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TEST REPORT

of

FCC Part 15 Subpart C §15.247

FCC ID: PO5009164

Equipment Under Test	:	Polaroid Hi-Print 4x6 Photo Printer
Model Name	:	009164
Variant Model Name(s)	:	Refer to page 3
Applicant	:	Prinics Co., Ltd.
Manufacturer	:	Prinics Co., Ltd.
Date of Receipt	:	2024.07.04
Date of Test(s)	:	2024.07.12 ~ 2024.09.19
Date of Issue	:	2024.09.19

In the configuration tested, the EUT complied with the standards specified above. This test report does not assure KOLAS accreditation.

1) The results of this test report are effective only to the items tested.
2) The SGS Korea is not responsible for the sampling, the results of this test report apply to the sample as received.
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4) The data marked ※ in this report was provided by the customer and may affect the validity of the test results.

We are responsible for all the information of this test report except for the data(※) provided by the customer.

Tested by: Hahyun Sung

Technical Manager: Jinhyoung Cho

SGS Korea Co., Ltd. Gunpo Laboratory

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1. General Information

1.1 Testing Laboratory

SGS Korea Co., Ltd. (Gunpo Laboratory)
- 10-2, LS-ro 182beon-gil, Gunpo-si, Gyeonggi-do, Korea, 15807
- 4, LS-ro 182beon-gil, Gunpo-si, Gyeonggi-do, Korea, 15807
- Designation number: KR0150

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1.2. Details of Applicant

Applicant : Prinics Co., Ltd.
Address : 228-92, Saneop-ro 155beon-gil, Gwonseon-gu, Suwon-Si, Gyeonggi-do, South Korea, 16648
Contact Person : Kim, Jung-bok
Phone No. : +82 31 293 5990

1.3. Details of Manufacturer

Company : Same as applicant
Address : Same as applicant

1.4. Description of EUT

Kind of Product	Polaroid Hi-Print 4x6 Photo Printer
Model Name	009164
Varient Model Name	009165, 009166
Serial Number	Conducted: 91644340D0001 Radiated: 91644340D0002
Power Supply	DC 24 V
Frequency Range	2 402 ㎒ ~ 2 480 ㎒ (Bluetooth)
Modulation Technique	GFSK, 8DPSK, π/4DQPSK
Number of Channels	79 channels (Bluetooth)
Antenna Type	PCB Pattern Antenna
Antenna Gain※	-0.37 ㏈i
H/W Version	V4.7
S/W Version	V2.33
FVIN	N/A

1.5. Information about the FHSS characteristics:

1.5.1. Pseudorandom Frequency Hopping Sequence

The channel is represented by a pseudo-random hopping sequence hopping through the 79 RF channels. The hopping sequence is unique for the piconet and is determined by the Bluetooth device address of the master; the phase in the hopping sequence is determined by the Bluetooth clock of the master. The channel is divided into time slots where each slot corresponds to an RF hop frequency. Consecutive hops correspond to different RF hop frequencies. The nominal hop rate is 1 600 hops/s.

1.5.2. Equal Hopping Frequency Use

The channels of this system will be used equally over the long-term distribution of the hopsets.

1.5.3. Example of a 79 hopping sequence in data mode:

02, 05, 31, 24, 20, 10, 43, 36, 30, 23, 40, 06, 21, 50, 44, 09, 71, 78, 01, 13, 73, 07, 70, 72, 35, 62, 42, 11, 41, 08, 16, 29, 60, 15, 34, 61, 58, 04, 67, 12, 22, 53, 57, 18, 27, 76, 39, 32, 17, 77, 52, 33, 56, 46, 37, 47, 64, 49, 45, 38, 69, 14, 51, 26, 79, 19, 28, 65, 75, 54, 48, 03, 25, 66, 05, 16, 68, 74, 59, 63, 55

1.5.4. System Receiver Input Bandwidth

Each channel bandwidth is 1 ㎒.
The system receivers have input bandwidths that match the hopping channel bandwidths of their corresponding transmitters and shift frequencies in synchronization with the transmitted signals.

1.5.5. Equipment Description

15.247(a) (1) that the Rx input bandwidths shift frequencies in synchronization with the transmitted signals.

15.247(g): In accordance with the Bluetooth Industry Standard, the system is designed to comply with all of the regulations in Section 15.247 when the transmitter is presented with a continuous data (or information) system.

15.247(h): In accordance with the Bluetooth Industry Standard, the system does not coordinate it channels selection/ hopping sequence with other frequency hopping systems for the express purpose of avoiding the simultaneous occupancy of individual hopping frequencies by multiple transmitters.

1.6. Test Equipment List

Equipment	Manufacturer	Model	S/N	Cal. Date	Cal. Interval	Cal. Due
Signal Generator	R&S	SMA100B	106887	Oct. 06, 2023	Annual	Oct. 06, 2024
Spectrum Analyzer	R&S	FSV30	103453	Oct. 31, 2023	Annual	Oct. 31, 2024
Spectrum Analyzer	R&S	FSW8	101659	May 28, 2024	Annual	May 28, 2025
Spectrum Analyzer	Agilent	N9030A	US51350132	Nov. 27, 2023	Annual	Nov. 27, 2024
Bluetooth Tester	TESCOM	TC-3000C	3000C000142	Dec. 01, 2023	Annual	Dec. 01, 2024
Directional Coupler	KRYTAR	152613	122660	Jul. 09, 2024	Annual	Jul. 09, 2025
Bridge Coupler	MARKI MICROWAVE INC	CBR16-0012	1542	May 13, 2024	Annual	May 13, 2025
High Pass Filter	Wainwright Instrument GmbH	WHKX3.0/18G-10SS	21	Jun. 07, 2024	Annual	Jun. 07, 2025
High Pass Filter	Wainwright Instrument GmbH	WHNX7.5/26.5G-6SS	15	Jun. 07, 2024	Annual	Jun. 07, 2025
Low Pass Filter	Mini-Circuits	NLP-1200+	V8979400903-1	May 17, 2024	Annual	May 17, 2025
Power Sensor	R&S	NRP-Z81	100669	May 17, 2024	Annual	May 17, 2025
Preamplifier	H.P.	8447F	2944A03909	Aug. 09, 2024	Annual	Aug. 09, 2025
Signal Conditioning Unit	R&S	SCU-18F	101058	Dec. 07, 2023	Annual	Dec. 07, 2024
Preamplifier	MITEQ Inc.	JS44-18004000-35-8P	1546891	Oct. 06, 2023	Annual	Oct. 06, 2024
DC Power Supply	R&S	HMP2020	022802107	Oct. 31, 2023	Annual	Oct. 31, 2024
Bilog Antenna	Schwarzbeck Mess-Elektronik	VULB 9163	9163-396	Apr. 02, 2024	Biennial	Apr. 02, 2026
Horn Antenna	R&S	HF906	100326	Feb. 19, 2024	Annual	Feb. 19, 2025
Horn Antenna	Schwarzbeck Mess-Elektronik	BBHA 9170	BBHA9170223	Oct. 10, 2023	Annual	Oct. 10, 2024
EMI Test Receiver	R&S	ESU26	100109	Jan. 16, 2024	Annual	Jan. 16, 2025
Turn Table	Innco systems GmbH	DS 1200 S	N/A	N.C.R.	N/A	N.C.R.
Controller	Innco systems GmbH	CONTROLLER CO3000-4P	CO3000/963/383 30516/L	N.C.R.	N/A	N.C.R.
Antenna Mast	Innco systems GmbH	MA4640-XP-ET	MA4640/536/383 30516/L	N.C.R.	N/A	N.C.R.
Anechoic Chamber	SY Corporation	L × W × H (9.6 m × 6.4 m × 6.6 m)	N/A	N.C.R.	N/A	N.C.R.
Coaxial Cable	SENSORVIEW	NMST-13A26-NMST-5 m	TPC2402190004	Apr. 03, 2024	Semi-Annual	Oct. 03, 2024
Coaxial Cable	SENSORVIEW	NMST-13A26-NMST-10 m	TPC2402190001	Apr. 03, 2024	Semi-Annual	Oct. 03, 2024
Coaxial Cable	RADIALL	TESTPRO 3	182287	Apr. 12, 2024	Semi-Annual	Oct. 12, 2024
Coaxial Cable	RADIALL	TESTPRO 3	182288	Apr. 12, 2024	Semi-Annual	Oct. 12, 2024
Coaxial Cable	RADIALL	TESTPRO 3	182290	Apr. 12, 2024	Semi-Annual	Oct. 12, 2024
Test Receiver	R&S	ESCI 7	100911	Feb. 26, 2024	Annual	Feb. 26, 2025
Two-Line V-Network	R&S	ENV216	100190	May 23, 2024	Annual	May 23, 2025
Shield Room	SY Corporation	L × W × H (6.5 m × 3.5 m × 3.5 m)	N/A	N.C.R.	N/A	N.C.R.

Note;

For equipment listed above that has a calibration date or calibration due date that falls within the test date range, care was taken to ensure that this equipment was used after the calibration date and before the calibration due date

1.7. Declaration by the Manufacturer

- Adaptive Frequency Hopping is supported and use at least 20 channels.

1.8. Summary of Test Results

The EUT has been tested according to the following specifications:

APPLIED STANDARD: FCC Part15 Subpart C		
Section	**Test Item(s)**	**Result**
15.205(a) 15.209 15.247(d)	Transmitter Radiated Spurious Emissions and Conducted Spurious Emission	Complied
15.247(a)(1)	20 dB Bandwidth	Complied
15.247(a)(1) 15.247(b)(1)	Maximum Peak Conducted Output Power	Complied
15.247(a)(1)	Carrier Frequency Separation	Complied
15.247(a)(1)(iii)	Number of Hopping Frequencies	Complied
15.247(a)(1)(iii)	Time of Occupancy (Dwell Time)	Complied
15.207	AC Power Line Conducted Emission	Complied

1.9. Test Procedure(s)

The measurement procedures described in the American National Standard of Procedure for Compliance Testing of unlicensed Wireless Devices (ANSI C63.10-2013) and the guidance provided in KDB 558074 D01 15.247 Meas Guidance v05r02 were used in the measurement of the DUT.

1.10. Sample Calculation

Where relevant, the following sample calculation is provided:

1.10.1. Conducted Test

Offset value (dB) = Directional coupler (dB) + Cable loss (dB)

1.10.2. Radiation Test

Field strength level(dBμV/m) = Measured level(dBμV) + Antenna factor(dB/m) + Cable loss (dB) - Amplifier gain(dB)
+ Duty factor (dB)

1.11. Information of software for test

- Using the software of BR BlueletSuite v5.11 to testing of EUT.

1.12. Measurement Uncertainty

Where relevant, the following measurement uncertainty levels have been estimated for tests performed on the apparatus:

Parameter	Uncertainty	
Maximum Peak Conducted Output Power	0.33 dB	
20 dB Bandwidth	9.43 kHz	
Conducted Spurious Emission	0.84 dB	
Time of Occupancy	0.01 ms	
AC Power line Conducted Emission	3.10 dB	
Radiated Emission, 9 kHz to 30 MHz	H	3.60 dB
	V	3.60 dB
Radiated Emission, below 1 GHz	H	4.60 dB
	V	4.90 dB
Radiated Emission, above 1 GHz	H	3.90 dB
	V	3.80 dB

All measurement uncertainty values are shown with a coverage factor k = 2 to indicate a 95 % level of confidence.

1.13. Test Report Revision

Revision	Report Number	Date of Issue	Description
0	F690501-RF-RTL005438	2024.09.19	Initial

1.14. Description of variant models

Model name		Description
Basic model	009164	- Representative production model
Variant model	009165	- Basic model and alternative model are the same, only seller is different.
	009166	- Basic model and alternative model are the same, only seller is different.

1.15. Descriptions of Test Mode

Preliminary tests were performed in different data rates and recorded the RF output power in the following table:

Mode	Data Rate (Mbps)	Channel	Frequency (㎒)	RF Peak Output Power (㏈ m)
GFSK	1	Low	2 402	**-3.18**
		Middle	2 441	-4.04
		High	2 480	-5.20
π/4DQPSK	2	Low	2 402	**-3.82**
		Middle	2 441	-3.83
		High	2 480	-5.35
8DPSK	3	Low	2 402	**-3.49**
		Middle	2 441	-4.13
		High	2 480	-5.29

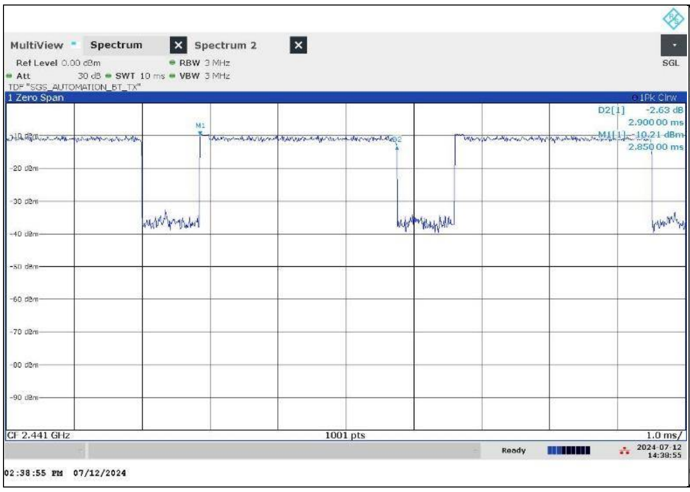
Note;

1. For transmitter radiated spurious emissions, conducted spurious emission, carrier frequency separation and number of hopping frequencies, GFSK / DH5 and 8DPSK / 3DH5 are tested as worst condition.
2. For 20 ㏈ bandwidth, 99 % bandwidth and maximum peak conducted output power, GFSK / DH5, π/4DQPSK / 2DH5 and 8DPSK / 3DH5 are tested as worst condition.
3. For Time of Occupancy, GFSK / DH1, DH3, DH5 and 8DPSK / 3DH1, 3DH3, 3DH5 are tested as worst condition.

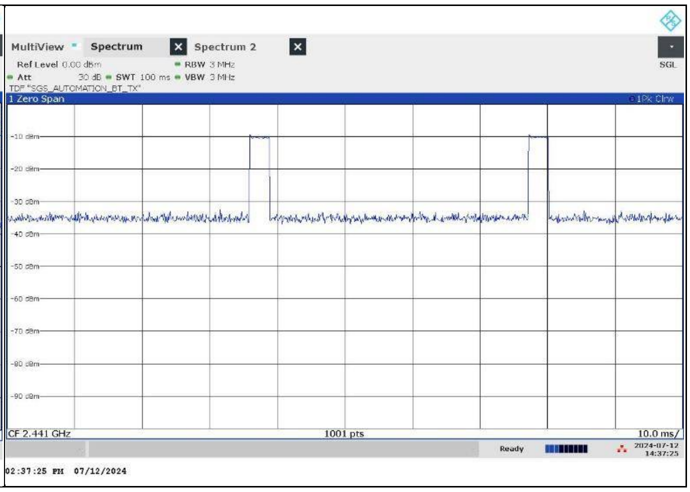
1.16. Duty Cycle Correction Factor of EUT

According to KDB 558074 D01 15.247 Meas Guidance v05r02, 9, as a “duty cycle correction factor”, pulse averaging with 20 log (worst case dwell time / 100 ㎳) has to be used for average result.

3DH5 on time (One Pulse) Plot on Channel 39



3DH5 on time (Count Pulses) Plot on Channel 39



In AFH mode, the minimum hopping frequencies are 20, to get the longest dwell time 3DH5 packet is observed;
the period to have 3DH5 packet completing one hopping sequence is 2.90 ㎳ x 20 channels = 58.00 ㎳

There cannot be 2 complete hopping sequences within 100 ㎳ period, considering the random hopping behavior, maximum 2 hops can be possibly observed within the period. [100 ㎳ / 58.00㎳] = 2 hops

Thus, the maximum possible ON time:

2.90 ㎳ x 2 = 5.80 ㎳

Worst case Duty Cycle Correction factor, which is derived from the maximum possible ON time:

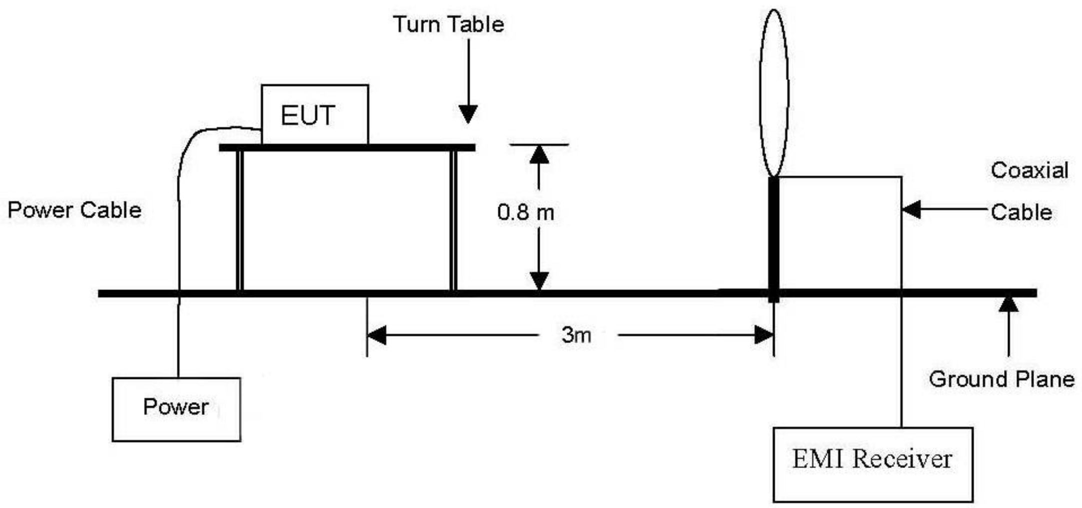
20 x log (5.80 ㎳/100 ㎳) = -24.73 ㏈

2. Transmitter Radiated Spurious Emissions and Conducted Spurious Emissions

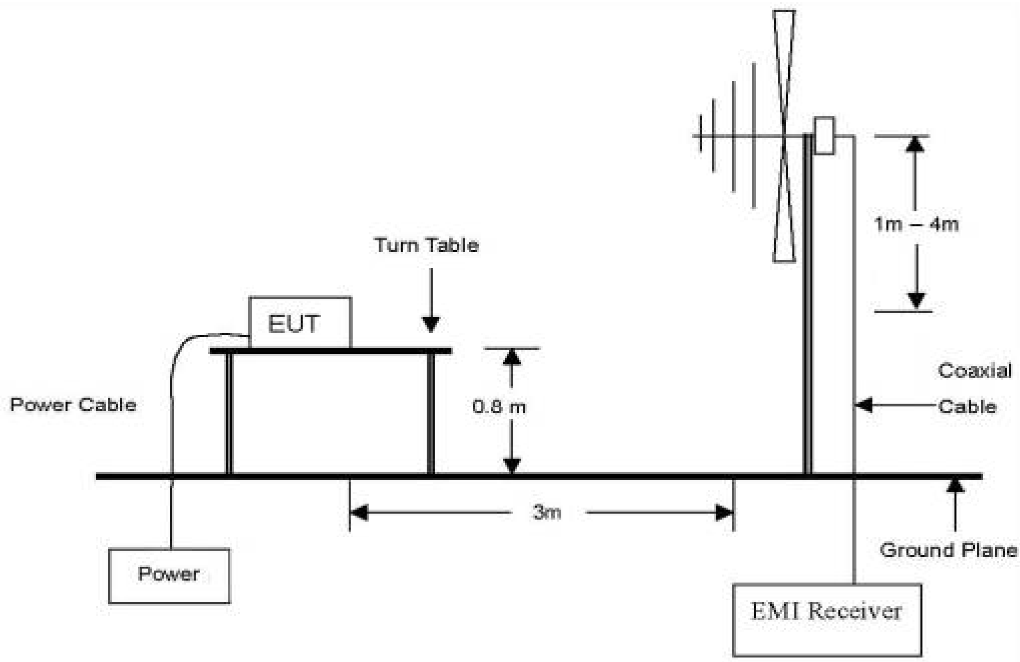
2.1. Test Setup

2.1.1. Transmitter Radiated Spurious Emissions

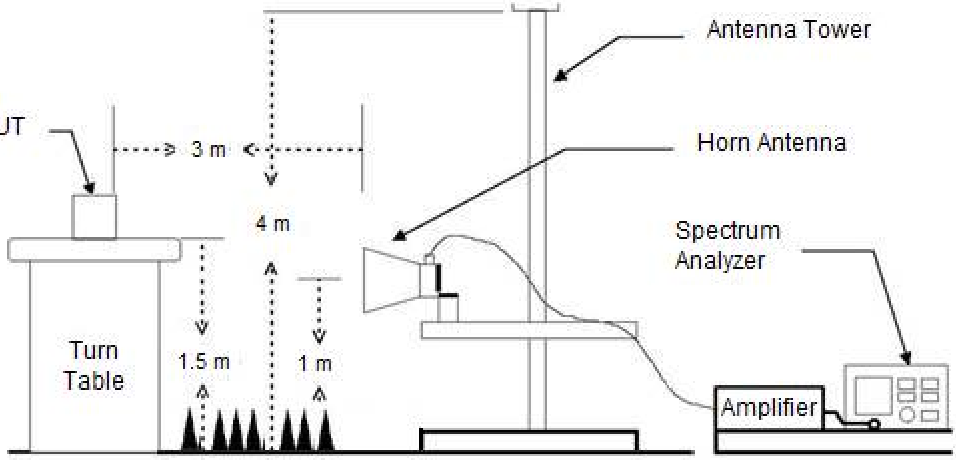
The diagram below shows the test setup that is utilized to make the measurements for emission from 9 ㎑ to 30 ㎒.



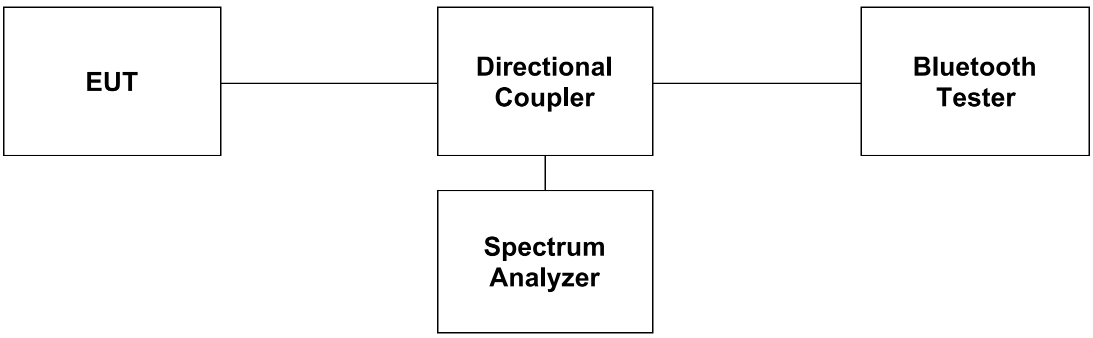
The diagram below shows the test setup that is utilized to make the measurements for emission from 30 ㎒ to 1 ㎓.



The diagram below shows the test setup that is utilized to make the measurements for emission. The spurious emissions were investigated from 1 ㎓ to the 10th harmonic of the highest fundamental frequency or 40 ㎓, whichever is lower.



2.1.2. Conducted Spurious Emissions



2.2. Limit

According to §15.247(d), in any 100 ㎑ 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 ㏈ below that in the 100 ㎑ bandwidth within the band that contains the highest level of the desired power, based on either an RF conducted or a radiated measurement, provided the transmitter demonstrates compliance with the peak conducted power limits. 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 ㏈ instead of 20 ㏈. Attenuation below the general limits specified in §15.209(a) is not required. In addition, radiated emission which fall in the restricted bands, as defined in §15.205(a), must also comply with the radiated emission limits specified in §15.209(a) (see §15.205(c)).

According to §15.209(a), except as provided elsewhere in this subpart, the emissions from an intentional radiator shall not exceed the field strength levels specified in the following table:

Frequency (㎒)	**Field Strength (㎶/m)**	**Measurement Distance (Meters)**
0.009-0.490	2 400/F(㎑)	300
0.490-1.705	24 000/F(㎑)	30
1.705-30.0	30	30
30-88	100**	3
88-216	150**	3
216-960	200**	3
Above 960	500	3

** Except as provided in paragraph (g), fundamental emissions from intentional radiators operating under this section shall not be located in the frequency bands 54-72 ㎒, 76-88 ㎒, 174-216 ㎒ or 470-806 ㎒. However, operation within these frequency bands is permitted under other sections of this part, e.g., §§15.231 and 15.241.

2.3. Test Procedures

Radiated emissions from the EUT were measured according to the dictates of ANSI C63.10-2013 and only the radiated emissions of the configuration that produced the worst case emissions are reported in this section.

2.3.1. Test Procedures for emission below 30 ㎒

1. The EUT was placed on the top of a rotating table 0.8 meters above the ground at a 3 meter anechoic chamber test site. The table was rotated 360 degrees to determine the position of the highest radiation.
2. Then antenna is a loop antenna is fixed at one meter above the ground to determine the maximum value of the field strength. Both parallel and perpendicular of the antenna are set to make the measurement.
3. For each suspected emission, the EUT was arranged to its worst case and then the table was turned from 0 degrees to 360 degrees to find the maximum reading.
4. The test-receiver system was set to average or quasi peak detect function and Specified Bandwidth with Maximum Hold Mode.

2.3.2. Test Procedures for emission from above 30 ㎒

1. The EUT was placed on the top of a rotating table 0.8 meters above the ground at a 3 meter anechoic chamber test site below 1 ㎓ and 1.5 meter above the ground at a 3 meter anechoic chamber test site above 1 ㎓. The table was rotated 360 degrees to determine the position of the highest radiation.
2. During performing radiated emission below 1 ㎓, the EUT was set 3 meters away from the interference receiving antenna, which was mounted on the top of a variable -height antenna tower. During performing radiated emission above 1 ㎓, the EUT was set 3 meter away from the interference -receiving antenna.
3. The antenna is a bi-log antenna, a horn antenna and its height is varied from one meter to four meters above the ground to determine the maximum value of the field strength. Both horizontal and vertical polarizations of the antenna are set to make the measurement.
4. For each suspected emission, the EUT was arranged to its worst case and then the antenna was tuned to heights from 1 meter to 4 meters and the table was turned from 0 degrees to 360 degrees to find the maximum reading.
5. For measurements below 1 ㎓ resolution bandwidth is set to 100 ㎑ for peak detection measurements or 120 ㎑ for quasi-peak detection measurements. Peak detection is used unless otherwise noted as quasi-peak.
6. For measurements Above 1 ㎓ resolution bandwidth is set to 1 ㎒, the video bandwidth is set to 3 ㎒ for peak measurements and as applicable for average measurements.

2.3.3. Definition of EUT Axis.

The radiation test of the EUT was investigated in three orthogonal orientations X, Y, and Z described in the test setup photo. All radiated testing of EUT was performed with worst case axis.

2.3.3. Test Procedures for Conducted Spurious Emissions

2.3.3.1. Band-edge Compliance of RF Conducted Emissions

The transmitter output was connected to the spectrum analyzer.
Span = wide enough to capture the peak level of the emission operating on the channel closest to the band edge, as well as any modulation products which fall outside of the authorized band of operation.
RBW ≥ 100 ㎑
VBW = 300 ㎑
Sweep = auto
Detector function = peak
Trace = max hold

2.3.3.2. Spurious RF Conducted Emissions

The transmitter output was connected to the spectrum analyzer.
RBW = 1 ㎒
VBW = 3 ㎒
Sweep = auto
Detector function = peak
Trace = max hold

2.3.3.3. TDF function

- For plots showing conducted spurious emissions from 9 ㎑ to 25 ㎓, all path loss of wide frequency range was investigated and compensated to spectrum analyzer as TDF function.
So, the reading values shown in plots were final result.

2.4. Test Results

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

2.4.1. Radiated Spurious Emission below 1 000 ㎒

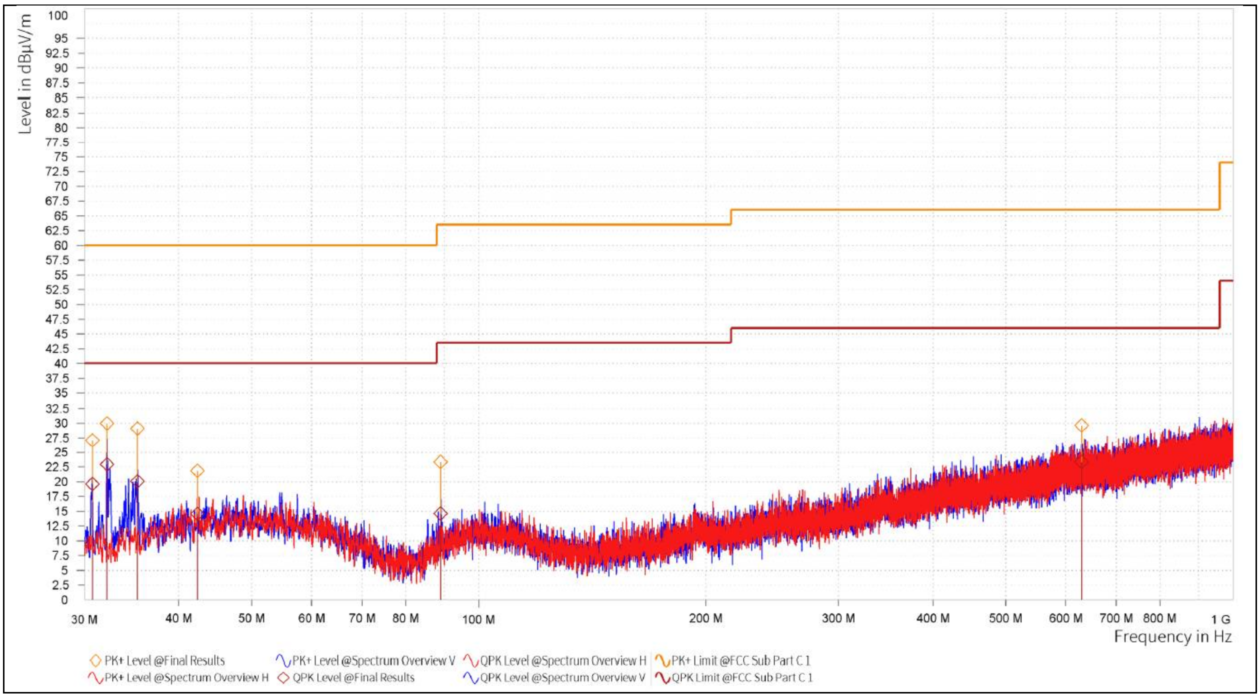
The frequency spectrum from 9 ㎑ to 1 000 ㎒ was investigated. All reading values are peak values.

Radiated Emissions			Ant	Correction (dB/m)	Total	Limit	
Frequency (㎒)	Reading (dB㎶)	Detect Mode	Pol.		Actual (dB㎶/m)	Limit (dB㎶/m)	Margin (dB)
32.17	34.72	Quasi-peak	V	-11.81	22.91	40.00	17.09
35.30	30.73	Quasi-peak	V	-10.70	20.03	40.00	19.97
Above 100.00	Not Detected	-	-	-	-	-	-

Remark.

1. Spurious emissions for all channels and modes were investigated and almost the same below 1 ㎓.
2. Test from 30 ㎒ to 1 000 ㎒ was performed using the software of ELEKTRA(V5.02) from Rohde & Schwarz GmbH & Co. KG.
3. Reported spurious emissions are in **BDR / DH5 / Low channel** as worst case among other modes.
4. Radiated spurious emission measurement as below.
   (Actual = Reading + AF + AMP + CL)
5. According to §15.31(o), emission levels are not report much lower than the limits by over 20 dB.

- Test plot



2.4.2. Radiated Spurious Emission above 1 000 ㎒

The frequency spectrum above 1 000 ㎒ was investigated. All reading values are peak values.

Operating Mode: GFSK

A. Low Channel (2 402 ㎒)

Radiated Emissions			Ant.	Correction Factors			Total	Limit	
Frequency (㎒)	Reading (dB㎶)	Detect Mode	Pol.	AF (dB/m)	CL (dB)	DF (dB)	Actual (dB㎶/m)	Limit (dB㎶/m)	Margin (dB)
*2 310.00	26.44	Peak	H	27.96	6.01	-	60.41	74.00	13.59
*2 310.00	-	Average	-	-	-	-24.73	35.68	54.00	18.32
*2 381.38	27.38	Peak	H	28.14	6.11	-	61.63	74.00	12.37
*2 381.38	-	Average	-	-	-	-24.73	36.90	54.00	17.10
*2 390.00	25.67	Peak	H	28.12	6.12	-	59.91	74.00	14.09
*2 390.00	-	Average	-	-	-	-24.73	35.18	54.00	18.82

Radiated Emissions			Ant.	Correction Factors			Total	Limit	
Frequency (㎒)	Reading (dB㎶)	Detect Mode	Pol.	AF (dB/m)	AMP+CL (dB)	DF (dB)	Actual (dB㎶/m)	Limit (dB㎶/m)	Margin (dB)
*4 804.27	42.03	Peak	H	32.72	-30.82	-	43.93	74.00	30.07
Above 4 900.00	Not detected	-	-	-	-	-	-	-	-

B. Middle Channel (2 441 ㎒)

Radiated Emissions			Ant.	Correction Factors			Total	Limit	
Frequency (㎒)	Reading (dB㎶)	Detect Mode	Pol.	AF (dB/m)	AMP+CL (dB)	DF (dB)	Actual (dB㎶/m)	Limit (dB㎶/m)	Margin (dB)
*4 882.41	40.22	Peak	H	33.03	-30.74	-	42.51	74.00	31.49
Above 4 900.00	Not detected	-	-	-	-	-	-	-	-

C. High Channel (2 480 ㎒)

Radiated Emissions			Ant.	Correction Factors			Total	Limit	
Frequency (㎒)	Reading (dB㎶)	Detect Mode	Pol.	AF (dB/m)	CL (dB)	DF (dB)	Actual (dB㎶/m)	Limit (dB㎶/m)	Margin (dB)
*2 483.50	33.93	Peak	H	28.33	6.24	-	**68.50**	74.00	5.50
*2 483.50	-	Average	-	-	-	-24.73	43.77	54.00	10.23
*2 483.57	32.85	Peak	H	28.33	6.24	-	67.42	74.00	6.58
*2 483.57	-	Average	-	-	-	-24.73	42.69	54.00	11.31
*2 500.00	25.84	Peak	H	28.40	6.26	-	60.50	74.00	13.50
*2 500.00	-	Average	-	-	-	-24.73	35.77	54.00	18.23

Radiated Emissions			Ant.	Correction Factors			Total	Limit	
Frequency (㎒)	Reading (dB㎶)	Detect Mode	Pol.	AF (dB/m)	AMP+CL (dB)	DF (dB)	Actual (dB㎶/m)	Limit (dB㎶/m)	Margin (dB)
*4 960.03	38.83	Peak	H	33.32	-30.67	-	41.48	74.00	32.52
Above 5 000.00	Not detected	-	-	-	-	-	-	-	-

Operating Mode: 8DPSK

A. Low Channel (2 402 ㎒)

Radiated Emissions			Ant.	Correction Factors			Total	Limit	
Frequency (㎒)	Reading (dB㎶)	Detect Mode	Pol.	AF (dB/m)	CL (dB)	DF (dB)	Actual (dB㎶/m)	Limit (dB㎶/m)	Margin (dB)
*2 310.00	25.68	Peak	H	27.96	6.01	-	59.65	74.00	14.35
*2 310.00	-	Average	-	-	-	-24.73	34.92	54.00	19.08
*2 334.76	27.51	Peak	H	28.11	6.04	-	61.66	74.00	12.34
*2 334.76	-	Average	-	-	-	-24.73	36.93	54.00	17.07
*2 390.00	26.06	Peak	H	28.12	6.12	-	60.30	74.00	13.70
*2 390.00	-	Average	-	-	-	-24.73	35.57	54.00	18.43

Radiated Emissions			Ant.	Correction Factors			Total	Limit	
Frequency (㎒)	Reading (dB㎶)	Detect Mode	Pol.	AF (dB/m)	AMP+CL (dB)	DF (dB)	Actual (dB㎶/m)	Limit (dB㎶/m)	Margin (dB)
*4 804.12	41.68	Peak	H	32.72	-30.82	-	43.58	74.00	30.42
Above 4 900.00	Not detected	-	-	-	-	-	-	-	-

B. Middle Channel (2 441 ㎒)

Radiated Emissions			Ant.	Correction Factors			Total	Limit	
Frequency (㎒)	Reading (dB㎶)	Detect Mode	Pol.	AF (dB/m)	AMP+CL (dB)	DF (dB)	Actual (dB㎶/m)	Limit (dB㎶/m)	Margin (dB)
*4 881.65	39.56	Peak	H	33.03	-30.74	-	41.85	74.00	32.15
Above 4 900.00	Not detected	-	-	-	-	-	-	-	-

C. High Channel (2 480 ㎒)

Radiated Emissions			Ant.	Correction Factors			Total	Limit	
Frequency (㎒)	Reading (dB㎶)	Detect Mode	Pol.	AF (dB/m)	CL (dB)	DF (dB)	Actual (dB㎶/m)	Limit (dB㎶/m)	Margin (dB)
*2 483.50	29.50	Peak	H	28.33	6.24	-	64.07	74.00	9.93
*2 483.50	-	Average	-	-	-	-24.73	39.34	54.00	14.66
*2 483.77	30.93	Peak	H	28.34	6.24	-	**65.51**	74.00	8.49
*2 483.77	-	Average	-	-	-	-24.73	40.78	54.00	13.22
*2 500.00	26.27	Peak	H	28.40	6.26	-	60.93	74.00	13.07
*2 500.00	-	Average	-	-	-	-24.73	36.20	54.00	17.80

Radiated Emissions			Ant.	Correction Factors			Total	Limit	
Frequency (㎒)	Reading (dB㎶)	Detect Mode	Pol.	AF (dB/m)	AMP+CL (dB)	DF (dB)	Actual (dB㎶/m)	Limit (dB㎶/m)	Margin (dB)
*4 959.85	38.13	Peak	H	33.32	-30.67	-	40.78	74.00	33.22
Above 5 000.00	Not detected	-	-	-	-	-	-	-	-

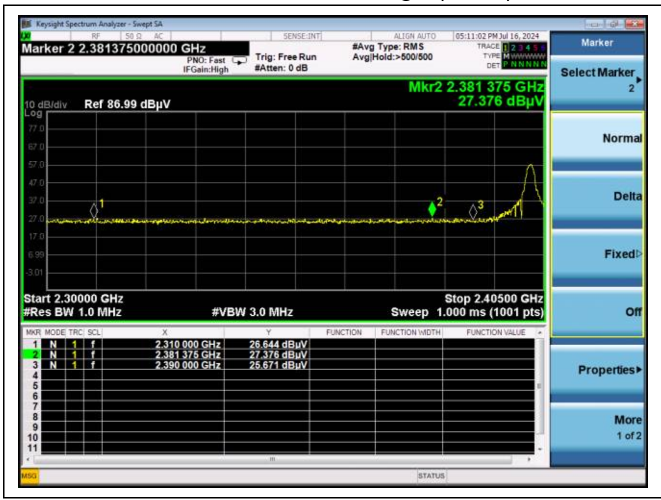
Remark;

1. "*" means the restricted band.
2. Measuring frequencies from 1 ㎓ to the 10th harmonic of highest fundamental frequency.
3. Radiated emissions measured in frequency above 1 000 ㎒ were made with an instrument using peak/average detector mode.
4. Actual = Reading + AF + CL + (DF) or Reading + AF + AMP + CL + (DF).
5. According to § 15.31(o), emission levels are not reported much lower than the limits by over 20 ㏈.
6. The maximized peak measured value complies with the average limit, to perform an average measurement is unnecessary.
7. AF = Antenna Factor, CL = Cable Loss, DF = Duty Correction Factor.

- Test plots

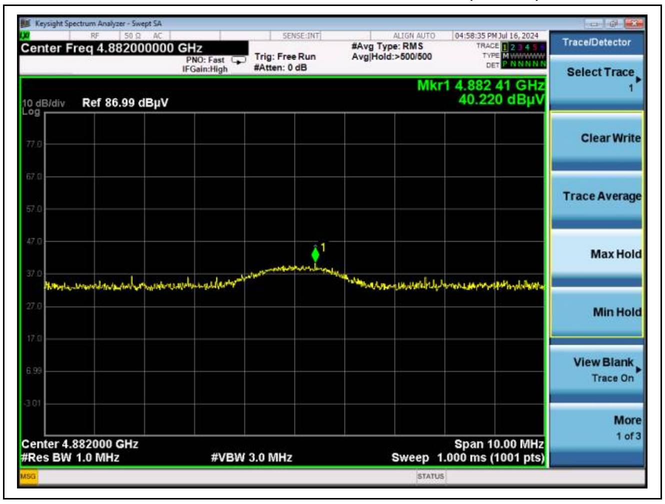
Mode: GFSK

Low channel band edge (Peak)



Low channel 2nd harmonic (Peak)

Middle channel 2nd harmonic (Peak)



High channel band edge (Peak)

High channel 2nd harmonic (Peak)

Mode: 8DPSK

Low channel band edge (Peak)

Low channel 2nd harmonic (Peak)

Middle channel 2nd harmonic (Peak)

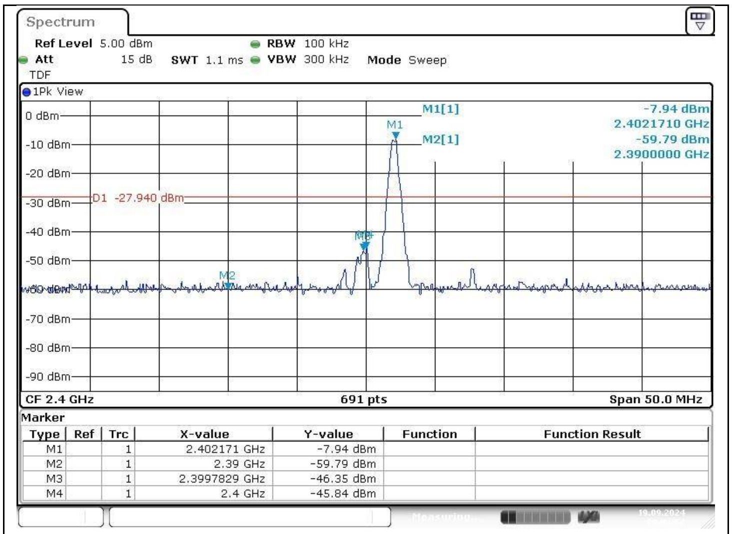
High channel band edge (Peak)

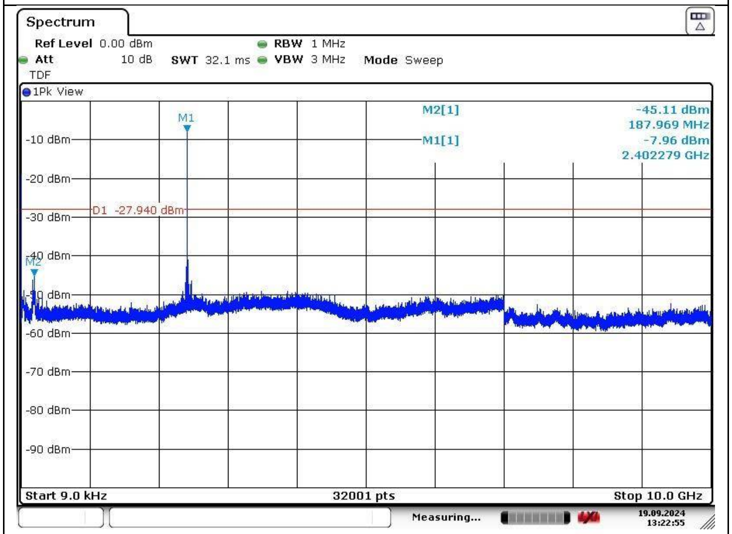
High channel 2nd harmonic (Peak)

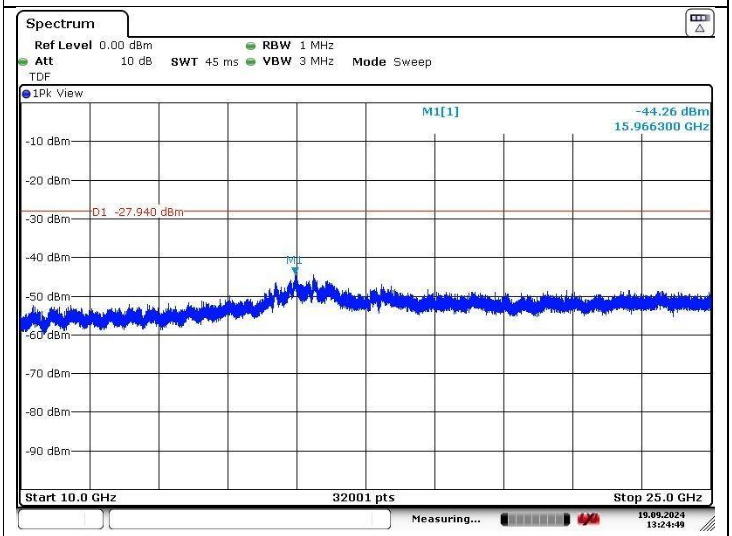
2.4.3. Plot of Conducted Spurious Emissions

Mode: GFSK_hopping function turned off

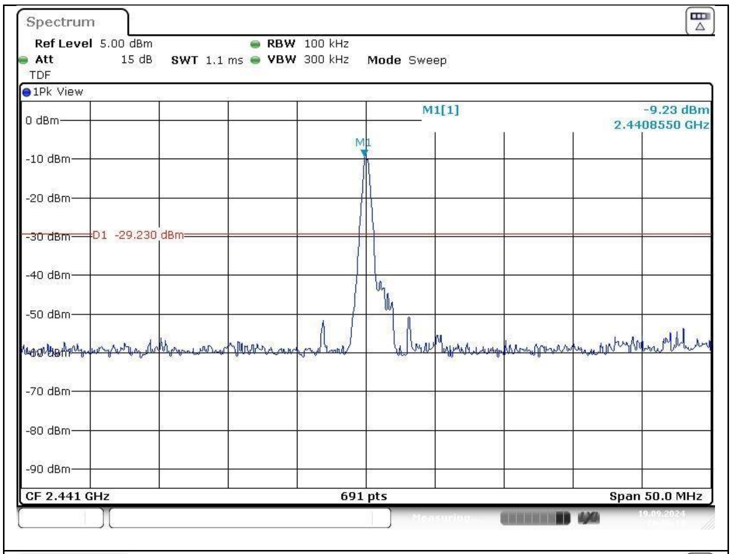
Low Channel

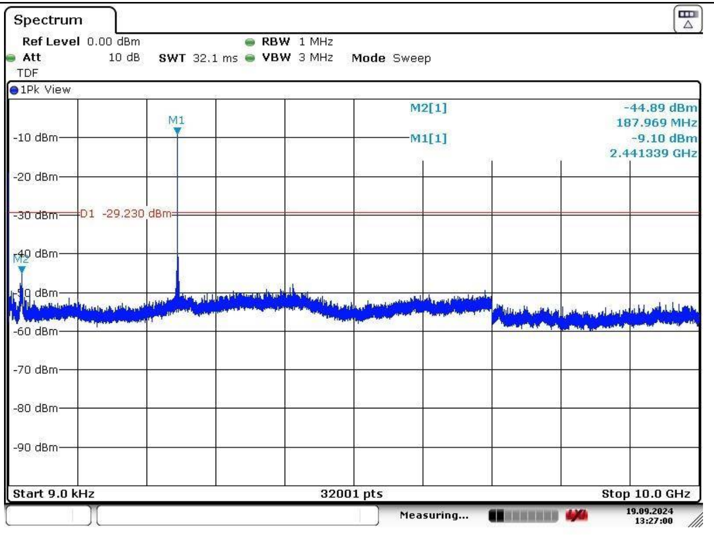


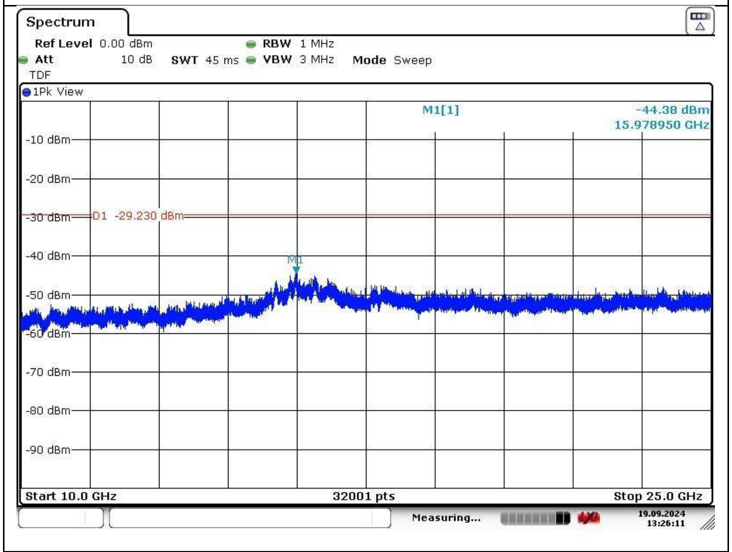




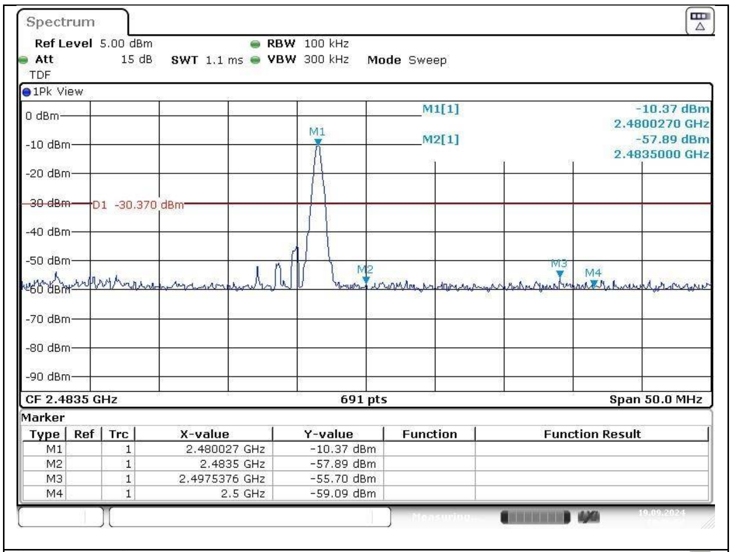
Middle Channel

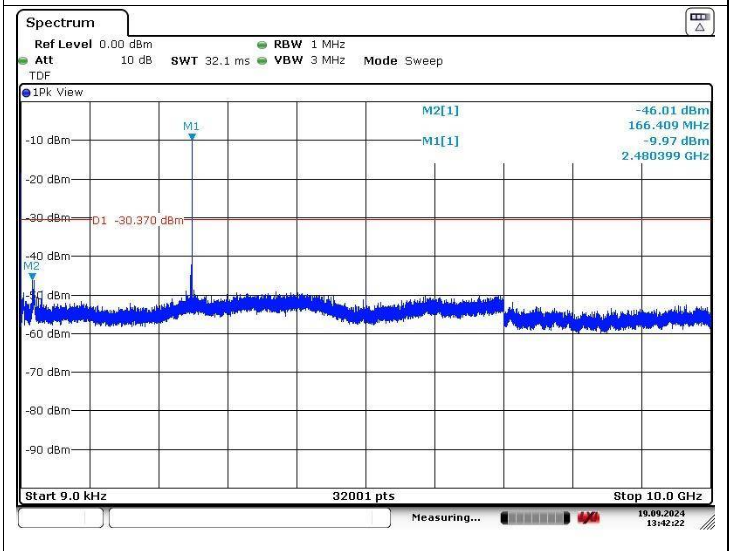


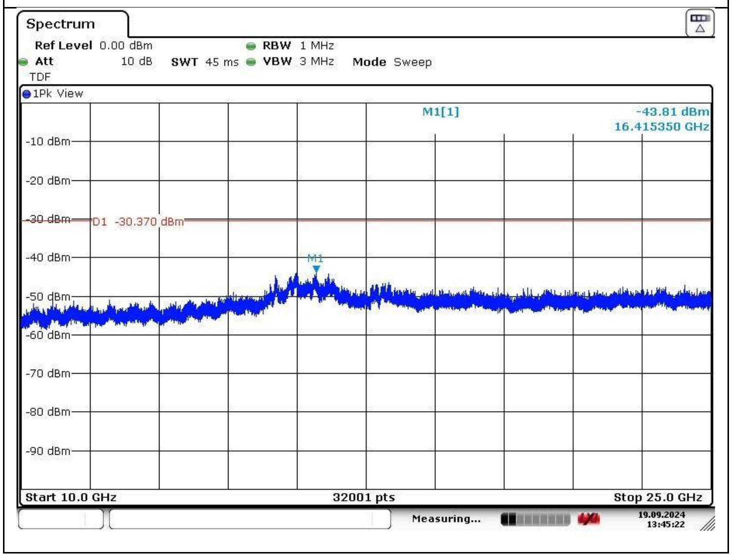




High Channel



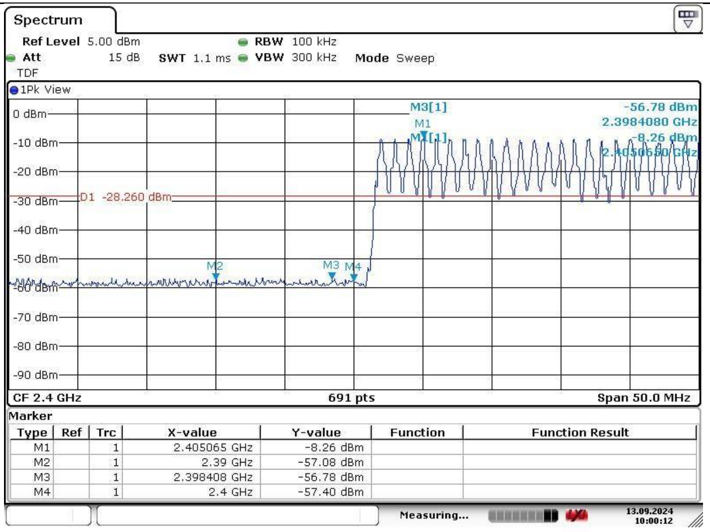




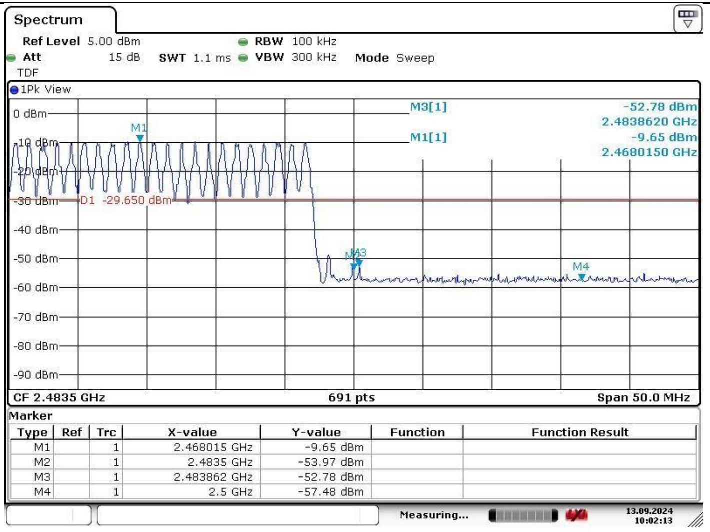
Mode: GFSK_hopping function turned on

Band edge compliance

Low Channel

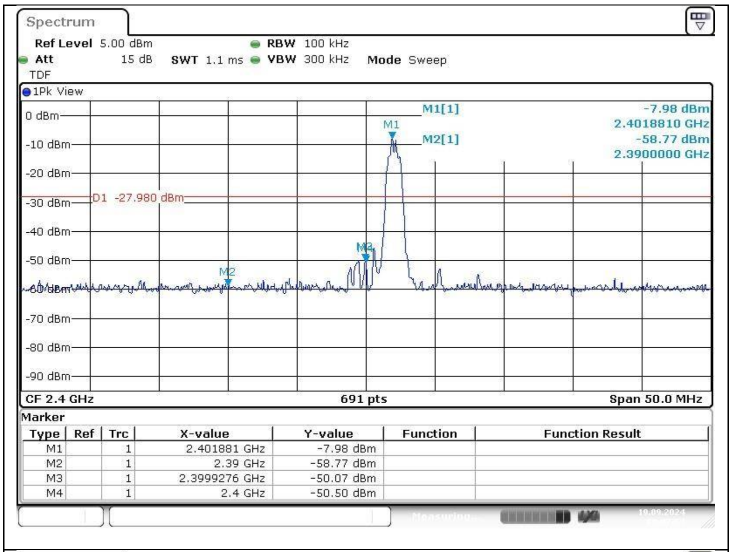


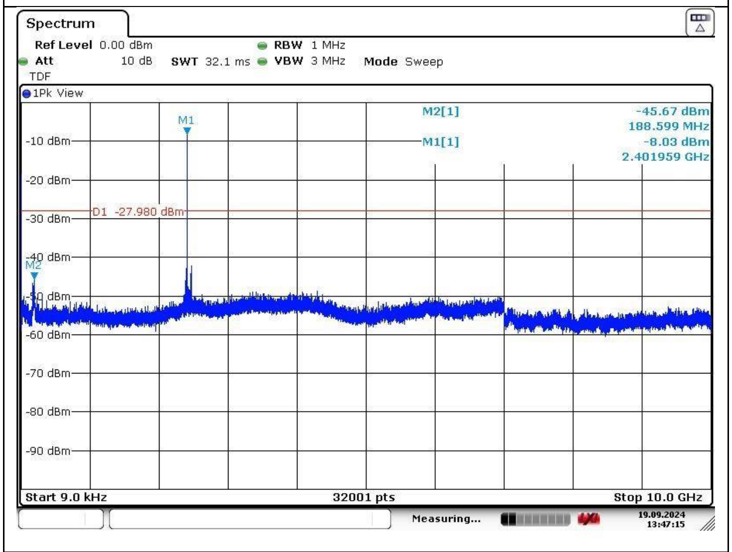
High Channel

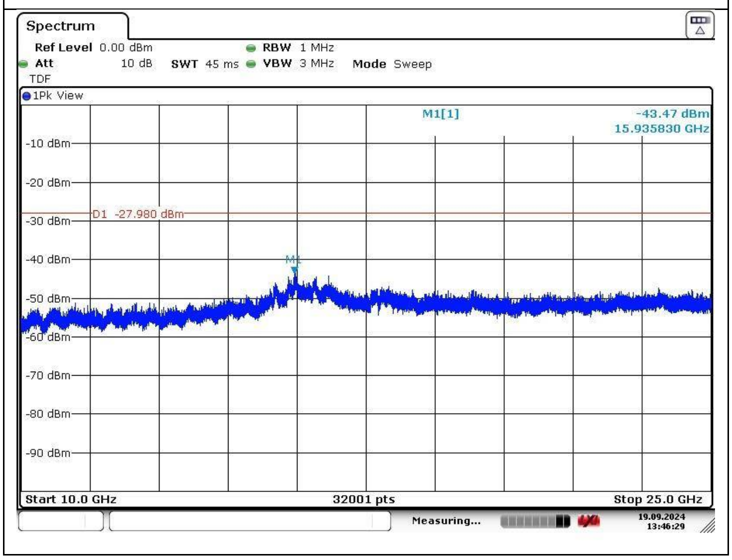


Mode: 8DPSK_hopping function turned off

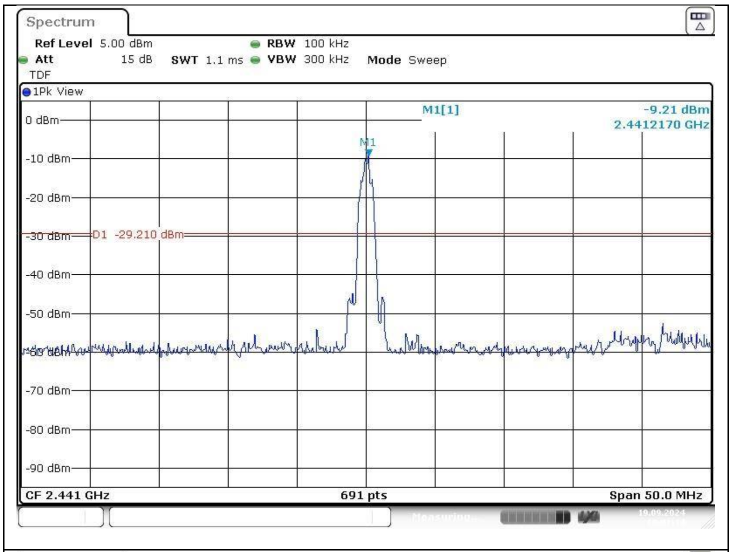
Low channel

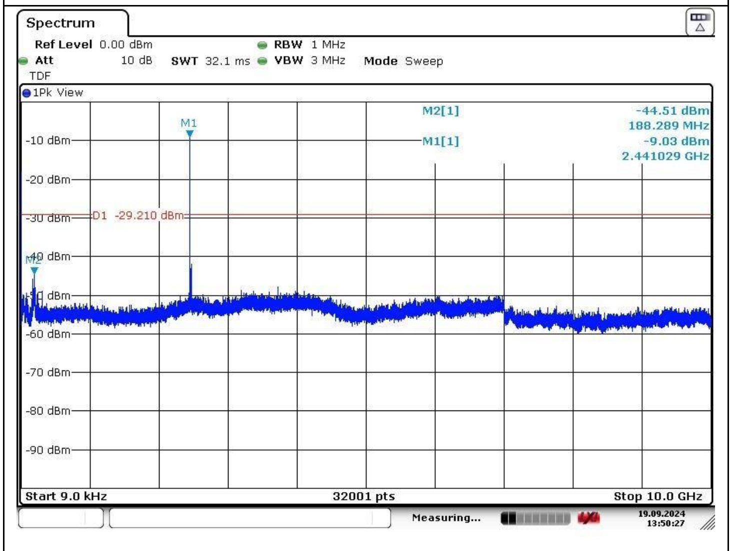


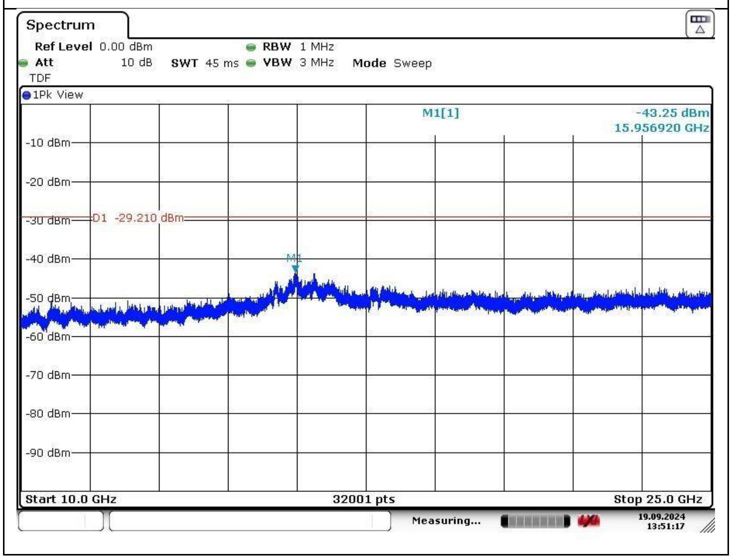




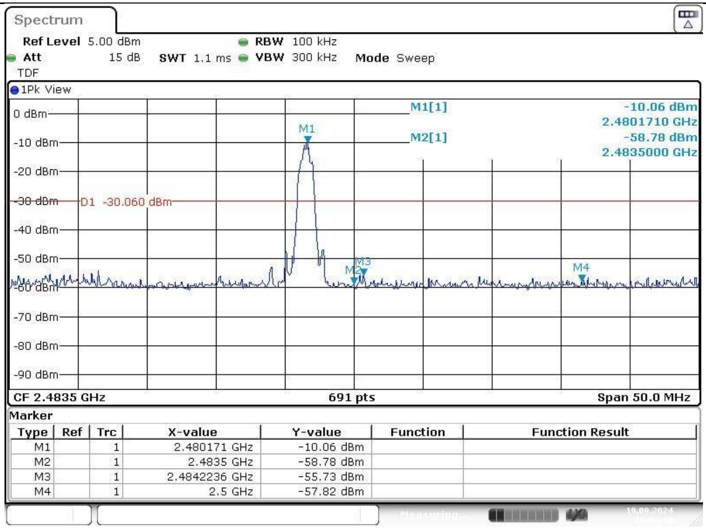
Middle channel

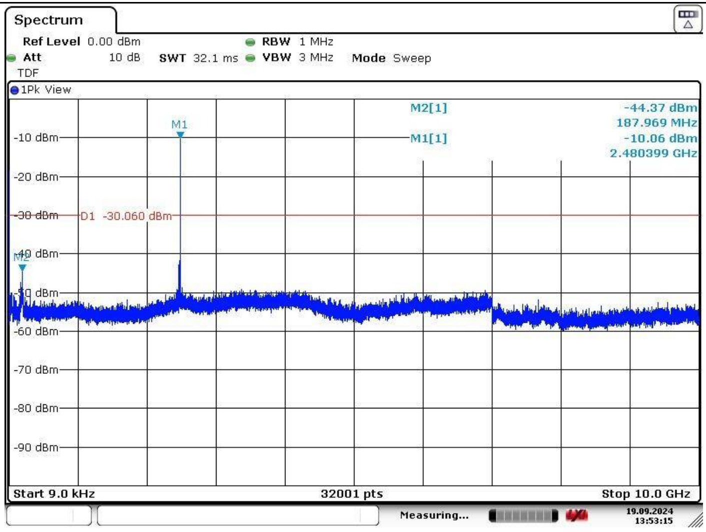


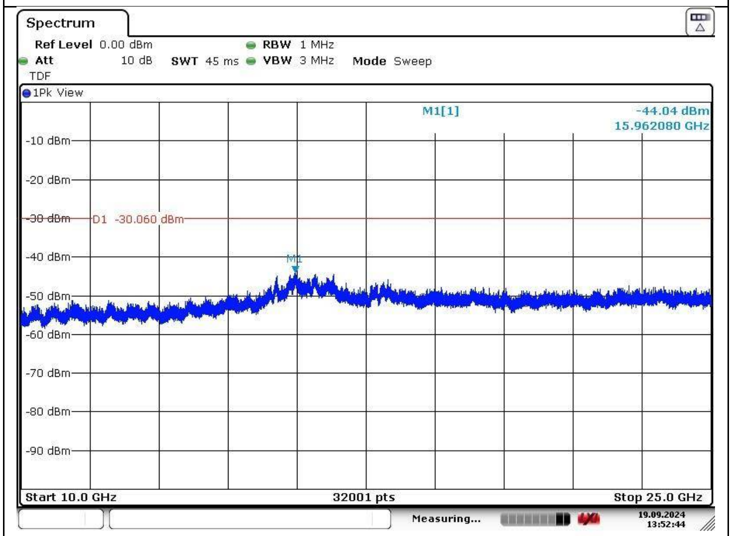




High channel



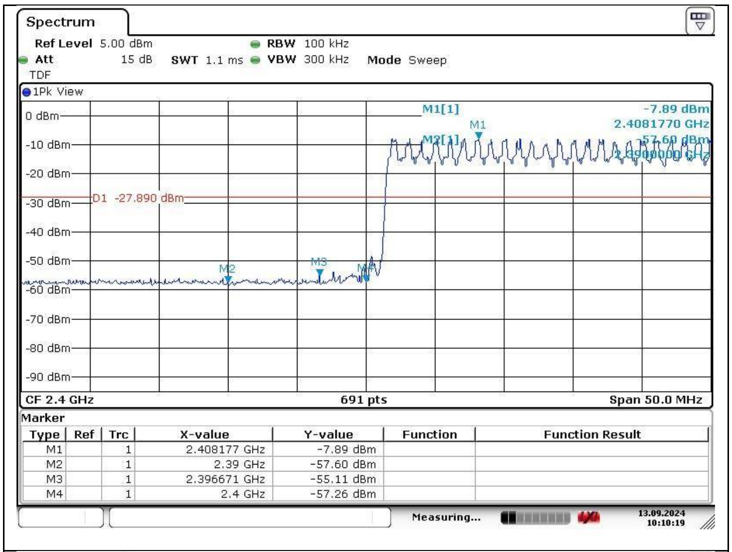




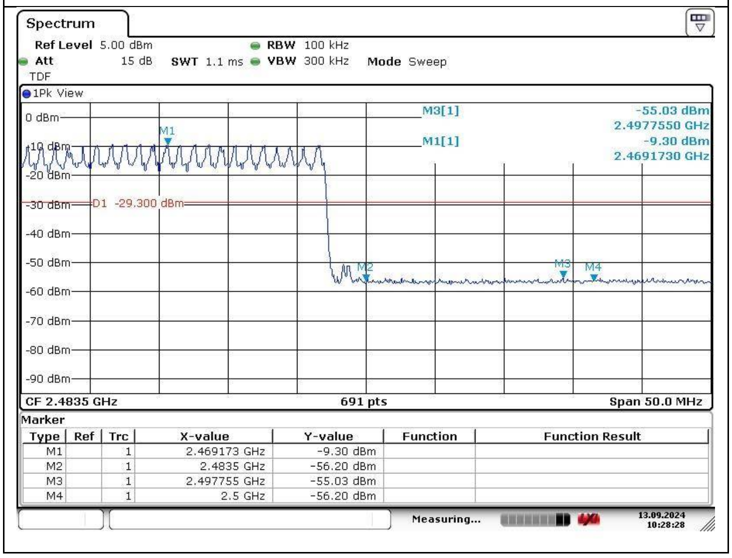
Mode: 8DPSK_hopping function turned on

Band edge compliance

Low channel

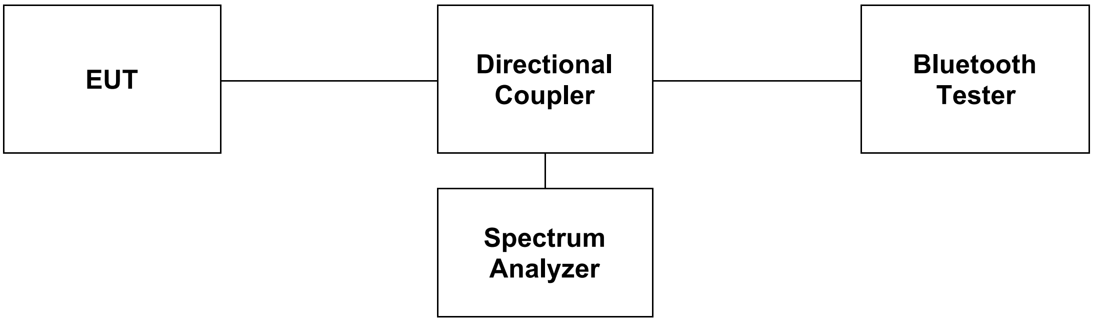


High channel



3. 20 ㏈ Bandwidth

3.1. Test Setup



3.2. Limit

Limit: Not Applicable

3.3. Test Procedure

20 ㏈ Bandwidth

The test follows ANSI C63.10-2013.

The 20 ㏈ bandwidth was measured with a spectrum analyzer connected to RF antenna connector (conducted measurement) while EUT was operating in transmit mode at the appropriate center frequency.

Use the following spectrum analyzer setting:

1. Span = approximately 2 to 5 times the 20 ㏈ bandwidth.
2. RBW ≥ 1 % to 5 % of the 20 ㏈ bandwidth.
3. VBW ≥ 3 x RBW
4. Sweep = auto
5. Detector = peak
6. Trace = max hold

The marker-to-peak function to set the mark to the peak of the emission. Use the marker-delta function to measure 20 ㏈ down one side of the emission. Reset the function, and move the marker to the other side of the emission, until it is (as close as possible to) even with the reference marker level. The marker-delta reading at this point is 20 ㏈ bandwidth of the emission.

3.4. Test Results

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

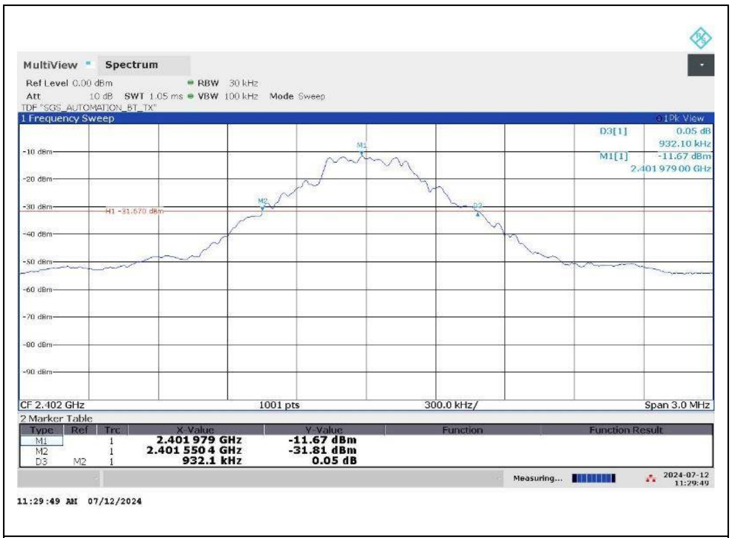
Mode	Data Rate (Mbps)	Channel	Frequency (㎒)	20 ㏈ Bandwidth (㎒)
GFSK	1	Low	2 402	0.932
		Middle	2 441	0.932
		High	2 480	0.932
π/4DQPSK	2	Low	2 402	1.231
		Middle	2 441	1.232
		High	2 480	1.229
8DPSK	3	Low	2 402	1.220
		Middle	2 441	1.220
		High	2 480	1.220

- Test plots

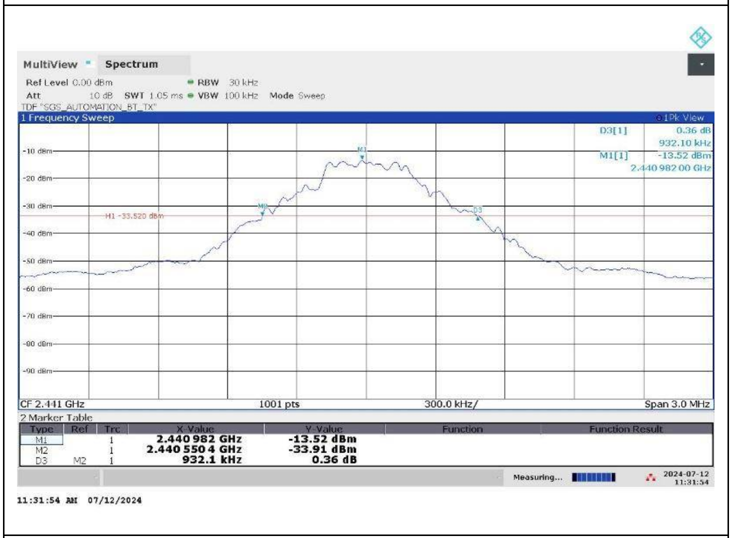
20 ㏈ Bandwidth

Mode: GFSK

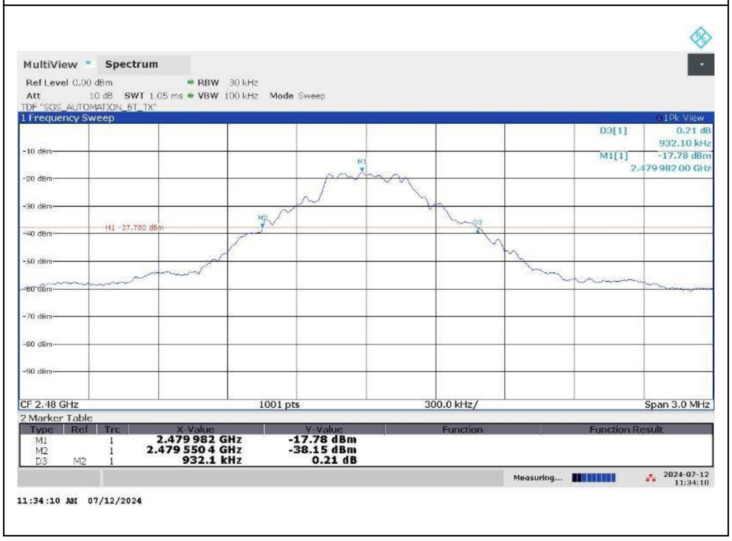
Low Channel



Middle Channel

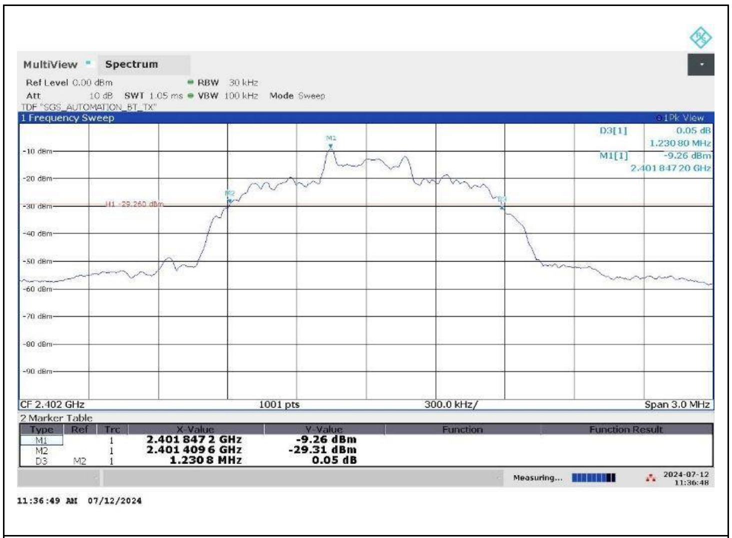


High Channel

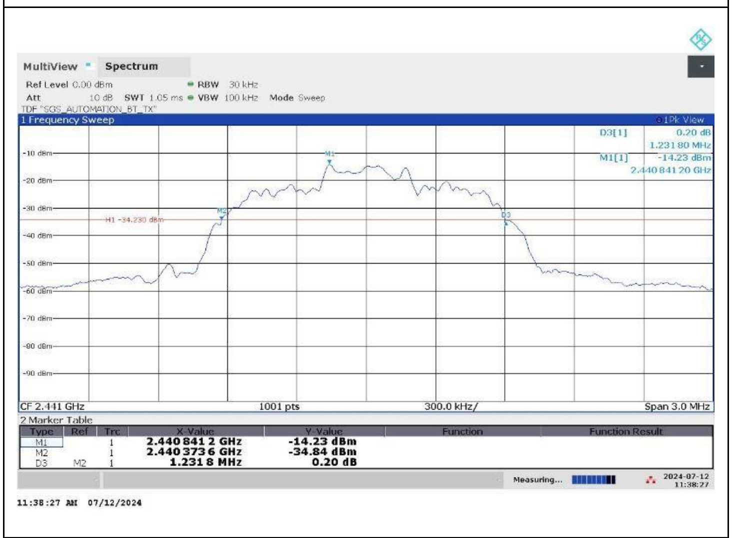


Mode: π/4DQPSK

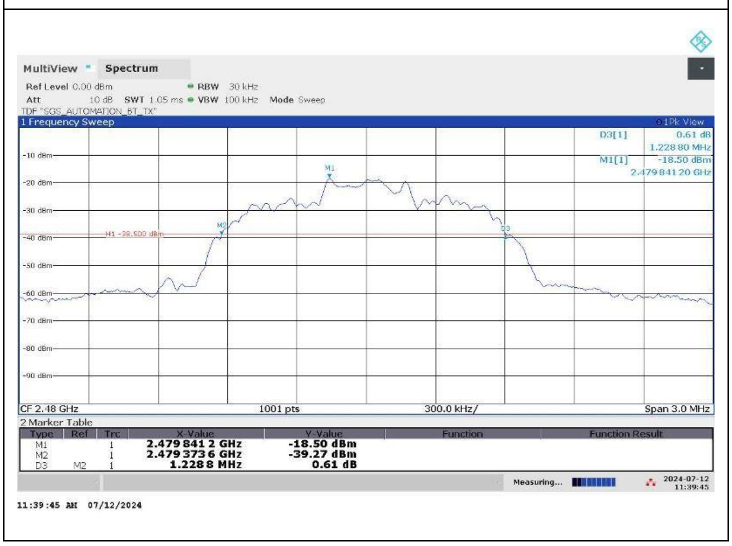
Low Channel



Middle Channel

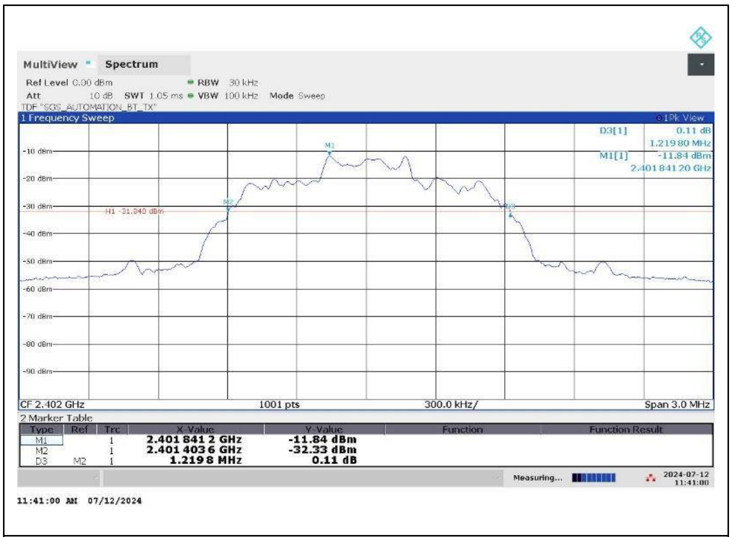


High Channel

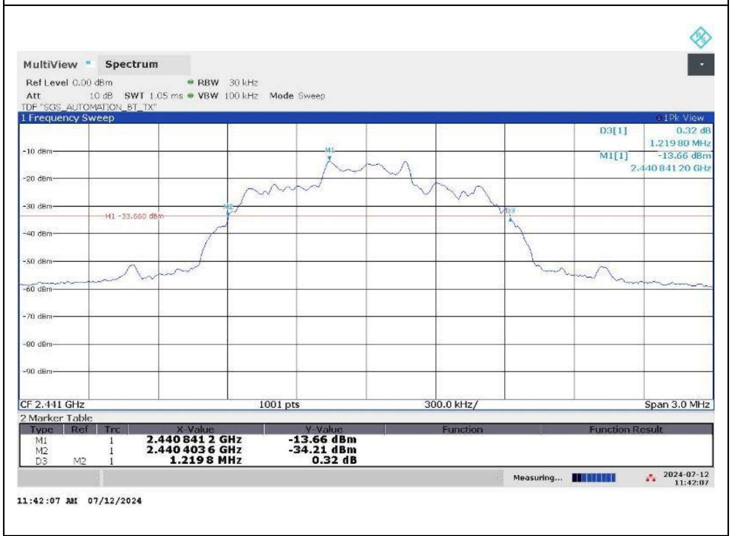


Mode: 8DPSK

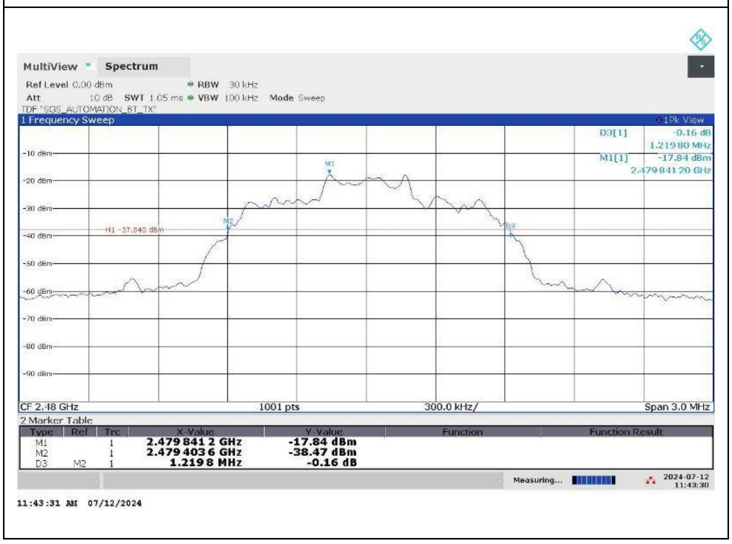
Low Channel



Middle Channel

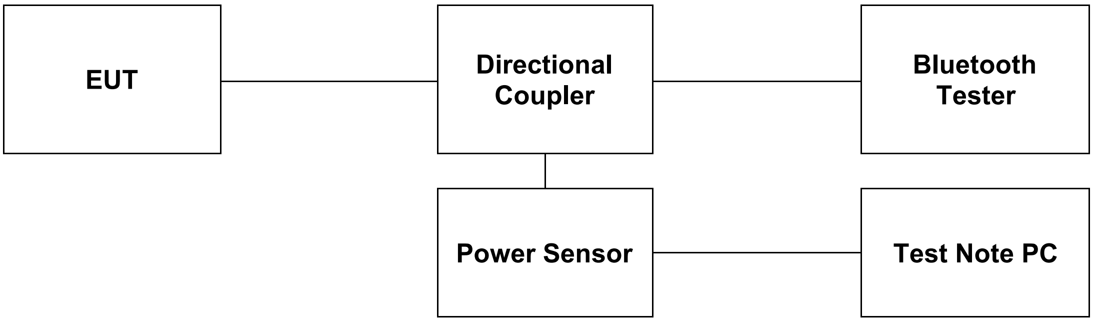


High Channel



4. Maximum Peak Conducted Output Power

4.1. Test Setup



4.2. Limit

1. §15.247(a)(1), Frequency hopping systems shall have hopping channel carrier frequencies separated by a minimum of 25 ㎑ or the 20 ㏈ bandwidth of the hopping channel, whichever is greater. Alternatively, frequency hopping systems operating in the 2 400-2 483.5 ㎒ band may have hopping channel carrier frequencies that are separated by 25 ㎑ or two-thirds of the 20 ㏈ bandwidth of the hopping channel, whichever is greater, provided the systems operate with an output power no greater than 125 ㎽.
2. §15.247(b)(1), For frequency hopping systems operating in the 2 400-2 483.5 ㎒ band employing at least 75 non-overlapping hopping channels, and all frequency hopping systems in the 5 725-5 850㎒ band: 1 watt. For all other frequency hopping systems in the 2 400-2 483.5㎒ band: 0.125 watts.

4.3. Test Procedure

The test follows ANSI C63.10-2013. 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 each channel.

4.4. Test Results

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

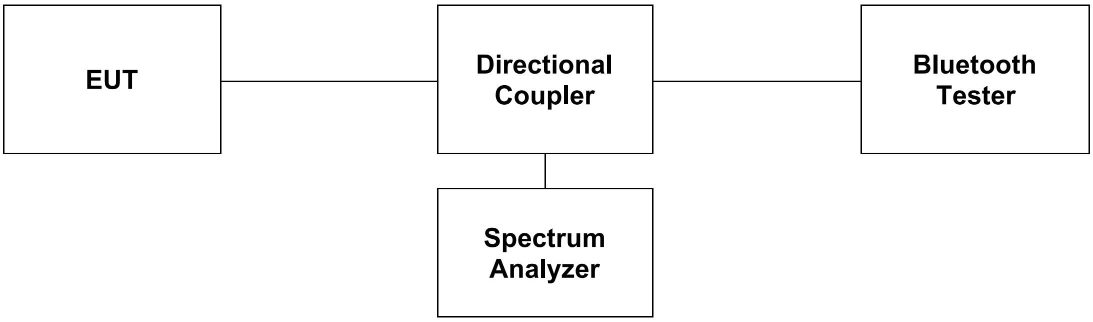
Mode	Data Rate (Mbps)	Channel	Frequency (㎒)	Average Power Result (㏈ m)	Peak Power Result (㏈ m)	Limit (㏈ m)
GFSK	1	Low	2 402	**-7.18**	**-3.18**	30
		Middle	2 441	-9.13	-4.04	
		High	2 480	-13.94	-5.20	
π/4DQPSK	2	Low	2 402	**-9.62**	**-3.82**	20.97
		Middle	2 441	-11.45	-3.83	
		High	2 480	-15.18	-5.35	
8DPSK	3	Low	2 402	**-9.54**	**-3.49**	
		Middle	2 441	-12.49	-4.13	
		High	2 480	-14.49	-5.29	

Remark;

In the case of AFH, the limit for peak power is 0.125 W.

5. Carrier Frequency Separation

5.1. Test Setup



5.2. Limit

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

5.3. Test Procedure

The test follows section 7.8.2 Carrier frequency separation of ANSI C63.10-2013.

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:

1. Span: Wide enough to capture the peaks of two adjacent channels
2. RBW: Start with the RBW set to approximately 30 % of the channel spacing; adjust as necessary to best identify the center of each individual channel.
3. VBW ≥ RBW
4. Sweep: Auto
5. Detector function: Peak
6. Trace: Max hold
7. Allow the trace to stabilize.

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

5.4. Test Results

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

Mode	Frequency (㎒)	Adjacent Hopping Channel Separation (㎑)	20 ㏈ Bandwidth (㎑)
GFSK	2 441	1 000	932

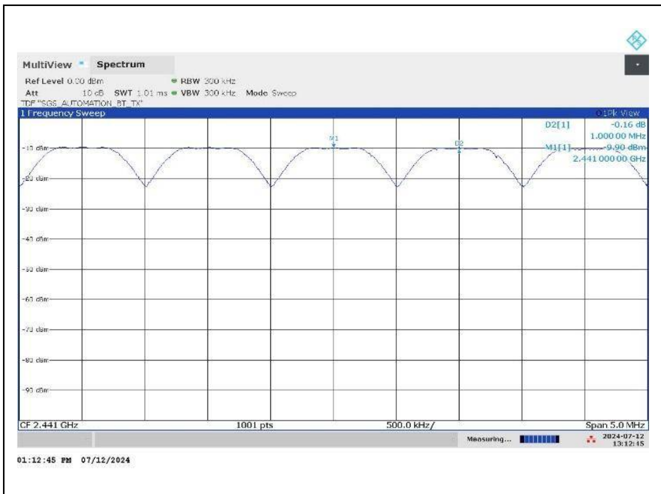
Mode	Frequency (㎒)	Adjacent Hopping Channel Separation (㎑)	Two-third of 20 ㏈ Bandwidth (㎑)
8DPSK	2 441	1 000	813

Remark;

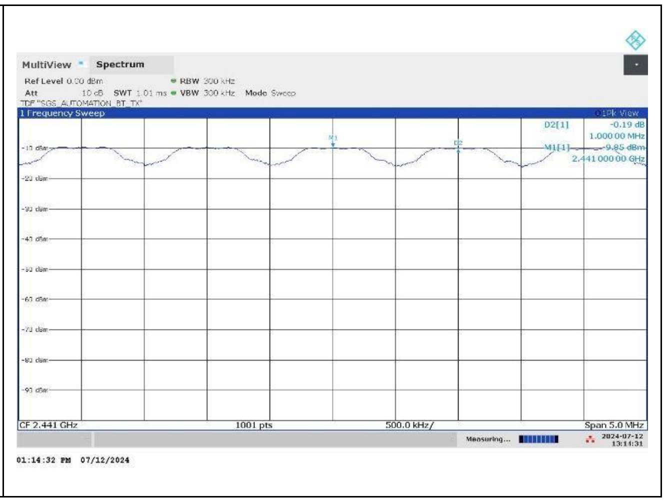
Measurement is made with EUT operating in hopping mode between 79 channels providing a worst case scenario as compared to AFH mode hopping between 20 channels.

- Test plots

GFSK

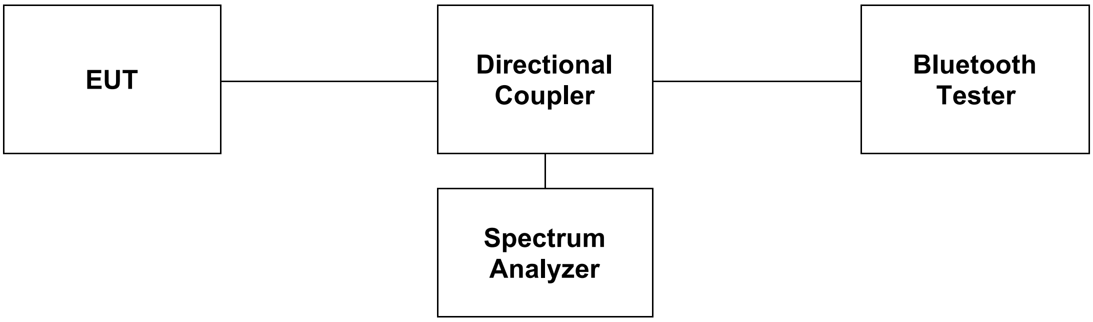


8DPSK



6. Number of Hopping Frequencies

6.1. Test Setup



6.2. Limit

§15.247(a)(1)(iii), Frequency hopping systems in the 2 400-2 483.5 ㎒ 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

The test follows section 7.8.3 Number of hopping frequencies of ANSI C63.10-2013.

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

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

1. Span: The frequency band of operation. Depending on the number of channels the device supports, it may be necessary to divide the frequency range of operation across multiple spans, to allow the individual channels to be clearly seen.
2. RBW: To identify clearly the individual channels, set the RBW to less than 30 % of the channel spacing or the 20 ㏈ bandwidth, whichever is smaller.
3. VBW ≥ RBW
4. Sweep: Auto
5. Detector function: Peak
6. Trace: Max hold
7. Allow the trace to stabilize.

6.4. Test Results

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

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

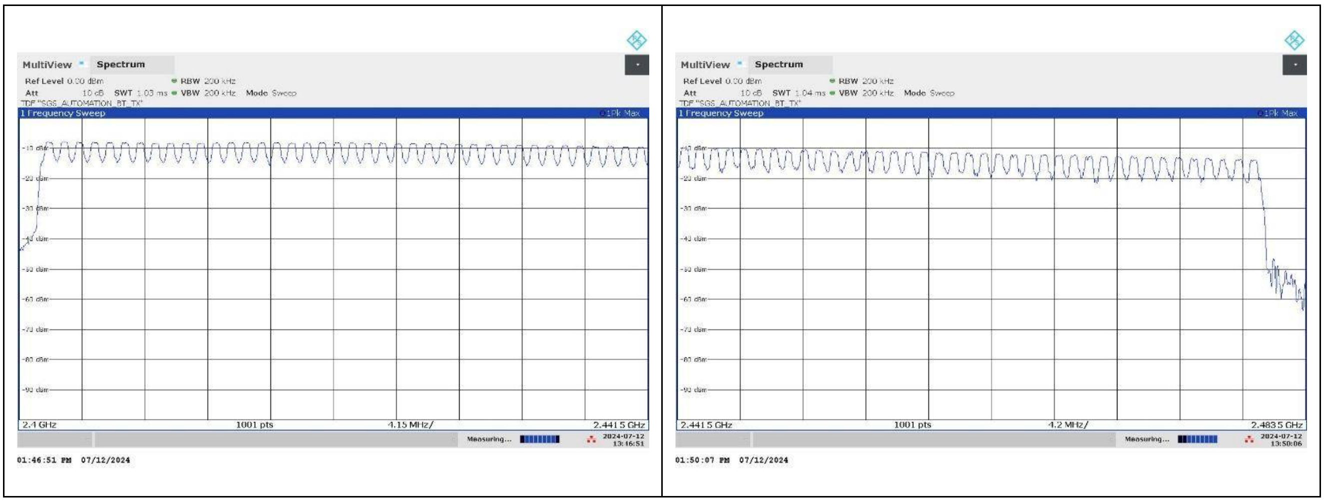
Remark;

Measurement is made with EUT operating in hopping mode between 79 channels providing a worst case scenario as compared to AFH mode hopping between 20 channels.

- Test plots

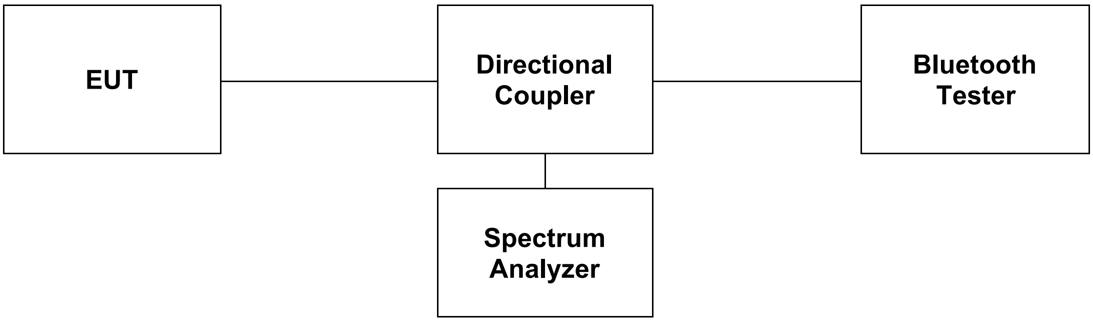
GFSK

8DPSK



7. Time of Occupancy (Dwell Time)

7.1. Test Set up



7.2. Limit

§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.

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

The test follows section 7.8.4 Time of occupancy of 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 shall be ≤ channel spacing and where possible RBW should be set >> 1/T, where T is the expected dwell time per channel.
3. Sweep = As necessary to capture the entire dwell time per hopping channel; where possible use a video trigger and trigger delay so that the transmitted signal starts a little to the right of the start of the plot.
4. Detector function: Peak
5. Trace: Max hold

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

7.4. Test Results

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

7.4.1. Packet Type: DH1,3DH1

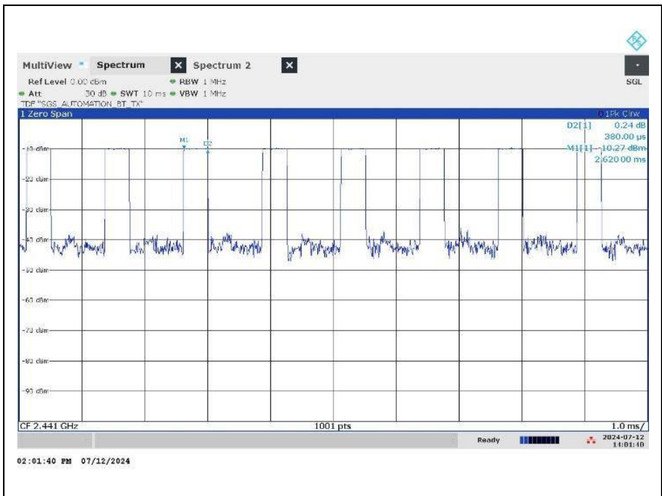
Mode	Frequency (㎒)	Dwell Time (㎳)	Time of occupancy on the Tx Channel in 31.6 sec (㎳)	Limit for time of occupancy on the Tx Channel in 31.6 sec (㎳)
GFSK	2 441	0.38	121.60	400
8DPSK	2 441	0.39	124.80	400

Remark;

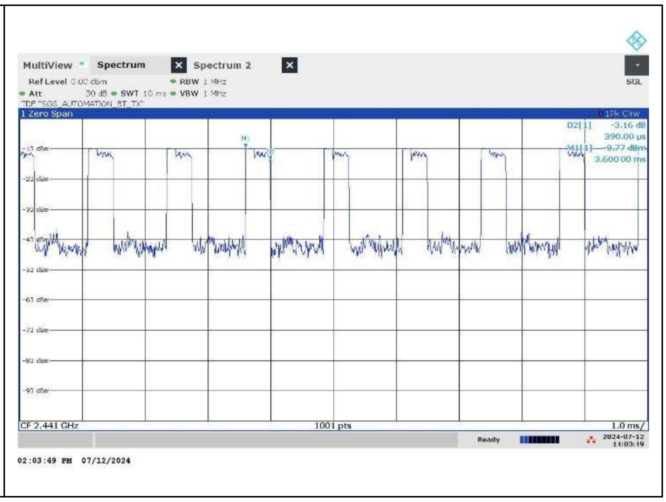
Time of occupancy on the TX channel in 31.6 sec
In case of GFSK: 0.38 × {(1 600 ÷ 2) / 79} × 31.6 = 121.60 ㎳
In case of 8DPSK: 0.39 × {(1 600 ÷ 2) / 79} × 31.6 = 124.80 ㎳

- Test plots

GFSK



8DPSK



7.4.2. Packet Type: DH3, 3DH3

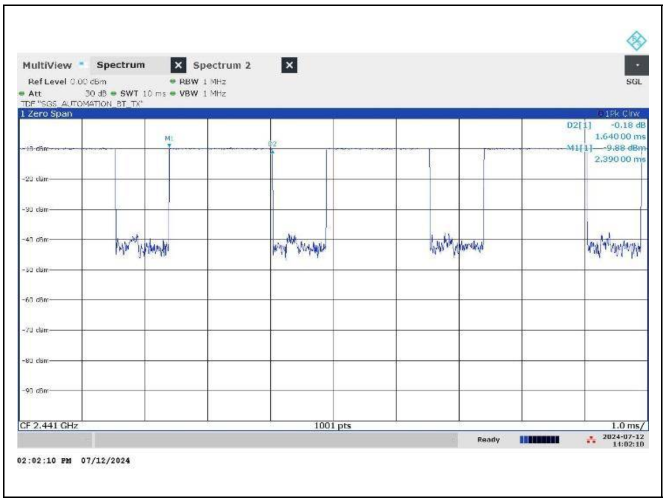
Mode	Frequency (㎒)	Dwell Time (㎳)	Time of occupancy on the Tx Channel in 31.6 sec (㎳)	Limit for time of occupancy on the Tx Channel in 31.6 sec (㎳)
GFSK	2 441	1.64	262.40	400
8DPSK	2 441	1.64	262.40	400

Remark;

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

- Test plots

GFSK



8DPSK

7.4.3. Packet Type: DH5, 3DH5

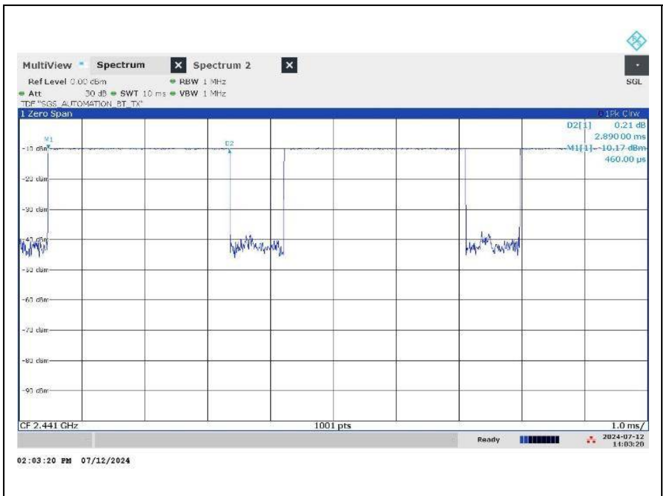
Mode	Frequency (㎒)	Dwell Time (㎳)	Time of occupancy on the Tx Channel in 31.6 sec (㎳)	Limit for time of occupancy on the Tx Channel in 31.6 sec (㎳)
GFSK	2 441	2.89	308.27	400
8DPSK	2 441	2.89	308.27	400

Remark;

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

- Test plots

GFSK



8DPSK

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

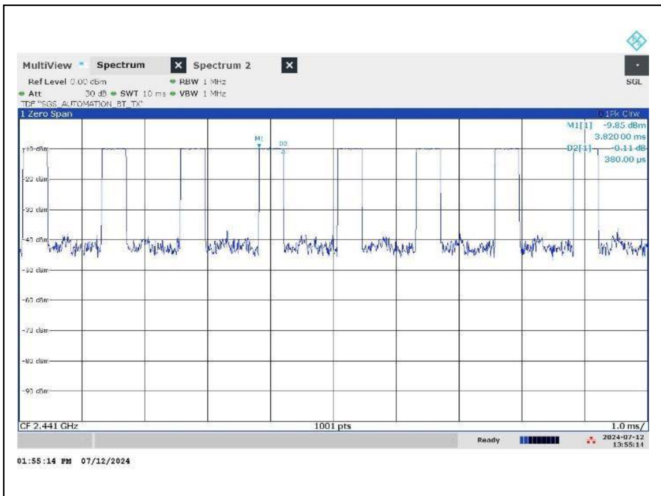
Mode	Frequency (㎒)	Dwell Time (㎳)	Time of occupancy on the Tx Channel in 8 sec (㎳)	Limit for time of occupancy on the Tx Channel in 8 sec (㎳)
GFSK	2 441	0.38	60.80	400
8DPSK	2 441	0.39	62.40	400

Remark;

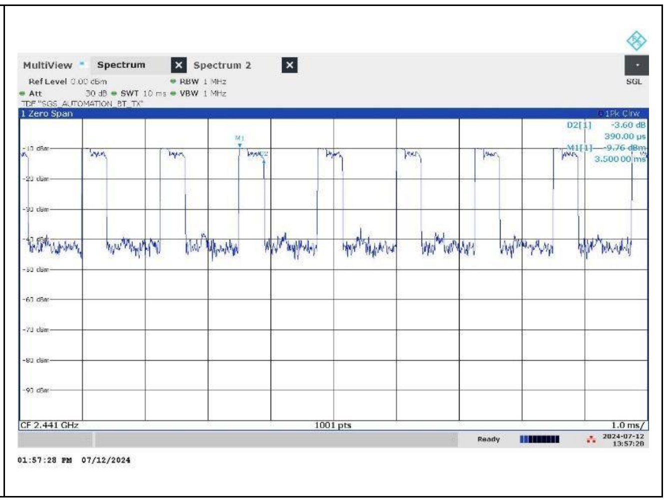
Time of occupancy on the TX channel in 8 sec
In case of GFSK: 0.38 × {(800 ÷ 2) / 20} × 8 = 60.80 ㎳
In case of 8DPSK: 0.39 × {(800 ÷ 2) / 20} × 8 = 62.40 ㎳

- Test plots

GFSK



8DPSK



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

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

Remark;

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

- Test plots

GFSK

8DPSK

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

Mode	Frequency (㎒)	Dwell Time (㎳)	Time of occupancy on the Tx Channel in 8 sec (㎳)	Limit for time of occupancy on the Tx Channel in 8 sec (㎳)
GFSK	2 441	2.89	154.13	400
8DPSK	2 441	2.89	154.13	400

Remark;

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

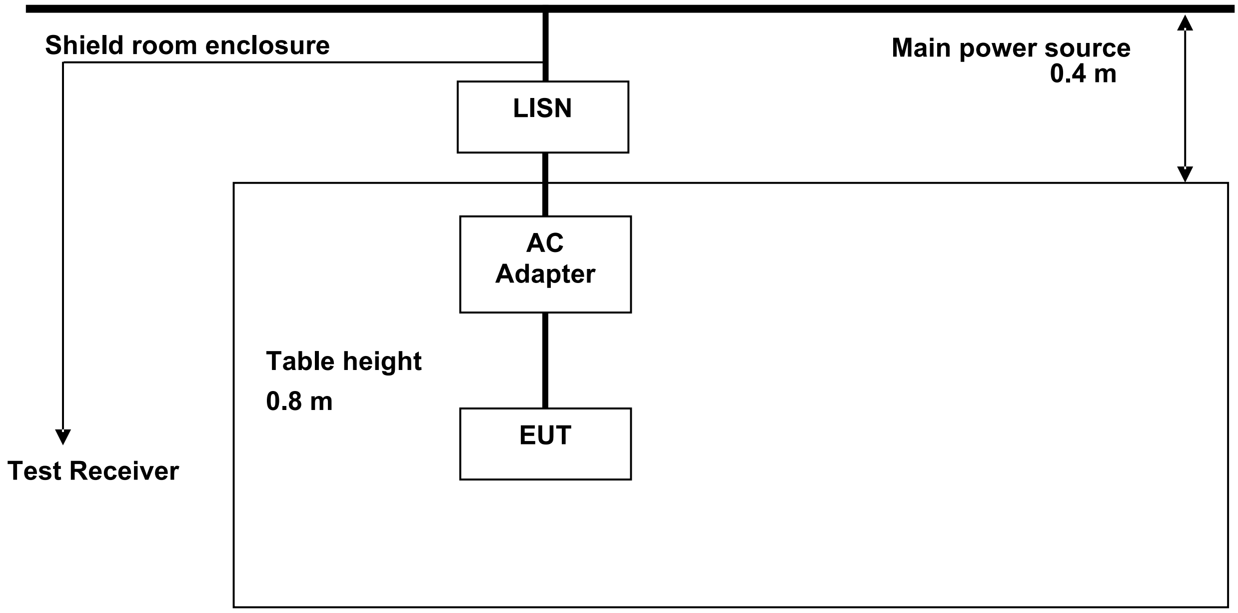
- Test plots

GFSK

8DPSK

8. 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 ㎑ 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.

8.3. 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 ㎑

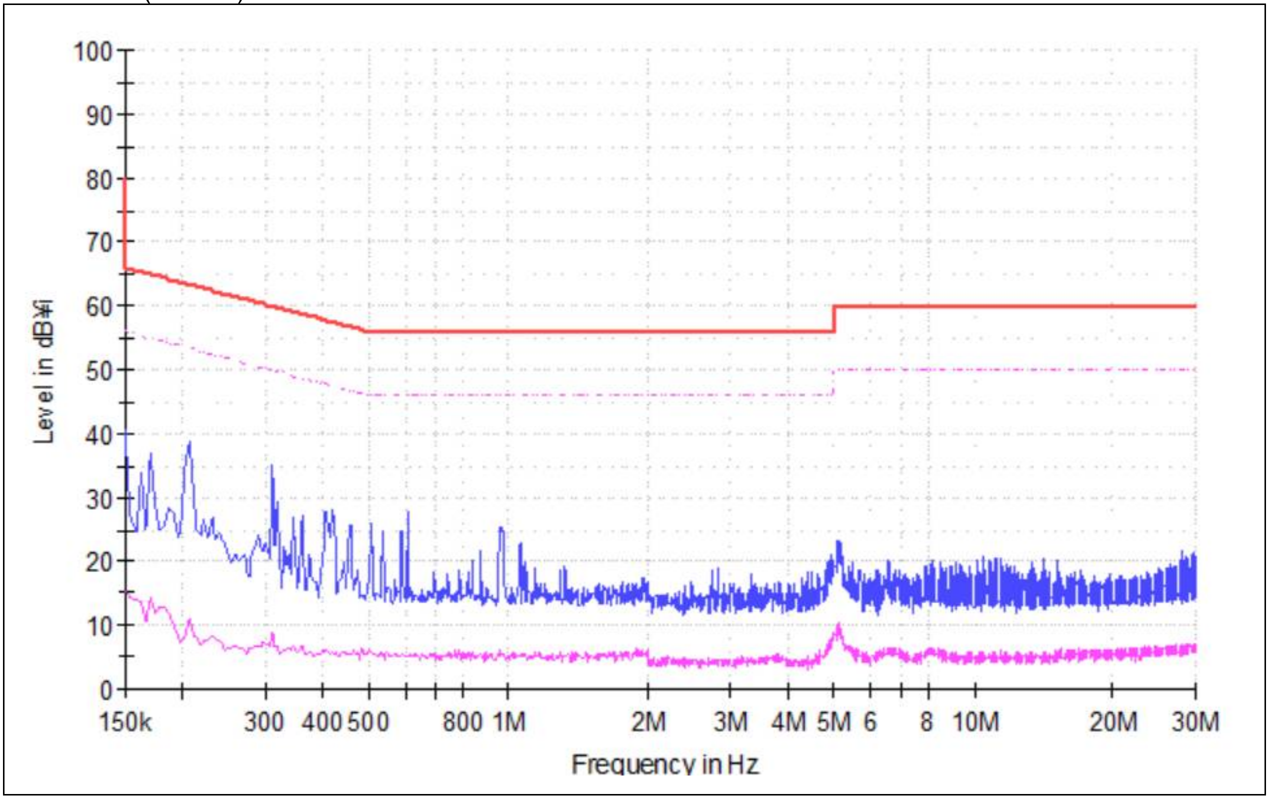
Freq.	Reading (dB㎶)		Correction Factor (dB)	Result (dB㎶)		Line	Limit (dB㎶)		Margin (dB)	
(㎒)	Quasi-peak	Average		Quasi-peak	Average		Quasi-peak	Average	Quasi-peak	Average
0.206	14.08	-0.42	9.62	23.70	9.20	N	63.37	53.37	39.67	44.17
0.310	9.86	-3.24	9.64	19.50	6.40	N	59.97	49.97	40.47	43.57
0.406	7.97	-3.63	9.73	17.70	6.10	N	57.73	47.73	40.03	41.63
0.606	13.26	-2.94	9.74	23.00	6.80	N	56.00	46.00	33.00	39.20
0.970	6.35	-3.85	9.75	16.10	5.90	N	56.00	46.00	39.90	40.10
5.082	8.35	-0.45	9.95	18.30	9.50	N	60.00	50.00	41.70	40.50
0.174	16.78	1.78	9.72	26.50	11.50	H	64.77	54.77	38.27	43.27
0.258	13.87	-2.33	9.73	23.60	7.40	H	61.50	51.50	37.90	44.10
0.346	9.76	-3.04	9.74	19.50	6.70	H	59.06	49.06	39.56	42.36
0.438	8.36	-3.34	9.74	18.10	6.40	H	57.10	47.10	39.00	40.70
5.134	8.84	-0.16	10.06	18.90	9.90	H	60.00	50.00	41.10	40.10
28.626	0.43	-4.77	11.17	11.60	6.40	H	60.00	50.00	48.40	43.60

Remark;

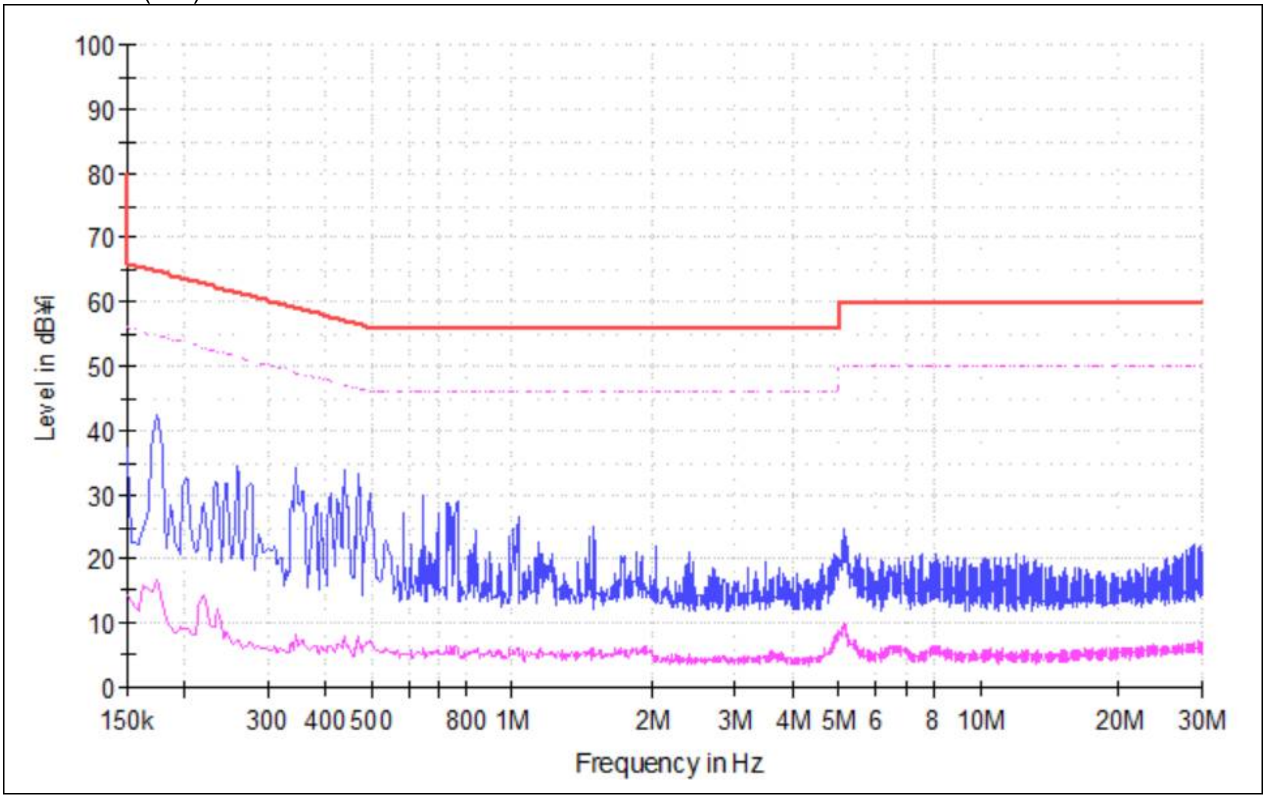
1. Line (H): Hot, Line (N): Neutral.
2. All channels were investigated and the worst-case emissions were reported using **BDR / DH5 / Low channel.**
3. The limit for Class B device(s) from 150 ㎑ to 30 ㎒ are specified in Section of the Title 47 CFR.
4. Test from 150 ㎑ to 30 ㎒ was performed using the software of EMC32(V10.60.20) from R&S.
5. Traces shown in plot were made by using a Quasi-peak detector and average detector.
6. Deviations to the Specifications: None.
7. Result (dB㎶) = Reading (dB㎶) + Correction Factor(dB)
8. Correction Factor(dB) = LISN factor (dB) + Cable loss (dB)

- 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. The use of a permanently attached antenna or of an antenna that uses a unique coupling to the intentional radiator shall be considered sufficient to comply with the provisions of this section. The manufacturer may design the unit so that a broken antenna can be replaced by the user, but the use of a standard antenna jack or electrical connector is prohibited. And according to FCC 47 CFR Section §15.247(b) if transmitting antennas of directional gain greater than 6 ㏈i are used, the conducted output power shall be reduced appropriate, by the amount in ㏈ that the directional gain of the antenna exceeds 6 ㏈i.

9.2. Antenna Connected Construction

Antenna used in this product is PCB antenna with gain of -0.37 ㏈i

- End of the Test Report -