

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

<b>Matériel testé :</b> <i>Equipment under test:</i>	<b>SORHEA / SORADIO</b> <i>(Trademark / Marketing name or product reference)</i> <i>(902-928MHz radio communication link)</i>
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**Demandeur de certification :** **SORHEA**  
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69120 Vaulx en Velin - France

**Client :** **SORHEA**  
*Customer:* M. Aymeric Caradec  
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**Numéro d'affaire :** 13647  
*Work number :*

**Référence de la proposition :** 062020-24121  
*Proposal number:*

**Date de l'essai :** Du 26 janvier au 19 avril 2021  
*Date of test:* January 26<sup>th</sup> to April 19<sup>th</sup>, 2021

**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, 385 Rue René Rambaud  
*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	April 23 <sup>rd</sup> , 2021	Initial Edition	Laurent CHAPUS	Regis ANCEL
2	June 23 <sup>rd</sup> , 2021	TCB review ATCB027055 file	<i>Technical Manager</i>	<i>General Manager</i>

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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 (April 2021)	X	Telecommunication – Federal Communication Commission – Radio frequency devices, Sections 15.109 / 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

TEST	Paragraph number FCC Part 15 / ISED RSS	Spec. FCC Part 15 / ISED RSS	RESULTS  (comments)
Conducted emissions test	15.207 (a) RSS-Gen § 8.8	Table 15.207 (a) Table 4 / RSS-Gen	<b>PASS</b>
6dB Bandwidth	15.247 (a) (2) RSS-247 § 5.2 (a)	At least 500kHz	<b>PASS</b>
Maximum Peak Output Power	15.247 (b) (3) & (4) RSS-247 § 5.4 (d)	1W max / 30dBm (Conducted) 4W max / 36dBm (EIRP)	<b>PASS</b>
Maximum Power Spectral Density	15.247 (e) RSS-247 § 5.2 (b)	8dBm in a 3kHz band segment	<b>PASS</b>
Unwanted emissions into Non Restricted Frequency Bands	15.247 (d) RSS-247 § 5.5	-20dBc in any 100kHz outside frequency band.	<b>PASS</b>
Unwanted emissions into Restricted Frequency Bands	15.209 (a) / 15.247 (d) / 15.205 (a) RSS-GEN §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	<b>PASS</b>
Occupied Bandwidth	RSS-GEN § 6.7	BW at 99%	<b>PASS</b>

- General conclusion:**

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

### 3. Equipment Under Test (EUT)

Nom /  
Identification

**SORHEA / SORADIO**  
(Trademark / Marketing name or product reference)

Sn: 0003611

FCC ID: QVA-SORADIO  
IC: 11664A-SORADIO  
Model / HVIN: SORADIO

Alimentation /  
Power supply: 12V DC from external power supply

Auxiliaires /  
Auxiliaries: Laptop ASUS, model F200M for equipment programming only.

Entrées-Sorties /  
Input / Output

	Câbles pour essai / Cables for test	Blindé / Shielded	Prévu pour >3m / Intended for >3m
Power input (12V DC)	1.5m (2 wires)	No	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 at 906/915/924MHz

Programme de test /  
Test program

Use only for board programming:  
ProgramLoaderJLINK.exe

Logiciel embarqué de test /  
Test firmware

LORA Mode: EMISSION\_PERMANENTE\_LORA\_9xxMhz\_BW500.hex (xx is channel 906 to 924)  
(14dBm output power, SF9 and LORA modulation with 500kHz bandwidth)

Informations supplémentaires /  
Additional informations

Declaration of the applicant:  
- Type of technology: Proprietary RF protocol in DTS mode  
- Frequency transmission band: 906 to 924MHz.  
- 19 channels used spaced by 1MHz  
- Rated conducted output power: 14dBm  
- Modulation: LORA with 500kHz nominal BW / SF9  
- Equipment intended for use as a mobile station  
- Equipment designed for continuous operation  
- Antenna type: PCB design (PIFA), max antenna gain is 0dBi

Dimensions de l'EST /  
Dimensions of EUT

65mm x 75 x 13 (PCB)

### 4. Test conditions

Power supply voltage:

Equipment under test: 12V DC

Auxiliaries: 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 (30-200MHz, SAC 3m)	± 5.6dB
Radiated emission test (200-1000MHz, SAC 3m)	± 5.6dB
Radiated emission test (1-18GHz, FAC 3m)	± 5.6dB
Radiated emission test (18-40GHz, FAC 3m)	± 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

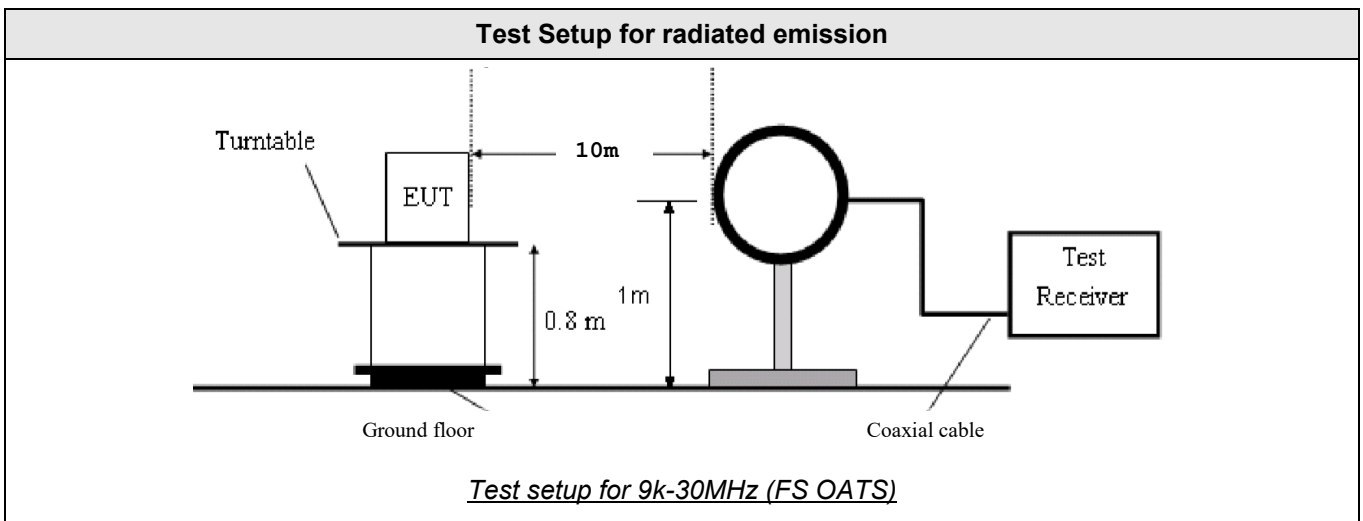
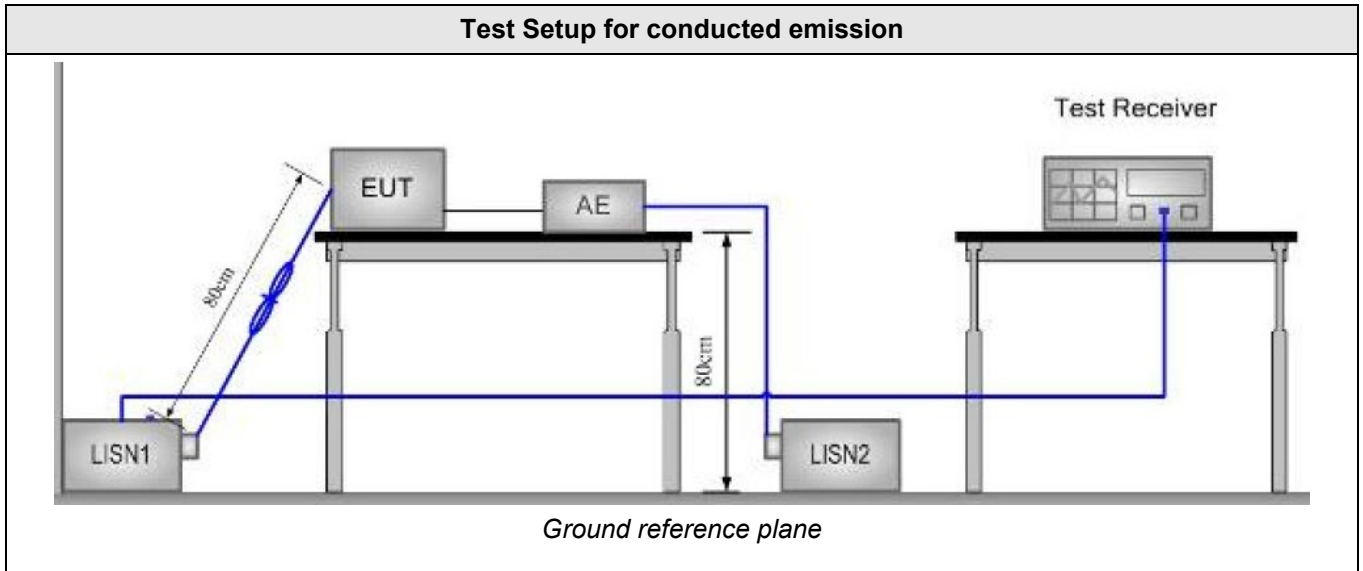
Example:

RA: 14.0dB $\mu$ V / AF: 16.5 dBm<sup>-1</sup> / CF: 3.5dB / AG: 15dB

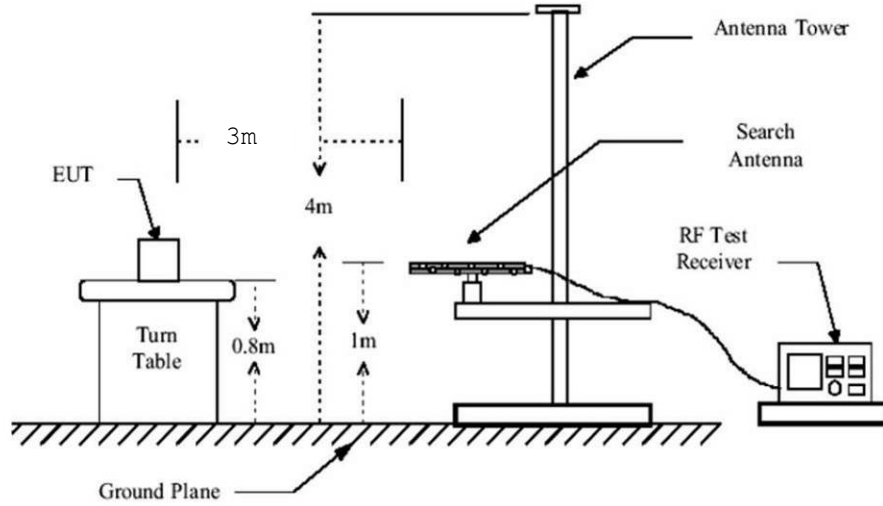
→ Total factor: 5dBm<sup>-1</sup>

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

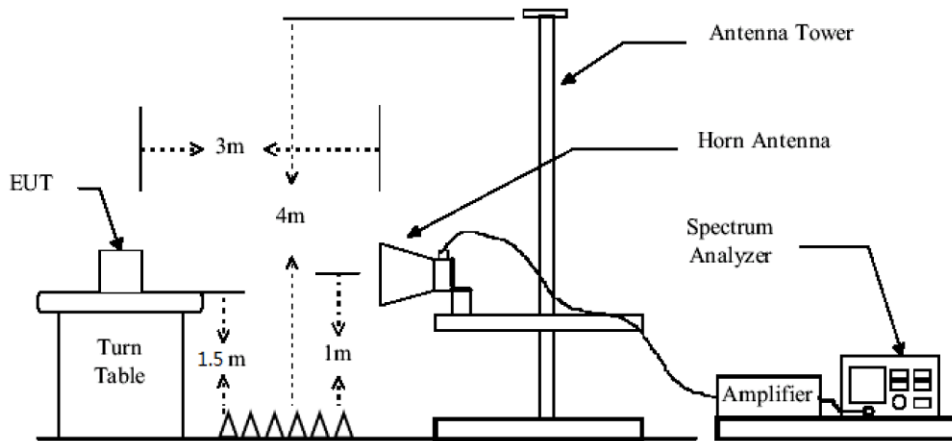
9. Test Setup Diagram



## Test Setup for radiated emission



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



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



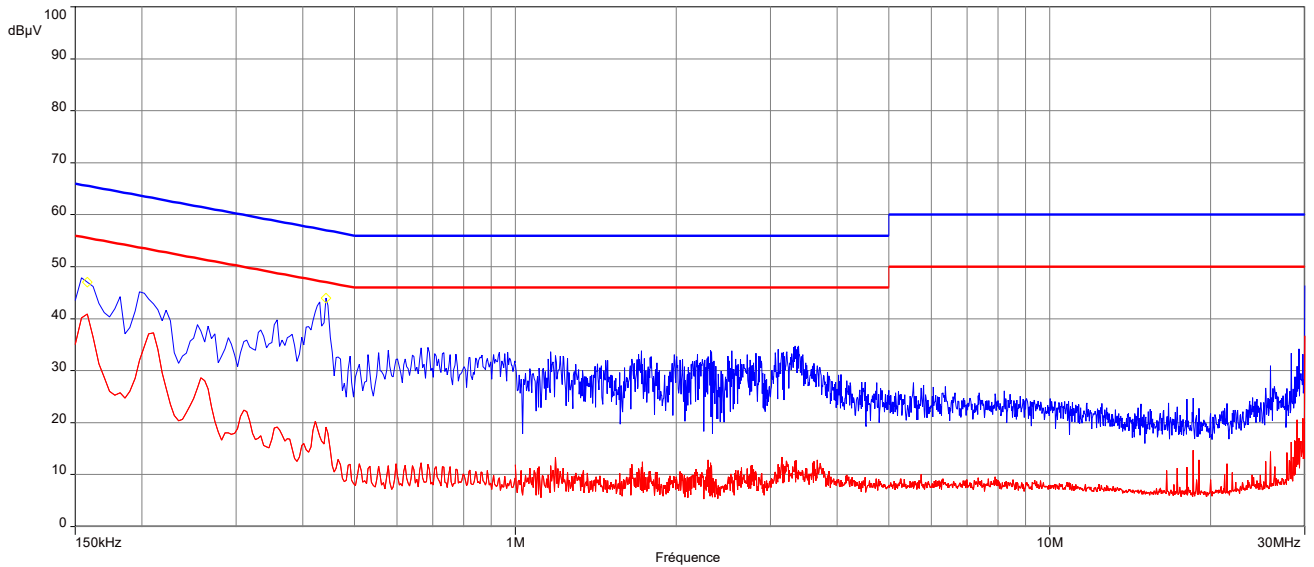
**10. Conducted Emission Measurement (150kHz-30MHz)**

<b>TEST: Limits for conducted disturbance 150kHz – 30MHz</b>				<b>Verdict</b>
<p><b>Method:</b> 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>				<b>Pass</b>
<b>Laboratory Parameters:</b>	Required prior to the test		During the test	
Ambient Temperature	20 to 30 °C		21°C ± 2	
Relative Humidity	25 to 70 %		30% ± 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)	
<b>Limits</b>				
Frequency (MHz)	Limit dB (µV)			
	Quasi-Peak	Result	Average	Result
0.15 – 0.50	66 \ 56	<b>PASS</b>	56 \ 46	<b>PASS</b>
0.50 - 5	56	<b>PASS</b>	46	<b>PASS</b>
5 – 30	60	<b>PASS</b>	50	<b>PASS</b>
Supplementary information: Test location: SMEE Test date: January 26, 2021. Tested by L. CHAPUS Power supply voltage: AC mains 110V/60Hz				

## Tabulated Results for Mains Terminal Disturbance Voltage on AC port

FREQ (MHz)	Meas. PK (dB $\mu$ V)	Mes. QP (dB $\mu$ V)	LIMIT QP (dB $\mu$ V)	Margin QP (dB)	Mes. AV (dB $\mu$ V)	LIMIT AV (dB $\mu$ V)	Margin AV (dB)	Line
0.158	48.4	42.2	65.6	-23.4	37.7	55.6	-17.9	L1
0.442	43.8	38.8	57.0	-18.2	19.4	47.0	-27.7	L1
0.154	48.9	42.4	65.8	-23.4	38.7	55.8	-17.1	N
0.426	44.7	38.3	57.3	-19.1	19.9	47.3	-27.5	N
<b>RBW:</b>			9kHz					
<b>Voltage:</b>			110V/60Hz					
<b>Limit:</b>			FCC Part 15.209 a) / RSS-Gen: Issue 5, §8.8 Table 4					
<b>Final measurement detector:</b>			Quasi-Peak and CISPR Average (AV)					
<b>RESULT:</b>			PASS					
<b>Measured value calculation:</b>			<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 Meas. = Level (dB<math>\mu</math>V)  RA = Receiver Amplitude  CF = Cable Factor  ATT<sub>TRAN</sub> = Transient suppressor attenuation  ATT<sub>LISN</sub> = LISN attenuation</p> <p>Margin value = Emission level – Limit value (A negative margin shows compliance to limit)</p>					

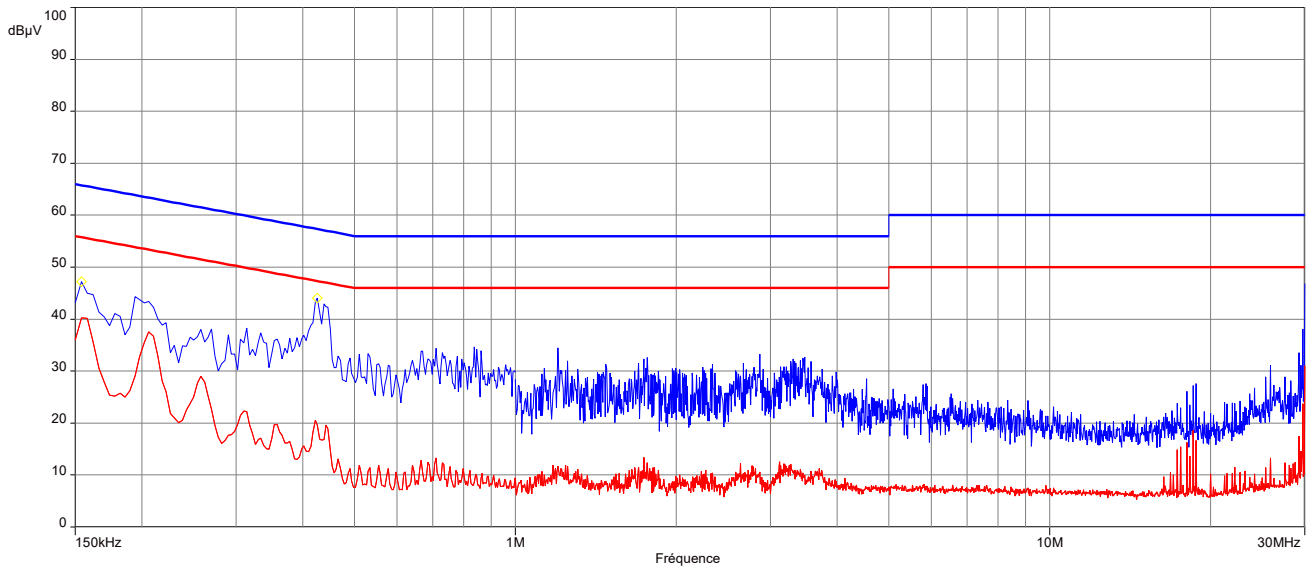
## Graphical representation of Conducted Disturbance Measurement (Peak and Average detection) AC port, Line L1



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.

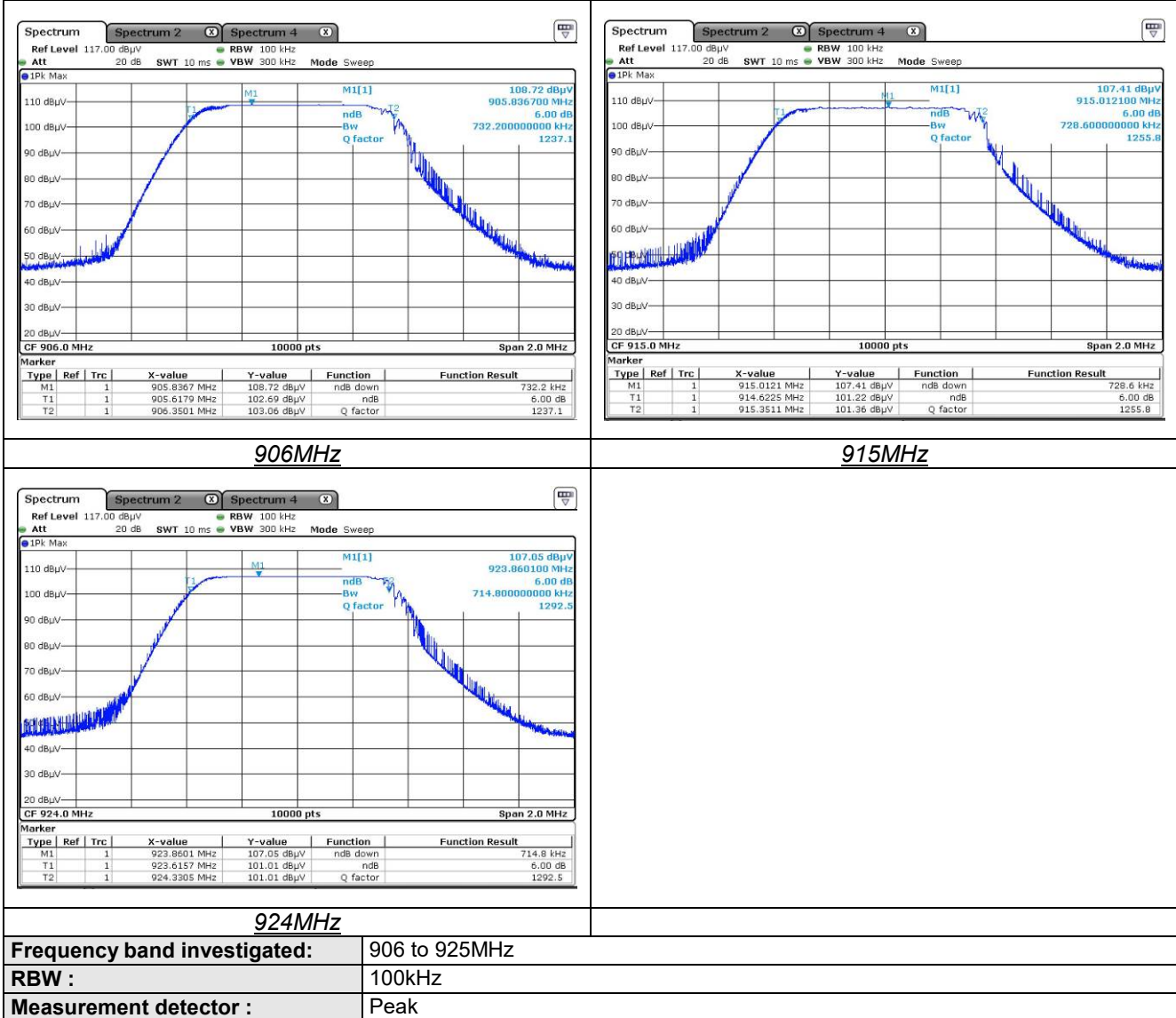
----: Peak      ----: Average

**11. DTS Bandwidth**

<b>TEST: DTS Bandwidth</b>		<b>Verdict</b>
<p><u>Method:</u> The setup is in an anechoic chamber. The spectrum analyzer is connected to the measuring antenna. A radiated measurement is performed.            The RBW is 100kHz, with VBW <math>\geq 3 \times</math> RBW.            The SPAN is wide enough to capture all products of the modulation process.            A MaxHold Peak detector is used. Automatic function of the spectrum analyser is used.            The tested equipment is set to transmit operation with modulation on low, mid and high channels.</p>		<b>Pass</b>
<b>Laboratory Parameters:</b>	<b>Required prior to the test</b>	<b>During the test</b>
Ambient Temperature	20 to 30 °C	21°C $\pm$ 2
Relative Humidity	25 to 70 %	30% $\pm$ 5
<b>Limits – FCC Part 15.247 (a) / RSS-247 §5.2 (a)</b>		
<b>Frequency (MHz)</b>	<b>Level for Bandwidth</b>	<b>Limit</b>
906.0	6dB below the maximum output power	At least 500kHz
915.0		
924.0		
Supplementary information: Test location: SMEE Test date: January 26, 2021. Tested by L. CHAPUS		

<b>Tabulated Results for Occupied Bandwidth</b>		
<b>Frequency (MHz)</b>	<b>6dB Bandwidth (kHz)</b>	<b>Result</b>
906.0	732.2	<b>Pass</b>
915.0	728.6	<b>Pass</b>
924.0	714.8	<b>Pass</b>

## Graphical representation of 6dB Bandwidth



**12. Maximum Peak Output power**

<b>TEST: Maximum peak conducted output power</b>		<b>Verdict</b>
Method: A radiated measurement is performed. The RBW is wide enough to capture the maximum amplitude level. The SPAN is wide enough to capture all products of the modulation process. A MaxHold Peak detector is used. Radiated field strength of RF Output Power is measured at 3m in a Semi Anechoic Chamber (SAC) that complies with ANSI C63.10 / ANSI C63.4. Maximum field strength (Peak) is 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. Three orthogonal axis measurements on EUT are performed to obtain the maximum peak field strength. The tested equipment is set to transmit operation with modulation on low, mid and high channels.		<b>Pass</b>
Laboratory Parameters:	Required prior to the test	During the test
Ambient Temperature	20 to 30 °C	22°C ± 2
Relative Humidity	25 to 70 %	33% ± 5
<b>Limits – FCC Part 15.247 (b) / RSS-247 §5.4 (d)</b>		
Frequency (MHz)	Limits (dBµV/m)	
	Level / Detector	Results
906 to 924	36 dBm / Pk / 3m (Radiated)	<b>Pass</b>
906 to 924	30 dBm / Pk (Conducted)	<b>Pass</b>
Supplementary information: Test location: SMEE Test date: April 19th, 2021. Tested by L. CHAPUS		

<b>Tabulated Results for Maximum peak output power (Radiated measurement)</b>				
<b>FREQ</b>	<b>Field Strength 3m</b>	<b>Calculated EIRP</b>	<b>Limit</b>	<b>Result</b>
(MHz)	(dBµV/m)	(dBm)	(dBm)	
906.0	114.5	14.5	36.0	<b>Pass</b>
915.0	114.5	14.5	36.0	<b>Pass</b>
924.0	113.5	13.5	36.0	<b>Pass</b>
<b>RBW:</b>	1MHz			
<b>Measurement distance:</b>	3m			
<b>Limit:</b>	FCC Part 15.247 / RSS-247			
<b>Final measurement detector:</b>	Peak			
<b>RESULT:</b>	PASS			
<b>Note:</b>	EIRP is calculated using the following equation: $EIRP = E + 20 \times \log(D) - 104.8 - GR$ Where EIRP = Equivalent Isotropic Radiated Power in dBm E = Electric field strength in dBµV/m D = Measuring distance in meter GR = Ground reflection in dB (4.7dB for frequencies between 30MHz and 1000 MHz; 0dB above 1GHz)			

Tabulated Results for Maximum peak output power (Conducted)			
FREQ (MHz)	Conducted power (dBm)	Limit (dBm)	Result
906.0	14.5	30.0	Pass
915.0	14.5	30.0	Pass
924.0	13.5	30.0	Pass
<b>RBW:</b>	1MHz		
<b>Limit:</b>	FCC Part 15.247 / IC RSS-247		
<b>Final measurement detector:</b>	Peak		
<b>RESULT:</b>	PASS		
<b>Note:</b>	(1): Maximum conducted Peak output power is calculated as follow: $P_c = EIRP - G$ Where $P_c$ = Conducted power dBm $EIRP$ = Equivalent Isotropic Radiated Power in dBm $G$ = Antenna gain in dBi (0dBi, as declared by the manufacturer)		

### 13. Maximum Power Spectral Density Level in the fundamental emission

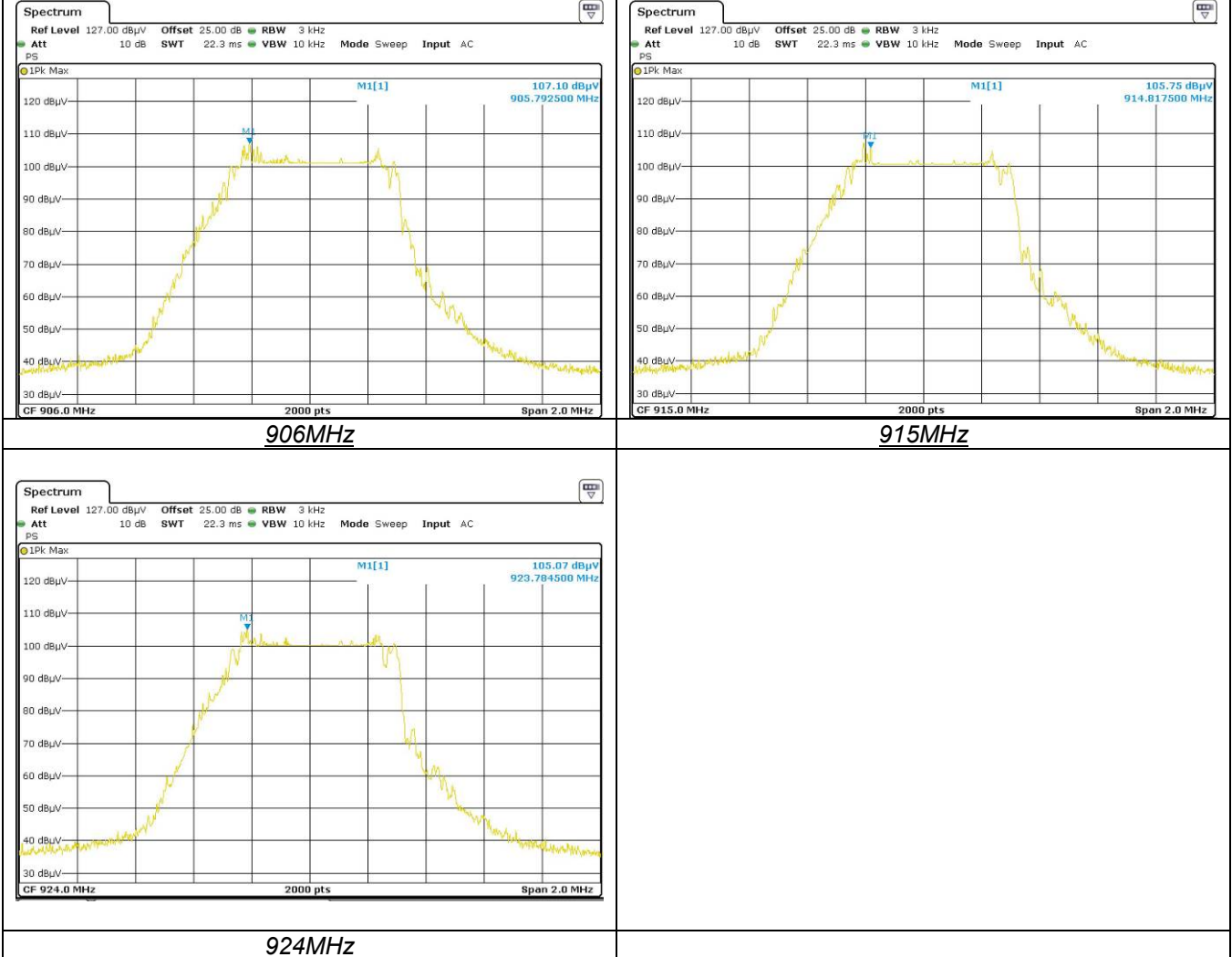
TEST: Maximum Peak Power Spectral Density		Verdict
<p><b>Method:</b> A radiated measurement is performed.            The RBW is set at 3kHz.            The SPAN is wide enough to capture all products of the modulation process.            A MaxHold Peak detector is used.            Radiated field strength of RF Output Power is measured at 3m in a Semi Anechoic Chamber (SAC) that complies with ANSI C63.10 / ANSI C63.4.            Maximum field strength (Peak) is 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.            Three orthogonal axis measurements on EUT are performed to obtain the maximum peak field strength.            The tested equipment is set to transmit operation with modulation on low, mid and high channels.</p>		<b>Pass</b>
Laboratory Parameters:	Required prior to the test	During the test
Ambient Temperature	20 to 30 °C	22°C ± 2
Relative Humidity	25 to 70 %	33% ± 5
<b>Limits – FCC Part 15.247 (e) / RSS-247 §5.2 (b)</b>		
<b>Frequency (MHz)</b>	<b>Level (Detector)</b>	<b>Limit</b>
906 / 915 / 924	8 dBm/3kHz (Pk)	<b>Pass</b>
Supplementary information: Test location: SMEE Test date: April 19th, 2021. Tested by L. CHAPUS		

Tabulated Results for Maximum Spectral Density (Radiated measurement)				
FREQ	Field Strength 3m	Calculated Radiated PSD (EIRP)	Limit	Result
(MHz)	(dBµV/m)	(dBm)	(dBm)	
906.0	107.3	7.3	-	-
915.0	106.0	6.0	-	-
924.0	105.3	5.3	-	-
<b>RBW:</b>	3kHz			
<b>Measurement distance:</b>	3m			
<b>Limit:</b>	FCC Part 15.247 / RSS-247			
<b>Final measurement detector:</b>	Peak			
<b>Note:</b>	EIRP/PSD is calculated using the following equation: $EIRP = E + 20 \times \log(D) - 104.8 - GR$ Where EIRP = Equivalent Isotropic Radiated Power in dBm E = Electric field strength in dBµV/m D = Measuring distance in meter GR = Ground reflection in dB (0dB above 1GHz)			



Tabulated Results for Maximum Conducted Power Spectral Density			
Frequency (MHz)	PSD (dBm/3kHz)	Limit	Result
906.0	7.3	8dBm/3kHz	<b>Pass</b>
915.0	6.0	8dBm/3kHz	<b>Pass</b>
924.0	5.3	8dBm/3kHz	<b>Pass</b>
<b>RBW:</b>	3kHz		
<b>Limit:</b>	FCC Part 15.247 / RSS-247		
<b>Final measurement detector:</b>	Peak		
<b>RESULT:</b>	PASS		
<b>Note:</b>	Maximum conducted power spectral density is calculated as follow: $P_{SD} = P_{SD-EIRP} - G$ Where $P_{SD}$ = Conducted power spectral density $P_{SD-EIRP}$ = Equivalent Isotropic Radiated PSD in dBm $G$ = Antenna gain in dBi (0dBi, as declared by the manufacturer)		

## Graphical representation of Conducted output power density



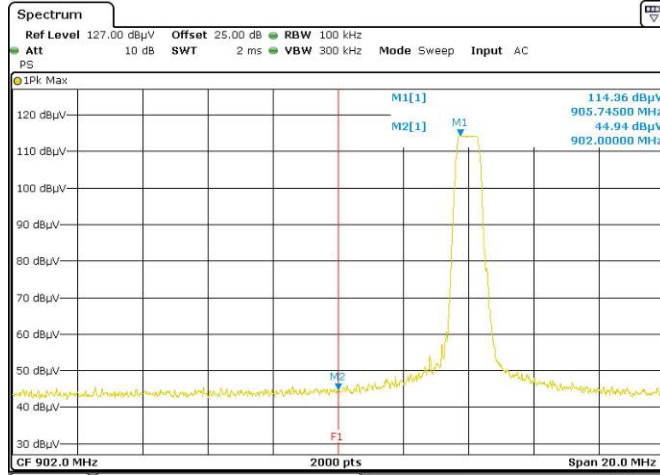
## 14. Unwanted emissions in Non-Restricted Frequency bands (Radiated emissions)

TEST: Unwanted emissions in Non-Restricted Frequency Bands		Verdict	
<p><b>Method:</b> 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>		<b>Pass</b>	
Laboratory Parameters:	Required prior to the test	During the test	
Ambient Temperature	20 to 30 °C	22°C ± 2	
Relative Humidity	25 to 70 %	33% ± 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	
<b>Limits – FCC Part 15.247 (d) / RSS-247 § 5.5</b>			
Frequency (MHz)	Limits (dBµV/m)		
	Detector / Analyser RBW	Limit	Results
30 to 10000	Pk / 100kHz	20dB below the maximum Peak level	<b>Pass</b>
Supplementary information:			
Test location: SMEE			
Test date: April 19th, 2021. Tested by L. CHAPUS			
Note: Tests are performed with only LORA radiating source.			
Test with both LORA and BLE sources transmitting simultaneously does not show additional spurious emission.			

Tabulated Results for Peak Output Radiated reference level	
FREQ	Field Strength 3m
(MHz)	(dBµV/m)
906.0	114.4 (1)
915.0	114.1 (1)
924.0	114.2 (1)
<b>RBW:</b>	100kHz
<b>Measurement distance:</b>	3m
<b>Limit:</b>	Ref. level only – For 15.247 (d) / RSS-247 § 5.5
<b>Final measurement detector:</b>	Peak
<b>Note:</b>	(1): Only for identification of limit in non-restricted band. Limit is <b>94.1 dBµV/m</b> Peak for out-of-band frequencies in Non-Restricted bands (with a 100kHz RBW on the spectrum analyser)

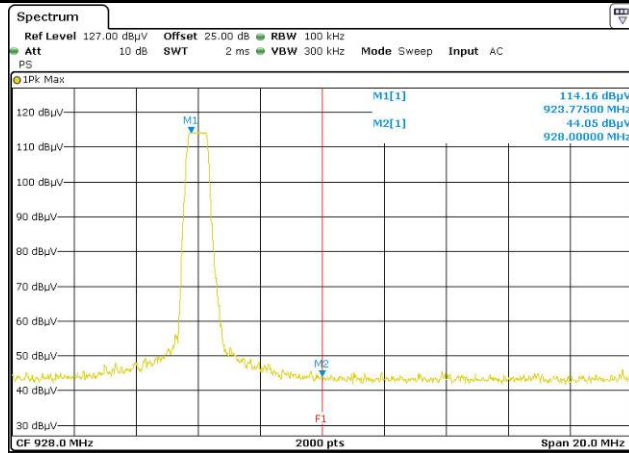
Tabulated Results for Unwanted emissions in Non-Restricted bands				
FREQ (MHz)	Field Strength 3m (dBµV/m)	Limit (dBµV/m)	Margin (dBµV/m)	Result (dBµV/m)
Levels are at least 20 dB below the -20dBc limit See pre-scan graphs in chapter 17.				
<b>RBW:</b>	100kHz			
<b>Measurement distance:</b>	3m			
<b>Limit: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

## Graphical representation of Band-edge compliance (LOW)



Unit :	dBμV/m
RBW :	100kHz
Measurement detector:	Peak
Limit:	94.1dBμV/m
Note:	F1 is 902MHz

## Graphical representation of Band-edge compliance (High)



Unit :	dBμV/m
RBW :	100kHz
Measurement detector:	Peak
Limit:	94.1dBμV/m
Note:	F1 is 928MHz

**15. Unwanted emissions in Restricted Frequency bands**

<b>TEST: Unwanted emissions into Restricted Frequency Bands</b>		<b>Verdict</b>
<p><b>Method:</b> 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>		<b>Pass</b>
Laboratory Parameters:	Required prior to the test	During the test
Ambient Temperature	20 to 30 °C	22°C ± 2
Relative Humidity	25 to 70 %	33% ± 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
<b>Limits – FCC Part 15.205, 15.209 (a), 15.247 (d) / RSS-GEN §8.9, §8.10, RSS-247 §5.5</b>		
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	<b>Pass</b>
0.090 to 0.110	87.6 – 85.9 / QP / 10m	<b>Pass</b>
0.110 to 0.490	85.7 – 72.9 / AV / 10m 105.7 – 92.9 / PK / 10m	<b>Pass</b>
0.490 to 1.705	52.9 – 42.1 / QP / 10m	<b>Pass</b>
1.705 to 30	48.6 / QP / 10m	<b>Pass</b>
30 to 88	40.0 / QP / 3m	<b>Pass</b>
88 to 216	43.5 / QP / 3m	<b>Pass</b>
216 to 960	46.0 / QP / 3m	<b>Pass</b>
960-1000	54.0 / QP / 3m	<b>Pass</b>
Above 1GHz	54.0 / AV / 3m 74.0 / PK / 3m	<b>Pass</b>
Supplementary information: Test location: SMEE Test date: April 19th, 2021. Tested by L. CHAPUS Note: Tests are performed with only LORA radiating source. Test with both LORA and BLE sources transmitting simultaneously does not show additional spurious emission.		

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.							
<b>Frequency band investigated:</b>		9kHz-490kHz					
<b>RBW:</b>		200Hz (9kHz-150kHz) 9kHz (150kHz-30MHz)					
<b>Measurement distance:</b>		10m					
<b>Final measurement detector:</b>		Peak / Quasi-Peak / Average					
<b>Limit:</b>		FCC Part 15.209 / RSS-Gen					
<b>Note:</b>		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.					

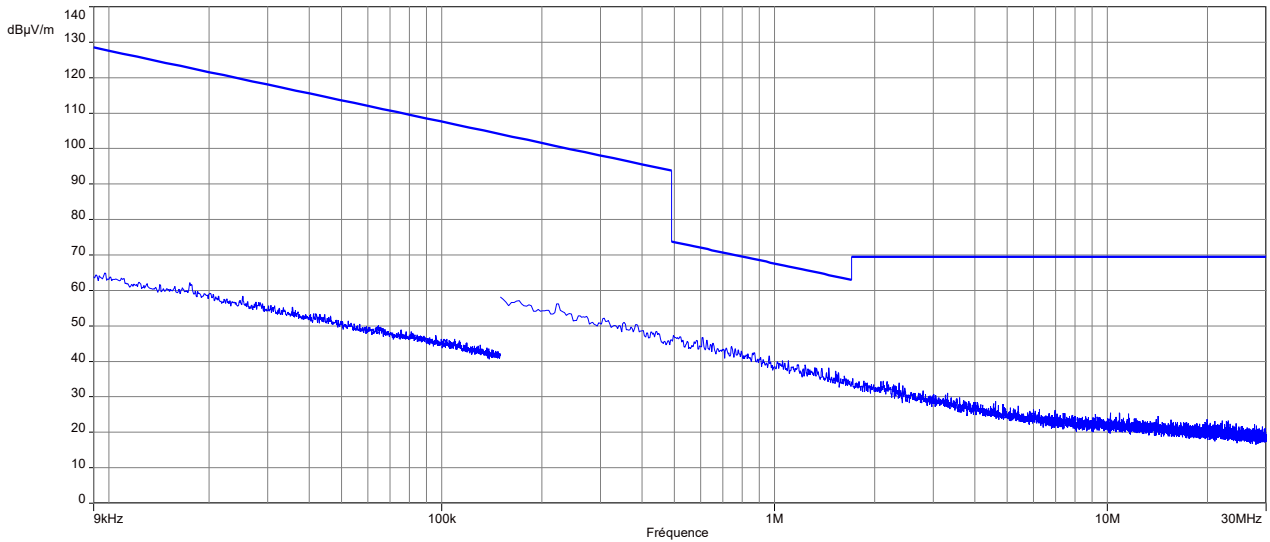
Tabulated Results for Unwanted emissions (490kHz-30MHz)							
FREQ	RF field @ 30m	Limit @ 30m	Detector	Margin	Ant. angle	Table angle	Correc. Fact. (CF)
MHz	dBµV/m	dBµV/m	Pk / QP	dB	Degree	Degree	dB
All levels are at least 20dB below applicable limits							
Supplementary information: Frequency list measured has been created with pre-scan results.							
<b>Frequency band investigated:</b>		490kHz-30MHz					
<b>RBW:</b>		9kHz (150kHz-30MHz)					
<b>Measurement distance:</b>		10m					
<b>Final measurement detector:</b>		Quasi-Peak					
<b>Limit:</b>		FCC Part 15.209 / RSS-Gen					
<b>Note:</b>		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 $\mu$ V	(Pk) dB $\mu$ V	dB	(QP) dB $\mu$ V/m	(Pk) dB $\mu$ V/m		cm	Degree	(QP) dB $\mu$ V/m	dB
Margin < -10dB										
Supplementary information: Frequency list has been created with pre-scan results.										
<b>Frequency band investigated:</b>				30MHz-1GHz						
<b>RBW:</b>				120kHz						
<b>Measurement distance:</b>				3m						
<b>Limit:</b>				FCC Part 15.205 - 15.209 / RSS-GEN						
<b>Final measurement detector:</b>				Quasi-Peak						
<b>RESULT:</b>				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 $\mu$ V/m	(AV) dB $\mu$ V/m	(PK) dB $\mu$ V/m	(PK) dB	(AV) dB $\mu$ V/m	(AV) dB	Degree	m	dB	
<b>Low channel</b>										
3623.9	50.9	43.0	74.0	-22.3	54.0	-11.0	213.0	2.2	21.8	V
<b>Middle channel</b>										
3659.4	51.7	42.9	74.0	-22.3	54.0	-11.1	346.6	1.0	21.8	V
<b>High channel</b>										
3695.2	52.9	41.2	74.0	-21.1	54.0	-12.8	9.0	2.0	21.0	V
Supplementary information: Frequency list has been created with pre-scan results.										
<b>RBW</b>					1MHz					
<b>Measurement distance:</b>					3m					
<b>Limit:</b>					FCC Part 15.205, 15.209, 15.247 / RSS-Gen, RSS-247					
<b>Final measurement detector:</b>					Peak / CISPR Average					
<b>RESULT:</b>					PASS					



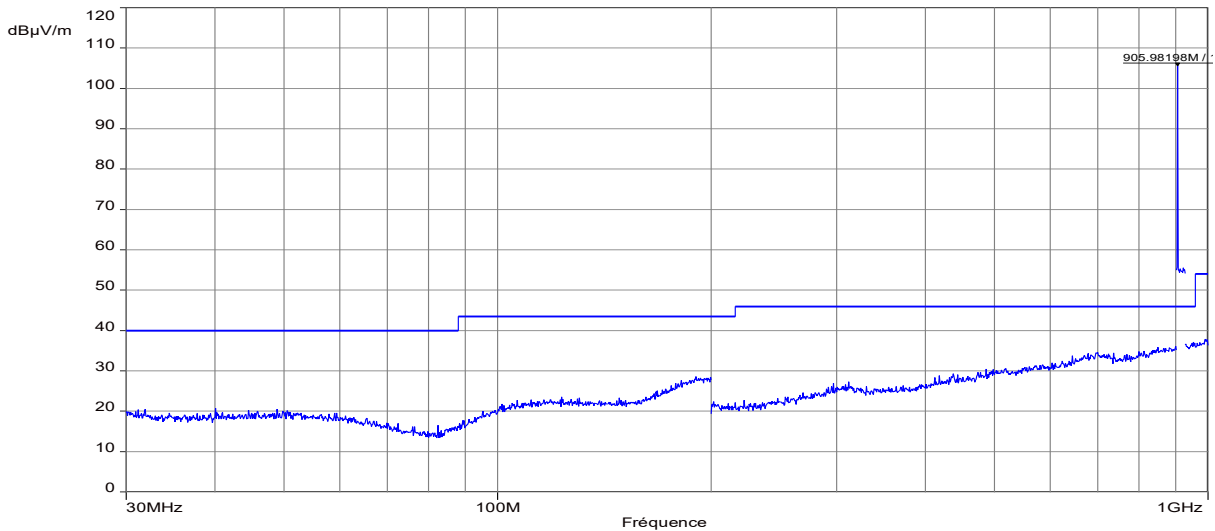
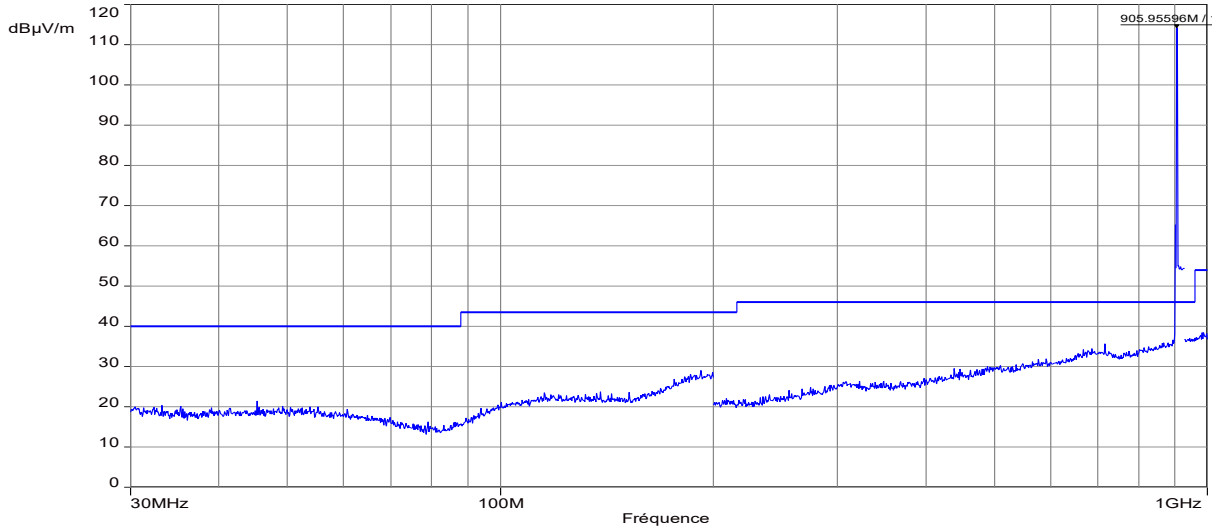
**Graphical representation of Radiated Disturbance Measurement (Peak detection, Anechoic chamber pre-scan, 9kHz-30MHz / 3m / Parallel & Perpendicular antenna position / Transmit mode)**



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

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

## Graphical representation of Radiated Disturbance Measurement (Peak detection, Anechoic chamber pre-scan, 30MHz-1GHz / 3m / Horizontal & Vertical (Low channel))



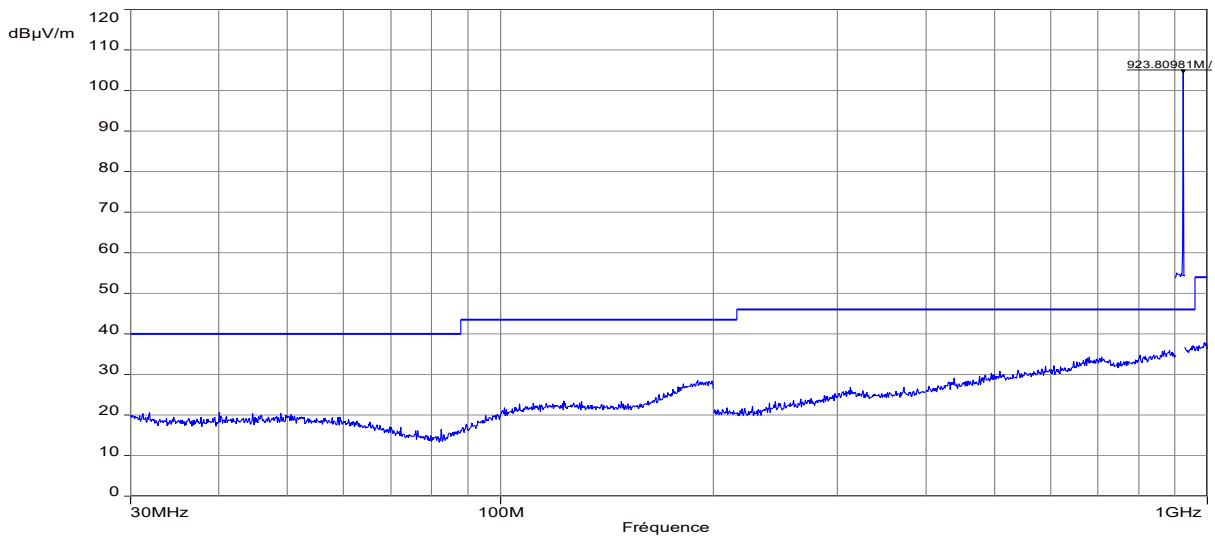
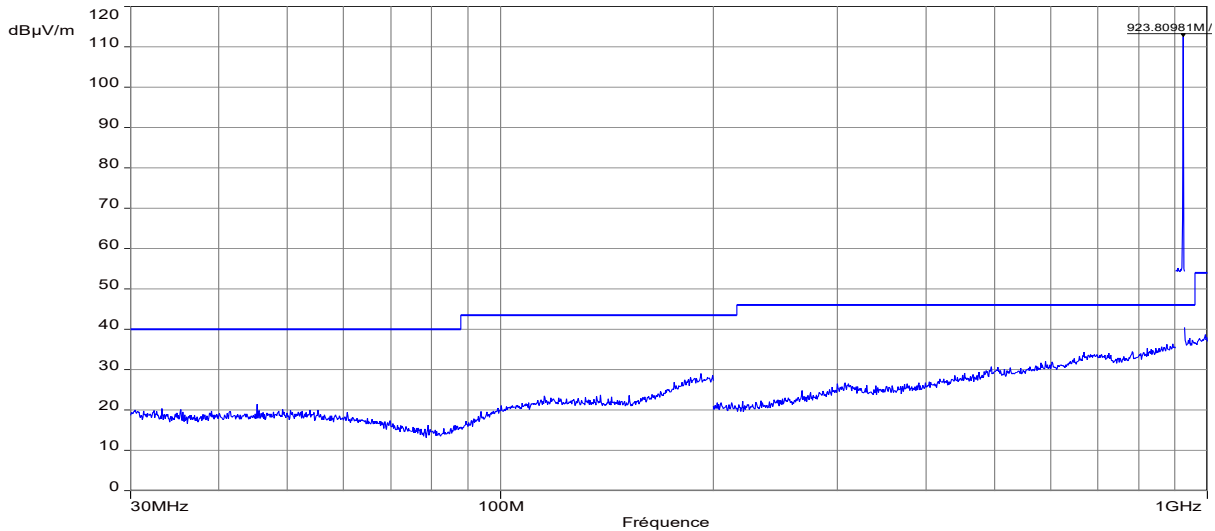
Note: Pre-scan graph only for identification purpose.

<b>Frequency band investigated:</b>	30MHz-1GHz
<b>Unit :</b>	dBµV/m
<b>RBW :</b>	100kHz
<b>Antenna polarization :</b>	Horizontal & Vertical
<b>Limit:</b>	FCC 15.247 / RSS-247
<b>Measurement detector:</b>	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 (Peak detection, Anechoic chamber pre-scan, 30MHz-1GHz / 3m / Horizontal & Vertical (High channel))



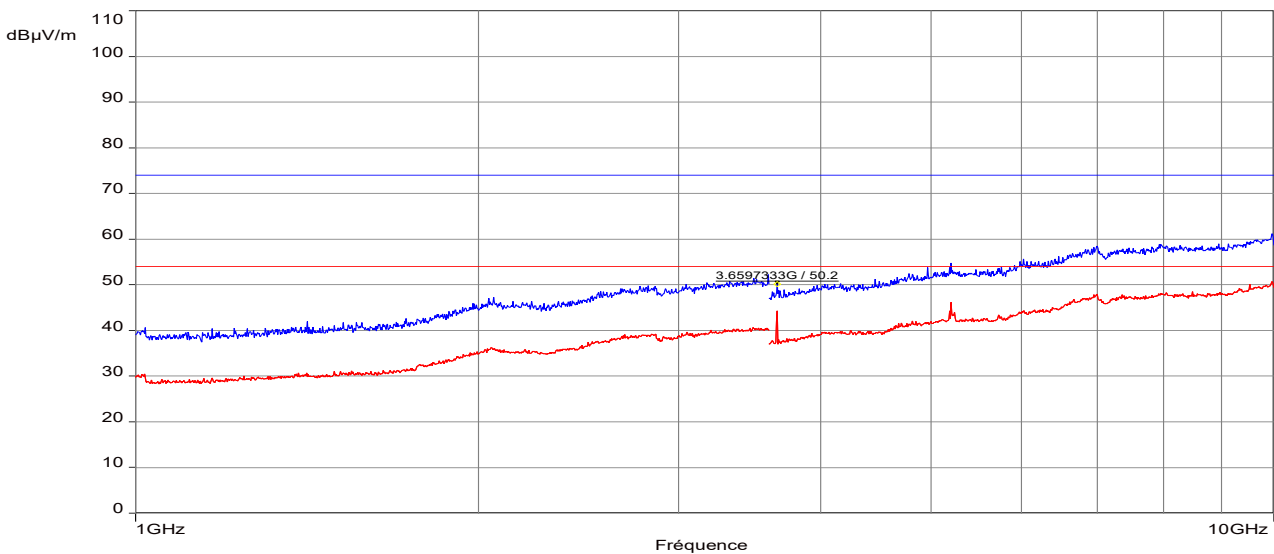
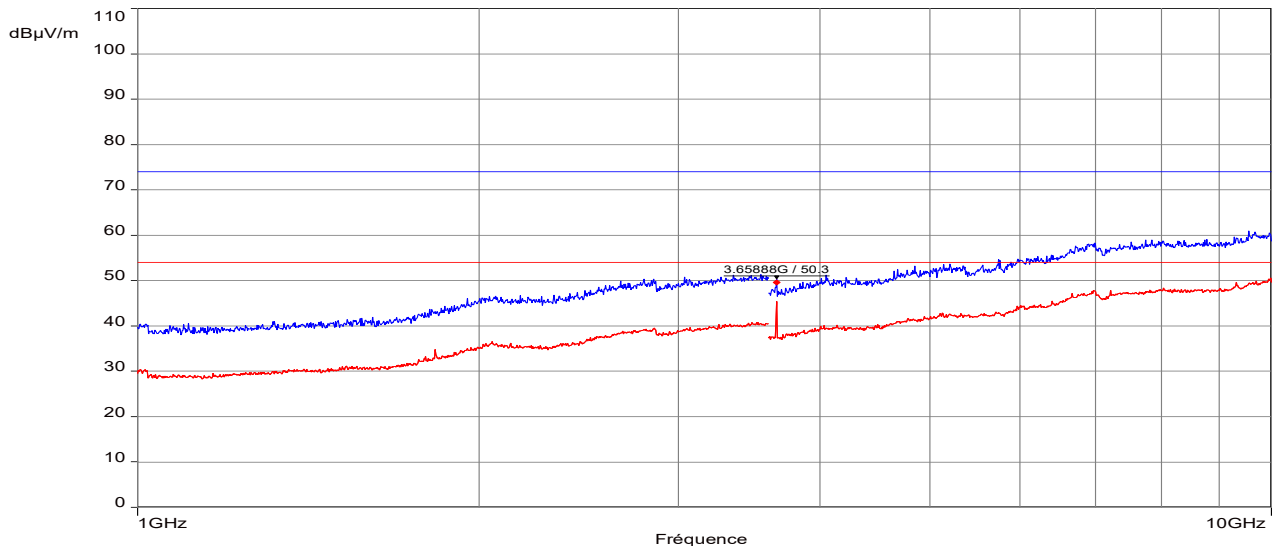
Note: Pre-scan graph only for identification purpose.

<b>Frequency band investigated:</b>	30MHz-1GHz
<b>Unit :</b>	dBµV/m
<b>RBW :</b>	100kHz
<b>Antenna polarization :</b>	Horizontal & Vertical
<b>Limit:</b>	FCC 15.247 / RSS-247
<b>Measurement detector:</b>	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 / Horizontal & Vertical, mid channel)



Note: Pre-scan graph only for identification purpose.

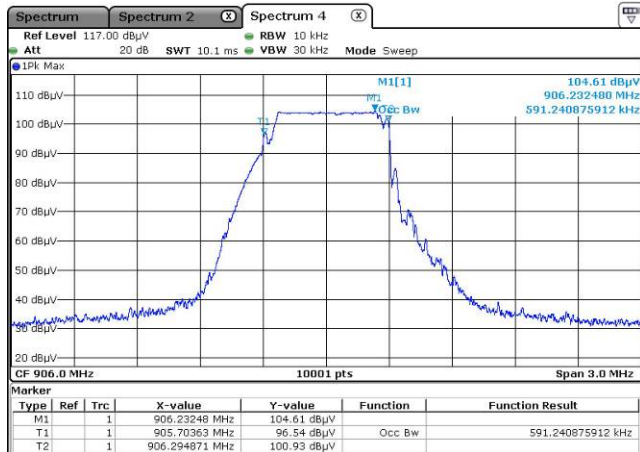
----- : Peak measure	----- : Average measure
<b>Frequency band investigated:</b>	1GHz-10GHz
<b>Unit :</b>	dBµV/m
<b>RBW :</b>	1MHz
<b>Antenna polarization :</b>	Horizontal & Vertical
<b>Limit:</b>	FCC 15.247 / RSS-247
<b>Measurement detector:</b>	Peak / Average

**16. Occupied bandwidth (99%)**

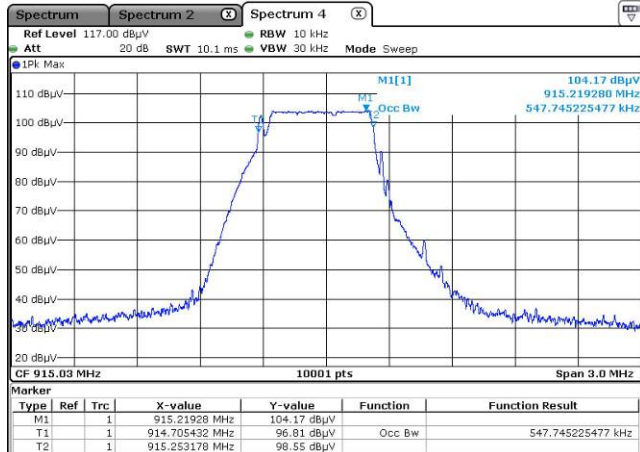
<b>TEST: Occupied bandwidth (99%) / RSS-GEN</b>		<b>Verdict</b>								
<p><u>Method:</u> The setup is in an anechoic chamber. The spectrum analyzer is connected to the measuring antenna. A radiated measurement is performed.            The RBW is set in the range of 1% to 5% of the OBW, with VBW <math>\geq 3 \times</math> RBW.            The SPAN is wide enough to capture all products of the modulation process. (Between 1.5 to 5 times the OBW)            A MaxHold Peak detector is used. Automatic function of the spectrum analyser is used.            The tested equipment is set to transmit operation with modulation on low, mid and high channels.</p>		<b>Pass</b>								
Laboratory Parameters:	<table border="1" style="width: 100%; border-collapse: collapse;"> <thead> <tr> <th style="width: 33%;"></th> <th style="width: 33%;">Required prior to the test</th> <th style="width: 33%;">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;">21°C <math>\pm</math> 2</td> </tr> <tr> <td>Relative Humidity</td> <td style="text-align: center;">25 to 70 %</td> <td style="text-align: center;">30% <math>\pm</math> 5</td> </tr> </tbody> </table>			Required prior to the test	During the test	Ambient Temperature	20 to 30 °C	21°C $\pm$ 2	Relative Humidity	25 to 70 %
	Required prior to the test	During the test								
Ambient Temperature	20 to 30 °C	21°C $\pm$ 2								
Relative Humidity	25 to 70 %	30% $\pm$ 5								
Supplementary information: Test location: SMEE Test date: January 26, 2021. Tested by L. CHAPUS										

<b>Tabulated Results for Occupied Bandwidth</b>	
<b>Frequency (MHz)</b>	<b>99% Occupied Bandwidth (kHz)</b>
906.0	591.24
915.0	547.75
924.0	598.14

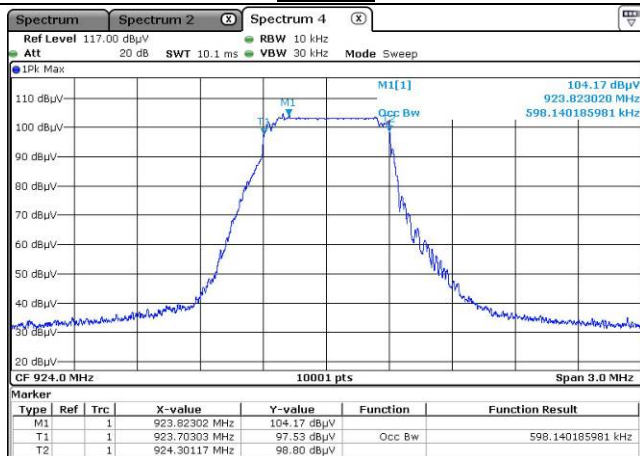
## Graphical representation of Occupied Bandwidth



**906MHz**



**915MHz**



**924MHz**

**17. Test Equipment List**

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 Equipment Used for radiated emission					
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/20m	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	-	-