

FCC EVALUATION REPORT FOR CERTIFICATION

Applicant: LG Electronics Inc.**84, Wanam-ro, Seongsan-gu, Changwon-si,****Gyeongsangnam-do, Rep. of Korea****Attn : Kyeong Seon, Jeong / Chief research engineer****Date of Issue: May 30, 2016****Order Number: GETEC-C1-15-603****Test Report Number: GETEC-E3-15-047****Test Site: GUMI UNIVERSITY EMC CENTER**
(Test firm Registration Number: 269701)**FCC ID. : BEJLGS512TX****Applicant : LG Electronics Inc.**

Rule Part(s)	: FCC Part 15 Subpart C-Intentional Radiator § 15.247
Equipment Class	: FCC Part 15 Spread Spectrum Transmitter (DSS)
EUT Type	: RF Module(TX)
Type of Authority	: Certification
Model Name	: EAT63294801
Trade Name	: LG Electronics

This equipment has been shown to be in compliance with the applicable technical standards as indicated in the measurement report and was tested in accordance with the measurement procedures specified in ANSI C63.10 (2013)

I attest to the accuracy of data. All measurements reported herein were performed by me or were made under my supervision and are correct to the best of my knowledge and belief. I assume full responsibility for the completeness of these measurements and vouch for the qualifications of all persons taking them.

Tested by,**Reviewed by,**

Soon-Hoon Jeong, Senior Engineer
GUMI UNIVERSITY EMC CENTER



Jae-Hoon Jeong, Technical Manager
GUMI UNIVERSITY EMC CENTER



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Scope: Measurement and determination of electromagnetic emissions (EME) of radio frequency devices including intentional and / or unintentional radiators for compliance with technical rules and regulations of the Federal Communications Commission.

1. General Information

Applicant: LG Electronics Inc.

Applicant Address: 84 Wanam-ro, Seongsan-gu Changwon-si, Gyeongsangnam-do
Republic of Korea

Manufacturer: Ohsung Electronics CO., LTD.

Manufacturer Address: #181 Gongdan-dong, Gumi-si, Gyeongsangbuk-do, Republic of Korea.

Contact Person: Kyeong Seon, Jeong / Chief research engineer

Tel. Number: +82-55-269-3245

Fax Number: +82-55-269-3245

● FCC ID.	BEJLGS512TX
● Equipment Class	FCC Part 15 Spread Spectrum Transmitter (DSS)
● EUT Type	RF Module(TX)
● Model Name	EAT63294801
● Trade Name	LG Electronics
● Serial Number	Prototype
● Rule Part(s)	FCC Part 15 Subpart C-Intentional Radiator § 15.247
● Type of Authority	Certification
● Test Procedure(s)	ANSI C63.10 (2013)
● Dates of Test	January 06, 2016 ~ May 30, 2016
● Place of Test	GUMI UNIVERSITY EMC CENTER (FCC Test firm Registration No.: 269701) 37 Yaeun-ro, Gumi-si, Gyeongsangbuk-do, 730-711, Republic of Korea
● Test Report Number	GETEC-E3-15-047
● Dates of Issue	May 30, 2016



2. Introduction

The measurement procedure described in American National Standard for Methods of Measurement of Radio-Nose Emissions From Low-Voltage Electrical and Electronic Equipment in the Range of 9 kHz to 40 GHz (ANSI C63.10-2013) was used in determining radiated and conducted emissions emanating from **LG Electronics Inc.**

RF Module(TX) (Model Name: EAT63294801) FCC ID.: BEJLGS512TX

These measurement tests were conducted at **GUMI UNIVERSITY EMC CENTER.**

The site address is 37 Yaeun-ro, Gumi-si, Gyeongsangbuk-do, 730-711, Republic of Korea.

This test site is one of the highest point of GUMI UNIVERSITY at about 200 km away from Seoul city and 40 km away from Daegu city. It is located in the valley surrounded by mountains in all directions where ambient radio signal conditions are quiet and a favorable area to measure the radio frequency interference on open field test site for the computing and ISM devices manufactures. The detailed description of the measurement facility was found to be in compliance with the requirements of FCC §2.948 according to ANSI C63.10 (2013)



Fig 1. The map above shows the GUMI UNIVERSITY in vicinity area.



3. Product Information

3.1 Description of EUT

The Equipment under Test (EUT) is the **LG Electronics Inc.**
RF Module(TX) (Model Name: EAT63294801) FCC ID.: BEJLGS512TX

- Model Name	: EAT63294801
- EUT Type	: RF Module(TX)
- Power supply	: DC 3 V (AA 1.5 V battery X 2EA)
- Frequency Range	: 2 405 MHz ~ 2 476 MHz
- Transmit Power	: 6 dBm
- Tolerance	: + 1.0 dB / -1.5 dB
- Modulation Technique	: GFSK
- Number of Channels	: 16
- Type of antenna	: Integral antenna
- Antenna specification	: Manufacturer : Ohsung Electronics Co., Ltd. Antenna type : PCB Pattern Peak Gain : 1.22 dBi
- H/W VERSION	: P1302B
- S/W VERSION	: V1.0

3.2 Frequency list

Channel No.	Frequency(MHz)	Channel No.	Frequency(MHz)
1	2405	9	2440
2	2409	10	2445
3	2413	11	2450
4	2417	12	2455
5	2422	13	2460
6	2426	14	2465
7	2430	15	2470
8	2435	16	2476

※ 15.247 (a) (1) Requirements for device which use Frequency hopping system

The 15.247 (a) (1) Requirements was declaration by manufacturer.

1. The hopping sequence is pseudorandom.
2. All channels are used equally on average.
3. The receiver input bandwidth approximately equal the transmit bandwidth.
4. The receiver hop in sequence with the transmit signal.



3.3 Support Equipment / Cables used

3.2.1 Used Support Equipment

Description	Manufacturer	Model Name	S/N & FCC ID
Control board for test mode	Ohsung Electronics Co., Ltd.	Prototype	S/N: None FCC ID.: None
Battery Cradle	Ohsung Electronics Co., Ltd.	Prototype	S/N: None FCC ID.: None

See "Appendix E– Test Setup Photographs" for actual system test set-up

3.3.2 System configuration

Description	Manufacturer	Model Name	S/N & FCC ID.
None	-	-	-

3.3.3 Used Cable(s)

Cable Name	Condition	Description
Control button board	Connected between EUT and control button board	0.10 m with Unshielded cable.

3.4 Modification Item(s)

- None



4. Antenna Requirement - §15.203

An intentional radiator antenna shall be designed to ensure that no antenna other than that furnished by the applicant can be used with the device. The use of permanently attached antenna or of an antenna that uses a unique coupling to the intentional radiator shall be considered sufficient to comply with this requirement.

4.1 Description of Antenna

The **LG Electronics Inc. RF Module(TX)** comply with the requirement of §15.203 with a built-in PCB pattern antenna permanently attached to the transmitter.

5. Description of tests

5.1 Test Condition

- Test Voltage / Frequency:

RF Test: DC 3 V supplied from DC power supply
AC Line Conducted Emission: Not applicable¹⁾

Note: 1) The EUT is not applicable to test of AC Line Conducted emission.
Because the EUT is supplied power from battery.

- Test Mode(s) are:

RF Test: Continuous RF transmitting mode



6. SUMMARY OF TEST RESULTS

FCC Part Section(s)	Test Description	Test Result
§ 15.247(a)(1)(ii) or (iii)	20 dB Bandwidth	Pass
§ 15.247(b)(1)	Conducted Maximum Peak Output Power	Pass
§15.247(a)(1)	Carrier Frequency Separation	Pass
§15.247(a)(1)(iii)	Number of Hopping Frequencies	Pass
§15.247(a)(1)(iii)	Time of Occupancy (dwell time)	Pass
§15.247(d)	Conducted Spurious Emissions	Pass
§15.247(d)	Band Edge(Out of Band Emissions)	Pass
§15.207(a)	AC Power line Conducted Emissions	N/A ¹⁾
§15.247(d), 15.205, 15.209	Radiated Spurious Emissions	Pass
§15.247(d), 15.205, 15.209	Radiated Restricted Band Edge	Pass

Note)

1) The EUT is supplied power from battery. Therefore the test was not applicable.

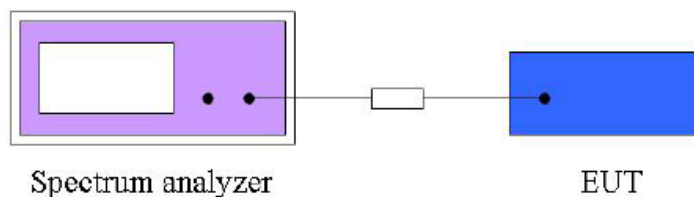


7. 20 dB Bandwidth

7.1 Operating Environment

Temperature : 23.0 °C
Relative Humidity : 36.0 % R.H.

7.2 Test Set-up



7.3 Limits

For frequency hopping system operating in the 2 400 MHz ~ 2 483.5 MHz, If the 20 dB bandwidth of hopping channel is greater than 25 kHz, two-thirds 20 dB bandwidth of hopping channel shall be a minimum limit for the hopping channel separation.

7.4 Test Equipment used

Model Name	Manufacturer	Description	Serial Number	Due to Calibration
■ - FSP	Rohde & Schwarz	EMI Test Receiver	101431	Jan. 04, 2017
■ - 56-10	Weinschel	10dB Attenuator	53184	Apr. 20, 2017

7.5 Test Result

- Test Date : May 30, 2016
- Reference Standard : Part 15 Subpart C, Sec. 15.247(a)(1) (ii) or (iii)
- Test Procedure : ANSI 63.10(2013), DA 00-705
- Modulation : GFSK
- Power Source : DC 3.0 V supplied from the DC power supply

Spectrum Parameter set following ANSI 63.10(2013)

Span = approximately between two times and five times the OBW

RBW = 1%~5% of the 20 dB bandwidth

VBW = 3 X RBW

Sweep = auto

Detector function = peak

Trace = max hold

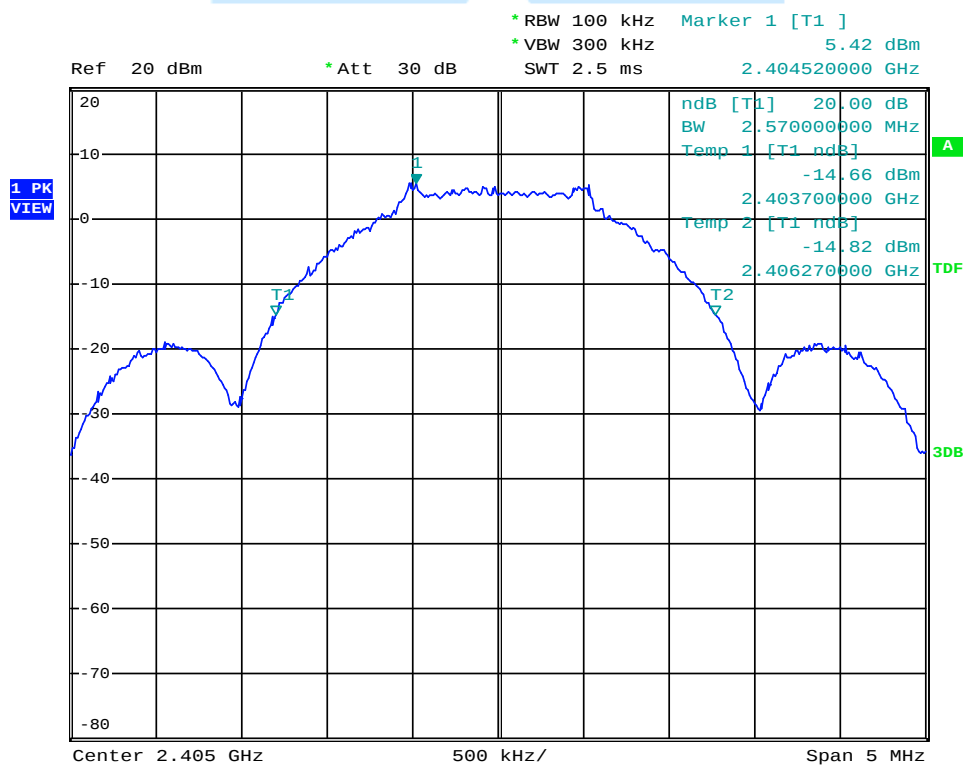


Modulation = GFSK, Data rate 2 Mbps

Channel	20 dB Bandwidth (MHz)	Channel	20 dB Bandwidth (MHz)
1	2.57	9	2.64
2	2.63	10	2.63
3	2.63	11	2.65
4	2.67	12	2.65
5	2.63	13	2.67
6	2.62	14	2.62
7	2.58	15	2.63
8	2.63	16	2.59

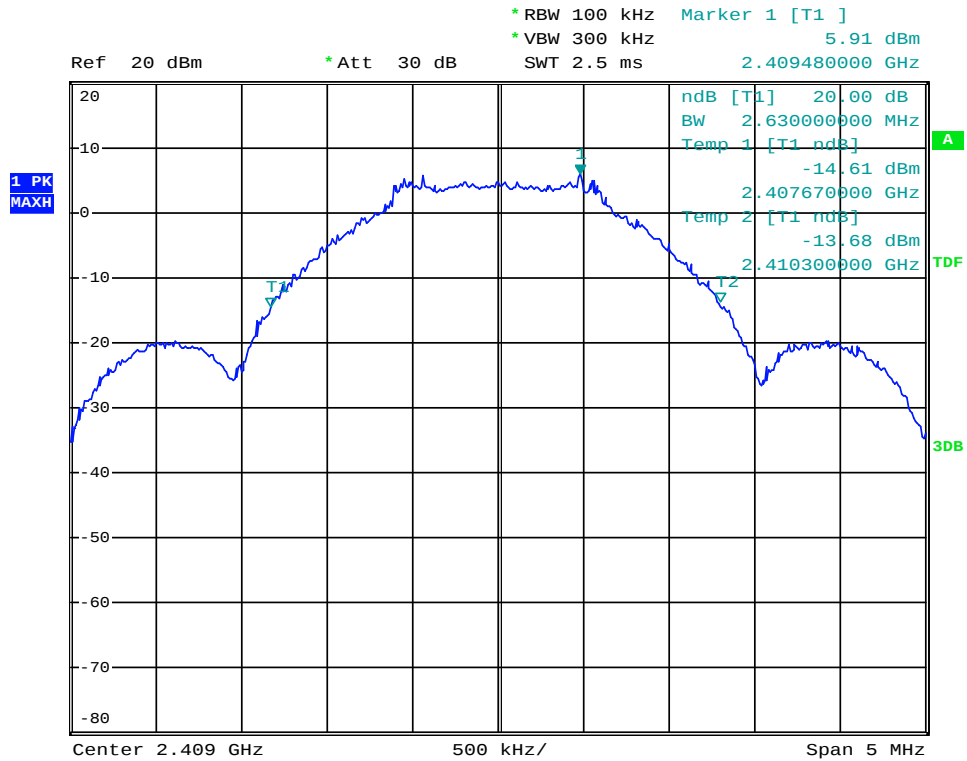
-Test Result Plot

Channel bandwidth used Plot on Configuration 1 CH (2 405 MHz)

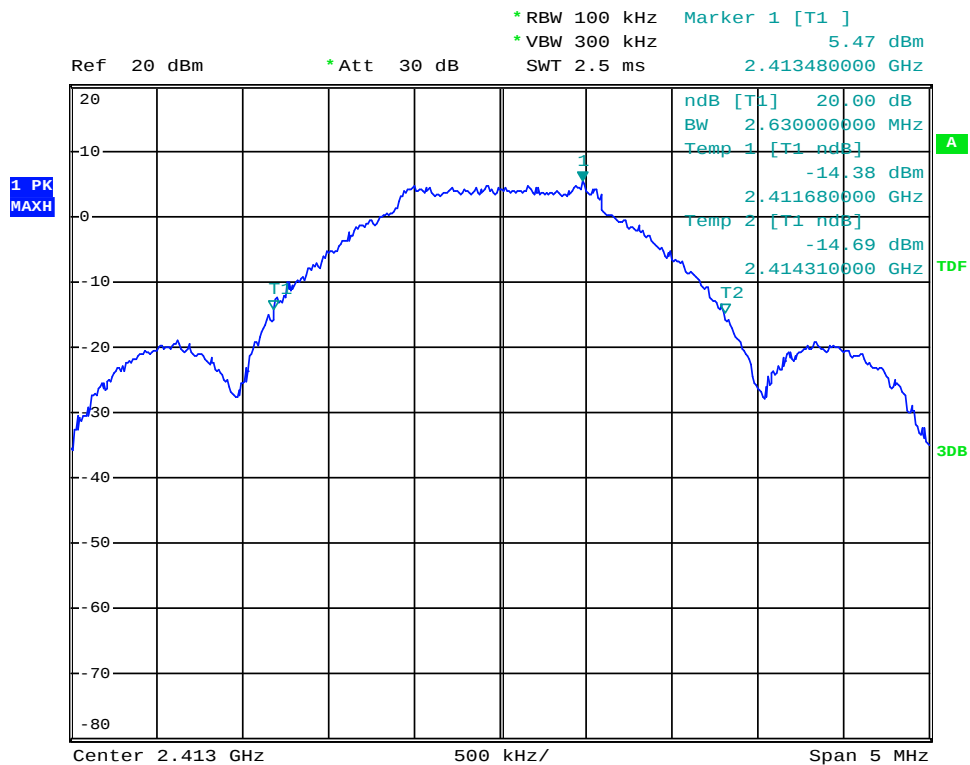




Channel bandwidth used Plot on Configuration 2 CH (2 409 MHz)

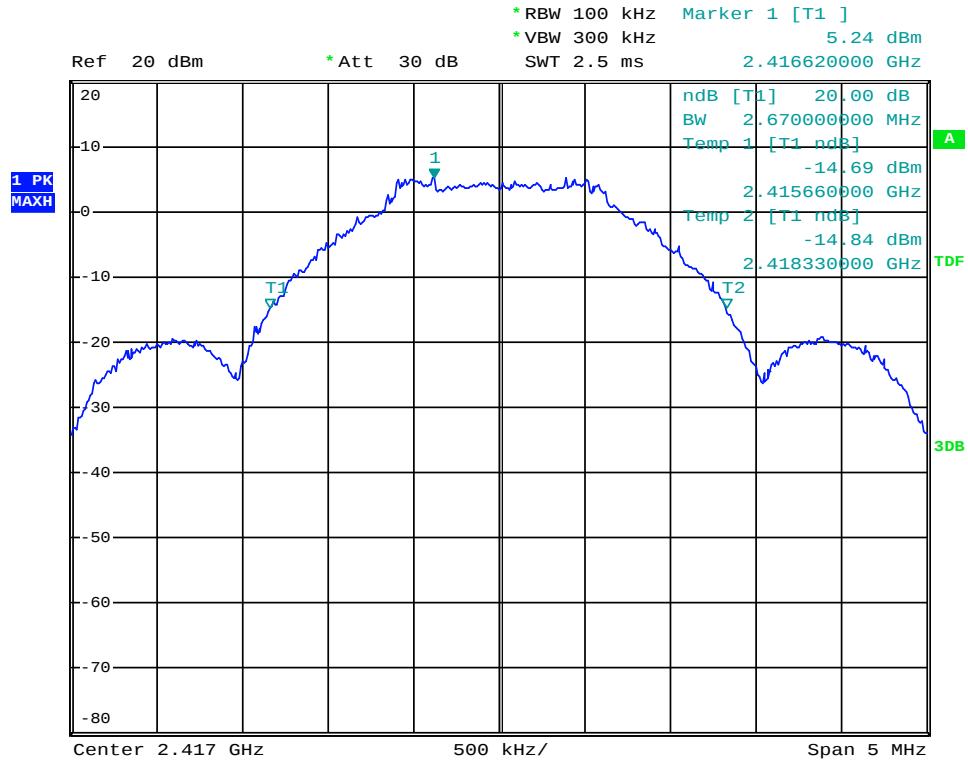


Channel bandwidth used Plot on Configuration 3 CH (2 413 MHz)

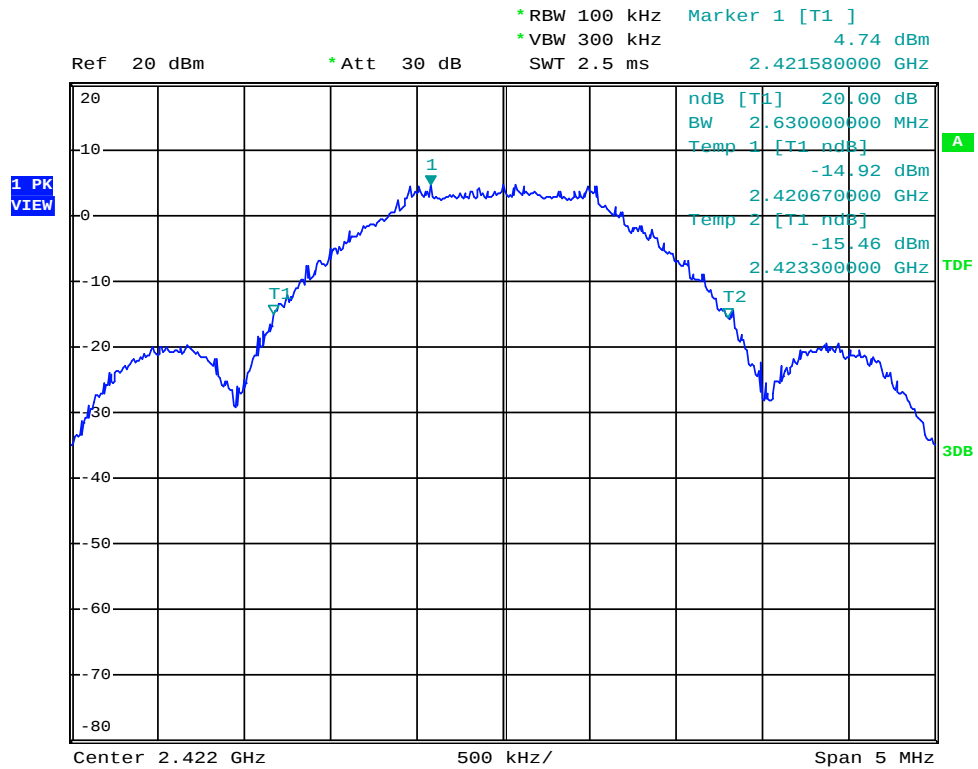




Channel bandwidth used Plot on Configuration 4 CH (2 417 MHz)

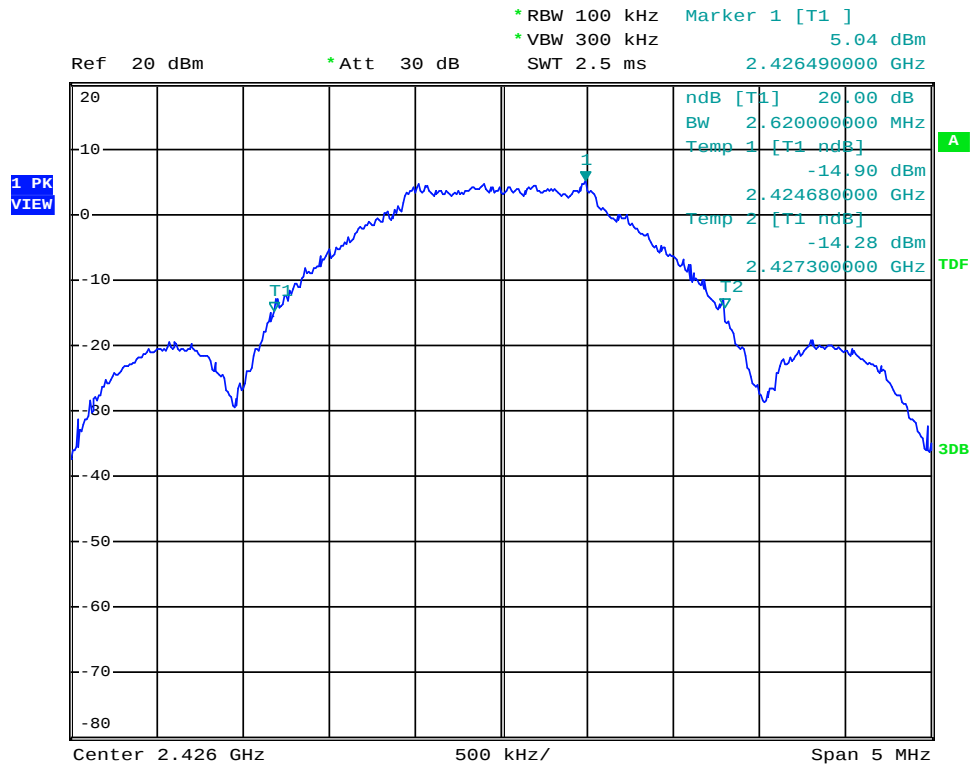


Channel bandwidth used Plot on Configuration 5 CH (2 422 MHz)

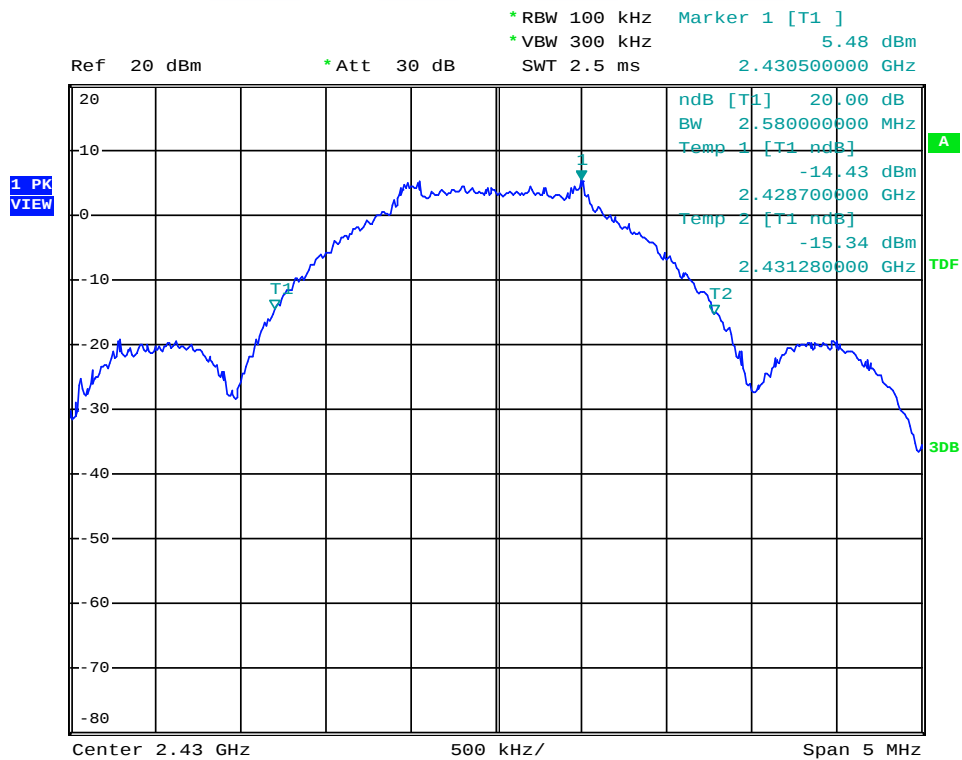




Channel bandwidth used Plot on Configuration 6 CH (2 426 MHz)

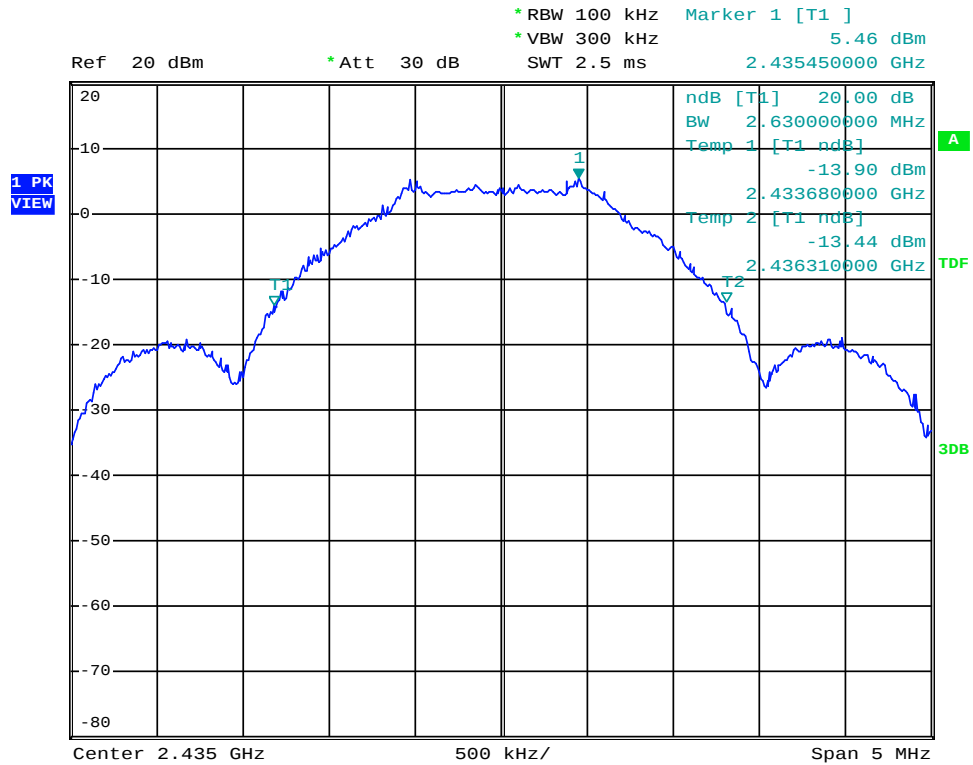


Channel bandwidth used Plot on Configuration 7 CH (2 430 MHz)

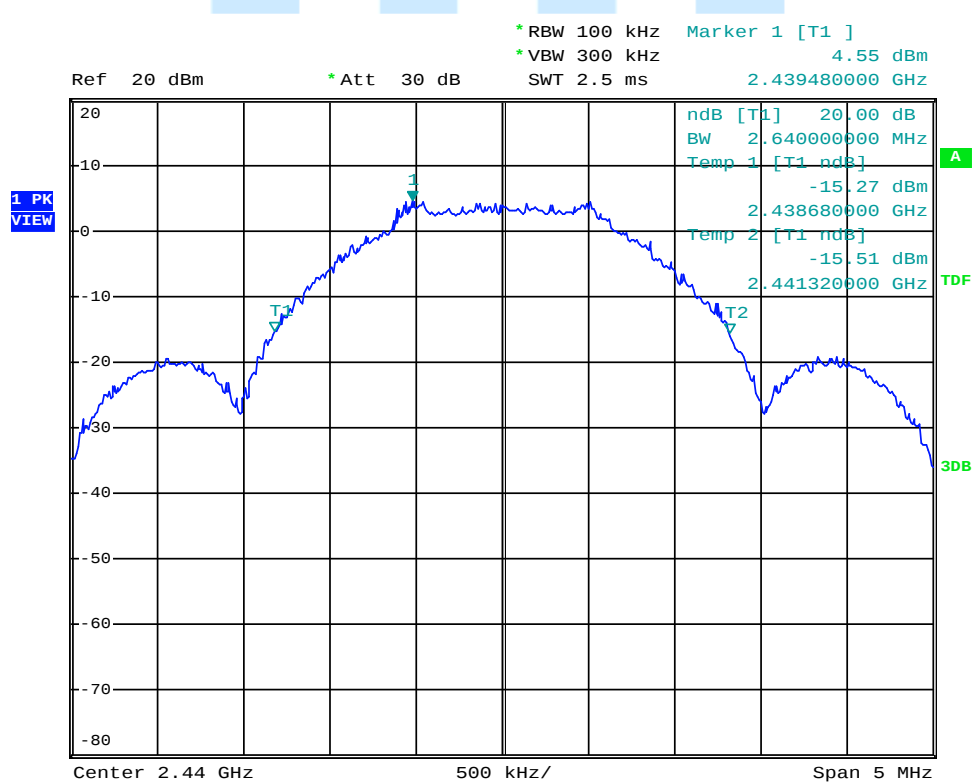




Channel bandwidth used Plot on Configuration 8 CH (2 435 MHz)

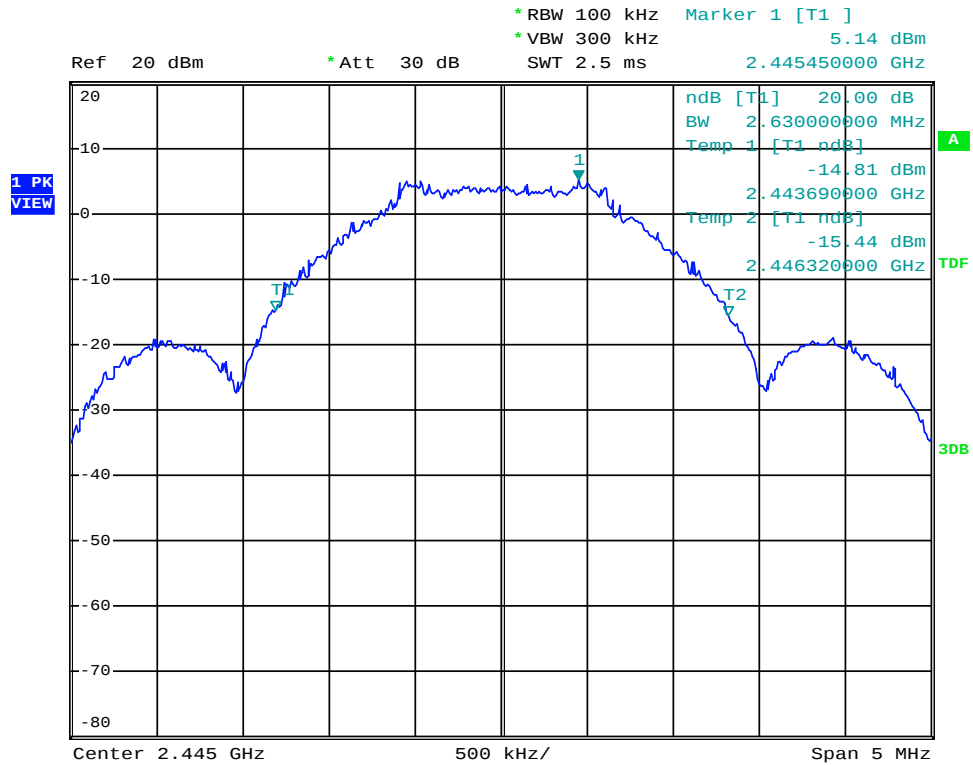


Channel bandwidth used Plot on Configuration 9 CH (2 440 MHz)

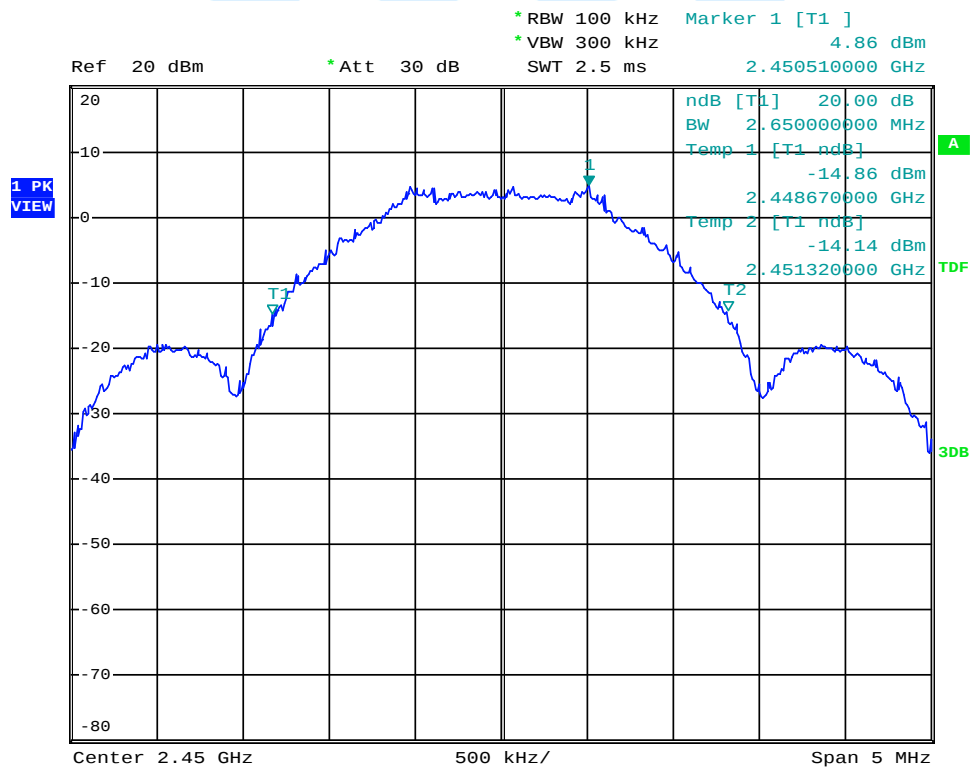




Channel bandwidth used Plot on Configuration 10 CH (2 445 MHz)

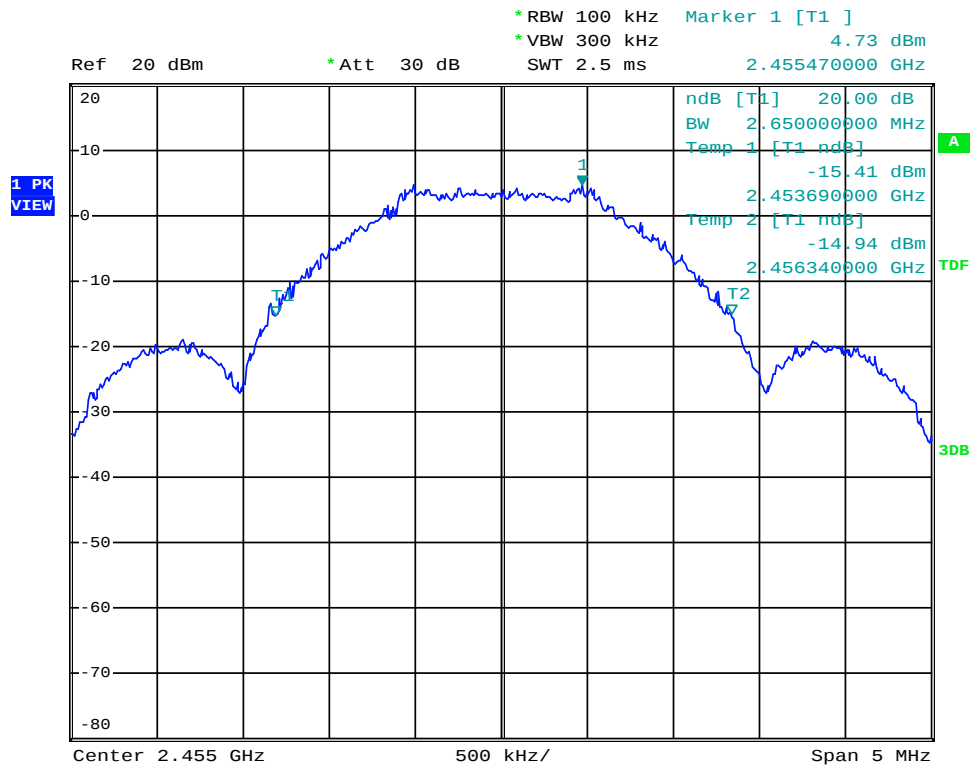


Channel bandwidth used Plot on Configuration 11 CH (2 450 MHz)

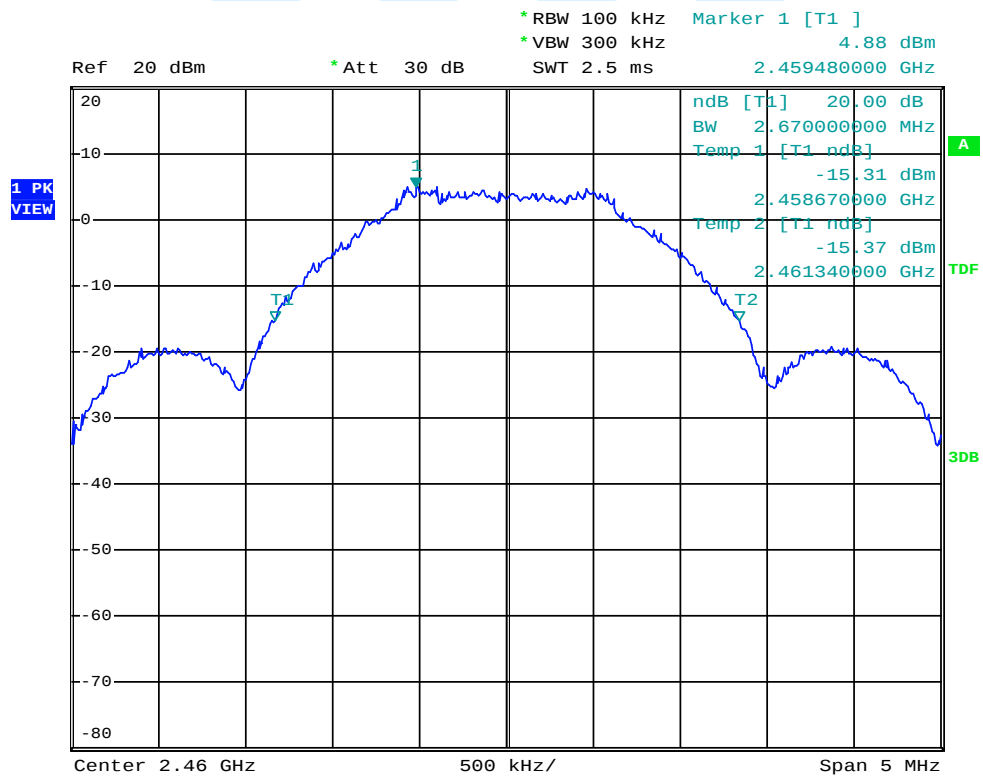




Channel bandwidth used Plot on Configuration 12 CH (2 455 MHz)

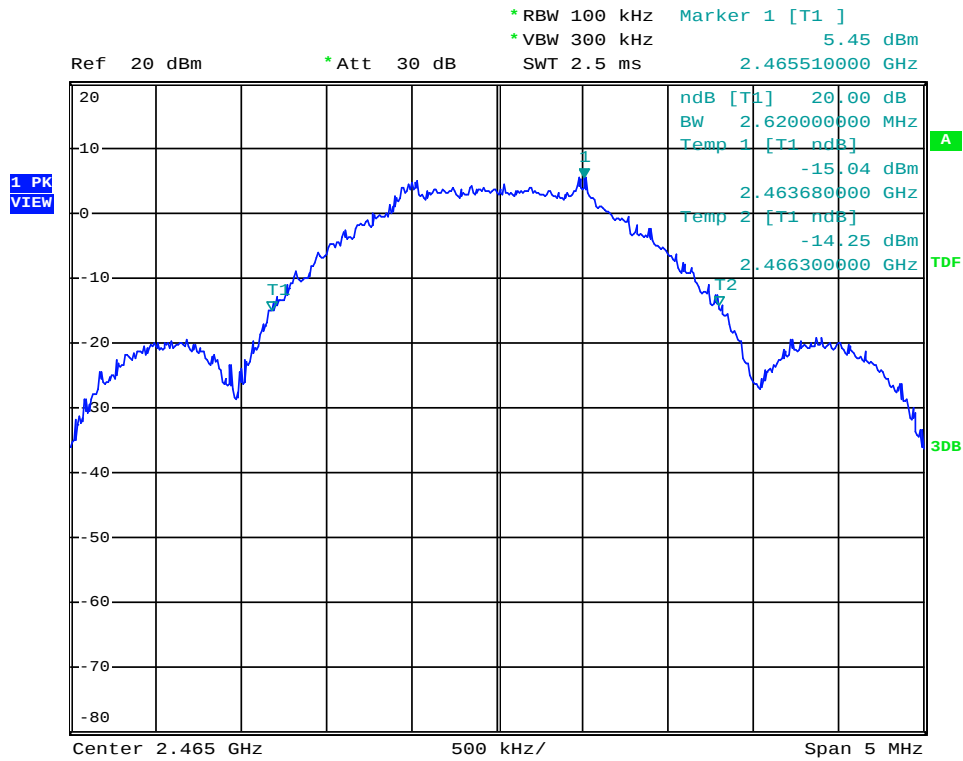


Channel bandwidth used Plot on Configuration 13 CH (2 460 MHz)

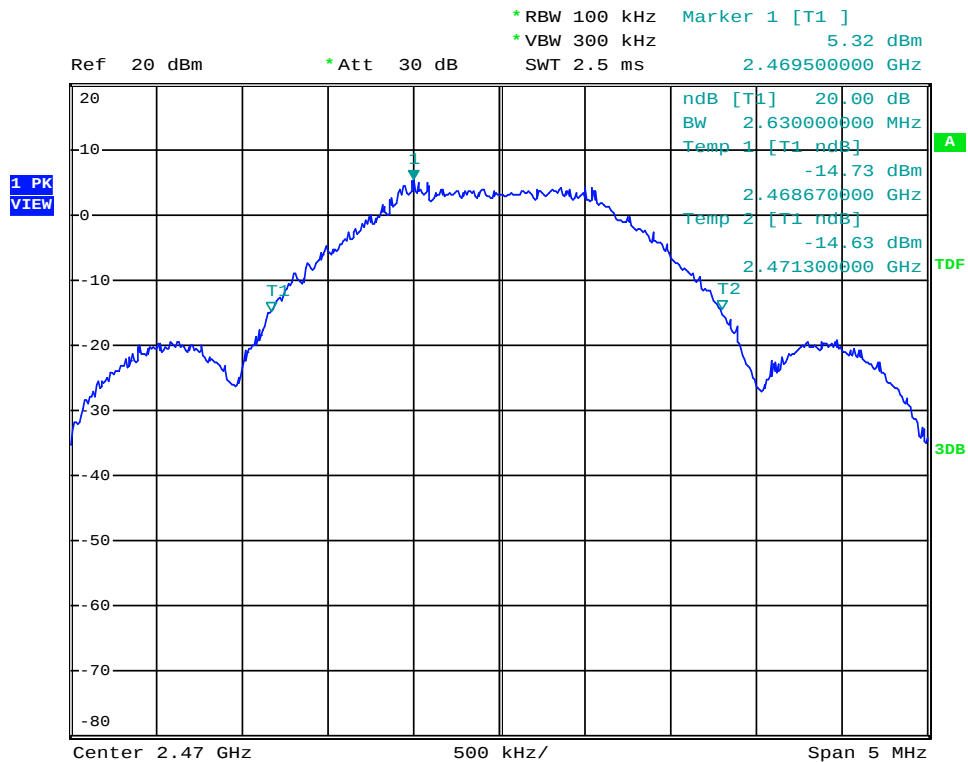




Channel bandwidth used Plot on Configuration 14 CH (2 465 MHz)

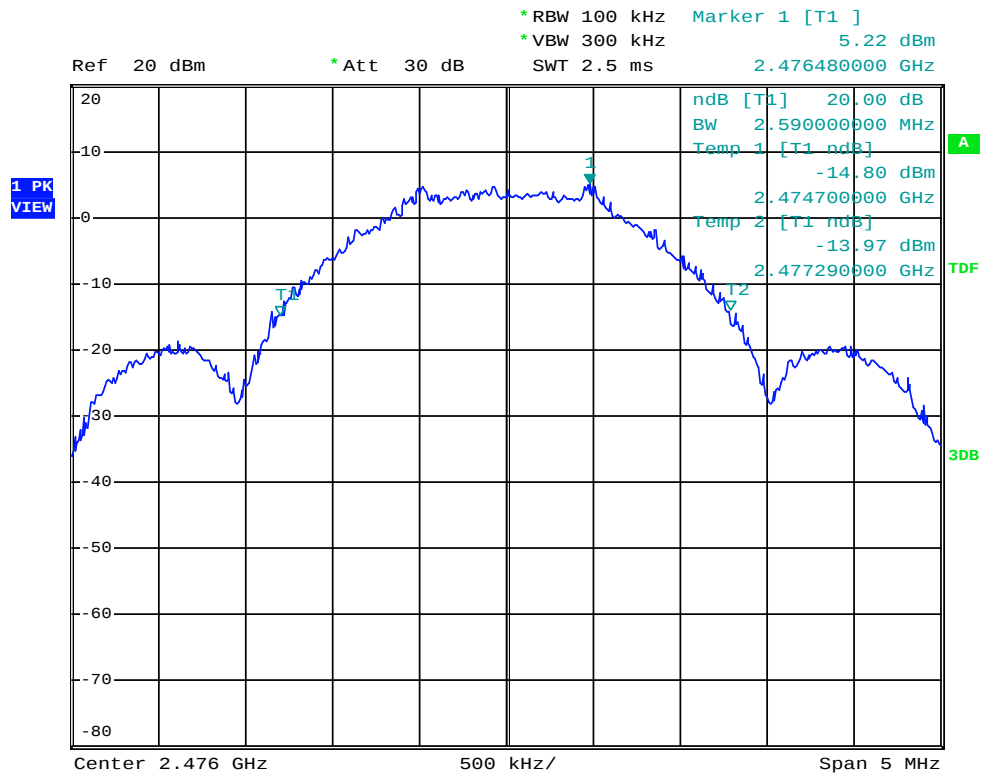


Channel bandwidth used Plot on Configuration 15 CH (2 470 MHz)





Channel bandwidth used Plot on Configuration 16 CH (2 476 MHz)



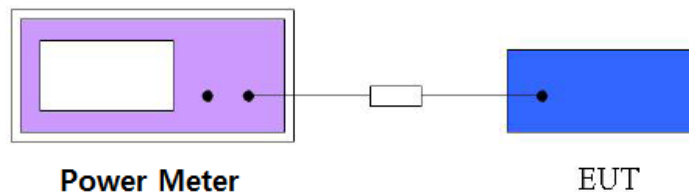


8. MAXIMUM PEAK OUTPUT POWER

8.1 Operating Environment

Temperature : 20.2 °C
Relative Humidity : 37.3 % R.H.

8.2 Test Set-up (Layout)



8.3 Limit

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

- §15.247(a)(1), Frequency hopping systems shall have hopping channel carrier frequencies separated by a minimum of 25 kHz or the 20 dB bandwidth of the hopping channel, whichever is greater, provided the systems operate with an output power no greater than 125 mW.
- §15.247(b)(1), For frequency hopping systems operating in the 2 400 – 2 483.5 MHz employing at least 75 non-overlapping hopping channels, and all frequency hopping systems in the 5 725 – 5 805 MHz band : 1Watt.

8.4 Test Equipment used

Model Name	Manufacturer	Description	Serial Number	Due to Calibration
■ - NRV-Z32	Rohde & Schwarz	Peak Power sensor	100049	Jan. 05, 2017
■ - NRVD	Rohde & Schwarz	Dual Channel Power Meter	837794/048	Apr. 24, 2016
■ - NRP-Z51	Rohde & Schwarz	Power sensor	1138.0005.02	Jan. 05, 2017

8.5 Test Result

- Test Date : January 12, 2016
- Reference Standard : Part 15 Subpart C, Sec. 15.247(b)(1)
- Modulation : GFSK
- Power Source : DC 3.0 V supplied from the DC power supply

Modulation = GFSK, Data rate 2 Mbps

Channel	Channel frequency (MHz)	Average output power ¹⁾ (dBm)	Peak output power (dBm)	Peak output power (mW)	Limit (mW)	Result
1	2 405	7.04	7.23	5.28	125	Complies
11	2 450	7.02	7.06	5.08	125	Complies
16	2 476	7.02	7.08	5.10	125	Complies

Note: 1) The Average output power is reference data for RF Exposure

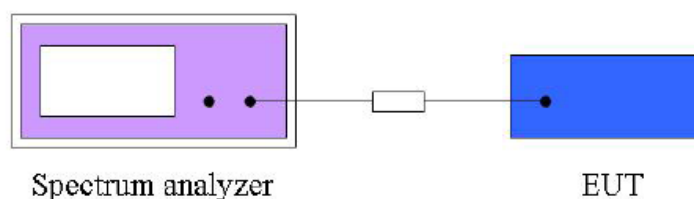


9. Carrier Frequency Separation

9.1 Operating Environment

Temperature : 19.8 °C
Relative Humidity : 36.5 % R.H.

9.2 Test Set-up (Layout)



9.3 Limit

§15.247(a)(1) Frequency hopping system operating in 2 400 – 2 483.5 MHz. Band may have hopping channel carrier frequencies that are separated by 25 kHz or two-third of 20 dB bandwidth of the hopping channel, whichever is greater.

9.4 Test Equipment used

Model Name	Manufacturer	Description	Serial Number	Due to Calibration
■ - FSP	Rohde & Schwarz	EMI Test Receiver	101431	Jan. 04, 2017
■ - 56-10	Weinschel	10dB Attenuator	53184	Apr. 20, 2017

9.5 Test Result

- Test Date : May 30, 2016
- Reference Standard : Part 15 Subpart C, Sec. 15.247(a)(1)
- Modulation : GFSK
- Power Source : DC 3.0 V supplied from the DC power supply

Spectrum Parameter set following ANSI 63.10(2013)

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

- 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.
- Video (or average) bandwidth (VBW) $\leq$ RBW.
- Sweep: Auto.
- Detector function: Peak.
- Trace: Max hold.
- Allow the trace to stabilize.

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



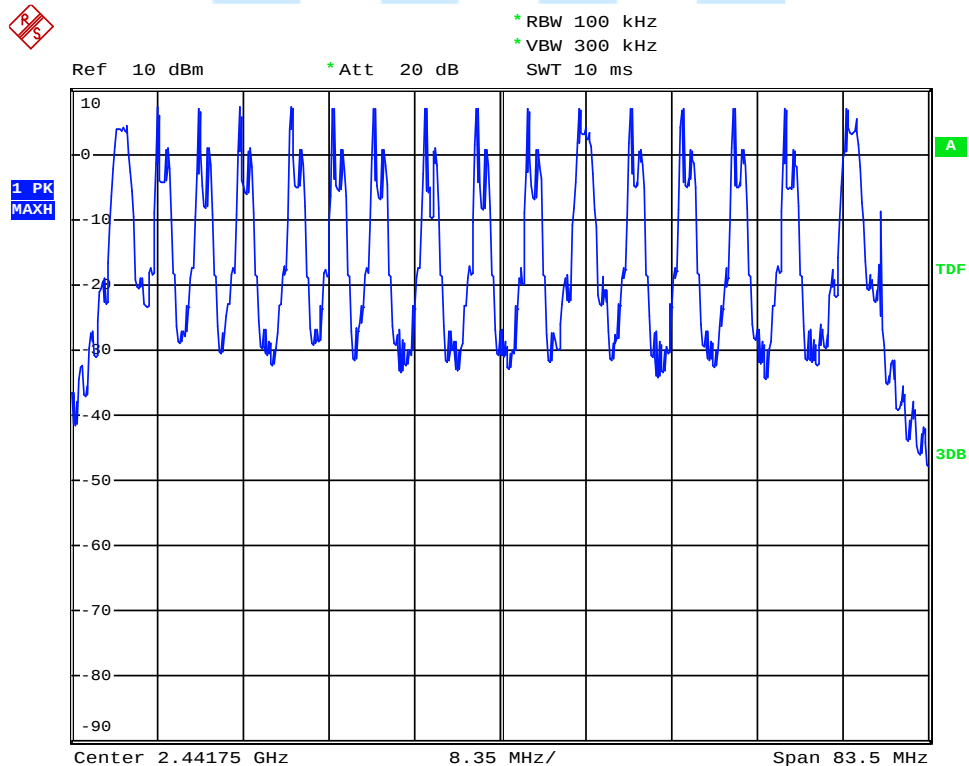
Result table of Carrier Frequency Separation

Modulation = GFSK, data rate = 2 Mbps

Channel	Frequency separation (MHz)	Limits(MHz) [25 kHz or 2/3 of 20 dB bandwidth]	Result
1-2	4.10	> 1.75	Complies
2-3	4.03	> 1.75	Complies
3-4	3.94	> 1.78	Complies
4-5	4.99	> 1.75	Complies
5-6	4.03	> 1.75	Complies
6-7	4.01	> 1.72	Complies
7-8	5.04	> 1.75	Complies
8-9	5.04	> 1.76	Complies
9-10	4.99	> 1.75	Complies
10-11	4.99	> 1.77	Complies
11-12	5.64	> 1.77	Complies
12-13	5.06	> 1.78	Complies
13-14	5.11	> 1.75	Complies
14-15	5.02	> 1.75	Complies
15-16	6.02	> 1.73	Complies

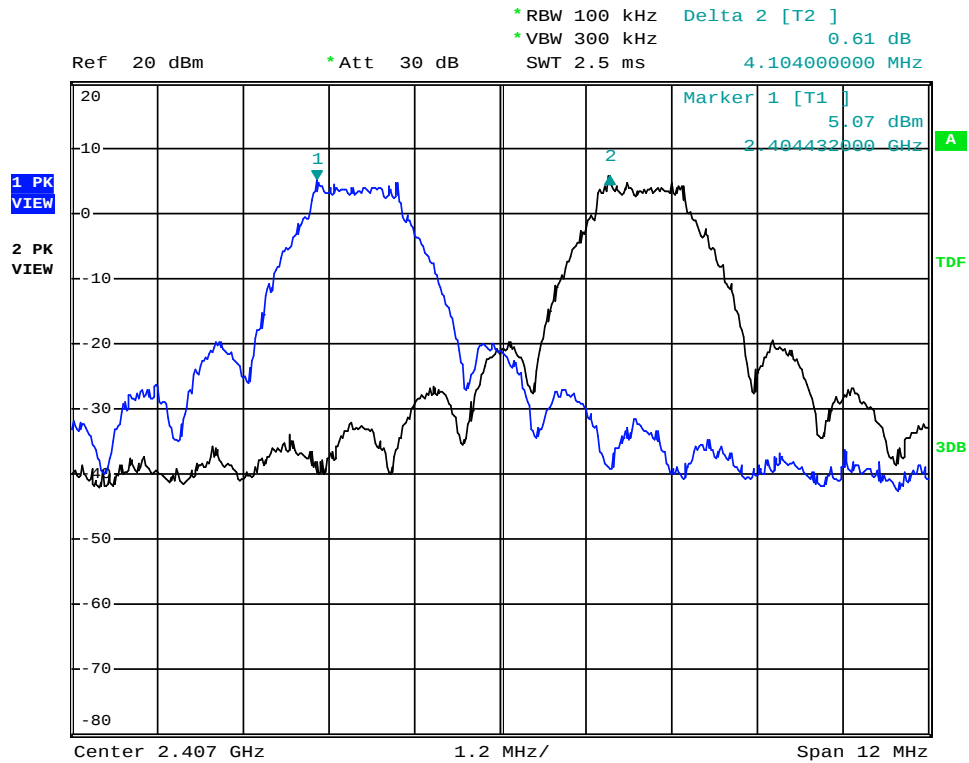
-Test Result Plot

Channel Separation (full channel)

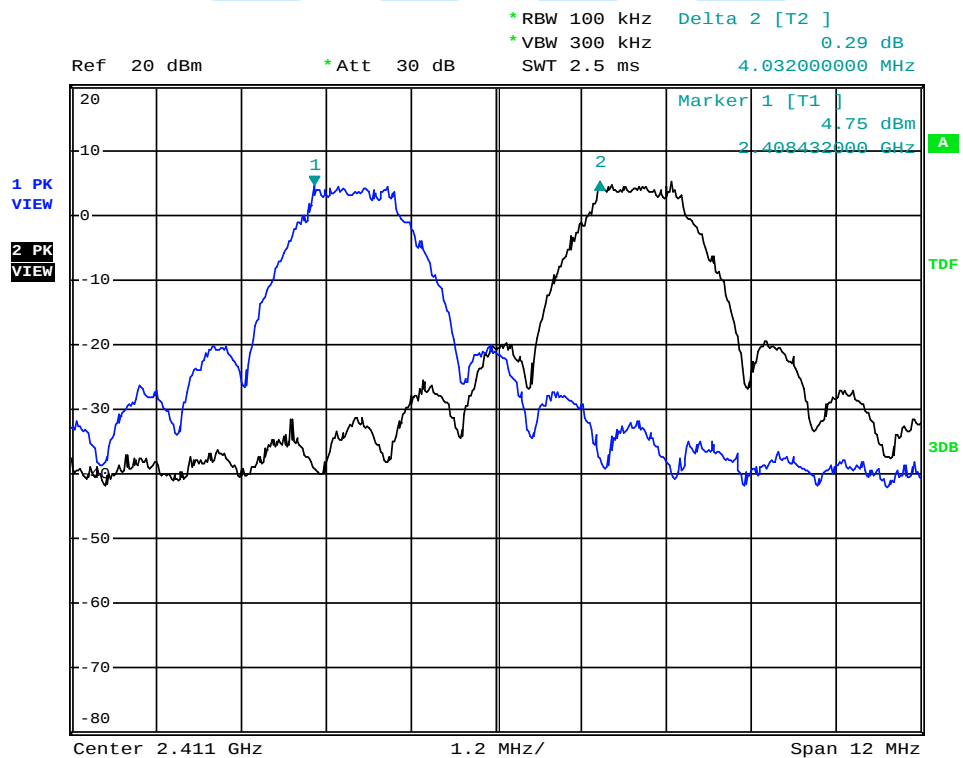




Channel Separation (1CH ~ 2 CH)

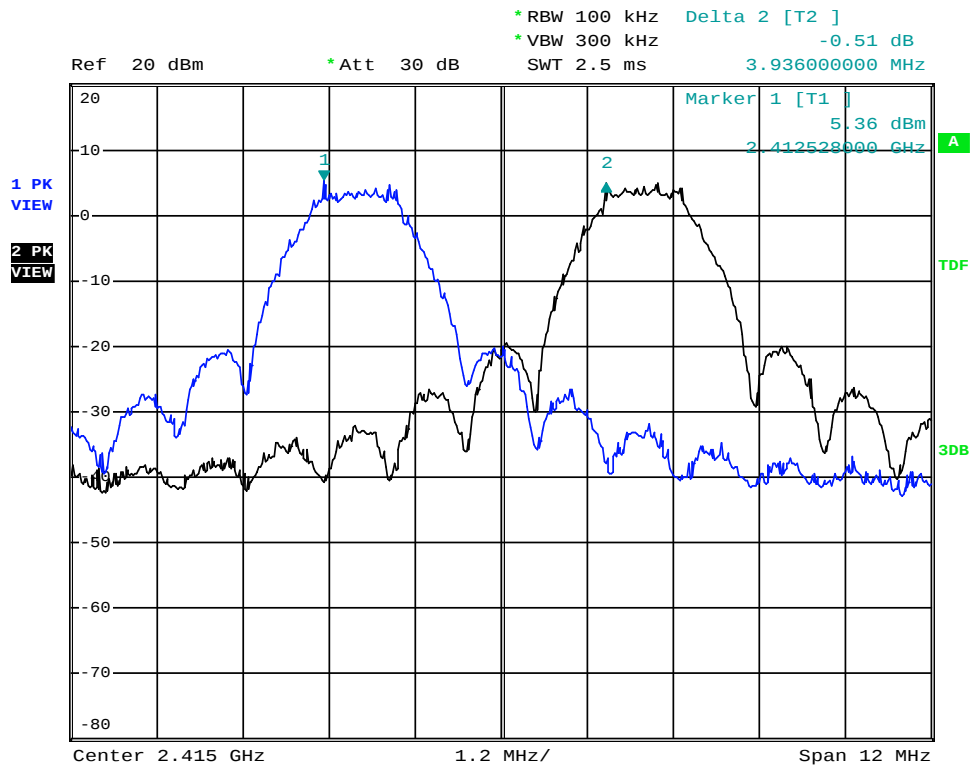


Channel Separation (2CH ~ 3 CH)

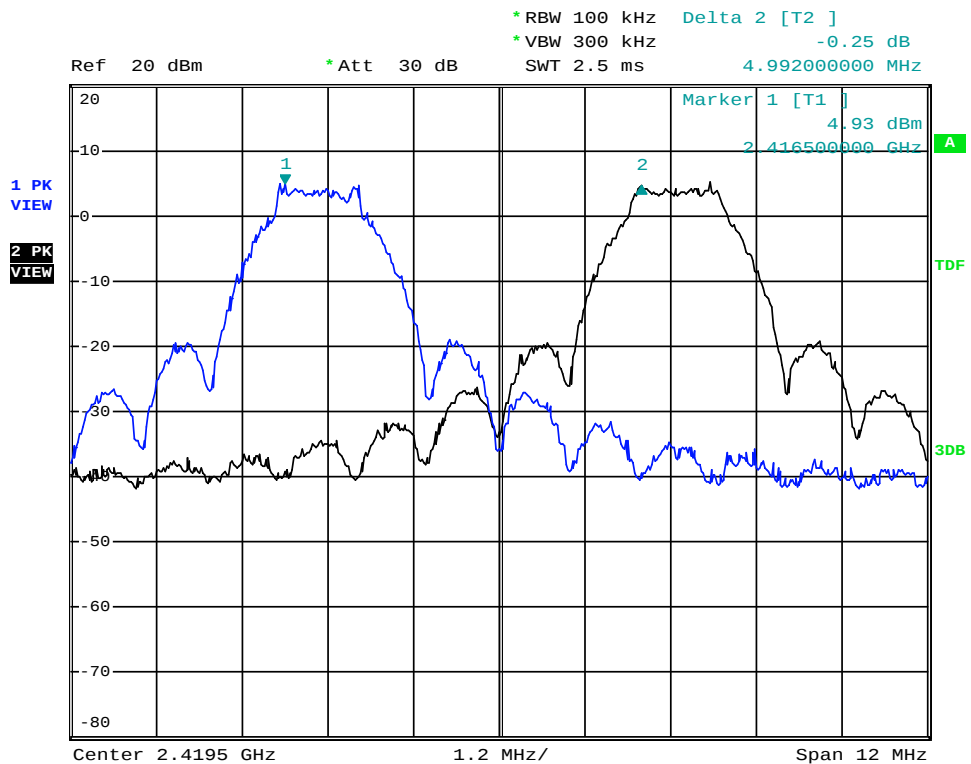




Channel Separation (3 CH ~ 4 CH)

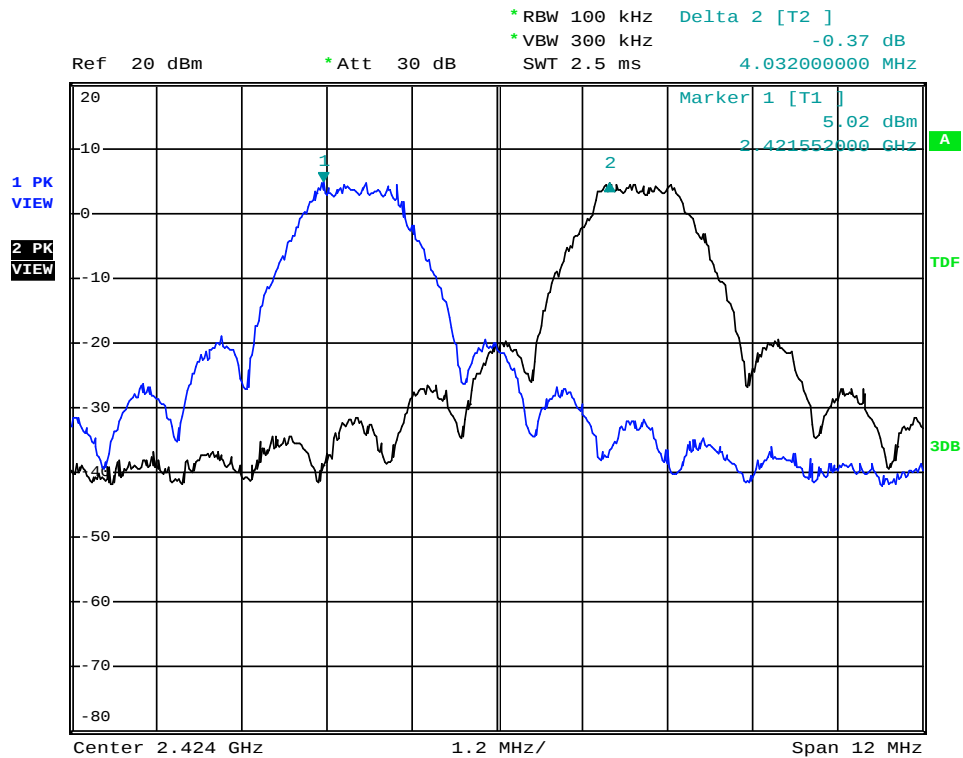


Channel Separation (4 CH ~ 5 CH)

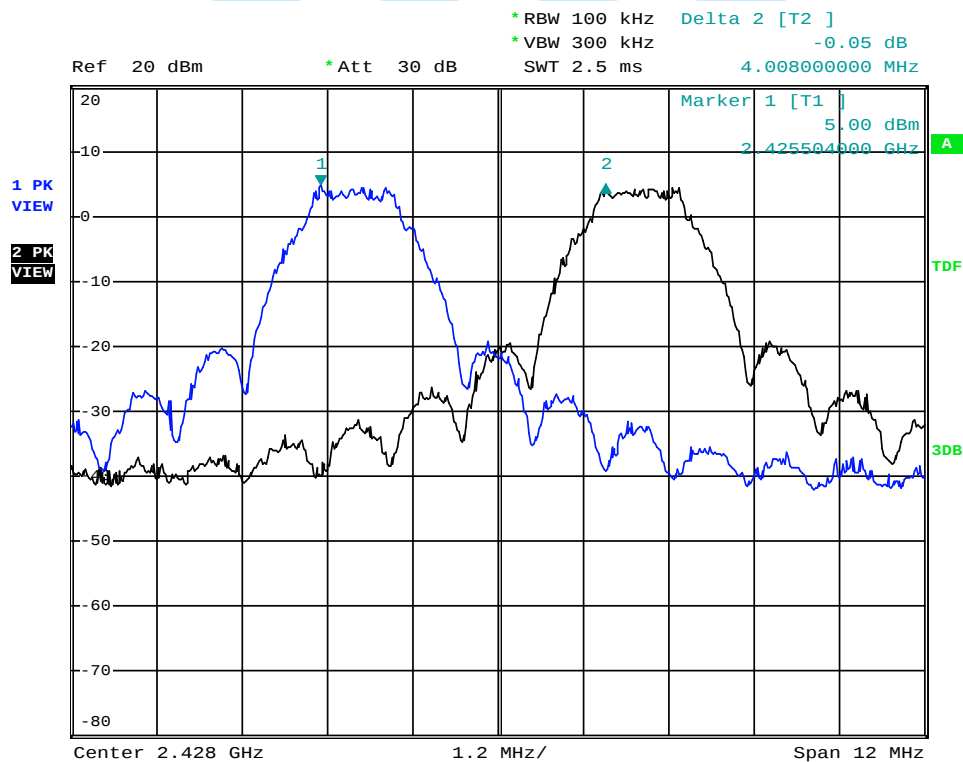




Channel Separation (5 CH ~ 6 CH)

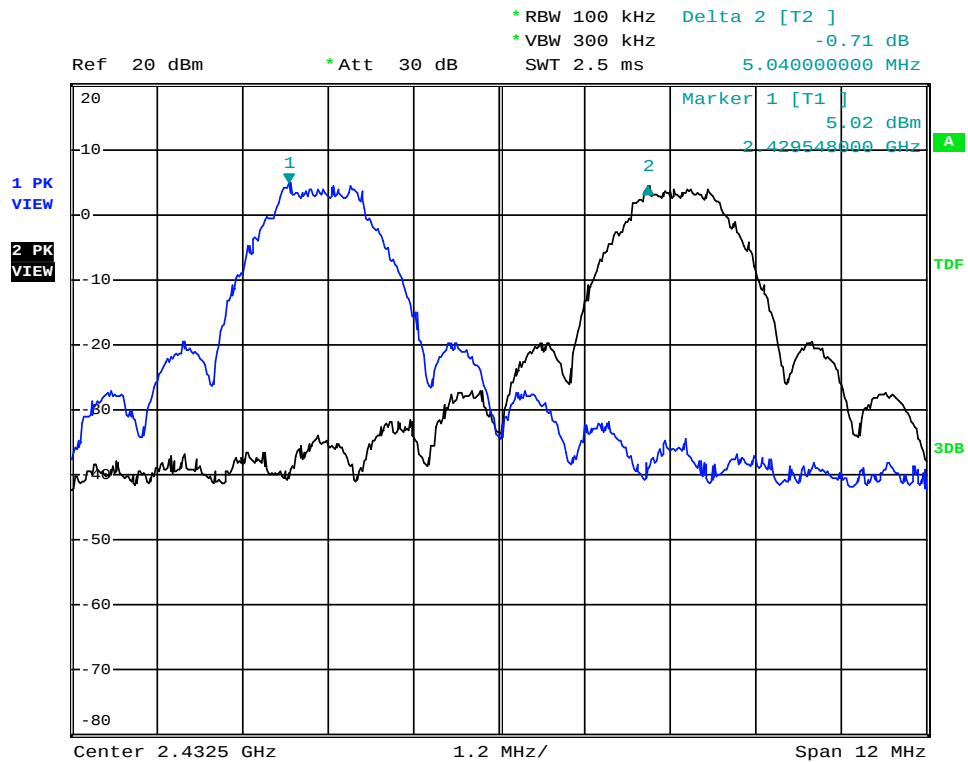


Channel Separation (6 CH ~ 7 CH)

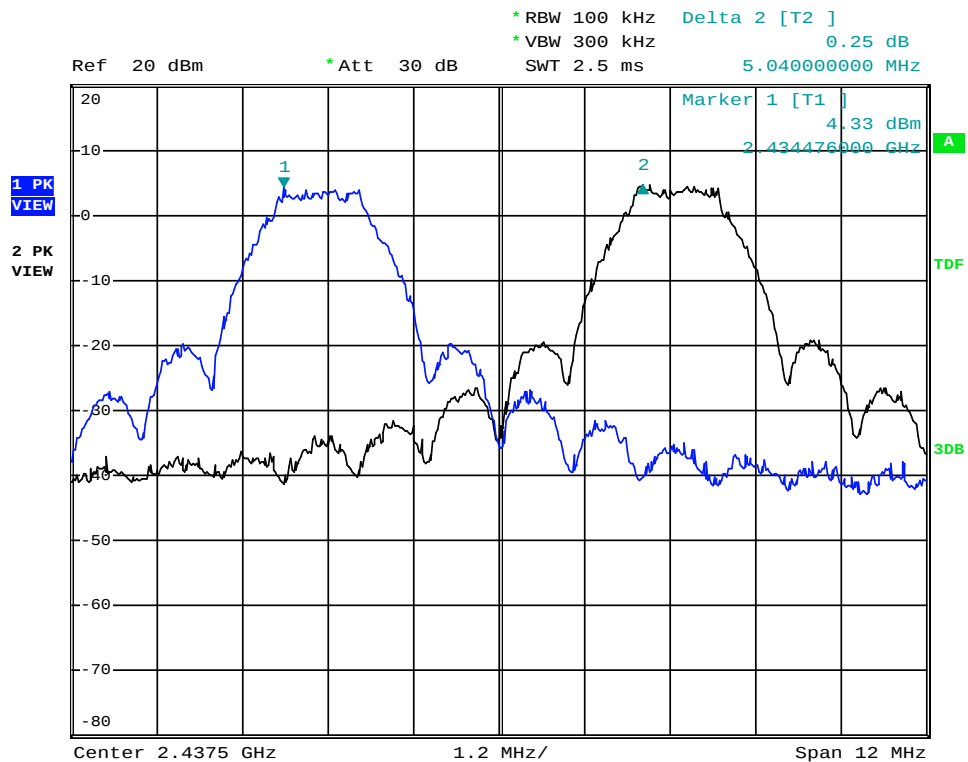




Channel Separation (7 CH ~ 8 CH)

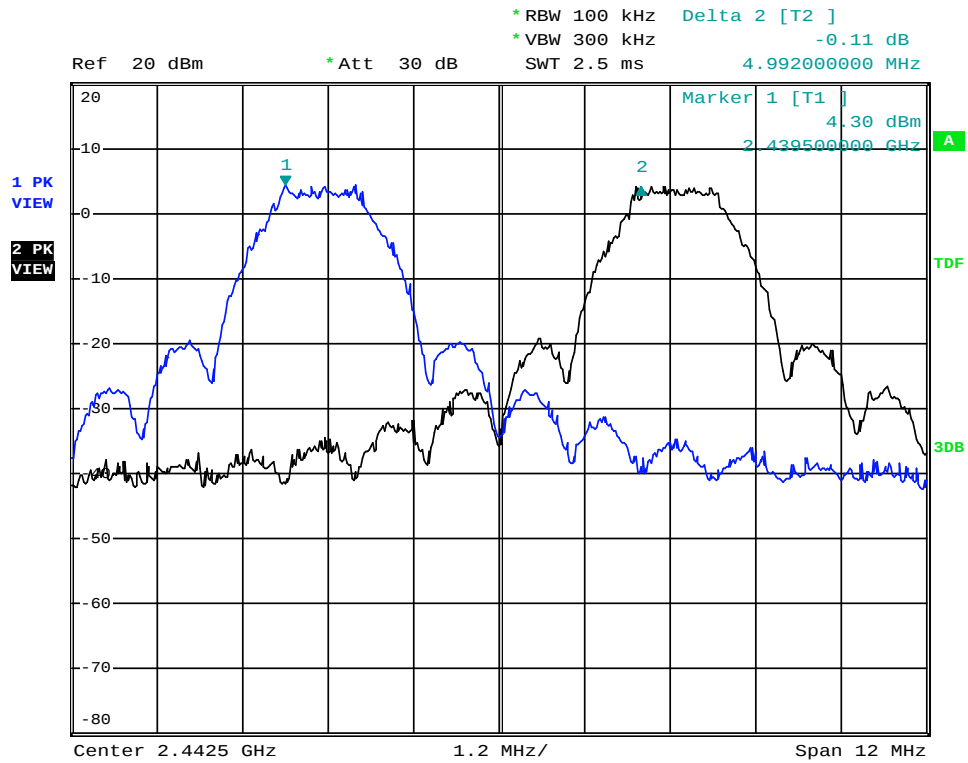


Channel Separation (8 CH ~ 9 CH)

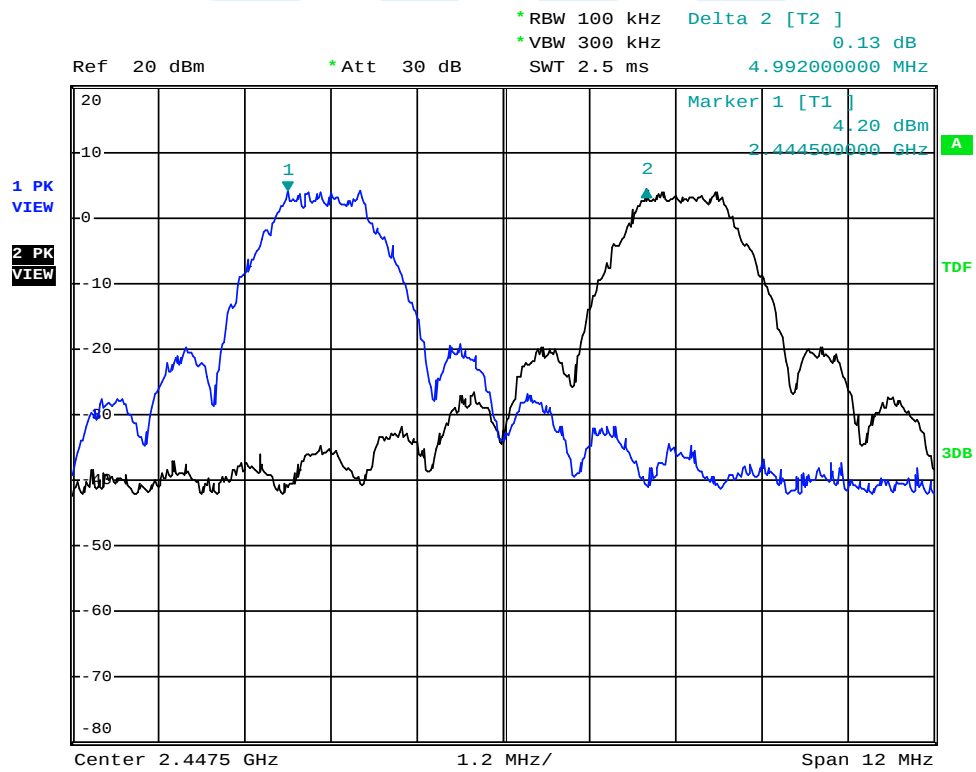




Channel Separation (9 CH ~ 10 CH)

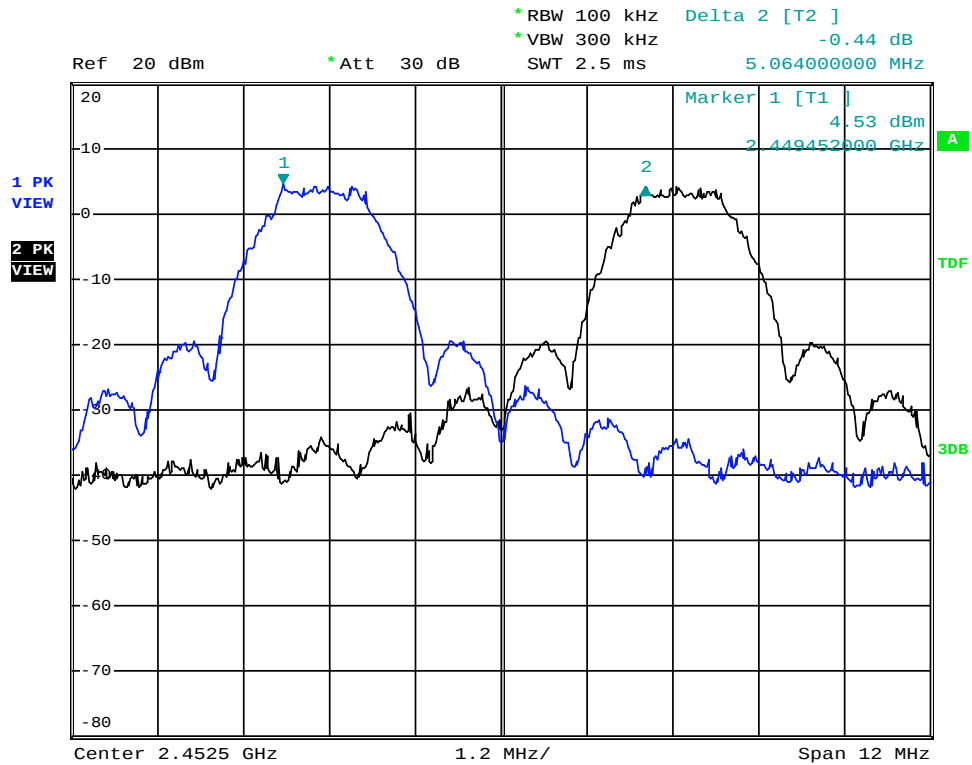


Channel Separation (10 CH ~11 CH)

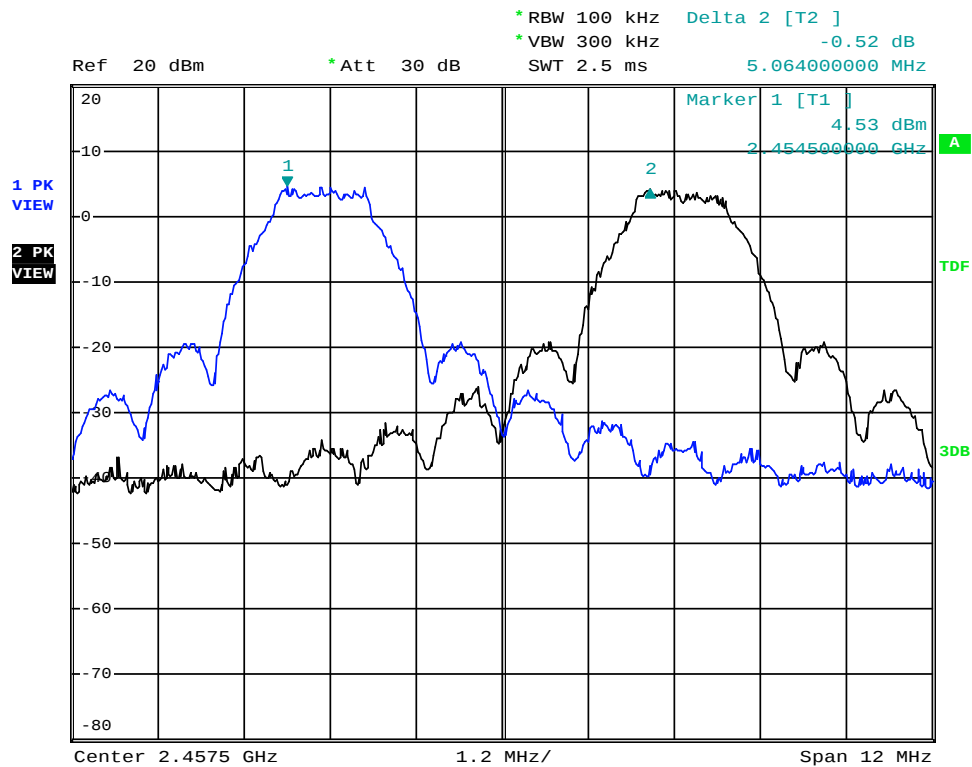




Channel Separation (11 CH ~ 12 CH)

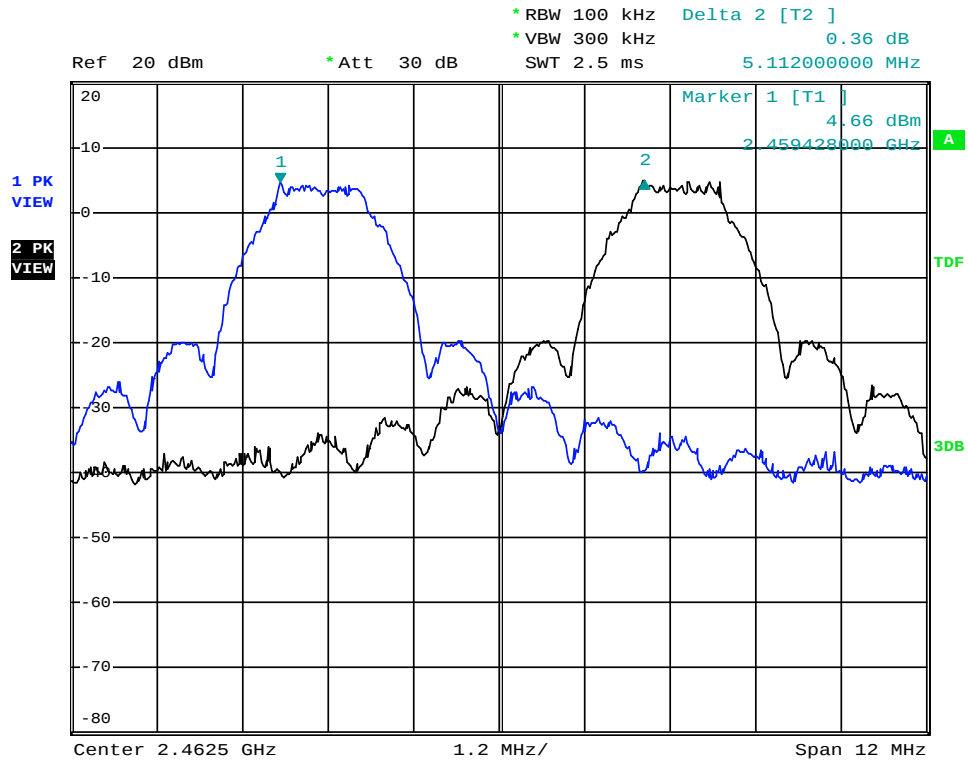


Channel Separation (12 CH ~ 13 CH)

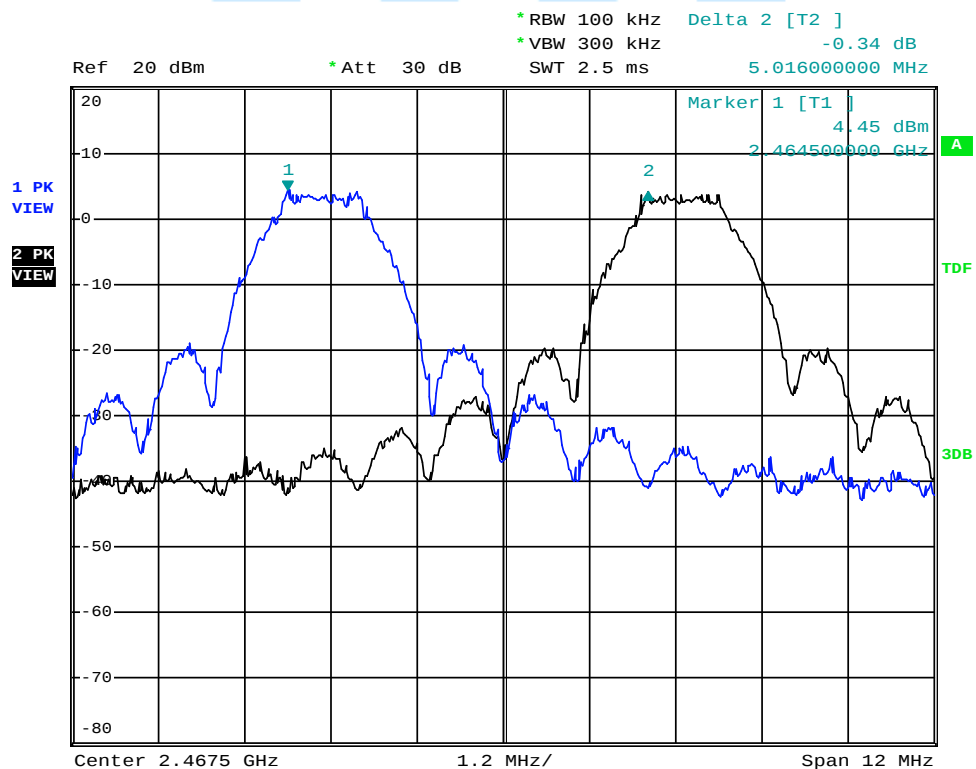




Channel Separation (13 CH ~ 14 CH)

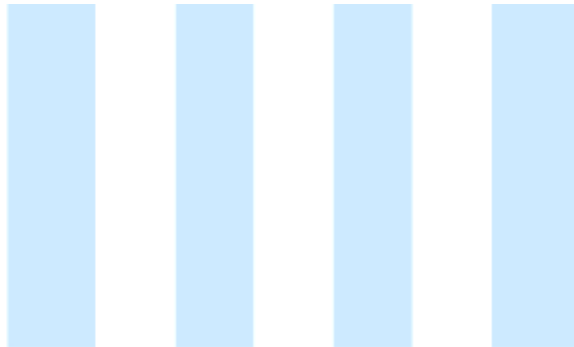
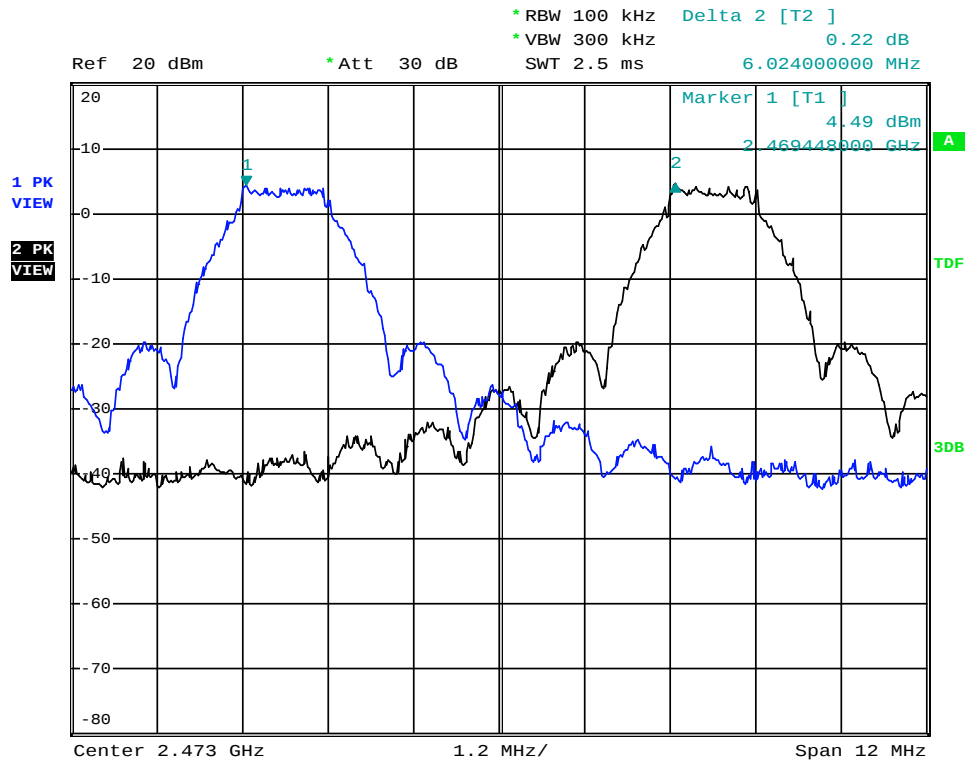


Channel Separation (14 CH ~15 CH)





Channel Separation (15 CH ~ 16 CH)



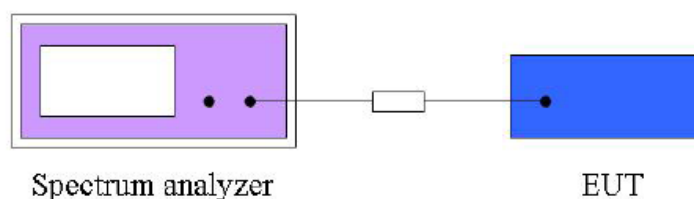


10. NUMBER OF HOPPING FREQUENCIES

10.1 Operating Environment

Temperature : 19.8 °C
Relative Humidity : 36.5 % R.H.

10.2 Test Set-up (Layout)



10.3 Limit

At least 15 channels frequencies, and should be equally spaced

10.4 Test Equipment used

Model Name	Manufacturer	Description	Serial Number	Due to Calibration
■ - FSP	Rohde & Schwarz	EMI Test Receiver	101431	Jan. 04, 2017
■ - 56-10	Weinschel	10dB Attenuator	53184	Apr. 20, 2017

10.5 Test Result

- Test Date : January 11, 2016
- Reference Standard : Part 15 Subpart C, Sec. 15.247(a)(1)(iii)
- Modulation : GFSK
- Power Source : DC 3.0 V supplied from the DC Power supply

Spectrum Parameter set to following to ANSI 63.10(2013)

- 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.
- 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 $\geq$ RBW.
- Sweep: Auto.
- Detector function: Peak.
- Trace: Max hold.
- Allow the trace to stabilize.



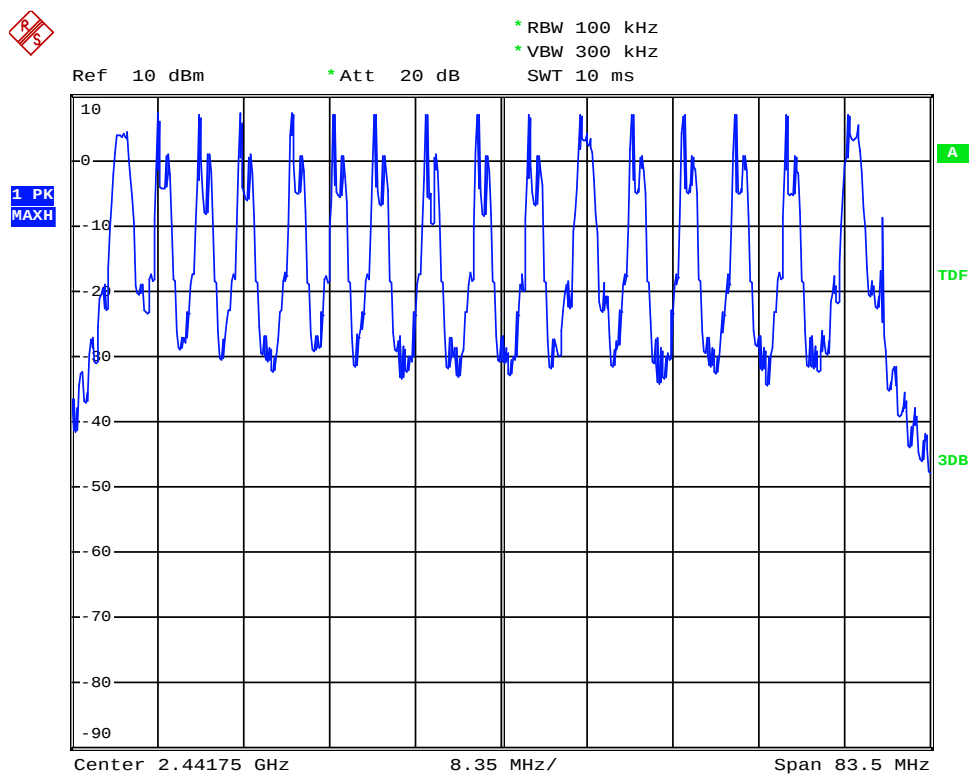
Result table of Number of Hopping Frequencies

Modulation = GFSK, data rate = 2 Mbps

Modulation	Total channel No.	Hopping channel No.	Limit	Result
GFSK	16	16	> 15	Complies

-Test Result Plot

Channel Separation (full channel)



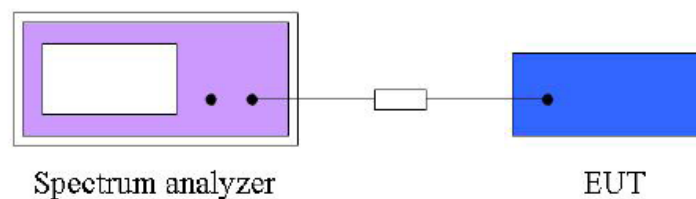


11. Time of Occupancy (dwell time)

11.1 Operating Environment

Temperature : 23.0 °C
Relative Humidity : 45.0 % R.H.

11.2 Test Set-up (Layout)



11.3 Limit

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.

11.4 Test Equipment used

Model Name	Manufacturer	Description	Serial Number	Due to Calibration
■ - FSP	Rohde & Schwarz	EMI Test Receiver	101431	Jan. 04, 2017
■ - 56-10	Weinschel	10dB Attenuator	53184	Apr. 20, 2017

11.5 Test Result

- Test Date : May 02, 2016
- Reference Standard : Part 15 Subpart C, Sec. 15.247(a)(1)(iii)
- Modulation : GFSK
- Power Source : DC 3.0 V supplied from the DC Power supply

Spectrum Parameter set to following to ANSI 63.10(2013)

- Span: Zero span, centered on a hopping channel
- RBW: $\leq$ channel spacing and where possible RBW should be set $\gg 1/T$, where T is the expected dwell time per channel.
- VBW $\geq$ RBW
- Sweep = as necessary to capture the entire dwell time per hopping channel
- Detector = peak
- Trace = max hold.



The EUT's packet need 1 time slot for transmitting and 1 time slot for receiving. Then the System makes worst case 62/2 hops per second with 16 channels. So the system has each channel 1.94 times per second(62/2/16)

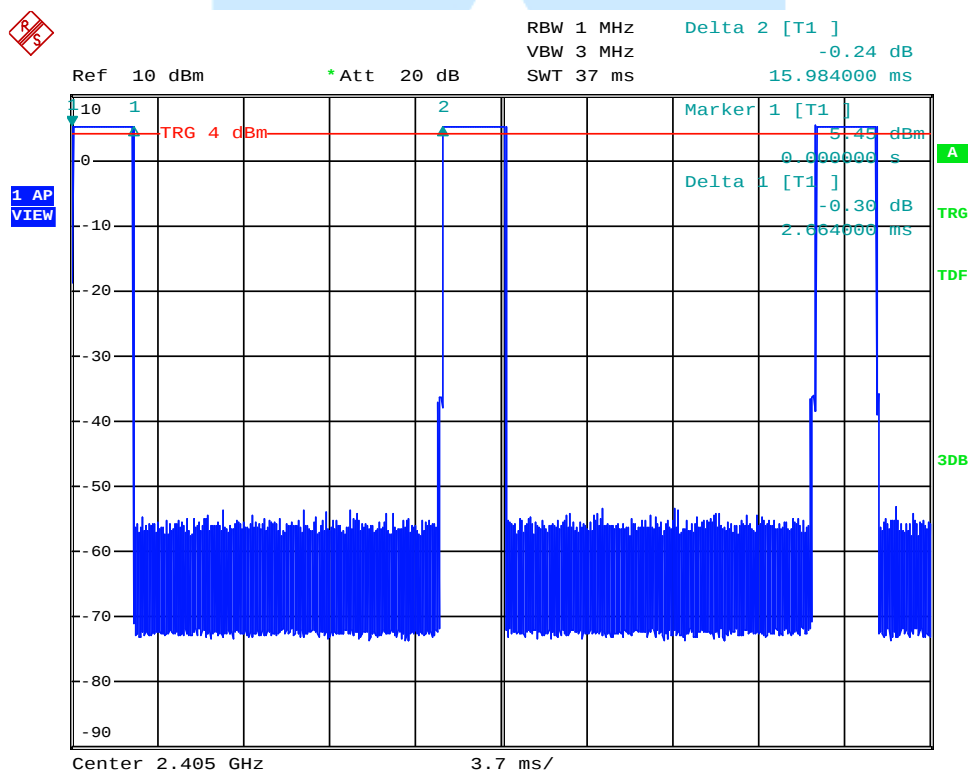
Result table of Time of occupancy (dwell time)

Modulation = GFSK, data rate = 2 Mbps

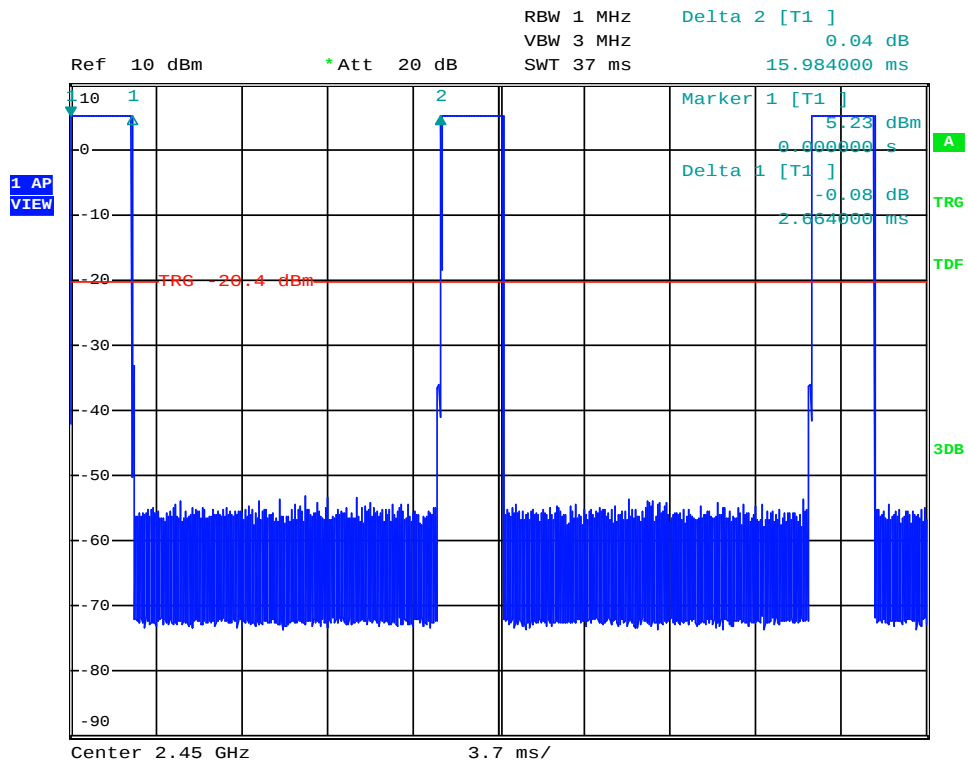
Frequency (MHz)	Pulse on time (ms)	Hops per second with channel	Period time	Occupancy time(ms)	Limit (ms)	Result
2405	2.664	1.94	6.4	33.08	400	Complies
2450	2.664	1.94	6.4	33.08	400	Complies
2476	2.664	1.94	6.4	33.08	400	Complies

※ Occupancy time(ms): Pulse on time x Hops per second with channel x Period time

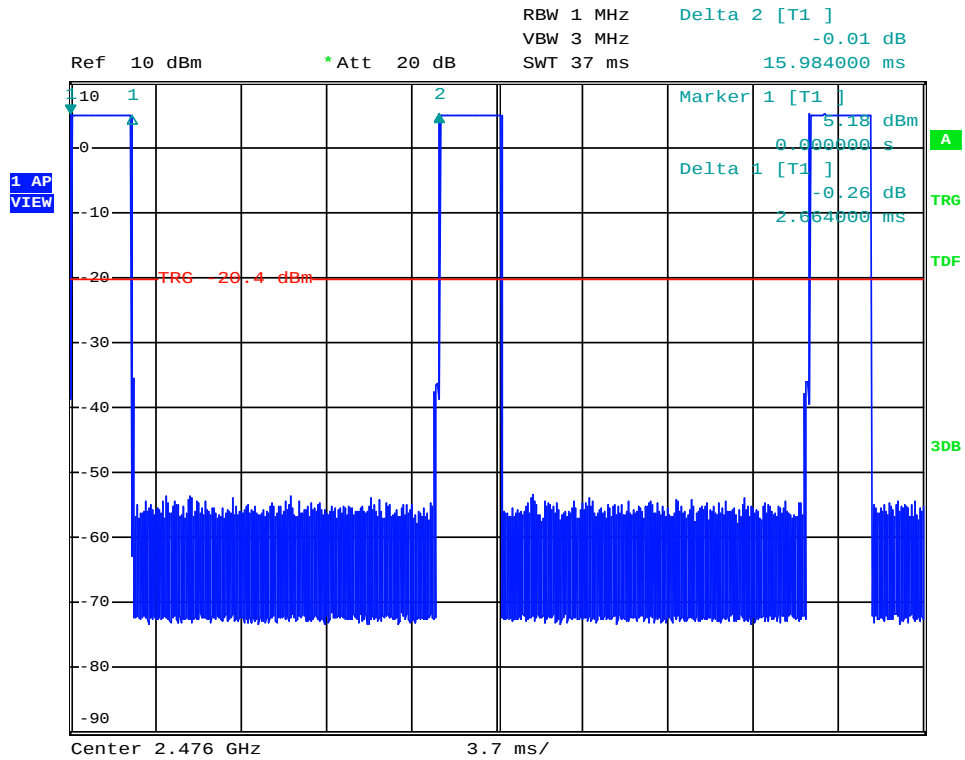
-Test Result Plot(Pulse on time)



< Lowest Channel >



< Middle Channel >



< Highest Channel >

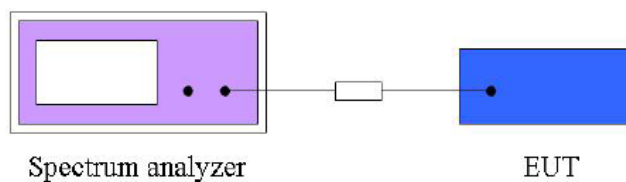


12. Conducted Spurious Emissions

12.1 Operating Environment

Temperature : 23.0 °C
Relative Humidity : 45.0 % R.H.

12.2 Test Set-up (Layout)



12.3 Limit

Below -20 dB of the highest emission level of operating band (in 100 kHz resolution band width)

12.4 Test Equipment used

Model Name	Manufacturer	Description	Serial Number	Due to Calibration
■ - FSP	Rohde & Schwarz	EMI Test Receiver	101431	Jan. 04, 2017
■ - 56-10	Weinschel	10dB Attenuator	53184	Apr. 20, 2017

12.5 Test Result

-. Test Date : February 04, 2016
-. Reference Standard : Part 15 Subpart C, Sec. 15.247(b)
-. Modulation : GFSK
-. Power Source : DC 3.0 V supplied from the DC Power supply

The spectrum plots are attached on the following 3 images, Marker 1 indicates the highest level, D1 line indicates the 20 dB offset below Marker 1. It shows compliance with the requirement in part 15.247(d)

Spectrum Parameter set to following to ANSI 63.10(2013)

- 1) Span: 30 MH to 10 times the operating frequency in GHz.
- 5) Resolution bandwidth: 100 kHz.
- 6) Video bandwidth: 300 kHz.
- 4) Sweep time: Coupled.
- 7) Detector: Peak.
- 8) Trace: Max hold.

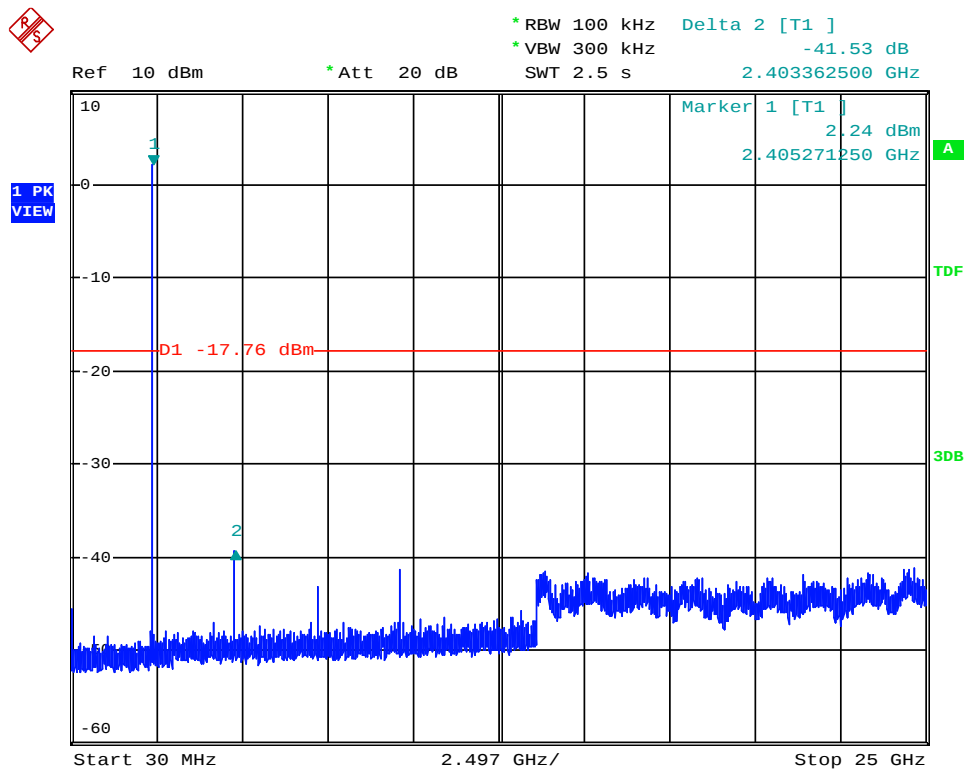


Result table of Conducted Spurious emission

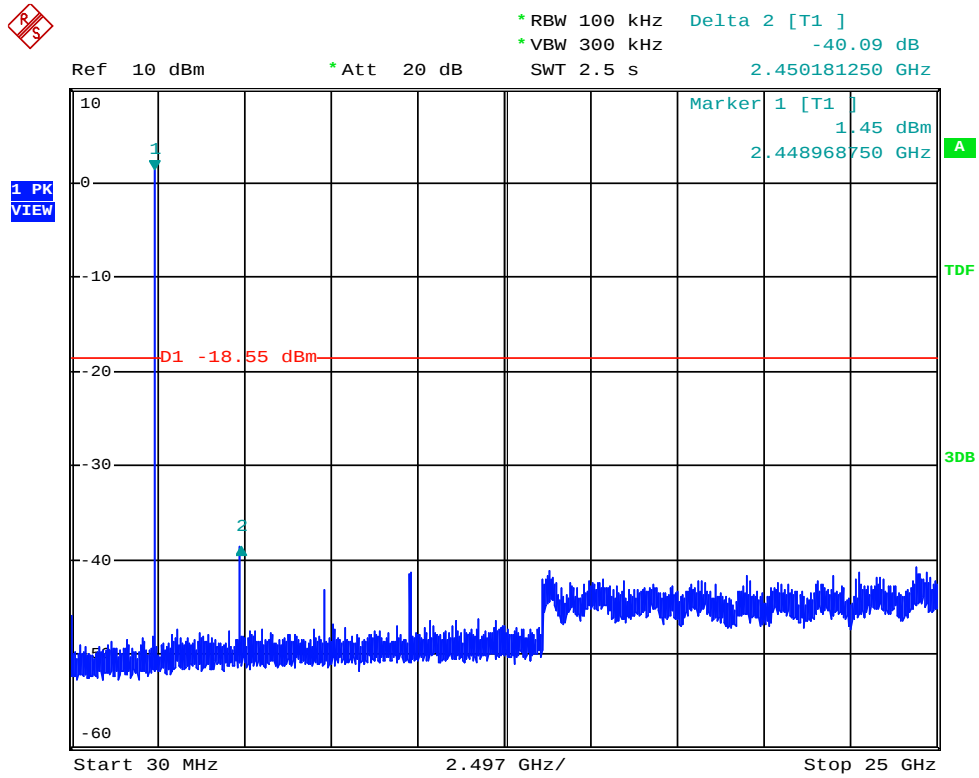
Modulation = GFSK, data rate = 2 Mbps

Operating Frequency	Lower band (dBc)	Limits (dBc)	Result
2405	-41.53	-20.00	Complies
2450	-40.09		Complies
2476	-40.71		Complies

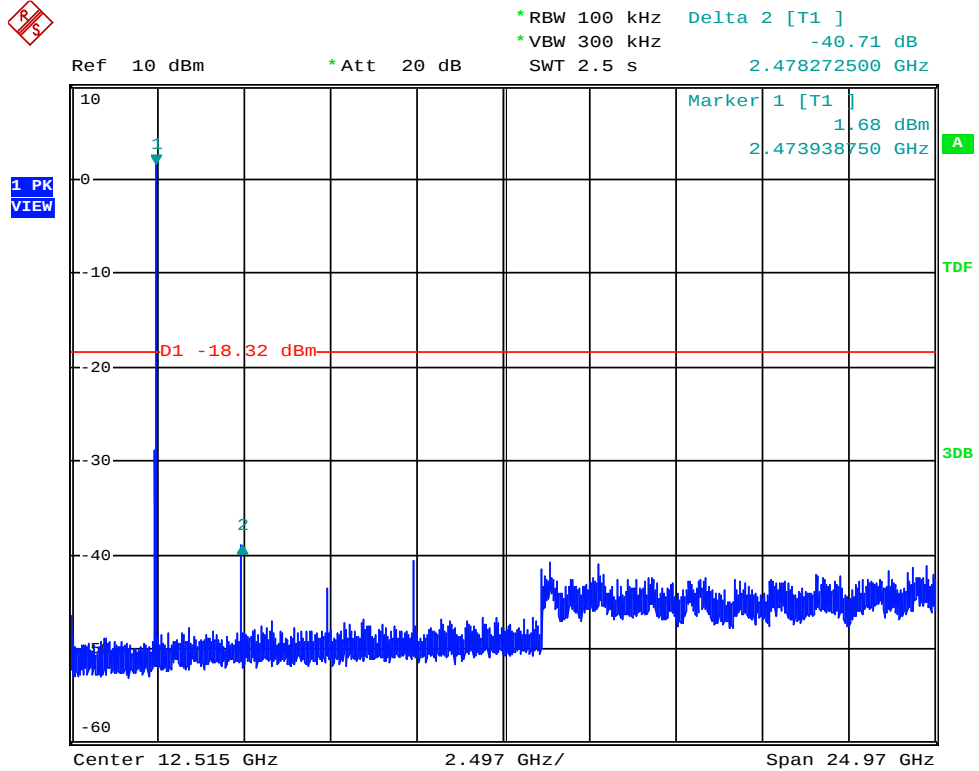
-Test Result Plot(Pulse on time)



< Lowest Channel >



< Middle Channel >



< Highest Channel >

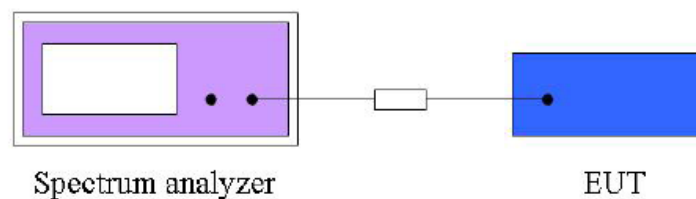


13. Band Edge(Out of Band Emissions)

13.1 Operating Environment

Temperature : 23.0 °C
Relative Humidity : 45.0 % R.H.

13.2 Test Set-up (Layout)



13.3 Limit

Below -20 dB of the highest emission level of operating band (in 100 kHz resolution band width)

13.4 Test Equipment used

Model Name	Manufacturer	Description	Serial Number	Due to Calibration
■ - FSP	Rohde & Schwarz	EMI Test Receiver	101431	Jan. 04, 2017
■ - 56-10	Weinschel	10dB Attenuator	53184	Apr. 20, 2017

13.5 Test Result

- Test Date : February 04, 2016
- Reference Standard : Part 15 Subpart C, Sec. 15.247(b)
- Modulation : GFSK
- Power Source : DC 3.0 V supplied from the DC power supply

The spectrum plots are attached on the following 4 images, Marker 1 line indicates the highest level, D1 line indicates the 20 dB offset below Marker 1. It shows compliance with the requirement in part 15.247(d)

Spectrum Parameter set to following to ANSI 63.10(2013)

- 1) 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 that fall outside of the authorized band of operation.
- 2) Reference level: As required to keep the signal from exceeding the maximum instrument input mixer level for linear operation. In general, the peak of the spectral envelope shall be more than $[10 \log (OBW/RBW)]$ below the reference level.
- 3) Attenuation: Auto (at least 10 dB preferred).
- 4) Sweep time: Coupled.
- 5) Resolution bandwidth: 100 kHz.
- 6) Video bandwidth: 300 kHz.
- 7) Detector: Peak.
- 8) Trace: Max hold.

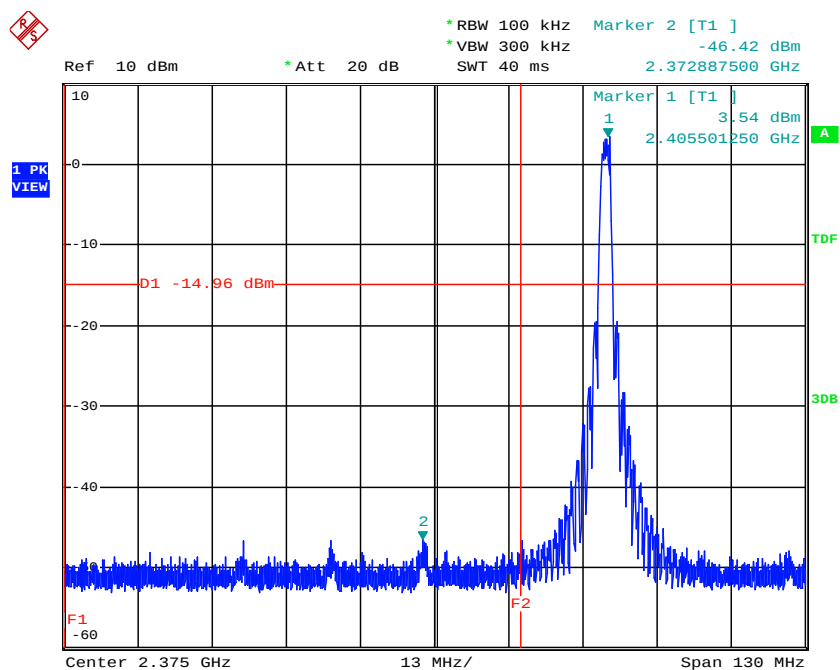


Result table of Conducted Spurious emission

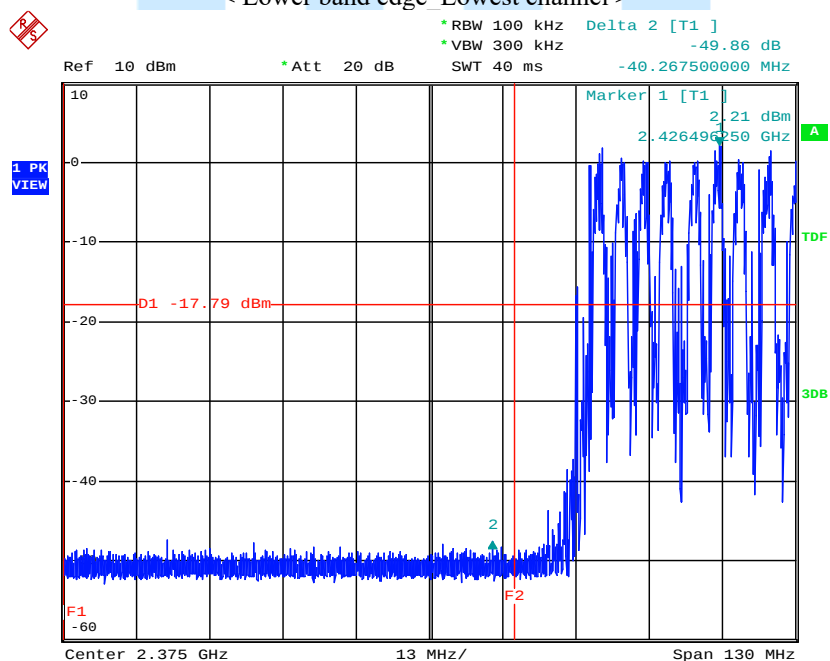
Modulation = GFSK, data rate = 2 Mbps

Operating Frequency	Lower band (dBc)	Upper band (dBc)	Limits (dBc)	Result
Non Hopping	-45.96	-49.86	-20.00	Complies
Hopping	-46.42	-49.74	-20.00	Complies

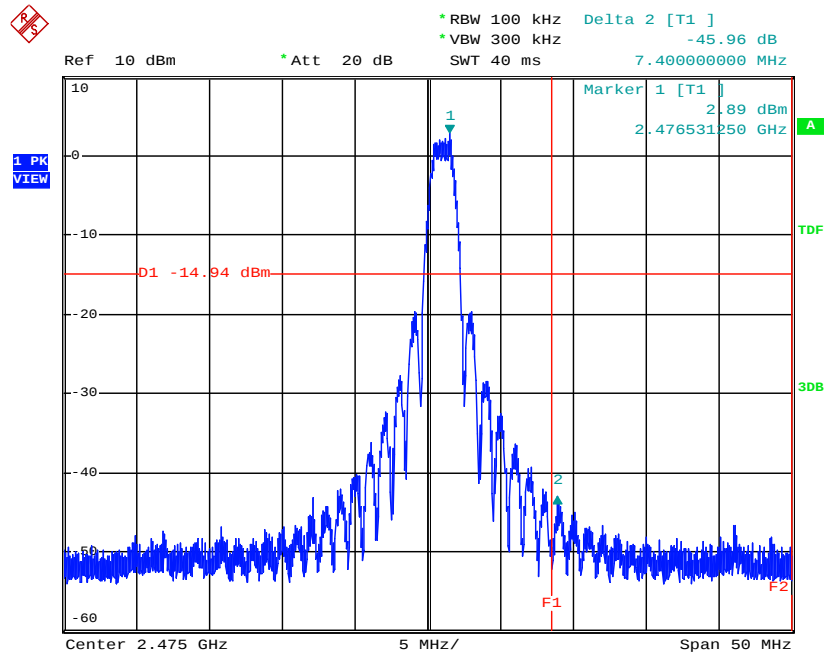
-Test Result Plot_Band edge(Out of Band emission)



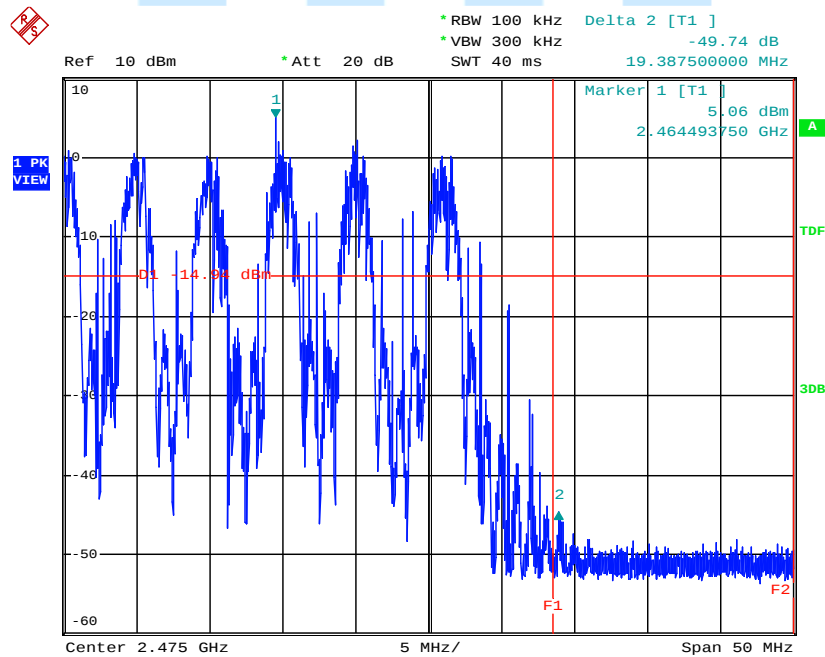
< Lower band edge Lowest channel >



< Lower band edge_ frequency hopping >



< Upper band edge_Highest channel >



< Upper band edge _ frequency hopping >



14. AC Power line Conducted emission

The Line conducted emission test facility is inside a 4 m × 8 m × 2.5 m shielded enclosure.

The EUT was placed on a non-conducting 1.0 m by 1.5 m table, which is 0.8 m in height and 0.4 m away from the vertical wall of the shielded enclosure.

The EUT is powered from the Rohde & Schwarz LISN (ESH2-Z5) and the support equipment is powered from the Rohde & Schwarz LISN (ESH3-Z5). Powers to the LISN are filtered by high-current high insertion loss power line filter.

Sufficient time for EUT, support equipment, and test equipment was allowed in order for them to warm up to their normal operating condition.

The RF output of the LISN was connected to the EMI test receiver (Rohde & Schwarz, ESCS30).

Exploratory measurements were conducted to identify the highest emission by operating the EUT in a range of typical modes of operation, cable positions, system configuration and arrangement.

Based on exploratory measurements, the final measurements were conducted at the worst test conditions.

Exploratory measurements were scanned using Peak mode of EMI Test receiver from 150 kHz to 30 MHz with 20 ms sweep time. The final measurements were measured with Quasi-Peak and Average mode.

The bandwidth of EMI Test Receiver was set to 9 kHz. Interface cables were connected to the available interface ports of the test unit. Excess cable lengths were bundled at center with 30 cm ~ 40 cm.

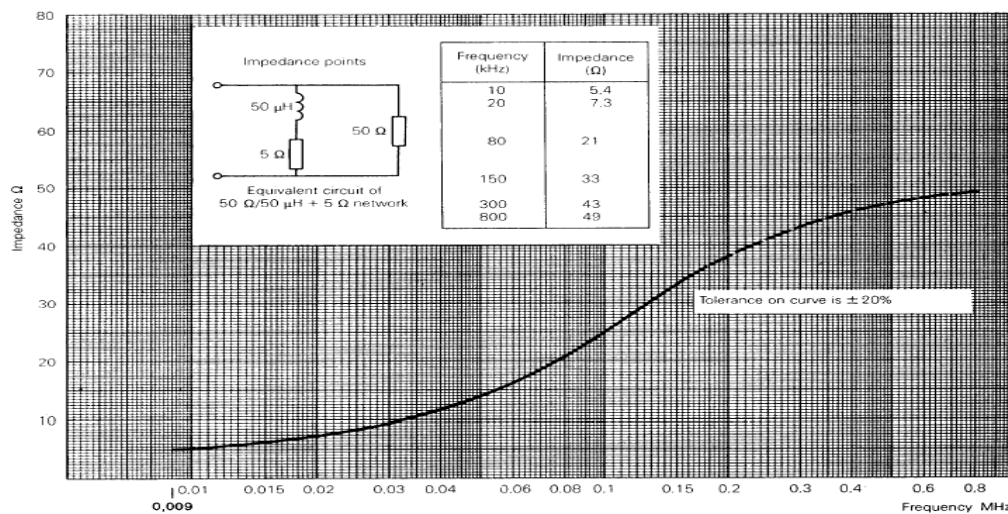


Fig 2. Impedance of LISN



14.1 Operating Environment

Temperature : -
Relative Humidity : -

14.2 Test Set-up

The conducted emission measurements were performed in the shielded room.

The EUT was placed on wooden table, 0.8 m heights above the floor, 0.4 m from the reference ground plane (GRP) wall and 0.8 m from AMN & ISN.

AMN is bonded on horizontal reference ground plane.

The ground plane, which was electrically bonded to the shield room, ground system and all power lines entering the shield room, were filtered.

14.3 Measurement Uncertainty

The measurement uncertainty was calculated in accordance with ISO "Guide to the expression of uncertainty in measurement."

The measurement uncertainty was given with a confidence of 95 %.

Test Items	Uncertainty	Remark
Conducted emission (9 kHz ~ 150 kHz)	± 3.94 dB	Confidence level of approximately 95 % ($k = 2$)
Conducted emission (150 kHz ~ 30 MHz)	± 3.43 dB	Confidence level of approximately 95 % ($k = 2$)



14.4 Limit

RFI Conducted	FCC Limit(dBμV/m) Class B	
Freq. Range	Quasi-Peak	Average
150 kHz ~ 0.5 MHz	66 ~ 56*	56 ~ 46*
0.5 MHz ~ 5 MHz	56	46
5 MHz ~ 30 MHz	60	50
*Limits decreases linearly with the logarithm of frequency.		

14.5 Test Equipment used

Model Name	Manufacturer	Description	Serial Number	Due to Calibration
☐ - ESCI	Rohde & Schwarz	EMI test receiver	100237	Apr 23. 2016
☐ -- ENV216	Rohde & Schwarz	LISN	100172	Apr 23. 2016
☐ - ENV216	Rohde & Schwarz	LISN	100173	Apr 23. 2016
☐ - ISN T8	TESEQ. GmbH	ISN	24568	Apr 27. 2016

14.6 Test data for Conducted Emission

- Test Date :
- Reference Standard :
- Test Procedure(s) :
- Operating Condition :
- Frequency range :
- Comment : Not applicable
※ The EUT is supplied power from battery. Therefore this test was not applicable.

15. Radiated Emission

Exploratory Radiated measurements were conducted at the 3m semi anechoic chamber in order to identify the highest emission by operating the EUT in a range of typical modes of operation, cable positions, system configuration and arrangement.

Based on exploratory measurements, the final measurements were conducted at the worst test conditions.

Final measurements of below 1GHz were made at 3m or 10 m Chamber that complies with CISPR 16/ANSI C63.10. Above 1GHz final measurements were conducted at the 3m Chamber only.

For measurements above 1GHz, the bottom side of 3m chamber was installed with absorbers in order to meet SVSWR Limit.

Exploratory measurements were scanned using Peak mode of EMI Test receiver and final measurements were measured with Quasi-Peak mode (Below 1GHz) and Peak & Average mode (Above 1GHz).

The measurements were performed by rotating the EUT 360° and adjusting the receive antenna height from 1.0 m to 4.0 m. All frequencies were investigated in both horizontal and vertical antenna polarity.

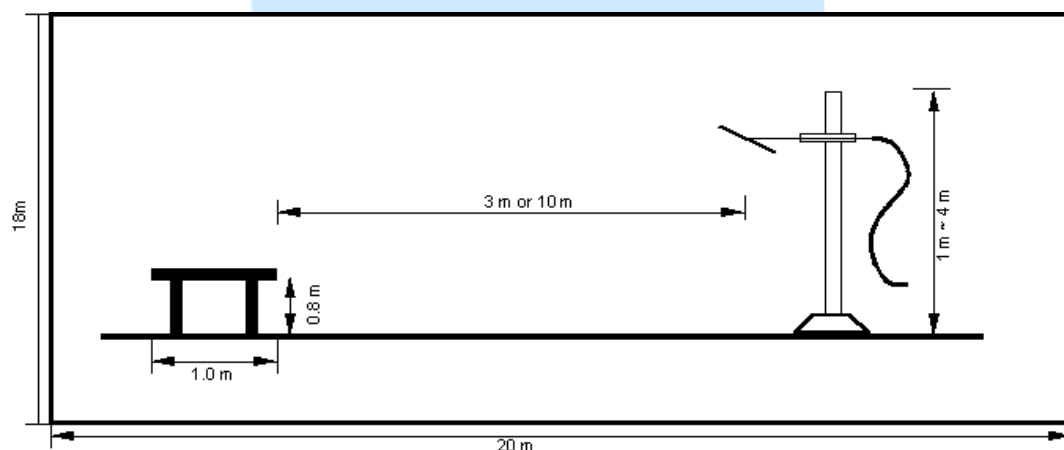


Fig 3. Dimensions of test site (Below 1GHz)

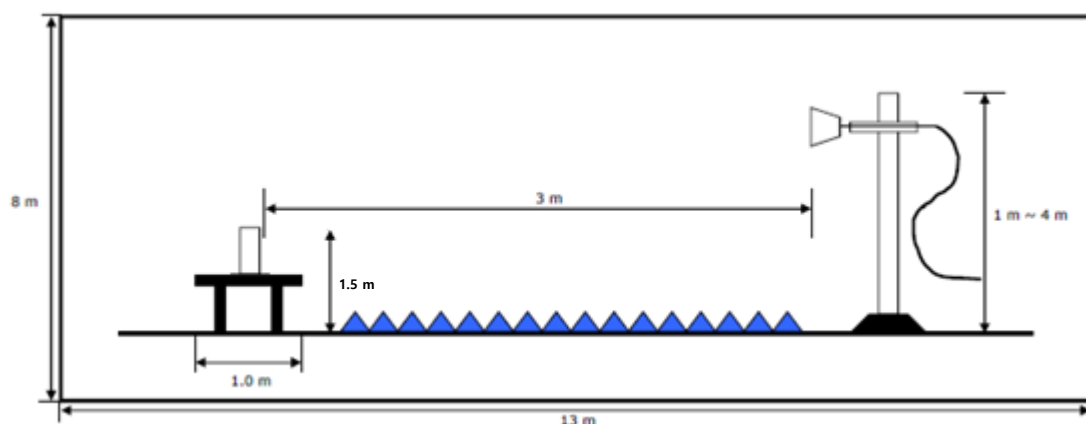


Fig 4. Dimensions of test site (Above 1GHz)



15.1 Operating environment

Temperature : 22.4 °C
Relative humidity : 51.3 % R.H.

15.2 Test set-up

A preliminary and final measurement was at 3 m anechoic chamber.

The EUT was placed on a non-conducting table.

For emissions testing at or below 1 GHz, the table height is 80 cm above the reference ground plane.

For emission measurements above 1 GHz, the table height is 1.5 m.

The turntable with EUT was rotated 360°, and the antenna was varied in height between 1.0 m and 4.0 m in order to determine the maximum emission levels.

This procedure was performed for both horizontal and vertical polarization of the receiving antenna.

15.3 Measurement uncertainty

The measurement uncertainty was calculated in accordance with ISO “Guide to the expression of uncertainty in measurement”.

The measurement uncertainty was given with a confidence of 95 %.

Test items(Anechoic Chamber)	Uncertainty	Remark
Radiated emission (30 MHz ~ 300 MHz, 3 m, Vertical)	± 4.66 dB	Confidence level of approximately 95 % ($k = 2$)
Radiated emission (30 MHz ~ 300 MHz, 3 m, Horizontal)	± 4.65 dB	Confidence level of approximately 95 % ($k = 2$)
Radiated emission (300 MHz ~ 1 000 MHz, 3 m, Vertical)	± 4.91 dB	Confidence level of approximately 95 % ($k = 2$)
Radiated emission (300 MHz ~ 1 000 MHz, 3 m, Horizontal)	± 4.88 dB	Confidence level of approximately 95 % ($k = 2$)
Radiated emission (1 000 MHz ~ 6 000 MHz, 3 m, V/H)	± 5.32 dB	Confidence level of approximately 95 % ($k = 2$)
Radiated emission (6 000 MHz ~ 18 000 MHz, 3 m, V/H)	± 5.45 dB	Confidence level of approximately 95 % ($k = 2$)



16.4 Limit

20 dB in any 100 kHz bandwidth outside the operating frequency band. In case the emission fall within the restricted band specified on 15.205(a) limit in the table below has to be followed.

Frequencies (MHz)	Field Strength (microvolt/meter)	Measurement Distance (meters)
0.009 ~ 0.490	2 400/F (kHz)	300
0.490 ~ 1.705	2 400/F (kHz)	30
1.705 ~ 30.0	30	30
30 ~ 88	100	3
88 ~ 216	150	3
216 ~ 960	200	3
Above 960	500	3

16.5 Test Equipment used

Model Name	Manufacturer	Description	Serial Number	Due to Calibration
■ - ESIB26	Rohde & Schwarz	EMI Test Receiver	830482/010	Apr. 23, 2016
■ - HFH2-Z2	Rohde & Schwarz	Loop Antenna	100041	Dec. 21, 2017
■ - VULB9160	Schwarzbeck	Broadband Test Antenna	3099	Aug. 03. 2017
■ - BBHA9120D	Schwarzbeck	Horn Antenna	597	May 11. 2016
■ - 3160-09	Schwarzbeck	Horn Antenna	LM3981	Nov. 29. 2017
■ - MCU066	maturo GmbH	Position Controller	1390306	N/A
■ - TT2.5SI	maturo GmbH	Turntable	1390307	N/A
■ - AM 4.0	maturo GmbH	Antenna Mast	1390308	N/A
■ - AFS 44 00101800-25-10P-44	MITEQ	Preamplifier	1258943	Jan. 05. 2017
■ - SCU-F1826-G47-BZ42-CSS	BONN Elektronik	Preamplifier	10003	Jan. 12. 2017



16.6 Test data for Radiated Emission

- Test Date : March 15~17, 2016
- Reference Standard : Part 15 Subpart C, Sec. 15.247(d)
- Measuring Distance : 3 m
- Spectrum Resolution : 120 kHz / 1 MHz / 10 Hz / 100 kHz
Bandwidth(6 dB)
- Detector mode : Peak detector mode / Quasi Peak detector mode
- Power Source : DC 3.0 V supplied from the a batteries
- Note : Through three orthogonal axes were investigated and the worst case is report

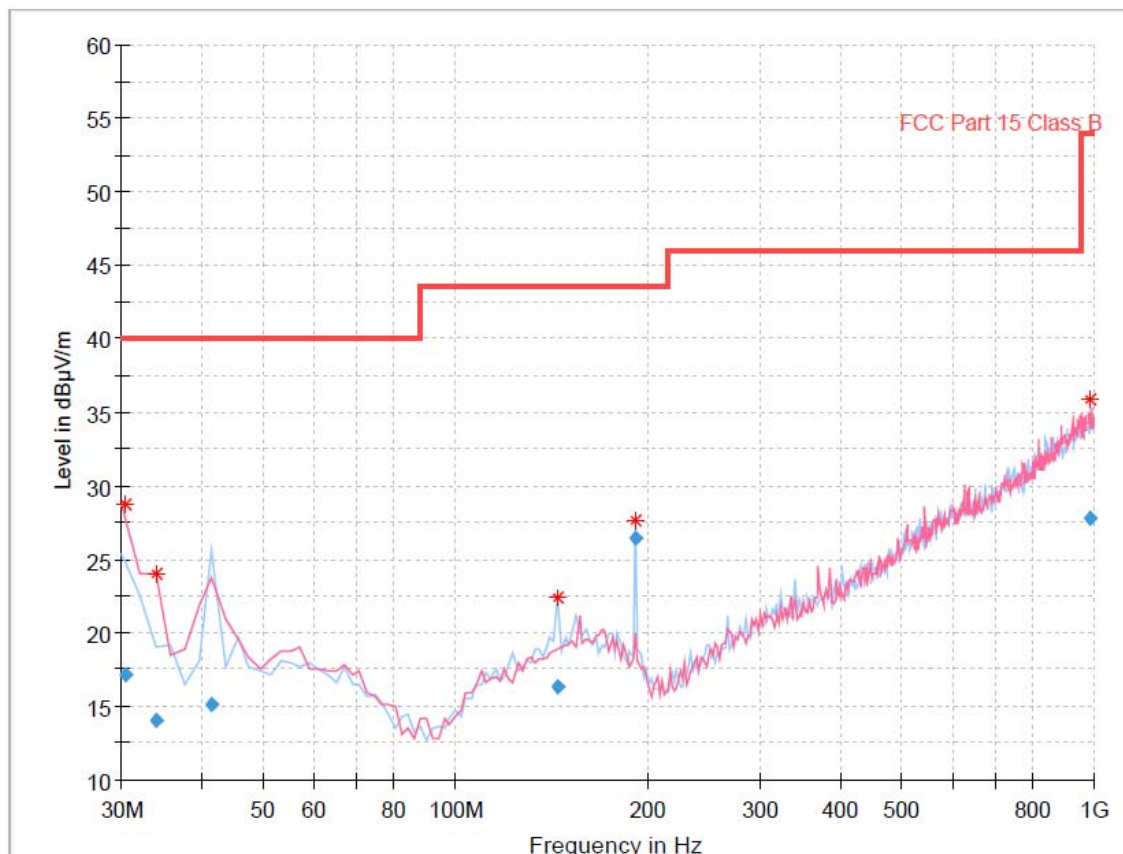
Radiated emission_Spurious Emission (9 kHz to 30 MHz): Middle channel (2 450 MHz)

Frequency (MHz)	Measurement Level							Limit (dBμV/m)		Margin (dB)		Positioning System		
	Reading Value (dBμV/m)		AF	AMP / CL	Duty Cycle collection	Test Result (dBμV/m)						Pol.	Height	Angle
	Peak	Average				(dB/m)	(dB)	(dB)	Peak	Average	Peak			

The emission level was not found



Radiated emission_Spurious Emission (30 MHz to 1 000 MHz): Middle channel (2 450 MHz)



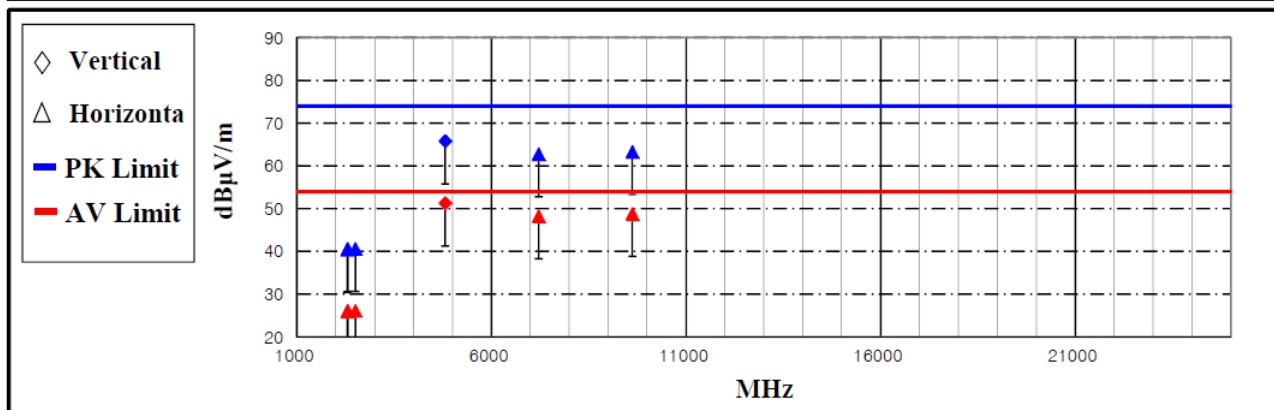
Final Result

Frequency (MHz)	QuasiPeak (dBμV/m)	Limit (dBμV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)
30.360000	17.20	40.00	22.80	1000.0	120.000	125.0	V	66.0
33.887760	14.10	40.00	35.90	1000.0	120.000	300.0	V	331.0
41.423327	15.10	40.00	24.90	1000.0	120.000	120.0	H	109.0
144.289379	16.37	43.50	27.13	1000.0	120.000	209.0	H	-3.0
191.982685	26.48	43.50	17.02	1000.0	120.000	183.0	H	180.0
984.968898	27.75	54.00	26.25	1000.0	120.000	400.0	H	301.0



Radiated emission_Spurious Emission (1 GHz to 25 GHz): Lowest channel (2 405 MHz)

Frequency (MHz)	Measurement Level							Limit (dBμV/m)		Margin (dB)		Positioning System		
	Reading Value (dBμV/m)		AF	AMP / CL	Duty Cycle collection	Test Result (dBμV/m)						Pol.	Height	Angle
	Peak	Average	(dB/m)	(dB)	(dB)	Peak	Average	Peak	Average	Peak	Average	(H/V)	(cm)	(°)
2294.59	50.28	-	26.71	-36.61	-14.47	40.38	25.91	74.00	54.00	33.62	28.09	H	150	76
2306.61	50.29	-	26.74	-36.44	-14.47	40.59	26.12	74.00	54.00	33.41	27.88	H	150	120
2507.01	49.89	-	27.27	-36.57	-14.47	40.59	26.12	74.00	54.00	33.41	27.88	H	150	130
4810.81	69.34	-	31.21	-34.80	-14.47	65.75	51.28	74.00	54.00	8.25	2.72	V	156	37
7213.62	58.12	-	35.82	-31.20	-14.47	62.74	48.27	74.00	54.00	11.26	5.73	H	218	234
9618.03	51.97	-	38.26	-26.94	-14.47	63.29	48.82	74.00	54.00	10.71	5.18	H	225	11



Note:

Emission level (dBμV/m) = 20 log × Emission level (μV/m).

Corrected reading: Reading Value + (AF + AMP/CL) = Test result

※ AF : Antenna factor, AMP/CL : preamplifier gain + cable loss + High pass filter(if use)

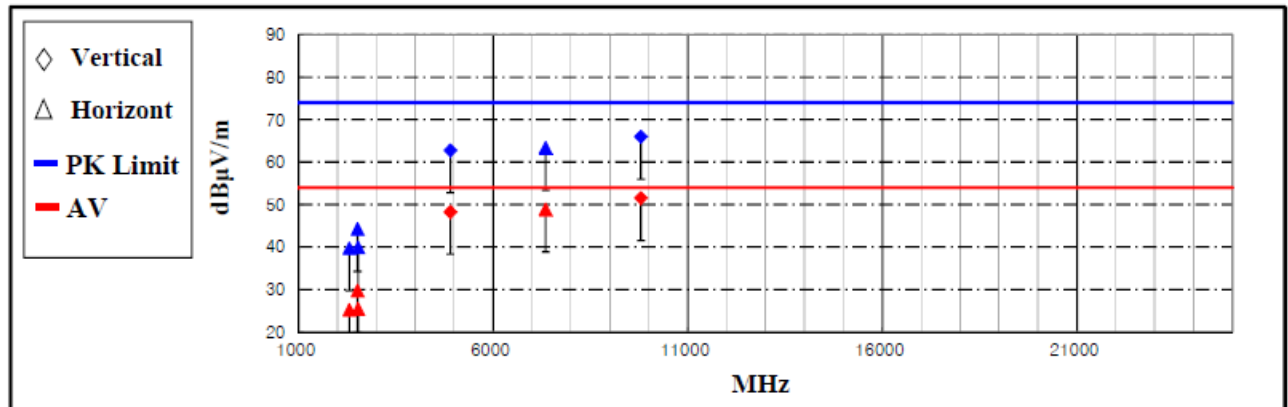
Duty cycle collection (dB) : 20log(dwell time / 100ms or T) dB = -14.47 dB

Pol.: H(Horizontal), V(Vertical)



Radiated emission_Spurious Emission (1 GHz to 25 GHz): Middle channel (2 450 MHz)

Frequency (MHz)	Measurement Level							Limit (dBμV/m)		Margin (dB)		Positioning System		
	Reading Value (dBμV/m)		AF	AMP / CL	Duty Cycle collection	Test Result (dBμV/m)						Pol.	Height	Angle
	Peak	Average	(dB/m)	(dB)	(dB)	Peak	Average	Peak	Average	Peak	Average	(H/V)	(cm)	(°)
2306.61	49.50	-	26.74	-36.54	-14.47	39.70	25.22	74.00	54.00	34.31	28.78	H	150	125
2514.57	53.44	-	27.29	-36.49	-14.47	44.24	29.77	74.00	54.00	29.76	24.23	H	211	126
2531.06	49.09	-	27.33	-36.53	-14.47	39.89	25.42	74.00	54.00	34.11	28.58	H	200	120
4898.99	65.88	-	31.37	-34.51	-14.47	62.74	48.27	74.00	54.00	11.26	5.73	V	154	37
7351.52	58.26	-	35.99	-30.92	-14.47	63.33	48.86	74.00	54.00	10.67	5.14	H	203	235
9797.99	54.18	-	38.43	-26.63	-14.47	65.98	51.51	74.00	54.00	8.02	2.49	V	221	4



Note:

Emission level (dBμV/m) = 20 log × Emission level (μV/m).

Corrected reading: Reading Value + (AF + AMP/CL) = Test result

※ AF : Antenna factor, AMP/CL : preamplifier gain + cable loss + High pass filter(if use)

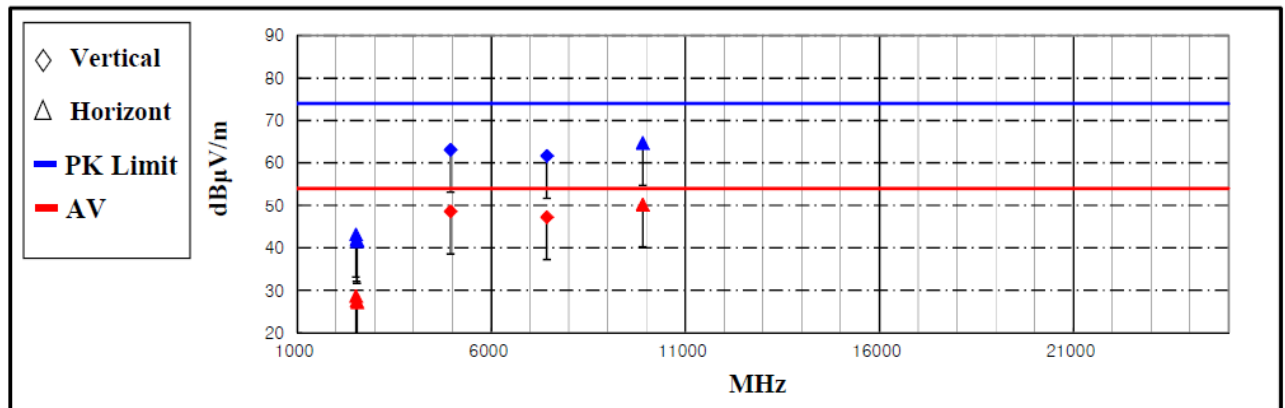
Duty cycle collection (dB) : 20log(dwell time / 100ms or T) dB = -14.47 dB

Pol.: H(Horizontal), V(Vertical)



Radiated emission_Spurious Emission (1 GHz to 25 GHz): Highest channel (2 476 MHz)

Frequency (MHz)	Measurement Level							Limit (dBμV/m)		Margin (dB)		Positioning System		
	Reading Value (dBμV/m)		AF	AMP / CL	Duty Cycle collection	Test Result (dBμV/m)						Pol.	Height	Angle
	Peak	Average	(dB/m)	(dB)	(dB)	Peak	Average	Peak	Average	Peak	Average	(H/V)	(cm)	(°)
2511.02	52.45	-	27.28	-36.58	-14.47	43.15	28.68	74.00	54.00	30.85	25.32	H	200	316
2527.05	51.25	-	27.32	-36.52	-14.47	42.05	27.57	74.00	54.00	31.95	26.43	H	200	196
2543.09	50.72	-	27.36	-36.46	-14.47	41.62	27.15	74.00	54.00	32.38	26.85	H	150	120
4951.11	66.11	-	31.46	-34.51	-14.47	63.06	48.59	74.00	54.00	10.94	5.41	V	150	69
7429.64	56.32	-	36.09	-30.76	-14.47	61.65	47.18	74.00	54.00	12.35	6.82	V	200	316
9901.83	52.64	-	38.52	-26.45	-14.47	64.71	50.24	74.00	54.00	9.29	3.76	H	215	3



Note:

Emission level (dBμV/m) = 20 log × Emission level (μV/m).

Corrected reading: Reading Value + (AF + AMP/CL) = Test result

※ AF : Antenna factor, AMP/CL : preamplifier gain + cable loss + High pass filter(if use)

Duty cycle collection (dB) : 20log(dwell time / 100ms or T) dB = -14.47 dB

Pol.: H(Horizontal), V(Vertical)



Result of radiated emission (Band Edge)

Lowest channel (2 405 MHz)

Frequency (MHz)	Measurement Level						Limit (dBμV/m)		Margin (dB)		Positioning System			
	Reading Value (dBμV/m)		AF	AMP / CL	Duty Cycle collection	Test Result (dBμV/m)					Pol.	Height	Angle	
	Peak	Average	(dB/m)	(dB)	(dB)	Peak	Average	Peak	Average	(H/V)	(cm)	(°)		
2388.40	59.57	-	26.95	-36.98	-14.47	49.54	35.07	74.00	54.00	24.46	18.93	H	199	179

Highest channel (2 476 MHz)

Frequency (MHz)	Measurement Level						Limit (dBμV/m)		Margin (dB)		Positioning System			
	Reading Value (dBμV/m)		AF	AMP / CL	Duty Cycle collection	Test Result (dBμV/m)					Pol.	Height	Angle	
	Peak	Average	(dB/m)	(dB)	(dB)	Peak	Average	Peak	Average	(H/V)	(cm)	(°)		
2483.50	65.01	-	27.21	-36.95	-14.47	55.27	40.80	74.00	54.00	18.73	13.20	H	145	123

Note:

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

Emission level (dBμV/m) = 20 log Emission level (μV/m).

Corrected reading: Reading Value + (AF + AMP/CL) = Test result

※ AF : Antenna factor, AMP/CL : preamplifier gain + cable loss

Duty cycle collection (dB) : 20log(dwell time / 100ms or T) dB = -14.47 dB

Pol.: H(Horizontal), V(Vertical)



17. Sample Calculations

$$\begin{aligned} \text{dB}\mu\text{V} &= 20 \text{ Log}_{10}(\mu\text{V}/\text{m}) \\ \text{dB}\mu\text{V} &= \text{dBm} + 107 \\ \mu\text{V} &= 10^{(\text{dB}\mu\text{V}/20)} \end{aligned}$$

17.1 Example 1 :

■ 20.3 MHz

Class B Limit = 250 μV = 48 dB μV
Reading = 39.2 dB μV
 $10^{(39.2\text{dB}\mu\text{V}/20)}$ = 91.2 μV
Margin = 48 dB μV - 39.2 dB μV
= 8.8 dB

17.2 Example 2 :

■ 66.7 MHz

Class B Limit = 100 $\mu\text{V}/\text{m}$ = 40.0 dB $\mu\text{V}/\text{m}$
Reading = 31.0 dB μV
Antenna Factor + Cable Loss = 5.8 dB
Total = 36.8 dB $\mu\text{V}/\text{m}$
Margin = 40.0 dB $\mu\text{V}/\text{m}$ – 36.8 dB $\mu\text{V}/\text{m}$
= 3.2 dB



18. Recommendation & Conclusion

The data collected shows that the **LG Electronics Inc. RF Module(TX) (Model Name: EAT63294801)** was complies with §15.247 of the FCC Rules.

- The end -

