FCC Test Firm Registration Number: 171131
Industry Canada Test Firm Number: Site# 9545A-1

Matériel testé : *Equipment under test*:	**POWERNODE Radio module**

Constructeur:
Manufacturer:
TAGSYS RFID
785, voie Antiope, Athélia III
13600 LA CIOTAT - France

Rapport délivré à :
Issued to:
TAGSYS RFID
785, voie Antiope, Athélia III
13600 LA CIOTAT - France

Référence de la proposition :
Proposal number:
032015-21359

Date de l'essai :
Date of test:
May 26th & 27th, 2015

Objectif des essais :
Test purpose:
EMC qualification accordingly to following standards:
- CFR 47, FCC Part 15, Subpart C *(Chapter 15.247 - Operation within the bands 902–928 MHz, 2400–2483.5 MHz, and 5725–5850 MHz)*

FCC ID:
QHKRTILPNCORE

Lieu du test:
Test location:
SMEE
38 VOIRON - France

Test réalisé par :
Test realized by:
Laurent CHAPUS - Jérémy BLANCHER

Conclusion :
Conclusion:
L'équipement satisfait aux prescriptions des normes citées en référence.
The appliance complies with requirements of above mentioned standards.

Ed.	Date	Modifications / Pages	Written by:	Approved by: Visa
1 2	June 25th, 2015 July 15th, 2015	Initial Edition Added info	Jeremy Blancher	Laurent Chapus

Sommaire / *Contents*

1. Références Normatives / Normative references

Standard : FCC CFR 47, PART 15, Subpart C
ANSI C63.4 (2009): American National Standard for Methods of Measurement of Radio-Noise Emissions from Low-Voltage Electrical and Electronic Equipment in the Range of 9 kHz to 40 GHz.

ANSI C63.10 (2009): American National Standard for Testing Unlicensed Wireless Devices

2. Synthèse des essais / *Test synthesis*

TEST	Paragraph number (FCC Part 15.247)	Spec. (FCC Part 15.247)	RESULTS (comments)
Conducted emissions test	15.107 / 15.207 (a)	Table 15.207 (a)	**PASS**
20dB Bandwidth	15.247 (a) (1) (i)	Maximum 500kHz	**PASS**
Carrier Frequency Separation	15.247 (a) (1)	Minimum separation 25kHz or the 20dB bandwidth, whichever is greater	**PASS**
Number of Hopping Frequencies	15.247 (a) (1) (i)	At least 50 channels	**PASS**
Time of Occupancy (Dwell Time)	15.247 (a) (1) (i)	Maximum 400ms per channel within 20s period	**PASS**
Maximum Peak Output Power	15.247 (b) (2)	1W max / 30dBm (Conducted) 4W max / 36dBm (EIRP)	**PASS**
Unwanted emissions into Non Restricted Frequency Bands	15.247 (d) /	-20dBc in any 100kHz outside frequency band.	**PASS**
Unwanted emissions into Restricted Frequency Bands	15.209 / 15.247 (d) / 15.205	Measure at 300m 9-490kHz: 2400µV/m/F(kHz) Measure at 30m 0.490-1.705: 24000µV/m/F(kHz) 1.705-30MHz: 30µV/m Measure at 3m 30MHz-88MHz : 40 dBµV/m 88MHz-216MHz : 43.5 dBµV/m 216MHz-960MHz : 46.0 dBµV/m Above 960MHz : 54.0 dBµV/m	**PASS**

- **General conclusion:**

Measures and tests performed on the sample of the product PowerNode Radio module, in configuration and description presented in this test report, show compliance with standards FCC CFR 47, PART 15, Subpart C.

3. Equipement Sous Test (EST) / *Equipment Under Test* (EUT)

Nom /
Identification

PowerNode Radio module

Sn: N.C

Alimentation /
Power supply

5V dc from external power supply unit
(Golden Profit Electronics, model GPE010H-050210-Z)

Auxiliaires /
Auxiliaries

- External power supply unit
- Hotspot module, TAGSYS equipment (Radio communication, 2.4GHz)

Entrées-Sorties /
Input / Output

	Câbles pour essai / *Cables for test*	Blindé / *Shielded*	Prévu pour >3m / *Intended for >3m*
MMCX to Tx antenna	0.15m	Yes	No
MMCX to Rx antenna	0.15m	Yes	No
2 pins for DC supply	1.5m	No	No
11 pins for command	1.0m	No	No

Version programme /
Firmware version

N.C

Mode de fonctionnement /
Running mode

Equipment is able to transmit in the 902-928MHz frequency band
- Transmit hopping frequencies sequence
- Different modulation types are available
- Be in standby mode (no transmission)

The RF input of the module is connected to a 2.45GHz receive antenna

Programme de test /
Test program /

None

- **<u>Equipment information:</u>**

- Frequency band: 902 to 928MHz (Transmit)
- Antenna type: PCB antenna (MMCX connector, max antenna gain 2dBi)
- ISM Frequency band: 2400 to 2483.5MHz (Receive only)
- FHSS equipment
- Equipment intended for use as a fixed station
- Equipment designed for continuous operation
- Normal power source: 5V DC from external power supply

4. Conditions pendant les essais / *Test conditions*

Humidité relative / *Relative Humidity* : 55%
Température / *Temperature* : 20°C

<u>Tension d'alimentation / *Power supply voltage*</u>:
Equipment sous test / *Equipment under test* : 5V DC from external power supply
Tension secteur / AC mains : 110V/60Hz

5. Modifications de l'EST / *Modifications of the EUT*

None

6. Conducted Emission Measurement (150kHz-30MHz)

TEST: Limits for conducted disturbance 150kHz – 30MHz / FCC part 15.107 – 15.207	**Verdict**
Method: The LISN is placed 0,8 m from the boundary of the unit under test and bonded to a ground reference plane. This distance was between the closest points of the AMN and the EUT. All other units of the EUT and associated equipment were at least 0,8 m from the AMN. All power was connected to the system through Artificial Mains Network (AMN). Conducted voltage measurements on lines were made at the output of the LISN. The EUT is 80cm above the ground reference plane and 40cm from the vertical ground plane. The AC power cable is 1m length. The measurements are performed while the equipment is transmitting continually on the middle band.	**Pass**

Laboratory Parameters:	Required prior to the test	During the test
Ambient Temperature	10 to 40 °C	20°C
Relative Humidity	10 to 90 %	55%
Fully configured sample scanned over the following frequency range	Frequency range on each side of line	Measurement Point
	150kHz to 30MHz	AC input port (on external power supply unit)

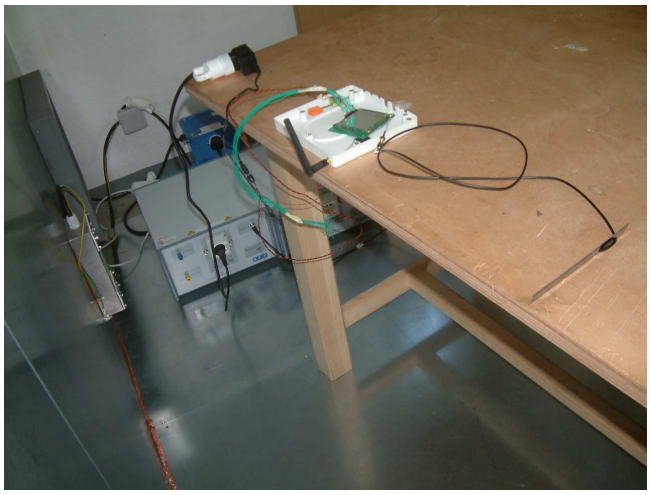
Limits

Frequency (MHz)	Limit dB (µV)			
	Quasi-Peak	Result	Average	Result
0.15 – 0.50	66 \ 56	**Pass**	56 \ 46	**Pass**
0.50 – 5	56	**Pass**	46	**Pass**
5 – 30	60	**Pass**	50	**Pass**

Supplementary information:
Test location: SMEE
Test date: May 27th, 2015
Power supply voltage: 110V / 60Hz

Test Equipment Used					
Description	Manufacturer	Model	Identifier	Cal. Date	Cal. Due
Attenuator / limiter	SMEE	ATT#1	ATT-101-004	2015/3	2016/3
Cable RF	Div	2m	CAB-101-007	2015/3	2016/3
LISN (50Ω / 50µH)	AFJ	LS16C	RSI-101-001	2015/3	2016/3
LISN (50Ω / 50µH)	AFJ	LS16C	RSI-101-002	2015/3	2016/3
Measuring receiver	Rohde & Schwarz	ESL3	REC-101-001	2012/6	2015/6
Ref. Comb generator	SMEE	EMC-250K	REF-111-001	-	-

Photo of test setup for Mains Terminal Disturbance Voltage



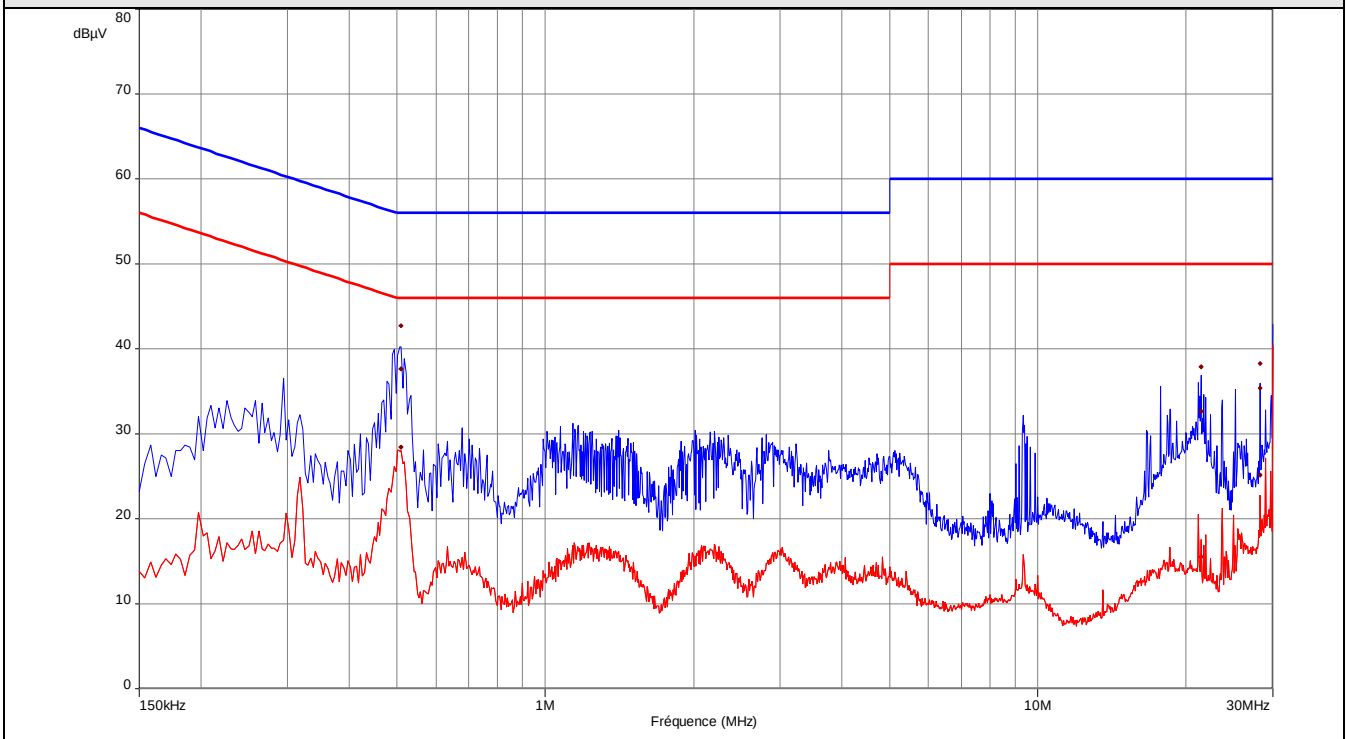
Tabulated Results for Mains Terminal Disturbance Voltage on AC port

FREQ	Meas. PK	Mes. QP	LIMIT QP	Margin QP	Mes. AV	LIMIT AV	Margin AV	Line
(MHz)	(dBµV)	(dBµV)	(dBµV)	(dB)	(dBµV)	(dBµV)	(dB)	
0,510	42,7	37,7	56,0	**-18,3**	28,4	46,0	**-17,6**	Line L1
21,464	37,9	32,7	60,0	**-27,3**	15,6	50,0	**-34,4**	Line L1
28,292	38,3	35,4	60,0	**-24,6**	25,2	50,0	**-24,8**	Line L1
0,512	40,4	36,8	56,0	**-19,2**	32,6	46,0	**-13,4**	Neutral
20,488	38,9	33,6	60,0	**-26,4**	14,3	50,0	**-35,7**	Neutral
29,020	30,5	25,4	60,0	**-34,6**	17,5	50,0	**-32,5**	Neutral

Frequency band investigated:	150kHz-30MHz
RBW:	9kHz
Voltage:	110V / 60Hz
Limit:	15.107 / 15.207
Final measurement detector:	Quasi-Peak and Average
Wide Measurement Uncertainty:	± 3.6dB (k=2)
RESULT:	PASS

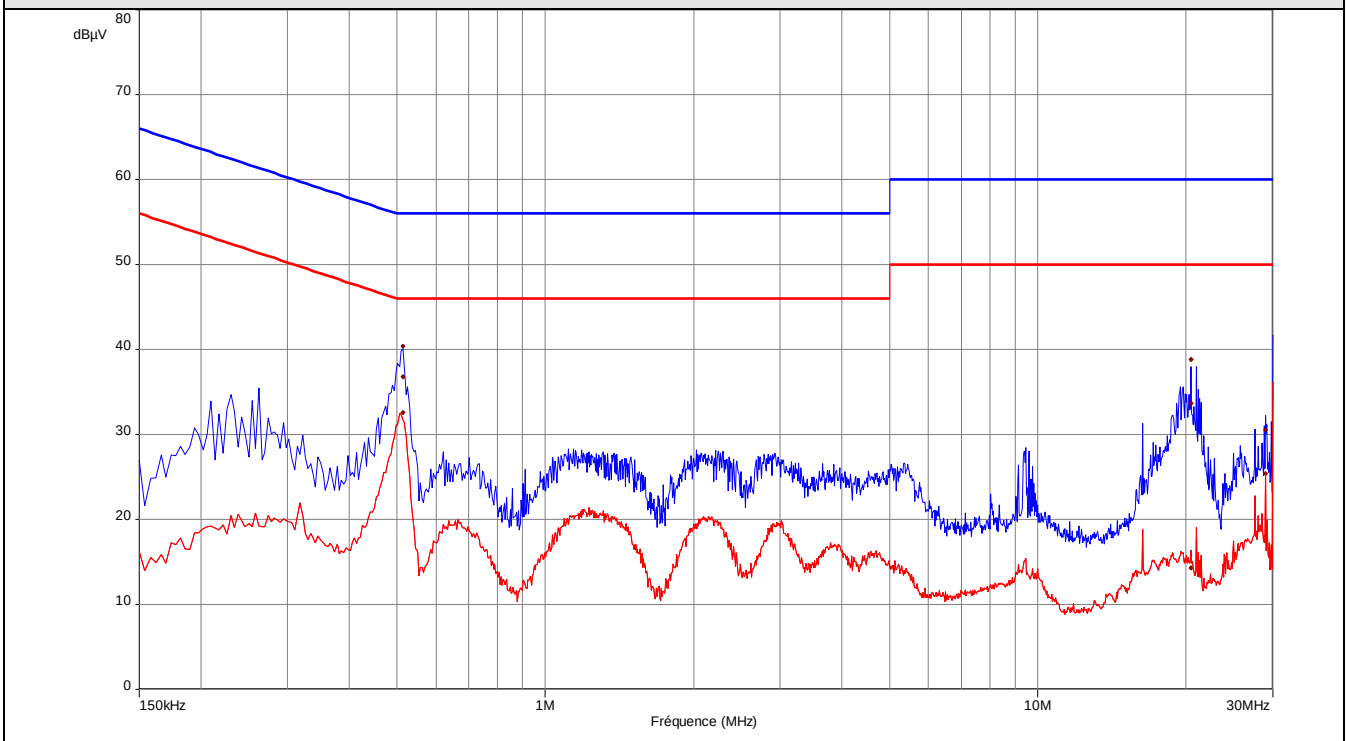
Supplementary information:
Worst case result for lowest, middle and highest channel

Graphical representation of Conducted Disturbance Measurement (Peak and Average detection)
AC port, Line L1



----: Peak | ----: Average

Graphical representation of Conducted Disturbance Measurement (Peak and Average detection)
AC port, Line Neutral



----: Peak | ----: Average

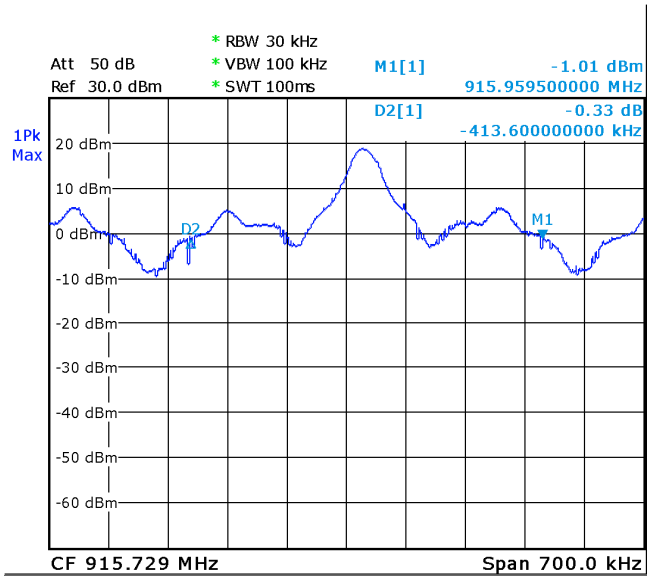
7. 20dB Bandwidth

TEST: 20dB Bandwidth / FCC part 15.247		**Verdict**
Method: The Equipment under test is connected to the measuring receiver with suitable mean (conducted measurement). RBW on spectrum analyser shall be 1-5% of the Equipment Bandwidth (EBW); RBW is adjust for RBW/EBW ration is 1-5% The tested equipment is set to transmit operation on middle channel.		**Pass**
Laboratory Parameters:	Required prior to the test	During the test
Ambient Temperature	10 to 40 °C	20°C
Relative Humidity	10 to 90 %	55%
Limits – FCC Part 15.247 (a)(1)(i)		
Frequency (MHz)	**Level for Bandwidth**	**Limit**
902.75	20dB below the maximum output power	Maximum 500kHz
915.25		
927.25		
Supplementary information: Test location: SMEE / Test date: May 26th, 2015 Power supply voltage: 5V dc		

Test Equipment Used					
Description	Manufacturer	Model	Identifier	Cal. Date	Cal. Due
Measuring Rec.	Rohde&Schwarz	ESL3	REC-101-001	2012/6	2015/6
Cable	Pasternack	PE354-150	CAB-131-025	2015/3	2016/3

Tabulated Results for 20dB Occupied Bandwidth (Conducted measurement)		
Modulation	**Frequency** (MHz)	**20dB Bandwidth** (kHz)
Auto Set Single Reader (worst case)	915.75 MHz	413.6 kHz

Graphical representation of 20dB Bandwidth



Mid channel

Note :Peak Level is 18.63dBm
Note: above plot may show images of the transmitter in adjacent channels.
Worst case result for lowest, middle and highest channel

Modulation:	Auto Set Single Reader
Frequency band investigated:	902MHz to 928MHz
RBW :	30kHz
Measurement detector:	Peak

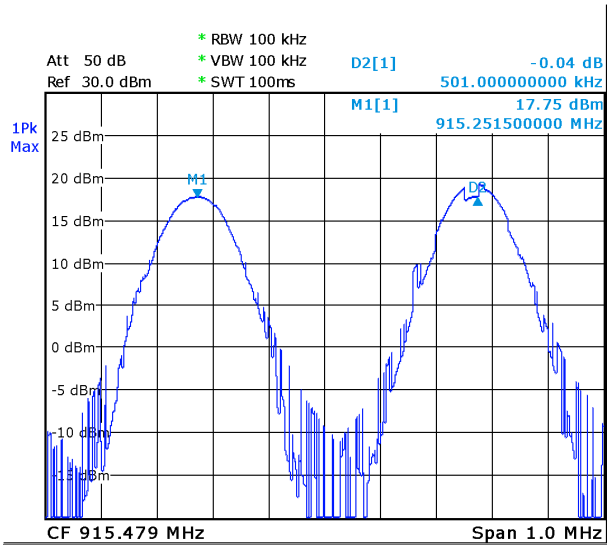
8. Carrier Frequency Separation

TEST: Channel Separation / FCC part 15.247		**Verdict**
Method: The Equipment under test is connected to the measuring receiver with suitable mean. SPAN is adjusted to capture two peaks of two adjacent channels. RBW on spectrum analyser shall be > 1% of the SPAN. The tested equipment is set to transmit hopping sequences on middle channel.		**Pass**
Laboratory Parameters:	Required prior to the test	During the test
Ambient Temperature	10 to 40 °C	20°C
Relative Humidity	10 to 90 %	55%
Limits – FCC Part 15.247 (a)(1)		
Frequency (MHz)	**Minimum Channel Separation**	**Result**
902.75	25kHz or the 20dB bandwidth, whichever is greater	**Pass**
915.25		
927.25		
Supplementary information: Test location: SMEE / Test date: May 26th, 2015 Power supply voltage: 5V dc		

Test Equipment Used					
Description	Manufacturer	Model	Identifier	Cal. Date	Cal. Due
Measuring Rec.	Rohde&Schwarz	ESL3	REC-101-001	2012/6	2015/6
Cable	Pasternack	PE354-150	CAB-131-025	2015/3	2016/3

Tabulated Results for Hopping Channel Separation (Conducted measurement)				
Channel frequency (MHz)	**Adjacent channel separation** (MHz)	**Max. 20dB Bandwidth** (MHz)	**Minimum limit** (MHz)	**Result**
915.25	**0.501**	0.414	0.414	PASS

Graphical representation of Channel Separation



Mid channel

Worst case result for lowest, middle and highest channel

Frequency band investigated:	902MHz to 928MHz
RBW :	100kHz
Measurement detector:	Peak

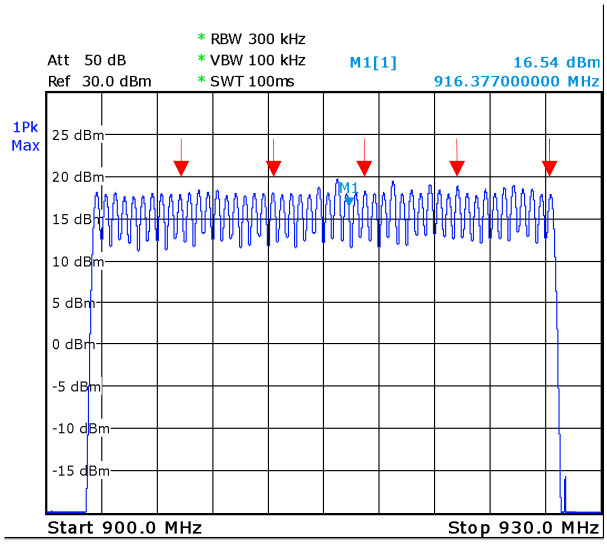
9. Number of Hopping frequencies

TEST: Number of channels / FCC part 15.247		**Verdict**
Method: The Equipment under test is connected to the measuring receiver with suitable mean. SPAN is adjusted to capture the frequency band of operation. RBW on spectrum analyser shall be > 1% of the SPAN. The tested equipment is set to transmit hopping sequences.		**Pass**
Laboratory Parameters:	Required prior to the test	During the test
Ambient Temperature	10 to 40 °C	20°C
Relative Humidity	10 to 90 %	55%
Limits – FCC Part 15.247 (a)(1)(i)		
Frequency band (MHz)	**Minimum number of channels**	**Result**
902MHz – 928MHz	At least 50 channels	**Pass**
Supplementary information: Test location: SMEE / Test date: May 6th, 2015 Power supply voltage: 5V dc		

Test Equipment Used					
Description	Manufacturer	Model	Identifier	Cal. Date	Cal. Due
Measuring Rec.	Rohde&Schwarz	ESL3	REC-101-001	2012/6	2015/6
Cable	Pasternack	PE354-150	CAB-131-025	2015/3	2016/3

Tabulated Results for Number of Hopping Frequencies (Conducted measurement)			
Frequency band (MHz)	**Number of channels measured**	**Minimum required**	**Result**
902 – 928 MHz	**50**	50	PASS

Graphical representation of Number of Hopping Frequencies



Mid band

Note: Interval between two pointers corresponds to 10 hopping channels

Frequency band investigated:	902MHz to 928MHz
RBW :	300kHz
Measurement detector:	Peak

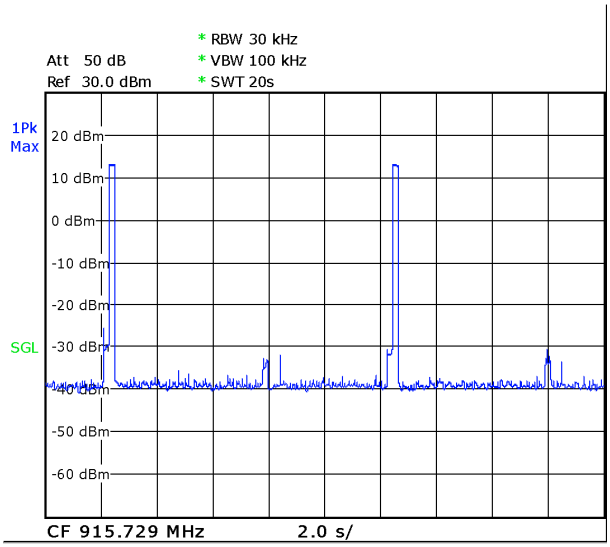
10. Time of Occupancy (Dwell time)

TEST: Dwell Time / FCC part 15.247		**Verdict**
Method: The Equipment under test is connected to the measuring receiver with suitable mean. SPAN is centred on a hopping channel. Zero SPAN is used. The sweep time is adjusted to observe the time of occupancy of a channel. The tested equipment is set to transmit hopping sequences.		**Pass**
Laboratory Parameters:	Required prior to the test	During the test
Ambient Temperature	10 to 40 °C	20°C
Relative Humidity	10 to 90 %	55%
Limits – FCC Part 15.247 (a)(1)(i)		
Observation time	**Maximum time of occupancy per channel**	**Result**
20s	0,4s	**Pass**
Supplementary information: Test location: SMEE / Test date: May 26th, 2015 Power supply voltage: 5V dc		

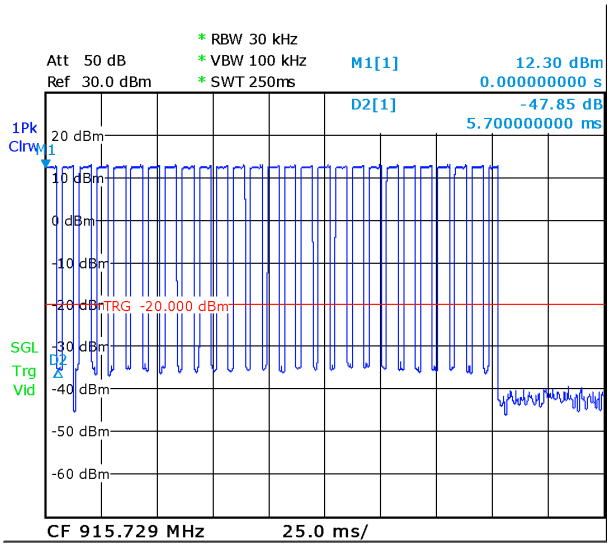
Test Equipment Used					
Description	Manufacturer	Model	Identifier	Cal. Date	Cal. Due
Measuring Rec.	Rohde&Schwarz	ESL3	REC-101-001	2012/6	2015/6
Cable	Pasternack	PE354-150	CAB-131-025	2015/3	2016/3

Tabulated Results for Dwell Time (Conducted measurement)					
Number of transmit time per 20s	**Number of pulse per transmit time**	**Length of 1 pulse (ms)**	**Time of occupancy (ms)**	**Limit (ms)**	**Result**
2	27	5.7ms	308ms	400ms	PASS
Additional information: In 20s, 2 pulses observed					

Graphical representation of Time of Occupancy



20s observation time



250ms observation time (One transmit pulse)

Frequency band investigated:	902MHz to 928MHz
RBW :	30kHz
Measurement detector:	Peak

11. Maximum Peak Output power

TEST: Maximum peak conducted output power / FCC part 15.247			**Verdict**
Method: Measurements were performed with peak detector using a 1MHz RBW. The VBW is set to 3MHz. The spectrum analyzer is connected via suitable means to the RF output of the tested equipment. (Conducted measurement). For field strength, the measure is performed on a 3m Open Area Test Site. The tested equipment is set to transmit operation with modulations on lowest, middle and highest channel.			**Pass**
Laboratory Parameters:	Required prior to the test	During the test	
Ambient Temperature	10 to 40 °C	20°C	
Relative Humidity	10 to 90 %	55%	
Limits – FCC Part 15.247 (b)			
Frequency (MHz)	Limits (dBµV/m)		
	Level / Detector / Distance	Results	
902 to 928	30 dBm / Pk / 3m (Conducted)	**Pass**	
902 to 928	36 dBm / Pk / 3m (Radiated)	**Pass**	
Supplementary information: Test location: SMEE / Test date: May 26th, 2015 Power supply voltage: 5V dc			

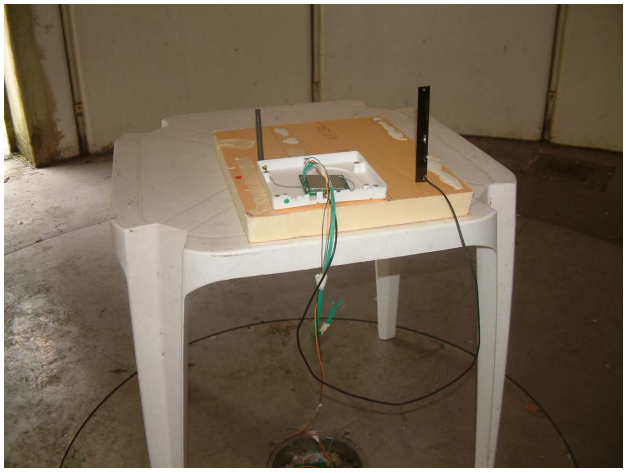
Test Equipment Used					
Description	Manufacturer	Model	Identifier	Cal. Date	Cal. Due
Measuring Rec.	Rohde&Schwarz	ESL3	REC-101-001	2012/6	2015/6
Horn antenna	ETS-LINDGREN	3115	ANT-141-013	2014/3	2017/3
RF cable	Div	OATS/25m	CAB-101-017	2015/3	2016/3
OATS	Div	3 / 10m	SIT-101-001	2014/5	2015/6
Antenna mast	Innco- Systems	MA4000EP	MAT-101-001	-	-
Turntable	Innco- Systems	DS1200S	PLA-101-001	-	-

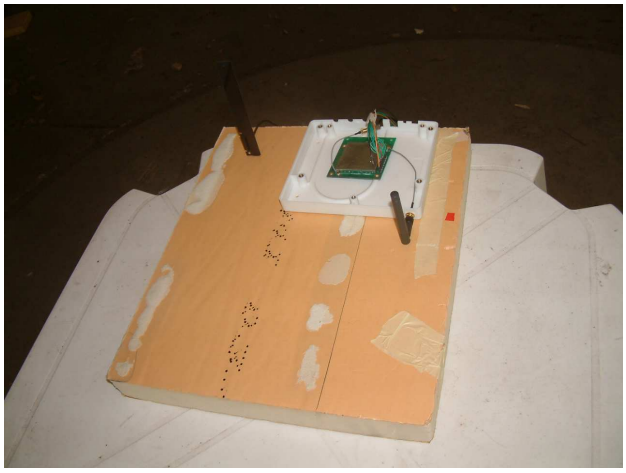
Tabulated Results for Maximum peak output power (Conducted measurement)			
FREQ	**Peak Power conducted**	**Limit**	**Result**
(MHz)	(dBm)	(dBm)	
902,75	**29.7**	30.0	**Pass**
915,25	**29.2**	30.0	**Pass**
927,25	**29.2**	30.0	**Pass**
RBW:	1MHz		
Measurement distance:	Conducted measurement		
Limit:	FCC Part 15.247 (b)		
Final measurement detector:	Peak		
RESULT:	PASS		

Tabulated Results for Maximum peak output power (Radiated measurement)				
FREQ	**Field Strength 3m**	**Calculated EIRP**	**Limit**	**Result**
(MHz)	(dBµV/m)	(dBm)	(dBm)	
902.75	127.0	**31.8**	36.0	**Pass**
915.25	127.7	**32.5**	36.0	**Pass**
927.25	125.6	**30.4**	36.0	**Pass**

RBW:	1MHz
Measurement distance:	3m
Limit:	FCC Part 15.247 (b)
Final measurement detector:	Peak
Wide Measurement Uncertainty:	± 5.2dB (k=2)
RESULT:	PASS
Notes:	(1): Field strength is measured on the Open Area Test Site at a distance of 3m. Three orthogonal axis measurements are performed for both horizontal and vertical antenna (measure) polarization in order to obtain the maximum peak field strength. The power (EIRP) was calculated using the following equation: **EIRP = (E x d)²/30** Where D is the distance in meters from which the field strength was measured E is the maximum field strength in V/m

Photo of test setup for Radiated Disturbance





12. Radiated (Non-Restricted Frequency bands) & Conducted Unwanted emissions

TEST: Unwanted emissions (Radiated / Conducted) / FCC part 15.247 (d)	**Verdict**
Method: Radiated measurements were made in a 3-meter Open Area Test Site (OATS) that complies to ANSI C63.4. Preliminary (peak) measurements were performed at an antenna to EUT separation distance of 10 meter (Freq < 30MHz) or 3 meter (Freq > 30MHz). The EUT was rotated 360° about its azimuth with the receive antenna located at various heights in horizontal and vertical polarities. Final measurements (Peak, Quasi-peak) were then performed by rotating the EUT 360° and adjusting the receive antenna height from 1 to 4 m. All frequencies were investigated in both horizontal and vertical antenna polarity, where applicable. A pre-scan frequency identification of the EUT has been performed in full anechoic chamber. The measured radiated field of the EUT is realised at 3-meters of distance. Antenna is 1.25-meters high. The pre-characterization graphs are obtained in PEAK detection. Conducted measurement was performed with peak detector using a 100kHz RBW. The spectrum analyzer was connected via suitable means to the RF output of the tested equipment. The SPAN was wide enough to capture peak level from lower frequency of the equipment to the 10th harmonic.	**Pass**

Laboratory Parameters:	Required prior to the test	During the test
Ambient Temperature	10 to 40 °C	20°C
Relative Humidity	10 to 90 %	55%
Fully configured sample scanned over the following frequency range	Frequency range on each side of line	Measurement Points
	30MHz – 15.5GHz	3 m measurement distance / Conducted measurement

Limits – FCC Part 15.247 (d)

Frequency (MHz)	Limits (dBµV/m)		
	Detector / Analyser RBW	Limit	Results
30 to 15500	Pk / 100kHz	20dB below the maximum Peak level	**Pass**

Supplementary information:
Test location: SMEE / Test date: May 26th, 2015
Power supply voltage: 5V dc

Test Equipment Used

Description	Manufacturer	Model	Identifier	Cal. Date	Cal. Due
Log-periodic antenna	TDK	PLP3003	ANT-101-001	2014/5	2015/6
Biconnic antenna	COM-POWER	AB- 900	ANT-101-003	2014/5	2015/6
BiConiLog antenna	EMCO	3142B	ANT-101-010	2014/11	2015/11
Horn antenna	ETS-LINDGREN	3115	ANT-141-013	2014/3	2017/3
RF cable	Div	2m	CAB-101-011	2015/3	2016/3
RF cable	Div	OATS/25m	CAB-101-019	2015/3	2016/3
RF cable	Div	OATS/10m	CAB-101-020	2015/3	2016/3
RF cable	Pasternack	PE302-120	CAB-131-023	2015/3	2016/3
RF cable	Pasternack	PE302-120	CAB-131-024	2015/3	2016/3
RF cable	HUBER+SUHNER	RG214U	CAB-141-026	2015/3	2016/3
RF cable	HUBER+SUHNER	RG214U	CAB-141-029	2015/3	2016/3

Test Equipment Used					
Description	Manufacturer	Model	Identifier	Cal. Date	Cal. Due
RF cable	HUBER+SUHNER	SF104	CAB-141-030	2015/3	2016/3
Anechoic chamber	COMTEST	214263	CAG-141-001	-	-
OATS	Div	10m	SIT-101-001	2014/5	2015/6
Antenna mast	Innco- Systems	MA4000EP	MAT-101-001	-	-
Turntable	Innco- Systems	DS1200S	PLA-101-001	-	-
Turntable	Innco- Systems	CT0800	PLA-141-001	-	-
Measuring Rec	Rohde&Schwarz	ESL3	REC-101-001	2012/6	2015/6
Spectrum analyzer	AGILENT HP	8563E	ASP-111-003	2013/9	2016/9

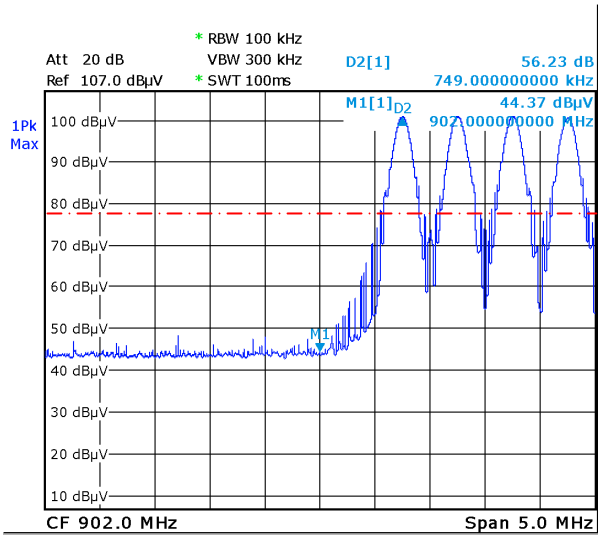
Photo of test setup for Radiated Disturbance

Tabulated Results for Peak Output Power Reference level (Radiated)	
FREQ	**Field Strength 3m**
(MHz)	(dBµV/m)
902.75 / 915.25 / 927.25	127.7
RBW:	100kHz
Measurement distance:	3m
Limit:	Ref. level only – For 15.247 (d)
Final measurement detector:	Peak
Wide Measurement Uncertainty:	± 5.2dB (k=2)
Note:	Only for identification of limit in non-restricted band Limit is **107.7 dBµV/m** Peak for out-of-band frequencies in Non-Restricted bands radiated emissions (with a 100kHz RBW on the spectrum analyser)

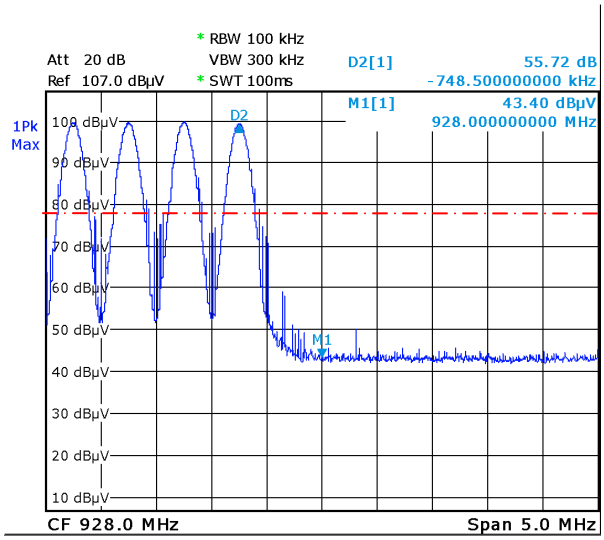
Tabulated Results for Unwanted emissions in Non-Restricted bands (Radiated measurement)			
FREQ	**Field Strength 3m**	**Limit**	**Result**
(MHz)	(dBµV/m)	(dBµV/m)	(dBµV/m)
902.0 (Band Edge)	71.5	107.7	PASS
928.0 (Band Edge)	72.0	107.7	PASS

RBW:	100kHz
Measurement distance:	3m
Limit:	15.247 (d)
Final measurement detector:	Peak
Wide Measurement Uncertainty:	± 5.2dB (k=2)
RESULT:	PASS
Note:	See chapter 13. for graphical representation of radiated spurious
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 is as follow: FS = RA + AF + CF – AG Where FS = Field Strength (Level) RA = Receiver Amplitude (Meter reading) AF = Antenna Factor CF = Cable Factor AG = Amplifier Gain Total factor (dB) is AF + CF – AG

Graphical representation of Band-Edge (Conducted measurement)
(Peak detection, Transmit mode)



Low Band-Edge measurement

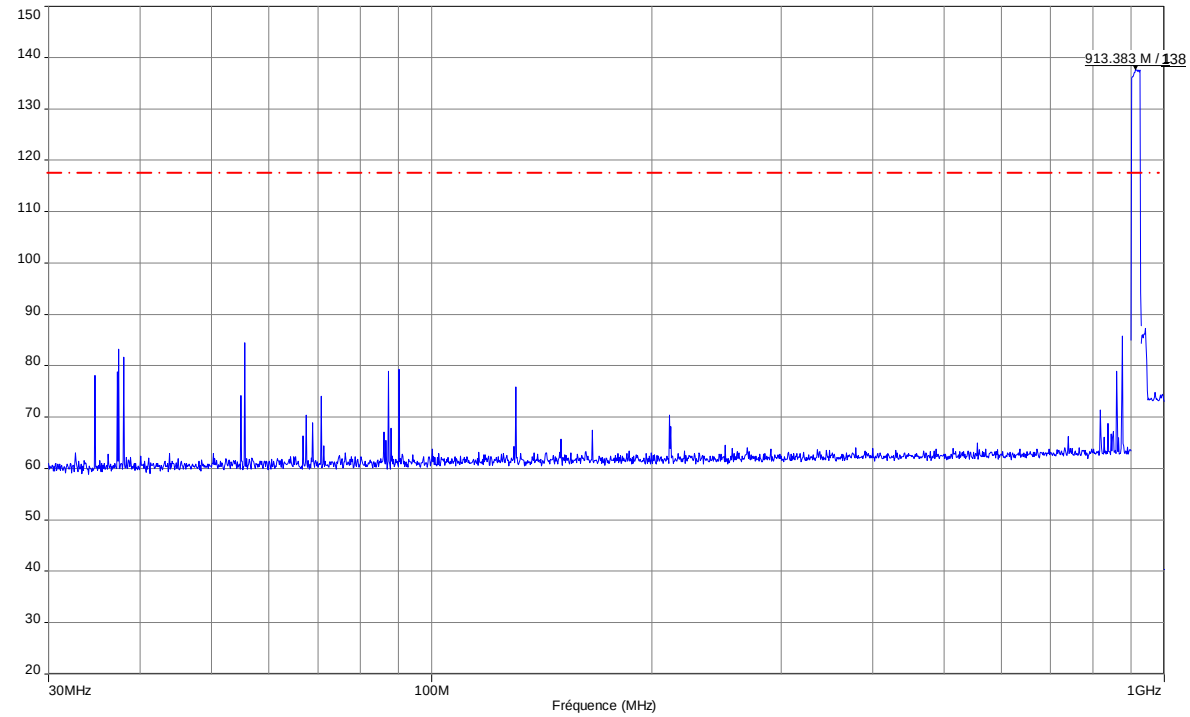


High Band-Edge measurement

– · – : Limit for conducted spurious emissions (116.7dBµV)

Frequency band investigated:	900MHz to 930MHz
Unit :	dBµV
RBW :	100kHz
Measurement method	Conducted
Voltage:	5V DC
Limit:	15.247 (d)
Measurement detector:	Peak

Graphical representation of Conducted Disturbance Measurement (Peak detection, 30MHz-1GHz / Transmit mode)

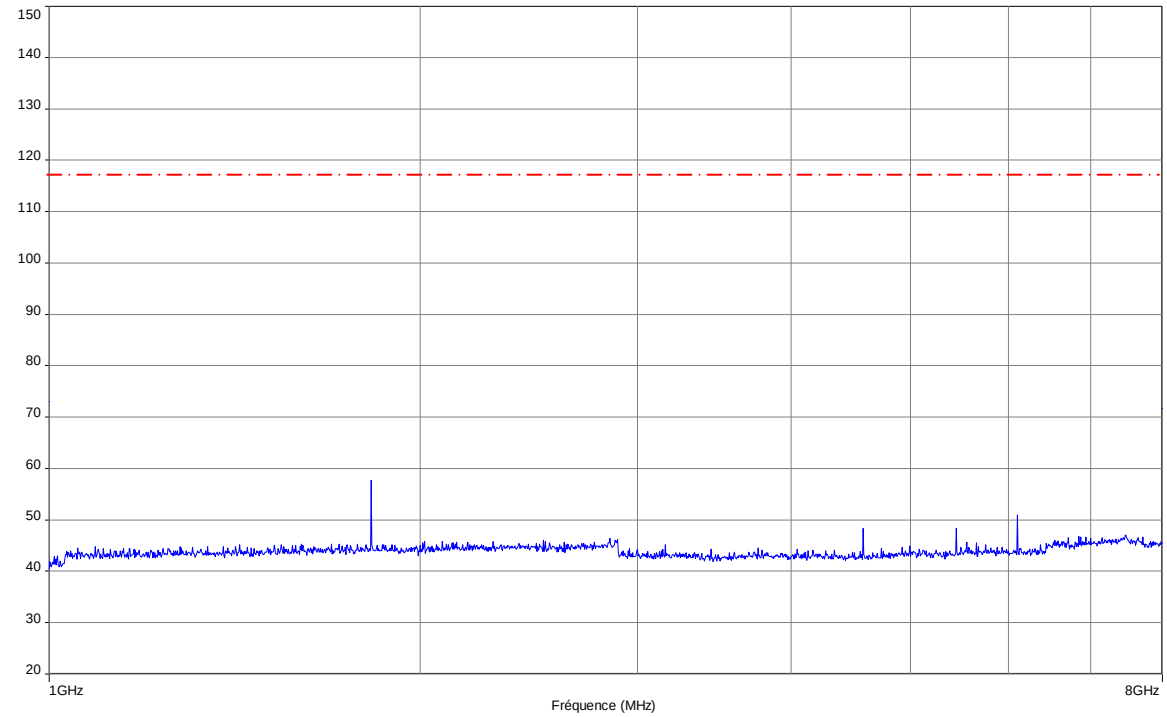


-·- : Limit for conducted spurious emissions (116.7dBµV)

Note: No conducted spurious observed. Worst case plot for lowest, middle and highest channel.

Frequency band investigated:	30MHz-1GHz
Unit :	dBµV
RBW :	100kHz
Measurement method	Conducted
Voltage:	5V DC
Limit:	15.247 (d)
Measurement detector:	Peak
Wide Measurement Uncertainty:	± 5dB (k=2)

Graphical representation of Conducted Disturbance Measurement (Peak detection, 1GHz-8GHz / Transmit mode)

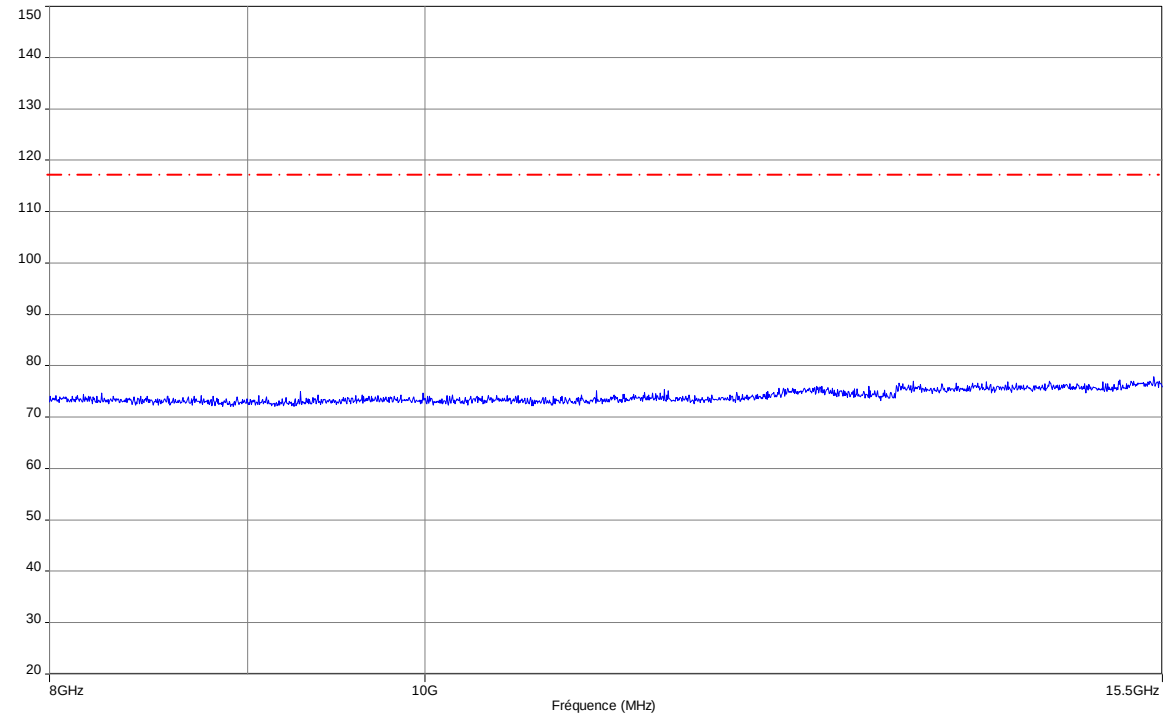


-·- : Limit for conducted spurious emissions (116.7dBµV)

Note: No conducted spurious observed. Worst case plot for lowest, middle and highest channel.

Frequency band investigated:	1GHz-8GHz
Unit :	dBµV
RBW :	100kHz
Measurement method	Conducted
Voltage:	5V DC
Limit:	15.247 (d)
Measurement detector:	Peak
Wide Measurement Uncertainty:	± 5dB (k=2)

Graphical representation of Conducted Disturbance Measurement (Peak detection, 8GHz-15.5GHz / Transmit mode)



-·- : Limit for conducted spurious emissions (116.7dBµV)

Note: No conducted spurious observed. Worst case plot for lowest, middle and highest channel.

Frequency band investigated:	8GHz-15.5GHz
Unit :	dBµV
RBW :	100kHz
Measurement method	Conducted
Voltage:	5V DC
Limit:	15.247 (d)
Measurement detector:	Peak
Wide Measurement Uncertainty:	± 5dB (k=2)

13. Unwanted emissions in Restricted Frequency bands

TEST: Unwanted emissions into Restricted Frequency Bands / FCC part 15.205, 15.209, 15.247		**Verdict**
Method: Measurements were made in a 3-meter Open Area Test Site (OATS) that complies to ANSI C63.4. Preliminary (peak) measurements were performed at an antenna to EUT separation distance of 10 meter (Freq < 30MHz) or 3 meter (Freq > 30MHz). The EUT was rotated 360° about its azimuth with the receive antenna located at various heights in horizontal and vertical polarities. Final measurements (Peak, Quasi-peak) were then performed by rotating the EUT 360° and adjusting the receive antenna height from 1 to 4 m. All frequencies were investigated in both horizontal and vertical antenna polarity, where applicable. A pre-scan frequency identification of the EUT has been performed in full anechoic chamber. The measured radiated field of the EUT is realised at 3-meters of distance. Antenna is 1.25-meters high. The pre-characterization graphs are obtained in PEAK detection. For frequency above 10GHz, a manual search is performed at a distance of 1m or less in order to identify any frequency radiated by the equipment under test.		**Pass**

Laboratory Parameters:	Required prior to the test	During the test
Ambient Temperature	10 to 40 °C	20°C
Relative Humidity	10 to 90 %	55%
Fully configured sample scanned over the following frequency range	Frequency range on each side of line	Measurement Point
	9kHz – 30MHz	10 m measurement distance
	30MHz – 15.5GHz	3 m measurement distance

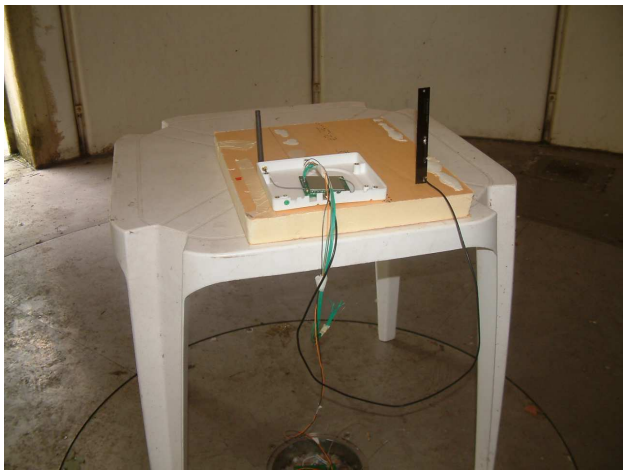
Limits – FCC Part 15.205, 15.209, 15.247

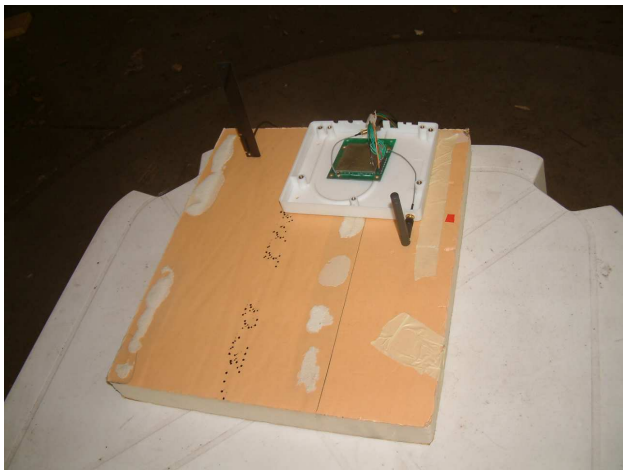
Frequency (MHz)	Limits (dBµV/m)	
	Level / Detector / Distance	Results
0.009 to 0.490	107.6 to 72.9 / QP / 10m	**Pass**
0.490 to 1.705	52.9 to 42.1 / QP / 10m	**Pass**
1.705 to 30	48.6 / QP / 10m	**Pass**
30 to 88	40.0 / QP / 3m	**Pass**
88 to 216	43.5 / QP / 3m	**Pass**
216 to 960	46.0 / QP / 3m	**Pass**
960 to 1000	54.0 / QP / 3m	**Pass**
Above 1GHz	54.0 / AV / 3m 74.0 / PK / 3m	**Pass**

Supplementary information:
Test location: SMEE / Test date: May 26th, 2015
Power supply voltage: 5V dc

Test Equipment Used					
Description	Manufacturer	Model	Identifier	Cal. Date	Cal. Due
Log-periodic antenna	TDK	PLP3003	ANT-101-001	2014/5	2015/6
Biconnic antenna	COM-POWER	AB- 900	ANT-101-003	2014/5	2015/6
BiConiLog antenna	EMCO	3142B	ANT-101-010	2014/11	2015/11
Horn antenna	ETS-LINDGREN	3115	ANT-141-013	2014/3	2017/3
RF cable	Div	2m	CAB-101-011	2015/3	2016/3
RF cable	Div	OATS/25m	CAB-101-019	2015/3	2016/3
RF cable	Div	OATS/10m	CAB-101-020	2015/3	2016/3
RF cable	Pasternack	PE302-120	CAB-131-023	2015/3	2016/3
RF cable	Pasternack	PE302-120	CAB-131-024	2015/3	2016/3
RF cable	HUBER+SUHNER	RG214U	CAB-141-026	2015/3	2016/3
RF cable	HUBER+SUHNER	RG214U	CAB-141-029	2015/3	2016/3
RF cable	HUBER+SUHNER	SF104	CAB-141-030	2015/3	2016/3
Anechoic chamber	COMTEST	214263	CAG-141-001	-	-
OATS	Div	10m	SIT-101-001	2014/5	2015/6
Antenna mast	Innco- Systems	MA4000EP	MAT-101-001	-	-
Turntable	Innco- Systems	DS1200S	PLA-101-001	-	-
Turntable	Innco- Systems	CT0800	PLA-141-001	-	-
Measuring Rec	Rohde&Schwarz	ESL3	REC-101-001	2012/6	2015/6
Spectrum analyzer	AGILENT HP	8563E	ASP-111-003	2013/9	2016/9

Photo of test setup for Radiated Disturbance





Tabulated Results for Unwanted emissions (9kHz-30MHz)						
FREQ	**RF field @ 30m**	**Limit @ 30m**	**Margin**	**Antenna angle**	**Table angle**	**Correc. Fact. (CF)**
MHz	(QP) dBµV/m	(QP) dBµV/m	dB	Degree	Degree	dB
Margin > 10dB						
Supplementary information: Frequency list measured on the Open Area Test Site has been created with pre-scan results. (Worst case result for lowest, middle and highest channel)						

Frequency band investigated:	9kHz-30MHz
RBW:	200Hz (9kHz-150kHz) 9kHz (150kHz-30MHz)
Measurement distance:	10m
Limit:	FCC Part 15.205 - 15.209
Final measurement detector:	Quasi-Peak
Wide Measurement Uncertainty:	± 5 dB (k=2)
Note:	CF: Correction factor = Antenna factor + Cable loss *[1]: Measure have been done at 10m distance and corrected according to requirements of 15.209.e) (M@30m = M@10m-19.1dB)

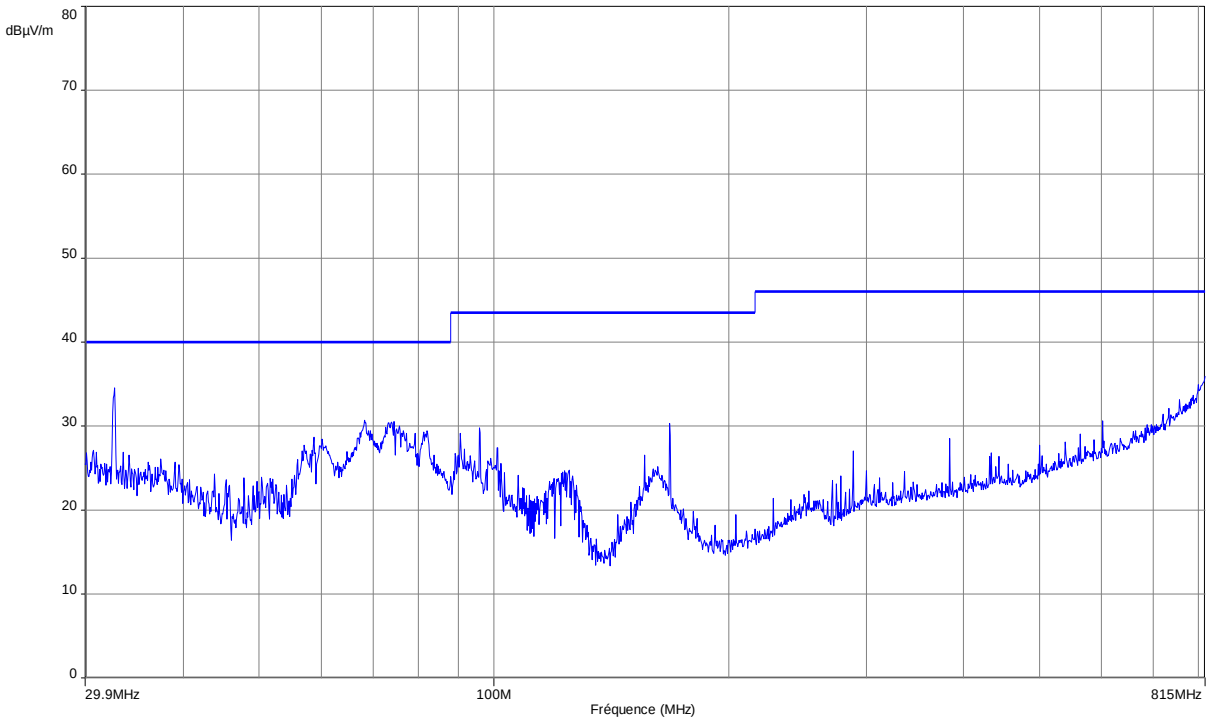
Tabulated Results for Unwanted emissions (30MHz-1GHz)										
FREQ	**Meter reading**	**Meter reading**	**CF total**	**Field level**	**Field level**	**Pol**	**Antenna height**	**Table angle**	**Limit**	**Margin**
MHz	(QP) dBµV	(Pk) dBµV	dB	(QP) dBµV/m	(Pk) dBµV/m		cm	Degré	(QP) dBµV/m	dB
Margin > 10dB										
Supplementary information: Frequency list measured on the Open Area Test Site has been created with pre-scan results. (Worst case result for lowest, middle and highest channel)										

Frequency band investigated:	30MHz-1GHz
RBW:	120kHz
Measurement distance:	3m
Limit:	FCC Part 15.205 - 15.209
Final measurement detector:	Quasi-Peak
Wide Measurement Uncertainty:	± 5.2dB (k=2)
RESULT:	PASS
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 is as follow: FS = RA + AF + CF – AG Where FS = Field Strength (Level) RA = Receiver Amplitude (Meter reading) AF = Antenna Factor CF = Cable Factor AG = Amplifier Gain Total factor (dB) is AF + CF – AG Margin value = Emission level – Limit value

Tabulated Results for Unwanted emissions (1GHz-25GHz)				
FREQ	**Field level**	**Detector**	**Limit**	**Result**
(MHz)	dBµV/m		(dBm)	
9160.0	**48.0**	Pk / Av	74 / Pk 54 / Av	**Pass**
Supplementary information: Frequency list measured on the Open Area Test Site has been created with pre-scan results. (Worst case result for lowest, middle and highest channel)				

Frequency band investigated:	1GHz-26GHz
RBW:	1MHz (RBW) / 3MHz (VBW) for Peak measurement 1MHz (RBW) / 10Hz (VBW) for Average measurement
Measurement distance:	3m
Limit:	FCC Part 15.205 - 15.209
Final measurement detector:	Peak / Average
Wide Measurement Uncertainty:	± 5.2dB (k=2)
RESULT:	PASS
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 is as follow: FS = RA + AF + CF – AG Where FS = Field Strength (Level) RA = Receiver Amplitude (Meter reading) AF = Antenna Factor CF = Cable Factor AG = Amplifier Gain Total factor (dB) is AF + CF – AG Margin value = Emission level – Limit value

Graphical representation of Radiated Disturbance Measurement (Peak detection, Anechoic chamber pre-scan, 30MHz-815MHz / 3m / Horizontal / Transmit mode)

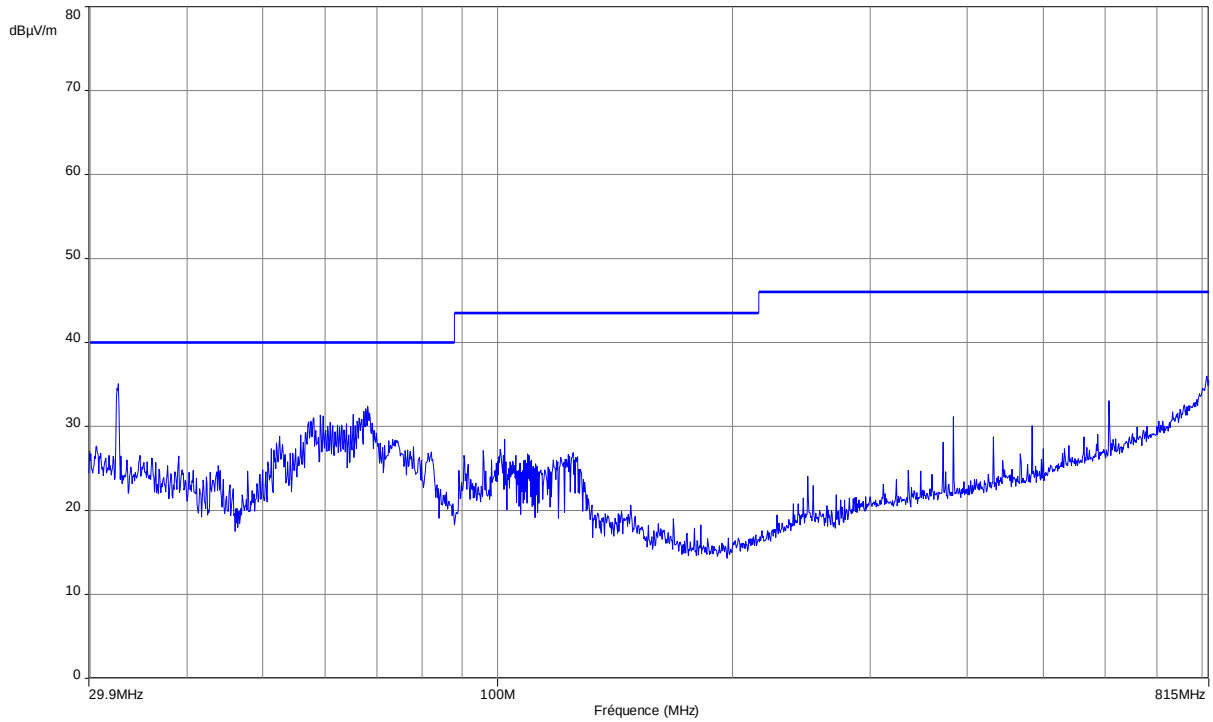


Frequency (MHz)	Peak Level (dBµV/m)	Comments
32,650	34,5	Not in Rest. Band (Limit : 107.7dBµV/m)

Note: Pre-scan graph only for identification purpose.
(Worst case result for lowest, middle and highest channel)

Frequency band investigated:	30MHz-815MHz
Unit :	dBµV/m
RBW :	100kHz
Antenna polarization :	Horizontal
Voltage:	5V DC
Limit:	15.205 - 15.209
Measurement detector:	Peak
Wide Measurement Uncertainty:	± 5dB (k=2)

Graphical representation of Radiated Disturbance Measurement (Peak detection, Anechoic chamber pre-scan, 30MHz-815MHz / 3m / Vertical / Transmit mode)

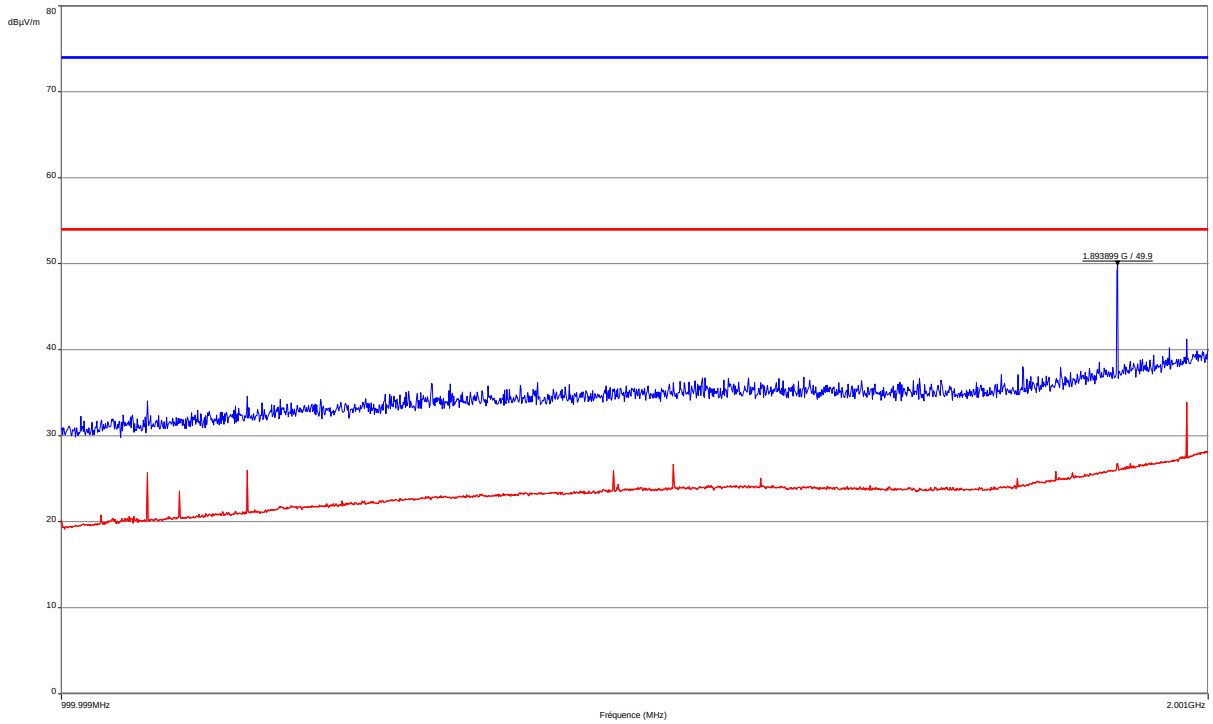


Frequency (MHz)	Peak Level (dBµV/m)	Comments
32,650	34,6	Not in Rest. Band (Limit : 107.7dBµV/m)

Note: Pre-scan graph only for identification purpose.
(Worst case result for lowest, middle and highest channel)

Frequency band investigated:	30MHz 815MHz
Unit :	dBµV/m
RBW :	100kHz
Antenna polarization :	Vertical
Voltage:	5V DC
Limit:	15.205 - 15.209
Measurement detector:	Peak
Wide Measurement Uncertainty:	± 5dB (k=2)

Graphical representation of Radiated Disturbance Measurement (Peak detection, Anechoic chamber pre-scan, 1GHz-2GHz / 3m / Horizontal / Transmit mode)

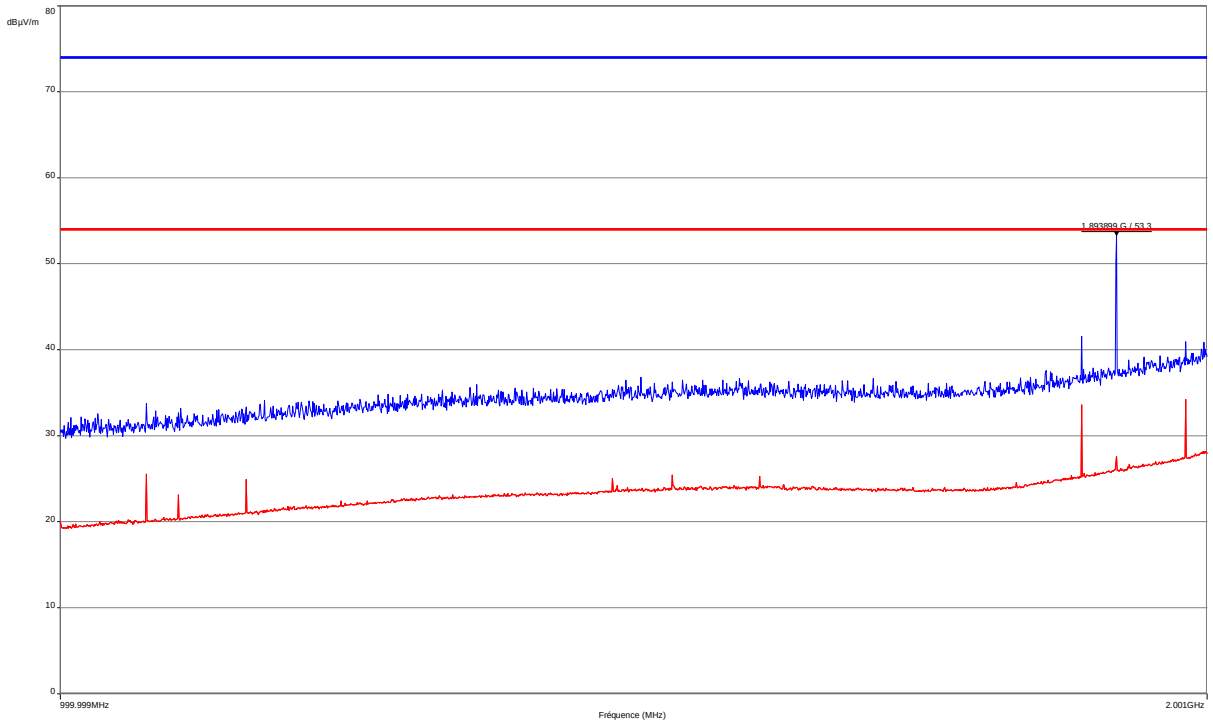


Frequency (MHz)	Peak Level (dBµV/m)	Comments
1893,899	49,9	Ambient noise

Note: Pre-scan graph only for identification purpose.
(Worst case result for lowest, middle and highest channel)

------ : Peak measure	------ : Average measure
Frequency band investigated:	1GHz-2GHz
Unit :	dBµV/m
RBW :	1MHz
Antenna polarization :	Horizontal
Voltage:	5V DC
Limit:	15.205 - 15.209
Measurement detector:	Peak
Wide Measurement Uncertainty:	± 5dB (k=2)

Graphical representation of Radiated Disturbance Measurement (Peak detection, Anechoic chamber pre-scan, 1GHz-2GHz / 3m / Vertical / Transmit mode)

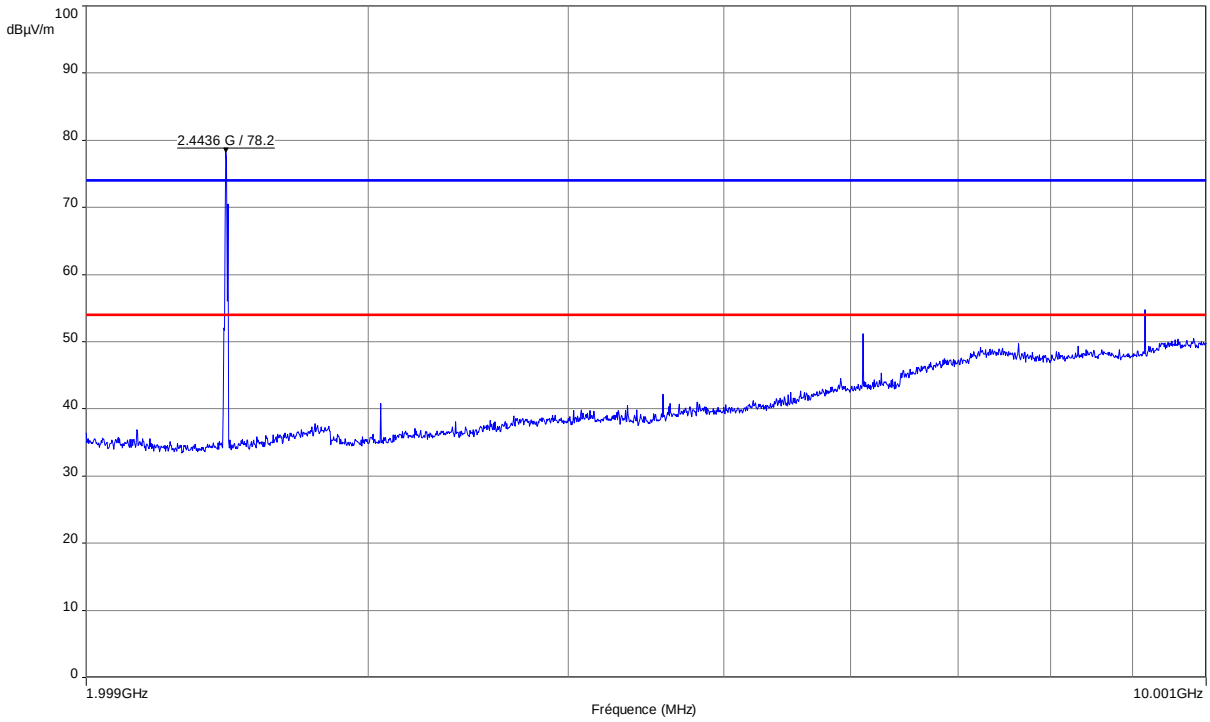


Frequency (MHz)	Peak Level (dBµV/m)	Comments
1893,899	53,3	Ambient noise

Note: Pre-scan graph only for identification purpose.
(Worst case result for lowest, middle and highest channel)

------ : Peak measure	------ : Average measure
Frequency band investigated:	1GHz-2GHz
Unit :	dBµV/m
RBW :	1MHz
Antenna polarization :	Vertical
Voltage:	5V DC
Limit:	15.205 - 15.209
Measurement detector:	Peak
Wide Measurement Uncertainty:	± 5dB (k=2)

Graphical representation of Radiated Disturbance Measurement (Peak detection, Anechoic chamber pre-scan, 1GHz-2GHz / 3m / Horizontal / Transmit mode)

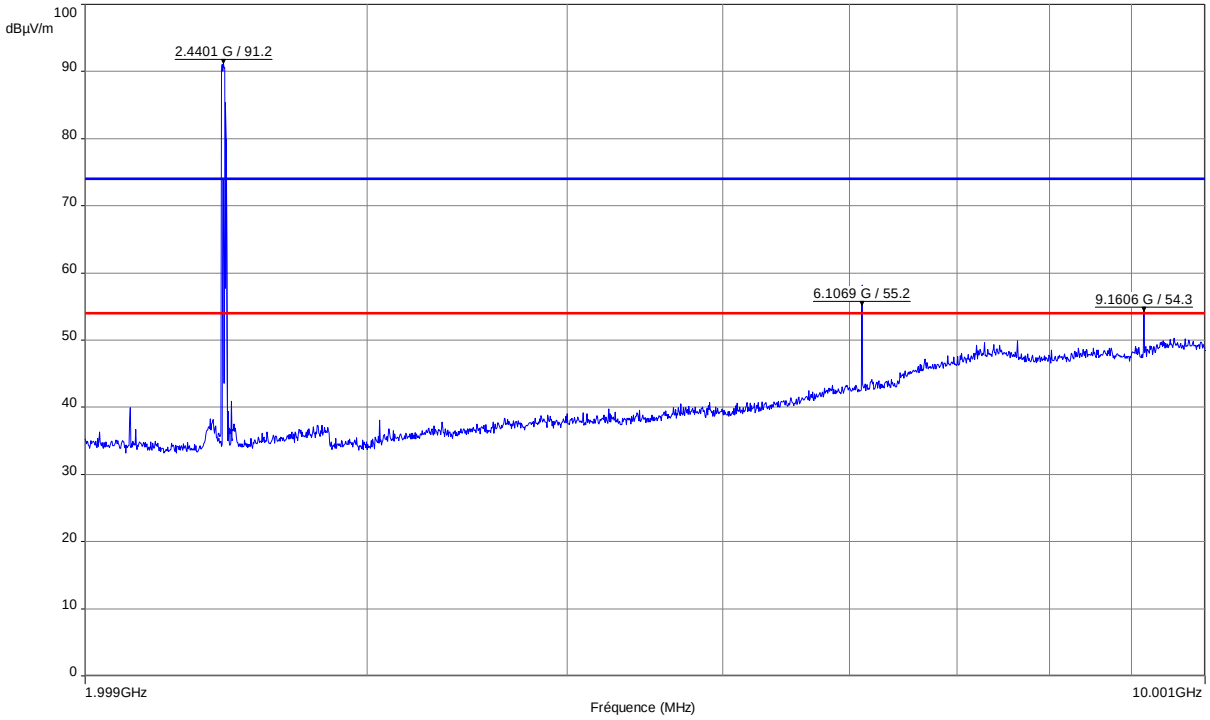


Frequency (MHz)	Peak Level (dBµV/m)	Comments
2443,6	78,2	External noise, from radio ancillary equipment (HotSpot Radio Module)
6107,1	51,5	Not in Rest. Band (Limit: 107.7dBµV/m)
9160,6	54,9	Restricted band

Note: Pre-scan graph only for identification purpose. No frequency observed above 10GHz.
(Worst case result for lowest, middle and highest channel)

------ : Peak measure	------ : Average measure
Frequency band investigated:	2GHz-10GHz
Unit :	dBµV/m
RBW :	1MHz
Antenna polarization :	Horizontal
Voltage:	5V DC
Limit:	15.205 - 15.209
Measurement detector:	Peak
Wide Measurement Uncertainty:	± 5dB (k=2)

Graphical representation of Radiated Disturbance Measurement (Peak detection, Anechoic chamber pre-scan, 2GHz-10GHz / 3m / Vertical / Transmit mode)



Frequency (MHz)	Peak Level (dBµV/m)	Comments
2440,1	91.2	External noise, from radio ancillary equipment (HotSpot Radio Module)
6107,1	55,2	Not in Rest. Band (Limit: 107.7dBµV/m)
9160,6	54,3	Restricted band

Note: Pre-scan graph only for identification purpose. No frequency observed above 10GHz.
(Worst case result for lowest, middle and highest channel)

------ : Peak measure	------ : Average measure
Frequency band investigated:	2GHz-10GHz
Unit :	dBµV/m
RBW :	1MHz
Antenna polarization :	Vertical
Voltage:	5V DC
Limit:	15.205 - 15.209
Measurement detector:	Peak
Wide Measurement Uncertainty:	± 5dB (k=2)