FCC Part 15 Subpart C Requirement and Industry Canada RSS-210

Measurement and Test Report

For

Sanwa Electronic Instrument Co., Ltd

1-2-50, Yoshida Honmachi, Higashi-Osaka, Osaka 578-0982, Japan

FCC ID: L73-92015
IC: 7377A-92015

July 30, 2013

This Report Concerns:	**Equipment Type:**
☒ Original Report	2.4GHz Radio Control System

Tested By:	Bossco He *(Test Engineer)*
Report Number:	SE13G-223FI
Test Date:	July 10 to 23, 2013
Reviewed By:	Karbon Y.Chung *(Senior Manager)*
Prepared By:	S&E Technologies Laboratory Ltd Room 407, Block A Shennan Garden, Hi-Tech Industrial Park, Shenzhen 518057, P.R. China. Tel: 86-755-26636573, 26630631 Fax: 86-755-26630557

Note: This test report is limited to the above client company and the product model only. It may not be duplicated without prior written consent of S&E Technologies Laboratory Ltd.

Table of Contents

1-Test Result Certification

Applicant:	Sanwa Electronic Instrument Co., Ltd 1-2-50, Yoshida Honmachi, Higashi-Osaka, Osaka 578-0982, Japan
Equipment Under Test:	2.4GHz Radio Control System
Trade Name:	***AIRTRONICS***
Model:	92015
Type of Modulation:	FHSS
Number of Channels:	76 (FH4 mode) 56 (FH4T mode) 41 (FH4FT mode)
Channel Separation:	1MHz
Operation Frequency:	2403 ~ 2478MHz (FH4 mode) 2410 ~ 2465MHz (FH4T mode) 2410 ~ 2450MHz (FH4FT mode) *Note: The above three operation modes can be mutually switched by matched transmitters.*
Antenna Designation:	Non-user replaceable (fixed)
Battery Voltage:	DC6.0V [1.5V*4 “AA” Ni-MH battery pack]
Date of Test:	July 10 to 23, 2013

Applicable Standards	
Standard	Test Result
FCC 47 CFR Part 15 Subpart C: 2012, §15.247 Industry Canada: RSS-210 issue 8: 2010, Annex 8 Industry Canada: RSS-Gen issue 3: 2010	No non-compliance noted

We hereby certify that:

The above equipment was tested at ATC Lab Co., Ltd (Guangdong, China). The test data, data evaluation, test procedures, and equipment configurations shown in this report were made in accordance with the procedures given in ANSI C63.4: 2003 and Public Notice DA00-705. The energy emitted by the sample EUT tested as described in this report is in compliance with conducted and radiated emission limits of FCC Rules Part 15C: 2012, §15.247 and RSS-210 Issue 8, Annex 8.

The test results of this report relate only to the tested sample identified in this report.

2- EUT Description

Product	2.4GHz Radio Control System
Trade Name	SANWA
Model Number	92015
Model Difference	N/A
Type of Modulation:	FHSS
Number of Channels:	76 (FH4 mode) 56 (FH4T mode) 41 (FH4FT mode)
Channel Separation:	1MHz
Power Supply	6.0V DC power from [1.5V*4 “AA” Ni-MH battery pack]
Operation Frequency:	2403 ~ 2478MHz (FH4 mode) 2410 ~ 2465MHz (FH4T mode) 2410 ~ 2450MHz (FH4FT mode)
Antenna Designation	Non-user replaceable (fixed)

Remark: This submittal(s) of test report is intended for FCC ID: L73-92015, IC: 7377A–92015 filing to comply with Section 15.247 of the FCC Part 15, Subpart C Rules and RSS-210 Issue 8, Annex 8.

3-Test System

3.1 Test Mode

The compliance test was performed under test modes:

Mode 1: Transmitting at 2403MHz without hopping at FH4 mode.
Mode 2: Transmitting at 2442MHz without hopping at FH4 mode.
Mode 3: Transmitting at 2478MHz without hopping at FH4 mode.
Mode 4: Transmitting with hopping at FH4 mode.
Mode 5: Transmitting at 2410MHz without hopping at FH4T mode.
Mode 6: Transmitting at 2438MHz without hopping at FH4T mode.
Mode 7: Transmitting at 2465MHz without hopping at FH4T mode.
Mode 8: Transmitting with hopping at FH4T mode.
Mode 9: Transmitting at 2410MHz without hopping at FH4FT mode.
Mode 10: Transmitting at 2430MHz without hopping at FH4FT mode.
Mode 11: Transmitting at 2450MHz without hopping at FH4FT mode.
Mode 12: Transmitting with hopping at FH4FT mode.

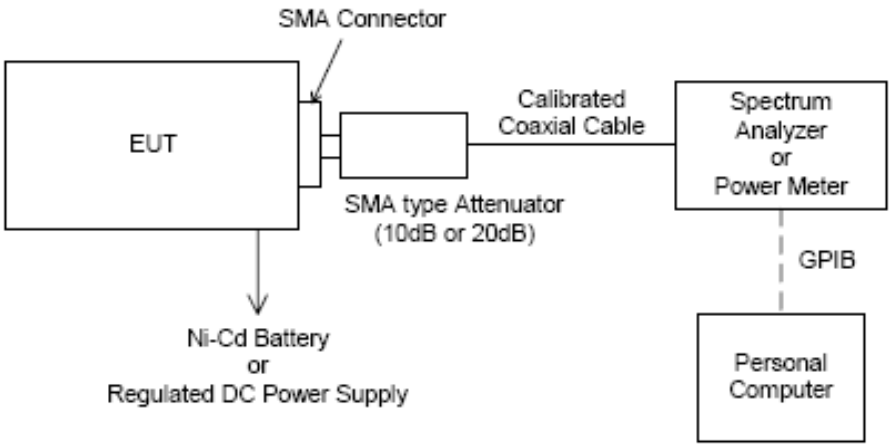
The EUT is designed to be both of horizontally and vertically placed.
During radiated emission measurement, each condition was conducted.

As a result, the operation that produces the maximum emission under was reported.

a) Carrier Frequency Separation Measurement ---Mode 4, Mode 8, Mode 12.
b) Number of Hopping Frequencies Measurement --- Mode 4, Mode 8, Mode 12.
c) Time of Occupancy Measurement --- Mode 4, Mode 8, Mode 12.
d) Peak Output Power Measurement --- Mode 1, Mode 2, Mode 3, Mode 5, Mode 6, Mode 7, Mode 9, Mode 10, Mode 11.
e) Band Edge of RF Conducted Measurement --- Mode 4, Mode 8, Mode 12.
f) Radiated Emission Measurement --- Mode 1, Mode 2, Mode 3, Mode 5, Mode 6, Mode 7, Mode 9, Mode 10, Mode 11.
g) Band Edge and Restricted Band of Radiated Emission Measurement--- Mode 1, Mode 3, Mode 4, Mode 5, Mode 7, Mode 8, Mode 9, Mode 11, Mode 12.
h) 99% and 20dB Bandwidth measurement --- Mode 1, Mode 2, Mode 3, Mode 5, Mode 6, Mode 7, Mode 9, Mode 10, Mode 11.

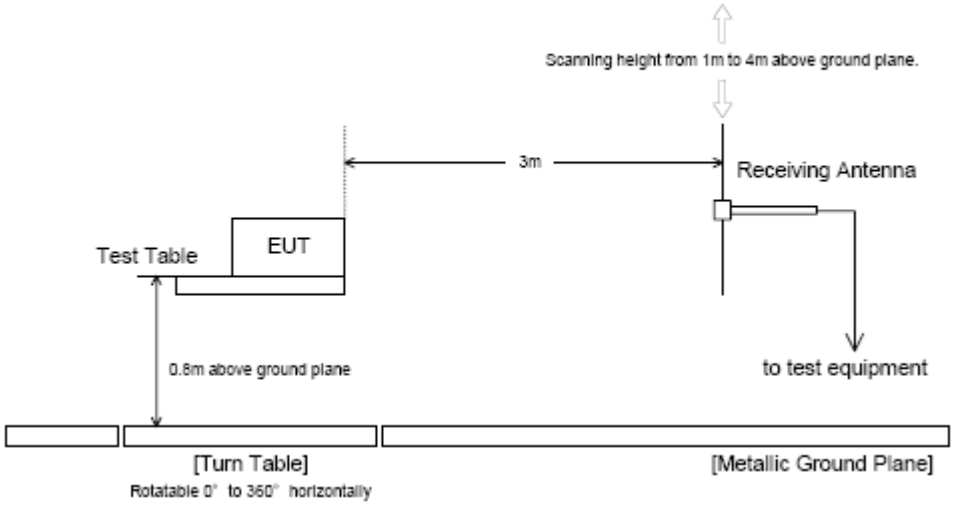
3.2 Test Setup Diagram

. Carrier Frequency Separation
. Number of Hopping Frequencies
. Time of Occupancy (Dwell Time)
. Peak Output Power
. Band Edge of RF Conducted Emission
. Band Edge and Restricted Band of Radiated Emission measurement
. 99% Bandwidth
. 20dB Bandwidth



Note: Regulated DC power supply is not used in this report.

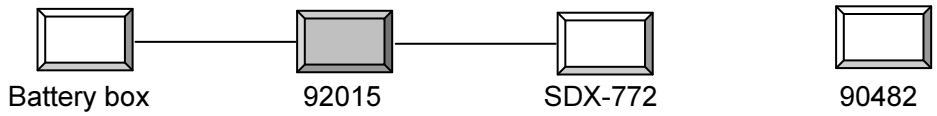
.
. Radiated Emission



3.3 Description of Test Auxiliary Equipments

Description	Manufacturer	Model No.	Certificate
Transmitter	Sanwa Electronic Instrument Co., Ltd	90482	L73-90482
Servo motor		SDX-772	FCC
Battery box		4xAA	N/A

3.4 Block Diagram of EUT System



3.5 List of Cables

No	Cable Name	Shielded (Y/N)	Length (m)	Note	Remark
1	Antenna	Y	0.20	/	/

4- Test Equipment and Calibration

Equipment type	Manufacturer	Model	Serial Number	Last Calibration	Calibration Period
Biconilog Antenna	ETS	3142C	00042672	2012/09	1 year
Receiver	SCHAFFNER	SMR4503	11725	2013/07	1 year
Spectrum Analyzer	R/S	FSP30	100755	2012/11	1 year
Double-Ridged-Wave-guide Horn Antenna	ETS	3115	6587	2012/08	1 year
Double-Ridged-Wave-guide Horn Antenna	ETS	3160	00052486	2012/08	1 year
Amplifier	Agilent	83017A	MY39500438	2012/11	1 year
Band-pass Filter	Micro-Tronic	BRM50702	S/N-030	2012/11	1 year
HF Loop Antenna	TESEQ	HLA6120	26348	2012/10	1 year
Anechoic Chamber	ETS	N/A	N/A	2013/05	1 year

5- Laboratory Accreditations and Measurement Uncertainty

5.1 Laboratory Accreditation

FCC-Registration No.: 415467

ATC Lab Co., Ltd (Guangdong, China) EMC Laboratory has been registered and fully described in a report filed with the FCC (Federal Communications Commission). The acceptance letter from the FCC is maintained in our files. Listing date: December 01, 2011.

IC-Registration No.: 7949A

The 3m Alternate Test Site of ATC Lab Co., Ltd (Guangdong, China) has been registered by Certification and Engineering Bureau of Industry Canada for the performance of radiated measurements with Registration No. 7949A on May 25th, 2011.

5.2 Measurement Uncertainty

of +/- 3×10-9 for Carrier Frequency Separation Measurement
of +/- 3×10-9 for Number of Hopping Frequencies Measurement
of +/- 3×10-9 for 20dB Bandwidth Measurement
of +/- 3×10-9 for Time of Occupancy (Dwell time) Measurement
of +/- 0.8 dB for Peak Output Power Measurement
of +/- 0.8 dB for Band Edge RF Conducted Measurement
of +/- 0.8 dB for Spurious RF Conducted Emission Measurement
of +/- 0.8 dB for Power Density
of +/- 4.8 dB for Radiated Emissions
of +/- 2.3 dB for Conducted Emissions

6- Technical Requirements and Results

6.1 Carrier Frequency Separation Measurement

Applicable Standard:

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.

According to RSS 210 issue 8, A8.1(b), 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 20dB bandwidth of the hopping channel, whichever is greater.

Test Procedure:

1. Connect the EUT RF output port to spectrum analyzer via calibrated coaxial cable and suitable attenuator (if necessary).
2. Activates the EUT system and execute the software prepared for test, if necessary.
3. To find out the maximum emission condition, the transmitting data rate of EUT is set to maximum data rate.
4. The spectrums are scanned and allow the trace stabilized.
5. The separation between the peaks of the peaks of adjacent channel were measured by using delta-maker function of the spectrum analyzer

Spectrum analyzer setup conditions:

Frequency span : 2MHz
Resolution bandwidth : 100kHz
Video bandwidth : 300KHz
Sweep : Auto
Detector function : Peak
Trace mode : Max Hold

Test Result:

Temperature:	25 °C
Humidity:	49%
EUT Operation:	Data Transmission (Hopping)
Test Date:	July 15, 2013

Test Mode	Carrier Frequency Separation [MHz]	[MHz] Limit
FH4	1.000MHz	>0.909
FH4T	1.028MHz	> 0.912
FH4FT	1.004MHz	> 0.899
Note: Test plots shown in figures 1, 2, 3 on pages 12, 13.		

Figure 1: Channel separation at FH4 mode

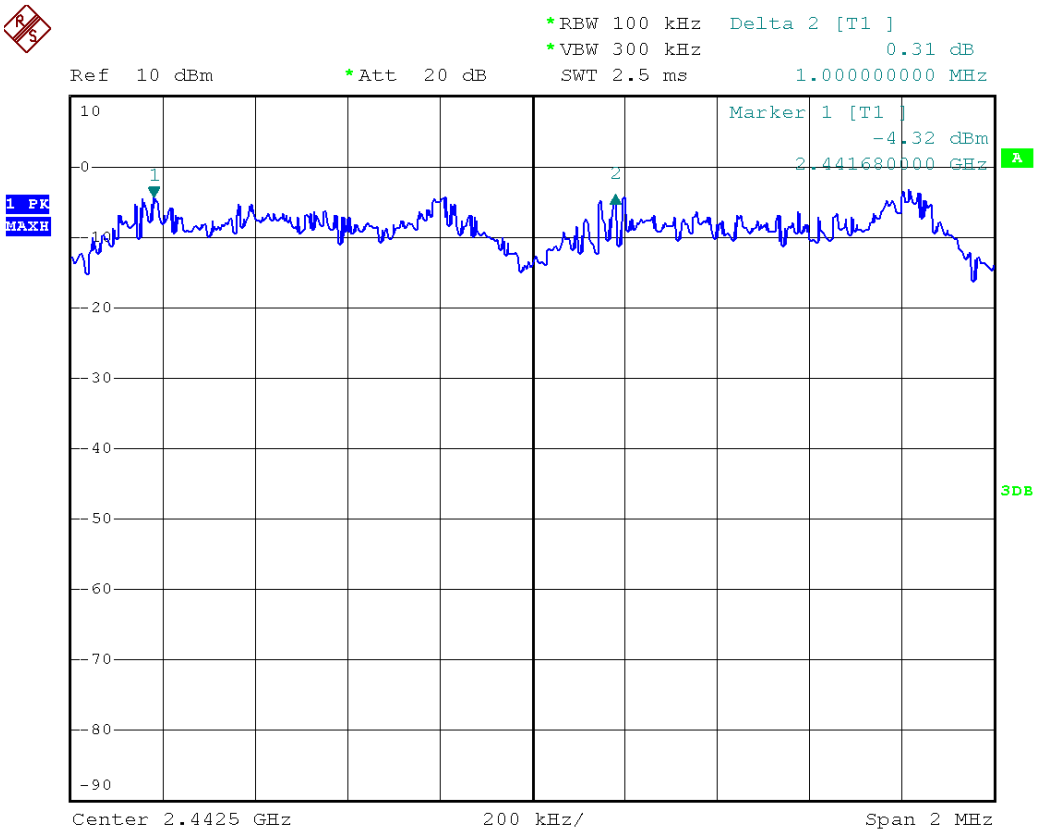


Figure 2: Channel separation at FH4T mode

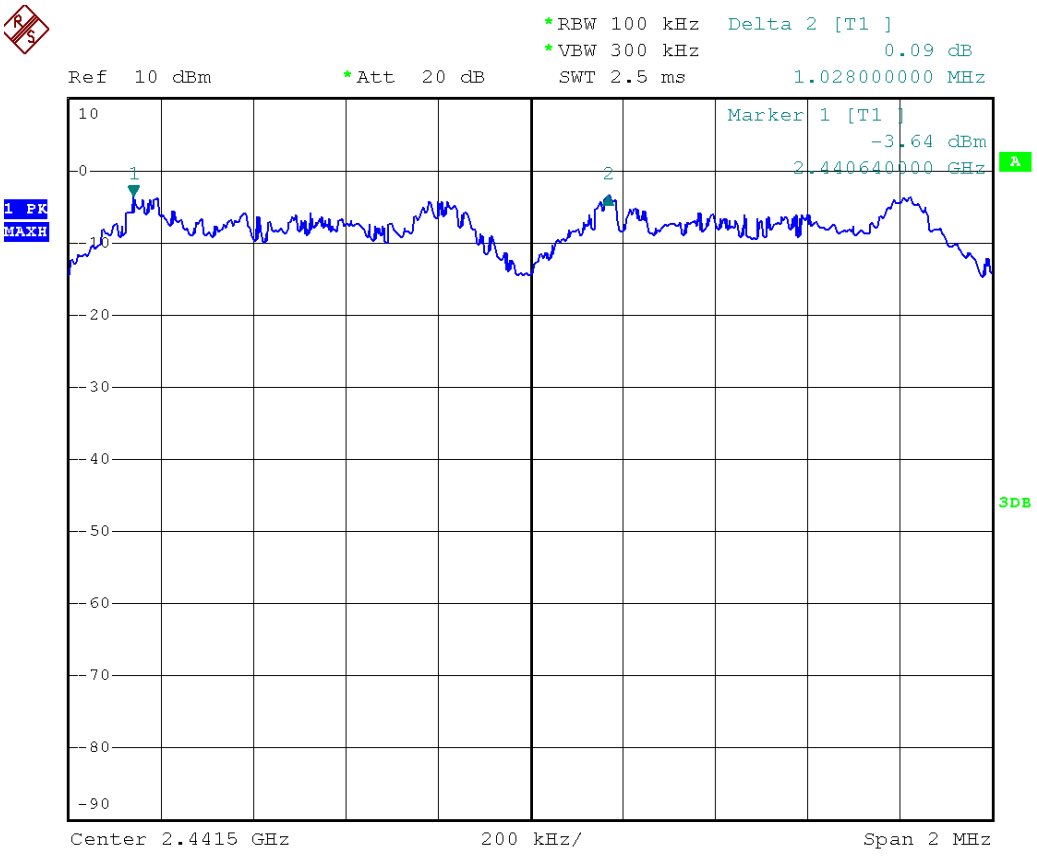
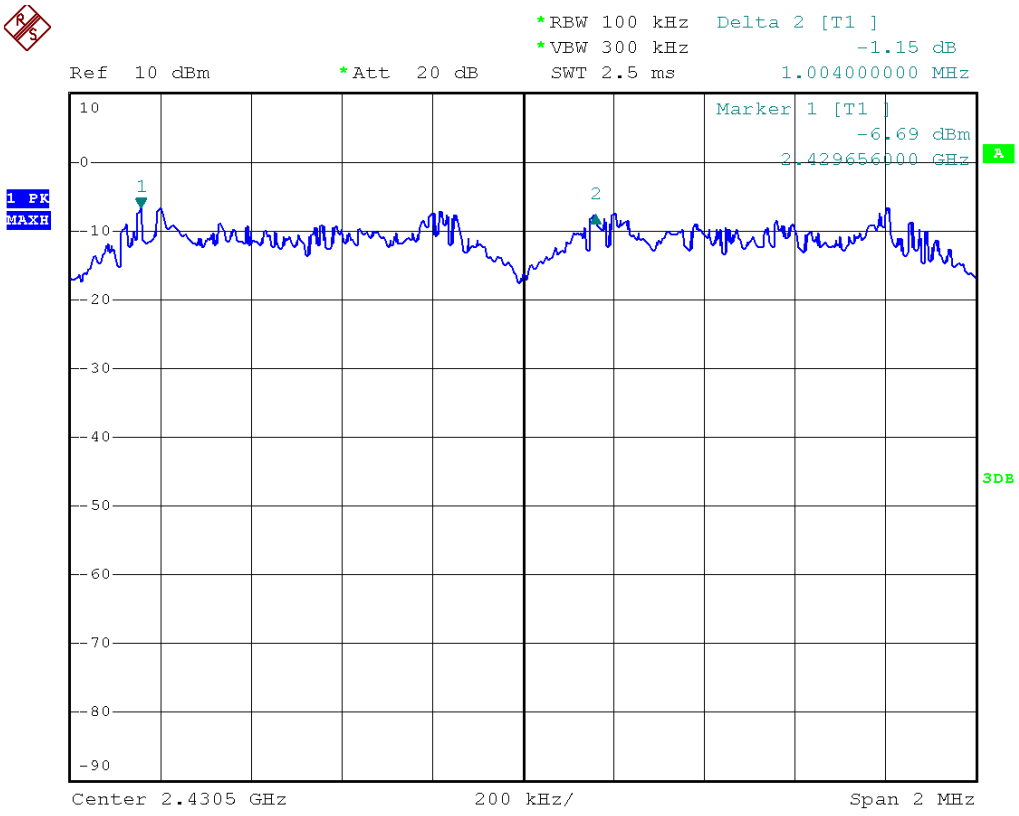


Figure 3: Channel separation at FH4FT mode



6.2 Number of Hopping Frequencies Measurement

Applicable Standard:

According to §15.247(a)(1)(iii), frequency hopping systems operating in the 2400MHz-2483.5 MHz bands shall use at least 15 hopping frequencies.

According to RSS-210 issue 8, §A8.1(d), frequency hopping systems operating in the 2400-2483.5MHz band shall use at least 15 hopping channels. 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. Transmissions on particular hopping frequencies may be avoided or suppressed provided that a minimum of 15 hopping channels are used.

Test Procedure:

1. Connect the EUT RF output port to spectrum analyzer via calibrated coaxial cable and suitable attenuator (if necessary).
2. Activates the EUT system and executes the software prepared for test, if necessary.
3. To find out the maximum emission condition, the transmitting data rate of EUT is set to maximum data rate.
4. The spectrums are scanned and allow the trace to stabilize.
5. The number of hopping frequencies were counted on the spectrum analyzer and recorded.

Spectrum analyzer setup conditions:

Resolution bandwidth : 100KHz
Video bandwidth : ≧RBW
Sweep : Auto
Detector function : Peak
Trace mode : Max Hold

Test Result:

Temperature:	26 °C
Humidity:	50%
EUT Operation:	Data Transmission (Hopping)
Test Date:	July 13, 2013

Test Mode	Number of Hopping Frequencies	[MHz] Limit
FH4	76	>15
FH4T	56	> 15
FH4FT	41	> 15
Note: Test plots shown in figures 4 to 9 on pages 15 to 17.		

Figure 4: Number of hopping frequencies at FH4 mode

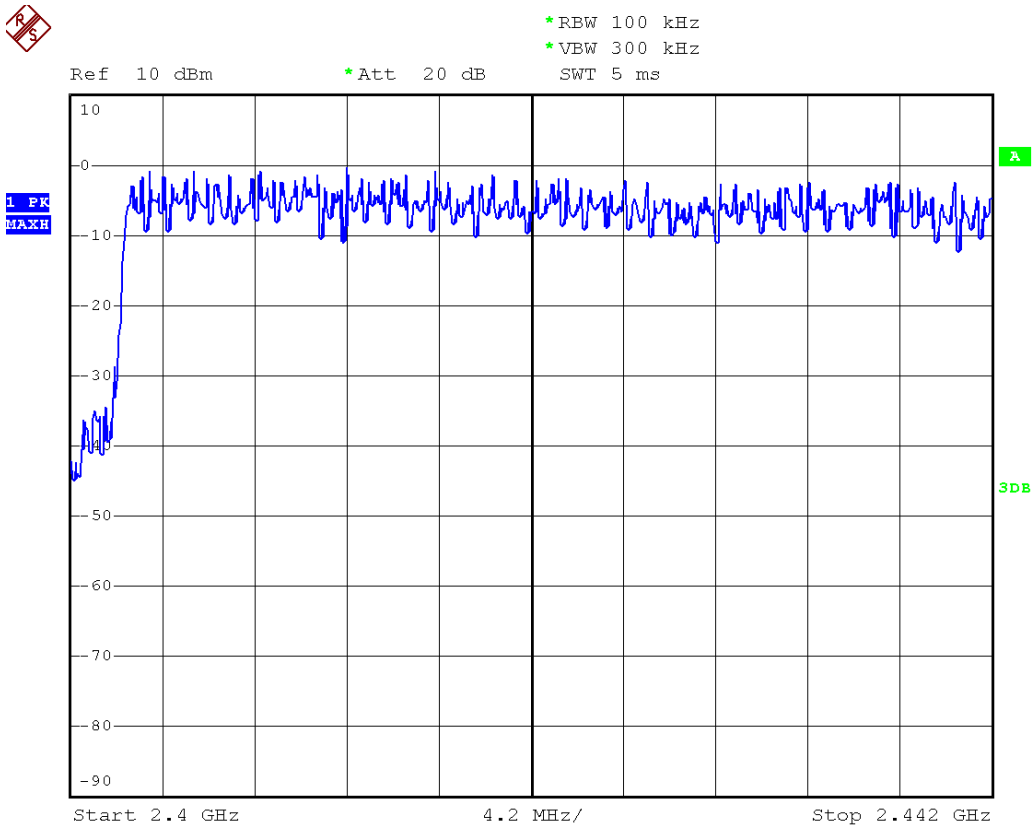


Figure 5: Number of hopping frequencies at FH4 mode

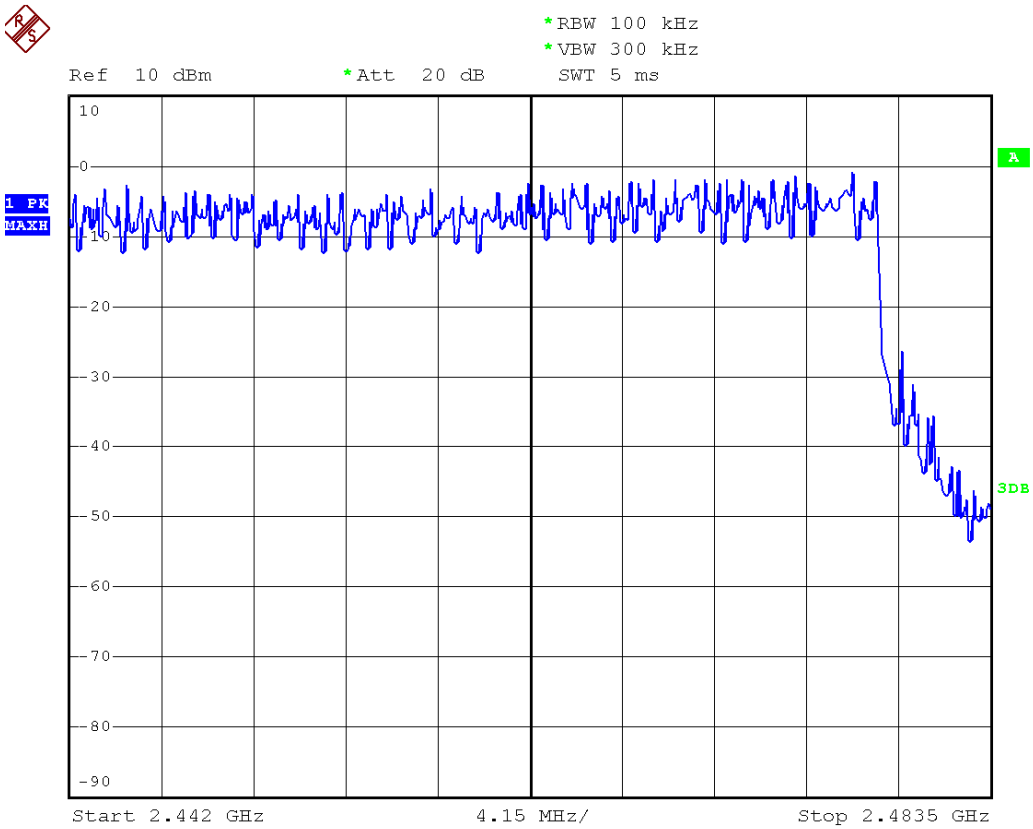


Figure 6: Number of hopping frequencies at FH4T mode

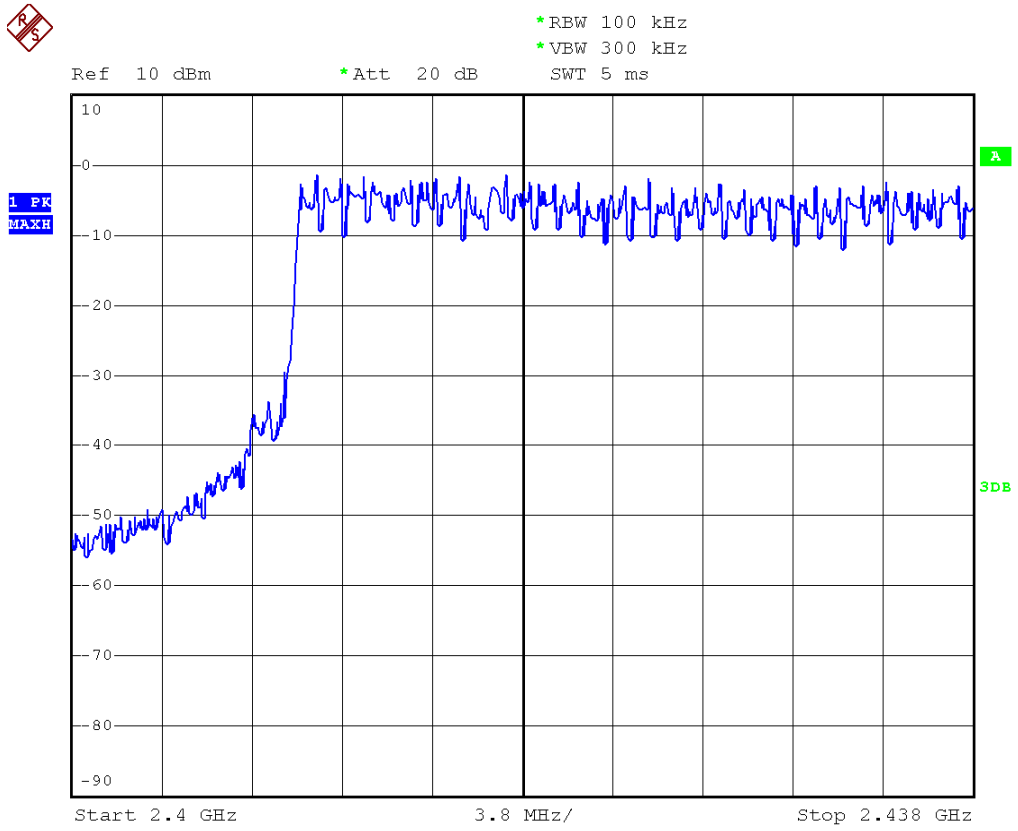


Figure 7: Number of hopping frequencies at FH4T mode

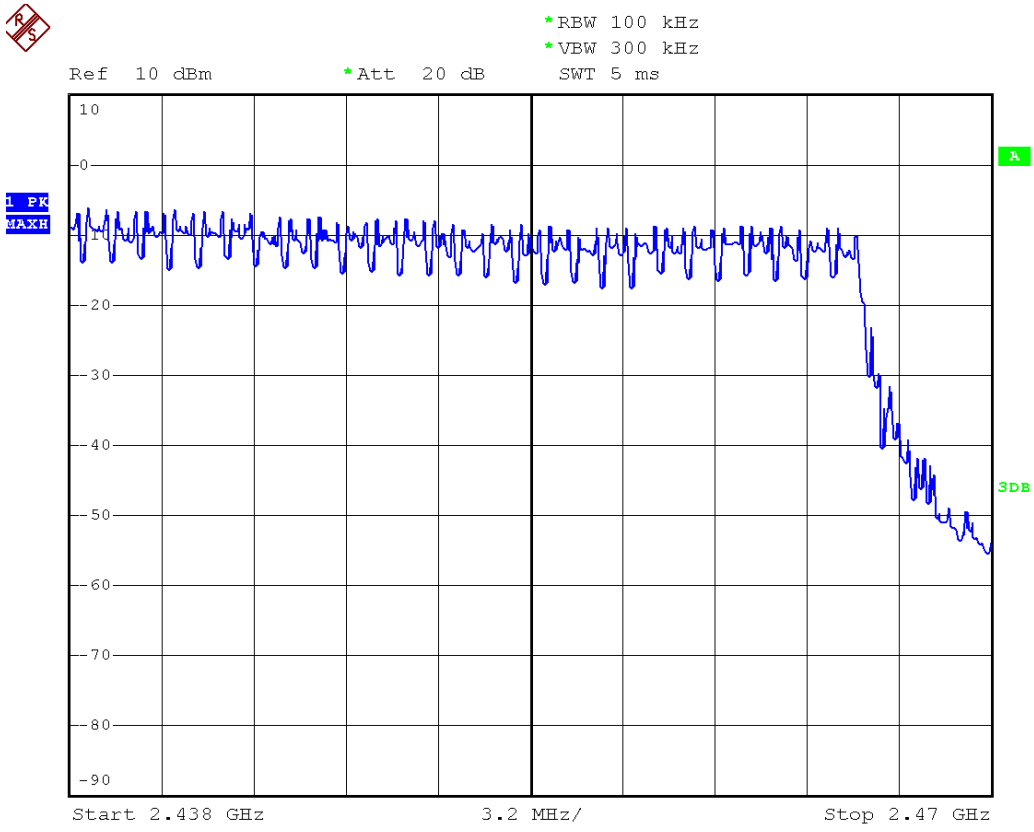


Figure 8: Number of hopping frequencies at FH4FT mode

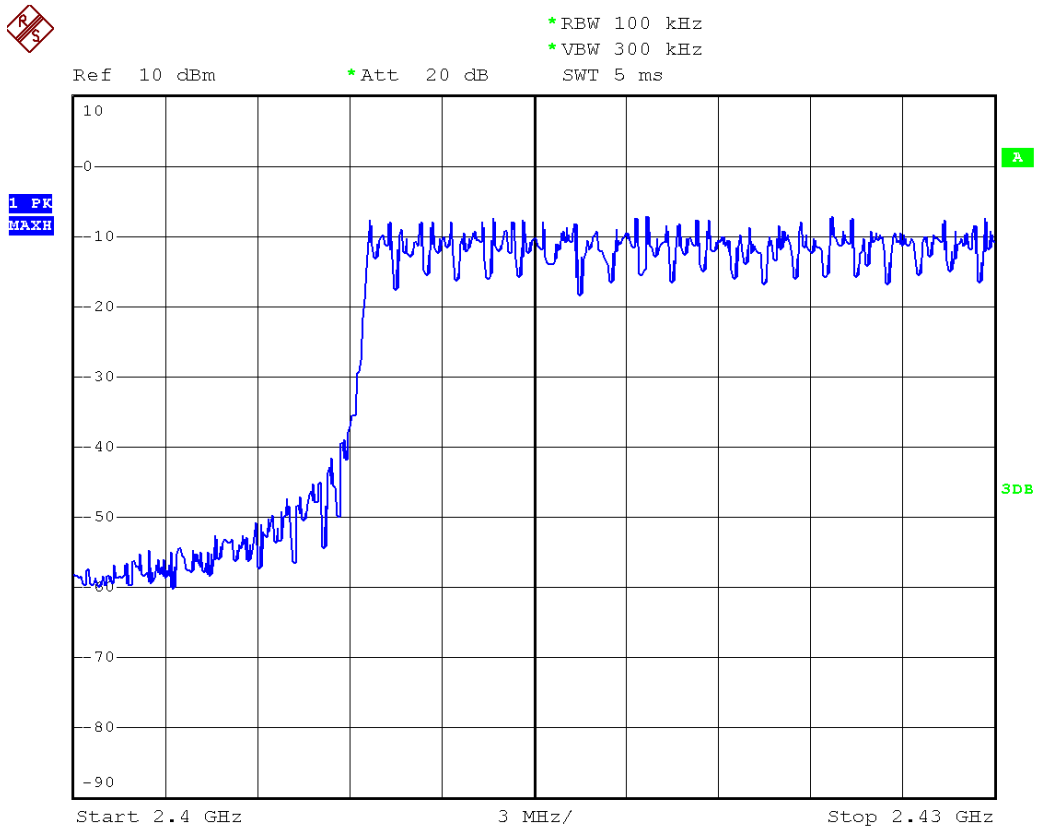
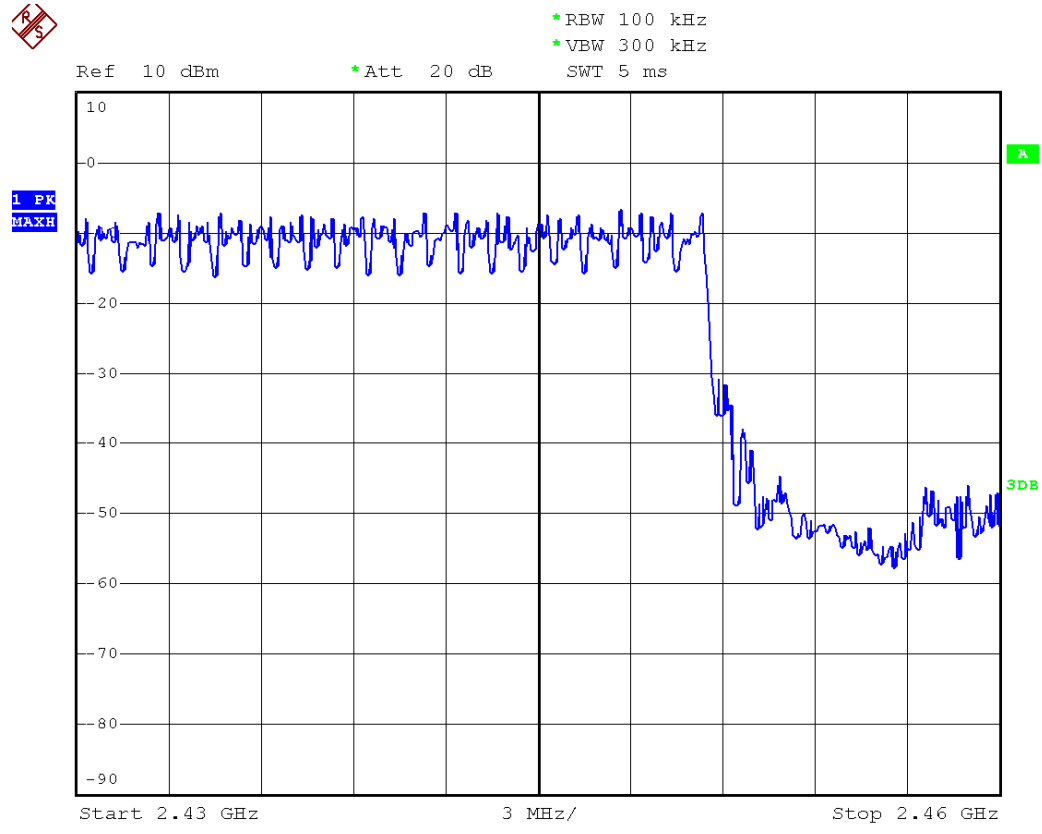


Figure 9: Number of hopping frequencies at FH4FT mode



6.3 Time of Occupy (Dwell Time) Measurement

Applicable Standard:

According to §15.247(a)(1)(iii), frequency hopping systems operating in the 2400MHz-2483.5 MHz. The average time of occupancy on any frequency shall not greater than 0.4 s within period of 0.4 seconds multiplied by the number of hopping channel employed.

According to RSS-210 issue 8, §A8.1 (d), frequency hopping systems operating in the 2400-2483.5MHz bands shall use at least 15 hopping channels. 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. Transmissions on particular hopping frequencies may be avoided or suppressed provided that a minimum of 15 hopping channels are used.

.

Test Procedure:

1. Connect the EUT RF output port to spectrum analyzer via calibrated coaxial cable and suitable attenuator (if necessary).
2. Activates the EUT system and execute the software prepared for test, if necessary.
3. To find out the maximum emission condition, the transmitting data rate of EUT is set to maximum data rate.
4. The span of spectrum analyzer was set to zero (sweep time 30msec). The occupied time at center on a hopping frequency was observed and recorded as “Ton”.
5. The spectrums are scanned by using the spectrum analyzer (*1). And the numbers of occupied channel per Nsec (period of 0.4 seconds multiplied by the number of hopping channels employed) were counted by using the delta-marker function of spectrum analyzer and recorded as “N”.
6. The dwell time was calculated by Ton × N.

Spectrum analyzer setup conditions:

Frequency span : Zero span
Resolution bandwidth : 1MHz
Video bandwidth : ≧ RBW
Sweep : As necessary to capture the entire dwell time per hopping channel.
Detector function : Peak
Trace mode : Max Hold

Test Result:

Temperature:	25 °C
Humidity:	52%
EUT Operation:	Data Transmission (Hopping)
Test Date:	July 14, 2013

Test Mode	[ms]Dwell Time	[ms] Limit
FH4	0.40ms x 308 = 123.2	< 400
FH4T	0.40ms x 204 = 81.6	< 400
FH4FT	0.34ms x 156 = 53.04	< 400
Note: Test plots shown in figures 10 to15 on pages 20 to 21.		

Figure 10: Duration of one transmission at FH4 mode

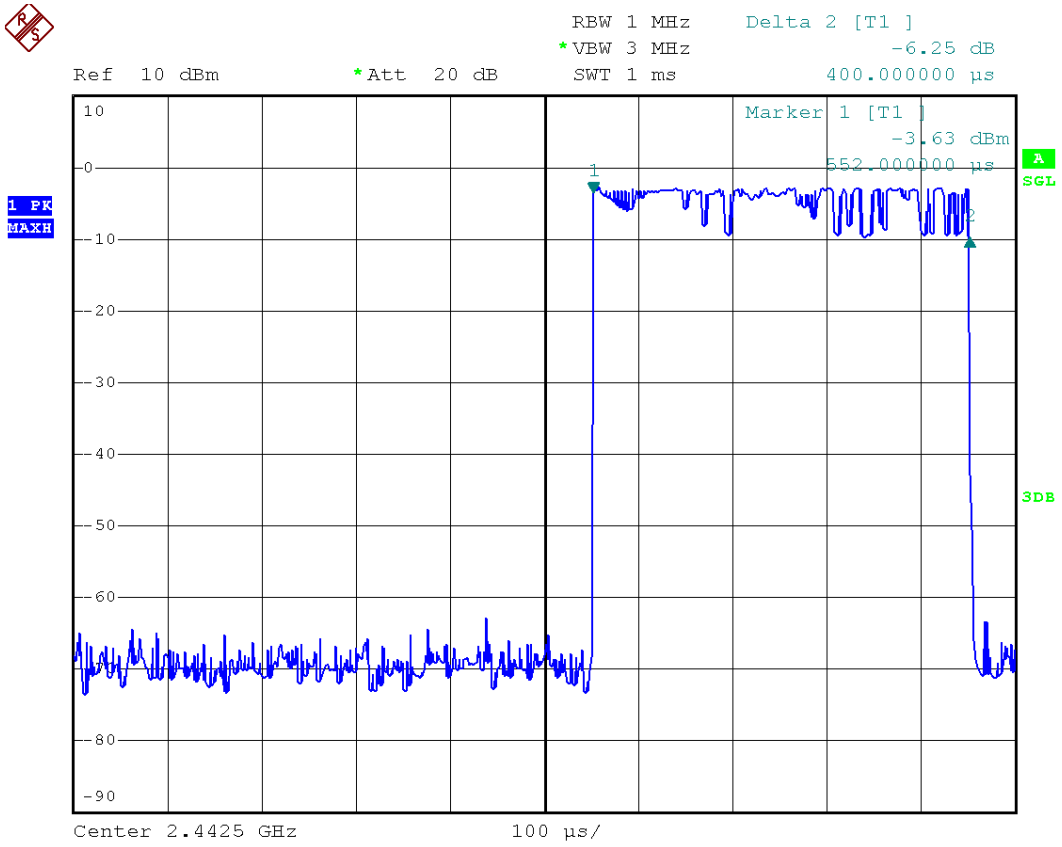


Figure 11: Number of Transmission at 30.4 s at FH4 mode

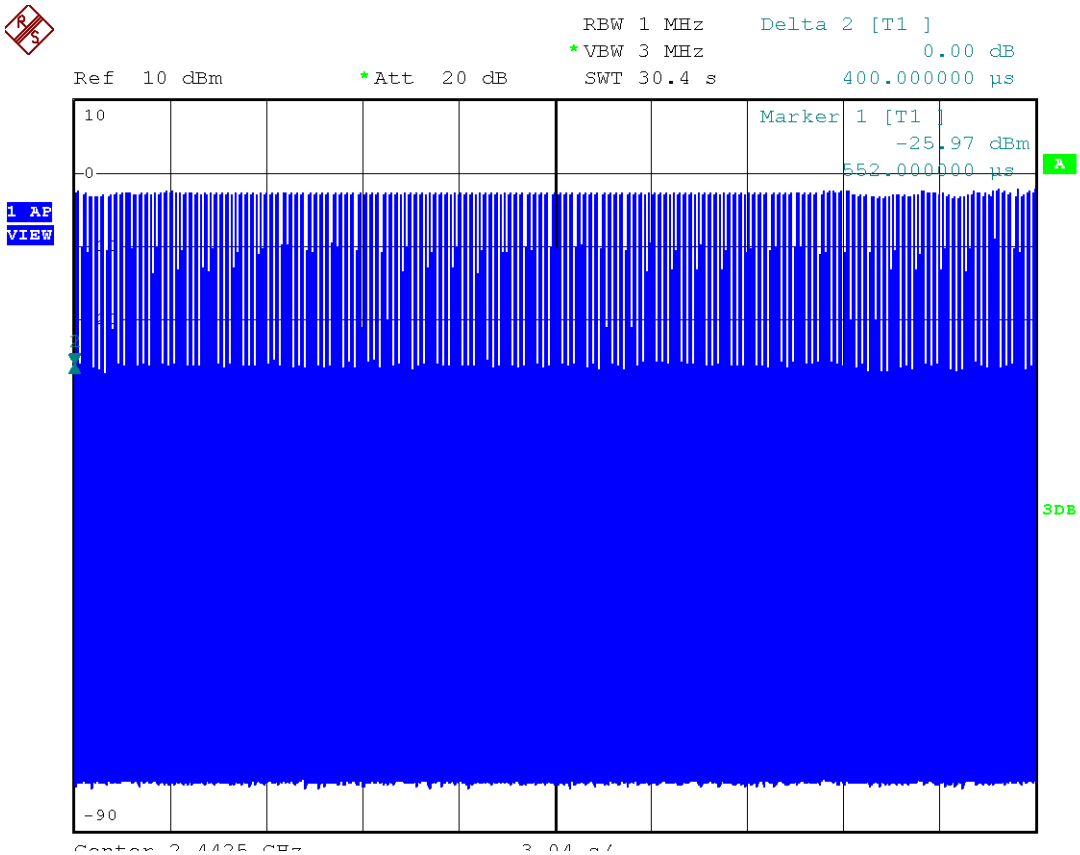


Figure 12: Duration of one transmission at FH4T mode

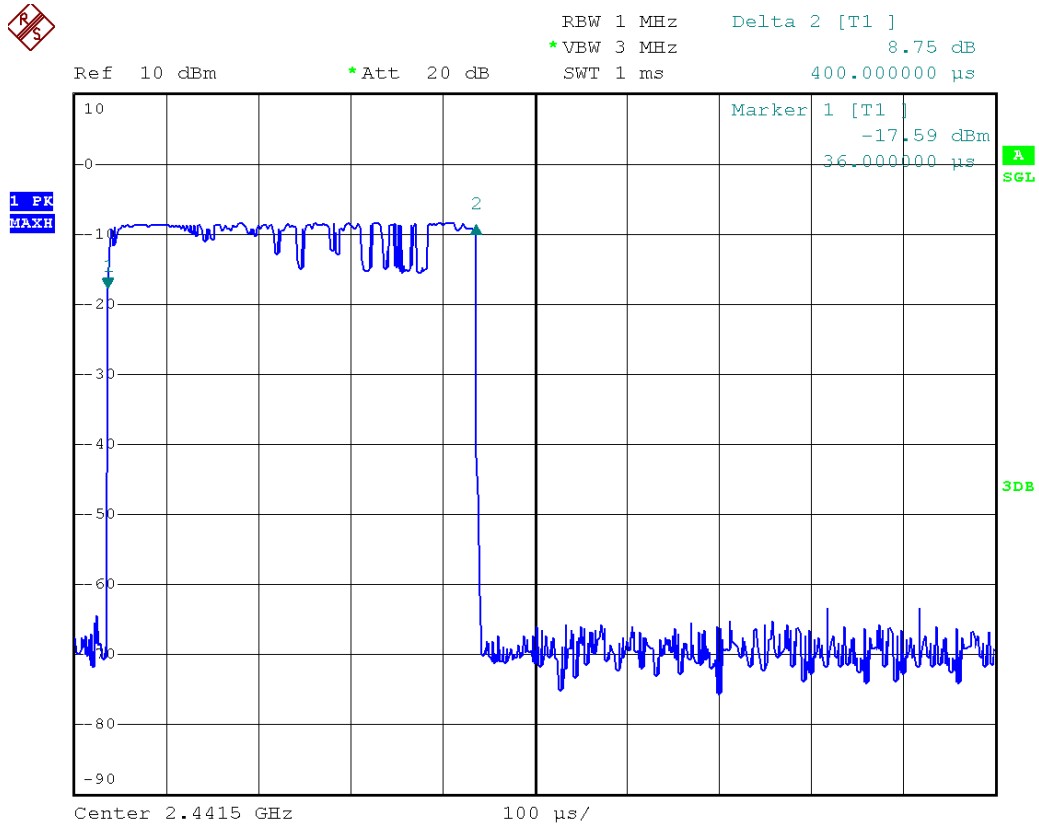


Figure 13: Number of Transmission at 22.4 s with FH4T mode

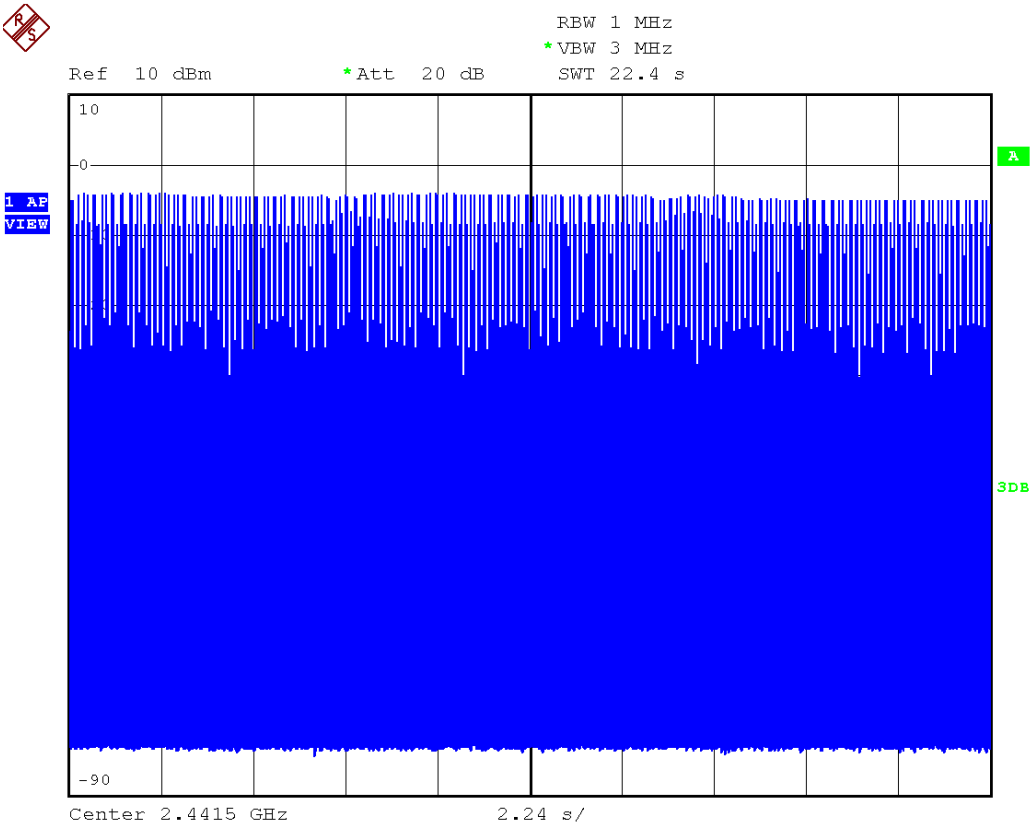


Figure 14: Duration of one transmission at FH4FT mode

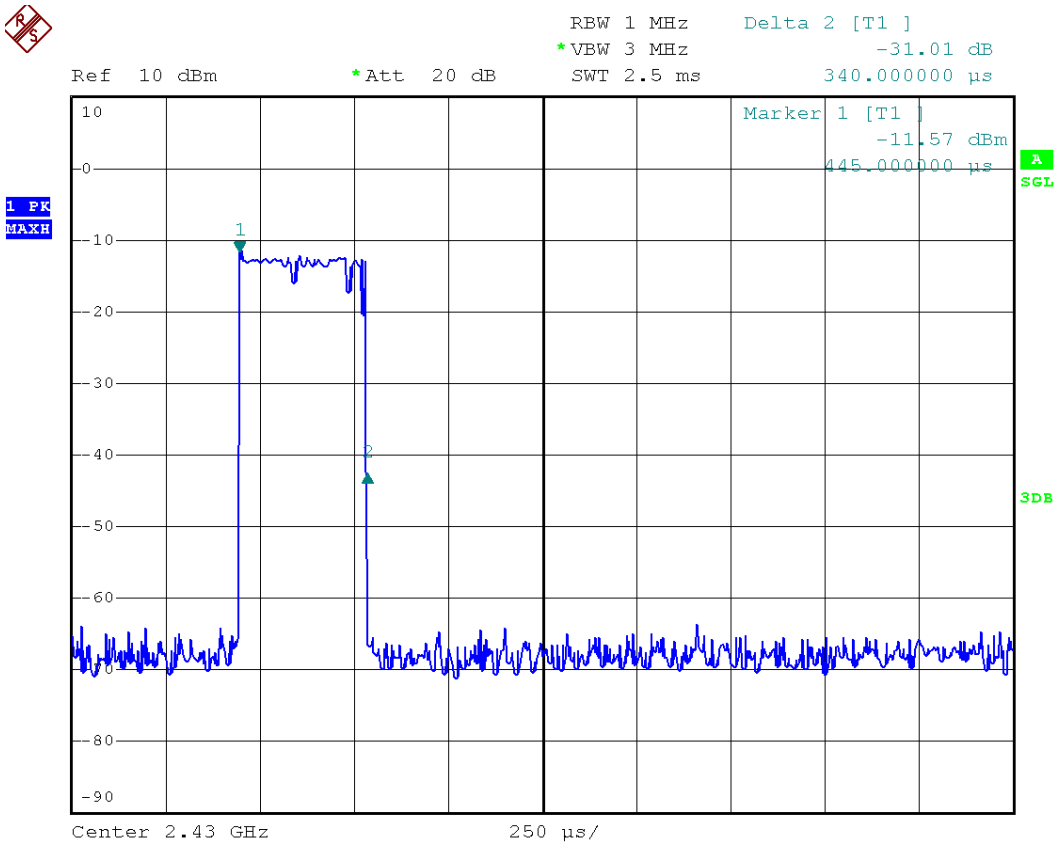
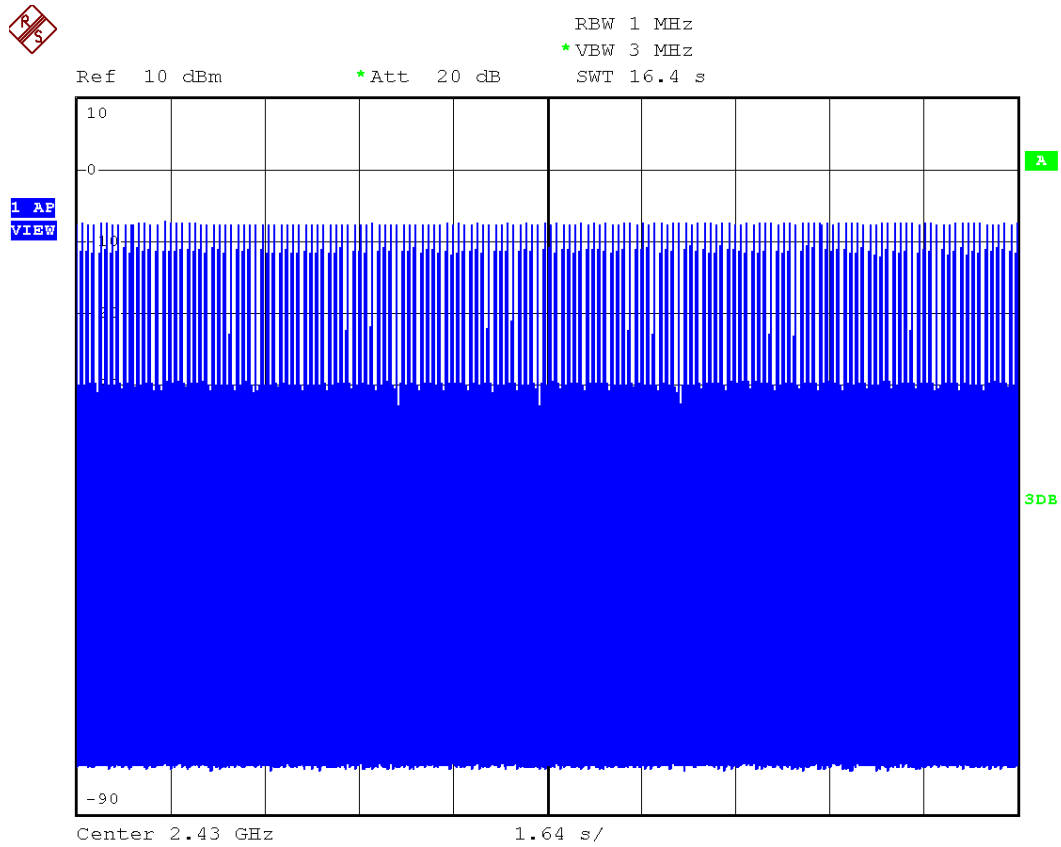


Figure 15: Number of Transmission at 16.4 s with FH4FT mode



6.4 Peak Output Power Measurement

Applicable Standard:

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

According to RSS-210 issue 8, §A8.4 (2), for frequency hopping systems operating in the 2400-2483.5 MHz band employing at least 75 hopping channels, the maximum conducted output power shall not exceed 1 W. For all other frequency hopping systems, the maximum peak conducted output power shall not exceed 0.125W.

.

Test Procedure:

1. Connect the EUT RF output port to spectrum analyzer via calibrated coaxial cable and suitable attenuator (if necessary).
2. Activates the EUT system and executes the software prepared for test, if necessary.
3. To find out the worst case, the transmitting data rate of EUT is varied with the different modes of operation. The final test condition is recorded in this report.
4. The spectrums are scanned and allow the trace to stabilize.
5. The peak output power was determined by using the marker-data function of spectrum analyzer or peak type power meter.

Spectrum analyzer setup conditions:

Frequency span : Above 20dB bandwidth of the emission being measured
Resolution bandwidth : 3MHz
Video bandwidth : 10MHz
Sweep : Auto
Detector function : Peak
Trace mode : Max Hold

Test Result:

Temperature:	25 °C
Humidity:	51%
EUT Operation:	Data Transmission (without hopping)
Test Date:	July 16, 2013

FH4 Mode					
Frequency	Cable Loss	Reading	Power	Limit	Margin
[MHz]	[dB]	[dBm]	[dBm]	[dBm]	[dB]
2403	2.00	1.94	3.94	30.00	-26.06
2442	2.00	1.61	3.61	30.00	-26.39
2478	2.00	1.67	3.67	30.00	-26.33
Note: Test plots shown in figures 16 to 18 on pages 25, 26.					

FH4T Mode					
Frequency	Cable Loss	Reading	Power	Limit	Margin
[MHz]	[dB]	[dBm]	[dBm]	[dBm]	[dB]
2410	2.00	1.97	3.97	20.97	-17.00
2438	2.00	1.52	3.52	20.97	-17.45
2465	2.00	1.79	3.79	20.97	-17.18
Note: Test plots shown in figures 19 to 21 on pages 26, 27.					

FH4FT Mode					
Frequency	Cable Loss	Reading	Power	Limit	Margin
[MHz]	[dB]	[dBm]	[dBm]	[dBm]	[dB]
2410	2.00	1.85	3.85	20.97	-17.12
2430	2.00	1.61	3.61	20.97	-17.36
2450	2.00	1.67	3.67	20.97	-17.30
Note: Test plots shown in figures 22 to 24 on pages 28, 29.					

Figure 16: Peak output power - low channel at FH4 mode

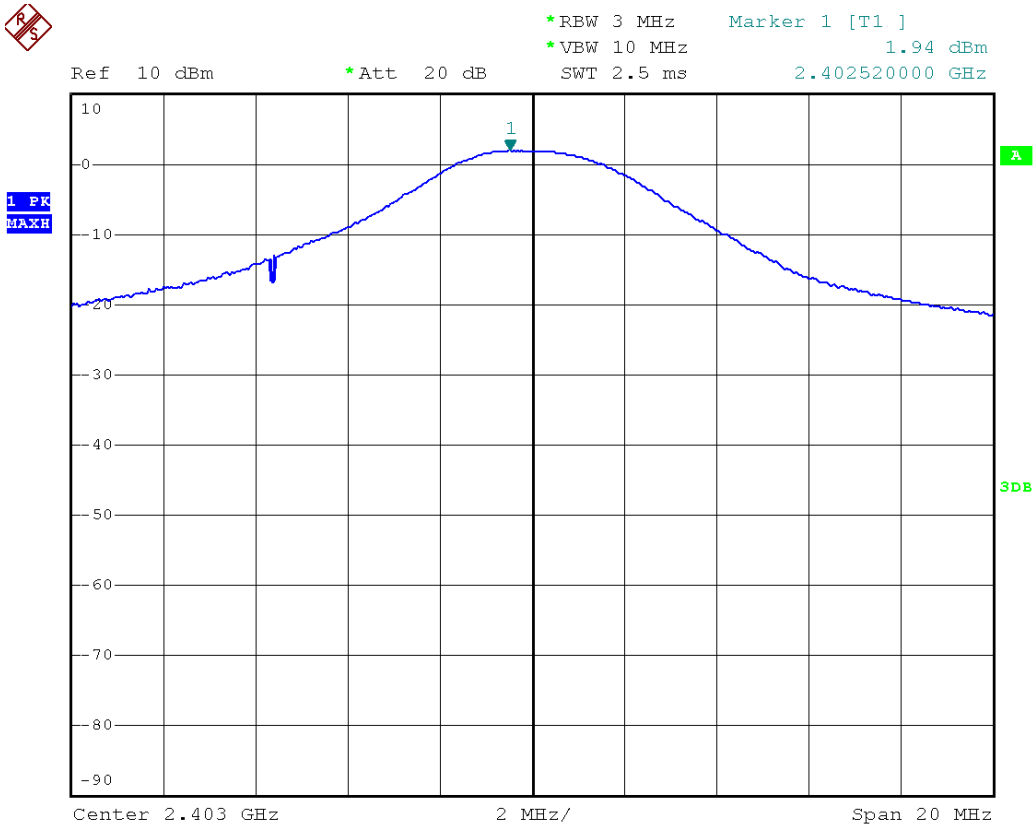


Figure 17: Peak output power - middle channel at FH4 mode

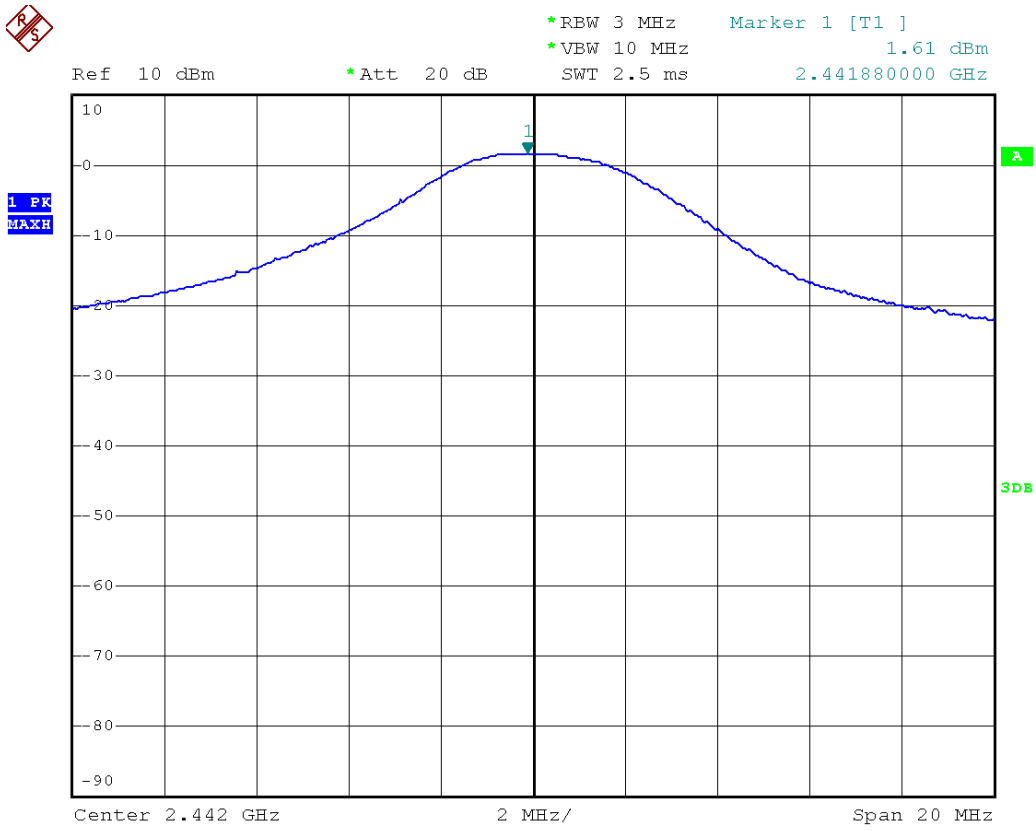


Figure 18: Peak output power - high channel at FH4 mode

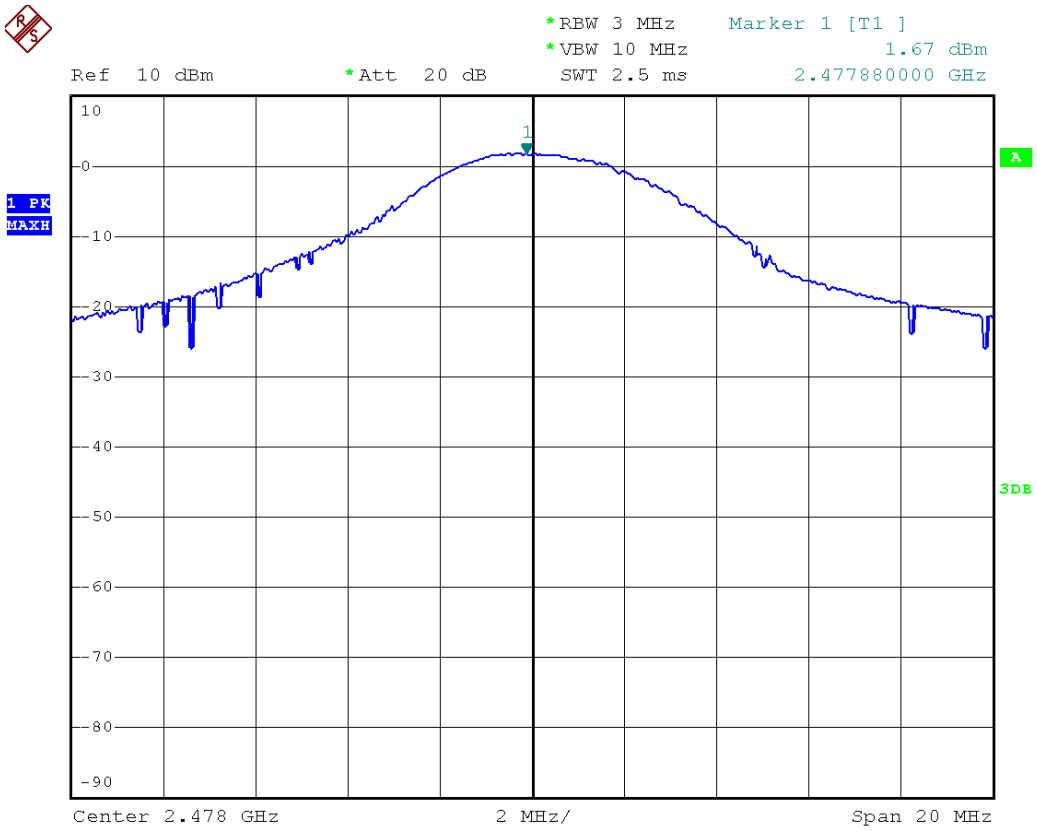


Figure 19: Peak output power - low channel at FH4T mode

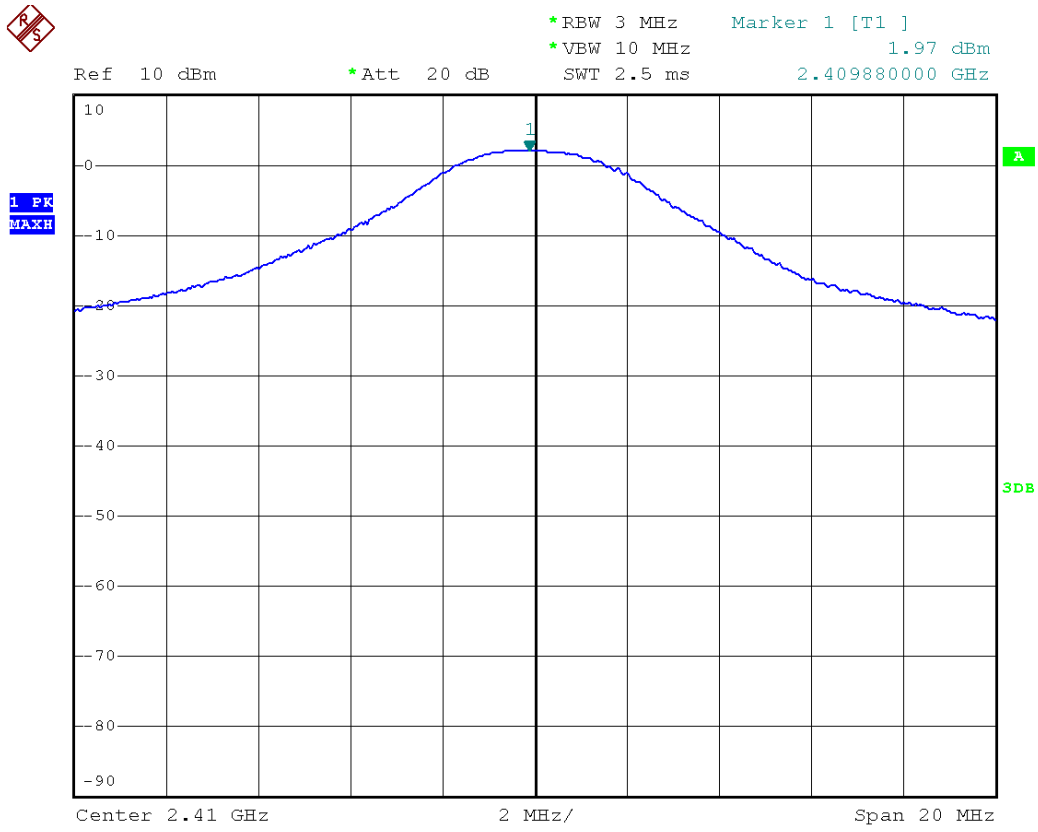


Figure 20: Peak output power - middle channel at FH4T mode

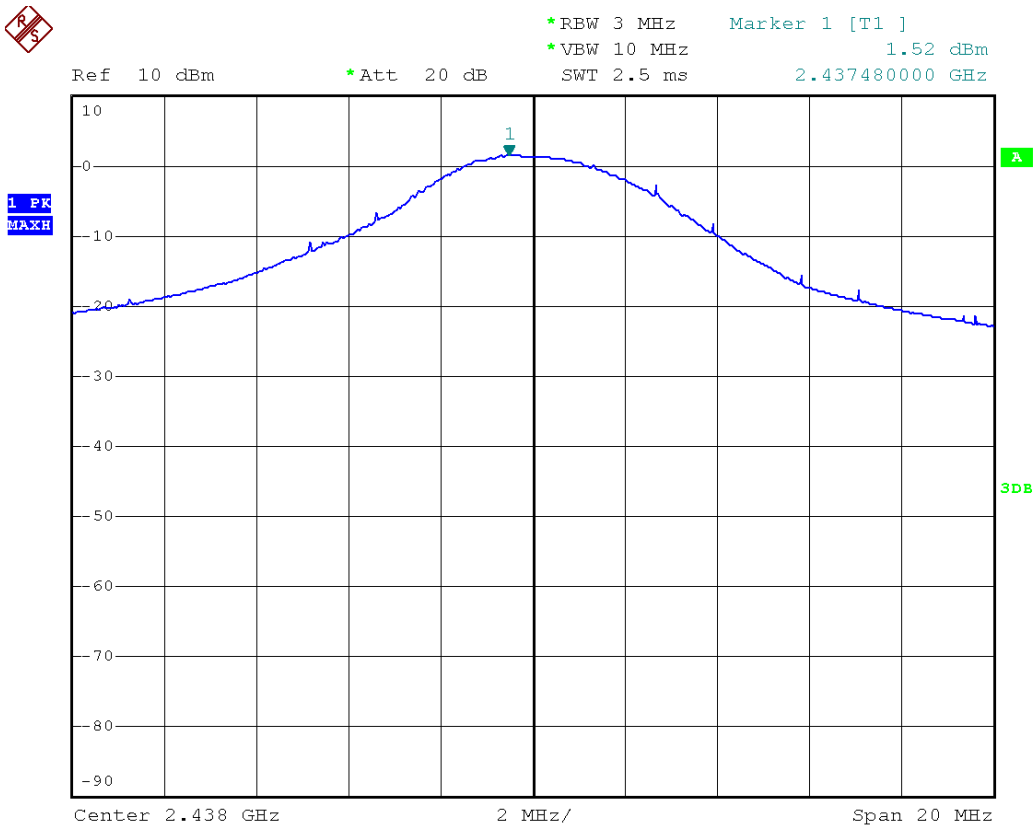


Figure 21: Peak output power - high channel at FH4T mode

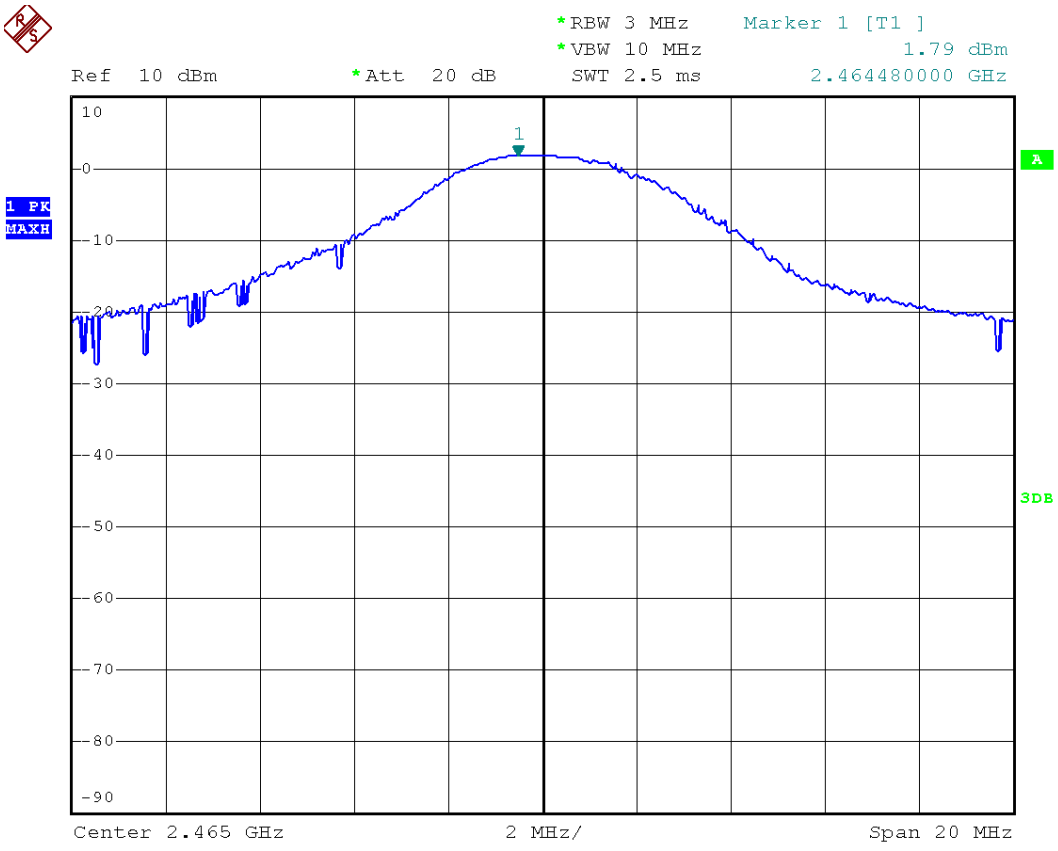


Figure 22: Peak output power - low channel at FH4FT mode

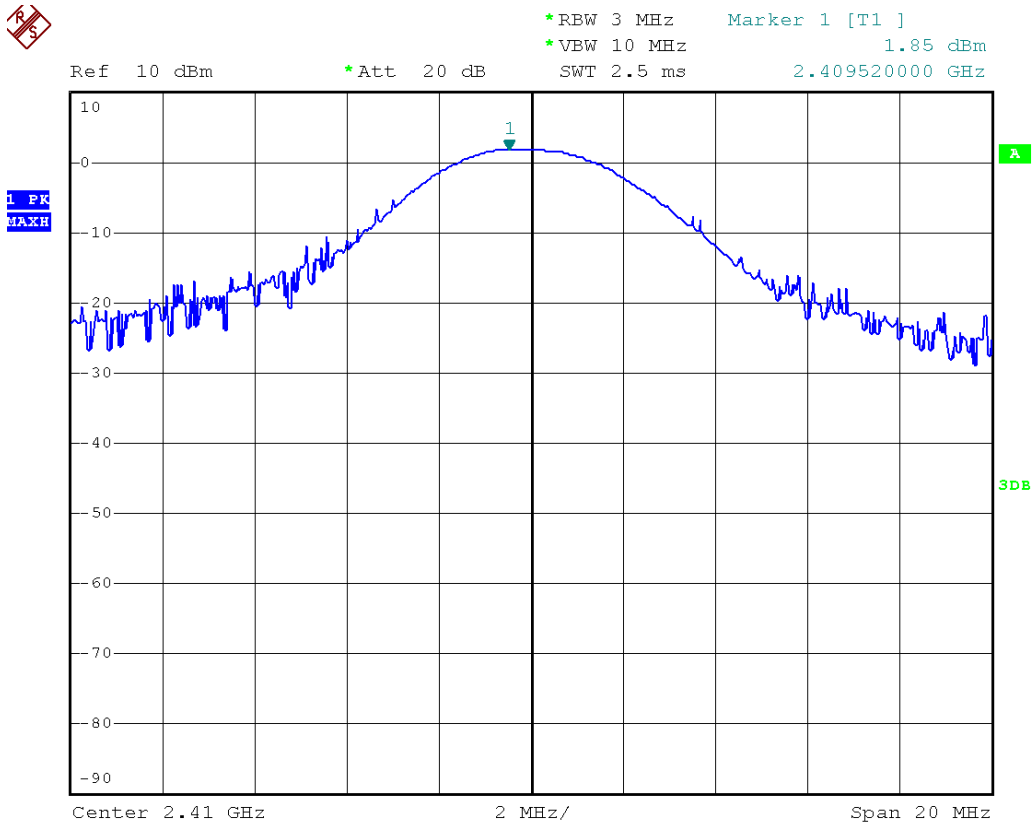


Figure 23: Peak output power - middle channel at FH4FT mode

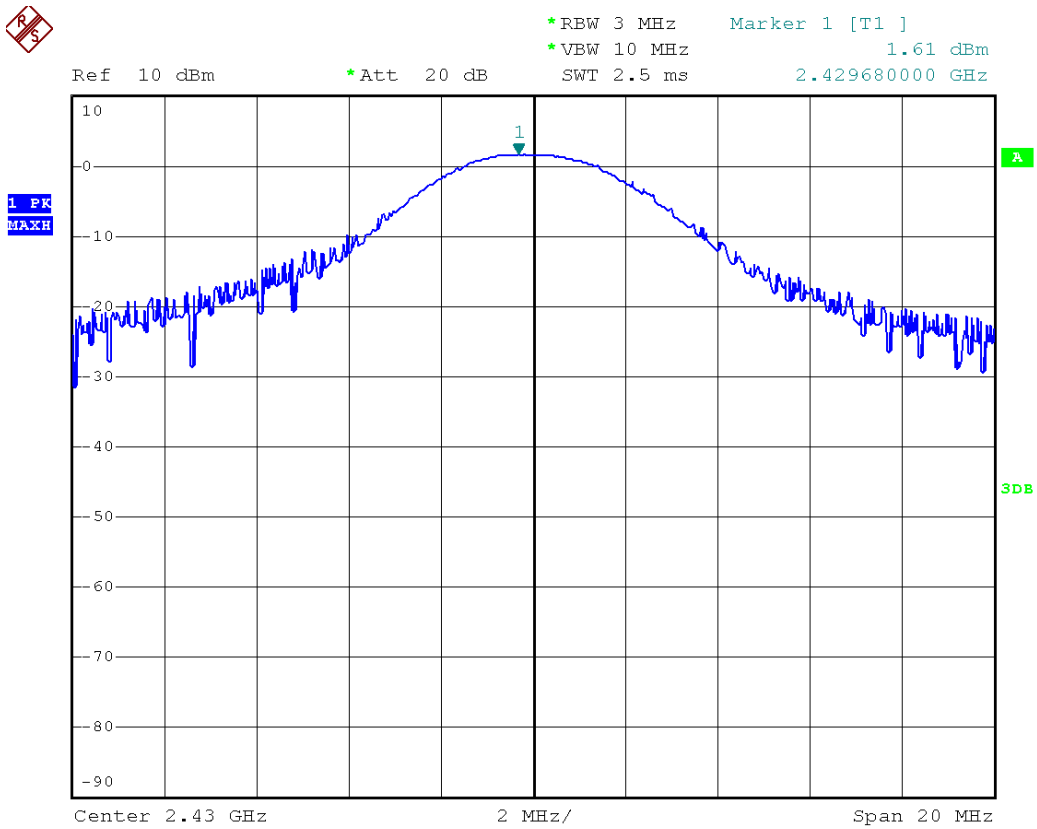
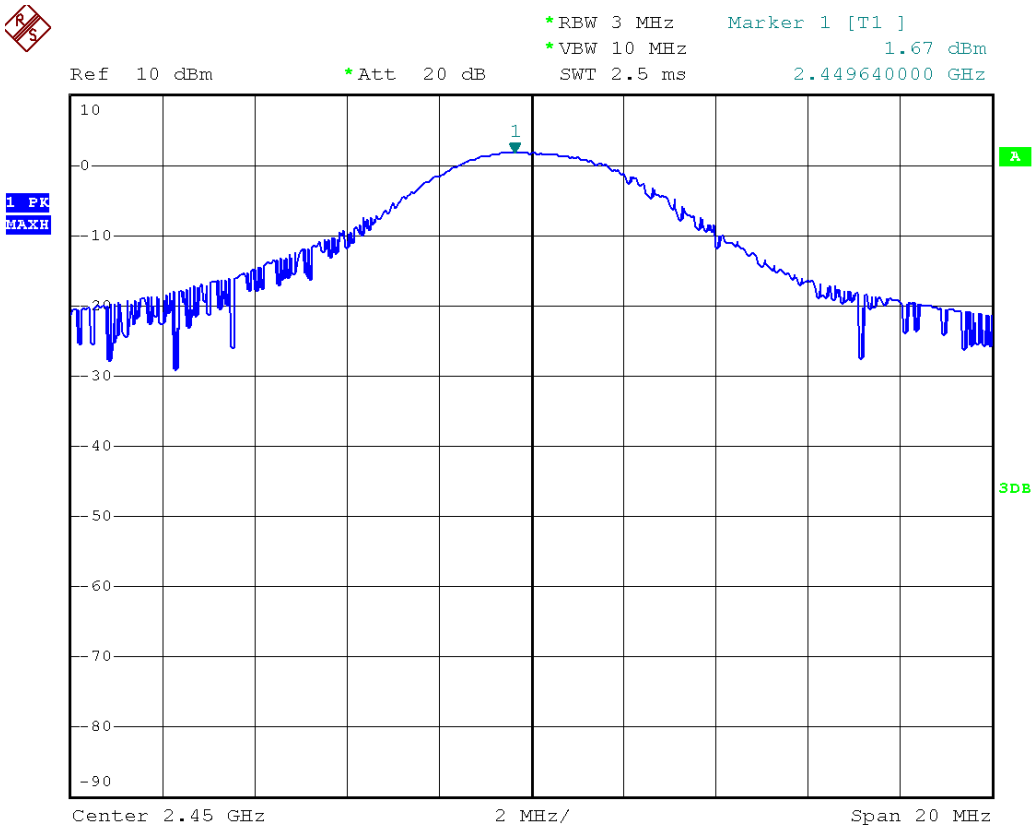


Figure 24: Peak output power - high channel at FH4FT mode



6.5 Band Edge of Conducted Emission and Spurious RF Conducted Emissions

Applicable Standard:

According to §15.247(d), in any 100 KHz bandwidth outside the frequency bands in which the spread spectrum intentional radiator in operating, the radio frequency power that is produced by the intentional radiator shall be at least 20dB below that in the 100KHz bandwidth within the band that contains the highest level of the desired power, In addition, radiated emissions which fall in the restricted bands, as defined in §15.205(a), must also comply with the radiated emission limits specified in15.209(a).

According to RSS-210 issue 8, §A8.5, in any 100 kHz bandwidth outside the frequency band in which the spread spectrum or digitally modulated device is operating, the radio frequency power that is produced 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 section A8.4(4), the attenuation required shall be 30 dB instead of 20 dB. Attenuation below the general limits specified in Tables 2 and 3 is not required. In addition, radiated emissions which fall in the restricted bands of Table 1 must also comply with the radiated emission limits specified in Tables 2 and 3.

.

Test Procedure:

1. Connect the EUT RF output port to the spectrum analyzer via calibrated coaxial cable and suitable attenuator (if necessary).
2. Activates the EUT System and executes the software prepared for test, if necessary.
3. To find out the maximum emission condition, the transmitting data rate of EUT is set to maximum data rate.
4. The spectrum are scanned.
5. The emission at the band edge or the highest modulation product outside of band were measured by using the marker function of spectrum analyzer (*1).
6. The peak of the in-band emission were measured by using the marker to peak function of spectrum analyzer.
7. Above measurement were repeated at other side band edge.

Spectrum analyzer setup conditions:

Frequency span : Wide enough to capture the peak level of emission on the band edge
Resolution bandwidth : 100kHz
Video bandwidth : ≧RBW
Sweep : Auto
Detector function : Peak
Trace Mode : Max Hold

Test Results:

Temperature:	25 °C
Humidity:	51%
EUT Operation:	Transmission (without hopping and normal operation)
Test Date:	July 16, 2013

The unit does meet the requirement.

Note: Test plots shown in figures 25 to 45 on pages 32 to 42

Figure 25: Band edge - low frequency side at FH4 mode without hopping

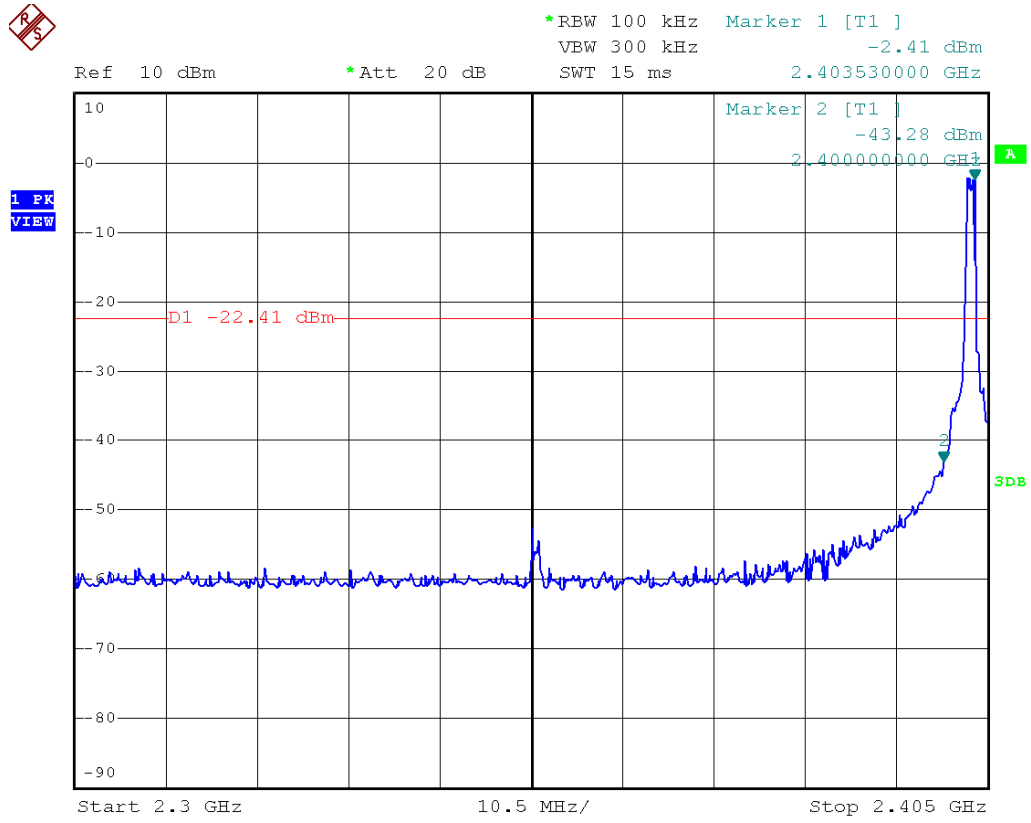


Figure 26: Band edge – high frequency side at FH4 mode without hopping

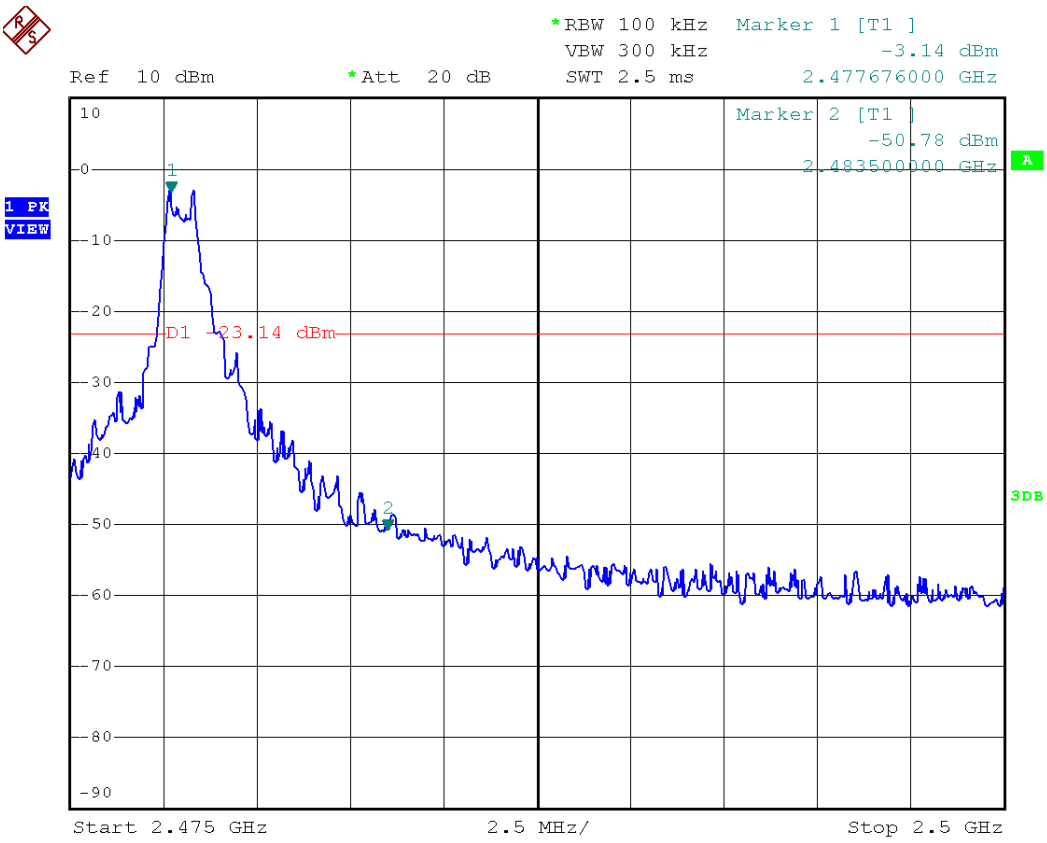


Figure 27: Band edge – low frequency side at FH4 mode with normal operation

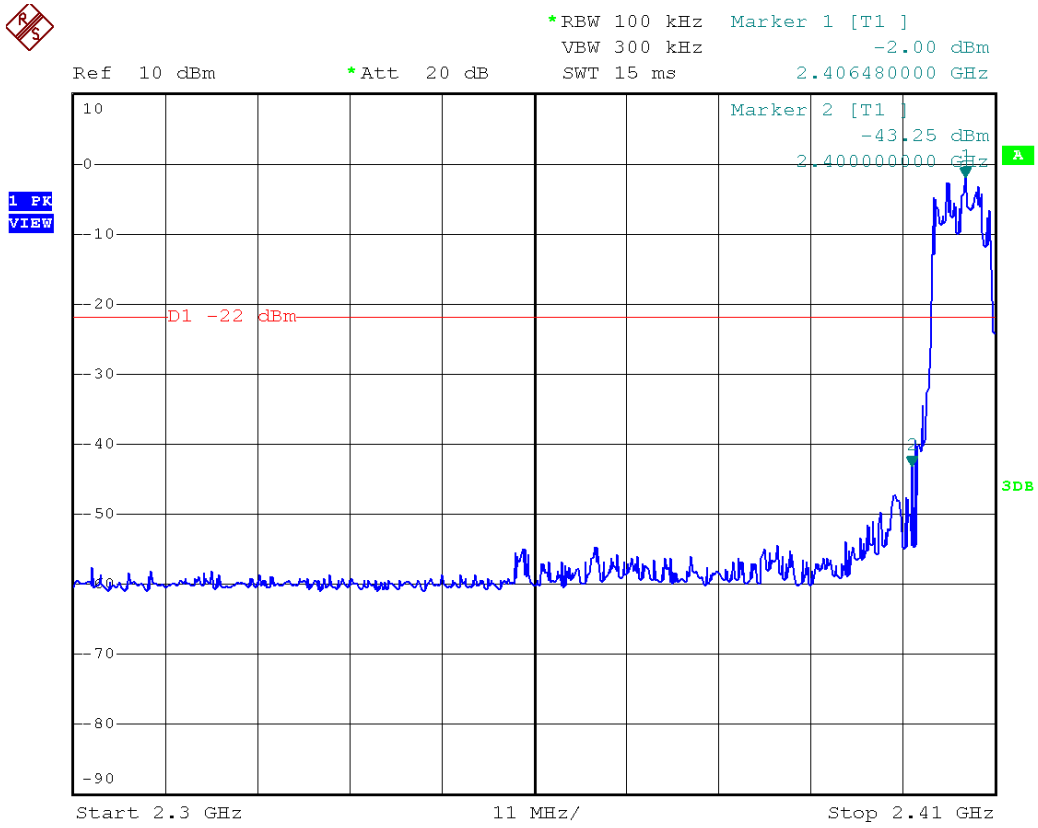


Figure 28: Band edge – high frequency side at FH4 mode with normal operation

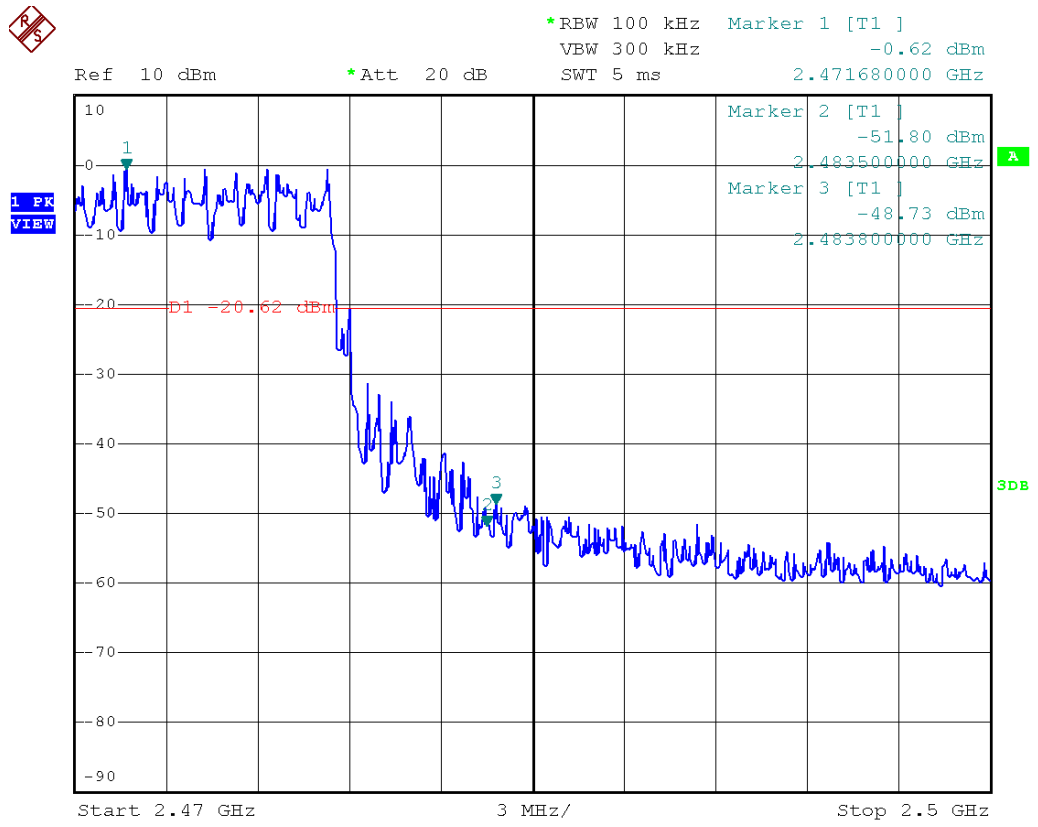


Figure 29: Band edge - low frequency side at FH4T mode without hopping

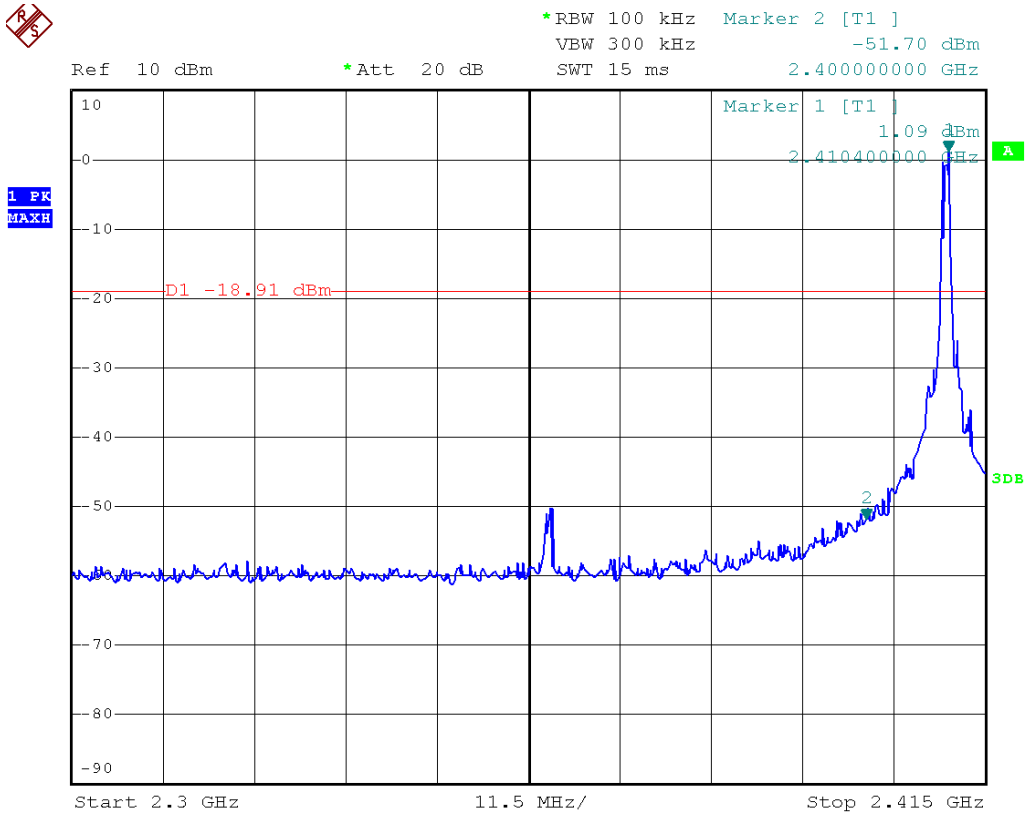


Figure 30: Band edge – high frequency side at FH4T mode without hopping

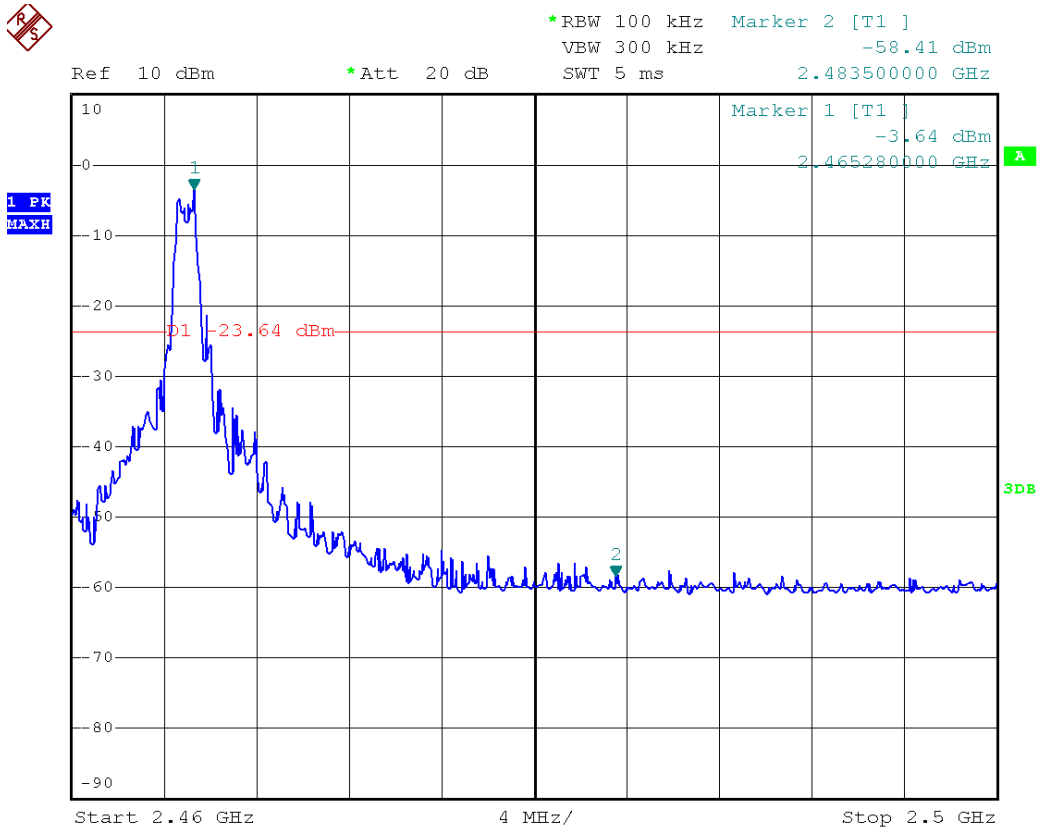


Figure 31: Band edge – low frequency side at FH4T mode with normal operation

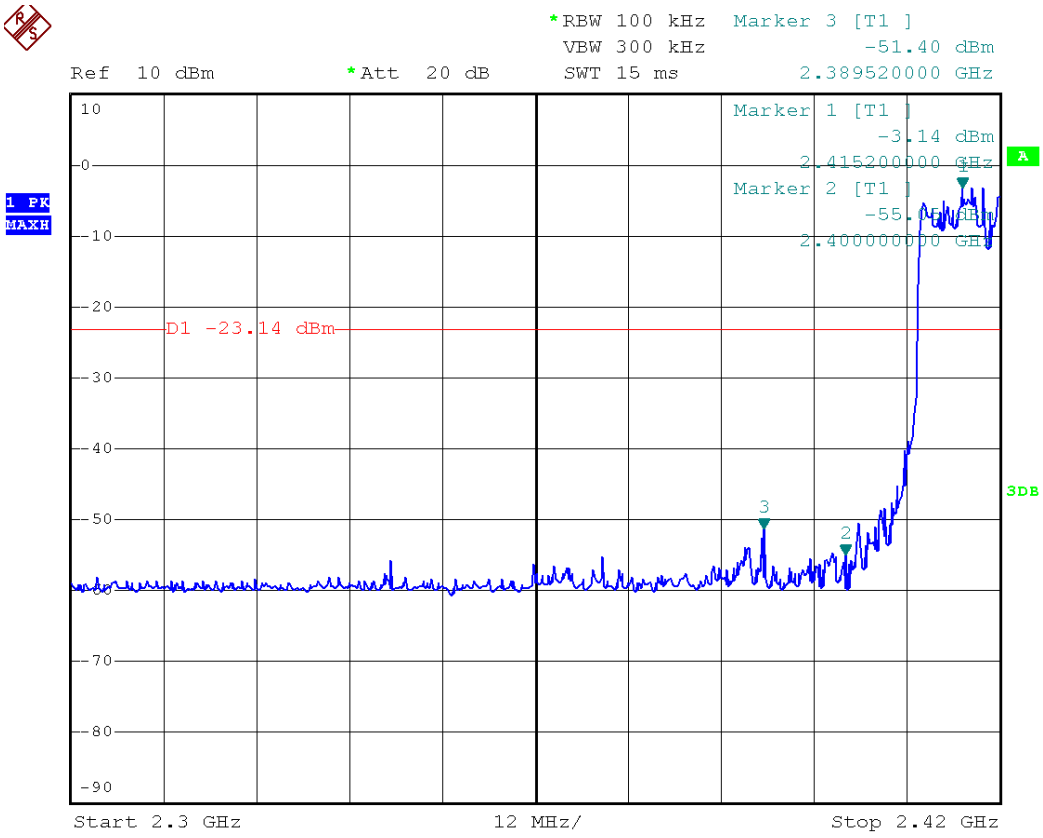


Figure 32: Band edge – high frequency side at FH4T mode with normal operation

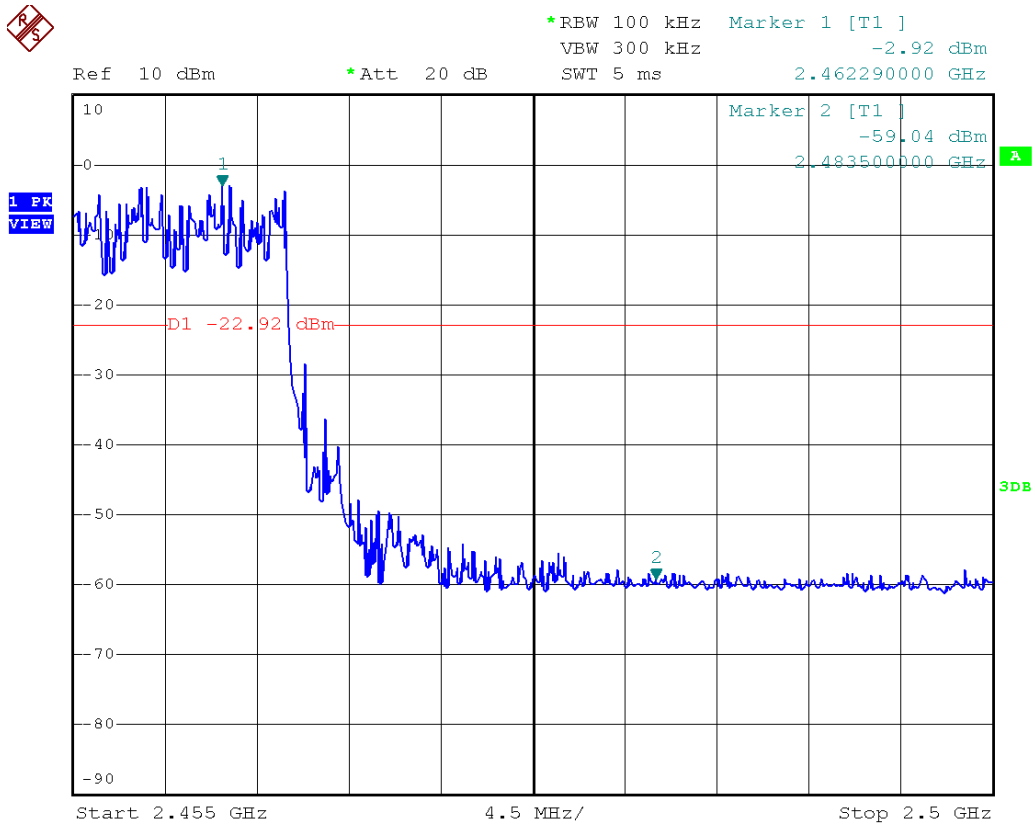


Figure 33: Band edge - low frequency side at FH4FT mode without hopping

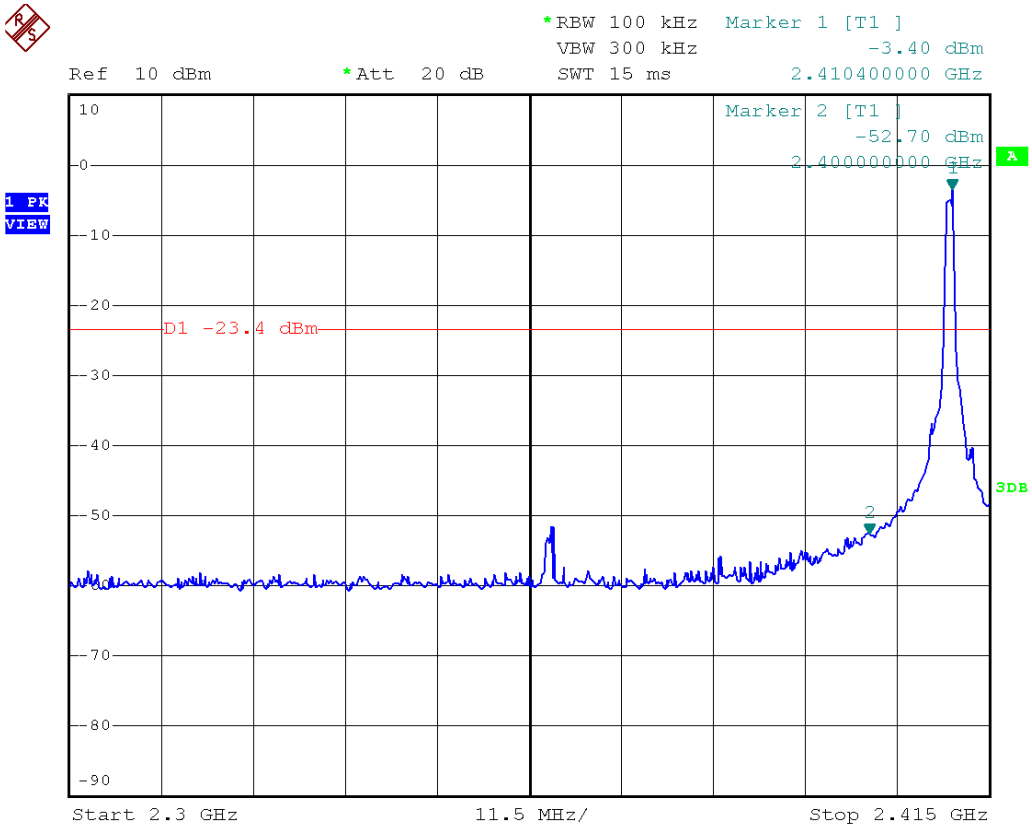


Figure 34: Band edge – high frequency side at FH4FT mode without hopping

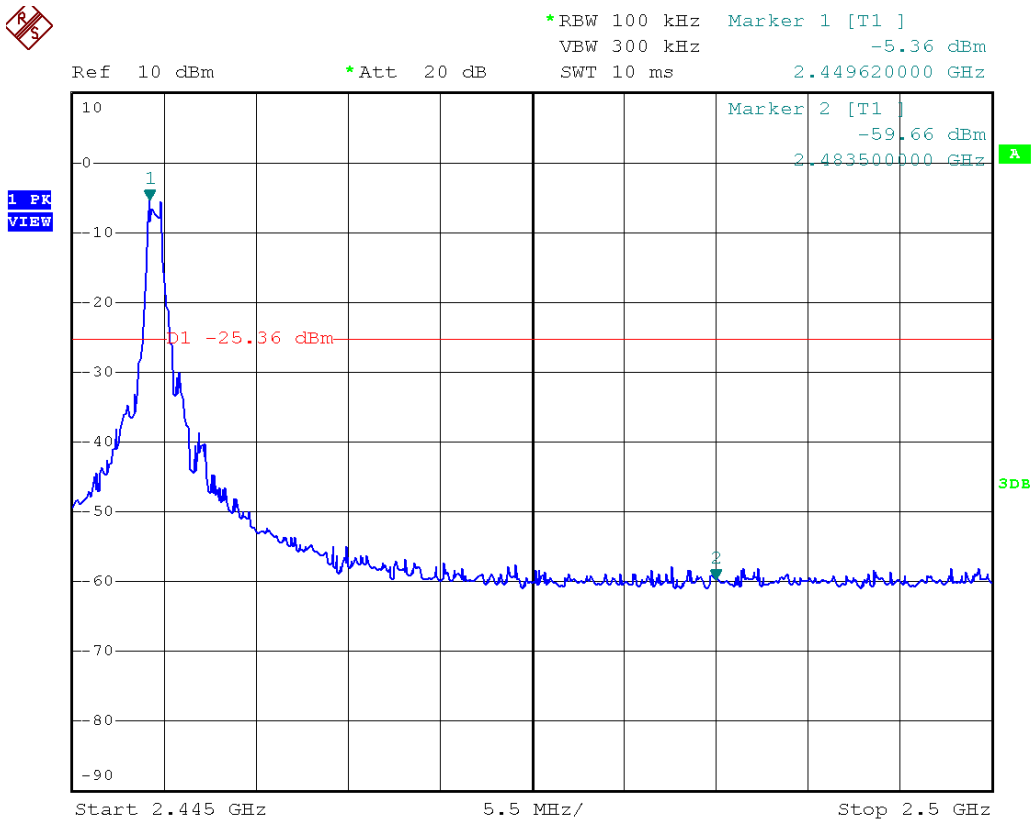


Figure 35: Band edge – low frequency side at FH4FT mode with normal operation

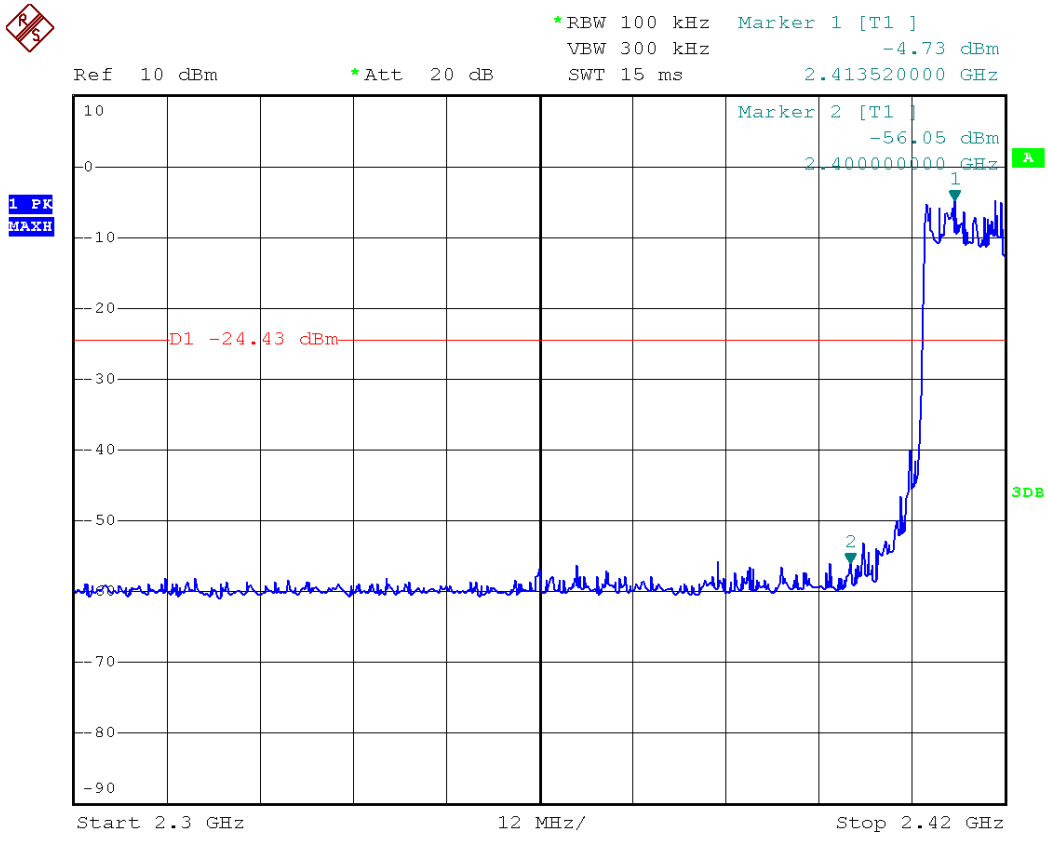


Figure 36: Band edge – high frequency side at FH4FT mode with normal operation

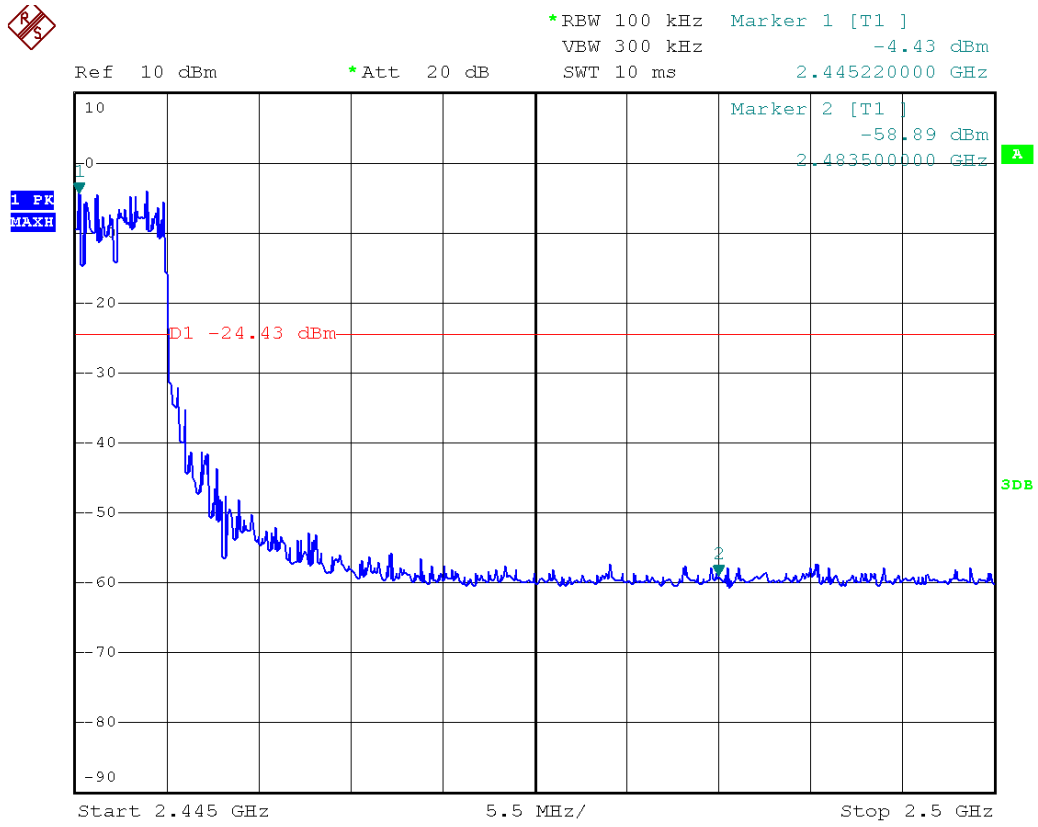


Figure 37 Conducted spurious emissions with FH4 mode at low channel

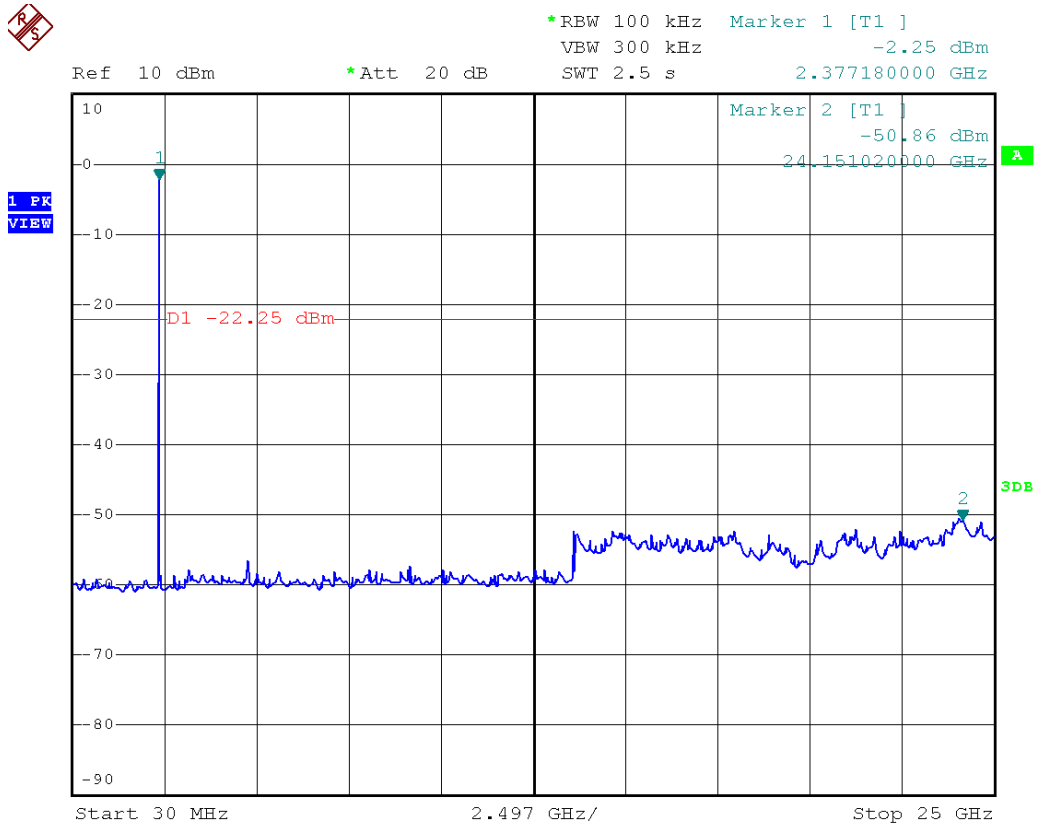


Figure 38 Conducted spurious emissions with FH4 mode at middle channel

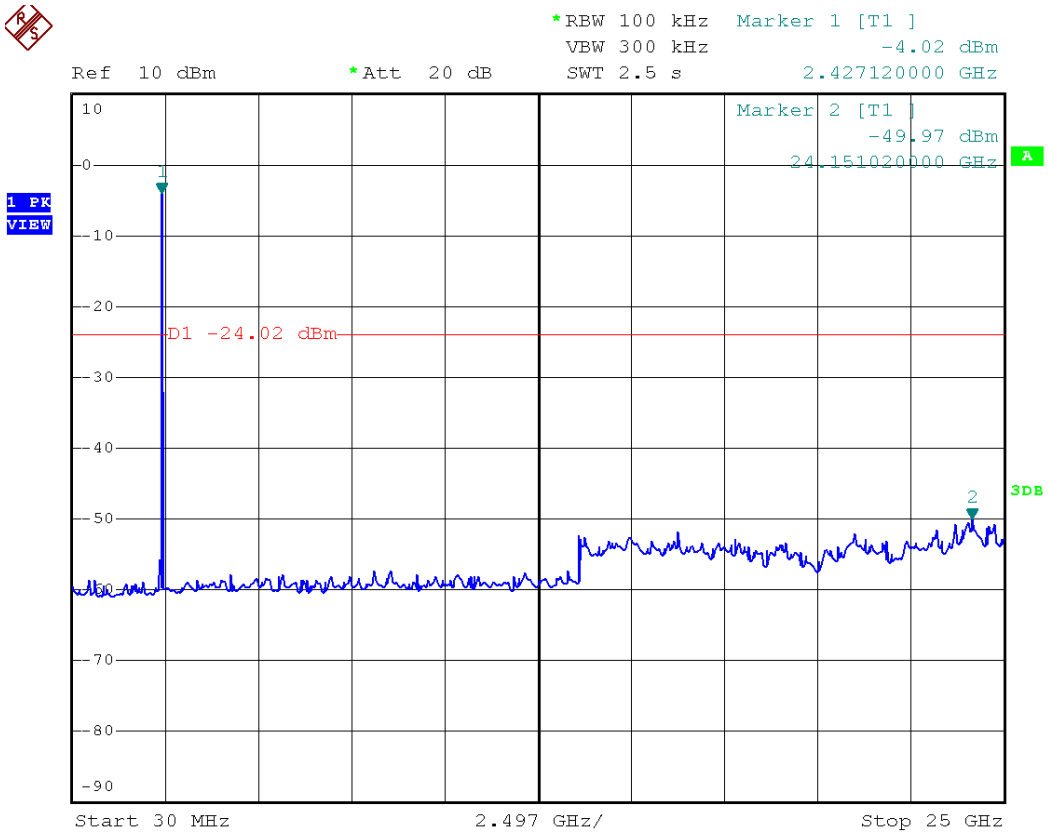


Figure 39 Conducted spurious emissions with FH4 mode at high channel

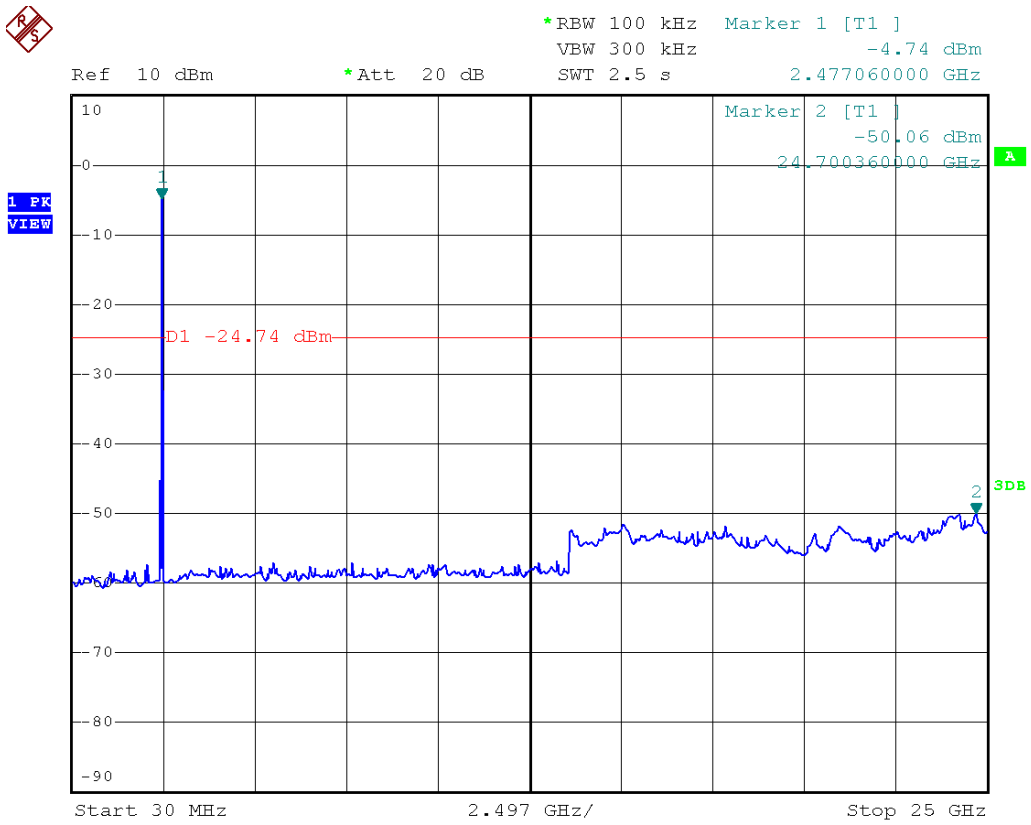


Figure 40 Conducted spurious emissions with FH4T mode at low channel

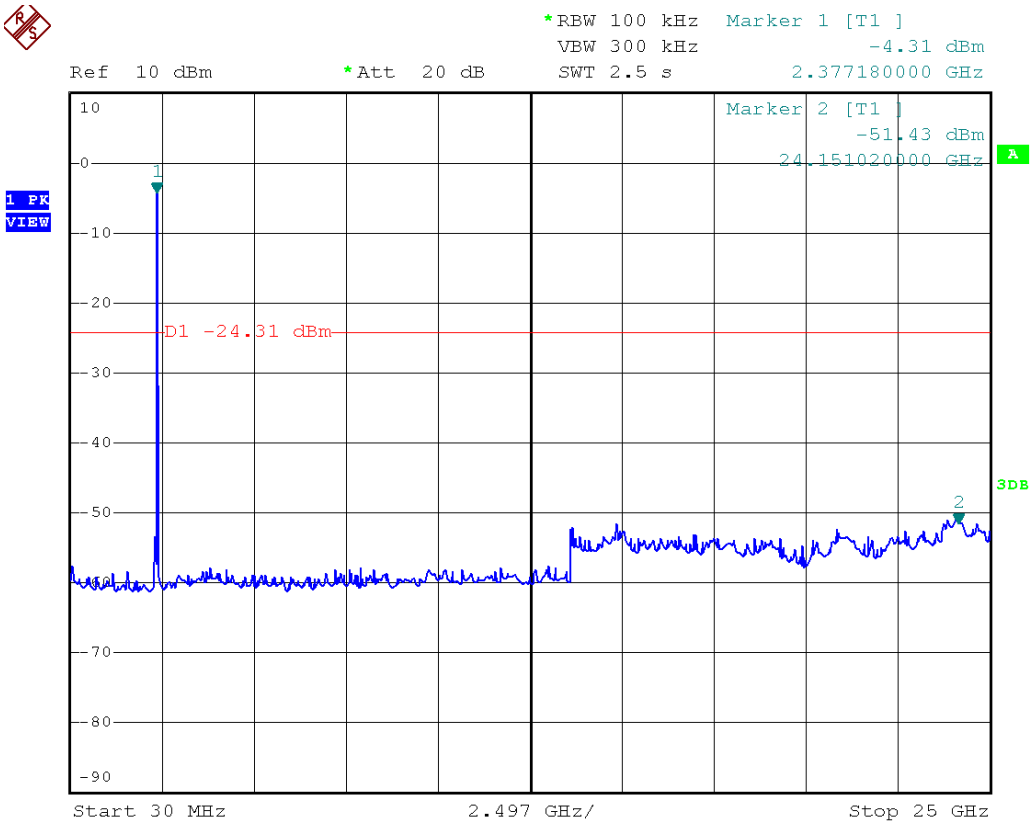


Figure 41 Conducted spurious emissions with FH4Tmode at middle channel

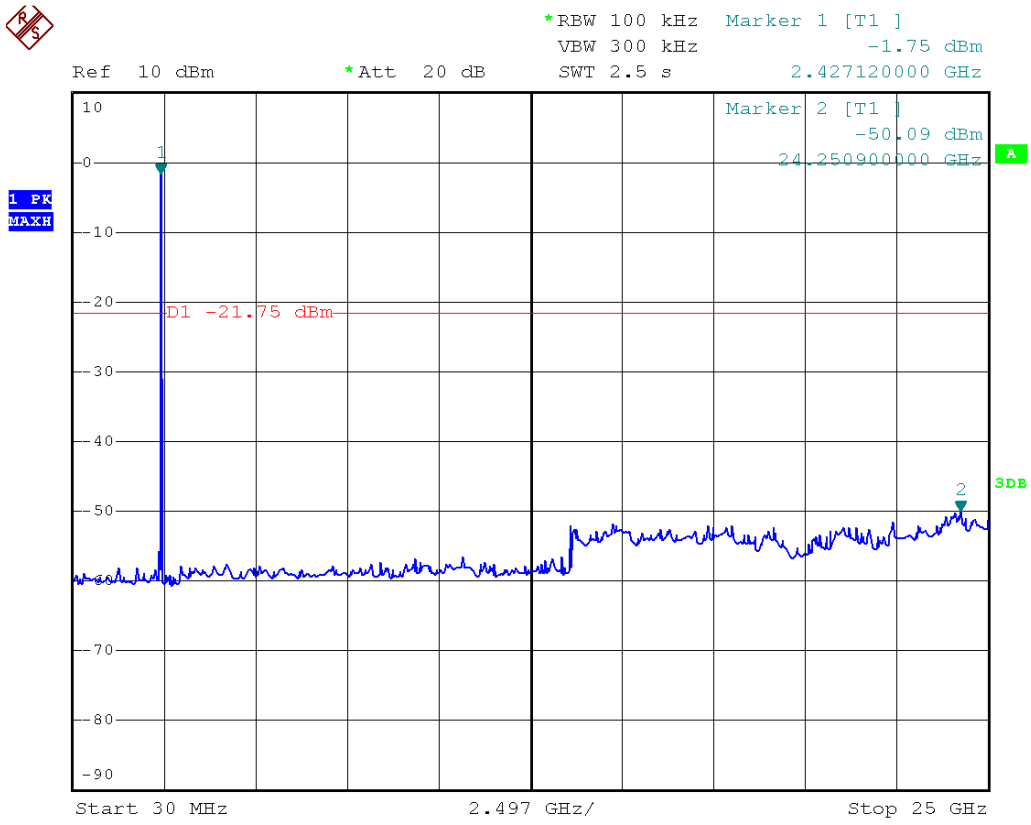


Figure 42 Conducted spurious emissions with FH4T mode at high channel

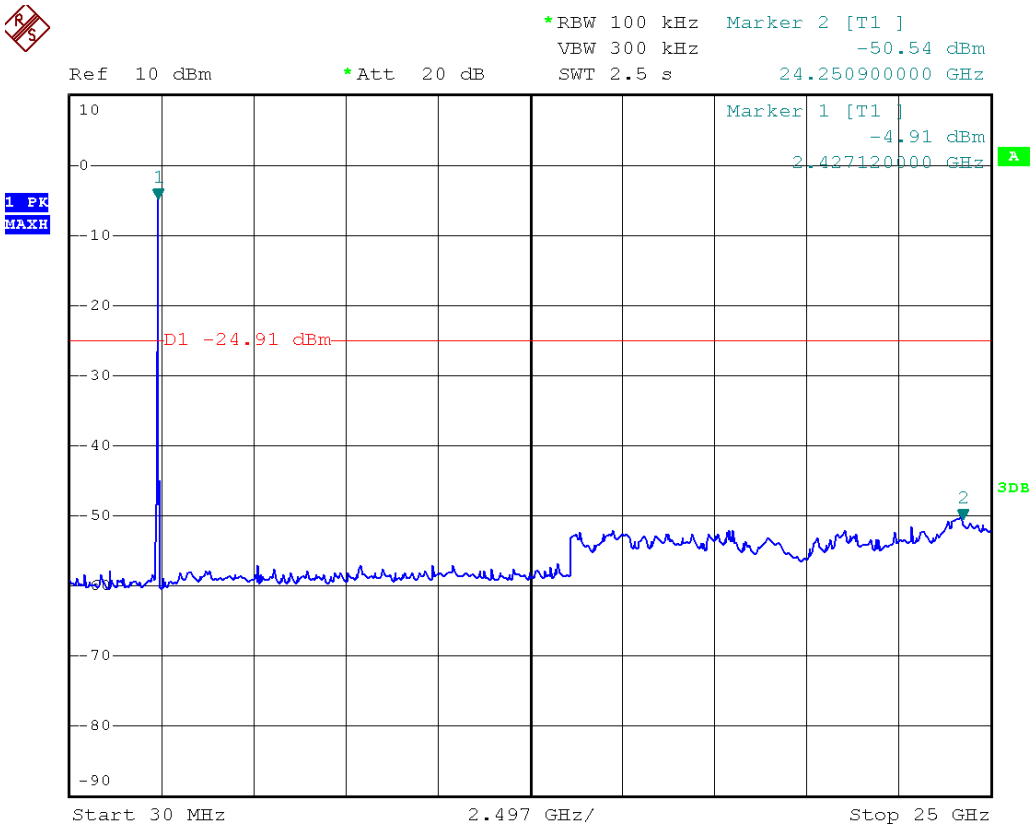


Figure 43 Conducted spurious emissions with FH4FT mode at low channel

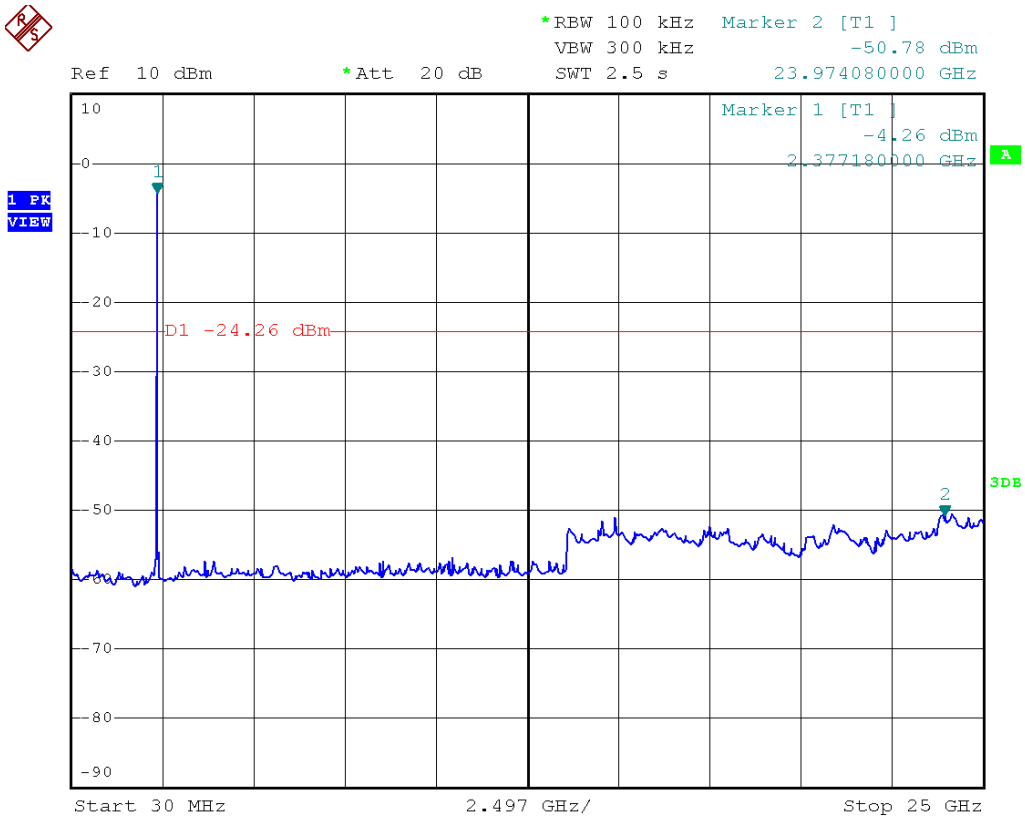


Figure 44 Conducted spurious emissions with FH4FT mode at middle channel

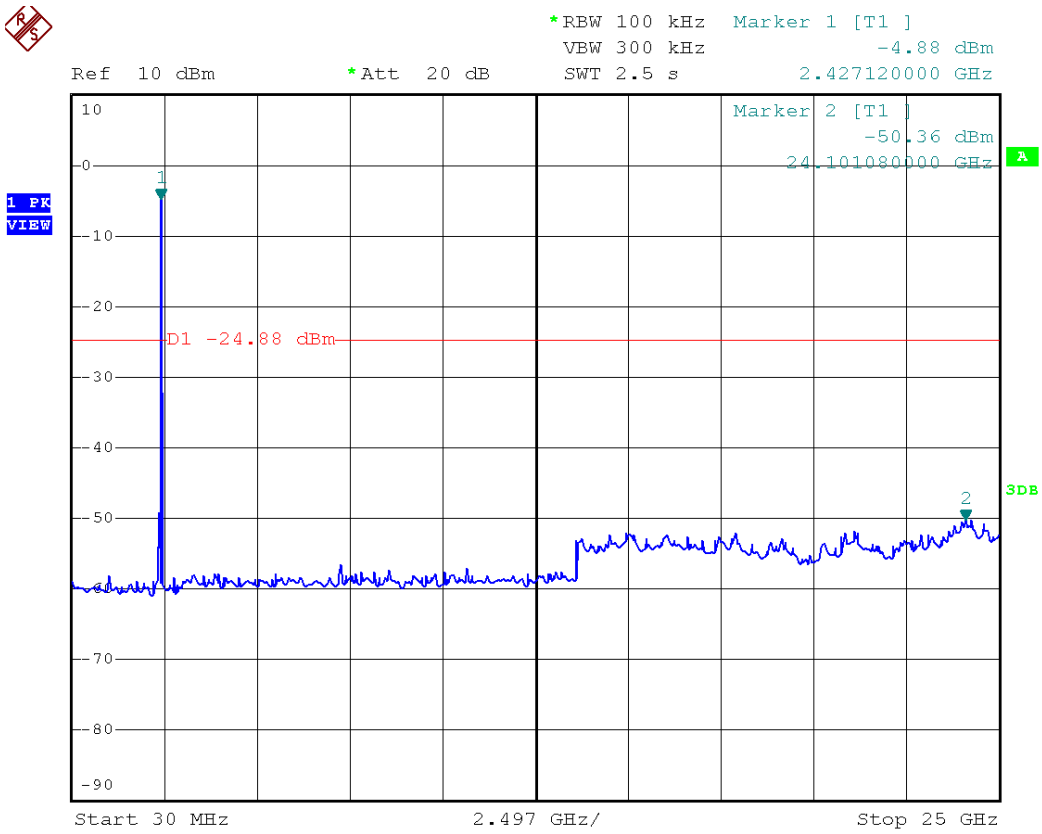
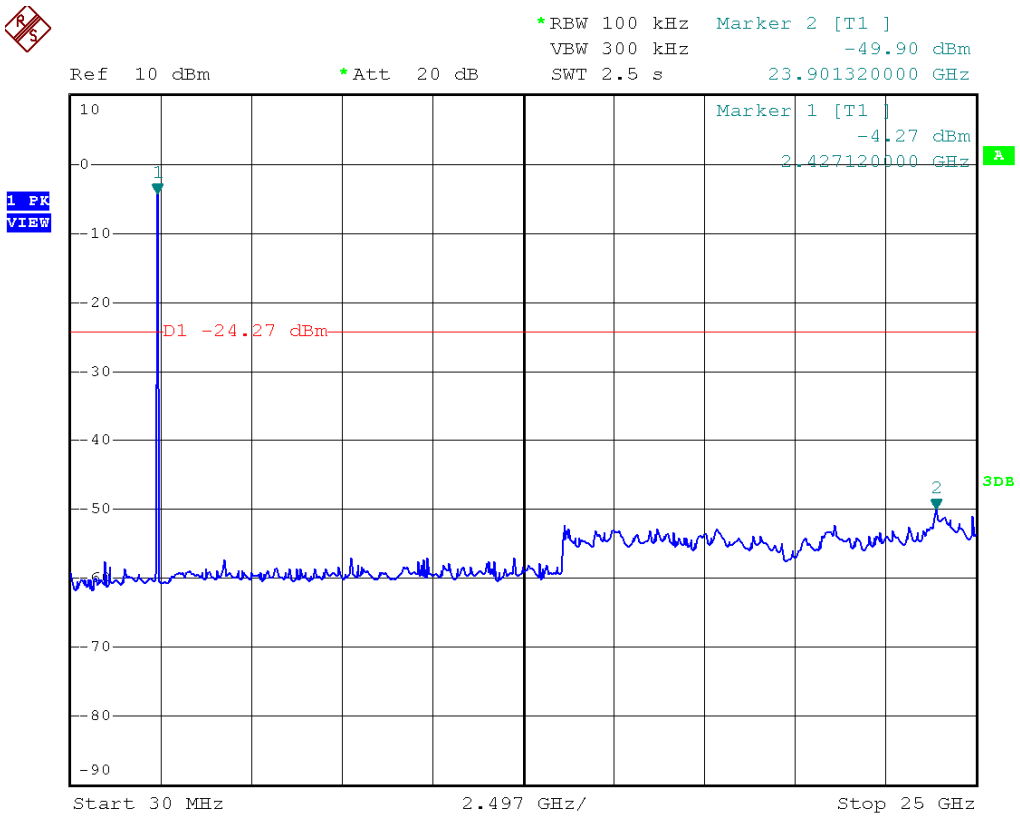


Figure 45 Conducted spurious emissions with FH4FT mode at high channel



6.6 Spurious Radiated Emission Measurement

Applicable Standard:

According to §15.247(c), all other emissions outside these bands shall not exceed the general radiated emission limits specified in §15.209(a). And according to §15.33(a)(1), for an intentional radiator operates below 10GHz, the frequency range of measurements: to the tenth harmonic of the highest fundamental frequency or to 40GHz, whichever is lower. According to §15.31(o), 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.

According to RSS-210 issue 8, §A8.5, in any 100 kHz bandwidth outside the frequency band in which the spread spectrum or digitally modulated device is operating, the radio frequency power that is produced 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 section A8.4(4), the attenuation required shall be 30 dB instead of 20 dB. Attenuation below the general limits specified in Tables 2 and 3 is not required. In addition, radiated emissions which fall in the restricted bands of Table 1 must also comply with the radiated emission limits specified in Tables 2 and 3.

Test Procedure:

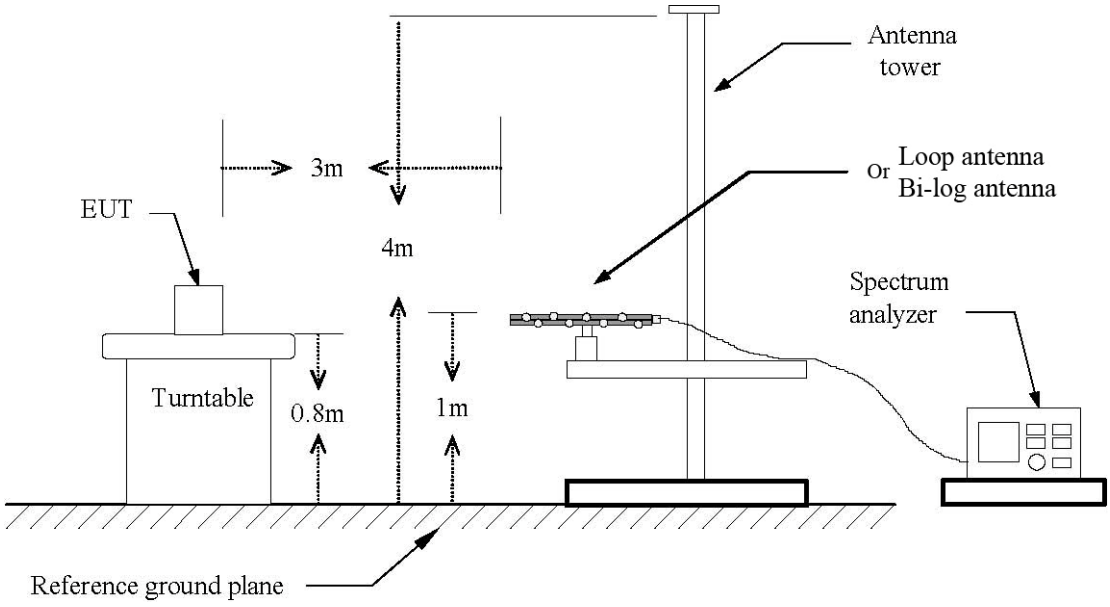
1. The EUT was placed on a turn table which is 0.8m above ground plane.
2. The turn table shall rotate 360 degrees to determine the position of maximum emission level.
3. EUT is set 3m away from the receiving antenna which varied from 1m to 4m to find out the highest emissions.
4. Maximum procedure was 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 all frequency measured were complete.

The field strength is calculated by adding the Antenna Factor and Cable Factor and subtracting the Amplifier Gain and Duty Cycle Correction Factor(if any) from the measured reading. The basic equation with a sample calculation is as follows:

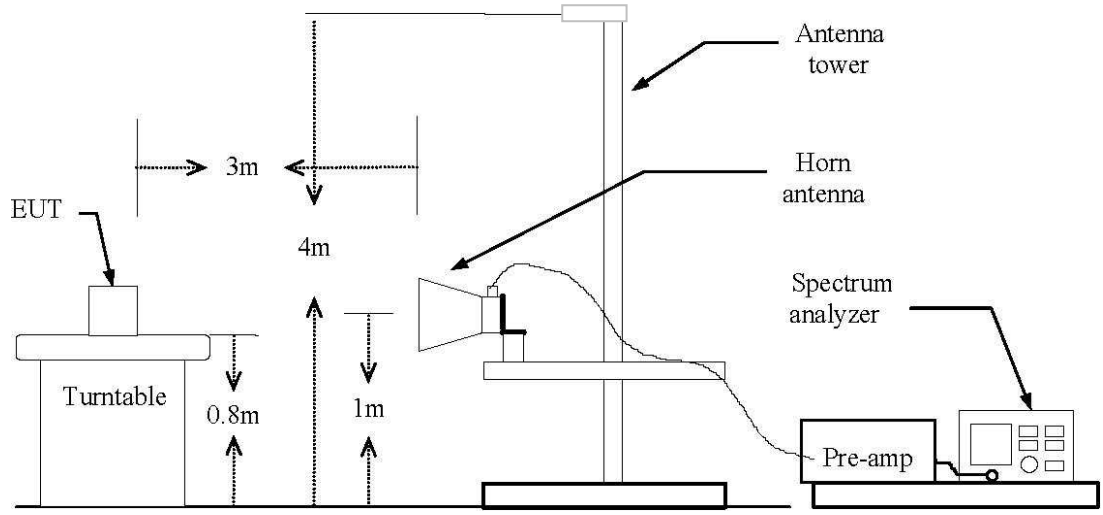
FS = RA + AF + CL - AG

Where FS = Field Strength	CL = Cable Attenuation Factor (Cable Loss)
RA = Reading Amplitude	AG = Amplifier Gain
AF = Antenna Factor	

Test Configuration between 9K and 1 GHz:



Test Configuration above 1 GHz:



Test Results:

Temperature:	25°C
Humidity:	51%
EUT Operation:	Data Transmission (without hopping)
Test Date:	July 15, 2013

Spurious Emission In the Frequency Rang between 9kHz to 1GHz:

Pre-scan the EUT with FH4, FH4T and FH4FT mode respectively and find out the worst case is at FH4 mode without hopping in transmitting.

At FH4 mode: Fc= 2403MHz transmitting operation

Freq. (MHz)	Ant.Pol. (H/V)	Detector Mode (PK/QP)	Reading (dBuV)	Ant./CL/ Amp.CF (dB)	Actual FS (dBuV/m)	Limit 3m (dBuV/m)	Margin (dB)
70.02	H	QP	21.6	5.3	26.9	43.5	-16.6
819.66	H	QP	10.5	22.7	33.2	46.0	-12.8
70.02	V	QP	28.8	5.3	34.1	43.5	-9.4
135.00	V	QP	20.8	8.3	29.1	43.5	-14.4
-	-	-	-	-	-	-	-

At FH4 mode: Fc= 2442MHz transmitting operation

Freq. (MHz)	Ant.Pol. (H/V)	Detector Mode (PK/QP)	Reading (dBuV)	Ant./CL/ Amp.CF (dB)	Actual FS (dBuV/m)	Limit 3m (dBuV/m)	Margin (dB)
70.02	H	QP	22.0	5.3	27.3	43.5	-16.2
819.66	H	QP	8.7	22.7	31.4	46.0	-14.6
70.02	V	QP	30.0	5.3	35.3	43.5	-8.2
135.00	V	QP	22.6	8.3	30.2	43.5	-13.3
-	-	-	-	-	-	-	-

At FH4 mode: Fc= 2478MHz transmitting operation

Freq. (MHz)	Ant.Pol. (H/V)	Detector Mode (PK/QP)	Reading (dBuV)	Ant./CL/ Amp.CF (dB)	Actual FS (dBuV/m)	Limit 3m (dBuV/m)	Margin (dB)
70.02	H	QP	23.4	5.3	28.7	43.5	-14.8
819.66	H	QP	12.1	22.7	34.8	46.0	-11.2
70.02	V	QP	28.5	5.3	33.8	43.5	-9.7
817.98	V	QP	8.9	22.7	31.6	46.0	-14.4
-	-	-	-	-	-	-	-

Note: For spurious emission measurement, the compliance tests were performed both of horizontally and vertically placed in EUT(X position, Y position, Z position). As a result, the data of operation mode that produce the maximum emission were reported. The other emissions shown "-" are more than 20dB below the limits.

Spurious Emission In the Frequency Rang above 1GHz:

Pre-scan the EUT with FH4, FH4T and FH4FT mode respectively and find out the worst case is at FH4 mode without hopping in transmitting.

At FH4 mode: Fc= 2403MHz transmitting operation - Horizontal

Freq. (MHz)	Peak Reading (dBuV)	AV Reading (dBuV)	Ant./CL/ Amp.CF (dB)	Actual FS		Peak Limit (dBuV/m)	AV Limit (dBuV/m)	Margin
				Peak (dBuV/m)	AV (dBuV/m)			
4806.20	51.22	31.50	2.70	53.92	34.20	74.00	54.00	-19.80
7209.40	53.16	35.33	4.22	57.38	39.55	74.00	54.00	-14.45
-	-	-	-	-	-	-	-	-

At FH4 mode: Fc= 2403MHz transmitting operation - Vertical

Freq. (MHz)	Peak Reading (dBuV)	AV Reading (dBuV)	Ant./CL/ Amp.CF (dB)	Actual FS		Peak Limit (dBuV/m)	AV Limit (dBuV/m)	Margin
				Peak (dBuV/m)	AV (dBuV/m)			
4806.20	50.02	30.24	2.70	52.72	32.94	74.00	54.00	-21.06
7209.40	52.49	33.96	4.22	56.71	38.18	74.00	54.00	-15.82
-	-	-	-	-	-	-	-	-

Note: Data of measurement within this frequency range shown "-" in the table above means the reading of emissions are attenuated more than 20dB below the permissible limits or the field strength is too small to be measured.

At FH4 mode: Fc= 2442MHz transmitting operation - Horizontal

Freq. (MHz)	Peak Reading (dBuV)	AV Reading (dBuV)	Ant./CL/ Amp.CF (dB)	Actual FS		Peak Limit (dBuV/m)	AV Limit (dBuV/m)	Margin
				Peak (dBuV/m)	AV (dBuV/m)			
4883.50	49.86	31.03	2.70	52.56	33.73	74.00	54.00	-20.27
7324.82	53.69	34.05	4.22	57.91	38.27	74.00	54.00	-15.73
-	-	-	-	-	-	-	-	-

At FH4 mode: Fc= 2442MHz transmitting operation - Vertical

Freq. (MHz)	Peak Reading (dBuV)	AV Reading (dBuV)	Ant./CL/ Amp.CF (dB)	Actual FS		Peak Limit (dBuV/m)	AV Limit (dBuV/m)	Margin
				Peak (dBuV/m)	AV (dBuV/m)			
4883.50	50.56	30.69	2.70	53.26	33.39	74.00	54.00	-20.61
7324.82	53.48	33.14	4.22	57.70	37.36	74.00	54.00	-16.30
-	-	-	-	-	-	-	-	-

Note: Data of measurement within this frequency range shown "-" in the table above means the reading of emissions are attenuated more than 20dB below the permissible limits or the field strength is too small to be measured.

At FH4 mode: Fc= 2478MHz transmitting operation - Horizontal

Freq. (MHz)	Peak Reading (dBuV)	AV Reading (dBuV)	Ant./CL/ Amp.CF (dB)	Actual FS		Peak Limit (dBuV/m)	AV Limit (dBuV/m)	Margin
				Peak (dBuV/m)	AV (dBuV/m)			
4954.36	51.82	31.26	2.70	54.52	33.96	74.00	54.00	-19.48
7434.20	54.30	32.14	4.22	58.52	36.36	74.00	54.00	-15.48
-	-	-	-	-	-	-	-	-

At FH4 mode: Fc= 2478MHz transmitting operation - Vertical

Freq. (MHz)	Peak Reading (dBuV)	AV Reading (dBuV)	Ant./CL/ Amp.CF (dB)	Actual FS		Peak Limit (dBuV/m)	AV Limit (dBuV/m)	Margin
				Peak (dBuV/m)	AV (dBuV/m)			
4955.60	52.09	32.46	2.70	54.79	35.16	74.00	54.00	-18.84
7434.20	55.13	34.07	4.22	59.35	38.29	74.00	54.00	-14.65
-	-	-	-	-	-	-	-	-

Note: Data of measurement within this frequency range shown "-" in the table above means the reading of emissions are attenuated more than 20dB below the permissible limits or the field strength is too small to be measured.

6.7 Conducted Emission Measurement

Applicable Standard:

According to §15.207(a), 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 150 kHz to 30 MHz shall not exceed the limits in the following table, as measured using a 50 μH/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 of Emission (MHz)	Conducted Limit (dBμV)	
	Quasi-peak	Average
0.15 ~ 0.5	66 to 56*	56 to 46*
0.5 ~ 5	56	46
5 ~ 30	60	50

*Note: *Decreases with the logarithm of the frequency.*

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. Devices that include, or make provisions for, the use of battery chargers which permit operating while charging, AC adapters or battery eliminators or that connect to the AC power lines indirectly, obtaining their power through another device which is connected to the AC power lines, shall be tested to demonstrate compliance with the conducted limits.

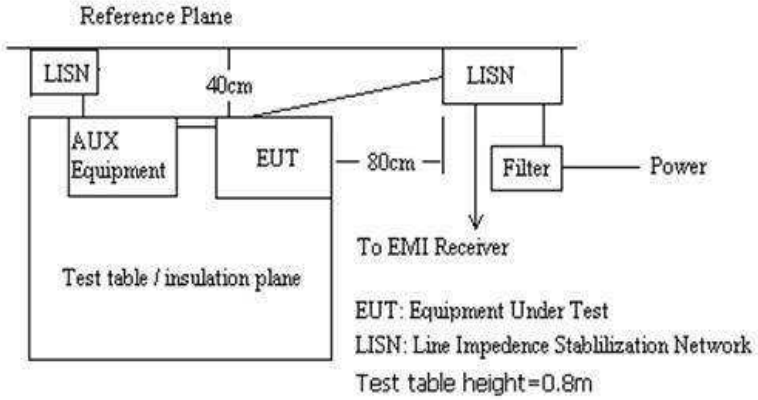
According to RSS-GEN Section 7.2.2, the purpose of this test is to measure unwanted radio frequency currents induced in any AC conductor external to the equipment which could conduct interference to other equipment via the AC electrical network. Except when the requirements applicable to a given device state otherwise, for any licence-exempt radio communication device equipped to operate from the public utility AC power supply, either directly or indirectly, the radio frequency voltage that is conducted back onto the AC power lines in the frequency range of 0.15 MHz to 30 MHz shall not exceed the limits shown in Table 2. The tighter limit applies at the frequency range boundaries.

The conducted emissions shall be measured with a 50 ohm/50 microhenry line impedance stabilization network.

Test Procedure:

1. The EUT was placed on a table which is at least 0.8 m high. Place the EUT so that it is 0.4 m from the wall of the shielding room, or place the EUT on a table which is 0.4 m high so that the bottom of the EUT is 0.4 m above the ground plane.
2. All the other conductive surface of the EUT shall be at least 0.8 m from the reference ground plane.
3. If the mains lead of the EUT is longer than necessary to be connected to the LISN the length of this lead in excess of 0.8 m shall be folded back and forth parallel to the lead so as to form a horizontal bundle with a length between 0.3 m and 0.4 m.
4. Maximum procedure was performed on the six highest emissions to ensure EUT compliance.

Test Configuration:



Test Result:

This test is not applicable to the EUT.

6.8 Band Edge and Restricted Band of Radiated Emission Measurement

Applicable Standard:

According to §15.247(d), radiated emissions which fall in the restricted bands, as defined in §15.205(a), must also comply with the radiated emission limits specified in 15.209(a).

According to RSS-210 issue 8, §A8.5, radiated emissions which fall in the restricted bands of Table 1 must also comply with the radiated emission limits specified in Tables 2 and 3.

According to DA 00-705, in making radiated band-edge measurements, the following technique for determining band edge compliance.

Step 1: perform an in band field strength measurement of the fundamental emission using the RBW and detector function required by ANSI C63.4: 2003 and our Rules for the frequency being measured. For transmitters operating above 1 GHz, use a 1 MHz RBW, a 1 MHz VBW, and a peak detector (as required by Section 15.35). Repeat the measurement with an average detector (i.e., 1 MHz RBW with 10 Hz VBW).

Step 2: choose a spectrum analyzer span that encompasses both the peak of the fundamental emission and the band-edge emission under investigation. Set the analyzer RBW to 1% of the total span (but never less than 30 kHz) with a video bandwidth equal to or greater than the RBW. Record the peak levels of the fundamental emission and the relevant band-edge emission (i.e., run several sweeps in peak hold mode). Observe the stored trace and measure the amplitude delta between the peak of the fundamental and the peak of the band-edge emission. This is not a field strength measurement, it is only a relative measurement to determine the amount by which the emission drops at the band edge relative to the highest fundamental emission level.

Step 3: subtract the delta measured in step (2) from the field strengths measured in step (1). The resultant field strengths (CISPR QP, average, or peak, as appropriate) are then used to determine band edge compliance as required by Section 15.205.

Step 4: the above "delta" measurement technique may be used for measuring emissions that are up to two "standard" bandwidths away from the band edge, where a "standard" bandwidth is the bandwidth specified by ANSI C63.4: 2003 for the frequency being measured.

Test Procedure:

1. The EUT was placed on a turn table which is 0.8m above ground plane.
2. The turn table shall rotate 360 degrees to determine the position of maximum emission level.
3. EUT is set 3m away from the receiving antenna which varied from 1m to 4m to find out the highest emissions.
4. Maximum procedure was performed on the highest emissions in restricted band to ensure EUT compliance.

The field strength is calculated by adding the Antenna Factor and Cable Factor and subtracting the Amplifier Gain and Duty Cycle Correction Factor(if any) from the measured reading. The basic equation with a sample calculation is as follows:

FS = RA + AF + CL - AG

Where FS = Field Strength	CL = Cable Attenuation Factor (Cable Loss)
RA = Reading Amplitude	AG = Amplifier Gain
AF = Antenna Factor	

Test Results:

Temperature:	24°C
Humidity:	50%
EUT Operation:	FHSS modulation without hopping
Test Date:	July 17, 2013

Pre-scan the EUT with FH4, FH4T and FH4FT mode respectively and find out the worst case is FH3 mode without hopping in transmitting.
The unit does meet the requirements.
Note: Test plots shown in figures 46 to 53 on pages 53 to 56.

Figure 46 Band edge of radiated emission – low frequency side without hopping at FH4 mode
Peak measurement in horizontal polarization

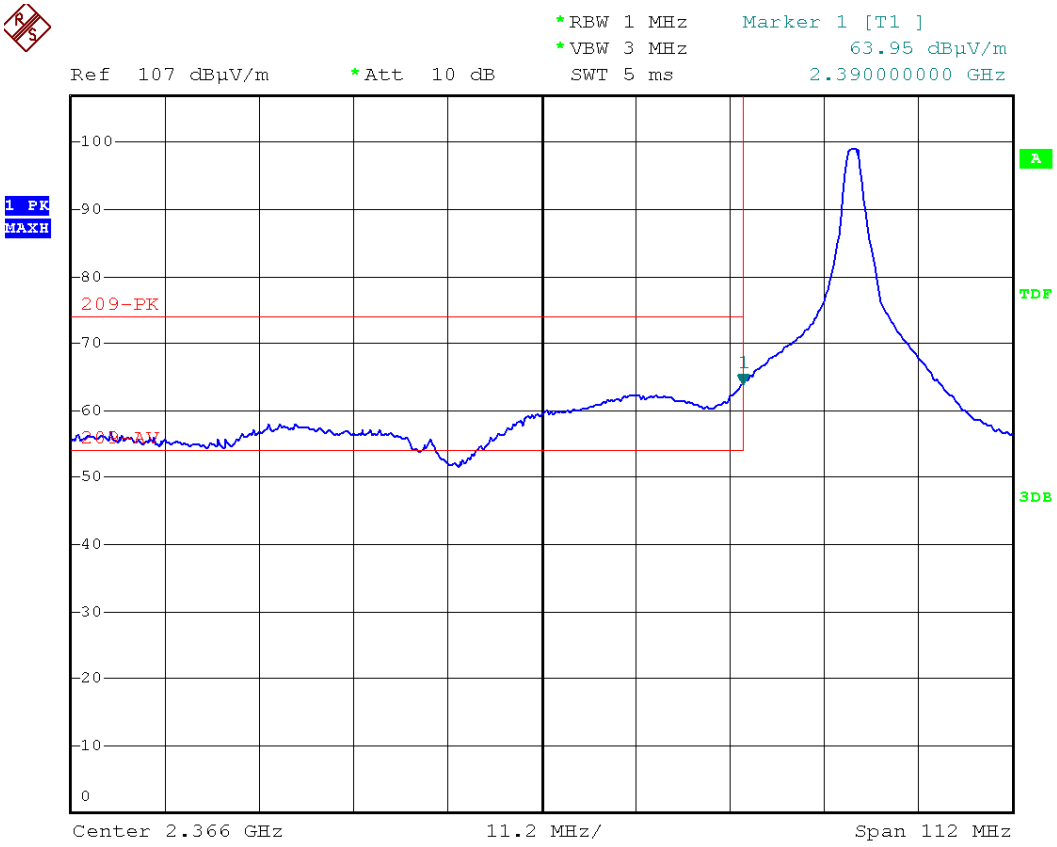


Figure 47 Band edge of radiated emission – low frequency side without hopping at FH4 mode
Average measurement in horizontal polarization

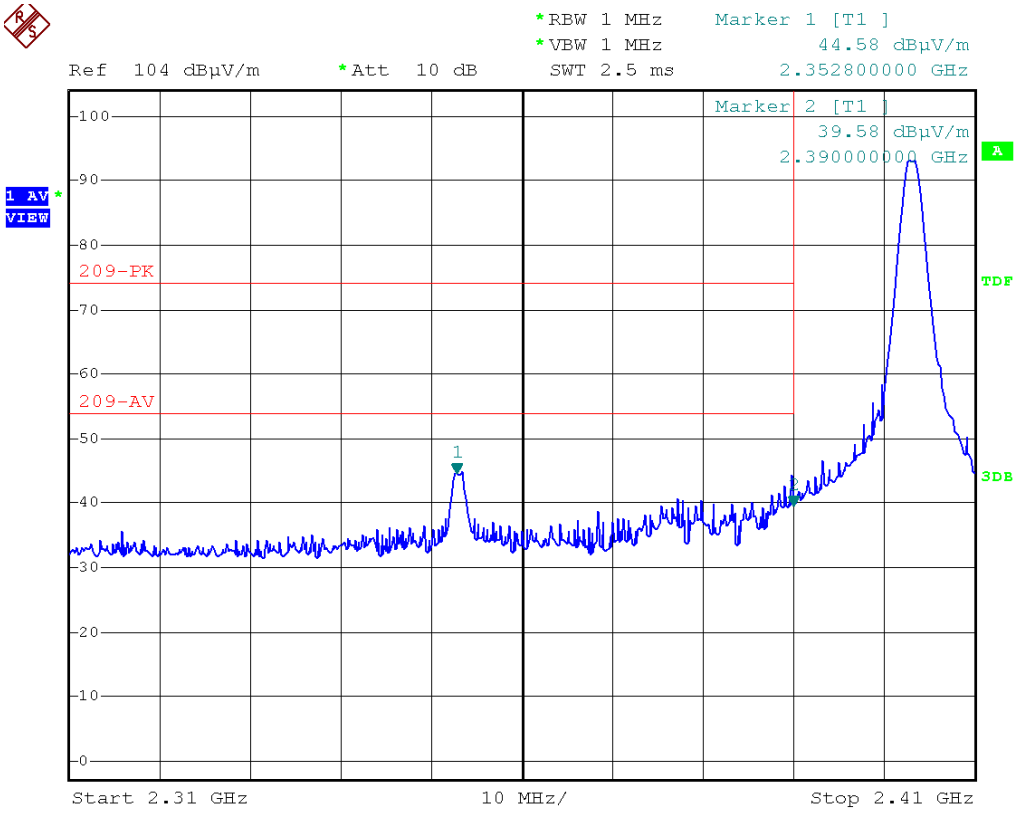


Figure 48 Band edge of radiated emission – low frequency side without hopping at FH4 mode
Peak measurement in vertical polarization

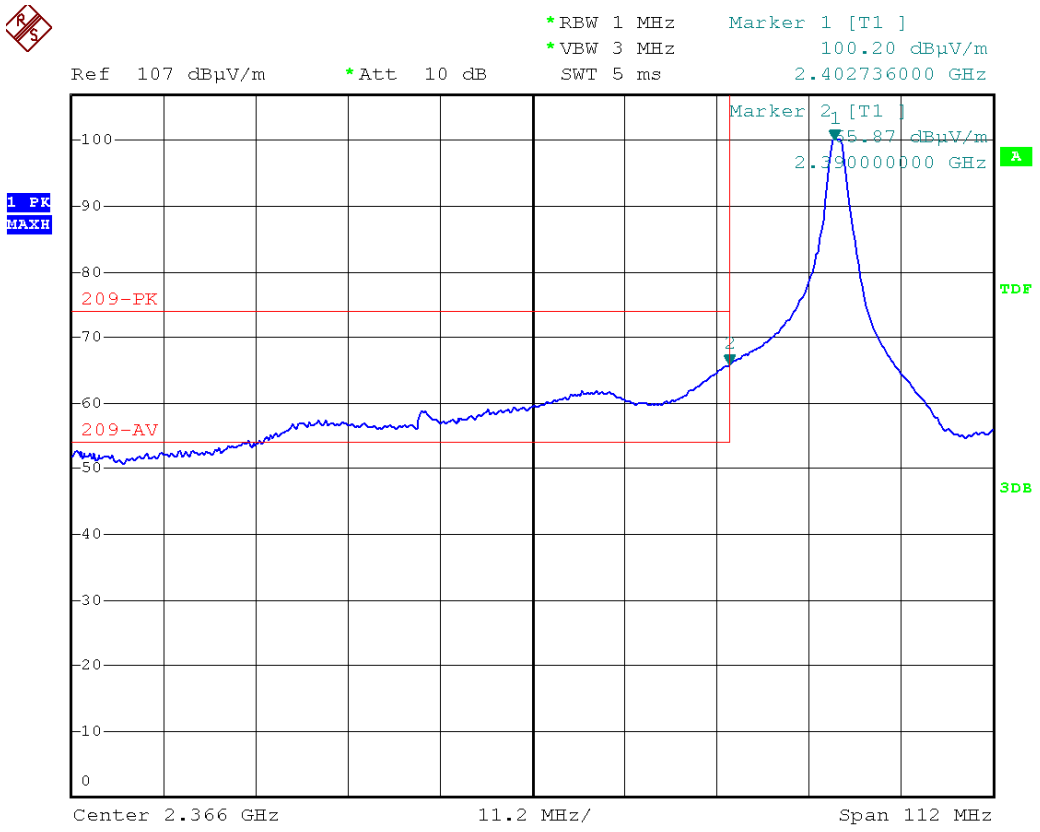


Figure 49 Band edge of radiated emission – low frequency side without hopping at FH4 mode
Average measurement in vertical polarization

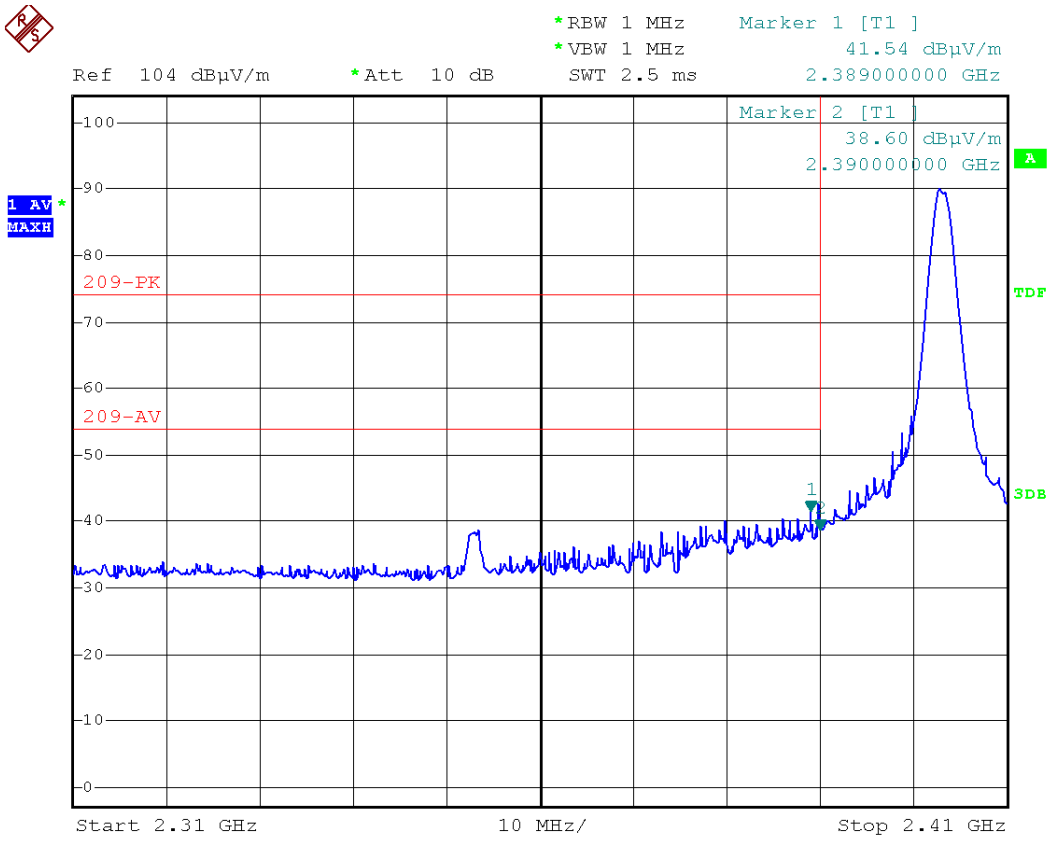


Figure 50 Band edge of radiated emission – high frequency side without hopping at FH4 mode
Peak measurement in horizontal polarization

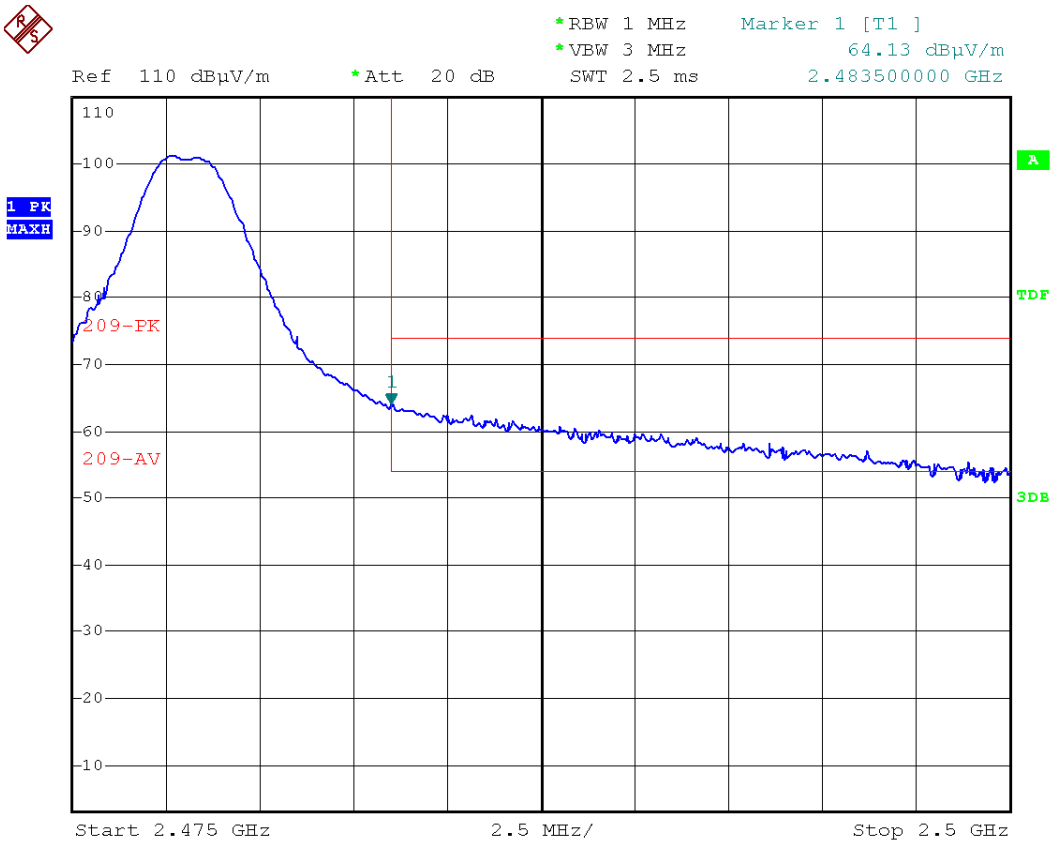


Figure 51 Band edge of radiated emission – high frequency side without hopping at FH4 mode
Average measurement in horizontal polarization

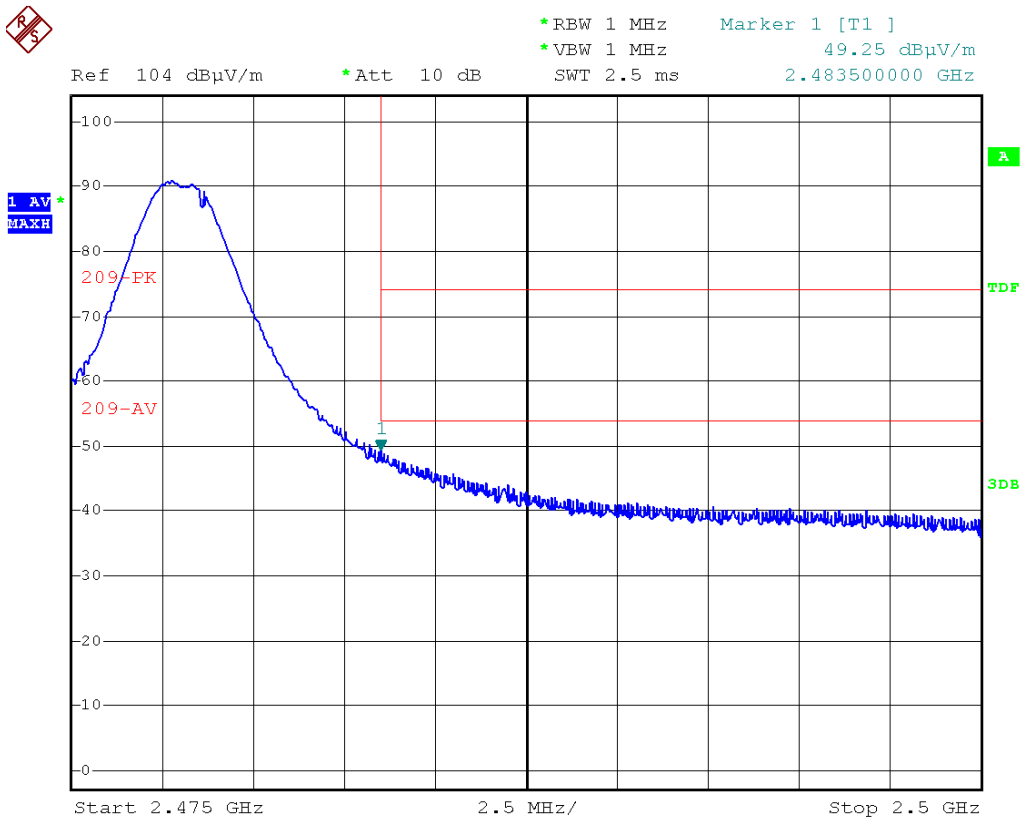


Figure 52 Band edge of radiated emission – high frequency side without hopping at FH4 mode
Peak measurement in vertical polarization

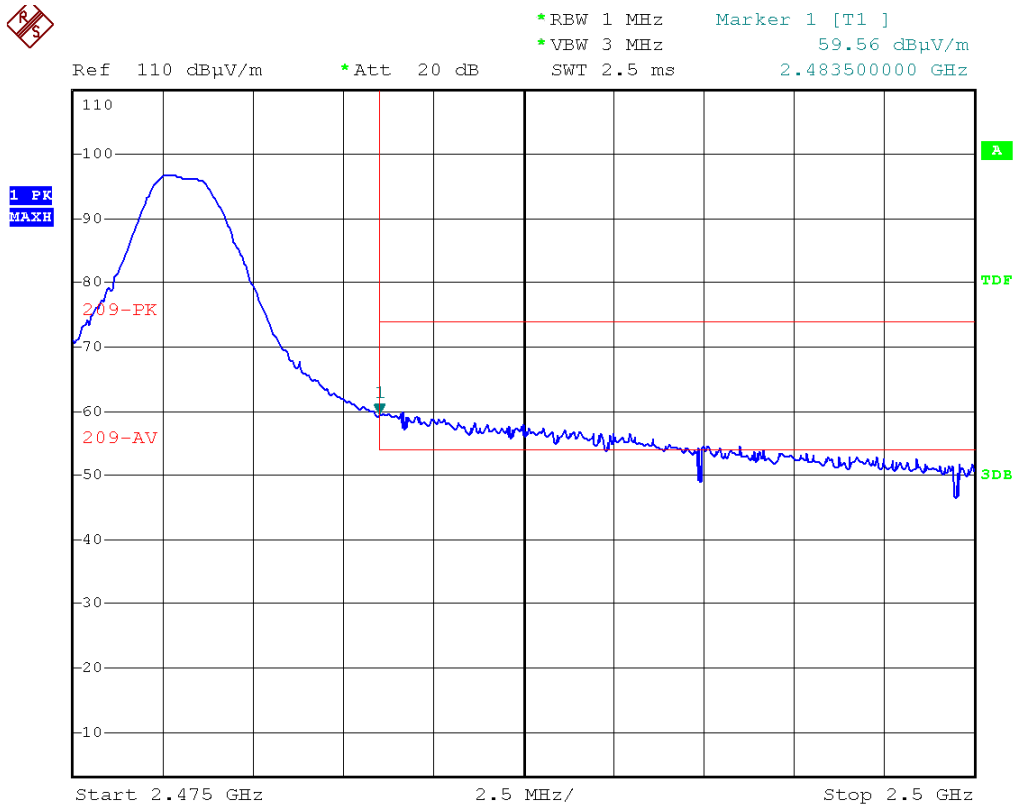
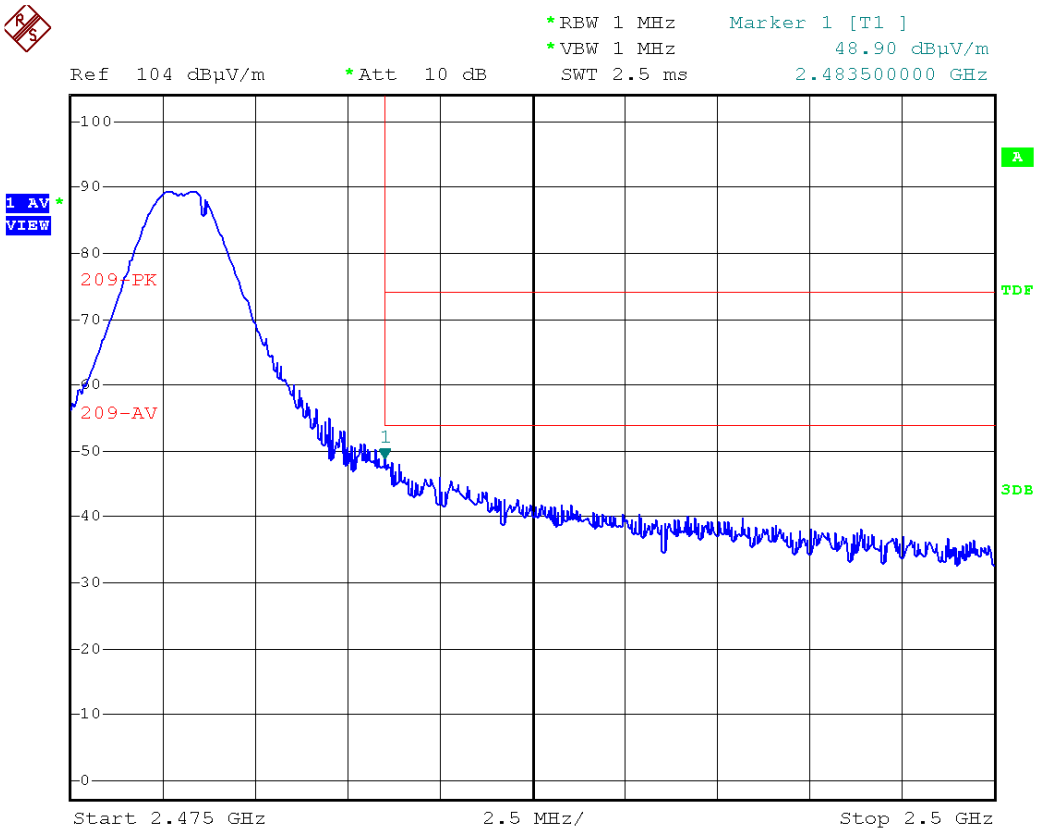


Figure 53 Band edge of radiated emission – high frequency side without hopping at FH4 mode
Average measurement in vertical polarization



6.9 99% Bandwidth Measurement

Applicable Standard:

RSS-Gen §4.4.1, the transmitter shall be operated at its maximum carrier power measured under normal test conditions. The span of the analyzer shall be set to capture all products of the modulation process, including the emission skirts. The resolution bandwidth shall be set to as close to 1% of the selected span as is possible without being below 1%. The video bandwidth shall be set to 3 times the resolution bandwidth. Video averaging is not permitted. Where practical, a sampling detector shall be used since a peak or, peak hold, may produce a wider bandwidth than actual.

The trace data points are recovered and are directly summed in linear terms. The recovered amplitude data points, beginning at the lowest frequency, are placed in a running sum until 0.5% of the total is reached and that frequency recorded. The process is repeated for the highest frequency data points. This frequency is recorded. The span between the two recorded frequencies is the occupied bandwidth.

Spectrum analyzer set up conditions:

Span = 2MHz
Resolution Bandwidth = 100KHz
Video Bandwidth = 300KHz
Sweep = auto
Detector function = peak
Trace = max hold

Test Results:

Temperature:	25°C
Humidity:	51%
EUT Operation:	Data Transmission (without hopping)
Test Date:	July 17, 2013

Operation Mode	Frequency	99% Bandwidth
	[MHz]	(MHz)
FH4	2403	1.140
	2442	1.188
	2478	1.192
FH4T	2410	1.132
	2438	1.160
	2465	1.192
FH4FT	2410	1.152
	2430	1.156
	2450	1.164
Note: Test plots shown in figures 54 to 62 on pages 59 to 63.		

Figure 54 - 99% Bandwidth measurement (fc=2403MHz) at FH4 mode

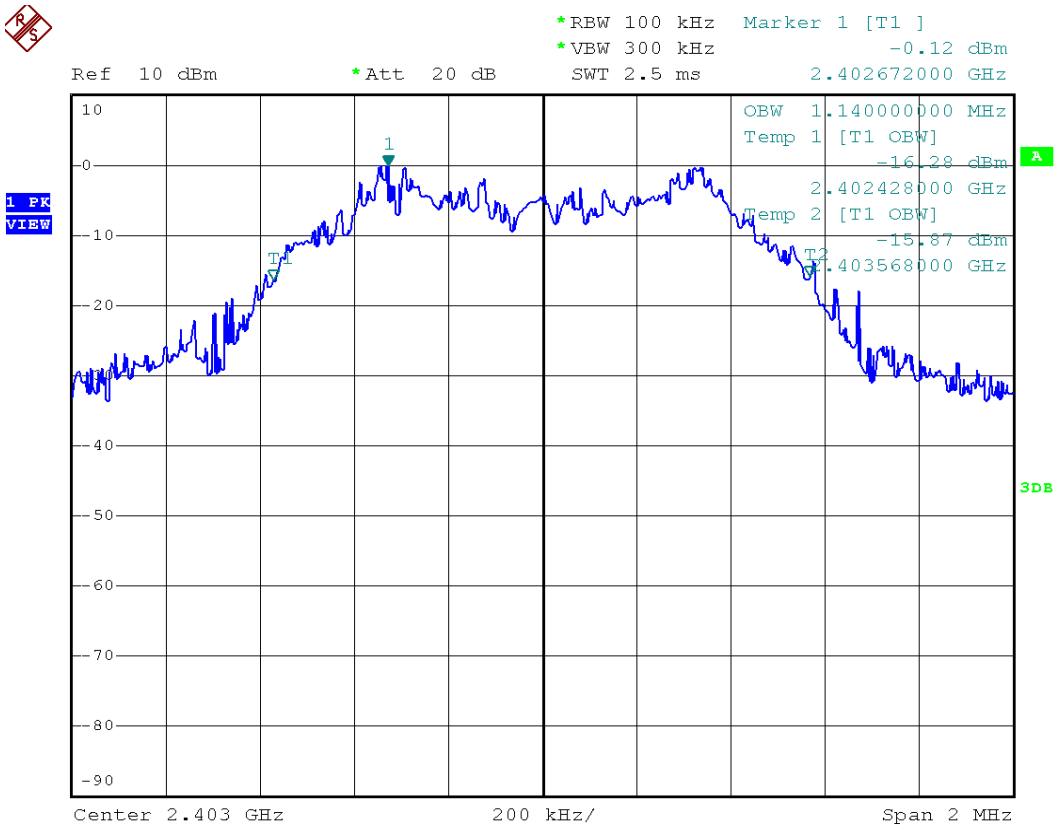


Figure 55 - 99% Bandwidth measurement (fc=2442MHz) at FH4 mode

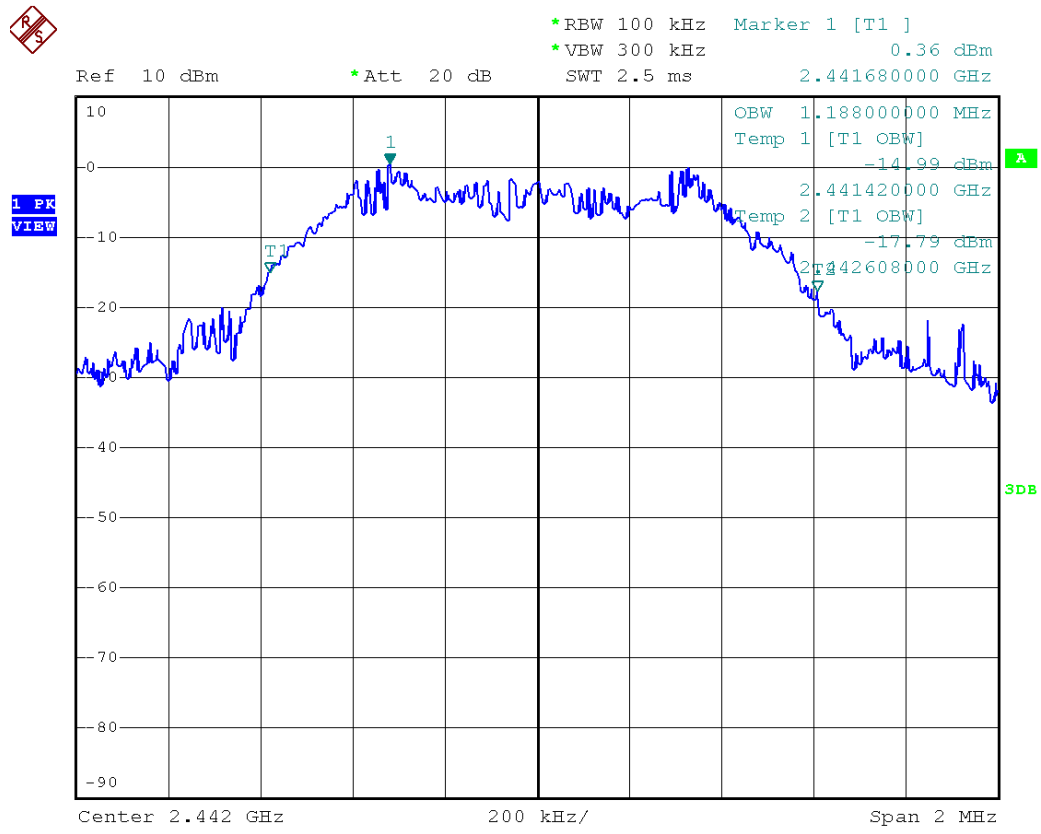


Figure 56 - 99% Bandwidth measurement (fc=2478MHz) at FH4 mode

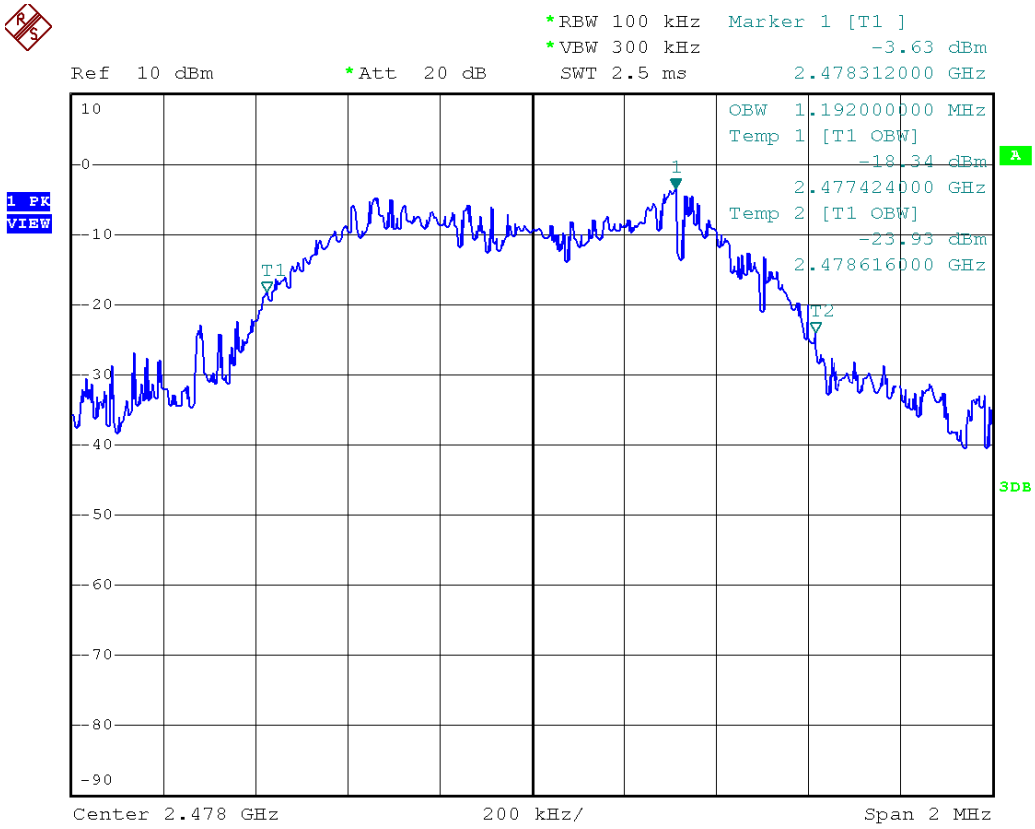


Figure 57 - 99% Bandwidth measurement (fc=2410MHz) at FH4T mode

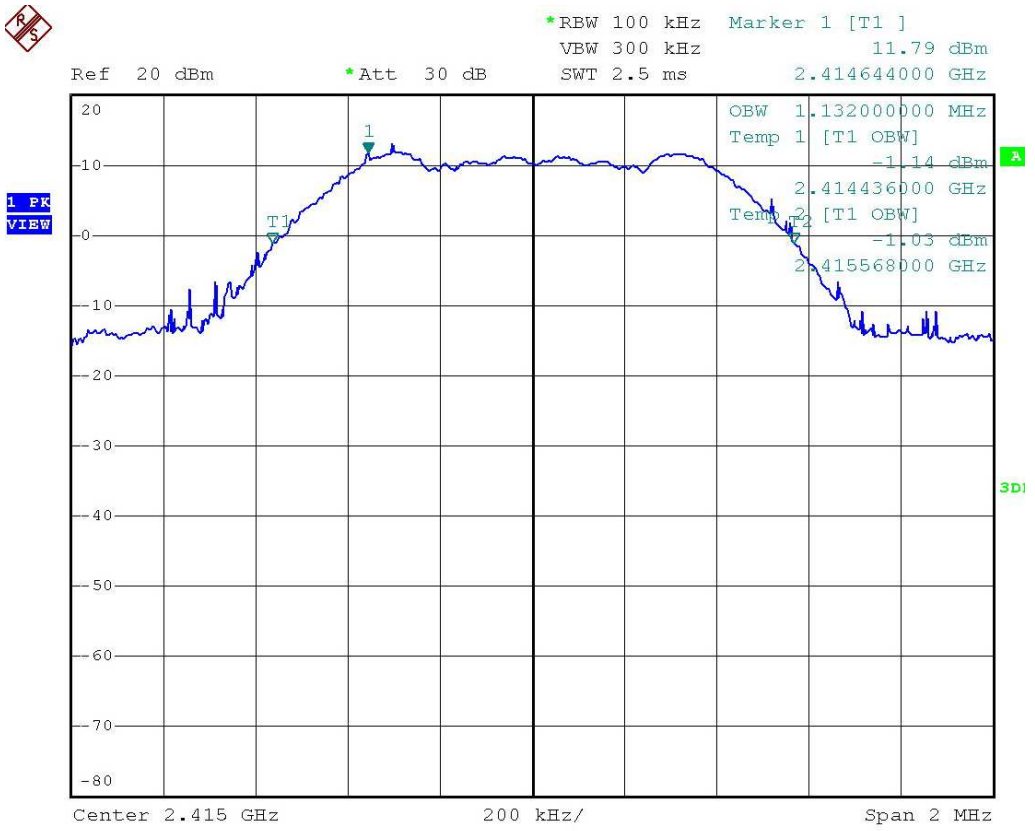


Figure 58 - 99% Bandwidth measurement (fc=2438MHz) at FH4T mode

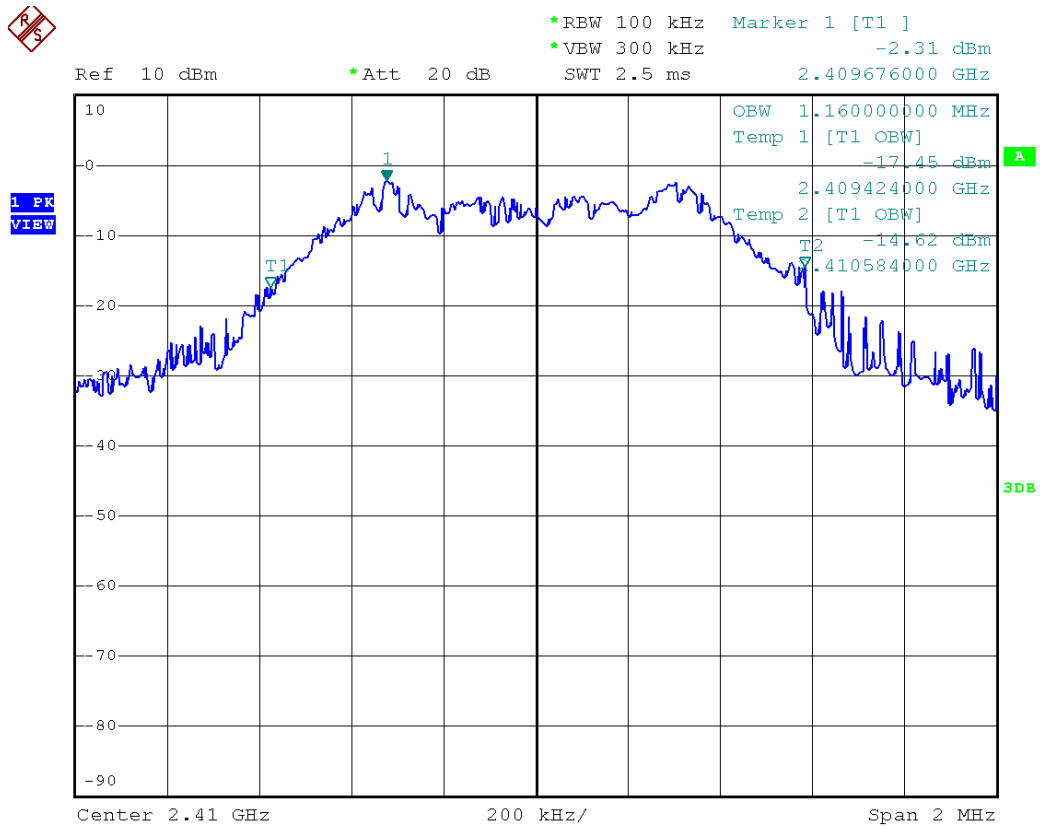


Figure 59 - 99% Bandwidth measurement (fc=2465MHz) at FH4T mode

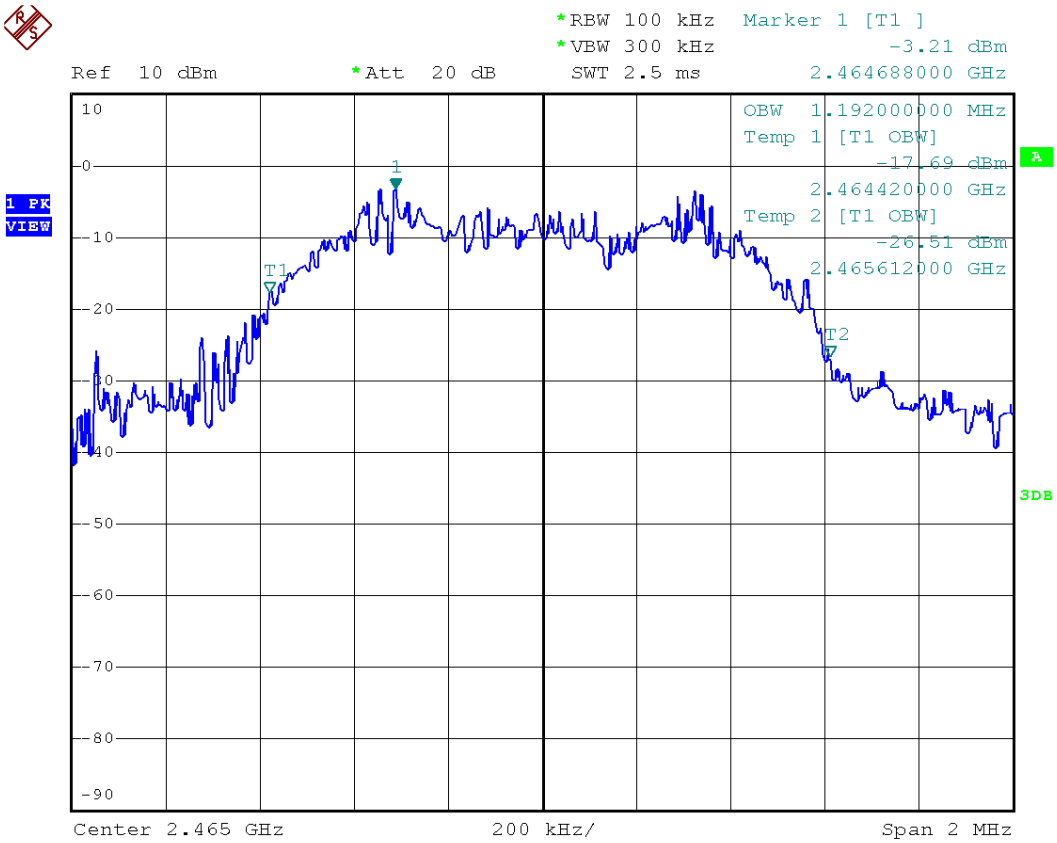


Figure 60 - 99% Bandwidth measurement (fc=2410MHz) at FH4T mode

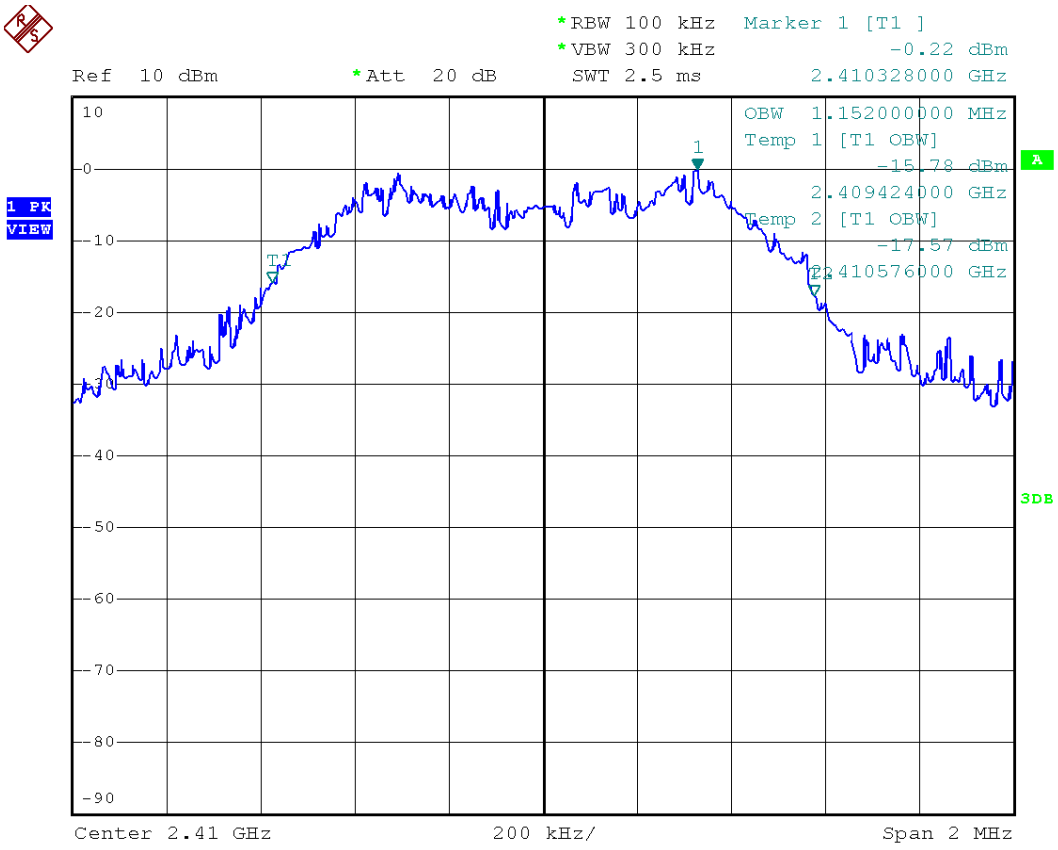


Figure 61 - 99% Bandwidth measurement (fc=2430MHz) at FH4T mode

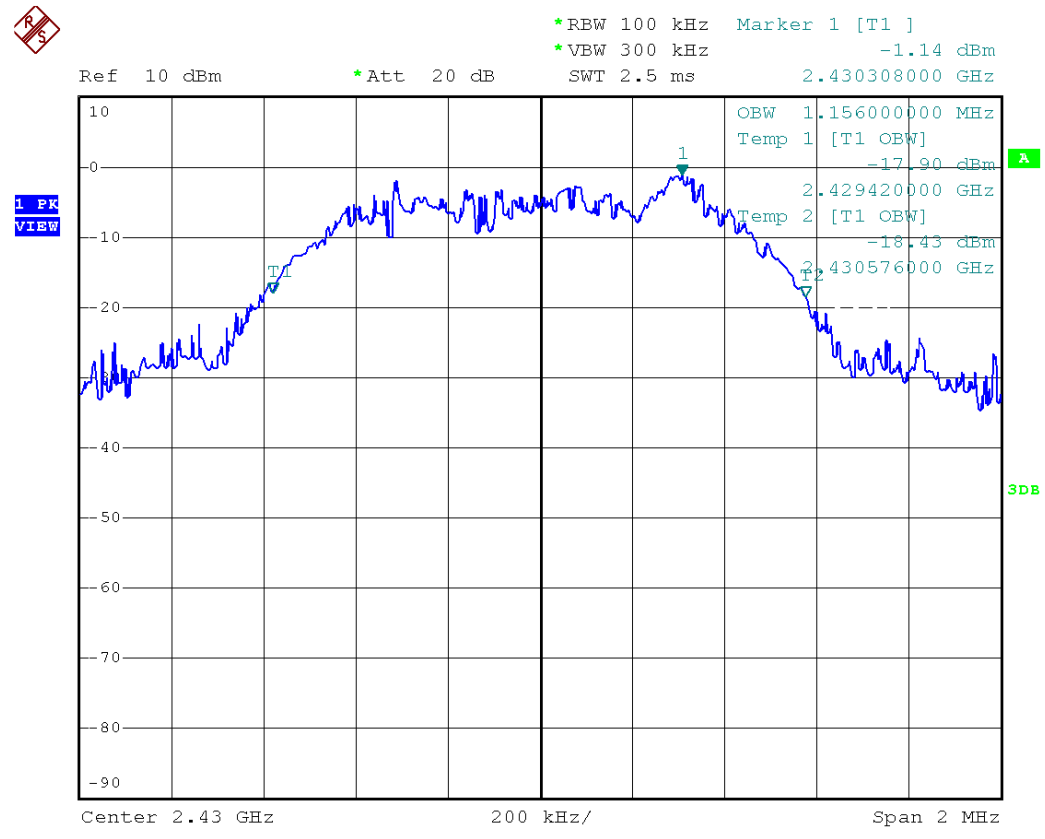
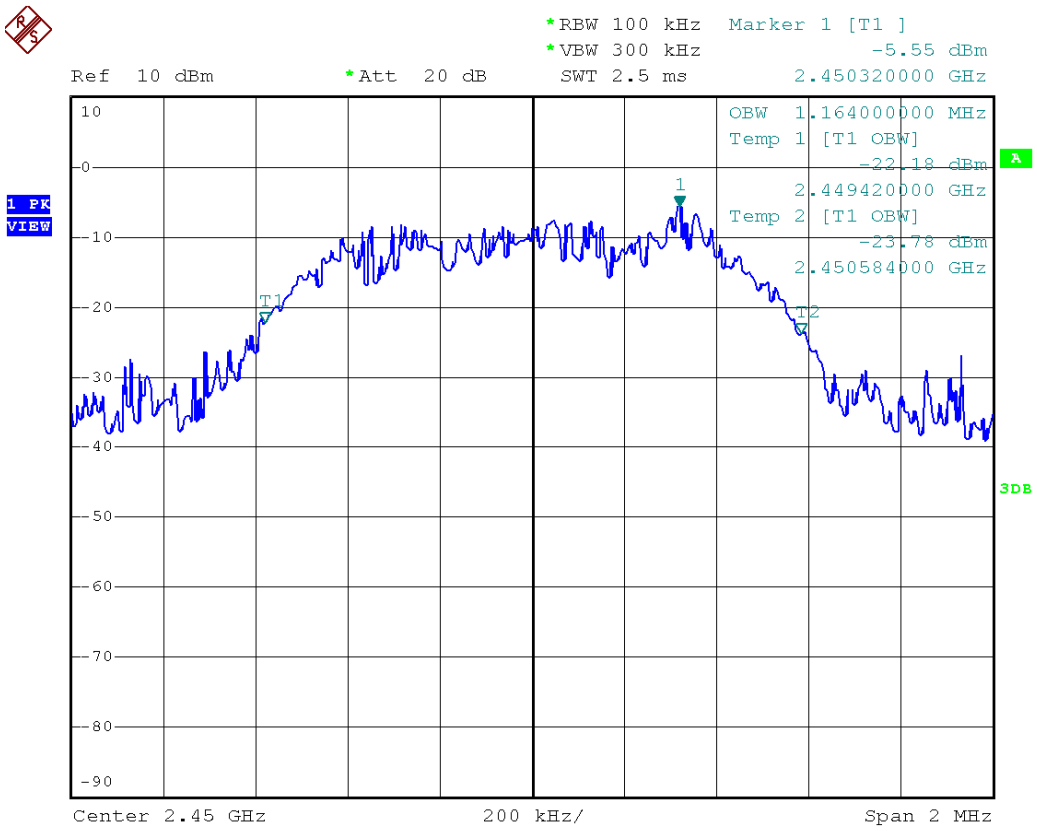


Figure 62 - 99% Bandwidth measurement (fc=2450MHz) at FH4T mode



6.10 20dB Bandwidth Measurement

Applicable Standard:

According to §15.247(a)(1) Frequency hopping systems shall have hopping channel carrier frequencies separated by a minimum of 25kHz 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. 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.

The trace data points are recovered and are directly summed in linear terms. The recovered amplitude data points, beginning at the lowest frequency, are placed in a running sum until 0.5% of the total is reached and that frequency recorded. The process is repeated for the highest frequency data points. This frequency is recorded. The span between the two recorded frequencies is the occupied bandwidth.

Spectrum analyzer set up conditions:

Span = 2MHz
Resolution Bandwidth = 100KHz
Video Bandwidth = 300KHz
Sweep = auto
Detector function = peak
Trace = max hold

Test Results:

Temperature:	25°C
Humidity:	51%
EUT Operation:	Data Transmission (without hopping)
Test Date:	July 23, 2013

Operation Mode	Frequency	20dB Bandwidth
	[MHz]	(MHz)
FH4	2403	1.364
	2442	1.272
	2478	1.268
FH4T	2410	1.368
	2438	1.228
	2465	1.200
FH4FT	2410	1.348
	2430	1.272
	2450	1.236
Note: Test plots shown in figures 63 to 71 on pages 66 to 70.		

Figure 63 – 20dB Bandwidth measurement (fc=2403MHz) at FH4 mode

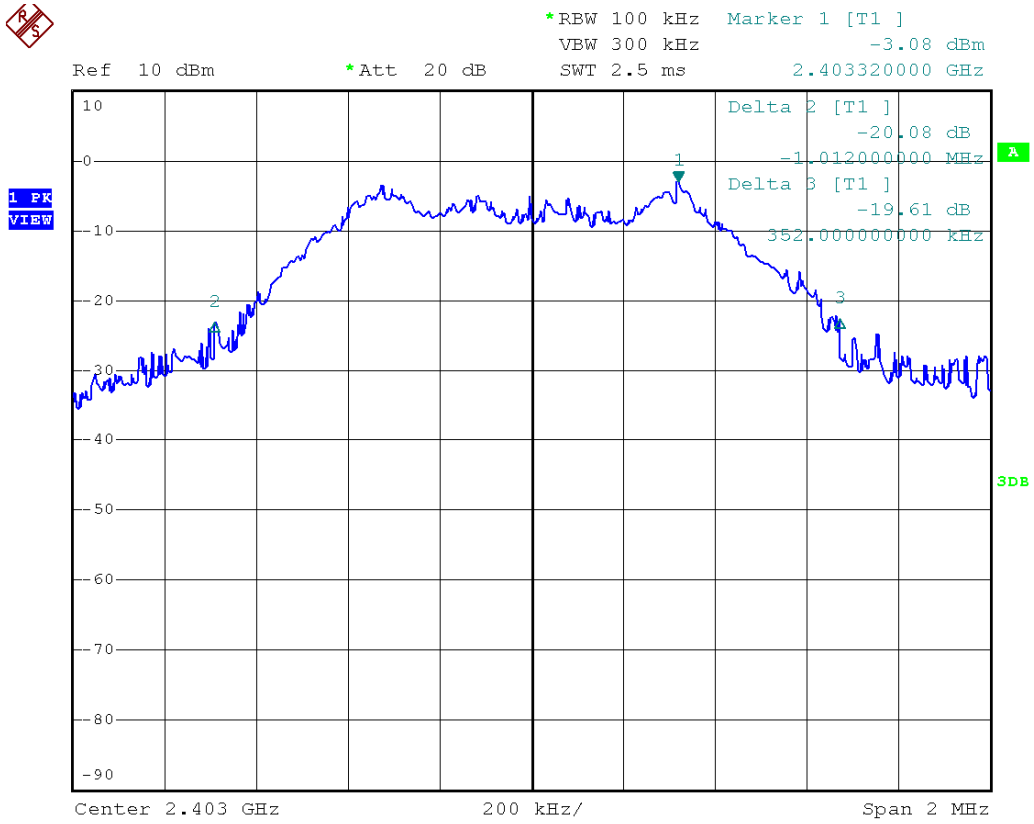


Figure 64 - 20dB Bandwidth measurement (fc=2442MHz) at FH4 mode

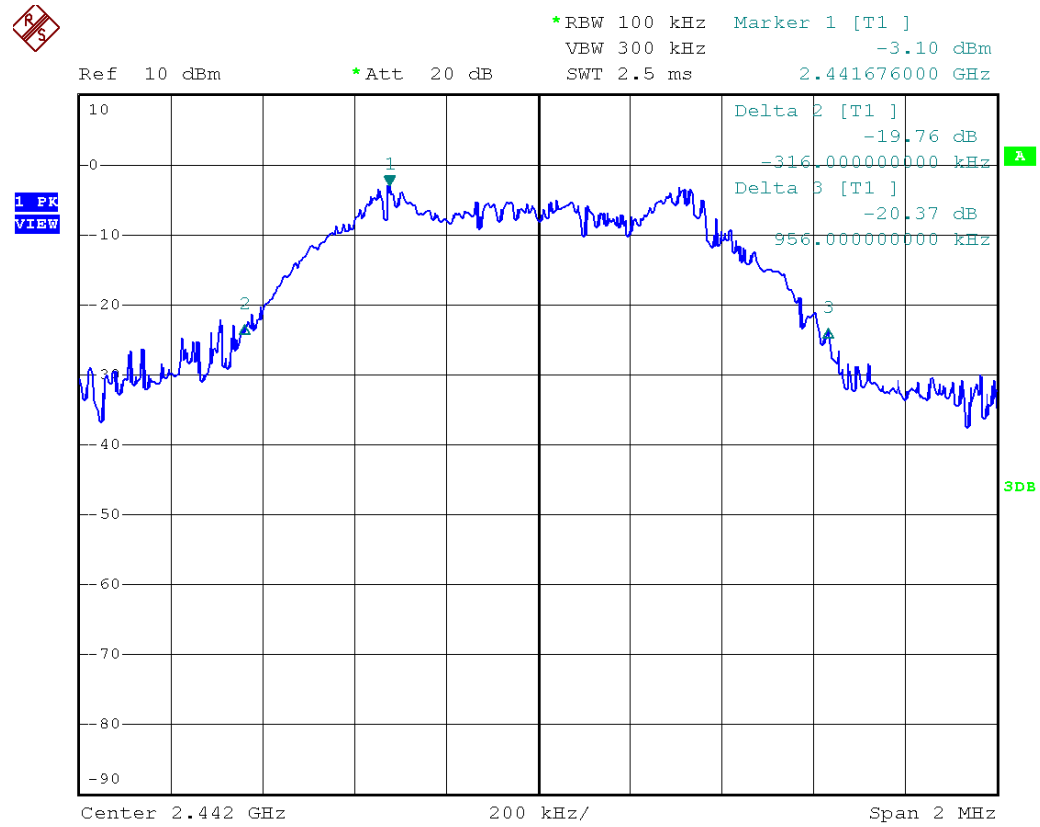


Figure 65- 20dB Bandwidth measurement (fc=2478MHz) at FH4 mode

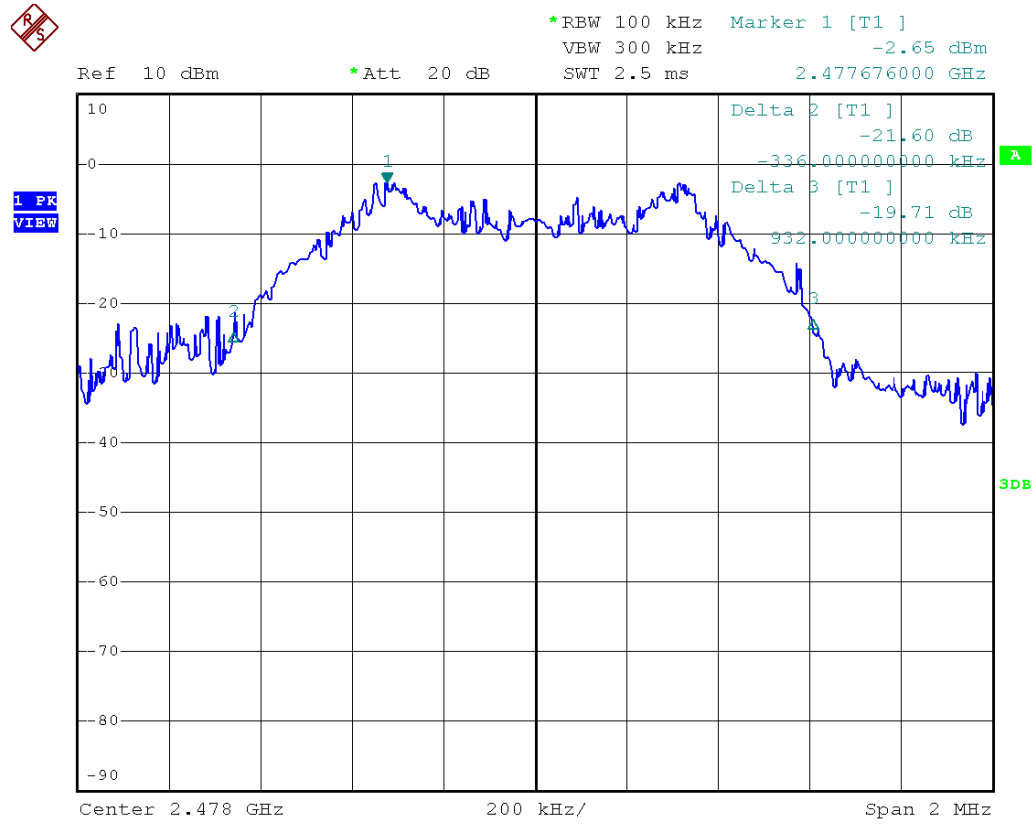


Figure 66 - 20dB Bandwidth measurement (fc=2410MHz) at FH4T mode

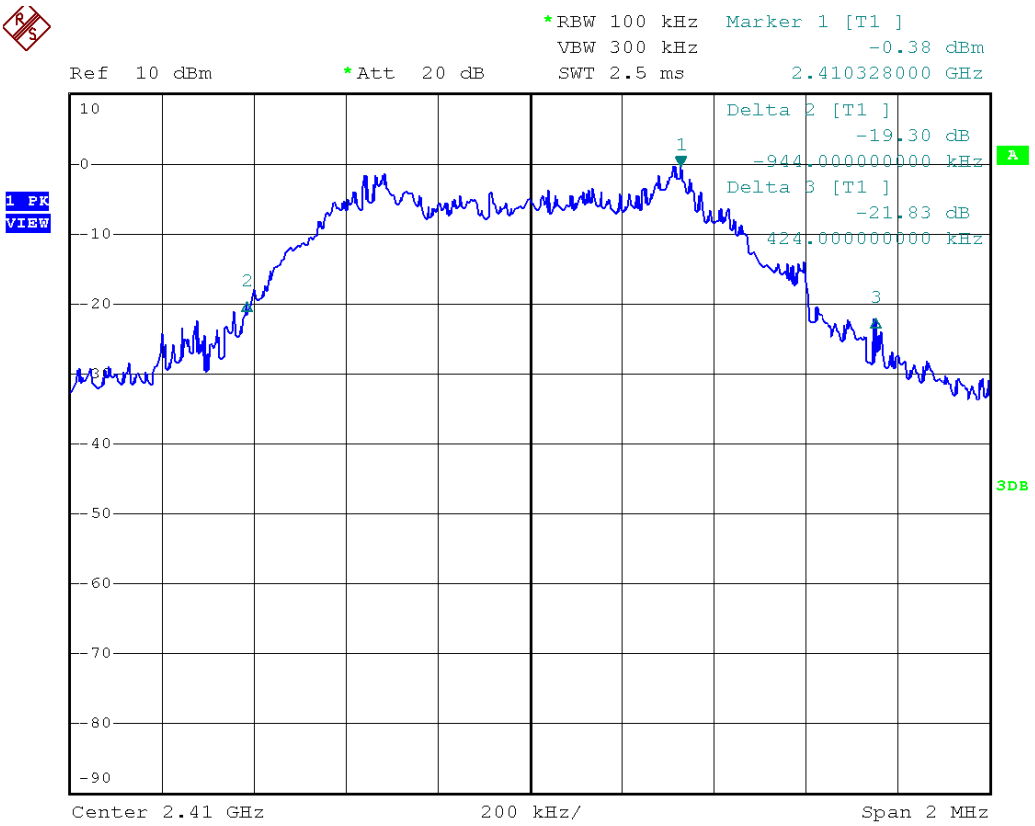


Figure 67 - 20dB Bandwidth measurement (fc=2438MHz) at FH4T mode

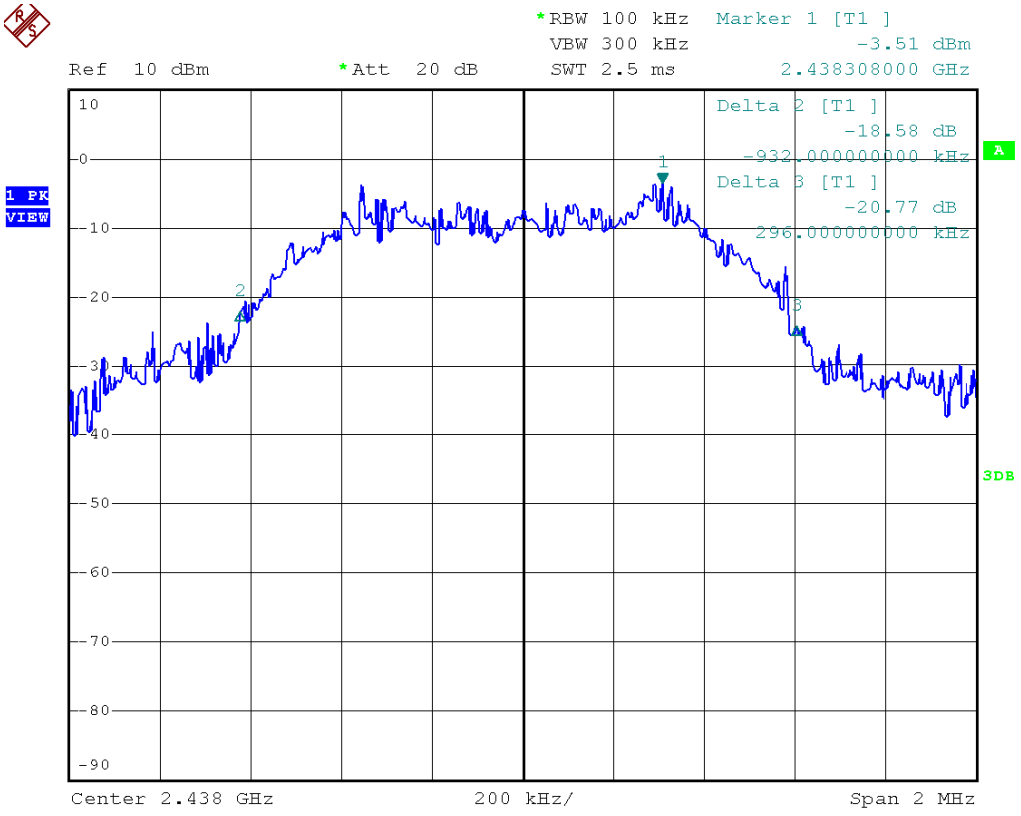


Figure 68 - 20dB Bandwidth measurement (fc=2465MHz) at FH4T mode

Figure 69 - 20dB Bandwidth measurement (fc=2410MHz) at FH4FT mode

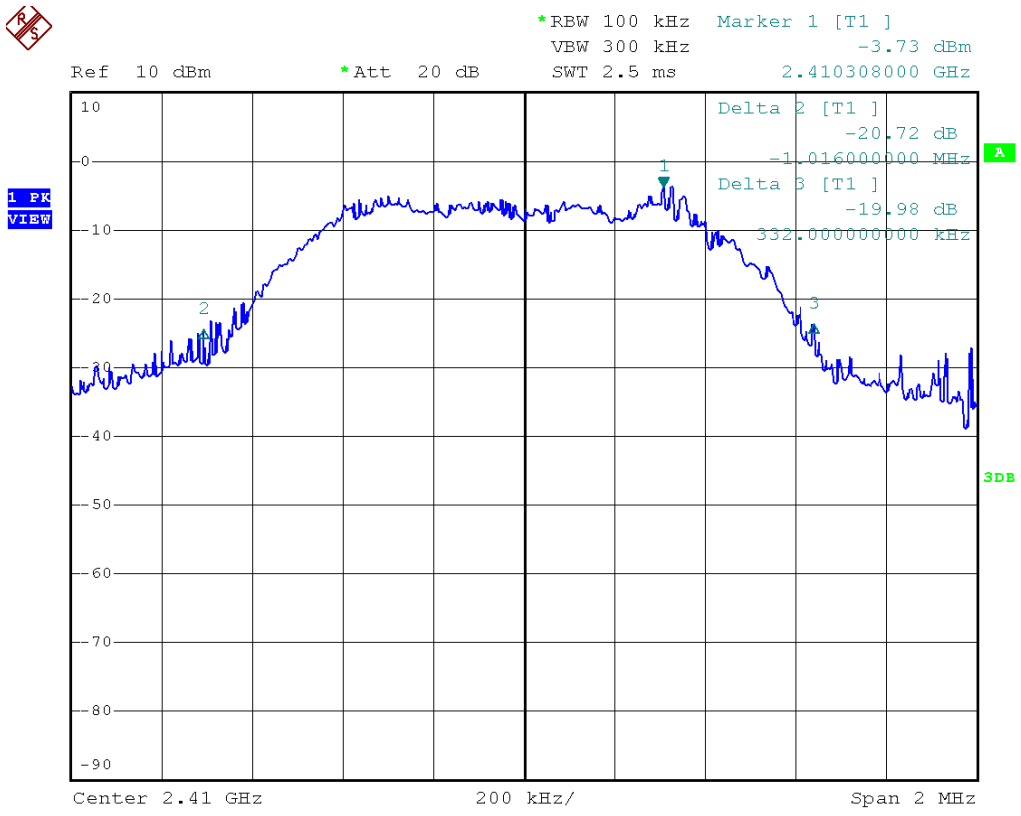


Figure 70 - 20dB Bandwidth measurement (fc=2430MHz) at FH4FT mode

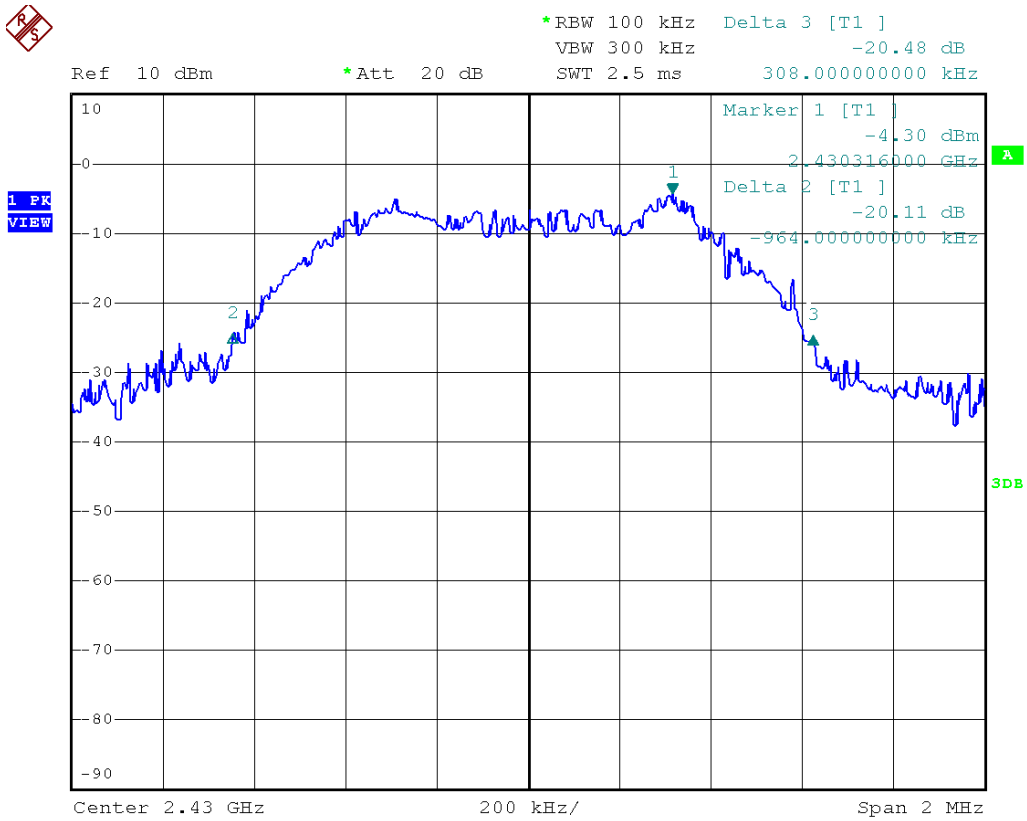
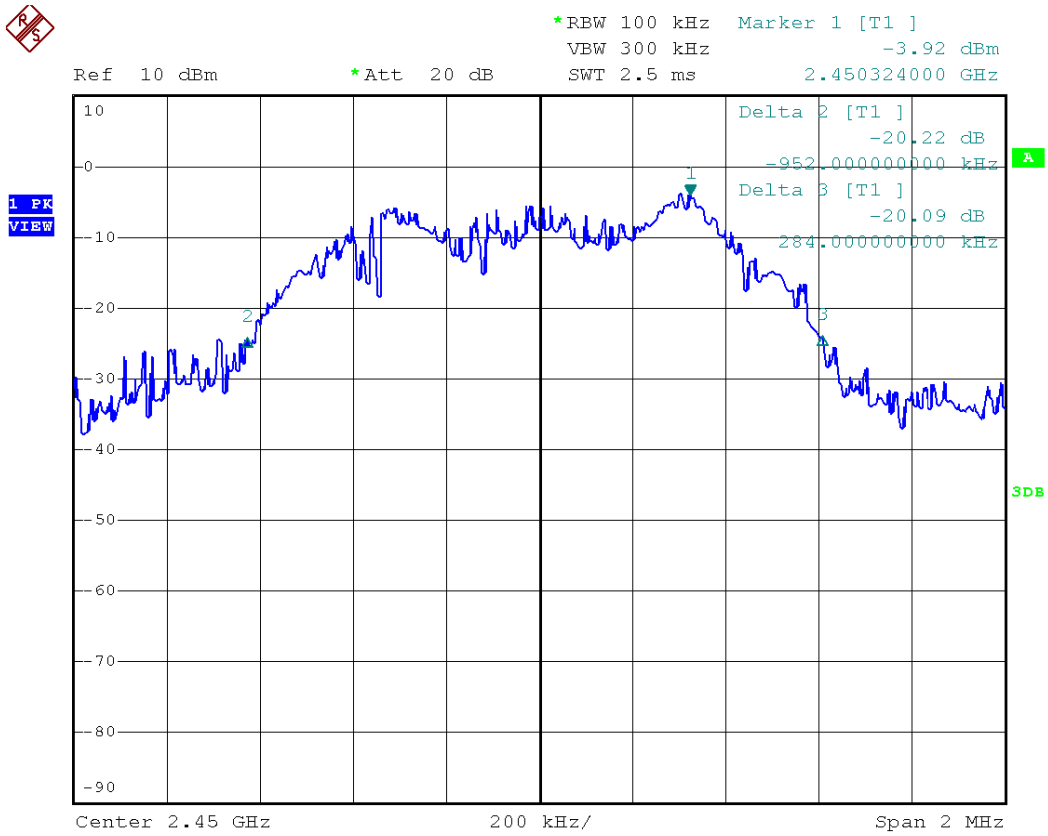


Figure 71 - 20dB Bandwidth measurement (fc=2450MHz) at FH4FT mode



6.11 RF Exposure

Applicable Standard:

According to FCC part 15.247(i) and 1.1307 (b)(1), systems operating under the provisions of this section shall be operated in a manner that ensures that the public is not exposed to radio frequency energy levels in excess of the Commission's guidelines.

And for KDB 447498 SAR D01 General RF Exposure Guidance v05 Appendix B

SAR Test Exclusion Thresholds for 100 MHz – 6 GHz and > 50 mm

Approximate SAR test exclusion power thresholds at selected frequencies and test separation distances are illustrated in the following table.

MHz	50	60	70	80	90	100	110	120	130	140	150	160	170	180	190	mm
100	474	481	487	494	501	507	514	521	527	534	541	547	554	561	567	
150	387	397	407	417	427	437	447	457	467	477	487	497	507	517	527	
300	274	294	314	334	354	374	394	414	434	454	474	494	514	534	554	
450	224	254	284	314	344	374	404	434	464	494	524	554	584	614	644	
835	164	220	275	331	387	442	498	554	609	665	721	776	832	888	943	
900	158	218	278	338	398	458	518	578	638	698	758	818	878	938	998	
1500	122	222	322	422	522	622	722	822	922	1022	1122	1222	1322	1422	1522	mW
1900	109	209	309	409	509	609	709	809	909	1009	1109	1209	1309	1409	1509	
2450	96	196	296	396	496	596	696	796	896	996	1096	1196	1296	1396	1496	
3600	79	179	279	379	479	579	679	779	879	979	1079	1179	1279	1379	1479	
5200	66	166	266	366	466	566	666	766	866	966	1066	1166	1266	1366	1466	
5400	65	165	265	365	465	565	665	765	865	965	1065	1165	1265	1365	1465	
5800	62	162	262	362	462	562	662	762	862	962	1062	1162	1262	1362	1462	

According to RSS-102 Section 2.5.1, SAR evaluation is required if the separation distance between the user and the radiating element of the device is less than or equal to 20cm, except when the device operates above 2.2 GHz and up to 3 GHz inclusively, and with output power [i.e. the higher of the conducted or radiated (e.i.r.p.) source-based, time-averaged output power] that is less than or equal to 20 mW for general public use and 100 mW for controlled use.

Test Results:

For FCC evaluation, the peak output power 3.97dBm (2.50mW) is less than the corresponding SAR test exclusion power thresholds (96mW).

For IC evaluation, the peak output power 3.97dBm (2.50mW) is less than SAR test exclusion power thresholds (20mW) for general public use.

The unit does meet the requirements of SAR exemption.

6.12 Antenna Requirement

Standard Applicable

According to §15.203, an intentional radiator shall be designed to ensure that no antenna other than furnished by the responsible party shall be used with the device. And according to §15.246(1), if transmitting antennas of directional gain greater than 6dBi are used the power shall be reduced by the amount in dB that the directional gain of the antenna exceeds 6 dBi.

According to RSS-GEN 7.1.4, a transmitter can only be sold or operated with antennas with which it was certified. A transmitter may be certified with multiple antenna types. An antenna type comprises antennas having similar in-band and out-of-band radiation patterns. Testing shall be performed using the highest-gain antenna of each combination of transmitter and antenna type for which certification is being sought, with the transmitter output power set at the maximum level. Any antenna of the same type and having equal or lesser gain as an antenna that had been successfully tested for certification with the transmitter, will also be considered certified with the transmitter, and may be used and marketed with the transmitter. The manufacturer shall include with the application for certification a list of acceptable antenna types to be used with the transmitter.

Antenna Construction:

The directional gain of antenna used for transmitting is 1.8 dBi, and the antenna connector is designed with permanent attachment and no consideration of replacement. Please see EUT photo for details.

The unit does meet the requirement.