Test Report

Customer:

HBC-radiomatic GmbH

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RF test report

110498-AU01+W02

HBC-radiomatic GmbH

RF module

TC240100 / TC240010

EMV TESTHAUS

The test result refers exclusively to the model tested.

This report must not be copied without the written authorization by the lab.
Revision: 1.1

Deutscher Akkreditierungs Rat

DGA-PL-224/95-03 / BNetzA-CAB-02/21-02/2

EMV **TESTHAUS** GmbH

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Accreditation:

Deutscher Akkreditierungs Rat

Registration number: DGA-PL-224/95-03
CAB (EMC) registration number: BNetzA-CAB-02/21-02/3
FCC facility registration number: 221458
MRA US-EU, FCC designation number: DE0010

Test Laboratory:

EMV **TESTHAUS** GmbH
Gustav-Hertz-Straße 35
94315 Straubing
Germany

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: 10-2011	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: 10-2011	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	Conducted emission at AC power line 0.150 MHz to 30 MHz	RSS Gen Issue 2 Section 7.2.2
15.247(a)	Carrier Frequency Separation	RSS 210 Issue 8 A 8.1(b)
15.247(a)	Number of Hopping Frequencies	RSS 210 Issue 8 A 8.1(d)
15.247(a)	Time of Occupancy (Dwell time)	RSS 210 Issue 8 A 8.1(d)
2.247(a)	Occupied bandwidth (20dB)	RSS 210 Issue 8 A 8.1(a)
15.247(b)	Conducted output power	RSS Gen Issue 3 Section 4.8
2.247(c)	Band-edge Compliance	RSS 210 Issue 8 A 8.5
2.247(c)	Conducted spurious emission	RSS Gen Issue 3 Section 4.9
2.247(c)	Radiated emission 30 MHz to 10th Harmonics	RSS Gen Issue 3 Section 4.9
2.1091	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	Passed
RSS-210 Issue 8 Annex 8 and RSS-Gen Issue 3	Passed

2 Equipment under Test (EUT)

Product type:	RF module
Model Name:	TC 240100 / TC240010
Manufacturer:	HBC-radiomatic GmbH
Serial number:	Prototype
FCC ID:	NO9TC240
IC	2977A-TC240
Application freq. band:	2400 MHz – 2483.5 MHz
Frequency range:	2402MHz – 2480 MHz
Operating frequency:	2402MHz – 2480 MHz
Channel spacing:	1MHz
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 +85°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 15cm 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: TC240100 (20 pin connector)
Type 2: TC240010 (38 pin connector)
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 type 1 and type 2. Therefore only type one was measured and 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
RF module	TC 240100	Prototype
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 / 0.6m / unshielded	N/A
1	Antenna cable / 0.3m / shielded	

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

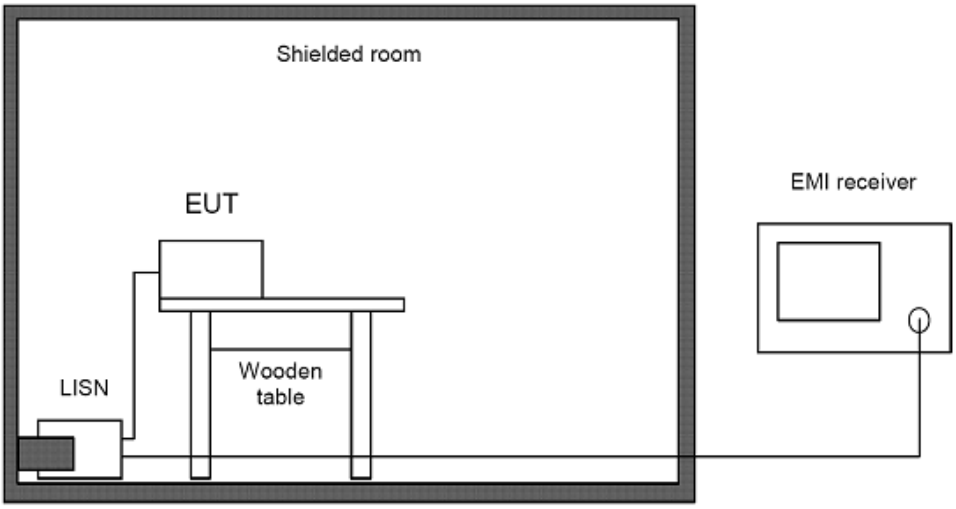
Frequency [MHz]	Quasi-peak [dBµV]	Avarage [dBµV]
0.15 – 0.5	66 - 56	56 – 46
0.5 – 5.0	56	46
5 – 30	60	50

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

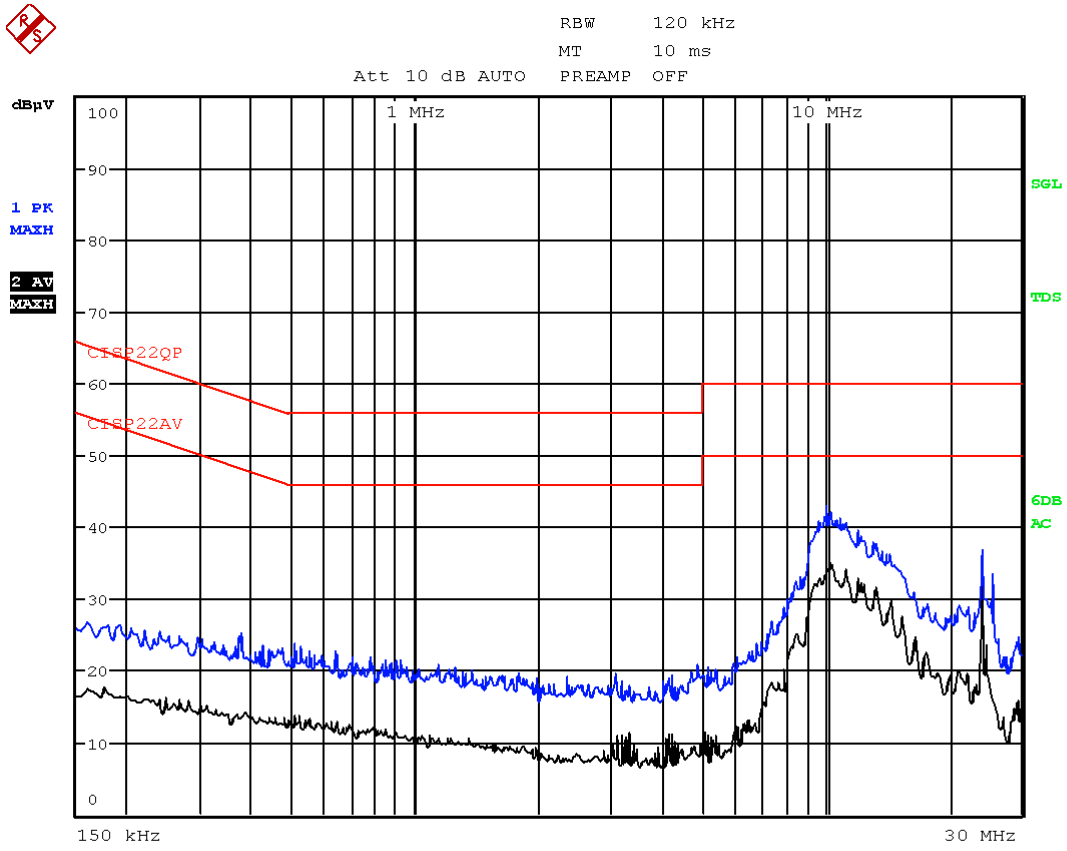


Picture 1: Outline of conducted emission test setup

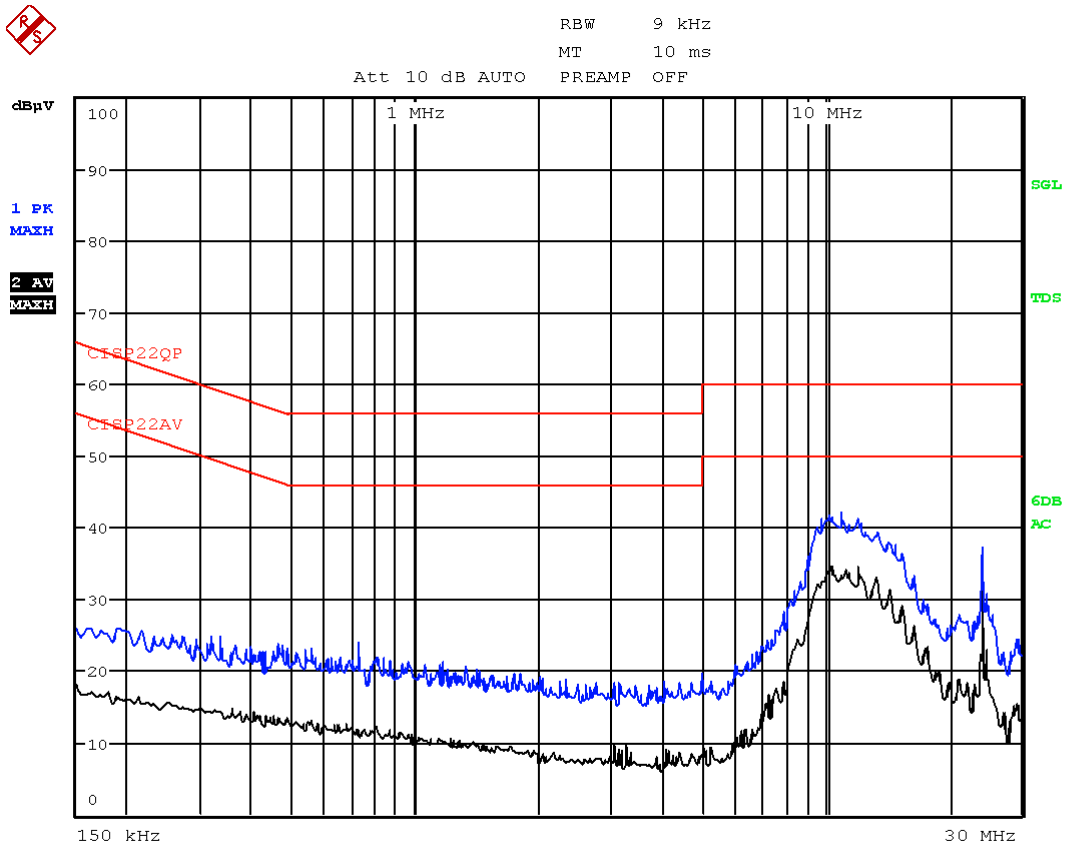
Comments: All peripheral devices were additionally decoupled by means of a line stabilization network.
The measurements were performed with 120V/60Hz.

3.6 Test results

Temperature:	22°C	Humidity:	44%
Tested by:	Ch.Kiermeier	Test date:	2012-01-23



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)(1)

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

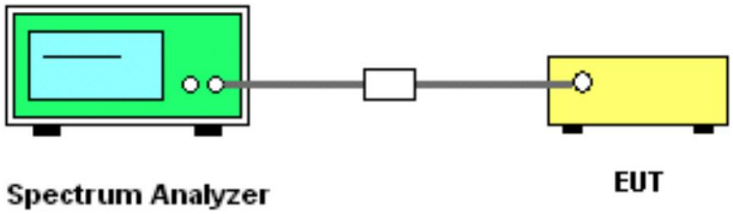
4.3 Limits

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.

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.

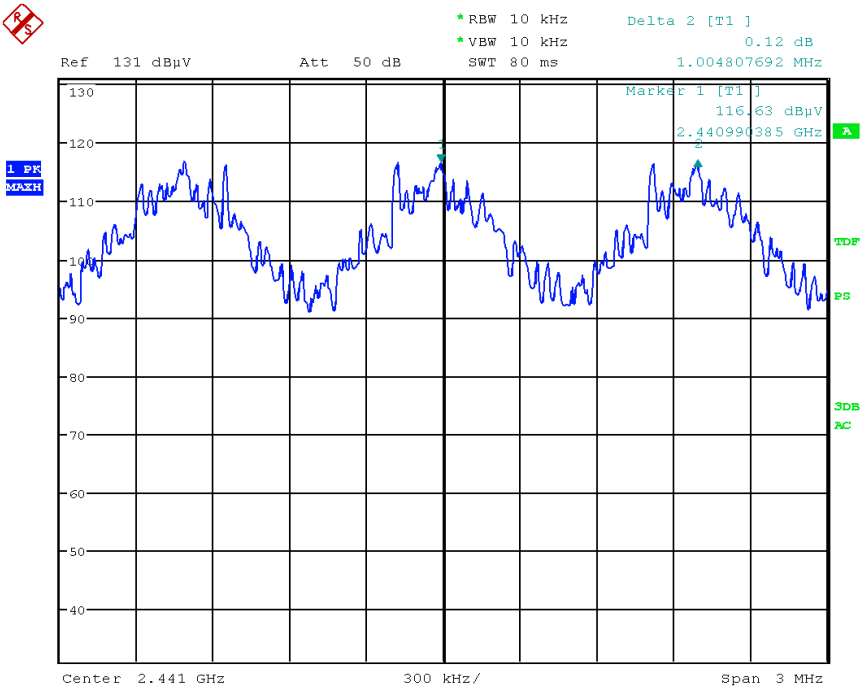
4.7 EUT operation during test

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

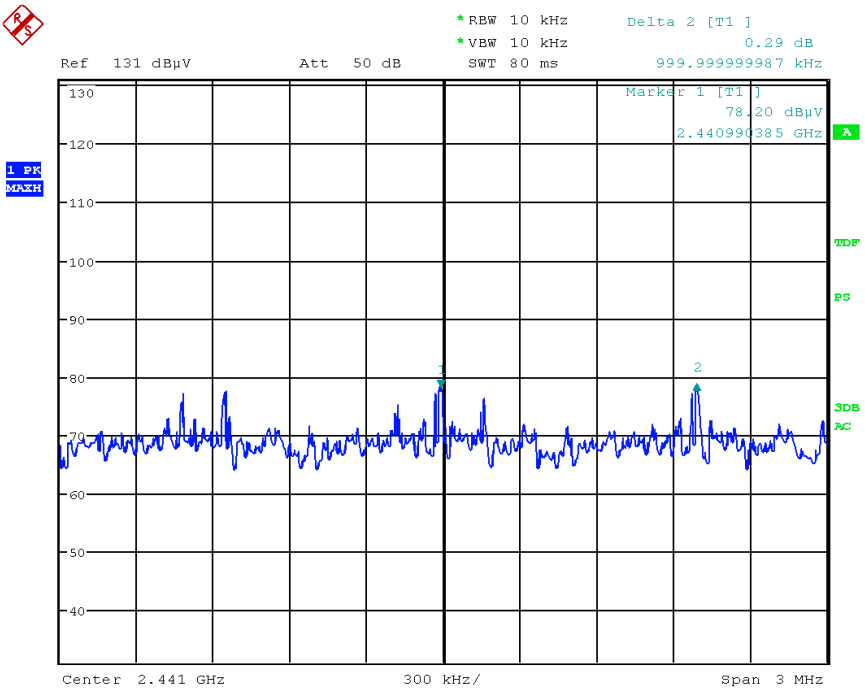
4.8 Test results

Temperature:	23°C	Humidity:	41%
Tested by:	CH.Kiermeier	Test date:	2012-01-26

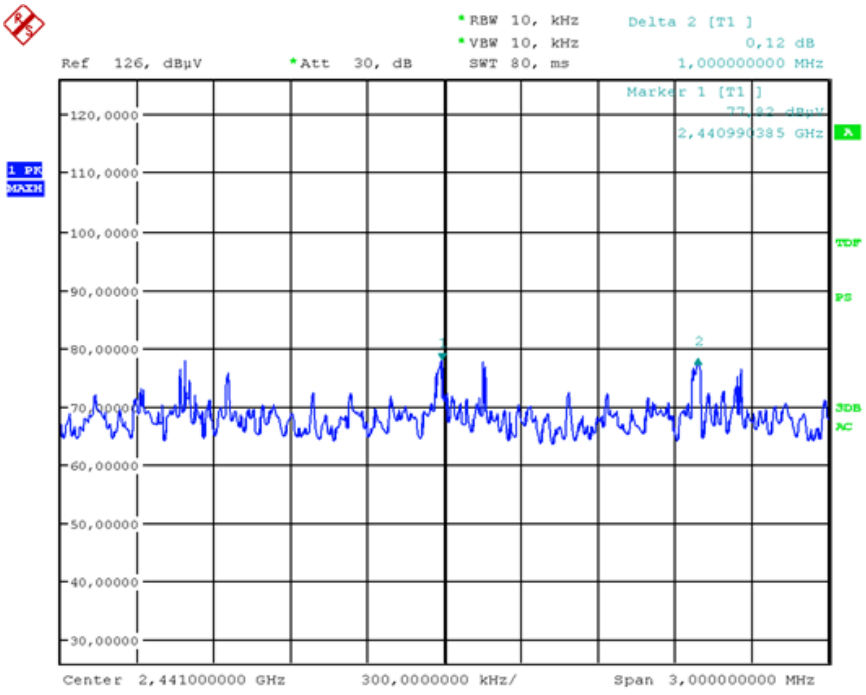
Test Result	
Carrier Frequency Separation (MHz)	**Result**
1,0048	PASS
0,99999	PASS
1,0000	PASS



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)

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

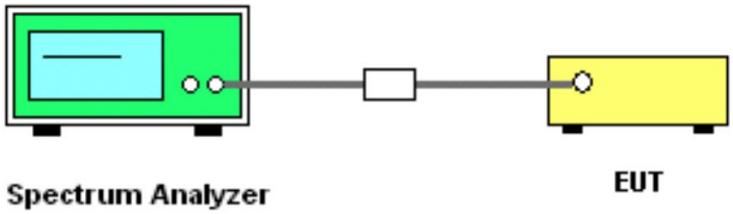
5.3 Limits

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.

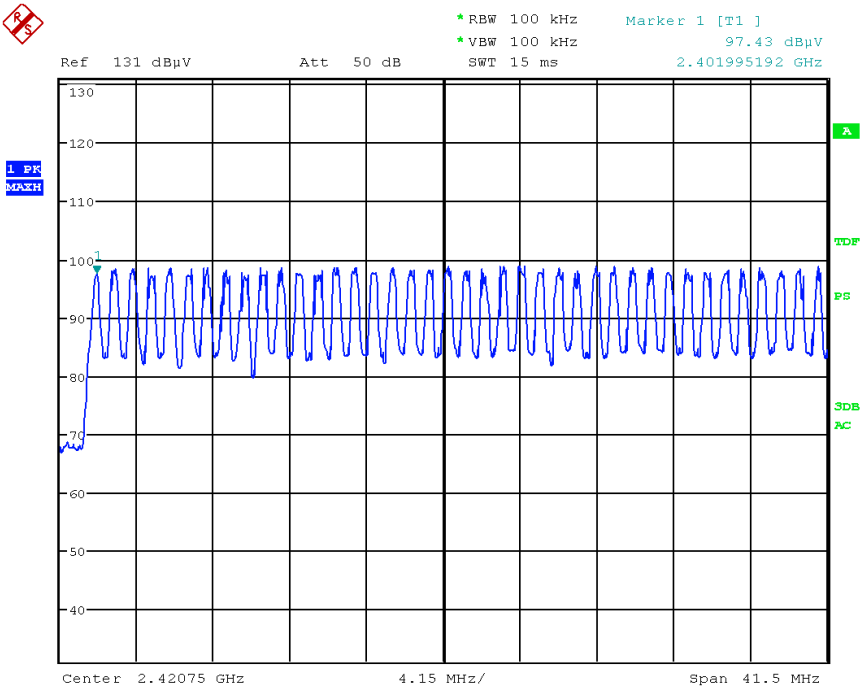
5.7 EUT operation during test

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

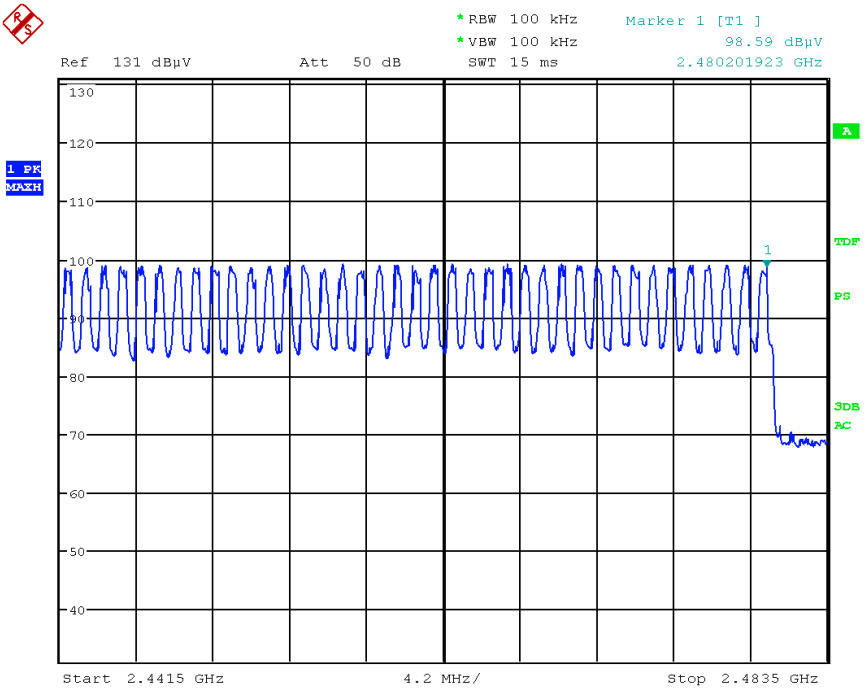
5.8 Test results

Temperature:	23°C	Humidity:	41%
Tested by:	CH.Kiermeier	Test date:	2012-01-26

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)

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

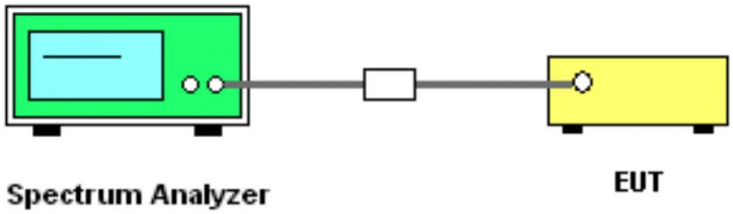
6.3 Limits

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

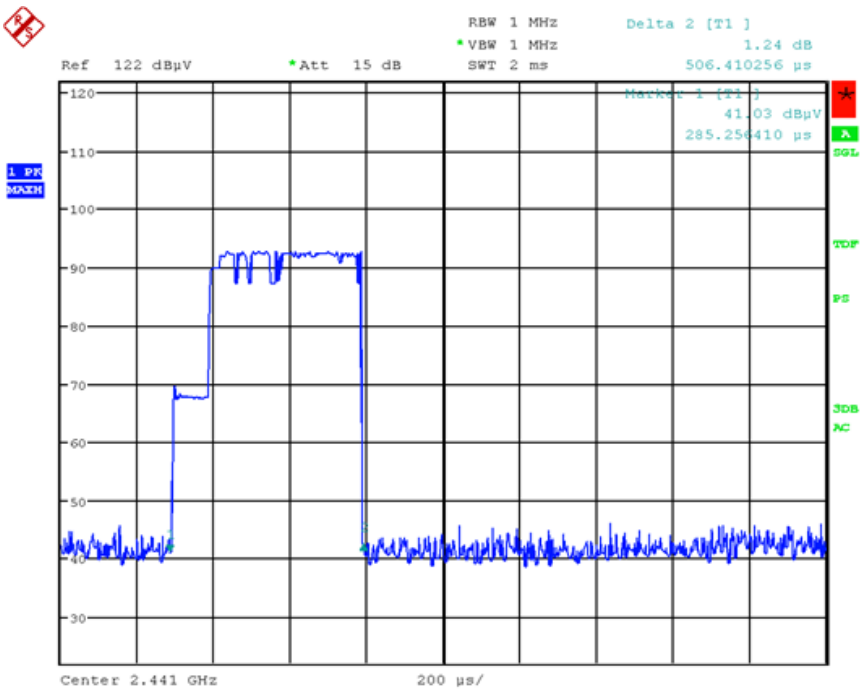
The EUT was programmed to be in continuously transmitting mode with enabled hopping function.

6.8 Test results

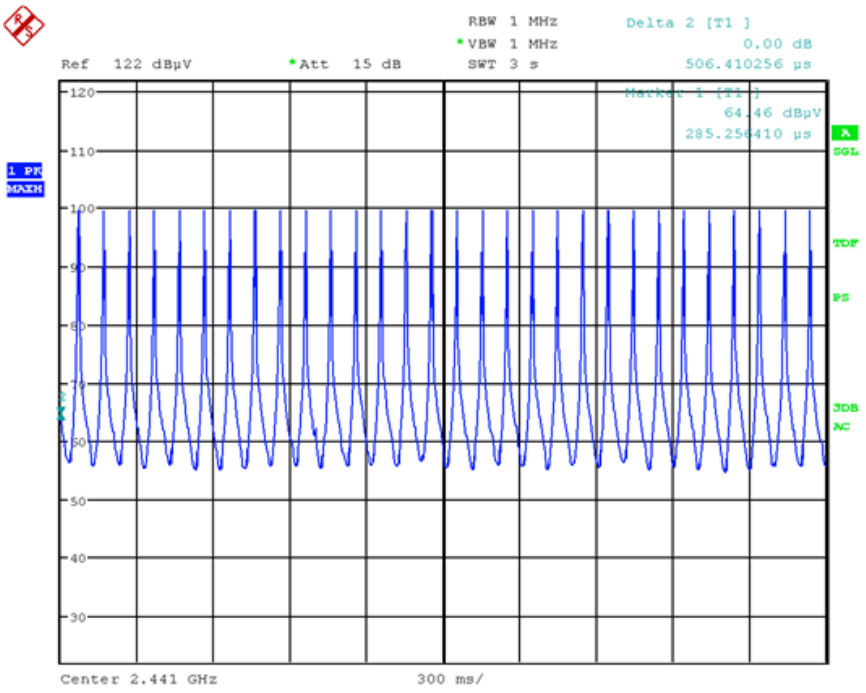
Temperature:	23°C	Humidity:	41%
Tested by:	CH.Kiermeier	Test date:	2012-01-26

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	0.506	159.9	400	PASS
DH3 (GFSK)	31.6s	15	5	1.69	267.0	400	PASS
DH5 (GFSK)	31.6s	10	3,33	3.03	319.2	400	PASS
EDR 3Mbps DH5 (8DPSK)	31.6s	10	3,33	2.96	311.8	400	PASS
EDR 2Mbps DH5 (Pi/4 DQPSK)	31,6s	10	3,33	2,93	308,3	400	PASS

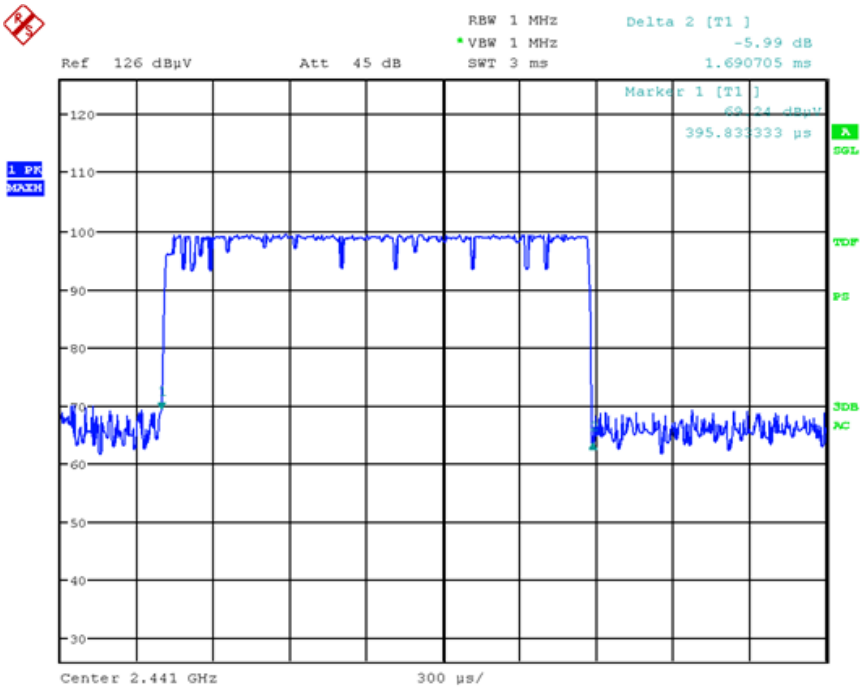
Dwell Time = Number of hopping in 1sec * Time of Transmission*Signal On Time



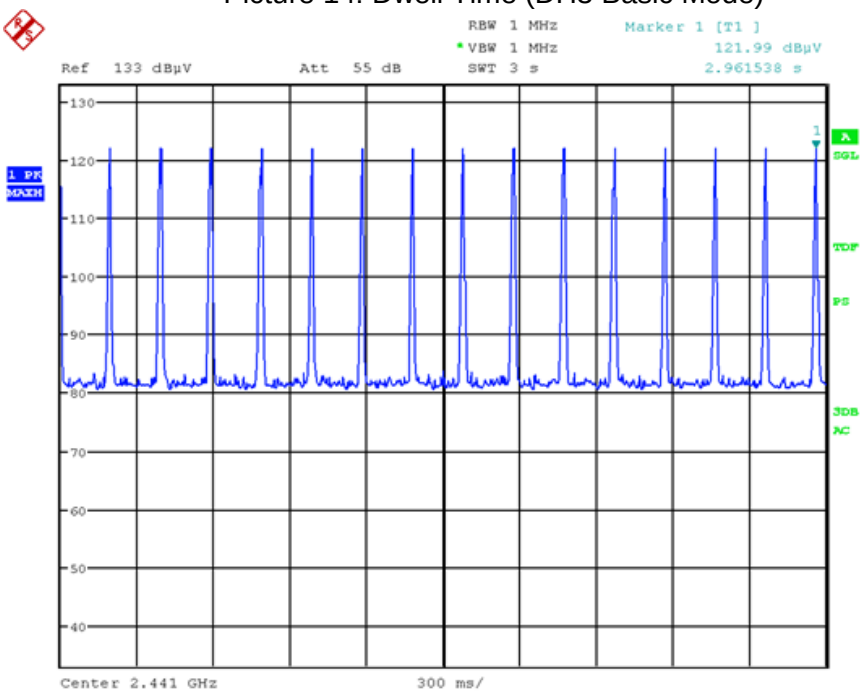
Picture 12: Dwell Time (DH1 Basic Mode)



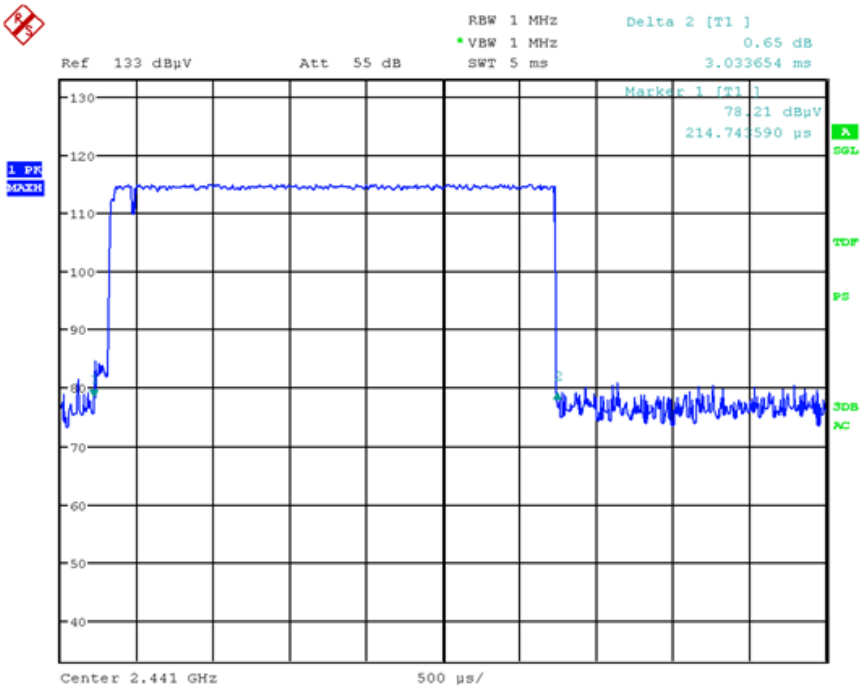
Picture 13: Dwell Time (DH1 Basic Mode)



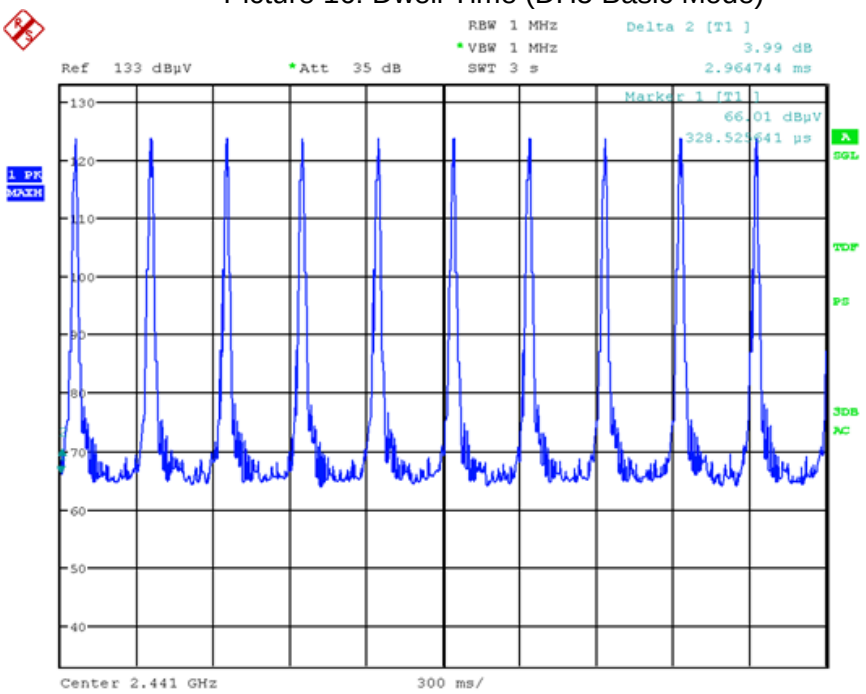
Picture 14: Dwell Time (DH3 Basic Mode)



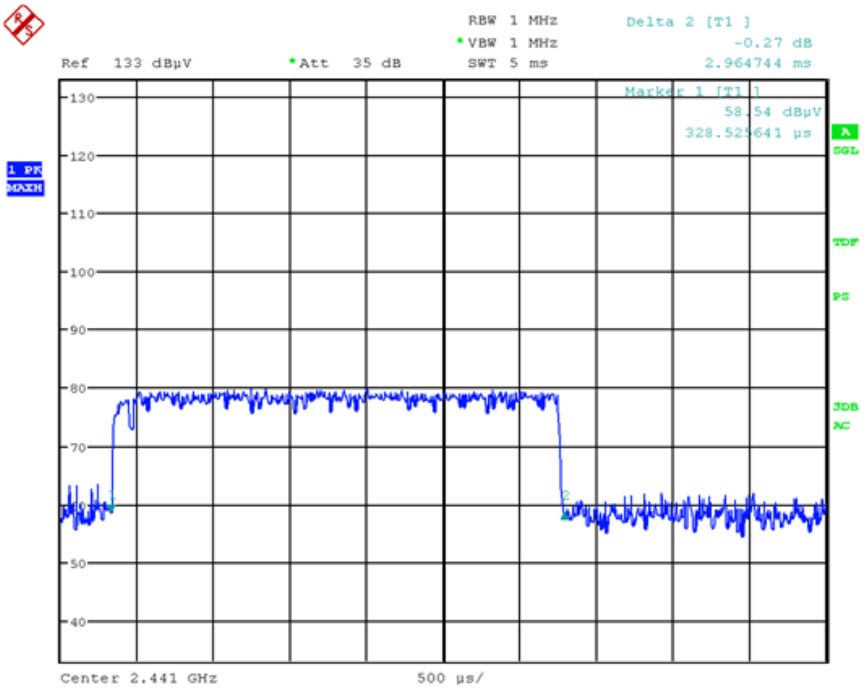
Picture 15: Dwell Time (DH3 Basic Mode)



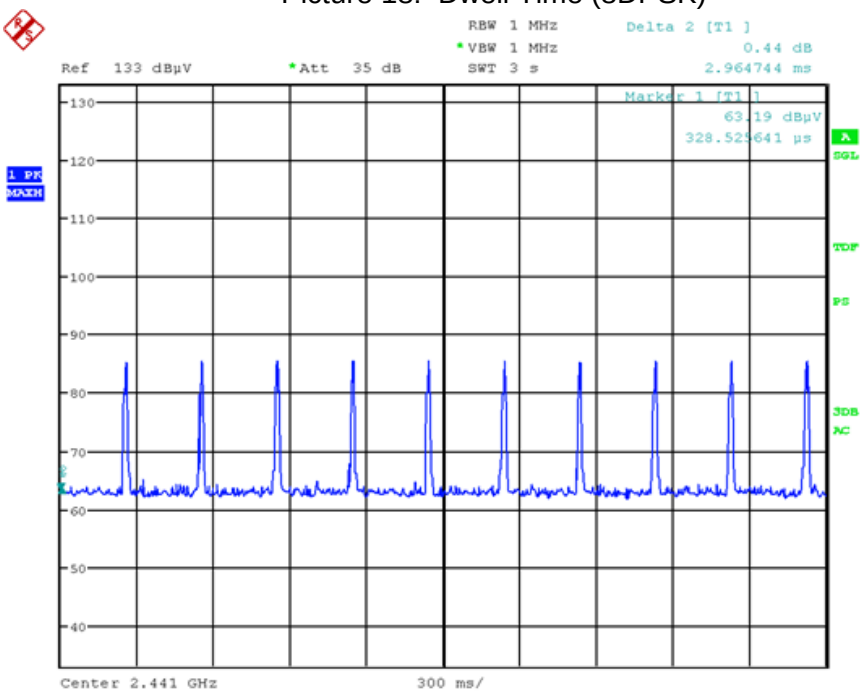
Picture 16: Dwell Time (DH5 Basic Mode)



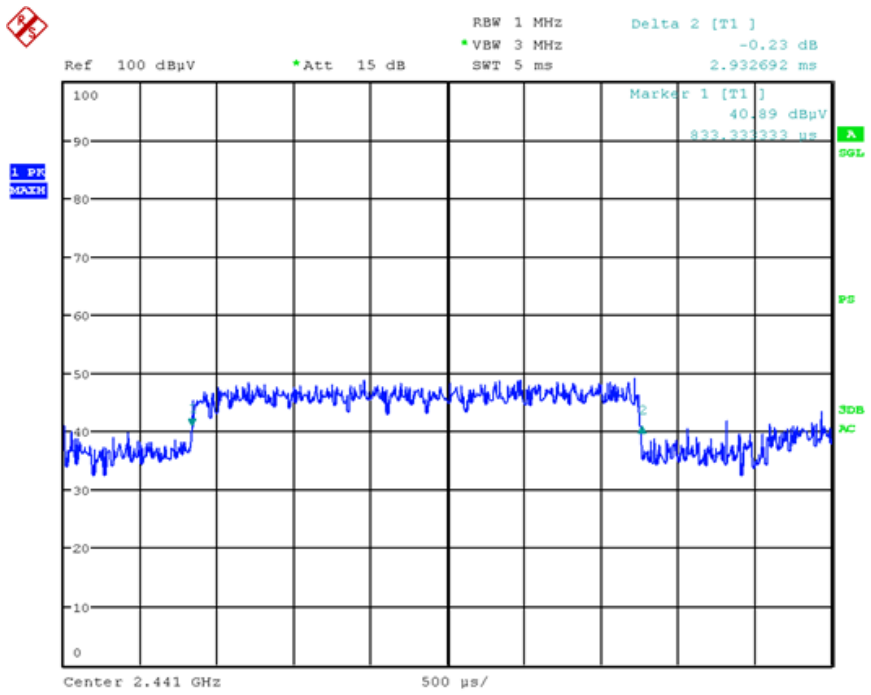
Picture 17: Dwell Time (DH5 Basic Mode)



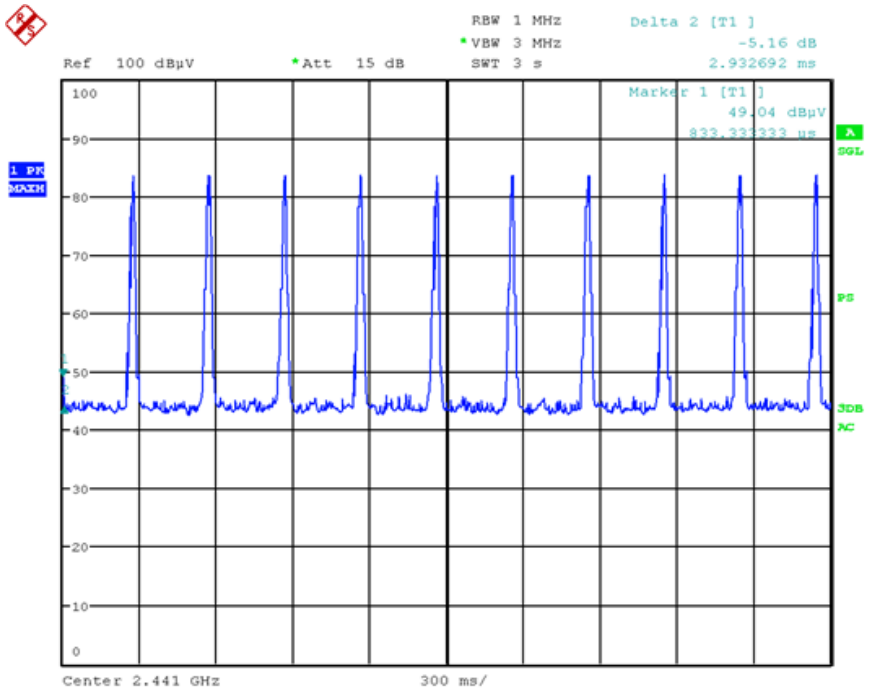
Picture 18: Dwell Time (8DPSK)



Picture 19: Dwell Time (8DPSK)



Picture 20: Dwell Time (Pi/4 DQPSK)



Picture 21: Dwell Time (Pi/4 DQPSK)

,

7 20dB bandwidth

according to CFR 47 Part 15 section 2.247(a)

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

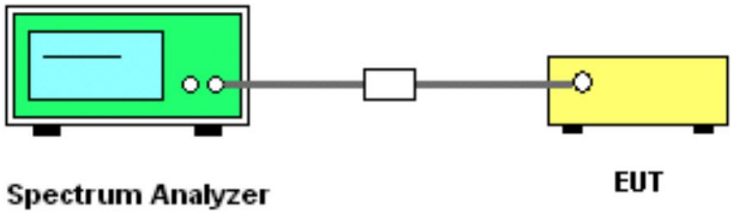
7.3 Limits

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.

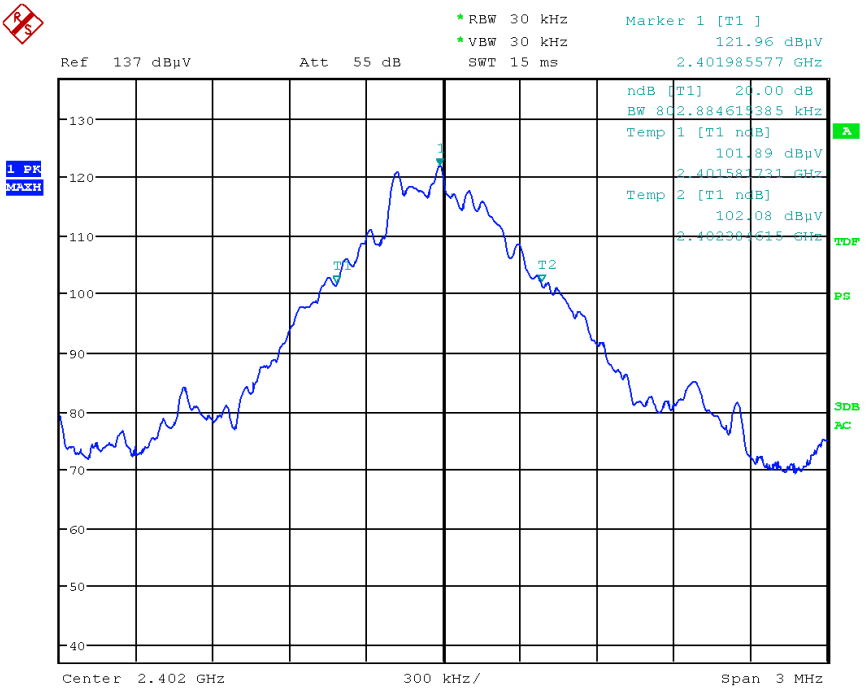
7.7 EUT operation during test

The EUT was programmed to be in continuously transmitting mode.

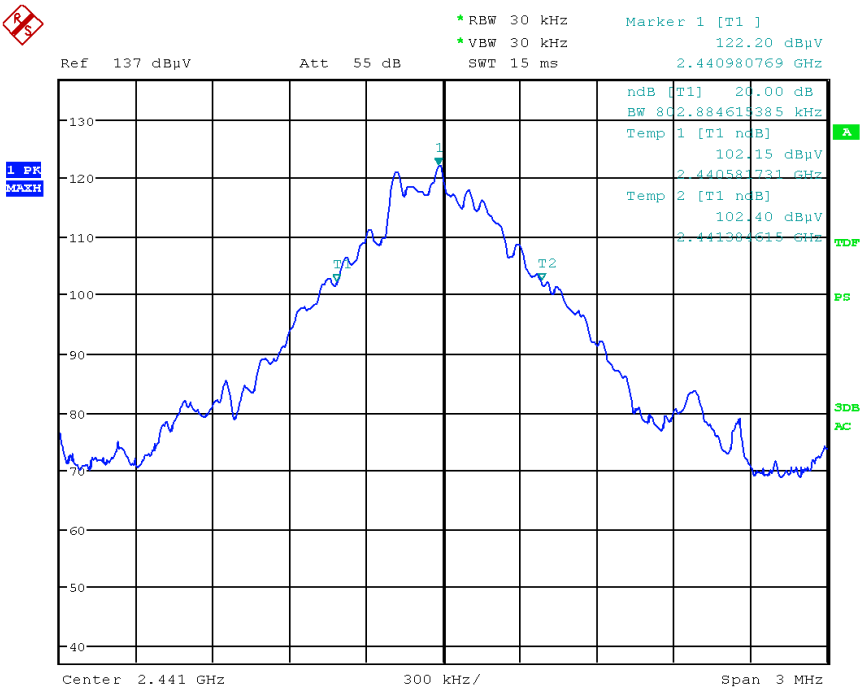
7.8 Test results

Temperature:	22°C	Humidity:	44%
Tested by:	Ch.Kiermeier	Test date:	2012-01-26

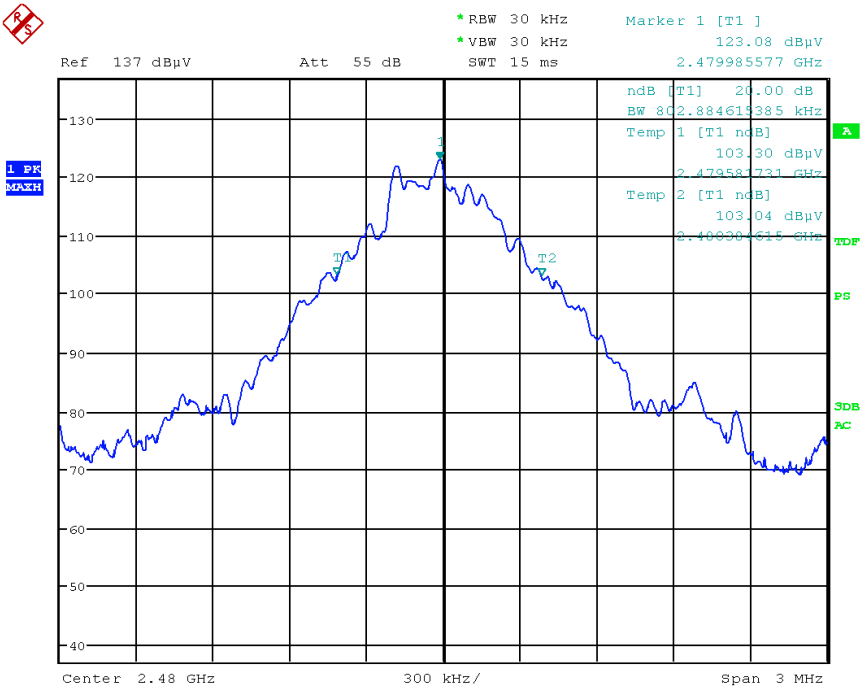
GFSK		
Channel	**Frequency (GHz)**	**20 dB bandwidth (MHz)**
0	2.402	0.802
39	2.441	0.802
78	2.480	0.802
8DPSK		
Channel	**Frequency (GHz)**	**20 dB bandwidth (MHz)**
0	2.402	1.264
39	2.441	1.264
78	2.480	1.264
Pi/4 DQPSK		
Channel	**Frequency (GHz)**	**20 dB bandwidth (MHz)**
0	2.402	1,240
39	2.441	1,235
78	2.480	1,250



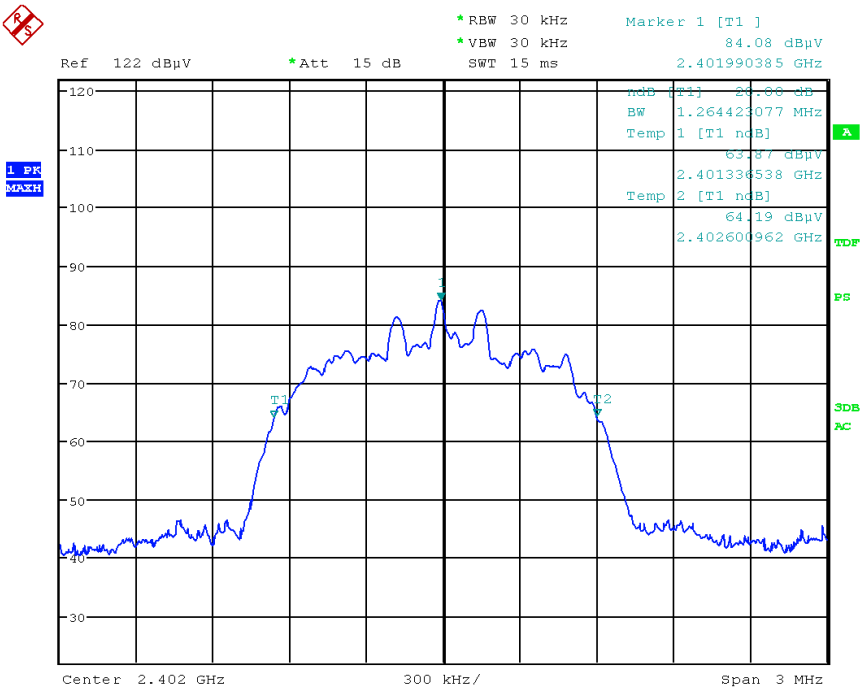
Picture 23: 20dB bandwidth channel 0 (GFSK)



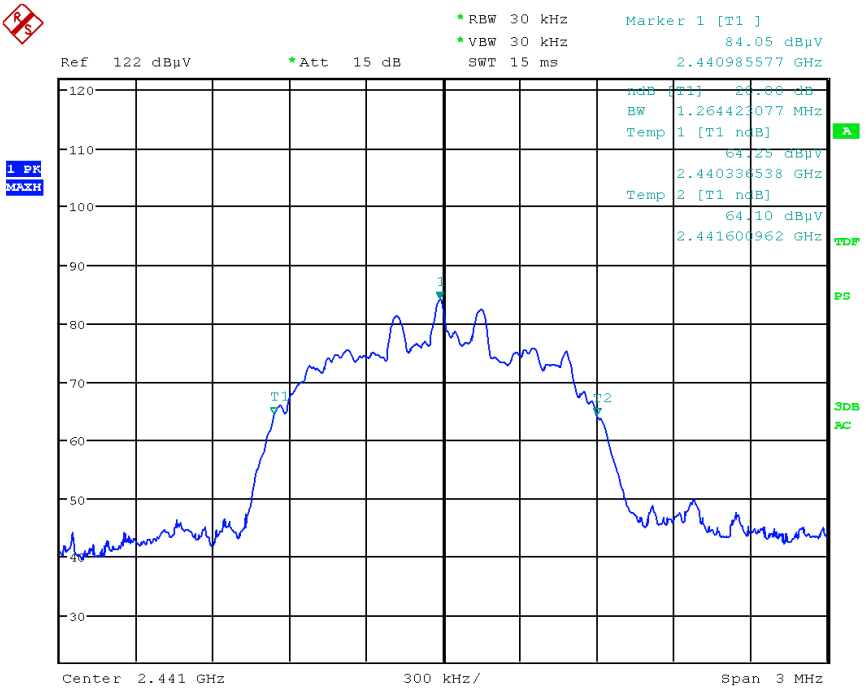
Picture 24: 20dB bandwidth channel 39 (GFSK)



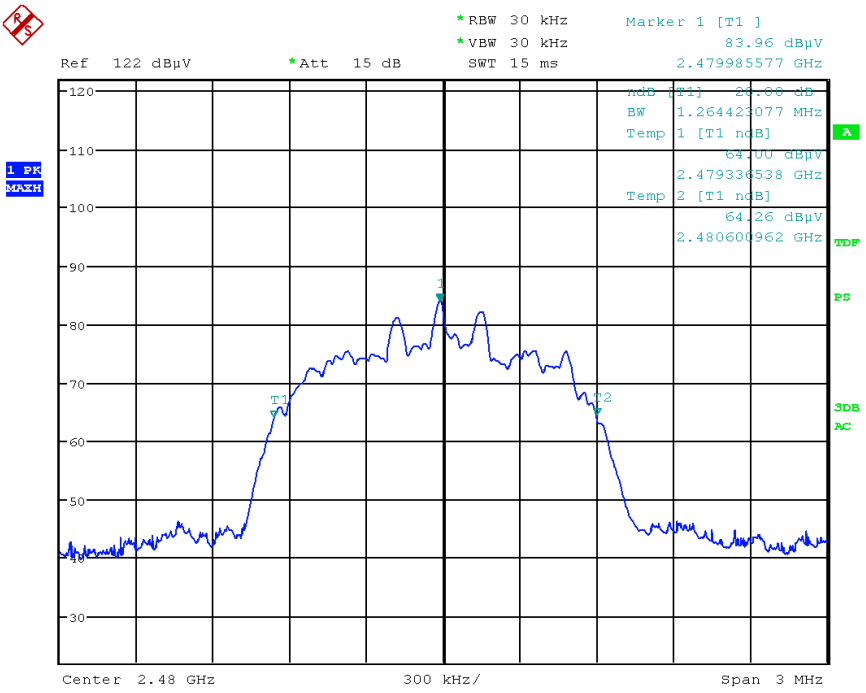
Picture 25: 20dB bandwidth channel 78 (GFSK)



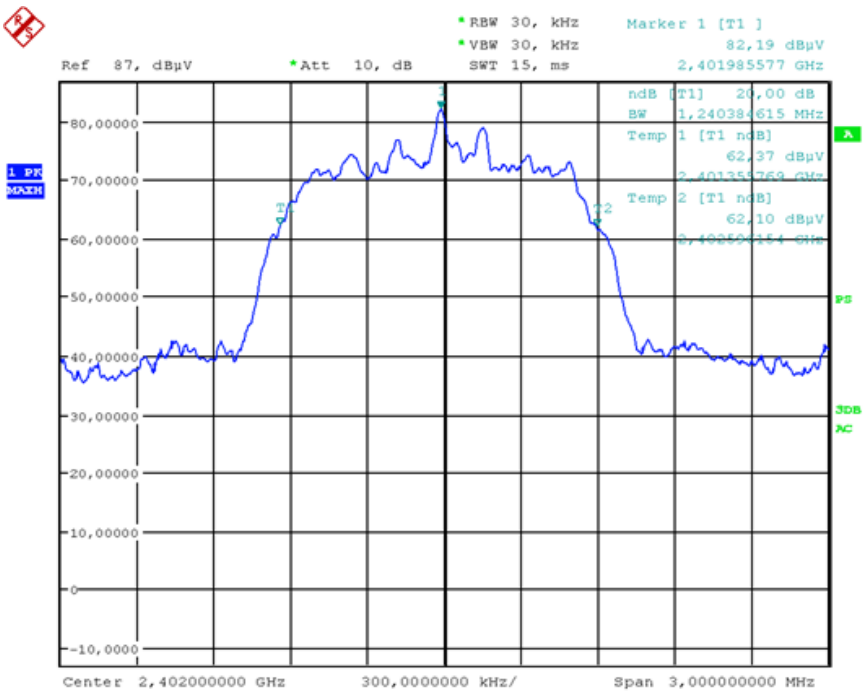
Picture 26: 20dB bandwidth channel 0 (8DPSK)



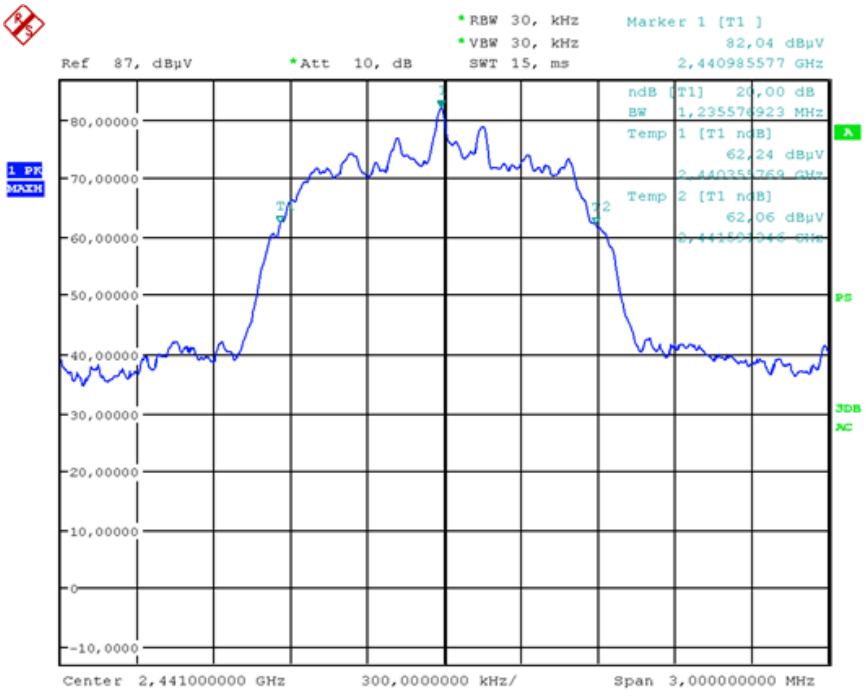
Picture 27: 20dB bandwidth channel 39 (8DPSK)



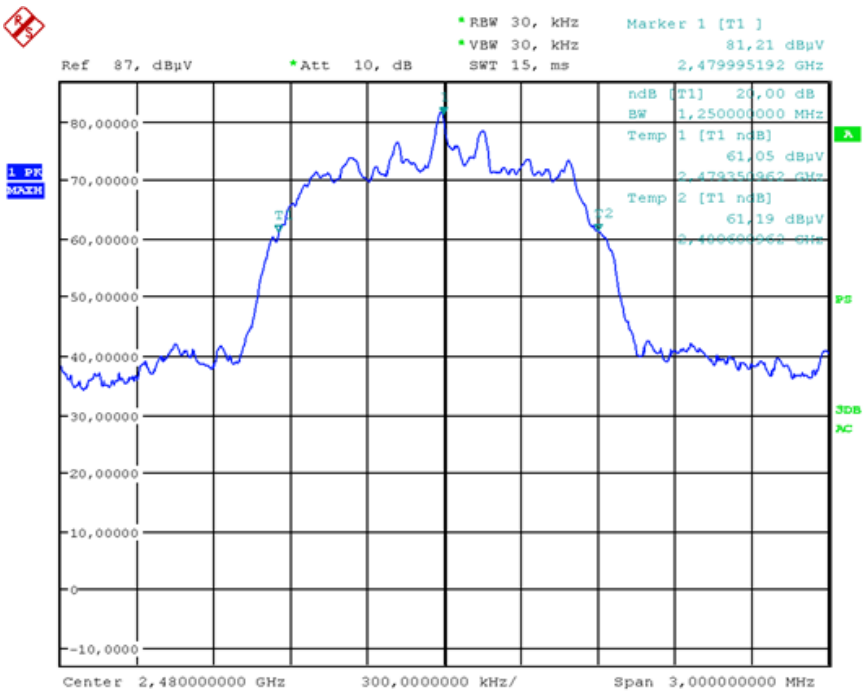
Picture 28: 20dB bandwidth channel 78 (8DPSK)



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 Maximum conducted output power

according to CFR 47 Part 15, section 15.247(b)

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	Rohde & Schwarz	W00002
☐	ESCI (CDC)	Rohde & Schwarz	E00001
☐	HFH2-Z2	Rohde & Schwarz	E00060
☐	VULB 9163 (FF)	Schwarzbeck	E00013
☐	VULB 9160 (CDC)	Schwarzbeck	E00011

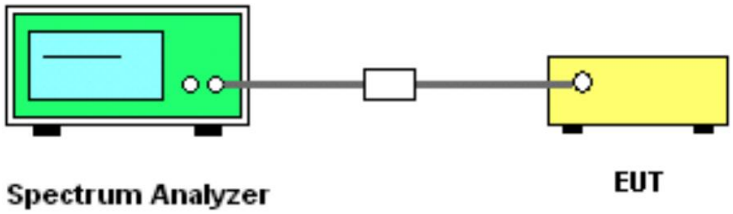
8.3 Limits

For systems using digital modulation in the 902-928 MHz, 2400-2483.5 MHz, and 5725-5850 MHz bands is 1 Watt (30dBm).
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.

8.4 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.

8.5 Test setup



Picture 32: Test setup for conducted output power measurement

8.6 Test deviation

There is no deviation with the original standard.

8.7 EUT operation during Test

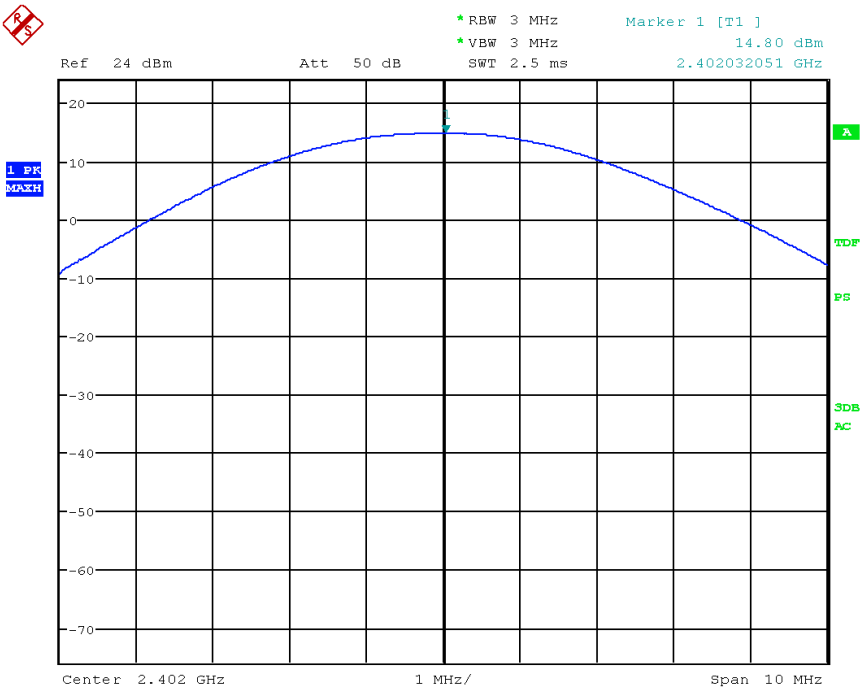
The EUT was programmed to be in continuously transmitting mode.

8.8 Test results

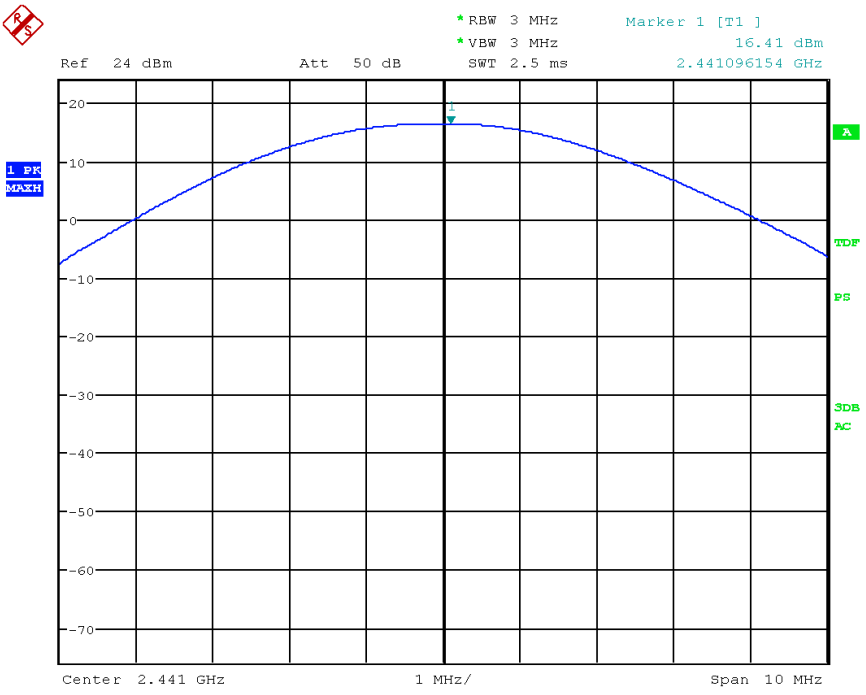
Temperature:	22°C	Humidity:	44%
Tested by:	Ch.Kiermeier	Test date:	2012-01-26

GFSK					
Channel	**Frequency (GHz)**	**Detector**	**Conducted power (dBm)**	**Limit (dBm)**	**Result**
0	2.402	PK	14,80	30	PASS
39	2.441	PK	16.41	30	PASS
78	2.480	PK	16.72	30	PASS
8DPSK					
Channel	**Frequency (GHz)**	**Detector**	**Conducted power (dBm)**	**Limit (dBm)**	**Result**
0	2.402	PK	-7.24	30	PASS
39	2.441	PK	-6.35	30	PASS
78	2.480	PK	-6.61	30	PASS
Pi/4 DQPSK					
Channel	**Frequency (GHz)**	**Detector**	**Conducted power (dBm)**	**Limit (dBm)**	**Result**
0	2.402	PK	-22,73	30	PASS
39	2.441	PK	-22,78	30	PASS
78	2.480	PK	-23,02	30	PASS

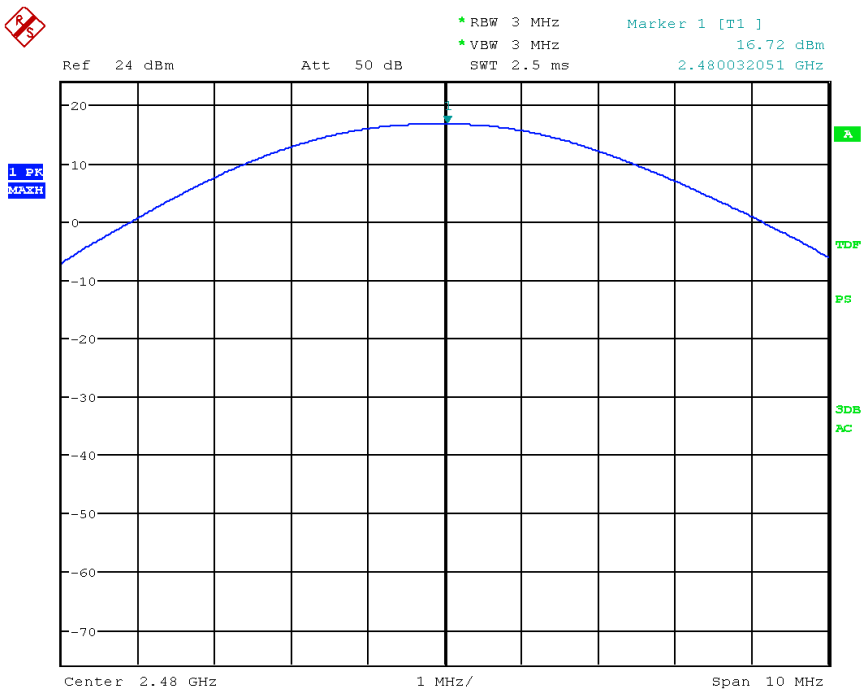
Comments: The reduction of the output power in EDR mode is given by the firmware of the EUT.



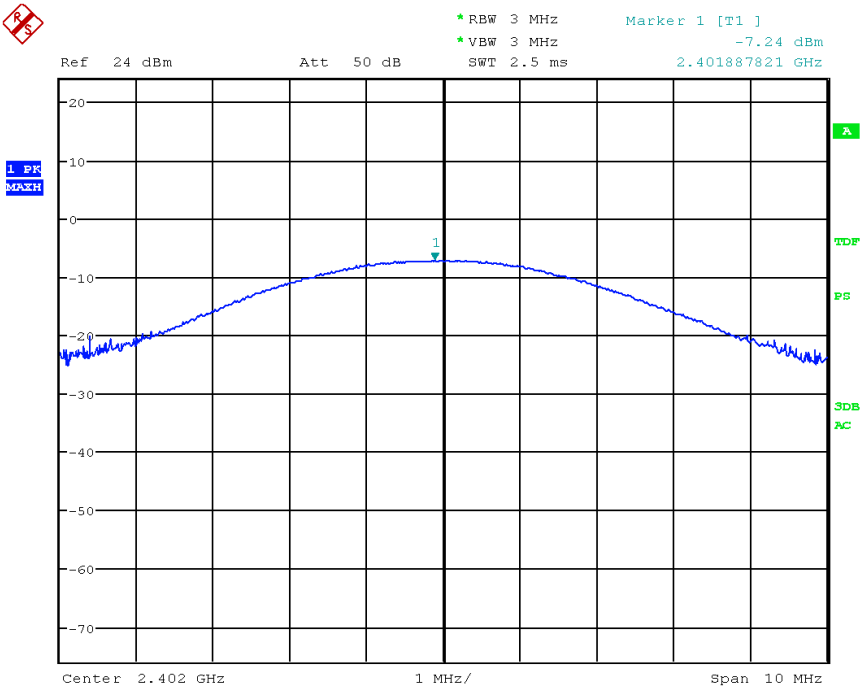
Picture 33: Conducted output power channel 0 (GFSK)



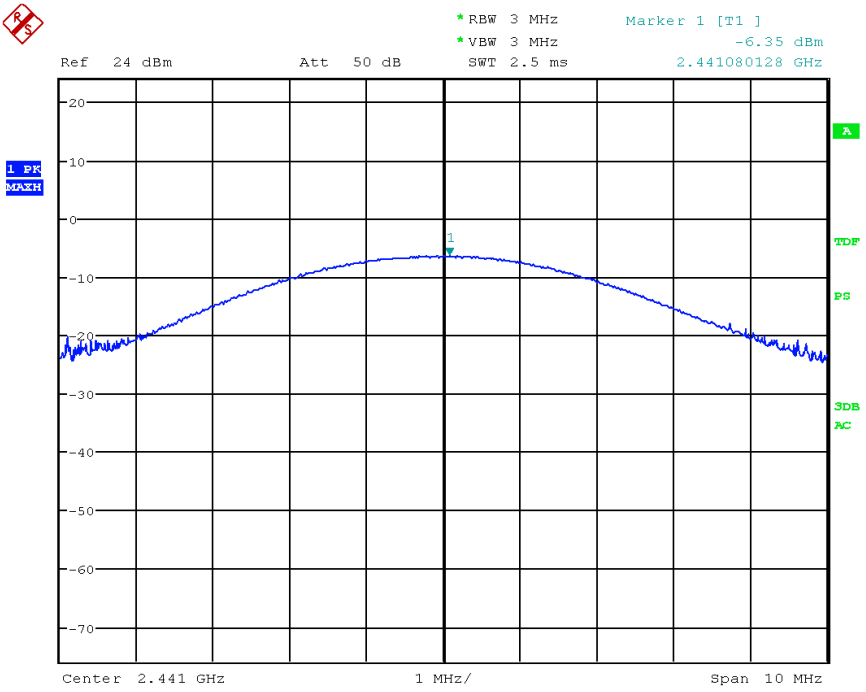
Picture 34: Conducted output power channel 39 (GFSK)



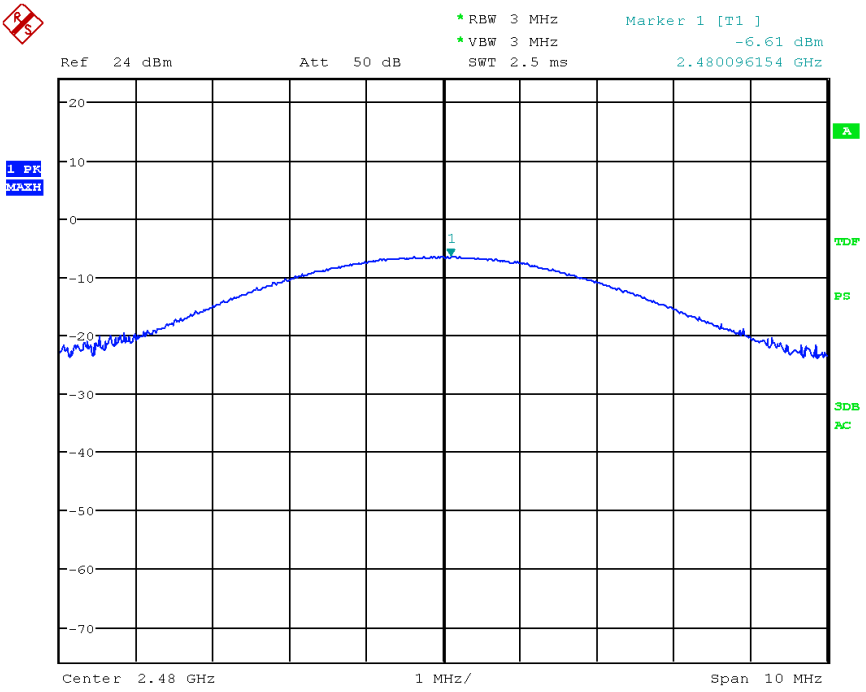
Picture 35: Conducted output power channel 78 (GFSK)



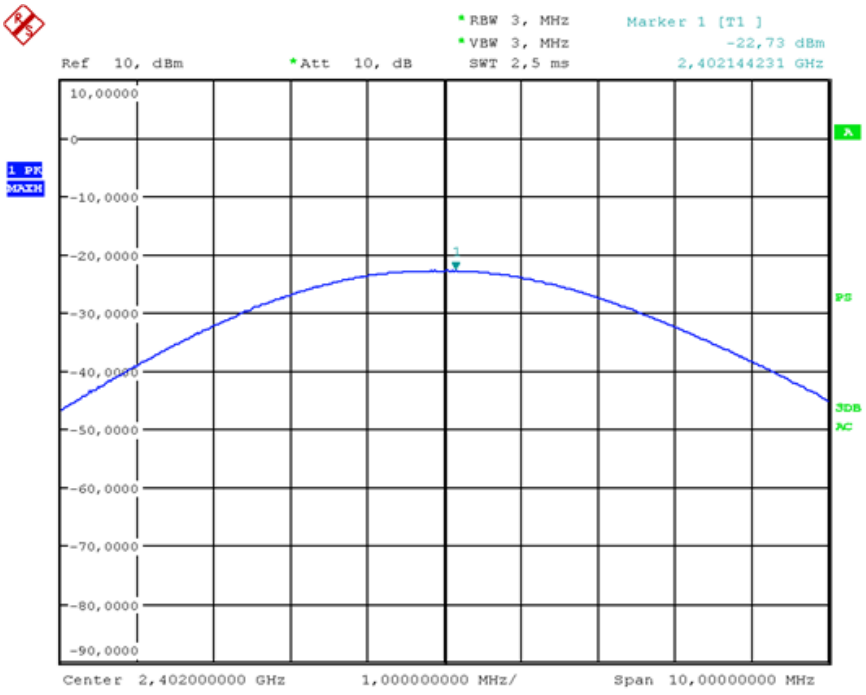
Picture 36: Conducted output power channel 0 (8DPSK)



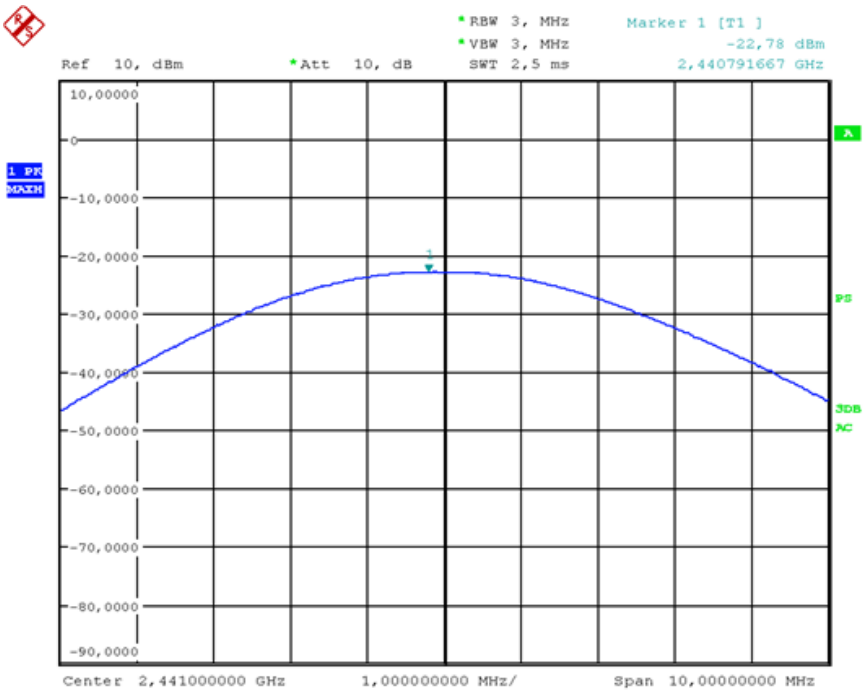
Picture 37: Conducted output power channel 39 (8DPSK)



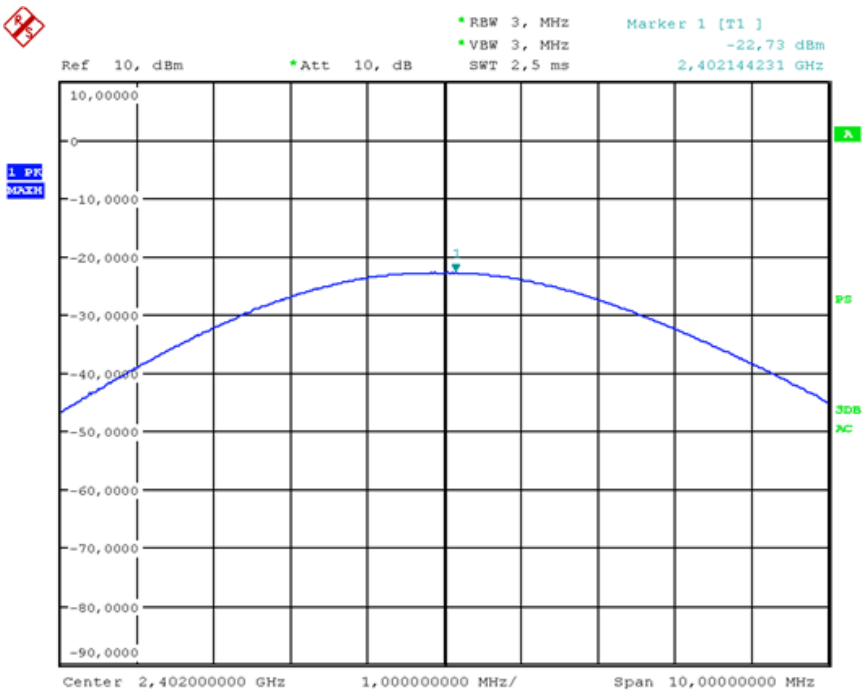
Picture 38: Conducted output power channel 78 (8DPSK)



Picture 39: Conducted output power channel 0 (Pi/4 DQPSK)



Picture 40: Conducted output power channel 39 (Pi/4 DQPSK)



Picture 41: Conducted output power channel 78 (Pi/4 DQPSK)

9 Band-edge Compliance

according to CFR 47 Part 15 section 2.247(c)

9.1 Test location

☑ Scan with peak detector in 3 m anechoic chamber

9.2 Test Instruments

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

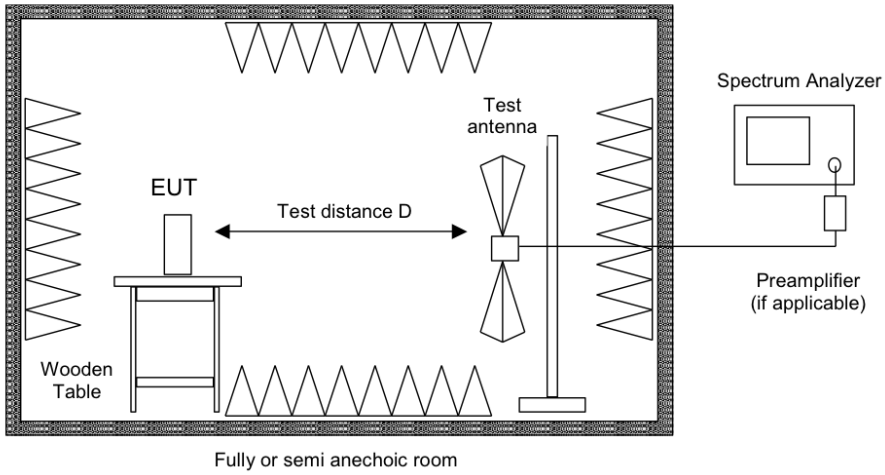
9.3 Limits

>20dBc outside restricted bands
54dBµV inside restricted bands

9.4 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.

9.5 Test setup



Picture 42: Test setup for band-edge compliance measurement

9.6 Test deviation

There is no deviation with the original standard.

9.7 EUT operation during test

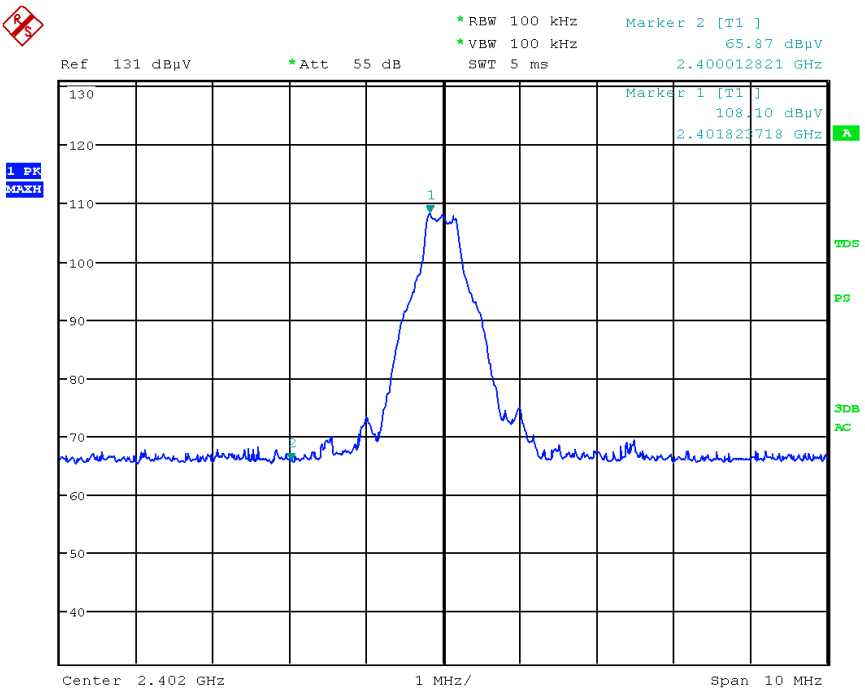
The EUT was programmed to be in continuously transmitting mode.

9.8 Test results

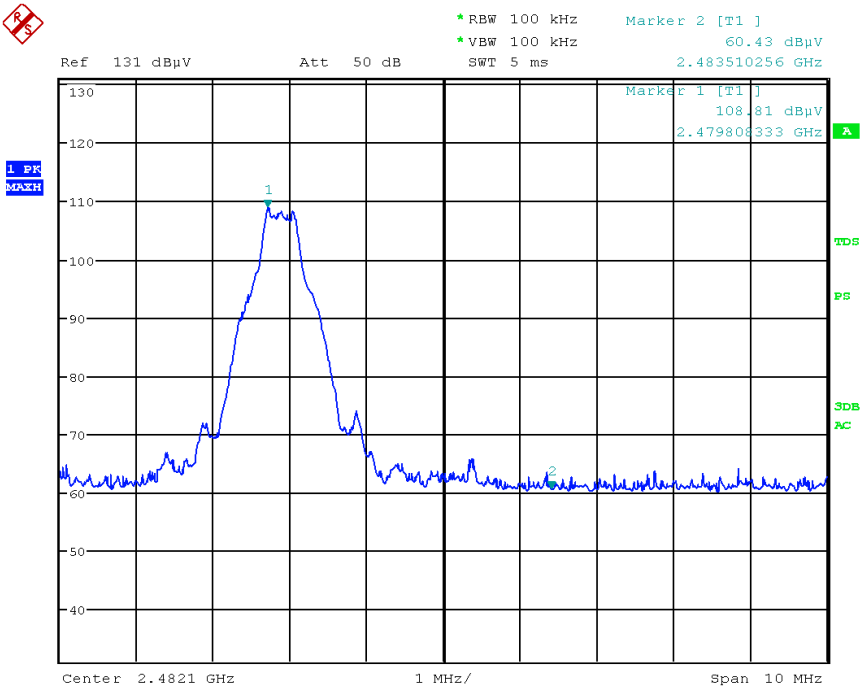
Temperature:	22°C	Humidity:	44%
Tested by:	Ch.Kiermeier	Test date:	2012-01-26

GFSK			
Frequency (GHz)	**Detector**	**Reading value (dBµV)**	**Limit**
2.4835	PK	60.43	74
2.4835	AV	40.28	54
8DPSK			
Frequency (GHz)	**Detector**	**Reading value (dBµV)**	**Limit**
2.4835	PK	37,12	74
2.4835	AV	25,15	54
Pi/4 DQPSK			
Frequency (GHz)	**Detector**	**Reading value (dBµV)**	**Limit**
2.4835	PK	38,65	74
2.4835	AV	26,30	54

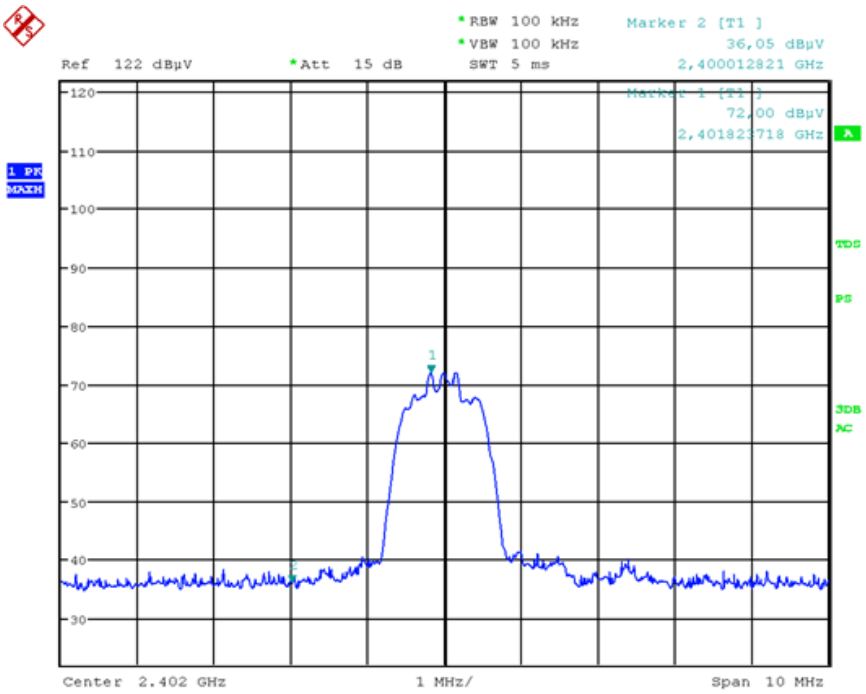
GFSK			
Frequency (GHz)	**Detector**	**Reading value (dBµV)**	**Limit**
2.400	PK	65,87	74
2.400	AV	44.64	54
8DPSK			
Frequency (GHz)	**Detector**	**Reading value (dBµV)**	**Limit**
2.400	PK	36,05	74
2.400	AV	26,14	54
Pi/4 DQPSK			
Frequency (GHz)	**Detector**	**Reading value (dBµV)**	**Limit**
2.400	PK	36,26	74
2.400	AV	26,14	54



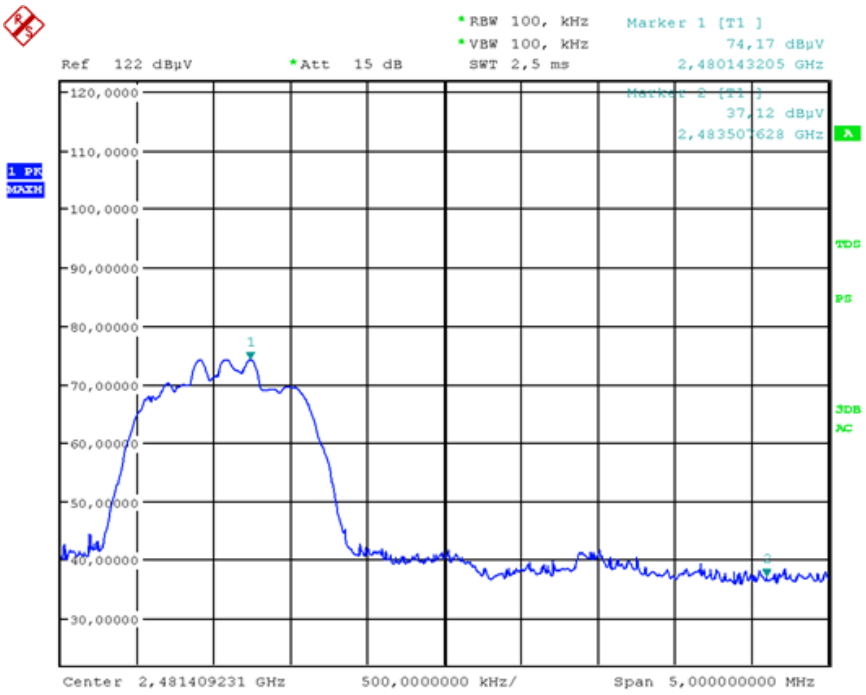
Picture 43: lower edge (GFSK)



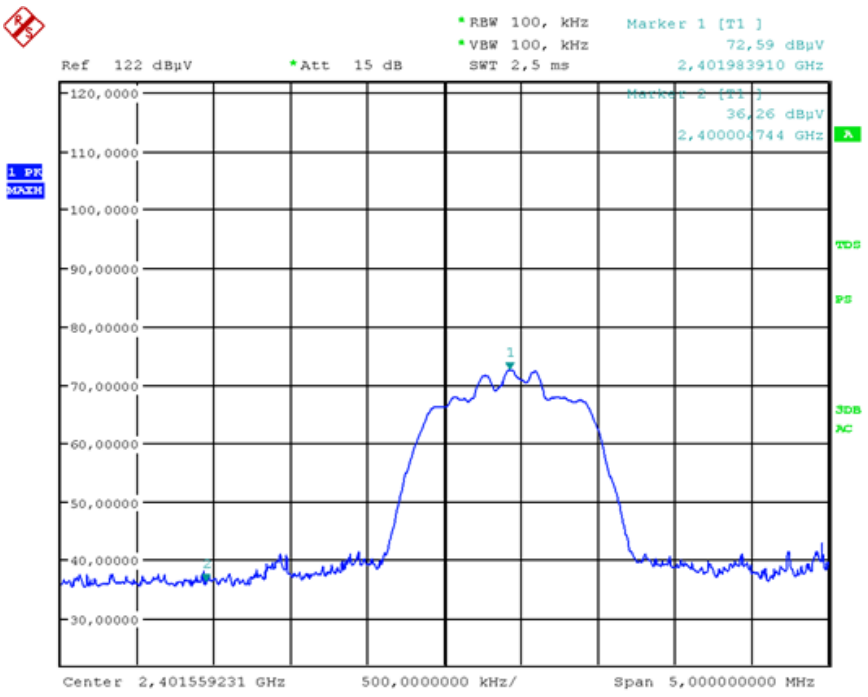
Picture 44: upper edge (GFSK)



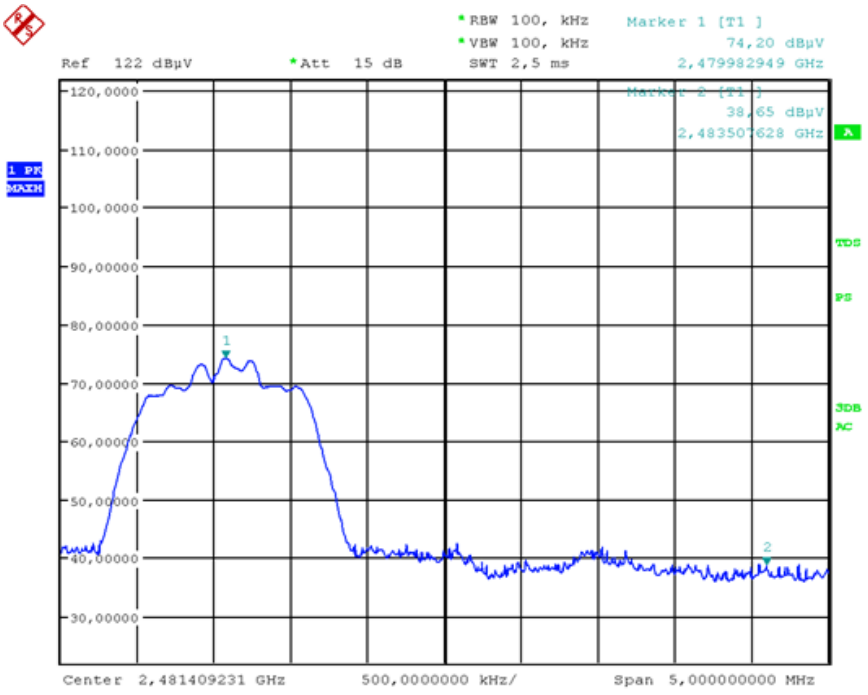
Picture 45: lower edge (8DPSK)



Picture 46: upper edge (8DPSK)



Picture 47: lower edge (Pi/4 DQPSK)



Picture 48: upper edge (Pi/4 DQPSK)

10 Spurious RF Conducted Emission

according to CFR 47 Part 15 section 2.247(c)

10.1 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

10.2 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

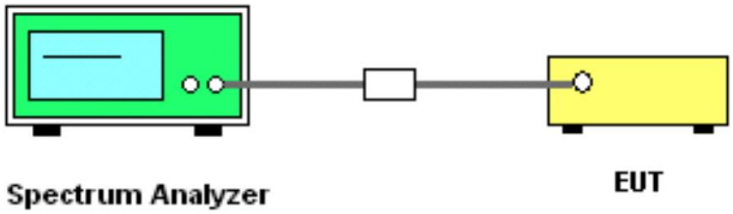
10.3 Limits

74dBµV (PK) according to 15.209

10.4 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 10^{th} harmonic.

10.5 Test setup



Picture 49: Test setup for conducted spurious emission measurement

10.6 Test deviation

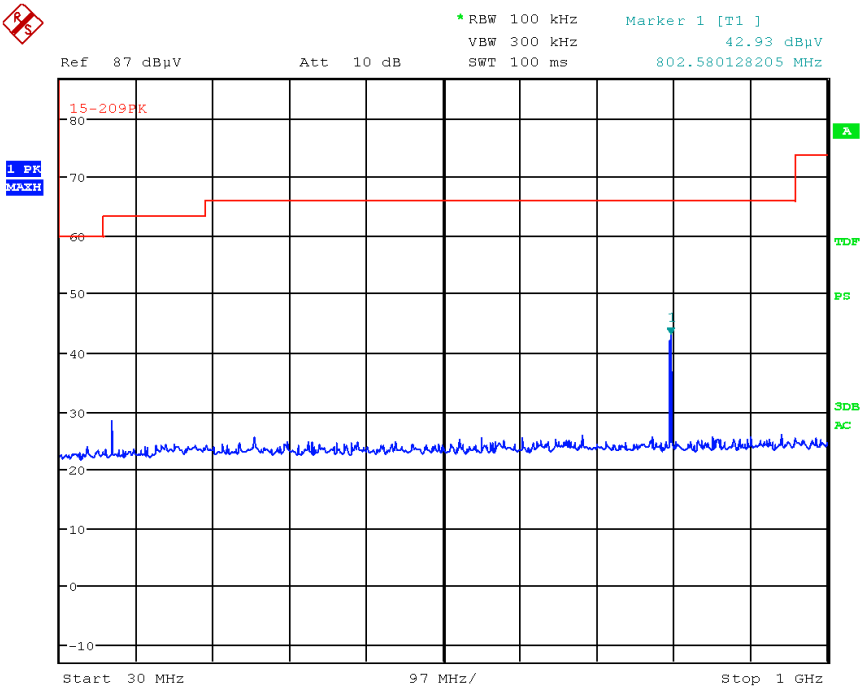
There is no deviation with the original standard.

10.7 EUT operation during test

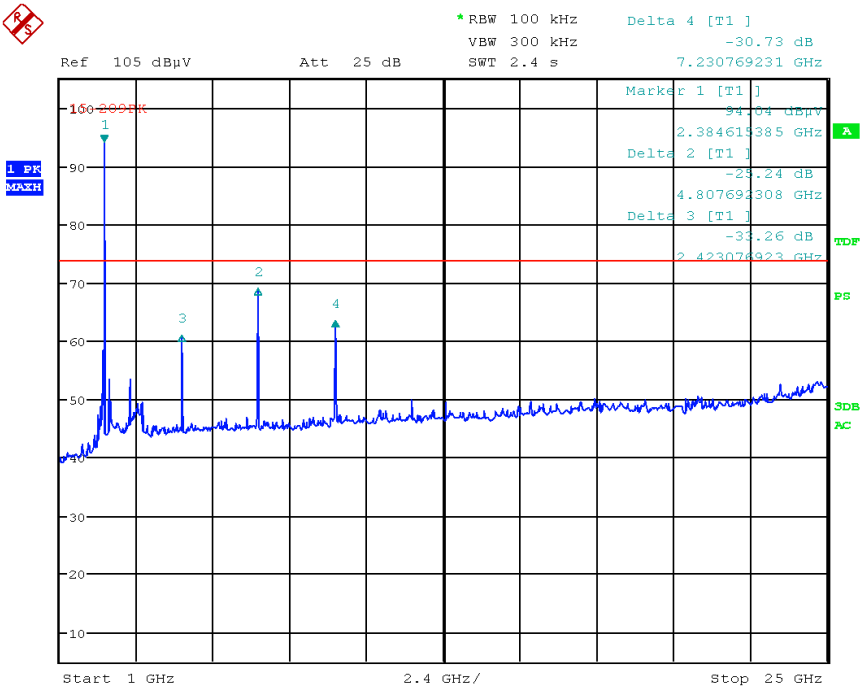
The EUT was programmed to be in continuously transmitting mode.

10.8 Test results

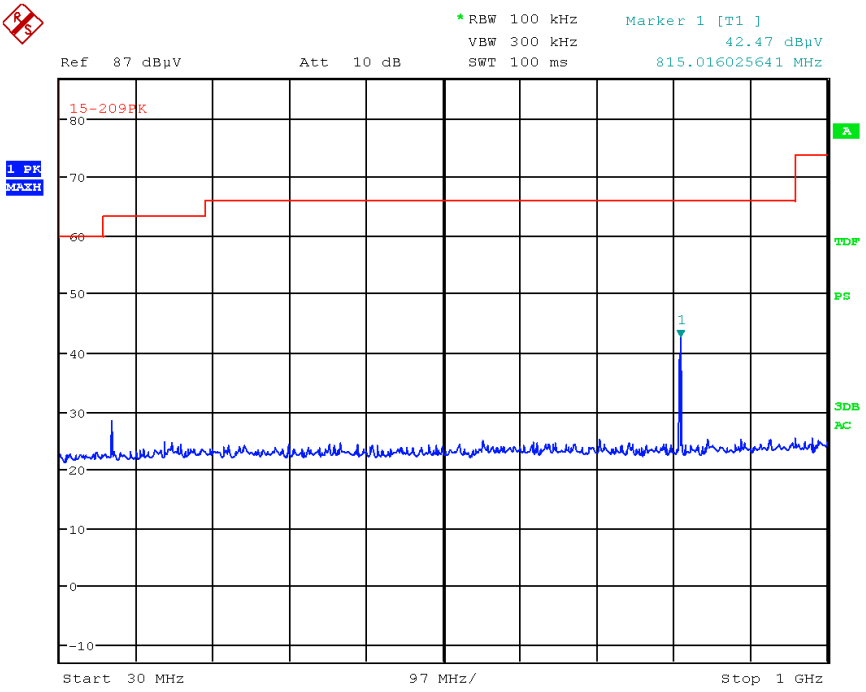
Temperature:	22°C	Humidity:	44%
Tested by:	Ch.Kiermeier	Test date:	2012-01-26



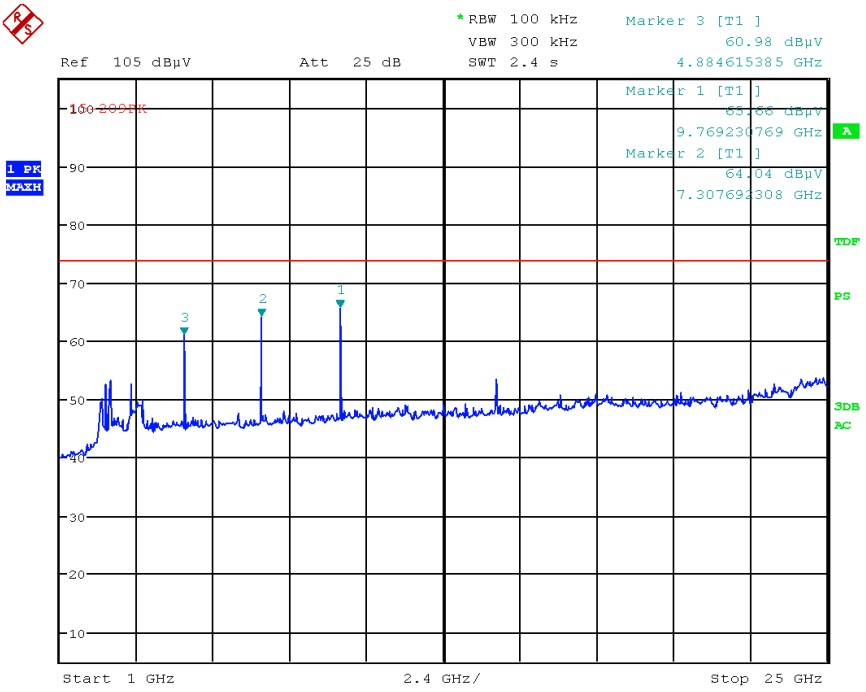
Picture 50: spurious emission channel 0 (30MHz – 1GHz) - GFSK



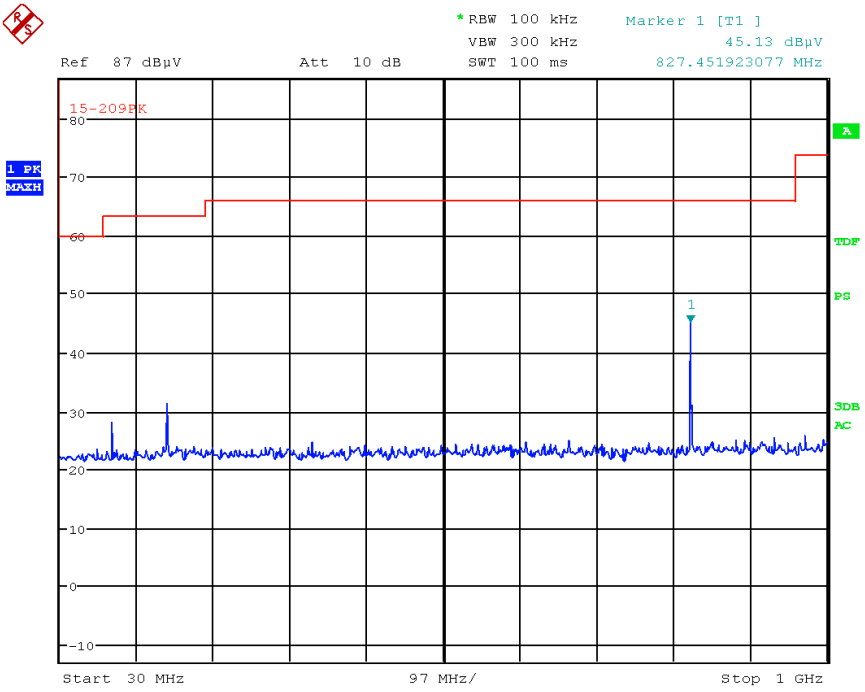
Picture 51: spurious emission channel 0 (1GHz – 25GHz) - GFSK



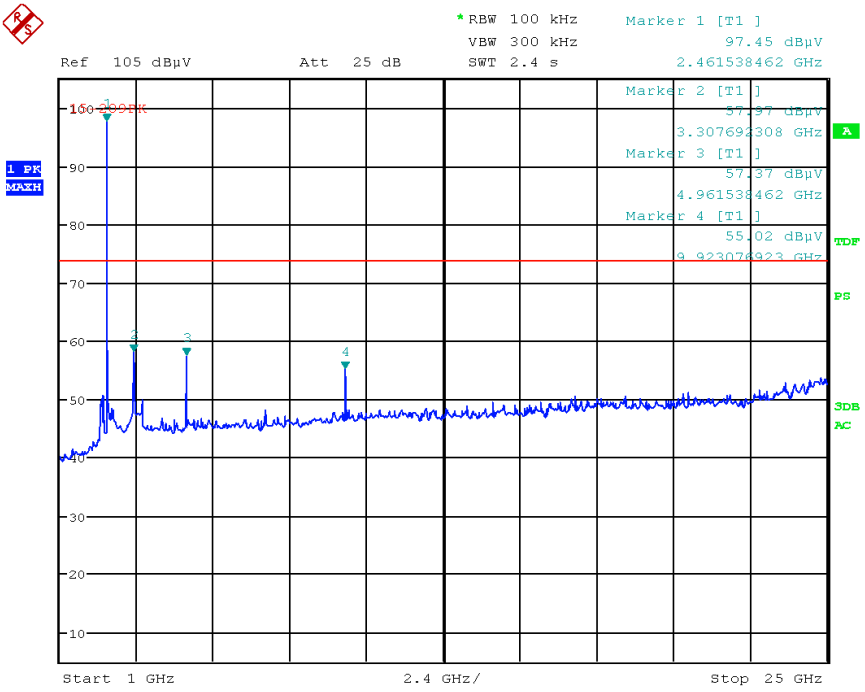
Picture 52: spurious emission channel 39 (30MHz – 1GHz - GFSK



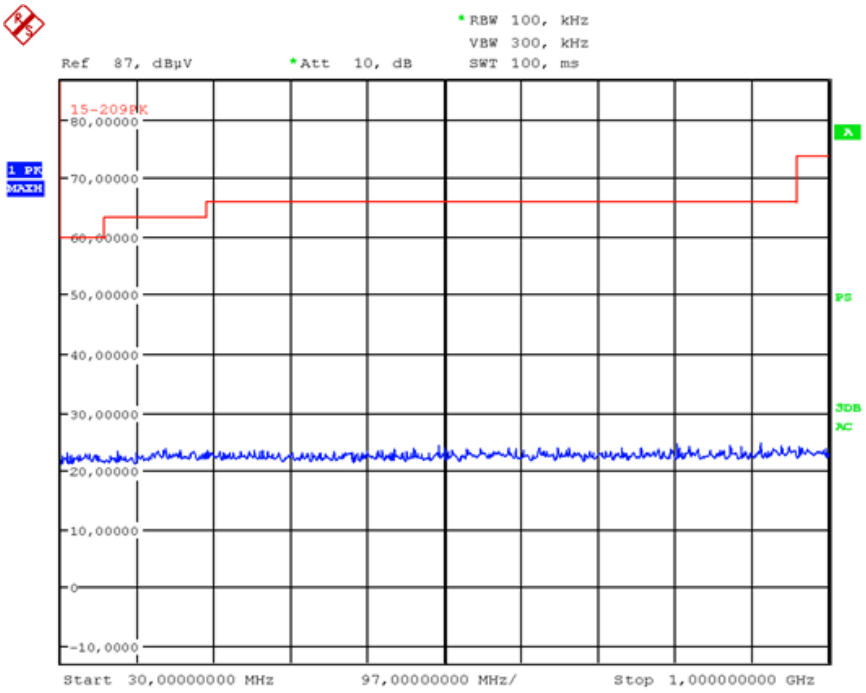
Picture 53: spurious emission channel 39 (1GHz – 25GHz) - GFSK



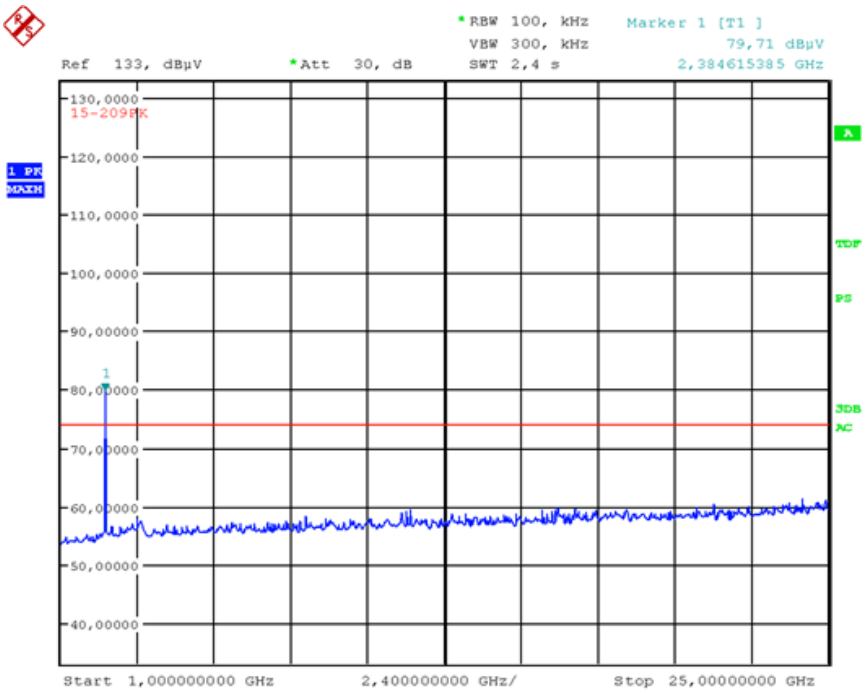
Picture 54: spurious emission channel 78 (30MHz – 1GHz) - GFSK



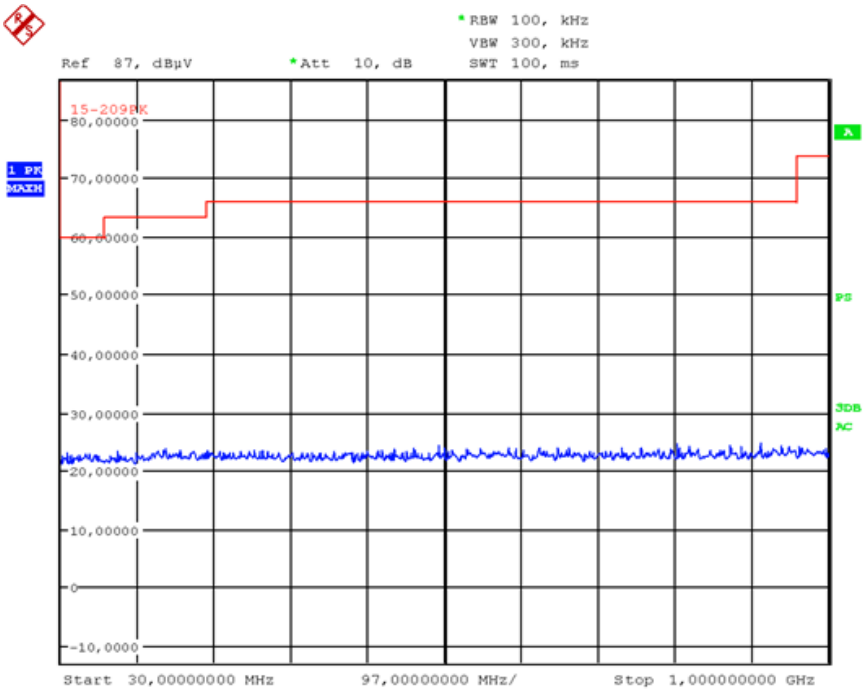
Picture 55: spurious emission channel 78 (1GHz – 25GHz) - GFSK



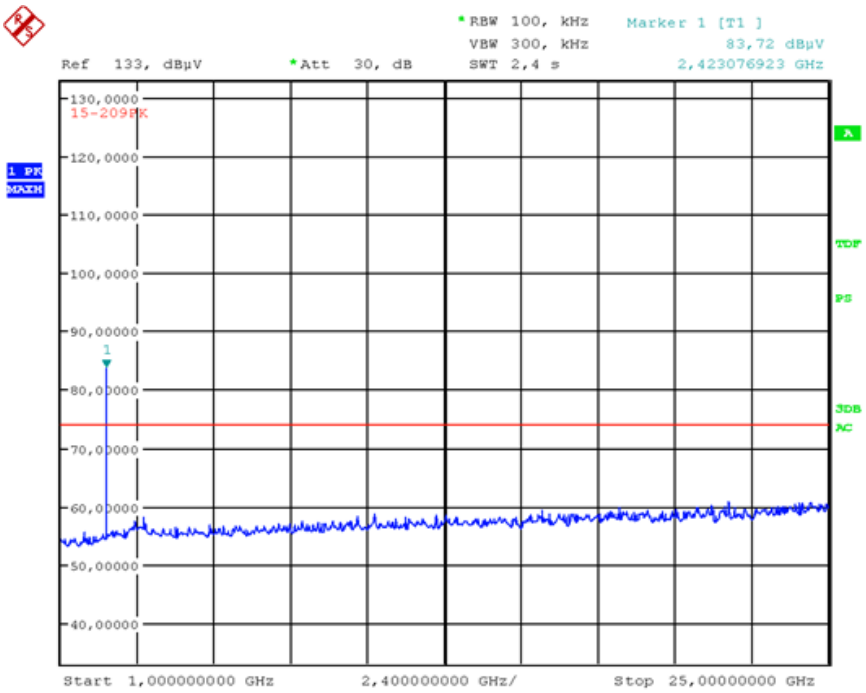
Picture 56: spurious emission channel 0 (30MHz – 1GHz) – 8DPSK



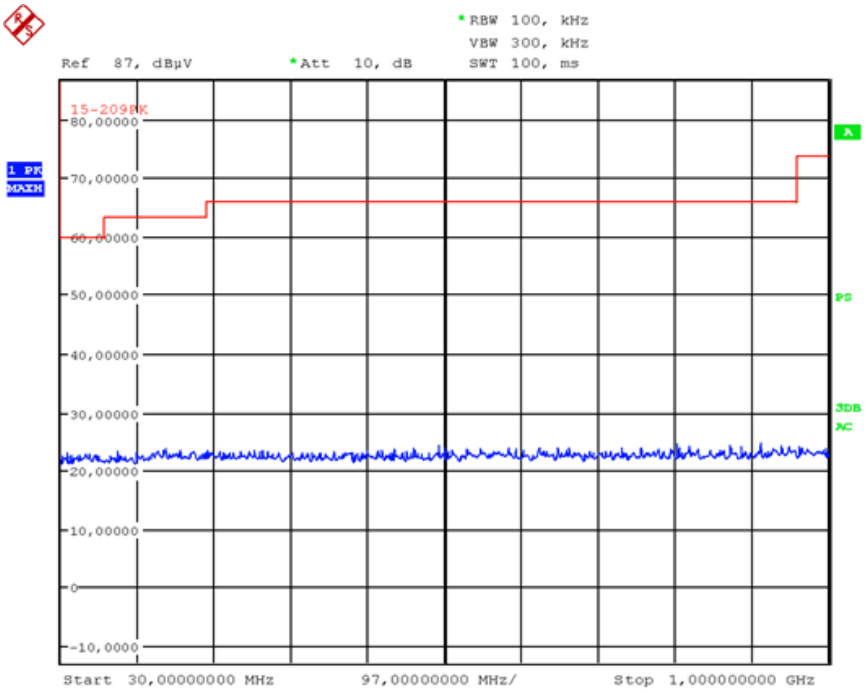
Picture 57: spurious emission channel 0 (1GHz – 25GHz) - 8DPSK



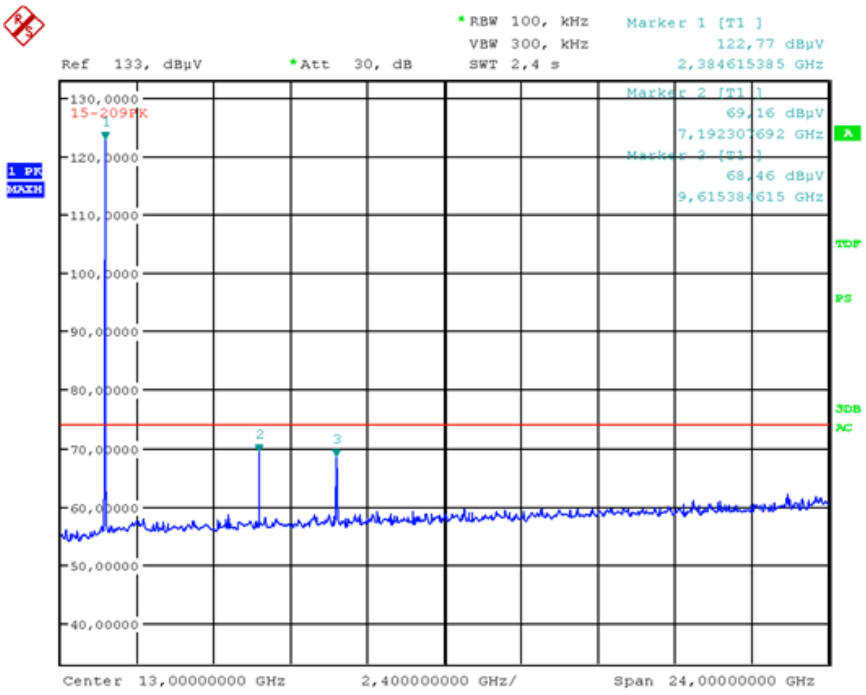
Picture 58: spurious emission channel 39 (30MHz – 1GHz - 8DPSK



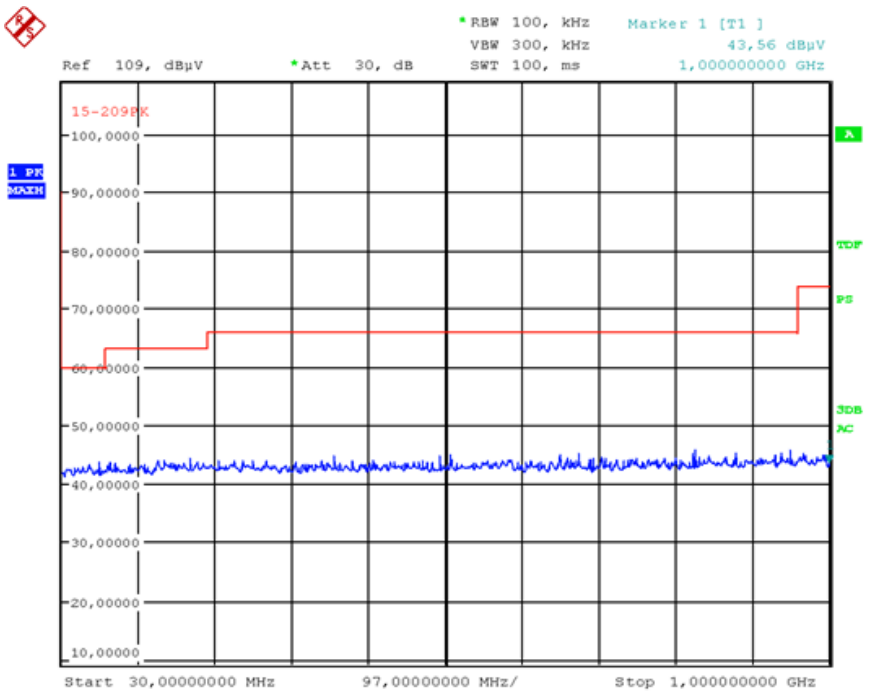
Picture 59: spurious emission channel 39 (1GHz – 25GHz) - 8DPSK



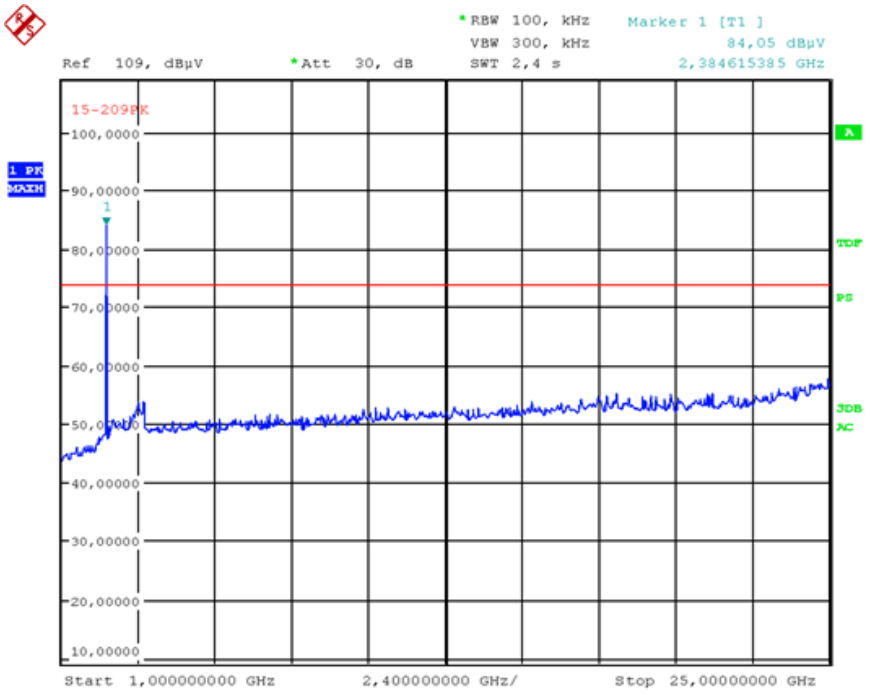
Picture 60: spurious emission channel 78 (30MHz – 1GHz) - 8DPSK



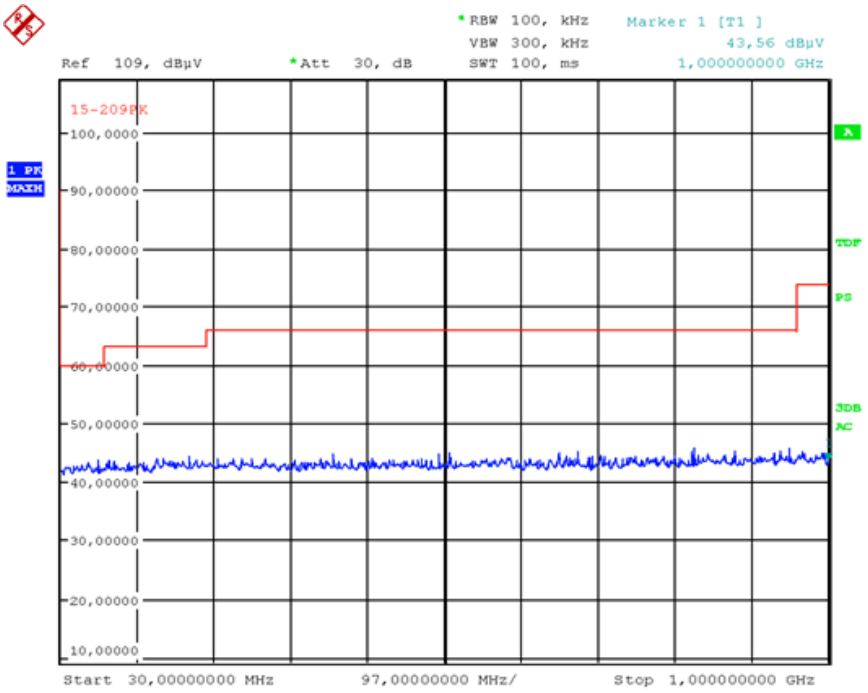
Picture 61: spurious emission channel 78 (1GHz – 25GHz) - 8DPSK



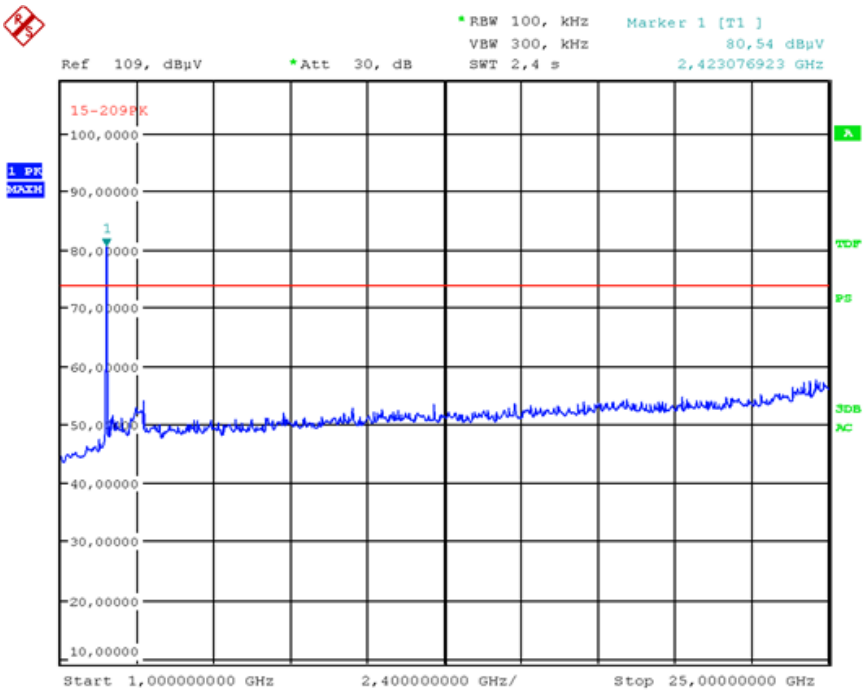
Picture 62: spurious emission channel 0 (30MHz – 1GHz) – Pi/4 DQPSK



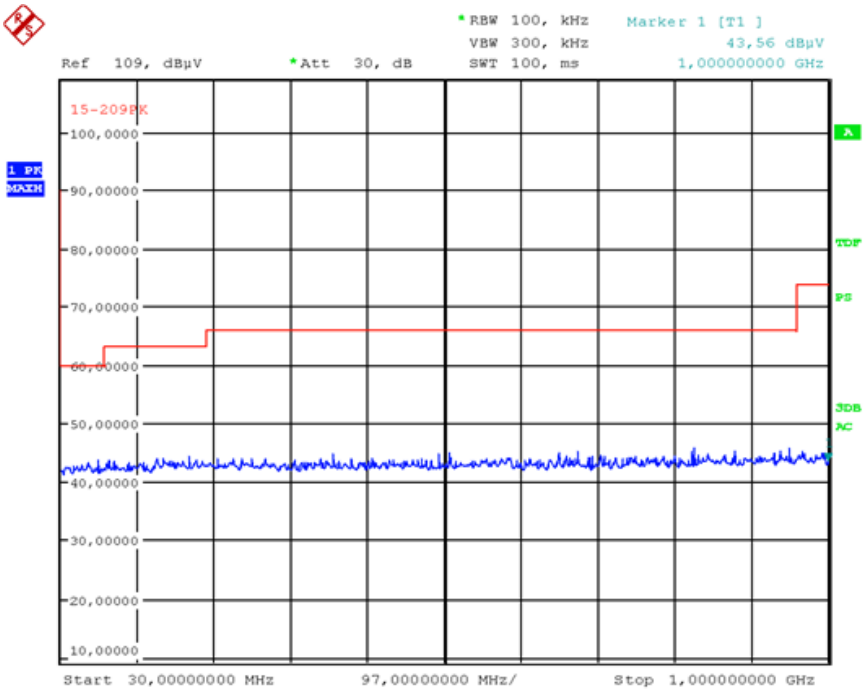
Picture 63: spurious emission channel 0 (1GHz – 25GHz) - Pi/4 DQPSK



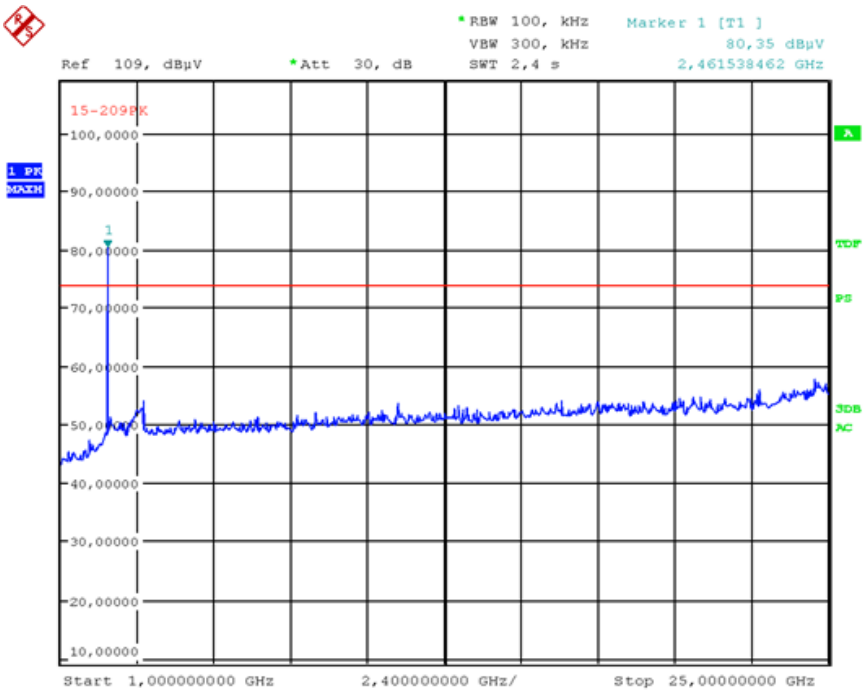
Picture 64: spurious emission channel 39 (30MHz – 1GHz - Pi/4 DQPSK



Picture 65: spurious emission channel 39 (1GHz – 25GHz) - Pi/4 DQPSK



Picture 66: spurious emission channel 78 (30MHz – 1GHz) - Pi/4 DQPSK



Picture 67: spurious emission channel 78 (1GHz – 25GHz) - Pi/4 DQPSK

11 Radiated emission measurement (<1 GHz)

according to CFR 47 Part 15, section 15.205(a), 15.209(a), 15.247(d)

11.1 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

11.2 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

11.3 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.

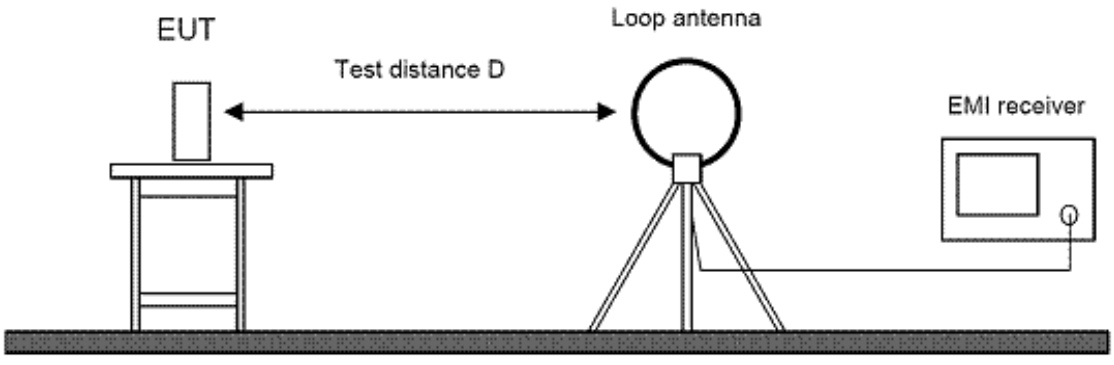
Frequency [MHz]	Field strength Fs [µV/m]	Field strength [dBµV/m]	Measurement distance d [m]
0.009 – 0.490	266.6 – 4.9	48.5 – 13.8	300
0.490 – 1.705	48.98 – 14.08	33.8 – 22.97	30
1.705 – 30.0	30	29.54	30

30 – 88	100	40	3
88 – 216	150	43.5	3
216 - 960	200	46	3
Above 960	500	54	3

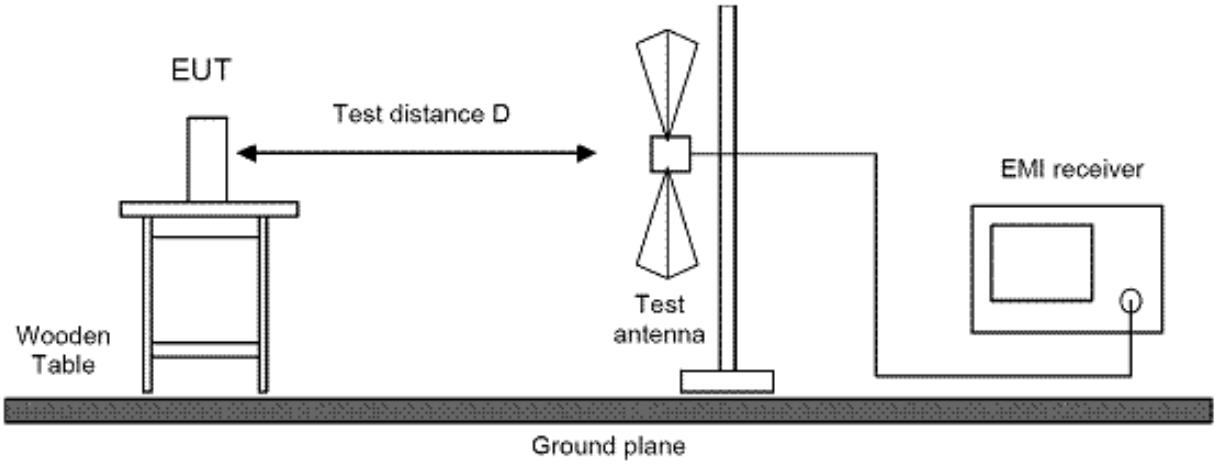
11.4 Test procedure

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 compact diagnostic chamber.
2. Power on the EUT and all peripherals.
3. The broadband antenna was set to vertical polarization.
4. The EMI receiver performed a scan from 30MHz to 1000MHz with the detector set to peak and the measurement bandwidth to 120 kHz.
5. The turn table was rotated to 6 different positions (360° / 6) and the antenna polarization was changed to horizontal.
6. Repeat the test procedure at step 4 and 5.
7. The test setup was then placed in an OATS at 3 m distance and all peak values over or with less distance to limit then 6dB were marked and re-measured with a quasi-peak detector.
8. The turntable was rotated by 360 degrees to determine the position of the highest radiation.
9. The height of the broadband receiving antenna was 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 was recorded.
10. For emissions below 30MHz, measurements were done with a loop antenna. The recorded data were measured in QP mode oft he receiver. The antenna height was not changed during this test.

11.5 Test setup



Picture 68: Test setup for radiated emission measurement (< 30 MHz)



Picture 69: Test setup for radiated emission measurement (< 1 GHz)

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

Transmit mode

Temperature:	22°C	Humidity:	44%
Tested by:	M. Janker	Test date:	2010-11-19

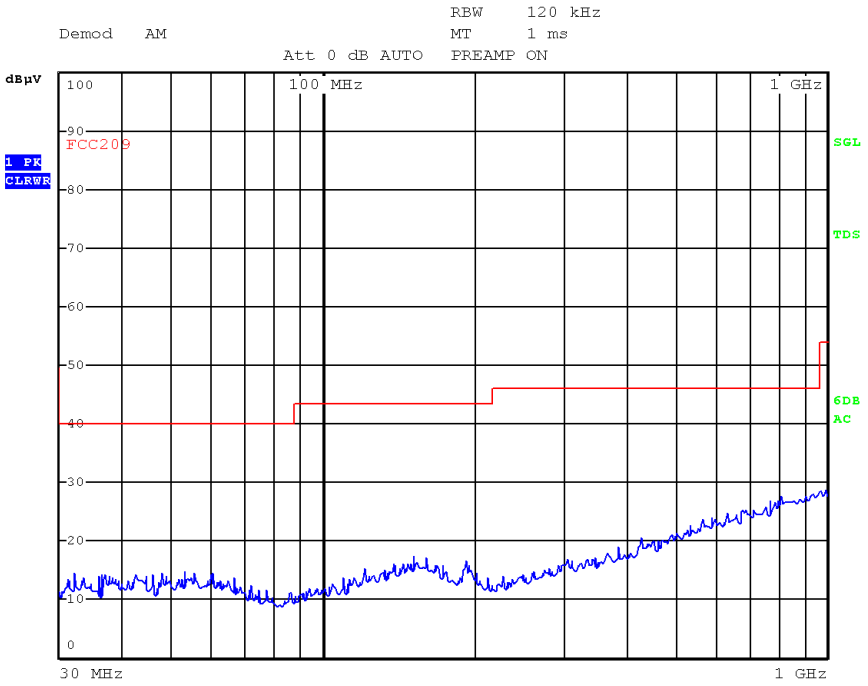
Radiated Emission Measurement 9 kHz – 30 MHz

Amplitudes of spurious emissions that are attenuated more than 20 dB below the permissible limit are not reported.

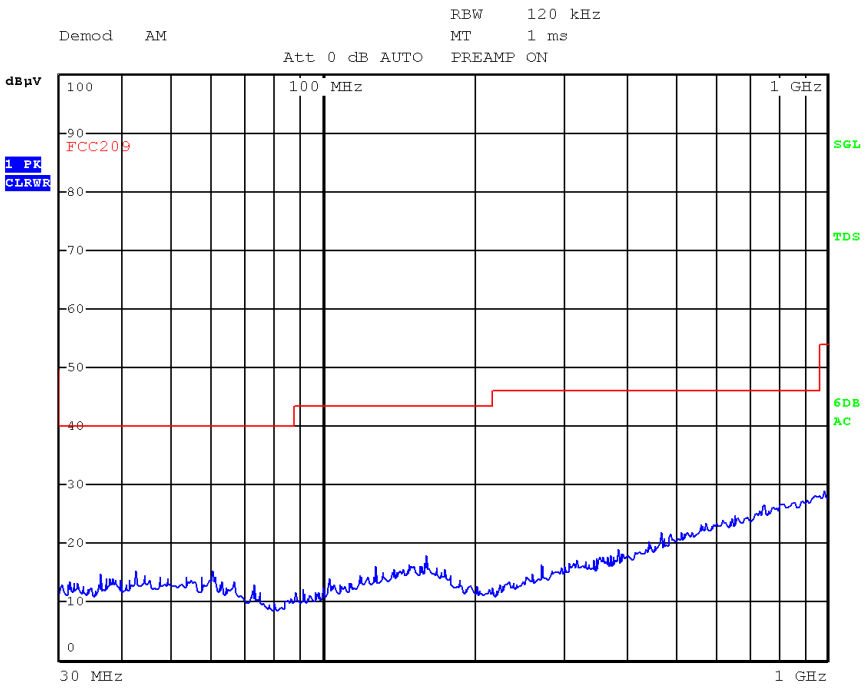
Frequency (MHz)	Reading (dBµV/m)	Detector	Recalculation factor (dB/decade)	Field strength (dBµV/m)	Limit (dBµV/m)	Margin	Result
			40				N/A

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

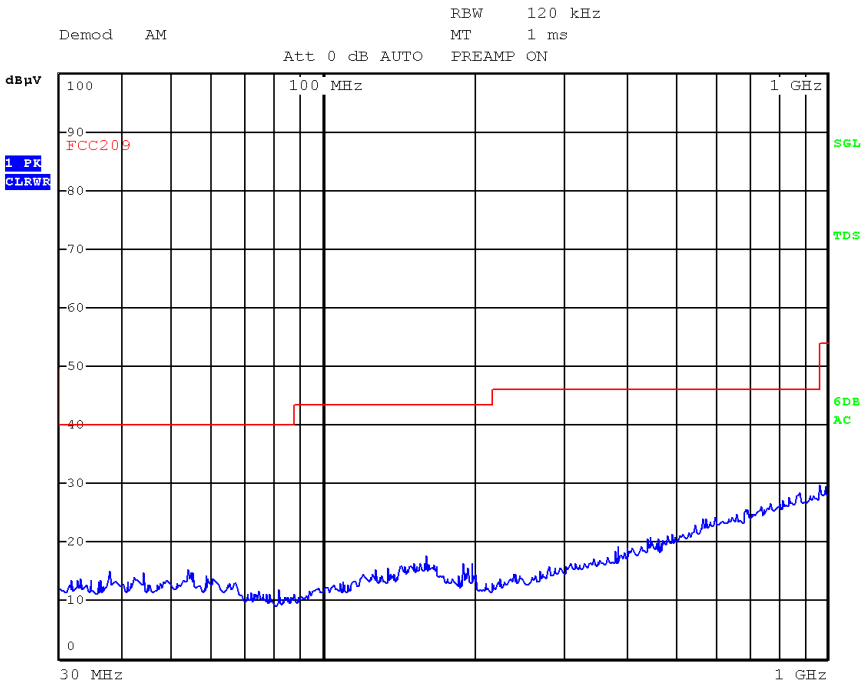
There was no difference between the measurement results below 1GHz depending on the modulation. Therefore only the GFSK modulation was documented.



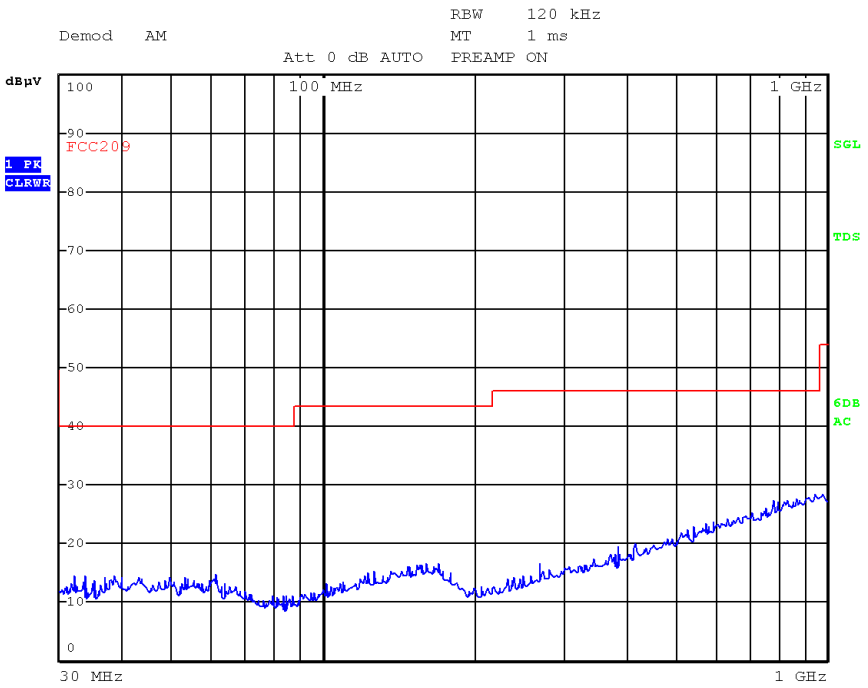
Picture 70: Radiated emission 30 MHz – 1000MHz (Channel 0) Vertical - GFSK



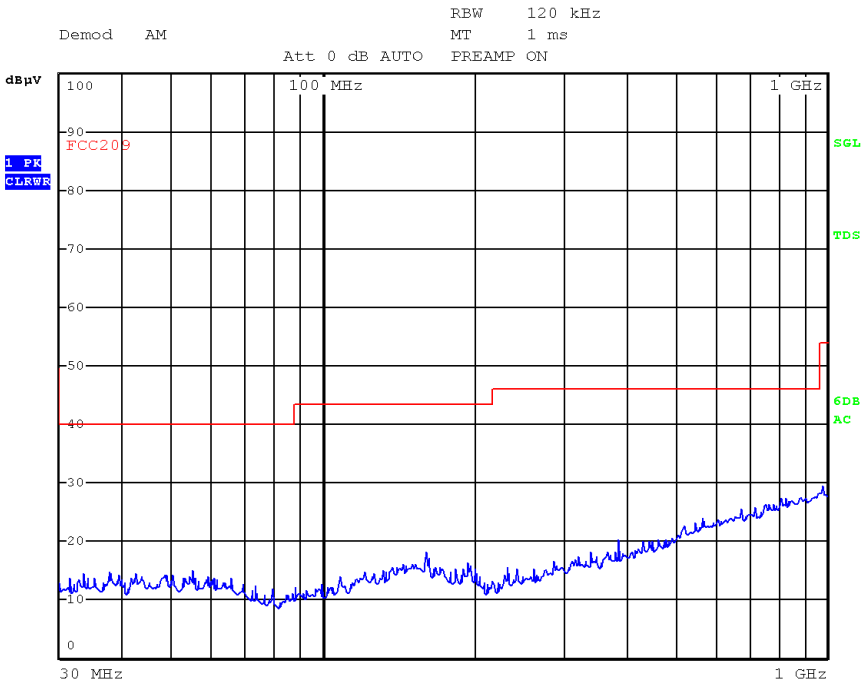
Picture 71: Radiated emission 30 MHz – 1000MHz Channel 0) Horizontal - GFSK



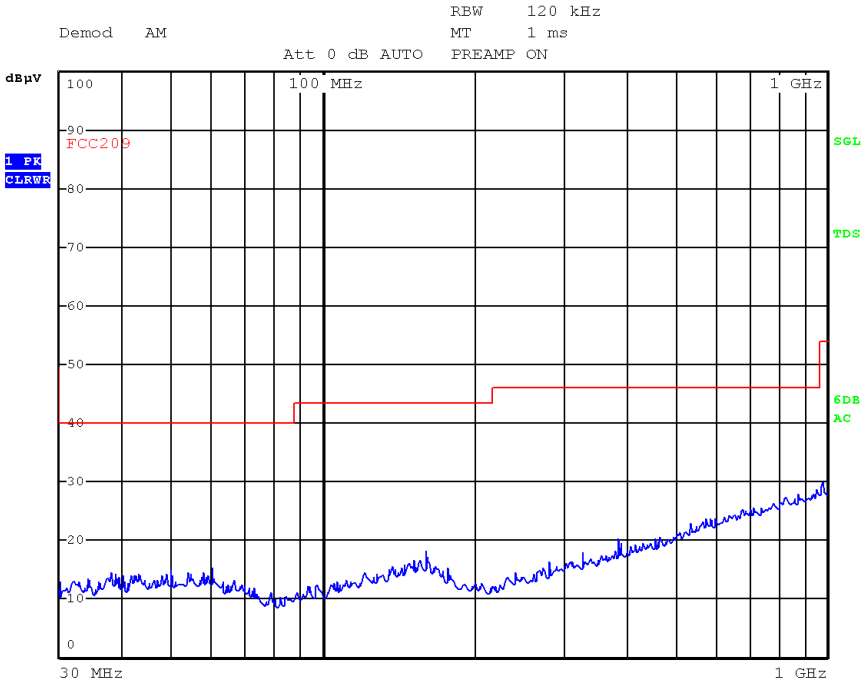
Picture 72: Radiated emission 30 MHz – 1000MHz (Channel 39) Vertical - GFSK



Picture 73: Radiated emission 30 MHz – 1000MHz Channel 39) Horizontal - GFSK



Picture 74: Radiated emission 30 MHz – 1000MHz (Channel 78) Vertical - GFSK



Picture 75: Radiated emission 30 MHz – 1000MHz Channel 78) Horizontal - GFSK

12 Radiated emission measurement (>1 GHz)

according to CFR 47 Part 15, section 15.205(a), 15.209(a), 15.247(d)

12.1 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

12.2 Test instruments

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

12.3 Limits

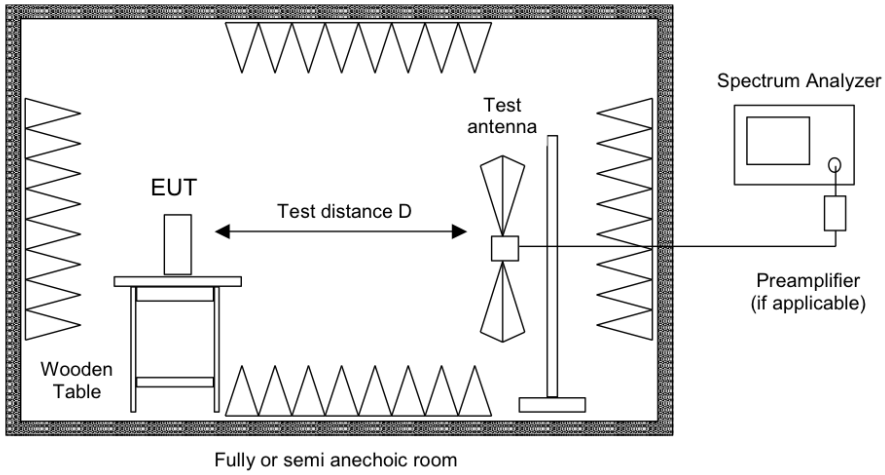
In any 100 kHz bandwidth outside the frequency band in which the spread spectrum or digitally modulated intentional radiator is operating, the radio frequency power that is produced by the intentional radiator shall be at least 20 dB below that in the 100 kHz bandwidth within the band that contains the highest level of the desired power. 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

12.4 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.

12.5 Test setup



Picture 76: 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

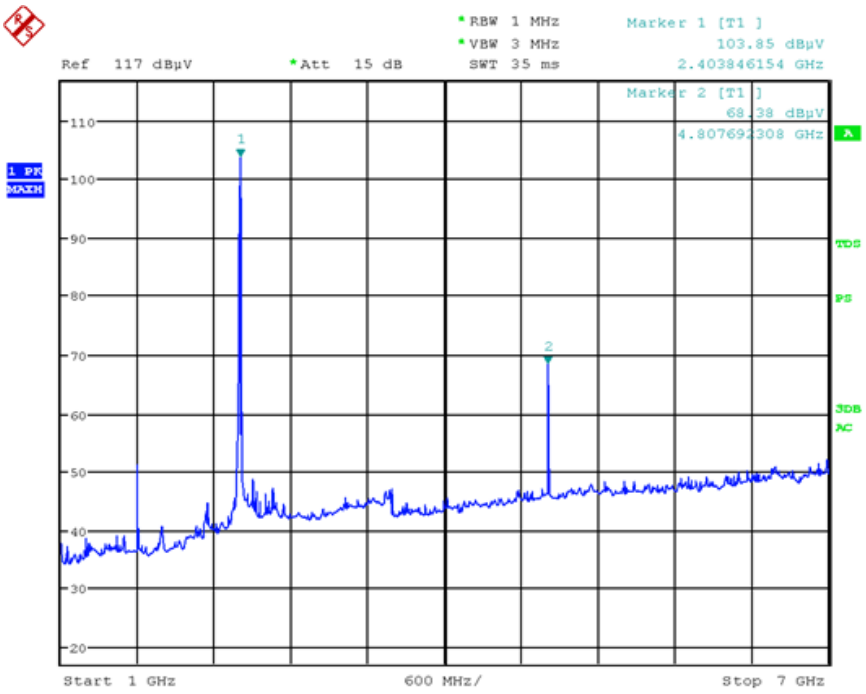
The EUT was programmed to be in continuously transmitting mode.

12.8 Test results channel 0

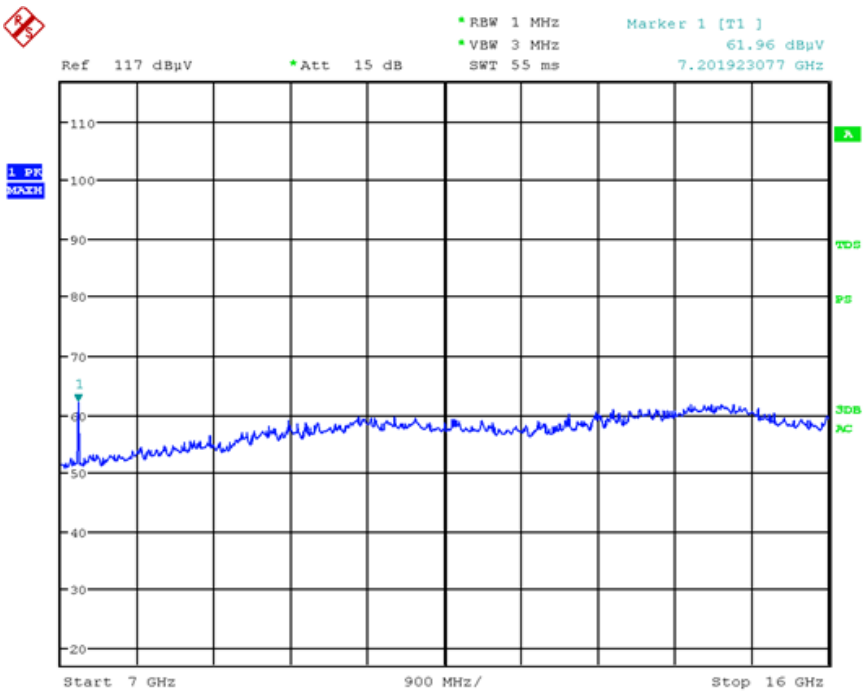
Temperature:	22°C	Humidity:	44%
Tested by:	Ch.Kiermeier	Test date:	2012-01-25

Frequency (GHz)	Reading (dBµV/m)	Detector	Limit (dBµV/m)	Restricted band	Result
2.4038	103.85	PK	-	No	Passed
4.807	68.33	PK	74	Yes	Passed
4.807	45.27	AV	54	Yes	Passed
7.201	61,96	PK	>20dBc	No	Passed

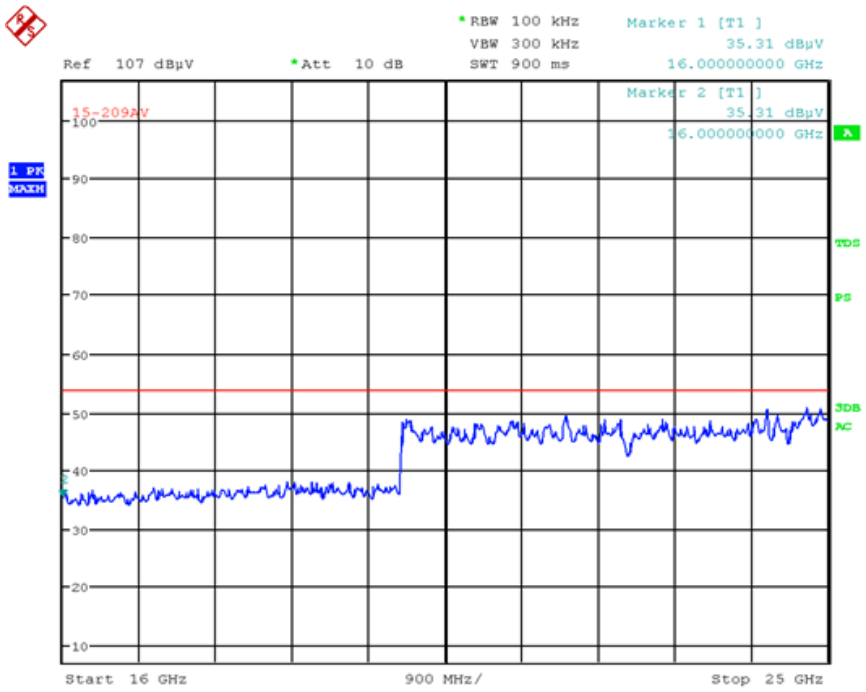
In receive mode there were no significant emissions detected!



Picture 77: Spurious emissions channel 0, 1 GHz-7 GHz (Overview scan) - GFSK



Picture 78: Spurious emissions channel 0, 7 GHz-16 GHz (overview scan) - GFSK



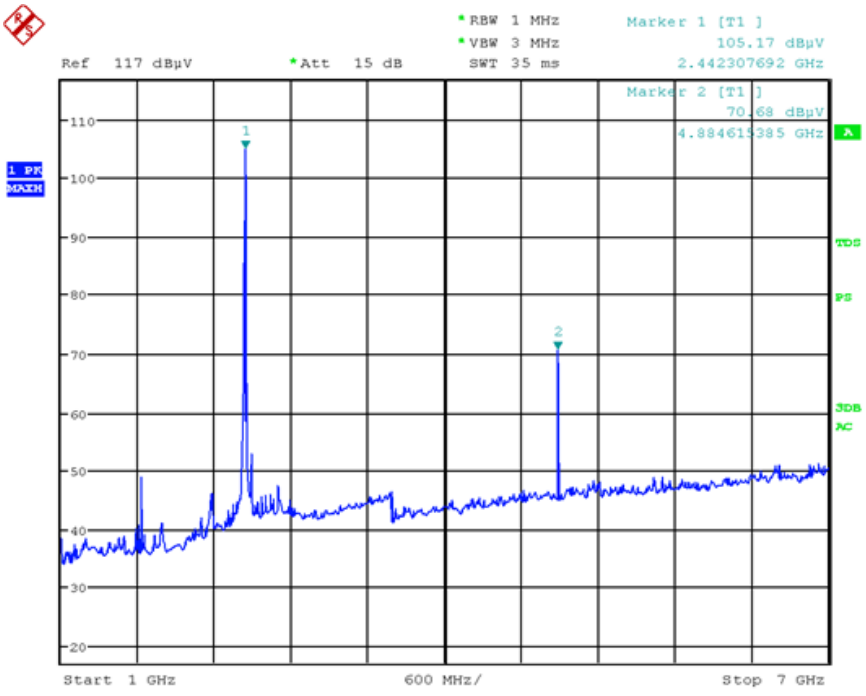
Picture 79: Spurious emissions channel 0, 16 GHz-25 GHz (overview scan) - GFSK

12.9 Test results channel 39

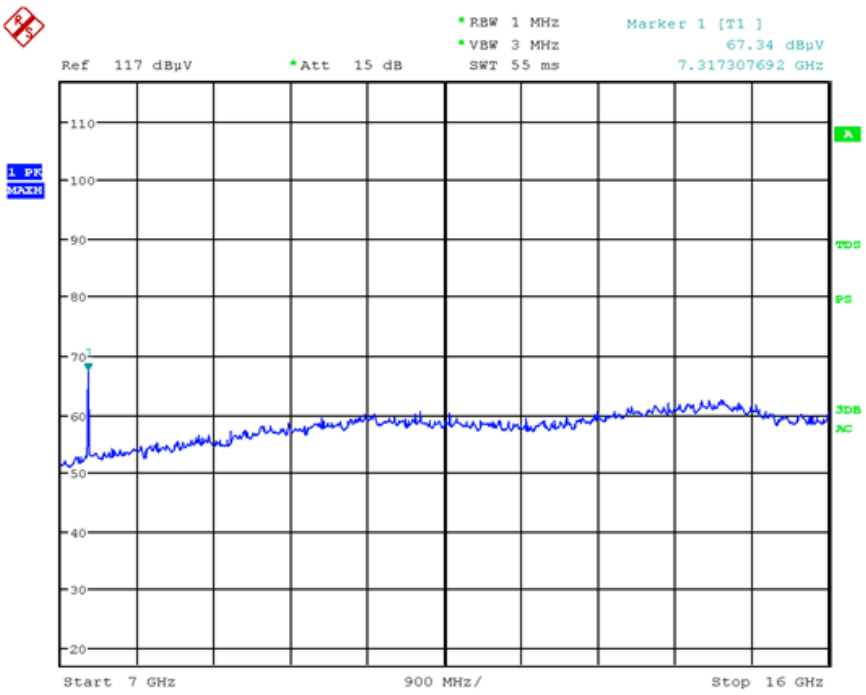
Temperature:	22°C	Humidity:	44%
Tested by:	Ch.Kiermeier	Test date:	2012-01-25

Frequency (GHz)	Reading (dBµV/m)	Detector	Limit (dBµV/m)	Restricted band	Result
2.442	105,16	PK	--	No	Passed
4.884	70,68	PK	74	Yes	Passed
4.884	45,77	AV	54	Yes	Passed
7.315	67,34	PK	74	Yes	Passed
7.315	48,73	AV	54	Yes	Passed

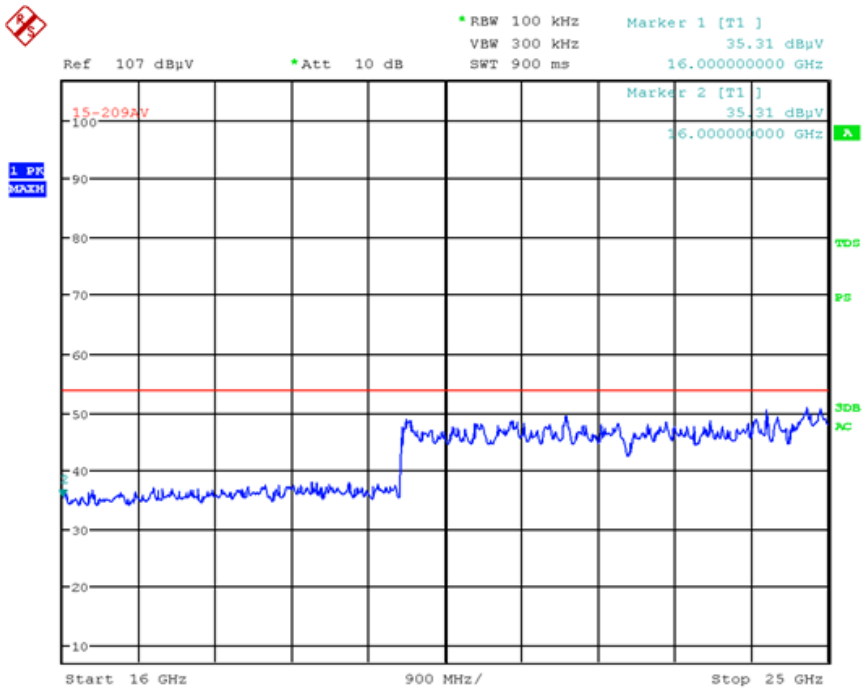
In receive mode there were no significant emissions detected!



Picture 80: Spurious emissions channel 39, 1 GHz-7 GHz (Overview scan) GFSK



Picture 81: Spurious emissions channel 39, 7 GHz-16 GHz (overview scan) GFSK



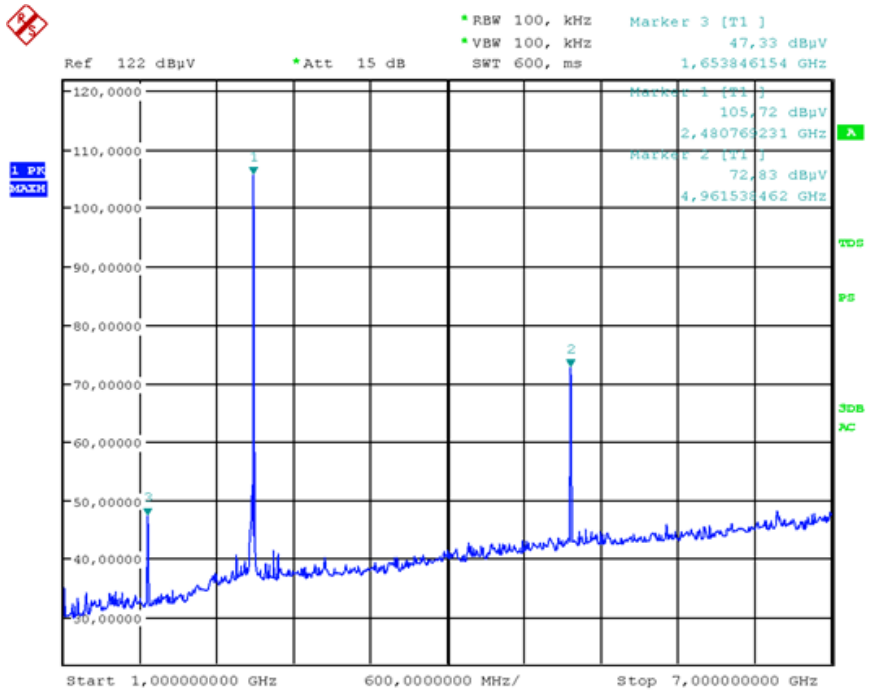
Picture 82: Spurious emissions channel 39, 16 GHz-25 GHz (overview scan) GFSK

12.10 Test results channel 78

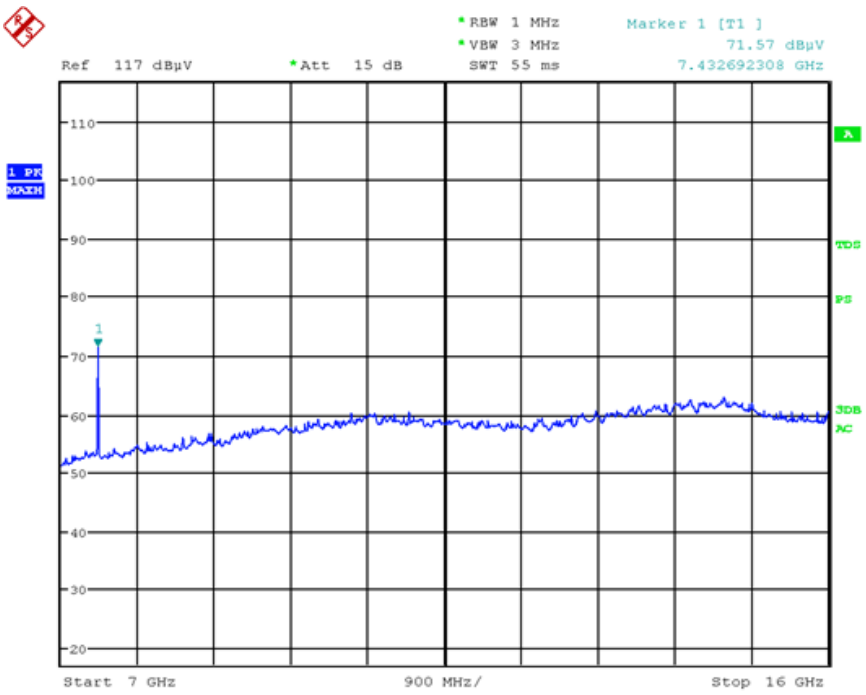
Temperature:	22°C	Humidity:	44%
Tested by:	Ch.Kiermeier	Test date:	2012-01-25

Frequency (GHz)	Reading (dBµV/m)	Detector	Limit (dBµV/m)	Restricted band	Result
2.480	105.72	PK	--	No	Passed
4.961	72,83	PK	74	Yes	Passed
4.961	48.36	AV	54	Yes	Passed
7.432	71.57	PK	74	Yes	Passed
7.432	50.58	AV	54	Yes	Passed

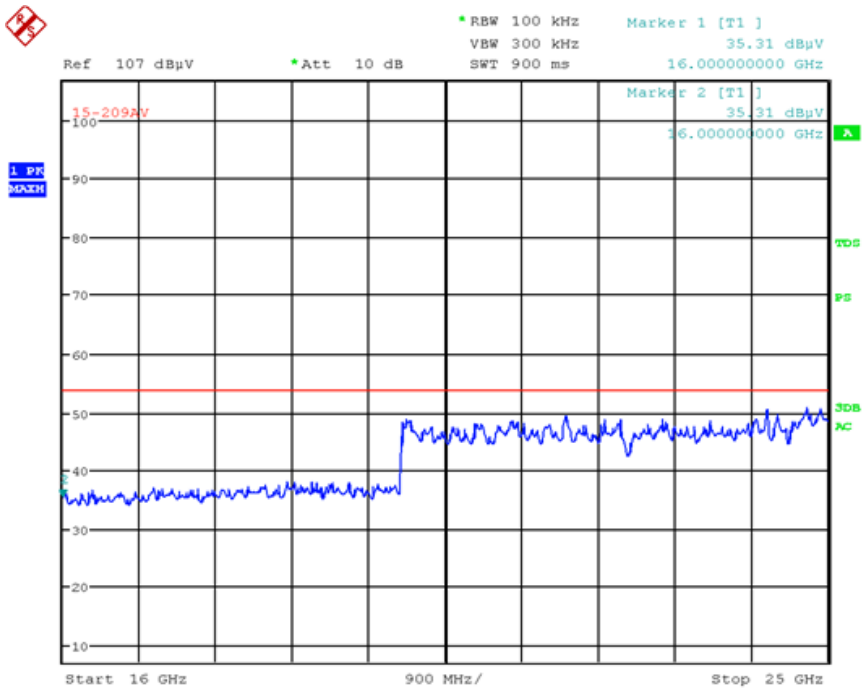
In receive mode there were no significant emissions detected!



Picture 83: Spurious emissions channel 78, 1 GHz-7 GHz (Overview scan) GFSK



Picture 84: Spurious emissions channel 78, 7 GHz-16 GHz (overview scan) GFSK



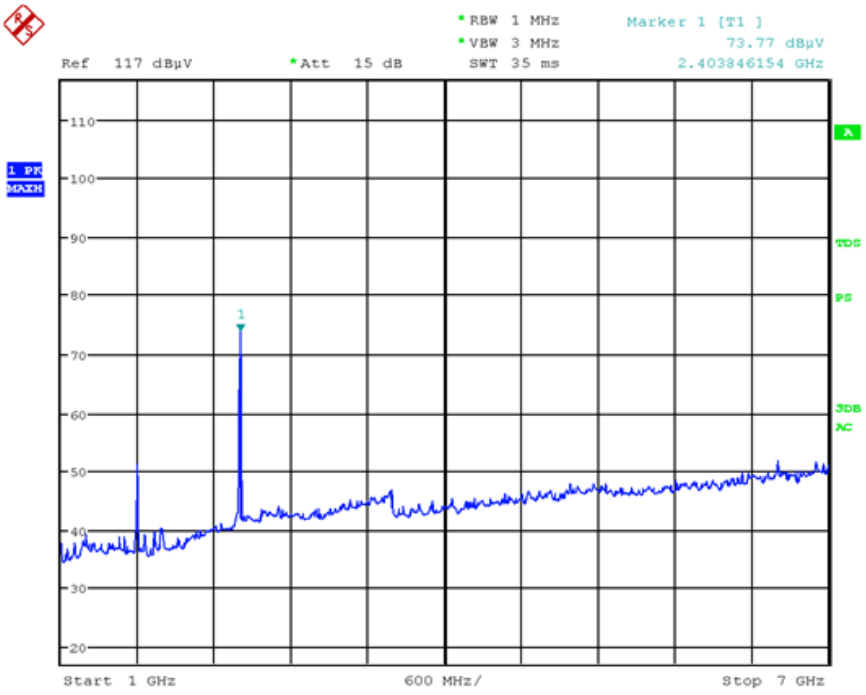
Picture 85: Spurious emissions channel 78, 16 GHz-25 GHz (overview scan) GFSK

12.11 Test results channel 0

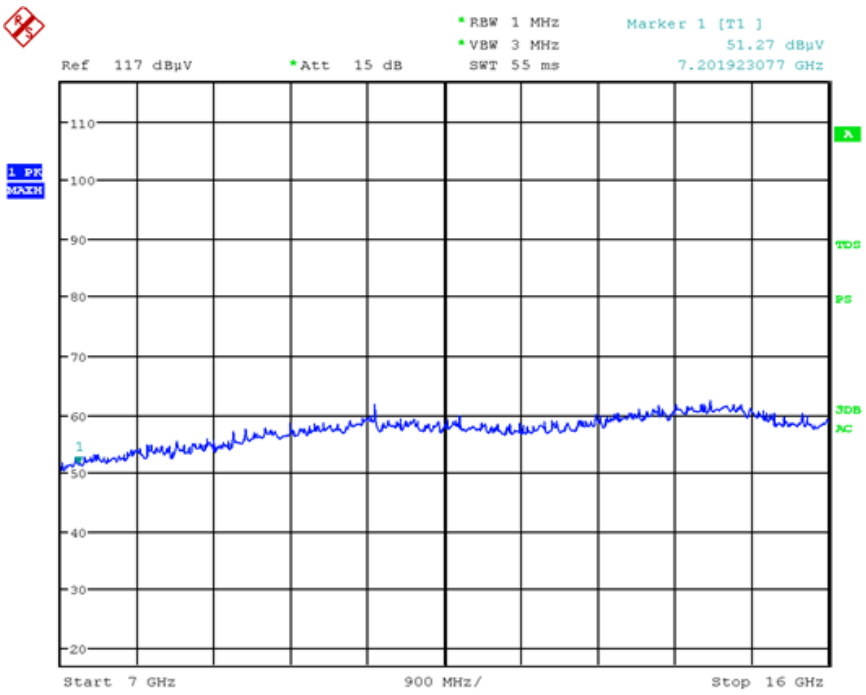
Temperature:	22°C	Humidity:	44%
Tested by:	Ch.Kiermeier	Test date:	2012-01-25

Frequency (GHz)	Reading (dBµV/m)	Detector	Limit (dBµV/m)	Restricted band	Result
2.4038	73,77	PK	-	No	Passed

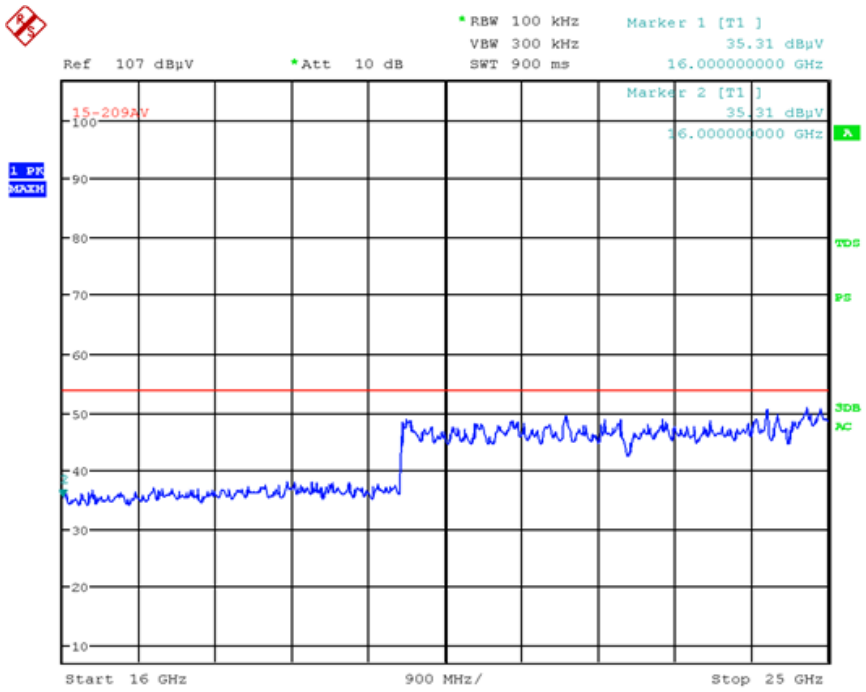
In receive mode there were no significant emissions detected!



Picture 86: Spurious emissions channel 0, 1 GHz-7 GHz (Overview scan) – 8DPSK



Picture 87: Spurious emissions channel 0, 7 GHz-16 GHz (overview scan) - 8DPSK



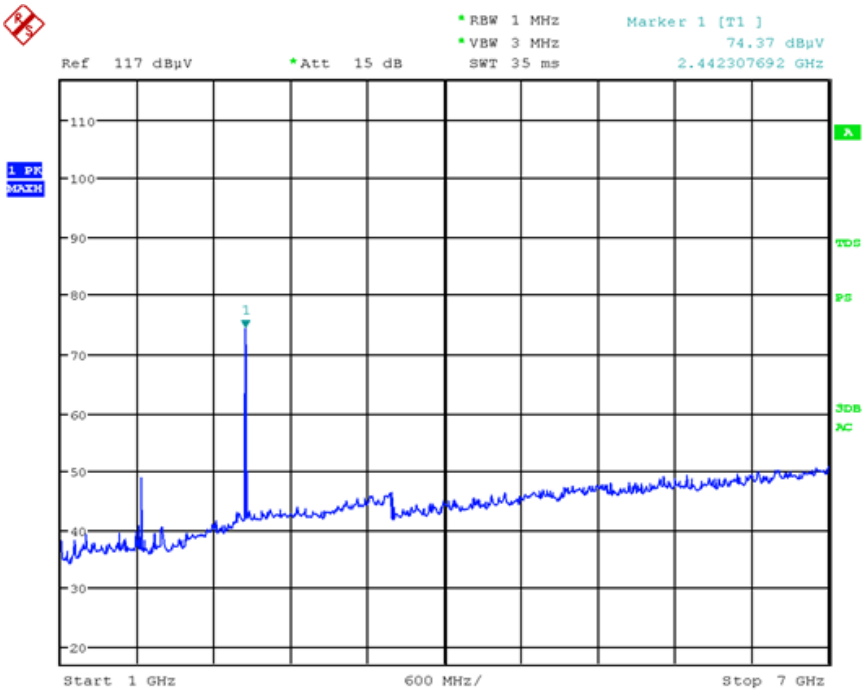
Picture 88: Spurious emissions channel 0, 16 GHz-25 GHz (overview scan) - 8DPSK

12.12 Test results channel 39

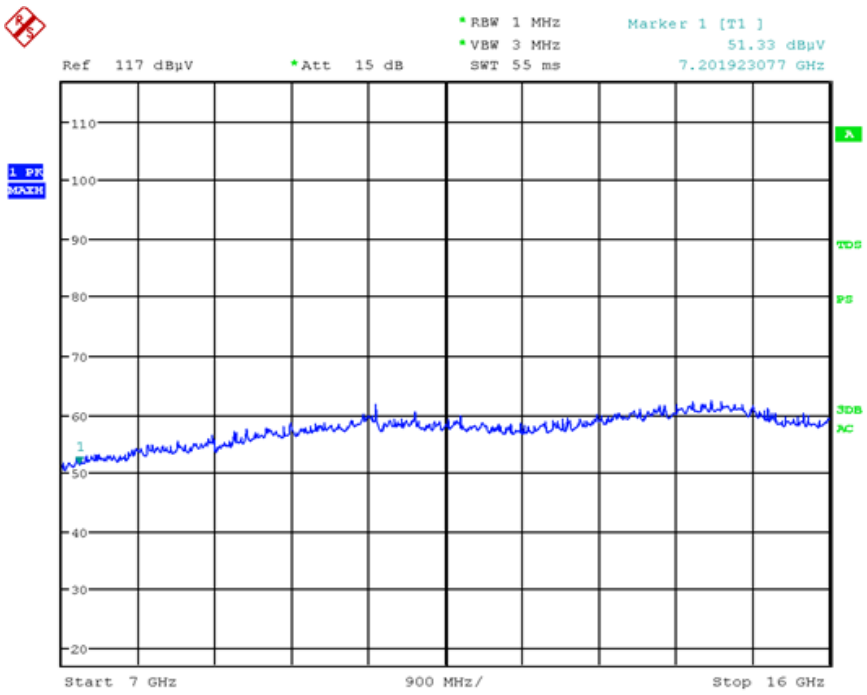
Temperature:	22°C	Humidity:	44%
Tested by:	Ch.Kiermeier	Test date:	2012-01-25

Frequency (GHz)	Reading (dBµV/m)	Detector	Limit (dBµV/m)	Restricted band	Result
2.442	74,37	PK	--	No	Passed

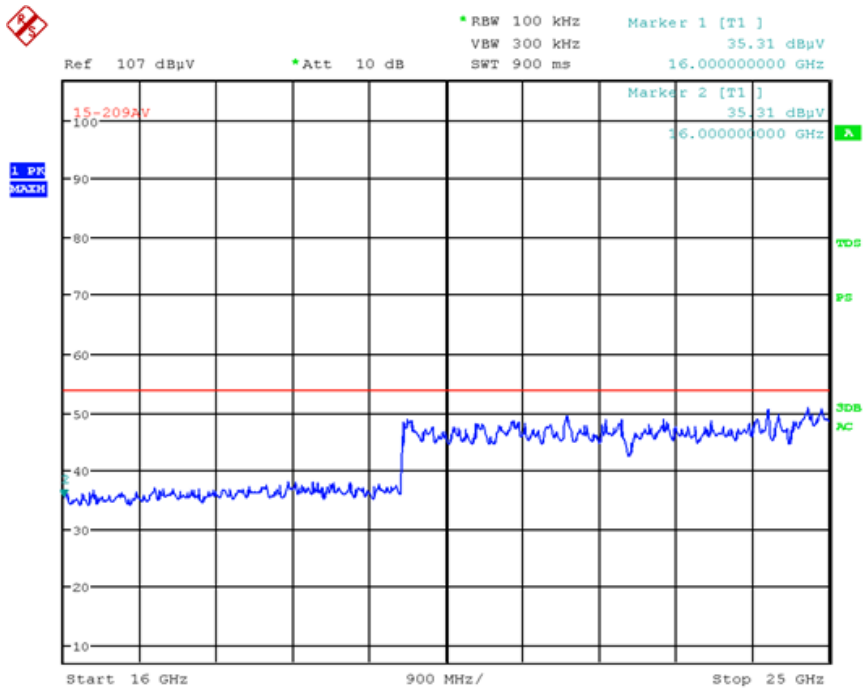
In receive mode there were no significant emissions detected!



Picture 89: Spurious emissions channel 39, 1 GHz-7 GHz (Overview scan) 8DPSK



Picture 90: Spurious emissions channel 39, 7 GHz-16 GHz (overview scan) 8DPSK



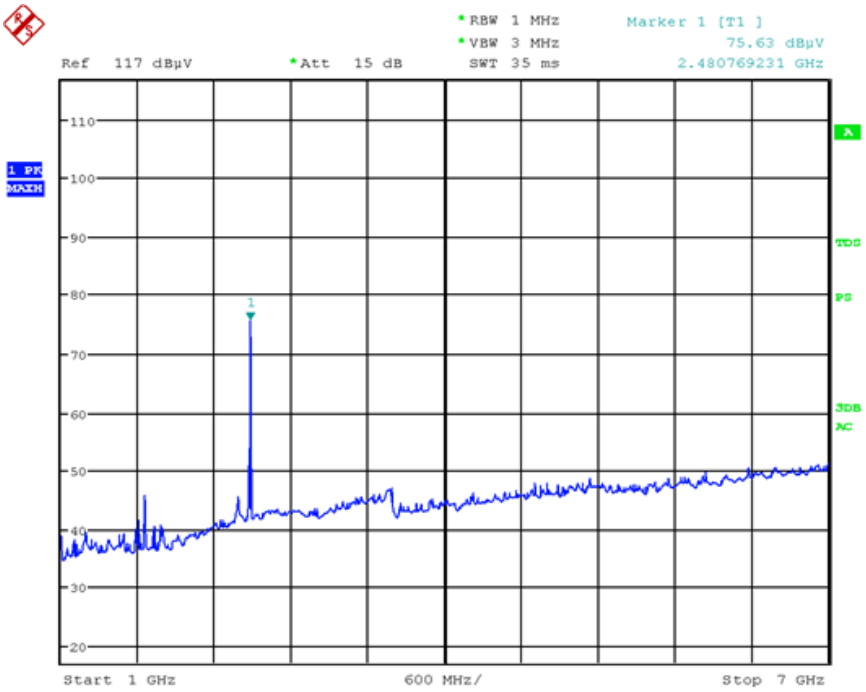
Picture 91: Spurious emissions channel 39, 16 GHz-25 GHz (overview scan) 8DPSK

12.13 Test results channel 78

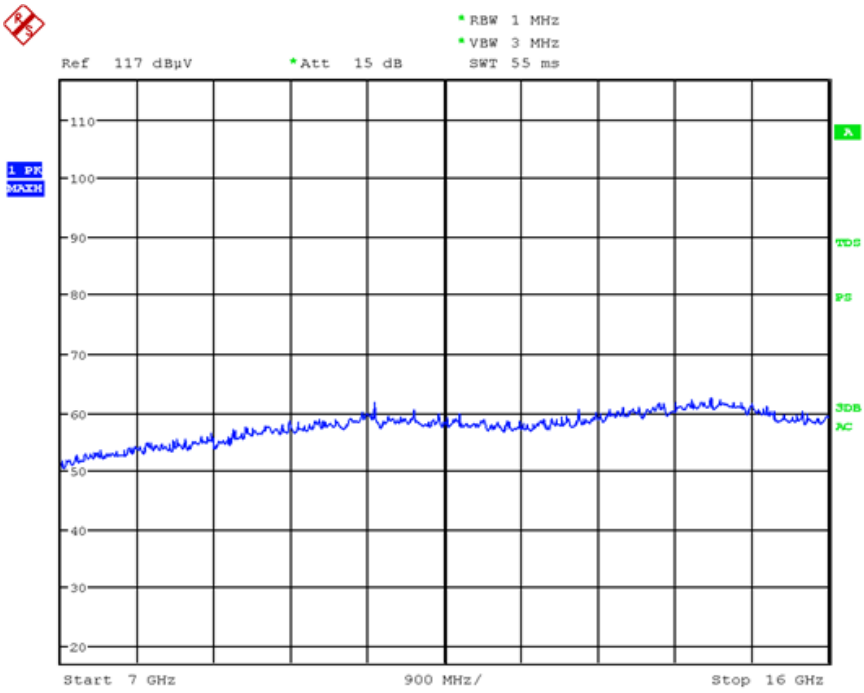
Temperature:	22°C	Humidity:	44%
Tested by:	Ch.Kiermeier	Test date:	2012-01-25

Frequency (GHz)	Reading (dBµV/m)	Detector	Limit (dBµV/m)	Restricted band	Result
2.480	75,34	PK	--	No	Passed

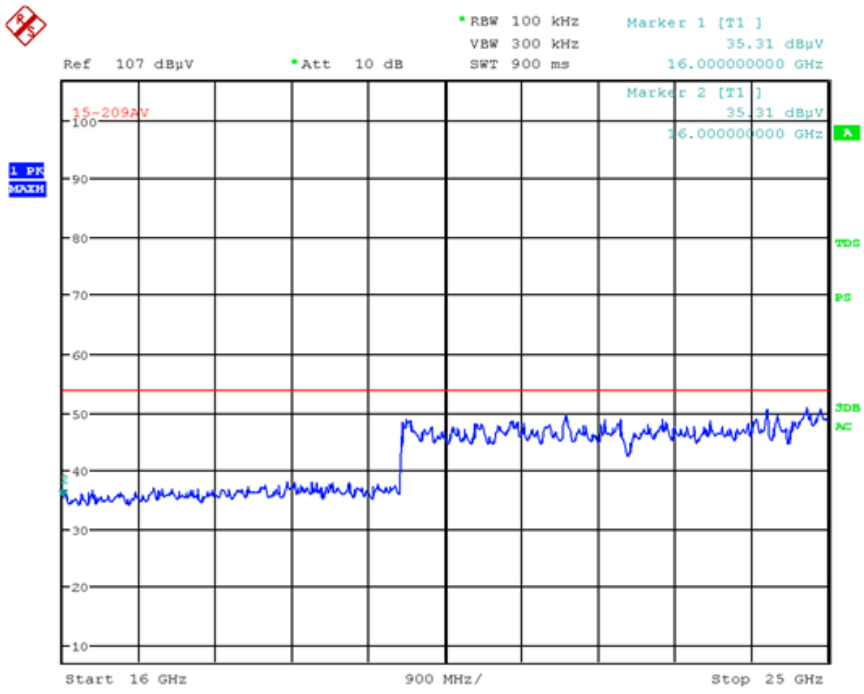
In receive mode there were no significant emissions detected!



Picture 92: Spurious emissions channel 78, 1 GHz-7 GHz (Overview scan) 8DPSK



Picture 93: Spurious emissions channel 78, 7 GHz-16 GHz (overview scan) 8DPSK



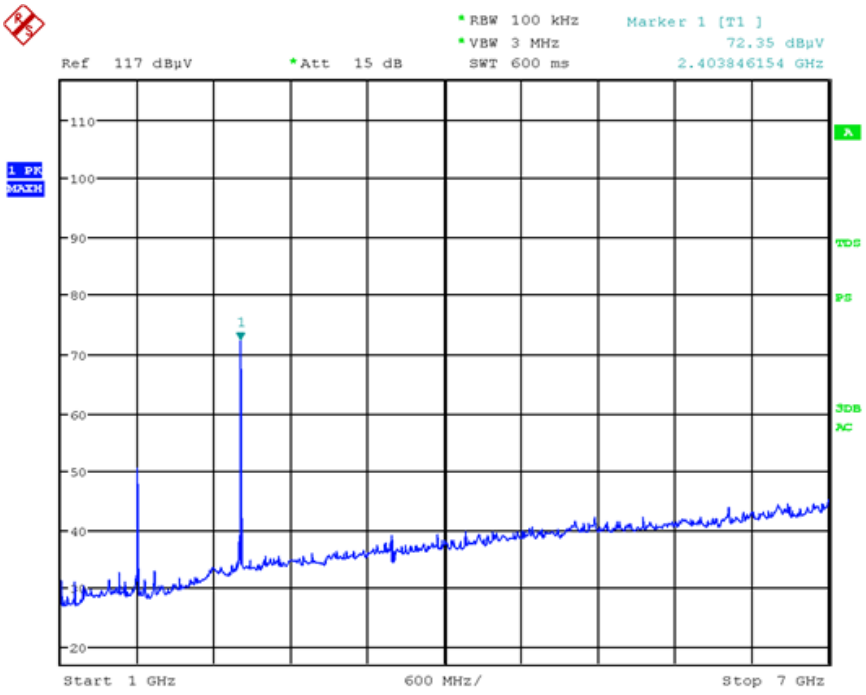
Picture 94: Spurious emissions channel 78, 16 GHz-25 GHz (overview scan) 8DPSK

12.14 Test results channel 0

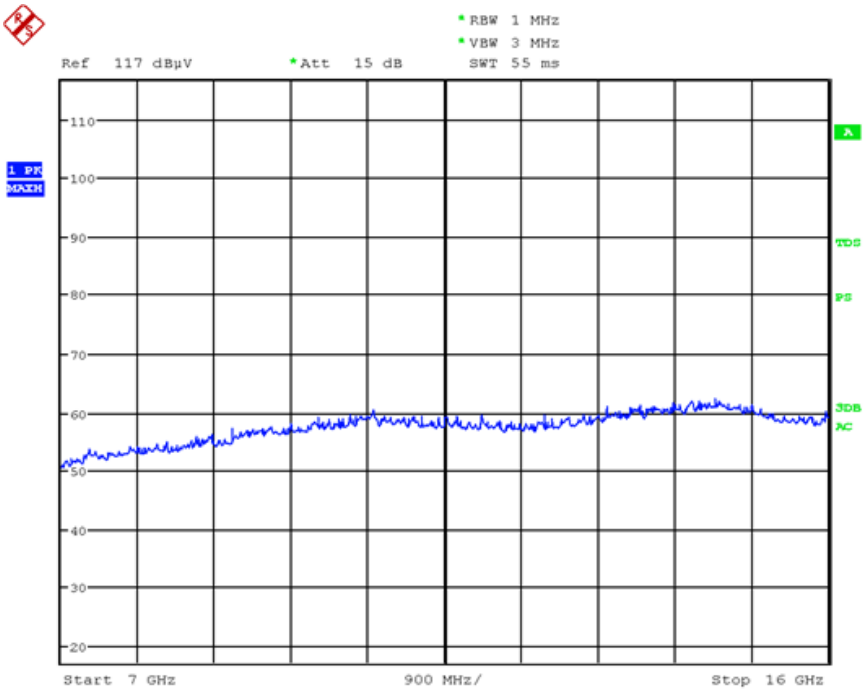
Temperature:	22°C	Humidity:	44%
Tested by:	Ch.Kiermeier	Test date:	2012-01-25

Frequency (GHz)	Reading (dBµV/m)	Detector	Limit (dBµV/m)	Restricted band	Result
2.4038	72,35	PK	-	No	Passed

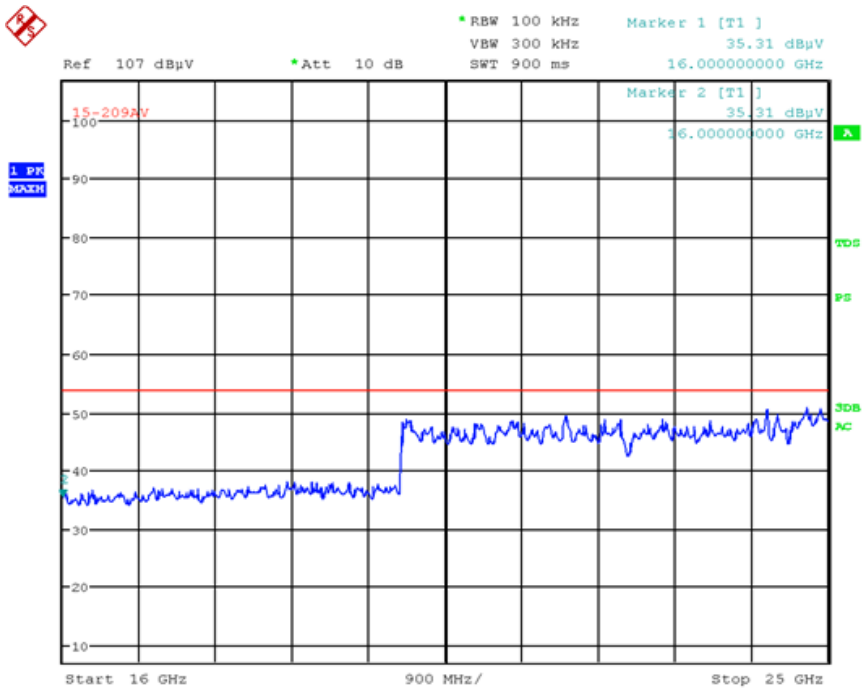
In receive mode there were no significant emissions detected!



Picture 95: Spurious emissions channel 0, 1 GHz-7 GHz (Overview scan) – Pi/4 DQPSK



Picture 96: Spurious emissions channel 0, 7 GHz-16 GHz (overview scan) - Pi/4 DQPSK



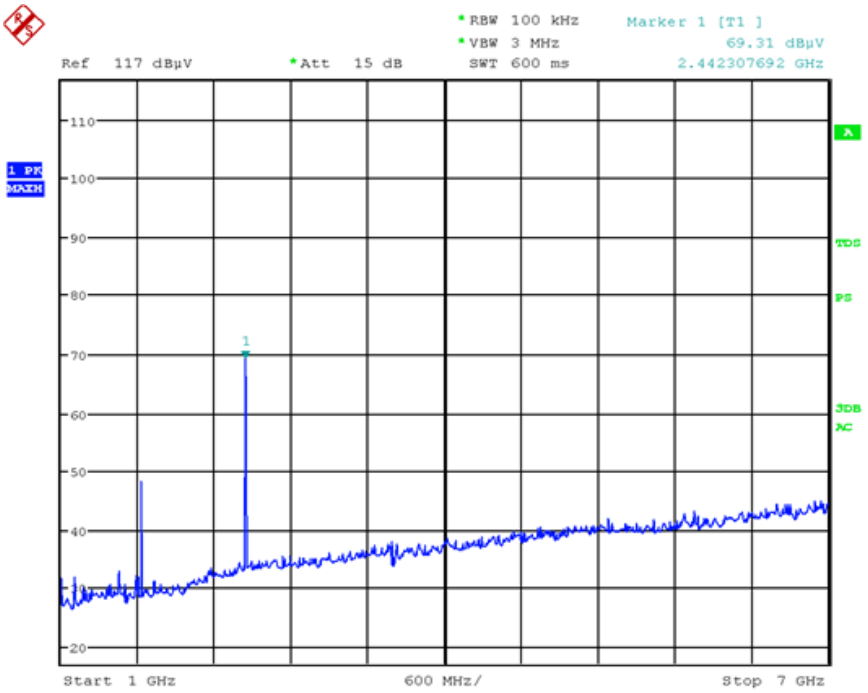
Picture 97: Spurious emissions channel 0, 16 GHz-25 GHz (overview scan) - Pi/4 DQPSK

12.15 Test results channel 39

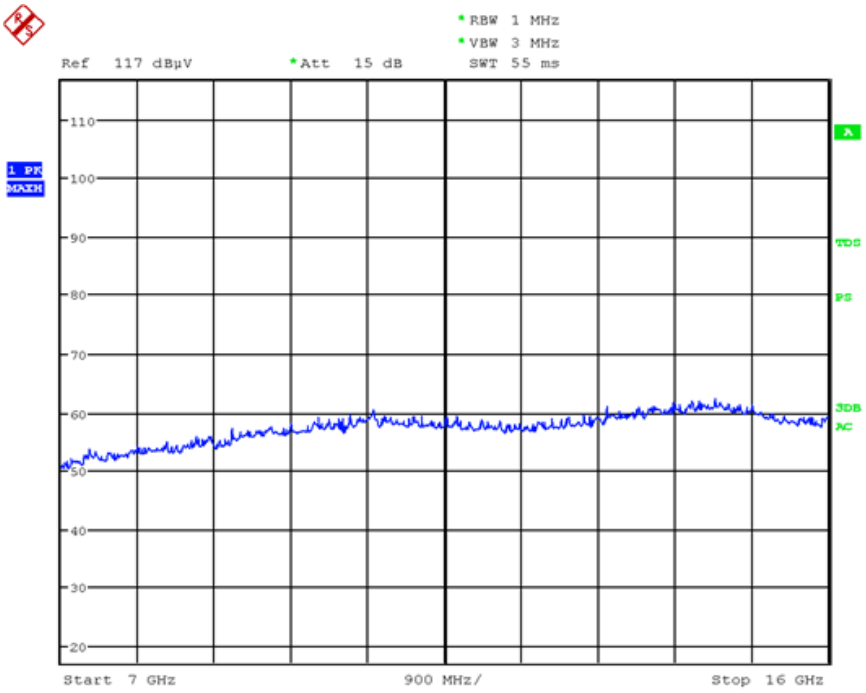
Temperature:	22°C	Humidity:	44%
Tested by:	Ch.Kiermeier	Test date:	2012-01-25

Frequency (GHz)	Reading (dBµV/m)	Detector	Limit (dBµV/m)	Restricted band	Result
2.442	69,31	PK	--	No	Passed

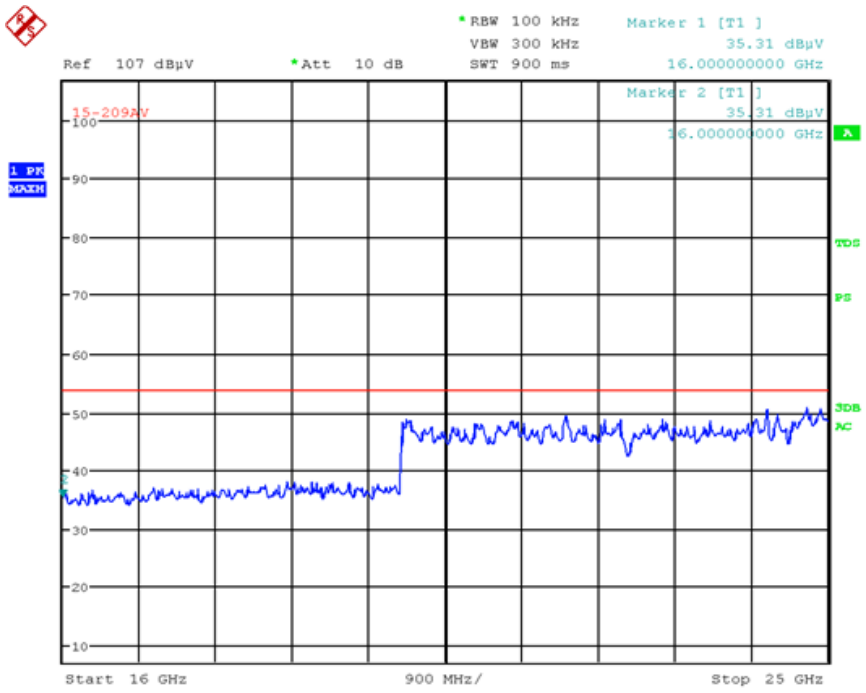
In receive mode there were no significant emissions detected!



Picture 98: Spurious emissions channel 39, 1 GHz-7 GHz (Overview scan) Pi/4 DQPSK



Picture 99: Spurious emissions channel 39, 7 GHz-16 GHz (overview scan) Pi/4 DQPSK



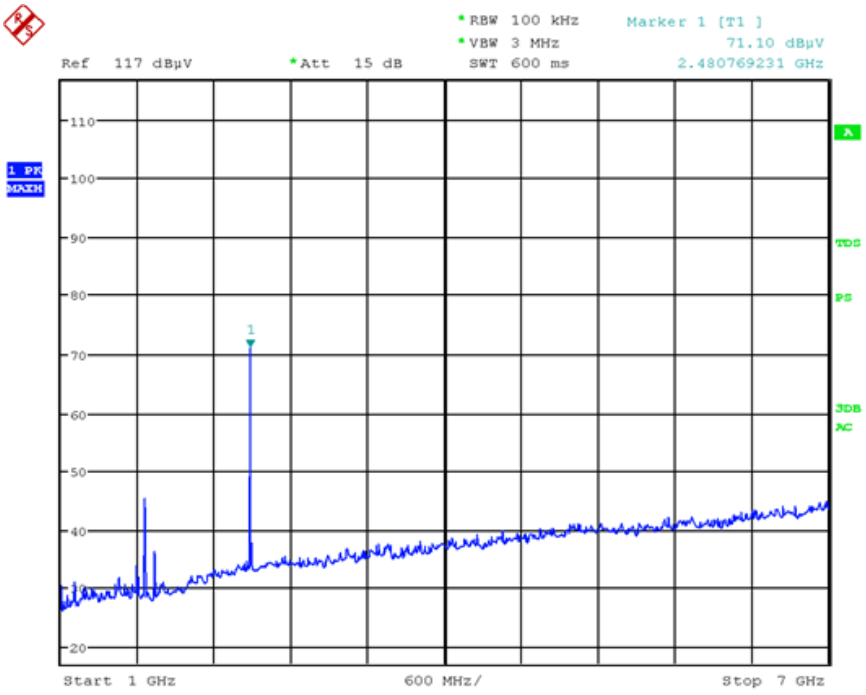
Picture 100: Spurious emissions channel 39, 16 GHz-25 GHz (overview scan) Pi/4 DQPSK

12.16 Test results channel 78

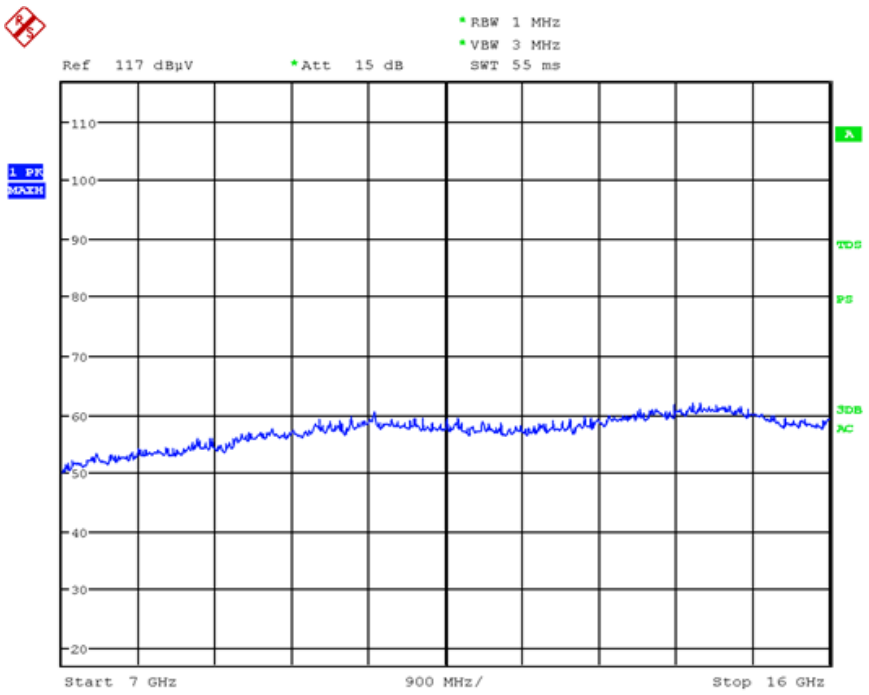
Temperature:	22°C	Humidity:	44%
Tested by:	Ch.Kiermeeir	Test date:	2012-01-25

Frequency (GHz)	Reading (dBµV/m)	Detector	Limit (dBµV/m)	Restricted band	Result
2.480	71,10	PK	--	No	Passed

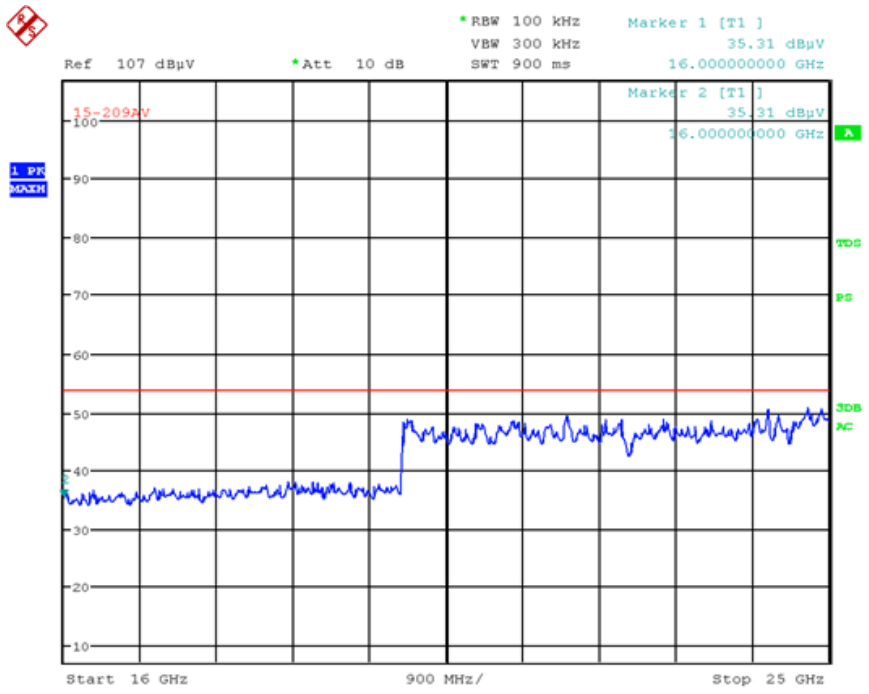
In receive mode there were no significant emissions detected!



Picture 101: Spurious emissions channel 78, 1 GHz-7 GHz (Overview scan) Pi/4 DQPSK



Picture 102: Spurious emissions channel 78, 7 GHz-16 GHz (overview scan) Pi/4 DQPSK



Picture 103: Spurious emissions channel 78, 16 GHz-25 GHz (overview scan) Pi/4 DQPSK

13 Exposure of humans to RF fields

according to RSS-Gen Issue 3, section 5.6 and RSS-102 Issue 4, section 2.5.2

13.1 Antenna type and power calculation

External detachable antenna (see antenna specification)
Gi: 2,15dBi = numeric gain 1,63
Output power conducted: 16,72dBm = 46,98mW
π =3,1416
R=20cm

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

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

$$S = \frac{1{,}63 \cdot 46{,}98mW}{4 * \pi * 20cm^2} = 0{,}0152mW / cm^2$$

Limit:
1mW/cm²

14 Equipment calibration status

Inventory Number	Model Number	Manufacturer	Last calibration	Next calibration	Cycle of calibration
W00002	ESU26	Rohde & Schwarz	Jan 12	Jan 14	2 Years
E00001	ESCI	Rohde & Schwarz	Jul 11	Jul 13	2 Years
E00003	ESCS 30	Rohde & Schwarz	Dec 11	Dec 12	1 Year
E00004	ESH 2-Z5	Rohde & Schwarz	Jan 11	Jan 13	2 Years
E00005	ESH 2-Z5	Rohde & Schwarz	Jan 12	Jan 14	2 Years
E00060	HFH2-Z2	Rohde & Schwarz	Jan 12	Jan 15	3 Years
E00012	VULB 9163	Schwarzbeck	Mar 11	Mar 12	1 Years
C00015	VC^{3}4034	Vötsch	Aug 10	Aug 13	3 Years
W00052	BBHA 9120	Schwarzbeck	Feb 10	Feb 13	3 Years
W00055	BBHA 9170	Schwarzbeck	Jan 12	Jan 15	3 Years

Table 1: Equipment Calibration status

15 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 %.

16 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, February 24, 2012

Christian Kiermeier	Markus Biberger
Test engineer	Technical executive
EMV **TESTHAUS** GmbH	EMV **TESTHAUS** GmbH