Accreditation
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Template : May 28th, 2024

TEST REPORT

N°: **22393572-801092-A (FILE#8533359)** Version: **02**

Subject	**Radio spectrum tests according to the standards:** **FCC CFR 47 Part 15.247 & ANSI C63.10** **RSS-247 & RSS-Gen**
Issued to	**MICHELIN NORTH AMERICA (US) INC.** One Parkway South 29615 –GREENVILLE
Apparatus under test	
Product	**Tire Mounted Sensor**
Trade mark	**Michelin**
Manufacturer	**MANUFACTURE FRANCAISE DES PNEUMATIQUES MICHELIN**
Model under test	**TMS AP-01**
Serial number	**BC:03:A7:69:34:12 & BC:03:A7:69:2F:22**
FCCID	**FI5TMSAP01**
IC	**5056A-TMSAP01**
Conclusion	See Test Program chapter
Test date	May 22, 2024 to June 04, 2024
Test location	LCIE Grenoble
FCC Test site	FR0008 - 918017 (MOI)
ISED Test site	6500A (MOI)
Sample receipt date	May 22, 2024
Composition of document	52 pages
Document issued on	July 30, 2024

Written by :
Majid MOURZAGH
Tests operator

Approved by :
Anthony MERLIN
Technical manager

PUBLICATION HISTORY

Version	Date	Author	Modification
01	July 15, 2024	Majid MOURZAGH	Creation of the document
02	July 30, 2024	Majid MOURZAGH	Mask the photos for confidentiality product On Page 5, 11, 15, 18, 21, 24, 28, & 35

Each new edition of this test report replaces and cancels the previous edition. The control of the old editions of report is under responsibility of client.

SUMMARY

1. TEST PROGRAM

References

- **47 CFR Part 15.247 (2023)**
- **RSS 247 Issue 3**
- **RSS Gen Issue 5**
- **KDB 558074 D01 DTS Meas Guidance v05r02**
- **KDB 662911 D01 Multiple Transmitter Output v02r01**
- **ANSI C63.10 (2013)**

Radio requirement:

Clause - Test Description		Test result - Comments
Occupied Bandwidth	***ISED***	**PASS**
6dB Bandwidth	***FCC & ISED***	**PASS**
Maximum Conducted Output Power	***FCC & ISED***	**PASS**
Power Spectral Density	***FCC & ISED***	**PASS**
Unwanted Emissions in Non-Restricted Frequency Bands	***FCC & ISED***	**PASS**
Unwanted Emissions in Restricted Frequency Bands	***FCC & ISED***	**PASS**
Receiver Radiated Emissions	***ISED***	**PASS(2)**
This table is a summary of test report, see conclusion of each clause of this test report for detail.		

(1) Limited program
(2) Testing covered the receive mode, and receiver spurious emissions are considered to be the same as transmitter.

PASS: EUT complies with standard's requirement
FAIL: EUT does not comply with standard's requirement
NA: Not Applicable
NP: Test Not Performed

2. EQUIPMENT UNDER TEST: CONFIGURATION (DECLARED BY PROVIDER)

2.1. HARDWARE IDENTIFICATION (EUT AND AUXILIARIES):

Equipment under test (EUT):

Model under test:	**TMS AP-01**
Serial Number:	**BC:03:A7:69:2F:22 & BC:03:A7:69:34:12**
Dimensions:	2.8cm x 2.8cm x 1.5cm (Length x Width x Height)
Type:	Table-Top

Power supply:

During all the tests, EUT is supplied by V_{nom}: **3.0VDC**
For measurement with different voltage, it will be presented in test method.

Name	Type	Rating	Reference / Sn	Comments
Supply1	Battery	3.0VDC	Maxell CR2450HR-EX	/

NC: Not communicated by provider

Inputs/outputs - Cable:

Access	Type	Length used (m)	Declared <3m	Shielded	Under test	Comments
Supply1	Battery	/	/	/	/	Inside

NC: Not communicated by provider

Auxiliary equipment used during test:

Type	Reference	Sn	Comments
Automated programmer	CYCLONE FX	/	To set running mode configuration BLE

NC: Not communicated by provider

Equipment information (declaration of provider):

Bluetooth Low Energy:	**V4.2**
Chipset / RF Module	NCV-RSL10-101Q48-AVG
Frequency band:	[2400 – 2483.5] MHz
Spectrum Modulation:	DSSS (Tested like it – international agreements)
Number of Channel:	40
Spacing channel:	2MHz
Channel bandwidth:	1MHz
Antenna Type:	Internal
Antenna connector:	None
Antenna requirements §15.203	Conducted Method (welded connection, according to manufacturer's requirements)
Transmit chains:	1
Receiver chains	1

CHANNEL PLAN			
Channel	**Frequency (MHz)**	**Channel**	**Frequency (MHz)**
Cmin: 0	2402	**20**	2442
1	2404	21	2444
2	2406	22	2446
3	2408	23	2448
4	2410	24	2450
5	2412	25	2452
6	2414	26	2454
7	2416	27	2456
8	2418	28	2458
9	2420	29	2460
10	2422	30	2462
11	2424	31	2464
Cmid :12	**2426**	32	2466
13	2428	33	2468
14	2430	34	2470
15	2432	35	2472
16	2434	36	2474
17	2436	37	2476
18	2438	38	2478
19	2440	Cmax: 39	2480

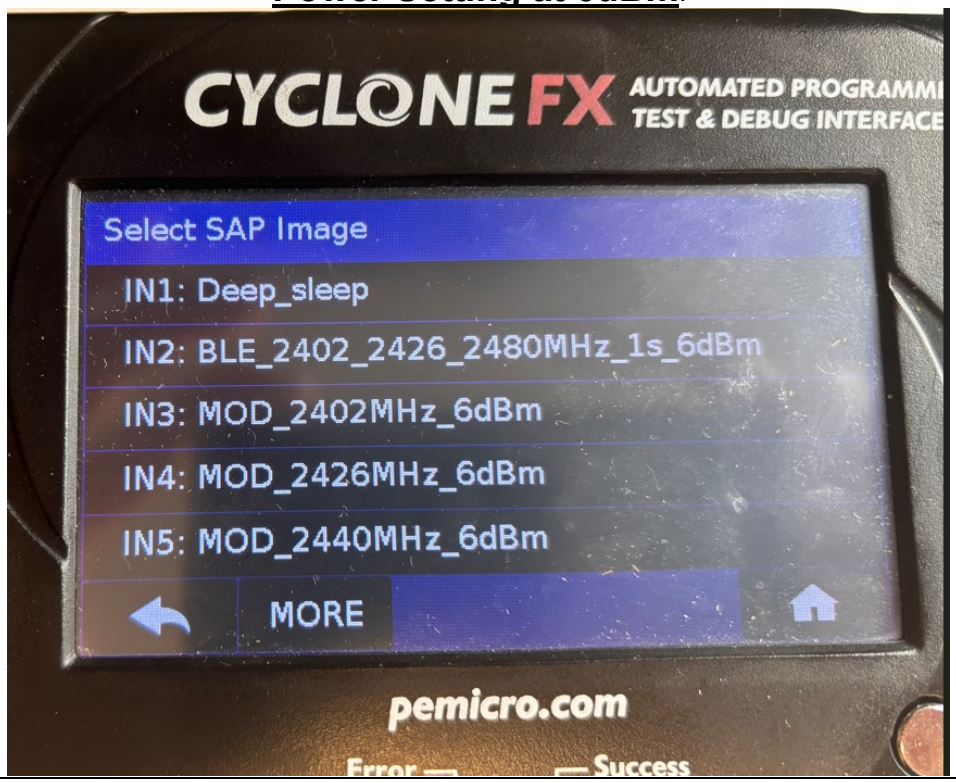
DATA RATE			
Available	**Data Rate (Mbps)**	**Modulation Type**	**Worst Case Modulation**
☑	0.25	GFSK (1MHz)	☐
☑	1	GFSK (1MHz)	☑

Antenna Characteristic			
Antenna reference	Gain (dBi)	Frequency Band (MHz)	Impedance(Ω)
KOCYERA PN : 9001978	3	2400-2485	50

Hardware information				
Highest internal frequency (PLL, Quartz, Clock, Microprocessor…):		**$F_{Highest}$:**	**2480**	**MHz**
Firmware (if applicable):		**V:**	AAS-003	
Software (if applicable):		**V:**	None	
Equipment intended:	Mobile			
Type of equipment:	Stand-alone			
Equipment sample:	Production model			
Duty cycle:	Continuous duty			
Operating temperature range:	T_{min}:	-40 °C		
	T_{nom}:	20°C		
	T_{max}:	+125 °C		
Operating voltage:	V_{nom}:	3.0VDC		

NC: Not communicated by provider

2.2. RUNNING MODE

Test mode	Description of test mode
Test mode 1	Permanent emission with modulation on a fixed channel in the data rate that produced the highest power **Power Setting at 6dBm**. 

Test	Running mode
Occupied Bandwidth	Test mode 1
6dB Bandwidth	Test mode 1
Maximum Conducted Output Power	Test mode 1
Power Spectral Density	Test mode 1
Conducted Spurious Emission at the Band Edge	Test mode 1
Unwanted Emissions in Non-Restricted Frequency Bands	Test mode 1
Unwanted Emissions in Restricted Frequency Bands	Test mode 1
Receiver Radiated Emissions	Not applicable

2.3. EQUIPMENT LABELLING

Label
None

2.4. EQUIPMENT MODIFICATIONS DURING THE TESTS

None

2.5. FIELD STRENGTH CALCULATION

The field strength is calculated by adding the Antenna Factor and Cable Factor, and subtracting the Amplifier Gain (if any) from the measured reading. The basic equation with a sample calculation is as follow:

$$FS = RA + AF + CF - AG$$

Where:
FS = Field Strength
RA = Receiver Amplitude
AF = Antenna Factor
CF = Cable Factor
AG = Amplifier Gain

Example:
Assume a receiver reading of 52.5dBµV is obtained. The antenna factor of 7.4 and a cable factor of 1.1 are added. The amplifier gain of 29dB is subtracted, giving a field strength of 32 dBµV/m.
FS = 52.5 + 7.4 + 1.1 – 29 = 32 dBµV/m
The 32 dBµV/m value can be mathematically converted to its corresponding level in µV/m.
Level in µV/m = Common Antilogarithm [(32dBµV/m)/20] = 39.8 µV/m.

2.6. TEST DISTANCE EXTRAPOLATION – FCC/ISED

The field strength is extrapolated to the new measurement distance using formula from FCC Part15.31 (f) and §6.5-6.6 RSS-GEN:

Below 30MHz,

$$FS_{\text{limit}} = FS_{\text{max}} - 40\log\left(\frac{d_{\text{limit}}}{d_{\text{measure}}}\right)$$

Above 30MHz,

$$FS_{\text{limit}} = FS_{\text{max}} - 20\log\left(\frac{d_{\text{limit}}}{d_{\text{measure}}}\right)$$

Where:
FS_{limit} is the calculation of field strength at the limit distance, expressed in dBµV/m
FS_{max} is the measured field strength, expressed in dBµV/m
$d_{measure}$ is the distance of the measurement point from the EUT
d_{limit} is the reference limit distance

2.7. CALIBRATION DATE

The calibration intervals are extended at 12+2 months. This extended interval is based on the fact that there is sufficient calibration data to statistically establish a trend or based on experience of use of the test equipment to assure good measurement results for a longer period.

2.8. METHOD TO DETERMINATE THE SPURIOUS RADIATED EMISSION

The Normalized Site Attenuation (NSA) is added to the maximum values observed during the azimuth search in order to obtain the spurious radiated emission. For spurious above -6dB from the limit found with the NSA, the Substitution Method is applied.
The substitution antenna replaces the equipment under test (EUT) for Effective Radiated Power (ERP) or Effective Isotropically Radiated Power (EIRP) measurement following the standard. Power is measured for a high level and calculated for the same level of radiated field strength obtained on the measuring antenna and EUT.

3. DUTY CYCLE

3.1. *TEST CONDITIONS*

Date of test	:	May 29, 2024
Test performed by	:	Majid MOURZAGH
Relative humidity (%)	:	38
Ambient temperature (°C)	:	23

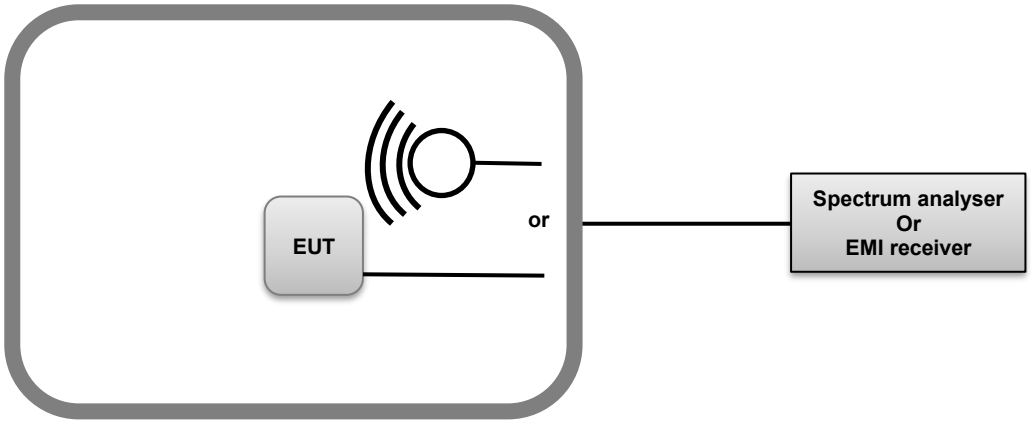
3.2. *TEST SETUP*

The Equipment Under Test is installed in a climatic chamber.
Measurement is performed with a spectrum analyzer in conducted method.

The EUT is turned ON, the center frequency of the spectrum analyzer is set to the fundamental frequency.
The captured power is measured and recorded.

Test Procedure:
ANSI C63.10 § 11.6

- Zero-span mode
- RBW ≥ OBW if possible; otherwise, set RBW to the largest available value
- VBW ≥ RBW
- Detector = Peak
- Trace mode = Max Hold.
- Sweep time > 3 * Period time anticipated
- Sweep = Single
- Trigger Video



Test setup of Duty Cycle

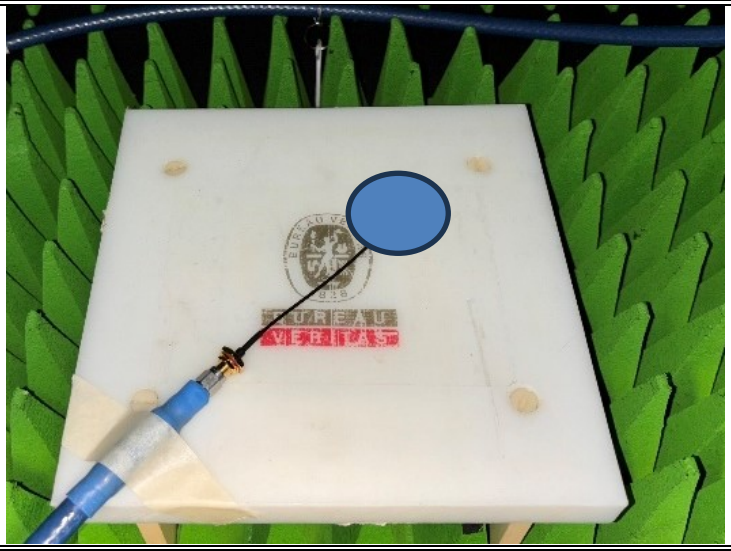


Photo of Duty Cycle

3.3. *LIMIT*

None

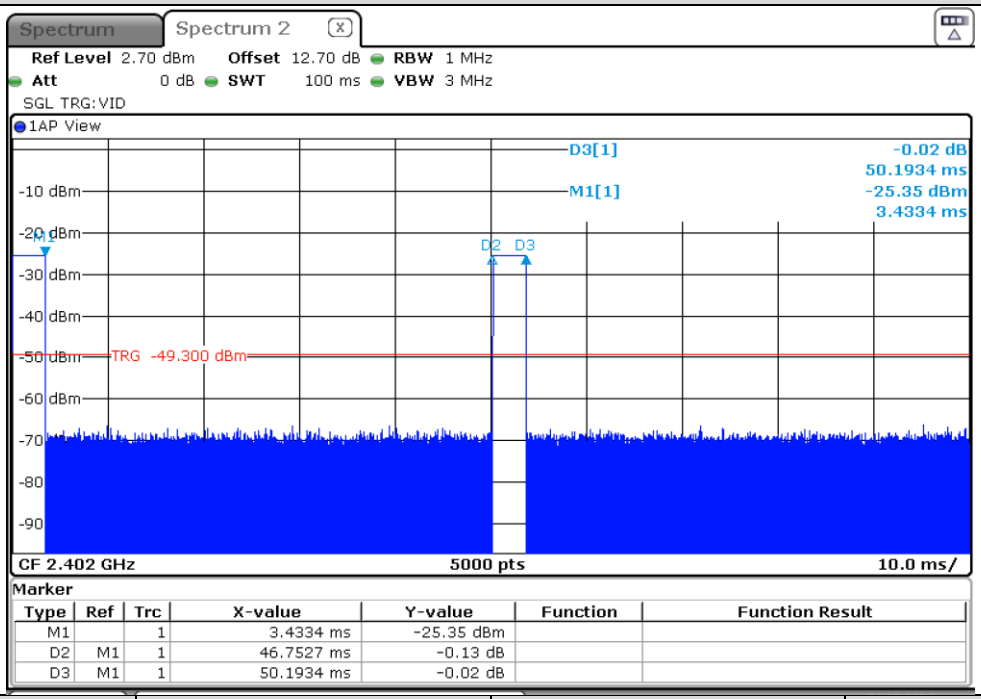
3.4. TEST EQUIPMENT LIST

TEST EQUIPMENT USED					
Description	**Manufacturer**	**Model**	**Identifier**	**Cal_Date**	**Cal_Due**
Attenuator 10dB	AEROFLEX	_	A7122268	07/23	07/25
Comb EMR HF	YORK	CGE01	A3169114		
Full Anechoic Room	SIEPEL	_	D3044024		
Multimeter - CEM	FLUKE	87	A1240251	10/23	10/25
SMA 1.5m	SUCOFLEX	18GHz	A5329864	10/23	10/24
SMK 1.2m (Ampl <-> chamber)	HUBER-SUHNER	SUCOFLEX 102	A5330062	04/23	04/26
Spectrum analyzer	ROHDE & SCHWARZ	FSV 40	A4060059	04/24	04/26
Thermo-hygrometer	TESTO	608-H1	B4204120	03/23	03/25
Thermo-hygrometer (PM1/2/3)	KIMO	HQ 210	B4206022	05/23	05/25

3.5. DIVERGENCE, ADDITION OR SUPPRESSION ON THE TEST SPECIFICATION

None

3.6. *RESULTS*

Duty Cycle			
Cmin			
BLE - 1MBits/s			
			
Test Period (ms)	**Total Time ON (ms)**	**Duty Cycle (%)**	**Duty Cycle Factor (dB)**
50.1934	3.4407	6.85	11.64
*Duty Cycle (%) = (Total Time ON / Test Period) * 100*		*Duty Factor (dB) = 10*log(100 / Duty Cycle(%))*	

Therefore, for average measurements à correction factor of 11.64dB is use in all tests.

4. OCCUPIED BANDWIDTH

4.1. *TEST CONDITIONS*

Date of test	:	June 04, 2024
Test performed by	:	Majid MOURZAGH
Relative humidity (%)	:	38
Ambient temperature (°C)	:	23

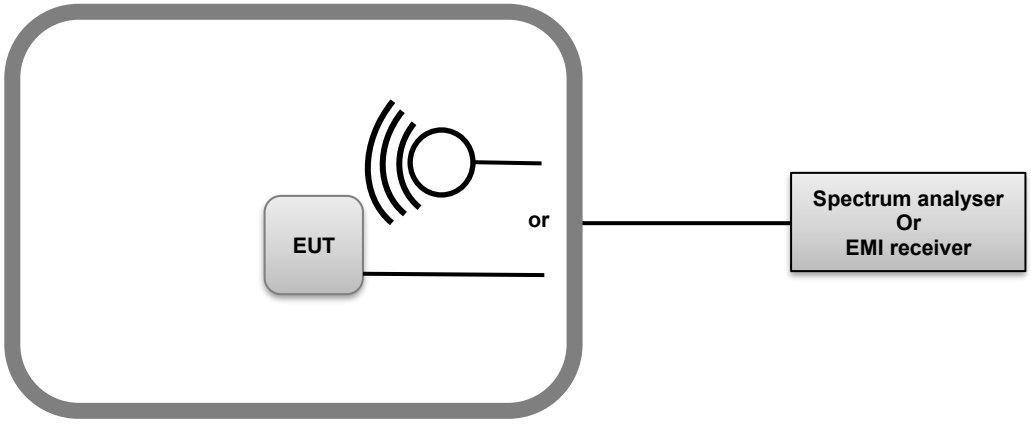
4.2. *TEST SETUP*

The Equipment Under Test is installed in a climatic chamber.
Measurement is performed with a spectrum analyzer in conducted method.

The EUT is turned ON, the center frequency of the spectrum analyzer is set to the fundamental frequency. The captured power is measured and recorded; the measurement is repeated until all frequencies required were complete.

Test Procedure:
ANSI C63.10 § 6.9.2 and RSS-Gen Issue 5 § 6.7

- RBW used in the range of 1% to 5% of the anticipated emission bandwidth
- Set the video bandwidth (VBW) ≥ 3 x RBW.
- Detector = Peak.
- Trace mode = Max Hold.
- Sweep = Auto couple.
- Allow the trace to stabilize.
- OBW 99% function of spectrum analyzer used



Test setup of Occupied Bandwidth

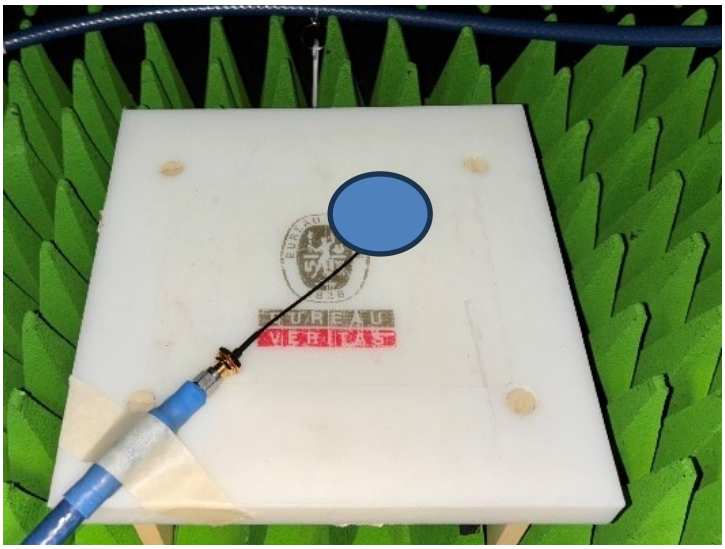


Photo of Occupied bandwidth

4.3. *LIMIT*

None

4.4. TEST EQUIPMENT LIST

TEST EQUIPMENT USED					
Description	**Manufacturer**	**Model**	**Identifier**	**Cal_Date**	**Cal_Due**
Attenuator 10dB	AEROFLEX	_	A7122268	07/23	07/25
Comb EMR HF	YORK	CGE01	A3169114		
Full Anechoic Room	SIEPEL	_	D3044024		
Multimeter - CEM	FLUKE	87	A1240251	10/23	10/25
SMA 1.5m	SUCOFLEX	18GHz	A5329864	10/23	10/24
SMK 1.2m (Ampl <-> chamber)	HUBER-SUHNER	SUCOFLEX 102	A5330062	04/23	04/26
Spectrum analyzer	ROHDE & SCHWARZ	FSV 40	A4060059	04/24	04/26
Thermo-hygrometer	TESTO	608-H1	B4204120	03/23	03/25
Thermo-hygrometer (PM1/2/3)	KIMO	HQ 210	B4206022	05/23	05/25

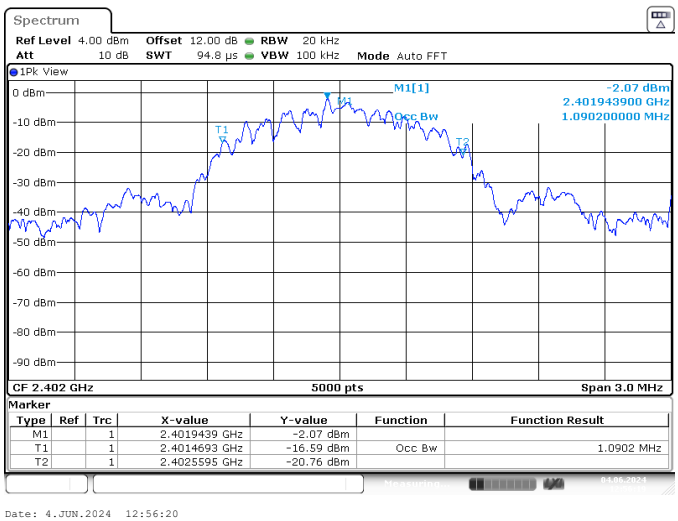
4.5. DIVERGENCE, ADDITION OR SUPPRESSION ON THE TEST SPECIFICATION

None

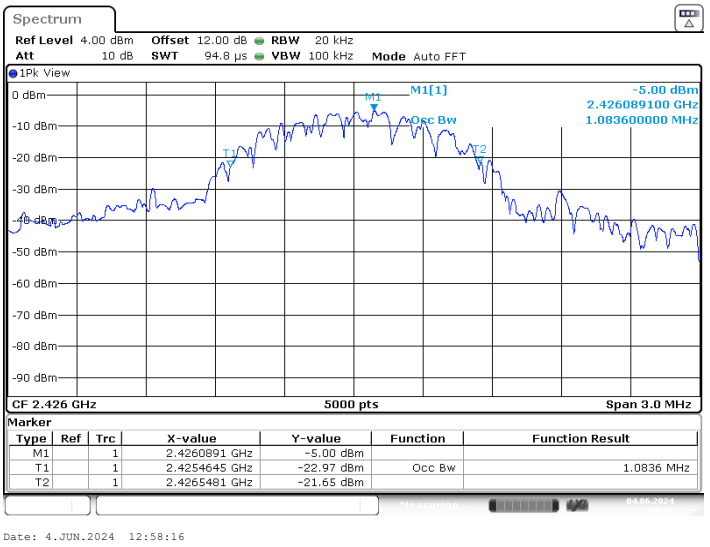
4.6. *RESULTS*

Occupied Bandwidth

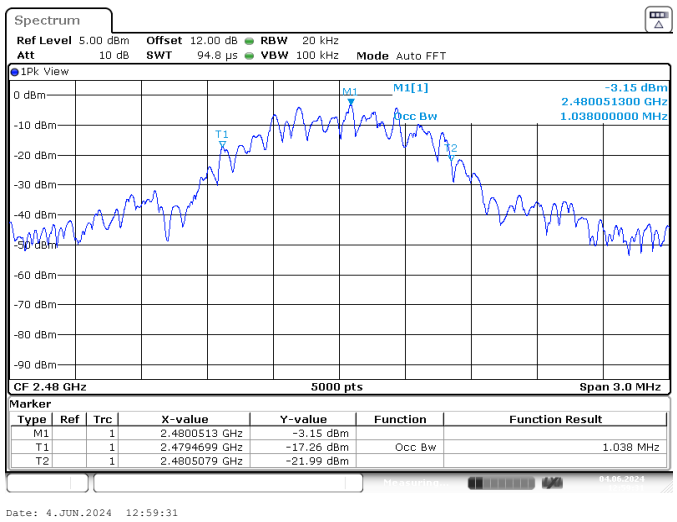
Cmin



Cmid



Cmax



Configuration: BLE - 1MBits/s

Channel	Occupied Bandwidth (MHz)
Cmin	1.090
Cmid	1.084
Cmax	1.038

4.7. *CONCLUSION*

Occupied Channel Bandwidth measurement performed on the sample of the product **TMS AP-01**, Sn: **BC:03:A7:69:34:12**, in configuration and description presented in this test report, show levels **compliant** to the **RSS-GEN** limits.

5. 6dB BANDWIDTH

5.1. *TEST CONDITIONS*

Date of test	:	June 04, 2024
Test performed by	:	Majid MOURZAGH
Relative humidity (%)	:	38
Ambient temperature (°C)	:	23

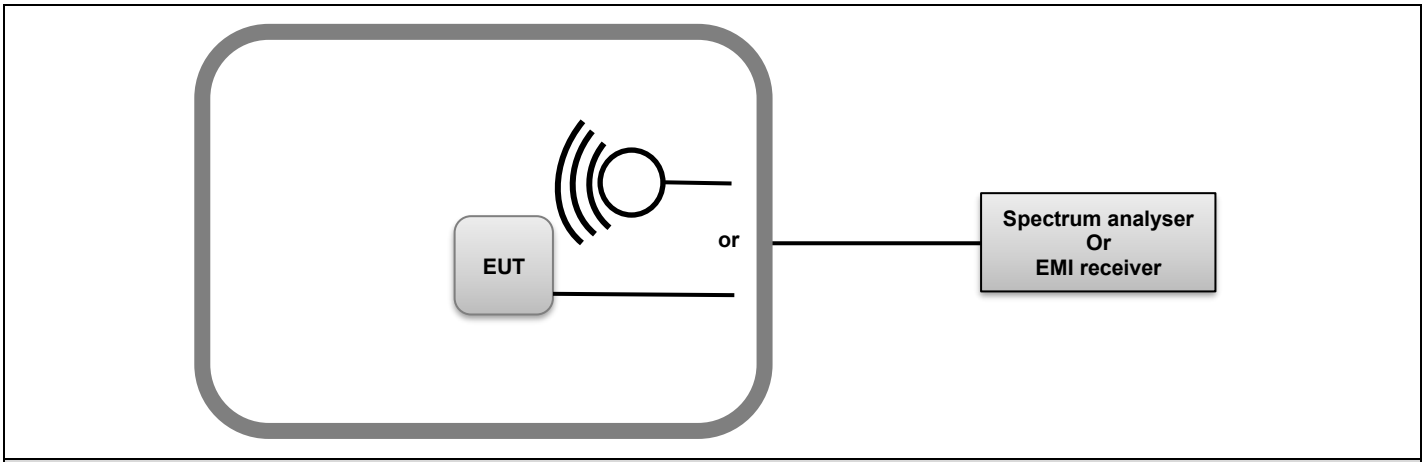
5.2. *TEST SETUP*

The Equipment Under Test is installed in a climatic chamber.
Measurement is performed with a spectrum analyzer in conducted method.

The EUT is turned ON, the center frequency of the spectrum analyzer is set to the fundamental frequency. The captured power is measured and recorded; the measurement is repeated until all frequencies required were complete.

Test Procedure:
KDB 558074 D01 DTS Meas Guidance v05r02 § 8.2

- Set resolution bandwidth (RBW) = 100kHz.
- Set the video bandwidth (VBW) ≥ 3 x RBW.
- Detector = Peak.
- Trace mode = max hold.
- Sweep = auto couple.
- Allow the trace to stabilize.
- Measure the maximum width of the emission that is constrained by the frequencies associated with the two outermost amplitude points (upper and lower) that are attenuated by 6 dB relative to the maximum level measured in the fundamental emission. Compare the resultant bandwidth with the RBW setting of the analyzer.



Test setup of 6dB Bandwidth

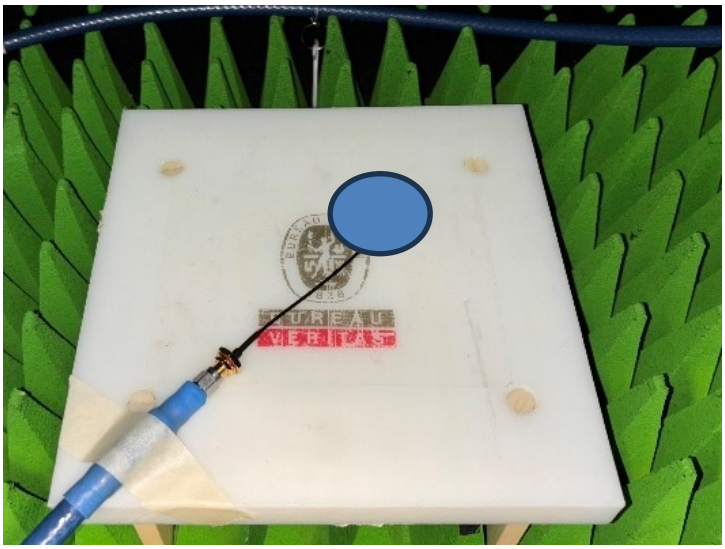


Photo of 6dB bandwidth

5.3. *LIMIT*

Frequency range	6dB bandwidth
902-928MHz 2400MHz to 2483.5MHz 5725-5850 MHz	≥500kHz

5.4. TEST EQUIPMENT LIST

TEST EQUIPMENT USED					
Description	**Manufacturer**	**Model**	**Identifier**	**Cal_Date**	**Cal_Due**
Attenuator 10dB	AEROFLEX	_	A7122268	07/23	07/25
Comb EMR HF	YORK	CGE01	A3169114		
Full Anechoic Room	SIEPEL	_	D3044024		
Multimeter - CEM	FLUKE	87	A1240251	10/23	10/25
SMA 1.5m	SUCOFLEX	18GHz	A5329864	10/23	10/24
SMK 1.2m (Ampl <-> chamber)	HUBER-SUHNER	SUCOFLEX 102	A5330062	04/23	04/26
Spectrum analyzer	ROHDE & SCHWARZ	FSV 40	A4060059	04/24	04/26
Thermo-hygrometer	TESTO	608-H1	B4204120	03/23	03/25
Thermo-hygrometer (PM1/2/3)	KIMO	HQ 210	B4206022	05/23	05/25

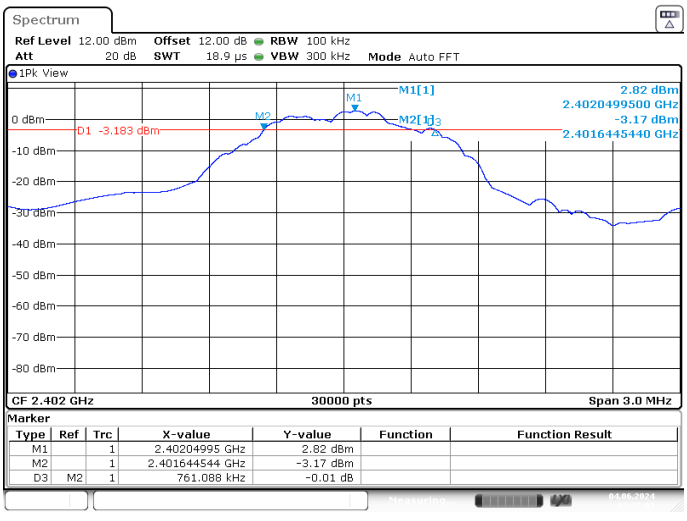
5.5. DIVERGENCE, ADDITION OR SUPPRESSION ON THE TEST SPECIFICATION

None

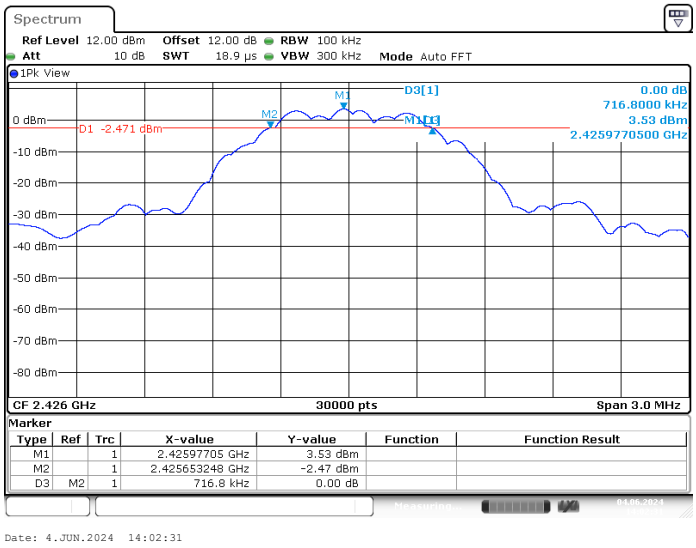
5.6. *RESULTS*

6dB Bandwidth

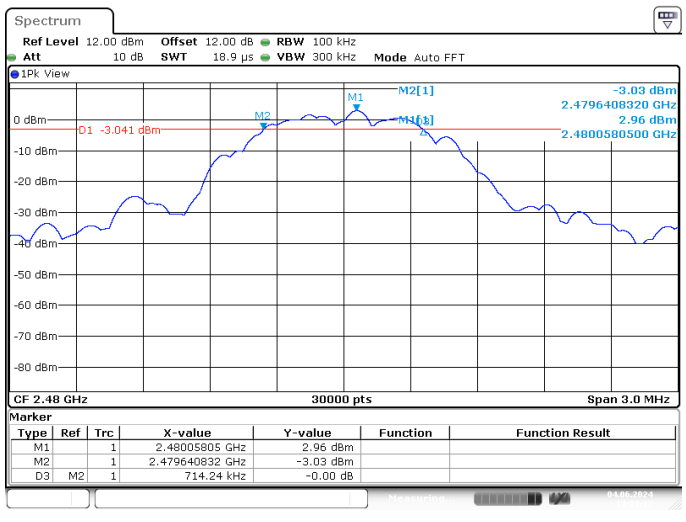
Cmin



Cmid



Cmax



Configuration: BLE - 1MBits/s

Channel	6dB Bandwidth (MHz)	Limit (MHz)
Cmin	0.761	**> 0.5**
Cmid	0.717	**> 0.5**
Cmax	0.714	**> 0.5**

5.7. *CONCLUSION*

6dB Bandwidth measurement performed on the sample of the product **TMS AP-01**, Sn: **BC:03:A7:69:34:12**, in configuration and description presented in this test report, show levels **compliant** to the **47 CFR PART 15.247 & RSS 247** limits.

6. MAXIMUM CONDUCTED OUTPUT POWER

6.1. *TEST CONDITIONS*

Date of test	:	June 04, 2024
Test performed by	:	Majid MOURZAGH
Relative humidity (%)	:	38
Ambient temperature (°C)	:	23

6.2. *TEST SETUP*

The Equipment Under Test is installed in a climatic chamber.
Measurement is performed with a spectrum analyzer in conducted method.

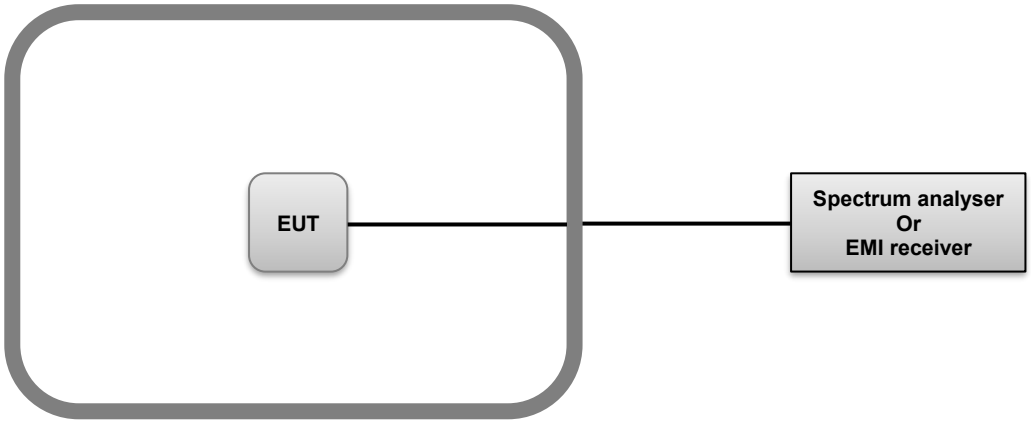
The EUT is turned ON, the center frequency of the spectrum analyzer is set to the fundamental frequency. The captured power is measured and recorded; the measurement is repeated until all frequencies required were complete.

Test Procedure used: KDB 558074 D01 DTS Meas Guidance v05r02 § 8.3.1.1

KDB 558074 D01 DTS Meas Guidance v05r02 § 8.3.1.1

This procedure shall be used when the measurement instrument has available a resolution bandwidth that is greater than the DTS bandwidth.

- Set the RBW ≥ DTS bandwidth.
- Set VBW ≥ 3 x RBW.
- Set span ≥ 3 x RBW
- Sweep time = auto couple.
- Detector = peak.
- Trace mode = max hold.
- Allow trace to fully stabilize.
- Use peak marker function to determine the peak amplitude level.



Test setup of Maximum Conducted Output Power

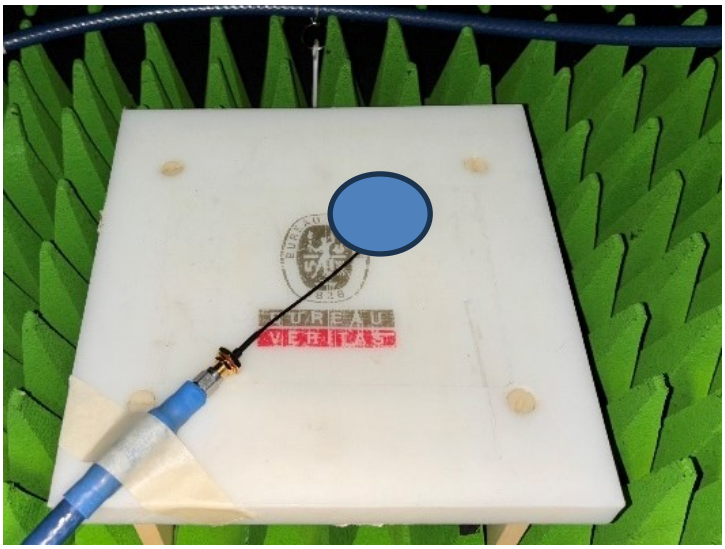


Photo of Maximum Conducted Output Power

6.3. *LIMIT*

Frequency range	Maximum Conducted Output Power
902-928MHz 2400MHz to 2483.5MHz 5725-5850 MHz	≤30dBm*

*Remark: Limits are reduced by G-6dBi if Overall Antenna Gain above 6dBi

6.4. TEST EQUIPMENT LIST

TEST EQUIPMENT USED					
Description	**Manufacturer**	**Model**	**Identifier**	**Cal_Date**	**Cal_Due**
Attenuator 10dB	AEROFLEX	_	A7122268	07/23	07/25
Comb EMR HF	YORK	CGE01	A3169114		
Full Anechoic Room	SIEPEL	_	D3044024		
Multimeter - CEM	FLUKE	87	A1240251	10/23	10/25
SMA 1.5m	SUCOFLEX	18GHz	A5329864	10/23	10/24
SMK 1.2m (Ampl <-> chamber)	HUBER-SUHNER	SUCOFLEX 102	A5330062	04/23	04/26
Spectrum analyzer	ROHDE & SCHWARZ	FSV 40	A4060059	04/24	04/26
Thermo-hygrometer	TESTO	608-H1	B4204120	03/23	03/25
Thermo-hygrometer (PM1/2/3)	KIMO	HQ 210	B4206022	05/23	05/25

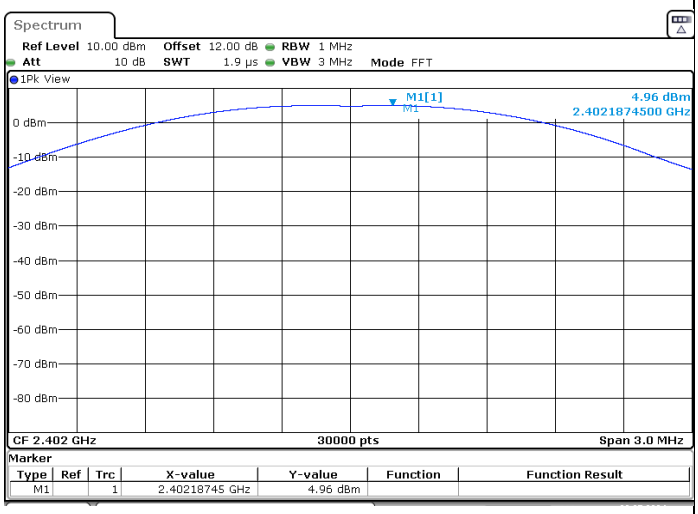
6.5. DIVERGENCE, ADDITION OR SUPPRESSION ON THE TEST SPECIFICATION

None

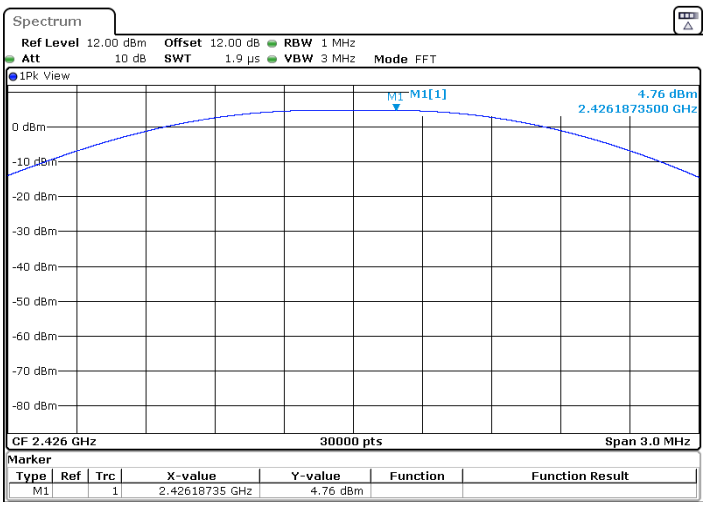
6.6. RESULTS

Maximum Conducted Output Power

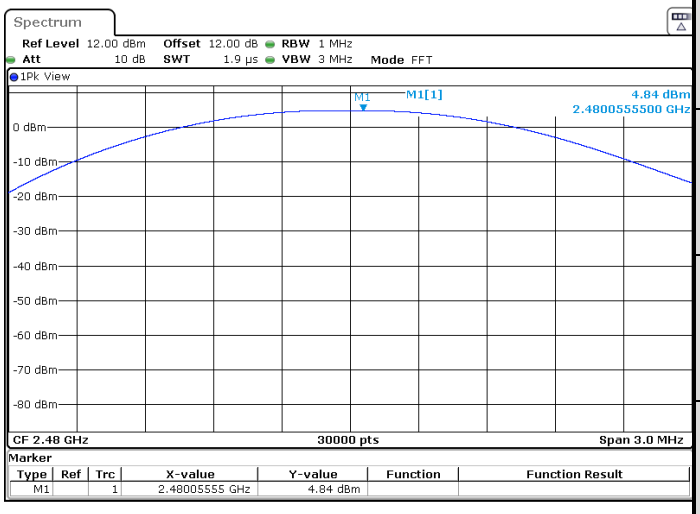
Cmin



Cmid



Cmax



Configuration: BLE - 1MBits/s

Channel	Offset Cable+Att (dB)	Antenna Gain (dBi)	Conducted Power (dBm)	Limit (dBm)
Cmin	12.0	3	4.96	**30**
Cmid	12.0	3	4.76	**30**
Cmax	12.0	3	4.84	**30**

6.7. CONCLUSION

Maximum Output Conducted Power measurement performed on the sample of the product **TMS AP-01**, Sn: **BC:03:A7:69:34:12**, in configuration and description presented in this test report, show levels **compliant** to the **47 CFR PART 15.247 & RSS 247** limits.

7. POWER SPECTRAL DENSITY

7.1. *TEST CONDITIONS*

Date of test	:	June 04, 2024
Test performed by	:	Majid MOURZAGH
Relative humidity (%)	:	38
Ambient temperature (°C)	:	23

7.2. *TEST SETUP*

The Equipment Under Test is installed in a climatic chamber.
Measurement is performed with a spectrum analyzer in conducted method.

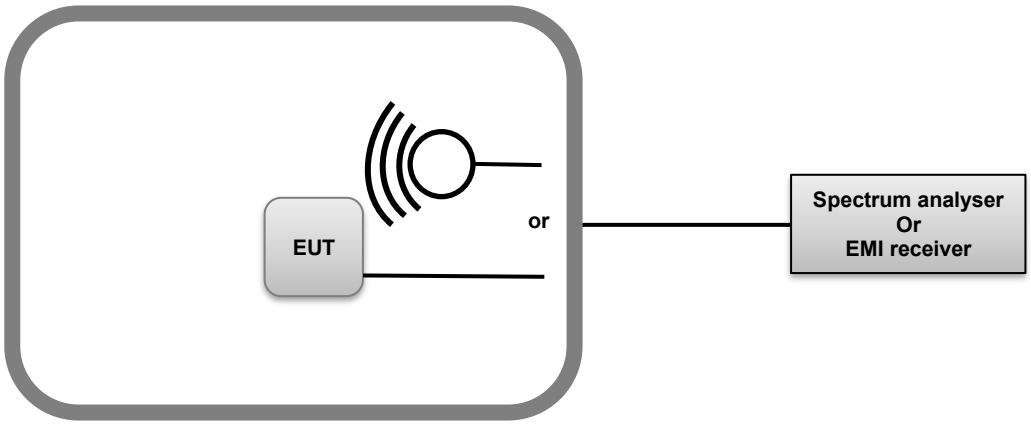
The EUT is turned ON, the center frequency of the spectrum analyzer is set to the fundamental frequency. The captured power is measured and recorded; the measurement is repeated until all frequencies required were complete.

Test Procedure used: KDB 558074 D01 DTS Meas Guidance v05r02 § 8.4 (Method PKPSD)

KDB 558074 D01 DTS Meas Guidance v05r02 § 8.4 (Method PKPSD)

Subclause 11.10 of ANSI C63.10 is applicable

- Set analyzer center frequency to DTS channel center frequency.
- Set the span to 1.5 times the DTS bandwidth.
- Set the RBW to: 3 kHz.
- Set the VBW ≥ 3 x RBW.
- Detector = peak.
- Sweep time = auto couple.
- Trace mode = max hold.
- Allow trace to fully stabilize.
- Use the peak marker function to determine the maximum amplitude level within the RBW.
- If measured value exceeds limit, reduce RBW (no less than 3 kHz) and repeat.



Test setup of Power Spectral Density

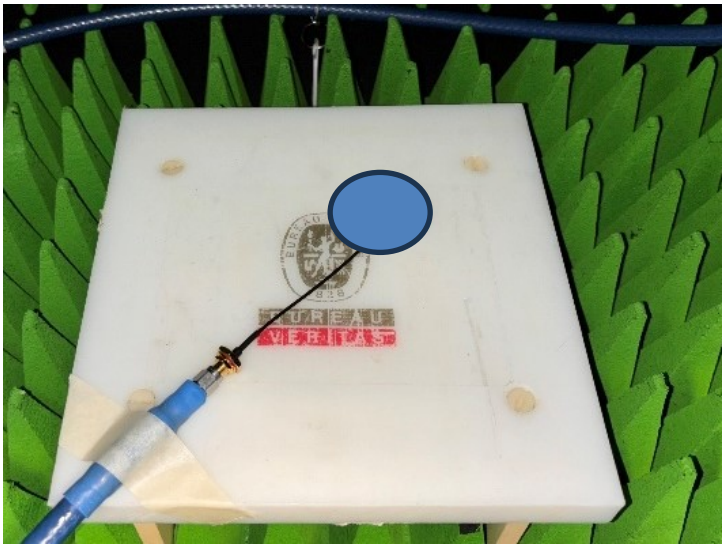


Photo of Power Spectral Density

7.3. *LIMIT*

Frequency range	Power Spectral Density
902-928MHz 2400MHz to 2483.5MHz 5725-5850 MHz	≤8dBm / 3kHz *

*Remark: Limits are reduced by G-6dBi if Overall Antenna Gain above 6dBi

7.4. TEST EQUIPMENT LIST

TEST EQUIPMENT USED					
Description	**Manufacturer**	**Model**	**Identifier**	**Cal_Date**	**Cal_Due**
Attenuator 10dB	AEROFLEX	_	A7122268	07/23	07/25
Comb EMR HF	YORK	CGE01	A3169114		
Full Anechoic Room	SIEPEL	_	D3044024		
Multimeter - CEM	FLUKE	87	A1240251	10/23	10/25
SMA 1.5m	SUCOFLEX	18GHz	A5329864	10/23	10/24
SMK 1.2m (Ampl <-> chamber)	HUBER-SUHNER	SUCOFLEX 102	A5330062	04/23	04/26
Spectrum analyzer	ROHDE & SCHWARZ	FSV 40	A4060059	04/24	04/26
Thermo-hygrometer	TESTO	608-H1	B4204120	03/23	03/25
Thermo-hygrometer (PM1/2/3)	KIMO	HQ 210	B4206022	05/23	05/25

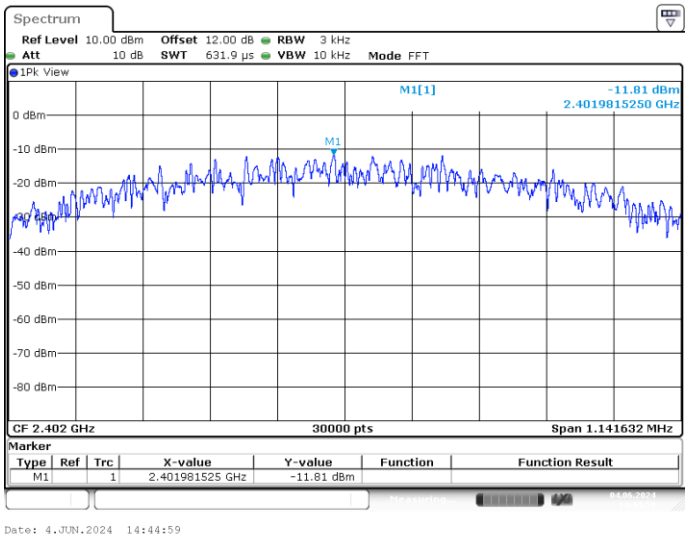
7.5. DIVERGENCE, ADDITION OR SUPPRESSION ON THE TEST SPECIFICATION

None

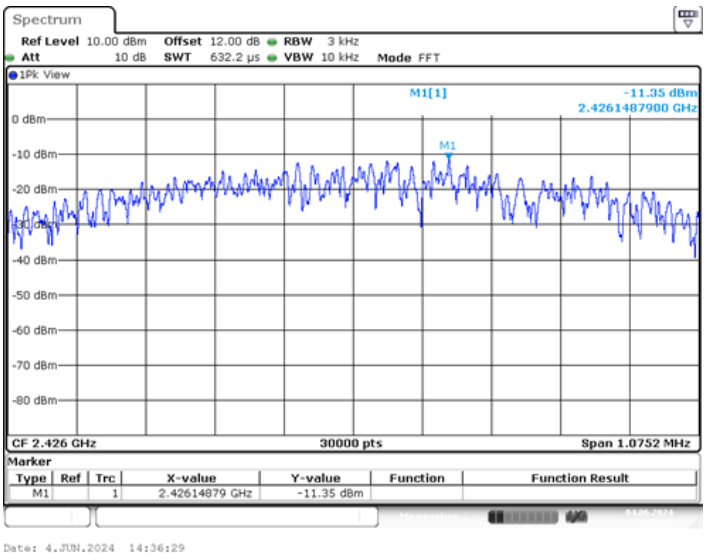
7.6. RESULTS

Power Spectral Density

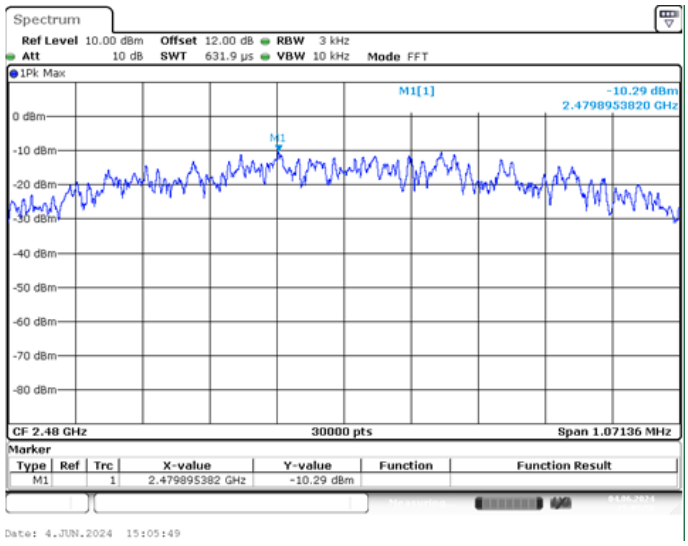
Cmin



Cmid



Cmax



Configuration: BLE - 1MBits/s

Channel	Offset Cable+Att (dB)	Antenna Gain (dBi)	Power Spectral Density (dBm)	Limit (dBm)
Cmin	12.00	3	-11.81	**≤ 8**
Cmid	12.00	3	-11.35	**≤ 8**
Cmax	12.00	3	-10.29	**≤ 8**

7.7. CONCLUSION

Power Spectral Density measurement performed on the sample of the product **TMS AP-01**, Sn: **BC:03:A7:69:34:12**, in configuration and description presented in this test report, show levels **compliant** to the **47 CFR PART 15.247 & RSS 247** limits.

8. UNWANTED EMISSIONS IN NON-RESTRICTED FREQUENCY BANDS

8.1. *TEST CONDITIONS*

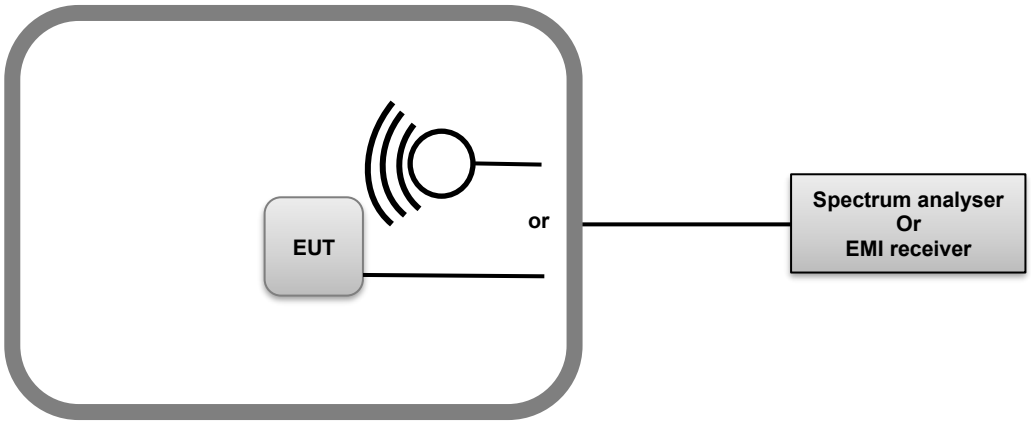
Date of test	:	June 04, 2024
Test performed by	:	Majid MOURZAGH
Relative humidity (%)	:	38
Ambient temperature (°C)	:	23

8.2. *TEST SETUP*

The Equipment Under Test is installed on a table.
Measurement is performed with a spectrum analyzer in conducted method.

The EUT is turned ON, the captured power is measured and recorded; the measurement is repeated until all frequencies required were complete.

Test Procedure:
KDB 558074 D01 DTS Meas Guidance v05r02 § 8.5



Test setup of Unwanted emissions in non-restricted frequency bands

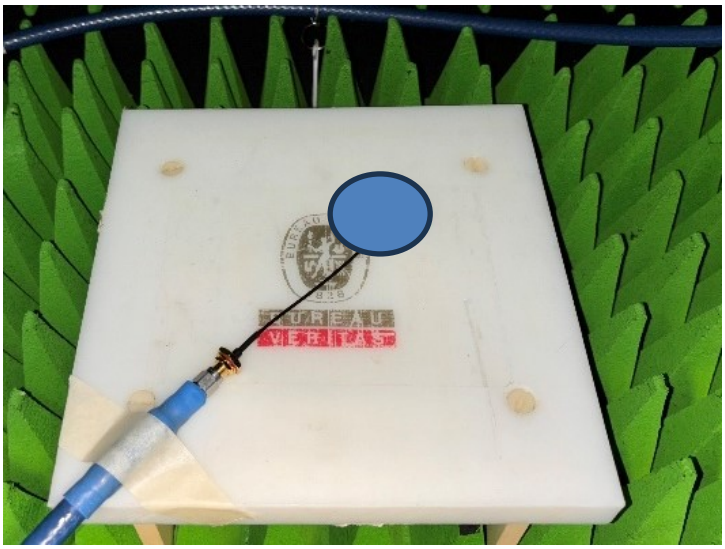


Photo of Unwanted emissions in non-restricted frequency bands

8.3. *LIMIT*

All Spurious Emissions must be at least 20dB below the Fundamental Radiator Level at the Band Edge of operating frequency band and in non-restricted bands.

8.4. TEST EQUIPMENT LIST

TEST EQUIPMENT USED					
Description	**Manufacturer**	**Model**	**Identifier**	**Cal_Date**	**Cal_Due**
Attenuator 10dB	AEROFLEX	_	A7122268	07/23	07/25
Comb EMR HF	YORK	CGE01	A3169114		
Full Anechoic Room	SIEPEL	_	D3044024		
Multimeter - CEM	FLUKE	87	A1240251	10/23	10/25
SMA 1.5m	SUCOFLEX	18GHz	A5329864	10/23	10/24
SMK 1.2m (Ampl <-> chamber)	HUBER-SUHNER	SUCOFLEX 102	A5330062	04/23	04/26
Spectrum analyzer	ROHDE & SCHWARZ	FSV 40	A4060059	04/24	04/26
Thermo-hygrometer	TESTO	608-H1	B4204120	03/23	03/25
Thermo-hygrometer (PM1/2/3)	KIMO	HQ 210	B4206022	05/23	05/25

8.5. DIVERGENCE, ADDITION OR SUPPRESSION ON THE TEST SPECIFICATION

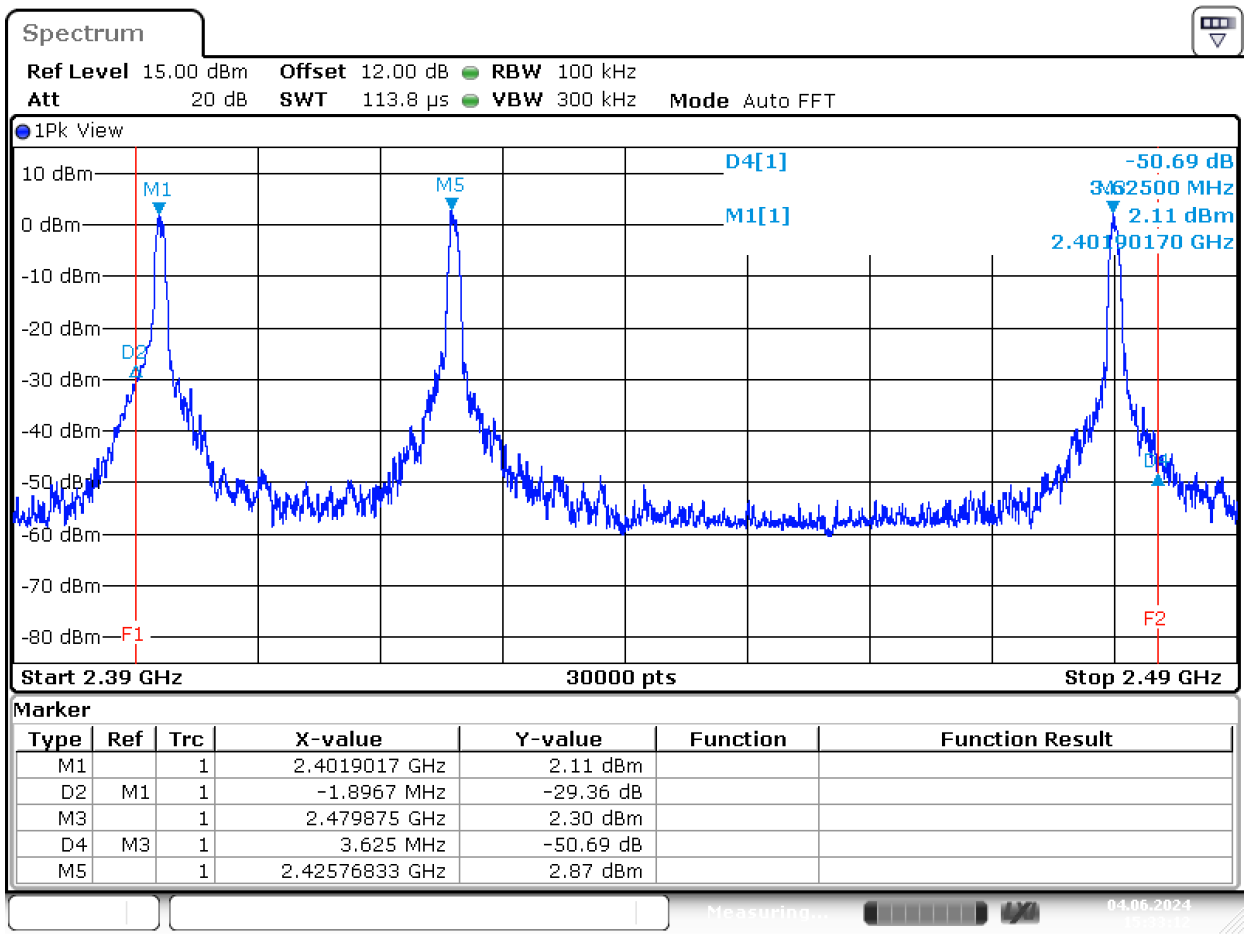
None

8.6. RESULTS

8.6.1. At the band edge

8.6.2. At the band edge

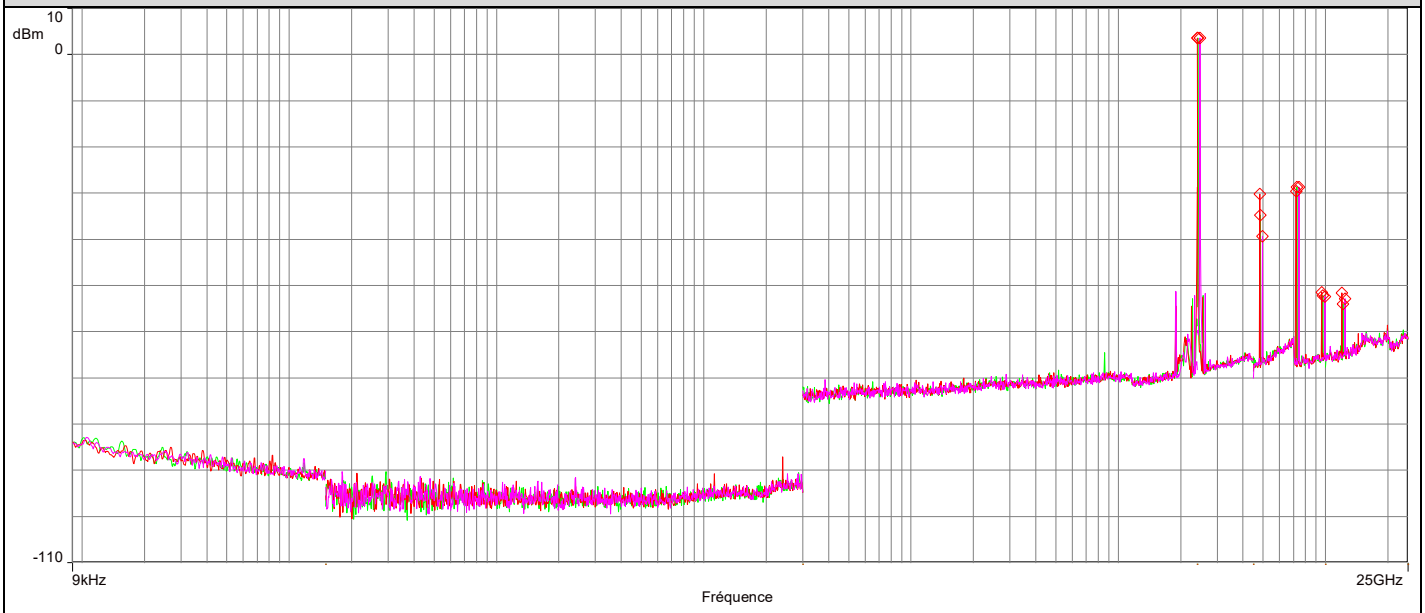
Unwanted emissions in non-restricted bands at the band edge
Configuration: BLE - 1MBits/s
Cmin / Cmid / Cmax
Lower band edge / Higher band edge



Frequency (MHz)	Level (dBc)	Limit (dBc)
2400	-29.33	**-20**
243.5	-50.69	**-20**

8.6.3. Non restricted frequency bands

Unwanted emissions in non-restricted bands
Configuration: BLE - 1MBits/s
Cmin / Cmid / Cmax



Frequency (MHz)	Level (dBc)	Limit (dBc)
2402.03		/
4083.96	**-38.41**	**-20**
7206.55	**-33.26**	**-20**
9608.58	**-55.09**	**-20**
12010.5	**-55.09**	**-20**
2425.97		
4852	**-38.42**	**-20**
7277.50	**-32.32**	**-20**
9704.65	**-55.8**	**-20**
12129.5	**-47.55**	**-20**
2480.01		
4995.96	**-42.93**	**-20**
7440.67	**-32.34**	**-20**
9920.62	**-55.99**	**-20**
12400	**-56.5**	**-20**

8.7. CONCLUSION

Unwanted emissions in non-restricted bands and at the band edge measurement performed on the sample of the product **TMS AP-01**, Sn: **BC:03:A7:69:34:12**, in configuration and description presented in this test report, show levels **compliant** to the **47 CFR PART 15.247 & RSS 247** limits.

9. UNWANTED EMISSIONS IN RESTRICTED FREQUENCY BANDS

9.1. *TEST CONDITIONS*

Date of test : May 29, 2024
Test performed by : Majid MOURZAGH
Relative humidity (%) : 37
Ambient temperature (°C) : 23

9.2. *TEST SETUP*

Test procedure:
ANSI C63.10 & FCC Part 15 subpart C

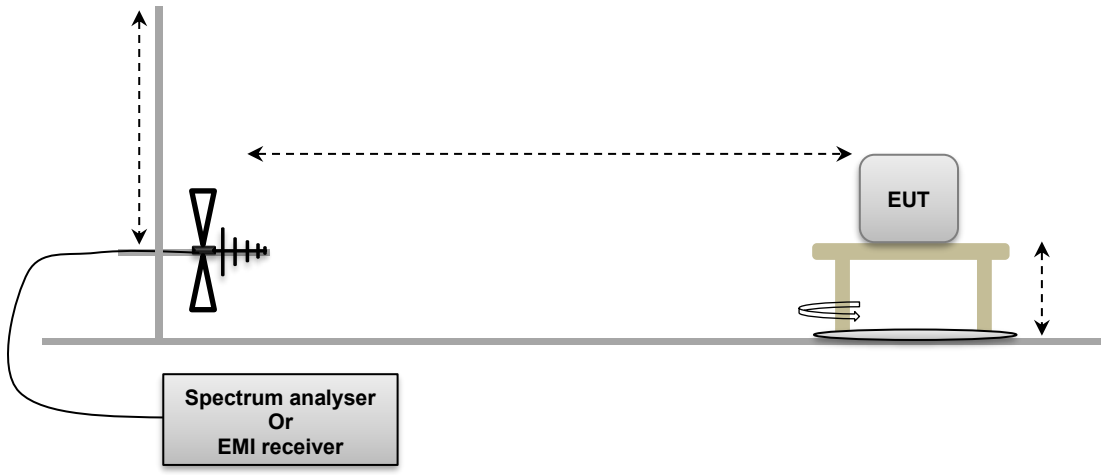
Following frequency ranges, test setup parameters are different and specified in this table:

Frequency range:	**9kHz to 30MHz**	
Test:	**Pre-Characterization**	**Qualification**
Antenna Polarization:	Parallel, Perpendicular and Ground parallel	
Antenna Height:	Centered on EUT (§6.6.5 ANSI C63-10)	Varied from 1m to 4m
Antenna Type:	Loop	
RBW Filter:	200Hz below 150kHz / 9kHz above 150kHz	
Maximization:	Turntable rotation of 360 degrees range and all axis of EUT used in normal configuration	
EUT height:	1.5m	1.5m
Test site:	Full Anechoic Chamber	Open Aera Test Site
Distance EUT - Antenna:	3m	3m
Detector:	Peak	QPeak

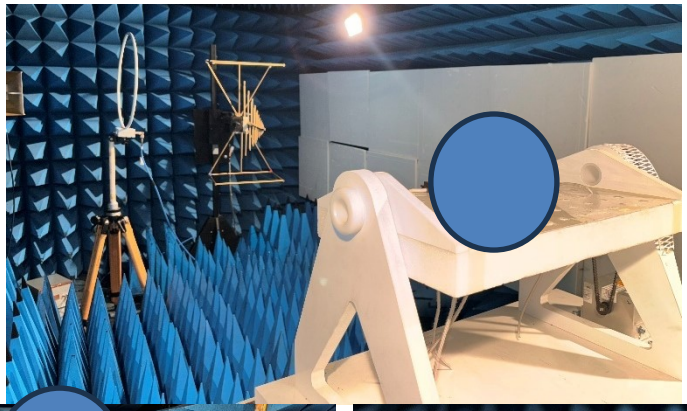
Frequency range:	**30MHz to 1GHz**	
Test:	**Pre-Characterization**	**Qualification**
Antenna Polarization:	Horizontal and Vertical	
Antenna Height:	Centered on EUT (§6.6.5 ANSI C63-10)	Varied from 1m to 4m
Antenna Type:	Biconical & Bi-Log	
RBW Filter:	120kHz	
Maximization:	Turntable rotation of 360 degrees range and all axis of EUT used in normal configuration	
EUT height:	1.5m	0.8m
Test site:	Full Anechoic Chamber	Open Aera Test Site
Distance EUT - Antenna:	3m	10m
Detector:	Peak	QPeak

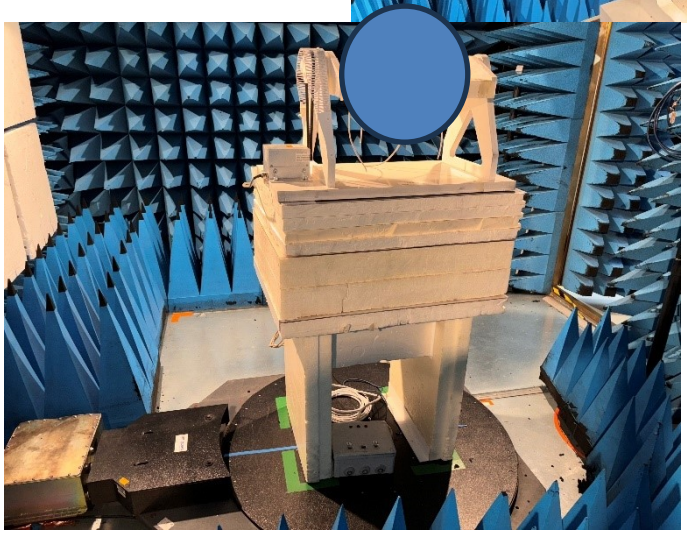
Frequency range:	1GHz to 14GHz	
Test:	**Pre-Characterization**	**Qualification**
Antenna Polarization:	Horizontal and Vertical	
Antenna Height:	Centered on EUT (§6.6.5 ANSI C63-10)	Centered on EUT (§6.6.5 ANSI C63-10)
Antenna Type:	Horn	
RBW Filter:	1MHz	
Maximization:	Turntable rotation of 360 degrees range and all axis of EUT used in normal configuration	
EUT height:	1.5m	1.5m
Test site:	Full Anechoic Chamber	Full Anechoic Chamber
Distance EUT - Antenna:	3m	3m
Detector:	Peak & Average	Peak & Average

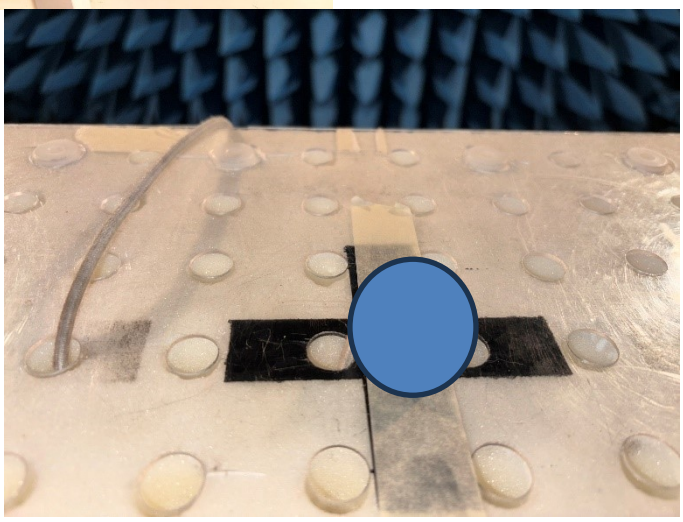
Frequency range:	14GHz to 25GHz	
Test:	**Pre-Characterization**	**Qualification**
Antenna Polarization:	Horizontal and Vertical	
Antenna Height:	Centered on EUT (§6.6.5 ANSI C63-10)	Centered on EUT (§6.6.5 ANSI C63-10)
Antenna Type:	Horn	
RBW Filter:	1MHz	
Maximization:	Turntable rotation of 360 degrees range and all axis of EUT used in normal configuration	
EUT height:	1.5m	1.5m
Test site:	Full Anechoic Chamber	Full Anechoic Chamber
Distance EUT - Antenna:	1m	1m
Detector:	Peak & Average	Peak & Average

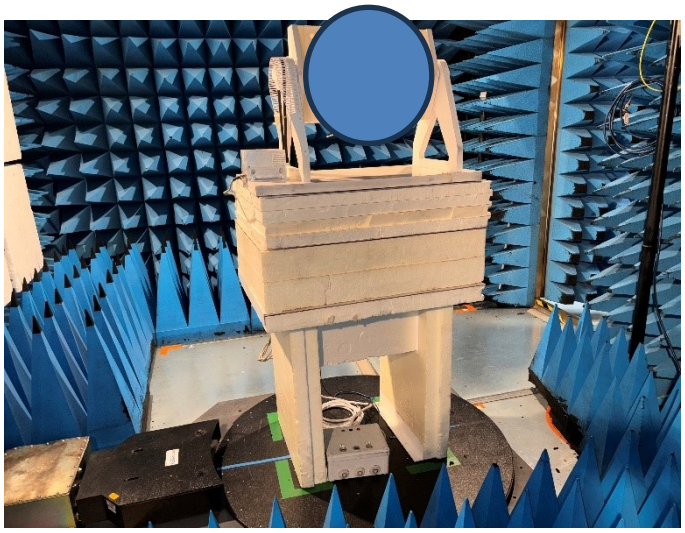


Test setup of Unwanted Emissions in Restricted Frequency Bands









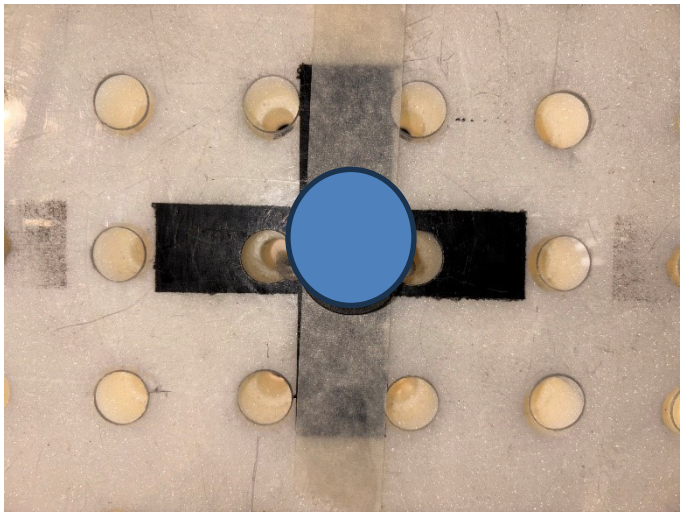


Photo of Unwanted Emissions in Restricted Frequency Bands

9.3. *LIMIT*

Measure at 300m		
Frequency range	**Level**	**Detector**
9kHz-490kHz	67.6dBµV/m /F(kHz)	QPeak
Measure at 30m		
Frequency range	**Level**	**Detector**
490kHz-1.705MHz	87.6dBµV/m /F(kHz)	QPeak
1.705MHz-30MHz	29.5dBµV/m	QPeak
Measure at 10m		
Frequency range	**Level**	**Detector**
30MHz to 88MHz	29.5dBµV/m	QPeak
88MHz to 216MHz	33dBµV/m	QPeak
216MHz to 960MHz	35.5BµV/m	QPeak
960MHz to 1000MHz	43.5dBµV/m	QPeak
Above 1000MHz	63.5dBµV/m	Peak
	43.5dBµV/m	Average
Measure at 3m		
Frequency range	**Level**	**Detector**
30MHz to 88MHz	40dBµV/m	QPeak
88MHz to 216MHz	43.5dBµV/m	QPeak
216MHz to 960MHz	46BµV/m	QPeak
960MHz to 1000MHz	54dBµV/m	QPeak
Above 1000MHz	74dBµV/m	Peak
	54dBµV/m	Average

9.4. TEST EQUIPMENT LIST

TEST EQUIPMENT USED					
Description	**Manufacturer**	**Model**	**Identifier**	**Cal_Date**	**Cal_Due**
Amplifier 10MHz - 18GHz	LCIE SUD EST	_	A7102082	05/22	05/24
Antenna Bi-log	AH System	SAS-521-7	C2040180	05/23	05/25
Antenna horn 18GHz	EMCO	3115	C2042029	03/22	03/25
BAT EMC	NEXIO	v3.21.0.32	L1000115		
CABLE	TELEDYNE	R82-0404-0.5M	A5330010	03/22	03/25
Cable 0.75m	-	18GHz	A5329900	08/22	08/24
Cable SMA 40cm	WITHWAVE	W101-SM1-0.4M	A5329979	10/23	10/26
Comb EMR HF	YORK	CGE01	A3169114		
CONTROLLER	INNCO	CO3000	D3044034		
Emission Cable (SMA 1m)	TELEDYNE	26GHz	A5329874	08/22	08/25
Emission Cable (SMA 3.3m)	TELEDYNE	26GHz	A5329875	08/22	08/25
Filter Matrice	LCIE SUD EST	Combined filters	A7484078	03/23	03/25
Rehausse Table C3	LCIE	_	F2000507		
Rehausse Table C3	LCIE	_	F2000511		
Semi-Anechoic chamber #3 (BF)	SIEPEL	_	D3044017_BF	04/22	04/25
Semi-Anechoic chamber #3 (VSWR)	SIEPEL	_	D3044017_VSWR	04/22	04/25
Spectrum analyzer	ROHDE & SCHWARZ	FSU 26	A4060058	09/23	09/25
Table C3	LCIE	_	F2000461		
Thermo-hygrometer (PM1/2/3)	KIMO	HQ 210	B4206022	05/23	05/25
TILT	INNCO	TILT	D3044033		
Turntable chamber (Cage#3)	ETS Lingren	Model 2165	F2000371		
Turntable controller (Cage#3)	ETS Lingren	Model 2090	F2000444		
Antenna Mat (OATS)	ETS Lingren	2071-2	F2000392		
Cable (OATS)	_	1GHz	A5329623	09/23	09/24
Emission Cable	RADIALEX		A5329061	07/23	07/24
OATS	_	_	F2000409	08/23	08/24
Table C1/OATS	LCIE	_	F2000445		
Thermo-hygrometer (PM1/2/3)	KIMO	HQ 210	B4206022	05/23	05/25
Antenna Bi-log	CHASE	CBL6111A	C2040172	04/22	04/24
Antenna horn 40GHz	SCHWARZBECK	BBHA 9170	C2042028	06/22	06/25
Cable 1m 40GHz	INTELLICONNECT	C-KPKP-1503-1M	A5329987	04/21	04/24
Emission Cable 0.5m (Ampl <-> receptor)	INTELLICONNECT	C-KPKP-1503-500MM	A5329988	04/23	04/26
PRE-AMPLIFIER	LCIE SUD EST	PRE-AMPLIFIER (40GHz)	A7080078	09/22	09/24
SMA 1.5m	SUCOFLEX	18GHz	A5329864	10/23	10/24
Spectrum analyzer	ROHDE & SCHWARZ	FSV 40	A4060059	11/21	11/23

9.5. DIVERGENCE, ADDITION OR SUPPRESSION ON THE TEST SPECIFICATION

None

9.6. RESULTS

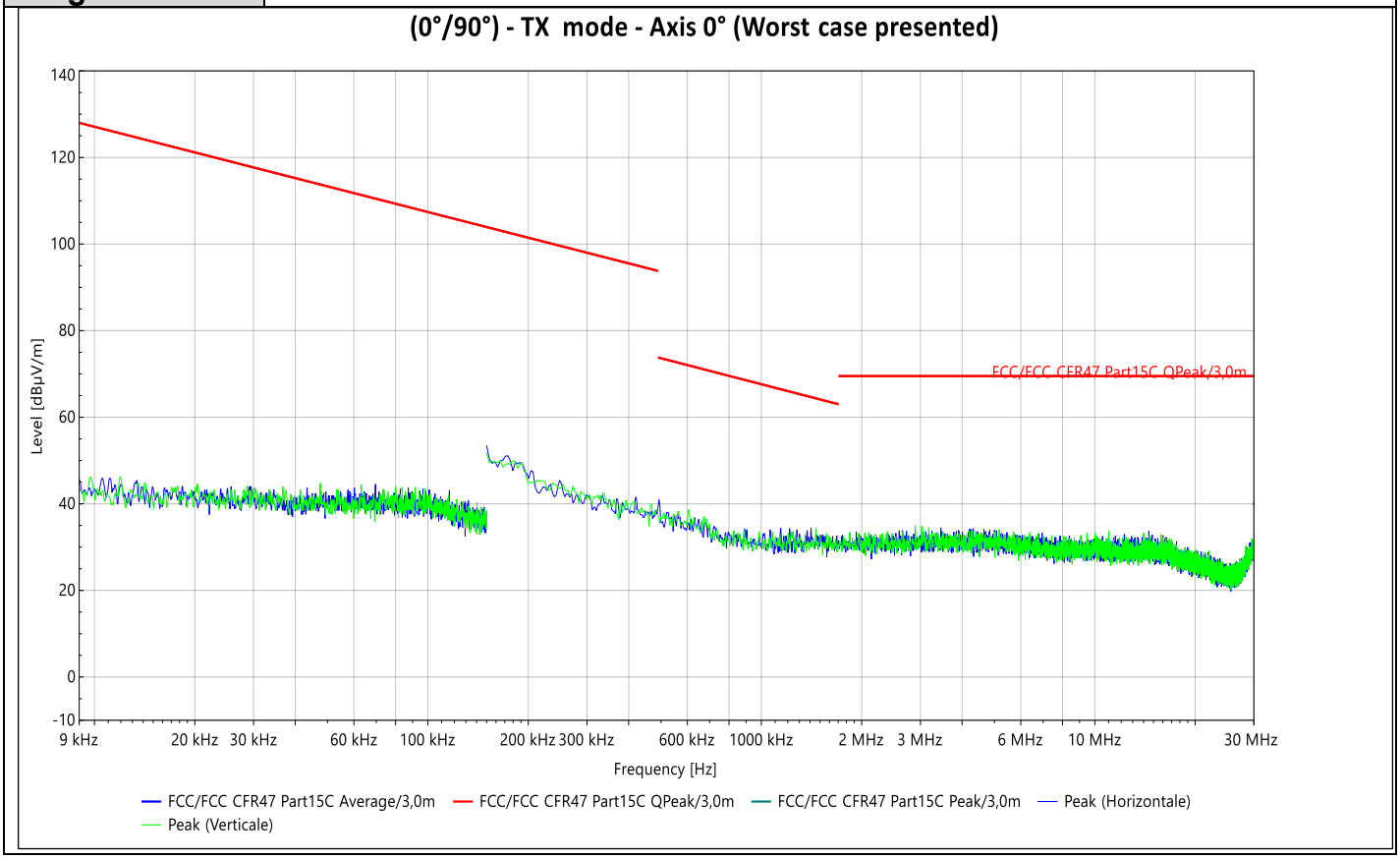
For all following measurements, worst case is presented with different configurations and modulations of EUT.

9.6.1. 9kHz to 30MHz

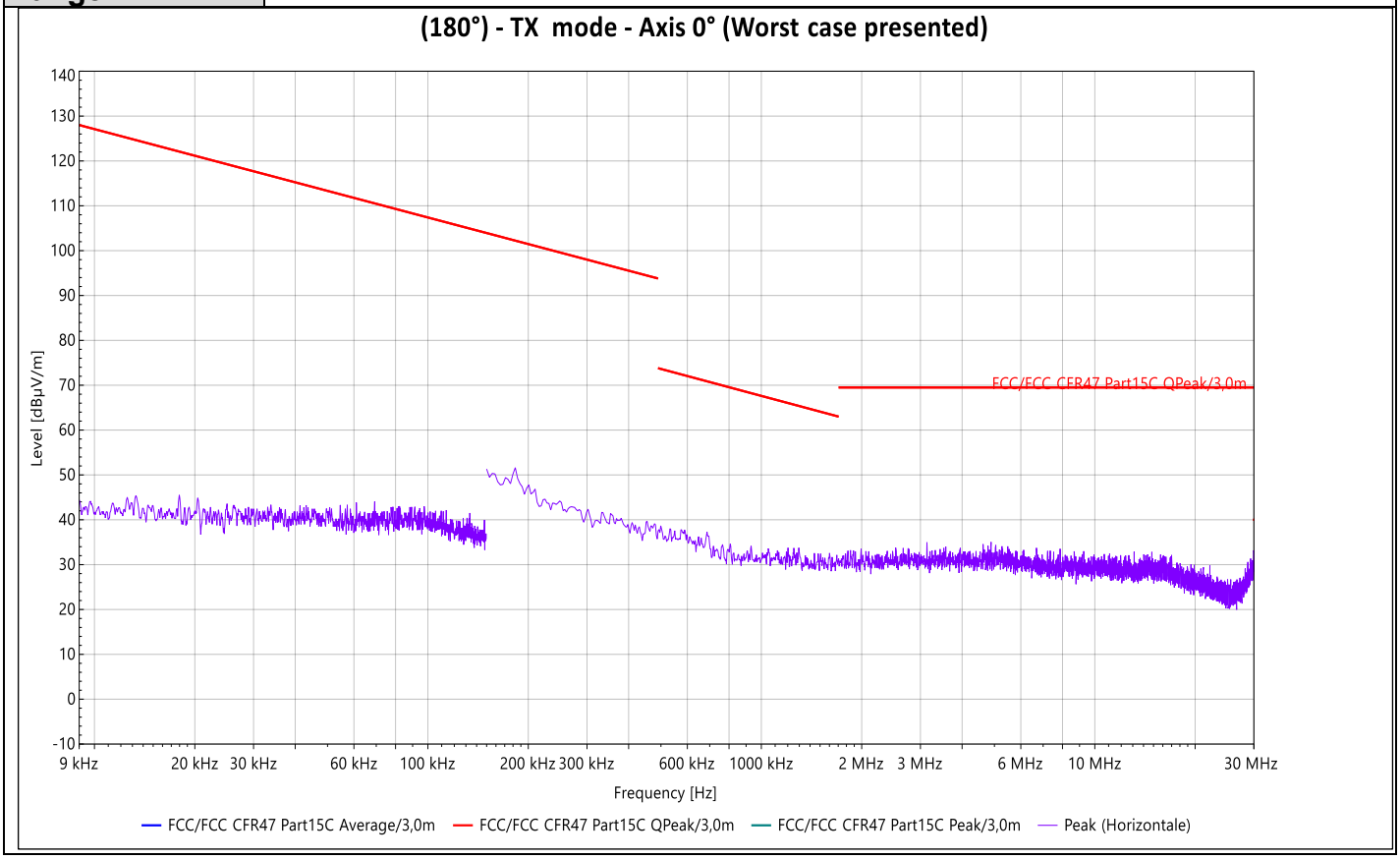
Graphs – Pre characterization: worst case presented

Graph identifier	Polarization	Mode	Channel	EUT position	Comments
Emr# 1	0°/90°	TX	Cmin	Axis XY/Z	See the following results
Emr# 2	180°	TX	Cmin	Axis XY/Z	See the following results

Radiated Emissions	
Graph name:	Emr#1
Frequency range:	9 kHz to 30 MHz



Radiated Emissions	
Graph name:	Emr#2
Frequency range:	9 kHz to 30 MHz



Pre-Characterization:

Frequency

Final measurement:

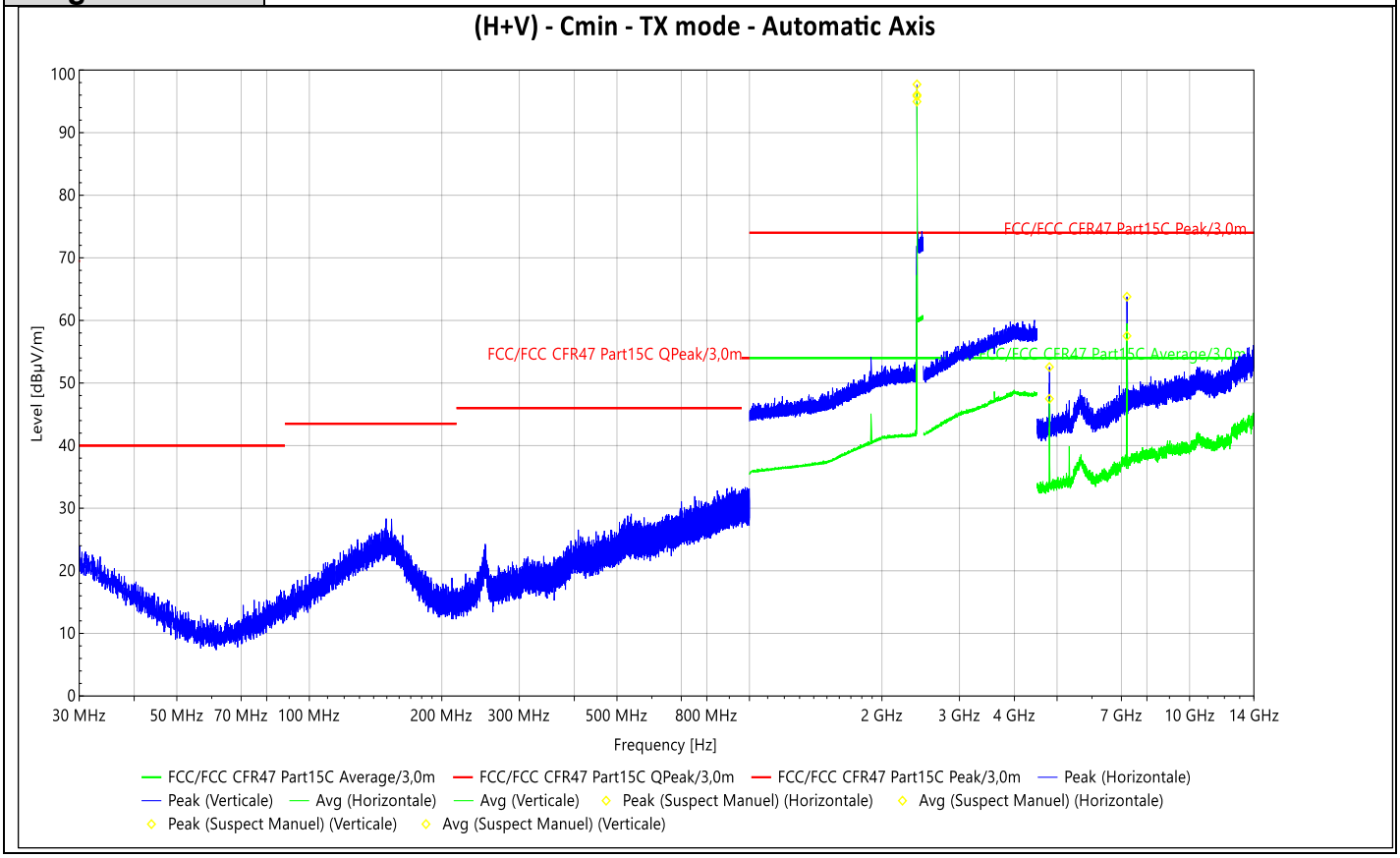
No significant frequency observed

9.6.2. 30MHz to 14GHz

Graphs – Pre characterization:

Graph identifier	Polarization	Mode	Channel	EUT position	Comments
Emr# 3	H/V	TX	Cmin	0-150°/ Step 30°	See the following results
Emr# 4	H/V	TX	Cmin	0-150°/ Step 30°	See the following results
Emr# 5	H/V	TX	Cmin	0-150°/ Step 30°	See the following results

Radiated Emissions	
Graph name:	Emr#3
Frequency range:	30 MHz to 14 GHz

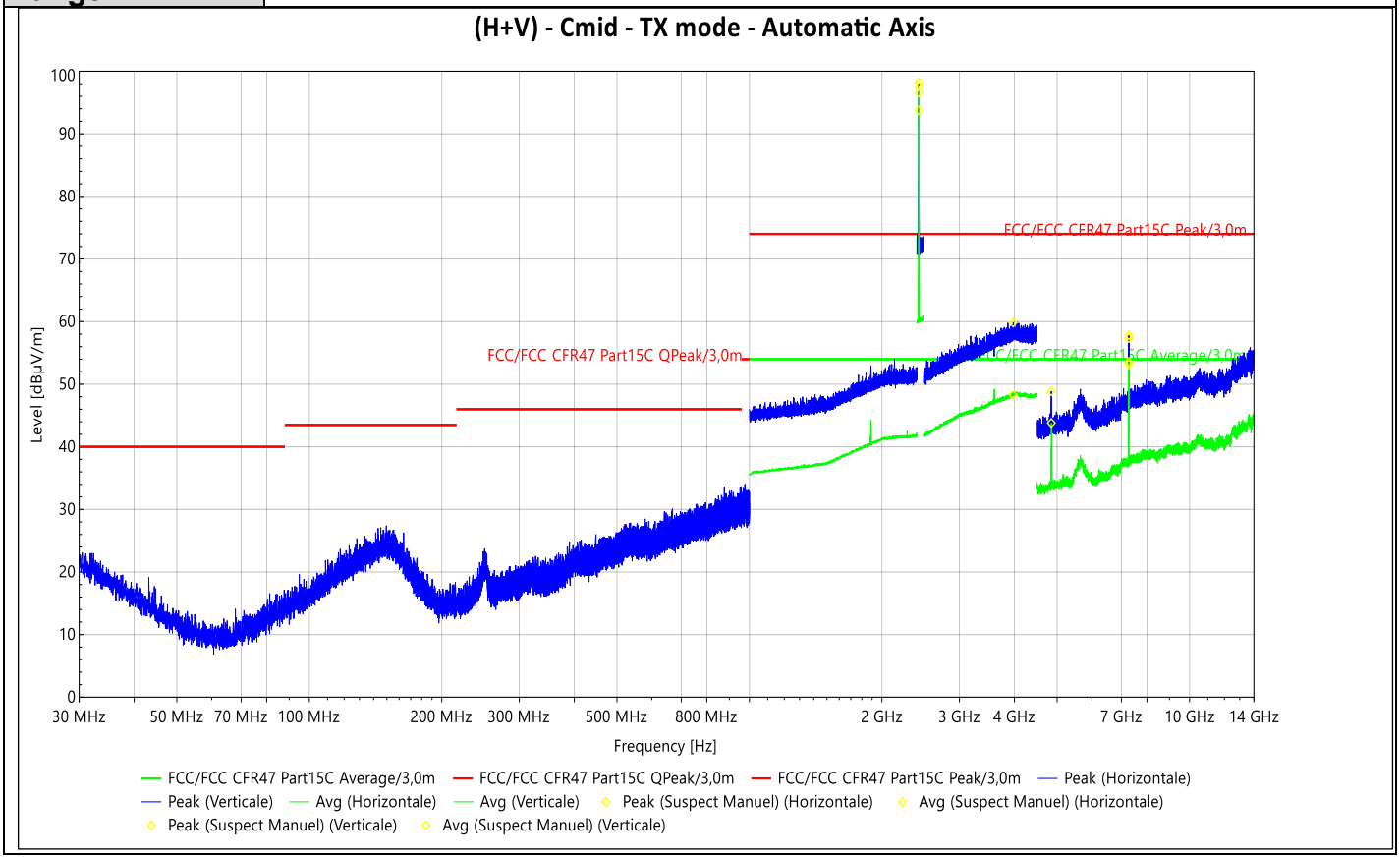


Pre-Characterization:

Frequency	PK Level (dBµV/m)	Lim.PK (dBµV/m)	Avg (dBµV/m)	Lim.Avg (dBµV/m)	Angle (°)	Polar.	Correct. (dB)
2.40212925 GHz	97.71	/	95.83	/	143	H	35.71
4.804 GHz	52.55	74.00	47.48	54.00	336	H	-18.50
7.206549999 GHz*	63.79	74.00	57.52	54.00	314	V	-13.14
2.401837 GHz	96.04	/	94.96	/	29	V	35.71

*** : See final measurement: C63.10 ,§ 4.1.4.2.3**

Radiated Emissions	
Graph name:	Emr#4
Frequency range:	30 MHz to 14 GHz

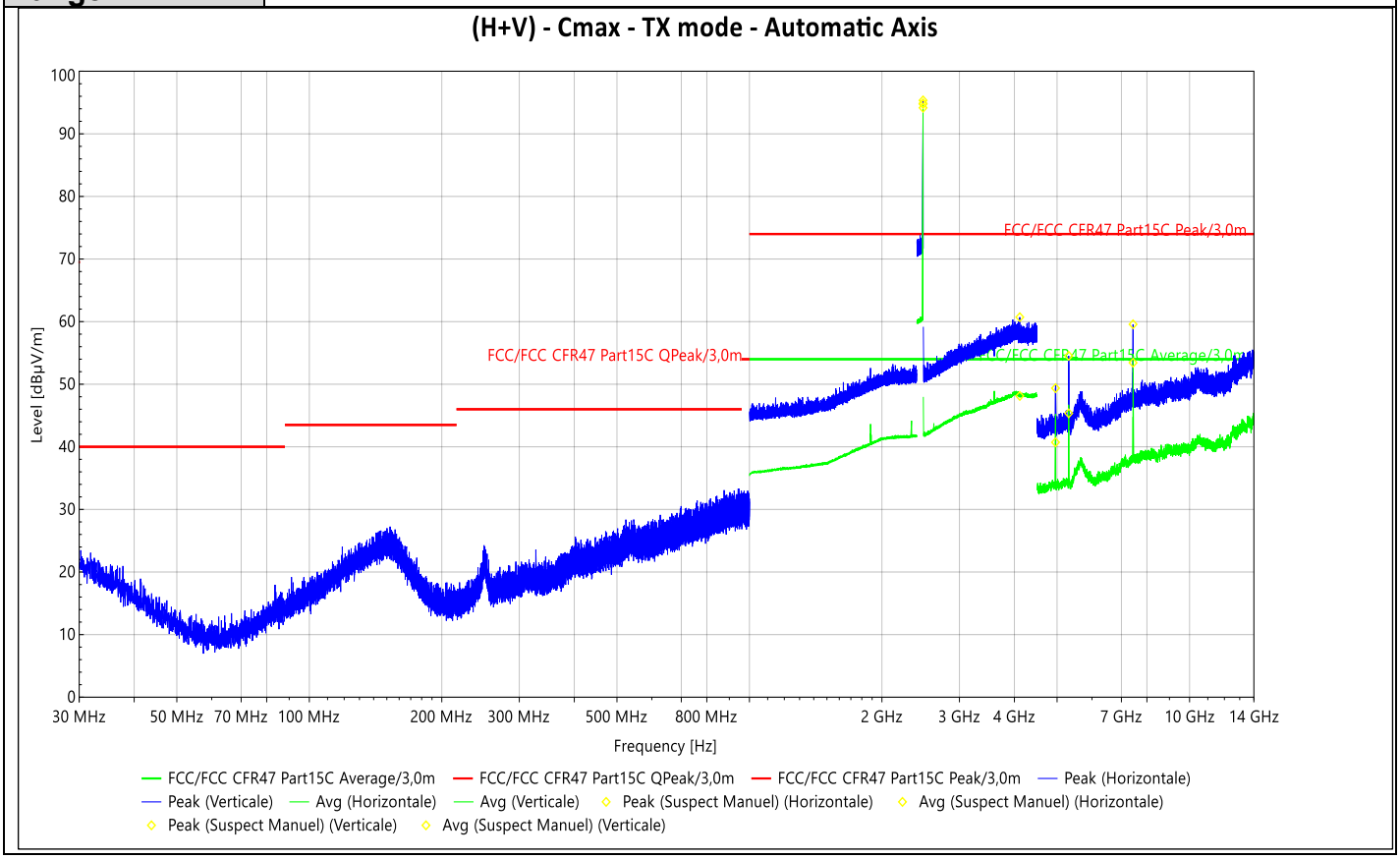


Pre-Characterization:

Frequency	PK Level (dBµV/m)	Lim.PK (dBµV/m)	Avg (dBµV/m)	Lim.Avg (dBµV/m)	Angle (°)	Polar.	Correct. (dB)
2.426052 GHz	98.20	/	97.57	/	144	H	35.75
2.4261355 GHz	96.58	/	93.74	/	85	V	35.75
4.8515 GHz	48.89	74.00	43.81	54.00	0	H	-18.52
7.277799999 GHz*	57.37	74.00	53.19	54.00	0	H	-13.01
7.277799999 GHz*	57.83	74.00	53.55	54.00	8	V	-13.01
3.9740968 GHz	59.85	74.00	48.27	54.00	152	H	41.59

*** : See final measurement: C63.10 ,§ 4.1.4.2.**

Radiated Emissions	
Graph name:	Emr#5
Frequency range:	30 MHz to 14 GHz

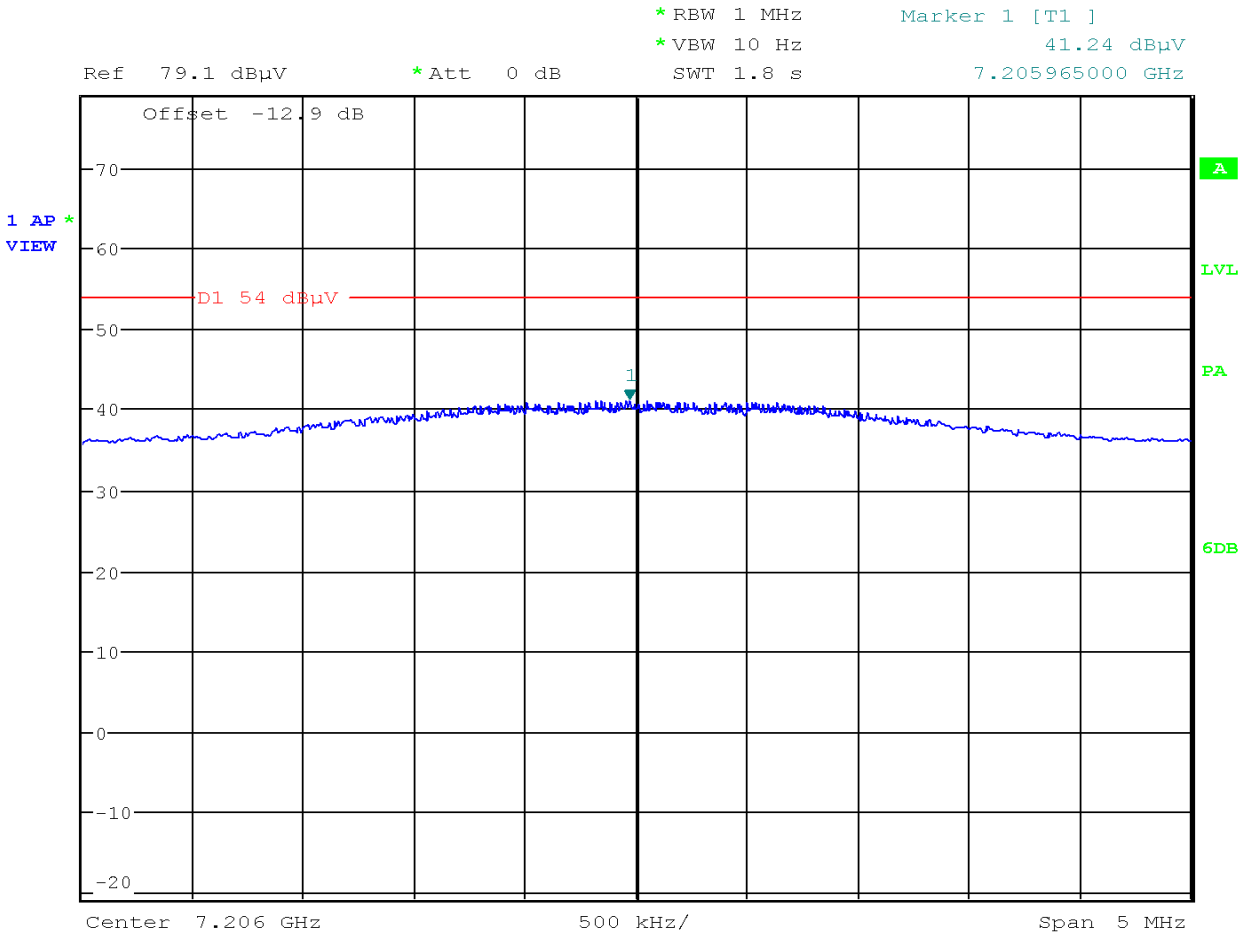


Pre-Characterization:

Frequency	PK Level (dBµV/m)	Lim.PK (dBµV/m)	Avg (dBµV/m)	Lim.Avg (dBµV/m)	Angle (°)	Polar.	Correct. (dB)
2.48003475 GHz	95.34	/	94.76	/	150	H	35.77
2.48003475 GHz	94.85	/	94.16	/	97	V	35.77
4.95885 GHz	49.37	74.00	40.72	54.00	0	H	-18.23
5.31415 GHz	54.53	74.00	45.35	54.00	85	H	-17.56
4.1136386 GHz	60.71	74.00	48.12	54.00	99	V	41.55
7.439299999 GHz*	59.57	74.00	53.43	54.00	93	V	-12.86

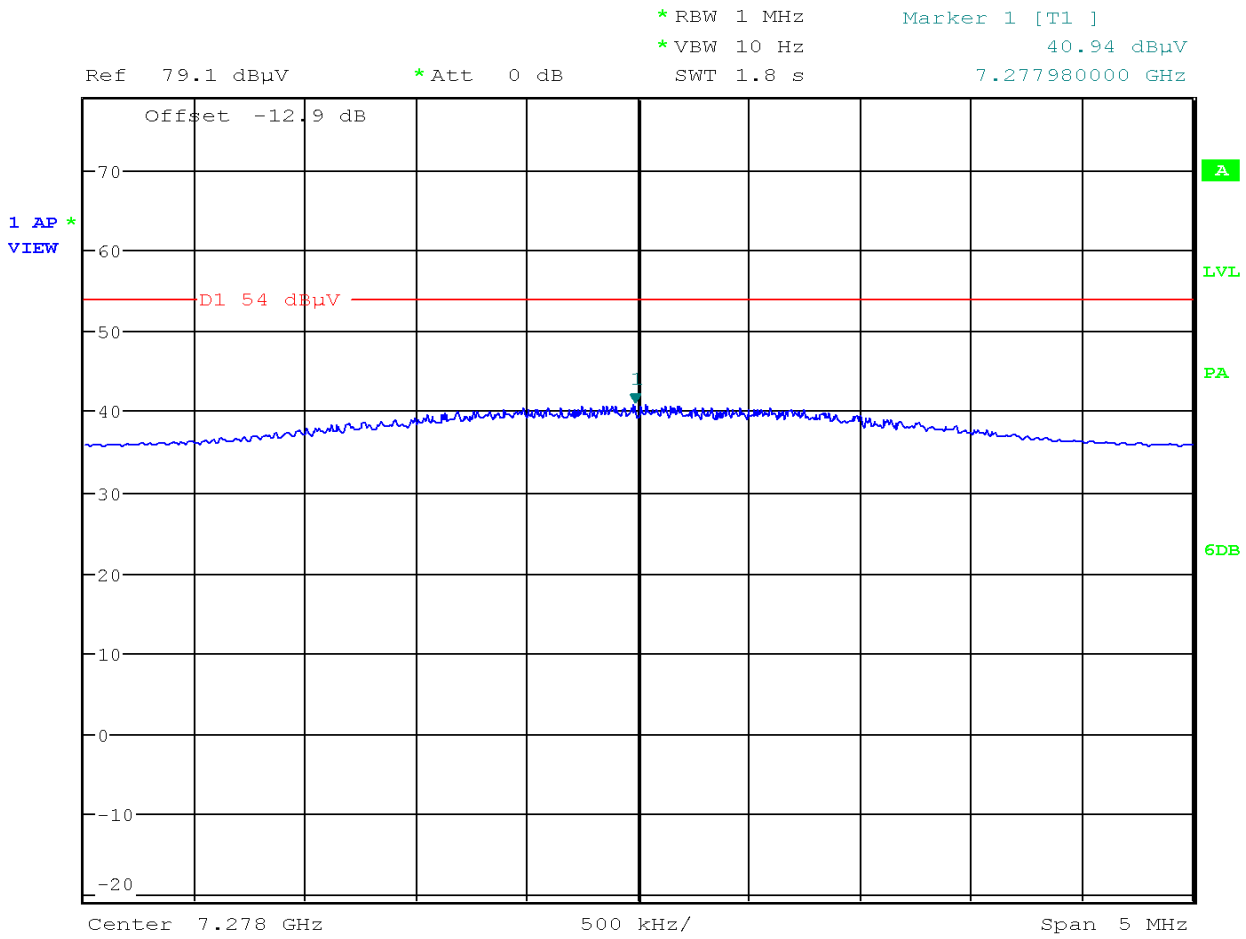
*** : See final measurement: C63.10 ,§ 4.1.4.2.**

Final measurement: C63.10 ,§ 4.1.4.2.3



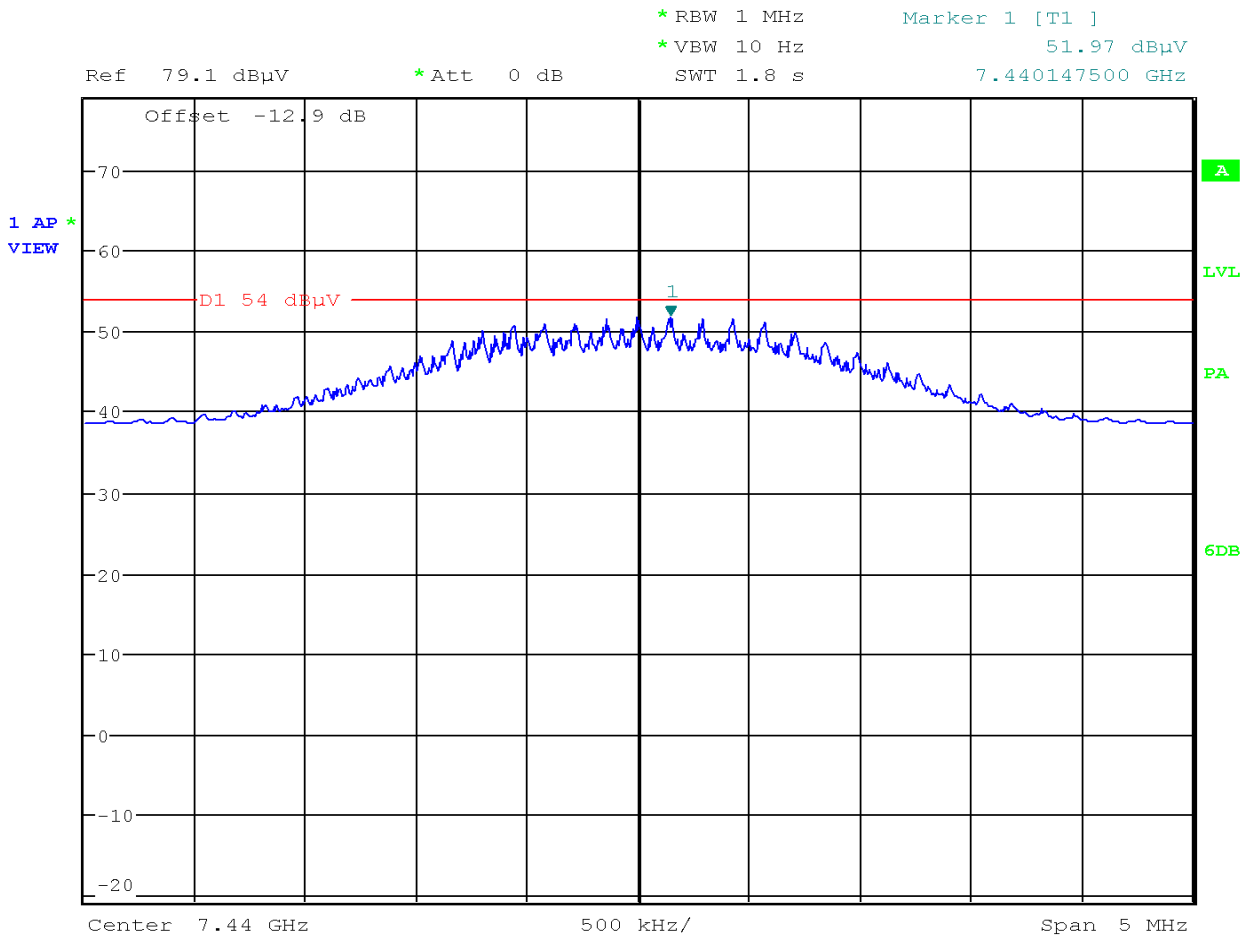
Date: 29.MAY.2024 08:15:01

Test Frequency (MHz)	Meter Reading dB(µV)	Detector (Pk/QP/Av)	Polarity (V/H)	TILT (Degrees)	Antenna Height (cm) (cm)	Transducer Factor (dB)	Level (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Remark
7206.000	55.14	Av	V	0	165	-12.9	42.2	54.0	**-11.8**	Max Power



Date: 29.MAY.2024 08:29:34

Test Frequency (MHz)	Meter Reading dB(µV)	Detector (Pk/QP/Av)	Polarity (V/H)	TILT (Degrees)	Antenna Height (cm) (cm)	Transducer Factor (dB)	Level (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Remark
7278.000	54.84	Av	V	0	165	-12.9	41.9	54.0	**-12.1**	Max Power



Date: 29.MAY.2024 07:38:16

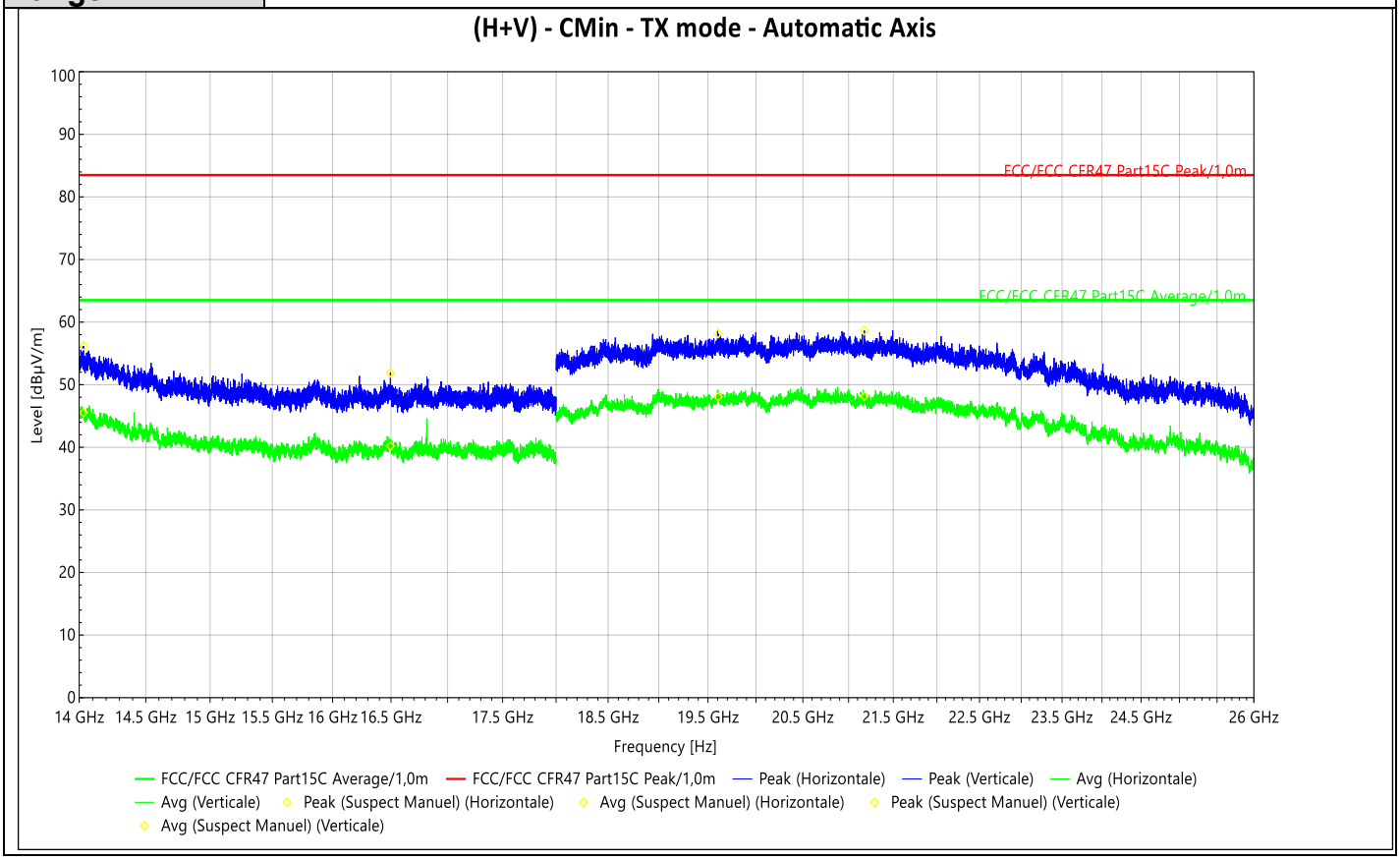
Test Frequency (MHz)	Meter Reading dB(µV)	Detector (Pk/QP/Av)	Polarity (V/H)	TILT (Degrees)	Antenna Height (cm) (cm)	Transducer Factor (dB)	Level (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Remark
7440.000	64.87	Av	H	0	165	-12.9	52.0	54.0	**-2.0**	Max Power

9.6.3. 1GHz to 25GHz

Graphs – Pre characterization:

Graph identifier		Polarization	Mode	Channel	EUT position	Comments
Emr#	6	H/V	TX	Cmin	Axis XY/Z	See the following results
Emr#	7	H/V	TX	Cmid	Axis XY/Z	See the following results
Emr#	8	H/V	TX	Cmax	Axis XY/Z	See the following results

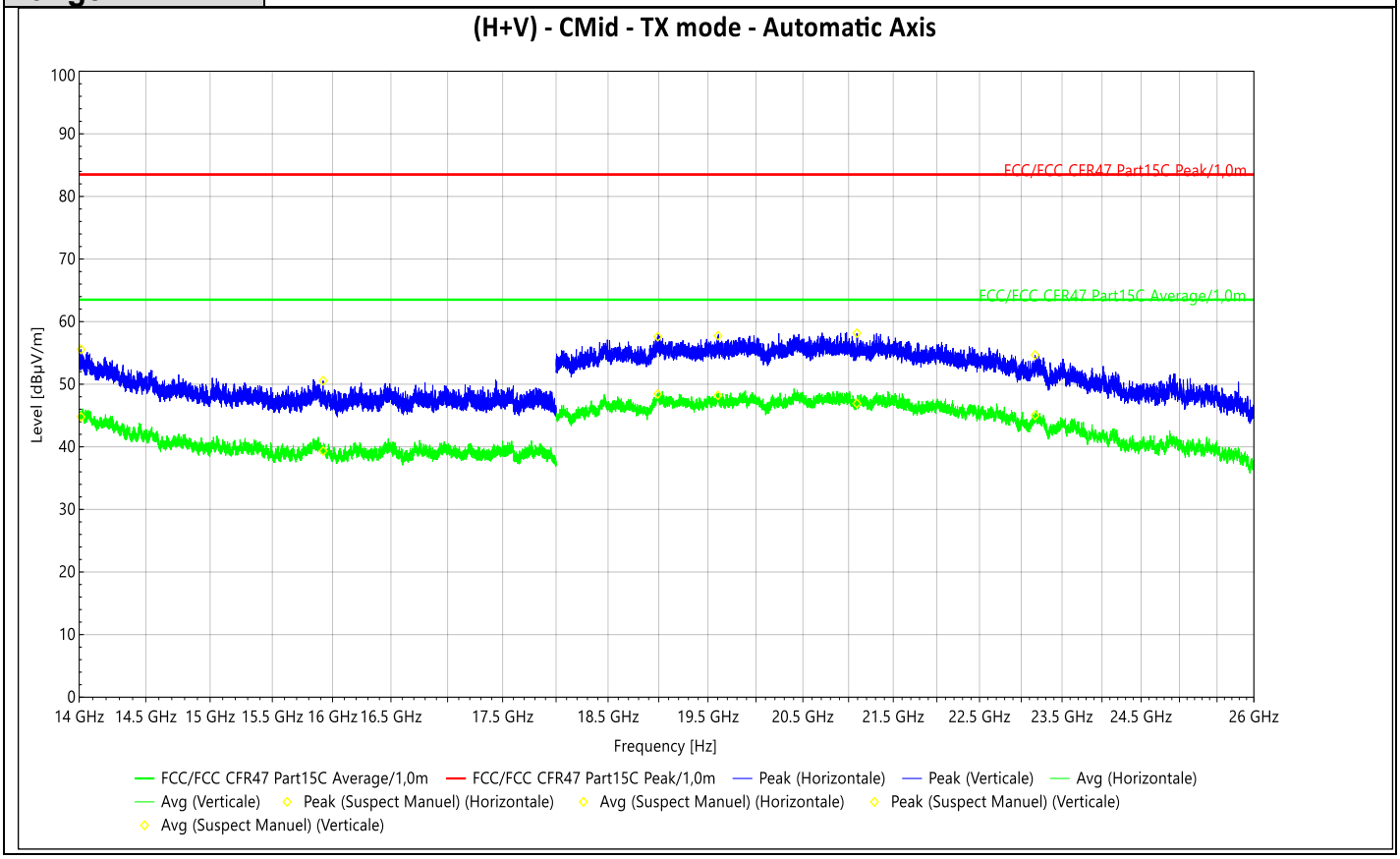
Radiated Emissions	
Graph name:	Emr#6
Frequency range:	14 GHz to 26 GHz



Pre-Characterization:

Frequency	PK Level (dBµV/m)	Lim.PK (dBµV/m)	Avg (dBµV/m)	Lim.Avg (dBµV/m)	Angle (°)	Polar.	Correct. (dB)
14.0315 GHz	56.20	83.50	45.56	63.50	250	H	3.44
21.176 GHz	58.64	83.50	48.17	63.50	1	H	2.56
16.4945 GHz	51.90	83.50	40.22	63.50	301	V	-4.84
19.605 GHz	58.17	83.50	48.08	63.50	54	V	3.75

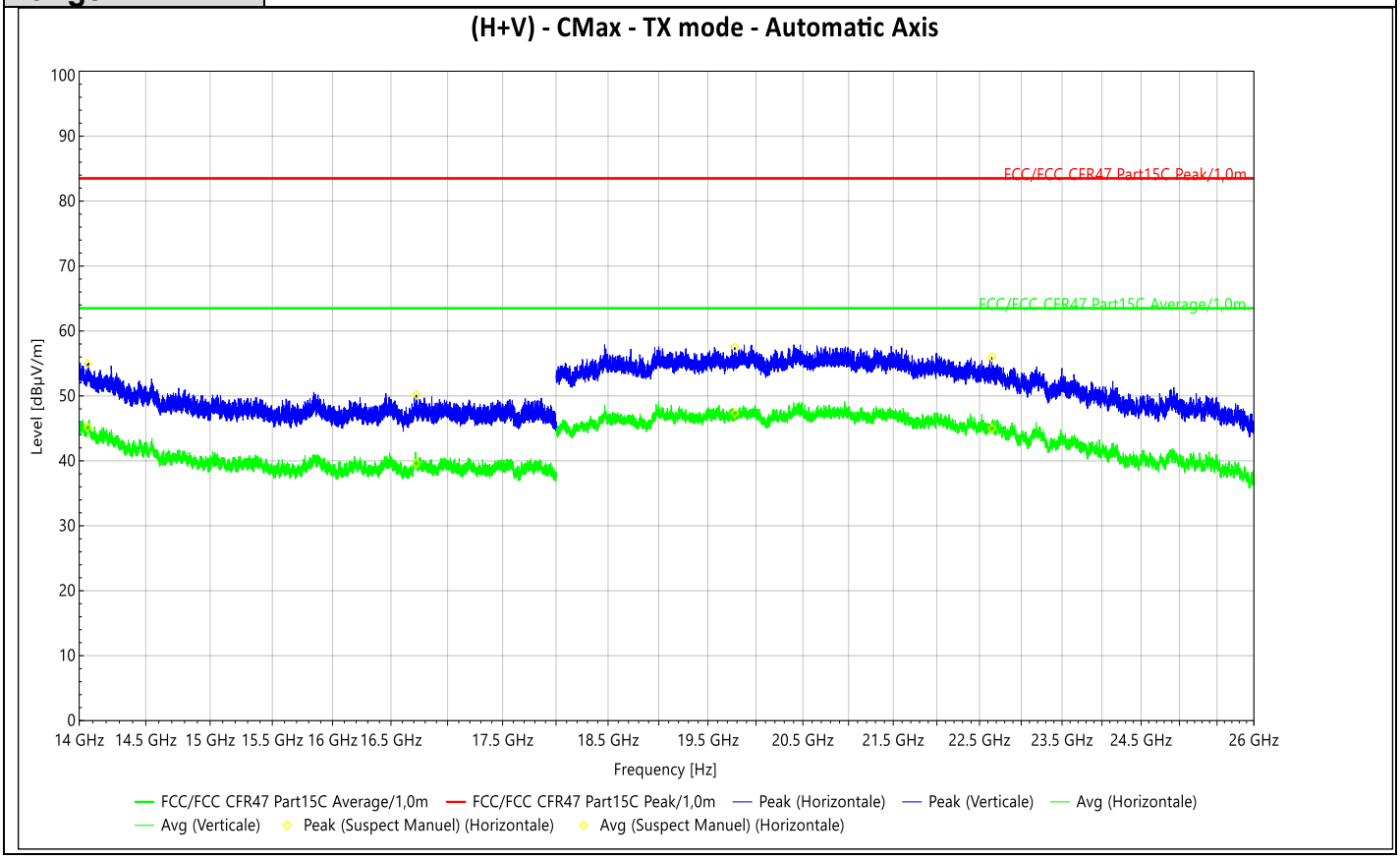
Radiated Emissions	
Graph name:	Emr#7
Frequency range:	14 GHz to 26 GHz



Pre-Characterization:

Frequency	PK Level (dBµV/m)	Lim.PK (dBµV/m)	Avg (dBµV/m)	Lim.Avg (dBµV/m)	Angle (°)	Polar.	Correct. (dB)
19.603 GHz	57.74	83.50	48.21	63.50	350	H	3.74
23.169 GHz	54.68	83.50	45.03	63.50	26	H	2.72
14.014 GHz	55.56	83.50	44.79	63.50	309	V	3.55
15.921 GHz	50.56	83.50	39.33	63.50	173	V	-4.45
18.991 GHz	57.58	83.50	48.44	63.50	295	V	3.77
21.092 GHz	58.16	83.50	46.92	63.50	345	V	2.78

Radiated Emissions	
Graph name:	Emr#8
Frequency range:	14 GHz to 26 GHz



Pre-Characterization:

Frequency	PK Level (dBµV/m)	Lim.PK (dBµV/m)	Avg (dBµV/m)	Lim.Avg (dBµV/m)	Angle (°)	Polar.	Correct. (dB)
14.062 GHz	55.00	83.50	45.16	63.50	269	H	3.25
16.7225 GHz	50.17	83.50	39.62	63.50	28	H	-4.30
19.777 GHz	57.49	83.50	47.36	63.50	310	H	3.76
22.647 GHz	55.99	83.50	45.01	63.50	36	H	2.71

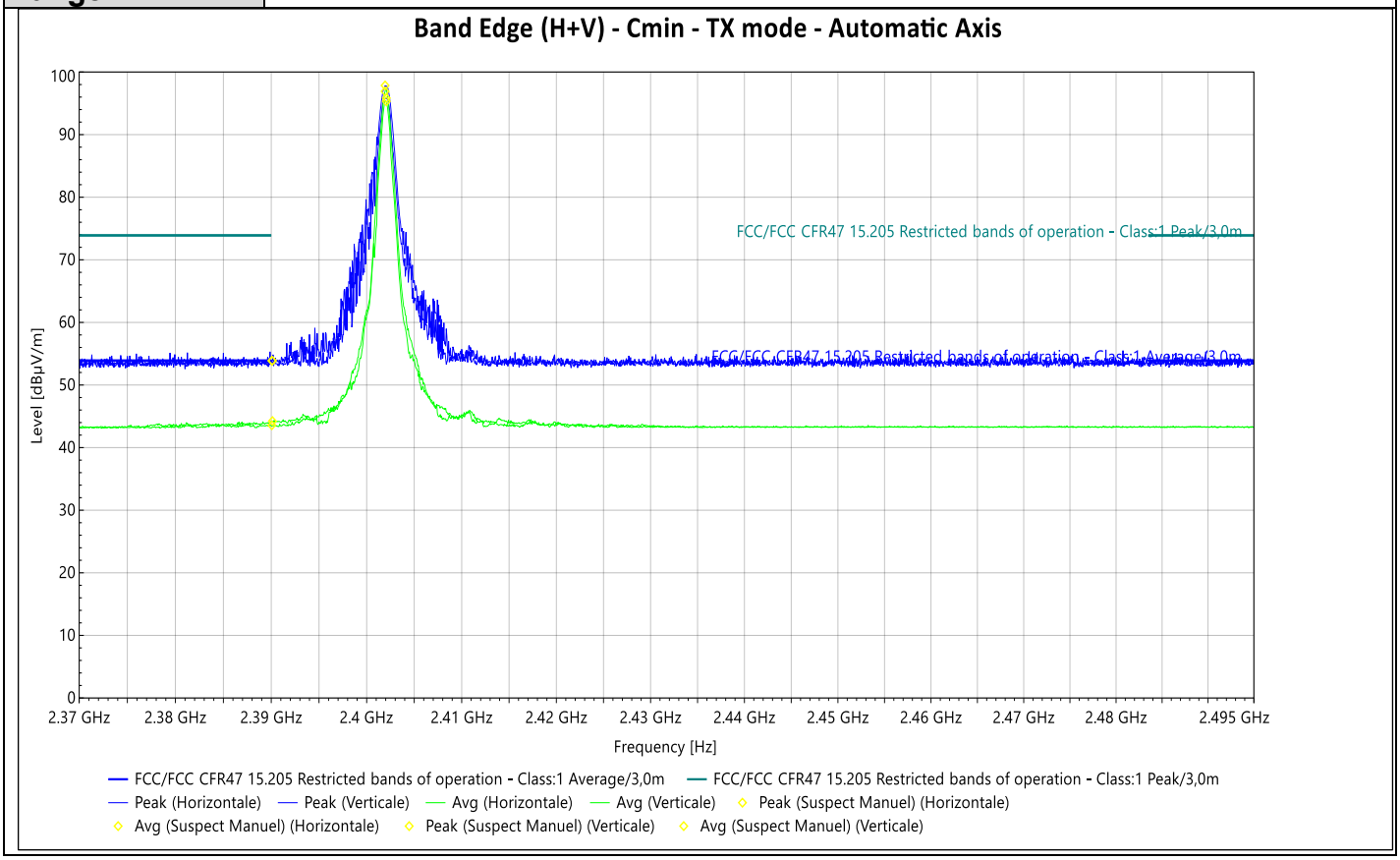
Final measurement:
No significant frequency observed

9.6.4. Restricted Band

Graphs – Pre characterization:

Graph identifier	Polarization	Mode	Channel	EUT position	Comments
Emr# 1	H/V	TX	Cmin	Axis XY/Z	-
Emr# 2	H/V	TX	Cmid	Axis XY/Z	-
Emr# 3	H/V	TX	Cmax	Axis XY/Z	-

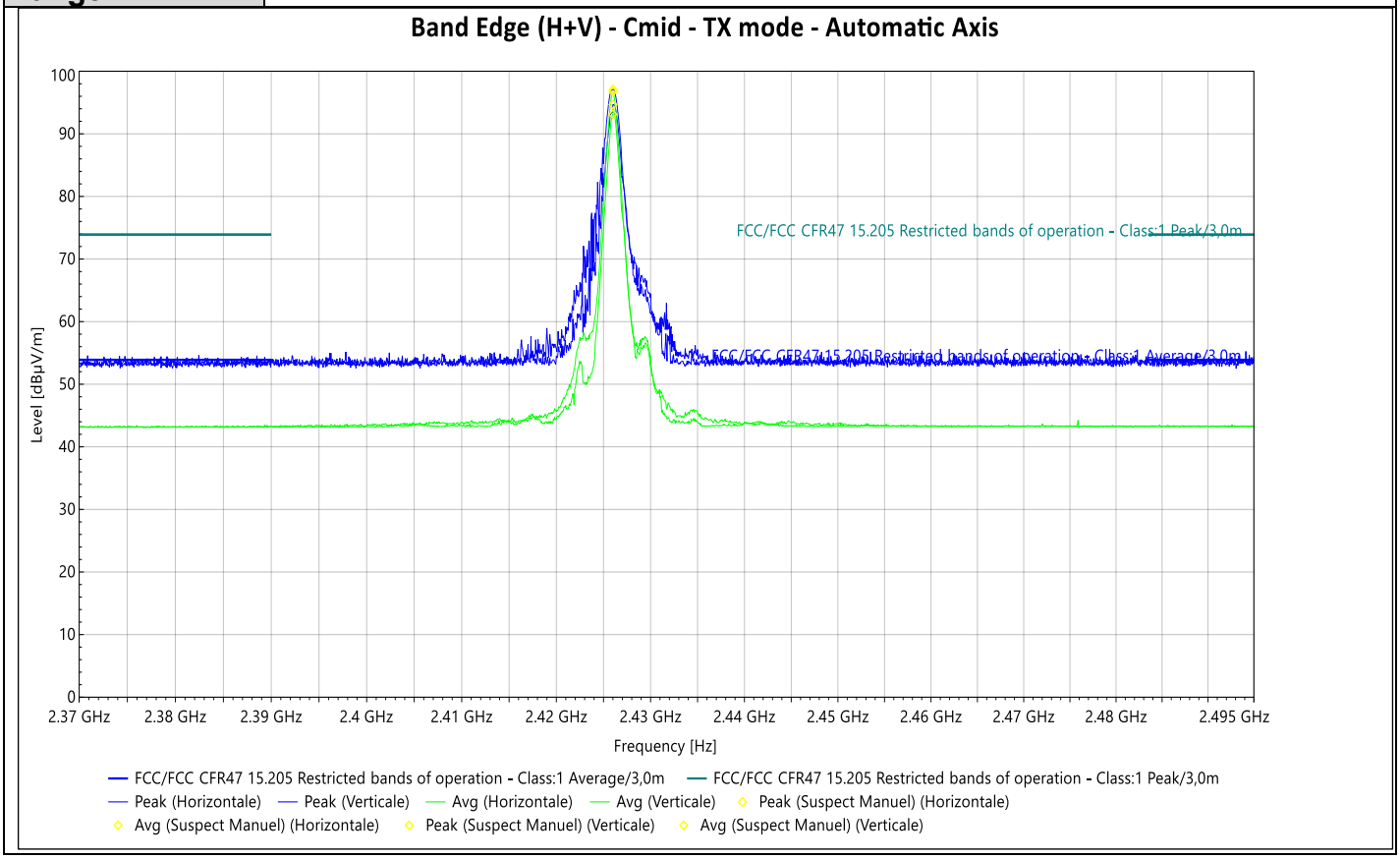
Radiated Emissions	
Graph name:	Emr#9
Frequency range:	2,37 GHz to 2,495 GHz



Pre-Characterization:

Frequency	PK Level (dBµV/m)	Lim.PK (dBµV/m)	Avg (dBµV/m)	Lim.Avg (dBµV/m)	Angle (°)	Polar.	Correct. (dB)
2.390125 GHz	53.88		44.23		171	H	35.70
2.4019375 GHz	97.85		96.91		138	H	35.71
2.3900625 GHz	53.88		43.57		352	V	35.70
2.4020625 GHz	95.83		95.32		77	V	35.71

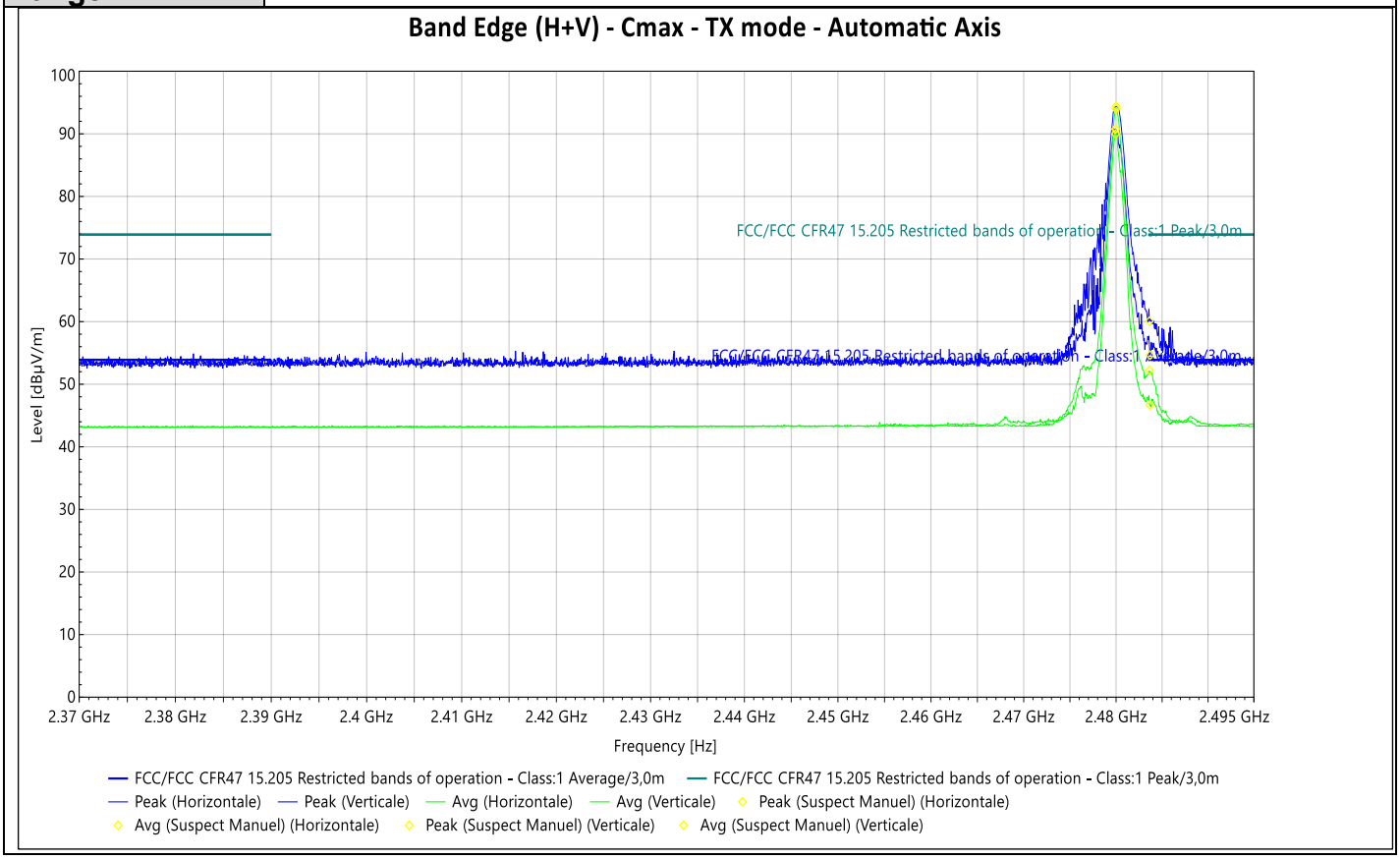
Radiated Emissions	
Graph name:	Emr#10
Frequency range:	2,37 GHz to 2,495 GHz



Pre-Characterization:

Frequency	PK Level (dBµV/m)	Lim.PK (dBµV/m)	Avg (dBµV/m)	Lim.Avg (dBµV/m)	Angle (°)	Polar.	Correct. (dB)
2.426 GHz	97.09		96.76		186	H	35.75
2.426 GHz	94.69		93.12		40	V	35.75

Radiated Emissions	
Graph name:	Emr#11
Frequency range:	2,37 GHz to 2,495 GHz



Pre-Characterization:

Frequency	PK Level (dBµV/m)	Lim.PK (dBµV/m)	Avg (dBµV/m)	Lim.Avg (dBµV/m)	Angle (°)	Polar.	Correct. (dB)
2.48 GHz	94.39		94.00		137	H	35.77
2.483625 GHz	60.08	73.90	52.23	53.90	206	H	35.77
2.4799375 GHz	90.78		89.97		85	V	35.77
2.4836875 GHz	54.64	73.90	46.68	53.90	259	V	35.77

9.7. CONCLUSION

Unwanted emissions in non-restricted bands measurement performed on the sample of the product **TMS AP-01**, Sn: **BC:03:A7:69:2F:22**, in configuration and description presented in this test report, show levels **compliant** to the **47 CFR PART 15.247 & RSS 247** limits.

10. UNCERTAINTIES CHART

Kind of measurement	*Wide uncertainty laboratory*
Occupied Channel Bandwidth	±2.8 %
Humidity	±3.2 %
Power Spectral Density, Conducted	±1.7 dB
Radio frequency	±0.3 ppm
RF power, conducted	±1.2 dB
RF power, radiated (Full anechoic chamber above 1GHz)	±3.7 dB
RF power, radiated (Semi anechoic chamber & open test site)	±5.6 dB
Spurious emission, conducted	±2.3 dB
Spurious emission, radiated (Full anechoic chamber above 1GHz)	±3.8 dB
Spurious emission, radiated (Semi anechoic chamber & open test site)	±5.7 dB
Temperature	±0.75 °C
Time	±2.3 %
Voltage	±1.7 %

The uncertainty values calculated by the laboratory are lower than limit uncertainty values defined by the standard. The conformity of the sample is directly established by the applicable limit values. This table includes all uncertainties maximum feasible for testing in the laboratory, whether or not made in this report.