



LCIE

Bluetooth Low Energy Template: Release February 6, 2020

# TEST REPORT

N°: 170170-759425-A(FILE#1056757)

Version : 01

**Subject** Radio spectrum matters  
tests according to standards:  
47 CFR Part 15.247 & RSS-247 Issue 2 & RSS-Gen Issue 5

**Issued to** MICHELIN  
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FRANCE

**Apparatus under test**  
↪ Product TIRE MOUNTED SENSOR  
↪ Trade mark MICHELIN  
↪ Manufacturer MICHELIN  
↪ P/N TMS AF-02-02  
↪ Model under test TMS AF-02  
↪ Serial number CERTIF-C-03, CERTIF-R-03  
(PCB serial number): 000007/2023, 000008/2023 & 000009/2023  
↪ FCC ID FI5TMSAF02  
↪ IC 5056A-TMSAF02

**Conclusion** See Test Program chapter

**Test date** September 8, 2020 to December 8, 2020

**Test location** Moirans

**Test Site** 6500A-1 & 6500A-3

**Sample receipt date** September 8, 2020 for 000007/2023, 000008/2023 & 000009/2023

November 25, 2020 for CERTIF-C-03, CERTIF-R-03

**Composition of document** 37 pages

**Document issued on** October 20, 2020

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## PUBLICATION HISTORY

<b>Version</b>	<b>Date</b>	<b>Author</b>	<b>Modification</b>
01	October 20, 2020	Gaetan DESCHAMPS	Creation of the document

*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.*



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## 1. TEST PROGRAM

### References

- 47 CFR Part 15.247
- RSS 247 Issue 2
- RSS Gen Issue 5
- KDB 558074 D01 DTS Meas Guidance v05r02
- ANSI C63.10-2013

### Radio requirement:

Clause (47CFR Part 15.247 & RSS-247 Issue 2 & RSS-Gen Issue 5) Test Description	Test result - Comments
Occupied Bandwidth	<input checked="" type="checkbox"/> PASS <input type="checkbox"/> FAIL <input type="checkbox"/> NA <input type="checkbox"/> NP(1)
6dB Bandwidth	<input checked="" type="checkbox"/> PASS <input type="checkbox"/> FAIL <input type="checkbox"/> NA() <input type="checkbox"/> NP(1)
Duty Cycle	<input type="checkbox"/> PASS <input type="checkbox"/> FAIL <input checked="" type="checkbox"/> NA <input type="checkbox"/> NP(1)
Maximum Conducted Output Power	<input checked="" type="checkbox"/> PASS <input type="checkbox"/> FAIL <input type="checkbox"/> NA <input type="checkbox"/> NP(1)
Power Spectral Density	<input checked="" type="checkbox"/> PASS <input type="checkbox"/> FAIL <input type="checkbox"/> NA <input type="checkbox"/> NP(1)
Conducted Spurious Emission at the Band Edge	<input checked="" type="checkbox"/> PASS <input type="checkbox"/> FAIL <input type="checkbox"/> NA() <input type="checkbox"/> NP(1)
Unwanted Emissions into Non-Restricted Frequency Bands	<input checked="" type="checkbox"/> PASS <input type="checkbox"/> FAIL <input type="checkbox"/> NA() <input type="checkbox"/> NP(1)
AC Power Line Conducted Emission	<input type="checkbox"/> PASS <input type="checkbox"/> FAIL <input checked="" type="checkbox"/> NA(2) <input type="checkbox"/> NP(1)
Unwanted Emissions into Restricted Frequency Bands	<input checked="" type="checkbox"/> PASS <input type="checkbox"/> FAIL <input type="checkbox"/> NA <input type="checkbox"/> NP(1)
Receiver Radiated emissions	<input type="checkbox"/> PASS <input type="checkbox"/> FAIL <input checked="" type="checkbox"/> NA <input type="checkbox"/> NP(1)
This table is a summary of test report, see conclusion of each clause of this test report for detail.	

(1): Limited program

(2): EUT not directly or indirectly connected to the AC Power Public Network

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):**

**MICHELIN TMS AF-02** Serial Number: **CERTIF-C-03, CERTIF-R-03, 000007/2023, 000008/2023 & 000009/2023**



Equipment Under Test

**Power supply:**

During all the tests, EUT is supplied by  $V_{nom}$ : 3VDC

For measurement with different voltage, it will be presented in test method.

Name	Type	Rating	Reference / Sn	Comments
Supply1	<input type="checkbox"/> AC <input type="checkbox"/> DC <input checked="" type="checkbox"/> Battery	3VDC	-	Lithium

**Inputs/outputs - Cable:**

Access	Type	Length used (m)	Declared <3m	Shielded	Under test	Comments
None						

**Auxiliary equipment used during test:**

Type	Reference	Sn	Comments
None			



**Equipment information:**

Bluetooth LE Type:	<input type="checkbox"/> BLE	<input type="checkbox"/> v4.1	<input checked="" type="checkbox"/> v4.2	<input type="checkbox"/> v5.0
Frequency band:	[2400 – 2483.5] MHz			
Spectrum Modulation:	<input checked="" type="checkbox"/> DSSS (Tested like it)			
Number of Channel:	40			
Spacing channel:	2MHz			
Channel bandwidth:	<input checked="" type="checkbox"/> 1MHz		<input type="checkbox"/> 2MHz	
Antenna Type:	<input checked="" type="checkbox"/> Integral	<input type="checkbox"/> External	<input type="checkbox"/> Dedicated	
Antenna connector:	<input type="checkbox"/> Yes	<input checked="" type="checkbox"/> No	<input type="checkbox"/> Temporary for test	
Antenna requirements §15.203	<i>The transmitter uses an integral antenna and it permanently connected. Therefore, the transmitter meets the requirements of 15.203.</i>			
Transmit chains:	1			
	Single antenna			
	Gain: 0 dBi			
Beam forming gain:	No			
Duty cycle:	<input checked="" type="checkbox"/> Continuous duty	<input type="checkbox"/> Intermittent duty	<input type="checkbox"/> 100% duty	
Equipment type:	<input checked="" type="checkbox"/> Production model		<input type="checkbox"/> Pre-production model	
Operating temperature range:	Tmin:	<input type="checkbox"/> -20°C	<input type="checkbox"/> 0°C	<input checked="" type="checkbox"/> -40°C
	Tnom:	20°C		
	Tmax:	<input type="checkbox"/> 35°C	<input type="checkbox"/> 55°C	<input checked="" type="checkbox"/> 125°C
Type of power source:	<input type="checkbox"/> AC power supply	<input type="checkbox"/> DC power supply	<input checked="" type="checkbox"/> Battery	
Operating voltage range:	Vnom:	<input type="checkbox"/> 230V/50Hz	<input checked="" type="checkbox"/> 3Vdc	

Nc: Not communicated



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CHANNEL PLAN			
Channel	Frequency (MHz)	Channel	Frequency (MHz)
<b>Cmin: 0</b>	2402	<b>Cmid: 20</b>	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
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	<b>Cmax: 39</b>	2480

DATA RATE			
Available	Data Rate (Mbps)	Modulation Type	Worst Case Modulation
<input type="checkbox"/>	0.25	GFSK	<input type="checkbox"/>
<input checked="" type="checkbox"/>	1	GFSK	<input checked="" type="checkbox"/>
<input type="checkbox"/>	2	GFSK	<input type="checkbox"/>



## 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	
Test mode 2	Permanent reception	
Test	Running mode	
Occupied Bandwidth	<input checked="" type="checkbox"/> Test mode 1 (1)	<input type="checkbox"/> Alternative test mode()
6dB Bandwidth	<input checked="" type="checkbox"/> Test mode 1 (1)	<input type="checkbox"/> Alternative test mode()
Duty Cycle	<input type="checkbox"/> Test mode 1 (1)	<input checked="" type="checkbox"/> NA
Maximum Conducted Output Power	<input checked="" type="checkbox"/> Test mode 1 (1)	<input type="checkbox"/> Alternative test mode()
Power Spectral Density	<input checked="" type="checkbox"/> Test mode 1 (1)	<input type="checkbox"/> Alternative test mode()
Conducted Spurious Emission at the Band Edge	<input checked="" type="checkbox"/> Test mode 1 (1)	<input type="checkbox"/> Alternative test mode()
Unwanted Emissions into Non-Restricted Frequency Bands	<input checked="" type="checkbox"/> Test mode 1 (1)	<input type="checkbox"/> Alternative test mode()
AC Power Line Conducted Emission	<input type="checkbox"/> Test mode 1 (1)	<input checked="" type="checkbox"/> NA
Unwanted Emissions into Restricted Frequency Bands	<input checked="" type="checkbox"/> Test mode 1 (1)	<input type="checkbox"/> Alternative test mode()

- (1) Following commands with the specific test software "TEST RADIO" are used to set the product:  
 - Permanent emission with modulation on a fixed channel in the data rate that produced the highest power

Hardware information		
Software (if applicable): TEST RADIO	V. :	1.0
There are 2 equipment used for radiated emission measurement. The EUT are set in the following modes during tests: - 200ms off - 200ms on with modulation alternatively on a fixed channel Cmin or Cmid or Cmax(CERTIF-R-03 & CERTIF-C-03) in the data rate that produced the highest power There are 3 equipment for Cmid (sn: 000007/2023), Cmid (sn: 000008/2023) and Cmax (sn: 000009/2023) for conducted measurement.		

## 2.3. EQUIPMENT MODIFICATION

None       Modification:



### 3. OCCUPIED BANDWIDTH

#### 3.1. TEST CONDITIONS

Test performed by : Gaetan DESCHAMPS  
 Date of test : October 16, 2020  
 Ambient temperature : 22 °C  
 Relative humidity : 34 %

#### 3.2. TEST SETUP

- The Equipment under Test is installed:

- On a table
- In an anechoic chamber

- Measurement is performed with a spectrum analyzer in:

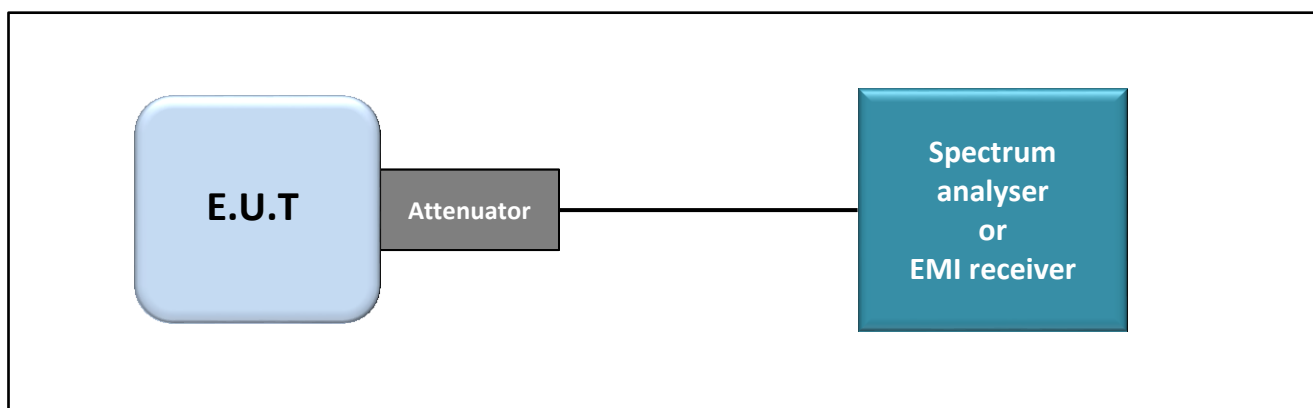
- Conducted Method (welded connection, according to manufacturer's requirement)
- Radiated Method

- Test Procedure:

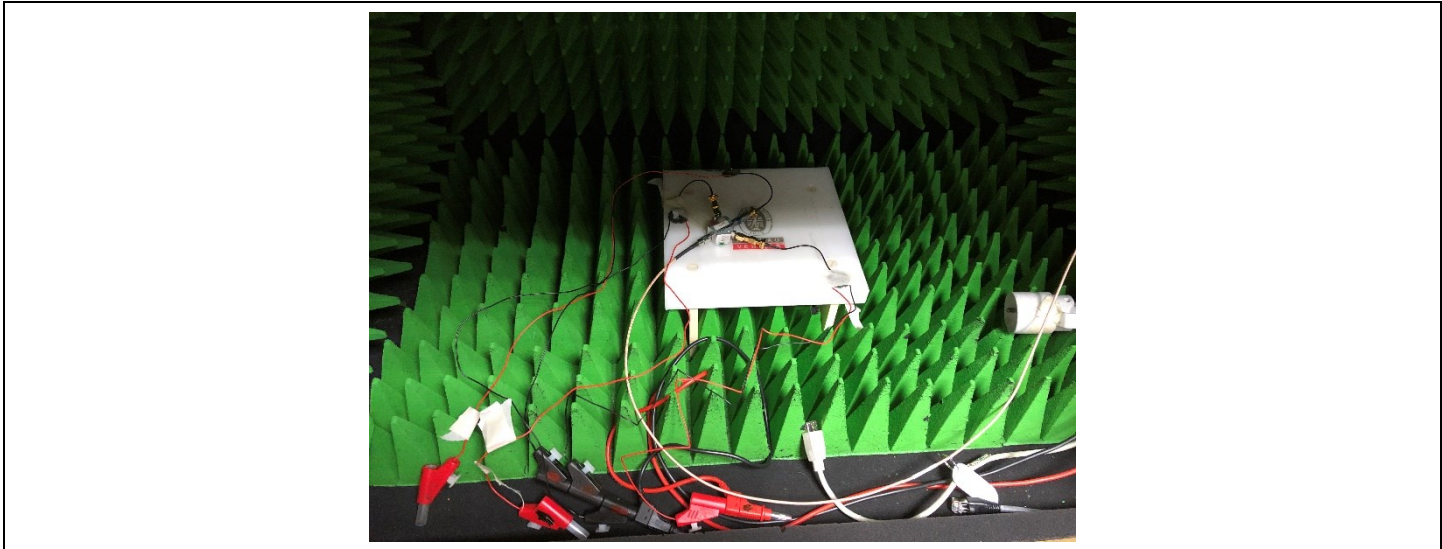
- RSS-Gen Issue 5 § 6.7
- ANSI C63.10 § 6.9.2

**Measurement Procedure:**

- a) RBW shall be in the range of 1% to 5% of the anticipated occupied bandwidth
- b) Set the video bandwidth (VBW)  $\geq 3 \times$  RBW
- c) SPAN = Capture all products of the modulation process
- d) Detector = Peak.
- e) Trace mode = max hold.
- f) Sweep = auto couple.
- g) Allow the trace to stabilize.
- h) OBW 99% function of spectrum analyzer used



Test set up of Occupied Bandwidth



Photograph for Occupied bandwidth

**3.3. LIMIT**

None

**3.4. TEST EQUIPMENT LIST**

TEST EQUIPMENT USED					
Description	Manufacturer	Model	Identifier	Cal_Date	Cal_Due
Thermo-hygrometer (PM1/2/3)	KIMO	HQ 210	B4206022	08/18	12/20
LCIE FCC 247 (BLE_ZIGBEE...)	LCIE SUD EST	LCIE FCC 247 (BLE_ZIGBEE...)	L2000059	-	-
CABLE SMA 1m	RADIALL	18GHz	A5329862	11/18	11/20
Full Anechoic Room	SIEPEL	-	D3044024		
POWER SUPPLY DC 20V	SODILEC	SDRI 205	A7040058		
Spectrum analyzer	ROHDE & SCHWARZ	FSV 40	A4060059	05/19	05/21
Multimeter - CEM	FLUKE	87	A1240251	11/18	11/20
SMA 1.5m	SUCOFLEX	18GHz	A5329863	11/18	11/20
Splitter	JFW	50PD-292	A7132009	06/20	06/21
Attenuator 10dB	AEROFLEX	-	A7122267	05/19	05/21

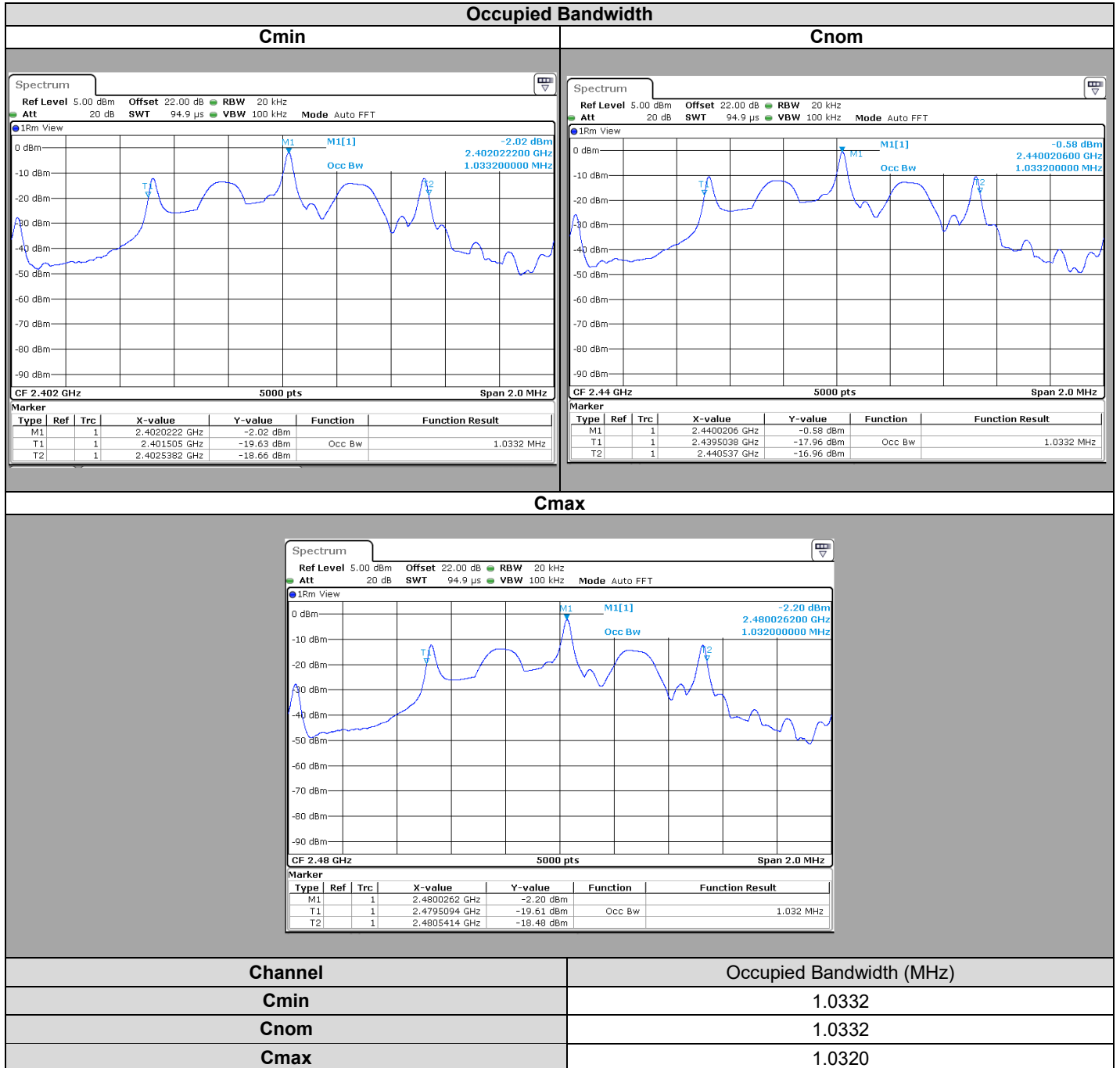
Note: In our quality system, the test equipment calibration due is more & less 2 months



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### 3.5. RESULTS

1Mbits/s



### 3.6. CONCLUSION

Occupied Channel Bandwidth measurement performed on the sample of the product **MICHELIN TMS AF-02**, SN: **000007/2023, 000008/2023 & 000009/2023**, in configuration and description presented in this test report, show levels compliant to the **47 CFR PART 15.247 & RSS-GEN ISSUE 5** limits.

## 4. 6dB EMISSION BANDWIDTH

### 4.1. TEST CONDITIONS

Test performed by : Gaetan DESCHAMPS  
Date of test : October 16, 2020  
Ambient temperature : 22 °C  
Relative humidity : 34 %

### 4.2. TEST SETUP

- The Equipment under Test is installed:

- On a table
- In an anechoic chamber

- Measurement is performed with a spectrum analyzer in:

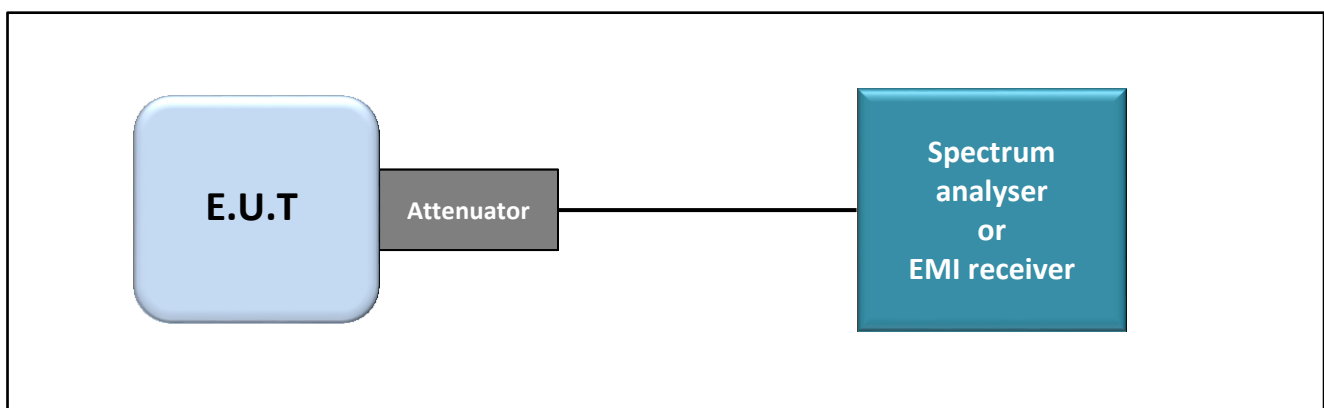
- Conducted Method (welded connection, according to manufacturer's requirement)
- Radiated Method

- Test Procedure:

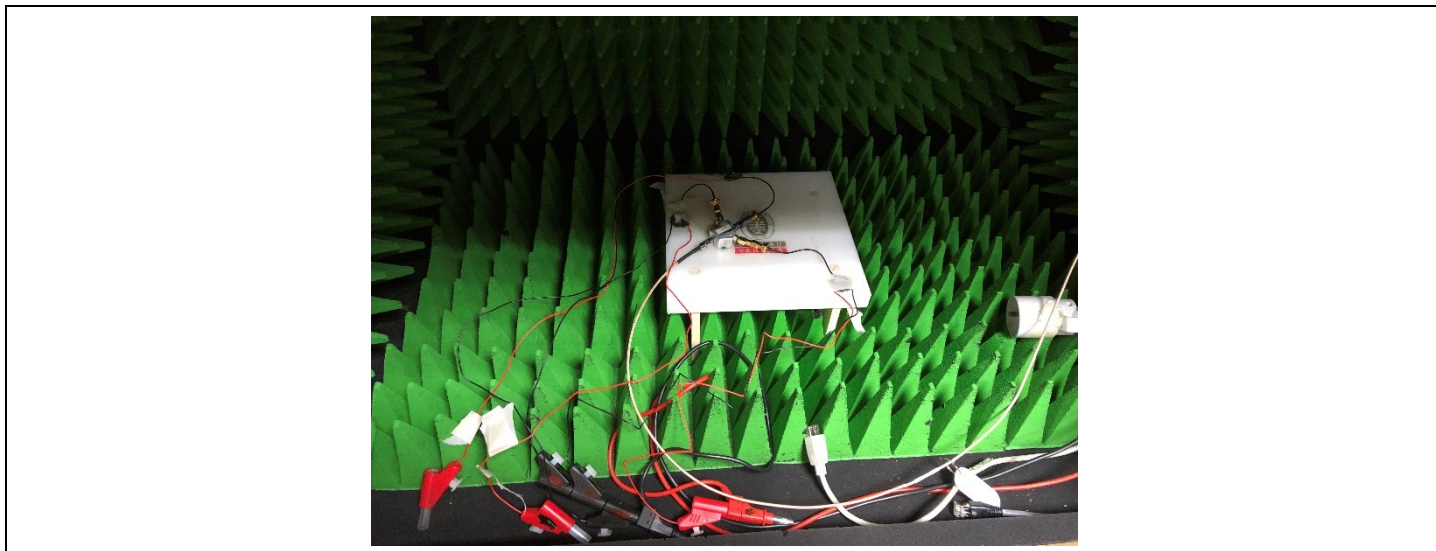
- KDB 558074 D01 DTS Meas Guidance v05r02 § 8.2

#### **Measurement Procedure:**

1. Set resolution bandwidth (RBW) = 100kHz.
2. Set the video bandwidth (VBW)  $\geq 3 \times$  RBW.
3. Detector = Peak.
4. Trace mode = max hold.
5. Sweep = auto couple.
6. Allow the trace to stabilize.
7. 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 set up of 6dB Emission Bandwidth



Photograph for 6dB emission bandwidth

#### 4.3. LIMIT

The 6dB bandwidth shall be at least 500kHz

#### 4.4. TEST EQUIPMENT LIST

TEST EQUIPMENT USED					
Description	Manufacturer	Model	Identifier	Cal_Date	Cal_Due
Thermo-hygrometer (PM1/2/3)	KIMO	HQ 210	B4206022	08/18	12/20
LCIE FCC 247 (BLE_ZIGBEE...)	LCIE SUD EST	LCIE FCC 247 (BLE_ZIGBEE...)	L2000059	-	-
CABLE SMA 1m	RADIALL	18GHz	A5329862	11/18	10/20
Full Anechoic Room	SIEPEL	-	D3044024		
POWER SUPPLY DC 20V	SODILEC	SDRI 205	A7040058		
Spectrum analyzer	ROHDE & SCHWARZ	FSV 40	A4060059	05/19	05/21
Multimeter - CEM	FLUKE	87	A1240251	11/18	11/20
SMA 1.5m	SUCOFLEX	18GHz	A5329863	11/18	10/20
Splitter	JFW	50PD-292	A7132009	06/20	06/21
Attenuator 10dB	AEROFLEX	-	A7122267	05/19	05/21

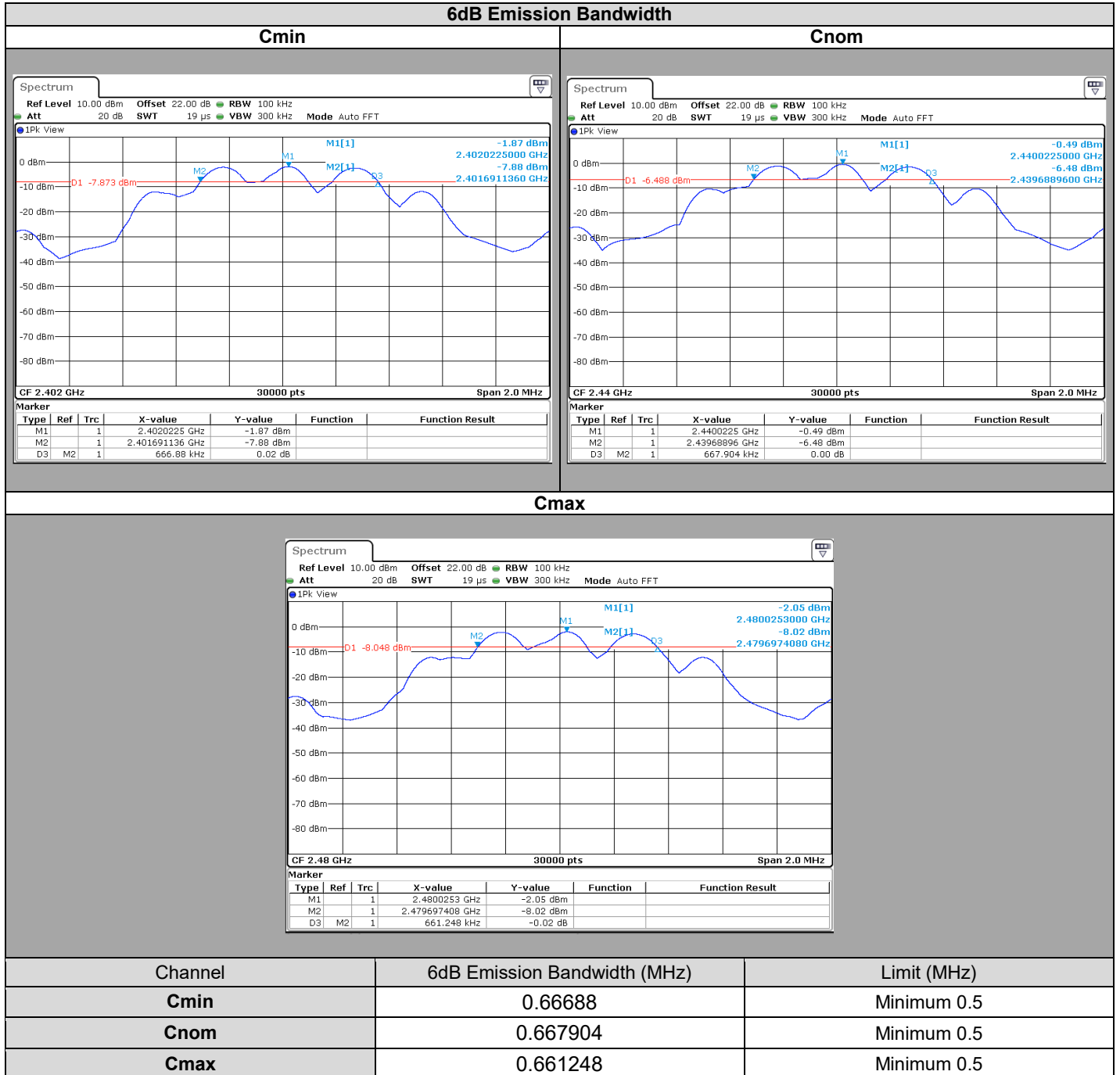
Note: In our quality system, the test equipment calibration due is more & less 2 months



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## 4.5. RESULTS

1Mbits/s



## 4.6. CONCLUSION

6dB Emission Bandwidth measurement performed on the sample of the product **MICHELIN TMS AF-02**, SN: **000007/2023, 000008/2023 & 000009/2023**, in configuration and description presented in this test report, show levels compliant to the **47 CFR PART 15.247 & RSS 247 ISSUE 2** limits.



## 5. MAXIMUM CONDUCTED OUTPUT POWER

### 5.1. TEST CONDITIONS

Test performed by : Gaetan DESCHAMPS  
Date of test : October 19, 2020  
Ambient temperature : 22 °C  
Relative humidity : 34 %

### 5.2. TEST SETUP

- The Equipment under Test is installed:

- On a table
- In an anechoic chamber

- Measurement is performed with a spectrum analyzer in:

- Conducted Method (welded connection, according to manufacturer's requirement)
- Radiated Method

- Test Procedure:

- KDB 558074 D01 DTS Meas Guidance v05r02 § 8.3.1.1

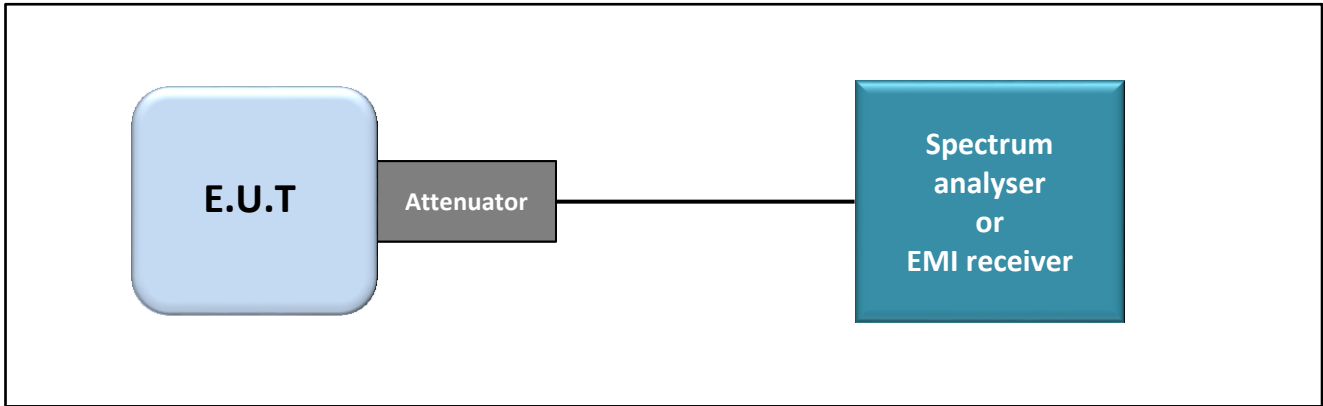
This procedure shall be used when the measurement instrument has available a resolution bandwidth that is greater than the DTS bandwidth.

- a) Set the RBW  $\geq$  DTS bandwidth.
- b) Set VBW  $\geq$  3 x RBW.
- c) Set span  $\geq$  3 x RBW
- d) Sweep time = auto couple.
- e) Detector = peak.
- f) Trace mode = max hold.
- g) Allow trace to fully stabilize.
- h) Use peak marker function to determine the peak amplitude level.

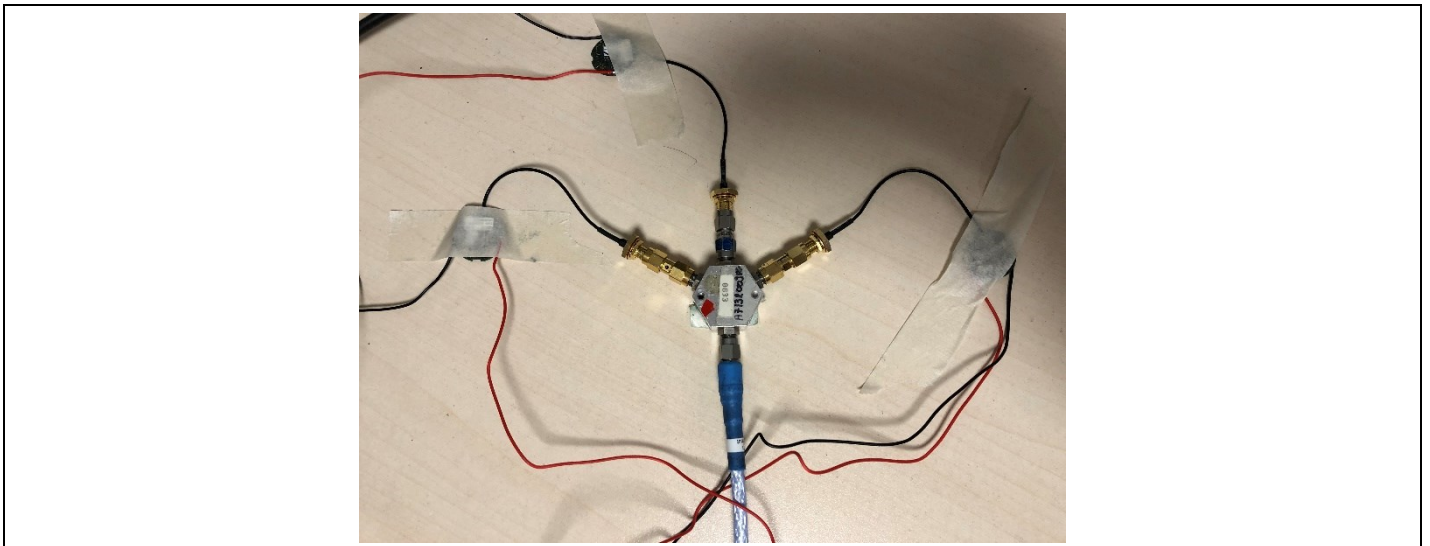
- KDB 558074 D01 DTS Meas Guidance v05r02 § 8.3.1.2

This procedure may be used when the maximum available RBW of the measurement instrument is less than the DTS bandwidth.

- a) Set the RBW = 1 MHz.
- b) Set the VBW  $\geq$  3 x RBW
- c) Set the span  $\geq$  1.5 x DTS bandwidth.
- d) Detector = peak.
- e) Sweep time = auto couple.
- f) Trace mode = max hold.
- g) Allow trace to fully stabilize.
- h) Use the instrument's band/channel power measurement function with the band limits set equal to the DTS bandwidth edges



Test set up of Maximum Conducted Output Power



Photograph for Maximum Conducted Output Power

### 5.3. LIMIT

Maximum Conducted Output power:  
2400MHz-2483.5MHz: Shall not exceed 30dBm  
Limits are reduced by G-6dBi if Overall Antenna Gain above 6dBi





#### 5.4. TEST EQUIPMENT LIST

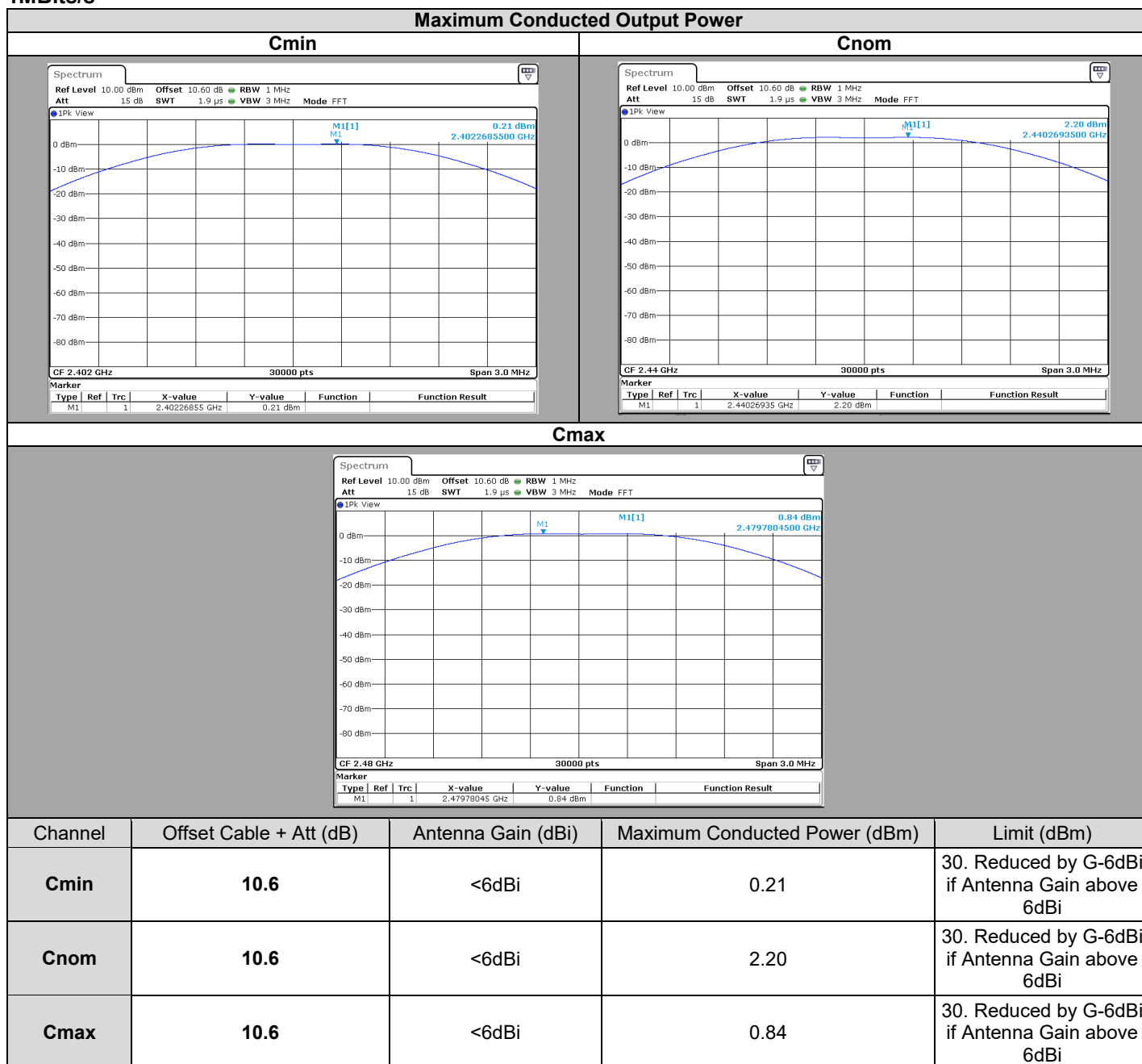
TEST EQUIPMENT USED					
Description	Manufacturer	Model	Identifier	Cal_Date	Cal_Due
Thermo-hygrometer (PM1/2/3)	KIMO	HQ 210	B4206022	08/18	12/20
LCIE FCC 247 (BLE_ZIGBEE...)	LCIE SUD EST	LCIE FCC 247 (BLE_ZIGBEE...)	L2000059	-	-
Multimeter - CEM	FLUKE	87	A1240251	11/18	11/20
Splitter	JFW	50PD-292	A7132009	06/20	06/21
AC source 1kW	KEYSIGHT	AC6802A	A7042305		
Spectrum analyzer	ROHDE & SCHWARZ	FSV 30	A4060051	09/20	09/22
Cable 1m	HUBER & SUHNER	18GHz	A5329705	02/19	10/20*

\*Under Derogation

Note: In our quality system, the test equipment calibration due is more & less 2 months

## 5.5. RESULTS

### 1Mbits/s



## 5.6. CONCLUSION

Maximum Conducted Output Power measurement performed on the sample of the product **MICHELIN TMS AF-02**, SN: **000007/2023, 000008/2023 & 000009/2023**, in configuration and description presented in this test report, show levels compliant to the **47 CFR PART 15.247 & RSS 247 ISSUE 2** limits.

## 6. POWER SPECTRAL DENSITY

### 6.1. TEST CONDITIONS

Test performed by : Gaetan DESCHAMPS  
 Date of test : October 19, 2020  
 Ambient temperature : 22 °C  
 Relative humidity : 34 %

### 6.2. TEST SETUP

- The Equipment Under Test is installed:

- On a table
- In an anechoic chamber

- Measurement is performed with a spectrum analyzer in:

- Conducted Method (welded connection, according to manufacturer's requirement)
- Radiated Method

- Test Procedure:

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

a) Set analyzer center frequency to DTS channel center frequency.

b) Set the span to 1.5 times the DTS bandwidth.

Divergence, using of 2MHz Span, same results none impact.

c) Set the RBW to: 3 kHz.

d) Set the VBW  $\geq 3 \times$  RBW.

e) Detector = peak.

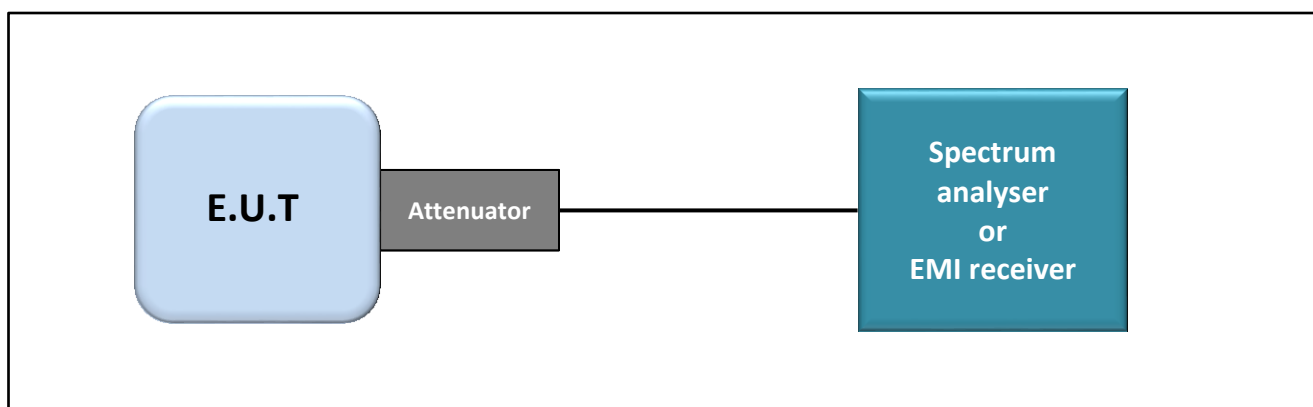
f) Sweep time = auto couple.

g) Trace mode = max hold.

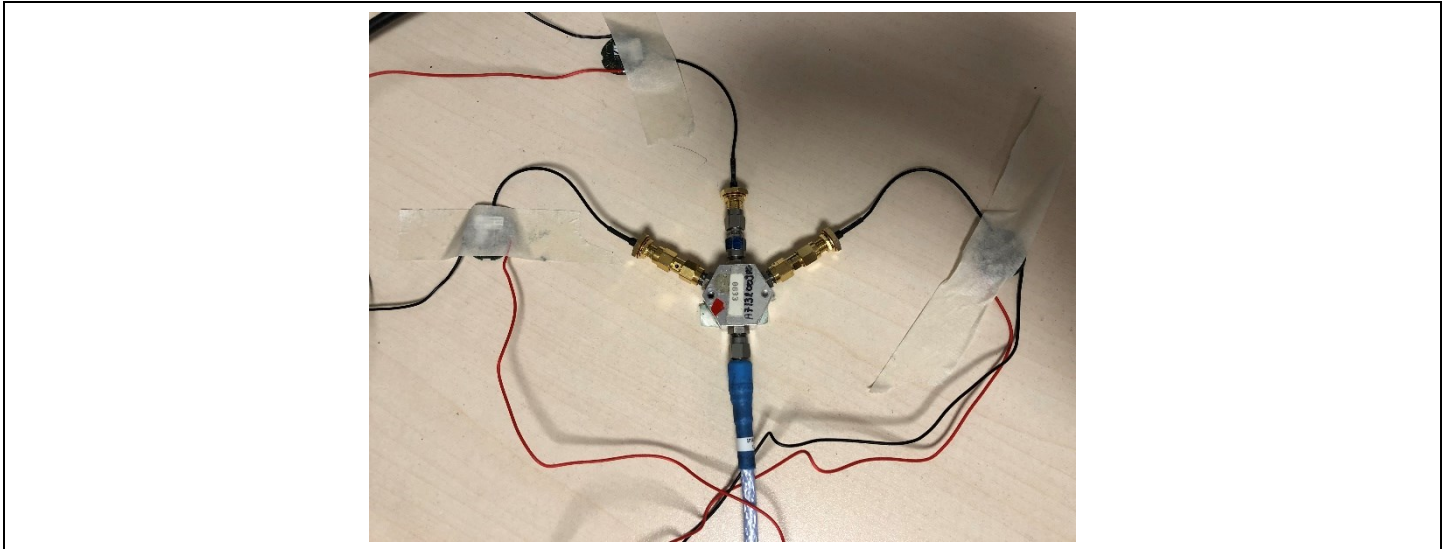
h) Allow trace to fully stabilize.

i) Use the peak marker function to determine the maximum amplitude level within the RBW.

j) If measured value exceeds limit, reduce RBW (no less than 3 kHz) and repeat.



Test set up of Power Spectral Density



Photograph for Power Spectral Density

### 6.3. LIMIT

Power Spectral Density:  
 2400MHz-2483.5MHz: Shall not exceed 8dBm/3kHz  
 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
Thermo-hygrometer (PM1/2/3)	KIMO	HQ 210	B4206022	08/18	12/20
LCIE FCC 247 (BLE_ZIGBEE...)	LCIE SUD EST	LCIE FCC 247 (BLE_ZIGBEE...)	L2000059	-	-
Multimeter - CEM	FLUKE	87	A1240251	11/18	11/20
Splitter	JFW	50PD-292	A7132009	06/20	06/21
AC source 1kW	KEYSIGHT	AC6802A	A7042305		
Spectrum analyzer	ROHDE & SCHWARZ	FSV 30	A4060051	09/20	09/22
Cable 1m	HUBER & SUHNER	18GHz	A5329705	02/19	10/20*

\*Under Derogation

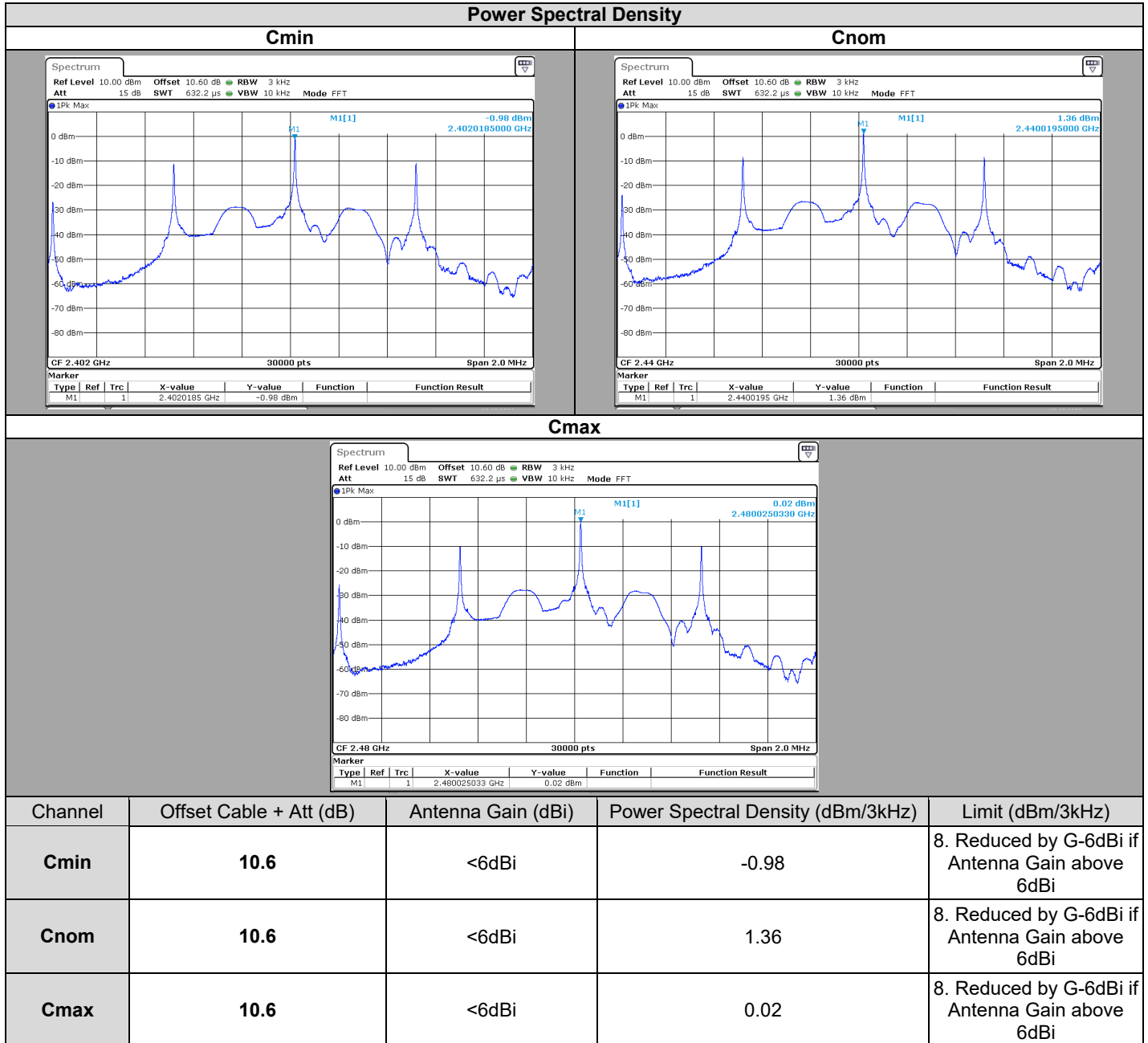
Note: In our quality system, the test equipment calibration due is more & less 2 months



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## 6.5. RESULTS

1Mbits/s



## 6.6. CONCLUSION

Power Spectral Density measurement performed on the sample of the product **MICHELIN TMS AF-02**, SN: **000007/2023, 000008/2023 & 000009/2023**, in configuration and description presented in this test report, show levels **compliant** to the **47 CFR PART 15.247 & RSS 247 ISSUE 2** limits.

## 7. UNWANTED EMISSIONS INTO NON-RESTRICTED FREQUENCY BANDS AT THE BAND EDGE

### 7.1. TEST CONDITIONS

Test performed by : Gaetan DESCHAMPS  
Date of test : December 4, 2020  
Ambient temperature : 23 °C  
Relative humidity : 32 %

### 7.2. TEST SETUP

- The Equipment Under Test is installed:

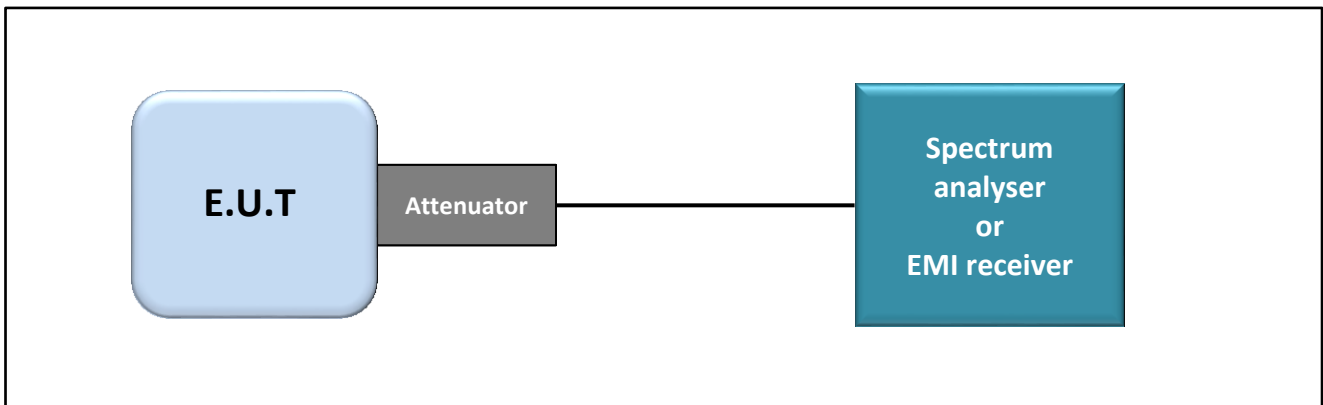
- On a table
- In an anechoic chamber

- Measurement is performed with a spectrum analyzer in:

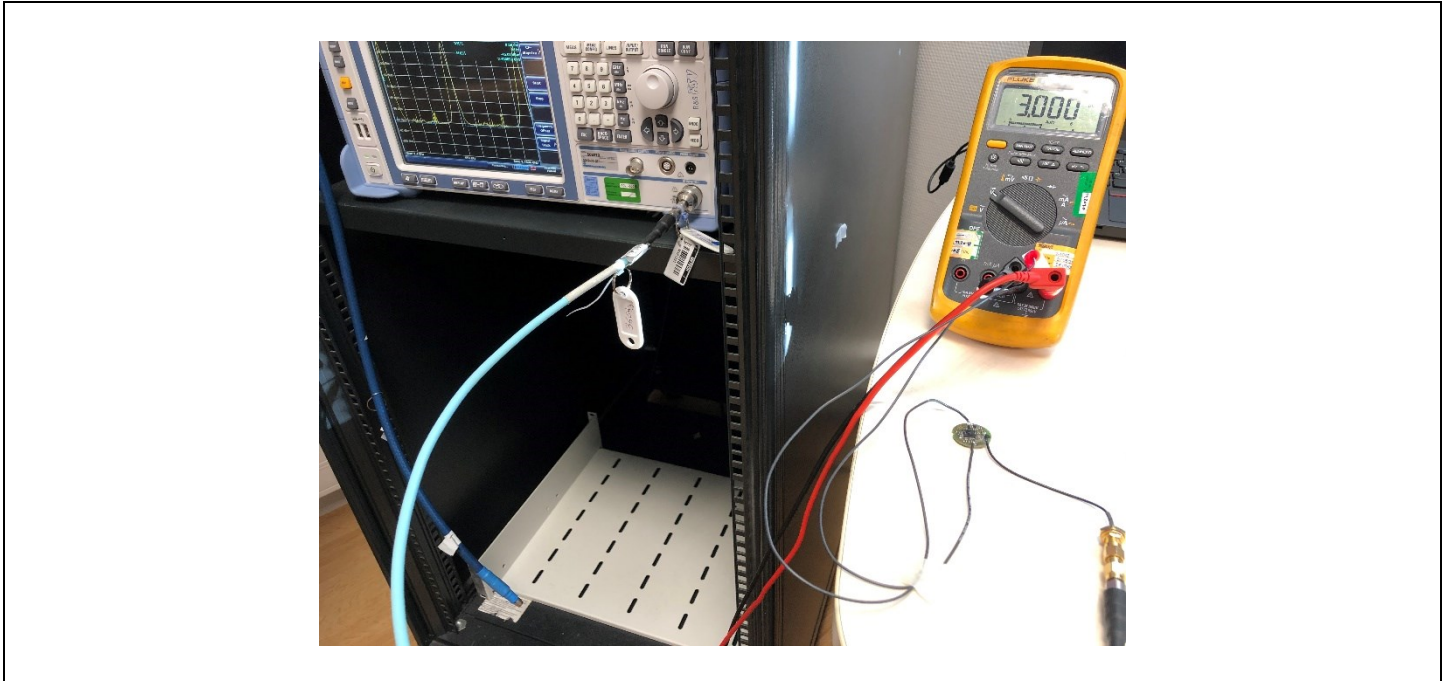
- Conducted Method (welded connection, according to manufacturer's requirement)
- Radiated Method

- Test Procedure:

- KDB 558074 D01 DTS Meas Guidance v05r02 § 8.5



Test set up of Unwanted Emissions into Non-Restricted Frequency Bands at the Band Edge



Photograph for Unwanted Emission into non-restricted frequency bands at the band edge

### 7.3. LIMIT

All Spurious Emissions must be at least 20dB below the Fundamental Radiator Level at the Band Edge Edge “2400MHz & 2483,5MHz”

### 7.4. TEST EQUIPMENT LIST

TEST EQUIPMENT USED					
Description	Manufacturer	Model	Identifier	Cal_Date	Cal_Due
Attenuator 10dB	AEROFLEX	_	A7122269	09/20	03/22
Cable Measure	_	36G	A5329604	02/19	12/20
Multimeter - CEM	FLUKE	87	A1240251	11/18	12/20*
POWER SUPPLY DC 20V	SODILEC	SDRI 205	A7040058		
Spectrum analyzer	ROHDE & SCHWARZ	FSV 40	A4060059	05/19	05/21
Thermo-hygrometer (PM1/2/3)	KIMO	HQ 210	B4206022	08/18	12/20

\*Under Derogation

Note: In our quality system, the test equipment calibration due is more & less 2 months

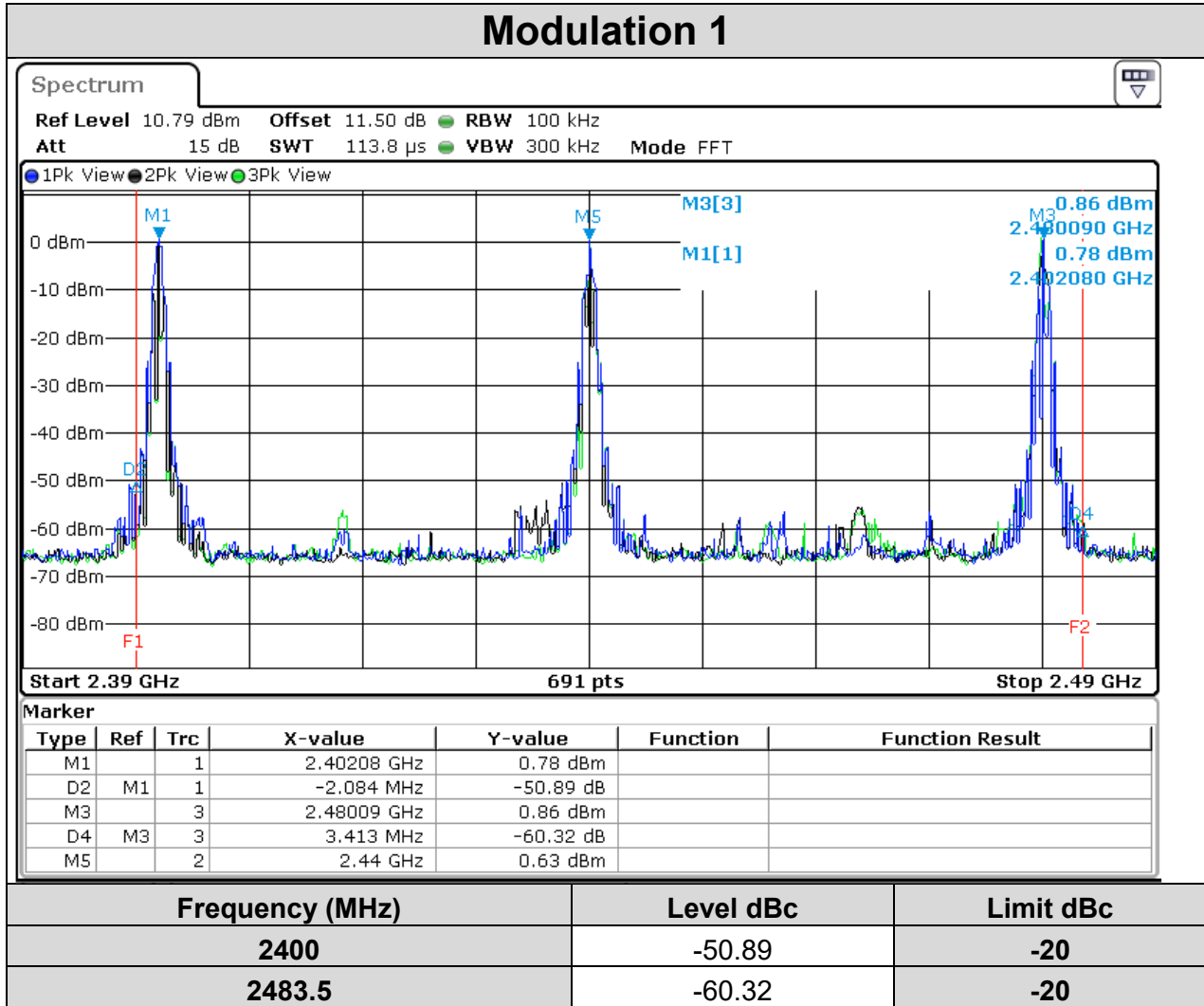


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7.5. RESULTS

1Mbits/s

Cmin/Cnom/Cmax



7.6. CONCLUSION

Unwanted Emission into non-restricted frequency bands at the band edge measurement performed on the sample of the product **MICHELIN TMS AF-02**, SN: **CERTIF-C-03** in configuration and description presented in this test report, show levels **compliant** to the **47 CFR PART 15.247 & RSS 247 ISSUE 2** limits.



## 8. UNWANTED EMISSIONS INTO NON-RESTRICTED FREQUENCY BANDS

### 8.1. TEST CONDITIONS

Test performed by : Gaetan DESCHAMPS  
Date of test : December 4, 2020  
Ambient temperature : 23 °C  
Relative humidity : 32 %

### 8.2. TEST SETUP

- The Equipment under Test is installed:

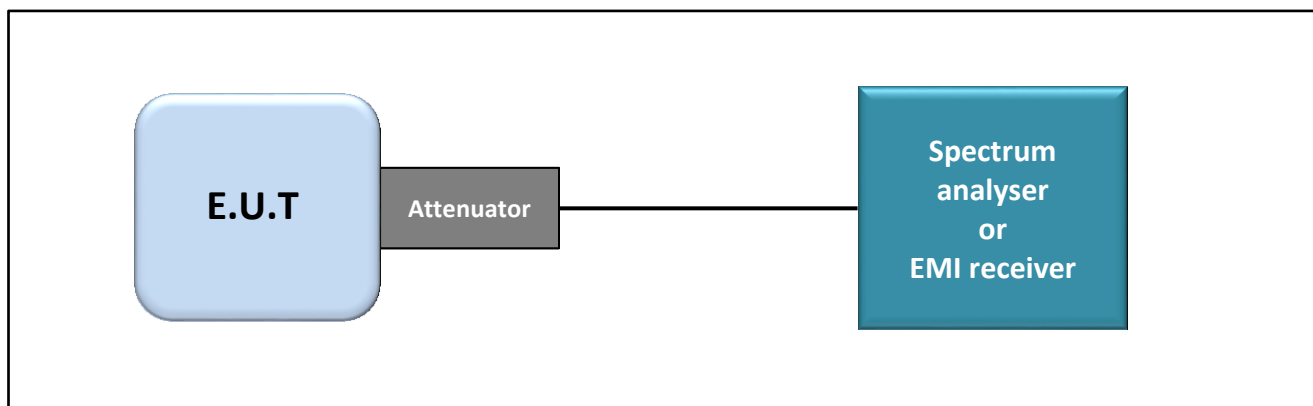
- On a table
- In an anechoic chamber

- Measurement is performed with a spectrum analyzer in:

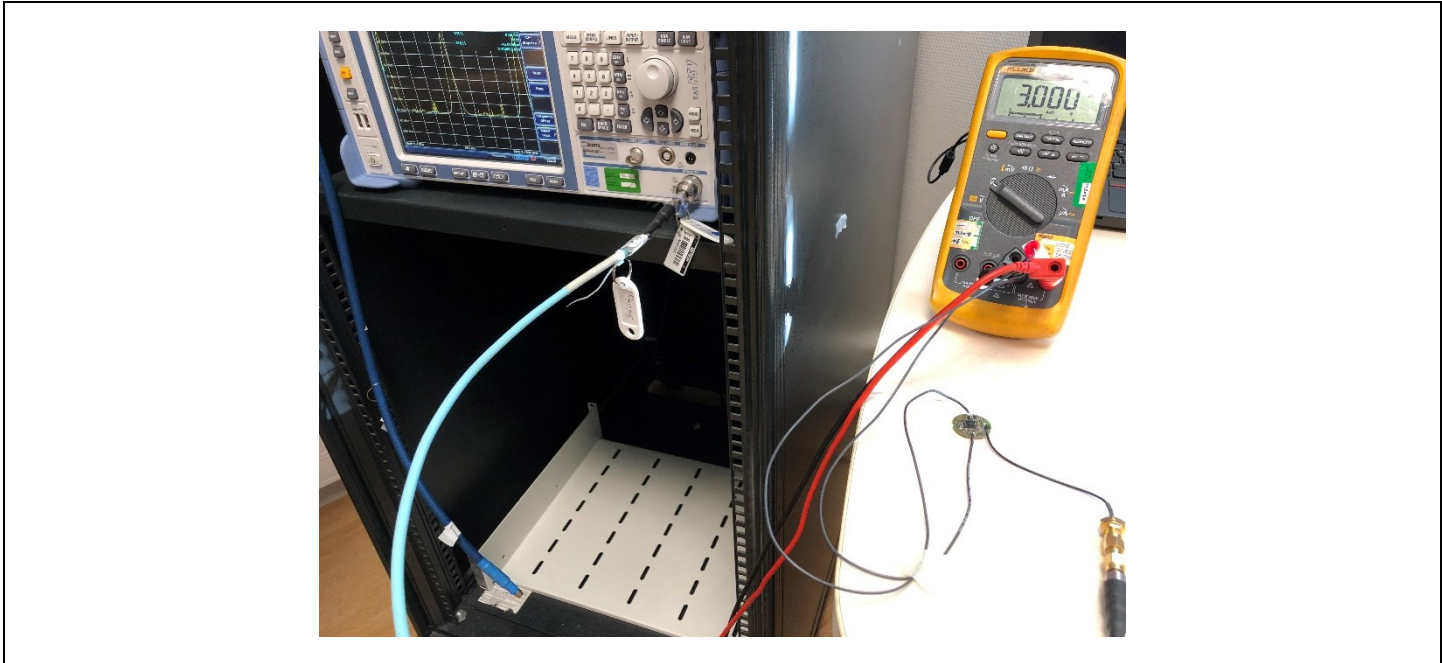
- Conducted Method (welded connection, according to manufacturer's requirement)
- Radiated Method

- Test Procedure:

- KDB 558074 D01 DTS Meas Guidance v05r02 § 8.5



Test set up of Unwanted Emissions into Non-Restricted Frequency Bands



Photograph for Unwanted Emission into non-restricted frequency bands

### 8.3. LIMIT

All Spurious Emissions must be at least 20 below the Fundamental Radiator Level

### 8.4. TEST EQUIPMENT LIST

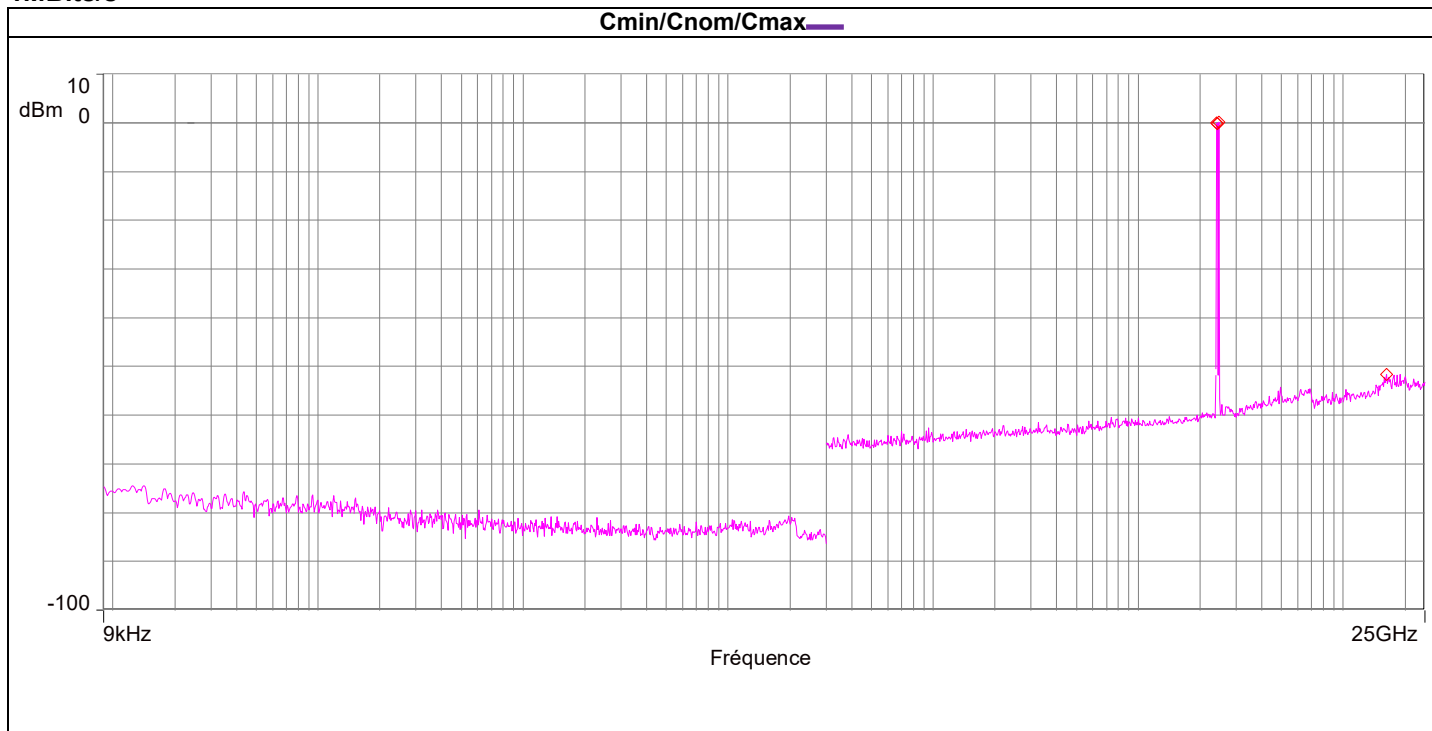
TEST EQUIPMENT USED					
Description	Manufacturer	Model	Identifier	Cal_Date	Cal_Due
Thermo-hygrometer (PM1/2/3)	KIMO	HQ 210	B4206022	08/18	12/20
LCIE FCC 247 (BLE ZIGBEE...)	LCIE SUD EST	LCIE FCC 247 (BLE ZIGBEE...)	L2000059	-	-
Multimeter - CEM	FLUKE	87	A1240251	11/18	12/20*
Splitter	JFW	50PD-292	A7132009	06/20	06/21
AC source 1kW	KEYSIGHT	AC6802A	A7042305		
Spectrum analyzer	ROHDE & SCHWARZ	FSV 30	A4060051	09/20	09/22
Cable 1m	HUBER & SUHNER	18GHz	A5329705	02/19	12/20*

\*Under Derogation

Note: In our quality system, the test equipment calibration due is more & less 2 months

## 8.5. RESULTS

1Mbits/s



Frequency (MHz)	Level (dBm)	Level (dBc)	Limit (dBc)
2402.00	-0.01		
2442.00	-0.12		
2480.00	0.13		
16209	-51.59	-51.60	-20

## 8.6. CONCLUSION

Unwanted Emission into non-restricted frequency bands measurement performed on the sample of the product **MICHELIN TMS AF-02**, SN **CERTIF-C-03** in configuration and description presented in this test report, show levels **compliant** to the **47 CFR PART 15.247 & RSS 247 ISSUE 2** limits.

## 9. UNWANTED EMISSIONS IN RESTRICTED FREQUENCY BANDS

### 9.1. TEST CONDITIONS

Test performed by : Gaetan DESCHAMPS  
 Date of test : December 4, 2020  
 Ambient temperature : 23 °C  
 Relative humidity : 32 %

### 9.2. TEST SETUP

The product has been tested according to ANSI C63.10 (2013) and FCC part15 subpart C.

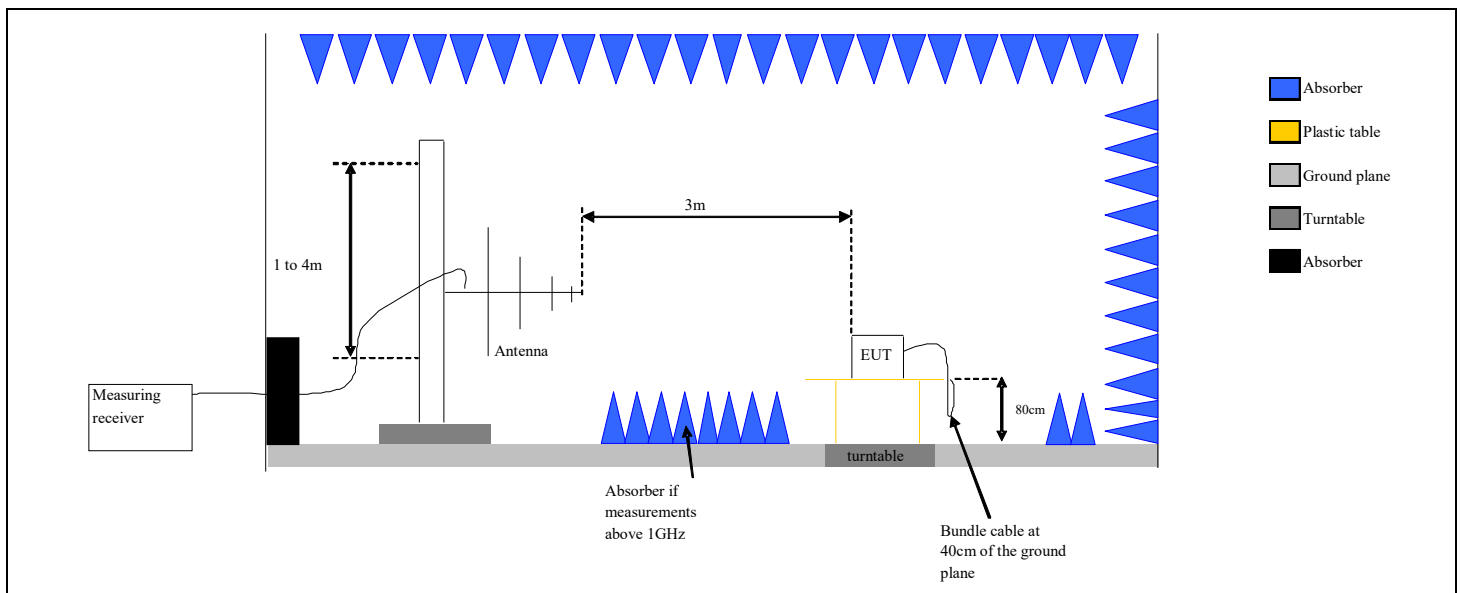
Test is performed in parallel, perpendicular and ground parallel axis with a loop antenna below 30MHz. Measurement bandwidth was 200Hz below 150kHz and 9kHz between 150kHz & 30MHz. The level has been maximised by the turntable rotation of 360 degrees range on all axis of EUT used in normal configuration. Antenna height was 1m. The EUT is placed **on an open area test site**. Distance between measuring antenna and the EUT is **10m**.

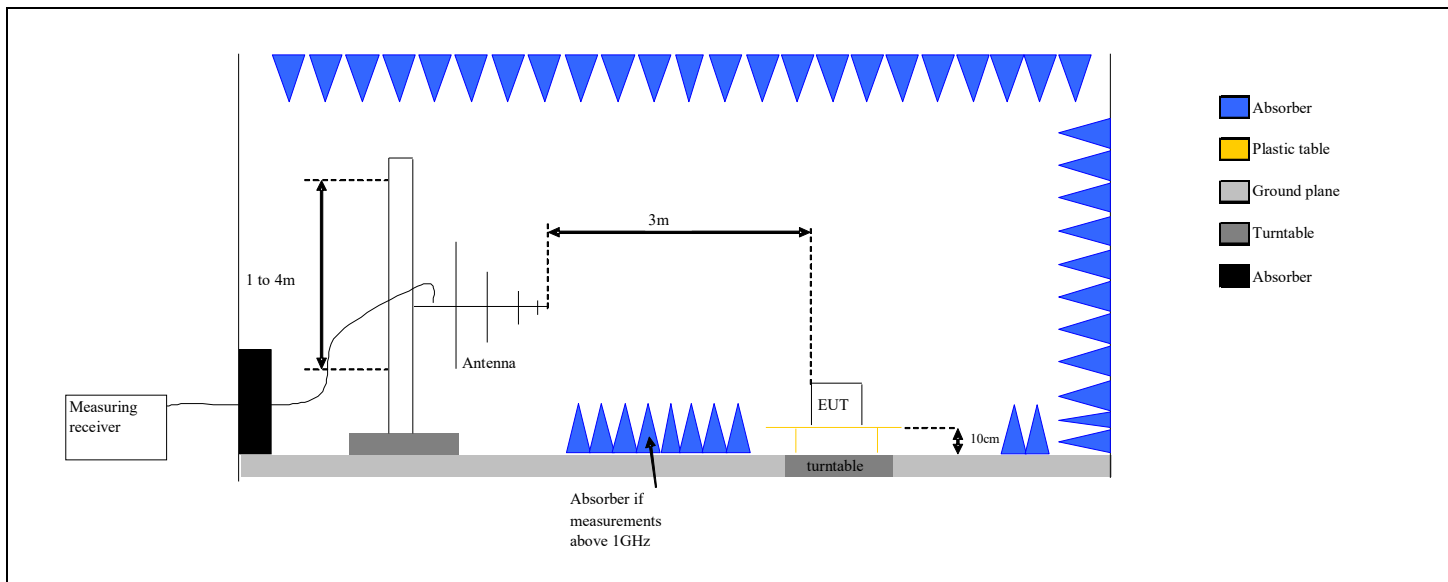
Test is performed in horizontal (H) and vertical (V) polarization with **bilog** between 30MHz & 1GHz and with a horn antenna above 1GHz. Measurement bandwidth was 120kHz below 1GHz and 1MHz above 1GHz. The level has been maximised by the turntable rotation of 360 degrees range on all axis of EUT used in normal configuration. The EUT is placed at 1.5m high above 1GHz and at 0.8m high under 1GHz. The EUT is placed **in a full anechoic chamber** above 1GHz and **on an open area test site** from 30MHz to 1GHz. Distance between measuring antenna and the EUT is **3m**. The height antenna is varied from 1m to 4m from 30MHz to 1GHz and above 1GHz is:

On mast, varied from 1m to 4m

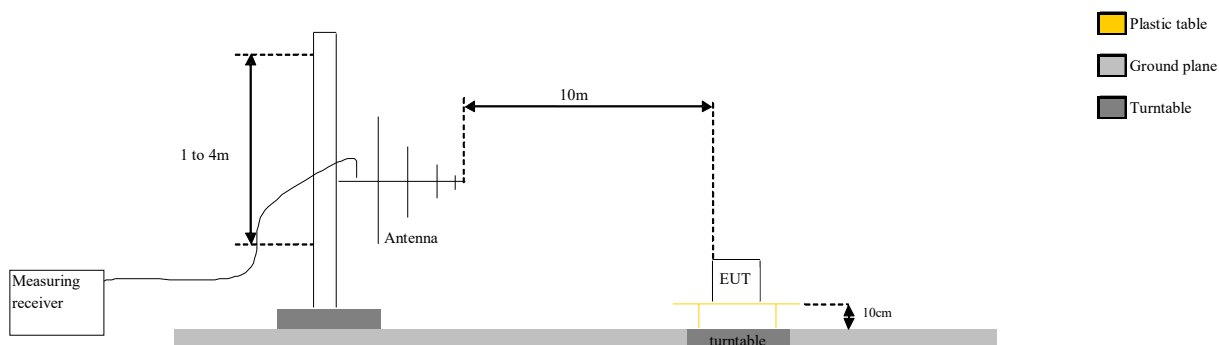
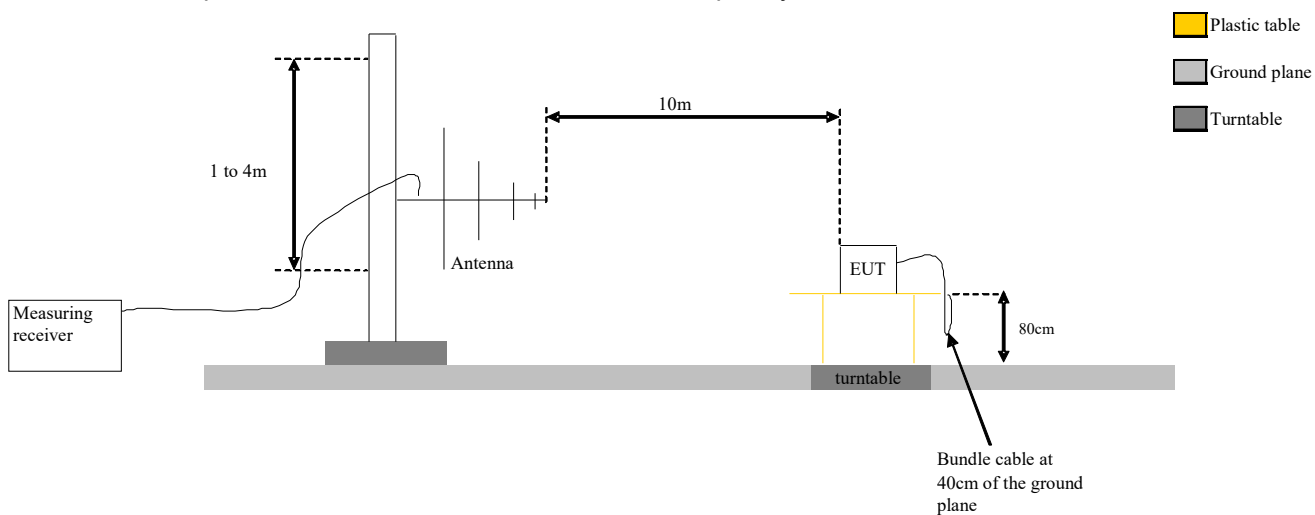
Fixed and centered on the EUT (EUT smaller than the beamwidth of the measurement antenna, ANSI C63.10 §6.6.5)

Frequency list has been created with anechoic chamber pre-scan results.

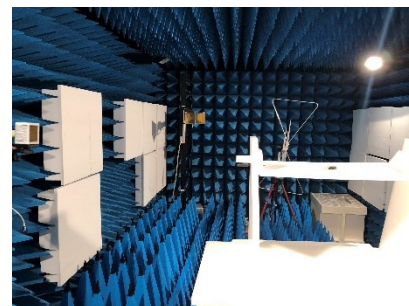
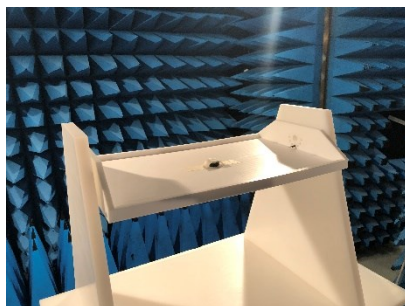




Test set up of Unwanted Emissions in Restricted Frequency Bands in semi anechoic chamber



Test Set up for radiated measurement in open area test site



*Test setup in Axis 0°:*



*Test setup in OATS°:*

Photograph for Unwanted Emission in restricted frequency bands

### 9.3. LIMIT

Measure at 300m		
Frequency range	Level	Detector
9kHz-490kHz	67.6dB $\mu$ V/m /F(kHz)	QPeak
Measure at 30m		
Frequency range	Level	Detector
490kHz-1.705MHz	87.6dB $\mu$ V/m /F(kHz)	QPeak
1.705MHz-30MHz	29.5dB $\mu$ V/m	QPeak
Measure at 10m		
Frequency range	Level	Detector
30MHz to 88MHz	29.5dB $\mu$ V/m	QPeak
88MHz to 216MHz	33dB $\mu$ V/m	QPeak
216MHz to 960MHz	35.5dB $\mu$ V/m	QPeak
960MHz to 1000MHz	43.5dB $\mu$ V/m	QPeak
Above 1000MHz	63.5dB $\mu$ V/m	Peak
	43.5dB $\mu$ V/m	Average



LCIE

Measure at 3m		
Frequency range	Level	Detector
30MHz to 88MHz	40dB $\mu$ V/m	QPeak
88MHz to 216MHz	43.5dB $\mu$ V/m	QPeak
216MHz to 960MHz	46B $\mu$ V/m	QPeak
960MHz to 1000MHz	54dB $\mu$ V/m	QPeak
Above 1000MHz	74dB $\mu$ V/m	Peak
	54dB $\mu$ V/m	Average

#### 9.4. TEST EQUIPMENT LIST

TEST EQUIPMENT USED					
Description	Manufacturer	Model	Identifier	Cal_Date	Cal_Due
Amplifier 9kHz - 40GHz	LCIE SUD EST	_	A7102082	06/20	06/21
Antenna Bi-Log	CHASE	UPA6192	C2040221	01/18	01/23
BAT EMC	NEXIO	v3.19.1.23	L1000115		
Cable 1m	HUBER & SUHNER	18GHz	A5329705	02/19	12/20*
Comb EMR HF	YORK	CGE01	A3169114		
Emission Cable	_	6GHz	A5329069	02/20	02/21
Emission Cable (SMA 1m)	TELEDYNE	26GHz	A5329874	10/20	10/21
Emission Cable (SMA 3.3m)	TELEDYNE	26GHz	A5329875	10/20	10/21
Emission Cable <1GHz (Ampl <-> Cage)	-	18GHz	A5329907	08/20	08/21
Filter Matrice	LCIE SUD EST	Combined filters	A7484078	09/20	09/21
Multimeter - CEM	FLUKE	87	A1240251	11/18	12/20*
Power supply DC	METRIX	AX503	A7042308		
Radiated emission comb generator	BARDET	_	A3169050		
Rehausse Table C3	LCIE	_	F2000511		
Rehausse Table C3	LCIE	_	F2000507		
Semi-Anechoic chamber #3 (BF)	SIEPEL	_	D3044017_BF	12/19	12/22
Semi-Anechoic chamber #3 (VSWR)	SIEPEL	_	D3044017_VSWR	12/19	12/22
Spectrum analyzer	ROHDE & SCHWARZ	FSU 26	A4060058	09/19	09/21
Table C3	LCIE	_	F2000461		
Thermo-hygrometer (C3)	OREGON	BAR206	B4204078	10/18	12/20*
Thermo-hygrometer (PM1/2/3)	KIMO	HQ 210	B4206022	08/18	12/20*
Turntable chamber (Cage#3)	ETS Lingren	Model 2165	F2000371		
Turntable controller (Cage#3)	ETS Lingren	Model 2090	F2000444		

\*Under Derogation

Note: In our quality system, the test equipment calibration due is more & less 2 months



LCIE

TEST EQUIPMENT USED					
Description	Manufacturer	Model	Identifier	Cal_Date	Cal_Due
Antenna Bi-log	CHASE	CBL6111A	C2040051	06/19	06/21
Antenna Biconic	EMCO	3104C	C2040175	03/20	03/22
Antenna Mat (OATS)	ETS Lingren	2071-2	F2000392		
BAT EMC	NEXIO	v3.19.1.23	L1000115		
Cable (OATS)	—	1GHz	A5329623	05/20	05/21
Emission Cable	SUCOFLEX	6GHz	A5329061	06/20	06/21
Multimeter - CEM	FLUKE	87	A1240251	11/18	12/20*
OATS	—	—	F2000409	04/20	04/21
Radiated emission comb generator	BARDET	—	A3169050		
Receiver 20Hz – 8GHz	ROHDE & SCHWARZ	ESU8	A2642019	11/20	05/23
Rehausse Table C1/OATS	LCIE	—	F2000512		
Table C1/OATS	LCIE	—	F2000445		
Thermo-hygrometer (PM1/2/3)	KIMO	HQ 210	B4206022	08/18	12/20*
Turntable (OATS)	ETS Lingren	Model 2187	F2000403		
Turntable / Mast controller (OATS)	ETS Lingren	Model 2066	F2000372		
Spectrum analyzer	ROHDE & SCHWARZ	FSV 40	A4060059	05/19	05/21
Antenna Horn	SCHWARZBECK	BBHA 9170	C2042053	01/18	01/21

\*Under Derogation

Note: In our quality system, the test equipment calibration due is more & less 2 months

#### 9.5. DIVERGENCE, ADDITION OR SUPPRESSION ON THE TEST SPECIFICATION

None       Divergence:

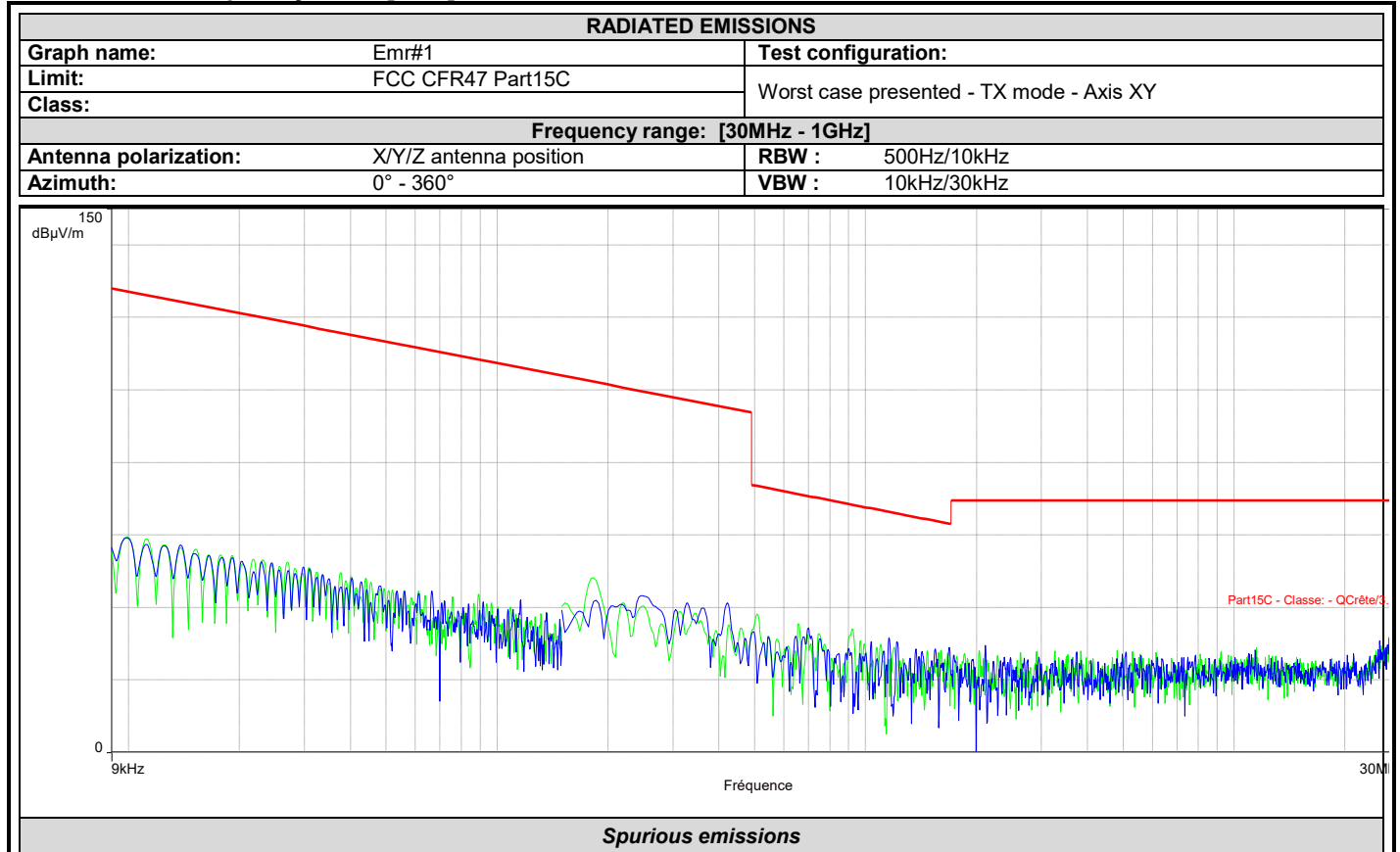




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9.6. RESULTS

Results in the frequency band [9-30] kHz:

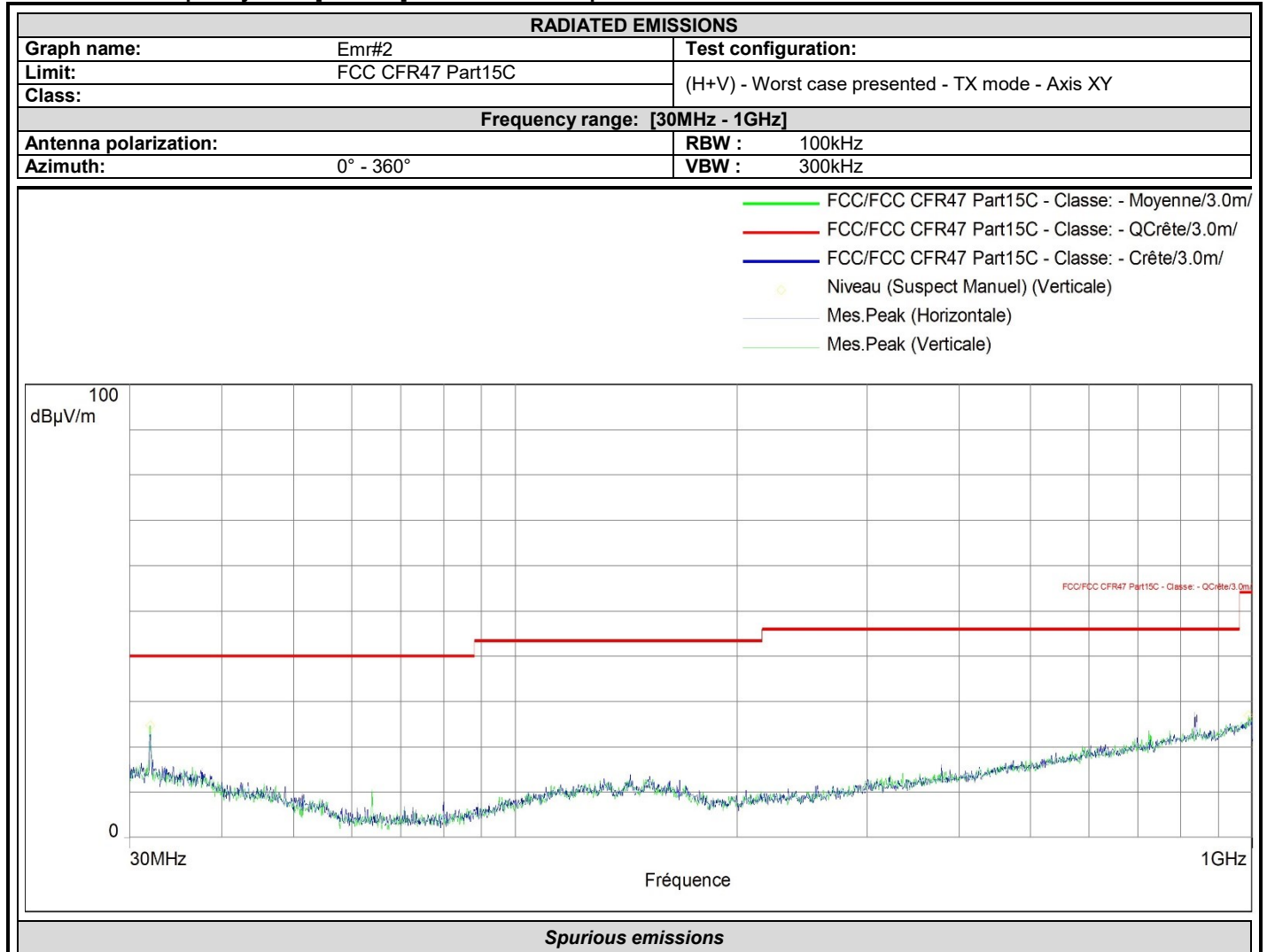


Frequency (MHz)	QPeak Level (dBµV/m)	Polarization	Correction (dB)
No significant frequency observed in 20dB below limit of restricted frequency bands			



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**Results in the frequency band [30-1000] MHz: Worst case presented:**



**QUALIFICATION (30MHz-1GHz):** 10 meters measurement on the Open Area Test Site.

Frequency list has been created with semi-anechoic chamber pre-scan results.

Measurements are performed using a QUASI-PEAK detection.

Test Frequency (MHz)	Meter Reading dB(µV)	Detector (Pk/QP/Av)	Polarity (V/H)	Azimuth (Degrees)	Antenna Height (cm)	Transducer Factor (dB)	Level (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Remark
32.584	2.8	QP	V	120	100	12.5	11.8	40.0	-28.2	

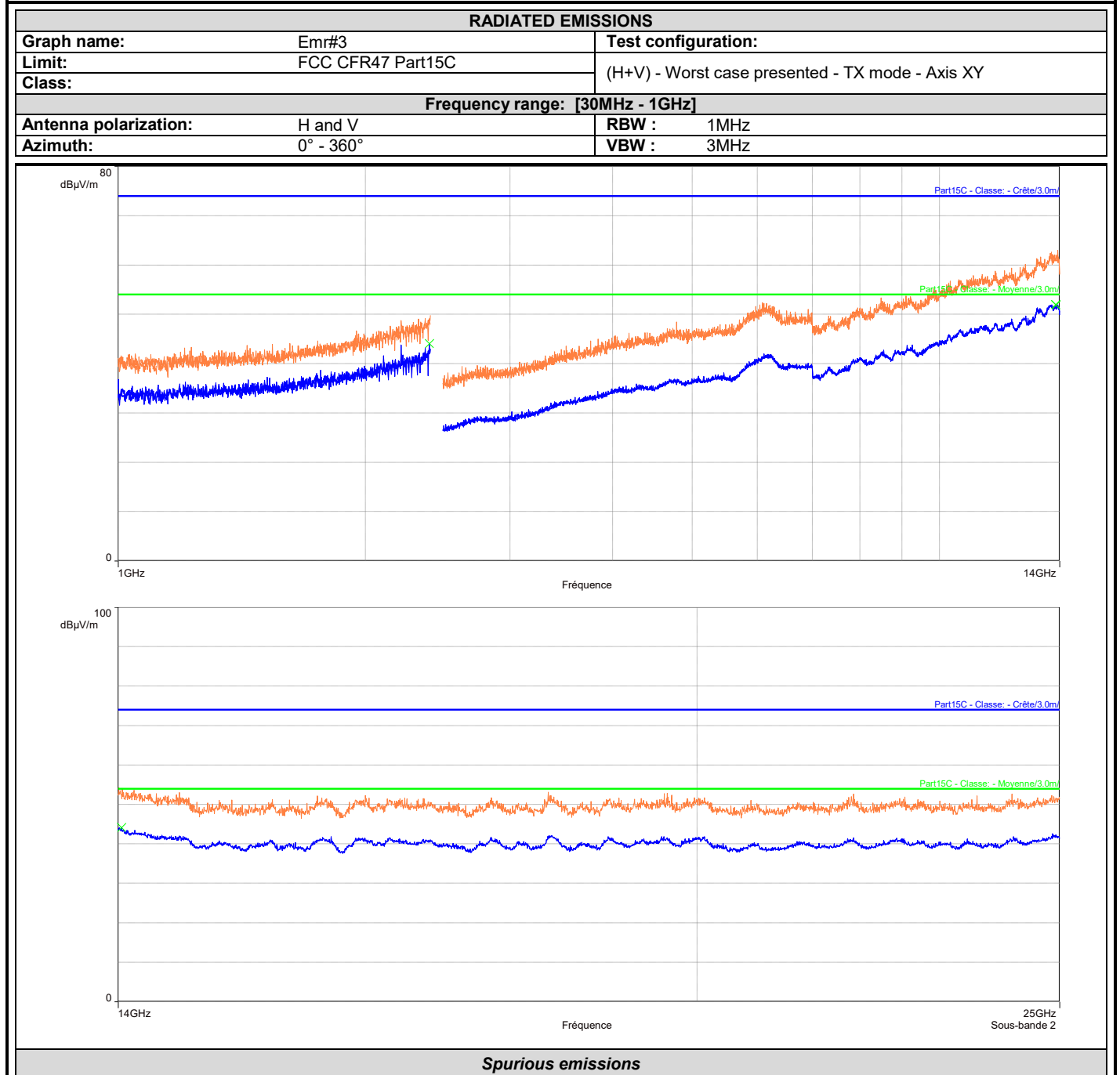
Note: Measure have been done at 10m distance and corrected according to requirements of 15.209.e)

(M@3m = M@10m+10.5dB)



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Results in the frequency band [1-25] GHz:



Highest frequencies in restricted bands of operation §15.205:

Frequency (MHz)	Peak Level (dBµV/m)	Peak Limit (dBµV/m)	Margin (dB)	Avg Level (dBµV/m)	Avg Limit (dBµV/m)	Margin (dB)	Polarization	Correction (dB)
1519.706	42.6	74.0	<b>-31.4</b>	34.5	54.0	<b>-19.5</b>	Horizontale	2.4
1671.869	41.8	74.0	<b>-32.2</b>	35.8	54.0	<b>-18.2</b>	Horizontale	3.0
2211.175	47.8	74.0	<b>-26.2</b>	43.7	54.0	<b>-10.3</b>	Verticale	5.2
2211.175	47.5	74.0	<b>-26.5</b>	43.2	54.0	<b>-10.8</b>	Horizontale	5.2
2364.606	46.6	74.0	<b>-27.4</b>	42.5	54.0	<b>-11.5</b>	Horizontale	5.9
2365.131	46.6	74.0	<b>-27.4</b>	42.3	54.0	<b>-11.7</b>	Verticale	5.8
2392.344	47.1	74.0	<b>-26.9</b>	44.1	54.0	<b>-9.9</b>	Horizontale	6.0
9131.760	47.8	74.0	<b>-26.2</b>	42.5	54.0	<b>-11.5</b>	Verticale	9.7
10597.594	57.1	74.0	<b>-16.9</b>	46.6	54.0	<b>-7.4</b>	Verticale	12.6
11698.500	58.7	74.0	<b>-15.3</b>	48.1	54.0	<b>-5.9</b>	Verticale	14.1
12242.654	59.1	74.0	<b>-14.9</b>	48.4	54.0	<b>-5.6</b>	Verticale	14.1
12662.646	59.4	74.0	<b>-14.6</b>	49.0	54.0	<b>-5.0</b>	Verticale	14.6
13301.812	61.6	74.0	<b>-12.4</b>	50.7	54.0	<b>-3.3</b>	Verticale	17.0
13942.227	63.5	74.0	<b>-10.5</b>	51.4	54.0	<b>-2.6</b>	Verticale	32.1
14475.750	51.5	74.0	<b>-22.5</b>	42.1	54.0	<b>-11.9</b>	Horizontale	7.4
15860.375	50.8	74.0	<b>-23.3</b>	41.0	54.0	<b>-13.0</b>	Horizontale	4.3
18262.500	51.7	74.0	<b>-22.3</b>	42.2	54.0	<b>-11.8</b>	Horizontale	4.4
18983.000	51.4	74.0	<b>-22.6</b>	42.3	54.0	<b>-11.7</b>	Horizontale	4.8
19988.813	52.6	74.0	<b>-21.4</b>	41.9	54.0	<b>-12.1</b>	Horizontale	4.6
22642.219	51.6	74.0	<b>-22.4</b>	41.5	54.0	<b>-12.5</b>	Horizontale	5.4

## 9.7. CONCLUSION

Unwanted Emission in restricted frequency bands measurement performed on the sample of the product **MICHELIN TMS AF-02**, SN: **CERTIF-R-03** in configuration and description presented in this test report, show levels **compliant** to the 47 CFR PART 15.247 & RSS 247 ISSUE 2 limits.

## 10. UNCERTAINTIES CHART

Type de mesure / Kind of measurement	Incertitude élargie laboratoire / Wide uncertainty laboratory (k=2) ± x	Incertitude limite du CISPR / CISPR uncertainty limit ± y
Measurement of conducted disturbances in voltage on the power port	3.29dB	3.4 dB
Measurement of conducted disturbances in voltage on the telecommunication port.	3.26 dB	5dB
Measurement of discontinuous conducted disturbances in voltage	3.33 dB	3.4 dB
Measurement of conducted disturbances in current	2.67 dB	2.9dB
Spurious emission, radiated (Semi anechoic chamber & open test site)	5.60 dB	6 dB
Spurious emission, radiated (Full anechoic chamber above 1GHz)	±3.8 dB	±6 dB
Occupied Channel Bandwidth	±2.8 %	±5 %
RF power, conducted	±1.2 dB	±1.5 dB
Power Spectral Density, Conducted	±1.7 dB	±3 dB
Spurious emission, conducted	±2.3 dB	±3 dB
Temperature	±0.75 °C	±3 °C
Supply Voltages	±1.7 %	±3 %

Les valeurs d'incertitudes calculées du laboratoire étant inférieures aux valeurs d'incertitudes limites établies par la norme, la conformité de l'échantillon est établie directement par les niveaux limites applicables. / 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 limits values.