FCC Part 15
EMI TEST REPORT

Part I – Bluetooth (FHSS)

of

E.U.T. ： JRVCS2 Display Commander
Model ： JRVCS2DC
FCC ID ： HQXJRVCS2DC

for

APPLICANT : SYSGRATION LTD.
ADDRESS : 6F-2., No.1, Sec.1, Tiding Blvd., Neihu Dist.,
Taipei City 114, Taiwan

Test Performed by

ELECTRONICS TESTING CENTER, TAIWAN
NO. 34. LIN 5, DINGFU VIL., LINKOU DIST.,
NEW TAIPEI CITY, TAIWAN, 24442, R.O.C.
Tel:(02)26023052 Fax:(02)26010910
http://www.etc.org.tw ; e-mail : emc@etc.org.tw

Report Number : 16-10-RBF-031-01

TEST REPORT CERTIFICATION

Applicant : SYSGRATION LTD.
6F-2.,No.1,Sec.1,Tiding Blvd., Neihu Dist., Taipei City 114, Taiwan
Manufacture : SYSGRATION LTD.(Nan-Kang Factory)
No.28,North Industry Rd., Nan-Kang Industrial Zone, Nan-Tou City, Nan-Tou County 540, Taiwan

Description of Device :
a) Type of EUT : JRVCS2 Display Commander
b) Trade Name : iN・Command
c) Model No. : JRVCS2DC
d) Power Supply : DC 12V

Regulation Applied : FCC Rules and Regulations Part 15 Subpart C

I HEREBY CERTIFY THAT: The data shown in this report were made in accordance with the procedures given in ANSI C63.10-2013, and the energy emitted by the device was founded to be within the limits applicable. I assume full responsibility for accuracy and completeness of these data.

Note: 1. The result of the testing report relate only to the item tested.
2. The testing report shall not be reproduced expect in full, without the written approval of ETC.

Summary of Tests

Test	Results
Radiated Emission	**Pass**
Conducted Emission	**N/A**
Hopping Channel Separation	**Pass**
Number of Hopping frequencies used	**Pass**
Hopping Channel Bandwidth	**Pass**
Dwell Time of each frequency	**Pass**
Output Power Requirement	**Pass**
100 kHz Bandwidth of Frequency Band Edges Requirement	**Pass**
Out-of-Band Conducted Emission Requirement	**Pass**
Duty Cycle	**N/A**

Date Test Item Received : *Oct. 07, 2016*
Date Test Campaign Completed : *Dec. 05, 2016*
Date of Issue : *Dec. 12, 2016*

Test Engineer : Vincent Chang
(Vincent Chang , Engineer)

Approve & Authorized : S S Liou
S. S. Liou, Section Manager
EMC Dept. II of ELECTRONICS
TESTING CENTER, TAIWAN

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1 GENERAL INFORMATION

1.1 Product Description

a)	Type of EUT	:	JRVCS2 Display Commander
b)	Trade Name	:	iN・Command
c)	Model No.	:	JRVCS2DC
d)	Power Supply	:	DC 12V

1.2 Test Methodology

Both conducted and radiated emissions were performed according to the procedures illustrated in ANSI C63.10-2013. Other required measurements were illustrated in separate sections of this test report for details.

Measurement Software

Software	Version	Note
e3	Version 6.100618b	Radiated Emission Test
e3	Version 6.100421	Conducted Emission Test

1.3 Test Facility

The open area test site and conducted measurement facility used to collect the radiated data is located on the roof top of Building at No.34, Lin 5, Dingfu Vil., Linkou Dist., New Taipei City, Taiwan 24442, R.O.C.
This site is FCC 2.948 listed and accepted in a letter dated Jan. 29, 2014.
Registration Number: 90589

2 PROVISIONS APPLICABLE

2.1 Definition

Unintentional radiator:

A device that intentionally generates and radio frequency energy for use within the device, or that sends radio frequency signals by conduction to associated equipment via connecting wiring, but which is not intended to emit RF energy by radiation or induction.

Class A Digital Device:

A digital device which is marketed for use in commercial or business environment; exclusive of a device which is market for use by the general public, or which is intended to be used in the home.

Class B Digital Device :

A digital device which is marketed for use in a residential environment notwithstanding use in a commercial, business of industrial environment. Example of such devices that are marketed for the general public.

Note : A manufacturer may also qualify a device intended to be marketed in a commercial, business, or industrial environment as a Class B digital device, and in fact is encouraged to do so, provided the device complies with the technical specifications for a Class B Digital Device. In the event that a particular type of device has been found to repeatedly cause harmful interference to radio communications, the Commission may classify such a digital device as a Class B Digital Device, Regardless of its intended use.

Intentional radiator:

A device that intentionally generates and emits radio frequency energy by radiation or induction.

2.2 Requirement for Compliance

(1) Conducted Emission Requirement

Except as shown in paragraphs (b) and (c) of this section, 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 150kHz to 30 MHz shall not exceed the limits in the following table, as measured using a 50μH/50 ohms line impedance stabilization network (LISN). Compliance with the provisions of this paragraph shall be based on the measurement of the radio frequency voltage between each power line and ground at the power terminal. The lower limit applies at the boundary between the frequency ranges.

Frequency MHz	**Quasi Peak dBμV**	**Average dBμV**
0.15 - 0.5	66-56*	56-46*
0.5 - 5.0	56	46
5.0 - 30.0	60	50

* Decreases with the logarithm of the frequency

For intentional device, according to §15.207(a) Line Conducted Emission Limits is same as above table.

(2) Radiated Emission Requirement

For unintentional device, according to §15.109(a), except for Class A digital devices, the field strength of radiated emissions from unintentional radiators at a distance of 3 meters shall not exceed the following values:

Frequency MHz	**Distance Meters**	**Radiated dBμV/m**	**Radiated μV/m**
30 - 88	3	40.0	100
88 - 216	3	43.5	150
216 - 960	3	46.0	200
Above 960	3	54.0	500

For intentional device, according to §15.209(a), the general requirement of field strength of radiated emissions from intentional radiators at a distance of 3 meters shall not exceed the above table.

(3) Antenna Requirement

For intentional device, 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.

(4) Hopping Channel Separation

According to 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.

(5) Number of Hopping frequencies used

According to 15.247(a)(1)(iii), frequency hopping systems in the 2400–2483.5 MHz band shall use at least 15 channels.

(6) Hopping Channel Bandwidth

For frequency hopping system operating in the 2400–2483.5 MHz band, there is no requirement for the maximum 20dB bandwidth of the hopping channel. The measurement of the hopping channel bandwidth is for the reference of the hopping channel separation requirement.

(7) Dwell Time of each frequency

According to 15.247(a)(1)(iii), for frequency hopping system operating in the 2400-2483.5 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.

(8) Output Power Requirement

According to 15.247(b)(1), for frequency hopping systems operating in the 2400–2483.5 MHz band employing at least 75 non-overlapping hopping channels, and all frequency hopping systems in the 5725–5850 MHz band: 1 watt. For all other frequency hopping systems in the 2400–2483.5 MHz band: 0.125 watts.

(9) 100 kHz Bandwidth of Frequency Band Edges Requirement

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 §15.209(a) is not required.

(10) Out-of-Band Conducted Emission Requirement

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 §15.209(a) is not required.

2.3 Restricted Bands of Operation

Only spurious emissions are permitted in any of the frequency bands listed below :

MHz	MHz	MHz	GHz
0.090 - 0.110	16.42-16.423	399.9-410	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	37.5-38.25	1435-1626.5	9.0-9.2
4.20725-4.20775	73-74.6	1645.5-1646.5	9.3-9.5
6.215-6.218	74.8-75.2	1660-1710	10.6-12.7
6.26775-6.26825	108-121.94	1718.8-1722.2	13.25-13.4
6.31175-6.31225	123-138	2200-2300	14.47-14.5
8.291-8.294	149.9-150.05	2310-2390	15.35-16.2
8.362-8.366	156.52475 - 156.52525	2483.5-2500	17.7-21.4
8.37625-8.38675	156.7-156.9	2655-2900	22.01-23.12
8.41425-8.41475	162.0125-167.17	3260-3267	23.6-24.0
12.29-12.293	167.72-173.2	3332-3339	31.2-31.8
12.51975-12.52025	240-285	3345.8-3358	36.43-36.5
12.57675-12.57725	322-335.4	3360-4400	Above 38.6
13.36-13.41			

** : Until February 1, 1999, this restricted band shall be 0.490-0.510 MHz

2.4 Labeling Requirement

The device shall bear the following statement in a conspicuous location on the device :

This device complies with part 15 of the FCC Rules. Operation is subject to the following two conditions : (1) This device may not cause harmful interference, and (2) this device must accept any interference received, including interference that may cause undesired operation.

2.5 User Information

The users manual or instruction manual for an intentional or unintentional radiator shall caution the user that changes or modifications not expressly approved by the party responsible for compliance could void the user's authority to operate the equipment.

For a Class B digital device or peripheral, the instructions furnished the user shall include the following or similar statement, placed in a prominent location in the text of the manual.

The Federal Communications Commission Radio Frequency Interference Statement includes the following paragraph.

This equipment has been tested and found to comply with the limits for a Class B Digital Device, pursuant to Part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference in a residential installation.

This equipment generates, uses and can radiate radio frequency energy and, if not installed and used in accordance with the instruction may cause harmful interference to radio communication. However, there is no guarantee that interference will not occur in a particular installation.

If this equipment does cause harmful interference to radio or television reception, which can be determined by turning the equipment off and on, the user is encouraged to try to correct the interference by one or more of the following measures:

-- Reorient or relocate the receiving antenna.

-- Increase the separation between the equipment and receiver.

-- Connect the equipment into an outlet on a circuit different from that to which the receiver is connected.

-- Consult the dealer or an experienced radio / TV technician for help.

3 SYSTEM TEST CONFIGURATION

3.1 Justification

For both radiated and conducted emissions below 1 GHz, the system was configured for testing in a typical fashion as a customer would normally use it. The peripherals other than EUT were connected in normally standing by situation. Measurement was performed under the condition that a computer program was exercised to simulate data communication of EUT, and the transmission rate was set to maximum allowed by EUT. Three highest emissions were verified with varying placement of the transmitting antenna connected to EUT (if applicable) to maximize the emission from EUT.

For conducted and radiated emissions, whichever RF channel is operated, the digital circuits' function identically. As the reason, measurement of emissions from digital circuits is performed with the highest, middle and the lowest channel by transmitting mode.

For portable device, the EUT was pretested in three orthogonal plans: put on table horizontally, stands vertically and side up vertically. The worst case was chosen for final test.

The following modes were invastegated and the worst cases (mode 1 and 3) were chosen for final test.

1. Basic Rate (BR) 1 Mbps uses GFSK modulation
2. Enhanced Data Rate (EDR) 2Mbps uses pi/4-DQPSK modulation
3. Enhanced Data Rate (EDR) 3Mbps uses 8DPSK modulation

3.2 Devices for Tested System

Device	Manufacture	Model / FCC ID.	Description
JRVCS2 Display Commander *	SYSGRATION LTD.(Nan-Kang Factory)	JRVCS2DC/ HQXJRVCS2DC	1.0m Unshielded DC Power Line
Battery	YUASA	YTX9-BS	---
JRVCS2 Body Control Module	SYSGRATION LTD.(Nan-Kang Factory)	JRVCS2DC	1.0m Unshielded DC Power Line

Remark "*" means equipment under test.

4 RADIATED EMISSION MEASUREMENT

4.1 Applicable Standard

For unintentional radiator, the radiated emission shall comply with §15.109(a).
For intentional radiators, according to §15.247 (a), operation under this provision is limited to frequency hopping and direct sequence spread spectrum, and the out band emission shall be comply with §15.247 (d)

4.2 Measurement Procedure

A. Preliminary Measurement For Portable Devices

For portable devices, the following procedure was performed to determine the maximum emission axis of EUT:

1. With the receiving antenna is H polarization, rotate the EUT in turns with three orthogonal axes to determine the axis of maximum emission.
2. With the receiving antenna is V polarization, rotate the EUT in turns with three orthogonal axes to determine the axis of maximum emission.
3. Compare the results derived from above two steps. So, the axis of maximum emission from EUT was determined and the configuration was used to perform the final measurement.

B. Final Measurement

1. Setup the configuration per figure 1 and 2 for frequencies measured below and above 1 GHz respectively. Turn on EUT and make sure that it is in normal function.
2. For emission frequencies measured below 1 GHz, a pre-scan is performed in a shielded chamber to determine the accurate frequencies of higher emissions will be checked on a open test site. As the same purpose, for emission frequencies measured above 1 GHz, a pre-scan also be performed with a 1 meter measuring distance before final test.
3. For emission frequencies measured below and above 1 GHz, set the spectrum analyzer on a 100 kHz and 1 MHz resolution bandwidth respectively for each frequency measured in step 2.
4. The search antenna is to be raised and lowered over a range from 1 to 4 meters in horizontally polarized orientation. Position the highness when the highest value is indicated on spectrum analyzer, then change the orientation of EUT on test table over a range from 0 ◦ to 360 ◦ with a speed as slow as possible, and keep the azimuth that highest emission is indicated on the spectrum analyzer. Vary the antenna position again and record the highest value as a final reading. A RF test receiver is also used to confirm emissions measured.

5. Repeat step 4 until all frequencies need to be measured were complete.
6. Repeat step 5 with search antenna in vertical polarized orientations.
7. Check the three frequencies of highest emission with varying the placement of cables (if any) associated with EUT to obtain the worse case and record the result.

Figure 1 : Frequencies measured below 1 GHz configuration

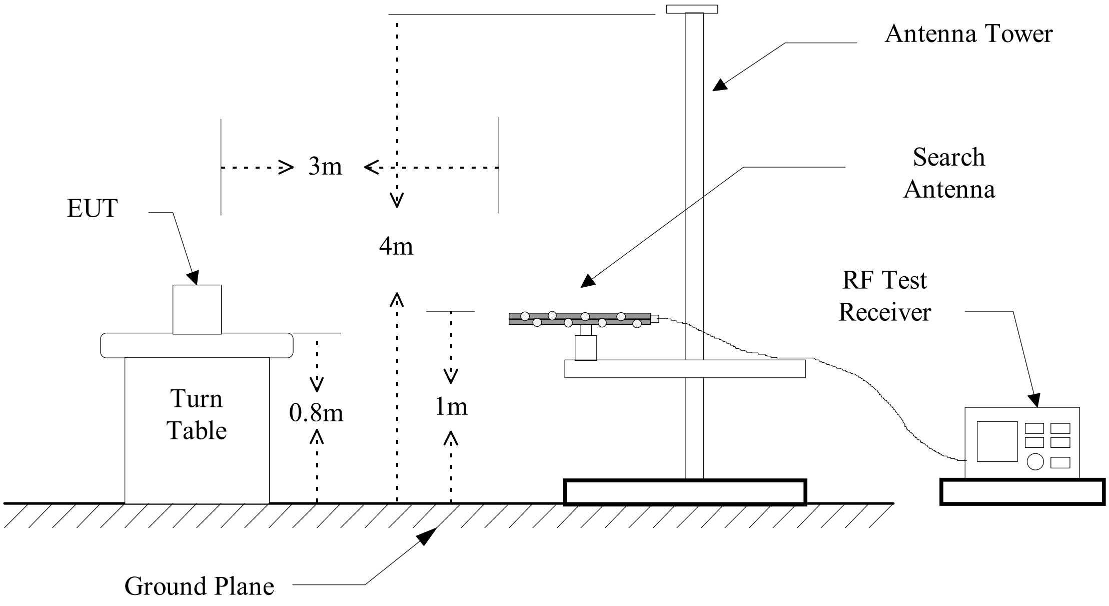
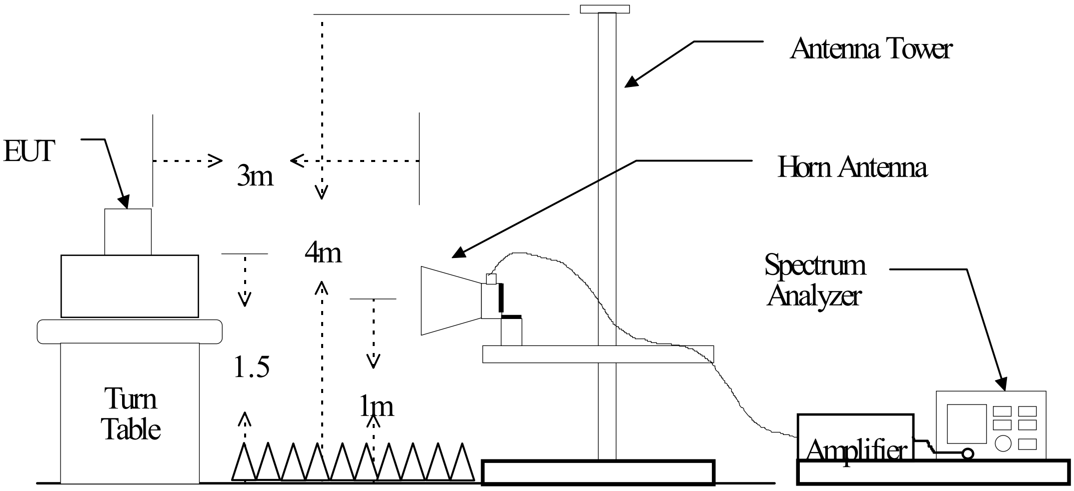

Antenna Tower
Search Antenna
EUT
3m
4m
RF Test Receiver
Turn Table
0.8m
1m
Ground Plane

Figure 2 : Frequencies measured above 1 GHz configuration


Antenna Tower
EUT
3m
Horn Antenna
4m
Spectrum Analyzer
1.5
Turn Table
1m
Amplifier

4.3 Measuring Instrument

The following instrument are used for radiated emissions measurement:

Equipment	Manufacturer	Model No.	Calibration Date	Next Cal. Date
Spectrum	Rohde & Schwarz	FSP40	2016/10/03	2017/10/02
EMI Test Receiver	Rohde & Schwarz	ESCI	2016/09/07	2017/09/06
Double Ridged Antenna	EMCO	3115	2016/10/05	2017/10/04
Double Ridged Guide Horn Antenna	EMCO	3116	2016/10/05	2017/10/04
Log-periodic Antenna	EMCO	3146	2016/07/05	2017/07/04
Biconical Antenna	EMCO	3110B	2016/07/05	2017/07/04
Amplifier	HP	8449B	2016/10/14	2017/10/13
Amplifier	HP	8447D	2016/09/26	2017/09/25
Amplifier	HP	83051A	2016/07/18	2017/07/17

Measuring instrument setup in measured frequency band when specified detector function is used :

Frequency Band (MHz)	Instrument	Function	Resolution bandwidth	Video Bandwidth
30 to 1000	RF Test Receiver	Quasi-Peak	120 kHz	N/A
	Spectrum Analyzer	Peak	100 kHz	100 kHz
Above 1000	Spectrum Analyzer	Peak	1 MHz	1 MHz
	Spectrum Analyzer	Average	1 MHz	10 Hz or ≥ 1/T (Note 1)

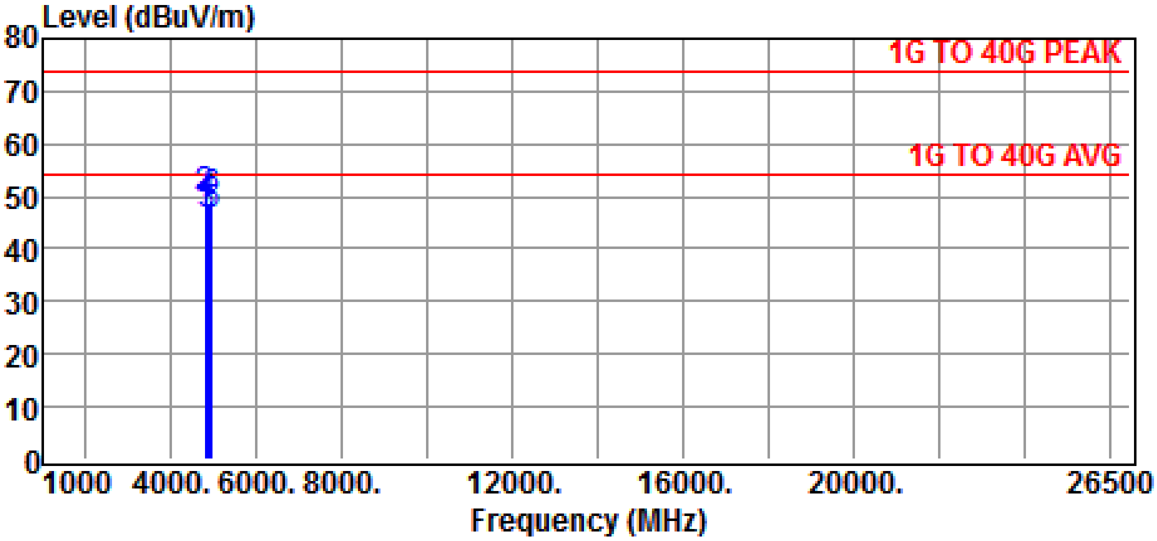
Note 1:
VBW = 10 Hz, when the duty cycle is no less than 98%.
VBW ≥ 1/T, when duty cycle is less than 98% where T is the minimum transmission duration over which the transmitter is on and is transmitting at its maximum power control level for the tested mode of operation.

4.4 Radiated Emission Data

4.4.1 Tx Portion

A. Bluetooth BR

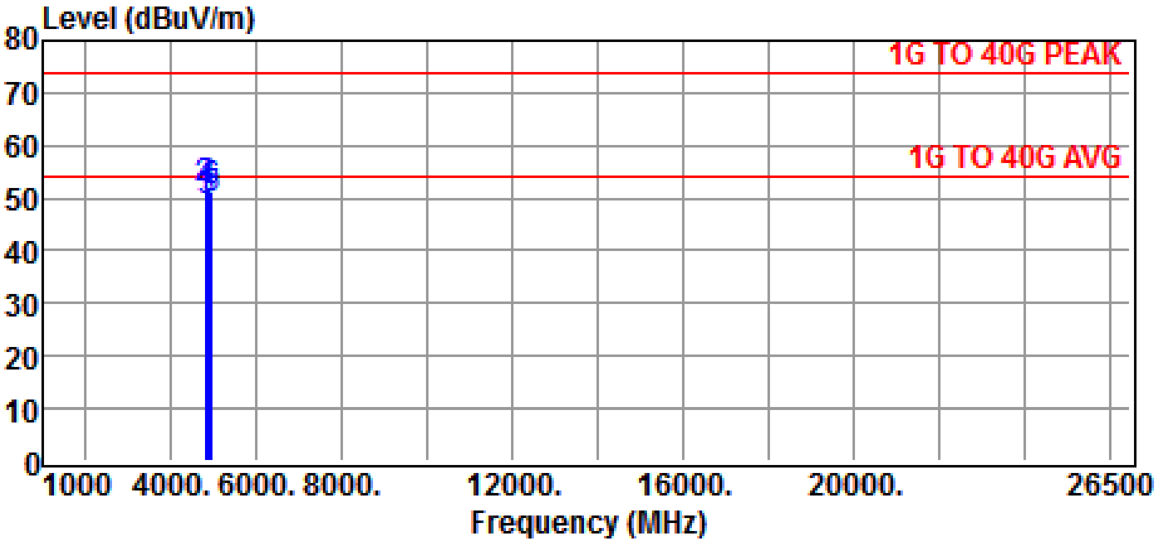
Test Date : Oct. 14, 2016 Temperature : 25 °C Humidity : 55 %



Site :CHAMBER #2
Date :2016-10-14
EUT :JRVCS2 Display Commander
Ant. Pol. :HORIZONTAL
Model :JRVCS2DC
Detector :
Power Rating :DC 12V
Engineer :VC
Limit :1G TO 40G PEAK
Temp. :25 ˚C
Memo :BR
Humi. :55 %
Test Mode : EUT stands vertically on table (worst case)

Freq MHz	Reading dBμV	Correction Factor dB	Result dBμV/m	Limits dBμV/m	Over limit dB	Detector
4804.0000	46.2	1.2	47.4	54.0	-6.6	Average
4804.0000	48.7	1.2	49.9	74.0	-24.1	Peak
4882.0000	44.9	1.5	46.4	54.0	-7.6	Average
4882.0000	46.9	1.5	48.4	74.0	-25.6	Peak
4960.0000	44.7	1.7	46.4	54.0	-7.6	Average
4960.0000	47.5	1.7	49.2	74.0	-24.8	Peak

1. Result = Reading + Corrected Factor
2. Corrected Factor = Antenna Factor + Cable Loss - Amplifier Gain (if any)
3. The margin value=Limit – Result



Site :CHAMBER #2
Date :2016-10-14
EUT :JRVCS2 Display Commander
Ant. Pol. :VERTICAL
Model :JRVCS2DC
Detector :
Power Rating :DC 12V
Engineer :VC
Limit :1G TO 40G PEAK
Temp. :25 ˚C
Memo :BR
Humi. :55 %
Test Mode : EUT stands vertically on table (worst case)

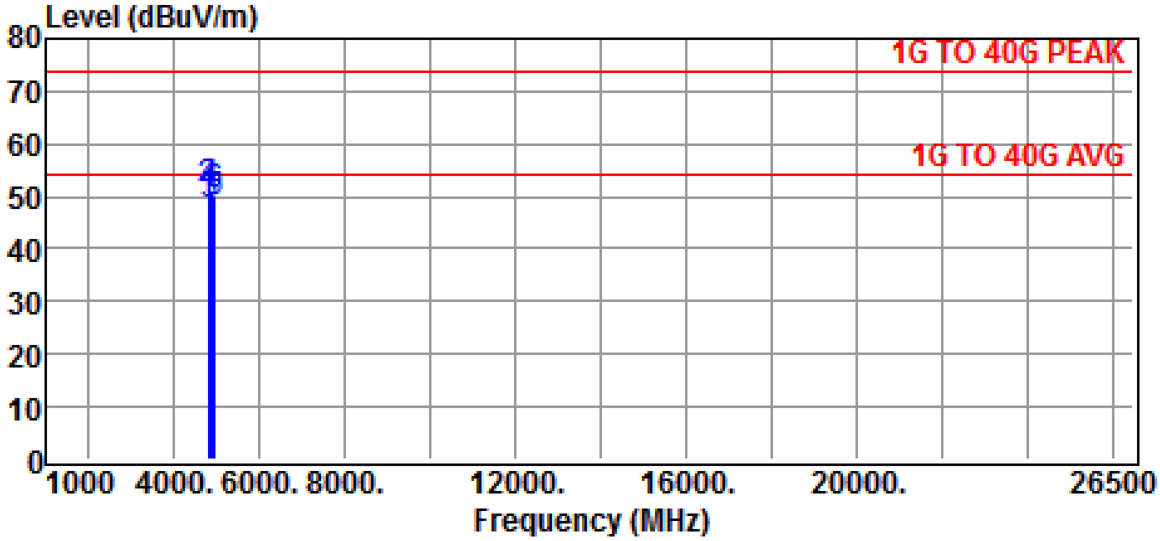
Freq MHz	Reading dBμV	Correction Factor dB	Result dBμV/m	Limits dBμV/m	Over limit dB	Detector
4804.0000	48.4	1.2	49.6	54.0	-4.4	Average
4804.0000	50.3	1.2	51.5	74.0	-22.5	Peak
4882.0000	48.0	1.5	49.5	54.0	-4.5	Average
4882.0000	50.1	1.5	51.6	74.0	-22.4	Peak
4960.0000	47.9	1.7	49.6	54.0	-4.4	Average
4960.0000	49.7	1.7	51.4	74.0	-22.6	Peak

Note :

1. Result = Reading + Corrected Factor
2. Corrected Factor = Antenna Factor + Cable Loss - Amplifier Gain (if any)
3. The margin value=Limit – Result

B. Bluetooth EDR

Test Date : Oct. 14, 2016 Temperature : 25 °C Humidity : 55 %

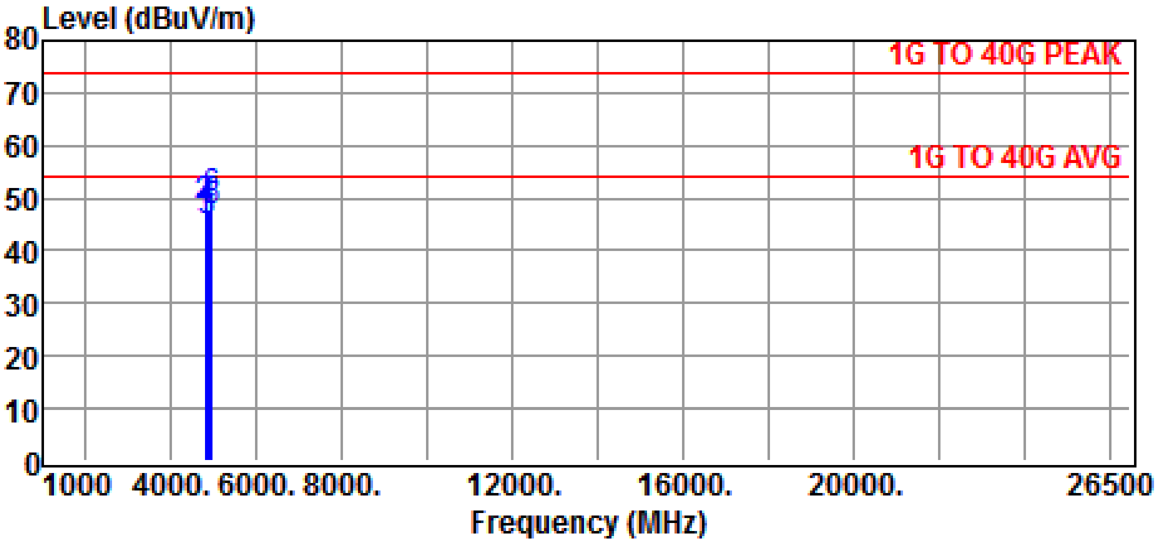


Site	:CHAMBER #2	Date	:2016-10-14
EUT	:JRVCS2 Display Commander	Ant. Pol.	:HORIZONTAL
Model	:JRVCS2DC	Detector	:
Power Rating	:DC 12V	Engineer	:VC
Limit	:1G TO 40G PEAK	Temp.	:25 ˚C
Memo	:EDR	Humi.	:55 %
Test Mode	: EUT stands vertically on table (worst case)		

Freq MHz	Reading dBμV	Correction Factor dB	Result dBμV/m	Limits dBμV/m	Over limit dB	Detector
4804.0000	48.0	1.2	49.2	54.0	-4.8	Average
4804.0000	50.2	1.2	51.4	74.0	-22.6	Peak
4882.0000	47.1	1.5	48.6	54.0	-5.4	Average
4882.0000	49.9	1.5	51.4	74.0	-22.6	Peak
4960.0000	47.0	1.7	48.7	54.0	-5.3	Average
4960.0000	48.8	1.7	50.5	74.0	-23.5	Peak

Note :

1. Result = Reading + Corrected Factor
2. Corrected Factor = Antenna Factor + Cable Loss - Amplifier Gain (if any)
3. The margin value=Limit – Result



Site :CHAMBER #2
Date :2016-10-14
EUT :JRVCS2 Display Commander
Ant. Pol. :VERTICAL
Model :JRVCS2DC
Detector :
Power Rating :DC 12V
Engineer :VC
Limit :1G TO 40G PEAK
Temp. :25 ˚C
Memo :EDR
Humi. :55 %
Test Mode : EUT stands vertically on table (worst case)

Freq MHz	Reading dBµV	Correction Factor dB	Result dBµV/m	Limits dBµV/m	Over limit dB	Detector
4804.0000	45.0	1.2	46.2	54.0	-7.8	Average
4804.0000	47.1	1.2	48.3	74.0	-25.7	Peak
4882.0000	44.0	1.5	45.5	54.0	-8.5	Average
4882.0000	46.6	1.5	48.1	74.0	-25.9	Peak
4960.0000	45.8	1.7	47.5	54.0	-6.5	Average
4960.0000	48.1	1.7	49.8	74.0	-24.2	Peak

Note :

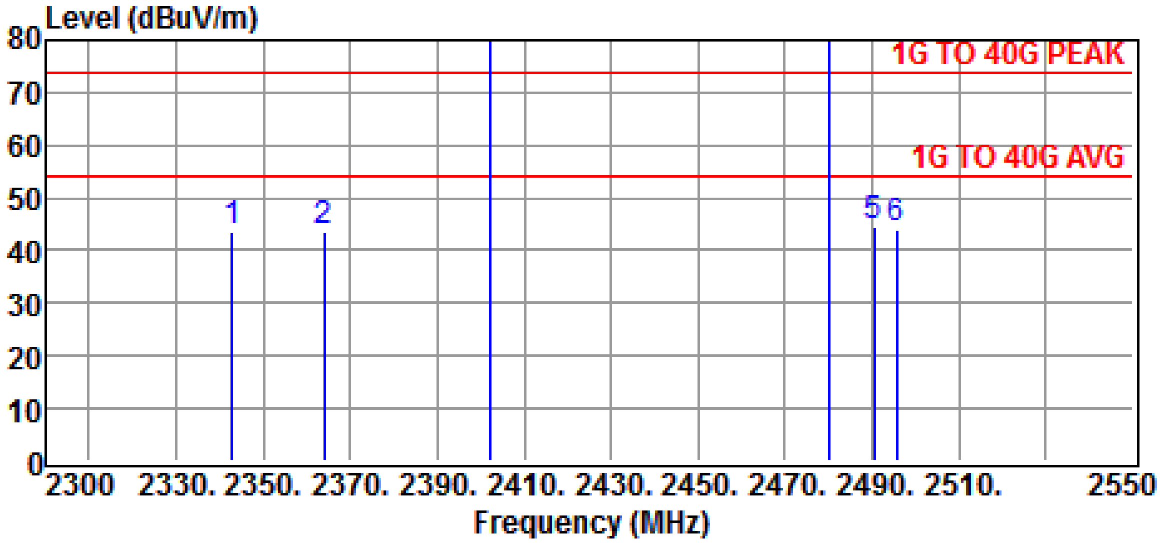
1. Result = Reading + Corrected Factor
2. Corrected Factor = Antenna Factor + Cable Loss - Amplifier Gain (if any)
3. The margin value=Limit - Result

4.4.2 Radiated Emissions in Restricted Bands

Operation Mode : Bluetooth TX/RX

A. Bluetooth BR

Test Date : Oct. 14, 2016 Temperature : 25 °C Humidity : 53 %



Site :CHAMBER #2

Date :2016-10-14

Limit :1G TO 40G PEAK

Ant. Pol. :HORIZONTAL

EUT :JRVCS2 Display Commander

Model :JRVCS2DC

Power Rating :DC 12V

Temp. :25˚C

Engineer :VC

Humi. :53 %

Test Mode :OPERATION MODE

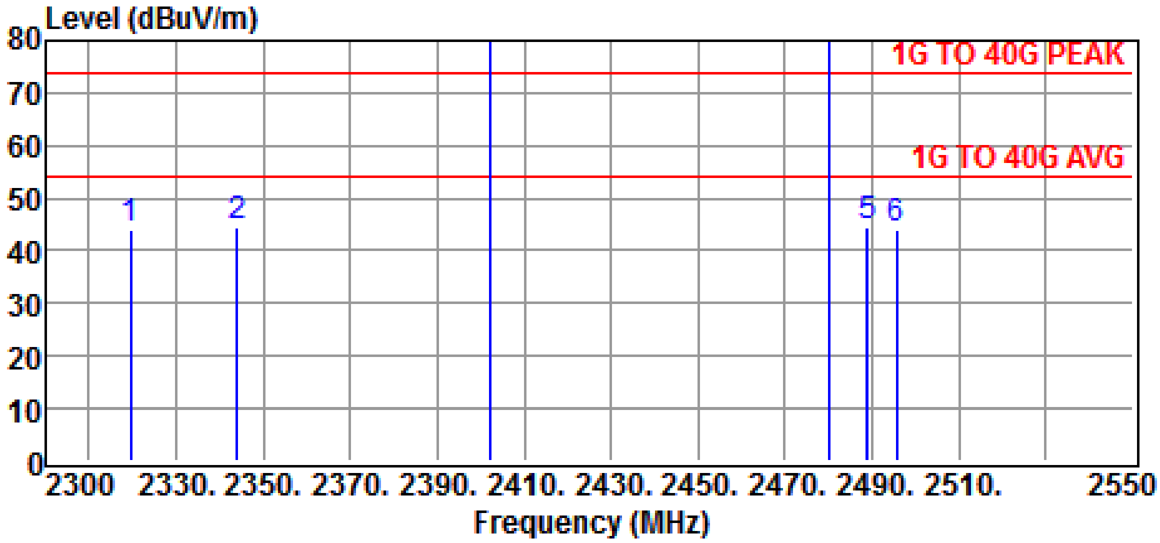
Test Mode :BR

Test Mode : EUT stands vertically on table (worst case)

Freq MHz	Reading dBμV	Correction Factor dB	Result dBμV/m	Limits (AVG) dBμV/m	Over limit dB	Detector
2343.0000	49.5	-5.7	43.8	54.0	-10.2	Peak
2364.0000	49.4	-5.7	43.7	54.0	-10.3	Peak
2402.0000	91.0	-5.6	85.4	---	---	Peak
2480.0000	91.2	-5.4	85.8	---	---	Peak
2490.5000	50.0	-5.4	44.6	54.0	-9.4	Peak
2495.5000	49.5	-5.4	44.1	54.0	-9.9	Peak

Note :

1. Result = Reading + Corrected Factor
2. Corrected Factor = Antenna Factor + Cable Loss - Amplifier Gain (if any)
3. The margin value=Limit - Result
4. Peak measurements are compared to the average limit - as peak measurements are below the average limit, they also comply with the peak limit.



Site :CHAMBER #2
Date :2016-10-14
Limit :1G TO 40G PEAK
Ant. Pol. :VERTICAL
EUT :JRVCS2 Display Commander
Model :JRVCS2DC
Power Rating :DC 12V
Temp. :25˚C
Engineer :VC
Humi. :53 %
Test Mode :OPERATION MODE
Test Mode :BR
Test Mode : EUT stands vertically on table (worst case)

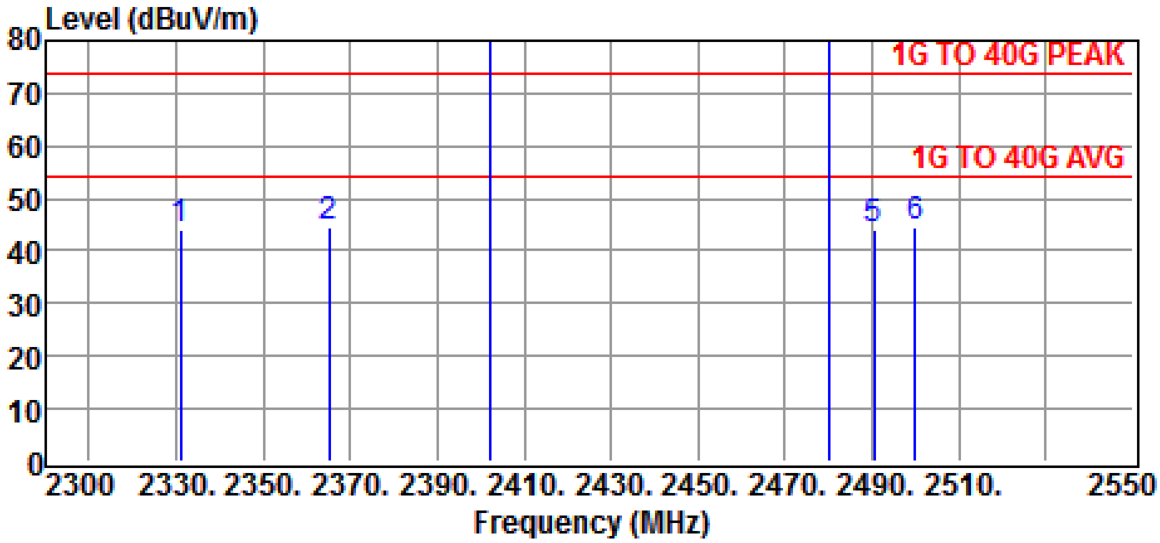
Freq MHz	Reading dBμV	Correction Factor dB	Result dBμV/m	Limits (AVG) dBμV/m	Over limit dB	Detector
2319.5000	49.8	-5.8	44.0	54.0	-10.0	Peak
2344.0000	50.1	-5.7	44.4	54.0	-9.6	Peak
2402.0000	96.9	-5.6	91.3	---	---	Peak
2480.0000	98.0	-5.4	92.6	---	---	Peak
2489.0000	50.0	-5.4	44.6	54.0	-9.4	Peak
2495.5000	49.5	-5.4	44.1	54.0	-9.9	Peak

Note :

1. Result = Reading + Corrected Factor
2. Corrected Factor = Antenna Factor + Cable Loss - Amplifier Gain (if any)
3. The margin value=Limit - Result
4. Peak measurements are compared to the average limit - as peak measurements are below the average limit, they also comply with the peak limit.

B. Bluetooth EDR

Test Date : Oct. 14, 2016 Temperature : 25 °C Humidity : 53 %



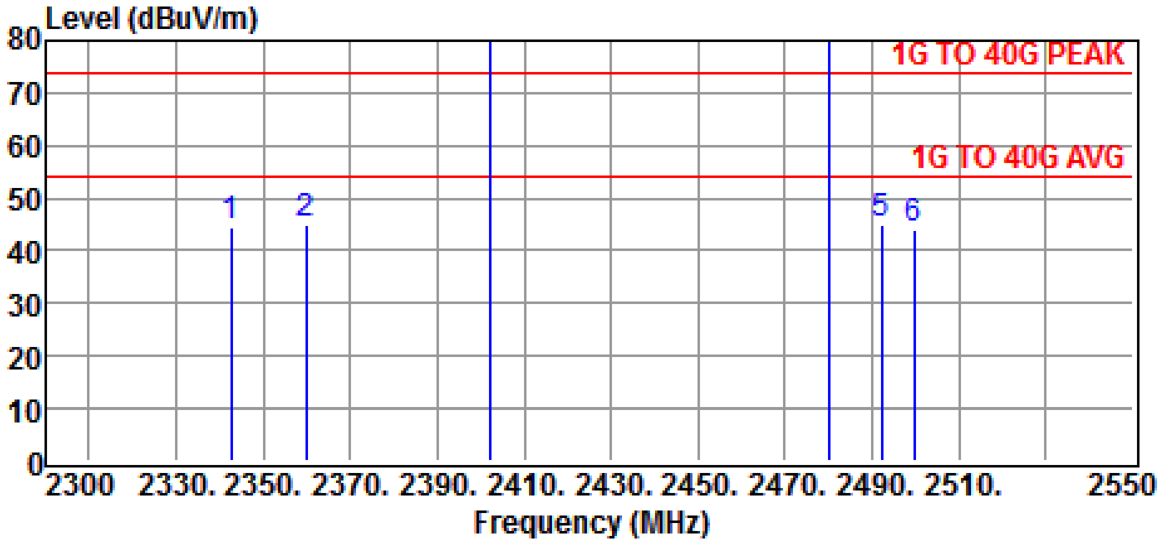
Site	:CHAMBER #2	Date	:2016-10-14
Limit	:1G TO 40G PEAK	Ant. Pol.	:HORIZONTAL
EUT	:JRVCS2 Display Commander	Model	:JRVCS2DC
Power Rating	:DC 12V	Temp.	:25˚C
Engineer	:VC	Humi.	:53 %
Test Mode	:OPERATION MODE	Test Mode	:BR

Test Mode : EUT stands vertically on table (worst case)

Freq MHz	Reading dBμV	Correction Factor dB	Result dBμV/m	Limits (AVG) dBμV/m	Over limit dB	Detector
2331.0000	49.9	-5.8	44.1	54.0	-9.9	Peak
2365.0000	50.3	-5.7	44.6	54.0	-9.4	Peak
2402.0000	92.3	-5.6	86.7	---	---	Peak
2480.0000	92.3	-5.4	86.9	---	---	Peak
2490.5000	49.3	-5.4	43.9	54.0	-10.1	Peak
2500.0000	49.8	-5.4	44.4	54.0	-9.6	Peak

Note :

1. Result = Reading + Corrected Factor
2. Corrected Factor = Antenna Factor + Cable Loss - Amplifier Gain (if any)
3. The margin value=Limit - Result
4. Peak measurements are compared to the average limit - as peak measurements are below the average limit, they also comply with the peak limit.



Site :CHAMBER #2
Date :2016-10-14
Limit :1G TO 40G PEAK
Ant. Pol. :VERTICAL
EUT :JRVCS2 Display Commander
Model :JRVCS2DC
Power Rating :DC 12V
Temp. :25˚C
Engineer :VC
Humi. :53 %
Test Mode :OPERATION MODE
Test Mode :BR
Test Mode : EUT stands vertically on table (worst case)

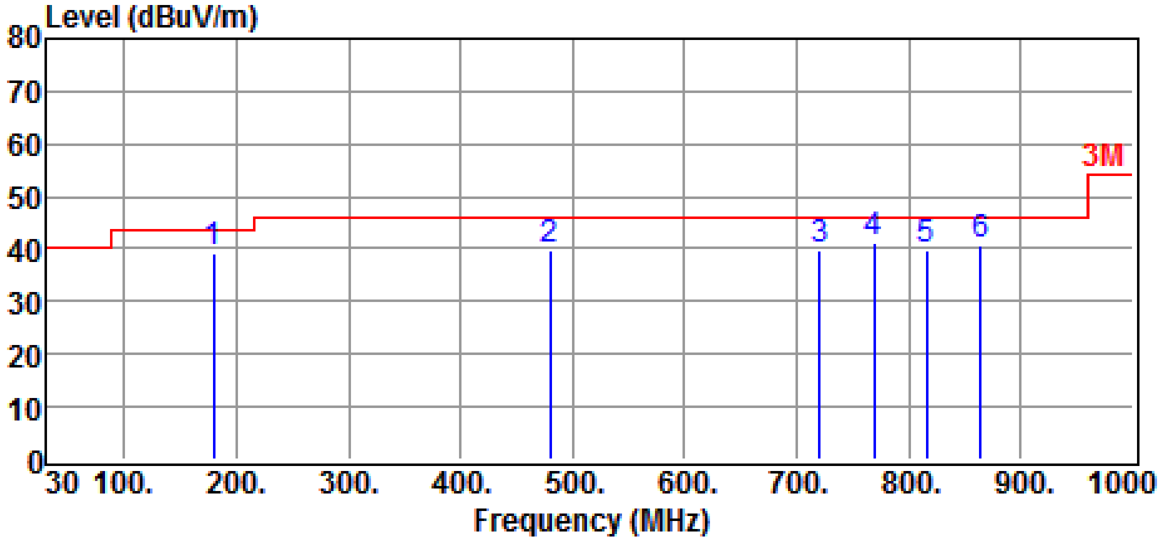
Freq MHz	Reading dBμV	Correction Factor dB	Result dBμV/m	Limits (AVG) dBμV/m	Over limit dB	Detector
2342.5000	50.2	-5.7	44.5	54.0	-9.5	Peak
2360.0000	50.6	-5.7	44.9	54.0	-9.1	Peak
2402.0000	99.2	-5.6	93.6	---	---	Peak
2480.0000	99.2	-5.4	93.8	---	---	Peak
2492.0000	50.2	-5.4	44.8	54.0	-9.2	Peak
2499.7500	49.4	-5.4	44.0	54.0	-10.0	Peak

Note :

1. Result = Reading + Corrected Factor
2. Corrected Factor = Antenna Factor + Cable Loss - Amplifier Gain (if any)
3. The margin value=Limit - Result
4. Peak measurements are compared to the average limit - as peak measurements are below the average limit, they also comply with the peak limit.

4.4.3 Other Emissions

a) Emission frequencies below 1 GHz

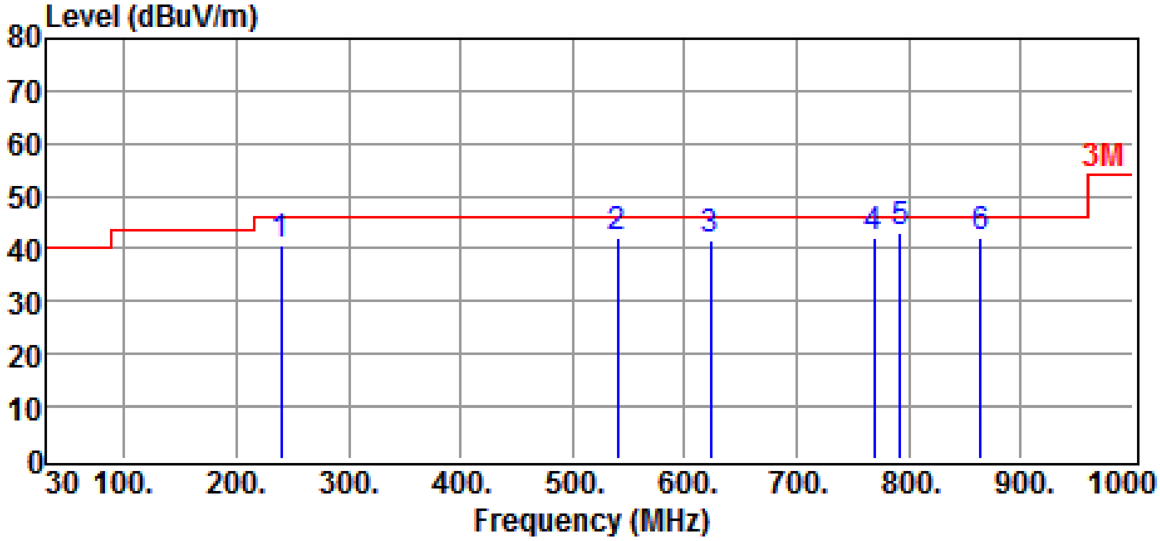


Site	:CHAMBER #2	Date	:2016-12-05
Limit	:3M	Ant. Pol.	:HORIZONTAL
EUT	:JRVCS2 Display Commander	Model	:JRVCS2DC
Power Rating	:DC 12V	Temp.	:25˚C
Engineer	:VC	Humi.	:65 %
Test Mode	:OPERATION MODE		
Test Mode	: EUT stands vertically on table (worst case)		

Freq MHz	Reading dBµV	Correction Factor dB	Result dBµV/m	Limits dBµV/m	Over limit dB	Detector
179.3800	48.75	-9.26	39.49	43.50	-4.01	QP
480.0800	40.22	-0.49	39.73	46.00	-6.27	QP
720.6400	36.58	3.05	39.63	46.00	-6.37	QP
769.1400	37.68	3.71	41.39	46.00	-4.61	QP
815.7000	35.25	4.68	39.93	46.00	-6.07	QP
864.2000	35.31	5.37	40.68	46.00	-5.32	QP

Note :

1. Result = Reading + Corrected Factor
2. Corrected Factor = Antenna Factor + Cable Loss
3. The margin value=Limit - Result



Site	:CHAMBER #2	Date	:2016-12-05
Limit	:3M	Ant. Pol.	:VERTICAL
EUT	:JRVCS2 Display Commander	Model	:JRVCS2DC
Power Rating	:DC 12V	Temp.	:25˚C
Engineer	:VC	Humi.	:65 %
Test Mode	:OPERATION MODE		
Test Mode	: EUT stands vertically on table (worst case)		

Freq MHz	Reading dBμV	Correction Factor dB	Result dBμV/m	Limits dBμV/m	Over limit dB	Detector
239.5200	47.29	-6.52	40.77	46.00	-5.23	QP
540.2200	41.59	0.34	41.93	46.00	-4.07	QP
623.6400	40.17	1.57	41.74	46.00	-4.26	QP
769.1400	38.64	3.71	42.35	46.00	-3.65	QP
792.4200	38.53	4.37	42.90	46.00	-3.10	QP
864.2000	36.71	5.37	42.08	46.00	-3.92	QP

Note :

1. Result = Reading + Corrected Factor
2. Corrected Factor = Antenna Factor + Cable Loss
3. The margin value=Limit - Result

b) Emission frequencies above 1 GHz

Radiated emission frequencies above 1 GHz to 26.5 GHz were too low to be measured with a pre-amplifier of 35 dB.

c) Emission frequencies below 30MHz (9kHz - 30MHz)

According to exploratory test no any obvious emission were detected from 9kHz to 30MHz. Although these tests were performed other than open area test site, adequate comparison measurements were confirmed against 30 m open are test site. Therefore sufficient tests were made to demonstrate that the alternative site produces results that correlate with the ones of tests made in an open field based on KDB 937606.

4.5 Field Strength Calculation

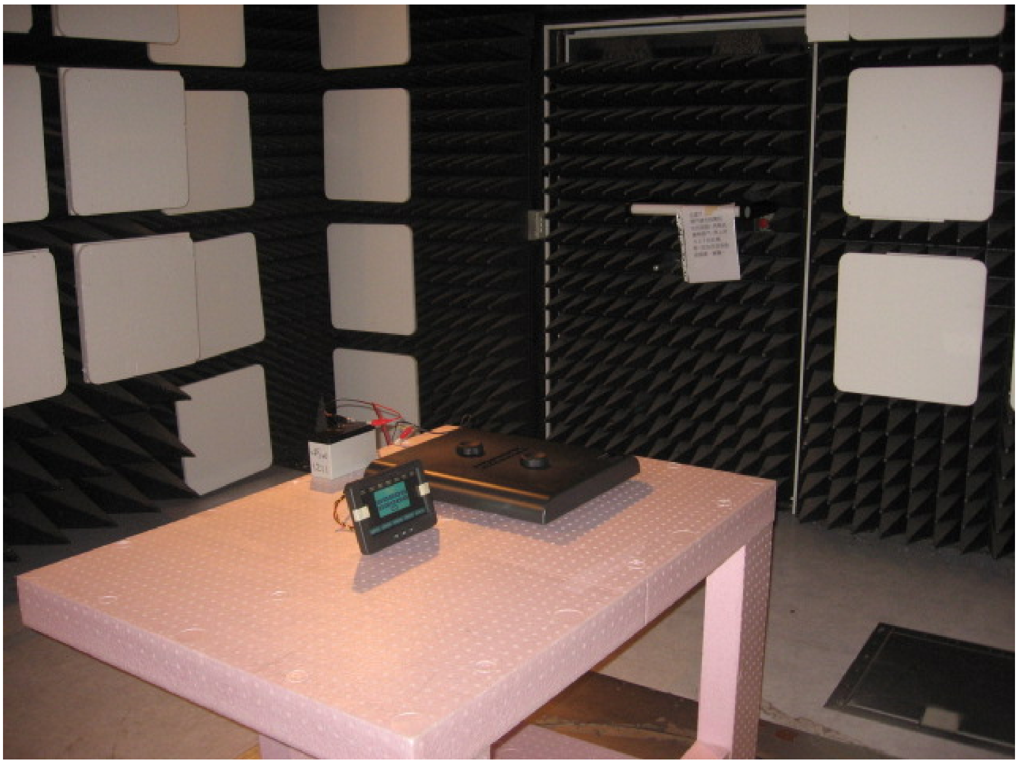
The field strength is calculated by adding the Antenna Factor, High Pass Filter Loss (if used) and Cable Loss, and subtracting the Amplifier Gain (if any) from the measured reading. The basic equation calculation is as follows:

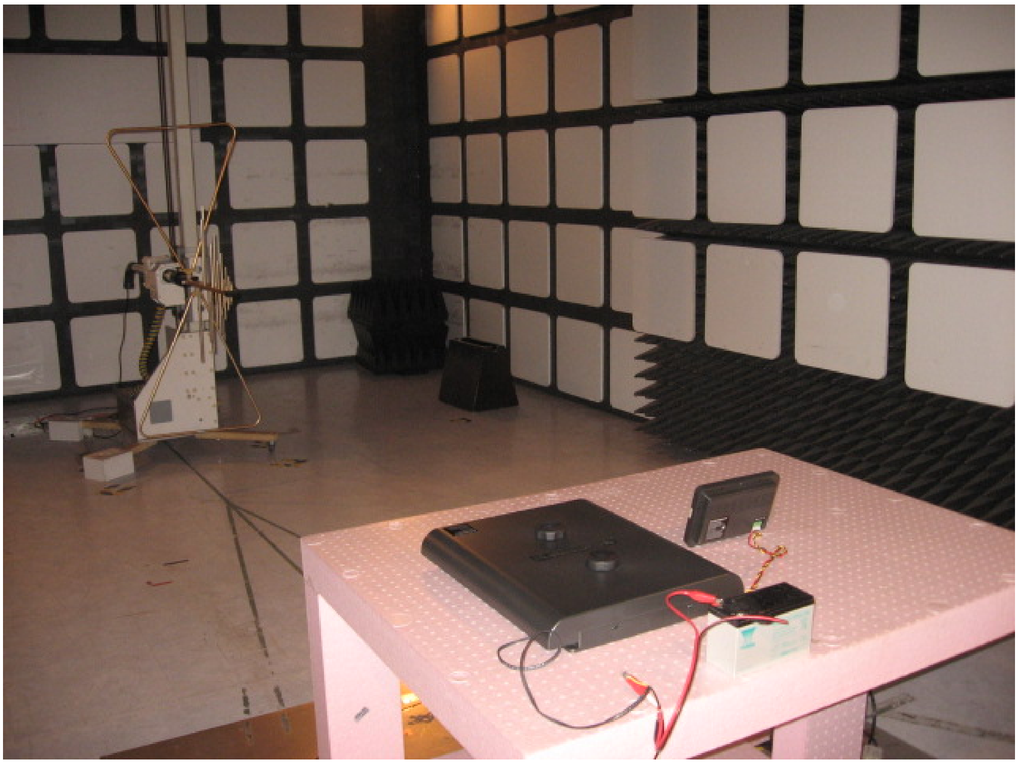
Result = Reading + Corrected Factor

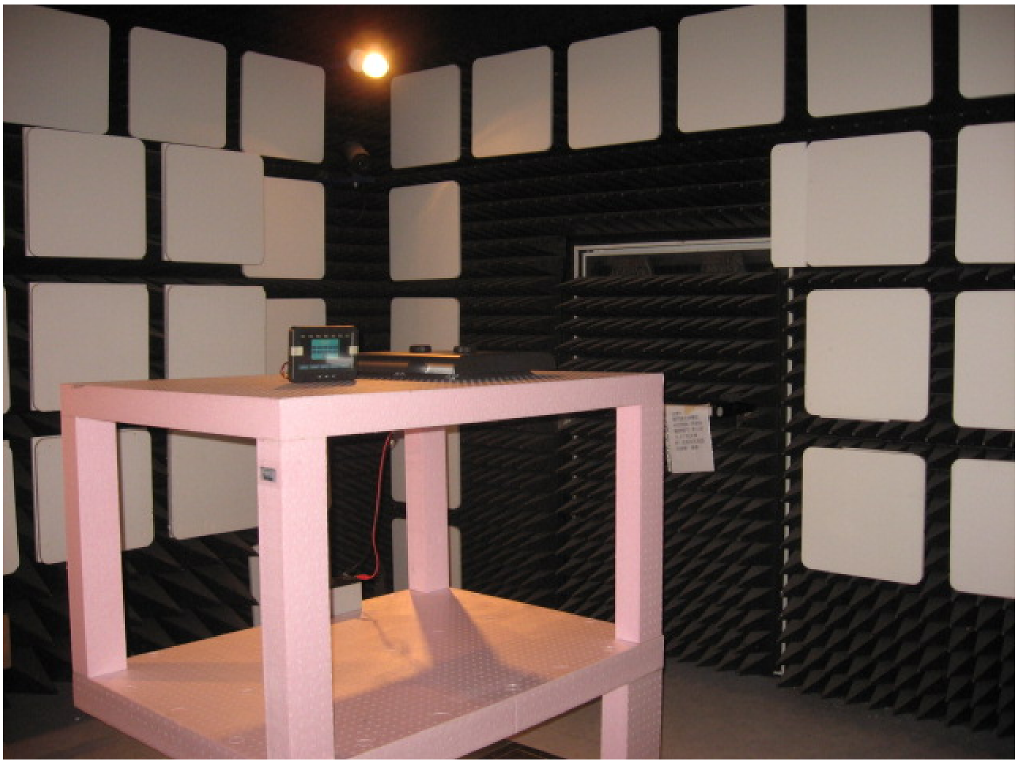
where Corrected Factor

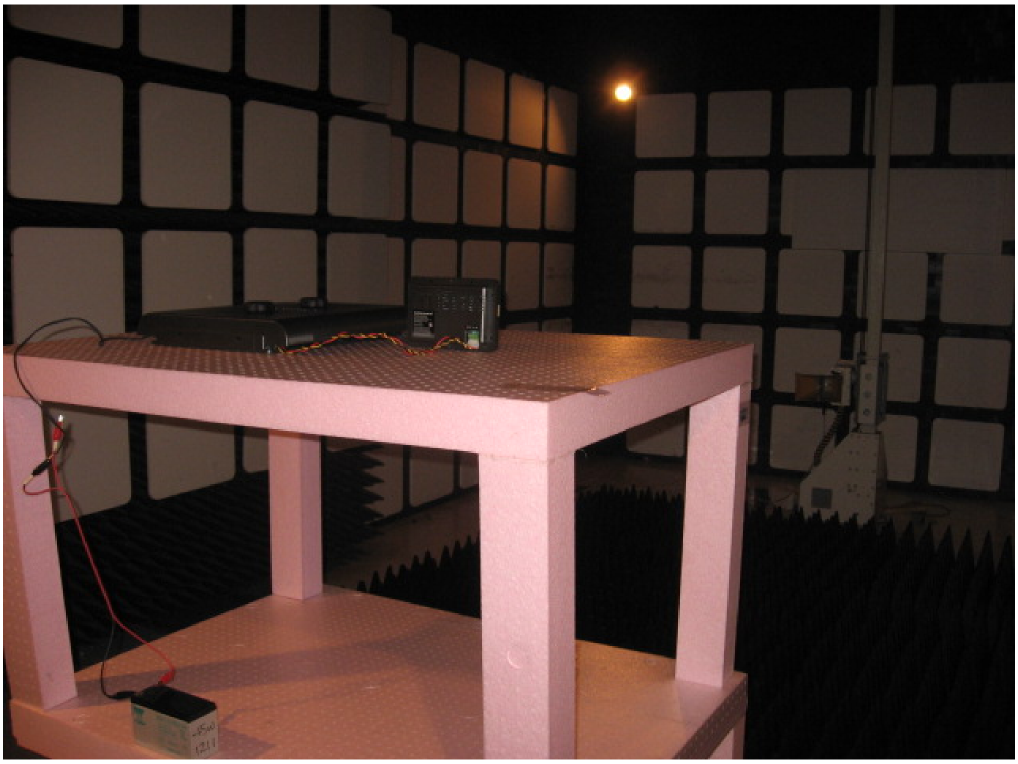
= Antenna FACTOR + Cable Loss + High Pass Filter Loss - Amplifier Gain

4.6 Photos of Radiation Measuring Setup









5 CONDUCTED EMISSION MEASUREMENT

5.1 Description

This EUT is excused from investigation of conducted emission, for it is powered by DC battery only. According to §15.207 (d), measurements to demonstrate compliance with the conducted limits are not required for devices which only employ battery power for operation and which do not operate from the AC power lines or contain provisions for operation while connected to the AC power lines.

6 ANTENNA REQUIREMENT

6.1 Standard Applicable

For intentional device, 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.

6.2 Antenna Construction

The antenna is conected to the main PCB and installed inside the houseing, no consideration of replacement.
Please refer to the construction Photo for details.

7 HOPPING CHANNEL SEPARATION

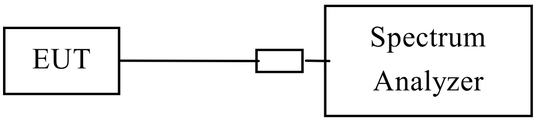
7.1 Standard Applicable

According to 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.

7.2 Measurement Procedure

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 figure 4 without connection to measurement instrument. Turn on the EUT and connect it to measurement instrument. The EUT must have its hopping function enabled. Then set it to any one convenient frequency within its operating range.
3. Use the following spectrum analyzer settings:
   Span = wide enough to capture the peaks of two adjacent channels
   Resolution (or IF) Bandwidth (RBW) ≥ 1% of the span
   Video (or Average) Bandwidth (VBW) ≥ RBW
   Sweep = auto
   Detector function = peak
   Trace = max hold
4. Allow the trace to stabilize. Use the marker-delta function to determine the separation between the peaks of the adjacent channels. Plot the result on the screen of spectrum analyzer.
5. Repeat above procedures until all frequencies measured were complete.

Figure 4 : Measurement configuration.



7.3 Measurement Equipment

Equipment	Manufacturer	Model No.	Calibration Date	Next Cal. Date
Spectrum Analyzer	Rohde & Schwarz	FSP40	2016/10/03	2017/10/02
Attenuator	MINI-CIRCUITS	BW-S10W2+	2016/09/30	2017/09/29
Attenuator	MINI-CIRCUITS	BW-S20W2+	2016/09/30	2017/09/29
Attenuator	MINI-CIRCUITS	BW-S30W2+	2016/09/30	2017/09/29

7.4 Measurement Data

Test Date : Oct. 20, 2016 Temperature : 24 °C Humidity : 60 %

Mode: Bluetooth BR

a) Channel Low	: Adjacent Hopping Channel Separation is	1.000 MHz
b) Channel Middle	: Adjacent Hopping Channel Separation is	1.000 MHz
c) Channel High	: Adjacent Hopping Channel Separation is	1.000 MHz

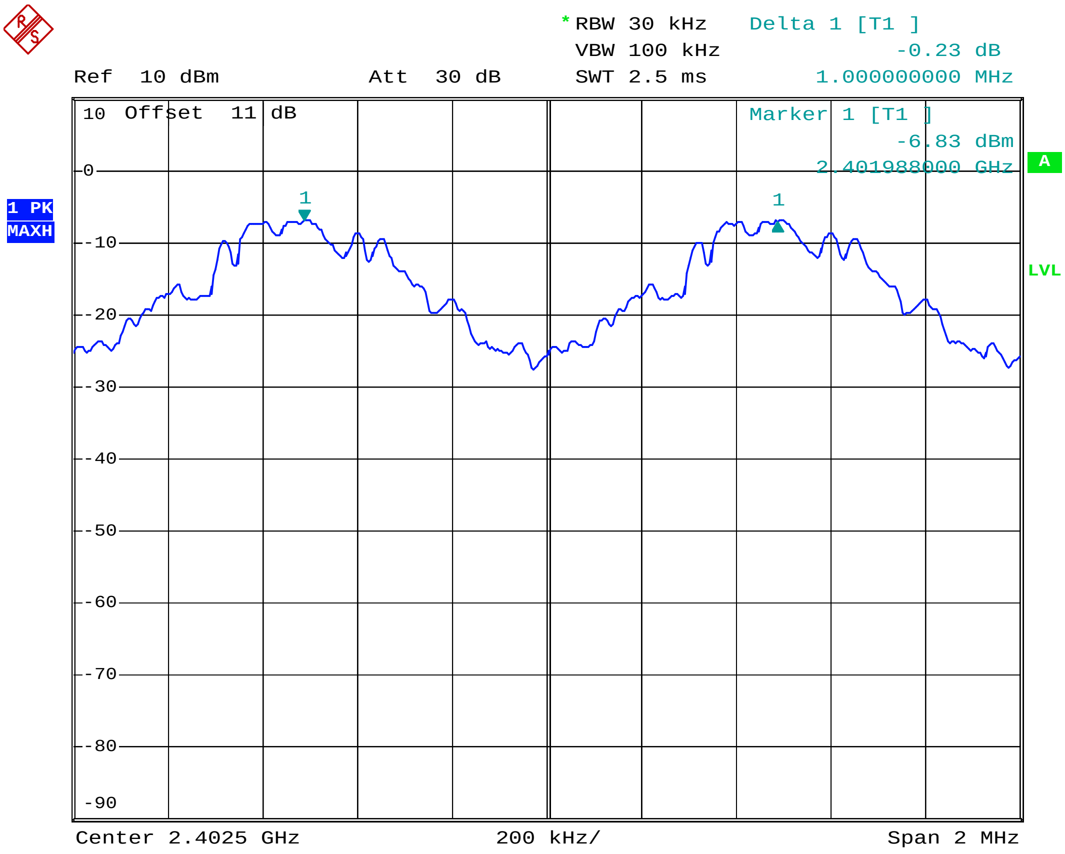
Mode: Bluetooth EDR

a) Channel Low	: Adjacent Hopping Channel Separation is	1.002 MHz
b) Channel Middle	: Adjacent Hopping Channel Separation is	1.002 MHz
c) Channel High	: Adjacent Hopping Channel Separation is	1.002 MHz

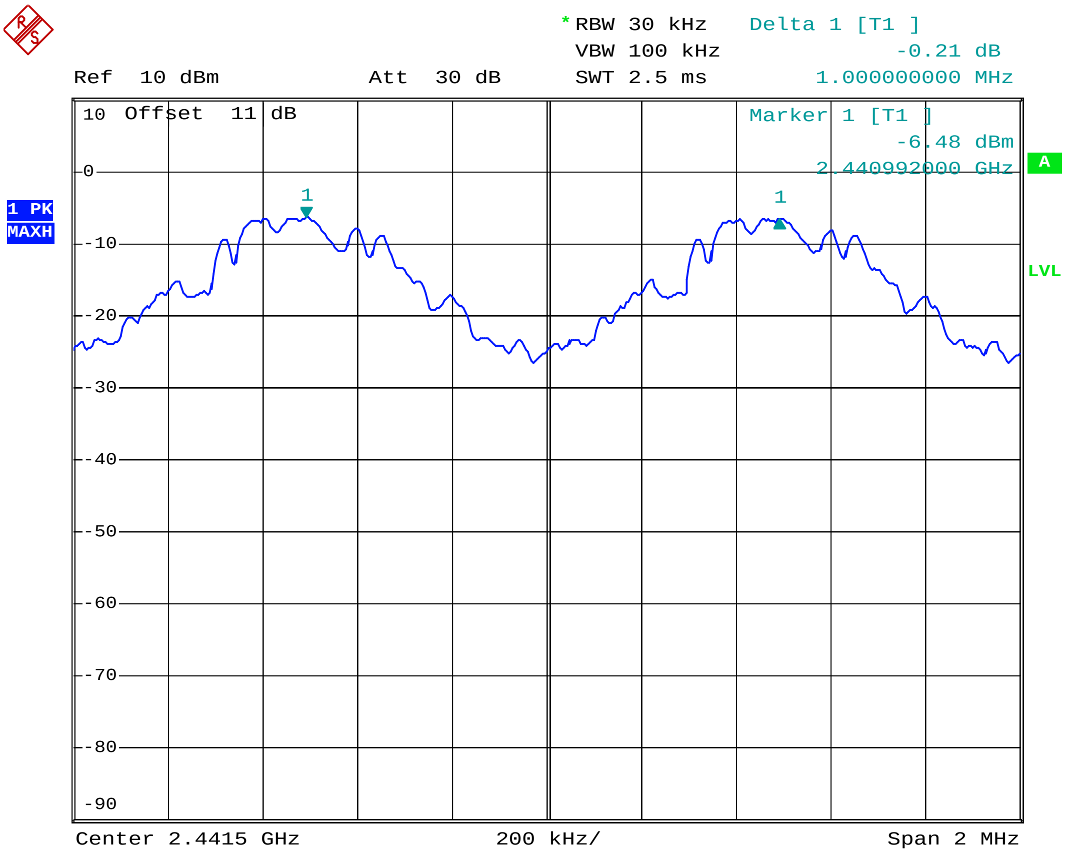
Note : The expanded uncertainty: frequency** $\times 1.65\times 10^{-6}$ **(1 GHz** $< f \leq$ **18 GHz).

Mode: Bluetooth BR

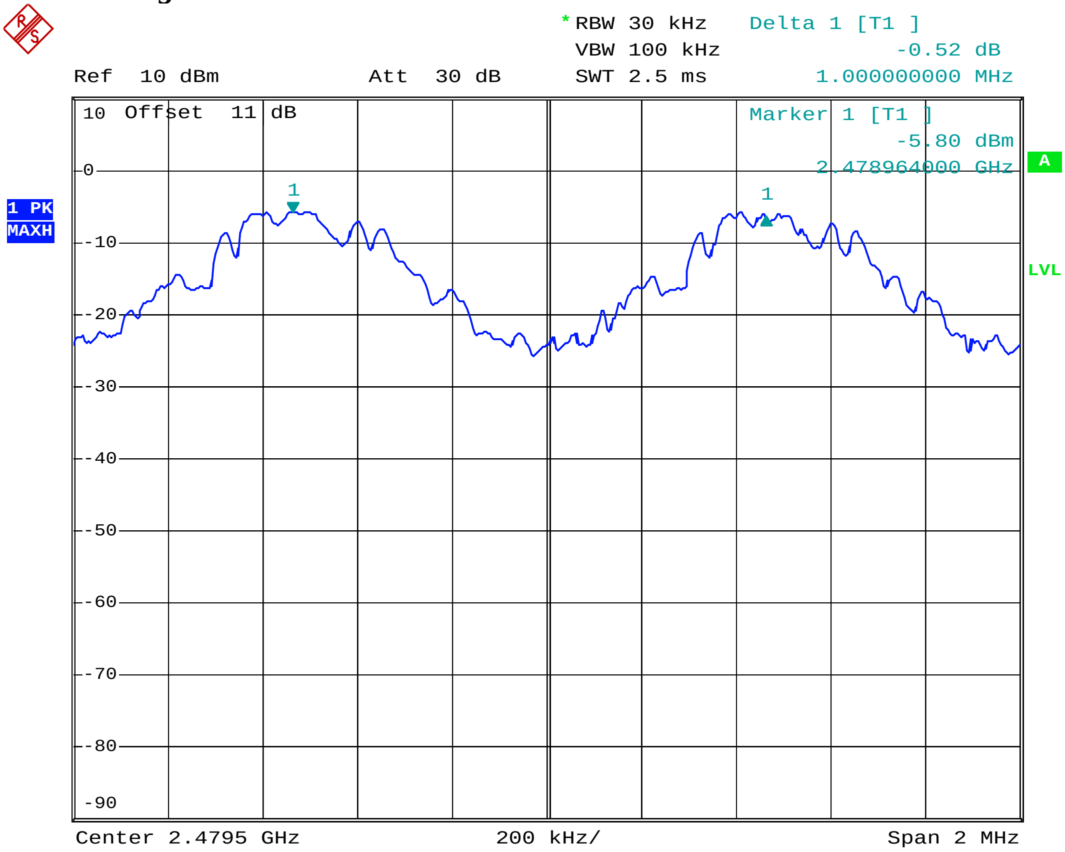
Channel Low



Channel Middle

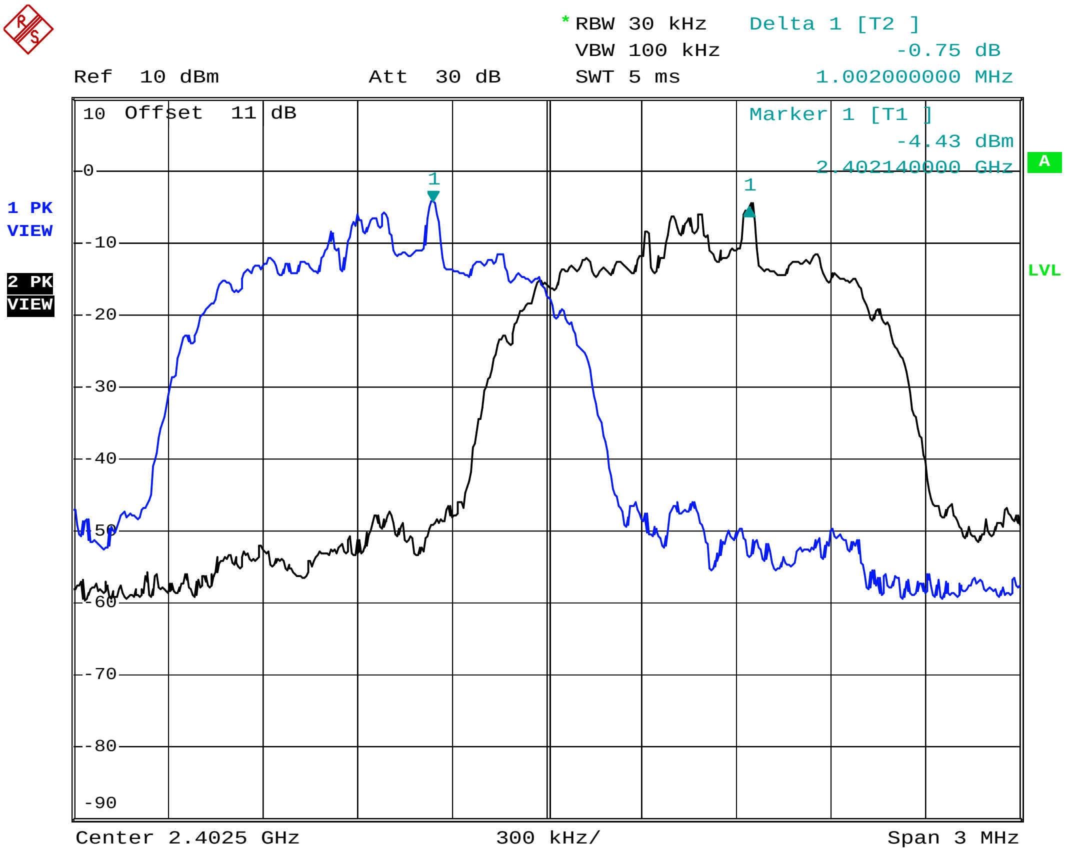


Channel High

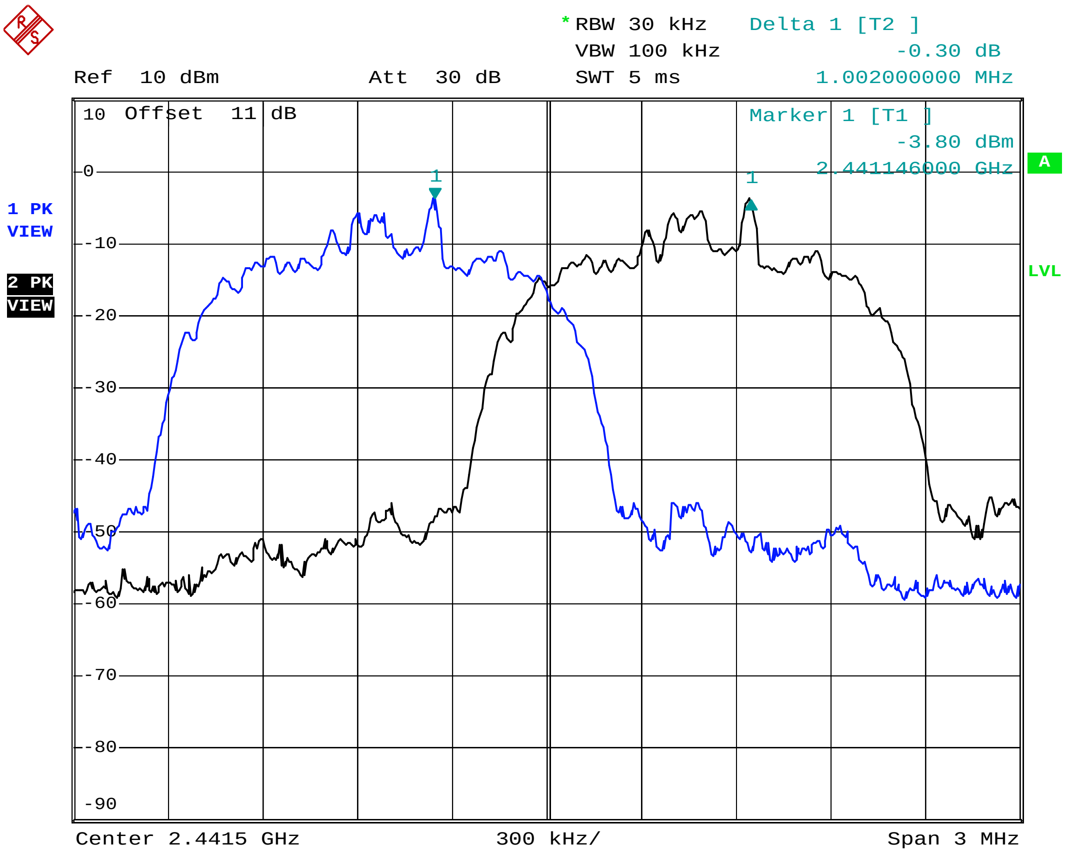


Mode: Bluetooth EDR

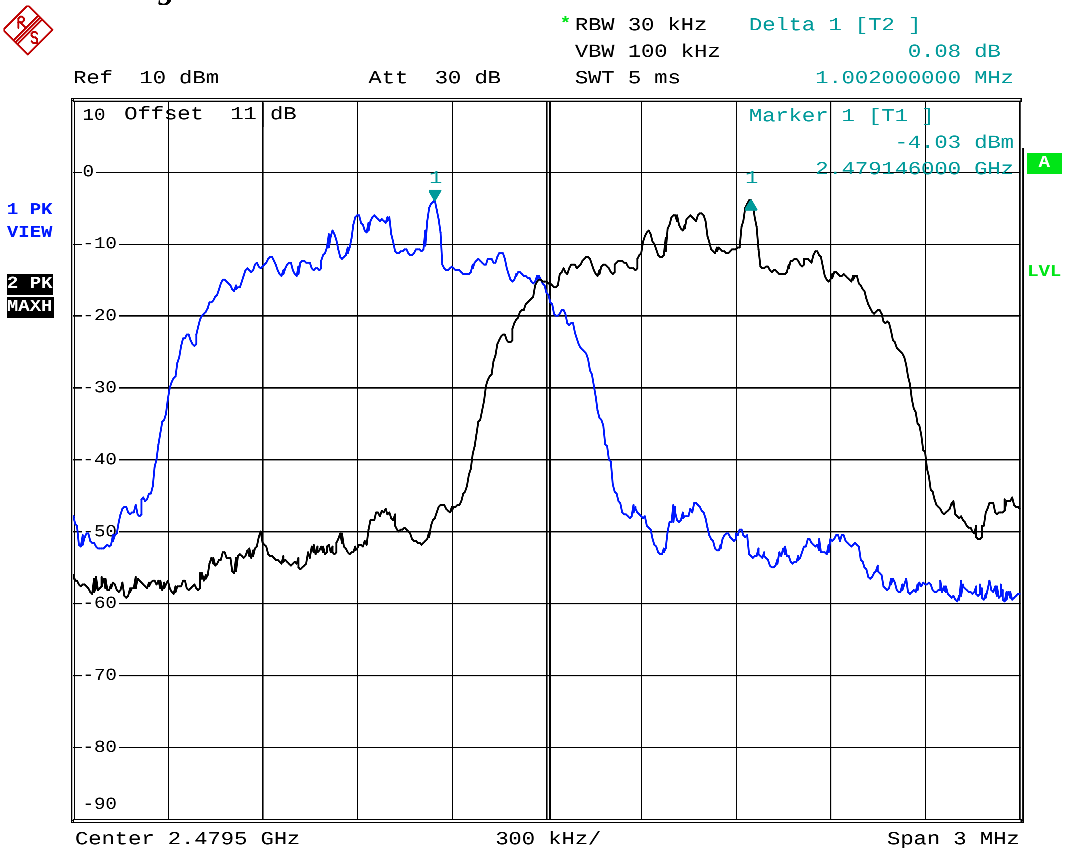
Channel Low



Channel Middle



Channel High



8 NUMBER OF HOPPING FREQUENCY USED

8.1 Standard Applicable

According to 15.247(a)(1)(iii), frequency hopping systems in the 2400–2483.5 MHz band shall use at least 15 channels.

8.2 Measurement Procedure

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 figure 4 without connection to measurement instrument. Turn on the EUT and connect it to measurement instrument. The EUT must have its hopping function enabled.
3. Use the following spectrum analyzer settings:
   Span = the frequency band of operation
   RBW ≥ 1% of the span
   VBW ≥ RBW
   Sweep = auto
   Detector function = peak
   Trace = max hold
4. Allow the trace to stabilize. Plot the result on the screen of spectrum analyzer.
5. Repeat above procedures until all frequencies measured were complete.

8.3 Measurement Equipment

Equipment	Manufacturer	Model No.	Calibration Date	Next Cal. Date
Spectrum Analyzer	Rohde & Schwarz	FSP40	2016/10/03	2017/10/02
Attenuator	MINI-CIRCUITS	BW-S10W2+	2016/09/30	2017/09/29
Attenuator	MINI-CIRCUITS	BW-S20W2+	2016/09/30	2017/09/29
Attenuator	MINI-CIRCUITS	BW-S30W2+	2016/09/30	2017/09/29

8.4 Measurement Data

Test Date : Oct. 20, 2016 Temperature : 24 °C Humidity : 60 %

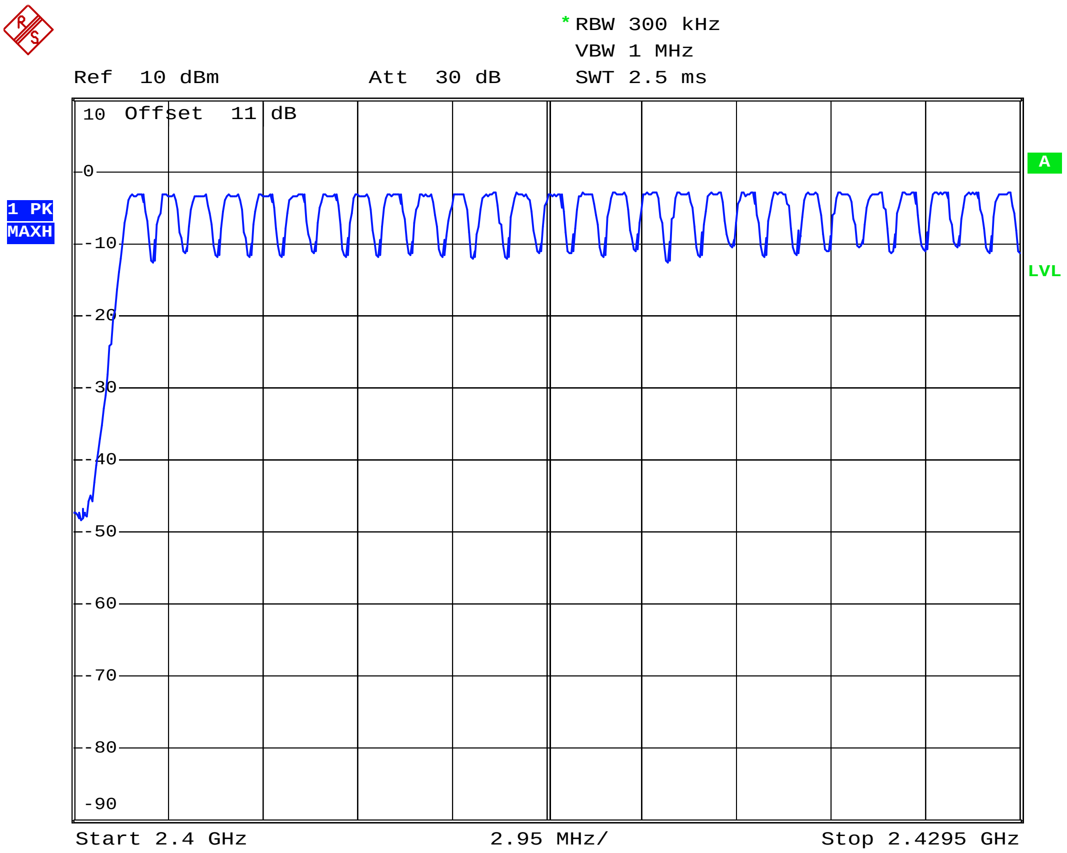
There are 79 hopping frequencies used.

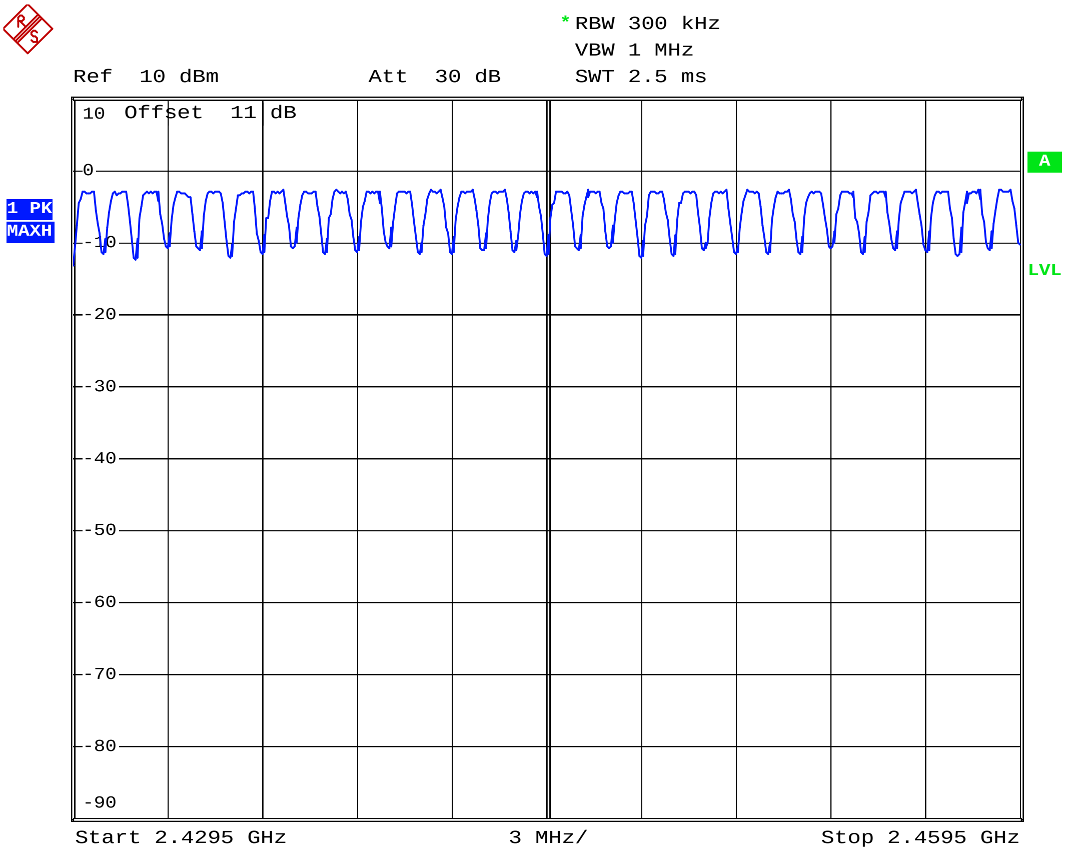
Justification on AFH mode:

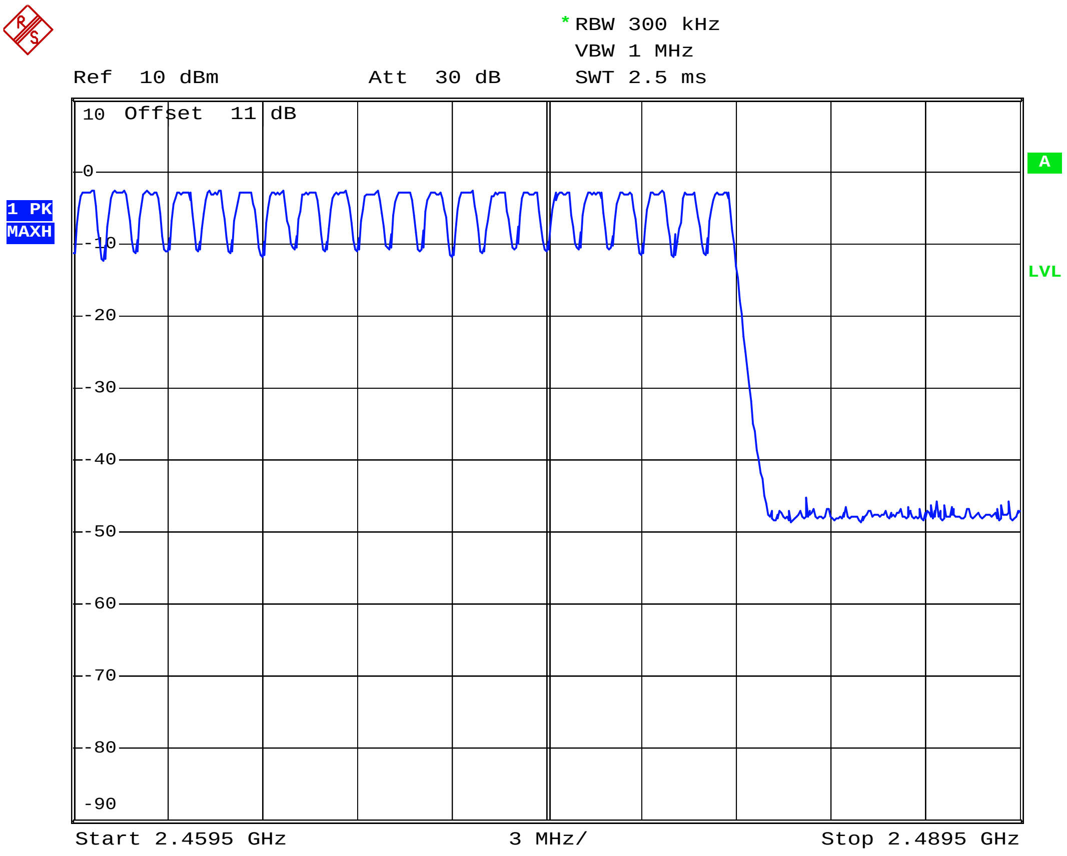
Adaptive Frequency Hopping (AFH) means that a device can hop over a reduced set of frequencies. The frequencies hopped may reduced in AFH mode but at least 15 channels will be used, normally AFH mode has 20 channels.

Note : The expanded uncertainty: frequency $\times 1.65 \times 10^{-6}$ ***(1 GHz*** $< f \leq$ ***18 GHz).***

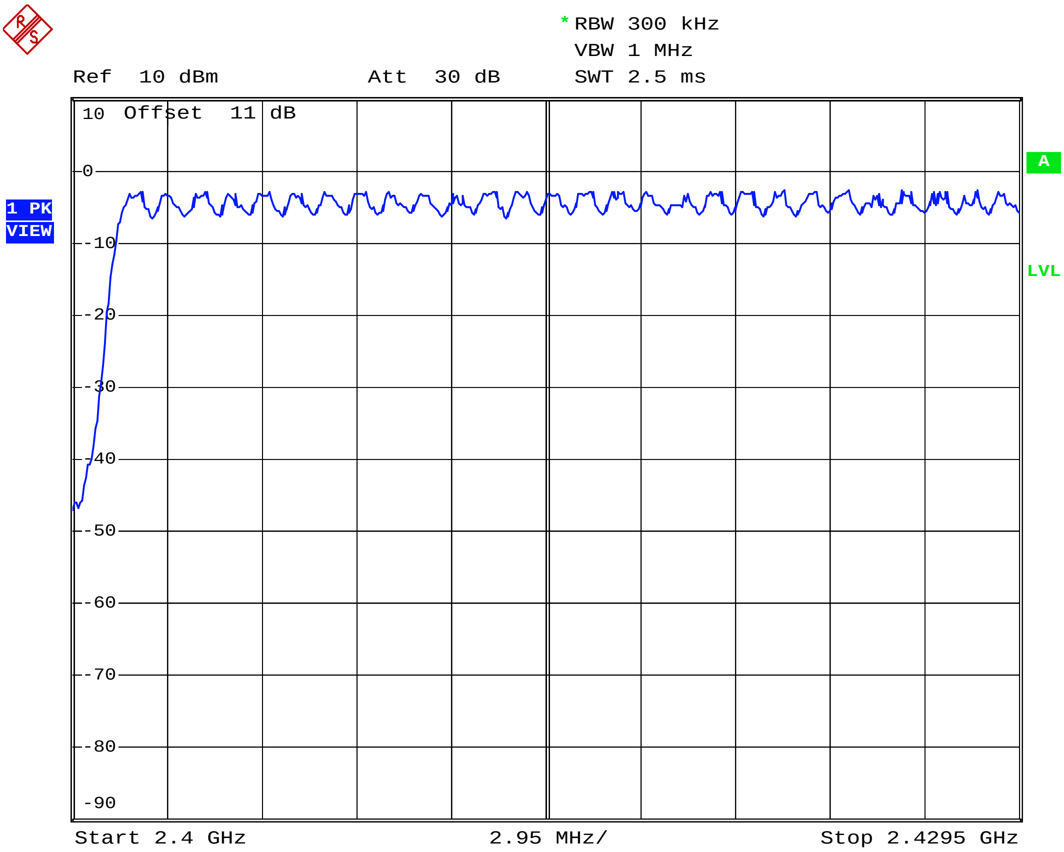
Mode: Bluetooth BR

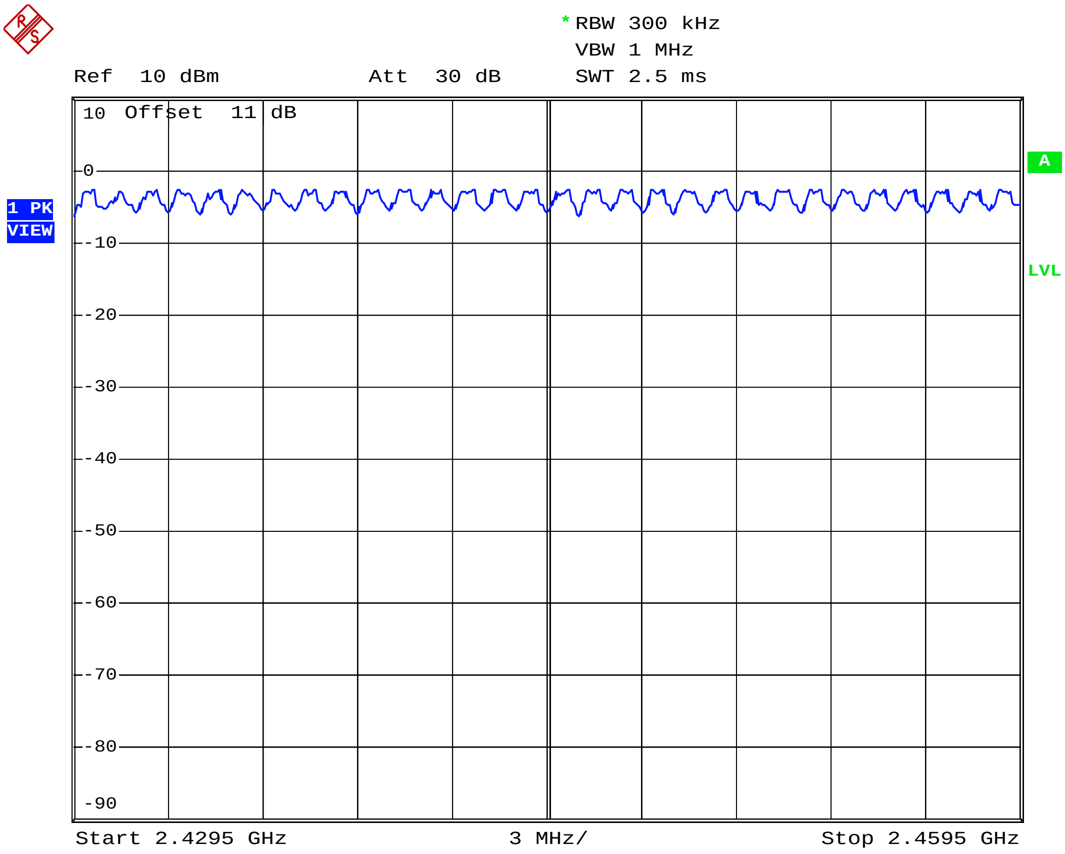


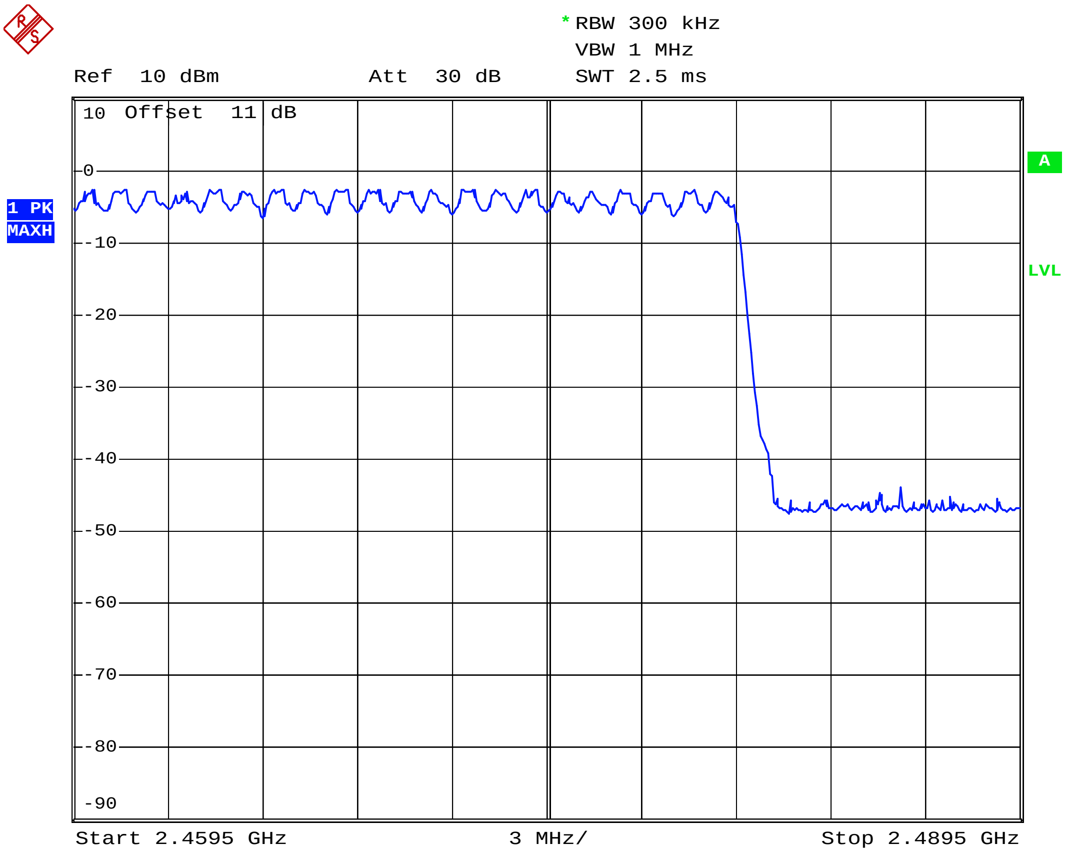

*RBW 300 kHz
VBW 1 MHz
SWT 2.5 ms
Ref 10 dBm
Att 30 dB
10 Offset 11 dB
0
-10
-20
-30
-40
-50
-60
-70
-80
-90
1 PK
MAXH
A
LVL
Start 2.4295 GHz
3 MHz/
Stop 2.4595 GHz


*RBW 300 kHz
VBW 1 MHz
Ref 10 dBm
Att 30 dB
SWT 2.5 ms
10 Offset 11 dB
0
1 PK
MAXH
-10
-20
-30
-40
-50
-60
-70
-80
-90
A
LVL
Start 2.4595 GHz
3 MHz/
Stop 2.4895 GHz

Mode: Bluetooth EDR




*RBW 300 kHz
VBW 1 MHz
SWT 2.5 ms
Ref 10 dBm
Att 30 dB
10 Offset 11 dB
0
-10
-20
-30
-40
-50
-60
-70
-80
-90
1 PK
VIEW
A
LVL
Start 2.4295 GHz
3 MHz/
Stop 2.4595 GHz


*RBW 300 kHz
VBW 1 MHz
Ref 10 dBm
Att 30 dB
SWT 2.5 ms
10 Offset 11 dB
0
-10
-20
-30
-40
-50
-60
-70
-80
-90
1 PK
MAXH
A
LVL
Start 2.4595 GHz
3 MHz/
Stop 2.4895 GHz

9 CHANNEL BANDWIDTH

9.1 Standard Applicable

For frequency hopping system operating in the 2400–2483.5 MHz band, there is no requirement for the maximum 20dB bandwidth of the hopping channel. The measurement of the hopping channel bandwidth is for the reference of the hopping channel separation requirement.

9.2 Measurement Procedure

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 figure 4 without connection to measurement instrument. Turn on the EUT and connect it to measurement instrument. Then set it to any one convenient frequency within its operating range.
3. Use the following spectrum analyzer settings:
   Span = approximately 2 to 3 times the 20 dB bandwidth, centered on a hopping channel
   RBW ≥ 1% of the 20 dB bandwidth
   VBW ≥ RBW
   Sweep = auto
   Detector function = peak
   Trace = max hold
4. Allow the trace to stabilize. 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. Plot the result on the screen of spectrum analyzer.
5. Repeat above procedures until all frequencies measured were complete.

9.3 Measurement Equipment

Equipment	Manufacturer	Model No.	Calibration Date	Next Cal. Date
Spectrum Analyzer	Rohde & Schwarz	FSP40	2016/10/03	2017/10/02
Attenuator	MINI-CIRCUITS	BW-S10W2+	2016/09/30	2017/09/29
Attenuator	MINI-CIRCUITS	BW-S20W2+	2016/09/30	2017/09/29
Attenuator	MINI-CIRCUITS	BW-S30W2+	2016/09/30	2017/09/29

9.4 Measurement Data

Test Date : Oct. 20, 2016 Temperature : 24 °C Humidity : 60 %

Mode: Bluetooth BR

a) Channel Low : Channel Bandwidth is 0.976 MHz
b) Channel Middle : Channel Bandwidth is 0.984 MHz
c) Channel High : Channel Bandwidth is 0.988 MHz

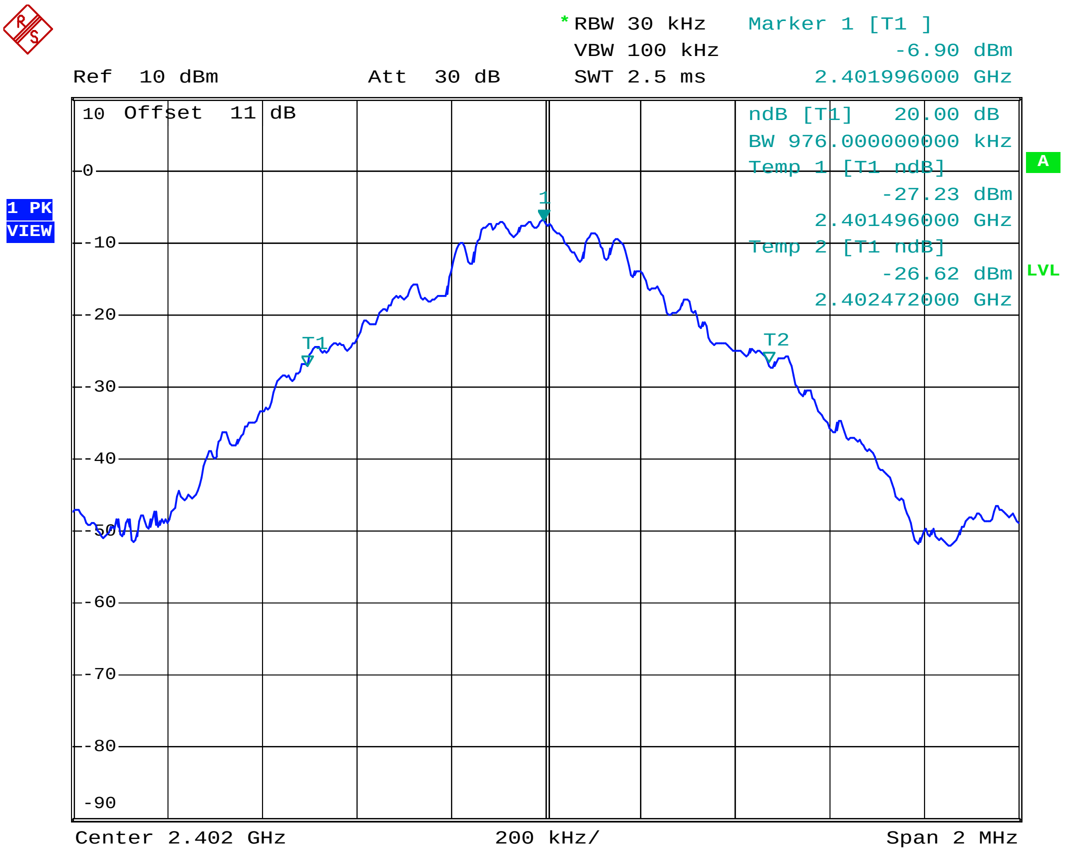
Mode: Bluetooth EDR

a) Channel Low : Channel Bandwidth is 1.240 MHz
b) Channel Middle : Channel Bandwidth is 1.260 MHz
c) Channel High : Channel Bandwidth is 1.264 MHz

Note : The expanded uncertainty: frequency $\times 1.65\times 10^{-6}$ ***(1 GHz*** $< f \leq$ ***18 GHz).***

Mode:Bluetooth BR

Channel Low



*RBW 30 kHz
VBW 100 kHz
SWT 2.5 ms

Ref 10 dBm
Att 30 dB

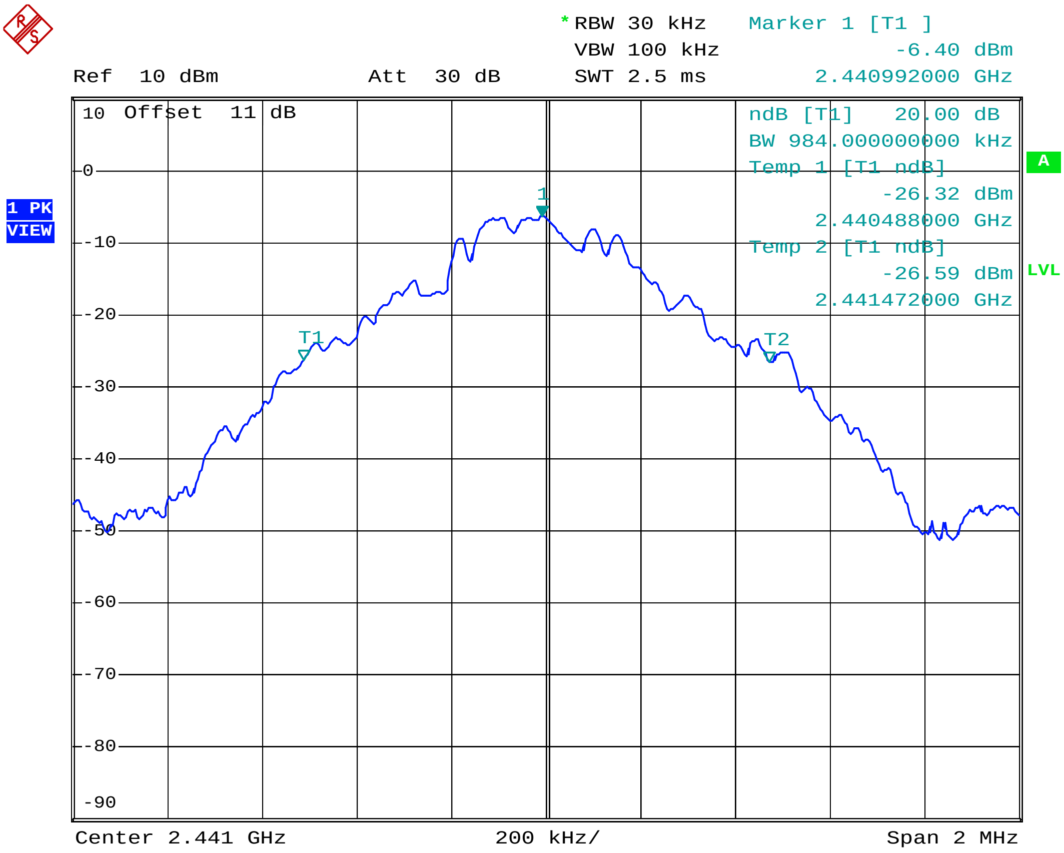
Marker 1 [T1]
-6.90 dBm
2.401996000 GHz

ndB [T1] 20.00 dB
BW 976.000000000 kHz
Temp 1 [T1 ndB]
-27.23 dBm
2.401496000 GHz
Temp 2 [T1 ndB]
-26.62 dBm
2.402472000 GHz

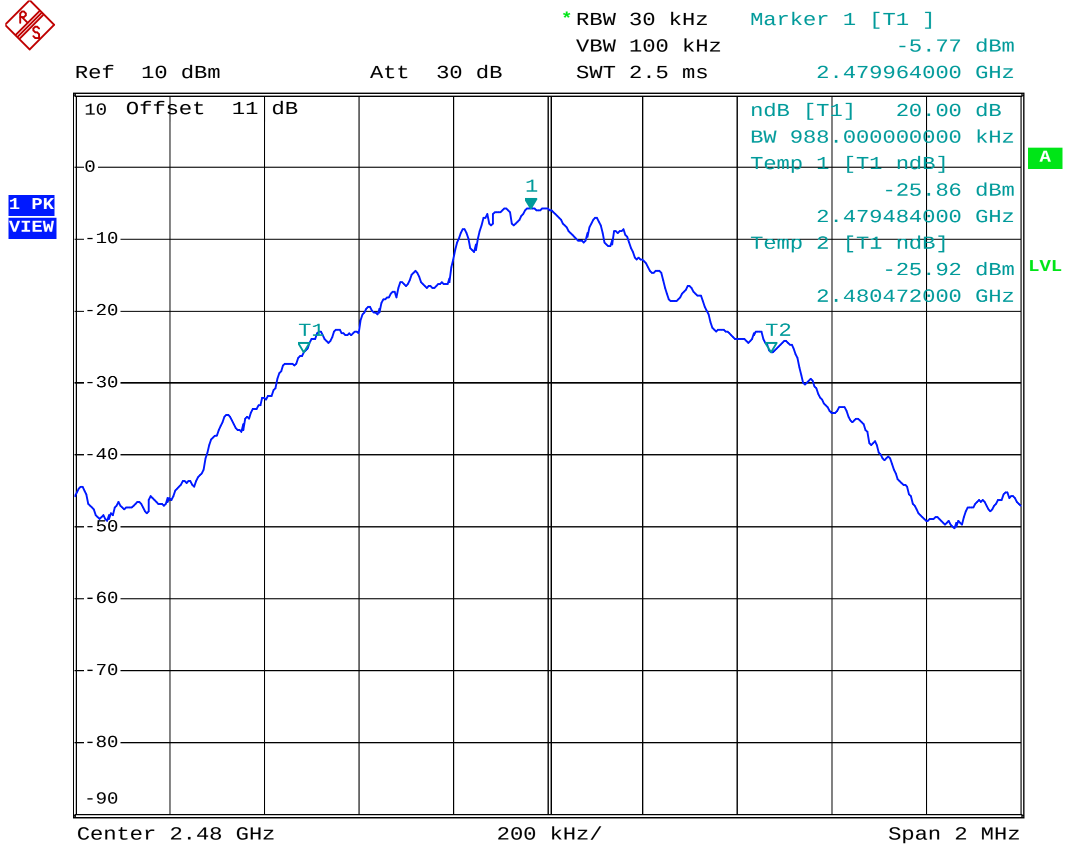
Center 2.402 GHz
200 kHz/
Span 2 MHz

10 Offset 11 dB
0
-10
-20
-30
-40
-50
-60
-70
-80
-90
1 PK
VIEW
A
LVL
1
T1
T2

Channel Middle



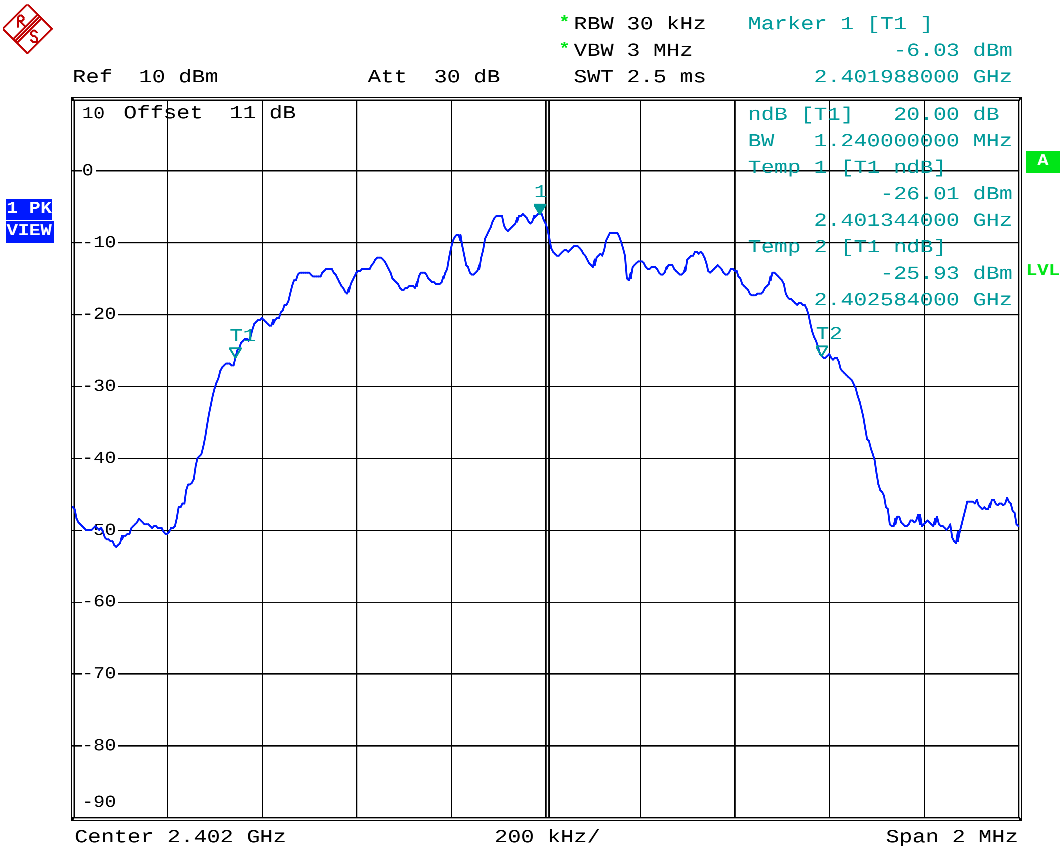
Channel High



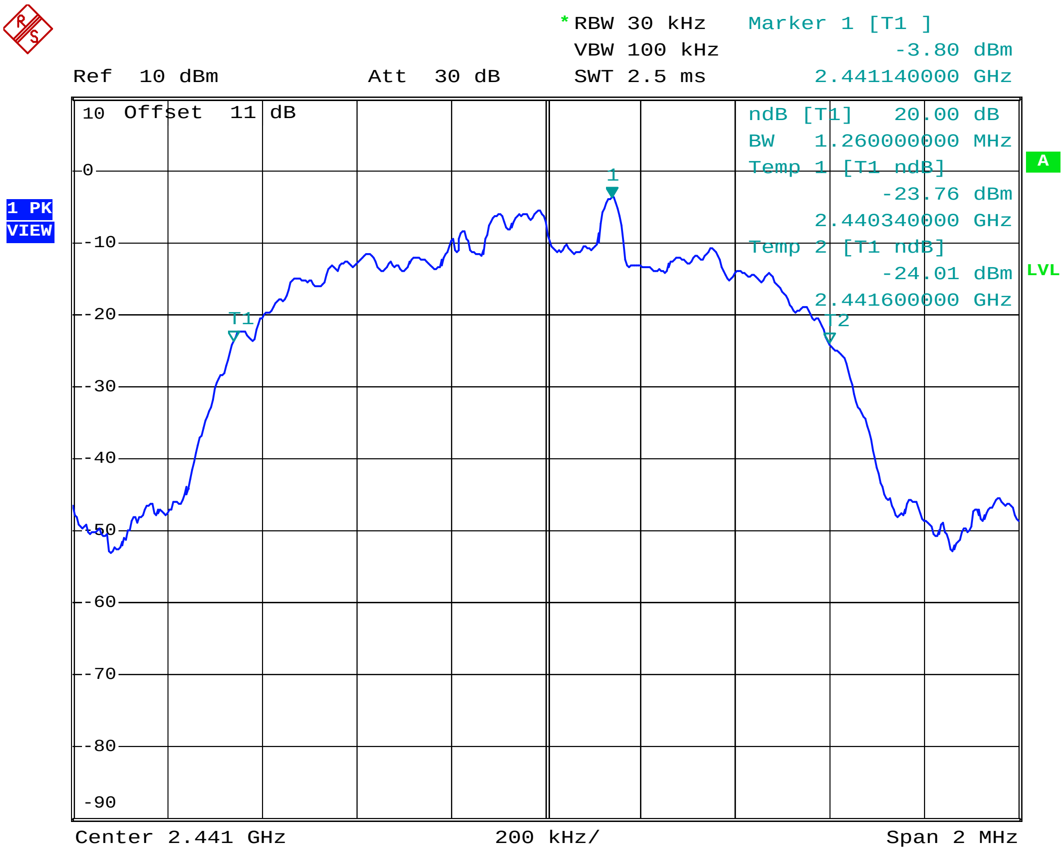
```
                                *RBW 30 kHz     Marker 1 [T1 ]
                                 VBW 100 kHz             -5.77 dBm
Ref   10 dBm         Att   30 dB SWT 2.5 ms         2.479964000 GHz

10  Offset   11  dB                          ndB [T1]     20.00 dB
                                             BW 988.000000000 kHz
                                             Temp 1 [T1 ndB]
                                                        -25.86 dBm
                                                    2.479484000 GHz
                                             Temp 2 [T1 ndB]
                                                        -25.92 dBm
                                                    2.480472000 GHz

Center 2.48 GHz                 200 kHz/                 Span 2 MHz
```

Mode: Bluetooth EDR

Channel Low

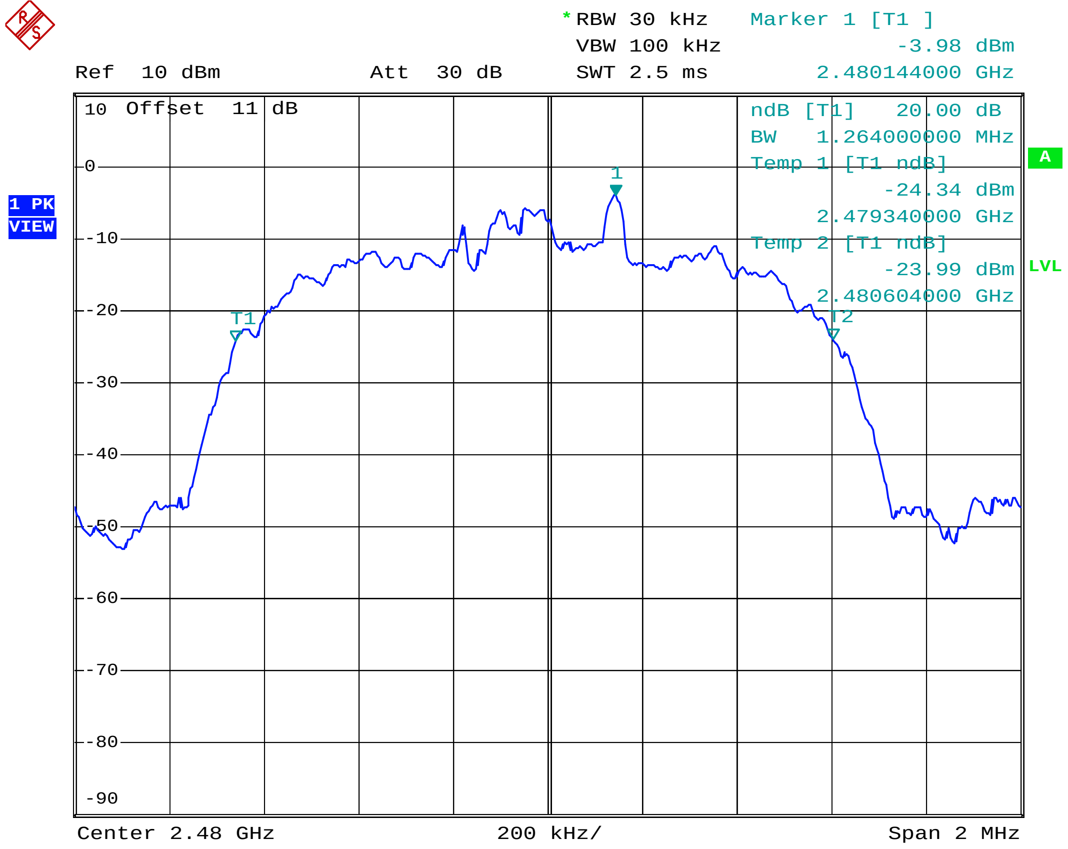


Channel Middle



```
*RBW 30 kHz      Marker 1 [T1 ]
 VBW 100 kHz              -3.80 dBm
 SWT 2.5 ms        2.441140000 GHz
Ref 10 dBm      Att 30 dB
Offset 11 dB
ndB [T1]     20.00 dB
BW     1.260000000 MHz
Temp 1 [T1 ndB]
            -23.76 dBm
       2.440340000 GHz
Temp 2 [T1 ndB]
            -24.01 dBm
       2.441600000 GHz
Center 2.441 GHz    200 kHz/    Span 2 MHz
```

Channel High



*RBW 30 kHz
VBW 100 kHz
SWT 2.5 ms
Ref 10 dBm
Att 30 dB
Offset 11 dB

Marker 1 [T1]
-3.98 dBm
2.480144000 GHz

ndB [T1] 20.00 dB
BW 1.264000000 MHz

Temp 1 [T1 ndB]
-24.34 dBm
2.479340000 GHz

Temp 2 [T1 ndB]
-23.99 dBm
2.480604000 GHz

Center 2.48 GHz
200 kHz/
Span 2 MHz

10 DWELL TIME ON EACH CHANNEL

10.1 Standard Applicable

According to 15.247(a)(1)(iii), for frequency hopping system operating in the 2400-2483.5 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.

10.2 Measurement Procedure

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 figure 4 without connection to measurement instrument. Turn on the EUT and connect it to measurement instrument. The EUT must have its hopping function enabled.
3. Use the following spectrum analyzer settings:
   Span = zero span, centered on a hopping channel
   RBW = 1 MHz
   VBW ≥ RBW
   Sweep = as necessary to capture the entire dwell time per hopping channel
   Detector function = peak
   Trace = max hold
4. Use the marker-delta function to determine the dwell time. Plot the result on the screen of spectrum analyzer.

5. Repeat above procedures until all frequencies measured were complete.

Justification on AFH mode:
Adaptive Frequency Hopping (AFH) means that a device can hop over a reduced set of frequencies. The frequencies hopped may reduced in AFH mode but at least 15 channels will be used, normally AFH mode has 20 channels.

10.3 Measurement Equipment

Equipment	Manufacturer	Model No.	Calibration Date	Next Cal. Date
Spectrum Analyzer	Rohde & Schwarz	FSP40	2016/10/03	2017/10/02
Attenuator	MINI-CIRCUITS	BW-S10W2+	2016/09/30	2017/09/29
Attenuator	MINI-CIRCUITS	BW-S20W2+	2016/09/30	2017/09/29
Attenuator	MINI-CIRCUITS	BW-S30W2+	2016/09/30	2017/09/29

10.4 Measurement Data

Test Mode: Bluetooth BR

Test Date : Oct. 20, 2016 Temperature : 24 °C Humidity : 60 %

Period = 0.4(seconds) x 79(channels) = 31.6 seconds

A. DH1 Mode

The Bluetooth system hops at a rate of 1600 times per second. This means there are 1600 timeslots in one second. The DH1 data rate operates on a one-slot transmission and one-slot receiving basis. Thus there are 1600/(1+1) = 800 transmissions per second. In one period for each particular channel there are 10.13 x 31.6 = 320.1 times of transmissions.

a) Channel Low : the dwell time is 0.40 ms x 320.1 = 128.040 ms
b) Channel Middle : the dwell time is 0.40 ms x 320.1 = 128.040 ms
c) Channel High : the dwell time is 0.40 ms x 320.1 = 128.040 ms

The maximum time of occupancy for a particular channel is 128.040ms in any 31.6 second period, which is less than the 400ms allowed by the rules; therefore, it meets the requirements of this section.

B. DH3 Mode

The Bluetooth system hops at a rate of 1600 times per second. This means there are 1600 timeslots in one second. The DH3 data rate operates on a three-slot transmission and one-slot receiving basis. Thus there are 1600/(3+1) = 400 transmissions per second. In one period for each particular channel there are 5.06 x 31.6 = 159.9 times of transmissions.

a) Channel Low : the dwell time is 1.70 ms x 159.9 = 271.830 ms
b) Channel Middle : the dwell time is 1.70 ms x 159.9 = 271.830 ms
c) Channel High : the dwell time is 1.70 ms x 159.9 = 271.830 ms

The maximum time of occupancy for a particular channel is 271.830ms in any 31.6 second period, which is less than the 400 ms allowed by the rules; therefore, it meets the requirements of this section.

C. DH5 Mode

The Bluetooth system hops at a rate of 1600 times per second. This means there are 1600 timeslots in one second. The DH5 data rate operates on a five-slot transmission and one-slot receiving basis. Thus there are 1600/(5+1) = 266.7 transmissions per second. In one period for each particular channel there are 3.38 x 31.6 = 106.81 times of transmissions.

a) Channel Low : the dwell time is 3.00 ms x106.81 = 320.430 ms
b) Channel Middle : the dwell time is 3.00 ms x106.81 = 320.430 ms
c) Channel High : the dwell time is 3.00 ms x106.81 = 320.430 ms

The maximum time of occupancy for a particular channel is 320.430ms in any 31.6 second period, which is less than the 400 ms allowed by the rules; therefore, it meets the requirements of this section.

Note : The expanded uncertainty of dwell time on each channel tests is 2dB.

Test Mode: Bluetooth BR (AFH mode)

Test Date : Oct. 20, 2016 Temperature : 24 °C Humidity : 60 %

Period = 0.4(seconds) x 20(channels) = 8 seconds

A. DH1 Mode

The Bluetooth system hops at a rate of 800 times per second. This means there are 800 timeslots in one second. The DH1 data rate operates on a one-slot transmission and one-slot receiving basis. Thus there are 800/(1+1) = 400 transmissions per second. In one period for each particular channel there are 20 x 8 = 160 times of transmissions.

a) Channel Low : the dwell time is 0.40ms x 160 = 64 ms
b) Channel Middle : the dwell time is 0.40ms x 160 = 64 ms
c) Channel Hi : the dwell time is 0.40ms x 160 = 64 ms

The maximum time of occupancy for a particular channel is 64ms in any 8 second period, which is less than the 400ms allowed by the rules; therefore, it meets the requirements of this section.

B. DH3 Mode

The Bluetooth system hops at a rate of 800 times per second. This means there are 800 timeslots in one second. The DH3 data rate operates on a three-slot transmission and one-slot receiving basis. Thus there are 800/(3+1) = 200 transmissions per second. In one period for each particular channel there are 10 x 8 = 80 times of transmissions.

a) Channel Low : the dwell time is 1.70ms x 80 = 136 ms
b) Channel Middle : the dwell time is 1.70ms x 80 = 136 ms
c) Channel Hi : the dwell time is 1.70ms x 80 = 136 ms

The maximum time of occupancy for a particular channel is 136ms in any 8 second period, which is less than the 400 ms allowed by the rules; therefore, it meets the requirements of this section.

C. DH5 Mode

The Bluetooth system hops at a rate of 800 times per second. This means there are 800 timeslots in one second. The DH5 data rate operates on a five-slot transmission and one-slot receiving basis. Thus there are 800/(5+1) = 133.3 transmissions per second. In one period for each particular channel there are 6.665 x 8 = 53.32 times of transmissions.

a) Channel Low : the dwell time is 3.00ms x 53.32 = 159.96 ms
b) Channel Middle : the dwell time is 3.00ms x 53.32 = 159.96 ms
c) Channel Hi : the dwell time is 3.00ms x 53.32 = 159.96 ms

The maximum time of occupancy for a particular channel is 159.96ms in any 8 second period, which is less than the 400 ms allowed by the rules; therefore, it meets the requirements of this section.

Note : The expanded uncertainty of dwell time on each channel tests is 2dB.

Test Mode:Bluetooth EDR

Test Date : Oct. 20, 2016 Temperature : 24 °C Humidity : 60 %

Period = 0.4(seconds) x 79(channels) = 31.6 seconds

A. DH1 Mode

The Bluetooth system hops at a rate of 1600 times per second. This means there are 1600 timeslots in one second. The DH1 data rate operates on a one-slot transmission and one-slot receiving basis. Thus there are 1600/(1+1) = 800 transmissions per second. In one period for each particular channel there are 10.13 x 31.6 = 320.1 times of transmissions.

a) Channel Low : the dwell time is 0.408 ms x 320.1 = 130.601 ms
b) Channel Middle : the dwell time is 0.408 ms x 320.1 = 130.601 ms
c) Channel High : the dwell time is 0.408 ms x 320.1 = 130.601 ms

The maximum time of occupancy for a particular channel is 147.246ms in any 31.6 second period, which is less than the 400ms allowed by the rules; therefore, it meets the requirements of this section.

B. DH3 Mode

The Bluetooth system hops at a rate of 1600 times per second. This means there are 1600 timeslots in one second. The DH3 data rate operates on a three-slot transmission and one-slot receiving basis. Thus there are 1600/(3+1) = 400 transmissions per second. In one period for each particular channel there are 5.06 x 31.6 = 159.9 times of transmissions.

a) Channel Low : the dwell time is 1.70 ms x 159.9 = 271.83 ms
b) Channel Middle : the dwell time is 1.70 ms x 159.9 = 271.83 ms
c) Channel High : the dwell time is 1.70 ms x 159.9 = 271.83 ms

The maximum time of occupancy for a particular channel is 287.820ms in any 31.6 second period, which is less than the 400 ms allowed by the rules; therefore, it meets the requirements of this section.

C. DH5 Mode

The Bluetooth system hops at a rate of 1600 times per second. This means there are 1600 timeslots in one second. The DH5 data rate operates on a five-slot transmission and one-slot receiving basis. Thus there are 1600/(5+1) = 266.7 transmissions per second. In one period for each particular channel there are 3.38 x 31.6 = 106.81 times of transmissions.

a) Channel Low : the dwell time is 3.00 ms x106.81 = 320.43 ms
b) Channel Middle : the dwell time is 3.00 ms x106.81 = 320.43 ms
c) Channel High : the dwell time is 3.00 ms x106.81 = 320.43 ms

The maximum time of occupancy for a particular channel is 341.792ms in any 31.6 second period, which is less than the 400 ms allowed by the rules; therefore, it meets the requirements of this section.

Note : The expanded uncertainty of dwell time on each channel tests is 2dB.

Test Mode:Bluetooth EDR (AFH mode)

Test Date : Oct. 20, 2016 Temperature : 24 °C Humidity : 60 %

Period = 0.4(seconds) x 20(channels) = 8 seconds

A. DH1 Mode

The Bluetooth system hops at a rate of 800 times per second. This means there are 800 timeslots in one second. The DH1 data rate operates on a one-slot transmission and one-slot receiving basis. Thus there are 800/(1+1) = 400 transmissions per second. In one period for each particular channel there are 20 x 8 = 160 times of transmissions.

a) Channel Low : the dwell time is 0.408ms x 160 = 65.28 ms
b) Channel Middle : the dwell time is 0.408ms x 160 = 65.28 ms
c) Channel Hi : the dwell time is 0.408ms x 160 = 65.28 ms

The maximum time of occupancy for a particular channel is 65.28ms in any 8 second period, which is less than the 400ms allowed by the rules; therefore, it meets the requirements of this section.

B. DH3 Mode

The Bluetooth system hops at a rate of 800 times per second. This means there are 800 timeslots in one second. The DH3 data rate operates on a three-slot transmission and one-slot receiving basis. Thus there are 800/(3+1) = 200 transmissions per second. In one period for each particular channel there are 10 x 8 = 80 times of transmissions.

a) Channel Low : the dwell time is 1.70ms x 80 = 136. 00 ms
b) Channel Middle : the dwell time is 1.70ms x 80 = 136. 00 ms
c) Channel Hi : the dwell time is 1.70ms x 80 = 136. 00 ms

The maximum time of occupancy for a particular channel is 136.000ms in any 8 second period, which is less than the 400 ms allowed by the rules; therefore, it meets the requirements of this section.

C. DH5 Mode

The Bluetooth system hops at a rate of 800 times per second. This means there are 800 timeslots in one second. The DH5 data rate operates on a five-slot transmission and one-slot receiving basis. Thus there are 800/(5+1) = 133.3 transmissions per second. In one period for each particular channel there are 6.665 x 8 = 53.32 times of transmissions.

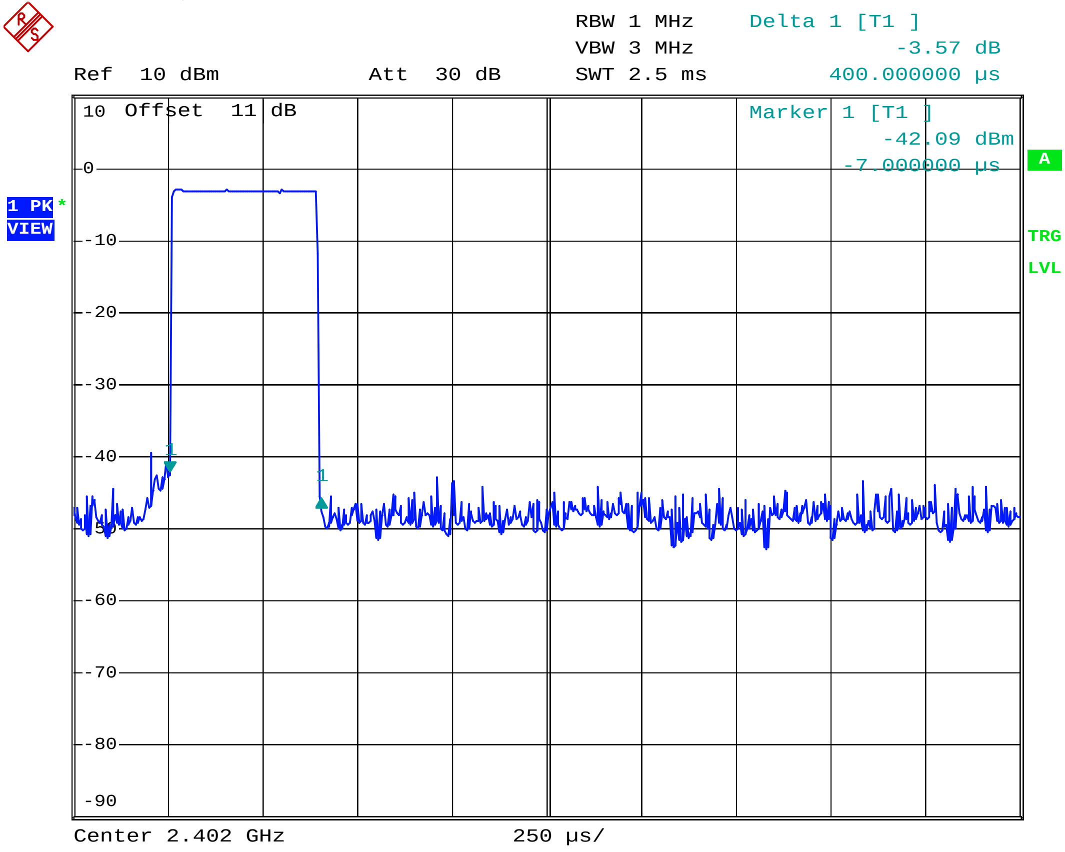
a) Channel Low : the dwell time is 3.00ms x 53.32 = 159.960 ms
b) Channel Middle : the dwell time is 3.00ms x 53.32 = 159.960 ms
c) Channel Hi : the dwell time is 3.00ms x 53.32 = 159.960 ms

The maximum time of occupancy for a particular channel is 159.960ms in any 8 second period, which is less than the 400 ms allowed by the rules; therefore, it meets the requirements of this section.

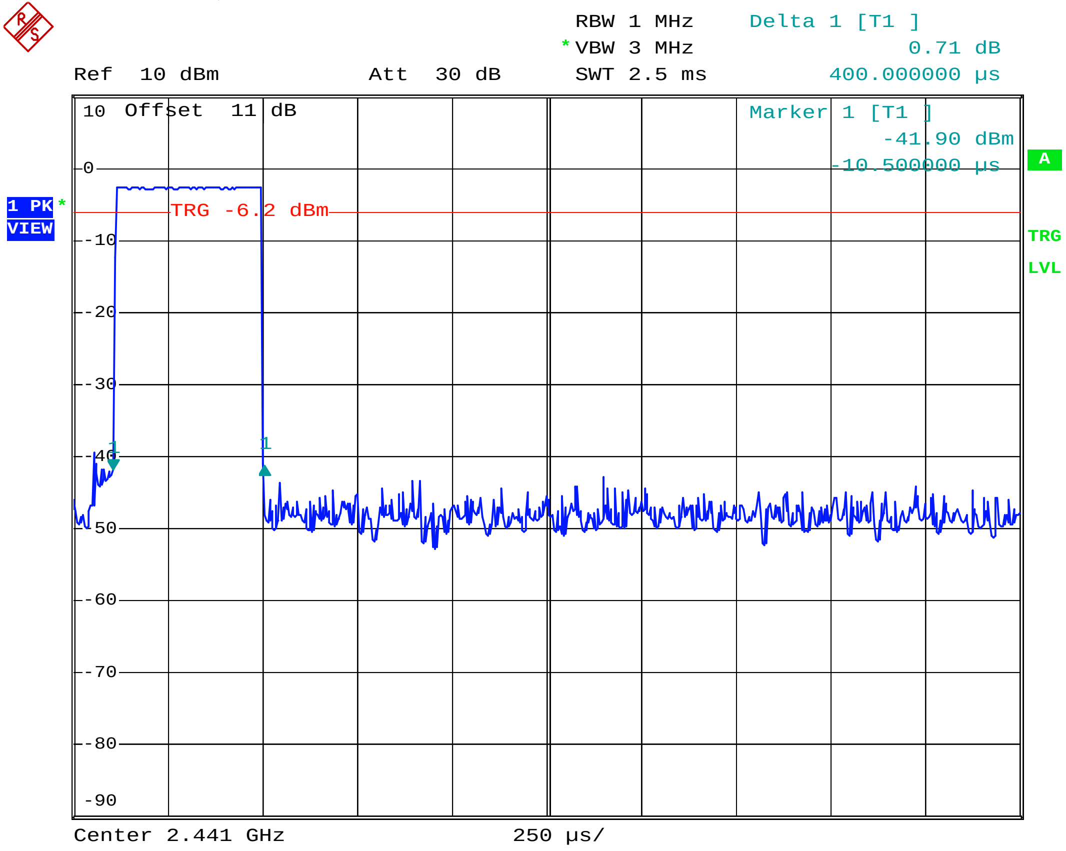
Note : The expanded uncertainty of dwell time on each channel tests is 2dB.

Mode: Bluetooth BR

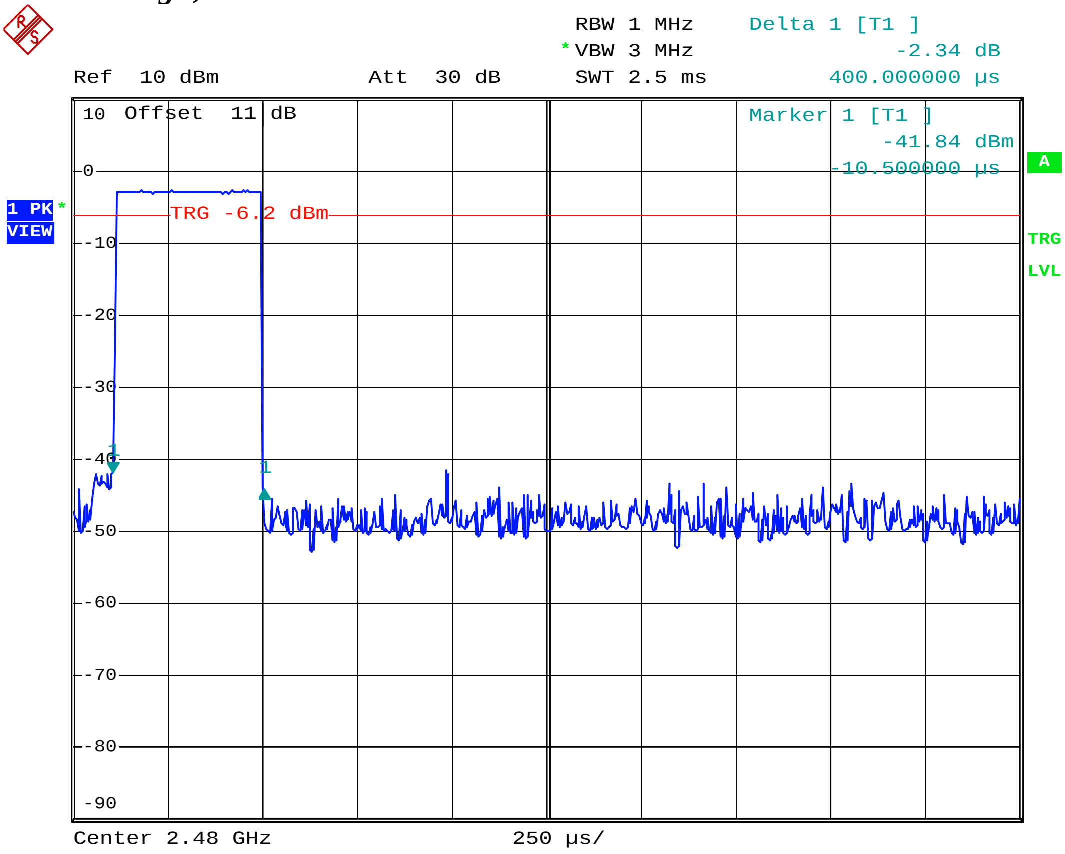
Channel Low; DH1


RBW 1 MHz
VBW 3 MHz
SWT 2.5 ms
Delta 1 [T1]
-3.57 dB
400.000000 µs
Ref 10 dBm
Att 30 dB
10 Offset 11 dB
Marker 1 [T1]
-42.09 dBm
-7.000000 µs
0
-10
-20
-30
-40
-50
-60
-70
-80
-90
1 PK
VIEW
A
TRG
LVL
1
1
Center 2.402 GHz
250 µs/

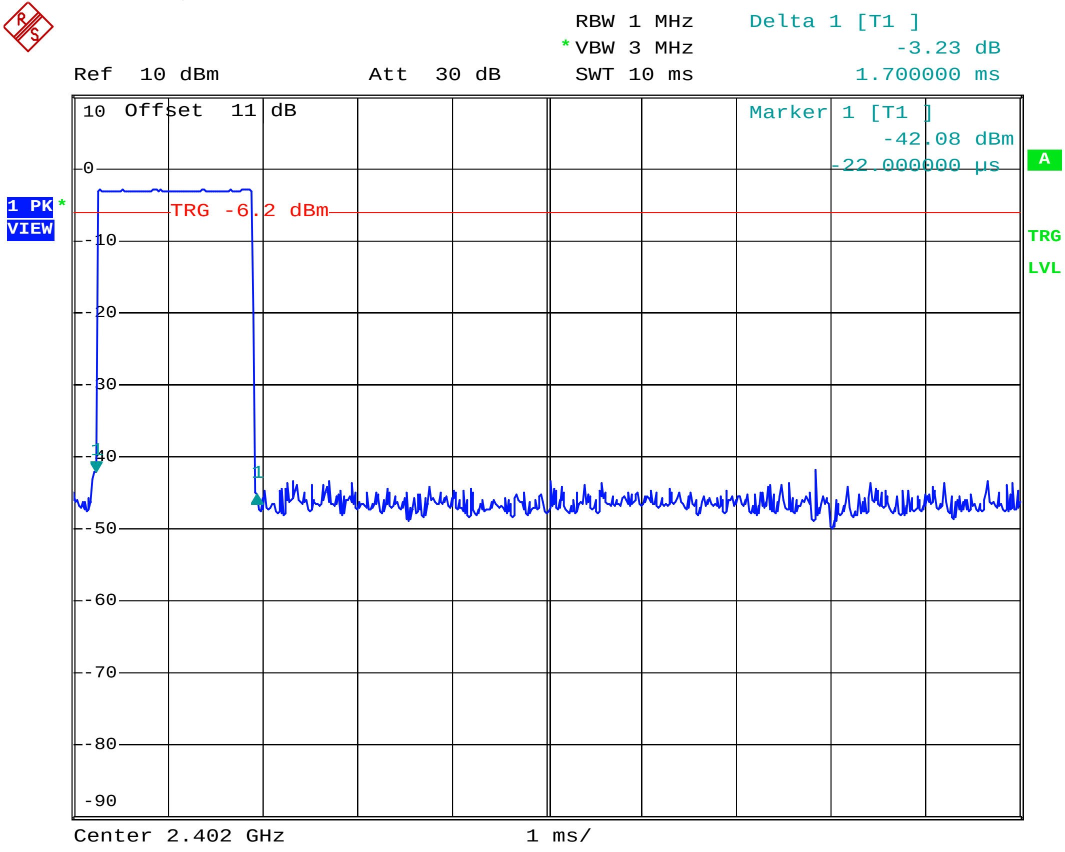
Channel Middle; DH1



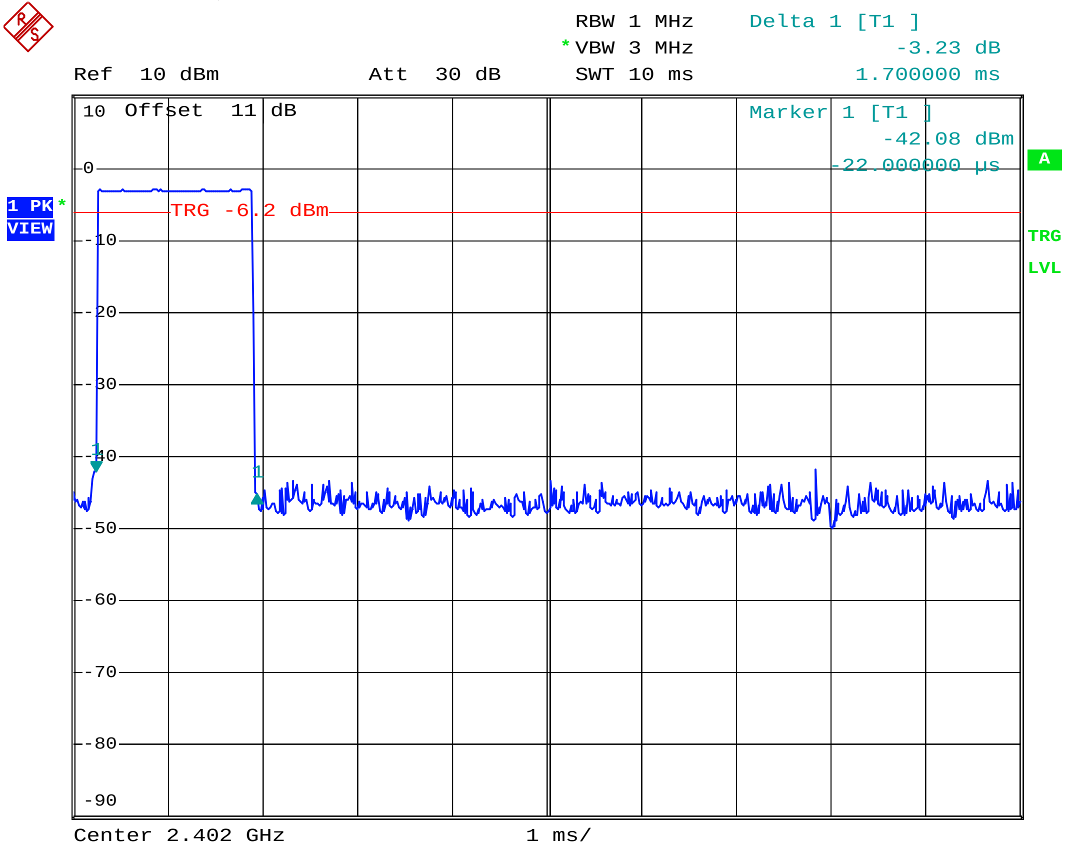
Channel High; DH1



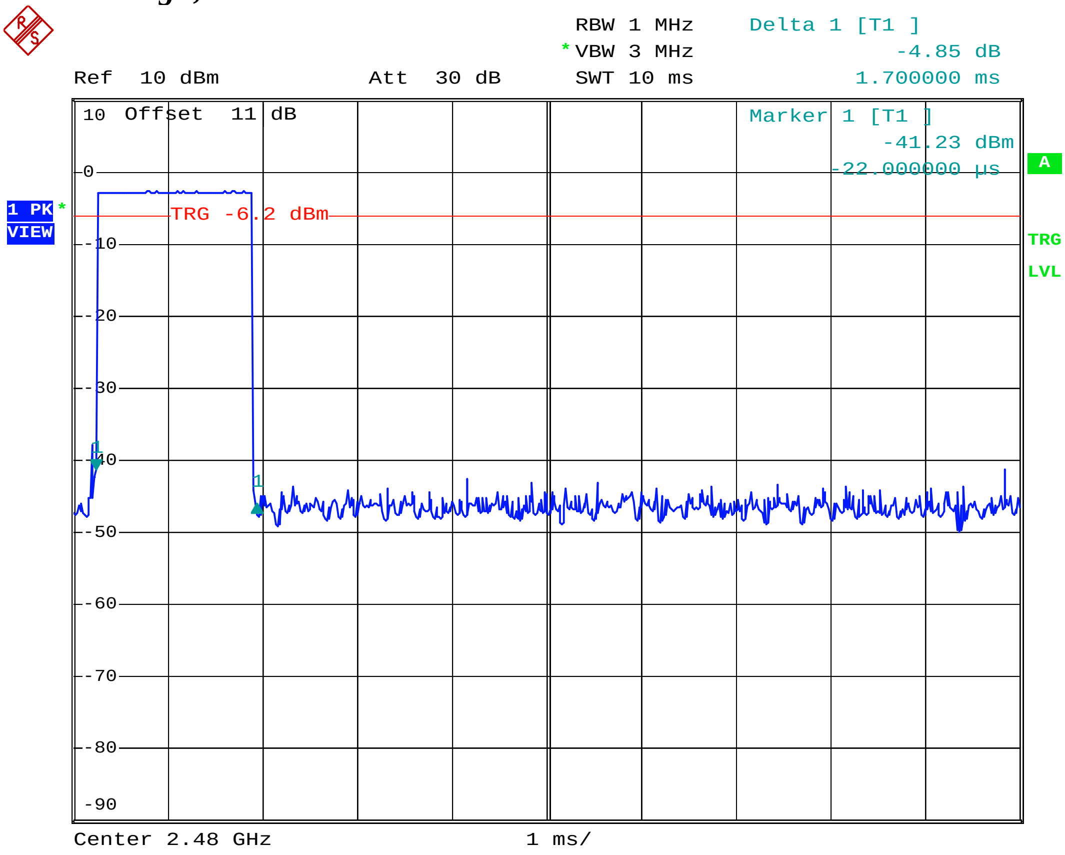
Channel Low; DH3



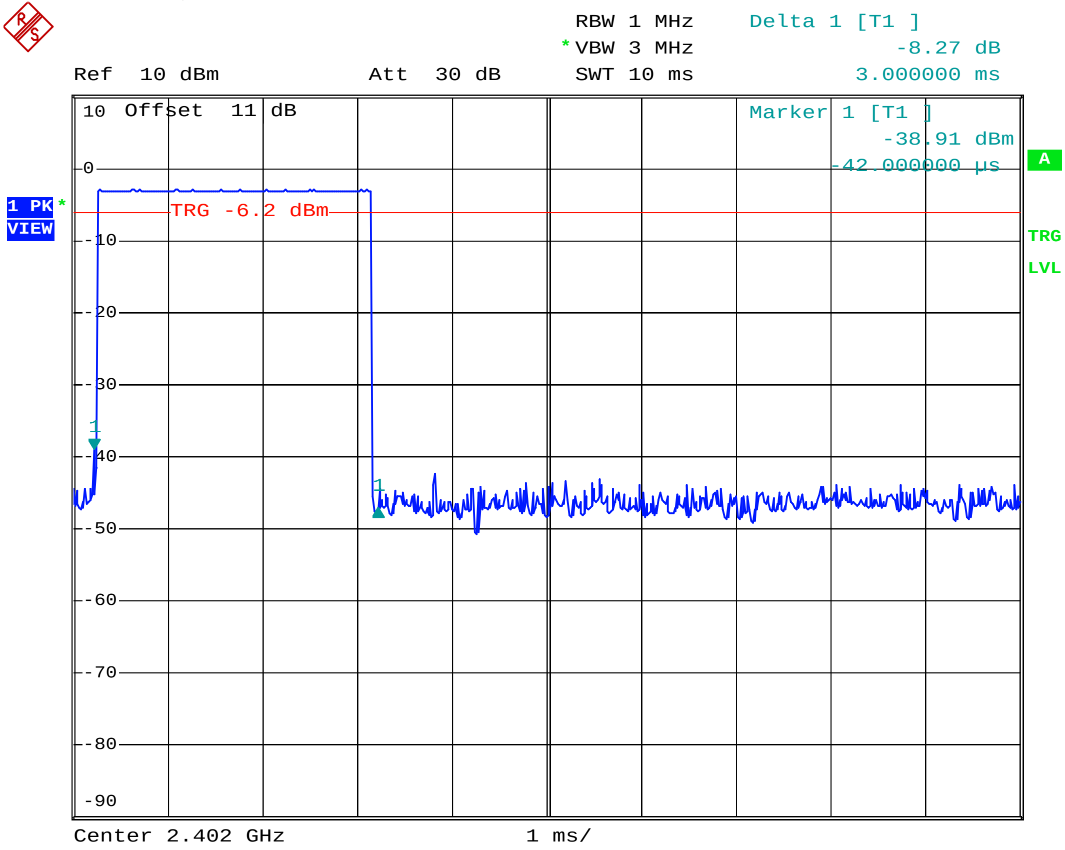
Channel Middle; DH3


RBW 1 MHz
* VBW 3 MHz
SWT 10 ms
Delta 1 [T1]
-3.23 dB
1.700000 ms
Ref 10 dBm
Att 30 dB
10 Offset 11 dB
Marker 1 [T1]
-42.08 dBm
-22.000000 µs
A
1 PK
VIEW
TRG -6.2 dBm
TRG
LVL
0
-10
-20
-30
-40
-50
-60
-70
-80
-90
Center 2.402 GHz
1 ms/

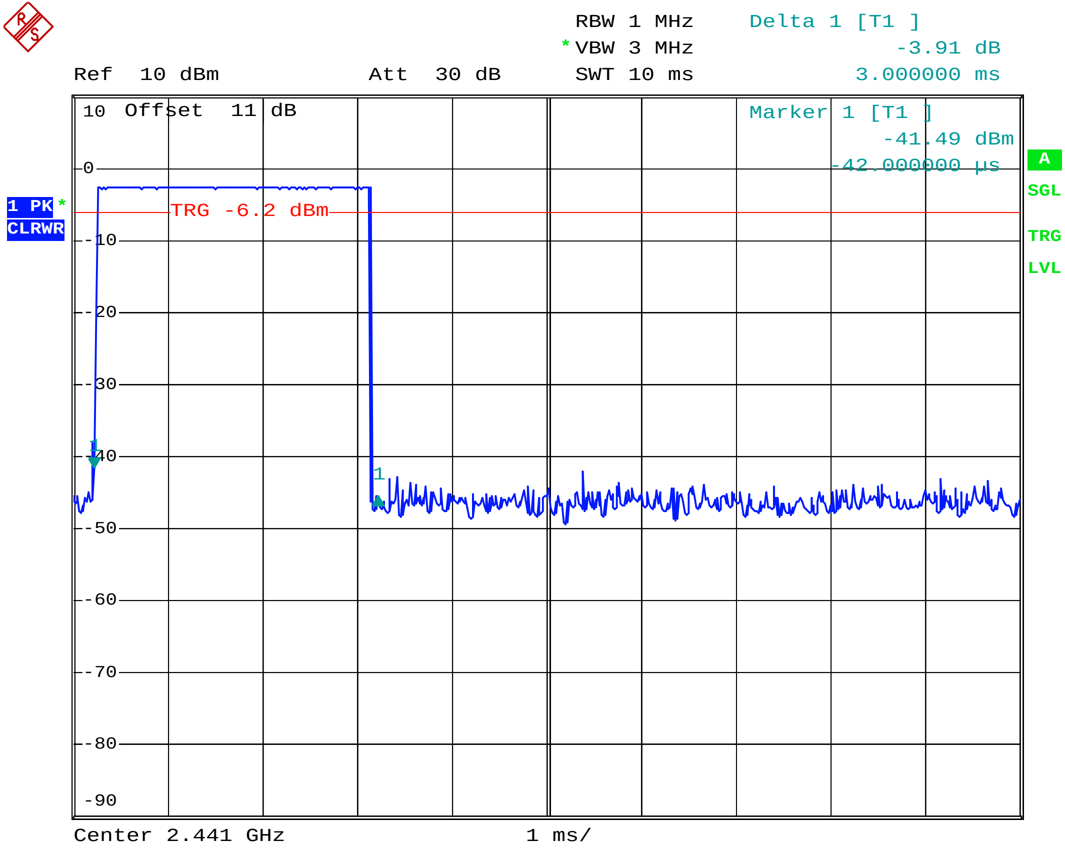
Channel High; DH3



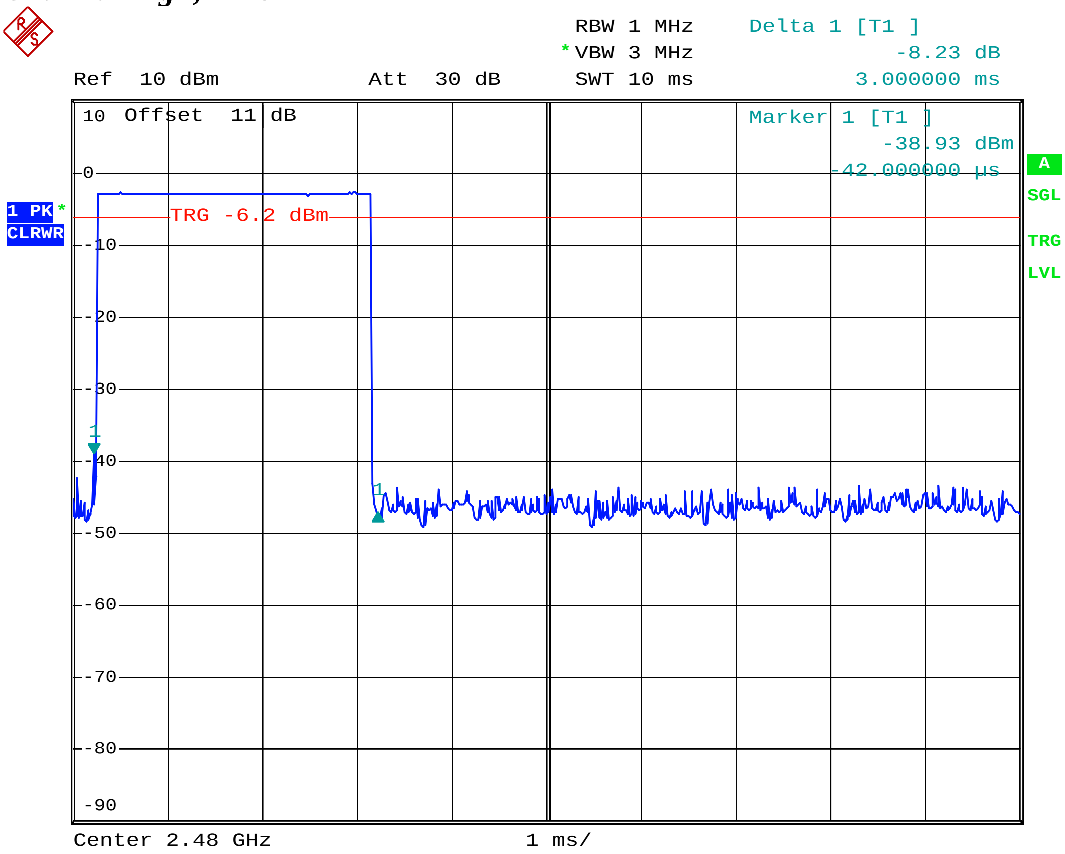
Channel Low; DH5



Channel Middle; DH5


RBW 1 MHz
*VBW 3 MHz
SWT 10 ms
Ref 10 dBm
Att 30 dB
Delta 1 [T1]
-3.91 dB
3.000000 ms
Marker 1 [T1]
-41.49 dBm
-42.000000 µs
Offset 11 dB
TRG -6.2 dBm
1 PK
CLRWR
A
SGL
TRG
LVL
10
0
-10
-20
-30
-40
-50
-60
-70
-80
-90
1
Center 2.441 GHz
1 ms/

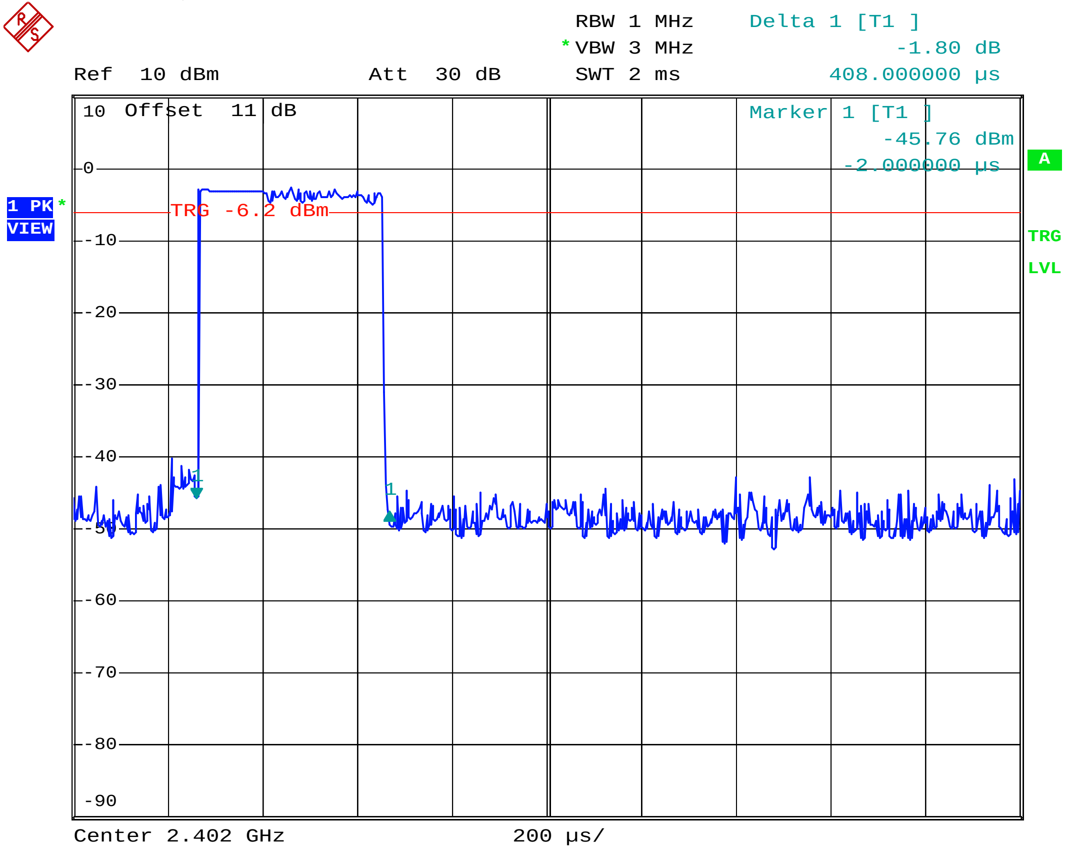
Channel High; DH5



RBW 1 MHz
* VBW 3 MHz
SWT 10 ms
Ref 10 dBm
Att 30 dB
Delta 1 [T1]
-8.23 dB
3.000000 ms
Marker 1 [T1]
-38.93 dBm
-42.000000 µs
10 Offset 11 dB
0
-10
-20
-30
-40
-50
-60
-70
-80
-90
TRG -6.2 dBm
1 PK *
CLRWR
A
SGL
TRG
LVL
1
1
Center 2.48 GHz
1 ms/

Mode: Bluetooth EDR

Channel Low; DH1



RBW 1 MHz
*VBW 3 MHz
SWT 2 ms

Ref 10 dBm
Att 30 dB

Delta 1 [T1]
-1.80 dB
408.000000 µs

Marker 1 [T1]
-45.76 dBm
-2.000000 µs

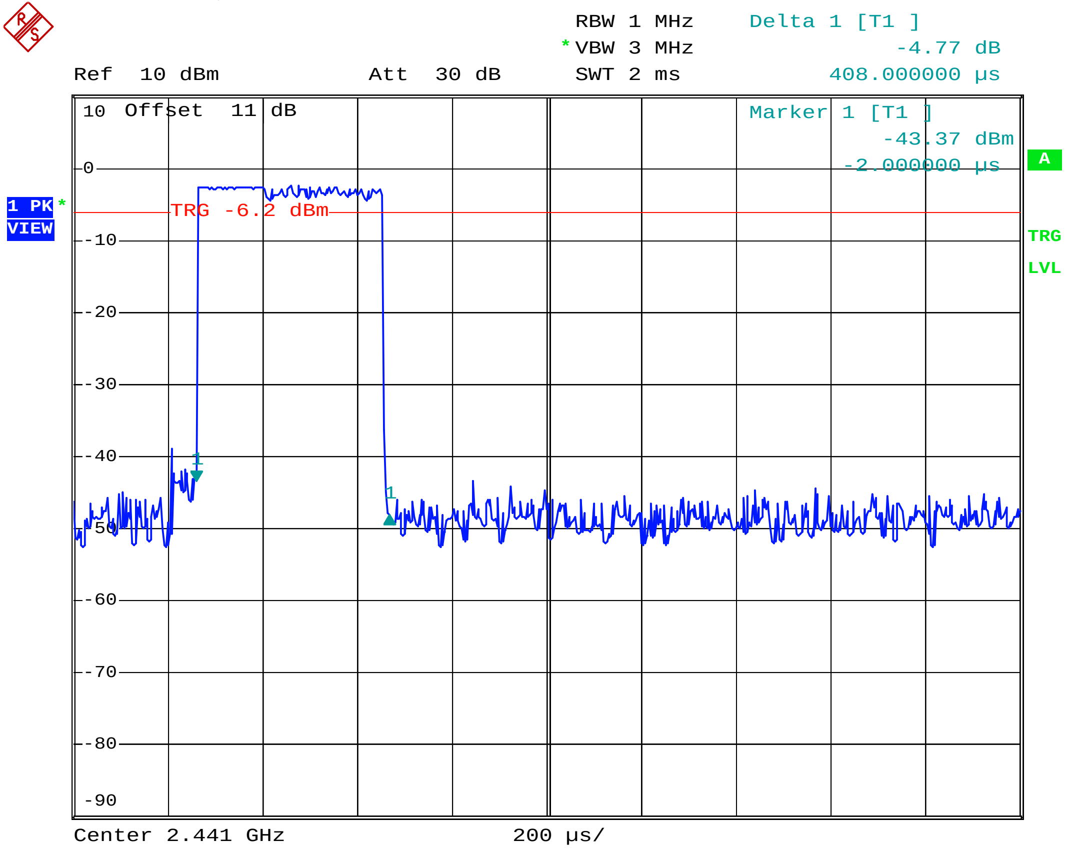
Offset 11 dB

TRG -6.2 dBm

Center 2.402 GHz
200 µs/

1 PK
VIEW
A
TRG
LVL
10
0
-10
-20
-30
-40
-50
-60
-70
-80
-90
1

Channel Middle; DH1



RBW 1 MHz
*VBW 3 MHz
SWT 2 ms

Delta 1 [T1]
-4.77 dB
408.000000 µs

Ref 10 dBm
Att 30 dB

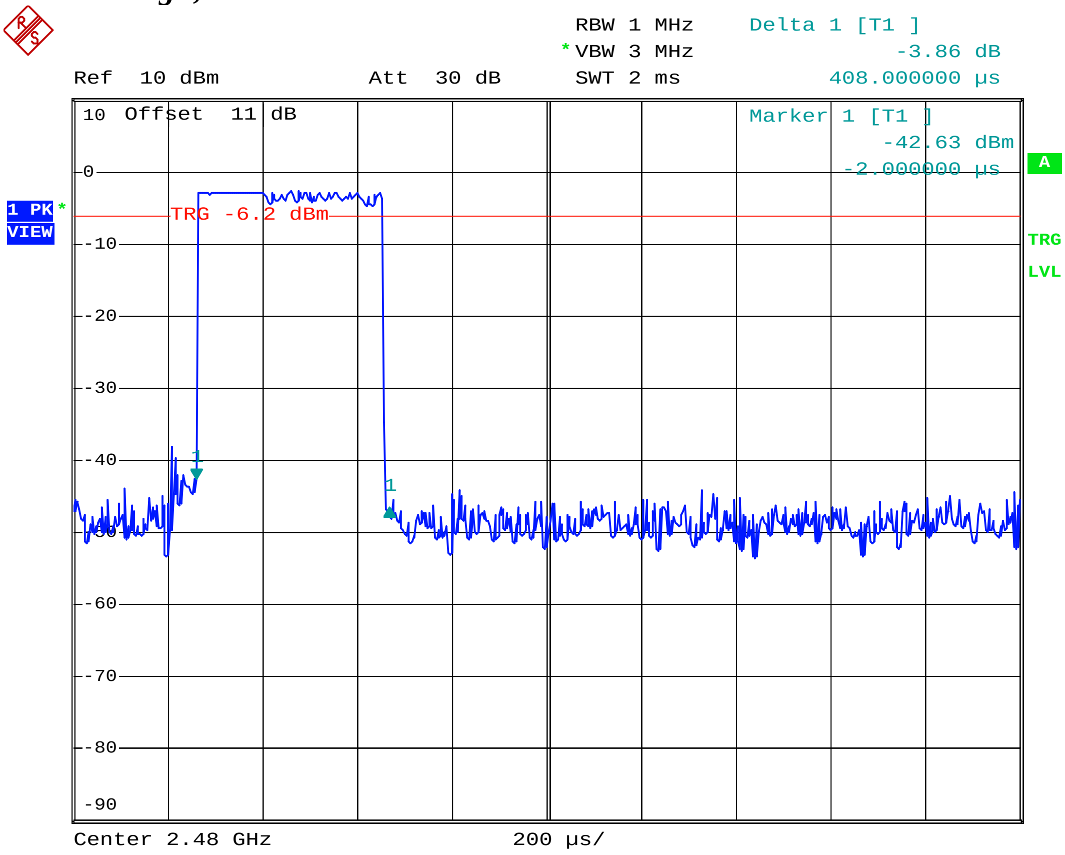
Offset 11 dB

Marker 1 [T1]
-43.37 dBm
-2.000000 µs

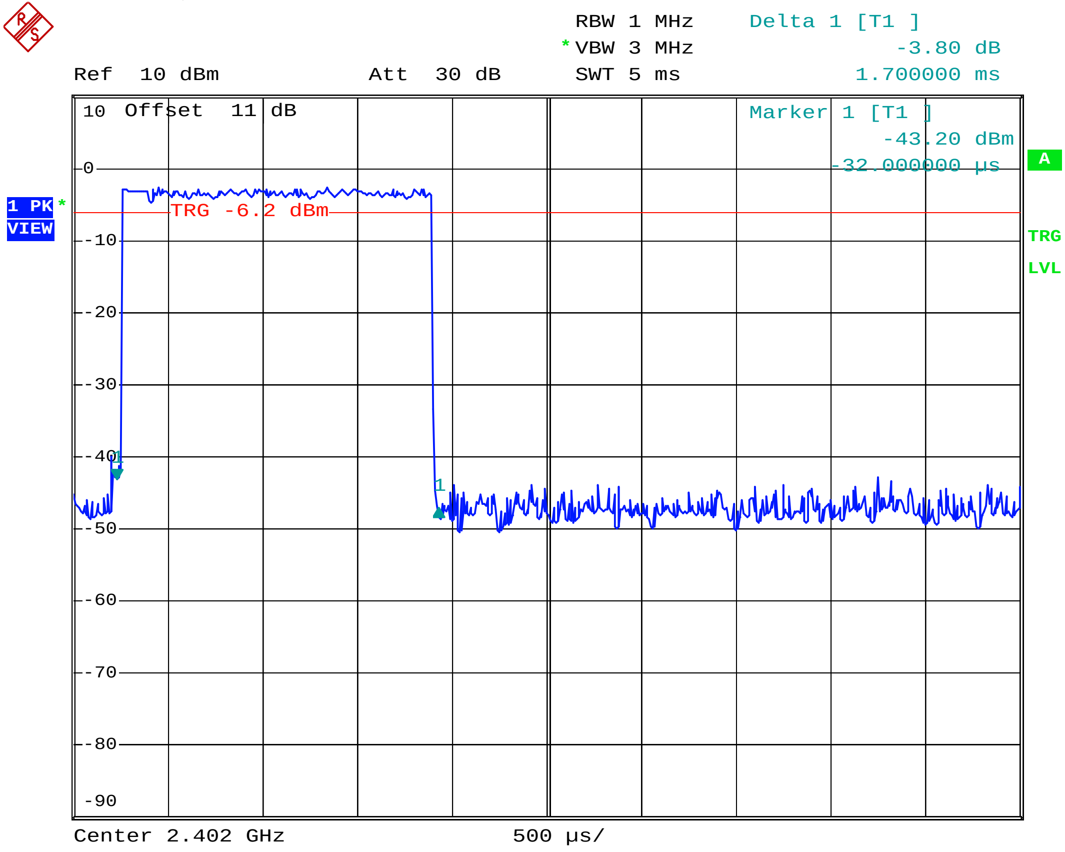
TRG -6.2 dBm

Center 2.441 GHz
200 µs/

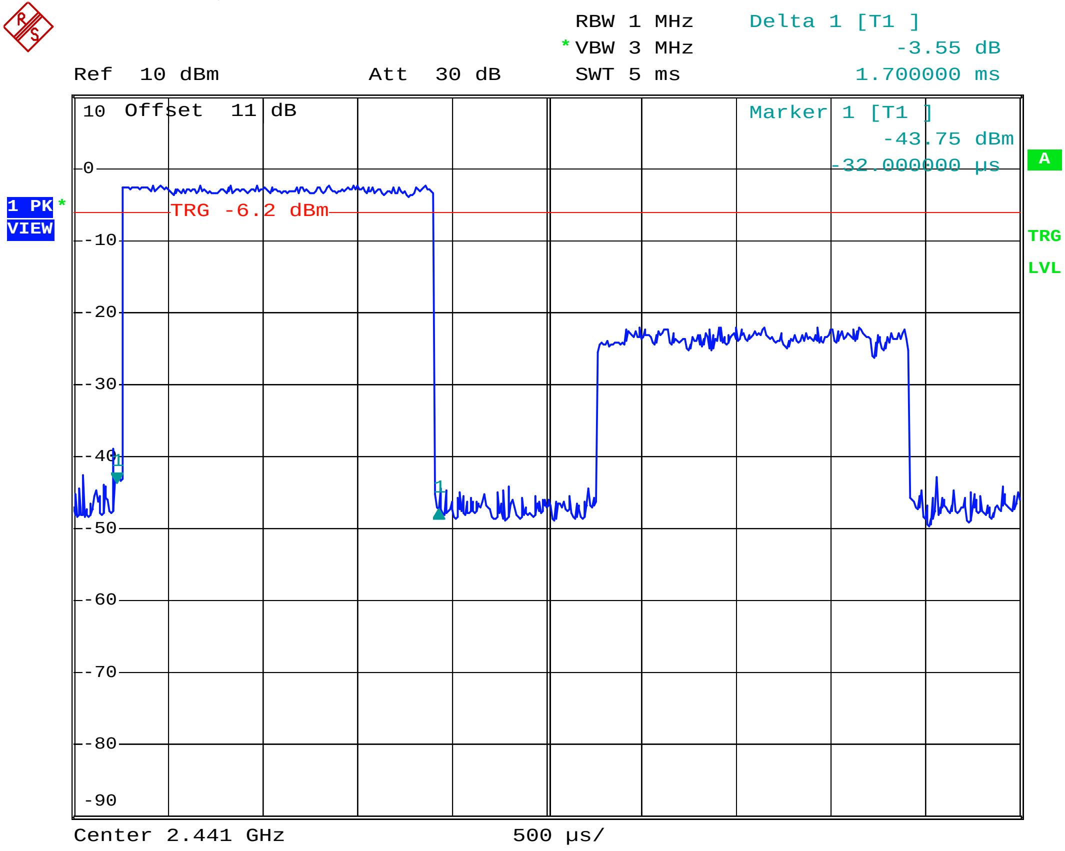
Channel High; DH1



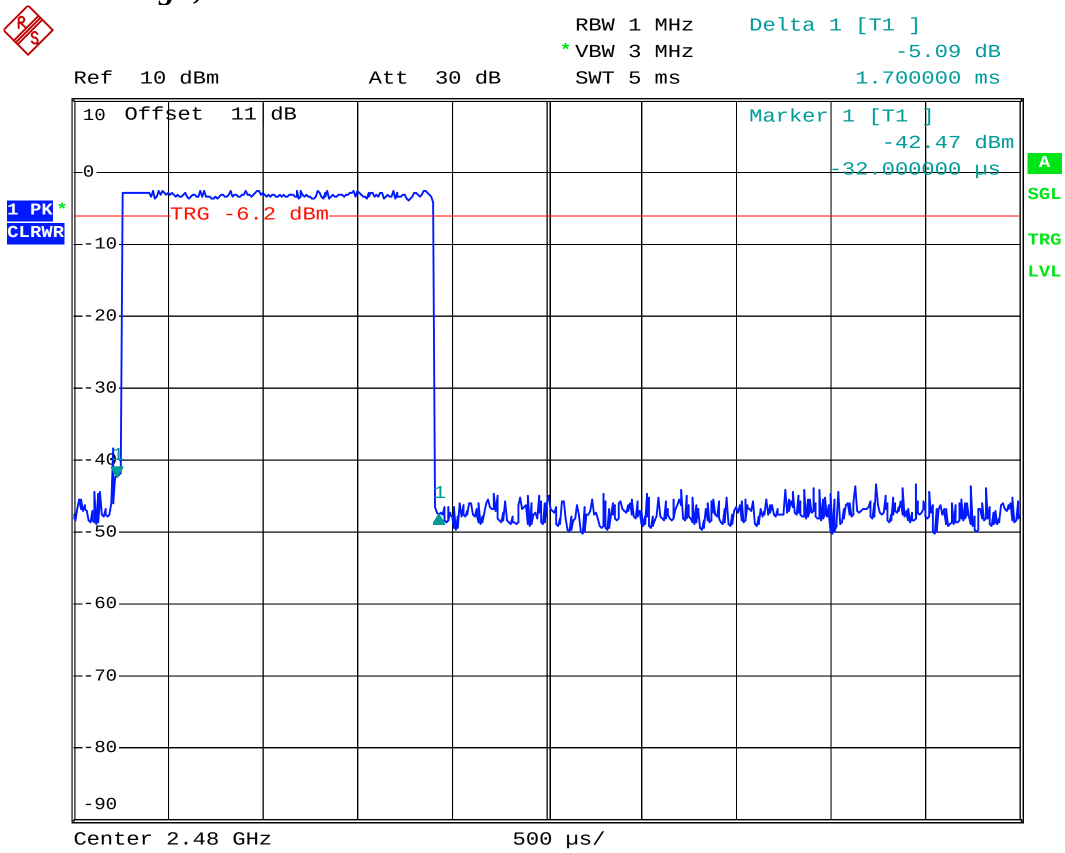
Channel Low; DH3



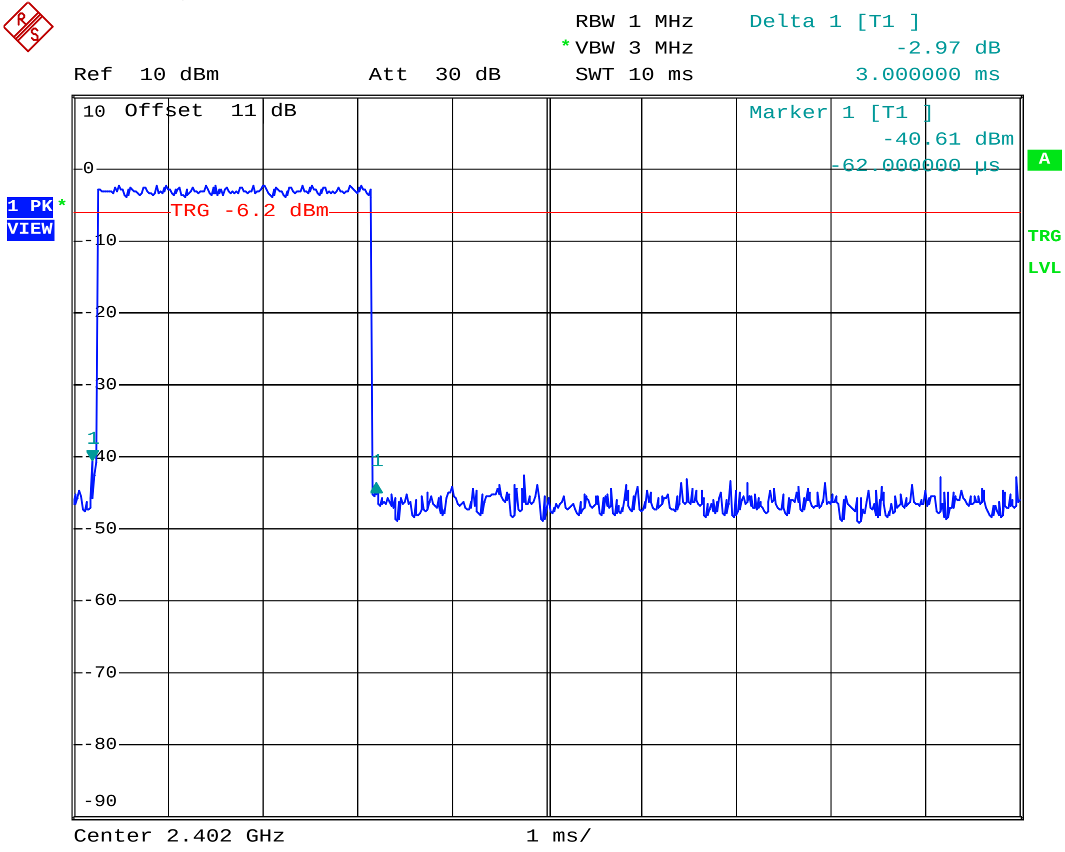
Channel Middle; DH3



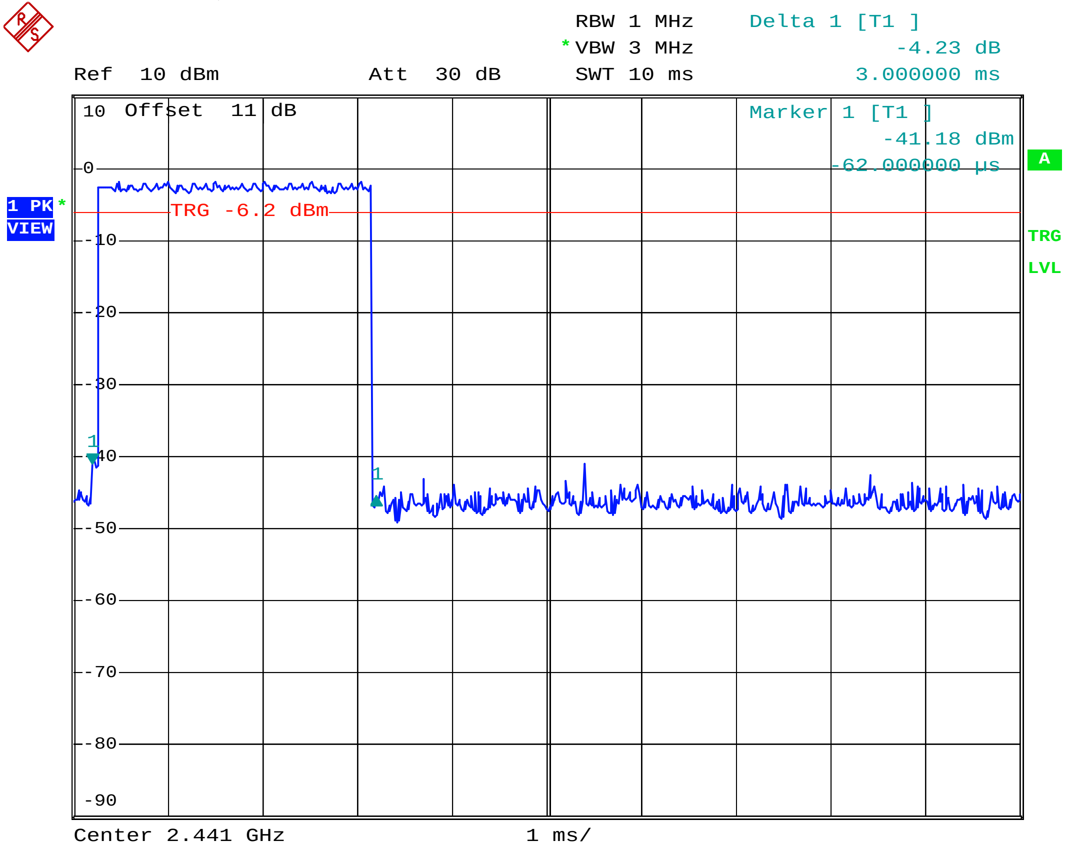
Channel High; DH3


RBW 1 MHz
*VBW 3 MHz
SWT 5 ms
Delta 1 [T1]
-5.09 dB
1.700000 ms
Ref 10 dBm
Att 30 dB
Offset 11 dB
Marker 1 [T1]
-42.47 dBm
-32.000000 µs
1 PK
CLRWR
A
SGL
TRG
LVL
TRG -6.2 dBm
10
0
-10
-20
-30
-40
-50
-60
-70
-80
-90
1
Center 2.48 GHz
500 µs/

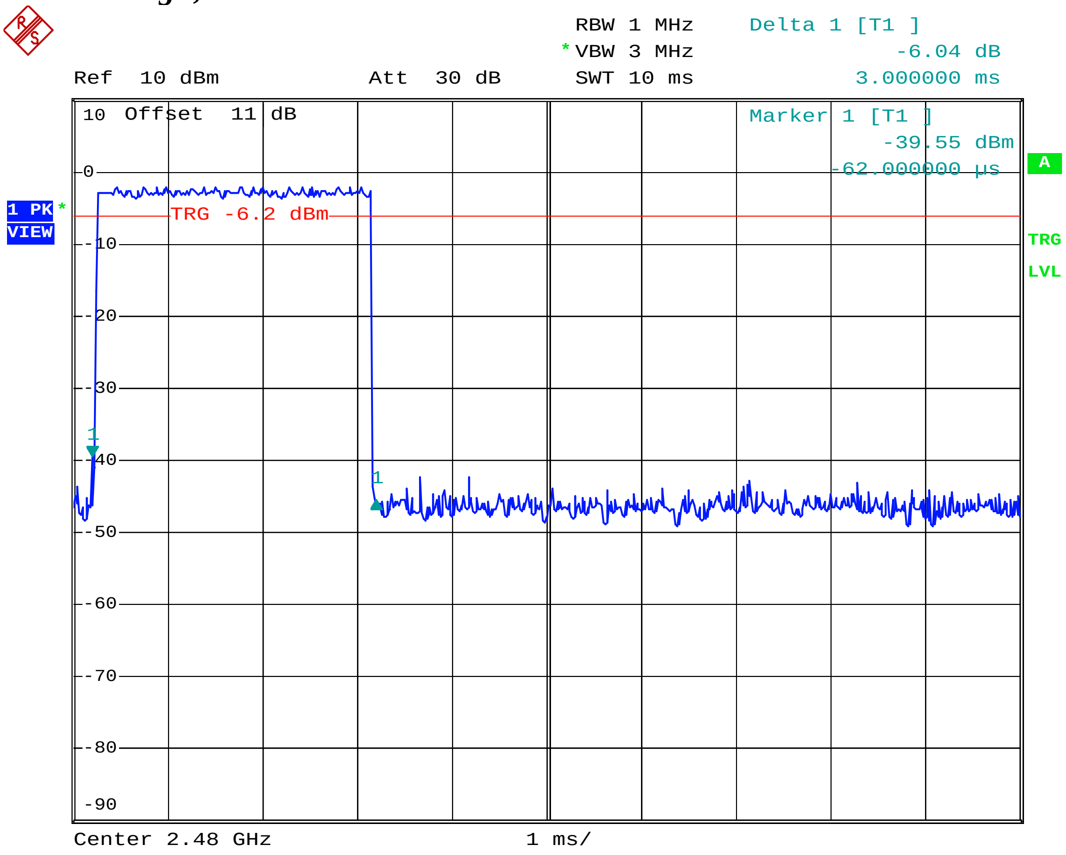
Channel Low; DH5



Channel Middle; DH5



Channel High; DH5



11 OUTPUT POWER MEASUREMENT

11.1 Standard Applicable

According to 15.247(b)(1), for frequency hopping systems operating in the 2400–2483.5 MHz band employing at least 75 non-overlapping hopping channels, and all frequency hopping systems in the 5725–5850 MHz band: 1 watt. For all other frequency hopping systems in the 2400–2483.5 MHz band: 0.125 watts.

11.2 Measurement Procedure

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 figure 4 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. Use the following spectrum analyzer settings:
   Span = approximately 5 times the 20 dB bandwidth, centered on a hopping channel
   RBW > the 20 dB bandwidth of the emission being measured
   VBW ≥ RBW
   Sweep = auto
   Detector function = peak
   Trace = max hold
4. Allow the trace to stabilize. Use the marker-to-peak function to set the marker to the peak of the emission. The indicated level is the peak output power. Plot the result on the screen of spectrum analyzer.
5. Repeat above procedures until all frequencies measured were complete.

11.3 Measurement Equipment

Equipment	Manufacturer	Model No.	Calibration Date	Next Cal. Date
Spectrum Analyzer	Rohde & Schwarz	FSP40	2016/10/03	2017/10/02
Attenuator	MINI-CIRCUITS	BW-S10W2+	2016/09/30	2017/09/29
Attenuator	MINI-CIRCUITS	BW-S20W2+	2016/09/30	2017/09/29
Attenuator	MINI-CIRCUITS	BW-S30W2+	2016/09/30	2017/09/29

11.4 Measurement Data

Test Date : Oct. 20, 2016 Temperature : 24 °C Humidity : 60 %

Mode: Bluetooth BR

a)	Channel Low	: Output Peak Power is	-3.91	dBm or	0.406	mW。
b)	Channel Middle	: Output Peak Power is	-3.44	dBm or	0.453	mW。
c)	Channel High	: Output Peak Power is	-2.65	dBm or	0.543	mW。

Mode: Bluetooth EDR

a)	Channel Low	: Output Peak Power is	-1.59	dBm or	0.693	mW。
b)	Channel Middle	: Output Peak Power is	-1.25	dBm or	0.750	mW。
c)	Channel High	: Output Peak Power is	-1.37	dBm or	0.729	mW。

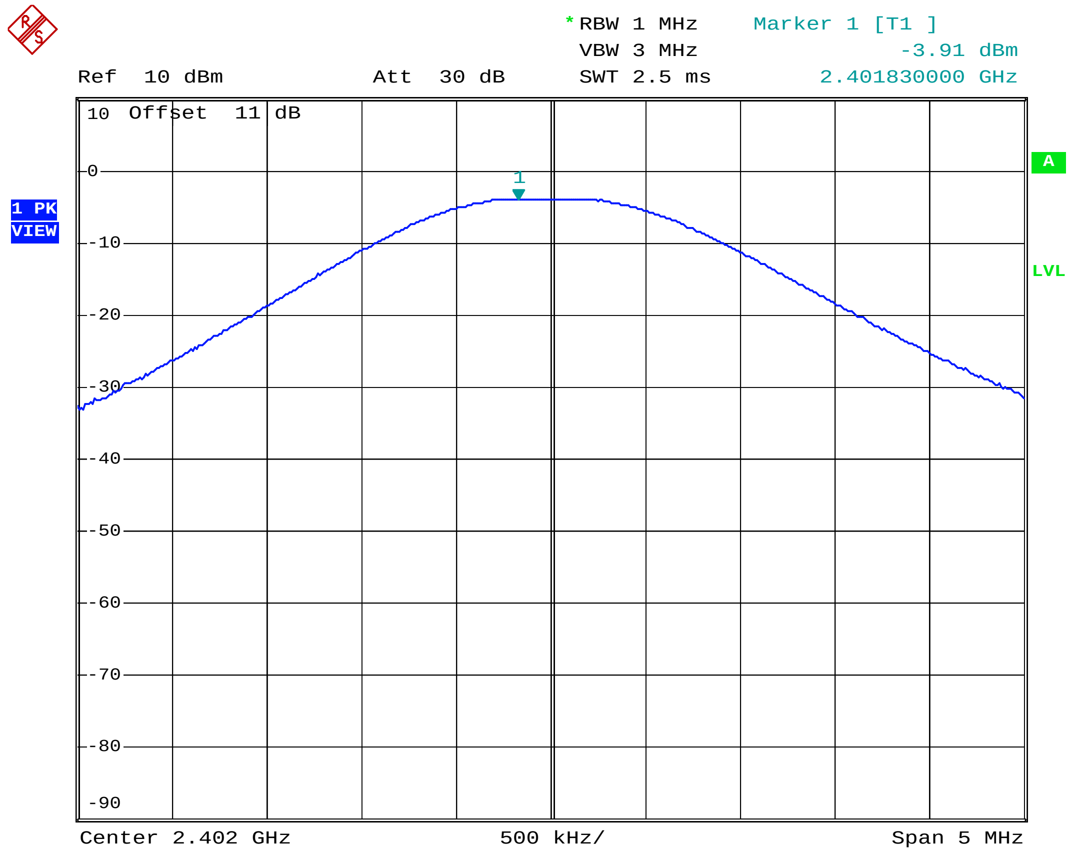
Justification on AFH mode:

Adaptive Frequency Hopping (AFH) means that a device can hop over a reduced set of frequencies. The frequencies hopped may reduced in AFH mode but at least 15 channels will be used. Hence the output power limit is 125mW.

Note : The expanded uncertainty: 2dB.

Mode: Bluetooth BR

Channel Low



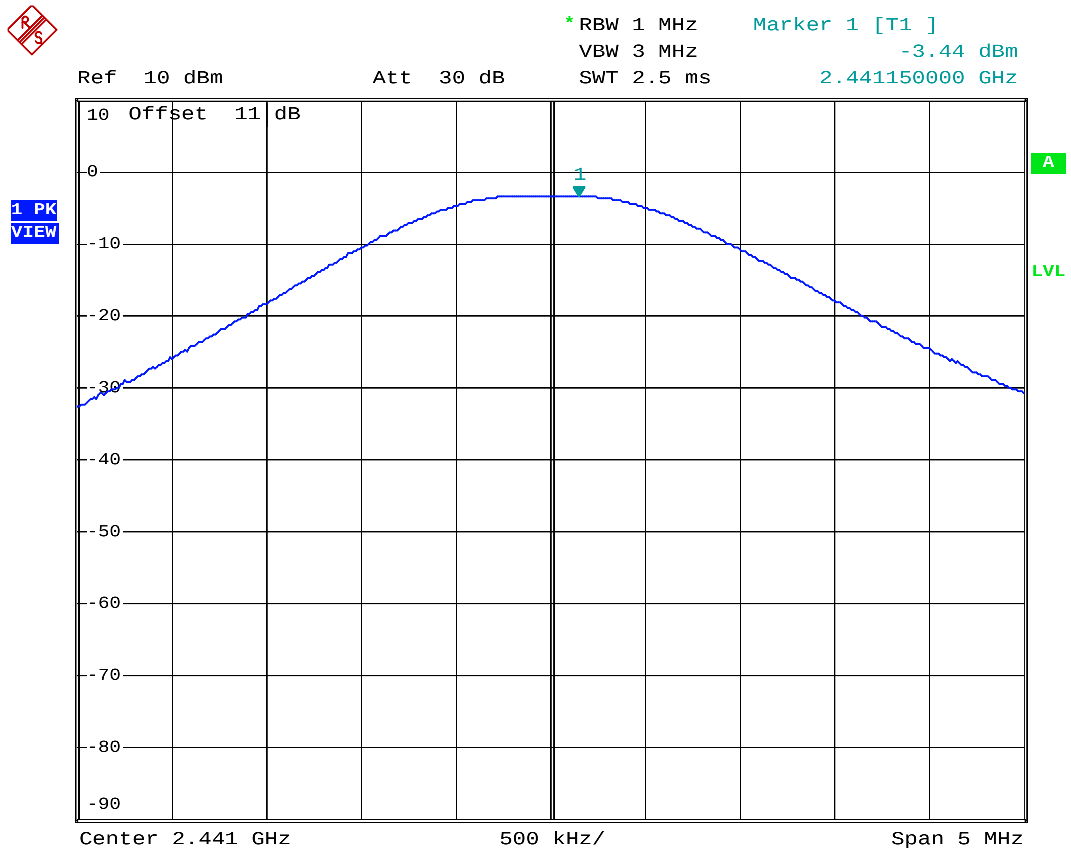
*RBW 1 MHz Marker 1 [T1]
VBW 3 MHz -3.91 dBm
Ref 10 dBm Att 30 dB SWT 2.5 ms 2.401830000 GHz

Offset 11 dB

Center 2.402 GHz 500 kHz/ Span 5 MHz

1 PK
VIEW
A
LVL
1
10
0
-10
-20
-30
-40
-50
-60
-70
-80
-90

Channel Middle



*RBW 1 MHz
VBW 3 MHz
SWT 2.5 ms

Marker 1 [T1]
-3.44 dBm
2.441150000 GHz

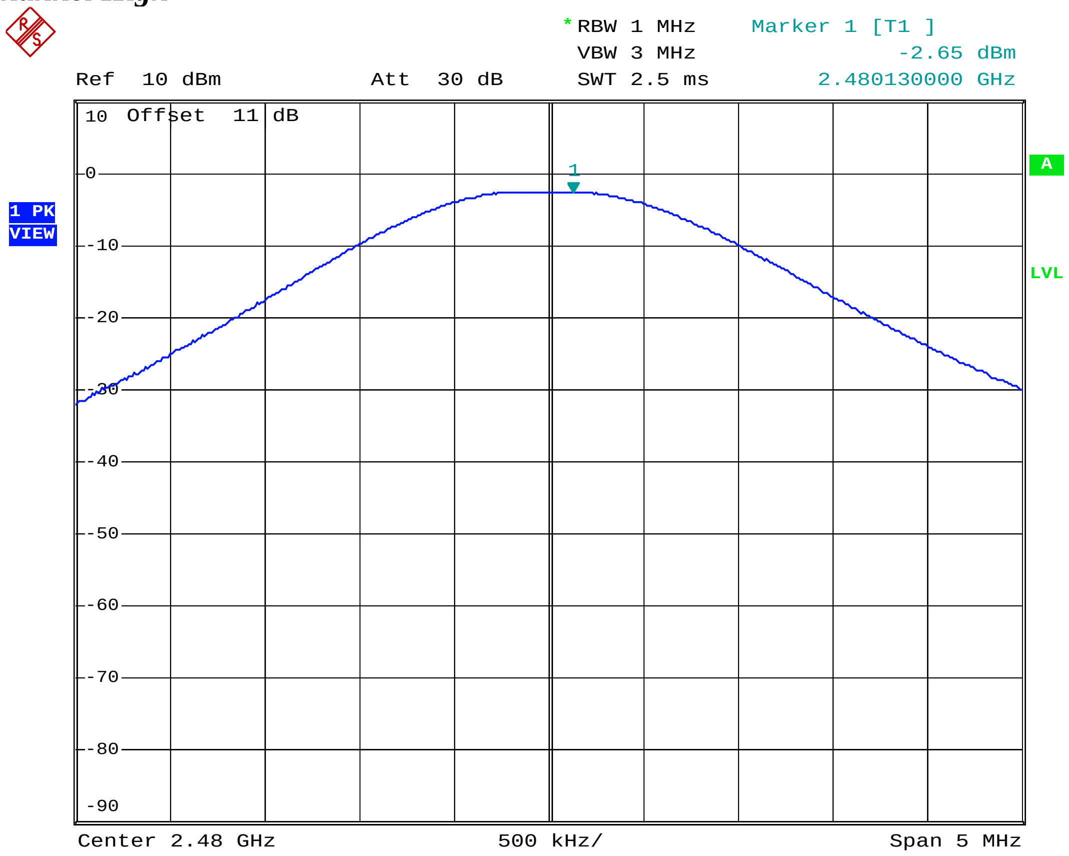
Ref 10 dBm
Att 30 dB

Offset 11 dB

Center 2.441 GHz
500 kHz/
Span 5 MHz

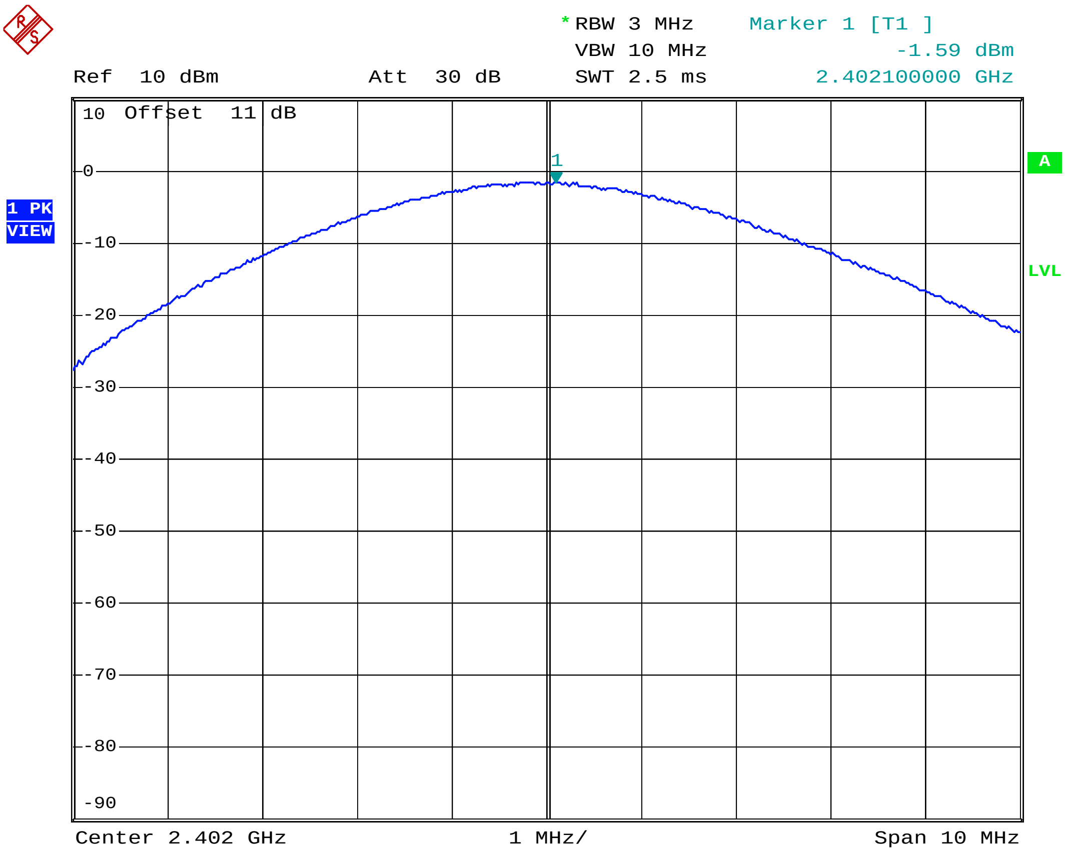
1 PK
VIEW
A
LVL
1
10
0
-10
-20
-30
-40
-50
-60
-70
-80
-90

Channel High

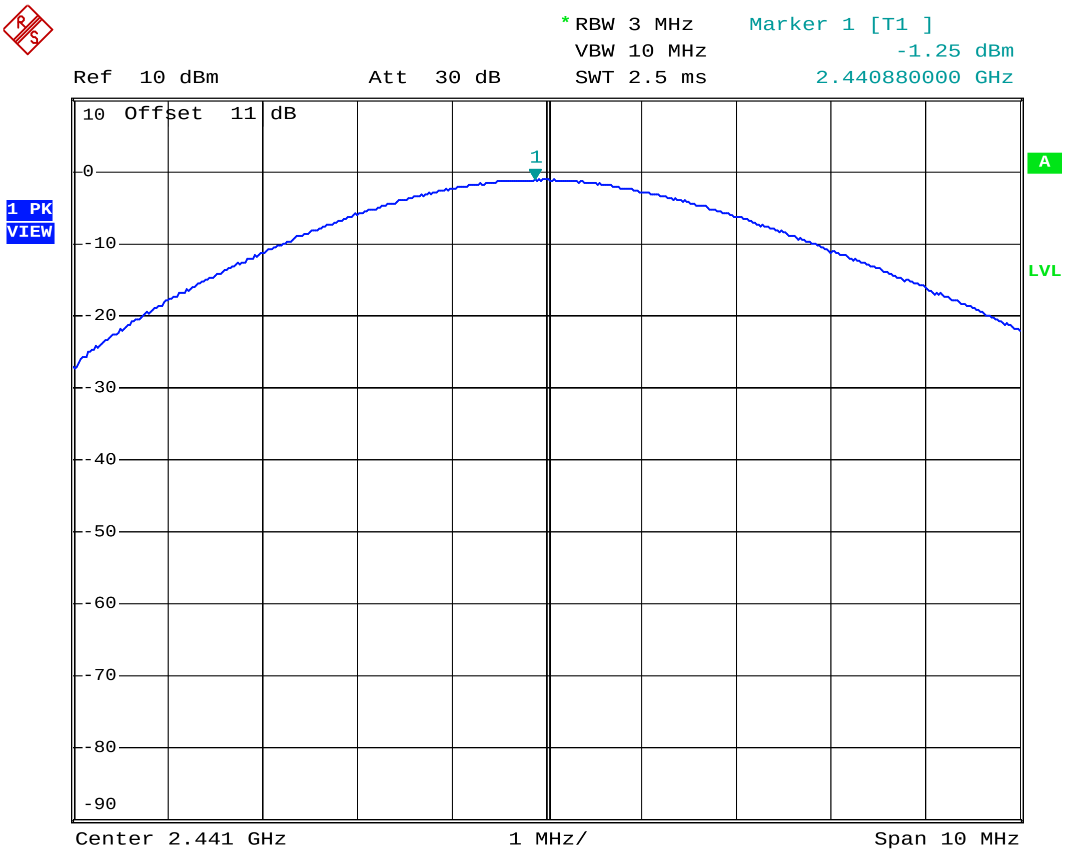


Mode: Bluetooth EDR

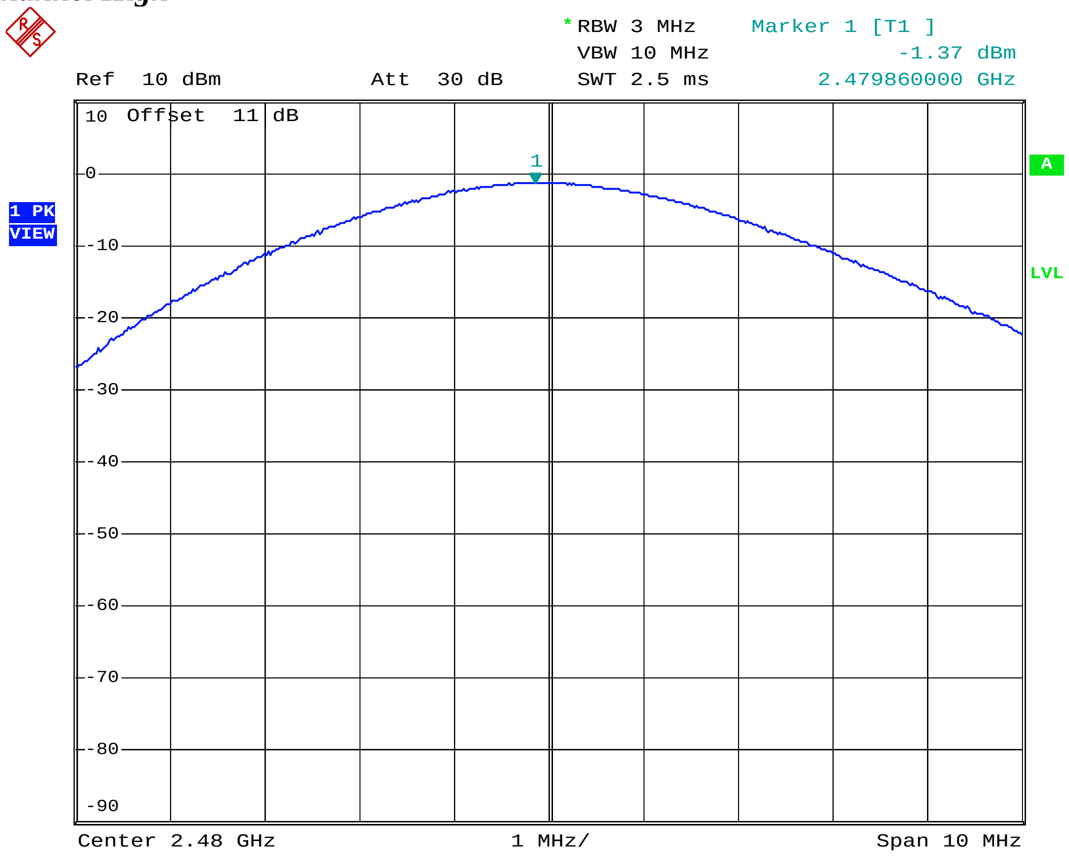
Channel Low


*RBW 3 MHz
VBW 10 MHz
SWT 2.5 ms
Marker 1 [T1]
-1.59 dBm
2.402100000 GHz
Ref 10 dBm
Att 30 dB
10 Offset 11 dB
0
-10
-20
-30
-40
-50
-60
-70
-80
-90
1
A
LVL
1 PK
VIEW
Center 2.402 GHz
1 MHz/
Span 10 MHz

Channel Middle



Channel High



12 100 kHz BANDWIDTH OF BAND EDGES MEASUREMENT

12.1 Standard Applicable

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 §15.209(a) is not required.

12.2 Measurement Procedure

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 figure 4 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. Use the following spectrum analyzer settings:
   Span = wide enough to capture the peak level of the emission operating on the channel closest to the bandedge, as well as any modulation products which fall outside of the authorized band of operation
   RBW ≥ 1% of the span
   VBW ≥ RBW
   Sweep = auto
   Detector function = peak
   Trace = max hold
4. Allow the trace to stabilize. Set the marker on the emission at the bandedge, or on the highest modulation product outside of the band, if this level is greater than that at the bandedge. Enable the marker-delta function, then use the marker-to-peak function to move the marker to the peak of the in-band emission. Plot the result on the screen of spectrum analyzer.
5. Repeat above procedures until all measured frequencies were complete.

12.3 Measurement Equipment

Equipment	Manufacturer	Model No.	Calibration Date	Next Cal. Date
Spectrum Analyzer	Rohde & Schwarz	FSP40	2016/10/03	2017/10/02
Attenuator	MINI-CIRCUITS	BW-S10W2+	2016/09/30	2017/09/29
Attenuator	MINI-CIRCUITS	BW-S20W2+	2016/09/30	2017/09/29
Attenuator	MINI-CIRCUITS	BW-S30W2+	2016/09/30	2017/09/29

12.4 Measurement Data

Test Date : Oct. 20, 2016 Temperature : 24 °C Humidity : 60 %

Mode: Bluetooth BR

a) Lower Band Edge : All emissions in this 100kHz bandwidth are attenuated more than 20dB from the carrier.
b) Upper Band Edge : All emissions in this 100kHz bandwidth are attenuated more than 20dB from the carrier.

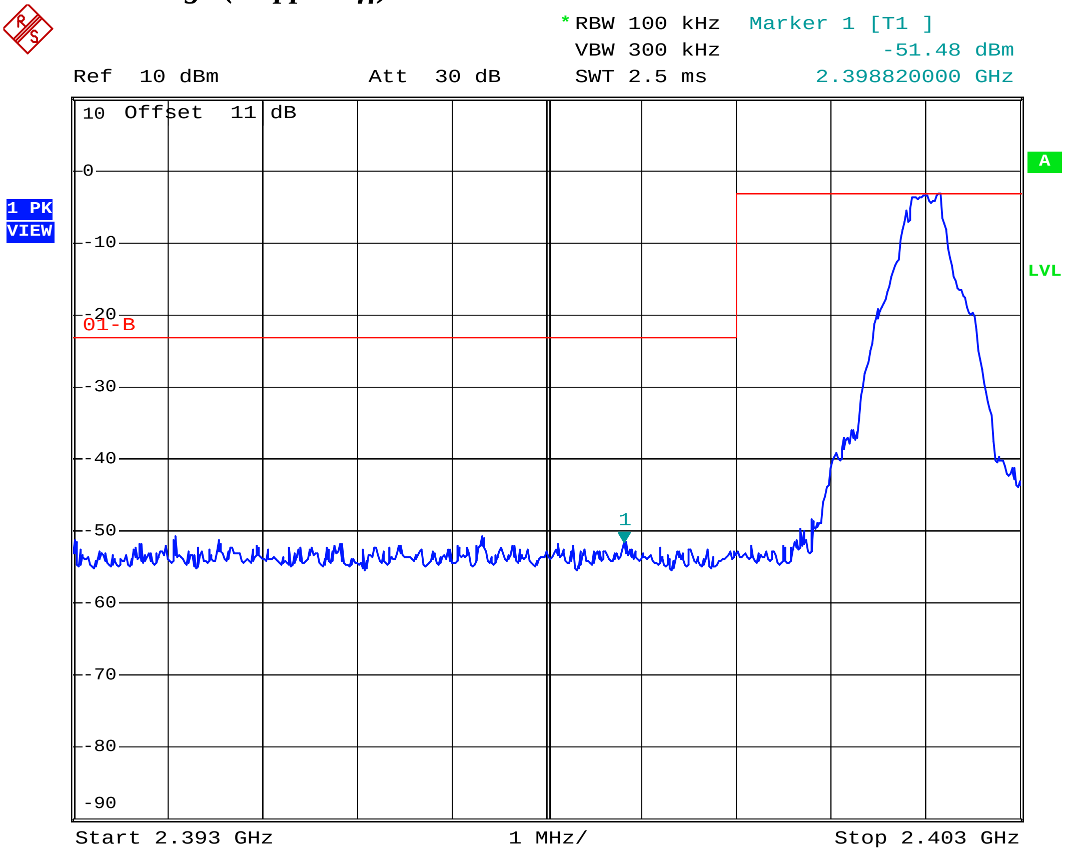
Mode: Bluetooth EDR

a) Lower Band Edge : All emissions in this 100kHz bandwidth are attenuated more than 20dB from the carrier.
b) Upper Band Edge : All emissions in this 100kHz bandwidth are attenuated more than 20dB from the carrier.

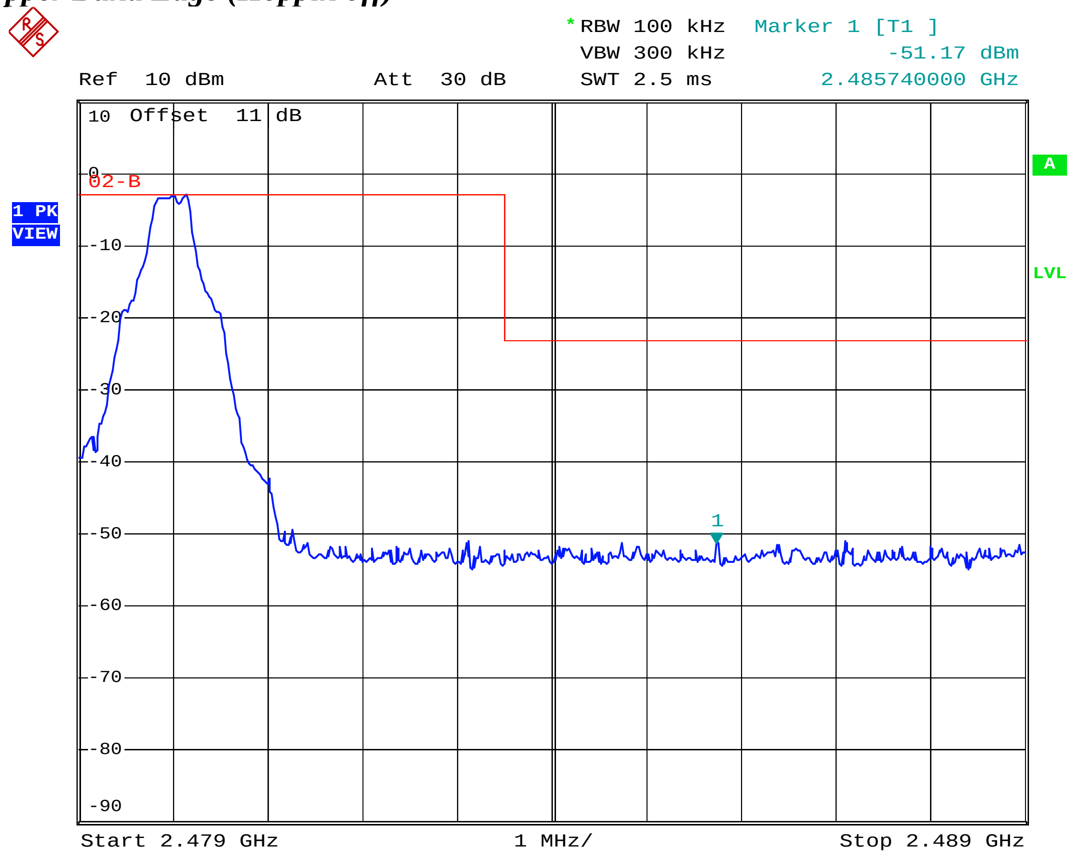
Note : The expanded uncertainty: 2dB.

Mode: Bluetooth BR

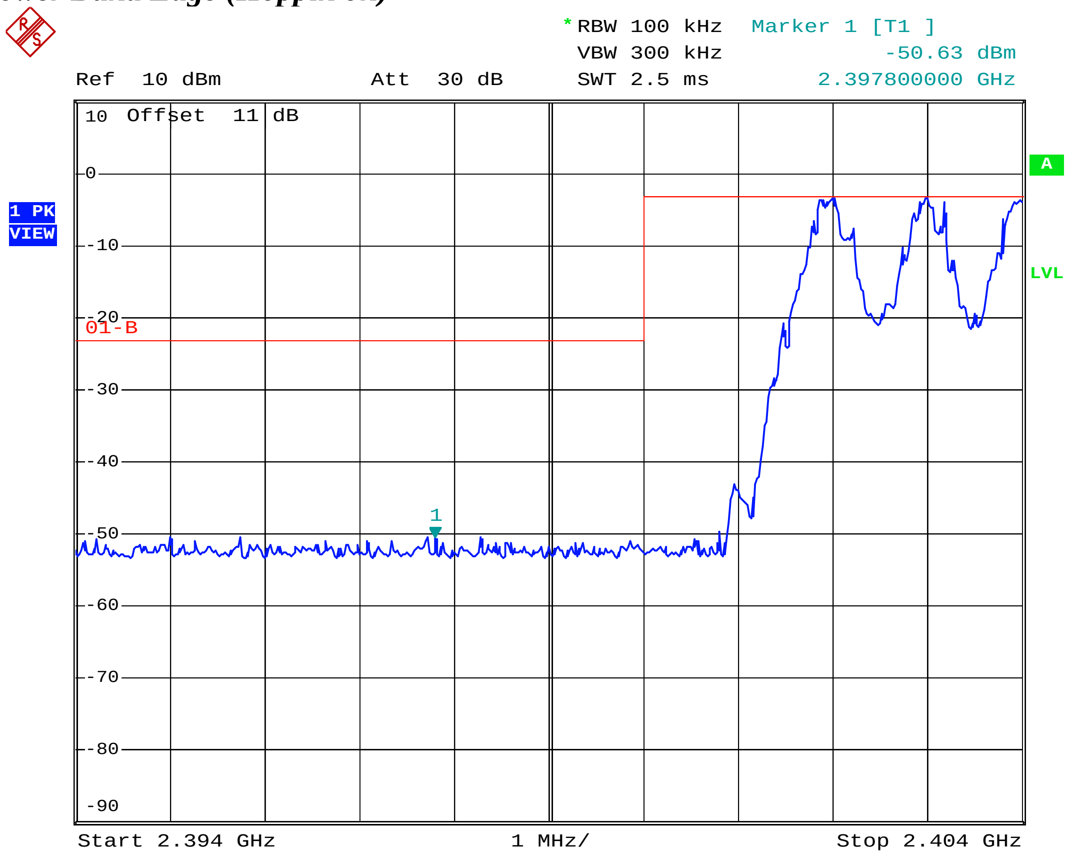
Lower Band Edge (Hoppin off)



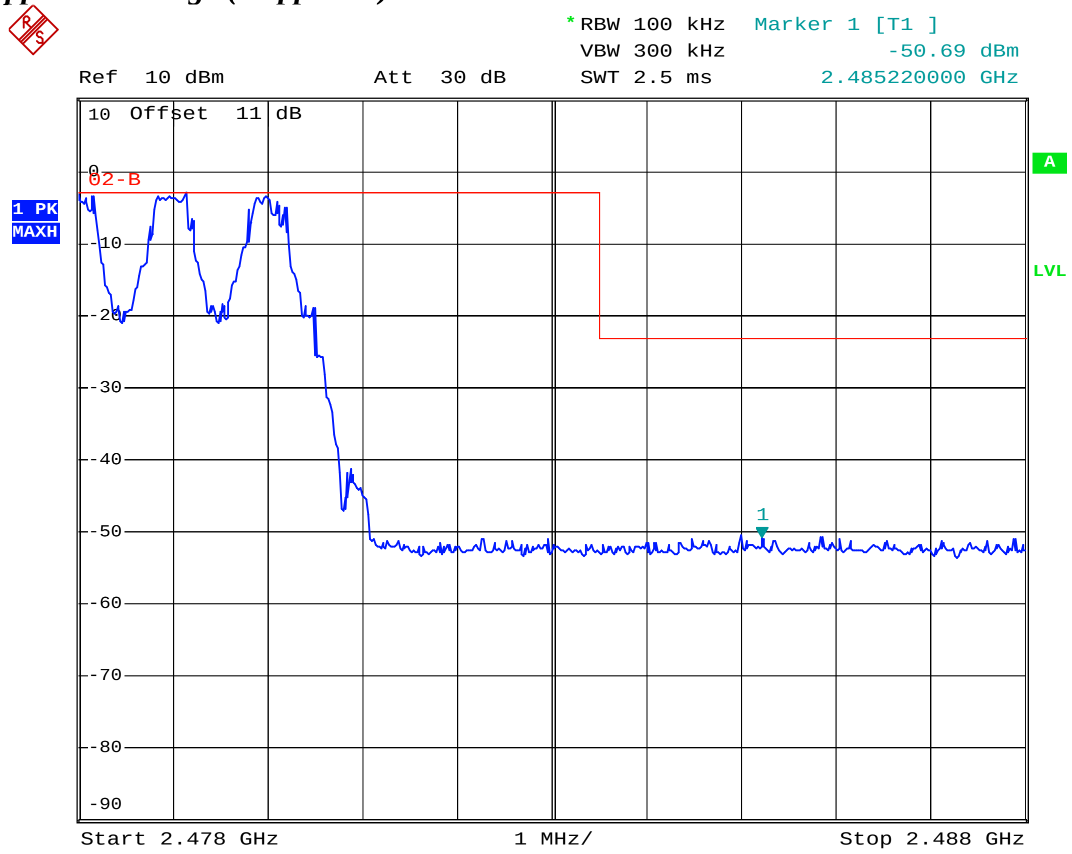
Upper Band Edge (Hoppin off)



Lower Band Edge (Hoppin on)

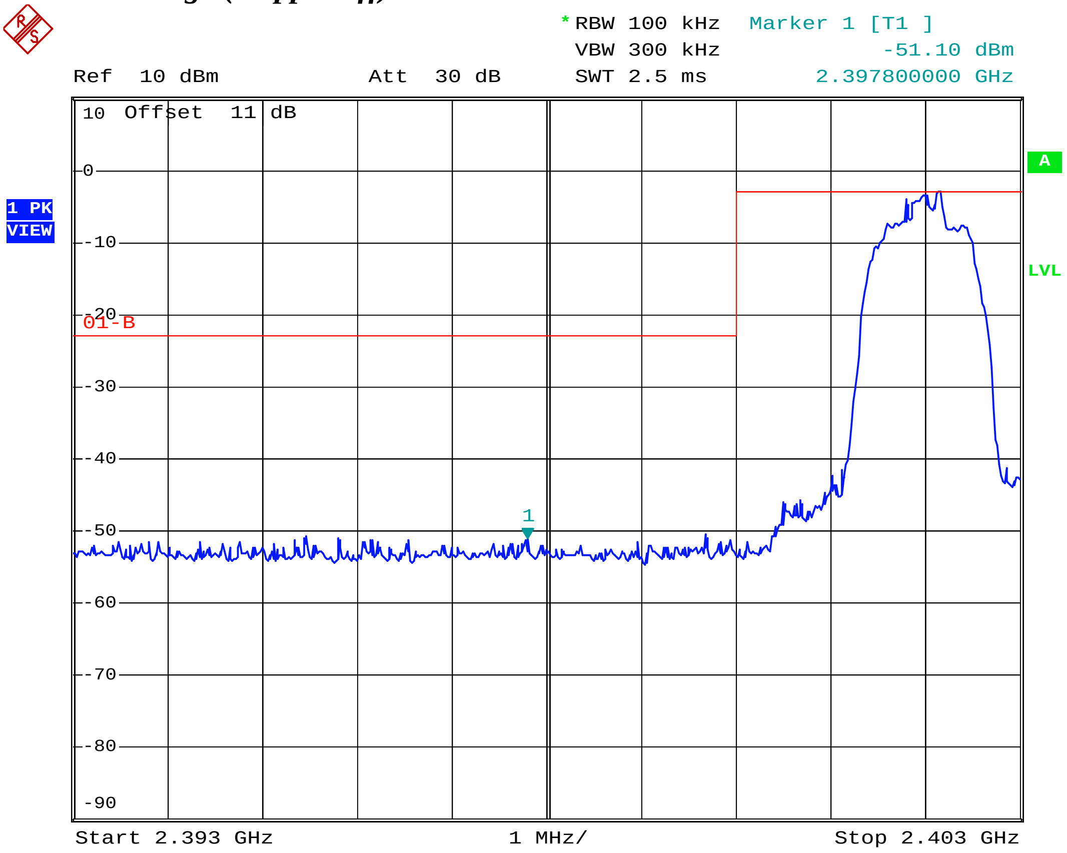


Upper Band Edge (Hoppin on)

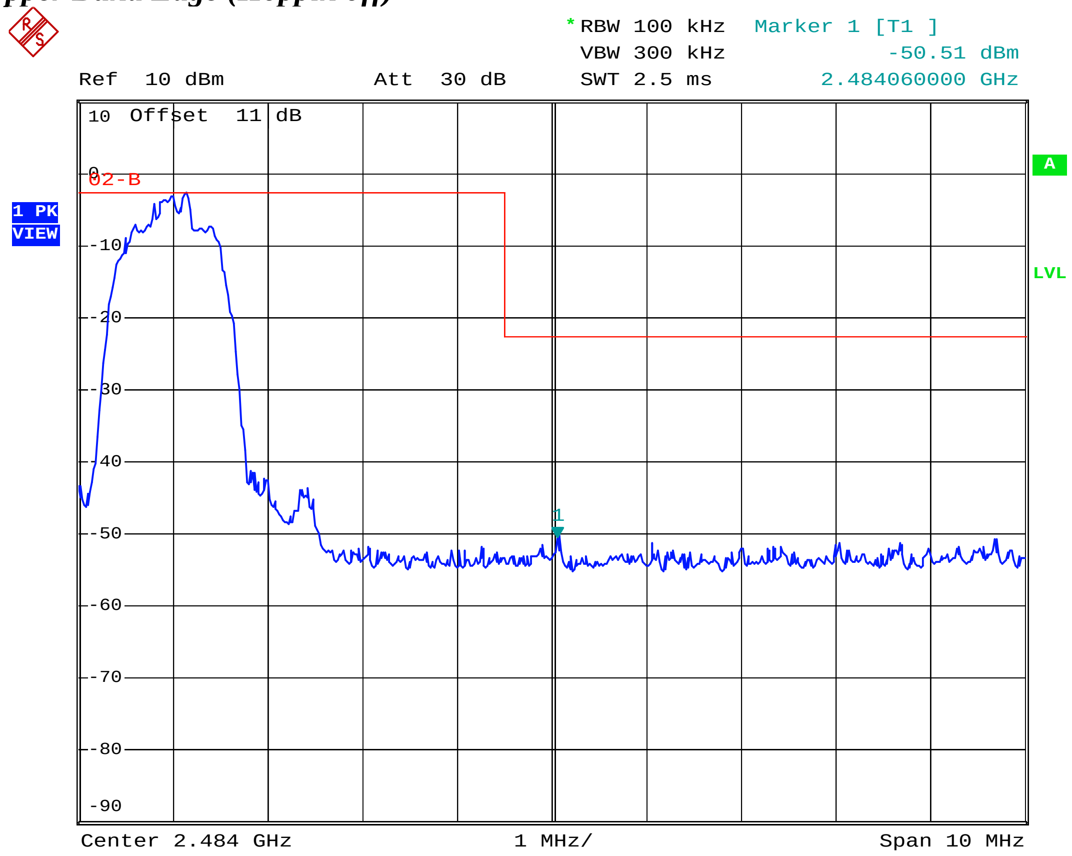


Mode: Bluetooth EDR

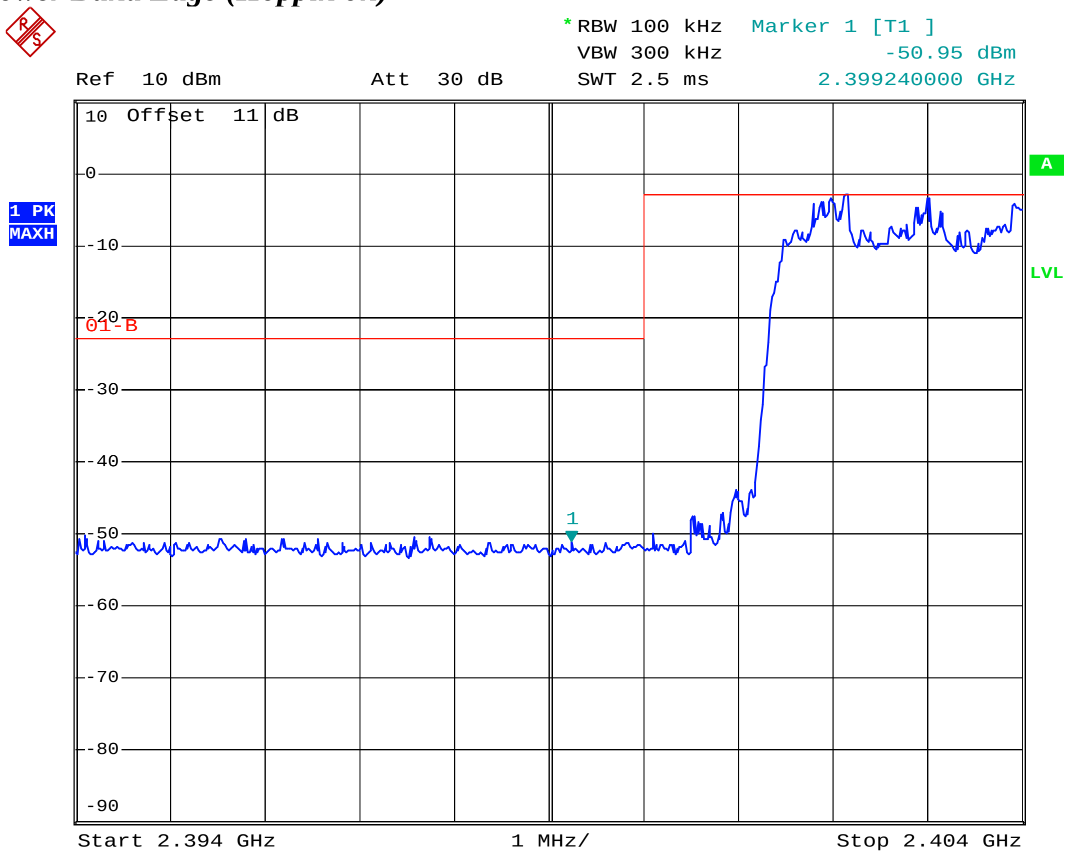
Lower Band Edge (Hoppin off)



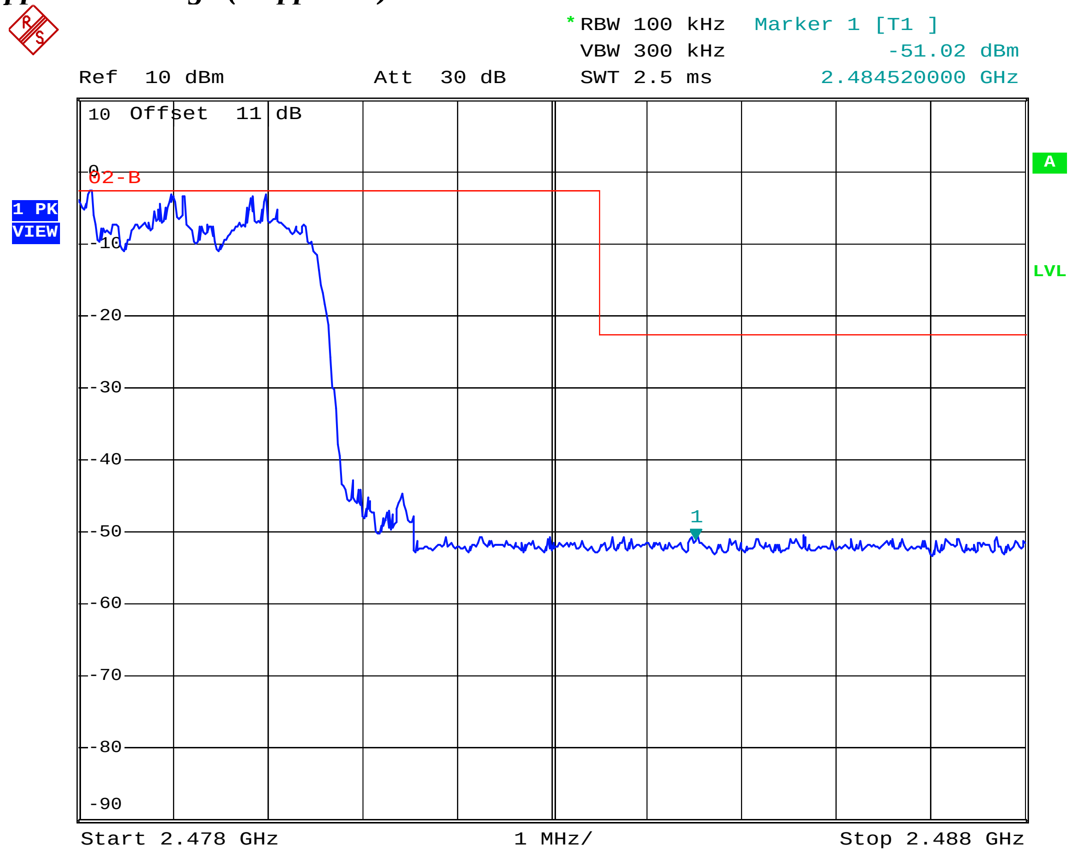
Upper Band Edge (Hoppin off)



Lower Band Edge (Hoppin on)



Upper Band Edge (Hoppin on)



13 CONDUCTED SPURIOUS EMISSION MEASUREMENT

13.1 Standard Applicable

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 §15.209(a) is not required.

13.2 Measurement Procedure

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 figure 4 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. Use the following spectrum analyzer settings:
   Span = wide enough to capture the peak level of the in-band emission and all spurious emissions (e.g., harmonics) from the lowest frequency generated in the EUT up through the 10th harmonic. Typically, several plots are required to cover this entire span.
   RBW = 100 kHz
   VBW ≥ RBW
   Sweep = auto
   Detector function = peak
   Trace = max hold.
4. Allow the trace to stabilize. Set the marker on the peak of any spurious emission recorded. Plot the result on the screen of spectrum analyzer.
5. Repeat above procedures until all measured frequencies were complete.

13.3 Measurement Equipment

Equipment	**Manufacturer**	**Model No.**	**Calibration Date**	**Next Cal. Date**
Spectrum Analyzer	Rohde & Schwarz	FSP40	2016/10/03	2017/10/02
Attenuator	MINI-CIRCUITS	BW-S10W2+	2016/09/30	2017/09/29
Attenuator	MINI-CIRCUITS	BW-S20W2+	2016/09/30	2017/09/29
Attenuator	MINI-CIRCUITS	BW-S30W2+	2016/09/30	2017/09/29

13.4 Measurement Data

Test Date : Oct. 20, 2016 Temperature : 24 °C Humidity : 60 %

Mode: Bluetooth BR
Mode : Low Channel/ Mid Channel/ Hi Channel

a) 1 GHz to 26.5 GHz frequency band: All emissions are attenuated more than 20dB from the carrier.

Mode: Bluetooth EDR

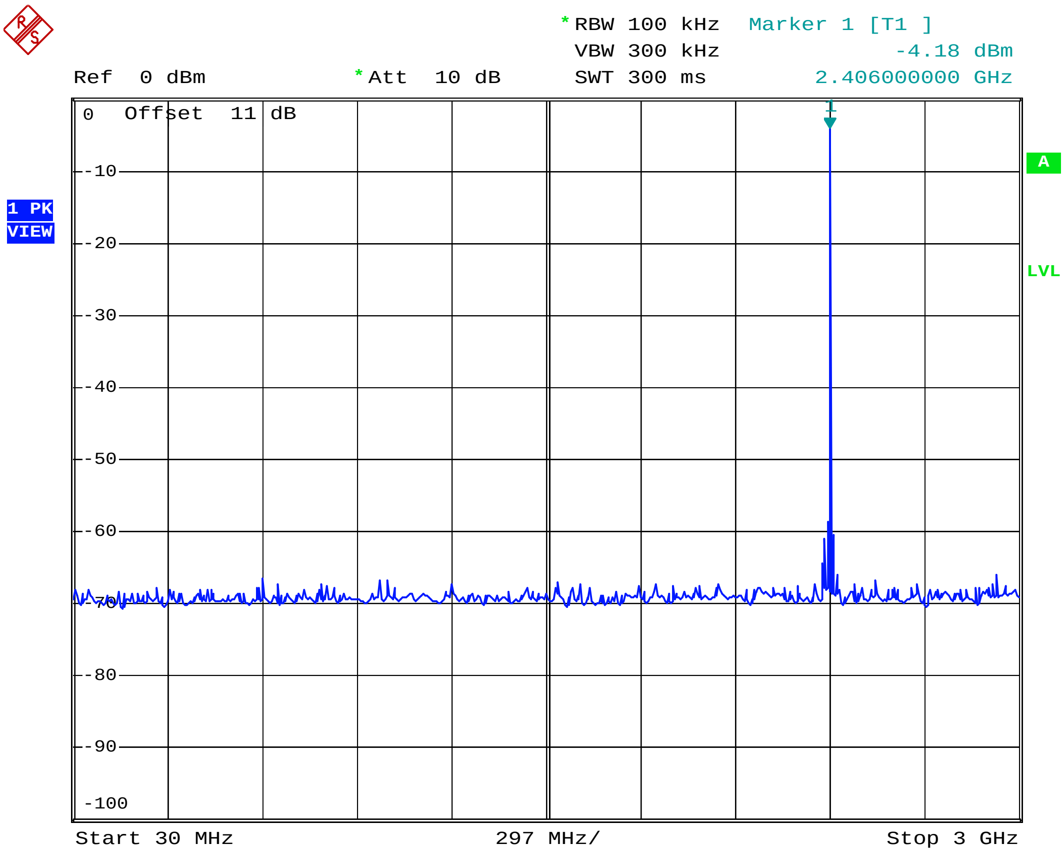
Mode : Low Channel/ Mid Channel/ Hi Channel

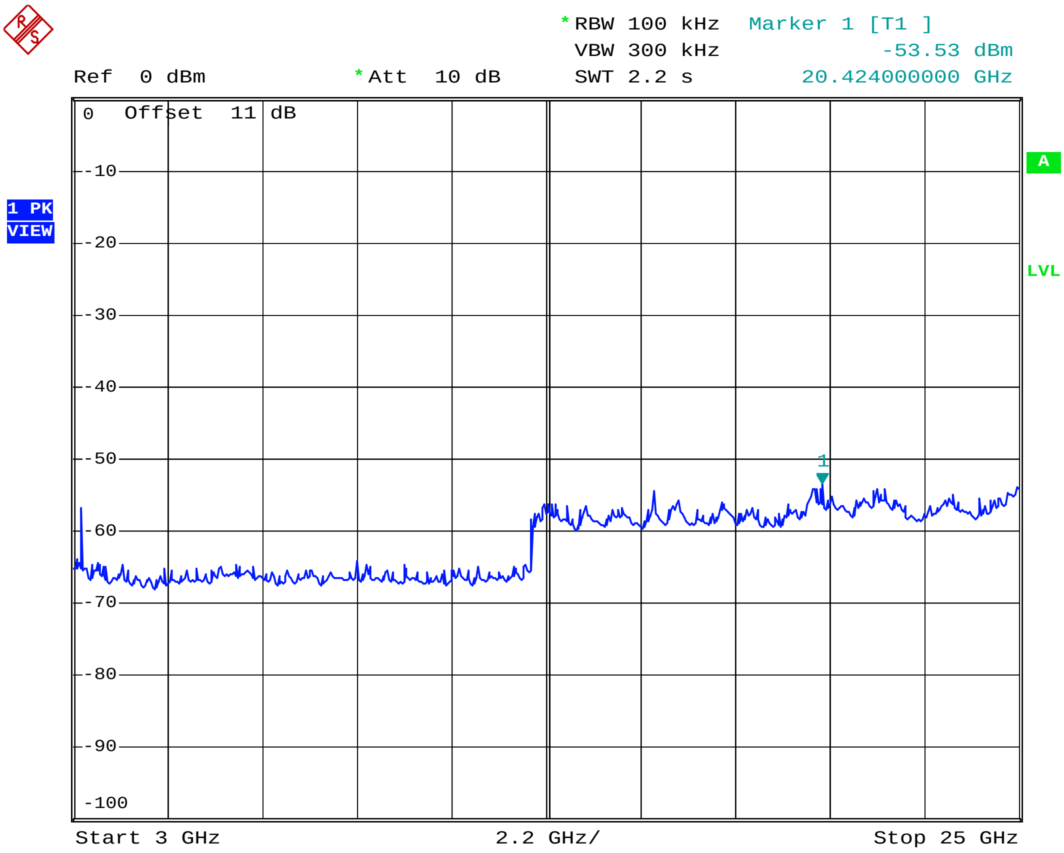
a) 1 GHz to 26.5 GHz frequency band: All emissions are attenuated more than 20dB from the carrier.

Note : The expanded uncertainty: 2dB.

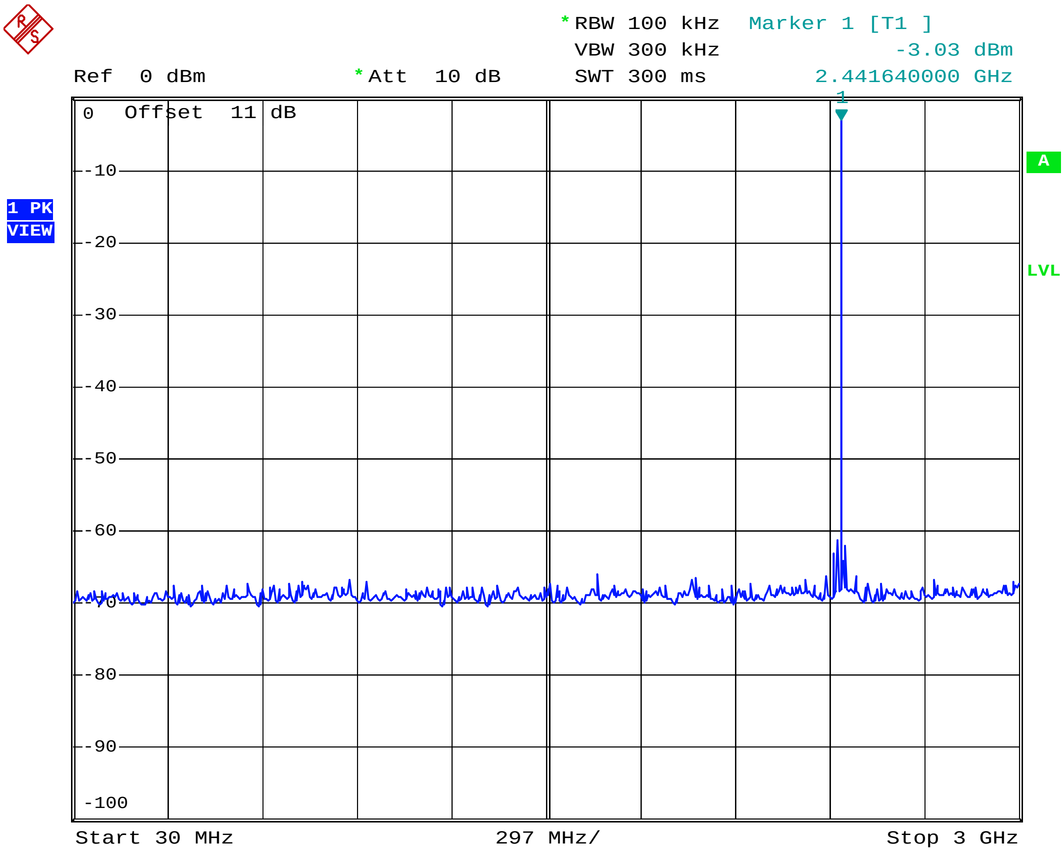
Mode: Bluetooth BR

Mode : Low Channel

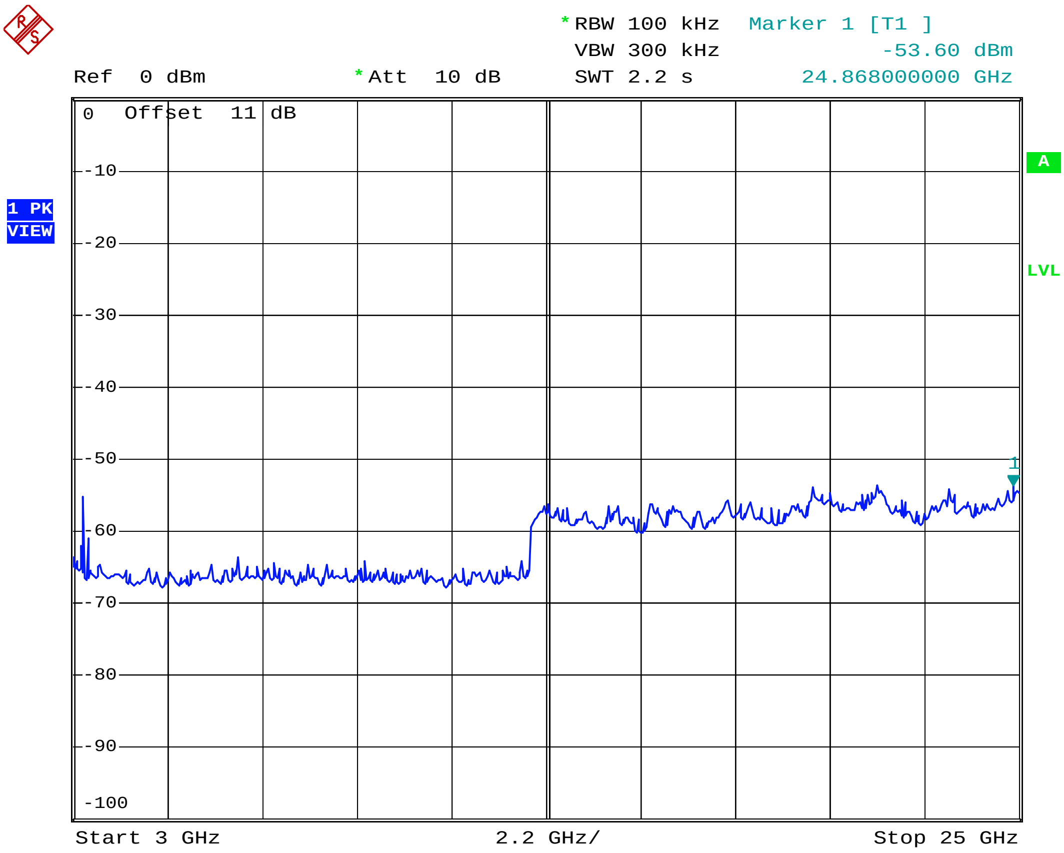




Mode : Mid Channel

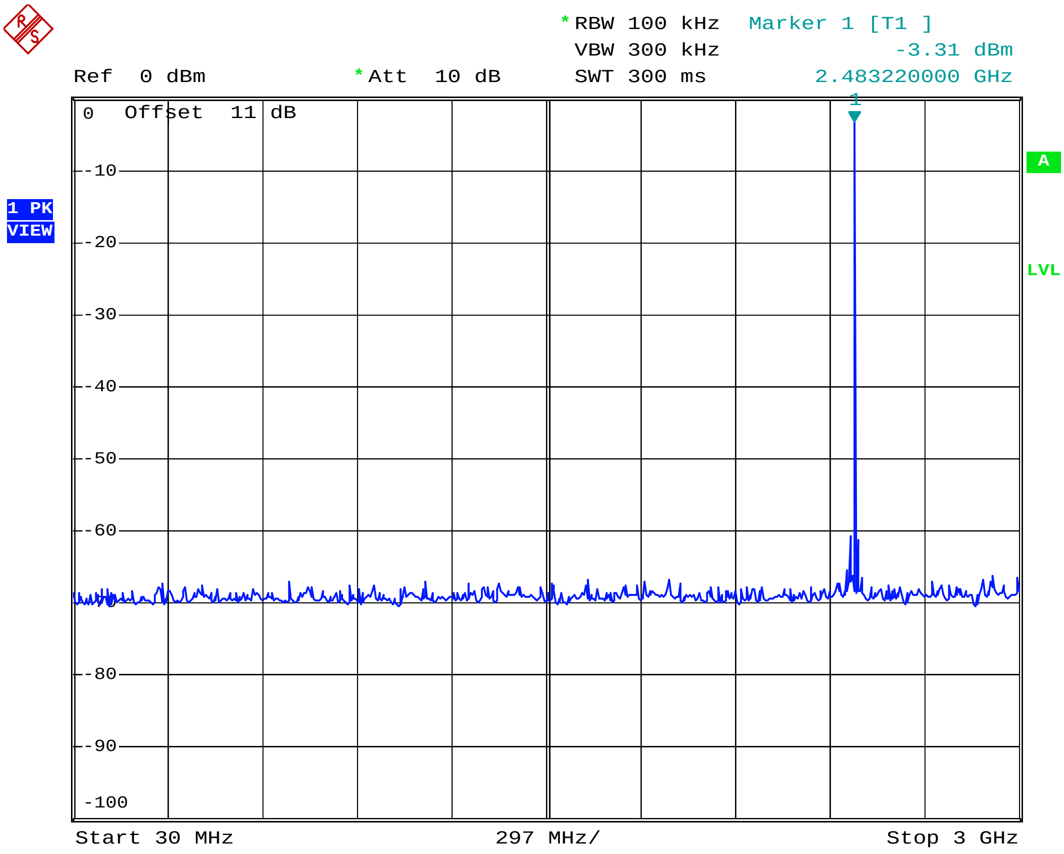


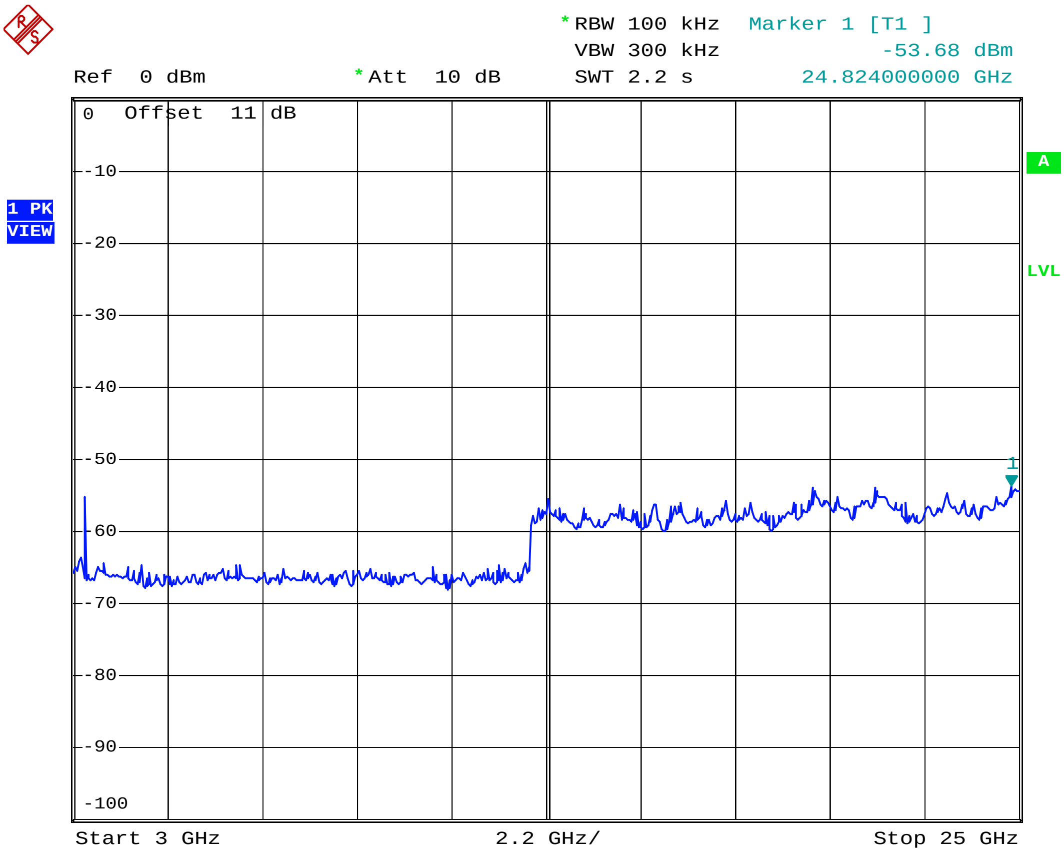
*RBW 100 kHz
VBW 300 kHz
SWT 300 ms
Ref 0 dBm
*Att 10 dB
Offset 11 dB
Marker 1 [T1]
-3.03 dBm
2.441640000 GHz



*RBW 100 kHz
VBW 300 kHz
SWT 2.2 s
Ref 0 dBm
*Att 10 dB
Offset 11 dB
Marker 1 [T1]
-53.60 dBm
24.868000000 GHz

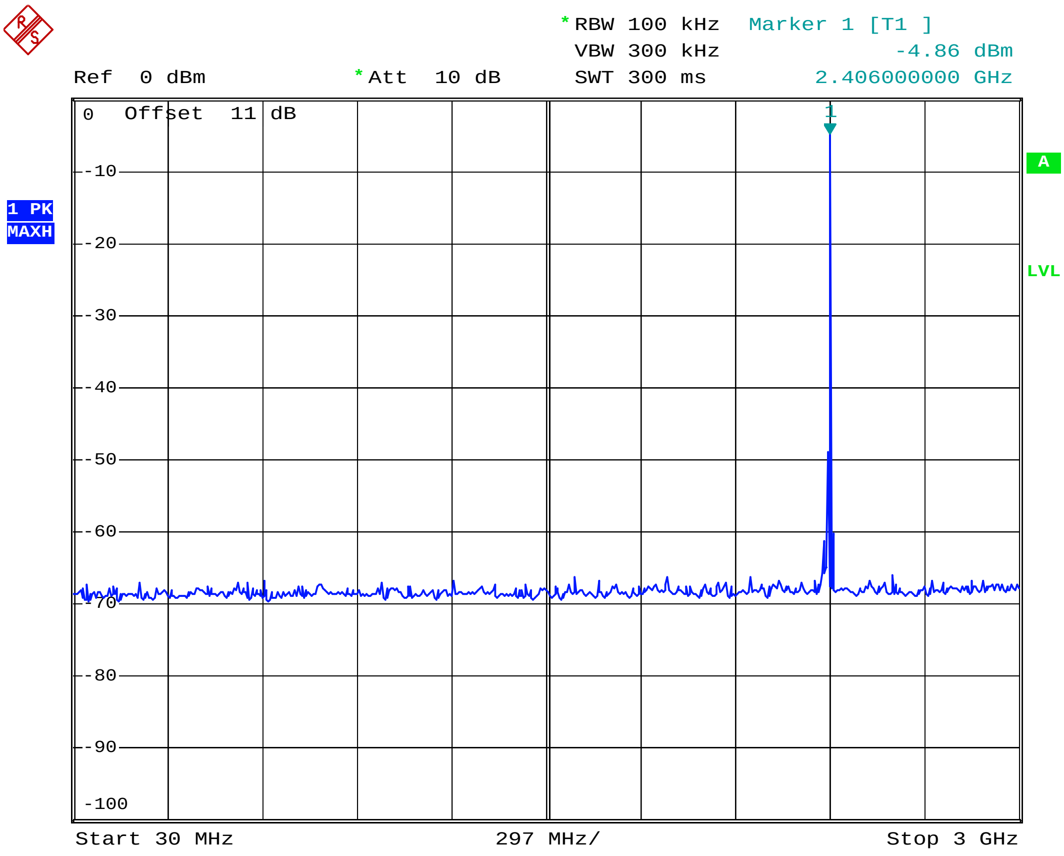
Mode : Hi Channel

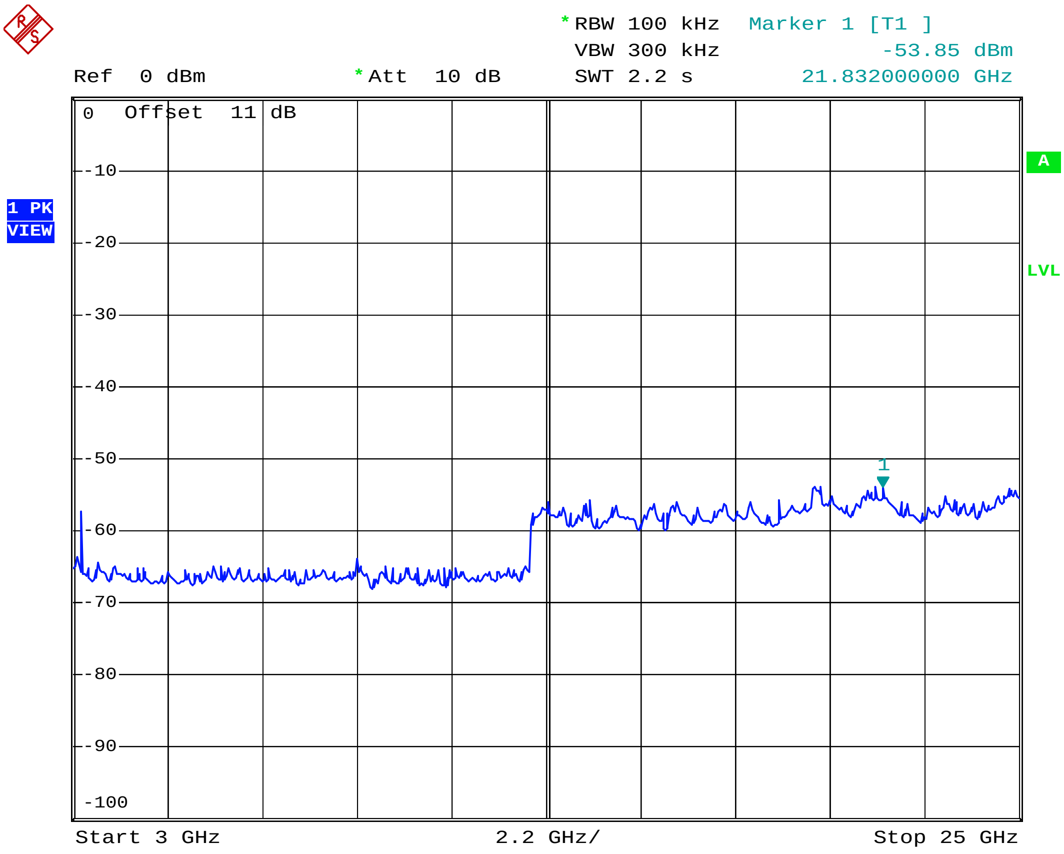




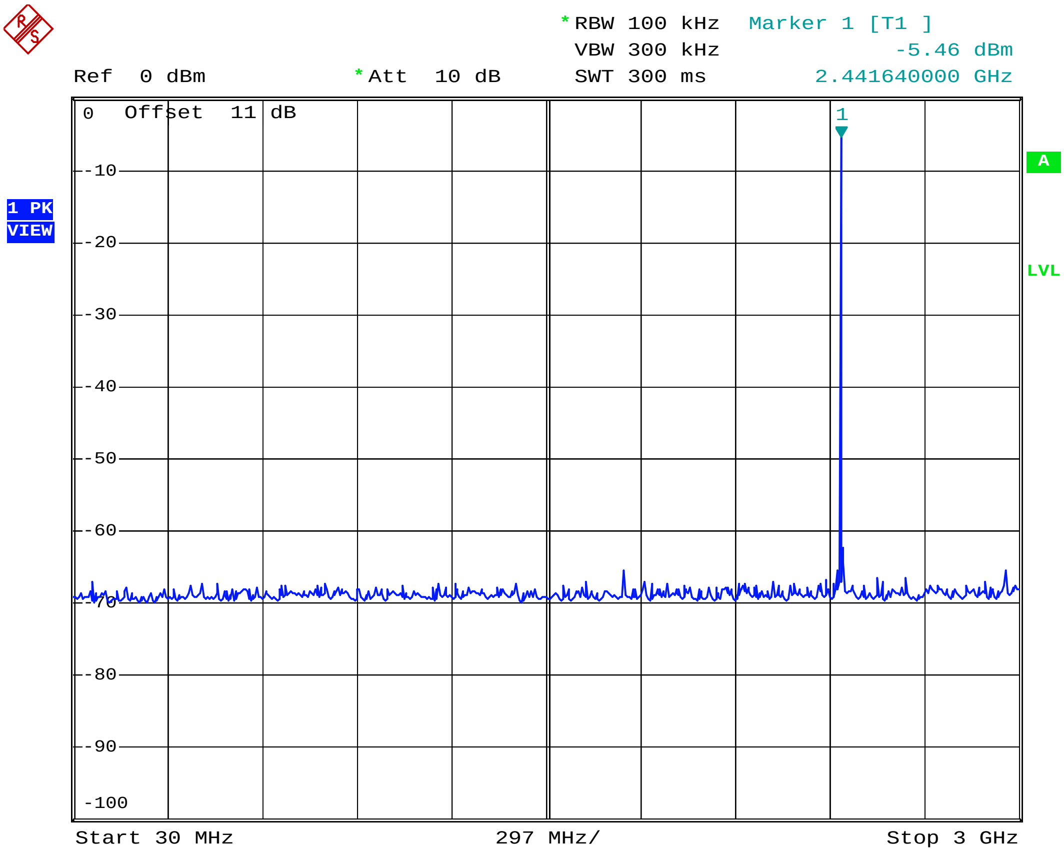
Mode: Bluetooth EDR

Mode : Low Channel

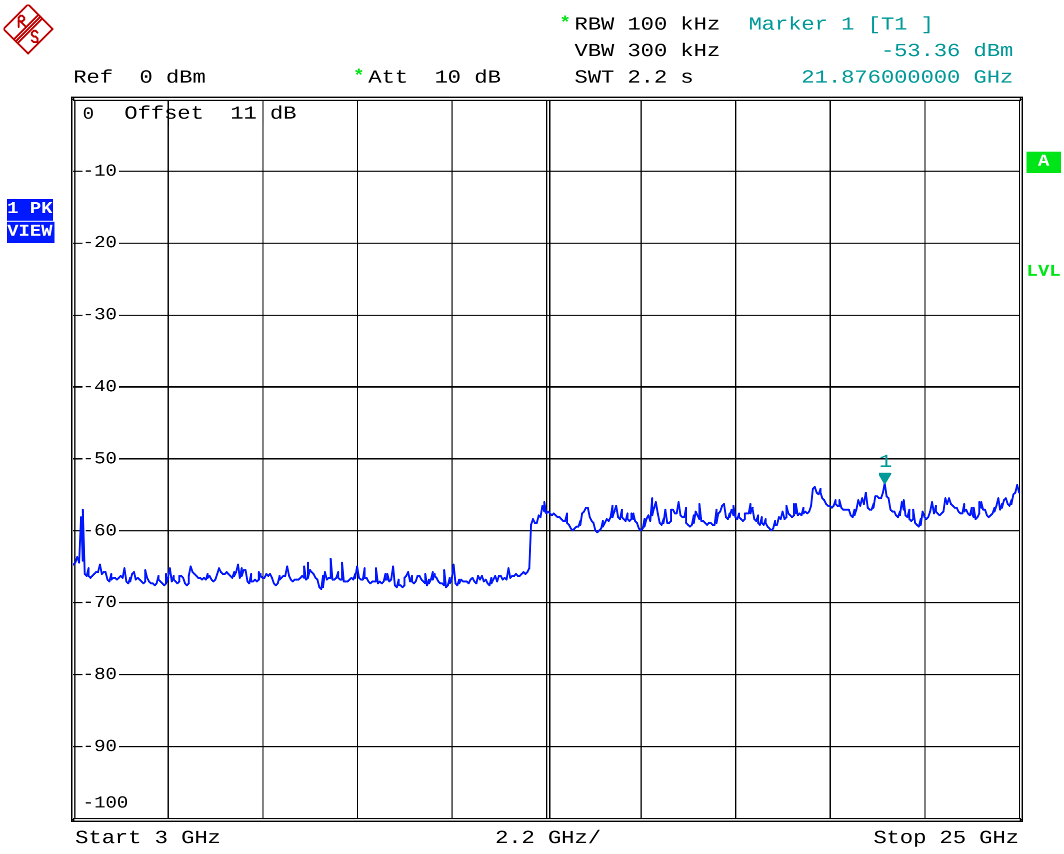




Mode : Mid Channel

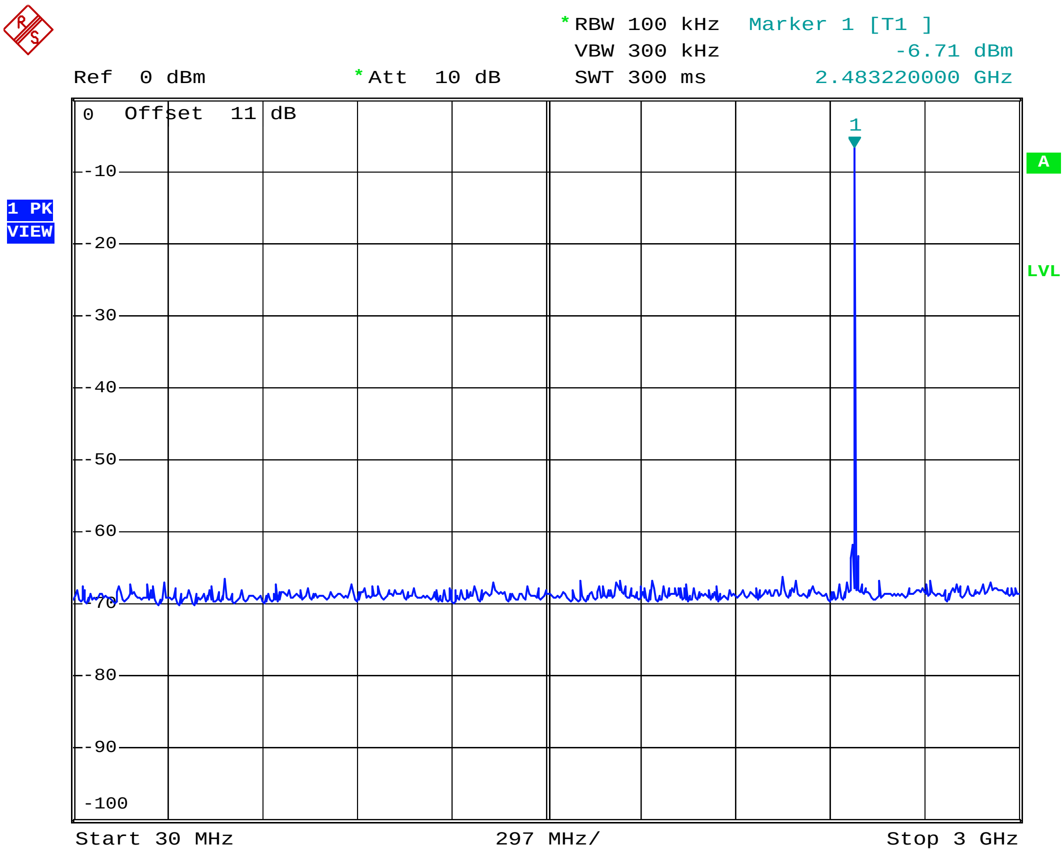


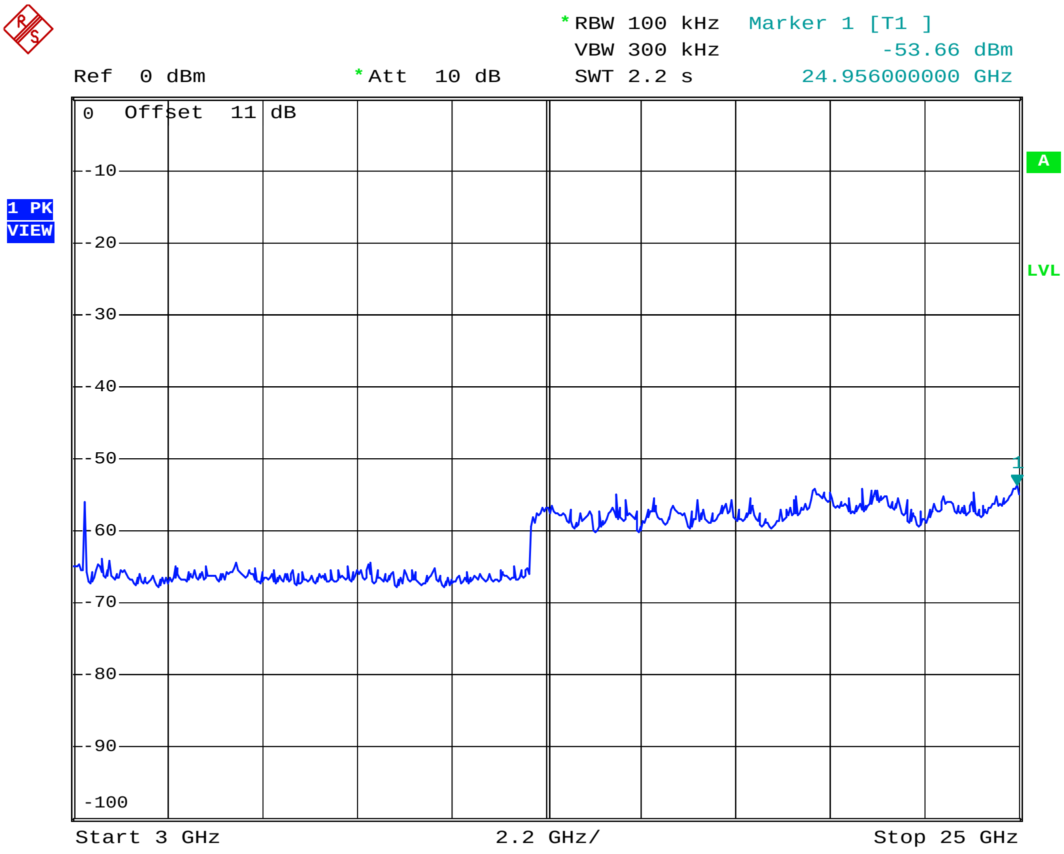
*RBW 100 kHz Marker 1 [T1]
VBW 300 kHz -5.46 dBm
Ref 0 dBm *Att 10 dB SWT 300 ms 2.441640000 GHz



*RBW 100 kHz Marker 1 [T1]
VBW 300 kHz -53.36 dBm
Ref 0 dBm *Att 10 dB SWT 2.2 s 21.876000000 GHz

Mode : Hi Channel





14. DYTY CYCLE

14.1 Standard Applicable

None. Refereency only.

14.2 Measurement Equipment

Equipment	Manufacturer	Model No.	Calibration Date	Next Cal. Date
Spectrum Analyzer	Rohde & Schwarz	FSP40	2016/10/03	2017/10/02
Attenuator	MINI-CIRCUITS	BW-S10W2+	2016/09/30	2017/09/29
Attenuator	MINI-CIRCUITS	BW-S20W2+	2016/09/30	2017/09/29
Attenuator	MINI-CIRCUITS	BW-S30W2+	2016/09/30	2017/09/29

14.3 Measurement Data

Test Date : Oct. 20, 2016 Temperature : 24 °C Humidity : 60 %

Duty Cycle Calculation

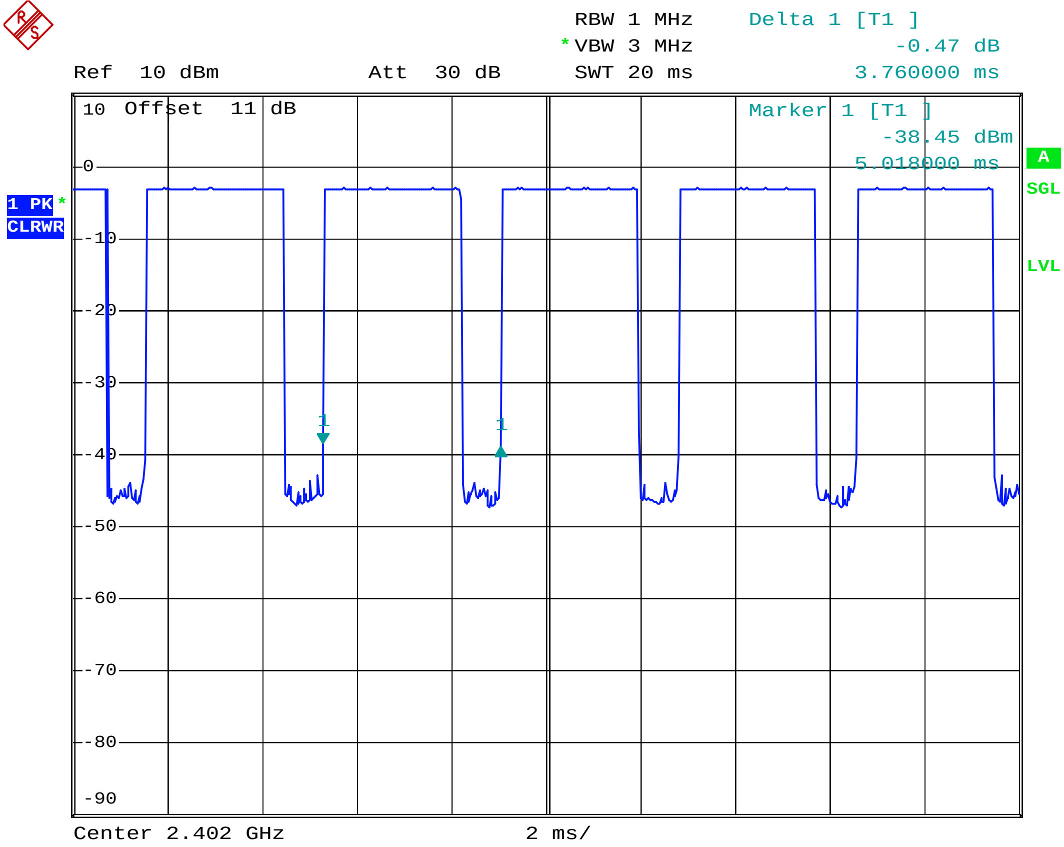
Mode	Period (ms)	Transmission duration (T) (ms)	Duty Cycle (%)	1/T (kHz)	VBW setting (kHz)
BR / DH5	3.76	3.0	79.7	0.33	1
EDR / DH5	3.76	3.0	79.7	0.33	1

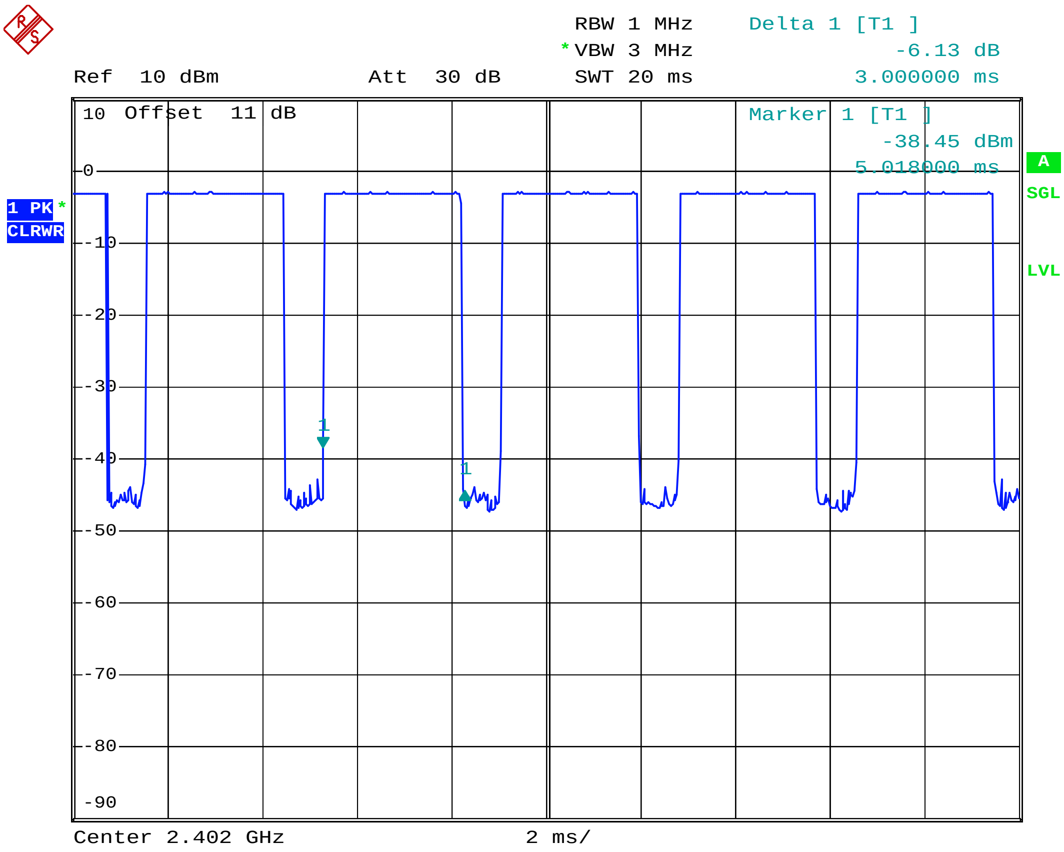
Note:

1. DH5 has the highest duty cycle worst case and is reported.
2. When the duty cycle is less than 98%, for the average measurement of the radiated emission test, the VBW setting is >1/T where the T is the minimum transmission duration over which the transmitter is on and is transmitting at its maximum power control level for the tested mode of operation.

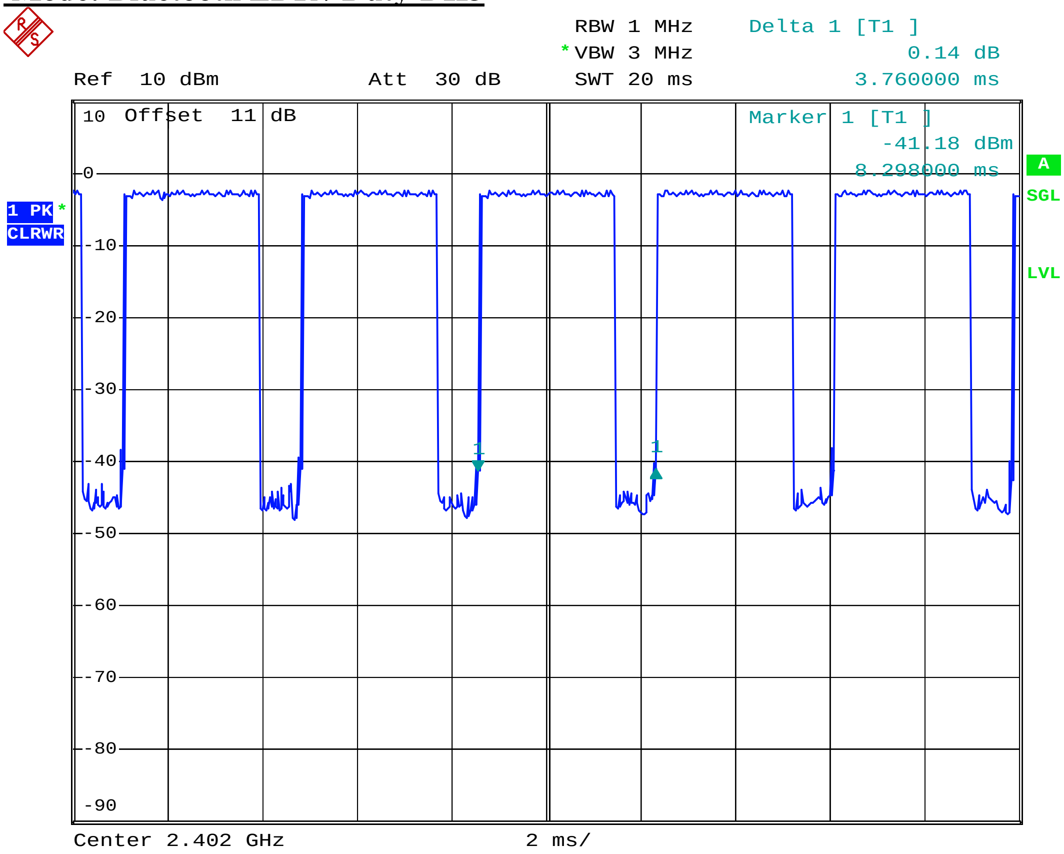
Refer to the following page for data plots.

Mode: Bluetooth BR / Duty-DH5





Mode: Bluetooth EDR / Duty-DH5

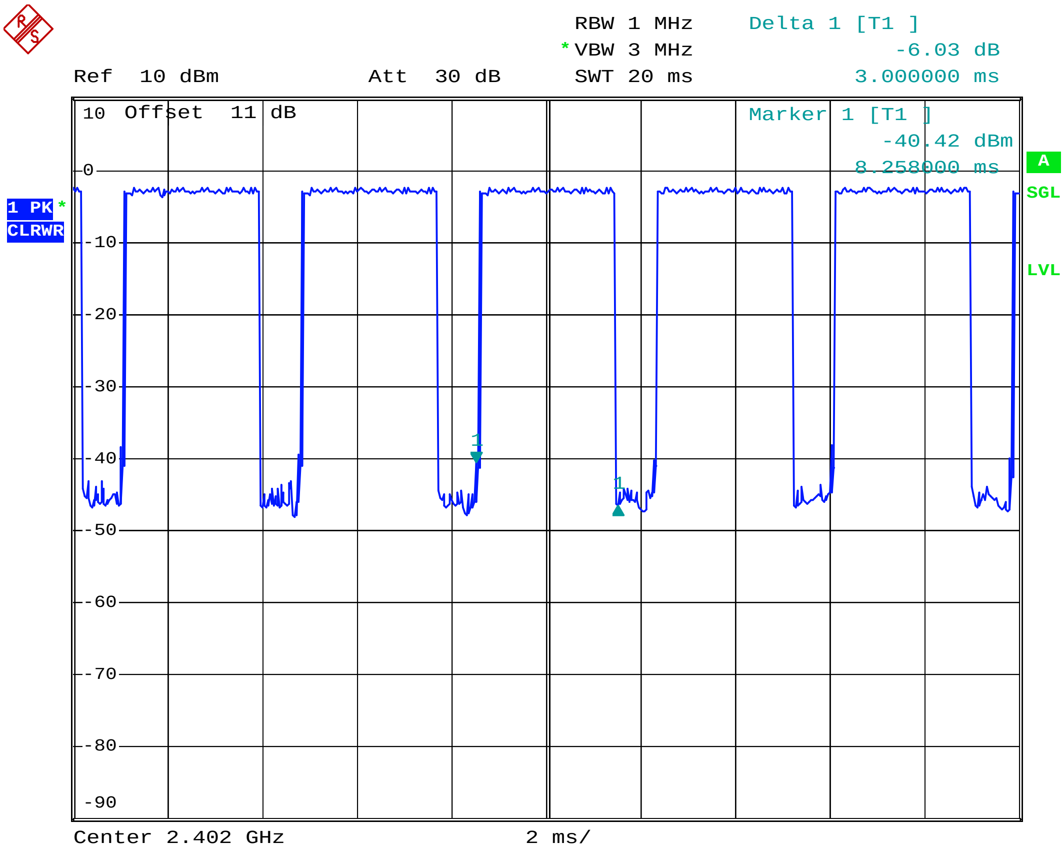


RBW 1 MHz
*VBW 3 MHz
SWT 20 ms
Ref 10 dBm
Att 30 dB
Offset 11 dB

Delta 1 [T1]
0.14 dB
3.760000 ms

Marker 1 [T1]
-41.18 dBm
8.298000 ms

Center 2.402 GHz
2 ms/



RBW 1 MHz
*VBW 3 MHz
SWT 20 ms
Ref 10 dBm
Att 30 dB
Offset 11 dB

Delta 1 [T1]
-6.03 dB
3.000000 ms

Marker 1 [T1]
-40.42 dBm
8.258000 ms

Center 2.402 GHz
2 ms/