Test Report

1. Client
   - Name : SENA TECHNOLOGIES.Inc
   - Address : 19, Heolleung-ro 569-gil, Gangnam-gu, Seoul, Korea
2. Use of Report : FCC & IC Approval
3. Sample Description
   - Product Name : EXPAND MESH
   - Model Name : SP122
4. Date of Receipt : 2022-07-01
5. Date of Test : 2022-09-08 ~ 2022-09-21
6. Test Method : FCC Part 15 Subpart C 15.247
   RSS-247 Issue 2(2017-02), RSS-GEN Issue 5(2019-03)
7. Test Results : Refer to the test results

This test report must not be reproduced or reproduced in any way.
The results shown in this test report are the results of testing the samples provided.
This test report is prepared according to the requirements of ISO / IEC 17025.

Affirmation	Tested by Dae-Seong, Choi (signature)	Technical Manager Yong-Min, Won (signature)

Sep 26, 2022

EMC Labs Co., Ltd. (seal)

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Version

TEST REPORT NO.	DATE	DESCRIPTION
KR0140-RF2209-012	Sep 26, 2022	Initial Issue

1. Applicant & Manufacturer & Test Laboratory Information

1.1 Applicant Information

Applicant	SENA TECHNOLOGIES.Inc
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Contact Person	Seunghyun Kim
Telephone No.	+82-2-573-7772
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1.2. Manufacturer Information

Manufacturer	SENA TECHNOLOGIES.Inc
Manufacturer Address	19, Heolleung-ro 569-gil, Gangnam-gu, Seoul, Korea

1.3 Test Laboratory Information

Laboratory	EMC Labs Co., Ltd.
Applicant Address	100, Jangjateo-ro, Hobeop-myeon, Icheon-si, Gyeonggi-do, Republic of Korea
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FCC Designation No.	KR0140
FCC Registration No.	58000
IC Site Registration No.	28751

2. Equipment under Test(EUT) Information

2.1 General Information

Product Name	EXPAND MESH
Model Name	SP122
FCC ID	S7A-SP122
IC	8154A-SP122
Power Supply	DC 3.8 V

2.2 Additional Information

Operating Frequency	2 402 MHz ~ 2 480 MHz
Number of channel	79
Modulation Type	BDR Mode(GFSK), EDR Mode(Pi/4 DQPSK, 8DPSK)
Antenna Type	Chip Antenna
Antenna Gain	0.3 dBi
Firmware Version	1.0
Hardware Version	1.0
Test software	Lab Test Tool V2.9.1

2.3 Test Frequency

Test mode	Test Frequency (MHz)		
	Low Frequency	Middle Frequency	High Frequency
GFSK	2 402	2 441	2 480
Pi/4 DQPSK	2 402	2 441	2 480
8DPSK	2 402	2 441	2 480

2.4 Used Test Software Setting Value

Test Mode	Setting Item
	Power
GFSK	51
Pi/4 DQPSK	51
8DPSK	51

2.5 Worst-Case

BDR	GFSK (DH5)
EDR	8DPSK (3-DH5)

Note: The power measurement has been conducted to determine the worst-case mode from all possible Combinations between available modulations, data rates.

2.6 Mode of operation during the test

- The EUT continuous transmission mode during the test with set at Low Channel, Middle Channel, and High Channel. To get a maximum radiated emission levels from the EUT, the EUT was moved throughout the XY, YZ, XZ planes.

2.7 Modifications of EUT

- None

3. Test Summary

Applied	FCC Rule	IC Rule	Test Items	Test Condition	Result
☒	15.203	-	Antenna Requirement	Conducted	C
☒	15.247(a)	-	20 dB Bandwidth		C
☒	-	RSS GEN (6.7)	Occupied Bandwidth (99%)		C
☒	15.247(a)	RSS-247 (5.1)	Number of Hopping Frequencies		C
☒	15.247(a)	RSS-247 (5.1)	Time of Occupancy (Dwell Time)		C
☒	15.247(a)	RSS-247 (5.1)	Carrier Frequencies Separation		C
☒	15.247(b)	RSS-247 (5.4)	Peak Output Power		C
☒	15.247(d)	RSS-247 (5.5)	Conducted Spurious Emission		C
☒	15.247(d) 15.205 & 15.209	RSS-247 (5.5) RSS-GEN (8.9 & 8.10)	Radiated Spurious Emission	Radiated	C
☒	15.207	RSS-GEN (8.8)	Conducted Emissions	AC Line Conducted	C

Note 1: C=Complies NC=Not Complies NT=Not Tested NA=Not Applicable

The sample was tested according to the following specification: ANSI C63.10:2013.
Compliance was determined by specification limits of the applicable standard according to customer requirements.

4. Used equipment on test

	Description	Manufacturer	Model Name	Serial Name	Next Cal.
■	TEMP & HUMID CHAMBER	JFM	JFMA-001	20200929-01	2022.12.17
■	CONTROLLER	AMWON TECHNOLOGY	TEMI2500	S7800VK191 0707	2022.12.17
■	PSA SERIES SPECTRUM ANALYZER	AGILENT	E4440A	MY45304057	2022.12.15
■	MXG ANALOG SIGNAL GENERATOR	AGILENT	N5183A	MY50141890	2022.12.15
■	SYSTEM DC POWER SUPPLY	AGILENT	6674A	MY53000118	2022.12.15
□	VECTOR SIGNAL GENERATOR	ROHDE & SCHWARZ	SMBV100A	257524	2022.12.15
□	BLUETOOTH TESTER	TESCOM	TC-3000A	3000A480088	2022.12.15
□	DIRECTIONAL COUPLER	AGILENT	773D	2839A01855	2022.12.15
□	ATTENUATOR	AGILENT	8493C	73193	2022.12.15
■	ATTENUATOR	ACE RF COMM	ATT SMA 20W 20dB 8GHz	A-0820.SM20.2	2023.04.11
□	TERMINATIOM	HEWLETT PACKARD	909D	07492	2022.12.15
□	POWER DIVIDER	HEWLETT PACKARD	11636A	06916	2022.12.15
□	SLIDE-AC	DAEKWANG TECH	SV-1023	-	-
□	DIGITAL MULTIMETER	HUMANTECHSTORE	15B+	50561541WS	2022.12.15
■	ACTIVE LOOP ANTENNA	TESEQ	HLA 6121	55685	2022.12.30
■	Biconilog ANT	Schwarzbeck	VULB 9160	3260	2023.02.03
□	Biconilog ANT	Schwarzbeck	VULB9168	902	2023.01.14
■	Horn Ant.	Schwarzbeck	BBHA9120D	974	2023.01.08
□	Horn Ant.	S/B	BBHA9120D	1497	2023.01.25
■	Amplifier	TESTEK	TK-PA18H	200104-L	2023.03.17
■	EMI TEST RECEIVER	ROHDE& SCHWARZ	ESW44	101952	2023.04.07
□	PROGRAMMABLE DC POWER SUPPLY	ODA	OPE-305Q	oda-01-09-23-1831	2023.01.10
□	DC POWER SUPPLY	AGILENT	E3634A	MY40012120	2023.02.03
■	POWER SENSOR	AGILENT	U2001H	MY51140028	2023.02.19
■	Test Receiver	ROHDE & SCHWARZ	ESR7	101616	2023.06.28
■	LISN	ROHDE & SCHWARZ	ENV216	100409	2023.01.10
■	PULSE LIMITER	lignex1	EPL-30	NONE	2023.01.24

5. Antenna Requirement

According to §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.

According to §15.247(b)(4) e conducted output power limit specified in paragraph (b) of this section is based on the use of antennas with directional gains that do not exceed 6 dBi. Except as shown in paragraph (c) of this section, if transmitting antennas of directional gain greater than 6 dBi are used, the conducted output power from the intentional radiator shall be reduced below the stated values in paragraphs (b)(1), (b)(2), and (b)(3) of this section, as appropriate, by the amount in dB that the directional gain of the antenna exceeds 6 dBi.

5.1 Result

Complies
(The transmitter has a Chip Antenna. The directional peak gain of the antenna is 0.3 dBi.)

6. 20 dB Bandwidth & Occupied Bandwidth (99%)

6.1 Test Setup

Refer to the APPENDIX I.

6.2 Limit

Limit : Not Applicable

6.3 Test Procedure

1. The 20 dB bandwidth & Occupied bandwidth were measured with a spectrum analyzer connected to RF antenna Connector (conducted measurement) while EUT was operating in transmit mode. The analyzer center frequency was set to the EUT carrier frequency, using the analyzer.

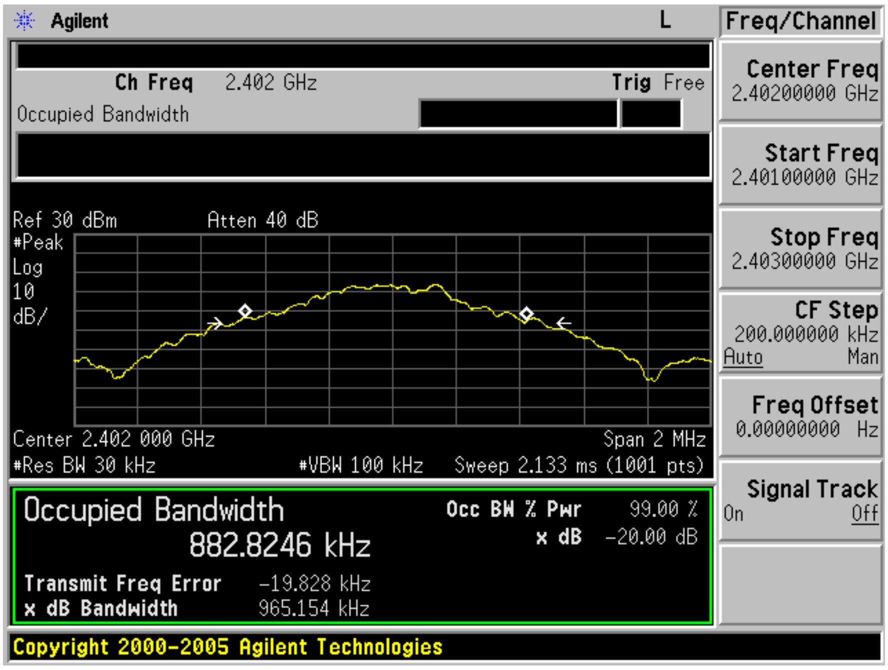
2. The bandwidth of the fundamental frequency was measured with the spectrum analyzer using below setting:
   RBW = 1% to 5% of the 20 dB Bandwidth & Occupied Bandwidth
   VBW ≥ 3 × RBW
   Span = between two times and five times the 20 dB Bandwidth & Occupied Bandwidth
   Sweep = Auto
   Detector function = Peak
   Trace = Max Hold

6.4 Test Result

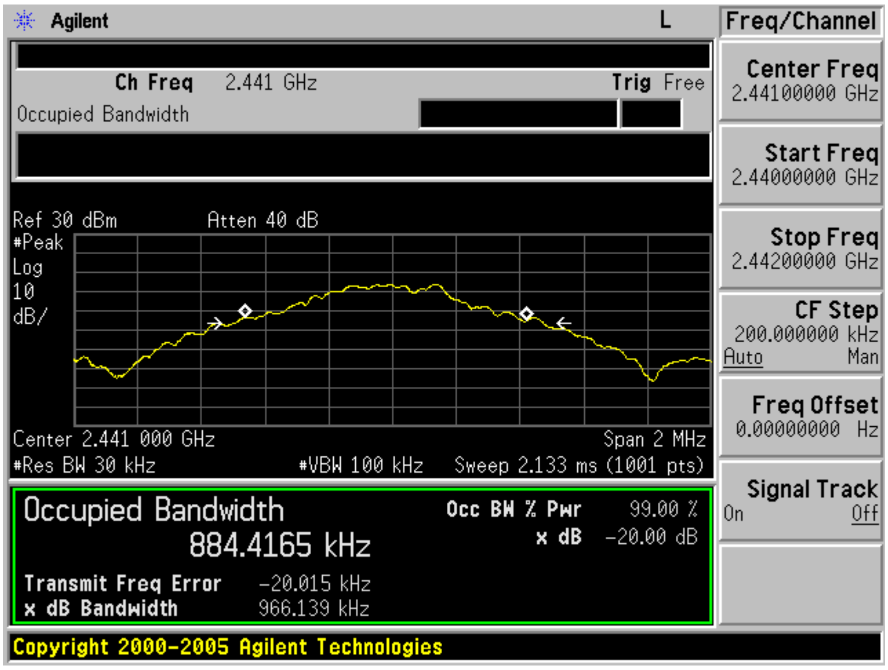
Test Mode	Test Frequency	20 dB Bandwidth (MHz)	Occupied Bandwidth (MHz)
GFSK	Low	0.965	0.883
	Middle	0.966	0.884
	High	0.965	0.883
8DPSK	Low	1.272	1.152
	Middle	1.275	1.154
	High	1.273	1.157

6.5 Test Plot

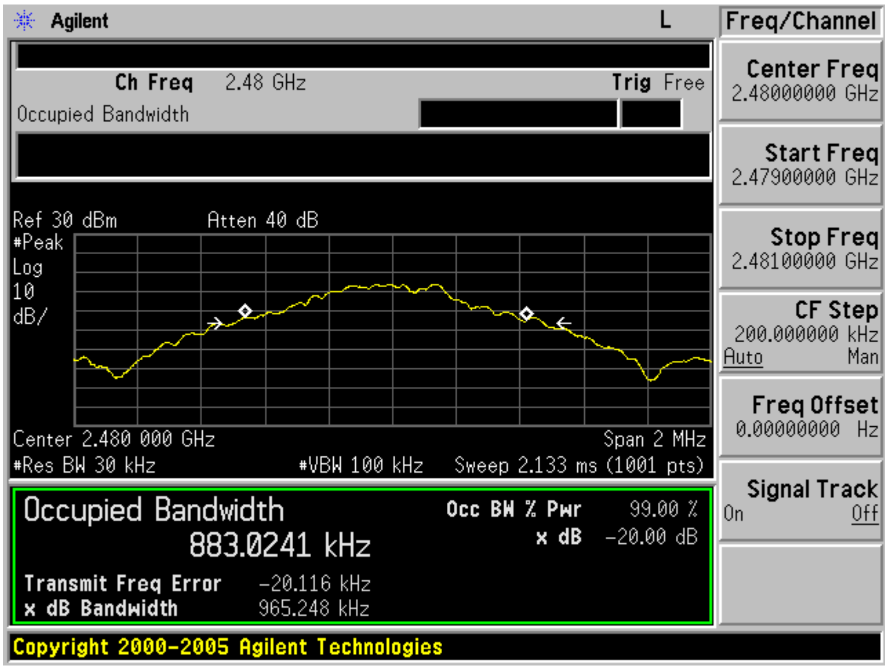
GFSK _ Low frequency	20 dB Bandwidth & Occupied Bandwidth



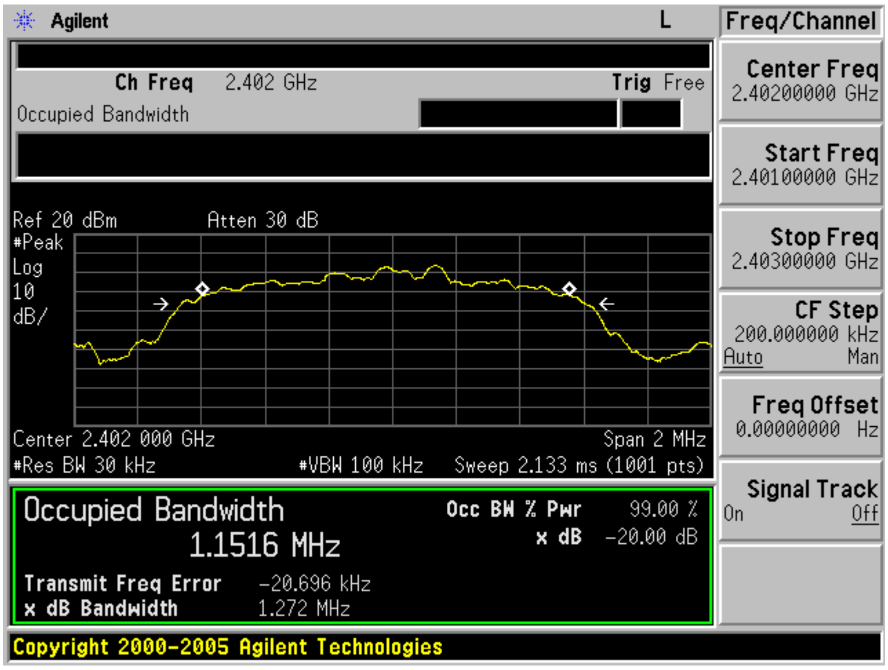
GFSK _ Middle frequency	20 dB Bandwidth & Occupied Bandwidth



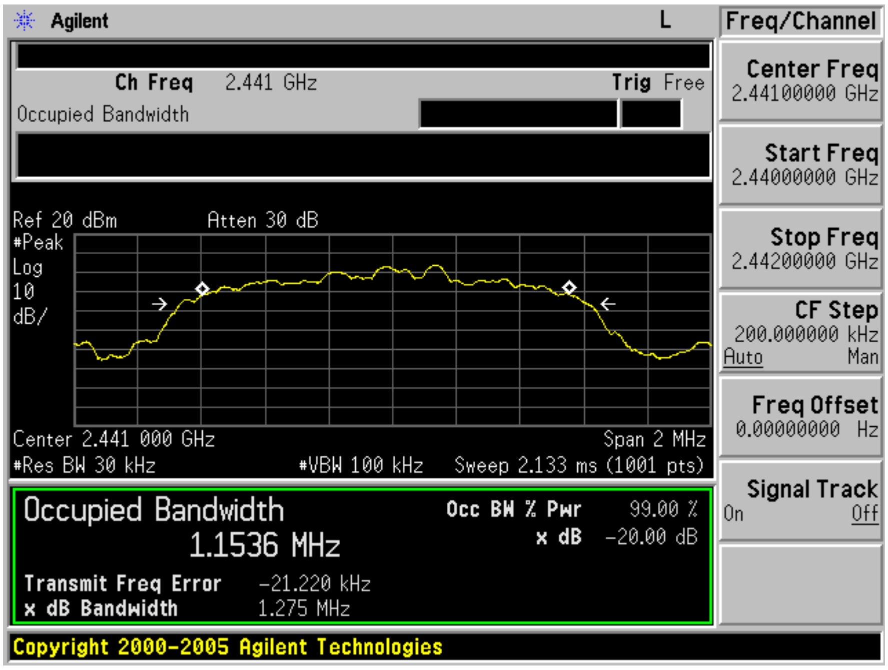
GFSK _ High frequency	20 dB Bandwidth & Occupied Bandwidth



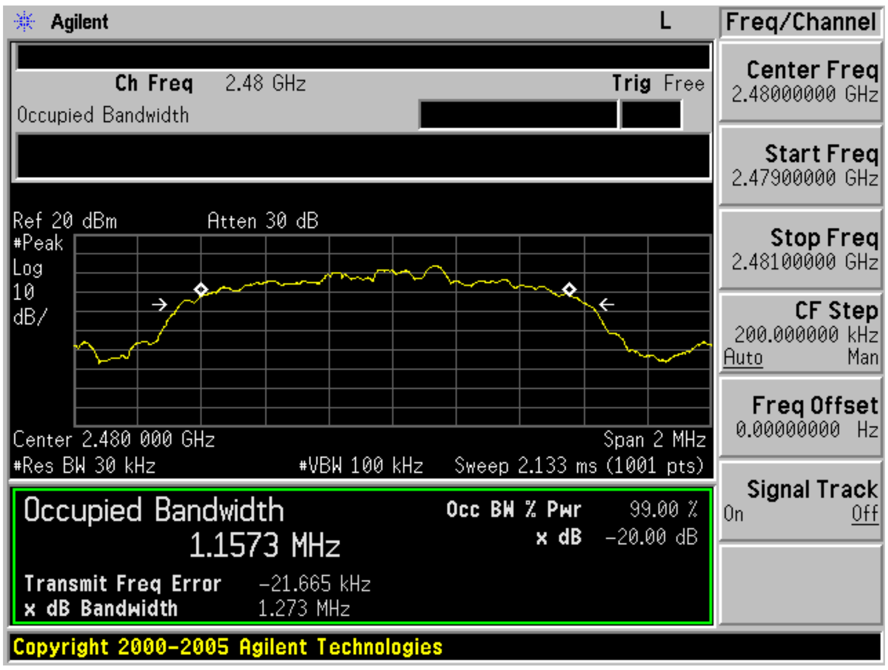
8DPSK _ Low frequency	20 dB Bandwidth & Occupied Bandwidth



8DPSK _ Middle frequency	20 dB Bandwidth & Occupied Bandwidth



8DPSK _ High frequency	20 dB Bandwidth & Occupied Bandwidth



7. Number of Hopping Frequencies

7.1 Test Setup

Refer to the APPENDIX I.

7.2 Limit

Limit : >= 15 hops

7.3 Test Procedure

The number of hopping frequencies was measured with a spectrum analyzer connected to the antenna terminal, while EUT had its hopping function enabled.
To get higher resolution, two frequency ranges for FH mode within the 2400 ~ 2483.5 MHz were examined.

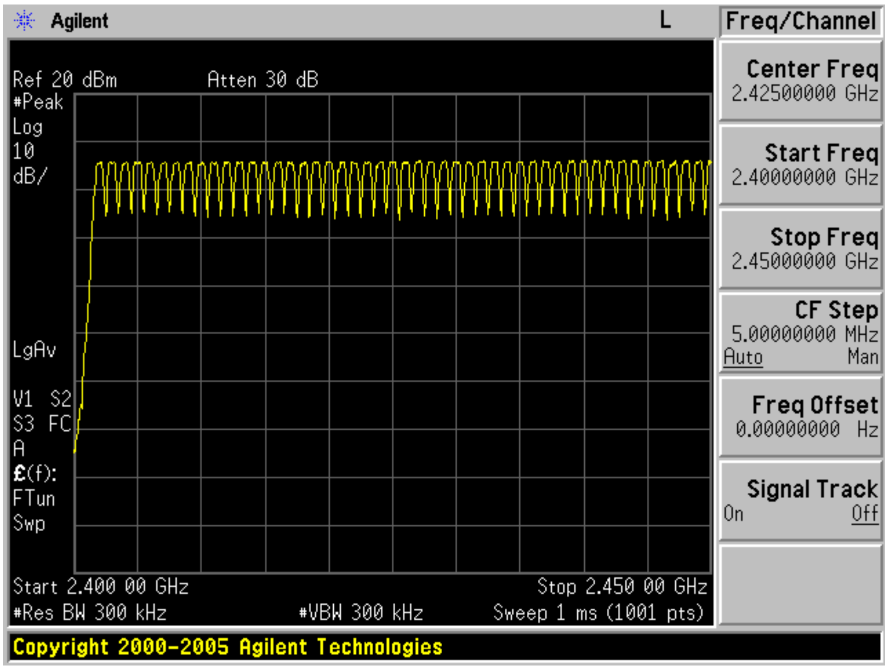
The spectrum analyzer is set to:
Span = 50 MHz
RBW = To identify clearly the individual channels, set the RBW to less than 30% of the channel spacing or the 20 dB bandwidth, whichever is smaller.
VBW ≥ RBW
Sweep = Auto
Detector = Peak
Trace = Max hold

7.4 Test Result

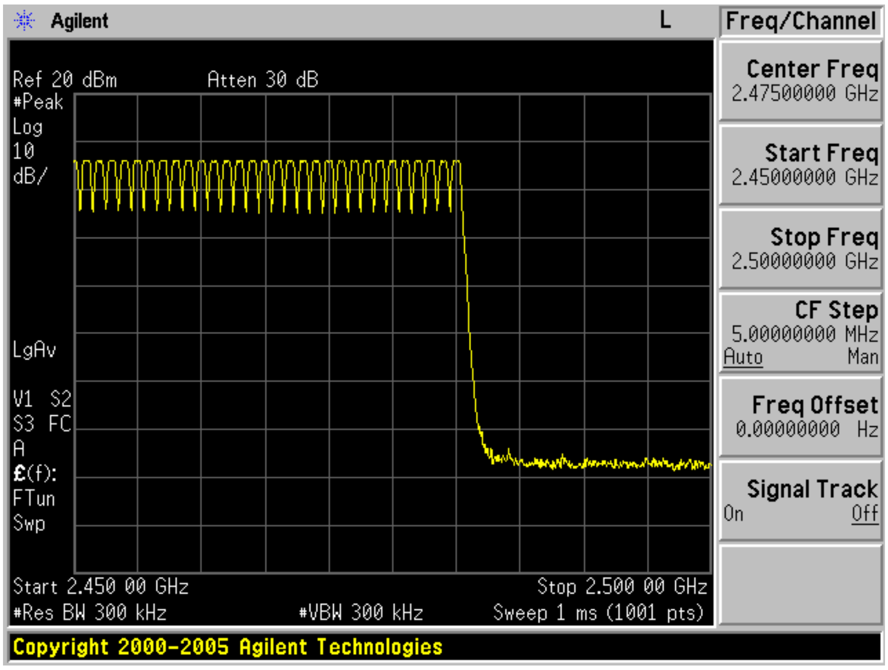
Test Mode	Number of Hopping Channels
GFSK	79
8DPSK	79

7.5 Test Plot

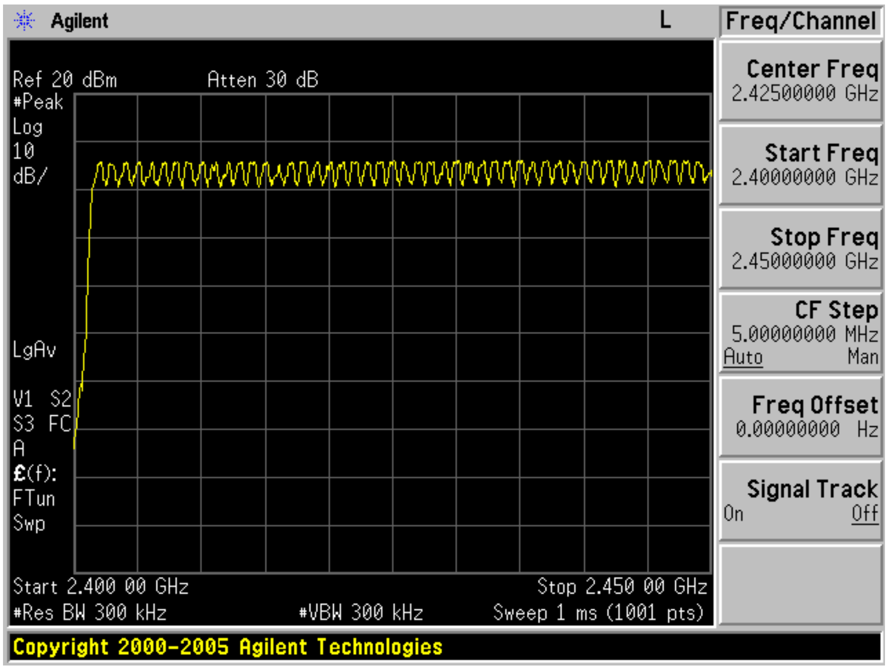
GFSK _ Hopping Mode	Number of Hopping Frequencies



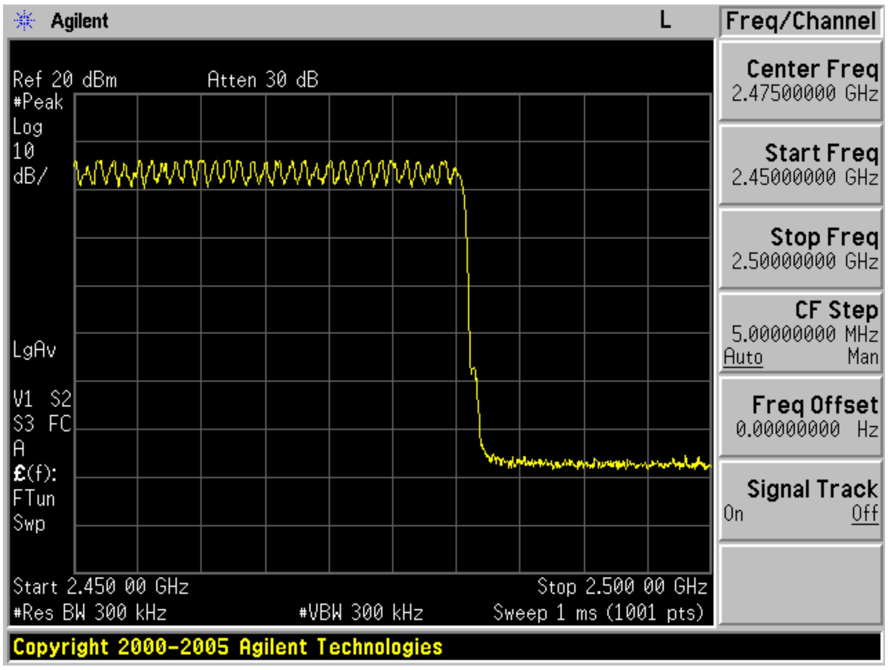
GFSK _ Hopping Mode	Number of Hopping Frequencies



8DPSK _ Hopping Mode	Number of Hopping Frequencies



8DPSK _ Hopping Mode	Number of Hopping Frequencies



8. Time of Occupancy (Dwell Time)

8.1 Test Setup

Refer to the APPENDIX I.

8.2 Limit

The maximum permissible time of occupancy is 400 ms within a period of 400 ms multiplied by the number of hopping channels employed.

8.3 Test Procedure

The dwell time was measured with a spectrum analyzer connected to the antenna terminal, while EUT had its hopping function enabled.

The spectrum analyzer is set to:
Center frequency = 2441 MHz Span = Zero
RBW = 1 MHz (RBW shall be ≤ channel spacing and where possible RBW should be set >> 1 / T, where T is the expected dwell time per channel)
VBW ≥ RBW Detector = Peak
Trace = Max hold

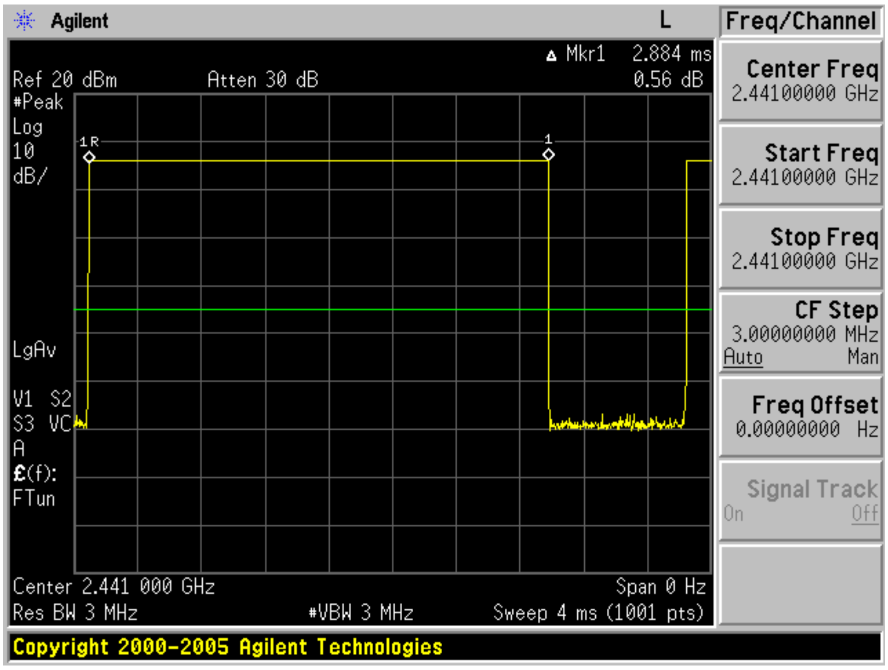
8.4 Test Result

Test Mode	Number of Hopping Channels	Burst On Time (ms)	Result (sec)	Limit (sec)
GFSK (non-AFH)	79	2.884	0.31	0.40
GFSK (AFH)	20	2.884	0.15	0.40
8DPSK (non-AFH)	79	2.875	0.31	0.40
8DPSK (AFH)	20	2.875	0.15	0.40

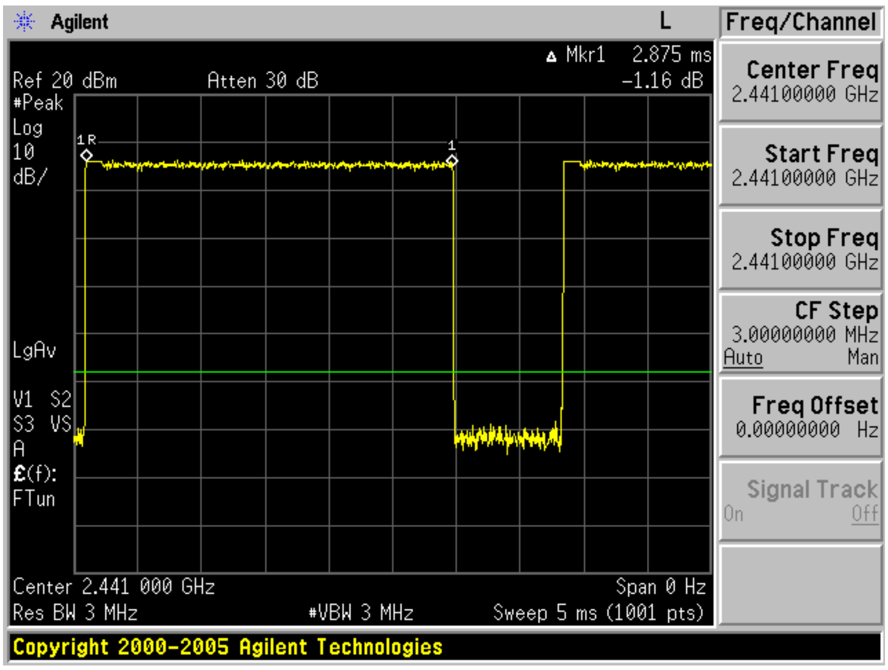
Note: Dwell Time = 0.4 x Hopping channel x Burst On Time x ((Hopping rate / Time slots) / Hopping channel)
- Time slots for DH5 = 6 slots (TX = 5 slot / RX = 1 slot)
- Hopping Rate = 1600 for FH mode & 800 for AFH mode

8.5 Test Plot

GFSK	Time of Occupancy



8DPSK	Time of Occupancy



9. Carrier Frequencies Separation

9.1 Test Setup

Refer to the APPENDIX I.

9.2 Limit

Limit : ≥ 25 kHz or ≥ Two-Thirds of the 20 dB Bandwidth whichever is greater.

9.3 Test Procedure

The carrier frequency separation was measured with a spectrum analyzer connected to the antenna terminal, while EUT had its hopping function enabled.
After the trace being stable, the reading value between the peaks of the adjacent channels using the marker delta function was recorded as the measurement results.

The spectrum analyzer is set to:
Span = wide enough to capture the peaks of two adjacent channels
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.
VBW ≥ RBW
Sweep = Auto
Detector = Peak
Trace = Max hold

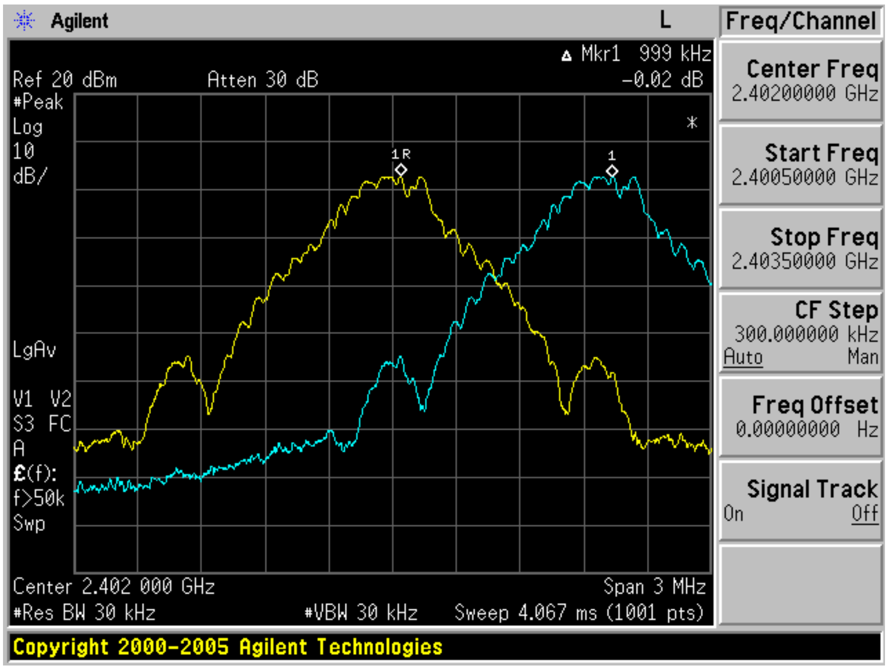
9.4 Test Result

Test Mode	Test Frequency	Carrier Frequencies Separation (MHz)	Min. Limit (MHz)
GFSK	Low	0.999	0.643
	Middle	0.999	0.644
	High	1.002	0.643
8DPSK	Low	1.002	0.848
	Middle	0.999	0.850
	High	1.002	0.849

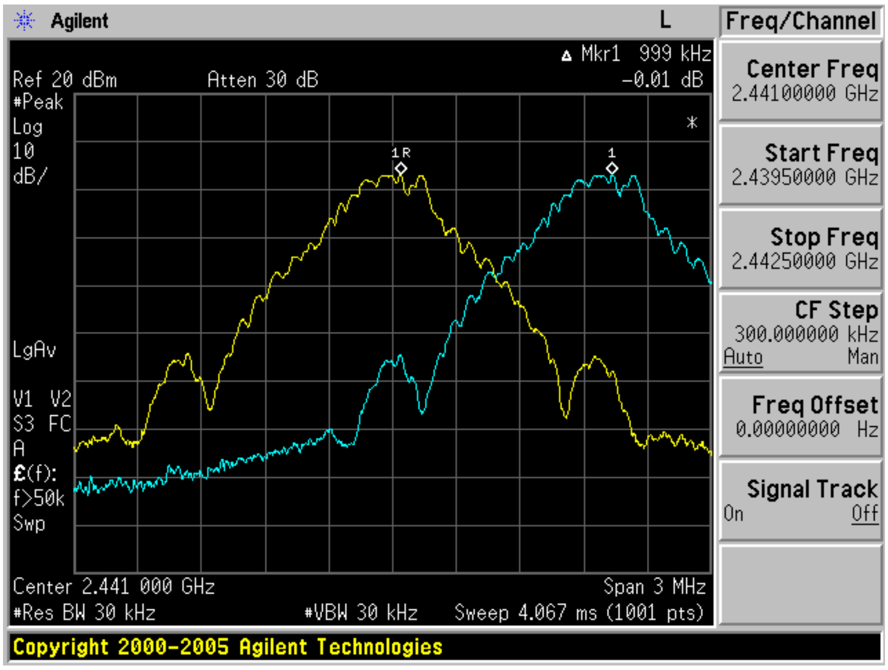
Note: Limit(kHz) = Test Result of 20 dB BW * 2/3

9.5 Test Plot

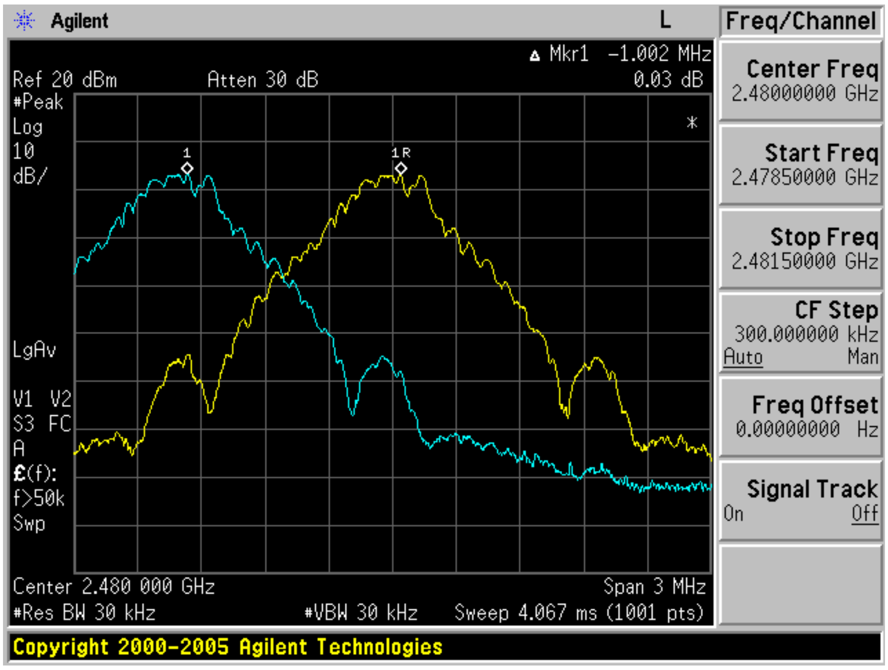
GFSK _ Low frequency	Carrier Frequency Separation



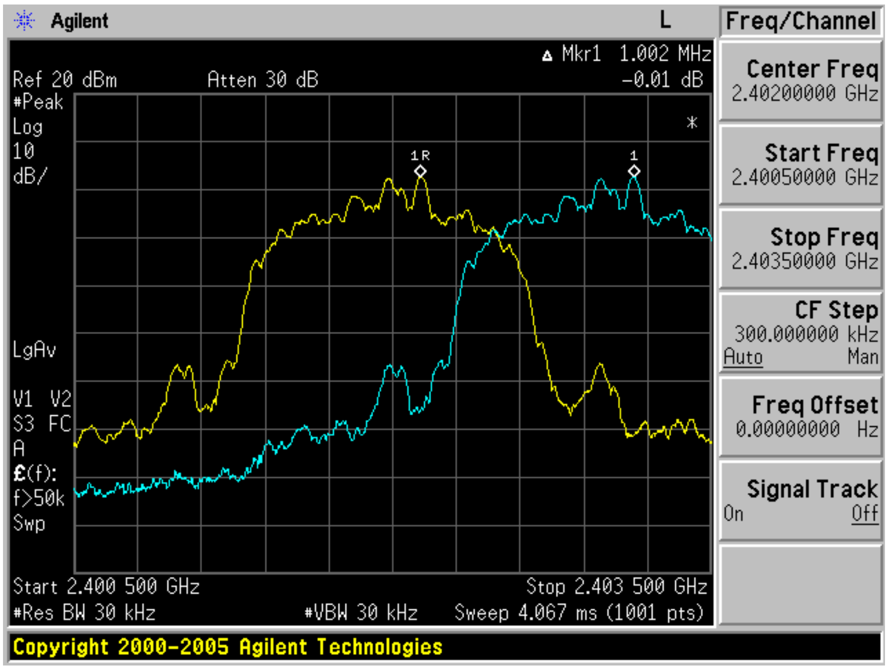
GFSK _ Middle frequency	Carrier Frequency Separation



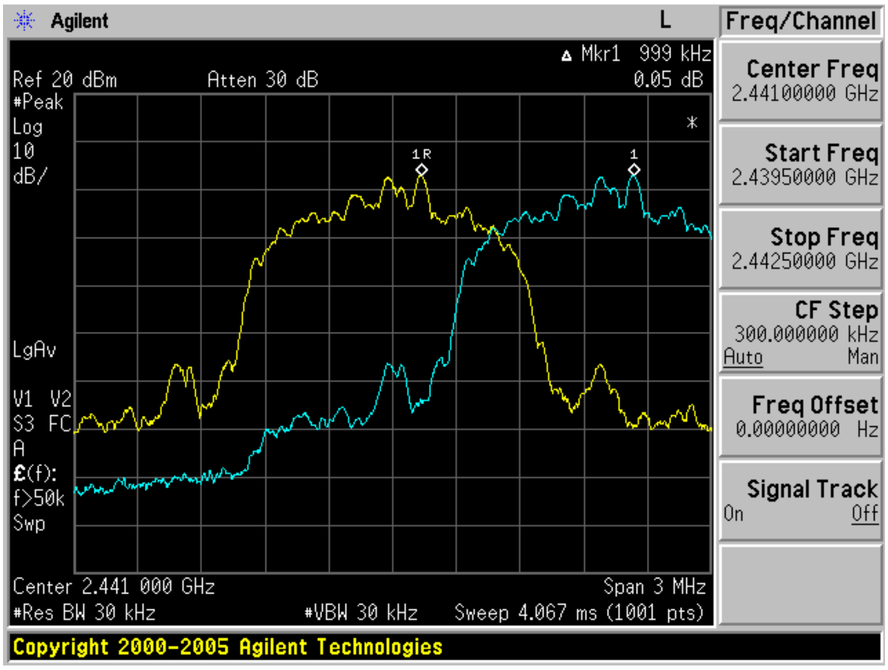
GFSK _ High frequency	Carrier Frequency Separation



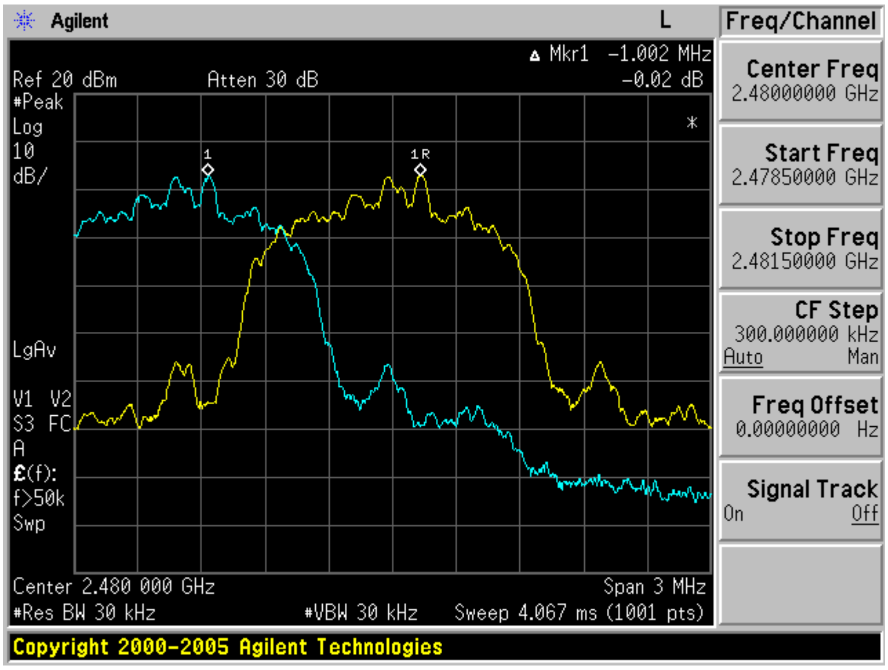
8DPSK _ Low frequency	Carrier Frequency Separation



8DPSK _ Middle frequency	Carrier Frequency Separation



8DPSK _ High frequency	Carrier Frequency Separation



10. Peak Output Power

10.1 Test Setup

Refer to the APPENDIX I.

10.2 Limit

■ FCC Requirements

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. Alternatively, frequency hopping systems operating in the 2400-2483.5 MHz band may have hopping channel carrier frequencies that are separated by 25 kHz or two-thirds of the 20 dB bandwidth of the hopping channel, whichever is greater, provided the systems operate with an output power no greater than 125 mW.
2. §15.247(b)(1), For frequency hopping systems operating in the 2400 – 2483.5 MHz employing at least 75 non-overlapping hopping channels, and all frequency hopping systems in the 5725 – 5805 MHz band: 1 Watt. For all other frequency hopping systems in the 2400-2483.5 MHz band: 0.125 watts.

■ IC Requirements

1. RSS-247(5.4) (b), For FHSS operating in the band 2400 – 2483.5 MHz, the maximum peak conducted output power shall not exceed 1.0 W if the hopset uses 75 or more hopping channels, the maximum peak conducted output power shall not exceed 0.125 W if the hopset uses less than 75 hopping channels. The e.i.r.p shall not exceed 4 W, except as provided in section 5.4(e)

10.3 Test Procedure

1. The RF output power was measured with a spectrum analyzer connected to the RF Antenna connector (conducted measurement) while EUT was operating in transmit mode at the appropriate center frequency, a spectrum analyzer was used to record the shape of the transmit signal.
2. The peak output power of the fundamental frequency was measured with the spectrum analyzer using;

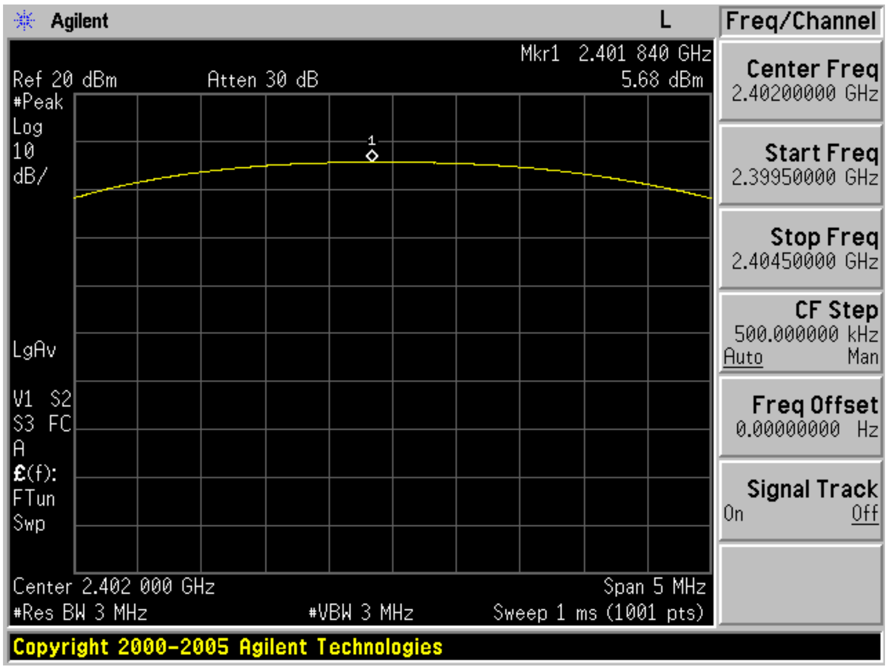
   Span = approximately 5 times of the 20 dB bandwidth, centered on a hopping channel
   RBW ≥ 20 dB Bandwidth
   VBW ≥ RBW
   Sweep = Auto
   Detector function = Peak
   Trace = Max Hold

10.4 Test Result

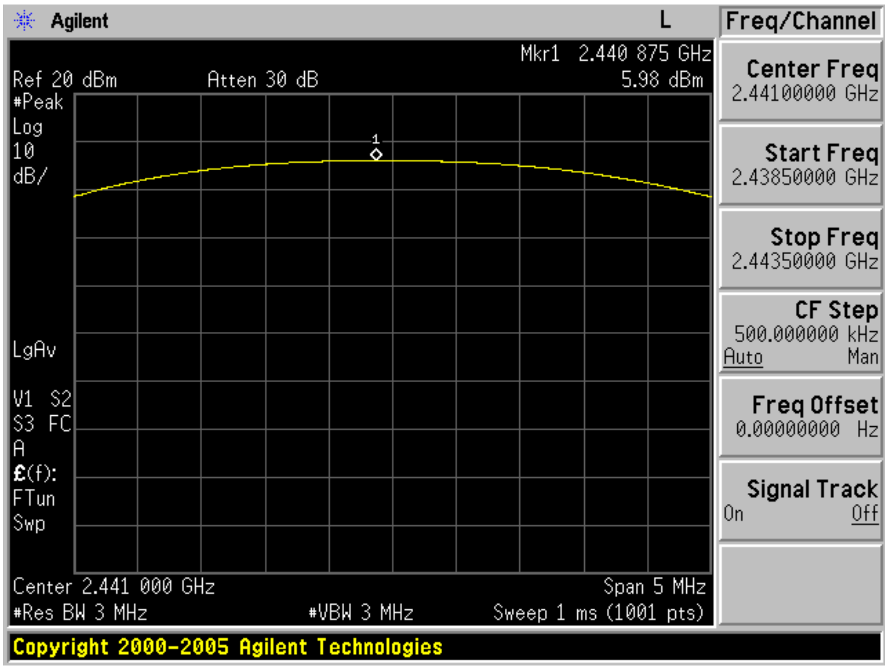
Test Mode	Test Frequency	Peak Output Power	
		dBm	mW
GFSK	Low	5.68	3.70
	Middle	5.98	3.96
	High	6.02	4.00
Pi/4 DQPSK	Low	5.66	3.68
	Middle	5.98	3.96
	High	6.02	4.00
8DPSK	Low	5.84	3.84
	Middle	6.14	4.11
	High	6.17	4.14

10.5 Test Plot

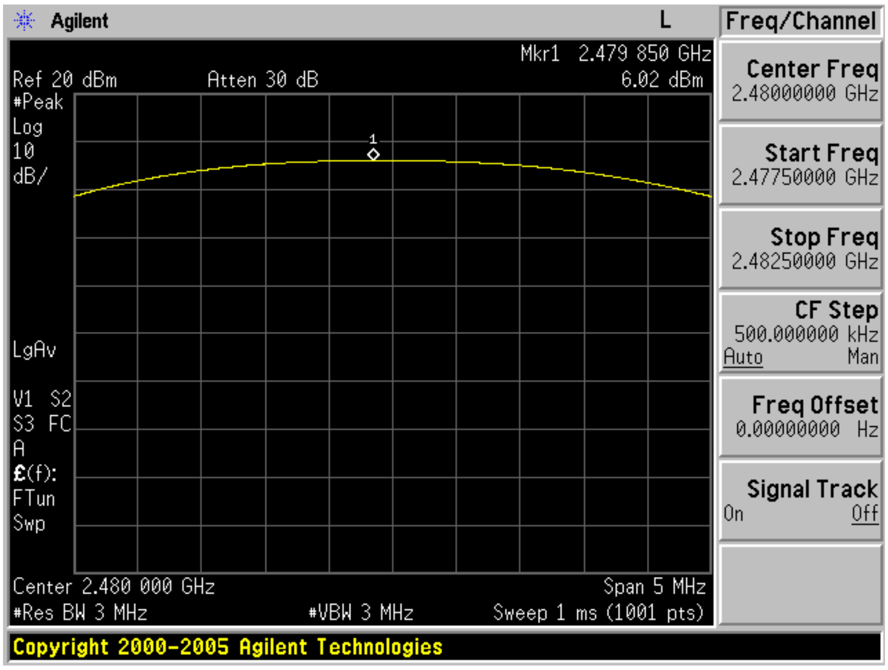
GFSK _ Low frequency	Peak Output Power



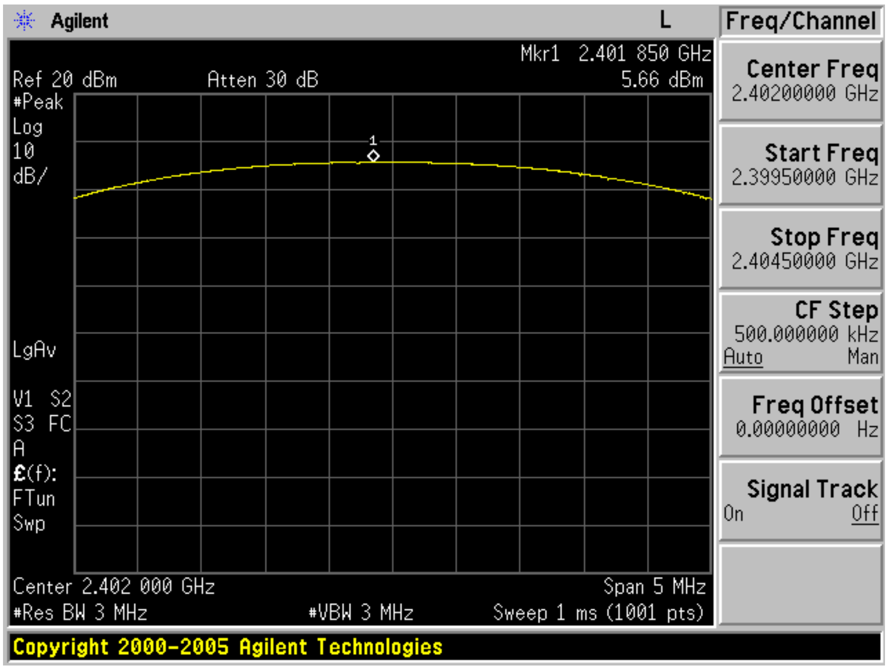
GFSK _ Middle frequency	Peak Output Power



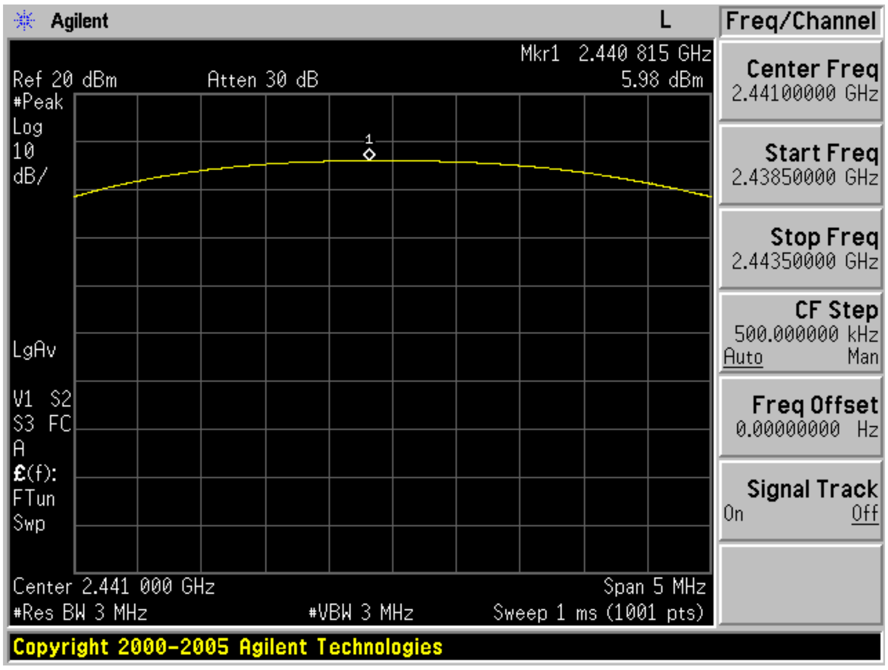
GFSK _ High frequency	Peak Output Power



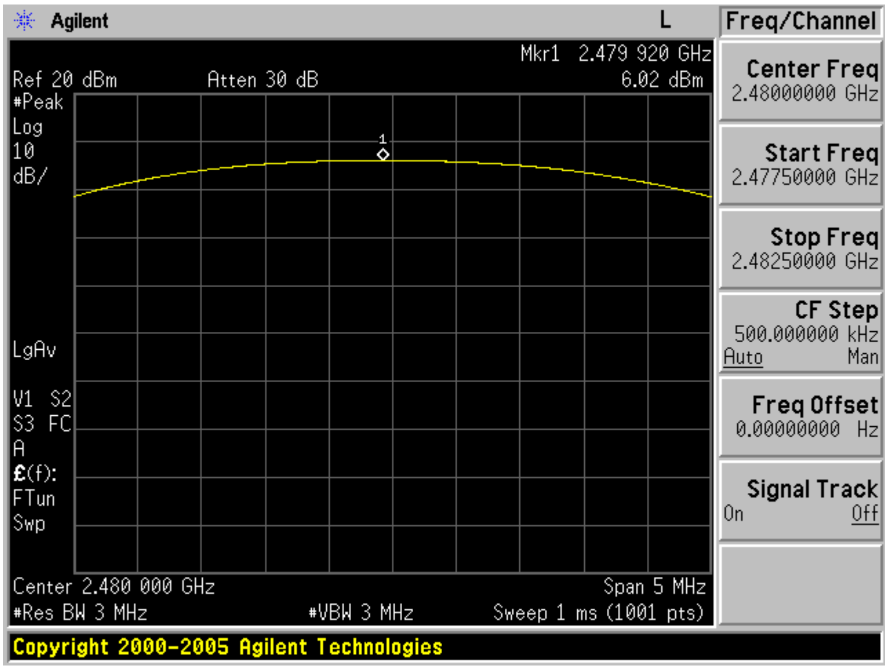
Pi/4 DQPSK _ Low frequency	Peak Output Power



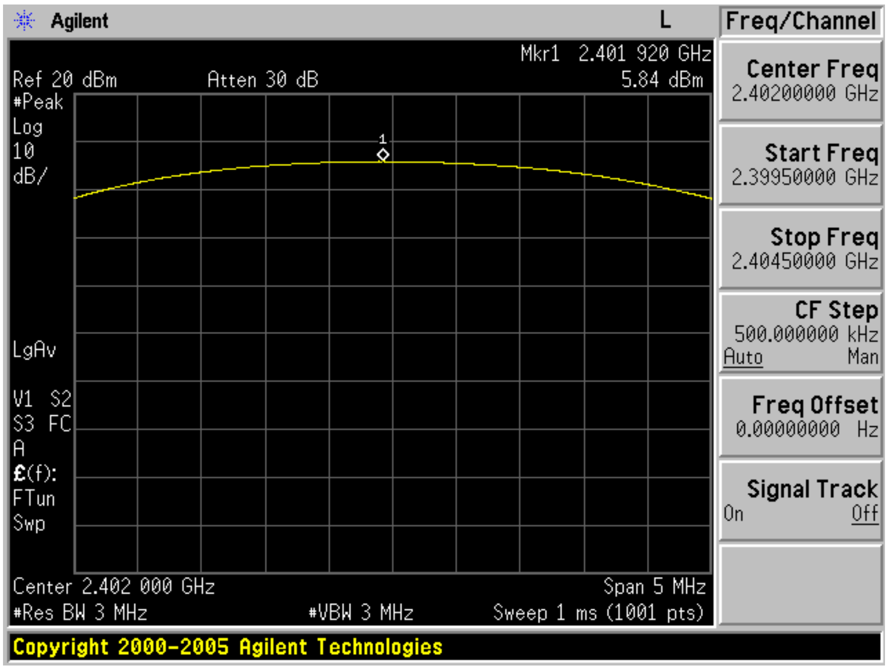
Pi/4 DQPSK _ Middle frequency	Peak Output Power



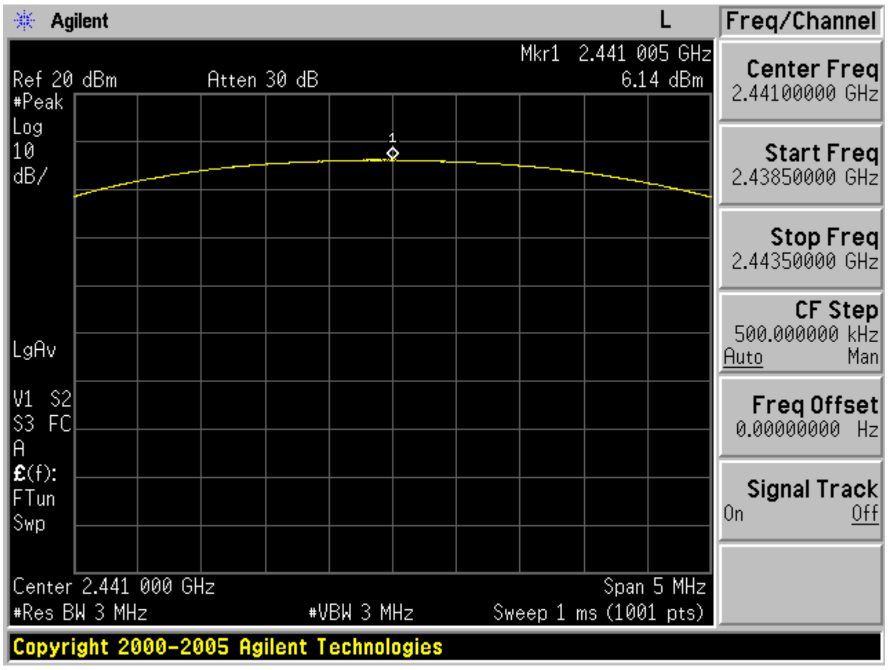
Pi/4 DQPSK _ High frequency	Peak Output Power



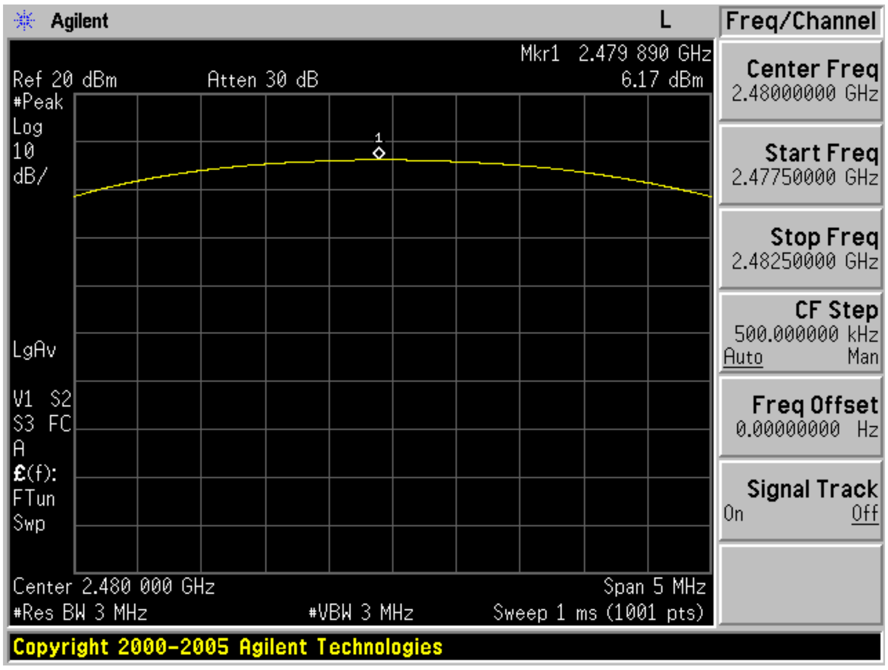
8DPSK _ Low frequency	Peak Output Power



8DPSK _ Middle frequency	Peak Output Power



8DPSK _ High frequency	Peak Output Power



11. TX Radiated Spurious Emission and Conducted Spurious Emission

11.1 Test Setup

Refer to the APPENDIX I.

11.2 Limit

According to §15.247(d), 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, 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 dB instead of 20 dB. Attenuation below the general limits specified in section §15.209(a) is not required. In addition, radiated emission which in the restricted band, as define in section §15.205(a), must also comply the radiated emission limits specified in section §15.209(a) (see section §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 (MHz)	Limit (uV/m)	Measurement Distance (meter)
0.009 ~ 0.490	2400/F (kHz)	300
0.490 ~ 1705	24000/F (kHz)	30
1705 ~ 30.0	30	30
30 ~ 88	100 **	3
88 ~ 216	150 **	3
216 ~ 960	200 **	3
Above 960	500	3

** Except as provided in 15.209(g), fundamental emissions from intentional radiators operating under this Section shall not be located in the frequency bands 54 – 72 MHz, 76 – 88 MHz, 174 – 216 MHz or 470 – 806 MHz. However, operation within these frequency bands is permitted under other sections of this Part, e.g. 15.231 and 15.241.

According to § 15.205(a) and (b), only spurious emissions are permitted in any of
The frequency bands listed below:

MHz	MHz	MHz	GHz
0.009 ~ 0.110	16.42 ~ 16.423	399.90 ~ 410	4.5 ~ 5.15
0.495 ~ 0.505	16.69475 ~ 16.69525	608 ~ 614	5.35 ~ 5.46
2.1735 ~ 2.1905	16.80425 ~ 16.80475	960 ~ 1240	7.25 ~ 7.75
4.125 ~ 4.128	25.5 ~ 25.67	1300 ~ 1427	8.025 ~ 8.5
4.17725 ~ 4.17775	37.5 ~ 38.	1435 ~ 1626.5	9.0 ~ 9.2
4.20725 ~ 4.20775	25 73 ~ 74.6	1645.5 ~ 1646.5	9.3 ~ 9.5
4.17725 ~ 4.17775	74.8 ~ 75.2	1660 ~ 1710	10.6 ~ 12.7
6.215 ~ 6.218	108 ~ 121.94	1718.8 ~ 1722.2	13.25 ~ 13.4
6.26775 ~ 6.26825	149.9 ~ 150.05	2200 ~ 2300	14.47 ~ 14.5
6.31175 ~ 6.31225	156.52475 ~ 156.52525	2310 ~ 2390	15.35 ~ 16.2
8.291 ~ 8.294	156.7 ~ 156.9	2483.5 ~ 2500	17.7 ~ 21.4
8.362 ~ 8.366	162.0125 ~ 167.17	2690 ~ 2900	22.01 ~ 23.12
8.37625 ~ 8.38675	3345.8 ~ 3358	3260 ~ 3267	23.6 ~ 24.0
8.41425 ~ 8.41475	3600 ~ 4400	3332 ~ 3339	31.2 ~ 31.8
12.51975 ~ 12.52025	3345.8 ~ 3358	240 ~ 285	36.43 ~ 36.5
12.57675 ~ 12.57725	3600 ~ 4400	322 ~ 335.4	Above 38.6
13.36 ~ 13.41			

The field strength of emissions appearing within these frequency bands shall not exceed the limits shown in §15.209. At frequencies equal to or less than 1000 MHz, compliance with the limits in §15.209 shall be demonstrated using measurement instrumentation employing a CISPR quasi-peak detector. Above 1000 MHz, compliance with the emission limits in §15.209 shall be demonstrated based on the average value of the measured emissions. The provisions in §15.35 apply to these measurements.

11.3 Test Procedure for Radiated Spurious Emission

1. The EUT is placed on a non-conductive table. For emission measurements at or below 1 GHz, the table height is 80 cm. For emission measurements above 1 GHz, the table height is 1.5 m. The table was rotated 360 degrees to determine the position of the highest radiation.

2. During performing radiated emission below 1 GHz, 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 GHz, the EUT was set 1 or 3 meter away from the interference-receiving antenna.

3. For measurements above 1 GHz absorbers are placed on the floor between the turn table and the antenna mast in such a way so as to maximize the reduction of reflections. For measurements below 1 GHz, the absorbers are removed.

4. The antenna is a broadband 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.

5. 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.
   (The EUT was pre-tested with three axes (X, Y, Z) and the final test was performed at the worst case.)

6. The test-receiver system was set to Peak Detect Function and Specified Bandwidth with Maximum Hold Mode.

7. If the emission level of the EUT in peak mode was 10 dB lower than the limit specified, then testing could be stopped and the peak values of the EUT would be reported. Otherwise the emissions that did not have 10 dB margin would be re-tested one by one using peak, quasi-peak or average method as specified and then reported in a data sheet.

Measurement Instrument Setting

1. Frequency Range: Below 1 GHz
   RBW = 100 or 120 kHz, VBW = 3 x RBW, Detector = Peak or Quasi Peak

2. Frequency Range: Above 1 GHz
   Peak Measurement
   RBW = 1 MHz, VBW = 3 MHz, Detector = Peak, Sweep time = Auto,
   Trace mode = Max Hold until the trace stabilizes

   Average Measurement
   RBW = 1MHz, VBW ≥ 1/T, Detector = Peak, Sweep Time = Auto,
   Trace Mode = Max Hold until the trace stabilizes

11.4 Test Procedure for Conducted Spurious Emission

1. The transmitter output was connected to the spectrum analyzer.

2. The reference level of the fundamental frequency was measured with the spectrum analyzer using
   RBW = 100 kHz, VBW = 300 kHz.

3. The conducted spurious emission was tested each ranges were set as below.
   Frequency range: 30 MHz ~ 26.5 GHz
   RBW = 100 kHz, VBW = 300 kHz, Sweep Time = Auto, Detector = Peak,
   Trace = Max Hold

   LIMIT LINE = 20 dB below of the reference level of above measurement procedure Step 2. (RBW = 100 kHz, VBW = 300 kHz)

11.5 Test Result

9 kHz ~ 25 GHz Data (Modulation: GFSK)

- Low frequency

Frequency	Reading		Pol.	Factor (dB)	DCCF (dB)	Limits		Result		Margin	
	(dBuV/m)					(dBuV/m)		(dBuV/m)		(dB)	
(MHz)	AV / Peak					AV / Peak		AV / Peak		AV / Peak	
2 389.96	N/A	26.10	H	11.84	-24.78	54.0	74.0	13.2	37.9	40.8	36.1
4 803.96	N/A	41.07	H	4.30	-24.78	54.0	74.0	20.6	45.4	33.4	28.6

- Middle frequency

Frequency	Reading		Pol.	Factor (dB)	DCCF (dB)	Limits		Result		Margin	
	(dBuV/m)					(dBuV/m)		(dBuV/m)		(dB)	
(MHz)	AV / Peak					AV / Peak		AV / Peak		AV / Peak	
4 882.07	N/A	41.10	H	4.04	-24.78	54.0	74.0	20.4	45.1	33.6	28.9

- High frequency

Frequency	Reading		Pol.	Factor (dB)	DCCF (dB)	Limits		Result		Margin	
	(dBuV/m)					(dBuV/m)		(dBuV/m)		(dB)	
(MHz)	AV / Peak					AV / Peak		AV / Peak		AV / Peak	
2 483.69	N/A	31.85	H	12.21	-24.78	54.0	74.0	19.3	44.1	34.7	29.9
4 960.11	N/A	41.12	H	4.21	-24.78	54.0	74.0	20.6	45.3	33.4	28.7

Note 1: The radiated emissions were inverstigated 9 kHz to 25 GHz. And no other spurious and harmonic emissions were found above listed frequencies.
Note 2: DCCF(Duty Cycle Correction Factor)
- Time to cycle through all channels = Δt = T [ms] X 20 minimum hopping channels, where T = pulse width = 2.884 ms
- 100 ms / Δt [ms] = H -> Round up to next highest integer, to account for worst case, H' = 100 / (2.884 X 20) = 1.73 ≒ 2
- The Worst Case Dwell Time = T [ms] x H' = 2.884 ms X 2 = 5.77 ms
- DCCF = 20 x log(The Worst Case Dwell Time / 100 ms) dB = 20 x log(5.77 / 100) = -24.78 dB

Note 3: Sample Calculation.
Margin = Limit - Result / Peak Result = Peak Reading + TF / Average Result = Peak Reading + TF + DCCF
TF = Ant factor + Cable Loss + Filter Loss - Amp Gain

9 kHz ~ 25 GHz Data (Modulation: 8DPSK)

- Low frequency

Frequency (MHz)	Reading (dBuV/m) AV	Reading (dBuV/m) Peak	Pol.	Factor (dB)	DCCF (dB)	Limits (dBuV/m) AV	Limits (dBuV/m) Peak	Result (dBuV/m) AV	Result (dBuV/m) Peak	Margin (dB) AV	Margin (dB) Peak
2 389.56	N/A	26.55	H	11.84	-24.81	54.0	74.0	13.6	38.4	40.4	35.6
4 804.12	N/A	40.01	H	4.30	-24.81	54.0	74.0	19.5	44.3	34.5	29.7

- Middle frequency

Frequency (MHz)	Reading (dBuV/m) AV	Reading (dBuV/m) Peak	Pol.	Factor (dB)	DCCF (dB)	Limits (dBuV/m) AV	Limits (dBuV/m) Peak	Result (dBuV/m) AV	Result (dBuV/m) Peak	Margin (dB) AV	Margin (dB) Peak
4 881.82	N/A	40.58	H	4.04	-24.81	54.0	74.0	19.8	44.6	34.2	29.4

- High frequency

Frequency (MHz)	Reading (dBuV/m) AV	Reading (dBuV/m) Peak	Pol.	Factor (dB)	DCCF (dB)	Limits (dBuV/m) AV	Limits (dBuV/m) Peak	Result (dBuV/m) AV	Result (dBuV/m) Peak	Margin (dB) AV	Margin (dB) Peak
2 483.52	N/A	35.63	H	12.21	-24.81	54.0	74.0	23.0	47.8	31.0	26.2
4 960.15	N/A	40.58	H	4.21	-24.81	54.0	74.0	20.0	44.8	34.0	29.2

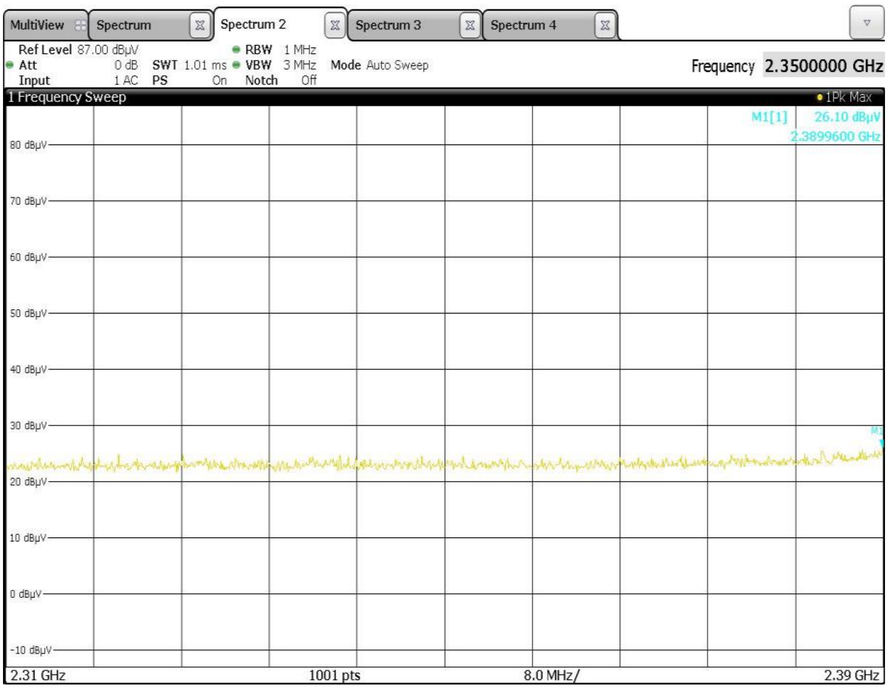
Note 1: The radiated emissions were inverstigated 9 kHz to 25 GHz.
Note 2: DCCF(Duty Cycle Correction Factor)
- Time to cycle through all channels = Δt = T [ms] X 20 minimum hopping channels, where T = pulse width = 2.875 ms
- 100 ms / Δt [ms] = H -> Round up to next highest integer, to account for worst case, H' = 100 / (2.875 X 20) = 1.74 ≒ 2
- The Worst Case Dwell Time = T [ms] x H' = 2.875 ms X 2 = 5.75 ms
- DCCF = 20 x log(The Worst Case Dwell Time / 100 ms) dB = 20 x log(5.75 / 100) = -24.81 dB

Note 3: Sample Calculation.
Margin = Limit – Result / Peak Result = Peak Reading + TF / Average Result = Peak Reading + TF + DCCF
TF = Ant factor + Cable Loss + Filter Loss – Amp Gain

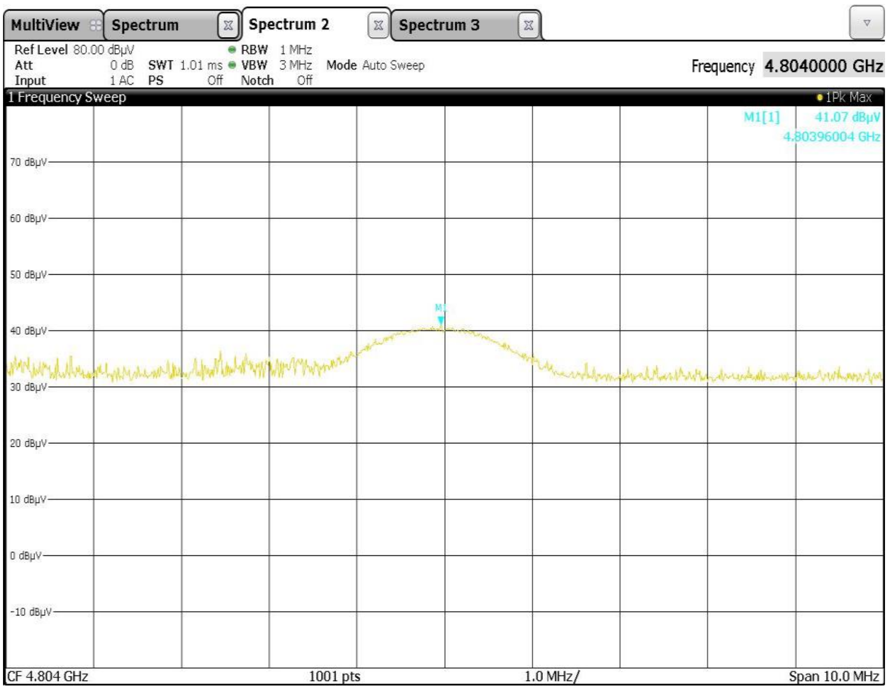
11.6 Test Plot for Radiated Spurious Emission

- GFSK _ Low frequency

Restricted Band – Peak

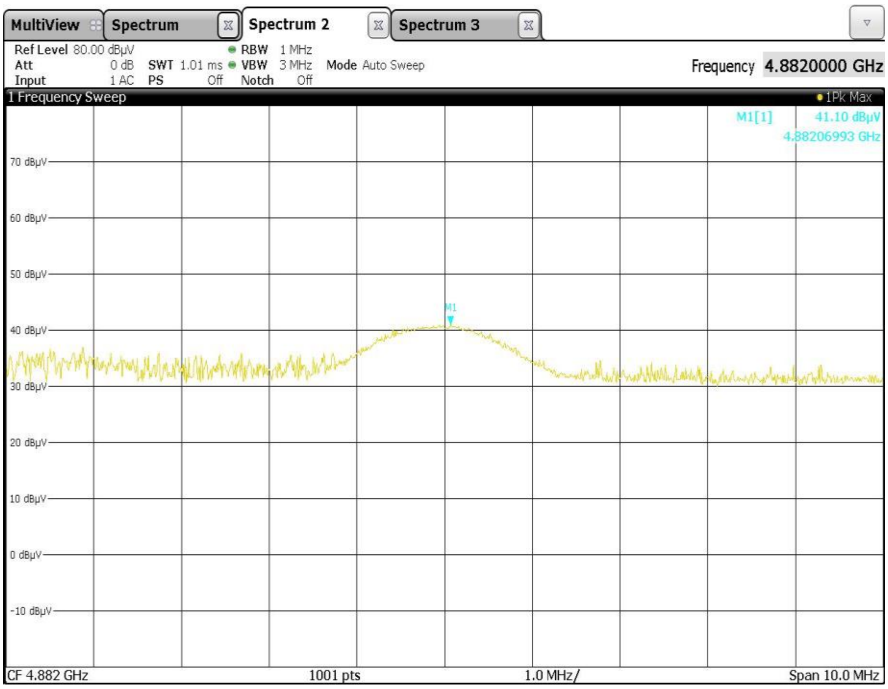


Spurious – Peak



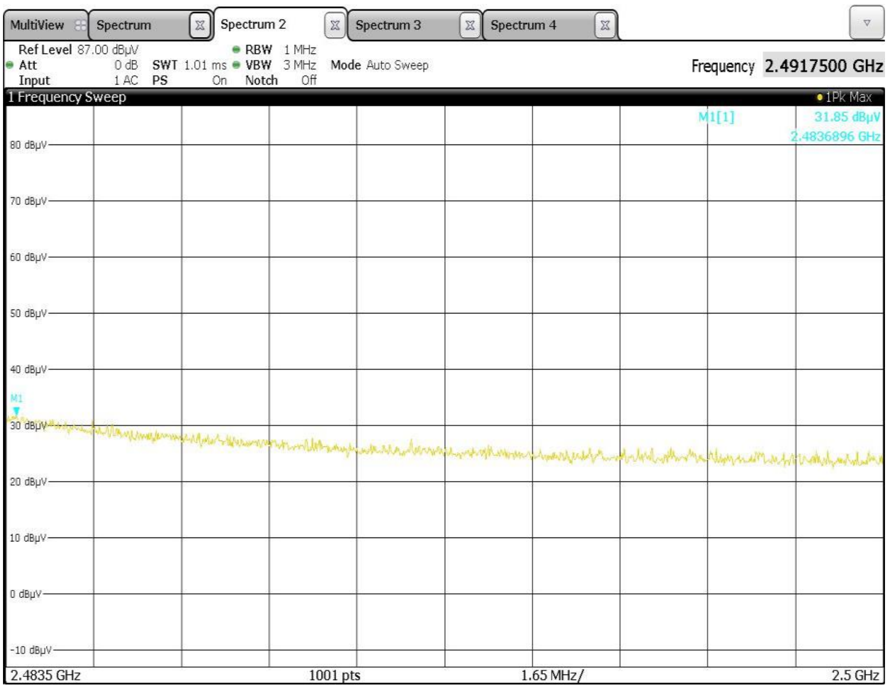
- GFSK _ Middle frequency

	Spurious – Peak

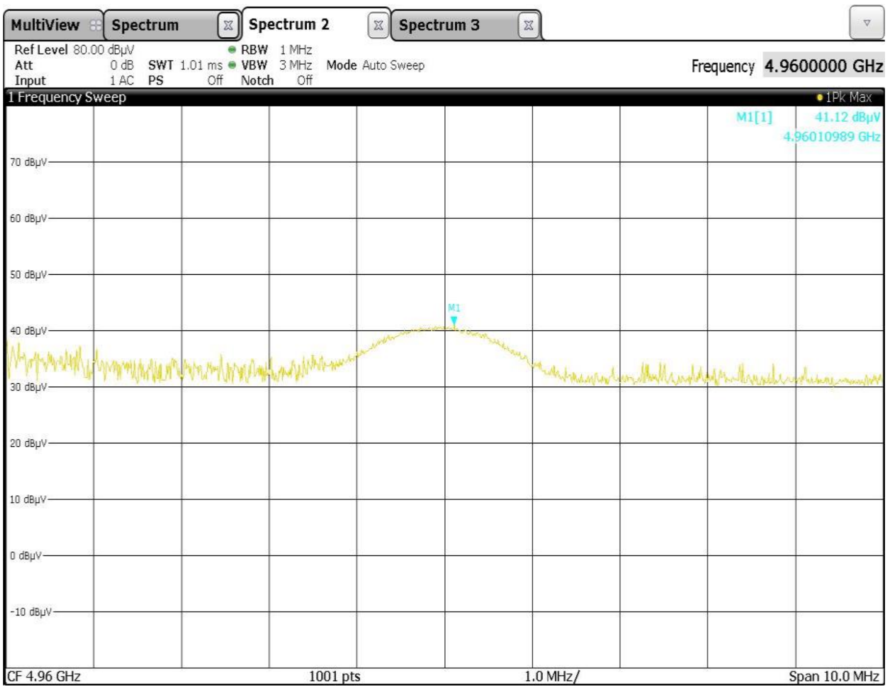


- GFSK _ High frequency

	Restricted Band – Peak

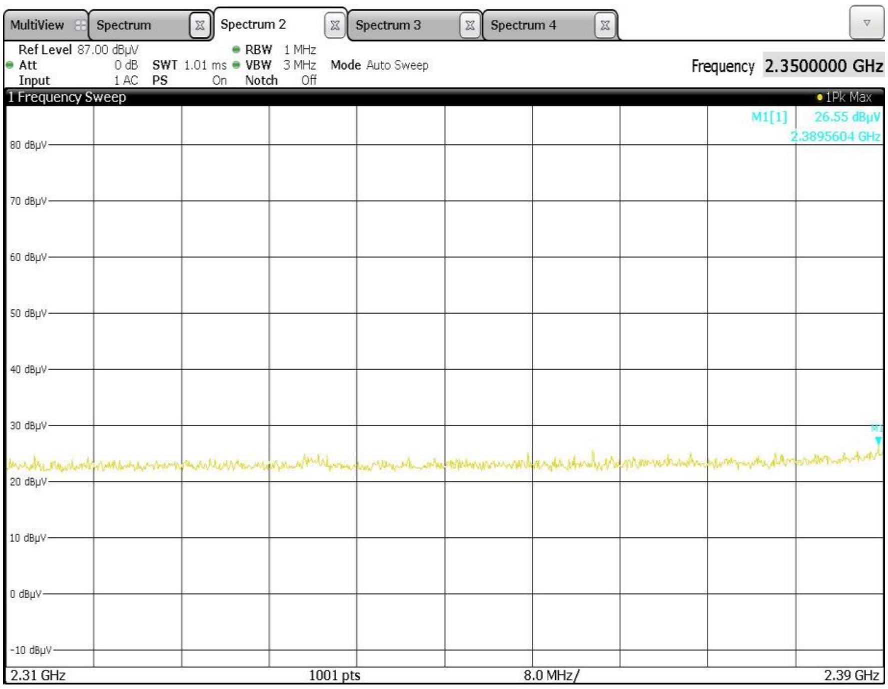


	Spurious – Peak

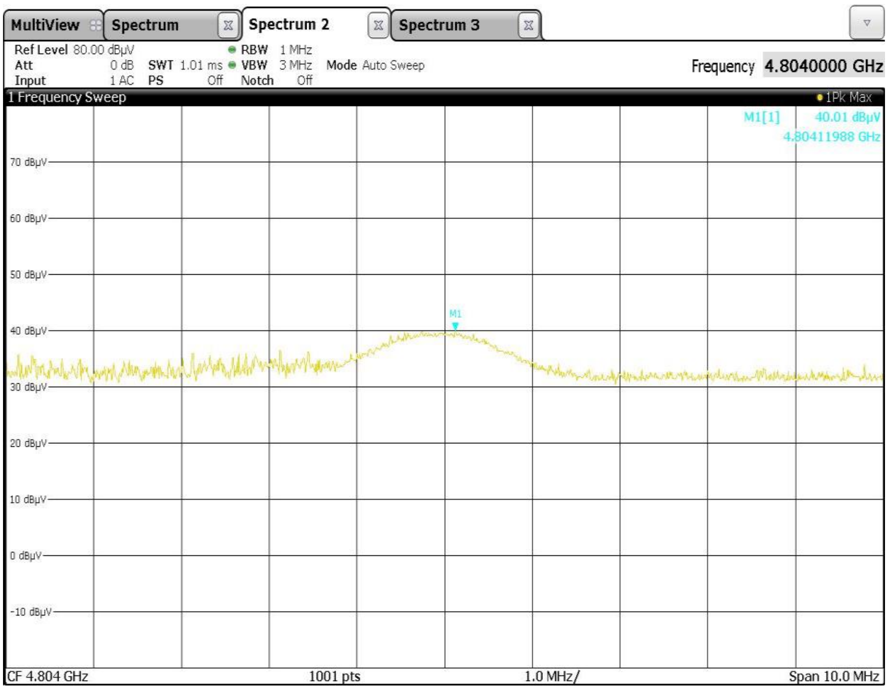


- 8DPSK _ Low frequency

	Restricted Band – Peak

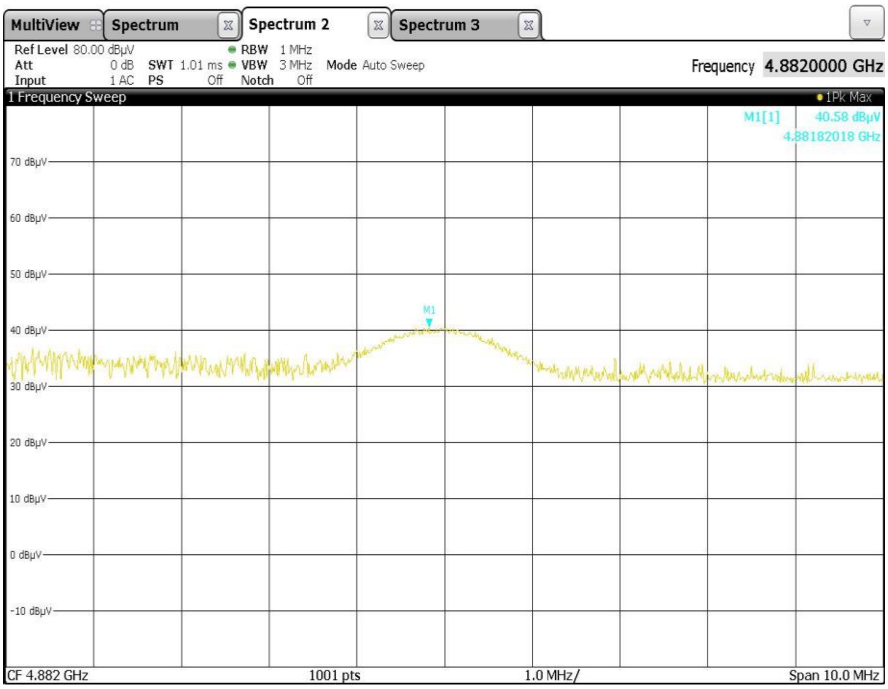


	Spurious – Peak



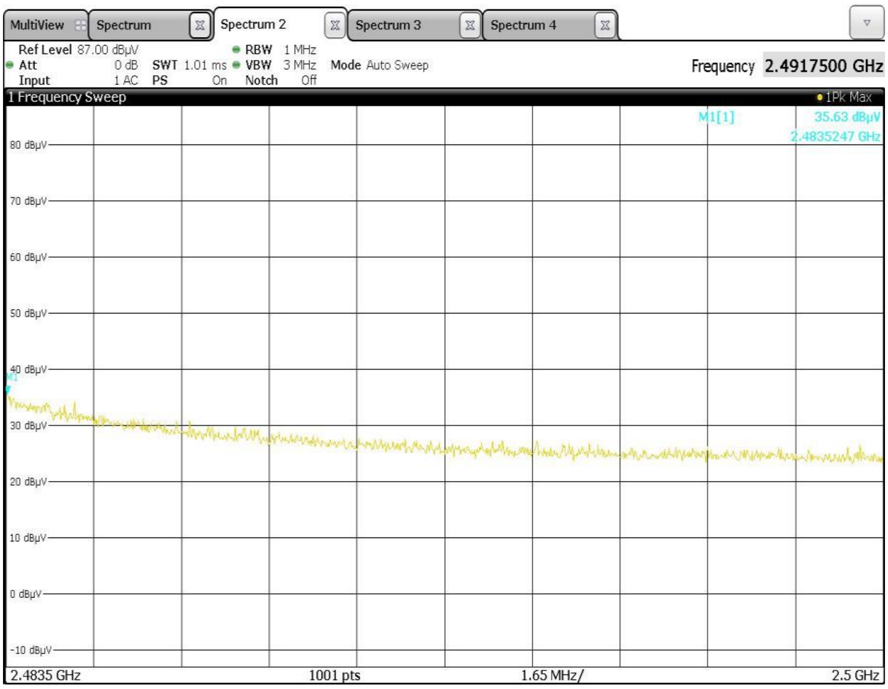
- 8DPSK _ Middle frequency

	Spurious – Peak

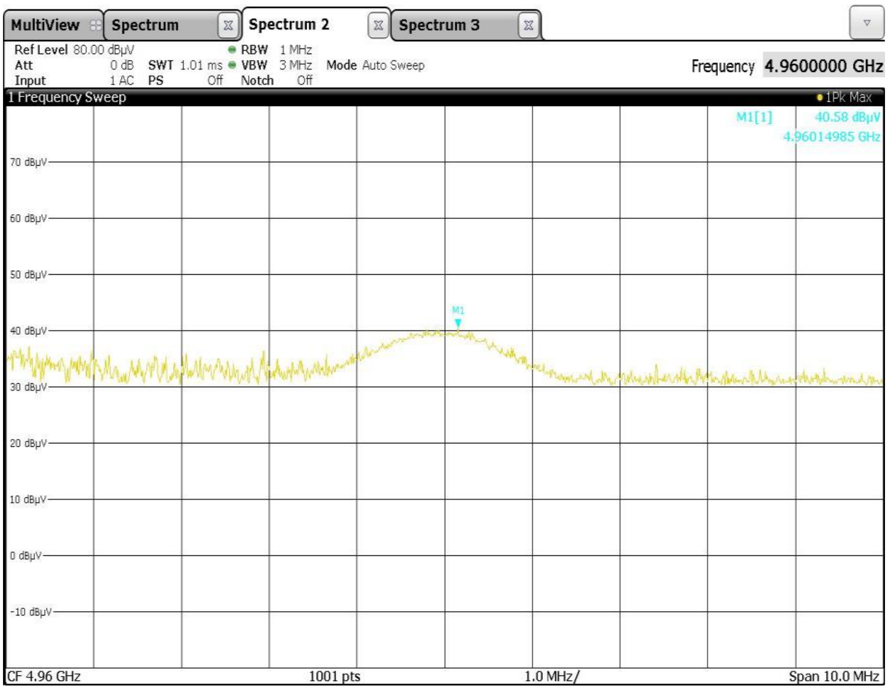


- 8DPSK _ High frequency

	Restricted Band – Peak



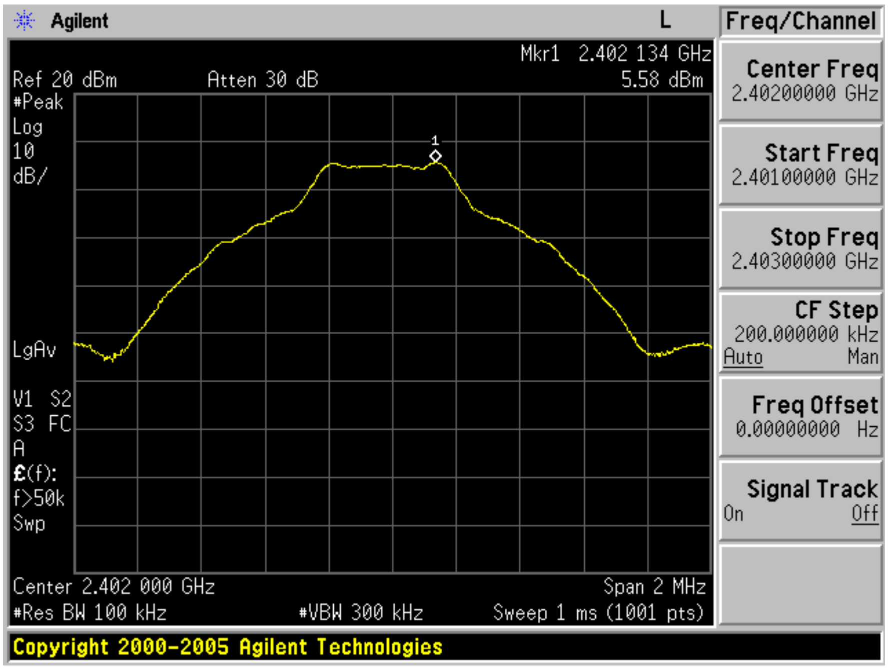
	Restriced Band – Peak



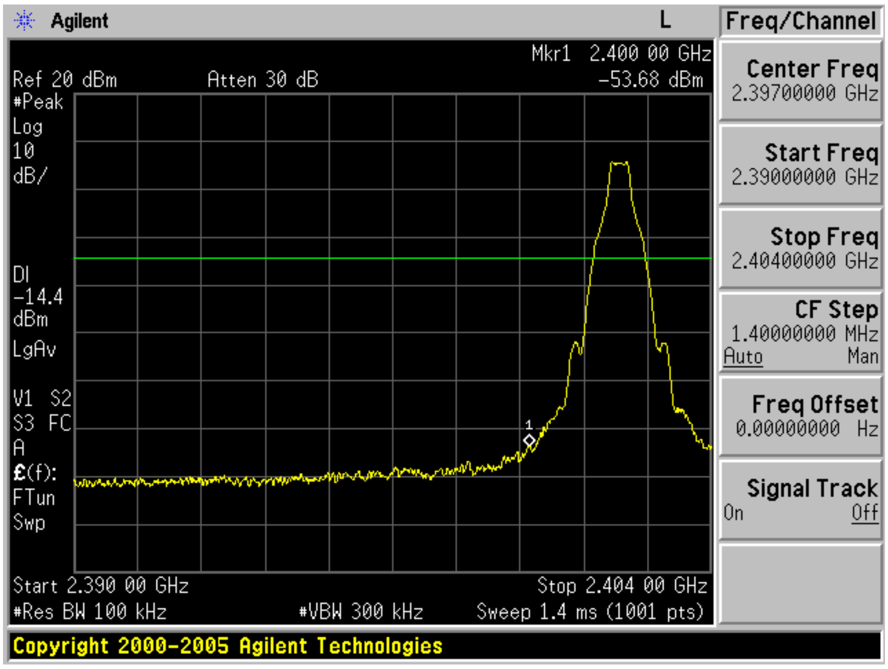
11.7 Test Plot for Conducted Spurious Emission

- GFSK _ Low frequency

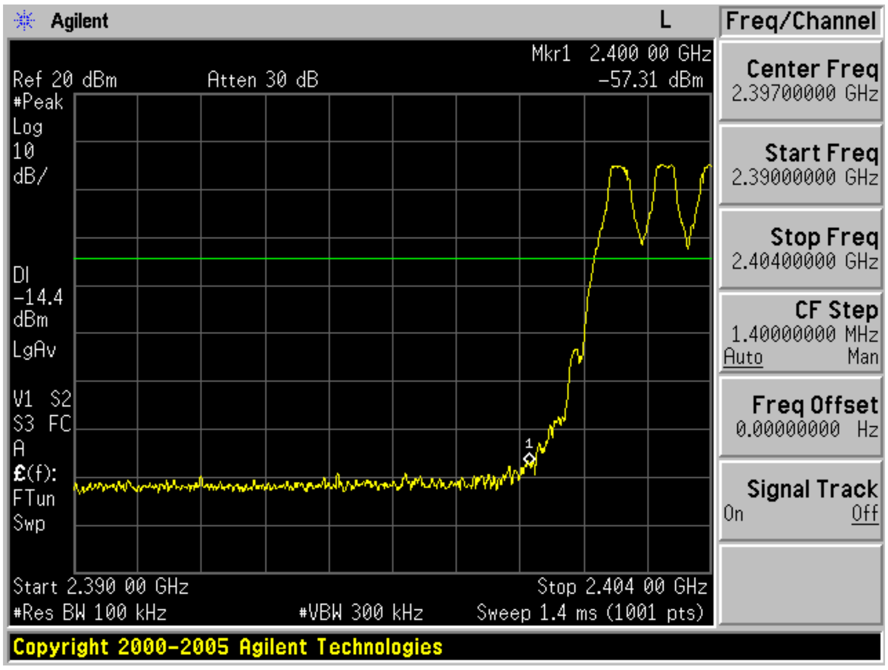
	Reference



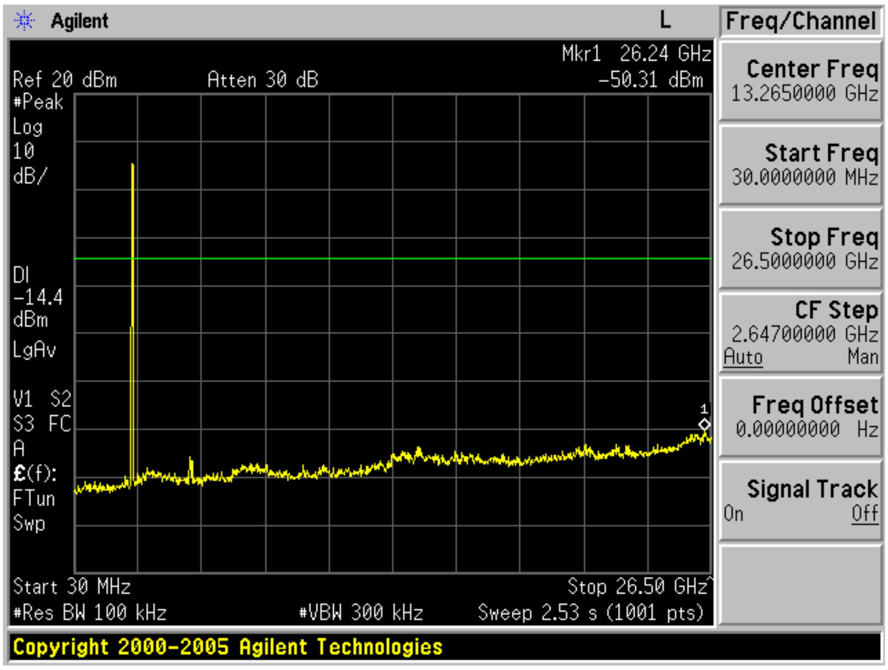
	Bandedge _ Single



	Bandedge _ Hopping

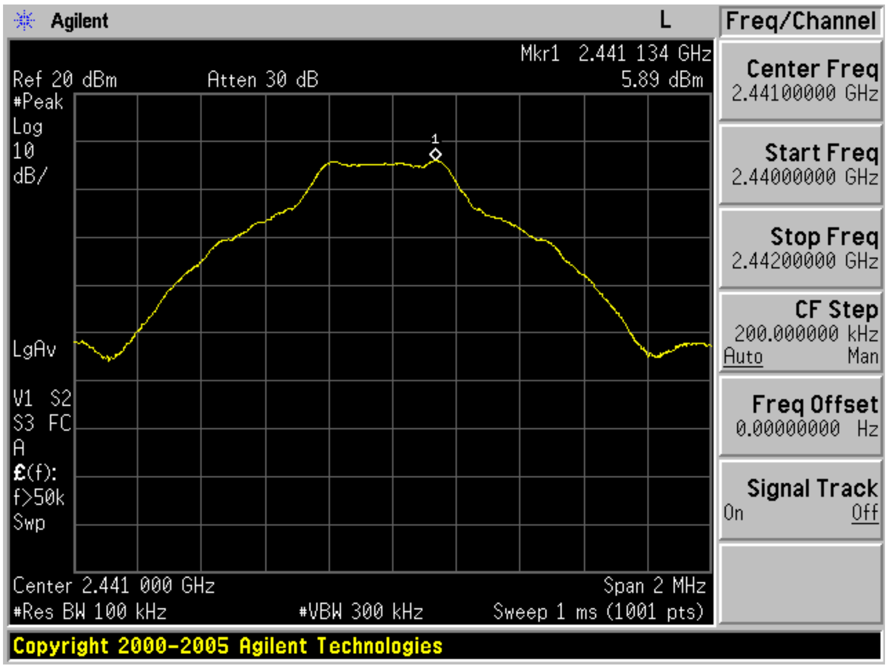


	Spurious



- GFSK _ Middle frequency

	Reference



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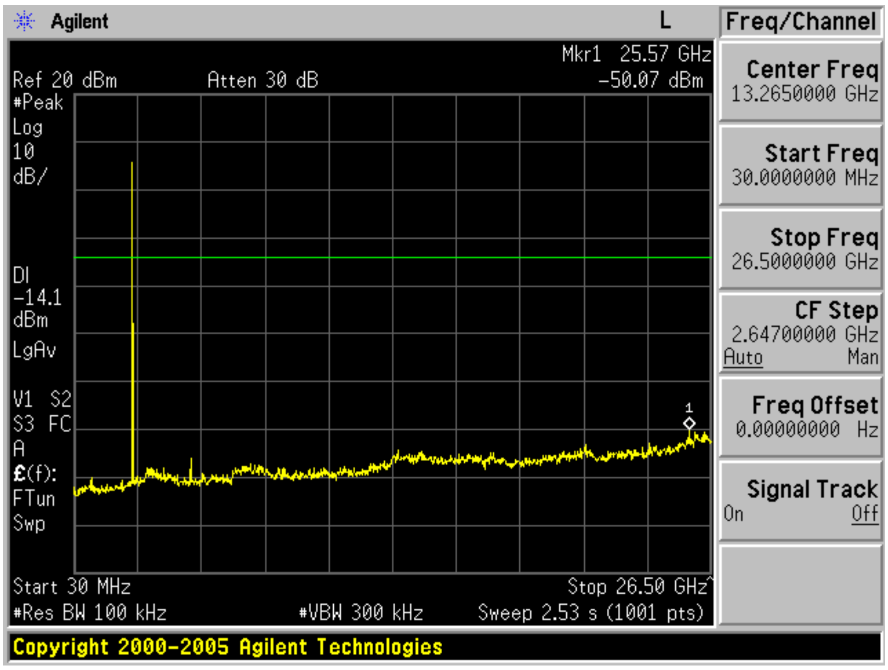
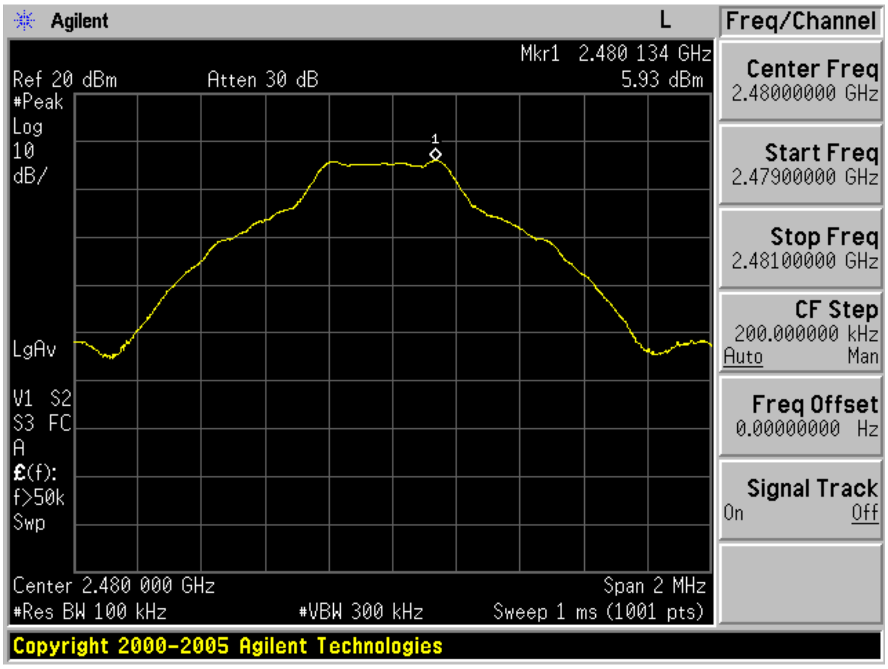
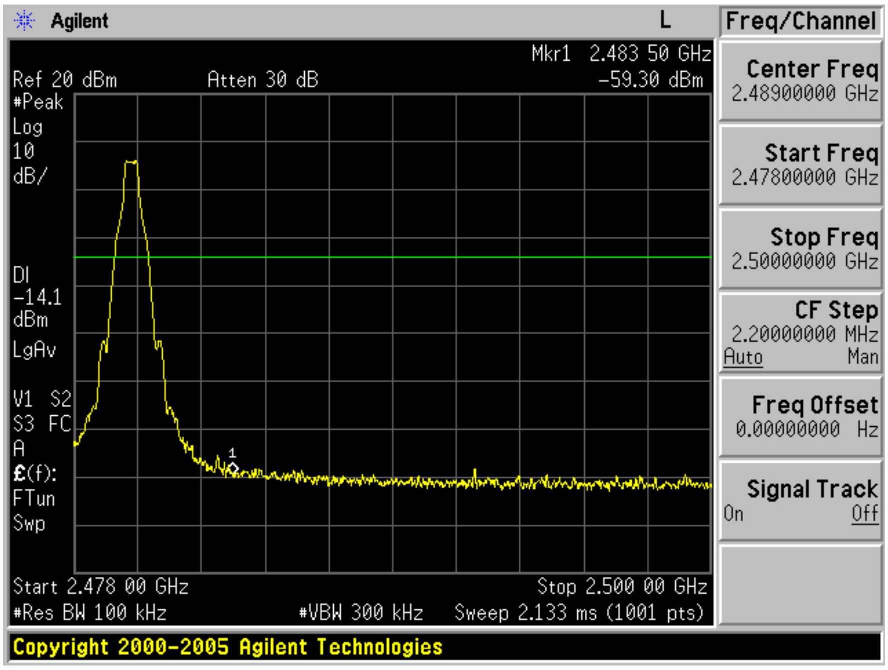


- GFSK _ High frequency

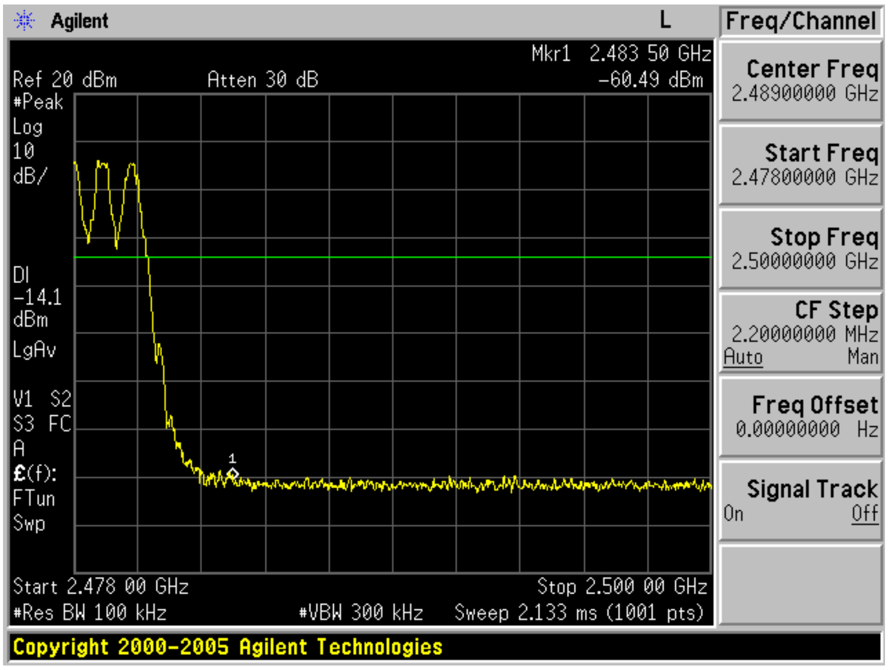
	Reference



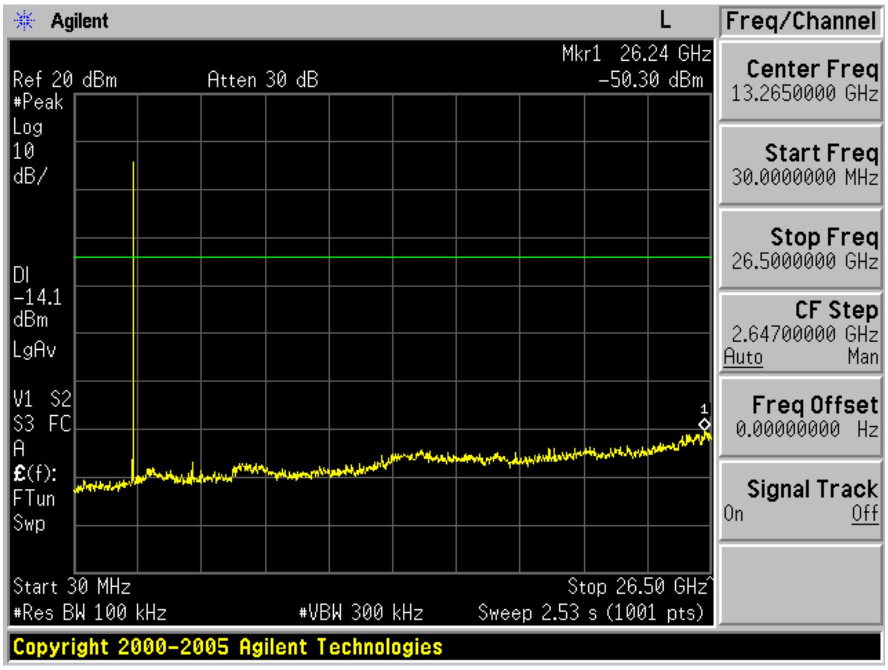
	Bandedge _ Single



	Bandedge _ Hopping

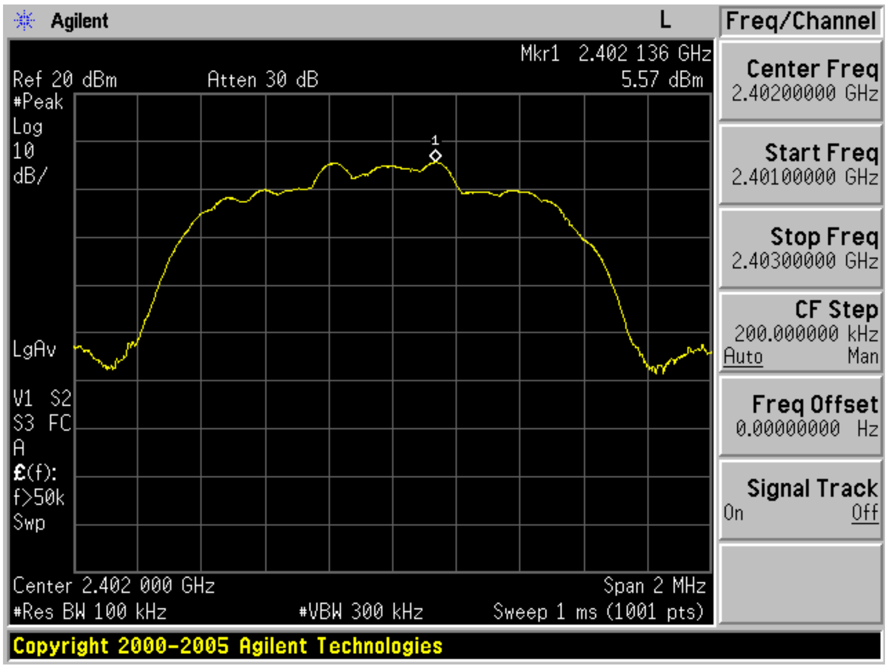


	Spurious

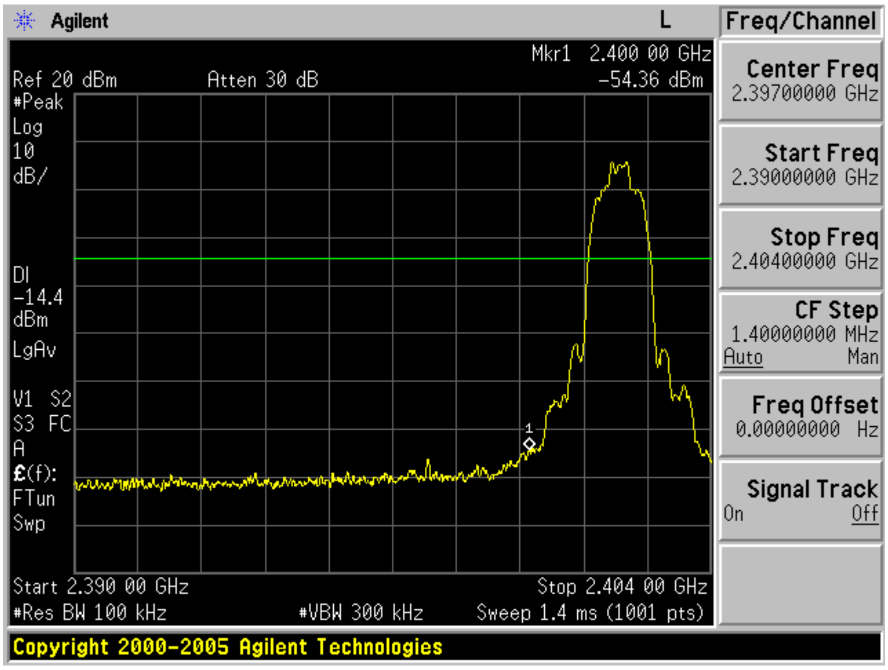


- 8DPSK _ Low frequency

	Reference



	Bandedge _ Single



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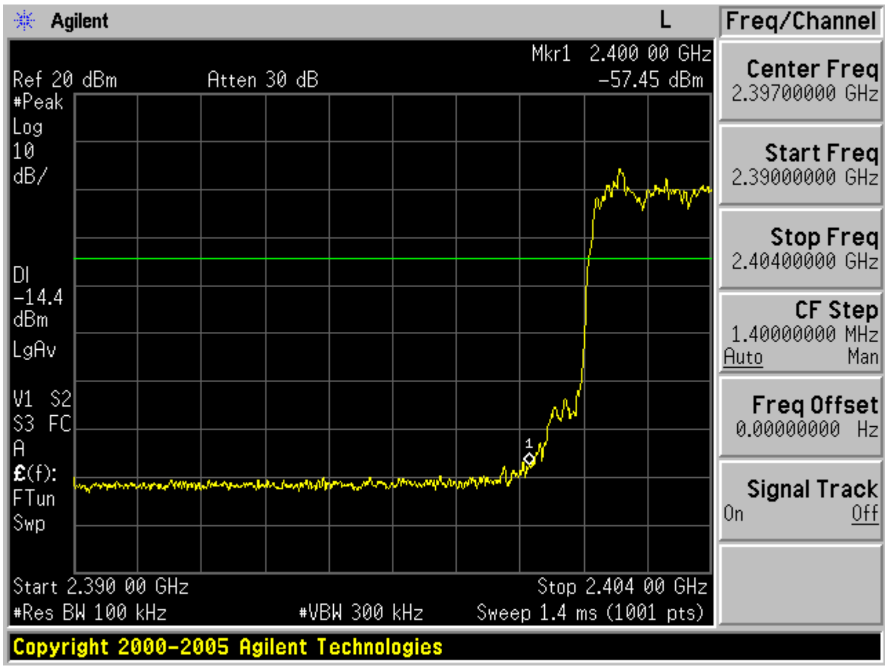
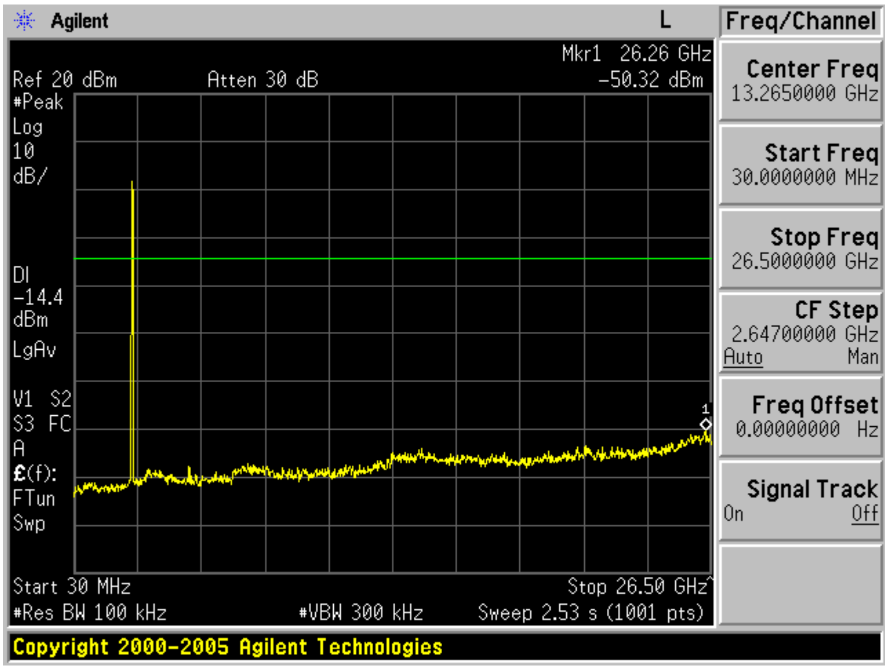
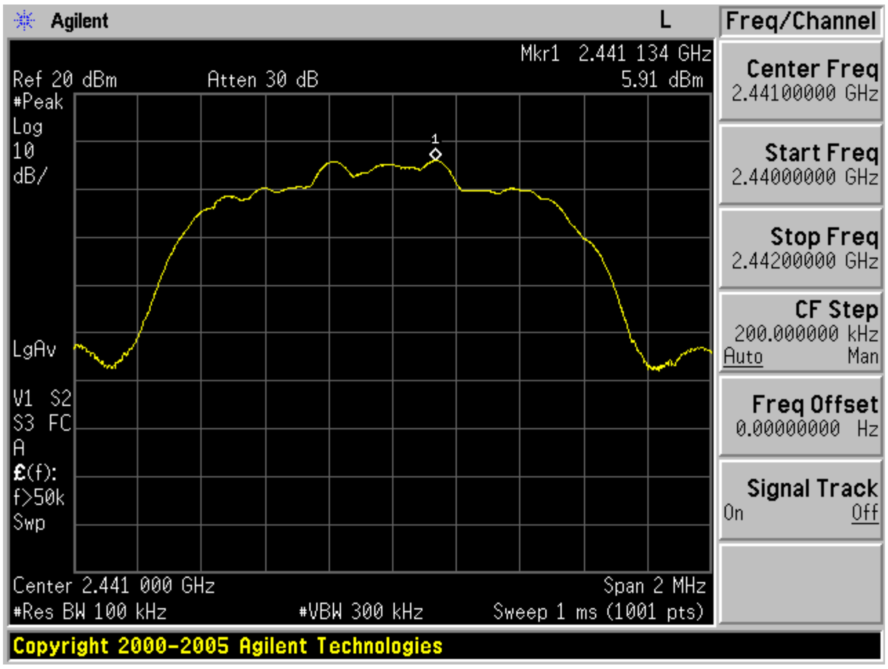


	Spurious



- 8DPSK _ Middle frequency

	Reference



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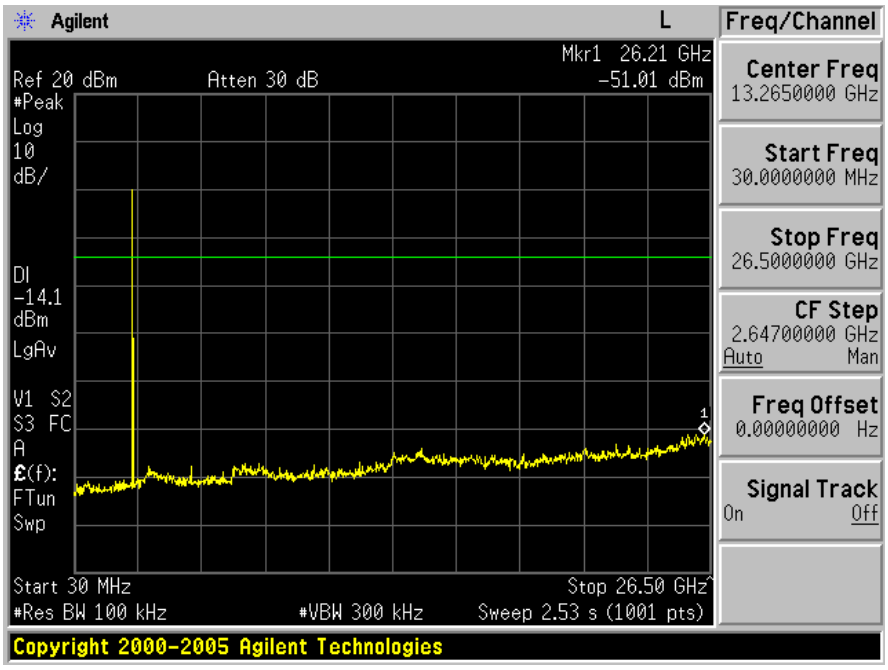
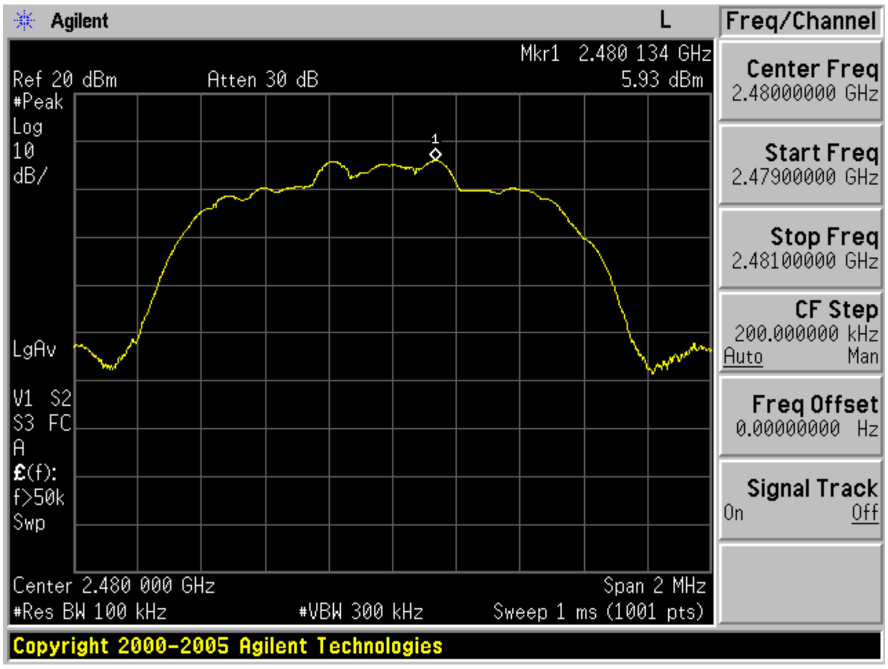
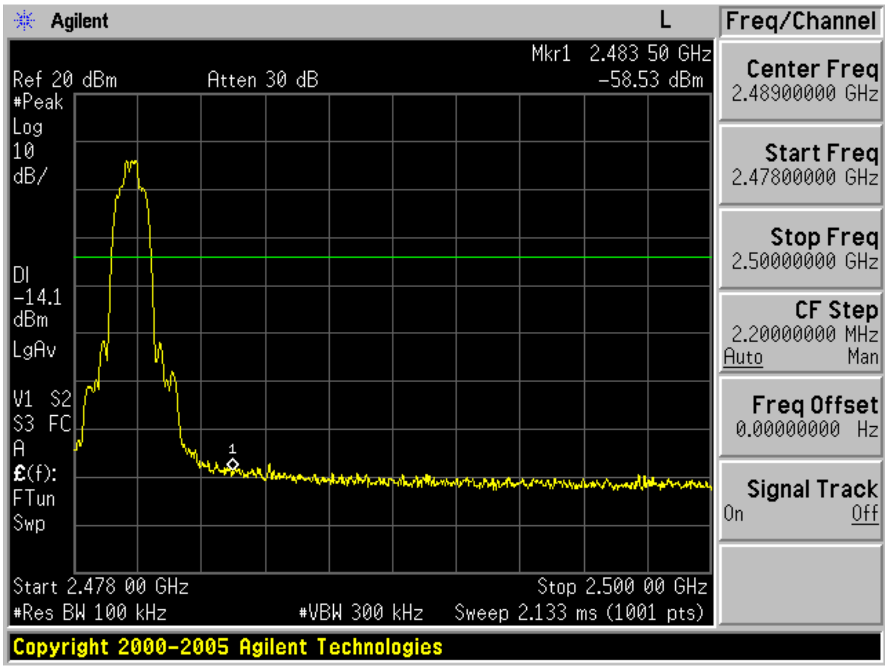


- 8DPSK _ High frequency

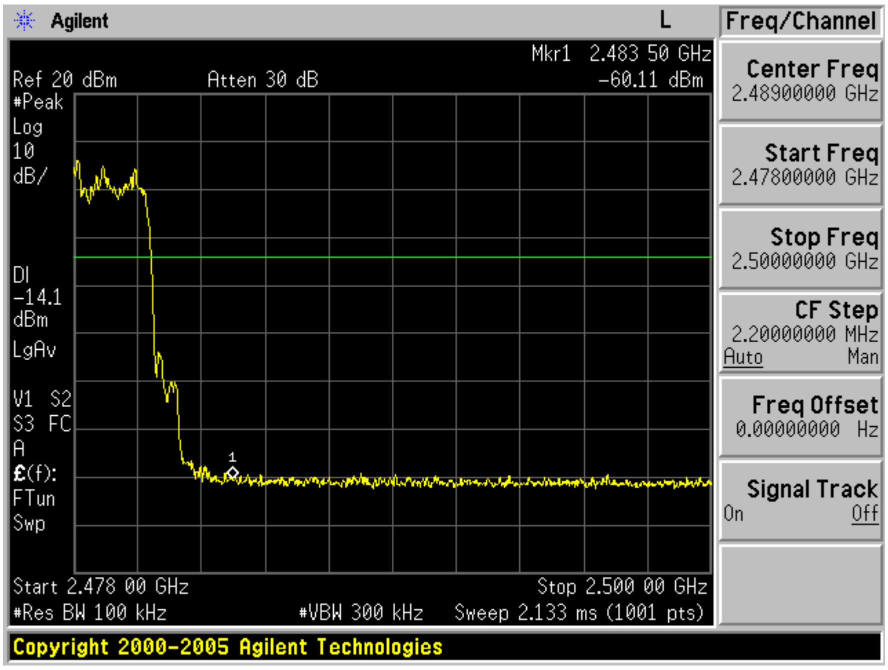
	Reference



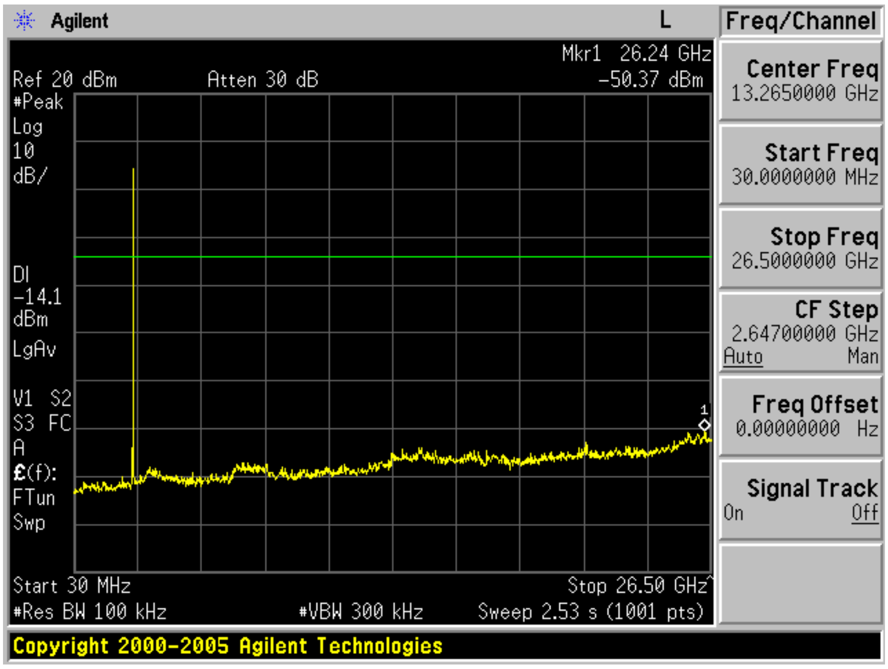
	Bandedge _ Single



	Bandedge _ Hopping



	Spurious



12. Conducted Emission

12.1 Test Setup

See test photographs for the actual connections between EUT and support equipment.

12.2 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 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 Range (MHz)	Conducted Limit (dBuV)	
	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

12.3 Test Procedure

Conducted emissions from the EUT were measured according to the ANSI C63.10.

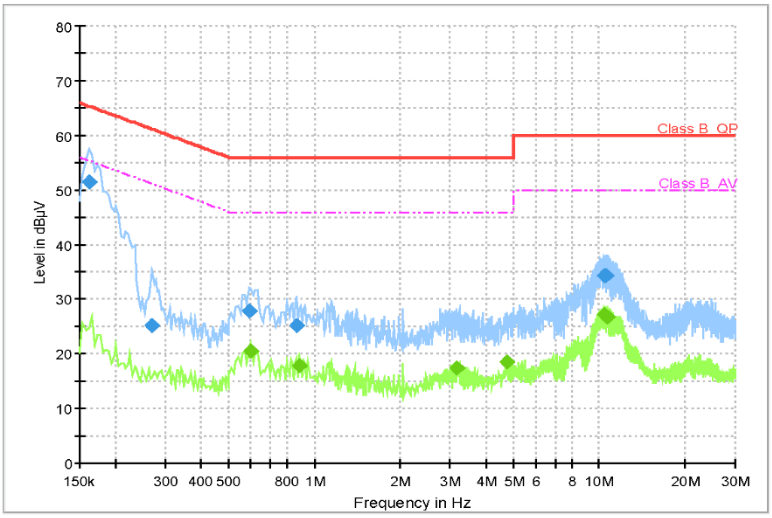
1. The test procedure is performed in a 6.5 m × 3.5 m × 3.5 m (L × W × H) shielded room. The EUT along with its peripherals were placed on a 1.0 m (W) × 1.5 m (L) and 0.8 m in height wooden table and the EUT was adjusted to maintain a 0.4 meter space from a vertical reference plane.
2. The EUT was connected 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.

12.4 Test Result

- AC Line Conducted Emission (Graph)

SP122_BT_L1

Conducted Emission

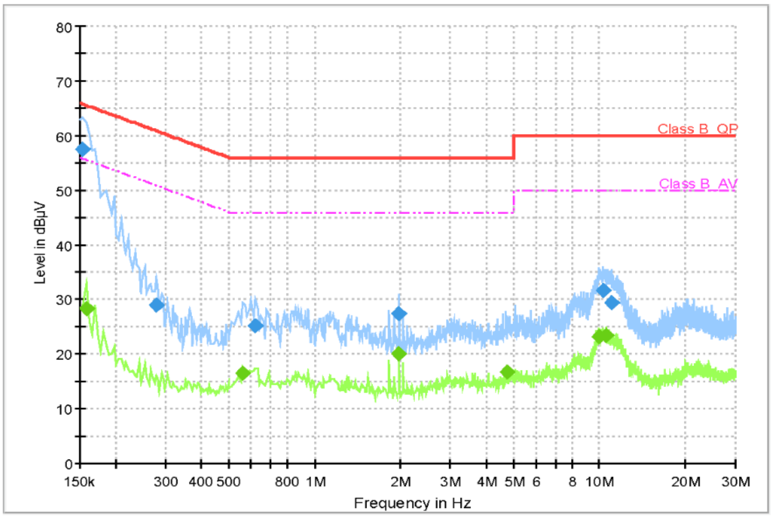


Final_Result

Frequency (MHz)	QuasiPeak (dBµV)	CAverage (dBµV)	Limit (dBµV)	Margin (dB)	Bandwidth (kHz)	Line	Corr. (dB)
0.162	51.55	---	65.36	13.81	9	L1	19.4
0.270	25.25	---	61.12	35.87	9	L1	19.4
0.590	27.84	---	56.00	28.16	9	L1	19.8
0.600	---	20.60	46.00	25.40	9	L1	19.8
0.870	25.13	---	56.00	30.87	9	L1	19.8
0.890	---	17.84	46.00	28.16	9	L1	19.7
3.150	---	17.37	46.00	28.63	9	L1	19.7
4.760	---	18.46	46.00	27.54	9	L1	19.8
10.370	34.42	---	60.00	25.58	9	L1	20.0
10.380	---	27.08	50.00	22.92	9	L1	20.0
10.500	34.35	---	60.00	25.65	9	L1	20.0
10.700	---	26.77	50.00	23.23	9	L1	20.0

SP122_BT_N

Conducted Emission



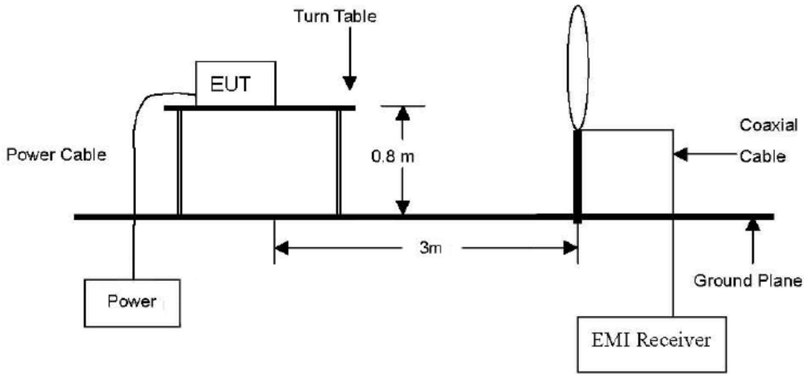
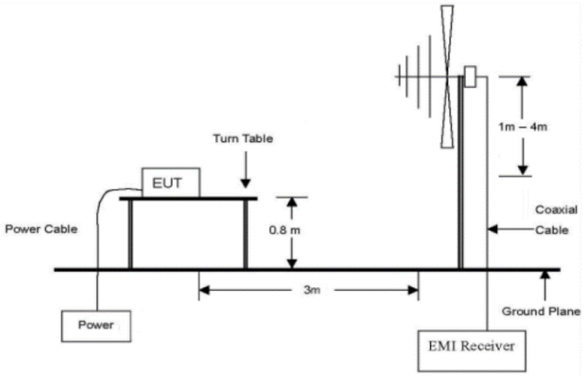
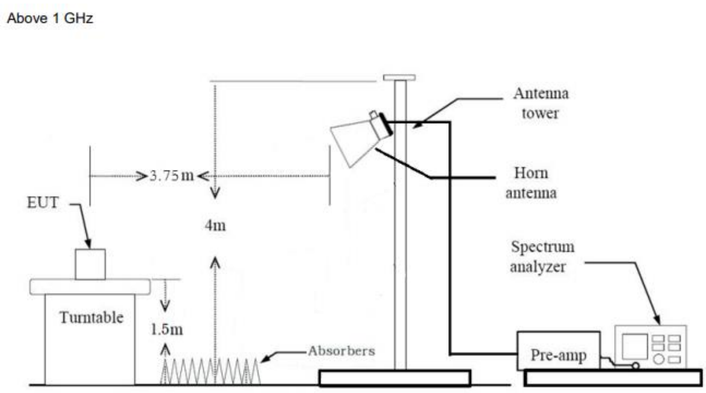
Final_Result

Frequency (MHz)	QuasiPeak (dBµV)	CAverage (dBµV)	Limit (dBµV)	Margin (dB)	Bandwidth (kHz)	Line	Corr. (dB)
0.154	57.54	---	65.78	8.25	9	N	19.3
0.158	---	28.26	55.57	27.31	9	N	19.4
0.278	28.88	---	60.88	31.99	9	N	19.4
0.560	---	16.40	46.00	29.60	9	N	19.8
0.620	25.22	---	56.00	30.78	9	N	19.8
1.980	27.47	---	56.00	28.53	9	N	19.7
1.980	---	20.12	46.00	25.88	9	N	19.7
4.760	---	16.73	46.00	29.27	9	N	19.8
9.960	---	23.12	50.00	26.88	9	N	20.0
10.260	31.64	---	60.00	28.36	9	N	20.0
10.520	---	23.38	50.00	26.62	9	N	20.0
11.080	29.42	---	60.00	30.58	9	N	20.0

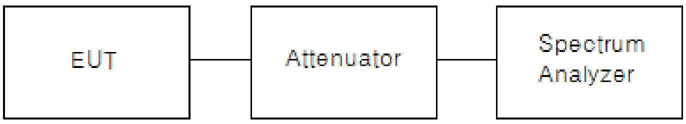
APPENDIX I

TEST SETUP

- Radiated Measurement

below 30 MHz	
below 1 GHz	
above 1 GHz	

- Conducted Measurement

Conducted	

APPENDIX II

UNCERTAINTY

Measurement Item	Expanded Uncertainty U = *k*Uc (*k*=2)
Conducted RF power	0.32 dB
Conducted Spurious Emissions	0.32 dB
Radiated Spurious Emissions	6.34 dB
Conducted Emissions	1.74 dB