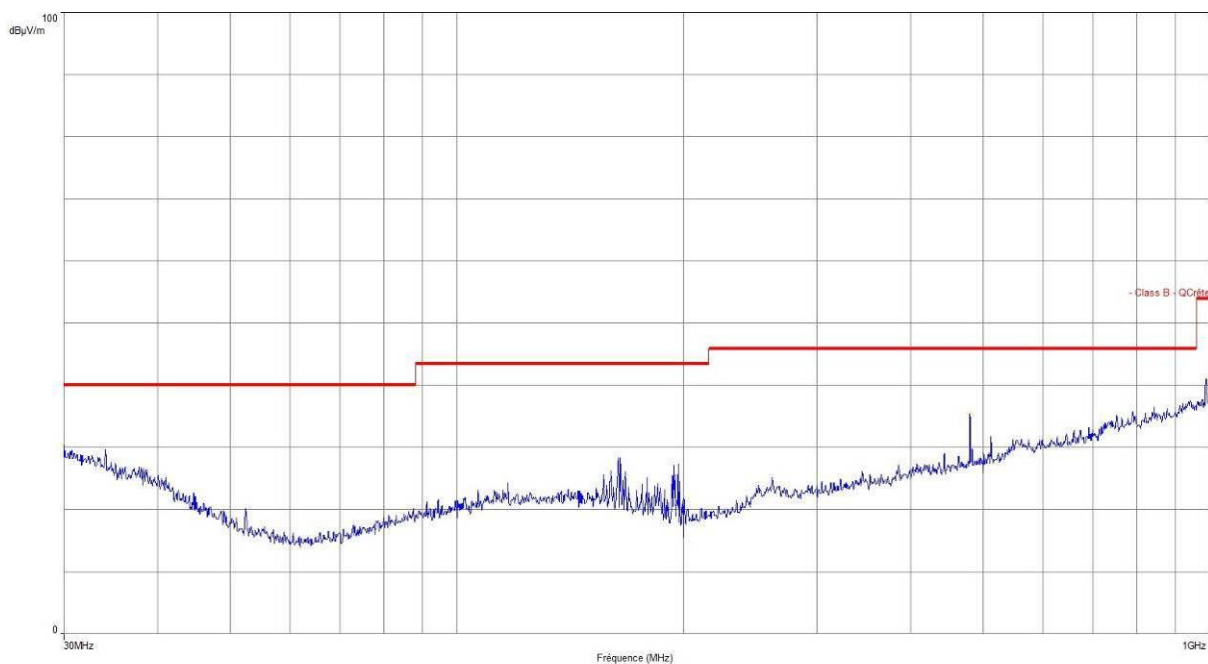


RADIATED EMISSIONS

Graph name :	Emr#6	Test configuration:
Limit :	FCC Part15C	(H) - Axis Z - TX C11
Class :	B	

PARAMETERS

Antenna polarization:	Horizontal	Legend:
Azimuth :	0° - 360°	Peak Measure
RBW :	100kHz	
VBW :	300kHz	QPeak Limit@3m
Frequency :	30MHz- 1GHz	



Frequency (MHz)	Peak (dBμV/m)
30.007	30.41
480.01	35.37
987.5*	41.16

* Frequency due to spectrum analyzer, not EUT.

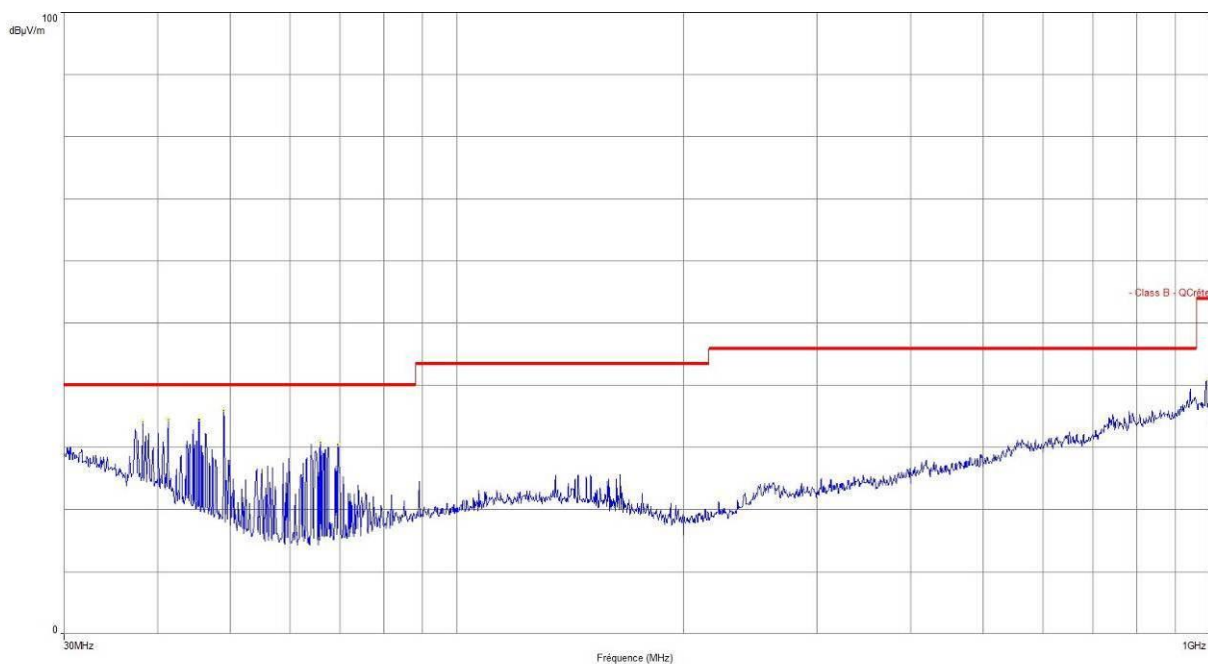


RADIATED EMISSIONS

Graph name :	Emr#7	Test configuration:
Limit :	FCC Part15C	(V) - Axis XY - TX C11
Class :	B	

PARAMETERS

Antenna polarization:	Vertical	Legend:
Azimuth :	0° - 360°	Peak Measure
RBW :	100kHz	
VBW :	300kHz	QPeak Limit@3m
Frequency :	30MHz- 1GHz	



Frequency (MHz)	Niveau (dBμV/m)
38.218	34.28
41.305	34.59
45.372	34.65
49.019	36.04
65.763	30.89
69.41	30.61

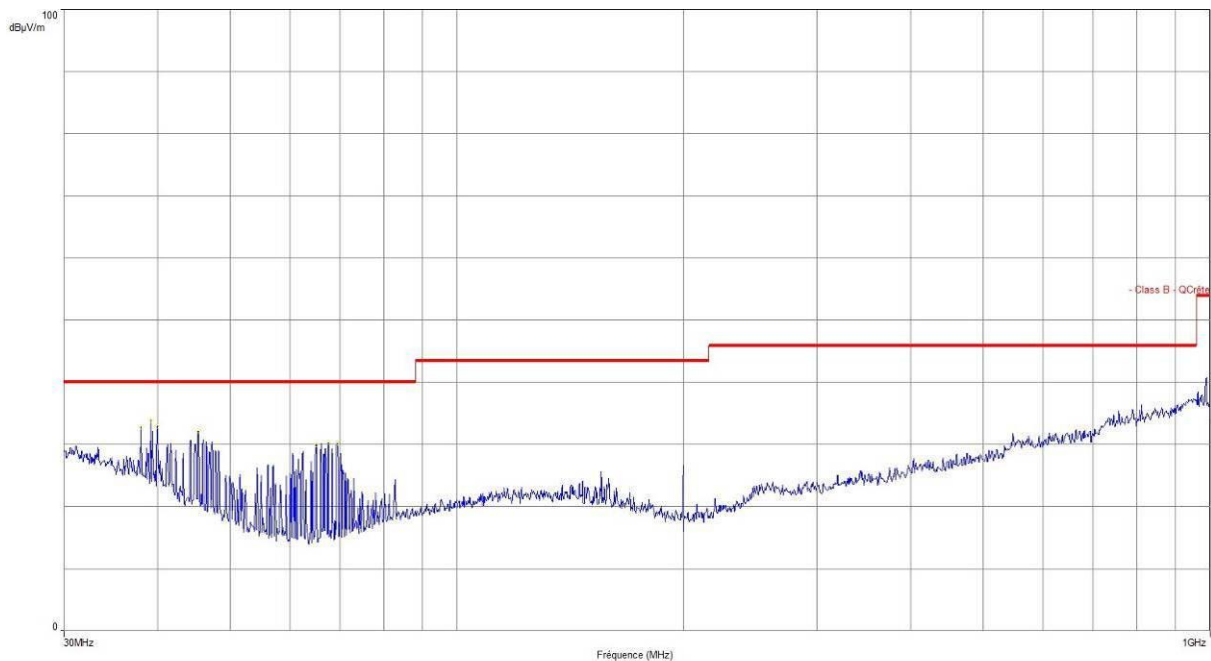


RADIATED EMISSIONS

Graph name :	Emr#8	Test configuration:
Limit :	FCC Part15C	(V) - Axis Z - TX C11
Class :	B	

PARAMETERS

Antenna polarization:	Vertical	Legend:
Azimuth :	0° - 360°	Peak Measure
RBW :	100kHz	
VBW :	300kHz	QPeak Limit@3m
Frequency :	30MHz- 1GHz	



Frequency (MHz)	Niveau (dBμV/m)
38.036	32.79
39.156	33.89
39.94	32.99
45.33	32.15
64.965	29.95
67.408	30.38
69.263	30.24



RADIATED EMISSIONS

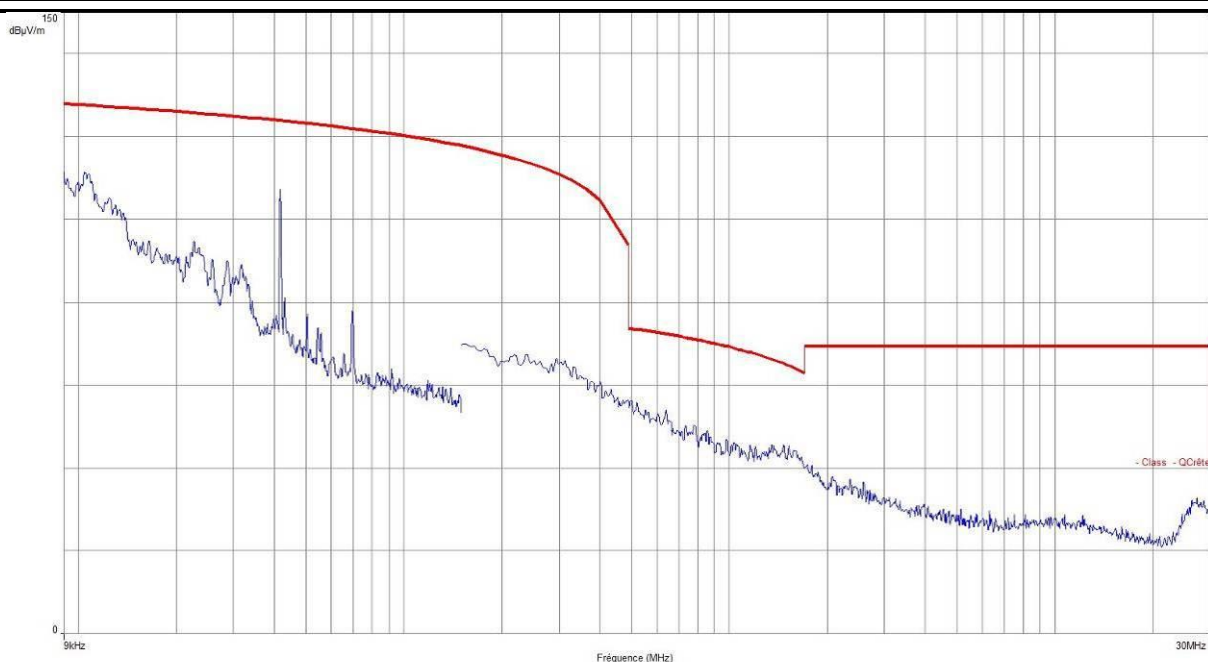
Graph name :	Emr#9	Test configuration:
Limit :	FCC Part15C	(C-0°) - Axis XY - TX C26
Class :	B	

PARAMETERS

Antenna polarization:	0°	Legend:
Azimuth :	0° - 360°	Peak Measure
RBW :	300Hz	QPeak Limit@3m
VBW :	1kHz	
Frequency :	9kHz- 150kHz	

PARAMETERS

Antenna polarization:	0°	Legend:
Azimuth :	0° - 360°	Peak Measure
RBW :	10kHz	QPeak Limit@3m
VBW :	30kHz	
Frequency :	150kHz- 30MHz	





RADIATED EMISSIONS

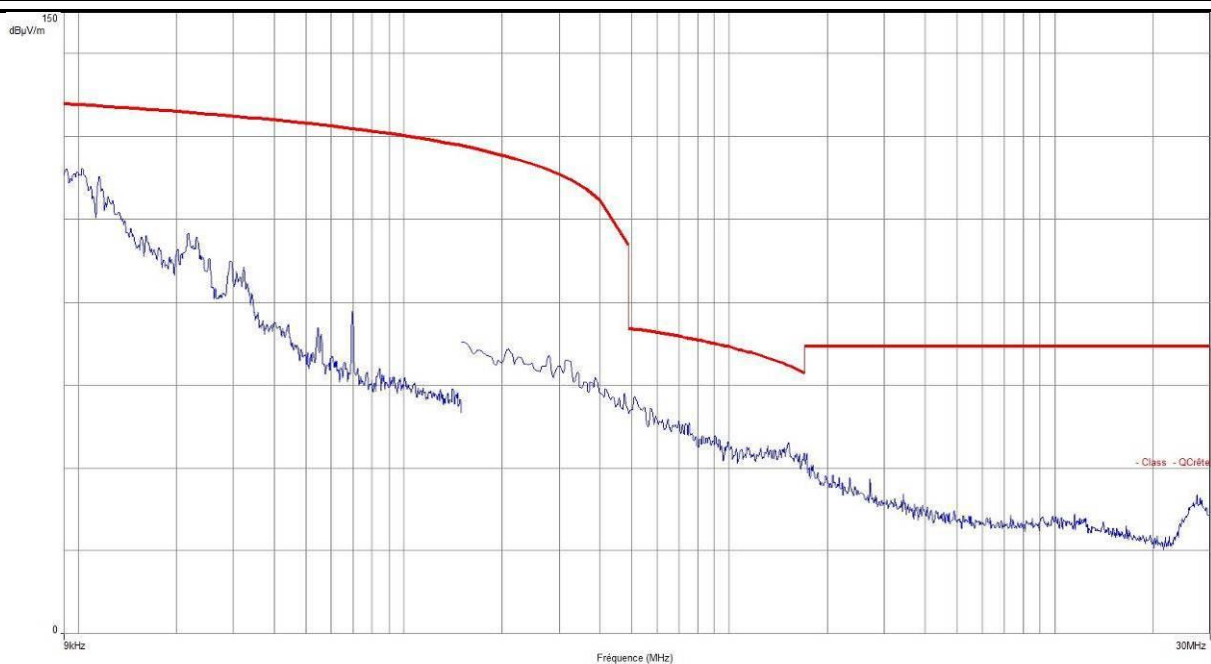
Graph name :	Emr#10	Test configuration:
Limit :	FCC Part15C	(C-0°) - Axis Z - TX C26
Class :	B	

PARAMETERS

Antenna polarization:	0°	Legend:
Azimuth :	0° - 360°	Peak Measure
RBW :	300Hz	QPeak Limit@3m
VBW :	1kHz	
Frequency :	9kHz- 150kHz	

PARAMETERS

Antenna polarization:	0°	Legend:
Azimuth :	0° - 360°	Peak Measure
RBW :	10kHz	QPeak Limit@3m
VBW :	30kHz	
Frequency :	150kHz- 30MHz	





RADIATED EMISSIONS

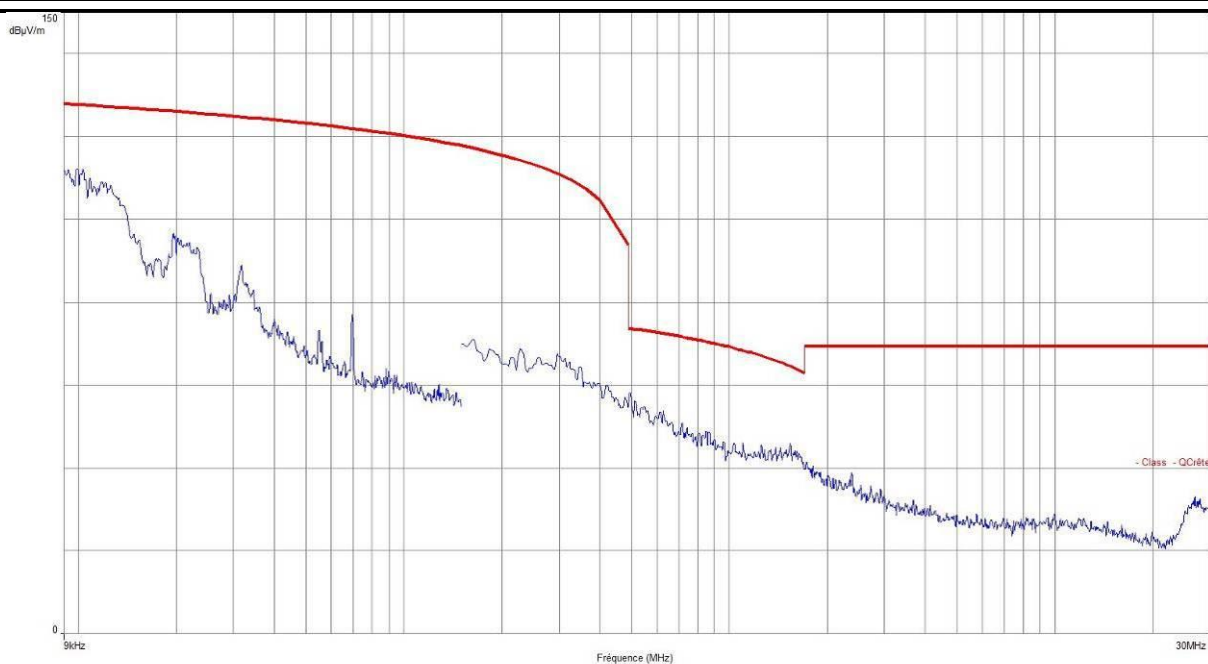
Graph name :	Emr#11	Test configuration:
Limit :	FCC Part15C	(C-90°) - Axis XY - TX C26
Class :	B	

PARAMETERS

Antenna polarization:	90°	Legend:
Azimuth :	0° - 360°	Peak Measure
RBW :	300Hz	QPeak Limit@3m
VBW :	1kHz	
Frequency :	9kHz- 150kHz	

PARAMETERS

Antenna polarization:	90°	Legend:
Azimuth :	0° - 360°	Peak Measure
RBW :	10kHz	QPeak Limit@3m
VBW :	30kHz	
Frequency :	150kHz- 30MHz	





RADIATED EMISSIONS

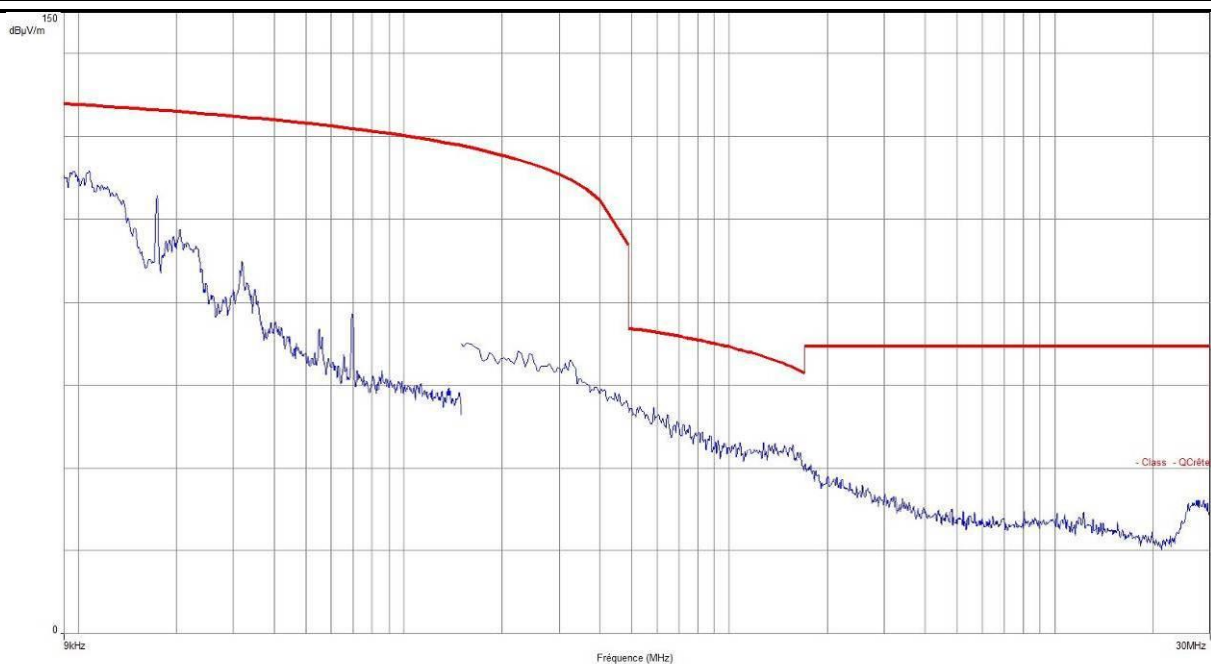
Graph name :	Emr#12	Test configuration:
Limit :	FCC Part15C	(C-90°) - Axis Z - TX C26
Class :	B	

PARAMETERS

Antenna polarization:	90°	Legend:
Azimuth :	0° - 360°	Peak Measure
RBW :	300Hz	QPeak Limit@3m
VBW :	1kHz	
Frequency :	9kHz- 150kHz	

PARAMETERS

Antenna polarization:	90°	Legend:
Azimuth :	0° - 360°	Peak Measure
RBW :	10kHz	QPeak Limit@3m
VBW :	30kHz	
Frequency :	150kHz- 30MHz	



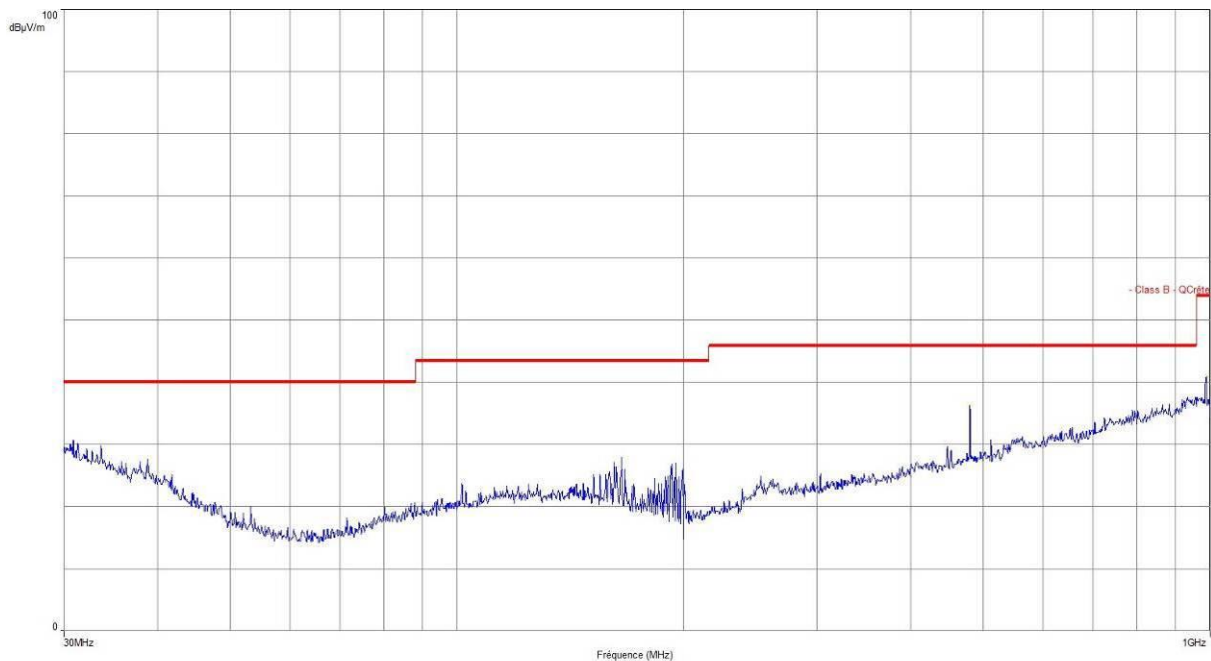


RADIATED EMISSIONS

Graph name :	Emr#13	Test configuration:
Limit :	FCC Part15C	(H) - Axis XY - TX C26
Class :	B	

PARAMETERS

Antenna polarization:	Horizontal	Legend:
Azimuth :	0° - 360°	Peak Measure
RBW :	100kHz	
VBW :	300kHz	QPeak Limit@3m
Frequency :	30MHz- 1GHz	



Frequency (MHz)	Peak (dBμV/m)
480	36.2
987.52*	40.9

* Frequency due to spectrum analyzer, not EUT.

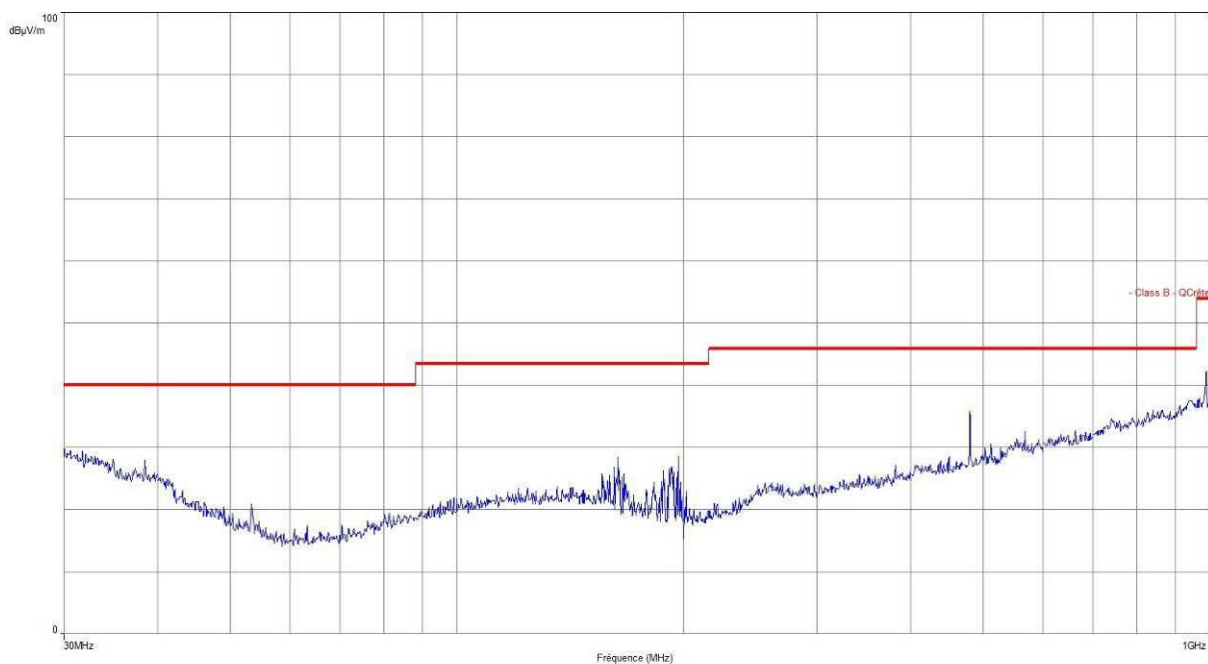


RADIATED EMISSIONS

Graph name :	Emr#14	Test configuration:
Limit :	FCC Part15C	(H) - Axis Z - TX C26
Class :	B	

PARAMETERS

Antenna polarization:	Horizontal	Legend:
Azimuth :	0° - 360°	Peak Measure
RBW :	100kHz	QPeak Limit@3m
VBW :	300kHz	
Frequency :	30MHz- 1GHz	



Frequency (MHz)	Peak (dBμV/m)
30.056	29.9
196.52	28.53
479.99	35.74
987.53*	42.27

* Frequency due to spectrum analyzer, not EUT.

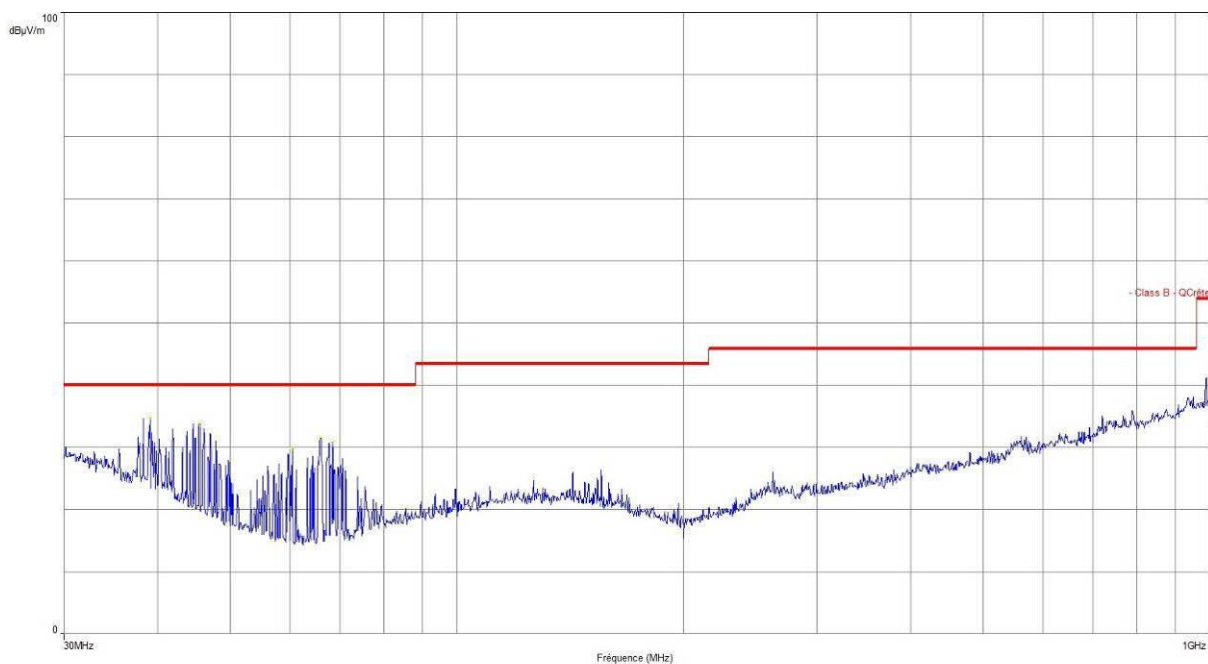


RADIATED EMISSIONS

Graph name :	Emr#15	Test configuration:
Limit :	FCC Part15C	(V) - Axis XY - TX C26
Class :	B	

PARAMETERS

Antenna polarization:	Vertical	Legend:
Azimuth :	0° - 360°	Peak Measure
RBW :	100kHz	
VBW :	300kHz	QPeak Limit@3m
Frequency :	30MHz- 1GHz	



Frequency (MHz)	Niveau (dBμV/m)
39.1	34.85
45.463	33.81
60.373	29.81
65.819	31.56
68.402	30.95

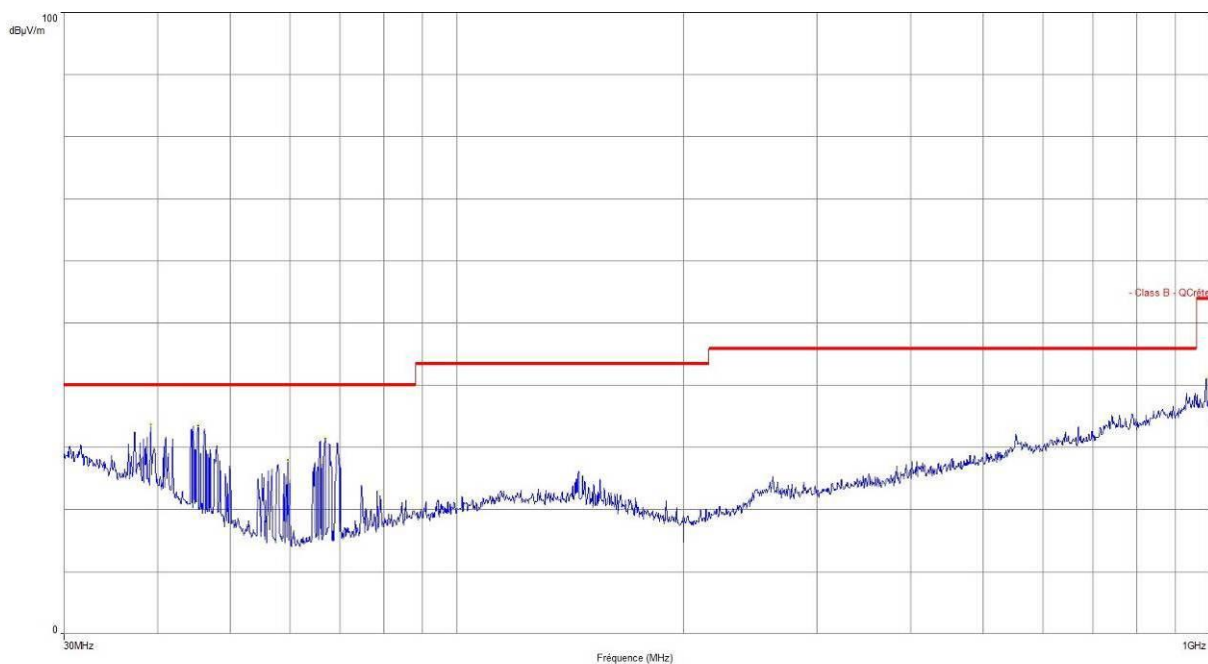


RADIATED EMISSIONS

Graph name :	Emr#16	Test configuration:
Limit :	FCC Part15C	(V) - Axis Z - TX C26
Class :	B	

PARAMETERS

Antenna polarization:	Vertical	Legend:
Azimuth :	0° - 360°	Peak Measure
RBW :	100kHz	
VBW :	300kHz	QPeak Limit@3m
Frequency :	30MHz- 1GHz	



Frequency (MHz)	Niveau (dBμV/m)
39.142	33.78
45.253	33.64
59.505	28.09
66.778	31.5
987.5*	41.19

* Frequency due to spectrum analyzer, not EUT.

**11. 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.