TEST REPORT

N°: 154198-717711-A(FILE#992732) **Version : 02**

Subject **Electromagnetic compatibility and Radio spectrum Matters (ERM) tests according to standards:**
FCC CFR 47 Part 15, Subpart C
RSS-247 Issue 2.0

Issued to **ADEUNIS**
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FRANCE

Apparatus under test

↳ Product	**VOKKERO WIRELESS DIGITAL AUDIO TRANCEIVER**
↳ Trade mark	**ADEUNIS**
↳ Manufacturer	**ADEUNIS**
↳ Model under test	**ARF8320D**
↳ Serial number	**I180400077**
↳ FCCID	**U3Z-ARF8320**
↳ IC	**7016A-ARF8320**
Conclusion	See Test Program chapter
Test date	March 19, 2018 to March 21, 2018
Test location	MOIRANS
IC Test site	6500A-1
Composition of document	46 pages

Document issued on April 9, 2018

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PUBLICATION HISTORY

Version	Date	Author	Modification
01	April 4, 2018	Gaetan DESCHAMPS	Creation of the document
02	April 9, 2018	Gaetan DESCHAMPS	Error on antenna type

SUMMARY

1. TEST PROGRAM

Standard:
- **FCC Part 15, Subpart C 15.247**
- **ANSI C63.10 (2013)**
- **RSS-247 Issue 2.0**
- **RSS-Gen Issue 4**

EMISSION TEST	LIMITS	RESULTS (Comments)
Limits for conducted disturbance at mains ports 150kHz-30MHz	**Frequency** / **Quasi-peak value (dBµV)** / **Average value (dBµV)** 150-500kHz / 66 to 56 / 56 to 46 0.5-5MHz / 56 / 46 5-30MHz / 60 / 50	☐ **PASS** ☐ **FAIL** ☑ **NA** ☐ **NP**
Radiated emissions 9kHz-30MHz *CFR 47 §15.209 (a)* *CFR 47 §15.247 (d)* *RSS-247 §5.5*	**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** ☐ **FAIL** ☑ **NA** ☐ **NP**
Radiated emissions 30MHz-25GHz* *CFR 47 §15.209 (a)* *CFR 47 §15.247 (d)* *RSS-247 §5.5* ***Highest frequency : 32MHz*** ***(Declaration of provider)***	**Measure at 3m** 30MHz-88MHz : 40 dBµV/m 88MHz-216MHz : 43.5 dBµV/m 216MHz-960MHz : 46.0 dBµV/m 960MHz-1GHz : 54.0 dBµV/m 1GHz – 25GHz: 54.0 dBµV/m (AV) 74.0 dBµV/m (PK)	☑ **PASS** ☐ **FAIL** ☐ **NA** ☐ **NP**
Maximum Peak Output Power *CFR 47 §15.247 (b)* *RSS-247 §5.4*	**Limit: 24dBm** Conducted or Radiated measurement	☑ **PASS** ☐ **FAIL** ☐ **NA** ☐ **NP**
Hopping Channel Separation *CFR 47 §15.247 (a) (1)* *RSS-247 §5.1*	**FHSs shall have hopping channel carrier frequencies separated by a minimum of 25 kHz or the 20 dB bandwidth of the hopping channel, whichever is greater.**	☑ **PASS** ☐ **FAIL** ☐ **NA** ☐ **NP**
Number of Hopping Frequencies *CFR 47 §15.247 (a) (1) (iii)* *RSS-247 §5.1*	**At least 25 channels used**	☑ **PASS** ☐ **FAIL** ☐ **NA** ☐ **NP**
Time of Occupancy (Dwell Time) *CFR 47 §15.247 (a) (1) (iii)* *RSS-247 §5.1*	**Maximum 0.4 sec within 10sec**	☑ **PASS** ☐ **FAIL** ☐ **NA** ☐ **NP**
Band Edge Measurement *CFR 47 §15.209 (a)* *CFR 47 §15.247 (d)* *RSS-247 §5.5*	**Limit: -20dBc**	☑ **PASS** ☐ **FAIL** ☐ **NA** ☐ **NP**
Occupied bandwidth *RSS-Gen §4.6.1*	**No limit**	☑ **PASS** ☐ **FAIL** ☐ **NA** ☐ **NP**
Receiver Spurious Emission** *RSS-Gen §4.10*	**See RSS-Gen §4.10**	☐ **PASS** ☐ **FAIL** ☑ **NA** ☐ **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. *FAMILY RANGE*

GUARDIAN REFERENCES

	Name	Reference	Fonctionality
CAN	STD	ARF8320A	Standard (color orange)
	STD BT	ARF8320B	Standard with Bluetooth (color orange)
	PLUS	ARF8320C	Same product as ARF8320A but specific commercial reference for Audio Pro security (color Black)
	PLUS BT	ARF8320D	Same as ARF8320B but specific commercial reference for audio Pro security with Bluetooth(color Black)
	ATEX	ARF8320E	Same as ARF8320B intended for explosive atmospheres (color Blue)
	STD 4+2 users	ARF8320F	Same product as ARF8320A with 4+2users (With particular configuration: 2 slots audio can be shared by several users. No impact on the RF performance of products.) color orange
	STD BT 4+2 users	ARF8320G	Same product as ARF8320B with 4+2users (With particular configuration: 2 slots audio can be shared by several users. No impact on the RF performance of products.) color orange
	PLUS 4+2 users	ARF8320H	Same product as ARF8320C with 4+2users (With particular configuration: 2 slots audio can be shared by several users. No impact on the RF performance of products.) Color Black
	PLUS BT 4+2 users	ARF8320I	Same product as ARF8320D with 4+2users (With particular configuration: 2 slots audio can be shared by several users. No impact on the RF performance of products.) Color Black
	ATEX 4+2 users	ARF8320J	Same product as ARF8320E with 4+2users (With particular configuration: 2 slots audio can be shared by several users. No impact on the RF performance of products.) Color Blue

Worst case: ARF8320D with RF special RF parameters to test all channels and RF band.

2.2. HARDWARE IDENTIFICATION (EUT AND AUXILIARIES):

Equipment under test (EUT):
ARF8320D
Serial Number: I180400077

Photography of EUT

Power supply:
During all the tests, EUT is supplied by V_{nom}: 3.7VdC
For measurement with different voltage, it will be presented in test method.

Name	Type	Rating	Reference / Sn	Comments
Supply1	☐ AC ☐ DC ☑ Battery	3.7VDC	-	Li-Polymer

Inputs/outputs - Cable:

Access	Type	Length used (m)	Declared <3m	Shielded	Under test	Comments
Supply1	Battery	-	☐	☐	☑	-
Access1	Micro	1.0	☑	☑	☑	-

Auxiliary equipment used during test:

Type	Reference	Sn	Comments
LAPTOP	VAIO	-	-
Power supply :VOKKERO	ARF8118AA	B18070008	-

Equipment information:

<table>
<tr><td>Frequency band:</td><td colspan="6">[902 – 928]* MHz</td></tr>
<tr><td>Spectrum Modulation:</td><td colspan="6">☑ FHSS</td></tr>
<tr><td>Number of Channel:</td><td colspan="6">See the following table.</td></tr>
<tr><td>Spacing channel:</td><td colspan="6">1MHz</td></tr>
<tr><td>Channel bandwidth:</td><td colspan="6">1MHz</td></tr>
<tr><td>Antenna Type:</td><td colspan="2">☐ Integral</td><td colspan="2">☑ External</td><td colspan="2">☑ Dedicated</td></tr>
<tr><td>Antenna connector:</td><td colspan="2">☐ Yes</td><td colspan="2">☑ No</td><td colspan="2">☐ Temporary for test</td></tr>
<tr><td rowspan="3">Transmit chains:</td><td colspan="6">☑ 1</td></tr>
<tr><td colspan="6">Single antenna</td></tr>
<tr><td colspan="6">Gain 1: 0dBi</td></tr>
<tr><td>Beam forming gain:</td><td colspan="6">No</td></tr>
<tr><td>Receiver chains</td><td colspan="6">1</td></tr>
<tr><td>Type of equipment:</td><td colspan="2">☐ Stand-alone</td><td colspan="2">☑ Plug-in</td><td colspan="2">☐ Combined</td></tr>
<tr><td>Ad-Hoc mode:</td><td colspan="3">☐ Yes</td><td colspan="3">☑ No</td></tr>
<tr><td>Dwell time:</td><td colspan="6">800µs</td></tr>
<tr><td>Duty cycle:</td><td colspan="2">☑ Continuous duty</td><td colspan="2">☐ Intermittent duty</td><td colspan="2">☐ 100% duty</td></tr>
<tr><td>Equipment type:</td><td colspan="3">☑ Production model</td><td colspan="3">☐ Pre-production model</td></tr>
<tr><td rowspan="3">Operating temperature range:</td><td>Tmin:</td><td colspan="2">☑ -20°C</td><td colspan="2">☐ 0°C</td><td>☐ X°C</td></tr>
<tr><td>Tnom:</td><td colspan="5">20°C</td></tr>
<tr><td>Tmax:</td><td colspan="2">☐ 35°C</td><td colspan="2">☑ 55°C</td><td>☐ X°C</td></tr>
<tr><td>Type of power source:</td><td colspan="2">☐ AC power supply</td><td colspan="2">☐ DC power supply</td><td colspan="2">☑ Battery</td></tr>
<tr><td>Operating voltage range:</td><td colspan="2">Vnom:</td><td colspan="2">☐ 230V/50Hz</td><td colspan="2">☑ 3.7Vdc</td></tr>
</table>

*The equipment uses the different frequency range in the frequency band [902 – 928]MHz, see the following table.
The frequency range C1 is the worst case (number of channel and the biggest frequency range).

2.3. EUT CONFIGURATION

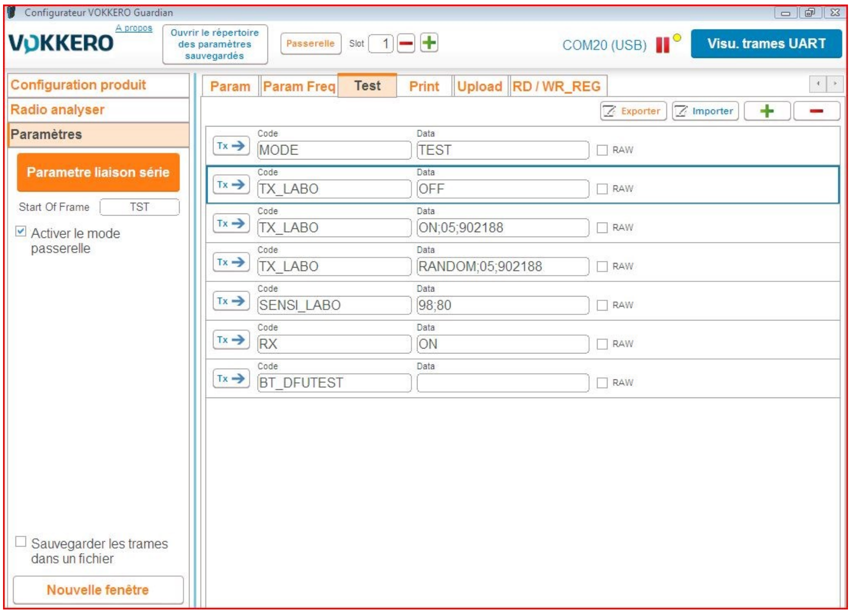
All tests are performed at Cmin and Cmax on the frequency range table C1 (the biggest in frequency range and channel number). The Table H1, A1, H2, A2, H3 and A3 are tested only the Hopping channel separation, number of hopping frequencies and “Time of occupancy. The different tables use the same modulation.

Frequency range table

H1	A1	H2	A2	H3	A3	**C1**
Min	Min	Min	Min	Min	Min	**Min**
Max	Max	Max	Max	Max	Max	**Max**
916.698	902.188	903.688	902.75	902.188	903.313	**902.188**
927.573	916.063	927.313	926.375	917.938	917.563	**927.688**
916.698	902.188	903.688	902.75	902.188	903.313	902.188
917.073	902.938	904.438	904.625	902.563	903.688	903.688
917.448	903.688	904.813	907.25	902.938	904.813	904.438
917.823	904.438	905.188	907.625	904.813	905.188	904.813
918.198	905.188	905.563	908.375	905.938	905.563	905.188
920.448	905.563	906.313	908.75	906.688	906.313	905.938
920.823	905.938	906.688	910.625	907.063	906.688	906.313
921.198	906.313	907.813	911	907.813	907.438	906.688
921.573	907.063	909.313	913.25	908.188	908.188	907.063
921.948	907.813	909.688	913.625	908.938	908.563	908.563
922.323	908.188	910.063	914.375	909.313	909.313	909.313
922.698	908.563	911.188	915.5	910.063	909.688	909.688
923.073	908.938	912.313	915.875	910.438	910.813	910.813
923.448	909.313	912.688	916.625	910.813	911.188	911.188
923.823	910.063	914.938	917.375	911.188	912.313	**Cmid : 912.313**
924.198	910.438	915.313	917.75	911.563	912.688	913.063
924.573	910.813	916.813	920.375	913.063	913.063	914.563
924.948	911.188	917.938	920.75	914.938	913.438	914.938
925.323	911.563	922.063	921.5	915.313	913.813	915.313
925.698	912.313	924.313	922.25	915.688	914.188	915.688
926.073	912.688	925.063	922.625	916.063	914.563	916.438
926.448	913.813	925.438	923	916.813	914.938	917.188
926.823	914.188	926.563	923.375	917.188	915.313	917.563
927.198	914.938	926.938	923.75	917.563	916.438	920.938
927.573	915.313	927.313	926	917.938	916.813	921.688
	915.688		926.375		917.563	922.063
	916.063					923.188
						924.313
						925.813
						926.563
						926.938
						927.688

Following commands with the specific test software “VOKKERO Guadian”(see the following capture) is used to set the product:

- Permanent emission with modulation on a fixed channel
- Permanent emission without modulation on a fixed channel



2.4. EQUIPMENT MODIFICATIONS

☑ None ☐ Modification:

2.5. 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 dBµV/m

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

Level in µV/m = Common Antilogarithm [(32dBµV/m)/20] = 39.8 µV/m.

2.6. CALIBRATION DATE

The calibration intervals are extended at 12+2 months. This extended interval is based on the fact that there is sufficient calibration data to statistically establish a trend or based on experience of use of the test equipment to assure good measurement results for a longer period

3. RADIATED EMISSION DATA

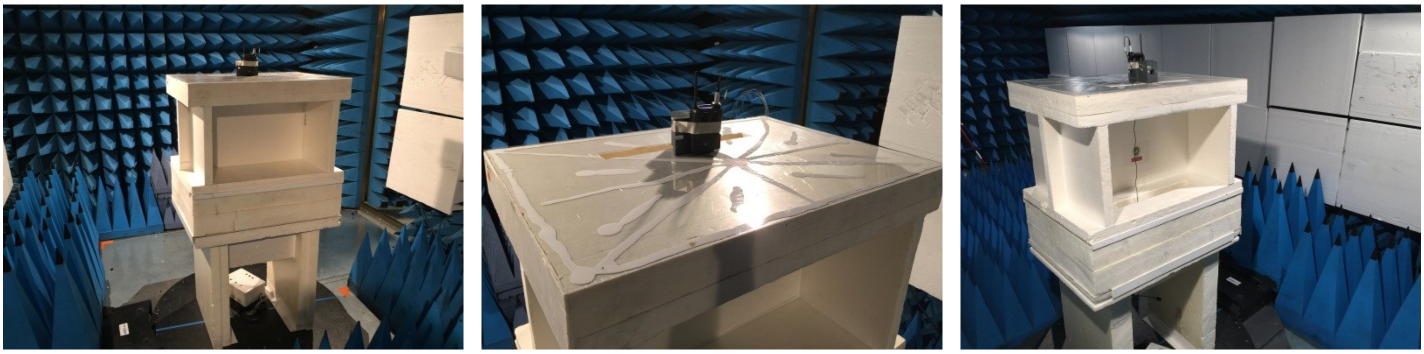
3.1. *ENVIRONMENTAL CONDITIONS*

Date of test	:	March 19, 2018
Test performed by	:	Gaëtan DESCHAMPS
Atmospheric pressure (hPa)	:	1080
Relative humidity (%)	:	32
Ambient temperature (°C)	:	23

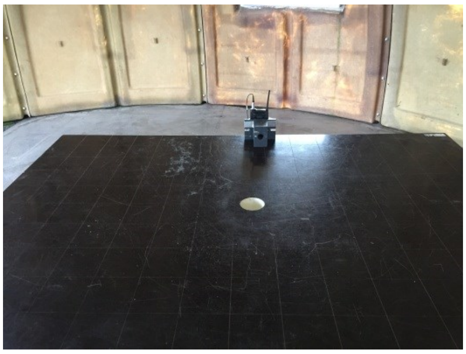
3.2. *TEST SETUP*

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) - Below 1GHz
☑ 150cm above the ground on the non-conducting table (Table-top equipment) - Above 1GHz
☐ 10cm above the ground on isolating support (Floor standing equipment)
The EUT is powered by V_{nom}.

Test setup in anechoic chamber <1GHz



Test setup in anechoic chamber >1GHz (measure performed for the band edge measurement)

Test setup in OATS:

3.3. TEST METHOD

The product has been tested according to ANSI C63.10, FCC part 15 subpart C.

Pre-characterisation measurement: (9kHz – 1GHz)
A pre-scan of all the setup has been performed in a 3 meters semi-anechoic chamber for frequency from 30MHz to 1GHz. Test is performed in horizontal (H) and vertical (V) polarization, the loop antenna was rotated during the test to maximize 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.

Characterization on 10 meters open site from 9kHz to 1GHz:
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 limits. 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 to maximize 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 10GHz:
The product has been tested at a distance of **3 meters** from the antenna and compared to the FCC part 15 subpart C limits. Measurement bandwidth was 1MHz from 1GHz to 10GHz.
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 (EUT smaller than the beamwidth of the measurement antenna, ANSI C63.10 §6.6.5)
Frequency list has been created with anechoic chamber pre-scan results.

3.4. TEST EQUIPMENT LIST

DESCRIPTION	MANUFACTURER	MODEL	N° LCIE	Cal_Date	Cal_Due
Antenna Bi-log	CHASE	CBL6111A	C2040172	06/16	06/18
Cable Measure @3m	-	1GHz	A5329206	06/17	06/18
Cable emission	-	-	A5329639	09/17	09/18
Semi-Anechoic chamber #3	SIEPEL	-	D3044017	03/16	03/19
Radiated emission comb generator	BARDET	-	A3169050	-	-
Spectrum analyzer	ROHDE & SCHWARZ	FSV 30	A4060050	12/17	12/18
BAT EMC	NEXIO	v3.9.0.10	L1000115	-	-
Thermo-hygrometer (C3)	OREGON	BAR206	B4204078	10/16	10/18
Thermo-hygrometer (PM1/2/3)	KIMO	HQ 210	B4206022	08/16	08/18
Turntable chamber (Cage#3)	ETS Lingren	Model 2165	F2000371	-	-
Table C3	LCIE	-	F2000461	-	-
Turntable controller (Cage#3)	ETS Lingren	Model 2090	F2000444	-	-
Antenna horn 18GHz	EMCO	3115	C2042029	08/16	08/18
Cable Measure @1m	STORMFLEX	26GHz	A5329680	12/17	12/18
Cable Measure @1m	STORMFLEX	26GHz	A5329682	12/17	12/18
High Pass (1-15GHz)	WAINRIGHT	WHKX 1.03/15G-10SS	A7484035	05/17	05/19
Antenna Bi-log	CHASE	CBL6111A	C2040051	01/18	01/19
Emission Cable	-	6GHz	A5329069	07/17	07/18
OATS	-	-	F2000409	10/17	10/18
Turntable / Mast controller (OATS)	ETS Lindgren	Model 2066	F2000372	-	-
Antenna mast (OATS)	ETS Lindgren	2071-2	F2000392	-	-
Turntable (OATS)	ETS Lindgren	Model 2187	F2000403	-	-
Rehausse Table C1/OATS	LCIE	-	F2000512	-	-

3.5. DIVERGENCE, ADDITION OR SUPPRESSION ON THE TEST SPECIFICATION

☑ None ☐ Divergence:

3.6. TEST RESULTS

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

See graphs for 30MHz-1GHz:

Graph identifier	Polarization	Mode	EUT position	Channel	Comments
Emr# 1	H/V	TX	Axis Z	Hopping mode	See annex 1

3.6.2. 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 significant frequency observed (only sees frequencies due to RF module, see results in “Band edge measurement” in §8.7)

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

<u>Worst case final data result</u>:
Frequency list has been created with semi-anechoic chamber pre-scan results.
Measurements are performed using a QUASI-PEAK detection.

No significant frequency observed (only sees frequencies due to RF module, see results in “Band edge measurement” in §8.7)

Worst case see in “Band edge measurement” and measured in OATS:

Test Frequency (MHz)	Meter Reading dB(µV)	Detector (Pk/QP/Av)	Polarity (V/H)	Azimuth (Degrees)	Antenna Height (cm)	Gain/Loss Factor (dB)	Transducer Factor (dB)	Level (dBµV/m)	Limit (dBµV/m)	Margin (dB)
969.497	3.6	QP	V	200	310	-	31.5	35.1	54.0	**-18.9**
979.396	5.0	QP	V			-	31.7	36.7	54.0	**-17.3**
992.002	11.0	QP	V	210	145	-	32.0	43.0	54.0	**-11.0**

3.6.4. Characterization on 3meters anechoic chamber from 1GHz to 10GHz

<u>Worst case final data result</u>:
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.

Test Frequency (MHz)	Meter Reading dB(µV)	Detector (Pk/QP/Av)	Polarity (V/H)	Azimuth (Degrees)	Antenna Height (cm)	Gain/Loss Factor (dB)	Transducer Factor (dB)	Level (dBµV/m)	Limit (dBµV/m)	Margin (dB)
1718.733	17.0	Pk	V	200	150	-	28.7	45.7	74.0	**-28.3**
1718.733	5.0	Av	V	200	150	-	28.7	33.7	54.0	**-20.3**
2706.880	36.4	Pk	V	200	150	-	31.7	68.1	74.0	**-5.9**
2706.880	10.0	Av	V	200	150	-	31.7	41.7	54.0	**-12.3**
2737.180	34.0	Pk	V	200	150	-	31.8	65.8	74.0	**-8.2**
2737.180	10.0	Av	V	200	150	-	31.8	41.8	54.0	**-12.2**
2783.070	32.8	Pk	V	200	150	-	32.0	64.8	74.0	**-9.2**
2783.070	10.0	Av	V	200	150	-	32.0	42.0	54.0	**-12.0**

Note: Measures have been done at 3m distance.

3.7. CONCLUSION

Radiated emission data measurement performed on the sample of the product **ARF8320D**, SN: **I180400077**, in configuration and description presented in this test report, show levels below the FCC CFR 47 Part 15 and RSS-247 limits.

4. MAXIMUM PEAK OUTPUT POWER (15.247)

4.1. ENVIRONMENTAL CONDITIONS

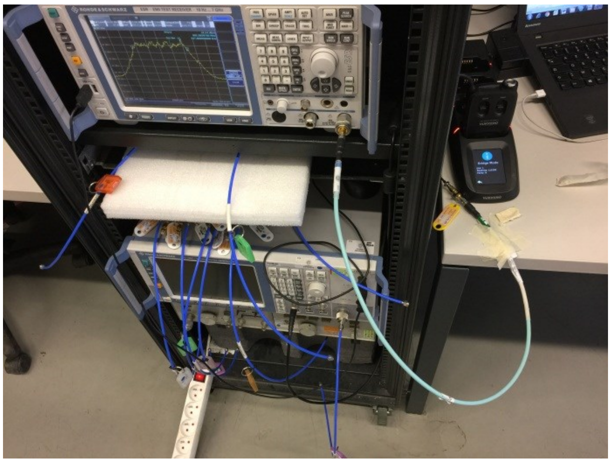
Date of test	:	March 19, 2018
Test performed by	:	Gaëtan DESCHAMPS
Atmospheric pressure (hPa)	:	1080
Relative humidity (%)	:	32
Ambient temperature (°C)	:	23

4.2. EQUIPMENT CONFIGURATION

Packet type: Random 05
Hopping sequence: ☐ ON ☑ OFF

4.3. 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 500kHz RBW and 2MHz 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 500kHz RBW and 2MHz 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 ≥ 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:

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

4.4. TEST EQUIPMENT LIST

DESCRIPTION	MANUFACTURER	MODEL	N° LCIE	Cal_Date	Cal_Due
Attenuator 10dB	TECHNIWAVE	-	A7122273	09/17	09/18
Cable Measure	-	36G	A5329604	12/17	12/18
Thermo-hygrometer (C3)	OREGON	BAR206	B4204078	10/16	10/18
Thermo-hygrometer (PM1/2/3)	KIMO	HQ 210	B4206022	08/16	08/18
Receiver 20Hz – 8GHz	ROHDE & SCHWARZ	ESU8	A2642019	12/17	12/18

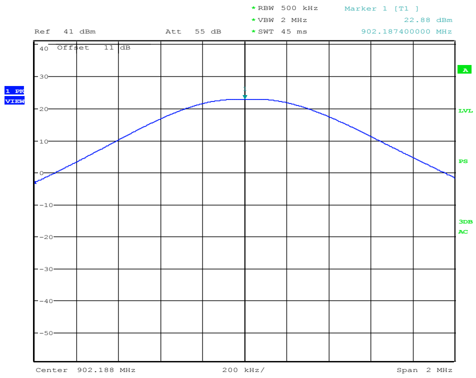
4.5. DIVERGENCE, ADDITION OR SUPPRESSION ON THE TEST SPECIFICATION

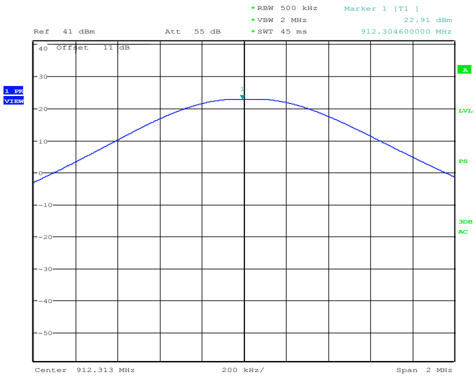
☑ None ☐ Divergence:

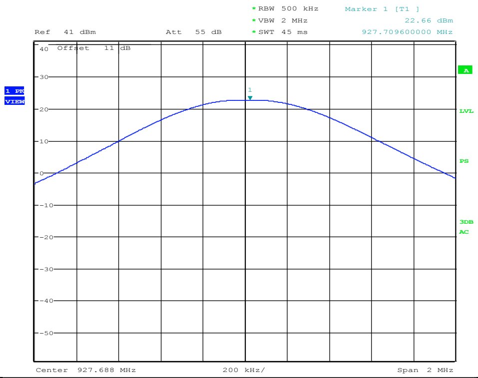
4.6. TEST RESULTS

Packet type: Random 05
Hopping sequence: ☐ ON ☑ OFF
Frequency range tested: C1 (see table in §2.1)

Channel	Channel Frequency (MHz)	Peak Output Power (dBm)	Power Limit (dBm)
Cmin	902.188	22.88	24
Cmid	912.313	22.91	24
Cmax	927.688	22.66	24







4.7. CONCLUSION

Maximum Peak Output Power measurement performed on the sample of the product **ARF8320D**, SN: **I180400077**, in configuration and description presented in this test report, show levels below the FCC CFR 47 Part 15 and RSS-247 limits.

5. CARRIER FREQUENCY SEPARATION (15.247)

5.1. ENVIRONMENTAL CONDITIONS

Date of test	:	March 20, 2018
Test performed by	:	Gaëtan DESCHAMPS
Atmospheric pressure (hPa)	:	1100
Relative humidity (%)	:	34
Ambient temperature (°C)	:	22

5.2. LIMIT

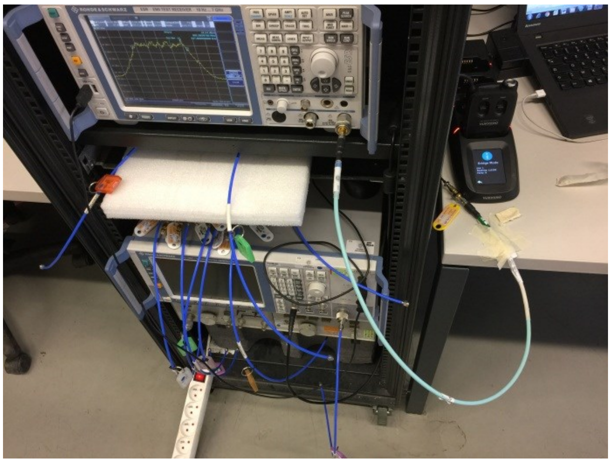
For frequency hopping system, hopping channel carrier frequencies must be separated by a minimum of 25kHz or the 20dB bandwidth of hopping channel, whichever is greater.
For frequency hopping system operating in the 902-928MHz with 20dB bandwidth of hopping channel is equal or greater than 250kHz:

- System shall use at least 25 channels
- Average time of occupancy on any frequency shall not greater than 0.4s within 10s period

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

5.3. EQUIPMENT CONFIGURATION

Packet type: Random 05
Hopping sequence: ☐ ON ☑ OFF



5.4. SETUP – OBW (20DB BANDWIDTH)

The occupied bandwidth is measured as the width of the spectral envelope of the modulated signal, at an amplitude level reduced from a reference value by a specified ratio (or in decibels, a specified number of dB down from the reference value).
Setting:

- The spectrum analyzer center frequency is set to the nominal EUT channel center frequency.
- RBW shall be in the range of 1 % to 5% of the OBW
- Span < 5 X OBW
- ndBdown set at 20dB.

5.5. 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.
Setting:

- Span: Wide enough to capture the peaks of two adjacent channels.
- RBW: Start with the RBW set to approximately 30% of the channel spacing; adjust as necessary to best identify the center of each individual channel.
- Video bandwidth (VBW) ≥ RBW.
- Sweep: Auto.
- Detector function: Peak.
- Trace: Max hold.
- Allow the trace to stabilize.

Use the marker-delta function to determine the separation between the peaks of the adjacent channels.
Compliance of an EUT with the appropriate regulatory limit shall be determined. A plot of the data shall be included in the test report.

5.6. TEST EQUIPMENT LIST

DESCRIPTION	MANUFACTURER	MODEL	N° LCIE	Cal_Date	Cal_Due
Attenuator 10dB	TECHNIWAVE	-	A7122273	09/17	09/18
Cable Measure	-	36G	A5329604	12/17	12/18
Thermo-hygrometer (C3)	OREGON	BAR206	B4204078	10/16	10/18
Thermo-hygrometer (PM1/2/3)	KIMO	HQ 210	B4206022	08/16	08/18
Receiver 20Hz – 8GHz	ROHDE & SCHWARZ	ESU8	A2642019	12/17	12/18

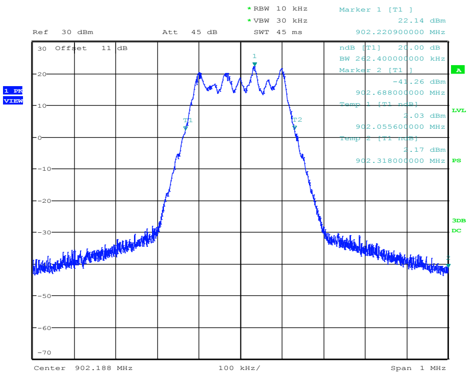
5.7. DIVERGENCE, ADDITION OR SUPPRESSION ON THE TEST SPECIFICATION

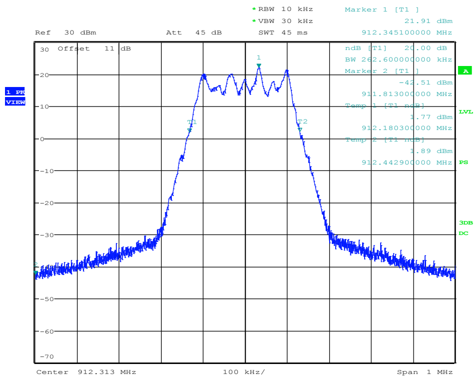
☑ None ☐ Divergence:

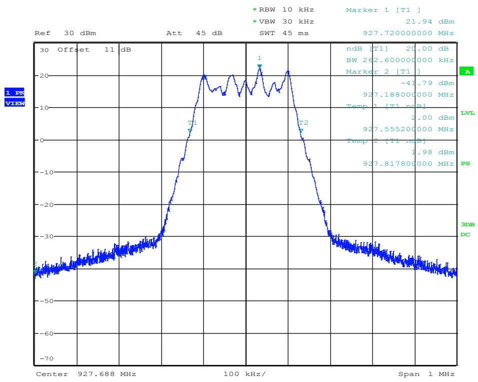
5.8. TEST SEQUENCE AND RESULTS

Packet type: Random 05
Hopping sequence: ☐ ON ☑ OFF

5.8.1. 20dB Bandwidth (identical for each frequency range table, same modulation):



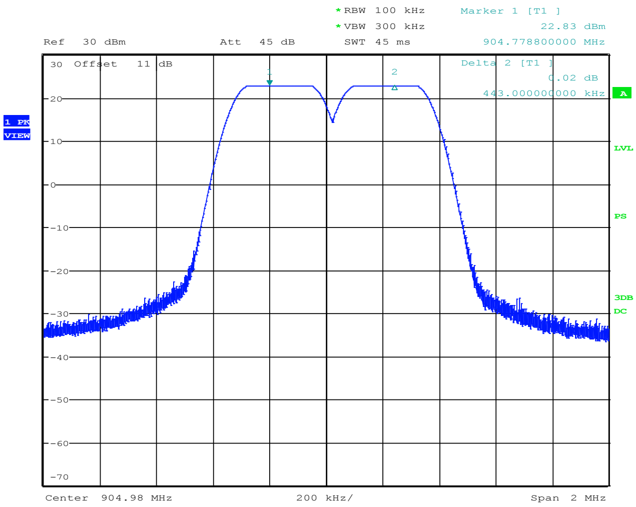




5.8.2. Adjacent frequency separation

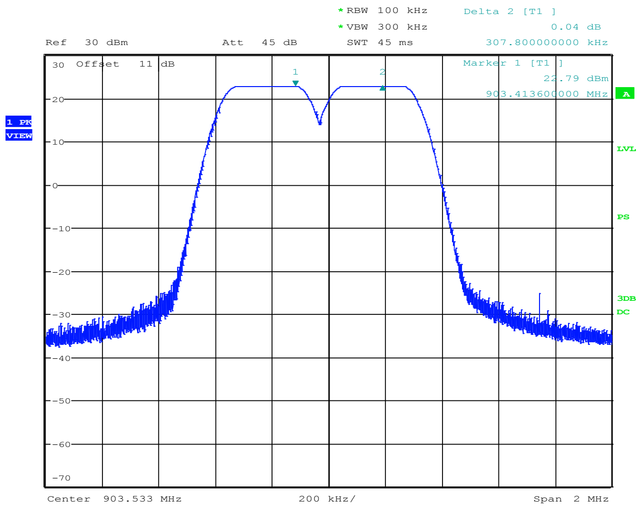
In function of frequency range table: Worst case sees in table C1 (see table in §2.1)

Minimum channel spacing frequency measured between (MHz)	Adjacent Channel Separation (kHz)	20dB Bandwidth (kHz)	Minimum Limit (kHz)
[904.813-905.188]	443.0	262.4	262.6



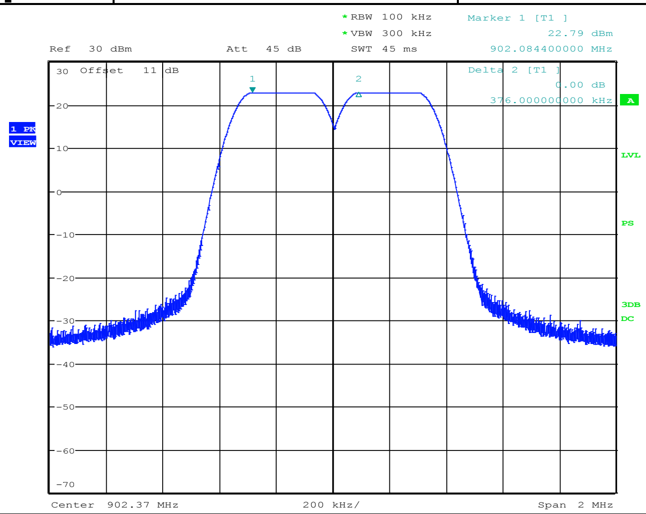
In function of frequency range table: Worst case sees in table A3 (see table in §2.1)

Minimum channel spacing frequency measured between (MHz)	Adjacent Channel Separation (kHz)	20dB Bandwidth (kHz)	Minimum Limit (kHz)
[903.313-903.688]	307.8	262.4	262.6



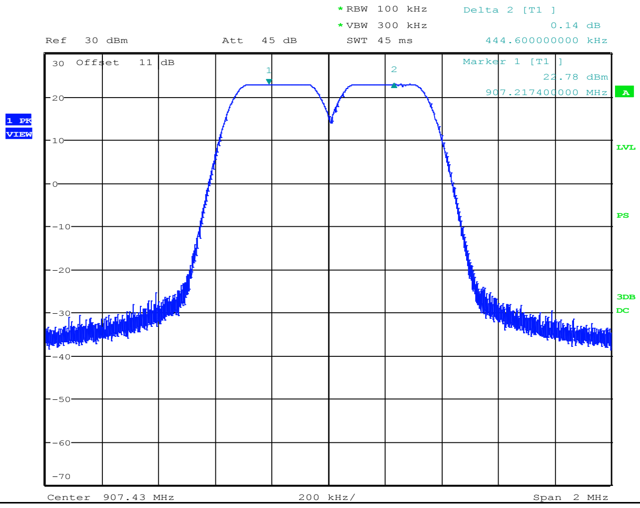
In function of frequency range table: Worst case sees in table H3 (see table in §2.1)

Minimum channel spacing frequency measured between (MHz)	Adjacent Channel Separation (kHz)	20dB Bandwidth (kHz)	Minimum Limit (kHz)
[902.188-902.563]	376.0	262.4	262.6



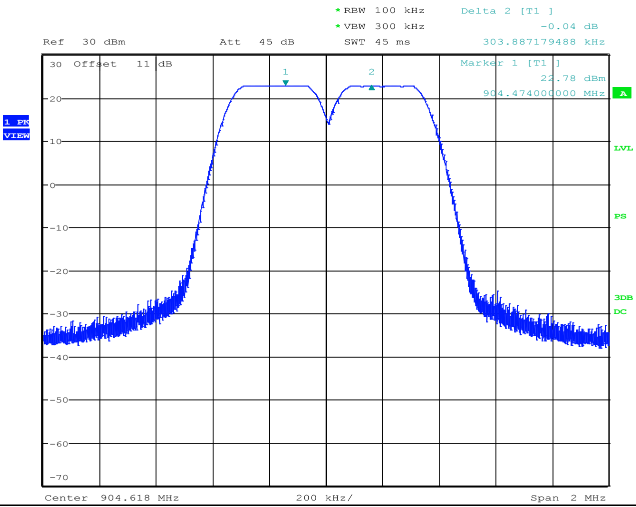
In function of frequency range table: Worst case sees in table A2(see table in §2.1)

Minimum channel spacing frequency measured between (MHz)	Adjacent Channel Separation (kHz)	20dB Bandwidth (kHz)	Minimum Limit (kHz)
[907.25-907.625]	444.6	262.4	262.6



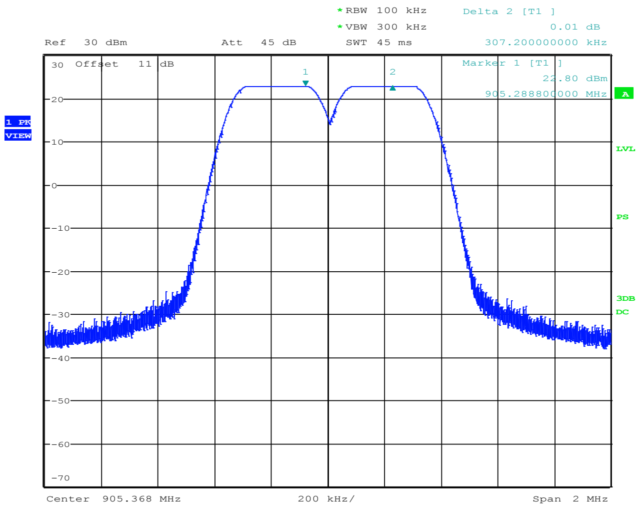
In function of frequency range table: Worst case sees in table H2(see table in §2.1)

Minimum channel spacing frequency measured between (MHz)	Adjacent Channel Separation (kHz)	20dB Bandwidth (kHz)	Minimum Limit (kHz)
[904.438-904.813]	303.887	262.4	262.6



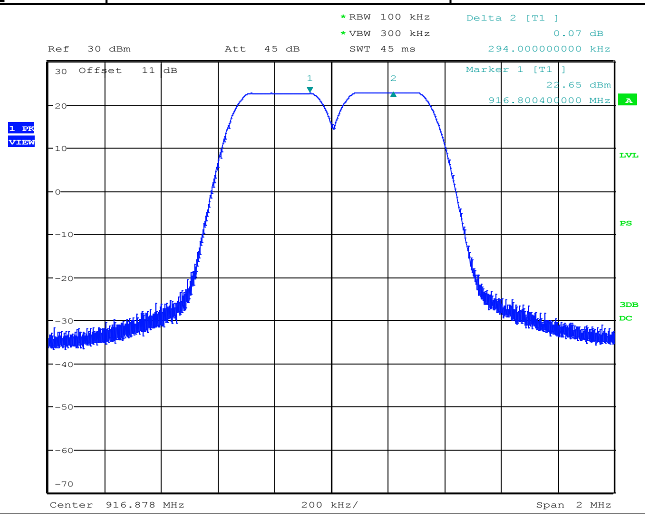
In function of frequency range table: Worst case sees in table A1(see table in §2.1)

Minimum channel spacing frequency measured between (MHz)	Adjacent Channel Separation (kHz)	20dB Bandwidth (kHz)	Minimum Limit (kHz)
[905.188-905.563]	**307.2**	**262.4**	**262.6**



In function of frequency range table: Worst case sees in table H1(see table in §2.1)

Minimum channel spacing frequency measured between (MHz)	Adjacent Channel Separation (kHz)	20dB Bandwidth (kHz)	Minimum Limit (kHz)
[916.698-917.073]	**294.0**	**262.4**	**262.6**



5.9. CONCLUSION

Hopping Channel Separation measurement performed on the sample of the product **ARF8320D**, SN: **I180400077**, in configuration and description presented in this test report, show levels below the FCC CFR 47 Part 15 and RSS-247 limits.

6. Number of Hopping Frequencies (15.247)

6.1. ENVIRONMENTAL CONDITIONS

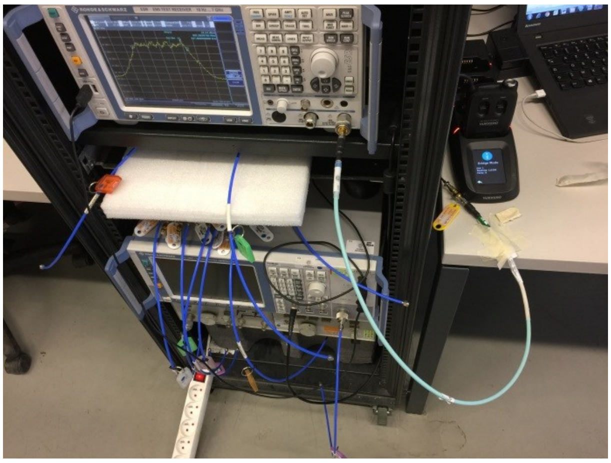
Date of test : March 26, 2018
Test performed by : Gaëtan DESCHAMPS
Atmospheric pressure (hPa) : 1080
Relative humidity (%) : 23
Ambient temperature (°C) : 32

6.2. LIMIT

For frequency hopping system operating in the 902-928MHz, at least 25 channels frequencies must be used.

6.3. EQUIPMENT CONFIGURATION

Packet type: Random 05
Hopping sequence: ☑ ON ☐ OFF



6.4. 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.

Setting:
- Span: The frequency band of operation.
- RBW: To identify clearly the individual channels, set the RBW to less than 30% of the channel spacing or the 20 dB bandwidth, whichever is smaller.
- VBW ≥ RBW.
- Sweep: Auto.
- Detector function: Peak.
- Trace: Max hold.
- Allow the trace to stabilize.

6.5. TEST EQUIPMENT LIST

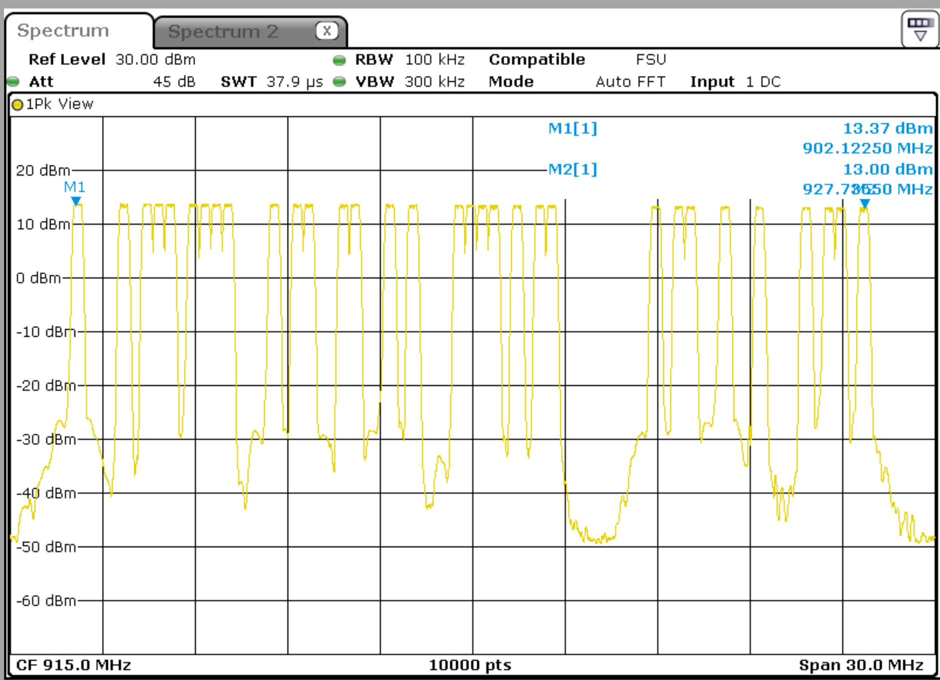
DESCRIPTION	MANUFACTURER	MODEL	N° LCIE	Cal_Date	Cal_Due
Attenuator 10dB	TECHNIWAVE	-	A7122273	09/17	09/18
Cable Measure	-	36G	A5329604	12/17	12/18
Thermo-hygrometer (C3)	OREGON	BAR206	B4204078	10/16	10/18
Thermo-hygrometer (PM1/2/3)	KIMO	HQ 210	B4206022	08/16	08/18
Receiver 20Hz – 8GHz	ROHDE & SCHWARZ	ESU8	A2642019	12/17	12/18

6.6. DIVERGENCE, ADDITION OR SUPPRESSION ON THE TEST SPECIFICATION

☑ None ☐ Divergence:

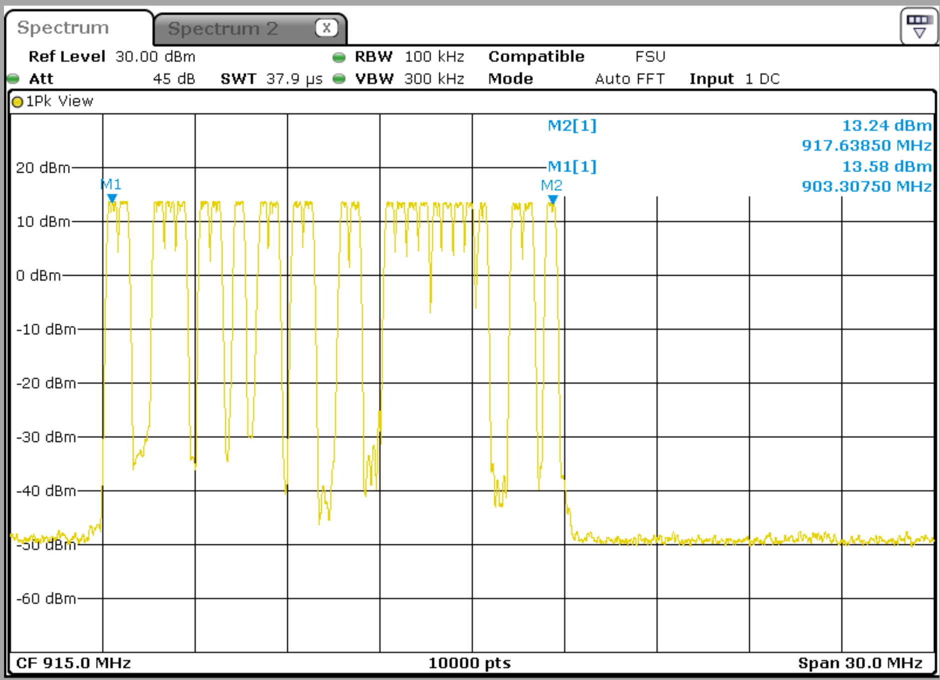
6.7. TEST SEQUENCE AND RESULTS

Channel Table C1

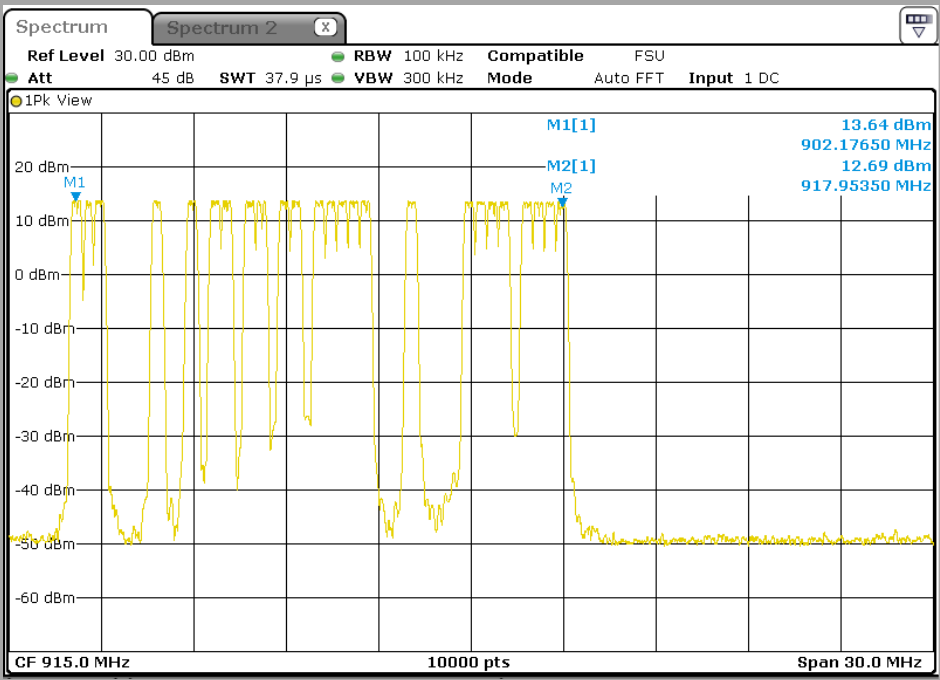


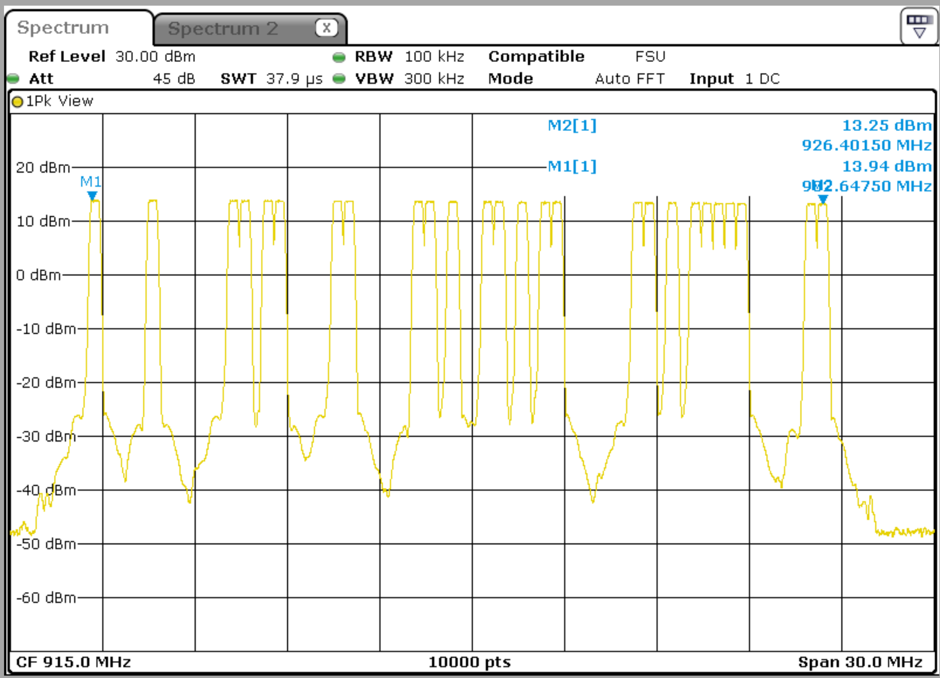
Hopping Sequence	32	Channels

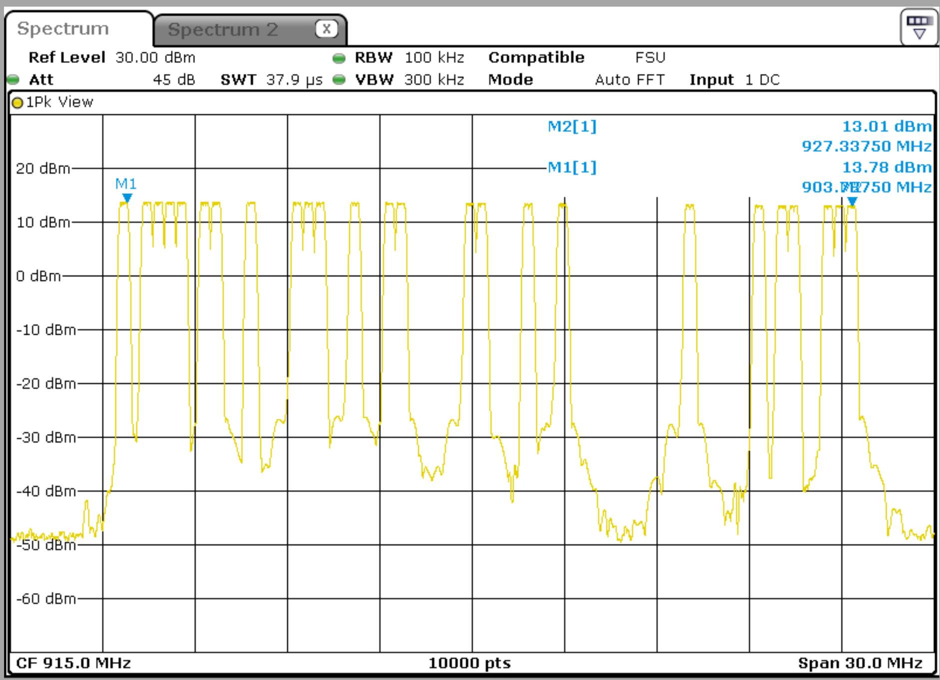
Channel Table A3



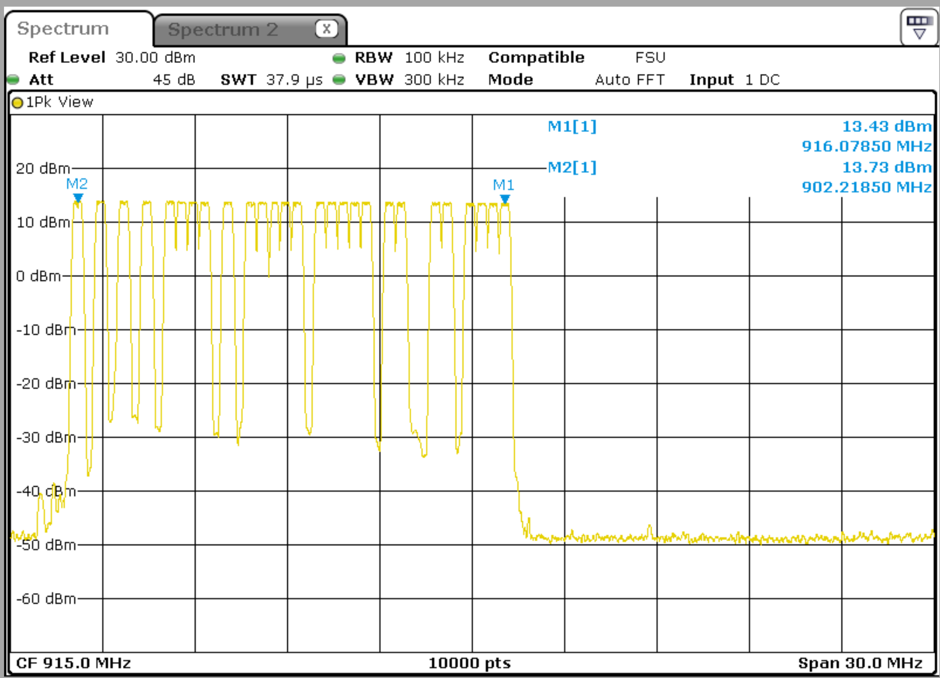
Hopping Sequence	26	Channels

Channel Table H3		
		
Hopping Sequence	25	Channels

Channel Table A2		
		
Hopping Sequence	**26**	**Channels**

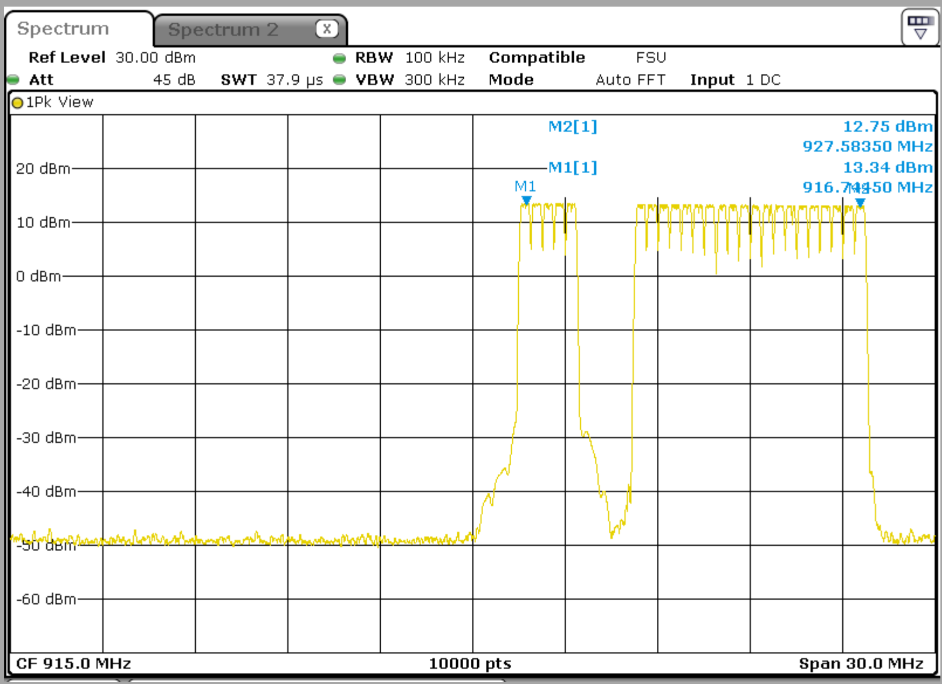
Channel Table H2		
		
Hopping Sequence	**25**	**Channels**

Channel Table A1



Hopping Sequence	27	Channels

Channel Table H1



Hopping Sequence	**25**	**Channels**

6.8. CONCLUSION

Number of hopping frequencies measurement performed on the sample of the product **ARF8320D**, SN: **I180400077**, in configuration and description presented in this test report, show levels below the FCC CFR 47 Part 15 and RSS-247 limits.

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

7.1. ENVIRONMENTAL CONDITIONS

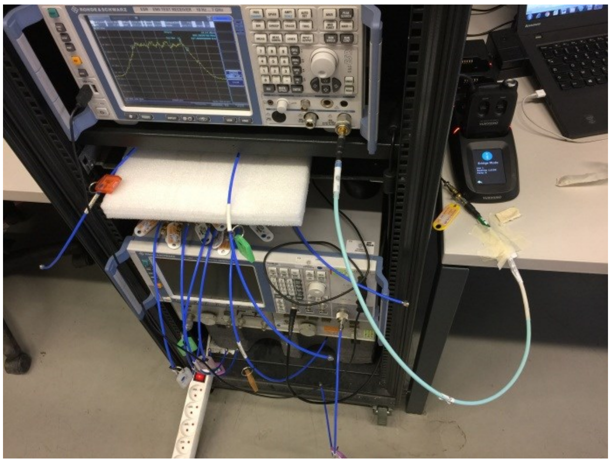
Date of test	:	March 26, 2018
Test performed by	:	Gaëtan DESCHAMPS
Atmospheric pressure (hPa)	:	1080
Relative humidity (%)	:	23
Ambient temperature (°C)	:	32

7.2. LIMIT

The average time of occupancy on any channel shall not be greater than 0.4 seconds within period of 10 seconds

7.3. EQUIPMENT CONFIGURATION

Packet type: Random 05
Hopping sequence: ☑ ON ☐ OFF



7.4. 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.

Measurement Procedure:
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

7.5. TEST EQUIPMENT LIST

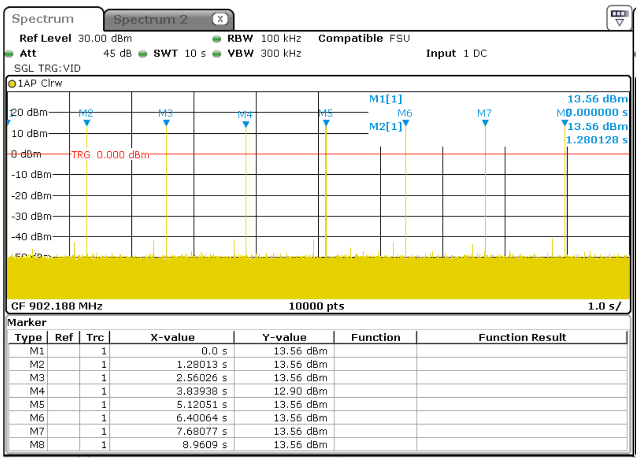
DESCRIPTION	MANUFACTURER	MODEL	N° LCIE	Cal_Date	Cal_Due
Attenuator 10dB	TECHNIWAVE	-	A7122273	09/17	09/18
Cable Measure	-	36G	A5329604	12/17	12/18
Thermo-hygrometer (C3)	OREGON	BAR206	B4204078	10/16	10/18
Thermo-hygrometer (PM1/2/3)	KIMO	HQ 210	B4206022	08/16	08/18
Receiver 20Hz – 8GHz	ROHDE & SCHWARZ	ESU8	A2642019	12/17	12/18

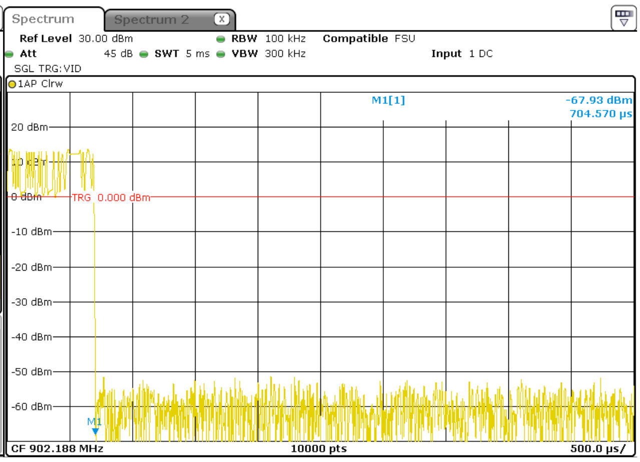
7.6. DIVERGENCE, ADDITION OR SUPPRESSION ON THE TEST SPECIFICATION

☑ None ☐ Divergence:

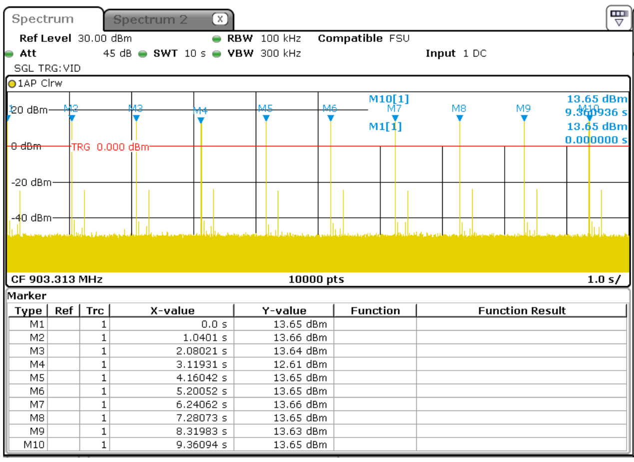
7.7. TEST SEQUENCE AND RESULTS

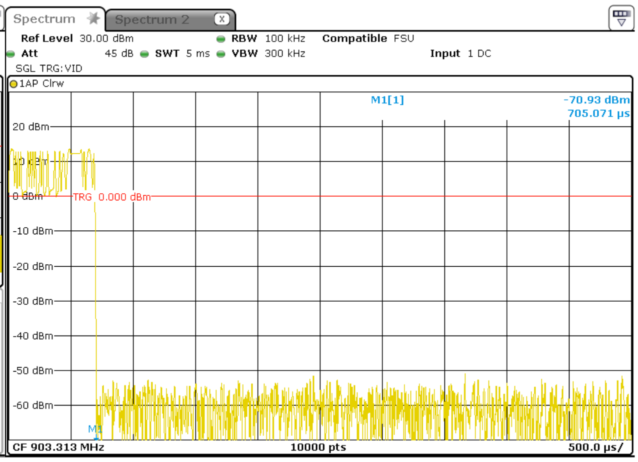
Frequency range table	Number of transmission in the period at 10s	Length of transmission time (ms)	Result (ms)	Limit (ms)
C1 Channel observed : Cmin	8 (hop)	0.70457	5.63656	400

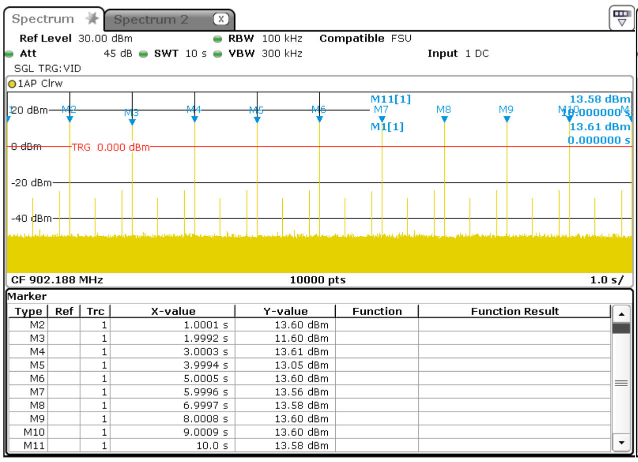


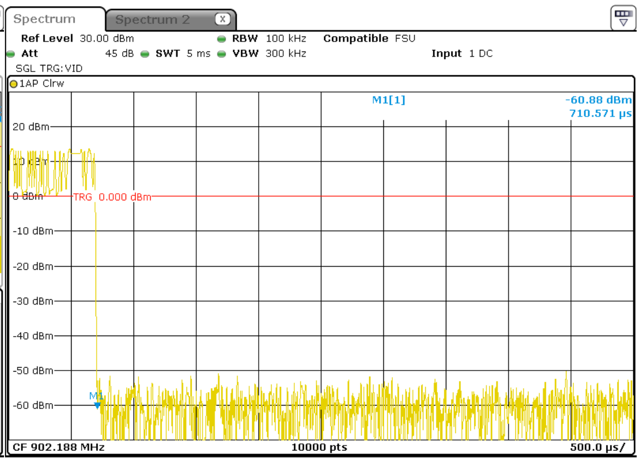


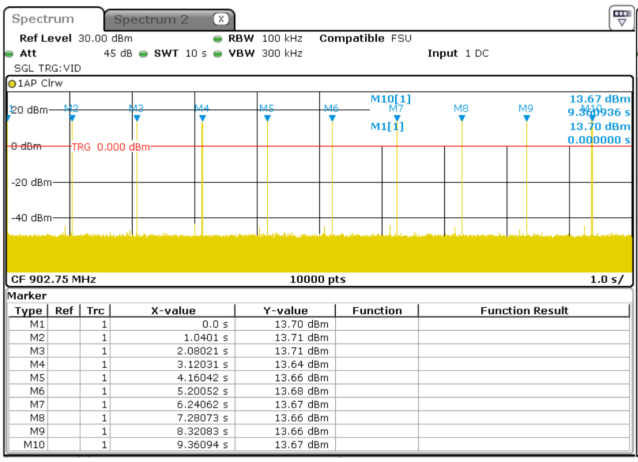
A3 Channel observed : Cmin	10(hop)	0.705071	7.05071	400

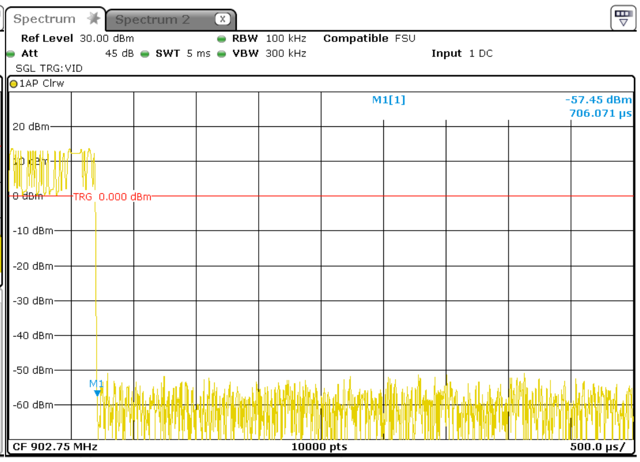




<table>
<tr><th>Frequency range table</th><th>Number of transmission in the period at 10s</th><th>Length of transmission time (ms)</th><th>Result (ms)</th><th>Limit (ms)</th></tr>
<tr><td>H3
Channel observed : Cmin</td><td>11 (hop)</td><td>0.710571</td><td>7.816281</td><td>400</td></tr>
<tr><td colspan="5">


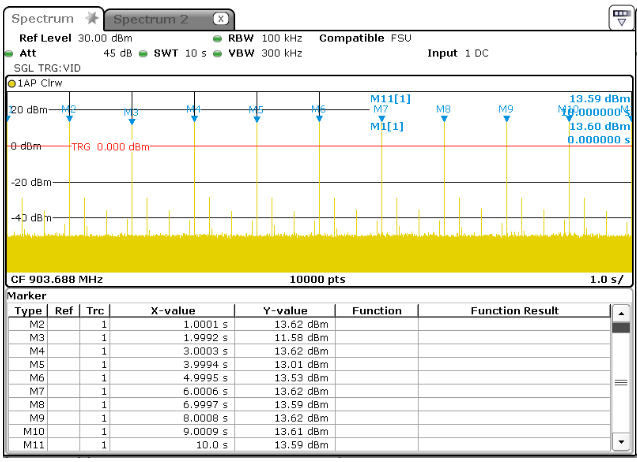


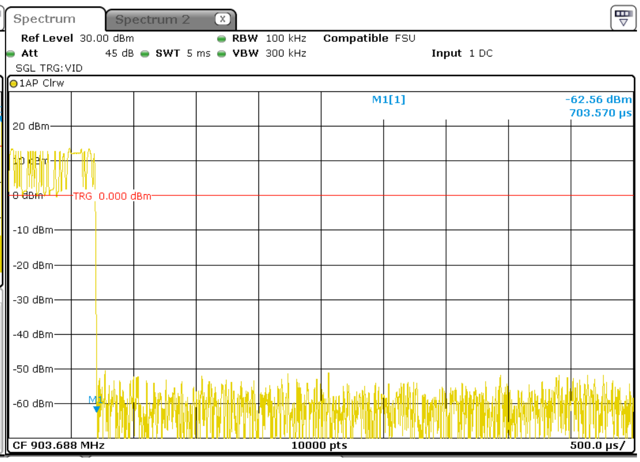
</td></tr>
<tr><td>A2
Channel observed : Cmin</td><td>10(hop)</td><td>0.706071</td><td>7.06071</td><td>400</td></tr>
<tr><td colspan="5">




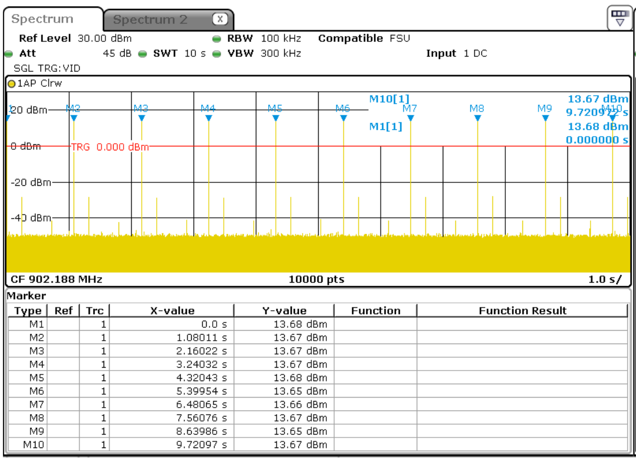
</td></tr>
</table>

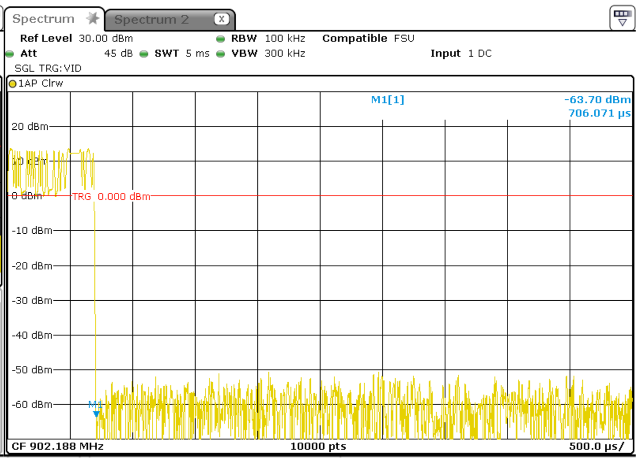
Frequency range table	Number of transmission in the period at 10s	Length of transmission time (ms)	Result (ms)	Limit (ms)
H2 Channel observed : Cmin	**11 (hop)**	**0.70357**	**7.73927**	**400**



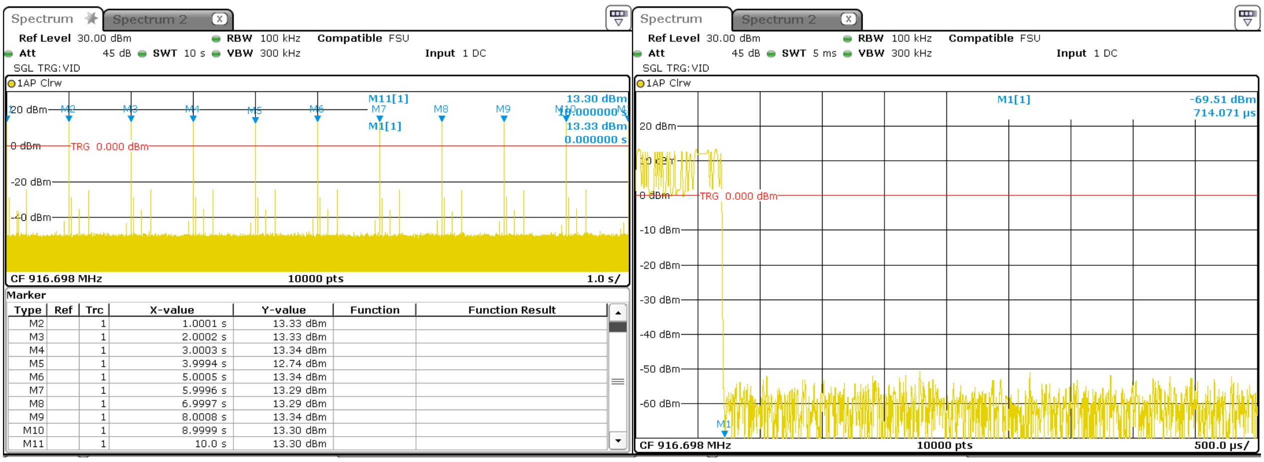


Frequency range table	Number of transmission in the period at 10s	Length of transmission time (ms)	Result (ms)	Limit (ms)
A1 Channel observed : Cmin	**10(hop)**	**0.706071**	**7.06071**	**400**





Frequency range table	Number of transmission in the period at 10s	Length of transmission time (ms)	Result (ms)	Limit (ms)
H1 Channel observed : Cmin	11 (hop)	0.714071	7.854781	400



7.8. CONCLUSION

Time of occupancy measurement performed on the sample of the product **ARF8320D**, SN: **I180400077**, in configuration and description presented in this test report, show levels below the FCC CFR 47 Part 15 and RSS-247 limits.

8. BAND EDGE MEASUREMENT (15.247)

8.1. ENVIRONMENTAL CONDITIONS

Date of test : March 20, 2018
Test performed by : Gaëtan DESCHAMPS
Atmospheric pressure (hPa) : 1080
Relative humidity (%) : 32
Ambient temperature (°C) : 22

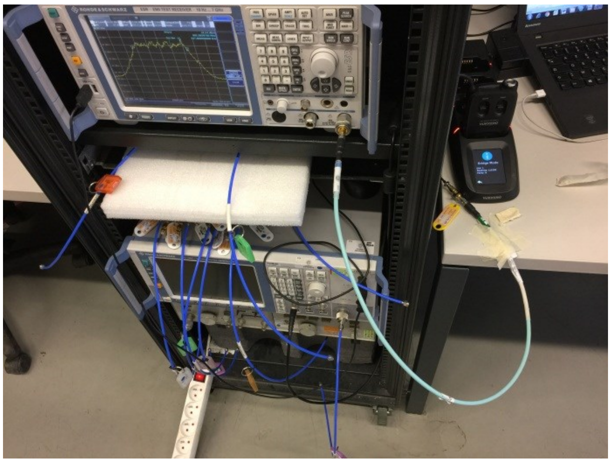
8.2. LIMIT

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.
For -20dBc limit, lowest power output level is considered, worst case.

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.

8.3. EQUIPMENT CONFIGURATION

Packet type: Random 05
Hopping sequence: ☐ ON ☑ OFF
Frequency range tested: C1 (see table in §2.1, the biggest frequency range table)



8.4. 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

8.5. TEST EQUIPMENT LIST

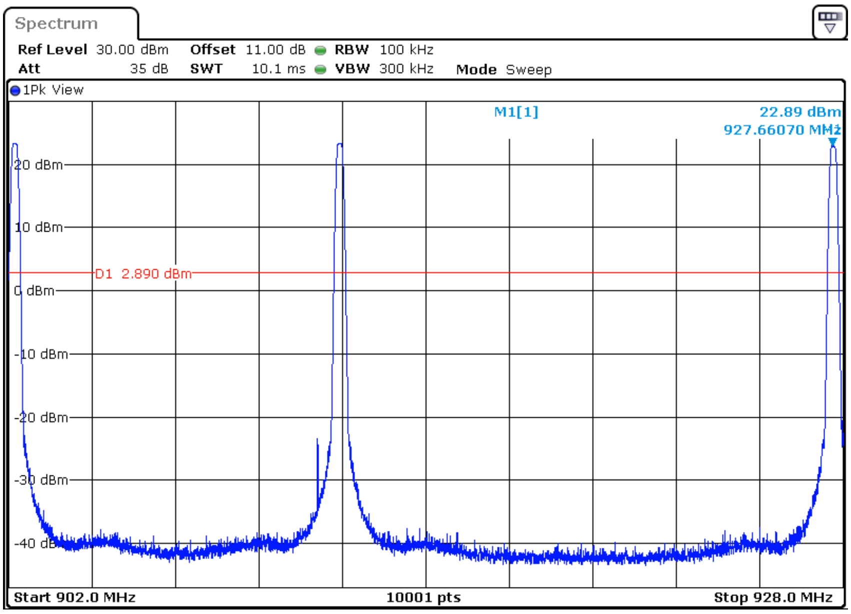
DESCRIPTION	MANUFACTURER	MODEL	N° LCIE	Cal_Date	Cal_Due
Attenuator 10dB	TECHNIWAVE	-	A7122273	09/17	09/18
Cable Measure	-	36G	A5329604	12/17	12/18
Thermo-hygrometer (C3)	OREGON	BAR206	B4204078	10/16	10/18
Thermo-hygrometer (PM1/2/3)	KIMO	HQ 210	B4206022	08/16	08/18
High Pass (1-15GHz)	WAINRIGHT	WHKX 1.03/15G-10SS	A7484035	05/17	05/19
Spectrum analyzer	ROHDE & SCHWARZ	FSV 30	A4060050	12/17	12/18

8.6. DIVERGENCE, ADDITION OR SUPPRESSION ON THE TEST SPECIFICATION

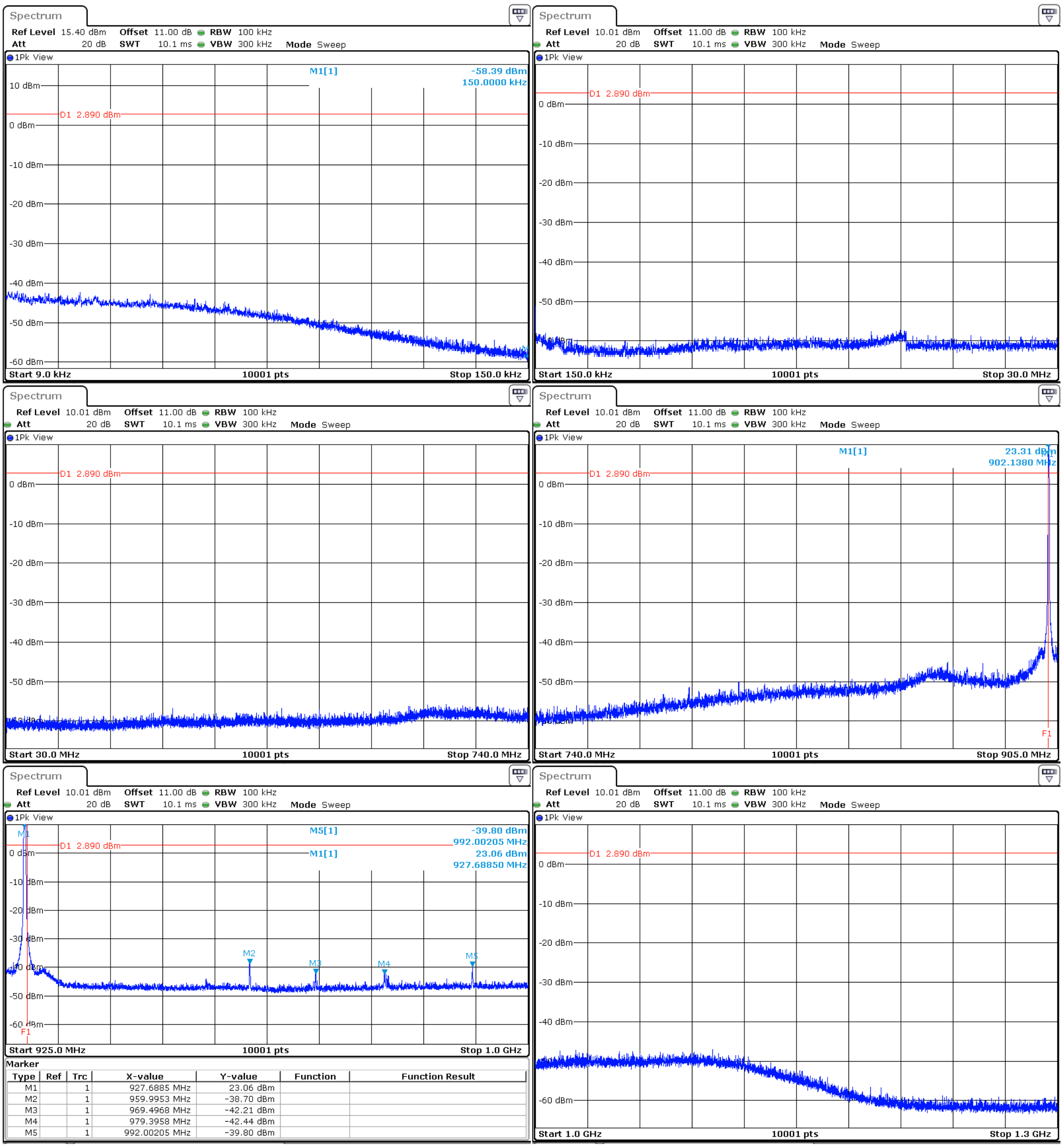
☑ None ☐ Divergence:

8.7. TEST SEQUENCE AND RESULTS

GRAPH / MODULATION.

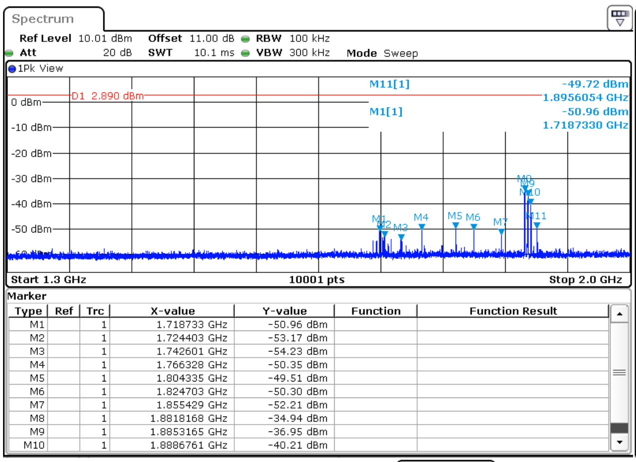


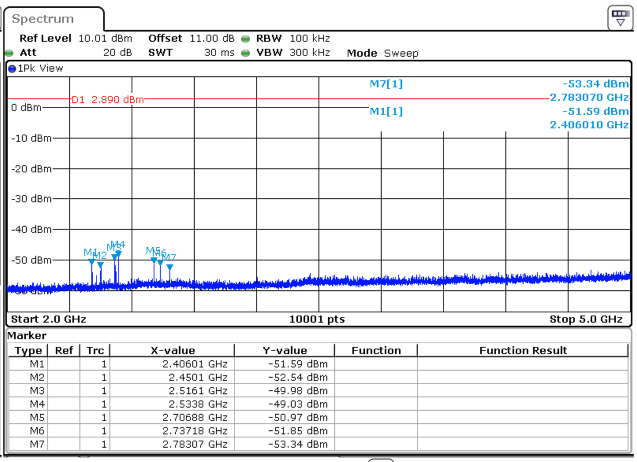
Worst case: Cmax and dysplay line at 2.89dBm.

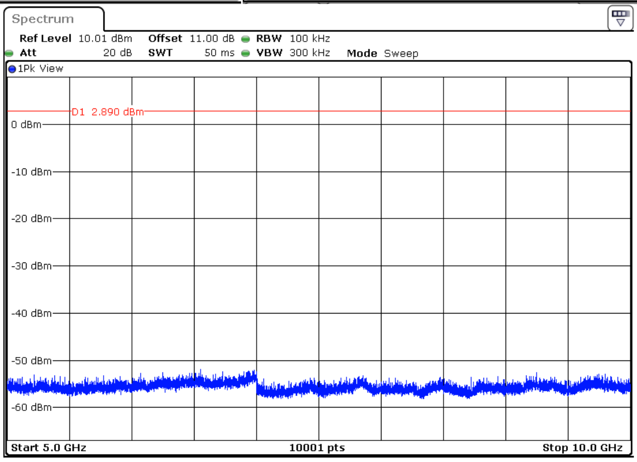


Marker

Type	Ref	Trc	X-value	Y-value	Function	Function Result
M1		1	927.6885 MHz	23.06 dBm		
M2		1	959.9953 MHz	-38.70 dBm		
M3		1	969.4968 MHz	-42.21 dBm		
M4		1	979.3958 MHz	-42.44 dBm		
M5		1	992.00205 MHz	-39.80 dBm		







Results:

See test results in §3.6.4

8.8. CONCLUSION

Band edge measurement performed on the sample of the product **ARF8320D**, SN: **I180400077**, in configuration and description presented in this test report, show levels below the FCC CFR 47 Part 15 and RSS-247 limits.

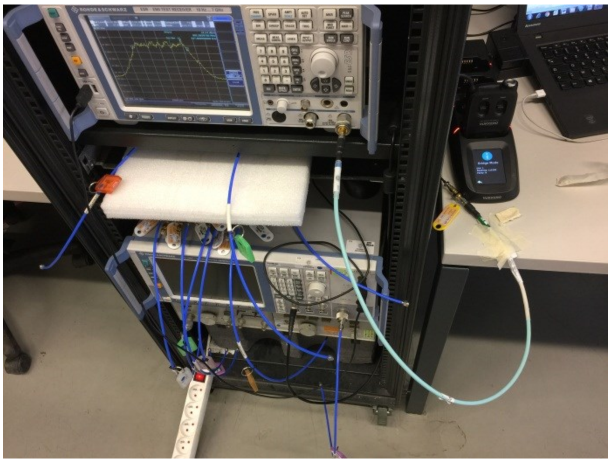
9. OCCUPIED BANDWIDTH

9.1. ENVIRONMENTAL CONDITIONS

Date of test	:	March 26, 2018
Test performed by	:	Gaëtan DESCHAMPS
Atmospheric pressure (hPa)	:	1080
Relative humidity (%)	:	23
Ambient temperature (°C)	:	32

9.2. EQUIPMENT CONFIGURATION

Packet type: 1-DH5 / 2-DH5 / 3-DH5 worst case presented
Hopping sequence: ☐ ON ☐ OFF



9.3. 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.
Offset: Attenuator+cable 11dB

☐ ***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.

Measurement Procedure:
1. RBW used in the range of 1% to 5% of the anticipated emission bandwidth
2. Set the video bandwidth (VBW) ≥ 3 x RBW.
3. Detector = Peak.
4. Trace mode = max hold.
5. Sweep = auto couple.
6. Allow the trace to stabilize.
7. OBW 99% function of spectrum analyzer used

9.4. TEST EQUIPMENT LIST

DESCRIPTION	MANUFACTURER	MODEL	N° LCIE	Cal_Date	Cal_Due
Attenuator 10dB	TECHNIWAVE	-	A7122273	09/17	09/18
Cable Measure	-	36G	A5329604	12/17	12/18
Thermo-hygrometer (C3)	OREGON	BAR206	B4204078	10/16	10/18
Thermo-hygrometer (PM1/2/3)	KIMO	HQ 210	B4206022	08/16	08/18
Receiver 20Hz – 8GHz	ROHDE & SCHWARZ	ESU8	A2642019	12/17	12/18

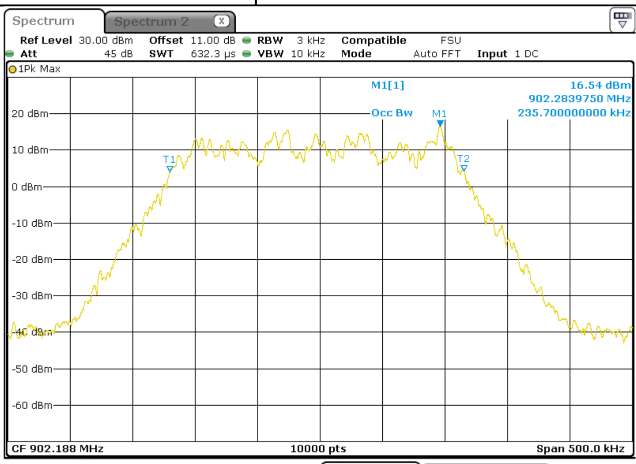
9.5. DIVERGENCE, ADDITION OR SUPPRESSION ON THE TEST SPECIFICATION

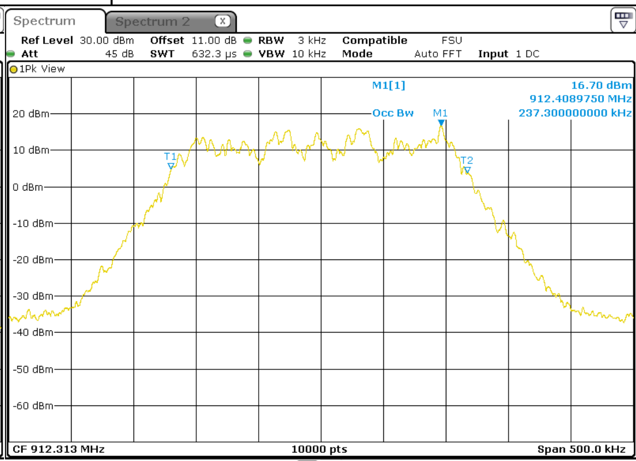
☑ None ☐ Divergence:

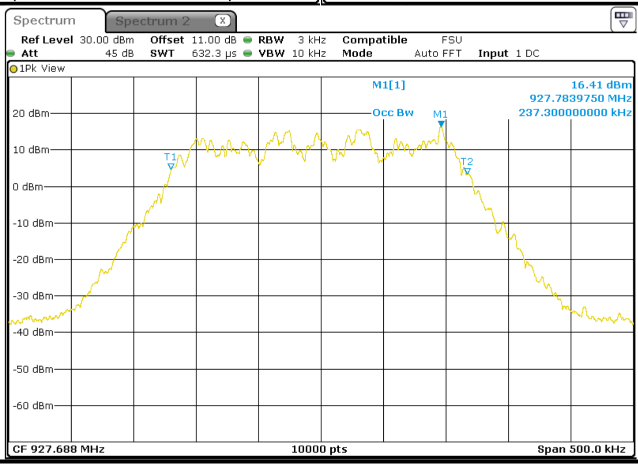
9.6. TEST SEQUENCE AND RESULTS

Packet type: Random 05
Hopping sequence: ☐ ON ☑ OFF
Frequency range tested: C1 (see table in §2, same modulation for each frequency range table)

C1		
Channel	**Channel Frequency (MHz)**	**99% Occupied Bandwidth (kHz)**
Cmin	902.188	**235.7**
Cmid	912.313	**237.3**
Cmax	927.688	**237.3**

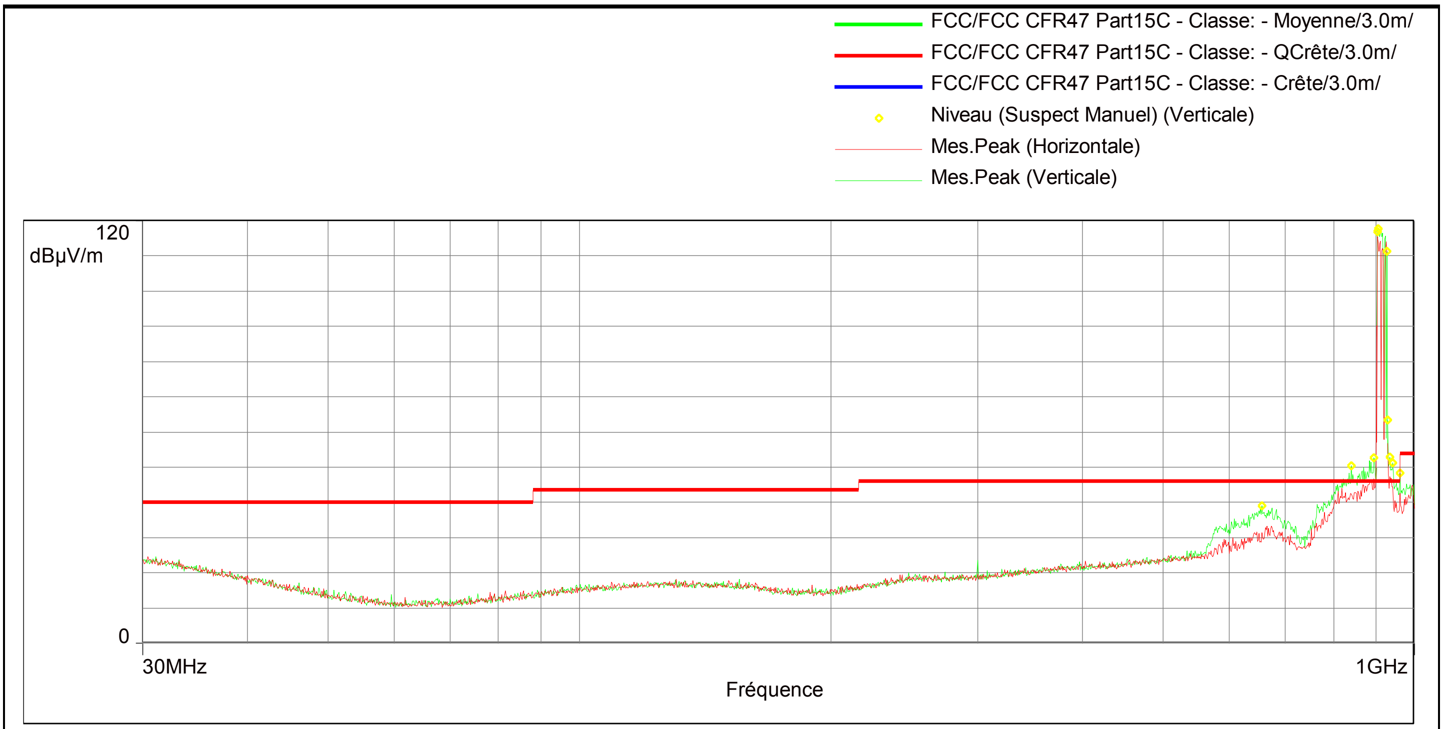






10. ANNEX 1 (GRAPHS)

RADIATED EMISSIONS			
Graph name:	Emr#1	**Test configuration:**	
Limit:	FCC CFR47 Part15C	(H+V) - Configuration 1 <1GHz	
Class:			
Frequency range: [30MHz - 1GHz]			
Antenna polarization:	Horizontal & Vertical	**RBW :**	100kHz
Azimuth:	0° - 360°	**VBW :**	300kHz



Spurious emissions

Frequency (MHz)	Peak Level (dBµV/m)	Polarization
656.293	39.0	Vertical
839.546	50.4	Vertical
893.876	52.8	Vertical
902.211*	117.0	Vertical
905.214*	117.7	Vertical
926.960*	111.3	Vertical
928.007*	63.4	Vertical
933.580	52.8	Vertical
942.515	51.3	Vertical
960.004	48.2	Vertical

*Carrier frequency

11. 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 *Measurement of conducted disturbances in voltage on the power port*	3.51 dB	3.6 dB
Mesure des perturbations conduites en tension sur le réseau de télécommunication *Measurement of conducted disturbances in voltage on the telecommunication port.*	3.26 dB	A l'étude / Under consid.
Mesure des perturbations discontinues conduites en tension *Measurement of discontinuous conducted disturbances in voltage*	3.45 dB	3.6 dB
Mesure des perturbations conduites en courant *Measurement of conducted disturbances in current*	3.09 dB	A l'étude / Under consid.
Mesure du champ électrique rayonné sur le site en espace libre de Moirans *Measurement of radiated electric field on the Moirans open area test site*	5.20 dB	6.3 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.*