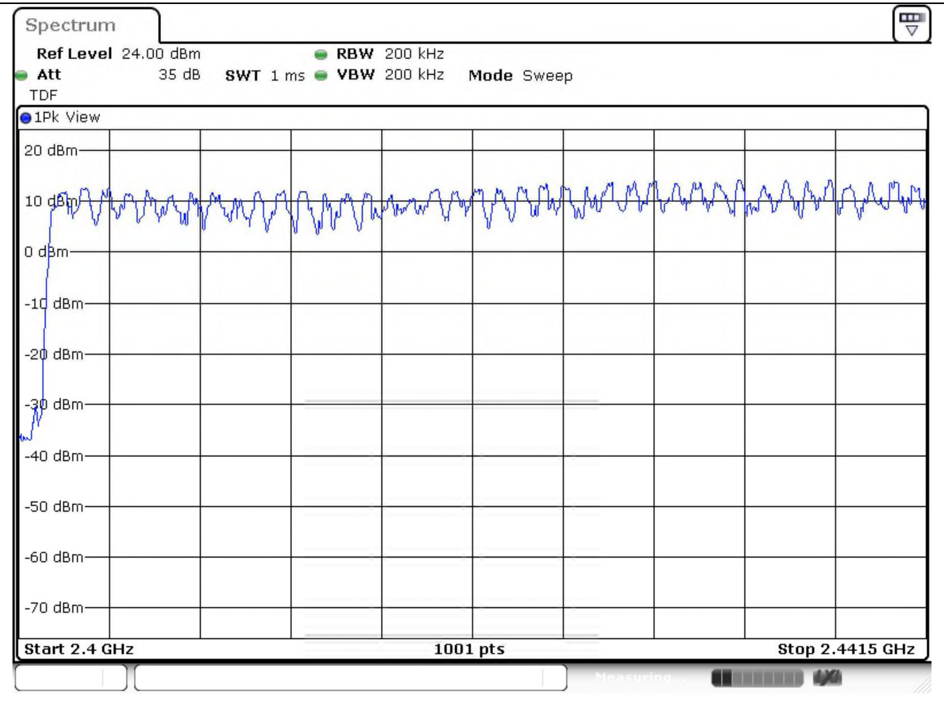
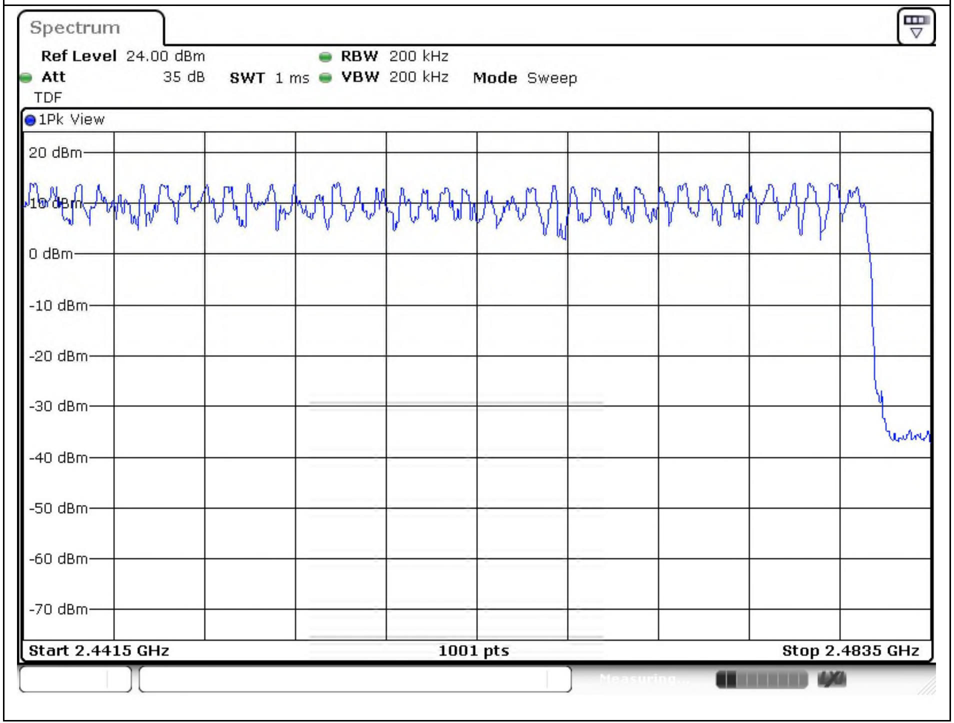
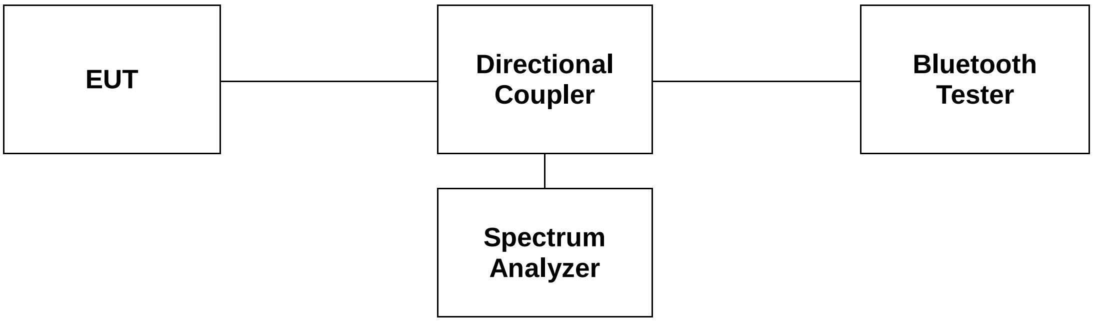
Operating Mode: 8DPSK_Ant.2





7. Time of Occupancy (Dwell Time)

7.1. Test Set up



7.2. Limit

7.2.1. FCC

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

7.2.2. IC

According to RSS-247 Issue 2, 5.1(d), FHSs operating in the band 2 400-2 483.5 ㎒ shall use at least 15 hopping 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. Transmissions on particular hopping frequencies may be avoided or suppressed provided that at least 15 hopping channels are used.

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

***Adaptive Frequency Hopping**

A period time = 0.4 (s) * 20 = 8 (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 ANSI C63.10-2013.

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 3DH1, 3DH3, 3DH5.The hopping rate is insisted of 1 600 per second.

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

1. Span = Zero span, centered on a hopping channel.
2. RBW = 1 ㎒.
3. VBW ≥ RBW.
4. Sweep = As necessary to capture the entire dwell time per hopping channel.
5. Detector = Peak.
6. Trace = Max hold.

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

7.4. Test Results

Ambient temperature : (23 ± 1) ℃
Relative humidity : 47 % R.H.

7.4.1. Packet Type: DH1, 3DH1

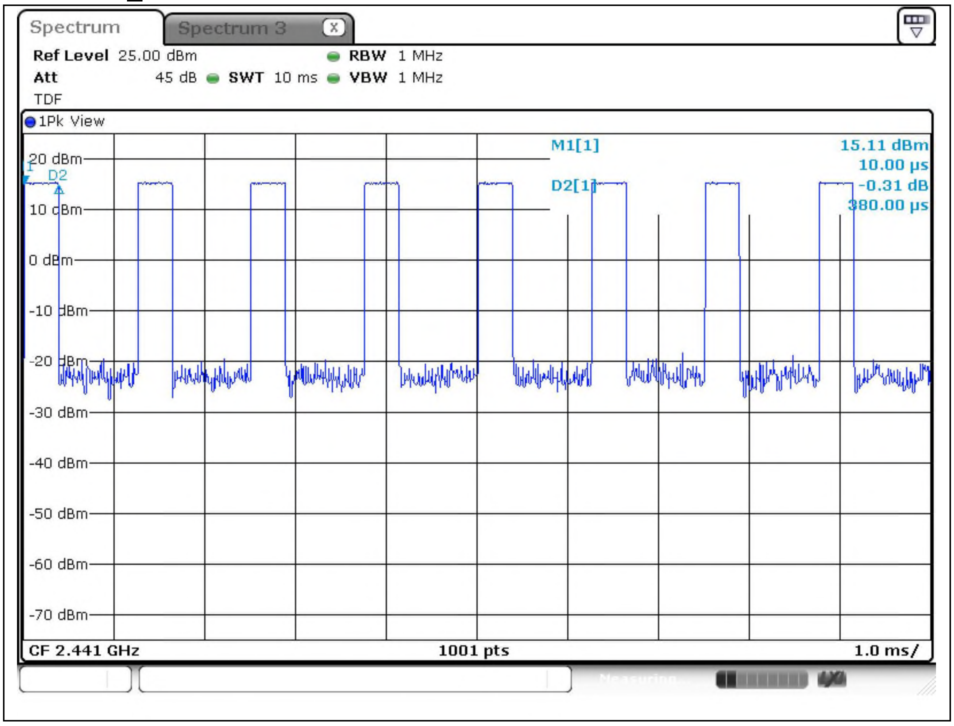
Port	Operation Mode	Frequency (㎒)	Dwell Time (㎳)	Time of occupancy on the Tx Channel in 31.6 sec (㎳)	Limit for time of occupancy on the Tx Channel in 31.6 sec (㎳)
Ant.1	GFSK	2 441	0.38	121.60	400
	8DPSK		0.38	121.60	
Ant.2	GFSK		0.38	121.60	
	8DPSK		0.39	124.80	

Remark;

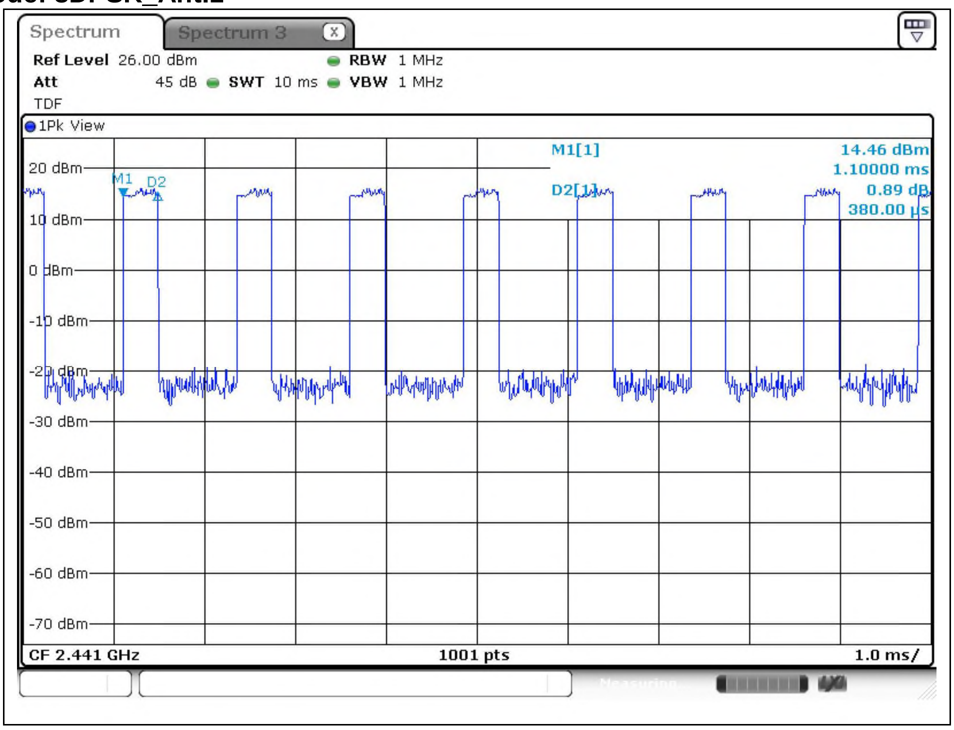
Time of occupancy on the TX channel in 31.6 sec.
Ant.1: In case of GFSK and 8DPSK: 0.38 × {(1 600 ÷ 2) / 79} × 31.6 = 121.60 ㎳
Ant.2: In case of GFSK: 0.38 × {(1 600 ÷ 2) / 79} × 31.6 = 121.60 ㎳
In case of 8DPSK: 0.39 × {(1 600 ÷ 2) / 79} × 31.6 = 124.80 ㎳

- Test plots

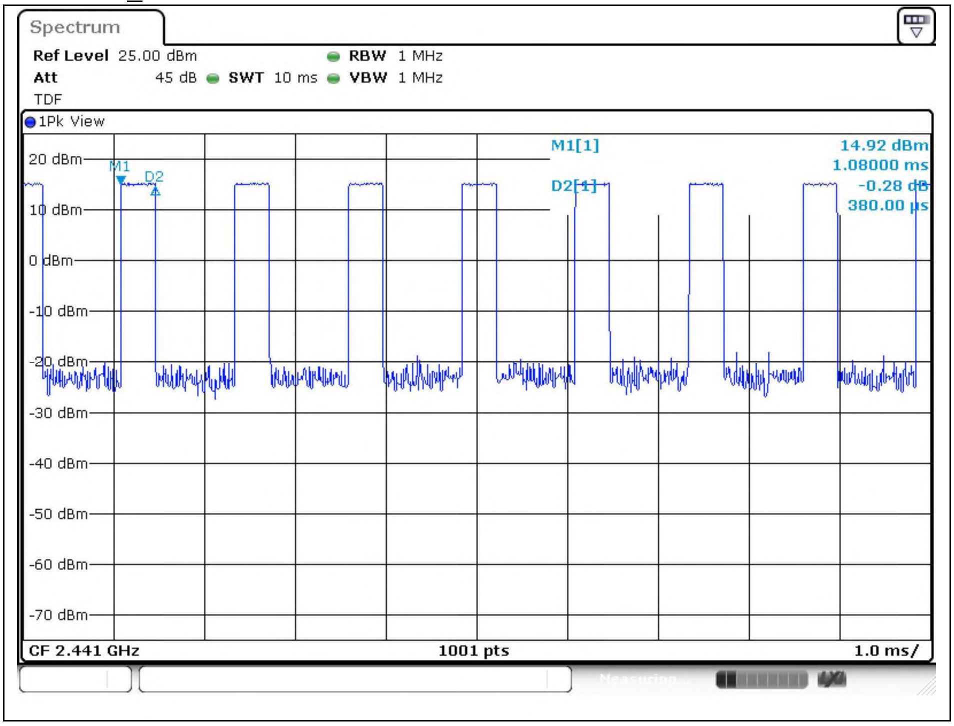
Operating Mode: GFSK_Ant.1



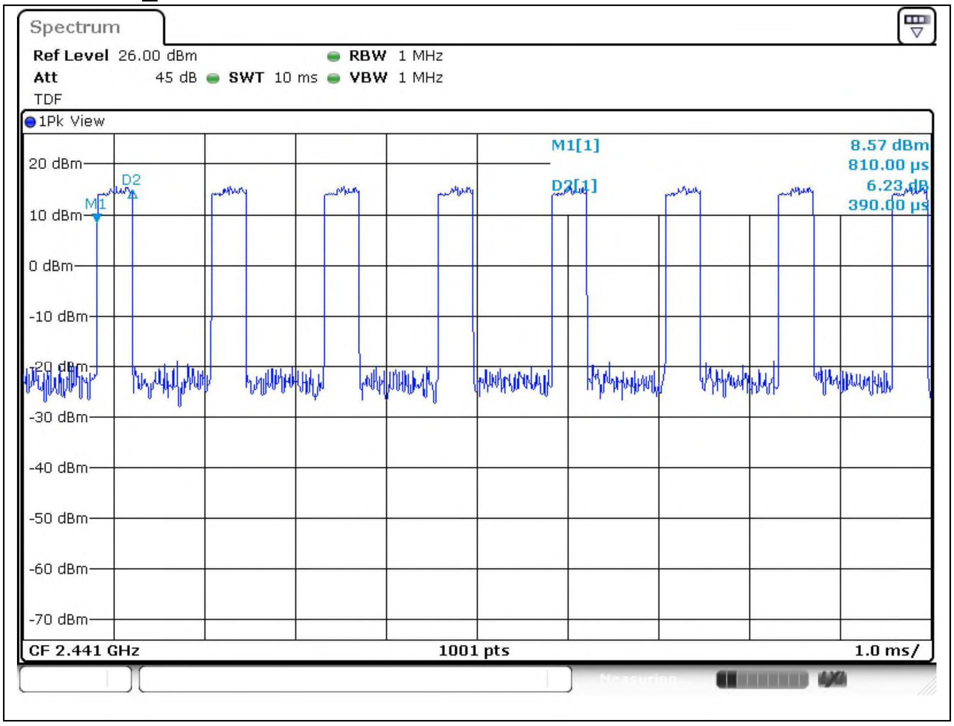
Operating Mode: 8DPSK_Ant.1



Operating Mode: GFSK_Ant.2



Operating Mode: 8DPSK_Ant.2



7.4.2. Packet Type: DH3, 3DH3

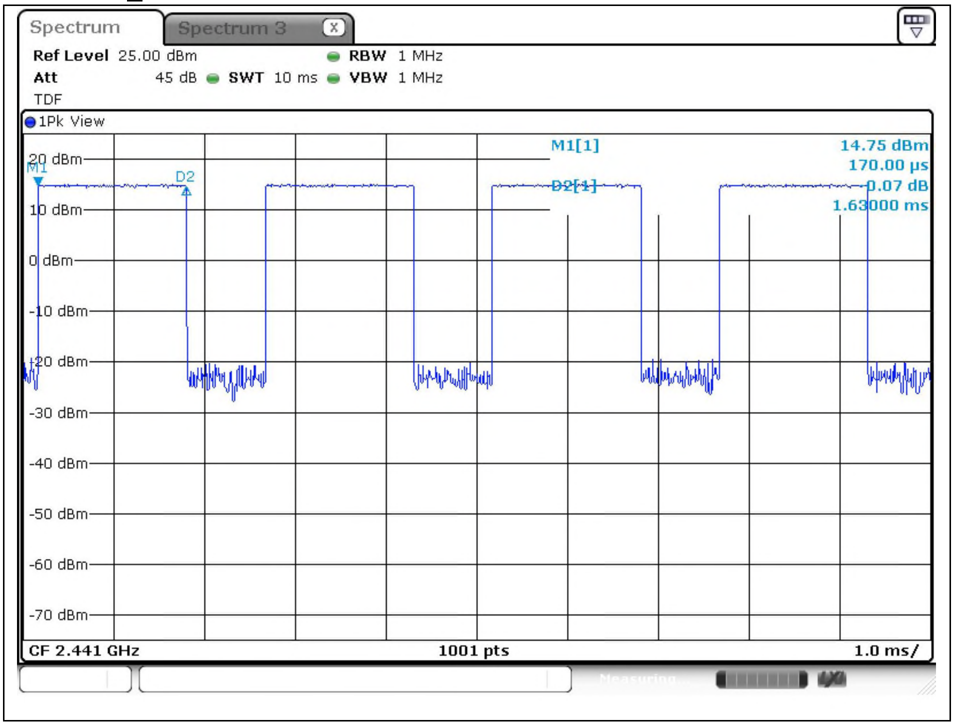
Port	Operation Mode	Frequency (㎒)	Dwell Time (㎳)	Time of occupancy on the Tx Channel in 31.6 sec (㎳)	Limit for time of occupancy on the Tx Channel in 31.6 sec (㎳)
Ant.1	GFSK	2 441	1.63	260.80	400
	8DPSK		1.64	262.40	
Ant.2	GFSK		1.64	262.40	
	8DPSK		1.64	262.40	

Remark;

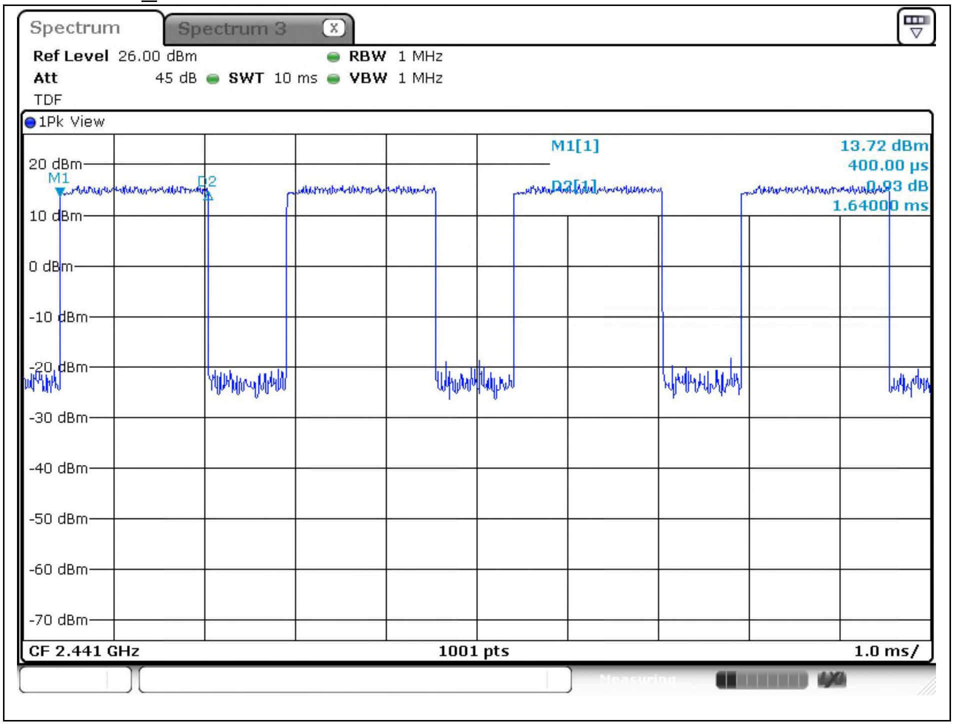
Time of occupancy on the TX channel in 31.6 sec.
Ant.1: In case of GFSK: 1.63 × {(1 600 ÷ 4) / 79} × 31.6 = 260.80 ㎳
In case of 8DPSK: 1.64 × {(1 600 ÷ 4) / 79} × 31.6 = 262.40 ㎳
Ant.2: In case of GFSK and 8DPSK: 1.64 × {(1 600 ÷ 4) / 79} × 31.6 = 262.40 ㎳

- Test plots

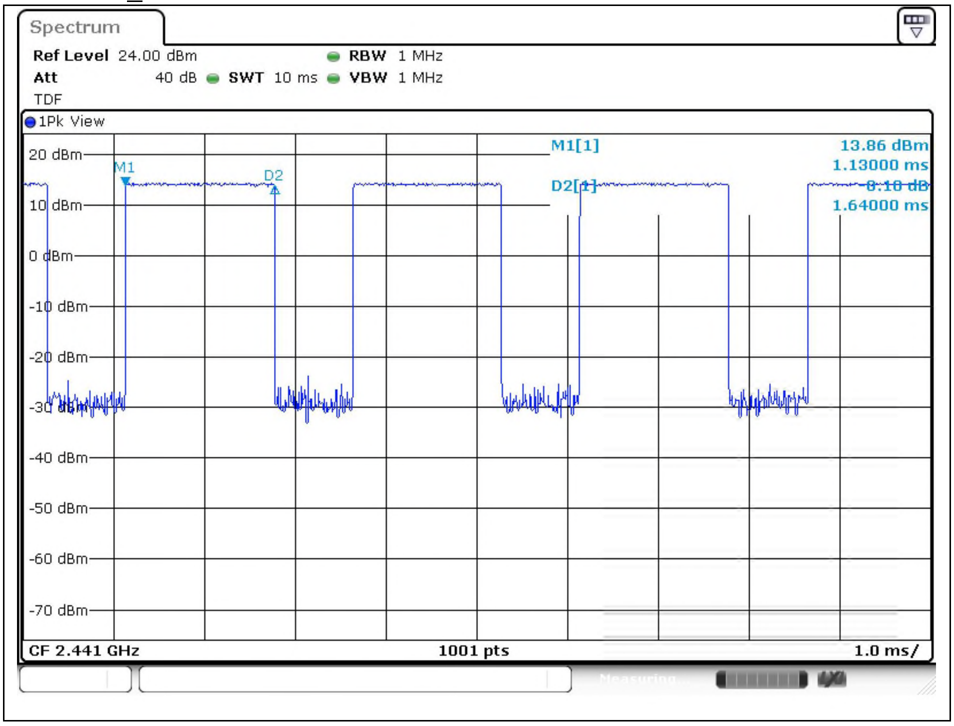
Operating Mode: GFSK_Ant.1



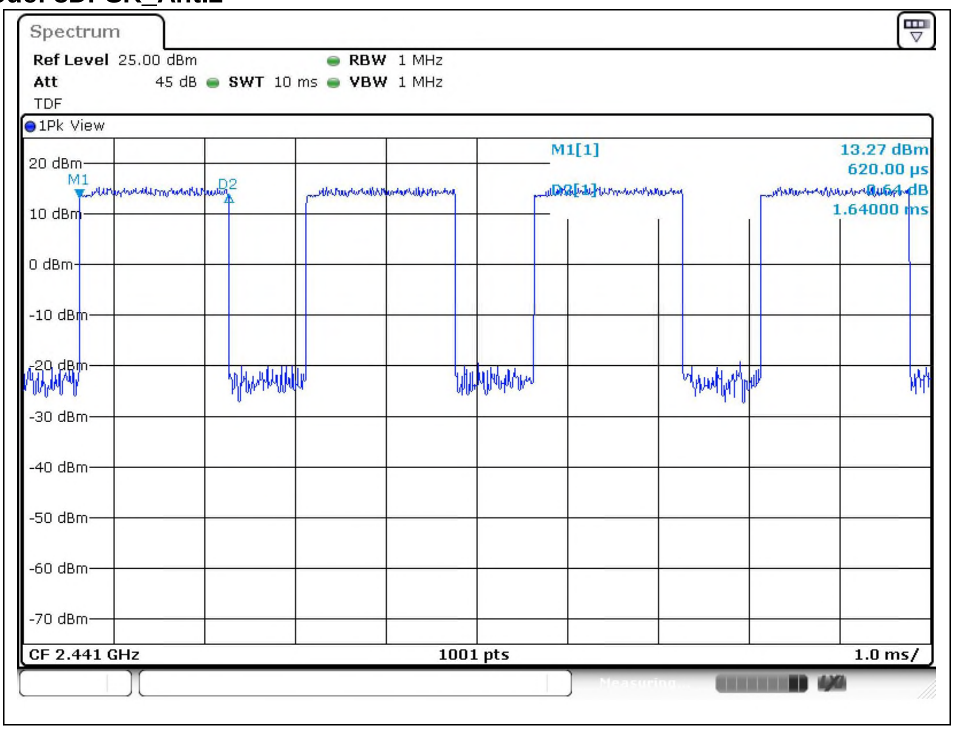
Operating Mode: 8DPSK_Ant.1



Operating Mode: GFSK_Ant.2



Operating Mode: 8DPSK_Ant.2



7.4.3. Packet Type: DH5, 3DH5

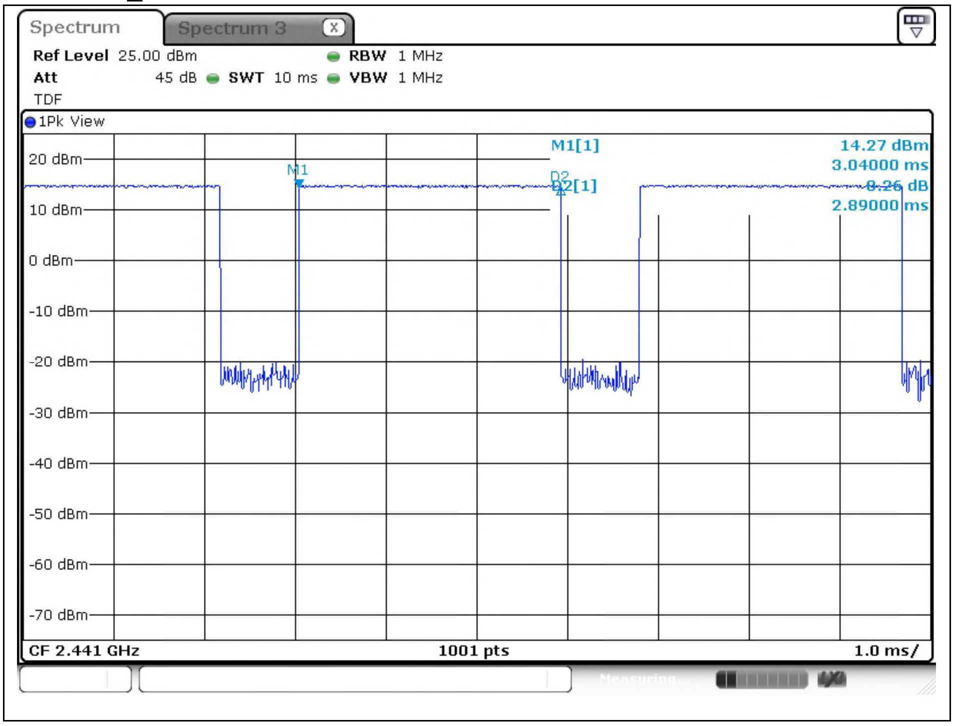
Port	Operation Mode	Frequency (㎒)	Dwell Time (㎳)	Time of occupancy on the Tx Channel in 31.6 sec (㎳)	Limit for time of occupancy on the Tx Channel in 31.6 sec (㎳)
Ant.1	GFSK	2 441	2.89	308.27	400
	8DPSK		2.89	308.27	
Ant.2	GFSK		2.88	307.20	
	8DPSK		2.89	308.27	

Remark;

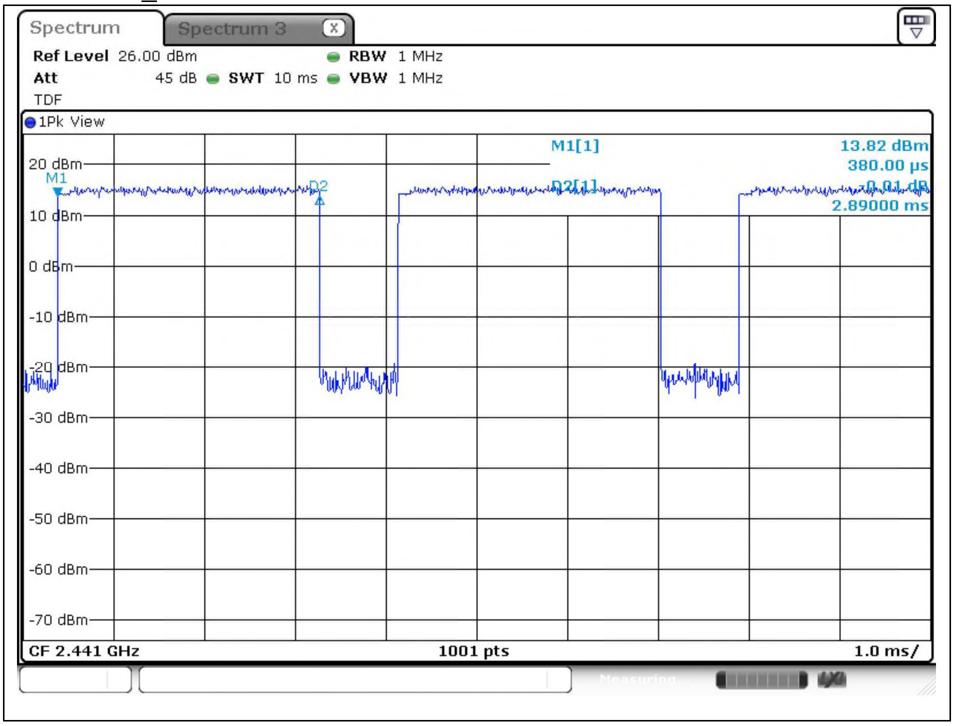
Time of occupancy on the TX channel in 31.6 sec.
Ant.1: In case of GFSK and 8DPSK: 2.89 × {(1 600 ÷ 6) / 79} × 31.6 = 308.27 ㎳
Ant.2: In case of GFSK: 2.88 × {(1 600 ÷ 6) / 79} × 31.6 = 307.20 ㎳
In case of 8DPSK: 2.89 × {(1 600 ÷ 6) / 79} × 31.6 = 308.27 ㎳

- Test plots

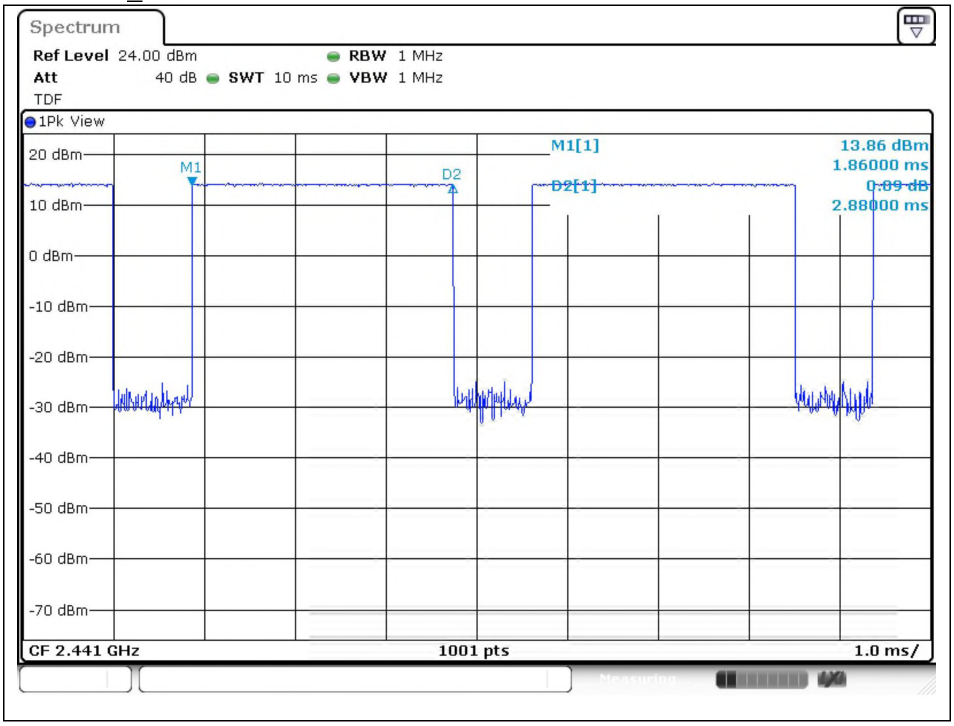
Operating Mode: GFSK_Ant.1



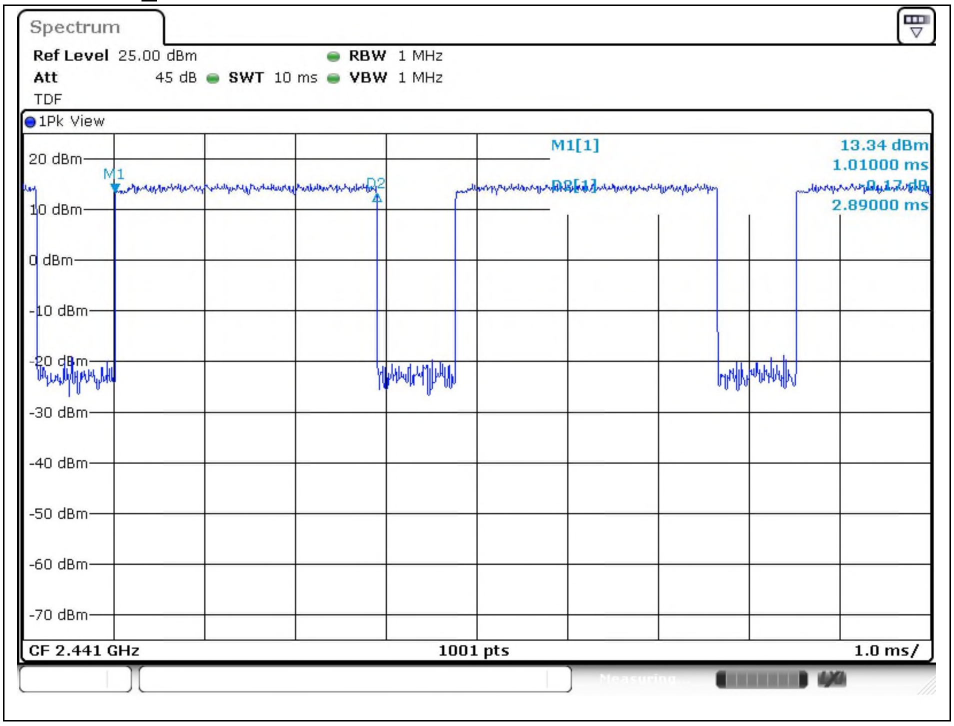
Operating Mode: 8DPSK_Ant.1



Operating Mode: GFSK_Ant.2



Operating Mode: 8DPSK_Ant.2



7.4.4. Packet Type: DH1, 3DH1 (Adaptive Frequency Hopping)

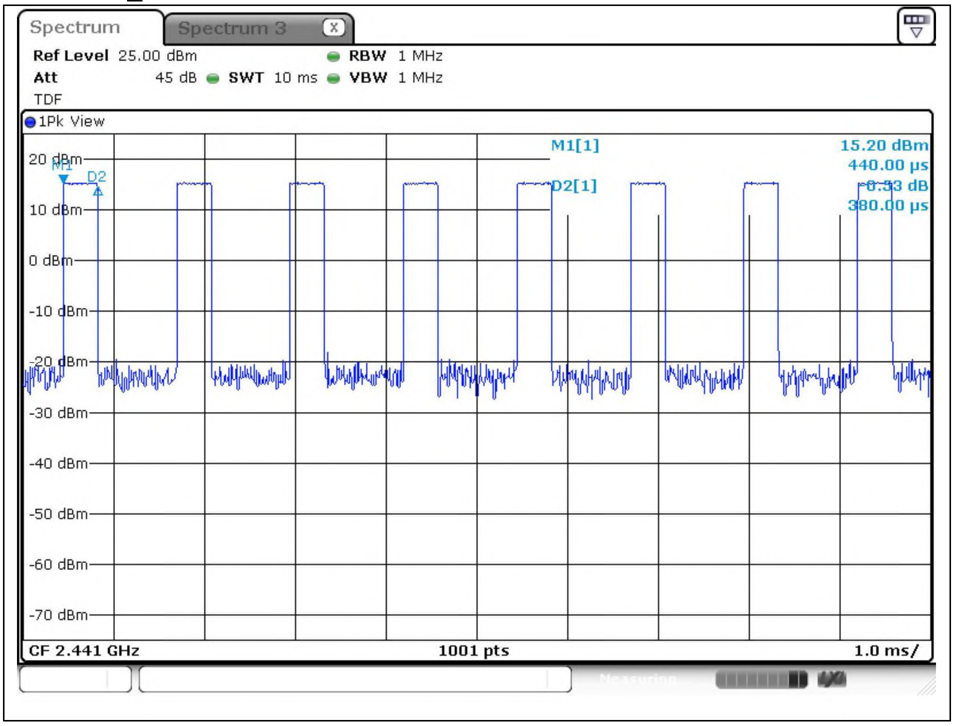
Port	Operation Mode	Frequency (㎒)	Dwell Time (㎳)	Time of occupancy on the Tx Channel in 31.6 sec (㎳)	Limit for time of occupancy on the Tx Channel in 31.6 sec (㎳)
Ant.1	GFSK	2 441	0.38	60.80	400
	8DPSK		0.39	62.40	
Ant.2	GFSK		0.38	60.80	
	8DPSK		0.38	60.80	

Remark;

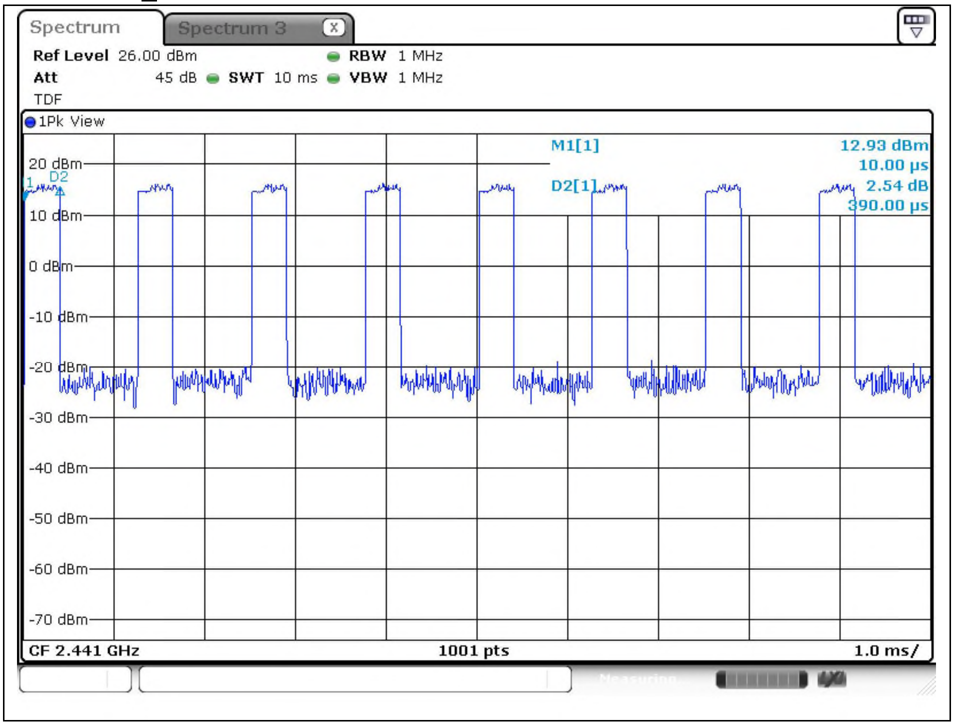
Time of occupancy on the TX channel in 8 sec.
Ant.1: In case of GFSK: 0.38 × {(800 ÷ 2) / 20} × 8 = 60.80 ㎳
In case of 8DPSK: 0.39 × {(800 ÷ 2) / 20} × 8 = 62.40 ㎳
Ant.2: In case of GFSK and 8DPSK: 0.38 × {(800 ÷ 2) / 20} × 8 = 60.80 ㎳

- Test plots

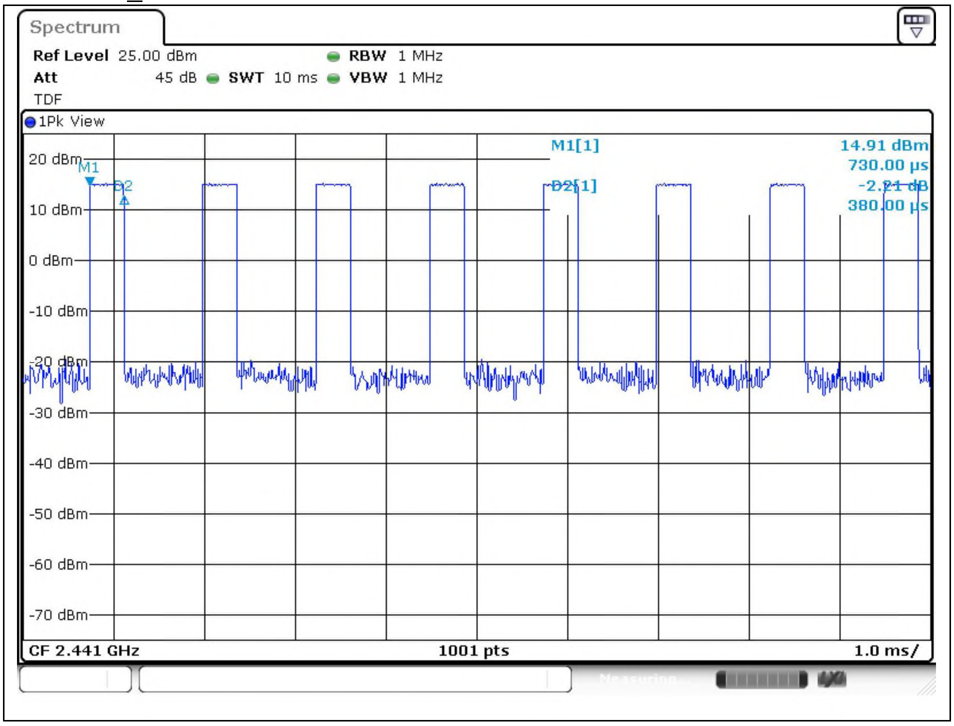
Operating Mode: GFSK_Ant.1



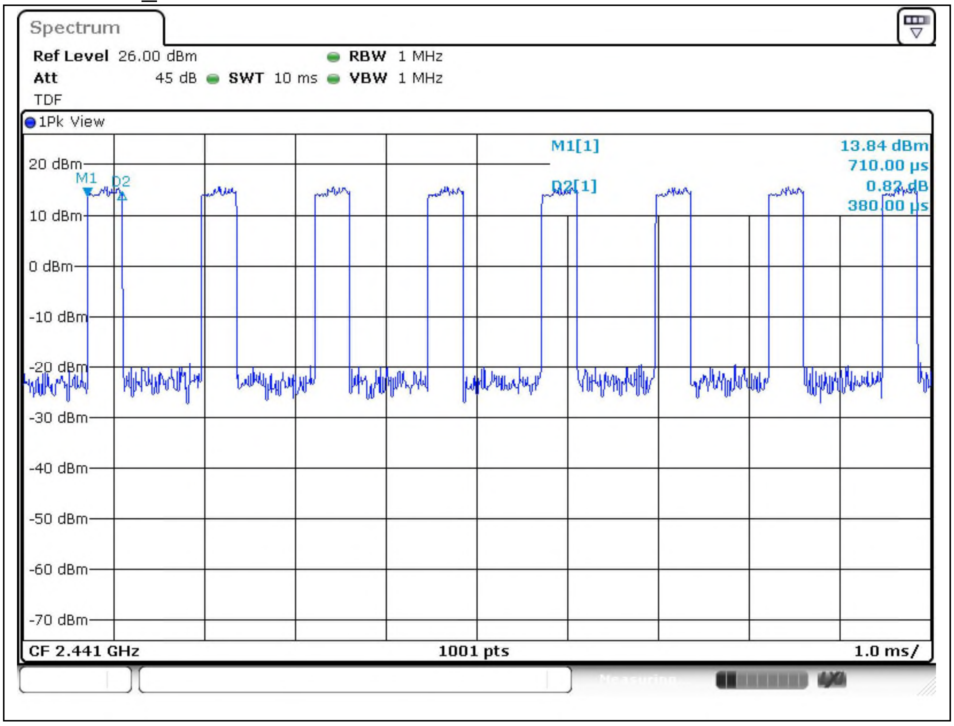
Operating Mode: 8DPSK_Ant.1



Operating Mode: GFSK_Ant.2



Operating Mode: 8DPSK_Ant.2



7.4.5. Packet Type: DH3, 3DH3 (Adaptive Frequency Hopping)

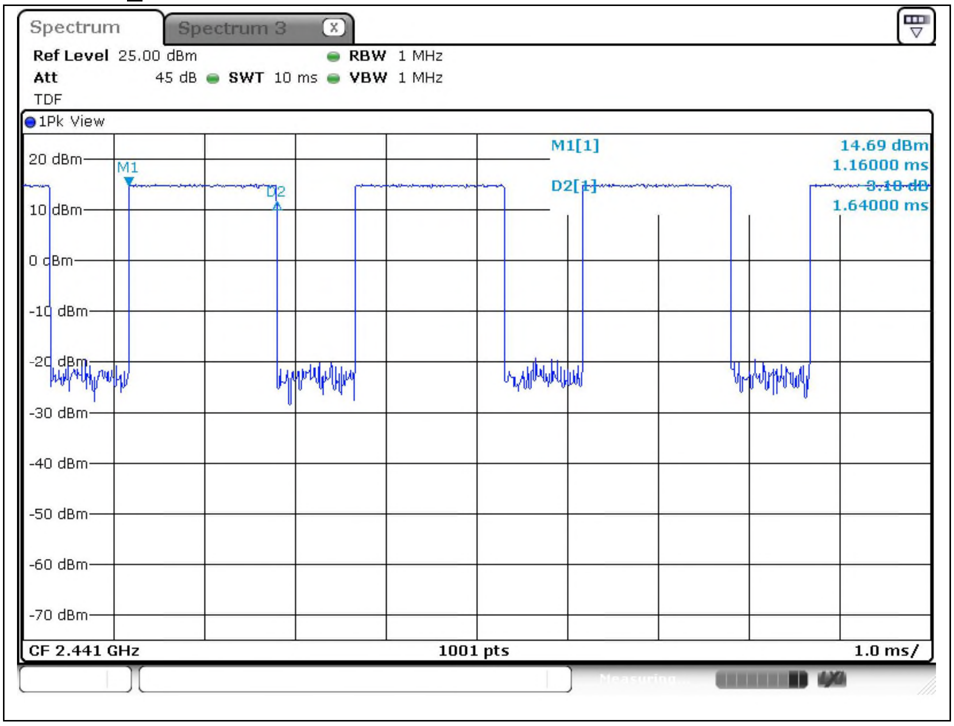
Port	Operation Mode	Frequency (㎒)	Dwell Time (㎳)	Time of occupancy on the Tx Channel in 31.6 sec (㎳)	Limit for time of occupancy on the Tx Channel in 31.6 sec (㎳)
Ant.1	GFSK	2 441	1.64	131.20	400
	8DPSK		1.64	131.20	
Ant.2	GFSK		1.64	131.20	
	8DPSK		1.64	131.20	

Remark;

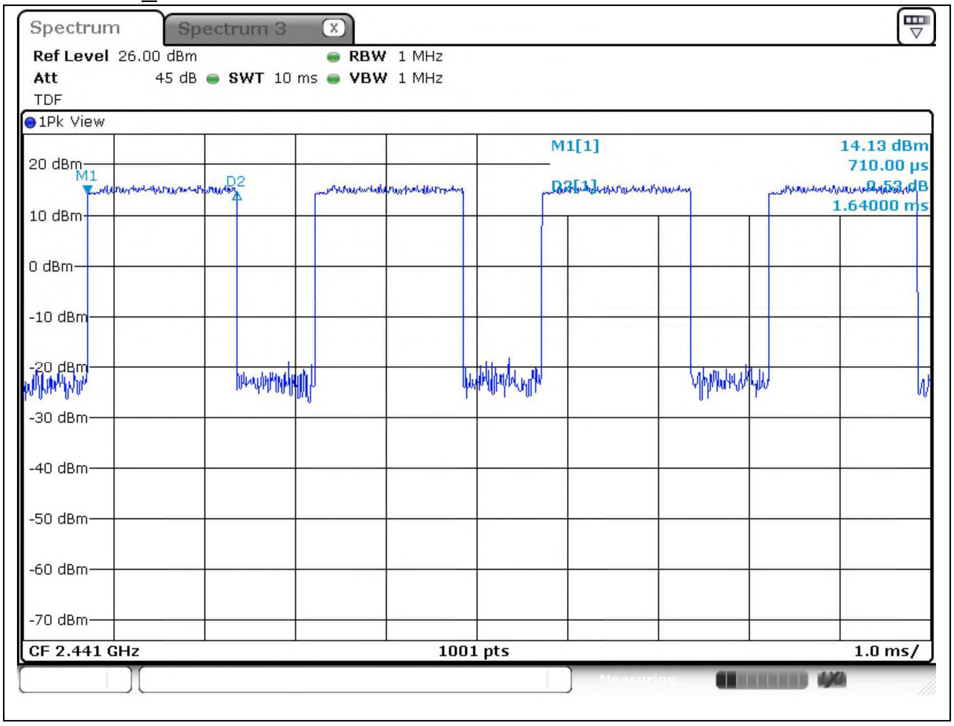
Time of occupancy on the TX channel in 8 sec.
Ant.1: In case of GFSK and 8DPSK: 1.64 × {(800 ÷ 4) / 20} × 8 = 131.20 ㎳
Ant.2: In case of GFSK and 8DPSK: 1.64 × {(800 ÷ 4) / 20} × 8 = 131.20 ㎳

- Test plots

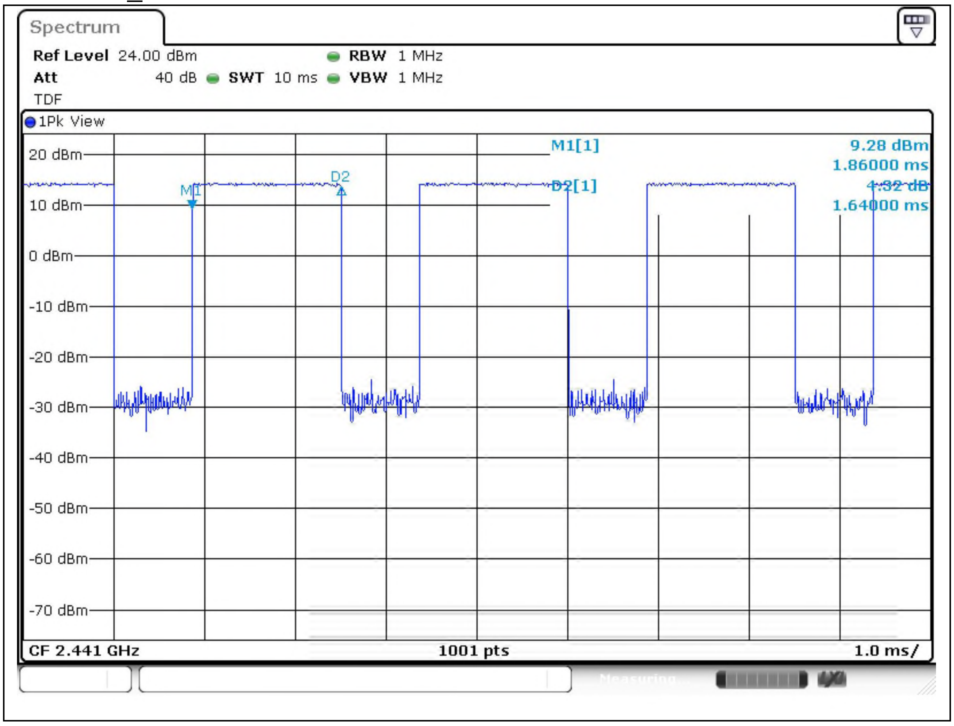
Operating Mode: GFSK_Ant.1



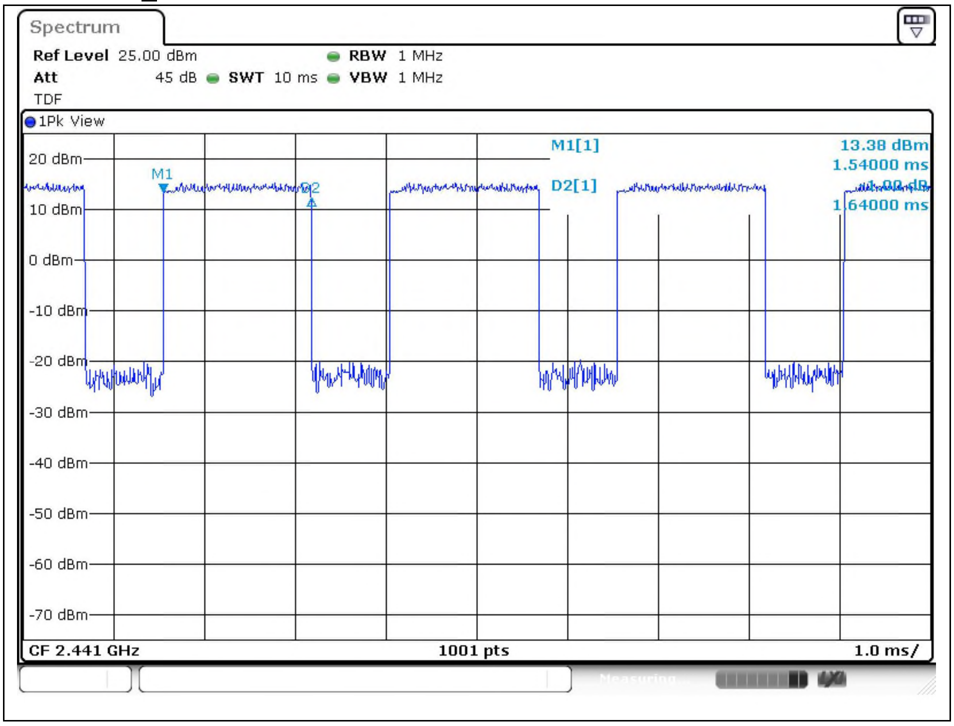
Operating Mode: 8DPSK_Ant.1



Operating Mode: GFSK_Ant.2



Operating Mode: 8DPSK_Ant.2



7.4.6. Packet Type: DH5, 3DH5 (Adaptive Frequency Hopping)

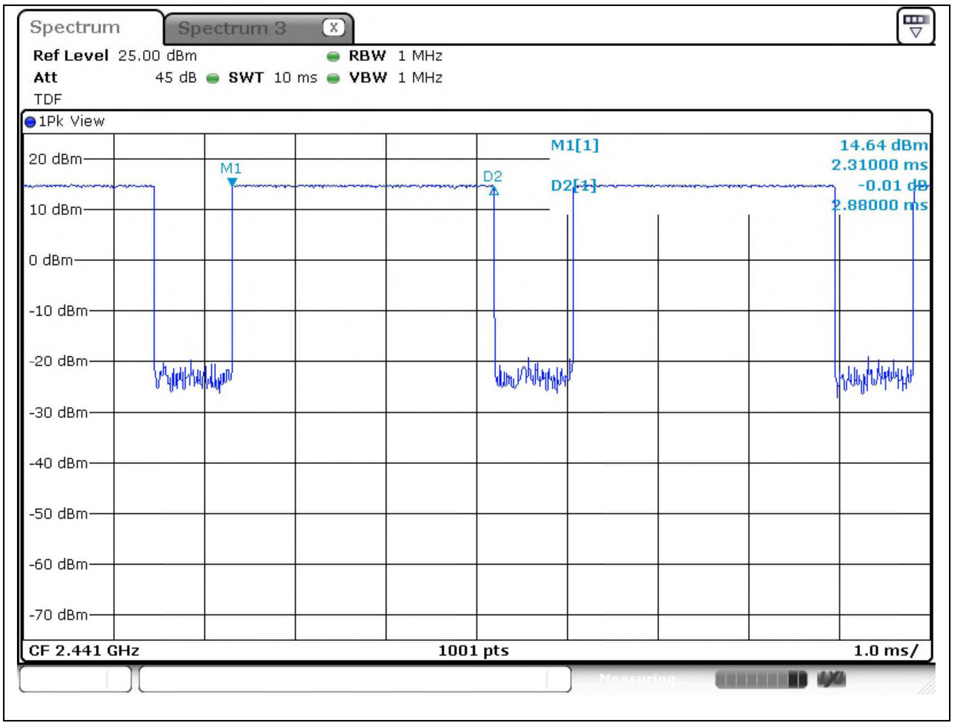
Port	Operation Mode	Frequency (㎒)	Dwell Time (㎳)	Time of occupancy on the Tx Channel in 31.6 sec (㎳)	Limit for time of occupancy on the Tx Channel in 31.6 sec (㎳)
Ant.1	GFSK	2 441	2.88	153.60	400
	8DPSK		2.89	154.13	
Ant.2	GFSK		2.89	154.13	
	8DPSK		2.89	154.13	

Remark;

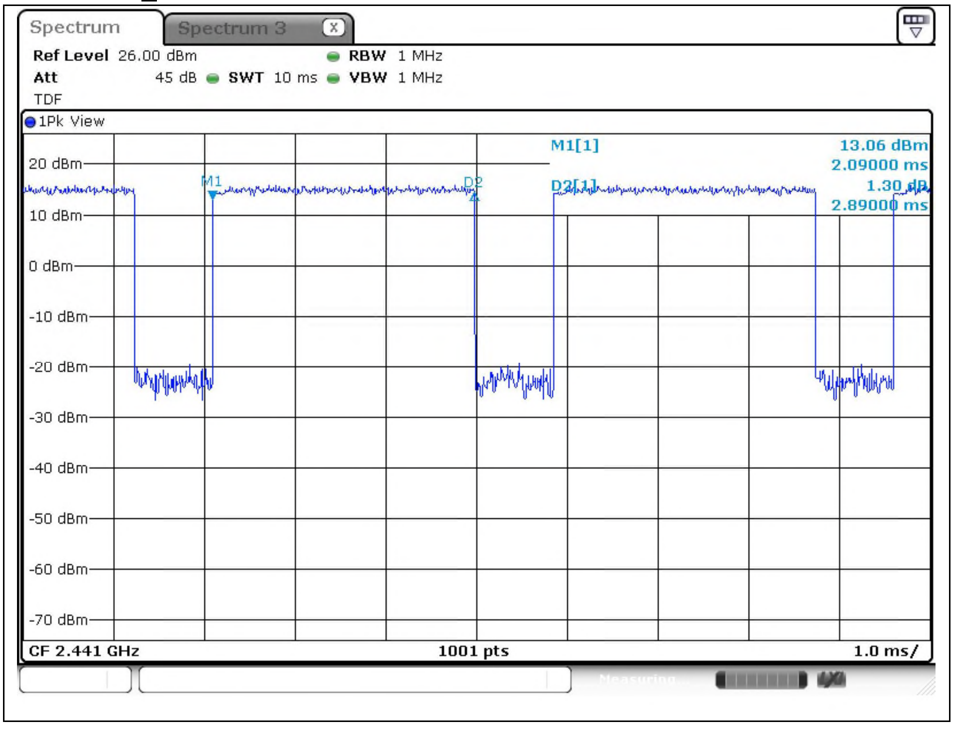
Time of occupancy on the TX channel in 8 sec.
Ant.1: In case of GFSK: 2.88 × {(800 ÷ 6) / 20} × 8 = 153.60 ㎳
In case of 8DPSK: 2.89 × {(800 ÷ 6) / 20} × 8 = 154.13 ㎳
Ant.2: In case of GFSK and 8DPSK: 2.89 × {(800 ÷ 6) / 20} × 8 = 154.13 ㎳

- Test plots

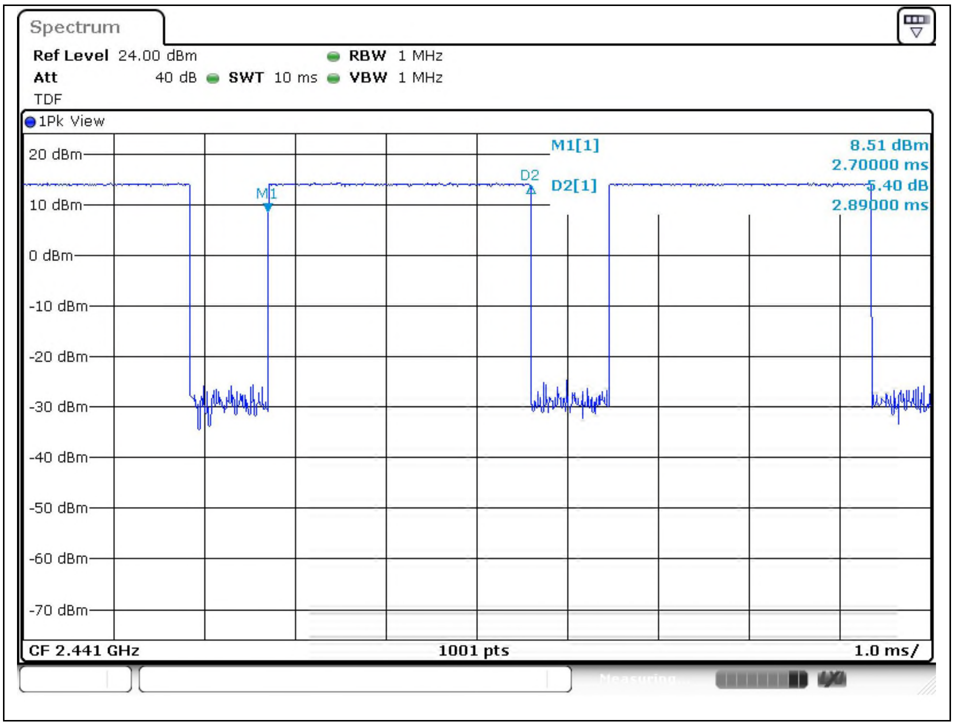
Operating Mode: GFSK_Ant.1



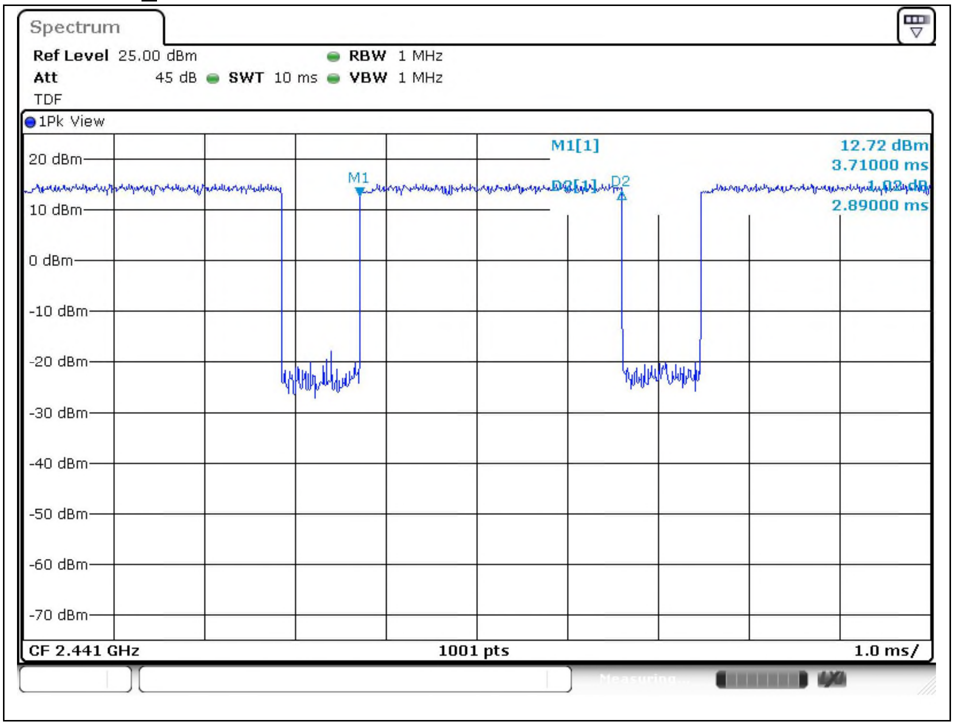
Operating Mode: 8DPSK_Ant.1



Operating Mode: GFSK_Ant.2

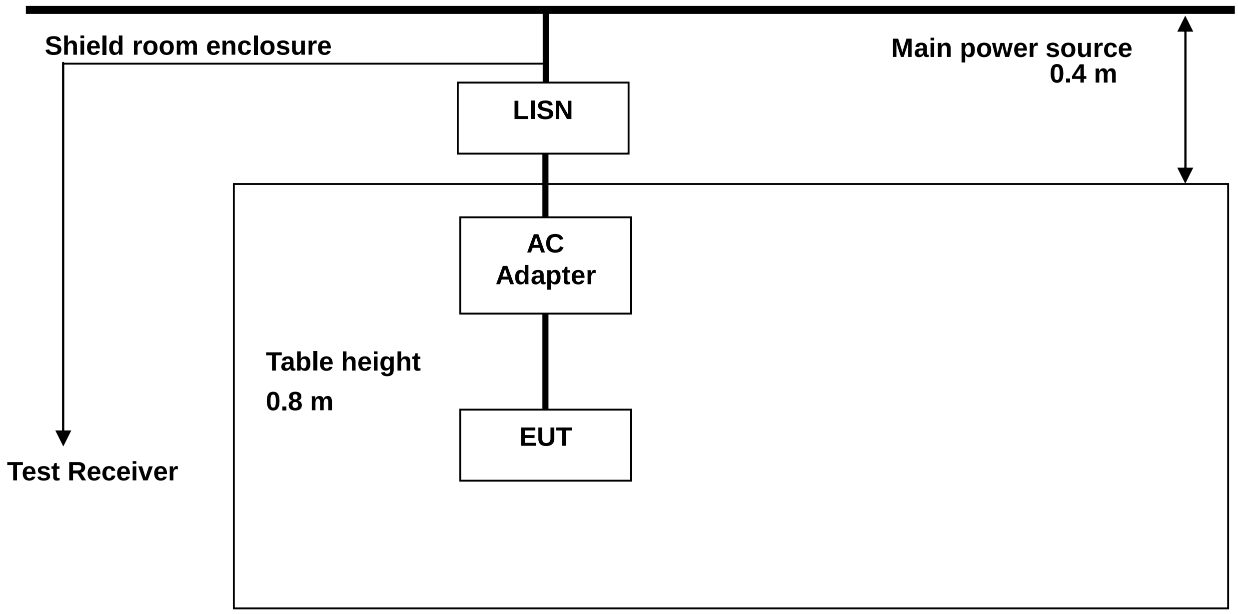


Operating Mode: 8DPSK_Ant.2



8. AC Power Line Conducted Emission

8.1. Test Setup



8.2. Limit

8.2.1. FCC

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 ㎑ to 30 ㎒, shall not exceed the limits in the following table, as measured using a 50 μH /50 ohms line impedance stabilization network (LISN).
Compliance with the provision of this paragraph shall be based on the measurement of the radio frequency voltage between each power line and ground at the power terminal. The lower limit applies at the boundary between the frequency ranges.

Frequency of emission (㎒)	Conducted limit (dB㎶)	
	Quasi-peak	Average
0.15-0.5	66 to 56*	56 to 46*
0.5-5	56	46
5-30	60	50

* Decreases with the logarithm of the frequency.

8.2.2. IC

RSS-Gen Issue 5, 8.8, Unless stated otherwise in the applicable RSS, for radio apparatus that are designed to be connected to the public utility AC power network, the radio frequency voltage that is conducted back onto the AC power line on any frequency or frequencies within the range 150 ㎑ to 30 ㎒ shall not exceed the limits in table 4, as measured using a 50 µH / 50 Ω line impedance stabilization network. This requirement applies for the radio frequency voltage measured between each power line and the ground terminal of each AC power-line mains cable of the EUT.

For an EUT that connects to the AC power lines indirectly, through another device, the requirement for compliance with the limits in table 4 shall apply at the terminals of the AC power-line mains cable of a representative support device, while it provides power to the EUT. The lower limit applies at the boundary between the frequency ranges. The device used to power the EUT shall be representative of typical applications.

Table 4 - AC power-line conducted emissions limits

Frequency (㎒)	Conducted limit (dBµV)	
	Quasi-peak	Average
0.15-0.5	66 to 56[1]	56 to 46[1]
0.5-5	56	46
5-30	60	50

Note 1: The level decreases linearly with the logarithm of the frequency.

For an EUT with a permanent or detachable antenna operating between 150 ㎑ and 30 ㎒, the AC power-line conducted emissions must be measured using the following configurations:

(a) Perform the AC power-line conducted emissions test with the antenna connected to determine compliance with the limits of table 4 outside the transmitter's fundamental emission band.

(b) Retest with a dummy load instead of the antenna to determine compliance with the limits of table 4 within the transmitter's fundamental emission band. For a detachable antenna, remove the antenna and connect a suitable dummy load to the antenna connector. For a permanent antenna, remove the antenna and terminate the RF output with a dummy load or network that simulates the antenna in the fundamental frequency band.

8.3. Test Procedures

AC conducted emissions from the EUT were measured according to the dictates of ANSI C63.10-2013

1. The test procedure is performed in a 6.5 m × 3.5 m × 3.5 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.

8.4. Test Results

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

Ambient temperature : (23 ± 1) ℃
Relative humidity : 47 % R.H.

Frequency range : 0.15 ㎒ - 30 ㎒
Measured Bandwidth : 9 ㎑

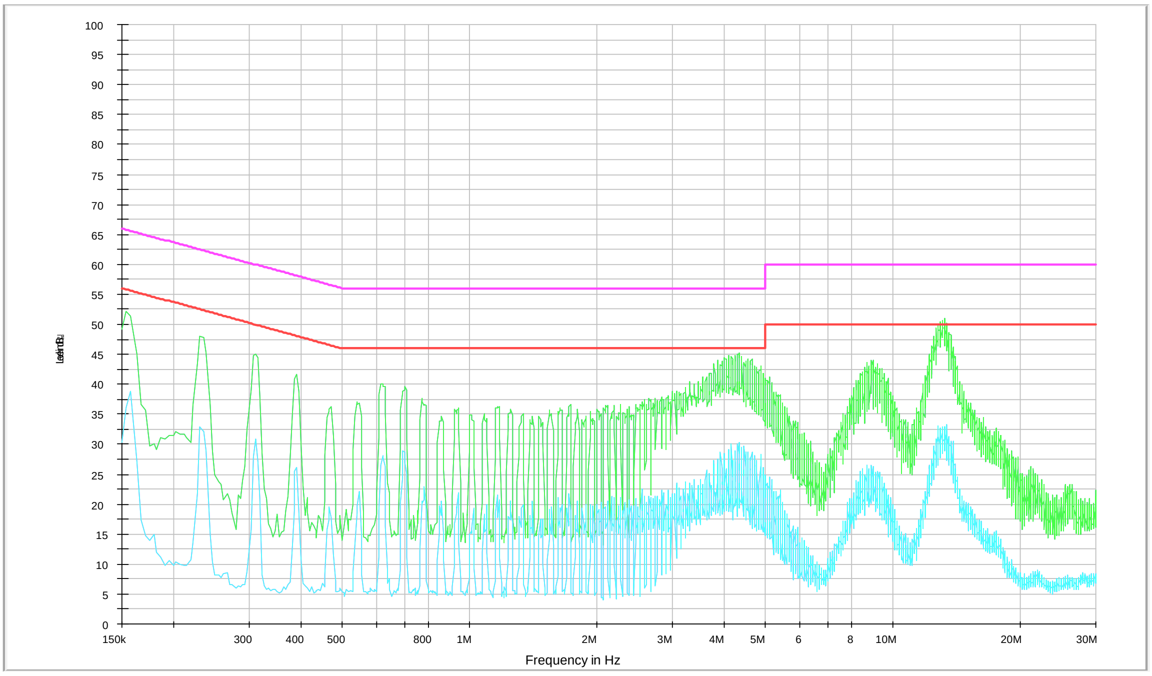
FREQ.	LEVEL (dB㎶)		LINE	LIMIT (dB㎶)		MARGIN (dB)	
(㎒)	Q-Peak	Average		Q-Peak	Average	Q-Peak	Average
0.16	49.30	35.80	N	65.46	55.46	16.16	19.66
0.63	37.60	24.80	N	56.00	46.00	18.40	21.20
1.71	31.80	16.80	N	56.00	46.00	24.20	29.20
4.23	42.20	25.70	N	56.00	46.00	13.80	20.30
8.83	39.40	24.80	N	60.00	50.00	20.60	25.20
13.07	45.10	29.00	N	60.00	50.00	14.90	21.00
0.16	48.70	36.10	H	65.46	55.46	16.76	19.36
0.31	42.00	30.00	H	59.97	49.97	17.97	19.97
0.69	28.70	31.20	H	56.00	46.00	27.30	14.80
2.26	35.20	23.10	H	56.00	46.00	20.80	22.90
4.12	40.90	25.50	H	56.00	46.00	15.10	20.50
8.93	34.80	19.80	H	60.00	50.00	25.20	30.20

Remark;

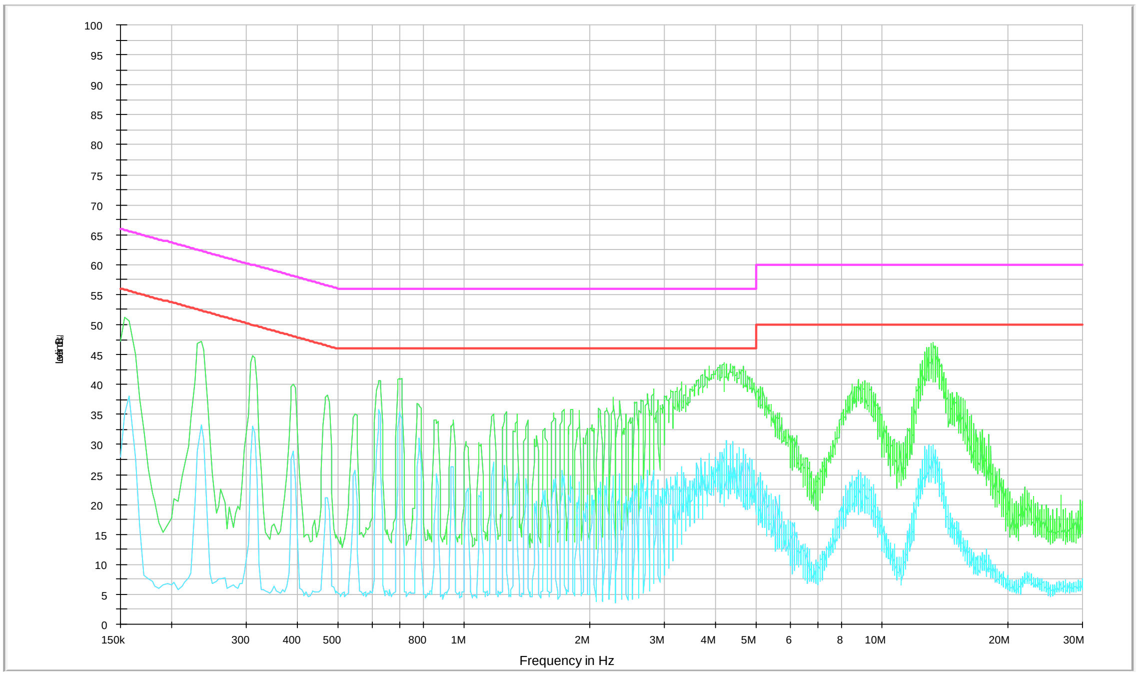
1. Line (H): Hot, Line (N): Neutral.
2. All channels of operation were investigated and the worst-case emissions were reported using **EDR / 3DH1 / High channel.**
3. The limit for Class B device(s) from 150 ㎑ to 30 ㎒ are specified in Section of the Title 47 CFR.
4. Traces shown in plot were made by using a peak detector and average detector.
5. Deviations to the Specifications: None.

- Test plots

Test mode: (Neutral)



Test mode: (Hot)



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 ㏈i are used, the power shall be reduced by the amount in ㏈ that the gain of the Antenna exceeds 6 ㏈i.

9.2. Antenna Connected Construction

Ant.1 used in this product is Metal Frame Antenna with gain of -5.10 ㏈i
Ant.2 used in this product is Metal Frame Antenna with gain of -4.80 ㏈i

- End of the Test Report -