

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

Matériel testé :
Equipment under test:

ST / NUCLEO-WL55JC1
(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 : 13295
Work number :

Référence de la proposition : 012020-23903
Proposal number:

Date de l'essai : Du 22 au 24 juillet 2020
Date of test: July 22nd to 24th, 2020

Objectif des essais : EMC qualification accordingly to following standards:
Test purpose: - 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: SMEE, Rue de Taille
Test location: 38500 VOIRON - France

Test réalisé par : Laurent CHAPUS
Test realized by:

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

Ed.	Date	Modifications Pages /	Written by : Visa	Approved by: Visa
1	November 12 th , 2020	Initial Edition	Laurent CHAPUS	Regis ANCEL
2	December 17 th , 2020	TCB review	<i>Technical Manager</i>	<i>General Manager</i>

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COORDONNEES

SMEE
Rue de Taille – ZI Des Blanchisseries
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

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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	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 5/2019)	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)	<u>Minimum separation</u> 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-D01
Sn: C202100012

FCC ID: FCC ID: YCP-MB1389000
IC: IC: 8976A-MB1389000
Model: NUCLEO-WL55JC1

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, OATS)	± 5.6dB
Radiated emission test (300-1000MHz, OATS)	± 5.3dB
Radiated emission test (1-40GHz, OATS / FAC)	± 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: 14.0dBμV / AF: 16.5 dBm⁻¹ / CF: 3.5dB / AG: 15dB

→ Total factor: 5dBm⁻¹

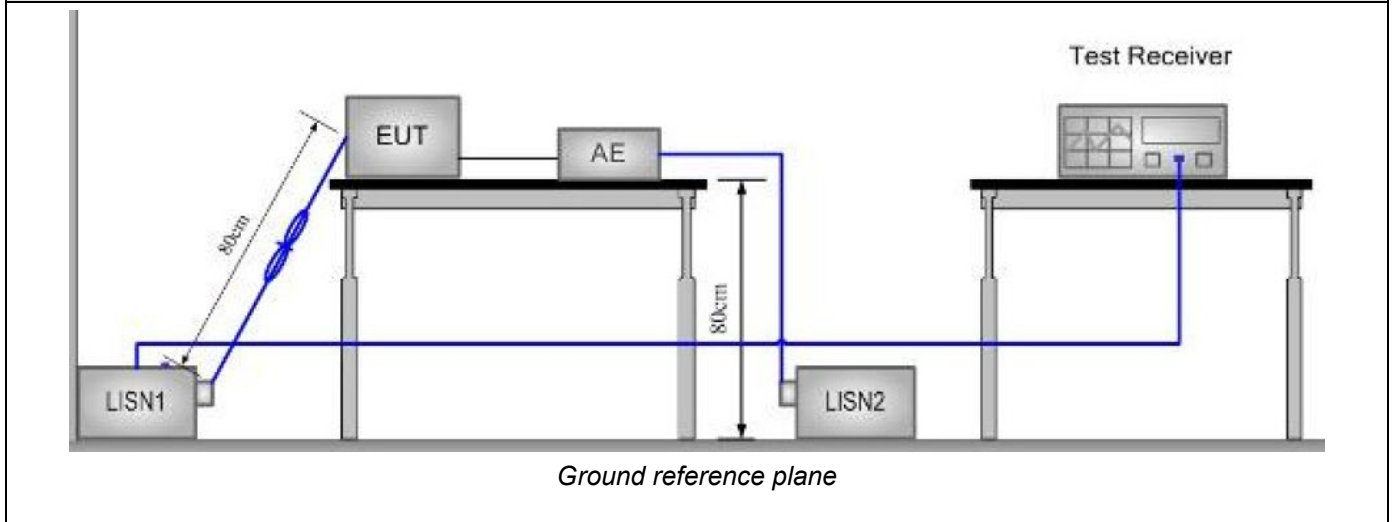
→ Field level: 19.0dBμV/m (-21.0dB for margin if limit is 40dBμV/m)

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

TEST: Limits for conducted disturbance 150kHz – 30MHz				Verdict	
<p>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.</p>				Pass	
Laboratory Parameters:		Required prior to the test		During the test	
Ambient Temperature		20 to 30 °C		25°C ± 2	
Relative Humidity		25 to 70 %		57% ± 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: July 24 th , 2020. Tested by L. CHAPUS					
Power supply voltage: AC mains 110V/60Hz					

Test Equipment Used					
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	2020/4	2021/4
Cable RF	Div	1m	CAB-101-021	2020/4	2021/4
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	-	-

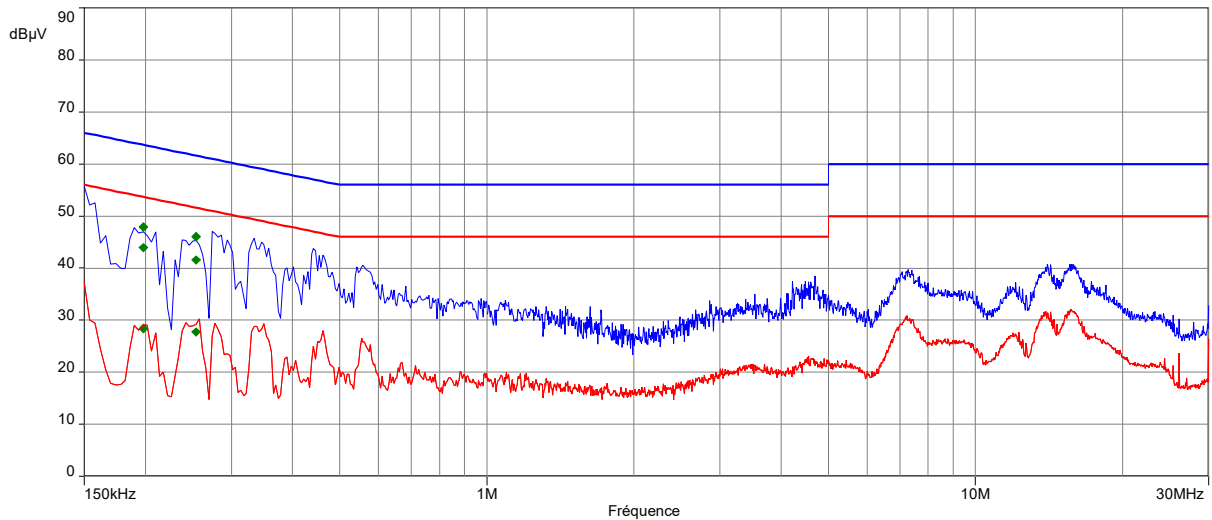
Test Setup for conducted emission



Tabulated Results for Mains Terminal Disturbance Voltage on AC port

FREQ (MHz)	Meas. PK (dBμV)	Mes. QP (dBμV)	LIMIT QP (dBμV)	Margin QP (dB)	Mes. AV (dBμV)	LIMIT AV (dBμV)	Margin AV (dB)	Line
0.198	47.87	43.93	63.69	-19.76	28.41	53.69	-25.28	L1
0.254	46.08	41.6	61.63	-20.03	27.82	51.63	-23.81	L1
0.166	54.39	51.84	65.16	-13.32	36.66	55.16	-18.5	N
0.226	45.35	40.95	62.6	-21.65	24.65	52.6	-27.95	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:			<p>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:</p> $\text{Meas.} = \text{RA} + \text{CF} + \text{ATT}_{\text{TRAN}} + \text{ATT}_{\text{LISN}}$ <p>Where</p> <ul style="list-style-type: none"> Meas. = Level (dBμV) RA = Receiver Amplitude CF = Cable Factor ATT_{TRAN} = Transient suppressor attenuation ATT_{LISN} = LISN attenuation <p>Margin value = Emission level – Limit value (A negative margin shows compliance to limit)</p>					

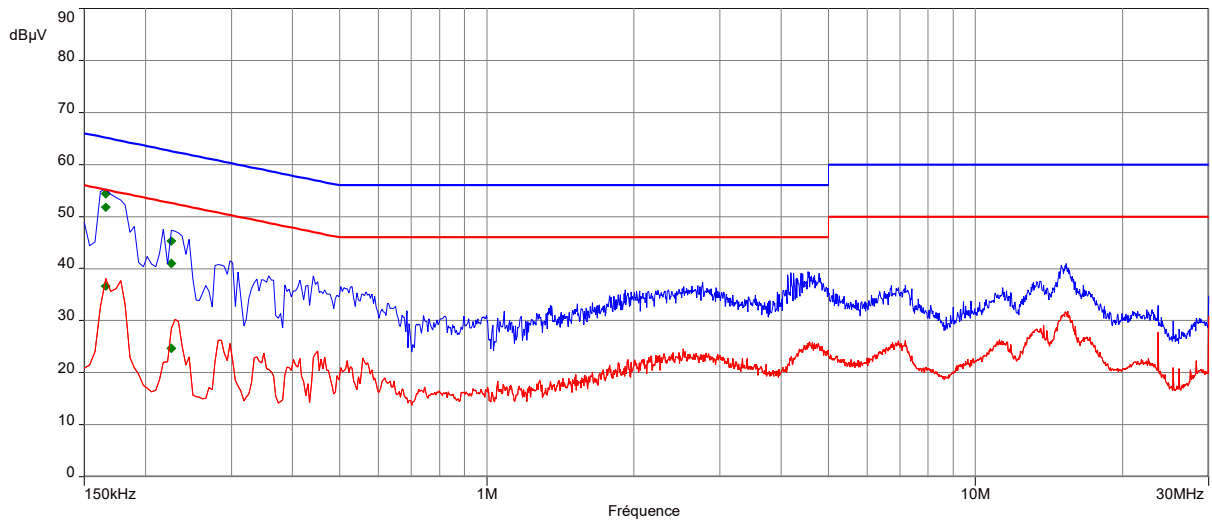
Graphical representation of Conducted Disturbance Measurement (Peak and Average detection) AC port, Line L1



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



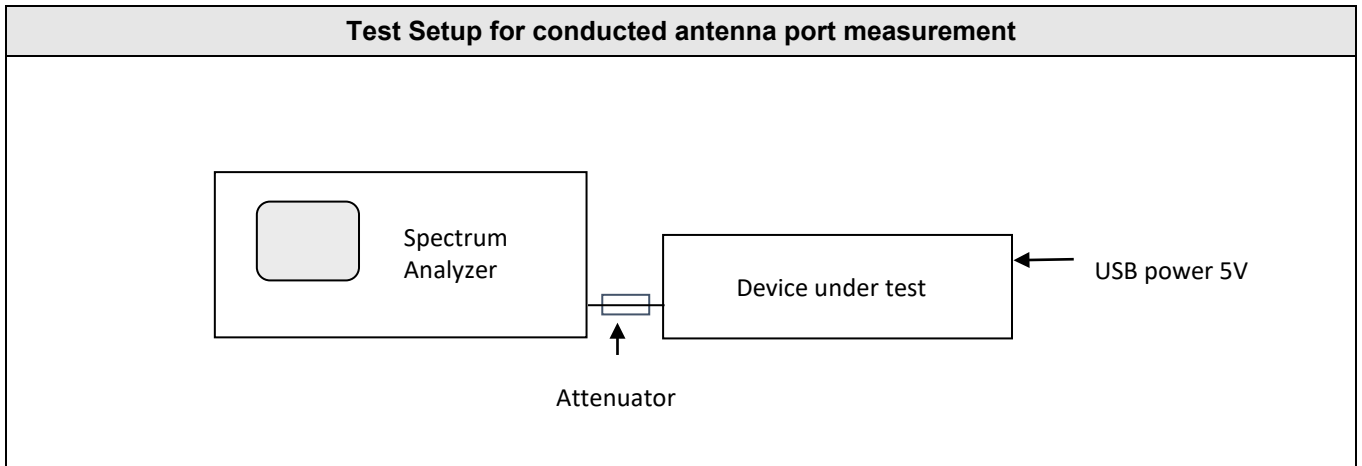
Note : Same result for all transmit modes on all channels.

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

10. Channel Separation

TEST: Hopping channel measurement (Separation)			Verdict
<p>Method: The Equipment under test is connected to the measuring receiver with suitable mean. The SPAN is adapted to see the frequency band of operation. The spectrum analyzer RBW was 100kHz and VBW was 100kHz.</p> <p>The channel separation is measured with the hopping function enable on the EUT.</p> <p>Limits: Minimum separation between channels shall be 25kHz or the two-third 20dB bandwidth, whichever is greater.</p>			Pass
Laboratory Parameters:	Required prior to the test	During the test	
Ambient Temperature	20 to 30 °C	25°C ± 2	
Relative Humidity	25 to 70 %	57% ± 5	
<p>Supplementary information: Test location: SMEE Test date: July 22nd, 2020. Tested by L. CHAPUS</p>			

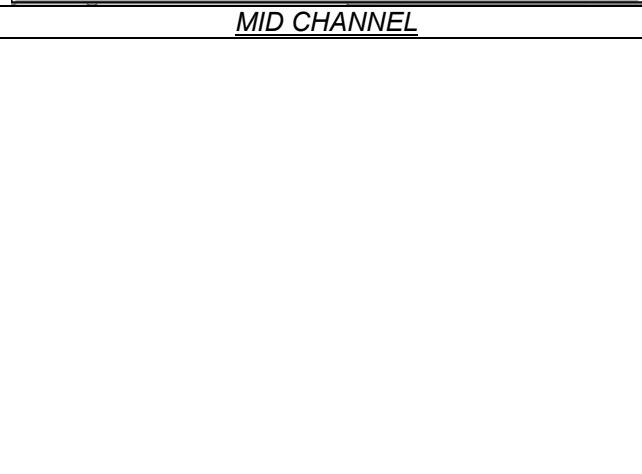
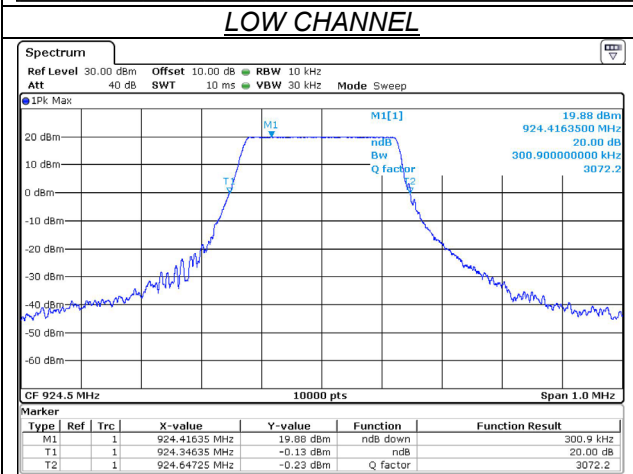
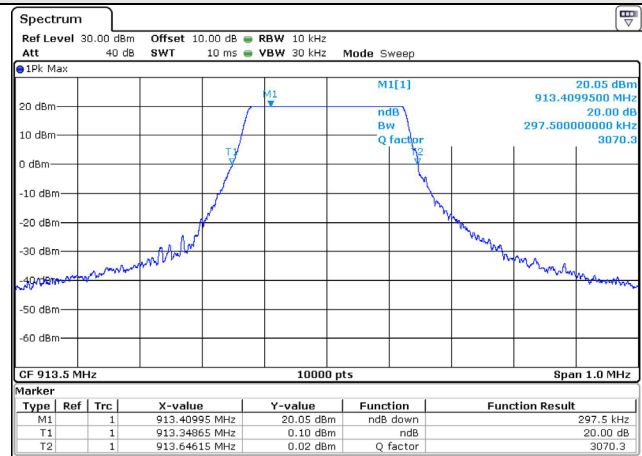
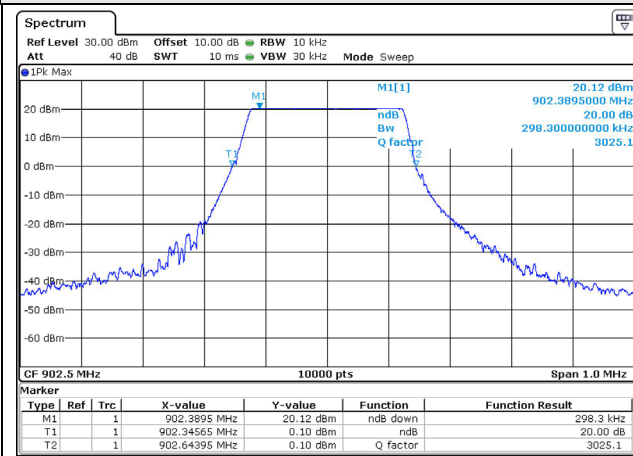
Test Equipment Used					
Description	Manufacturer	Model	Identifier	Cal. Date	Cal. Due
Attenuator	Mini-Circuit	BW-N10W5+	ATT-171-008	2020/6	2020/4
Spectrum analyzer	Rohde&Schwarz	FSV40	ASP-171-004	2019/8	2021/8



Tabulated Results for Hopping Channel Separation

Channel frequency (MHz)	Adjacent channel separation (kHz)	20dB Bandwidth (kHz)	Minimum limit (kHz)	Result
902.5	496.0	298.3	298.3	PASS
913.5		297.5	297.5	PASS
924.5		300.9	300.9	PASS

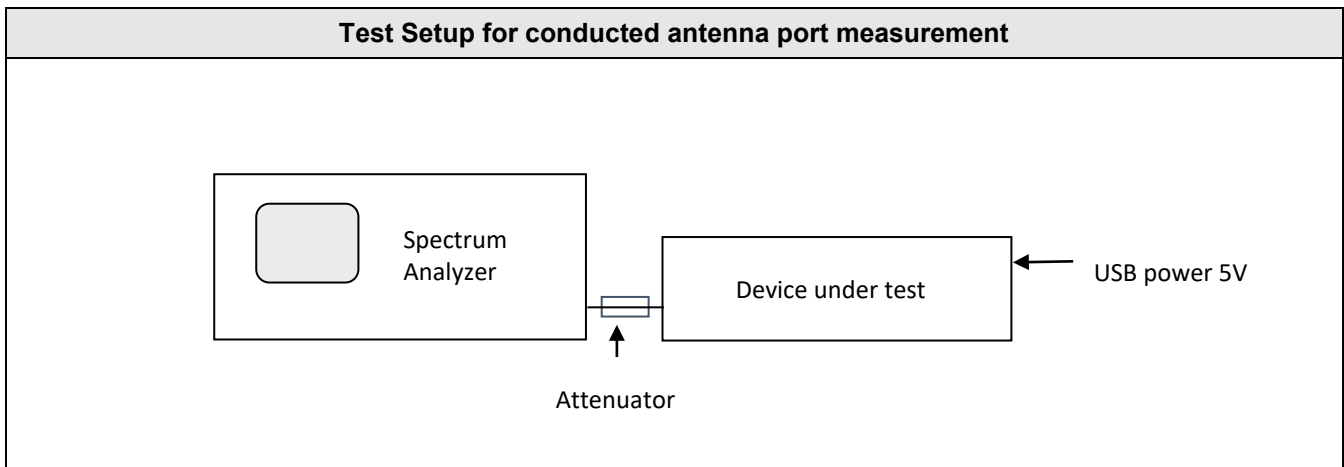
Graphical representation of 20dB Bandwidth



11. Number of hopping channels

TEST: Number of hopping channels			Verdict
Method: The Equipment under test is connected to the measuring receiver with suitable mean. The SPAN is adapted to see the frequency band of operation. The EUT has its hopping function enable. Limits: None for hybrid mode			Pass
Laboratory Parameters:	Required prior to the test	During the test	
Ambient Temperature	20 to 30 °C	25°C ± 2	
Relative Humidity	25 to 70 %	57% ± 5	
Supplementary information: Test location: SMEE Test date: July 22 nd , 2020. Tested by L. CHAPUS			

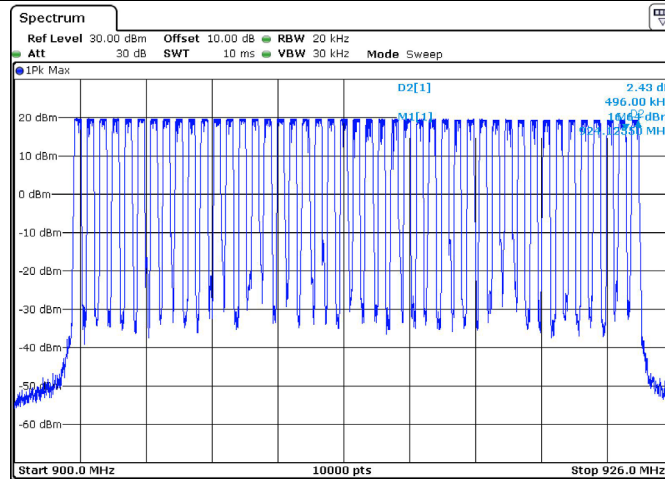
Test Equipment Used					
Description	Manufacturer	Model	Identifier	Cal. Date	Cal. Due
Attenuator	Mini-Circuit	BW-N10W5+	ATT-171-008	2020/6	2020/4
Spectrum analyzer	Rohde&Schwarz	FSV40	ASP-171-004	2019/8	2021/8



Tabulated Results for Number of Hopping Channel

Number of channels	Minimum number of channels	Result
45	25	PASS

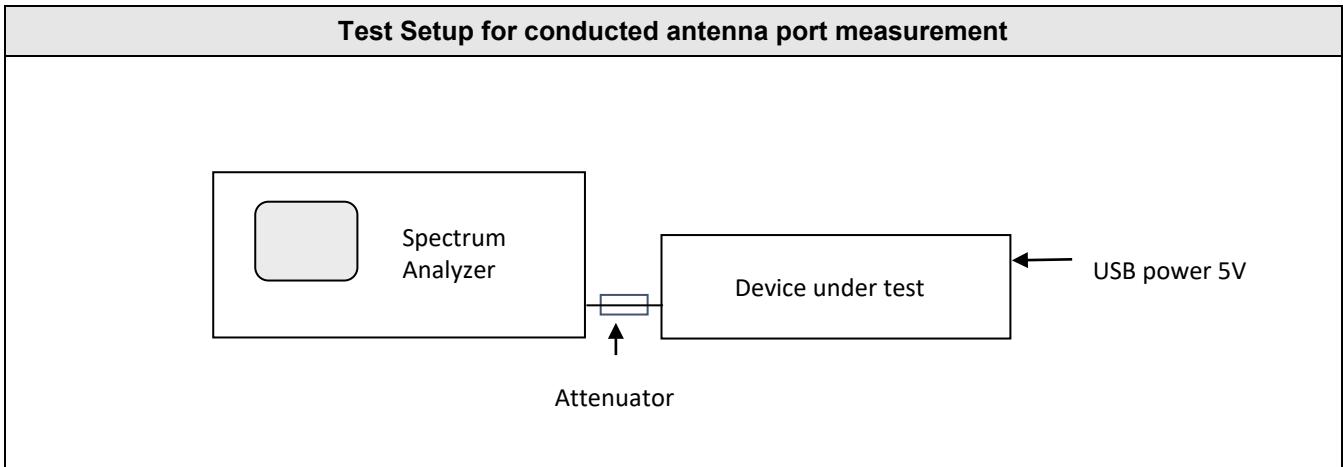
Graphical representation for Number of Hopping Channel



12. Average Time of occupancy

TEST: Time of occupancy		Verdict
<u>Method:</u> The Equipment under test is connected to the measuring receiver with suitable mean. The spectrum analyser is set to zero-span. The EUT has its hopping function enable. <u>Limits:</u> 400ms of transmission by channel on a period 10s. (45 channels used)		Pass
Laboratory Parameters:	Required prior to the test	During the test
Ambient Temperature	20 to 30 °C	25°C ± 2
Relative Humidity	25 to 70 %	57% ± 5
Supplementary information: Test location: SMEE Test date: July 22 nd , 2020. Tested by L. CHAPUS		

Test Equipment Used					
Description	Manufacturer	Model	Identifier	Cal. Date	Cal. Due
Attenuator	Mini-Circuit	BW-N10W5+	ATT-171-008	2020/6	2020/4
Spectrum analyzer	Rohde&Schwarz	FSV40	ASP-171-004	2019/8	2021/8

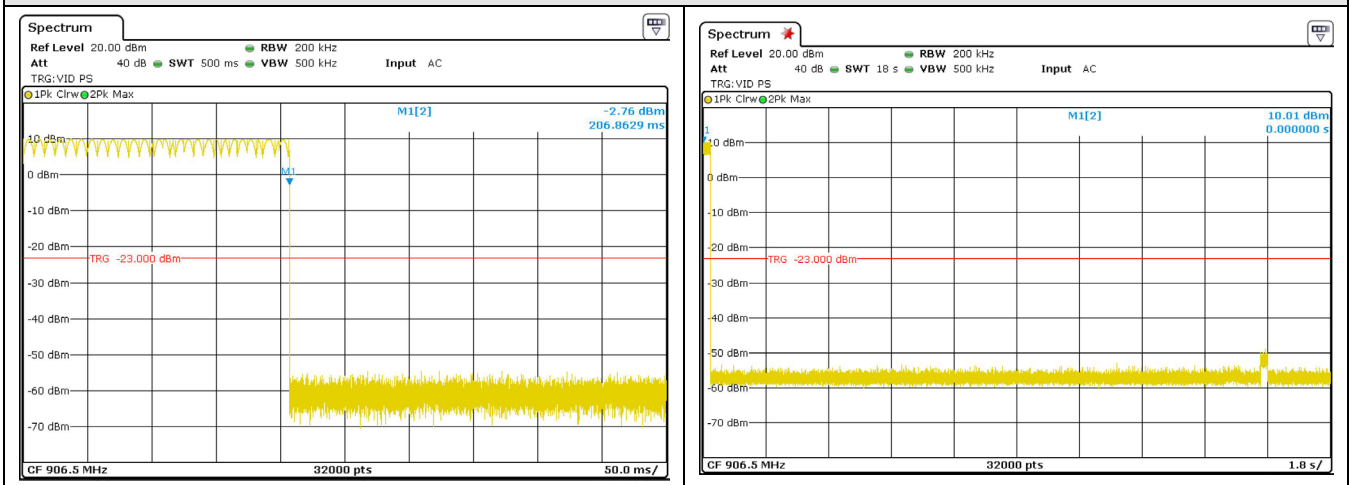


Tabulated Results for Dwell time

Modulation	Number of pulses per 10 period	Length of 1 pulse (ms)	Average Time of occupancy (ms)	Limit (ms)	Result
LORA	1	206.9	206.9	400ms	PASS

Additional information:

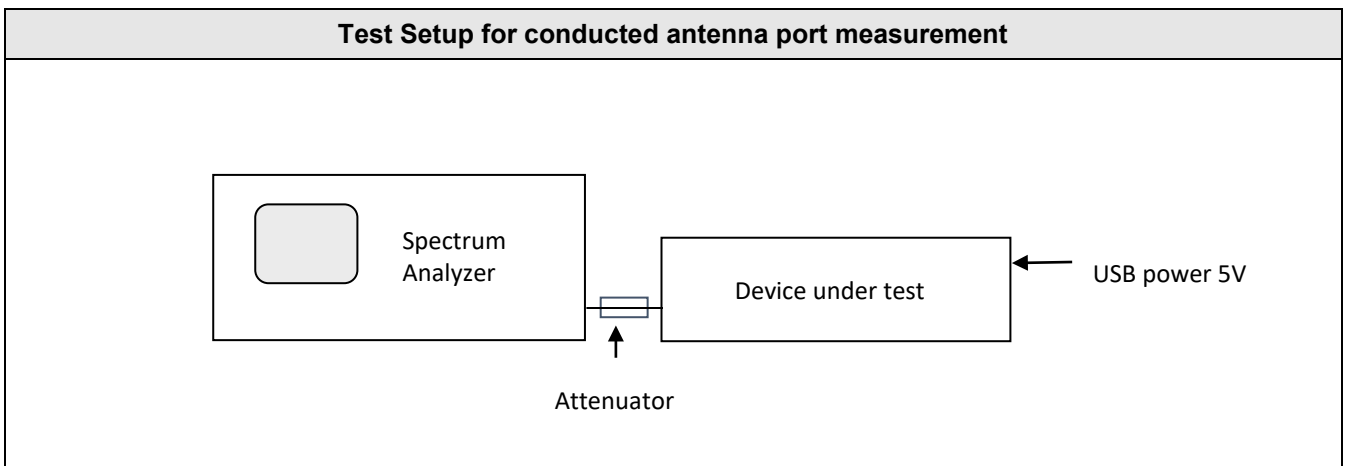
Graphical representation for dwell time



13. Fundamental emission output power

TEST: Maximum conducted output power		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, middle and high channels.</p>		Pass
Laboratory Parameters:	Required prior to the test	During the test
Ambient Temperature	10 to 40 °C	25°C ± 2
Relative Humidity	10 to 90 %	57% ± 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
<p>Supplementary information: Test location: SMEE Test date: July 22nd, 2020. Tested by L. CHAPUS</p>		

Test Equipment Used					
Description	Manufacturer	Model	Identifier	Cal. Date	Cal. Due
Attenuator	Mini-Circuit	BW-N10W5+	ATT-171-008	2020/6	2020/4
Spectrum analyzer	Rohde&Schwarz	FSV40	ASP-171-004	2019/8	2021/8



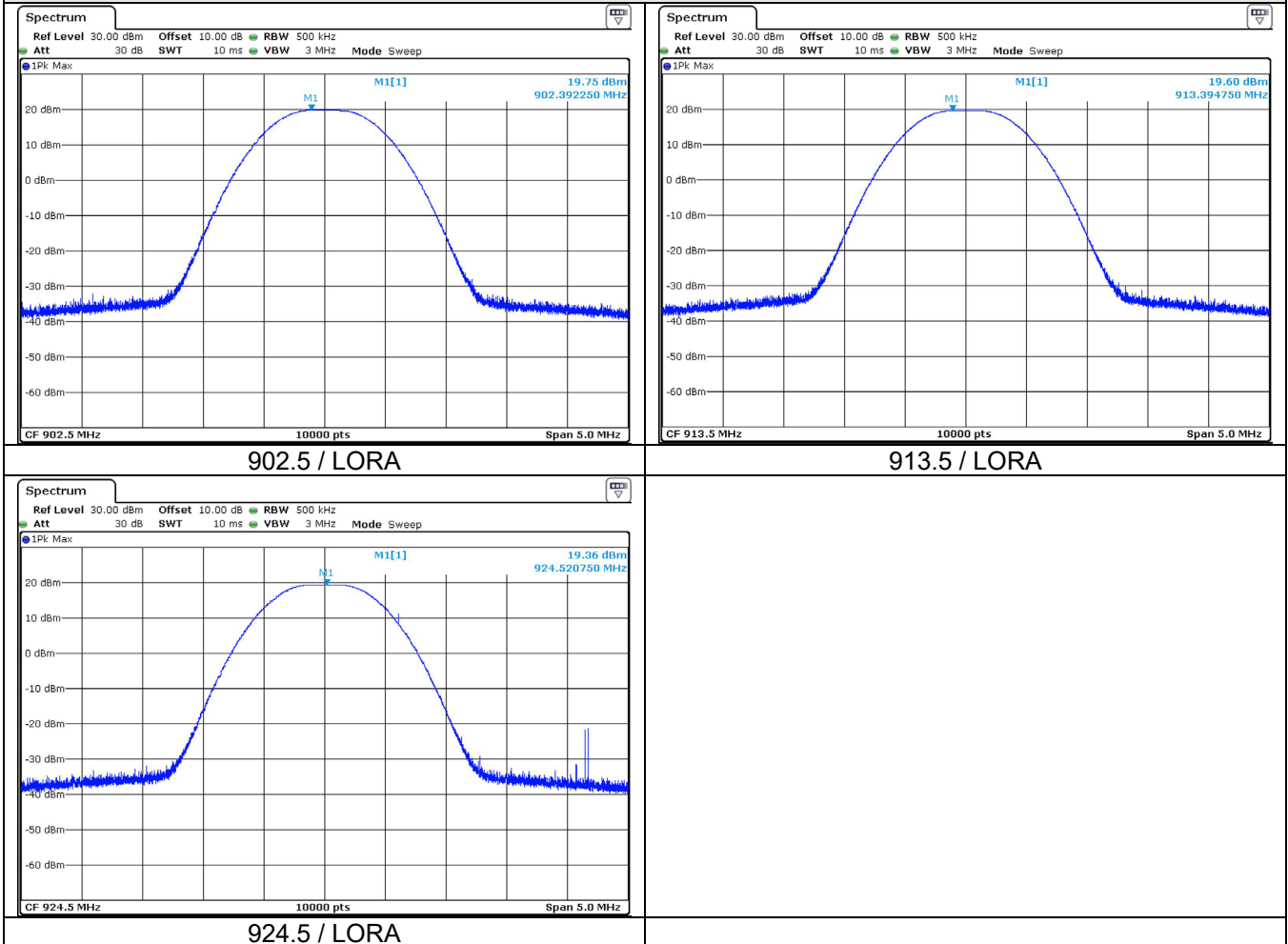
Tabulated Results for Maximum (Peak) output power (Conducted)

FREQ (MHz)	Measured conducted power (dBm)	Duty cycle factor (dB)	Maximum output power (dBm)	Limit (dBm)	Result
902.5	19.8	-	19.8	24.0	Pass
913.5	19.6	-	19.6	24.0	Pass
914.5	19.4	-	19.4	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	19.8	2.0	21.8	30.0	Pass
913.5	19.6	2.0	21.6	30.0	Pass
914.5	19.4	2.0	19.4	30.0	Pass
RESULT:		PASS			

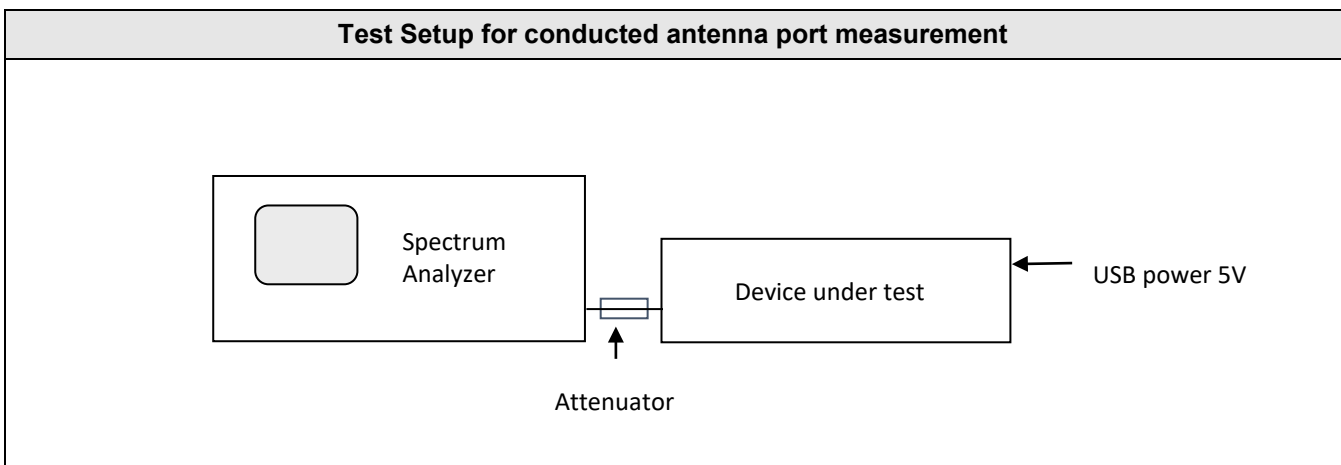
Graphical representation of Conducted output power



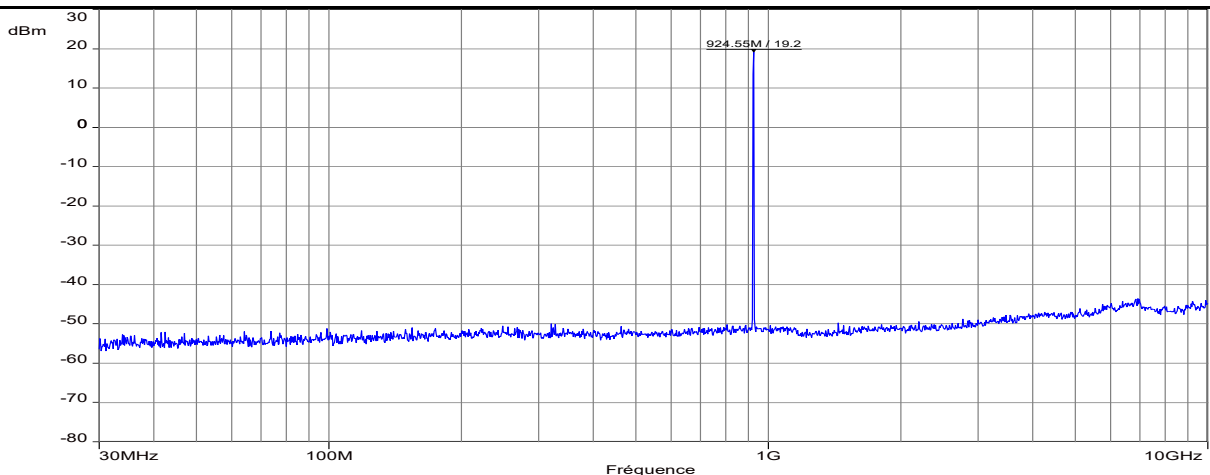
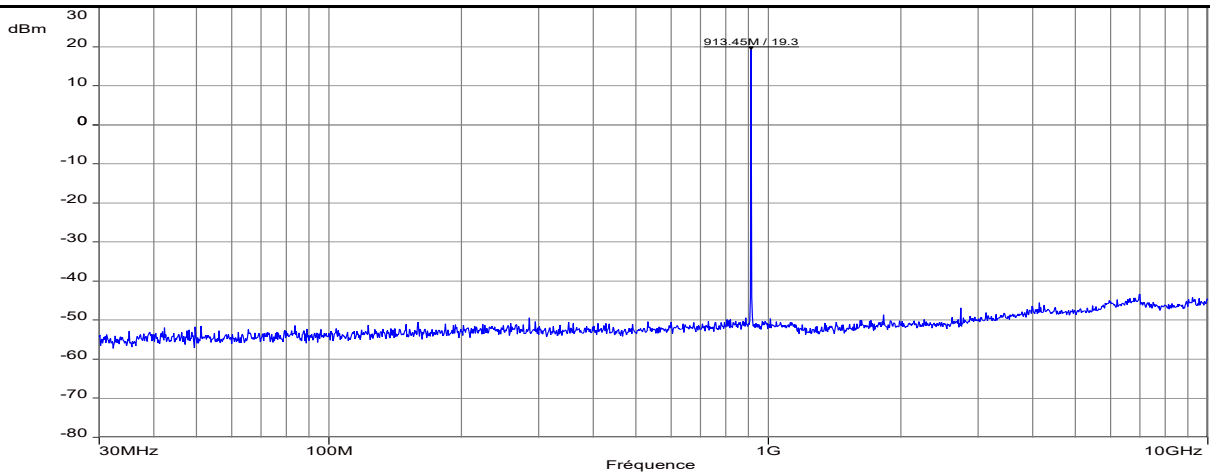
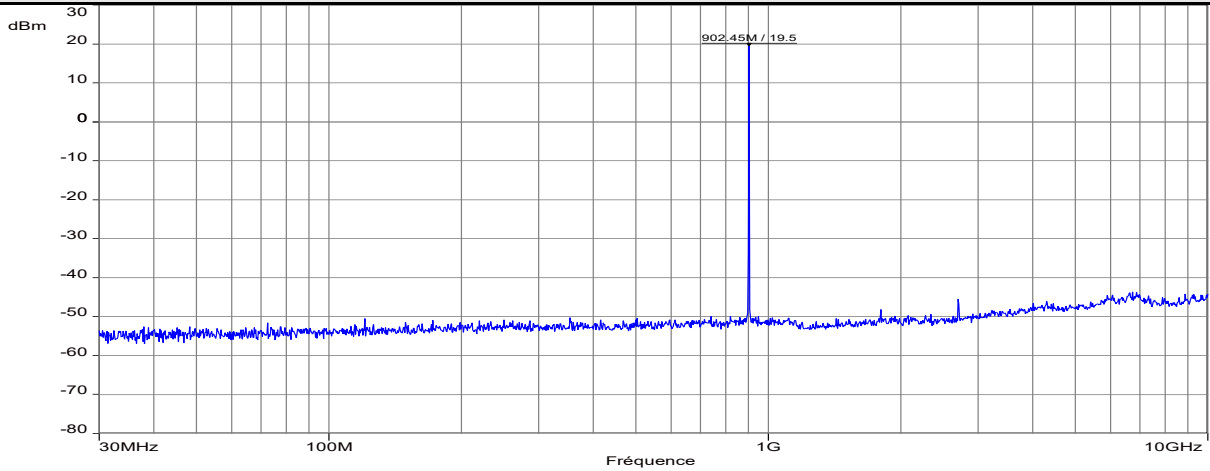
14. Unwanted Spurious Emissions (Conducted emissions)

TEST: Conducted Spurious emissions			Verdict
<p>Method: 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.</p> <p>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	20 to 30 °C	25°C ± 2	
Relative Humidity	25 to 70 %	57% ± 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: July 22nd, 2020. Tested by L. CHAPUS</p>			

Test Equipment Used					
Description	Manufacturer	Model	Identifier	Cal. Date	Cal. Due
Attenuator	Mini-Circuit	BW-N10W5+	ATT-171-008	2020/6	2020/4
Spectrum analyzer	Rohde&Schwarz	FSV40	ASP-171-004	2019/8	2021/8



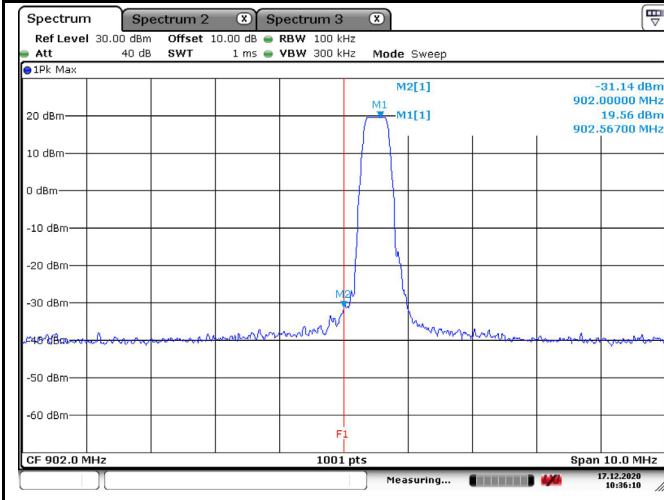
Graphical representation of Conducted Spurious emissions (LORA mode / Low, Mid and High channels)



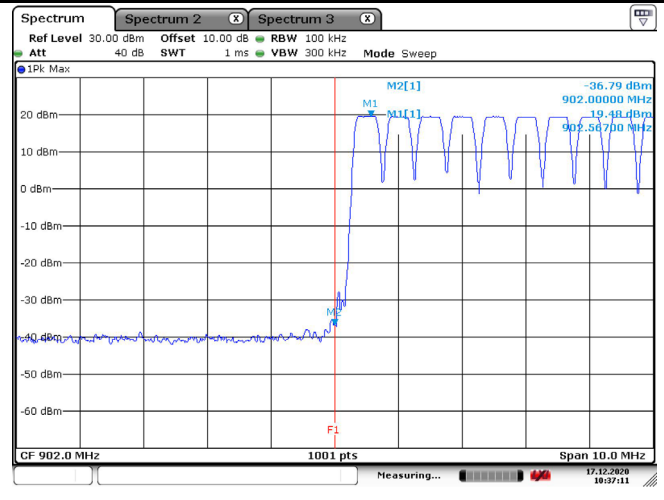
Frequency band investigated:	30MHz-10GHz
Unit :	dBm
RBW :	100kHz (Frequency step 50kHz)
Measurement detector:	Peak
Limit:	-0.8 dBm

Graphical representation of Band-edge compliance (LOW)

LORA / Hopping Disable



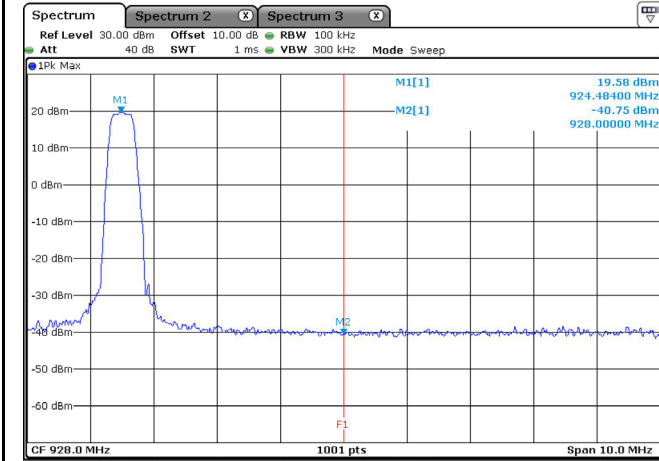
LORA / Hopping Enabled



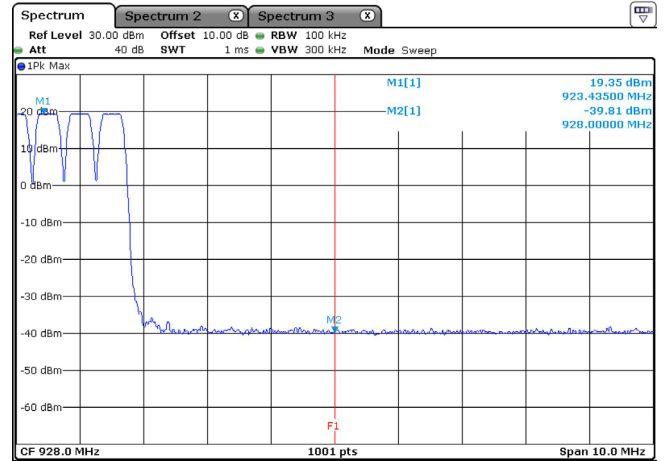
Unit :	dBm
RBW :	100kHz
Measurement detector:	Peak
Limit:	-0.8 dBm
Note:	F1 is 902MHz

Graphical representation of Band-edge compliance (High)

LORA / Hopping Disable



LORA / Hopping Enabled



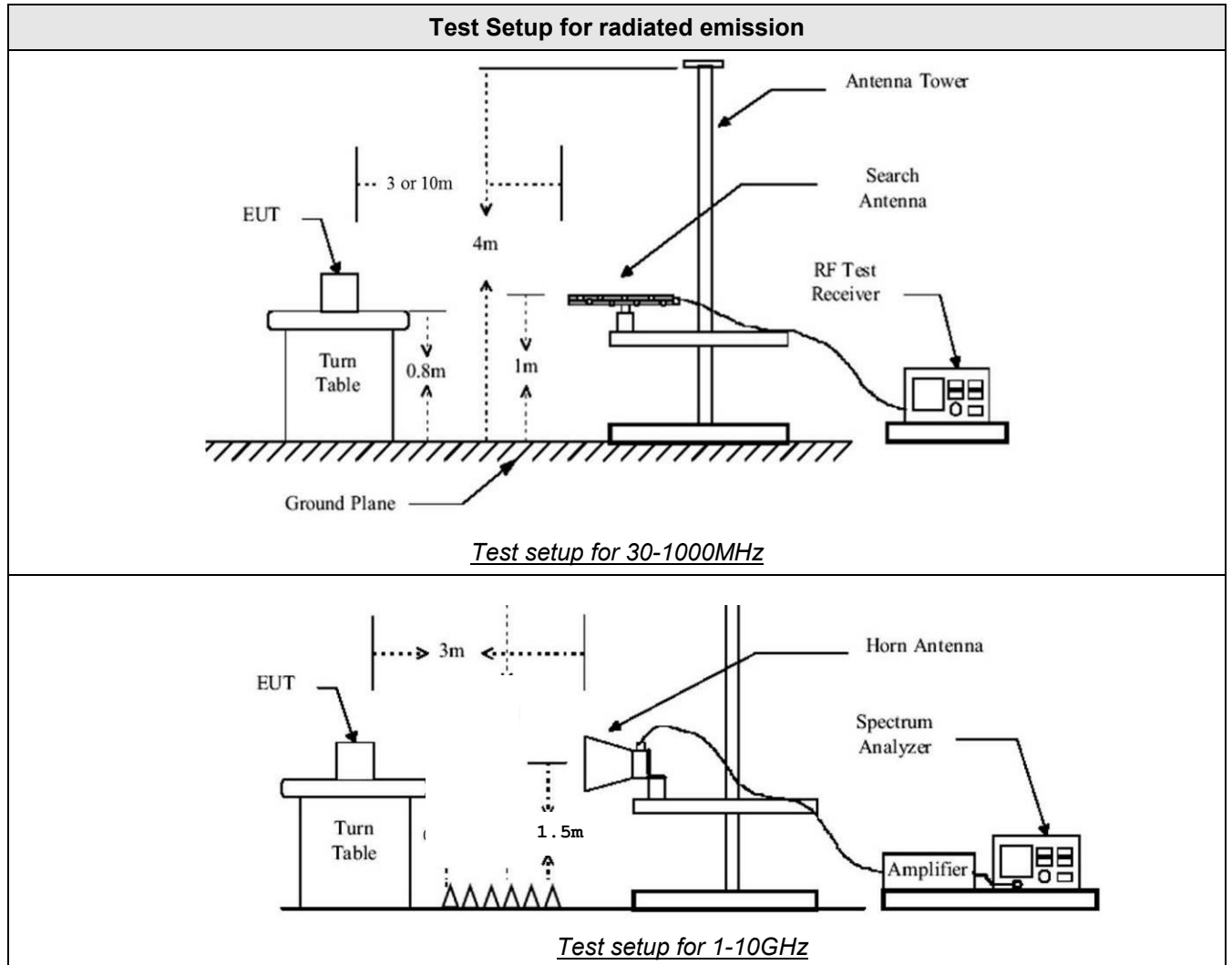
Unit :	dBm
RBW :	100kHz
Measurement detector:	Peak
Limit:	-0.8 dBm
Note:	F1 is 902MHz

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

TEST: Unwanted emissions in Non-Restricted Frequency Bands			Verdict
<p>Method: Measurements were performed on a 3-meter Open Area Test Site (OATS) for frequency below 1GHz. The EUT was rotated 360° about its azimuth with the receive antenna located at various heights in horizontal and vertical polarities. Final measurements (Peak) were then performed by rotating the EUT on 360° and adjusting the receive antenna height from 1 to 4 m</p> <p>For frequency above 1GHz, final measurements were made at 3m in a Full Anechoic Chamber (FAC) that complies with ANSI C63.10. 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 in horizontal and vertical polarities.</p> <p>Three orthogonal axis measurements on EUT are performed to obtain the maximum peak field strength, with 60° rotation on each axis. (Clause 6.6.5 of ANSI C63.10).</p> <p>A pre-scan frequency identification of the EUT has been performed in full anechoic chamber. The measured radiated field of the EUT is performed (or corrected) at 3-meters of distance. Antenna is 1.25-meters high. The pre-characterization graphs are obtained in PEAK detection with 360° continuous rotation of the device under test.</p>			Pass
Laboratory Parameters:	Required prior to the test	During the test	
Ambient Temperature	20 to 30 °C	25°C ± 2	
Relative Humidity	25 to 70 %	57% ± 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: July 22 nd , 2020. Tested by L. CHAPUS			

Test Equipment Used					
Description	Manufacturer	Model	Identifier	Cal. Date	Cal. Due
Log-periodic antenna	EMCO	3146	ANT-191-019	2019/6	2021/6
Biconnic antenna	COM-POWER	AB- 900	ANT-101-003	2019/6	2021/6
Loop antenna	EMCO	6502	ANT-101-009	2019/8	2021/8
BiConiLog antenna	EMCO	3142B	ANT-101-010	2019/8	2021/8
Horn antenna	ETS-LINDGREN	3115	ANT-141-013	2018/10	2021/10
Spectrum analyzer	Rohde&Schwarz	FSV40	ASP-171-004	2019/8	2021/8
RF cable	Div	OATS/25m	CAB-101-017	2020/4	2021/4
RF cable	Pasternack RF	PE302-120	CAB-131-024	2020/4	2021/4
RF cable	HUBER+SUHNER	RG214U	CAB-141-026	2020/4	2021/4
RF cable	HUBER+SUHNER	RG214U	CAB-141-029	2020/4	2021/4
RF cable	HUBER+SUHNER	SF104	CAB-141-030	2020/4	2021/4

Test Equipment Used					
Description	Manufacturer	Model	Identifier	Cal. Date	Cal. Due
Pre-amplifier	Pasternack RF	PE1524	PRE-101-002	2020/4	2021/4
Anechoic chamber	COMTEST	214263	CAG-141-001	2020/6	2023/6
OATS	Div	10m	SIT-101-001	2020/7	2023/7
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	ESRP	REC-151-002	2019/9	2021/9
EMC Software	NEXIO	BAT EMC V3.18	SOF-101-001	-	-



Tabulated Results for Peak Output Radiated level	
FREQ (MHz)	Field Strength 3m (dB μ V/m)
902.5	118.1
913.5	118.4
924.5	118.3
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 98.1 dBμV/m Peak for out-of-band frequencies in Non-Restricted bands (with a 100kHz RBW on the spectrum analyser)

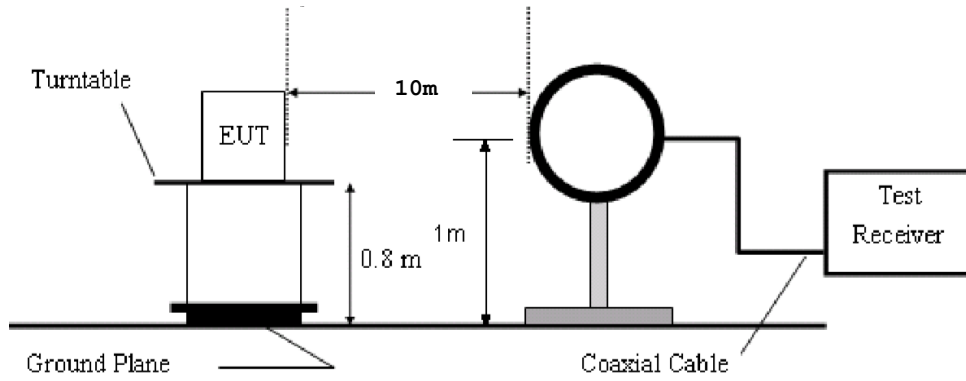
Tabulated Results for Unwanted emissions in Non-Restricted bands				
FREQ (MHz)	Field Strength 3m (dB μ V/m)	Limit (dB μ V/m)	Margin (dB μ V/m)	Result (dB μ V/m)
Levels are at least 10 dB below the -20dBc limit See pre-scan graphs in chapter 17.				
RBW:	100kHz			
Measurement distance:	3m			
Limit:	15.247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

16. Unwanted emissions in Restricted Frequency bands

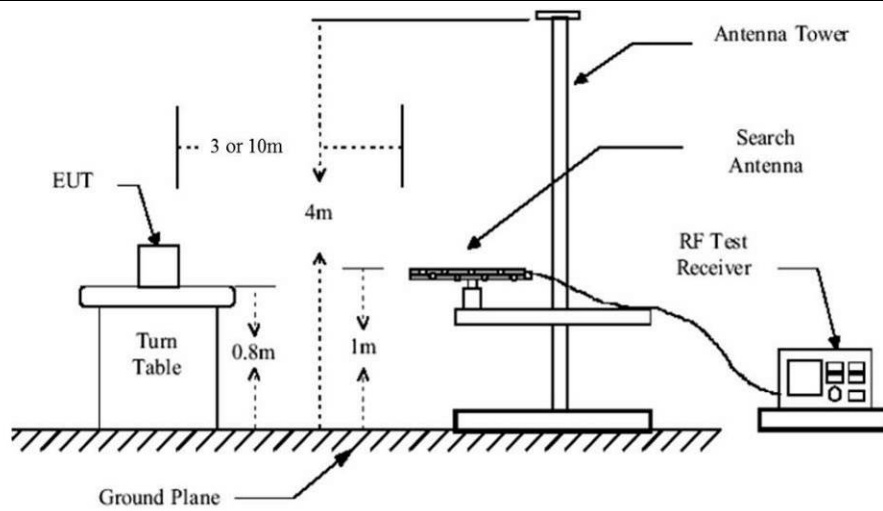
TEST: Unwanted emissions into Restricted Frequency Bands		Verdict
<p>Method: Measurements were performed on a 10 or 3-meter Open Area Test Site (OATS) for frequency below 1GHz. The EUT was rotated 360° about its azimuth with the receive antenna located at various heights in horizontal and vertical polarities. Final measurements (Peak) were then performed by rotating the EUT on 360° and adjusting the receive antenna height from 1 to 4 m for frequency between 30MHz to 1GHz. For frequency above 1GHz, final measurements were made at 3m in a Full Anechoic Chamber (FAC) that complies with ANSI C63.10. 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 in horizontal and vertical polarities.</p> <p>Three orthogonal axis measurements on EUT are performed to obtain the maximum peak field strength, with 60° rotation on each axis.(Clause 6.6.5 of ANSI C63.10).</p> <p>A pre-scan frequency identification of the EUT has been performed in full anechoic chamber. The measured radiated field of the EUT is performed (or corrected) at 3-meters of distance. Antenna is 1.25-meters high. The pre-characterization graphs are obtained in PEAK detection with 360° continuous rotation of the device under test.</p>		Pass
Laboratory Parameters:	Required prior to the test	During the test
Ambient Temperature	20 to 30 °C	25°C ± 2
Relative Humidity	25 to 70 %	57% ± 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: July 24 th , 2020. Tested by L. CHAPUS		

Test Equipment Used					
Description	Manufacturer	Model	Identifier	Cal. Date	Cal. Due
Log-periodic antenna	EMCO	3146	ANT-191-019	2019/6	2021/6
Biconnic antenna	COM-POWER	AB- 900	ANT-101-003	2019/6	2021/6
Loop antenna	EMCO	6502	ANT-101-009	2019/8	2021/8
BiConiLog antenna	EMCO	3142B	ANT-101-010	2019/8	2021/8
Horn antenna	ETS-LINDGREN	3115	ANT-141-013	2018/10	2021/10
Spectrum analyzer	Rohde&Schwarz	FSV40	ASP-171-004	2019/8	2021/8
RF cable	Div	OATS/25m	CAB-101-017	2020/4	2021/4
RF cable	Pasternack RF	PE302-120	CAB-131-024	2020/4	2021/4
RF cable	HUBER+SUHNER	RG214U	CAB-141-026	2020/4	2021/4
RF cable	HUBER+SUHNER	RG214U	CAB-141-029	2020/4	2021/4
RF cable	HUBER+SUHNER	SF104	CAB-141-030	2020/4	2021/4
Pre-amplifier	Pasternack RF	PE1524	PRE-101-002	2020/4	2021/4
Anechoic chamber	COMTEST	214263	CAG-141-001	2020/6	2023/6
OATS	Div	10m	SIT-101-001	2020/7	2023/7
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	ESRP	REC-151-002	2019/9	2021/9
EMC Software	NEXIO	BAT EMC V3.18	SOF-101-001	-	-

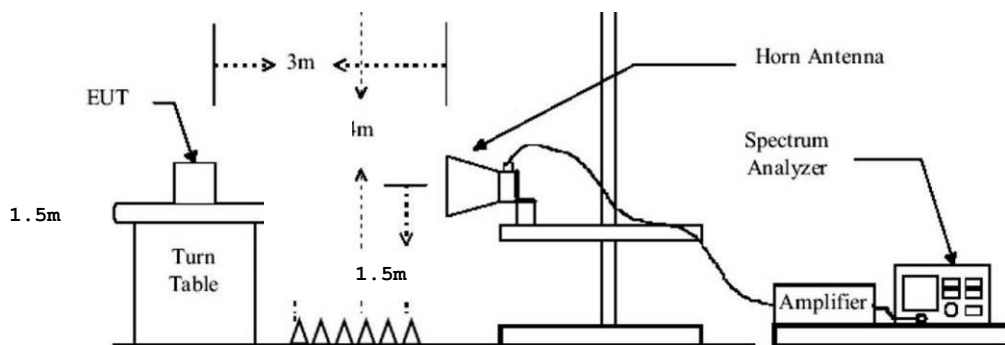
Test Setup for radiated emission



Test setup for 9k-30MHz



Test setup for 30-1000MHz



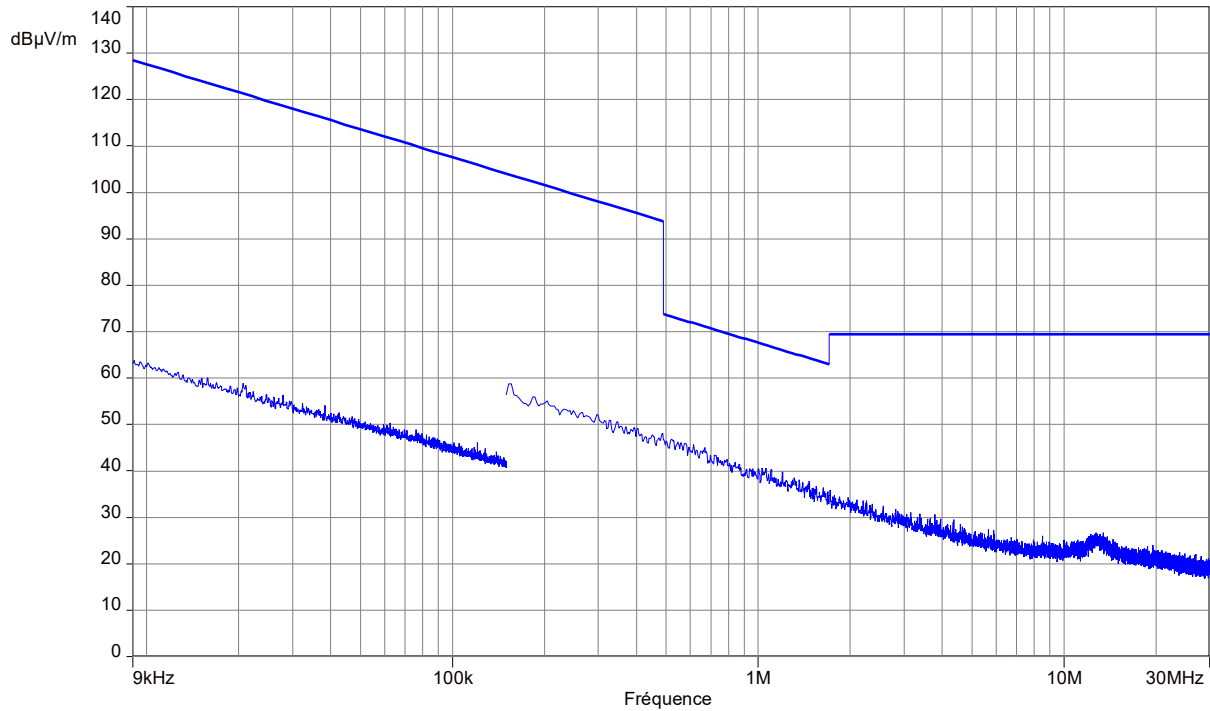
Test setup for 1-10GHz

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.						
Frequency band investigated:		9kHz-30MHz				
RBW:		200Hz (9kHz-150kHz) 9kHz (150kHz-30MHz)				
Measurement distance:		10m				
Limit:		FCC Part 15.205 - 15.209 / RSS-GEN				
Final measurement detector:		Peak / Quasi-Peak / Average				
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	Total factor	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.										
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 (MHz)	Field Strength 3m (dBµV/m)	Detector	Limit (dBµV/m)	Margin (dBµV/m)	Result
Low channel					
2707.5	58.6	Pk	74	-15.4	Pass
2707.5	53.5	Avg	54	-0.5	Pass
4512.5	50.3	Pk	74	-23.7	Pass
4512.5	45.3	Avg	54	-8.7	Pass
7220	53.6	Pk	74	-20.4	Pass
7220	49.8	Avg	54	-4.2	Pass
8122.5	56.0	Pk	74	-18.0	Pass
8122.5	51.2	Avg	54	-2.8	Pass
Mid channel					
2740.5	57.1	Pk	74	-16.9	Pass
2740.5	52.9	Avg	54	-1.1	Pass
4567.5	49.2	Pk	74	-24.8	Pass
4567.5	44.2	Avg	54	-9.8	Pass
7308	54.0	Pk	74	-20.0	Pass
7308	49.9	Avg	54	-4.1	Pass
8221.5	55.5	Pk	74	-18.5	Pass
8221.5	51.0	Avg	54	-3.0	Pass
High channel					
2773.5	57.9	Pk	74	-16.1	Pass
2773.5	53	Avg	54	-1.0	Pass
4622.5	50.1	Pk	74	-23.9	Pass
4622.5	45.6	Avg	54	-8.4	Pass
7396	53.8	Pk	74	-20.2	Pass
7396	49.8	Avg	54	-4.2	Pass
8320.5	56.2	Pk	74	-17.8	Pass
8320.5	51.3	Avg	54	-2.7	Pass
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			
Notes:		<p>(1): 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 RA = Receiver Amplitude AF = Antenna Factor CF = Cable Factor AG = Amplifier Gain Total factor (dB) is $AF + CF - AG$ Margin value = Emission level - Limit value</p> <p>(2): All frequencies not specified have margin < -10dB (for peak and average detector)</p>			

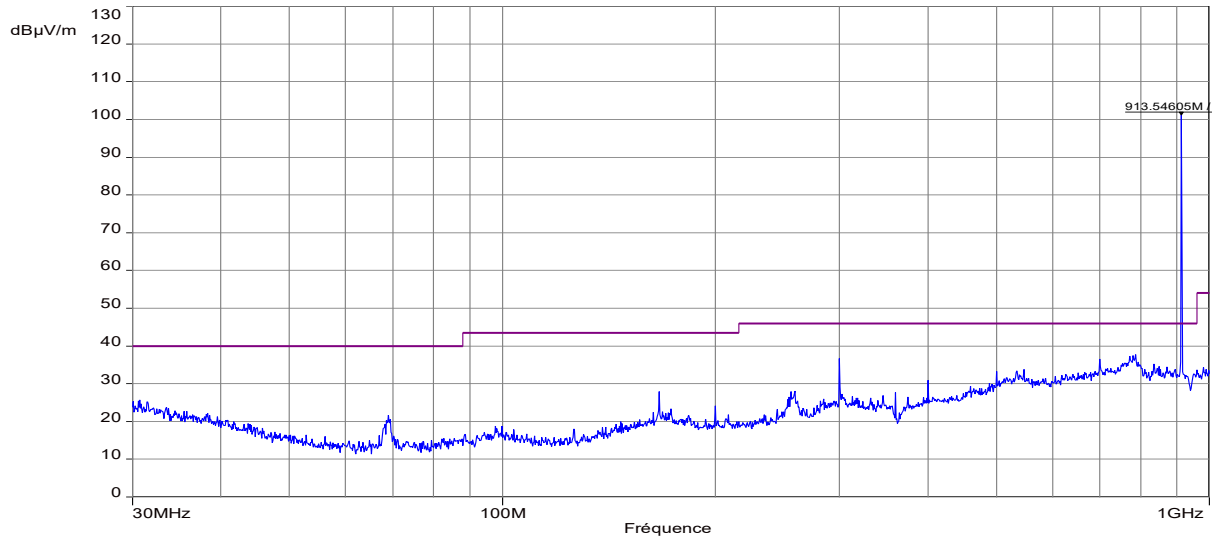
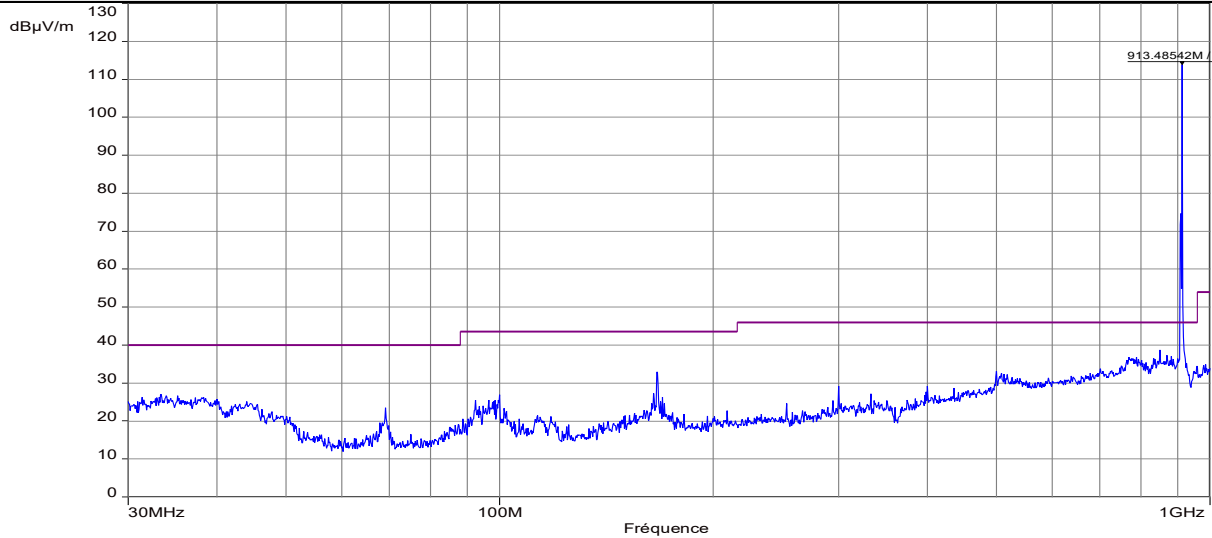
Graphical representation of Radiated Disturbance Measurement (Peak detection, Anechoic chamber pre-scan, 9kHz-30MHz / 3m / Parallel & Perpendicular antenna position / Transmit mode)



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 / Horizontal & Vertical)



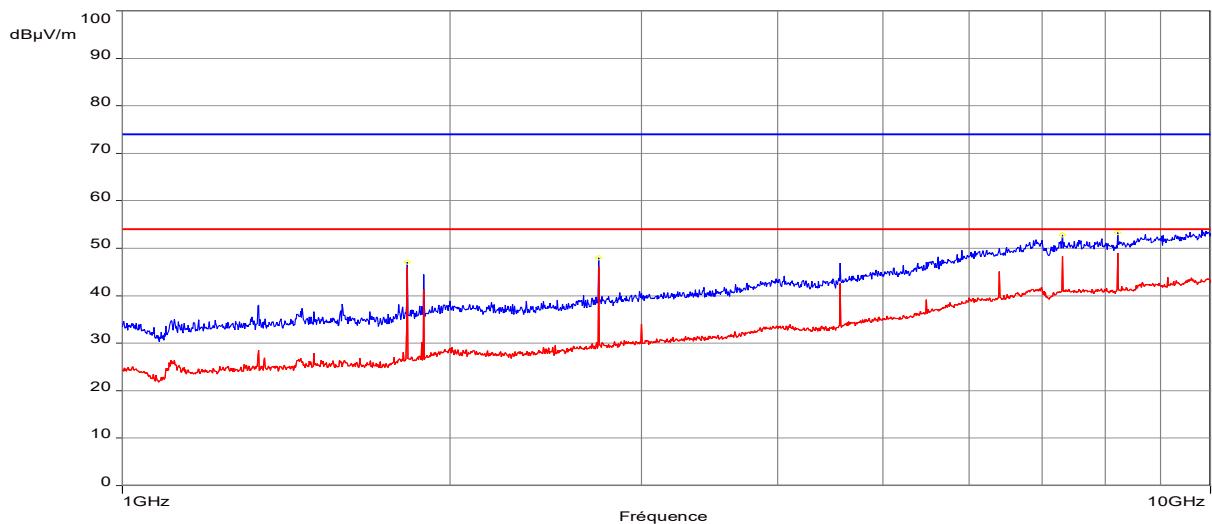
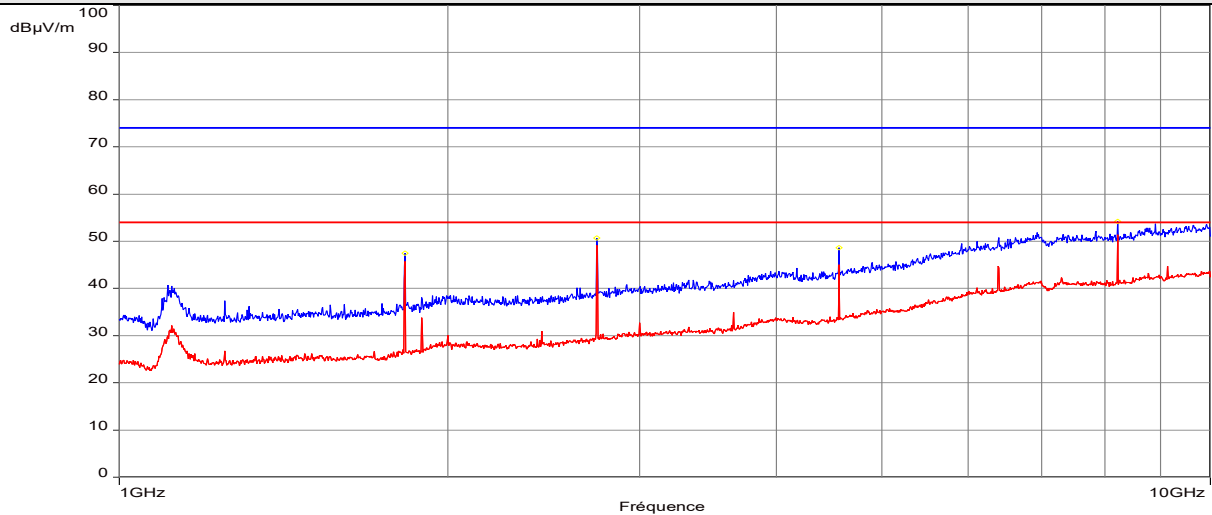
Note: Pre-scan graph only for identification purpose.
Pre-scan performed on the mid channel of the whole frequency band.

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	-	-	-	-	Only PC's frequency

Graphical representation of Radiated Disturbance Measurement (Anechoic chamber pre-scan, 1GHz-10GHz / 3m / Horizontal & Vertical)



Note: Pre-scan graph only for identification purpose.

Pre-scan performed on the mid channel of the whole frequency band. Worst case position shown.

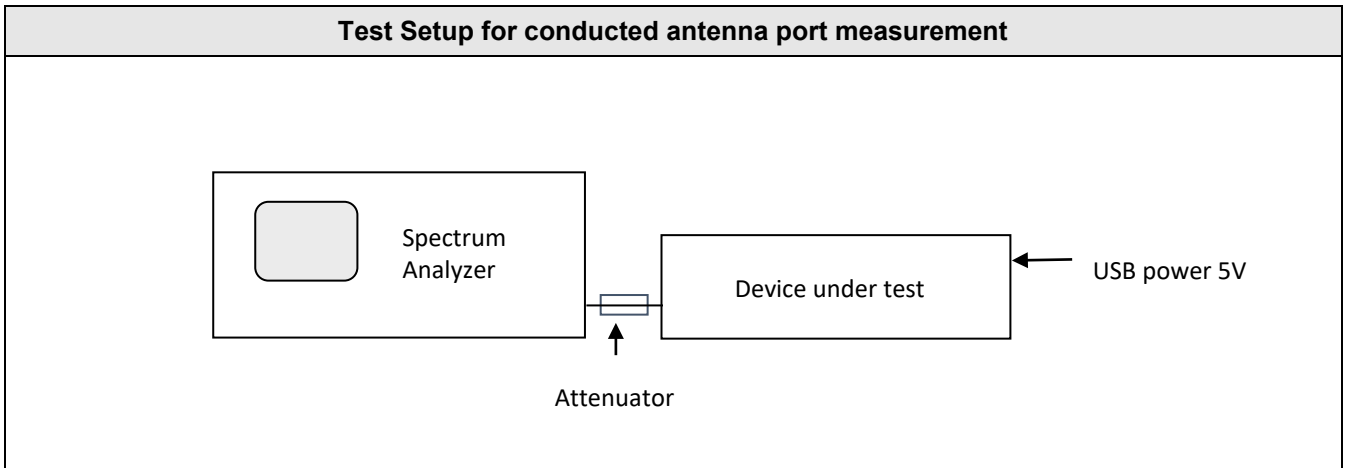
----- : Peak measure	----- : Average measure
Frequency band investigated:	1GHz-10GHz
Unit :	dBµV/m
RBW :	1MHz
Antenna polarization :	Horizontal & Vertical
Limit:	FCC 15.247 / RSS-247
Measurement detector:	Peak / Average

PEAK LIST FROM PRE-SCAN					
Frequency (MHz)	Peak Level (dB μ V/m)	Angle (°)	Average Limit (dB μ V/m)	Polarization	Comments
1826.9	47.44	116.4	54.0	H	-
2740.43	50.65	116.4	54.0	H	-
4567.77	48.6	339.2	54.0	H	-
8221.32	54.24	153.3	54.0	H	-
1827.18	47.11	133.4	54.0	V	-
2740.71	47.99	151.9	54.0	V	-
7307.79	52.81	96.7	54.0	V	-
8221.6	53.3	247.4	54.0	V	-

17. Occupied bandwidth (99%)

TEST: Occupied bandwidth (99%) / RSS-GEN		Verdict								
<p><u>Method:</u> The setup is in an anechoic chamber. The spectrum analyzer is connected to the measuring antenna. The RBW is set in the range of 1% to 5% of the occupied bandwidth, with VBW ≥ 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								
<p>Laboratory Parameters:</p> <table border="1" style="width: 100%; border-collapse: collapse;"> <thead> <tr> <th style="width: 30%;"></th> <th style="width: 35%;">Required prior to the test</th> <th style="width: 35%;">During the test</th> </tr> </thead> <tbody> <tr> <td>Ambient Temperature</td> <td style="text-align: center;">20 to 30 °C</td> <td style="text-align: center;">25°C ± 2</td> </tr> <tr> <td>Relative Humidity</td> <td style="text-align: center;">25 to 70 %</td> <td style="text-align: center;">57% ± 5</td> </tr> </tbody> </table>				Required prior to the test	During the test	Ambient Temperature	20 to 30 °C	25°C ± 2	Relative Humidity	25 to 70 %
	Required prior to the test	During the test								
Ambient Temperature	20 to 30 °C	25°C ± 2								
Relative Humidity	25 to 70 %	57% ± 5								
<p>Supplementary information: Test location: SMEE Test date: July 22nd, 2020. Tested by L. CHAPUS</p>										

Test Equipment Used					
Description	Manufacturer	Model	Identifier	Cal. Date	Cal. Due
Attenuator	Mini-Circuit	BW-N10W5+	ATT-171-008	2020/6	2020/4
Spectrum analyzer	Rohde&Schwarz	FSV40	ASP-171-004	2019/8	2021/8



Tabulated Results for Occupied Bandwidth

Frequency (MHz)	99% Occupied Bandwidth (kHz)
902.5	263.674
913.5	262.274
924.5	265.473

Graphical representation of Occupied Bandwidth

