FCC Part 15 Subpart B&C §15.247
RSS-247 ISSUE No.:2

Test Report

Equipment Under Test	**Wireless Headphones**
Model Name	**ATH-SR50BT**
Variant Model Name	**ATH-SR50BT BK, ATH-SR50BT BW, ATH-SR50BT BK(EX), ATH-SR50BT BW(EX), ATH-SR50BT BK(DF), ATH-SR50BT BW(DF)**
Applicant	**Audio-Technica Corporation**
Manufacturer	**Audio-Technica Corporation**
Date of Test(s)	**2018. 10. 24 ~ 2018. 10. 29**
Date of Issue	**2018. 11. 26**

In the configuration tested, the EUT complied with the standards specified above.

Issue to	Issue by
Audio-Technica Corporation 2-46-1 Nishi-Naruse, Machida , Tokyo, 194-8666, Japan Tel.: +81-42-739-9162 Fax: +81-42-739-9160	**MOVON Corporation** 194-1 Geumeo-ri, Pogok-eup, Cheoin-gu, Yongin-si, Gyeonggi-do, Korea, 449-812 Tel.: +82-31-338-8837 Fax: +82-31-338-8847

Revision history

Revision	Date of issue	Description	Revised by
--	Nov 26, 2018	Initial	--

Table of contents

1. Applicant Information & Laboratory Information

1.1.1 Details of applicant & Manufacturer

Applicant	:	Audio-Technica Corporation
Address	:	2-46-1 Nishi-Naruse, Machida , Tokyo, 194-8666, Japan
Contact Person	:	Kamimura Fumio
Telephone	:	+81-42-739-9168
Fax	:	+81-42-739-9160

1.1.2 Laboratory Information

Applicant	:	MOVON Corporation
Telephone	:	+ 82-31-338-8837
Fax	:	+ 82-31-338-8847
Test Site Number		*FCC(KR0151)*
Address	:	498-2, Geumeo-ro, Pogok-eup, Cheoin-gu, Yongin-si, Gyeonggi-do, South Korea
Test Site Number		*IC(6432B-3)*
Address	:	194-1 Geumeo-ri, Pogok-eup Cheoin-gu, Yongin-si, Gyeonggi-do 449-812 Korea
Test Site Number		*IC(21313-1)*
Address	:	494, Geumeo-ro, Pogok-eup, Cheoin-gu, Yongin-si, Gyeonggi-do, Korea, 170-30 Yongin IP 17030 Korea

1.2. Summary of test results

The EUT has been tested according to the following specifications;

Section in FCC part 15	Section in RSS-Gen, RSS-247	Description	Result
§15.205(a) §15.209 §15.247(d)	5.5	Transmitter radiated spurious emissions, Conducted spurious emission	C
§15.109(a)	RSS-Gen 7	Receiver radiated spurious emission	C
§15.247(a)(1)	5.1(1)	20 dB bandwidth&99 % bandwidth	C
§15.207(a)	RSS-Gen 8.8	AC Conducted power line test	C
§15.247(b)(1)	5.4(2)	Maximum peak output power	C
§15.247(a)(1)	5.1(2)	Frequency separation	C
§15.247(a)(1)(iii)	5.1(4)	Number of hopping frequency	C
§15.247(a)(1)(iii)	5.1(4)	Time of occupancy(Dwell time)	C
§15.247(i) §1.1307(b)(1)	RSS-Gen 5.5 RSS-102	RF exposure evaluation	C

The sample was tested according to the following specification:
FCC Parts 15.247; ANSI C63.4:2014, ANSI C63.10:2013
FCC Public Notice DA 00-705
RSS-247 ISSUE No.: 2
RSS-GEN ISSUE 4
TEST SITE REGISTRATION NUMBER: ***FCC(KR0151),IC(6432B-3),IC(21313-1)***

※ Abbreviation

C Complied
N/A Not applicable
F Fail

Approval Signatories

Test and Report Completed by :	Report Approval by :
Kin Son Test Engineer MOVON CORPORATION	Issac Jin Technical Manager MOVON CORPORATION

2. EUT Description

Kind of product	Wireless Headphones
Model	ATH-SR50BT
Variant Model Name	ATH-SR50BT BK, ATH-SR50BT BW, ATH-SR50BT BK(EX), ATH-SR50BT BW(EX), ATH-SR50BT BK(DF), ATH-SR50BT BW(DF)
FCC ID	JFZSR50BT
IC Number	1752B-SR50BT
Serial Number	N/A
Power supply	DC 3.7V
Frequency range	2 402 ㎒ ~ 2 480 ㎒
Modulation technique	GFSK(1Mbps), π/4DQPSK(2Mbps),8DPSK(3Mbps)
Number of channels	79
Antenna gain	3.609 ㏈ i (Max.)
Test Site Registration Number	FCC(KR0151), IC(6432B-3), IC(21313-1)

2.1. Declarations by the manufacturer

None

2.2. Details of modification

None

3. Frequency Hopping System Requirements

3.1. Standard Applicable

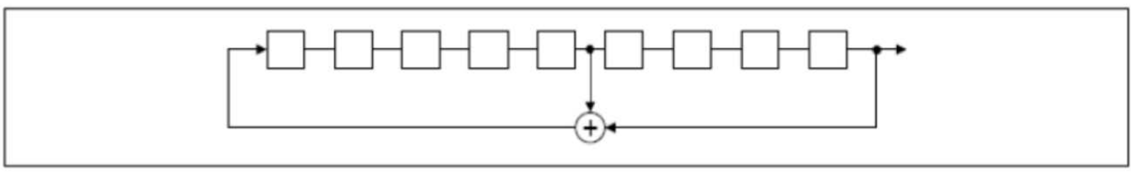
According to FCC Part 15.247(a)(1), The system shall hop to channel frequencies that are selected at the system hopping rate from a pseudo randomly ordered list of hopping frequencies. Each frequency must be used equally on the average by each transmitter. The system receivers shall have input bandwidths that match the hopping channel bandwidths of their corresponding transmitters and shall shift frequencies in synchronization with the transmitted signals.

(g) Frequency hopping spread spectrum systems are not required to employ all available hopping channels during each transmission. However, the system, consisting of both the transmitter and the receiver, must be designed to comply with all of the regulations in this section should the transmitter be presented with a continuous data (or information) stream. In addition, a system employing short transmission bursts must comply with the definition of a frequency hopping system and must distribute its transmissions over the minimum number of hopping channels specified in this section.

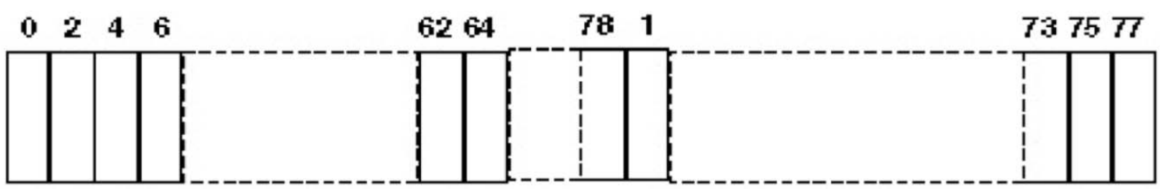
(h) The incorporation of intelligence within a frequency hopping spread spectrum system that permits the system to recognize other users within the spectrum band so that it individually and independently chooses and adapts its hopsets to avoid hopping on occupied channels is permitted. The coordination of frequency hopping systems in any other manner for the express purpose of avoiding the simultaneous occupancy of individual hopping frequencies by multiple transmitters is not permitted.

3.2. EUT Pseudorandom Frequency Hopping Sequence

The pseudorandom sequence may be generated in a nine-stage shift register whose 5th and 9th stage outputs are added in a modulo-two addition stage, and the result is fed back to the input of the first stage. The sequence begins with the first ONE of 9 consecutive ONEs; i.e. the shift register is initialized with nine ones. Number of shift register stages: 9 Length of pseudo-random sequence: 29-1 = 511 bits Longest sequence of zeros: 8 (non-inverted signal)



Linear Feedback Shift Register for Generation of the PRBS sequence



Each frequency used equally on the average by each transmitter. The system receiver have input bandwidths that match the hopping channel bandwidths of their corresponding transmitters and shift frequencies in synchronization with the transmitted signals.

3.3. Frequency Hopping System

This transmitter device is frequency hopping device, and complies with FCC part 15.247 rule. This device uses Bluetooth radio which operates in 2400-2483.5 MHz band. Bluetooth uses a radio technology called frequency-hopping spread spectrum, which chops up the data being sent and transmits chunks of it on up to 79 bands (1 MHz each; centred from 2402 to 2480 MHz) in the range 2,400-2,483.5 MHz. The transmitter switches hop frequencies 1,600 times per second to assure a high degree of data security. All Bluetooth devices participating in a given piconet are synchronized to the frequency-hopping channel for the piconet. The frequency hopping sequence is determined by the master's device address and the phase of the hopping sequence (the frequency to hop at a specific time) is determined by the master's internal clock. Therefore, all slaves in a piconet must know the master's device address and must synchronize their clocks with the master's clock.

Adaptive Frequency Hopping (AFH) was introduced in the Bluetooth specification to provide an effective way for a Bluetooth radio to counteract normal interference. AFH identifies "bad" channels, where either other wireless devices are interfering with the Bluetooth signal or the Bluetooth signal is interfering with another device. The AFH-enabled Bluetooth device will then communicate with other devices within its piconet to share details of any identified bad channels. The devices will then switch to alternative available "good" channels, away from the areas of interference, thus having no impact on the bandwidth used.

*Example for a Bluetooth device using channel numbers would be :
Ch 44, 35, 78, 03, 15, 21, 76, 40, 56, 13, 02, 19, 67, 39, 78, 20, 21, 64, 75 etc.

4. Measurement equipment.

Equipment	Manufacturer	Model	Serial number	Calibration Interval	Calibration due.
Test Receiver	R&S	ESVS30	829673/015	1 year	2018-12-07
Signal Generator	R&S	SMB100A	178128	1 year	2018-12-08
Spectrum Analyzer	R&S	FSV-40	100832	1 year	2019-05-28
Power Meter	Agilent	E4416A	GB41290645	1 year	2019-05-29
Power Sensor	Agilent	9327A	US40441490	1 year	2019-05-29
Horn Antenna	R&S	HF906	100236	2 year	2019-04-25
Horn Antenna	AH Systems	SAS-572	269	2 year	2019-08-01
Horn Antenna	AH Systems	SAS-573	164	2 year	2020-04-26
Bi-Log Ant.	S/B	VULB 9161SE	4159	2 year	2020-06-11
Power Amplifier	MITEQ	AFS43-01002600	2048519	1 year	2018-11-03
Controller	INNCO	CO2000	co200/064/6961003/L	N/A	N/A
Antenna Master	INNCO	MA4000	MA4000/038/6961003/L	N/A	N/A
Loop Antenna	ETS LINDGREN	6502	00118166	2 year	2018-10-31
TWO LINE-V-NETWORK	R&S	ESH3-Z5	100296	1 year	2019-03-07
Low Noise Amplifier	TESTEK	TK-PA18H	170013-L	1 year	2019-05-28
Power Amplifie	SONOMA INSTRUMENT	310N	185428	1 year	2018-12-07
WIDEBAND RADIO COMMUNICATION TESTER	R&S	CMW500	154160	1 year	2019-05-29
EMI TEST RECEVER	R&S	ESR3	101873	1 year	2019-05-28
PULSE LIMITER	R&S	ESH3-Z2	100288	1 year	2019-05-28
Power Divider	HP	11636B	12481	1 year	2019-05-31
RF Cable	SUHNER	SUCOFLEX100	84047746	N/A	N/A
RF Cable	SUHNER	SUCOFLEX102	801270/2	N/A	N/A
RF Cable	SUHNER	SUCOFLEX102	801270/2	N/A	N/A

※ Remark;

Support equipment

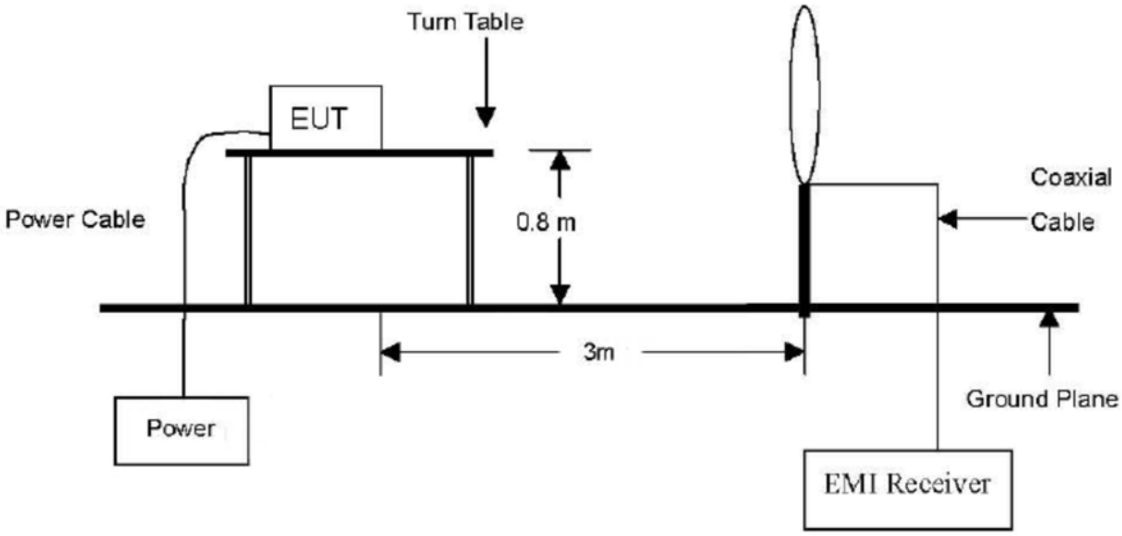
Description	Manufacturer	Model	Serial number
Notebook computer	DELL	Lattitude D510	-

5. Transmitter radiated spurious emissions and conducted spurious emissions

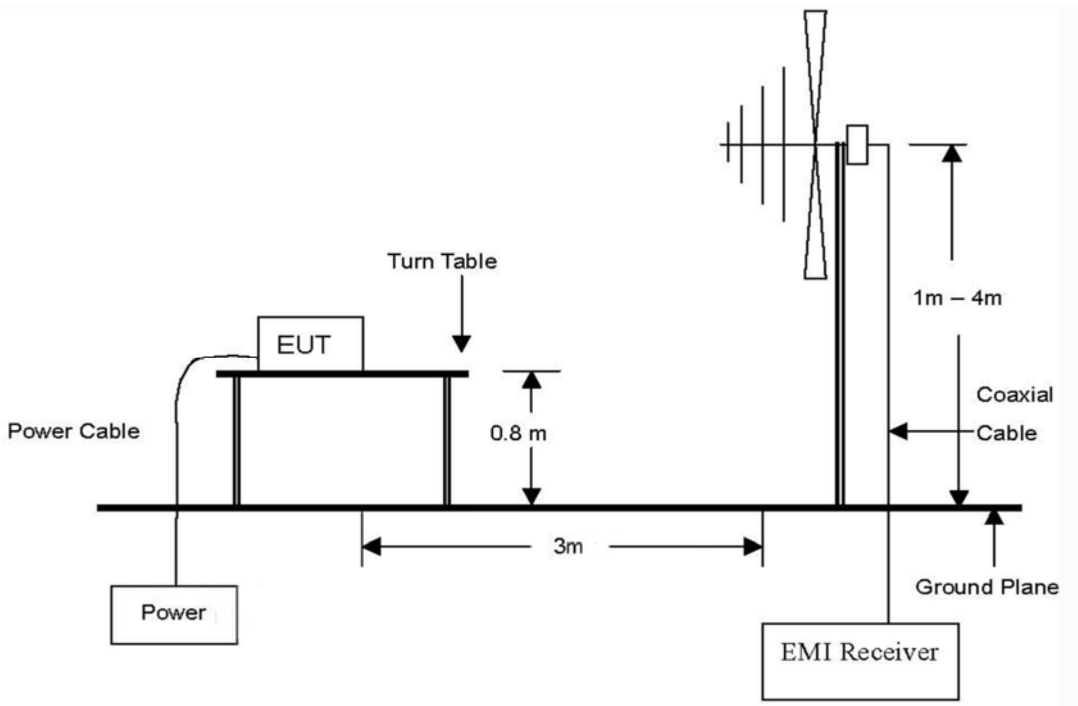
5.1. Test setup

5.1.1. Transmitter radiated spurious emissions

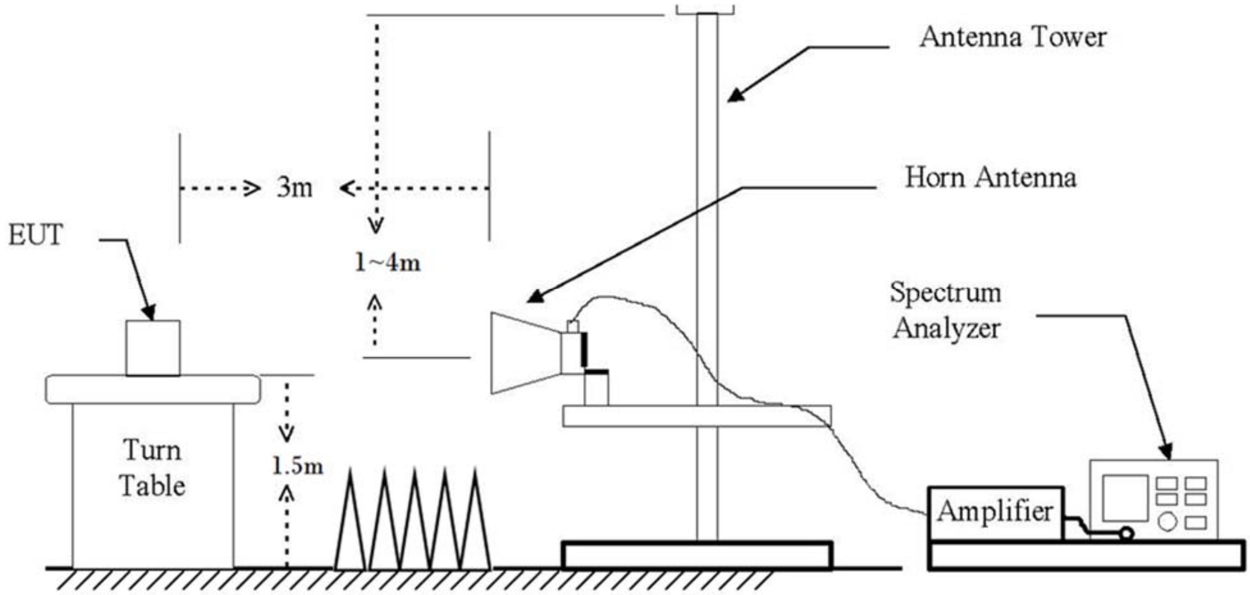
Thediagrambelowshowsthetestsetupthatisutilizedtomakethemeasurementsforemissionfrom9kHzto30MHzEmissions.



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



The diagram below shows the test setup that is utilized to make the measurements for emission Above 1 ㎓ emissions.



5.2. Limit

According to §15.247(d), in any 100 ㎑ bandwidth outside the frequency band in which the spread spectrum or digitally modulated intentional radiator is operating, the radio frequency power that is produced by the intentional radiator shall be at least 20 ㏈ below that in the 100 ㎑ bandwidth within the band that contains the highest level of the desired power, based on either an RF conducted or a radiated measurement , provided the transmitter demonstrates compliance with the peak conducted power limits. If the transmitter complies with the conducted power limits based on the use of RMS averaging over a time interval , as permitted under paragraph(b)(3) of this section , the attenuation required under this paragraph shall be 30 ㏈ instead of 20 ㏈. Attenuation below the general limits specified in section §15.209(a) is not required. In addition, radiated emission which in the restricted band, as define in section §15.205(a), must also comply the radiated emission limits specified in section §15.209(a) (see section §15.205(c))
According to § 15.109(a), for an intentional radiator devices, the general required of field strength of radiated emissions from unintentional radiators at a distance of 3 meters shall not exceed the following values：

Frequency (㎒)	Distance (Meters)	Radiated at 3M (㏈㎶/m)	Radiated (㎶/m)
0.009–0.490	300	See the remark	2400/F(㎑)
0.490–1.705	30		24000/F(㎑)
1.705–30.0	30		30
30 - 88	3	40.0	100
88 – 216	3	43.52	150
216 – 960	3	46.02	200
Above 960	3	53.97	500

*Remark

1. Emission level in ㏈ uV/m=20 log (uV/m)
2. Measurement was performed at an antenna to the closed point of EUT distance of meters.
3. Distance extrapolation factor =20log(Specific distance/ test distance)(㏈)
   Limit line=Specific limits(㏈ uV) + distance extrapolation factor.

5.3. Test procedures

Radiated emissions from the EUT were measured according to the dictates of ANSI C63.10:2013
In case of the air temperature of the test site is out of the range is 10 to 40°C before the testing proceeds the warm-up time of EUT maintain adequately

5.3.1. Test procedures for radiated spurious emissions

1. The EUT is placed on a turntable, which is 0.8 m (Below 1 ㎓.)/ 1.5 m (Above 1 ㎓) above ground plane.
2. The turntable shall be rotated for 360 degrees to determine the position of maximum emission level.
3. EUT is set 3 m away from the receiving antenna, which is varied from 1m to 4m to find out the highest emissions.
4. Maximum procedure was performed on the six highest emissions to ensure EUT compliance.
5. And also, each emission was to be maximized by changing the polarization of receiving antenna both horizontal and vertical.
6. Repeat above procedures until the measurements for all frequencies are complete.

※ **Remark;**
1. The resolution bandwidth and video bandwidth of test receiver/spectrum analyzer is 10 ㎑ for Peak detection (PK) at frequency below 30 ㎒
2. The resolution bandwidth and video bandwidth of test receiver/spectrum analyzer is 120 ㎑ for Peak detection (PK) or Quasi-peak detection (QP) at frequency below 1 ㎓.
3. The resolution bandwidth and video bandwidth of test receiver/spectrum analyzer is 1 ㎒ for Peak detection and frequency above 1 ㎓.
4. The resolution bandwidth of test receiver/spectrum analyzer is 1 ㎒z and the video bandwidth is 10 ㎐ for Average detection (AV) at frequency above 1 ㎓.

5.3.2. Test procedures for conducted spurious emissions

1. The transmitter output was connected to the spectrum analyzer through an attenuator.
2. The bandwidth of the fundamental frequency was measured with the spectrum analyzer using RBW=100 ㎑,VBW=100 ㎑.

5.4. Test result

Ambient temperature: 22℃
Relative humidity: 46% R.H.

5.4.1. Spurious radiated emission

The frequency spectrum from 9㎑ to 30㎒ was investigated. Emission levels are not reported much lower than the limits by over 20 ㏈. All reading values are peak values.
To get a maximum emission levels from the EUT, the EUT was moved throughout the XY, XZ, and YZ planes.

Operation mode : BDR
A. Low channel (2 402 ㎒)

Radiated emissions			Ant.	Correction factors		Total	Limit	
Frequency (㎒)	Reading (dB㎶)	Detector mode	Pol.	Ant. factor (dB/m)	C.L (dB)	Actual (dB㎶/m)	Limit (dB㎶/m)	Margin (dB)
No other emissions were detected at a level greater than 20dB below limit.								

B. Middle channel (2 441 ㎒)

Radiated emissions			Ant.	Correction factors		Total	Limit	
Frequency (㎒)	Reading (dB㎶)	Detector mode	Pol.	Ant. factor (dB/m)	C.L (dB)	Actual (dB㎶/m)	Limit (dB㎶/m)	Margin (dB)
No other emissions were detected at a level greater than 20dB below limit.								

C. High channel (2 480 ㎒)

Radiated emissions			Ant.	Correction factors		Total	Limit	
Frequency (㎒)	Reading (dB㎶)	Detector mode	Pol.	Ant. factor (dB/m)	C.L (dB)	Actual (dB㎶/m)	Limit (dB㎶/m)	Margin (dB)
No other emissions were detected at a level greater than 20dB below limit.								

※ Remark
1. Actual = Reading + Ant. factor + CL (Cable loss)
2. Limit line = specific Limits (dBuV) + Distance extrapolation factor
3. 15.31 Measurement standards.
The amplitude of spurious emissions from intentional radiators and emissions from unintentional radiators which are attenuated more than 20 dB below the permissible value need not be reported unless specifically required elsewhere in this part.

Operation mode : EDR

A. Low channel (2 402 ㎒)

Radiated emissions			Ant.	Correction factors		Total	Limit	
Frequency (㎒)	Reading (dB㎶)	Detector mode	Pol.	Ant. factor (dB/m)	C.L (dB)	Actual (dB㎶/m)	Limit (dB㎶/m)	Margin (dB)
No other emissions were detected at a level greater than 20dB below limit.								

B. Middle channel (2 441 ㎒)

Radiated emissions			Ant.	Correction factors		Total	Limit	
Frequency (㎒)	Reading (dB㎶)	Detector mode	Pol.	Ant. factor (dB/m)	C.L (dB)	Actual (dB㎶/m)	Limit (dB㎶/m)	Margin (dB)
No other emissions were detected at a level greater than 20dB below limit.								

C. High channel (2 480 ㎒)

Radiated emissions			Ant.	Correction factors		Total	Limit	
Frequency (㎒)	Reading (dB㎶)	Detector mode	Pol.	Ant. factor (dB/m)	C.L (dB)	Actual (dB㎶/m)	Limit (dB㎶/m)	Margin (dB)
No other emissions were detected at a level greater than 20dB below limit.								

※ Remark

1. Actual = Reading + Ant. factor + CL (Cable loss)
2. Limit line = specific Limits (dBuV) + Distance extrapolation factor
3. 15.31 Measurement standards.

The amplitude of spurious emissions from intentional radiators and emissions from unintentional radiators which are attenuated more than 20 dB below the permissible value need not be reported unless specifically required elsewhere in this part.

5.4.2. Spurious radiated emission

The frequency spectrum from 30 ㎒ to 1 000 ㎒ was investigated. Emission levels are not reported much lower than the limits by over 20 ㏈. All reading values are peak values.
To get a maximum emission levels from the EUT, the EUT was moved throughout the XY, XZ, and YZ planes.

Operation mode : BDR
A. Low channel (2 402 ㎒)

Radiated emissions			Ant.	Correction factors		Total	Limit	
Frequency (㎒)	Reading (dB㎶)	Detector mode	Pol.	Ant. factor (dB/m)	C.L (dB)	Actual (dB㎶/m)	Limit (dB㎶/m)	Margin (dB)
No other emissions were detected at a level greater than 20dB below limit.								

B. Middle channel (2 441 ㎒)

Radiated emissions			Ant.	Correction factors		Total	Limit	
Frequency (㎒)	Reading (dB㎶)	Detector mode	Pol.	Ant. factor (dB/m)	C.L (dB)	Actual (dB㎶/m)	Limit (dB㎶/m)	Margin (dB)
No other emissions were detected at a level greater than 20dB below limit.								

C. High channel (2 480 ㎒)

Radiated emissions			Ant.	Correction factors		Total	Limit	
Frequency (㎒)	Reading (dB㎶)	Detector mode	Pol.	Ant. factor (dB/m)	C.L (dB)	Actual (dB㎶/m)	Limit (dB㎶/m)	Margin (dB)
No other emissions were detected at a level greater than 20dB below limit.								

※ Remark
1. Actual = Reading + Ant. factor + CL (Cable loss)
2. Limit line = specific Limits (dBuV) + Distance extrapolation factor
3. 15.31 Measurement standards.
The amplitude of spurious emissions from intentional radiators and emissions from unintentional radiators which are attenuated more than 20 dB below the permissible value need not be reported unless specifically required elsewhere in this part.

Operation mode : EDR

A. Low channel (2 402 ㎒)

Radiated emissions			Ant.	Correction factors		Total	Limit	
Frequency (㎒)	Reading (dB㎶)	Detector mode	Pol.	Ant. factor (dB/m)	C.L (dB)	Actual (dB㎶/m)	Limit (dB㎶/m)	Margin (dB)
No other emissions were detected at a level greater than 20dB below limit.								

B. Middle channel (2 441 ㎒)

Radiated emissions			Ant.	Correction factors		Total	Limit	
Frequency (㎒)	Reading (dB㎶)	Detector mode	Pol.	Ant. factor (dB/m)	C.L (dB)	Actual (dB㎶/m)	Limit (dB㎶/m)	Margin (dB)
No other emissions were detected at a level greater than 20dB below limit.								

C. High channel (2 480 ㎒)

Radiated emissions			Ant.	Correction factors		Total	Limit	
Frequency (㎒)	Reading (dB㎶)	Detector mode	Pol.	Ant. factor (dB/m)	C.L (dB)	Actual (dB㎶/m)	Limit (dB㎶/m)	Margin (dB)
No other emissions were detected at a level greater than 20dB below limit.								

※ Remark

1. Actual = Reading + Ant. factor + CL(Cable loss)
2. 15.31 Measurement standards.

The amplitude of spurious emissions from intentional radiators and emissions from unintentional radiators which are attenuated more than 20 dB below the permissible value need not be reported unless specifically required elsewhere in this part.

5.4.3. Spurious radiated emission

The frequency spectrum above 1 000 ㎒was investigated. Emission levels are not reported much lower thanthe limits by over 20 ㏈.
To get a maximum emission levels from the EUT, the EUT was moved throughout the XY, XZ, and YZ planes.

Operation mode: BDR

A. Low channel (2 402 ㎒)

Radiated emissions			Ant.	Correction factors		Total	Limit	
Frequency (㎒)	Reading (㏈㎶)	Detector mode	Pol.	Ant. factor (㏈/m)	C.L (㏈)	Actual (㏈㎶/m)	Limit (㏈㎶/m)	Margin (㏈)
No other emissions were detected at a level greater than 20dB below limit.								

B. Middle channel (2 441 ㎒)

Radiated emissions			Ant.	Correction factors		Total	Limit	
Frequency (㎒)	Reading (㏈㎶)	Detector mode	Pol.	Ant. factor (㏈/m)	C.L (㏈)	Actual (㏈㎶/m)	Limit (㏈㎶/m)	Margin (㏈)
No other emissions were detected at a level greater than 20dB below limit.								

C. High channel (2 480 ㎒)

Radiated emissions			Ant.	Correction factors		Total	Limit	
Frequency (㎒)	Reading (㏈㎶)	Detector mode	Pol.	Ant. factor (㏈/m)	C.L (㏈)	Actual (㏈㎶/m)	Limit (㏈㎶/m)	Margin (㏈)
No other emissions were detected at a level greater than 20dB below limit.								

※ Remark

1. Measuring frequencies from 1 ㎓ to the 10th harmonic of highest fundamental Frequency.
2. Radiated emissions measured in frequency above 1 000 ㎒ were made with an instrument usingpeak/average detector mode.
3. Average test would be performed if the peak result were greater than the average limit.
4. Actual = Reading + Ant. factor- Amp + CL (Cable loss)
5. 15.31 Measurement standards.

THE AMPLITUDE OF SPURIOUS EMISSIONS FROM INTENTIONAL RADIATORS AND EMISSIONS FROM UNINTENTIONAL RADIATORS WHICH ARE ATTENUATED MORE THAN 20 DB BELOW THE PERMISSIBLE VALUE NEED NOT BE REPORTED UNLESS SPECIFICALLY REQUIRED ELSEWHERE IN THIS PART.

Operation mode: EDR

A. Low channel (2 402 ㎒)

Radiated emissions			Ant.	Correction factors		Total	Limit	
Frequency (㎒)	Reading (dB㎶)	Detector mode	Pol.	Ant. factor (dB/m)	C.L (dB)	Actual (dB㎶/m)	Limit (dB㎶/m)	Margin (dB)
No other emissions were detected at a level greater than 20dB below limit.								

B. Middle channel (2 441 ㎒)

Radiated emissions			Ant.	Correction factors		Total	Limit	
Frequency (㎒)	Reading (dB㎶)	Detector mode	Pol.	Ant. factor (dB/m)	C.L (dB)	Actual (dB㎶/m)	Limit (dB㎶/m)	Margin (dB)
No other emissions were detected at a level greater than 20dB below limit.								

C. High channel (2 480 ㎒)

Radiated emissions			Ant.	Correction factors		Total	Limit	
Frequency (㎒)	Reading (dB㎶)	Detector mode	Pol.	Ant. factor (dB/m)	C.L (dB)	Actual (dB㎶/m)	Limit (dB㎶/m)	Margin (dB)
No other emissions were detected at a level greater than 20dB below limit.								

※ Remark

1. Measuring frequencies from 1 ㎓ to the 10th harmonic of highest fundamental Frequency.
2. Radiated emissions measured in frequency above 1 000 ㎒ were made with an instrument usingpeak/average detector mode.
3. Average test would be performed if the peak result were greater than the average limit.
4. Actual = Reading + Ant. factor- Amp + CL (Cable loss)
5. 15.31 Measurement standards.

THE AMPLITUDE OF SPURIOUS EMISSIONS FROM INTENTIONAL RADIATORS AND EMISSIONS FROM UNINTENTIONAL RADIATORS WHICH ARE ATTENUATED MORE THAN 20 DB BELOW THE PERMISSIBLE VALUE NEED NOT BE REPORTED UNLESS SPECIFICALLY REQUIRED ELSEWHERE IN THIS PART.

5.4.4. Band Edge

Operation mode: BDR

A. 2 310 - 2 390 ㎒ measurement (2 402MHz)

Radiated emissions			Ant.	Correction factors			Total	Limit	
Frequency (㎒)	Reading (dB㎶)	Detector mode	Pol.	Ant. factor (dB/m)	Amp+CL (dB)	Duty factor (dB)	Actual (dB㎶/m)	Limit (dB㎶/m)	Margin (dB)
2388.76	59.80	Peak	V	28.09	44.63		43.26	74.00	30.74
2337.29	47.31	Average	V	28.09	44.63	1.08	31.85	54.00	22.15
2360.15	60.00	Peak	H	28.09	44.63		43.46	74.00	30.54
2337.37	47.31	Average	H	28.09	44.63	1.08	31.85	54.00	22.15

B. 2 483.5 – 2 500 ㎒ measurement (2 480MHz)

Radiated emissions			Ant.	Correction factors			Total	Limit	
Frequency (㎒)	Reading (dB㎶)	Detector mode	Pol.	Ant. factor (dB/m)	Amp+CL (dB)	Duty factor (dB)	Actual (dB㎶ /m)	Limit (dB㎶/m)	Margin (dB)
2487.20	59.61	Peak	V	28.09	44.63		43.07	74.00	30.93
2499.99	45.51	Average	V	28.09	44.63	1.08	30.05	54.00	23.95
2499.99	59.03	Peak	H	28.09	44.63		42.49	74.00	31.51
2491.39	45.46	Average	H	28.09	44.63	1.08	30.00	54.00	24.00

Operation mode: EDR

A. 2 310 - 2 390 ㎒ measurement (2 402MHz)

Radiated emissions			Ant.	Correction factors			Total	Limit	
Frequency (㎒)	Reading (dB㎶)	Detector mode	Pol.	Ant. factor (dB/m)	Amp+CL (dB)	Duty factor (dB)	Actual (dB㎶/m)	Limit (dB㎶/m)	Margin (dB)
2342.25	58.83	Peak	V	28.09	44.63		42.29	74.00	31.71
2337.37	47.29	Average	V	28.09	44.63	1.08	31.83	54.00	22.17
2368.56	59.91	Peak	H	28.09	44.63		43.37	74.00	30.63
2337.29	47.16	Average	H	28.09	44.63	1.08	31.70	54.00	22.30

B. 2 483.5 – 2 500 ㎒ measurement (2 480MHz)

Radiated emissions			Ant.	Correction factors			Total	Limit	
Frequency (㎒)	Reading (dB㎶)	Detector mode	Pol.	Ant. factor (dB/m)	Amp+CL (dB)	Duty factor (dB)	Actual (dB㎶ /m)	Limit (dB㎶/m)	Margin (dB)
2491.34	58.52	Peak	V	28.09	44.63		41.98	74.00	32.02
2499.93	45.52	Average	V	28.09	44.63	1.08	30.06	54.00	23.94
2494.92	58.12	Peak	H	28.09	44.63		41.58	74.00	32.42
2499.99	45.50	Average	H	28.09	44.63	1.08	30.04	54.00	23.96

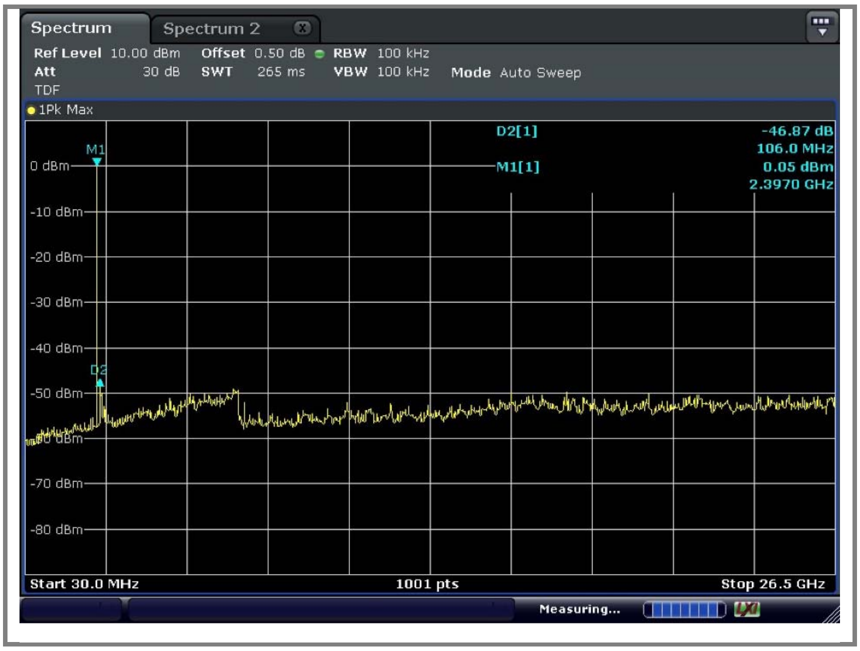
5.4.5. Spurious RF conducted emissions: Plot of spurious RF conducted emission

Operation mode: Basic mode

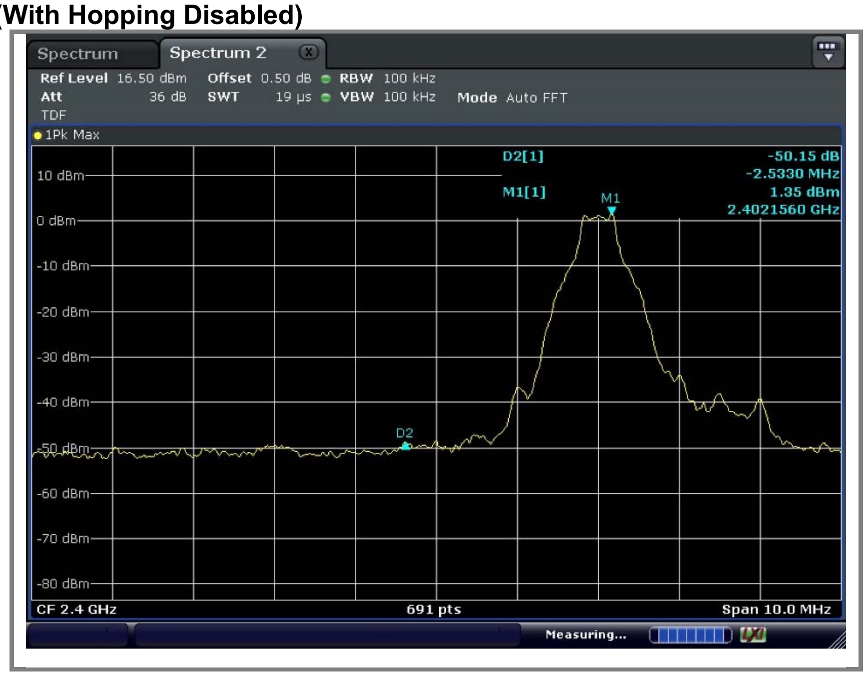
Operation mode: BDR

A. Low channel(2 402 ㎒)

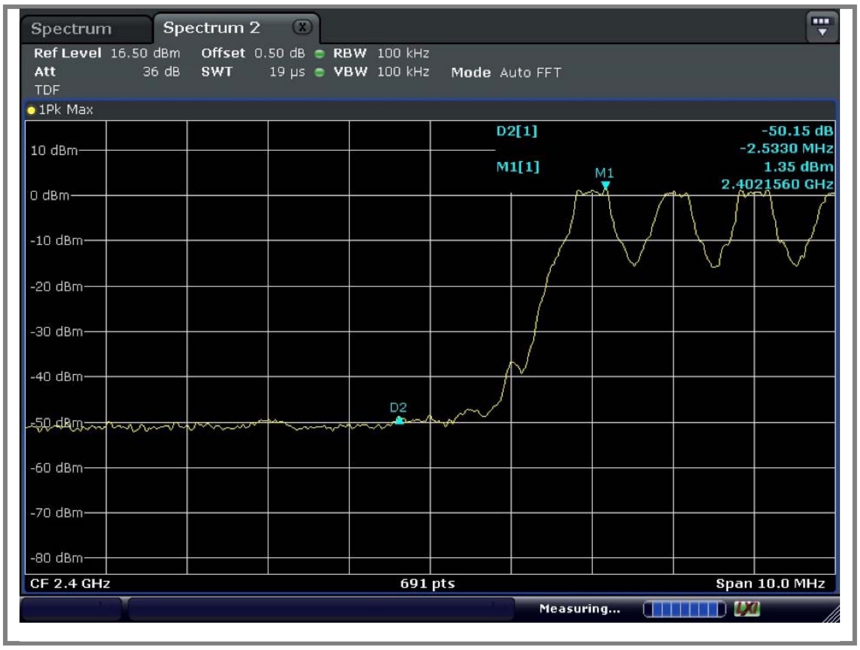
Unwanted Emission data



Band-edge data (With Hopping Disabled)

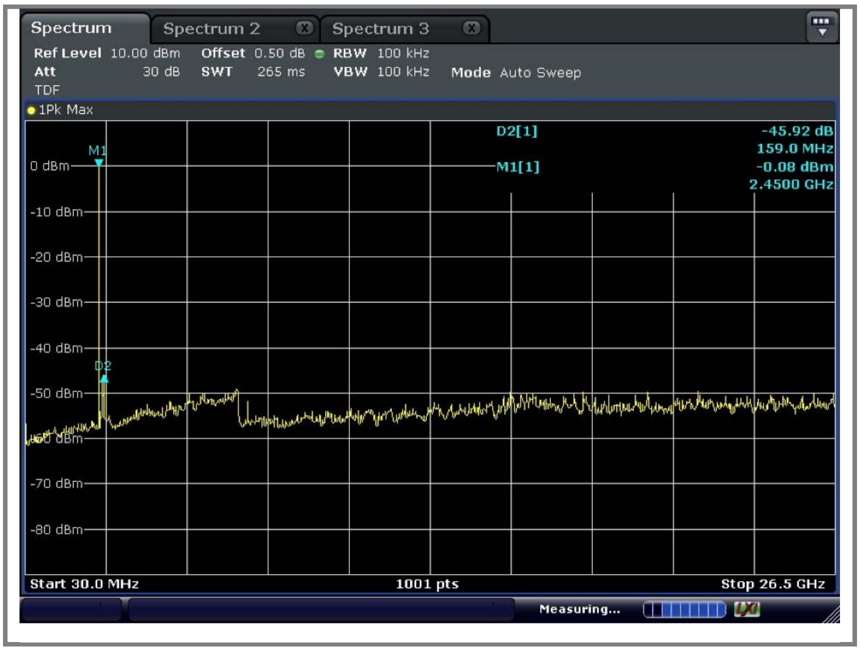


Band-edge data (With Hopping Enabled)



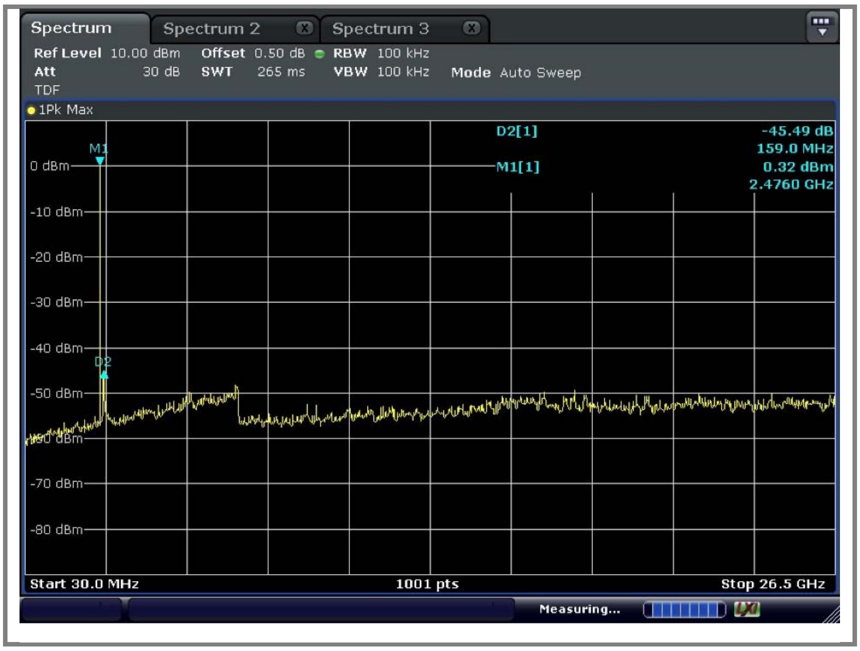
B. Middle channel(2 441 ㎒)

Unwanted Emission data

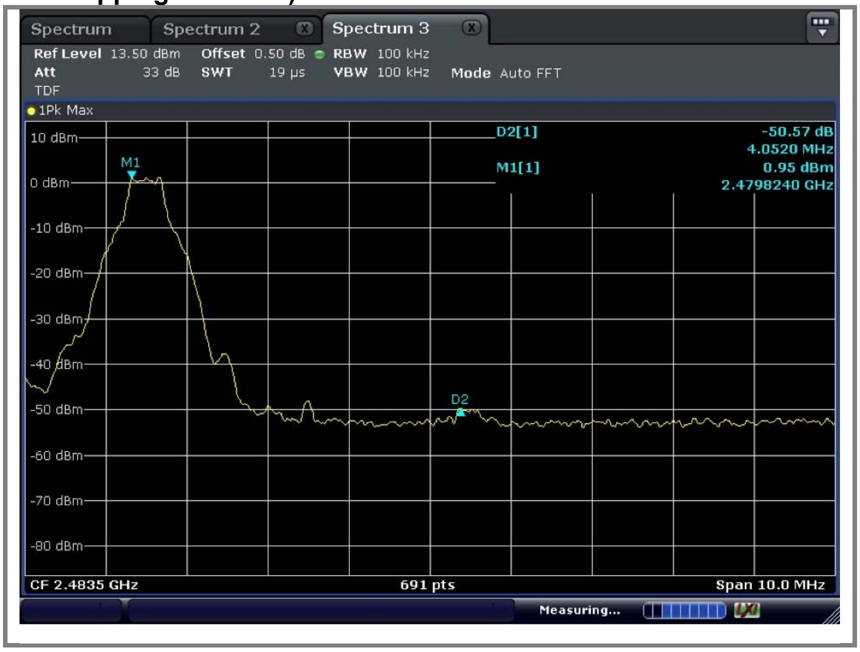


C. High channel(2 480 ㎒)

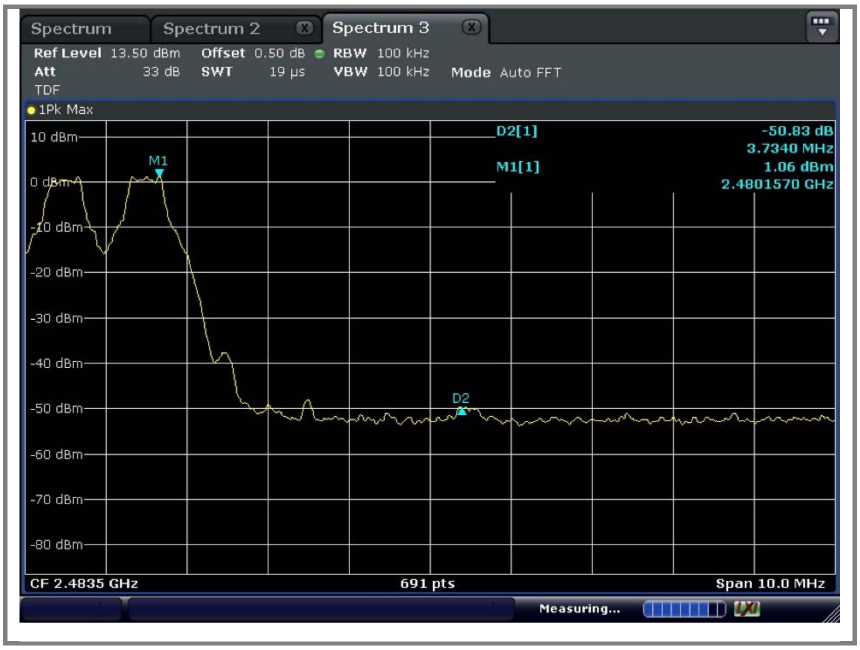
Unwanted Emission data



Band-edge data (With Hopping Disabled)

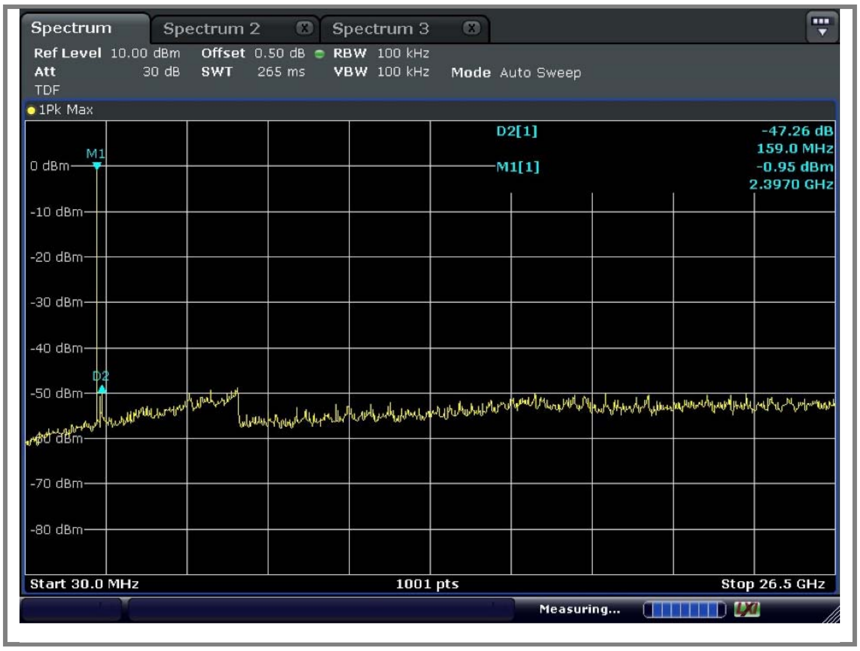


Unwanted Emission data (With Hopping Enabled)

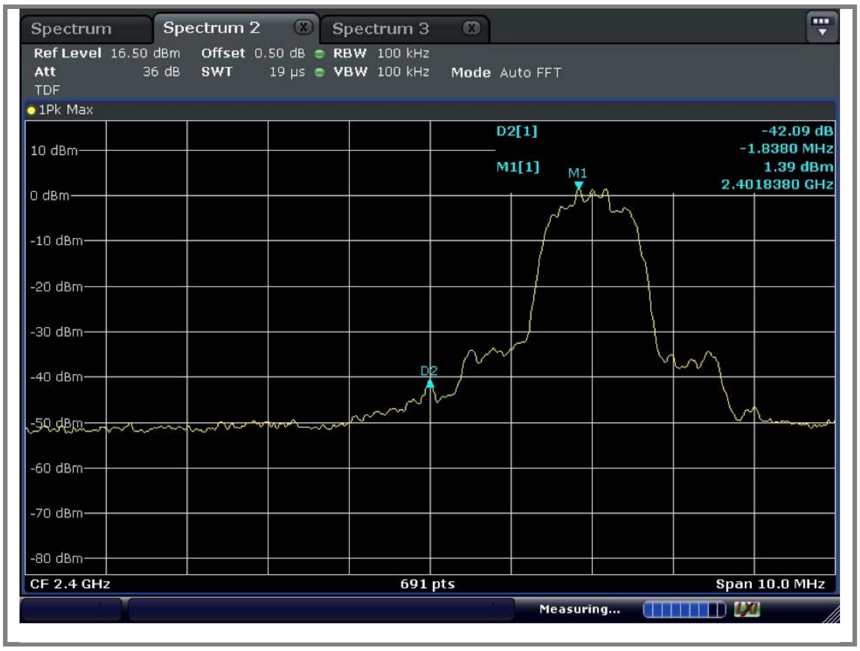


Operation mode:EDR

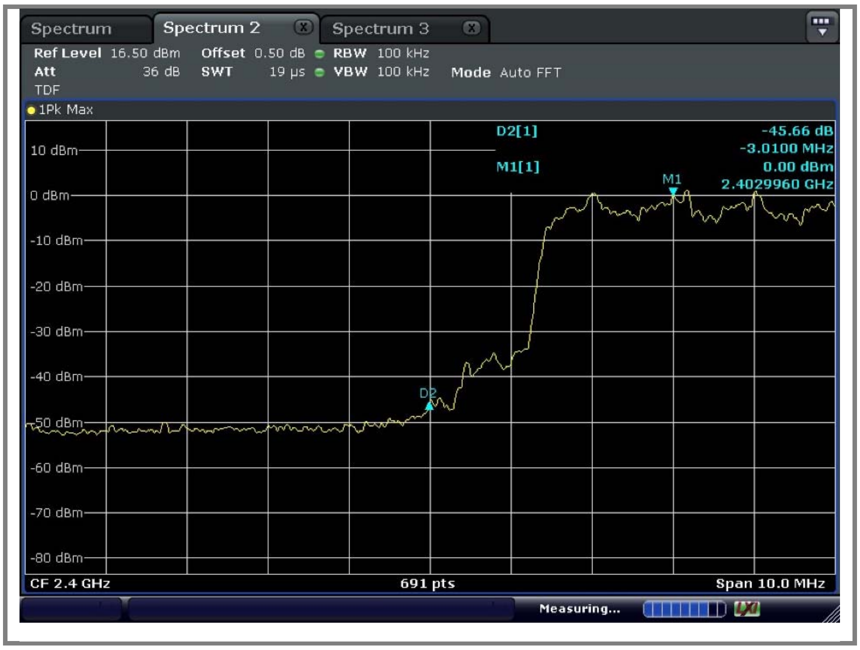
A. Low channel(2 402 ㎒)
Unwanted Emission data



Band-edge data (With Hopping Disabled)

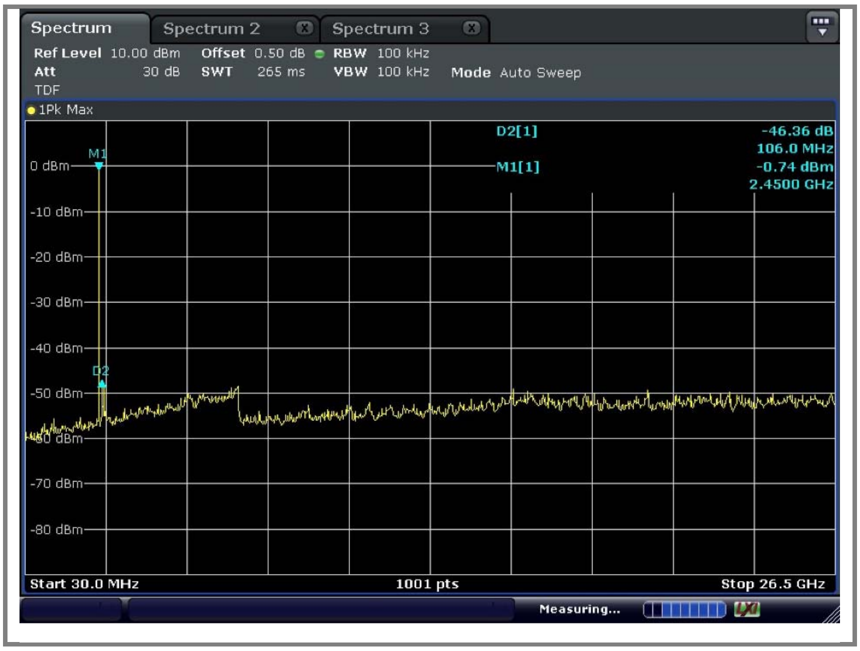


Band-edge data (With Hopping Enabled)



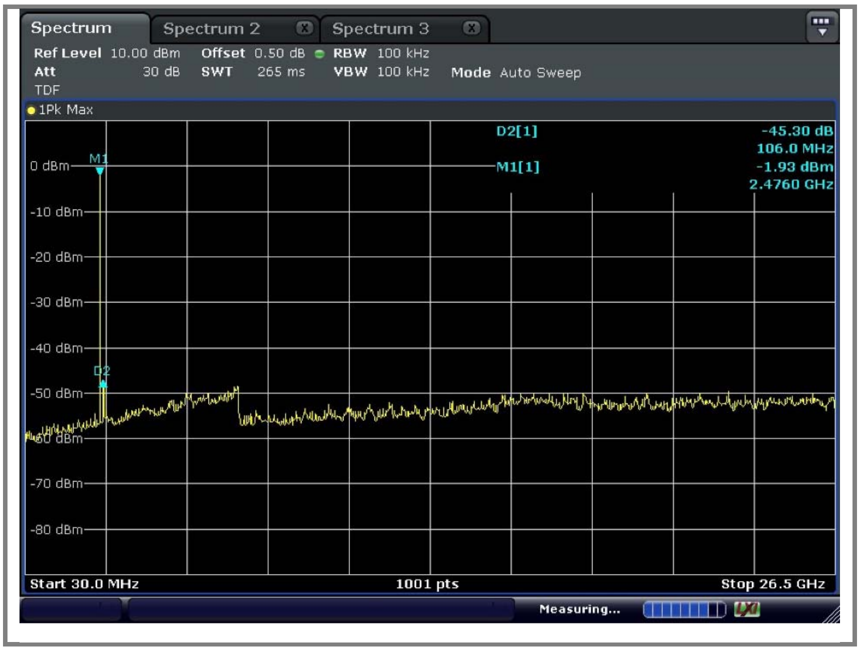
B. Middle channel(2 441 ㎒)

Unwanted Emission data

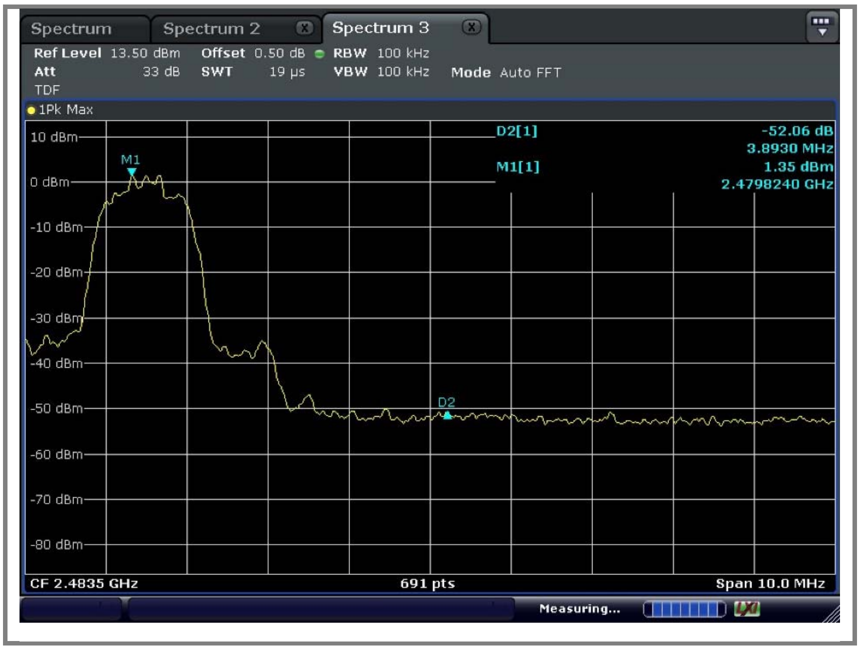


C. High channel(2 480 ㎒)

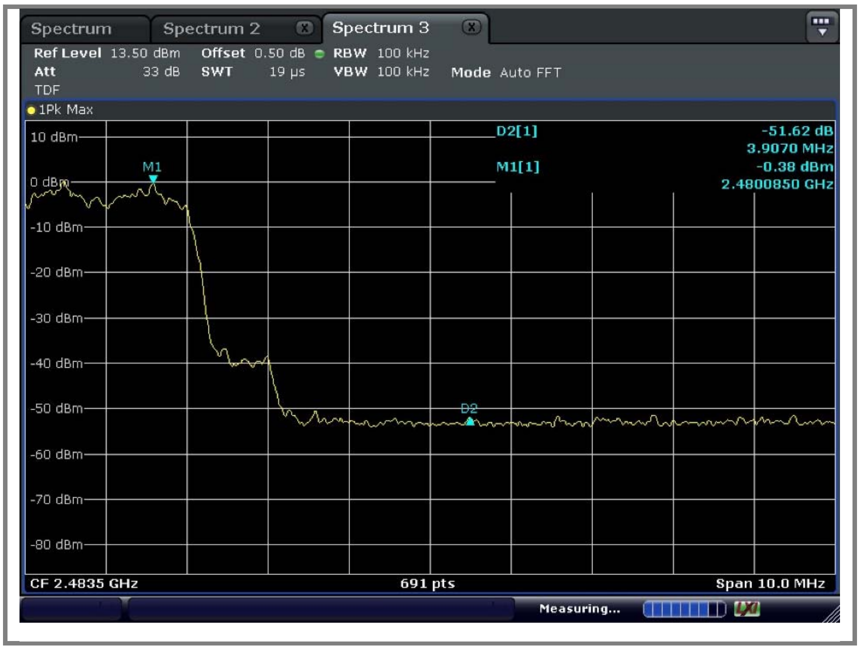
Unwanted Emission data



Band-edge data

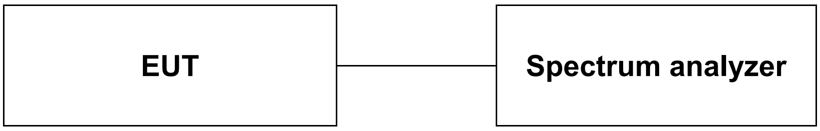


Unwanted Emission data (With Hopping Enabled)



6. 20 ㏈ bandwidth measurement& 99% bandwidth measurement

6.1. Test setup



6.2. Limit

Not applicable

6.3. Test procedure

1. The 20 ㏈ band width was measured with a spectrum analyzer connected to RF antenna
   connector(conducted measurement) while EUT was operating in transmit mode at the appropriate centerfrequency. The analyzer center frequency was set to the EUT carrier frequency, using the analyzer.Display Line and Marker Delta functions, the 20 ㏈band width of the emission was determined.
2. The bandwidth of the fundamental frequency was measured with the spectrum analyzer using RBW ≥ 10 ㎑,VBW ≥ 10 ㎑, Span = 3㎒.

6.4. Test results

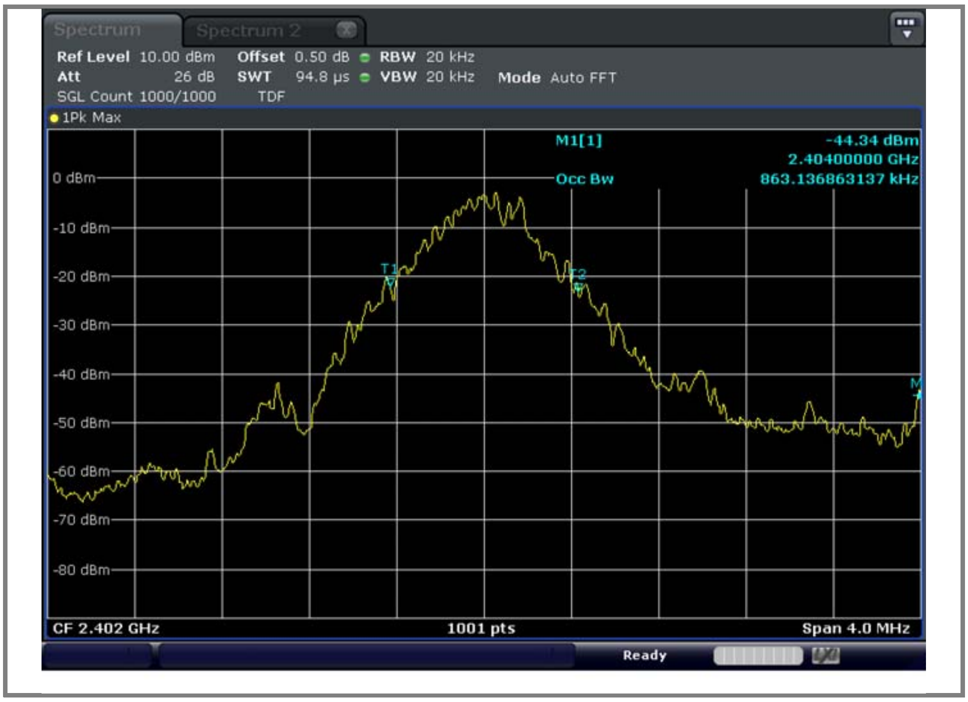
Ambient temperature: 24℃
Relative humidity: 49% R.H.

Operation mode	Frequency(㎒)	20 ㏈ bandwidth (㎒)	99% bandwidth(㎒)
BDR	2 402	0.81	0.86
	2 441	0.82	0.86
	2 480	0.82	0.86
EDR	2 402	1.26	1.17
	2 441	1.21	1.17
	2 480	1.21	1.17

Operation mode: BDR

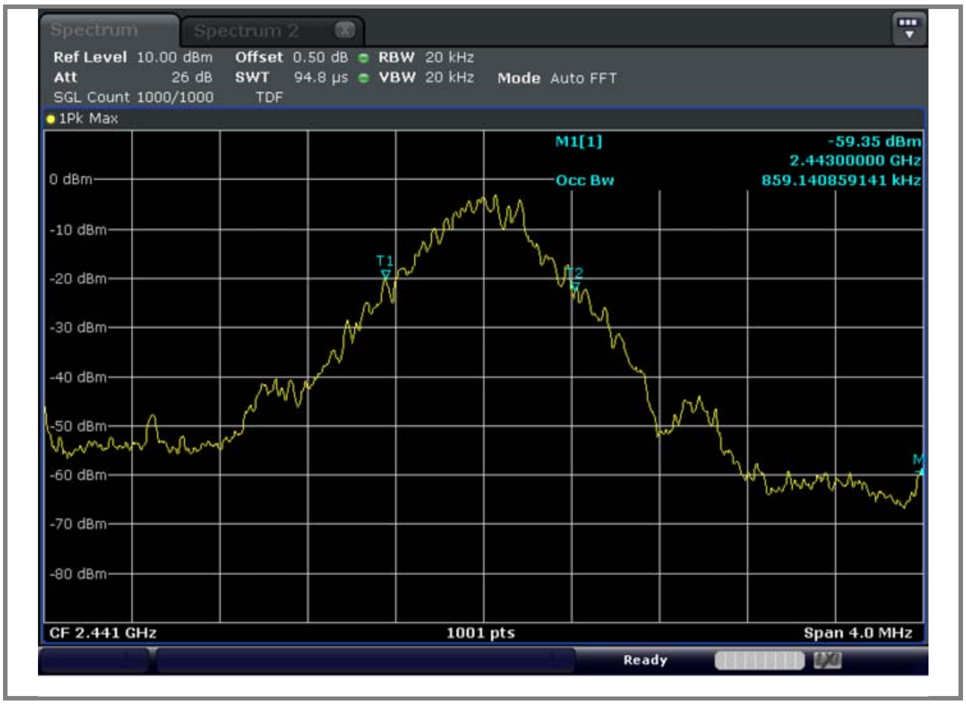
A. Low channel(2 402 ㎒)– 20 ㏈ bandwidth

A. Low channel(2 402 ㎒)–99 % bandwidth



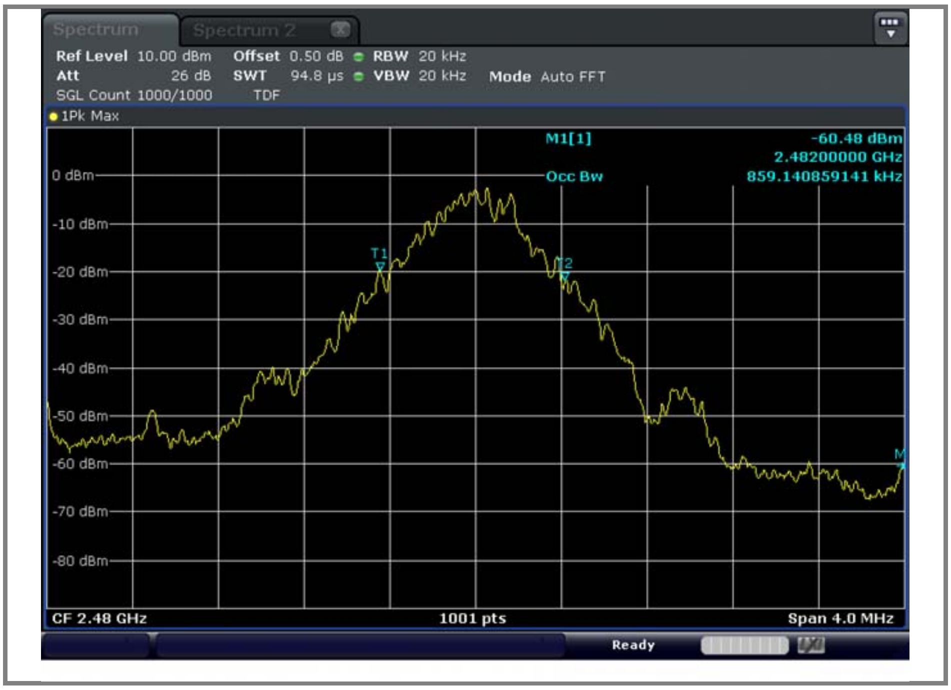
B. Middle channel(2 441 ㎒)– 20 ㏈ bandwidth

B. Middle channel(2 441 ㎒)–99 % bandwidth



C. High channel(2 480 ㎒)– 20 ㏈ bandwidth

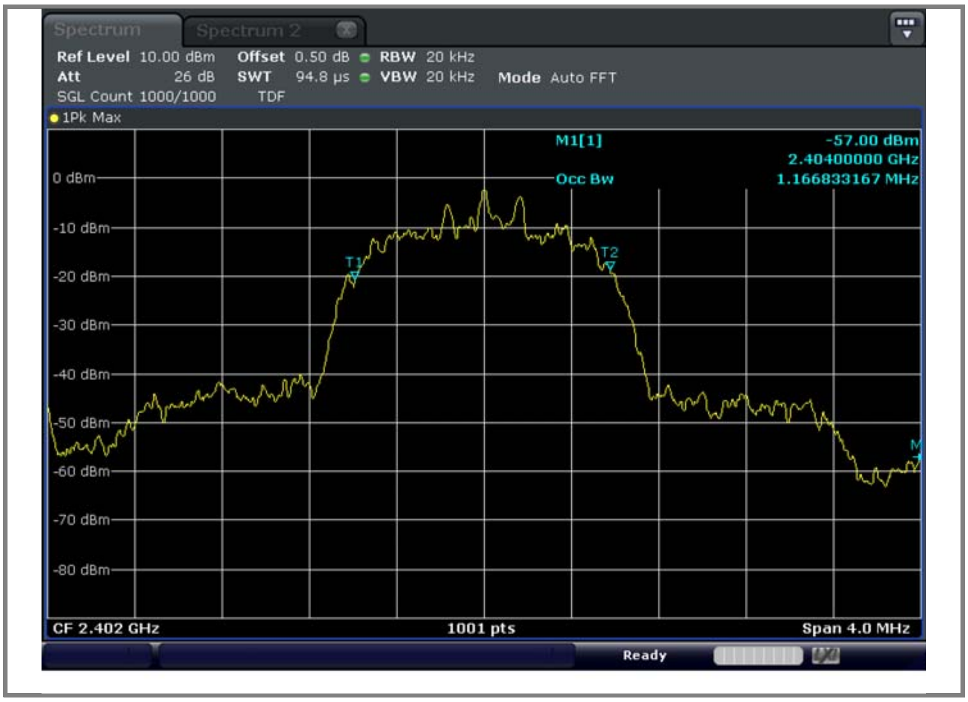
C. High channel(2 480 ㎒)–99 % bandwidth



Operation mode: EDR

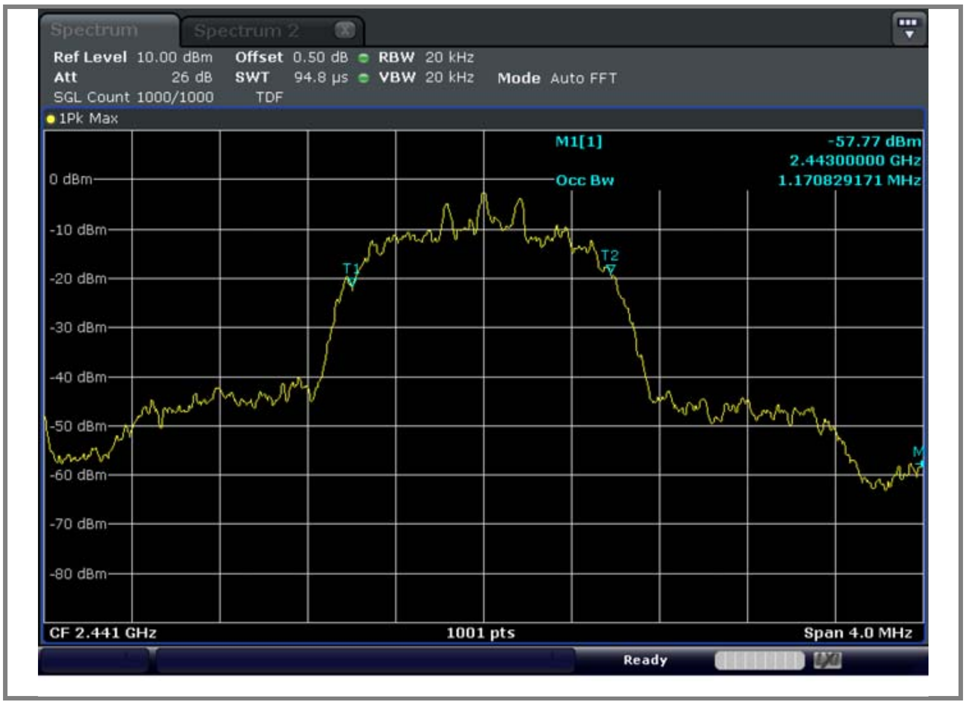
A. Low channel(2 402 ㎒)– 20 ㏈ bandwidth

A. Low channel(2 402 ㎒)–99 % bandwidth



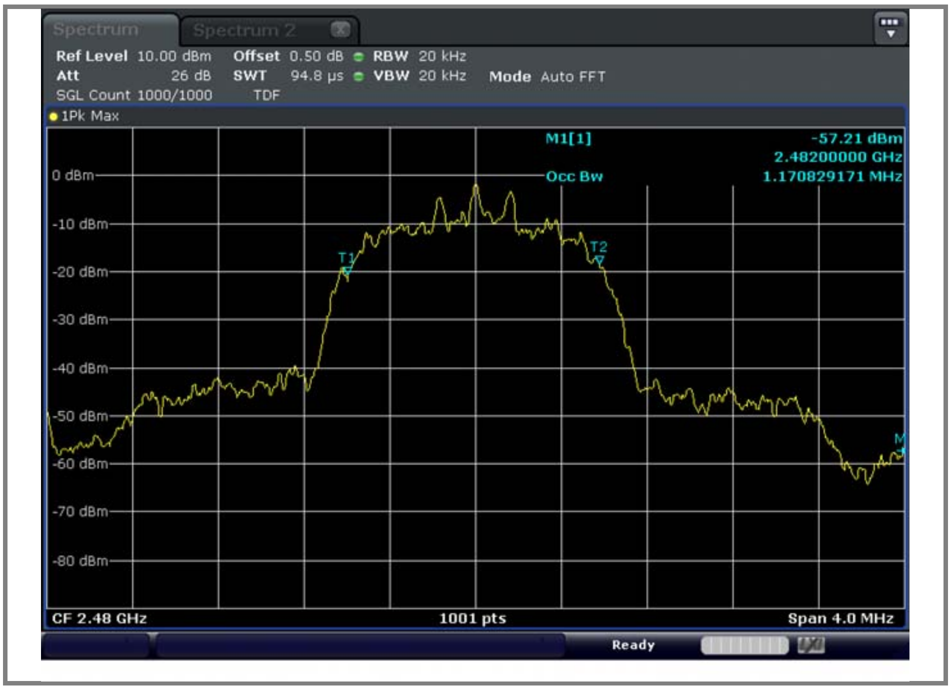
B. Middle channel(2 441 ㎒)– 20 ㏈ bandwidth

B. Middle channel(2 441 ㎒)–99 % bandwidth



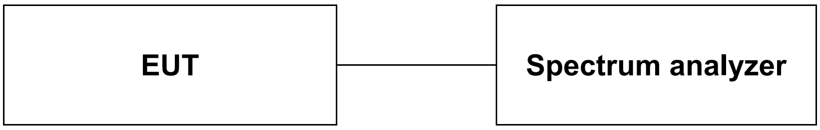
C. High channel(2 480 ㎒)– 20 ㏈ bandwidth

C. High channel(2 480 ㎒)–99 % bandwidth



7. Maximum peak output power measurement

7.1. Test setup.



7.2. Limit

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

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

7.3. Test procedure

1. The RF power output was measured with a Spectrum analyzer connected to the RF Antenna connector(conducted measurement) while EUT was operating in transmit mode at the appropriate center frequency,A spectrum analyzer was used to record the shape of the transmit signal.
2. The bandwidth of the fundamental frequency was measured with the spectrum analyzer using;
   Span = approximately 5 times the 20 ㏈ bandwidth, centered on a hopping channel
   RBW ≥ 20㏈ BW, VBW ≥ RBW, Sweep = auto, Detector function = peak, Trace = max hold

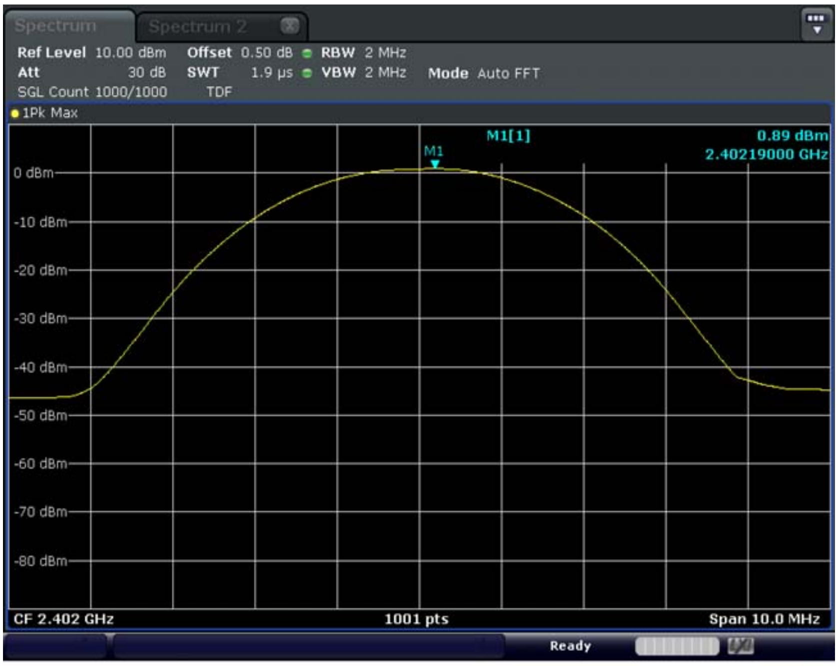
7.4. Test results

Ambient temperature: 24℃
Relative humidity: 49% R.H.

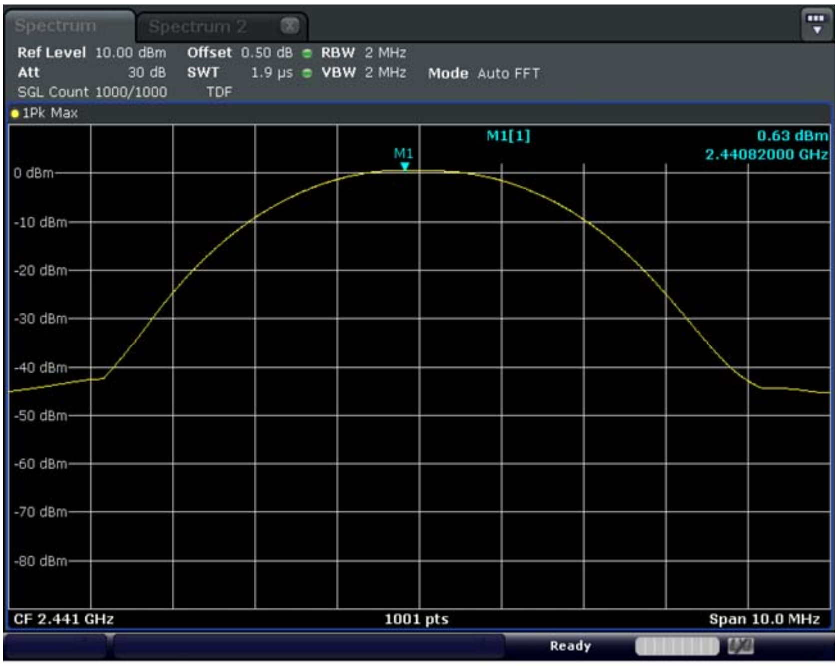
Operation mode	Frequency(㎒)	Peak output power(㏈m)	Limit(㏈m)
BDR	2 402	0.89	30
	2 441	0.63	30
	2 480	0.89	30
EDR	2 402	2.22	30
	2 441	1.71	30
	2 480	2.03	30

Operation mode: BDR

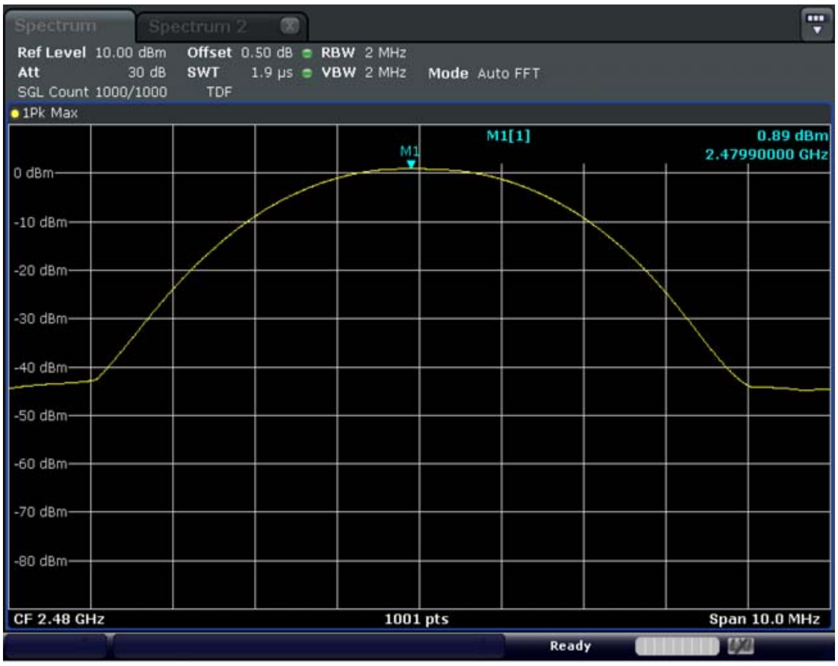
A. Low channel(2 402 ㎒)



B. Middle channel(2 441 ㎒)

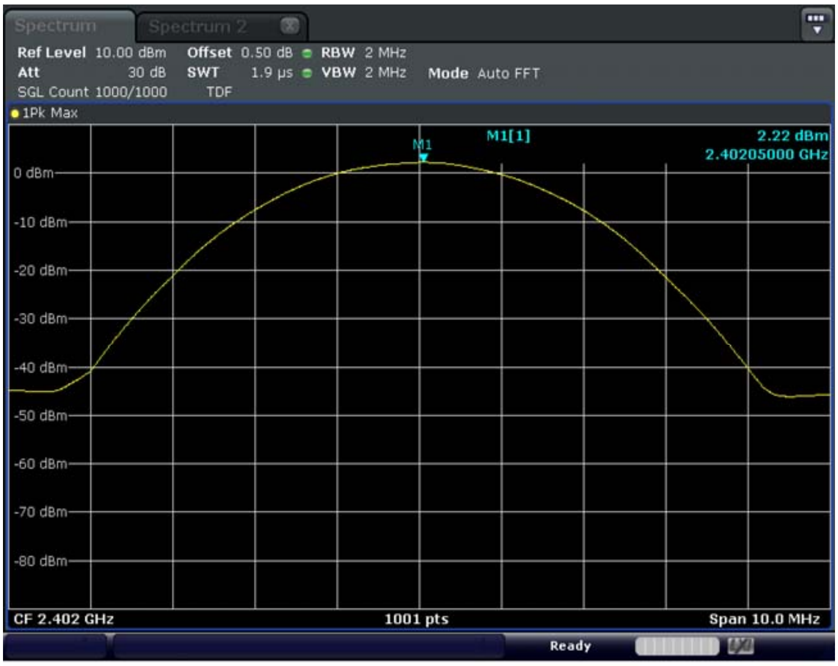


C. High channel(2 480 ㎒)

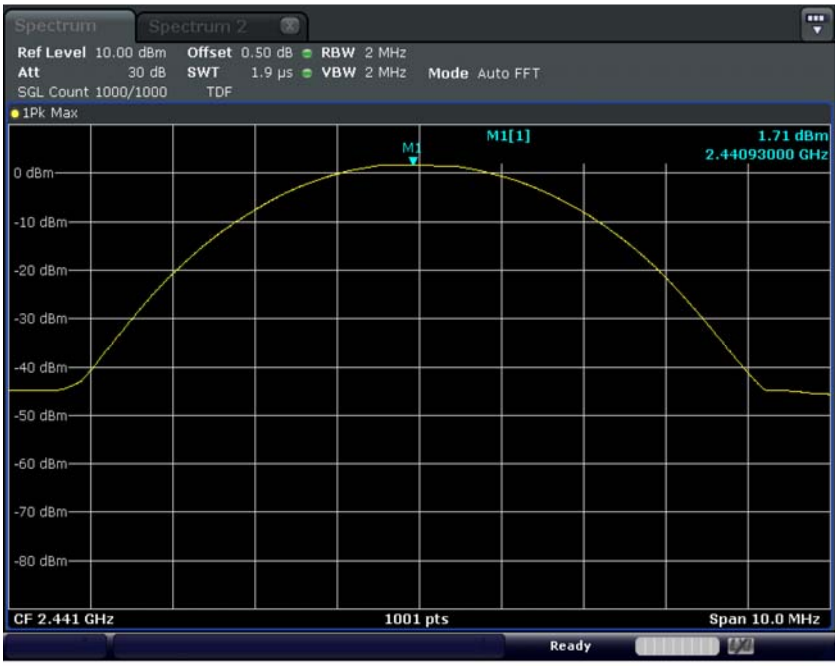


Operation mode: EDR

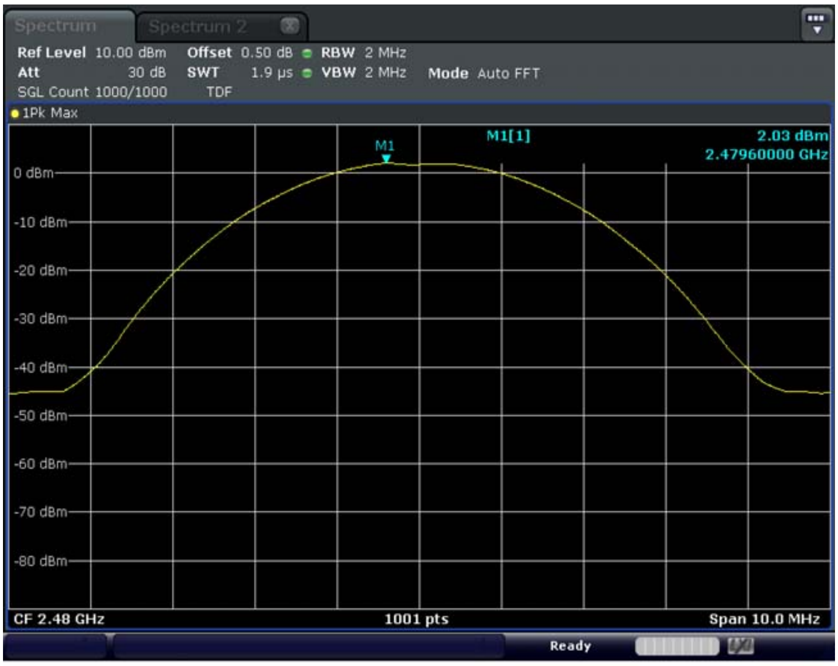
A. Low channel(2 402 ㎒)



B. Middle channel(2 441 ㎒)

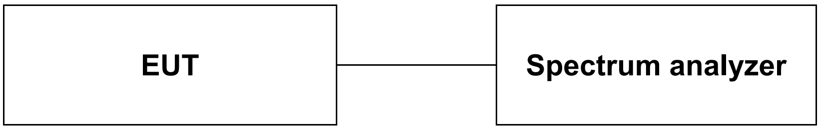


C. High channel(2 480 ㎒)



8. Hopping channel separation

8.1. Test setup



8.2. Limit

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

8.3. Test procedure

1. Check the calibration of the measuring instrument using either an internal calibrator or a known signalfrom an external generator.
2. Position the EUT as shown in test setup without connection to measurement instrument. Turn on the EUTand connect it to measurement instrument. Then set it to any one convenient frequency within its operatingrange.
3. By using the max hold function record the separation of adjacent channels.
4. Measure the frequency difference of these two adjacent channels by spectrum analyzer mark function.And then plot the result on spectrum analyzer screen.
5. Repeat above procedures until all frequencies measured were complete.
6. Set center frequency of spectrum analyzer = middle of hopping channel.
7. Set the spectrum analyzer as RBW = 10 ㎑, VBW = 10 ㎑, Span = 5 ㎒ and Sweep = auto.

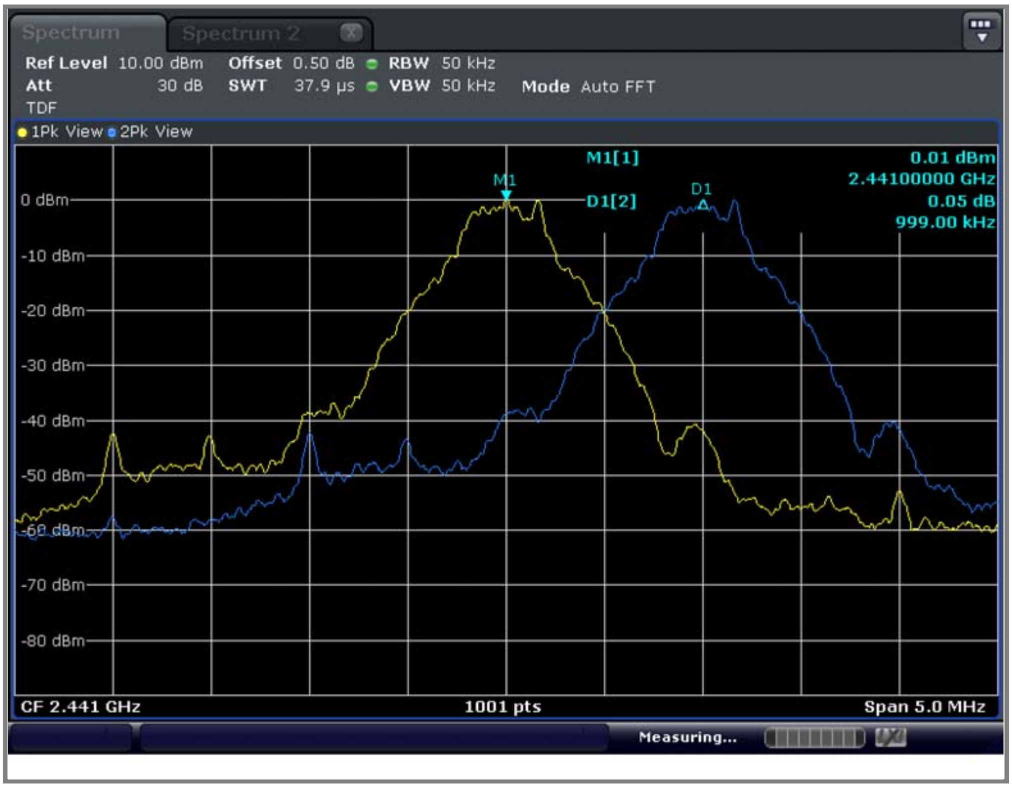
8.4. Test results

Ambient temperature: 24℃
Relative humidity: 49% R.H.

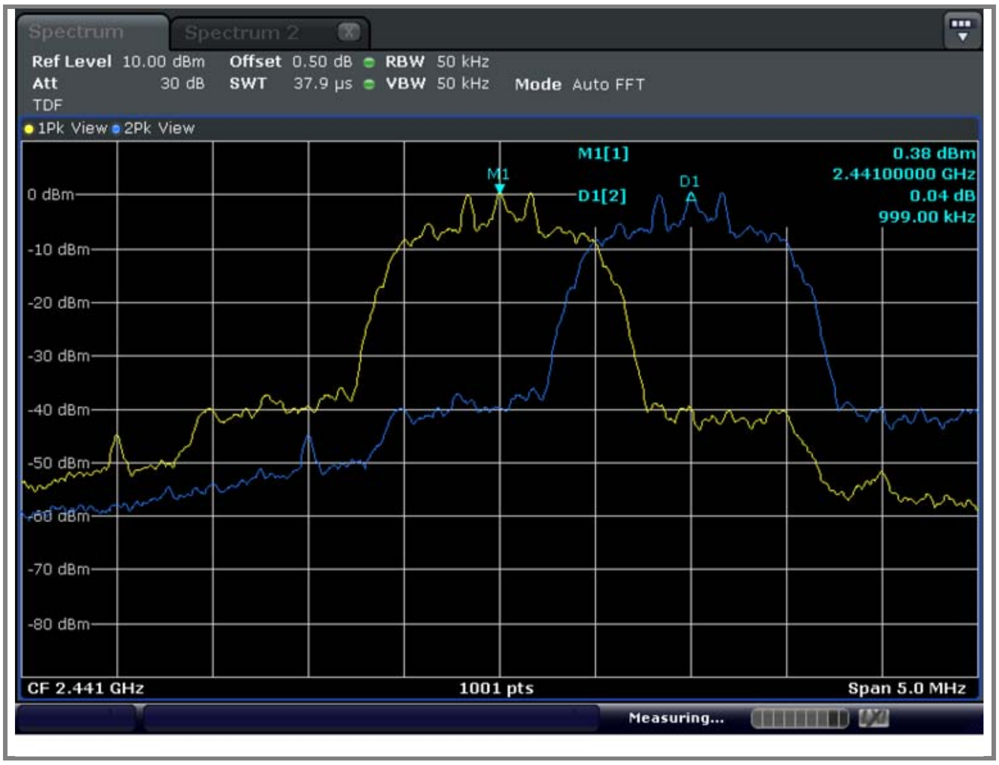
Operation mode	Frequency (㎒)	Adjacent hopping Channel separation (㎑)	Two-third of 20 ㏈ bandwidth (㎑)	Minimum bandwidth (㎑)
BDR	2 441	999	0.547	25
EDR	2 441	999	0.840	25

※ Remark:
20 ㏈bandwidth measurement, the measured channel separation should be greater than two-third of 20 ㏈bandwidth or Minimum bandwidth.

Operation mode :BDR

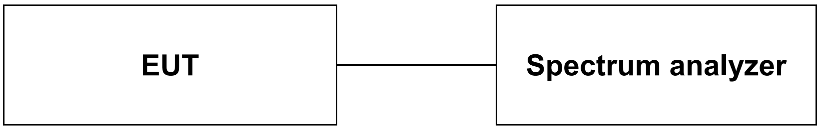


Operation mode: EDR



9. Number of hopping frequency

9.1. Test setup



9.2. Limit

§15.247(a)(1)(iii) For frequency hopping system operating in the 2400-2483.5㎒ bands shall use at least15 hopping frequencies.

9.3. Test procedure

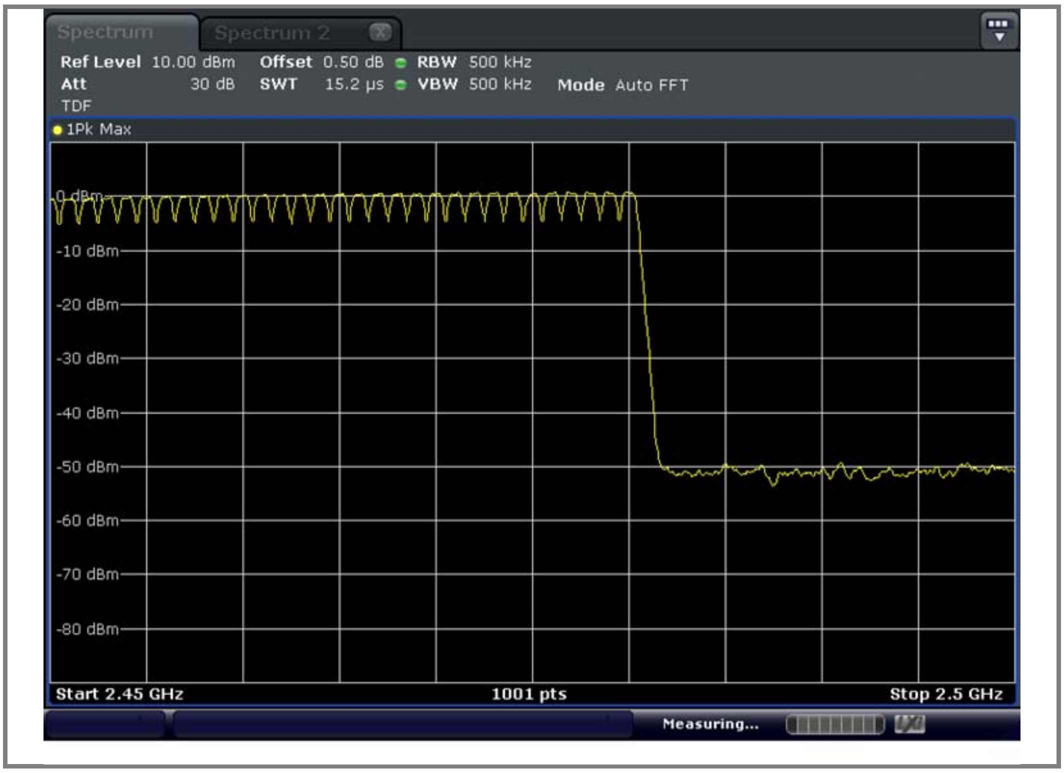
1. Place the EUT on the table and set it in transmitting mode.
2. Remove the antenna from the EUT and then connect a low loss RF cable from the antenna the port to theSpectrum analyzer
3. Set spectrum analyzer Start = 2400 ㎒, Stop = 2 441.5 ㎒, Sweep=auto and Start = 2 441.5 ㎒, Stop =2483.5 ㎒, Sweep = auto.
4. Set the spectrum analyzer as RBW, VBW=500 ㎑.
5. Max hold, view and count how many channel in the band.

9.4. Test results

Ambient temperature: 24℃
Relative humidity: 49% R.H.

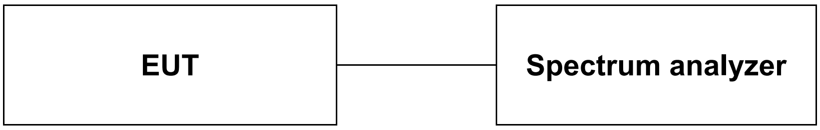
Number of Hopping Frequency	Limit
79	≥ 15

Operation mode: Hopping mode



10. Time of occupancy(Dwell time)

10.1. Test setup



10.2. Limit

§15.247(a)(1)(iii) For frequency hopping system operating in the 2 400 – 2 483.5 ㎒ band, theaverage timeof occupancy on any frequency shall not be greater than 0.4 second within a 31.6 second period.

A period time = 0.4(s) * 79 = 31.6(s)

10.3. Test procedure

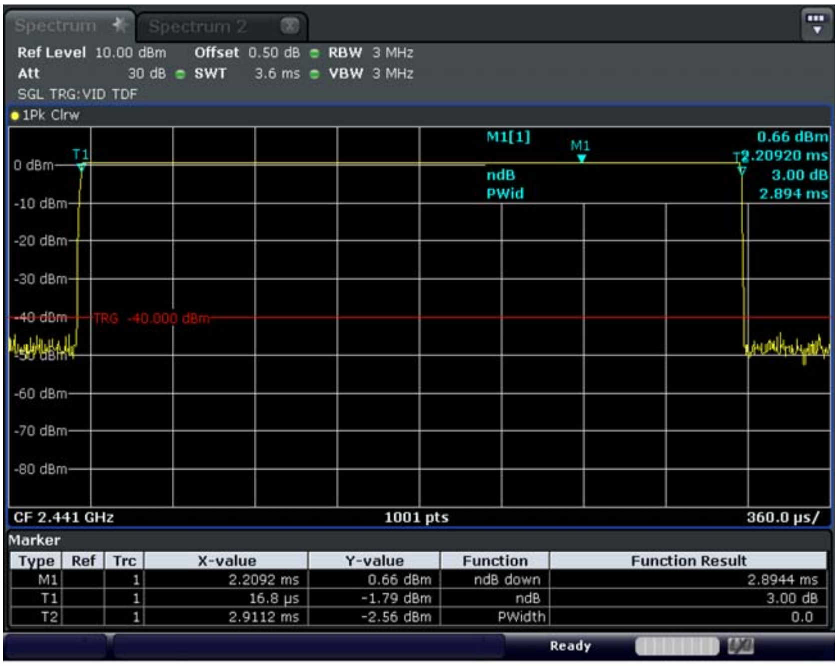
1. Check the calibration of the measuring instrument using either an internal calibrator or a known signalfrom an external generator.
2. Position the EUT as shown in test setup without connection to measurement instrument. Turn on the EUTand connect its antenna terminal to measurement instrument via a low loss cable.
3. Adjust the center frequency of spectrum analyzer on any frequency be measured and set spectrumanalyzer to zero span mode. And then, set RBW and VBW of spectrum analyzer to proper value.
4. Measure the time duration of one transmission on the measured frequency. And then plot the result withtime difference of this time duration.
5. Repeat above procedures until all frequencies measured were complete.
6. The hopping rate is1 600 per second.

10.4. Test results

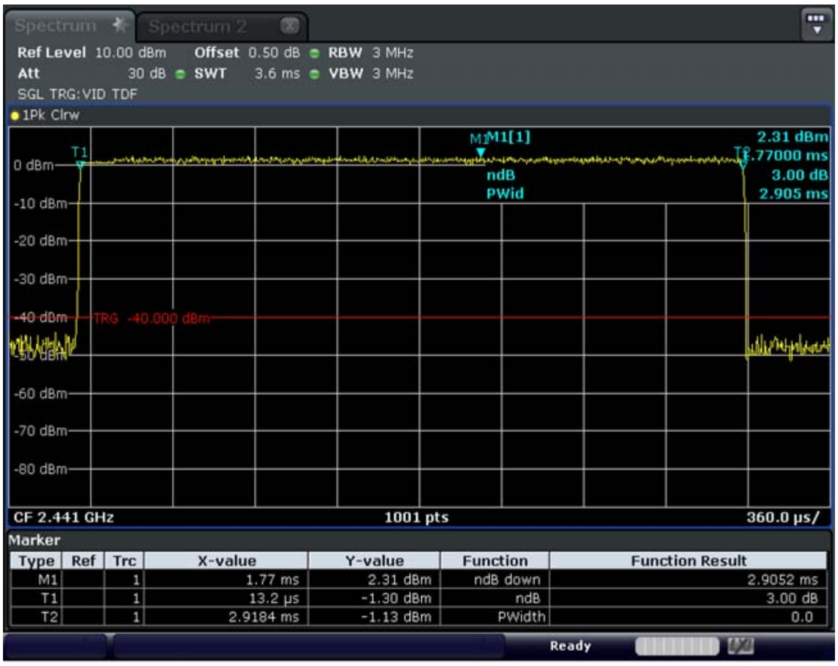
Ambient temperature: 24℃
Relative humidity: 49 % R.H.
0.4 seconds within a 30 second period per any frequency

Mode	On Time [ms]	Hopping Rate	Result [s]	Limit [s]
BDR	2.89	266.67	0.31	0.40
EDR	2.90	266.67	0.31	0.40

A. BDR

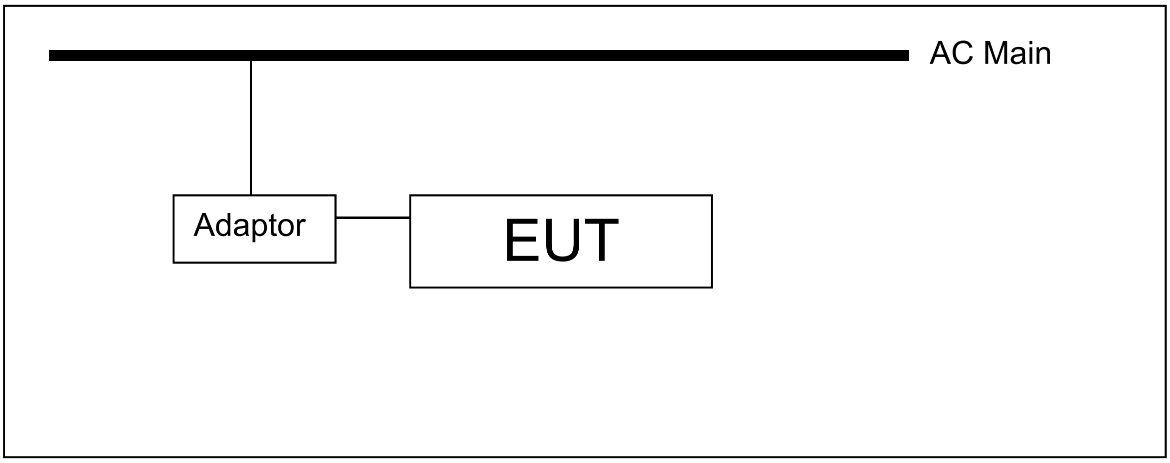

Ref Level 10.00 dBm Offset 0.50 dB RBW 3 MHz
Att 30 dB SWT 3.6 ms VBW 3 MHz
SGL TRG:VID TDF
1Pk Clrw
M1[1] 0.66 dBm
2.20920 ms
ndB 3.00 dB
PWid 2.894 ms
TRG -40.000 dBm
CF 2.441 GHz
1001 pts
360.0 µs/
Marker
Type Ref Trc X-value Y-value Function Function Result
M1 1 2.2092 ms 0.66 dBm ndB down 2.8944 ms
T1 1 16.8 µs -1.79 dBm ndB 3.00 dB
T2 1 2.9112 ms -2.56 dBm PWidth 0.0
Ready

B. EDR


Ref Level 10.00 dBm Offset 0.50 dB RBW 3 MHz
Att 30 dB SWT 3.6 ms VBW 3 MHz
SGL TRG:VID TDF
1Pk Clrw
M1[1] 2.31 dBm
1.77000 ms
ndB 3.00 dB
PWid 2.905 ms
TRG -40.000 dBm
CF 2.441 GHz
1001 pts
360.0 µs/
Marker
Type Ref Trc X-value Y-value Function Function Result
M1 1 1.77 ms 2.31 dBm ndB down 2.9052 ms
T1 1 13.2 µs -1.30 dBm ndB 3.00 dB
T2 1 2.9184 ms -1.13 dBm PWidth 0.0
Ready

11. AC Conducted power line test

11.1 Test setup



11.2 Limit

According to §15.107(a) for an intentional radiator that is designed to be connected to the public utility (AC) power line, the radio frequency voltage that is conducted back onto the AC power lineon any frequency or frequencies, within the band 150 ㎑ to 30 ㎒, shall not exceed the limitsin the following table, as measured using a 50 uH/50ohm line impedance stabilization network(LISN).
Compliance with the provision of this paragraph shall on the measurement of the radio frequencyvoltage between each power line and ground at the power terminal. The lower applies at the boundary between the frequencies ranges.

Frequency of Emission (㎒)	Conducted limit (dB㎶/m)	
	Quasi-peak	Average
0.15 – 0.50	66-56*	56-46*
0.50 – 5.00	56	46
5.00 – 30.0	60	50

※ **Remark**

Decreases with the logarithm of the frequency.

11.3 Test procedures

The test procedure is performed in a 6.5 m × 3.6 m × 3.6 m (L×W×H) shielded room. The EUTalong with its peripherals were placed on a 1.0m(W)× 1.5m(L) and 0.8m in heightwooden table and the EUT was adjusted to maintain a 0.4 meter space from a verticalreference plane.
The EUT was connected to power mains through a line impedancestabilization network (LISN) which provides 50 ohm coupling impedance for measuringinstrument and the chassis ground was bounded to the horizontal ground plane of shieldedroom. All peripherals were connected to the second LISN and the chassis ground alsobounded to the horizontal ground plane of shielded room. The excess power cablebetween the EUT and the LISN was bundled. The power cables of peripherals wereunbundled. All connecting cables of EUT and peripherals were moved to find themaximum emission.

11.4 Test results

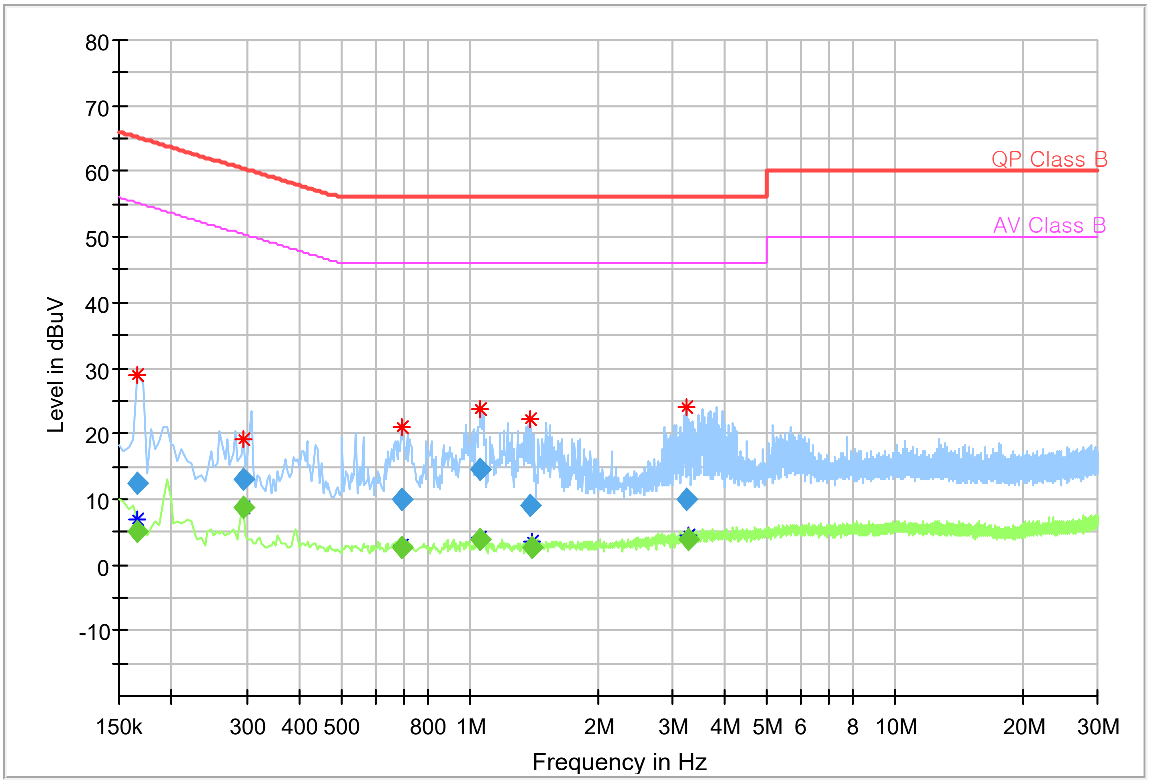
Ambient temperature: 22℃
Relative humidity: 48% R.H.

Frequency range: 0.15 ㎒ ~ 30 ㎒
Measured bandwidth: 9 ㎑

Frequency (MHz)	QuasiPeak (dBuV)	CAverage (dBuV)	Limit (dBuV)	Margin (dB)	Line
0.17	12.35	---	65.16	52.81	N
0.17	---	5.19	55.16	49.96	L1
0.29	---	8.78	50.41	41.63	N
0.29	13.00	---	60.41	47.41	N
0.69	9.99	---	56.00	46.01	L1
0.69	---	2.74	46.00	43.26	L1
1.06	---	3.89	46.00	42.11	N
1.06	14.45	---	56.00	41.55	L1
1.39	9.12	---	56.00	46.88	L1
1.41	---	2.51	46.00	43.49	L1
3.25	10.08	---	56.00	45.92	L1
3.27	---	3.93	46.00	42.07	L1

※ Remark
Line(L1): Hot
Line(N): Neutral

Plot of conducted power line



12. Antenna requirement

12.1.Standard Applicable

For intentional device, according to FCC 47 CFR Section §15.203, an intentional radiator shall be designedto ensure that no antenna other than that furnished by the responsible party shall be used with the device.And according to FCC 47 CFR Section §15.247 (b) if transmitting antennas of directional gain greater than 6㏈i are used.

12.2.Antenna Connected Construction

Antenna used in this product is PCB antenna
Antenna gain is 3.609 ㏈i.

13. RF exposure evaluation

13.1 RF Exposure Compliance Requirement

13.1.1 Standard Requirement

According to KDB447498D01 General RF Exposure Guidance v06
4.3.1. Standalone SAR test exclusion considerations
Unless specifically required by the published RF exposure KDB procedures, standalone 1-g head or body and 10-g extremity SAR evaluation for general population exposure conditions, by measurement or numerical simulation, is not required when the corresponding SAR Exclusion Threshold condition, listed below, is satisfied.

13.1.2 Limits

The 1-g and 10-g SAR test exclusion thresholds for 100 MHz to 6 GHz at test separation distances ≤ 50 mm are determined by:
[(max. power of channel, including tune-up tolerance, mW)/(min. test separation distance, mm)] · [√f(GHz)] ≤ 3.0 for 1-g SAR and ≤ 7.5 for 10-g extremity SAR, where
f(GHz) is the RF channel transmit frequency in GHz
Power and distance are rounded to the nearest mW and mm before calculation
The result is rounded to one decimal place for comparison
The test exclusions are applicable only when the minimum test separation distance is ≤ 50 mm and for transmission frequencies between 100 MHz and 6 GHz. When the minimum test separation distance is < 5 mm, a distance of 5 mm is applied to determine SAR test exclusion

The SAR exclusion table from RSS-102 issue 5 is reproduced below:

Table 1: SAR evaluation – Exemption limits for routine evaluation based on frequency and separation distance

Frequency (MHz)	Exemption Limits (mW)				
	At separation distance of ≤5 mm	At separation distance of 10 mm	At separation distance of 15 mm	At separation distance of 20 mm	At separation distance of 25 mm
≤300	71 mW	101 mW	132 mW	162 mW	193 mW
450	52 mW	70 mW	88 mW	106 mW	123 mW
835	17 mW	30 mW	42 mW	55 mW	67 mW
1900	7 mW	10 mW	18 mW	34 mW	60 mW
2450	4 mW	7 mW	15 mW	30 mW	52 mW
3500	2 mW	6 mW	16 mW	32 mW	55 mW
5800	1 mW	6 mW	15 mW	27 mW	41 mW

Frequency (MHz)	Exemption Limits (mW)				
	At separation distance of 30 mm	At separation distance of 35 mm	At separation distance of 40 mm	At separation distance of 45 mm	At separation distance of 50 mm
≤300	223 mW	254 mW	284 mW	315 mW	345 mW
450	141 mW	159 mW	177 mW	195 mW	213 mW
835	80 mW	92 mW	105 mW	117 mW	130 mW
1900	99 mW	153 mW	225 mW	316 mW	431 mW
2450	83 mW	123 mW	173 mW	235 mW	309 mW
3500	86 mW	124 mW	170 mW	225 mW	290 mW
5800	56 mW	71 mW	85 mW	97 mW	106 mW

13.1.3 EUT RF Exposure

Operation mode: BDR

The Max Conducted Average Output Power is 0.76dBm in Highest channel(2.480 GHz)

Target power & Tolerance
Target power:0.00 dBm Tolerance: ±1.00 dBm

1.00dBm logarithmic terms convert to numeric result is nearly 1.26 mW
According to the formula. calculate the Peak Output Power test result:

General RF Exposure = (1.26 mW / 5 mm) x √2.480 GHz = 0.397

So the SAR report is not required.

※ Remark
[(max. power of channel, including tune-up tolerance, mW)/(min. test separation distance, mm)] · [√f(GHz)]

Operation mode: EDR

The Max Conducted Average Output Power is -0.29dBm in Highest channel(2.402 GHz)

Target power & Tolerance
Target power:0.00 dBm Tolerance: ±1.00 dBm

7.00dBm logarithmic terms convert to numeric result is nearly 1.26 mW
According to the formula. calculate the Peak Output Power test result:

General RF Exposure = (1.26 mW / 5 mm) x √2.480 GHz = 0.397

So the SAR report is not required.

※ **Remark**
[(max. power of channel, including tune-up tolerance, mW)/(min. test separation distance, mm)] · [√f(GHz)]