Test Report

Customer:

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RF test report

140234-AU01+W01

Industry Canada Industrie Canada

HBC-radiomatic GmbH

RF module

TC241200 / TC241380

EMV TESTHAUS

The test result refers exclusively
to the model tested.

Revision: 1.1

DAkkS
Deutsche
Akkreditierungsstelle
D-PL-12155-01-01

EMV **TESTHAUS** GmbH

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Accreditation:

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The technical accuracy is guaranteed through the quality management of the
EMV **TESTHAUS** GmbH

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1 Test regulations

CFR 47 Part 2: 10-2013	Code of Federal Regulations Part 2 (Frequency allocation and radio treaty matters; General rules and regulations) of the Federal Communication Commission (FCC)
CFR 47 Part 15: 10-2013	Code of Federal Regulations Part 15 (Radio Frequency Devices) of the Federal Communication Commission (FCC)
Public Notice DA 00-705	Filing and Measurement Guidelines for Frequency Hopping Spread Spectrum Systems.
ANSI C63.4: December 2009	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
RSS-Gen Issue 3, December 2010	General Requirements and Information for the Certification of Radiocommunication Equimpment, published by Industry Canada
RSS-102 Issue 4, March 2010, updated December 2010	Radio Frequency Exposure Compliance of Radiocommunications Apperatus
RSS-210 Issue 8, December 2010	Low Power Licence-Exempt Radiocommunication Devices (All Frequency Bands): Category I Equipment, published by Industry Canada

1.1 Cross reference of FCC and Industry Canada standards

CFR 47 Part and Section	Test	Equivalent to IC
15.207	AC power line conducted emissions 0.150 MHz to 30 MHz	RSS Gen Issue 2 Section 7.2.2
15.247(a) Public Notice DA 00-705	Carrier Frequency Separation	RSS 210 Issue 8 A 8.1(b)
15.247(a) Public Notice DA 00-705	Number of Hopping Frequencies	RSS 210 Issue 8 A 8.1(d)
15.247(a) Public Notice DA 00-705	Time of Occupancy (Dwell time)	RSS 210 Issue 8 A 8.1(d)
15.247(a) Public Notice DA 00-705	20 dB bandwidth	RSS 210 Issue 8 A 8.1(a)
2.202(a) ANSI C63.4, section 13.7	Occupied bandwidth	RSS 210 Issue 8 A 8.1(a)
15.247(b) Public Notice DA 00-705	Maximum conducted output power	RSS Gen Issue 3 Section 4.8 RSS 210 Issue 8 A 8.4
15.247(d) Public Notice DA 00-705	Band-edge Compliance	RSS 210 Issue 8 A 8.5
15.247(d) Public Notice DA 00-705	Spurious RF Conducted Emission	RSS 210 Issue 8 A 8.5
15.247(d) Public Notice DA 00-705	Radiated emission 9 kHz to 10th Harmonic	RSS Gen Issue 3 Section 4.9 RSS 210 Issue 8 A 8.5
2.1091 Public Notice DA 00-705	Exposure of humans to RF fields	RSS Gen Issue 3Section 5.6 Exempted form SAR and RF evaluation

1.2 Summary of test results

Standard	Test result
FCC CFR 47 Part 15, section 15.247	Passed
RSS-210 Issue 8 Annex 8 and RSS-Gen Issue 3	Passed

2 Equipment under Test (EUT)

Product type:	RF module
Model Name:	TC241200 / TC241380
Manufacturer:	HBC-radiomatic GmbH
Serial number:	01/00010B, 01/00010D
FCC ID:	NO9TC241
IC	2977A-TC241
Application freq. band:	2400 MHz – 2483.5 MHz
Frequency range:	2402MHz – 2480 MHz
Operating frequency:	2402MHz – 2480 MHz
Channel spacing:	1 MHz
Number of RF-channels:	79
Type of modulation:	Basic mode (GFSK) / EDR mode (Pi/4 DQPSK, 8DPSK)
Antenna type:	External detachable antenna with MMCX connector
Power supply:	Host powered nominal: 3.0 V
Temperature range:	-30°C to +80°C

2.1 List of antennas

For detailed specification see annex C.

Manufacturer	Model	Gain	Antenna type
CELPHONE	60603030	2.14dBi	Dipole antenna

To connect the dipole antenna with SMA connector to the MMCX connector at the PCB, an adapter cable with 30 cm was used.

2.2 Photo documentation

For photos taken during testing, see annex A.
For photos of the EUT, see annex B.
For internal photos of the EUT, see annex C.

2.3 Short description of the EUT

The EUT is a RF module with Bluetooth technology which can be integrated in special industrial applications.
Type 1: TC241200 (20 pin connector, MMCX-plug)
Type 2: TC241380 (38 pin connector, MMCX-plug)

At both types the complete RF part is identical. The only difference is the connector type at the pcb.

During the pre-measurements it was observed that there is no difference in the results between both types. Therefore only type 1 was documented.

2.4 Operation mode

The EUT was tested in the following operation modes:

- Basic mode (GFSK)
- EDR mode 2Msymbols/s (Pi/4 DQPSK)
- EDR mode 3Msymbols/s (8 DQPSK)

2.5 Configuration

The following peripheral devices and interface cables were connected during the tests:

Device	Model:	S/N
Notebook with PSU	**Fujitsu Lifebook A531 PSU: ADP-65JH AD**	**YLDS0113893**
RF module	TC241200	01/00010B
RX232-UART-Adapter	AB044013	N/A
Power supply	Input 120V/60Hz /Output 0-30V DC Statron 3252.1	1201211

Used cables

Numbers:	Description: (type / lengths / remarks)	Serial No
1	DC cable / 1.5m / unshielded	N/A
1	Antenna cable / 0.3m / shielded	N/A

3 AC power line conducted emissions

according to CFR 47 Part 15, section 15.207

3.1 Test location

Description	Manufacturer	Inventory No.
Shielded chamber	Siemens - Matsushita	E00107

3.2 Test instruments

	Description	Manufacturer	Inventory No.
☑	ESCS 30	Rohde & Schwarz	E00003
☐	ESCI	Rohde & Schwarz	E00001
☐	ESH3 Z2	Rohde & Schwarz	E00028
☑	ESH 2-Z5	Rohde & Schwarz	E00004
☑	ESH 2-Z5	Rohde & Schwarz	E00005

3.3 Limits

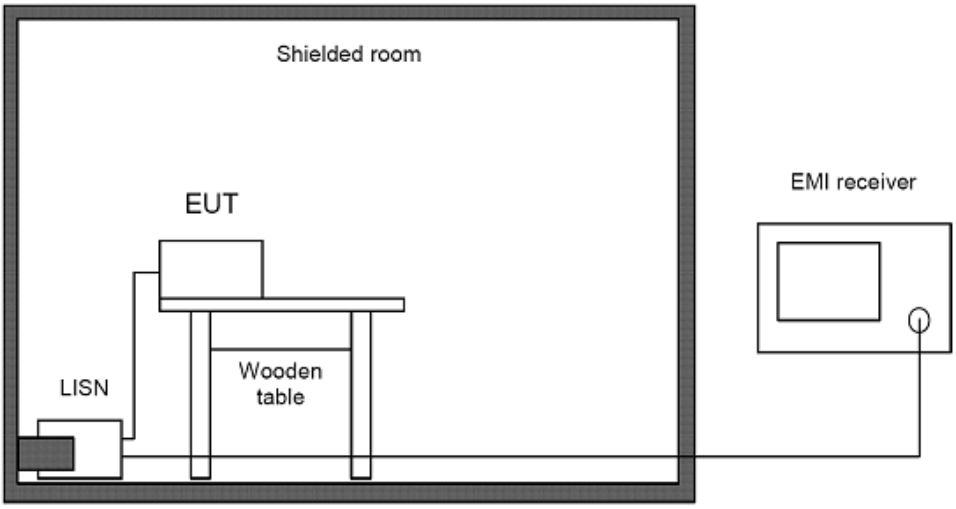
Frequency [MHz]	Quasi-peak [dBµV]	Avarage [dBµV]
0.15 – 0.5	66 - 56	56 – 46
0.5 – 5.0	56	46
5 – 30	60	50

3.4 Test procedure

1. The tests of conducted emission were carried out in a shielded room using a line impedance stabilization network (LISN) 50 µH/50 Ohms and an EMI test receiver.
2. The EMI test receiver was connected to the LISN and set to a measurement bandwidth of 9 kHz in the frequency range form 0.15 MHz to 30 MHz.
3. The EUT was placed on a wooden table and connected to the LISN.
4. To accelerate the measurement the detector of the EMI test receiver was set to peak and the whole frequency range form 0.15 MHz to 30 MHz were scanned.
5. After that all peaks values with fewer margins than 10 dB to quasi-peak limit or exceeding the limit were marked and re-measured with quasi-peak detector.
6. If after that all values are under the average limit no addition measurement is necessary. In case there are still values between quasi-peak and average limit than these values were re-measured again with an average detector.
7. These measurements were done on all current carrying conductors.

According to ANSI C63.4, section 13.1.3.1 testing of intentional radiators with detachable antennas shall be done with a dummy load otherwise the tests should be done with connected antenna and if adjustable fully extended.

3.5 Test setup



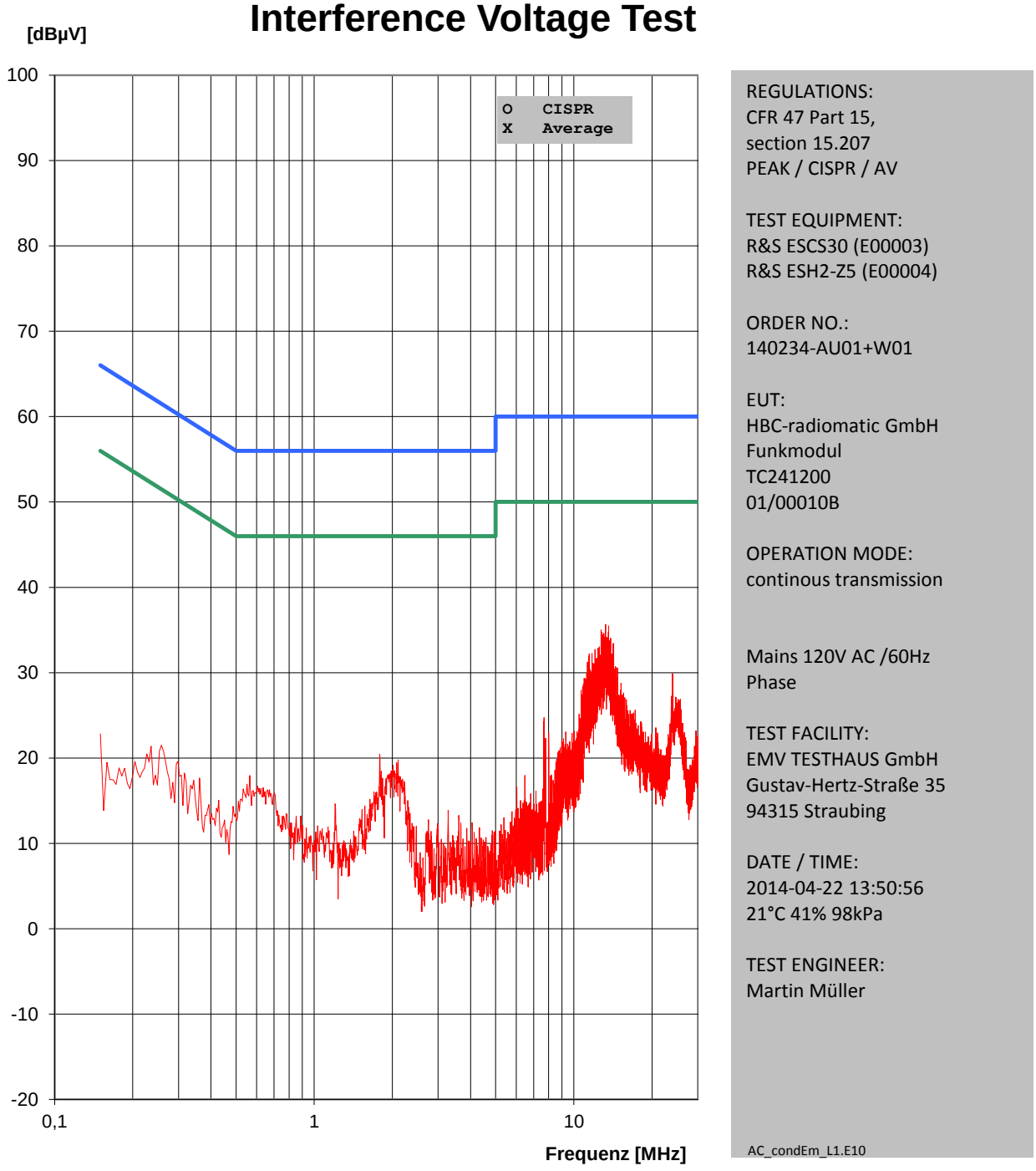
Picture 1: Outline of conducted emission test setup

Comments: All peripheral devices were additionally decoupled by means of a line stabilization network.
The measurements were performed with 120V/60Hz.

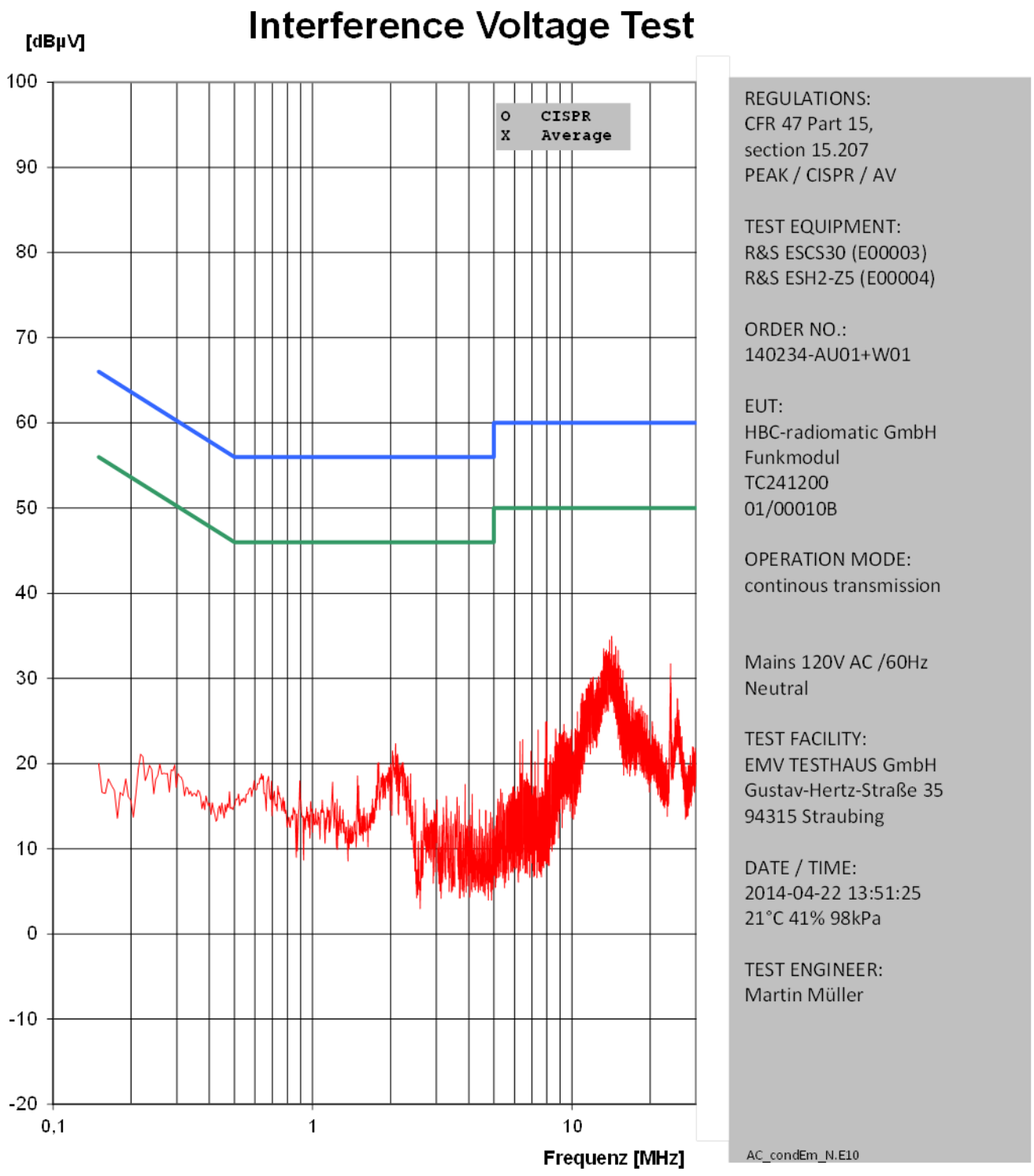
3.6 Test results

Temperature:	21°C	Humidity:	41%
Tested by:	M. Müller	Test date:	2014-04-22

Interference Voltage Test



Picture 2: Conducted emission on mains, phase 1 (120V 60Hz)



Picture 3: Conducted emission on mains, neutral (120V 60Hz)

4 Carrier Frequency Separation

according to CFR 47 Part 15, section 15.247(a), and Public Notice DA 00-705

4.1 Test location

☑ Conducted measurement
☐ Scan with peak detector in 3 m CDC
☐ CISPR measurement with quasi peak detector on 10m open area test site.
☐ Measurement with peak detector on 3m open area test site

Description	Manufacturer	Inventory No.
CDC	Albatross Projects	E00026
Open area test site	EMV **TESTHAUS** GmbH	E00354

4.2 Test instruments

	Description	Manufacturer	Inventory No.
☐	ESCS 30 (FF)	Rohde & Schwarz	E00003
☑	ESU 26	Rohde & Schwarz	W00002
☐	ESCI (CDC)	Rohde & Schwarz	E00001
☐	HFH2-Z2	Rohde & Schwarz	E00060
☐	VULB 9163 (FF)	Schwarzbeck	E00013
☐	VULB 9160 (CDC)	Schwarzbeck	E00011

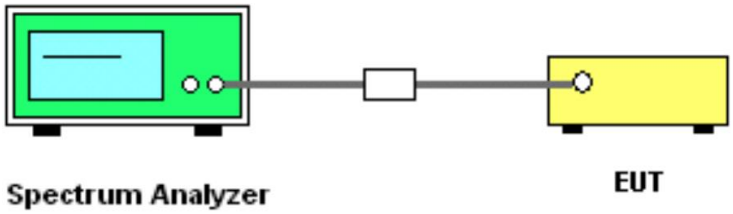
4.3 Limits

Frequency hopping systems shall have hopping channel carrier frequencies separated by a minimum of 25 kHz or the 20 dB bandwidth of the hopping channel, whichever is greater. Alternatively, frequency hopping systems operating in the 2400–2483.5 MHz band may have hopping channel carrier frequencies that are separated by 25 kHz or two-thirds of the 20 dB bandwidth of the hopping channel, whichever is greater, provided the systems operate with an output power no greater than 125 mW.

4.4 Test procedure

1. The EUT was connected to the spectrum analyzer
2. The EUT has its hopping function enabled
3. The unit was operated in continuous transmit mode with modulation.
4. After the trace has stabilized the peak of the adjacent channels was recorded using the delta Marker function.

4.5 Test setup



Picture 4: Test setup carrier frequency separation measurement

4.6 Test Deviation

There is no deviation with the original standard.

4.7 EUT operation during test

The EUT was programmed to be in continuously transmitting mode with enabled hopping function.

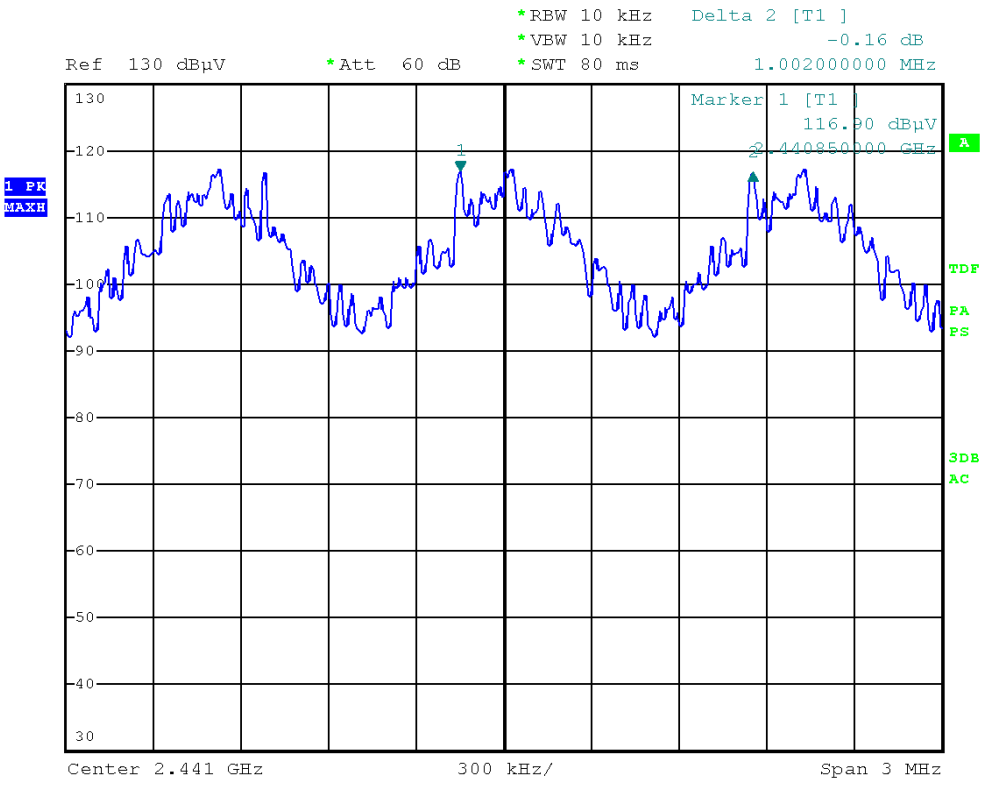
4.8 Test results

Temperature:	23°C	Humidity:	41%
Tested by:	M. Müller	Test date:	2014-04-23

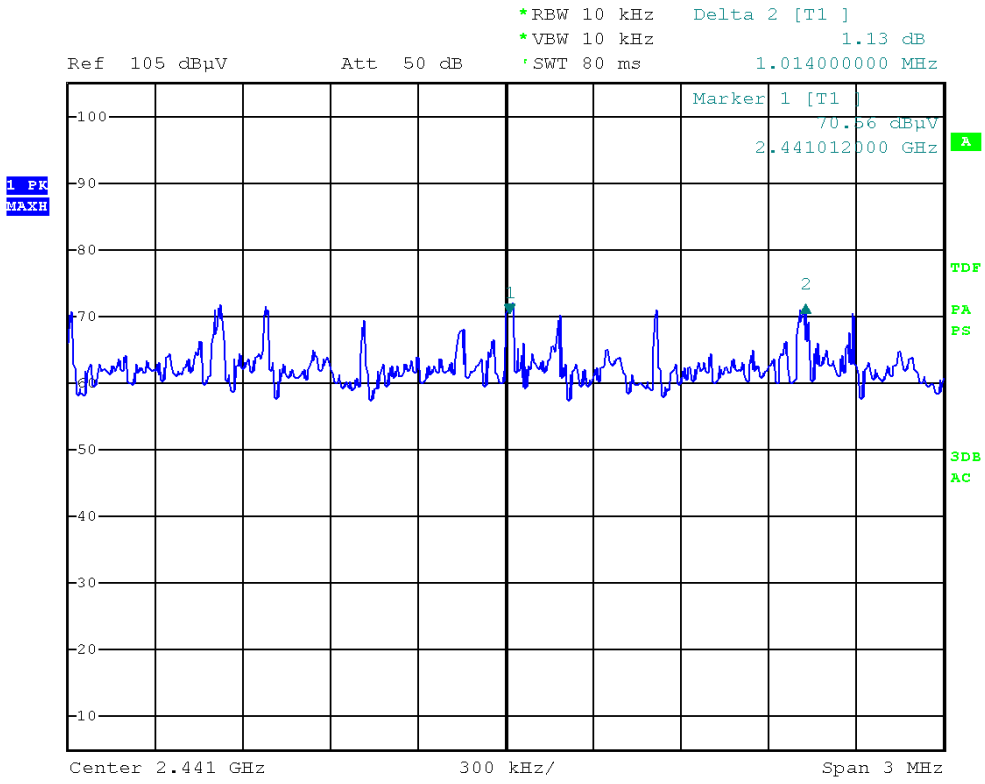
Test Result		
Carrier Frequency Separation (MHz)	**Minimum Separation (MHz)**	**Result**
1.002	0.840	PASS
1.014	0.840	PASS
1.002	0.840	PASS

with

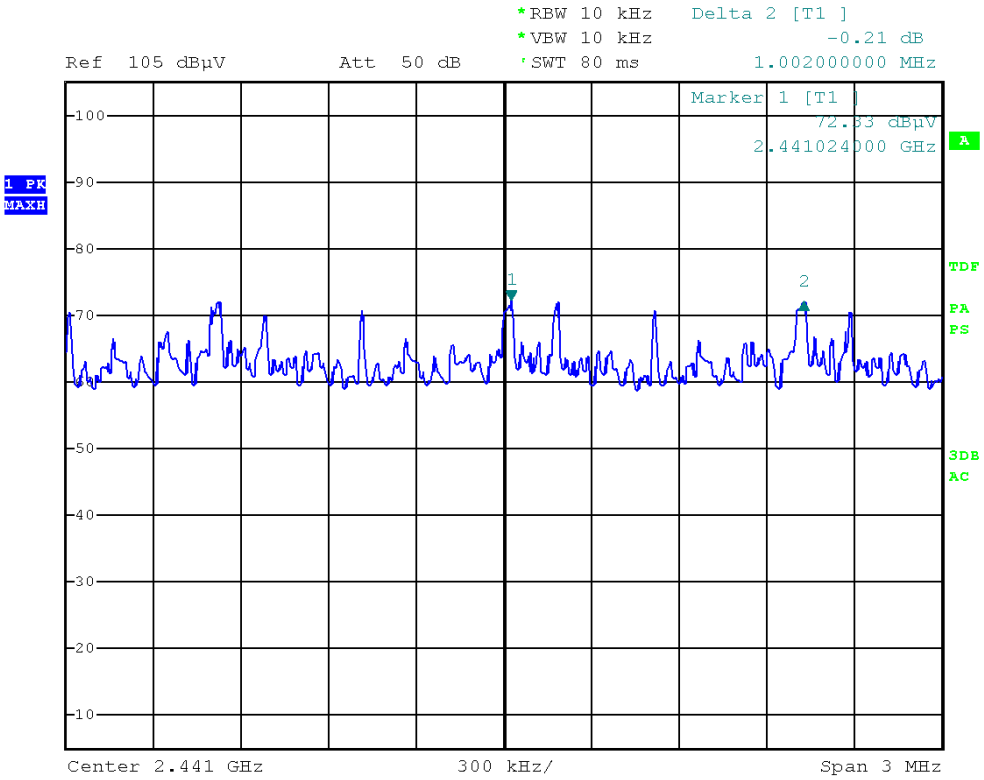
Maximum 20-dB-bandwidth: 1.260 MHz (>> 25 kHz), see clause 7.8 on page 33
Maximum output power: 16.33 dBm (43 mW < 125 mW), see clause 9.8 on page 50
Minimum separation required: 2/3 * 20-dB-Bandwidth = 0.840 MHz



Picture 5: Carrier Frequency Separation (Basic mode)



Picture 6: Carrier Frequency Separation (8DPSK)



Picture 7: Carrier Frequency Separation (Pi/4 DQPSK)

5 Number of Hopping Frequencies

according to CFR 47 Part 15, section 15.247(a), and Public Notice DA 00-705

5.1 Test location

☑ Conducted measurement
☐ Scan with peak detector in 3 m CDC
☐ CISPR measurement with quasi peak detector on 10m open area test site.
☐ Measurement with peak detector on 3m open area test site

Description	Manufacturer	Inventory No.
CDC	Albatross Projects	E00026
Open area test site	EMV **TESTHAUS** GmbH	E00354

5.2 Test instruments

	Description	Manufacturer	Inventory No.
☐	ESCS 30 (FF)	Rohde & Schwarz	E00003
☑	ESU 26	Rohde & Schwarz	W00002
☐	ESCI (CDC)	Rohde & Schwarz	E00001
☐	HFH2-Z2	Rohde & Schwarz	E00060
☐	VULB 9163 (FF)	Schwarzbeck	E00013
☐	VULB 9160 (CDC)	Schwarzbeck	E00011

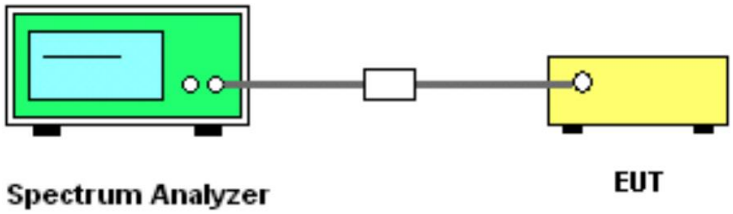
5.3 Limits

Frequency hopping systems in the 2400-2483.5 MHz band shall use at least 15 channels.

5.4 Test procedure

1. The EUT was connected to the spectrum analyzer
2. The EUT has its hopping function enabled
3. The unit was operated in continuous transmit mode with modulation.
4. After the trace has stabilized count the peaks.
5. To get a higher resolution the frequency range was split in two parts.

5.5 Test setup



Picture 8: Test setup Number of hopping channels measurement

5.6 Test Deviation

There is no deviation with the original standard.

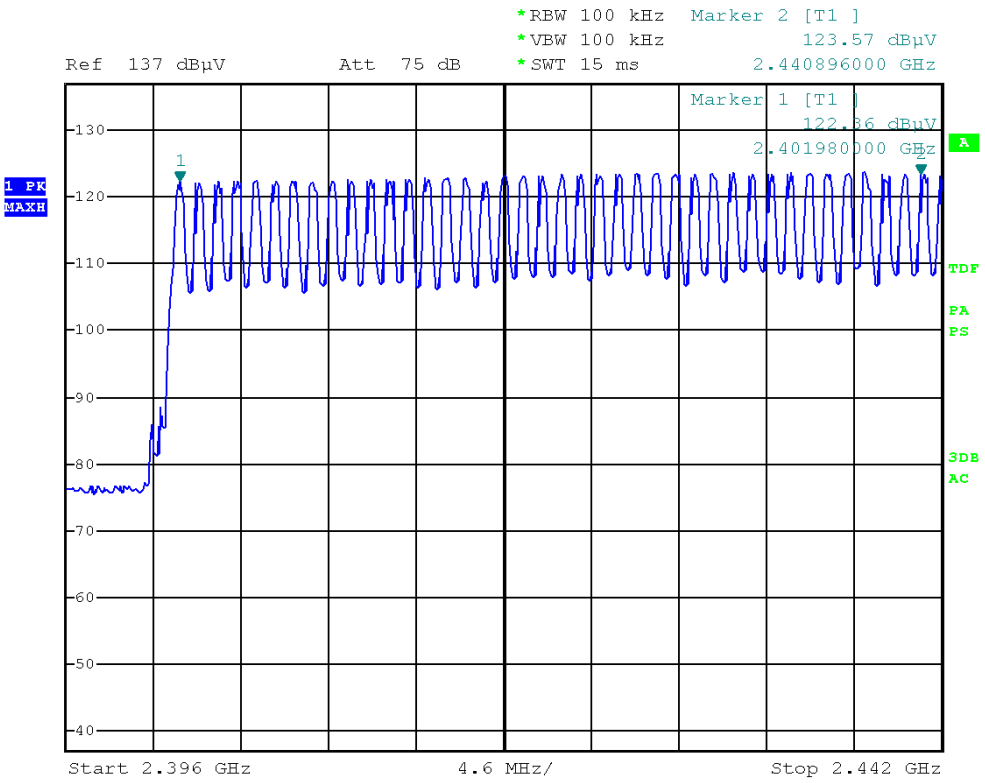
5.7 EUT operation during test

The EUT was programmed to be in continuously transmitting mode with enabled hopping function.

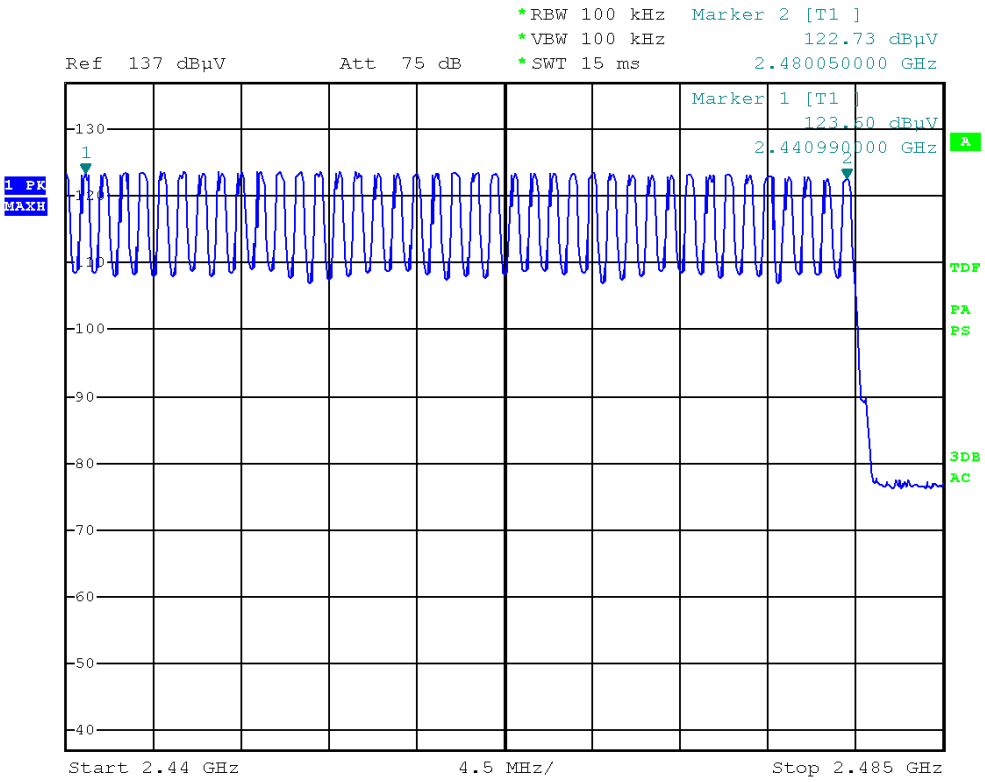
5.8 Test results

Temperature:	23°C	Humidity:	41%
Tested by:	M. Müller	Test date:	2014-04-23

Test Result	
Number of Hopping Channels	**79**



Picture 9: Number of hopping frequencies



Picture 10: Number of hopping frequencies

6 Time of Occupancy (Dwell time)

according to CFR 47 Part 15, section 15.247(a), and Public Notice DA 00-705

6.1 Test location

☑ Conducted measurement
☐ Scan with peak detector in 3 m CDC
☐ CISPR measurement with quasi peak detector on 10m open area test site.
☐ Measurement with peak detector on 3m open area test site

Description	Manufacturer	Inventory No.
CDC	Albatross Projects	E00026
Open area test site	EMV **TESTHAUS** GmbH	E00354

6.2 Test instruments

	Description	Manufacturer	Inventory No.
☐	ESCS 30 (FF)	Rohde & Schwarz	E00003
☑	ESU 26	Rohde & Schwarz	W00002
☐	ESCI (CDC)	Rohde & Schwarz	E00001
☐	HFH2-Z2	Rohde & Schwarz	E00060
☐	VULB 9163 (FF)	Schwarzbeck	E00013
☐	VULB 9160 (CDC)	Schwarzbeck	E00011

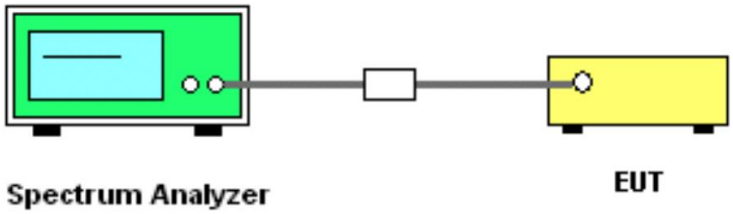
6.3 Limits

The average time of occupancy on any channel shall not be greater than 0.4 seconds within a period of 0.4 seconds multiplied by the number of hopping channels employed.

6.4 Test procedure

1. The EUT was connected to the spectrum analyzer
2. The EUT has its hopping function enabled
3. The unit was operated in continuous transmit mode with modulation.

6.5 Test setup



Picture 11: Test setup time of occupancy measurement

6.6 Test Deviation

There is no deviation with the original standard.

6.7 EUT operation during test

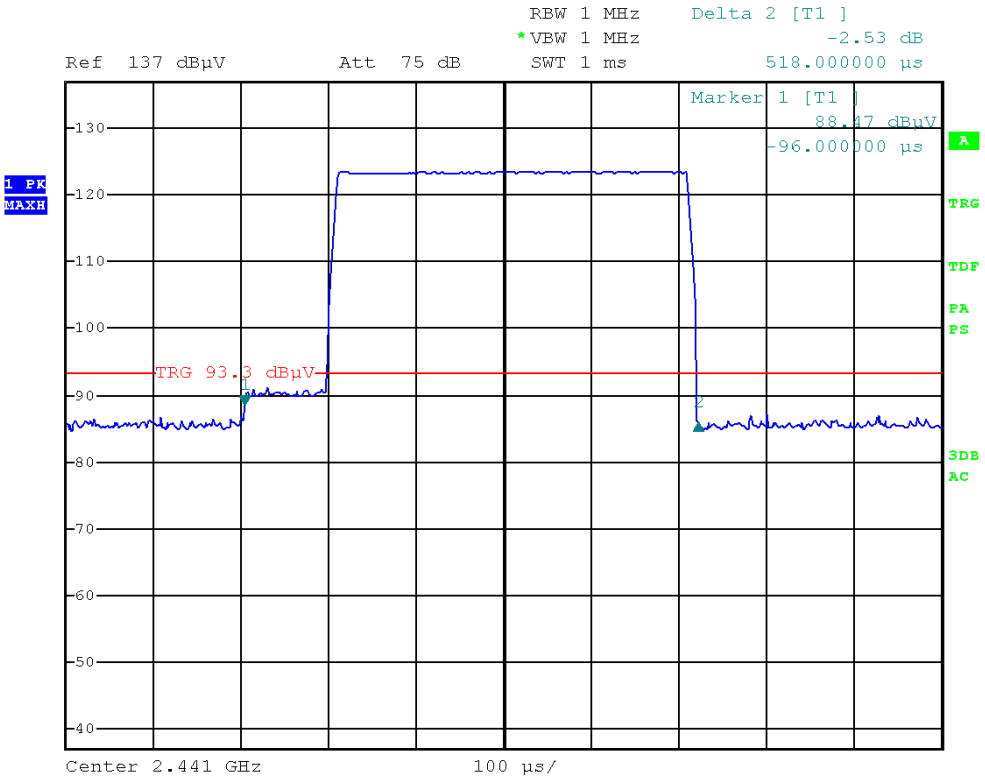
The EUT was programmed to be in continuously transmitting mode with enabled hopping function.

6.8 Test results

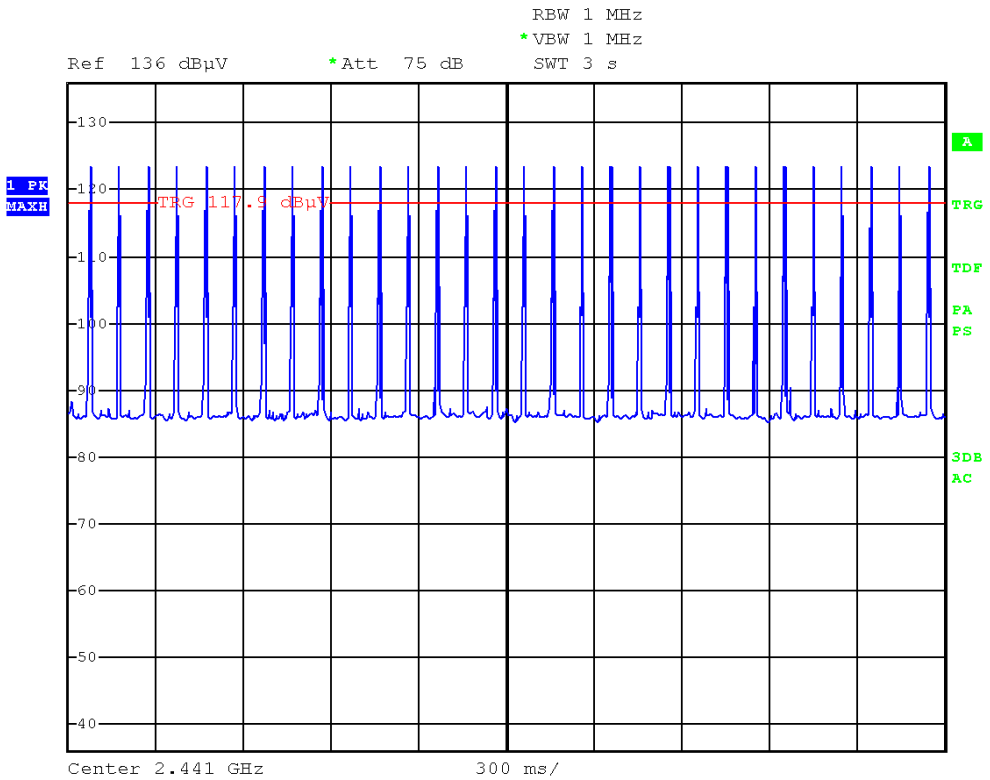
Temperature:	23°C	Humidity:	41%
Tested by:	M. Müller	Test date:	2014-04-23

Mode	Time of Transmission (79ch * 0.4s)	Number of hoppings in 3sec	Number of hoppings in 1sec	Signal On time (msec)	Result (Dwell Time) (msec)	Limit (msec)	Result
DH1(GFSK)	31.6s	30	10	0.518	163.688	400	PASS
DH3 (GFSK)	31.6s	15	5	1.795	283.610	400	PASS
DH5 (GFSK)	31.6s	10	3.33	3.06	321.998	400	PASS
EDR 3Mbps DH5 (8DPSK)	31.6s	10	3.33	3.08	324.102	400	PASS
EDR 2Mbps DH5 (Pi/4 DQPSK)	31.6s	10	3.33	3.06	321.998	400	PASS

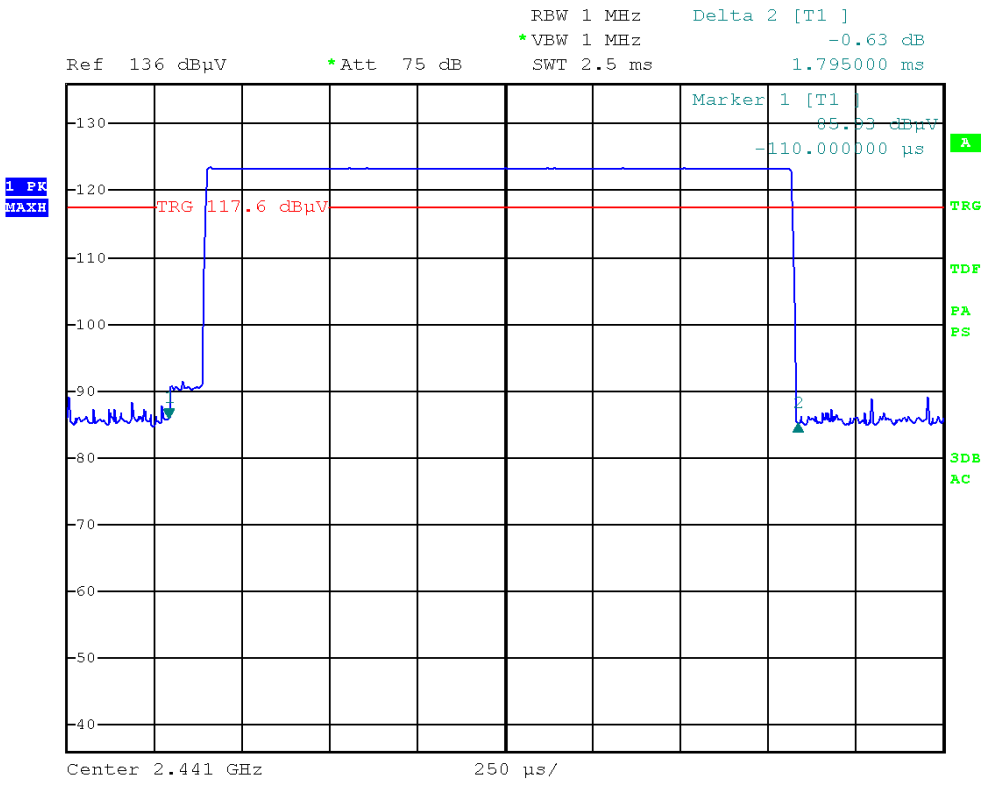
Dwell Time = Number of hopping in 1sec * Time of Transmission*Signal On Time



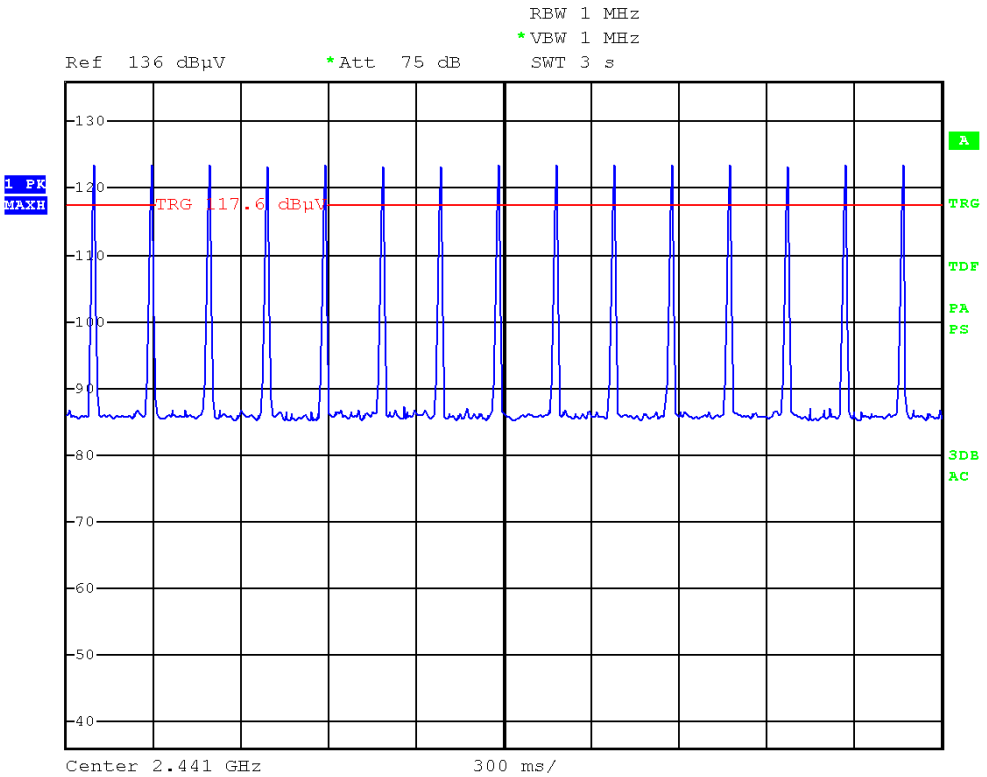
Picture 12: Signal-on-Time (DH1 Basic Mode)



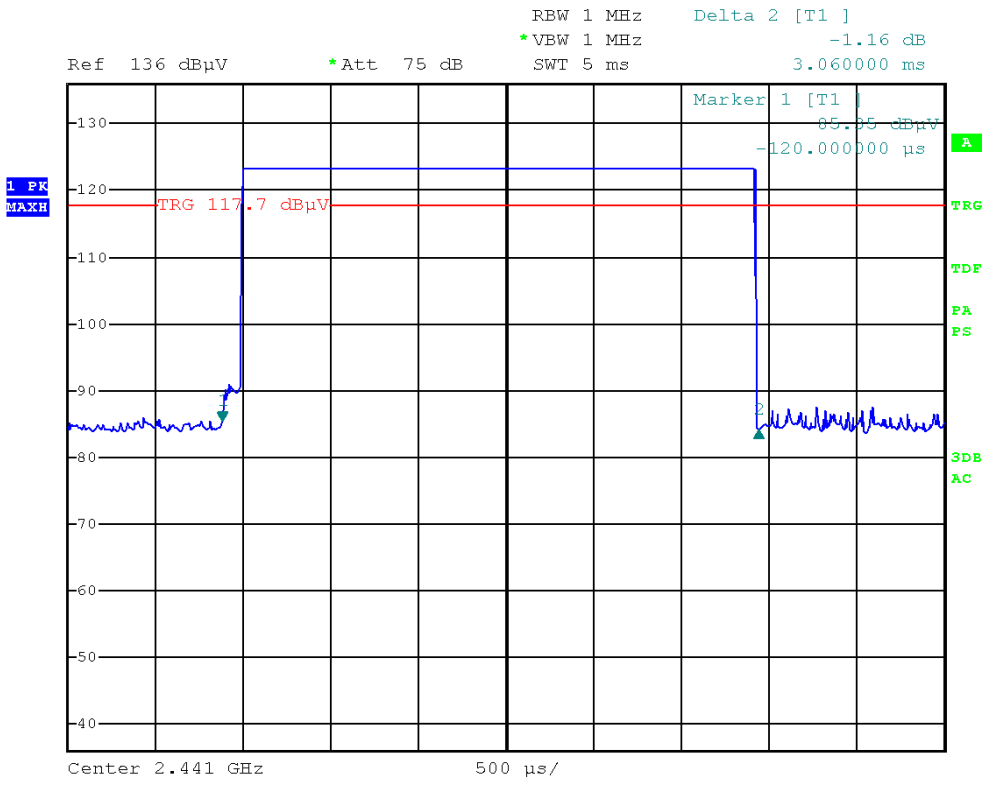
Picture 13: Nr. of hops within 3sec (DH1 Basic Mode)



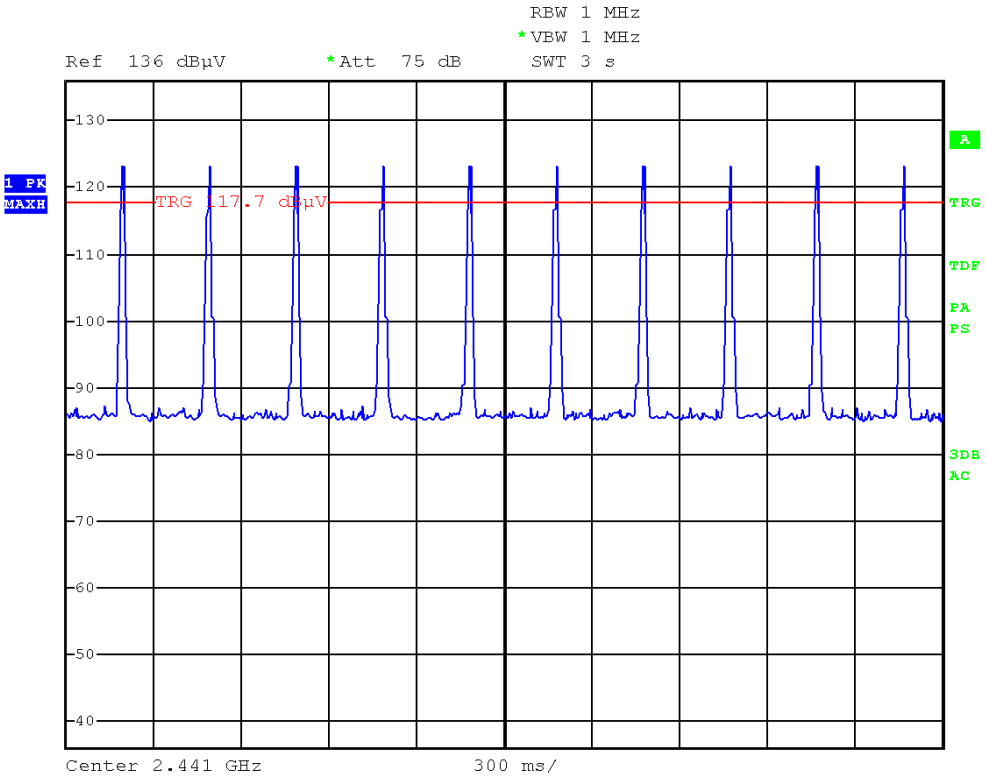
Picture 14: Signal-on-Time (DH3 Basic Mode)



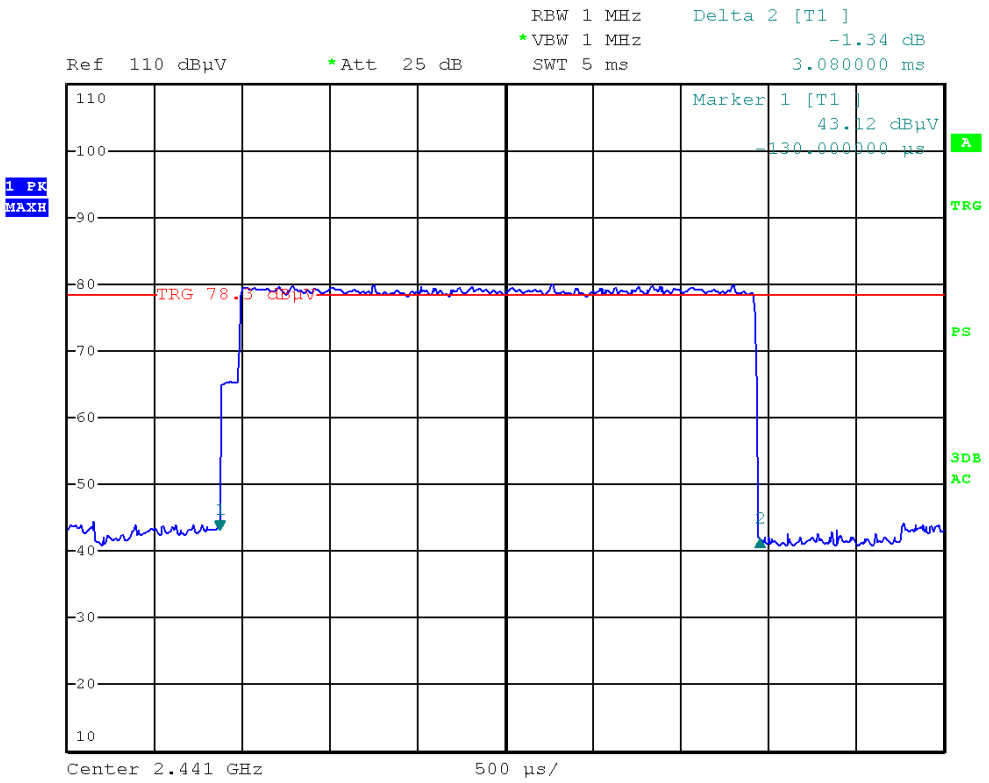
Picture 15: Nr. of hops within 3sec (DH3 Basic Mode)



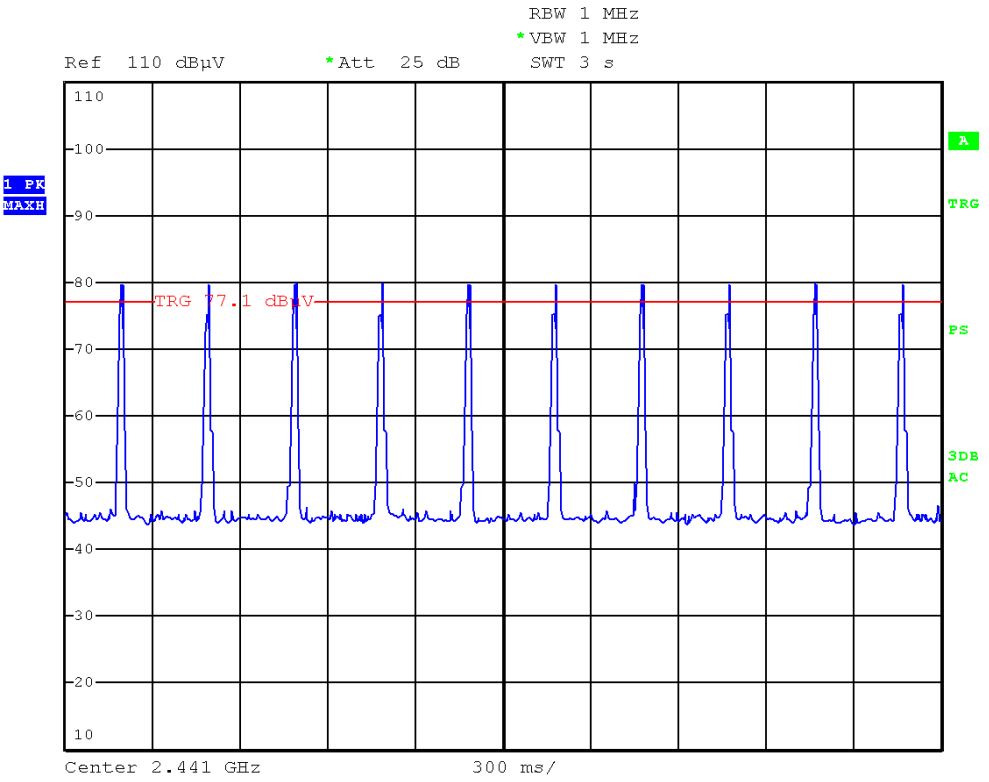
Picture 16: Signal-on-Time (DH5 Basic Mode)



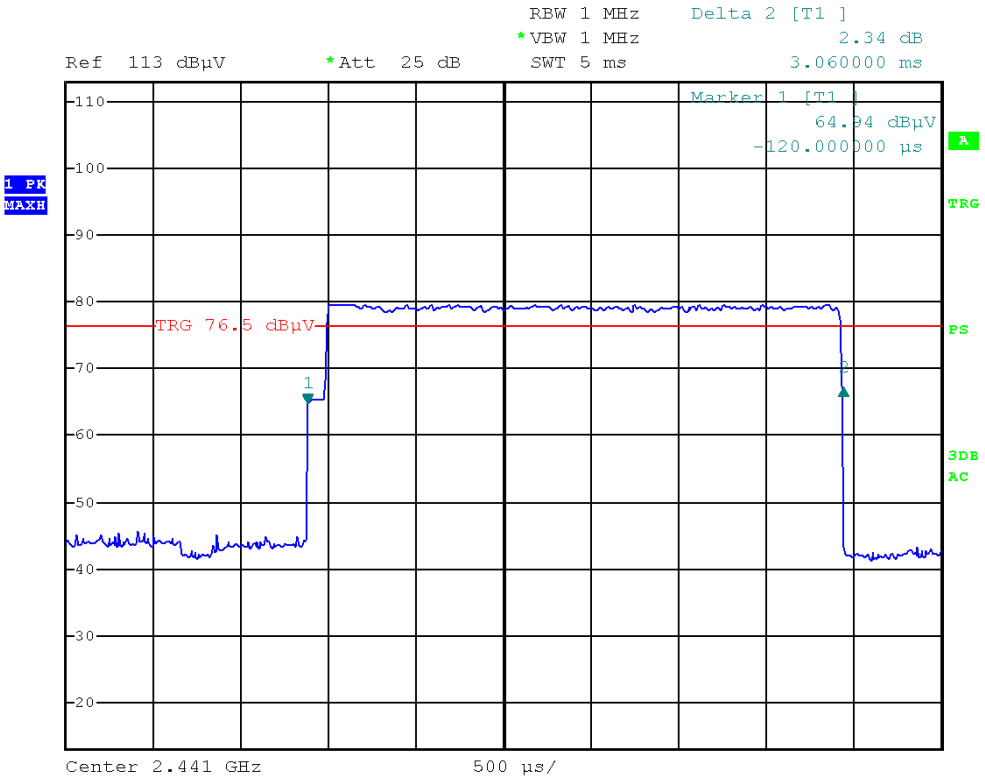
Picture 17: Nr. of hops within 3sec (DH5 Basic Mode)



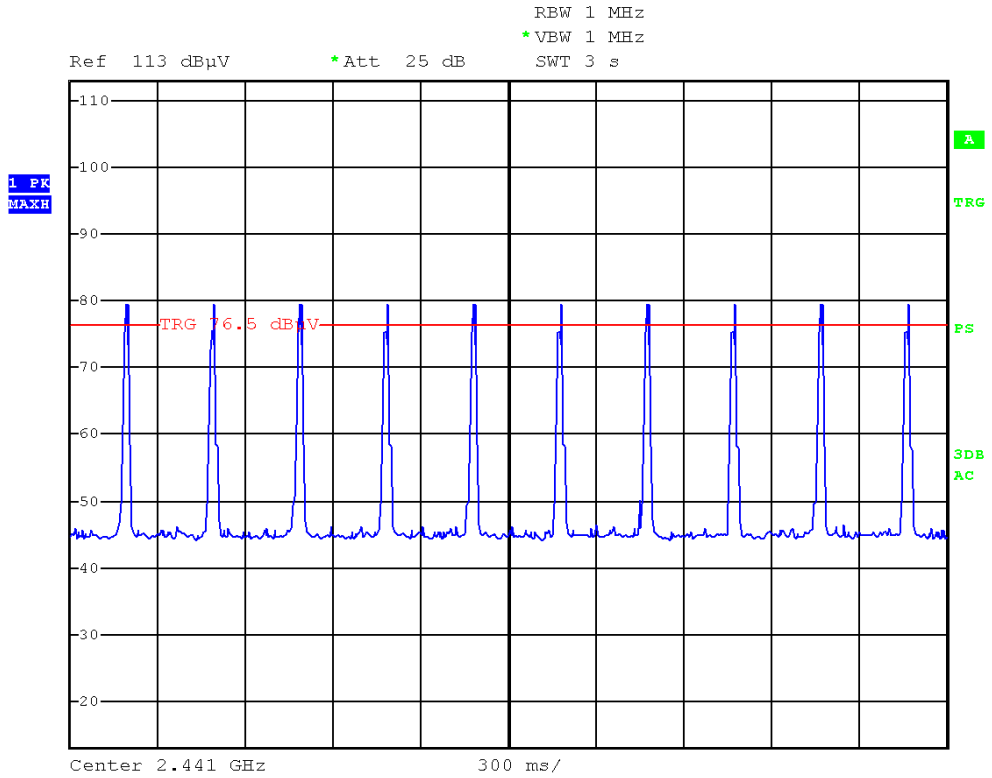
Picture 18 Signal-on-Time (8DPSK)



Picture 19: Nr. of hops within 3sec (8DPSK)



Picture 20: Signal-on-Time (Pi/4 DQPSK)



Picture 21: Nr. of hops within 3sec (Pi/4 DQPSK)

7 20 dB bandwidth

according to CFR 47 Part 15, section 15.247(a), and Public Notice DA 00-705

7.1 Test location

☑ Conducted measurement
☐ Scan with peak detector in 3 m CDC
☐ CISPR measurement with quasi peak detector on 10m open area test site.
☐ Measurement with peak detector on 3m open area test site

Description	Manufacturer	Inventory No.
CDC	Albatross Projects	E00026
Open area test site	EMV **TESTHAUS** GmbH	E00354

7.2 Test Instruments

	Description	Manufacturer	Inventory No.
☐	ESCS 30 (FF)	Rohde & Schwarz	E00003
☑	ESU 26	Rohde & Schwarz	W00002
☐	ESCI (CDC)	Rohde & Schwarz	E00001
☐	HFH2-Z2	Rohde & Schwarz	E00060
☐	VULB 9163 (FF)	Schwarzbeck	E00013
☐	VULB 9160 (CDC)	Schwarzbeck	E00011

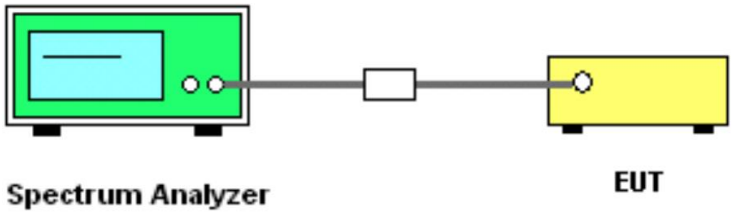
7.3 Limits

N/A

7.4 Test procedure

1. The test is performed in accordance with FCC Public Notice DA00-705
2. The transmitter output (antenna port) was connected to the spectrum analyzer in peak hold mode.
3. The unit was operated in continuous transmit mode with modulation.
4. The resolution bandwidth of 30 kHz and the video bandwidth of 30 kHz were used.
5. Measure the spectrum width with power higher than 20dB below carrier. The transmitter output (antenna port) was connected to the spectrum analyzer.

7.5 Test setup



Picture 22: Test setup for 20dB bandwidth measurement

7.6 Test deviation

There is no deviation with the original standard.

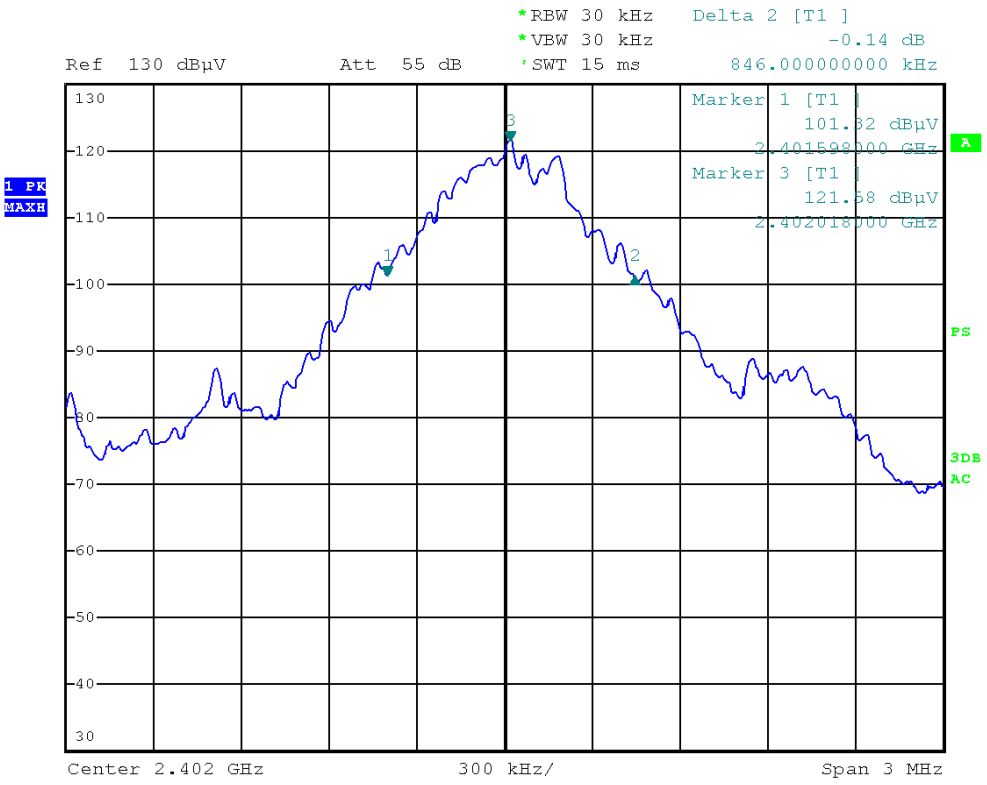
7.7 EUT operation during test

The EUT was programmed to be in continuously transmitting mode.

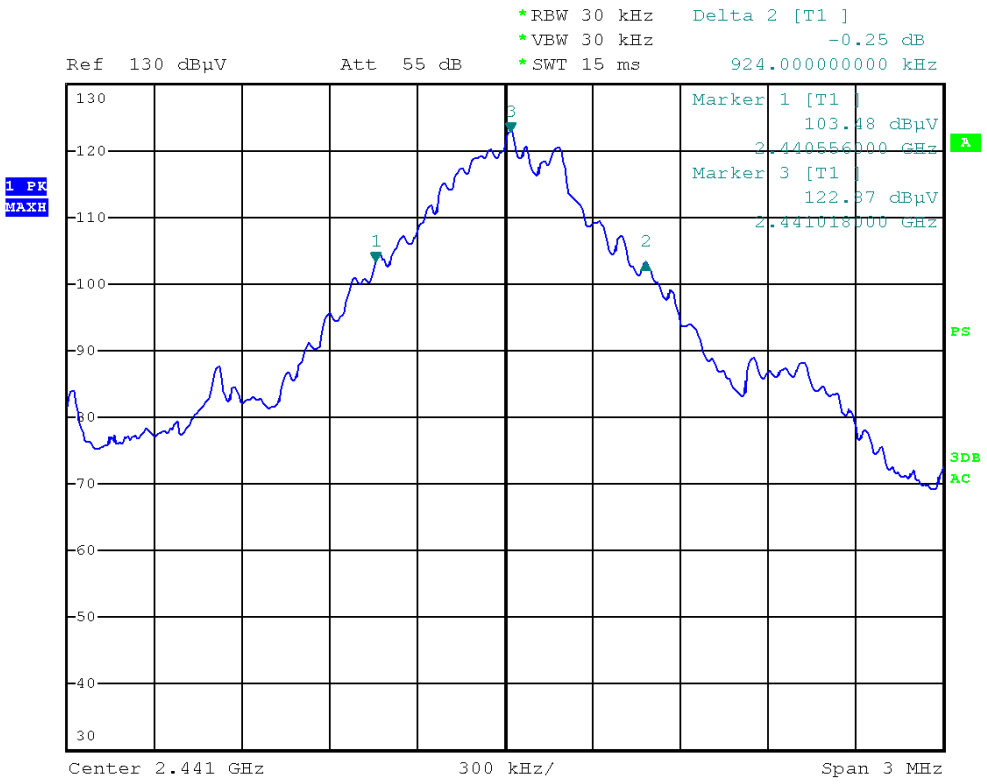
7.8 Test results

Temperature:	22°C	Humidity:	44%
Tested by:	M. Müller	Test date:	2014-04-23

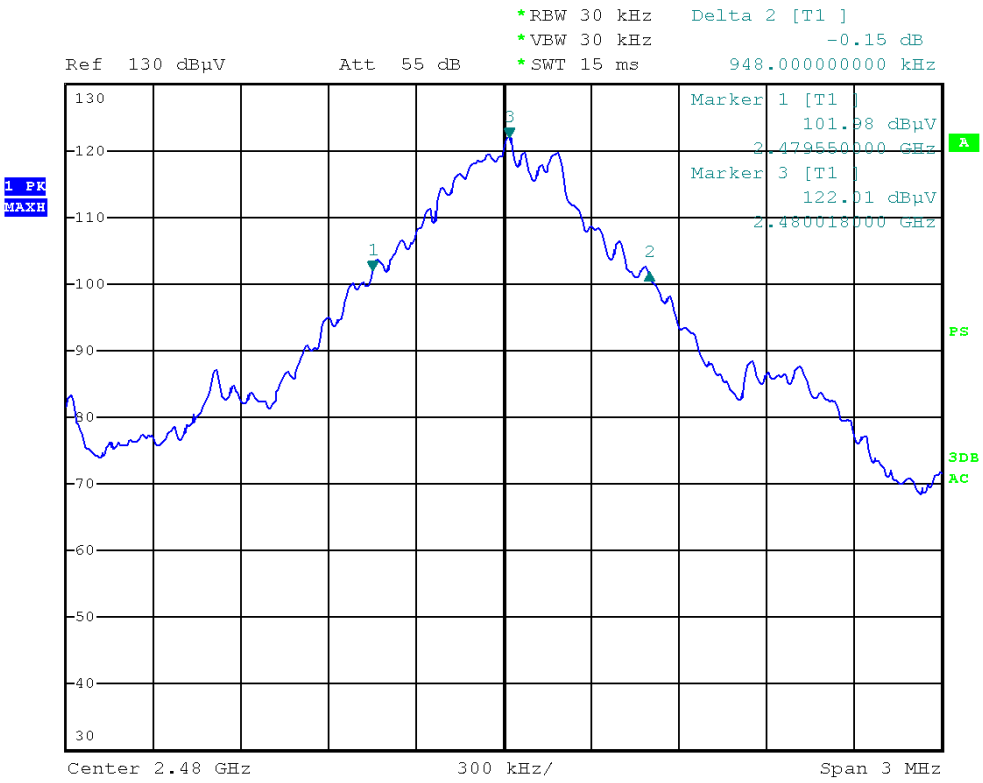
GFSK		
Channel	**Frequency (GHz)**	**20 dB bandwidth (MHz)**
0	2.402	0.846
39	2.441	0.924
78	2.480	0.948
8DPSK		
Channel	**Frequency (GHz)**	**20 dB bandwidth (MHz)**
0	2.402	1.260
39	2.441	1.260
78	2.480	1.260
Pi/4 DQPSK		
Channel	**Frequency (GHz)**	**20 dB bandwidth (MHz)**
0	2.402	1,230
39	2.441	1,236
78	2.480	1,242



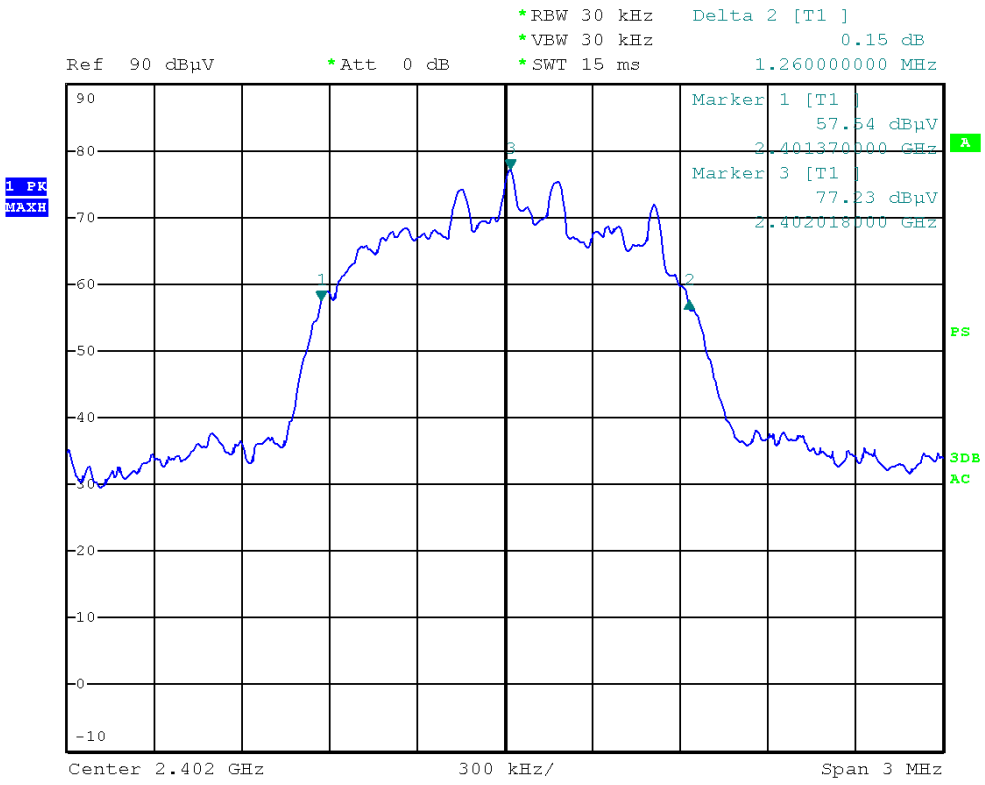
Picture 23: 20dB bandwidth channel 0 (GFSK)



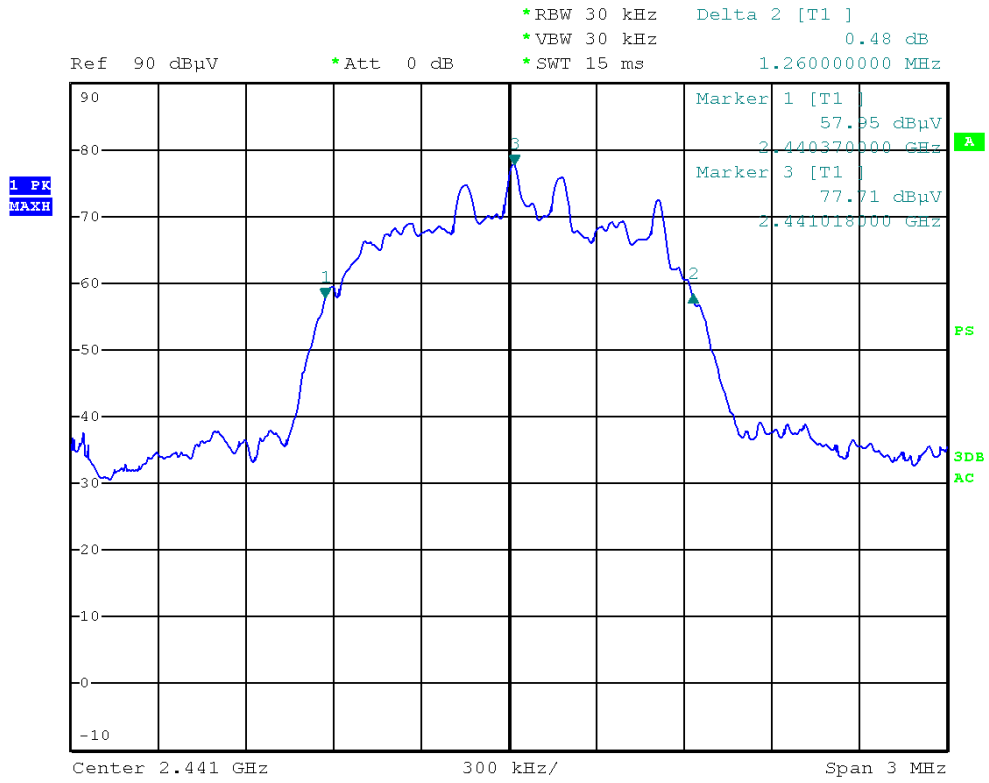
Picture 24: 20dB bandwidth channel 39 (GFSK)



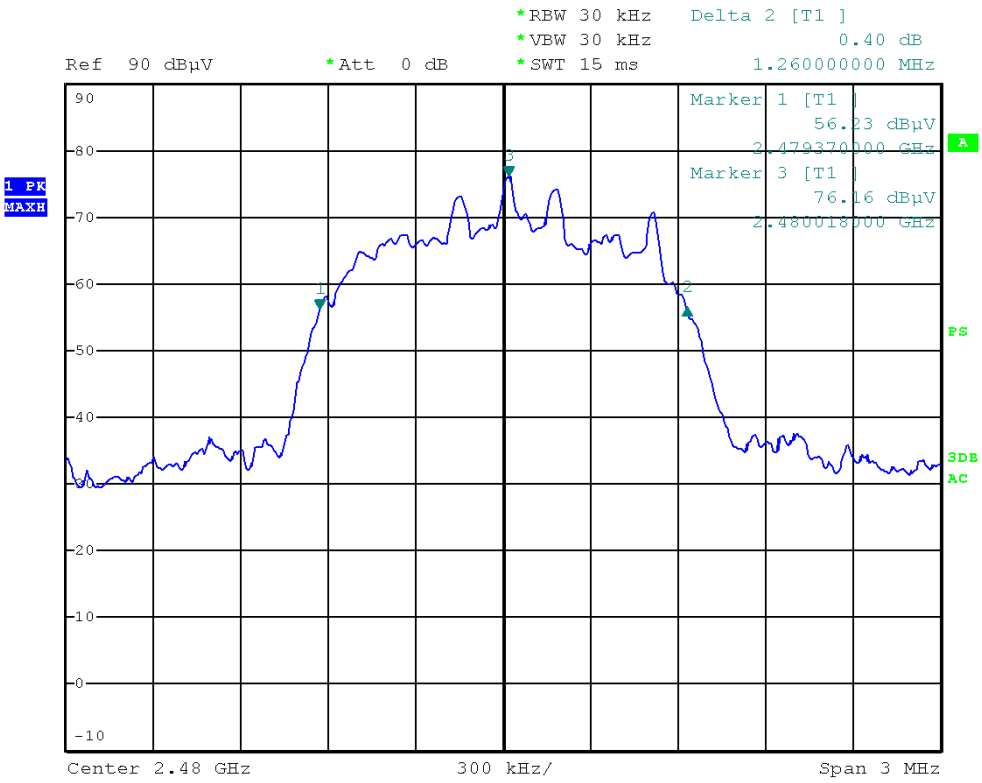
Picture 25: 20dB bandwidth channel 78 (GFSK)



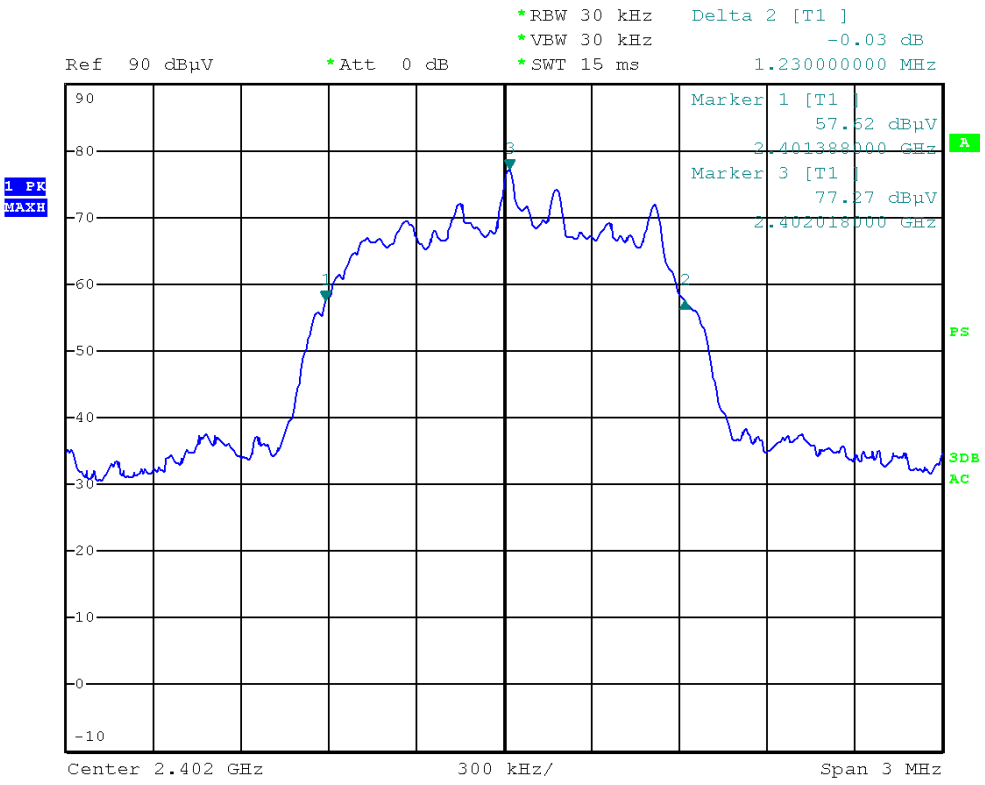
Picture 26: 20dB bandwidth channel 0 (8DPSK)



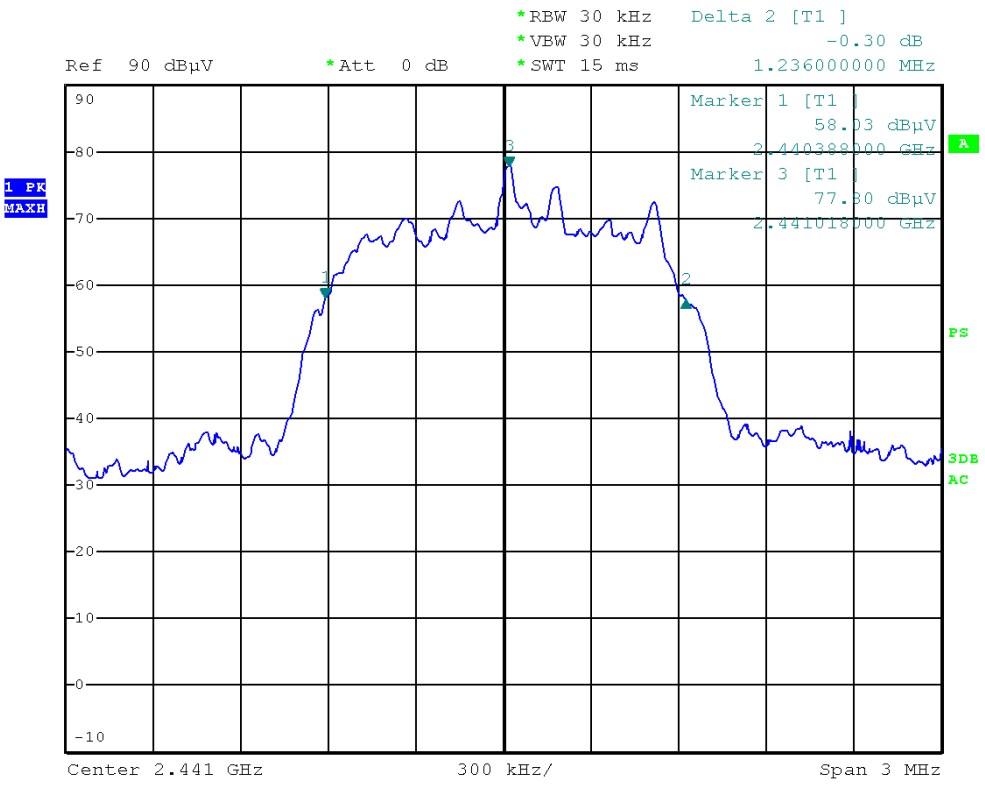
Picture 27: 20dB bandwidth channel 39 (8DPSK)



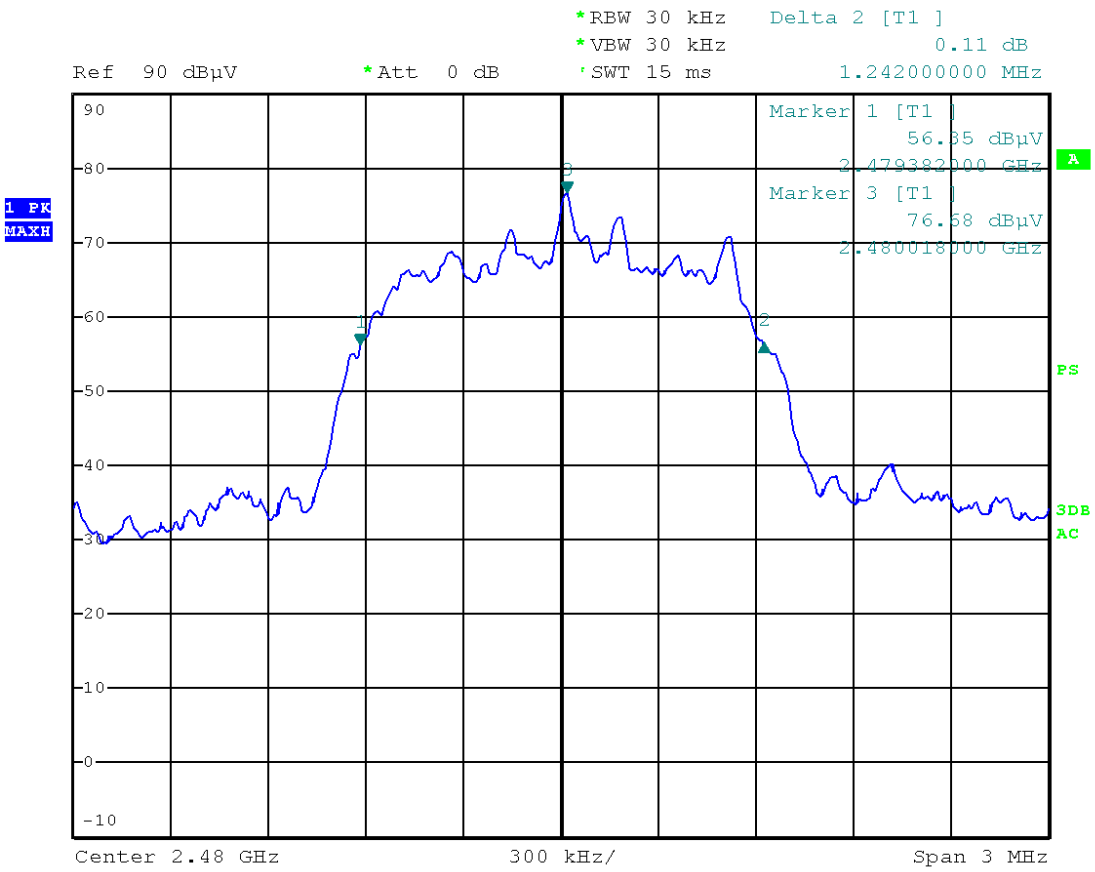
Picture 28: 20dB bandwidth channel 78 (8DPSK)



Picture 29: 20dB bandwidth channel 0 (Pi/4 DQPSK)



Picture 30: 20dB bandwidth channel 39 (Pi/4 DQPSK)



Picture 31: 20dB bandwidth channel 78 (Pi/4 DQPSK)

8 Occupied bandwidth

according to CFR 47 Part 2, section 2.202(a), and ANSI C63.4, section 13.7

8.1 Test location

☑ Conducted measurement
☐ Scan with peak detector in 3 m CDC
☐ CISPR measurement with quasi peak detector on 10m open area test site.
☐ Measurement with peak detector on 3m open area test site

Description	Manufacturer	Inventory No.
CDC	Albatross Projects	E00026
Open area test site	EMV **TESTHAUS** GmbH	E00354

8.2 Test Instruments

	Description	Manufacturer	Inventory No.
☐	ESCS 30 (FF)	Rohde & Schwarz	E00003
☑	ESU 26	Rohde & Schwarz	W00002
☐	ESCI (CDC)	Rohde & Schwarz	E00001
☐	HFH2-Z2	Rohde & Schwarz	E00060
☐	VULB 9163 (FF)	Schwarzbeck	E00013
☐	VULB 9160 (CDC)	Schwarzbeck	E00011

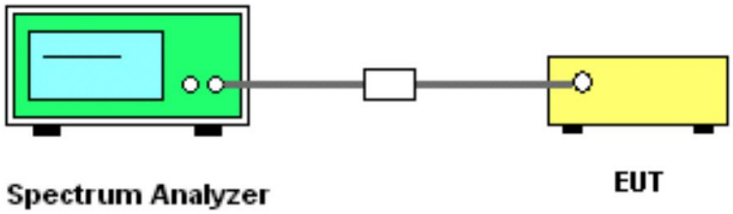
8.3 Limits

N/A

8.4 Test procedure

6. The test is performed in accordance with CFR 47 Part 2, section 2.202(a)
7. The transmitter output (antenna port) was connected to the spectrum analyzer in peak hold mode.
8. The unit was operated in continuous transmit mode with modulation.
9. As specified in ANSI C63.4, section 13.7, a minimum resolution bandwidth of 10 kHz for signals up to 1 GHz and 100 kHz above 1 GHz was used with video bandwidth set to at least the value of the resolution bandwidth.
10. The 99 % frequency bandwidth was measured so that, below its lower and above its upper frequency limits, the mean powers radiated were each equal to 0.5 percent of the total mean power radiated by a given emission.

8.5 Test setup



Picture 32: Test setup for 20dB bandwidth measurement

8.6 Test deviation

There is no deviation with the original standard.

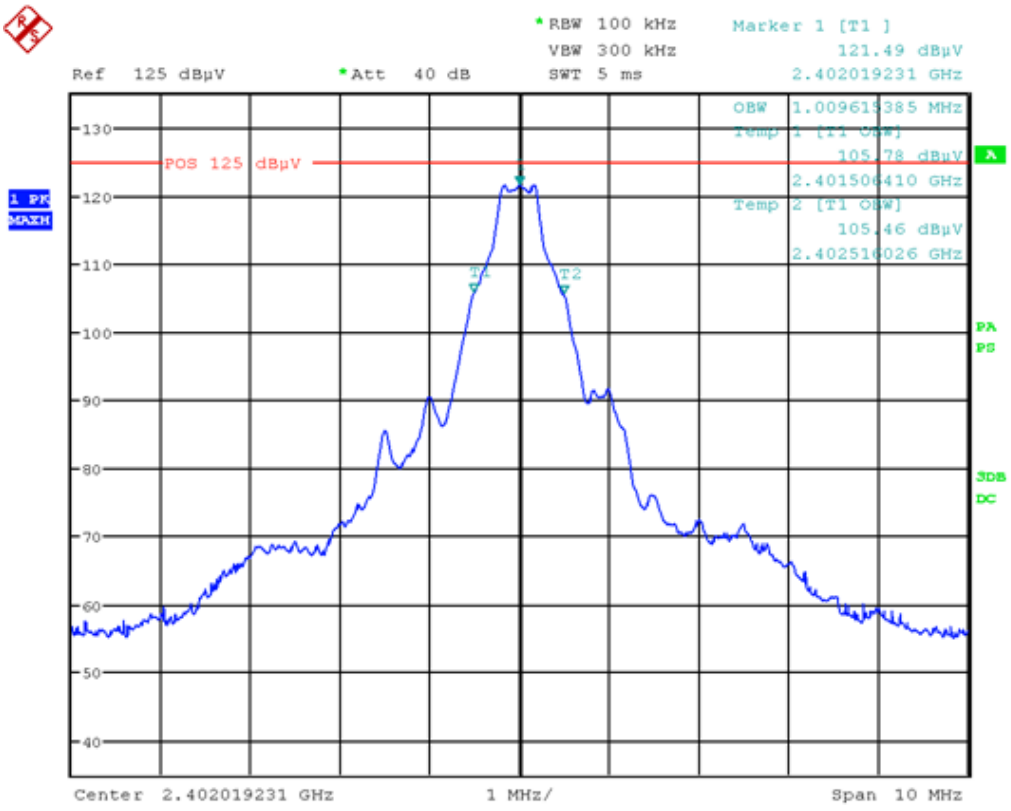
8.7 EUT operation during test

The EUT was programmed to be in continuously transmitting mode.

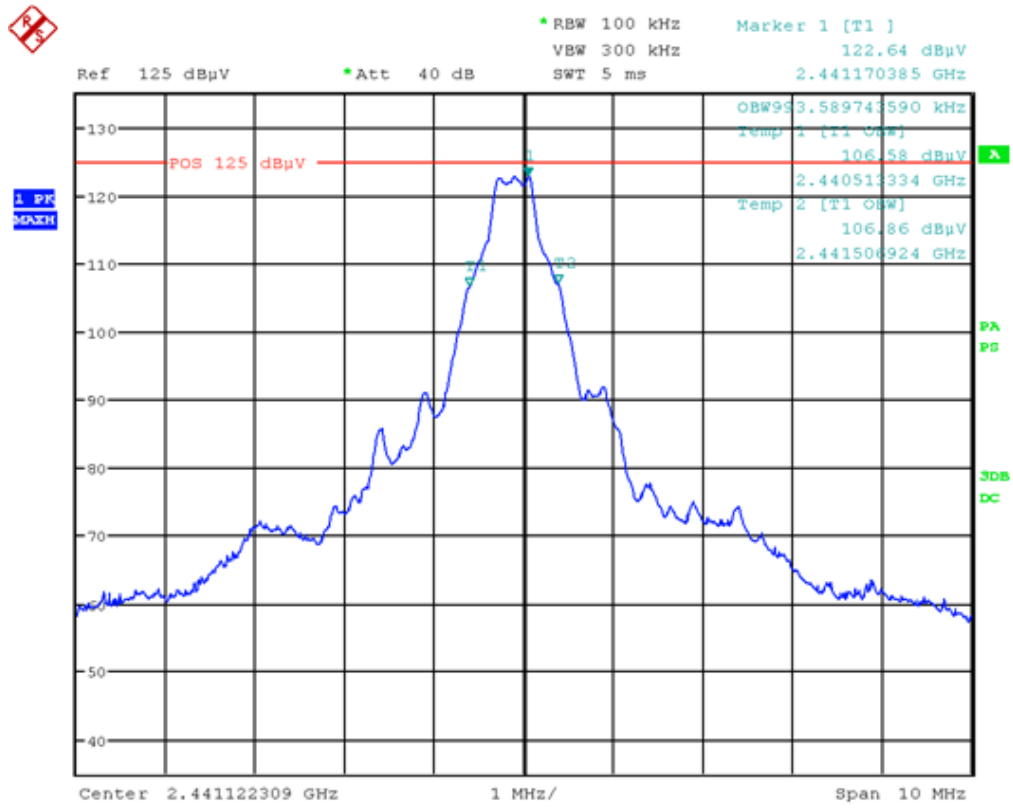
8.8 Test results

Temperature:	22°C	Humidity:	44%
Tested by:	M. Müller	Test date:	2014-05-22

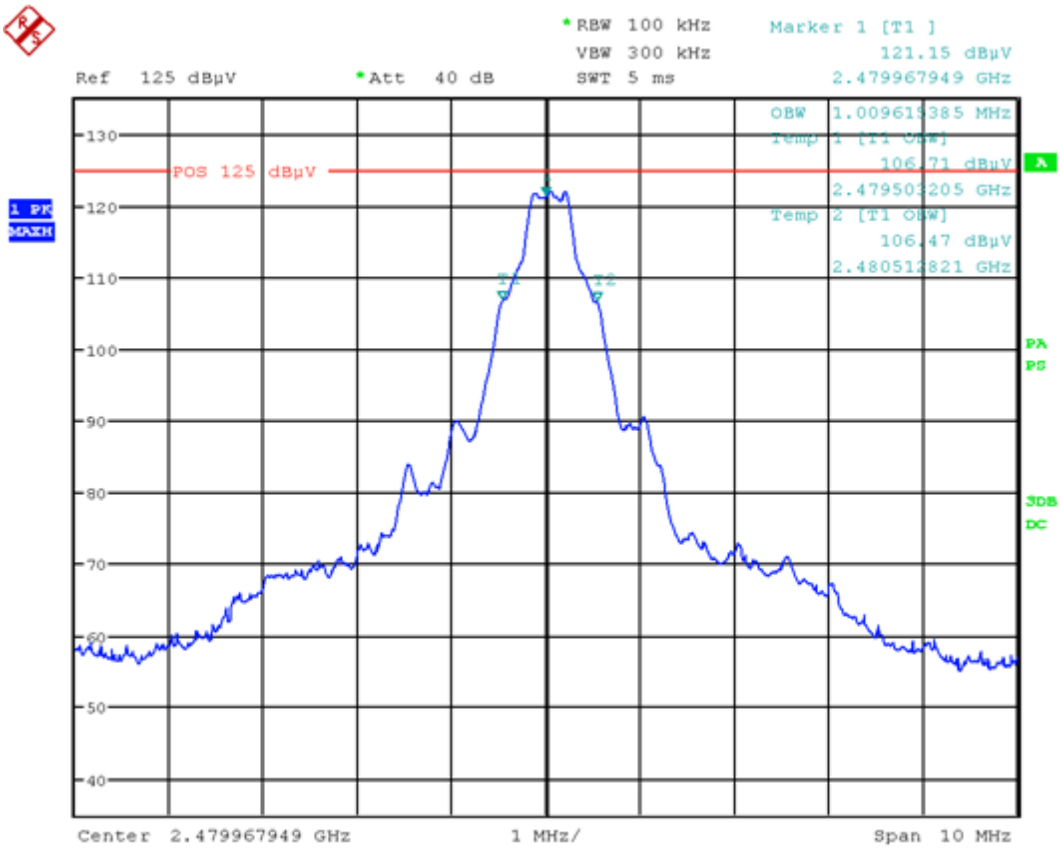
GFSK		
Channel	**Frequency (GHz)**	**Occupied bandwidth (MHz)**
0	2.402	1.0096
39	2.441	0.9936
78	2.480	1.0096
8DPSK		
Channel	**Frequency (GHz)**	**Occupied bandwidth (MHz)**
0	2.402	1.2340
39	2.441	1.2340
78	2.480	1.2340
Pi/4 DQPSK		
Channel	**Frequency (GHz)**	**Occupied bandwidth (MHz)**
0	2.402	1.2340
39	2.441	1.2340
78	2.480	1.2340



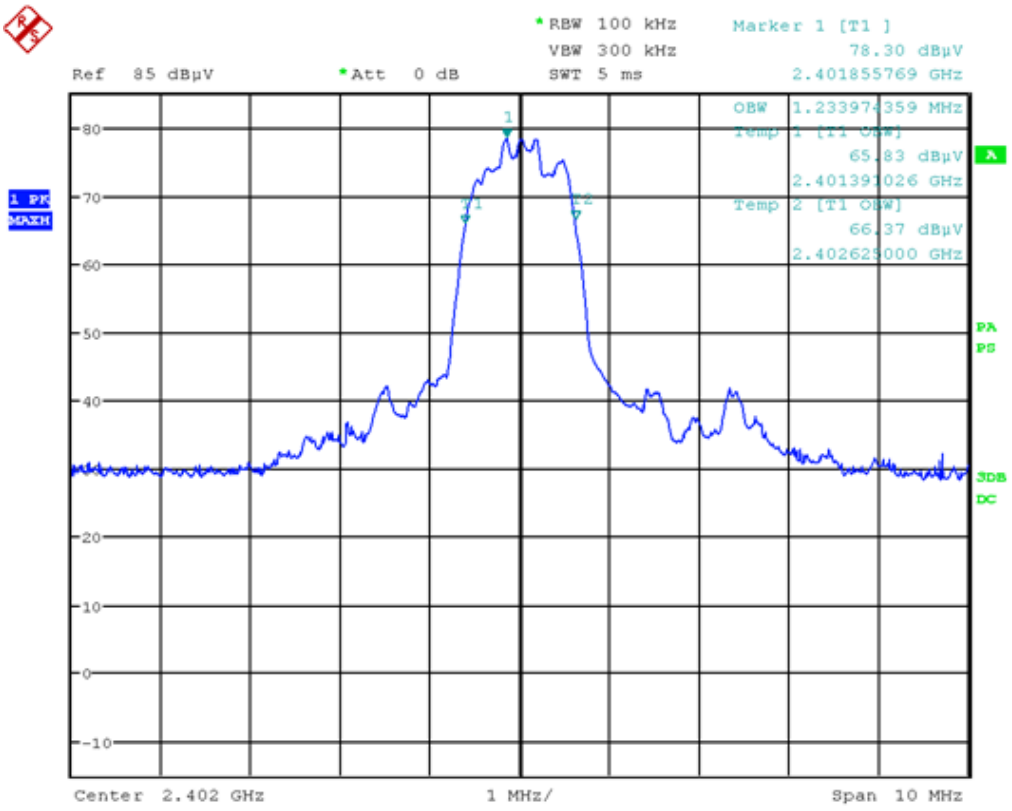
Picture 33: Occupied bandwidth channel 0 (GFSK)



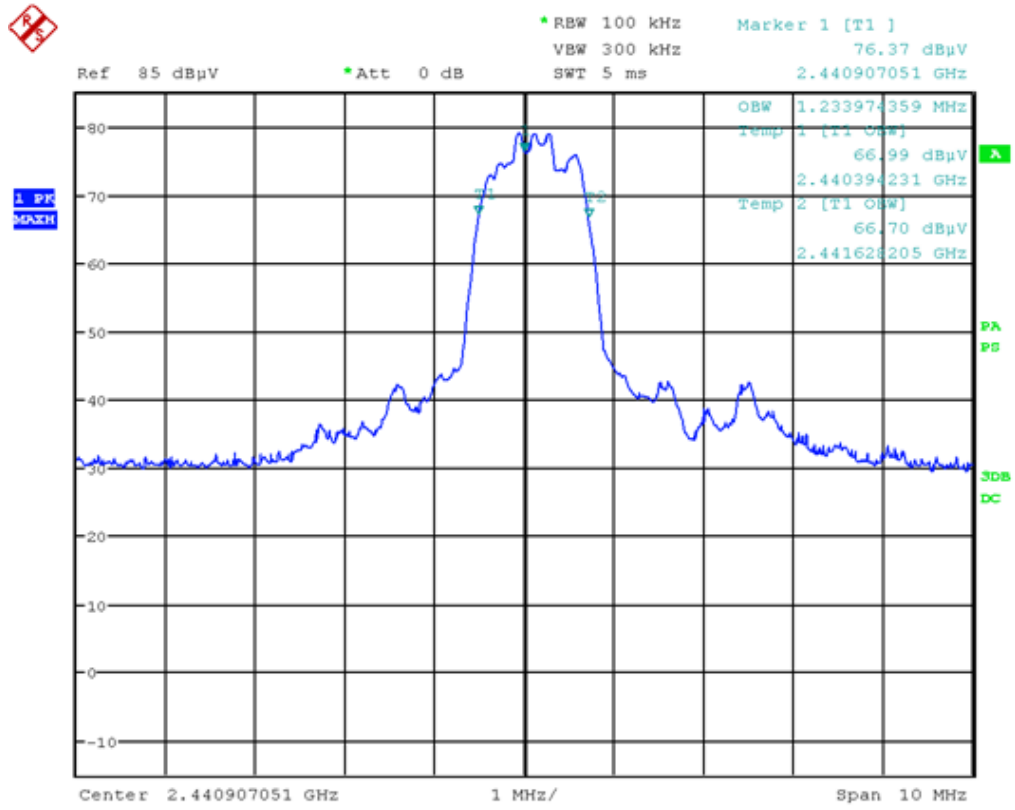
Picture 34: Occupied bandwidth channel 39 (GFSK)



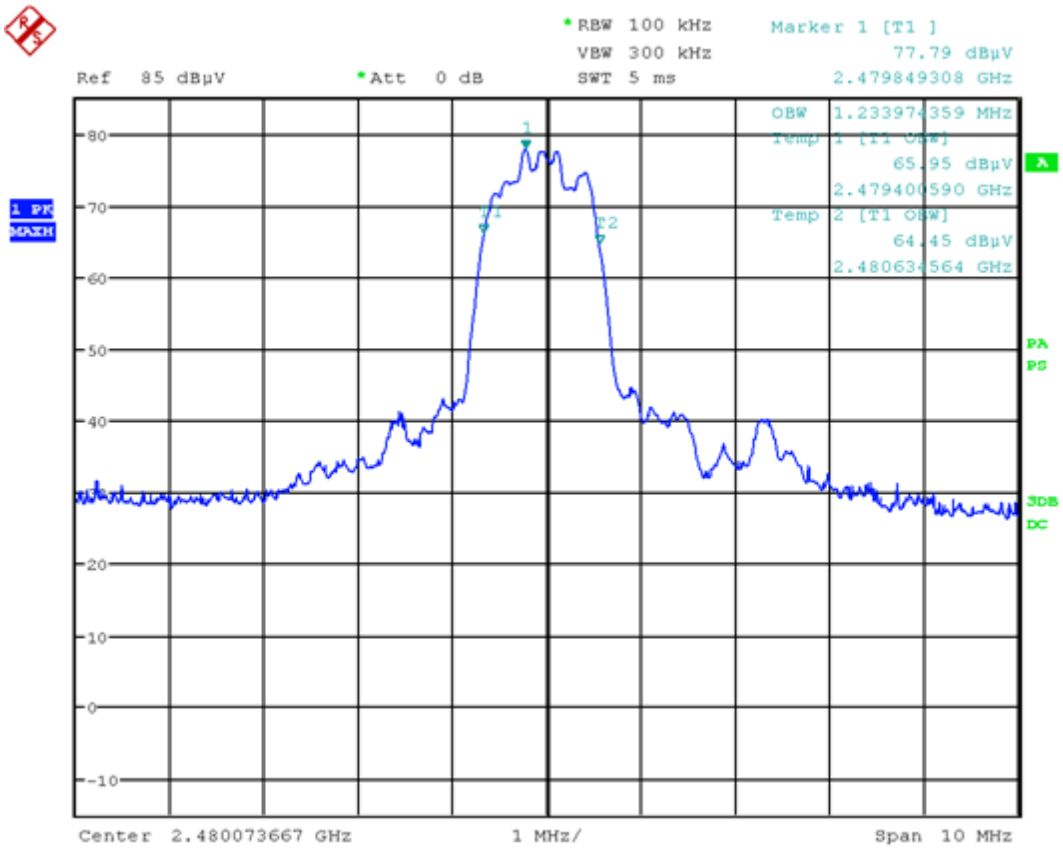
Picture 35: Occupied bandwidth channel 78 (GFSK)



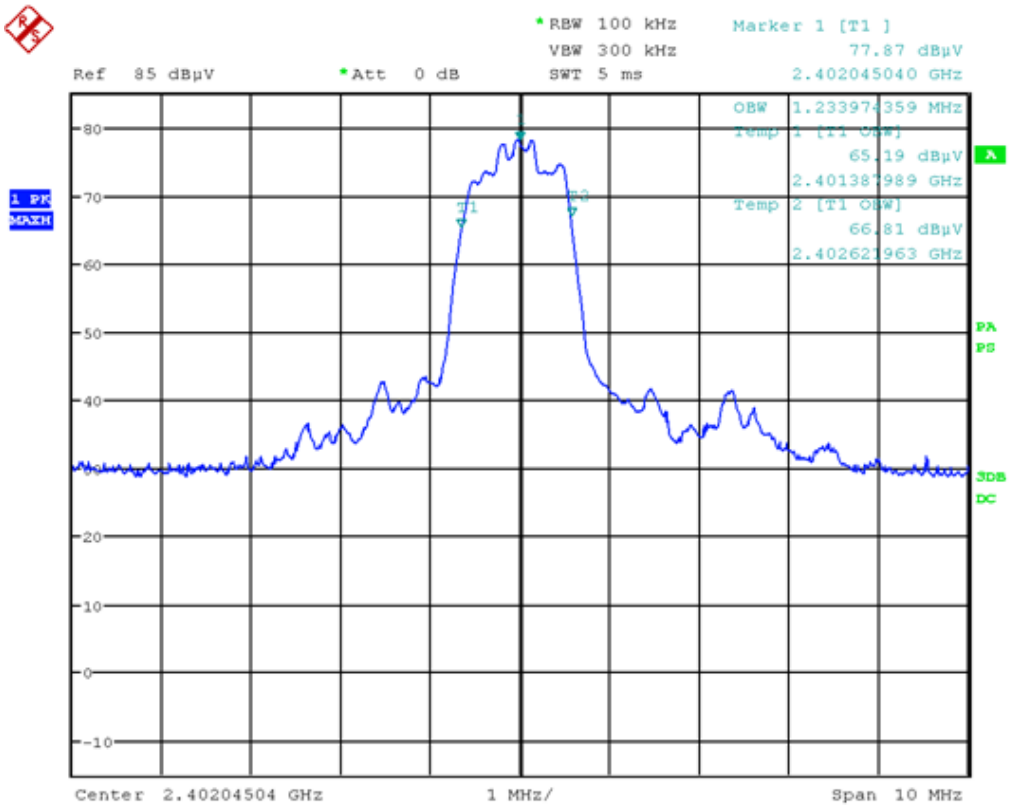
Picture 36: Occupied bandwidth channel 0 (8DPSK)



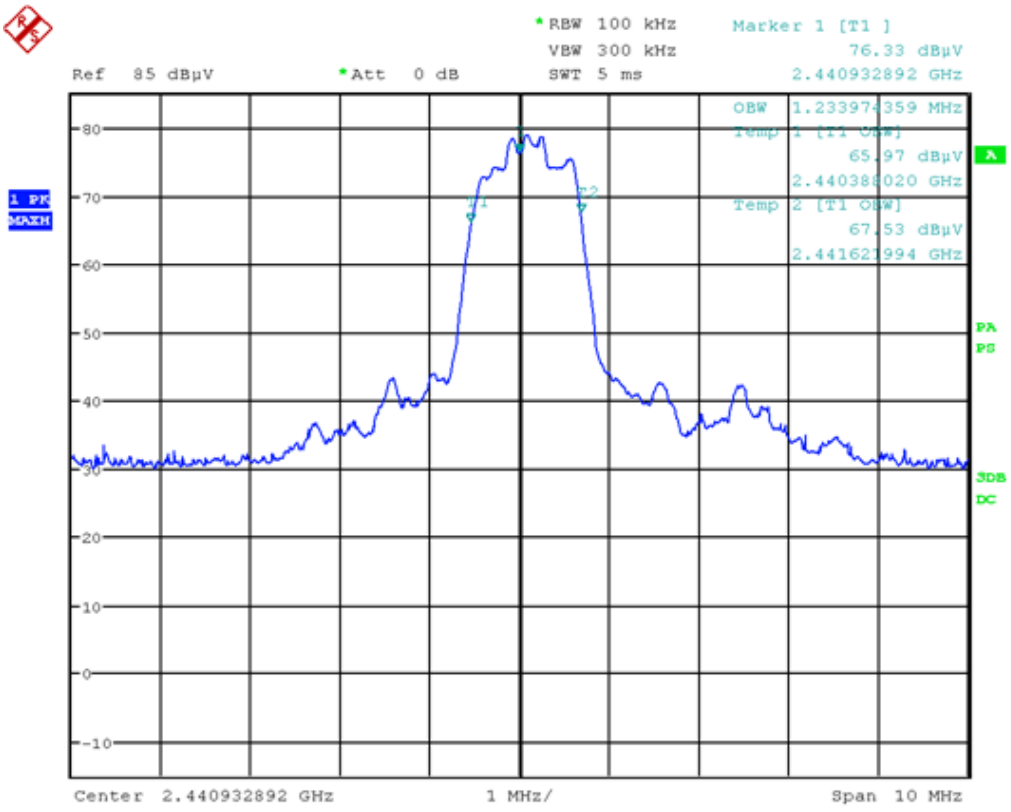
Picture 37: Occupied bandwidth channel 39 (8DPSK)



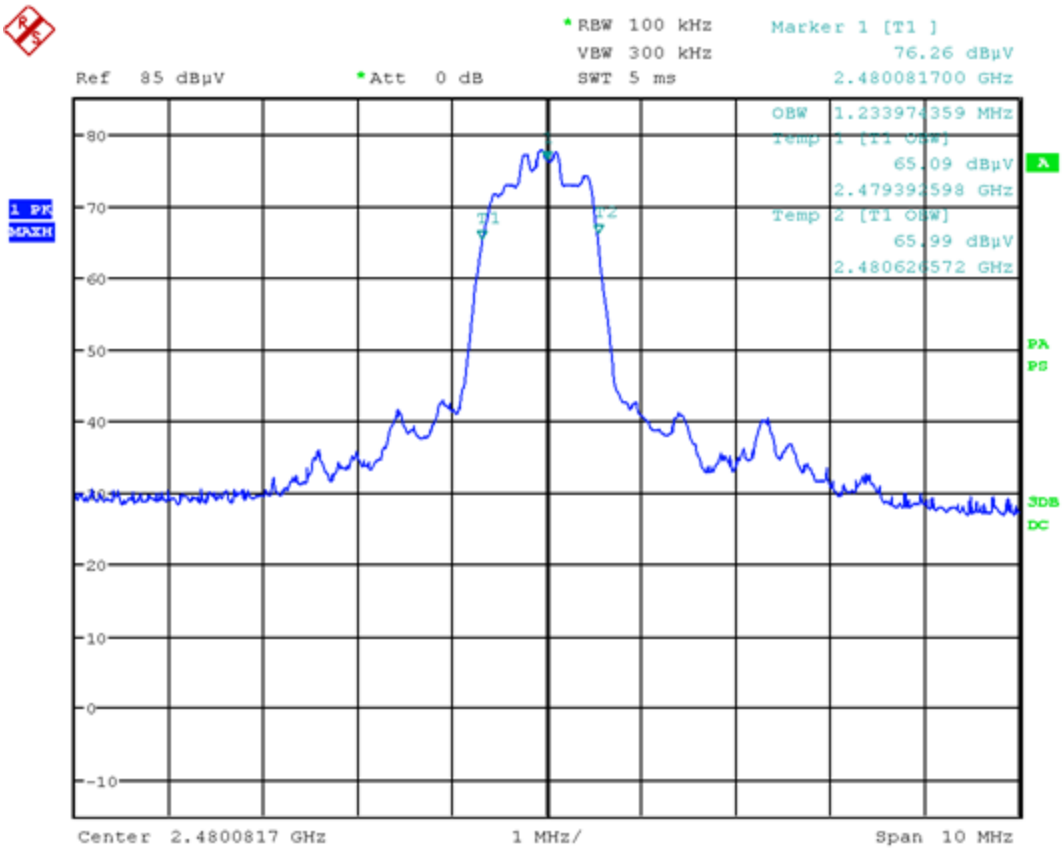
Picture 38: Occupied bandwidth channel 78 (8DPSK)



Picture 39: Occupied bandwidth channel 0 (Pi/4 DQPSK)



Picture 40: Occupied bandwidth channel 39 (Pi/4 DQPSK)



Picture 41: Occupied bandwidth channel 78 (Pi/4 DQPSK)

9 Maximum conducted output power

according to CFR 47 Part 15, section 15.247(b), and Public Notice DA 00-705

9.1 Test location

☑ Conducted measurement
☐ Scan with peak detector in 3 m CDC
☐ CISPR measurement with quasi peak detector on 10m open area test site.
☐ Measurement with peak detector on 3m open area test site

Description	Manufacturer	Inventory No.
CDC	Albatross Projects	E00026
Open area test site	EMV **TESTHAUS** GmbH	E00354

9.2 Test instruments

	Description	Manufacturer	Inventory No.
☐	ESCS 30 (FF)	Rohde & Schwarz	E00003
☑	ESU 26	Rohde & Schwarz	W00002
☐	ESCI (CDC)	Rohde & Schwarz	E00001
☐	HFH2-Z2	Rohde & Schwarz	E00060
☐	VULB 9163 (FF)	Schwarzbeck	E00013
☐	VULB 9160 (CDC)	Schwarzbeck	E00011

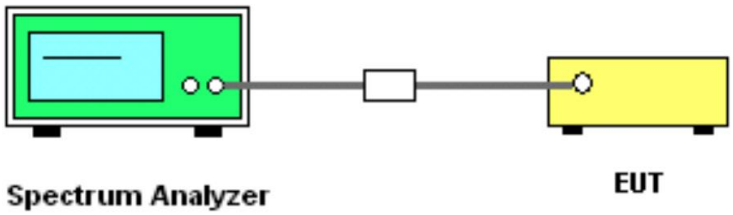
9.3 Limits

For frequency hopping systems operating in the 2400–2483.5 MHz band employing at least 75 non-overlapping hopping channels, and all frequency hopping systems in the 5725–5850 MHz band: 1 watt (30 dBm). For all other frequency hopping systems in the 2400–2483.5 MHz band: 0.125 watts (21 dBm).
Maximum Conducted Output Power is defined as the total transmit power delivered to all antennas and antenna elements averaged across all symbols in the signaling alphabet when the transmitter is operating at its maximum power control level. Power must be summed across all antennas and antenna elements. The average must not include any time intervals during which the transmitter is off or is transmitting at a reduced power level.
The conducted output power limit is based on the use of antennas with directional gains that do not exceed 6 dBi. If transmitting antennas of directional gain greater than 6 dBi are used, the conducted output power from the intentional radiator shall be reduced by the amount in dB that the directional gain of the antenna exceeds 6 dBi.

9.4 Test procedure

1. The transmitter output (antenna port) was connected to the spectrum analyzer.
2. Test was performed in accordance with Measurement of Digital Transmission Systems Operating under Section 15.247.

9.5 Test setup



Picture 42: Test setup for conducted output power measurement

9.6 Test deviation

There is no deviation with the original standard.

9.7 EUT operation during Test

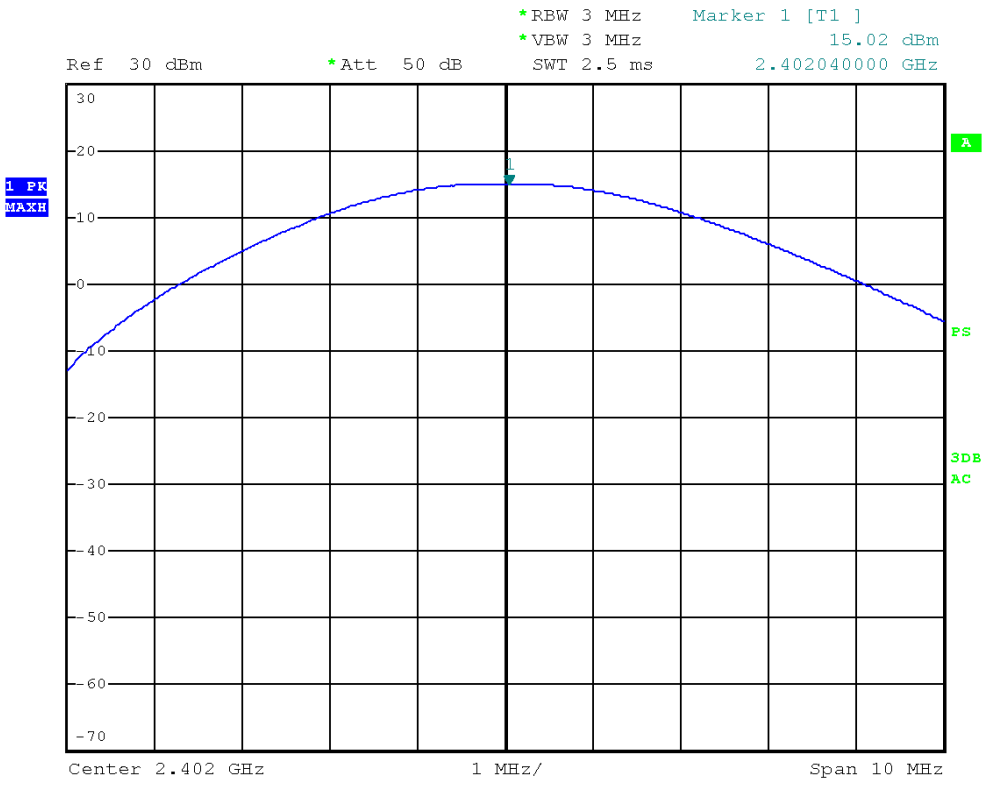
The EUT was programmed to be in continuously transmitting mode.

9.8 Test results

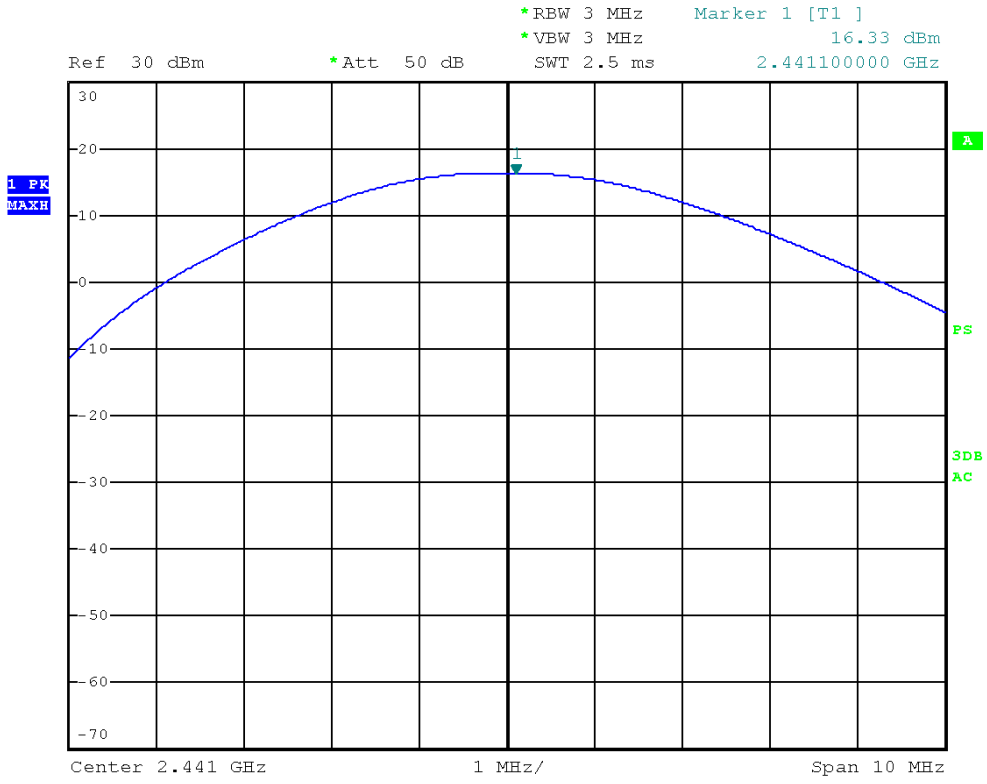
Temperature:	22°C	Humidity:	44%
Tested by:	M. Müller	Test date:	2014-04-23

GFSK					
Channel	**Frequency (GHz)**	**Detector**	**Conducted power (dBm)**	**Limit (dBm)**	**Result**
0	2.402	PK	15.02	21	PASS
39	2.441	PK	16.33	21	PASS
78	2.480	PK	15.39	21	PASS
8DPSK					
Channel	**Frequency (GHz)**	**Detector**	**Conducted power (dBm)**	**Limit (dBm)**	**Result**
0	2.402	PK	-26.50	21	PASS
39	2.441	PK	-25.85	21	PASS
78	2.480	PK	-26.85	21	PASS
Pi/4 DQPSK					
Channel	**Frequency (GHz)**	**Detector**	**Conducted power (dBm)**	**Limit (dBm)**	**Result**
0	2.402	PK	-26.93	21	PASS
39	2.441	PK	-26.20	21	PASS
78	2.480	PK	-27.23	21	PASS

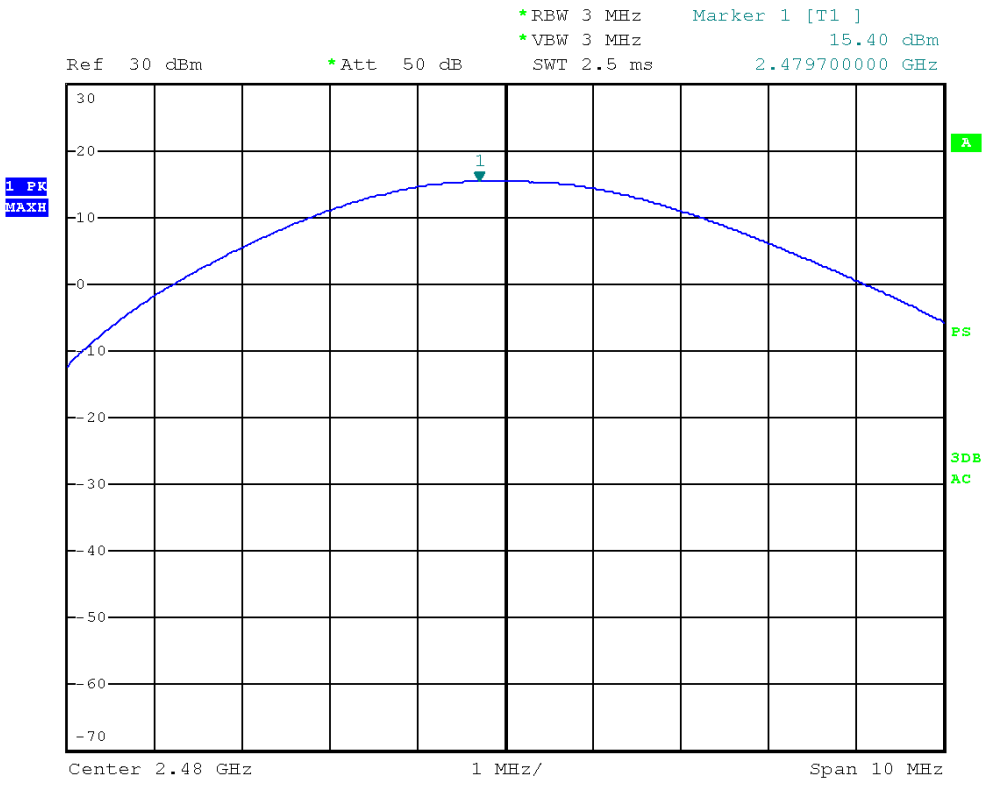
Comments: The reduction of the output power in EDR mode is given by the firmware of the EUT.



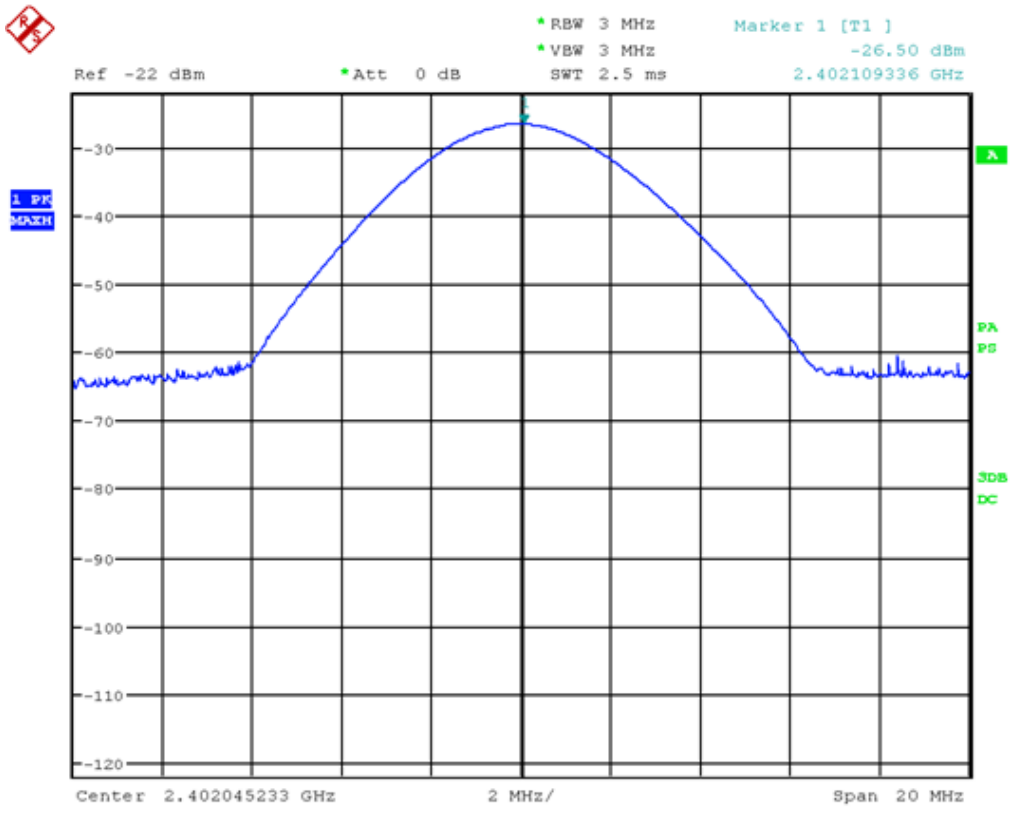
Picture 43: Conducted output power channel 0 (GFSK)



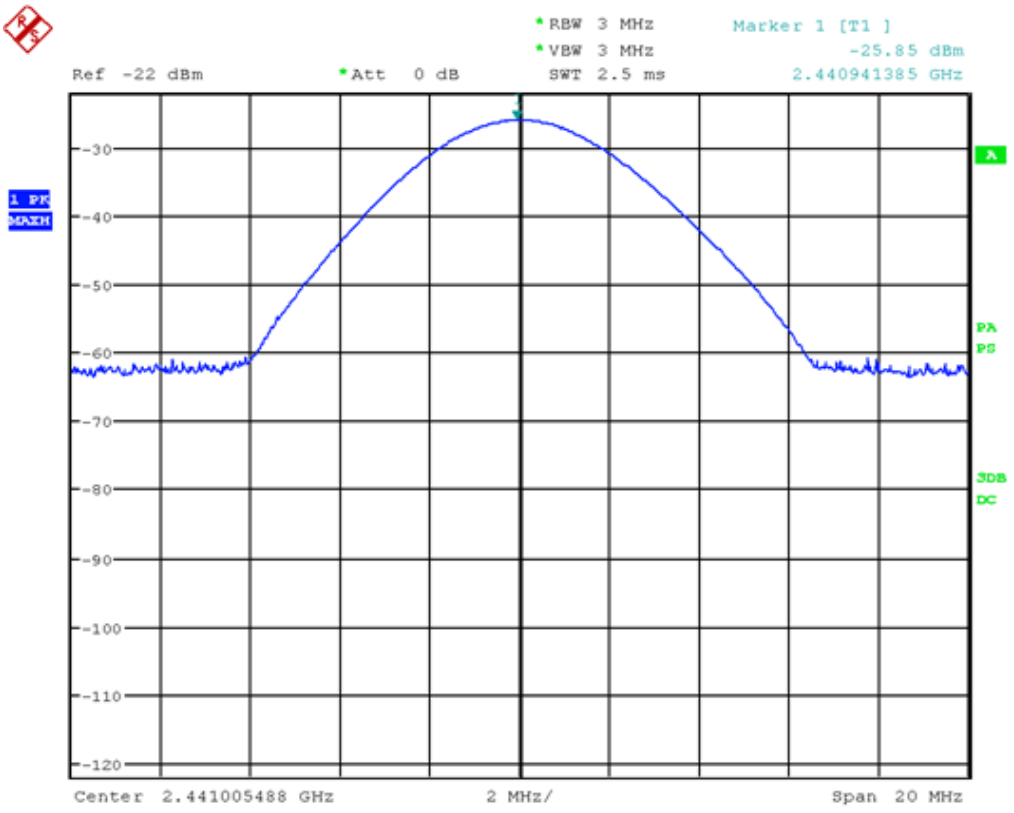
Picture 44: Conducted output power channel 39 (GFSK)



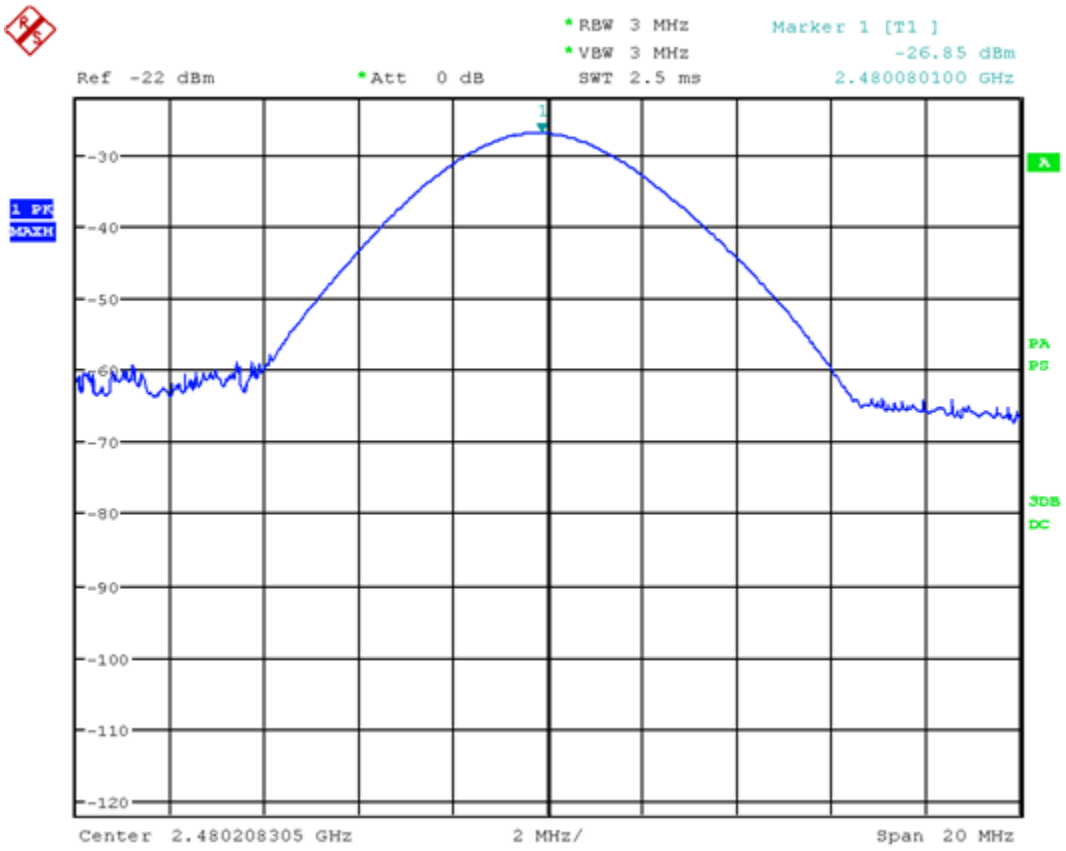
Picture 45: Conducted output power channel 78 (GFSK)



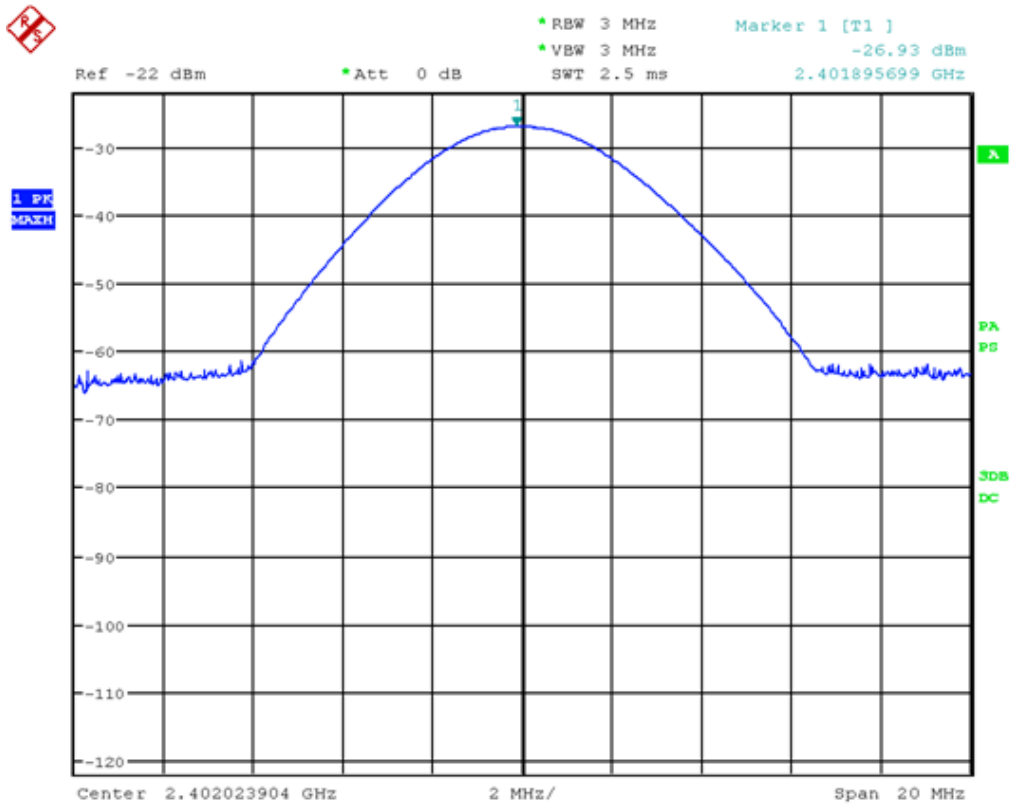
Picture 46: Conducted output power channel 0 (8DPSK)



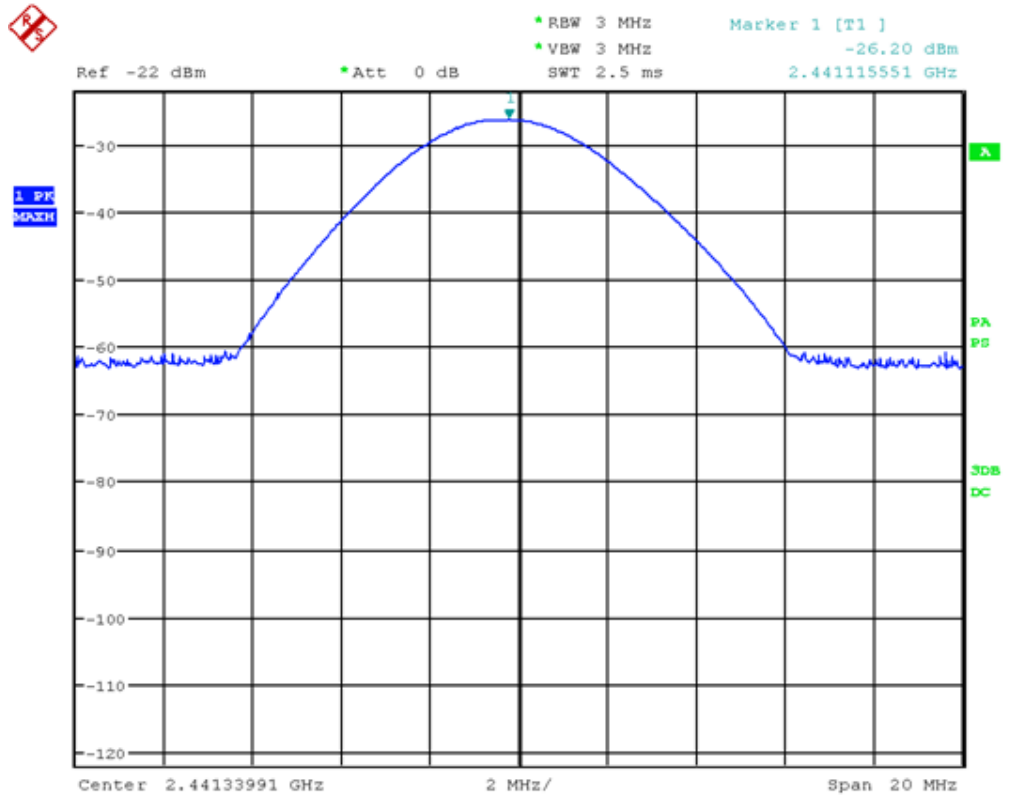
Picture 47: Conducted output power channel 39 (8DPSK)



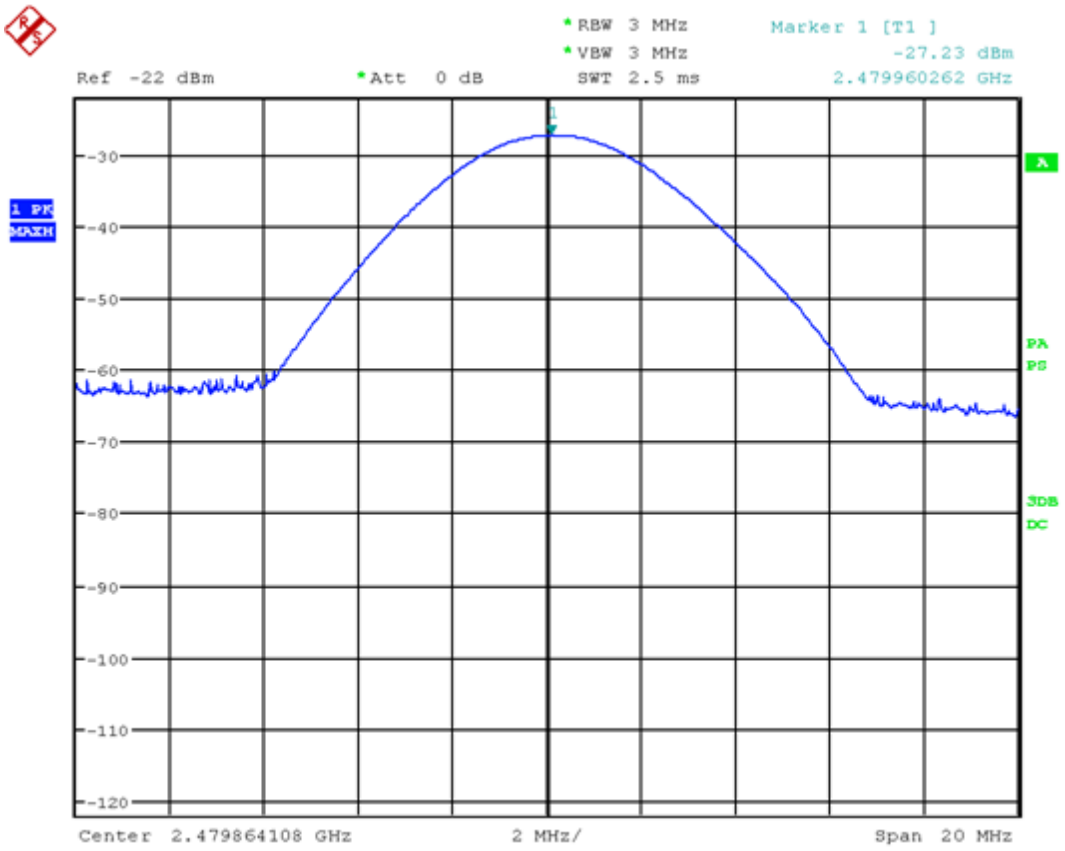
Picture 48: Conducted output power channel 78 (8DPSK)



Picture 49: Conducted output power channel 0 (Pi/4 DQPSK)



Picture 50: Conducted output power channel 39 (Pi/4 DQPSK)



Picture 51: Conducted output power channel 78 (Pi/4 DQPSK)

10 Band-edge Compliance

according to CFR 47 Part 15, section 15.247(d), and Public Notice DA 00-705

10.1 Test location

☑ Scan with peak detector in 3 m anechoic chamber

10.2 Test Instruments

	Description	Manufacturer	Inventory No.
☑	ESU26	Rohde & Schwarz	W00002
☑	AMF-5D-00501800-28-13P	Miteq	W00089
☐	AMF-6F-16002650-25-10P	Miteq	W00090
☑	BBHA 9170	Schwarzbeck	W00054
☐	BBHA 9170	Schwarzbeck	W00055
☑	COSB 4-1-26	Conformitas	W00091

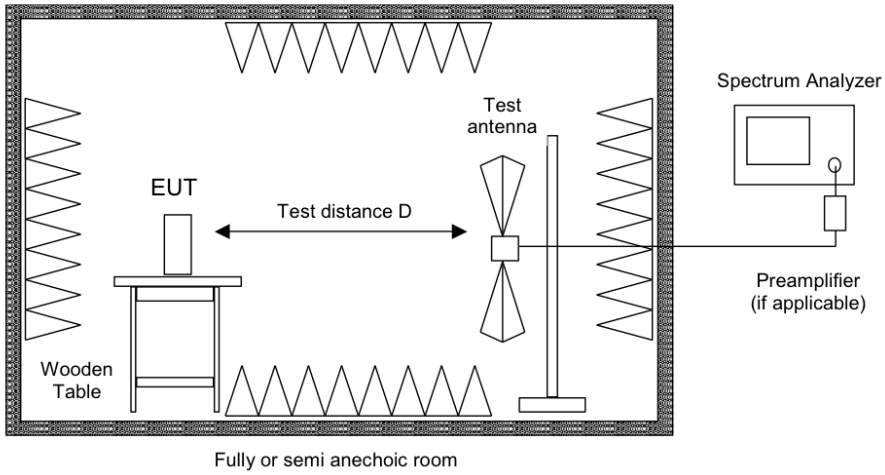
10.3 Limits

< -20dBc outside restricted bands
< 54dBµV (video average) inside restricted bands
< 74dBµV (peak detector) inside restricted bands

10.4 Test procedure

1. Configure the EUT according to ANSI C63.4. The EUT was placed on the top of the turntable 0.8 meter above ground. The receiving antenna was placed 3 meters from the turntable. The test setup was placed inside a fully anechoic chamber.
2. Power on the EUT and all peripherals.
3. Set frequency to lowest channel
4. Set marker 20dB below the peak both sides of the intentional emission.
5. Record this trace
6. Set frequency to highest channel
7. Repeat step 4 and 5.

10.5 Test setup



Picture 52: Test setup for band-edge compliance measurement

10.6 Test deviation

There is no deviation with the original standard.

10.7 EUT operation during test

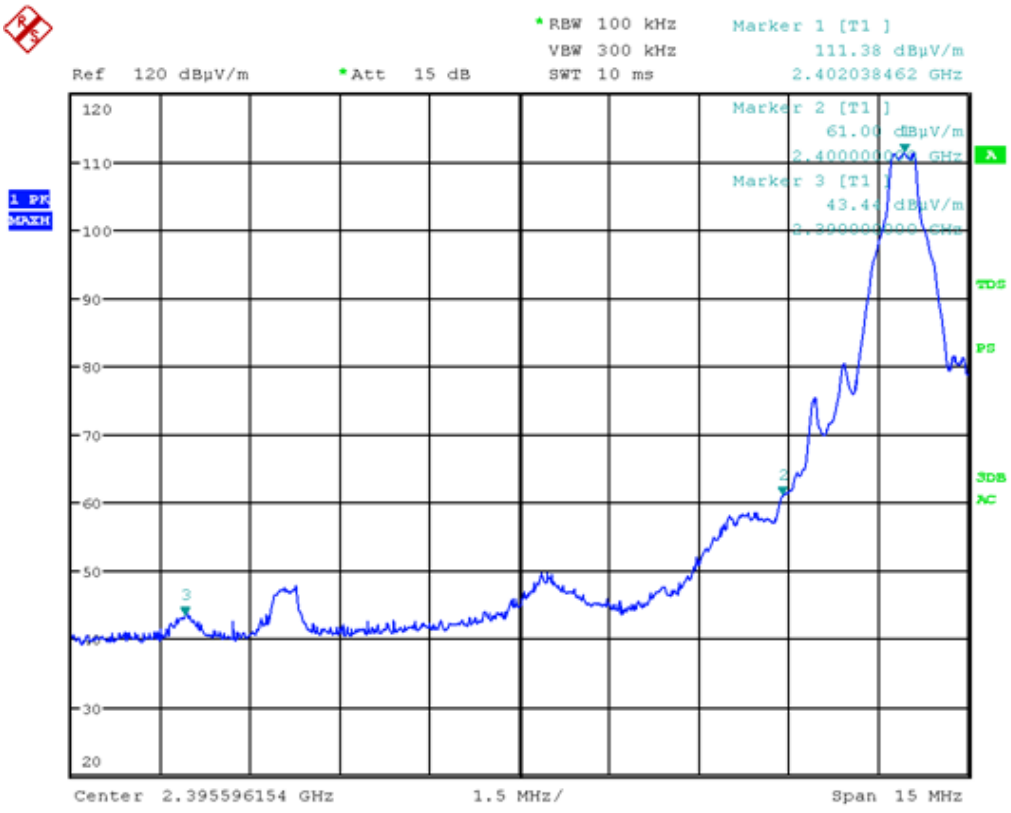
The EUT was programmed to be in continuously transmitting mode.

10.8 Test results

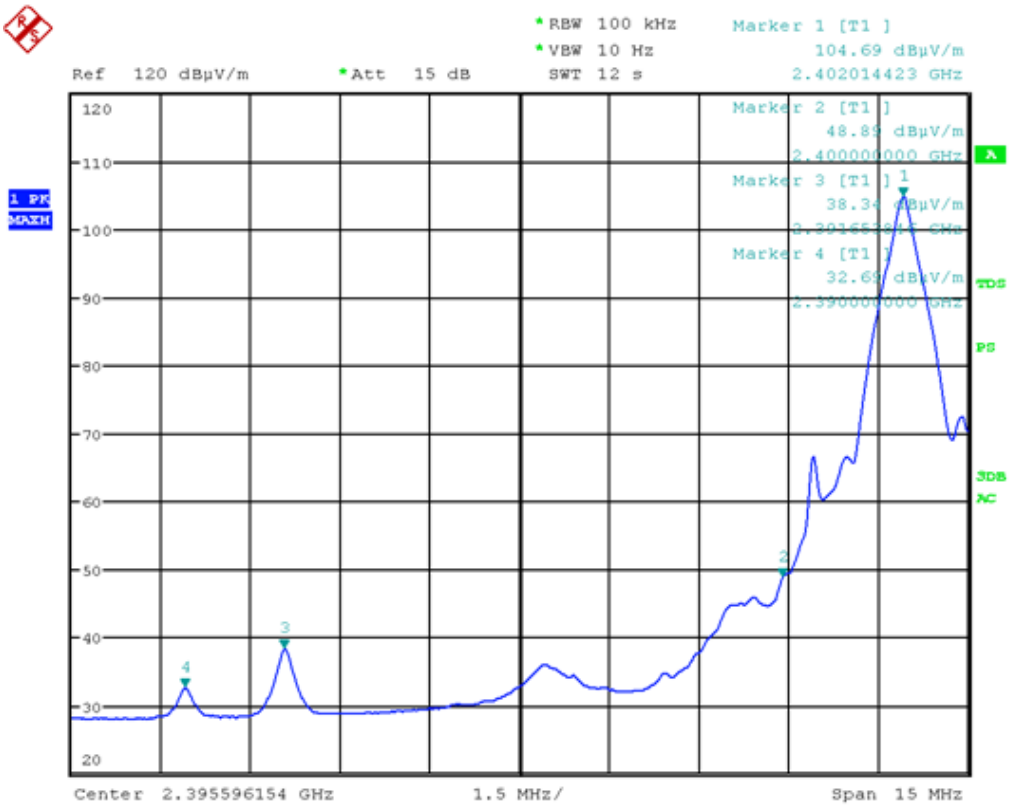
Temperature:	22°C	Humidity:	44%
Tested by:	M. Müller	Test date:	2014-04-28

GFSK			
Frequency (GHz)	**Detector**	**Reading value (dBµV)**	**Limit**
2.4800	PK	111.22	- - -
2.4800	AV	104.44	- - -
2.4835	PK	50.66	74
2.4835	AV	36.97	54
8DPSK			
Frequency (GHz)	**Detector**	**Reading value (dBµV)**	**Limit**
2.4800	PK	67.51	- - -
2.4800	AV	54.85	- - -
2.4835	PK	25.93	74
2.4835	AV	15.72	54
Pi/4 DQPSK			
Frequency (GHz)	**Detector**	**Reading value (dBµV)**	**Limit**
2.4800	PK	67.02	- - -
2.4800	AV	54.81	- - -
2.4835	PK	27.19	74
2.4835	AV	15.85	54

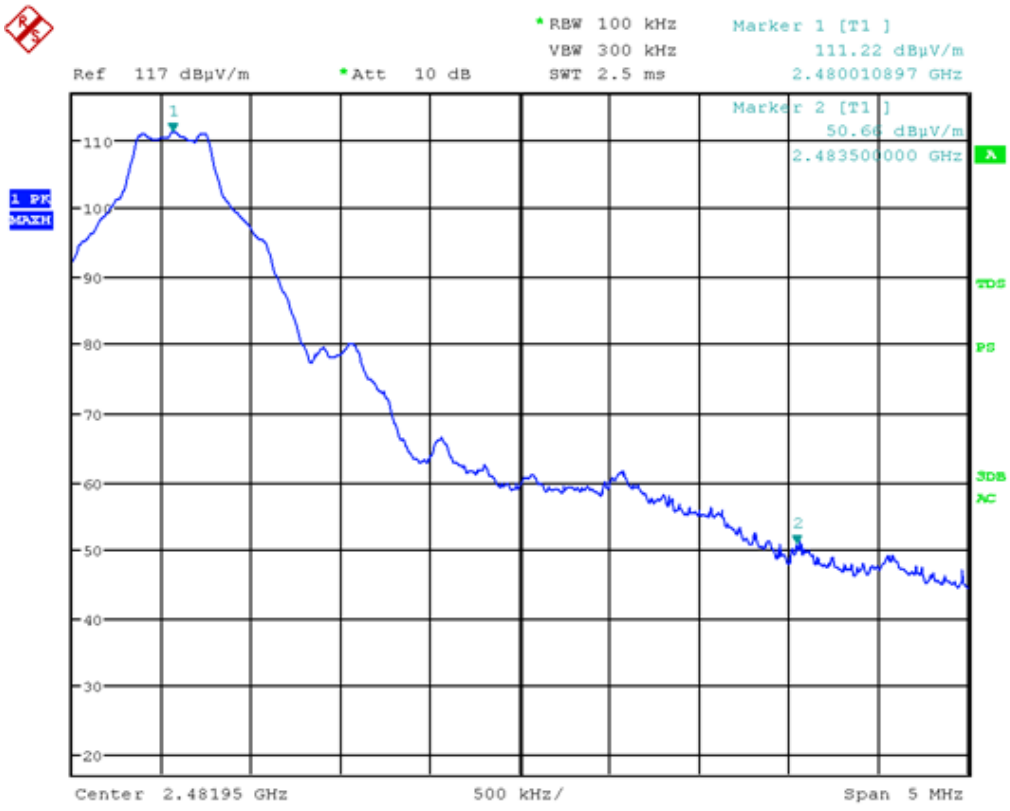
GFSK			
Frequency (GHz)	**Detector**	**Reading value (dBµV)**	**Limit**
2.390	PK	43.44	74
2.390	AV	32.69	54
2.400	PK	61.00	- 20dBc
2.400	AV	48.89	- 20dBc
2.402	PK	111.38	- - -
2.402	AV	104.69	- - -
8DPSK			
Frequency (GHz)	**Detector**	**Reading value (dBµV)**	**Limit**
2.390	PK	25.42	74
2.390	AV	14.46	54
2.400	PK	26.60	- 20dBc
2.400	AV	15.83	- 20dBc
2.402	PK	67.97	- - -
2.402	AV	56.21	- - -
Pi/4 DQPSK			
Frequency (GHz)	**Detector**	**Reading value (dBµV)**	**Limit**
2.390	PK	24.69	74
2.390	AV	14.59	54
2.400	PK	27.67	- 20dBc
2.400	AV	16.33	- 20dBc
2.402	PK	68.09	- - -
2.402	AV	56.58	- - -



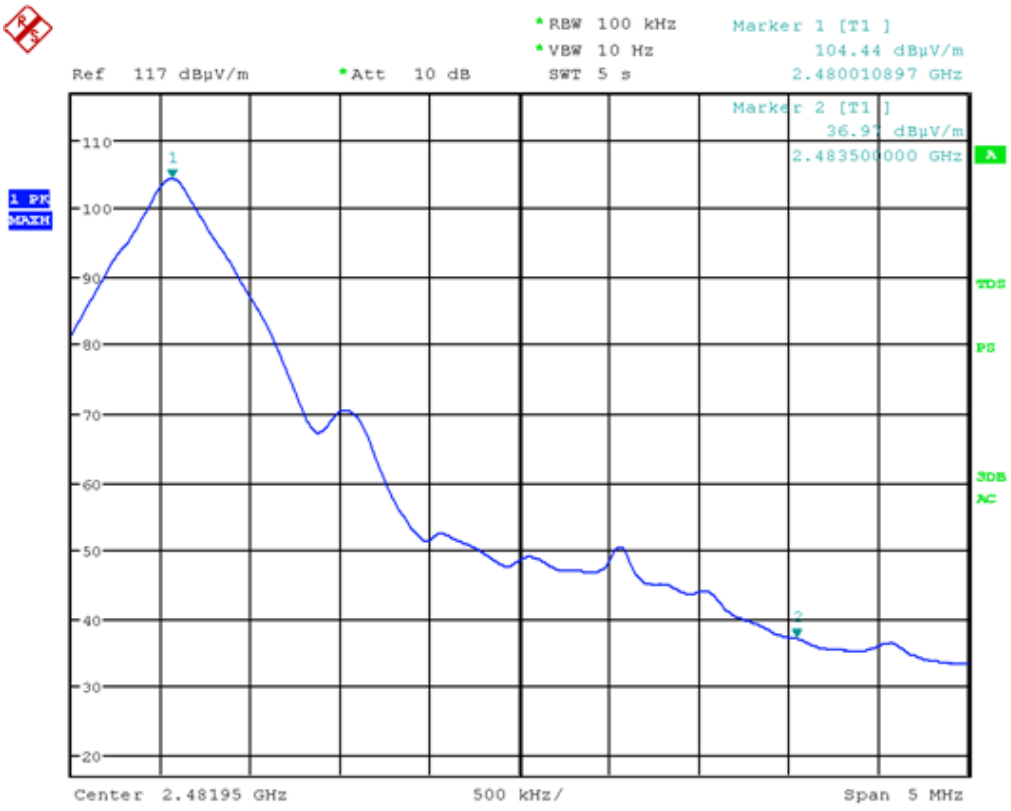
Picture 53: lower edge - PK (GFSK)



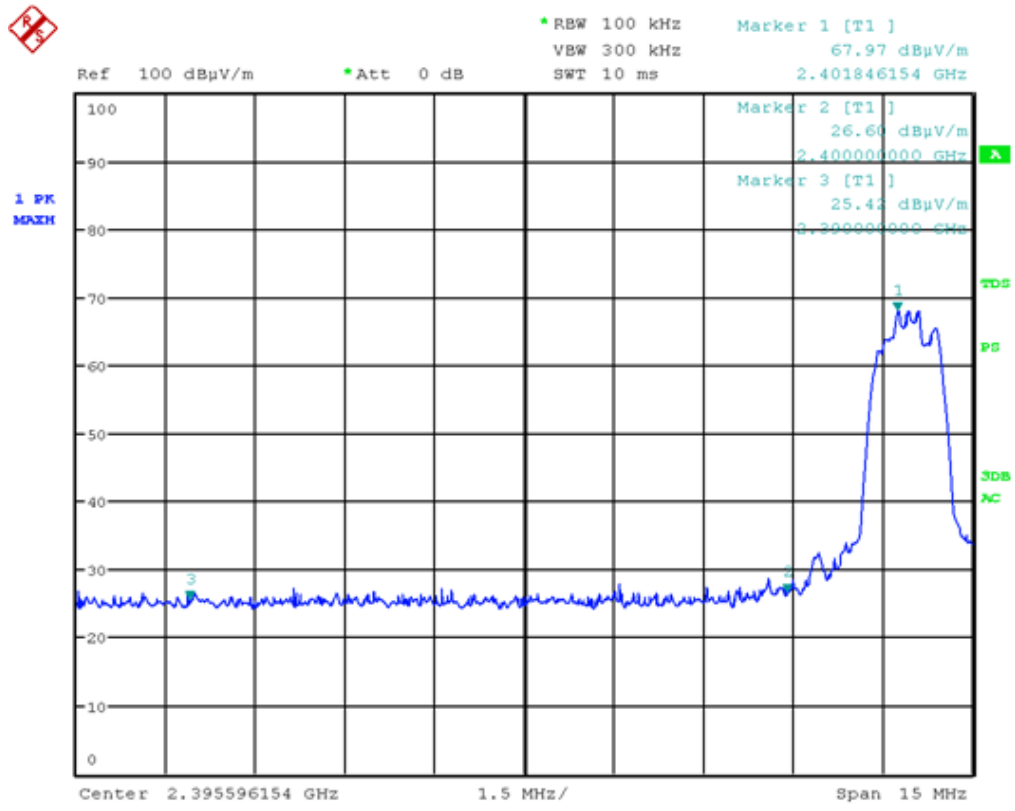
Picture 54: lower edge - AV (GFSK)



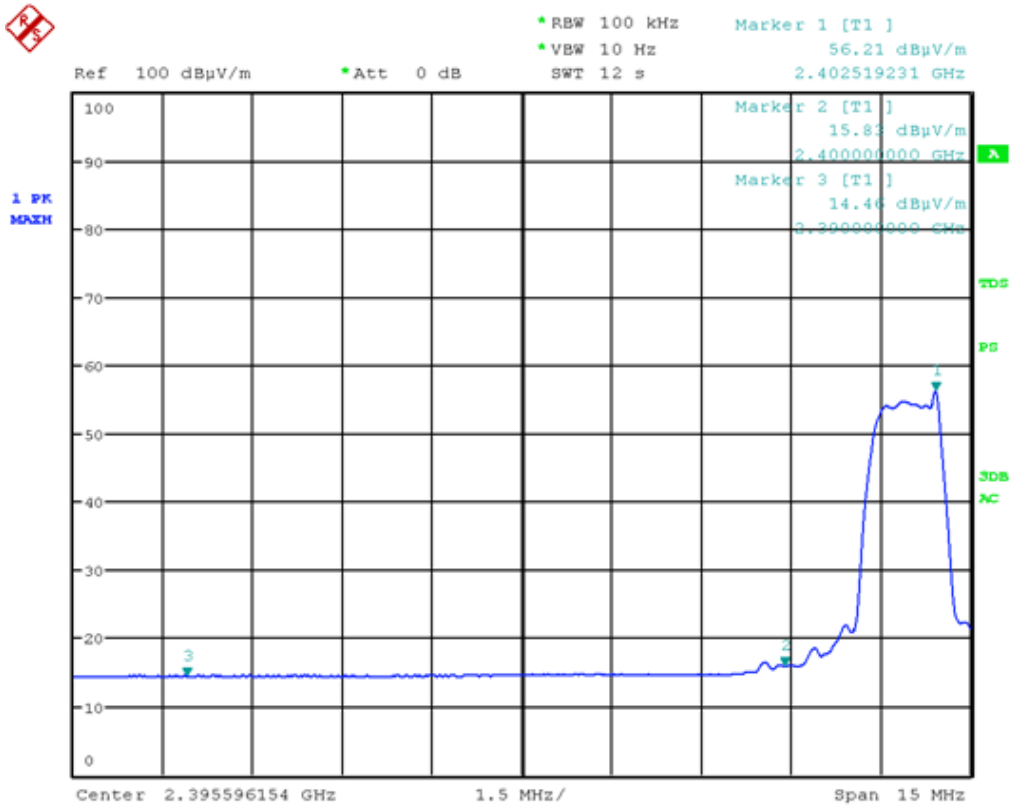
Picture 55: upper edge - PK (GFSK)



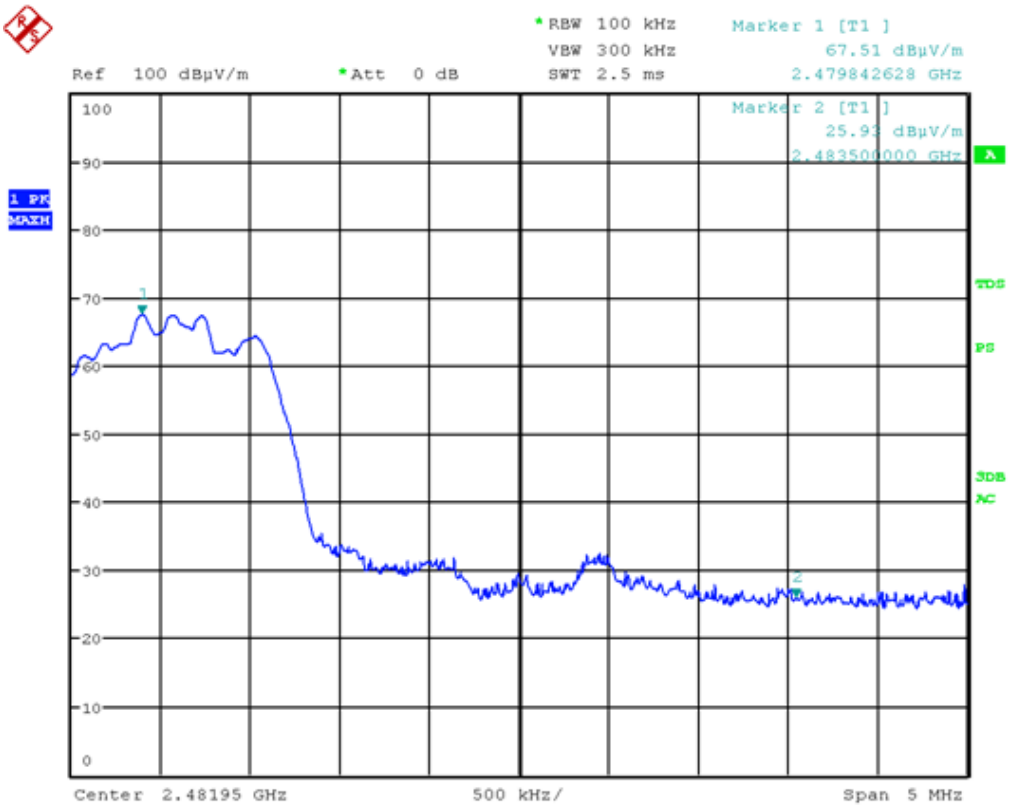
Picture 56: upper edge - AV (GFSK)



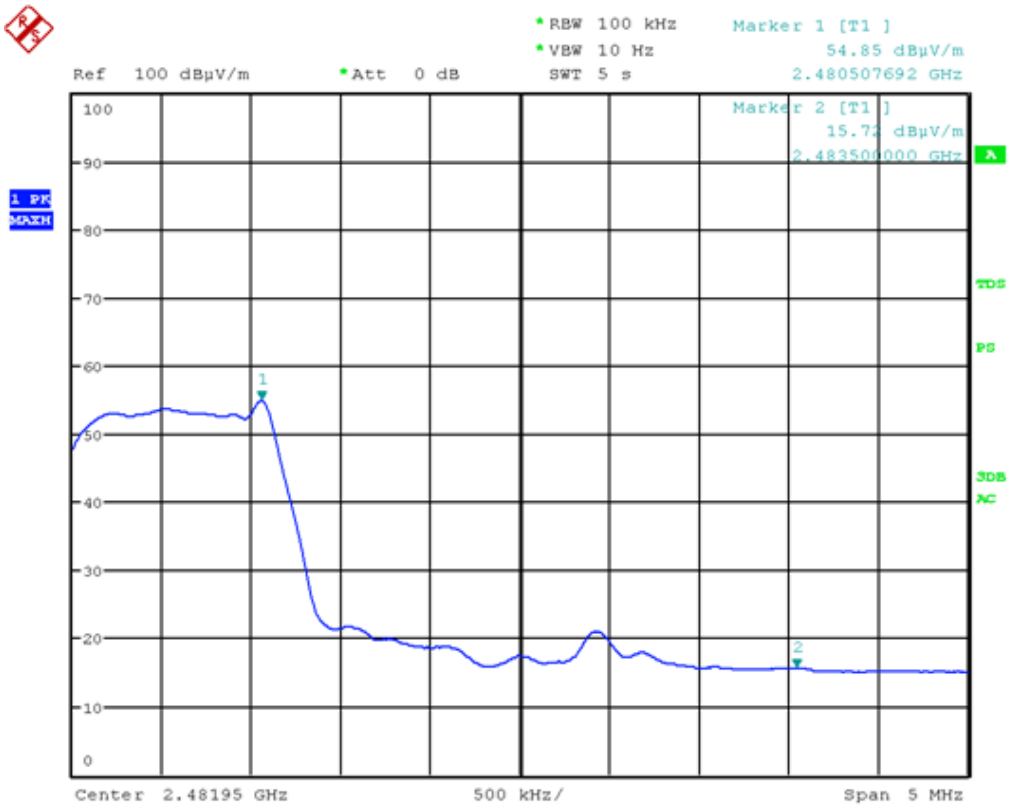
Picture 57: lower edge - PK (8DPSK)



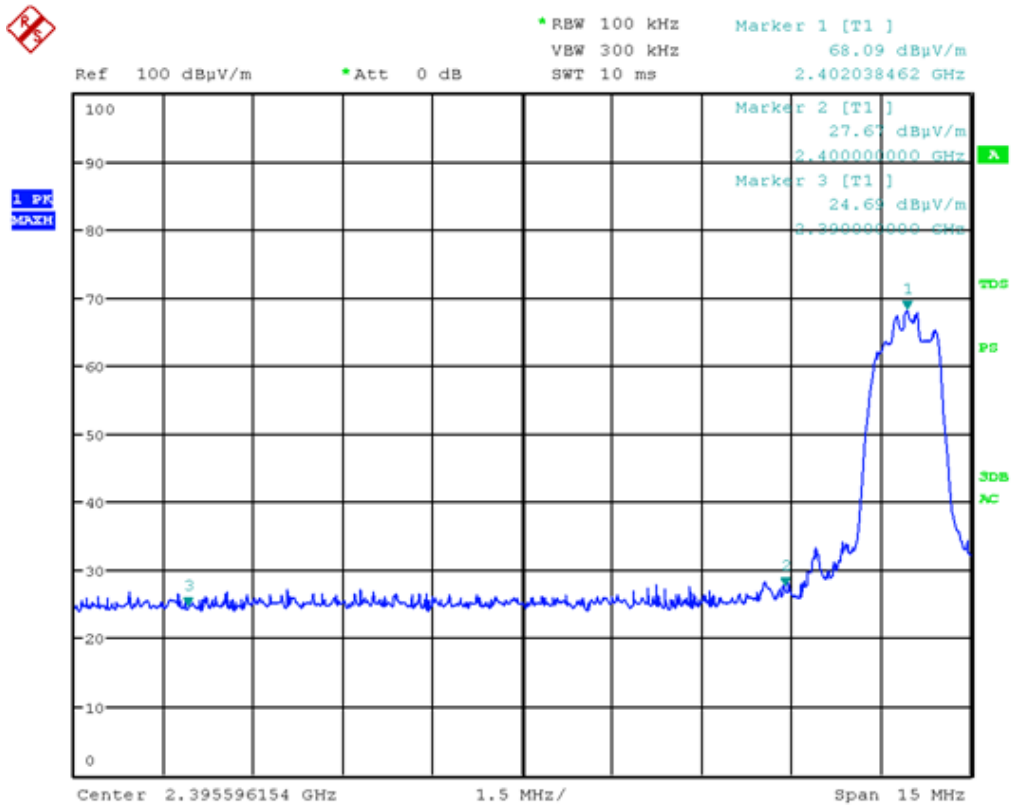
Picture 58: lower edge - AV (8DPSK)



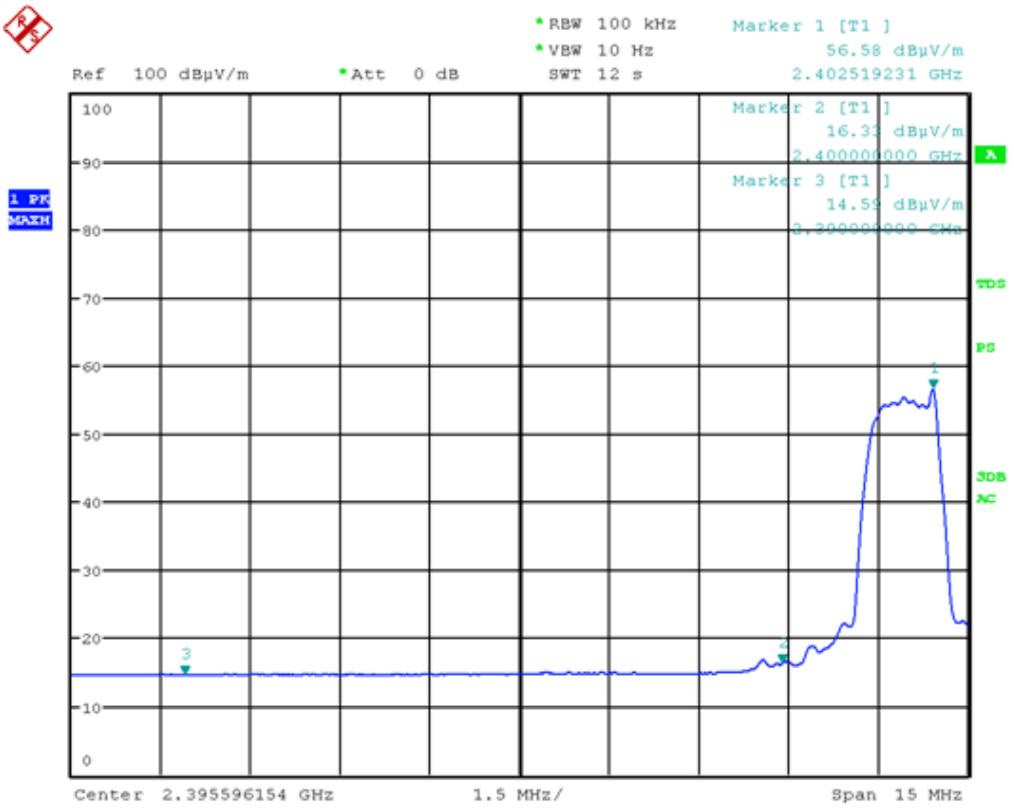
Picture 59: upper edge - PK (8DPSK)



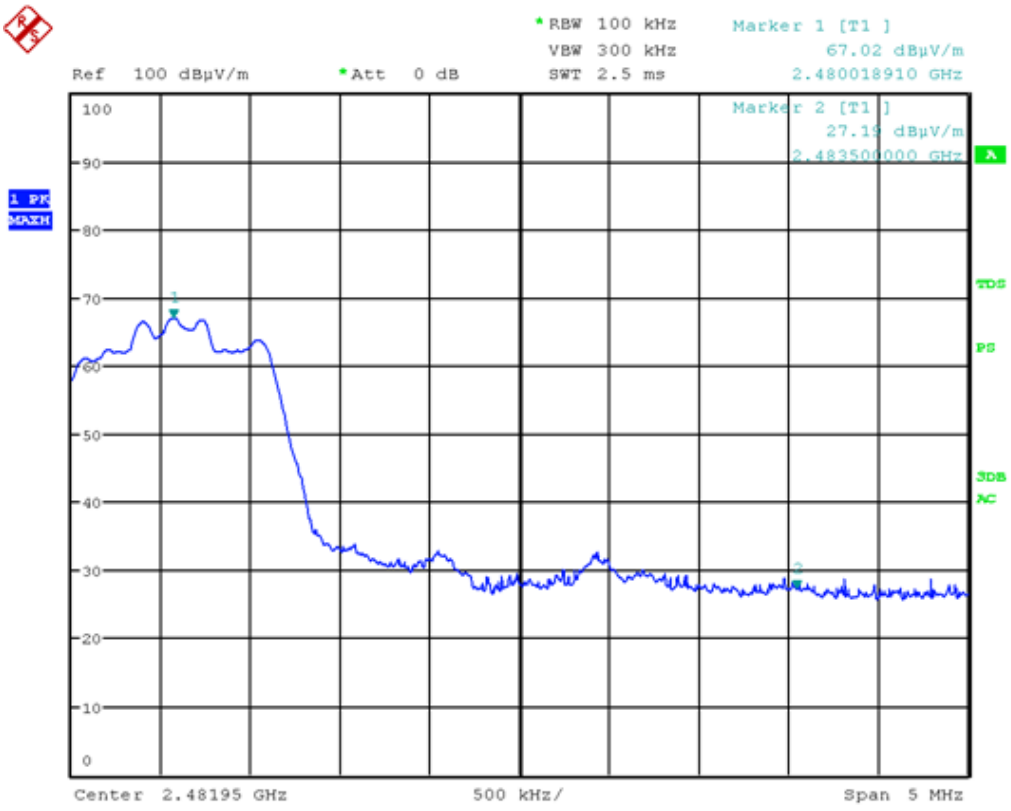
Picture 60: upper edge - AV (8DPSK)



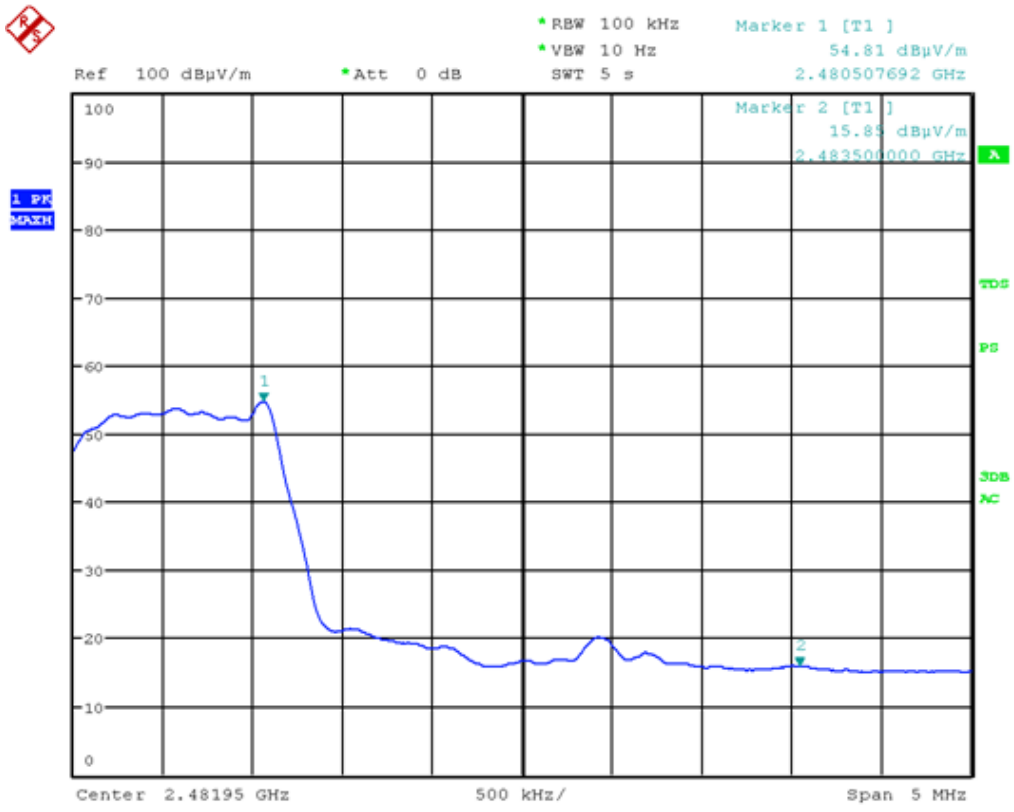
Picture 61: lower edge - PK (Pi/4 DQPSK)



Picture 62: lower edge - AV (Pi/4 DQPSK)



Picture 63: upper edge - PK (Pi/4 DQPSK)



Picture 64: upper edge - AV (Pi/4 DQPSK)

11 Spurious RF Conducted Emission

according to CFR 47 Part 15, section 15.247(d), and Public Notice DA 00-705

11.1 Test location

☑ Conducted measurement
☐ Scan with peak detector in 3 m CDC
☐ CISPR measurement with quasi peak detector on 10m open area test site.
☐ Measurement with peak detector on 3m open area test site

Description	Manufacturer	Inventory No.
CDC	Albatross Projects	E00026
Open area test site	EMV **TESTHAUS** GmbH	E00354

11.2 Test Instruments

	Description	Manufacturer	Inventory No.
☐	ESCS 30 (FF)	Rohde & Schwarz	E00003
☑	ESU 26	Rohde & Schwarz	W00002
☐	ESCI (CDC)	Rohde & Schwarz	E00001
☐	HFH2-Z2	Rohde & Schwarz	E00060
☐	VULB 9163 (FF)	Schwarzbeck	E00013
☐	VULB 9160 (CDC)	Schwarzbeck	E00011

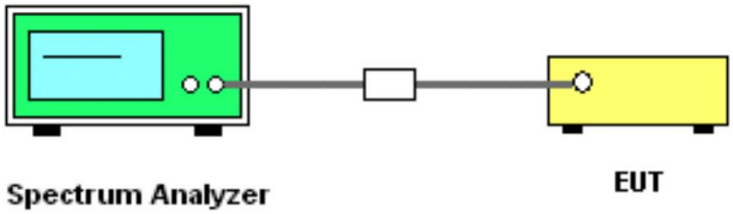
11.3 Limits

< - 20dBc outside restricted bands
< 54dBµV (video average) inside restricted bands
< 74dBµV (peak detector) inside restricted bands

11.4 Test procedure

1. The test is performed in accordance with FCC Public Notice KBD 558074
2. The transmitter output (antenna port) was connected to the spectrum analyzer in peak hold mode.
3. The unit was operated in continuous transmit mode with modulation.
4. The resolution bandwidth of 100 kHz and the video bandwidth of 100 kHz were used.
5. Measure the spectrum from the lowest frequency generated in the EUT up through the 10th harmonic.

11.5 Test setup



Picture 65: Test setup for conducted spurious emission measurement

11.6 Test deviation

There is no deviation with the original standard.

11.7 EUT operation during test

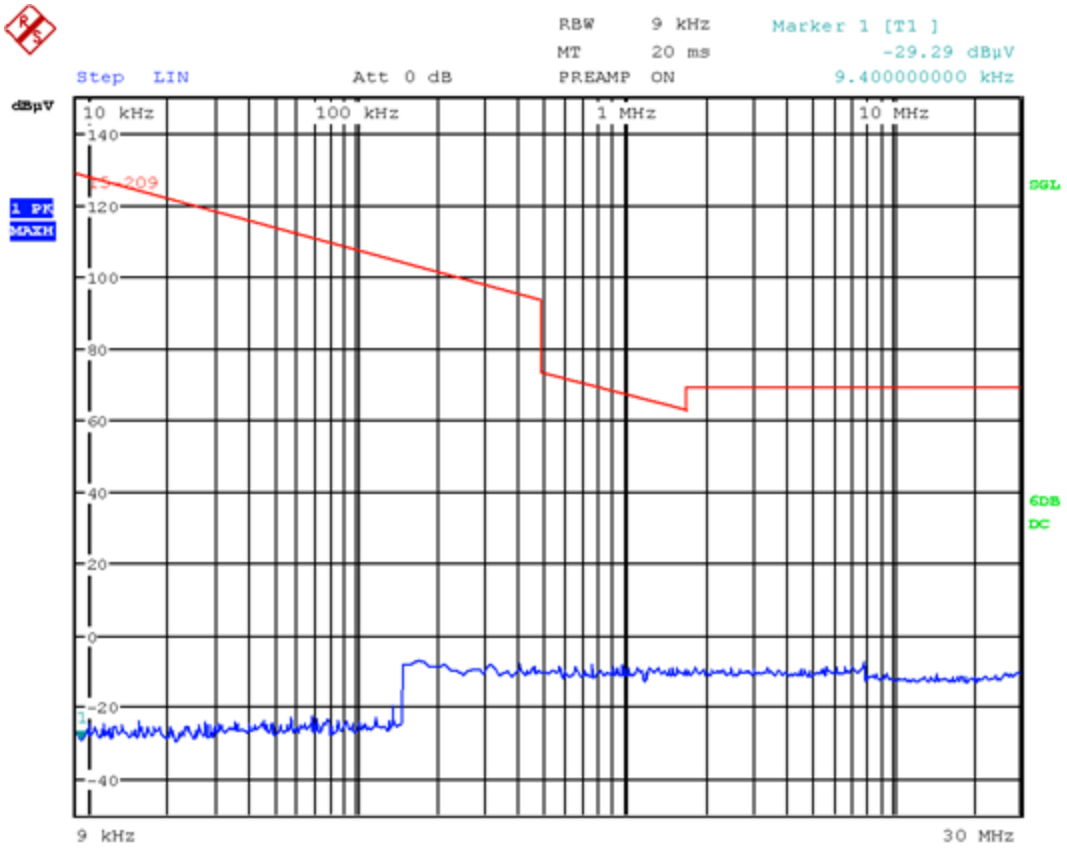
The EUT was programmed to be in continuously transmitting mode.

11.8 Test results

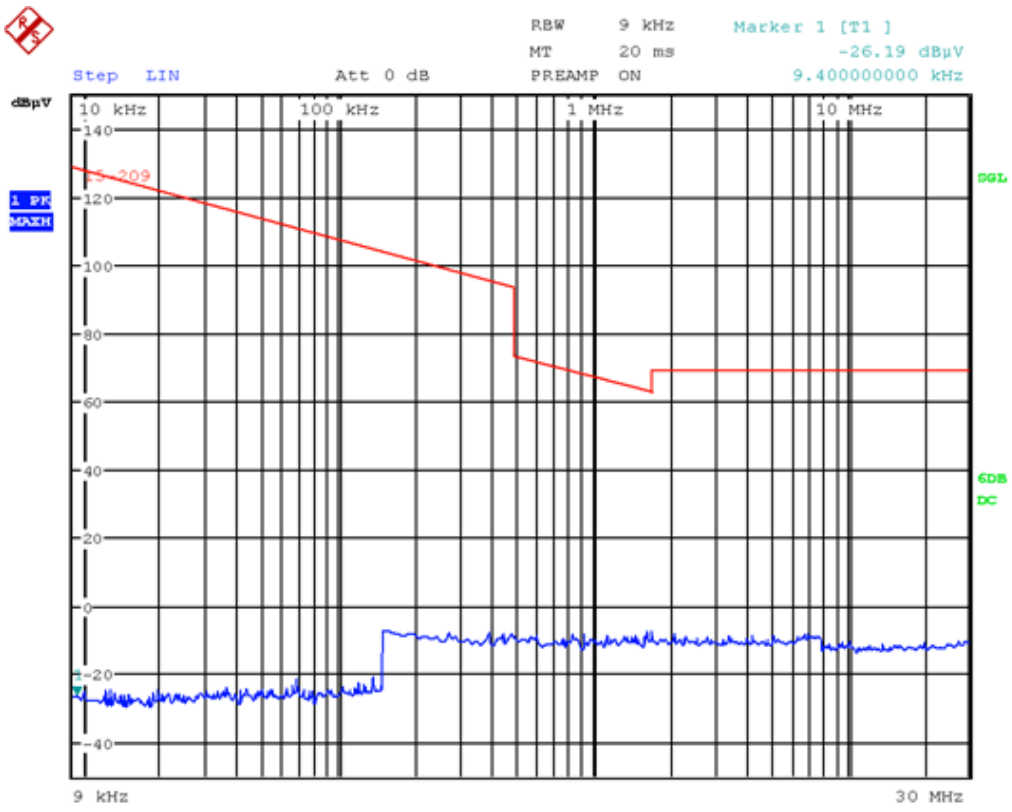
Temperature:	22°C	Humidity:	44%
Tested by:	M. Müller	Test date:	2014-04-24

There was no difference between the measurement results below 30 MHz depending on the modulation. Therefore only the GFSK modulation was documented.

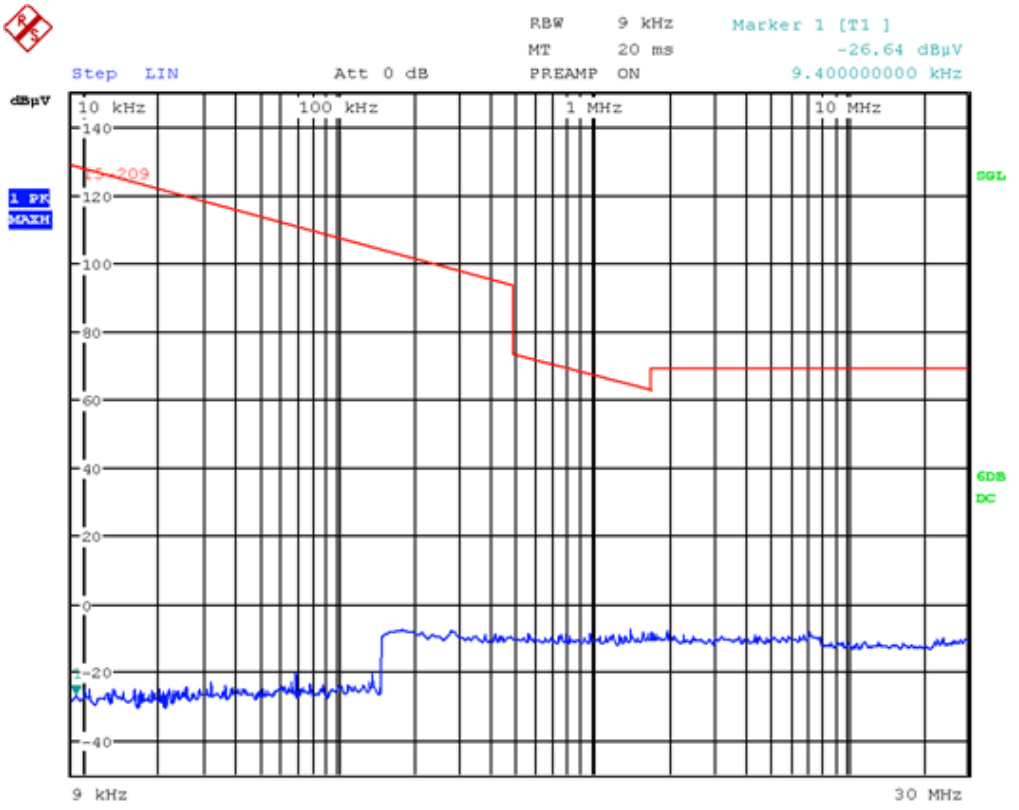
11.9 Test results GFSK 9kHz - 30MHz



Picture 66: spurious emission channel 0 (9kHz - 30MHz) - GFSK



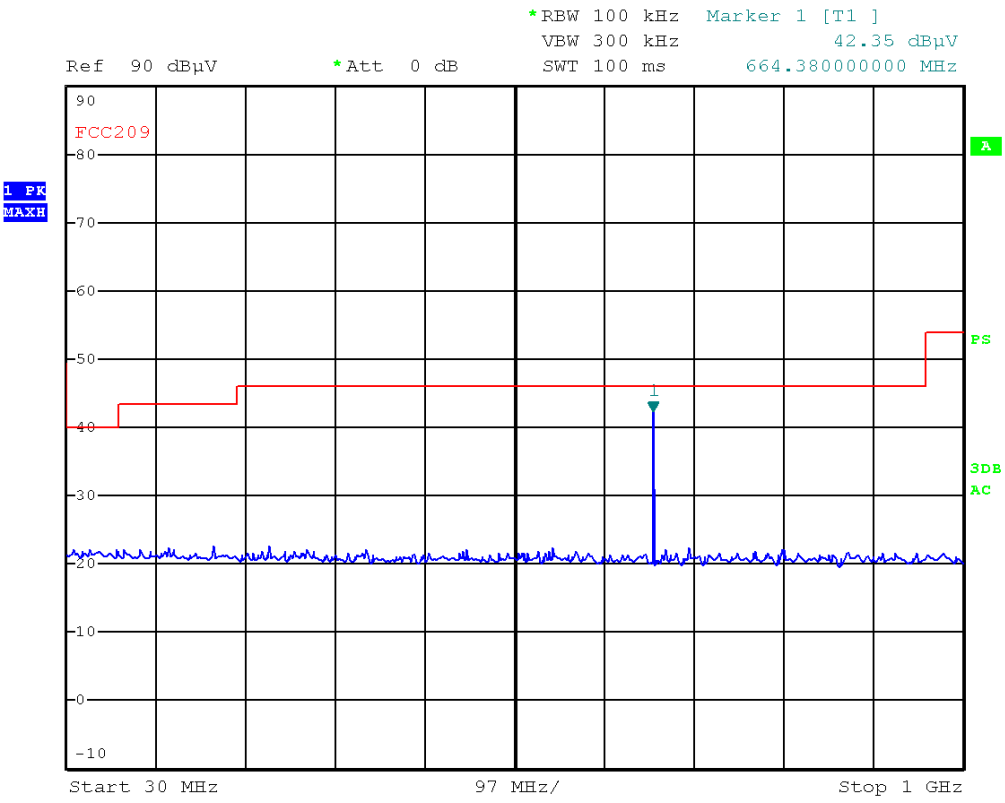
Picture 67: spurious emission channel 39 (9kHz - 30MHz) - GFSK



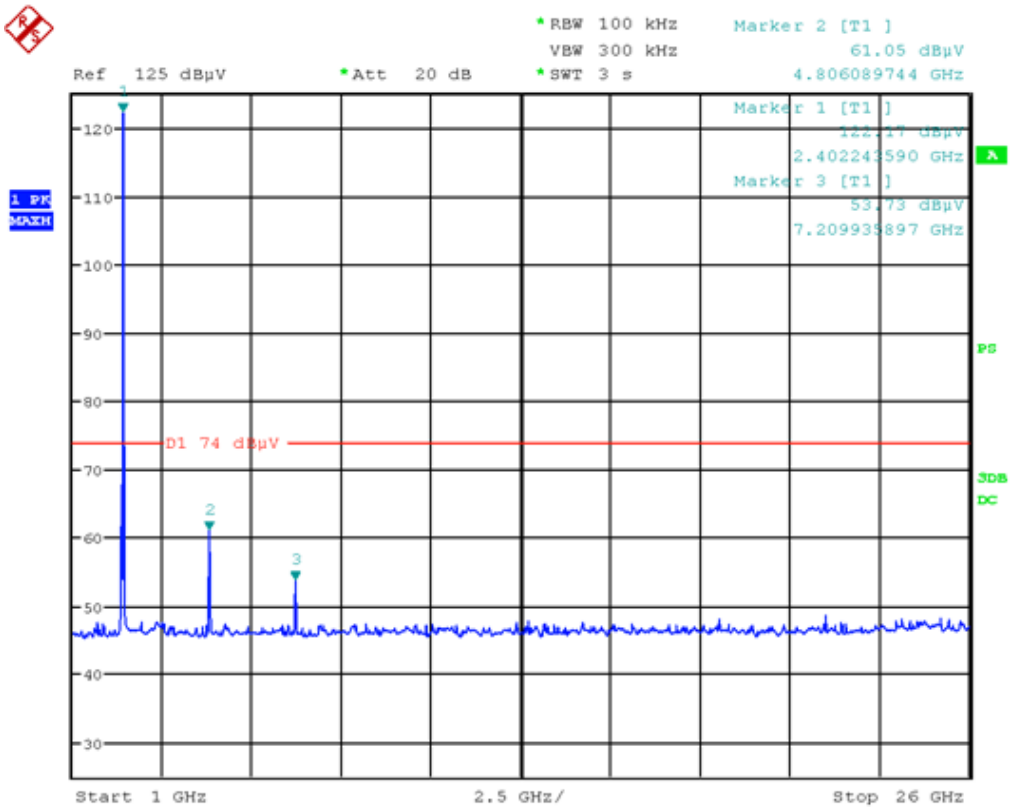
Picture 68: spurious emission channel 78 (9kHz - 30MHz) - GFSK

11.10 Test results GFSK 30MHz - 26GHz

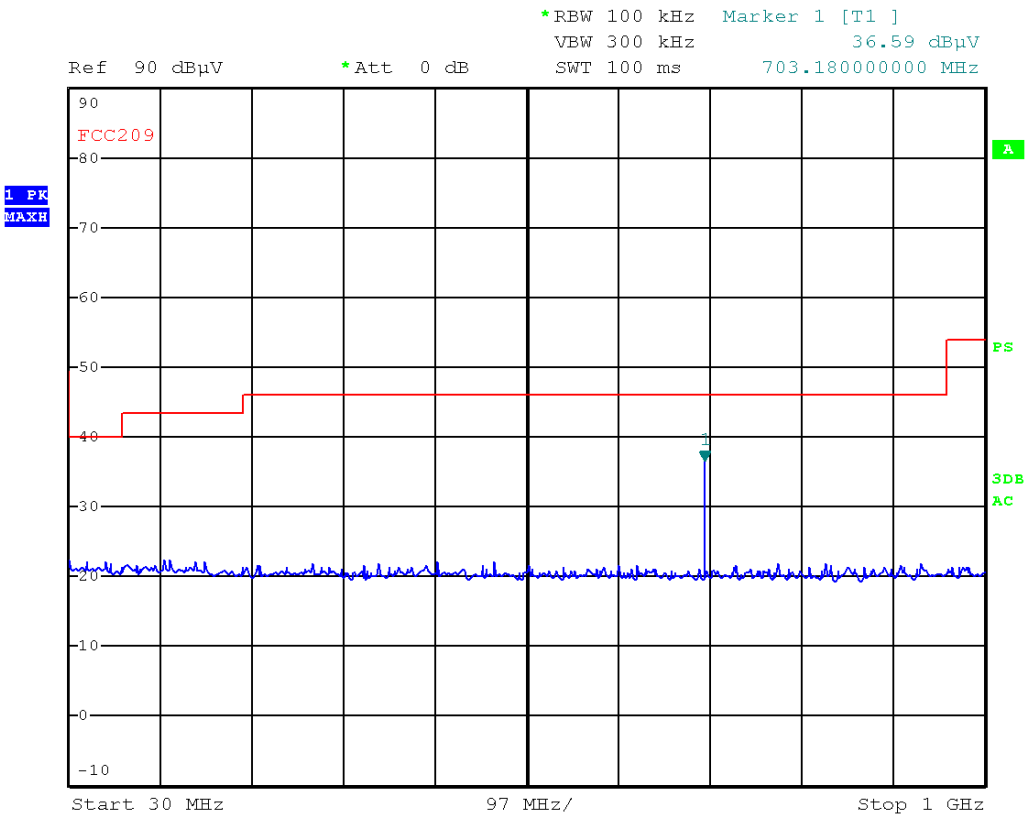
Frequency (GHz)	Reading (dBµV)	Detector	Limit (dBµV)	Restricted band	Result
Channel 0					
0.6644	42.35	PK	46 (QP)	No	Passed
2.4020	121.53	PK	Carrier	No	Carrier
2.4020	114.92	AV	Carrier	No	Carrier
4.8040	60.21	PK	74	Yes	Passed
4.8040	48.55	AV	54	Yes	Passed
7.2060	52.02	PK	- 20dBc	No	Passed
7.2060	42.85	AV	- 20dBc	No	Passed
Channel 39					
0.7032	36.59	PK	46 (QP)	No	Passed
2.4410	122.64	PK	Carrier	No	Carrier
2.4410	116.02	AV	Carrier	No	Carrier
4.8820	58.94	PK	74	Yes	Passed
4.8820	47.29	AV	54	Yes	Passed
7.3230	53.09	PK	74	Yes	Passed
7.3230	44.16	AV	54	Yes	Passed
14.6461	52.75	PK	- 20dBc	No	Passed
14.6461	42.43	AV	- 20dBc	No	Passed
Channel 78					
0.7420	35.14	PK	46 (QP)	No	Passed
2.4800	121.90	PK	Carrier	No	Carrier
2.4800	115.27	AV	Carrier	No	Carrier
7.4400	55.66	PK	74	Yes	Passed
7.4400	46.54	AV	54	Yes	Passed
14.8801	56.83	PK	- 20dBc	No	Passed
14.8801	46.50	AV	- 20dBc	No	Passed



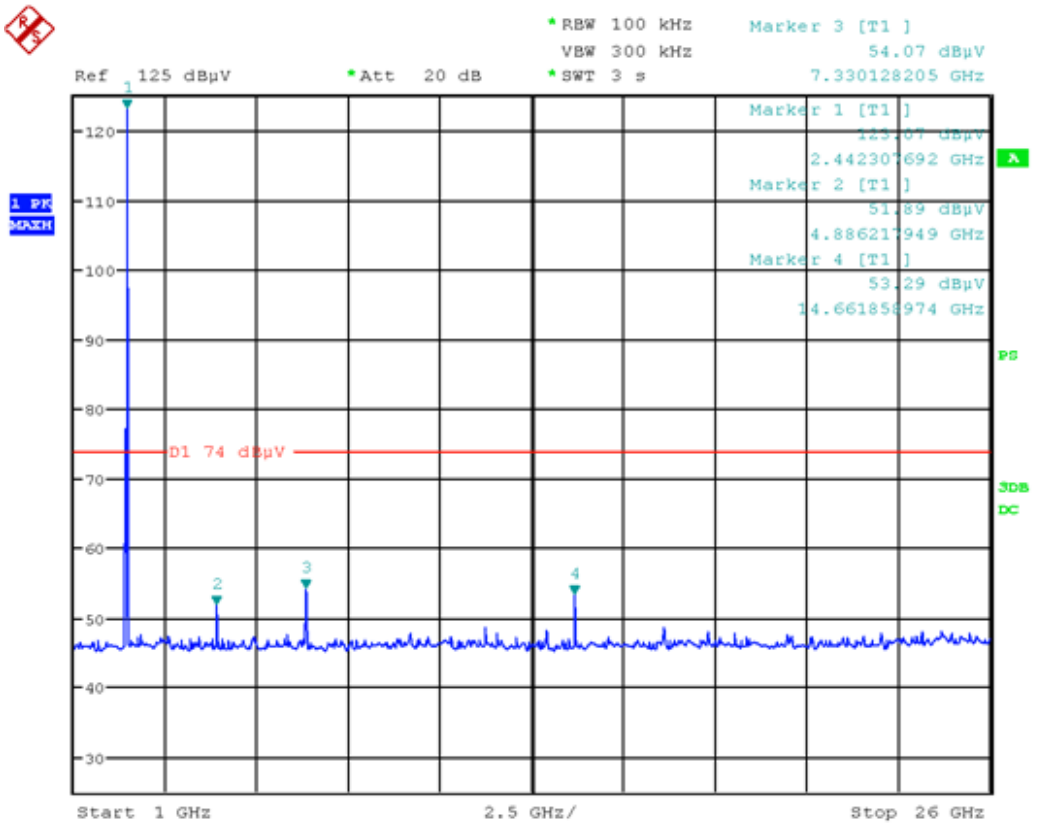
Picture 69: spurious emission channel 0 (30MHz – 1GHz) - GFSK



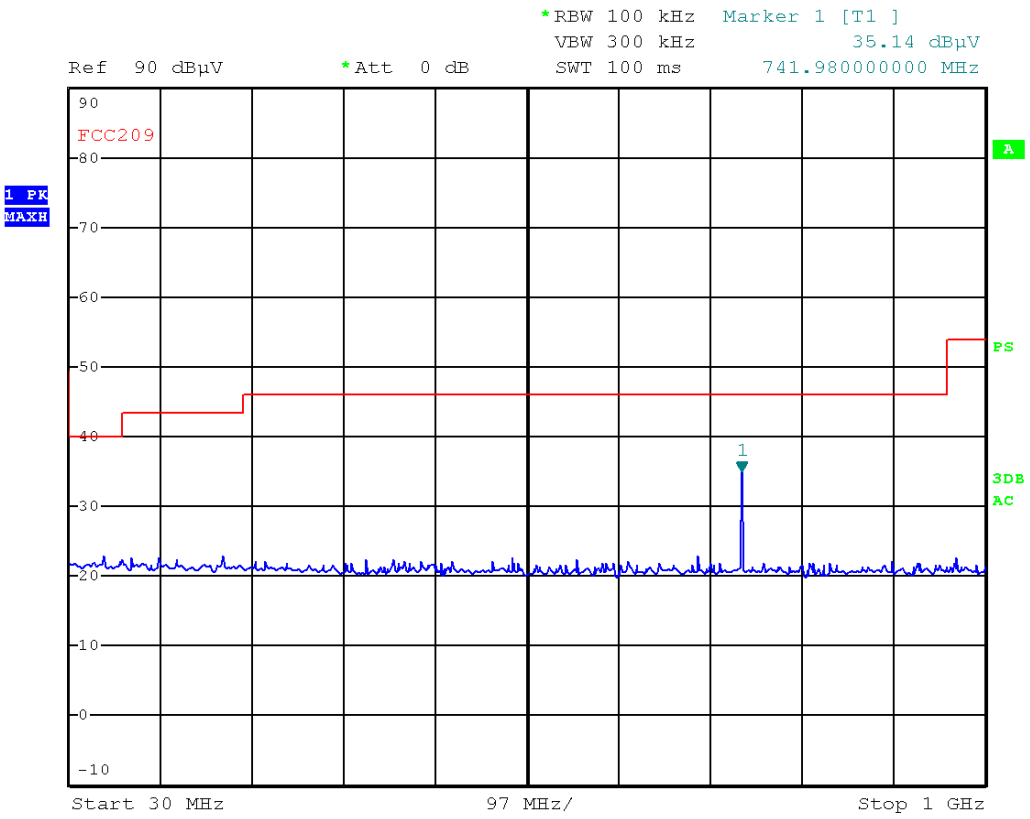
Picture 70: spurious emission channel 0 (1GHz – 26GHz) - GFSK



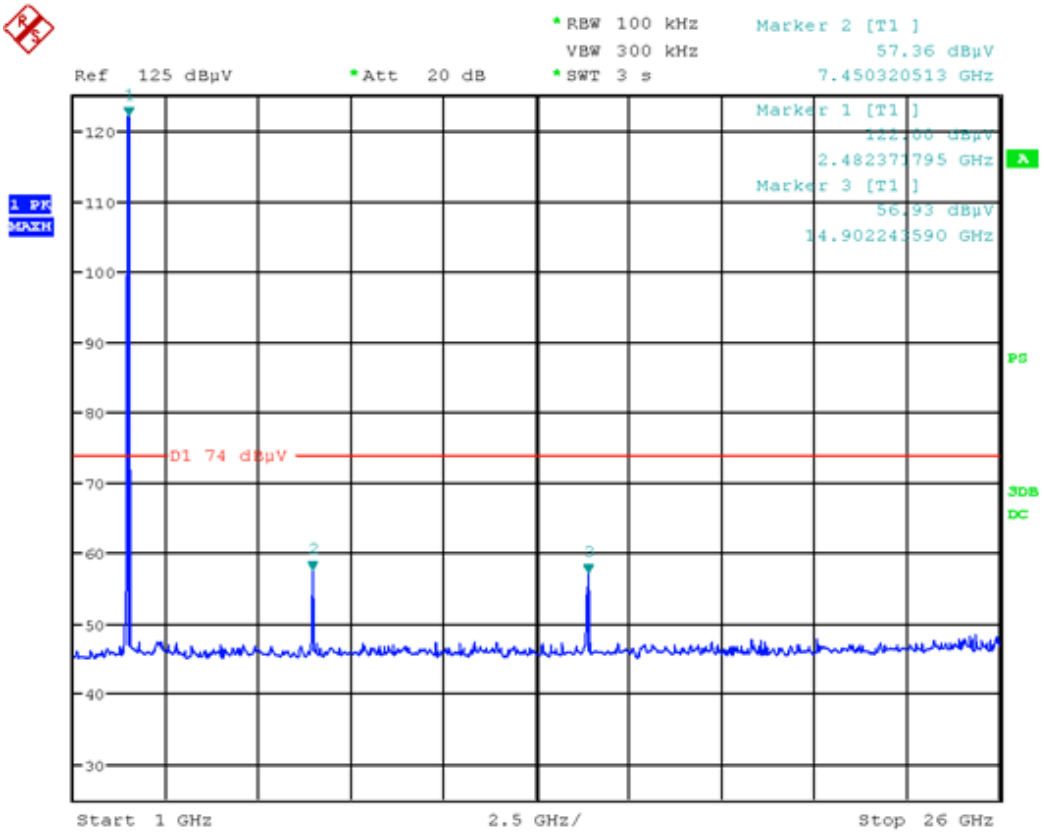
Picture 71: spurious emission channel 39 (30MHz – 1GHz) - GFSK



Picture 72: spurious emission channel 39 (1GHz – 26GHz) - GFSK



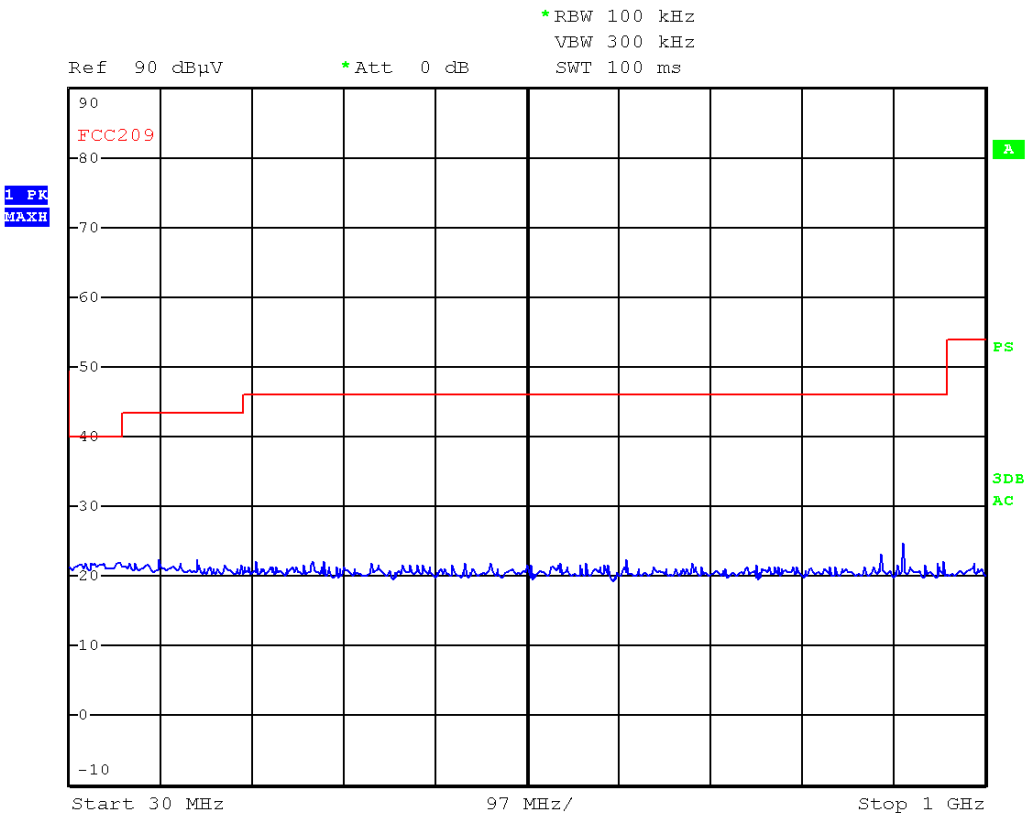
Picture 73: spurious emission channel 78 (30MHz – 1GHz) – GFSK



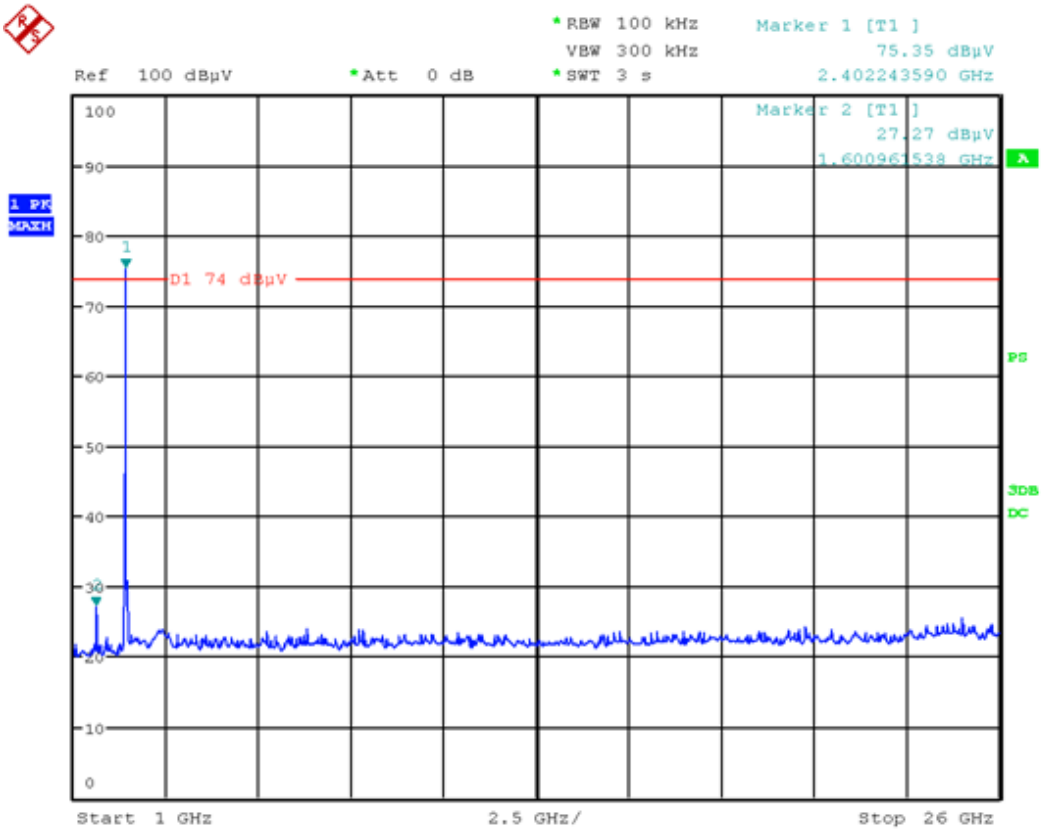
Picture 74: spurious emission channel 78 (1GHz – 26GHz) - GFSK

11.11 Test results 8DPSK 30MHz - 26GHz

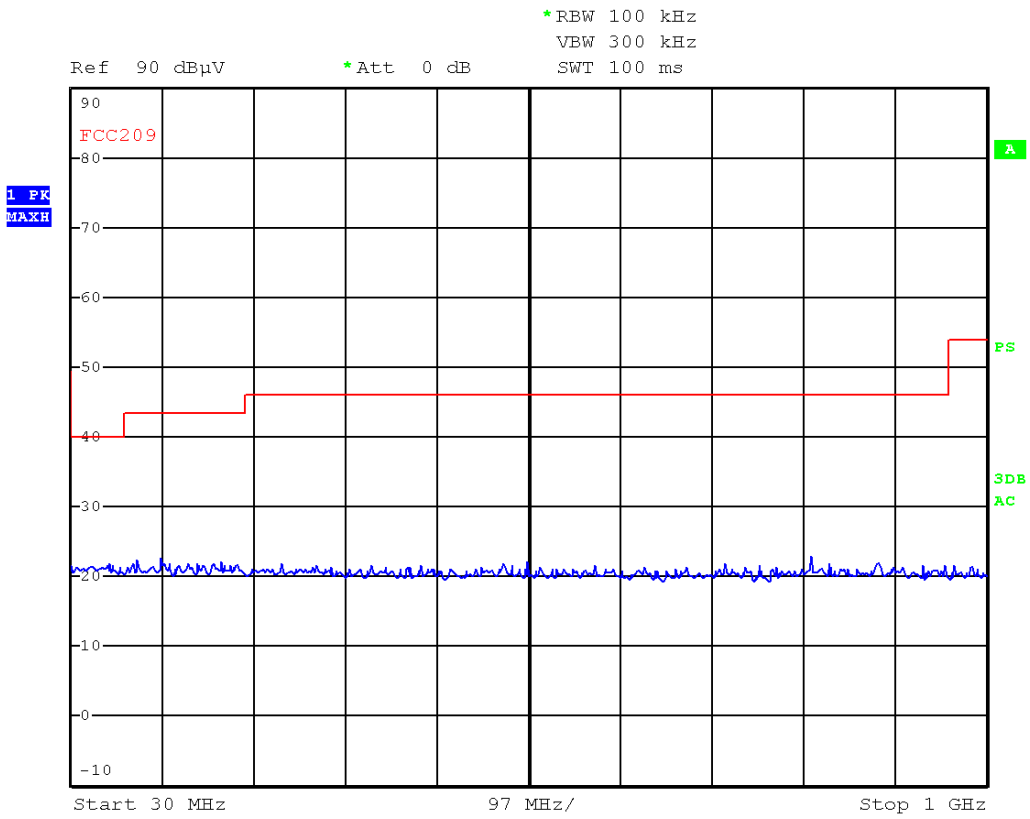
Frequency (GHz)	Reading (dBµV)	Detector	Limit (dBµV)	Restricted band	Result
Channel 0					
1.6017	27.17	PK	74	Yes	Passed
1.6017	22.93	AV	54	Yes	Passed
2.4020	78.32	PK	Carrier	No	Carrier
2.4020	65.39	AV	Carrier	No	Carrier
Channel 39					
1.6277	27.94	PK	74	No	Passed
1.6277	23.84	AV	54	No	Passed
2.4410	78.25	PK	Carrier	No	Carrier
2.4410	66.11	AV	Carrier	No	Carrier
Channel 78					
1.6537	26.76	PK	74	No	Passed
1.6537	22.15	AV	54	No	Passed
2.4800	77.51	PK	Carrier	No	Carrier
2.4800	64.83	AV	Carrier	No	Carrier



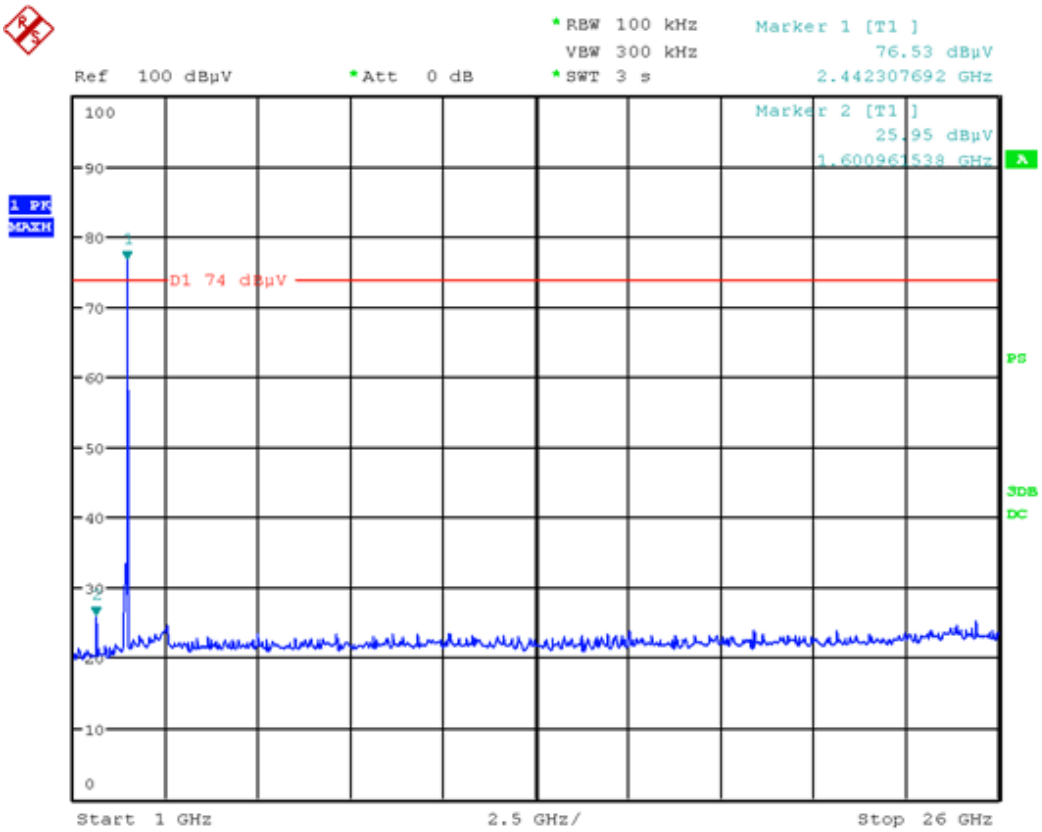
Picture 75: spurious emission channel 0 (30MHz – 1GHz) – 8DPSK



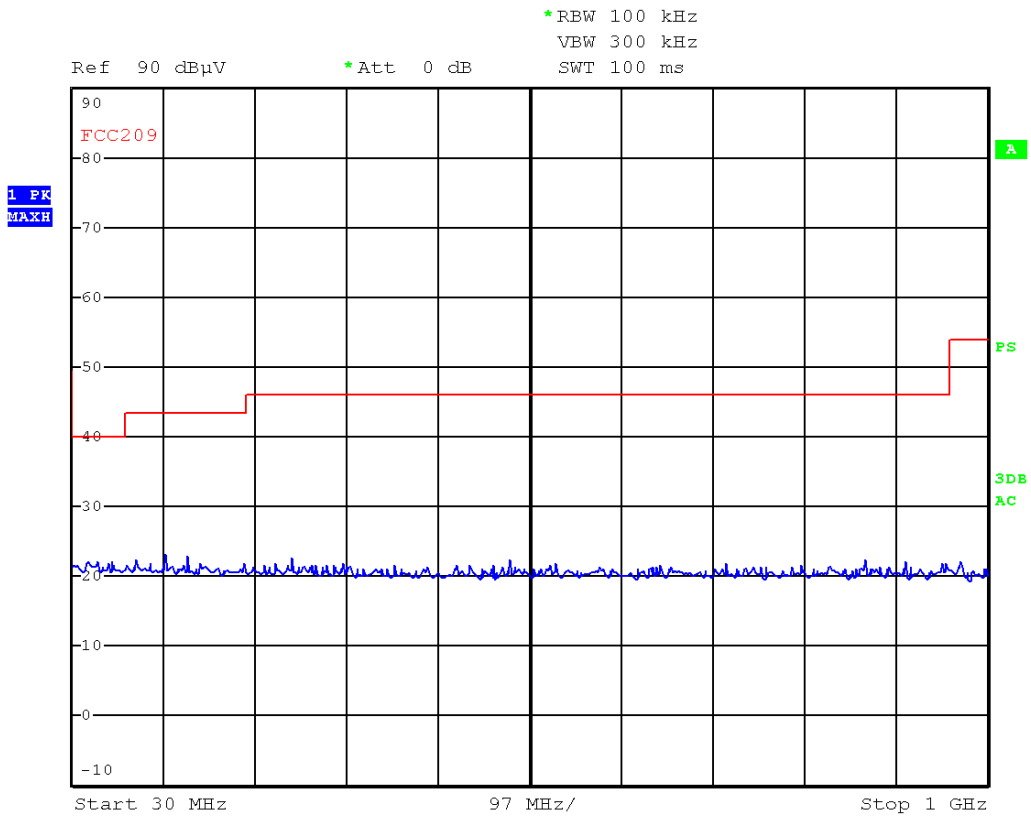
Picture 76: spurious emission channel 0 (1GHz – 26GHz) - 8DPSK



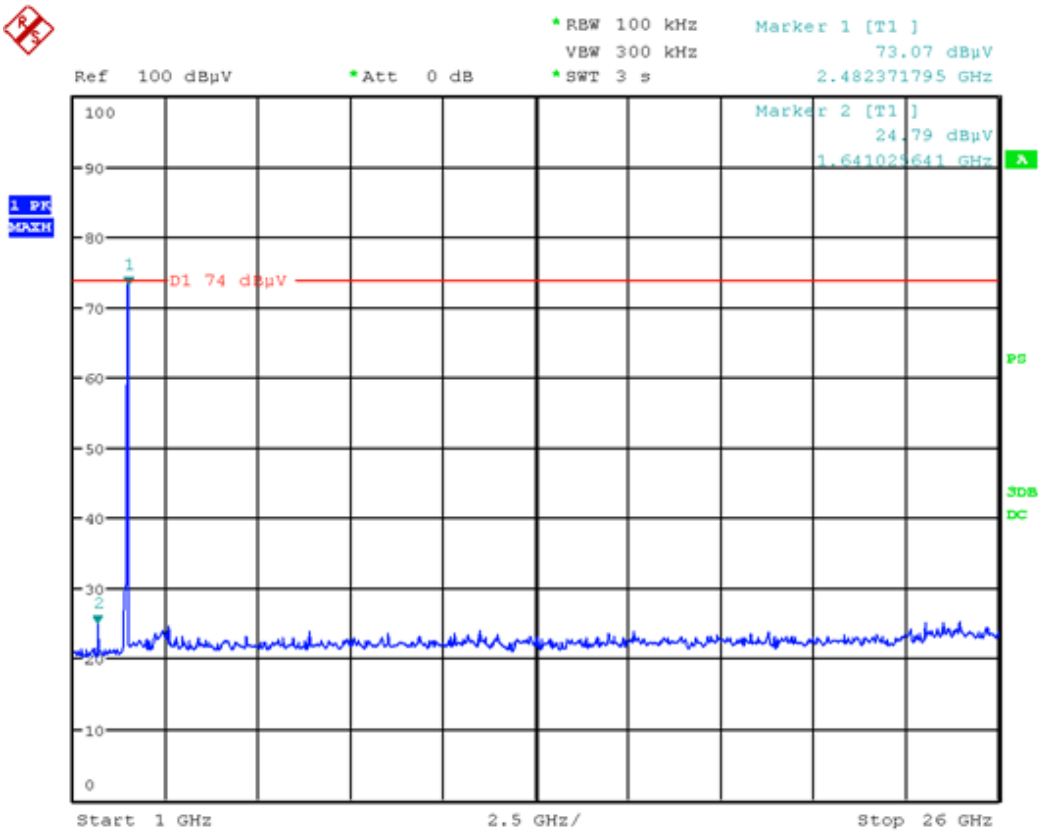
Picture 77: spurious emission channel 39 (30MHz – 1GHz) - 8DPSK



Picture 78: spurious emission channel 39 (1GHz – 26GHz) - 8DPSK



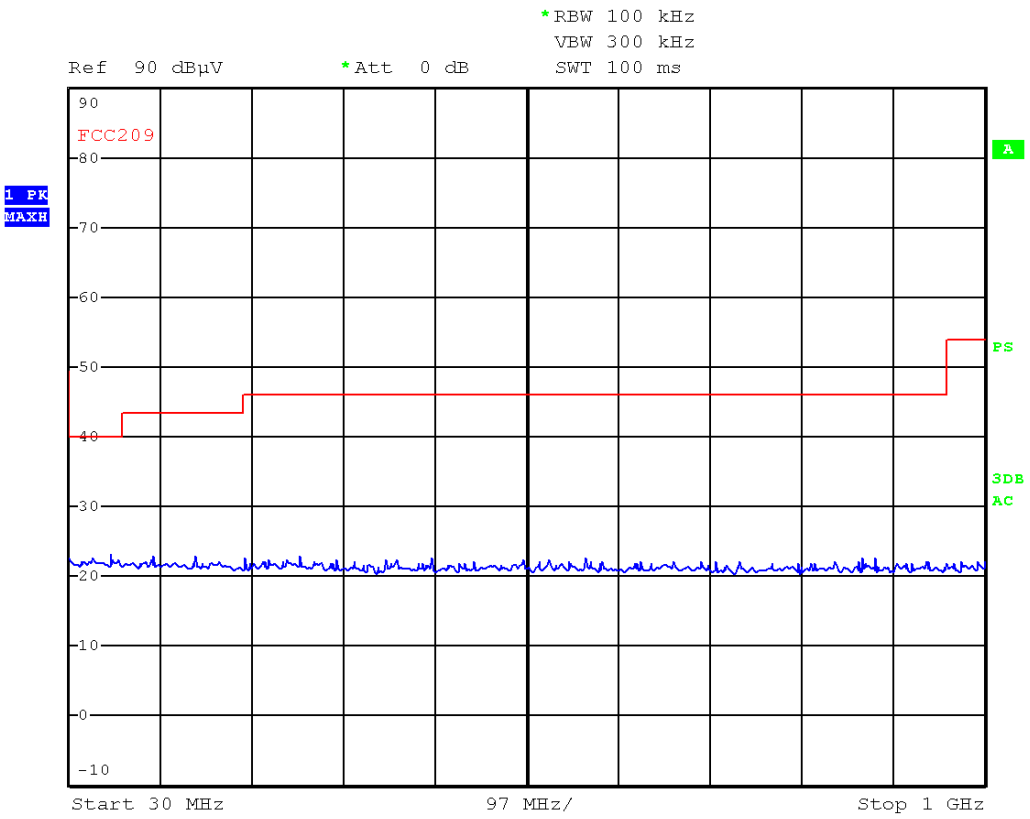
Picture 79: spurious emission channel 78 (30MHz – 1GHz) - 8DPSK



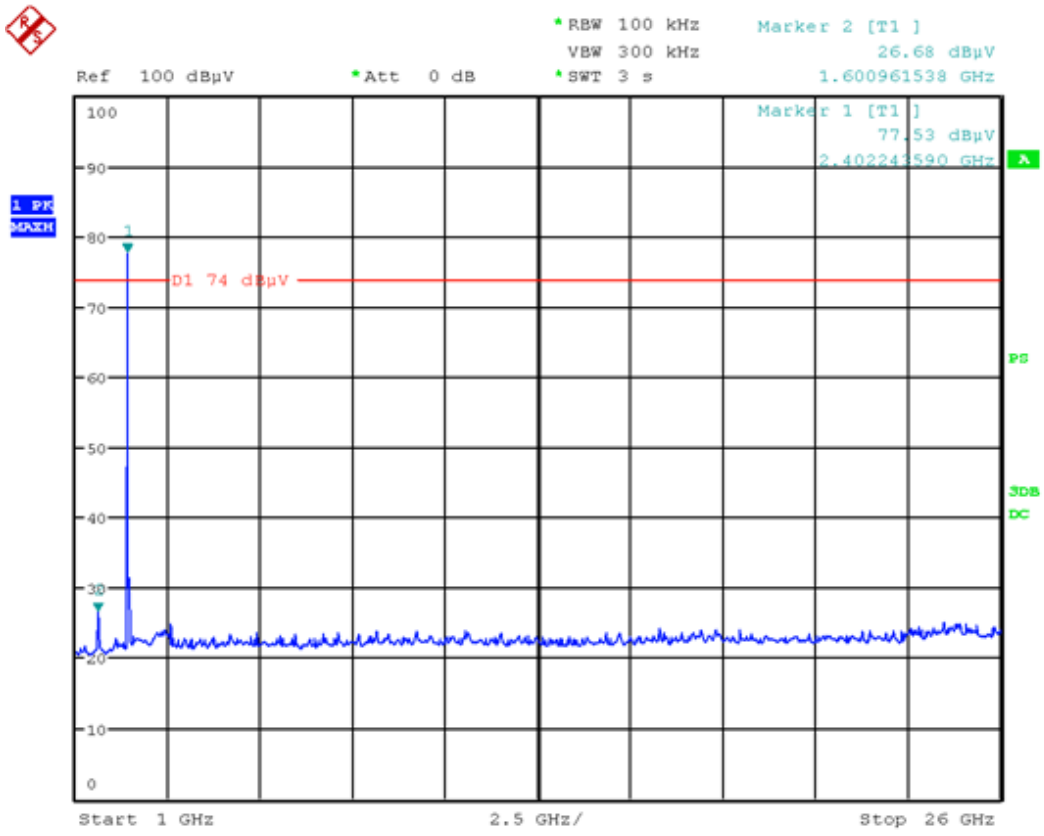
Picture 80: spurious emission channel 78 (1GHz – 26GHz) - 8DPSK

11.12 Test results Pi/4-DQPSK 30MHz - 26GHz

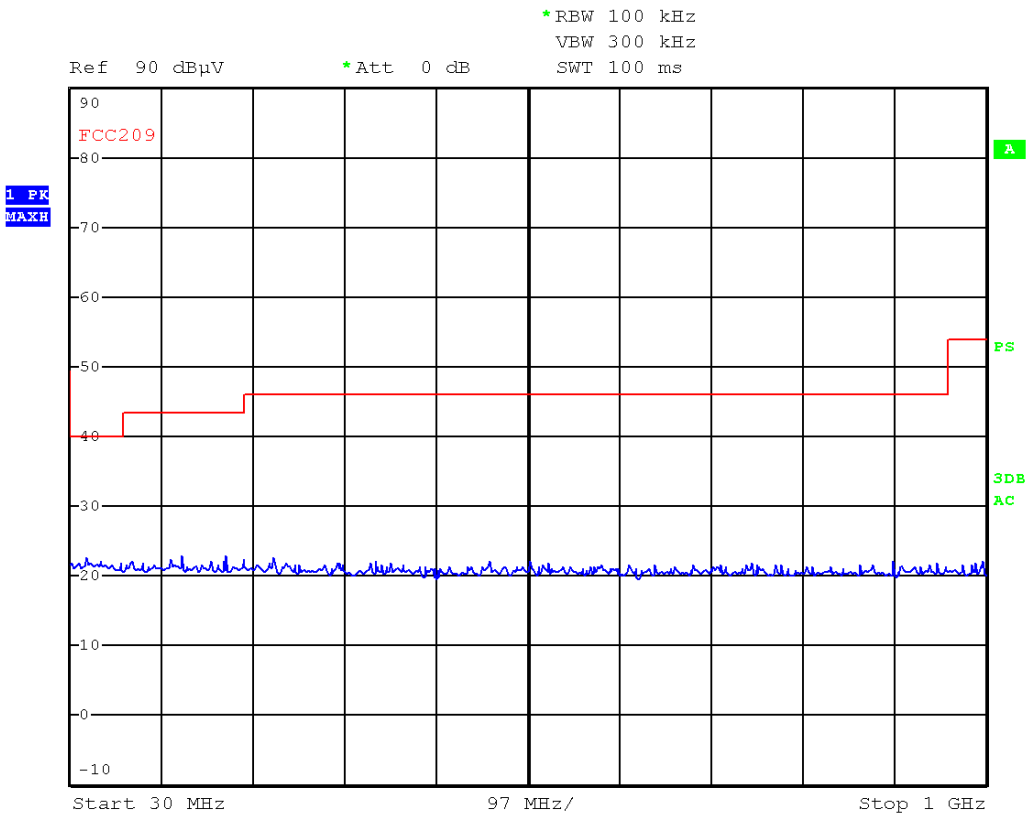
Frequency (GHz)	Reading (dBµV)	Detector	Limit (dBµV)	Restricted band	Result
Channel 0					
1.6017	27.25	PK	74	Yes	Passed
1.6017	23.02	AV	54	Yes	Passed
2.4020	77.76	PK	Carrier	No	Carrier
2.4020	65.34	AV	Carrier	No	Carrier
Channel 39					
1.6277	27.74	PK	74	No	Passed
1.6277	24.10	AV	54	No	Passed
2.4410	78.59	PK	Carrier	No	Carrier
2.4410	66.12	AV	Carrier	No	Carrier
Channel 78					
1.6537	26.99	PK	74	No	Passed
1.6537	22.75	AV	54	No	Passed
1.8975	29.32	PK	74	No	Passed
1.8975	10.29	AV	54	No	Passed
2.4800	77.37	PK	Carrier	No	Carrier
2.4800	64.93	AV	Carrier	No	Carrier



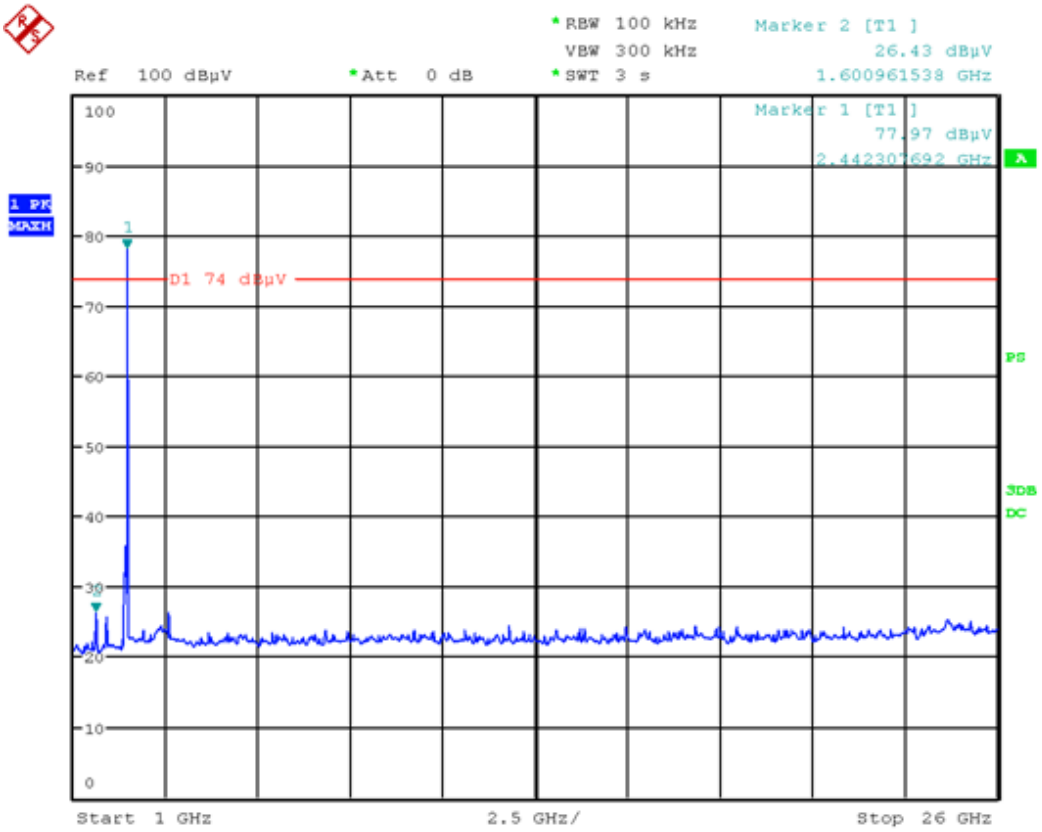
Picture 81: spurious emission channel 0 (30MHz – 1GHz) – Pi/4 DQPSK



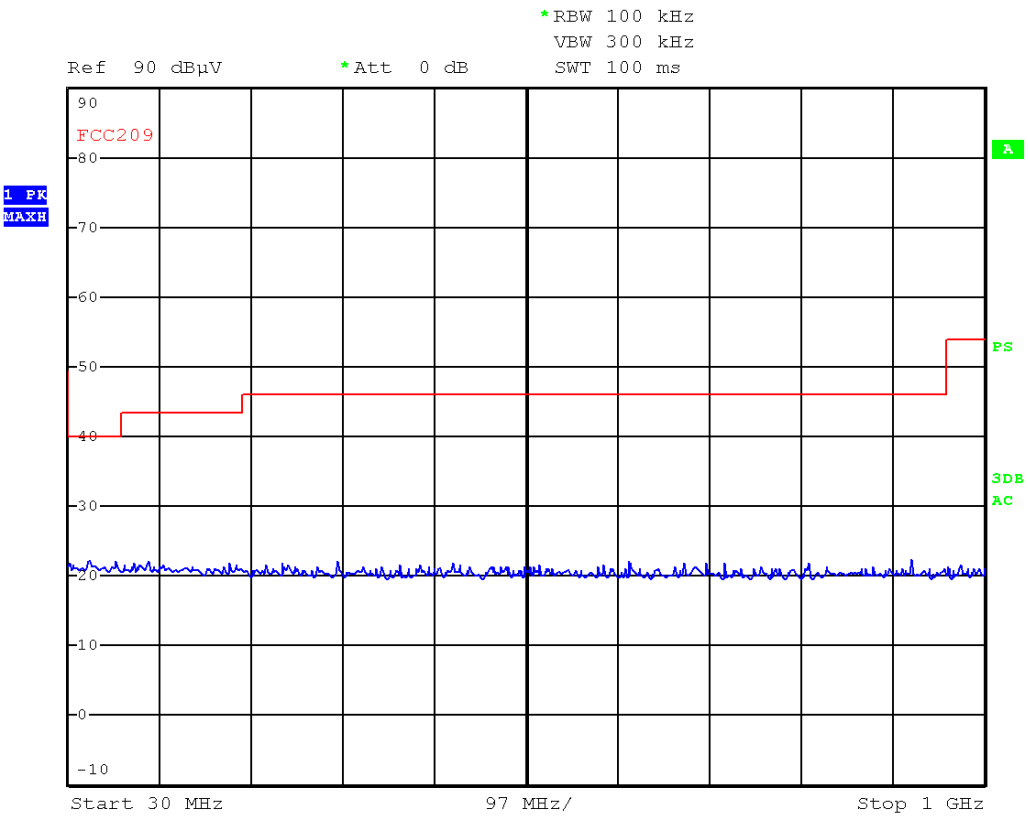
Picture 82: spurious emission channel 0 (1GHz – 26GHz) - Pi/4 DQPSK



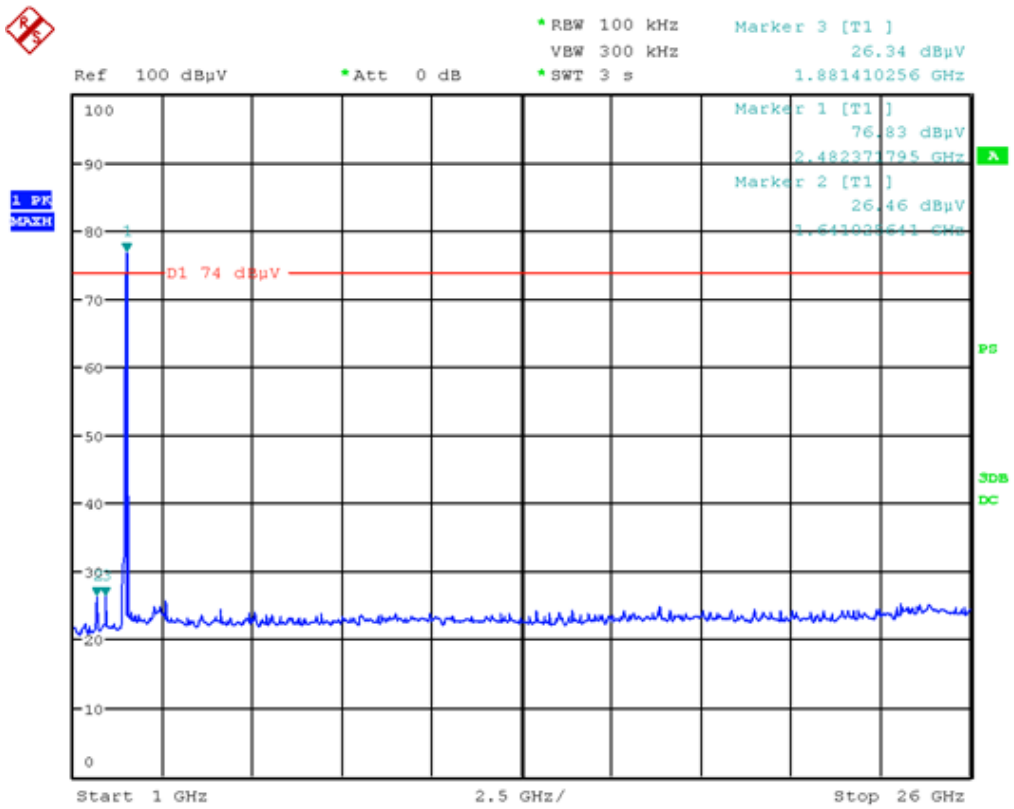
Picture 83: spurious emission channel 39 (30MHz – 1GHz - Pi/4 DQPSK



Picture 84: spurious emission channel 39 (1GHz – 26GHz) - Pi/4 DQPSK



Picture 85: spurious emission channel 78 (30MHz – 1GHz) - Pi/4 DQPSK



Picture 86: spurious emission channel 78 (1GHz – 26GHz) - Pi/4 DQPSK

12 Radiated emission measurement (<1 GHz)

according to CFR 47 Part 15, sections 15.205(a), 15.209(a), 15.247(d), and Public Notice DA 00-705

12.1 Test Location

☑ Scan with peak detector in 3 m CDC.

☑ Final CISPR measurement with quasi peak detector on 3 m open area test site.

Description	Manufacturer	Inventory No.
CDC	Albatross Projects	E00026
Open site area	EMV **TESTHAUS** GmbH	E00354

12.2 Test instruments

	Description	Manufacturer	Inventory No.
☑	ESCS 30 (FF)	Rohde & Schwarz	E00003
☐	ESU 26	Rohde & Schwarz	W00002
☑	ESCI (CDC)	Rohde & Schwarz	E00001
☑	VULB 9163 (FF)	Schwarzbeck	E00013
☑	VULB 9160 (CDC)	Schwarzbeck	E00011
☑	HFH2-Z2	Rohde & Schwarz	E00060
☑	Feedline OATS	Huber & Suhner	200024

12.3 Limits

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.
In case the emission fall within the restricted band specified on 15.205(a), then the 15.209(a) limit in the table below has to be followed.

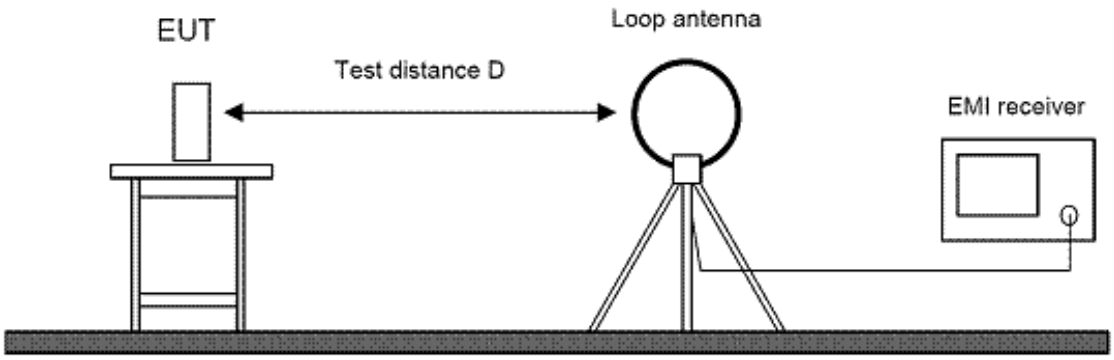
Frequency [MHz]	Field strength Fs [µV/m]	Field strength [dBµV/m]	Measurement distance d [m]
0.009 – 0.490	266.6 – 4.9	48.5 – 13.8	300
0.490 – 1.705	48.98 – 14.08	33.8 – 22.97	30
1.705 – 30.0	30	29.54	30

Frequency [MHz]	Field strength Fs [µV/m]	Field strength [dBµV/m]	Measurement distance d [m]
30 – 88	100	40	3
88 – 216	150	43.5	3
216 - 960	200	46	3
Above 960	500	54	3

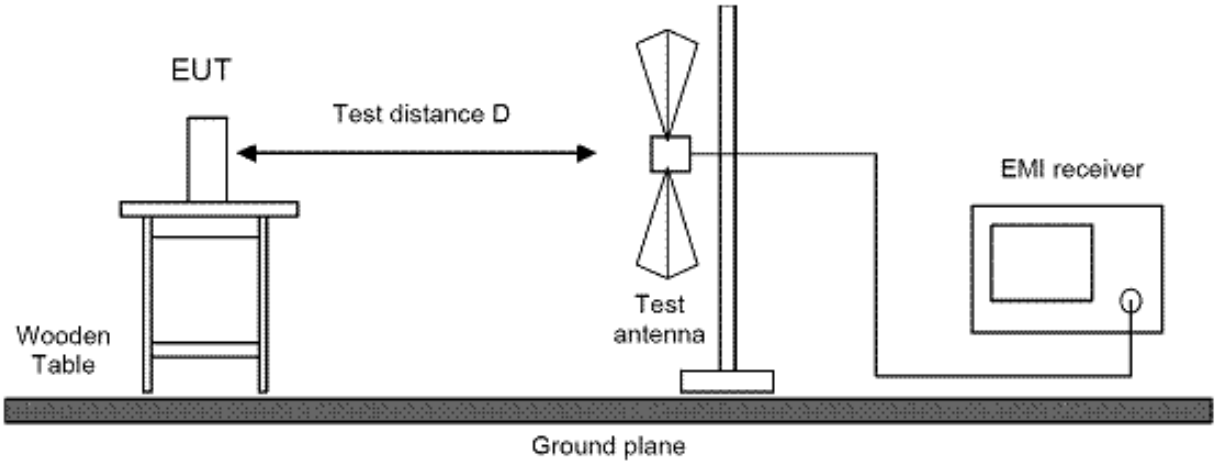
12.4 Test procedure

1. Configure the EUT according to ANSI C63.4. The EUT is placed on the top of the turntable 0.8 meter above ground. The receiving antenna is placed 3 meters from the turntable. For prescan measurements the test setup is placed inside a compact diagnostic chamber.
2. Power on the EUT and all peripherals.
3. The broadband antenna is set to vertical polarization.
4. The EMI receiver performes a scan from 9 kHz to 30 MHz or 30MHz to 1000MHz with the detector set to peak. Appropriate CISPR measurement bandwidths are used, i. e. 200 Hz for the frequency range 9 kHz to 150 kHz, 10 kHz for 150 kHz to 30 MHz and 120 kHz for 30MHz to 1000MHz.
5. The turn table is rotated to 6 different positions (360° / 6) and the antenna polarization is changed to horizontal.
6. Repeat the test procedure at step 4 and 5.
7. Then the test setup is placed in an OATS at 3 m distance and all peak values over or with less than 6dB margin to the limit are re-measured with quasi-peak detector (except for the frequency bands 9–90 kHz and 110–490 kHz where average detector is used). If the margin of all emissions recorded prescan in the compact diagnostic chamber is more than 6 dB no final test in OATS is performed.
8. The turntable is rotated by 360 degrees to determine the position of the highest radiation.
9. The height of the broadband receiving antenna is varied between one meter and four meters above ground to find the maximum emissions field strength of both horizontal and vertical polarization. The highest value is recorded.
10. For emissions below 30MHz, measurements are performed with a loop antenna. The antenna height is not changed during this test.

12.5 Test setup



Picture 87: Test setup for radiated emission measurement (< 30 MHz)



Picture 88: Test setup for radiated emission measurement (< 1 GHz)

12.6 Test deviation

There is no deviation with the original standard.

12.7 EUT operation during test

The EUT was programmed to be in continuously transmitting mode.

12.8 Test results

Transmit mode

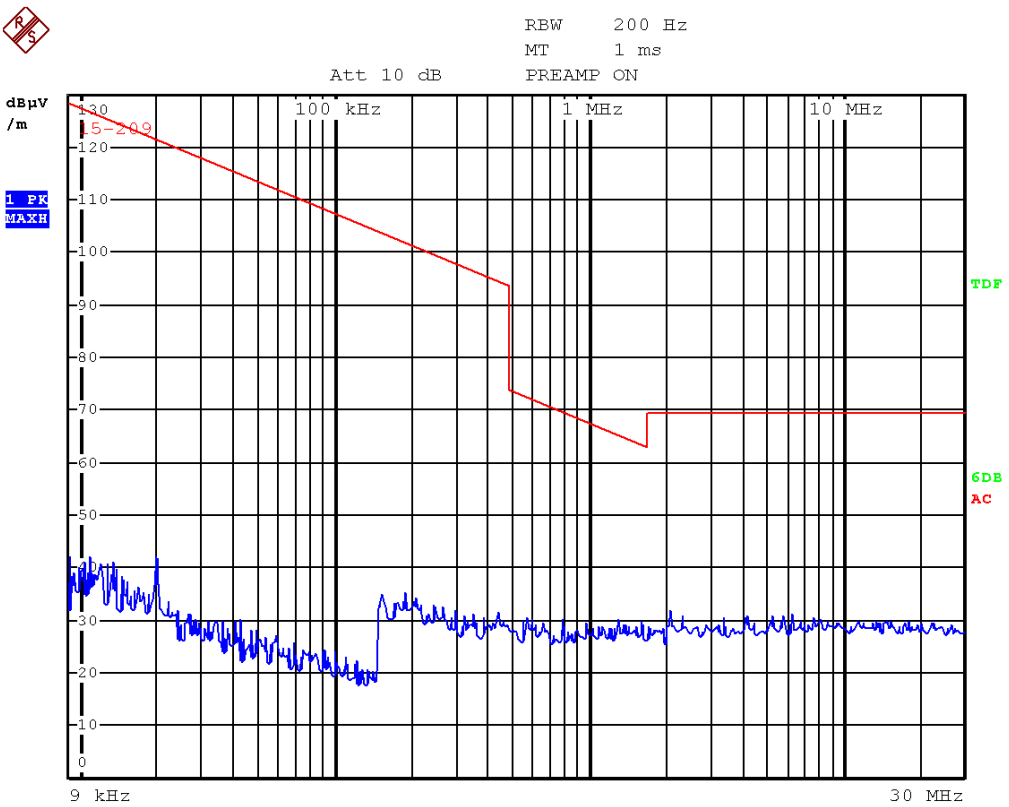
Temperature:	22°C	Humidity:	44%
Tested by:	M. Müller	Test date:	2014-04-25

Radiated Emission Measurement 9 kHz – 30 MHz

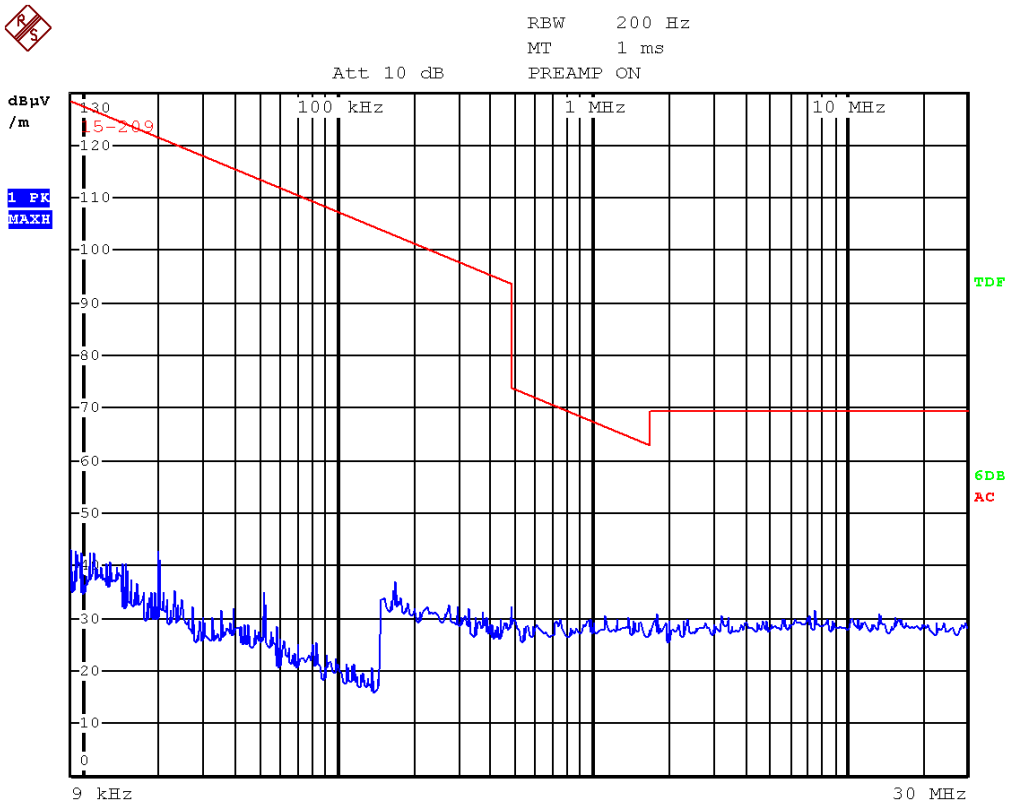
Frequency (MHz)	Reading (dBµV/m)	Detector	Recalculation factor (dB/decade)	Field strength (dBµV/m)	Limit (dBµV/m)	Margin	Result
0.009 - 30			40			> 20 dB	Passed

Note:
Measured value = dBµV/m @ 3 m
Recalculation factor = 40 dB / decade
Recalculated value1 = dBµV/m @ 3 m - 40 dB = **dBµV/m @ 30 m**
Recalculated value2 = dBµV/m @ 30 m - 40 dB = **dBµV/m @ 300 m**

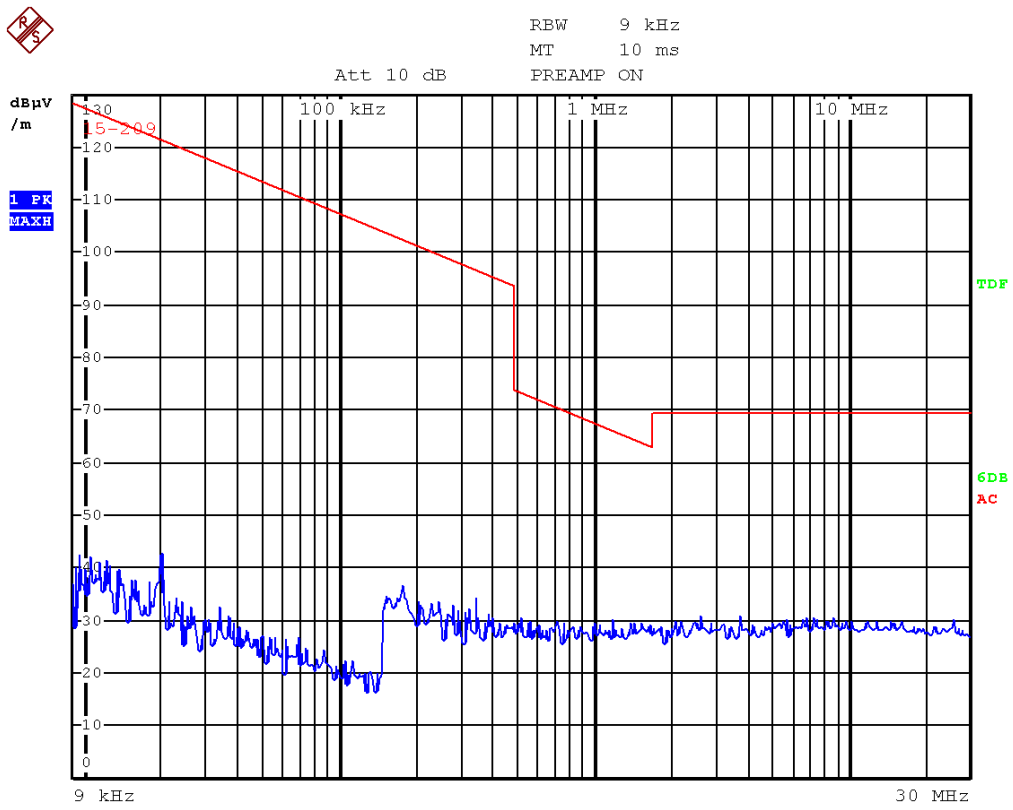
There was no difference between the measurement results below 30 MHz depending on the modulation. Therefore only the GFSK modulation was documented.



Picture 89: Radiated emission 9 kHz – 30MHz (Channel 0)l - GFSK



Picture 90: Radiated emission 9 kHz – 30MHz (Channel 39)l - GFSK



Picture 91: Radiated emission 9 kHz – 30MHz (Channel 78)l - GFSK

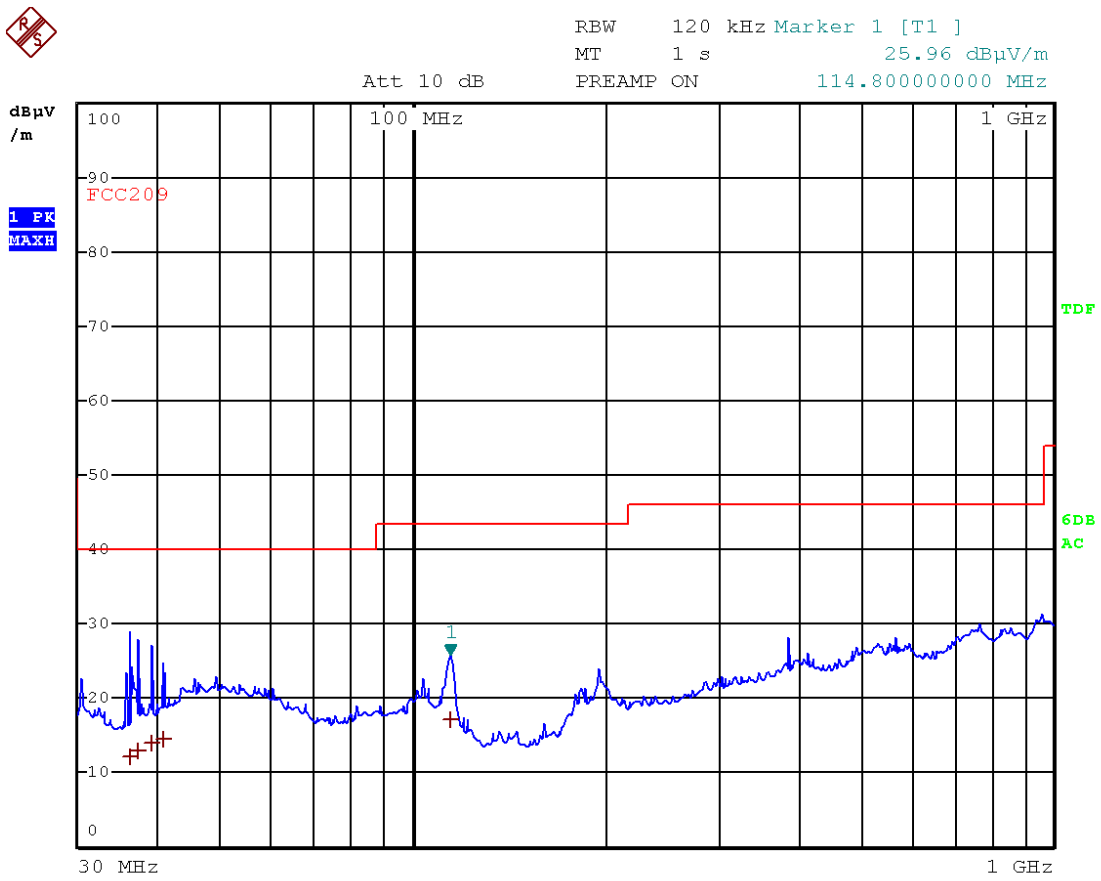
Transmit mode

Temperature:	22°C	Humidity:	44%
Tested by:	M. Müller	Test date:	2014-04-25

Radiated Emission Measurement 30 MHz - 1 GHz

Frequency (MHz)	Reading (dBµV/m)	Detector	Limit (dBµV/m)	Margin	Result
30 - 1000		PK / QP		> 15 dB	Passed

There was no difference between the measurement results below 30 MHz depending on the modulation. Therefore only the GFSK modulation was documented.



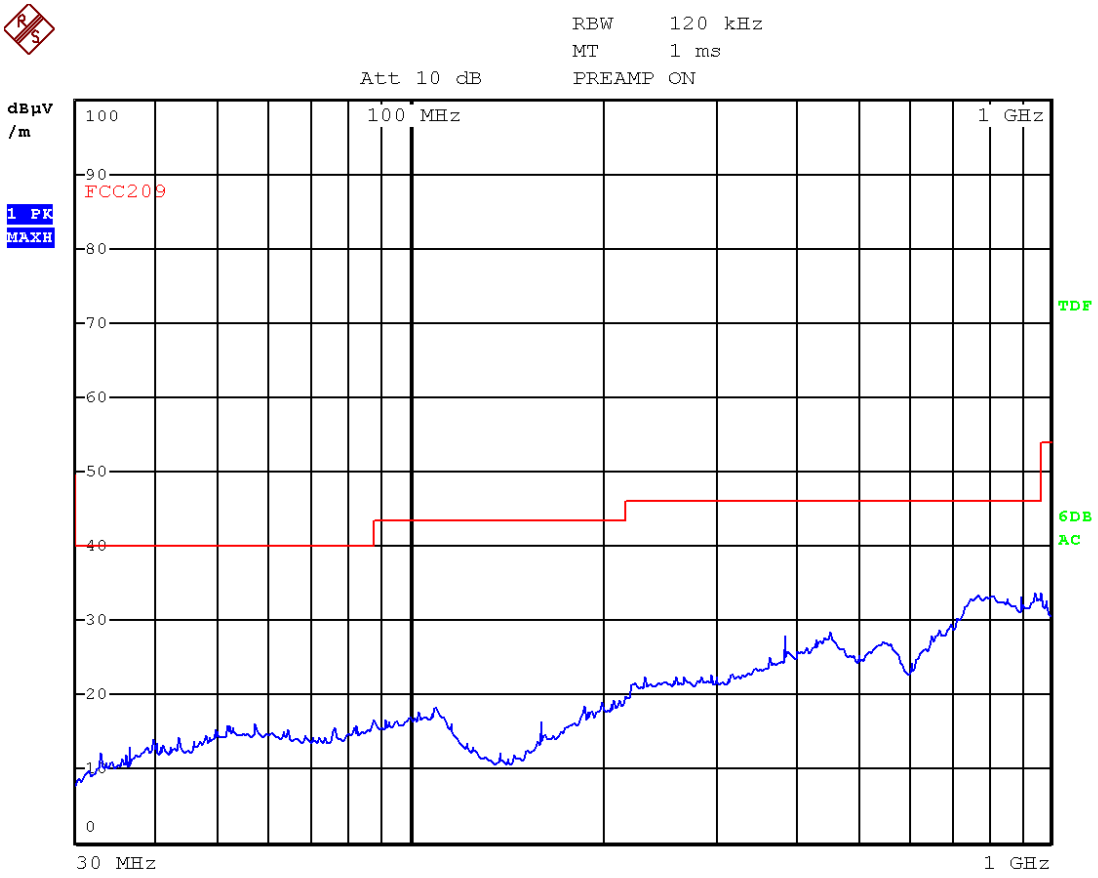
Picture 92: Radiated emission 30 MHz – 1000MHz (Channel 0) Trace, Vertical - GFSK

EDIT PEAK LIST (Final Measurement Results)

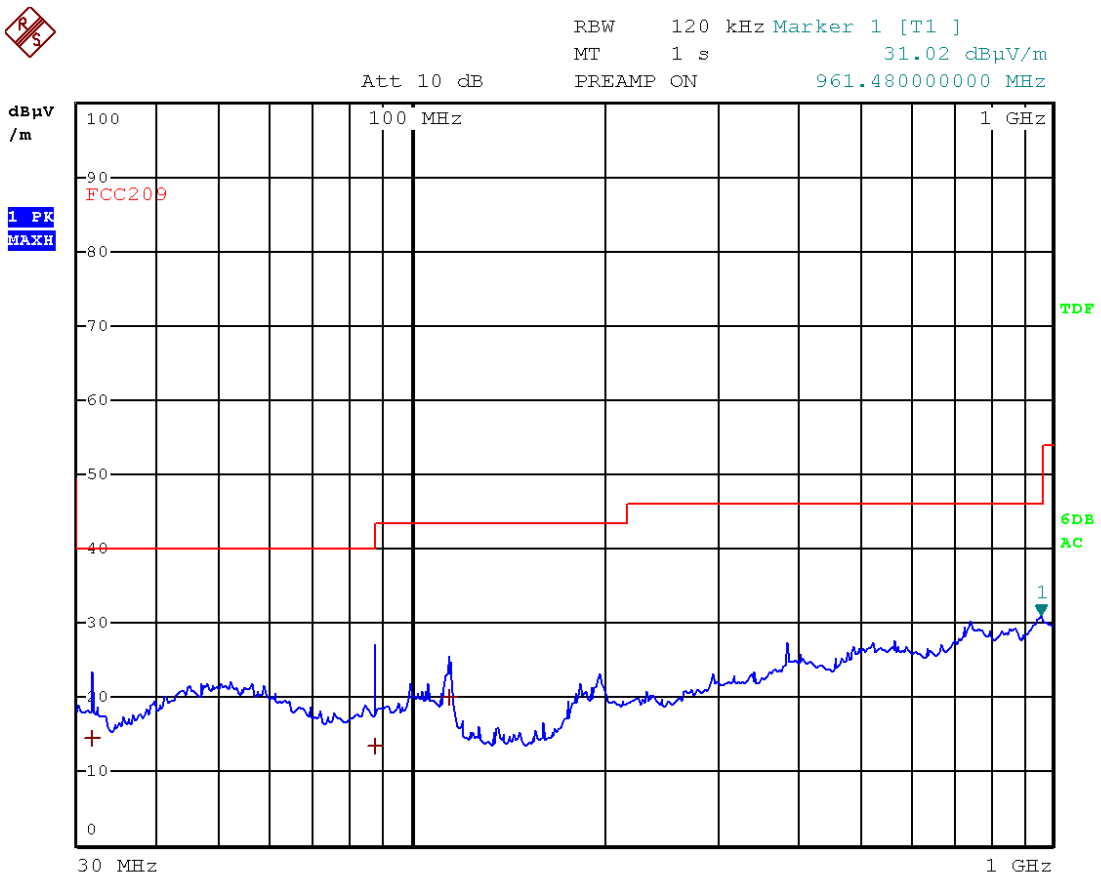
Trace1: FCC209
Trace2: ---
Trace3: ---

TRACE		FREQUENCY	LEVEL dBµV/m	DELTA LIMIT dB
1	Quasi Peak	36.16 MHz	12.33	-27.66
1	Quasi Peak	37.36 MHz	13.01	-26.98
1	Quasi Peak	39.16 MHz	13.91	-26.08
1	Quasi Peak	40.92 MHz	14.60	-25.39
1	Quasi Peak	114.8 MHz	17.17	-26.33

Picture 93: Radiated emission 30 MHz – 1000MHz (Channel 0) Table, Vertical - GFSK



Picture 94: Radiated emission 30 MHz – 1000MHz Channel 0) Trace, Horizontal - GFSK



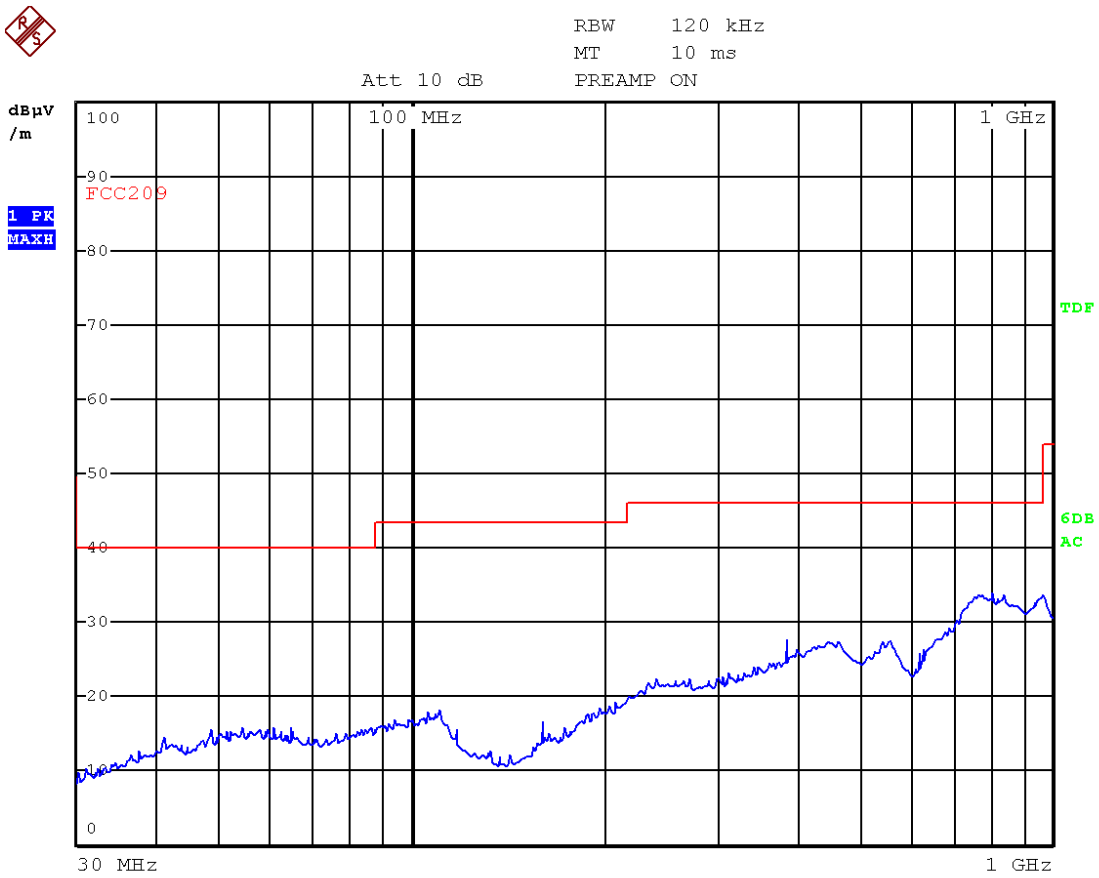
Picture 95: Radiated emission 30 MHz – 1000MHz (Channel 39) Trace, Vertical - GFSK

EDIT PEAK LIST (Final Measurement Results)

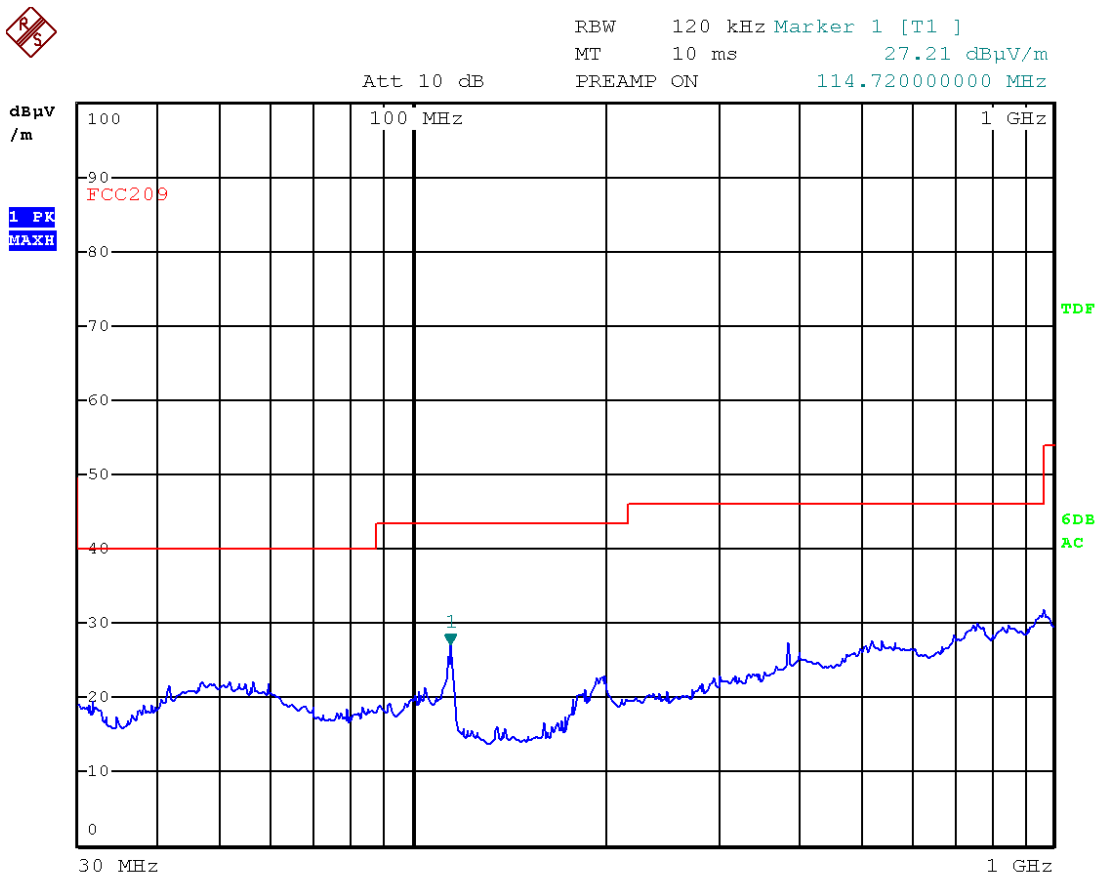
Trace1: FCC209
Trace2: ---
Trace3: ---

TRACE		FREQUENCY	LEVEL dBµV/m	DELTA LIMIT dB
1	Quasi Peak	31.6 MHz	14.44	-25.55
1	Quasi Peak	87.48 MHz	13.51	-26.49
1	Quasi Peak	114.2 MHz	20.13	-23.36

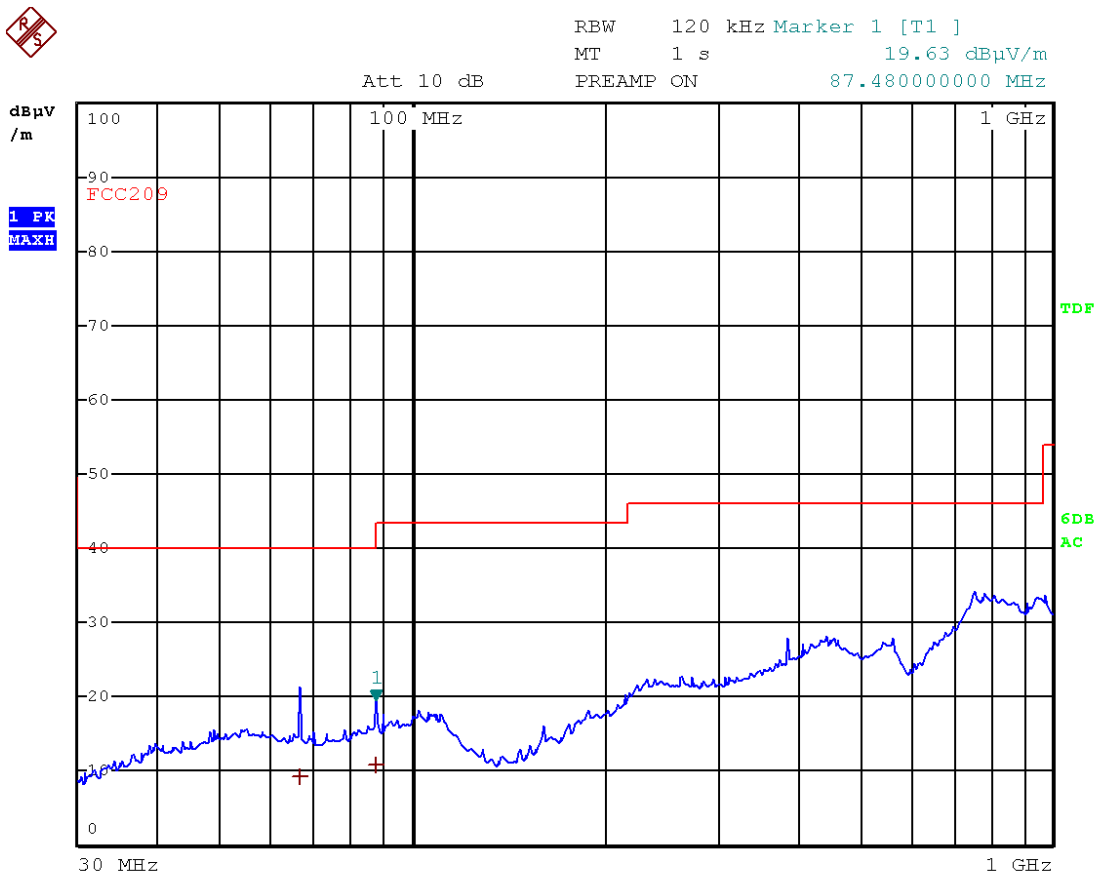
Picture 96: Radiated emission 30 MHz – 1000MHz (Channel 39) Table, Vertical - GFSK



Picture 97: Radiated emission 30 MHz – 1000MHz Channel 39) Trace, Horizontal - GFSK



Picture 98: Radiated emission 30 MHz – 1000MHz (Channel 78) Trace, Vertical - GFSK



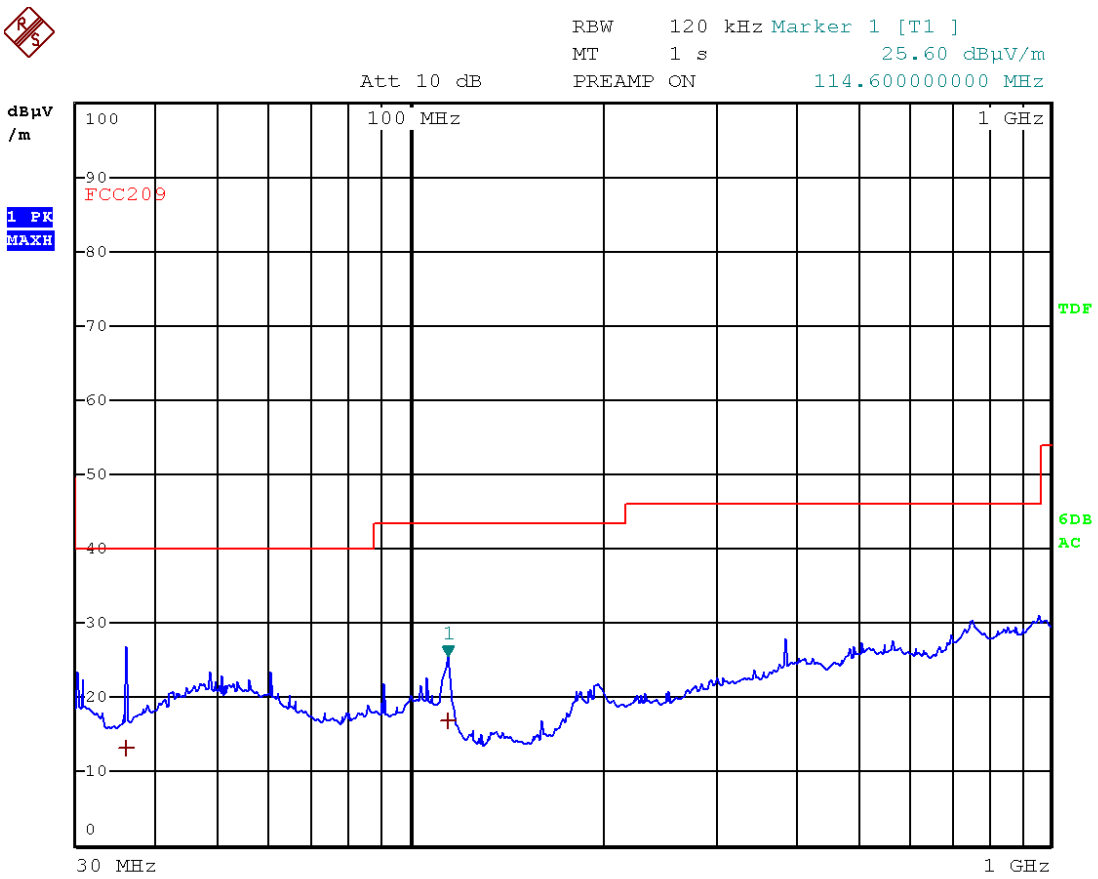
Picture 99: Radiated emission 30 MHz – 1000MHz Channel 78) Trace, Horizontal - GFSK

EDIT PEAK LIST (Final Measurement Results)

Trace1: FCC209
Trace2: ---
Trace3: ---

TRACE		FREQUENCY	LEVEL dBµV/m	DELTA LIMIT dB
1	Quasi Peak	66.52 MHz	9.38	-30.61
1	Quasi Peak	87.48 MHz	10.76	-29.23

Picture 100: Radiated emission 30 MHz – 1000MHz Channel 78) Table, Horizontal - GFSK



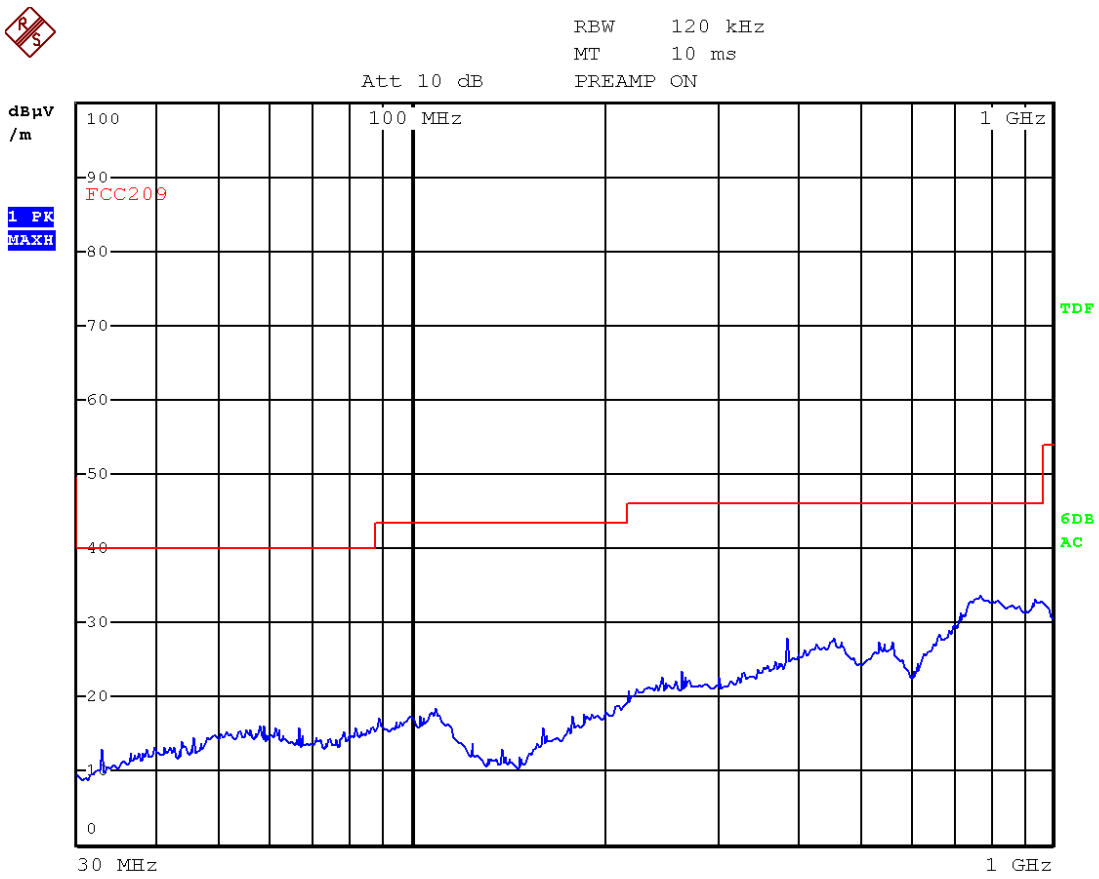
Picture 101: Radiated emission 30 MHz – 1000MHz Channel 0) Trace, Vertictal - Pi/4-DQPSK

EDIT PEAK LIST (Final Measurement Results)

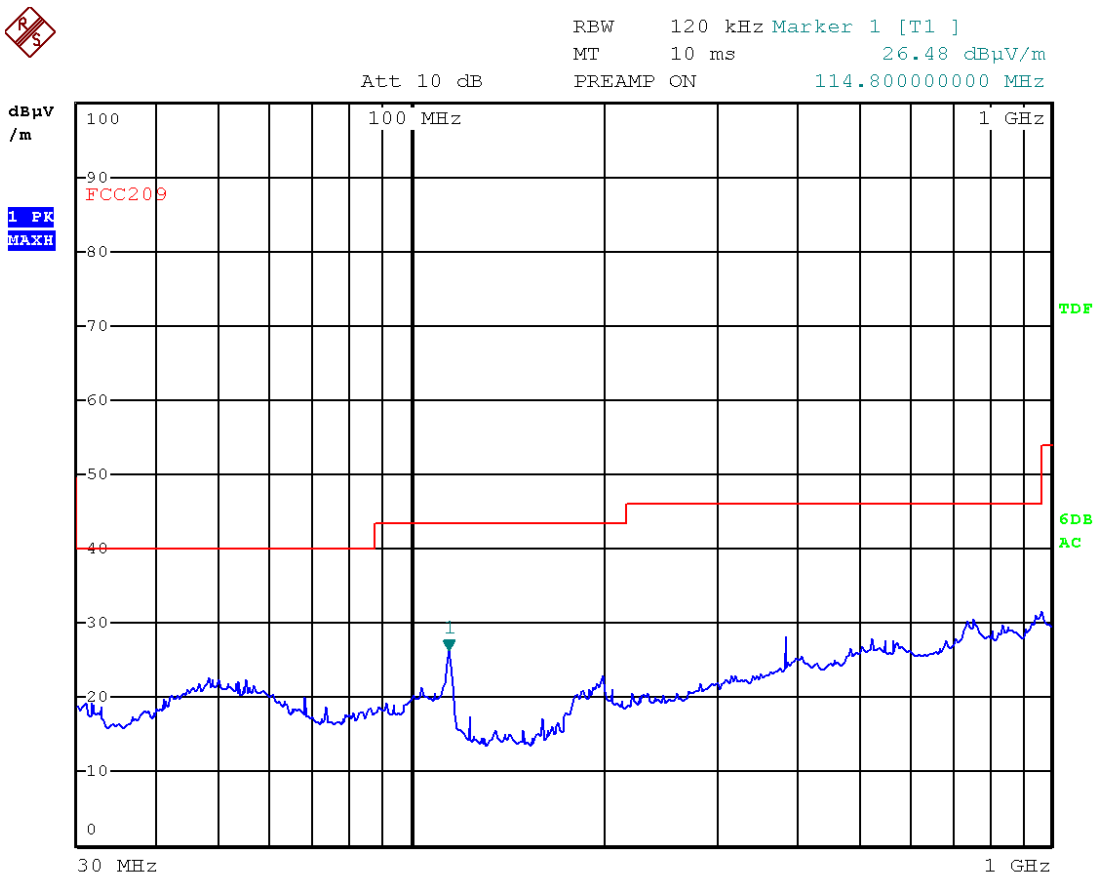
Trace1: FCC209
Trace2: ---
Trace3: ---

TRACE		FREQUENCY	LEVEL dBµV/m	DELTA LIMIT dB
1	Quasi Peak	36.04 MHz	13.37	-26.62
1	Quasi Peak	114.6 MHz	16.90	-26.59

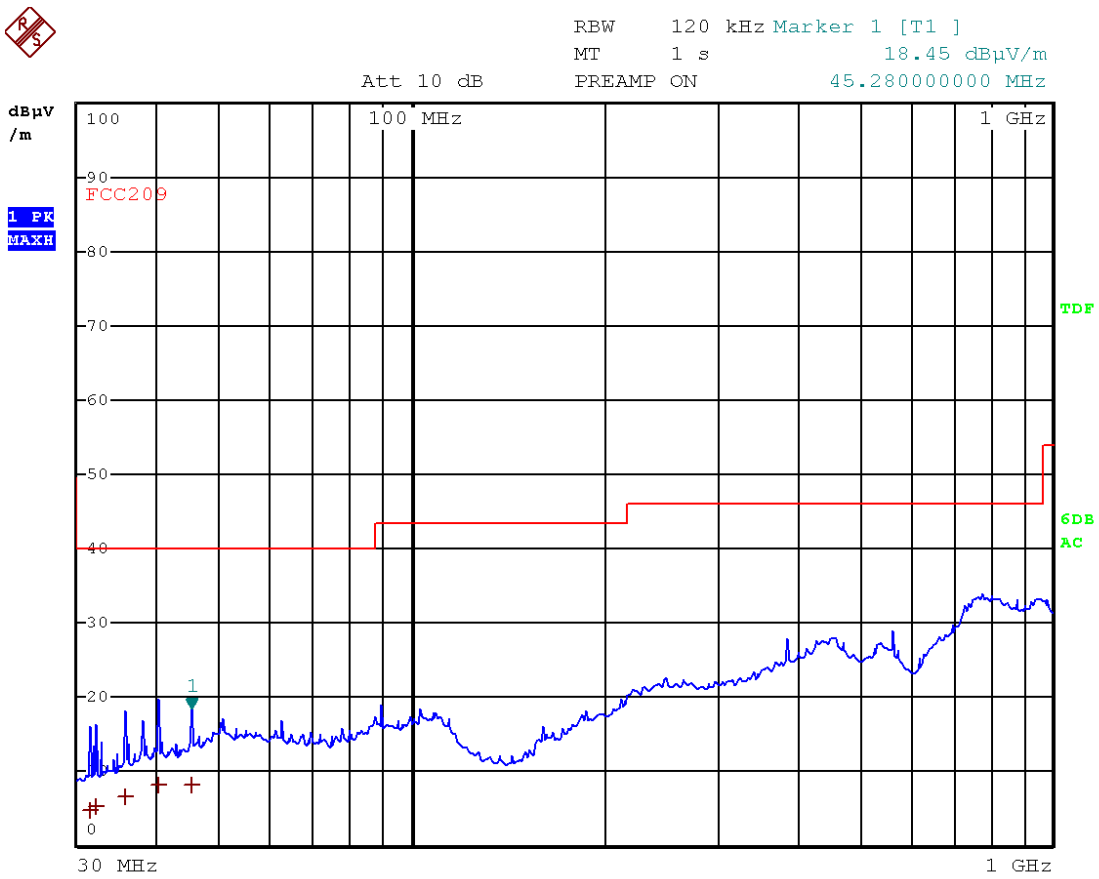
Picture 102: Radiated emission 30 MHz – 1000MHz Channel 0) Table, Vertical - Pi/4-DQPSK



Picture 103: Radiated emission 30 MHz – 1000MHz Channel 0) Trace, Horizontal - Pi/4-DQPSK



Picture 104: Radiated emission 30 MHz – 1000MHz Channel 39) Trace, Vertictal - Pi/4-DQPSK



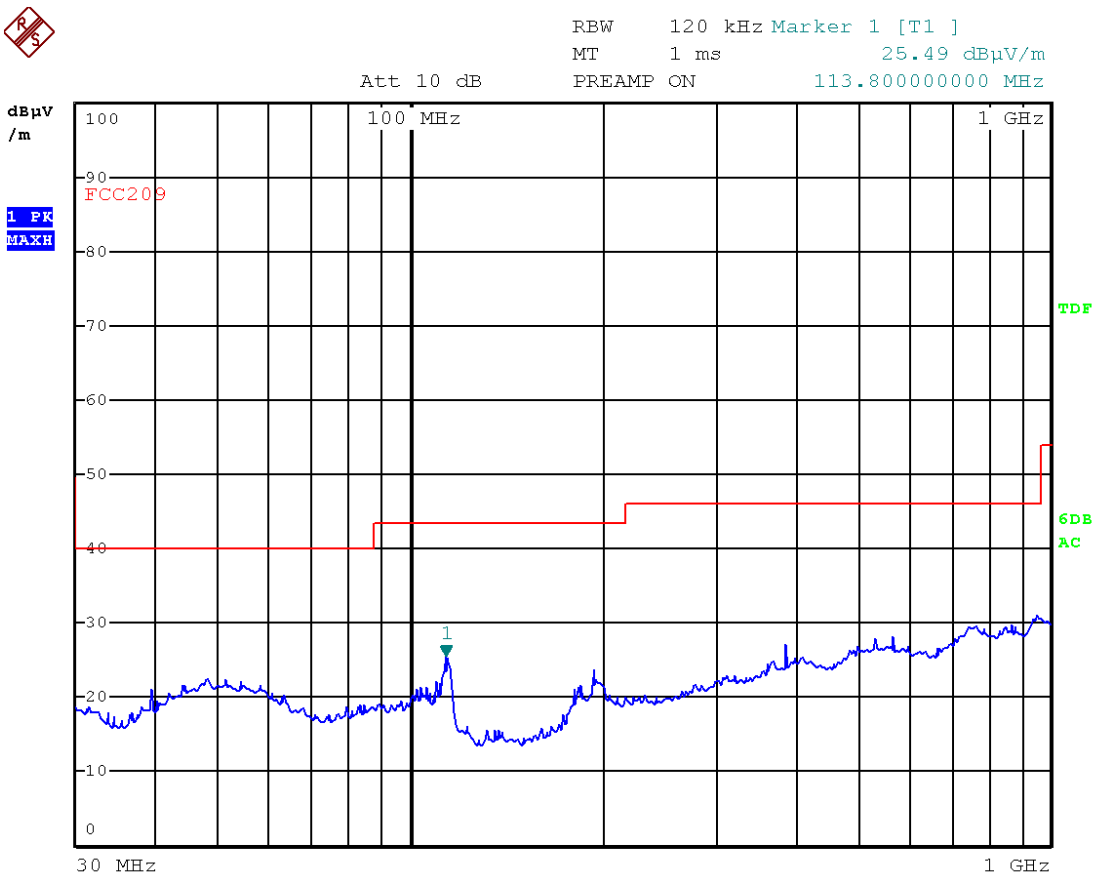
Picture 105: Radiated emission 30 MHz – 1000MHz Channel 39) Trace, Horizontal - Pi/4-DQPSK

EDIT PEAK LIST (Final Measurement Results)

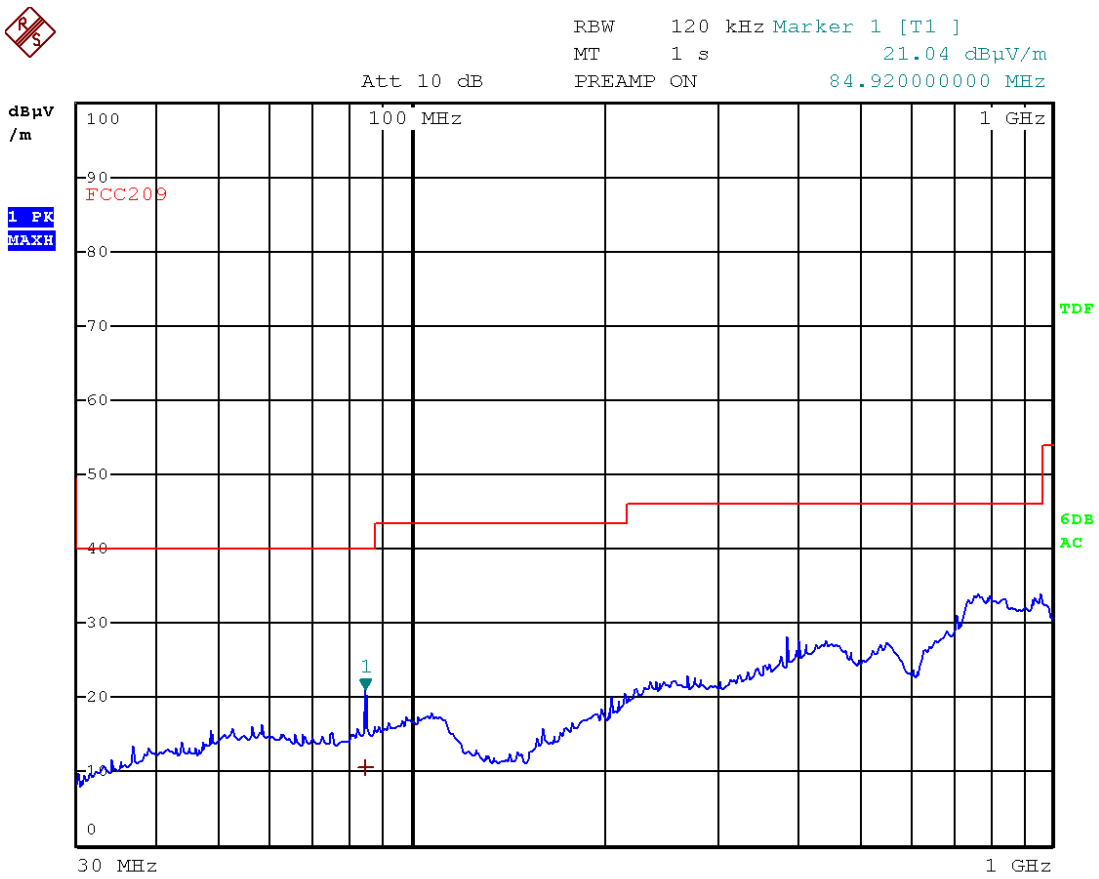
Trace1: FCC209
Trace2: ---
Trace3: ---

TRACE		FREQUENCY	LEVEL dBµV/m	DELTA LIMIT dB
1	Quasi Peak	31.52 MHz	4.88	-35.11
1	Quasi Peak	32.04 MHz	5.40	-34.59
1	Quasi Peak	35.72 MHz	6.64	-33.35
1	Quasi Peak	40.12 MHz	8.14	-31.85
1	Quasi Peak	45.28 MHz	8.32	-31.67

Picture 106: Radiated emission 30 MHz – 1000MHz Channel 39) Table, Horizontal - Pi/4-DQPSK



Picture 107: Radiated emission 30 MHz – 1000MHz Channel 78) Trace, Vertictal - Pi/4-DQPSK



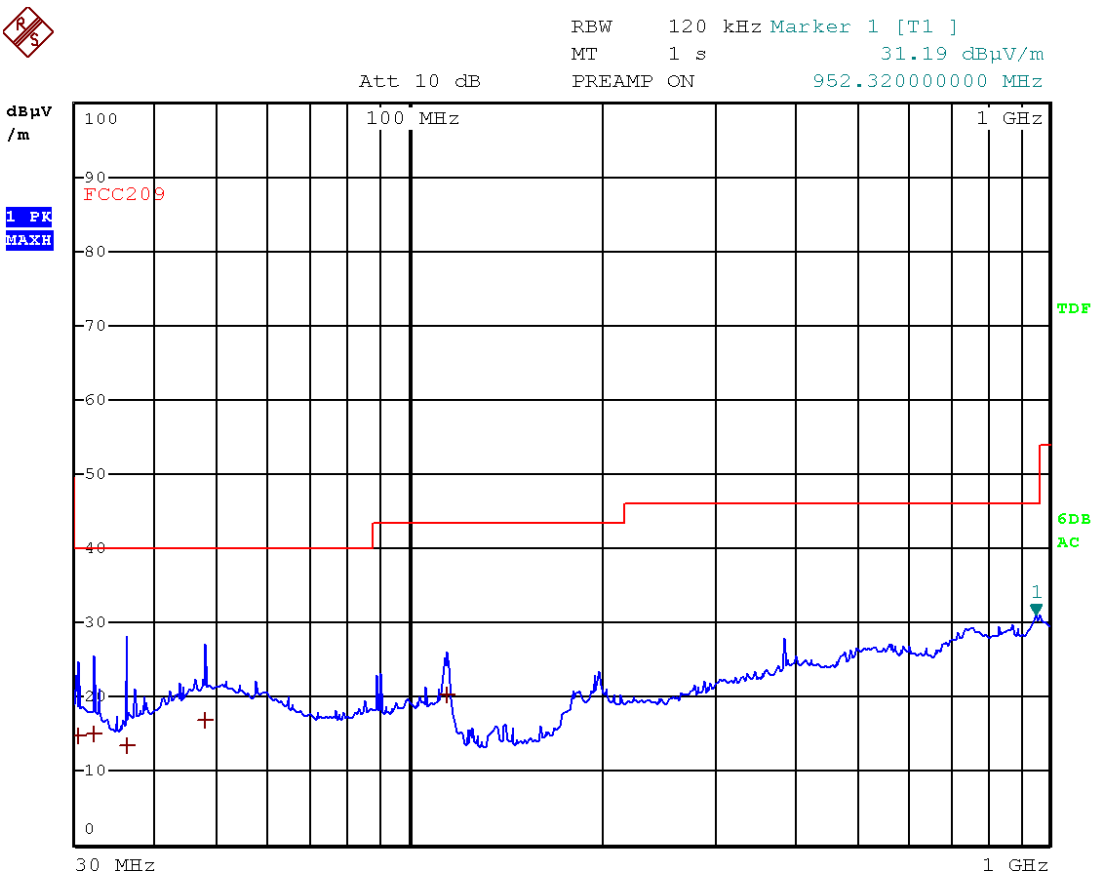
Picture 108: Radiated emission 30 MHz – 1000MHz Channel 78) Trace, Horizontal - Pi/4-DQPSK

EDIT PEAK LIST (Final Measurement Results)

Trace1: FCC209
Trace2: ---
Trace3: ---

TRACE		FREQUENCY	LEVEL dBµV/m	DELTA LIMIT dB
1	Quasi Peak	31.52 MHz	4.88	-35.11
1	Quasi Peak	32.04 MHz	5.40	-34.59
1	Quasi Peak	35.72 MHz	6.64	-33.35
1	Quasi Peak	40.12 MHz	8.14	-31.85
1	Quasi Peak	45.28 MHz	8.32	-31.67

Picture 109: Radiated emission 30 MHz – 1000MHz Channel 78) Table, Horizontal - Pi/4-DQPSK



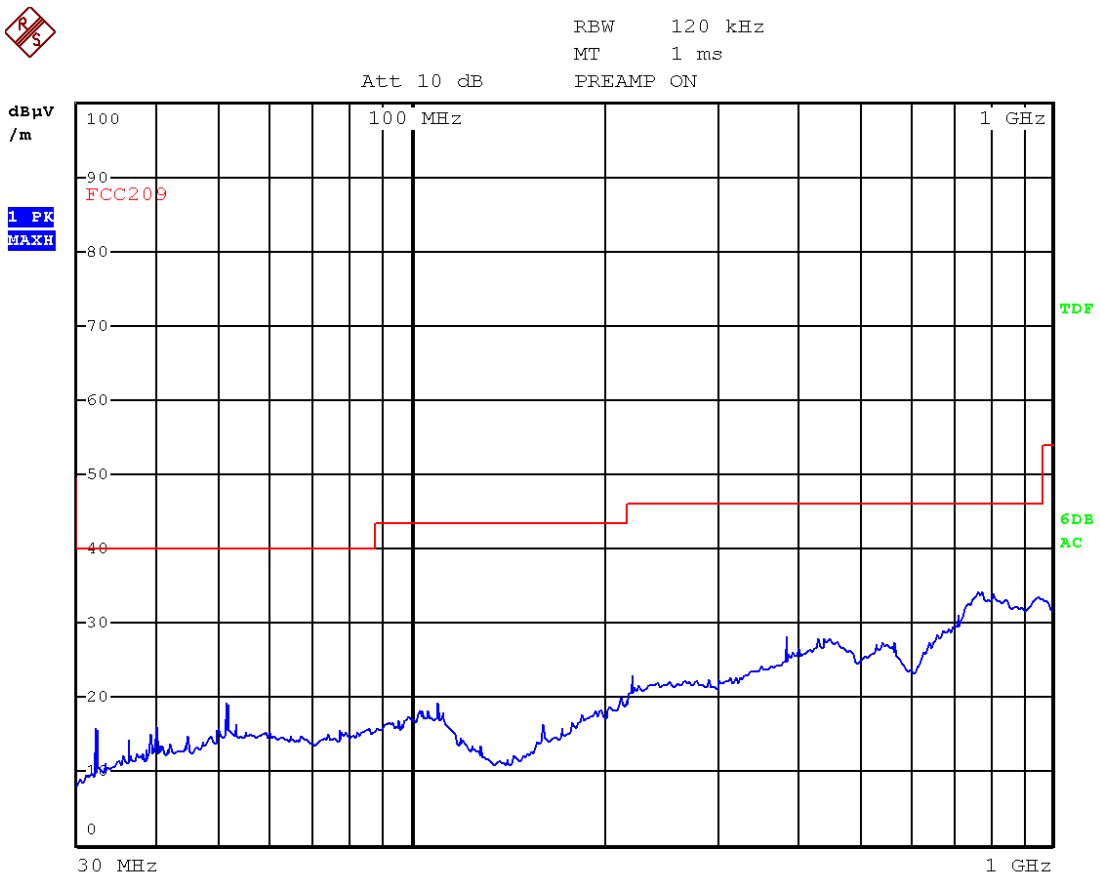
Picture 110: Radiated emission 30 MHz – 1000MHz Channel 0) Trace, Vertical - 8DPSK

EDIT PEAK LIST (Final Measurement Results)

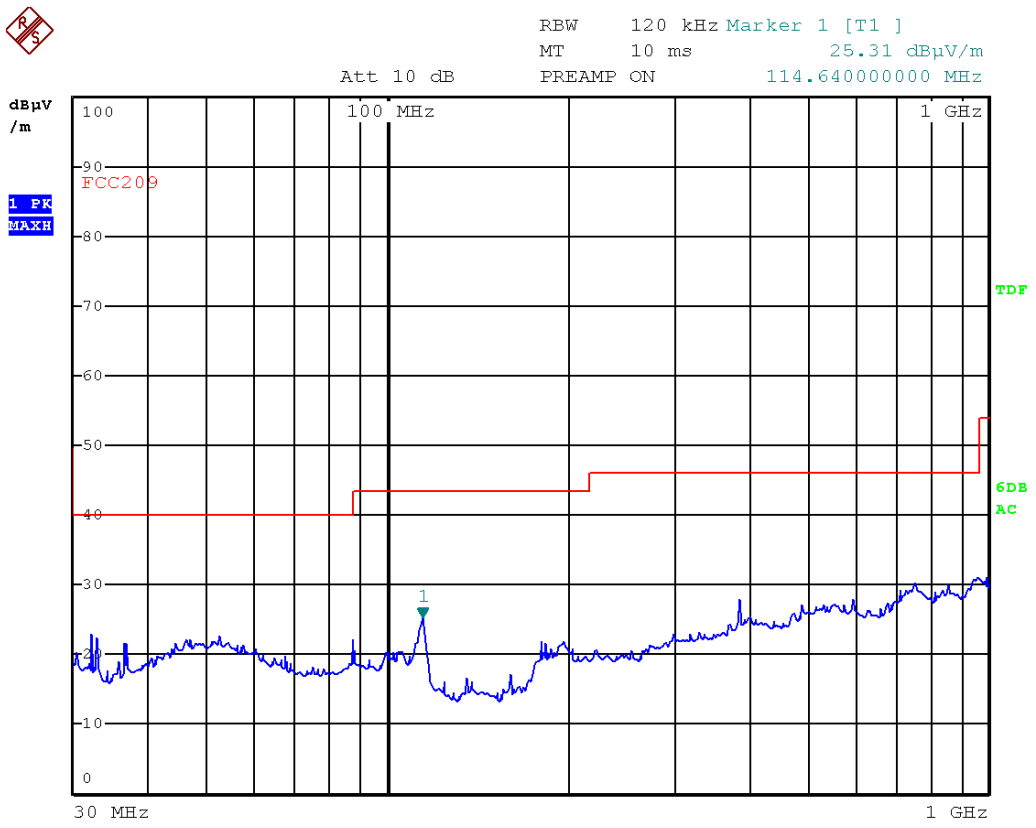
Trace1: FCC209
Trace2: ---
Trace3: ---

	TRACE	FREQUENCY	LEVEL dBµV/m	DELTA LIMIT dB
1	Quasi Peak	30.44 MHz	14.80	-25.19
1	Quasi Peak	32.2 MHz	15.00	-24.99
1	Quasi Peak	36.16 MHz	13.43	-26.56
1	Quasi Peak	47.88 MHz	16.96	-23.03
1	Quasi Peak	114.76 MHz	20.46	-23.03

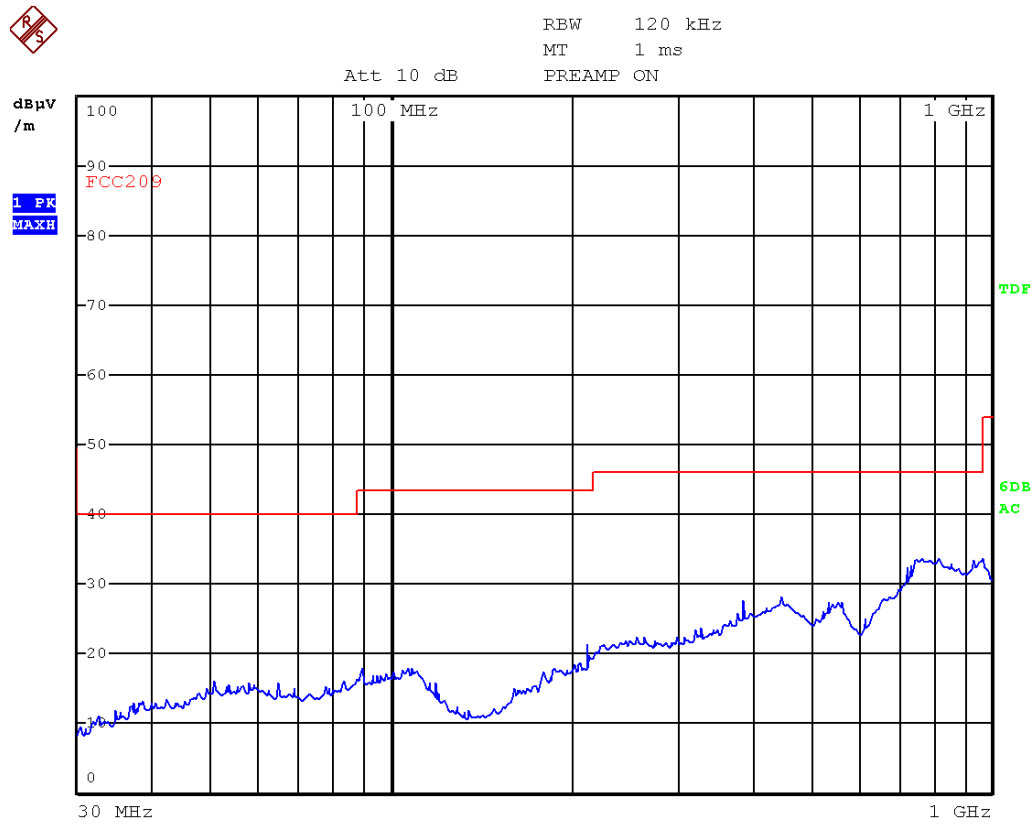
Picture 111: Radiated emission 30 MHz – 1000MHz Channel 0) Table, Vertical - 8DPSK



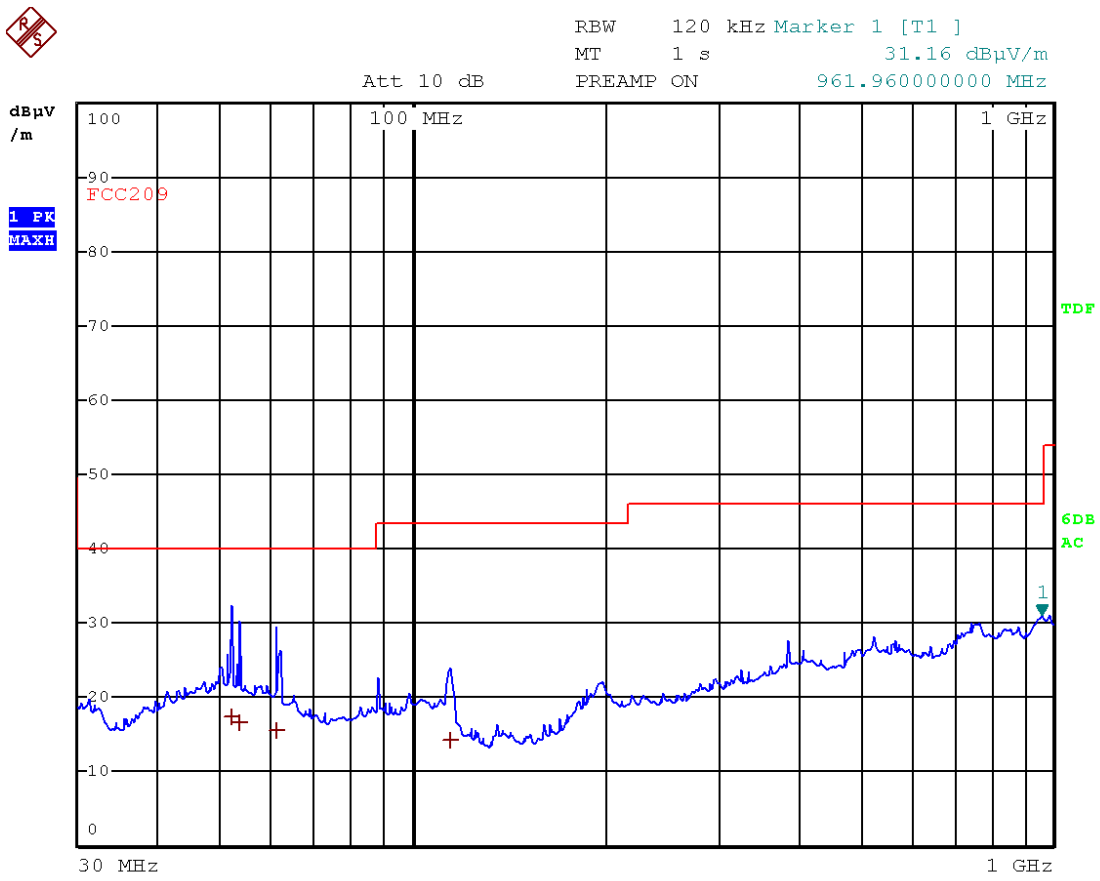
Picture 112: Radiated emission 30 MHz – 1000MHz Channel 0) Trace, Horizontal - 8DPSK



Picture 113: Radiated emission 30 MHz – 1000MHz Channel 39) Trace, Vertical - 8DPSK



Picture 114: Radiated emission 30 MHz – 1000MHz Channel 39) Trace, Horizontal - 8DPSK



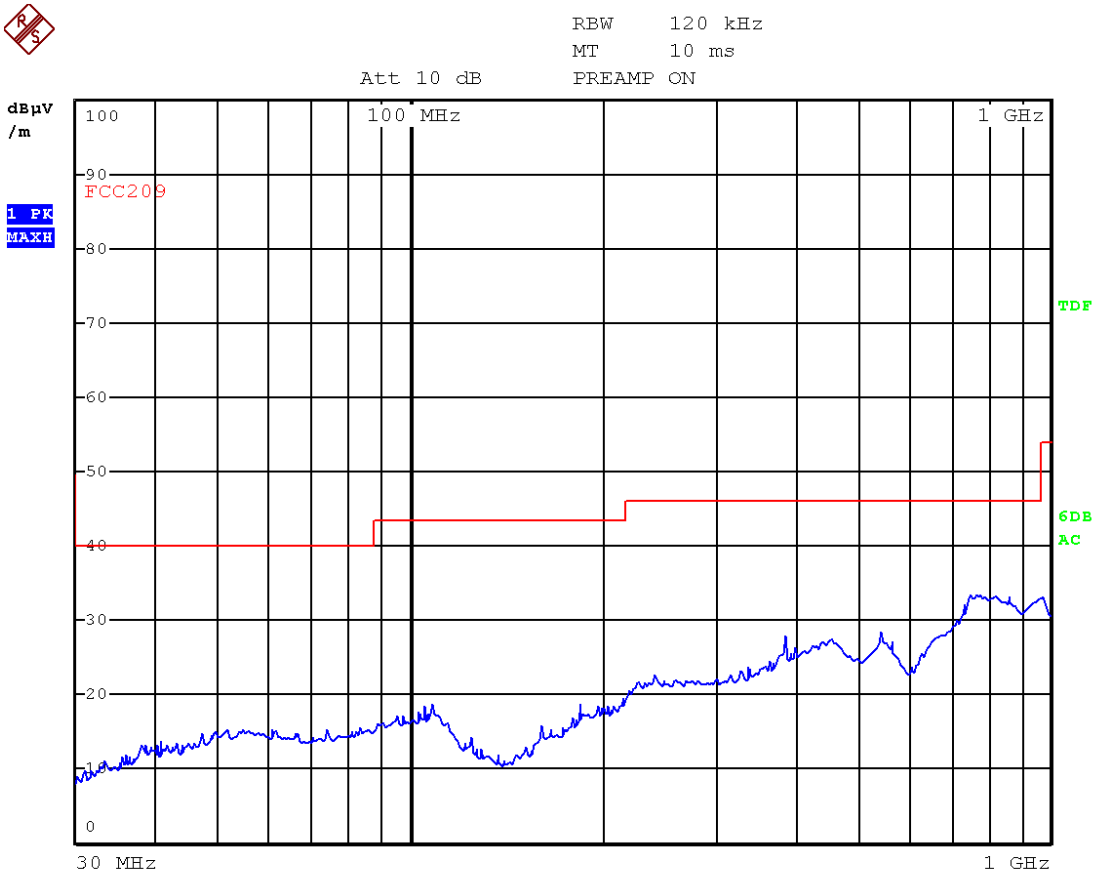
Picture 115: Radiated emission 30 MHz – 1000MHz Channel 78) Trace, Vertical - 8DPSK

EDIT PEAK LIST (Final Measurement Results)

Trace1: FCC209
Trace2: ---
Trace3: ---

TRACE		FREQUENCY	LEVEL dBµV/m	DELTA LIMIT dB
1	Quasi Peak	52 MHz	17.46	-22.54
1	Quasi Peak	53.52 MHz	16.58	-23.41
1	Quasi Peak	61.48 MHz	15.63	-24.36
1	Quasi Peak	114.24 MHz	14.23	-29.26

Picture 116: Radiated emission 30 MHz – 1000MHz Channel 78) Table, Vertical - 8DPSK



Picture 117: Radiated emission 30 MHz – 1000MHz Channel 78) Trace, Horizontal - 8DPSK

13 Radiated emission measurement (>1 GHz)

according to CFR 47 Part 15, sections 15.205(a), 15.209(a), 15.247(d), and Public Notice DA 00-705

13.1 Test location

☑ Scan with peak detector in 3 m anechoic chamber

☑ Final measurement with average and max peak detector.

Description	Manufacturer	Inventory No.
Anechoic chamber	EMV **TESTHAUS** GmbH	E00100

13.2 Test instruments

	Description	Manufacturer	Inventory No.
☑	ESU26	Rohde & Schwarz	W00002
☑	AMF-5D-00501800-28-13P	Miteq	W00089
☑	AMF-6F-16002650-25-10P	Miteq	W00090
☑	BBHA 9120D	Schwarzbeck	W00053
☑	BBHA 9170	Schwarzbeck	W00055
☑	COSB 4-1-26	Conformitas	W00091

13.3 Limits

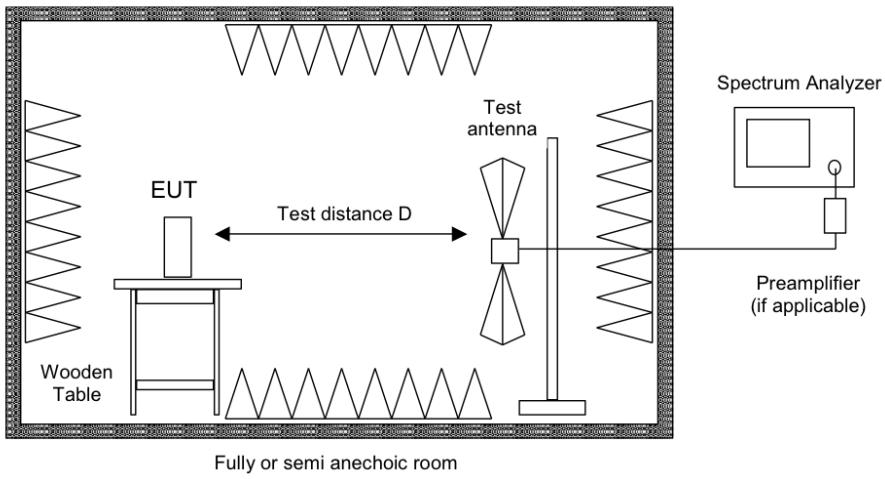
In any 100 kHz bandwidth outside the frequency band in which the spread spectrum or digitally modulated intentional radiator is operating, the radio frequency power that is produced by the intentional radiator shall be at least 20 dB below that in the 100 kHz bandwidth within the band that contains the highest level of the desired power. If the transmitter complies with the conducted power limits based on the use of RMS averaging over a time interval, as permitted under paragraph (b)(3) of this section, the attenuation required under this paragraph shall be 30 dB instead of 20 dB. Attenuation below the general limits specified in §15.209(a) is not required. In case the emission fall within the restricted band specified on 15.205(a), then the 15.209(a) limit in the table below has to be followed.

Frequency [MHz]	Field strength Fs [µV/m]	Field strength [dBµV/m]	Measurement distance d [m]
30 – 88	100	40	3
88 – 216	150	43.5	3
216 - 960	200	46	3
Above 960	500	54	3

13.4 Test procedure

6. Configure the EUT according to ANSI C63.4. The EUT was placed on the top of the turntable 0.8 meter above ground. The receiving antenna was placed 3 meters from the turntable. The test setup was placed inside a fully anechoic chamber.
7. Power on the EUT and all peripherals.
8. The broadband antenna was set to vertical polarization.
9. The EMI receiver performed a scan from 1000 MHz to 10th harmonic of the fundamental frequency with the detector set to peak and the measurement bandwidth set to 1 MHz (VBW ≥ 3 MHz). The trace data was recorded with the receiver Max Hold function.
10. The turn table was rotated in intervals of 15°.
11. After a full 360°-turn the antenna polarization was changed to horizontal and the test was repeated at step 4 and 5.
12. After the scan suspicious frequencies were selected and the RBW was set to 1 MHz and the VBW was set to 10Hz and the detector was changed to average reading.
13. The receiving antenna was set to vertical polarization.
14. The turntable was rotated by 360 degrees to determine the position of the highest radiation.
15. The receiving antenna was then set to horizontal polarization and the measurement was repeated at step 9.
16. The highest recorded level was noted.

13.5 Test setup



Picture 118: Test setup for radiated emission measurement (> 1 GHz)

13.6 Test deviation

There is no deviation with the original standard.

13.7 EUT operation during test

The EUT was programmed to be in continuously transmitting mode.

13.8 Test results GFSK channel 0

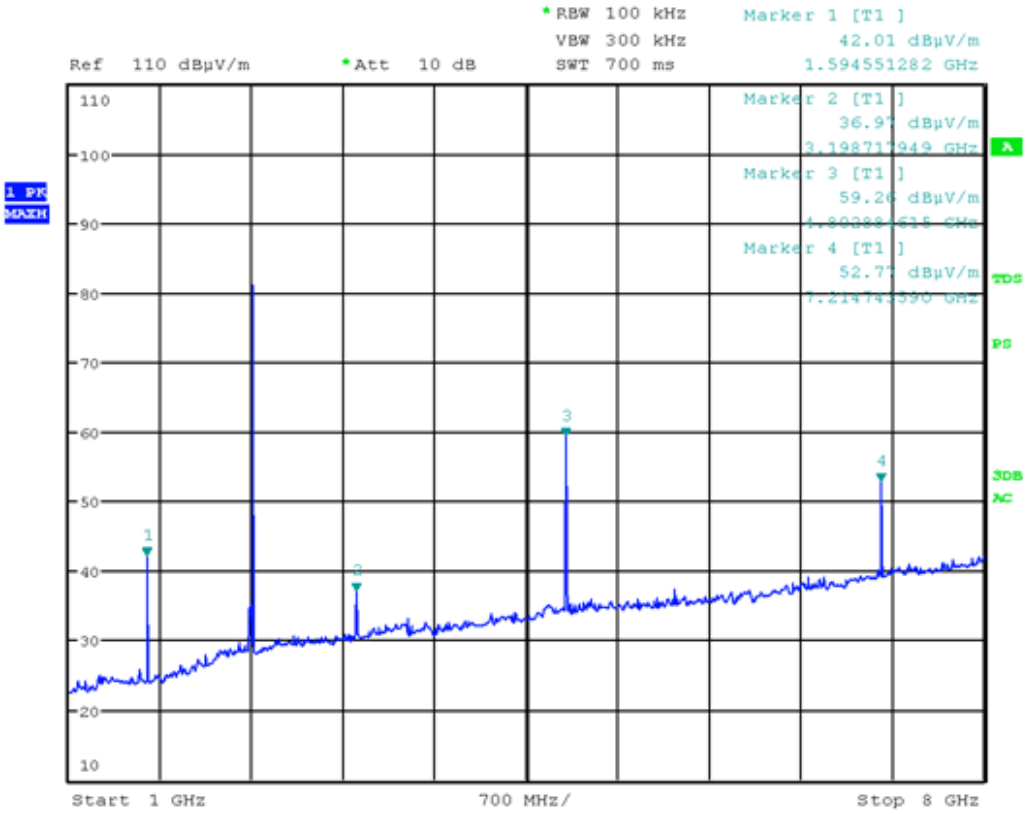
Temperature:	22°C	Humidity:	44%
Tested by:	M. Müller	Test date:	2014-04-30

Final Results:

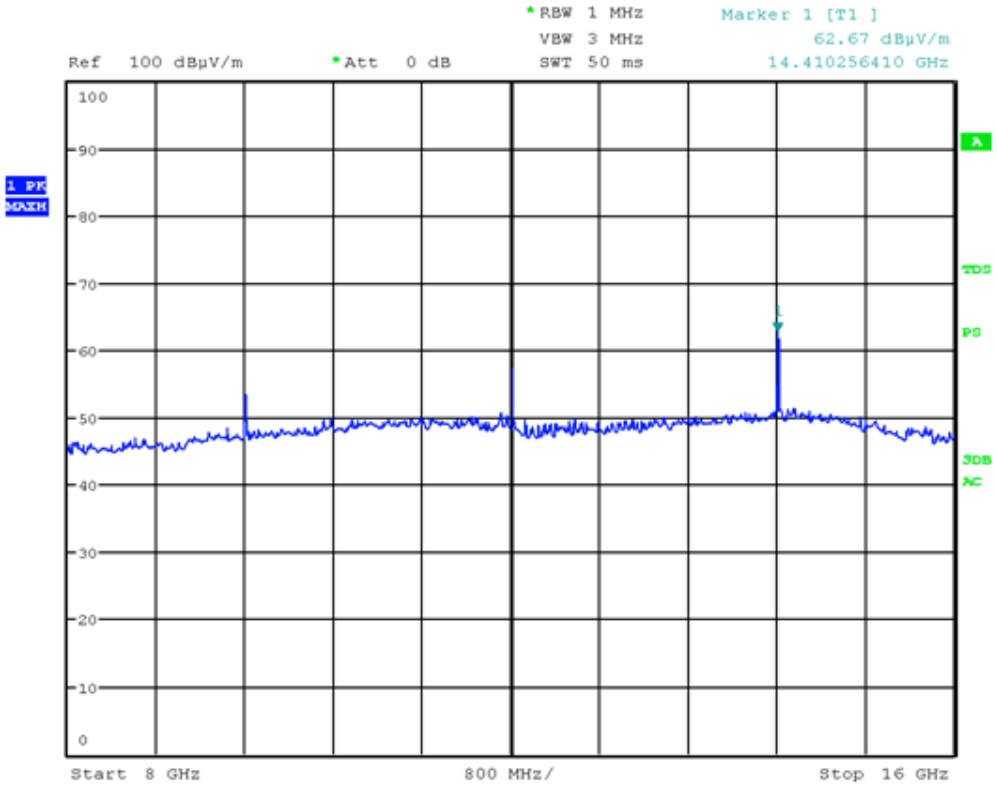
Frequency (GHz)	Reading (dBµV/m)	Detector	Limit (dBµV/m)	Restricted band	Result
1.5946	43.67	PK	74	Yes	Passed
1.5946	40.86	AV	54	Yes	Passed
2.4020	111.93	PK	(Carrier)	No	(Carrier)
2.4020	95.46	AV	(Carrier)	No	(Carrier)
3.1987	41.87	PK	74	No	Passed
3.1987	39.52	AV	54	No	Passed
4.8029	63.20	PK	74	Yes	Passed
4.8029	52.72	AV	54	Yes	Passed
7.2147	56.72	PK	- 20dBc	No	Passed
14.4103	62.67	PK	- 20dBc	No	Passed
16.8103	53.87	PK	- 20dBc	No	Passed
19.2212	52.72	PK	74	Yes	Passed
19.2212	34.76	AV	54	Yes	Passed
21.6250	55.15	PK	- 20dBc	No	Passed

In receive mode there were no significant emissions detected!

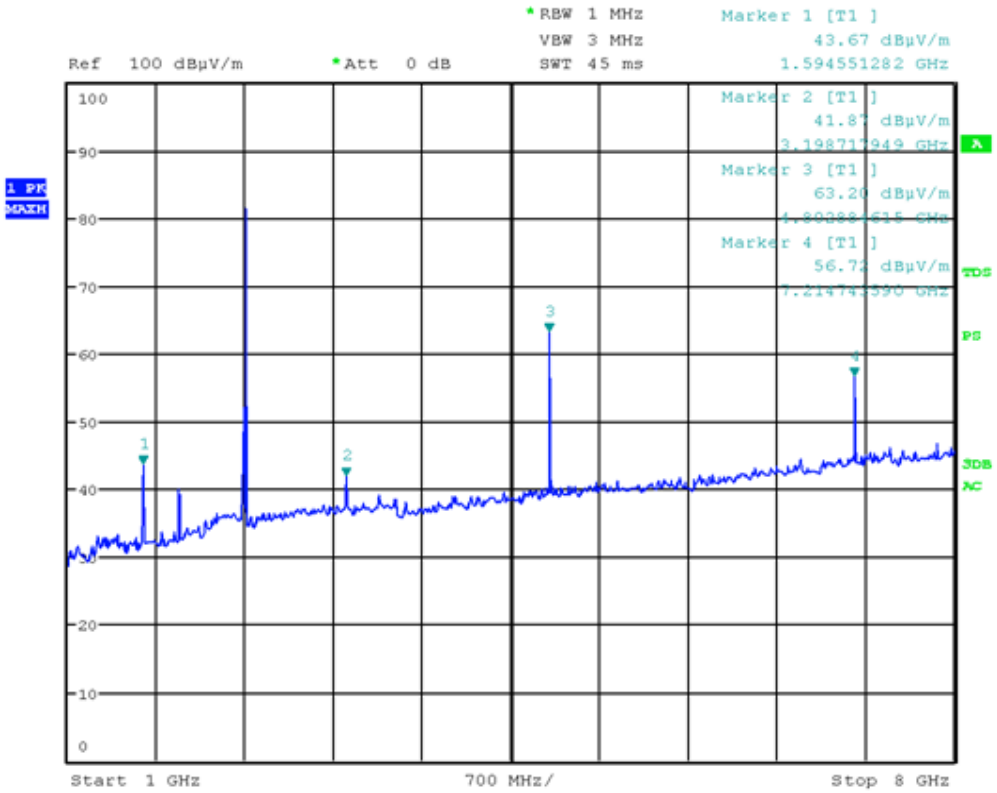
Preview Results:



Picture 119: Spurious emissions channel 0, 1 GHz-8 GHz (Overview scan) - GFSK



Picture 120: Spurious emissions channel 0, 8 GHz-16 GHz (overview scan) - GFSK



Picture 121: Spurious emissions channel 0, 16 GHz-26 GHz (overview scan) – GFSK

13.9 Test results GFSK channel 39

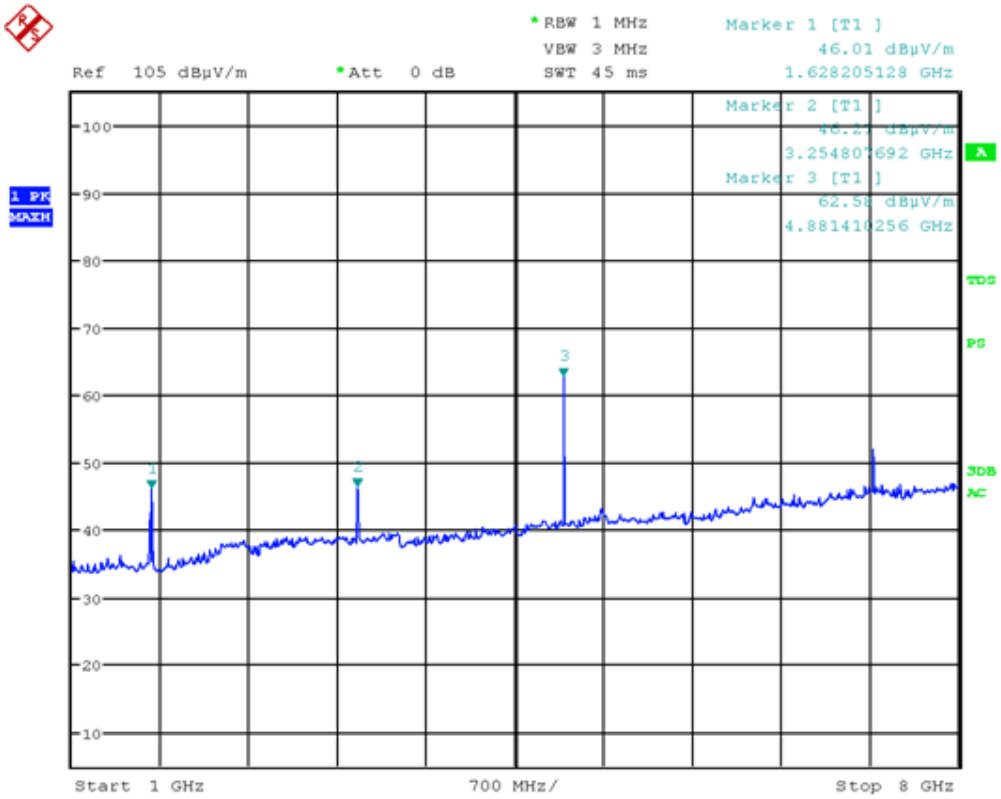
Temperature:	22°C	Humidity:	44%
Tested by:	M. Müller	Test date:	2014-04-30

Final Results:

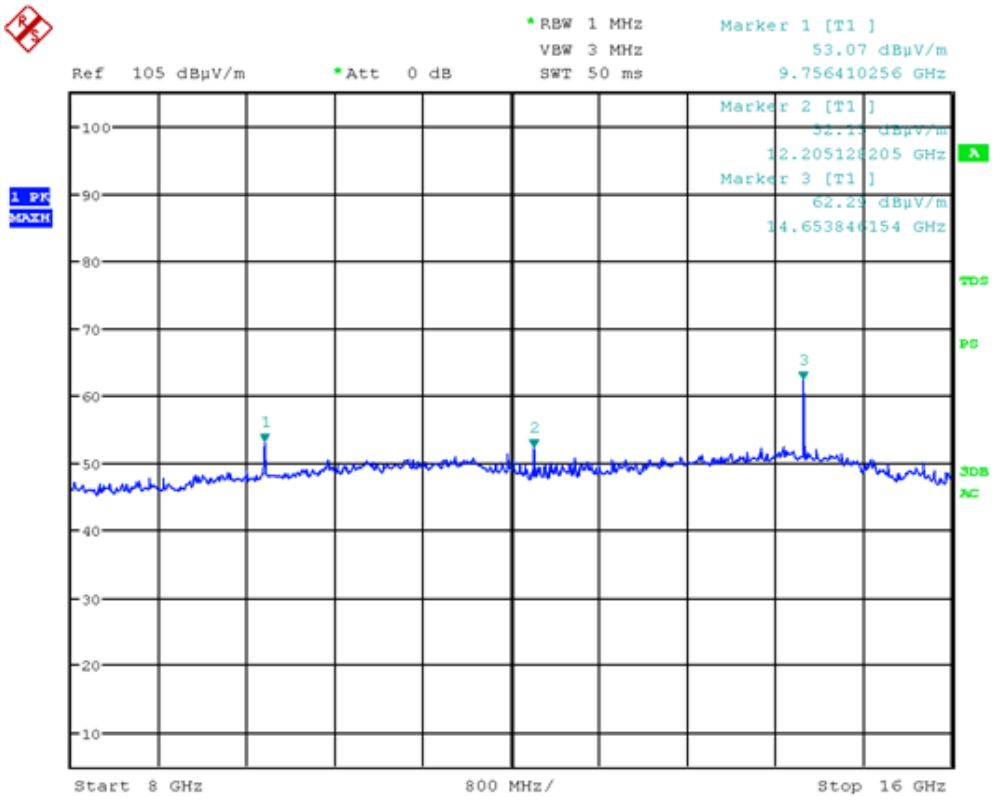
Frequency (GHz)	Reading (dBµV/m)	Detector	Limit (dBµV/m)	Restricted band	Result
1.6282	46.01	PK	74	No	Passed
1.6282	41.48	AV	54	No	Passed
2.4409	113.38	PK	(Carrier)	No	(Carrier)
2.4409	98.51	AV	(Carrier)	No	(Carrier)
3.2548	46.21	PK	74	No	Passed
3.2548	35.30	AV	54	No	Passed
4.8814	62.58	PK	74	Yes	Passed
4.8814	52.50	AV	54	Yes	Passed
7.3224	51.89	PK	74	Yes	Passed
7.3224	42.02	AV	54	Yes	Passed
9.7564	53.07	PK	- 20dBc	No	Passed
12.2051	52.15	PK	74	Yes	Passed
12.2051	40.40	AV	54	Yes	Passed
14.6538	62.29	PK	- 20dBc	No	Passed
17.0737	53.84	PK	- 20dBc	No	Passed
19.5256	52.58	PK	74	Yes	Passed
19.5256	37.41	AV	54	Yes	Passed
21.9776	55.08	PK	- 20dBc	No	Passed
24.4135	53.44	PK	- 20dBc	No	Passed

In receive mode there were no significant emissions detected!

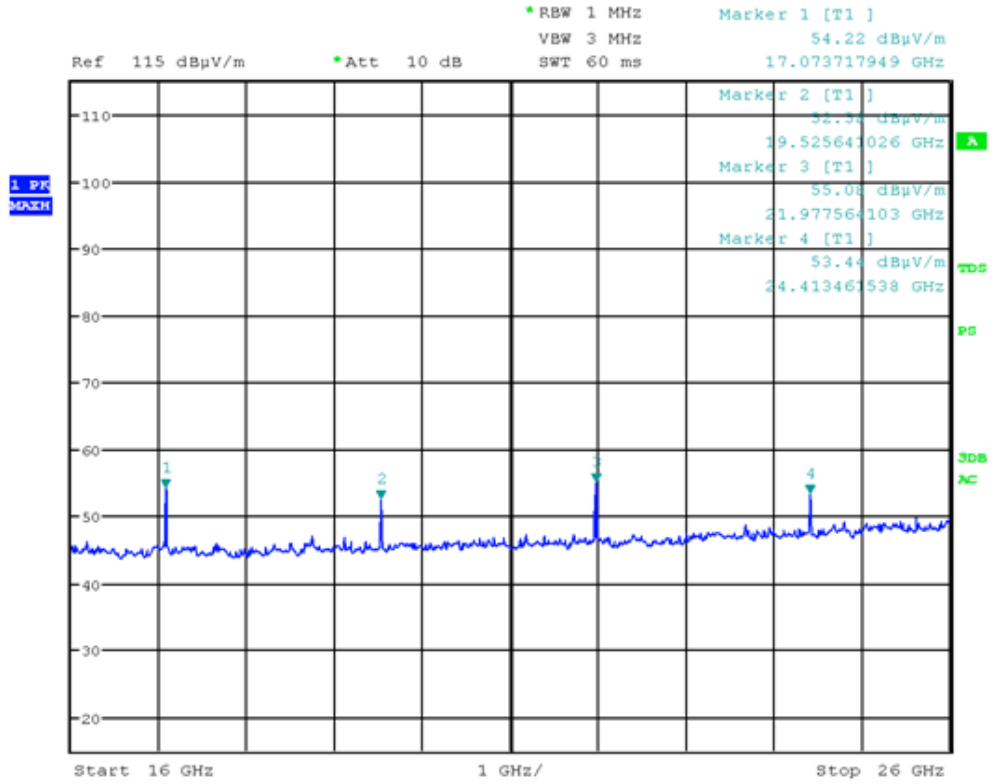
Preview Results:



Picture 122: Spurious emissions channel 39, 1 GHz 8 GHz (Overview scan) GFSK



Picture 123: Spurious emissions channel 39, 8 GHz-16 GHz (overview scan) GFSK



Picture 124: Spurious emissions channel 39, 16 GHz-26 GHz (overview scan) GFSK

13.10 Test results GFSK channel 78

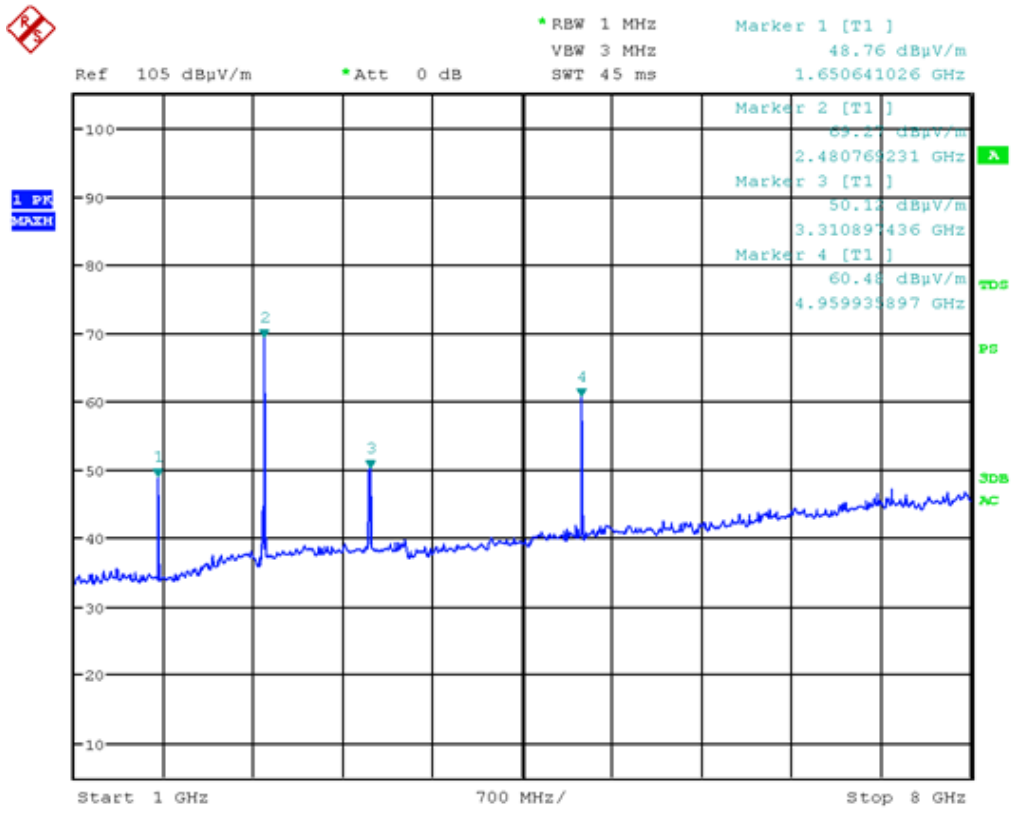
Temperature:	22°C	Humidity:	44%
Tested by:	M. Müller	Test date:	2014-04-30

Final Results:

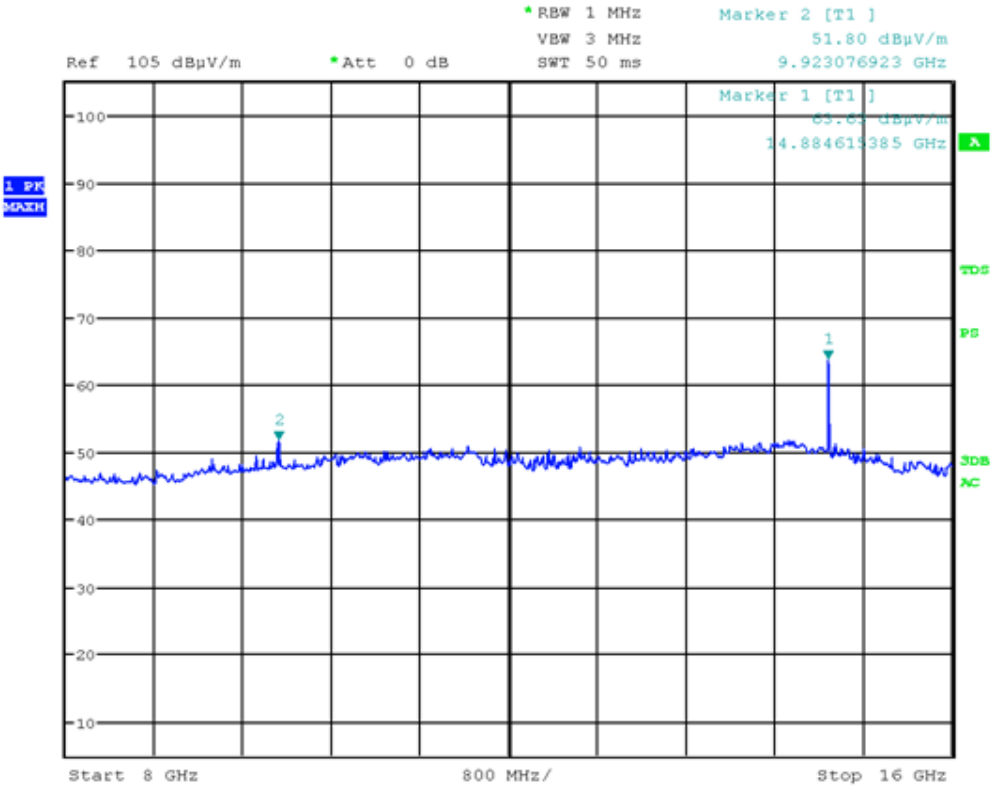
Frequency (GHz)	Reading (dBµV/m)	Detector	Limit (dBµV/m)	Restricted band	Result
1.6506	48.76	PK	74	No	Passed
1.6506	44.23	AV	54	No	Passed
2.4800	111.64	PK	(Carrier)	No	(Carrier)
2.4800	94.87	AV	(Carrier)	No	(Carrier)
3.3109	50.12	PK	74	No	Passed
3.3109	40.08	AV	54	No	Passed
4.9599	60.48	PK	74	Yes	Passed
4.9599	51.18	AV	54	Yes	Passed
9.9231	51.80	PK	- 20dBc	No	Passed
14.8846	63.63	PK	- 20dBc	No	Passed
17.3622	53.50	PK	- 20dBc	No	Passed
19.8462	50.96	PK	74	Yes	Passed
19.8462	38.53	AV	54	Yes	Passed
22.3301	55.95	PK	74	Yes	Passed
22.3301	40.27	AV	54	Yes	Passed
24.8141	51.01	PK	- 20dBc	No	Passed

In receive mode there were no significant emissions detected!

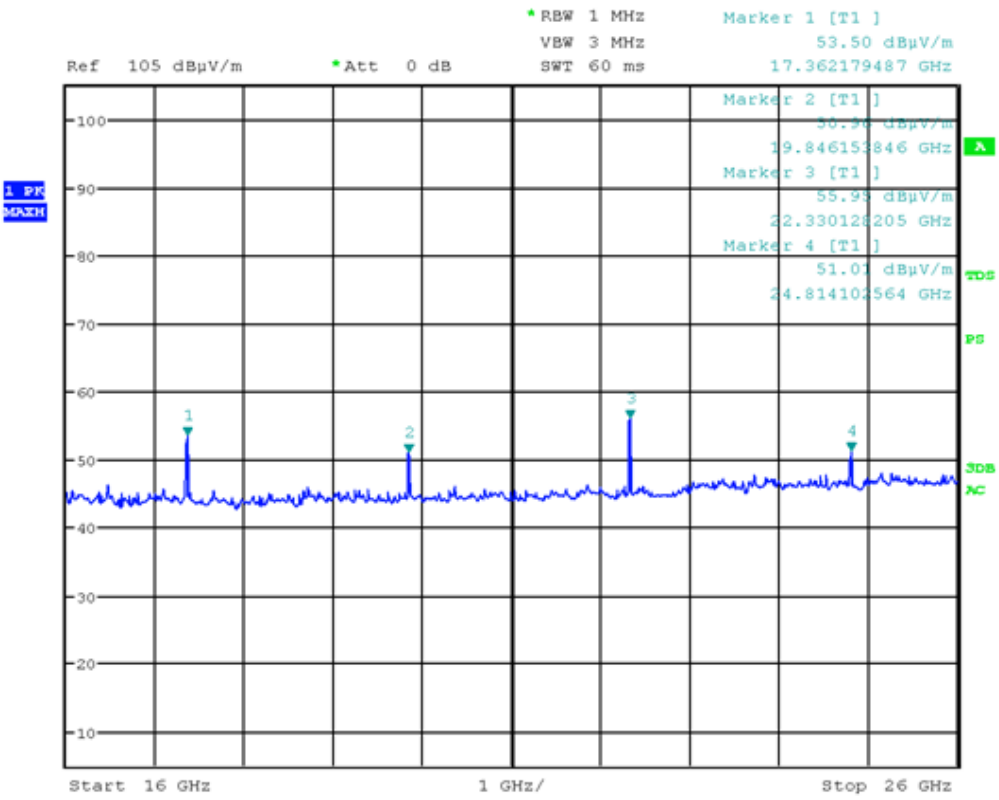
Preview Results:



Picture 125: Spurious emissions channel 78, 1 GHz-8 GHz (Overview scan) GFSK



Picture 126: Spurious emissions channel 78, 8 GHz-16 GHz (overview scan) GFSK



Picture 127: Spurious emissions channel 78, 16 GHz-26 GHz (overview scan) GFSK

13.11 Test results 8DPSK channel 0

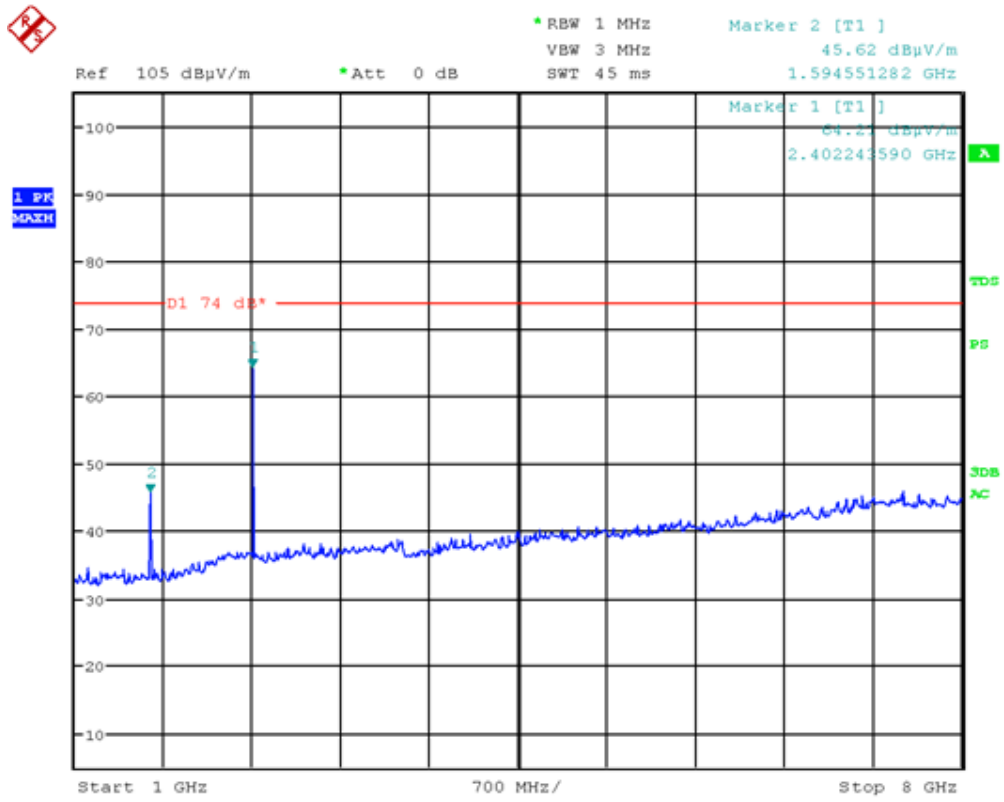
Temperature:	22°C	Humidity:	44%
Tested by:	M. Müller	Test date:	2014-04-30

Final Results:

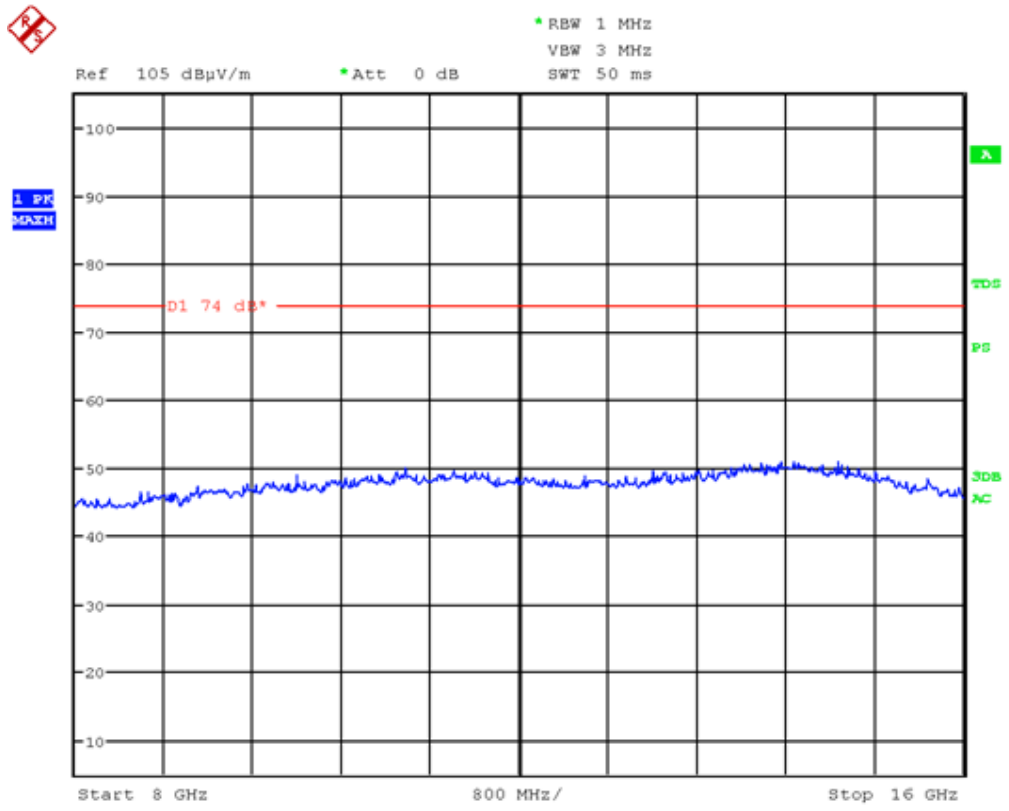
Frequency (GHz)	Reading (dBµV/m)	Detector	Limit (dBµV/m)	Restricted band	Result
1.5946	45.62	PK	74	Yes	Passed
1.5946	41.37	AV	54	Yes	Passed
2.4022	71.59	PK	(Carrier)	No	(Carrier)
2.4022	58.88	AV	(Carrier)	No	(Carrier)

In receive mode there were no significant emissions detected!

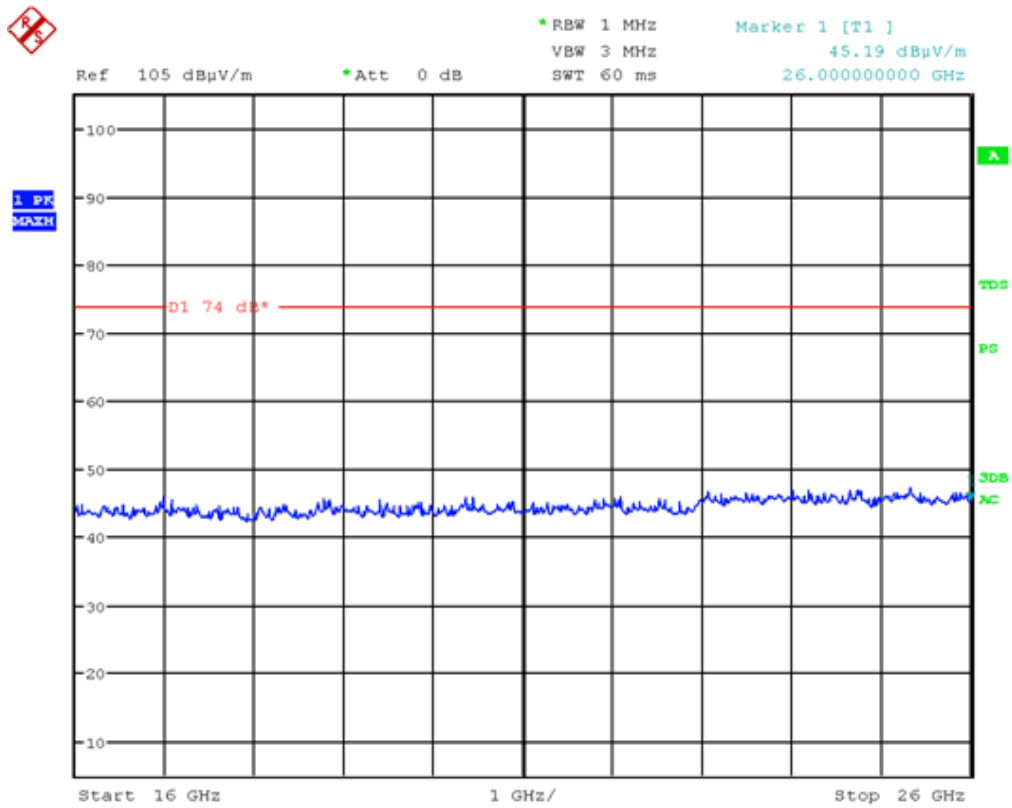
Preview Results:



Picture 128: Spurious emissions channel 0, 1 GHz-8 GHz (Overview scan) – 8DPSK



Picture 129: Spurious emissions channel 0, 8 GHz-16 GHz (overview scan) - 8DPSK



Picture 130: Spurious emissions channel 0, 16 GHz-26 GHz (overview scan) - 8DPSK

13.12 Test results 8DPSK channel 39

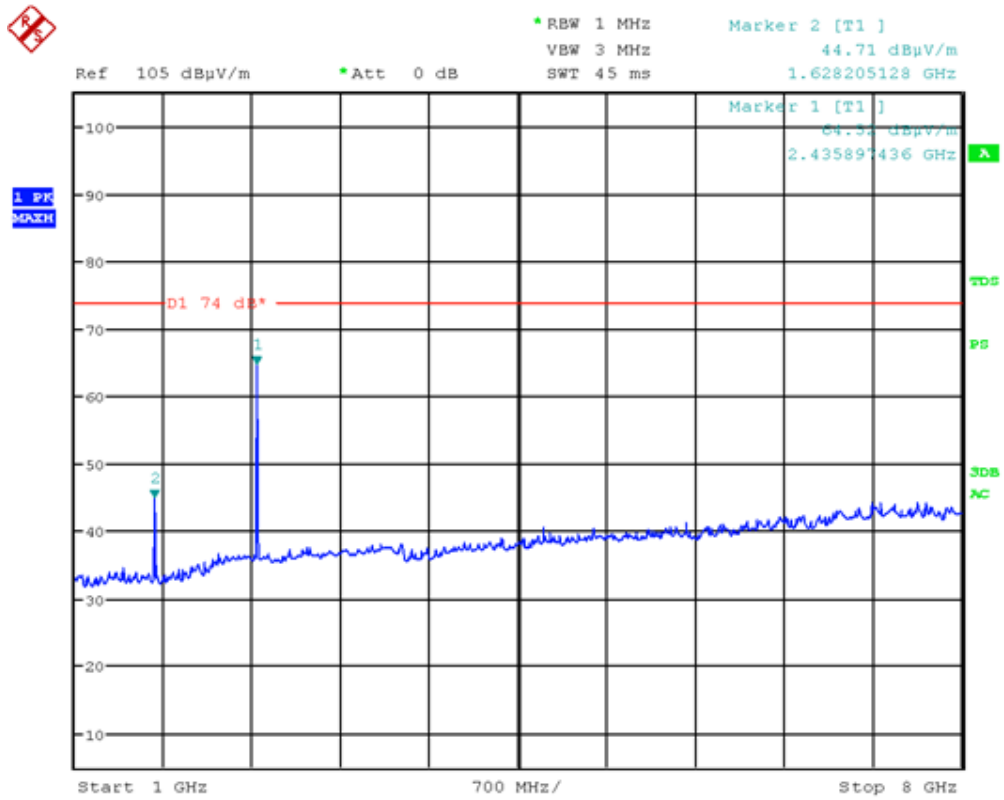
Temperature:	22°C	Humidity:	44%
Tested by:	M. Müller	Test date:	2014-04-30

Final Results:

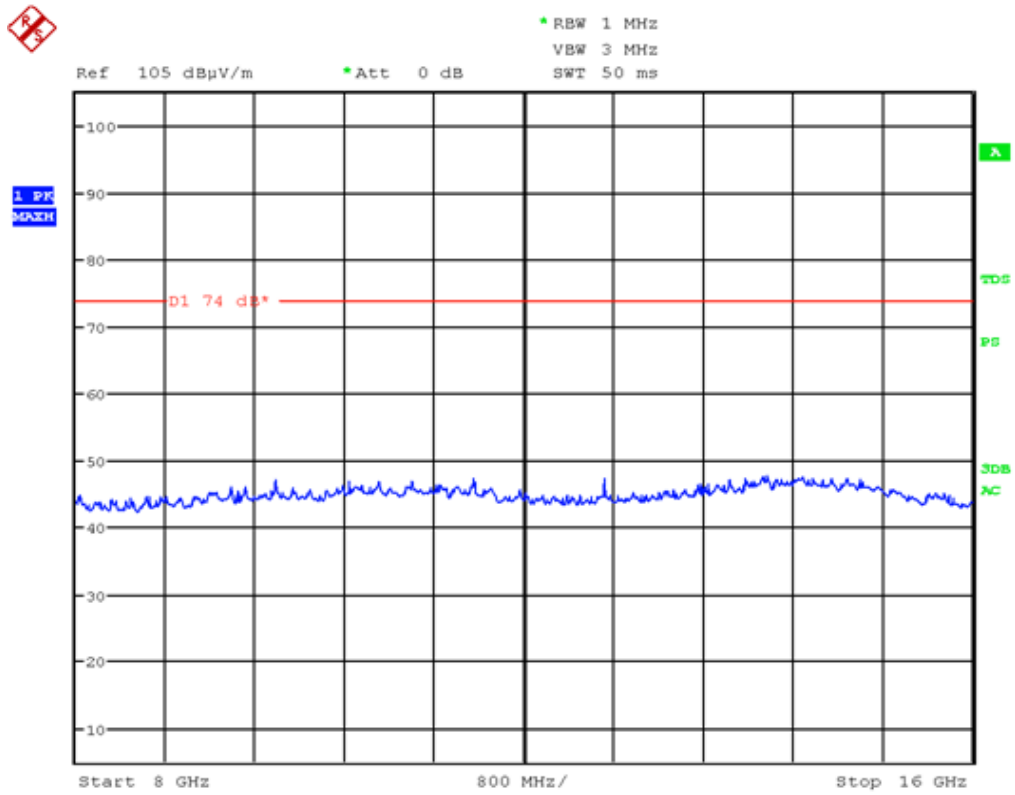
Frequency (GHz)	Reading (dBµV/m)	Detector	Limit (dBµV/m)	Restricted band	Result
1.6282	44.71	PK	74	No	Passed
1.6282	39.97	AV	54	No	Passed
2.4359	71.90	PK	(Carrier)	No	(Carrier)
2.4359	59.82	AV	(Carrier)	No	(Carrier)

In receive mode there were no significant emissions detected!

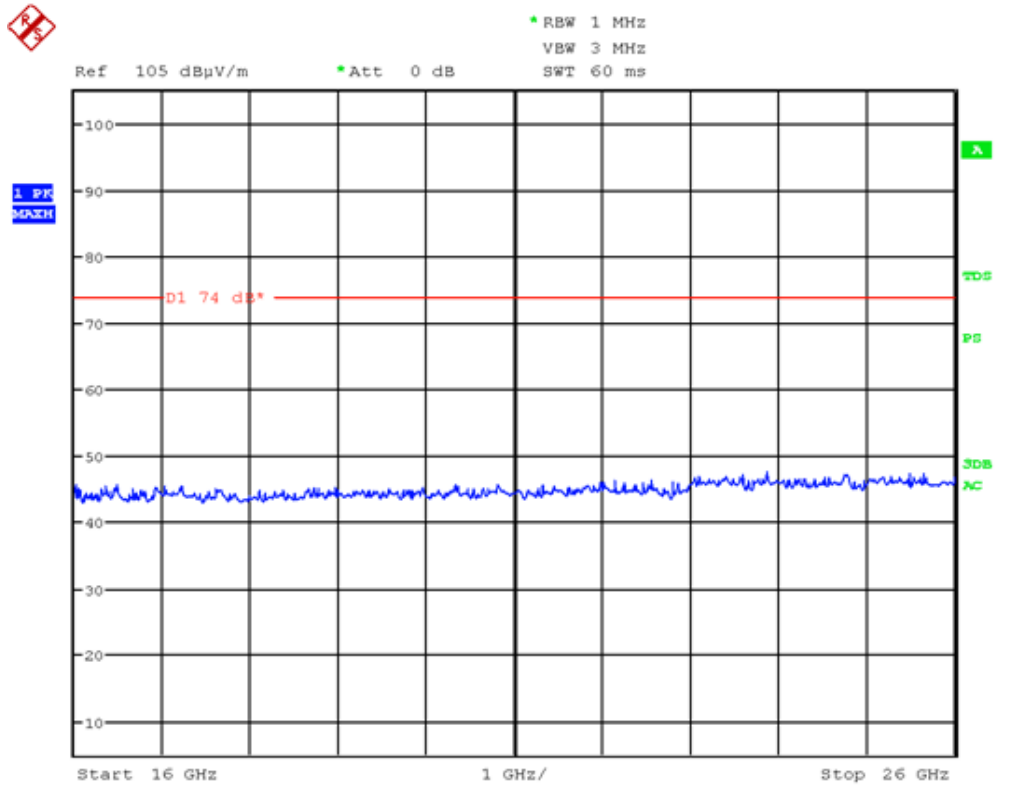
Preview Results:



Picture 131: Spurious emissions channel 39, 1 GHz-8 GHz (Overview scan) 8DPSK



Picture 132: Spurious emissions channel 39, 8 GHz-16 GHz (overview scan) 8DPSK



Picture 133: Spurious emissions channel 39, 16 GHz-26 GHz (overview scan) 8DPSK

13.13 Test results 8DPSK channel 78

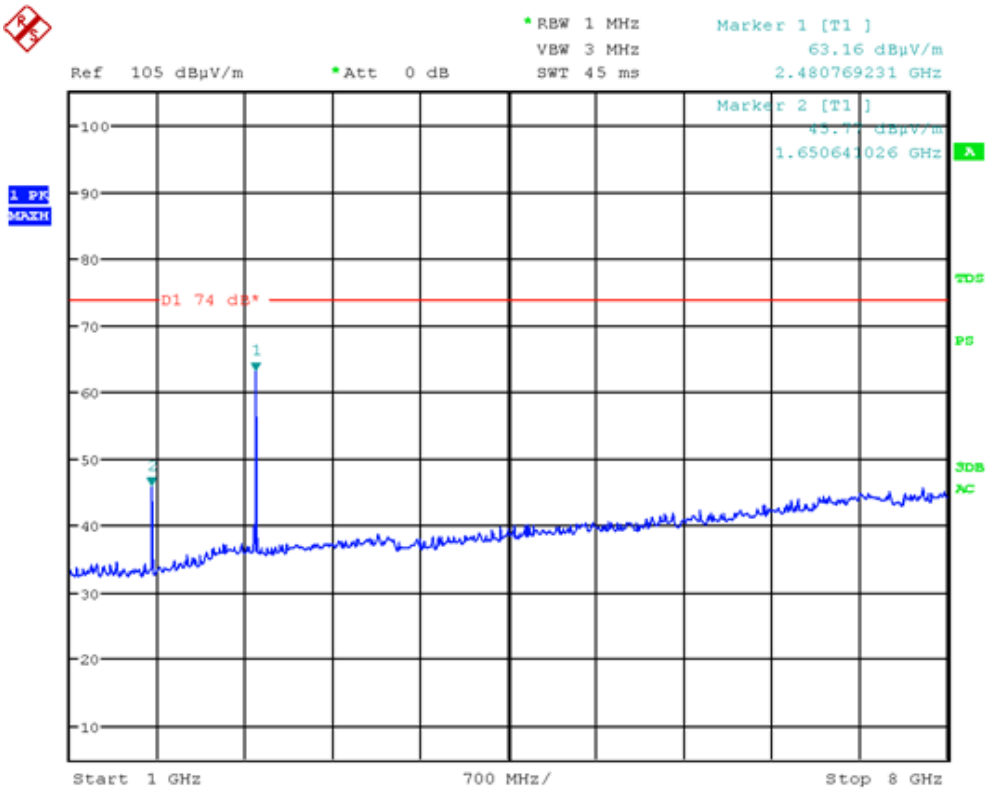
Temperature:	22°C	Humidity:	44%
Tested by:	M. Müller	Test date:	2014-04-30

Final Results:

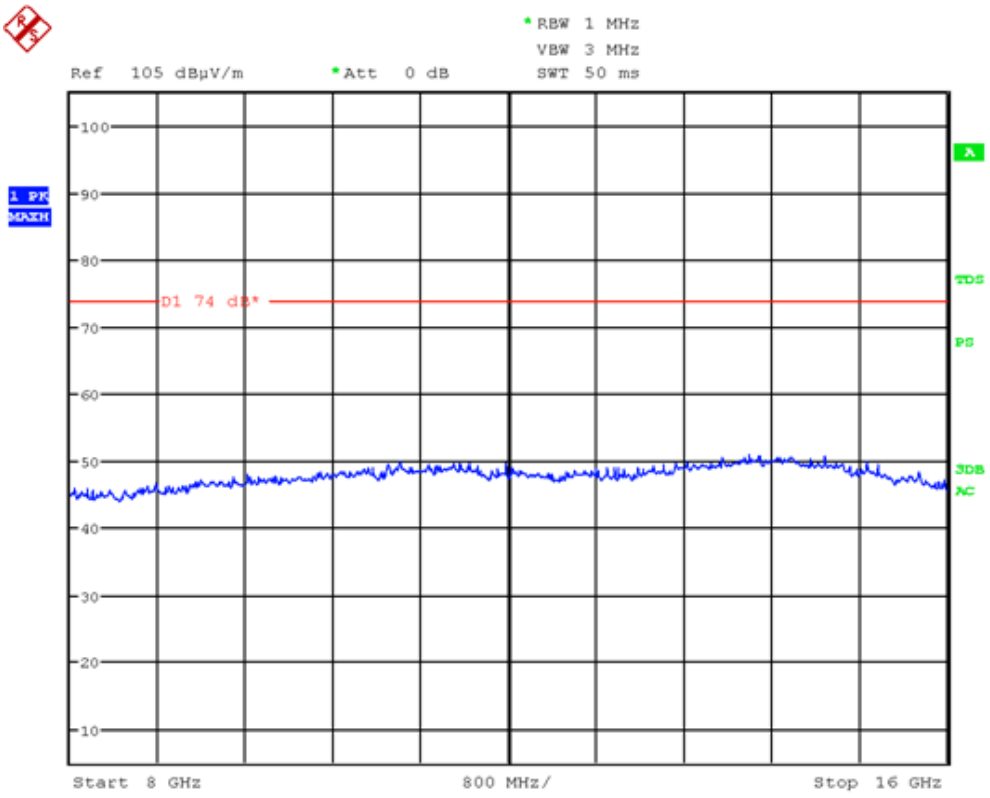
Frequency (GHz)	Reading (dBµV/m)	Detector	Limit (dBµV/m)	Restricted band	Result
1.6506	45.77	PK	74	No	Passed
1.6506	43.09	AV	54	No	Passed
2.4808	69.18	PK	(Carrier)	No	(Carrier)
2.4808	56.49	AV	(Carrier)	No	(Carrier)

In receive mode there were no significant emissions detected!

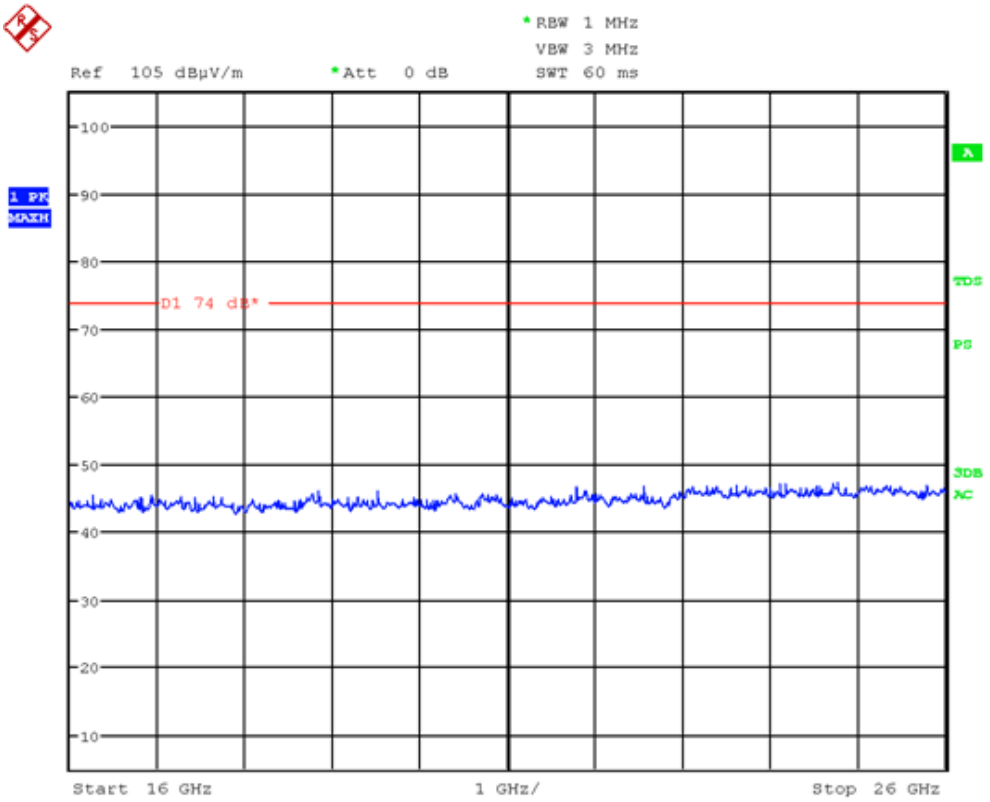
Preview Results:



Picture 134: Spurious emissions channel 78, 1 GHz-8 GHz (Overview scan) 8DPSK



Picture 135: Spurious emissions channel 78, 8 GHz-16 GHz (overview scan) 8DPSK



Picture 136: Spurious emissions channel 78, 16 GHz-26 GHz (overview scan) 8DPSK

13.14 Test results Pi/4 DQPSK channel 0

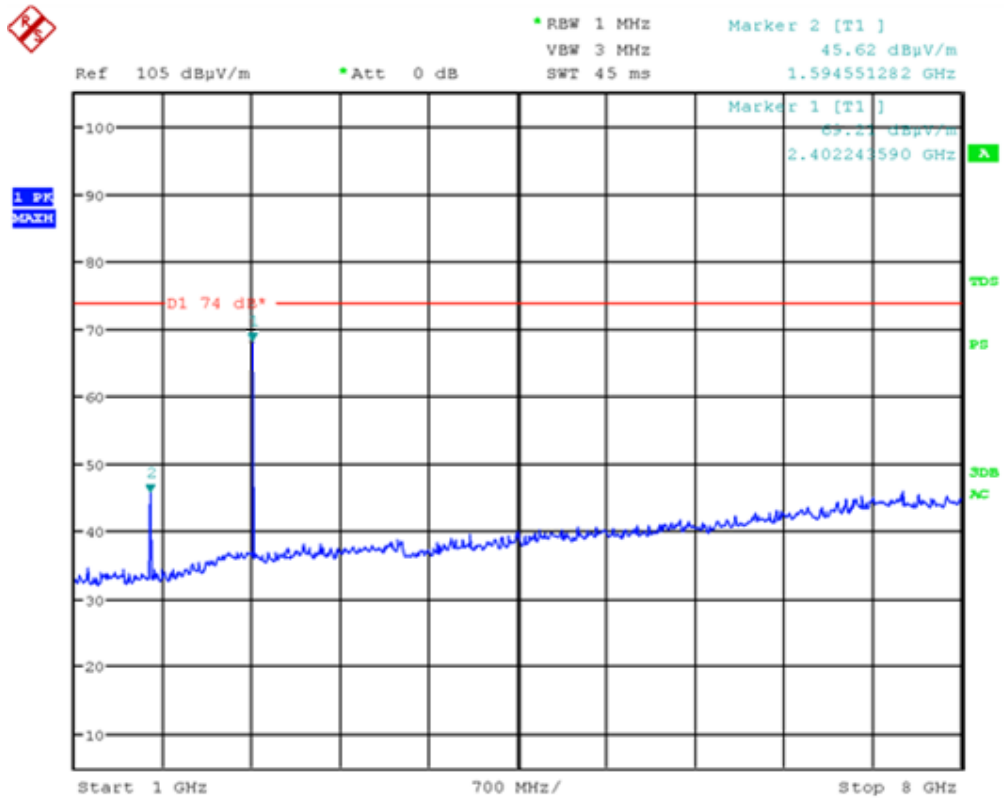
Temperature:	22°C	Humidity:	44%
Tested by:	M. Müller	Test date:	2014-04-30

Final Results:

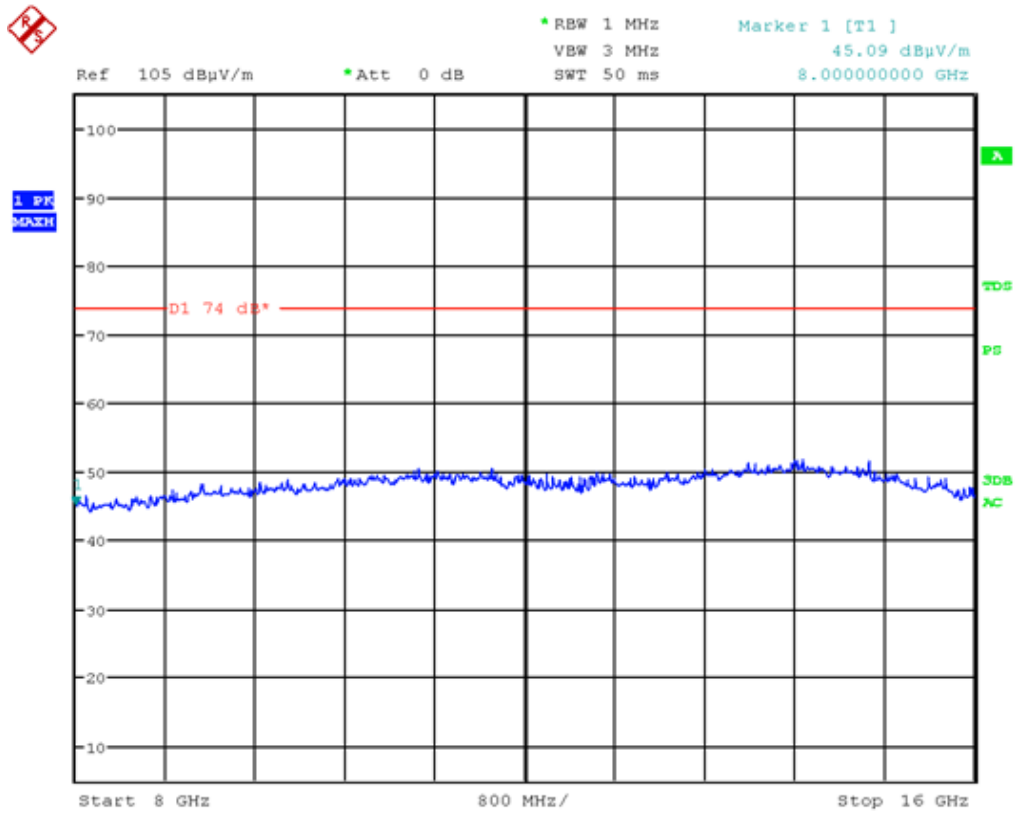
Frequency (GHz)	Reading (dBµV/m)	Detector	Limit (dBµV/m)	Restricted band	Result
1.5946	45.62	PK	74	Yes	Passed
1.5946	40.93	AV	54	Yes	Passed
2.4022	71.02	PK	(Carrier)	No	(Carrier)
2.4022	58.69	AV	(Carrier)	No	(Carrier)

In receive mode there were no significant emissions detected!

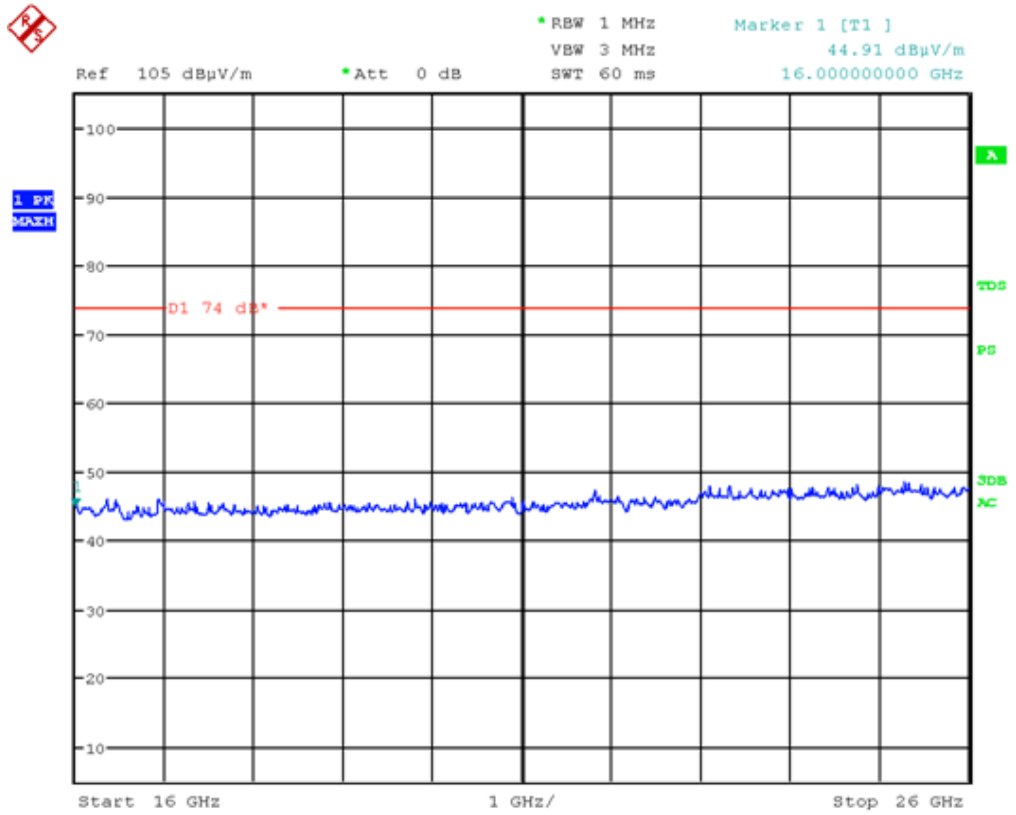
Preview Results:



Picture 137: Spurious emissions channel 0, 1 GHz-8 GHz (Overview scan) – Pi/4 DQPSK



Picture 138: Spurious emissions channel 0, 8 GHz-16 GHz (overview scan) - Pi/4 DQPSK



Picture 139: Spurious emissions channel 0, 16 GHz-26 GHz (overview scan) - Pi/4 DQPSK

13.15 Test results Pi/4 DQPSK channel 39

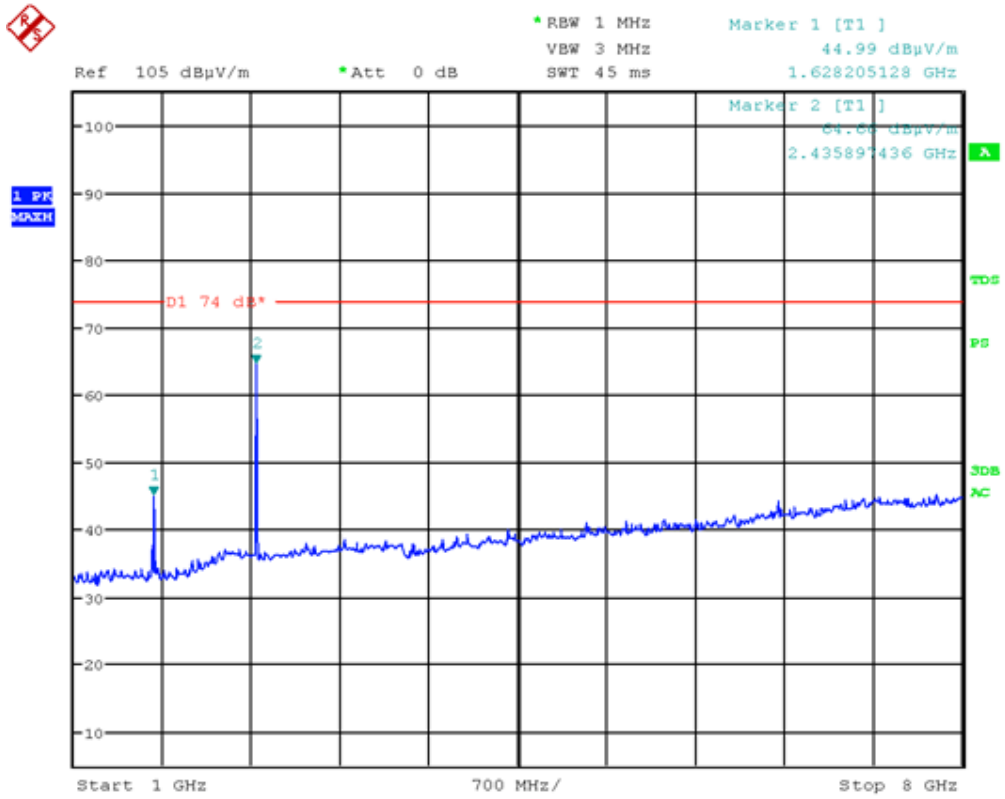
Temperature:	22°C	Humidity:	44%
Tested by:	M. Müller	Test date:	2014-04-30

Final Results:

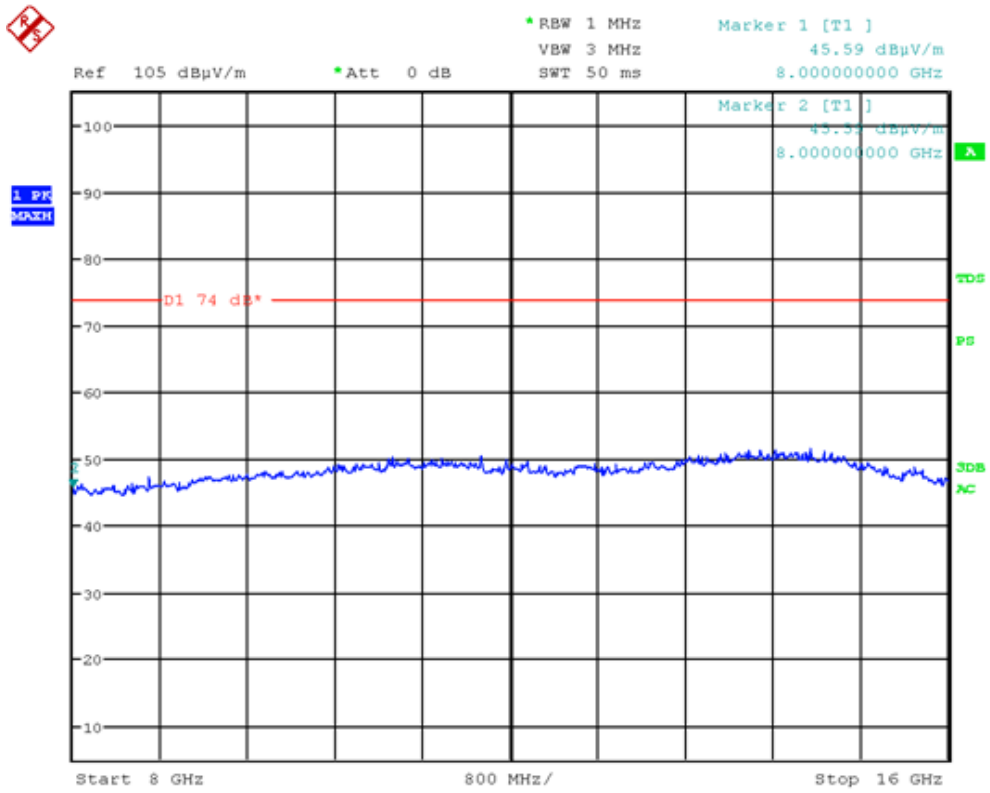
Frequency (GHz)	Reading (dBµV/m)	Detector	Limit (dBµV/m)	Restricted band	Result
1.6282	44.99	PK	74	No	Passed
1.6282	41.75	AV	54	No	Passed
2.4359	71.65	PK	(Carrier)	No	(Carrier)
2.4359	59.76	AV	(Carrier)	No	(Carrier)

In receive mode there were no significant emissions detected!

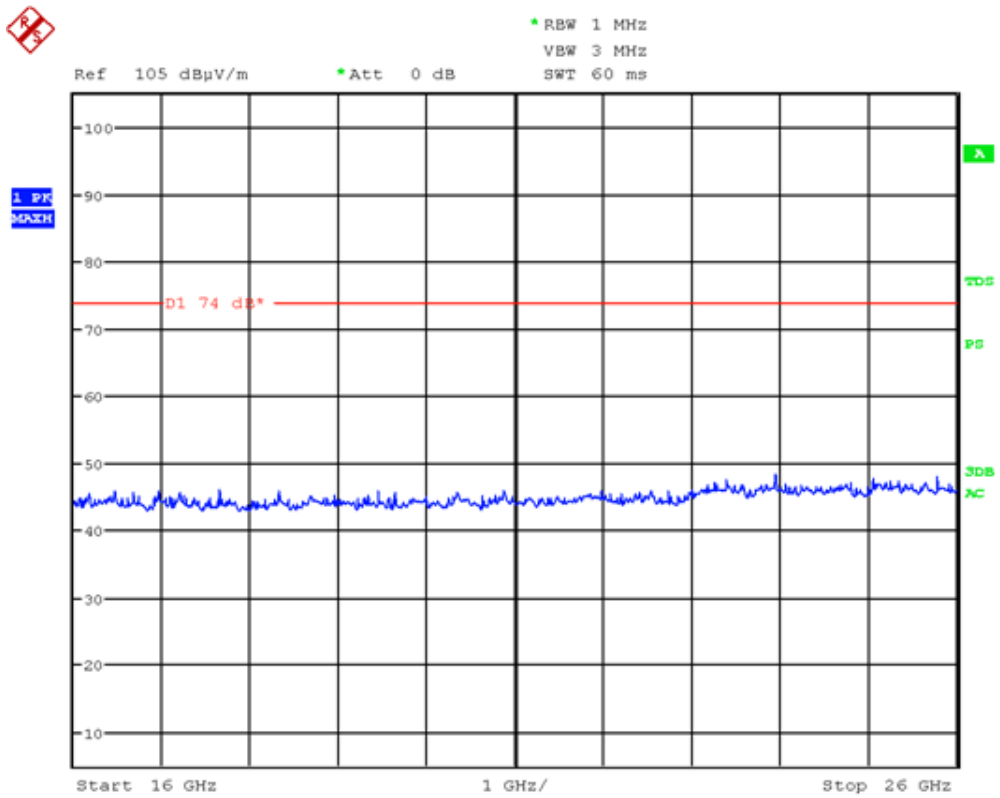
Preview Results:



Picture 140: Spurious emissions channel 39, 1 GHz-8 GHz (Overview scan) Pi/4 DQPSK



Picture 141: Spurious emissions channel 39, 8 GHz-16 GHz (overview scan) Pi/4 DQPSK



Picture 142: Spurious emissions channel 39, 16 GHz-26 GHz (overview scan) Pi/4 DQPSK

13.16 Test results Pi/4 DQPSK channel 78

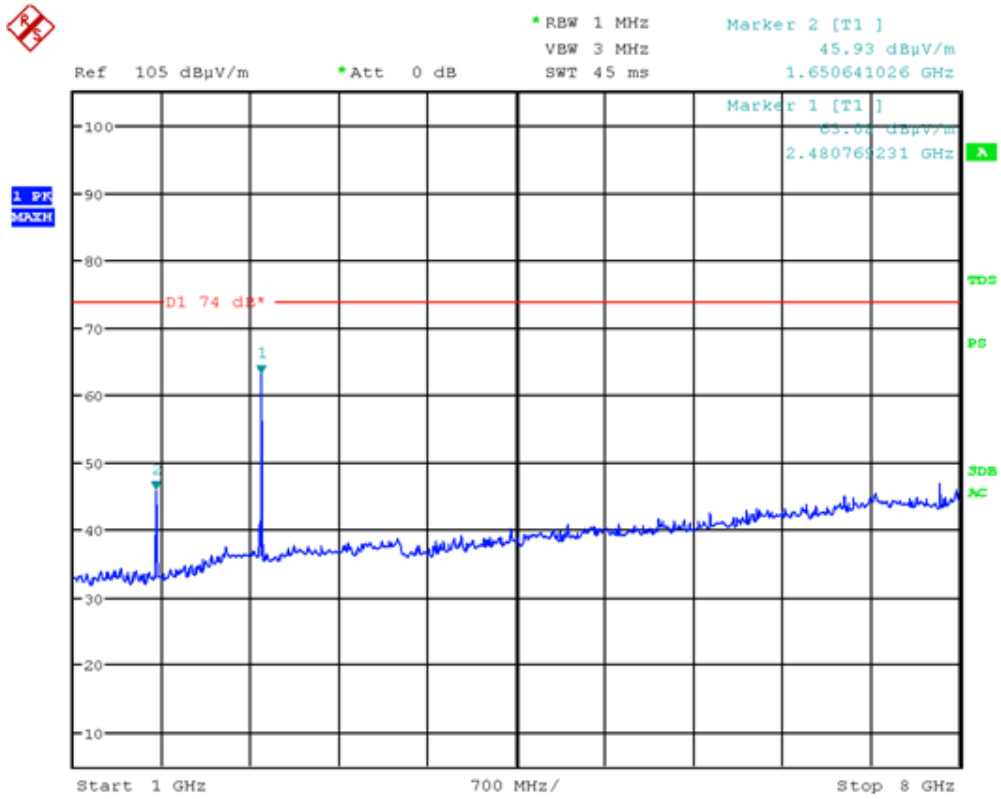
Temperature:	22°C	Humidity:	44%
Tested by:	M. Müller	Test date:	2014-04-30

Final Results:

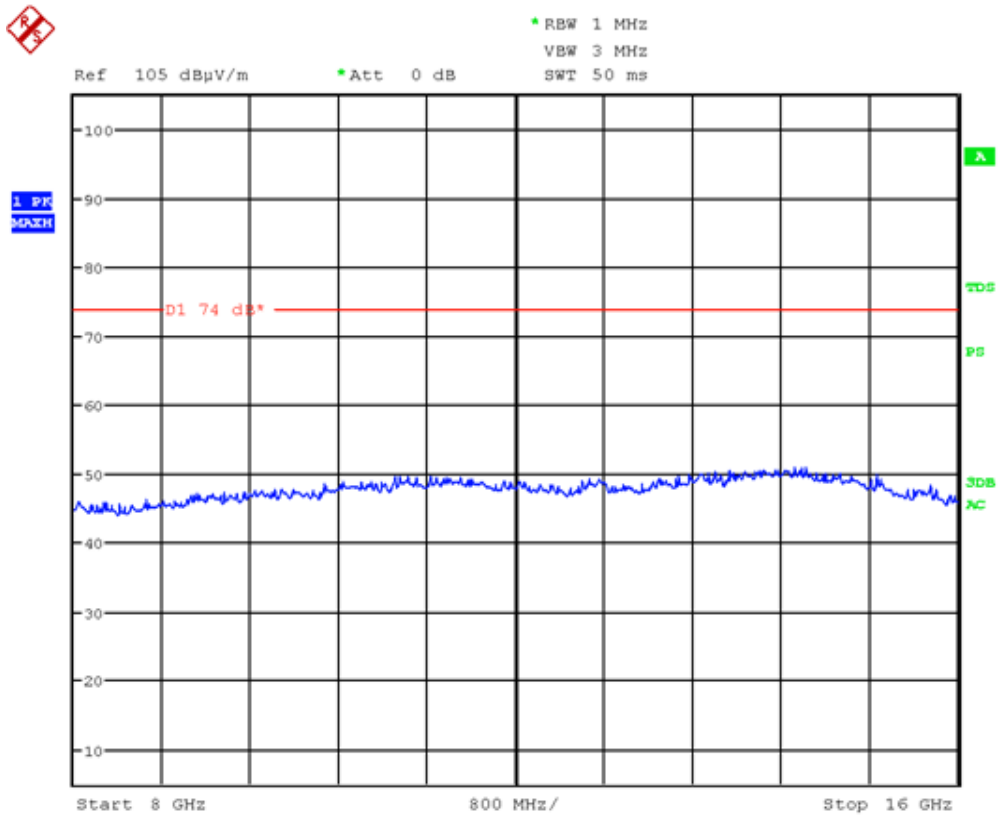
Frequency (GHz)	Reading (dBµV/m)	Detector	Limit (dBµV/m)	Restricted band	Result
1.6506	45.93	PK	74	No	Passed
1.6506	42.13	AV	54	No	Passed
2.4808	68.91	PK	(Carrier)	No	(Carrier)
2.4808	56.45	AV	(Carrier)	No	(Carrier)

In receive mode there were no significant emissions detected!

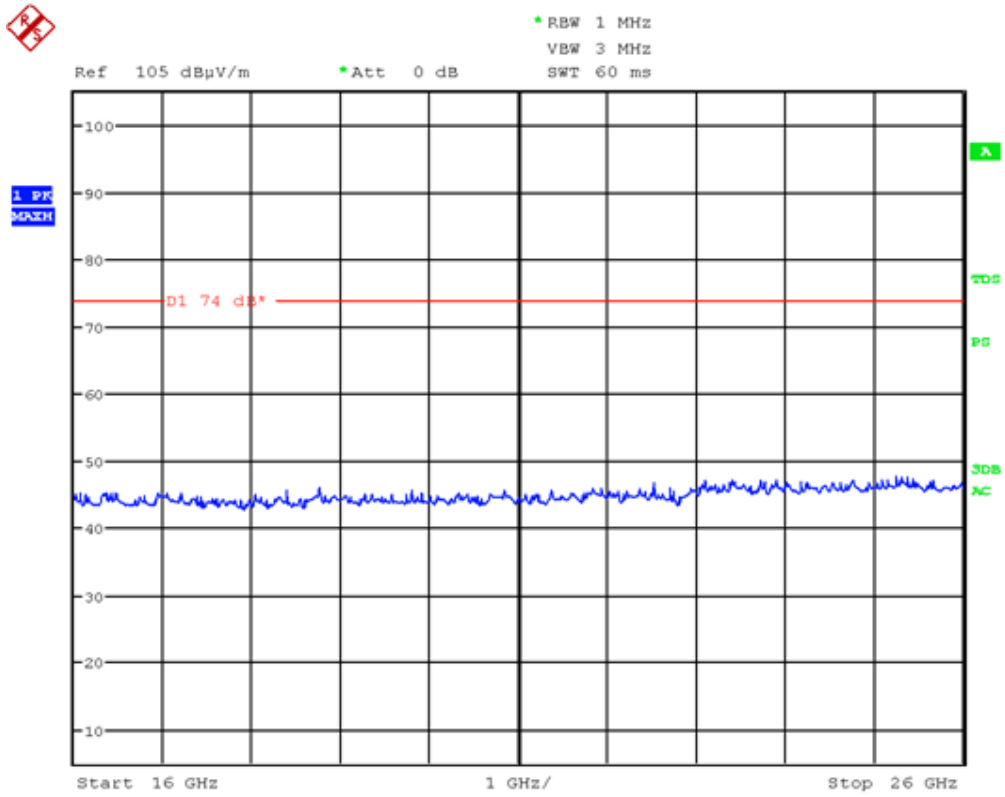
Preview Results:



Picture 143: Spurious emissions channel 78, 1 GHz-8 GHz (Overview scan) Pi/4 DQPSK



Picture 144: Spurious emissions channel 78, 8 GHz-16 GHz (overview scan) Pi/4 DQPSK



Picture 145: Spurious emissions channel 78, 16 GHz-26 GHz (overview scan) Pi/4 DQPSK

14 Exposure of humans to RF fields

according to CFR 47 Part 2, section 2.1091, Public Notice DA 00-705, RSS-Gen Issue 3, section 5.6, and RSS-102 Issue 4, section 2.5.2

14.1 Antenna type and power calculation

External detachable antenna (see antenna specification)
Gi: 2,14dBi = numeric gain 1,64
Output power conducted: 16,33dBm = 42,95mW
π =3,1416
R=20cm

$$S = \frac{G \cdot CP}{4 * \pi * R^2}$$

G:numerical antenna gain
CP: conducted output power [W]

$$S = \frac{1{,}64 \cdot 42{,}95\,mW}{4 * \pi * 400\ cm^2} = 0{,}0140\ \ mW\ /\ cm^2$$

Limit:
1mW/cm²

15 Equipment calibration status

Inventory Number	Model Number	Manufacturer	Last calibration	Next calibration	Cycle of calibration
W00002	ESU26	Rohde & Schwarz	Jan 14	Jan 16	2 Years
E00001	ESCI	Rohde & Schwarz	Dec 13	Dec 15	2 Years
E00003	ESCS 30	Rohde & Schwarz	Feb 14	Feb 15	1 Year
E00004	ESH 2-Z5	Rohde & Schwarz	Mar. 13	Mar. 15	2 Years
E00005	ESH 2-Z5	Rohde & Schwarz	Jan 14	Jan 16	2 Years
E00060	HFH2-Z2	Rohde & Schwarz	Dec 13	Dec 15	2 Years
E00013	VULB 9163	Schwarzbeck	Sep 13	Sep 15	2 Years
W00053	BBHA 9120D	Schwarzbeck	Mar 14	Mar 16	2 Years
W00055	BBHA 9170	Schwarzbeck	Mar 14	Mar 16	2 Years

Table 1: Equipment Calibration status

16 Measurement uncertainty

Description	Max. deviation	k=
Conducted emission AMN (9kHz to 30 MHz)	± 4,0 dB	2
Radiated emission open field (30 MHz to 1 GHz)	± 4,5 dB	2
Radiated emission absorber chamber (> 1000 MHz)	± 5,4 dB	2

Table 2: Measurement uncertainty

Comment: The uncertainty stated is the expanded uncertainty obtained by multiplying the standard uncertainty by the coverage factor k. If k=2 the value of the measurements lies within the assigned range of values with a probability of 95 %.

17 Summary

The EMC Regulations according to the marked specifications are

☑ **KEPT**

The EUT does fulfill the general approval requirements mentioned.

☐ **NOT KEPT**

The EUT does not fulfill the general approval requirements mentioned.

Place, Date: Straubing, May 23rd, 2014

Martin Müller	Rainer Heller
Test engineer	Chief of radio department and QMO
EMV **TESTHAUS** GmbH	EMV **TESTHAUS** GmbH