

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

Matériel testé :
Equipment under test:

ST / NUCLEO-WL33CC1
(Trademark / Marketing name or product reference)

Demandeur de certification : **STMicroelectronics (Rousset) SAS**
Applicant for certification: 190 Avenue Celestin Coq
13106 – ROUSSET – France

Client : **STMicroelectronics (Rousset) SAS**
Customer: 190 Avenue Celestin Coq
13106 – ROUSSET – France

Numéro d'affaire : OF-110288
Work number :

Référence de la proposition : DV-10206-2
Proposal number:

Date de l'essai : Du 18 juin au 1^{er} juillet 2024
Date of test: June 18th to July 1st, 2024

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)s
- Industry Canada RSS-247, Issue 3
(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 : Chemseddine KERMICHE
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	October 15 th , 2024	Initial Edition	Chemseddine KERMICHE	Laurent CHAPUS
2	January 24 th , 2025	TCB review	Test operator 	Technical Manager

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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 (June 2024)	X	Telecommunication – Federal Communication Commission – Radio frequency devices, Sections 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 (Issue 3/2023)	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 15.107 (a) / 15.207 (a) Table 4 / RSS-Gen	PASS
6dB Bandwidth	15.247 (a) (2) RSS-247 § 5.2 (a)	At least 500kHz	PASS
Maximum Peak Output Power	15.247 (b) (3) & (4) RSS-247 § 5.4 (d)	1W max / 30dBm (Conducted) 4W max / 36dBm (EIRP)	PASS
Maximum Power Spectral Density	15.247 (e) RSS-247 § 5.2 (b)	8dBm in a 3kHz band segment	PASS
Unwanted emissions into Non Restricted Frequency Bands	15.247 (d) / RSS-247 § 5.5	-30dBc in any 100kHz outside frequency band.	PASS
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	PASS
Occupied Bandwidth	RSS-GEN § 6.7	BW at 99%	PASS
Antenna requirement	FCC 15.203 RSS-GEN § 6.8		PASS

- General conclusion:**

Measures and tests performed on the sample of the product *ST / NUCLEO-WL33CC1*, 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

ST / NUCLEO-WL33CC1
(Trademark / Marketing name or product reference)

MB1801-NoUSB-D03
SN: C223900253.
MB2029-Highband-B02
SN: C241200018.
FG: NUWL33CC1\$CR1

FCC ID: YCP-MB202900
IC: 8976A-MB202900
Model / HVIN: NUCLEO-WL33CC1
Product name / PMN: NUCLEO-WL33CC1
FVIN: STM32WL3 CLI Application version 0.2.0
Modular approval: No
Software Defined Radio: No

Date de réception /
Date of receipt June 2024

Alimentation /
Power supply 5V DC via USB-Type A port from PC.

Auxiliaires /
Auxiliaries Laptop ASUS, model F200 (with its power supply unit) Ref: Ref: LABO_05

Entrées-Sorties / Input / Output

	Câbles pour essai / Cables for test	Blindé / Shielded	Prévu pour >3m / Intended for >3m
USB Micro-C (MB1801D)	1.0m	Yes	No

Mode de fonctionnement / Running mode

The MB2029B board is placed on a MB1801D. The EUT is linked to a laptop through a USB-C cable. The tested sample is able to:

- Transmit a carrier frequency on low, middle and high channels (Bluetooth Low Energy).

Programme de test / Test program /

STM32WL33x GUI v0.2.0 (c) 2024 STMicroelectronics.
Note : When used in Regulatory mode, the software settings for parameters is under complete control of the manufacturer, it can't be modified by a party other than the manufacturer that would affect the radio parameters.

Fréquence max interne EST /
Max internal EUT frequency 927.3 MHz for RF data transmission.

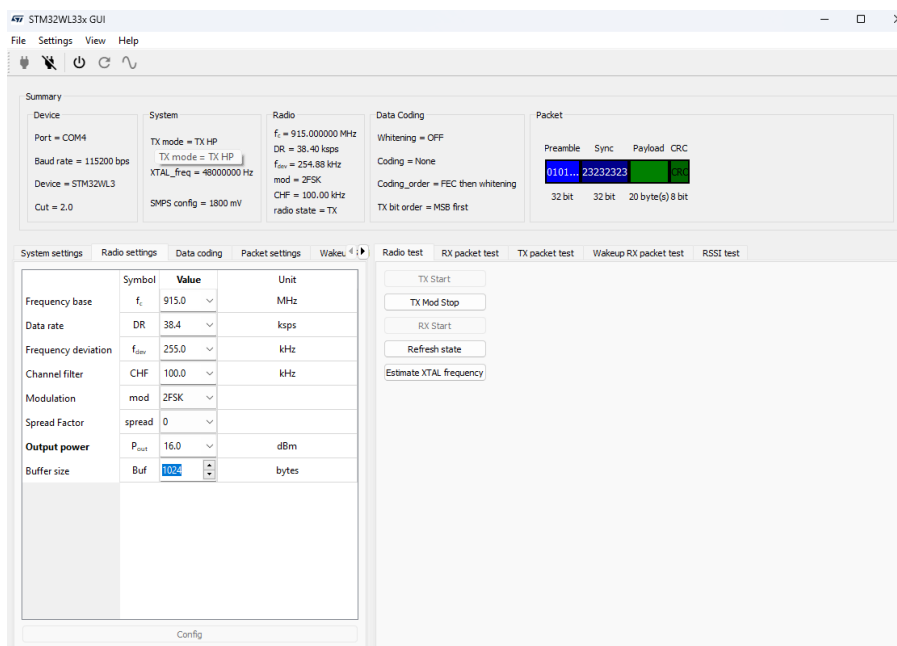
Informations supplémentaires / Additional informations

Declaration of the applicant:

- Frequency transmission band: 902-928MHz.
- Frequency channel: low: 902.7MHz, middle: 915MHz, high: 927.3MHz
- Power setting: 16dBm.
- SMPS setting: 1800mV
- Modulation: 2FSK ($F_{DEV} = 255\text{kHz}$)
- 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

88.3mm x 70.1 x 61 (Board)
Antenna length is 48.3mm



All Information above is declared by the customer / applicant and are under his responsibility.

4. Test conditions

Power supply voltage:

Equipment under test:

Auxiliaries:

5V DC from Laptop USB-Port.

120V/60Hz.

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)	± 5.3dB
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:

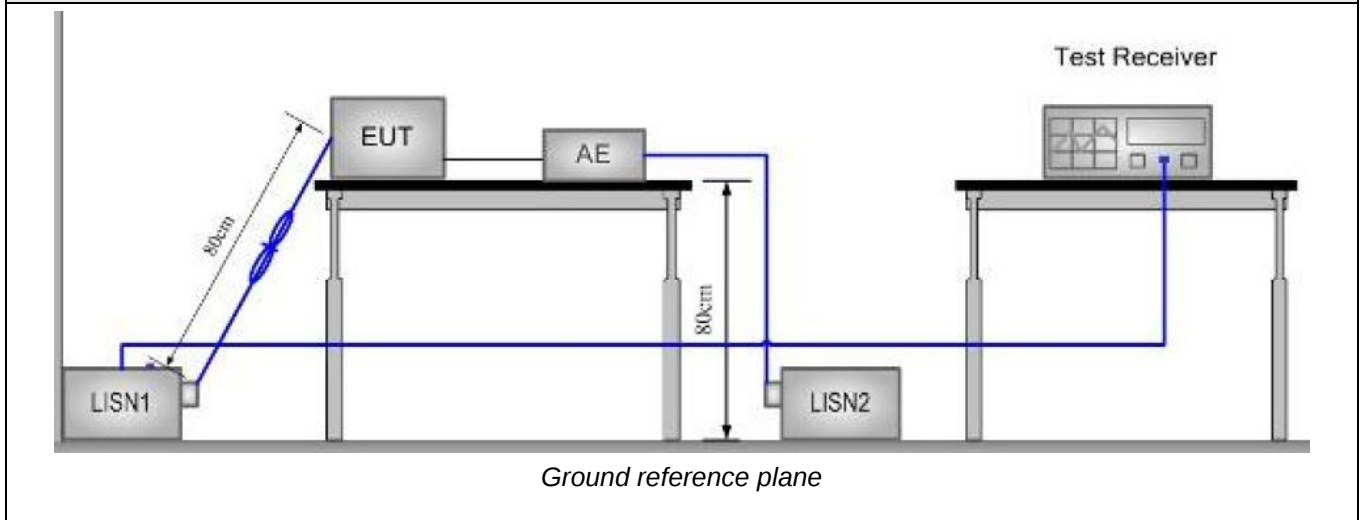
RA: 14.0dBμV / AF: 16.5 dBm⁻¹ / CF: 3.5dB / AG: 15dB

→ Total factor: 5dBm⁻¹

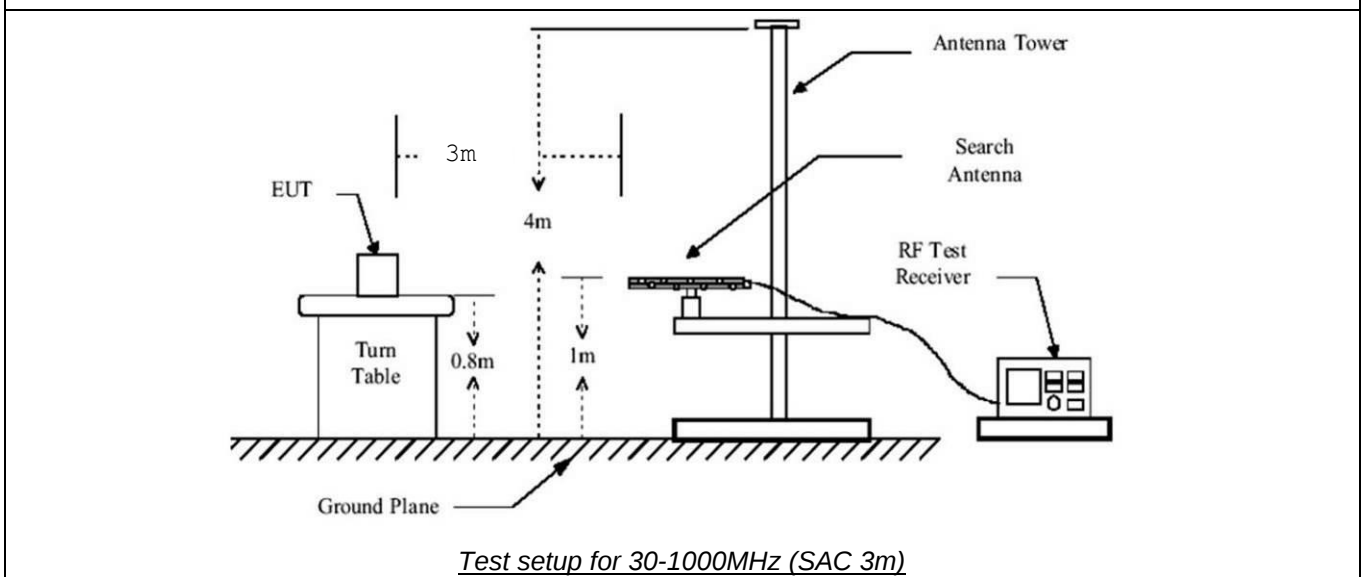
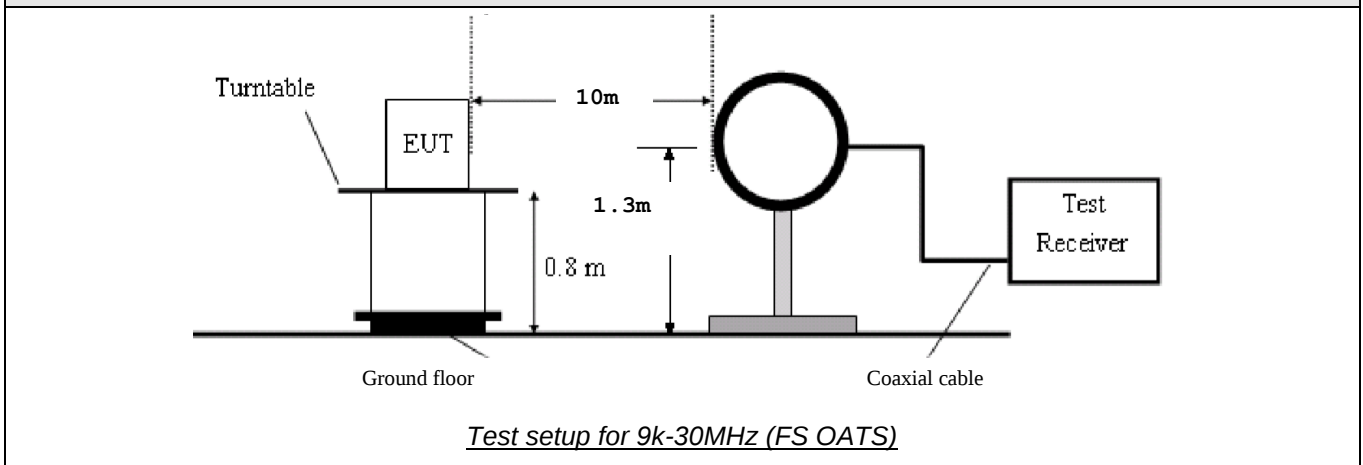
→ Field level: 19.0dBμV/m (-21.0dB for margin if limit is 40dBμV/m)

9. Test Setup Diagram

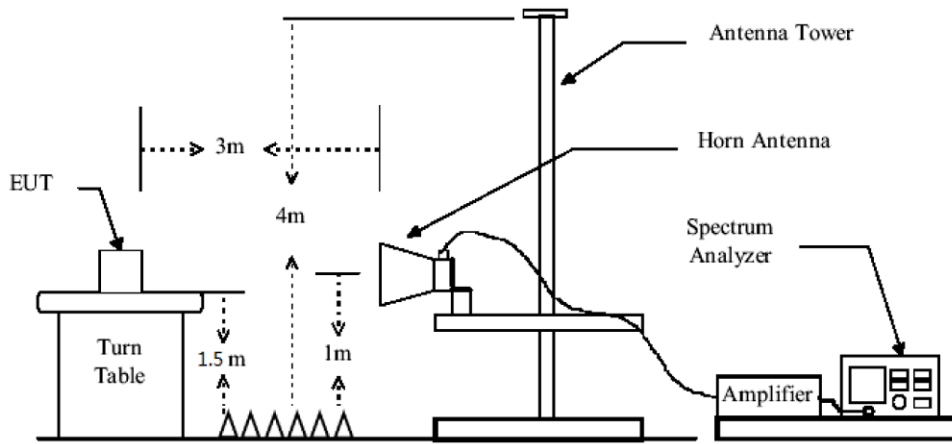
Test Setup for conducted emission



Test Setup for radiated emission

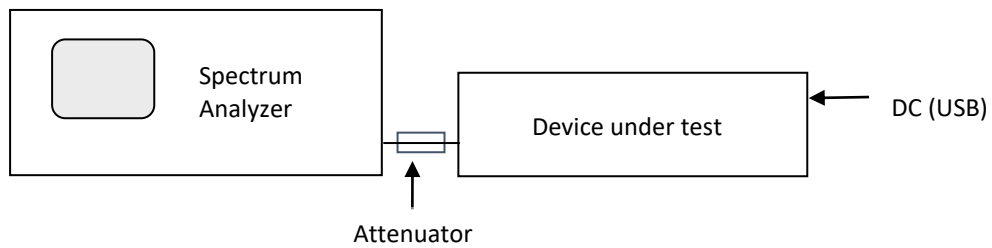


Test Setup for radiated emission



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

Test Setup for conducted antenna port measurement



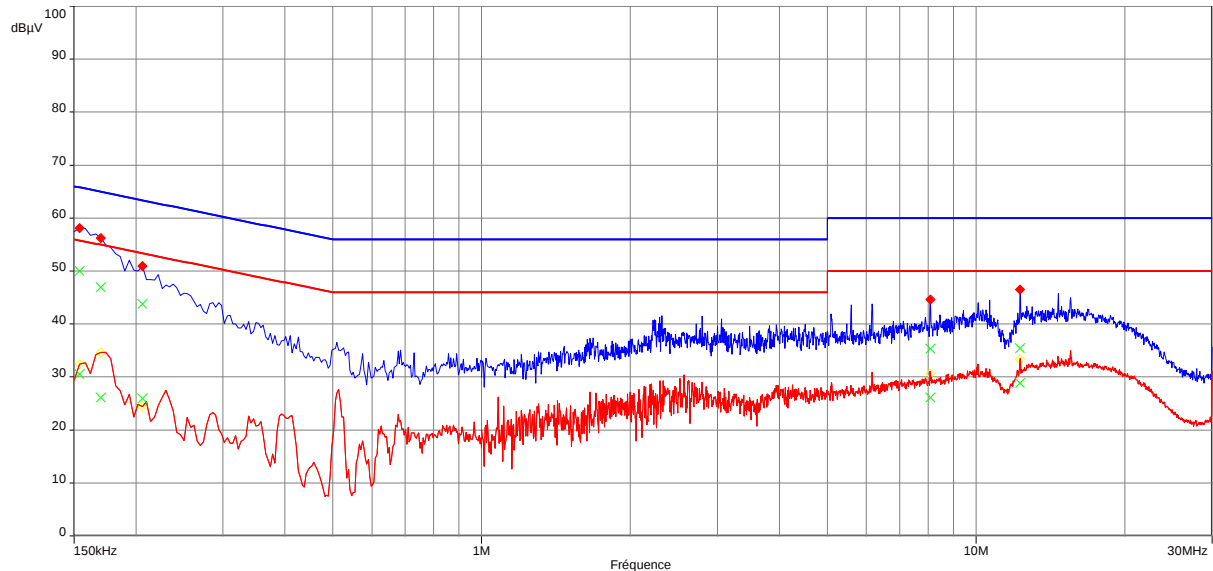
10. Conducted Emission Measurement (150 kHz-30MHz)

TEST: Limits for conducted disturbance 150kHz – 30MHz				Verdict
<u>Method:</u> 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 - 27 °C		23°C ± 2
Relative Humidity		25 - 65 %		52% ± 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 (120V/60Hz)
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: June 27 th , 2024 by C KERMICHE. Power supply voltage: 5V DC from USB-Port, powered with 120V 60Hz.				

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
0.154	58.40	49.99	65.78	-15.79	30.56	55.78	-25.22	L1
0.17	55.73	46.94	64.96	-18.02	26.13	54.96	-28.83	L1
0.206	51.67	43.82	63.37	-19.55	25.94	53.37	-27.43	L1
8.08	38.65	35.36	60.00	-24.64	26.15	50.00	-23.85	L1
12.276	39.78	35.39	60.00	-24.61	28.82	50.00	-21.18	L1
0.154	58.40	49.99	65.78	-15.79	30.56	55.78	-25.22	L1
0.162	56.50	48.23	65.36	-17.13	29.77	55.36	-25.60	N
0.226	49.43	40.80	62.60	-21.79	26.93	52.60	-25.66	N
0.258	46.33	37.59	61.50	-23.90	22.10	51.50	-29.40	N
0.458	44.83	42.02	56.73	-14.71	38.44	46.73	-8.29	N
0.49	44.68	41.67	56.17	-14.50	37.06	46.17	-9.11	N
11.52	46.79	43.38	60.00	-16.62	35.39	50.00	-14.61	N
RBW:			9kHz					
Voltage:			120V/60Hz					
Limit:			FCC Part 15.207 / 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

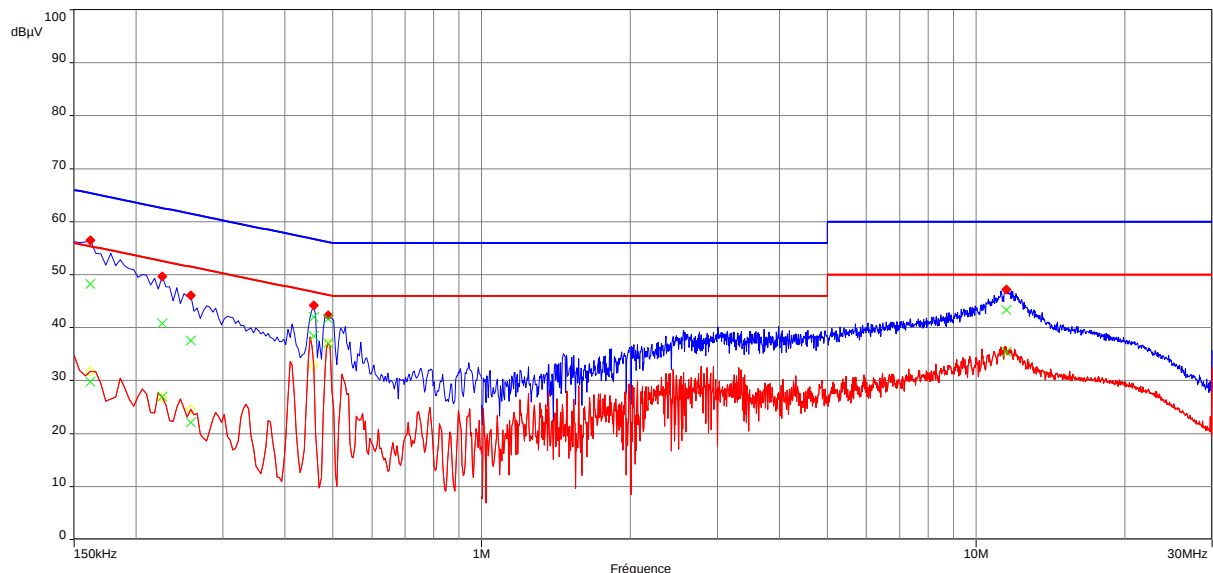


Note : Same result for all transmit modes on all channels.

~~~~~: 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.

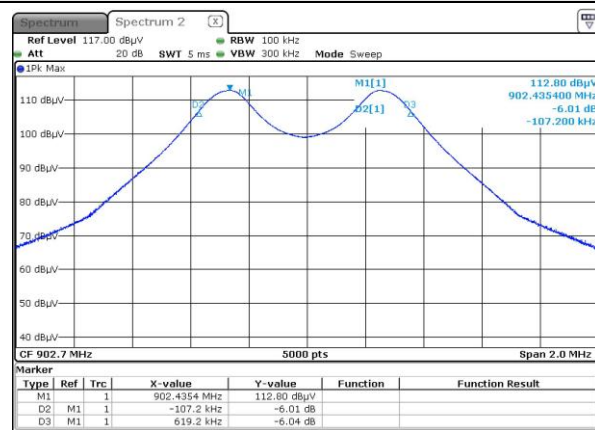
~~~~~: Peak

~~~~~: Average

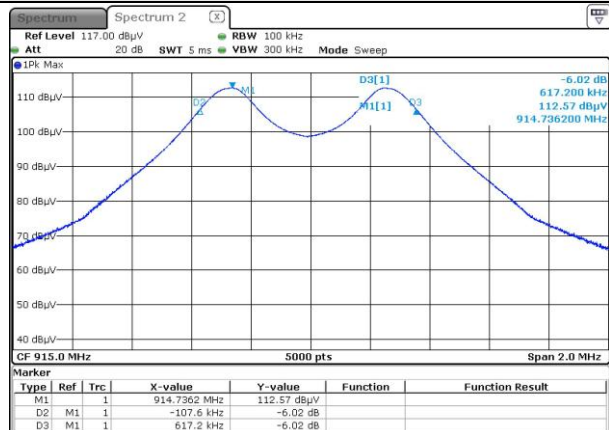
11. DTS Bandwidth

| TEST: DTS Bandwidth | | Verdict | |
|--|------------------------------------|-----------------|-----------------|
| <u>Method:</u> A conducted measurement is performed. The EUT RF output connector is connected to the spectrum analyzer.
The RBW is 100kHz, with VBW ≥ 3 x 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. | | 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 % | | 49% ± 5 |
| Limits – FCC Part 15.247 (a) / RSS-247 §5.2 (a) | | | |
| Frequency (MHz) | Level for Bandwidth | Limit | |
| 902.7 | 6dB below the maximum output power | At least 500kHz | |
| 915.0 | | | |
| 927.3 | | | |
| Supplementary information:
Test location: SMEE.
Test date: July 1 st , 2024 by C KERMICHE.
Power supply voltage: 5V DC from USB-Port. | | | |

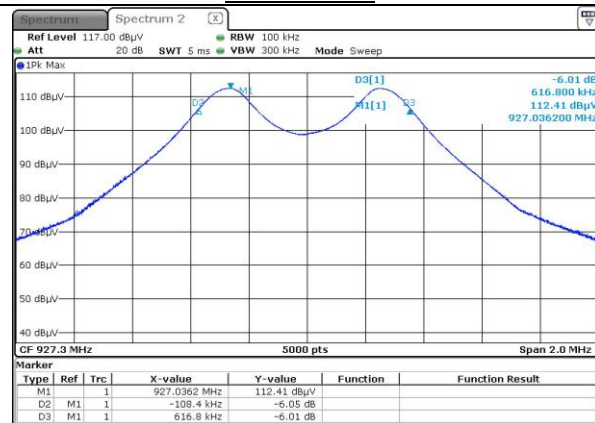
Graphical representation of 6dB Bandwidth



Low channel



Mid channel



High channel

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

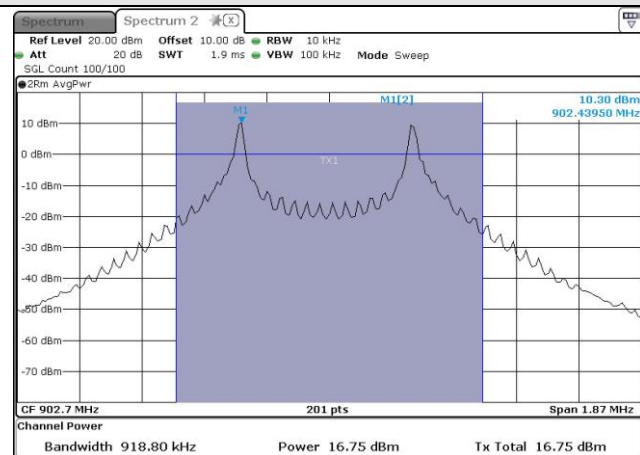
Tabulated Results for Occupied Bandwidth

| Frequency (MHz) | 6dB Bandwidth | Result |
|-----------------|---------------|--------|
| 902.7 | 726.4 kHz | Pass |
| 915.0 | 724.8 kHz | Pass |
| 927.3 | 725.2 kHz | Pass |

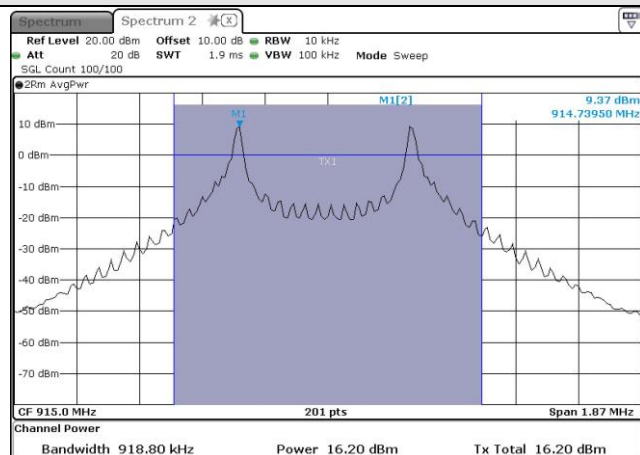
12. Maximum Peak Output power

| TEST: Maximum peak conducted output power | | Verdict |
|---|-----------------------------|-----------------|
| <p>Method: A conducted measurement is performed. The EUT RF output connector is connected to the spectrum analyzer.</p> <p>The RBW is wide enough to capture the maximum amplitude level.</p> <p>The SPAN is wide enough to capture all products of the modulation process.</p> <p>A MaxHold Peak detector is used.</p> <p>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.</p> <p>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</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 % | 52% ± 5 |
| Limits – FCC Part 15.247 (b) / RSS-247 §5.4 (d) | | |
| Frequency (MHz) | Limits (dBμV/m) | |
| | Level / Detector | Results |
| 902 to 928 | 36 dBm / Pk / 3m (Radiated) | Pass |
| 902 to 928 | 30 dBm / Pk (Conducted) | Pass |
| <p>Supplementary information:</p> <p>Test location: SMEE.</p> <p>Test date: July 1st, 2024 by C KERMICHE.</p> <p>Power supply voltage: 5V DC from USB-Port</p> | | |

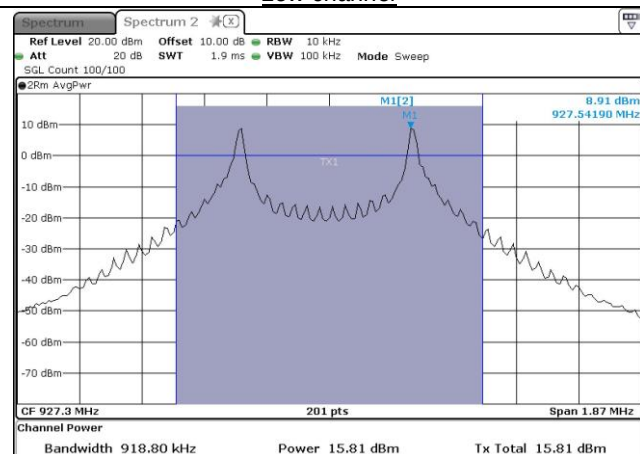
Graphical representation of Maximum conducted (average) output power



Low channel



Mid channel



High channel

| | |
|---------------------|-----------------------|
| Measurement: | Conducted measurement |
| RBW / VBW: | 10kHz / 100kHz |
| Detector: | Power averaging (rms) |
| RESULT: | PASS |

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

| FREQ | Conducted power | Antenna Gain | Radiated power E.I.R.P | Conducted Limit | Radiated Limit | Result |
|----------------|-----------------|--------------|--|-----------------|----------------|--------|
| (MHz) | (dBm) | (dBi) | (dBm) | (dBm) | (dBm) | |
| 902.7 | 16.8 | 2.0 | 18.8 | 30.0 | 36.0 | Pass |
| 915.0 | 16.2 | 2.0 | 18.2 | 30.0 | 36.0 | Pass |
| 927.3 | 15.8 | 2.0 | 17.8 | 30.0 | 36.0 | Pass |
| RESULT: | | | PASS | | | |
| Method | | | AVGSA-1 | | | |
| Note: | | | EIRP is calculated using the following equation:

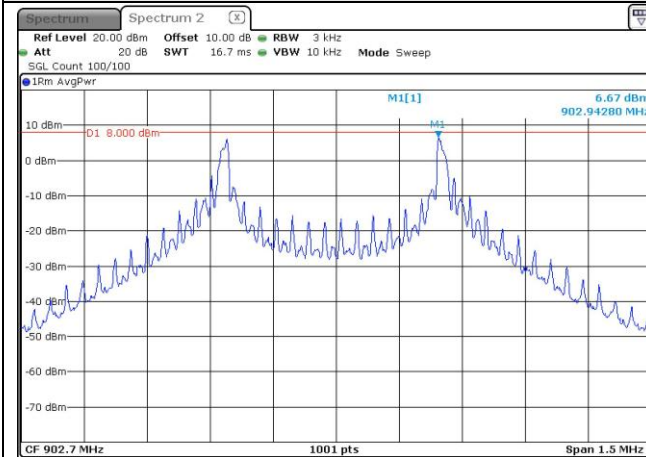
- EIRP = Conducted power (dBm) + Antenna Gain (dBi).

Where:
- Antenna gain = 2.0 dBi (declared by the manufacturer). | | | |

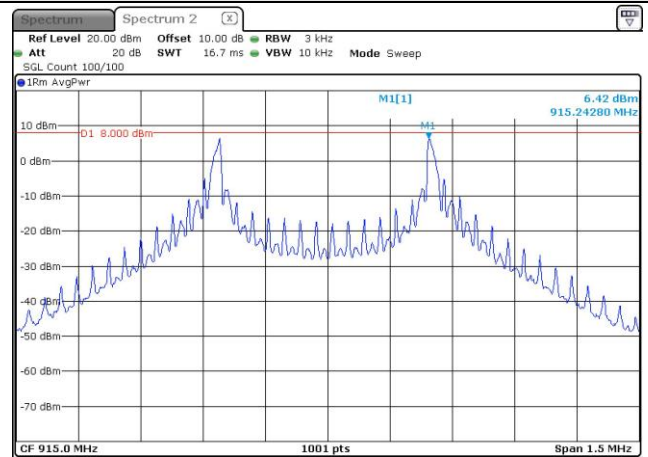
13. Maximum Power Spectral Density Level in the fundamental emission

| TEST: Maximum Peak Power Spectral Density | | Verdict |
|--|----------------------------|-----------------|
| <p>Method: A conducted measurement is performed. The EUT RF output connector is connected to the spectrum analyzer.</p> <p>The RBW is set at 3kHz.</p> <p>The SPAN is wide enough to capture all products of the modulation process.</p> <p>A MaxHold Peak detector is used.</p> <p>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.</p> <p>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</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 % | 49% ± 5 |
| Limits – FCC Part 15.247 (e) / RSS-247 §5.2 (b) | | |
| Frequency (MHz) | Level (Detector) | Limit |
| 902.7 / 915.0 / 927.3 | 8 dBm/3kHz (Pk) | Pass |
| <p>Supplementary information:</p> <p>Test location: SMEE.</p> <p>Test date: July 1st, 2024 by C KERMICHE.</p> <p>Power supply voltage: 5V DC from USB-Port.</p> | | |

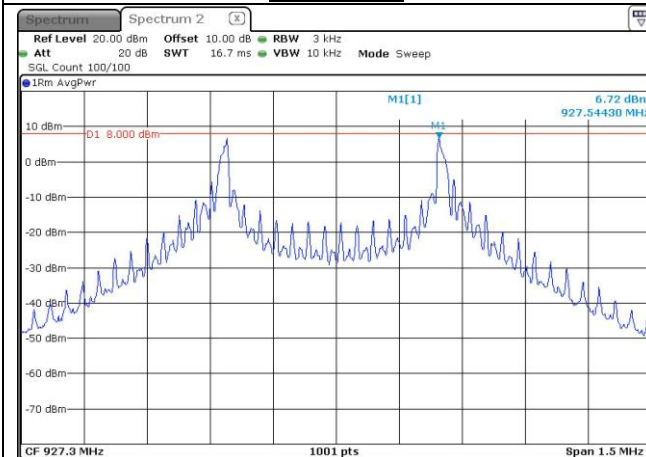
Graphical representation of Conducted output power density



Low channel



Middle channel



High channel

| | |
|------------|----------------------------|
| RBW | 3kHz |
| VBW | $\geq 3 \times \text{RBW}$ |
| Span | 1.5 times the OBW |
| Detector | Power averaging (rms) |
| Sweep time | Auto couple |

Tabulated Results for Maximum Conducted Power Spectral Density

| Frequency (MHz) | PSD (dBm/3kHz) | Limit | Result |
|-----------------|---------------------------|-----------|--------|
| 902.7 | 6.7 | 8dBm/3kHz | Pass |
| 915.0 | 6.4 | 8dBm/3kHz | Pass |
| 927.3 | 6.7 | 8dBm/3kHz | Pass |
| Limit: | FCC Part 15.247 / RSS-247 | | |
| Method | AVGPSD-1 | | |
| RESULT: | PASS | | |

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

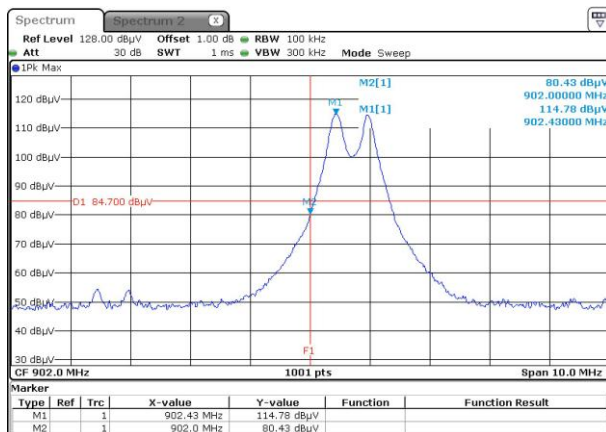
| TEST: Unwanted emissions in Non-Restricted Frequency Bands | | | Verdict |
|---|--------------------------------------|-----------------------------------|---------|
| <p><u>Method:</u> Measurements were made in a 3-meter Semi Anechoic Room (SAR) for frequency 30MHz to 1GHz and in a 3-meter Full Anechoic 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.</p> <p>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.</p> <p>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.</p> | | | Pass |
| Laboratory Parameters: | Required prior to the test | During the test | |
| Ambient Temperature | 20 to 30 °C | 23°C ± 2 | |
| Relative Humidity | 25 to 70 % | 49% ± 5 | |
| Fully configured sample scanned over the following frequency range | Frequency range on each side of line | Measurement Point | |
| | 30MHz – 10GHz | 3m measurement distance | |
| Limits – FCC Part 15.247 (d) / RSS-247 § 5.5 | | | |
| Frequency (MHz) | Limits (dBµV/m) | | Results |
| | Detector / Analyser RBW | Limit | |
| 30 to 10000 | Pk / 100kHz | 30dB below the maximum Peak level | Pass |
| Supplementary information:
Test location: SMEE
Test date: June 19 th , 2024 by C. KERMICHE
Power supply voltage: 5V DC from USB-Port | | | |

| Tabulated Results for Peak Output Radiated level | |
|--|---|
| FREQ | Field Strength 3m |
| (MHz) | (dBµV/m) |
| 902.7 | 114.7 ⁽¹⁾ |
| 915.0 | 115.3 ⁽¹⁾ |
| 927.3 | 116.9 ⁽¹⁾ |
| RBW: | 100kHz |
| Measurement distance: | 3m |
| Limit: | Ref. level only – For 15.247 (d) / RSS-247 § 5.5 |
| Final measurement detector: | Average |
| Note: | (1) : Only for identification of limit in non-restricted band
Limit is 84.7 dBµV/m Peak for out-of-band frequencies in Non-Restricted bands (with a 100kHz RBW on the spectrum analyzer). |

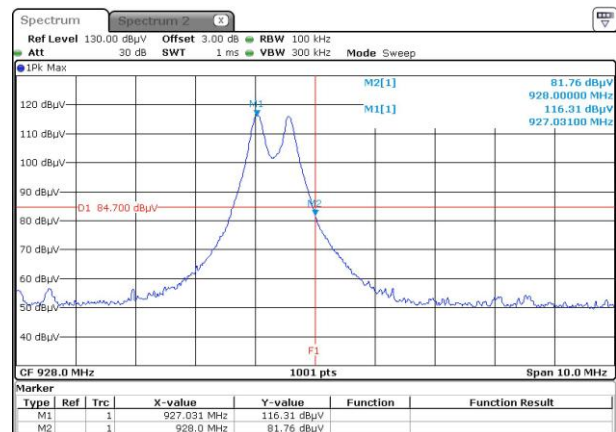
Tabulated Results for Unwanted emissions in Non-Restricted bands (30M-10GHz)

| FREQ (MHz) | Field Strength 3m (dBμV/m) | Limit (dBμV/m) | Margin (dBμV/m) | Result (dBμV/m) |
|--|--|----------------|-----------------|-----------------|
| All levels are at least 10dB below applicable limits | | | | |
| RBW: | 100kHz | | | |
| Measurement distance: | 3m | | | |
| Limit: | FCC 15.247 / RSS-247 | | | |
| Final measurement detector: | Peak | | | |
| RESULT: | PASS | | | |
| Note: | See band-edge measurement.
See pre-scan graphs in chapter 15. | | | |

Graphical representation of Band-edge compliance (Low & High channel)



Low frequency



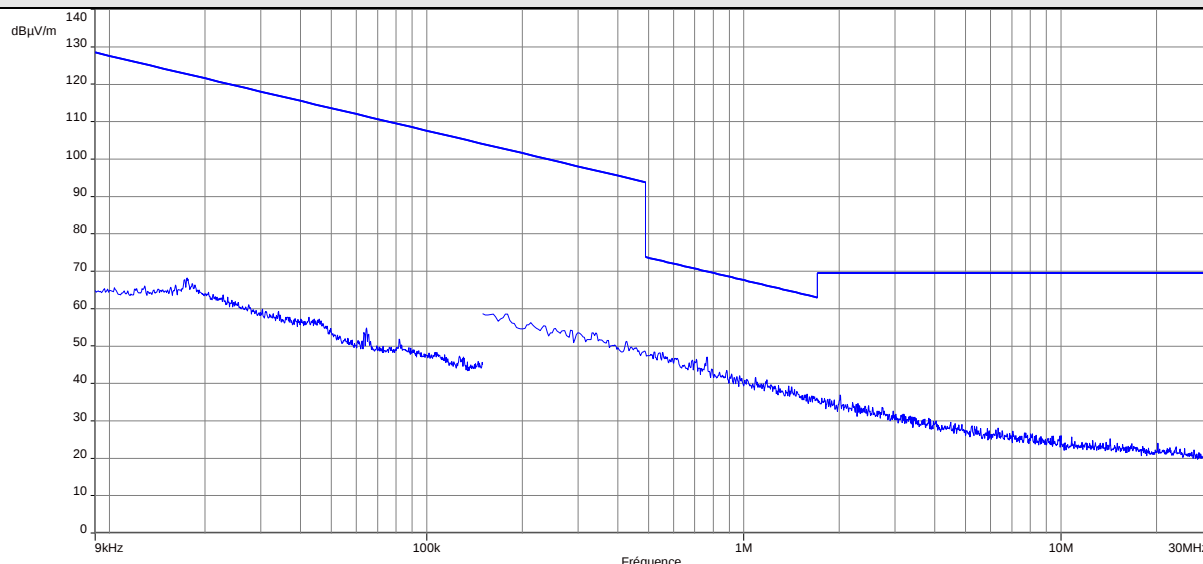
High frequency

| FREQ (MHz) | Field Strength (dBμV/m) | Limit (dBμV/m) | Margin (dB) | Result (dBμV/m) |
|------------|-------------------------|----------------|-------------|-----------------|
| 902.7 | 80.4 | 84.7 | -4.3 | Pass |
| 927.3 | 81.8 | 84.7 | -2.9 | Pass |
| RBW | 100kHz | | | |
| VBW | ≥ 3 x RBW | | | |
| Trace | Max Hold | | | |
| Detector | Peak | | | |
| Result | Pass | | | |

15. 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.</p> <p>The Semi Anechoic Room complies with CISPR16-1-4 / ANSI C63.4 requirements.</p> <p>For frequency 9kHz to 30MHz, measurements are performed on a free-space open area test site at 10m distance.</p> <p>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.</p> <p>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.</p> | | | Pass |
| Laboratory Parameters: | Required prior to the test | During the test | |
| Ambient Temperature | 20 to 30 °C | 23°C ± 2 | |
| Relative Humidity | 25 to 70 % | 49% ± 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: June 18 th , 2024 by C KERMICHE.
Power supply voltage: 5V DC from USB-Port. | | | |

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 transmit mode on all channels.

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
(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:

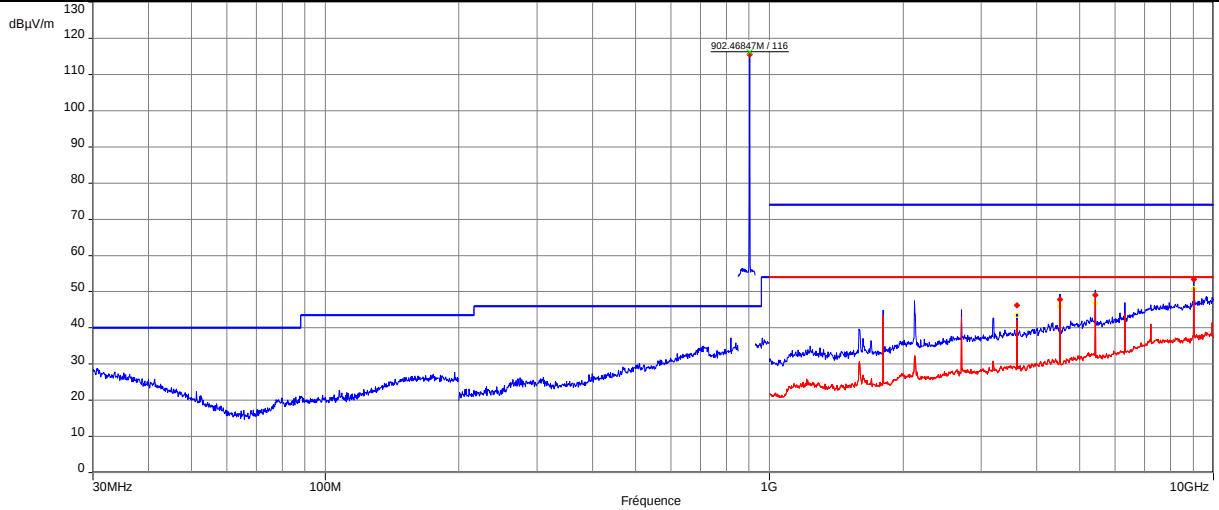
Frequency list measured has been created with pre-scan results.

| | |
|-------------------------------------|---|
| 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
(M@30m = M@10m-19.1dB)
Loop antenna used and rotated about its axis to maximize any emission. |

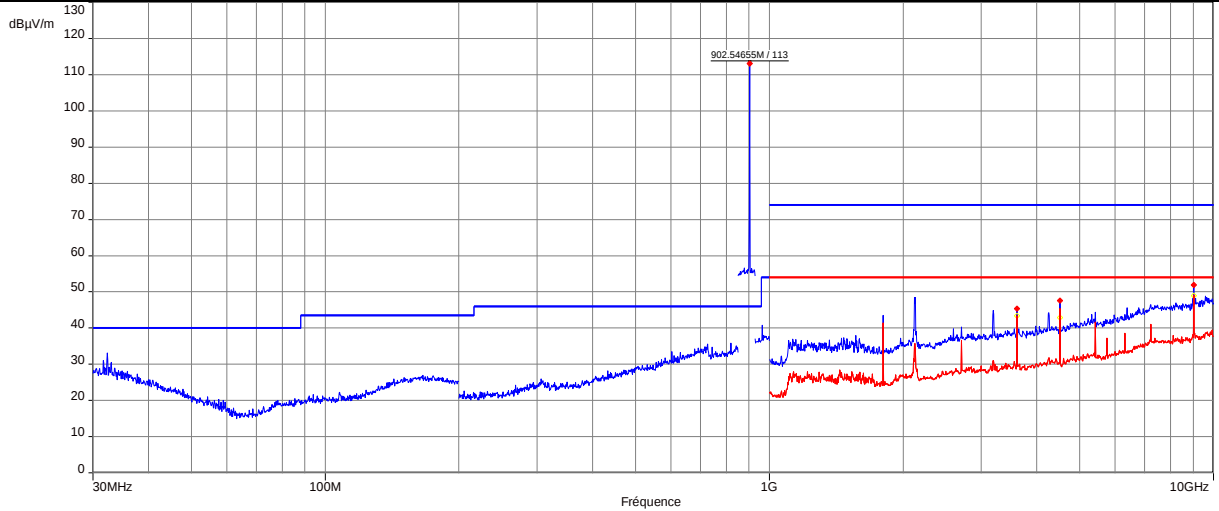
Graphical of Radiated Disturbance Measurement (Peak and Average Measurement, 30MHz-10GHz)

Center frequency: Tx / 902.7MHz

HORIZONTAL POLARIZATION



VERTICAL POLARIZATION

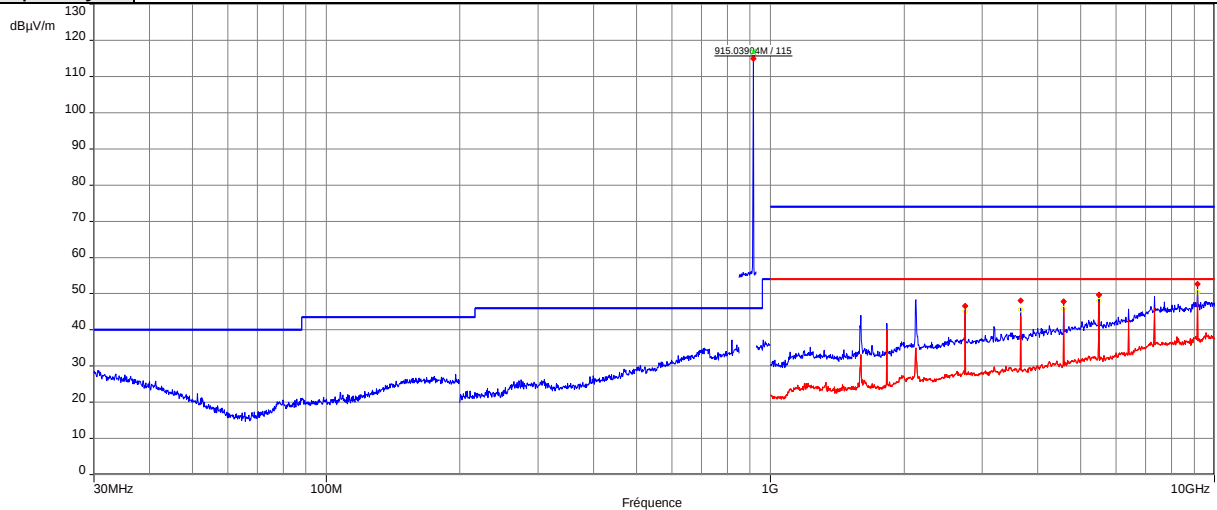


| FREQ (MHz) | Field Strength 3m PK (dBμV/m) | Field Strength 3m QP or AV (dBμV/m) | Limit PK (dBμV/m) | Margin Peak (dBμV/m) | Limit PQ or AV (dB) | Margin QP or AV (dBμV/m) | Table angle (°) | Ant height (m) | Total factor (dB) | Pol (H/V) | Detector & Limit QP |
|----------------------------------|-------------------------------|-------------------------------------|--|----------------------|---------------------|--------------------------|-----------------|----------------|-------------------|-----------|---------------------|
| 3609.98931 | 47.82 | 44.47 | 74.00 | -26.18 | 54.00 | -9.53 | 157.00 | 1.09 | -4.07 | H | PK&AV |
| 4512.53728 | 49.89 | 45.86 | 74.00 | -24.11 | 54.00 | -8.14 | 151.40 | 1.53 | -1.66 | H | PK&AV |
| 5415.12917 | 50.16 | 45.49 | 74.00 | -23.84 | 54.00 | -8.51 | 136.20 | 1.10 | 1.54 | H | PK&AV |
| 9025.09905 | 54.69 | 49.26 | 74.00 | -19.31 | 54.00 | -4.74 | 261.90 | 1.09 | 9.09 | H | PK&AV |
| 3610.17476 | 45.23 | 40.63 | 74.00 | -28.77 | 54.00 | -13.37 | 120.20 | 1.91 | -4.07 | V | PK&AV |
| 4512.3545 | 47.87 | 42.58 | 74.00 | -26.13 | 54.00 | -11.42 | 137.60 | 1.25 | -1.66 | V | PK&AV |
| 9025.18979 | 54.10 | 48.32 | 74.00 | -19.90 | 54.00 | -5.68 | 277.00 | 1.43 | 9.09 | V | PK&AV |
| Frequency and Limit band: | | | 30Mz-10GHz / FCC 15.209 / RSS-GEN. | | | | | | | | |
| RBW and Limit detector: | | | Below 1GHz: RBW= 120kHz, Quasi-Peak / above 1GHz: RBW= 1MHz, Peak and CISPR Average. | | | | | | | | |
| Results | | | PASS. | | | | | | | | |

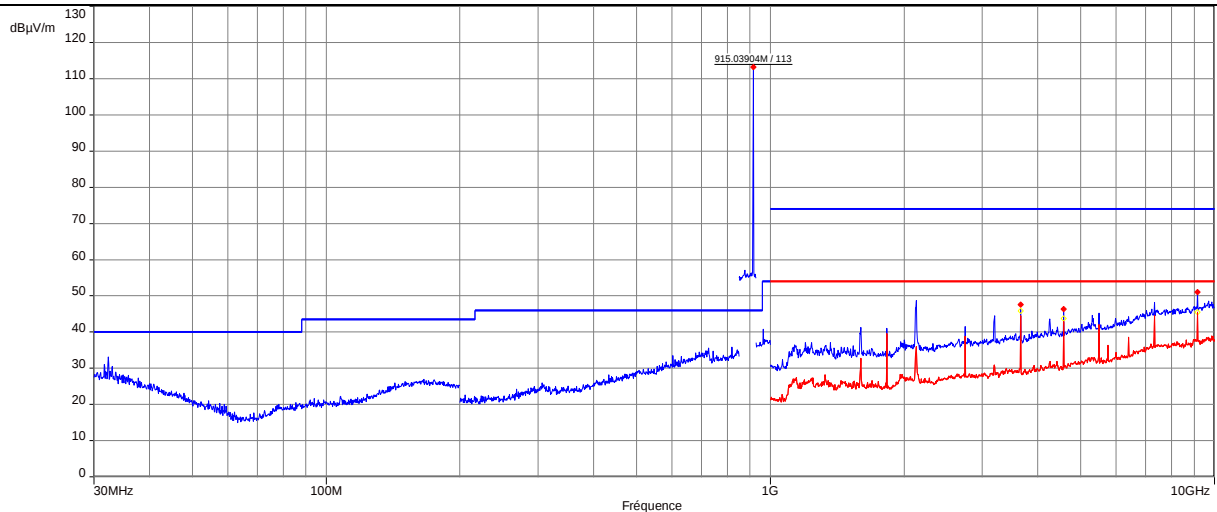
Graphical of Radiated Disturbance Measurement (Peak and Average Measurement, 30Mz-10GHz)

Center frequency: Tx / 915 MHz

HORIZONTAL POLARIZATION



VERTICAL POLARIZATION

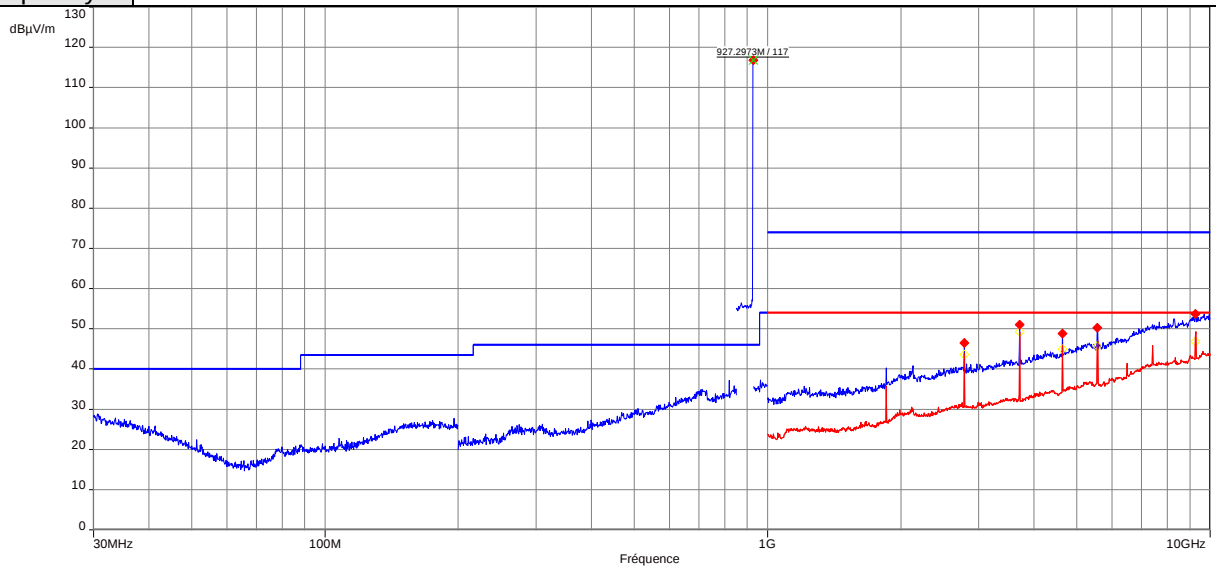


| FREQ (MHz) | Field Strength 3m PK (dBμV/m) | Field Strength 3m QP or AV (dBμV/m) | Limit PK (dBμV/m) | Margin Peak (dBμV/m) | Limit PQ or AV (dB) | Margin QP or AV (dBμV/m) | Table angle (°) | Ant height (m) | Total factor (dB) | Pol (H/V) | Detector & Limit QP |
|----------------------------------|-------------------------------|-------------------------------------|--|----------------------|---------------------|--------------------------|-----------------|----------------|-------------------|-----------|---------------------|
| 2744.96551 | 47.08 | 43.42 | 74.00 | -26.92 | 54.00 | -10.58 | 43.30 | 1.58 | -5.62 | H | PK&AV |
| 3659.89691 | 49.48 | 46.66 | 74.00 | -24.52 | 54.00 | -7.34 | 280.30 | 1.37 | -4.11 | H | PK&AV |
| 4574.89951 | 47.38 | 42.59 | 74.00 | -26.62 | 54.00 | -11.41 | 82.60 | 1.09 | -1.46 | H | PK&AV |
| 5489.9941 | 51.00 | 47.85 | 74.00 | -23.00 | 54.00 | -6.15 | 132.50 | 1.09 | 1.48 | H | PK&AV |
| 3660.16288 | 49.19 | 46.13 | 74.00 | -24.81 | 54.00 | -7.87 | 192.10 | 1.10 | -4.11 | V | PK&AV |
| 4575.1782 | 47.62 | 43.78 | 74.00 | -26.38 | 54.00 | -10.22 | 210.50 | 1.09 | -1.46 | V | PK&AV |
| 9150.03838 | 52.61 | 45.22 | 74.00 | -21.39 | 54.00 | -8.78 | 279.70 | 1.28 | 8.59 | V | PK&AV |
| Frequency and Limit band: | | | 30Mz-10GHz / FCC 15.209 / RSS-GEN. | | | | | | | | |
| RBW and Limit detector: | | | Below 1GHz: RBW= 120kHz, Quasi-Peak / above 1GHz: RBW= 1MHz, Peak and CISPR Average. | | | | | | | | |
| Results | | | PASS. | | | | | | | | |
| Note: | | | Pre-scan graphic only for identification. | | | | | | | | |

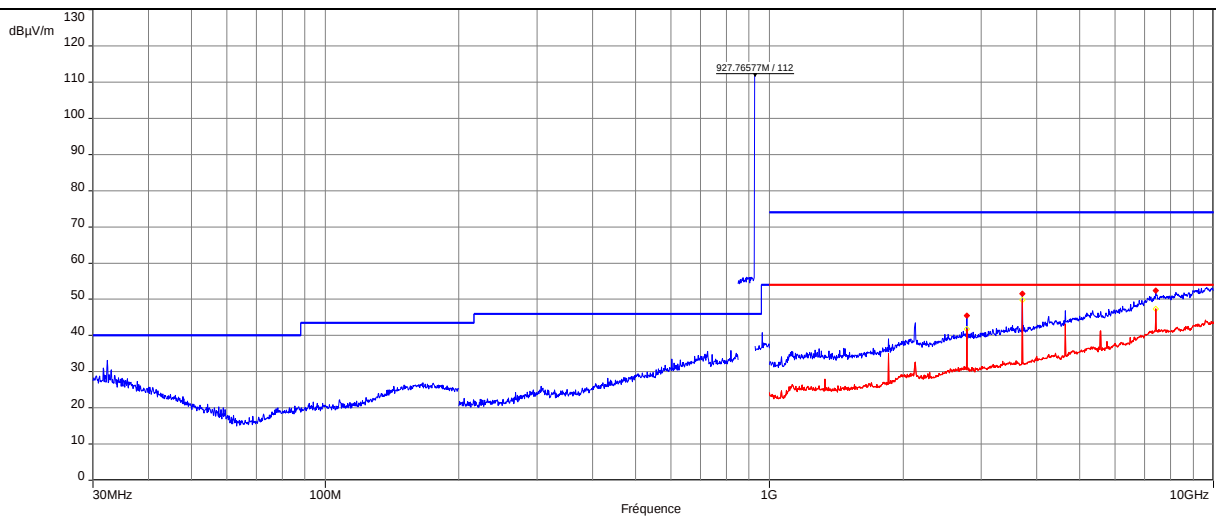
Graphical of Radiated Disturbance Measurement (Peak and Average Measurement, 30Mz-10GHz)

Center frequency: Tx / 927.3 MHz

HORIZONTAL POLARIZATION



VERTICAL POLARIZATION



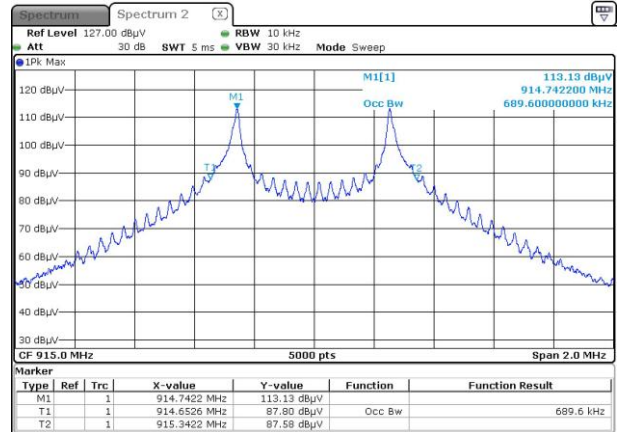
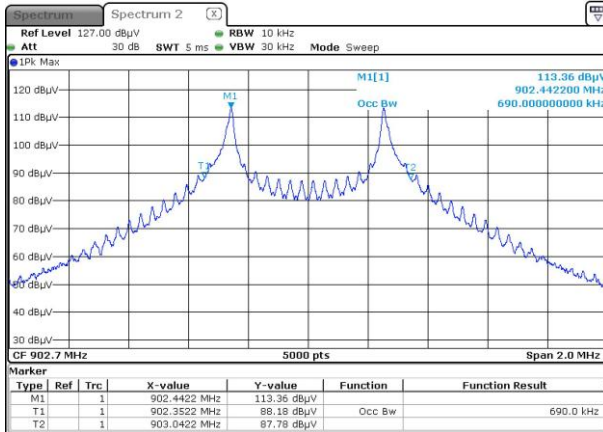
| FREQ (MHz) | Field Strength 3m PK (dBµV/m) | Field Strength 3m QP or AV (dBµV/m) | Limit PK (dBµV/m) | Margin Peak (dBµV/m) | Limit PQ or AV (dB) | Margin QP or AV (dBµV/m) | Table angle (°) | Ant height (m) | Total factor (dB) | Pol (H/V) | Detector & Limit QP |
|----------------------------------|-------------------------------|-------------------------------------|--|----------------------|---------------------|--------------------------|-----------------|----------------|-------------------|-----------|---------------------|
| 2781.72689 | 48.22 | 39.78 | 74.00 | -25.78 | 54.00 | -14.22 | 59.20 | 1.09 | -5.55 | H | PK&AV |
| 3710.96599 | 52.28 | 44.35 | 74.00 | -21.72 | 54.00 | -9.65 | 224.20 | 1.80 | -4.08 | H | PK&AV |
| 4636.27095 | 50.41 | 40.94 | 74.00 | -23.59 | 54.00 | -13.06 | 68.80 | 1.30 | -1.04 | H | PK&AV |
| 5563.38989 | 52.40 | 42.35 | 74.00 | -21.60 | 54.00 | -11.65 | 150.00 | 1.46 | 1.50 | H | PK&AV |
| 9272.4668 | 56.14 | 45.33 | 74.00 | -17.86 | 54.00 | -8.67 | 142.10 | 1.52 | 8.71 | H | PK&AV |
| 2781.75279 | 44.95 | 36.67 | 74.00 | -29.05 | 54.00 | -17.33 | 130.60 | 1.09 | -5.55 | V | PK&AV |
| 3708.90741 | 51.76 | 40.58 | 74.00 | -22.24 | 54.00 | -13.42 | 200.50 | 1.19 | -4.09 | V | PK&AV |
| 7417.79686 | 51.35 | 36.07 | 74.00 | -22.65 | 54.00 | -17.93 | 200.70 | 1.09 | 7.10 | V | PK&AV |
| Frequency and Limit band: | | | 30Mz-10GHz / FCC 15.209 / RSS-GEN. | | | | | | | | |
| RBW and Limit detector: | | | Below 1GHz: RBW= 120kHz, Quasi-Peak / above 1GHz: RBW= 1MHz, Peak and CISPR Average. | | | | | | | | |
| Results | | | PASS. | | | | | | | | |
| Note: | | | Pre-scan graphic only for identification. | | | | | | | | |

16. Occupied bandwidth (99%)

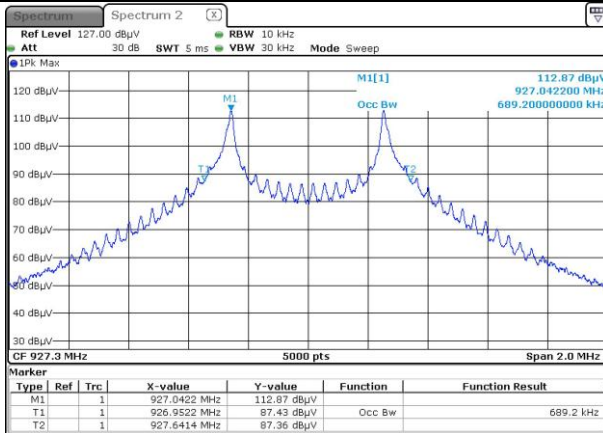
| TEST: Occupied bandwidth (99%) / RSS-GEN | | Verdict |
|--|----------------------------|-----------------|
| <p>Method: A conducted measurement is performed. The EUT RF output connector is connected to the spectrum analyzer.</p> <p>The RBW is set in the range of 1% to 5% of the OBW, with VBW $\geq 3 \times$ RBW.</p> <p>The SPAN is wide enough to capture all products of the modulation process. (Between 1.5 to 5 times the OBW).</p> <p>A MaxHold Peak detector is used. Automatic function of the spectrum analyser is used.</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 $\pm$ 2 |
| Relative Humidity | 25 to 70 % | 49% $\pm$ 5 |
| <p>Supplementary information:</p> <p>Test location: SMEE.</p> <p>Test date: July 1st, 2024 by C KERMICHE.</p> <p>Power supply voltage: 5V DC from USB-Port</p> | | |

| Tabulated Results for 99% Occupied Bandwidth | |
|--|---------------------------------|
| Frequency
(MHz) | 99% Occupied Bandwidth
(kHz) |
| 902.7 | 690.0 |
| 915.0 | 689.6 |
| 927.3 | 689.2 |

Graphical representation of 99% Occupied Bandwidth



Low channel



High channel

Mid channel

| | |
|------------------------------|------------------|
| Frequency band investigated: | 902MHz to 928MHz |
| RBW : | 10kHz |
| Measurement detector: | Peak |

17. Test Equipment List

| Test Equipment Used for conducted emission | | | | | |
|--|---------------|-----------------|-------------|-----------|----------|
| Description | Manufacturer | Model | Identifier | Cal. Date | Cal. Due |
| AC power supply | PACIFIC POWER | AMX-125 | ALI-101-002 | 2023/8 | 2024/8 |
| Attenuator / limiter | SMEE | ATT#2 | ATT-171-010 | 2024/4 | 2025/4 |
| RF cable | RADIAL | RG58 / BNC / 5m | CAB-211-042 | 2024/4 | 2025/4 |
| Measuring receiver | Rohde&Schwarz | ESRP | REC-151-002 | 2021/12 | 2024/7 |
| LISN (50Ω / 50μH) | AFJ | LS16C | RSI-101-001 | 2023/7 | 2025/7 |
| EMC Software | NEXIO | BAT EMC | SOF-101-001 | - | - |

| Test Equipment Used for conducted antenna port measurement | | | | | |
|--|---------------|-----------|-------------|-----------|----------|
| Description | Manufacturer | Model | Identifier | Cal. Date | Cal. Due |
| RF Attenuator | Mini-Circuit | BW-N10W5+ | ATT-171-008 | 2024/4 | 2025/4 |
| Spectrum analyzer | Rohde&Schwarz | FSV40 | ASP-171-004 | 2021/12 | 2024/7 |

| Test Equipment Used for radiated emission | | | | | |
|---|------------------|------------------|-------------|-----------|----------|
| Description | Manufacturer | Model | Identifier | Cal. Date | Cal. Due |
| AC power supply | PACIFIC POWER | AMX-125 | ALI-101-002 | 2023/8 | 2024/8 |
| Horn antenna | COM-POWER | AH-118 | ANT-101-004 | 2021/7 | 2024/7 |
| Loop antenna | EMCO | 6502 | ANT-101-009 | 2023/9 | 2025/9 |
| Log-periodic antenna | EMCO | 3146 | ANT-191-019 | 2024/3 | 2026/3 |
| Biconnic antenna | COM-POWER | AB- 900A | ANT-201-021 | 2023/01 | 2025/1 |
| Measuring receiver | Rohde&Schwarz | ESRP | REC-151-002 | 2021/12 | 2024/7 |
| Spectrum analyzer | Rohde&Schwarz | FSV40 | ASP-171-004 | 2024/4 | 2026/10 |
| RF cable | Div | OATS/25m | CAB-101-017 | 2024/4 | 2025/4 |
| RF cable | HUBER+SUHNER | SF104E (NN/1m) | CAB-231-049 | 2024/4 | 2025/4 |
| RF cable | HUBER+SUHNER | SF126E (NN/2m) | CAB-231-043 | 2024/4 | 2025/4 |
| RF cable | HUBER+SUHNER | SF104E (NN/5,3m) | CAB-231-044 | 2024/4 | 2025/4 |
| RF cable | HUBER+SUHNER | SF104E (NN/7m) | CAB-231-045 | 2024/4 | 2025/4 |
| Semi anechoic room | COMTEST | 218292 | CAG-201-002 | 2022/4 | 2025/4 |
| High-pass filter | Wainwright Inst. | HK6-948-1200 | FIL-141-004 | 2024/4 | 2025/4 |
| Antenna mast SAC | Innco- Systems | MA4640-XP-ET | MAT-201-002 | - | - |
| Turntable SAC | Innco- Systems | DS1500-S-1t | PLA-201-003 | - | - |
| Pre-amplifier | COM-POWER | 1-18GHz | PRE-221-005 | 2024/4 | 2025/4 |
| FS OATS | Div | 10m | SIT-201-002 | - | - |
| EMC Software | NEXIO | BAT EMC | SOF-101-001 | - | - |

END OF REPORT