

FCC Test Report for Part 15.247

Product name : Trinity Wireless Probe
Applicant : IBS Precision Engineering
FCC ID : 2ADZW-TRINITY

Test report No. : 20153829300 Ver 1.00

Laboratory information

Accreditation

Telefication complies with the accreditation criteria for test laboratories as laid down in ISO/IEC 17025:2005. The accreditation covers the quality system of the laboratory as well as the specific activities as described in the authorized annex bearing the accreditation number L021 and is granted on 30 November 1990 by the Dutch Council For Accreditation (RvA: Raad voor Accreditatie).

Telefication is designated by the FCC as an Accredited Test Firm for compliance testing of equipment subject to Certification under Parts 15 & 18. The Designation number is: NL0001

The Industry Canada registration number for the 3 meter test chamber of Telefication is: 4173A-1.

Documentation

The test report must always be reproduced in full; reproduction of an excerpt only is subject to written approval of the testing laboratory. The documentation of the testing performed on the tested devices is archived for 10 years at Telefication Netherlands

Testing Location

| | |
|--------------------|---|
| Test Site | Telefication BV |
| Test Site location | Edisonstraat 12a 6902 PK Zevenaar The Netherlands Tel. +31316583180 Fax. +31316583189 |
| Test Site FCC | NL0001 |

Revision History

| Version | Date | Remarks | By |
|---------|------------|-----------------|-----|
| v0.50 | 19-05-2016 | First draft | RvB |
| v1.00 | 09-06-2016 | Release version | RvB |
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |

Table of Contents

| | |
|---|----|
| Revision History | 2 |
| Summary of Test results..... | 5 |
| 1 General Description..... | 6 |
| 1.1 Applicant..... | 6 |
| 1.2 Manufacturer | 6 |
| 1.3 Tested Equipment Under Test (EUT) | 6 |
| 1.4 Product specifications of Equipment under test | 7 |
| 1.5 Environmental conditions..... | 7 |
| 1.6 Measurement Standards..... | 7 |
| 1.7 Applicable Standards | 7 |
| 1.8 Conclusions..... | 8 |
| 2 Test configuration of the Equipment Under Test | 9 |
| 2.1 Test mode | 9 |
| 2.2 Tested channels and Data rates | 9 |
| 2.3 Radiated Test setup | 10 |
| 2.4 Equipment used in the test configuration..... | 11 |
| 2.5 Sample calculations | 11 |
| 3 Test results | 12 |
| 3.1 6dB bandwidth Measurement..... | 12 |
| 3.1.1 Limit..... | 12 |
| 3.1.2 Measurement instruments | 12 |
| 3.1.3 Test setup..... | 12 |
| 3.1.4 Test procedure | 12 |
| 3.1.5 Test Results of the 6 dB bandwidth Measurement..... | 12 |
| 3.1.6 Plots of the 6 dB bandwidth Measurement | 13 |
| 3.2 Output Power Measurement | 15 |
| 3.2.1 Limit..... | 15 |
| 3.2.2 Measurement instruments | 15 |
| 3.2.3 Test setup..... | 15 |
| 3.2.4 Test procedure | 15 |
| 3.2.5 Test results of Output Power Measurement..... | 15 |
| 3.2.6 Plots of Peak Output Power Measurement | 16 |
| 3.3 Power Spectral Density..... | 17 |
| 3.3.1 Limit..... | 17 |
| 3.3.2 Measurement instruments | 17 |
| 3.3.3 Test setup..... | 17 |
| 3.3.4 Test procedure | 17 |

| | | |
|-------|---|----|
| 3.3.5 | Test results of Power Spectral Density Measurement | 17 |
| 3.3.6 | Plots of the Power Spectral Density Measurements..... | 18 |
| 3.4 | Band edge Measurement | 20 |
| 3.4.1 | Limit..... | 20 |
| 3.4.2 | Measurement instruments | 20 |
| 3.4.3 | Test setup..... | 20 |
| 3.4.4 | Test procedure | 20 |
| 3.4.5 | Test results of Band Edges Measurements | 20 |
| 3.4.6 | Notes | 20 |
| 3.4.7 | Plots of the Band edge Measurements | 20 |
| 3.5 | Radiated Spurious Emissions Measurement | 21 |
| 3.5.1 | Limit..... | 21 |
| 3.5.2 | Measurement instruments | 21 |
| 3.5.3 | Test setup..... | 21 |
| 3.5.4 | Test procedure | 21 |
| 3.5.5 | Plots of the Radiated Spurious Emissions Measurement..... | 22 |
| 3.5.6 | Measurement Uncertainty..... | 29 |

Summary of Test results

| FCC | Description | Section in report | Verdict |
|-----------|-----------------------------|-------------------|---------|
| 15.247(a) | 6dB Bandwidth | 3.1 | Pass |
| 15.247(b) | RF output power | 3.2 | Pass |
| 15.247(e) | Power spectral density | 3.3 | Pass |
| 15.247(d) | Radiated Band edge | 3.4 | Pass |
| 15.247(d) | Radiated Spurious emissions | 3.5 | Pass |

1 General Description

1.1 Applicant

| | |
|---------------|--|
| Client name: | IBS Precision Engineering |
| Address | Esp 201, Eindhoven |
| Zip code: | 5633 AD |
| Country | The Netherlands |
| Telephone: | +31 40 290 1270 |
| E-mail: | houben@ibspe.com |
| Contact name: | B. Houben |

1.2 Manufacturer

| | |
|--------------------|--|
| Manufacturer name: | IBS Precision Engineering |
| Address: | Esp 201, Eindhoven |
| Zip code: | 5633 AD |
| Country | The Netherlands |
| Telephone: | +31 40 290 1270 |
| E-mail: | houben@ibspe.com |
| Contact name: | B. Houben |

1.3 Tested Equipment Under Test (EUT)

| | |
|-------------------|----------------------------|
| Product name: | Trinity Wireless Probe |
| Brand name: | Trinity |
| Product type: | Wireless measurement probe |
| FCC ID: | 2ADZW-TRINITY |
| Model(s): | TP-001-0044 |
| Software version: | -- |
| Hardware version: | 001 |
| Tests started: | 17-06-2015 |
| Testing ended: | 24-04-2016 |

1.4 Product specifications of Equipment under test

| | |
|----------------------------------|-------------------|
| Tx Frequencies: | 2412 – 2462 MHz |
| Rx frequencies: | 2412 – 2462 MHz |
| Maximum output power to antenna: | 16 dBm |
| Antenna type and Gain | PCB antenna, 3dBi |
| Type of modulation: | DSSS |
| Emission designator: | 17M5GXW |

1.5 Environmental conditions

| | | |
|---------------------|------------|------------|
| Test date | 17-06-2015 | 24-04-2016 |
| Ambient temperature | 24°C | 20.7°C |
| Humidity | 42.1% | 38.1% |

1.6 Measurement Standards

- FCC KDB Publication No. 558074 D01DTS Meas. Guidance V03r05
- ANSI C63.10:2013

1.7 Applicable Standards

According to the specifications of the manufacturer, the EUT must comply with the requirements of the following standards:

- FCC Part 15 Subpart C §15.247.

1.8 Conclusions

The sample of the product showed NO NON-COMPLIANCES to the specifications stated in paragraph 1.7 of this report.

The results of the test as stated in this report, are exclusively applicable to the product items as identified in this report. Telefication accepts no responsibility for any properties of product items in this test report, which are not supported by the tests as specified in paragraph 1.7 *"Applicable standards"*.

All tests are performed by:

Name : ing. P.A. Suringa and ing R. van Barneveld

Review of test methods and report by:

Name : ing. P.A. Suringa

The above conclusions have been verified by the following signatory:

Date : 09-06-2016

Name : ing M.T.P.M Wouters v/d Oudenweijer

Function : Director Certification

Signature :



2 Test configuration of the Equipment Under Test

2.1 Test mode

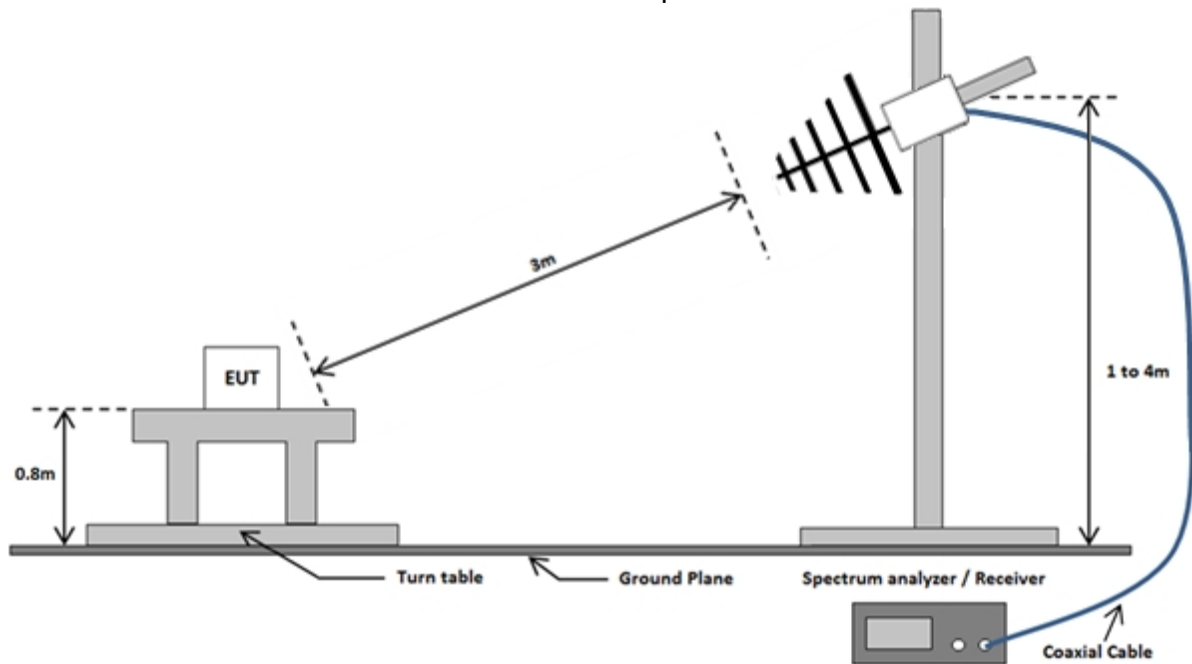
The applicant provided test mode firmware for the EUT, in which it was possible to configure the EUT into different test channels. (the applicant was present during the testing)

2.2 Tested channels and Data rates

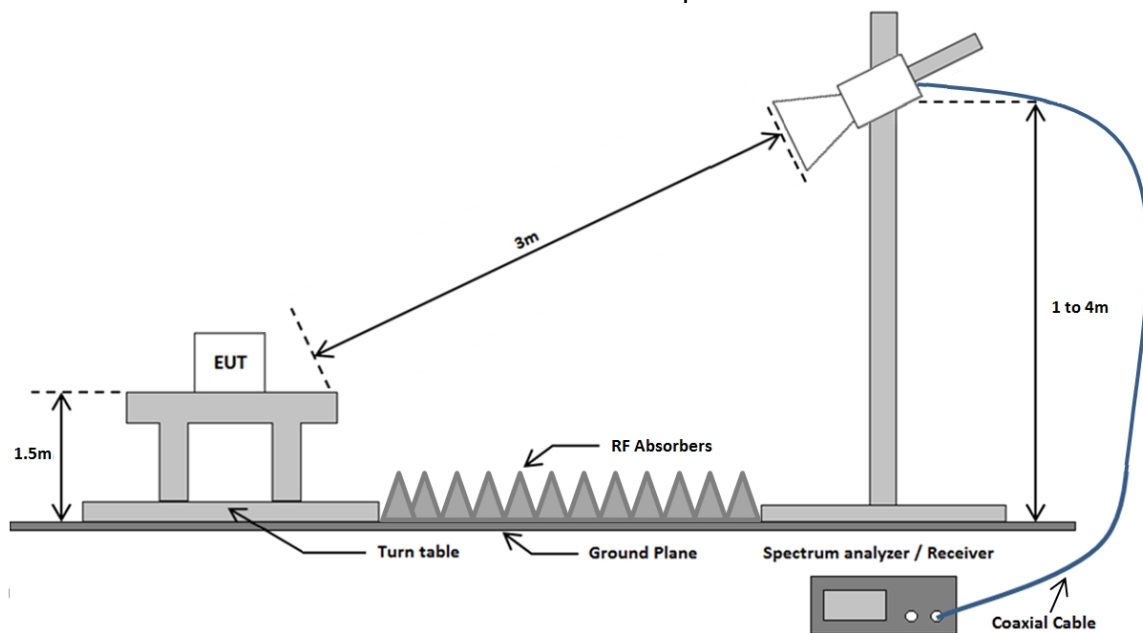
| Technology | Channels | Data rate | Frequency (MHz) |
|--------------|----------|-----------|-----------------|
| IEEE 802.11g | 1 (Low) | 54 Mbps | 2412 |
| | 4 (Mid | 54 Mbps | 2427 |
| | 10(High) | 54 Mbps | 2457 |

2.3 Radiated Test setup

Radiated emissions test setup 30 MHz - 1 GHz



Radiated emissions test setup above 1 GHz



2.4 Equipment used in the test configuration

| Description | Manufacturer | Model | ID | Used at Par. |
|-------------------|---------------------------------|--------------------------|---------|--------------|
| Spectrum Analyzer | Rohde & Schwarz | FSP40 | TE11125 | 3.1 to 3.5 |
| Spectrum Analyzer | Rohde & Schwarz | ESR7 | TE01220 | 3.1 to 3.5 |
| Biconilog Antenna | Chase | CBL6112A | TE00967 | 3.1 to 3.5 |
| Horn Antenna | EMCO The Electro – Mechanics Co | 3115 | TE00531 | 3.1 to 3.5 |
| Pre-amplifier | Miteq | AFS42-041001800-29-OP-42 | TE11132 | 3.1 to 3.5 |
| SAC Chamber | Comtest Engineering BV | - | TE00861 | 3.1 to 3.5 |

2.5 Sample calculations

1)

See chapters 3.1 to 3.4

| dBμV/m to dBm.(EIRP) | dBμV/m to dBm(ERP). | μV/m to dBμV/m |
|--|---|---|
| $E(\text{dB}\mu\text{V/m}) = \text{EIRP}(\text{dBm}) + 95.2$ | $E(\text{dB}\mu\text{V/m}) = \text{ERP}(\text{dBm}) + 97.4$ | $E(\text{dB}\mu\text{V/m}) = 20 \log (\mu\text{V/m})$ |

2)

Field Strength Measurement example (see chapter 3.5):

| Frequency (MHz) | Polarization | Height(m) | Peak (dBμV/m) |
|-----------------|--------------|-----------|---------------|
| 565,2 | Vertical | 1 | 47,1 |

The following relation applies:

$$E (\text{dB}\mu\text{V/m}) = U(\text{dB}\mu\text{V}) + \text{AF} (\text{dB/m}) + \text{CL} (\text{dB})$$

Where:

E = Electric field strength

U = Measuring receiver voltage

AF = Antenna factor

CL = Cable loss

$$(47,1 = 24.77 + 19.2 + 3.01)$$

3 Test results

3.1 6dB bandwidth Measurement

3.1.1 Limit

The minimum 6 dB Bandwidth shall be at least 500 kHz.

3.1.2 Measurement instruments

The measurement instruments are listed in chapter 2.4 of this report.

3.1.3 Test setup

The test setup is as shown in chapter 2.3 of this report.

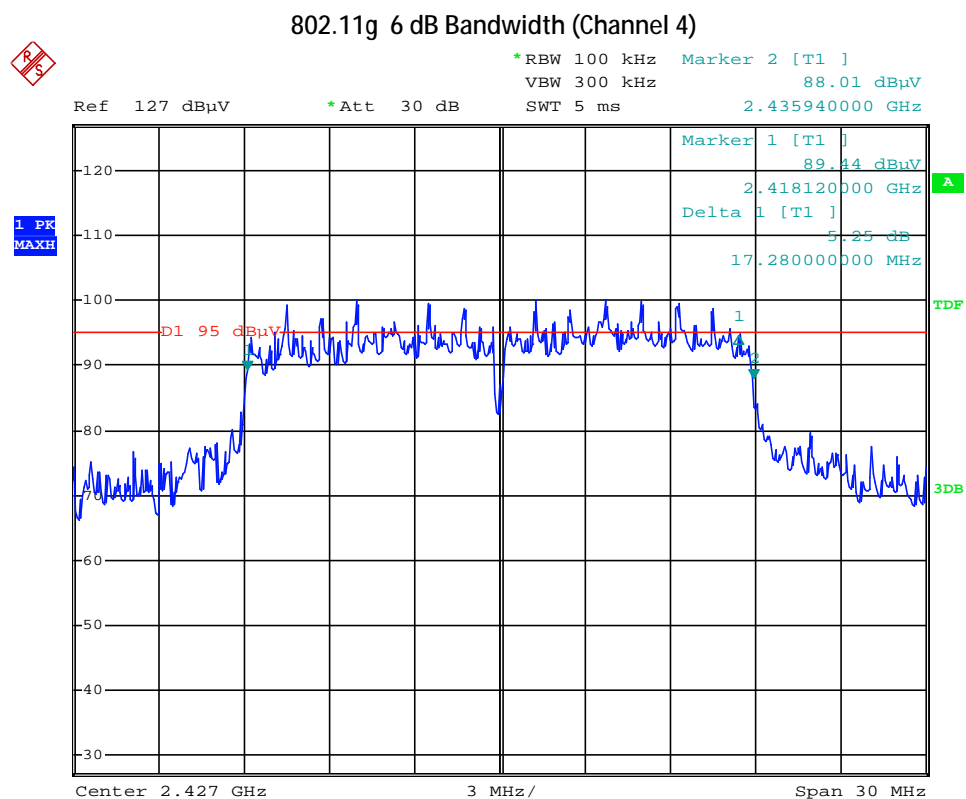
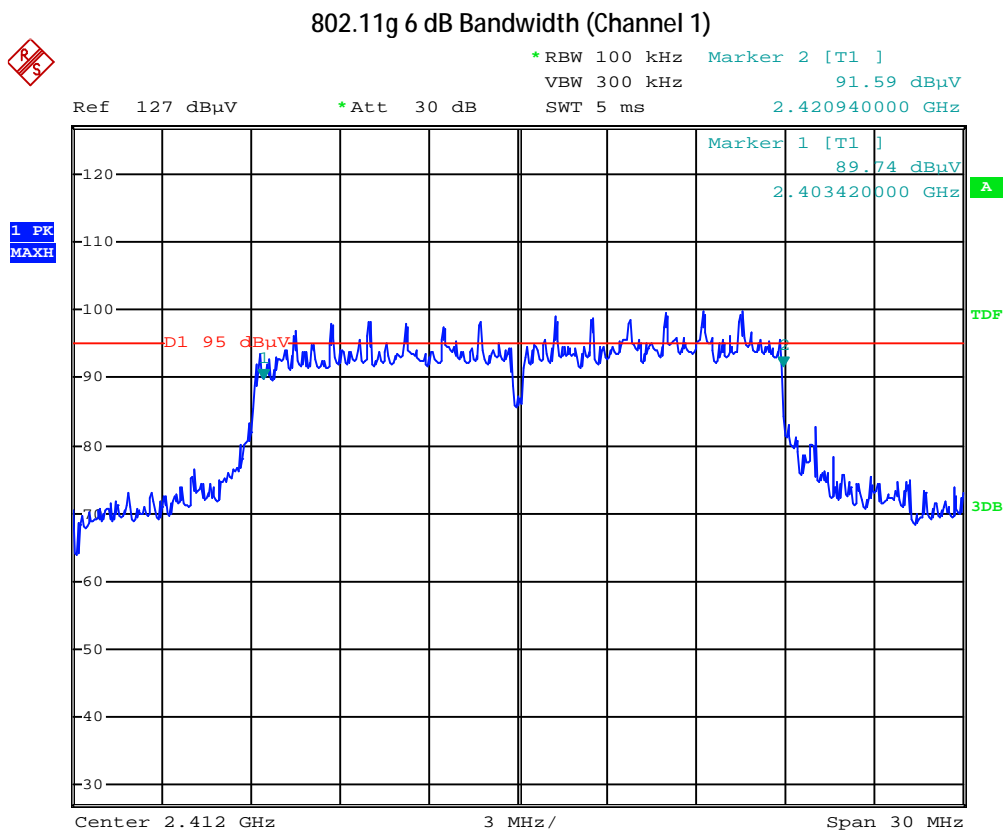
3.1.4 Test procedure

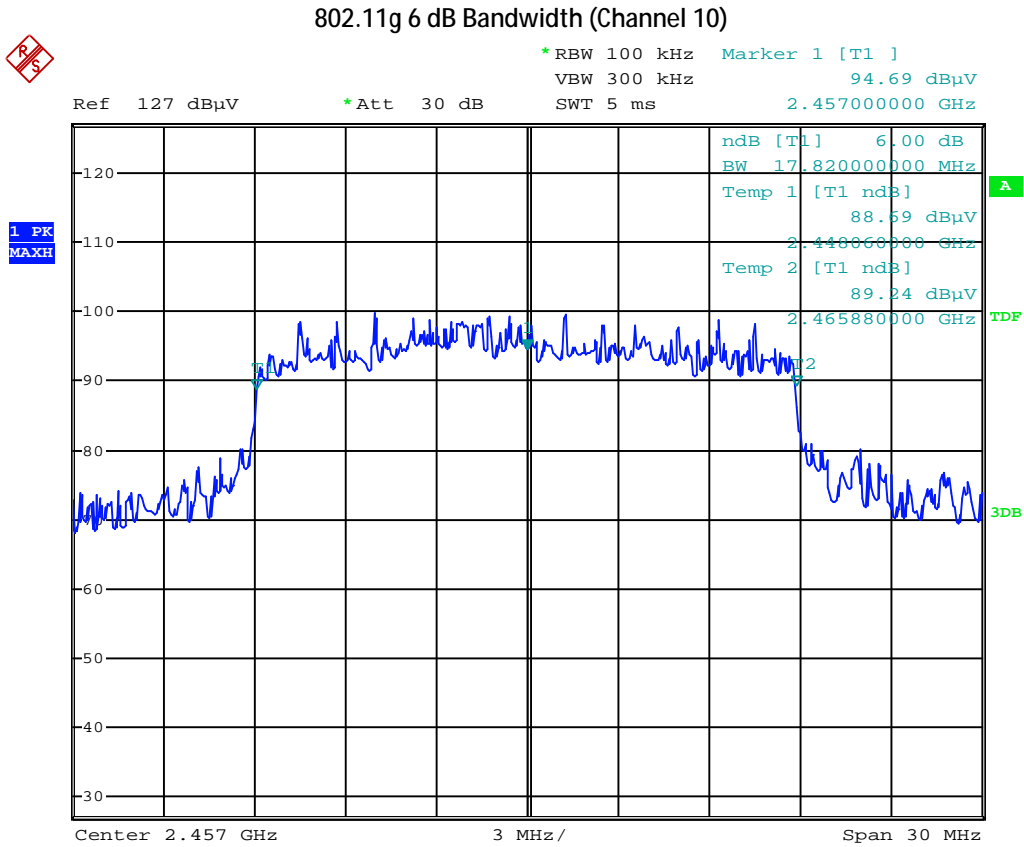
The testing follows FCC KDB Publication No. 558074 D01 DTS Meas. Guidance v03r05.

3.1.5 Test Results of the 6 dB bandwidth Measurement

| Technology Std. | Channel | Frequency (MHz) | Data rate | 6dB bandwidth (MHz) |
|-----------------|---------------|-----------------|-----------|---------------------|
| IEEE 802.11g | 1 | 2412 | 54 Mbps | 17.52 |
| | 4 | 2427 | 54 Mbps | 17.28 |
| | 10 | 2457 | 54 Mbps | 17.82 |
| Uncertainty | ± 707 kHz | | | |

3.1.6 Plots of the 6 dB bandwidth Measurement





3.2 Output Power Measurement

3.2.1 Limit

For systems using digital modulation in the 2400-2483.5 MHz, the limit for the peak output power is 30 dBm. If transmitting antenna of directional gain greater than 6 dBi is used, the peak output power from the intentional radiator shall be reduced below the above stated value by the amount in dB that the directional gain of the antenna exceeds 6 dBi. In case of point to point operation, the limit has to be reduced by 1 dB for every 3 dB that the directional gain of the antenna exceeds 6 dBi.

3.2.2 Measurement instruments

The measurement instruments are listed in chapter 2.4 of this report.

3.2.3 Test setup

The test setup is as shown in chapter 2.3 of this report.

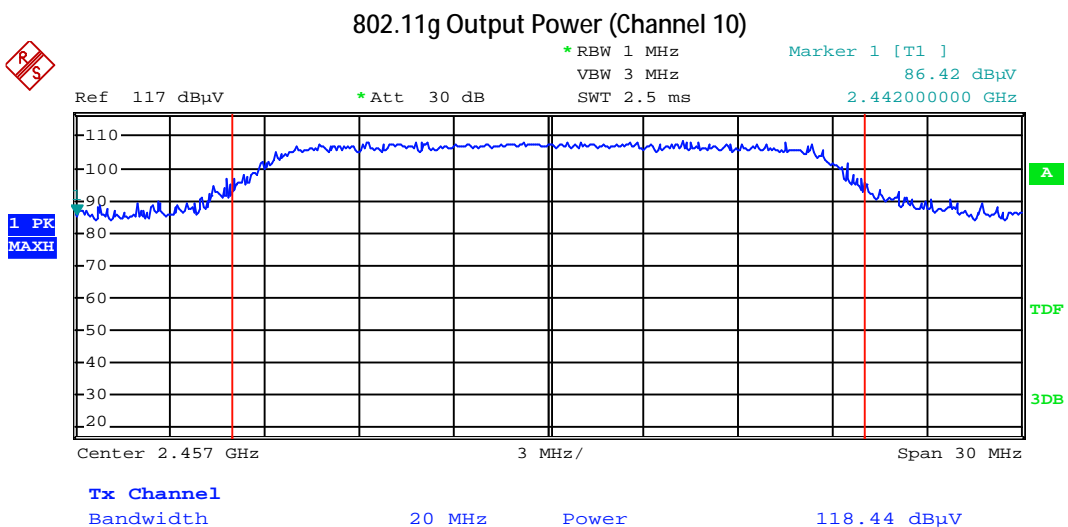
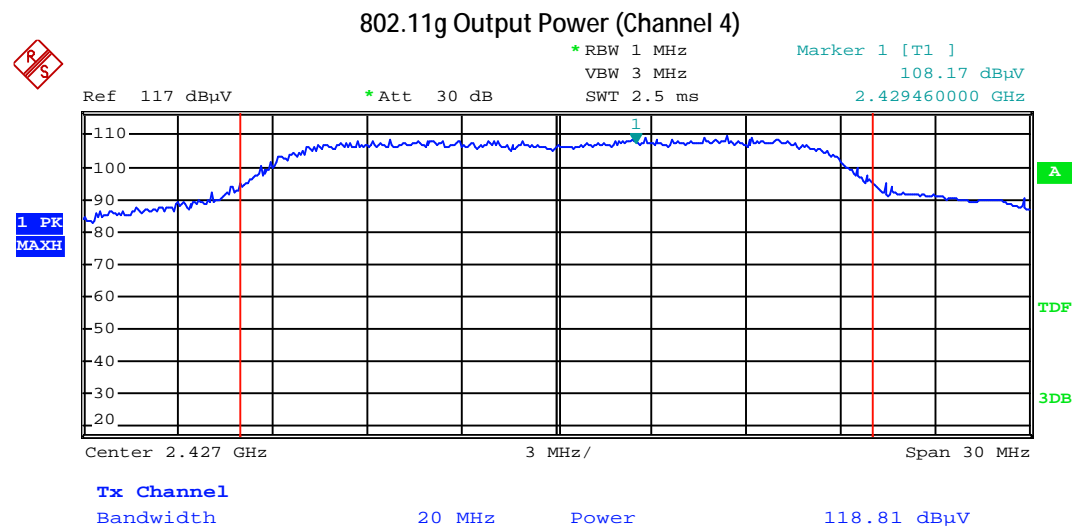
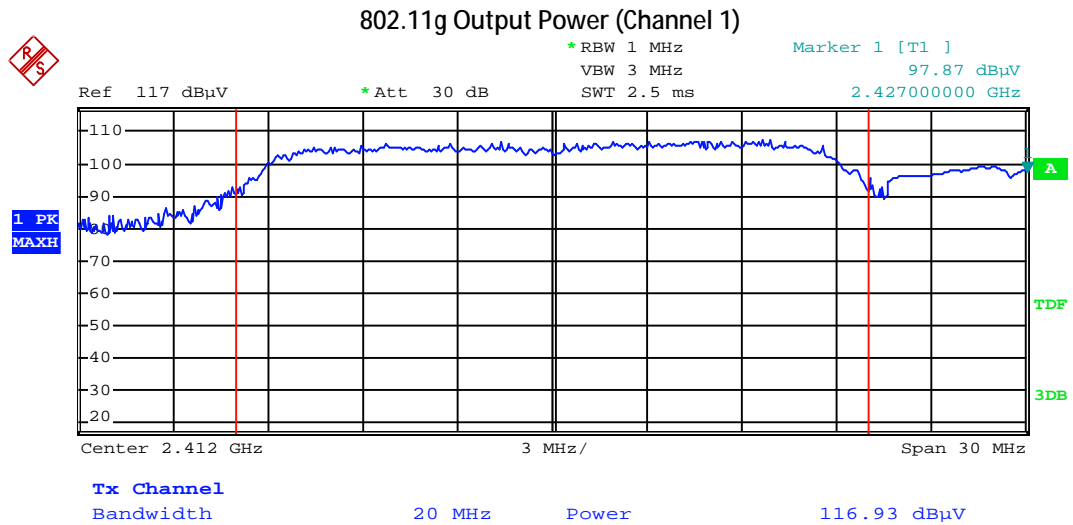
3.2.4 Test procedure

The testing follows FCC KDB Publication No. 558074 D01 DTS Meas. Guidance v03r05.

3.2.5 Test results of Output Power Measurement

| Technology Std. | Channels | Frequency (MHz) | Data rate | Output power (dBm) |
|-----------------|---------------|-----------------|-----------|--------------------|
| IEEE 802.11g | 1 | 2412 | 54 Mbps | 21.73 |
| | 4 | 2427 | 54 Mbps | 23.61 |
| | 10 | 2457 | 54 Mbps | 23.24 |
| Uncertainty | ± 1.78 dB | | | |

3.2.6 Plots of Peak Output Power Measurement



3.3 Power Spectral Density

3.3.1 Limit

The peak power spectral density shall not be greater than 8 dBm in any 3 kHz band at any time interval of continuous transmission.

3.3.2 Measurement instruments

The measurement instruments are listed in chapter 2.4 of this report.

3.3.3 Test setup

The test setup is as shown in chapter 2.3 of this report.

3.3.4 Test procedure

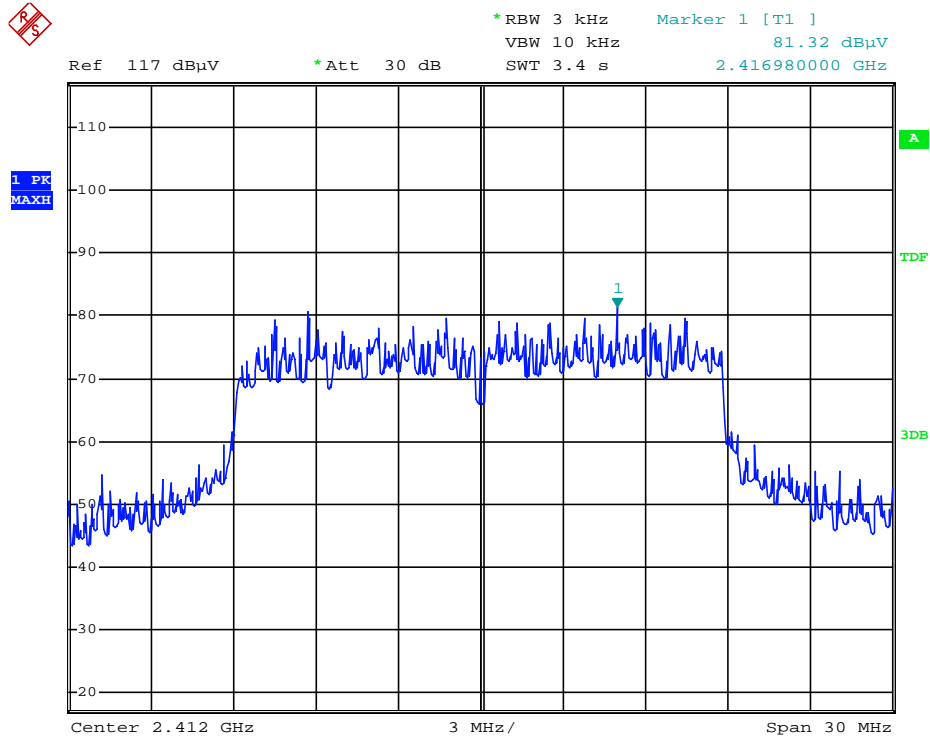
The testing follows FCC KDB Publication No. 558074 D01 DTS Meas. Guidance v03r05.

3.3.5 Test results of Power Spectral Density Measurement

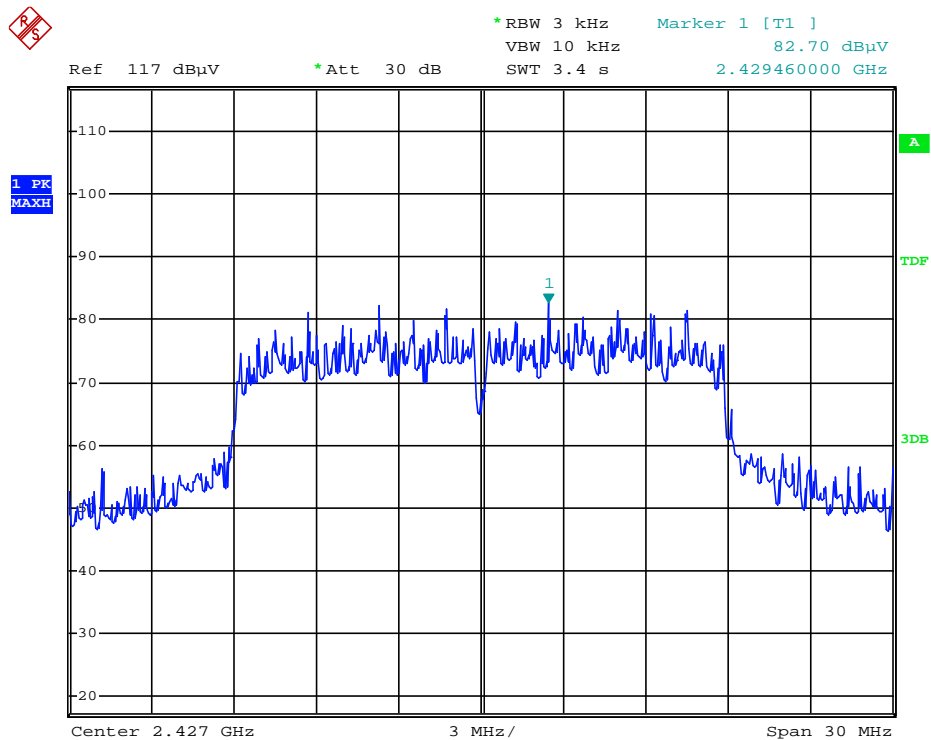
| Technology Std. | Channels | Frequency (MHz) | Data rate | PSD/3 kHz (dBm) |
|-----------------|---------------|-----------------|-----------|-----------------|
| IEEE 802.11g | 1 | 2412 | 54 Mbps | -13.88 |
| | 4 | 2427 | 54 Mbps | -12.5 |
| | 10 | 2457 | 54 Mbps | -9.68 |
| Uncertainty | ± 1.78 dB | | | |

3.3.6 Plots of the Power Spectral Density Measurements

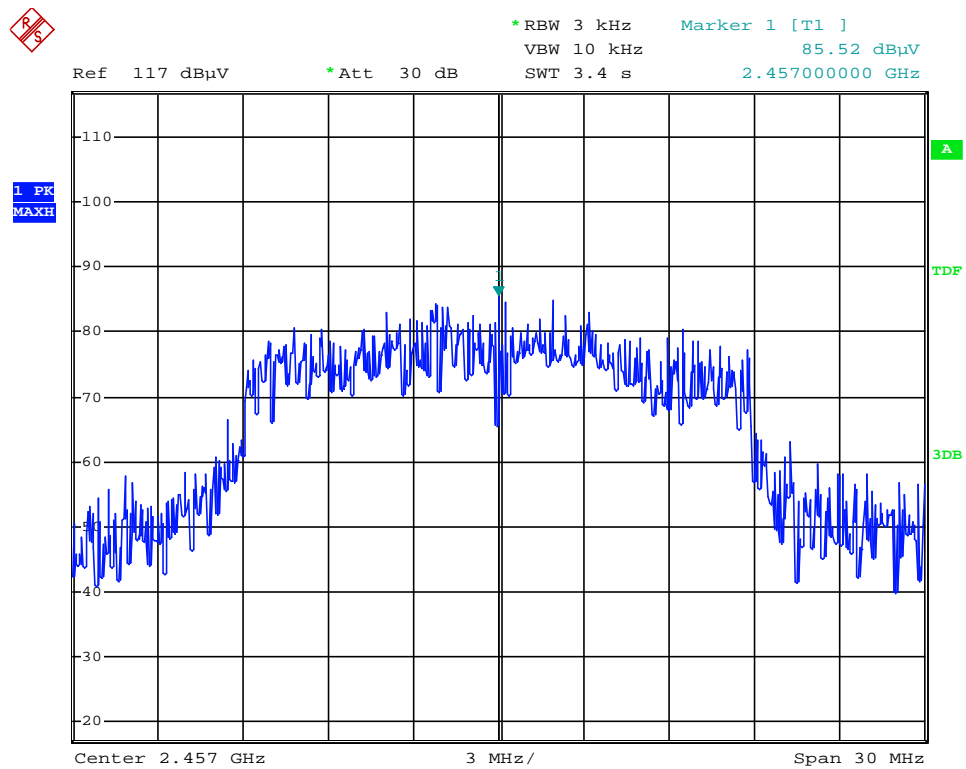
Power Spectral Density 3 kHz (channel 1)



Power Spectral Density 3 kHz (channel 4)



Power Spectral Density 3 kHz (channel 10)



3.4 Band edge Measurement

3.4.1 Limit

At the edge of the authorized band the RF power shall be at least 20 dB down.

3.4.2 Measurement instruments

The measurement instruments are listed in chapter 2.4 of this report.

3.4.3 Test setup

The test setup is as shown in chapter 2.3 of this report.

3.4.4 Test procedure

According to KDB Publication 558074 V02r05, sections 11.3 and 12.1

3.4.5 Test results of Band Edges Measurements

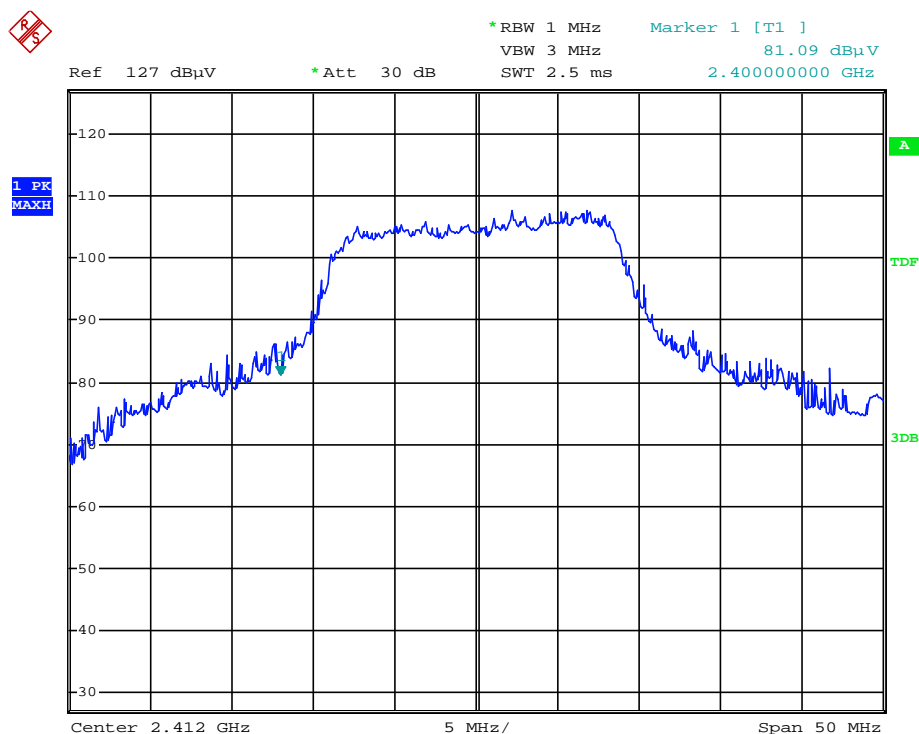
| Band edge | | | | | |
|-----------------|---------------|-----------------|-----------|------------------|-------------|
| Technology Std. | Channels | Frequency (MHz) | Data rate | 20 dB down (dBm) | Limit (dBm) |
| IEEE 802.11g | 1 | 2412 | 54 Mbps | -14.11 | 1.73 |
| Uncertainty | ± 0.63 dB | | | | |

3.4.6 Notes

- The upper band edge was not measured as the highest channel is more than 20 MHz from the upper band edge.

3.4.7 Plots of the Band edge Measurements

BLE Conducted Lower band edge(Channel 1)



3.5 Radiated Spurious Emissions Measurement

3.5.1 Limit

In any 100 kHz bandwidth outside the operating frequency band, the RF power shall be at least 20 dB below that in the 100 kHz bandwidth within the band that contains the highest level of the desired power, based on either a RF conducted or a radiated measurement.

3.5.2 Measurement instruments

The measurement instruments are listed in chapter 2.4 of this report.

3.5.3 Test setup

The test setup is as shown in chapter 2.4 of this report.

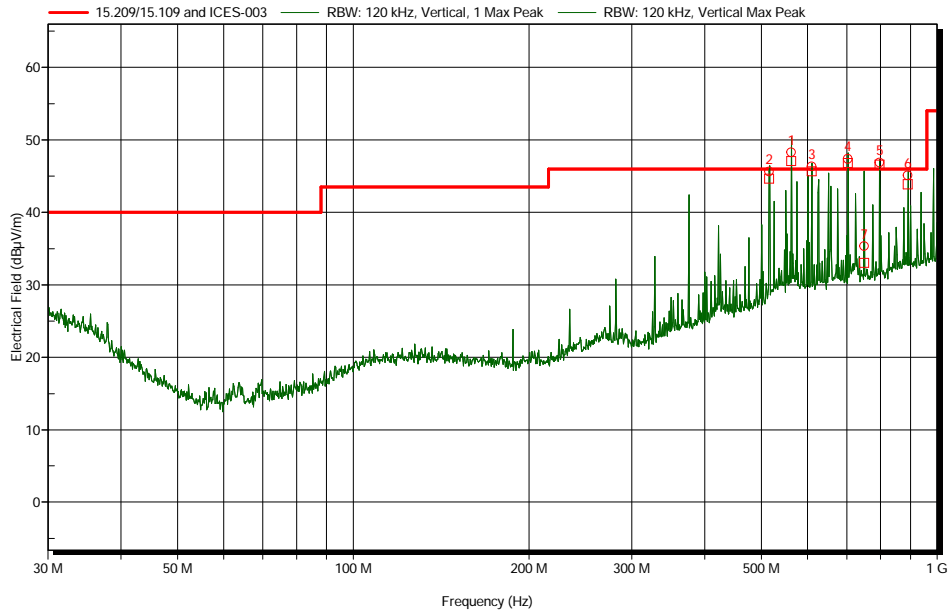
3.5.4 Test procedure

According to KDB Publication 558074 V02r05, sections 11.3 and 12.1

3.5.5 Plots of the Radiated Spurious Emissions Measurement

30 MHz to 1 GHz Low channel

Vertical polarization



Measured peaks Vertical 30 – 1000 MHz Low channel

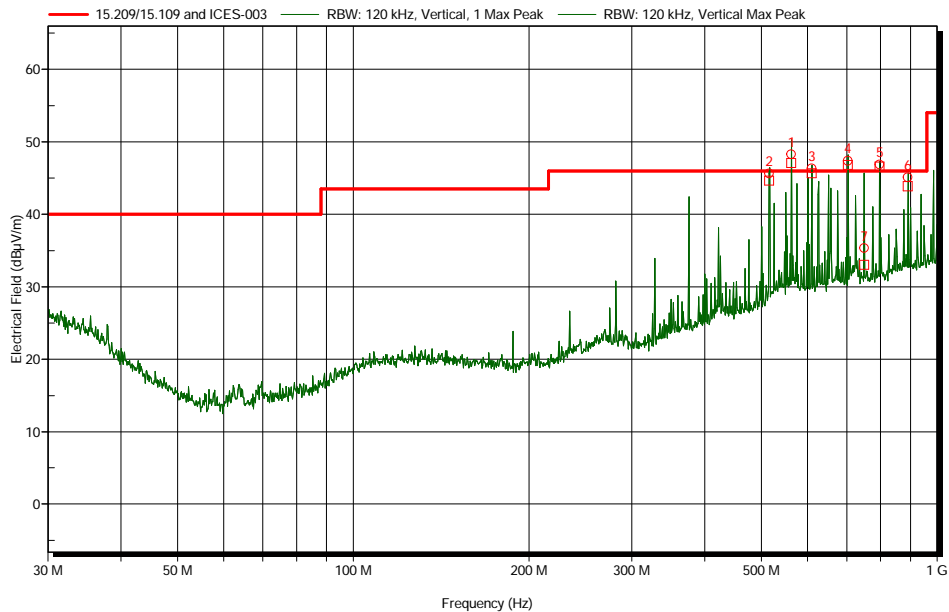
| Frequency (MHz) | Polarization | Height (m) | Quasi-Peak (dBμV/m) | Limit (dBμV/m) | Margin (dB) |
|-----------------|--------------|------------|---------------------|----------------|-------------|
| 562,5 | Vertical | 1 | 47, | 96.93 | -49,93 |
| 515,628 | Vertical | 1 | 44,7 | 96.93 | -52,23 |
| 609,378 | Vertical | 1 | 45,7 | 46 | -0,3 |
| 703,122 | Vertical | 2 | 46,8 | 96.93 | -50.13 |
| 796,872 | Vertical | 1,5 | 46,6 | 96.93 | -50,33 |
| 890,622 | Vertical | 2,5 | 43,9 | 96.93 | -53,03 |
| 749,994 | Vertical | 1 | 33 | 96.93 | -63,93 |

Note:

- Only 609.378 MHz falls within a restricted band (608 -614 MHz)which has a limit of 46 dBμV/m, for the other frequency the limit is 20 dB down from the measured output power (96.93 dBμV/m)
- In the plot only the restricted band limit is shown (15.209)

30 MHz to 1 GHz Middle channel

Vertical polarization



Measured peaks Vertical 30 – 1000 MHz Middle channel

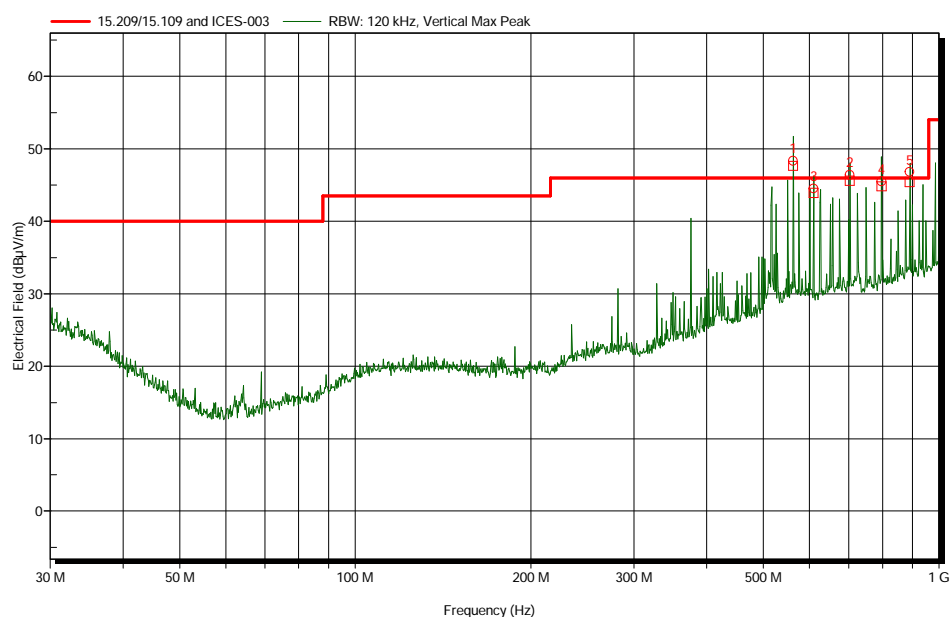
| Frequency (MHz) | Polarization | Height (m) | Quasi-Peak (dBμV/m) | Limit (dBμV/m) | Margin (dB) |
|-----------------|--------------|------------|---------------------|----------------|-------------|
| 562,500 | Vertical | 1 | 46,9 | 98.81 | -51,91 |
| 515,628 | Vertical | 1 | 44,2 | 98.81 | -54,61 |
| 609,378 | Vertical | 1 | 45,8 | 46 | -0,2 |
| 703,128 | Vertical | 2 | 46,6 | 98.81 | -52,21 |
| 796,872 | Vertical | 1,5 | 46,1 | 98.81 | -52,71 |
| 750 | Vertical | 1 | 31,3 | 98.81 | -67,51 |
| 890,622 | Vertical | 1,5 | 44,8 | 98.81 | -54.01 |

Note:

- Only 609.378 MHz falls within a restricted band (608 -614 MHz)which has a limit of 46 dBμV/m, for the other frequency the limit is 20 dB down from the measured output power (98.81 dBμV/m)
- In the plot only the restricted band limit is shown (15.209)

30 MHz to 1 GHz High channel

Vertical polarization



Measured peaks Vertical 30 – 1000 MHz High channel

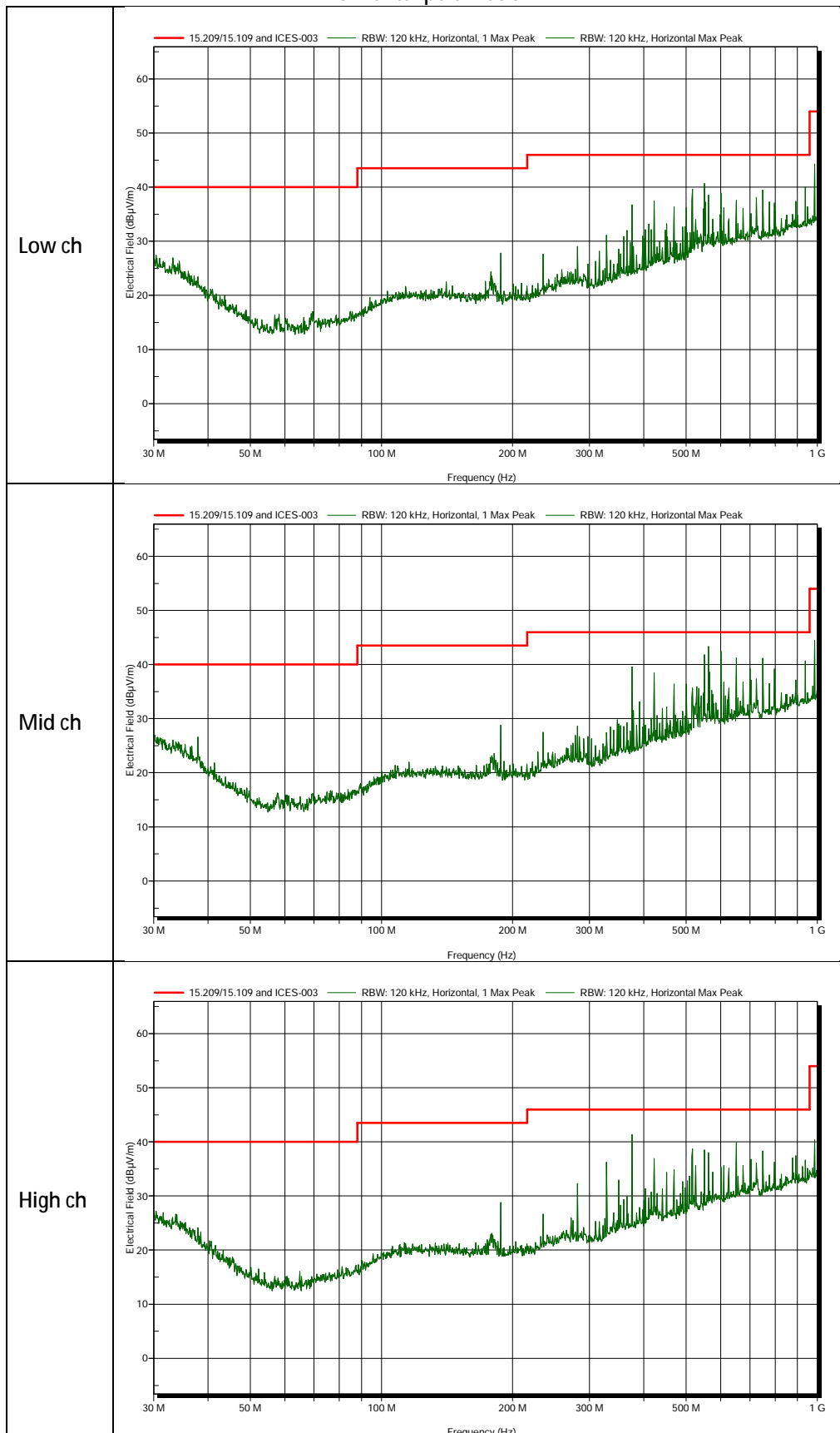
| Frequency (MHz) | Polarization | Height (m) | Quasi-Peak (dBμV/m) | Limit (dBμV/m) | Margin (dB) |
|-----------------|--------------|------------|---------------------|----------------|-------------|
| 562,5 | Vertical | 1 | 47,7 | 98.44 | -50,74 |
| 703,122 | Vertical | 2 | 45,6 | 98.44 | -52,84 |
| 609,372 | Vertical | 1 | 43,9 | 46 | -2,1 |
| 796,872 | Vertical | 1,5 | 44,8 | 98.44 | -53,64 |
| 890,628 | Vertical | 1,5 | 45,4 | 98.44 | -53,04 |

Note:

- Only 609.372 MHz falls within a restricted band (608 -614 MHz)which has a limit of 46 dBμV/m, for the other frequency the limit is 20 dB down from the measured output power (98.44 dBμV/m)
- In the plot only the restricted band limit is shown (15.209)

30 MHz to 1 GHz

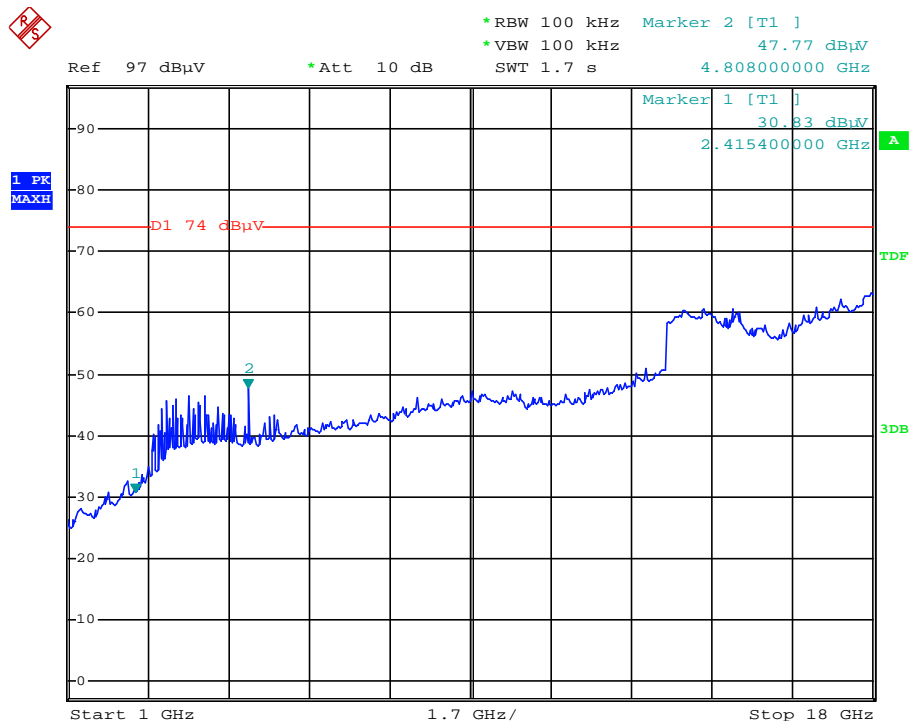
Horizontal polarization



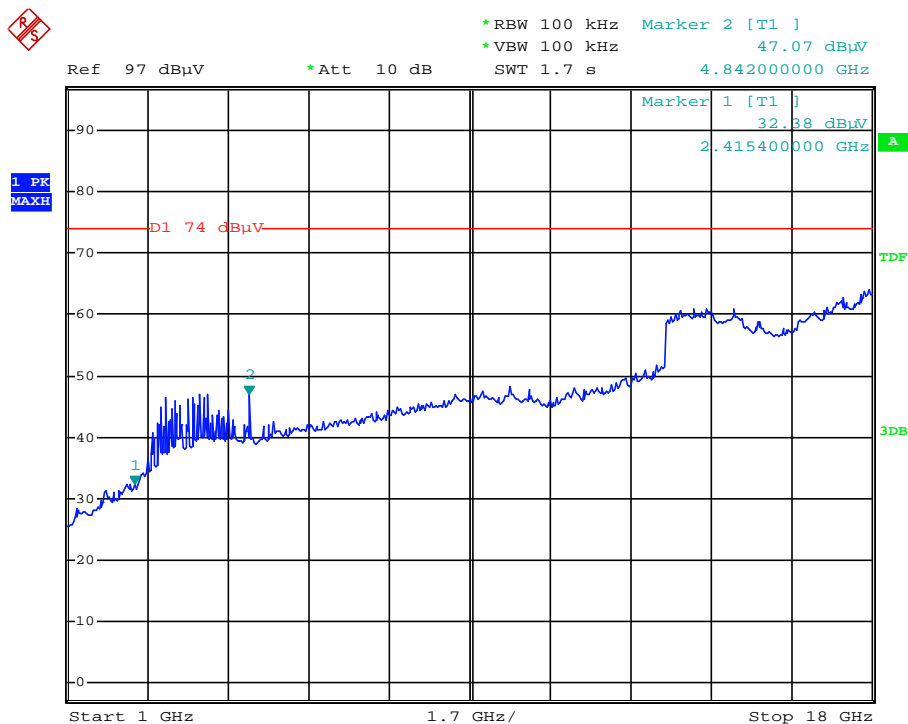
1 GHz to 18 GHz

Vertical polarization

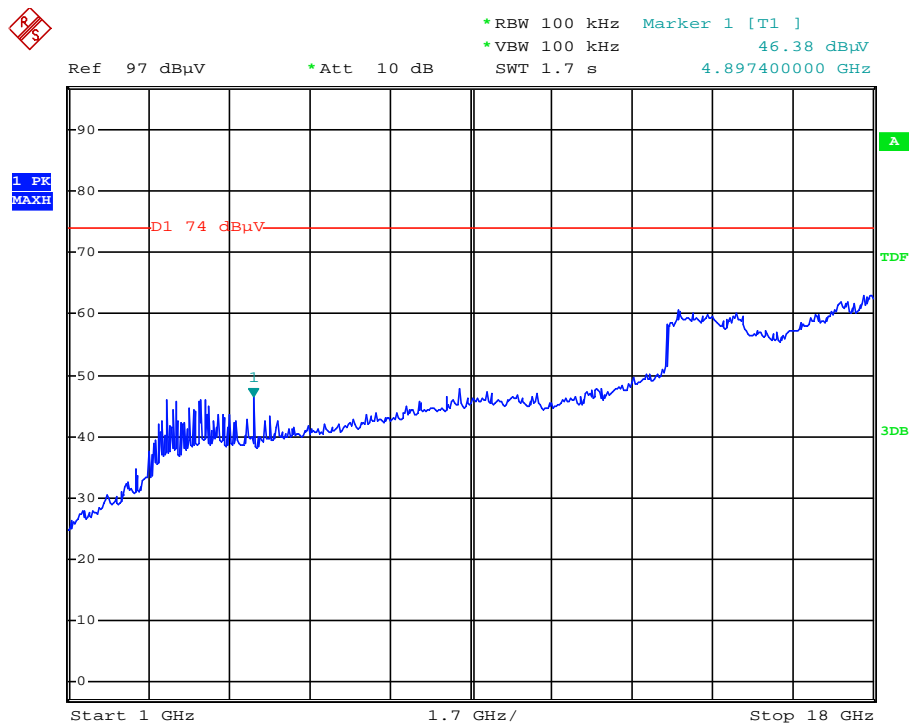
Low channel



Middle channel



High channel



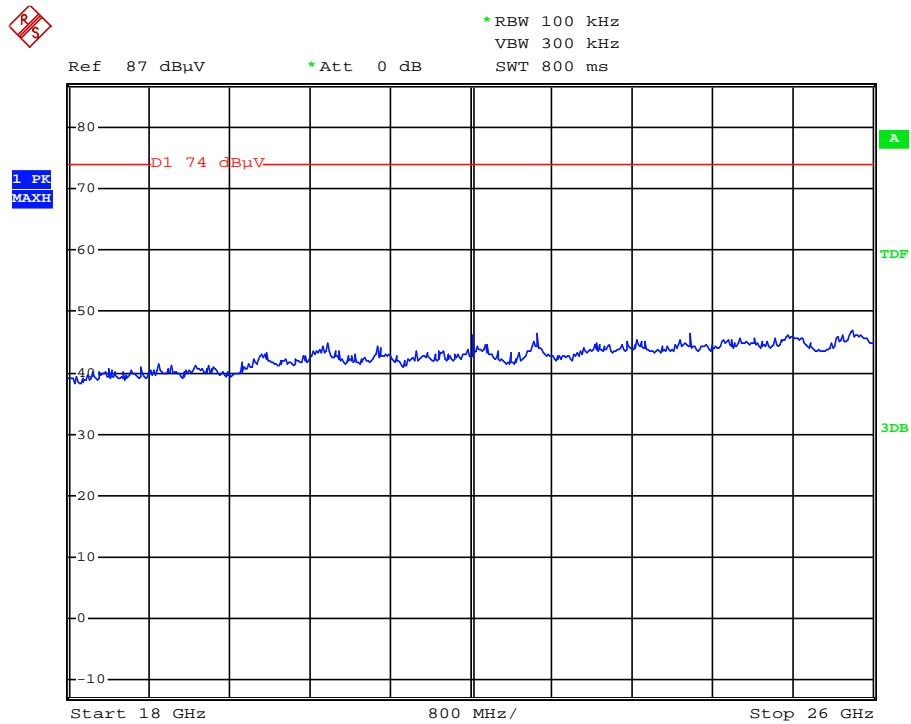
Note:

- the worst case emission is found with vertical polarization so no horizontal measurements were performed

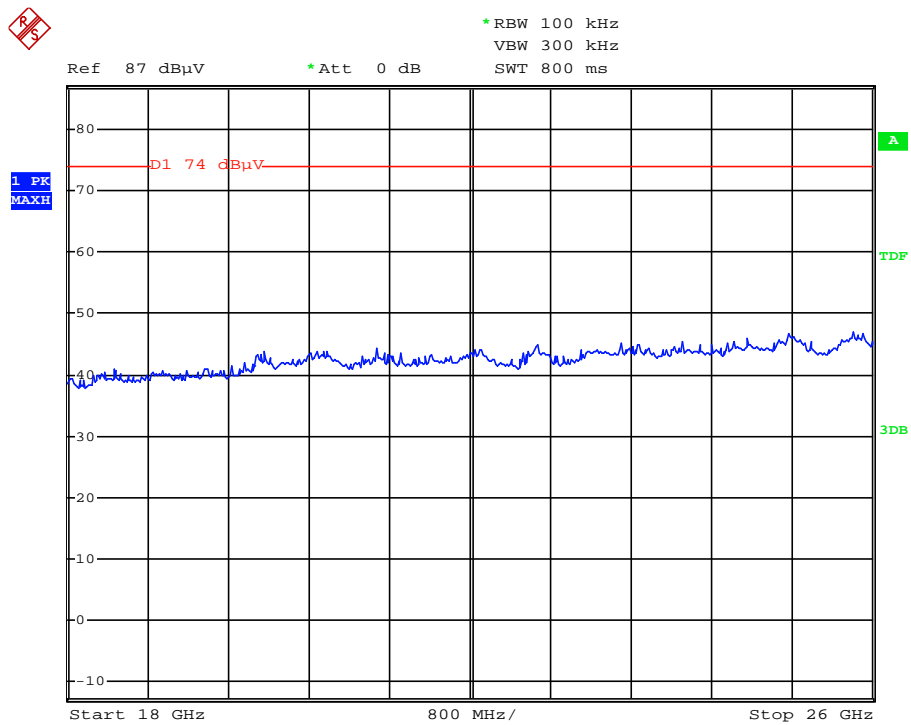
18 GHz to 26 GHz

Vertical polarization

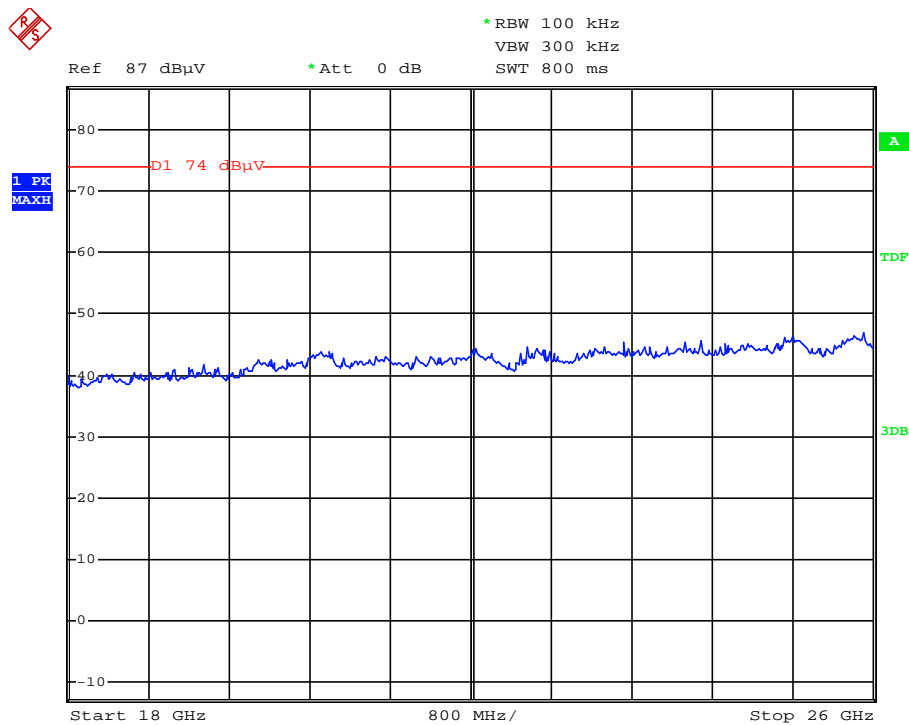
Low channel



Middle channel



High channel



Note:

- the worst case emission is found with vertical polarization so no horizontal measurements were performed

3.5.6 Measurement Uncertainty

Measurement uncertainty Radiated emissions below 1 GHz

| Horizontal polarization | |
|-------------------------|--------|
| 30 – 200 MHz | 4.5 dB |
| 200 – 1000 MHz | 3.6 dB |
| Vertical polarization | |
| 30 – 200 MHz | 5.4 dB |
| 200 – 1000 MHz | 4.6 dB |

Measurement uncertainty Radiated emissions above 1 GHz

| | |
|---------------|---------------|
| 1 – 18 GHz | + 5.7/- 5.7dB |
| 18 – 26,5 GHz | + 3 /- 3 dB |