

FCC Test Firm Designation Number: FR0014
ISED Wireless Device Testing Laboratory CAB Number: FR0004

Matériel testé :
Equipment under test:

ST / NUCLEO-WL55JC1 (MB1389E)
(Trademark / Marketing name or product reference)

Demandeur:
Applicant : **ST Microelectronics Rousset SAS**
190, rue Célestin Coq
13106 ROUSSET Cedex – France

Client :
Customer: **ST Microelectronics**
M. Patrice Derouet
9-11 rue Pierre Félix Delarue
72100 Le Mans – France

Numéro d'affaire :
Work number : 13860

Référence de la proposition :
Proposal number: 022021-24484

Date de l'essai :
Date of test: 6 mai 2021 et 10 mai 2021
May 6th and May 10th, 2021

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)
- Industry Canada RSS-247, Issue 2
(Digital Transmission Systems Operating in the Bands 902–928 MHz)
Measurement standards:
ANSI C63.10 (2013)

Lieu du test:
Test location: SMEE - 385 rue René Rambaud, ZA le Parvis 2
38500 VOIRON - France

Test réalisé par :
Test realized by: Laurent Chapus / Chemseddine KERMICHE

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

Ed.	Date	Modifications Pages	Written by : Visa	Approved by: Visa
1	June 16 th , 2021	Initial Edition	Laurent CHAPUS	Régis ANCEL
2	October 15 th , 2021	TCB review (ATCB027692)	<i>Test Operator</i>	<i>General Manager</i>

La copie de ce document n'est permise que sous sa forme intégrale. Ce document est le résultat d'essais effectués sur un échantillon. Il ne préjuge pas de la conformité de l'ensemble des produits fabriqués à l'objet essayé.
This document shall not be reproduced, except in full. This document contains results related only to the item tested. It does not imply the conformity of the whole production to the item tested.



Accréditation
N° 1-6356
Portée disponible sur :
Scope available on :
www.cofrac.fr

COORDONNEES

SMEE
385, Rue René Rambaud, ZA Le Parvis 2
38500 VOIRON - France

TEL : 04 76 65 76 50
FAX : 04 76 66 18 30

SAS au capital de 50 000 € / RC Grenoble B534 796 453 / SIRET 534 796 453 00015 / code APE 7490B / n° TVA : FR 59 534 796 453

Contents

1. NORMATIVES REFERENCES	3
2. TEST SYNTHESIS.....	4
3. EQUIPMENT UNDER TEST (EUT).....	5
4. TEST CONDITIONS.....	5
5. MODIFICATIONS OF THE EUT.....	5
6. SPECIAL ACCESSORY.....	5
7. MEASUREMENT UNCERTAINTY	6
8. FIELD STRENGTH CALCULATION.....	6
9. TEST SETUP DIAGRAM.....	7
10. CONDUCTED EMISSION MEASUREMENT (150KHZ-30MHZ)	11
11. CHANNEL SEPARATION.....	13
12. NUMBER OF HOPPING CHANNELS.....	16
13. AVERAGE TIME OF OCCUPANCY	17
14. FUNDAMENTAL EMISSION OUTPUT POWER.....	18
15. UNWANTED SPURIOUS EMISSIONS (CONDUCTED EMISSIONS)	20
16. UNWANTED EMISSIONS IN NON-RESTRICTED FREQUENCY BANDS (RADIATED EMISSIONS)	23
17. UNWANTED EMISSIONS IN RESTRICTED FREQUENCY BANDS.....	25
18. OCCUPIED BANDWIDTH (99%).....	31

1. Normatives References

FCC qualification according to:		
Standards	Applied	Title
ANSI C63.10 (2013)	X	American National Standard for Testing Unlicensed Wireless Devices
CFR47, Part 15 (May 2021)	X	Telecommunication – Federal Communication Commission – Radio frequency devices, Sections 15.205 / 15.207 / 15.209 / 15.247

ISED qualification according to:		
Standards	Applied	Title
RSS-Gen (Issue 5/2018, amendments 2019 and 2021)	X	General Requirements and Information for the Certification of Radio Apparatus
RSS-247 (Issue2/2017)	X	Digital Transmission Systems (DTSs), Frequency Hopping Systems (FHSs) and Licence-Exempt Local Area Network (LE-LAN) Devices

Note: Following guidance are used

- DTS Measurement Guidance 558074 D01 v05r02
- Determining ERP and EIRP Guidance 412172 D01 v01r01

Deviation from standard: None

2. Test synthesis

Requirement for FHSS systems

TEST	Paragraph number FCC Part 15 / IC RSS-247 / RSS-GEN	Spec. FCC Part 15 / IC RSS-247 / RSS-GEN	RESULTS (comments)
Conducted emissions test	15.207 (a) RSS-Gen § 8.8	Table 15.207 (a) Table 4 / RSS-Gen	PASS
20dB Bandwidth	15.247 (a) (1) RSS-247 § 5.1	No requirements	PASS
Hopping channel separation	15.247 (a) (1) / RSS-247 5.1 a) b)	Minimum separation 25kHz or the 20dB bandwidth whichever is greater	PASS
Number of hopping frequencies	15.247 (a) (1) / RSS-247 5.1 c)	Minimum 25 channels shall be used. (20dB BW > 250kHz)	PASS
Time of occupancy	15.247 (f) / RSS-247 5.3 a)	Maximum 400ms per channel within 10s	PASS
Maximum Peak Output Power & EIRP	15.247 (b) (3) RSS-247 § 5.4 (d)	0.25W max / 24dBm (Conducted) 1W max / 30dBm (EIRP)	PASS
Unwanted emissions into Non-Restricted Frequency Bands	15.247 (d) / RSS-247 § 5.5	-20dBc in any 100kHz outside frequency band.	PASS
Unwanted emissions into Restricted Frequency Bands	15.209 (a) / 15.247 (d) / 15.205 (a) RSS-GEN § 7.1, §8.9, § 8.10 / RSS-247 § 5.5	<u>Measure at 300m</u> 9-490kHz: 2400µV/m/F(kHz) 6.370µA/m/F (kHz) <u>Measure at 30m</u> 0.490-1.705: 24000µV/m/F(kHz) 63.70µA/m/F (kHz) 1.705-30MHz: 30µV/m 0.08µA/m <u>Measure at 3m</u> 30MHz-88MHz : 40 dBµV/m 88MHz-216MHz : 43.5 dBµV/m 216MHz-960MHz : 46.0 dBµV/m Above 960MHz : 54.0 dBµV/m	PASS
Occupied Bandwidth	RSS-GEN § 6.7	BW at 99%	PASS

- General conclusion:**

Measures and tests performed on the sample of the product *ST / NUCLEO-WL55JC1*, in configuration and description presented in this test report, show compliance with standards FCC CFR 47, PART 15, Subpart C and ISED RSS-Gen & RSS-247.

3. Equipment Under Test (EUT)

Nom /
Identification

NUCLEO – WL55JC1

MB1389-HIGHBAND-E02
Sn: C204800140

FCC ID: FCC ID: YCP-MB1389001
IC: IC: 8976A-MB1389001
Model / HVIN: MB1389E

Alimentation /
Power supply 5V DC from STLINK (Micro-USB cable)

Auxiliaires /
Auxiliaries Laptop ASUS, model F200M

Entrées-Sorties /
Input / Output
US

	Câbles pour essai / Cables for test	Blindé / Shielded	Prévu pour >3m / Intended for >3m
USB Micro-B (STLK+5V)	1.0m (USB 2.0)	Yes	No

Mode de fonctionnement /
Running mode

Equipment running modes are:

The tested sample is able to be set in following modes:

- Transmit a modulated carrier frequency on low, middle and high channels (902.5/913.5/924.5MHz)
- Normal hopping sequence from 902.5MHz to 924.5MHz

Version programme interne /
Firmware version

LoRa_ATSlave_hopping (Test mode)
Demo_Concentrator (Normal running mode)

Programme de test /
Test program /

PC test: serial command terminal

Informations supplémentaires /
Additional informations

Declaration of the applicant:

- Type of technology: Proprietary RF protocol
- Frequency transmission band: 902.5 to 924.5MHz.
- 45 channels used in FHSS mode
- Channel spacing for FHSS mode: 500kHz
- Rated conducted output power: 21dBm
- Modulation: LORA with 250kHz nominal BW / SF10
- Equipment intended for use as a mobile station
- Equipment designed for continuous operation
- Antenna type: Dipole antenna with max gain 2dBi

Dimensions de l'EST /
Dimensions of EUT

70mm x 65 x 20 (Board)
Antenna length is 53mm

4. Test conditions

Power supply voltage:

Equipment under test: 5V DC
Auxiliaries (AC mains): 230V/50Hz (Radiated emission)
110V/60Hz (Conducted emission)

5. Modifications of the EUT

None.

6. Special accessory

None.

7. Measurement Uncertainty

Test Description	Expanded uncertainty
Conducted emissions test (150k-30MHz, AC mains)	± 3.5dB
Radiated emission test (9kHz-30MHz, electric field)	± 4.0dB
Radiated emission test (30-300MHz, SAC 3m)	± 5.6dB
Radiated emission test (300-1000MHz, SAC 3m)	± 5.3dB
Radiated emission test (1-40GHz, SAC)	± 5.6dB
Conducted RF output power at antenna port	± 1.6dB
Radiated RF output power (Peak, Power density)	± 5.6dB
DTS Bandwidth, 99% OBW	±4%
Temperature	± 1°C
Time and duty cycle calculation	±1%
AC and DC voltage	±1%

Note: Expanded uncertainty at 95% confidence (k=2)

8. Field Strength Calculation

The field strength (level) 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

Margin value = Emission level – Limit value

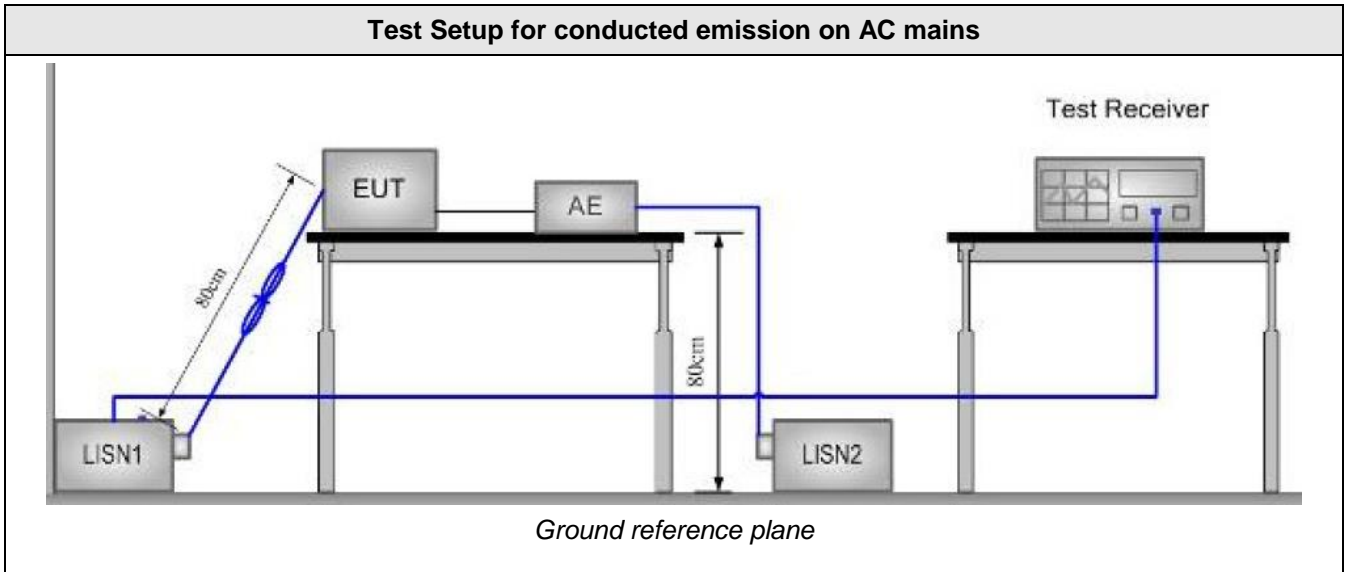
Example:

RA: 14.0dB μ V / AF: 16.5 dBm⁻¹ / CF: 3.5dB / AG: 15dB

→ Total factor: 5dBm⁻¹

→ Field level: 19.0dB μ V/m (-21.0dB for margin if limit is 40dB μ V/m)

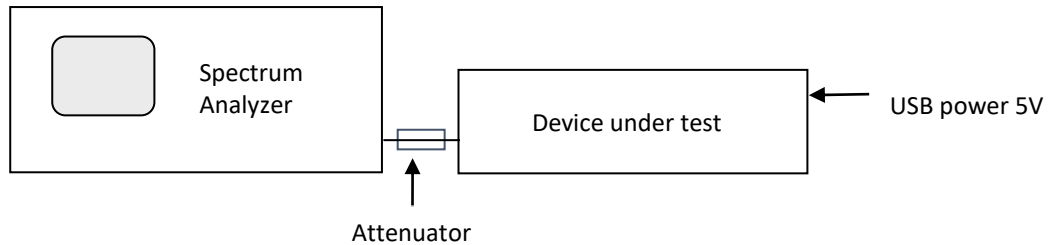
9. Test Setup Diagram



Test Equipment Used for conducted emission on AC mains

Description	Manufacturer	Model	Identifier	Cal. Date	Cal. Due
AC power supply	PACIFIC POWER	AMX-125	ALI-101-002	-	-
Attenuator / limiter	SMEE	ATT#2	ATT-171-010	2021/3	2022/3
Cable RF	Div	1m	CAB-101-021	2021/3	2022/3
Measuring receiver	Rohde&Schwarz	ESRP	REC-151-002	2019/9	2021/9
LISN (50Ω / 50μH) (Meas.)	AFJ	LS16C	RSI-101-001	2019/6	2021/6
LISN (50Ω / 50μH) (Aux.)	AFJ	LS16C	RSI-111-002	2019/6	2021/6
EMC Software	NEXIO	BAT EMC V3.18	SOF-101-001	-	-

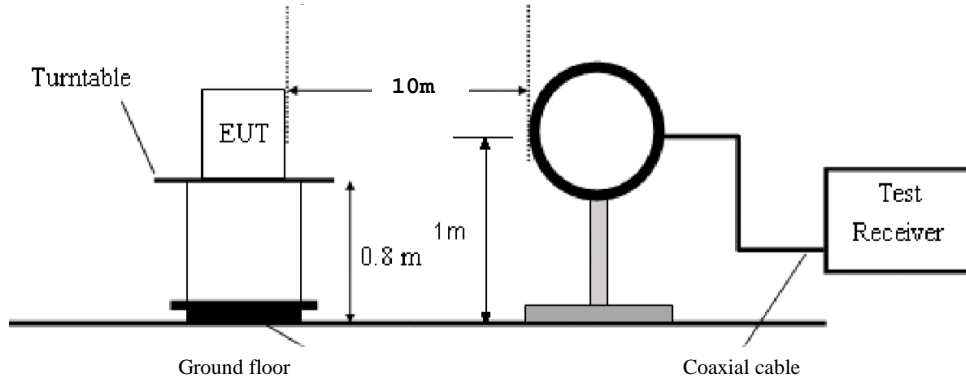
Test Setup for conducted antenna port measurement



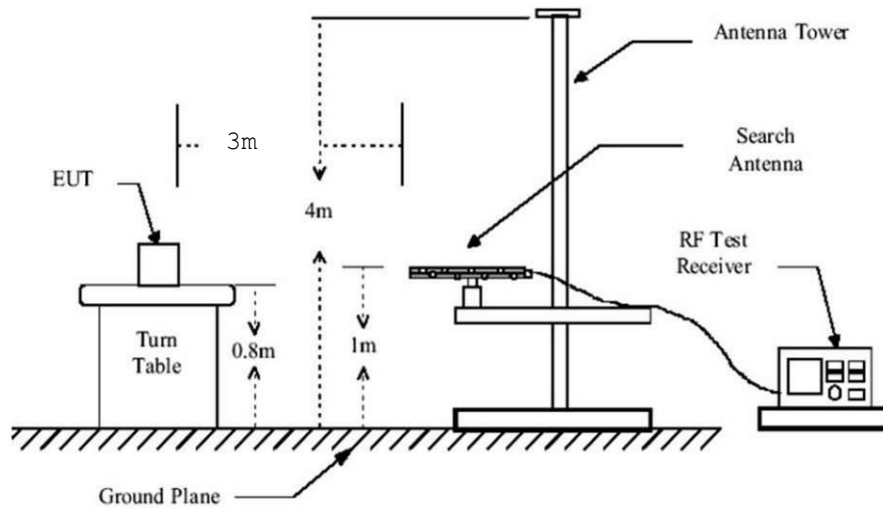
Test Equipment Used for conducted antenna port measurement

Description	Manufacturer	Model	Identifier	Cal. Date	Cal. Due
Spectrum analyzer	Rohde&Schwarz	FSV40	ASP-171-004	2019/8	2021/8
RF Attenuator	Mini-Circuit	BW-N10W5+	ATT-171-008	2021/3	2022/3
Measuring receiver	Rohde&Schwarz	ESRP	REC-151-002	2019/9	2021/9
EMC Software	NEXIO	BAT EMC V3.18	SOF-101-001	-	-

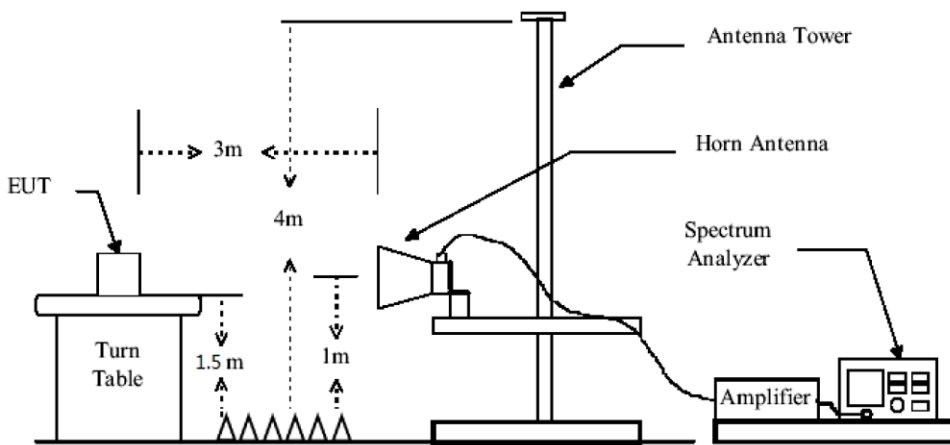
Test Setup for radiated emission



Test setup for 9k-30MHz (FS OATS)



Test setup for 30-1000MHz (SAC 3m)



Test setup for 1-10GHz (SAC 3m, tilt antenna mast used)

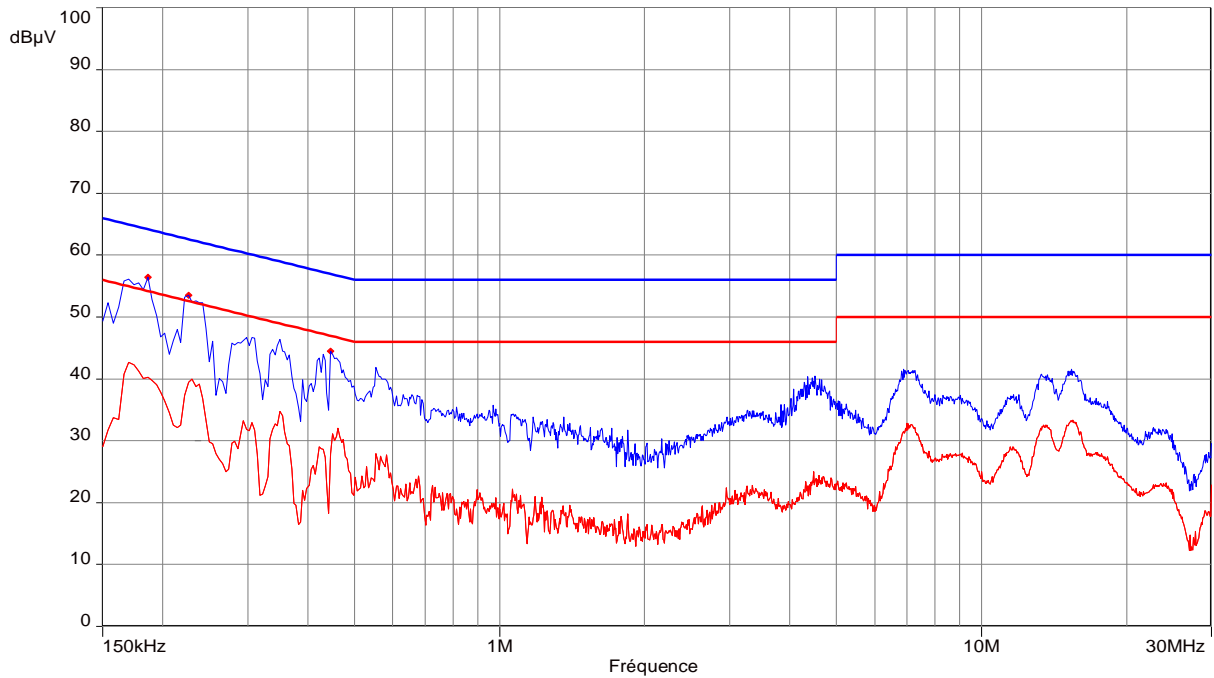
Test Equipment Used for radiated measurement					
Description	Manufacturer	Model	Identifier	Cal. Date	Cal. Due
Biconnic antenna	COM-POWER	AB- 900	ANT-101-003	2019/6	2021/6
Horn antenna	COM-POWER	AH-118	ANT-101-004	2018/10	2021/10
Loop antenna	EMCO	6502	ANT-101-009	2019/8	2021/8
Log-periodic antenna	EMCO	3146	ANT-191-019	2019/6	2021/6
Spectrum analyzer	Rohde&Schwarz	FSV40	ASP-171-004	2019/8	2021/8
RF cable	Div	OATS/25m	CAB-101-017	2021/3	2022/3
RF cable	Pasternack RF	PE302-120	CAB-131-023	2021/3	2022/3
RF cable	HUBER+SUHNER	SF102 (KN6m)	CAB-171-033	2021/3	2022/3
RF cable	TMS	LMR-400 / 9m	CAB-201-039	2021/3	2022/3
Semi anechoic room	COMTEST	218292	CAG-201-002	2021/2	2022/2
High-Pass filter	Wainwright Inst.	HK6-948-1200	FIL-141-004	2021/3	2022/3
Antenna mast SAC	Innco- Systems	MA4640-XP-ET	MAT-201-002	-	-
Turntable	Innco- Systems	CT0800	PLA-141-002	-	-
Turntable SAC	Innco- Systems	DS1500-S-1t	PLA-201-003	-	-
Pre-amplifier	PE	1524	PRE-101-002	2021/3	2022/3
Measuring receiver	Rohde&Schwarz	ESRP	REC-151-002	2019/9	2021/9
FS OATS	Div	10m	SIT-201-002	-	-
EMC Software	NEXIO	BAT EMC V3.18	SOF-101-001	-	-

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

TEST: Limits for conducted disturbance 150kHz – 30MHz			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.			Pass	
Laboratory Parameters:	Required prior to the test	During the test		
Ambient Temperature	17 to 27°C	21°C ± 2		
Relative Humidity	25 to 65 %	51% ± 5		
Fully configured sample scanned over the following frequency range	Frequency range on each side of line	Measurement Point		
	150kHz to 30MHz	AC input port (110V)		
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 10 th , 20201 Tested by C. KERMICHE				
Power supply voltage: AC mains 110V/60Hz				

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)	
0.186	56.85	52.89	64.21	-11.33	40.63	54.21	-13.58	L1
0.226	51.53	44.35	62.6	-18.24	27.27	52.6	-25.32	L1
0.446	40.81	35.66	56.95	-21.29	20.2	46.95	-26.75	L1
0.17	54	51.21	64.96	-13.75	36.86	54.96	-18.1	N
0.226	46.43	41.97	62.6	-20.62	31.16	52.6	-21.44	N
4.42	40.76	34.23	56	-21.77	24.42	46	-21.58	N
RBW:	9kHz							
Voltage:	110V/60Hz							
Limit:	FCC Part 15.209 a) / RSS-Gen: Issue 5, §8.8 Table 4							
Final measurement detector:	Quasi-Peak and CISPR Average (AV)							
RESULT:	PASS							
Measured value calculation:	The measured value (level) is calculated by adding the Cable Factor, the Transient suppressor attenuation and LISN attenuation from the receiver amplitude reading. The basic equation is as follow: $\text{Meas.} = \text{RA} + \text{CF} + \text{ATT}_{\text{TRAN}} + \text{ATT}_{\text{LISN}}$ Where Meas. = Level (dBµV) RA = Receiver Amplitude CF = Cable Factor ATT _{TRAN} = Transient suppressor attenuation ATT _{LISN} = LISN attenuation Margin value = Emission level – Limit value (A negative margin shows compliance to limit)							

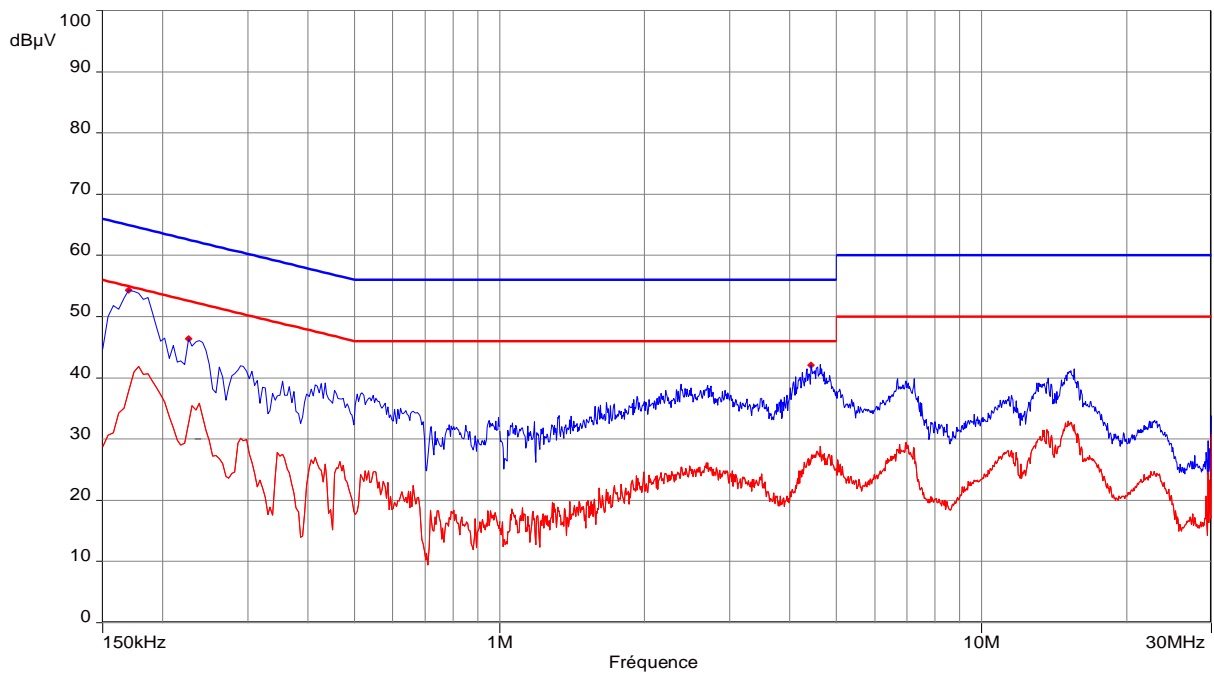
Graphical representation of Conducted Disturbance Measurement (Peak and Average detection) AC port, Line L1



Note : Same result for all transmit modes on all channels.

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

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



Note : Same result for all transmit modes on all channels.

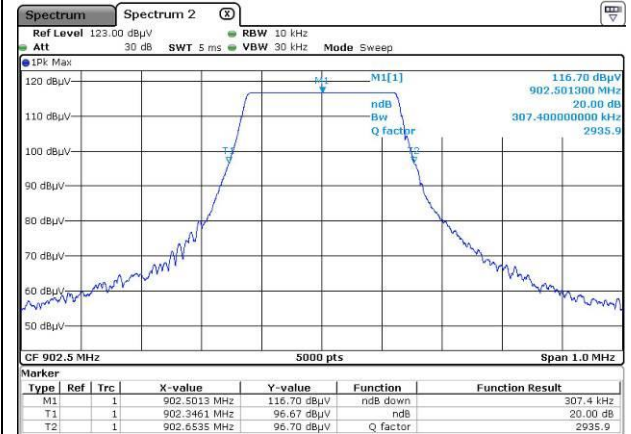
----: Peak ----: Average

11. Channel Separation

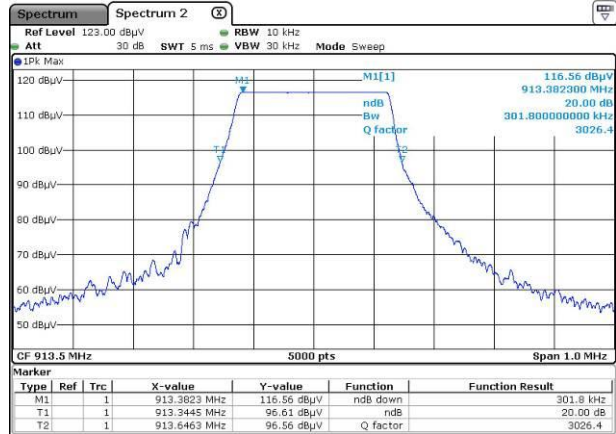
TEST: Hopping channel measurement (Separation)			Verdict								
<p><u>Method:</u> The Equipment under test is connected to the spectrum analyzer with suitable mean. The SPAN is adapted to see the frequency band of operation. The spectrum analyzer RBW was 10kHz and VBW was 30kHz. The channel separation is measured with the hopping function enable on the EUT.</p> <p><u>Limits:</u> Minimum separation between channels shall be 25kHz or the 20dB bandwidth, whichever is greater.</p>			Pass								
<table border="1"> <thead> <tr> <th>Laboratory Parameters:</th> <th>Required prior to the test</th> <th>During the test</th> </tr> </thead> <tbody> <tr> <td>Ambient Temperature</td> <td style="text-align: center;">17 to 27°C</td> <td style="text-align: center;">21°C ± 2</td> </tr> <tr> <td>Relative Humidity</td> <td style="text-align: center;">25 to 65 %</td> <td style="text-align: center;">42% ± 5</td> </tr> </tbody> </table>				Laboratory Parameters:	Required prior to the test	During the test	Ambient Temperature	17 to 27°C	21°C ± 2	Relative Humidity	25 to 65 %
Laboratory Parameters:	Required prior to the test	During the test									
Ambient Temperature	17 to 27°C	21°C ± 2									
Relative Humidity	25 to 65 %	42% ± 5									
<p>Supplementary information: Test location: SMEE Test date: May 06th, 2021. Tested by LC / CK</p>											

Tabulated Results for Hopping Channel Separation				
Channel frequency	Adjacent channel separation	20dB Bandwidth	Minimum limit	Result
(MHz)	(kHz)	(kHz)	(kHz)	
902.5	500.2	307.4	307.4	PASS
913.5		301.8	301.8	PASS
924.5		297.4	297.4	PASS

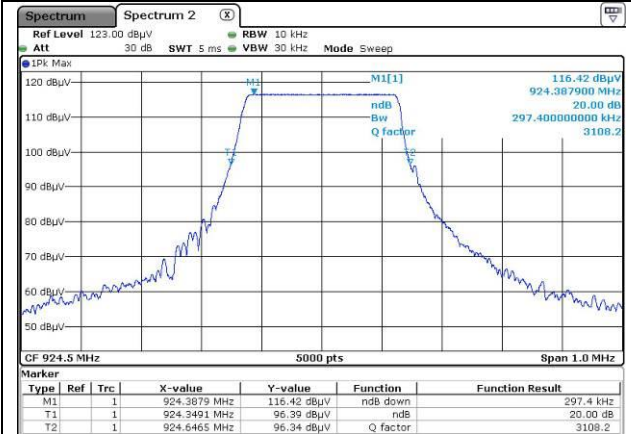
Graphical representation of 20dB Bandwidth



LOW CHANNEL

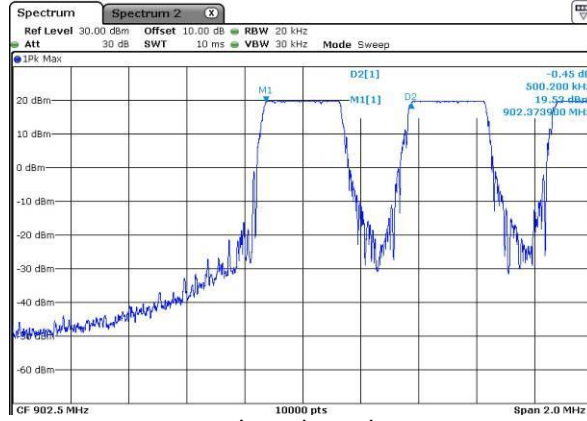


MID CHANNEL

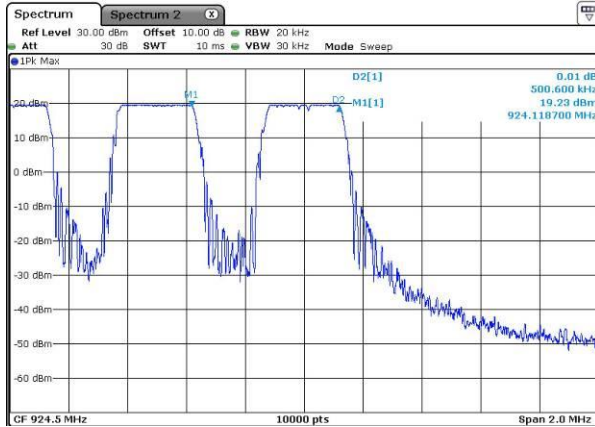


HIGH CHANNEL

Graphical representation of Hopping channel separation



Low channel



High channel

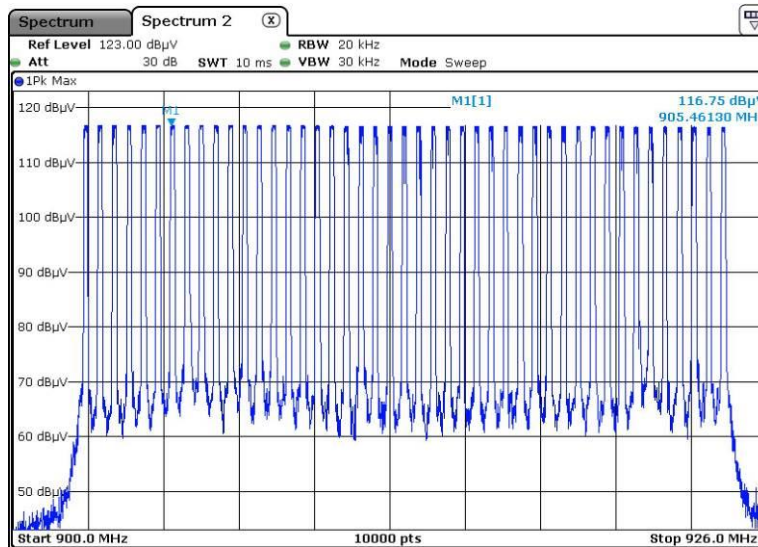
12. Number of hopping channels

TEST: Number of hopping channels		Verdict
Method: The Equipment under test is connected to the spectrum analyzer with suitable mean. The SPAN is adapted to see the frequency band of operation. The EUT has its hopping function enable. Limits: 25 channels		Pass
Laboratory Parameters:	Required prior to the test	During the test
Ambient Temperature	17 to 27°C	21°C ± 2
Relative Humidity	25 to 65 %	42% ± 5
Supplementary information: Test location: SMEE Test date: May 06 th , 2021. Tested by LC / CK.		

Tabulated Results for Number of Hopping Channel

Number of channels	Minimum number of channels	Result
45	25	PASS

Graphical representation for Number of Hopping Channel



13. Average Time of occupancy

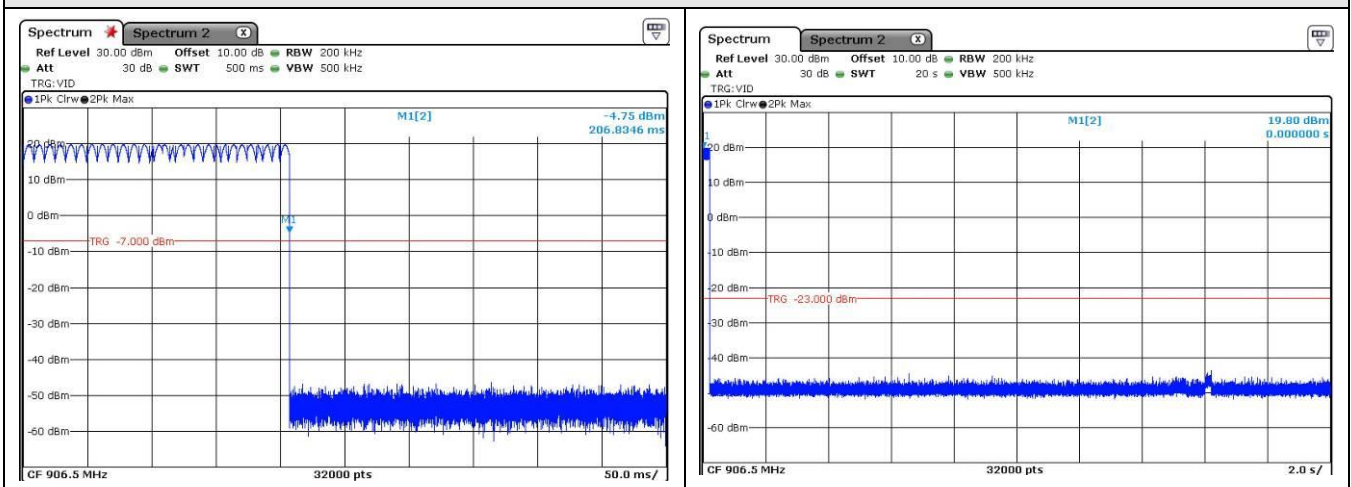
TEST: Time of occupancy		Verdict
<p><u>Method:</u> The Equipment under test is connected to the spectrum analyzer with suitable mean. The spectrum analyser is set to zero-span. The EUT has its hopping function enable.</p> <p><u>Limits:</u> 400ms of transmission by channel on a period 10s. (45 channels used)</p>		Pass
Laboratory Parameters:	Required prior to the test	During the test
Ambient Temperature	17 to 27°C	21°C ± 2
Relative Humidity	25 to 65 %	42% ± 5
<p>Supplementary information: Test location: SMEE Test date: May 06th, 2021. Tested by LC / CK.</p>		

Tabulated Results for Dwell time

Modulation	Number of pulses per 10s period	Length of 1 pulse (ms)	Average Time of occupancy (ms)	Limit (ms)	Result
LORA	1	206.8	206.8	400ms	PASS

Additional information:

Graphical representation for dwell time



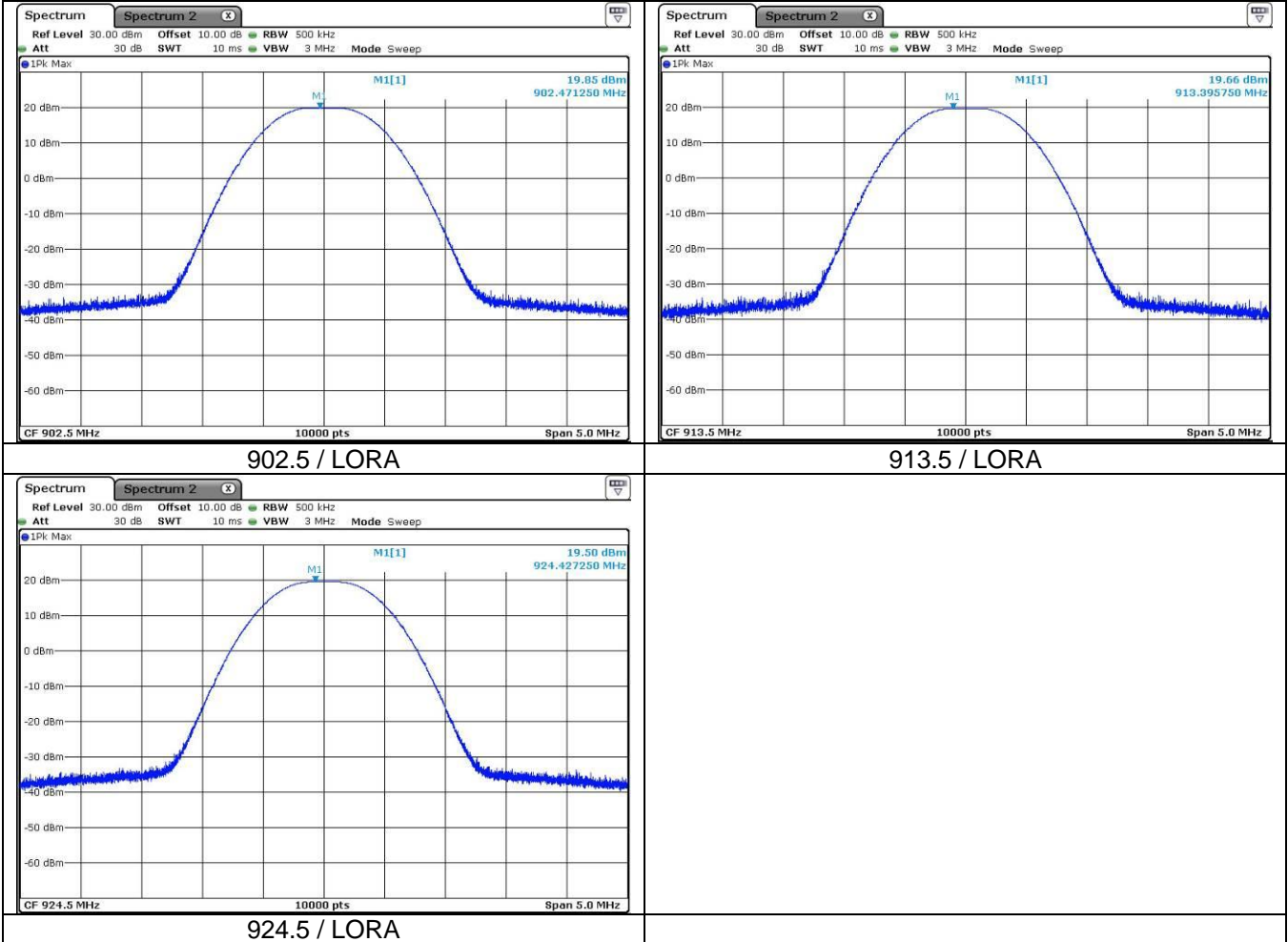
14. Fundamental emission output power

TEST: Maximum conducted output power			Verdict
<u>Method:</u> The setup is in an anechoic chamber. The spectrum analyzer is connected to the antenna port of the device under test. A conducted measurement is performed. The tested equipment is set to transmit operation with modulation on low, middle and high channels.			Pass
Laboratory Parameters:	Required prior to the test	During the test	
Ambient Temperature	17 to 27°C	21°C ± 2	
Relative Humidity	25 to 65 %	42% ± 5	
Limits – FCC Part 15.247 (b) / RSS-247 §5.4			
Frequency (MHz)	Limits		
	Level	Results	
902.5 to 924.5	24 dBm (Conducted)	Pass	
	30 dBm (Radiated, EIRP)	Pass	
Supplementary information: Test location: SMEE Test date: May 06 th , 2021. Tested by LC / CK.			

Tabulated Results for Maximum (Peak) output power (Conducted)					
FREQ (MHz)	Measured conducted power (dBm)	Duty cycle factor (dB)	Maximum output power (dBm)	Limit (dBm)	Result
902.5	19.9	-	19.9	24.0	Pass
913.5	19.7	-	19.7	24.0	Pass
914.5	19.5	-	19.5	24.0	Pass
RESULT:		PASS			
Note:		- Method used is ANSI C63.10 §7.8.5			

Tabulated Results for Maximum (Peak) output power (Radiated)					
FREQ (MHz)	Maximum output power Conducted (dBm)	Max Antenna Gain (dBi)	Maximum output power Radiated (dBm)	Limit (dBm)	Result
902.5	19.9	2.0	21.9	30.0	Pass
913.5	19.7	2.0	21.7	30.0	Pass
914.5	19.5	2.0	21.5	30.0	Pass
RESULT:		PASS			

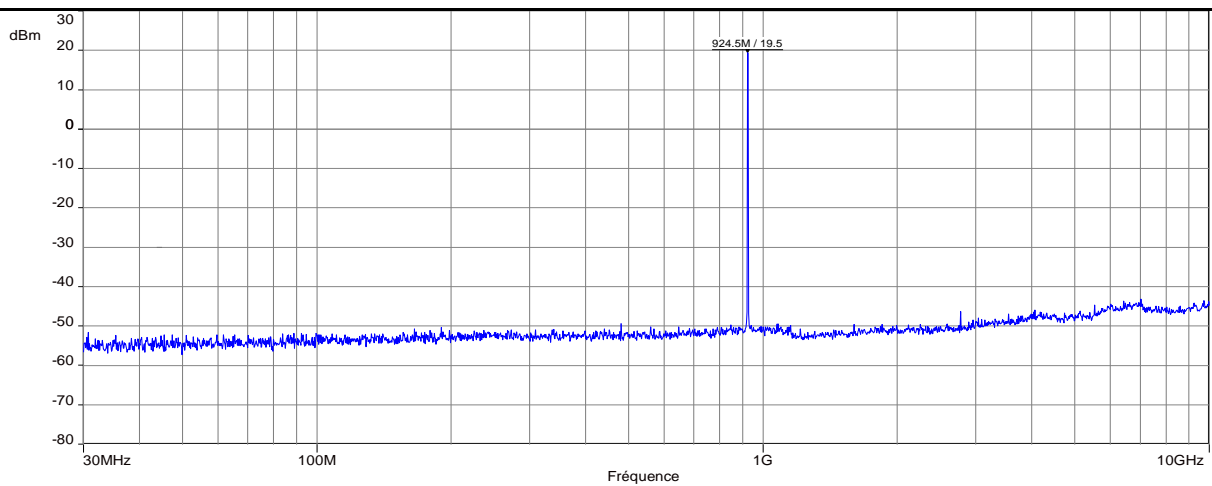
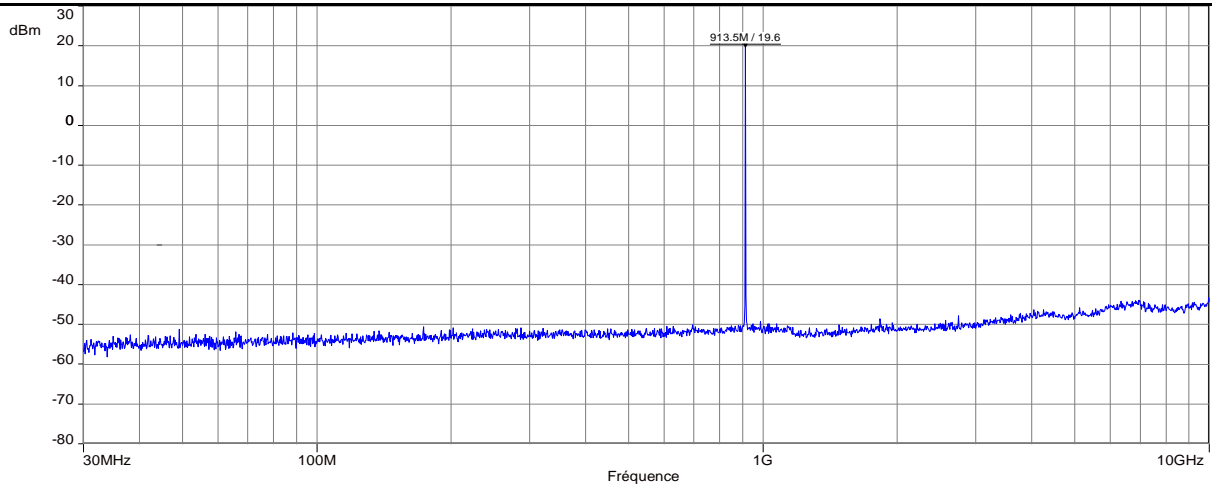
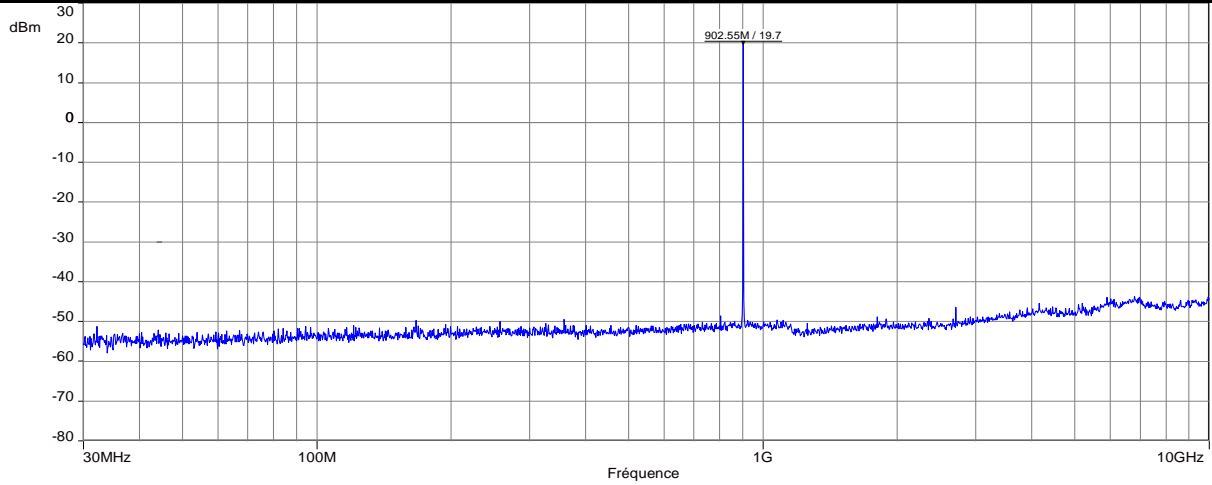
Graphical representation of Conducted output power



15. Unwanted Spurious Emissions (Conducted emissions)

TEST: Conducted Spurious emissions			Verdict
<p><u>Method:</u> The setup is in an anechoic chamber. The spectrum analyzer is connected to the antenna port of the device under test. A conducted measurement is performed. The tested equipment is set to transmit operation with modulation on low, mid and high channels.</p>			Pass
Laboratory Parameters:	Required prior to the test		During the test
Ambient Temperature	17 to 27°C		21°C ± 2
Relative Humidity	25 to 65 %		42% ± 5
Fully configured sample scanned over the following frequency range	Frequency range on each side of line		Measurement Point
	30MHz – 10GHz		Antenna port
Limits – FCC Part 15.247 (d) / RSS-247 § 5.5			
Frequency (MHz)	Limits (dBµV/m)		
	Detector / Analyser RBW	Limit	Results
30 to 10000	Pk / 100kHz	20dB below the maximum Peak level	Pass
<p>Supplementary information: Test location: SMEE Test date: May 06th, 2021. Tested by LC / CK.</p>			

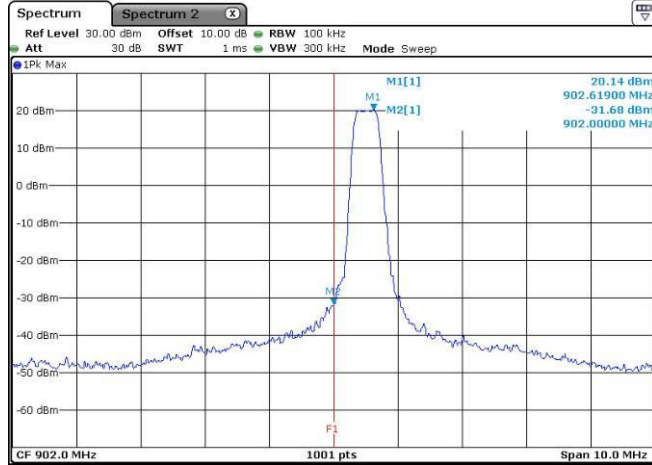
Graphical representation of Conducted Spurious emissions (LORA mode / Low, Mid and High channels)



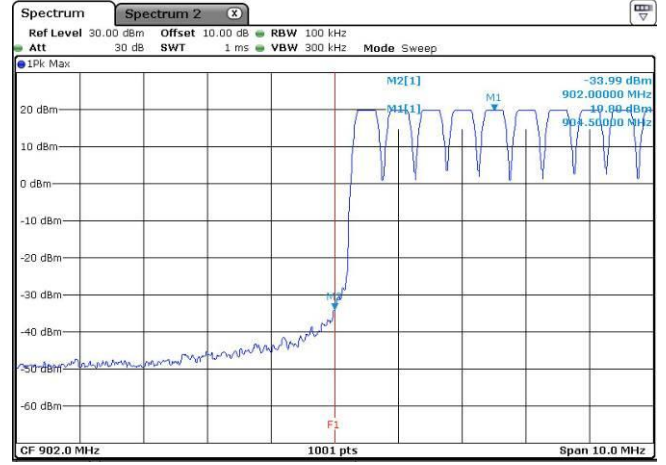
Frequency band investigated:	30MHz-10GHz
Unit :	dBm
RBW :	100kHz (Frequency step 50kHz)
Measurement detector:	Peak
Limit:	-0.5 dBm

Graphical representation of Band-edge compliance (LOW)

LORA / Hopping Disable



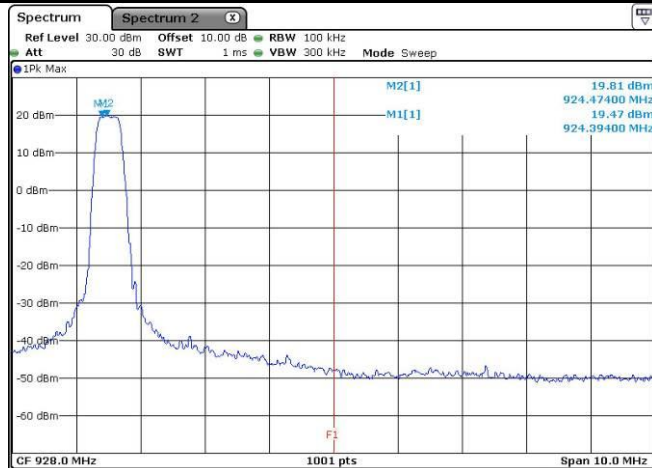
LORA / Hopping Enabled



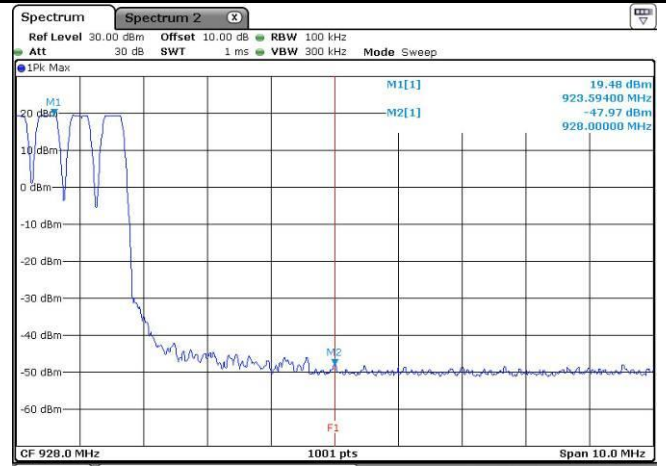
Unit :	dBm
RBW :	100kHz
Measurement detector:	Peak
Limit:	-0.5 dBm
Note:	F1 is 902MHz

Graphical representation of Band-edge compliance (High)

LORA / Hopping Disable



LORA / Hopping Enabled



Unit :	dBm
RBW :	100kHz
Measurement detector:	Peak
Limit:	-0.5 dBm
Note:	F1 is 928MHz

16. Unwanted emissions in Non-Restricted Frequency bands (Radiated emissions)

TEST: Unwanted emissions in Non-Restricted Frequency Bands			Verdict
<p>Method: Measurements were made in a 3-meter Semi Anechoic Room (SAR) up to 1GHz and in a 3-meter Full Anechoic environment (SAR with floor absorbers) above 1GHz. The Semi Anechoic Room complies with CISPR16-1-4 / ANSI C63.4 requirements. Preliminary (peak) measurements were performed at an antenna to EUT separation distance of 3 meter. The EUT was rotated 360° about its azimuth with the receive antenna located at various heights in horizontal and vertical polarities. The pre-characterization graphs are obtained in PEAK detection. Final measurements (Peak, Quasi-peak, Average) 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. Three orthogonal axis measurements on EUT are performed to obtain the maximum peak field strength.</p>			Pass
Laboratory Parameters:	Required prior to the test	During the test	
Ambient Temperature	17 to 27°C	21°C ± 2	
Relative Humidity	25 to 65 %	42% ± 5	
Fully configured sample scanned over the following frequency range	Frequency range on each side of line	Measurement Point	
	30MHz – 10GHz	3 m measurement distance	
Limits – FCC Part 15.247 (d) / RSS-247 § 5.5			
Frequency (MHz)	Limits (dBµV/m)		
	Detector / Analyser RBW	Limit	Results
30 to 10000	Pk / 100kHz	20dB below the maximum Peak level	Pass
Supplementary information: Test location: SMEE Test date: May 06 th , 2021. Tested by LC / CK.			

Tabulated Results for Peak Output Radiated level	
FREQ (MHz)	Field Strength 3m (dB μ V/m)
902.5	118.5
913.5	118.4
924.5	118.2
RBW:	100kHz
Measurement distance:	3m
Limit:	Ref. level only – For 15.247 (d) / RSS-247 § 5.5
Final measurement detector:	Peak
Note:	(1): Only for identification of limit in non-restricted band Limit is 98.2 dBμV/m Peak for out-of-band frequencies in Non-Restricted bands (with a 100kHz RBW on the spectrum analyzer)

Tabulated Results for Unwanted emissions in Non-Restricted bands				
FREQ (MHz)	Field Strength 3m (dB μ V/m)	Limit (dB μ V/m)	Margin (dB μ V/m)	Result (dB μ V/m)
Levels are at least 10 dB below the -20dBc limit See pre-scan graphs in chapter 17.				
RBW:	100kHz			
Measurement distance:	3m			
Limit:	15.247 / RSS-247			
Final measurement detector:	Peak			
RESULT:	PASS			
Note:	3-axis measurement performed for device under test.			

17. Unwanted emissions in Restricted Frequency bands

TEST: Unwanted emissions into Restricted Frequency Bands		Verdict
<p><u>Method:</u> Measurements were made in a 3-meter Semi Anechoic Room (SAR) for frequency 30MHz to 1GHz and in a 3-meter Full Anechoic environment (SAR with floor absorbers) above 1GHz. The Semi Anechoic Room complies with CISPR16-1-4 / ANSI C63.4 requirements. For frequency 9kHz to 30MHz, measurements are performed on a free-space open area test site at 10m distance. Preliminary (peak) measurements were performed at an antenna to EUT separation distance of 3 meter. 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, Average) 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. Three orthogonal axis measurements on EUT are performed to obtain the maximum peak field strength.</p>		Pass
Laboratory Parameters:	Required prior to the test	During the test
Ambient Temperature	17 to 27°C	21°C ± 2
Relative Humidity	25 to 65 %	42% ± 5
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 – 10GHz	3 m measurement distance
Limits – FCC Part 15.205, 15.209 (a), 15.247 (d) / RSS-GEN §8.9, §8.10, RSS-247 §5.5		
Frequency (MHz)	Limits (dBµV/m)	
	Level / Detector / Distance	Results
0.009 to 0.090	107.6 – 87.6 / AV / 10m 127.6 – 107.6 / PK / 10m	Pass
0.090 to 0.110	87.6 – 85.9 / QP / 10m	Pass
0.110 to 0.490	85.7 – 72.9 / AV / 10m 105.7 – 92.9 / PK / 10m	Pass
0.490 to 1.705	52.9 – 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
960-1000	54.0 / QP / 3m	Pass
Above 1GHz	54.0 / AV / 3m 74.0 / PK / 3m	Pass
Supplementary information: Test location: SMEE Test date: May 06 th , 2021. Tested by LC / CK.		

Tabulated Results for Unwanted emissions (9kHz-490kHz)

FREQ	RF field @ 300m	Limit @ 300m	Detector	Margin	Ant. angle	Table angle	Correc. Fact. (CF)
MHz	dBµV/m	dBµV/m	Pk / QP / AV	dB	Degree	Degree	dB
All levels are at least 20dB below applicable limits							
Supplementary information: Frequency list measured has been created with pre-scan results.							
Frequency band investigated:		9kHz-490kHz					
RBW:		200Hz (9kHz-150kHz) 9kHz (150kHz-30MHz)					
Measurement distance:		10m					
Final measurement detector:		Peak / Quasi-Peak / Average					
Limit:		FCC Part 15.209 / RSS-Gen					
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 / RSS-Gen clause 6.5) (M@300m = M@10m-59.1dB) Loop antenna used and rotated about its axis to maximize any emission.					

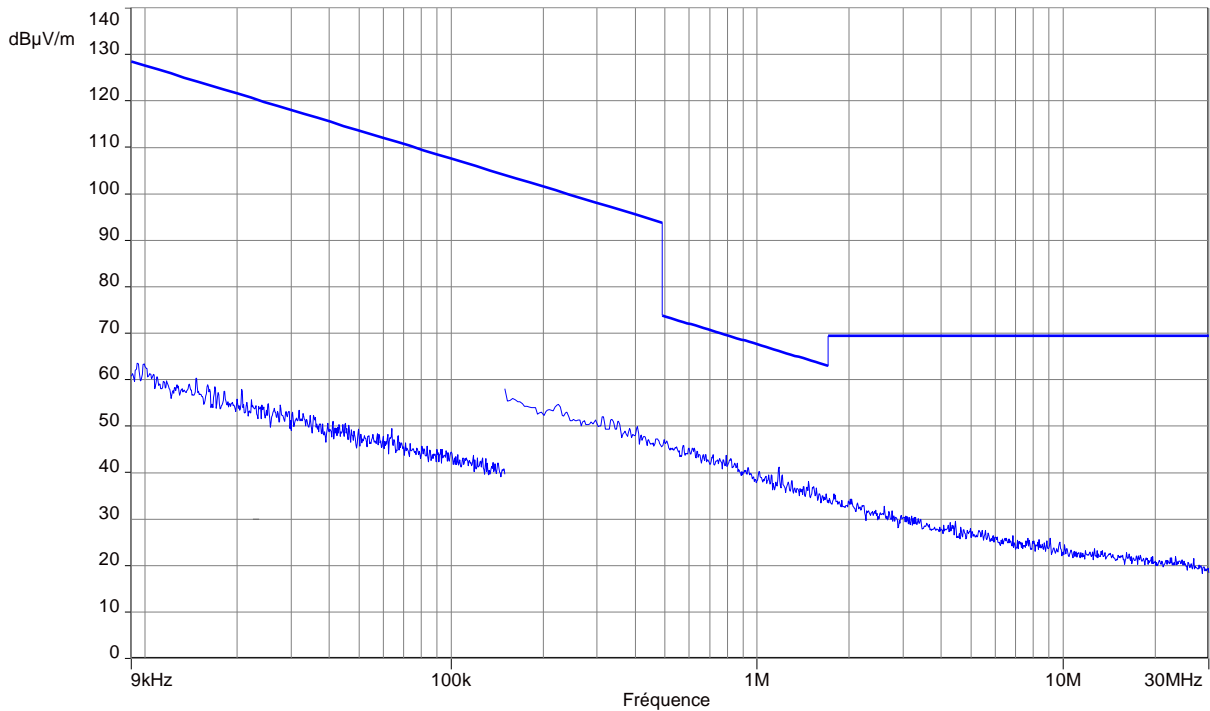
Tabulated Results for Unwanted emissions (490kHz-30MHz)

FREQ	RF field @ 30m	Limit @ 30m	Detector	Margin	Ant. angle	Table angle	Correc. Fact. (CF)
MHz	dBµV/m	dBµV/m	Pk / QP	dB	Degree	Degree	dB
All levels are at least 20dB below applicable limits							
Supplementary information: Frequency list measured has been created with pre-scan results.							
Frequency band investigated:		490kHz-30MHz					
RBW:		9kHz (150kHz-30MHz)					
Measurement distance:		10m					
Final measurement detector:		Quasi-Peak					
Limit:		FCC Part 15.209 / RSS-Gen					
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) Loop antenna used and rotated about its axis to maximize any emission.					

Tabulated Results for Unwanted emissions (30MHz-1GHz)										
FREQ	Meter reading	Meter reading	Total factor	Field level	Field level	Pol	Antenna height	Table angle	Limit	Margin
MHz	(QP) dB μ V	(Pk) dB μ V	dB	(QP) dB μ V/m	(Pk) dB μ V/m		cm	Degree	(QP) dB μ V/m	dB
Levels are at least 10dB below limits										
Supplementary information: Frequency list has been created with pre-scan results.										
Frequency band investigated:				30MHz-1GHz						
RBW:				120kHz						
Measurement distance:				3m						
Limit:				FCC Part 15.205 - 15.209 / RSS-GEN						
Final measurement detector:				Quasi-Peak						
RESULT:				PASS						

Tabulated Results for Unwanted emissions (1GHz-10GHz)										
FREQ	Field level	Field level	Limit	Margin	Limit	Margin	Table angle	Ant height	Total factor	Pol
MHz	(PK) dB μ V/m	(AV) dB μ V/m	(PK) dB μ V/m	(PK) dB	(AV) dB μ V/m	(AV) dB	Degree	cm	dB	
Low channel										
7308.0	54.9	49.4	74	-19.1	54	-4.6	266.2	1.5	27.05	V
8221.7	57.9	50.1	74	-16.1	54	-3.93	0.8	1.07	27.14	V
Middle channel										
2740.5	50.8	44.9	74	-23.2	54	-9.1	322.5	2.1	16.3	V
7308.0	54.9	52.9	74	-19.1	54	-1.1	166.2	1.5	27.4	V
8221.7	57.9	49.6	74	-16.1	54	-4.4	357.8	1.1	27.6	V
High channel										
2773.1	49.0	42.8	74	-25.0	54	-11.2	44	1.0	16.9	V
7401.0	58.1	49.4	74	-15.9	54	-4.6	56.6	1.5	27.4	V
8324.0	59.4	52.1	74	-14.6	54	-1.9	351.3	2.0	27.2	V
9245.9	56.6	48.3	74	-17.4	54	-5.7	0	1.5	28.0	V
Supplementary information: Frequency list has been created with pre-scan results.										
RBW					1MHz					
Measurement distance:					3m					
Limit:					FCC Part 15.205, 15.209, 15.247 / RSS-Gen, RSS-247					
Final measurement detector:					Peak / CISPR Average					
RESULT:					PASS					

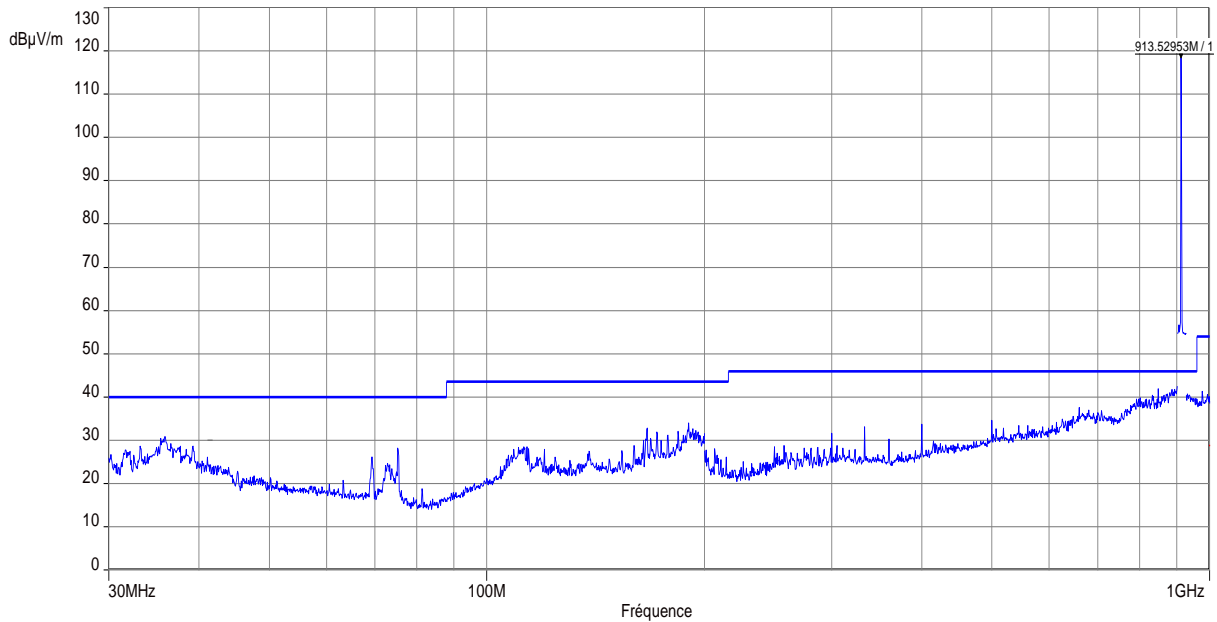
Graphical representation of Radiated Disturbance Measurement (Peak detection, Anechoic chamber pre-scan, 9kHz-30MHz / 3m / Parallel & Perpendicular antenna position / Transmit mode)



Notes: Pre-scan graph only for identification purpose.
Same result for all channels.

Frequency band investigated:	9kHz-30MHz
Unit :	dBµV/m
RBW :	200Hz (9kHz-150kHz) 9kHz (150kHz-30MHz)
Antenna polarization :	Parallel & Perpendicular to measurement axis
Measurement detector:	Peak

Graphical representation of Radiated Disturbance Measurement (Peak detection, Anechoic chamber pre-scan, 30MHz-1GHz / 3m / Vertical (Worst case))



Note: Pre-scan graph only for identification purpose.

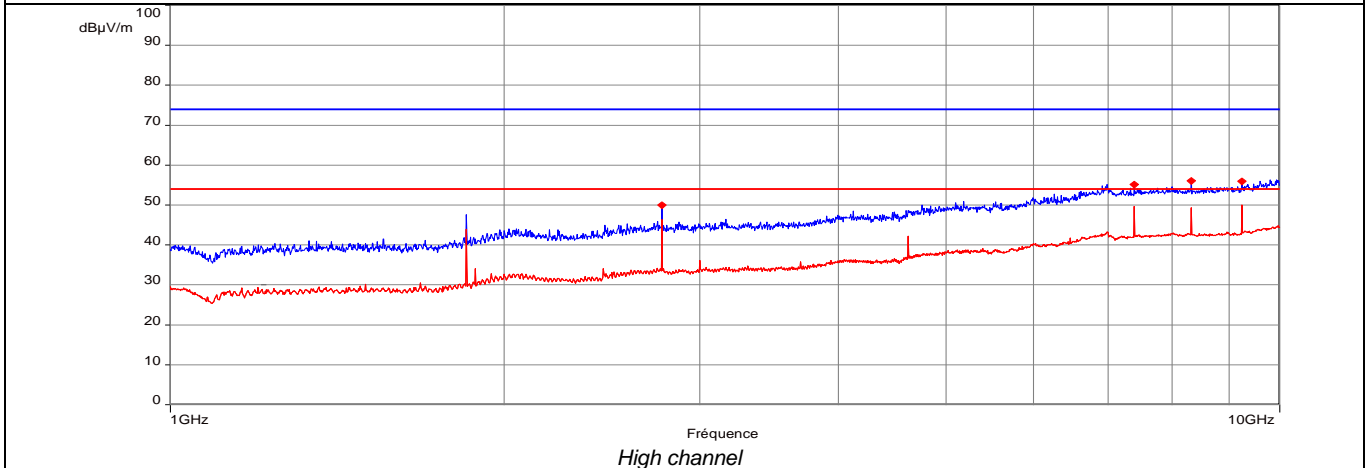
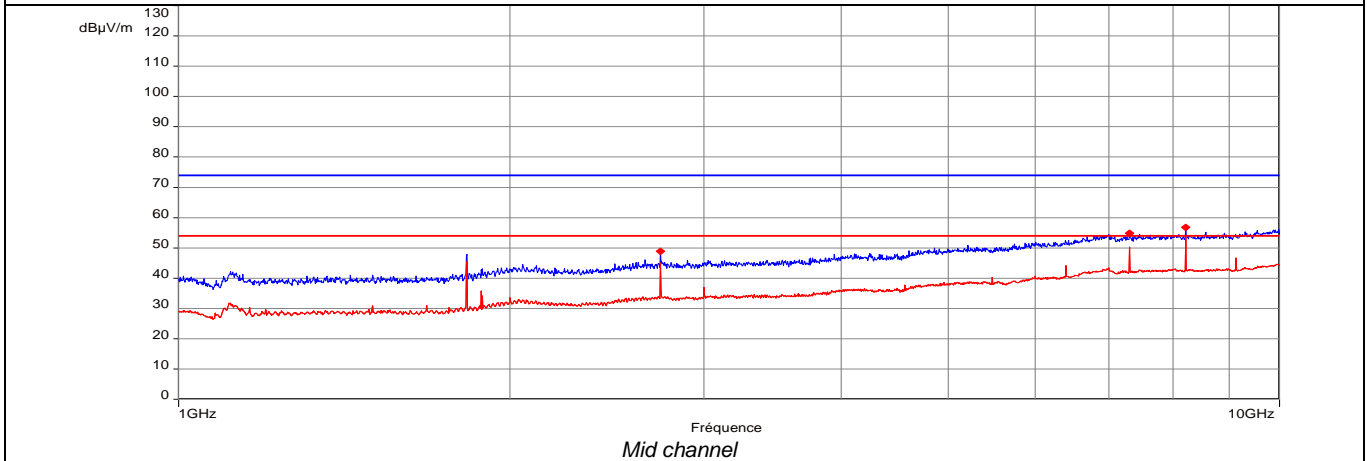
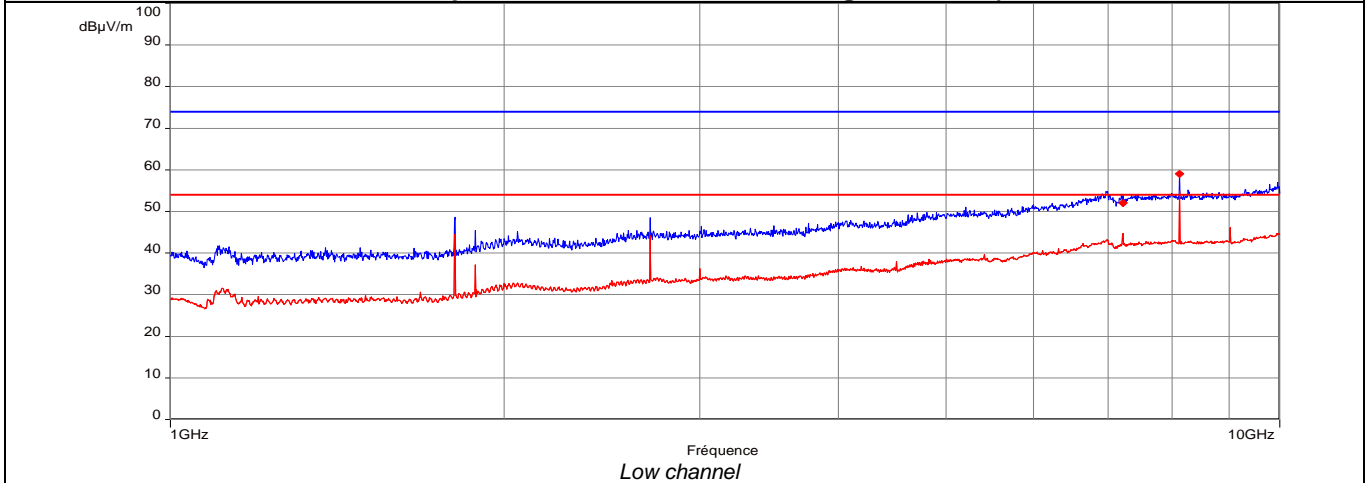
Pre-scan performed on the mid channel of the whole frequency band.

Frequency band investigated:	30MHz-1GHz
Unit :	dBµV/m
RBW :	100kHz
Antenna polarization :	Horizontal & Vertical
Limit:	FCC 15.247 / RSS-247
Measurement detector:	Peak

PEAK LIST FROM PRE-SCAN

Frequency (MHz)	Peak Level (dBµV/m)	Angle (°)	Limit (dBµV/m)	Polarization	Comments
None	-	-	-	-	

Graphical representation of Radiated Disturbance Measurement (Anechoic chamber pre-scan, 1GHz-10GHz / 3m / Worst case for V or H polarization / Low - Middle - High channels)



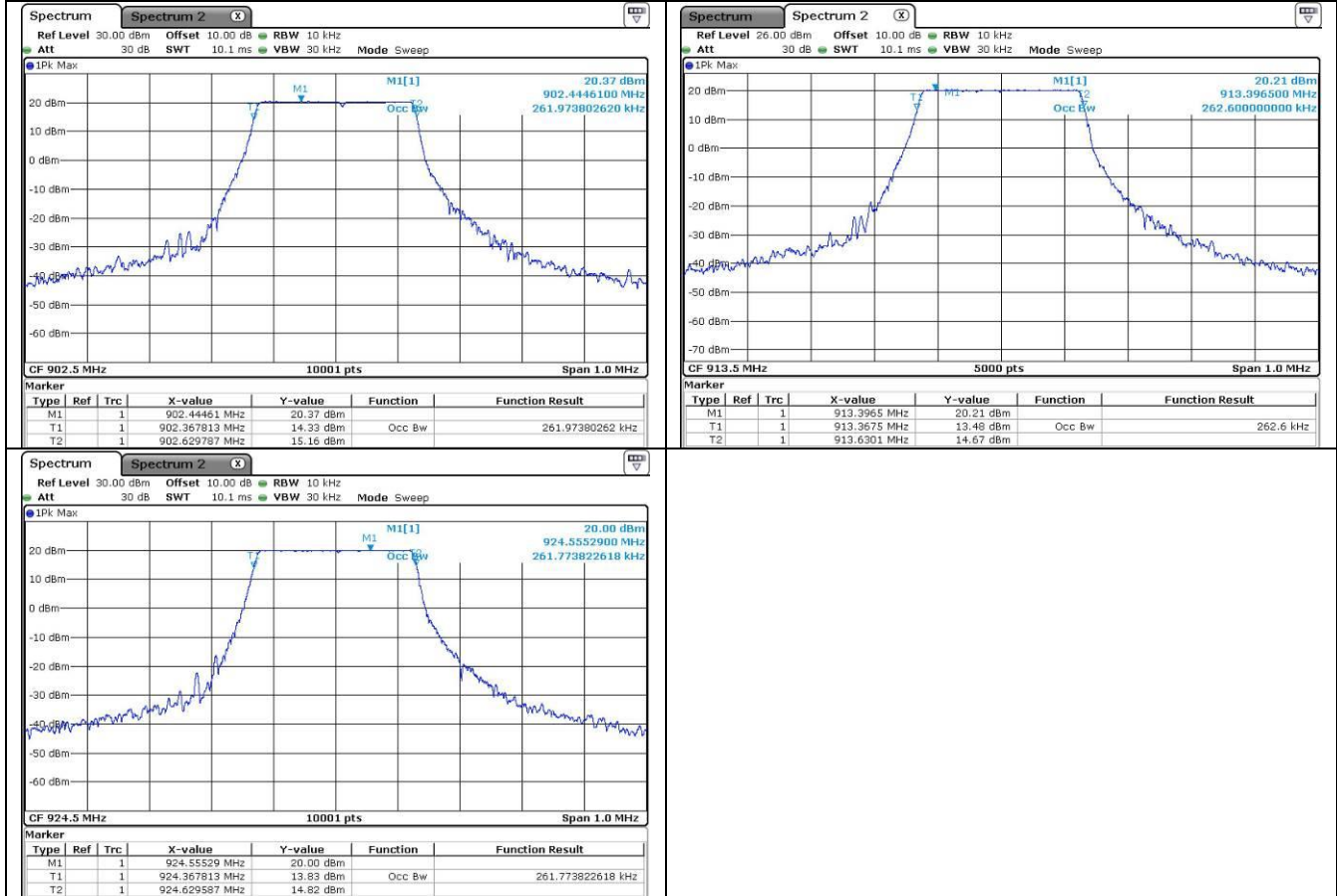
----- : Peak measure	----- : Average measure
Frequency band investigated:	1GHz-10GHz
Unit :	dBµV/m
RBW :	1MHz
Antenna polarization :	Horizontal & Vertical
Limit:	FCC 15.247 / RSS-247
Measurement detector:	Peak / Average
Notes:	Note: Pre-scan graph only for identification purpose. Worst case position shown

18. Occupied bandwidth (99%)

TEST: Occupied bandwidth (99%) / RSS-GEN		Verdict
<p><u>Method:</u> The setup is in an anechoic chamber. The Equipment under test is connected to the spectrum analyzer with suitable mean. The RBW is set in the range of 1% to 5% of the occupied bandwidth, with VBW \geq 3 x RBW. The SPAN is wide enough to capture all products of the modulation process. A Peak detector is used. Measure is performed with OBW 99% function of the spectrum analyser. The tested equipment is set to transmit operation with modulation on low, mid and high channels.</p>		Pass
Laboratory Parameters:	Required prior to the test	During the test
Ambient Temperature	17 to 27°C	21°C \pm 2
Relative Humidity	25 to 65 %	42% \pm 5
<p>Supplementary information: Test location: SMEE Test date: May 06th, 2021. Tested by LC / CK.</p>		

Tabulated Results for Occupied Bandwidth	
Frequency (MHz)	99% Occupied Bandwidth (kHz)
902.5	261.974
913.5	262.600
924.5	261.774

Graphical representation of Occupied Bandwidth



END OF TEST REPORT