

FCC ID: CWTUGZZC / IC:1788F-UGZZC

EMI - TEST REPORT

- FCC Part 15.247, RSS210 -

Deutsche
Akkreditierungsstelle
D-PL-12030-01-01

Test Report No. : T36209-00-04TK	2012-09-26 Date of issue
---	-----------------------------

Type / Model Name : UGZZC-G**Product Description** : Bluetooth Module 2.1 + EDR with Antenna**Applicant** : ALPS Electric Co., Ltd

Address : 6-3-36 Furukawanakazato

: Osaki-city Miyagi-pref 989-6181, JAPAN

Manufacturer : ALPS Electric Co., Ltd

Address : 6-3-36 Furukawanakazato

: Osaki-city Miyagi-pref 989-6181, JAPAN

Licence holder : ALPS Electric Co., Ltd

Address : 6-3-36 Furukawanakazato

: Osaki-city Miyagi-pref 989-6181, JAPAN

Test Result according to the standards listed in clause 1 test standards:	POSITIVE
--	-----------------



The test report merely corresponds to the test sample.
It is not permitted to copy extracts of these test results
without the written permission of the test laboratory.

FCC ID: CWTUGZZC / IC:1788F-UGZZC

Contents

1	<u>TEST STANDARDS</u>	<u>3</u>
2	<u>SUMMARY</u>	<u>4</u>
2.1	Test result summary	4
3	<u>EQUIPMENT UNDER TEST</u>	<u>7</u>
3.1	Photo documentation of the EUT	7
3.2	Power supply system utilised	10
3.3	Short description of the EUT	10
4	<u>TEST ENVIRONMENT</u>	<u>11</u>
4.1	Address of the test laboratory	11
4.2	Environmental conditions	11
4.3	Statement of the measurement uncertainty	11
4.4	Measurement protocol for FCC and IC	11
4.5	Determination of worst case measurement conditions	12
5	<u>TEST CONDITIONS AND RESULTS</u>	<u>13</u>
5.1	Conducted emissions	13
5.2	Emission bandwidth	19
5.3	Occupied bandwidth	26
5.4	Maximum peak output power conducted	33
5.5	Spurious emissions conducted	35
5.6	Band edge compliance	67
5.7	Radiated emissions in restricted bands	72
5.8	Pseudorandom frequency hopping sequence	78
5.9	Equal hopping frequency use	78
5.10	Receiver input bandwidth	79
5.11	Correction for pulsed operation (duty cycle)	79
5.12	Dwell time	80
5.13	Carrier frequency separation	81
5.14	Number of hopping channels	84
5.15	Antenna application	85
5.16	Maximum permissible exposure (MPE)	85
5.17	Receiver conducted emissions	87
5.18	Receiver radiated emissions	92
6	<u>USED TEST EQUIPMENT AND ACCESSORIES</u>	<u>95</u>

FCC ID: CWTUGZZC / IC:1788F-UGZZC

1 TEST STANDARDS

The tests were performed according to following standards:

FCC Rules and Regulations Part 15, Subpart A - General (September, 2011)

Part 15, Subpart A, Section 15.31	Measurement standards
Part 15, Subpart A, Section 15.33	Frequency range of radiated measurements
Part 15, Subpart A, Section 15.35	Measurement detector functions and bandwidths

FCC Rules and Regulations Part 15, Subpart C - Intentional Radiators (September, 2011)

Part 15, Subpart C, Section 15.203	Antenna requirement
Part 15, Subpart C, Section 15.204	External radio frequency power amplifiers and antenna modifications
Part 15, Subpart C, Section 15.205	Restricted bands of operation
Part 15, Subpart C, Section 15.207	Conducted limits
Part 15, Subpart C, Section 15.209	Radiated emission limits, general requirements
Part 15, Subpart C, Section 15.212	Modular Transmitters
Part 15, Subpart C, Section 15.247	Operation within the bands 902 - 928 MHz, 2400 - 2483.5 MHz and 5725 - 5850 MHz

FCC Rules and Regulations Part 1, Subpart I - Procedures Implementing the National Environmental Policy Act of 1969

Part 1, Subpart I, Section 1.1310	Radiofrequency radiation exposure limits
Part 1, Subpart 2, Section 2.1093	Radiofrequency radiation exposure evaluation: portable device

OET Bulletin 65, 65A, 65B, 65C Edition 97-01, August 1997 – Evaluating Compliance with FCC Guidelines for Human Exposure to Radio Frequency Electromagnetic Fields.

ANSI C63.4: 2003	Methods of Measurement of Radio-Noise Emissions from Low-Voltage Electrical and Electronic Equipment in the Range of 9 kHz to 40 GHz.
ANSI C95.1: 2005	IEEE Standard for Safety Levels with respect to Human Exposure to Radio Frequency Electromagnetic Fields, 3 kHz to 300 GHz
CISPR 16-4-2: 2003	Uncertainty in EMC measurement
CISPR 22: 2005 EN 55022: 2006	Information technology equipment
DA 00-705	Filing and measurement guidelines for FHSS systems

FCC ID: CWTUGZZC / IC:1788F-UGZZC

2 SUMMARY

2.1 Test result summary

Bluetooth device using frequency hopping:

Operating in the 2400 MHz – 2483.5 MHz band:

FCC Rule Part	RSS Rule Part	Description	Result
15.207(a)	RSS Gen, 7.2.4.	AC power line conducted emissions	passed
15.247(a)(1)	RSS210, A8.1(a)	20 dB EBW	passed
15.247(a)(1)	RSS-210, A8.1(b)	Channel separation	passed
15.247(a)(1)	RSS-210, A8.1(d)	Dwell time	passed
15.247(b)(1)	RSS-210, A8.4(2)	Peak power	passed
15.247(d)	RSS-210, A8.5	Spurious emissions	passed
15.247(d)	RSS-210, A8.5	Out-of-band emission, radiated	passed
15.247(d)	RSS-Gen, 7.2.2	Emissions in restricted bands	passed
15.247(e)	RSS-210, A8.2(b)	Hopping sequence	passed
15.247(a)	RSS-210, A8.1(b)	Receiver input bandwidth	passed
15.247(a)	RSS-210, A8.1(d)	Number of hopping channels	passed
15.247(a)	-	Equal hopping frequency use	passed
15.35(c)	RSS-Gen, 4.5	Pulsed operation	not applicable
15.247(i)	RSS 102, 2.5.2	MPE	passed
15.247(b)(4)	RSS-Gen, 7.1.2	Antenna requirement	passed
	RSS-Gen, 7.2.6	Transmitter frequency stability	not applicable
OET Bulletin 65	RSS102, 3.2	Co-location, Co-transmission	not applicable

The mentioned RSS Rule Parts in the above table are related to:

RSS Gen, Issue 3, December 2010

RSS 210, Issue 8, December 2010

RSS 102, Issue 4, March 2010

FCC ID: CWTUGZZC / IC:1788F-UGZZC
GENERAL REMARKS:

The EUT uses a Toshiba chip set which is fully compliant to Bluetooth V2.1+EDR and has an integrated PWB pattern antenna, a temporary connector installed by the manufacturer helping to perform most of the conducted measurements. The lowest frequency being generated by the EUT is 26 MHz. The EUT is defined as a Bluetooth Class 2 device with a maximum output power of 4 dBm, by the manufacturer.

Items	Description
BT Chip set	Toshiba TC 35655XBG
Power type	3.3 VDC
Modulation	FHSS (GFSK / $\pi/4$ -DQPSK / 8DPSK)
Frequency range	2402 MHz to 2480 MHz
Channel numbers	79
Data rate (Mbps)	1 (GFSK), 2 ($\pi/4$ -DQPSK), 3 (8DPSK)
Bluetooth version	V2.1+EDR
Bluetooth conformance test	approved
Antenna type	PWB pattern antenna, peak gain 0.6 dBi

Operation modes:

- synchronous mode (SCO or eSCO traffic, for HV, DV or DM packets) for transmitting voice or data,
- asynchronous mode (ACL traffic, for DM or DH packets) for transmitting data,
- mixed transfer mode (for voice and data)

The most important mode is the ACL mode at a data rate of 3 Mbps for the worst case.

Packets:

A summary of the packets in ACL mode and their characteristics is shown in the following table:

Type	Payload Header (bytes)	User Payload (bytes)	FEC	CRC	Symmetric Max. Rate (kb/s)	Asymmetric Max. Rate (kb/s)	
						Forward	Reverse
DM1	1	0-17	2/3	yes	108.8	108.8	108.8
DH1	1	0-27	no	yes	172.8	172.8	172.8
DM3	2	0-121	2/3	yes	258.1	387.2	54.4
DH3	2	0-183	no	yes	390.4	585.6	86.4
DM5	2	0-224	2/3	yes	286.7	477.8	36.3
DH5	2	0-339	no	yes	433.9	723.2	57.6
AUX1	1	0-29	no	no	185.6	185.6	185.6
2-DH1	2	0-54	no	yes	345.6	345.6	345.6
2-DH3	2	0-367	no	yes	782.9	1174.4	172.8
2-DH5	2	0-679	no	yes	869.1	1448.5	115.2
3-DH1	2	0-83	no	yes	531.2	531.2	531.2
3-DH3	2	0-552	no	yes	1177.6	1766.4	235.6
3-DH5	2	0-1021	no	yes	1306.9	2178.1	177.1

Modulation types:

For the DH5 packet the payload modulation GFSK, for 2-DH5 the modulation $\pi/4$ -DQPSK, for 3-DH5 the modulation 8DPSK is used. The packet 3-DH5 shows most of modulation side bands and means the worst case.

FCC ID: CWTUGZZC / IC:1788F-UGZZC**Operating frequency range:**

The manufacturer declares that the maximum frequency range of this device is from 2402 MHz to 2480 MHz. This is according to the Bluetooth Core Specification 2.1 + EDR (+ critical errata) for devices which will be operated in the USA. Other frequency ranges are not supported by this device.

The frequency range was scanned from 20 MHz to 25000 MHz. All emissions not reported in this test report were more than 20 dB below the specified limit.

FINAL ASSESSMENT:

The equipment under test **fulfills** the EMI requirements cited in clause 1 test standards.

Date of receipt of test sample : acc. to storage records

Testing commenced on : 31. August 2012

Testing concluded on : 18. September 2012

Checked by:

Tested by:

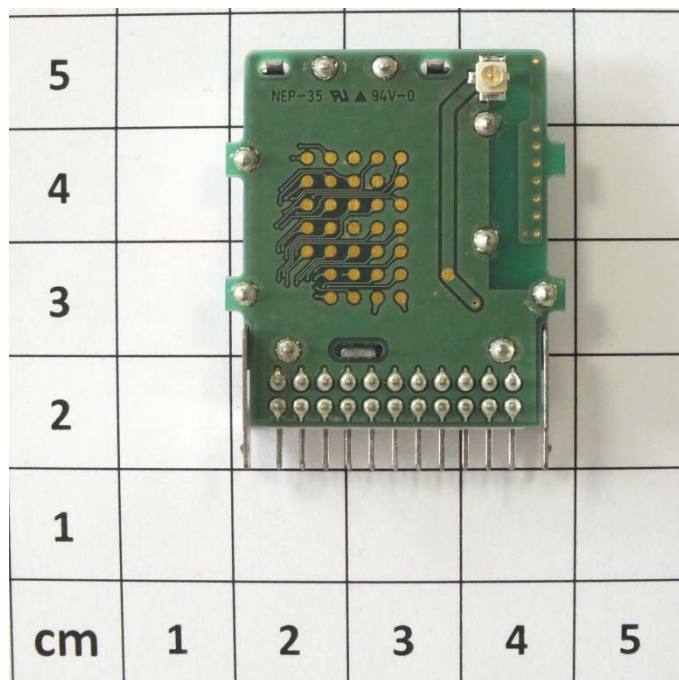
Klaus Gegenfurtner
Dipl. Ing. (FH)
Manager: Radio Group

Tobias Kammerer

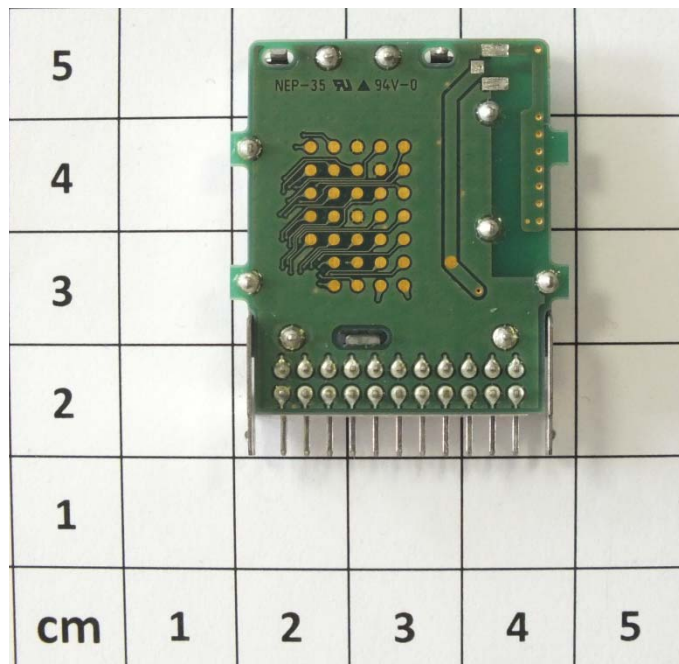
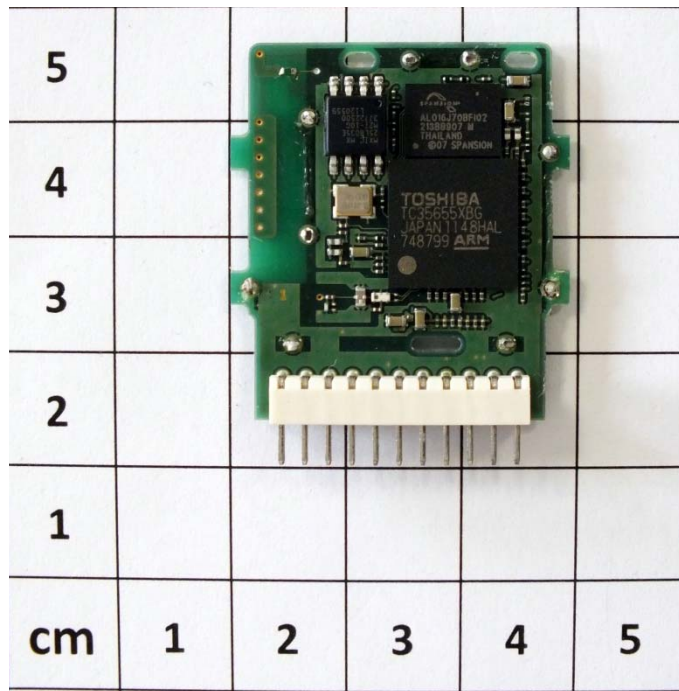
FCC ID: CWTUGZZC / IC:1788F-UGZZC

3 EQUIPMENT UNDER TEST

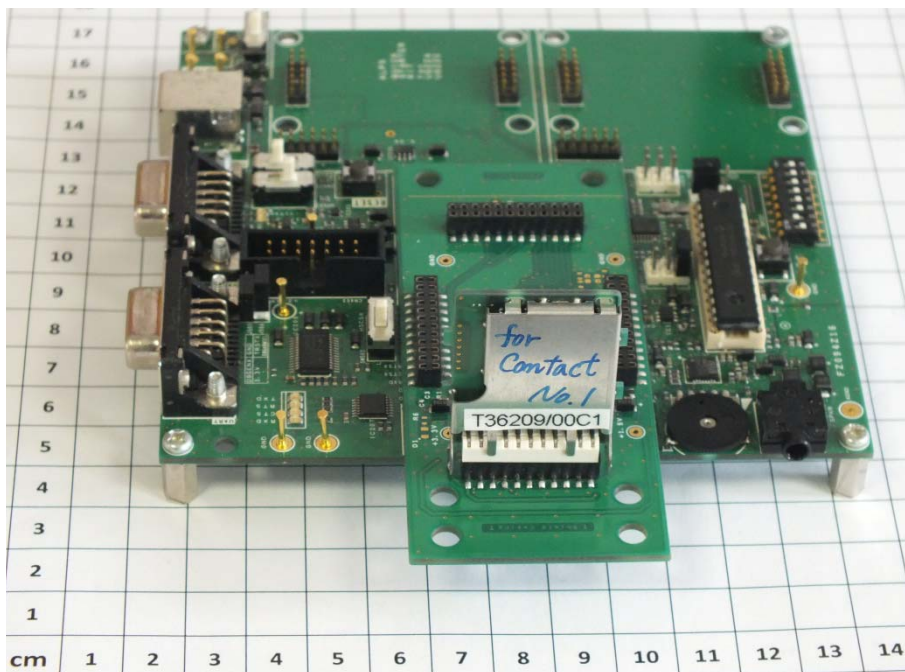
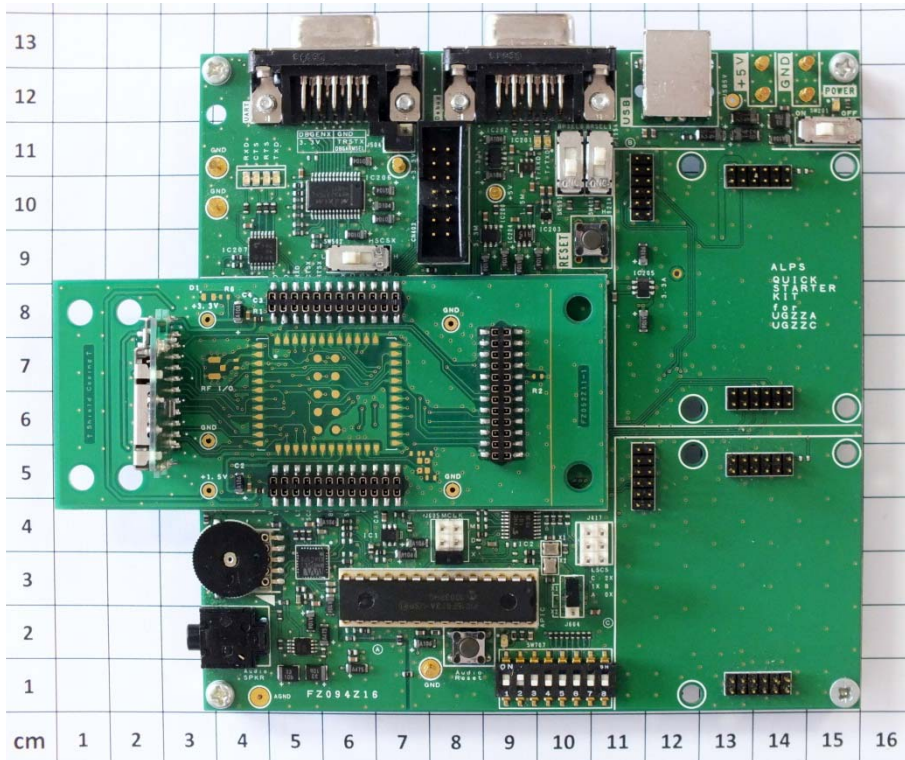
3.1 Photo documentation of the EUT



FCC ID: CWTUGZZC / IC:1788F-UGZZC



FCC ID: CWTUGZZC / IC:1788F-UGZZC



FCC ID: CWTUGZZC / IC:1788F-UGZZC

4 TEST ENVIRONMENT

4.1 Address of the test laboratory

mikes-testingpartners gmbh
Ohmstrasse 2-4
94342 Strasskirchen
Germany

4.2 Environmental conditions

During the measurement the environmental conditions were within the listed ranges:

Temperature: 15-35 ° C

Humidity: 30-60 %

Atmospheric pressure: 86-106 kPa

4.3 Statement of the measurement uncertainty

The data and results referenced in this document are true and accurate. The reader may notice that tolerances within the calibration of the equipment and facilities may cause additional uncertainty. The measurement uncertainty is calculated for all measurements listed in this test report acc. to CISPR 16-4-2 „Uncertainties, statistics and limit modelling – Uncertainty in EMC measurement“ and documented in the mikes-testingpartners gmbh quality system acc. to DIN EN ISO/IEC 17025. For all measurements shown in this report, the measurement uncertainty of the test laboratory, mikes-testingpartners gmbh, is below the measurement uncertainty as defined by CISPR. Therefore, no special measures must be taken into consideration with regard to the limits according to CISPR. Furthermore, component diversity and modifications in production process of devices may result in additional deviation. If necessary, refer to the test lab for the actual measurement uncertainty for the specific test. The manufacturer has the sole responsibility of continued compliance of the EUT.

4.4 Measurement protocol for FCC and IC

4.4.1 GENERAL INFORMATION

4.4.1.1 Test methodology

Conducted and radiated disturbance testing is performed according to the procedures set out by the International Special Committee on Radio Interference (CISPR) Publication 22, European Standard EN 55022 as shown under section 1 of this report.

The Open Area test site is a listed Open Site under the Canadian Test-Sites File-No:

IC 3009A-1

In compliance with RSS 210 testing for RSS compliance may be achieved by following the procedures set out in ANSI C63.4 and applying the CISPR 22 limits.

FCC ID: CWTUGZZC / IC:1788F-UGZZC

4.4.1.2 Justification

The equipment under test (EUT) is configured in a typical test arrangement in accordance with the manufacturer's instructions. The cables being connected to each available port and either terminated with a peripheral using the appropriate impedance characteristic or left unterminated. Where appropriate, cables are manually manipulated with respect to each other thus obtaining maximum disturbances from the unit.

4.4.1.3 Details of test procedures

The test methods used comply with CISPR Publication 22, EN 55022 - "Information technology equipment - Radio disturbance characteristics - Limits and methods of measurement" and with ANSI C63.4 - "Methods of Measurement of Radio-Noise Emissions from Low-Voltage Electrical and Electronic Equipment in the Range of 9 kHz to 40 GHz". In compliance with 47 CFR Part 15 Subpart A, Section 15.38 testing for FCC compliance may be achieved by following the procedures set out in ANSI C63.4 and applying the CISPR 22 limits.

4.5 Determination of worst case measurement conditions

Measurements have been made in all three orthogonal axes and the settings of the EUT were changed to locate at which position and at what setting of the EUT produce the maximum of the emissions. For the further measurement the EUT is set in X position with the following settings:

Following channels and test modes were selected for the final test as listed below:

Technology	Available channels	Tested channels	Modulation	Packet type
Bluetooth	1 - 79	1, 41, 79	GFSK	DH5
Bluetooth	1 - 79	1, 41, 79	$\pi/4$ -DQPSK	2-DH5
Bluetooth	1 - 79	1, 41, 79	8DPSK	3-DH5

FCC ID: CWTUGZZC / IC:1788F-UGZZC

5 TEST CONDITIONS AND RESULTS

5.1 Conducted emissions

For test instruments and accessories used see section 6 Part A 4.

Legend for tables:

QP-L ... QuasiPeak reading including correction factor
AV-L ... Average reading including correction factor
D-Limit... Measured value to limit delta (margin)

5.1.1 Description of the test location

Test location: Shielded Room 2

5.1.2 Photo documentation of the test set-up



5.1.3 Applicable standard

According to FCC Part 15C, Section 15.207(a):

Intentional radiator that is designed to be connected to the public utility (AC) power line, the radio frequency voltage that is conducted back onto the AC power line on any frequency or frequencies within the band 150 kHz to 30 MHz.

FCC ID: CWTUGZZC / IC:1788F-UGZZC**5.1.4 Description of measurement**

The conducted emission is measured with a test receiver in the frequency range from 150 kHz to 30 MHz. The EUT is connected to a line impedance stabilizing network which is compliant to FCC Part 15B, Section 15.207(a). The used power supply for the test board is a standard USB power supply delivering 5 V DC. The mains voltage is set to 120 V AC, 60 Hz.

Test receiver settings:

RBW: 10 kHz, Meas. time: 20 ms, Detector: Peak,

5.1.5 Test result

Frequency range: 150 kHz to 30 MHz

Min. limit margin QP/AV: 10.2 dB / 7.8 dB

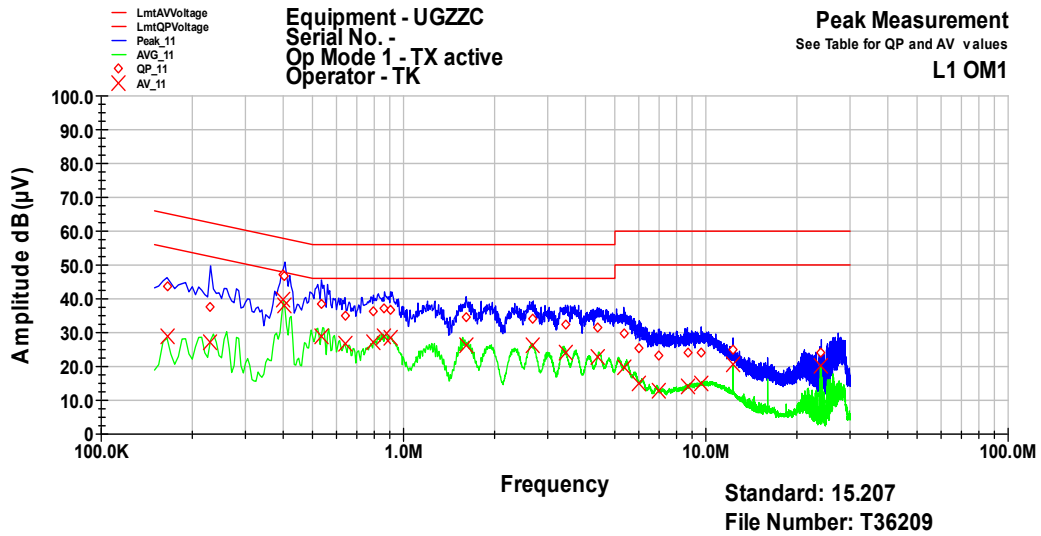
The requirements are fulfilled

Remarks: For detailed test results please refer to following test protocol.

FCC ID: CWTUGZZC / IC:1788F-UGZZC

5.1.6 Test protocol

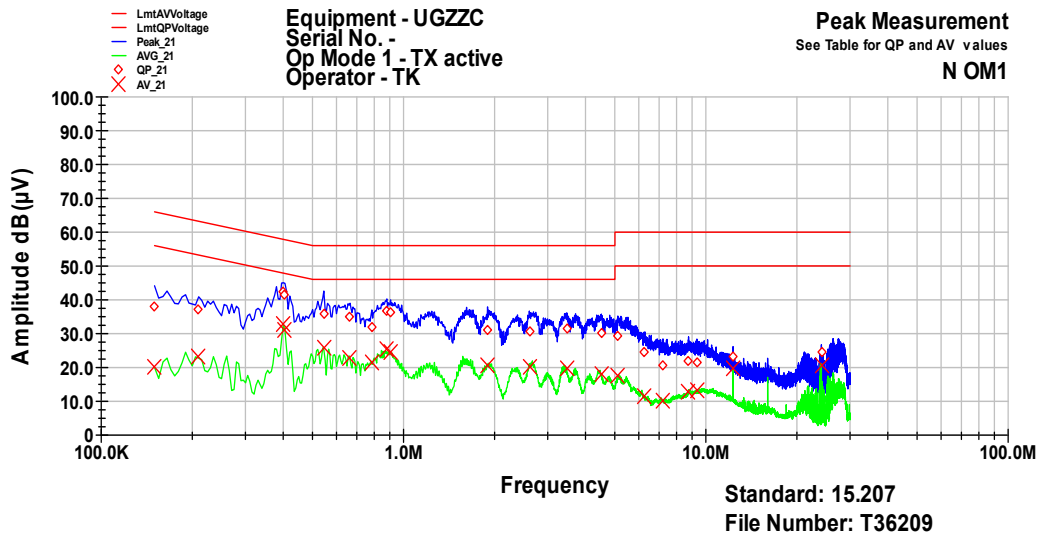
Results for operating mode TX active on AC power line L1



Frequency	QP Level	QP Margin	QP Limit	AV Level	AV Margin	AV Limit
MHz	dB(µV)	dB	dB	dB(µV)	dB	dB
0.165	43.6	-21.6	65.2	29	-26.2	55.2
0.230	37.7	-24.7	62.4	27	-25.4	52.4
0.400	47	-10.8	57.9	39.5	-8.3	47.9
0.405	46.8	-11	57.8	38	-9.8	47.8
0.535	38.4	-17.6	56	28.9	-17.1	46
0.640	35.2	-20.8	56	26.8	-19.2	46
0.795	36.3	-19.7	56	27.2	-18.8	46
0.865	37.2	-18.8	56	28.9	-17.1	46
0.905	36.7	-19.3	56	28.4	-17.6	46
1.610	34.5	-21.5	56	26.5	-19.5	46
2.685	34.1	-21.9	56	26.5	-19.5	46
3.430	32.4	-23.6	56	24	-22	46
4.375	31.5	-24.5	56	22.6	-23.4	46
5.350	29.7	-30.3	60	19.7	-30.3	50
6.015	25.6	-34.4	60	15.1	-34.9	50
7.015	23.4	-36.6	60	12.8	-37.2	50
8.680	23.9	-36.1	60	13.9	-36.1	50
9.650	23.9	-36.1	60	14.9	-35	50
12.285	25	-35	60	20.4	-29.6	50
23.900	24.2	-35.8	60	20	-30	50

FCC ID: CWTUGZZC / IC:1788F-UGZZC

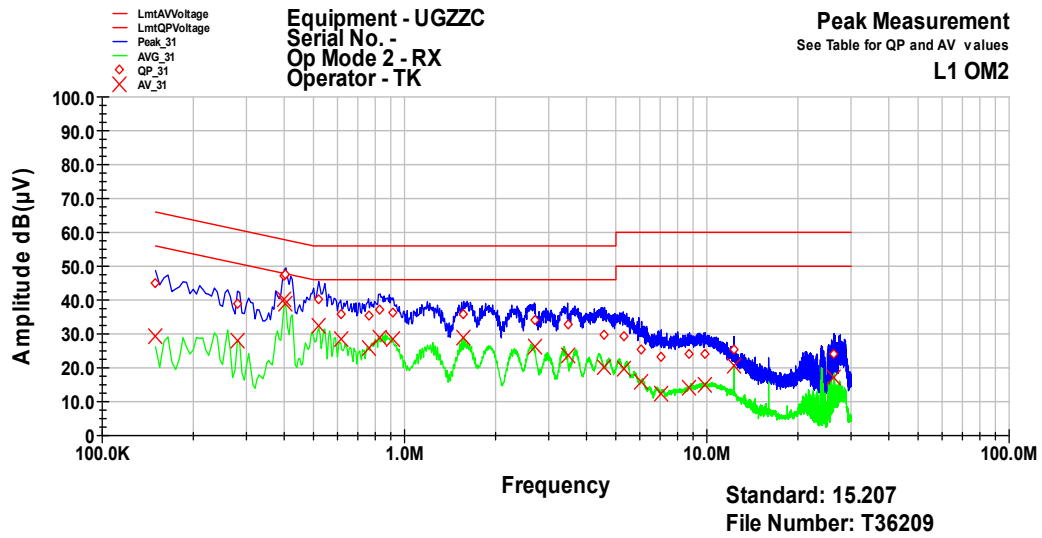
Results for operating mode TX active on AC power line N



Frequency	QP Level	QP Margin	QP Limit	AV Level	AV Margin	AV Limit
MHz	dB(µV)	dB	dB	dB(µV)	dB	dB
0.150	38	-28	66	20.3	-35.7	56
0.210	37	-26.2	63.2	23.3	-29.9	53.2
0.400	42.5	-15.4	57.9	32.7	-15.2	47.9
0.405	41.6	-16.1	57.8	31.1	-16.6	47.8
0.545	35.7	-20.3	56	25.9	-20.1	46
0.665	35.1	-20.9	56	22.9	-23.1	46
0.785	32.1	-23.9	56	21.5	-24.5	46
0.880	36.9	-19.1	56	25.3	-20.8	46
0.905	36.3	-19.7	56	24.3	-21.7	46
1.895	31.2	-24.8	56	20.5	-25.5	46
2.605	30.8	-25.2	56	20.3	-25.7	46
3.465	31.4	-24.6	56	19.6	-26.4	46
4.510	30.3	-25.7	56	18	-28	46
5.115	29.4	-30.6	60	17.7	-32.3	50
6.280	24.6	-35.4	60	11.6	-38.4	50
7.205	20.8	-39.2	60	10.3	-39.7	50
8.760	21.7	-38.3	60	12.7	-37.3	50
9.335	21.5	-38.5	60	13.1	-36.9	50
12.285	23.1	-36.9	60	19.7	-30.3	50
24.100	24.5	-35.5	60	20.8	-29.2	50

FCC ID: CWTUGZZC / IC:1788F-UGZZC

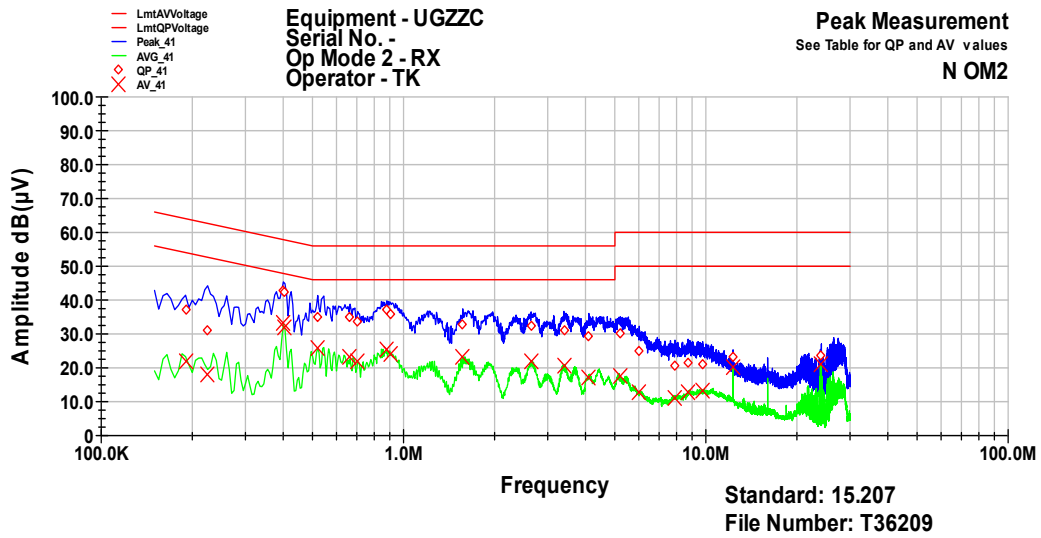
Results for operating mode RX continuous on AC power line L1



Frequency	QP Level	QP Margin	QP Limit	AV Level	AV Margin	AV Limit
MHz	dB(µV)	dB	dB	dB(µV)	dB	dB
0.150	45	-21	66	29.2	-26.8	56
0.280	39.1	-21.7	60.8	28.1	-22.7	50.8
0.400	47.3	-10.6	57.9	40.1	-7.8	47.9
0.405	47.6	-10.2	57.8	38.8	-9	47.8
0.520	40.1	-15.9	56	32.3	-13.7	46
0.615	36	-20	56	28.3	-17.7	46
0.760	35.6	-20.4	56	25.9	-20.1	46
0.830	37.3	-18.7	56	28.7	-17.3	46
0.915	36.3	-19.7	56	28.4	-17.6	46
1.570	36	-20	56	29.1	-16.9	46
2.690	34.2	-21.8	56	26.4	-19.6	46
3.460	32.7	-23.3	56	23.8	-22.2	46
4.585	29.8	-26.2	56	20	-26	46
5.290	29.4	-30.6	60	19.6	-30.4	50
6.080	25.6	-34.4	60	15.8	-34.2	50
7.055	23.2	-36.8	60	12.2	-37.8	50
8.760	24.2	-35.8	60	14.3	-35.8	50
9.860	23.9	-36.1	60	15.1	-35	50
12.285	25.2	-34.8	60	20.7	-29.3	50
26.330	24.2	-35.8	60	17	-33	50

FCC ID: CWTUGZZC / IC:1788F-UGZZC

Results for operating Mode RX continuous on AC power line L1



Frequency	QP Level	QP Margin	QP Limit	AV Level	AV Margin	AV Limit
MHz	dB(µV)	dB	dB	dB(µV)	dB	dB
0.150	38	-28	66	20.3	-35.7	56
0.210	37	-26.2	63.2	23.3	-29.9	53.2
0.400	42.5	-15.4	57.9	32.7	-15.2	47.9
0.405	41.6	-16.1	57.8	31.1	-16.6	47.8
0.545	35.7	-20.3	56	25.9	-20.1	46
0.665	35.1	-20.9	56	22.9	-23.1	46
0.785	32.1	-23.9	56	21.5	-24.5	46
0.880	36.9	-19.1	56	25.3	-20.8	46
0.905	36.3	-19.7	56	24.3	-21.7	46
1.895	31.2	-24.8	56	20.5	-25.5	46
2.605	30.8	-25.2	56	20.3	-25.7	46
3.465	31.4	-24.6	56	19.6	-26.4	46
4.510	30.3	-25.7	56	18	-28	46
5.115	29.4	-30.6	60	17.7	-32.3	50
6.280	24.6	-35.4	60	11.6	-38.4	50
7.205	20.8	-39.2	60	10.3	-39.7	50
8.760	21.7	-38.3	60	12.7	-37.3	50
9.335	21.5	-38.5	60	13.1	-36.9	50
12.285	23.1	-36.9	60	19.7	-30.3	50
24.100	24.5	-35.5	60	20.8	-29.2	50

FCC ID: CWTUGZZC / IC:1788F-UGZZC

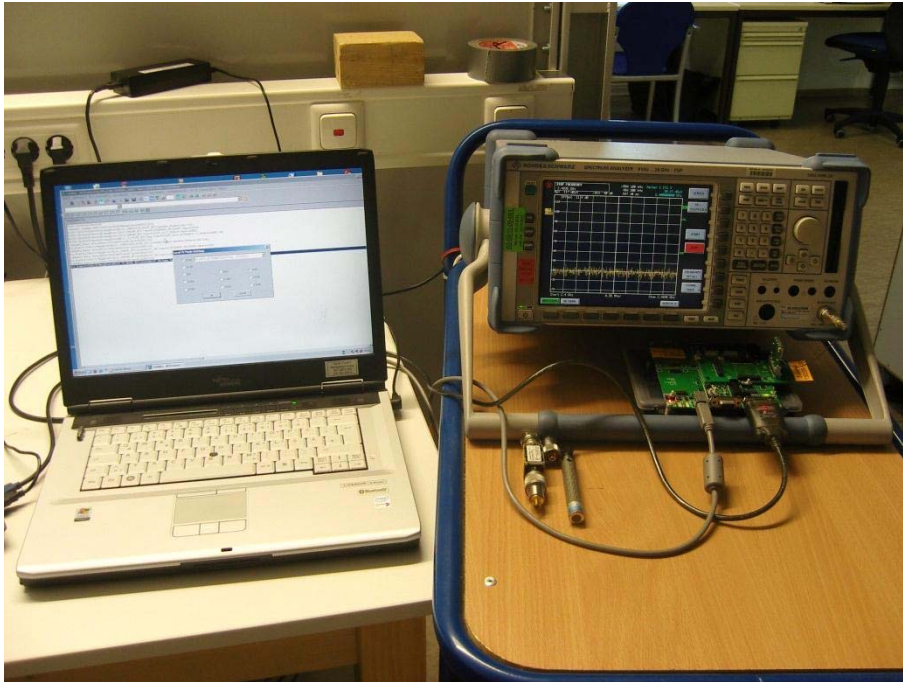
5.2 Emission bandwidth

For test instruments and accessories used see section 6 Part MB.

5.2.1 Description of the test location

Test location: Shielded Room 4

5.2.2 Photo documentation of the test set-up



FCC ID: CWTUGZZC / IC:1788F-UGZZC

5.2.3 Applicable Standard

According to FCC Part 15C, Section 15.247(a):

Frequency hopping systems shall have hopping carrier frequencies separated by a minimum of 25 kHz or the 20 dB bandwidth of the hopping channel, whichever is greater.

5.2.4 Description of Measurement

The bandwidth is measured at an amplitude level reduced from the reference level by a specified ratio of -20 dB. The reference level is the level of the highest signal amplitude observed from the transmitter at either the fundamental frequency or the first-order modulation products in all typical modes of operation including the unmodulated carrier, even if atypical.

Analyser settings:

RBW: 100 kHz, VBW: 300 kHz, Sweep time: auto, Detector: Peak, Trace mode: Max hold

5.2.5 Test result

DH5 Packet

Channel No.	20 dB Bandwidth (kHz)
CH1	1123.5
CH41	1128.0
CH79	1128.0

2-DH5 Packet

Channel No.	20 dB Bandwidth (kHz)
CH1	1384.5
CH41	1386.0
CH79	1386.0

3-DH5 Packet

Channel No.	20 dB Bandwidth (kHz)
CH1	1380.0
CH41	1380.0
CH79	1389.0

There is no bandwidth limit according to FCC Part15C, Section 15.247(a).

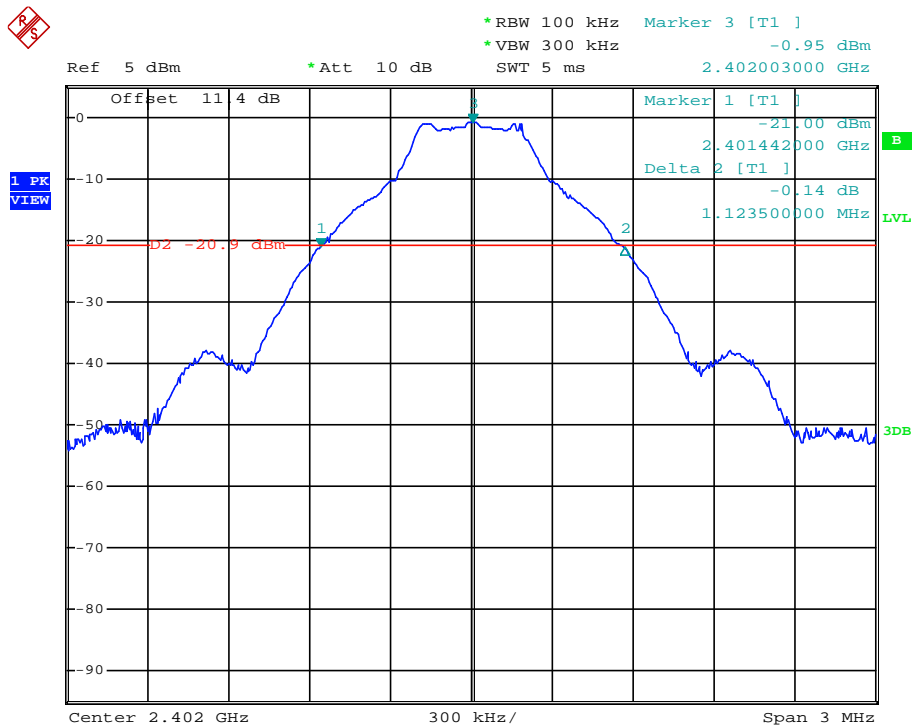
The requirements are fulfilled

Remarks: For detailed test results please refer to following test protocol.

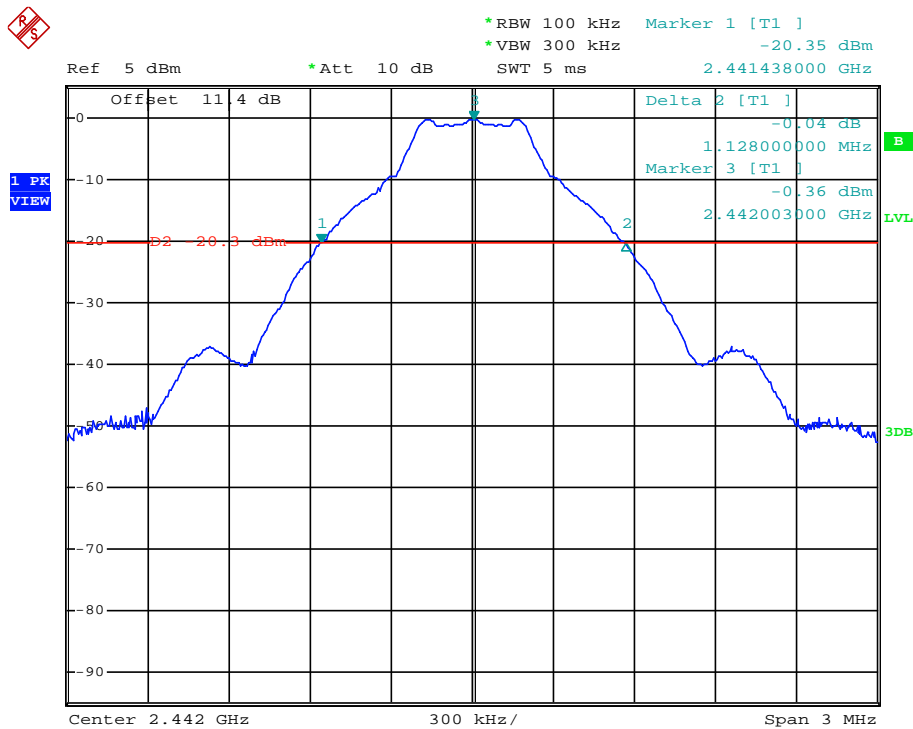
FCC ID: CWTUGZZC / IC:1788F-UGZZC

5.2.6 Test protocol

Emission bandwidth, channel 1, DH5 Packet

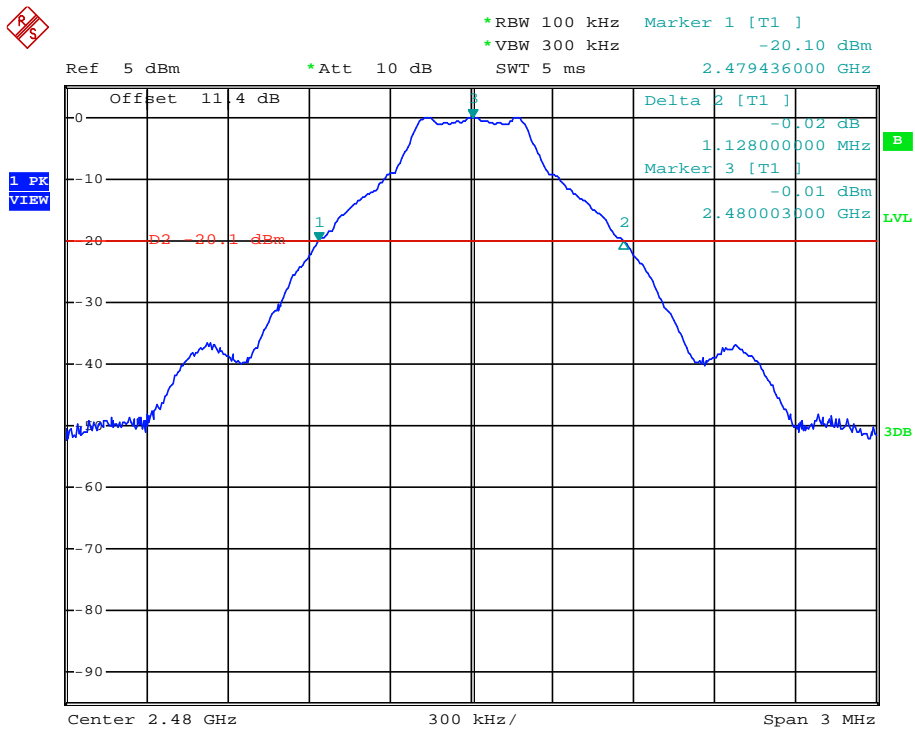


Emission bandwidth, channel 41, DH5 Packet

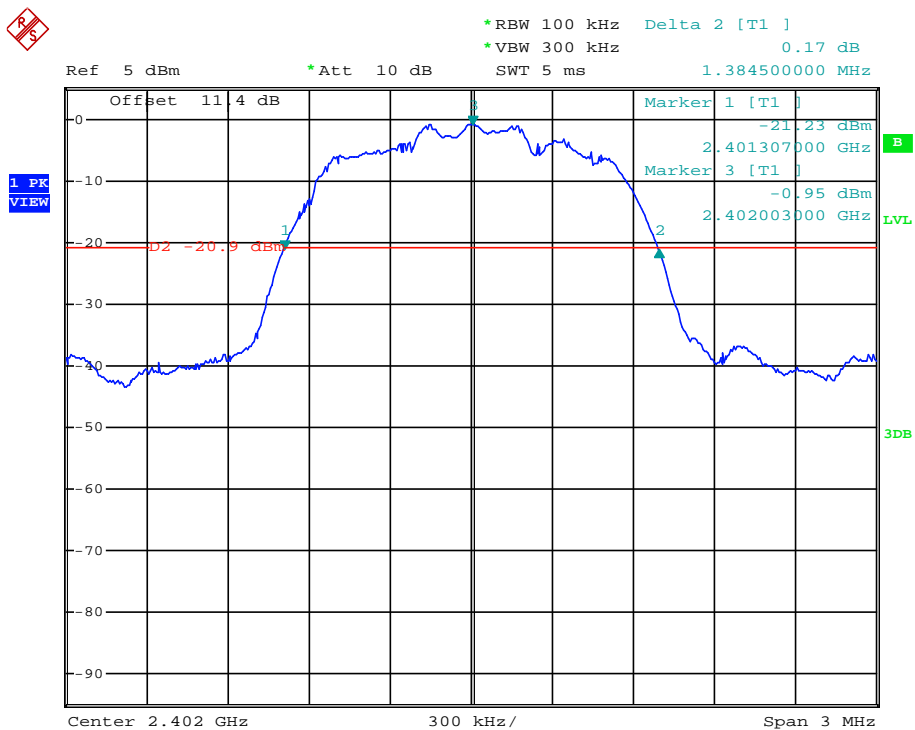


FCC ID: CWTUGZZC / IC:1788F-UGZZC

Emission bandwidth, channel 79, DH5 Packet

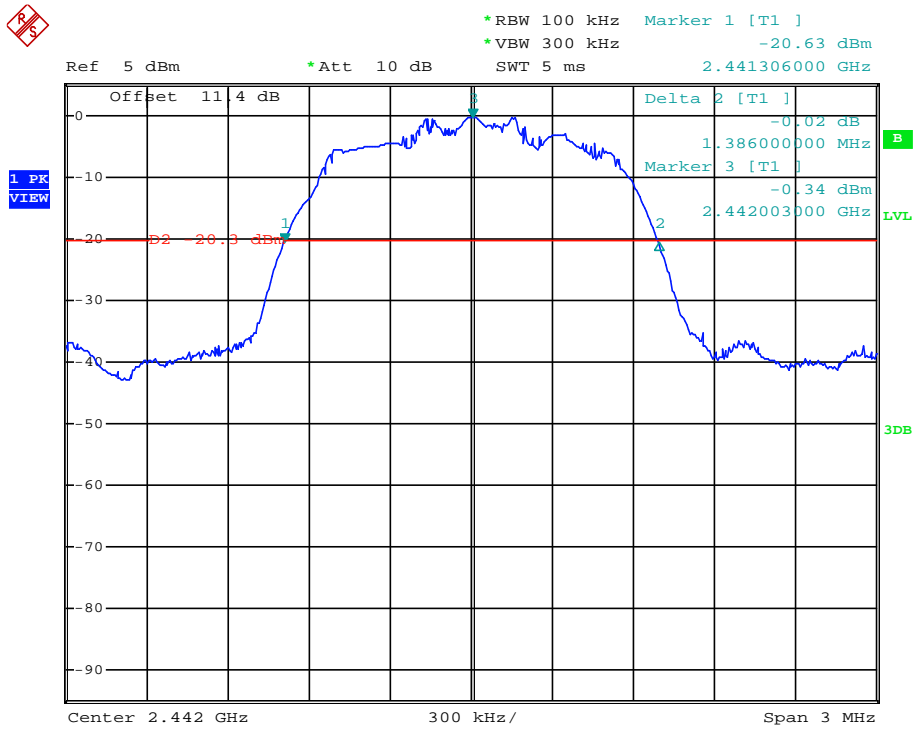


Emission bandwidth, channel 1, 2-DH5 Packet

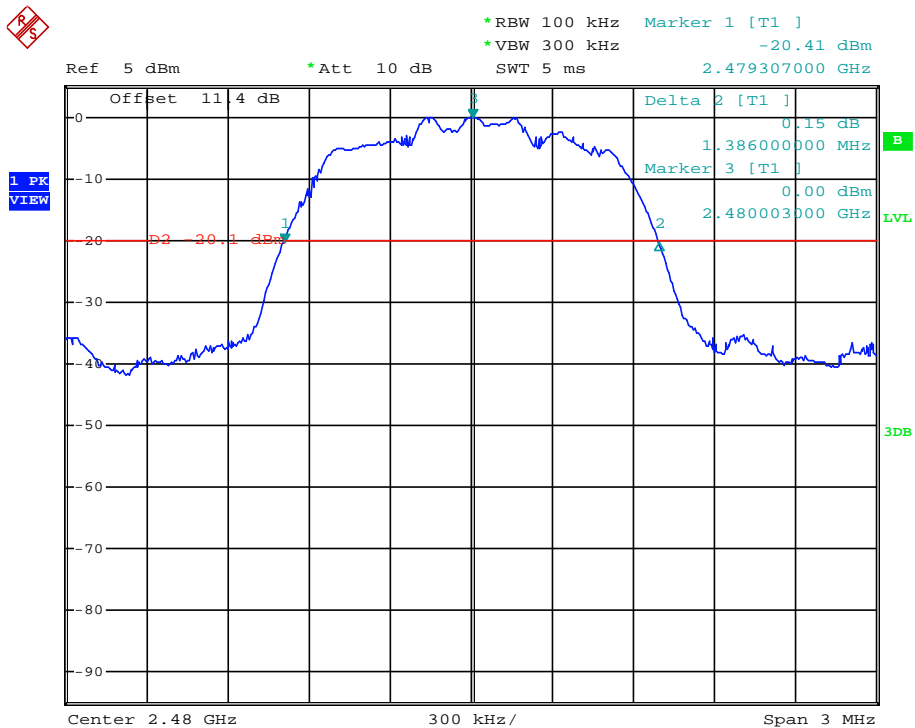


FCC ID: CWTUGZZC / IC:1788F-UGZZC

Emission bandwidth, channel 41, 2-DH5 Packet

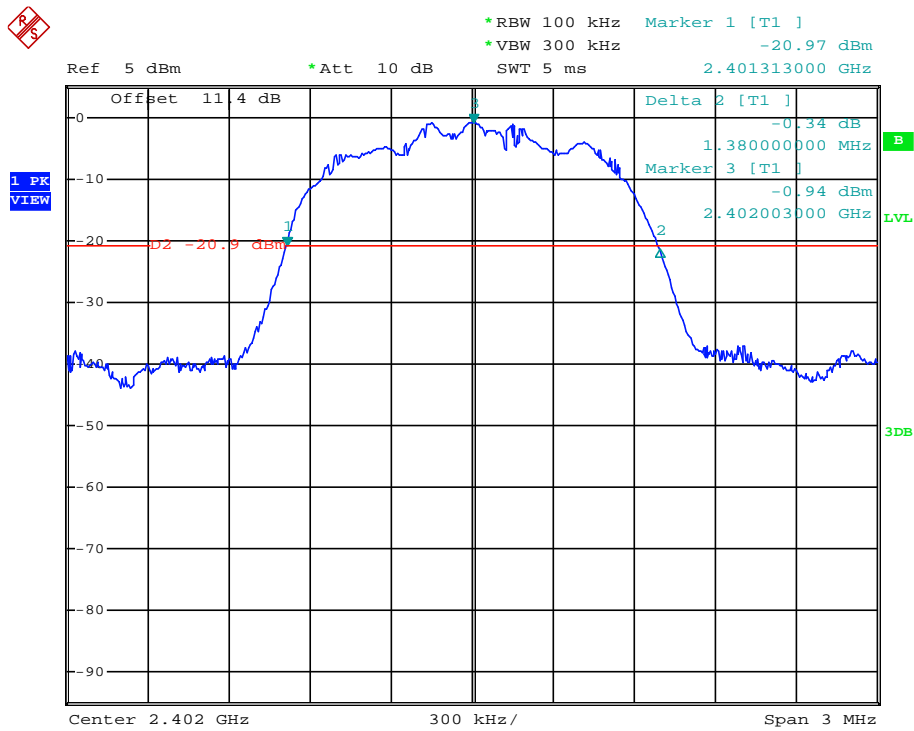


Emission bandwidth, channel 79, 2-DH5 Packet

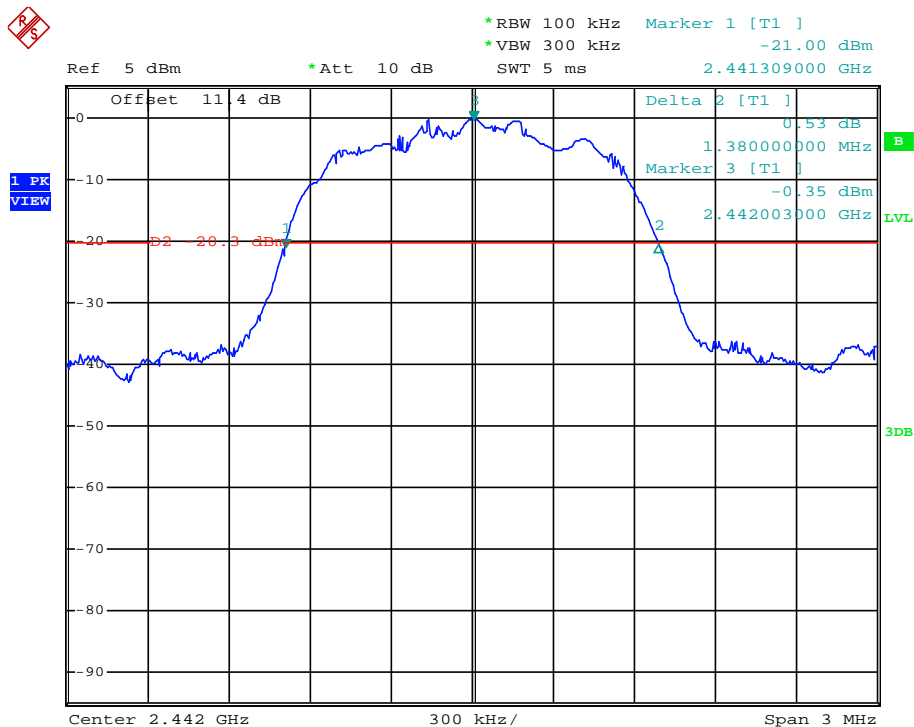


FCC ID: CWTUGZZC / IC:1788F-UGZZC

Emission bandwidth, channel 1, 3-DH5 Packet

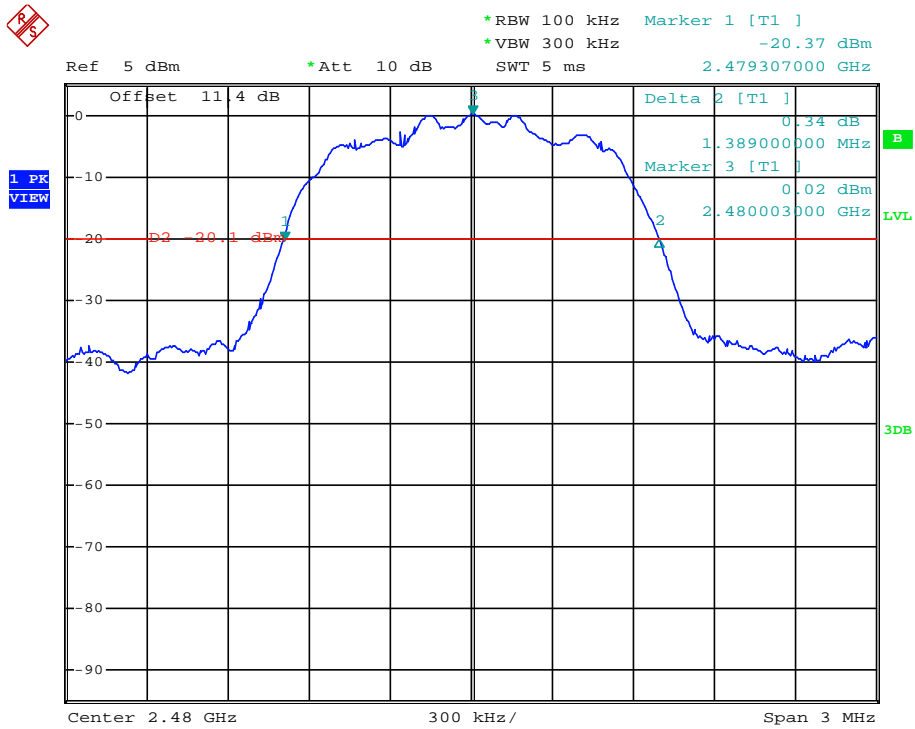


Emission bandwidth, channel 41, 3-DH5 Packet



FCC ID: CWTUGZZC / IC:1788F-UGZZC

Emission bandwidth, channel 79, 3-DH5 Packet

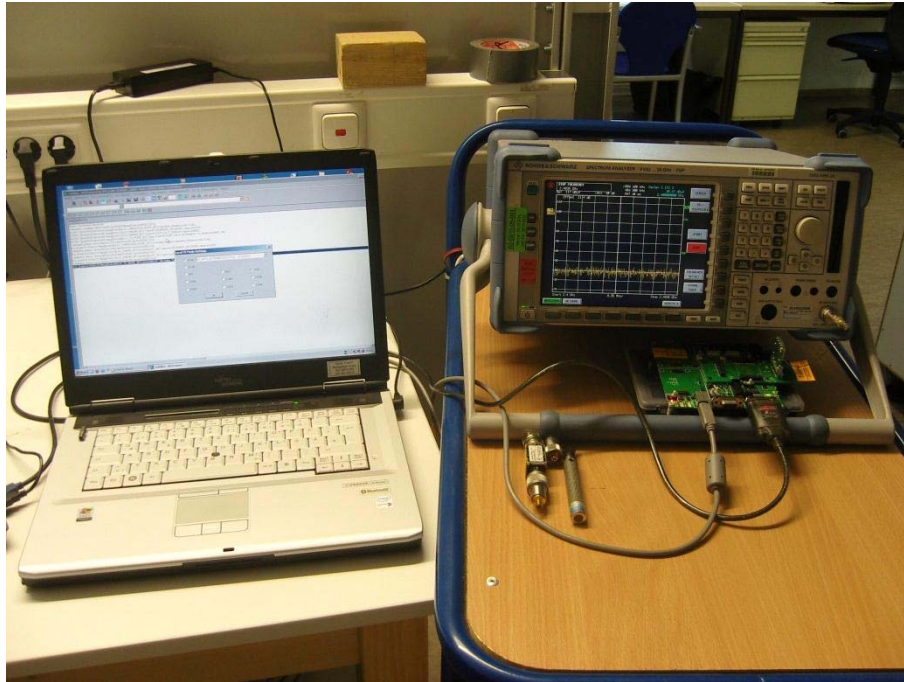


FCC ID: CWTUGZZC / IC:1788F-UGZZC**5.3 Occupied bandwidth**

For test instruments and accessories used see section 6 Part MB.

5.3.1 Description of the test location

Test location: Shielded Room 4

5.3.2 Photo documentation of the test set-up**5.3.1 Applicable standard**

According to RSS-Gen, 4.6.1:

When an occupied bandwidth value is not specified in the applicable RSS, the transmitted signal bandwidth to be reported is to be its 99 % emission bandwidth, as calculated or measured.

5.3.2 Description of Measurement

The bandwidth was measured with the function “bandwidth measurement” of the spectrum analyser. The EUT is connected via suitable attenuator at the spectrum analyser. The measurement is repeated for every different modulation standard of the EUT and recorded.

Spectrum analyser settings:

RBW: 100 kHz,

VBW: 300 kHz,

Detector: Peak,

Sweep time: auto

FCC ID: CWTUGZZC / IC:1788F-UGZZC

5.3.3 Test result

DH5 Packet

Channel No.	OBW99 Bandwidth (kHz)
CH1	948.0
CH41	948.0
CH79	948.0

2-DH5 Packet

Channel No.	OBW99 Bandwidth (kHz)
CH1	1218.0
CH41	1218.0
CH79	1224.0

3-DH5 Packet

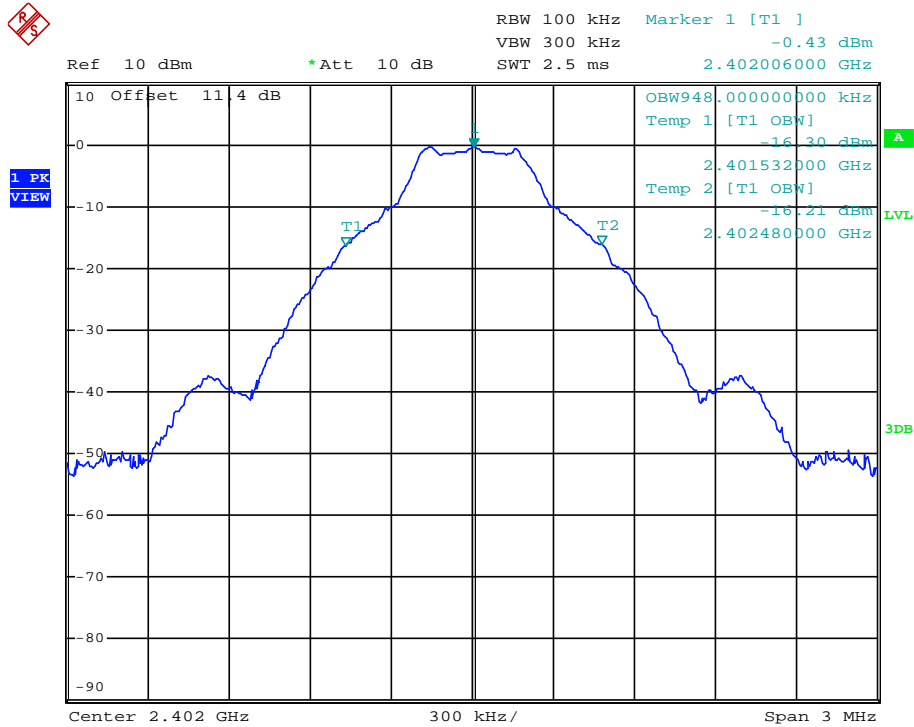
Channel No.	OBW Bandwidth (kHz)
CH1	1230.0
CH41	1230.0
CH79	1230.0

Remarks: For detailed test result please refer to following test protocols. The RSS Gen defines no limit for the occupied bandwidth!

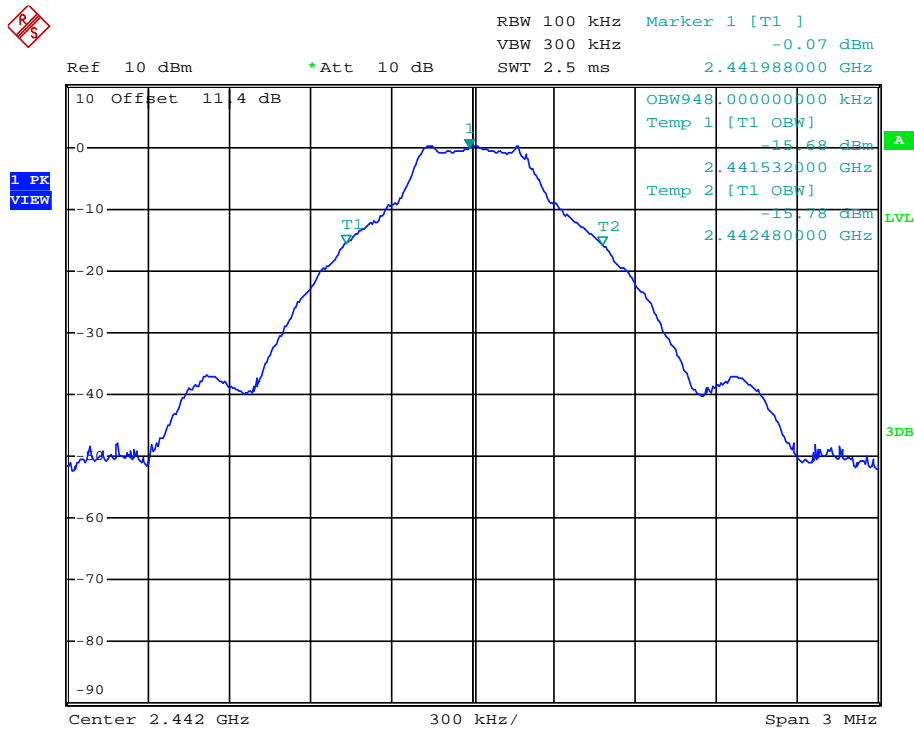
FCC ID: CWTUGZZC / IC:1788F-UGZZC

5.3.4 Test protocols

Occupied bandwidth, channel 1, DH5 Packet

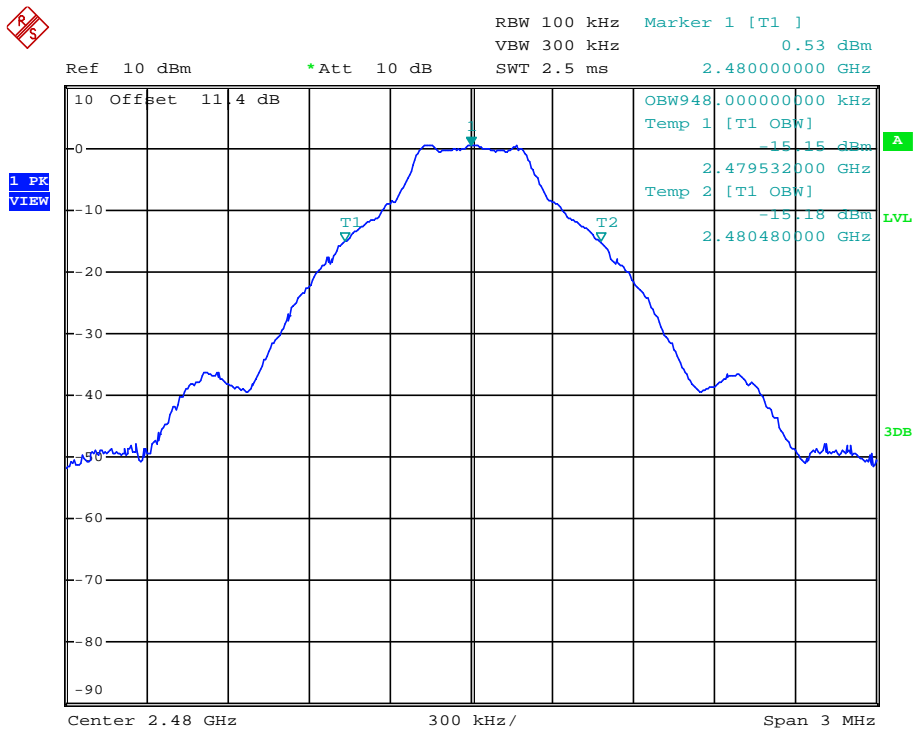


Occupied bandwidth, channel 41, DH5 Packet

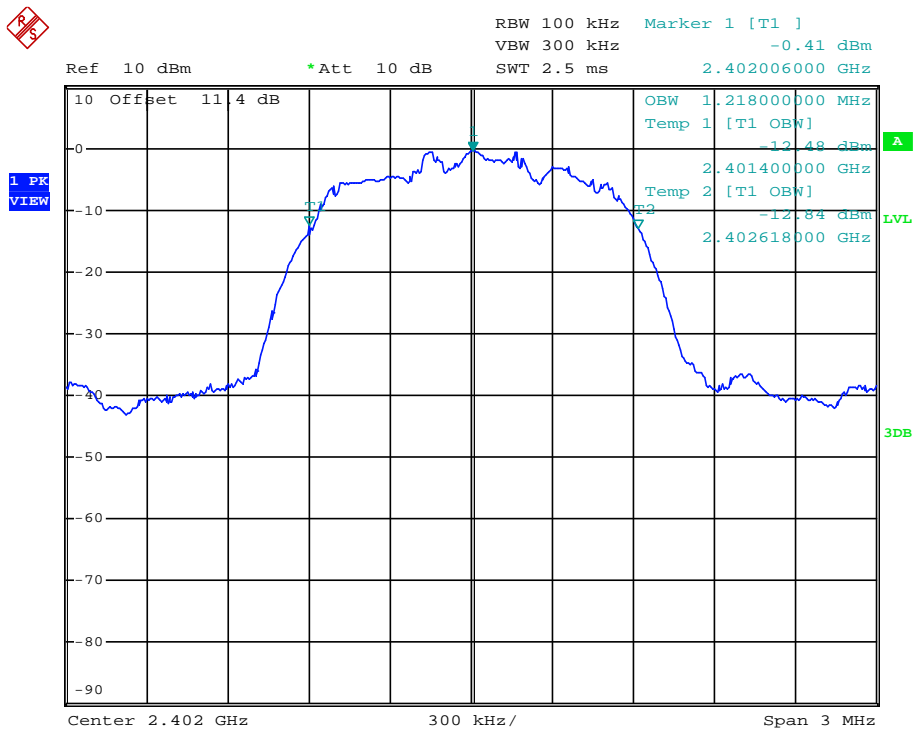


FCC ID: CWTUGZZC / IC:1788F-UGZZC

Occupied bandwidth, channel 79, DH5 Packet

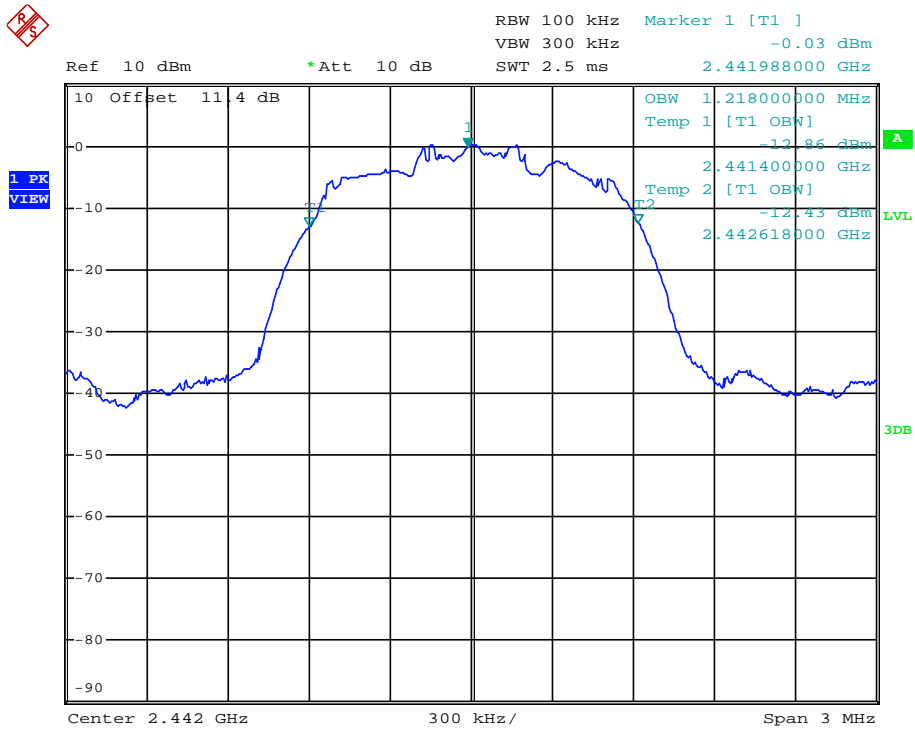


Occupied bandwidth, channel 1, 2-DH5 Packet

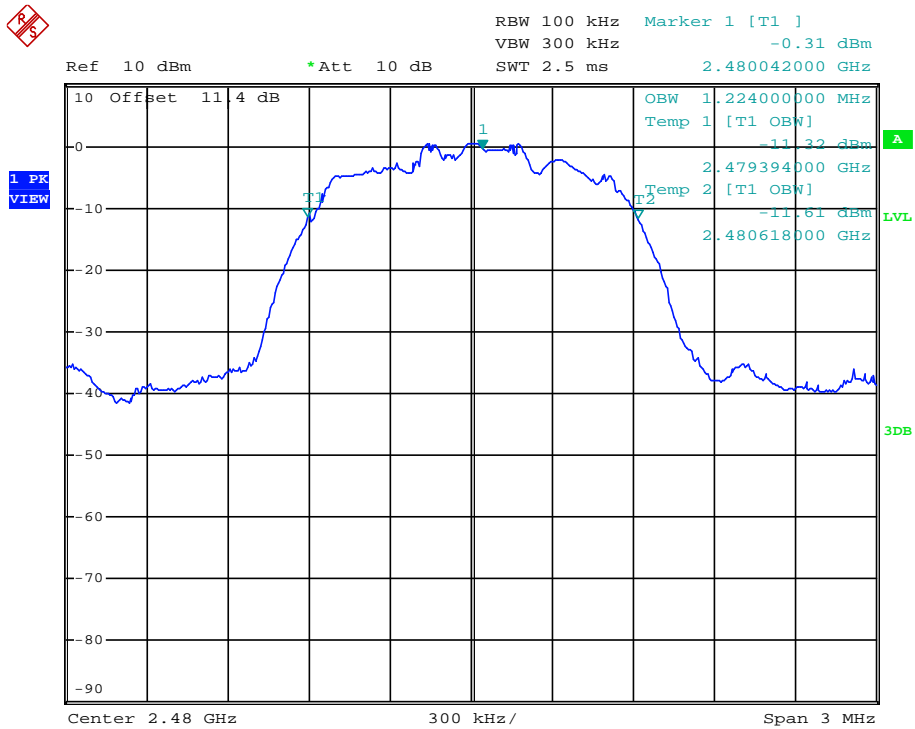


FCC ID: CWTUGZZC / IC:1788F-UGZZC

Occupied bandwidth, channel 41, 2-DH5 Packet

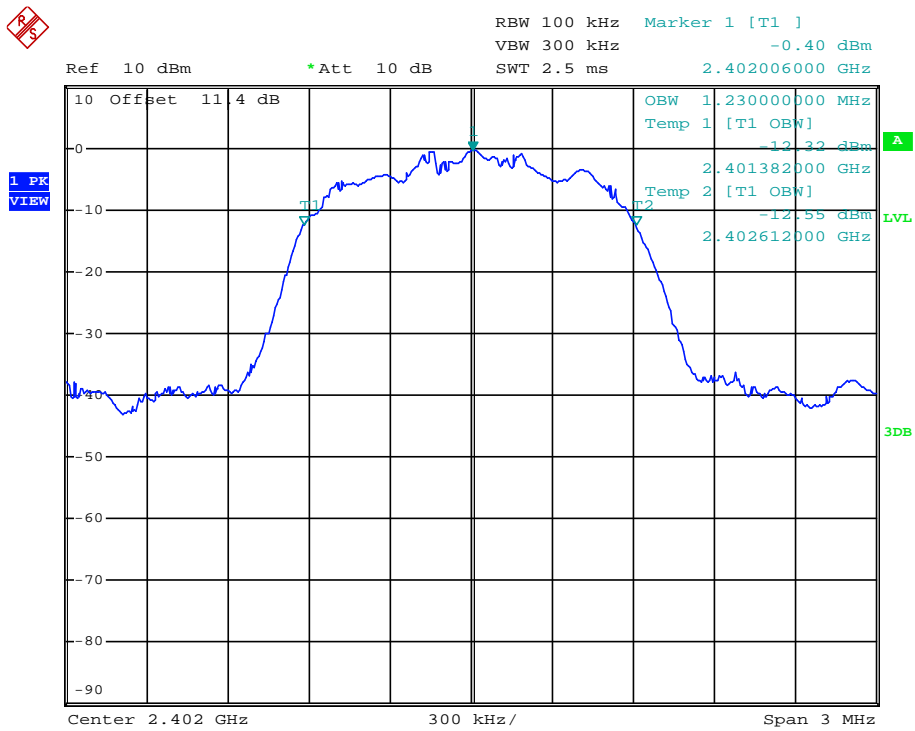


Occupied bandwidth, channel 79, 2-DH5 Packet

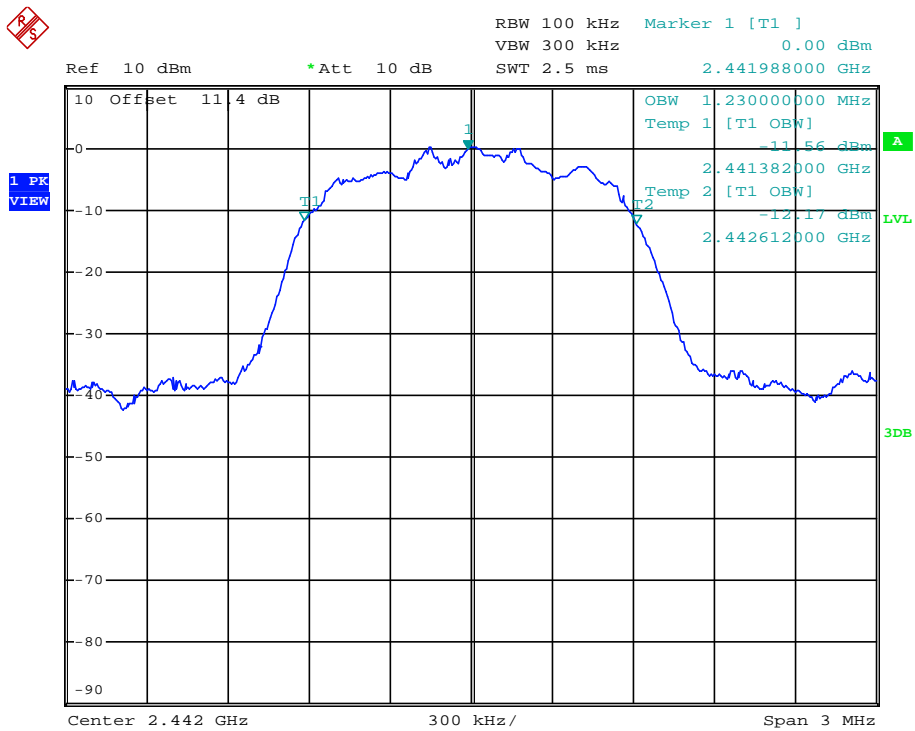


FCC ID: CWTUGZZC / IC:1788F-UGZZC

Occupied bandwidth, channel 1, 3-DH5 Packet

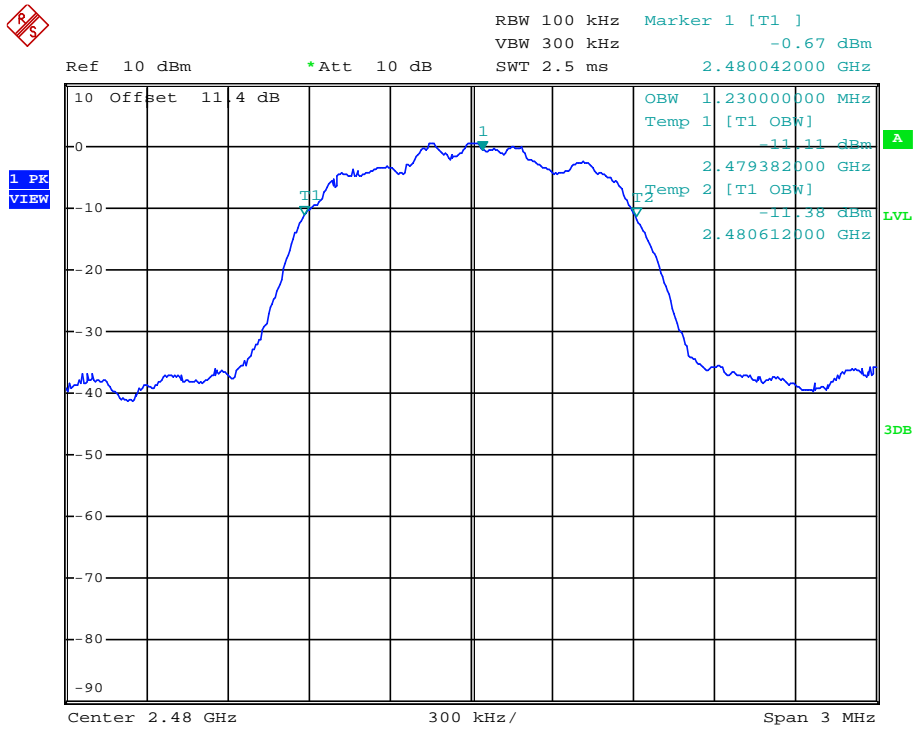


Occupied bandwidth, channel 41, 3-DH5 Packet



FCC ID: CWTUGZZC / IC:1788F-UGZZC

Occupied bandwidth, channel 79, 3-DH5 Packet



FCC ID: CWTUGZZC / IC:1788F-UGZZC

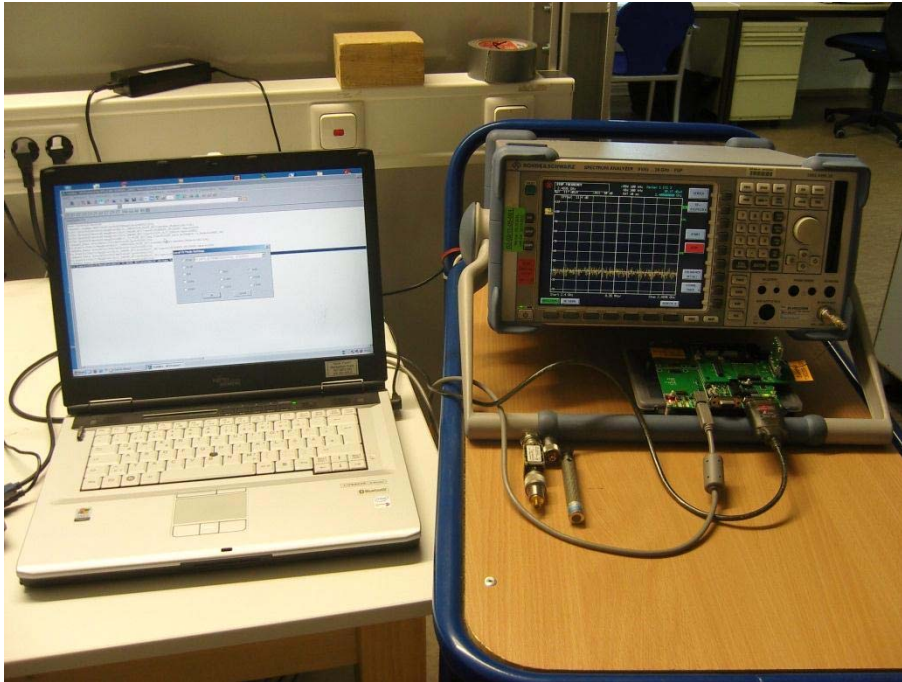
5.4 Maximum peak output power conducted

5.4.1 Description of the test location

For test instruments and accessories used see section 6 Part **CPC 3**.

Test location: Shielded Room 4

5.4.2 Photo documentation of the test set-up



5.4.3 Applicable standard

According to FCC Part 15C, Section 15.247(a)(1):

The maximum peak output power of an intentional radiator shall not exceed the limit defined in dependency of the channel separation and of the number of hopping channels.

5.4.4 Description of Measurement

A spectrum analyser is connected to the output of the transmitter via a suitable attenuator while EUT is operating in transmit mode using the assigned frequency according to DA 00-705. The cable loss and the 10 dB inline attenuator is summed up to a resulting attenuation of 11.4 dB which gives a correction factor. The correction factor is taken into account as offset during the measurements and is therefore not evident in the following tables.

Analyser settings:

RBW: 3 MHz, VBW \geq RBW, Detector: Max peak, Trace: Max hold, Sweep time: auto

FCC ID: CWTUGZZC / IC:1788F-UGZZC

5.4.5 Test result

DH5 Packet

Channel	Frequency (MHz)	Peak power (dBm)	Limit (dBm)	Delta (dB)
CH1	2402	-0.4	30	30.4
CH41	2441	0.1	30	29.9
CH79	2480	0.5	30	29.5

2-DH5 Packet

Channel	Frequency (MHz)	Peak power (dBm)	Limit (dBm)	Delta (dB)
CH1	2402	1.2	30	28.8
CH41	2441	1.8	30	28.2
CH79	2480	2.2	30	27.8

3-DH5 Packet

Channel	Frequency (MHz)	Peak power (dBm)	Limit (dBm)	Delta (dB)
CH1	2402	1.6	30	28.4
CH41	2441	2.1	30	27.9
CH79	2480	2.5	30	27.5

Peak Power Limit according to FCC Part 15C, Section 15.247(b)(1):

Frequency (MHz)	Channel separation (MHz)	Hop Channels	Peak power limit	
			(dBm)	(Watt)
2400-2483.5	1.0	≥ 75	30	1

The requirements are fulfilled

Remarks:

FCC ID: CWTUGZZC / IC:1788F-UGZZC

5.5 Spurious emissions conducted

For test instruments and accessories used see section 6 Part **SEC1**, **SEC2** and **SEC3**.

5.5.1 Description of the test location

Test location: Shielded Room 4

5.5.2 Applicable standard

According to FCC Part 15C, Section 15.247(d):

In any 100 kHz bandwidth outside the frequency bands 2400 – 2483.5 MHz and 5725 – 5850 MHz, the digitally modulated 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 an radiated measurement. Attenuation below the general limits specified in Section 15.209(a) is not required.

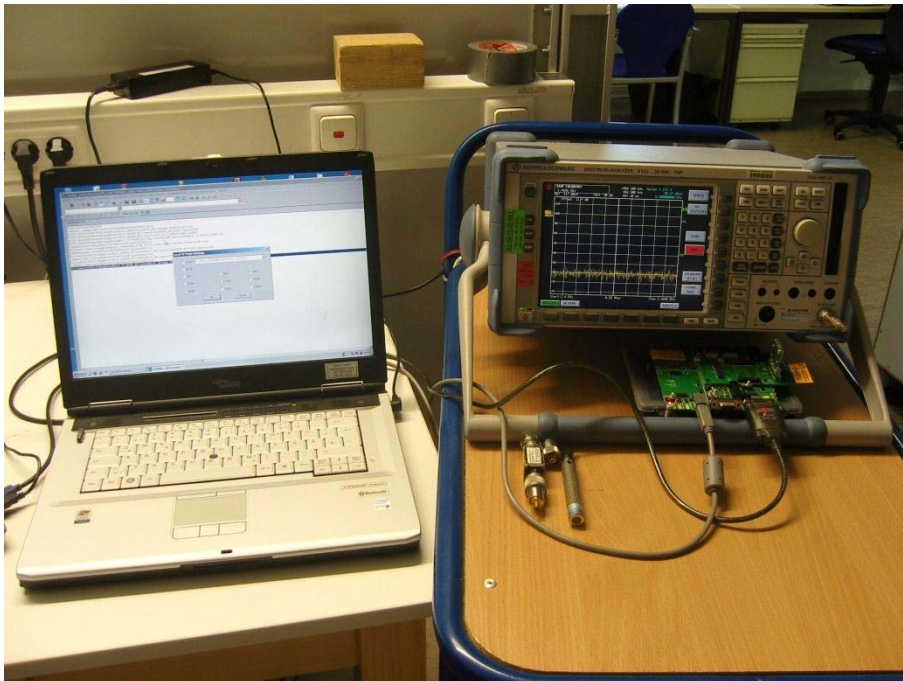
5.5.3 Description of Measurement

A spectrum analyser is connected to the output of the transmitter via a suitable attenuator while EUT is operating in transmit mode using the assigned frequency according to DA 00-705.

Spectrum analyser settings:

RBW: 100 kHz, VBW: 300 kHz, Detector: Max peak, Trace: Max hold, Sweep: auto

5.5.4 Photo documentation of the test set-up



FCC ID: CWTUGZZC / IC:1788F-UGZZC
5.5.5 Test result

Lowest frequency generated in the EUT: 26 MHz

DH5 Packet

CH1					
Range (MHz)	f (MHz)	P _{conducted} (dBm)	Ant. Gain (dBi)	EIRP (dBm)	Limit (dBm)
26-1000	95.5	-77.7	0.6	-77.1	-52
1000-4000	3124	-61.4	0.6	-60.8	-41.2
4000-10000	4804	-71.5	0.6	-70.9	-41.2
10000-17000	14977	-64.5	0.6	-63.9	-41.2
17000-25000	24008	-60.3	0.6	-59.7	-41.2
CH41					
Range (MHz)	f (MHz)	P _{conducted} (dBm)	Ant. Gain (dBi)	EIRP (dBm)	Limit (dBm)
26-1000	208.2	-77.9	0.6	-77.3	-52
1000-4000	2978.5	-62.7	0.6	-62.1	-41.2
4000-10000	4882	-70.5	0.6	-69.9	-41.2
10000-17000	14865	-64.5	0.6	-63.9	-41.2
17000-25000	23904	-59.7	0.6	-59.1	-41.2
CH79					
Range (MHz)	f (MHz)	P _{conducted} (dBm)	Ant. Gain (dBi)	EIRP (dBm)	Limit (dBm)
26-1000	863.8	-77.7	0.6	-77.1	-49.2
1000-4000	3907	-62.1	0.6	-61.5	-41.2
4000-10000	4954	-71.9	0.6	-71.3	-41.2
10000-17000	14977	-64.5	0.6	-63.9	-41.2
17000-25000	24056	-60	0.6	-59.4	-41.2

FCC ID: CWTUGZZC / IC:1788F-UGZZC

2-DH5 Packet

CH1					
Range (MHz)	f (MHz)	P _{conducted} (dBm)	Ant. Gain (dBi)	EIRP (dBm)	Limit (dBm)
26-1000	95.5	-78.5	0.6	-77.9	-52
1000-4000	3124	-61.4	0.6	-60.8	-41.2
4000-10000	4804	-71.5	0.6	-70.9	-41.2
10000-17000	14977	-64.7	0.6	-64.1	-41.2
17000-25000	240008	-60.3	0.6	-59.7	-41.2
CH41					
Range(MHz)	f (MHz)	P _{conducted} (dBm)	Ant. Gain (dBi)	EIRP (dBm)	Limit (dBm)
26-1000	156.2	-78.1	0.6	-77.5	-52
1000-4000	3764.5	-62.1	0.6	-61.5	-41.2
4000-10000	4882	-70.3	0.6	-69.7	-41.2
10000-17000	15047	-64	0.6	-63.4	-41.2
17000-25000	24016	-60.4	0.6	-59.8	-41.2
CH79					
Range (MHz)	f (MHz)	P _{conducted} (dBm)	Ant. Gain (dBi)	EIRP (dBm)	Limit (dBm)
26-1000	843.2	-77.9	0.6	-77.3	-49.2
1000-4000	3583	-62.6	0.6	-62	-41.2
4000-10000	4954	-71.6	0.6	-71	-41.2
10000-17000	14998	-65.3	0.6	-64.7	-41.2
17000-25000	23.9	-60.2	0.6	-59.6	-41.2

FCC ID: CWTUGZZC / IC:1788F-UGZZC

3-DH5 Packet

CH1					
Range (MHz)	f (MHz)	P _{conducted} (dBm)	Ant. Gain (dBi)	EIRP (dBm)	Limit (dBm)
26-1000	95.5	-76.8	0.6	-76.2	-52
1000-4000	3025	-61.8	0.6	-61.2	-41.2
4000-10000	4804	-72.8	0.6	-72.2	-41.2
10000-17000	13738	-64.6	0.6	-64.0	-41.2
17000-25000	23904	-59.9	0.6	-59.3	-41.2
CH41					
Range (MHz)	f (MHz)	P _{conducted} (dBm)	Ant. Gain (dBi)	EIRP (dBm)	Limit (dBm)
26-1000	905.9	-76.5	0.6	-75.9	-49.2
1000-4000	3847	-61.6	0.6	-61.0	-41.2
4000-10000	4882	-73	0.6	-72.4	-41.2
10000-17000	15005	-64.6	0.6	-64.0	-41.2
17000-25000	23968	-60.3	0.6	-59.7	-41.2
CH79					
Range (MHz)	f (MHz)	P _{conducted} (dBm)	Ant. Gain (dBi)	EIRP (dBm)	Limit (dBm)
26-1000	912.8	-79	0.6	-78.4	-49.2
1000-4000	3712	-62	0.6	-61.4	-41.2
4000-10000	4954	-70.7	0.6	-70.1	-41.2
10000-17000	14998	-64.9	0.6	-64.3	-41.2
17000-25000	24112	-60.4	0.6	-59.8	-41.2

Only the spurious falling in restricted bands has to be measured radiated additionally!!!

Peak-Limit according to FCC Part 15C, Section 15.247(d):

In any 100 kHz bandwidth outside the frequency band 2400 – 2483.50 MHz, 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 limit specified in Section 15.209(a).

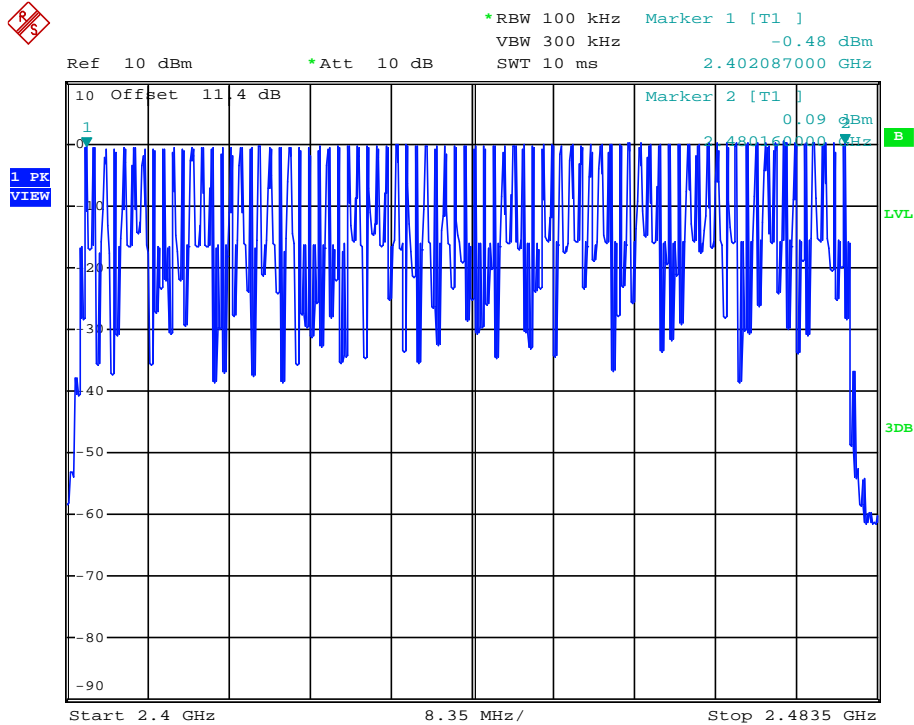
The requirements are fulfilled

Remarks: For detailed test results please refer to following test protocols.

FCC ID: CWTUGZZC / IC:1788F-UGZZC

5.5.6 Test protocol

Determination of the limit level
2400 MHz – 2483.5 MHz



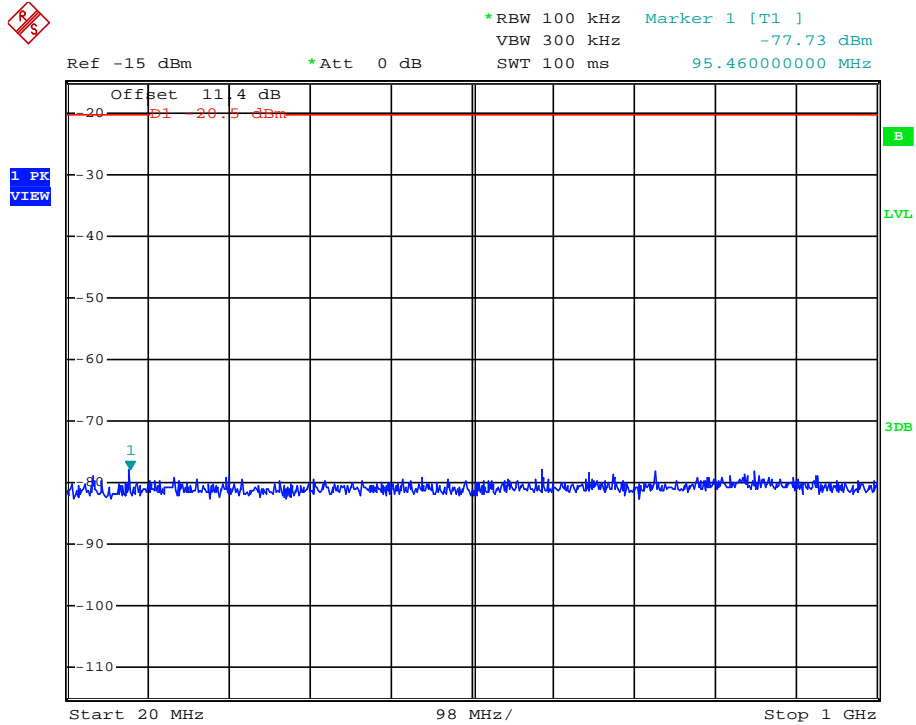
Note:

The plot shows a nearly linear channel power. Therefore it is considered to define the worst case of the emission at channel 1 (2402 MHz) with a measured power of -0.48 dBm and set the display line to a limit of -20.5 dBm.

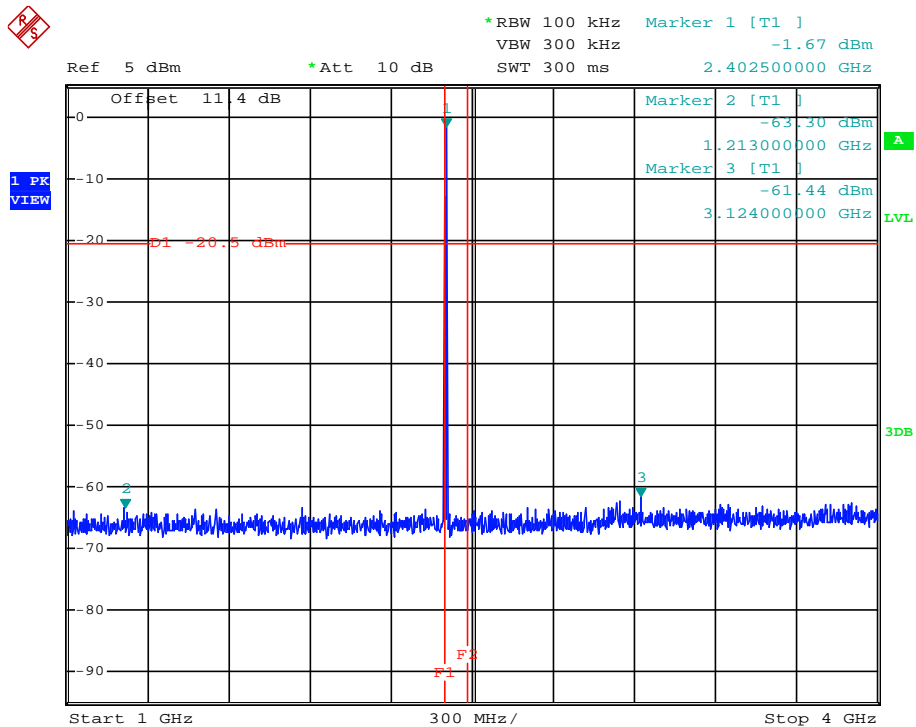
FCC ID: CWTUGZZC / IC:1788F-UGZZC

Spurious emissions conducted, DH5 packet:

20 MHz – 1 GHz, Channel 1

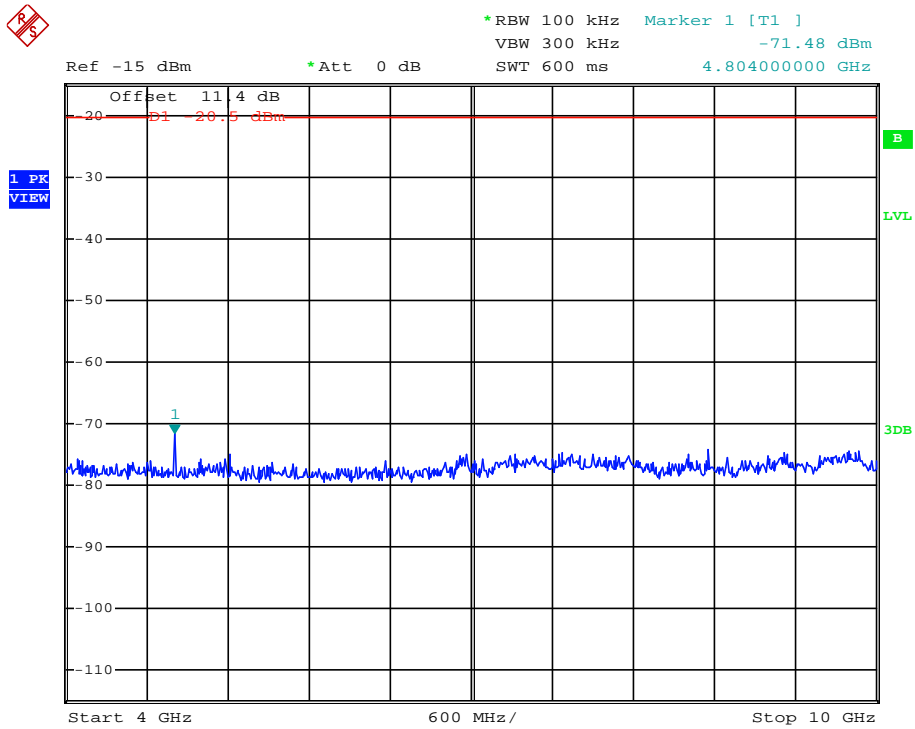


1 GHz – 4.0 GHz, Channel 1

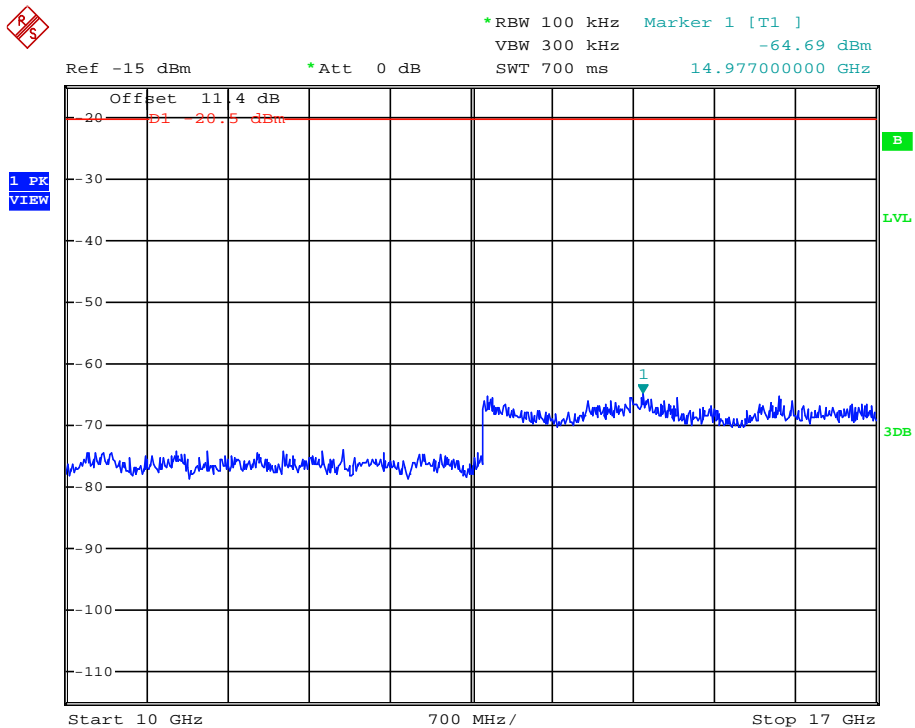


FCC ID: CWTUGZZC / IC:1788F-UGZZC

4.0 GHz – 10 GHz, Channel 1

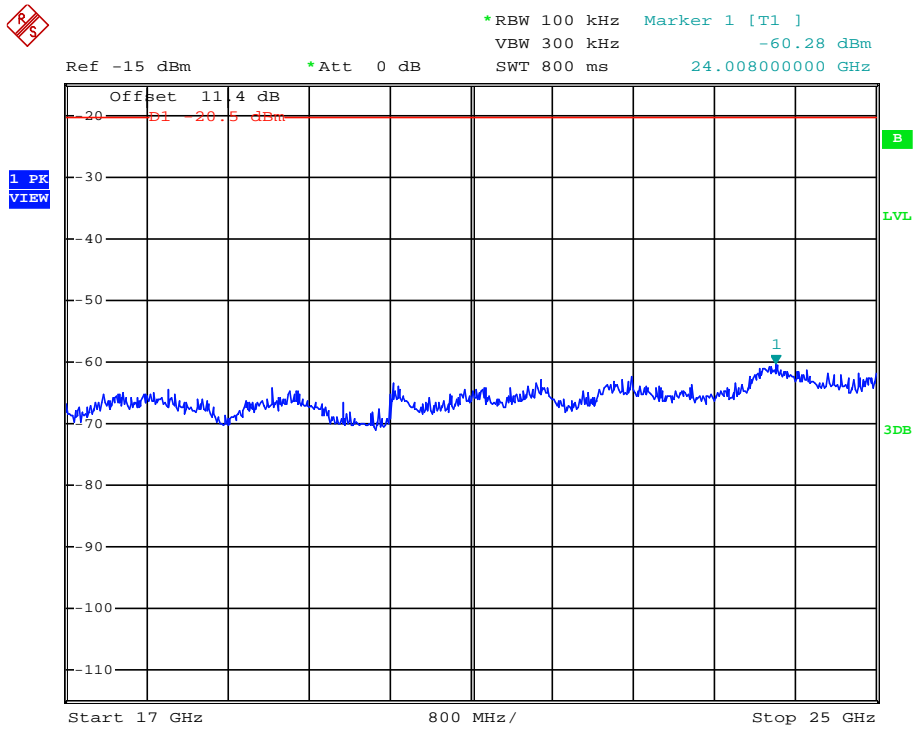


10 GHz – 17 GHz, Channel 1



FCC ID: CWTUGZZC / IC:1788F-UGZZC

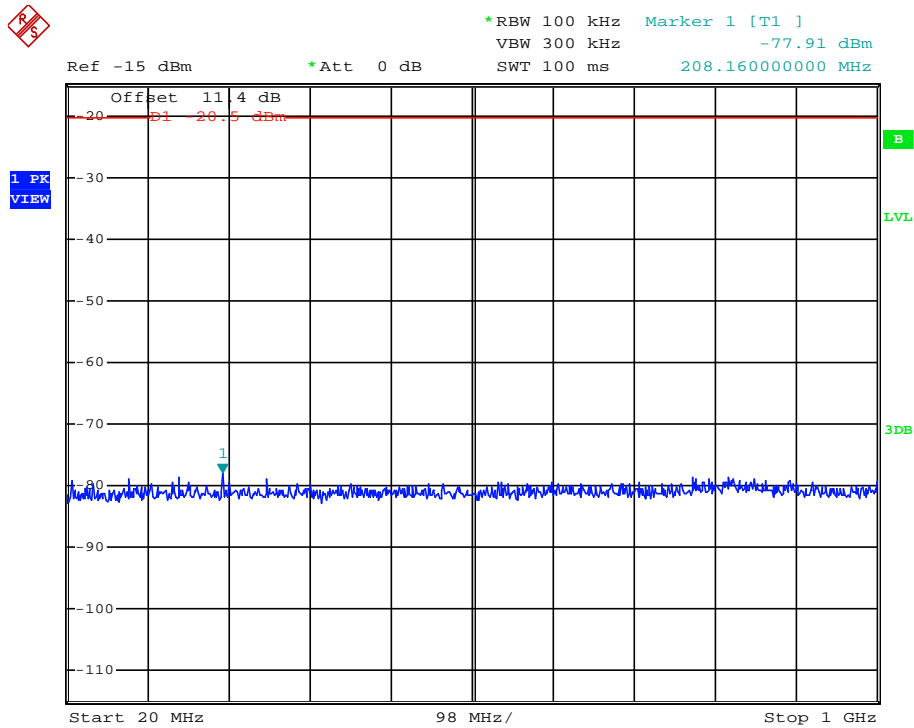
17 GHz – 25 GHz, Channel 1



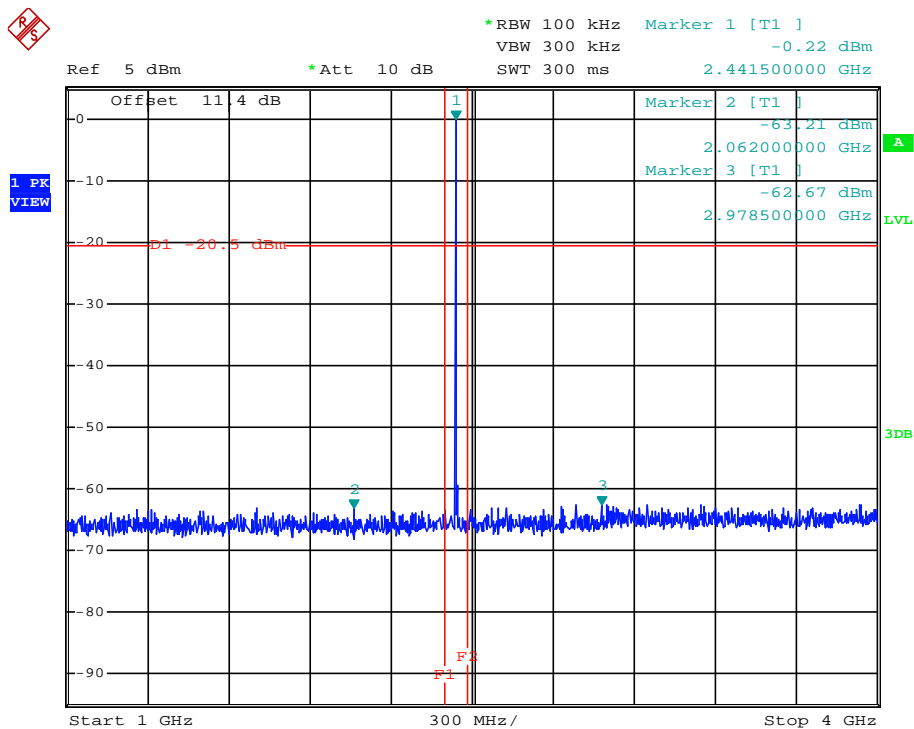
FCC ID: CWTUGZZC / IC:1788F-UGZZC

Spurious emissions conducted, DH5 packet:

20 MHz – 1 GHz, Channel 41

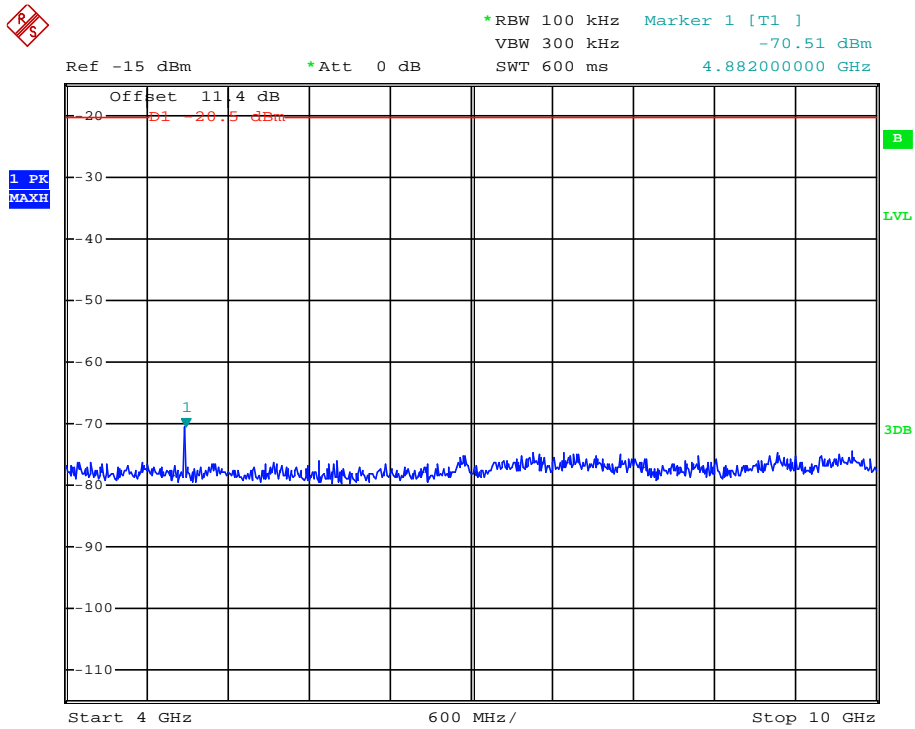


1 GHz – 4.0 GHz, Channel 41

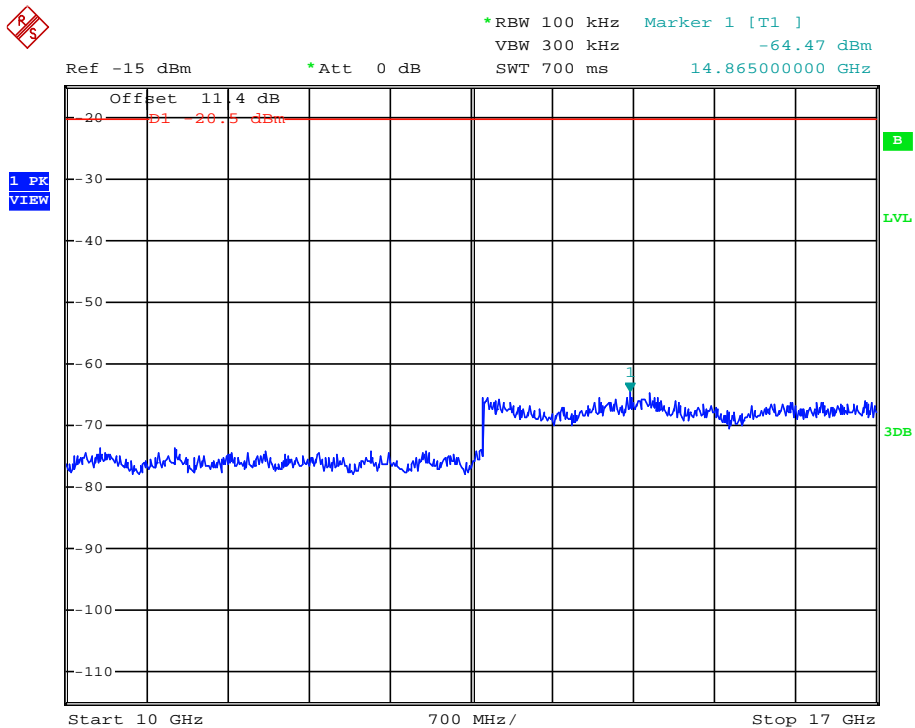


FCC ID: CWTUGZZC / IC:1788F-UGZZC

4.0 GHz – 10 GHz, Channel 41

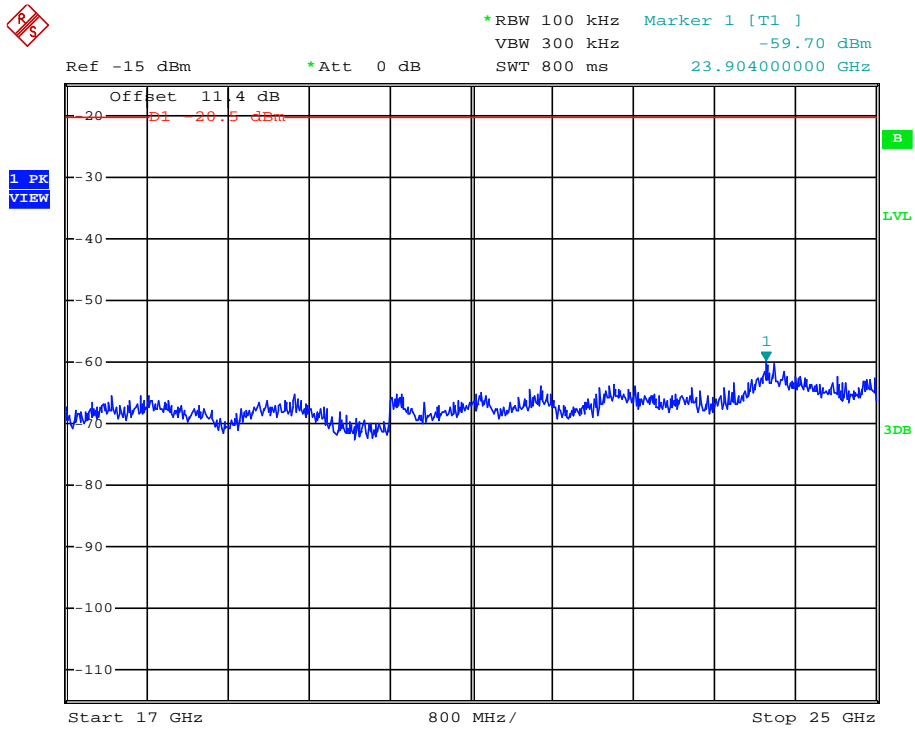


10 GHz – 17 GHz, Channel 41



FCC ID: CWTUGZZC / IC:1788F-UGZZC

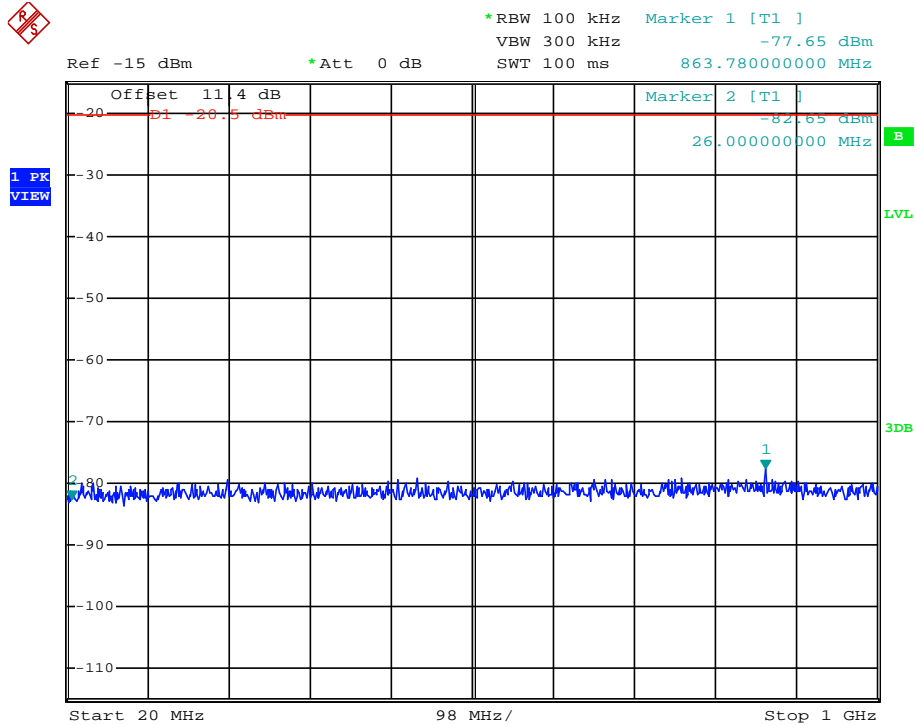
17 GHz – 25 GHz, Channel 41



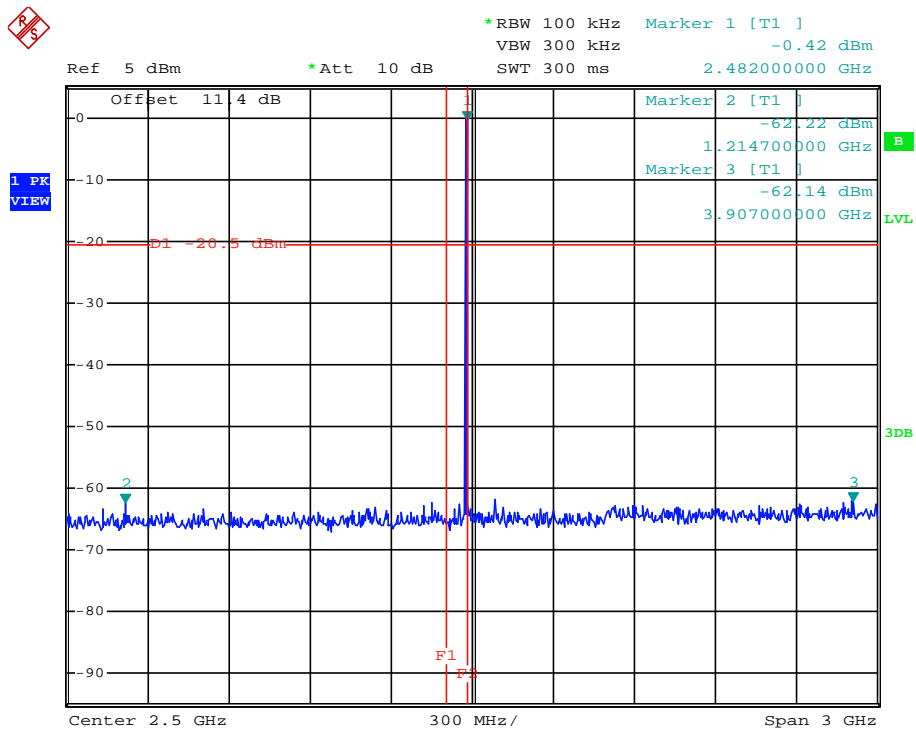
FCC ID: CWTUGZZC / IC:1788F-UGZZC

Spurious emissions conducted, DH5 packet:

20 MHz – 1 GHz, Channel 79

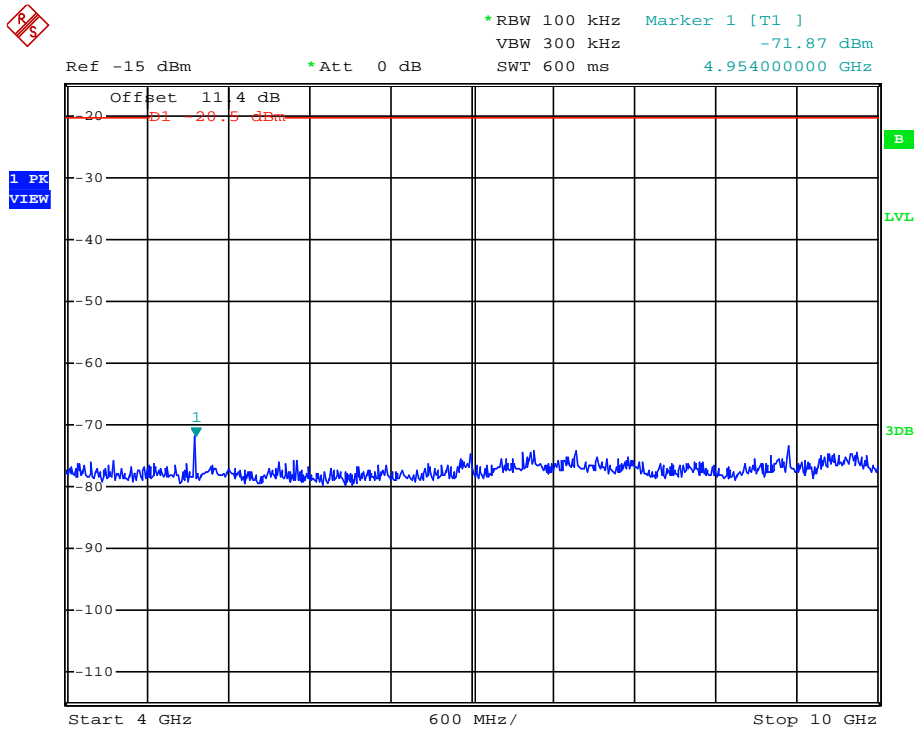


1 GHz – 4.0 GHz, Channel 79

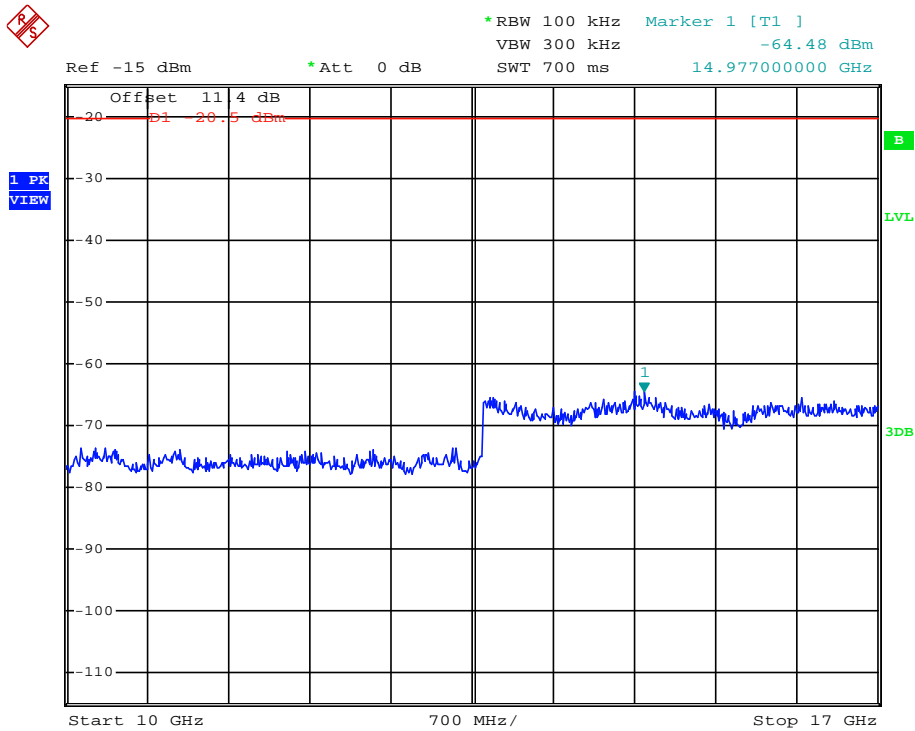


FCC ID: CWTUGZZC / IC:1788F-UGZZC

4.0 GHz – 10 GHz, Channel 79

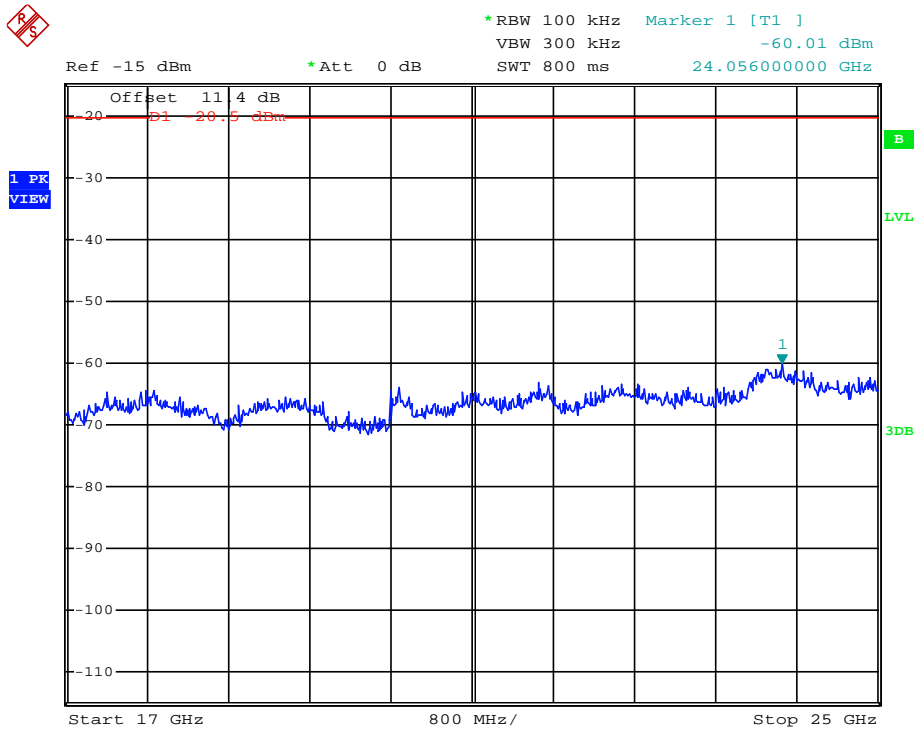


10 GHz – 17 GHz, Channel 79



FCC ID: CWTUGZZC / IC:1788F-UGZZC

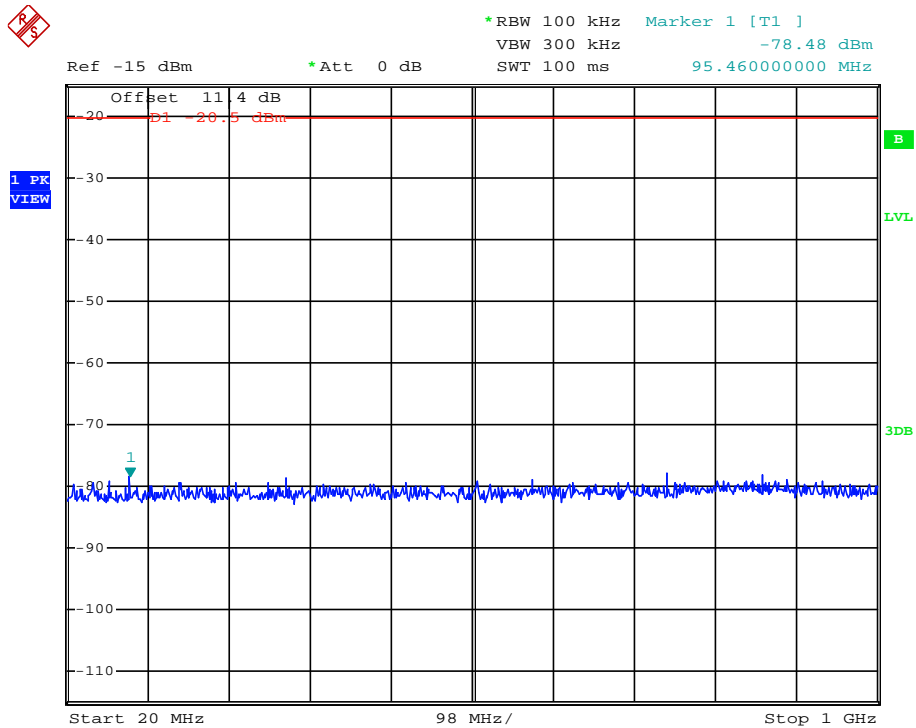
17 GHz – 25 GHz, Channel 79



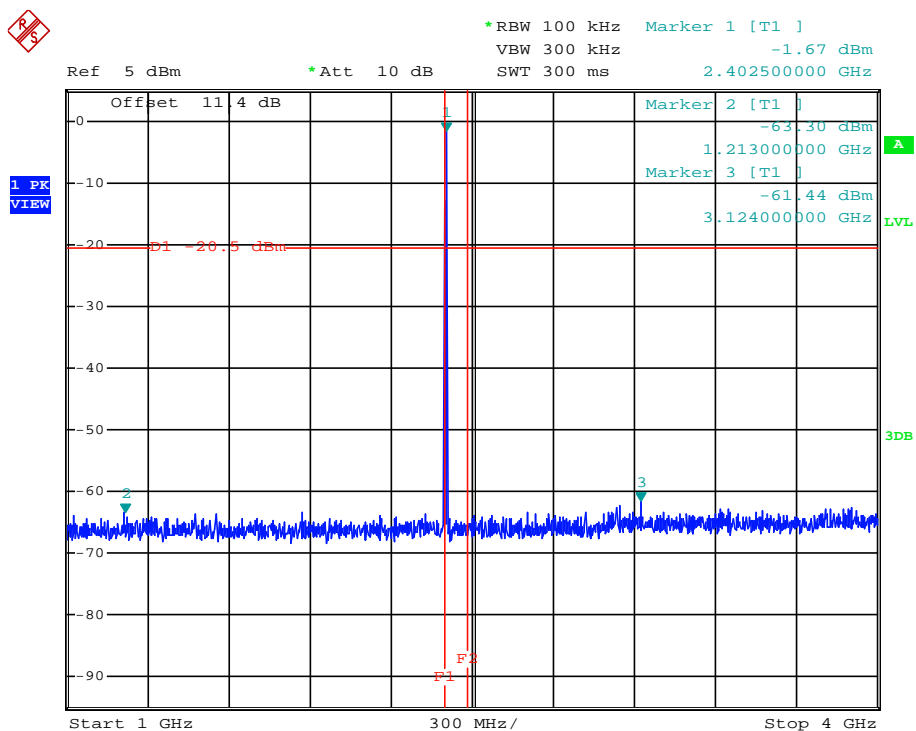
FCC ID: CWTUGZZC / IC:1788F-UGZZC

Spurious emissions conducted, 2-DH5 packet:

20 MHz – 1 GHz, Channel 1

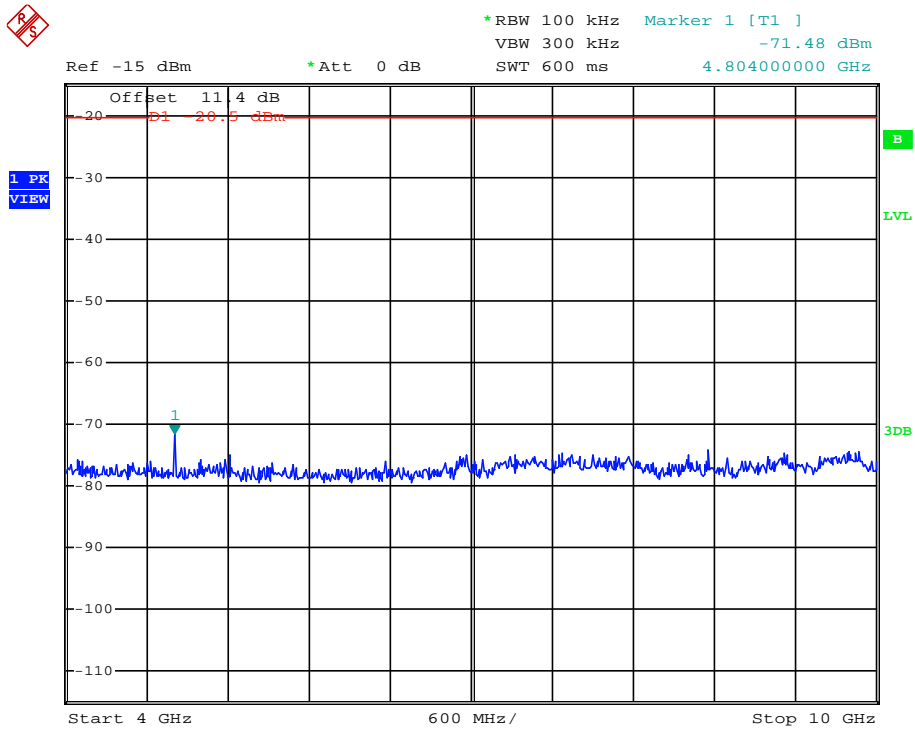


1 GHz – 4.0 GHz, Channel 1

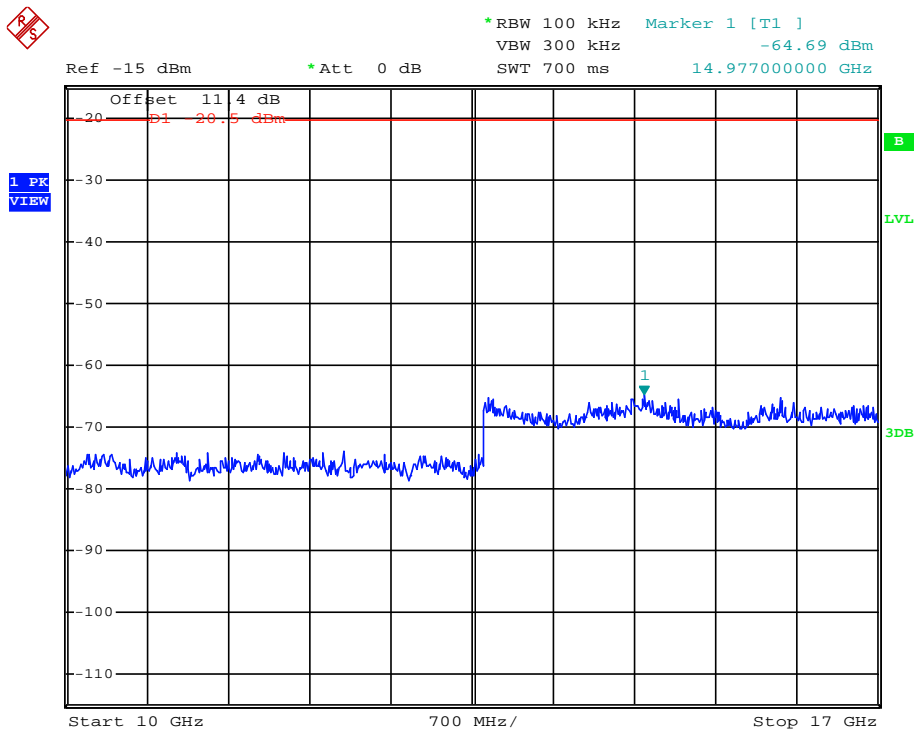


FCC ID: CWTUGZZC / IC:1788F-UGZZC

4.0 GHz – 10 GHz, Channel 1

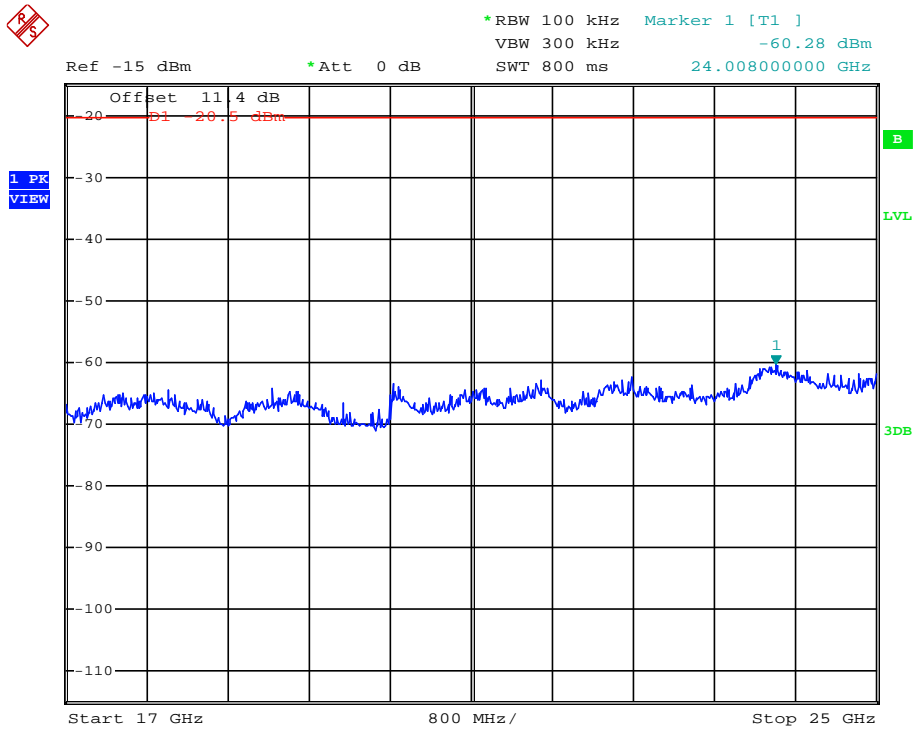


10 GHz – 17 GHz, Channel 1



FCC ID: CWTUGZZC / IC:1788F-UGZZC

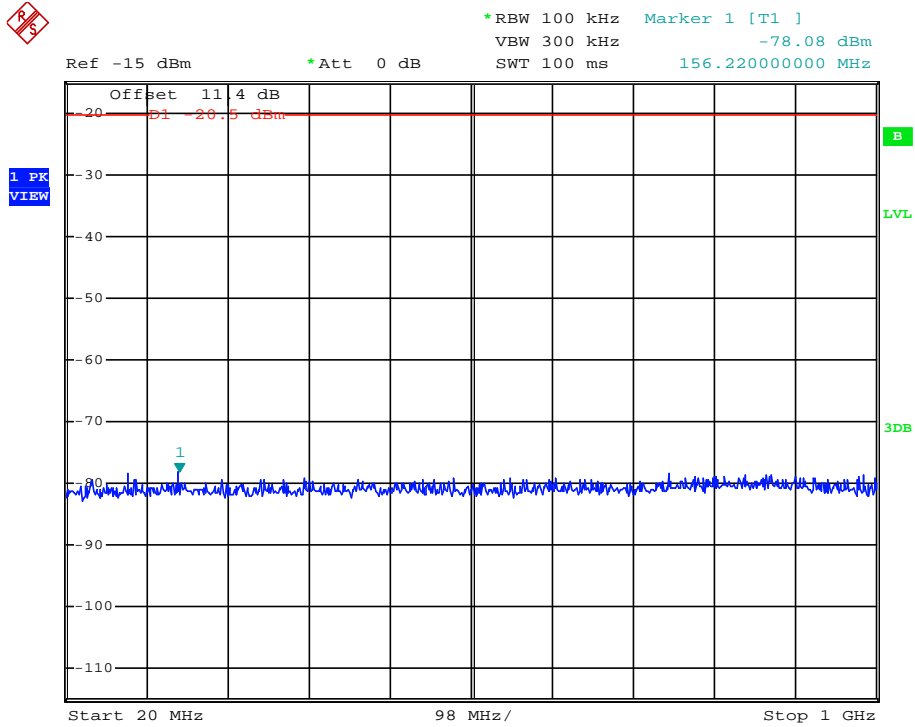
17 GHz – 25 GHz, Channel 1



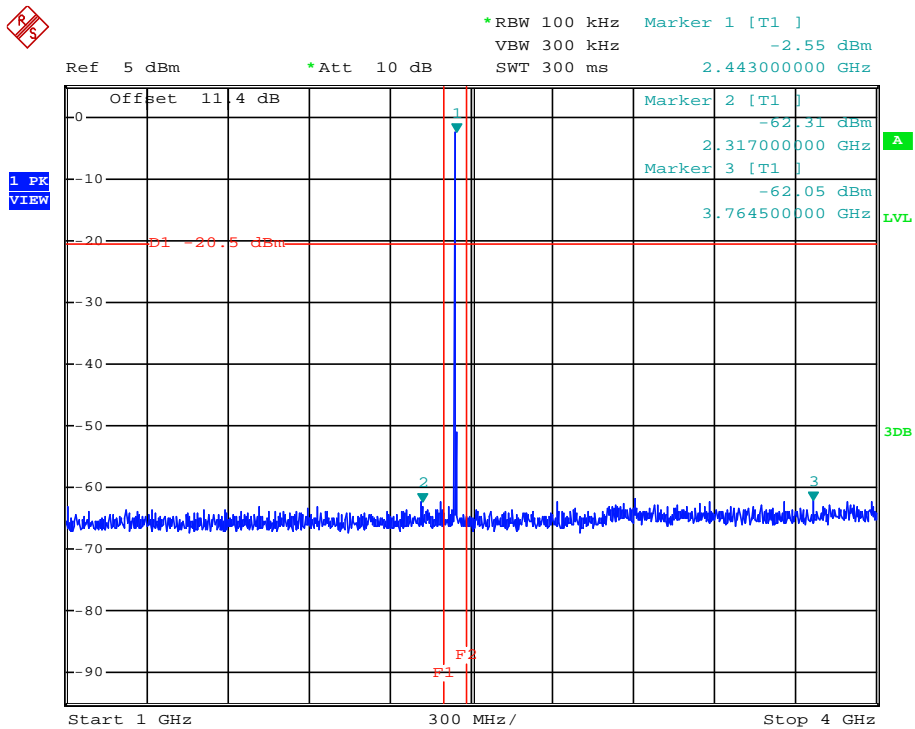
FCC ID: CWTUGZZC / IC:1788F-UGZZC

Spurious emissions conducted, 2-DH5 packet:

20 MHz – 1 GHz, Channel 41

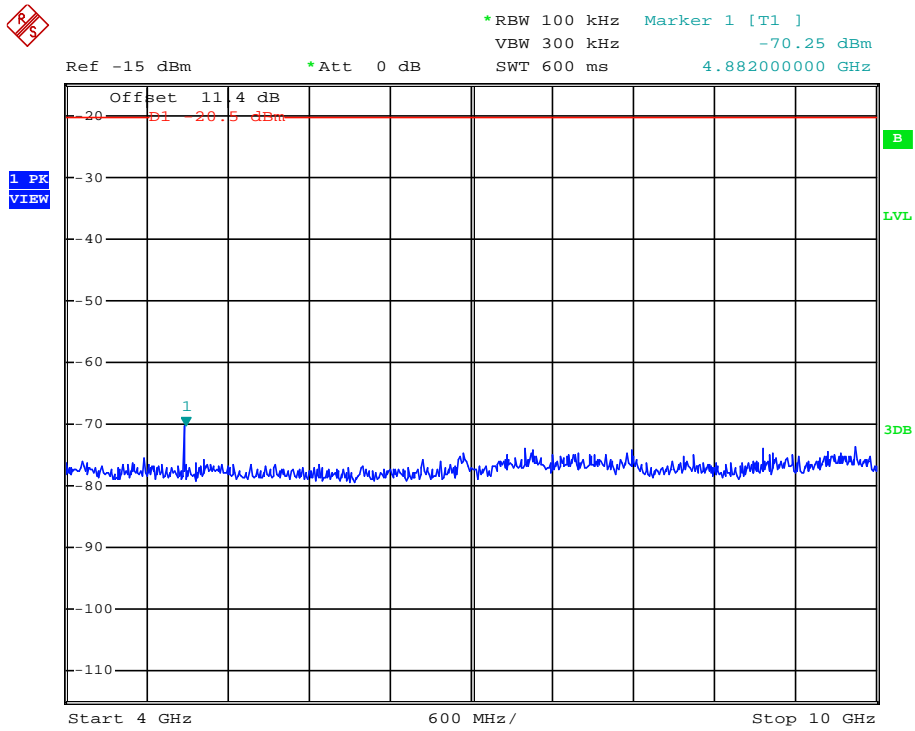


1 GHz – 4.0 GHz, Channel 41

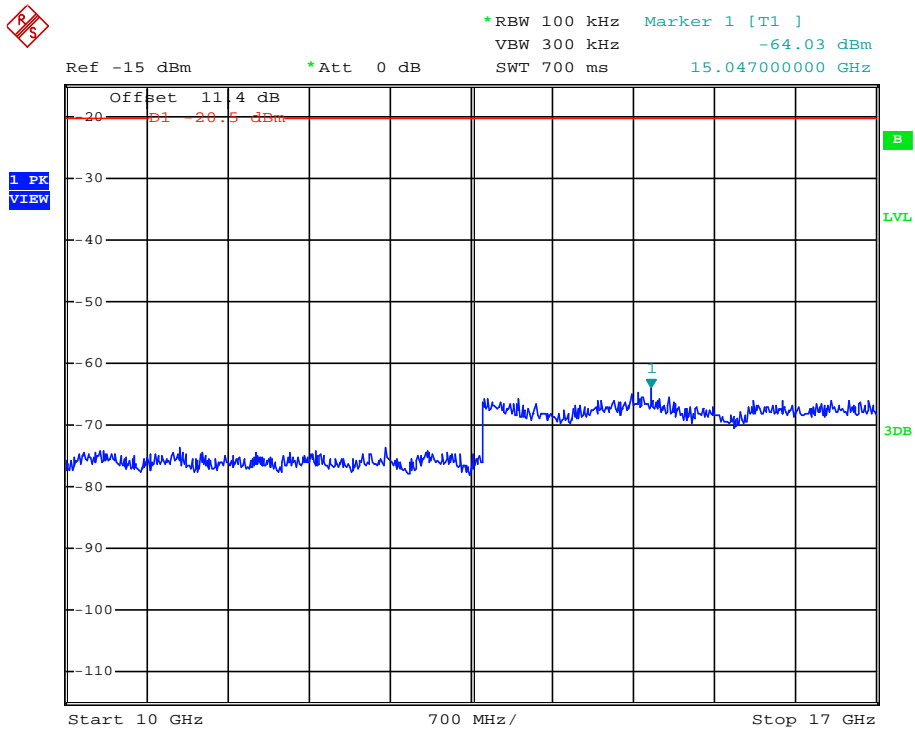


FCC ID: CWTUGZZC / IC:1788F-UGZZC

4.0 GHz – 10 GHz, Channel 41

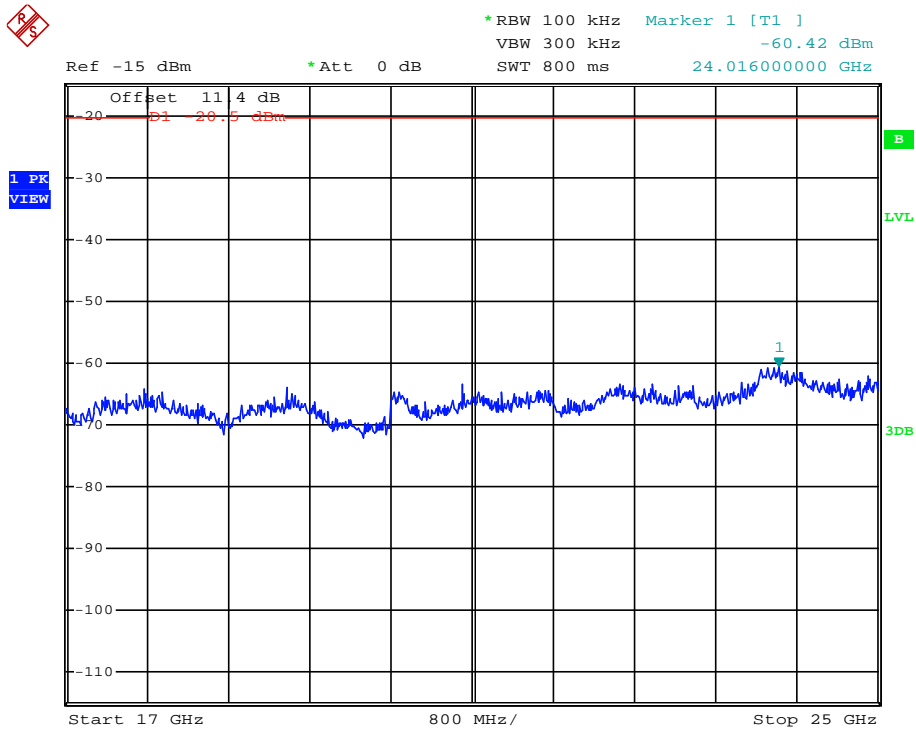


10 GHz – 17 GHz, Channel 41



FCC ID: CWTUGZZC / IC:1788F-UGZZC

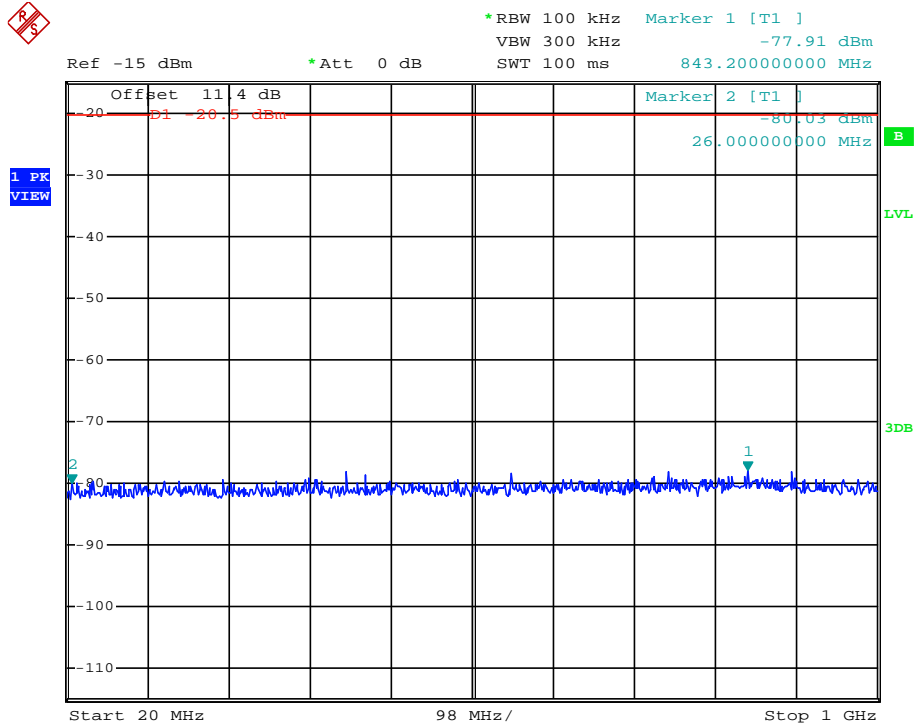
17 GHz – 25 GHz, Channel 41



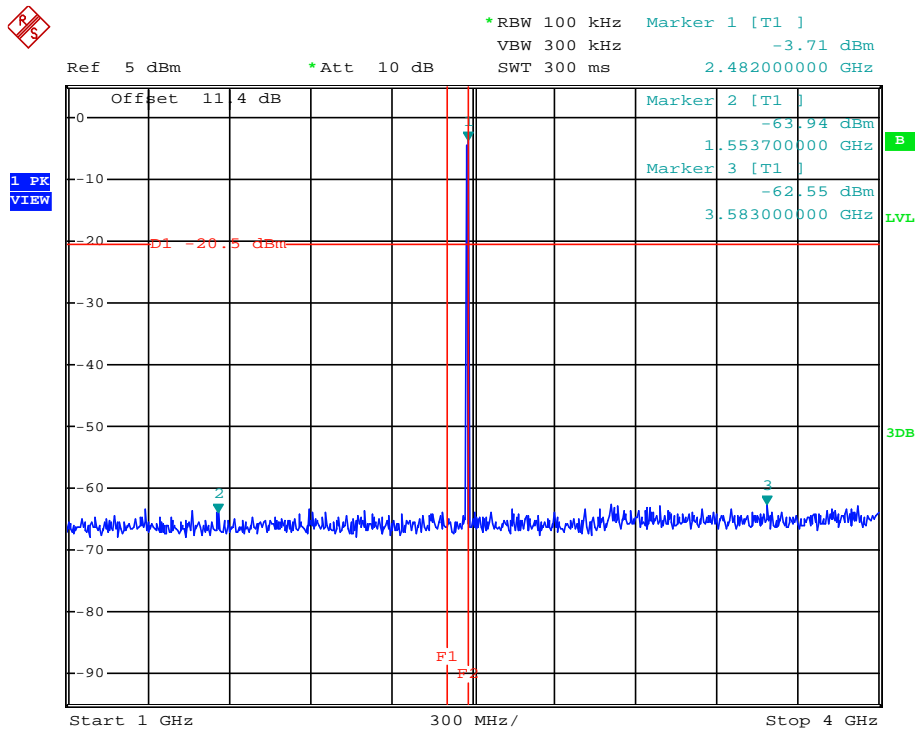
FCC ID: CWTUGZZC / IC:1788F-UGZZC

Spurious emissions conducted, 2-DH5 packet:

20 MHz – 1 GHz, Channel 79

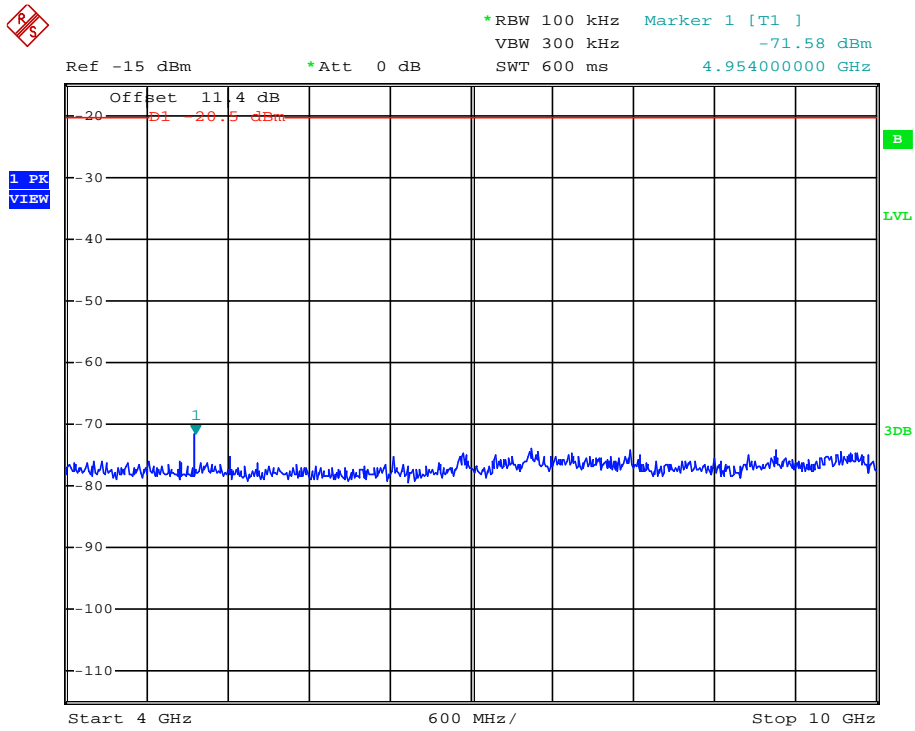


1 GHz – 4.0 GHz, Channel 79

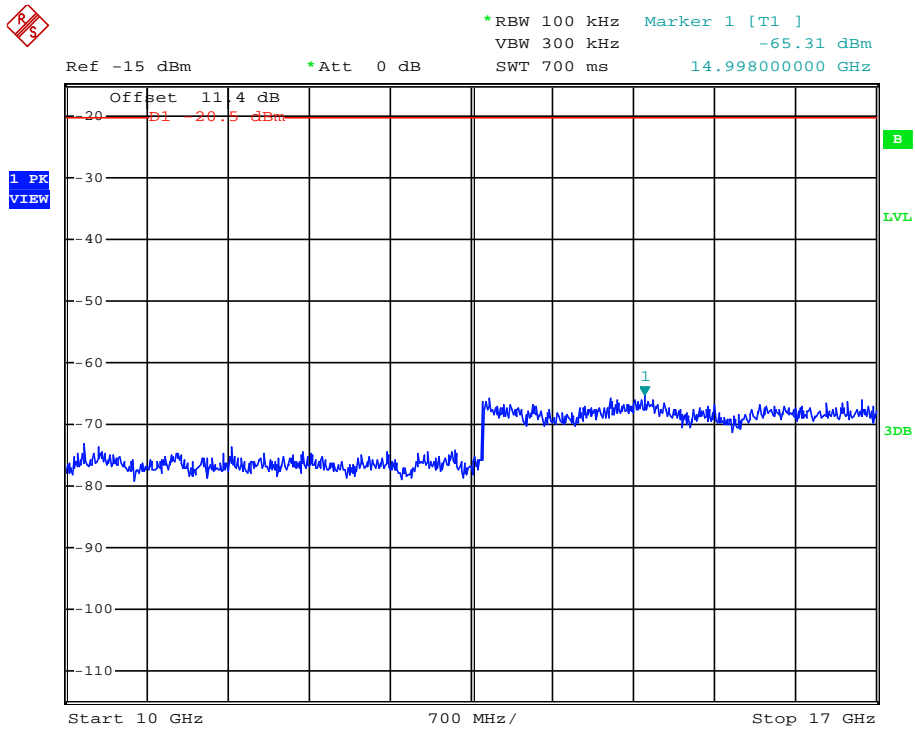


FCC ID: CWTUGZZC / IC:1788F-UGZZC

4.0 GHz – 10 GHz, Channel 79

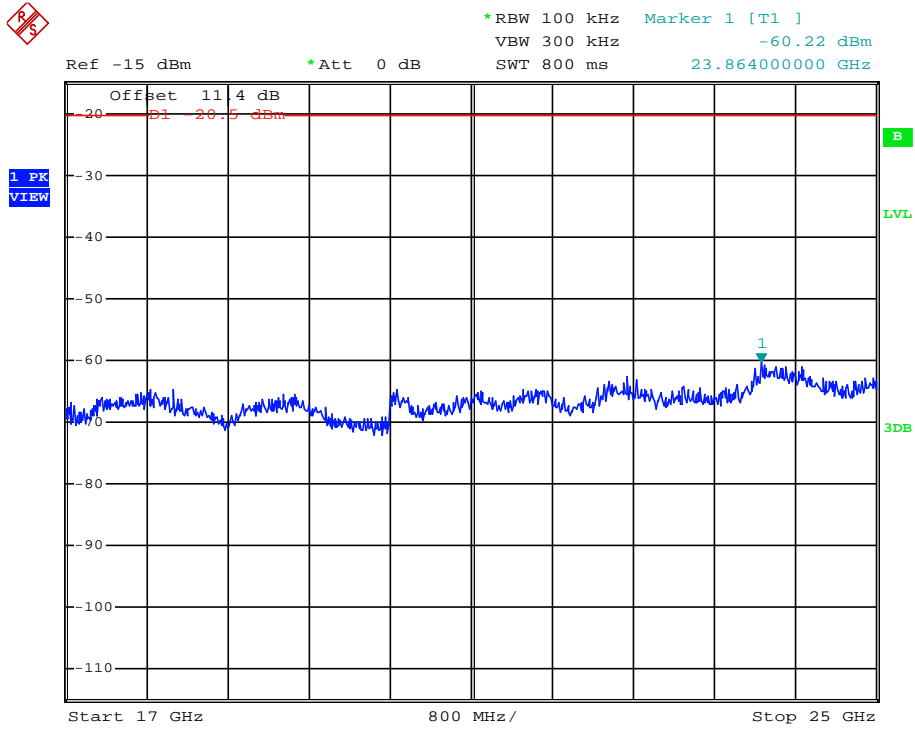


10 GHz – 17 GHz, Channel 79



FCC ID: CWTUGZZC / IC:1788F-UGZZC

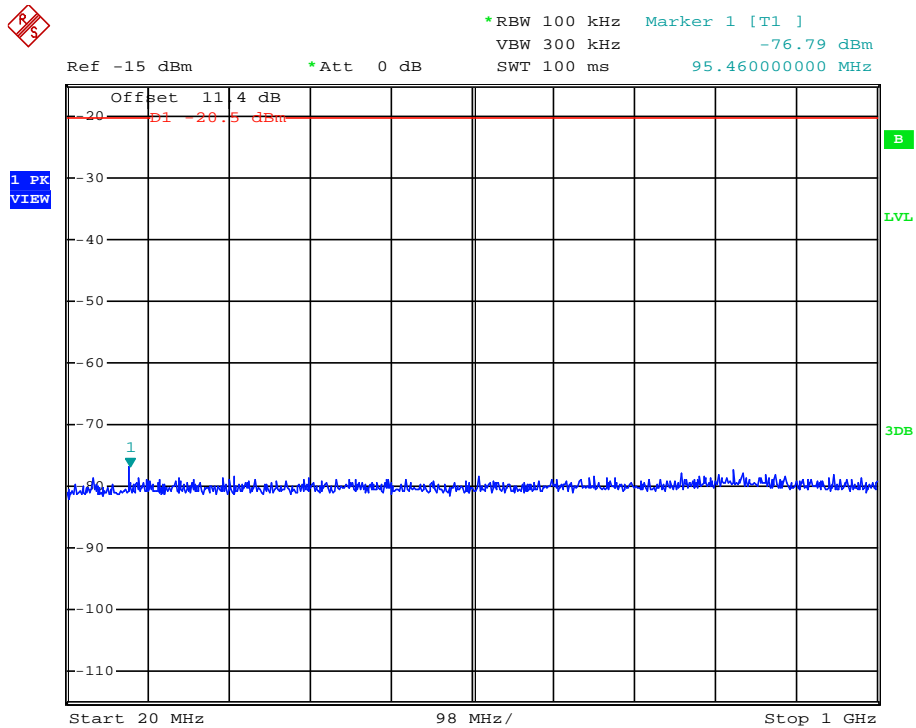
17 GHz – 25 GHz, Channel 79



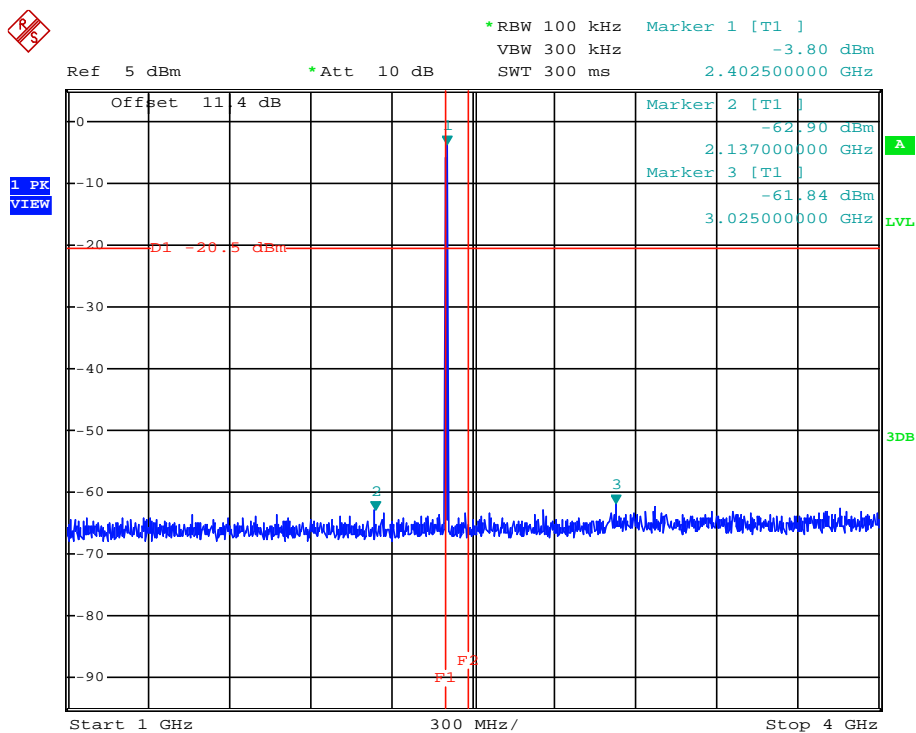
FCC ID: CWTUGZZC / IC:1788F-UGZZC

Spurious emissions conducted, 3-DH5 packet:

20 MHz – 1 GHz, Channel 1

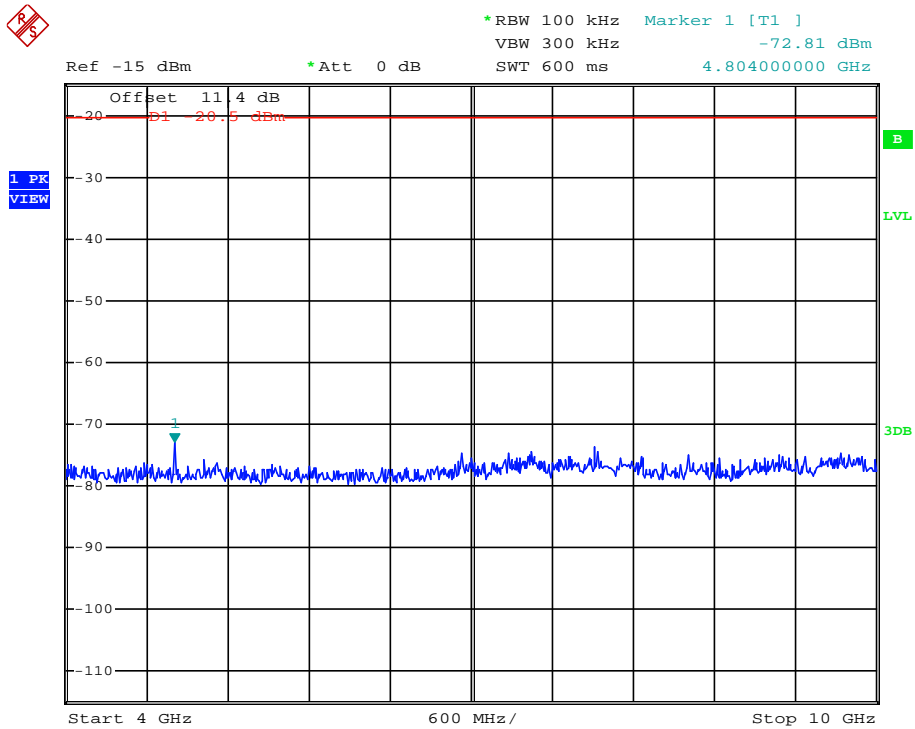


1 GHz – 4.0 GHz, Channel 1

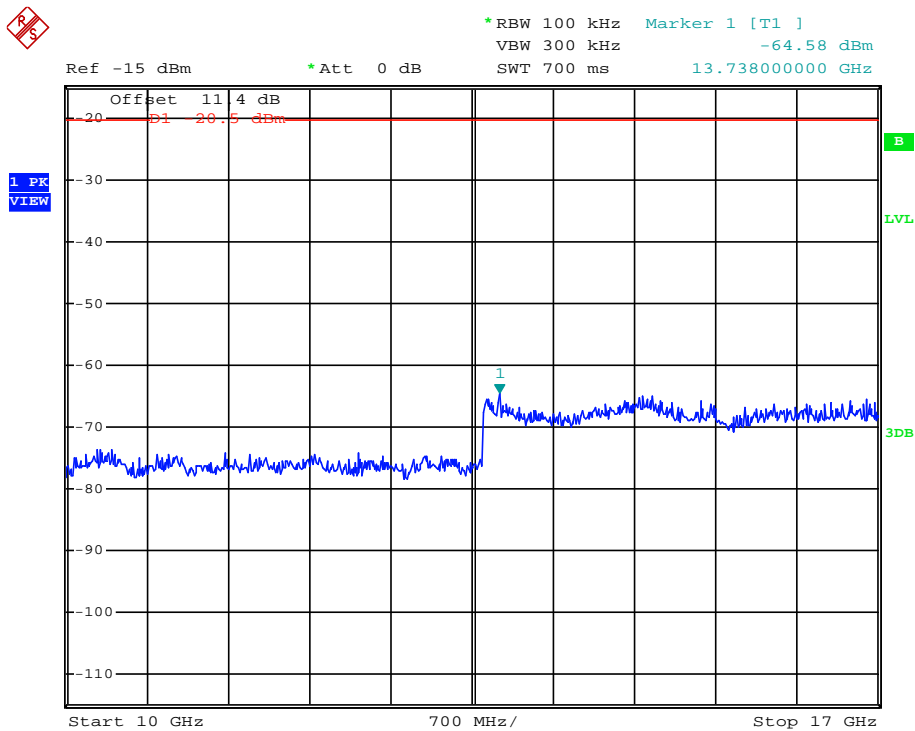


FCC ID: CWTUGZZC / IC:1788F-UGZZC

4.0 GHz – 10 GHz, Channel 1

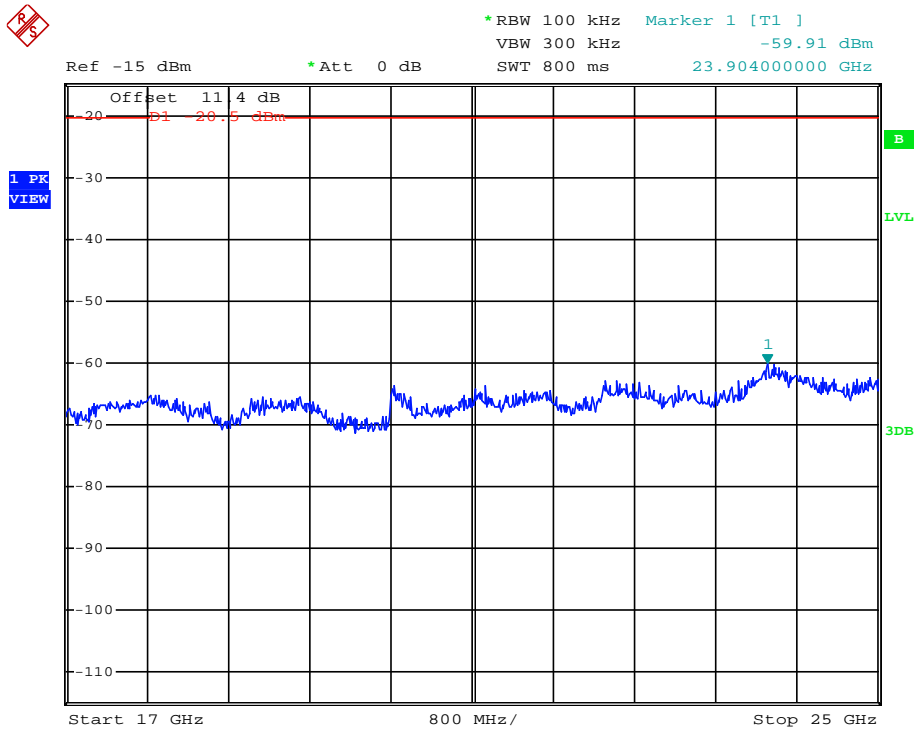


10 GHz – 17 GHz, Channel 1



FCC ID: CWTUGZZC / IC:1788F-UGZZC

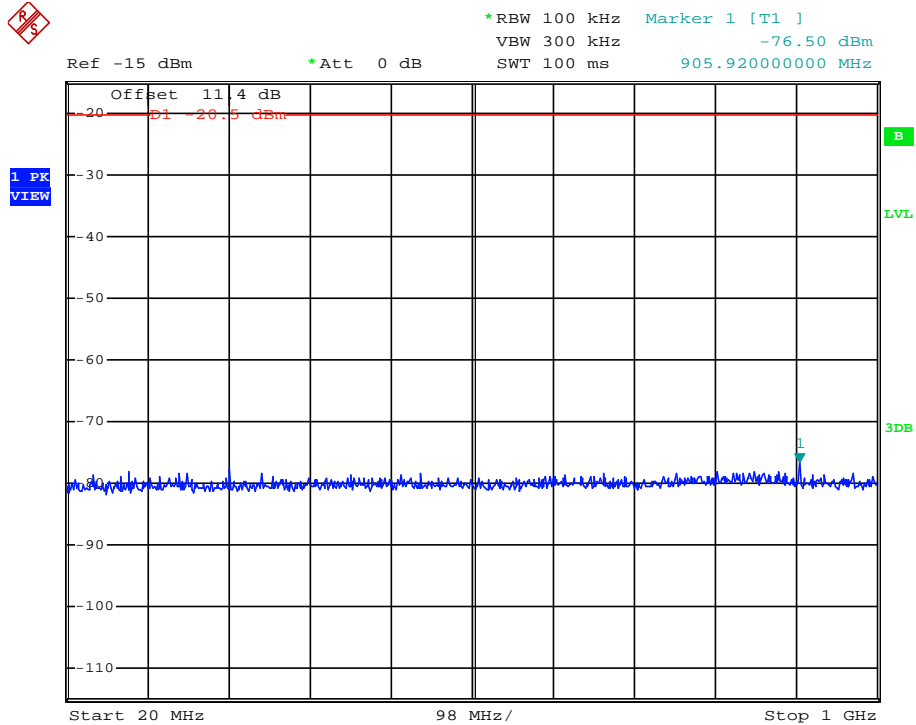
17 GHz – 25 GHz, Channel 1



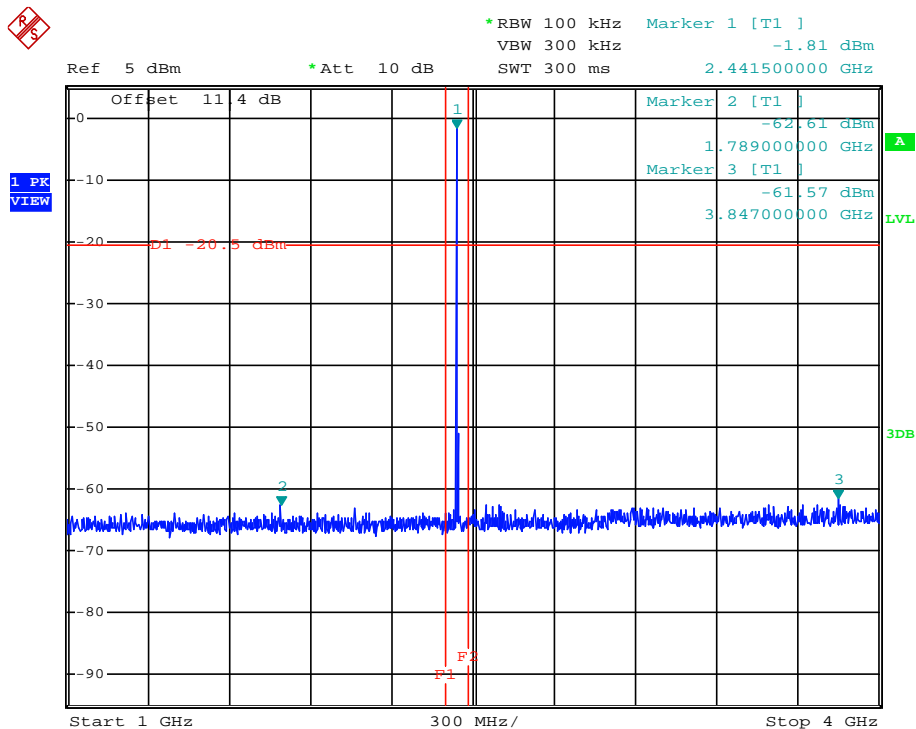
FCC ID: CWTUGZZC / IC:1788F-UGZZC

Spurious emissions conducted, 3-DH5 packet:

20 MHz – 1 GHz, Channel 41

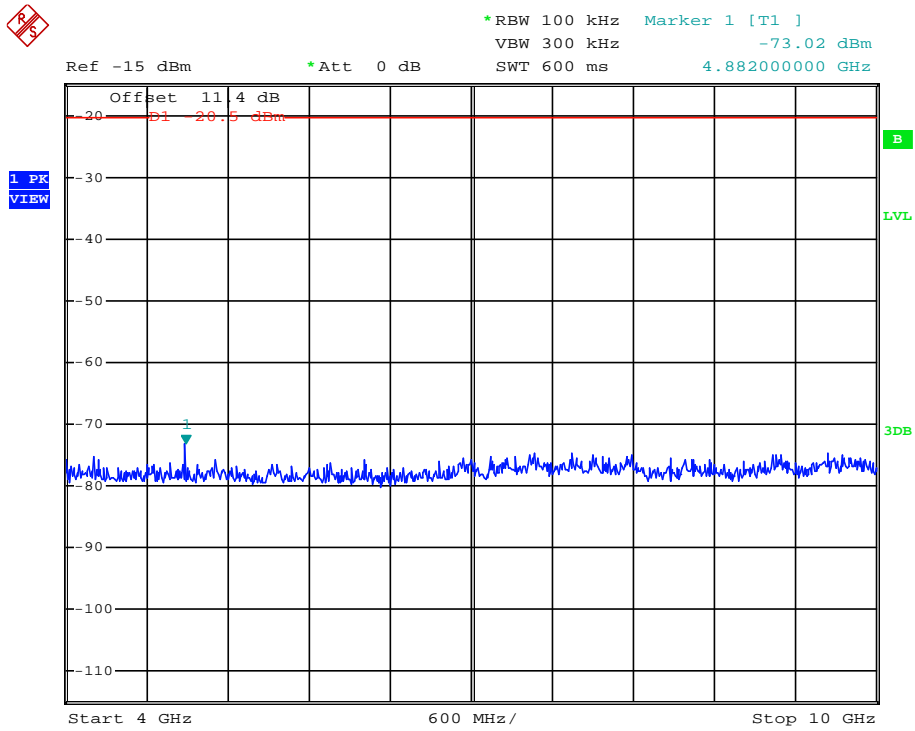


1 GHz – 4.0 GHz, Channel 41

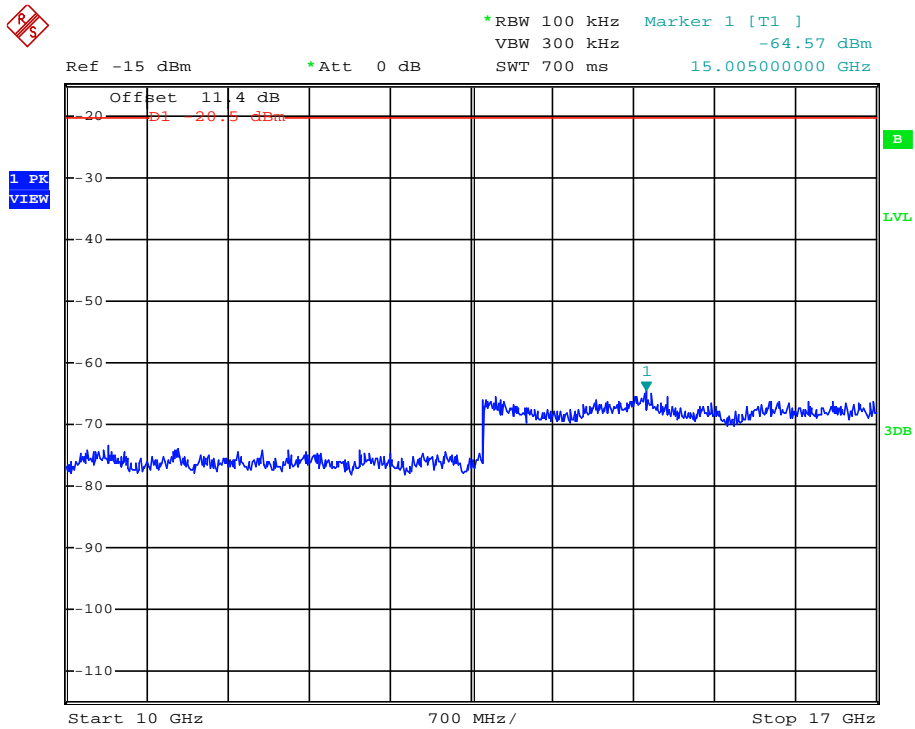


FCC ID: CWTUGZZC / IC:1788F-UGZZC

4.0 GHz – 10 GHz, Channel 41

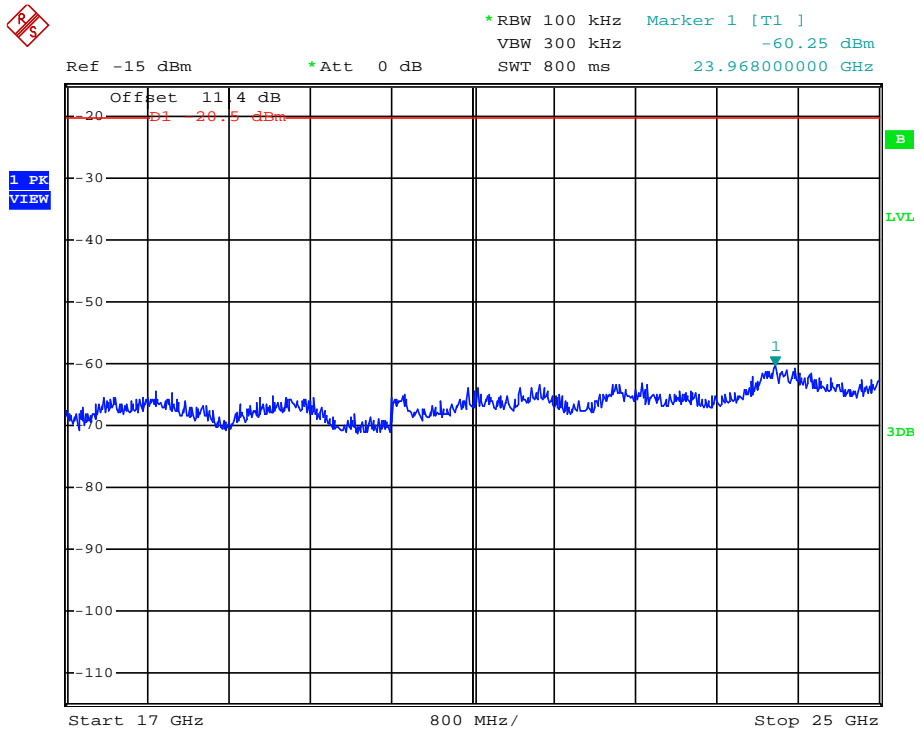


10 GHz – 17 GHz, Channel 41



FCC ID: CWTUGZZC / IC:1788F-UGZZC

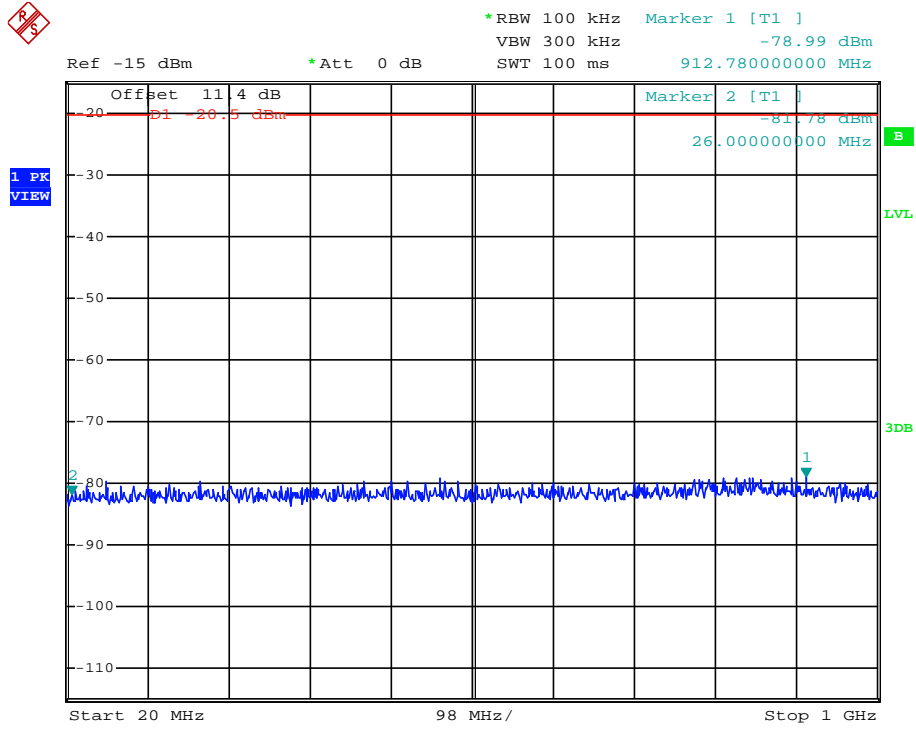
17 GHz – 25 GHz, Channel 41



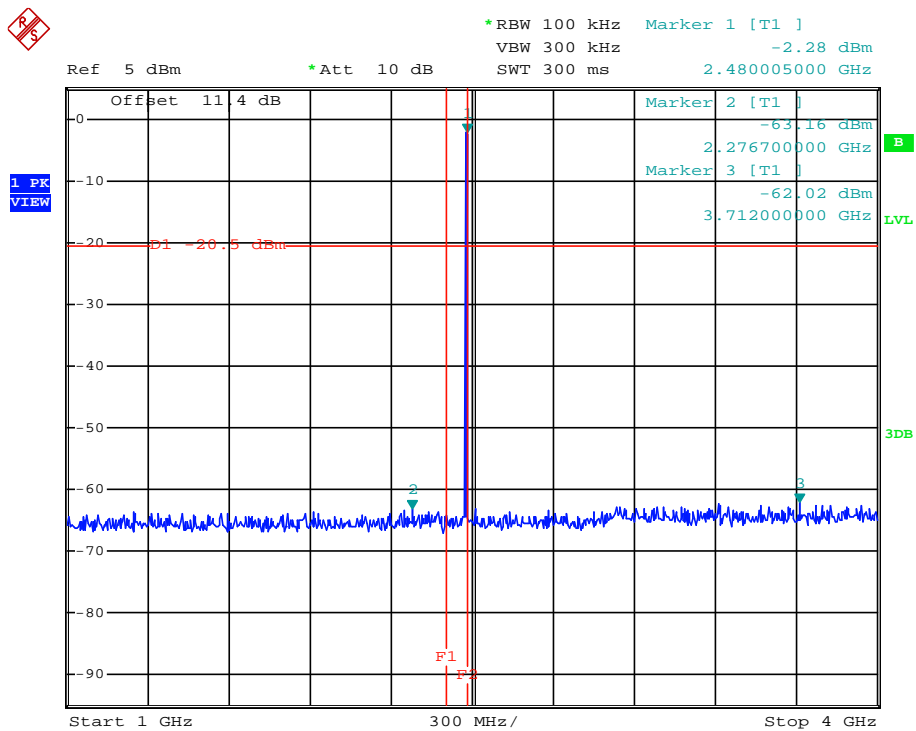
FCC ID: CWTUGZZC / IC:1788F-UGZZC

Spurious emissions conducted, 3-DH5 packet:

20 MHz – 1 GHz, Channel 79

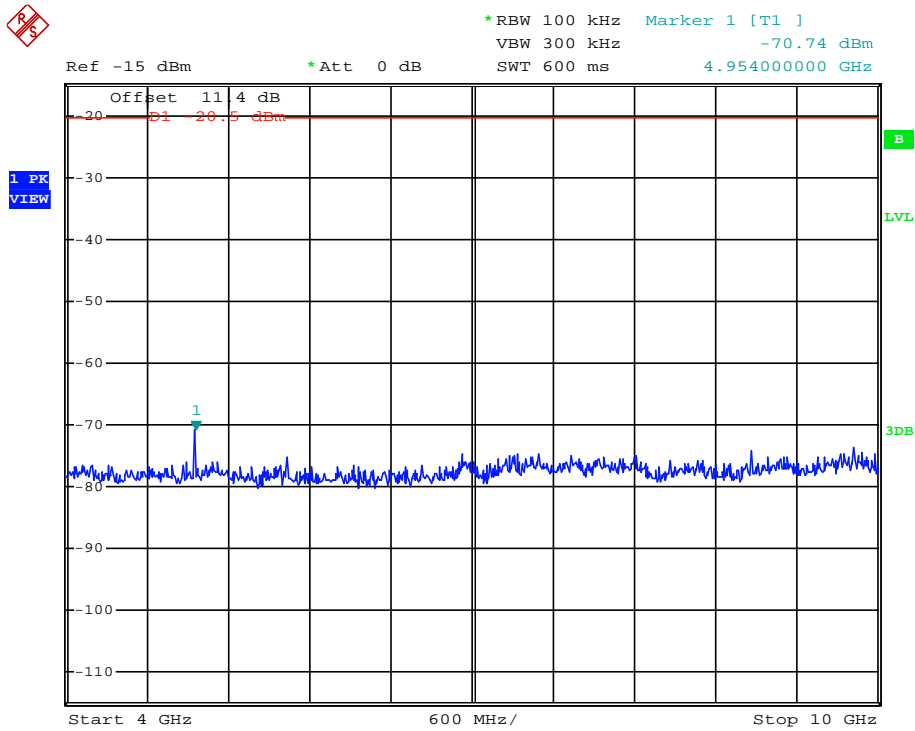


1 GHz – 4.0 GHz, Channel 79

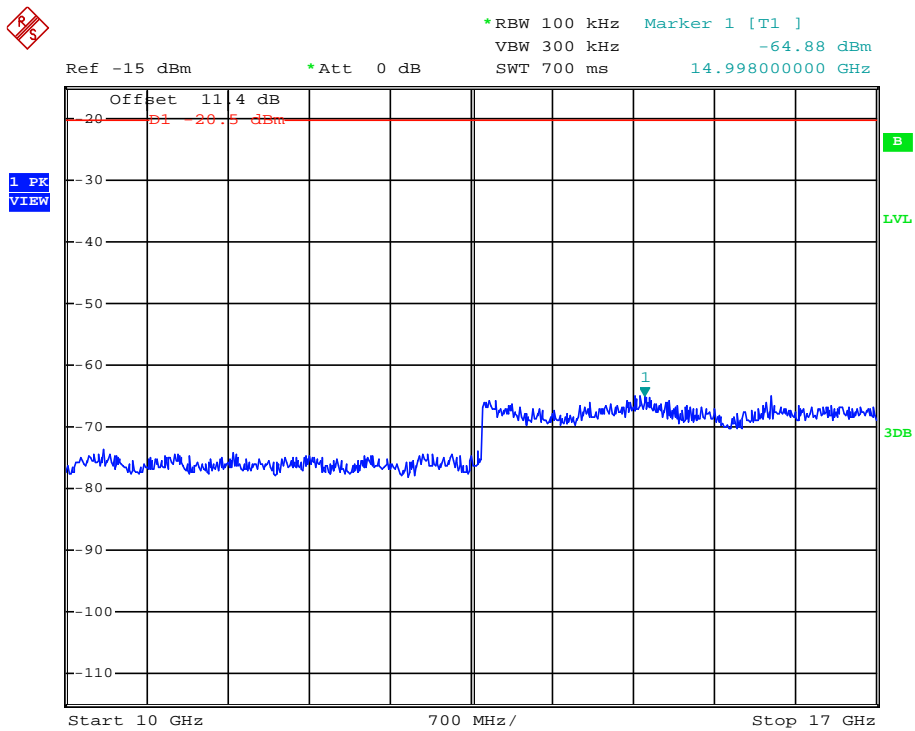


FCC ID: CWTUGZZC / IC:1788F-UGZZC

4.0 GHz – 10 GHz, Channel 79

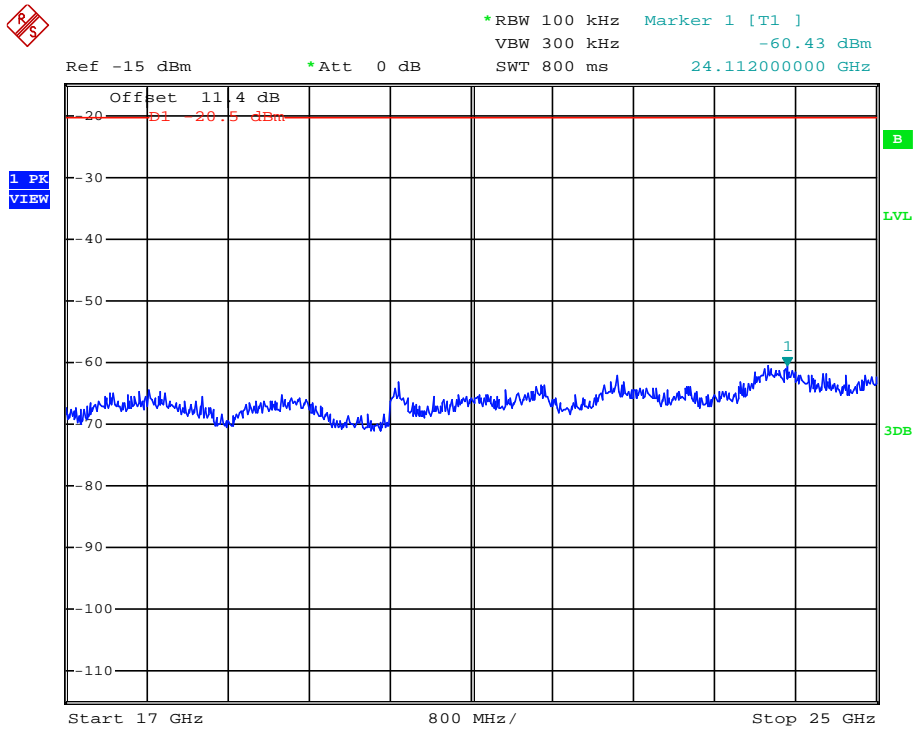


10 GHz – 17 GHz, Channel 79



FCC ID: CWTUGZZC / IC:1788F-UGZZC

17 GHz – 25 GHz, Channel 79



FCC ID: CWTUGZZC / IC:1788F-UGZZC

5.6 Band edge compliance

For test instruments and accessories used see section 6 Part **SEC3**.

5.6.1 Description of the test location

Test location: Shielded Room 4

5.6.2 Applicable standard

According to FCC Part 15C, Section 15.247(d):

In any 100 kHz bandwidth outside the frequency bands 2400 – 2483.5 MHz and 5725 – 5850 MHz, the digitally modulated 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 an radiated measurement. Attenuation below the general limits specified in Section 15.209(a) is not required.

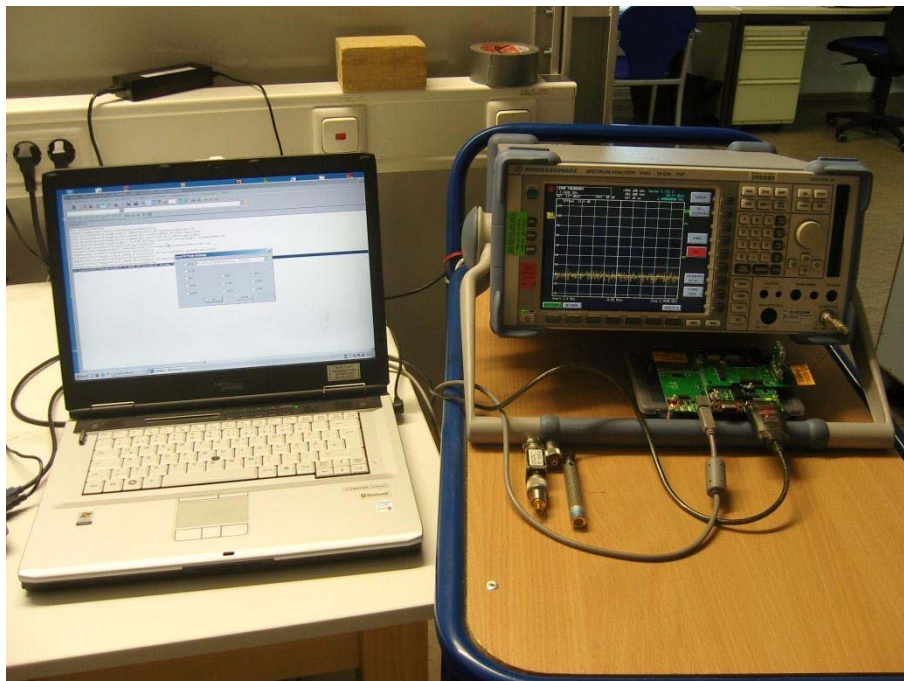
5.6.3 Description of Measurement

A spectrum analyser is connected to the output of the transmitter via a suitable attenuator while EUT was operating in transmit mode at the assigned frequency according DA 00-705:2000.

Spectrum analyser settings:

RBW: 100 kHz, VBW: 300 kHz, Detector: Max peak, Trace: Max hold, Sweep: auto

5.6.4 Photo documentation of the test set-up



FCC ID: CWTUGZZC / IC:1788F-UGZZC

5.6.5 Test result

DH5 Packet

f (MHz)	Delta level (dBc)	Limit (dBc)
Low Channel	33.9	< -20.5
High Channel	36.9	< -20.5

2-DH5 Packet

f (MHz)	Delta level (dBc)	Limit (dBc)
Low Channel	32.4	< -20.5
High Channel	38.0	< -20.5

3-DH5 Packet

f (MHz)	Delta level (dBc)	Limit (dBc)
Low Channel	32.1	< -20.5
High Channel	38.0	< -20.5

3-DH5 Packet (hopping mode)

f (MHz)	Delta level (dBc)	Limit (dBc)
Low Channel	36.0	< -20.5
High Channel	38.5	< -20.5

Peak-Limit according to FCC Part 15C, Section 15.247(d):

In any 100 kHz bandwidth outside the frequency band 2400 – 2483.50 MHz, 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 limit specified in Section 15.209(a).

The requirements are fulfilled

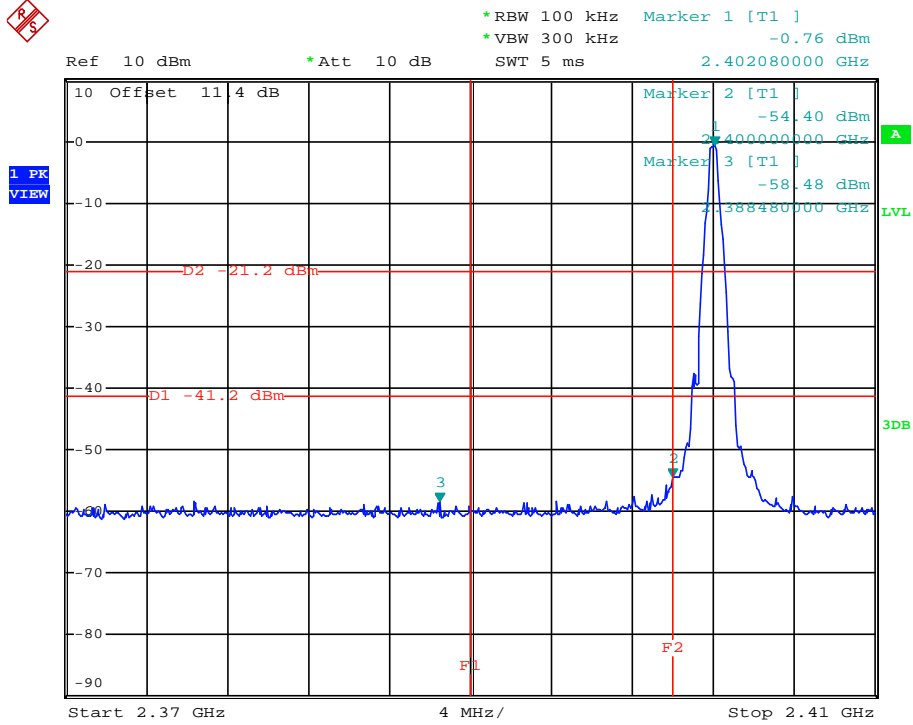
Remarks: For detailed test result please refer to following test protocol.

FCC ID: CWTUGZZC / IC:1788F-UGZZC

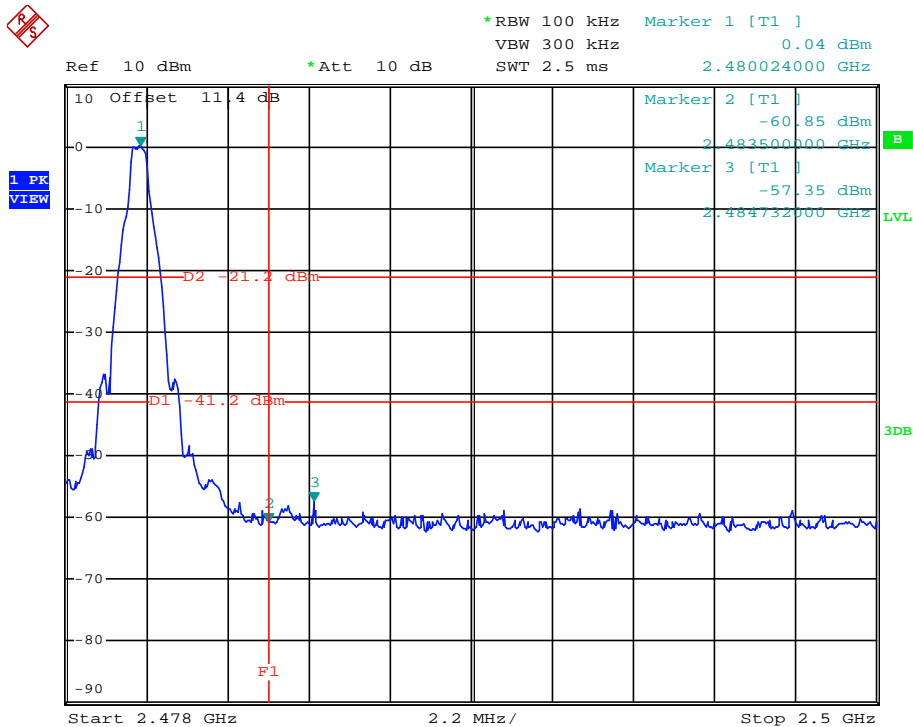
5.6.6 Test protocol

DH5 Packet

CH1



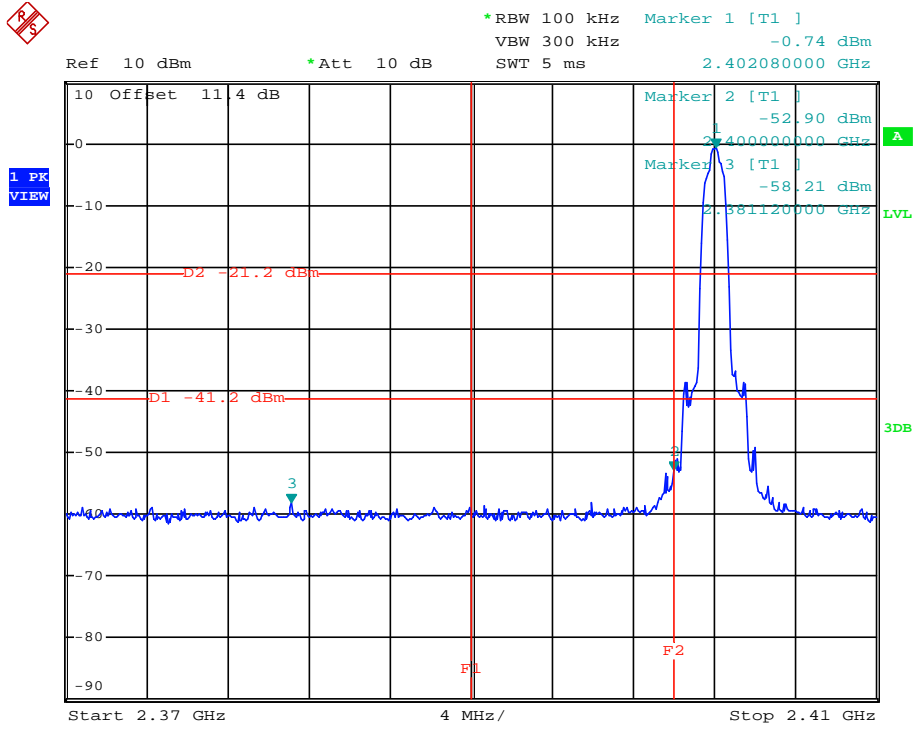
CH79



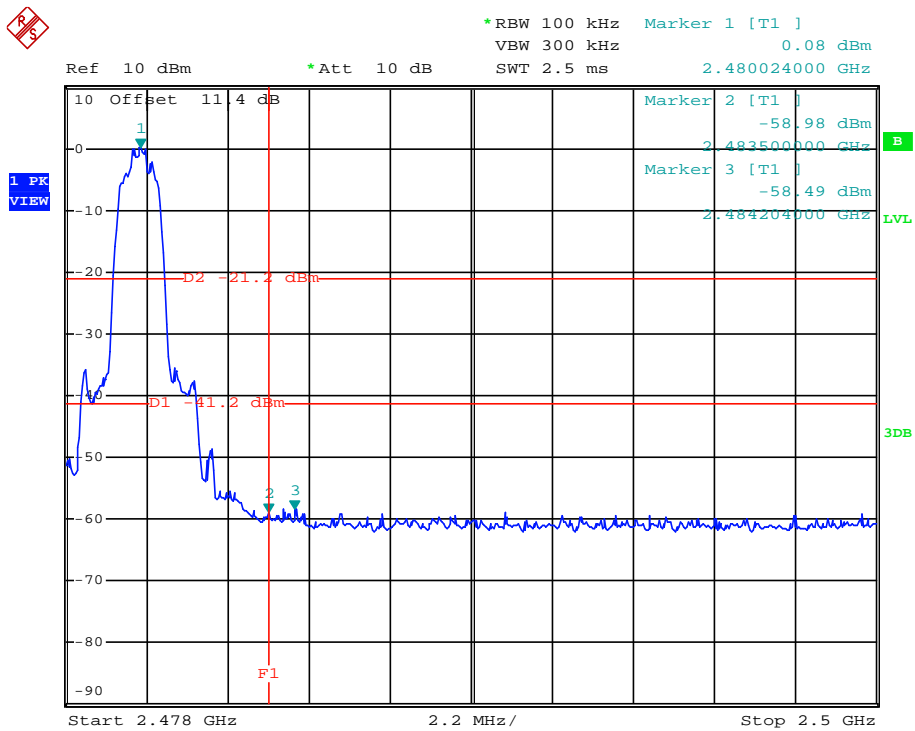
FCC ID: CWTUGZZC / IC:1788F-UGZZC

2-DH5 Packet

CH1



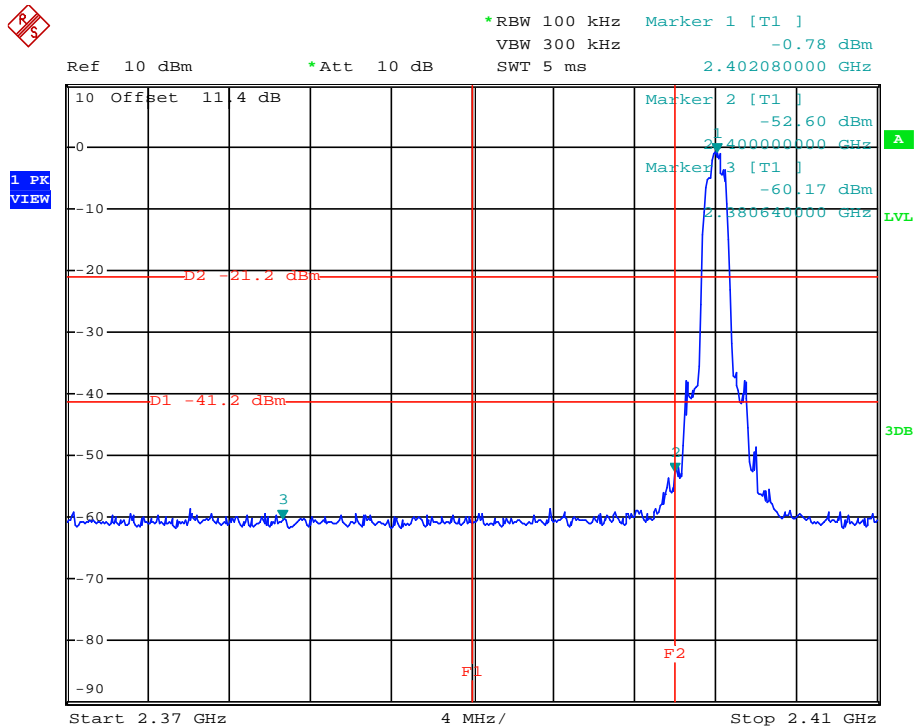
CH79



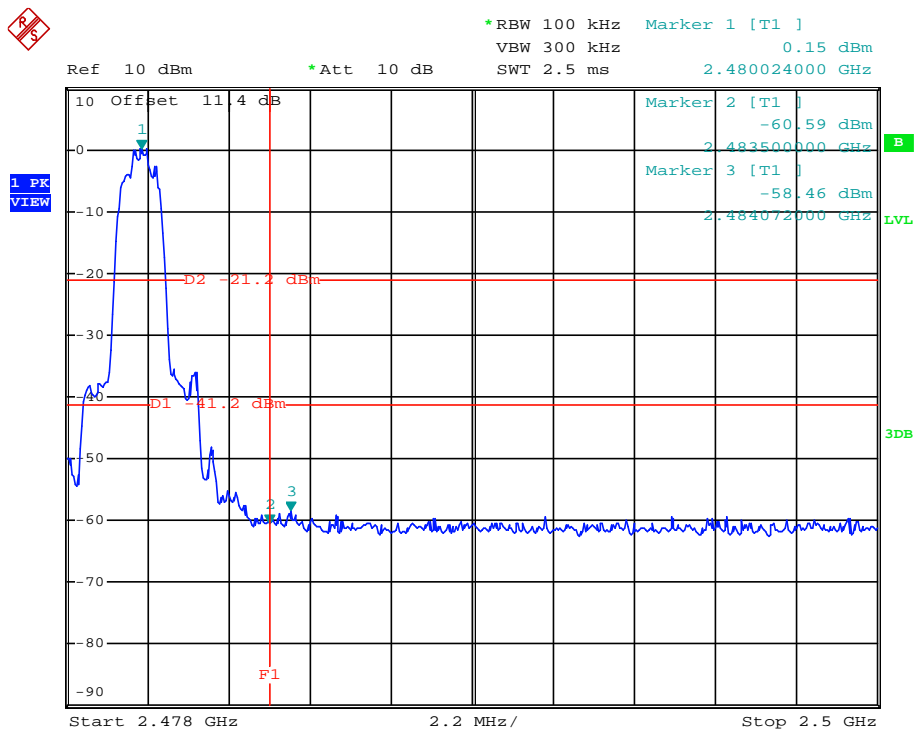
FCC ID: CWTUGZZC / IC:1788F-UGZZC

3-DH5 Packet

CH1



CH79



FCC ID: CWTUGZZC / IC:1788F-UGZZC

5.7 Radiated emissions in restricted bands

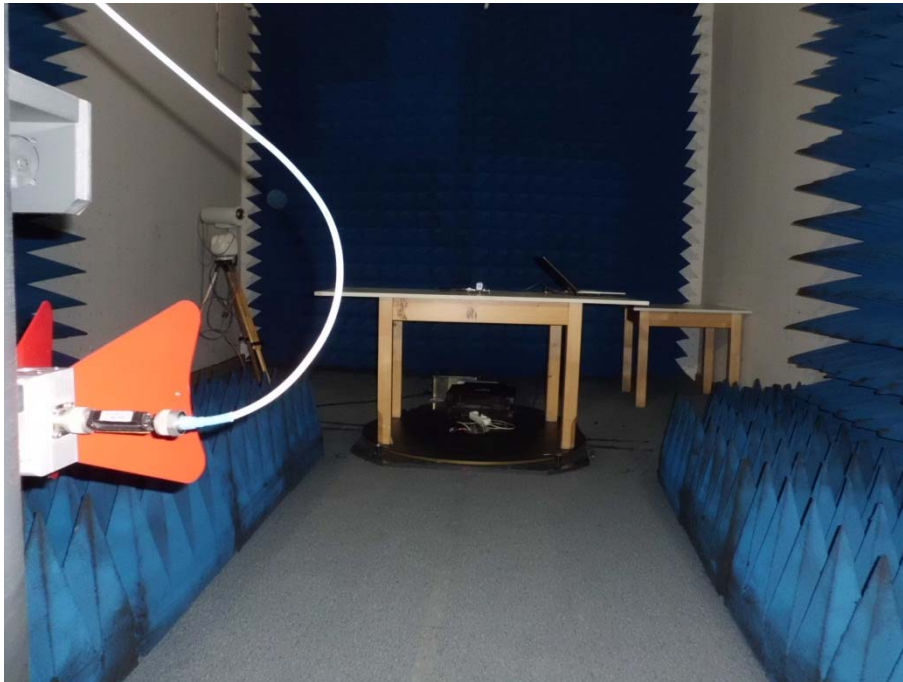
For test instruments and accessories used see section 6 Part **SEC3**.

5.7.1 Description of the test location

Test location: Shielded Room 4

5.7.2 Photo documentation of the test set-up

Test setup 1 – 25 GHz



5.7.3 Applicable standard

According to FCC Part 15, Section 15.205(a):

In addition, radiated emissions which fall in the restricted bands, as defined in Section 15.205(a), must also comply with the radiated emission limit specified in Section 15.209(a). In this test it is considered only to perform the worst case modulation 3-DH5 for the restricted bands from 2310 MHz to 2390 MHz, 2483.5 MHz to 2500 MHz, from 2655 MHz to 2900 MHz (RSS 210) and from 4500 MHz to 5150 MHz.

5.7.4 Description of Measurement

The restricted bands are measured radiated. The span of the spectrum analyser was set wide enough to capture the restricted band and measure the peak level of the emission operating on the channel closest to the band edge, as well as any modulation products which fall outside of the authorized band of operation.

Spectrum analyser settings:

RBW: 1 MHz, VBW: 3 MHz, Sweep: Auto, Detector function: Peak

5.7.5 Test result

FCC ID: CWTUGZZC / IC:1788F-UGZZC

Restricted band 2310 – 2390 MHz:

CH1:

CH1, Restricted Band 2310 MHz - 2390 MHz			
Modulation	f (MHz)	Fieldstrength dB μ V/m	Limit (dB μ V/m)
3-DH5	2358.64	41.6	54

Restricted band 2483.5 – 2500 MHz:

CH79

CH79, Restricted Band 2483.5 MHz - 2500 MHz			
Modulation	f (MHz)	Fieldstrength dB μ V/m	Limit (dB μ V/m)
3-DH5	2483.5	46.2	54

Restricted band 4500 – 5150 MHz:

CH1:

CH1, Restricted Band 4500 MHz - 5150 MHz			
Modulation	f (MHz)	Fieldstrength dB μ V/m	Limit (dB μ V/m)
3-DH5	4804.2	52.6	54

CH79:

CH79, Restricted Band 4500 MHz - 5150 MHz			
Modulation	f (MHz)	Fieldstrength dB μ V/m	Limit (dB μ V/m)
3-DH5	4960.2	51.9	54

Restricted band 2655 – 2900 MHz (Canada):

CH1

CH1, Restricted Band 2655 MHz - 2900 MHz			
Modulation	f (MHz)	Fieldstrength dB μ V/m	Limit (dB μ V/m)
3-DH5	2850.51	43.9	54

CH79

CH79, Restricted Band 2655 MHz - 2900 MHz			
Modulation	f (MHz)	Fieldstrength dB μ V/m	Limit (dB μ V/m)
3-DH5	2850.51	43.2	54

FCC ID: CWTUGZZC / IC:1788F-UGZZC

Restricted bands of operation:

The field strength of emissions appearing within these frequency bands shall not exceed the limits shown in Section 15.209:

MHz	MHz	MHz	GHz
0.090 – 0.110	16.42 – 16.423	399.9 – 410	4.5 – 5.15
0.495 – 0.505	16.69475 – 16.69525	608 – 614	5.35 – 5.46
2.1735 – 2.1905	16.80425 – 16.80475	960 – 1240	7.25 – 7.75
4.125 – 4.128	25.5 – 25.67	1300 – 1427	8.025 – 8.5
4.17725 – 4.17775	37.5 – 38.25	1435 – 1626.5	9.0 – 9.2
4.20725 – 4.20775	73 – 74.6	1645.5 – 1646.5	9.3 – 9.5
6.215 – 6.218	74.8 – 75.2	1660 – 1710	10.6 – 12.7
6.26775 – 6.26825	108 – 121.94	1718.8 – 1722.2	13.25 – 13.4
6.31175 – 6.31225	123 – 138	2200 – 2300	14.47 – 14.5
8.291 – 8.294	149.9 – 150.05	2310 – 2390	15.35 – 16.2
8.362 – 8.366	156.52475 – 156.52525	2483.5 – 2500	17.7 – 21.4
8.37625 – 8.38675	156.7 – 156.9	2690 – 2900	22.01 – 23.12
8.41425 – 8.41475	162.0125 – 167.17	3260 – 3267	23.6 – 24.0
12.29 – 12.293	167.72 – 173.2	3332 – 3339	31.2 – 31.8
12.51975 – 12.52025	240 – 285	3345.8 – 3358	36.43 – 36.5
12.57675 – 12.57725	322 – 335.4	3600 – 4400	Above 38.6

The requirements are fulfilled

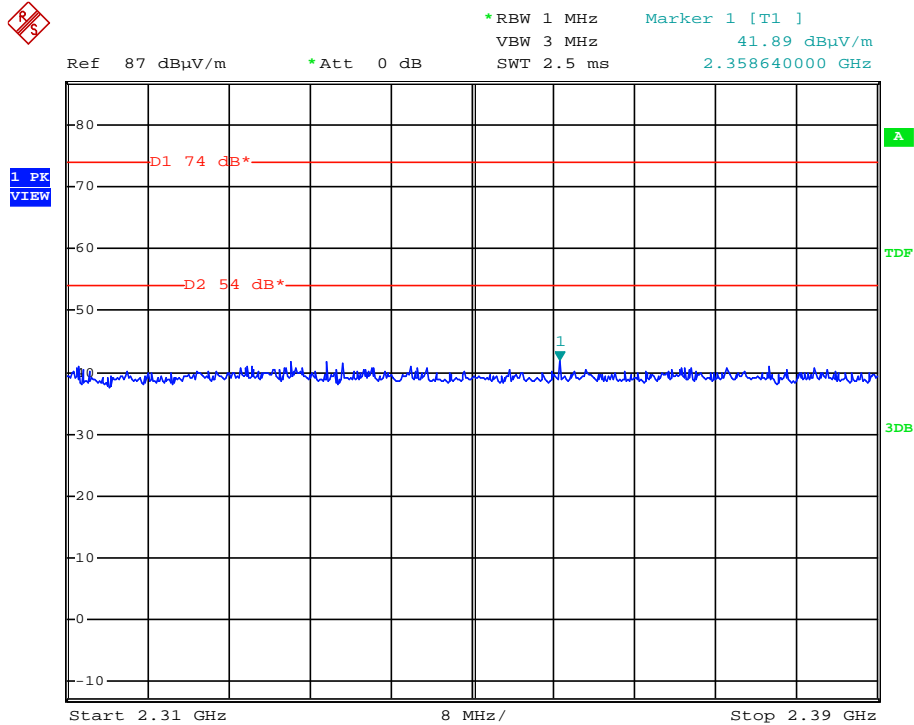
Remarks: For detailed test result please refer to following test protocol. Only the worst case plots are listed.

FCC ID: CWTUGZZC / IC:1788F-UGZZC

5.7.6 Test protocol

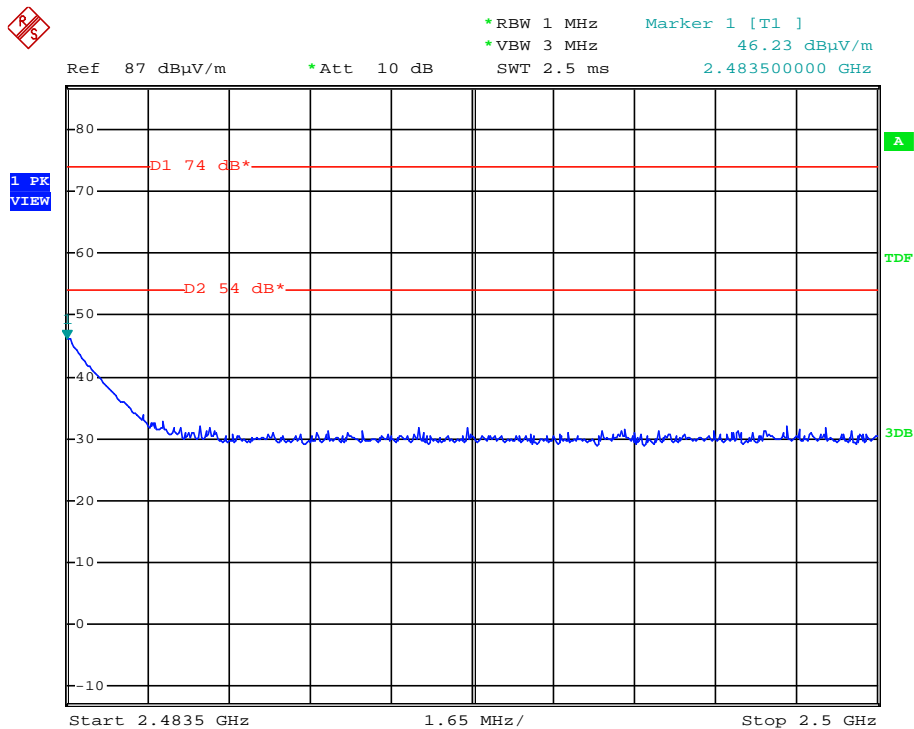
Restricted band 2310 MHz – 2390 MHz:

CH1, 3-DH5



Restricted band 2483.5 MHz – 2500 MHz:

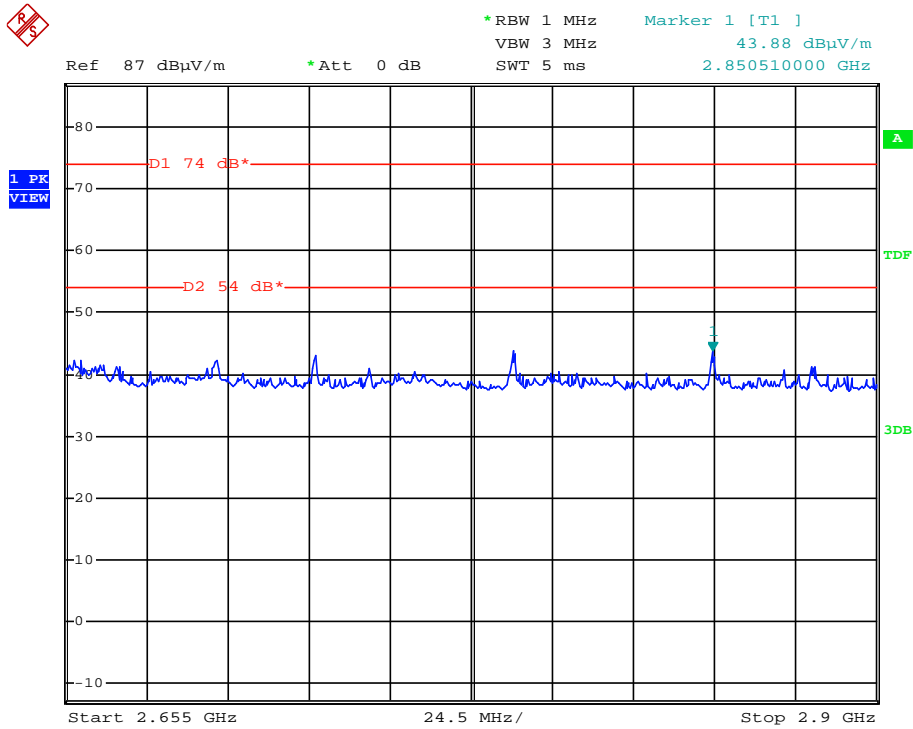
CH79, 3-DH5



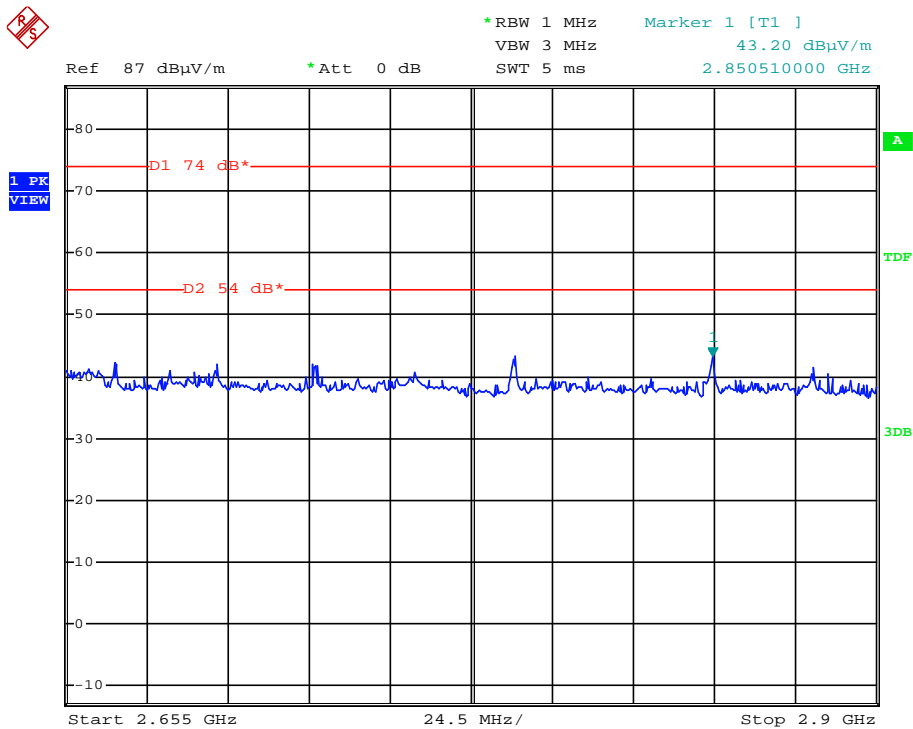
FCC ID: CWTUGZZC / IC:1788F-UGZZC

Restricted band 2655 - 2900 MHz:

CH1, 3-DH5



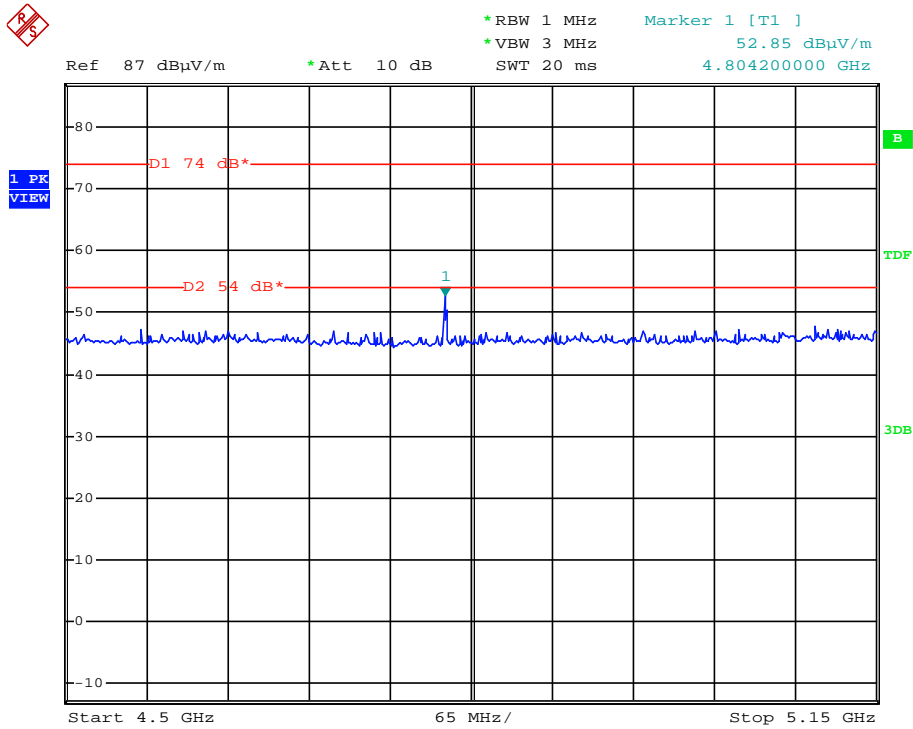
CH79, 3-DH5



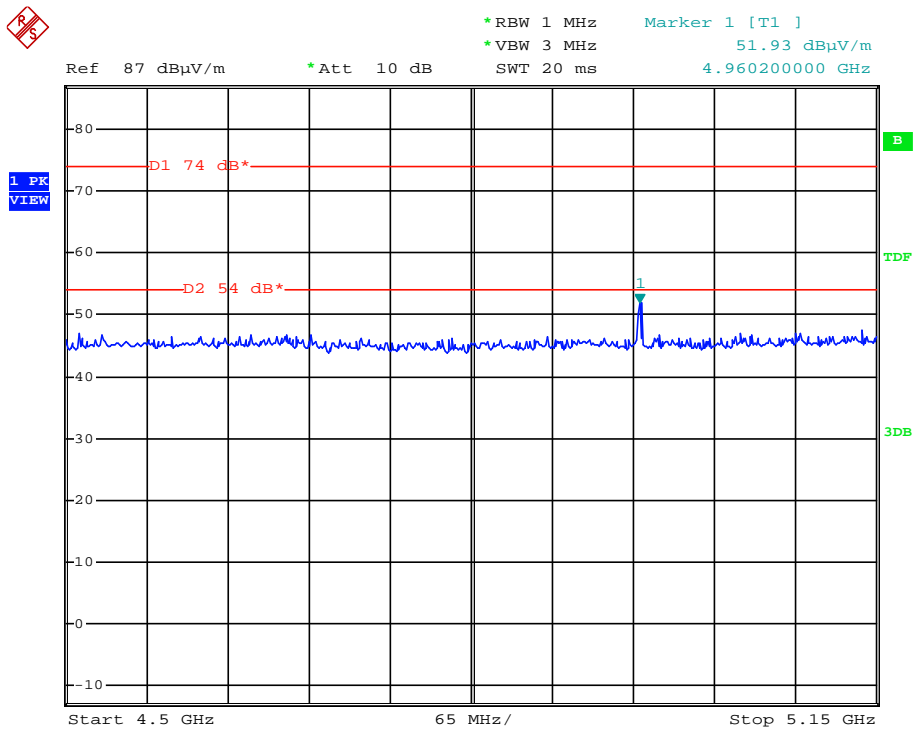
FCC ID: CWTUGZZC / IC:1788F-UGZZC

Restricted band 4500 MHz – 5150 MHz:

CH1, 3-DH5



CH79, 3-DH5



FCC ID: CWTUGZZC / IC:1788F-UGZZC

5.8 Pseudorandom frequency hopping sequence

Requirement according to FCC Part 15C, Section 15.247(a):

The system shall hop to channel frequencies that are selected at the system hopping rate from a pseudo randomly ordered list of hopping frequencies.

Co-ordination of the hopping sequence in data mode to avoid simultaneous occupancy by multiple transmitters:

Bluetooth units which want to communicate with other units must be organized in a structure called piconet. This piconet consists of maximum 8 Bluetooth units. One unit is the master the other seven are the slaves. The master co-ordinates frequency occupation in this piconet for all units. As the master hop sequence is derived from its BD address which is unique for each Bluetooth device, additional masters intending to establish new piconets will always use different hop sequences.

Example of a 79 hopping sequence in data mode:

40, 21, 44, 23, 42, 53, 46, 55, 48, 33, 52, 35, 50, 65, 54, 67, 56, 37, 60, 39, 58, 69, 62, 71, 64, 25, 68, 27, 66, 57, 70, 59, 72, 29, 76, 31, 74, 61, 78, 63, 01, 41, 05, 43, 03, 73, 07, 75, 09, 45, 13, 47, 11, 77, 15, 00, 64, 49, 66, 53, 68, 02, 70, 06, 01, 51, 03, 55, 05, 04

Derivation and examples for a hopping sequence in hybrid mode

For the generation of the inquiry and page hop sequences the same procedures as described for the data mode are used (see chapter 5), but this time with different input vectors:

a. For the inquiry hop sequence, a predefined fixed address is always used. This results in the same 32 frequencies used by all devices doing an inquiry but every time with a different start frequency and phase in this sequence.

b. For the page hop sequence, the device address of the paged unit is used as input vector. This results in the use of a subset of 32 frequencies which is specific for that initial state of the connection establishment between the two units. A page to different devices would result in a different subset of 32 frequencies.

So it is ensured that also in hybrid mode the frequency use equally averaged.

Example of a hopping sequence in inquiry mode:

48, 50, 09, 13, 52, 54, 41, 45, 56, 58, 11, 15, 60, 62, 43, 47, 00, 02, 64, 68, 04, 06, 17, 21, 08, 10, 66, 70, 12, 14, 19, 23

Example of a hopping sequence in paging mode:

08, 57, 68, 70, 51, 02, 42, 40, 04, 61, 44, 46, 63, 14, 50, 48, 16, 65, 52, 54, 67, 18, 58, 56, 20, 53, 60, 62, 55, 06, 66, 64

Remarks: This item is part of the Bluetooth Core Specifications V2.1+EDR compliance and approved.

5.9 Equal hopping frequency use

Requirement according to FCC Part 15C, Section 15.247(a):

Each frequency must be used equally on the average by each transmitter.

The generation of the hopping sequence in connection mode depends essentially on two input values:

1. LAP/UAP of the master of the connection.
2. Internal master clock.

The LAP (lower address part) is the 24 LSB's of the 48 BD_ADDRESS. The BD_ADDRESS is an unambiguous number of every Bluetooth unit. The UAP (upper address part) are the 24 MSB's of the 48 BD_ADDRESS. The internal clock of a Bluetooth unit is derived from a free running clock which is never adjusted and is never turned off. For synchronization with other units only offset are used. It has no relation to the time of the day. Its resolution is at least half the Rx/Tx slot length of 312.5 μ s. The clock has a cycle of about one day (23hr30min). In most case, it is implemented as 28 bit counter. For the deriving of the hopping sequence the entire LAP (24 bits), 4 LSB's (4 bits) (Input 1) and the 27 MSB's of the clock (Input 2) are used. With this input values different mathematical procedures

FCC ID: CWTUGZZC / IC:1788F-UGZZC

(permutations, additions, XOR-operations) are performed to generate the sequence. This will be done at the beginning of every new transmission.

Regarding short transmissions the Bluetooth system has the following behaviour: The first connection between the two devices is established, a hopping sequence was generated. For transmitting the wanted data the complete hopping sequence was not used. The connection ended. The second connection will be established. A new hopping sequence is generated. Due to the fact that the Bluetooth clock has a different value the hopping sequence will always differ from the first one, because the period between the two transmissions is longer and it cannot be shorter than the minimum resolution of the clock is 312.5 μ s. This circumstance is always the same therefore the average of the frequency use is the same on all transmitters.

Remarks: This item is part of the Bluetooth Core Specifications V2.1+EDR compliance and approved.

5.10 Receiver input bandwidth

Requirement according to FCC Part1 5C, Section 15.247(a):

The system receivers shall have input bandwidth that match the hopping channel bandwidths of their corresponding transmitters and shall shift frequencies in synchronization with the transmitted signal.

Receiver input bandwidth and behaviors for repeated single or multiple packets:

The input bandwidth of the receiver is 1 MHz. In every connection one Bluetooth device is the master and the other one is the slave. The master determines the hopping sequence (see chapter 5). The slave follows this sequence. Both devices shift between Rx and Tx time slot according to the clock of the master. Additionally the type of connection (e.g. single or multi-slot packet) is set up at the beginning of the connection. The master adapts its hopping frequency and its Tx/Rx timing according to the packet type of the connection. Also the slave of the connection will use these settings. Repeating of a packet has no influence on the hopping sequence. The hopping sequence generated by the master of the connection will be followed in any case. That means, a repeated packet will not be send on the same frequency, it is send on the next frequency of the hopping sequence.

Remarks: This item is part of the Bluetooth Core Specifications V2.1+EDR compliance and approved.

5.11 Correction for pulsed operation (duty cycle)

Remarks: Not applicable.

FCC ID: CWTUGZZC / IC:1788F-UGZZC

5.12 Dwell time

5.12.1 Applicable standard

According to FCC Part 15, Section 15.247(a):

In Section 15.247(a)(1i)(1ii) and (1iii) are dwell times defined for the special frequency ranges should not exceed by a frequency hopping system.

Dwell time in data mode:

The dwell time of 0.3797s within a 30 second period in data mode is independent from the packet type (packet length). The calculation for a 30 second period is as follows:

Dwell time = time slot length * hop rate / number of hopping channels * 30s

Example for a DH1 packet (with a maximum length of one time slot)

Dwell time = $625 \mu\text{s} * 1600 * 1/\text{s} / 79 * 30\text{s} = 0.3797\text{s}$ (in a 30s period)

For multi-slot packet the hopping is reduced according to the length of the packet.

Example for a DH5 packet (with a maximum length of five time slots)

Dwell time = $5 * 625 \mu\text{s} * 1600 * 1/5 * 1/\text{s} / 79 * 30\text{s} = 0.3797\text{s}$ (in a 30s period)

This is according to the Bluetooth Core Specification V 1.0B (+ critical errata) for all Bluetooth devices. There for all Bluetooth devices comply with the FCC dwell time requirement in data mode.

This was checked during the Bluetooth Qualification tests and approved.

The Dwell time in hybrid mode is approximately 2.6 ms (in a 12.8 s period).

Remarks: This item is part of the Bluetooth Core Specifications V2.1+EDR compliance and approved.

FCC ID: CWTUGZZC / IC:1788F-UGZZC

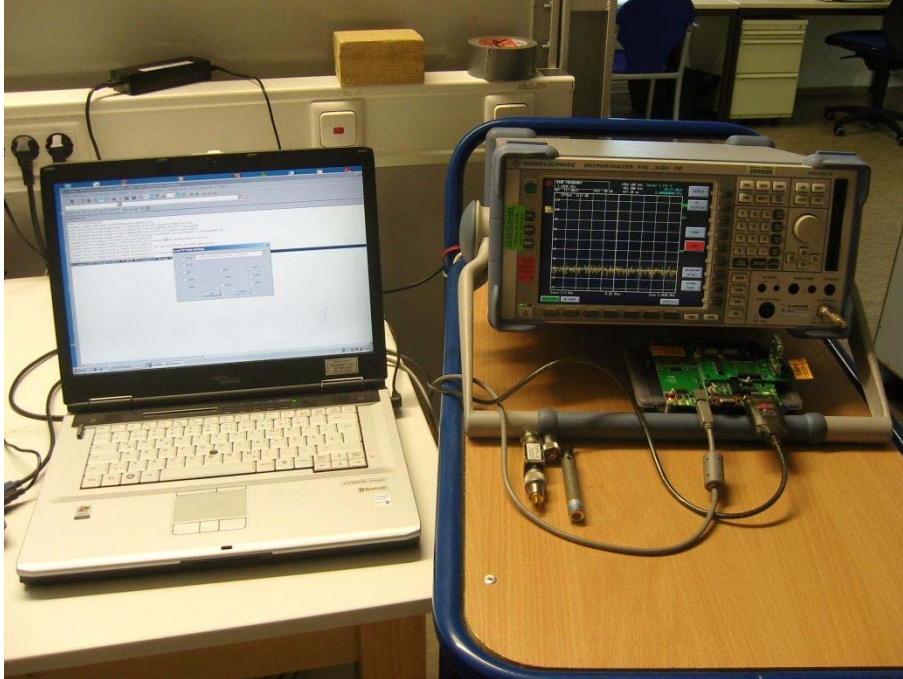
5.13 Carrier frequency separation

For test instruments and accessories used see section 6 Part MB.

5.13.1 Description of the test location

Test location: Shielded Room 4

5.13.2 Photo documentation of the test set-up



5.13.3 Applicable standard

According to FCC Part 15, Section 15.247(a):

Frequency hopping systems operating in the frequency band of 2400 MHz – 2483.5 MHz may have hopping channel carrier frequencies that are separated by 25 kHz or 2/3 of the 20 dB bandwidth of the hopping channel.

5.13.4 Description of Measurement

The measurement is performed using a spectrum analyser in single sweep mode. A part of the operating frequency is used for better resolution. In normal application mode all the channels of the part of operating frequency are displayed and the separation is measured. The 20 dB OBW has to be measured before to compare whether the OBW requirement is fulfilled.

5.13.5 Test result

Channel separation in hybrid mode:

The nominal channel spacing of the Bluetooth system is 1MHz independent of the operating mode. The maximum “initial carrier frequency tolerance” which is allowed for Bluetooth is $f_{\text{center}} = 75 \text{ kHz}$.

This was checked during the Bluetooth Qualification tests (Test Case: TRM/CA/07-E) for three frequencies (2402 MHz, 2441 MHz, and 2480 MHz) and approved.

FCC ID: CWTUGZZC / IC:1788F-UGZZC

Additionally an example for the channel separation is given below:

Channel	2/3 of 20 dB BW (kHz)	Hopping channels	Separation (MHz)	Limit (kHz)
1	827,1	79	1.0	667
41	837,75	79	1.0	667
79	827,1	79	1.0	667

Limit according to FCC Part 15C, Section 15.247(a):

Frequency (MHz)	Hopping channels	Limit channel separation
All systems		> 25 kHz or 20 dB bandwidth, which ever is greater
2400 - 2483.5	≥ 75	> 25 kHz or 2/3 of 20 dB bandwidth, which ever is greater

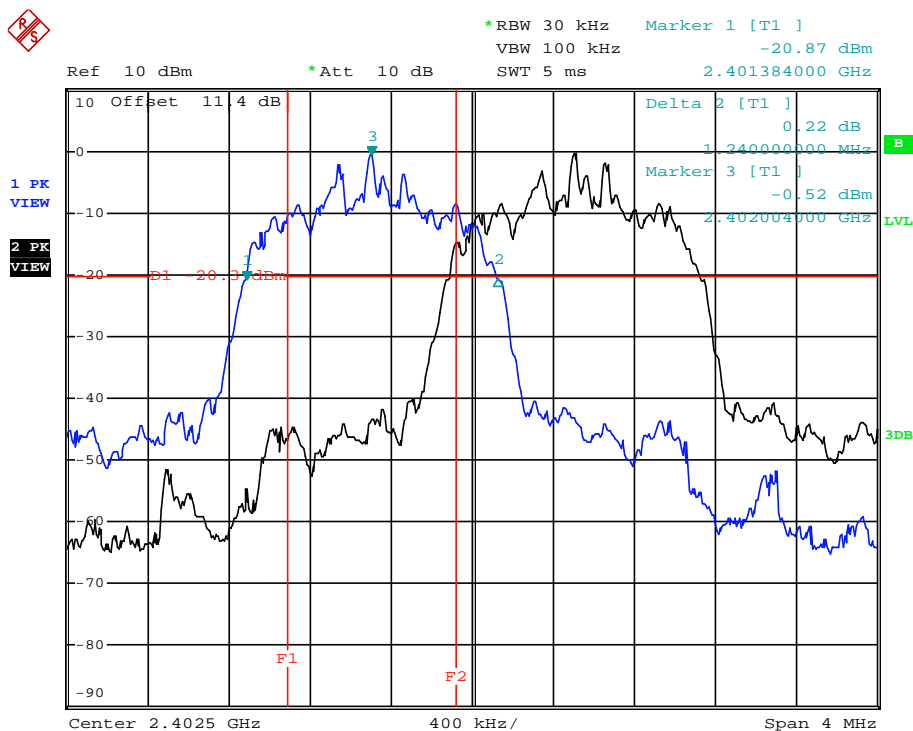
The requirements are fulfilled

Remarks: For detailed test result please refer to following test protocol.

F1 and F2 shows the two-thirds bandwidth channel separation with adjacent channel

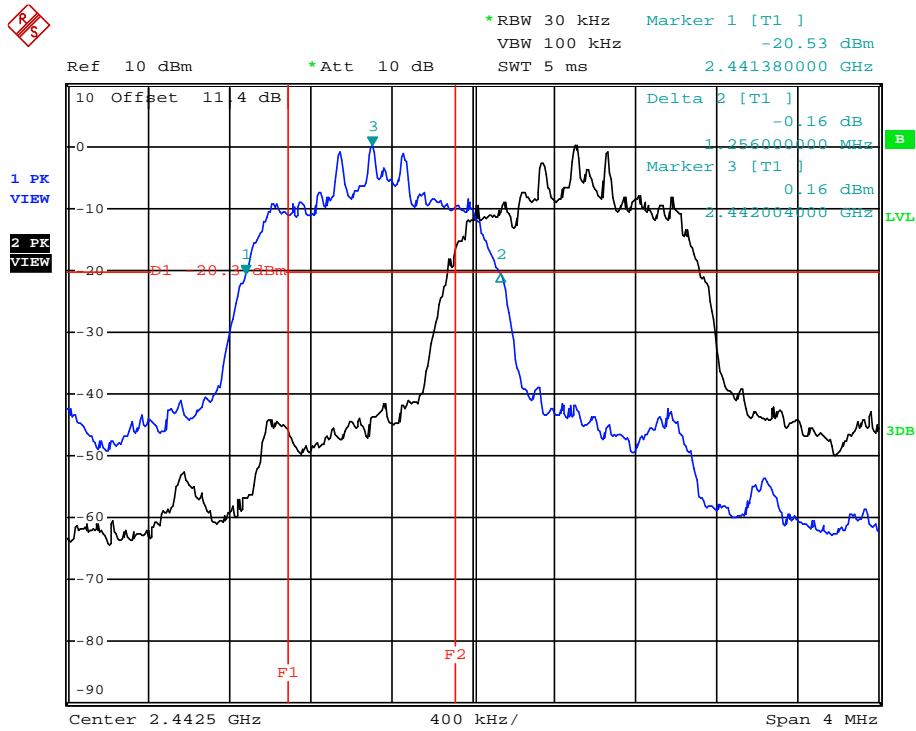
5.13.6 Test protocol

Channel separation, CH1, 3-DH5

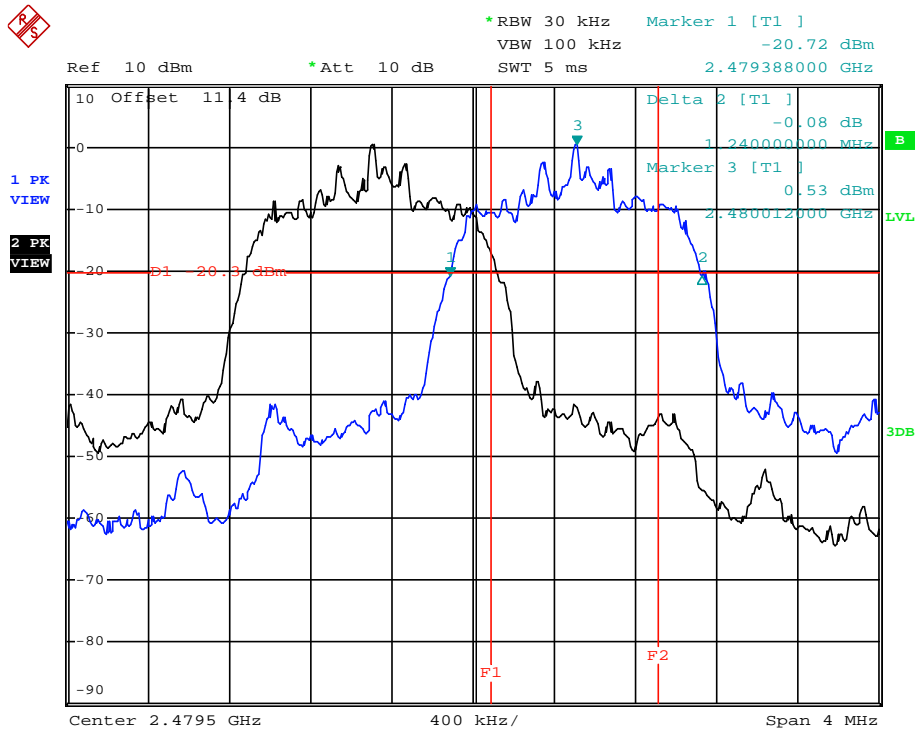


FCC ID: CWTUGZZC / IC:1788F-UGZZC

Channel separation, CH41, 3-DH5



Channel separation, CH79, 3-DH5



FCC ID: CWTUGZZC / IC:1788F-UGZZC

5.14 Number of hopping channels

For test instruments and accessories used see section 6 Part MB.

5.14.1 Description of the test location

Test location: Shielded Room 4

5.14.2 Test result

Hopping channel frequency range	Number of all available hopping channels
2402 - 2480	79

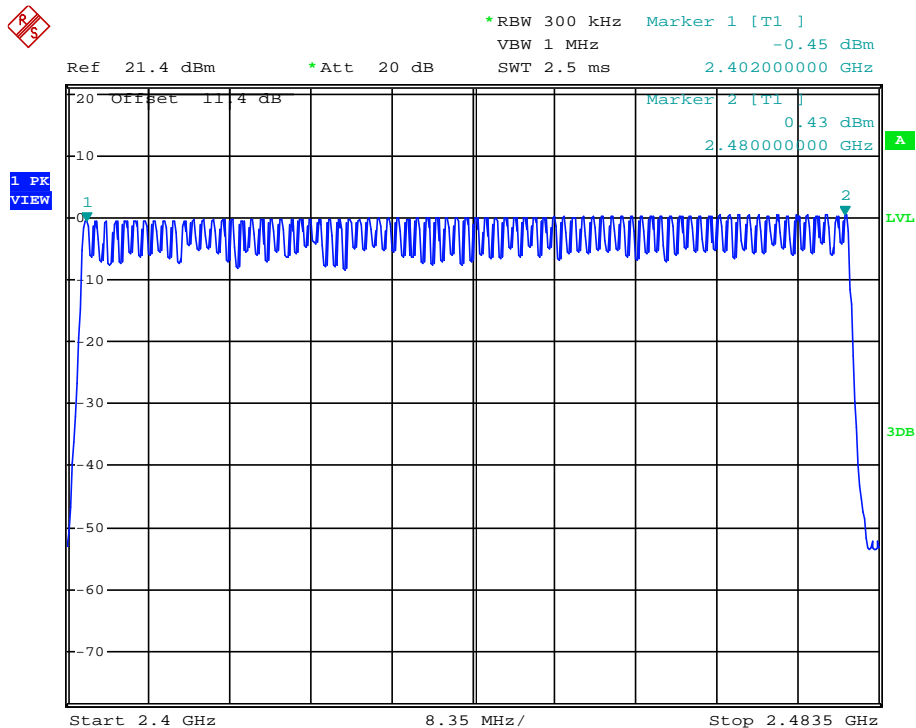
Limit according to FCC Part 15C, Section 15.247(1):

Frequency range (MHz)	LIMIT (Number of Hopping Channels)	
	20dB Bandwidth < 250kHz	20dB Bandwidth > 250kHz
2400 – 2483.5	0	79

The requirements are fulfilled

Remarks: For detailed test result please refer to following test protocol.

5.14.3 Test protocol



FCC ID: CWTUGZZC / IC:1788F-UGZZC

5.15 Antenna application

5.15.1 Applicable standard

According to FCC Part 15C, Section 15.203:

An intentional radiator shall be designed to ensure that no antenna other than that furnished by the responsible party shall be used with the device. The use of a permanently attached antenna or of an antenna that uses a unique coupling to the intentional radiator shall be considered sufficient to comply with the provisions of this section. The manufacturer may design the unit that broken antennas can be replaced by the user, but the use of a standard antenna jack is prohibited.

The EUT has a PWB pattern antenna. There is no possibility to replace the antenna that prevents manipulation by a user. No external power amplifier can be connected. The requirements of part 15.203 and 15.204 are met.

5.15.2 Antenna requirements

According to FCC Part 15C, Section 15.247 (b)(4):

The conducted output power limit specified in paragraph (b) of 15.247 is based on the use of antennas with directional gains that do not exceed 6 dBi. Except as shown in paragraph (c) of this section, if transmitting antennas of directional gain greater than 6 dBi are used, the conducted output power from intentional radiator shall be reduced below the stated values in paragraph (b)(1), (b)(2) and (b)(3) of this section, as appropriate, by the amount in dB that the directional gain of the antenna exceeds 6 dBi.

For the PWB pattern antenna type, an output power reduction is not necessary.

5.16 Maximum permissible exposure (MPE)

5.16.1 Description of the test location

Test location: Shielded Room 4

5.16.2 Photo documentation of the test set-up

Note:

Test shows no test set-up because the Maximum Permissible Exposure is calculated in the following tables under 5.15.5 .

5.16.3 Applicable standard

According to FCC Part 15, Section 15.247(i):

Systems operating under the provisions of this section shall be operated in a manner that the public is not exposed to radio frequency energy levels in excess of the Commission's guidelines.

The test methods used comply with ANSI/IEEE C95.1, "IEEE Standard for Safety Levels with respect to Human Exposure to Radio Frequency Electromagnetic Fields, 3 kHz to 300 GHz".

This test report shows the compliance with the limits for Maximum Permissible Exposure (MPE) specified in FCC Part 1, Section 1.1310 and the criteria to evaluate the environmental impact of human exposure to radio-frequency (RF) radiation as specified in FCC Part 1, Section 1.1307(b).

FCC ID: CWTUGZZC / IC:1788F-UGZZC
5.16.4 Description of Measurement

The maximum total power input to the antenna is measured conducted as described in clause 5.3 of this document. To calculate the MPE in a defined distance away from the product the Friis transmission formula is used.

Friis transmission formula:

$$P_d = \frac{P_{out} * G}{4 * \Pi * r^2}$$

Where

P_d = power density (mW/cm²)

P_{out} = output power to antenna (mW)

G = gain of antenna (linear scale)

r = distance between antenna and observation point (cm)

According to FCC Rules 47CFR 2.1093(b) the EUT is not a portable device. The EUT is designed to be used that radiating structures are 20 cm outside of the body of the user. ($r = 20$ cm)

5.16.5 Test result

Worst case: PWB Antenna with a peak antenna gain of 0.6 dBi.

DH5

Channel	Power setting	$P_{Antenna}$	Antenna gain	P_{out}	G	S	Limit S_{eq}
f (MHz)	fixed	(dBm)	(dBi)	(mW)	linear	(mW/cm ²)	(mW/cm ²)
2402	max.	-0.4	0.6	0.91	1.15	0.000208	1.0
2441	max.	0.1	0.6	1.02	1.15	0.000234	1.0
2480	max.	0.5	0.6	1.12	1.15	0.000256	1.0

2-DH5

Channel	Power setting	$P_{Antenna}$	Antenna gain	P_{out}	G	S	Limit S_{eq}
f (MHz)	fixed	(dBm)	(dBi)	(mW)	linear	(mW/cm ²)	(mW/cm ²)
2402	max.	1.2	0.6	1.32	1.15	0.000301	1.0
2441	max.	1.8	0.6	1.51	1.15	0.000346	1.0
2480	max.	2.2	0.6	1.66	1.15	0.000379	1.0

3-DH5

Channel	Power setting	$P_{Antenna}$	Antenna gain	P_{out}	G	S	Limit S_{eq}
f (MHz)	fixed	(dBm)	(dBi)	(mW)	linear	(mW/cm ²)	(mW/cm ²)
2402	max.	1.6	0.6	1.45	1.15	0.000330	1.0
2441	max.	2.1	0.6	1.62	1.15	0.000370	1.0
2480	max.	2.5	0.6	1.78	1.15	0.000406	1.0

FCC ID: CWTUGZZC / IC:1788F-UGZZC

Limits for maximum permissible exposure (MPE):

Frequency Range (MHz)	Electric Field Strength (V/m)	Magnetic Field Strength (A/m)	Power Density (mW/cm ²)	Averaging Time (minutes)
(B) Limits for General Population / Uncontrolled Exposure				
0.3 – 3.0	614	1.63	100	30
3.0 – 30	824/ <i>f</i>	2.19/ <i>f</i>	180/ <i>f</i> ²	30
30 - 300	27.5	0.073	0.2	30
300-1500	---	---	<i>f</i> /1500	30
1500-100000	---	---	1.0	30

f = Frequency (MHz)

The requirements are fulfilled

Remarks:

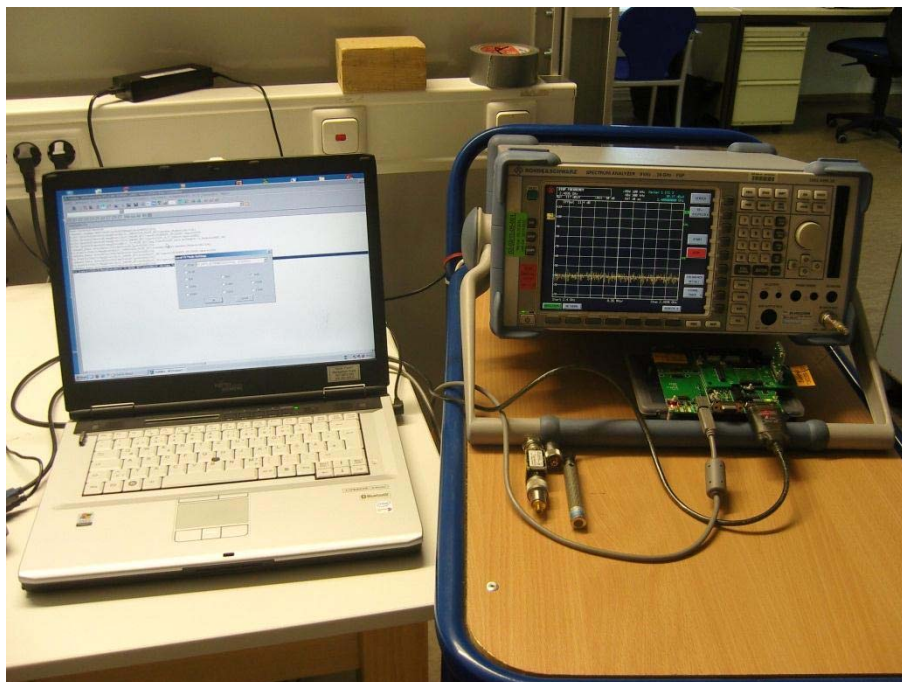
5.17 Receiver conducted emissions

For test instruments and accessories used see section 6 Part **SEC2** and **SEC3**.

Description of the test location

Test location: Shielded Room 4

5.17.1 Photo documentation of the test set-up



FCC ID: CWTUGZZC / IC:1788F-UGZZC
5.17.2 Description of the measurement:

A spectrum analyser is connected to the output of the transmitter via a suitable attenuator while EUT is operating in transmit mode using the assigned frequency according to DA 00-705.

Spectrum analyser settings:

RBW: 100 kHz, VBW: 300 kHz, Detector: Max peak, Trace: Max hold, Sweep: auto

5.17.3 Test Result

CH41, RX Continuous					
f (MHz)	f (MHz)	P _{conducted} (dBm)	Ant. Gain (dBi)	Corr.	Fieldstrength dB μ V/m
20-1000	814.3	-78.0	0.6	95.23	17.9
1000-5000	4888.0	-72.8	0.6	95.23	23.1
5000-10000	7447.5	-73.7	0.6	95.23	22.2
10000-15000	14860.0	-65.2	0.6	95.23	30.7
15000-20000	19200.0	-64.6	0.6	95.23	31.3
20000-25000	20000.0	-58.9	0.6	95.23	36.9

Limit according to RSS-Gen, Section 6.1 Table 2:

Frequency of emission (MHz)	Field strength limit (μ V/m)	Field strength limit dB(μ V/m)
30-88	100	40
88-216	150	43.5
216-960	200	46
Above 960	500	54

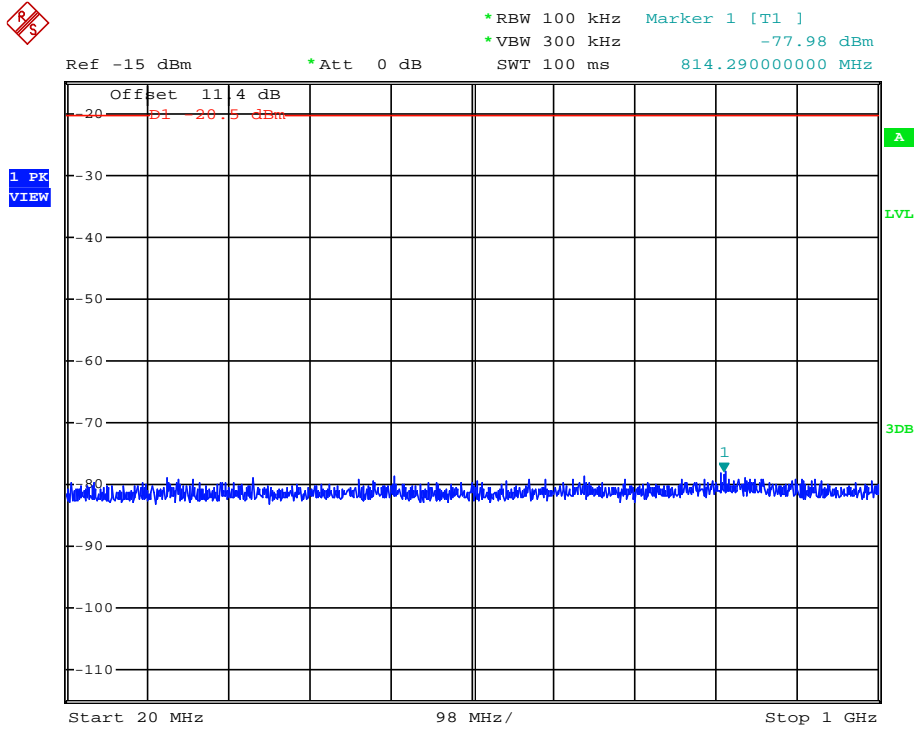
The requirements are fulfilled

Remarks: For detailed test result please refer to following test protocol.

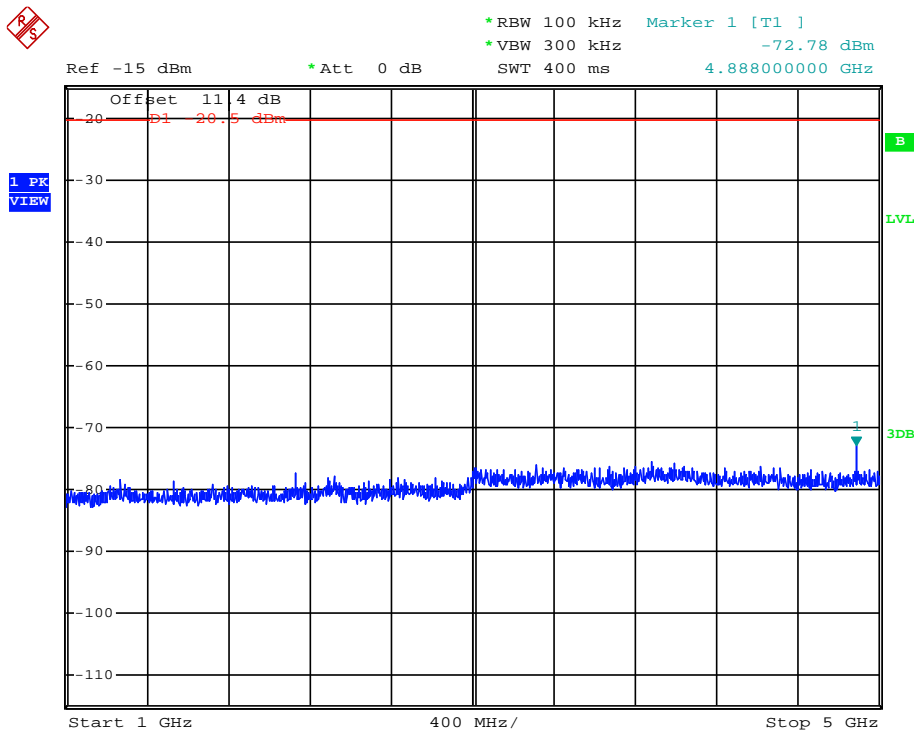
FCC ID: CWTUGZZC / IC:1788F-UGZZC

5.17.4 Test Protocol

CH41, 20 - 1000 MHz

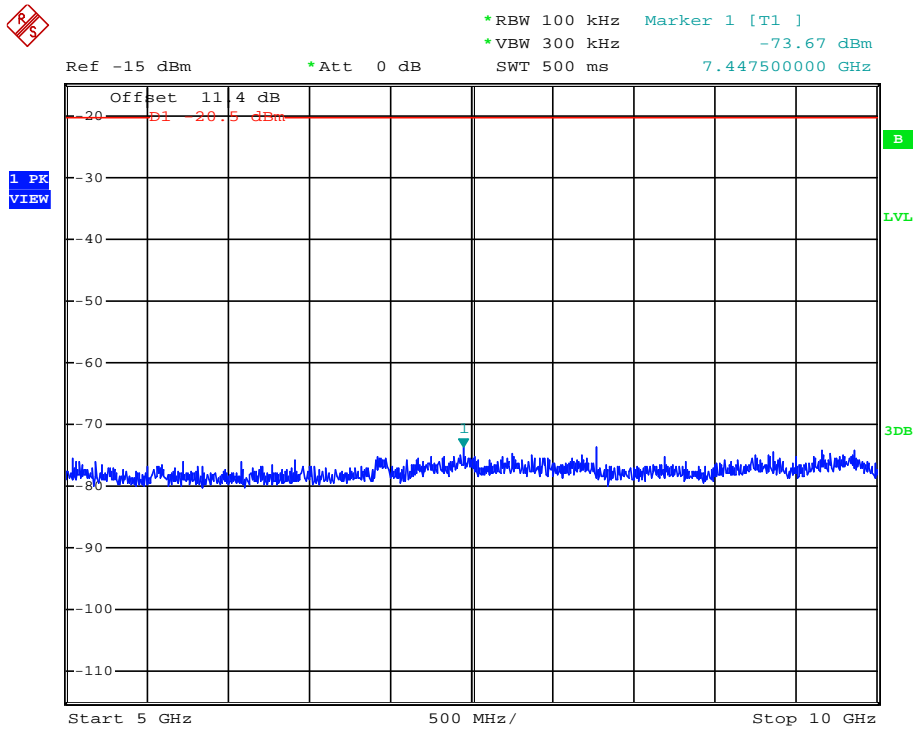


CH41, 1 - 5 GHz

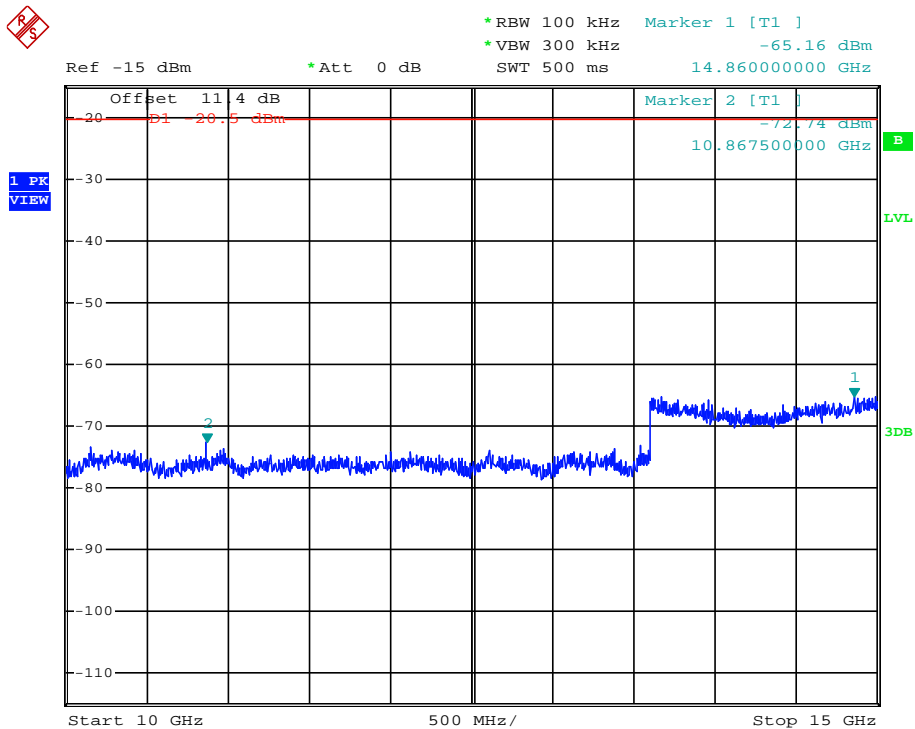


FCC ID: CWTUGZZC / IC:1788F-UGZZC

CH41, 5 - 10 GHz

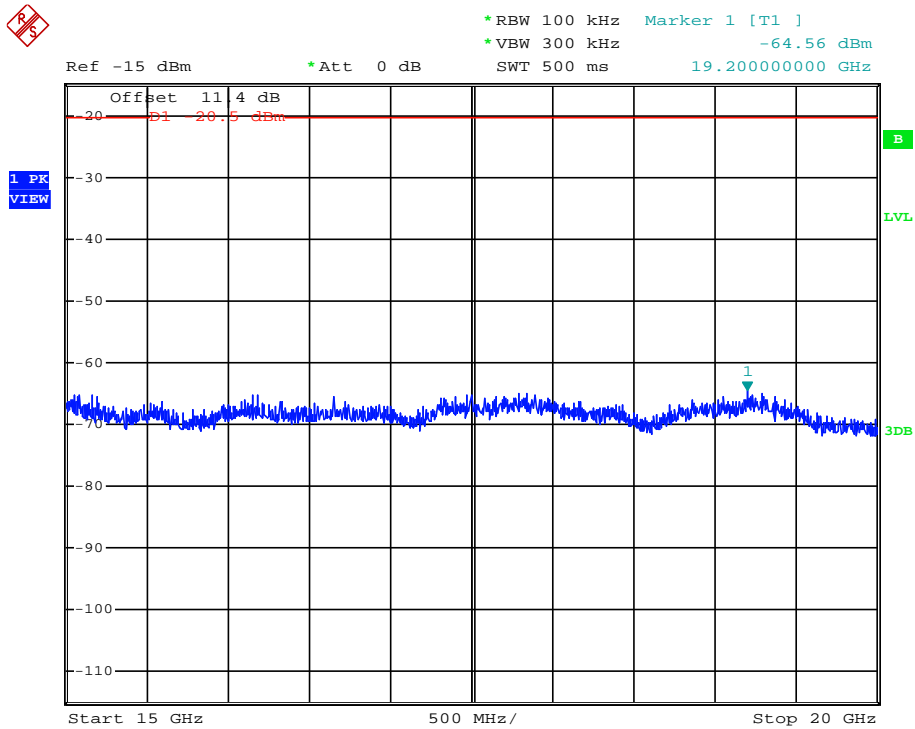


CH41, 10 - 15 GHz

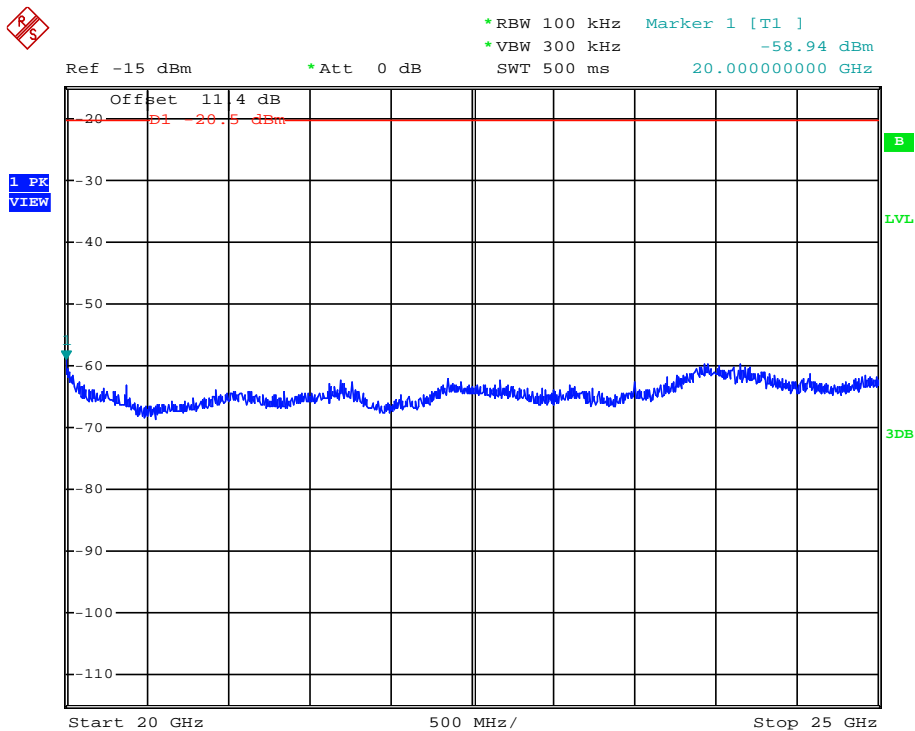


FCC ID: CWTUGZZC / IC:1788F-UGZZC

CH41, 15 - 20 GHz



CH41, 20 - 25 GHz



FCC ID: CWTUGZZC / IC:1788F-UGZZC

5.18 Receiver radiated emissions

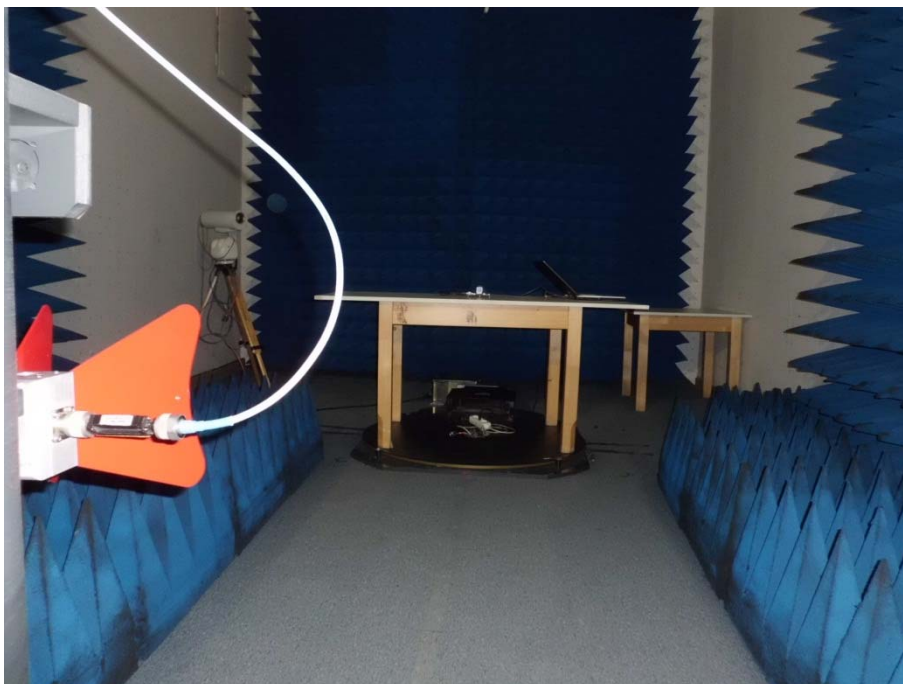
For test instruments and accessories used see section 6 Part **SER2** and **SER3**.

5.18.1 Description of the test location

Test location: OATS1
Test location: Anechoic Chamber A2
Test distance: 3 metres

5.18.2 Photo documentation of the test set-up

Test setup 1 – 18 GHz



5.18.3 According to RSS-Gen, Section 6.1:

Radiated spurious emission measurements shall be performed with the receiver antenna connected to the receiver antenna terminals. Spurious emissions from receivers shall not exceed the radiated limits shown in the table below.

5.18.4 Description of Measurement

Radiated emissions are measured according the requirements of ANSI C63.4. If the emission level in peak mode is lower as the average limit, then testing will be stopped and peak values of the EUT will be reported, otherwise, the emission will be measured in average mode again and reported.

FCC ID: CWTUGZZC / IC:1788F-UGZZC

5.18.5 Test result

f < 1 GHz:

Channel 1

Frequency (MHz)	Level QP (dB μ V)	Correct. factor (dB)	Corrected level QP dB(μ V/m)	Limit PK dB(μ V/m)	Limit AV dB(μ V/m)	Delta (dB)
25 - 1000	-					

Channel 41

Frequency (MHz)	Level QP (dB μ V)	Correct. factor (dB)	Corrected level QP dB(μ V/m)	Limit PK dB(μ V/m)	Limit AV dB(μ V/m)	Delta (dB)
25 - 1000	-					

Channel 79

Frequency (MHz)	Level QP (dB μ V)	Correct. factor (dB)	Corrected level QP dB(μ V/m)	Limit PK dB(μ V/m)	Limit AV dB(μ V/m)	Delta (dB)
25 - 1000	-					

Note: No emission could be detected up to 1000 MHz.

FCC ID: CWTUGZZC / IC:1788F-UGZZC

f > 1GHz:

Channel 1

Frequency (MHz)	L: PK (dB μ V)	Limit PK dB(μ V/m)	Limit AV dB(μ V/m)	Delta (dB)
		74.0	54.0	

Channel 41

Frequency (MHz)	L: PK (dB μ V)	Limit PK dB(μ V/m)	Limit AV dB(μ V/m)	Delta (dB)
		74.0	54.0	

Channel 79

Frequency (MHz)	L: PK (dB μ V)	Limit PK dB(μ V/m)	Limit AV dB(μ V/m)	Delta (dB)
		74.0	54.0	

Note: No Receiver emissions could be detected.

Limit according to RSS-Gen, Section 6.1 Table 2:

Frequency of emission (MHz)	Field strength limit (μ V/m)	Field strength limit dB(μ V/m)
30-88	100	40
88-216	150	43.5
216-960	200	46
Above 960	500	54

The requirements are **FULFILLED**.

Remarks: During the test, the EUT was set into continuous receiving mode. The measurement is performed up to 12.5 GHz.

FCC ID: CWTUGZZC / IC:1788F-UGZZC

6 USED TEST EQUIPMENT AND ACCESSORIES

All test instruments used are calibrated and verified regularly. The calibration history is available on request.

Test ID	Model Type	Equipment No.	Next Calib.	Last Calib.	Next Verif.	Last Verif.
A 4	C 1410	02-01/01-07-006				
	ESH 2 - Z 5	02-02/20-05-004	12/05/2013	12/05/2012	12/03/2013	12/09/2012
	N-4000-BNC	02-02/50-05-138				
	N-1500-N	02-02/50-05-140				
	ESH 3 - Z 2	02-02/50-05-155			05/10/2012	05/04/2012
CPC 3	C 1410	02-01/01-07-006				
	FSP 30	02-02/11-05-001	05/10/2012	05/10/2011		
MB	C 1410	02-01/01-07-006				
	FSP 30	02-02/11-05-001	05/10/2012	05/10/2011		
	WLJS 1200-3EF	02-02/50-05-041				
SEC 1-3	C 1410	02-01/01-07-006				
	FSP 30	02-02/11-05-001	05/10/2012	05/10/2011		
	WLJS 1200-3EF	02-02/50-05-041				
SER 2	C 1410	02-01/01-07-006				
	ESVS 30	02-02/03-05-006	26/06/2013	26/06/2012		
	VULB 9168	02-02/24-05-005	16/03/2013	16/03/2012	16/09/2012	16/03/2012
	S10162-B	02-02/50-05-031				
	NW-2000-NB	02-02/50-05-113				
	KK-EF393/U-16N-21N_20m	02-02/50-12-018				
SER 3	C 1410	02-01/01-07-006				
	FSP 30	02-02/11-05-001	05/10/2012	05/10/2011		
	AFS4-01000400-10-10P-4	02-02/17-05-003				
	AMF-4F-04001200-15-10P	02-02/17-05-004				
	AFS5-12001800-18-10P-6	02-02/17-06-002				
	3117	02-02/24-05-009	16/02/2013	16/02/2012		
	Sucoflex N-1600-SMA	02-02/50-05-073				
	Sucoflex N-2000-SMA	02-02/50-05-075				