

TEST REPORT

FCC Standards : FCC 47 CFR part 15 subpart C

Test Report No. : CTK-2016-00736
Date of Issue : 2016-06-13
FCC ID : 2AB99CMIT-AUTO-I100
Model/Type No. : AUTO-i 100
Kind of Product : Vehicle Diagnostic
Applicant : Carman International Co., Ltd.
Applicant Address : #209, Second Floor, Hanshin IT Tower, 272, Digital-ro, Guro-gu, Seoul, 08389, Korea
Manufacturer : Carman International Co., Ltd.
Manufacturer Address : #209, Second Floor, Hanshin IT Tower, 272, Digital-ro, Guro-gu, Seoul, 08389, Korea
Contact Person : Ahn Tae Min / Associate Research Engineer
Telephone : +82-2-2627-4592
Received Date : 2016-04-19
Test period : Start : 2016-05-18 End : 2016-06-09
Test Results : In Compliance Not in Compliance

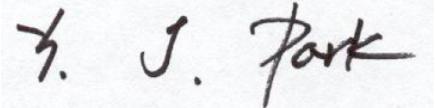
The test results presented in this report relate only to the object tested.

Tested by



Won-Jae, Hwang
Test Engineer
Date: 2016-06-13

Reviewed by



Young-Joon, Park
Technical Manager
Date: 2016-06-13



CTK Co., Ltd.

CTK Co., Ltd.
(Ho-dong), 113, Yejik-ro, Cheoin-gu, Yongin-si, Gyeonggi-do, Korea
Tel: +82-31-339-9970 Fax: +82-31-624-9501
www.e-ctk.com

REPORT REVISION HISTORY

Date	Revision	Page No
2016-06-13	Issued (CTK-2016-00736)	All

This report shall not be reproduced except in full, without the written approval of CTK Co., Ltd. This document may be altered or revised by CTK Co., Ltd. personnel only, and shall be noted in the revision section of the document. Any alteration of this document not carried out by CTK Co., Ltd. will constitute fraud and shall nullify the document.

TABLE OF CONTENTS

REPORT REVISION HISTORY	2
1.0 General Product Description	4
1.1 Tested Frequency	4
1.2 Tested Mode	4
1.3 EUT Operation Test Setup	5
1.4 EUT Exercise of Software	5
1.5 Device Modifications	5
1.6 Peripheral Devices	5
1.7 Configuration of System under Test	5
1.8 Calibration Details of Equipment Used for Measurement	6
1.9 Test Facility	6
1.10 Laboratory Accreditations and Listings	6
2.0 Summary of tests	7
2.1 Transmitter Requirements	8
2.1.1 Carrier Frequency Separation	8
2.1.2 Number of Hopping Frequencies	10
2.1.3 20 dB bandwidth	13
2.1.4 Time of Occupancy (Dwell Time)	19
2.1.5 Maximum peak Conducted Output Power	25
2.1.6 Band-edge	30
2.1.7 Field Strength of Emissions	41
2.1.8 AC Conducted Emissions	50
APPENDIX A – Test Equipment Used For Tests	53

1.0 General Product Description

Basic Model/Type No.	AUTO-i 100	
Serial number	Prototype	
EUT condition	Pre-production, not damaged	
Antenna type	Chip antenna	Gain 2.0 dBi
Frequency Range	2402 MHz - 2480 MHz	
RF power	2.197 dBm Peak Conducted (GFSK) 0.259 dBm Peak Conducted (8-DPSK)	
Number of channels	79	
Channel Spacing	1 MHz	
Channel Access Protocol	Frequency Hopping	
Type of Modulation	GFSK(1 Mbps), DQPSK(2 Mbps), 8-DPSK(3 Mbps)	
Power Source	DC 12 V	
Hardware Rev	V1.1	
Software Rev	1660	
Firmware Rev	160530	

1.1 Tested Frequency

	LOW	MID	HIGH
Frequency (MHz)	2402	2441	2480

1.2 Tested Mode

- Pre-Scan has been conducted to determine the worst-case mode from all possible combinations between available modulations, data rates and antenna ports.
- Following channel(s) was (were) selected for the final test as listed below.

Tested Ch	Modulation Technology	Modulation Type	Packet Type
Low, Mid, High	FHSS	GFSK	DH 5
Low, Mid, High	FHSS	8-DPSK	3DH 5

1.3 EUT Operation Test Setup

For Bluetooth function, the engineering test program was provided and enabled to make EUT continuous transmit/receive.

1.4 EUT Exercise of Software

The EUT was operated in the engineering mode to fix the Tx frequency that was for the purpose of the measurements. The software is using the android system to internal memory.

1.5 Device Modifications

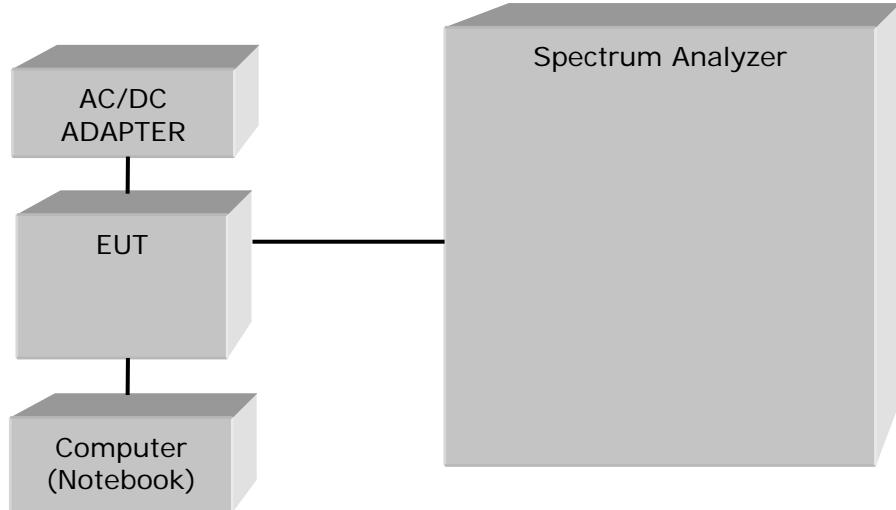
The following modifications was applied by the applicant:

Not applicable

1.6 Peripheral Devices

Device	Manufacturer	Model No.	Serial No.
Note Computer	HP	ProBook 650 G1	5CG5114KD2
AC ADAPTER	HP	PPP012D-S	-
AC ADAPTER	LI SHIN INTERNATIONAL ENTERPRISE CORP.	LSE9901B1260	-

1.7 Configuration of System under Test



1.8 Calibration Details of Equipment Used for Measurement

Test equipment and test accessories are calibrated on regular basis. The maximum time between calibrations is one year or what is recommended by the manufacturer, whichever is less. All test equipment calibrations are traceable to the Korea Research Institute of Standards and Science (KRISS), therefore, all test data recorded in this report is traceable to KRISS.

1.9 Test Facility

The measurement facility is located at (Ho-dong), 113, Yejik-ro, Cheoin-gu, Yongin-si, Gyeonggi-do, Korea. The sites are constructed in conformance with the requirements of ANSI C63.7, ANSI C63.4 and CISPR Publication 22.

1.10 Laboratory Accreditations and Listings

Country	Agency	Scope of Accreditation	Registration Number	Logo
USA	FCC	FCC Part 15 & 18 EMI (Electromagnetic Interference / Emission)	805871	
JAPAN	VCCI	VCCI V-3 EMI (Electromagnetic Interference / Emission)	C-986 T-1843 R-3627 G-387	
KOREA	MSIP	EMI (Electromagnetic Interference / Emission) EMS (Electromagnetic Susceptibility / Immunity)	KR0025	

2.0 Summary of tests

FCC Part Section(s)	IC Part Section(s)	Parameter	Test Condition	Status (note 1)
15.247(a)	-	Carrier Frequency Separation	Conducted	C
15.247(a)	-	Number of Hopping Frequencies		C
15.247(a)	-	20 dB Bandwidth		C
15.247	-	Dwell Time		C
15.247(b)	-	Transmitter Output Power		C
15.247(d)	-	Conducted Spurious emission		C
15.247(d)	-	Band Edge		C
15.209	-	Field Strength of Harmonics	Radiated	C
15.207	-	AC Conducted Emissions	Line Conducted	C

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

Note 2: The data in this test report are traceable to the national or international standards.

The sample was tested according to the following specification:

- FCC Part 15.247, IC RSS-247 Issue 1

The tests were performed according to the method of measurements prescribed in DA 00-705 and ANSI C63.10-2013.

2.1 Transmitter Requirements

2.1.1 Carrier Frequency Separation

Test Location

RF Test Room

Test Procedures

The carrier frequency separation was measured with a spectrum analyzer connected to the antenna terminal, while EUT has 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 = 5 MHz (wide enough to capture the peaks of two adjacent channels)

RBW = 30 kHz ($\geq 1\%$ of the span) Sweep = auto

VBW = 30 kHz (\geq RBW) Detector function = peak

Trace = max hold

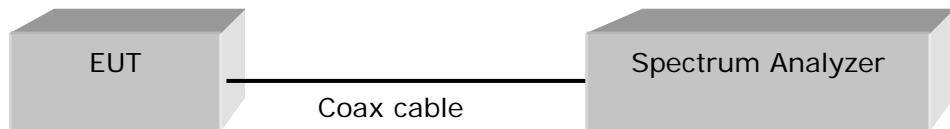


Figure 1 : Measurement setup for the carrier frequency separation

Limit

§15.247(a)(1) Frequency hopping system operating in the 2400-2483.5 MHz band may have hopping channel carrier frequencies that are separated by 25 kHz or two-third of 20dB bandwidth of the hopping channel, whichever is greater, provided the systems operate with an output power no greater than 125 mW.

Test Results

Test mode : GFSK, CFG PKT Packet Type : 15 Packet Size : 339(DH5)

Channel	Adjacent Hopping Channel Separation (kHz)	Two-third of 20dB bandwidth (kHz)	Minimum Bandwidth (kHz)	Result
2441MHz	1000	627.6	25	Complies

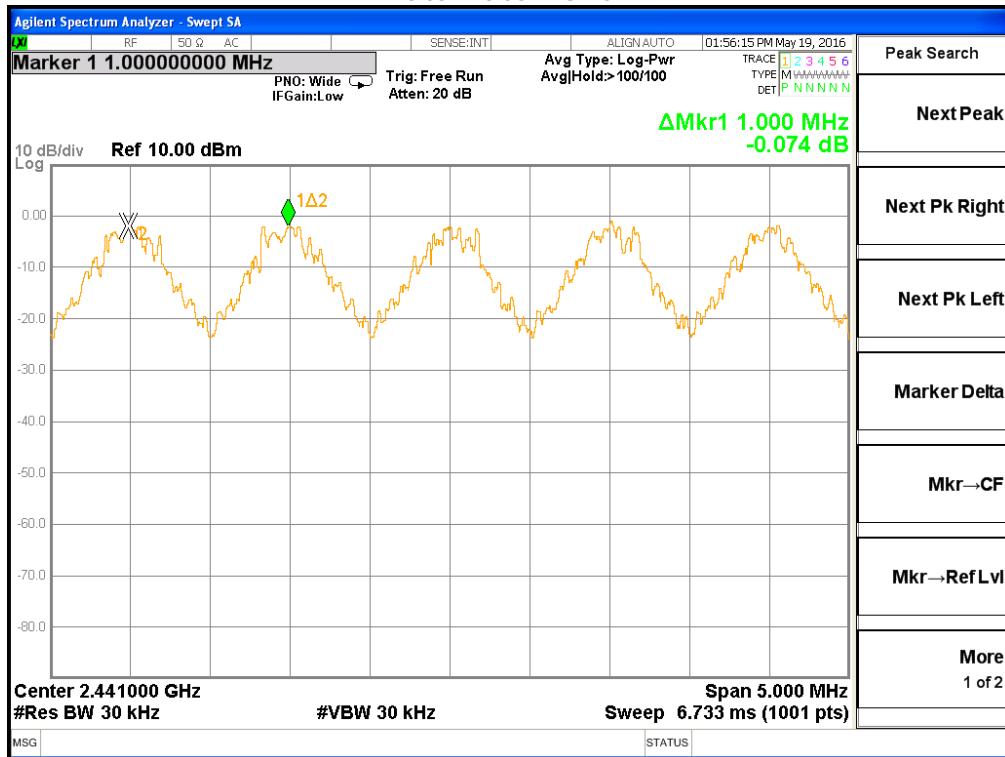
Test mode : 8-DPSK, CFG PKT Packet Type : 31 Packet Size : 1021(3DH5)

Channel	Adjacent Hopping Channel Separation (kHz)	Two-third of 20dB bandwidth (kHz)	Minimum Bandwidth (kHz)	Result
2441MHz	1005	840.0	25	Complies

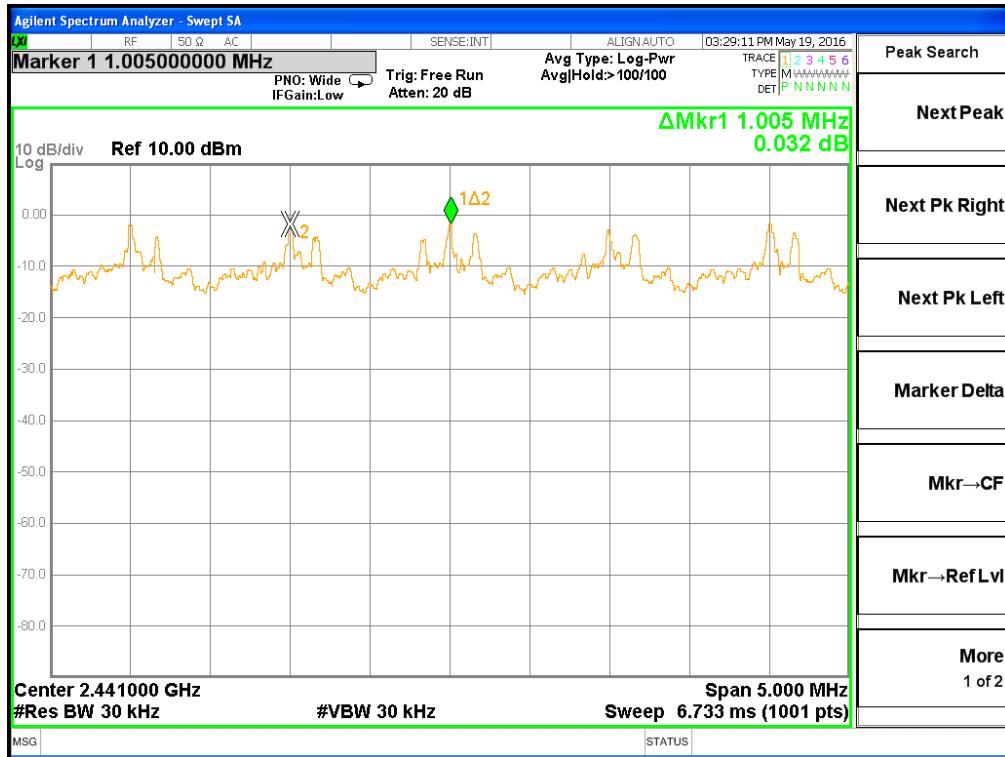
See next pages for actual measured spectrum plots.

Carrier Frequency Separation

Data Rate : GFSK



Data Rate : 8-DPSK



2.1.2 Number of Hopping Frequencies

Test Location

RF Test Room

Test Procedures

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

The spectrum analyzer is set to:

Frequency range 1: Start = 2389.5 MHz, Stop = 2439.5 MHz
 2: Start = 2439.5 MHz, Stop = 2489.5 MHz

Span = 50 MHz

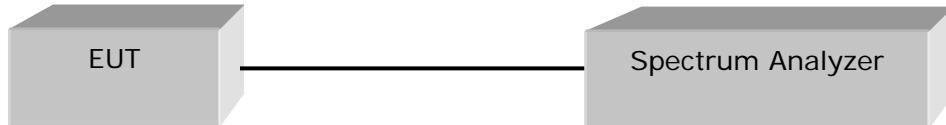
RBW = 300 kHz (\geq 1% of the span)

VBW = 300 kHz (\geq RBW)

Trace = max hold

Sweep = auto

Detector function = peak



Limit

§15.247(a)(1)(iii) For frequency hopping system operating in the 2400-2483.5 MHz band shall use at least 15 hopping frequencies.

Test Results

Test mode : GFSK, CFG PKT Packet Type : 15 Packet Size : 339(DH5)

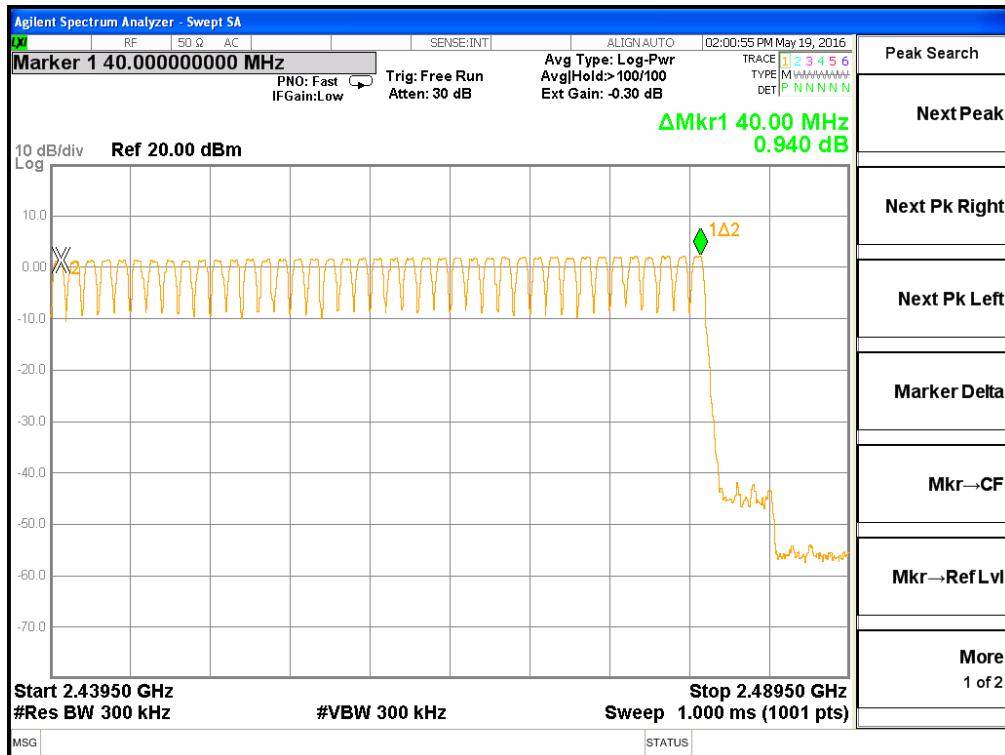
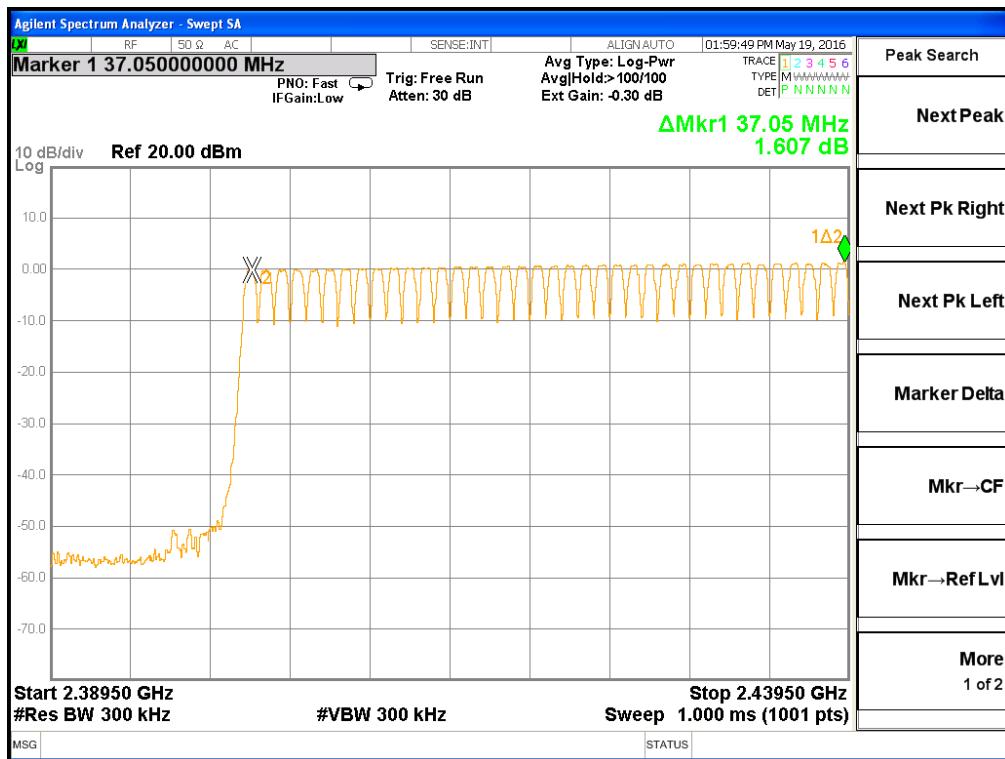
Total number of Hopping Channels	Result
79	Complies

Test mode : 8-DPSK, CFG PKT Packet Type : 31 Packet Size : 1021(3DH5)

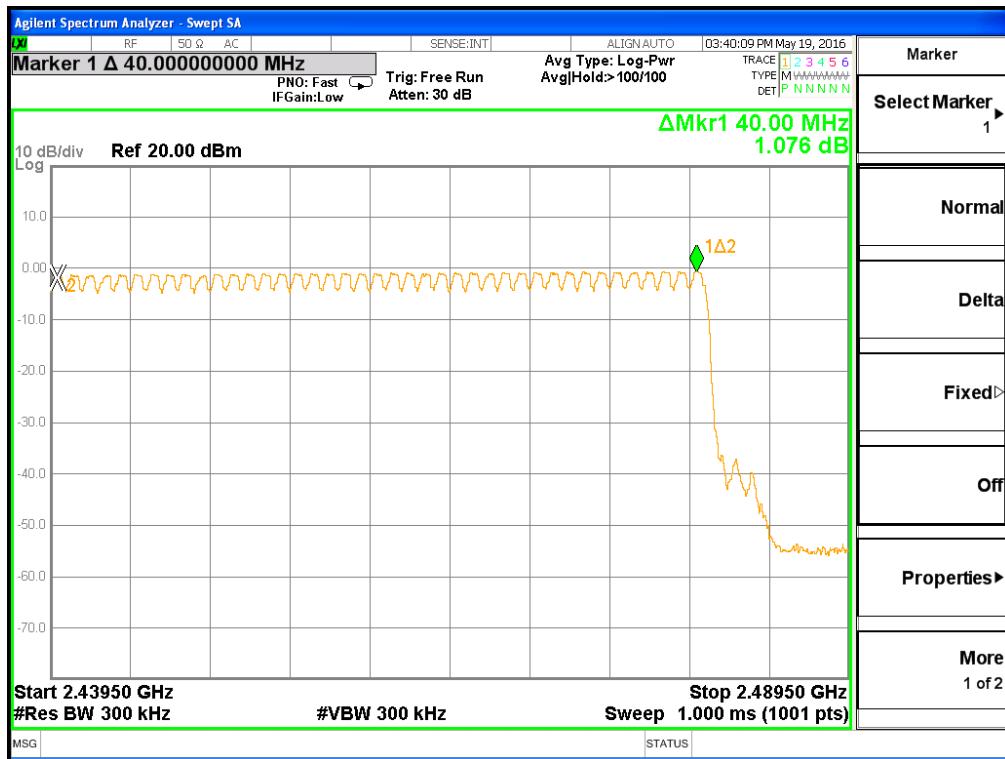
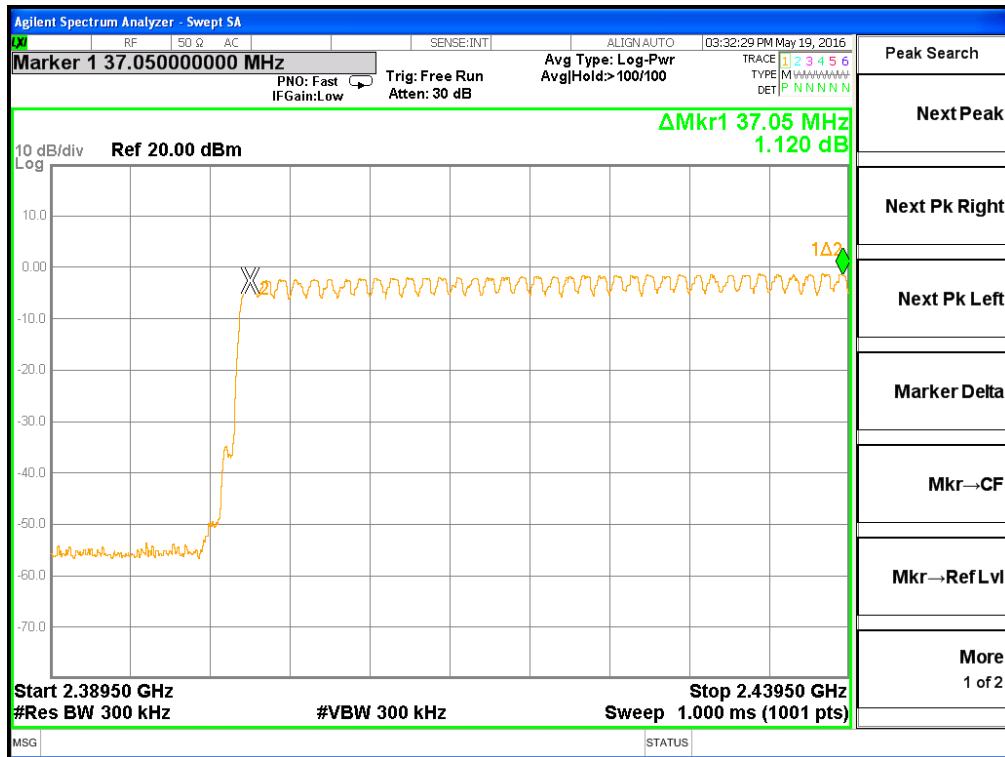
Total number of Hopping Channels	Result
79	Complies

See next pages for actual measured spectrum plots.

Number of Hopping Frequencies(GFSK)



Number of Hopping Frequencies(8-DPSK)



2.1.3 20 dB bandwidth

Test Location

RF Test Room

Test Procedures

The bandwidth at 20 dB below the highest inband spectral density was measured with a spectrum analyzer connected to the antenna terminal, while EUT had its hopping function disabled at the highest, middle and the lowest available channels.

After the trace being stable, Use the marker-to peak function to set the marker to the peak of the emission. Use the marker-delta function to measure 20 dB down one side of the emission. Reset the marker-delta 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 the 20 dB bandwidth of the emission.

The spectrum analyzer is set to:

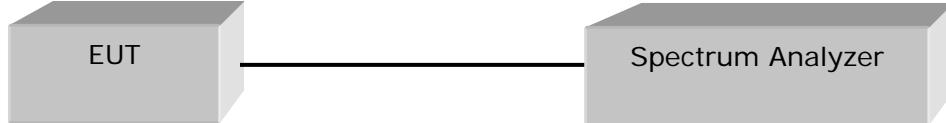
Center frequency = the highest, middle and the lowest channels

Span = 3 MHz (approximately 2 or 3 times of the 20 dB bandwidth)

RBW = 30 KHz (\geq 1% of the span) Sweep = auto

VBW = 100 KHz (\geq RBW) Detector function = peak

Trace = max hold



Limit

Limit : N/A

Test Results (20 dB bandwidth)

Test mode : GFSK, CFG PKT Packet Type : 15 Packet Size : 339(DH5)

Frequency (MHz)	Channel Number.	Measured Bandwidth (MHz)	Result
2402	0	0.939	Complies
2441	39	0.941	Complies
2480	78	0.941	Complies

Test mode : 8-DPSK, CFG PKT Packet Type : 31 Packet Size : 1021(3DH5)

Frequency (MHz)	Channel Number.	Measured Bandwidth (MHz)	Result
2402	0	1.259	Complies
2441	39	1.260	Complies
2480	78	1.255	Complies

Test Results (Occupied Bandwidth)

Test mode : GFSK, CFG PKT Packet Type : 15 Packet Size : 339(DH5)

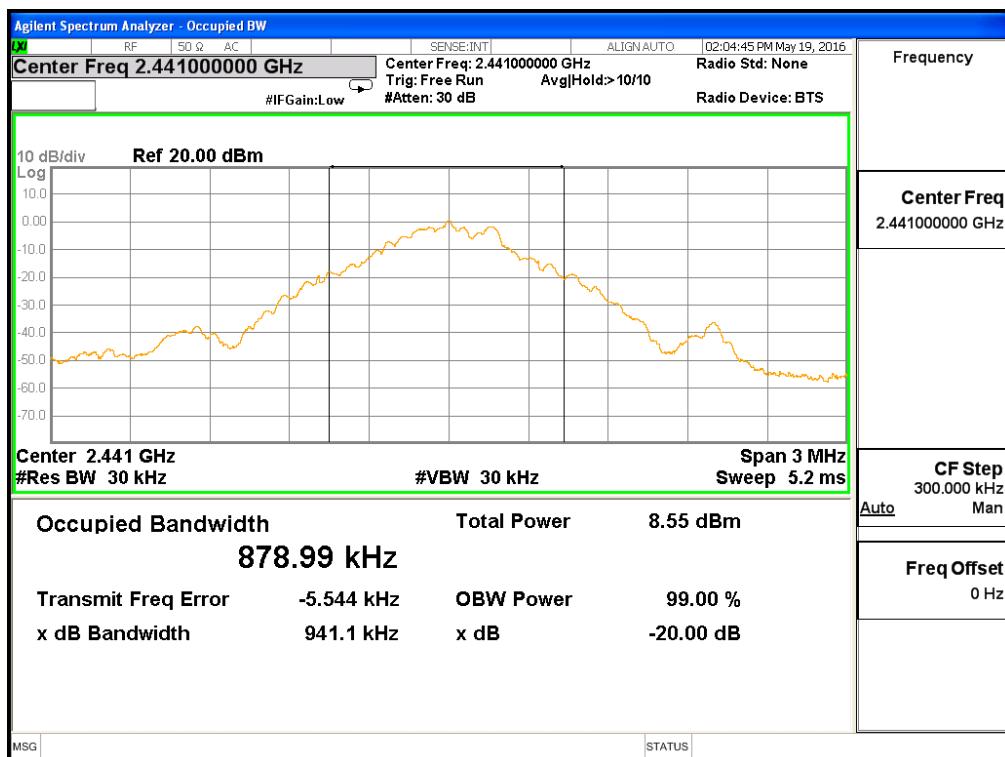
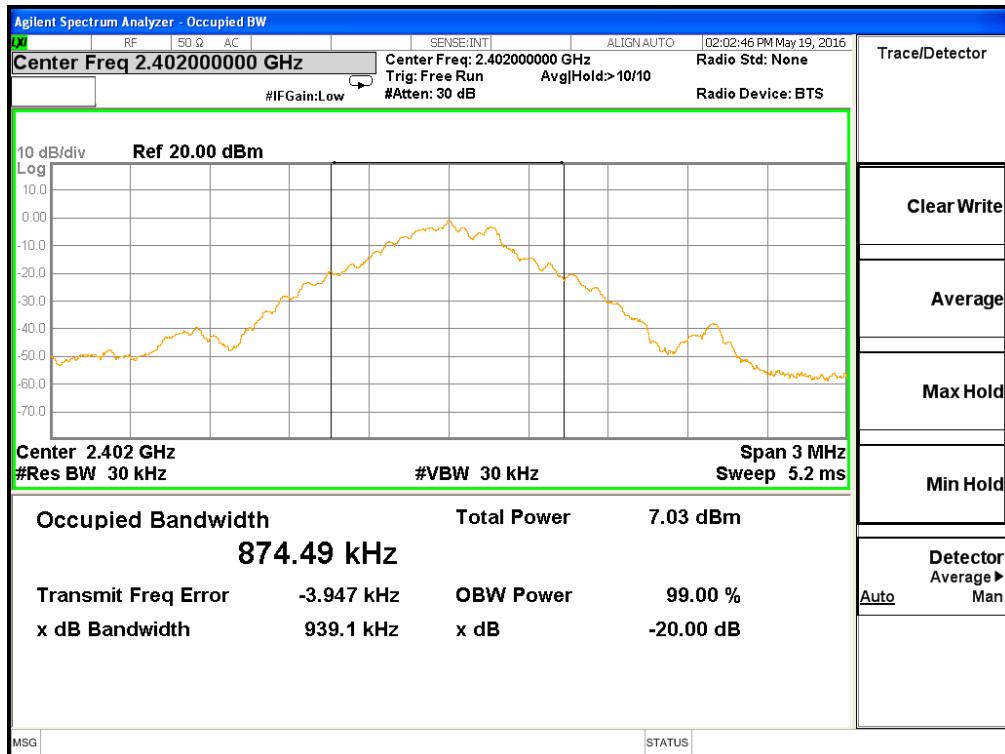
Frequency (MHz)	Channel Number.	Measured Bandwidth (MHz)	Result
2402	0	0.875	Complies
2441	39	0.879	Complies
2480	78	0.878	Complies

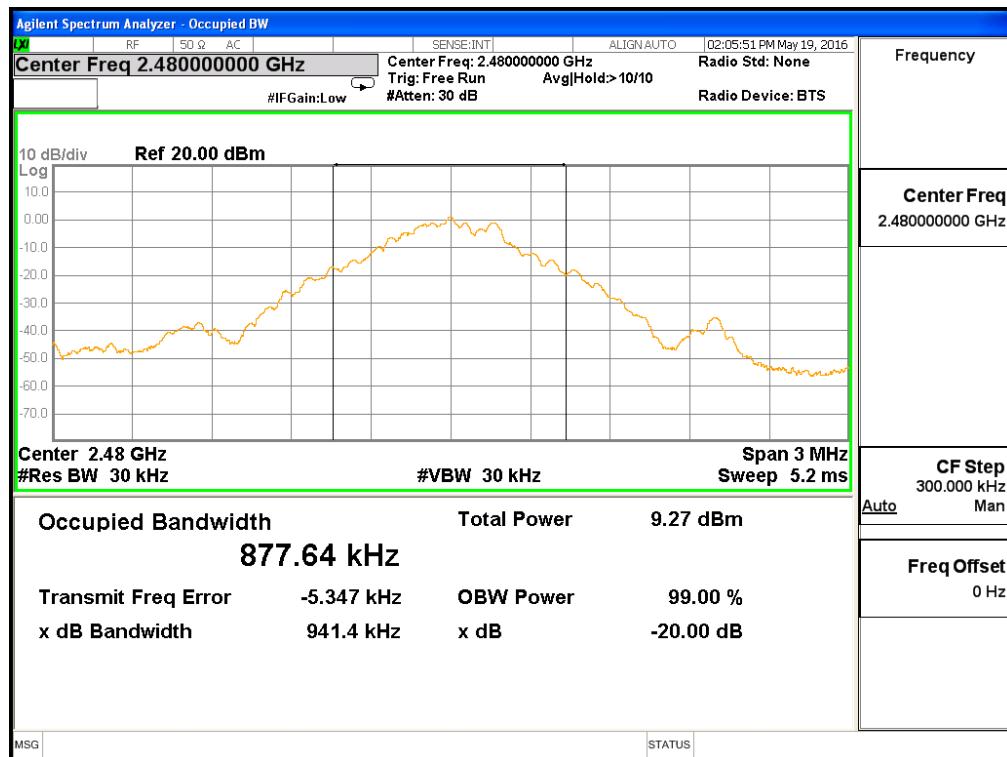
Test mode : 8-DPSK, CFG PKT Packet Type : 31 Packet Size : 1021(3DH5)

Frequency (MHz)	Channel Number.	Measured Bandwidth (MHz)	Result
2402	0	1.170	Complies
2441	39	1.169	Complies
2480	78	1.163	Complies

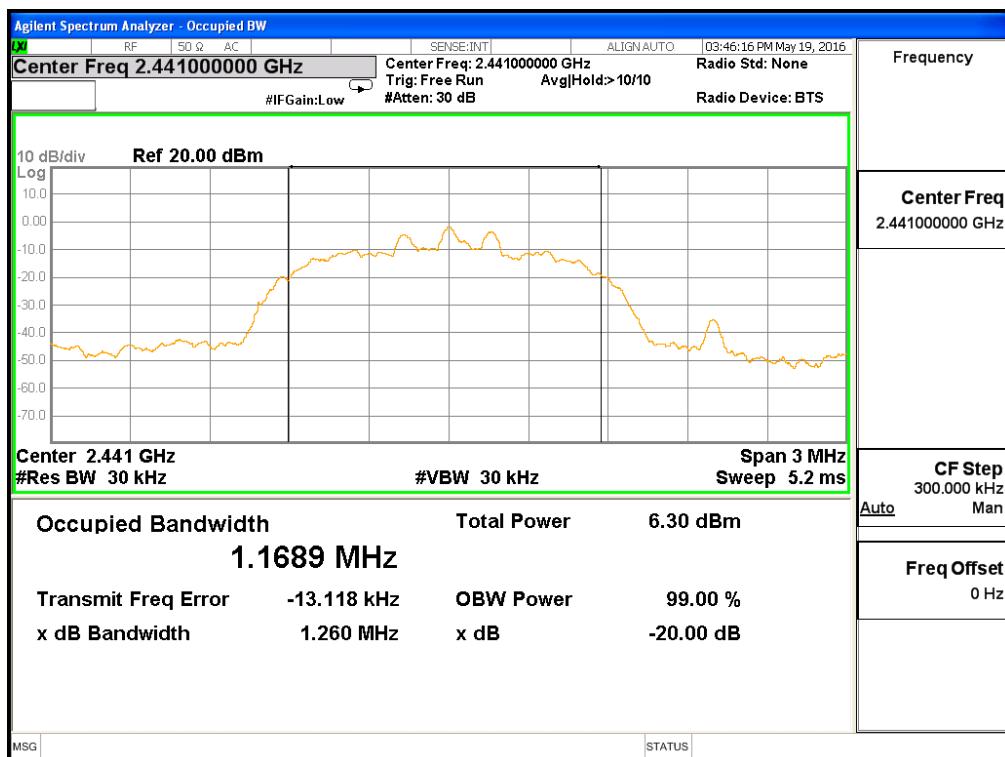
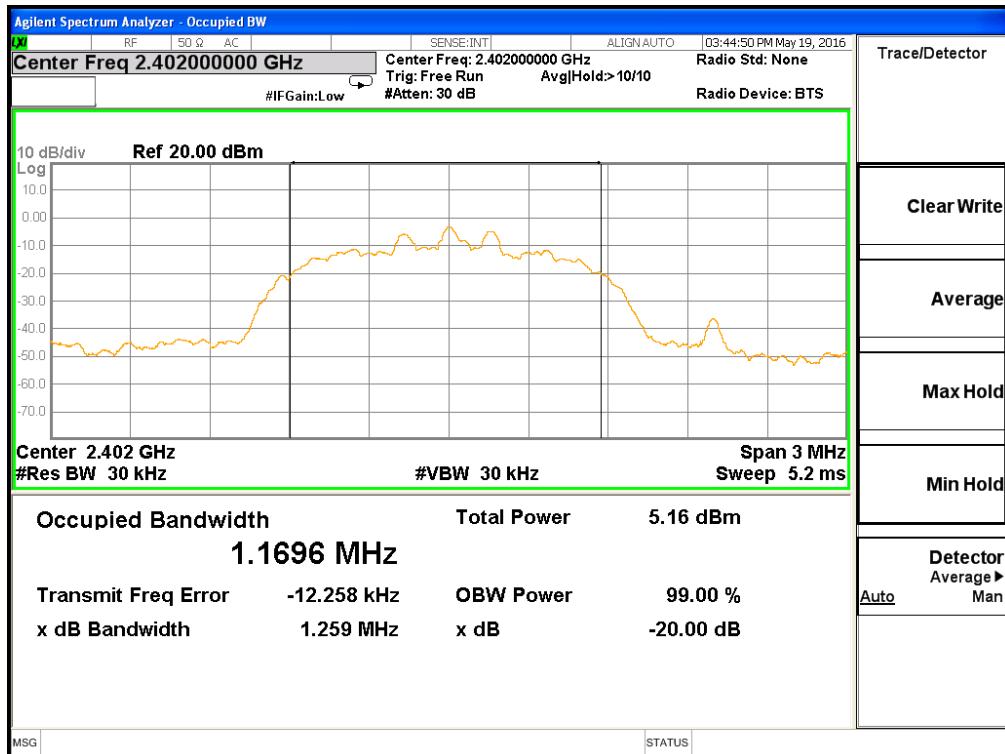
See next pages for actual measured spectrum plots.

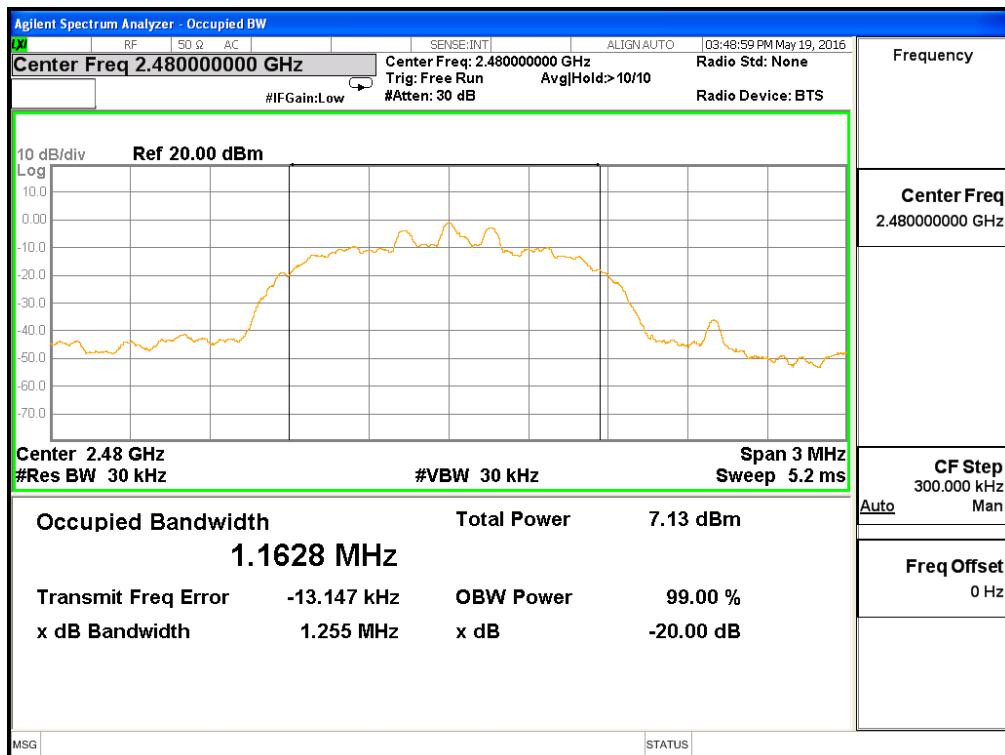
20 dB Bandwidth, Occupied Bandwidth (GFSK)





20 dB Bandwidth, Occupied Bandwidth (8-DPSK)





2.1.4 Time of Occupancy (Dwell Time)

Test Location

RF Test Room

Test Procedures

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

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. Then set it to any one measured frequency within its operating range and make sure the instrument is operated in its linear range.
3. Adjust the center frequency of spectrum analyzer on any frequency to be measured and set spectrum analyzer to zero span mode. And then, set RBW and VBW of spectrum analyzer to proper value.
4. Measure the time duration of one transmission on the measured frequency. And then plot the result with time difference of this time duration.
5. Repeat above procedures until all frequencies measured were complete.
6. The AUTO-i 100 has 3 type of payload, DH1, DH3, DH5. The hopping rate is 1600 per second.

The spectrum analyzer is set to:

Center frequency = the highest, middle, and the lowest channels

Span = zero

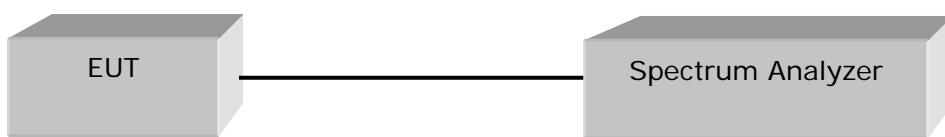
RBW = 1 MHz

Trace = max hold

VBW = 1 MHz (\geq RBW)

Detector function = peak

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



Limit

§15.247(a)(1)(iii) For frequency hopping system operating in 2400-2483.5 MHz band, 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.

Test Results

Time of occupancy on the TX channel in 31.6 sec = time domain slot length × hop rate ÷ number of hop per channel × 31.6

Test mode : GFSK

Channel Frequency (MHz)	Packet Type	Dwell Time (ms)	Test Results	
			Time of occupancy on the TX channel in 31.6sec (ms)	Result
2441	DH 1	0.414	132.5	Complies
	DH 3	1.672	267.5	Complies
	DH 5	2.923	311.8	Complies

$$\text{DH1 Dwell time} = 0.414 \text{ ms} \times (1600 \div 2) \div 79 \times 31.6 = 132.5 \text{ ms}$$

$$\text{DH3 Dwell time} = 1.672 \text{ ms} \times (1600 \div 4) \div 79 \times 31.6 = 267.5 \text{ ms}$$

$$\text{DH5 Dwell time} = 2.923 \text{ ms} \times (1600 \div 6) \div 79 \times 31.6 = 311.8 \text{ ms}$$

Test mode : 8-DPSK

Channel Frequency (MHz)	Packet Type	Dwell Time (ms)	Test Results	
			Time of occupancy on the TX channel in 31.6sec (ms)	Result
2441	3DH 1	0.437	139.8	Complies
	3DH 3	1.687	269.9	Complies
	3DH 5	2.938	313.4	Complies

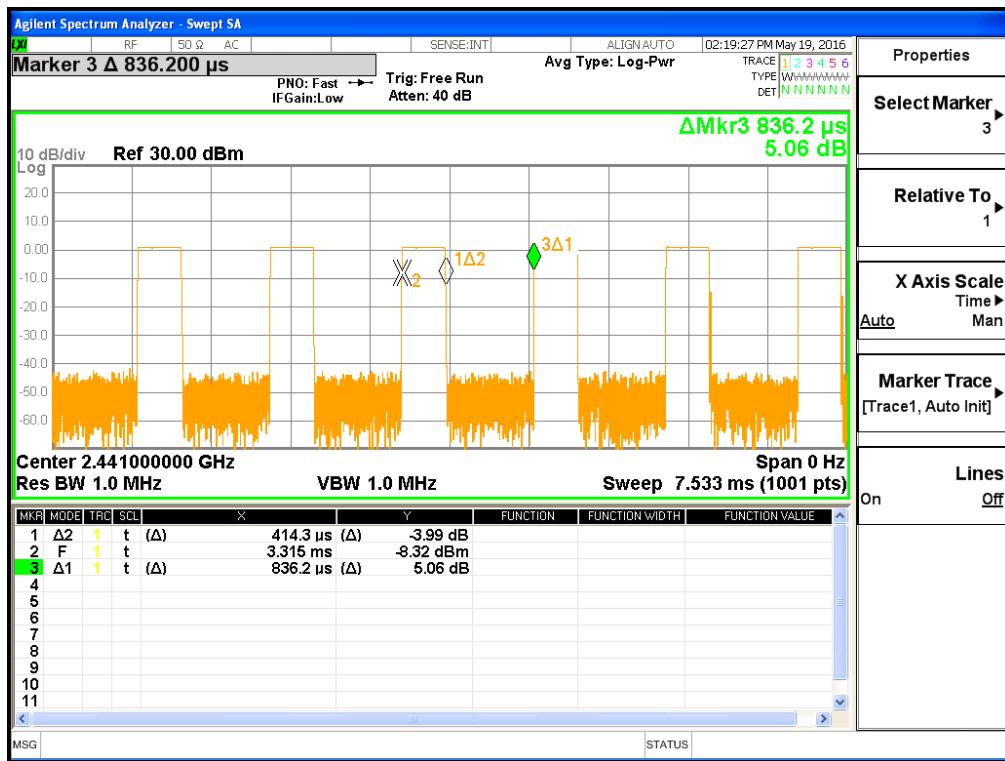
$$\text{3DH1 Dwell time} = 0.437 \text{ ms} \times (1600 \div 2) \div 79 \times 31.6 = 139.8 \text{ ms}$$

$$\text{3DH3 Dwell time} = 1.687 \text{ ms} \times (1600 \div 4) \div 79 \times 31.6 = 269.9 \text{ ms}$$

$$\text{3DH5 Dwell time} = 2.938 \text{ ms} \times (1600 \div 6) \div 79 \times 31.6 = 313.4 \text{ ms}$$

See next pages for actual measured spectrum plots.

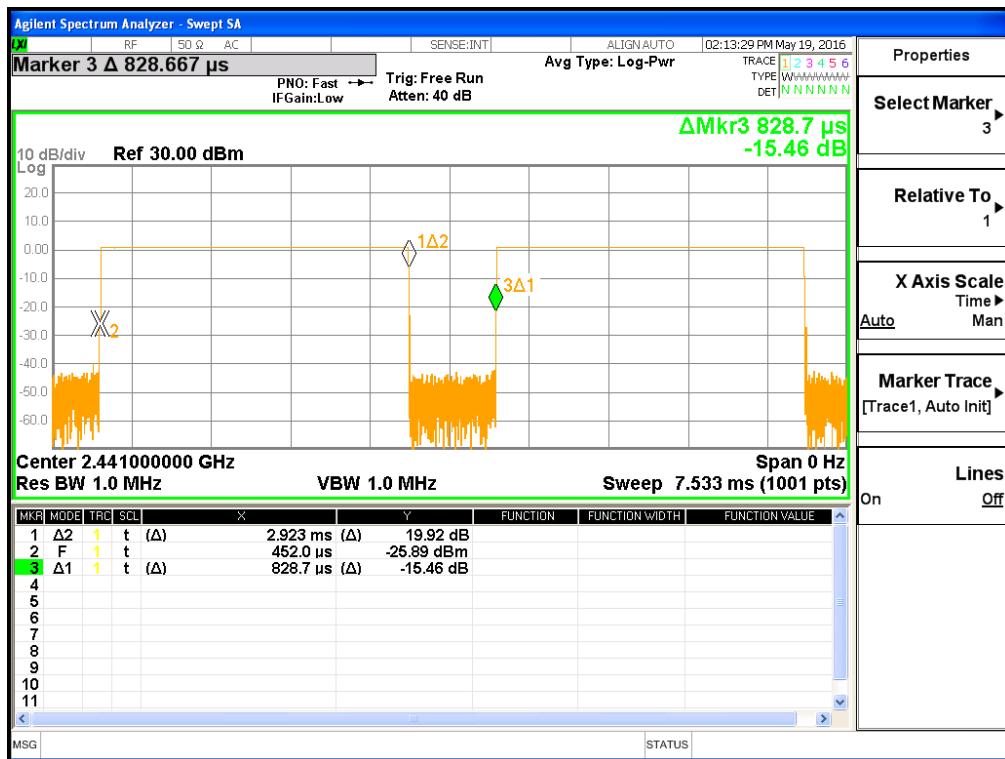
Time of Occupancy for PACKET Type DH1(GFSK)



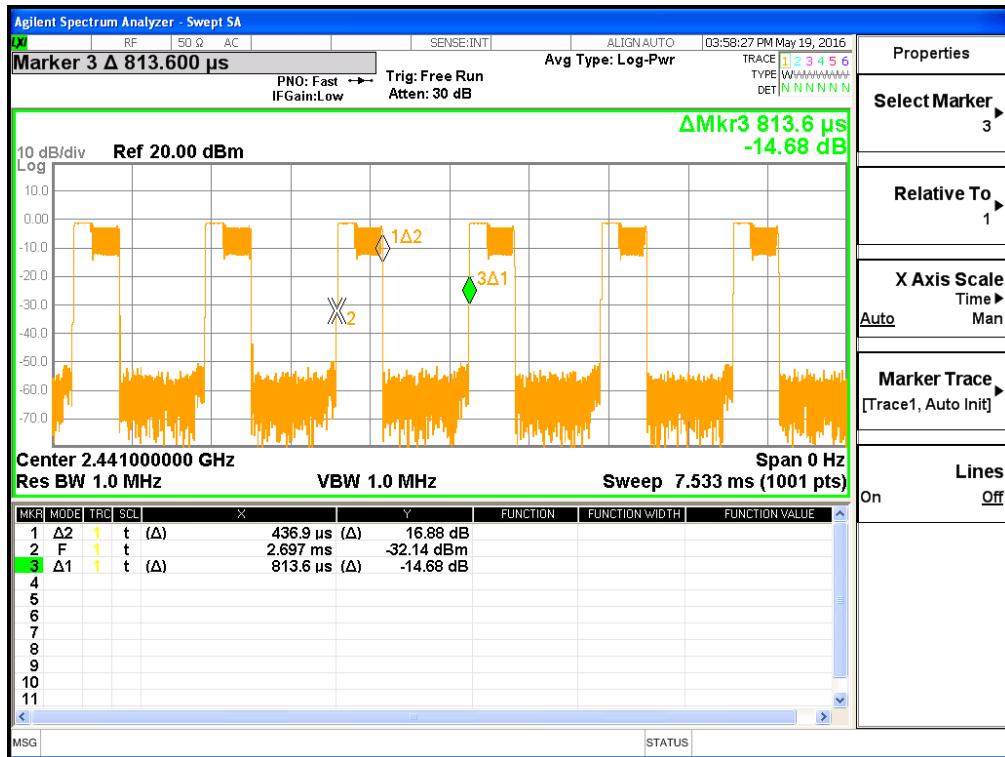
Time of Occupancy for PACKET Type DH3(GFSK)



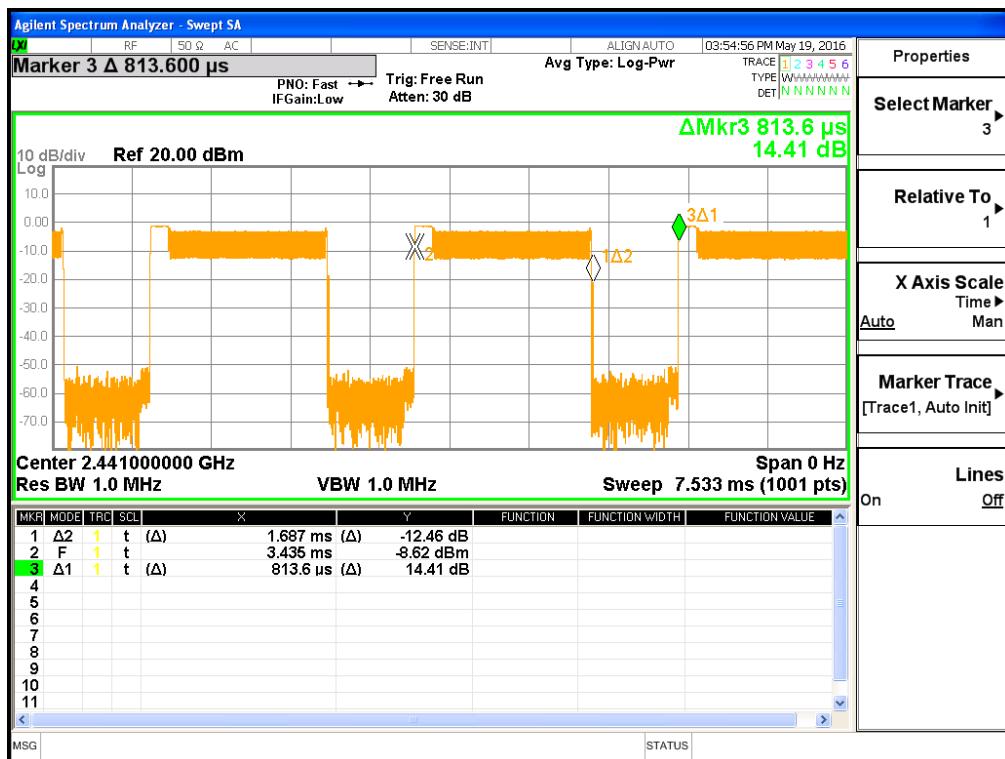
Time of Occupancy for PACKET Type DH5(GFSK)



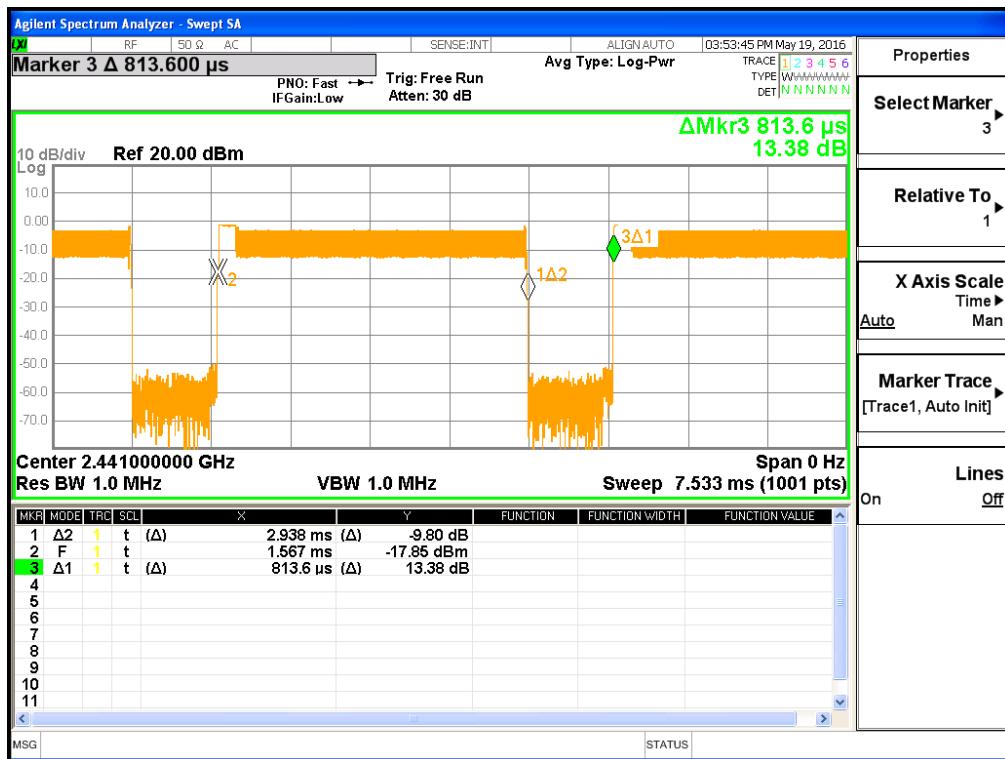
Time of Occupancy for PACKET Type 3DH1(8-DPSK)



Time of Occupancy for PACKET Type 3DH3(8-DPSK)



Time of Occupancy for PACKET Type 3DH5(8-DPSK)



2.1.5 Maximum peak Conducted Output Power

Test Location

RF Test Room

Test Procedures

The maximum peak conducted output power was measured with a spectrum analyzer connected to the antenna terminal, while EUT has its hopping function disabled at the highest, middle and the lowest available channels.

The spectrum analyzer is set to:

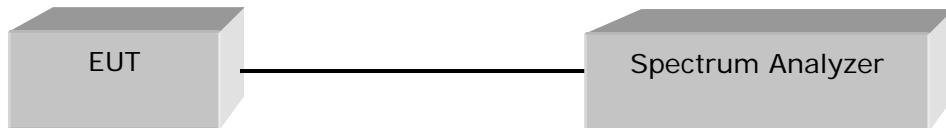
Center frequency = the highest, middle, and the lowest channels

Span = 5 MHz (approximately 5 times of the 20 dB bandwidth)

RBW = 3 MHz (greater than the 20 dB bandwidth of the emission being measured)

VBW = 3 MHz (\geq RBW) Detector function = peak

Trace = max hold Sweep = auto



Limit

§5.247(b)(1) The Maximum Peak Output Power Measurement is 0.125 Watts for frequency hopping system operating in 2400-2483.5 MHz employing at least 15 Hopping channels.

Test Results

Test mode : GFSK, CFG PKT Packet Type : 15 Packet Size : 339(DH5)

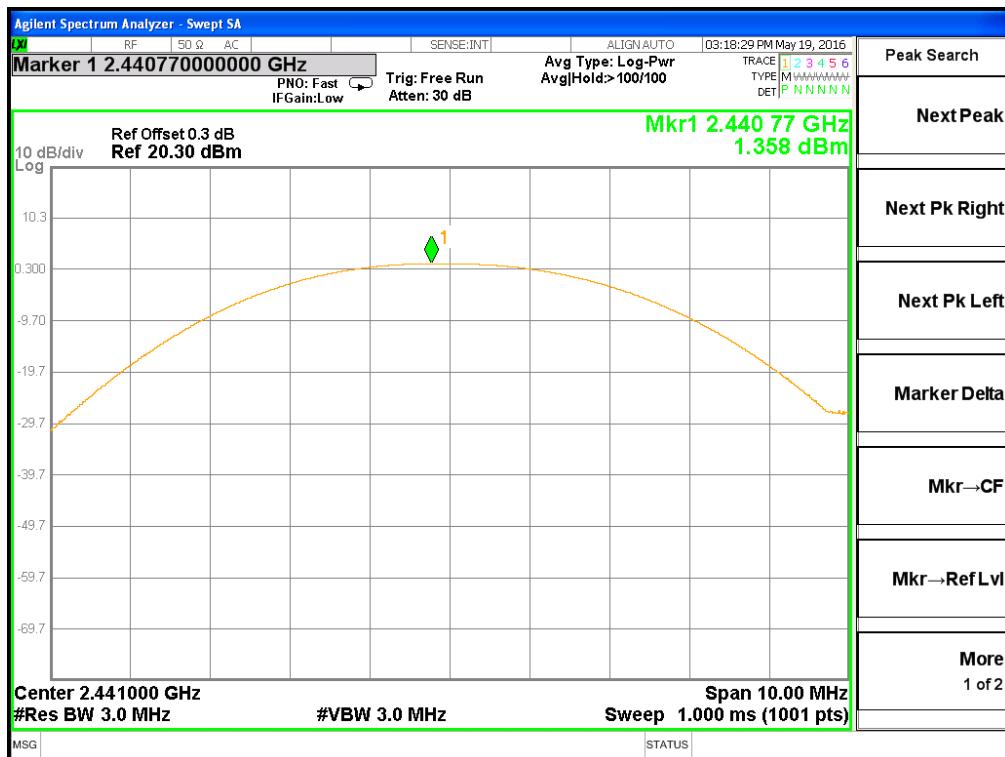
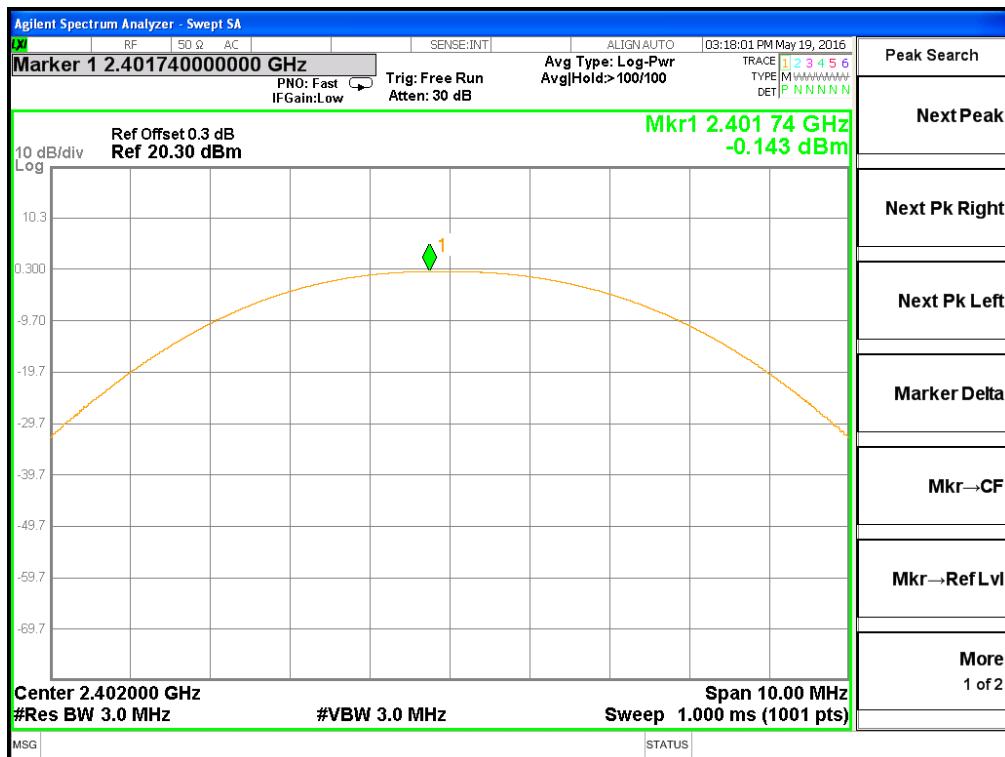
Frequency (MHz)	Channel No.	Peak output power(dBm)	Peak output power(mW)	Result
2402	0	-0.143	0.968	Complies
2441	39	1.358	1.367	Complies
2480	78	2.197	1.658	Complies

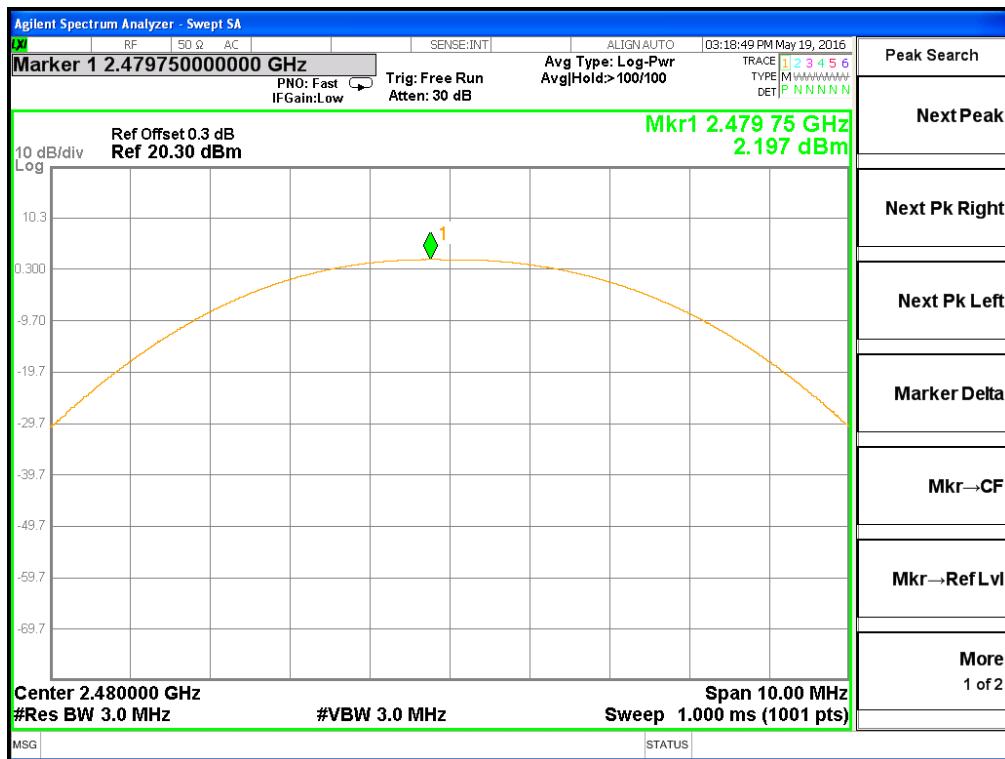
Test mode : 8-DPSK, CFG PKT Packet Type : 31 Packet Size : 1021(3DH5)

Frequency (MHz)	Channel No.	Peak output power(dBm)	Peak output power(mW)	Result
2402	0	-1.552	-1.552	Complies
2441	39	-0.344	-0.344	Complies
2480	78	0.259	0.259	Complies

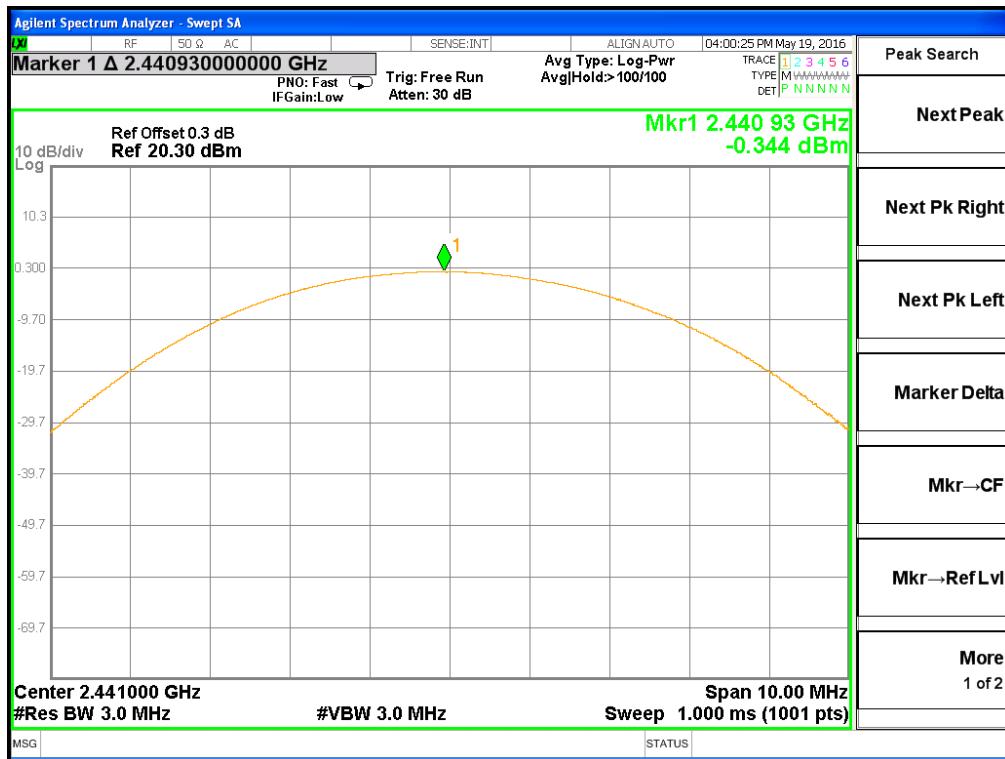
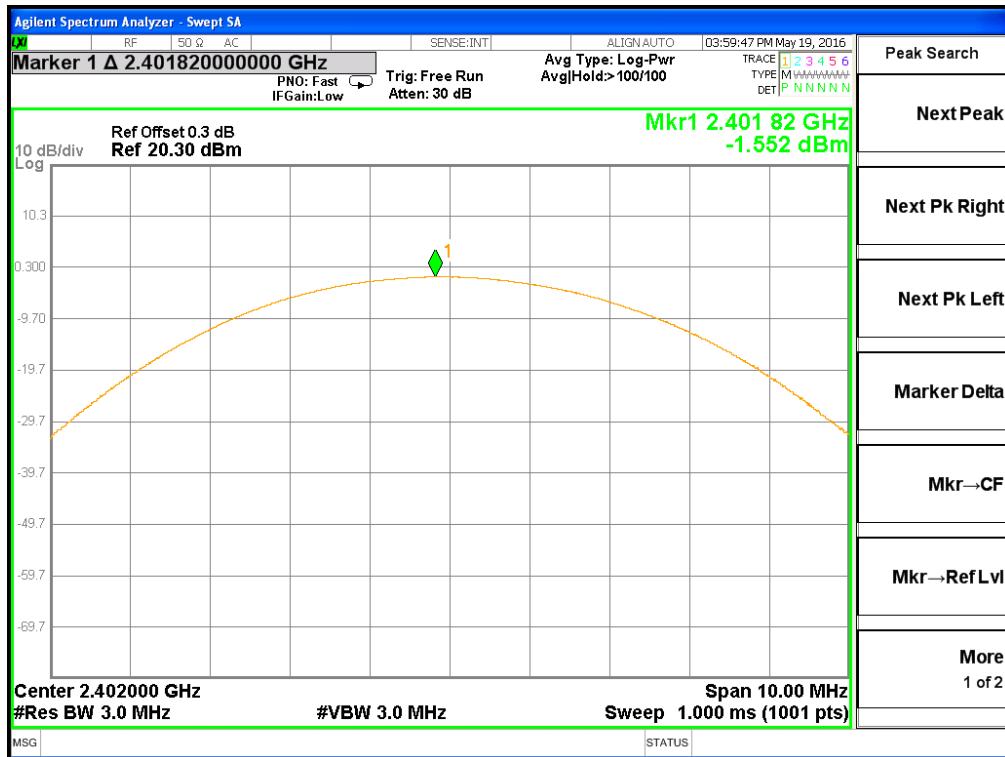
See next pages for actual measured spectrum plots.

Maximum peak Conducted Output Power - GFSK





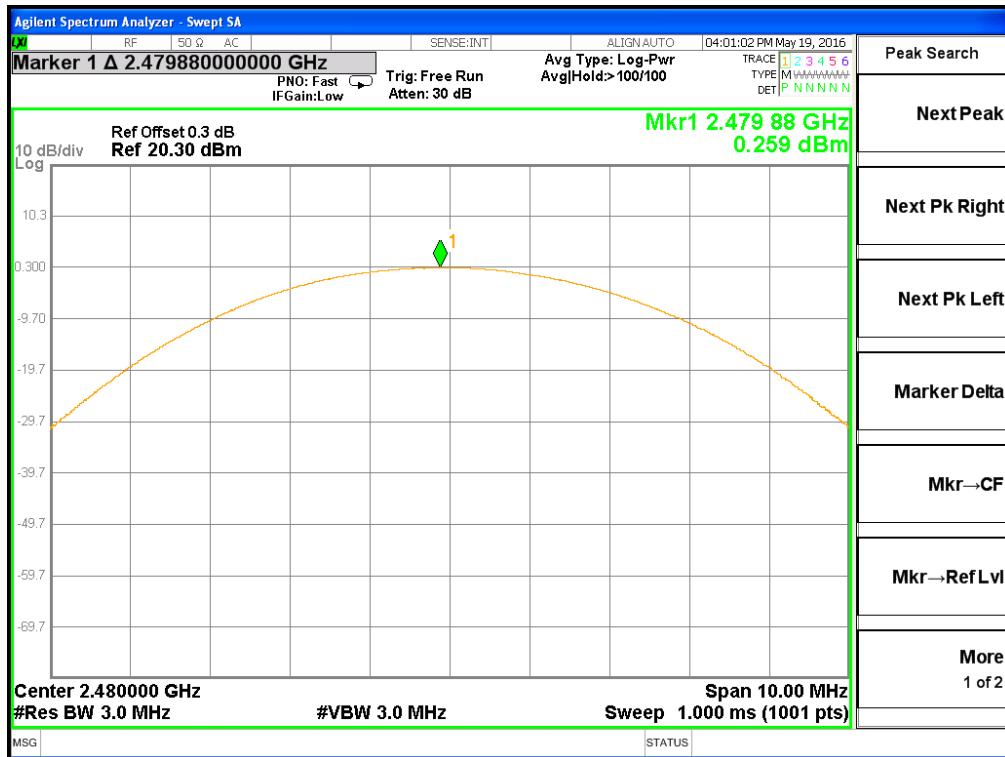
Maximum peak Conducted Output Power – 8-DPSK





CTK Co., Ltd.

CTK Co., Ltd.
(Ho-dong), 113, Yejik-ro, Cheoin-gu, Yongin-si, Gyeonggi-do, Korea
Tel: +82-31-339-9970 Fax: +82-31-624-9501
www.e-ctk.com



2.1.6 Band-edge

Test Location

RF Test Room

Test Procedures

The bandwidth at 20 dB down from the highest inband spectral density was measured with a spectrum analyzer connected to the antenna terminal, while EUT has its hopping function disabled at the highest, middle and the lowest available channels.

The spectrum analyzer is set to:

Center frequency = the highest, middle, and the lowest channels

RBW = 100 kHz

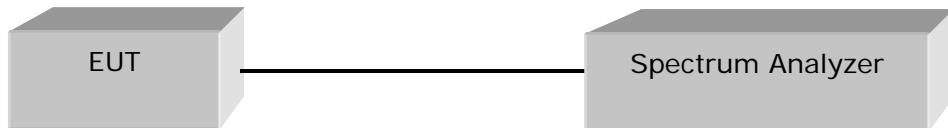
VBW = 300 kHz (\geq RBW)

Span = 10 MHz

Trace = max hold

Detector function = peak

Sweep = auto



Limit

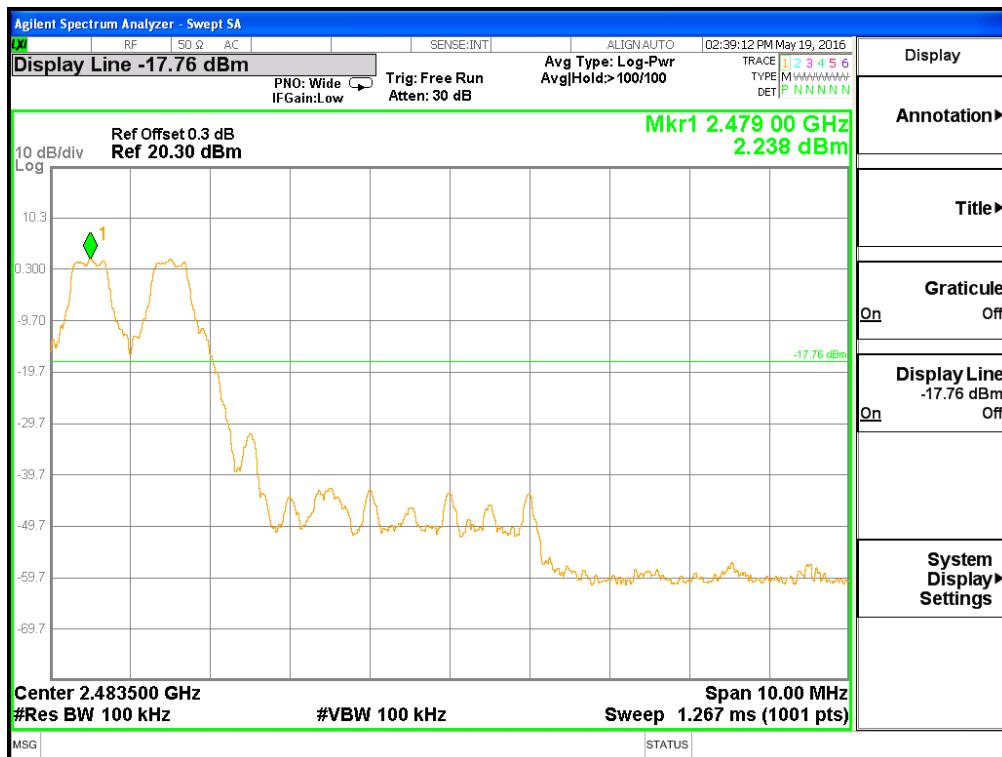
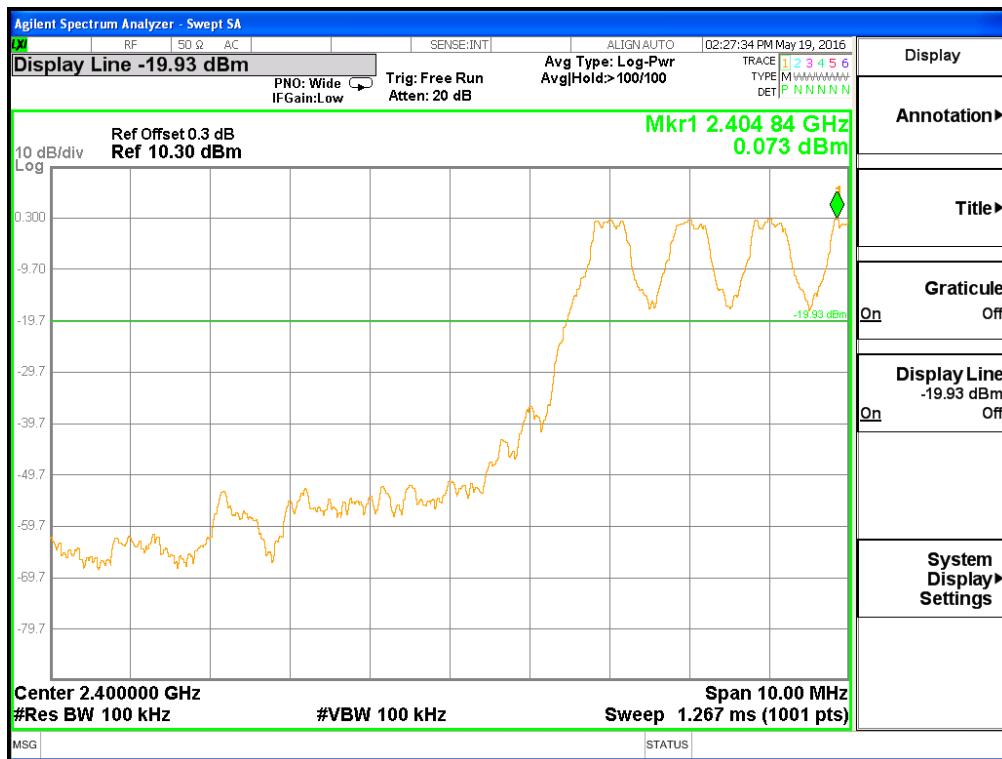
> 20 dBc

Test Results

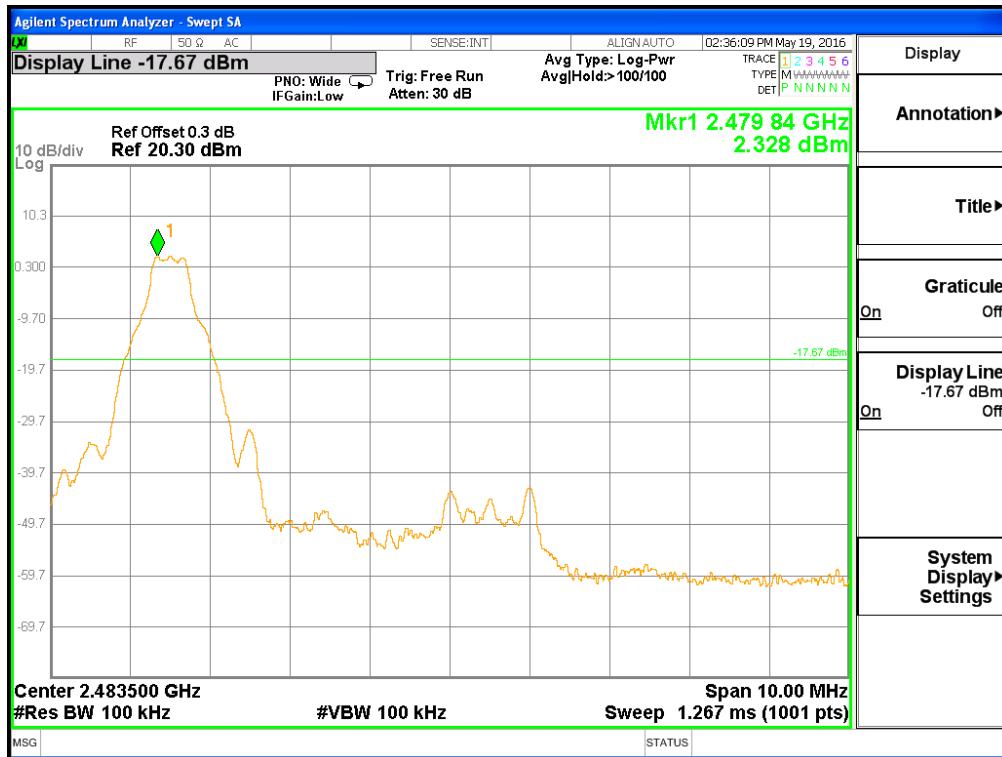
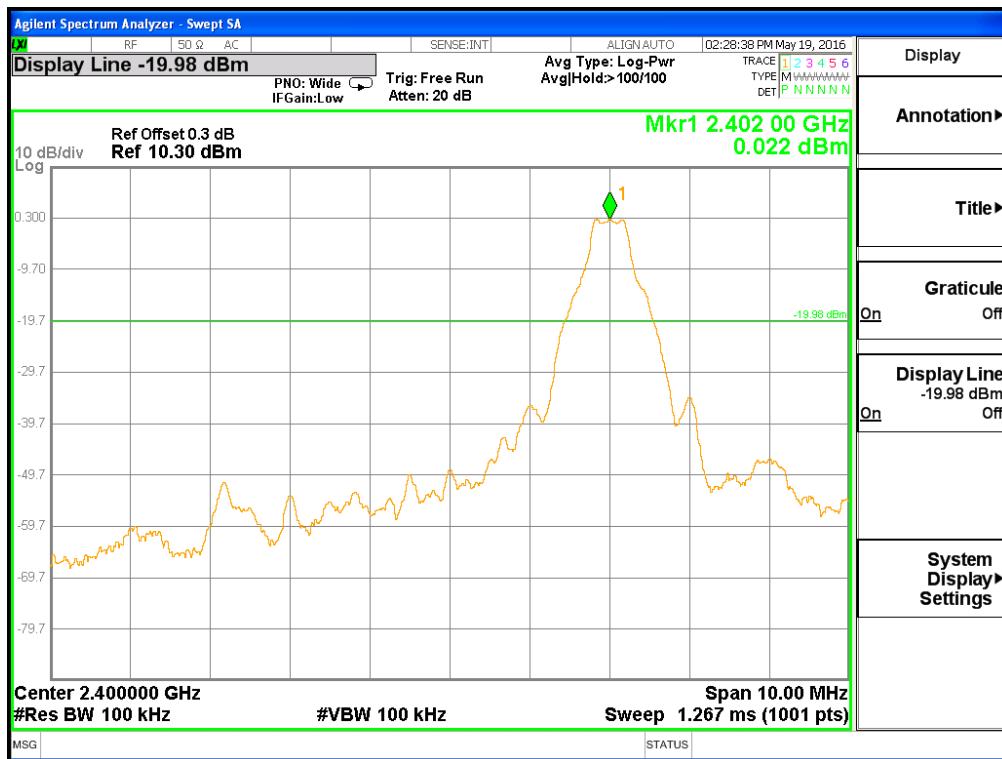
All conducted emission in any 100 kHz bandwidth outside of the spectrum band was at least 20 dB lower than the highest level of the inband spectral density. Therefore the applying equipment meets the requirement.

See next pages for actual measured spectrum plots.

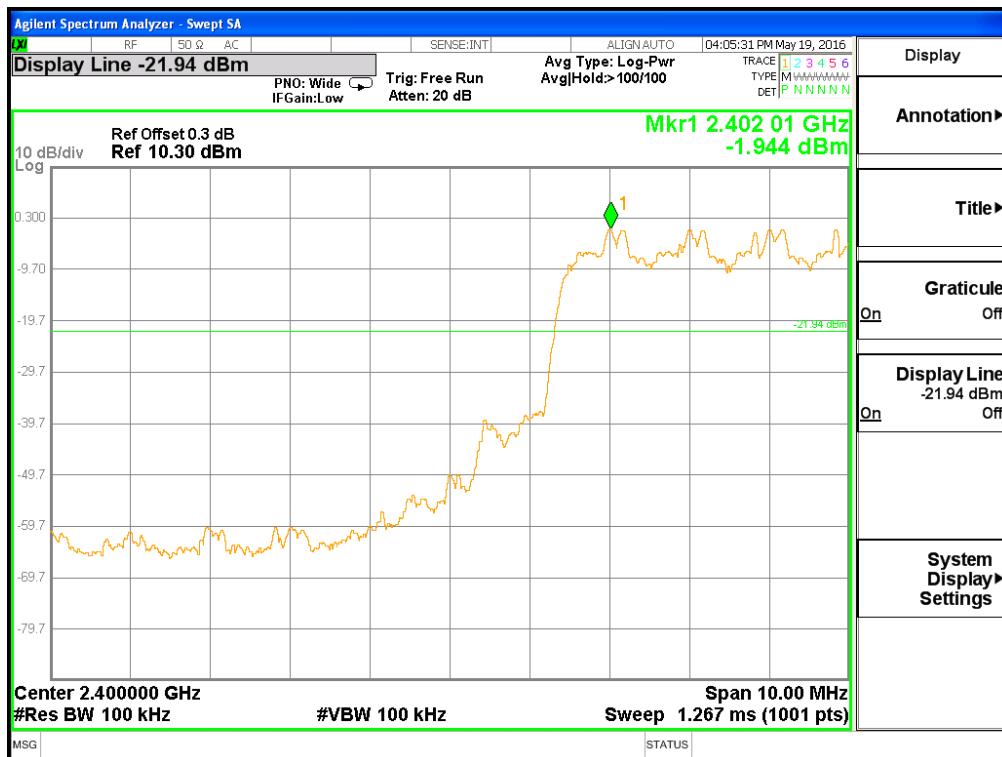
Band – edge (with Hopping) - GFSK



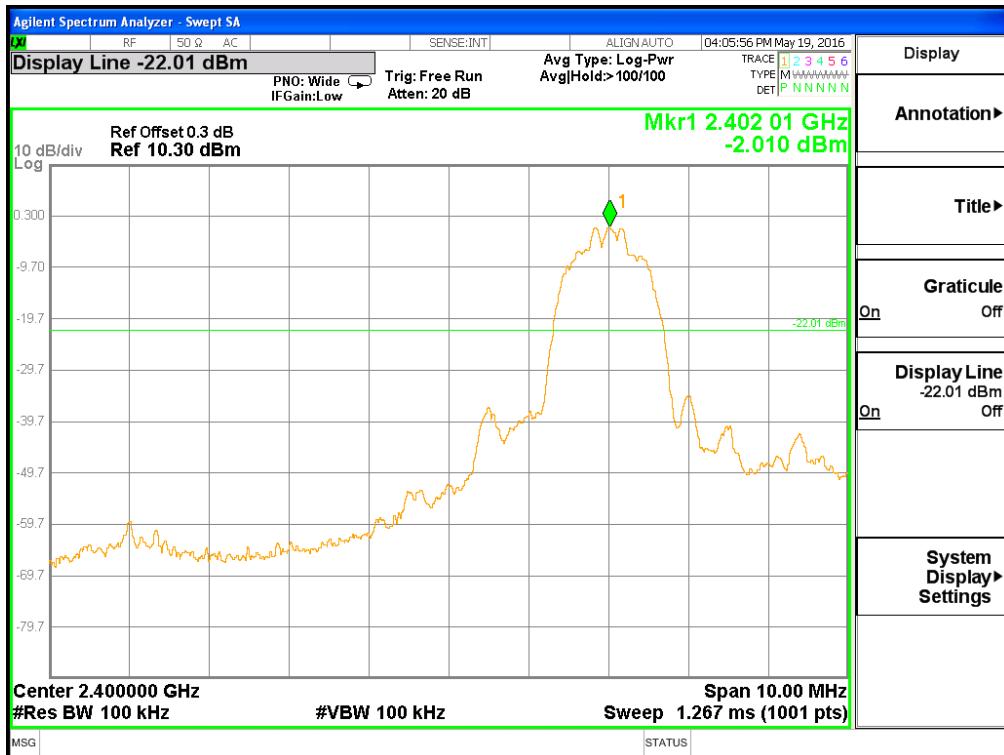
Band – edge (without Hopping) - GFSK



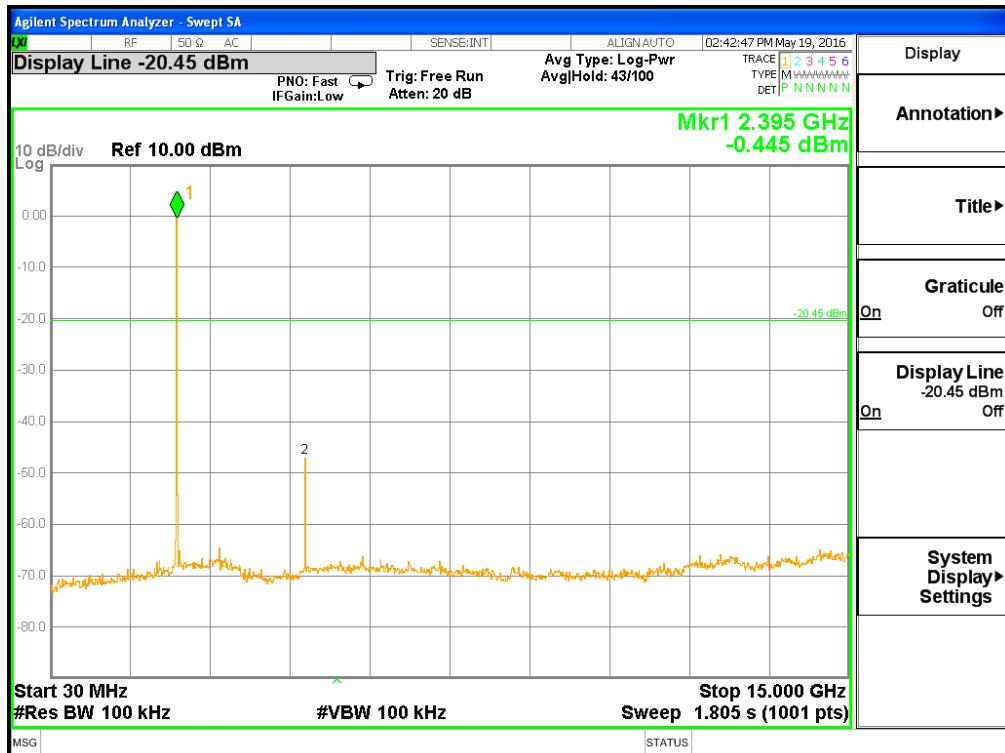
Band – edge (with Hopping) – 8-DPSK



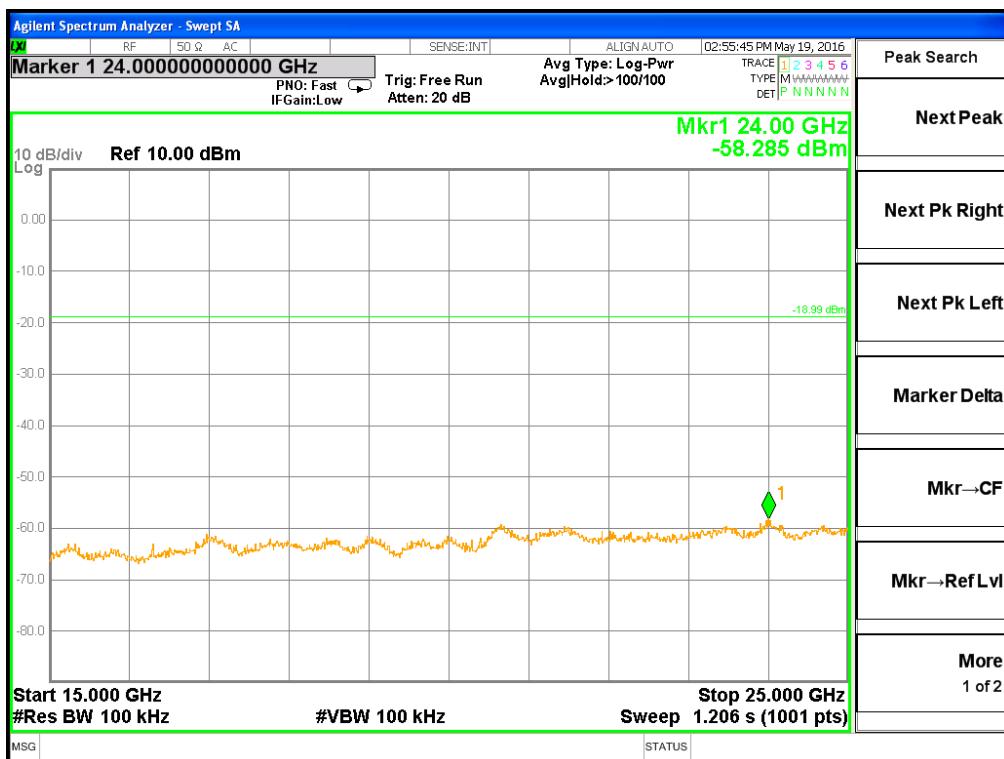
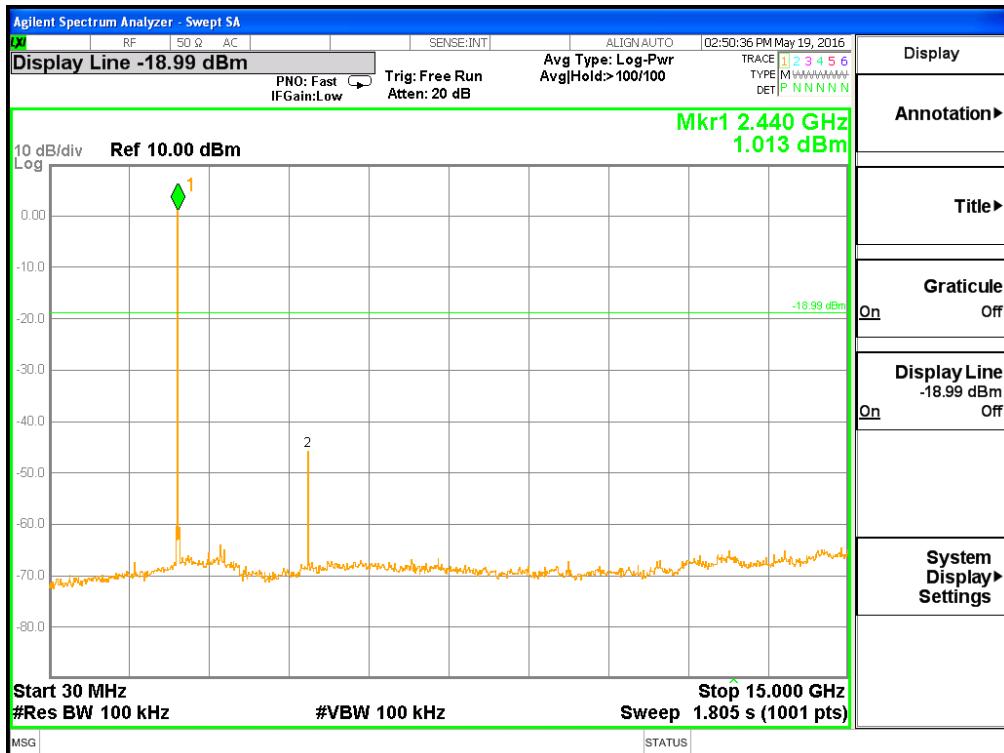
Band – edge (without Hopping) – 8-DPSK



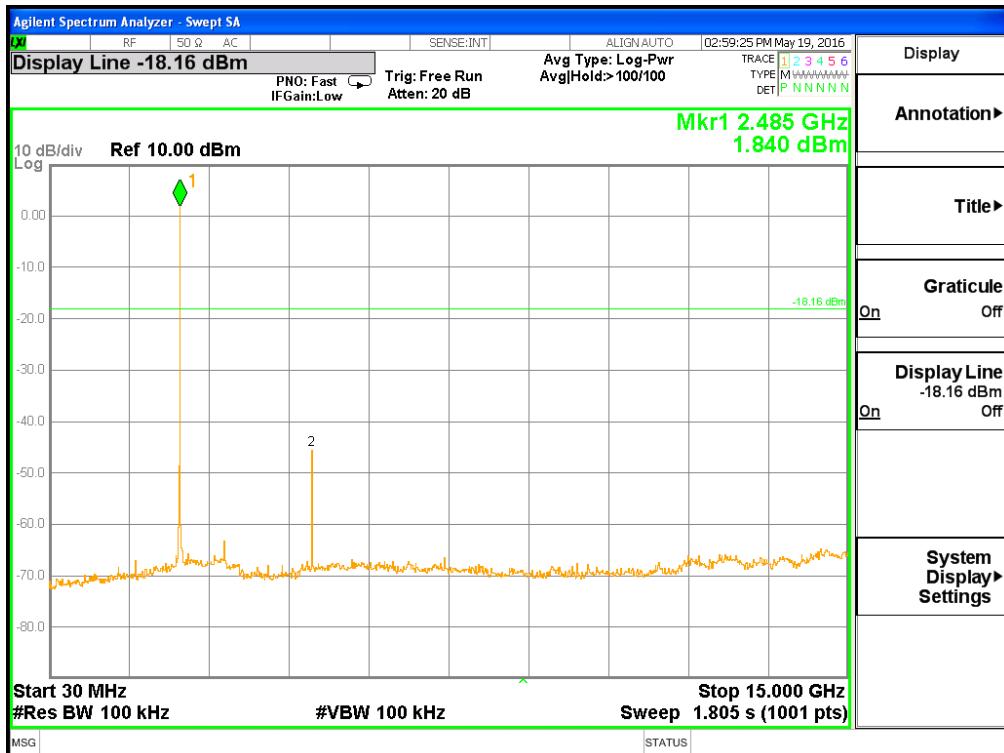
**Band – edge (at 20 dB blow) – Low channel
Frequency Range = 30 MHz ~ 10th harmonic
(GFSK : Worst-Case)**



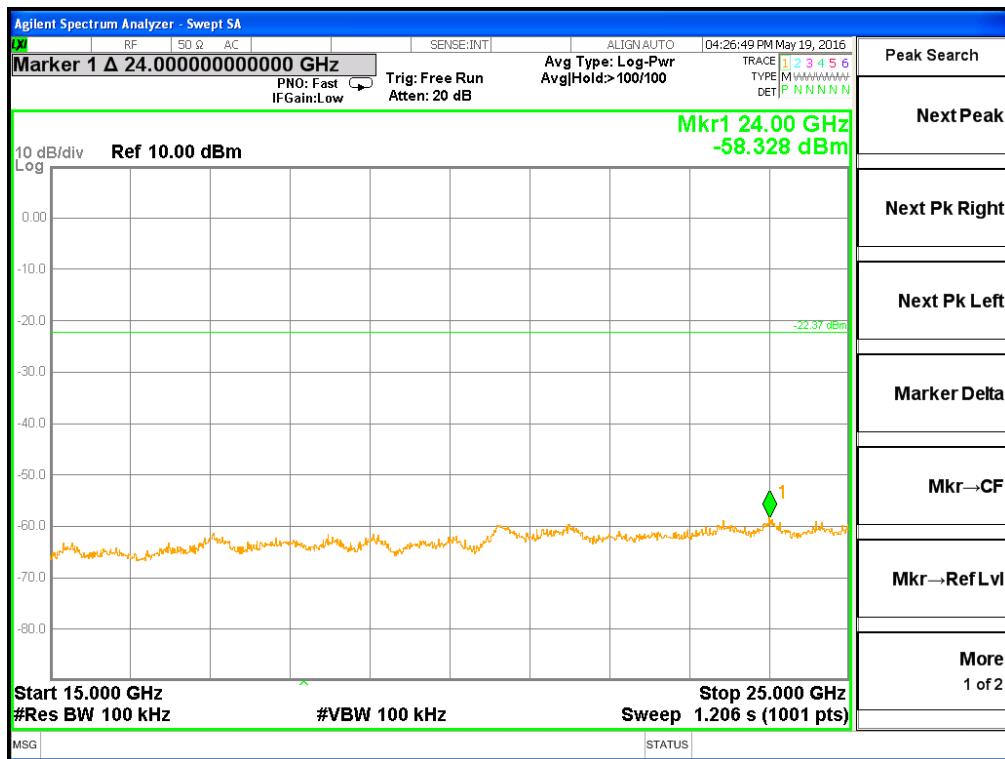
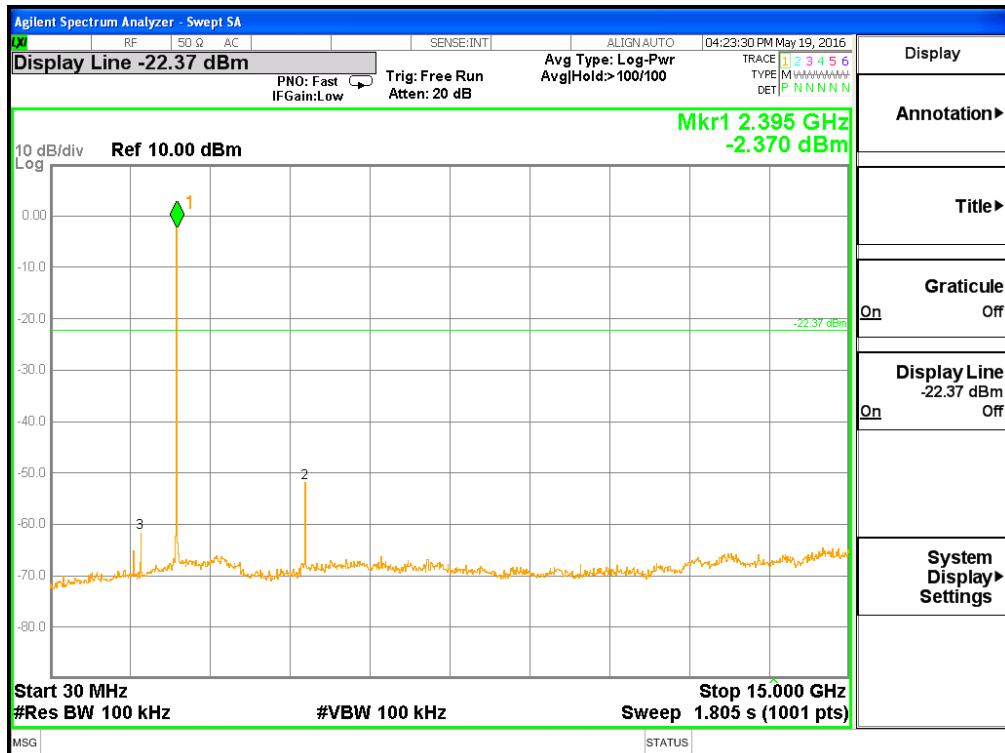
Band – edge (at 20 dB blow) – Mid channel
Frequency Range = 30 MHz ~ 10th harmonic
(GFSK : Worst-Case)



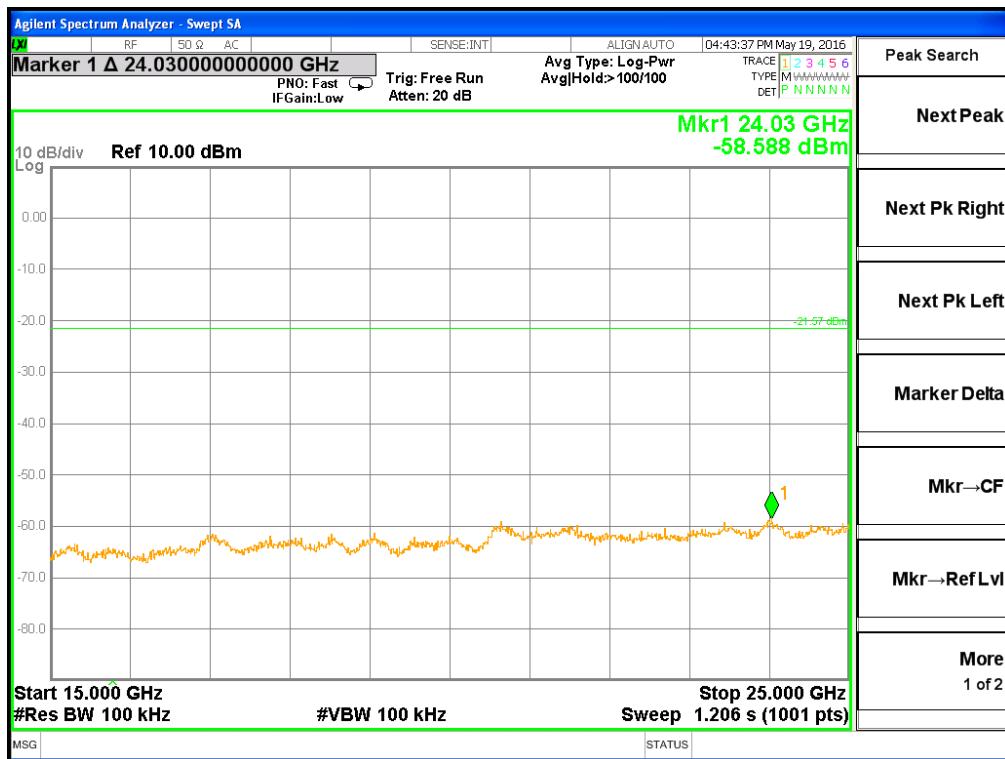
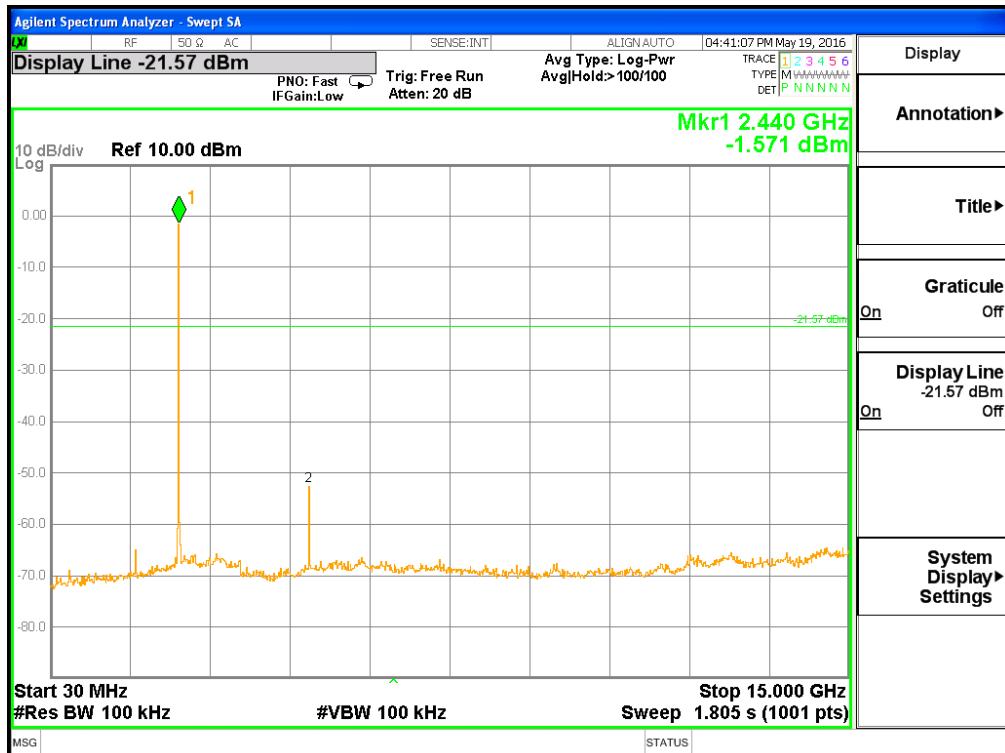
**Band – edge (at 20 dB blow) – High channel
Frequency Range = 30 MHz ~ 10th harmonic
(GFSK : Worst-Case)**



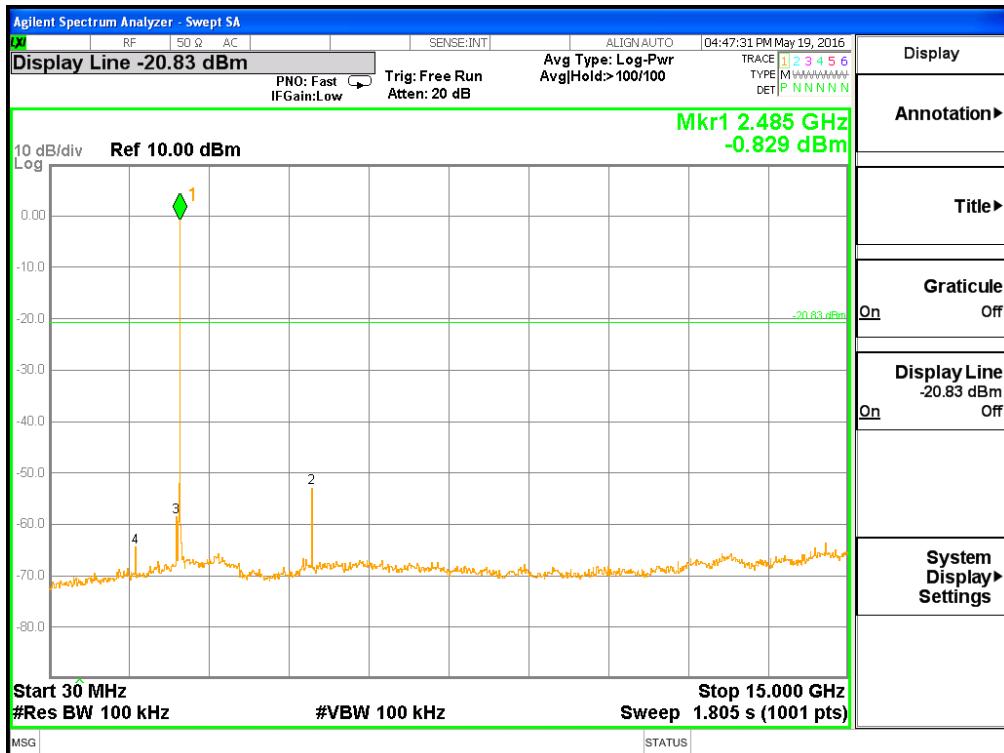
**Band – edge (at 20 dB blow) – Low channel
Frequency Range = 30 MHz ~ 10th harmonic
(8-DPSK : Worst-Case)**



Band – edge (at 20 dB blow) – Mid channel
Frequency Range = 30 MHz ~ 10th harmonic
(8-DPSK : Worst-Case)



**Band – edge (at 20 dB blow) – High channel
Frequency Range = 30 MHz ~ 10th harmonic
(8-DPSK : Worst-Case)**



2.1.7 Field Strength of Emissions

Test Location

- 10 m SAC (test distance : 10 m, 3 m)
- 3 m SAC (test distance : 3 m)

Test Procedures

- 1) In the frequency range of 9 kHz to 30 MHz, magnetic field is measured with Loop Antenna. The Test Antenna is positioned with its plane vertical at 1m distance from the EUT. The center of the Loop Test Antenna is 1m above the ground. During the measurement the Loop Test Antenna rotates about its vertical axis for maximum response at each azimuth about the EUT.
- 2) In the frequency range above 30 MHz, Bi-Log Test Antenna(30 MHz to 1 GHz) and Horn Test Antenna(above 1 GHz) are used. Test Antenna is 3m away from the EUT. Test Antenna height is carried from 1m to 4m above the ground to determine the maximum value of the field strength. The emissions levels at both horizontal and vertical polarizations should be tested.

The spectrum analyzer is set to:

Frequency Range = 9 kHz ~ 25 GHz (2.4 GHz 10th harmonic)

RBW = 1 MHz for f ≥ 1 GHz, 100 kHz for f < 1 GHz, 9 kHz for f < 30 MHz

VBW ≥ RBW

Sweep = auto

Limit

- 15.209(a)

Frequency(MHz)	Field Strength uV/m@3m	Field Strength dBuV/m@3m	Deasurement Distance (meters)
0.009-0.490	2400/F(kHz)	-	300
0.490-1.705	24000/F(kHz)	-	30
1.705-30	30	-	30
30-88	100**	40	3
88-216	150**	43.5	3
216-960	200**	46	3
Above 960	500	54	3

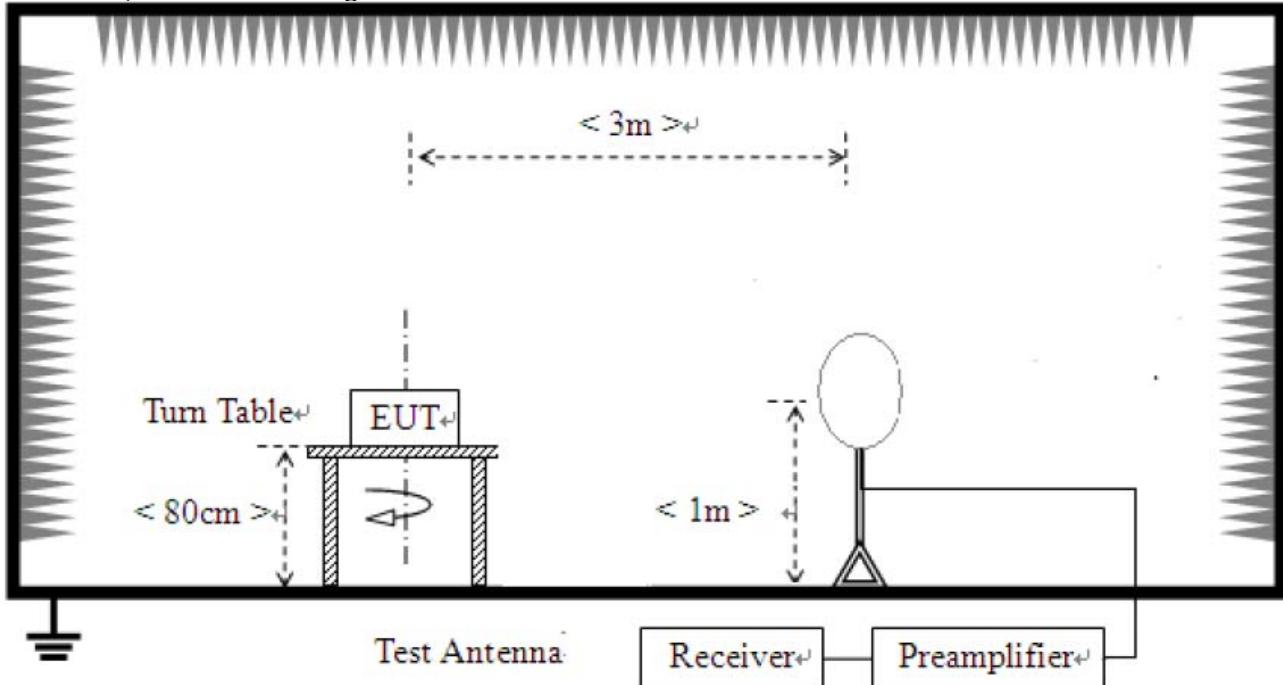
** Except as provided in 15.209(g).fundamental emissions from intentional radiators operating under this Section shall not be located in the frequency bands 54-72MHz, 76-88MHz, 174-216MHz, 470-806MHz. However, operation within these frequency bands is permitted under other sections of this Part, e.g.15.231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

Note :

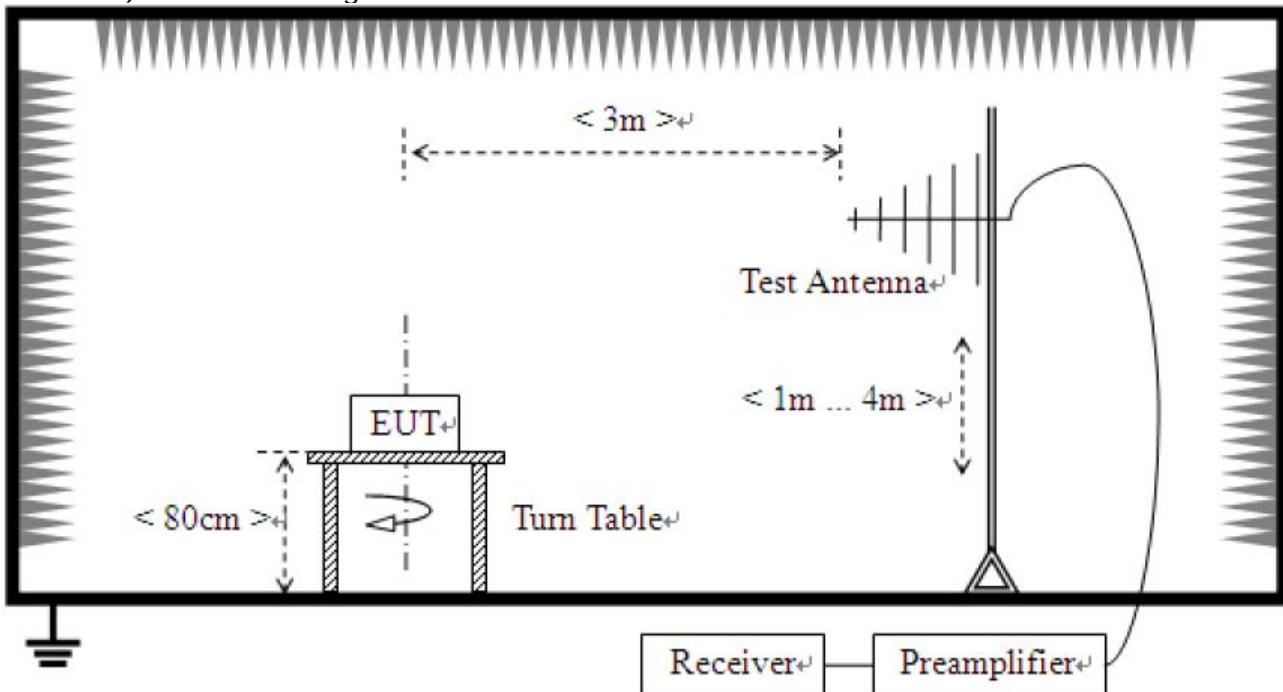
- 1) For above 1 GHz, the emission limit in this paragraph is based on measurement instrumentation employing an average detector, measurement using instrumentation with a peak detector function, corresponding to 20 dB above the maximum permitted average limit.
- 2) For above 1 GHz, limit field strength of harmonics : 54 dBuV/m@3m (AV) and 74 dBuV/m@3m (PK)

Test Setup:

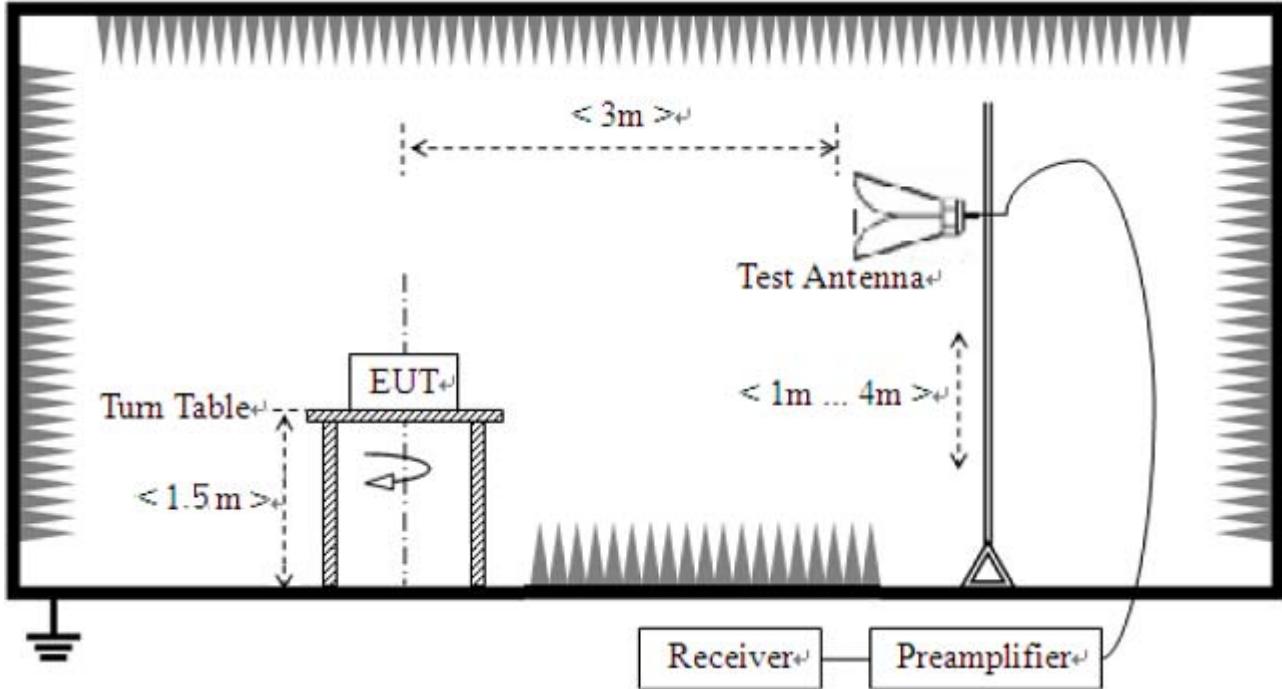
1) For field strength of emissions from 9 kHz to 30 MHz



2) For field strength of emissions from 30 MHz to 1 GHz



3) For field strength of emissions above 1 GHz



Test Results

1) 9 kHz to 30 MHz

Test mode : GFSK, CFG PKT Packet Type : 15 Packet Size : 339(DH5)

Test mode : 8-DPSK, CFG PKT Packet Type : 31 Packet Size : 1021(3DH5)

EUT	Vehicle Diagnostic	Measurement Detail	
Model	AUTO-i 100	Frequency Range	9 kHz – 30 MHz
Test mode	GFSK, 8-DPSK	Detector function	Quasi-Peak

The requirements are:

Complies

Frequency (MHz)	Measured Data (dBuV/m)	Margin (dB)	Remark
-	-	-	See note

Note :

The amplitude of spurious emissions that are attenuated by more than 20 dB below the permissible value has no need to be reported.

Distance extrapolation factor = $40 \log (\text{specific distance} / \text{test distance})$ (dB)

2) 30 MHz to 1 GHz

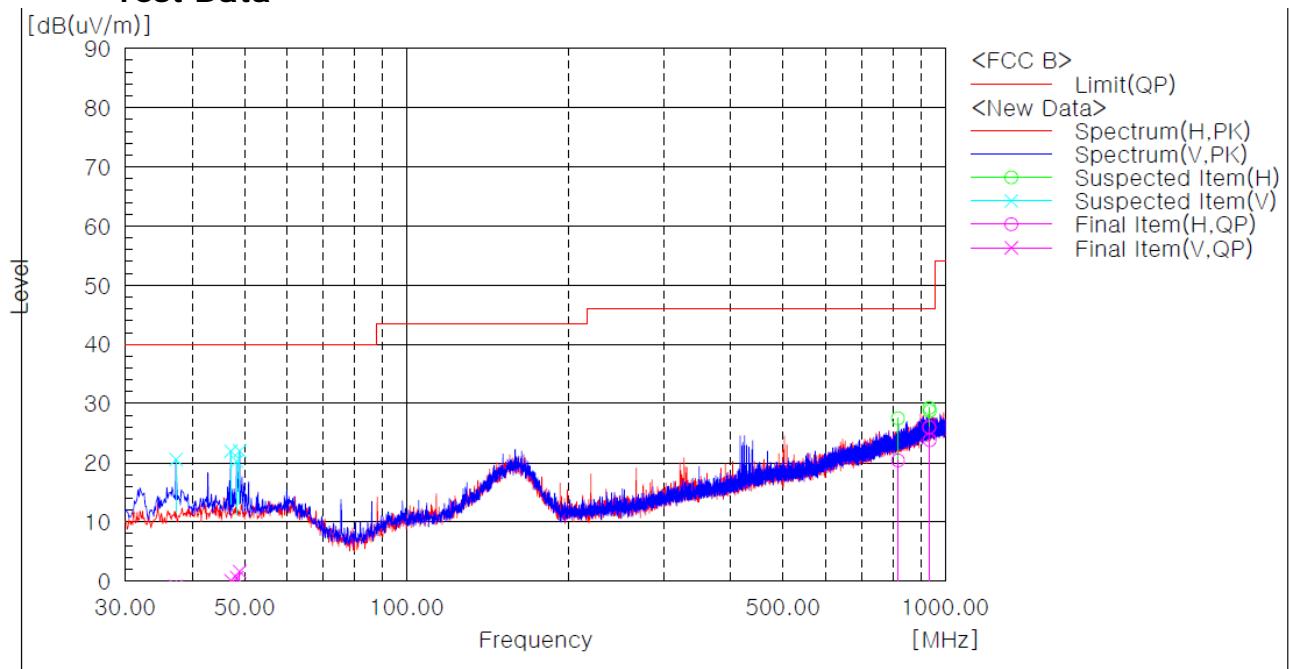
EUT	Vehicle Diagnostic	Measurement Detail	
Model	AUTO-i 100	Frequency Range	Below 1000MHz
Test mode	GFSK Hopping	Detector function	Quasi-Peak / Peak

The requirements are:

Complies

Frequency (MHz)	Measured Data (dBuV/m)	Margin (dB)	Remark
933.797	26.0	20.0	Quasi-Peak

Test Data



Final Result

No.	Frequency [MHz]	(P) [dB(uV)]	Reading QP [dB(1/m)]	c.f [dB(uV/m)]	Result QP [dB(uV/m)]	Limit QP [dB(uV/m)]	Margin QP [dB]	Angle [deg]
1	37.275	V	14.6	-15.5	-0.9	40.0	40.9	187.0
2	47.096	V	15.0	-14.9	0.1	40.0	39.9	281.8
3	48.309	V	15.6	-15.0	0.6	40.0	39.4	281.8
4	48.915	V	16.7	-15.1	1.6	40.0	38.4	281.8
5	817.276	H	24.0	-3.6	20.4	46.0	25.6	272.1
6	933.797	H	27.6	-1.6	26.0	46.0	20.0	347.1
7	935.980	H	25.4	-1.6	23.8	46.0	22.2	245.5

Remark :

- The field strength of spurious emission was measured in the following position: EUT stand-up position(Z axis), lie-down position(X,Y axis). The worst emission was found in lie-down position(X axis) and the worst case was recorded.

3) above 1 GHz

Test mode : GFSK, CFG PKT Packet Type : 15 Packet Size : 339(DH5)

EUT	Vehicle Diagnostic	Measurement Detail	
Model	AUTO-i 100	Frequency Range	1-25GHz
		Detector function	Average / Peak

Remarks

We have tested three mode (X, Y, Z). The worst mode (X axis) for final test.

The requirements are:

Complies

Frequency (MHz)	Measured Data (dBuV/m)	Margin (dB)	Remark
4960.00	46.09	7.91	Average

Test Data

Ch.0(Low Channel)

Frequency (MHz)	(P)	Reading AV [dB(uV)]	Reading PK [dB(uV)]	Factor [dB(1/m)]	Limit AV [dB(uV/m)]	Limit PK [dB(uV/m)]	Level AV [dB(uV/m)]	Level PK [dB(uV/m)]	Margin AV [dB]	Margin PK [dB]
4804.00	V	40.43	49.29	3.72	54.00	74.00	44.15	53.01	9.85	20.99
4804.00	H	41.05	49.32	3.72	54.00	74.00	44.77	53.04	9.23	20.96

Ch.39(Mid Channel)

Frequency (MHz)	(P)	Reading AV [dB(uV)]	Reading PK [dB(uV)]	Factor [dB(1/m)]	Limit AV [dB(uV/m)]	Limit PK [dB(uV/m)]	Level AV [dB(uV/m)]	Level PK [dB(uV/m)]	Margin AV [dB]	Margin PK [dB]
4882.00	V	42.26	52.26	3.72	54.00	74.00	45.98	55.98	8.02	18.02
4882.00	H	42.33	50.53	3.72	54.00	74.00	46.05	54.25	7.95	19.75

Ch.78(High Channel)

Frequency (MHz)	(P)	Reading AV [dB(uV)]	Reading PK [dB(uV)]	Factor [dB(1/m)]	Limit AV [dB(uV/m)]	Limit PK [dB(uV/m)]	Level AV [dB(uV/m)]	Level PK [dB(uV/m)]	Margin AV [dB]	Margin PK [dB]
4960.00	V	42.24	51.55	3.85	54.00	74.00	46.09	55.40	7.91	18.60
4960.00	H	41.31	49.82	3.85	54.00	74.00	45.16	53.67	8.84	20.33

Restricted band edge test data

Measured frequency range : 2310-2390 MHz, 2483.5-2500 MHz

Frequency (MHz)	(P)	Reading AV [dB(uV)]	Reading PK [dB(uV)]	Factor [dB(1/m)]	Limit AV [dB(uV/m)]	Limit PK [dB(uV/m)]	Level AV [dB(uV/m)]	Level PK [dB(uV/m)]	Margin AV [dB]	Margin PK [dB]

No emissions were detected at a level greater than 20dB below limit.



CTK Co., Ltd.
The Prime Leader of Global Regulatory Certification

CTK Co., Ltd.
(Ho-dong), 113, Yejik-ro, Cheoin-gu, Yongin-si, Gyeonggi-do, Korea
Tel: +82-31-339-9970 Fax: +82-31-624-9501
www.e-ctk.com

Test mode : 8-DPSK, CFG PKT Packet Type : 31 Packet Size : 1021(3DH5)

EUT	Vehicle Diagnostic	Measurement Detail	
Model	AUTO-i 100	Frequency Range	1-25GHz
		Detector function	Average / Peak

Remarks

We have tested three mode (X, Y, Z). The worst mode (X axis) for final test.

The requirements are:

Complies

Frequency (MHz)	Measured Data (dBuV/m)	Margin (dB)	Remark
2483.5	42.04	11.96	Average

Test Data

Ch.0(Low Channel)

Frequency [MHz]	(P)	Reading AV [dB(uV)]	Reading PK [dB(uV)]	Factor [dB(1/m)]	Limit AV [dB(uV/m)]	Limit PK [dB(uV/m)]	Level AV [dB(uV/m)]	Level PK [dB(uV/m)]	Margin AV [dB]	Margin PK [dB]

No emissions were detected at a level greater than 20dB below limit.

Ch.39(Mid Channel)

Frequency [MHz]	(P)	Reading AV [dB(uV)]	Reading PK [dB(uV)]	Factor [dB(1/m)]	Limit AV [dB(uV/m)]	Limit PK [dB(uV/m)]	Level AV [dB(uV/m)]	Level PK [dB(uV/m)]	Margin AV [dB]	Margin PK [dB]

No emissions were detected at a level greater than 20dB below limit.

Ch.78(High Channel)

Frequency [MHz]	(P)	Reading AV [dB(uV)]	Reading PK [dB(uV)]	Factor [dB(1/m)]	Limit AV [dB(uV/m)]	Limit PK [dB(uV/m)]	Level AV [dB(uV/m)]	Level PK [dB(uV/m)]	Margin AV [dB]	Margin PK [dB]

No emissions were detected at a level greater than 20dB below limit.

Restricted band edge test data

Measured frequency range : 2310-2390 MHz, 2483.5-2500 MHz

Frequency [MHz]	(P)	Reading AV [dB(uV)]	Reading PK [dB(uV)]	Factor [dB(1/m)]	Limit AV [dB(uV/m)]	Limit PK [dB(uV/m)]	Level AV [dB(uV/m)]	Level PK [dB(uV/m)]	Margin AV [dB]	Margin PK [dB]
2483.50	V	44.18	59.11	-2.52	54.00	74.00	41.66	56.59	12.34	17.41
2483.50	H	44.56	62.01	-2.52	54.00	74.00	42.04	59.49	11.96	14.51

Test Results

1) 9 kHz to 30 MHz

Test mode : Receiver

EUT	Vehicle Diagnostic	Measurement Detail	
Model	AUTO-i 100	Frequency Range	9 kHz – 30 MHz
Test mode	Receiver	Detector function	Quasi-Peak

The requirements are:

Complies

Frequency (MHz)	Measured Data (dBuV/m)	Margin (dB)	Remark
-	-	-	See note

Note :

The amplitude of spurious emissions that are attenuated by more than 20 dB below the permissible value has no need to be reported.

Distance extrapolation factor = $40 \log (\text{specific distance} / \text{test distance})$ (dB)

2) 30 MHz to 1 GHz

Test mode : Receiver

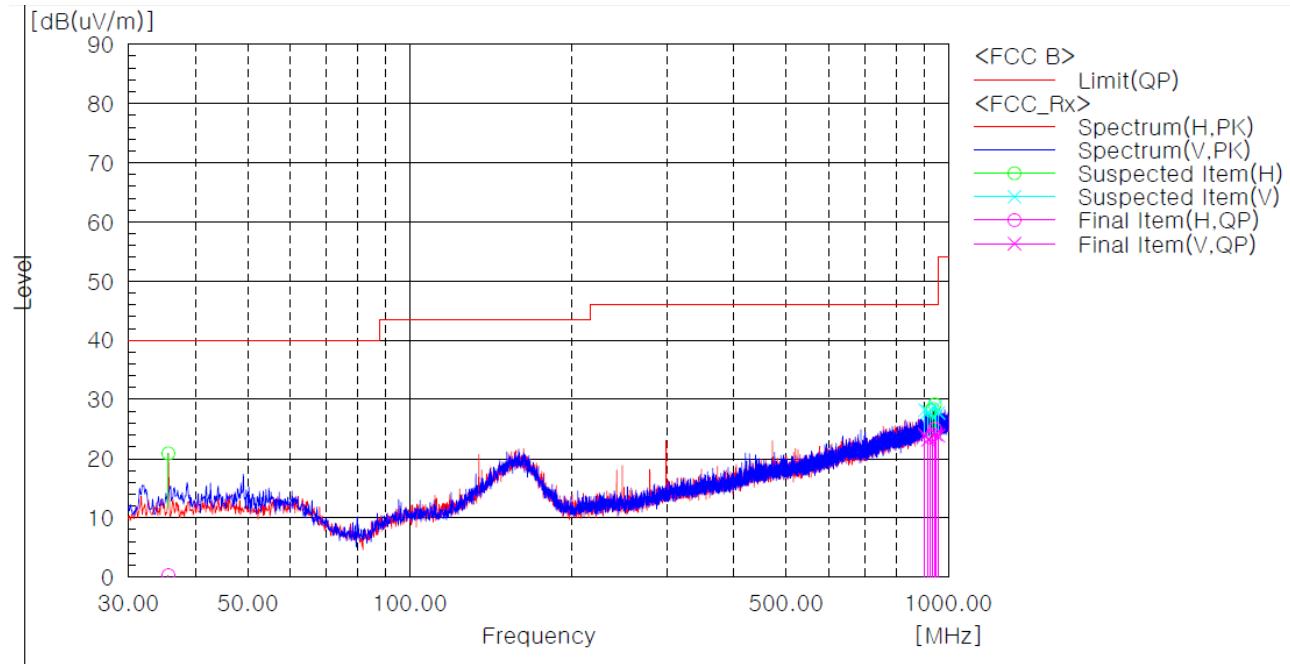
EUT	Vehicle Diagnostic	Measurement Detail	
Model	AUTO-i 100	Frequency Range	Below 1000MHz
Test mode	Receiver	Detector function	Quasi-Peak / Peak

The requirements are:

Complies

Frequency (MHz)	Measured Data (dBuV/m)	Margin (dB)	Remark
943.619	25.0	21.0	Quasi-Peak

Test Data



Final Result

No.	Frequency [MHz]	(P)	Reading QP [dB(uV)]	c. f [dB(1/m)]	Result QP [dB(uV/m)]	Limit QP [dB(uV/m)]	Margin QP [dB]	Angle [deg]
1	35.578	H	16.1	-15.8	0.3	40.0	39.7	56.9
2	904.455	V	26.0	-2.0	24.0	46.0	22.0	177.5
3	916.701	V	25.0	-1.8	23.2	46.0	22.8	1.5
4	926.765	H	25.3	-1.7	23.6	46.0	22.4	290.9
5	935.980	H	25.7	-1.6	24.1	46.0	21.9	43.4
6	943.619	H	26.5	-1.5	25.0	46.0	21.0	85.6
7	947.014	V	25.6	-1.5	24.1	46.0	21.9	7.0
8	957.684	V	25.3	-1.4	23.9	46.0	22.1	248.1

Remark :

1. The field strength of spurious emission was measured in the following position: EUT stand-up position(Z axis), lie-down position(X,Y axis). The worst emission was found in lie-down position(X axis) and the worst case was recorded.

3) above 1 GHz

Test mode : Receiver

EUT	Vehicle Diagnostic	Measurement Detail		
Model	AUTO-i 100		Frequency Range	1-25GHz
	Detector function		Average / Peak	

Remarks

We have tested three mode (X, Y, Z). The worst mode (X axis) for final test.

The requirements are:

Complies

Frequency (MHz)	Measured Data (dBuV/m)	Margin (dB)	Remark
No emissions were detected at a level greater than 20dB below limit.			

Test Data

Ch.0(Low Channel)

Frequency [MHz]	(P)	Reading AV [dB(uV)]	Reading PK [dB(uV)]	Factor [dB(1/m)]	Limit AV [dB(uV/m)]	Limit PK [dB(uV/m)]	Level AV [dB(uV/m)]	Level PK [dB(uV/m)]	Margin AV [dB]	Margin PK [dB]
No emissions were detected at a level greater than 20dB below limit.										

No emissions were detected at a level greater than 20dB below limit.

Ch.39(Mid Channel)

Frequency [MHz]	(P)	Reading AV [dB(uV)]	Reading PK [dB(uV)]	Factor [dB(1/m)]	Limit AV [dB(uV/m)]	Limit PK [dB(uV/m)]	Level AV [dB(uV/m)]	Level PK [dB(uV/m)]	Margin AV [dB]	Margin PK [dB]
No emissions were detected at a level greater than 20dB below limit.										

No emissions were detected at a level greater than 20dB below limit.

Ch.78(High Channel)

Frequency [MHz]	(P)	Reading AV [dB(uV)]	Reading PK [dB(uV)]	Factor [dB(1/m)]	Limit AV [dB(uV/m)]	Limit PK [dB(uV/m)]	Level AV [dB(uV/m)]	Level PK [dB(uV/m)]	Margin AV [dB]	Margin PK [dB]
No emissions were detected at a level greater than 20dB below limit.										

No emissions were detected at a level greater than 20dB below limit.

Restricted band edge test data

Measured frequency range : 2310-2390 MHz, 2483.5-2500 MHz

Frequency [MHz]	(P)	Reading AV [dB(uV)]	Reading PK [dB(uV)]	Factor [dB(1/m)]	Limit AV [dB(uV/m)]	Limit PK [dB(uV/m)]	Level AV [dB(uV/m)]	Level PK [dB(uV/m)]	Margin AV [dB]	Margin PK [dB]
No emissions were detected at a level greater than 20dB below limit.										

No emissions were detected at a level greater than 20dB below limit.

2.1.8 AC Conducted Emissions

Test Location

Shielded Room

Frequency Range of Measurement

150 kHz to 30 MHz

Instrument Settings

IF Band Width: 9 kHz

Test Procedures

The EUT was placed on a non-metallic table 0.8m above the metallic, grounded floor and 0.4m from the reference ground plane wall. The distance to other metallic surfaces was at least 0.8m.

Amplitude measurements were performed with a quasi-peak detector and an average detector.

Limit

- 15.207(a)

Frequency (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.

Test Results

The requirements are:

Complies

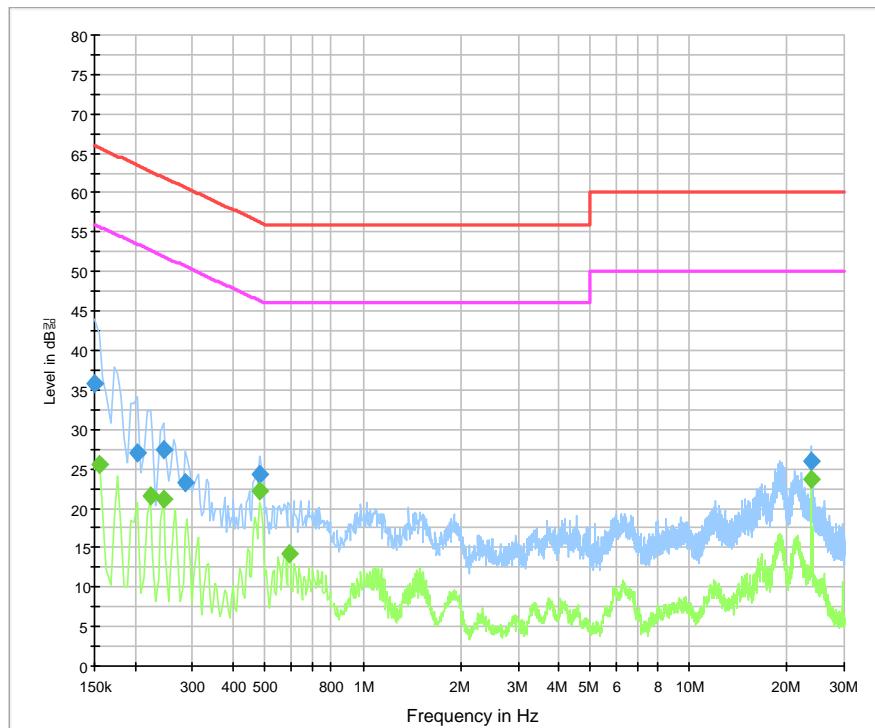
Test mode : USB Charge

Frequency (MHz)	Measured Data (dBuV/m)	Margin (dB)	Remark
0.4875	22.8	23.4	Average

Test Data

[L1]

CISPR 22 Class B_L1



Final Result 1

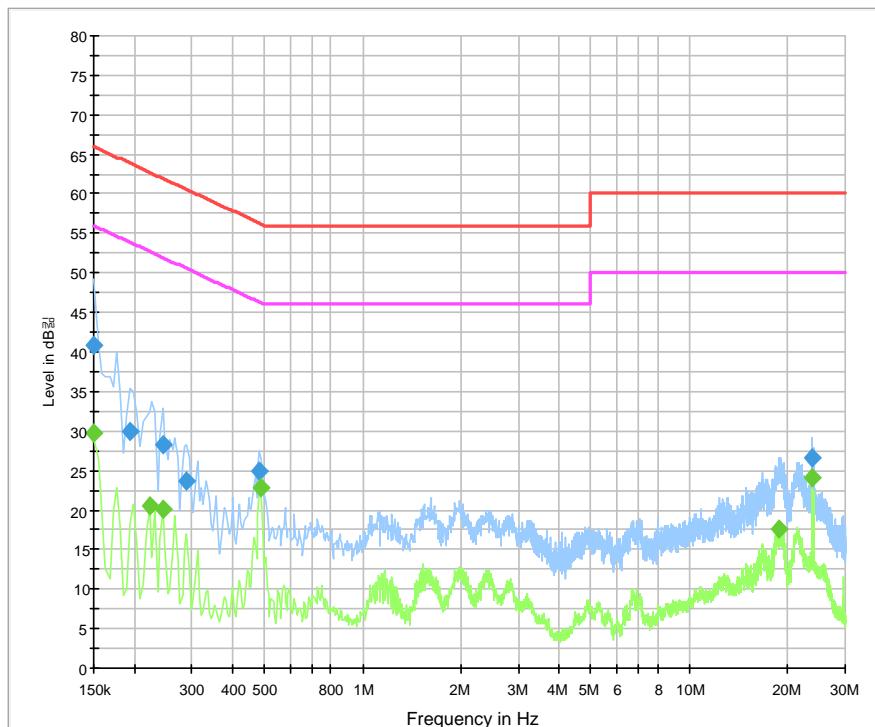
Frequency (MHz)	QuasiPeak (dBuV)	Meas. Time (ms)	Bandwidth (kHz)	Filter	Line	Corr. (dB)	Margin (dB)	Limit (dBuV)
0.150000	35.8	1000.0	9.000	On	L1	9.7	30.2	66.0
0.204000	26.9	1000.0	9.000	On	L1	9.8	36.5	63.4
0.244500	27.4	1000.0	9.000	On	L1	9.6	34.6	61.9
0.285000	23.2	1000.0	9.000	On	L1	9.7	37.5	60.7
0.483000	24.3	1000.0	9.000	On	L1	9.9	32.0	56.3
23.851500	25.9	1000.0	9.000	On	L1	9.9	34.1	60.0

Final Result 2

Frequency (MHz)	CAverage (dBuV)	Meas. Time (ms)	Bandwidth (kHz)	Filter	Line	Corr. (dB)	Margin (dB)	Limit (dBuV)
0.154500	25.6	1000.0	9.000	On	L1	9.7	30.1	55.8
0.222000	21.6	1000.0	9.000	On	L1	9.7	31.2	52.7
0.244500	21.1	1000.0	9.000	On	L1	9.6	30.8	51.9
0.483000	22.2	1000.0	9.000	On	L1	9.9	24.1	46.3
0.595500	14.2	1000.0	9.000	On	L1	9.9	31.8	46.0
23.851500	23.8	1000.0	9.000	On	L1	9.9	26.2	50.0

[NEUTRAL]

CISPR 22 Class B_N



Final Result 1

Frequency (MHz)	QuasiPeak (dBuV)	Meas. Time (ms)	Bandwidth (kHz)	Filter	Line	Corr. (dB)	Margin (dB)	Limit (dBuV)
0.150000	40.9	1000.0	9.000	On	N	9.7	25.1	66.0
0.195000	30.0	1000.0	9.000	On	N	9.8	33.8	63.8
0.244500	28.4	1000.0	9.000	On	N	9.6	33.6	61.9
0.289500	23.8	1000.0	9.000	On	N	9.7	36.8	60.5
0.483000	24.9	1000.0	9.000	On	N	9.9	31.4	56.3
23.851500	26.6	1000.0	9.000	On	N	10.0	33.4	60.0

Final Result 2

Frequency (MHz)	CAverage (dBuV)	Meas. Time (ms)	Bandwidth (kHz)	Filter	Line	Corr. (dB)	Margin (dB)	Limit (dBuV)
0.150000	29.8	1000.0	9.000	On	N	9.7	26.2	56.0
0.222000	20.4	1000.0	9.000	On	N	9.7	32.3	52.7
0.244500	20.1	1000.0	9.000	On	N	9.6	31.8	51.9
0.487500	22.8	1000.0	9.000	On	N	9.9	23.4	46.2
18.915000	17.5	1000.0	9.000	On	N	9.9	32.5	50.0
23.851500	24.0	1000.0	9.000	On	N	10.0	26.0	50.0



CTK Co., Ltd.

CTK Co., Ltd.
(Ho-dong), 113, Yejik-ro, Cheoin-gu, Yongin-si, Gyeonggi-do, Korea
Tel: +82-31-339-9970 Fax: +82-31-624-9501
www.e-ctk.com

APPENDIX A – Test Equipment Used For Tests

	Name of Equipment	Manufacturer	Model No.	Serial No.	Cal Date	Due Date
1	Signal Analyzer	Agilent	N9020A	MY48011598	2015-11-02	2016-11-02
2	Signal Generator	Rohde & Schwarz	SMB100A	175528	2016-01-20	2017-01-20
3	EMI Test Receiver	Rohde & Schwarz	ESCI7	100816	2015-11-02	2016-11-02
4	LISN	Rohde & Schwarz	ENV216	101760	2016-02-05	2017-02-05
5	EMI Test Receiver	Rohde & Schwarz	ESCI7	100814	2015-11-02	2016-11-02
6	Trilog Broadband Antenna	SCHWARZBECK	VULB 9161 SE	9161-4133	2015-06-18	2017-06-18
7	Active Loop Antenna	SCHWARZBECK	FMZB 1513	1513-126	2016-05-16	2018-05-16
8	6dB Attenuator	R&S	DNF	272.4110.50-2	2015-11-03	2016-11-03
9	AMPLIFIER	SONOMA	310	291721	2016-02-02	2017-02-02
10	EMI Test Receiver	Rohde & Schwarz	ESU40	100336	2015-05-14	2017-05-14
11	PREAMPLIFIER	Agilent	8449B	3008A02307	2015-10-01	2016-10-01
12	Horn Antenna	ETS-Lindgren	3115	00078894	2015-09-02	2017-09-02
13	Horn Antenna	ETS-Lindgren	3116	00062504	2015-09-04	2017-09-04
14	Horn Antenna	ETS-Lindgren	3116	00062916	2015-04-30	2017-04-30
15	Horn Antenna	ETS-Lindgren	3117	00154525	2015-09-02	2017-09-02