



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

23 Place des Carmes Déchaux
63040 – CLERMONT-FERRAND Cedex 9
FRANCE

Apparatus under test

Product
Trade mark
Manufacturer
P/N
Model under test
Serial number
(PCB serial number):

TIRE MOUNTED SENSOR

MICHELIN

MICHELIN

TMS AF-02-02

TMS AF-02

CERTIF-C-03, CERTIF-R-03

000007/2023, 000008/2023 & 000009/2023

FI5TMSAF02

5056A-TMSAF02

FCC ID

IC

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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|---------|------------------|------------------|--------------------------|
| 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.



SUMMARY

| | | |
|-----|-------------------------------------------------------------------------|----|
| 1. | TEST PROGRAM | 4 |
| 2. | EQUIPMENT UNDER TEST: CONFIGURATION (DECLARED BY PROVIDER) | 5 |
| 3. | OCCUPIED BANDWIDTH..... | 9 |
| 4. | 6DB EMISSION BANDWIDTH | 12 |
| 5. | MAXIMUM CONDUCTED OUTPUT POWER | 15 |
| 6. | POWER SPECTRAL DENSITY | 19 |
| 7. | UNWANTED EMISSIONS INTO NON-RESTRICTED FREQUENCY BANDS AT THE BAND EDGE | 22 |
| 8. | UNWANTED EMISSIONS INTO NON-RESTRICTED FREQUENCY BANDS..... | 25 |
| 9. | UNWANTED EMISSIONS IN RESTRICTED FREQUENCY BANDS | 28 |
| 10. | UNCERTAINTIES CHART | 37 |

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



| CHANNEL PLAN | | | |
|----------------|-----------------|-----------------|-----------------|
| Channel | Frequency (MHz) | Channel | Frequency (MHz) |
| Cmin: 0 | 2402 | Cmid: 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 |
| 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 |
| <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 |
| <p>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.</p> | | |

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:

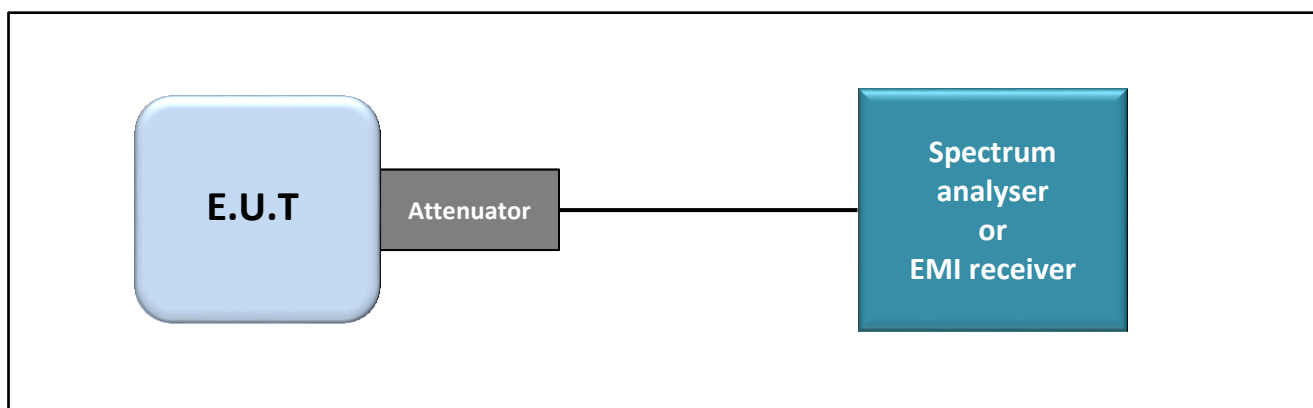
- ☒ Conducted Method (welded connection, according to manufacturer's requirement)
- ☐ Radiated Method

- Test Procedure:

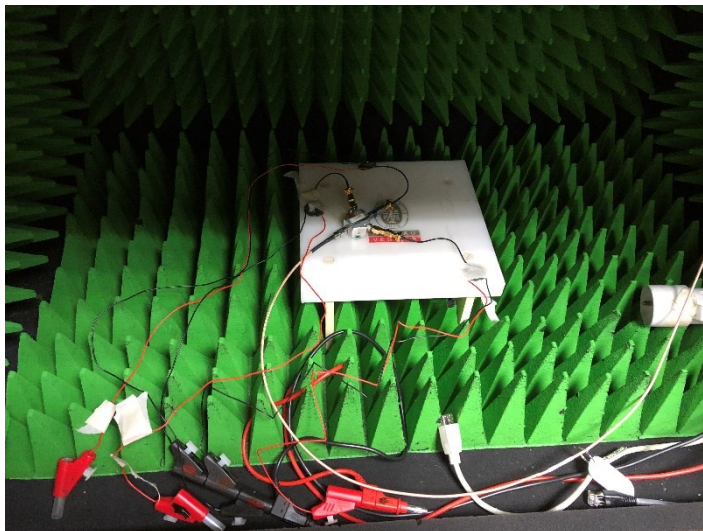
- ☒ RSS-Gen Issue 5 § 6.7
- ☐ ANSI C63.10 § 6.9.2

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

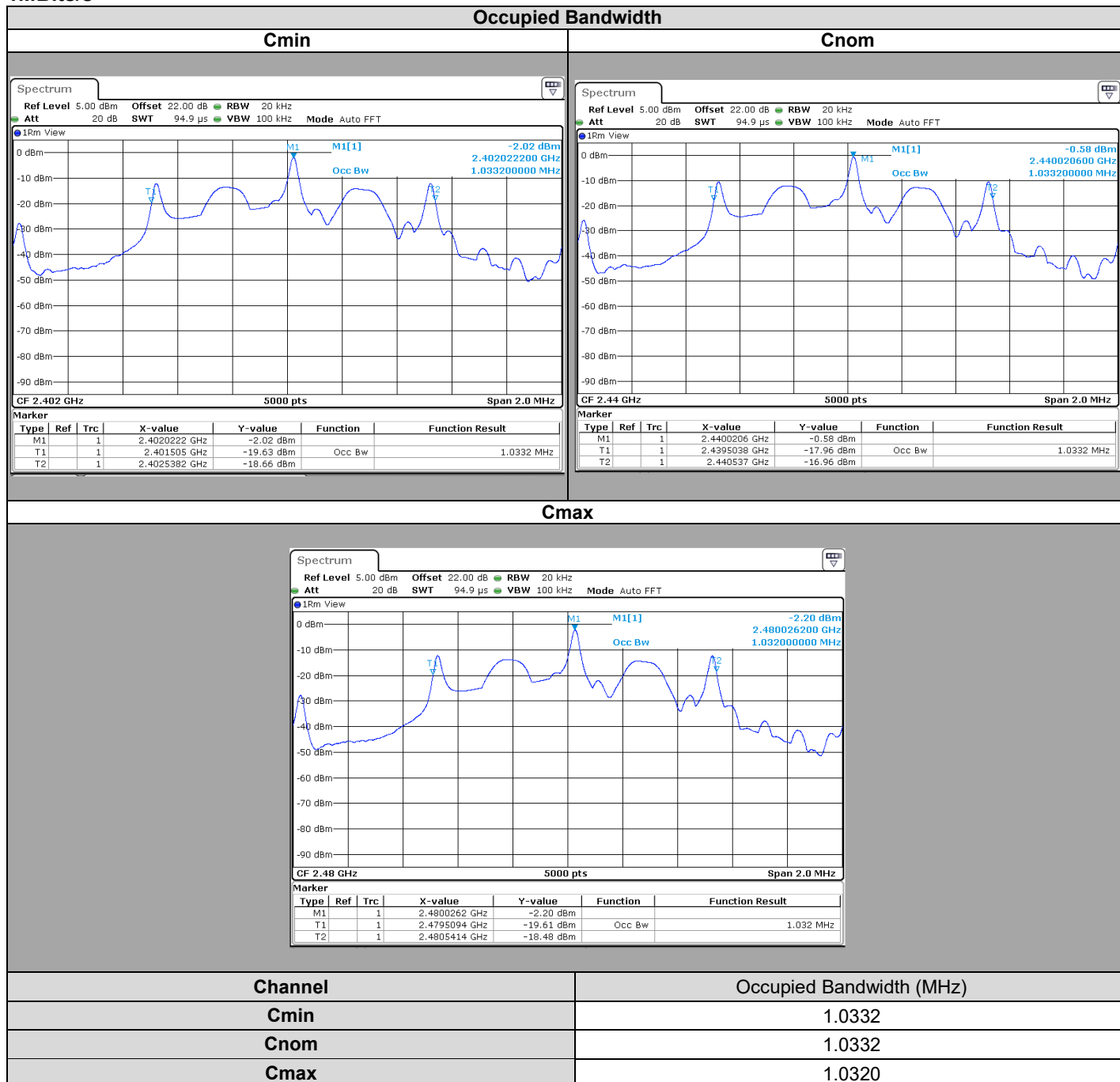
3.4. TEST EQUIPMENT LIST

| 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 | RADIAL | 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

3.5. RESULTS

1Mbits/s



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:

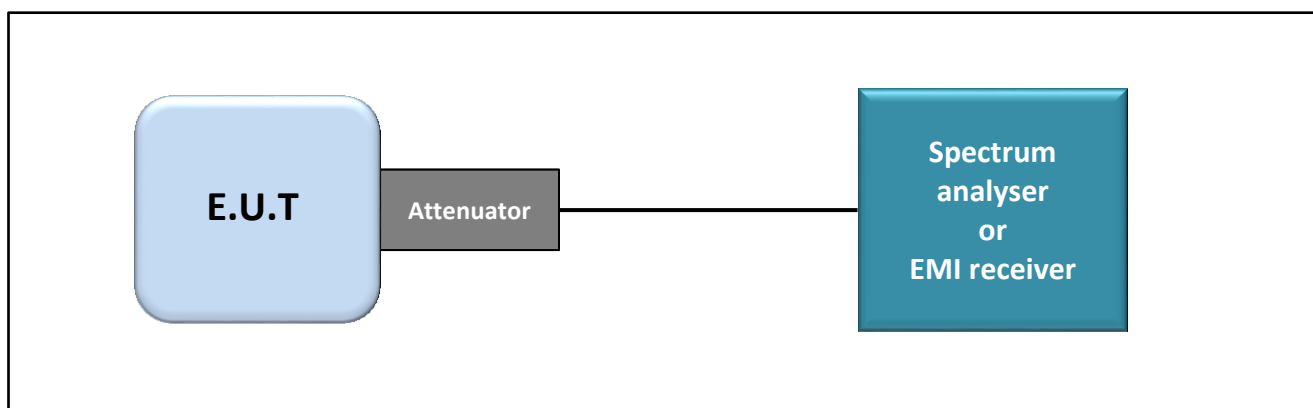
- ☒ Conducted Method (welded connection, according to manufacturer's requirement)
- ☐ Radiated Method

- Test Procedure:

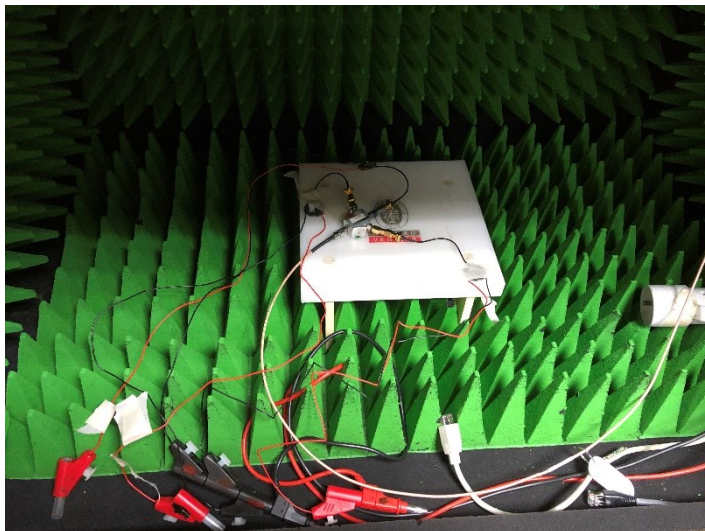
- ☒ KDB 558074 D01 DTS Meas Guidance v05r02 § 8.2

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

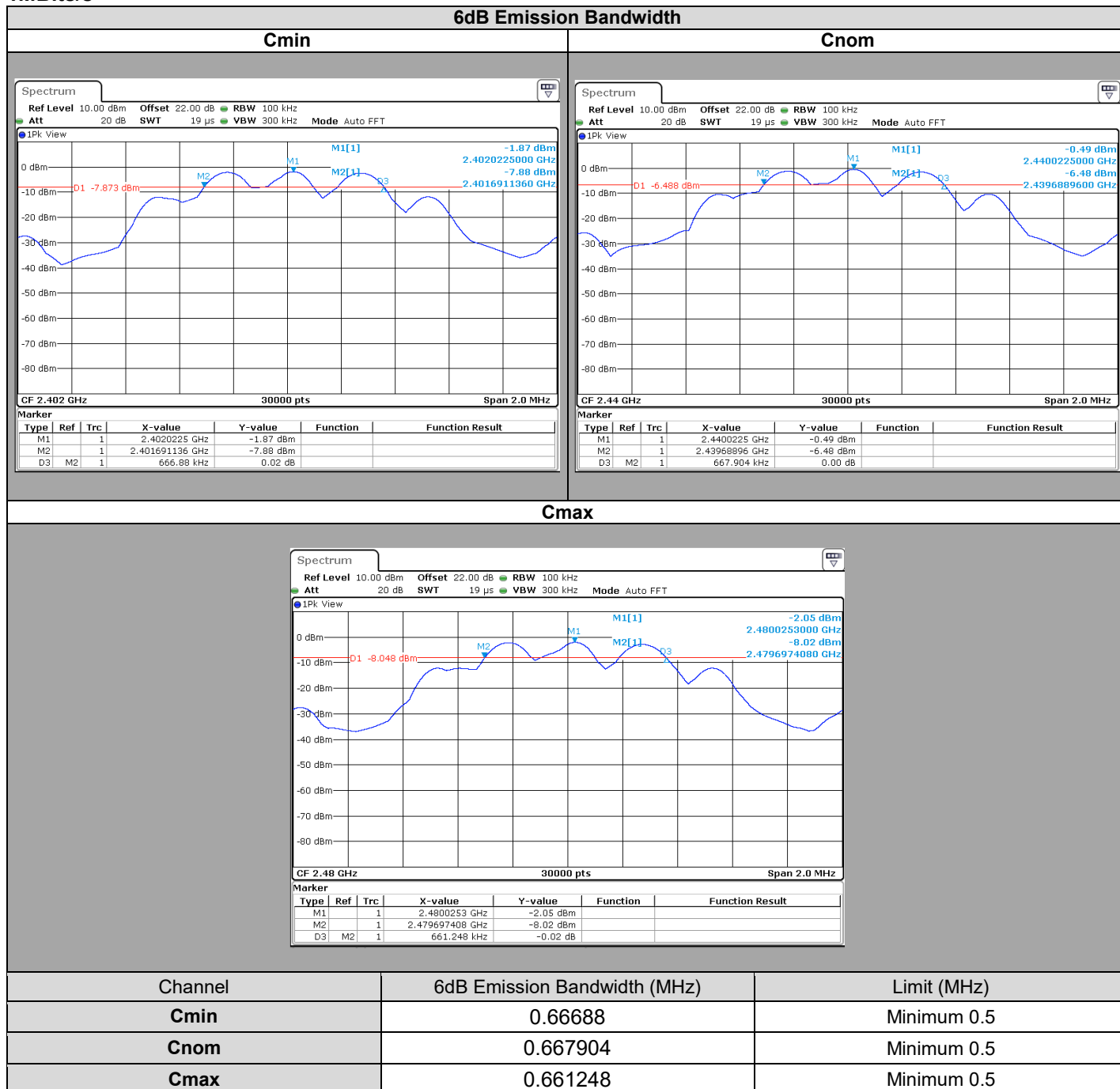
4.4. TEST EQUIPMENT LIST

| 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

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

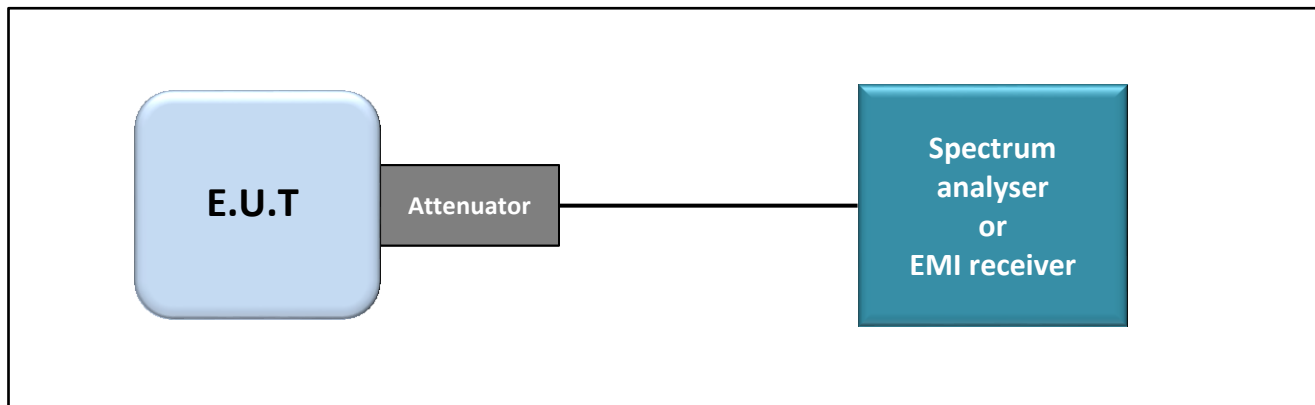
This procedure shall be used when the measurement instrument has available a resolution bandwidth that is greater than the DTS bandwidth.

- a) Set the RBW \geq DTS bandwidth.
- b) Set VBW $\geq 3 \times$ RBW.
- c) Set span $\geq 3 \times$ 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.

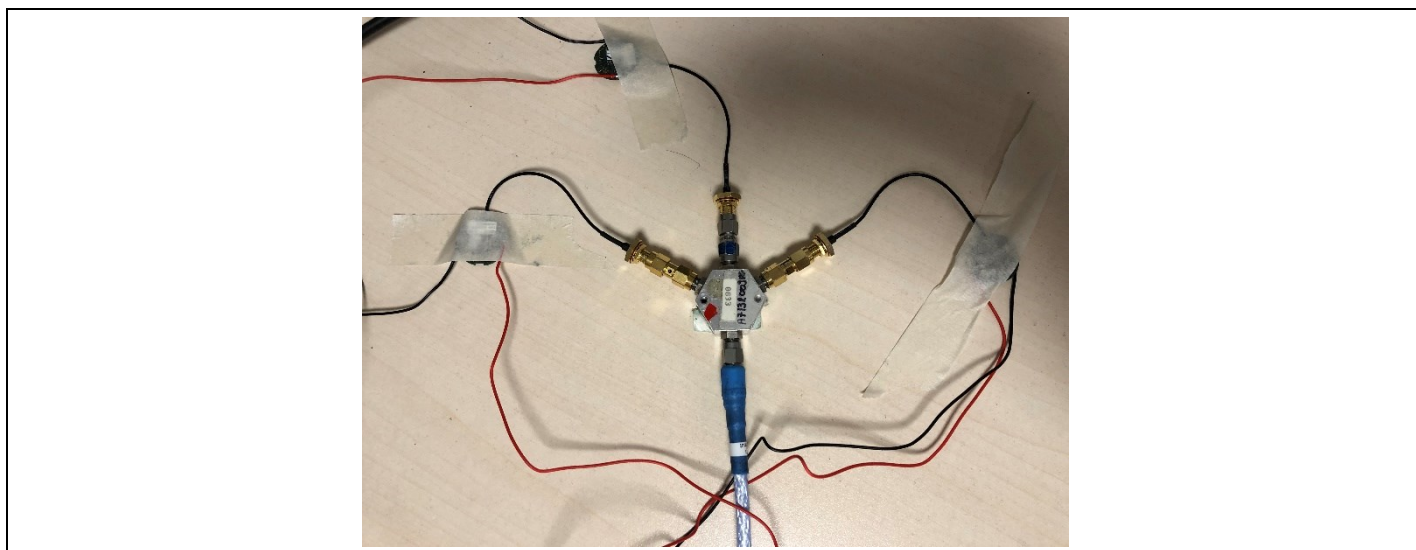
- ☐ KDB 558074 D01 DTS Meas Guidance v05r02 § 8.3.1.2

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 $\geq 3 \times$ RBW
- c) Set the span $\geq 1.5 \times$ 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.

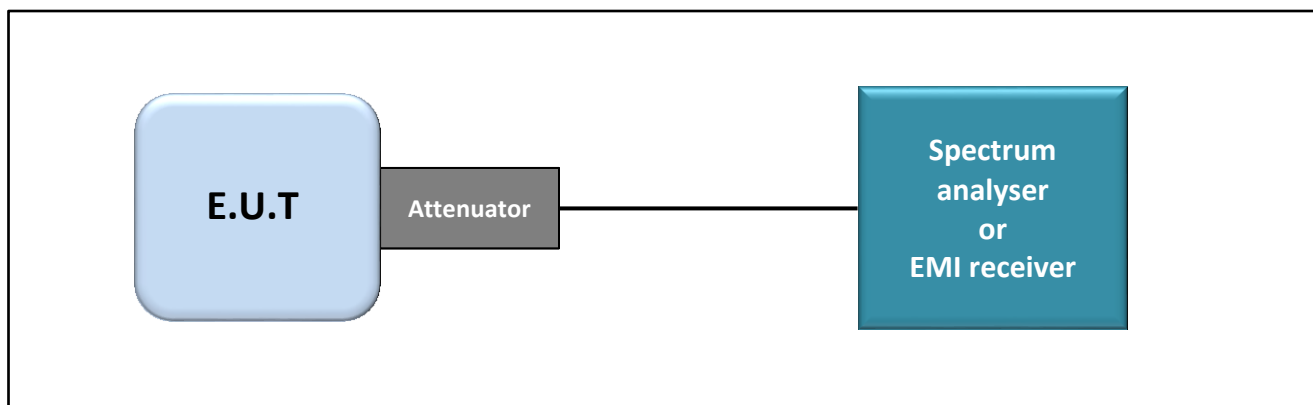
f) Sweep time = auto couple.

g) Trace mode = max hold.

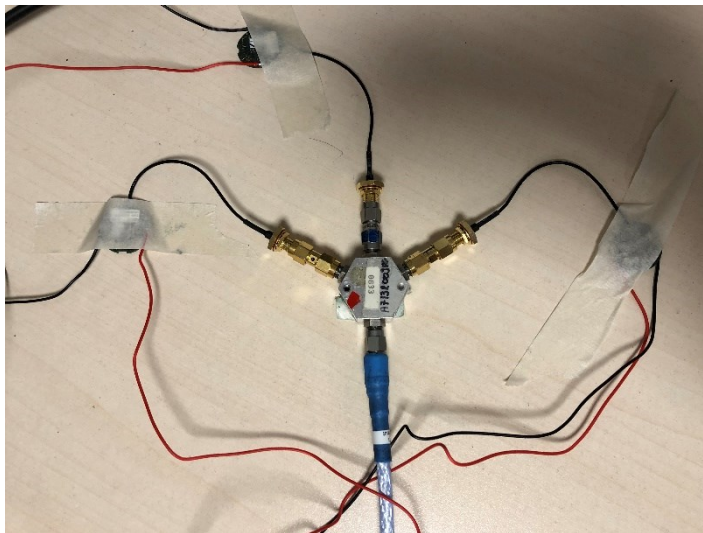
h) Allow trace to fully stabilize.

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

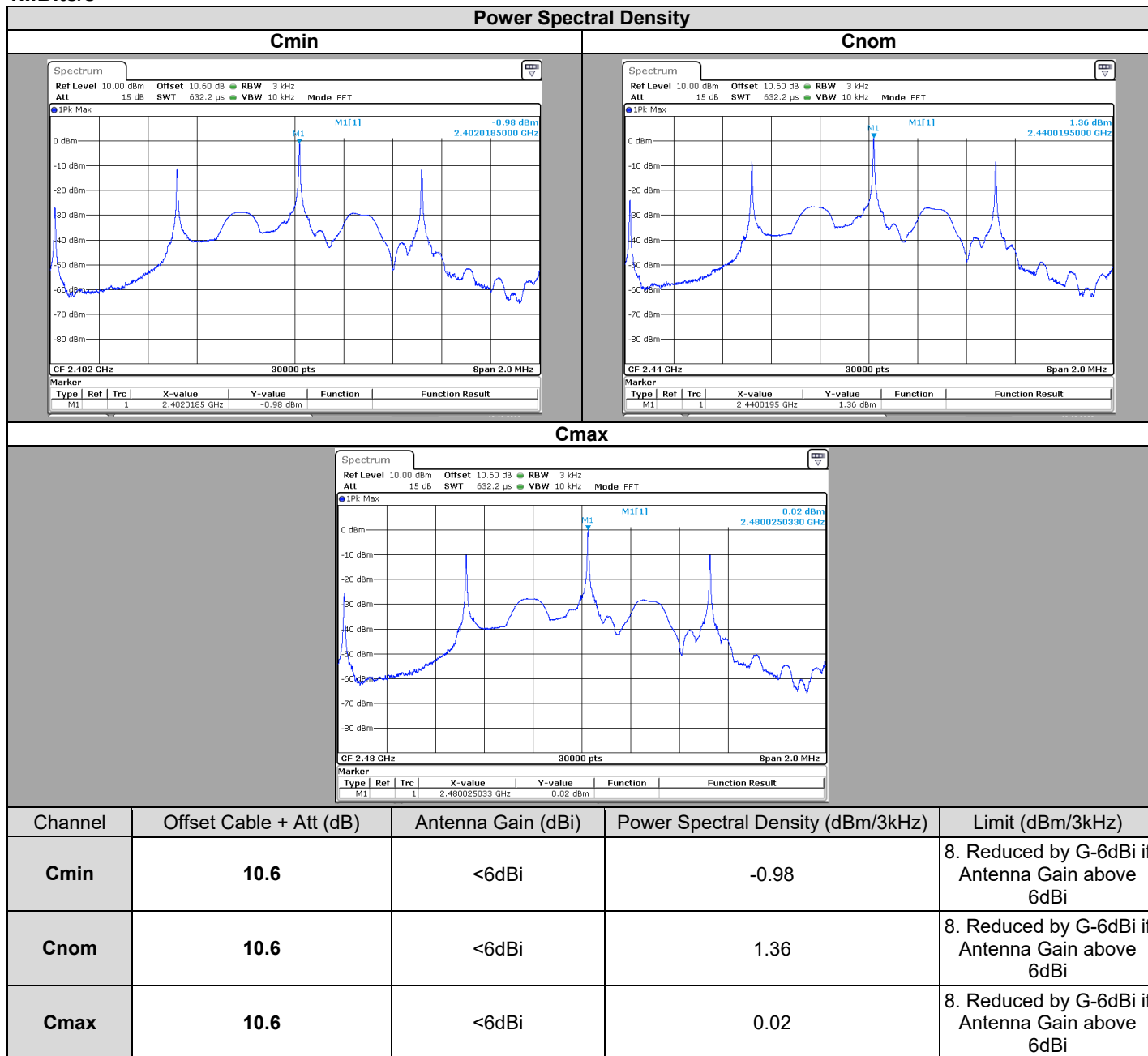
| TEST EQUIPMENT USED | | | | | |
|---------------------------------|--------------------|---------------------------------|------------|----------|---------|
| Description | Manufacturer | Model | Identifier | Cal_Date | Cal_Due |
| Thermo-hygrometer (PM1/2/3) | KIMO | HQ 210 | B4206022 | 08/18 | 12/20 |
| 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

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:

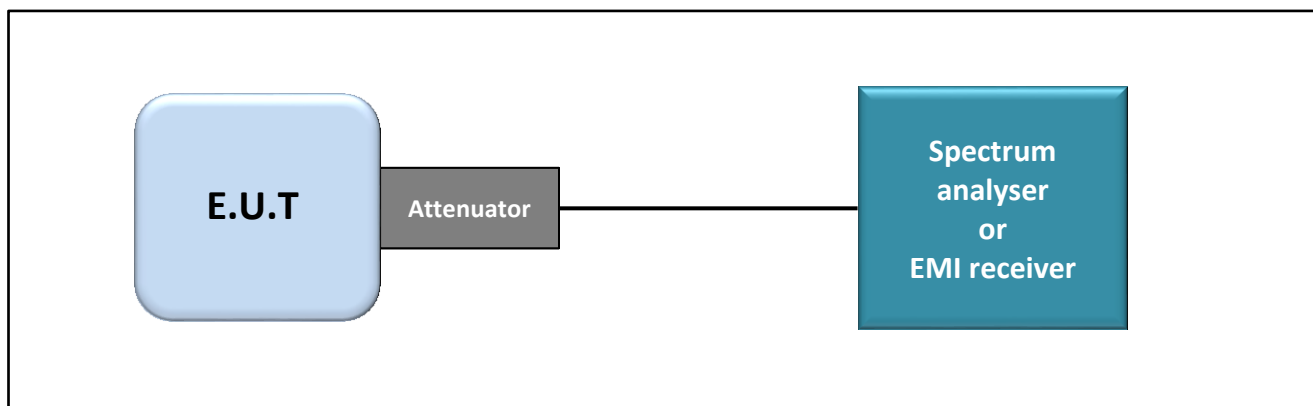
- ☒ On a table
- ☐ In an anechoic chamber

- 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 |

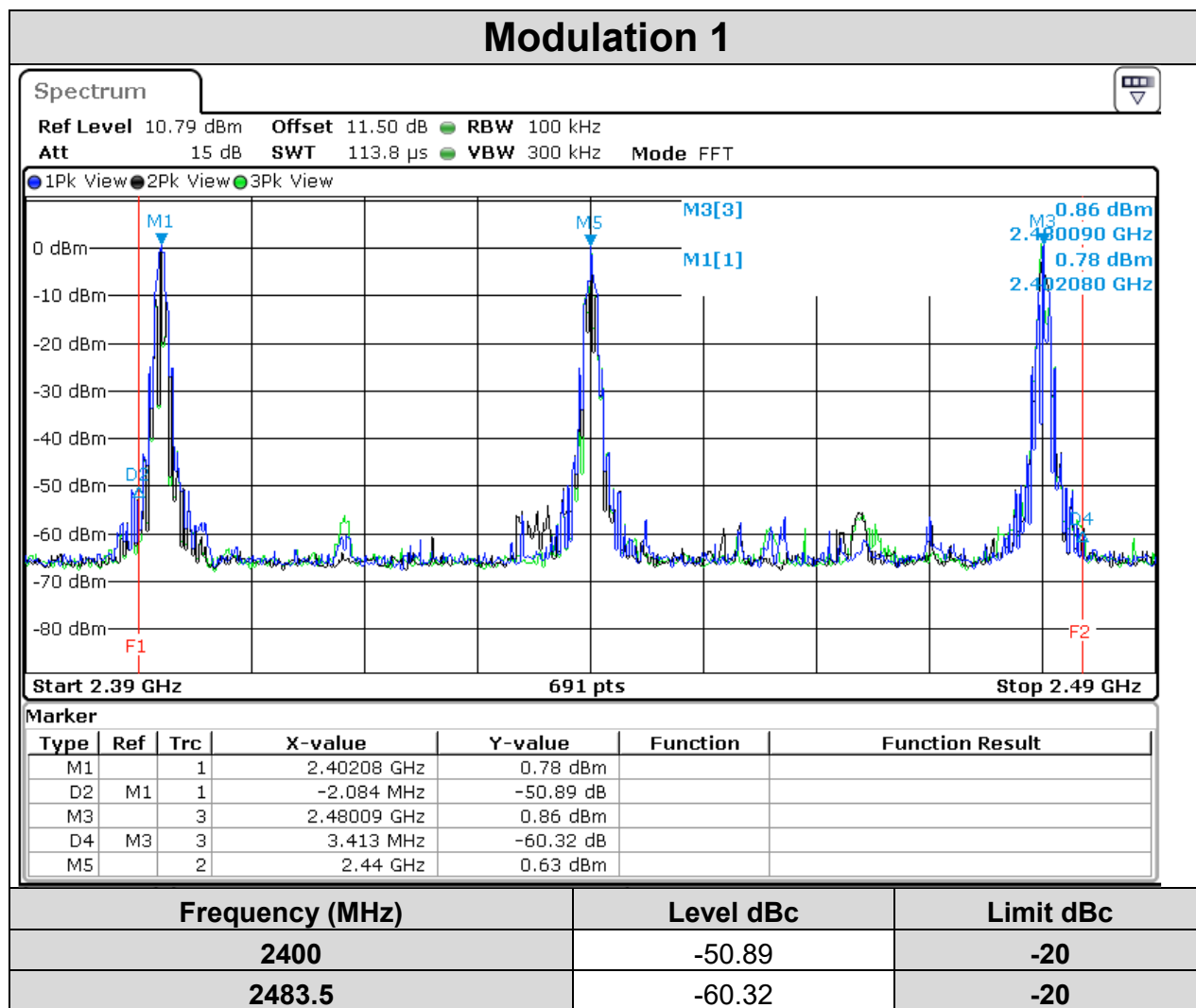
*Under Derogation

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

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:

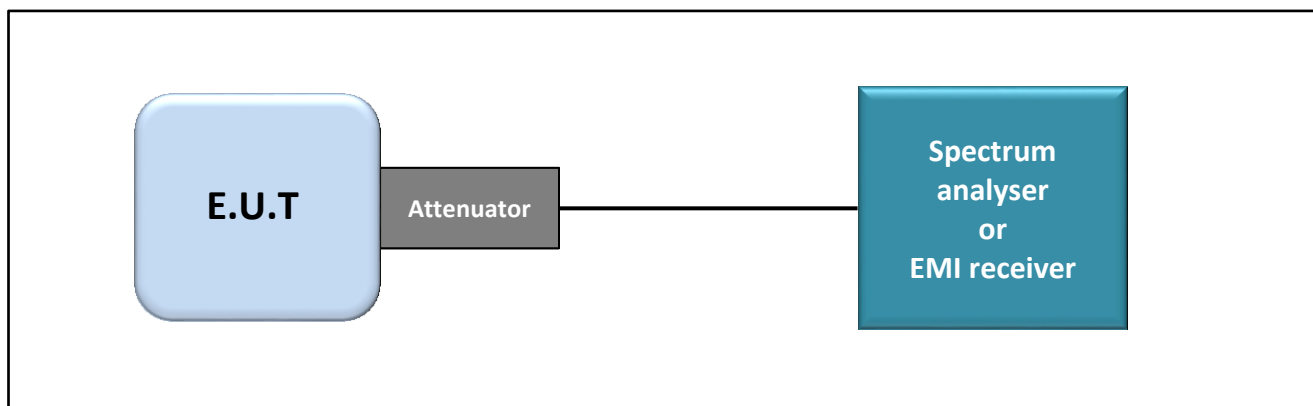
- ☒ On a table
- ☐ In an anechoic chamber

- 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

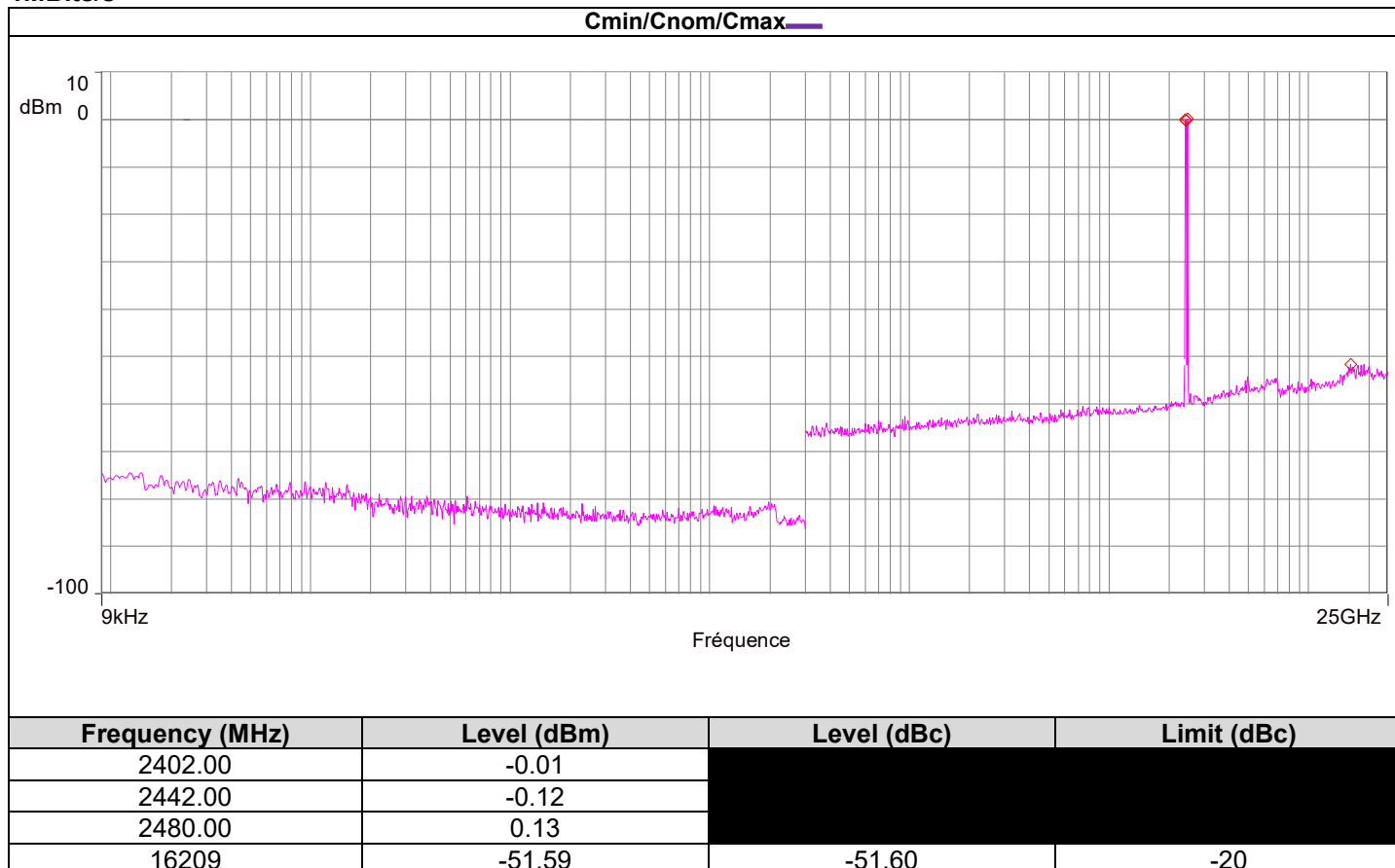
| TEST EQUIPMENT USED | | | | | |
|---------------------------------|--------------------|---------------------------------|------------|----------|---------|
| Description | Manufacturer | Model | Identifier | Cal_Date | Cal_Due |
| Thermo-hygrometer (PM1/2/3) | KIMO | HQ 210 | B4206022 | 08/18 | 12/20 |
| 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



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**.

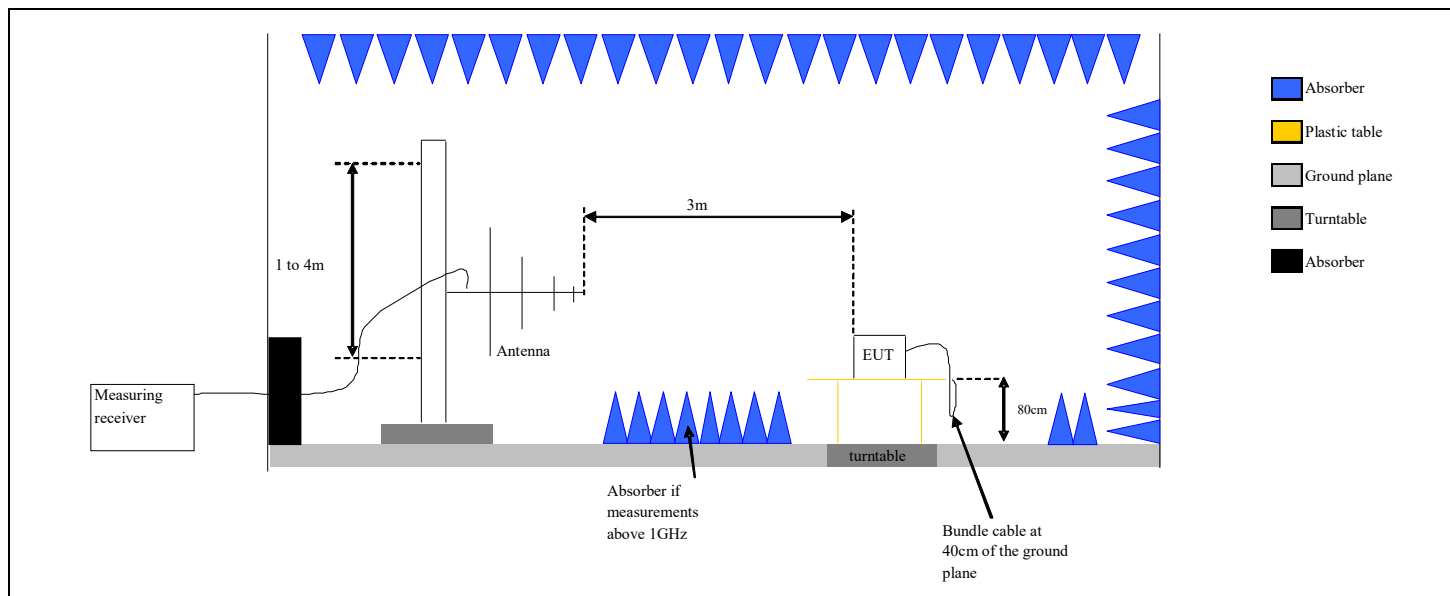
Test is performed in horizontal (H) and vertical (V) polarization with **bilog** between 30MHz & 1GHz and with a horn antenna above 1GHz. Measurement bandwidth was 120kHz below 1GHz and 1MHz above 1GHz. The level has been maximised by the turntable rotation of 360 degrees range on all axis of EUT used 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**.

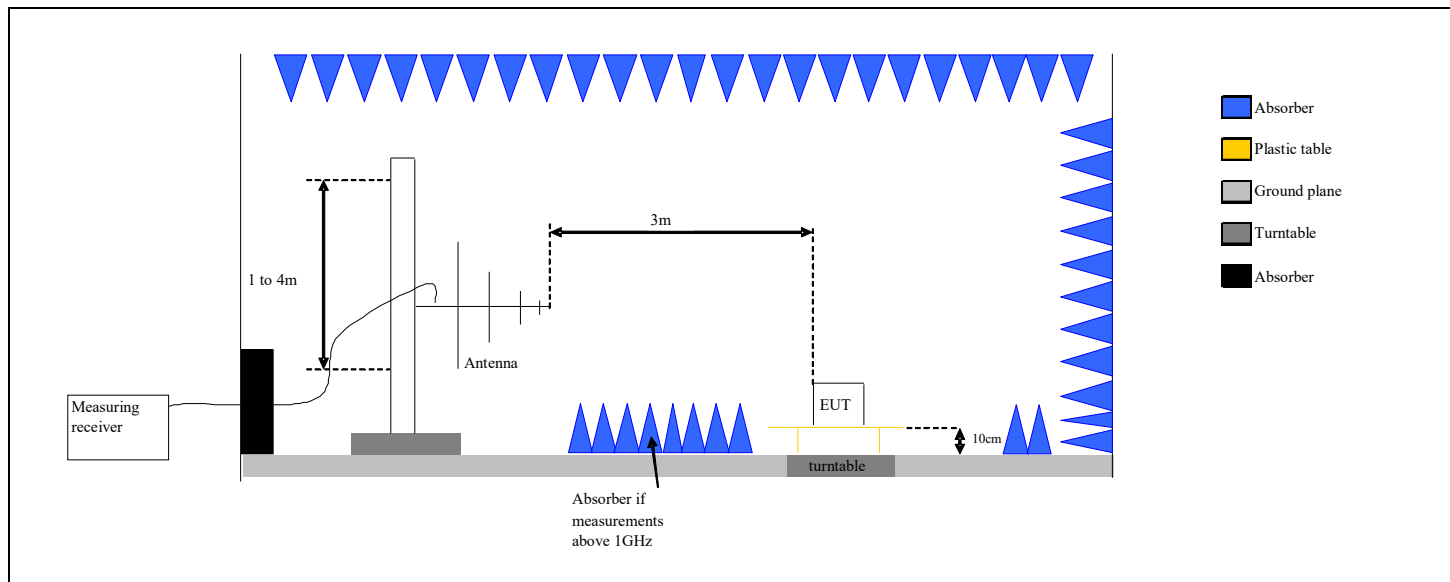
The height antenna is varied from 1m to 4m from 30MHz to 1GHz and above 1GHz is:

☐ On mast, varied from 1m to 4m

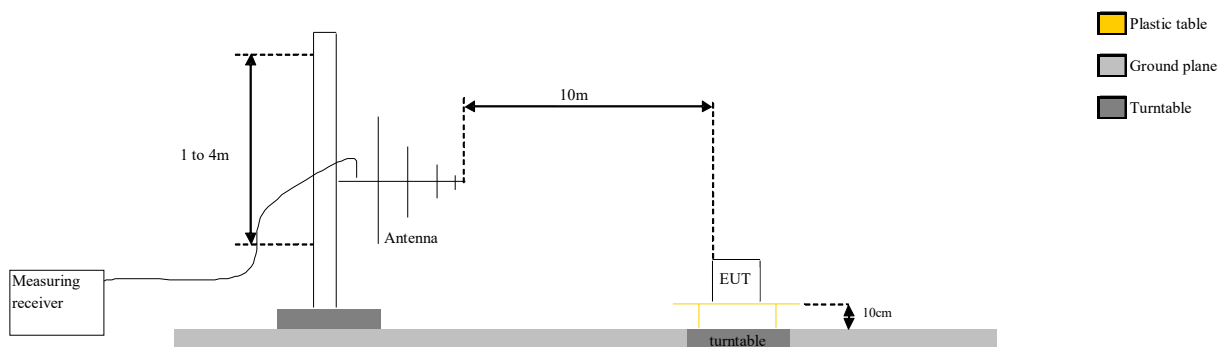
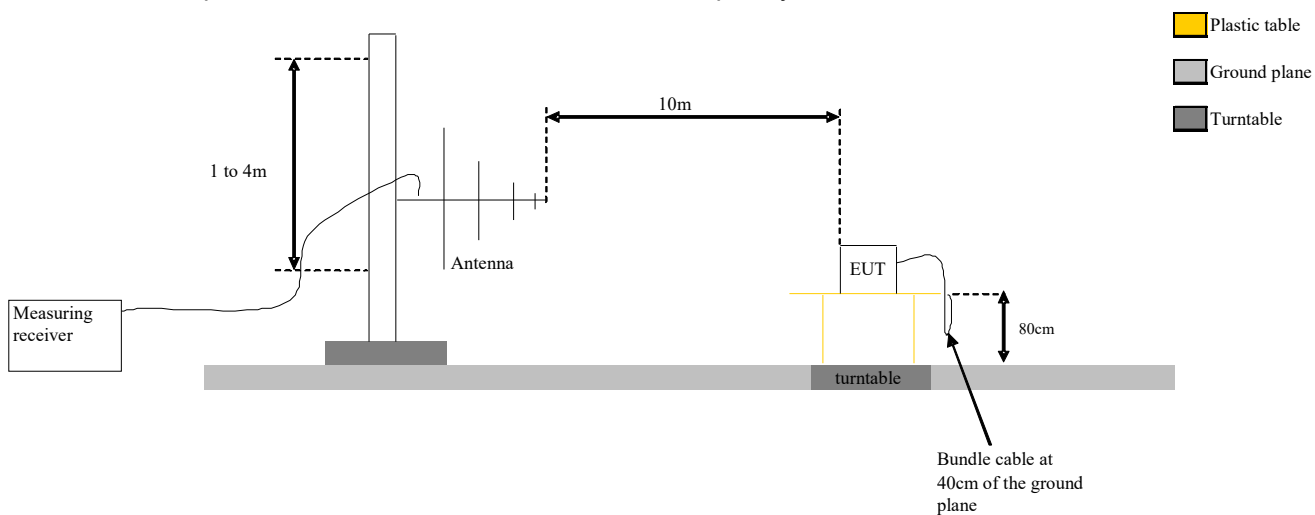
☒ Fixed and centered on the EUT (EUT smaller than the beamwidth of the measurement antenna, ANSI C63.10 §6.6.5)

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

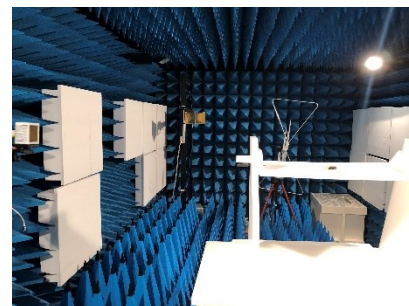
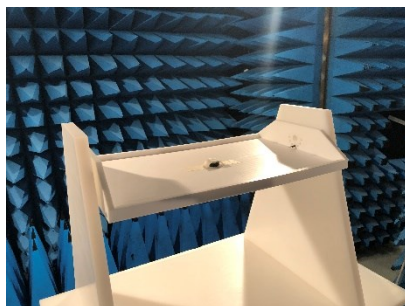




Test set up of Unwanted Emissions in Restricted Frequency Bands in semi anechoic chamber



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

| Measure at 3m | | |
|-------------------|------------------|----------|
| Frequency range | Level | Detector |
| 30MHz to 88MHz | 40dB μ V/m | QPeak |
| 88MHz to 216MHz | 43.5dB μ V/m | QPeak |
| 216MHz to 960MHz | 46B μ V/m | QPeak |
| 960MHz to 1000MHz | 54dB μ V/m | QPeak |
| Above 1000MHz | 74dB μ V/m | Peak |
| | 54dB μ 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



| 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

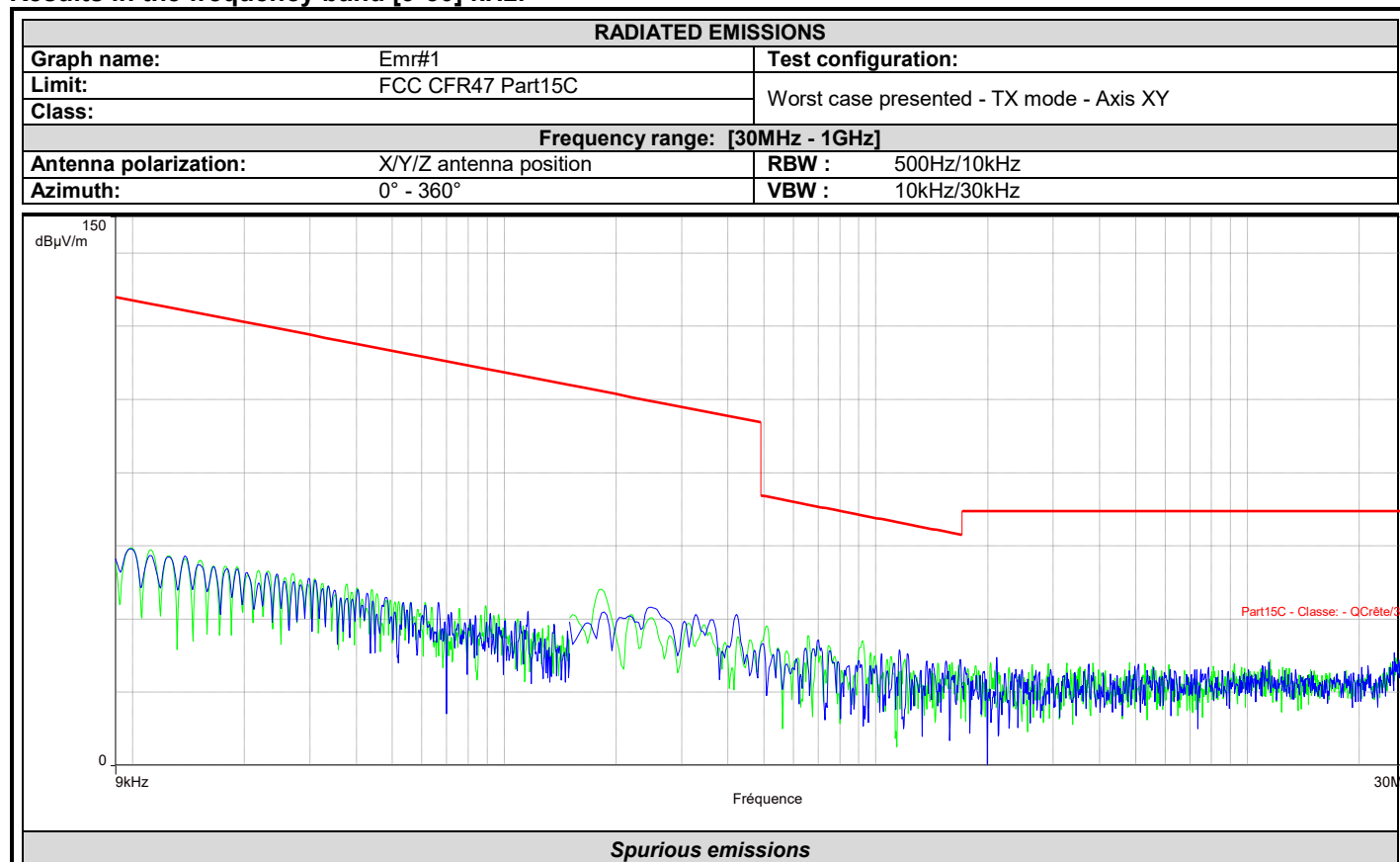
Note: In our quality system, the test equipment calibration due is more & less 2 months

9.5. DIVERGENCE, ADDITION OR SUPPRESSION ON THE TEST SPECIFICATION

☒ None ☐ Divergence:

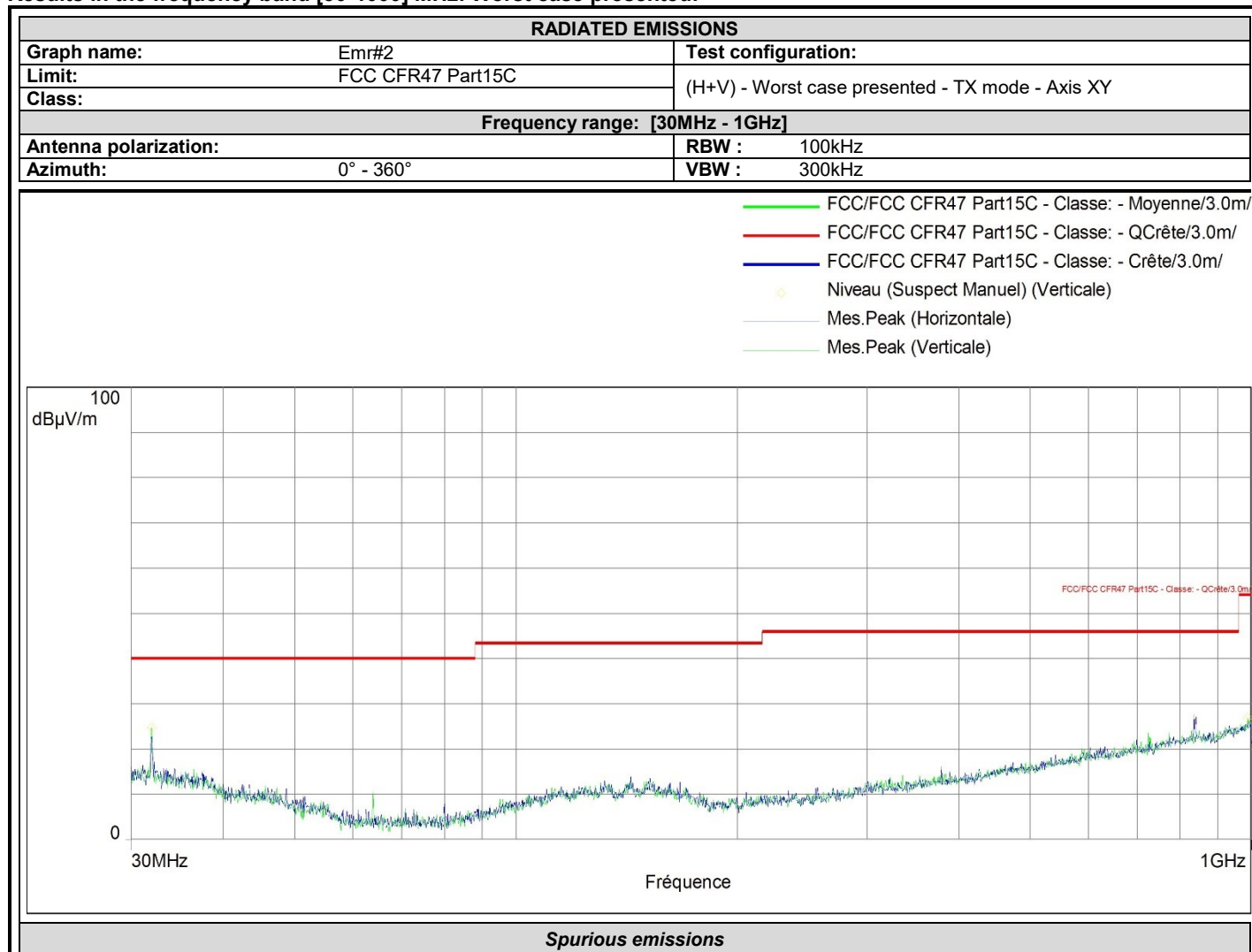
9.6. RESULTS

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 | | | |

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.

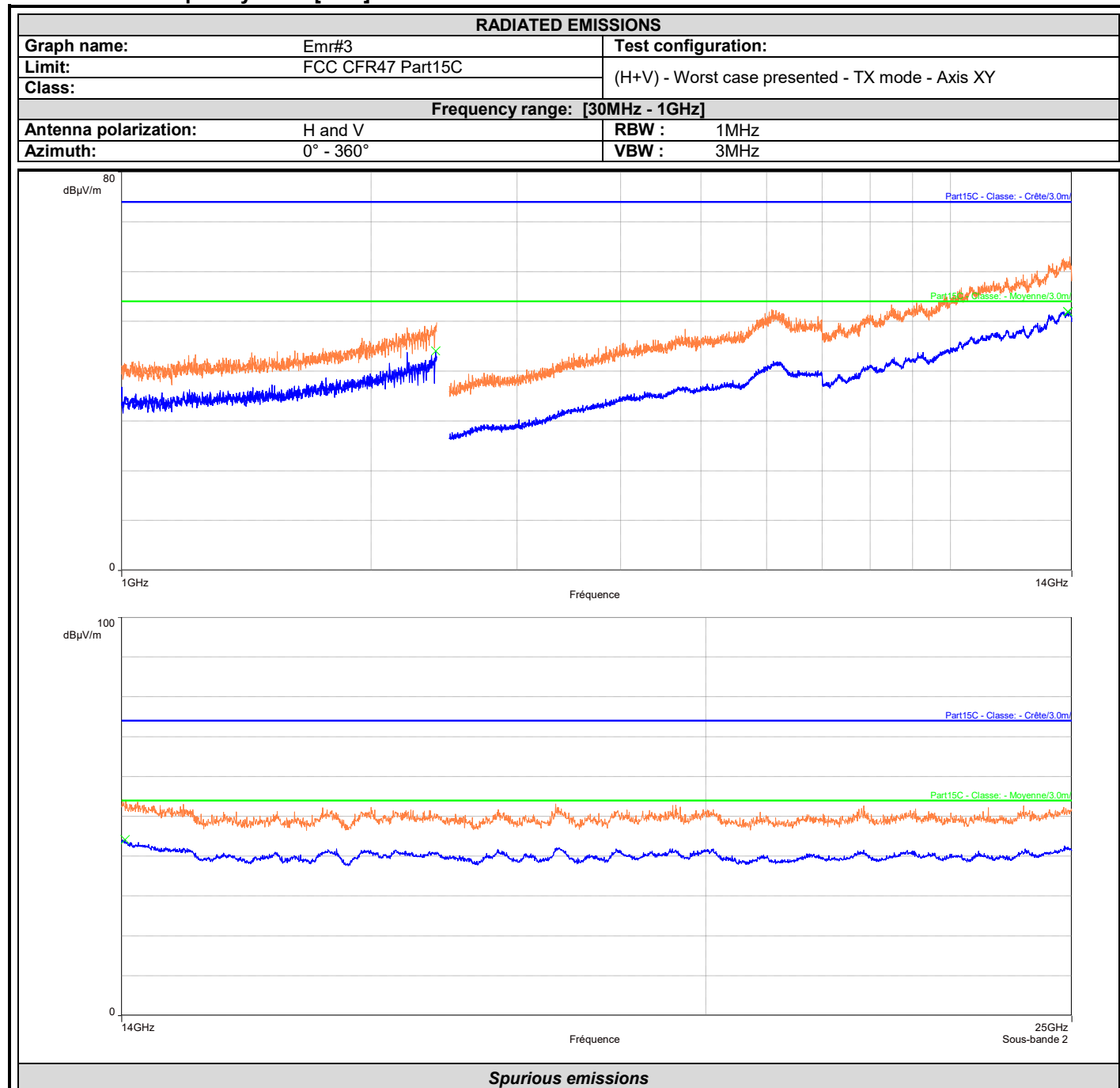
Measurements are performed using a QUASI-PEAK detection.

| 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)

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