

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

Matériel testé :
Equipment under test:

LIVING PACKETS / THE BOX-THE BOX PRO-THE TABLET

(Trademark / Marketing name or product reference)

Demandeur de certification : **LivingPackets SA**
Applicant for certification: Avenue C-F. Ramuz 80 - 1009 Pully – Switzerland

Client : **SGS FRANCE**
Customer: 135. rue René Descartes – 13857 Aix en Provence – France

Numéro d'affaire : 15417
Work number :

Référence de la proposition : 062022-25510-1
Proposal number:

Date de l'essai : Du 15 au 17 janvier 2024
Date of test: January 15th to 17th, 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 : 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	May 21 st , 2024	Initial Edition	Laurent CHAPUS Test operator	Géraldine Guyennot Technical reviewer

La copie de ce document n'est permise que sous sa forme intégrale. Ce document est le résultat d'essais effectués sur un échantillon. Il ne préjuge pas de la conformité de l'ensemble des produits fabriqués à l'objet essayé. Pour la déclaration de conformité de l'équipement, il n'est pas tenu compte de l'incertitude de mesure. Cette nouvelle édition de ce rapport annule et remplace l'édition précédente. Les modifications apportées à une nouvelle édition de ce rapport sont signalées par un trait vertical à gauche de la page. L'utilisation de la marque d'accréditation COFRAC est interdite.
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COORDONNEES

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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 (January 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 ICES & RSS	Spec. FCC Part 15 / ISED ICES & 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	-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 §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 LIVING PACKETS / THE BOX-THE BOX PRO-THE TABLET, 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**

**LIVING PACKETS / THE BOX-THE BOX PRO-THE
TABLET**

(Trademark / Marketing name or product reference)

FCC ID:

2BDUMTHEBOX

IC:

31698-THEBOX

Model / HVIN:

THE BOX-THE BOX PRO-THE TABLET

Product name / PMN:

THE BOX-THE BOX PRO-THE TABLET

FVIN:

3.7

Modular approval:

No

**Différence des modèles /
Model difference**

All models contain the same electronic tablet. (THE TABLET)
Difference is from the size of the box in which the tablet is integrated.
All tests are performed with the model THE BOX PRO (395mmx400x300)

**Alimentation /
Power supply**

5V DC for battery charging from USB C connector

**Auxiliaires /
Auxiliaries**

AC adapter
Laptop ASUS, model HP G6-2317sl for programming only (Sn: 5CD3124BOM)
AC/DC power adapter: UGREEN Group Limited, Model CD122 (5V/3.0A)

**Entrées-Sorties /
Input / Output**

	Câbles pour essai / Cables for test	Blindé / Shielded	Prévu pour >3m / Intended for >3m
USB-Type C Connector (Power only)	2.0m	Yes	No

**Mode de fonctionnement /
Running mode**

The tested sample is able to:
- Transmit a carrier frequency on low, middle and high channels (Bluetooth Low Energy).
The device is powered by 5V DC for battery charging.

**Programme de test /
Test program /**

LP-Tool 7.3.1

**Fréquence max interne EST /
Max internal EUT frequency**

2.480GHz for BLE RF data transmission.

**Information sur l'équipement /
Equipment information**

Declaration of the applicant:
- Frequency band: 2400 to 2483.5 MHz (Tx & Rx, Wideband Data Transmission systems)
- BLE Power Setting: Power is set at 1dBm
- Duty cycle: 50%
- Modulation: Bluetooth Low Energy GFSK (1Mbps) for DTS
- Antenna type: Stamp metal (Antenna gain 3.4dBi)
- Powered by 5V DC from external power supply
- Equipment intended for use as a mobile device
- Equipment designed for continuous operation

**Dimensions de l'EST /
Dimensions of EUT**

Tested sample 395mmx400x300
Sn : none

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

4. Test conditions

Power supply voltage:
Equipment under test: 5V DC from power adapter
Auxiliaries: 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

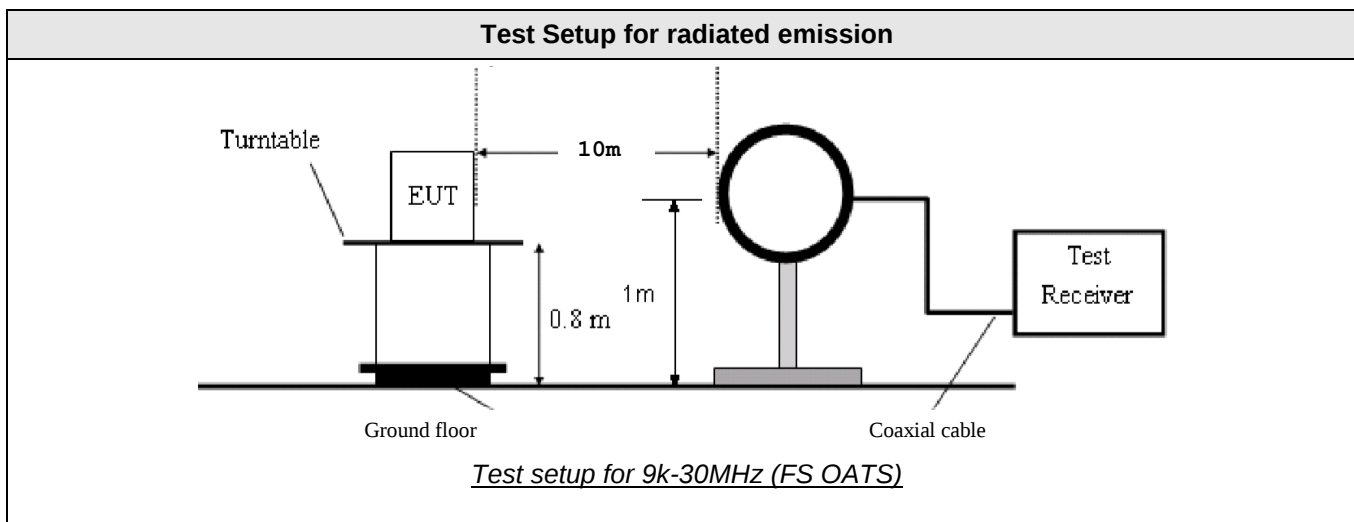
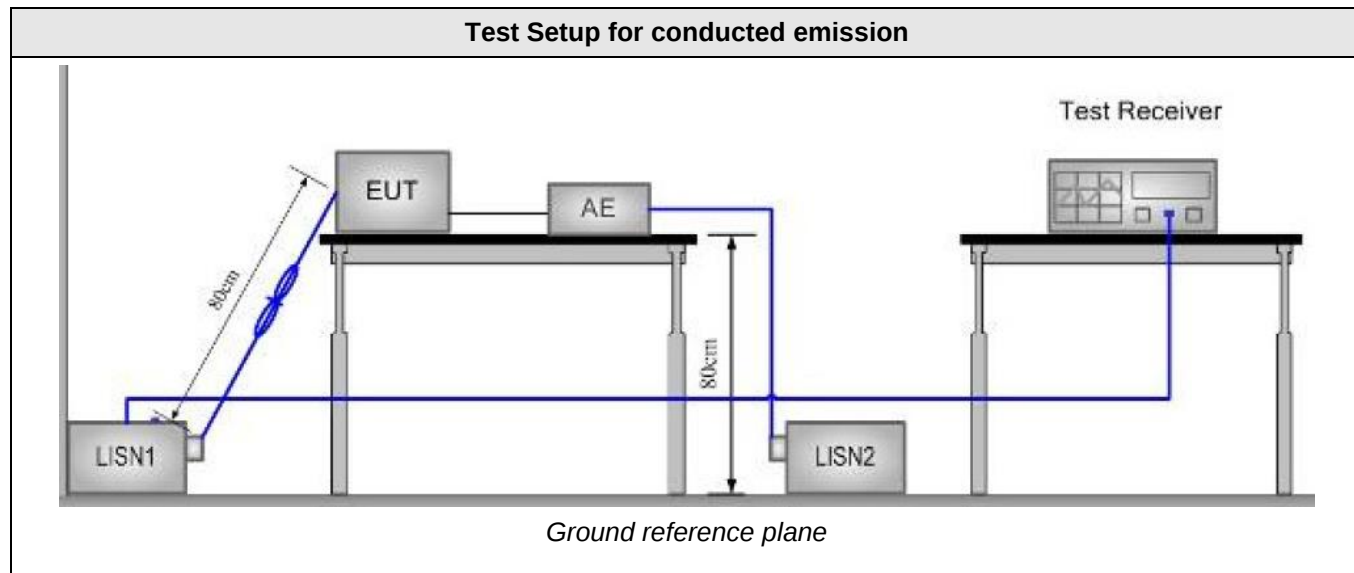
Example:

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

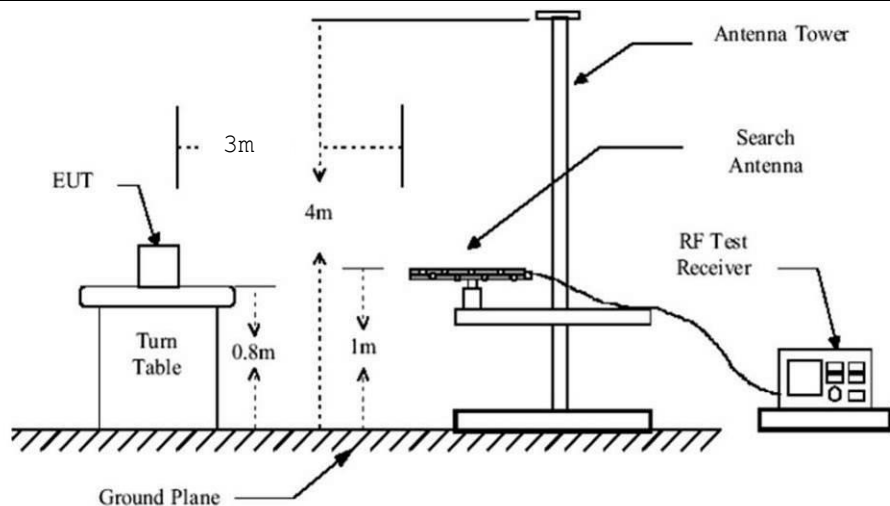
→ Total factor: 5dBm⁻¹

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

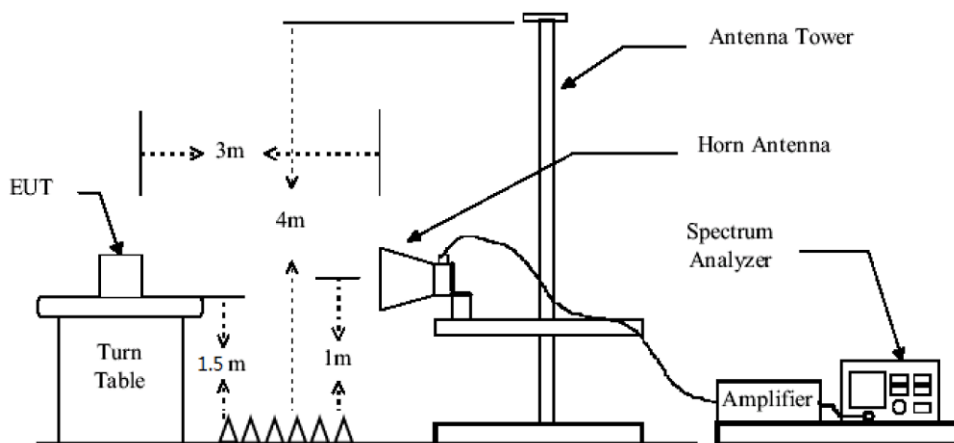
9. Test Setup Diagram



Test Setup for radiated emission



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



Test setup for 1-25GHz (SAC 3m, tilt antenna mast used)

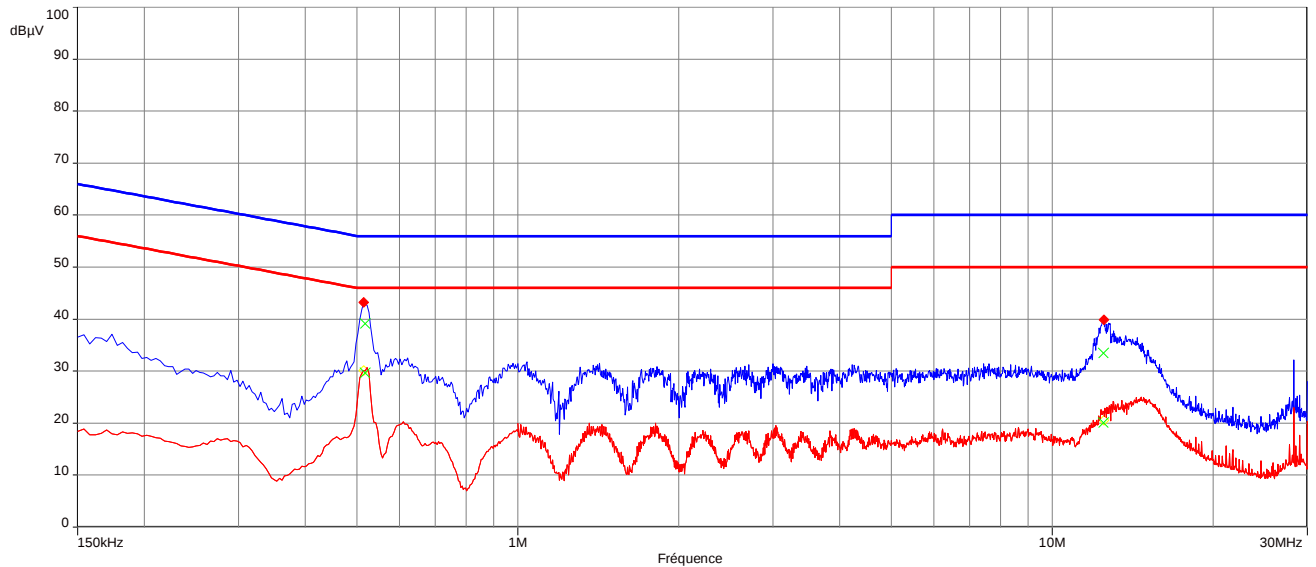
10. Conducted Emission Measurement (150 kHz-30MHz)

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		20°C ± 2
Relative Humidity		25 - 65 %		40% ± 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: January 17 th , 2024 by L. CHAPUS. Power supply voltage: 5V DC from USB adapter.				

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
0.5173	42.85	39.12	56	-16.88	29.64	46	-16.36	L1
12.4586	40.21	33.42	60	-26.58	20.06	50	-29.94	L1
0.519482	42.24	38.64	56	-17.36	33.44	46	-12.56	N
12.5024	38.76	31.99	60	-28.01	15.48	50	-34.52	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

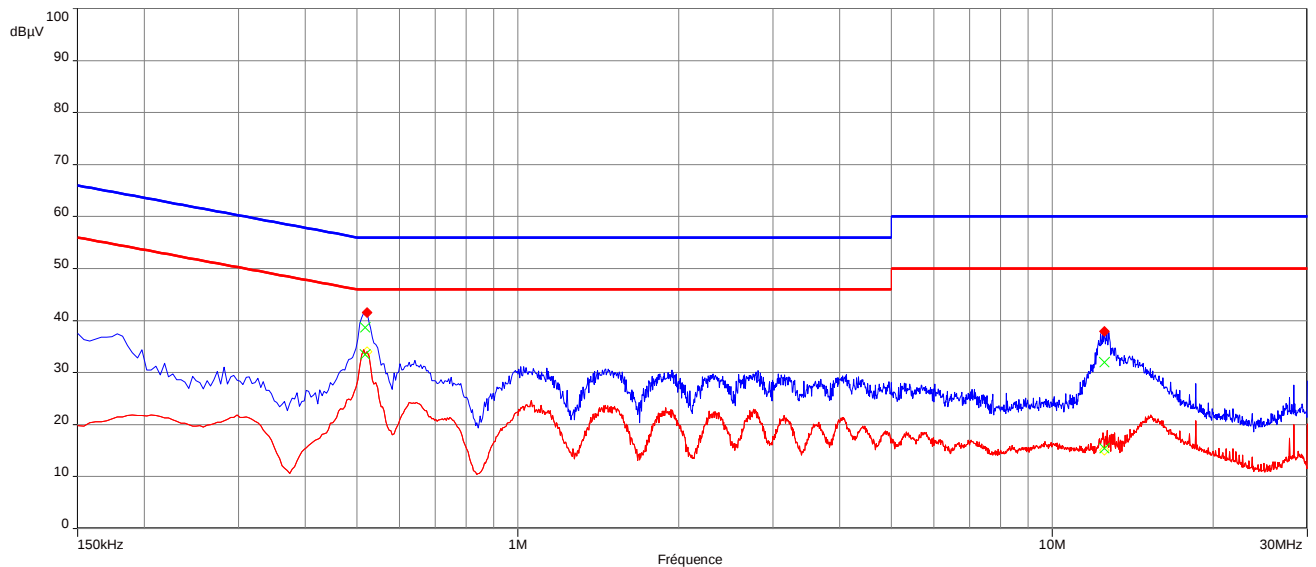


Note : Same result for all transmit modes on all channels.

~~~~~: 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

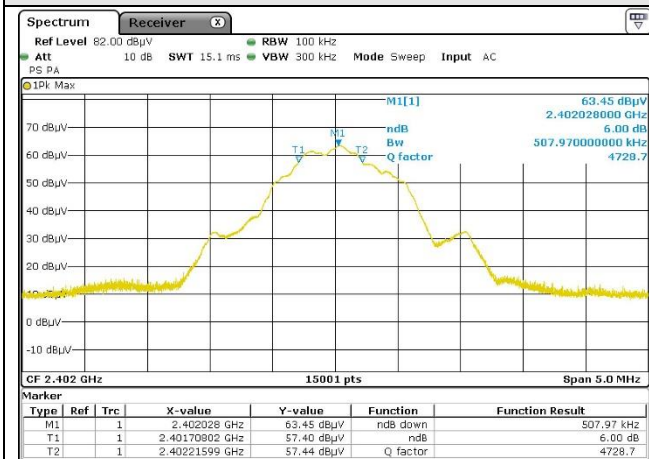
~~~~~: Average

11. DTS Bandwidth

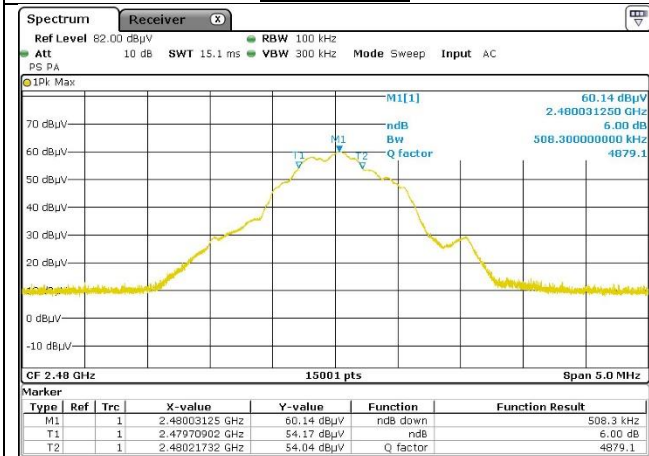
| TEST: DTS Bandwidth | | | Verdict |
|--|------------------------------------|-----------------|---------|
| <p>Method: The setup is in an anechoic chamber. The spectrum analyzer is connected to the measuring antenna. A radiated measurement is performed.</p> <p>The RBW is 100kHz, with VBW ≥ 3 x RBW.</p> <p>The SPAN is wide enough to capture all products of the modulation process.</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 | 17 - 27 °C | 20°C ± 2 | |
| Relative Humidity | 25 - 65 % | 40% ± 5 | |
| Limits – FCC Part 15.247 (a) / RSS-247 §5.2 (a) | | | |
| Frequency (MHz) | Level for Bandwidth | Limit | |
| 2402.0 | 6dB below the maximum output power | At least 500kHz | |
| 2440.0 | | | |
| 2480.0 | | | |
| Supplementary information:
Test location: SMEE
Test date: January 16 th , 2024 by L. CHAPUS.
Power supply voltage: 5V DC from USB adapter. | | | |

| Tabulated Results for Occupied Bandwidth | | |
|--|---------------------|--------|
| Frequency (MHz) | 6dB Bandwidth (kHz) | Result |
| 2402.0 | 507.97 | Pass |
| 2440.0 | 508.63 | Pass |
| 2480.0 | 508.30 | Pass |

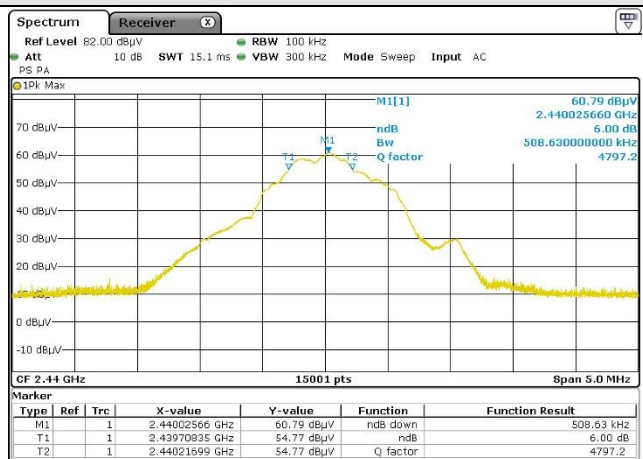
Graphical representation of 6dB Bandwidth / BLE: 1Mbps



Low channel



High channel



Mid channel

| | |
|------------------------------|----------------------|
| Frequency band investigated: | 2400MHz to 2483.5MHz |
| RBW : | 100kHz |
| Measurement detector : | Peak |

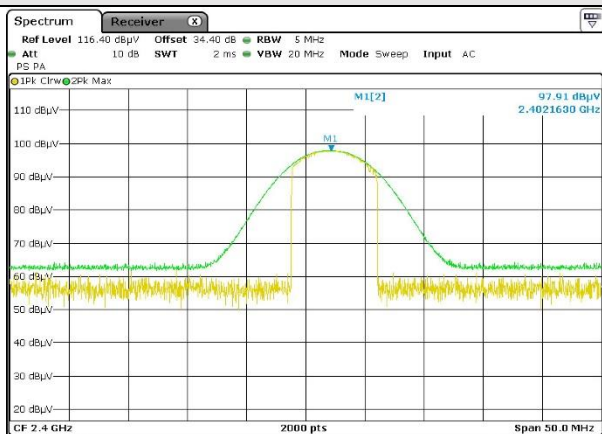
12. Maximum Peak Output power

| TEST: Maximum peak conducted output power | | Verdict |
|---|-----------------------------|-----------------|
| <p>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
 The tested equipment is set to transmit operation with modulation on low, mid and high channels.</p> | | Pass |
| Laboratory Parameters: | Required prior to the test | During the test |
| Ambient Temperature | 17 - 27 °C | 20°C ± 2 |
| Relative Humidity | 25 - 65 % | 40% ± 5 |
| Limits – FCC Part 15.247 (b) / RSS-247 §5.4 (d) | | |
| Frequency (MHz) | Limits (dBμV/m) | |
| | Level / Detector | Results |
| 2400 to 2483.5 | 36 dBm / Pk / 3m (Radiated) | Pass |
| 2400 to 2483.5 | 30 dBm / Pk (Conducted) | Pass |
| Supplementary information:
Test location: SMEE
Test date: January 15 th , 2024 by L. CHAPUS.
Power supply voltage: 5V DC from USB-Port. | | |

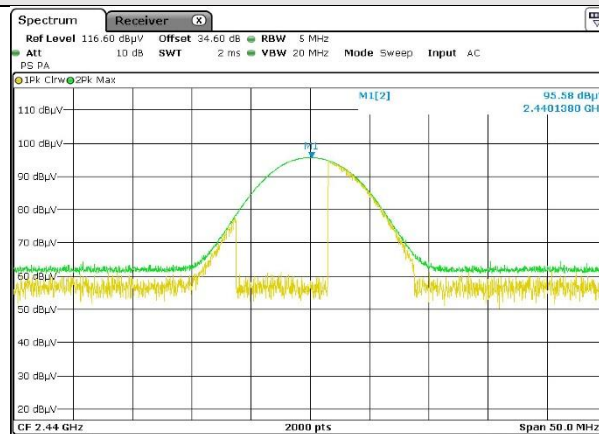
| Tabulated Results for Maximum peak output power (Radiated measurement) | | | | |
|--|---|--------------------------|----------------|--------|
| FREQ
(MHz) | Field Strength 3m
(dBμV/m) | Calculated EIRP
(dBm) | Limit
(dBm) | Result |
| 2402 | 97.8 | 2.5 | 36.0 | Pass |
| 2440 | 96.0 | 0.7 | 36.0 | Pass |
| 2480 | 95.4 | 0.1 | 36.0 | Pass |
| RBW: | 1MHz | | | |
| Measurement distance: | 3m | | | |
| Limit: | FCC Part 15.247 / RSS-247 | | | |
| Final measurement detector: | Peak | | | |
| RESULT: | PASS | | | |
| Note: | 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 (0dB above 1GHz) | | | |

| Tabulated Results for Maximum peak output power (Conducted) | | | |
|---|--------------------------|---|--------|
| FREQ
(MHz) | Conducted power
(dBm) | Limit
(dBm) | Result |
| 2402 | -0.9 | 30.0 | Pass |
| 2440 | -2.7 | 30.0 | Pass |
| 2480 | -3.3 | 30.0 | Pass |
| RBW: | | 1MHz | |
| Limit: | | FCC Part 15.247 / IC RSS-247 | |
| Final measurement detector: | | Peak | |
| RESULT: | | PASS | |
| Note: | | (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 is 3.4dBi | |

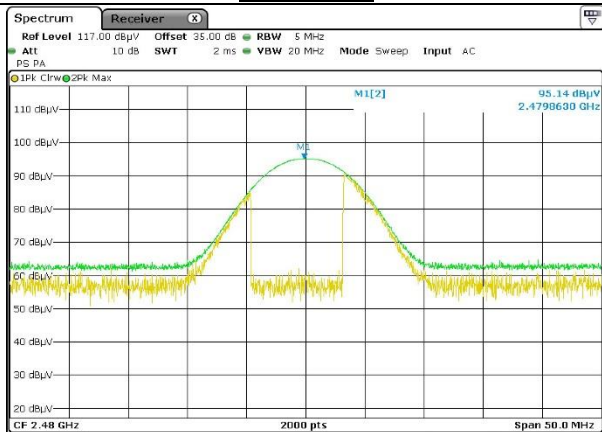
Graphical representation for Maximum Peak Output power (1Mbps)



Low channel



Mid channel



High channel

| | |
|--------------|--|
| Measurement: | Radiated measurement |
| Limit: | FCC Part 15.247 / RSS-247 |
| RBW: | 5MHz (RBW $\geq$ DTS bandwidth) |
| VBW: | 20MHz (VBW $\geq$ [3 $\times$ RBW]) |
| Span: | 50MHz (Set span $\geq$ [3 $\times$ RBW]) |

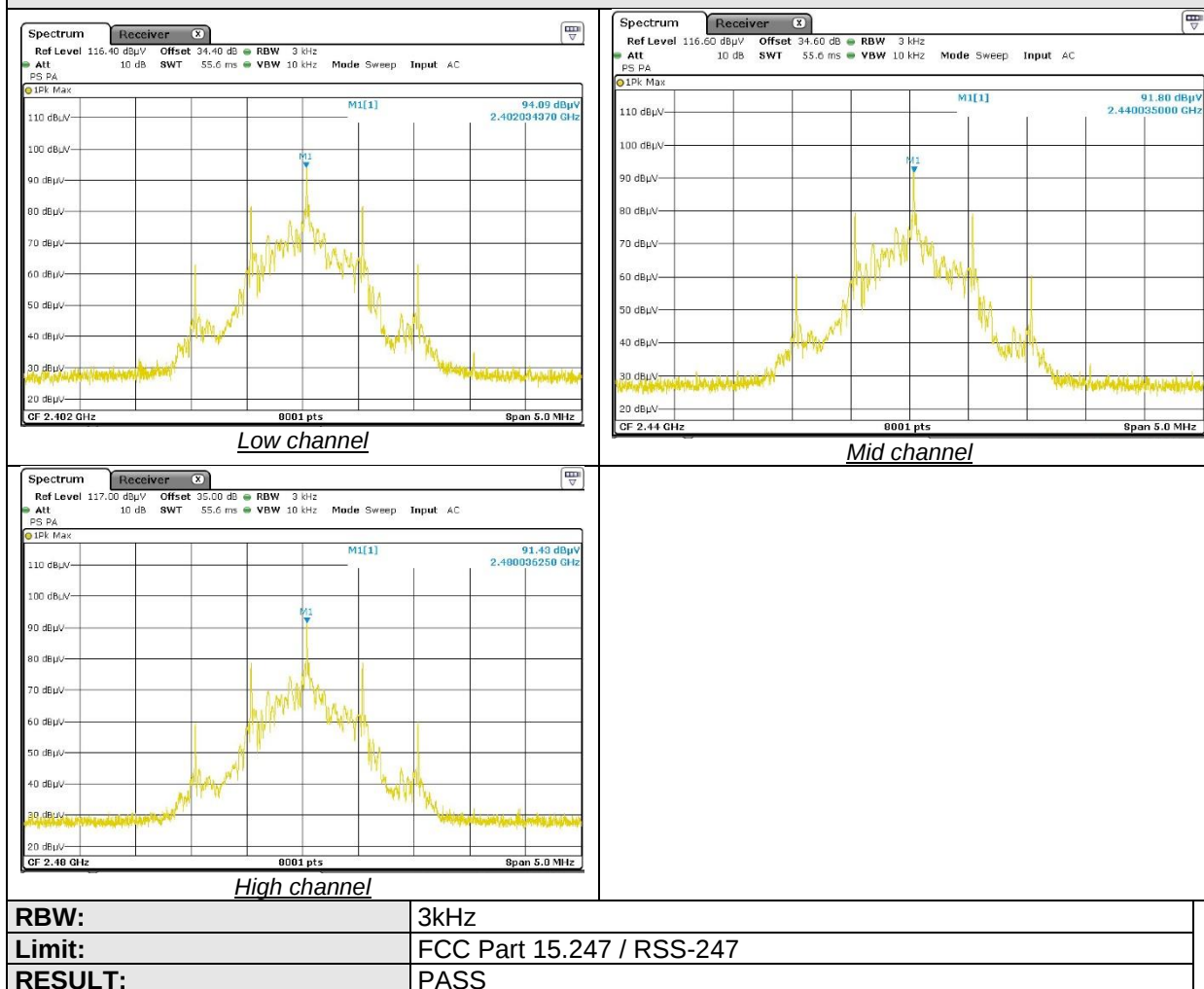
13. Maximum Power Spectral Density Level in the fundamental emission

| TEST: Maximum Peak Power Spectral Density | | | Verdict |
|--|----------------------------|-----------------|---------|
| <p>Method: 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
The tested equipment is set to transmit operation with modulation on low, mid and high channels.</p> | | | Pass |
| Laboratory Parameters: | Required prior to the test | During the test | |
| Ambient Temperature | 17 - 27 °C | 20°C ± 2 | |
| Relative Humidity | 25 - 65 % | 40% ± 5 | |
| Limits – FCC Part 15.247 (e) / RSS-247 §5.2 (b) | | | |
| Frequency (MHz) | Level (Detector) | Limit | |
| 2402 / 2440 / 2480 | 8 dBm/3kHz (Pk) | Pass | |
| Supplementary information:
Test location: SMEE
Test date: January 16 th , 2024 by L. CHAPUS.
Power supply voltage: 5V DC from USB adapter. | | | |

| Tabulated Results for Maximum Spectral Density (Radiated measurement) | | | | |
|---|-------------------|---|-------|--------|
| FREQ | Field Strength 3m | Calculated Radiated PSD (EIRP) | Limit | Result |
| (MHz) | (dBμV/m) | (dBm) | (dBm) | |
| 2402 | 94.1 | -1.2 | - | - |
| 2440 | 91.8 | -3.5 | - | - |
| 2480 | 91.4 | -3.9 | - | - |
| RBW: | | 3kHz | | |
| Measurement distance: | | 3m | | |
| Limit: | | FCC Part 15.247 / RSS-247 | | |
| Final measurement detector: | | Peak | | |
| Note: | | <p>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)</p> | | |

| Tabulated Results for Maximum Conducted Power Spectral Density | | | |
|--|--|-----------|--------|
| Frequency
(MHz) | PSD
(dBm/3kHz) | Limit | Result |
| 2402.0 | -4.6 | 8dBm/3kHz | Pass |
| 2440.0 | -6.9 | 8dBm/3kHz | Pass |
| 2480.0 | -7.3 | 8dBm/3kHz | Pass |
| RBW: | 3kHz | | |
| Limit: | FCC Part 15.247 / RSS-247 | | |
| Final measurement detector: | Peak | | |
| RESULT: | PASS | | |
| Note: | 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 (3.4dBi) | | |

Graphical representation for Maximum Power Spectral Density / BLE



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

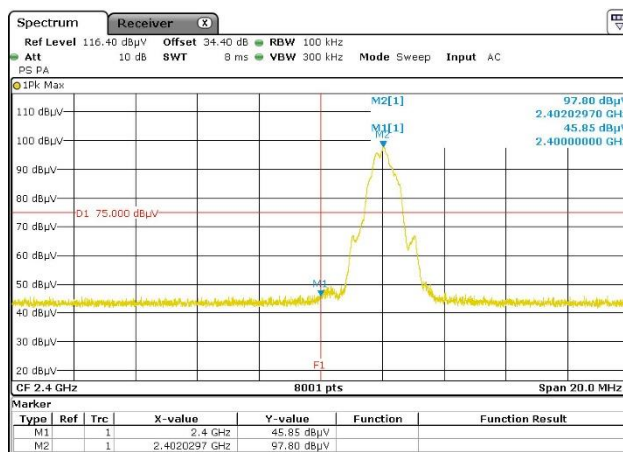
| TEST: Unwanted emissions in Non-Restricted Frequency Bands | | | Verdict |
|--|--------------------------------------|-----------------------------------|---------|
| <p><u>Method:</u> Measurements were made in a 3-meter Semi Anechoic Room (SAR) up to 1GHz and in a 3-meter Full Anechoic environment (SAR with floor absorbers) above 1GHz.</p> <p>The Semi Anechoic Room complies with CISPR16-1-4 / ANSI C63.4 requirements.</p> <p>Preliminary (peak) measurements were performed at an antenna to EUT separation distance of 3 meters.</p> <p>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.</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 | 17 - 27 °C | 20°C ± 2 | |
| Relative Humidity | 25 - 65 % | 40% ± 5 | |
| Fully configured sample scanned over the following frequency range | Frequency range on each side of line | Measurement Point | |
| | 30MHz – 25GHz | 3m measurement distance | |
| Limits – FCC Part 15.247 (d) / RSS-247 § 5.5 | | | |
| Frequency (MHz) | Limits (dBµV/m) | | |
| | Detector / Analyser RBW | Limit | Results |
| 30 to 25000 | Pk / 100kHz | 20dB below the maximum Peak level | Pass |
| Supplementary information:
Test location: SMEE
Test date: January 15 th , 2024 by L. CHAPUS.
Power supply voltage: 5V DC from USB adapter. | | | |

| Tabulated Results for Peak Output Power Reference level | |
|---|--|
| FREQ
(MHz) | Field Strength 3m
(dBµV/m) |
| 2402.0 | 97.8 ⁽¹⁾ |
| 2440.0 | 95.6 ⁽¹⁾ |
| 2480.0 | 95.0 ⁽¹⁾ |
| 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 75.0 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-25GHz)

| FREQ
(MHz) | Field Strength 3m
(dBμV/m) | Limit
(dBμV/m) | Margin
(dBμV/m) | Result
(dBμV/m) |
|--|-------------------------------|-------------------|--------------------|--------------------|
| Levels measured are at least 20dB below the limit.
See pre-scan graphs in chapter 15. | | | | PASS |
| RBW: | 100kHz | | | |
| Measurement distance: | 3m | | | |
| Limit: | FCC 15.247 / RSS-247 | | | |
| Final measurement detector: | Peak | | | |
| RESULT: | PASS | | | |

Graphical representation of Band-edge compliance (LOW)



Low band edge compliance: BLE

RESULT: PASS.

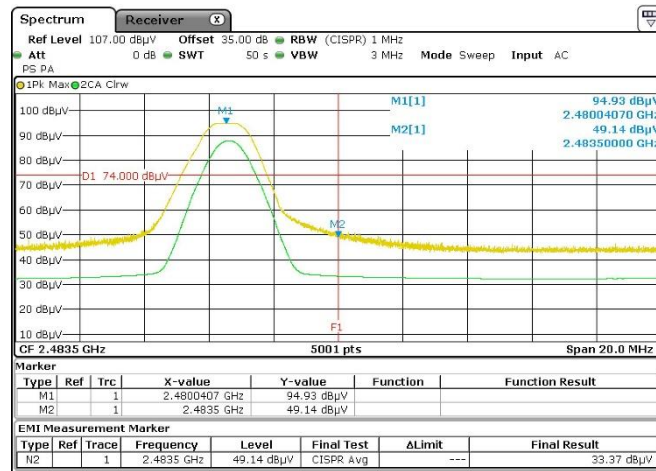
Note: Radiated measurement.

| FREQ
(MHz) | Field Strength 3m
(dBμV/m) | Limit
(dBμV/m) | Margin
(dBμV/m) | Result
(dBμV/m) |
|---------------|-------------------------------|-------------------|--------------------|--------------------|
| BLE: 1Mbps | | | | |
| 2400.00 | 45.9 | 75.0 | -29.1 | 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. 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 | 17 - 27 °C | 20°C ± 2 | |
| Relative Humidity | 25 - 65 % | 40% ± 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 – 25GHz | 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: January 15 th , 2024 by L. CHAPUS.
Power supply voltage: 5V DC from USB adapter | | | |

Graphical representation of Band-edge compliance (HIGH)



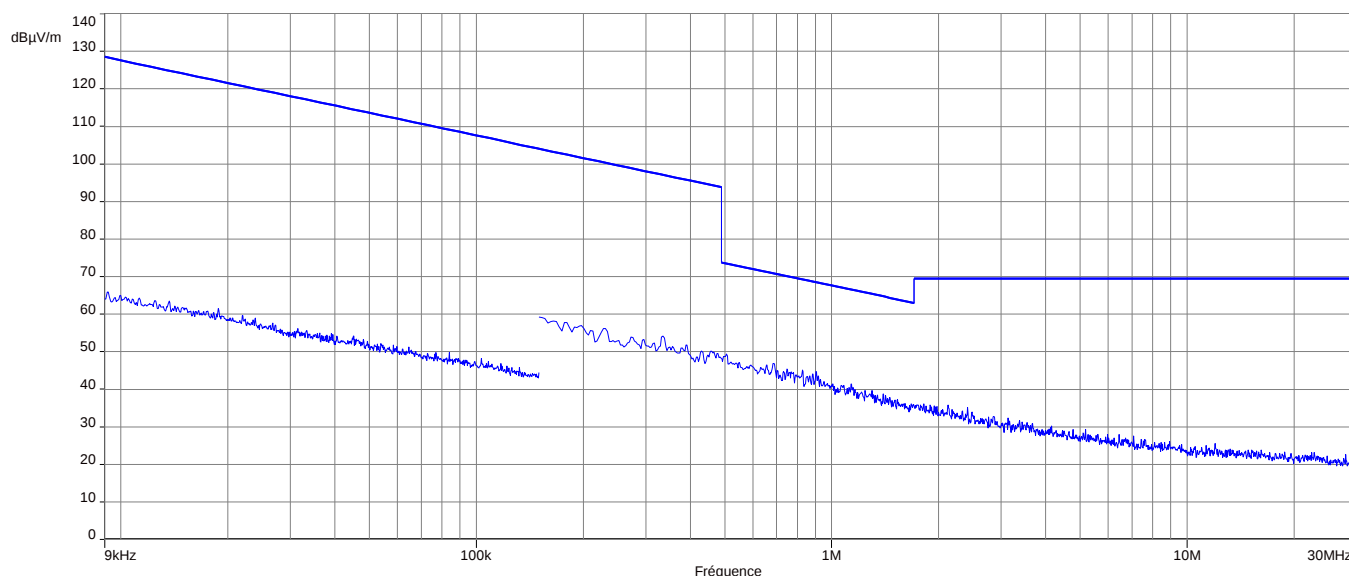
High band edge compliance: BLE/1Mbps

Radiated Peak level is 49.1 dBμV/m at 2483.5MHz (limit 74dBμV/m).

Max radiated Average level is 33.4 dBμV/m (limit 54dBμV/m, CISPR Average detector measurement).

RESULT: PASS

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

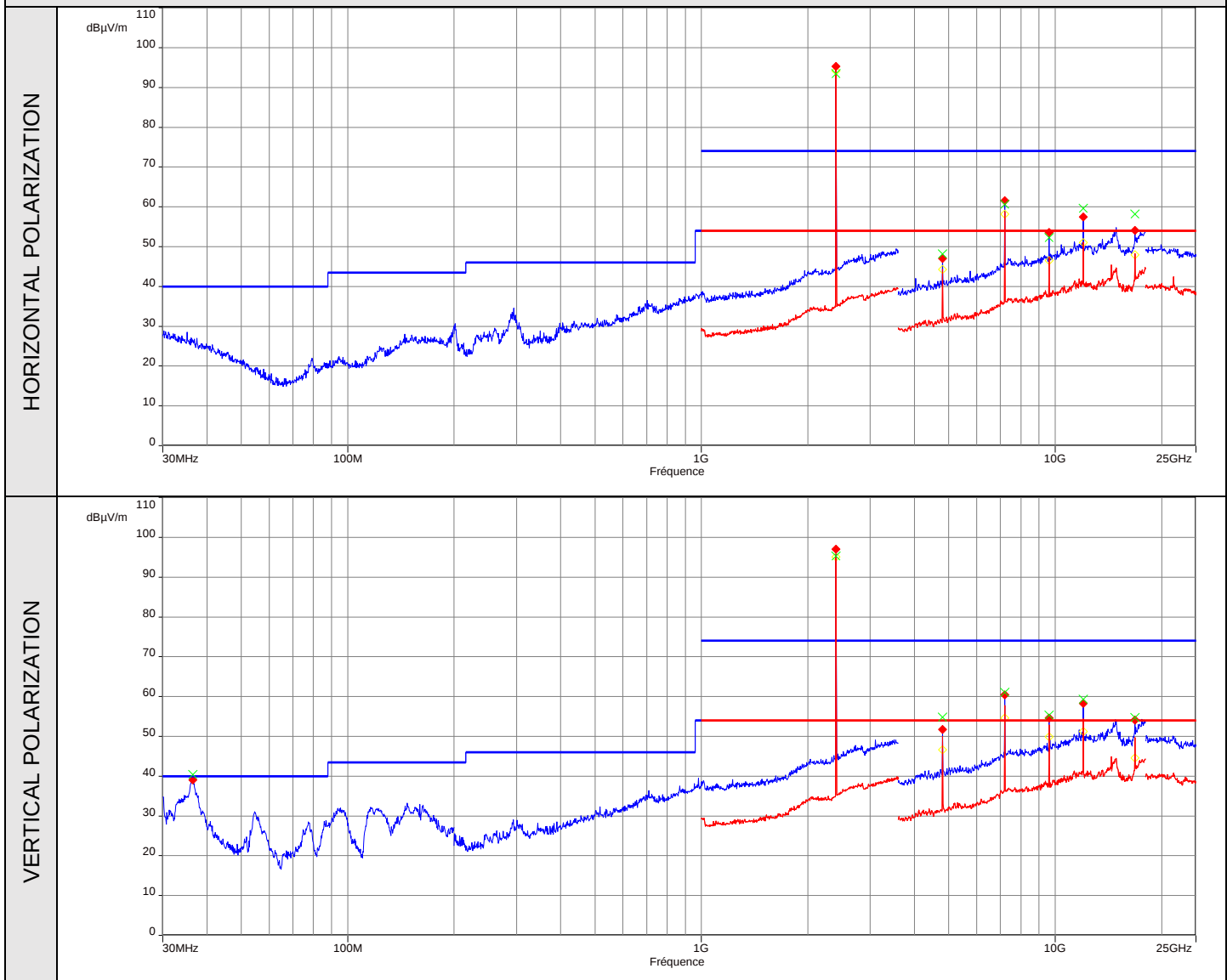


Notes: Pre-scan graph only for identification purpose. Same result for transmit mode on all channels.

Tabulated Results for Unwanted emissions (9kHz-30MHz)

| FREQ | RF field @
30m | Limit | Margin | Antenna | | Table
angle | Correc. Fact.
(CF) |
|--|-------------------|---|--------|-------------------|------|----------------|-----------------------|
| MHz | (QP)
dBμV/m | (QP)
dBμV/m | dB | Angle
(Degree) | Pol. | Degree | dB |
| Levels are at least 10dB below limits | | | | | | | |
| 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 15.209 / RSS-Gen §8.9 – RSS-210 §B.10 | | | | | |
| 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 / RSS-Gen clause 6.5)
M@300m = M@10m-59.1dB / M@30m = M@10m-19.1dB | | | | | |

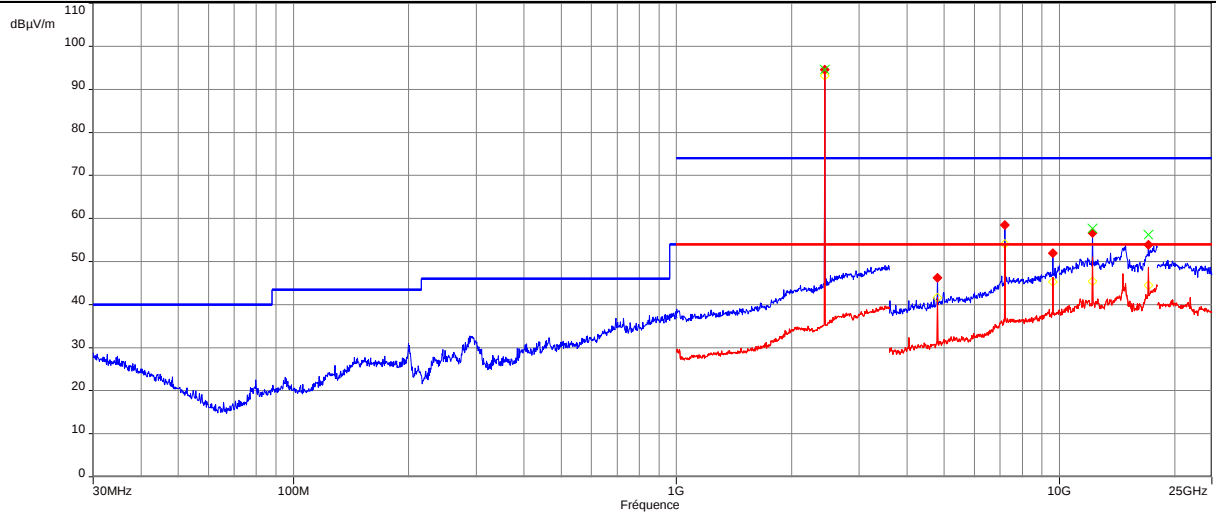
Graphical of Radiated Disturbance Measurement (Peak and Average Measurement, 30Mz-25GHz) – Tx/2402MHz



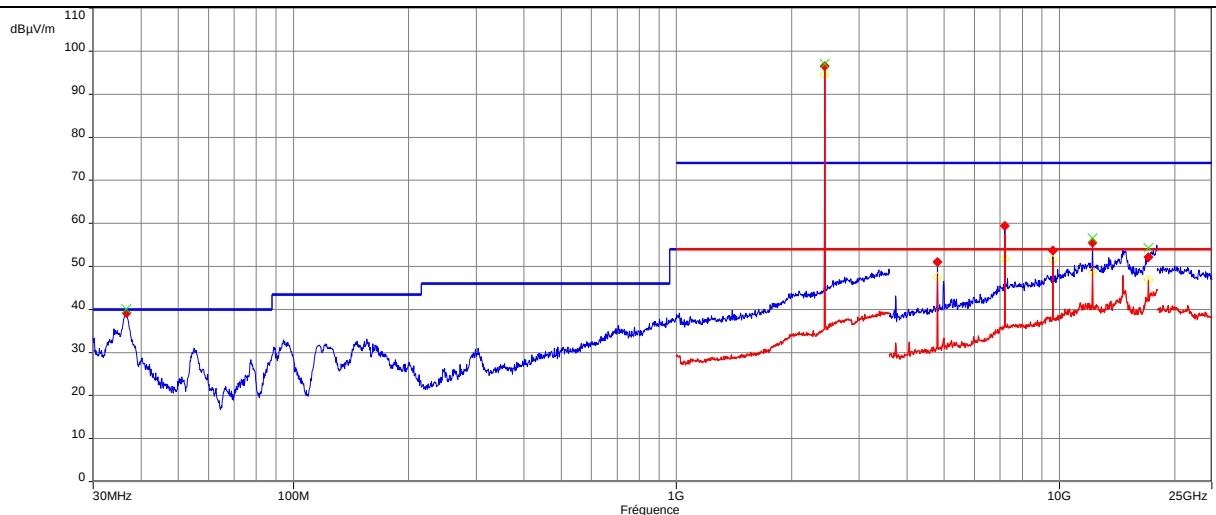
| FREQ (MHz) | Field Strength 3m PK (dBμV/m) | Field Strength 3m QP or AV (dBμV/m) | Limit Peak (dBμV/m) | Limit QP or AV (dBμV/m) | Margin Peak (dB) | Margin QP or AV (dB) | Total factor (dB) | Result | Pol | Detector & Limit |
|----------------------------------|-------------------------------|-------------------------------------|---|-------------------------|------------------|----------------------|-------------------|--------|-----|------------------|
| 4803.82518 | 48.12 | 38.19 | 74.00 | 54.00 | -25.88 | -15.81 | -0.37 | Pass | H | PK/AV |
| 7205.3836 | 60.63 | 47.28 | 74.00 | 54.00 | -13.37 | -6.72 | 6.02 | Pass | H | PK/AV |
| 12010.15051 | 59.57 | 44.90 | 74.00 | 54.00 | -14.43 | -9.10 | 12.25 | Pass | H | PK/AV |
| 16814.2183 | 58.17 | 43.38 | 74.00 | 54.00 | -15.83 | -10.62 | 19.27 | Pass | H | PK/AV |
| 36.503998 | 40.43 | 37.27 | - | 40.00 | - | -2.73 | 17.25 | Pass | V | QP |
| 4804.16278 | 54.82 | 45.93 | 74.00 | 54.00 | -19.18 | -8.07 | -0.37 | Pass | V | PK/AV |
| 7206.8636 | 61.02 | 50.53 | 74.00 | 54.00 | -12.98 | -3.47 | 6.01 | Pass | V | PK/AV |
| 12010.1392 | 59.26 | 43.75 | 74.00 | 54.00 | -14.74 | -10.25 | 12.25 | Pass | V | PK/AV |
| 16815.96499 | 54.68 | 40.67 | 74.00 | 54.00 | -19.32 | -13.33 | 19.28 | Pass | V | PK/AV |
| Frequency and Limit band: | | | 30Mz-25GHz / FCC 15.209 / RSS-GEN | | | | | | | |
| RBW and Limit detector: | | | Below 1GHz: RBW= 120kHz, Quasi-Peak Limit / Above 1GHz: RBW= 1MHz, Peak and CISPR-Average Limit | | | | | | | |
| Note: | | | Pre-scan graph only for identification purpose. | | | | | | | |

Graphical of Radiated Disturbance Measurement (Peak and Average Measurement, 30Mz-25GHz) – Tx/2440MHz

HORIZONTAL POLARIZATION

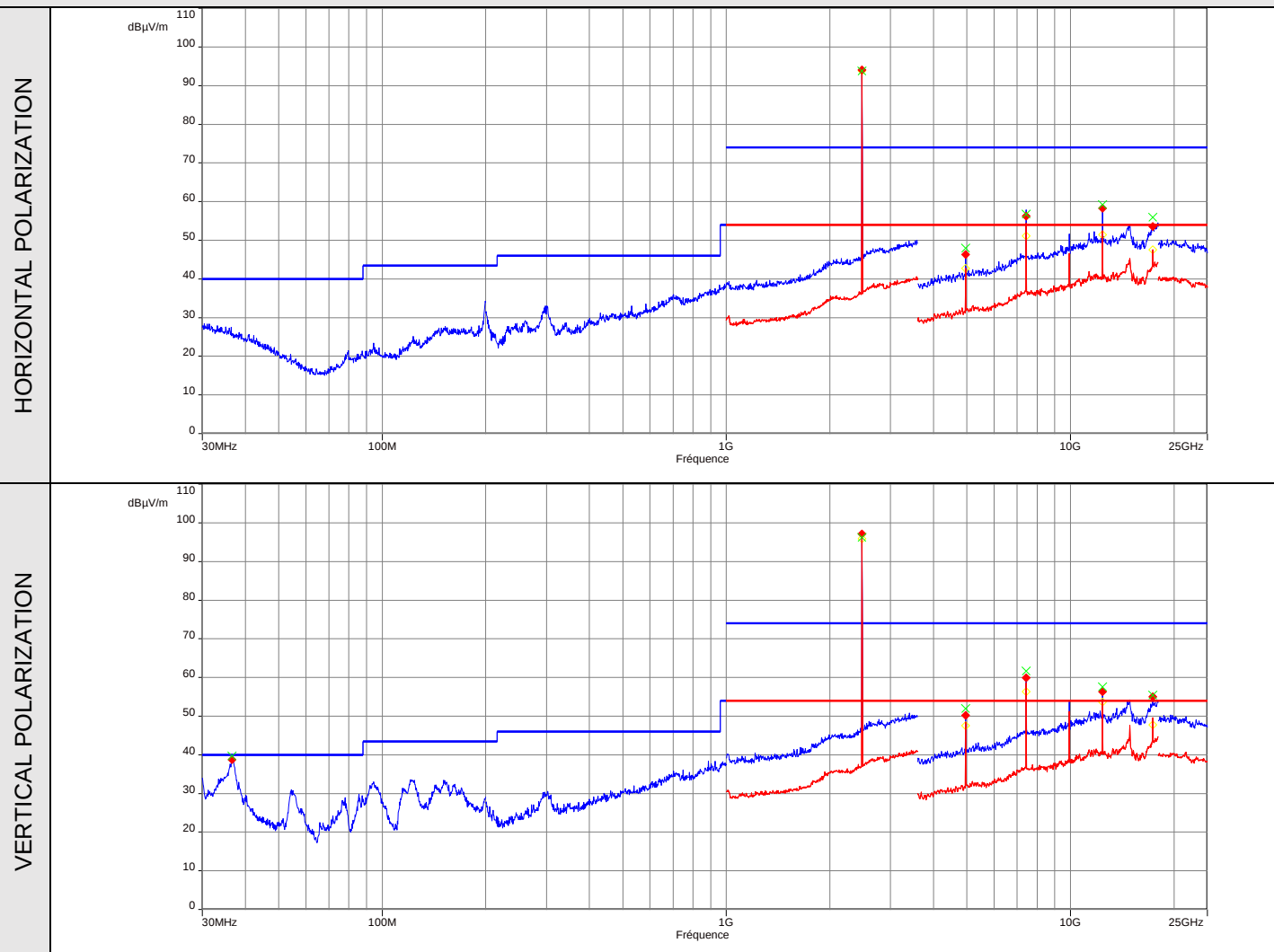


VERTICAL POLARIZATION



| FREQ (MHz) | Field Strength 3m PK (dBμV/m) | Field Strength 3m QP or AV (dBμV/m) | Limit Peak (dBμV/m) | Limit QP or AV (dBμV/m) | Margin Peak (dB) | Margin QP or AV (dB) | Total factor (dB) | Result | Pol | Detector & Limit |
|----------------------------------|-------------------------------|-------------------------------------|---|-------------------------|------------------|----------------------|-------------------|--------|-----|------------------|
| 4803.74762 | 46.62 | 36.22 | 74.00 | 54.00 | -27.38 | -17.78 | -1.40 | Pass | H | PK/AV |
| 7206.0719 | 60.70 | 50.26 | 74.00 | 54.00 | -13.30 | -3.74 | 5.06 | Pass | H | PK/AV |
| 12200.1989 | 57.65 | 43.07 | 74.00 | 54.00 | -16.35 | -10.93 | 12.30 | Pass | H | PK/AV |
| 17080.06892 | 56.24 | 41.56 | 74.00 | 54.00 | -17.76 | -12.44 | 19.88 | Pass | H | PK/AV |
| 36.62153 | 40.08 | 37.31 | - | 40.00 | - | -2.69 | 17.21 | Pass | V | QP |
| 4804.07855 | 53.43 | 44.27 | 74.00 | 54.00 | -20.57 | -9.73 | -1.40 | Pass | V | PK/AV |
| 7206.1092 | 61.83 | 51.31 | 74.00 | 54.00 | -12.17 | -2.69 | 5.06 | Pass | V | PK/AV |
| 12200.25779 | 56.52 | 41.85 | 74.00 | 54.00 | -17.48 | -12.15 | 12.70 | Pass | V | PK/AV |
| 17081.58357 | 54.34 | 40.31 | 74.00 | 54.00 | -19.66 | -13.69 | 20.38 | Pass | V | PK/AV |
| Frequency and Limit band: | | | 30Mz-25GHz / FCC 15.209 / RSS-GEN | | | | | | | |
| RBW and Limit detector: | | | Below 1GHz: RBW= 120kHz, Quasi-Peak Limit / Above 1GHz: RBW= 1MHz, Peak and CISPR-Average Limit | | | | | | | |
| Note: | | | Pre-scan graph only for identification purpose. | | | | | | | |

Graphical of Radiated Disturbance Measurement (Peak and Average Measurement, 30Mz-25GHz) – Tx/2480MHz



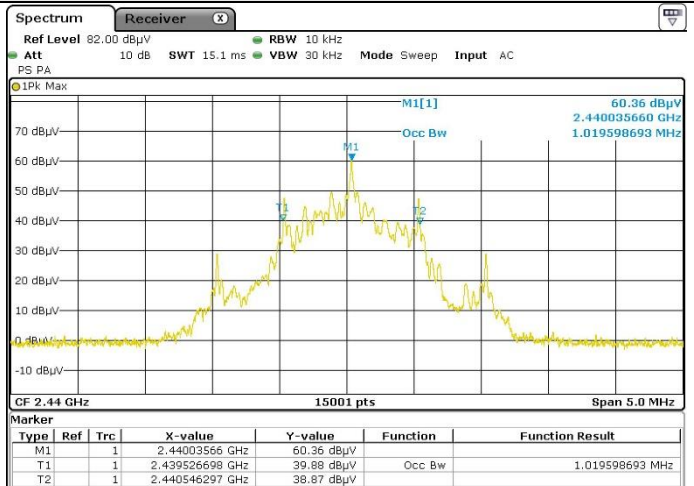
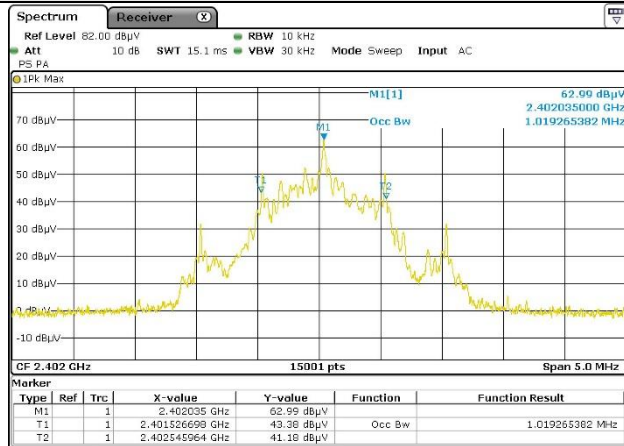
| FREQ (MHz) | Field Strength 3m PK (dBμV/m) | Field Strength 3m QP or AV (dBμV/m) | Limit Peak (dBμV/m) | Limit QP or AV (dBμV/m) | Margin Peak (dB) | Margin QP or AV (dB) | Total factor (dB) | Result | Pol | Detector & Limit |
|----------------------------------|-------------------------------|-------------------------------------|---|-------------------------|------------------|----------------------|-------------------|--------|-----|------------------|
| 4960.28259 | 47.93 | 37.05 | 74.00 | 54.00 | -26.07 | -16.95 | -0.06 | Pass | H | PK/AV |
| 7439.94632 | 56.72 | 43.55 | 74.00 | 54.00 | -17.28 | -10.45 | 6.60 | Pass | H | PK/AV |
| 12398.85823 | 59.15 | 44.08 | 74.00 | 54.00 | -14.85 | -9.92 | 13.27 | Pass | H | PK/AV |
| 17359.02938 | 55.91 | 41.61 | 74.00 | 54.00 | -18.09 | -12.39 | 21.39 | Pass | H | PK/AV |
| 36.605723 | 39.67 | 36.13 | - | 40.00 | - | -3.87 | 17.21 | Pass | V | QP |
| 4960.05275 | 51.98 | 42.85 | 74.00 | 54.00 | -22.02 | -11.15 | -0.06 | Pass | V | PK/AV |
| 7440.0785 | 61.70 | 48.11 | 74.00 | 54.00 | -12.30 | -5.89 | 6.60 | Pass | V | PK/AV |
| 12400.13819 | 57.58 | 43.17 | 74.00 | 54.00 | -16.42 | -10.83 | 13.28 | Pass | V | PK/AV |
| 17360.3838 | 55.40 | 40.80 | 74.00 | 54.00 | -18.60 | -13.20 | 21.39 | Pass | V | PK/AV |
| Frequency and Limit band: | | | 30Mz-25GHz / FCC 15.209 / RSS-GEN | | | | | | | |
| RBW and Limit detector: | | | Below 1GHz: RBW= 120kHz, Quasi-Peak Limit / Above 1GHz: RBW= 1MHz, Peak and CISPR-Average Limit | | | | | | | |
| Note: | | | Pre-scan graph only for identification purpose. | | | | | | | |

16. Occupied bandwidth (99%)

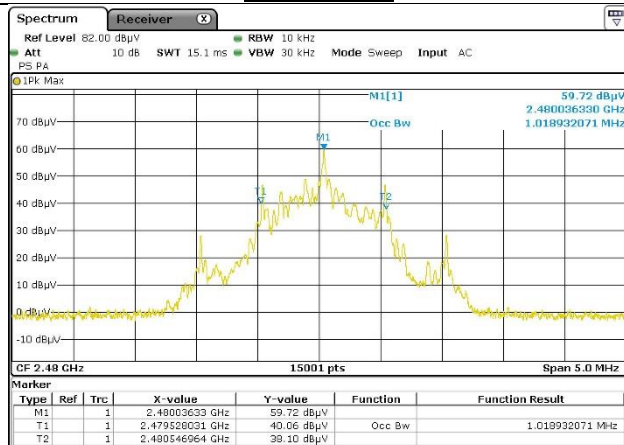
| TEST: Occupied bandwidth (99%) / RSS-GEN | | Verdict |
|--|----------------------------|-----------------|
| <p>Method: The setup is in an anechoic chamber. The spectrum analyzer is connected to the measuring antenna. A radiated measurement is performed.</p> <p>The RBW is set in the range of 1% to 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 | 17 - 27 °C | 20°C $\pm$ 2 |
| Relative Humidity | 25 - 65 % | 40% $\pm$ 5 |
| <p>Supplementary information:</p> <p>Test location: SMEE</p> <p>Test date: January 16th, 2024 by L. CHAPUS.</p> <p>Power supply voltage: 5V DC from USB adapter</p> | | |

| Tabulated Results for 99% Occupied Bandwidth | |
|--|---------------------------------|
| Frequency
(MHz) | 99% Occupied Bandwidth
(MHz) |
| 2402.0 | 1.019 |
| 2440.0 | 1.019 |
| 2480.0 | 1.019 |

Graphical representation of 99% Occupied Bandwidth / BLE: 1Mbps



Low channel



Mid channel

High channel

| | |
|------------------------------|--------------------|
| Frequency band investigated: | 2402MHz to 2480MHz |
| 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 | 2023/4 | 2024/4 |
| RF cable | RADIALL | RG58 / BNC / 5m | CAB-211-042 | 2023/4 | 2024/4 |
| Measuring receiver | Rohde&Schwarz | ESRP | REC-151-002 | 2021/12 | 2024/6 |
| 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 | 2023/4 | 2024/4 |
| Spectrum analyzer | Rohde&Schwarz | FSV40 | ASP-171-004 | 2021/10 | 2024/4 |
| Measuring receiver | Rohde&Schwarz | ESRP | REC-151-002 | 2021/12 | 2024/6 |

| 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 |
| Horn antenna | ETS-LINDGREN | 3116 | ANT-161-014 | 2021/7 | 2024/7 |
| Log-periodic antenna | EMCO | 3146 | ANT-191-019 | 2024/3 | 2026/9 |
| Biconnic antenna | COM-POWER | AB- 900A | ANT-201-021 | 2023/01 | 2025/1 |
| Spectrum analyzer | Rohde&Schwarz | FSV40 | ASP-171-004 | 2021/10 | 2024/4 |
| RF cable | Div | OATS/25m | CAB-101-017 | 2023/4 | 2024/4 |
| RF cable | HUBER+SUHNER | SF102 (K/2m) | CAB-171-034 | 2023/4 | 2024/4 |
| RF cable | HUBER+SUHNER | SF102 (K/3m) | CAB-171-035 | 2023/4 | 2024/4 |
| RF cable | RADIALL | R286301073 | CAB-201-036 | 2023/4 | 2024/4 |
| RF cable | HUBER+SUHNER | SF126E (NN/2m) | CAB-231-043 | 2023/4 | 2024/4 |
| RF cable | HUBER+SUHNER | SF104E (NN/5,3m) | CAB-231-044 | 2023/4 | 2024/4 |
| RF cable | HUBER+SUHNER | SF104E (NN/7m) | CAB-231-045 | 2023/4 | 2024/4 |
| Semi anechoic room | COMTEST | 218292 | CAG-201-002 | 2022/4 | 2025/4 |
| High-pass filter | RF-Lambda | RHPF23G03G18 | FIL-221-011 | 2023/4 | 2024/4 |
| Antenna mast SAC | Innco- Systems | MA4640-XP-ET | MAT-201-002 | - | - |

| Test Equipment Used for radiated emission | | | | | |
|---|----------------|-------------|-------------|-----------|----------|
| Description | Manufacturer | Model | Identifier | Cal. Date | Cal. Due |
| Turntable SAC | Innco- Systems | DS1500-S-1t | PLA-201-003 | - | - |
| Pre-amplifier | SMEE | 18-40GHz | PRE-171-004 | 2023/4 | 2024/4 |
| Pre-amplifier | COM-POWER | 1-18GHz | PRE-221-005 | 2023/4 | 2024/4 |
| Measuring receiver | Rohde&Schwarz | ESRP | REC-151-002 | 2021/12 | 2024/6 |
| FS OATS | Div | 10m | SIT-201-002 | - | - |
| EMC Software | NEXIO | BAT EMC | SOF-101-001 | - | - |

END OF REPORT