

cetecom  
advanced

## TEST REPORT

Test report no.: 1-7816-24-01-02\_TR1-R01



### Testing laboratory

#### cetecom advanced GmbH

Untertuerkheimer Strasse 6 – 10  
66117 Saarbruecken / Germany

Phone: + 49 681 5 98 - 0  
Fax: + 49 681 5 98 - 9075  
Internet: <https://cetecomadvanced.com>  
e-mail: [mail@cetecomadvanced.com](mailto:mail@cetecomadvanced.com)

#### Accredited Testing Laboratory:

The testing laboratory (area of testing) is accredited according to DIN EN ISO/IEC 17025 (2018-03) by the Deutsche Akkreditierungsstelle GmbH (DAkkS).

The accreditation is valid for the scope of testing procedures as stated in the accreditation certificate with the registration number:

D-PL-12047-01-00.

ISED Testing Laboratory Recognized Listing Number: DE0001

FCC designation number: DE0002

### Applicant

#### ANDREAS STIHL AG & Co. KG

Andreas-Stihl-Straße 4  
71336 Waiblingen / GERMANY

Phone: +49 7151 264669  
Contact: Markus Thielemann  
e-mail: [markus.thielemann@stihl.de](mailto:markus.thielemann@stihl.de)

### Manufacturer

#### ANDREAS STIHL AG & Co. KG

Andreas-Stihl-Straße 4  
71336 Waiblingen / GERMANY

### Test standard/s

FCC - Title 47 CFR Part 15

FCC - Title 47 of the Code of Federal Regulations; Chapter I; Part 15 - Radio frequency devices

RSS - 247 Issue 3

Digital Transmission Systems (DTSS), Frequency Hopping Systems (FHSs) and Licence-Exempt Local Area Network (LE-LAN) Devices

For further applied test standards please refer to section 3 of this test report.

### Test Item

Kind of test item:	Tracker
Model name:	Smart Connector 1
FCC ID:	2ALP8SC1
ISED certification number:	23431-SC1
Frequency:	2400 MHz to 2483.5 MHz
Technology tested:	Bluetooth® LE
Antenna:	Integrated antenna
Power supply:	3.0 V DC by C2023 battery
Temperature range:	-30°C to +60°C

This test report is electronically signed and valid without handwritten signature. For verification of the electronic signatures, the public keys can be requested at the testing laboratory.

### Test report authorized:

Marco Bertolino  
Supervisor Radio Services  
Radio Labs

### Test performed:

Andreas Curette  
Lab Manager  
Radio Labs

## 1 Table of contents

<b>1</b>	<b>Table of contents.....</b>	<b>2</b>
<b>2</b>	<b>General information.....</b>	<b>3</b>
2.1	Notes and disclaimer .....	3
2.2	Application details .....	3
2.3	Test laboratories sub-contracted .....	3
<b>3</b>	<b>Test standard/s, references and accreditations.....</b>	<b>4</b>
<b>4</b>	<b>Reporting statements of conformity – decision rule .....</b>	<b>5</b>
<b>5</b>	<b>Test environment .....</b>	<b>6</b>
<b>6</b>	<b>Test item .....</b>	<b>6</b>
6.1	General description.....	6
6.2	Additional information .....	6
<b>7</b>	<b>Sequence of testing.....</b>	<b>7</b>
7.1	Sequence of testing radiated spurious 9 kHz to 30 MHz .....	7
7.2	Sequence of testing radiated spurious 30 MHz to 1 GHz.....	8
7.3	Sequence of testing radiated spurious 1 GHz to 18 GHz .....	9
7.4	Sequence of testing radiated spurious above 18 GHz.....	10
<b>8</b>	<b>Description of the test setup.....</b>	<b>11</b>
8.1	Shielded semi anechoic chamber.....	12
8.2	Shielded fully anechoic chamber.....	13
8.3	Radiated measurements > 18 GHz .....	14
8.4	Conducted measurements Bluetooth system .....	15
<b>9</b>	<b>Measurement uncertainty.....</b>	<b>16</b>
<b>10</b>	<b>Summary of measurement results .....</b>	<b>17</b>
<b>11</b>	<b>Additional comments .....</b>	<b>18</b>
<b>12</b>	<b>Measurement results .....</b>	<b>19</b>
12.1	System gain.....	19
12.2	Power spectral density .....	20
12.3	DTS bandwidth – 6 dB bandwidth .....	21
12.4	Occupied bandwidth – 99% emission bandwidth.....	22
12.5	Maximum output power .....	23
12.6	Band edge compliance radiated.....	24
12.7	TX spurious emissions conducted .....	26
12.8	Spurious emissions radiated below 30 MHz .....	27
12.9	Spurious emissions radiated 30 MHz to 1 GHz .....	30
12.10	Spurious emissions radiated above 1 GHz.....	32
<b>13</b>	<b>Observations.....</b>	<b>35</b>
<b>14</b>	<b>Glossary.....</b>	<b>36</b>
<b>15</b>	<b>Document history.....</b>	<b>37</b>

## 2 General information

### 2.1 Notes and disclaimer

The test results of this test report relate exclusively to the test item specified in this test report. cetecom advanced GmbH does not assume responsibility for any conclusions and generalizations drawn from the test results with regard to other specimens or samples of the type of the equipment represented by the test item.

The test report may only be reproduced or published in full. Reproduction or publication of extracts from the report requires the prior written approval of cetecom advanced GmbH.

The testing service provided by cetecom advanced GmbH has been rendered under the current "General Terms and Conditions for cetecom advanced GmbH".

cetecom advanced GmbH will not be liable for any loss or damage resulting from false, inaccurate, inappropriate or incomplete product information provided by the customer.

Under no circumstances does the cetecom advanced GmbH test report include any endorsement or warranty regarding the functionality, quality or performance of any other product or service provided.

Under no circumstances does the cetecom advanced GmbH test report include or imply any product or service warranties from cetecom advanced GmbH, including, without limitation, any implied warranties of merchantability, fitness for purpose, or non-infringement, all of which are expressly disclaimed by cetecom advanced GmbH.

All rights and remedies regarding vendor's products and services for which cetecom advanced GmbH has prepared this test report shall be provided by the party offering such products or services and not by cetecom advanced GmbH.

In no case this test report can be considered as a Letter of Approval.

This test report is electronically signed and valid without handwritten signature. For verification of the electronic signatures, the public keys can be requested at the testing laboratory.

### 2.2 Application details

Date of receipt of order:	2025-01-22
Date of receipt of test item:	2025-04-14
Start of test:*	2025-04-25
End of test:*	2025-04-28
Person(s) present during the test:	-/-

\*Date of each measurement, if not shown in the plot, can be requested. Dates are stored in the measurement software.

### 2.3 Test laboratories sub-contracted

None

### 3 Test standard/s, references and accreditations

Test standard	Date	Description
FCC - Title 47 CFR Part 15	-/-	FCC - Title 47 of the Code of Federal Regulations; Chapter I; Part 15 - Radio frequency devices
RSS - 247 Issue 3	August 2023	Digital Transmission Systems (DTSs), Frequency Hopping Systems (FHSs) and Licence-Exempt Local Area Network (LE-LAN) Devices
RSS - Gen Issue 5 incl. Amendment 1 & 2	February 2021	Spectrum Management and Telecommunications Radio Standards Specification - General Requirements for Compliance of Radio Apparatus

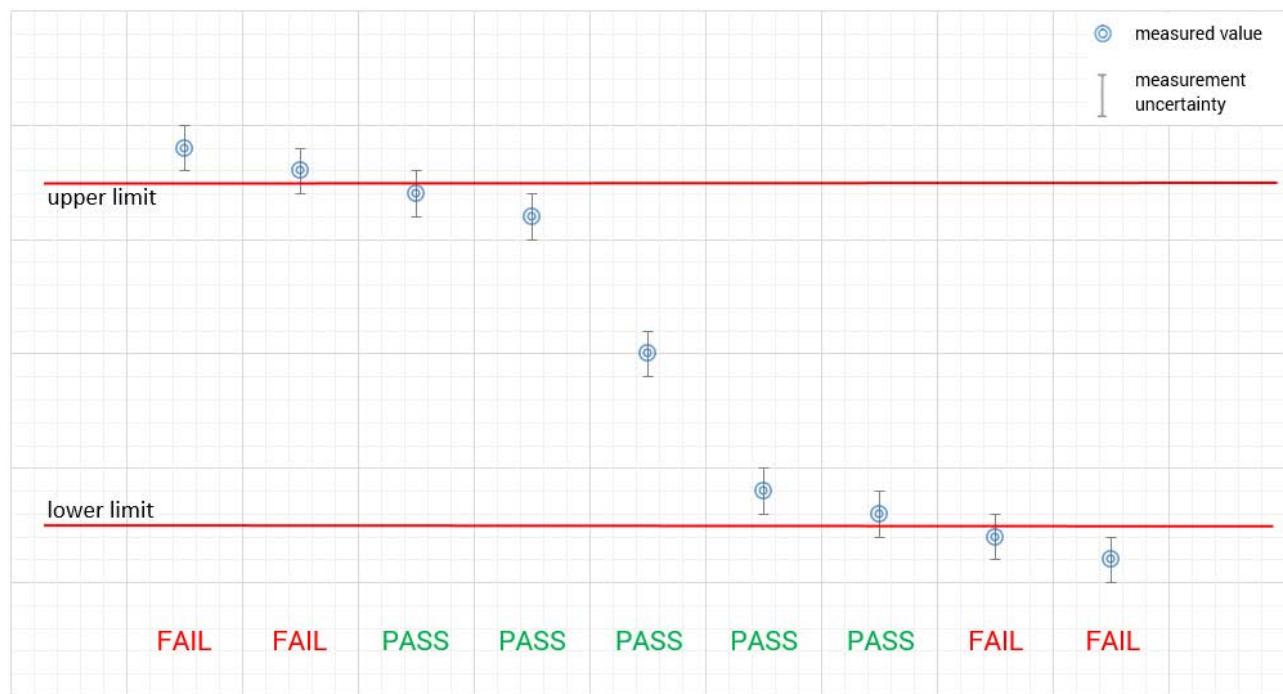
Guidance	Version	Description
KDB 558074 D01	v05r02	GUIDANCE FOR COMPLIANCE MEASUREMENTS ON DIGITAL TRANSMISSION SYSTEM, FREQUENCY HOPPING SPREAD SPECTRUM SYSTEM, AND HYBRID SYSTEM DEVICES OPERATING UNDER SECTION 15.247 OF THE FCC RULES
ANSI C63.4a-2017	-/-	American National Standard for Methods of Measurement of Radio-Noise Emissions from Low-Voltage Electrical and Electronic Equipment in the Range of 9 kHz to 40 GHz
ANSI C63.10-2020	-/-	American National Standard of Procedures for Compliance Testing of Unlicensed Wireless Devices

## 4 Reporting statements of conformity – decision rule

Only the measured values related to their corresponding limits will be used to decide whether the equipment under test meets the requirements of the test standards listed in chapter 3.

The measurement uncertainty is mentioned in this test report, see chapter 9, but is not taken into account - neither to the limits nor to the measurement results. Measurement results with a smaller margin to the corresponding limits than the measurement uncertainty have a potential risk of more than 5% that the decision might be wrong."

### measured value, measurement uncertainty, verdict



## 5 Test environment

Temperature	: T <sub>nom</sub> T <sub>max</sub> T <sub>min</sub>	22 °C during room temperature tests No tests under extreme temperature conditions required. No tests under extreme temperature conditions required.
Relative humidity content	: 55 %	
Barometric pressure	: 1021 hpa	
Power supply	: V <sub>nom</sub> V <sub>max</sub> V <sub>min</sub>	3.0 V DC by C2023 battery No tests under extreme voltage conditions required. No tests under extreme voltage conditions required.

## 6 Test item

### 6.1 General description

Kind of test item	: Tracker
Model name	: Smart Connector 1
HMN	: -/
PMN	: Smart Connector 1
HVIN	: SC1
FVIN	: -/
S/N serial number	: No S/N available!
Hardware status	: E08
Software status	: 1.0
Firmware status	: 1.6x
Frequency band	: 2400 MHz to 2483.5 MHz
Type of radio transmission	: DTS
Use of frequency spectrum	: -
Type of modulation	: GFSK
Number of channels	: 40
Antenna	: Integrated antenna
Power supply	: 3.0 V DC by C2023 battery
Temperature range	: -30°C to +60°C

### 6.2 Additional information

The content of the following annexes is defined in the QA. It may be that not all of the listed annexes are necessary for this report, thus some values in between may be missing.

Test setup and EUT photos are included in test report:

1-7816-24-01-01\_TR1-A101-R01  
1-7816-24-01-01\_TR1-A102-R01  
1-7816-24-01-01\_TR1-A103-R01

## 7 Sequence of testing

### 7.1 Sequence of testing radiated spurious 9 kHz to 30 MHz

#### Setup

- The equipment is set up to simulate normal operation mode as described in the user manual or defined by the manufacturer.
- If the EUT is a tabletop system, it is placed on a table with 0.8 m height.
- If the EUT is a floor standing device, it is placed directly on the turn table.
- Auxiliary equipment and cables are positioned to simulate normal operation conditions as described in ANSI C 63.4.
- The AC power port of the EUT (if available) is connected to a power outlet below the turntable.
- Measurement distance is 3 m (see ANSI C 63.4) – see test details.
- EUT is set into operation.

#### Premasurement\*

- The turntable rotates from 0° to 315° using 45° steps.
- The antenna height is 1 m.
- At each turntable position the analyzer sweeps with positive-peak detector to find the maximum of all emissions.

#### Final measurement

- Identified emissions during the pre-measurement are maximized by the software by rotating the turntable from 0° to 360°.
- Loop antenna is rotated about its vertical axis for maximum response at each azimuth about the EUT. (For certain applications, the loop antenna plane may also need to be positioned horizontally at the specified distance from the EUT)
- The final measurement is done in the position (turntable and elevation) causing the highest emissions with quasi-peak (as described in ANSI C 63.4).
- Final levels, frequency, measuring time, bandwidth, turntable position, correction factor, margin to the limit and limit will be recorded. A plot with the graph of the premeasurement and the limit is stored.

<sup>\*)</sup>Note: The sequence will be repeated three times with different EUT orientations.

## 7.2 Sequence of testing radiated spurious 30 MHz to 1 GHz

### Setup

- The equipment is set up to simulate normal operation mode as described in the user manual or defined by the manufacturer.
- If the EUT is a tabletop system, a table with 0.8 m height is used, which is placed on the ground plane.
- If the EUT is a floor standing device, it is placed on the ground plane with insulation between both.
- Auxiliary equipment and cables are positioned to simulate normal operation conditions as described in ANSI C 63.4.
- The AC power port of the EUT (if available) is connected to a power outlet below the turntable.
- Measurement distance is 10 m or 3 m (see ANSI C 63.4) – see test details.
- EUT is set into operation.

### Premeasurement

- The turntable rotates from 0° to 315° using 45° steps.
- The antenna is polarized vertical and horizontal.
- The antenna height changes from 1 m to 3 m.
- At each turntable position, antenna polarization and height the analyzer sweeps three times in peak to find the maximum of all emissions.

### Final measurement

- The final measurement is performed for at least six highest peaks according to the requirements of the ANSI C63.4.
- Based on antenna and turntable positions at which the peak values are measured the software maximize the peaks by changing turntable position  $\pm 45^\circ$  and antenna height between 1 and 4 m.
- The final measurement is done with quasi-peak detector (as described in ANSI C 63.4).
- Final levels, frequency, measuring time, bandwidth, antenna height, antenna polarization, turntable angle, correction factor, margin to the limit and limit are recorded. A plot with the graph of the premeasurement with marked maximum final results and the limit is stored.

## 7.3 Sequence of testing radiated spurious 1 GHz to 18 GHz

### Setup

- The equipment is set up to simulate normal operation mode as described in the user manual or defined by the manufacturer.
- If the EUT is a tabletop system, a 2-axis positioner with 1.5 m height is used.
- If the EUT is a floor standing device, it is placed directly on the turn table.
- Auxiliary equipment and cables are positioned to simulate normal operation conditions as described in ANSI C 63.4.
- The AC power port of the EUT (if available) is connected to a power outlet below the turntable.
- Measurement distance is 3 m (see ANSI C 63.4) – see test details.
- EUT is set into operation.

### Premereasurement

- The turntable rotates from 0° to 315° using 45° steps.
- The antenna is polarized vertical and horizontal.
- The antenna height is 1.5 m.
- At each turntable position and antenna polarization the analyzer sweeps with positive peak detector to find the maximum of all emissions.

### Final measurement

- The final measurement is performed for at least six highest peaks according to the requirements of the ANSI C63.4.
- Based on antenna and turntable positions at which the peak values are measured the software maximizes the peaks by rotating the turntable from 0° to 360°. This measurement is repeated for different EUT-table positions (0° to 150° in 30°-steps) and for both antenna polarizations.
- The final measurement is done in the position (turntable, EUT-table and antenna polarization) causing the highest emissions with Peak and RMS detector (as described in ANSI C 63.4).
- Final levels, frequency, measuring time, bandwidth, turntable position, EUT-table position, antenna polarization, correction factor, margin to the limit and limit are recorded. A plot with the graph of the premeasurement with marked maximum final results and the limit is stored.

## 7.4 Sequence of testing radiated spurious above 18 GHz

### Setup

- The equipment is set up to simulate normal operation mode as described in the user manual or defined by the manufacturer.
- Auxiliary equipment and cables are positioned to simulate normal operation conditions as described in ANSI C 63.4.
- The AC power port of the EUT (if available) is connected to a power outlet.
- The measurement distance is as appropriate (e.g. 0.5 m).
- The EUT is set into operation.

### Premereasurement

- The test antenna is handheld and moved carefully over the EUT to cover the EUT's whole sphere and different polarizations of the antenna.

### Final measurement

- The final measurement is performed at the position and antenna orientation causing the highest emissions with Peak and RMS detector (as described in ANSI C 63.4).
- Final levels, frequency, measuring time, bandwidth, correction factor, margin to the limit and limit are recorded. A plot with the graph of the premeasurement and the limit is stored.

## 8 Description of the test setup

Typically, the calibrations of the test apparatus are commissioned to and performed by an accredited calibration laboratory. The calibration intervals are determined in accordance with the DIN EN ISO/IEC 17025. In addition to the external calibrations, the laboratory executes comparison measurements with other calibrated test systems or effective verifications. Weekly chamber inspections and range calibrations are performed. Where possible, RF generating and signaling equipment as well as measuring receivers and analyzers are connected to an external high-precision 10 MHz reference (GPS-based or rubidium frequency standard).

In order to simplify the identification of the equipment used at some special tests, some items of test equipment and ancillaries can be provided with an identifier or number in the equipment list below (Lab/Item).

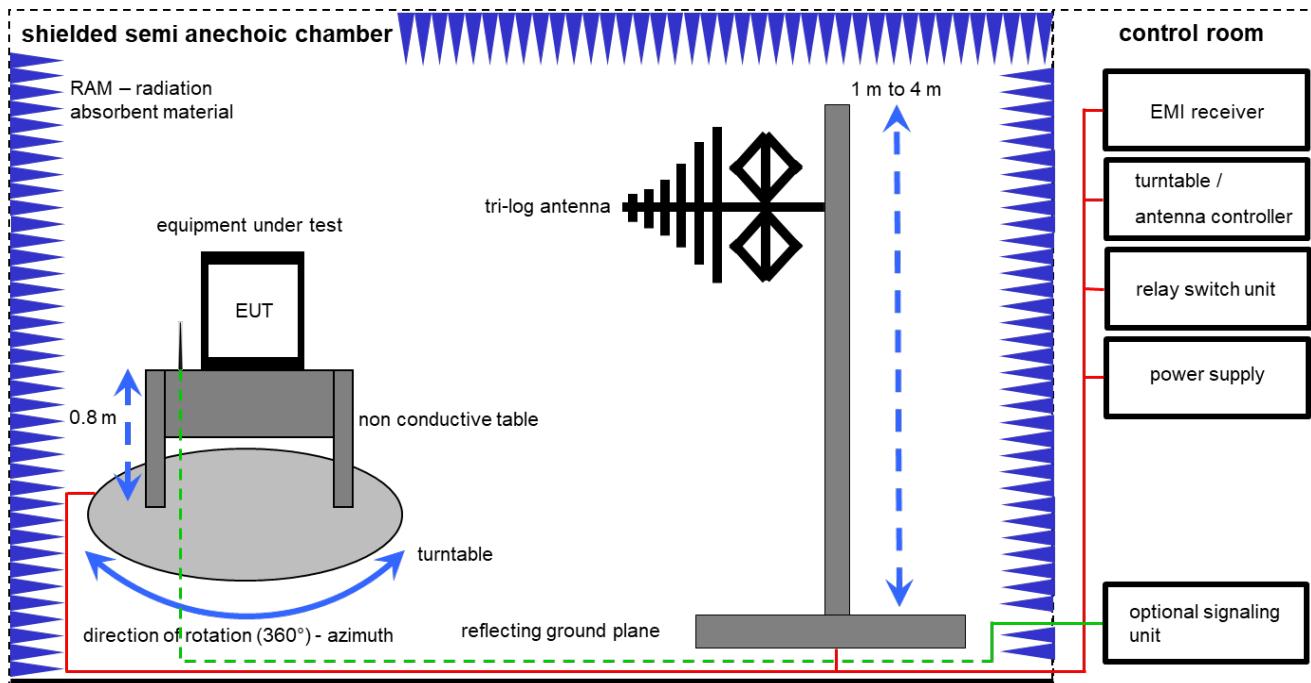
Each block diagram listed can contain several test setup configurations. All devices belonging to a test setup are identified with the same letter syntax. For example: Column Setup and all devices with an A.

### Agenda: Kind of Calibration

k/cal	calibration / calibrated	EK	limited calibration
Ne/cnn	not required (k, ev, izw, zw not required)	zw	cyclical maintenance (external cyclical maintenance)
Ev/chk	periodic self verification	izw	internal cyclical maintenance
Ve	long-term stability recognized	g	blocked for accredited testing
vlk!	Attention: extended calibration interval		
NK!	Attention: not calibrated	*)	next calibration ordered / currently in progress
cpu	check prior usage		

## 8.1 Shielded semi anechoic chamber

The radiated measurements are performed in vertical and horizontal plane in the frequency range from 30 MHz to 1 GHz in semi-anechoic chambers. The EUT is positioned on a non-conductive support with a height of 0.80 m above a conductive ground plane that covers the whole chamber. The receiving antennas are conform to specifications ANSI C63. These antennas can be moved over the height range between 1.0 m and 4.0 m in order to search for maximum field strength emitted from EUT. The measurement distances between EUT and receiving antennas are indicated in the test setups for the various frequency ranges. For each measurement, the EUT is rotated in all three axes until the maximum field strength is received. The wanted and unwanted emissions are received by spectrum analyzers where the detector modes and resolution bandwidths over various frequency ranges are set according to requirement ANSI C63.



Measurement distance: tri-log antenna 10 meter; EMC32 software version: 10.59.00

FS = UR + CL + AF

(FS-field strength; UR-voltage at the receiver; CL-loss of the cable; AF-antenna factor)

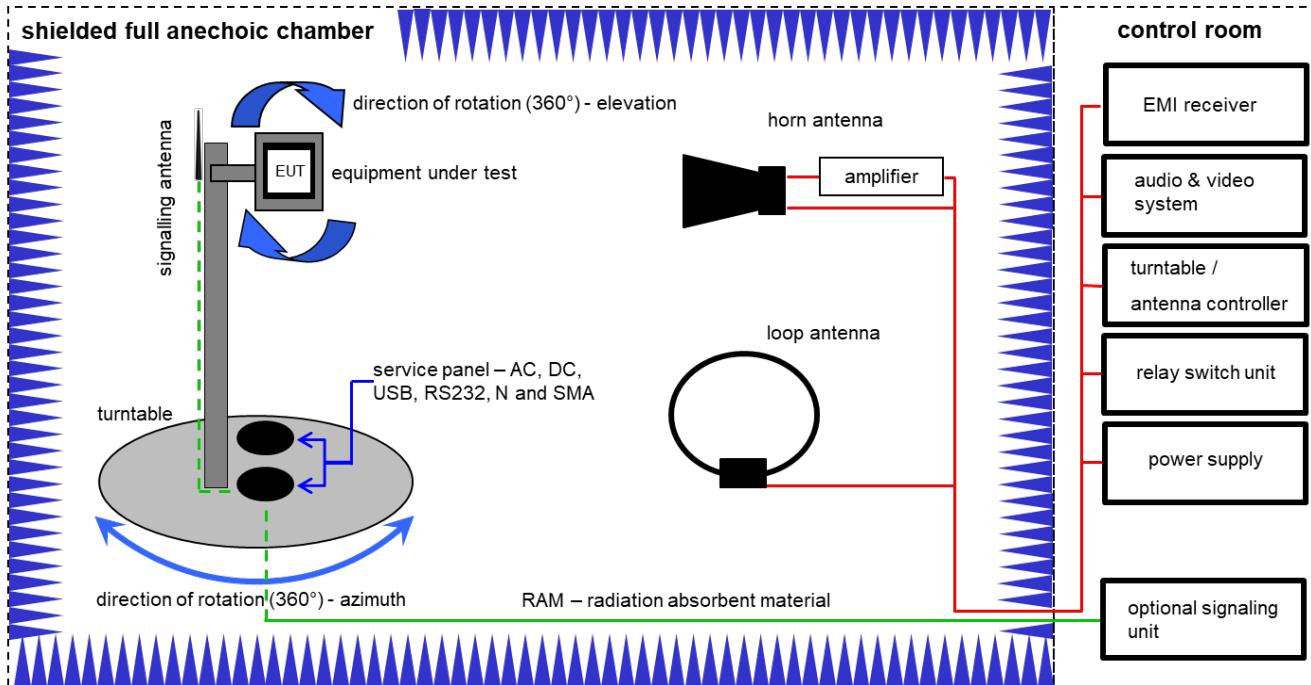
Example calculation:

FS [dB $\mu$ V/m] = 12.35 [dB $\mu$ V/m] + 1.90 [dB] + 16.80 [dB/m] = 31.05 [dB $\mu$ V/m] (35.69  $\mu$ V/m)

### Equipment table:

No.	Setup	Equipment	Type	Manufacturer	Serial No.	INV. No.	Kind of Calibration	Last Calibration	Next Calibration
1	A	Semi anechoic chamber	Semi anechoic chamber 3000023	MEC Import: MWB AG	-/-	40797	cnn	-/-	-/-
2	A	TRILOG Broadband Antenna	TRILOG Broadband Antenna VULB9163	Schwarzbeck Mess-Elektronik OHG / Schönau	371	40798	cal	11.07.2024	11.07.2026
3	A	Turntable	Turntable 2089-4.0	EMCO Elektronik GmbH / Gilching	-/-	40799	cnn	-/-	-/-
4	A	Switch-Unit	Switch-Unit 3488A	Hewlett Packard	2719A14505	50160	cpu	-/-	-/-
5	A	Antenna Tower	Antenna Tower 2175	ETS-Lindgren GmbH / Taufkirchen	64762	50279	cnn	-/-	-/-
6	A	Positioning Controller	Positioning Controller 2090	ETS-Lindgren GmbH / Taufkirchen	64672	50280	cnn	-/-	-/-
7	A	EMI Test Receiver	EMI Test Receiver ESR3	Rohde & Schwarz Messgerätebau GmbH / Memmingen	102587	50417	cal	05.12.2024	05.12.2025

## 8.2 Shielded fully anechoic chamber



Measurement distance: horn antenna 3 meter; loop antenna 3 meter

FS = UR + CA + AF

(FS-field strength; UR-voltage at the receiver; CA-loss of the signal path; AF-antenna factor)

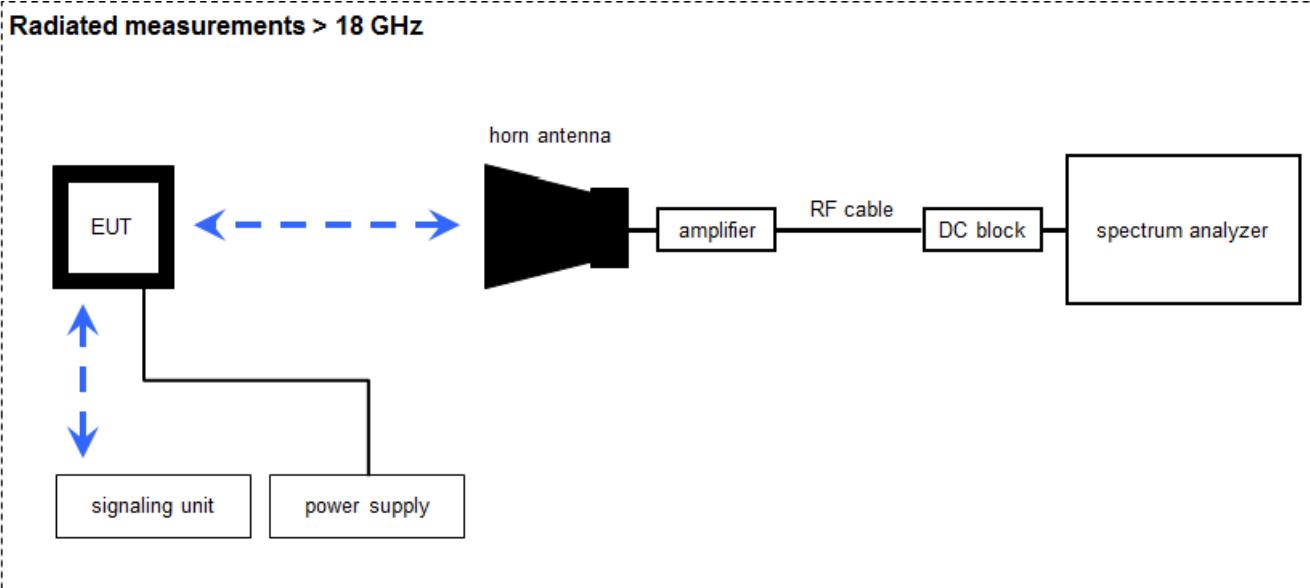
*Example calculation:*

$$\text{FS [dB}\mu\text{V/m]} = 40.0 \text{ [dB}\mu\text{V/m]} + (-35.8) \text{ [dB]} + 32.9 \text{ [dB/m]} = 37.1 \text{ [dB}\mu\text{V/m]} (71.61 \mu\text{V/m})$$

### Equipment table:

No.	Setup	Equipment	Type	Manufacturer	Serial No.	INV. No.	Kind of Calibration	Last Calibration	Next Calibration
1	A,B,C	EMI Test Receiver	EMI Test Receiver ESR26	Rohde & Schwarz Messgerätebau GmbH / Memmingen	101376	40301	cal	06.12.2024	06.12.2025
2	A,B	Double-Ridged Waveguide Horn Antenna	Double-Ridged Waveguide Horn Antenna 3115	EMCO Elektronik GmbH / Gilching	8812-3089	40344	cal	09.07.2024	09.07.2026
3	A	High Pass Filter	High Pass Filter VHF-3500+	Mini-Circuits / Brooklyn	-/-	40369	cnn	-/-	-/-
4	A	Highpass Filter	Highpass Filter WHKX7.0/18G-8SS	Wainwright Instruments GmbH / Andechs	18	40364	cpu	-/-	-/-
5	A	Band Reject Filter	Band Reject Filter WRCG2400/2483-2375/2505-50/10SS	Wainwright Instruments GmbH / Andechs	26	40367	cpu	-/-	-/-
6	A,B	Broadband Amplifier 0.5-18 GHz	Broadband Amplifier 0.5-18 GHz CBLU5184540	CERNEX	22050	40374	cpu	-/-	-/-
7	A,B,C	NEXIO EMV-Software	NEXIO EMV-Software BAT EMC V2022.0.32.0	Nexio	-/-	40383	cnn	-/-	-/-
8	A,B,C	Anechoic chamber	Anechoic chamber	TDK	-/-	40385	cnn	-/-	-/-
9	C	Active Loop Antenna	Active Loop Antenna 6502	EMCO Elektronik GmbH / Gilching	2210	50044	cal	02.08.2023	02.08.2025

### 8.3 Radiated measurements > 18 GHz



Measurement distance: horn antenna 50 cm

FS = UR + CA + AF

(FS-field strength; UR-voltage at the receiver; CA-loss signal path & distance correction; AF-antenna factor)

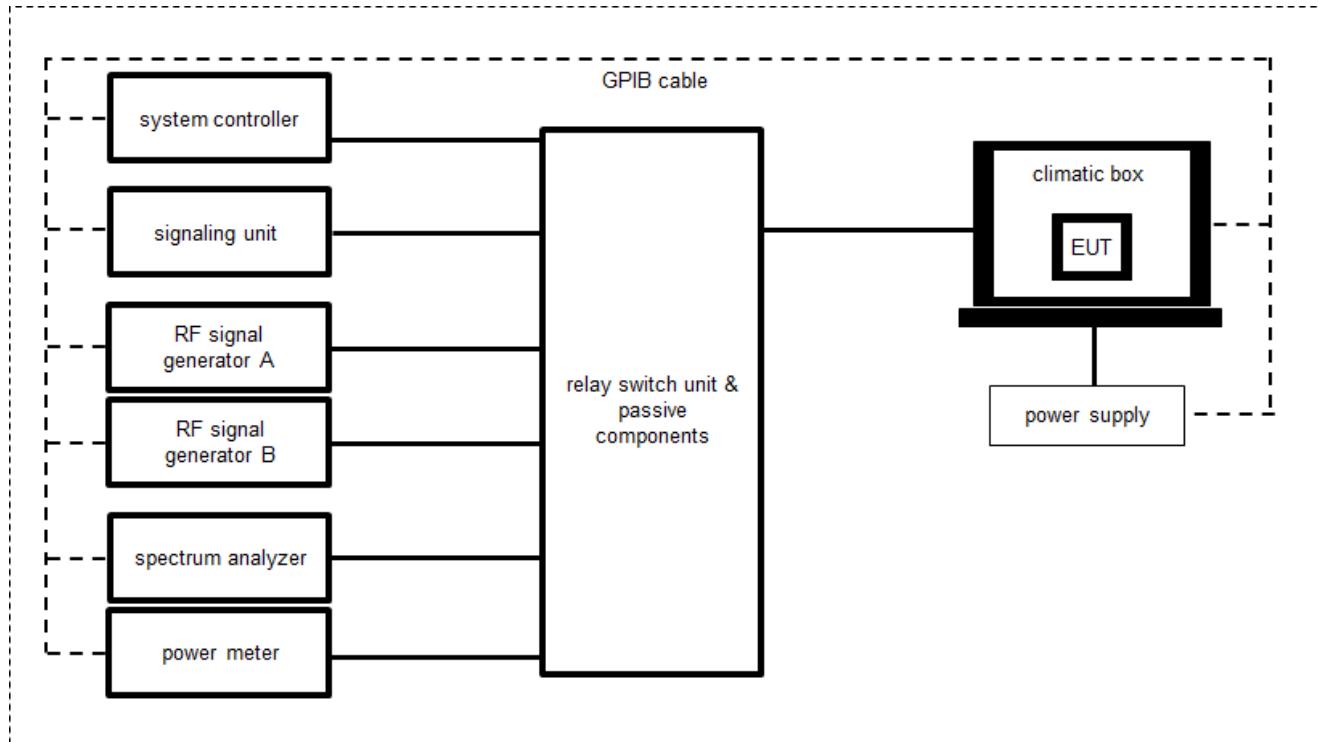
Example calculation:

$$\text{FS [dB}\mu\text{V/m]} = 40.0 \text{ [dB}\mu\text{V/m]} + (-60.1) \text{ [dB]} + 36.74 \text{ [dB/m]} = 16.64 \text{ [dB}\mu\text{V/m]} (6.79 \mu\text{V/m})$$

**Equipment table:**

No.	Setup	Equipment	Type	Manufacturer	Serial No.	INV. No.	Kind of Calibration	Last Calibration	Next Calibration
1	A	Microwave System Amplifier, 0.5-26.5 GHz	Microwave System Amplifier, 0.5-26.5 GHz 83017A	Hewlett Packard	00419	40014	cpu	-/-	-/-
2	A	Std. Gain Horn Antenna 18.0-26.5 GHz	Std. Gain Horn Antenna 18.0-26.5 GHz 638	Narda Microwave	8205	40085	cal	24.01.2024	31.01.2026
3	A	RF-Cable ST18/SMAm/SMAm /72	RF-Cable ST18/SMAm/SMAm /72	Huber & Suhner GmbH / Unterhaching	Batch no. 699714	40389	cpu	-/-	-/-
4	A	DC-Blocker 0.1-40 GHz	DC-Blocker 0.1-40 GHz 8141A	Inmet	-/-	40390	cpu	-/-	-/-
5	A	Signal analyzer	Signal analyzer FSV30	Rohde & Schwarz Messgerätebau GmbH / Memmingen	1321.3008K30/103170	18373	cal	15.01.2025	15.01.2027

## 8.4 Conducted measurements Bluetooth system



OP = AV + CA  
(OP-output power; AV-analyzer value; CA-loss signal path)

Example calculation:  
OP [dBm] = 6.0 [dBm] + 11.7 [dB] = 17.7 [dBm] (58.88 mW)

### Equipment table:

No.	Setup	Equipment	Type	Manufacturer	Serial No.	INV. No.	Kind of Calibration	Last Calibration	Next Calibration
1	A	Signal analyzer	Signal analyzer FSV30	Rohde & Schwarz Messgerätebau GmbH / Memmingen	1321.3008K30/ 103170	18373	cal	15.01.2025	15.01.2027
2	A	Switch Matrix	USM Switch Matrix	cetecom advanced GmbH / Saarbrücken	A001	40338	cpu	-/-	-/-
3	A	Power supply	Power supply HMP2020	Rohde & Schwarz Messgerätebau GmbH / Memmingen	102123	40401	cal	04.12.2024	04.12.2026
4	A	Tester Software RadioStar (C.BER2 for BT LE Conformance)	Tester Software RadioStar (C.BER2 for BT LE Conformance) System V 5.x, C.BER2 V 1.2.x.x	cetecom advanced GmbH / Saarbrücken	1	40407	cnn	-/-	-/-

## 9 Measurement uncertainty

<b>Measurement uncertainty</b>	
<b>Test case</b>	<b>Uncertainty</b>
Antenna gain	± 3 dB
Spectrum bandwidth	± 21.5 kHz absolute; ± 15.0 kHz relative
Maximum output power	± 1 dB
Detailed conducted spurious emissions @ the band edge	± 1 dB
Band edge compliance radiated	± 3 dB
Band edge compliance conducted	± 1.5 dB
Spurious emissions conducted	± 3 dB
Spurious emissions radiated below 30 MHz	± 3 dB
Spurious emissions radiated 30 MHz to 1 GHz	± 4.1 dB
Spurious emissions radiated 1 GHz to 12.75 GHz	± 3.7 dB
Spurious emissions radiated above 12.75 GHz	± 4.5 dB
Spurious emissions conducted below 30 MHz (AC conducted)	± 2.6 dB

## 10 Summary of measurement results

<input checked="" type="checkbox"/>	No deviations from the technical specifications were ascertained
<input type="checkbox"/>	There were deviations from the technical specifications ascertained
<input type="checkbox"/>	This test report is only a partial test report. The content and verdict of the performed test cases are listed below.

TC Identifier	Description	Verdict	Date	Remark
RF-Testing	CFR Part 15 RSS - 247, Issue 3	See table!	2025-05-19	-/-

Test specification clause	Test case	Guideline	Temperature conditions	Power source voltages	Mode	C	NC	NA	NP	Remark
§15.247(b)(4) RSS - 247 / 5.4 (4)	System gain	-/-	Nominal	Nominal	1 Msps	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	-/-
§15.247(e) RSS - 247 / 5.2 (b)	Power spectral density	KDB 558074 DTS clause: 8.4	Nominal	Nominal	1 Msps	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	-/-
§15.247(a)(2) RSS - 247 / 5.2 (a)	DTS bandwidth – 6 dB bandwidth	KDB 558074 DTS clause: 8.2	Nominal	Nominal	1 Msps	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	-/-
RSS Gen clause 4.6.1	Occupied bandwidth	-/-	Nominal	Nominal	1 Msps	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	-/-
§15.247(b)(3) RSS - 247 / 5.4 (4)	Maximum output power	KDB 558074 DTS clause: 8.3.1.1	Nominal	Nominal	1 Msps	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	-/-
§15.205 RSS - 247 / 5.5 RSS - Gen	Band edge compliance rad.	KDB 558074 DTS clause: 8.7.2 or 8.7.3	Nominal	Nominal	1 Msps	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	-/-
§15.247(d) RSS - 247 / 5.5	TX spurious emissions conducted	KDB 558074 DTS clause: 8.5	Nominal	Nominal	1 Msps	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	-/-
§15.209(a) RSS - Gen	Spurious emissions radiated below 30 MHz	-/-	Nominal	Nominal	1 Msps	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	-/-
15.247(d) RSS - 247 / 5.5 §15.109 RSS - Gen	Spurious emissions radiated 30 MHz to 1 GHz	-/-	Nominal	Nominal	1 Msps	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	-/-
§15.247(d) RSS - 247 / 5.5 §15.109 RSS - Gen	Spurious emissions radiated above 1 GHz	-/-	Nominal	Nominal	1 Msps	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	-/-
§15.107(a) §15.207	Conducted emissions below 30 MHz (AC conducted)	-/-	Nominal	Nominal	1 Msps	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	-/-

**Note:** C = Compliant; NC = Not compliant; NA = Not applicable; NP = Not performed

## 11 Additional comments

The Bluetooth® word mark and logos are owned by the Bluetooth SIG Inc. and any use of such marks by cetecom advanced GmbH is under license.

Reference documents: 1-7816-24-01-02\_TR1-A201-R1.pdf  
Zulassungs-u.Zertifizierungsmuster 2.pdf

Special test descriptions: None

Configuration descriptions:

Bluetooth Low Energy	
Longest Supported payload (37 – 255 Byte)	Tx: 255, RX: 255
LE 1M PHY supported	Yes
LE 2M PHY supported	No
Stable Modulation Index supported (SMI)	No
LE Coded PHY supported (S=2)	No
LE Coded PHY supported (S=8)	No

Test mode:  Bluetooth LE Test mode enabled  
(EUT is controlled by CMW)

Special software is used.  
EUT is transmitting pseudo random data by itself

Antennas and transmit operating modes:  Operating mode 1 (single antenna)

- *Equipment with 1 antenna,*
- *Equipment with 2 diversity antennas operating in switched diversity mode by which at any moment in time only 1 antenna is used,*
- *Smart antenna system with 2 or more transmit/receive chains, but operating in a mode where only 1 transmit/receive chain is used)*

 Operating mode 2 (multiple antennas, no beamforming)

- *Equipment operating in this mode contains a smart antenna system using two or more transmit/receive chains simultaneously but without beamforming.*

 Operating mode 3 (multiple antennas, with beamforming)

- *Equipment operating in this mode contains a smart antenna system using two or more transmit/receive chains simultaneously with beamforming.*
- *In addition to the antenna assembly gain (G), the beamforming gain (Y) may have to be taken into account when performing the measurements.*

## 12 Measurement results

### 12.1 System gain

#### Measurement:

The antenna gain of the complete system is calculated by the difference of radiated power in EIRP and the conducted power of the EUT.

Measurement parameters (radiated)	
Detector	Peak
Sweep time	Auto
Resolution bandwidth	3 MHz
Video bandwidth	3 MHz
Span	5 MHz
Trace mode	Max hold
Test setup	See sub clause 8.2 B
Measurement uncertainty	See sub clause 9

Measurement parameters (conducted)	
External result file	1-7816-24-01-02_TR1-A201-R1.pdf Common2G4 Peak OP 3 MHz/3 MHz
Test setup	See sub clause 8.4 A
Measurement uncertainty	See sub clause 9

#### Limits:

FCC	ISED
6 dBi / > 6 dBi output power and power density reduction required	

#### Results:

T <sub>nom</sub>	V <sub>nom</sub>	2402 MHz	2440 MHz	2480 MHz
Conducted power [dBm] Measured with GFSK modulation (1 Msps)		0.0	-0.7	-1.3
Radiated power [dBm] Measured with GFSK modulation (1 Msps)		3.8	4.1	1.7
Gain [dBi] Calculated		3.8	4.8	3.0

## 12.2 Power spectral density

### Description:

Measurement of the power spectral density of a digital modulated system.

Measurement parameters	
External result file	1-7816-24-01-02_TR1-A201-R1.pdf FCC Part 15.247 Peak Power Spectral Density DTS
Test setup	See sub clause 8.4 A
Measurement uncertainty	See sub clause 9

### Limits:

FCC	ISED
Power spectral density	
For digitally modulated systems the transmitter power spectral density conducted from the transmitter to the antenna shall not be greater than 8 dBm in any 3 kHz band during any time interval of continuous transmission or over 1.0 second if the transmission exceeds 1.0-second duration.	

### Results:

	Frequency		
	2402 MHz	2440 MHz	2480 MHz
<b>Power spectral density [dBm / 3kHz] 1 Msps</b>	-16.4	-17.0	-17.6

## 12.3 DTS bandwidth – 6 dB bandwidth

### Description:

Measurement of the 6 dB bandwidth of the modulated signal.

Measurement parameters	
External result file	1-7816-24-01-02_TR1-A201-R1.pdf FCC Part 15.247 Bandwidth 6dB DTS
Test setup	See sub clause 8.4 A
Measurement uncertainty	See sub clause 9

### Limits:

FCC	ISED
DTS bandwidth – 6 dB bandwidth	
Systems using digital modulation techniques may operate in the 2400–2483.5 MHz band. The minimum 6 dB bandwidth shall be at least 500 kHz.	

### Results:

	Frequency		
	2402 MHz	2440 MHz	2480 MHz
<b>6 dB bandwidth [kHz]</b> 1 Msps	694	695	699

## 12.4 Occupied bandwidth – 99% emission bandwidth

### Description:

Measurement of the 99% bandwidth of the modulated signal acc. RSS-GEN.

Measurement parameters	
External result file	1-7816-24-01-02_TR1-A201-R1.pdf FCC Part 15.247 Bandwidth 99PCT-20dB
Test setup	See sub clause 8.4 A
Measurement uncertainty	See sub clause 9

### Usage:

-/-	ISED
Occupied bandwidth – 99% emission bandwidth	
OBW is necessary for emission designator	

### Results:

	Frequency		
	2402 MHz	2440 MHz	2480 MHz
<b>99% bandwidth [kHz]</b> <b>1 Msps</b>	1046	1046	1047

## 12.5 Maximum output power

### Description:

Measurement of the maximum output power conducted. EUT in single channel mode.

Measurement parameters	
External result file	1-7816-24-01-02_TR1-A201-R1.pdf FCC Part 15.247 Maximum Peak Conducted Output Power DTS
Test setup	See sub clause 8.4 A
Measurement uncertainty	See sub clause 9

### Limits:

FCC	ISED
Maximum output power	
Conducted: 1.0 W – antenna gain max. 6 dBi	

### Results:

	Frequency		
	2402 MHz	2440 MHz	2480 MHz
<b>Maximum output power conducted [dBm] 1 Msps</b>	-0.1	-0.7	-1.3

## 12.6 Band edge compliance radiated

### Description:

Measurement of the radiated band edge compliance. The EUT is turned in the position that results in the maximum level at the band edge. Then a sweep over the corresponding restricted band is performed. The EUT is set to single channel mode and the transmit frequency 2402 MHz for the lower restricted band and 2480 MHz for the upper restricted band. Measurement distance is 3m.

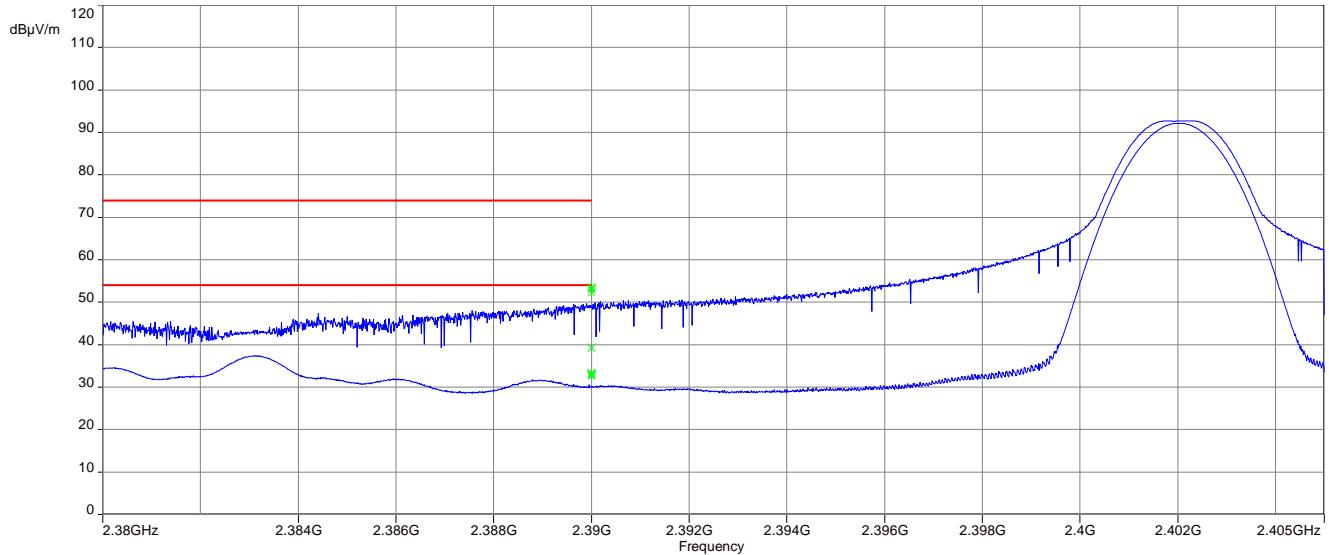
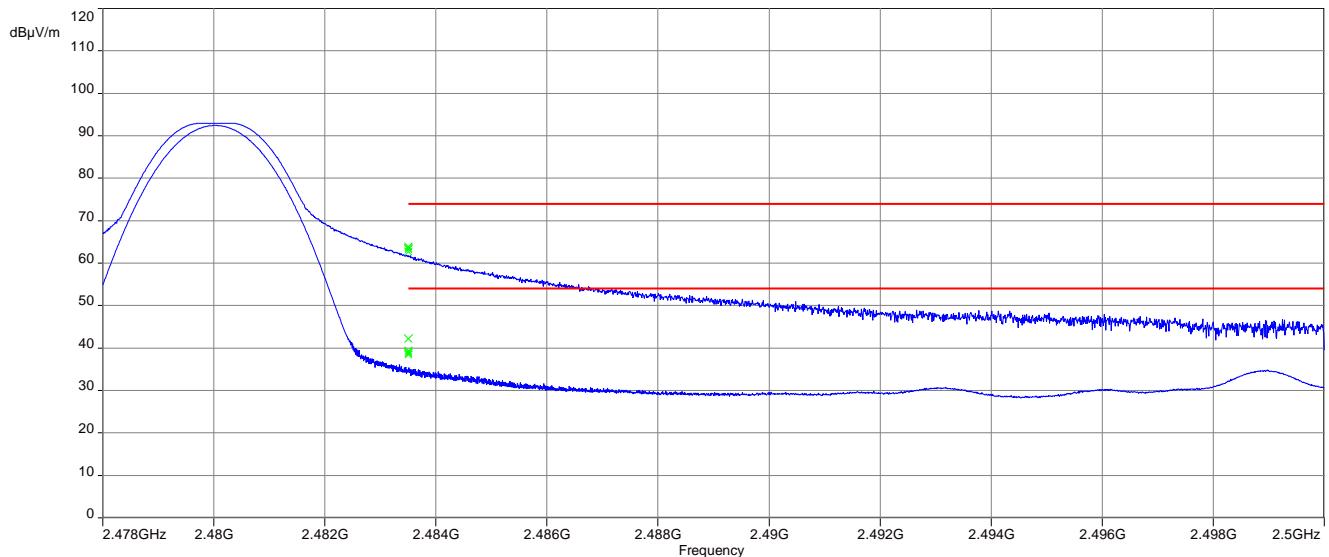
Measurement parameters	
Detector	Peak / RMS
Sweep time	Auto
Resolution bandwidth	1 MHz
Video bandwidth	3 MHz
Span	Lower Band: 2300 – 2400 MHz higher Band: 2480 – 2500 MHz
Trace mode	Max hold
Test setup	See sub clause 8.2 B
Measurement uncertainty	See sub clause 9

### Limits:

FCC	ISED
Band edge compliance radiated	
In any 100 kHz bandwidth outside the frequency band in which the spread spectrum or digitally modulated intentional radiator is operating, the radio frequency power that is produced by the intentional radiator 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 an RF conducted or a radiated measurement. Attenuation below the general limits specified in Section 15.209(a) is not required. In addition, radiated emissions which fall in the restricted bands, as defined in Section 15.205(a), must also comply with the radiated emission limits specified in Section 15.209(a) (see Section 5.205(c)).	
54 dB $\mu$ V/m AVG 74 dB $\mu$ V/m Peak	

### Result:

Scenario	Band edge compliance radiated [dB $\mu$ V/m]
Data rate	1 Msps
Lower restricted band	33.4 dB $\mu$ V/m AVG 53.6 dB $\mu$ V/m Peak
Upper restricted band	39.4 dB $\mu$ V/m AVG 63.9 dB $\mu$ V/m Peak

**Plots:****Plot 1: Lower restricted band, 1 Msps****Plot 2: Upper restricted band, 1 Msps**

## 12.7 TX spurious emissions conducted

### Description:

Measurement of the conducted spurious emissions in transmit mode. The EUT is set to single channel mode and the transmit frequencies are 2402 MHz, 2440 MHz and 2480 MHz.

Measurement parameters	
External result file	1-7816-24-01-02_TR1-A201-R1.pdf FCC Part 15.247 TX Spurious Conducted
Test setup	See sub clause 8.4 A
Measurement uncertainty	See sub clause 9

### Limits:

FCC	ISED
TX spurious emissions conducted	
In any 100 kHz bandwidth outside the frequency band in which the spread spectrum or digitally modulated intentional radiator is operating, the radio frequency power that is produced by the intentional radiator 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 an RF conducted or a radiated measurement. Attenuation below the general limits specified in Section 15.209(a) is not required	

**Results:** Compliant (see external result file)

## 12.8 Spurious emissions radiated below 30 MHz

### Description:

Measurement of the radiated spurious emissions in transmit mode below 30 MHz. The EUT is set to single channel mode and the transmit frequencies are 2402 MHz, 2440 MHz and 2480 MHz. The limits are recalculated to a measurement distance of 3 m according the ANSI C63.10.

Measurement parameters	
Detector	Peak / Quasi peak
Sweep time	Auto
Resolution bandwidth	F < 150 kHz: 200 Hz F > 150 kHz: 9 kHz
Video bandwidth	F < 150 kHz: 1 kHz F > 150 kHz: 30 kHz
Span	9 kHz to 30 MHz
Trace mode	Max hold
Test setup	See sub clause 8.2 C
Measurement uncertainty	See sub clause 9

### Limits:

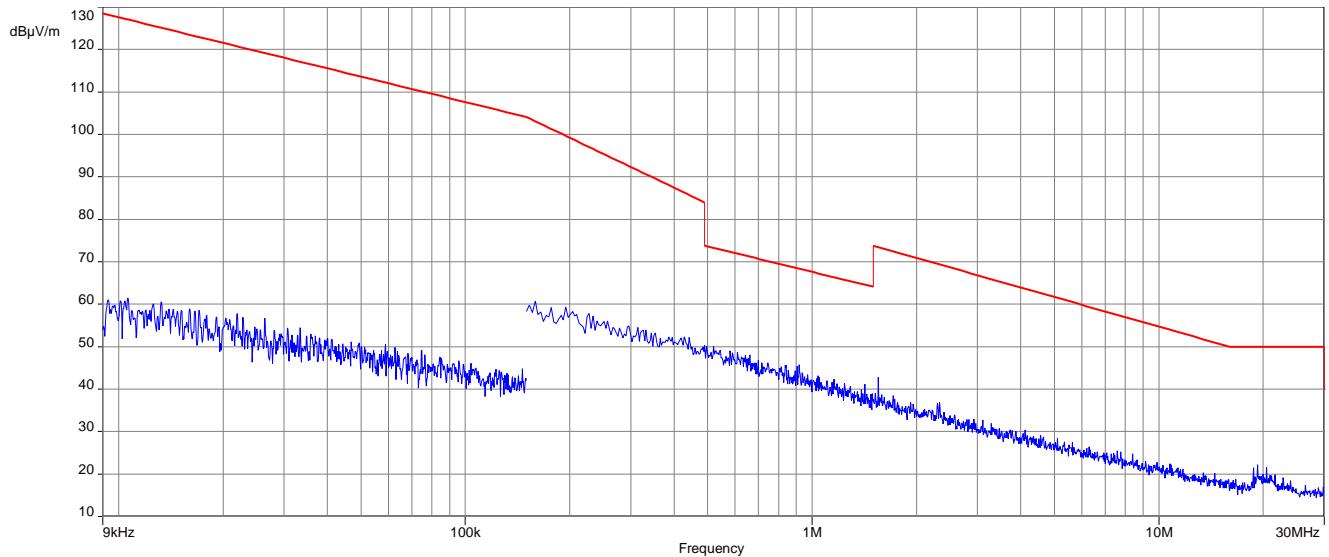
FCC		ISED
TX spurious emissions radiated below 30 MHz		
Frequency (MHz)	Field strength ( $\mu$ V/m)	Measurement distance (m)
0.009 – 0.490	2400/F(kHz)	300
0.490 – 1.705	24000/F(kHz)	30
1.705 – 30.0	30	30

### Results:

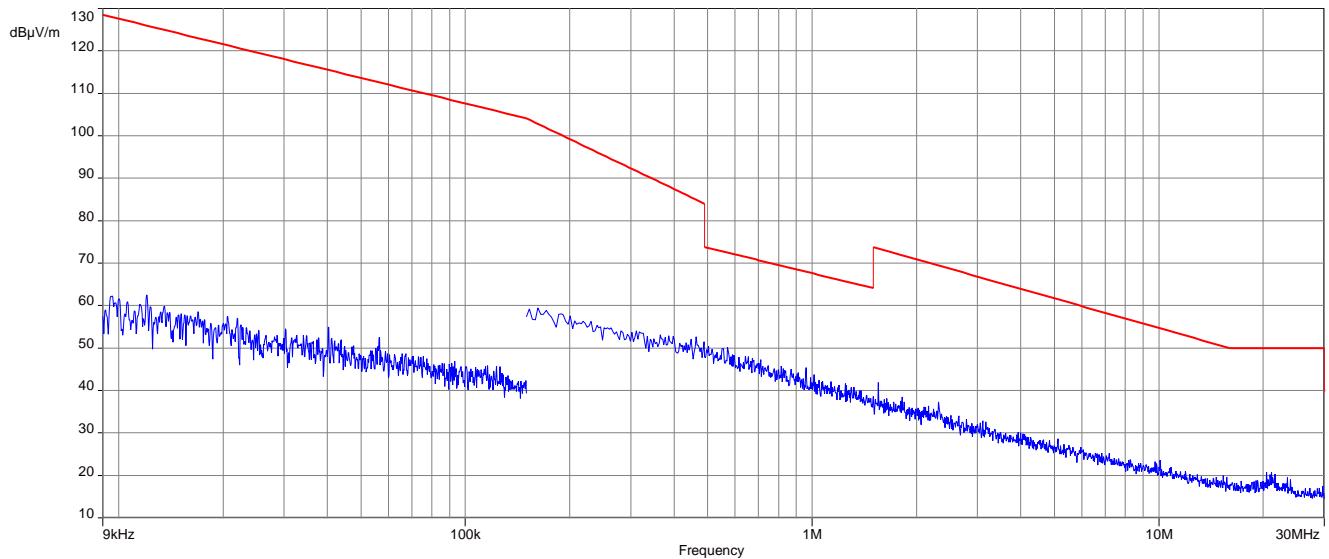
TX spurious emissions radiated below 30 MHz [ $\text{dB}\mu\text{V/m}$ ]		
F [MHz]	Detector	Level [ $\text{dB}\mu\text{V/m}$ ]
All detected emissions are more than 20 dB below the limit.		

**Plots:**

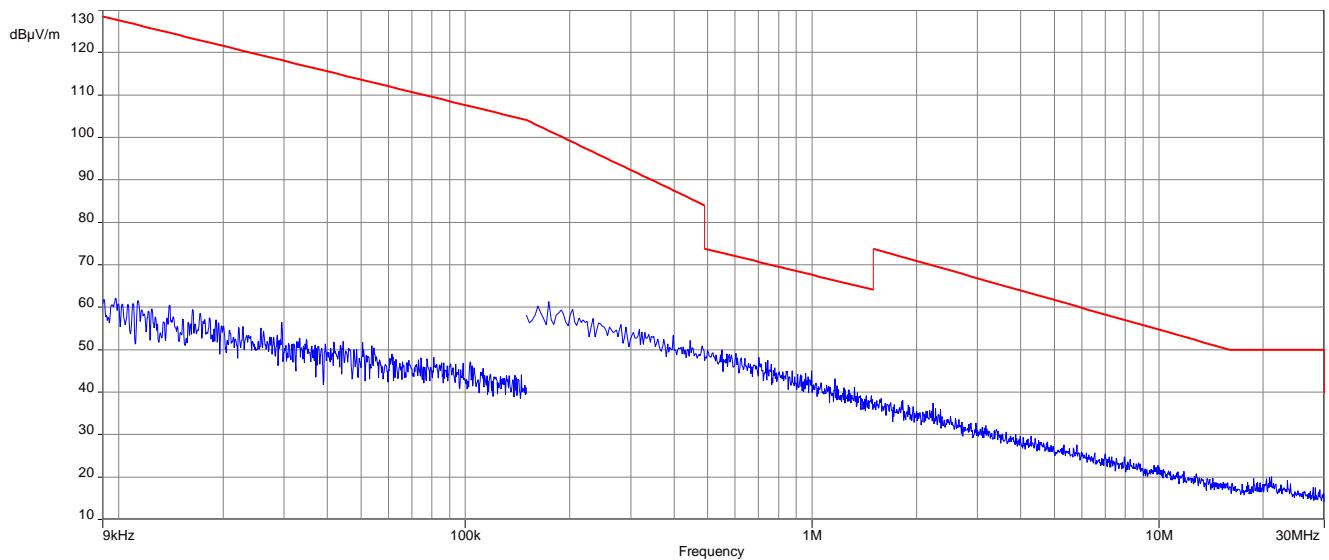
**Plot 1:** 9 kHz to 30 MHz, 2402 MHz, transmit mode, 1 Msps



**Plot 2:** 9 kHz to 30 MHz, 2440 MHz, transmit mode, 1 Msps



**Plot 3: 9 kHz to 30 MHz, 2480 MHz, transmit mode, 1 Msps**



## 12.9 Spurious emissions radiated 30 MHz to 1 GHz

### Description:

Measurement of the radiated spurious emissions in transmit mode. The EUT is set to single channel mode and the transmit frequencies are 2402 MHz, 2440 MHz and 2480 MHz.

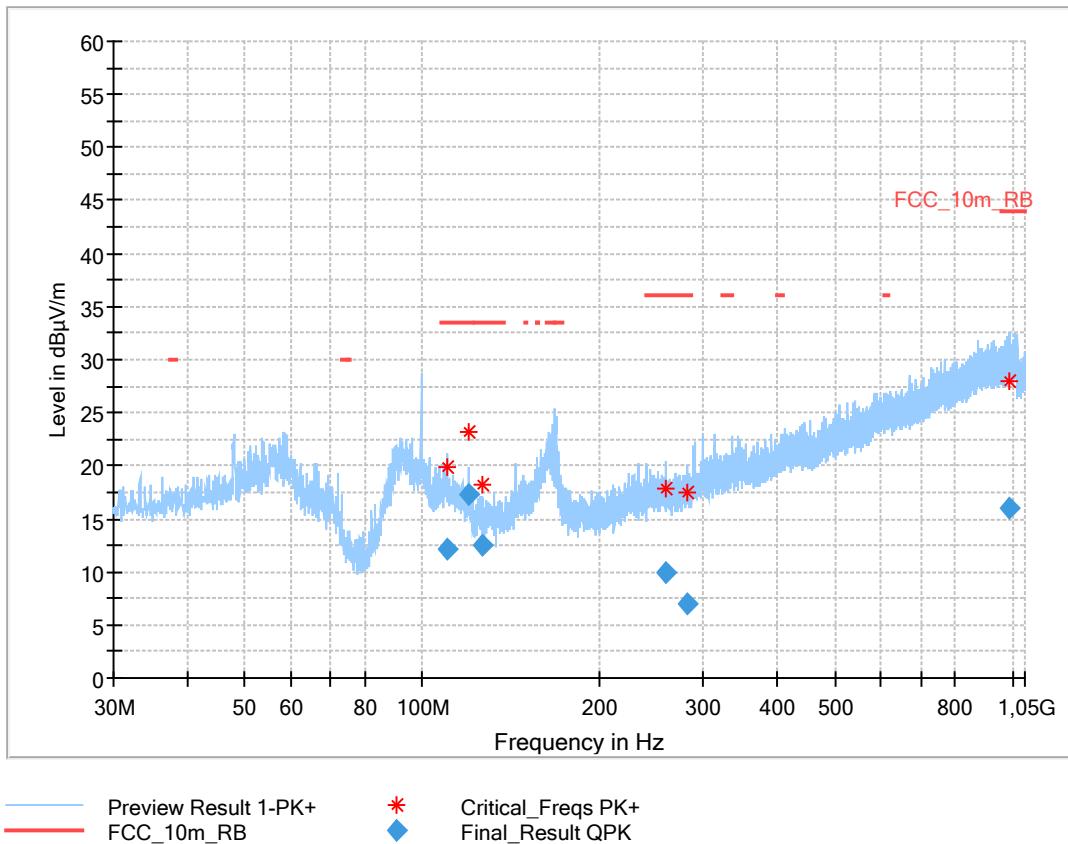
Measurement parameters	
Detector	Peak / Quasi Peak
Sweep time	Auto
Resolution bandwidth	120 kHz
Video bandwidth	3 x RBW
Span	30 MHz to 1 GHz
Trace mode	Max hold
Measured modulation	GFSK
Test setup	See sub clause 8.1 A
Measurement uncertainty	See sub clause 9

### Limits:

FCC	ISED															
TX spurious emissions radiated																
In any 100 kHz bandwidth outside the frequency band in which the spread spectrum or digitally modulated intentional radiator is operating, the radio frequency power that is produced by the intentional radiator 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 an RF conducted or a radiated measurement. Attenuation below the general limits specified in Section 15.209(a) is not required. In addition, radiated emissions which fall in the restricted bands, as defined in §15.205(a), must also comply with the radiated emission limits specified in §15.209(a) (see §15.205(c)).																
§15.209																
<table border="1" style="width: 100%; border-collapse: collapse;"> <thead> <tr> <th style="text-align: center;">Frequency (MHz)</th><th style="text-align: center;">Field strength (dB<math>\mu</math>V/m)</th><th style="text-align: center;">Measurement distance (m)</th></tr> </thead> <tbody> <tr> <td style="text-align: center;">30 - 88</td><td style="text-align: center;">30.0</td><td style="text-align: center;">10</td></tr> <tr> <td style="text-align: center;">88 - 216</td><td style="text-align: center;">33.5</td><td style="text-align: center;">10</td></tr> <tr> <td style="text-align: center;">216 - 960</td><td style="text-align: center;">36.0</td><td style="text-align: center;">10</td></tr> <tr> <td style="text-align: center;">Above 960</td><td style="text-align: center;">54.0</td><td style="text-align: center;">3</td></tr> </tbody> </table>		Frequency (MHz)	Field strength (dB $\mu$ V/m)	Measurement distance (m)	30 - 88	30.0	10	88 - 216	33.5	10	216 - 960	36.0	10	Above 960	54.0	3
Frequency (MHz)	Field strength (dB $\mu$ V/m)	Measurement distance (m)														
30 - 88	30.0	10														
88 - 216	33.5	10														
216 - 960	36.0	10														
Above 960	54.0	3														

**Plots:** Transmit mode

**Plot 1:** 30 MHz to 1 GHz, TX mode, vertical & horizontal polarization, 1 Msps, valid for all channels



**Final results:**

Frequency (MHz)	QuasiPeak (dBμV/m)	Limit (dBμV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB/m)
110.404	12.08	33.5	21.4	1000	120.0	281.0	V	91	13
120.014	17.25	33.5	16.3	1000	120.0	150.0	V	101	11
126.173	12.59	33.5	20.9	1000	120.0	200.0	V	127	10
258.690	9.94	36.0	26.1	1000	120.0	142.0	V	152	14
281.939	6.94	36.0	29.1	1000	120.0	124.0	V	115	15
987.041	15.98	44.0	28.0	1000	120.0	387.0	V	78	26

## 12.10 Spurious emissions radiated above 1 GHz

### Description:

Measurement of the radiated spurious emissions in transmit mode. The EUT is set to single channel mode and the transmit frequencies are 2402 MHz, 2440 MHz and 2480 MHz.

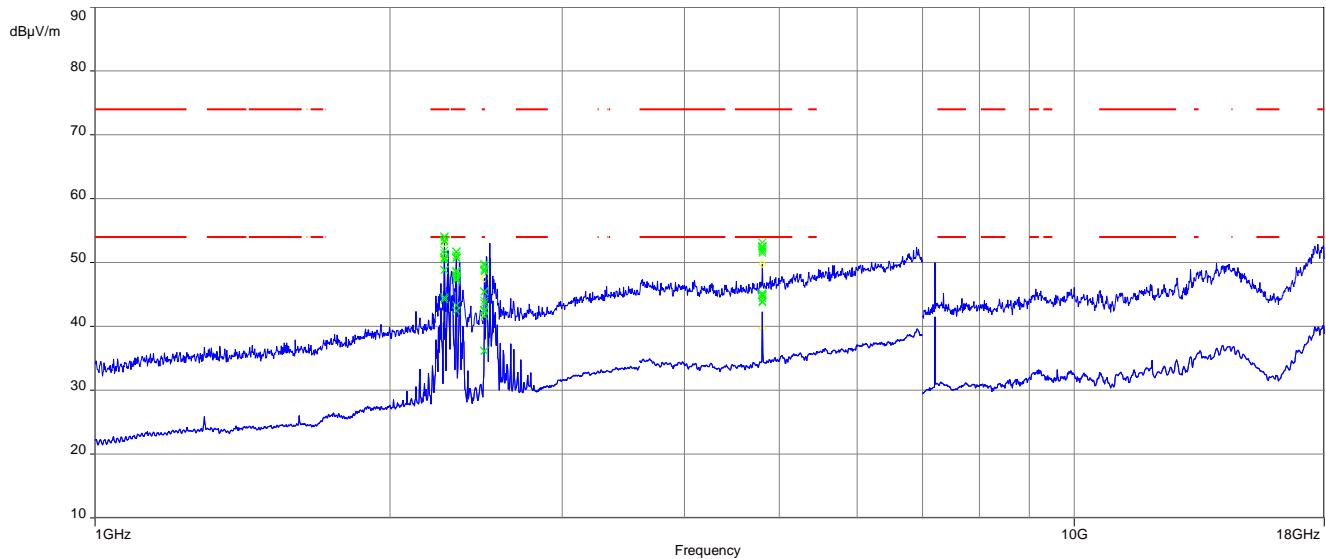
Measurement parameters	
Detector	Peak / RMS
Sweep time	Auto
Resolution bandwidth	1 MHz
Video bandwidth	3 x RBW
Span	1 GHz to 26 GHz
Trace mode	Max hold
Measured modulation	GFSK
Test setup	See sub clause 8.2 A (1 GHz - 18 GHz) See sub clause 8.3 A (18 GHz - 26 GHz)
Measurement uncertainty	See sub clause 9

### Limits:

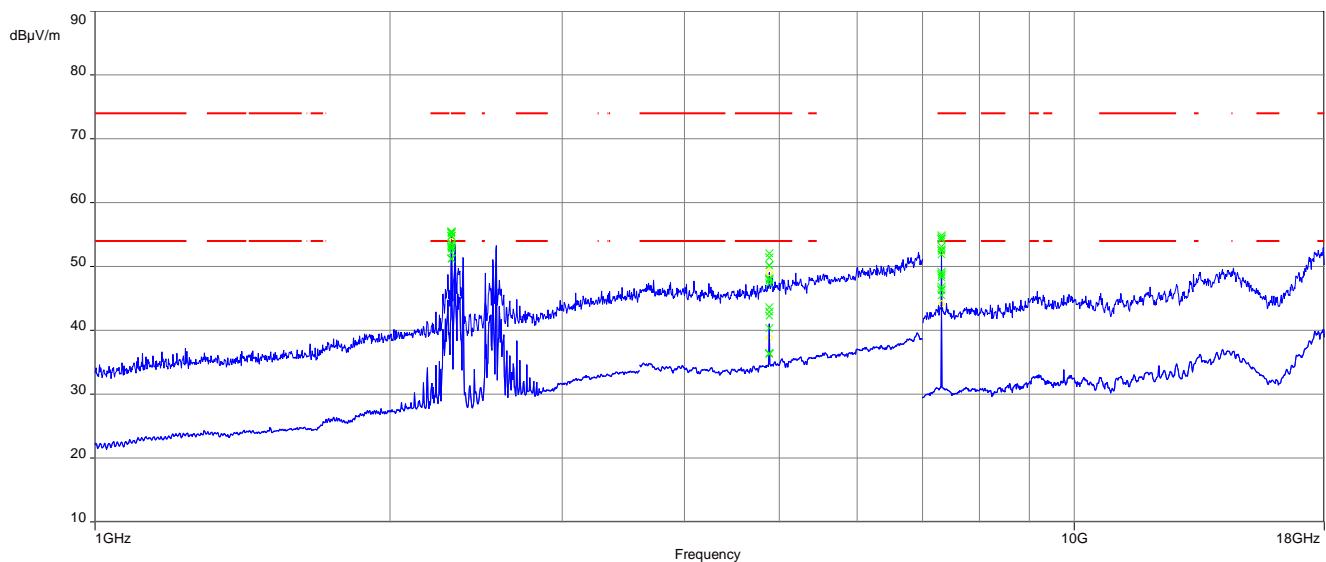
FCC	ISED	
TX spurious emissions radiated		
In any 100 kHz bandwidth outside the frequency band in which the spread spectrum or digitally modulated intentional radiator is operating, the radio frequency power that is produced by the intentional radiator shall be at least 20 dB below that in the 100 kHz bandwidth within the band that contains the highest level of the desired power, based on either an RF conducted or a radiated measurement. Attenuation below the general limits specified in Section 15.209(a) is not required. In addition, radiated emissions which fall in the restricted bands, as defined in §15.205(a), must also comply with the radiated emission limits specified in §15.209(a) (see §15.205(c)).		
§15.209		
Frequency (MHz)	Field strength (dB $\mu$ V/m)	Measurement distance (m)
Above 960	54.0 (Average)	3
Above 960	74.0 (Peak)	3

**Results:** Transmitter mode, 1 Msps

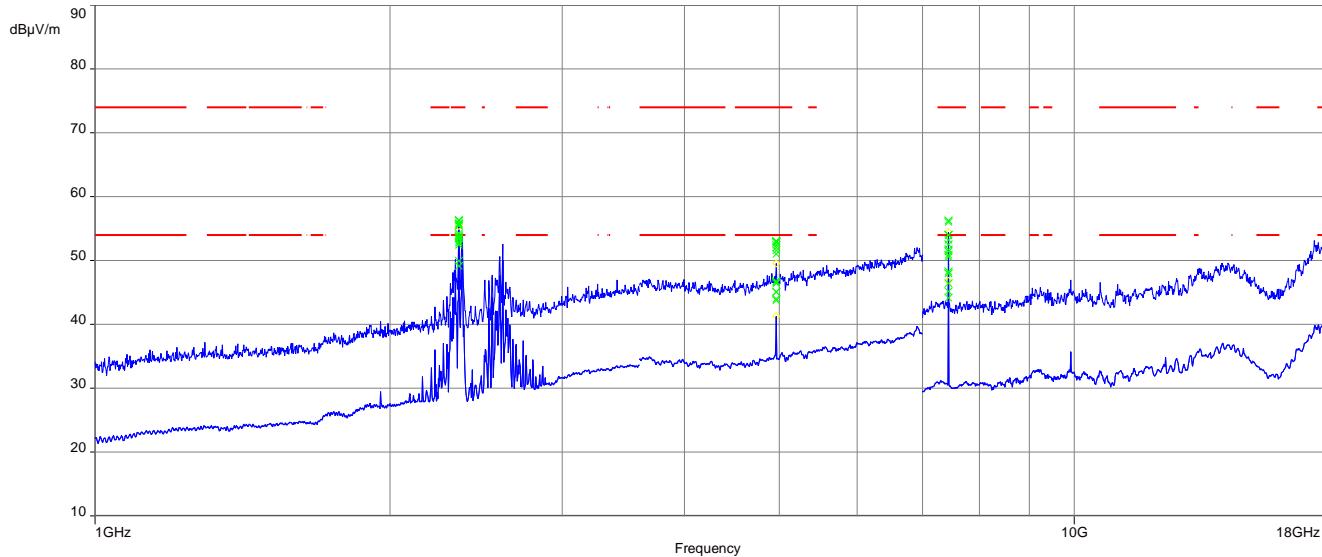
TX spurious emissions radiated [dB $\mu$ V/m]								
2402 MHz			2440 MHz			2480 MHz		
F [MHz]	Detector	Level [dB $\mu$ V/m]	F [MHz]	Detector	Level [dB $\mu$ V/m]	F [MHz]	Detector	Level [dB $\mu$ V/m]
All detected emissions are more than 20 dB below the limit.								
2274	Peak	53.9	2312	Peak	55.3	2353	Peak	56.2
	AVG	51.9		AVG	51.0		AVG	51.8
2338	Peak	51.6	4880	Peak	52.1	4960	Peak	53.0
	AVG	48.7		AVG	43.6		AVG	46.7
2498	Peak	49.8	7320	Peak	54.8	7440	Peak	56.3
	AVG	44.0		AVG	49.2		AVG	51.4
4804	Peak	51.7	-/-	Peak	-/-	-/-	Peak	-/-
	AVG	45.2		AVG	-/-		AVG	-/-

**Plots:** Transmitter mode**Plot 1:** 1 GHz to 18 GHz, TX mode, 2402 MHz, vertical & horizontal polarization, 1 Msps

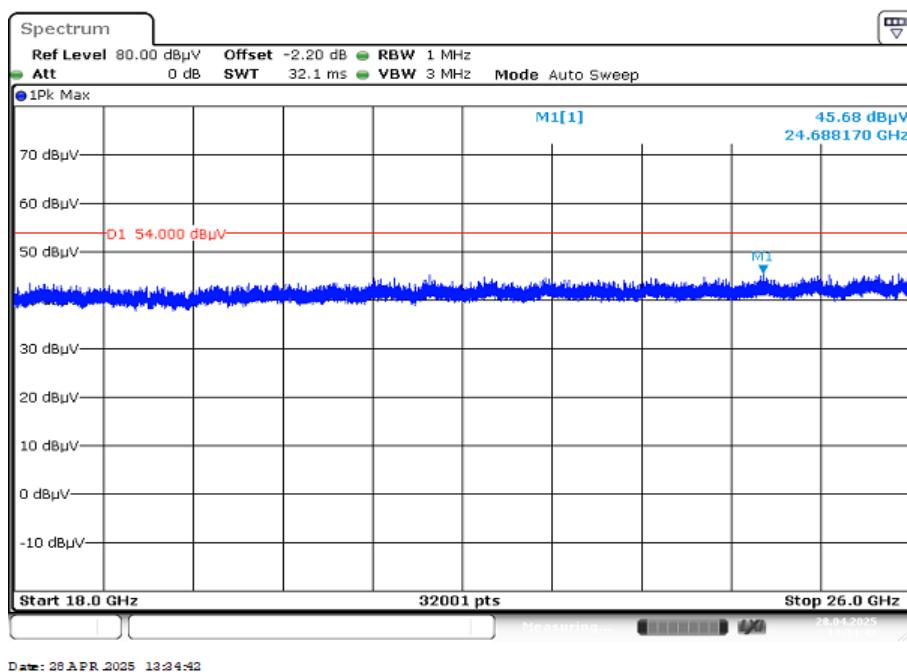
The carrier signal is notched with a 2.4 GHz band rejection filter.

**Plot 2:** 1 GHz to 18 GHz, TX mode, 2440 MHz, vertical & horizontal polarization, 1 Msps

The carrier signal is notched with a 2.4 GHz band rejection filter.

**Plot 3:** 1 GHz to 18 GHz, TX mode, 2480 MHz, vertical & horizontal polarization, 1 Msps

The carrier signal is notched with a 2.4 GHz band rejection filter.

**Plot 4:** 18 GHz to 26 GHz, TX mode, vertical & horizontal polarization, 1 Msps, valid for all channels

## 13 Observations

No observations except those reported with the single test cases have been made.

## 14 Glossary

<b>AVG</b>	Average
<b>C</b>	Compliant
<b>C/N<sub>0</sub></b>	Carrier to noise-density ratio, expressed in dB-Hz
<b>CAC</b>	Channel availability check
<b>CW</b>	Clean wave
<b>DC</b>	Duty cycle
<b>DFS</b>	Dynamic frequency selection
<b>DSSS</b>	Dynamic sequence spread spectrum
<b>DUT</b>	Device under test
<b>EN</b>	European Standard
<b>ETSI</b>	European Telecommunications Standards Institute
<b>EMC</b>	Electromagnetic Compatibility
<b>EUT</b>	Equipment under test
<b>FCC</b>	Federal Communications Commission
<b>FCC ID</b>	Company Identifier at FCC
<b>FHSS</b>	Frequency hopping spread spectrum
<b>FVIN</b>	Firmware version identification number
<b>GNSS</b>	Global Navigation Satellite System
<b>GUE</b>	GNSS User Equipment
<b>HMN</b>	Host marketing name
<b>HVIN</b>	Hardware version identification number
<b>HW</b>	Hardware
<b>IC</b>	Industry Canada
<b>Inv. No.</b>	Inventory number
<b>MC</b>	Modulated carrier
<b>NA</b>	Not applicable
<b>NC</b>	Not compliant
<b>NOP</b>	Non occupancy period
<b>NP</b>	Not performed
<b>OBW</b>	Occupied bandwidth
<b>OC</b>	Operating channel
<b>OCW</b>	Operating channel bandwidth
<b>OFDM</b>	Orthogonal frequency division multiplexing
<b>OOB</b>	Out of band
<b>OP</b>	Occupancy period
<b>PER</b>	Packet error rate
<b>PMN</b>	Product marketing name
<b>PP</b>	Positive peak
<b>QP</b>	Quasi peak
<b>RLAN</b>	Radio local area network
<b>S/N or SN</b>	Serial number
<b>SW</b>	Software
<b>UUT</b>	Unit under test
<b>WLAN</b>	Wireless local area network

## 15 Document history

Version	Applied changes	Date of release
R01	Initial release	2025-05-19

##### END OF TEST REPORT #####