

LCIE
Etablissement de Moirans
ZI Centr'alp
170, rue de Chatagnon
38430 Moirans
RCS Grenoble 408 363 174
Tél : +33 4 76 07 36 36
Fax : +33 4 76 55 90 88



Rapport d'essai / Test report

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9 Avenue de la Gare
Rovaltain TGV - Quartier de la gare
26300 ALIXAN - FRANCE

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

Matériel testé / Apparatus under test :

- **Produit / Product** : **Terminal de paiement - automate / Payment terminal - Automaton**
- **Marque / Trade mark** : **INGENICO**
- **Constructeur / Manufacturer** : **INGENICO**
- **Type / Model** : **IUI120B**
- **Type sous test / Model under test** : **IUI120-11T2662**
- **N° de série / serial number** : **None**
- **FCC ID** : **XKB-IUI12X-RF**
- **IC** : **2586D-IUI12XRFB**

Date des essais / Test date : Du 17 Janvier au 19 Mars 2014 / *From 17th January to 19th March, 2014*

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 / Gaëtan Deschamps

Ce document comporte / Composition of document : 46 pages.

MOIRANS, LE 20 MARS / MARCH 20TH, 2014

Ecrit par / *Written by*
Anthony Merlin

Approuvé par / *Approved by*
Jacques Lorguin



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LCIE

33, av du Général Leclerc
BP 8
92266 Fontenay-aux-Roses cedex
France

Tel : +33 1 40 95 60 60
Fax : +33 1 40 95 86 56
contact@lcie.fr
www.lcie.fr

Société par Actions Simplifiée
au capital de 15 745 981 €
RCS Nanterre B 408 363 174
www.lcie.com



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1. TEST PROGRAM

Standard:

- FCC Part 15, Subpart C 15.247
- ANSI C63.4 (2003)
- RSS-210 Issue 8 – Dec 2010
- RSS-Gen Issue 3 – Dec 2010

EMISSION Test	LIMITS			RESULTS (Comments)
	Frequency	Quasi-peak value (dBµV)	Average value (dBµV)	
Limits for conducted disturbance at mains ports 150kHz-30MHz	150-500kHz	66 to 56	56 to 46	<input checked="" type="checkbox"/> PASS <input type="checkbox"/> FAIL <input type="checkbox"/> NA <input type="checkbox"/> NP
	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			<input checked="" type="checkbox"/> PASS <input type="checkbox"/> FAIL <input type="checkbox"/> NA <input type="checkbox"/> NP
Radiated emissions 30MHz-25GHz* CFR 47 §15.209 (a) CFR 47 §15.247 (d) RSS-210 §A8.5 Highest frequency : (Declaration of provider)	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			<input checked="" type="checkbox"/> PASS <input type="checkbox"/> FAIL <input type="checkbox"/> NA <input type="checkbox"/> NP
Maximum Peak Output Power CFR 47 §15.247 (b) RSS-210 §A8.4(1)	Limit: 21dBm Conducted or Radiated measurement			<input checked="" type="checkbox"/> PASS <input type="checkbox"/> FAIL <input type="checkbox"/> NA <input type="checkbox"/> NP
Hopping Channel Separation CFR 47 §15.247 (a) (1) RSS-210 §A8.1(b)	Minimum between: Two-third 20dB Bandwidth or 25kHz Whichever is greater			<input checked="" type="checkbox"/> PASS <input type="checkbox"/> FAIL <input type="checkbox"/> NA <input type="checkbox"/> NP
Number of Hopping Frequencies CFR 47 §15.247 (a) (1) (iii) RSS-210 §A8.1(d)	At least 15 channels used			<input checked="" type="checkbox"/> PASS <input type="checkbox"/> FAIL <input type="checkbox"/> NA <input type="checkbox"/> NP
Time of Occupancy (Dwell Time) CFR 47 §15.247 (a) (1) (iii) RSS-210 §A8.1(d)	Maximum 0.4 sec within 31.6sec			<input checked="" type="checkbox"/> PASS <input type="checkbox"/> FAIL <input type="checkbox"/> NA <input type="checkbox"/> NP
Band Edge Measurement CFR 47 §15.209 (a) CFR 47 §15.247 (d) RSS-210 §A8.5	Limit: -20dBc			<input checked="" type="checkbox"/> PASS <input type="checkbox"/> FAIL <input type="checkbox"/> NA <input type="checkbox"/> NP
Occupied bandwidth RSS-Gen §4.6.1	No limit			<input checked="" type="checkbox"/> PASS <input type="checkbox"/> FAIL <input type="checkbox"/> NA <input type="checkbox"/> NP
Receiver Spurious Emission** RSS-Gen §4.10	See RSS-Gen §4.10			<input type="checkbox"/> PASS <input type="checkbox"/> FAIL <input checked="" type="checkbox"/> NA <input type="checkbox"/> NP

*§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).

The equipment IUI120 can be used with several internal option cards:

- COM2 + MDB + Bluetooth Configuration n°1
- COM2 + MDB + Bluetooth + GPRS modular approval Configuration n°2 (Worst case)

The Equipment Under Test will be the configuration n°2 to represent others configurations.

IUI120 has to be integrated in unattended devices. The test configuration is given by the manufacturer

2.2. HARDWARE IDENTIFICATION

Equipment under test (EUT):

IUI120-11T2662

Serial number: **None**
FCC ID: **XKB-IUI12X-RF**
IC: **2586D-IUI12XRFB**

Power supply:

- DC voltage, 10-45VDC, tested at 12VDC (worst case)

During all the tests, EUT is supplied by an AC/DC adaptor, not supplied with EUT so not tested, PHIHONG PSM36W-120TW, 100-240VAC / 1.5A / 50-60Hz, output 12VDC / 3A or power supply of laboratory.

Input/output:

- 1 x Power supply connector, 2 wires
- 5 x USB
- 1 x LAN
- 2 x COM
- 1 x Earth
- 1 x Jack "Clock"
- 1 x MDB master
- 1 x MDB slave, same connector that power supply
- 2 x SMA connector, GPRS and Bluetooth
- 2 x SAM
- 1 x SIM
- 1 x MicroSD

RF Module contained:

- 1 x GPRS, module certified, FCCID: VW3HILOV2 and IC: 9140A-HILOV2 with antenna, GC300M-011-2500 (not supplied by provider), it's a deported antenna, none collocation with BT antenna inferior at 20cm.

Auxiliaries used for testing:

- 1 x Laptop TOSHIBA SATELLITE, PS141E-04YC, Sn: 13594938G
- 2 x SAM
- 1 x SIM

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

- 1 x AC power cord, 2 wires, unshielded: 2m
- 1 x DC power supply cable (fixed on mains power unit), with ferrite, unshielded: 1.75m
- 1 x Ethernet cable Type: STP Cat 5e, shielded: 1m
- 5 x USB cables, shielded: 1m
- 2 x RS232 Com cables, RJ11, unshielded, 1.5m (COM 0 & COM 2)
- 1 x MDB-slave '6 pins' <-> MDB-master '8 pins' cable, unshielded, 4 wires with WE ferrite 74271222, length: 1m
- 1 x Jack cable, unshielded, length: 0.2cm

Equipment information: (Declared by provider)

- Frequency band: [2400.0 – 2483.5] MHz
- Standard: Wifi Bluetooth Zigbee
- Spectrum Modulation: FHSS DSSS
- Modulation type: GFSK Pi/4 DQPSK 8DPSK
- Packet type: 1-DH5 2-DH5 3-DH5
- Transfert data rate: 1Mbps 2Mbps 3Mbps
- Number of channel: 79
- Channel separation: 5MHz 2MHz 1MHz
- Channel bandwidth: 10MHz 20MHz 1MHz
- RF mode: TX/RX RX Standby
- Antenna type: SMA connector + Whip antenna (not supplied)
- Antenna for test: Bluetooth antenna, EAD-FBTS35024-SM-ST.
- Antenna connector: Permanent external Permanent internal
None Temporary (only for tests)



2.3. EUT CONFIGURATION

For all tests:

A generic program test is loaded on EUT, in order to perform in loop following functions:

- Reading / writing SAM card (SAM1 & SAM2)
- Reading / writing μ SD card (MMC)
- RX/TX on Serial port (COM0 & COM2)
- RX/TX between MDB master and slave

With laptop:

- Continuous Ethernet communication is performed from EUT to Laptop (Ping)

For special Bluetooth tests:

With a special mode of EUT a communication is performed with CMU, a permanent link with followings parameters is tested (worst case):

- Permanent emission of the carrier frequency with modulation, highest, middle and lowest channel
- Choice of modulation type: Worst case, packet type DH5 with all modulations
- FHSS mode ON or OFF

2.4. EQUIPMENT MODIFICATIONS

None

2.5. SPECIAL ACCESSORIES

None

2.6. 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.

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

3. CONDUCTED EMISSION DATA

3.1. ENVIRONMENTAL CONDITIONS

Date of test : January 20th, 2014
Test performed by : Gaëtan Deschamps / Anthony Merlin
Atmospheric pressure : 986hPa
Relative humidity : 32%
Ambient temperature : 23°C

3.2. TEST SETUP

Mains terminals

The EUT and auxiliaries are set:

80cm above the ground on the non-conducting table (Table-top equipment)

10cm above the ground on isolating support (Floor standing equipment)

The distance between the EUT and the LISN is 80cm. The EUT is 40cm away for the vertical ground plane.

The EUT is powered by V_{nom} .

The EUT is powered through a LISN (measure). Auxiliaries are powered by another LISN.



Test setup



3.3. TEST METHOD

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 120V/60Hz power line voltage and compared to the FCC Part 15 subpart B §15.107 and C §15.207 limits. Measurement bandwidth was 9kHz from 150kHz to 30MHz. 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.

Measurements are performed on the phase (L1) and neutral (N) of power line voltage. A measurement is also performed with a 50Ω dummy load replacing the transmitter antenna in order to demonstrate that some 13.56MHz may be cross-coupled to AC line connection. Graphs are obtained in PEAK detection. Measures are also performed in Quasi-Peak and Average for any strong signal.

3.4. TEST EQUIPMENT LIST

DESCRIPTION	MANUFACTURER	MODEL	N° LCIE
Cable	-	-	A5329578
Conducted emission comb generator	BARDET	-	A3169049
Coupling Decoupling Network	TESEQ	T8	C2320140
Load 50Ω	-	-	A7152036
Receiver 20Hz-26.5GHz	ROHDE & SCHWARZ	ESMI	A2642009
LISN tri-phase ESH2-Z5	RHODE & SCHWARZ	33852.19.53	C2320062
Power supply DC	ISO-TECH	-	A7044291
Transient limiter	RHODE & SCHWARZ	ESH3-Z2	A7122204
Thermo-hygrometer (PM2)	OREGON	BAR916HG-G	B4206011

3.5. DIVERGENCE, ADDITION OR SUPPRESSION ON THE TEST SPECIFICATION

None Divergence:

3.6. TEST RESULTS

Measurements are performed on the phase (L1) and neutral (N) of the power line.

Results: (PEAK detection)

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

3.7. CONCLUSION

RESULTS: PASS FAIL

4. RADIATED EMISSION DATA

4.1. ENVIRONMENTAL CONDITIONS

Date of test : March 3rd, 2014
Test performed by : Anthony Merlin / Gaëtan Deschamps
Atmospheric pressure : 990hPa
Relative humidity : 26%
Ambient temperature : 23°C

4.2. TEST SETUP

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

The EUT and auxiliaries are set:

- 80cm above the ground on the non-conducting table (Table-top equipment)
- 10cm above the ground on isolating support (Floor standing equipment)

The EUT is powered by V_{nom} .



Test setup on OATS





4.3. TEST METHOD

Pre-characterisation measurement: (9kHz –25GHz)

A pre-scan of all the setup has been performed in a 3 meters semi-anechoic chamber for frequency from 30MHz to 25GHz. Test is performed in horizontal (H) and vertical (V) polarization, the loop antenna was rotated during the test for maximized the emission measurement. Continuous linear turntable azimuth search was performed with 360 degrees range. Measurement performed on all axis of EUT used in normal configuration.

The pre-characterization graphs are obtained in PEAK detection and PEAK/AVERAGE from 1GHz to 25GHz.

Characterization on 10 meters open site from 9kHz to 1GHz:

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 §15.225 limits in the frequency range 13.553MHz 13.567MHz. Measurement bandwidth was 9kHz below 30MHz and 120kHz from 30 MHz to 1GHz. Test is performed in horizontal (H) and vertical (V) polarization, the loop antenna was rotated during the test for maximized the emission measurement. The height antenna is varied from 1m to 4m. Continuous linear turntable azimuth search was performed with 360 degrees range. Measurement performed on all axis of EUT used in normal configuration. A summary of the worst case emissions found in all test configurations and modes is shown.

Frequency list has been created with anechoic chamber pre-scan results.

Characterization on 3 meters full 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.

Test is performed in horizontal (H) and vertical (V) polarization. Continuous linear turntable azimuth search was performed with 360 degrees range. Measurement performed on all axis of EUT used in normal configuration. A summary of the worst case emissions found in all test configurations and modes is shown. The height antenna is

- On mast, varied from 1m to 4m
- Fixed and centered on the EUT

Frequency list has been created with anechoic chamber pre-scan results.



4.4. TEST EQUIPMENT LIST

DESCRIPTION	MANUFACTURER	MODEL	N° LCIE
Amplifier 1-13GHz	LCIE SUD EST	-	A7102067
Antenna horn	EMCO	3115	C2042029
Antenna horn	EMCO	3115	C2042027
Cable N/N	-	-	A5329038
Cable N/N	-	-	A5329206
Cable	-	-	A5329603
Semi-Anechoic chamber #3	SIEPEL	-	D3044017
Digital Radiocommunication Tester	ROHDE & SCHWARZ	CMU200	A2440006
High Pass (4.8-18GHz)	BL Microwave	SH4800-1800	A7484034
Receiver 20Hz – 8GHz	ROHDE & SCHWARZ	ESU8	A2642019
Thermo-hygrometer (C3)	OREGON	BAR206	B4204078
Thermo-hygrometer (PM2)	OREGON	BAR916HG-G	B4206011
Turntable chamber (Cage#3)	ETS Lingren	Model 2165	F2000371
Antenna Loop	ELECTRO-METRICS	EM-6879	C2040052
Antenna Bi-log	CHASE	CBL6111A	C2040172
Cable N/N	-	-	A5329038
Cable N/N	-	-	A5329206
Radiated emission comb generator	BARDET	-	A3169050
Antenna Bi-log	CHASE	CBL6111A	C2040051
Cable (OATS)	-	-	A5329623
Radiated emission comb generator	BARDET	-	A3169050
OATS	-	-	F2000409
Receiver 20-1000MHz	ROHDE & SCHWARZ	ESVS30	A2642006
Turntable / Mast controller (OATS)	ETS Lindgren	Model 2066	F2000372
Antenna mast (OATS)	ETS Lindgren	2071-2	F2000392
Turntable (OATS)	ETS Lindgren	Model 2187	F2000403
Table	MATURO GmbH	-	F2000437

4.5. DIVERGENCE, ADDITION OR SUPPRESSION ON THE TEST SPECIFICATION

None

Divergence:



4.6. TEST RESULTS

4.6.1. Pre-characterization at 3 meters [9kHz-30MHz]

See graph for 9kHz-30MHz band:

0° polarization	Emr#1	(See annex 1)
90° polarization	Emr#2	(See annex 1)

4.6.2. Pre-characterization at 3 meters [30MHz-1GHz]

See graphs for 30MHz-1GHz:

H polarization	Emr#3	(See annex 1)
V polarization	Emr#4	(See annex 1)

4.6.3. Pre-characterization at 3 meters [1GHz-25GHz]

See graphs for 1GHz-2GHz:

H polarization	Emr#5	(See annex 1)
V polarization	Emr#6	(See annex 1)

4.6.4. Characterization on 10 meters open site below 30 MHz

Worst case final data result:

Frequency list has been created with semi-anechoic chamber pre-scan results. Measurements are performed using a QUASI-PEAK detection.

No	Frequency (MHz)	QPeak Limit (dBµV/m) @ 30m	Qpeak (dBµV/m) @ 30m	Margin (Mes-Lim) (dB)	Angle Table (deg)	Pol Ant.	Ht Ant. (cm)	Correc. Factor (dB)	Comments
No suspect frequency observed									

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

Limits Sub clause §15.225

Frequency (MHz)	Field strength (µV/m)	Measurement distance (m)
13.553-13.567	15 848 84 dBµV/m	30
13.410-13.553 13.567-13.710	334 50.5 dBµV/m	30
13.110-13.410 13.710-14.010	106 40.5 dBµV/m	30

See following chapter of this test report for band edge measurements.



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

Worst case final data result:

Frequency list has been created with semi-anechoic chamber pre-scan results.
Measurements are performed using a QUASI-PEAK detection.

No	Frequency (MHz)	Limit Quasi-Peak (dBµV/m)	Measure Quasi-Peak (dBµV/m)	Margin (Mes-Lim) (dB)	Angle Table (deg)	Pol Ant.	Ht Ant. (cm)	Correc. Factor (dB)	Comments
1	37.530	40.0	34.4	-5.6	275	V	100	16.2	*
2	120.954	43.5	37.4	-6.1	280	V	100	14.1	
3	145.145	43.5	35.3	-8.2	270	V	100	14.0	
4	169.337	43.5	37.6	-5.9	360	V	100	12.3	
5	193.520	43.5	38.7	-4.8	300	V	300	11.4	
6	203.826	43.5	28.8	-14.7	260	V	100	11.6	
7	210.840	43.5	25.4	-18.1	0	H	250	11.7	
8	255.401	46.0	22.8	-23.2	55	V	155	12.5	
9	314.482	46.0	35.6	-10.4	230	V	135	16.1	
10	338.673	46.0	33.2	-12.8	100	V	100	17.0	
11	483.754	46.0	34.3	-11.7	100	H	280	20.8	
12	532.200	46.0	32.7	-13.3	0	H	250	22.2	

* Measures have been done at 3m distance.

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



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

Worst case final data result:

The frequency list is created from the results obtained during the pre-characterization in anechoic chamber. Measurements are performed using a PEAK and AVERAGE detection.

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	1604.615	74.0	45.9	-28.1	5	V	100	-5.7	
2	2350.354	74.0	38.2	-35.8	65	V	100	-2.8	
3	2359.356	74.0	36.3	-37.7	55	V	100	-2.8	
4	2376.025	74.0	38.9	-35.1	355	V	100	-2.7	
5	2389.745	74.0	37.1	-36.9	0	V	100	-2.6	
6	2484.647	74.0	36.8	-37.2	25	H	100	-2.2	
7	2491.358	74.0	33.8	-40.2	65	V	100	-2.1	
8	2494.326	74.0	34.9	-39.1	45	V	100	-2.1	
9	4804.000	74.0	61.8	-12.2	5	H	100	4.6	
10	4882.000	74.0	59.3	-14.7	90	H	100	4.8	
11	4960.000	74.0	59.4	-14.6	5	H	100	5.1	
12	7206.000	74.0	61.8	-12.2	350	V	100	8.2	
13	7323.000	74.0	57.9	-16.1	345	V	100	8.6	
14	7440.000	74.0	54.7	-19.3	10	H	100	8.8	

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	1604.615	54.0	33.8	-20.2	5	V	100	-5.7	
2	2350.354	54.0	28.5	-25.5	65	V	100	-2.8	
3	2359.356	54.0	27.5	-26.5	55	V	100	-2.8	
4	2376.025	54.0	25.9	-28.1	355	V	100	-2.7	
5	2389.745	54.0	28.4	-25.6	0	V	100	-2.6	
6	2484.647	54.0	29.8	-24.2	25	H	100	-2.2	
7	2491.358	54.0	30.5	-23.5	65	V	100	-2.1	
8	2494.326	54.0	25.0	-29.0	45	V	100	-2.1	
9	4804.000	54.0	53.5	-0.5	5	H	100	4.6	
10	4882.000	54.0	51.2	-2.8	90	H	100	4.8	
11	4960.000	54.0	50.7	-3.3	5	H	100	5.1	
12	7206.000	54.0	37.7	-16.3	90	H	100	8.2	
13	7323.000	54.0	46.3	-7.7	345	V	100	8.6	
14	7440.000	54.0	43.6	-10.4	10	H	100	8.8	

Note: Measures have been done at 3m distance.

4.7. CONCLUSION

RESULTS:

PASS

FAIL

**5. MAXIMUM PEAK OUTPUT POWER (15.247)****5.1. ENVIRONMENTAL CONDITIONS**

Date of test : March 3rd, 2014
Test performed by : Anthony Merlin / Gaëtan Deschamps
Atmospheric pressure : 990hPa
Relative humidity : 27%
Ambient temperature : 22°C

5.2. EQUIPMENT CONFIGURATION

Modulation: FHSS
Packet Type: 1-DH5
Hopping sequence: OFF

5.3. TEST 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 3MHz RBW and 10MHz VBW.

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

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:

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

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:

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

**5.4. TEST EQUIPMENT LIST**

DESCRIPTION	MANUFACTURER	MODEL	N° LCIE
Attenuator 10dB	JFW	-	A7122166
Antenna horn	EMCO	3115	C2042027
Cable	-	-	A5329352
Cable	-	-	A5329057
Cable	-	-	A5329604
Digital Radiocommunication Tester	ROHDE & SCHWARZ	CMU200	A2440006
Receiver 20Hz – 8GHz	ROHDE & SCHWARZ	ESU8	A2642019
Thermo-hygrometer (C3)	OREGON	BAR206	B4204078

5.5. DIVERGENCE, ADDITION OR SUPPRESSION ON THE TEST SPECIFICATION None Divergence:

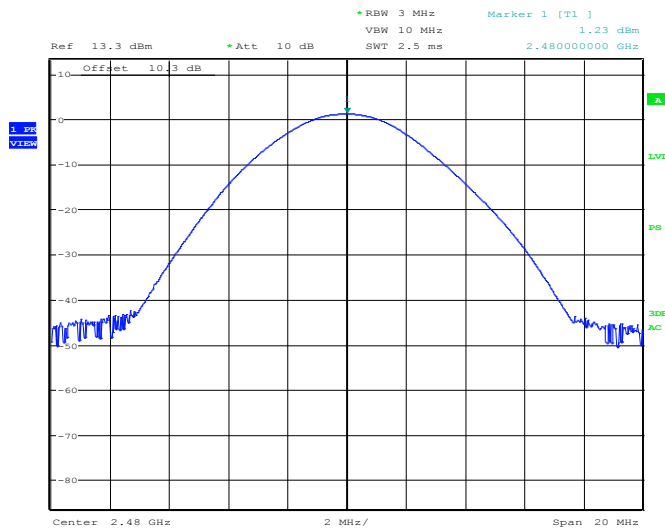
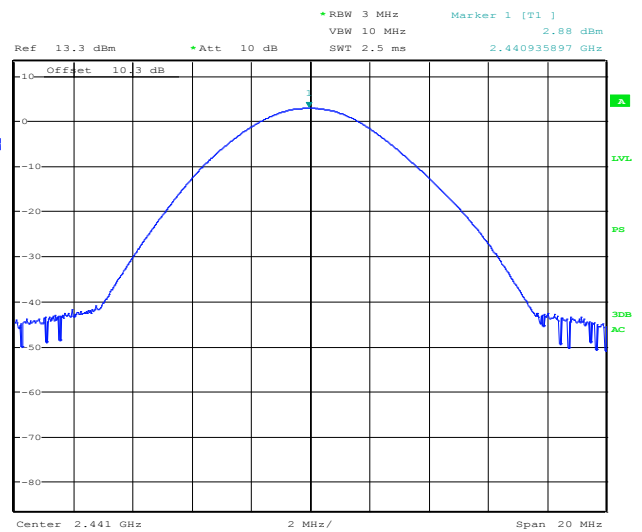
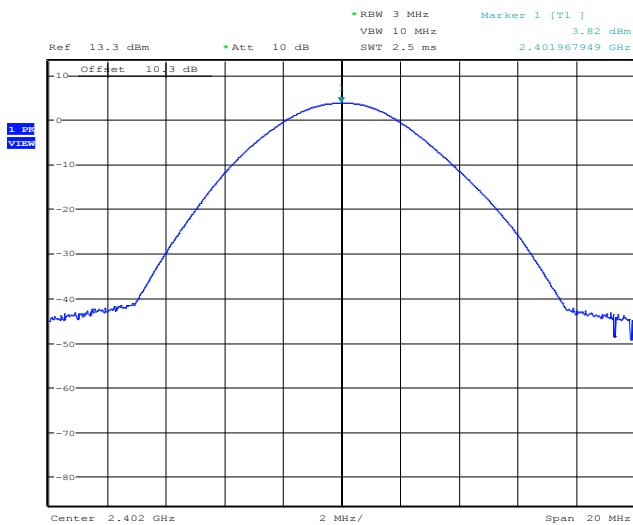


5.6. TEST RESULTS

Modulation: 1-DH5 worst case

Channel	Channel Frequency (MHz)	Peak Output Power (dBm)	Power Limit (dBm)
0	2402	3.9	30.0
39	2441	2.9	30.0
78	2480	1.3	30.0

Amplitude offset : cable + attenuator = 10.3 dB



5.7. CONCLUSION

RESULTS:

PASS

FAIL

**6. HOPPING CHANNEL SEPARATION (15.247)****6.1. ENVIRONMENTAL CONDITIONS**

Date of test : January 17th, 2014
Test performed by : A.MERLIN / G.DESCHAMPS
Atmospheric pressure : 978hPa
Relative humidity : 35%
Ambient temperature : 24°C

6.2. LIMIT

For frequency hopping system operating in the 2400-2483.5MHz, if the 20dB bandwidth of hopping channel is greater than 25kHz, two-thirds 20dB Bandwidth of hopping channel shall be a minimum limit for the hopping channel separation.

The maximum allowed 20dB bandwidth of hopping channel is 500kHz.

6.3. EQUIPMENT CONFIGURATION

Modulation type:	<input checked="" type="checkbox"/> GFSK	<input checked="" type="checkbox"/> Pi/4 DQPSK	<input checked="" type="checkbox"/> 8DPSK
Packet type:	DH1	DH3	DH5
Transfert data rate:	1Mbps	2Mbps	3Mbps
Hopping sequence:	ON		

6.4. SETUP – 20DB BANDWIDTH

The EUT is placed in an anechoic chamber; levels have been corrected to be in compliant with the Peak Output Power measured. The EUT is turn ON and using the MaxHold function, the frequency separation of two frequencies that were attenuated 20dB from the Peak Output Power level. A delta marker is used to measure the frequency difference as the emission bandwidth.

6.5. SETUP – ADJACENT CHANNEL SEPARATION

The EUT is placed in an anechoic chamber; levels have been corrected to be in compliant with the Peak Output Power measured. The EUT is turn ON and using the MaxHold function, the separation of two adjacent channels is recorded. A delta marker is used to measure the frequency difference.

**6.6. TEST EQUIPMENT LIST**

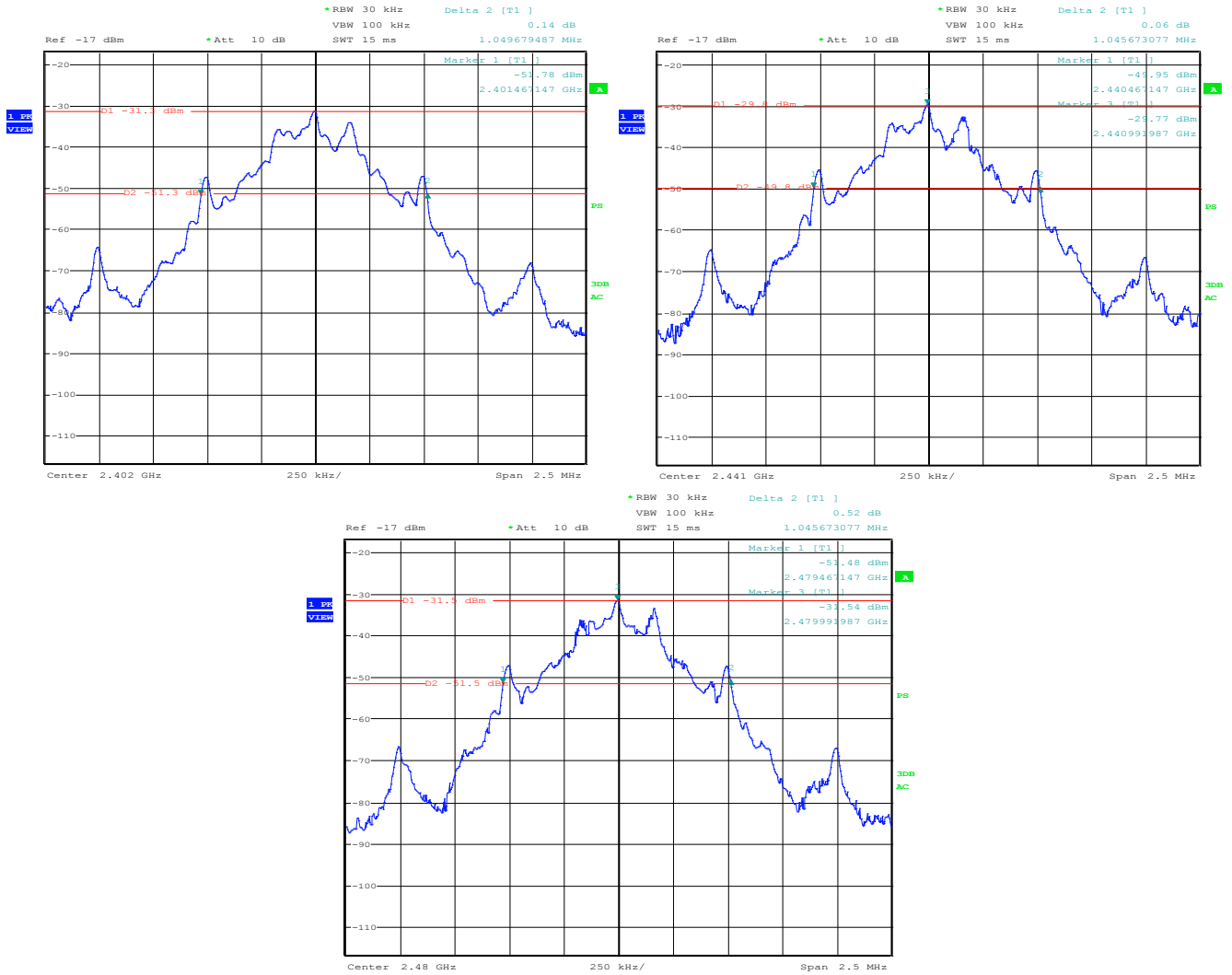
DESCRIPTION	MANUFACTURER	MODEL	N° LCIE
Antenna horn	EMCO	3115	C2042029
Cable N/N	-	-	A5329038
Cable N/N	-	-	A5329206
Antenna horn	EMCO	3115	C2042027
Cable	-	-	A5329352
Cable	-	-	A5329057
Semi-Anechoic chamber #3	SIEPEL	-	D3044017
Digital Radiocommunication Tester	ROHDE & SCHWARZ	CMU200	A2440006
Receiver 20Hz – 8GHz	ROHDE & SCHWARZ	ESU8	A2642019
Thermo-hygrometer (C3)	OREGON	BAR206	B4204078
Thermo-hygrometer (PM2)	OREGON	BAR916HG-G	B4206011
Turntable chamber (Cage#3)	ETS Lingren	Model 2165	F2000371

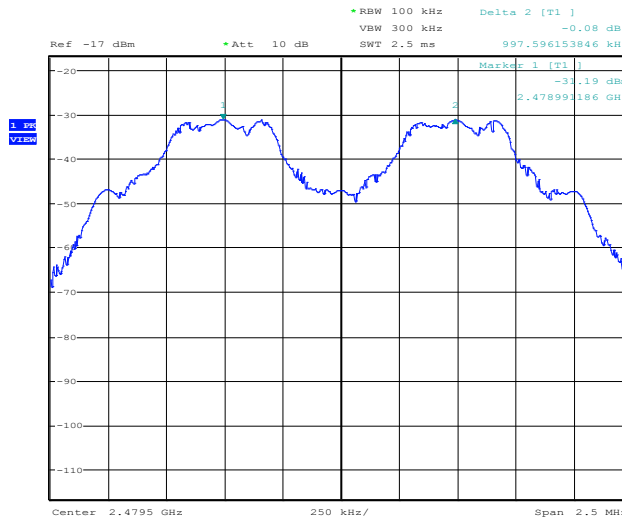
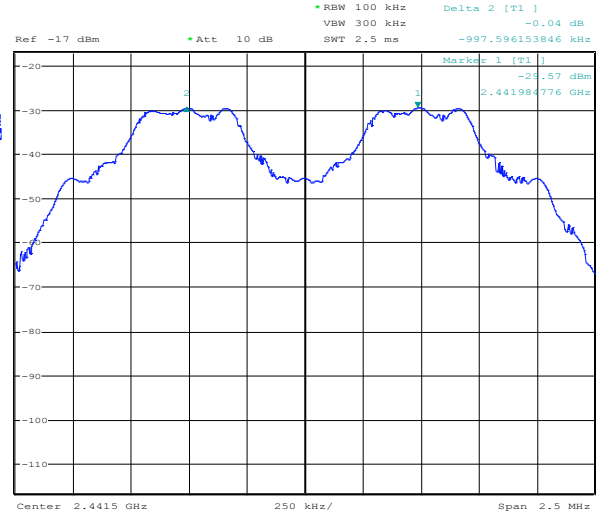
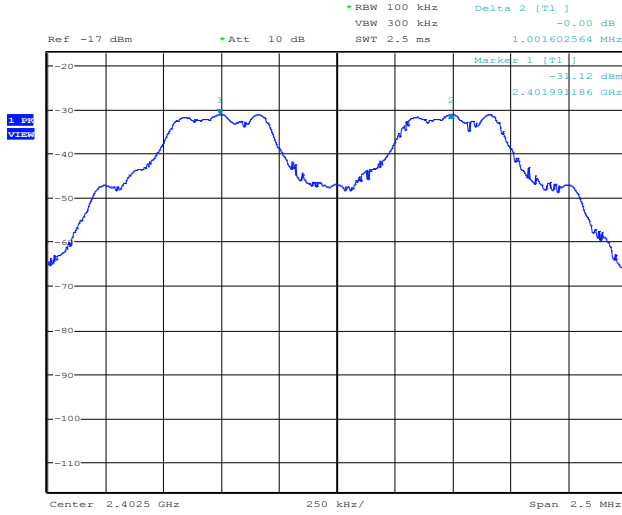
6.7. DIVERGENCE, ADDITION OR SUPPRESSION ON THE TEST SPECIFICATION None Divergence:



6.8. TEST SEQUENCE AND RESULTS

DH5 Packet:

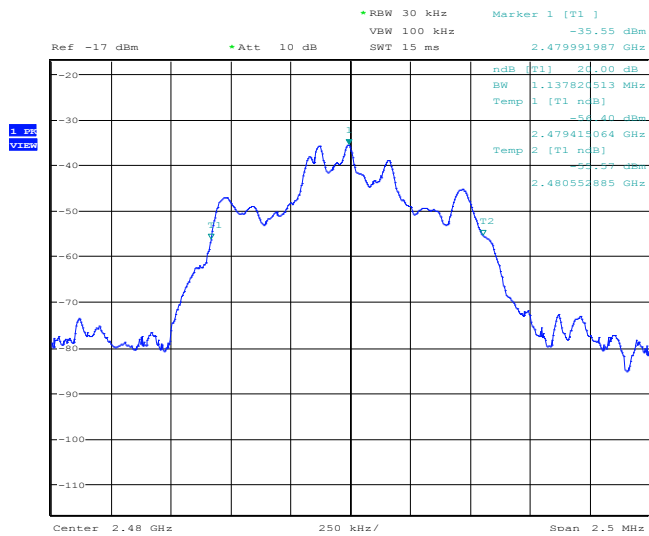
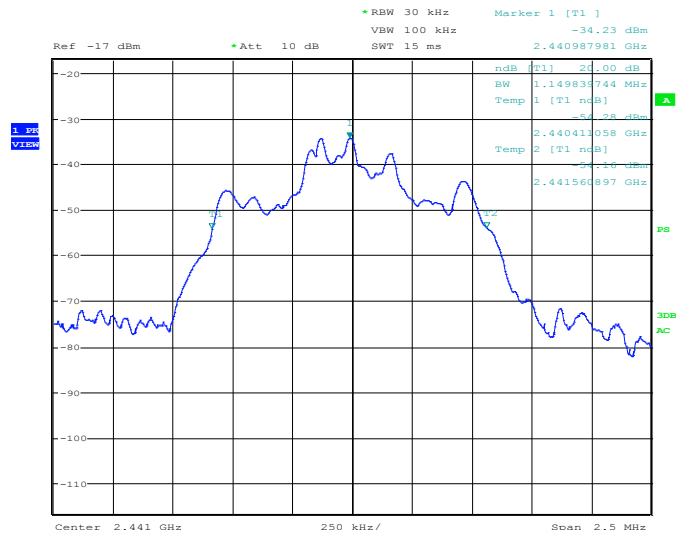
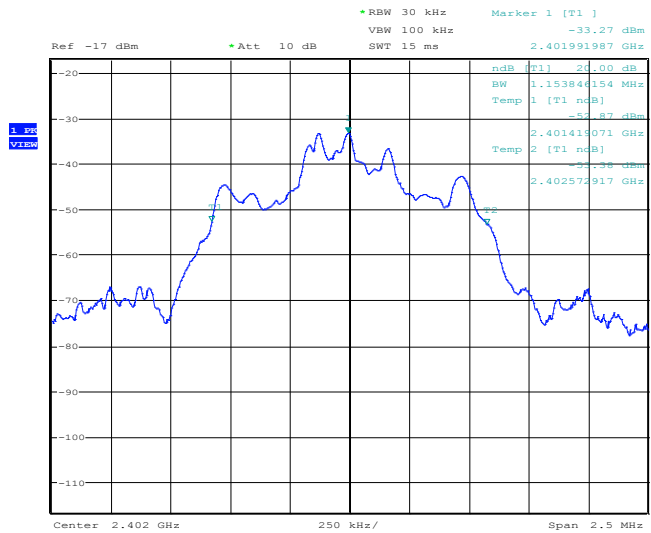


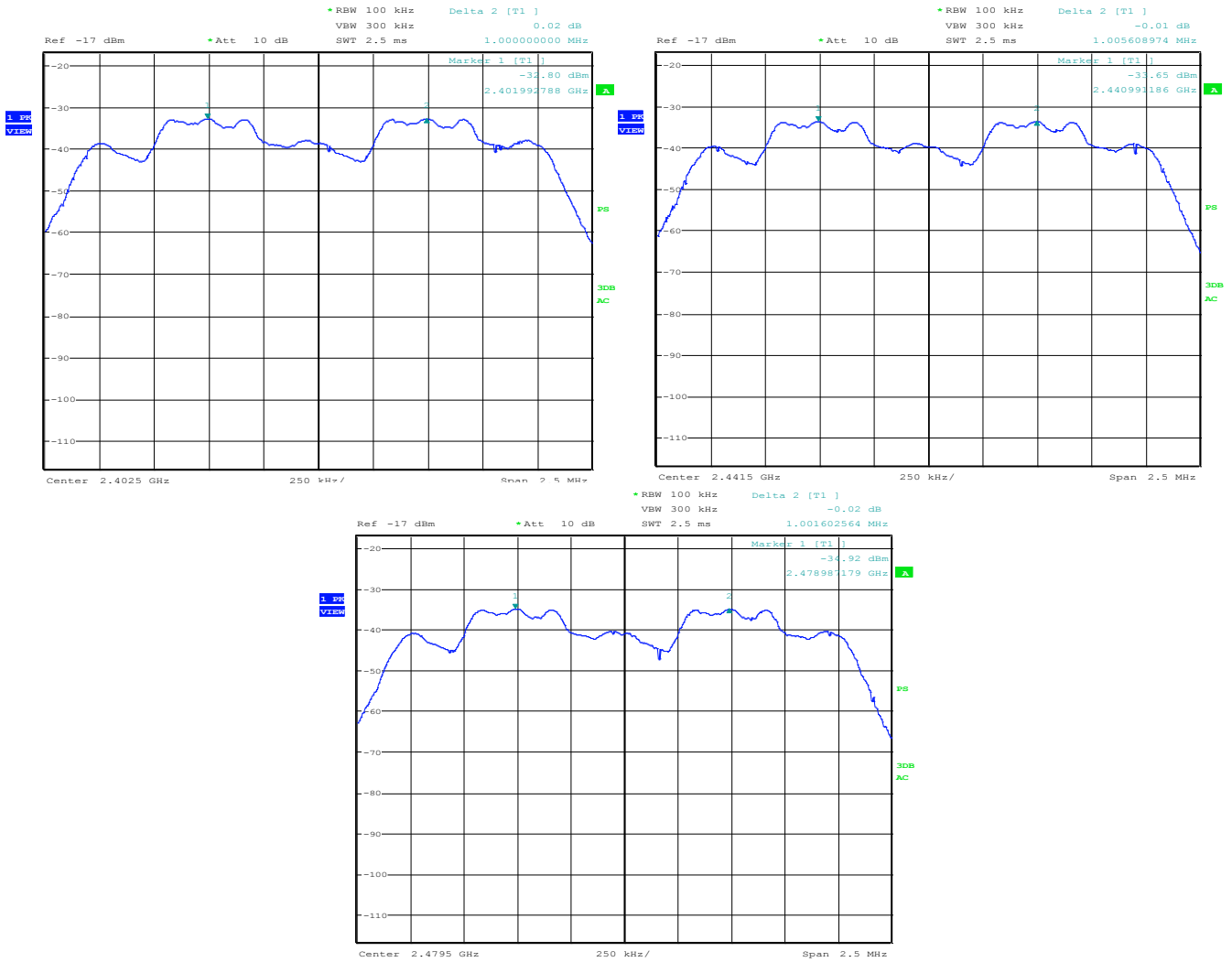


Channel	Channel Frequency (MHz)	Adjacent Channel Separation (MHz)	20dB Bandwidth (MHz)	Minimum Limit (MHz)	PASS / FAIL
0	2402	1.001	1.049	0.699	PASS
39	2441	0.997	1.045	0.697	PASS
78	2480	0.997	1.045	0.697	PASS

Limit used: Two-third 20dB Bandwidth

2-DH5 Packet:

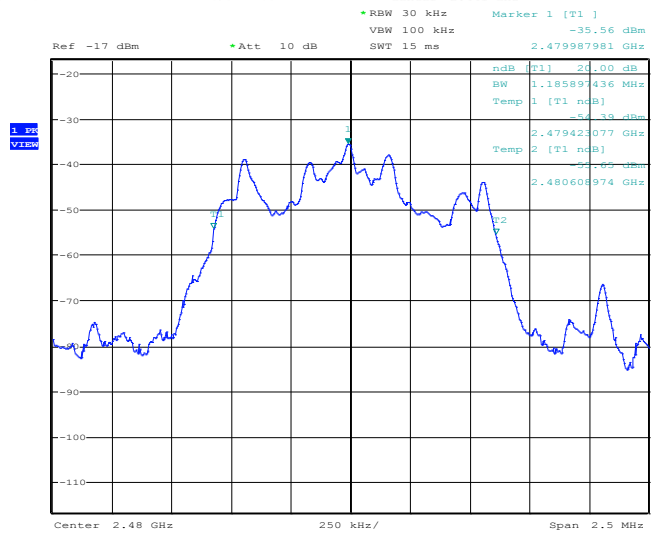
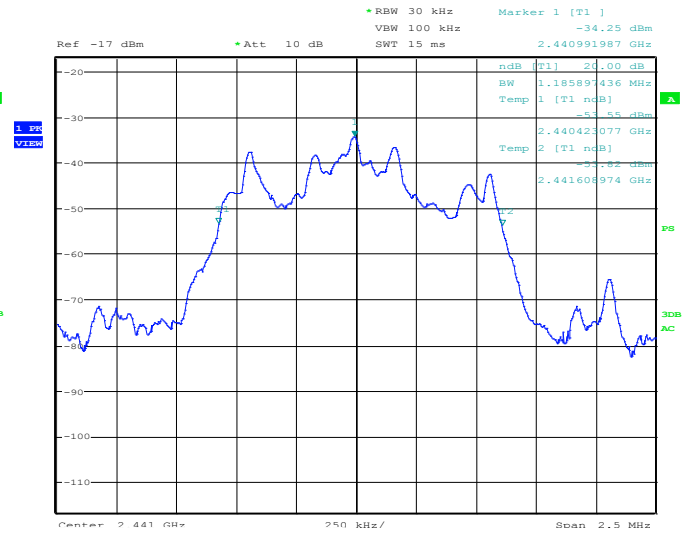
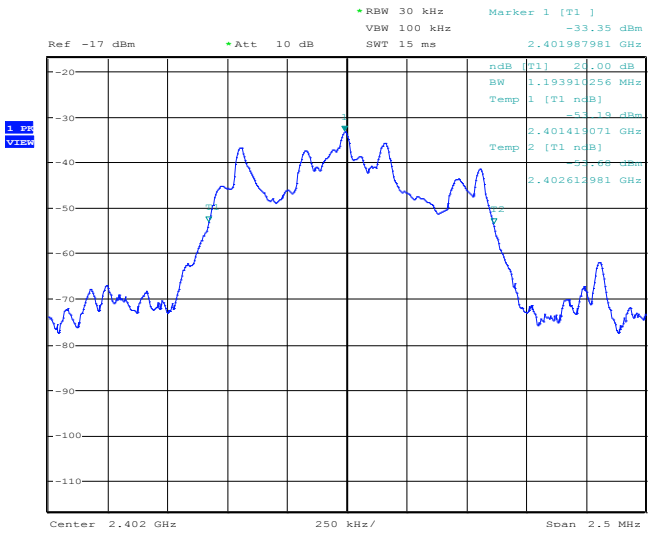


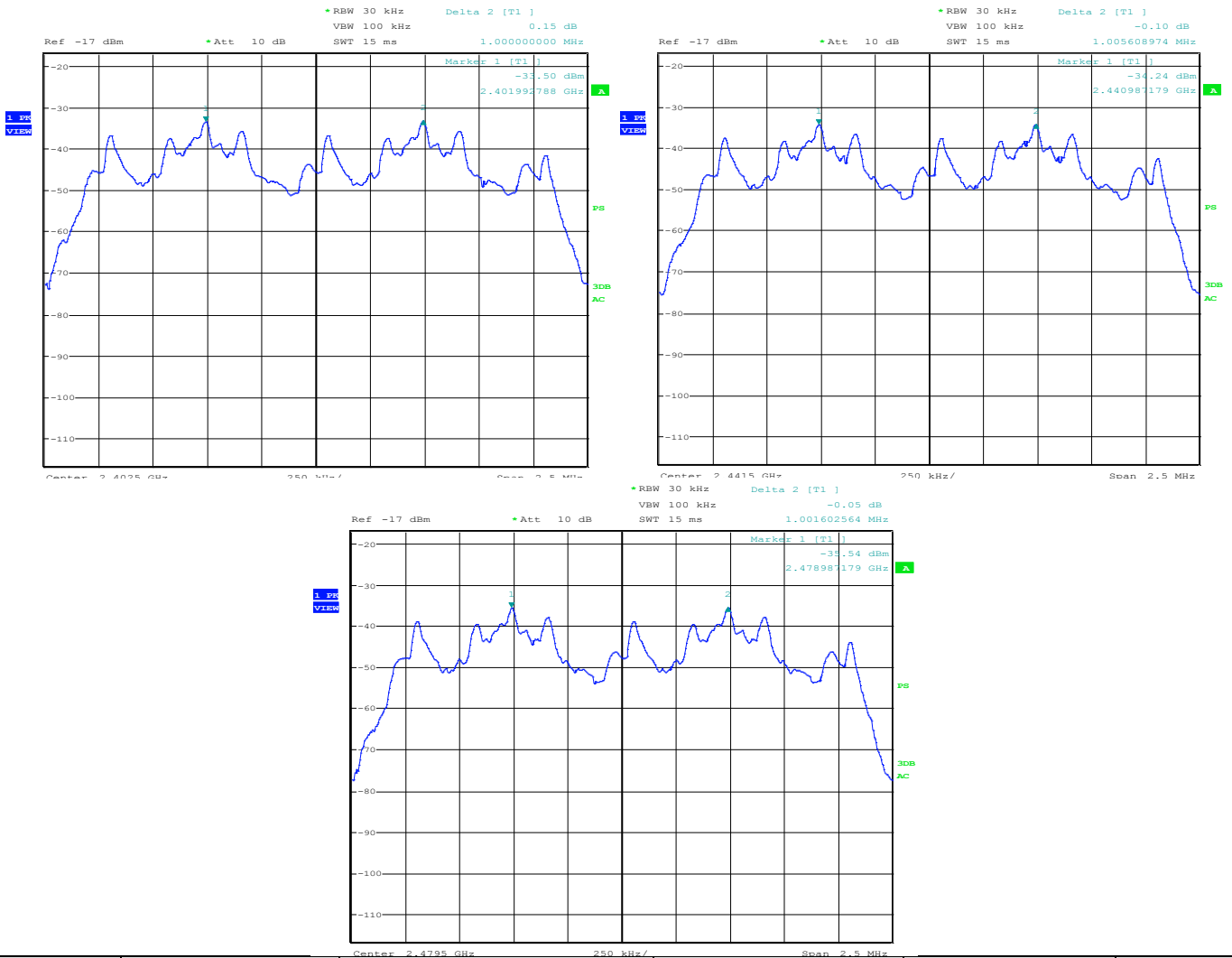


Channel	Channel Frequency (MHz)	Adjacent Channel Separation (MHz)	20dB Bandwidth (MHz)	Minimum Limit (MHz)	PASS / FAIL
0	2402	1.000	1.153	0.768	PASS
39	2441	1.005	1.149	0.766	PASS
78	2480	1.001	1.137	0.758	PASS

Limit used: Two-third 20dB Bandwidth

3-DH5 Packet:





Channel	Channel Frequency (MHz)	Adjacent Channel Separation (MHz)	20dB Bandwidth (MHz)	Minimum Limit (MHz)	PASS / FAIL
0	2402	1.000	1.193	0.795	PASS
39	2441	1.005	1.185	0.790	PASS
78	2480	1.001	1.185	0.790	PASS

Limit used: Two-third 20dB Bandwidth

6.9. CONCLUSION

RESULTS:

PASS

FAIL



7. NUMBER OF HOPPING FREQUENCIES (15.247)

7.1. ENVIRONMENTAL CONDITIONS

Date of test : January 17th, 2014
Test performed by : A.MERLIN / G.DESCHAMPS
Atmospheric pressure : 978hPa
Relative humidity : 35%
Ambient temperature : 24°C

7.2. LIMIT

For frequency hopping system operating in the 2400-2483.5MHz, at least 15 channels frequencies must be used and should be equally spaced.

7.3. EQUIPMENT CONFIGURATION

Modulation: 8DPSK
Packet Type: DH5 (same result with 2-DH5 or 3-DH5)
Hopping sequence: ON

7.4. SETUP

The EUT is placed in an anechoic chamber. The EUT is turn ON and using the MaxHold function and a delta marker the number of frequencies used for this FHSS system is recorded, see following graphs.

RBW: 100kHz
VBW: 300kHz

7.5. TEST EQUIPMENT LIST

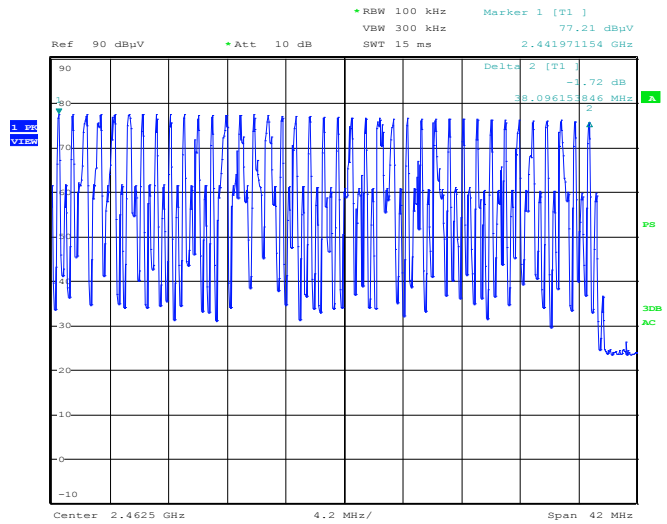
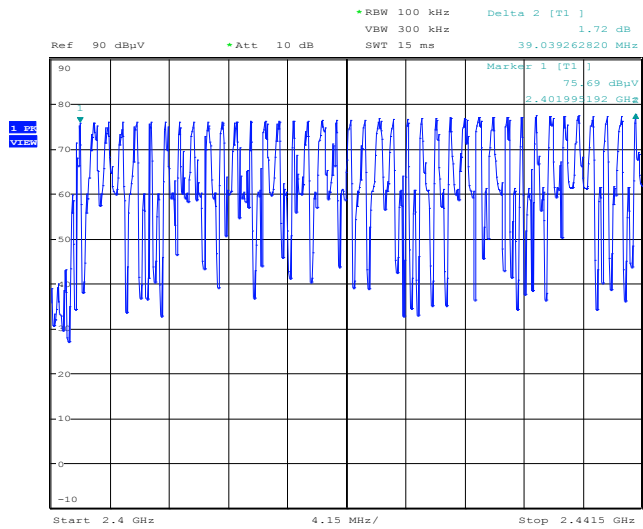
DESCRIPTION	MANUFACTURER	MODEL	N° LCIE
Antenna horn	EMCO	3115	C2042029
Cable N/N	-	-	A5329038
Cable N/N	-	-	A5329206
Antenna horn	EMCO	3115	C2042027
Cable	-	-	A5329352
Cable	-	-	A5329057
Semi-Anechoic chamber #3	SIEPEL	-	D3044017
Digital Radiocommunication Tester	ROHDE & SCHWARZ	CMU200	A2440006
Receiver 20Hz – 8GHz	ROHDE & SCHWARZ	ESU8	A2642019
Thermo-hygrometer (C3)	OREGON	BAR206	B4204078
Thermo-hygrometer (PM2)	OREGON	BAR916HG-G	B4206011
Turntable chamber (Cage#3)	ETS Lingren	Model 2165	F2000371

7.6. DIVERGENCE, ADDITION OR SUPPRESSION ON THE TEST SPECIFICATION

None Divergence:



7.7. TEST SEQUENCE AND RESULTS



Number of frequency used in the hopping sequence: 79 channels

7.8. CONCLUSION

RESULTS:

PASS

FAIL



8. TIME OF OCCUPANCY (DWELL TIME) (15.247)

8.1. ENVIRONMENTAL CONDITIONS

Date of test : January 17th, 2014
Test performed by : A.MERLIN / G.DESCHAMPS
Atmospheric pressure : 978hPa
Relative humidity : 35%
Ambient temperature : 24°C

8.2. LIMIT

The average time of occupancy on any channel shall not be greater than 0.4 seconds within period of 0.4 seconds multiplied by the number of hopping channels employed.

8.3. EQUIPMENT CONFIGURATION

Modulation type: GFSK Pi/4 DQPSK 8DPSK
Packet type: DH1 DH3 DH5
Transfert data rate: 1Mbps 2Mbps 3Mbps
Hopping sequence: ON

8.4. SETUP

The EUT is placed in an anechoic chamber. The EUT is turn ON; the Dwell Time is measured and calculated using the zero SPAN mode on a channel frequency and a SWEEP with an adapter value to measure the number of transmission within a period and the time of transmission
RBW: 100kHz
VBW: 300kHz

8.5. TEST EQUIPMENT LIST

DESCRIPTION	MANUFACTURER	MODEL	N° LCIE
Antenna horn	EMCO	3115	C2042029
Cable N/N	-	-	A5329038
Cable N/N	-	-	A5329206
Antenna horn	EMCO	3115	C2042027
Cable	-	-	A5329352
Cable	-	-	A5329057
Semi-Anechoic chamber #3	SIEPEL	-	D3044017
Digital Radiocommunication Tester	ROHDE & SCHWARZ	CMU200	A2440006
Receiver 20Hz – 8GHz	ROHDE & SCHWARZ	ESU8	A2642019
Thermo-hygrometer (C3)	OREGON	BAR206	B4204078
Thermo-hygrometer (PM2)	OREGON	BAR916HG-G	B4206011
Turntable chamber (Cage#3)	ETS Lingren	Model 2165	F2000371

8.6. DIVERGENCE, ADDITION OR SUPPRESSION ON THE TEST SPECIFICATION

None Divergence:

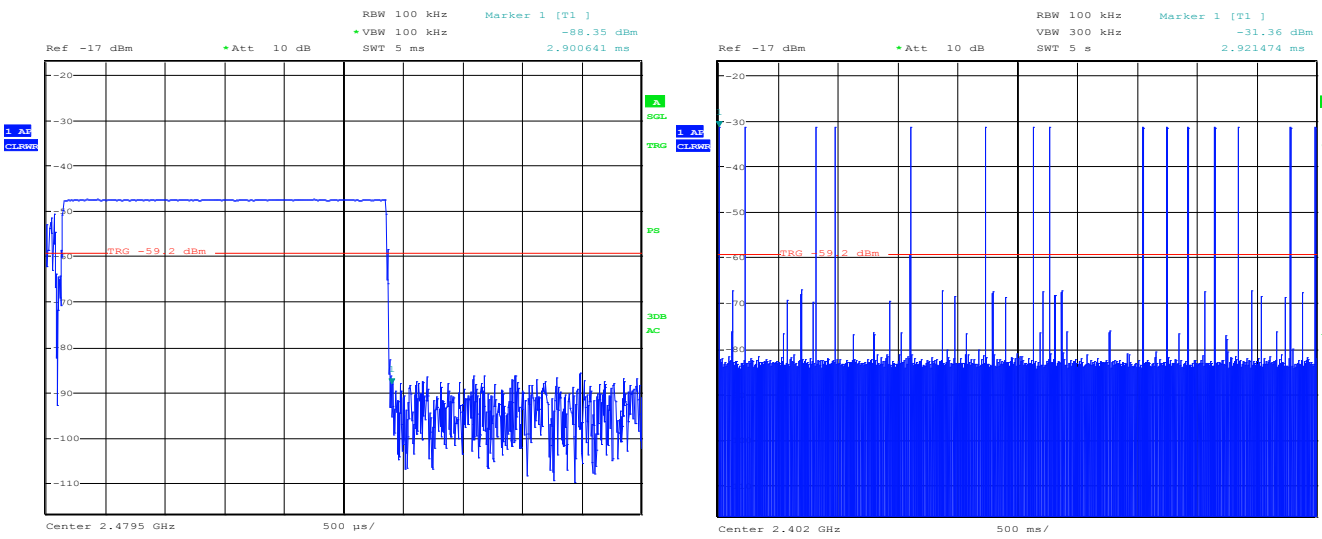


8.7. TEST SEQUENCE AND RESULTS

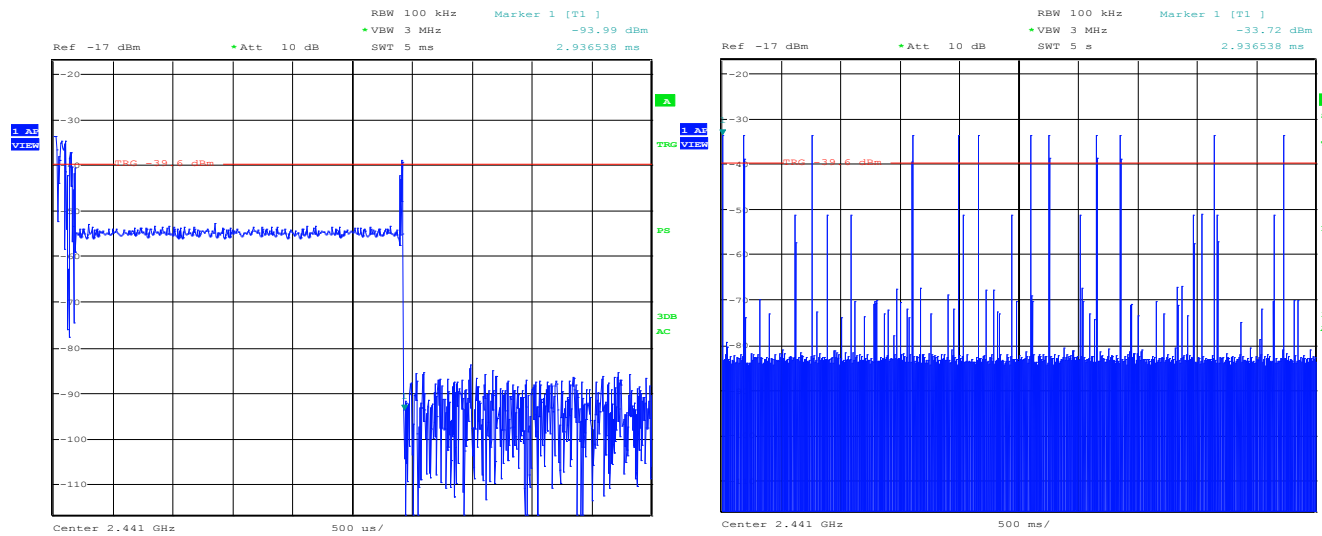
Packet Mode	Number of transmission in the period	Length of transmission time (ms)	Result (ms)	Limit (ms)	PASS / FAIL
DH5	20 (times/ 5 sec)	2.900	370	400	PASS
2-DH5	12 (times/ 5 sec)	2.936	222	400	PASS
3-DH5	16 (times/ 5 sec)	2.936	296	400	PASS

Note: Period of 31.6 seconds (79 channels x 0.4)

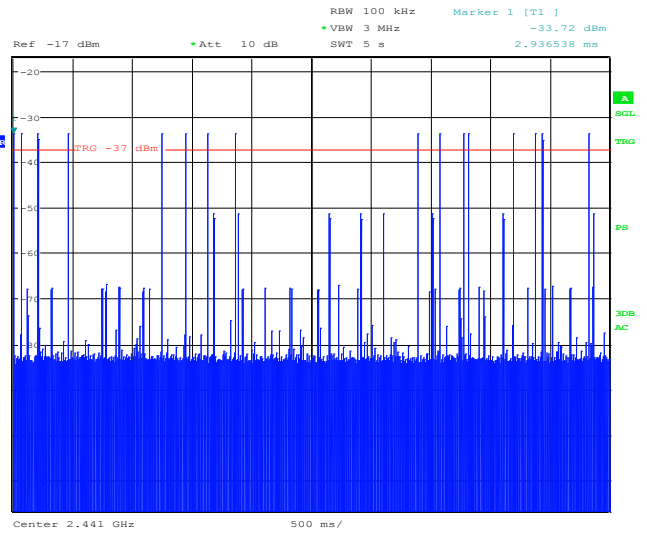
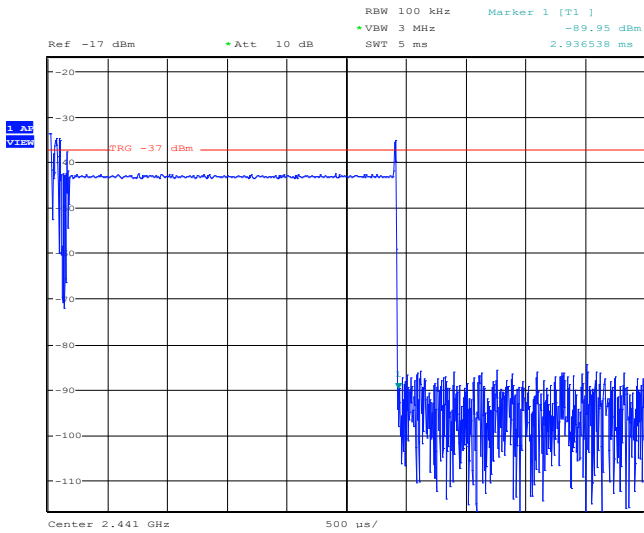
DH5:



2-DH5:



3-DH5 :



8.8. CONCLUSION

RESULTS:

PASS

FAIL

**9. BAND EDGE MEASUREMENT (15.247)****9.1. ENVIRONMENTAL CONDITIONS**

Date of test : March 3rd, 2014
Test performed by : Anthony Merlin / Gaëtan Deschamps
Atmospheric pressure : 990hPa
Relative humidity : 29%
Ambient temperature : 21°C

9.2. LIMIT

In Bandedge, the limit of spurious emissions are below -20dB of the highest emission level of operating band (in 100kHz RBW).

In the restrict band (2310-2390MHz) and (2483.5-2500MHz) including bandedge, the limit of spurious emissions are 15.209. (RBW:1MHz / VBW:1MHz)

9.3. EQUIPMENT CONFIGURATION

Modulation: FHSS
Packet Type: 1-DH5
Hopping sequence: ON

9.4. 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.

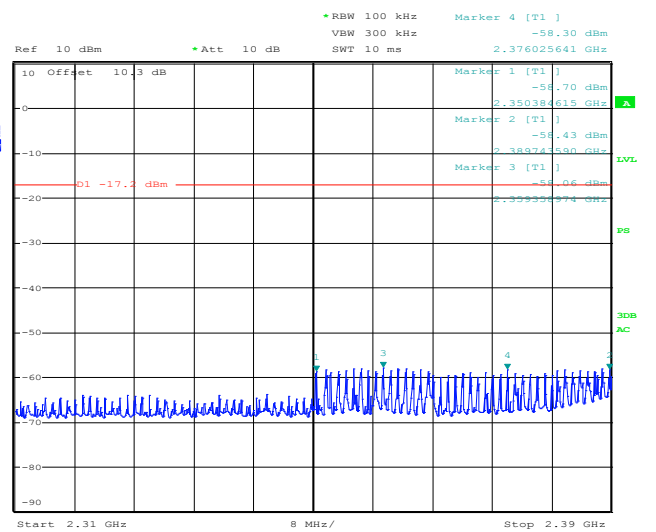
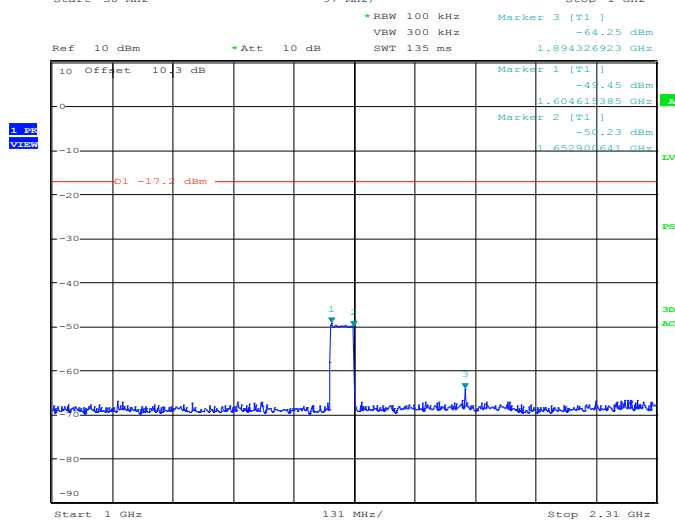
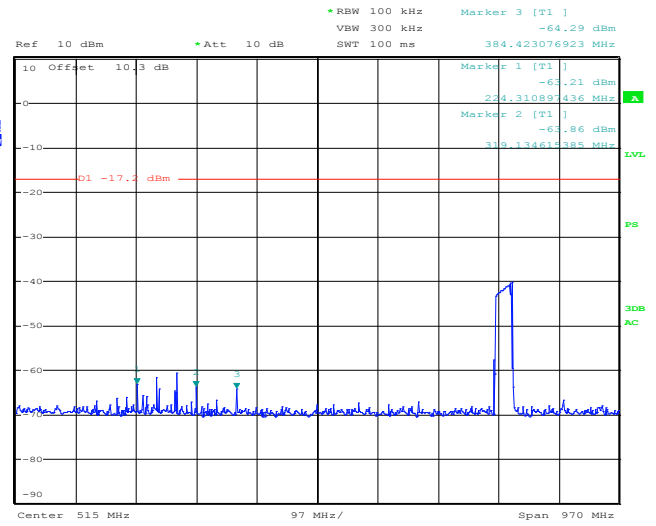
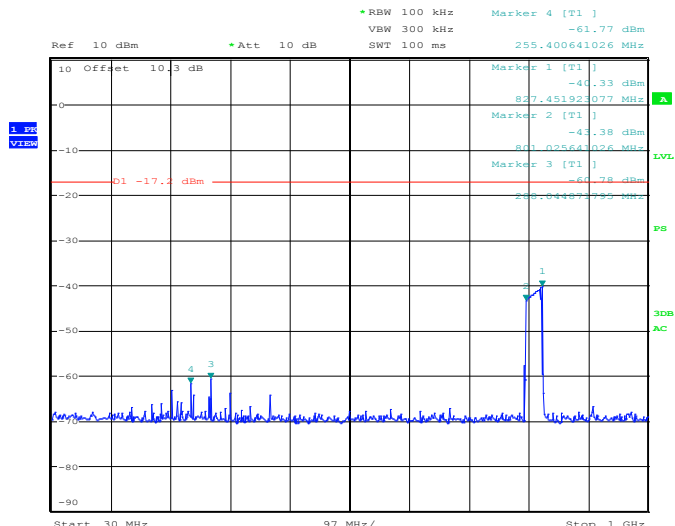
RBW: 100kHz
VBW: 300kHz

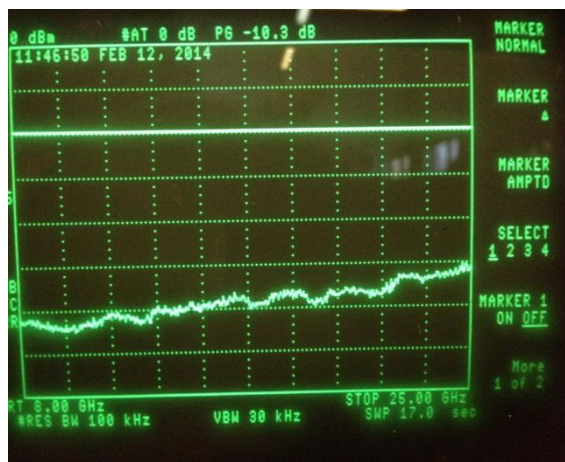
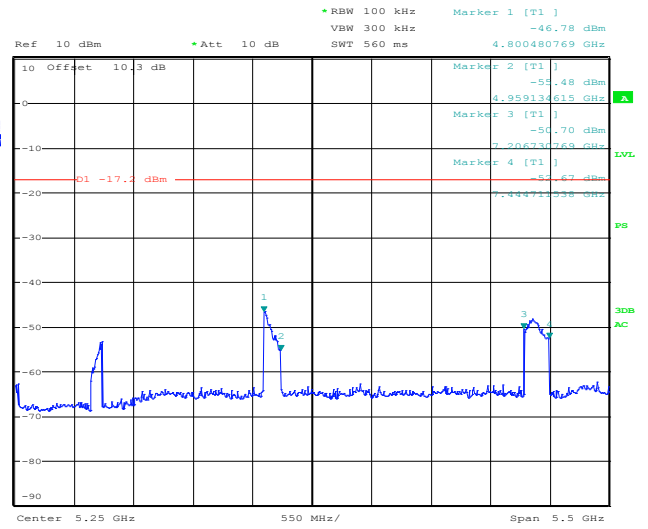
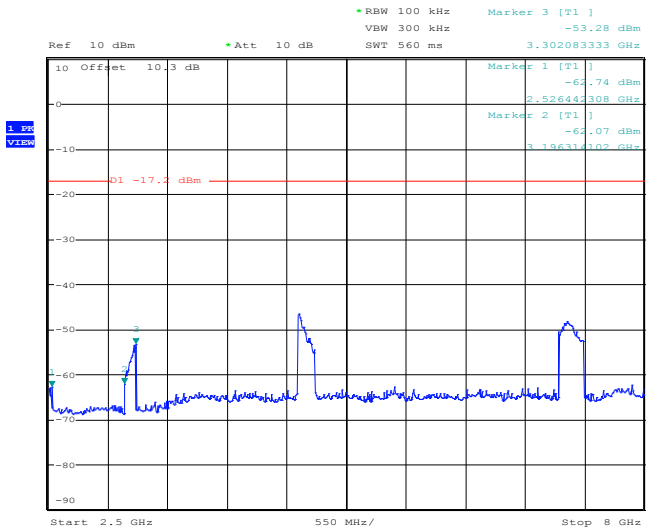
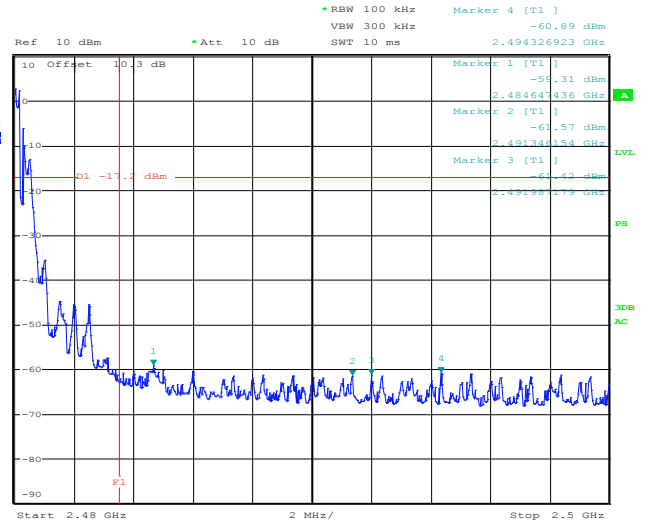
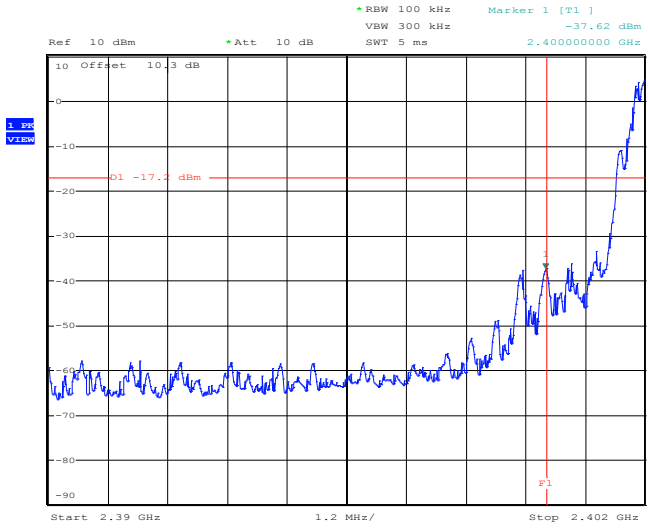
**9.5. TEST EQUIPMENT LIST**

DESCRIPTION	MANUFACTURER	MODEL	N° LCIE
Amplifier 1-13GHz	LCIE SUD EST	-	A7102067
Antenna horn	EMCO	3115	C2042029
Cable N/N	-	-	A5329038
Cable N/N	-	-	A5329206
Cable	-	-	A5329603
Antenna horn	EMCO	3115	C2042027
Cable	-	-	A5329352
Cable	-	-	A5329057
Semi-Anechoic chamber #3	SIEPEL	-	D3044017
Digital Radiocommunication Tester	ROHDE & SCHWARZ	CMU200	A2440006
High Pass (4.8-18GHz)	BL Microwave	SH4800-1800	A7484034
Receiver 20Hz – 8GHz	ROHDE & SCHWARZ	ESU8	A2642019
Thermo-hygrometer (C3)	OREGON	BAR206	B4204078
Thermo-hygrometer (PM2)	OREGON	BAR916HG-G	B4206011
Turntable chamber (Cage#3)	ETS Lingren	Model 2165	F2000371

9.6. DIVERGENCE, ADDITION OR SUPPRESSION ON THE TEST SPECIFICATION None Divergence:

9.7. TEST SEQUENCE AND RESULTS





9.8. CONCLUSION

RESULTS: PASS FAIL

**10. OCCUPIED BANDWIDTH****10.1. ENVIRONMENTAL CONDITIONS**

Date of test : January 17th, 2014
Test performed by : A.MERLIN / G.DESCHAMPS
Atmospheric pressure : 978hPa
Relative humidity : 35%
Ambient temperature : 24°C

10.2. EQUIPMENT CONFIGURATION

Modulation type: GFSK Pi/4 DQPSK 8DPSK (Worst)
Packet type: DH1 DH3 DH5
Transfert data rate: 1Mbps 2Mbps 3Mbps
Hopping sequence: OFF

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

 Radiated measurement:

The EUT is turned ON and connected to measurement instrument; the center frequency of the spectrum analyzer is set to the fundamental frequency. The captured power is measured and recorded; the measurement is repeated until all frequencies required were complete.

10.4. TEST EQUIPMENT LIST

DESCRIPTION	MANUFACTURER	MODEL	N° LCIE
Antenna horn	EMCO	3115	C2042029
Cable N/N	-	-	A5329038
Cable N/N	-	-	A5329206
Antenna horn	EMCO	3115	C2042027
Cable	-	-	A5329352
Cable	-	-	A5329057
Semi-Anechoic chamber #3	SIEPEL	-	D3044017
Digital Radiocommunication Tester	ROHDE & SCHWARZ	CMU200	A2440006
Receiver 20Hz – 8GHz	ROHDE & SCHWARZ	ESU8	A2642019
Thermo-hygrometer (C3)	OREGON	BAR206	B4204078
Thermo-hygrometer (PM2)	OREGON	BAR916HG-G	B4206011
Turntable chamber (Cage#3)	ETS Lingren	Model 2165	F2000371

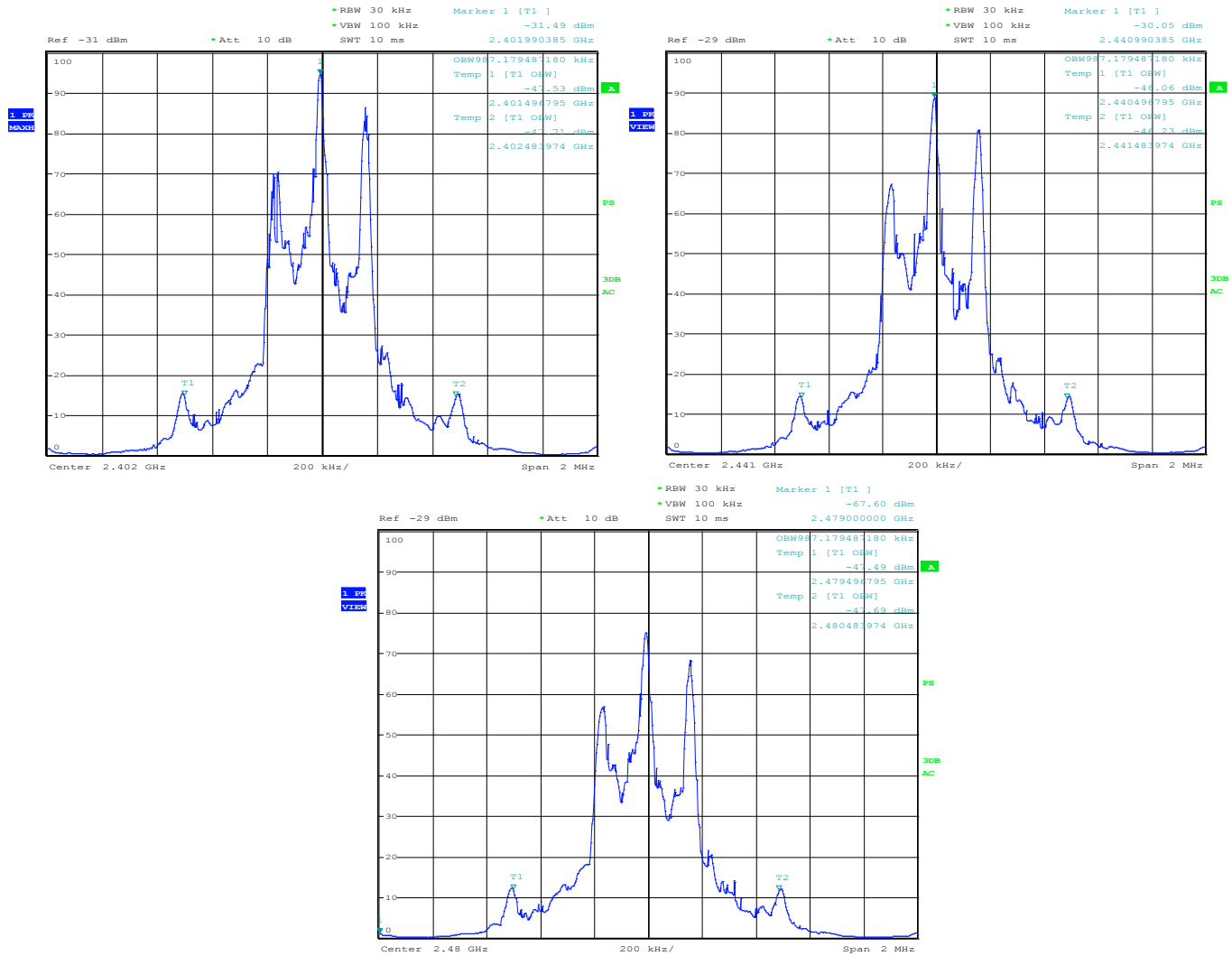
10.5. DIVERGENCE, ADDITION OR SUPPRESSION ON THE TEST SPECIFICATION

None Divergence:

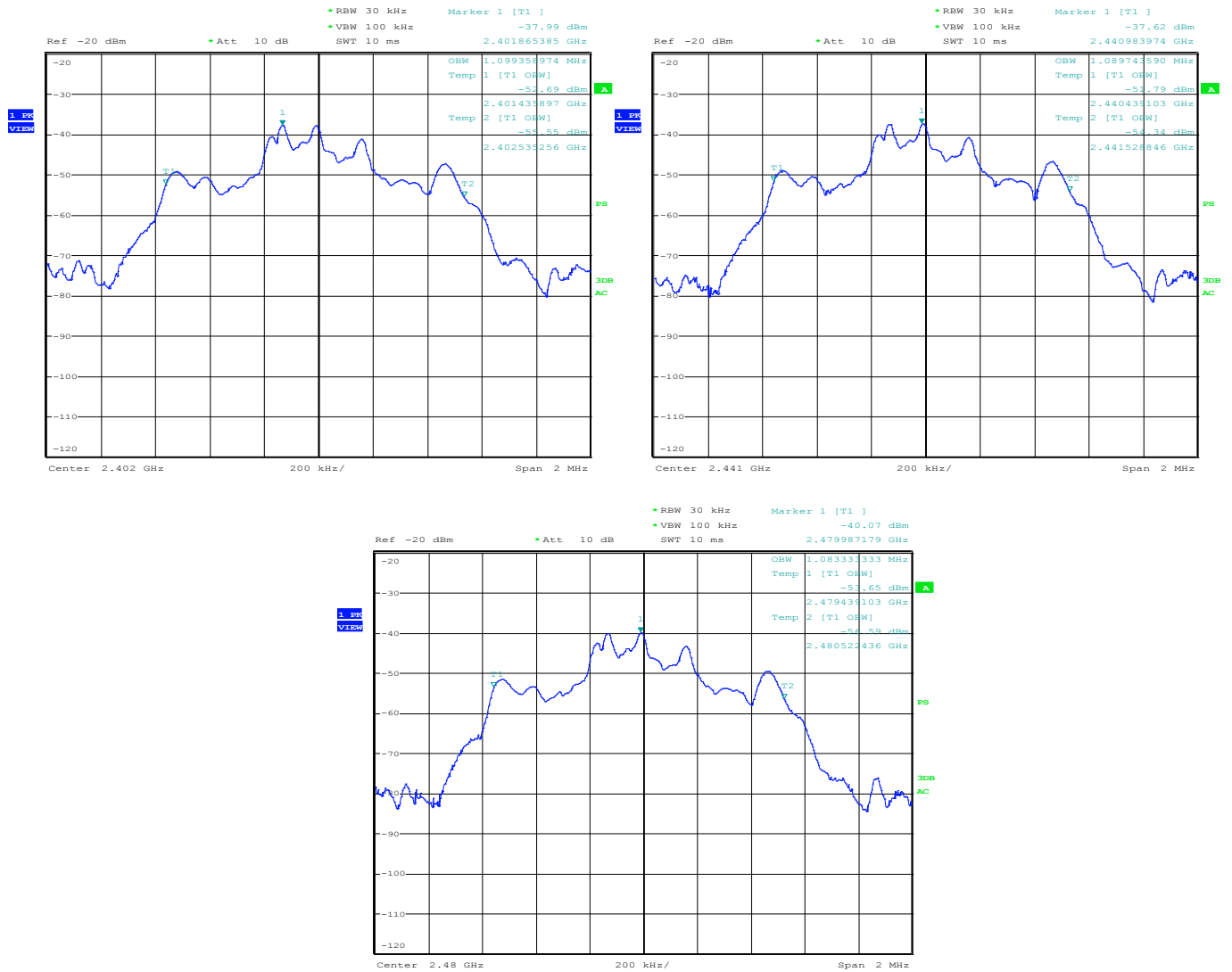
10.6. TEST SEQUENCE AND RESULTS

Measured occupied bandwidth is **1.135MHz** (worst case)

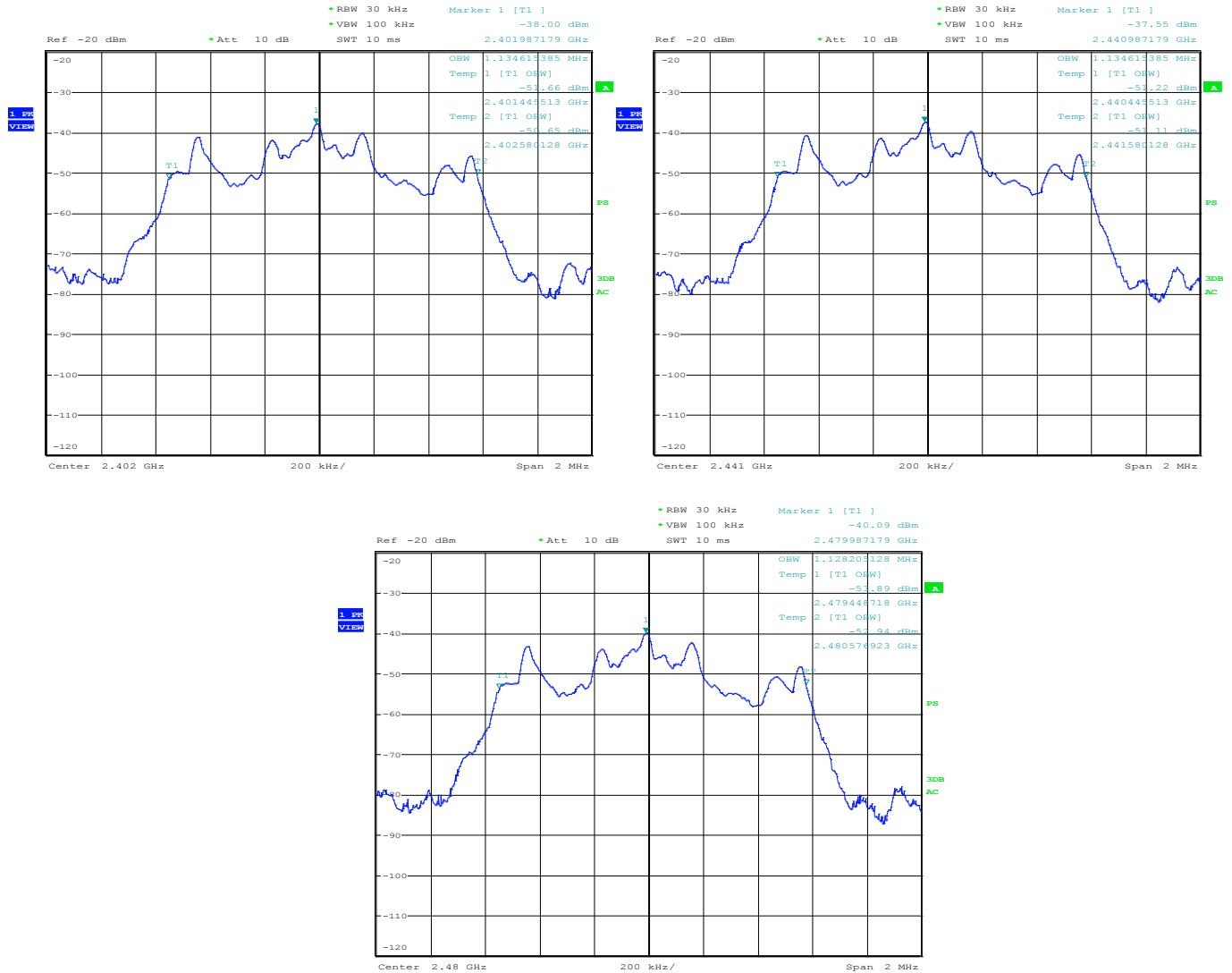
DH5:



2-DH5:



3-DH5:



Measurement settings:

RBW used should not be lower than 1% of the selected span

RBW = 30kHz / Video BW = 100kHz / SPAN = 2MHz / MaxHold / PEAK

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

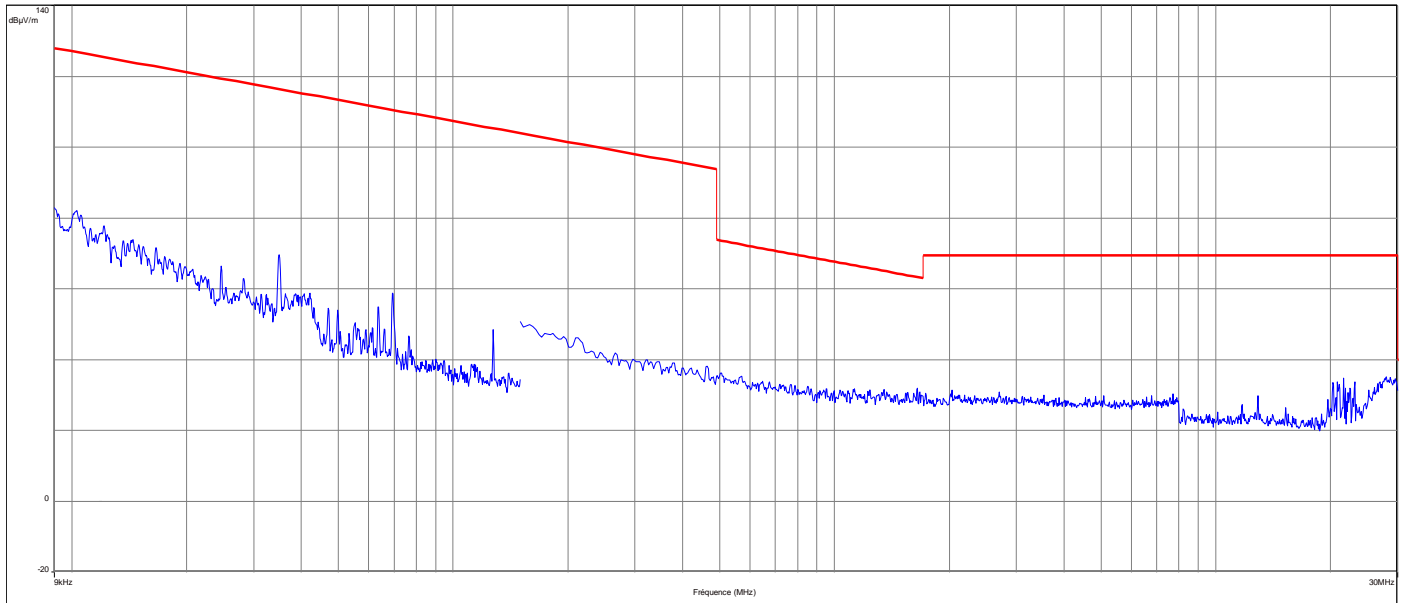


11. ANNEX 1 (GRAPHS)

RADIATED EMISSIONS

Graph name:	Emr#1	Test configuration:
Limit:	FCC CFR47 Part15C	
Class:		
Frequency range: [9kHz - 30MHz]		
Antenna polarization:	0°	RBW : 100kHz
Azimuth:	0° - 360°	VBW : 300kHz

- FCC/FCC CFR47 Part15C - Classe: - Moyenne/3.0m/
- FCC/FCC CFR47 Part15C - Classe: - QCrête/3.0m/
- FCC/FCC CFR47 Part15C - Classe: - Crête/3.0m/
- Mes.Peak (Horizontale)



Spurious emissions

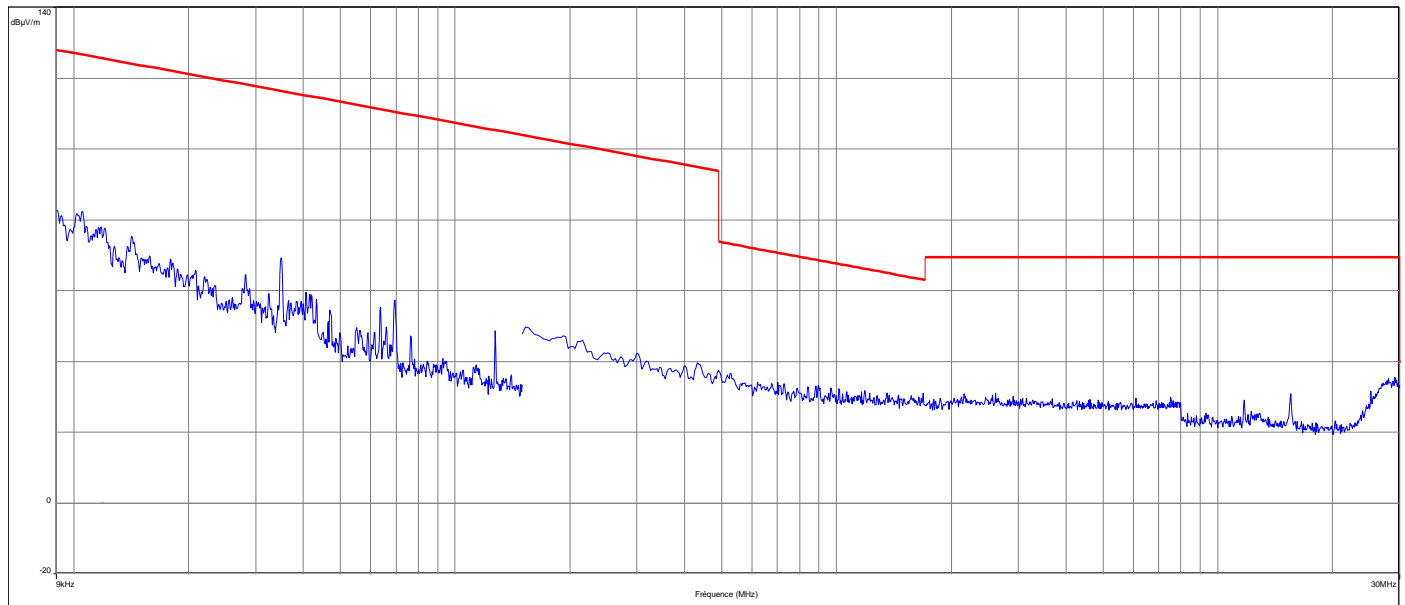
Frequency (MHz)	Peak (dBµV/m)
No suspect frequency observed	



RADIATED EMISSIONS

Graph name:	Emr#2	Test configuration:
Limit:	FCC CFR47 Part15C	
Class:		
Frequency range: [9kHz - 30MHz]		
Antenna polarization:	Horizontal	RBW : 100kHz
Azimuth:	0° - 360°	VBW : 300kHz

- FCC/FCC CFR47 Part15C - Classe: - Moyenne/3.0m/
- FCC/FCC CFR47 Part15C - Classe: - QCrête/3.0m/
- FCC/FCC CFR47 Part15C - Classe: - Crête/3.0m/
- Mes.Peak (Horizontale)



Spurious emissions

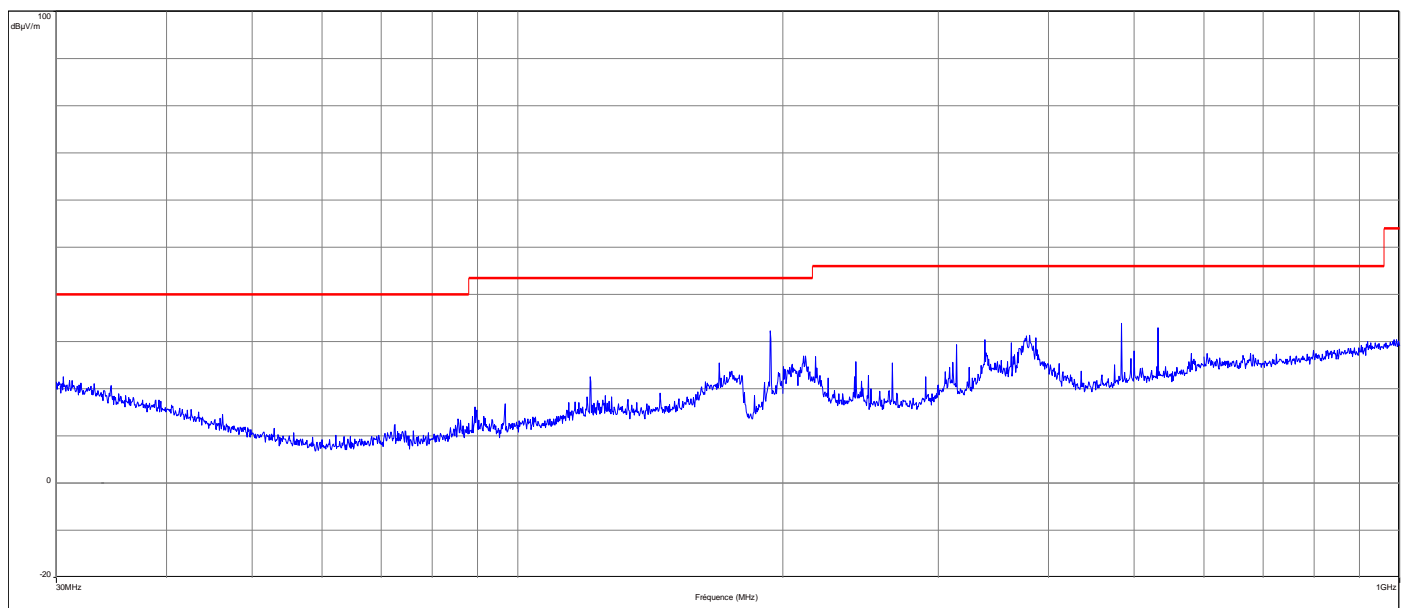
Frequency (MHz)	Peak (dBµV/m)
No suspect frequency observed	



RADIATED EMISSIONS

Graph name:	Emr#3	Test configuration:
Limit:	FCC CFR47 Part15C	
Class:		
Frequency range: [30MHz - 1GHz]		
Antenna polarization:	Horizontal	RBW : 100kHz
Azimuth:	0° - 360°	VBW : 300kHz

— FCC/FCC CFR47 Part15C - Classe: - QCrête/3.0m/
 — Mes.Peak (Horizontale)



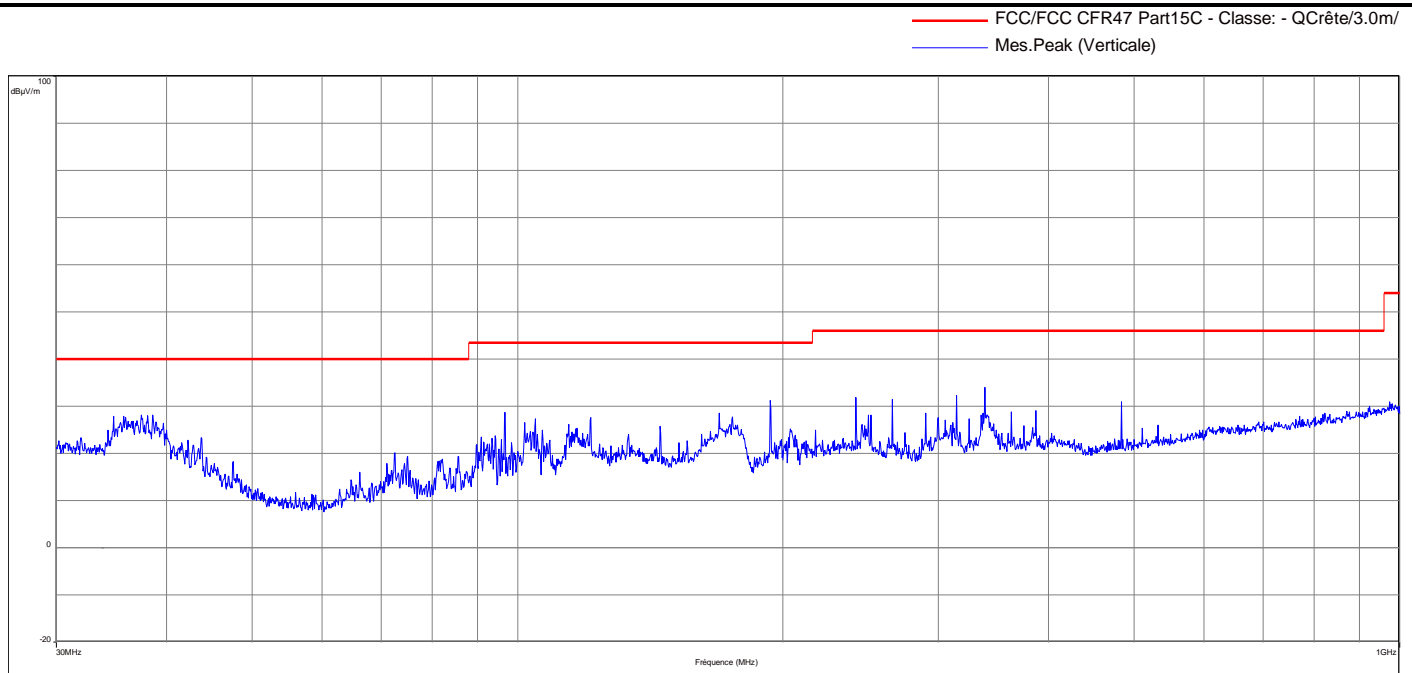
Spurious emissions

Frequency (MHz)	Peak (dBµV/m)
169.332	25.47
193.506	32.24
210.84	26.91
483.84	33.83
532.2	32.95



RADIATED EMISSIONS

Graph name:	Emr#4	Test configuration:
Limit:	FCC CFR47 Part15C	
Class:		
Frequency range: [30MHz - 1GHz]		
Antenna polarization:	Vertical	RBW : 100kHz
Azimuth:	0° - 360°	VBW : 300kHz



Spurious emissions

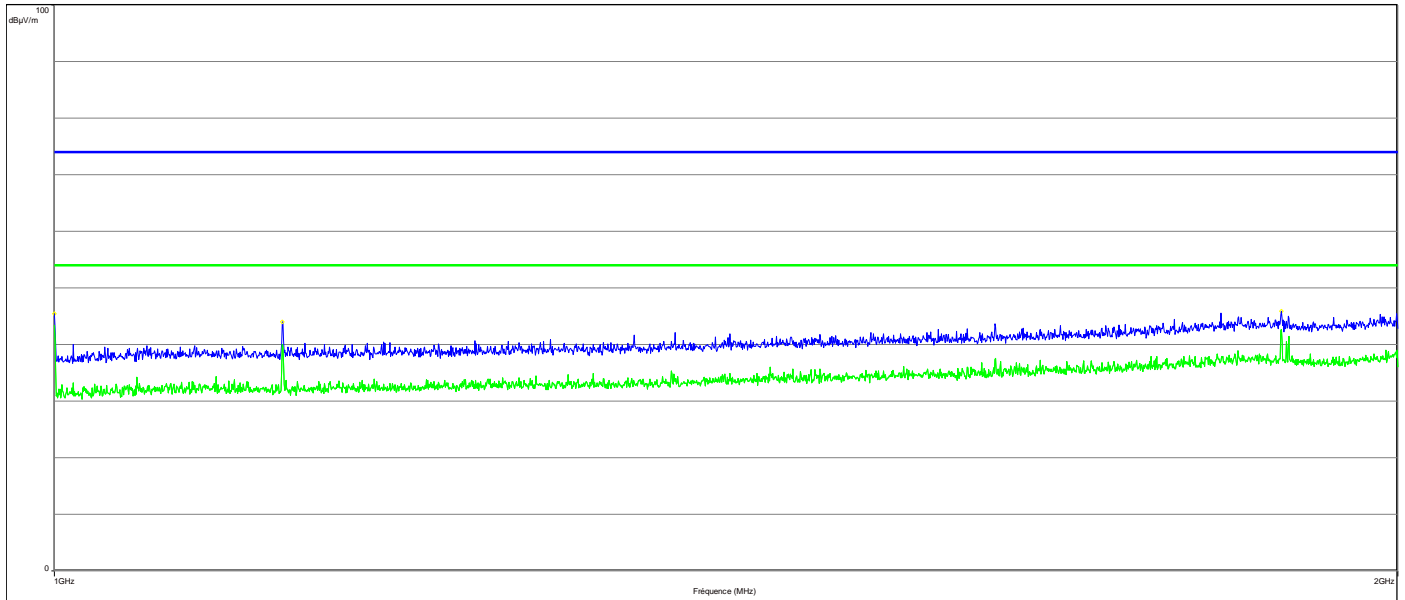
Frequency (MHz)	Peak (dBµV/m)
37.48	28.2
96.759	28.63
101.859	26.6
104.749	27.29
120.967	27.59
145.141	25.76
169.349	28.56
193.523	31.24
203.96	25.25
314.48	32.26
338.64	34



RADIATED EMISSIONS

Graph name:	Emr#5	Test configuration:
Limit:	FCC CFR47 Part15B	
Class:	B	
Frequency range: [1GHz - 2GHz]		
Antenna polarization:	Horizontal	RBW : 1MHz
Azimuth:	0° - 360°	VBW : 3MHz

- FCC/FCC CFR47 Part15B - Classe:B - Moyenne/3.0m/
- FCC/FCC CFR47 Part15B - Classe:B - Crête/3.0m/
- Niveau (Suspect Manuel) (Horizontale)
- Mes.Peak (Horizontale)
- Mes.Avg (Horizontale)
- Peak (Peak/LimAvg) (Horizontale)
- Peak (Peak/LimQ-Peak) (Horizontale)



Spurious emissions

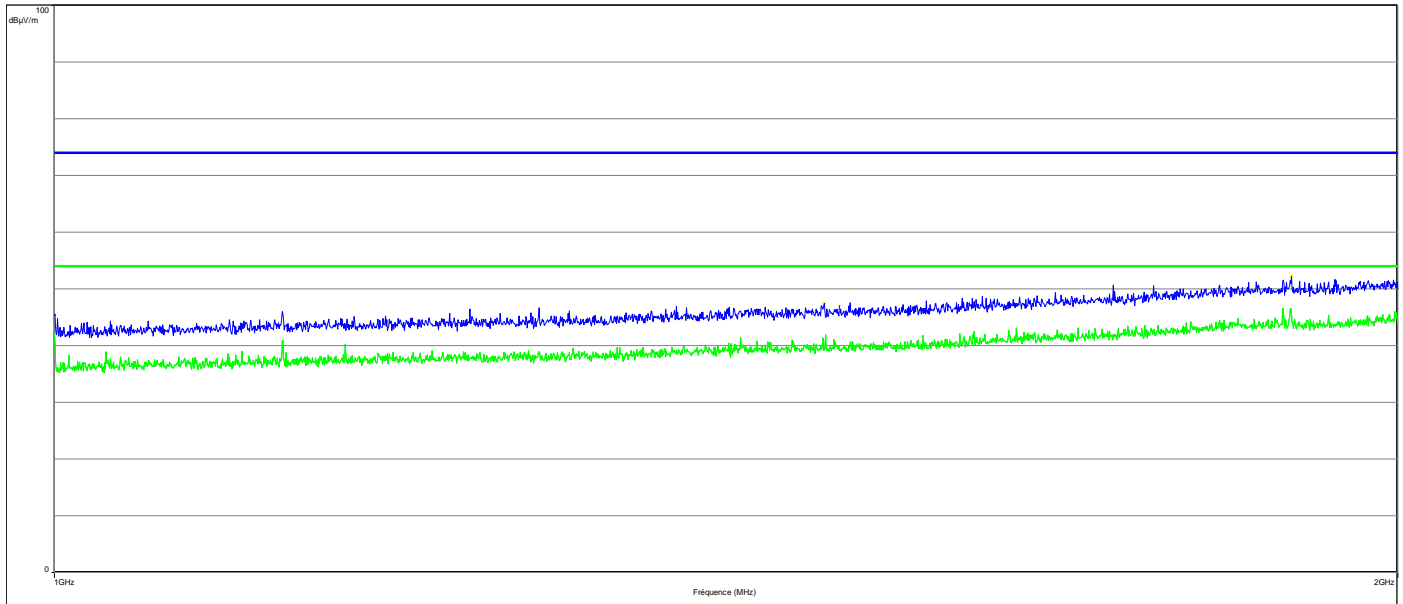
Frequency (MHz)	Peak (dBµV/m)
1000	45.44
1124.85	43.96
1883.35	45.84



RADIATED EMISSIONS

Graph name:	Emr#6	Test configuration:
Limit:	FCC CFR47 Part15B	
Class:	B	
Frequency range: [1GHz - 2GHz]		
Antenna polarization:	Vertical	RBW : 1MHz
Azimuth:	0° - 360°	VBW : 3MHz

- FCC/FCC CFR47 Part15B - Classe:B - Moyenne/3.0m/
- FCC/FCC CFR47 Part15B - Classe:B - QCrête/3.0m/
- FCC/FCC CFR47 Part15B - Classe:B - Crête/3.0m/
- Mes.Peak (Verticale)
- Mes.Avg (Verticale)
- Peak (Peak/LimAvg) (Verticale)



Spurious emissions

Frequency (MHz)	Peak (dBµV/m)
1487.7	47.48
1893.5	52.27

**12. UNCERTAINTIES CHART**

Type de mesure / Kind of measurement	Incertitude élargie laboratoire / Wide uncertainty laboratory (k=2) ± x	Incertitude limite du CISPR / CISPR uncertainty limit ± 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.