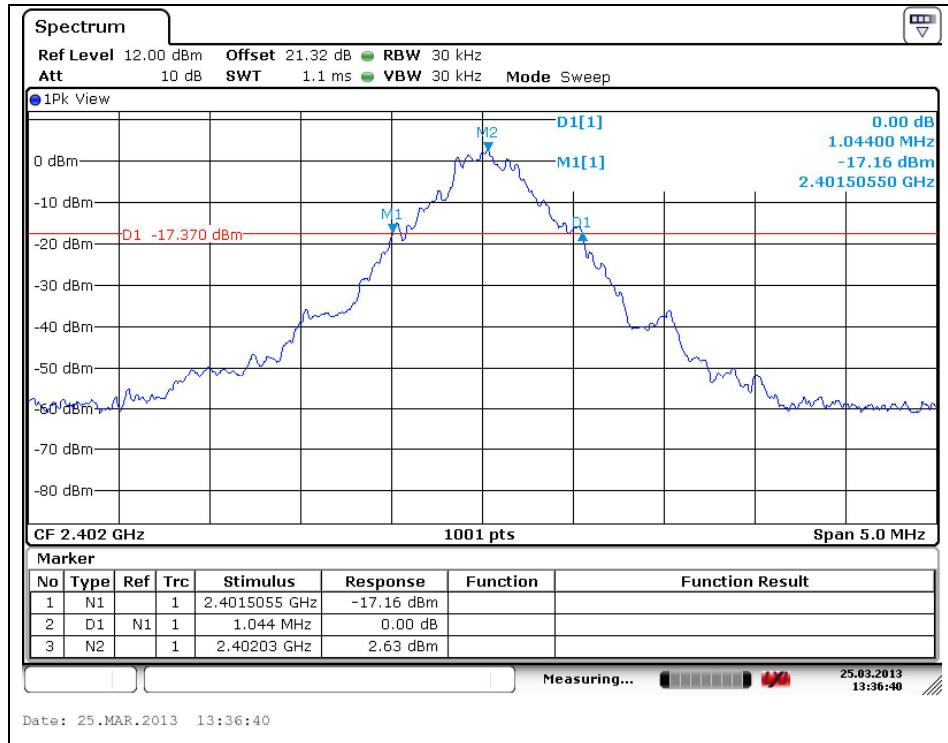


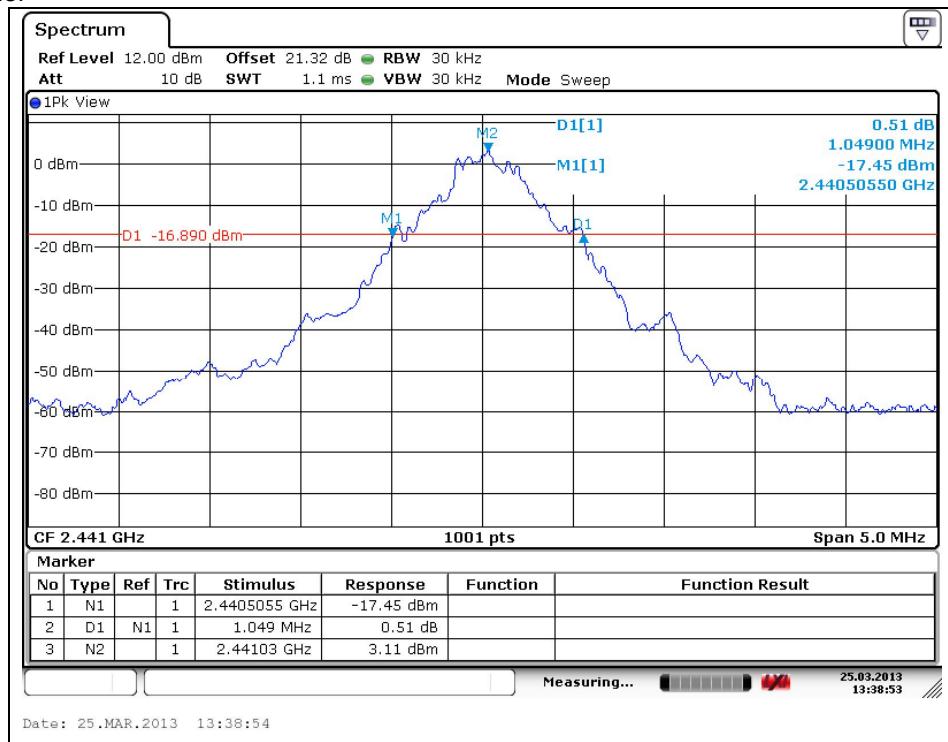
20 dB Bandwidth

Operating Mode: GFSK

Low Channel

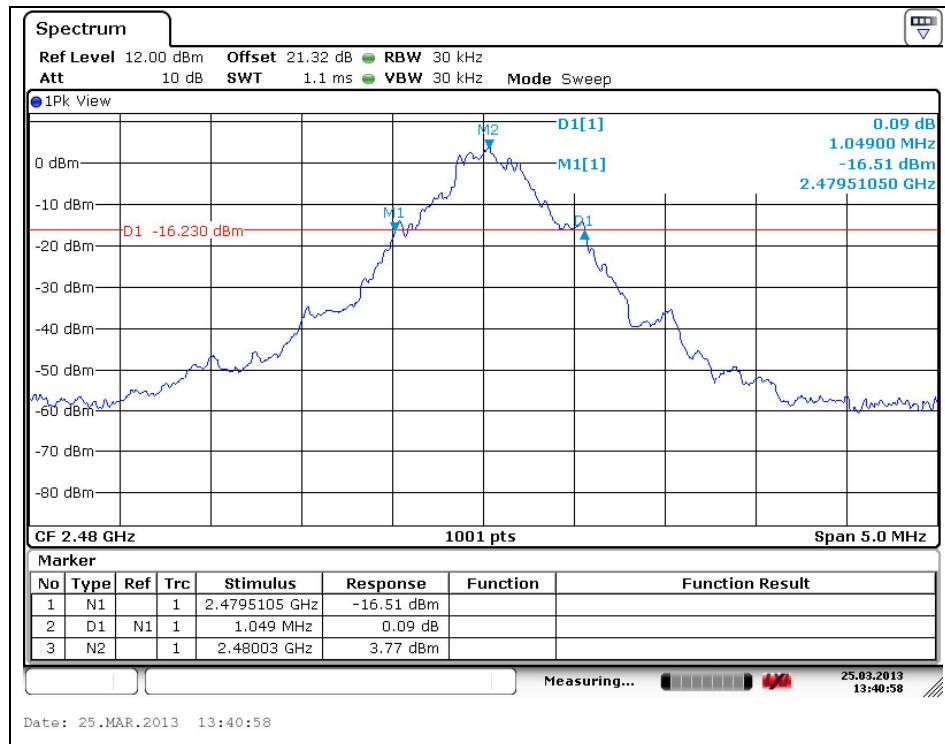


Middle Channel



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High Channel



Operating Mode: 8DPSK

Low Channel

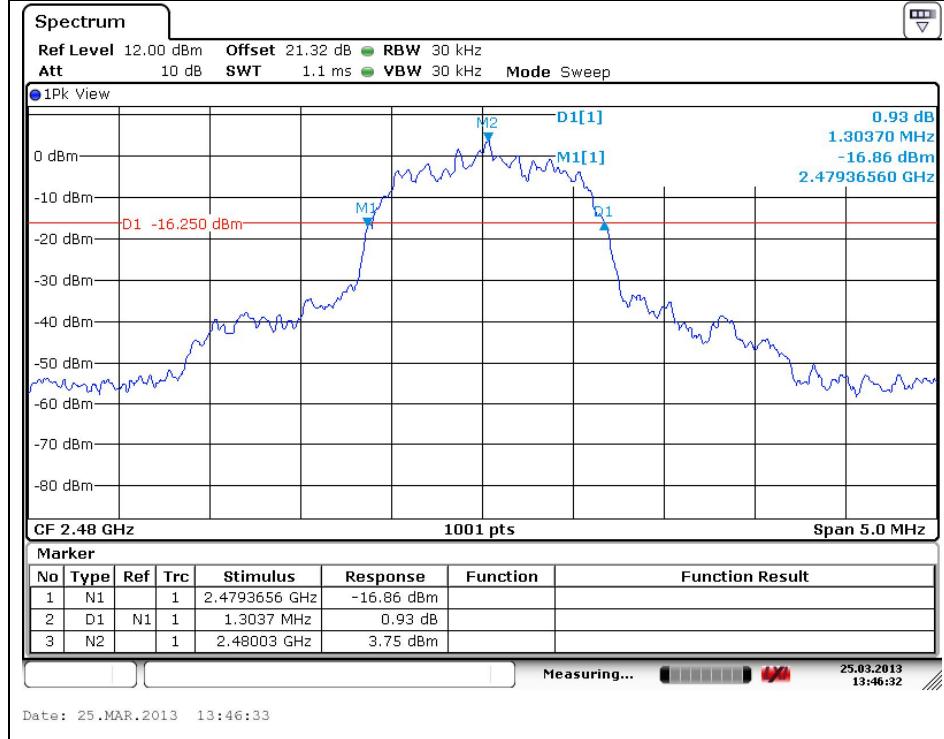


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Middle Channel



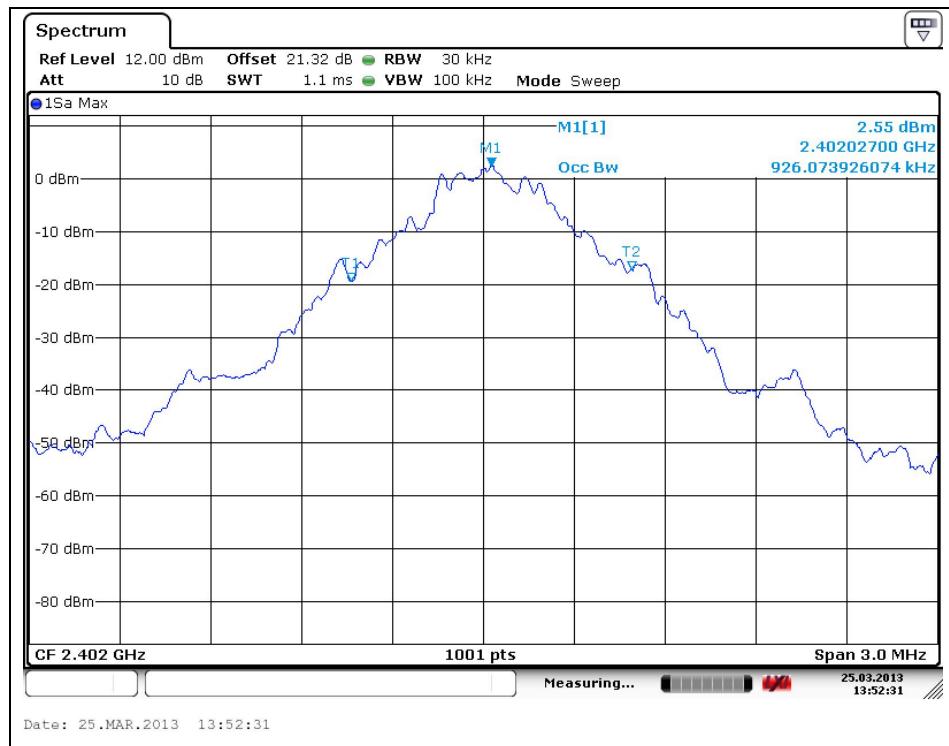
High Channel



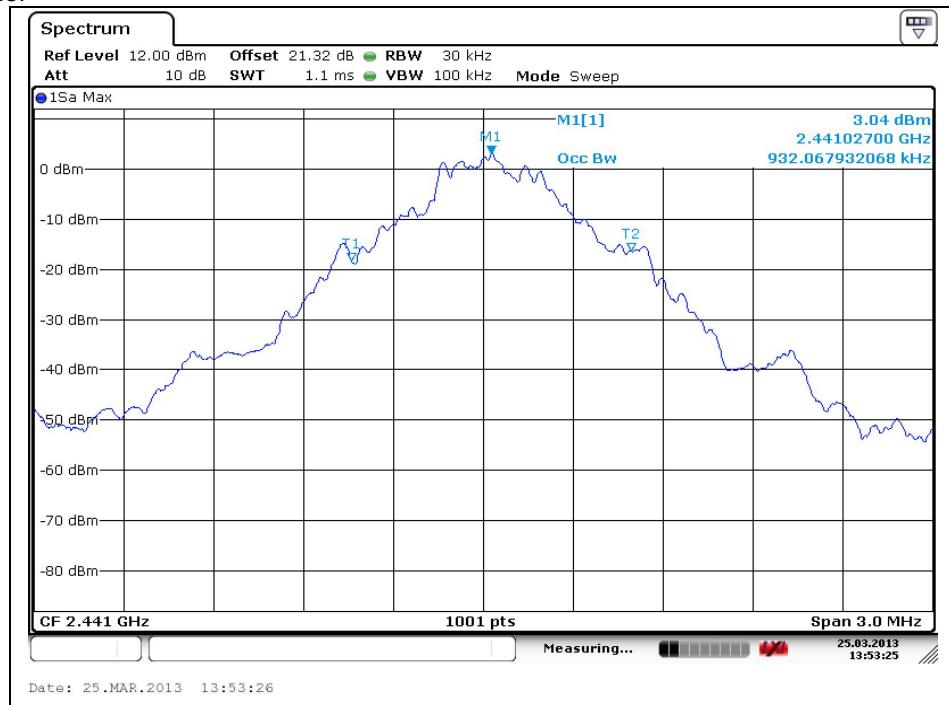
The results shown in this test report refer only to the sample(s) tested unless otherwise stated. This test report cannot be reproduced, except in full, without prior written permission of the Company.

99 % Bandwidth**Operating Mode: GFSK**

Low Channel



Middle Channel



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High Channel



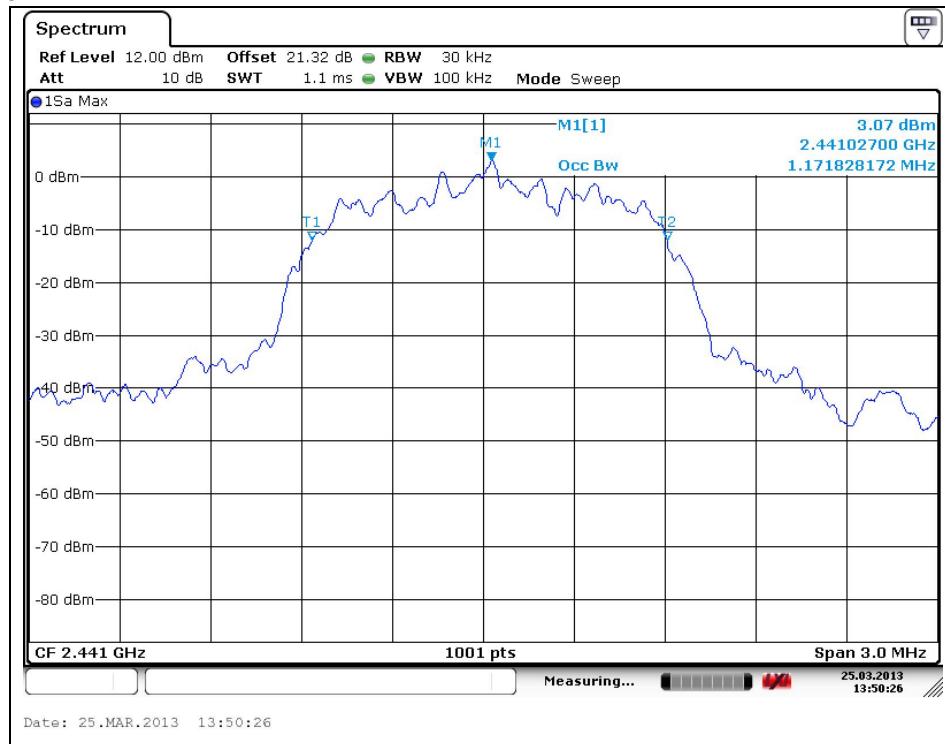
Operating Mode: 8DPSK

Low Channel

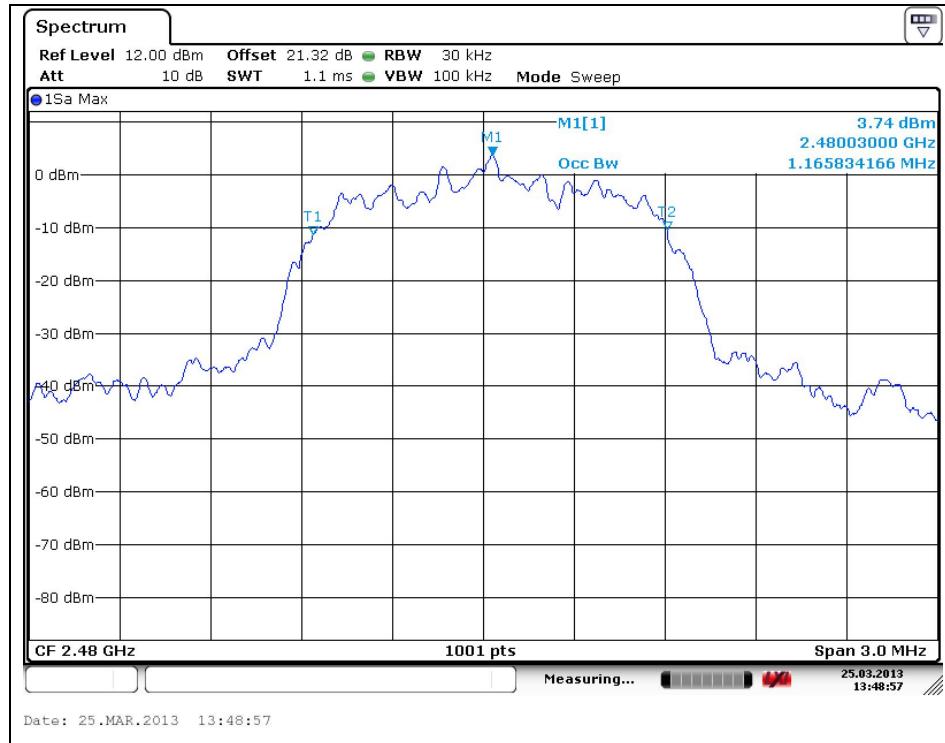


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Middle Channel



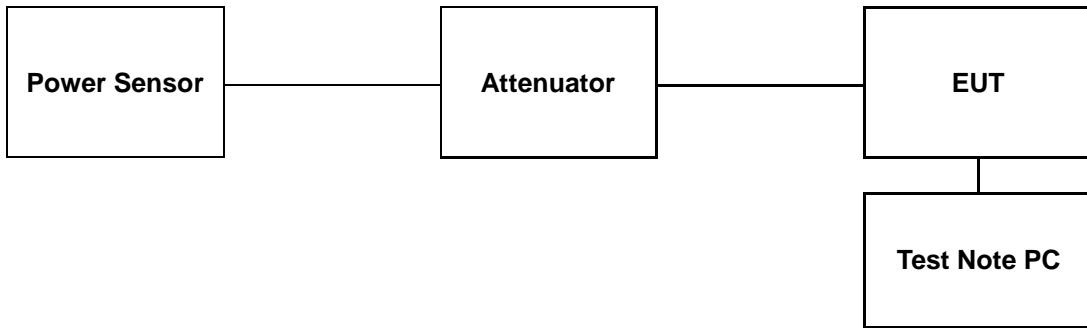
High Channel



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4. Maximum Peak Output Power Measurement

4.1. Test Setup



4.2. Limit

The maximum peak output power of the intentional radiator shall not exceed the following :

1. §15.247(a)(1), 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, provided the systems operate with an output power no greater than 125 mW.
2. §15.247(b)(1), For frequency hopping systems operating in the 2 400 – 2 483.5 MHz employing at least 75 non-overlapping hopping channels, and all frequency hopping systems in the 5 725 – 5 805 MHz band: 1 Watt.

4.3. Test Procedure

All data rates and modes were investigated for this test. The test follows DA000705. Using the power sensor instead of a spectrum analyzer.

1. Place the EUT on the table and set it in the transmitting mode.
2. Remove the antenna from the EUT and then connect a low loss RF cable from the antenna port to the Power sensor.
3. Test program : (S/W name : R&S Power Viewer, Version : 3.2.0)
4. Measure peak & average power each channel.

The results shown in this test report refer only to the sample(s) tested unless otherwise stated. This test report cannot be reproduced, except in full, without prior written permission of the Company.

4.4. Test Results

Ambient temperature : (23 ± 2) °C

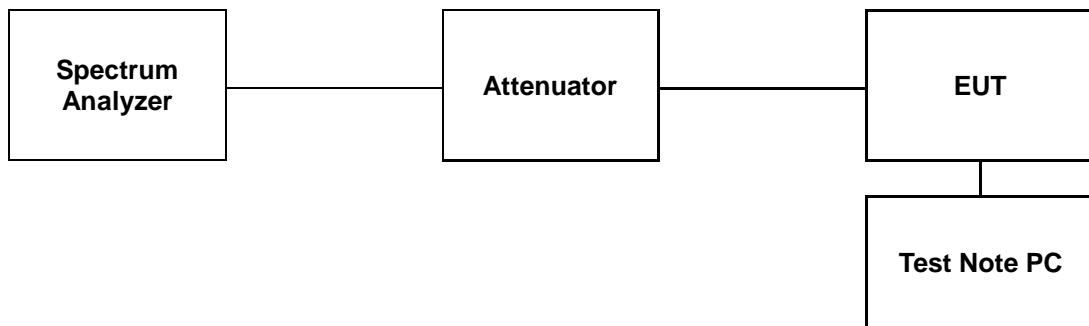
Relative humidity : 47 % R.H.

Operation Mode	Data Rate	Channel	Channel Frequency (MHz)	Attenuator + Cable offset (dB)	Average Power Result (dB m)	Peak Power Result (dB m)	Peak Power Limit (dB m)
GFSK	1 Mbps	Low	2 402	20.71	-0.30	6.07	30.00
		Middle	2 441	20.86	0.02	6.40	30.00
		High	2 480	20.75	0.74	7.05	30.00
$\pi/4$ DQPSK	2 Mbps	Low	2 402	20.71	-2.64	3.95	30.00
		Middle	2 441	20.86	-2.30	4.18	30.00
		High	2 480	20.75	-1.66	4.74	30.00
8DPSK	3 Mbps	Low	2 402	20.71	-0.21	8.54	30.00
		Middle	2 441	20.86	0.12	8.96	30.00
		High	2 480	20.75	0.83	9.67	30.00

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5. Hopping Channel Separation

5.1. Test Setup



5.2. Limit

§15.247(a)(1) Frequency hopping system operating in 2 400 – 2 483.5 MHz. Band may have hopping channel carrier frequencies that are separated by 25 kHz or two-third of 20 dB bandwidth of the hopping channel, whichever is greater, provided the systems operate with an output power no greater than 125 mW.

5.3. Test Procedure

All data rates and modes were investigated for this test. The full data for the worst case data rate are reported in this section. The test follows DA000705.

The device is operating in hopping mode between 79 channels and also supporting Adaptive Frequency Hopping with hopping between 20 channels. As compared with each operating mode, 79 channels are chosen as a representative for test.

Use the following spectrum analyzer settings:

Span = wide enough to capture the peaks of two adjacent channels.

RBW \geq 1 % of the span.

VBW = RBW

Sweep = auto

Detector = peak

Trace = max hold.

Allow the trace to stabilize. Use the marker-delta function to determine the between the peaks of the adjacent channels.

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5.4. Test Results

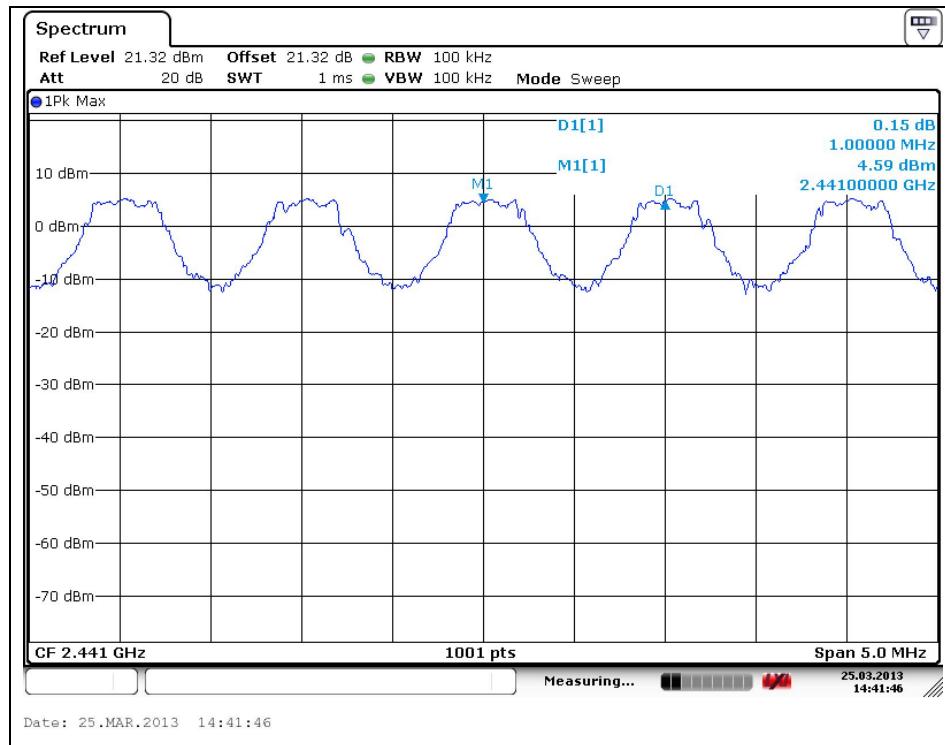
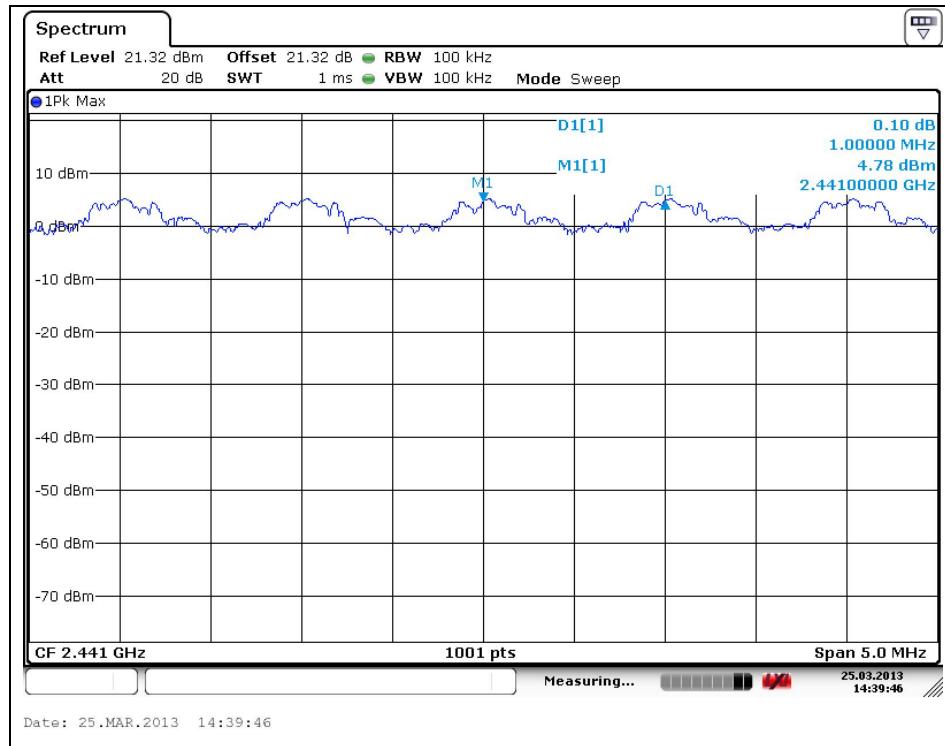
Ambient temperature : (23 ± 2) °C

Relative humidity : 47 % R.H.

Operation Mode	Channel (Middle)	Adjacent Hopping Channel Separation (kHz)	Two-third of 20 dB Bandwidth (kHz)	Minimum Bandwidth (kHz)
GFSK	2 441 MHz	1 000	700	25
8DPSK	2 441 MHz	1 000	867	25

Note;

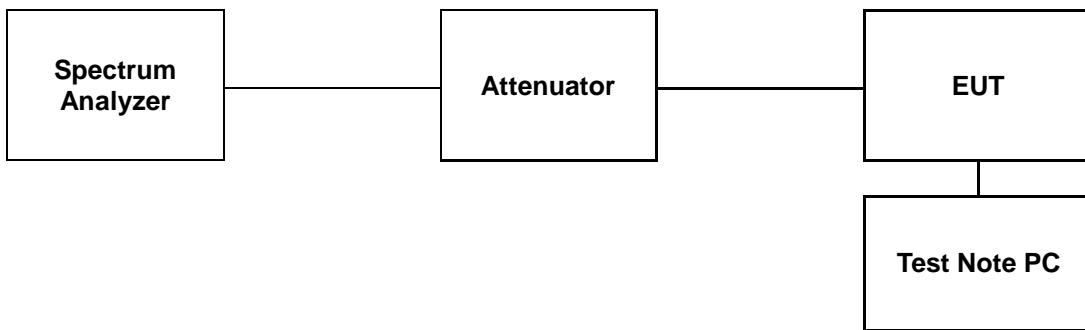
Measurement is made with EUT operating in hopping mode between 79 channels.

Operating Mode: GFSK**Operating Mode: 8DPSK**

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6. Number of Hopping Frequency

6.1. Test Setup



6.2. Limit

§15.247(a)(1)(iii), Frequency hopping systems in the 2 400–2 483.5 MHz band shall use at least 15 channels. 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. Frequency hopping systems may avoid or suppress transmissions on a particular hopping frequency provided that a minimum of 15 channels are used.

6.3. Test Procedure

All data rates and modes were investigated for this test. The full data for the worst case data rate are reported in this section. The test follows DA000705.

The device supports Adaptive Frequency Hopping and will use a minimum of 20 channels of the 79 available channels.

The EUT must have its hopping function enabled. Use the following spectrum analyzer settings:

1. Remove the antenna from the EUT and then connect a low loss RF cable from the antenna the port to the Spectrum analyzer
3. Set spectrum analyzer Start = 2 400 MHz, Stop = 2 441.5 MHz, Sweep=sweep and Start = 2 441.5 MHz, Stop = 2 483.5 MHz, Sweep = sweep. Detector = peak.
4. Set the spectrum analyzer as RBW, VBW = 300 kHz.
5. Max hold, allow the trace to stabilize and count how many channel in the band.

6.4. Test Results

Ambient temperature : (23 ± 2) °C

Relative humidity : 47 % R.H.

Operation Mode	Number of Hopping Frequency	Limit
GFSK	79	≥ 15
8DPSK	79	≥ 15

Remark:

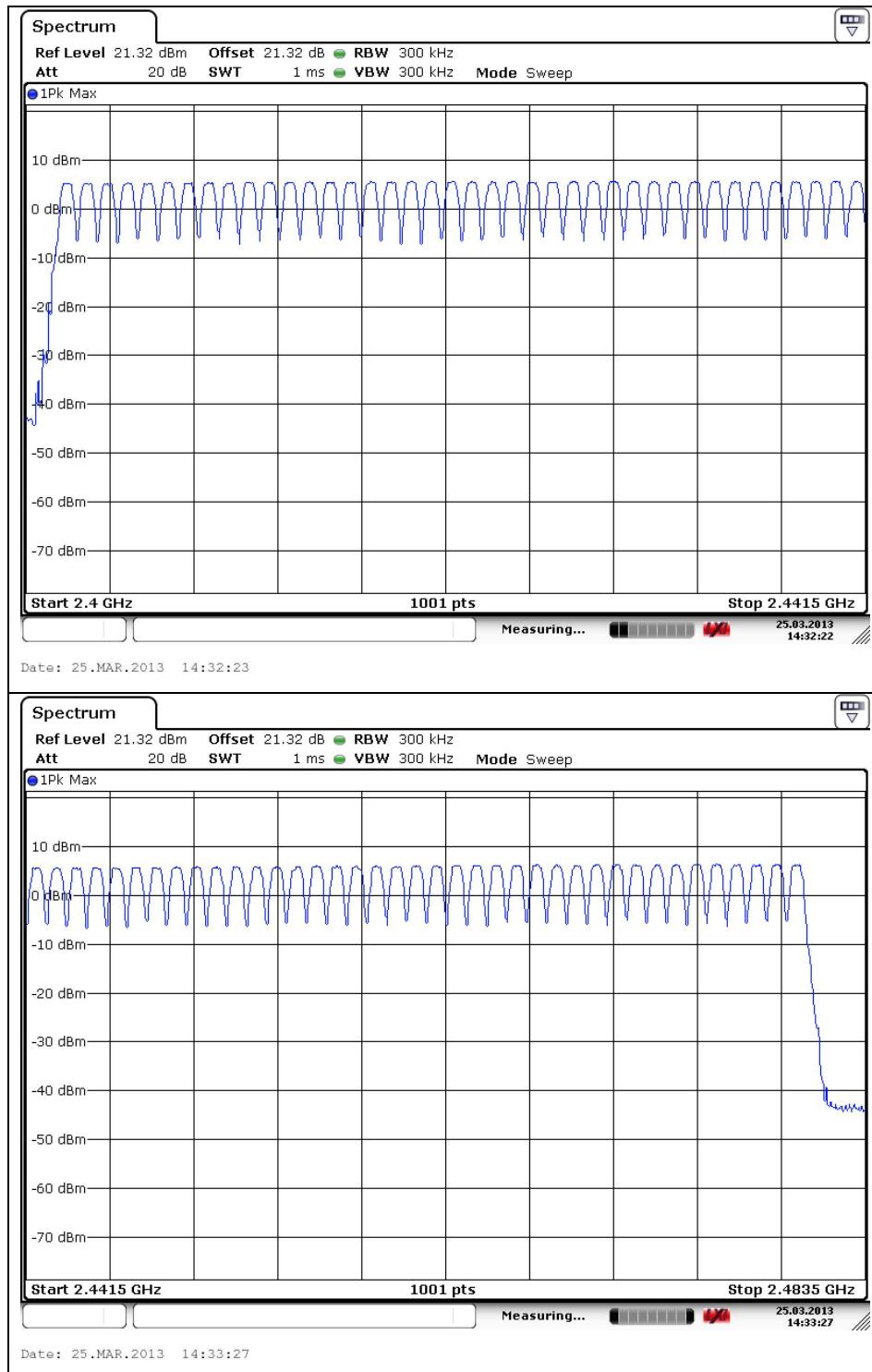
Measurement is made with EUT operating in hopping mode between 79 channels.

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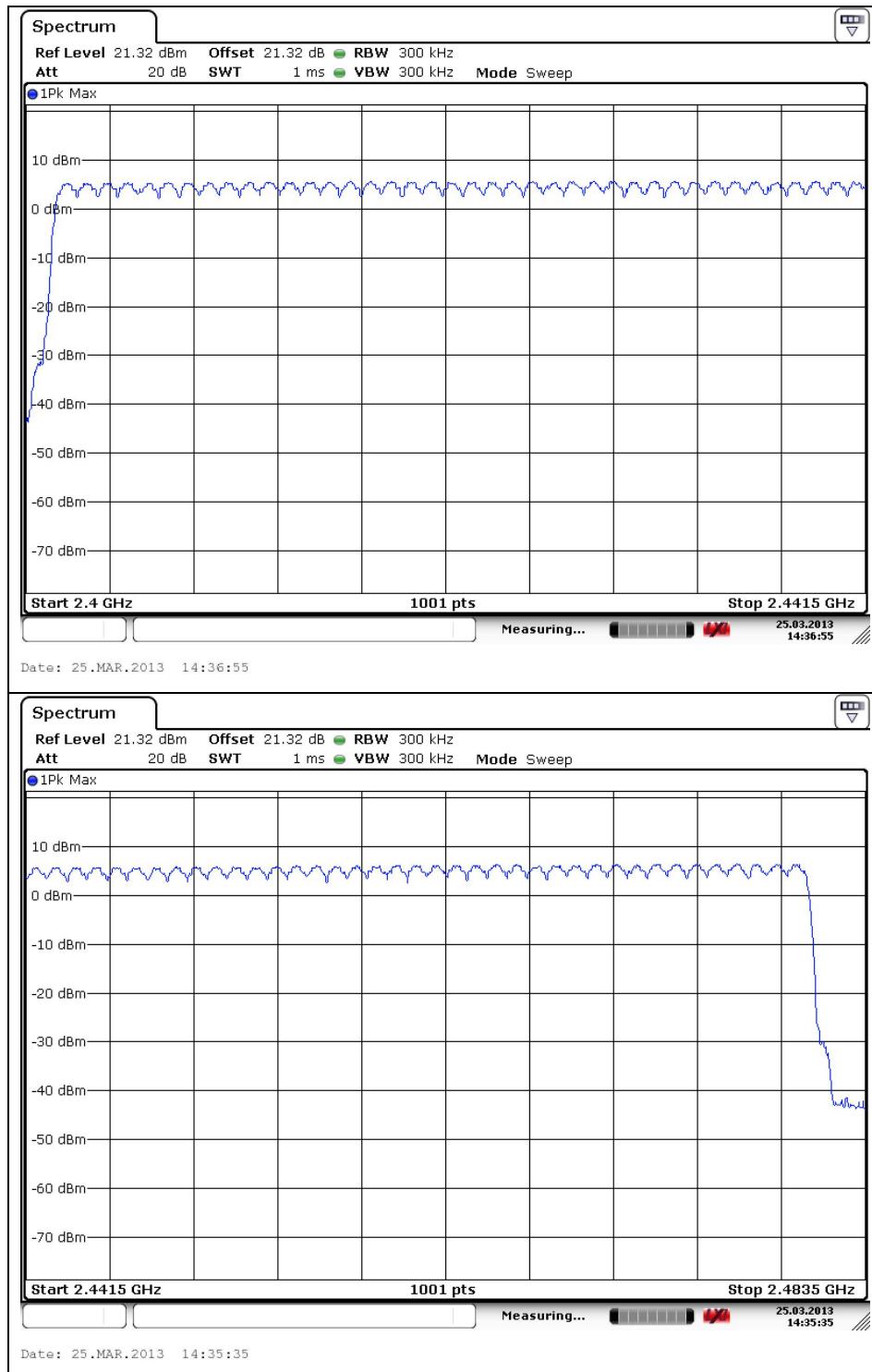
SGS Korea Co., Ltd. (Gunpo Laboratory) 18-34, Sanbon-dong, Gunpo-si, Gyeonggi-do, Korea, 435-040

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Operating Mode: GFSK

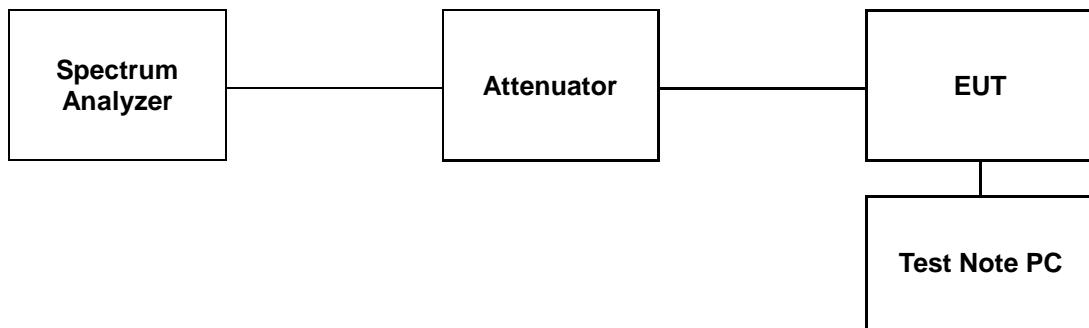
The results shown in this test report refer only to the sample(s) tested unless otherwise stated. This test report cannot be reproduced, except in full, without prior written permission of the Company.

Operating Mode : 8DPSK

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7. Time of Occupancy (Dwell Time)

7.1. Test Set up



7.2. Limit

§15.247(a)(1)(iii) For frequency hopping system operating in the 2 400 – 2 483.5 MHz band, the average time of occupancy on any frequency shall not be greater than 0.4 second within a 31.6 second period.

A period time = 0.4(s) * 79 = 31.6(s)

7.3. Test Procedure

All data rates and modes were investigated for this test. The full data for the worst case data rate are reported in this section. The test follows DA000705.

1. Check the calibration of the measuring instrument using either an internal calibrator or a known signal from an external generator.
2. Position the EUT as shown in test setup without connection to measurement instrument. Turn on the EUT and connect its antenna terminal to measurement instrument via a low loss cable.
3. Measure the time duration of one transmission on the measured frequency. And then plot the result with time difference of this time duration.
4. The Bluetooth has 3 type of payload, DH1, DH3, DH5 and 3-DH1, 3-DH3, 3-DH5. The hopping rate is insisted of 1 600 per second.

The EUT must have its hopping function enabled. Use the following spectrum analyzer setting:

Span = zero span, centered on a hopping channel

RBW = 1 MHz

VBW = RBW

Sweep = as necessary to capture the entire dwell time per hopping channel

Detector = peak

Trace = max hold

Use the marker-delta function to determine the dwell time. If this value varies with different modes of operation repeat this test for each variation.

7.4. Test Results

Ambient temperature : (23 ± 2) °C

Relative humidity : 47 % R.H.

7.4.1. Packet Type: DH1, 3-DH1

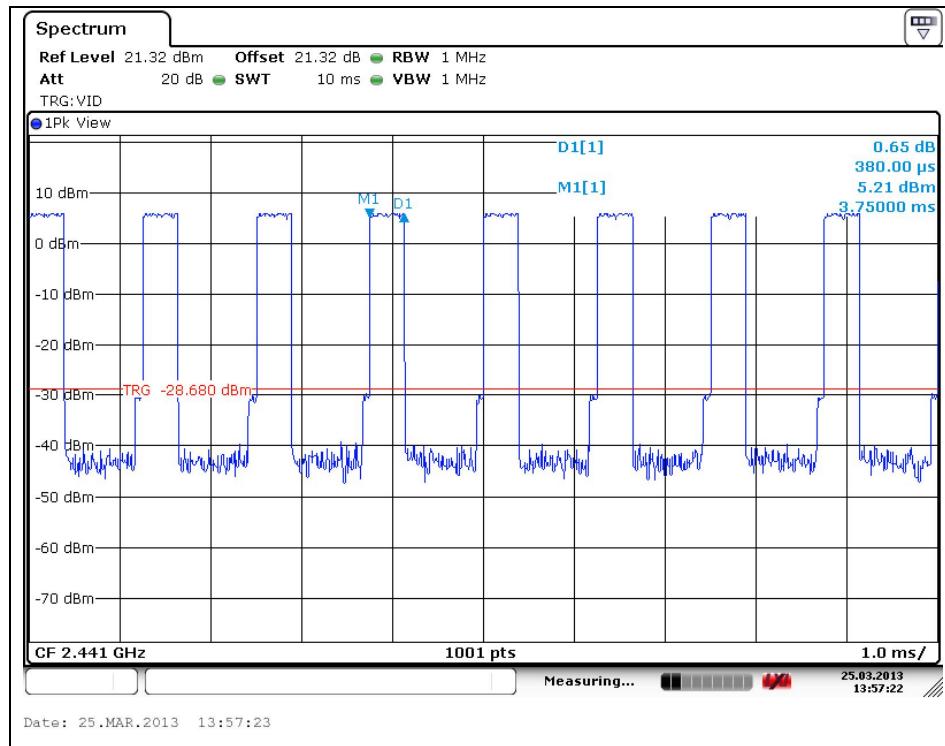
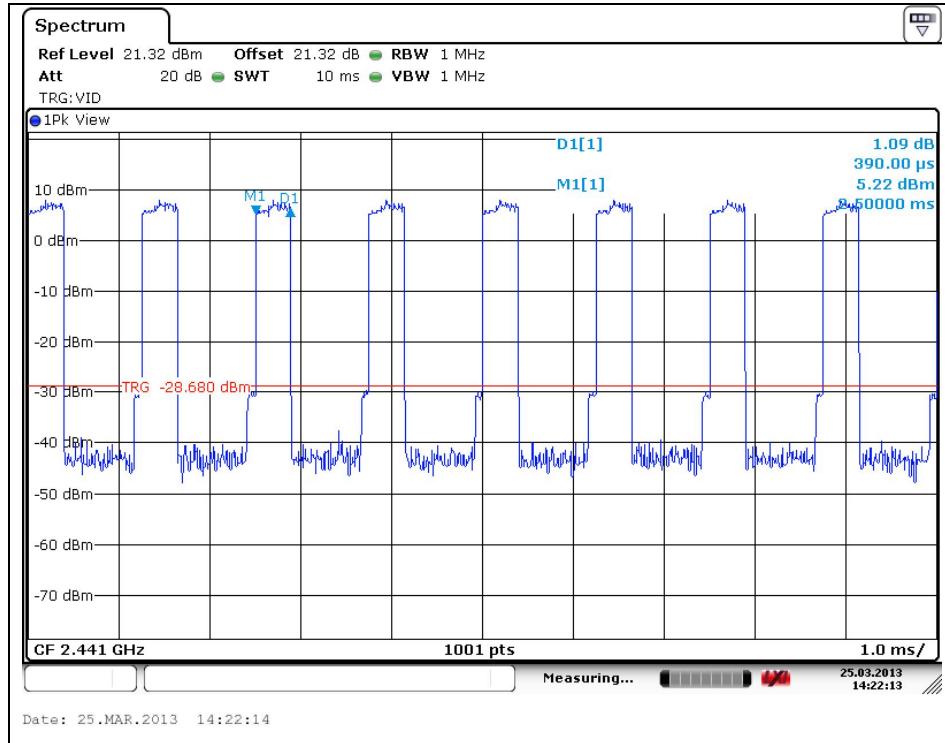
Operation Mode	Frequency	Dwell Time (ms)	Time of occupancy on the Tx Channel in 31.6 sec (ms)	Limit for time of occupancy on the Tx Channel in 31.6 sec (ms)
GFSK	2 441 MHz	0.38	121.6	400
8DPSK	2 441 MHz	0.39	124.8	400

Note:

Time of occupancy on the TX channel in 31.6 sec

In case of GFSK, $0.38 \times \{(1600 \div 2) / 79\} \times 31.6 = 121.6$ ms

In case of 8DPSK, $0.39 \times \{(1600 \div 2) / 79\} \times 31.6 = 124.8$ ms

Operating Mode: GFSK**Operating Mode: 8DPSK**

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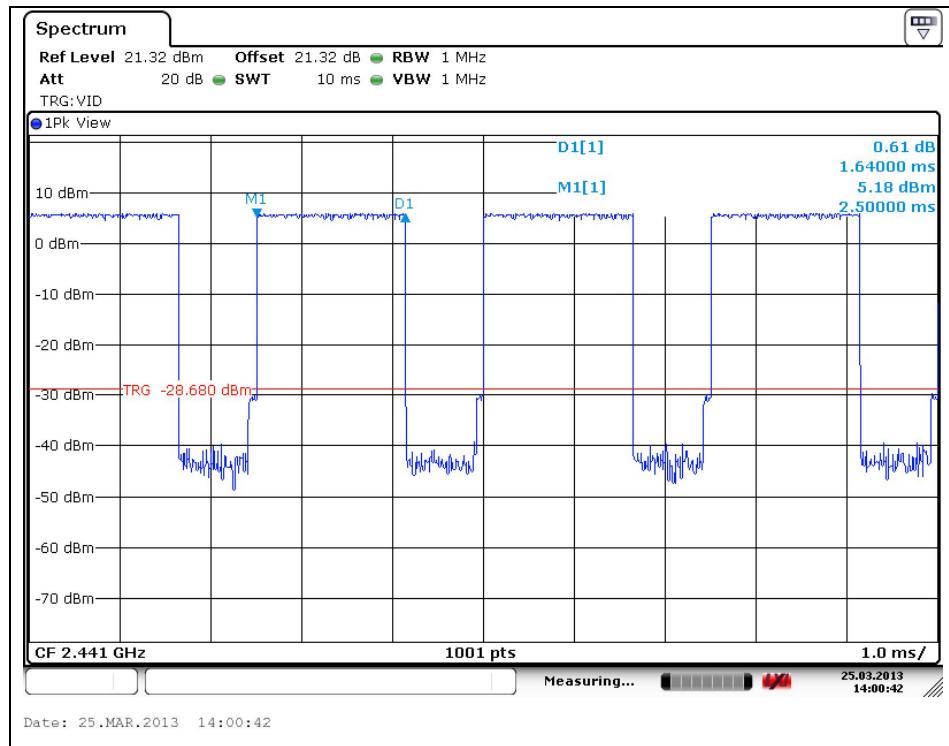
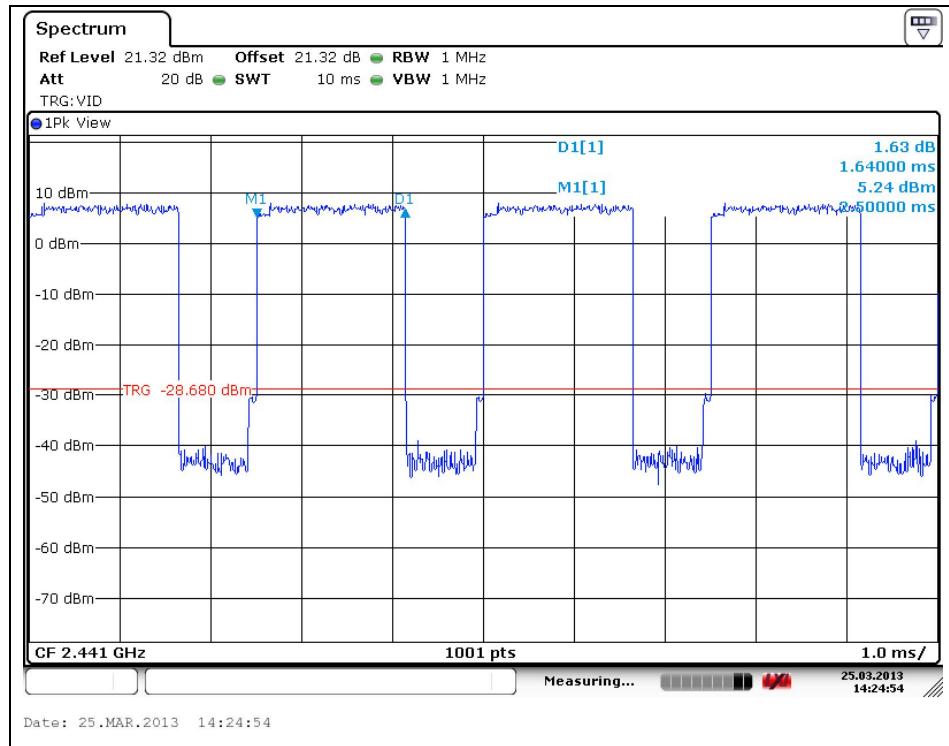
7.4.2. Packet Type: DH3, 3-DH3

Operation Mode	Frequency	Dwell Time (ms)	Time of occupancy on the Tx Channel in 31.6 sec (ms)	Limit for time of occupancy on the Tx Channel in 31.6 sec (ms)
GFSK	2 441 MHz	1.64	262.4	400
8DPSK	2 441 MHz	1.64	262.4	400

Note:

Time of occupancy on the TX channel in 31.6 sec

In case of GFSK and 8DPSK, $1.64 \times \{(1600 \div 4) / 79\} \times 31.6 = 262.4$ ms

Operating Mode: GFSK**Operating Mode: 8DPSK**

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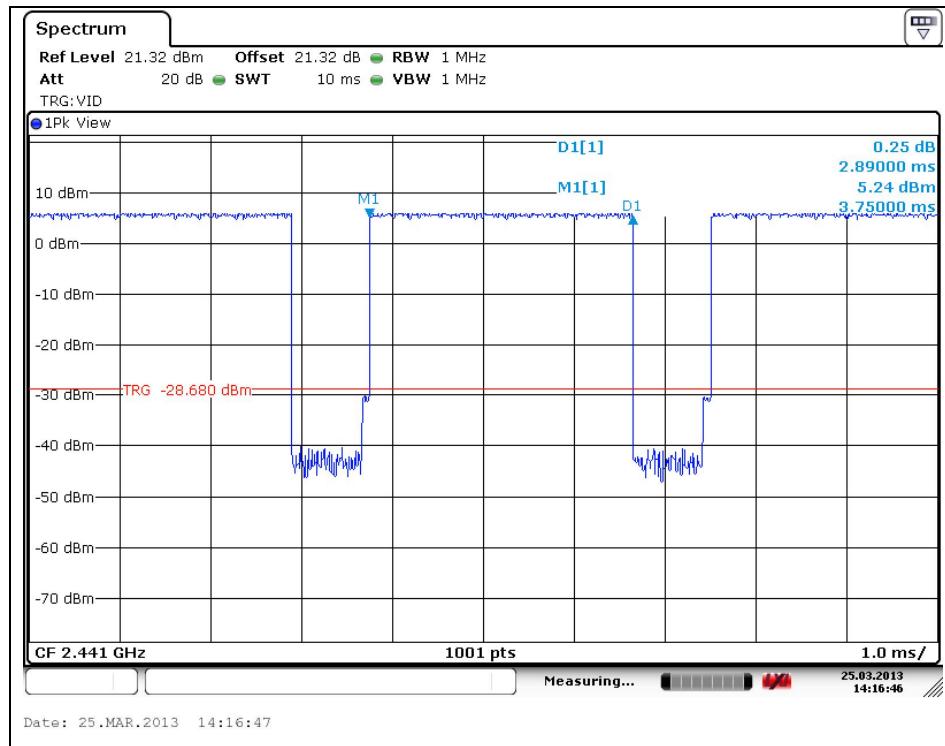
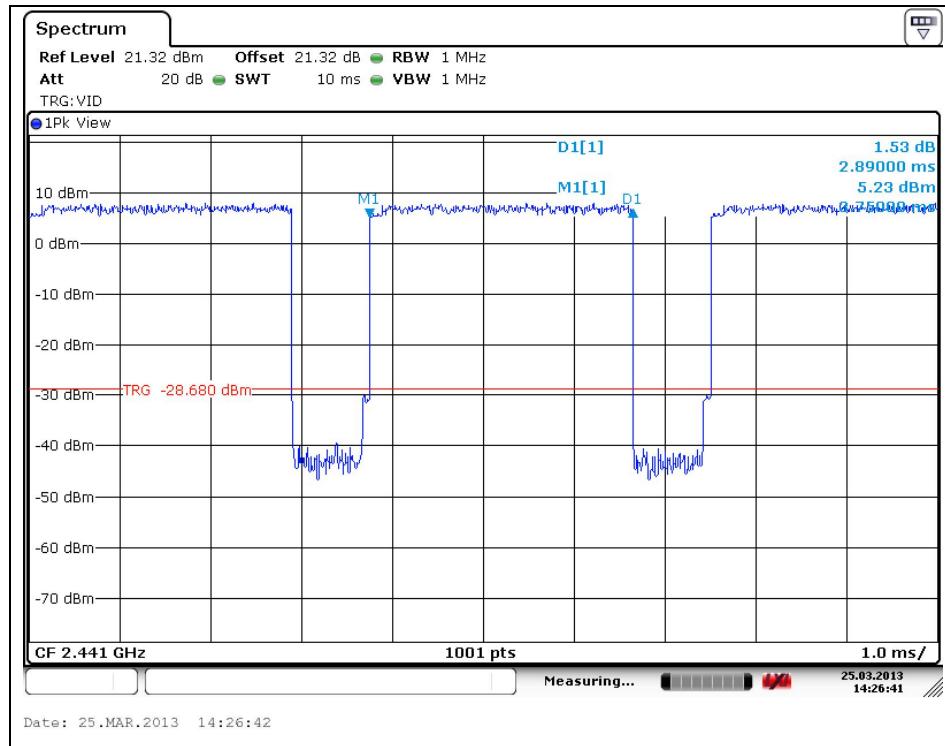
7.4.3. Packet Type: DH5, 3-DH5

Operation Mode	Frequency	Dwell Time (ms)	Time of occupancy on the Tx Channel in 31.6 sec (ms)	Limit for time of occupancy on the Tx Channel in 31.6 sec (ms)
GFSK	2 441 MHz	2.89	308.27	400
8DPSK	2 441 MHz	2.89	308.27	400

Note:

Time of occupancy on the TX channel in 31.6 sec

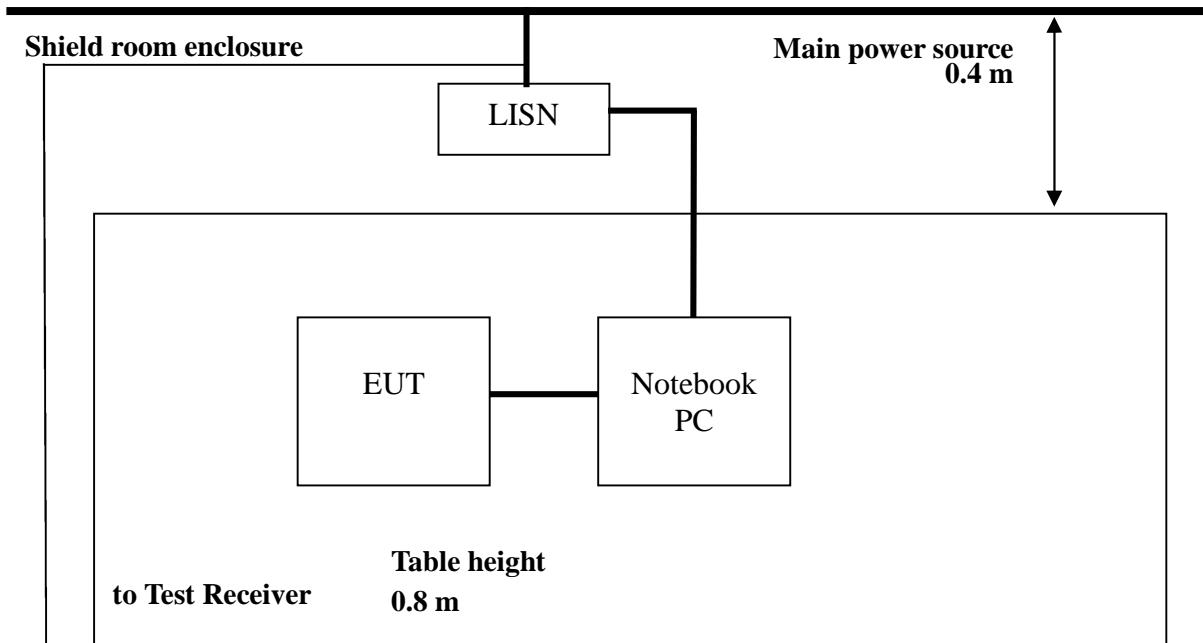
In case of GFSK and 8DPSK, $2.89 \times \{(1600 \div 6) / 79\} \times 31.6 = 308.27$ ms

Operating Mode: GFSK**Operating Mode: 8DPSK**

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8. Transmitter AC power line conducted emission

8.1. Test Setup



8.2. Limit

According to §15.207(a) for an intentional radiator that is designed to be connected to the public utility (AC) power line, the radio frequency voltage that is conducted back onto the AC power line on any frequency or frequencies, within the band 150 kHz to 30 MHz, shall not exceed the limits in the following table, as measured using a 50 uH/50 ohm line impedance stabilization network (LISN).

Compliance with the provision of this paragraph shall be on the measurement of the radio frequency voltage between each power line and ground at the power terminal. The lower applies at the boundary between the frequency ranges.

Frequency of Emission (MHz)	Conducted limit (dB μ V)	
	Quasi-peak	Average
0.15 – 0.50	66-56*	56-46*
0.50 – 5.00	56	46
5.00 – 30.0	60	50

* Decreases with the logarithm of the frequency.

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8.3. Test Procedures

Radiated emissions from the EUT were measured according to the dictates of ANSI C63.4:2003

1. The test procedure is performed in a 6.5 m × 3.6 m × 3.6 m (L×W×H) shielded room. The EUT along with its peripherals were placed on a 1.0 m(W)× 1.5 m(L) and 0.8 m in height wooden table and the EUT was adjusted to maintain a 0.4 meter space from a vertical reference plane.
2. The EUT was connected to power mains through a line impedance stabilization network (LISN) which provides 50 ohm coupling impedance for measuring instrument and the chassis ground was bounded to the horizontal ground plane of shielded room.
3. All peripherals were connected to the second LISN and the chassis ground also bounded to the horizontal ground plane of shielded room.
4. The excess power cable between the EUT and the LISN was bundled. The power cables of peripherals were unbundled. All connecting cables of EUT and peripherals were moved to find the maximum emission.

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8.4. Test Results

Ambient temperature : (23 ± 2) °C

Relative humidity : 47 % R.H.

The following table shows the highest levels of conducted emissions on both phase of Hot and Neutral line.

Frequency range : 0.15 MHz – 30 MHz

Measured Bandwidth : 9 kHz

FREQ. (MHz)	LEVEL(dB μ V)		LINE	LIMIT(dB μ V)		MARGIN(dB)	
	Q-Peak	Average		Q-Peak	Average	Q-Peak	Average
0.17	57.58	43.18	H	65.11	55.11	7.53	11.93
0.34	42.79	33.59	H	59.11	49.11	16.32	15.52
0.46	41.30	33.50	H	56.71	46.71	15.41	13.21
1.50	25.92	21.62	H	56.00	46.00	30.08	24.38
5.11	23.85	18.85	H	60.00	50.00	36.15	31.15
14.11	20.35	16.55	H	60.00	50.00	39.65	33.45
0.15	59.86	44.26	N	66.00	56.00	6.14	11.74
0.17	58.46	44.86	N	65.01	55.01	6.55	10.15
0.22	49.36	39.76	N	62.71	52.71	13.35	12.95
0.46	38.78	34.88	N	56.75	46.75	17.97	11.87
1.59	29.21	25.01	N	56.00	46.00	26.79	20.99
4.58	25.92	19.02	N	56.00	46.00	30.08	26.98

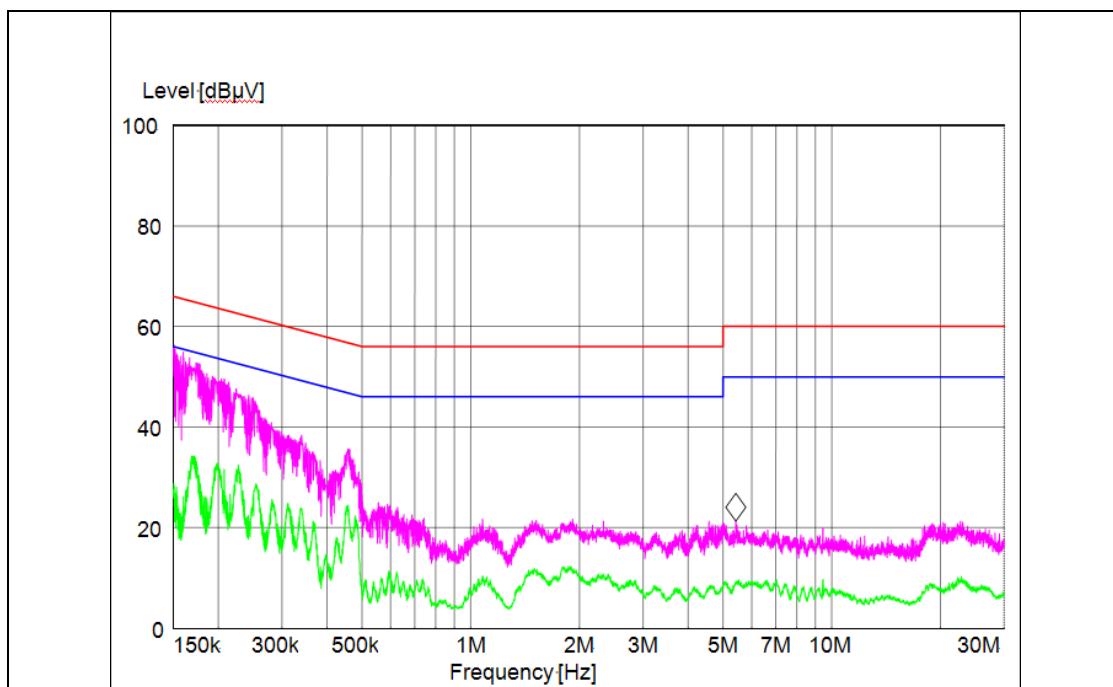
Note :

1. Line (H): Hot, Line (N): Neutral
2. All modes of operation were investigated and the worst-case emissions are reported using 8DPSK
3. The limit for Class B device(s) from 150 kHz to 30 MHz are specified in Section of the Title 47 CFR.
4. Traces shown in plot using a peak detector and average detector
5. Deviations to the Specifications: None.

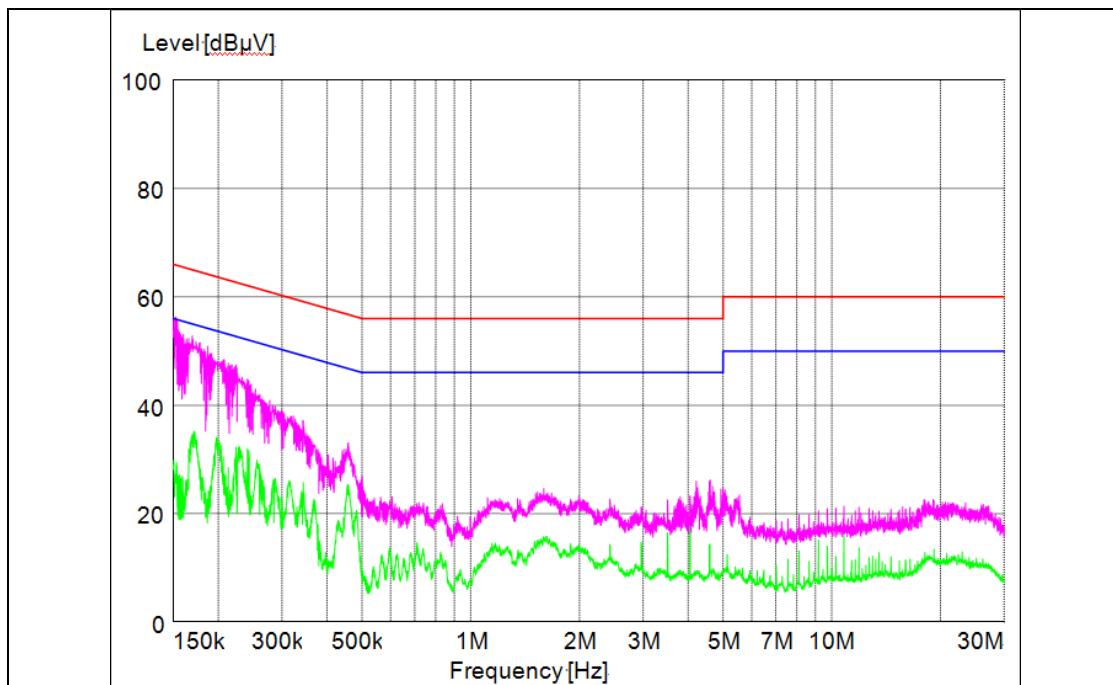
The results shown in this test report refer only to the sample(s) tested unless otherwise stated. This test report cannot be reproduced, except in full, without prior written permission of the Company.

Plot of Conducted Power line

Test mode : (Hot)



Test mode : (Neutral)



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9. Antenna Requirement

9.1. Standard Applicable

For intentional device, according to FCC 47 CFR Section §15.203, an intentional radiator shall be designed to ensure that no antenna other than that furnished by the responsible party shall be used with the device. And according to FCC 47 CFR Section §15.247 (b) if transmitting antennas of directional gain greater than 6 dB i are used, the power shall be reduced by the amount in dB that the gain of the antenna exceeds 6 dB i.

9.2. Antenna Connected Construction

Antenna used in this product is FPCB type with gain of 2.48 dB i.

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