TEST REPORT

of

FCC Part 15 Subpart C §15.247
RSS-247 Issue 1, RSS-Gen Issue 4

FCC ID / IC Certification: A3LSIP007AFS00 / 649E-SIP007AFS00

Equipment Under Test	:	ARTIK-0710
Model Name	:	SIP007AFS00
Applicant	:	Samsung Electronics Co., Ltd.
Manufacturer	:	Samsung Electronics Co., Ltd.
Date of Receipt	:	2016.06.01
Date of Test(s)	:	2016.06.14 ~ 2016.08.11
Date of Issue	:	2016.08.12

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

Tested By:	**Jungmin Yang**	**Date:**	**2016.08.12**
Technical Manager:	**Alvin Kim**	**Date:**	**2016.08.12**

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1. General Information

1.1. Testing Laboratory

SGS Korea Co., Ltd. (Gunpo Laboratory)
- Wireless Div. 2FL, 10-2, LS-ro 182beon-gil, Gunpo-si, Gyeonggi-do, Korea, 15807

All SGS services are rendered in accordance with the applicable SGS conditions of service available on request and accessible at http://www.sgs.com/en/Terms-and-Conditions.aspx.

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1.2. Details of Applicant

Applicant : Samsung Electronics Co., Ltd.
Address : 129, Samsung-ro, Yeongtong-gu, Suwon-si, Gyeonggi-do, 17113 Republic of Korea
Contact Person : Lee, Jae-Hyuk
Phone No. : +82 10 8848 6628

1.3. Description of EUT

Kind of Product	ARTIK-0710
Model Name	SIP007AFS00
Power Supply	DC 4.2 V
Frequency Range	2 402 ㎒ ~ 2 480 ㎒ (Bluetooth, Bluetooth Low Energy), 2 405 ㎒ ~ 2 475 ㎒ (Zigbee), 2 412 ㎒ ~ 2 462 ㎒ (11b/g/n_HT20), 5 745 ㎒ ~ 5 825 ㎒ (Band 3: 11a/n_HT20, 11ac_VHT20), 5 755 ㎒ ~ 5 795 ㎒ (Band 3: 11n_HT40, 11ac_VHT40), 5 775 ㎒ (Band 3: 11ac_VHT80), 5 180 ㎒ ~ 5 240 ㎒ (Band 1: 11a/n_HT20, 11ac_VHT20), 5 190 ㎒ ~ 5 230 ㎒ (Band 1: 11n_HT40, 11ac_VHT40), 5 210 ㎒ (Band 1: 11ac_VHT80), 5 260 ㎒ ~ 5 320 ㎒ (Band 2A: 11a/n_HT20, 11ac_VHT20), 5 270 ㎒ ~ 5 310 ㎒ (Band 2A: 11n_HT40, 11ac_VHT40), 5 290 ㎒ (Band 2A: 11ac_VHT80), 5 500 ㎒ ~ 5 720 ㎒ (Band 2C: 11a/n_HT20, 11ac_VHT20), 5 510 ㎒ ~ 5 710 ㎒ (Band 2C: 11n_HT40, 11ac_VHT40), 5 530 ㎒ ~ 5 690 ㎒ (Band 2C: 11ac_VHT80)
Modulation Technique	DSSS, OFDM, GFSK, π/4DQPSK, 8DPSK
Number of Channels	79 channel (Bluetooth), 40 channel (Bluetooth Low Energy), 15 channel (Zigbee), 11 channel (11b/g/n_HT20), 5 channel (Band 3: 11a/n_HT20, 11ac_VHT20), 2 channel (Band 3: 11n_HT40, 11ac_VHT40), 1 channel (Band 3: 11ac_VHT80), 4 channel (Band 1: 11a/n_HT20, 11ac_VHT20), 2 channel (Band 1: 11n_HT40, 11ac_VHT40), 1 channel (Band 1: 11ac_VHT80), 4 channel (Band 2A: 11a/n_HT20, 11ac_VHT20), 2 channel (Band 2A: 11n_HT40, 11ac_VHT40), 1 channel (Band 2A: 11ac_VHT80), 9 channel (Band 2C: 11a/n_HT20, 11ac_VHT20), 4 channel (Band 2C: 11n_HT40, 11ac_VHT40), 2 channel (Band 2C: 11ac_VHT80)
Antenna Type	Dipole antenna
Antenna Gain	2 400 ㎒ ~ 2 483.5 ㎒: 1.10 ㏈i, 5 150 ㎒ ~ 5 350 ㎒: 0.91 ㏈i, 5 470 ㎒ ~ 5 725 ㎒: 0.69 ㏈i, 5 725 ㎒ ~ 5 850 ㎒: -1.52 ㏈i
H/W Version	0710-1.0
S/W Version	0710GC0F-41F-01Q0

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1.4. Test Equipment List

Equipment	Manufacturer	Model	S/N	Cal Date	Cal Interval	Cal Due.
Signal Generator	Agilent	E8257D	MY51501169	Jul. 07, 2016	Annual	Jul. 07, 2017
Signal Generator	R&S	SMBV100A	255834	Jun. 22, 2016	Annual	Jun. 22, 2017
Spectrum Analyzer	R&S	FSV30	100768	Mar. 30, 2016	Annual	Mar. 30, 2017
Spectrum Analyzer	Agilent	N9020A	MY53421758	Sep. 24, 2015	Annual	Sep. 24, 2016
Attenuator	AEROFLEX / INMET	18N-20 dB	2	Feb. 29, 2016	Annual	Feb. 29, 2017
High Pass Filter	Wainwright Instrument GmbH	WHK3.0/18G-6SS	344	Jun. 03, 2016	Annual	Jun. 03, 2017
High Pass Filter	Wainwright Instrument GmbH	WHK7.5/26.5G-6SS	11	Jun. 03, 2016	Annual	Jun. 03, 2017
Low Pass Filter	Mini-Circuits	NLP-1200+	V 8979400903-2	Feb. 29, 2016	Annual	Feb. 29, 2017
Power Sensor	R&S	NRP-Z81	100669	Feb. 29, 2016	Annual	Feb. 29, 2017
DC Power Supply	Agilent	U8002A	MY50060028	Mar. 21, 2016	Annual	Mar. 21, 2017
Preamplifier	H.P.	8447F	2944A03909	Aug. 27, 2015	Annual	Aug. 27, 2016
Preamplifier	R&S	SCU-18	10117	Apr. 07, 2016	Annual	Apr. 07, 2017
Preamplifier	MITEQ Inc.	JS44-18004000-35-8P	1546891	May 12, 2016	Annual	May 12, 2017
Loop Antenna	R&S	HFH2-Z2	100118	Jun. 04, 2015	Biennial	Jun. 04, 2017
Bilog Antenna	Schwarzbeck Mess-Elektronik	VULB9163	396	Jun. 18, 2015	Biennial	Jun. 18, 2017
Horn Antenna	R&S	HF906	100608	Oct. 16, 2014	Biennial	Oct. 16, 2016
Horn Antenna	Schwarzbeck Mess-Elektronik	BBHA9170	BBHA9170223	Sep. 01, 2014	Biennial	Sep. 01, 2016
Antenna Master	INN-CO	MM4000	N/A	N.C.R.	N/A	N.C.R.
Turn Table	INN-CO	DS 1200 S	N/A	N.C.R.	N/A	N.C.R.
Test Receiver	R&S	ESU26	100109	Mar. 07, 2016	Annual	Mar. 07, 2017
Anechoic Chamber	SY Corporation	L × W × H (9.6 m × 6.4 m × 6.6 m)	N/A	N.C.R.	N/A	N.C.R.
Test Receiver	R&S	ESCI 7	100911	Dec. 22, 2015	Annual	Dec. 22, 2016
Two-Line V-Network	R&S	ENV216	100190	Dec. 21, 2015	Annual	Dec. 21, 2016
Shield Room	SY Corporation	L × W × H (6.5 m × 3.5 m × 3.5 m)	N/A	N.C.R.	N/A	N.C.R.

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1.5. Summary of Test Results

The EUT has been tested according to the following specifications:

APPLIED STANDARD: FCC Part15 Subpart C, RSS-247 Issue 1, RSS-Gen Issue 4			
Standard section		**Test Item(s)**	**Result**
15.205(a) 15.209 15.247(d)	RSS-247 Issue 1 5.5 RSS-Gen Issue 4 8.9	Transmitter Radiated Spurious Emissions Conducted Spurious Emission	Complied
15.247(a)(2)	RSS-247 Issue 1 5.2(1) RSS-Gen Issue 4 6.6	6 dB Bandwidth & 99 % Bandwidth	Complied
15.247(b)(3)	RSS-247 Issue 1 5.4(4)	Maximum Peak Conducted Output Power	Complied
15.247(e)	RSS-247 Issue 1 5.2(2)	Power Spectral Density	Complied
15.207	RSS-Gen Issue 4 8.8	AC Power Line Conducted Emissions	Complied

1.6. Test Procedure(s)

The measurement procedures described in the American National Standard of Procedure for Compliance Testing of unlicensed Wireless Devices (ANSI C63.10-2013) and the guidance provided in KDB 558074_v03r05 were used in the measurement of the DUT.

1.7. Sample calculation

Where relevant, the following sample calculation is provided:

1.7.1. Conducted test

Offset value (dB) = Attenuator (dB) + Cable loss (dB)

1.7.2. Radiation test

Field strength level (dBμV/m) = Measured level (dBμV) + Antenna factor (dB) + Cable loss (dB) - Amplifier gain (dB)

1.8. Test report revision

Revision	Report number	Date of Issue	Description
0	F690501/RF-RTL010225	2016.08.12	Initial

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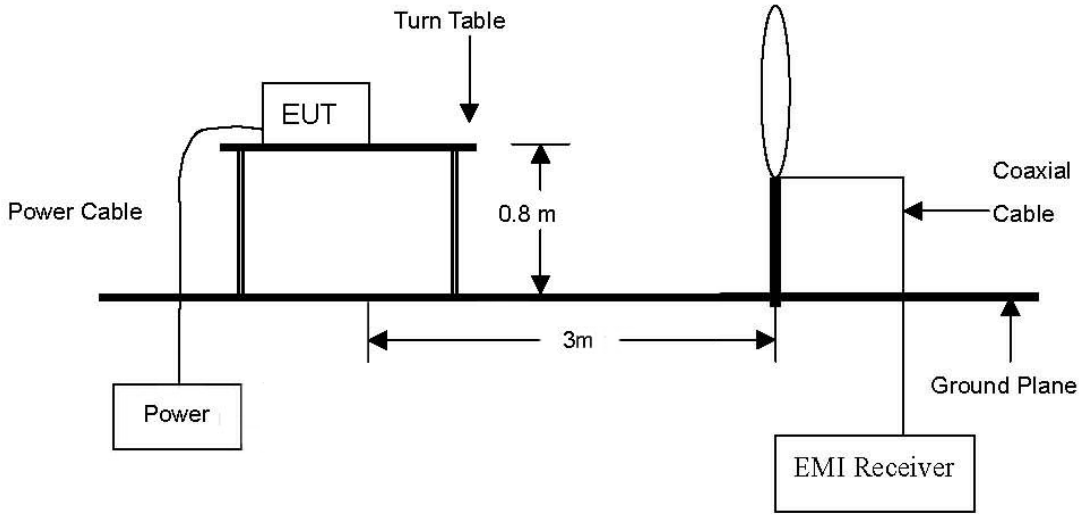
2. Transmitter Radiated Spurious Emissions and Conducted Spurious Emission

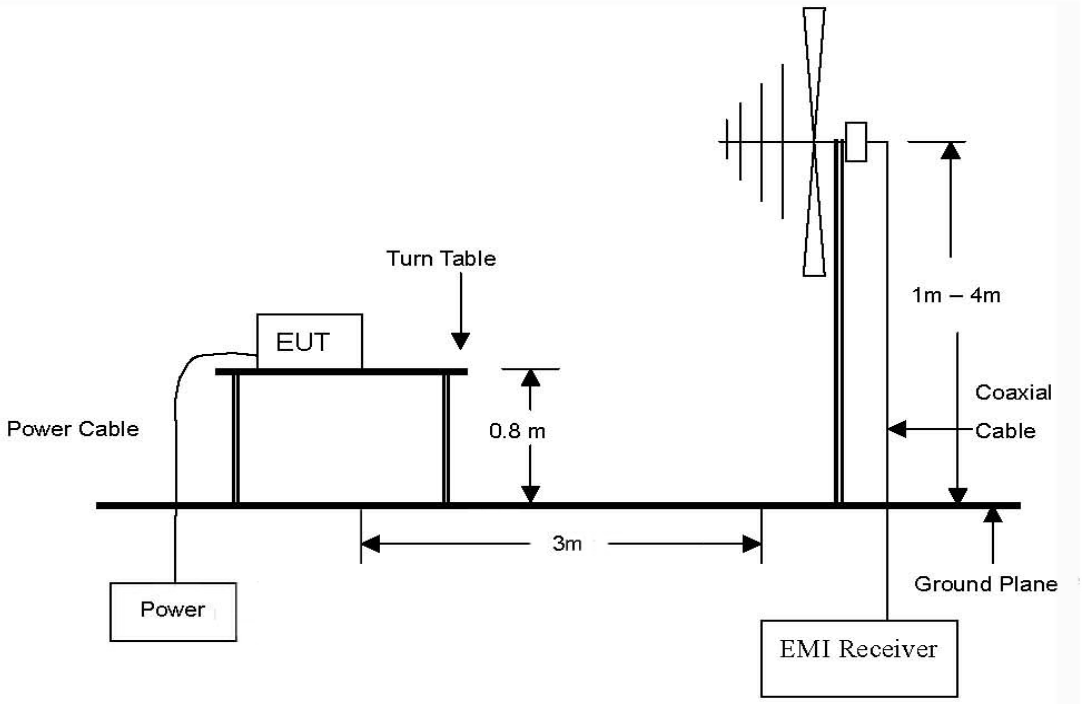
2.1. Test Setup

2.1.1. Transmitter Radiated Spurious Emissions

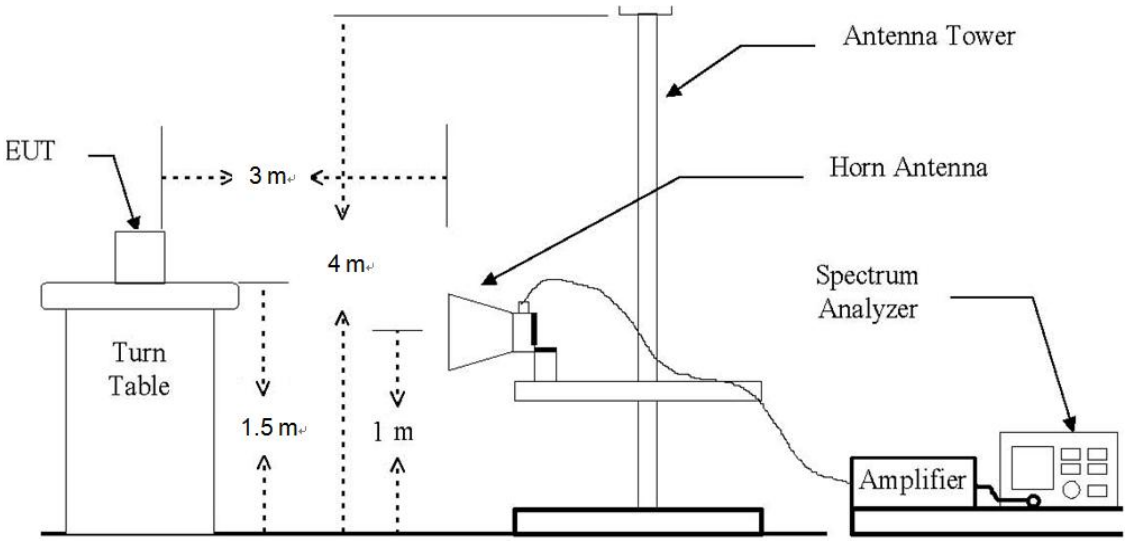
The diagram below shows the test setup that is utilized to make the measurements for emission from 9 ㎑ to 30 ㎒ Emissions.



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 .The spurious emissions were investigated form 1 ㎓ to the 10th harmonic of the highest fundamental frequency or 40 ㎓, whichever is lower.



2.1.2. Conducted Spurious Emission

2.2. Limit

FCC

§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))

§15.209(a), Except as provided elsewhere in this Subpart, the emissions from an intentional radiator shall not exceed the field strength levels specified in the following table：

Frequency (㎒)	Distance (Meters)	Field Strength (㏈㎶/m)	Field Strength (㎶/m)
0.009 - 0.490	300	20 log (2 400/F(㎑))	2 400/F(㎑)
0.490 - 1.705	30	20 log (24 000/F(㎑))	24 000/F(㎑)
1.705 - 30	30	29.54	30
30 - 88	3	40.0	100
88 - 216	3	43.5	150
216 - 960	3	46.0	200
Above 960	3	54.0	500

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RSS-247 Issue 1, 5.5, In any 100 ㎑ bandwidth outside the frequency band in which the spread spectrum or digitally modulated device is operating, the RF power that is produced 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 that the transmitter demonstrates compliance with the peak conducted power limits. If the transmitter complies with the conducted power limits based on the use of root-mean-square averaging over a time interval, as permitted under Section 5.4(4), the attenuation required shall be 30 ㏈ instead of 20 ㏈. Attenuation below the general field strength limits specified in RSS-Gen is not required.

RSS-Gen Issue 4, 8.9

Except when the requirements applicable to a given device state otherwise, emissions from licence-exempt transmitters shall comply with the field strength limits shown in Table 4 or Table 5 below. Additionally, the level of any transmitter emission shall not exceed the level of the transmitter's fundamental emission.

Table 4 – General Field Strength Limits for Licence-Exempt Transmitters at Frequencies Above 30 ㎒

Frequency (㎒)	Field Strength (㎶/m at 3 metres)
30 - 88	100
88 - 216	150
216 - 960	200
Above 960	500

***** Unless otherwise specified, for all frequencies greater than 1 GHz, the radiated emission limits for licence-exempt radio apparatus stated in applicable RSSs (including RSS-Gen) are based on measurements using a linear average detector function having a minimum resolution bandwidth of 1 MHz. If an average limit is specified for the EUT, then the peak emission shall also be measured with instrumentation properly adjusted for such factors as pulse desensitization to ensure the peak emission is less than 20 dB above the average limit.

Note: Transmitting devices are not permitted in restricted frequency bands unless stated otherwise in the specific RSS.

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Table 5 – General Field Strength Limits for Licence-Exempt Transmitters at Frequencies Below 30 MHz

Frequency	Electric Field Strength (μV/m)	Magnetic Field Strength (μA/m)	Measurement Distance (Metres)
0.009 - 0.490 kHz	2 400/F (F in kHz)	2 400/377F (F in kHz)	300
0.490 - 1.705 kHz	24 000/F (F in kHz)	24 000/377F (F in kHz)	30
1.705 - 30 MHz	30	N/A	30

Note: The emission limits for the bands 9-90 kHz and 110-490 kHz are based on measurements employing a linear average detector. Transmitting devices are not permitted in restricted frequency bands unless stated otherwise in the relevant RSS.

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2.3. Test Procedures

Radiated emissions from the EUT were measured according to the dictates in section 11.0 & 12.0 of KDB 558074_v03r05 and ANSI C63.10 2013.

2.3.1. Test Procedures for emission below 30 ㎒

1. The EUT was placed on the top of a rotating table 0.8 meters above the ground at a 3 meter anechoic chamber test site. The table was rotated 360 degrees to determine the position of the highest radiation.
2. Then antenna is a loop antenna is fixed at one meter above the ground to determine the maximum value of the field strength. Both parallel and perpendicular of the antenna are set to make the measurement.
3. For each suspected emission, the EUT was arranged to its worst case and then the table was turned from 0 degrees to 360 degrees to find the maximum reading.
4. The test-receiver system was set to average or quasi peak detect function and Specified Bandwidth with Maximum Hold Mode.

Note;
Although these tests were performed other than open field test site, adequate comparison measurements were confirmed against 30 meter open field test site. Therefore sufficient tests were made to demonstrate that the alternative site produces results that correlate with the ones of tests made in an open field based on KDB 937606.

2.3.2. Test Procedures for emission from above 30 ㎒

1. The EUT was placed on the top of a rotating table 0.8 meters above the ground at a 3 meter anechoic chamber test site below 1 ㎓ and 1.5 meters above the ground at a 3 meter anechoic chamber test site above 1 ㎓. The table was rotated 360 degrees to determine the position of the highest radiation.
2. During performing radiated emission below 1 ㎓, the EUT was set 3 meters away from the interference receiving antenna, which was mounted on the top of a variable-height antenna tower. During performing radiated emission above 1 ㎓, the EUT was set 3 meter away from the interference-receiving antenna.
3. The antenna is a bi-log antenna, a horn antenna and its height is varied from one meter to four meters above the ground to determine the maximum value of the field strength. Both horizontal and vertical polarizations of the antenna are set to make the measurement.
4. For each suspected emission, the EUT was arranged to its worst case and then the antenna was tuned to heights from 1 meter to 4 meters and the table was turned from 0 degrees to 360 degrees to find the maximum reading.
5. The test-receiver system was set to Peak Detect Function and Specified Bandwidth with Maximum Hold Mode.
6. If the emission level of the EUT in peak mode was 10 ㏈ lower than the limit specified, then testing could be stopped and the peak values of the EUT would be reported. Otherwise the emissions that did not have 10 ㏈ margin would be re-tested one by one using peak, quasi-peak or average method as specified and then reported in a data sheet.

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NOTE;

1. Unwanted Emissions into Non-Restricted Frequency Bands

- The Reference Level Measurement refer to section 11.2
Set analyzer center frequency to DTS channel center frequency, SPAN ≥ 1.5 times the DTS bandwidth, the RBW = 100 ㎑ and VBW ≥ 3 x RBW, Detector = Peak, Sweep time = Auto couple, Trace = Max hold.

- Unwanted Emissions Level Measurement refer to section 11.3
Set the center frequency and span to encompass frequency range to be measured, the RBW = 100 ㎑ and VBW ≥ 3 x RBW, Detector = Peak, Sweep time = Auto couple, Trace = Max hold.

2. Unwanted Emissions into Restricted Frequency Bands

- Peak Power measurement procedure refer to section 12.2.4
Set RBW = as specified in Table 1, VBW ≥ 3 x RBW, Detector = Peak, Sweep time = auto, Trace = Max hold.

Table 1- RBW as a function of frequency

Frequency	RBW
9 – 150 ㎑	200 – 300 ㎐
0.15 – 30 ㎒	9 – 10 ㎑
30 – 1 000 ㎒	100 – 120 ㎑
> 1 000 ㎒	1 ㎒

-Average Power measurements procedure refer to section 12.2.5.2
The EUT shall be configured to operate at the maximum achievable duty cycle.
Measure the duty cycle, x, of the transmitter output signal as described in section 6.0.
Set RBW = 1 ㎒, VBW ≥ 3 x RBW, Detector = RMS, if span / (# of points in sweep) ≤ (RBW/2).
Satisfying this condition may require increasing the number of points in the sweep or reducing the span. If this condition cannot be satisfied then the detector mode shall be set to peak.

Averaging type = power (i.e., RMS).
As an alternative the detector and averaging type may be set for linear voltage averaging.
Some instruments require linear display mode in order to use linear voltage averaging. Log or ㏈ averaging shall not be used. Sweep time = auto, Perform a trace average of at least 100 traces.

A correction factor shall be added to the measurement results prior to comparing to the emission limit in order to compute the emission level that would have been measured had the test been performed at 100 percent duty cycle. The correction factor is computed as follows:

1) If power averaging (RMS) mode was used in step f), then the applicable correction factor is 10 log (1/x), where x is the duty cycle.
3) If a specific emission is demonstrated to be continuous (≥ 98 percent duty cycle) rather than turning on and off with the transmit cycle, then no duty cycle correction is required for that emission.

3. To get a maximum emission level from the EUT, the EUT is manipulated through three orthogonal planes (X, Y, Z). Worst orthogonal plan of EUT is **Z – axis** during radiation test.

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2.3.3. Test Procedures for Conducted Spurious Emissions

Per the guidance of KDB 558074_v03r05, section 11.1 & 11.2 & 11.3, the reference level for out of band emissions is established from the plots of this section since the band edge emissions are measured with a RBW of 100 ㎑. This reference level is then used as the limit in subsequent plots for out of band spurious emissions shown in section 2.4.3. The limit for out of band spurious emission at the band edge is 20 ㏈ below the fundamental emission level measured in a 100 ㎑ bandwidth.

1. Conducted Emissions at Band Edge
 - The Measurement refer to section 11.2
   Set the center frequency and span to encompass frequency range to be measured, the RBW = 100 ㎑ and VBW ≥ 3 x RBW, Detector = Peak, Sweep time = Auto couple, Trace = Max hold, Ensure that the number of measurement points ≥ span/RBW, The trace was allowed to stabilize.

2. Conducted Spurious Emissions
 - The Measurement refer to section 11.3
   Start frequency was set to 9 ㎑ and stop frequency was set to 25 ㎓ (separated into two plots per channel), RBW = 100 ㎑, VBW ≥ 3 x RBW, Detector = Peak, Sweep time = Auto couple, Trace = Max hold, The trace was allowed to stabilize.

3. TDF function
 - For plots showing conducted spurious emissions from 9 ㎑ to 25 ㎓, all path loss of wide frequency range was investigated and compensated to spectrum analyzer as TDF function.
   So, the reading values shown in plots were final result.

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2.4. Test Results

Ambient temperature : (23 ± 1) ℃
Relative humidity : 47 % R.H.

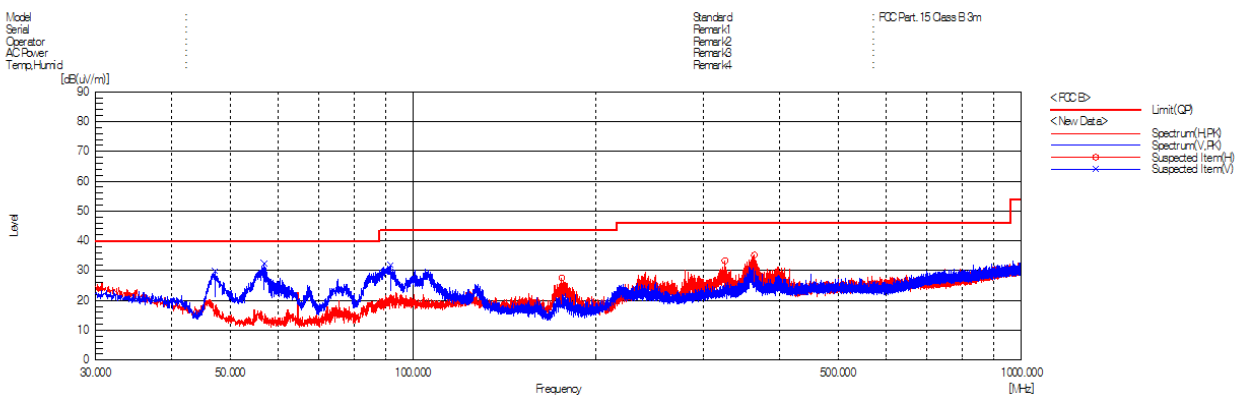
2.4.1. Radiated Spurious Emission below 1 000 ㎒

The frequency spectrum from 9 ㎑ to 1 000 ㎒ was investigated. All reading values are peak values.

Radiated Emissions			Ant	Correction Factors		Total	Limit	
Frequency (㎒)	Reading (dBμV)	Detect Mode	Pol.	AF (dB/m)	AMP + CL (dB)	Actual (dBμV/m)	Limit (dBμV/m)	Margin (dB)
47.18	47.00	Peak	V	10.00	-27.06	29.94	40.00	10.06
56.84	51.30	Peak	V	8.36	-26.97	32.69	40.00	7.31
91.84	47.80	Peak	V	10.88	-26.70	31.98	43.50	11.52
175.50	42.30	Peak	H	11.28	-25.96	27.62	43.50	15.88
325.57	43.70	Peak	H	14.93	-25.21	33.42	46.00	12.58
363.84	44.90	Peak	H	15.92	-25.44	35.38	46.00	10.62
Above 400.00	Not detected	-	-	-	-	-	-	-

Remark:
1. Spurious emissions for all channels were investigated and almost the same below 1 ㎓.
2. Reported spurious emissions are in **High channel** as worst case among other channels.
3. Radiated spurious emission measurement as below.
   (Actual = Reading + Antenna Factor + Amp + CL)
4. According to §15.31(o), emission levels are not report much lower than the limits by over 20 ㏈.

Test plot



2.4.2. Radiated Spurious Emission above 1 000 ㎒

The frequency spectrum above 1 000 ㎒ was investigated. All reading values are peak and average values.

A. Low channel (2 405 ㎒)

Radiated Emissions			Ant.	Correction Factors			Total	Limit	
Frequency (㎒)	Reading (dBμV)	Detect Mode	Pol.	AF (dB/m)	CL (dB)	Duty (dB)	Actual (dBμV/m)	Limit (dBμV/m)	Margin (dB)
*2 310.00	25.57	Peak	H	28.07	5.69	-	59.33	74.00	14.67
*2 310.00	14.58	Average	H	28.07	5.69	-	48.34	54.00	5.66
*2 389.04	26.68	Peak	H	28.15	5.79	-	60.62	74.00	13.38
*2 389.57	16.22	Average	H	28.15	5.79	-	50.16	54.00	3.84
*2 390.00	25.76	Peak	H	28.15	5.79	-	59.70	74.00	14.30
*2 390.00	16.03	Average	H	28.15	5.79	-	49.97	54.00	4.03

Radiated Emissions			Ant.	Correction Factors			Total	Limit	
Frequency (㎒)	Reading (dBμV)	Detect Mode	Pol.	AF (dB/m)	AMP+ CL (dB)	Duty (dB)	Actual (dBμV/m)	Limit (dBμV/m)	Margin (dB)
*4 808.97	42.89	Peak	H	32.67	-29.46	-	46.10	74.00	27.90
*4 810.87	32.94	Average	H	32.67	-29.46	-	36.15	54.00	17.85
Above 4 900.00	Not detected	-	-	-	-	-	-	-	-

B. Middle channel (2 440 ㎒)

Radiated Emissions			Ant.	Correction Factors			Total	Limit	
Frequency (㎒)	Reading (dBμV)	Detect Mode	Pol.	AF (dB/m)	AMP+ CL (dB)	Duty (dB)	Actual (dBμV/m)	Limit (dBμV/m)	Margin (dB)
*4 880.90	43.42	Peak	H	32.86	-29.12	-	47.16	74.00	26.84
*4 879.01	34.98	Average	H	32.86	-29.12	-	38.72	54.00	15.28
Above 4 900.00	Not detected	-	-	-	-	-	-	-	-

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C. High channel (2 475 ㎒)

Radiated Emissions			Ant.	Correction Factors			Total	Limit	
Frequency (㎒)	Reading (dBμV)	Detect Mode	Pol.	AF (dB/m)	CL (dB)	Duty (dB)	Actual (dBμV/m)	Limit (dBμV/m)	Margin (dB)
*2 483.50	26.27	Peak	H	28.24	5.82	-	60.33	74.00	13.67
*2 483.50	16.43	Average	H	28.24	5.82	-	50.49	54.00	3.51
*2 486.19	27.72	Peak	H	28.25	5.82	-	61.79	74.00	12.21
*2 483.76	16.64	Average	H	28.24	5.82	-	50.70	54.00	3.30
*2 500.00	25.86	Peak	H	28.26	5.85	-	59.97	74.00	14.03
*2 500.00	15.33	Average	H	28.26	5.85	-	49.44	54.00	4.56

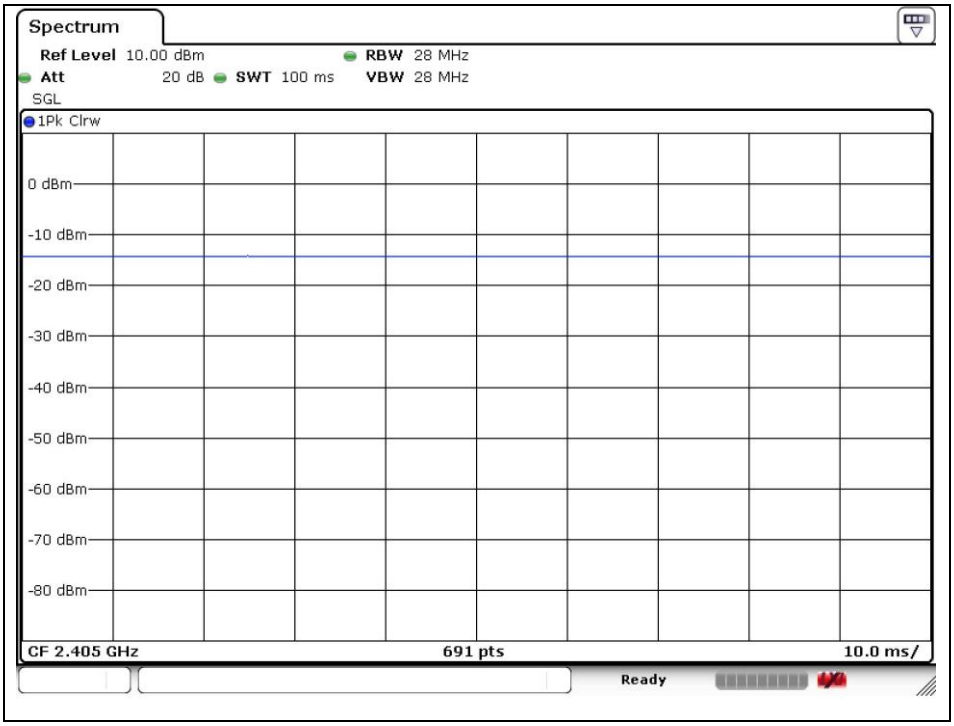
Radiated Emissions			Ant.	Correction Factors			Total	Limit	
Frequency (㎒)	Reading (dBμV)	Detect Mode	Pol.	AF (dB/m)	AMP+ CL (dB)	Duty (dB)	Actual (dBμV/m)	Limit (dBμV/m)	Margin (dB)
*4 948.80	42.28	Peak	H	33.04	-28.94	-	46.38	74.00	27.62
*4 951.01	32.28	Average	H	33.05	-28.94	-	36.39	54.00	17.61
Above 5 000.00	Not detected	-	-	-	-	-	-	-	-

Remarks;

1. "*" means the restricted band.
2. Measuring frequencies from 1 ㎓ to the 10th harmonic of highest fundamental frequency.
3. Radiated emissions measured in frequency above 1 000 ㎒ were made with an instrument using peak/average detector mode.
4. Actual = Reading + AF + AMP + CL + or Reading + AF + CL.
5. According to § 15.31(o), Emission levels are not reported much lower than the limits by over 20 ㏈.

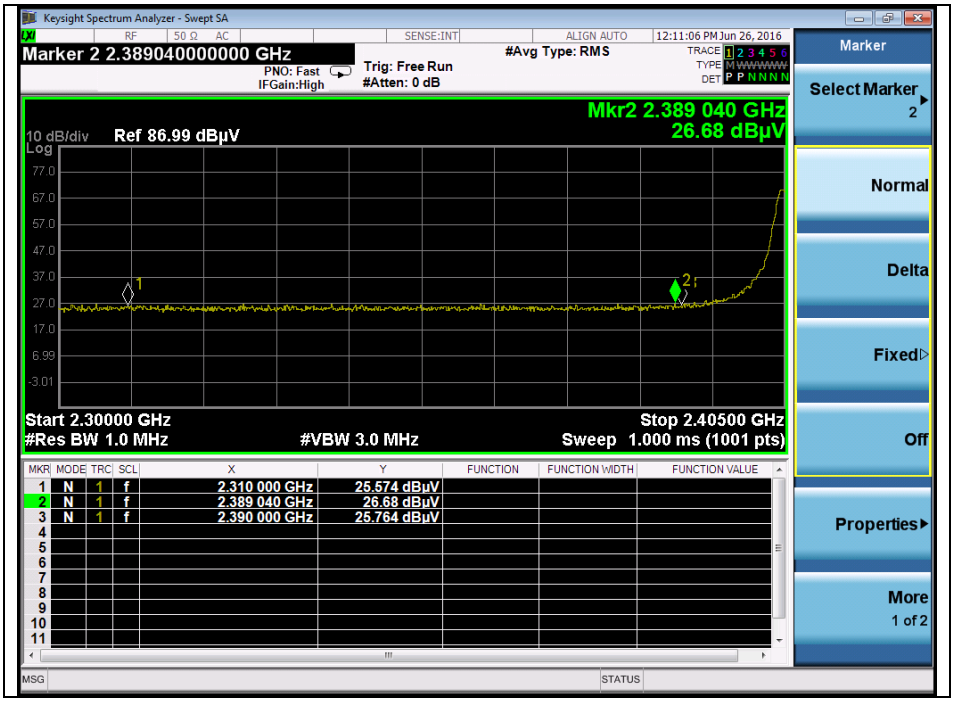
The results shown in this test report refer only to the sample(s) tested unless otherwise stated. This test report cannot be reproduced, except in full, without prior written permission of the Company.

Note;
Duty cycle measurement of EUT
Duty cycle (x) = Tx(on) / Tx(on+off) = 1
Duty factor = 10log(1/x), 10log(1/1) = 0

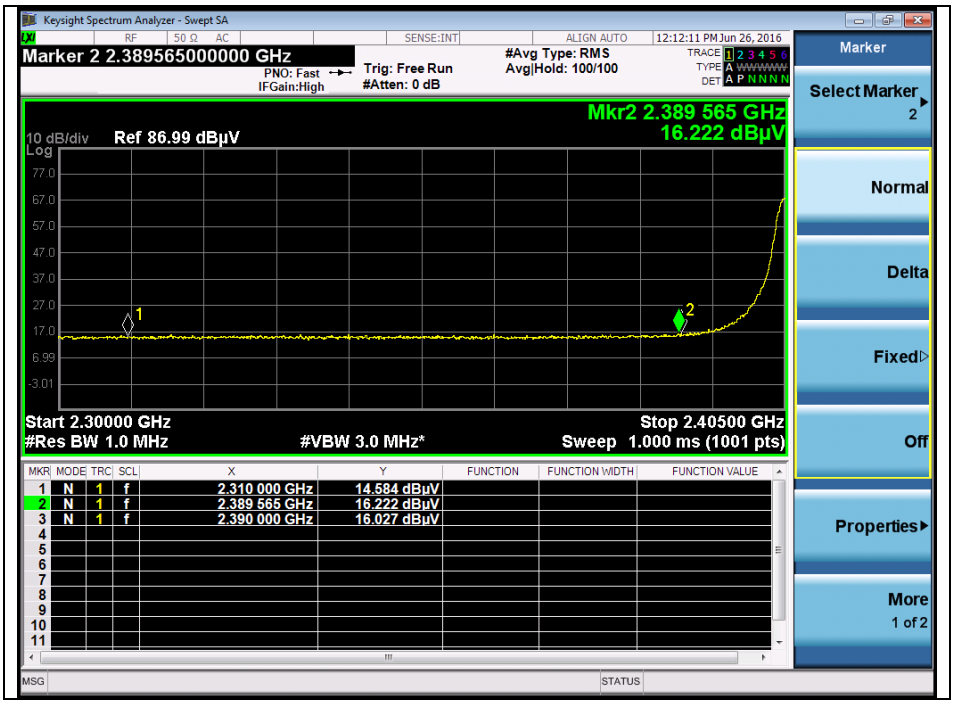


2.4.3. Plot of Transmitter Radiated Spurious Emissions

Low channel band edge (Peak)

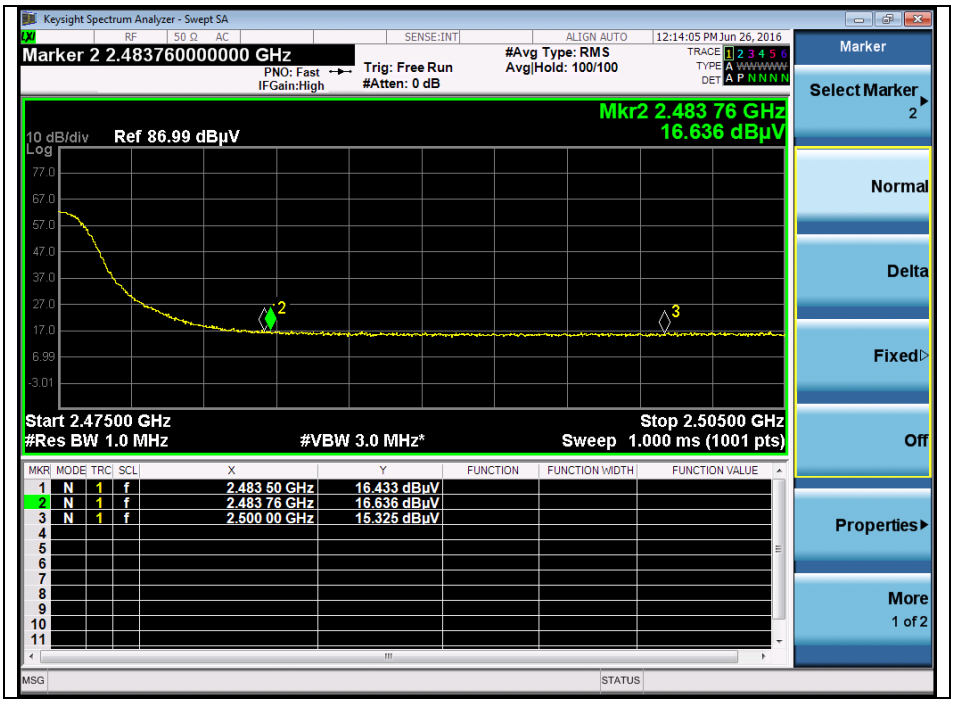


Low channel band edge (Average)

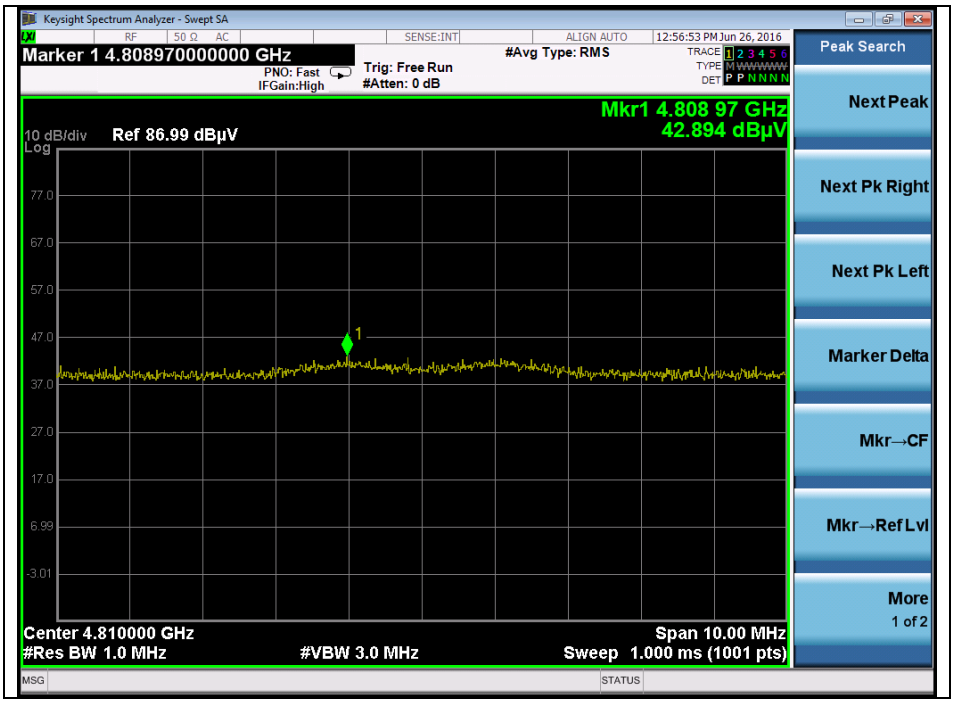


High channel band edge (Peak)

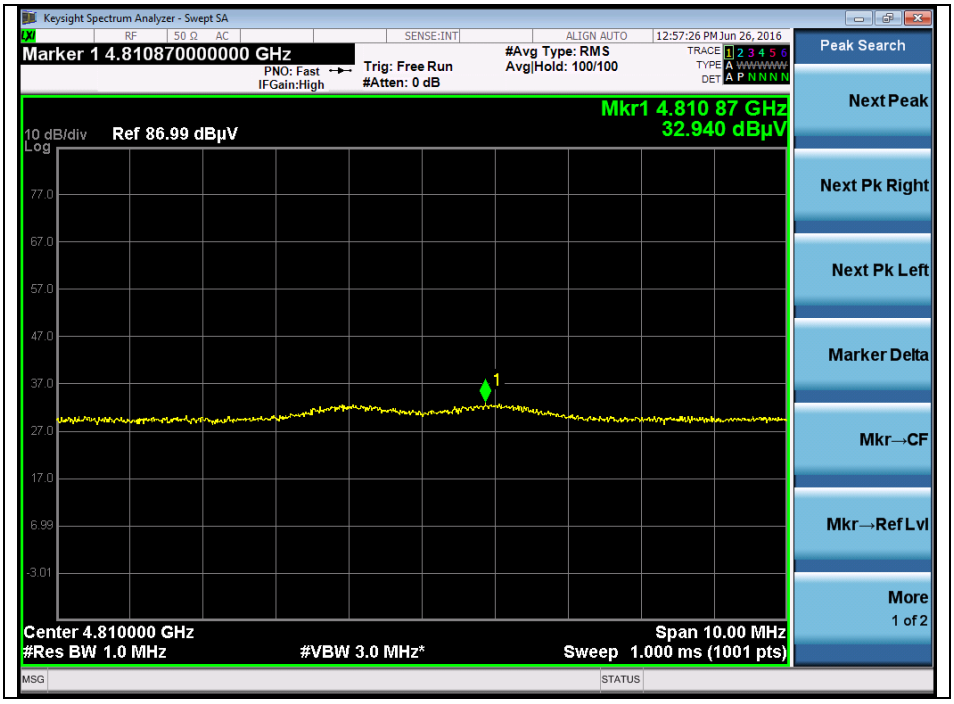
High channel band edge (Average)



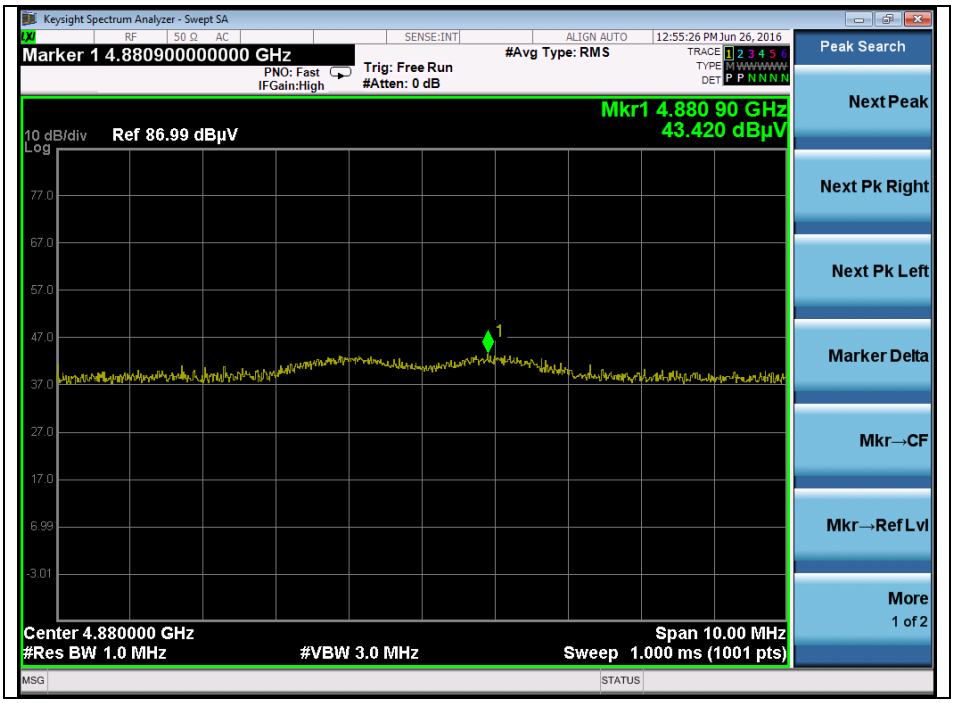
Low channel 2nd harmonic (Peak)



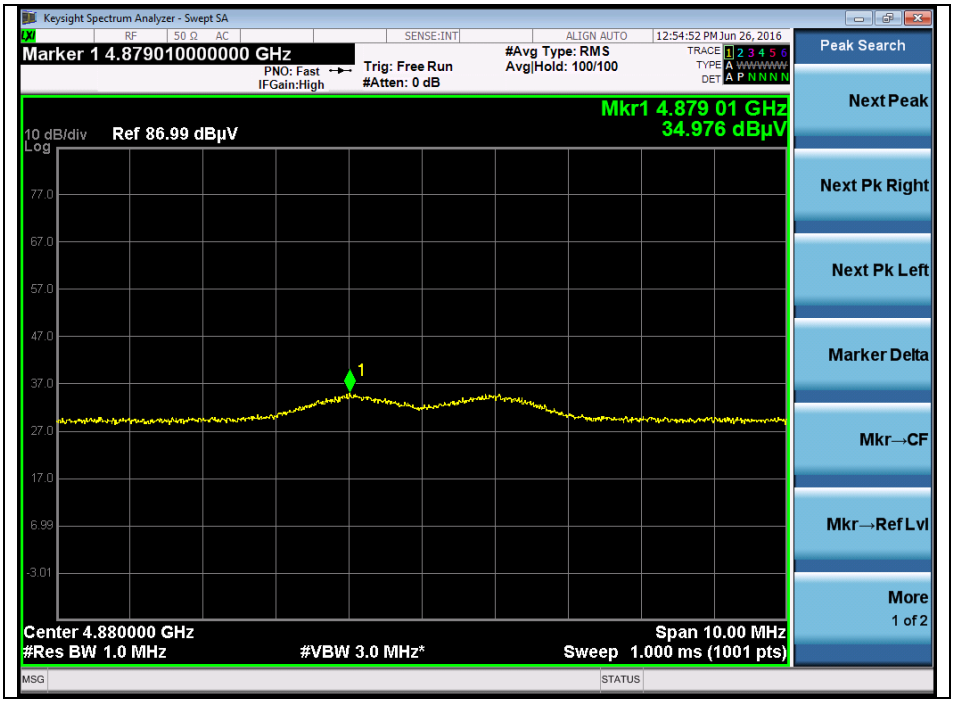
Low channel 2nd harmonic (Average)



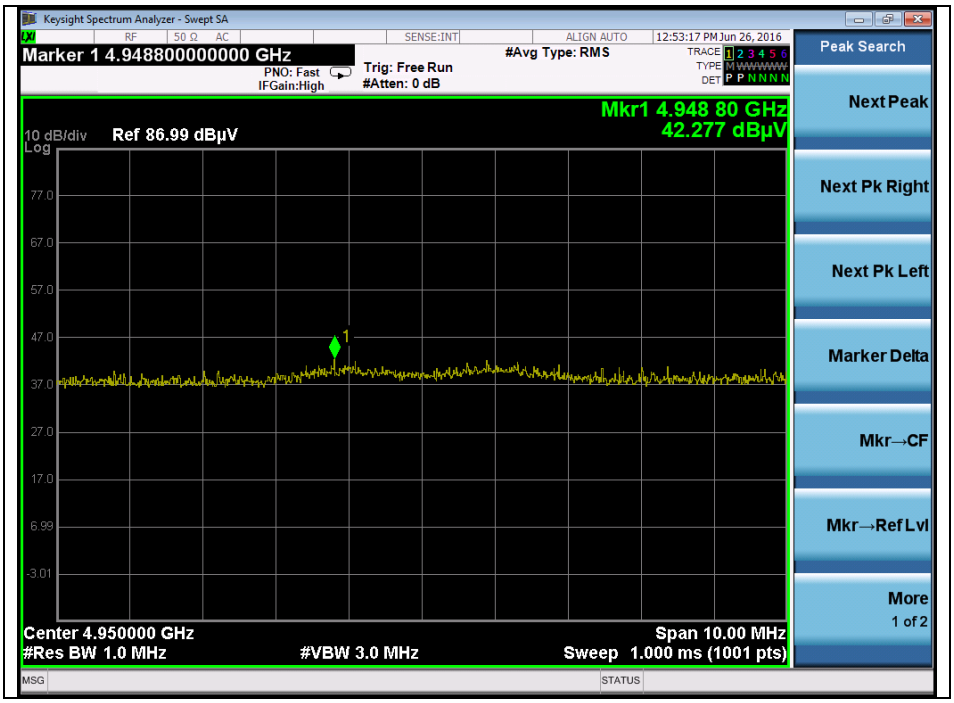
Middle channel 2nd harmonic (Peak)



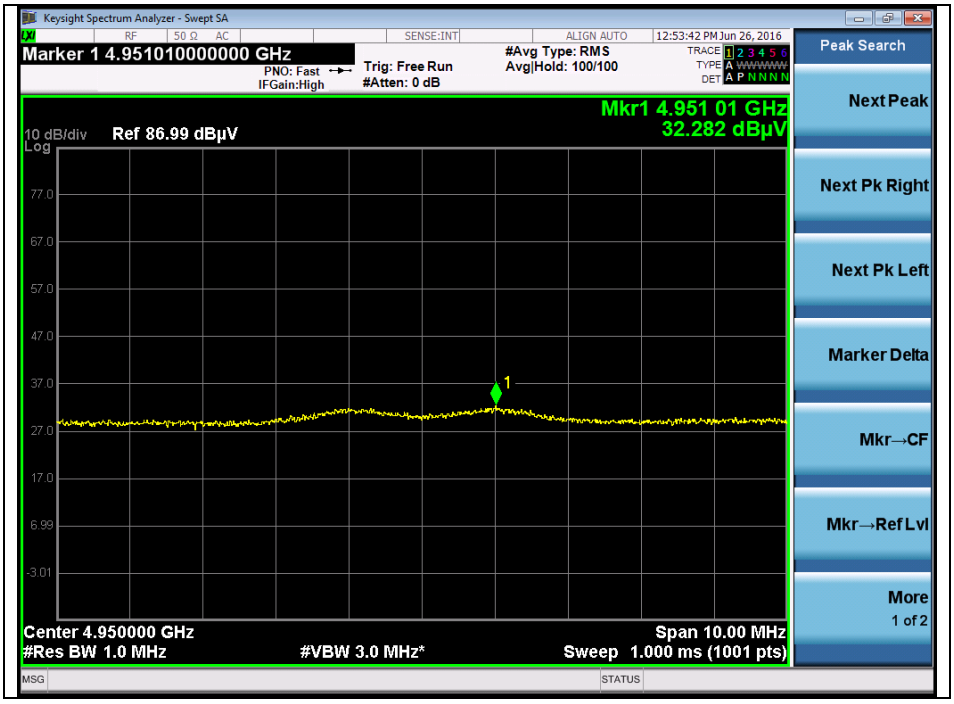
Middle channel 2nd harmonic (Average)



High channel 2nd harmonic (Peak)

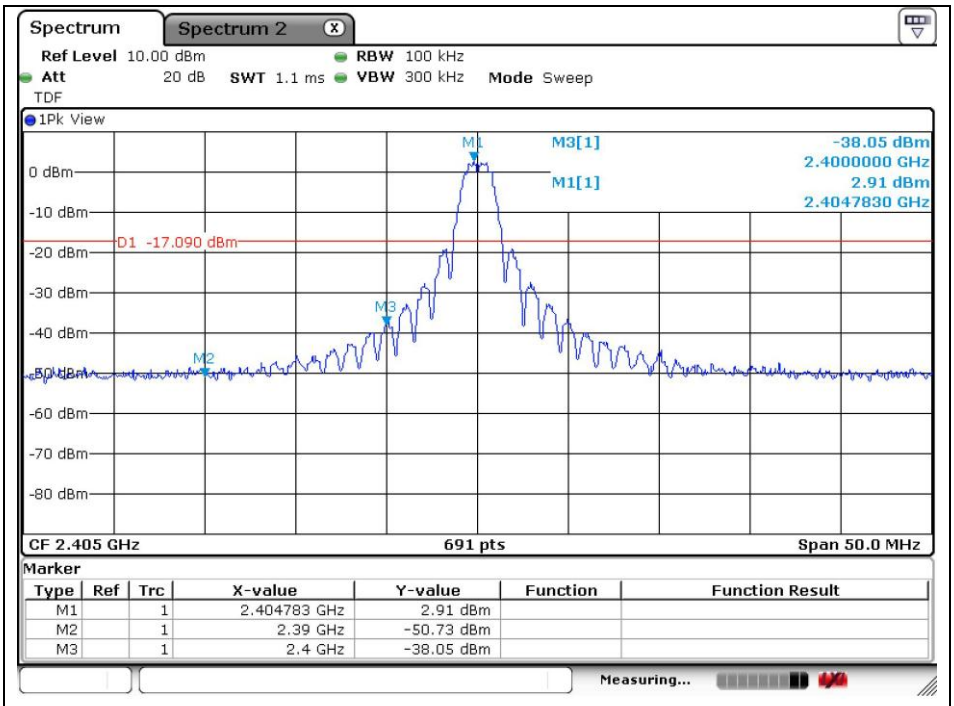


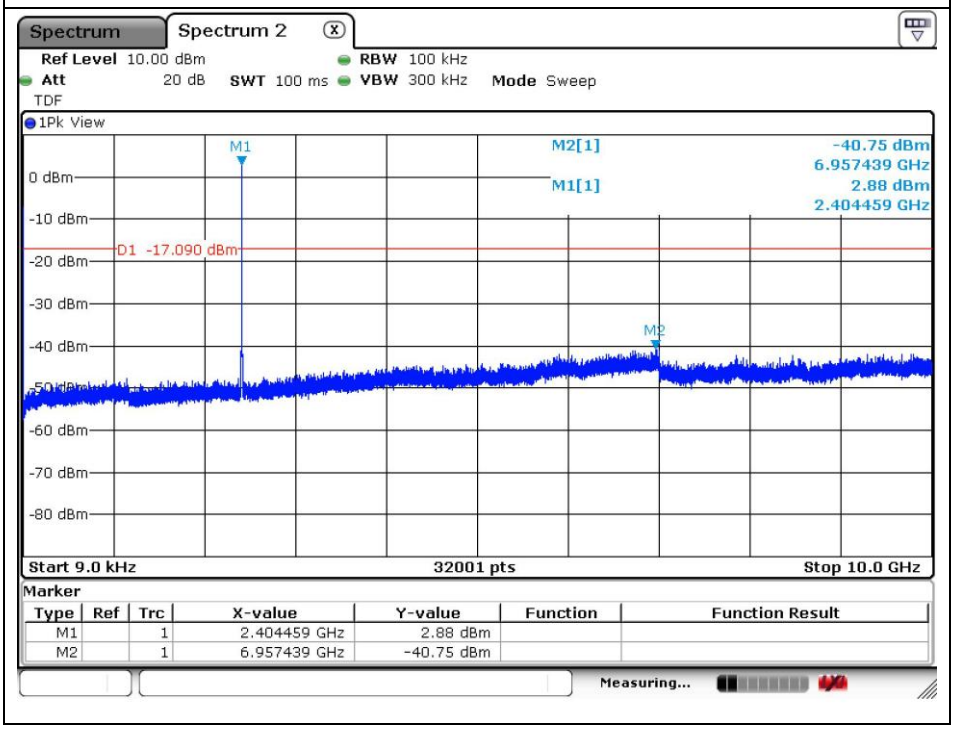
High channel 2nd harmonic (Average)



2.4.4. Plot of Conducted Spurious Emissions

Low channel





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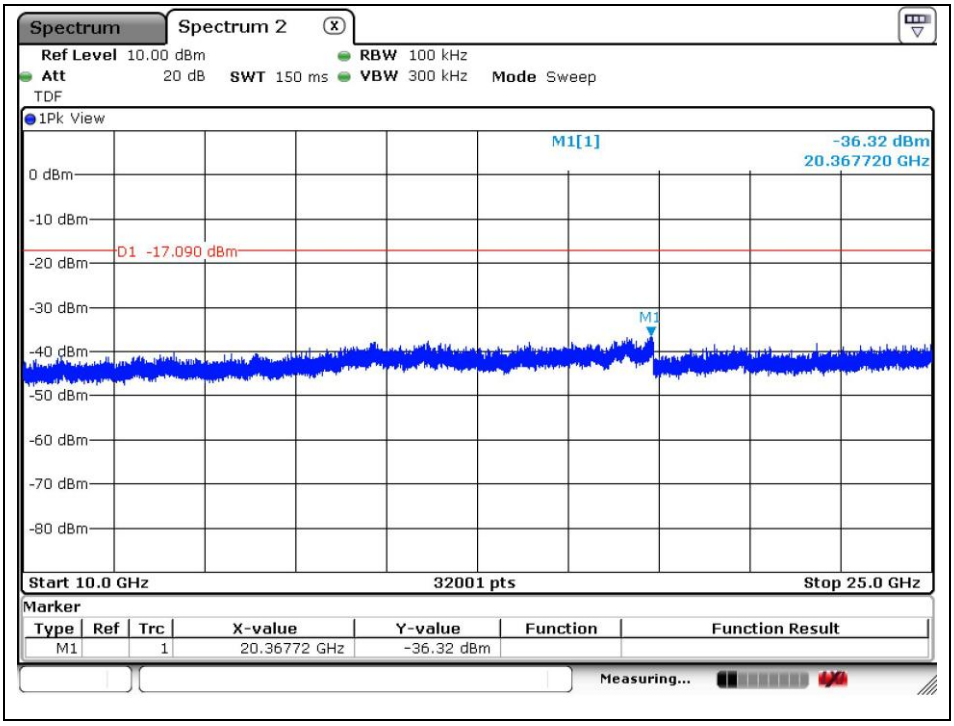
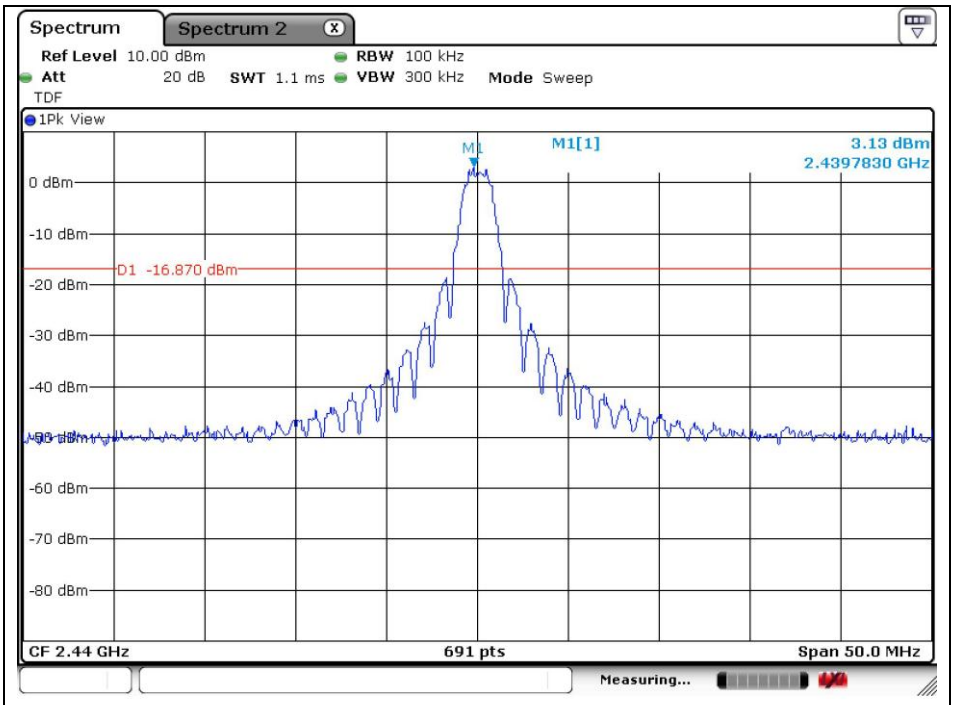
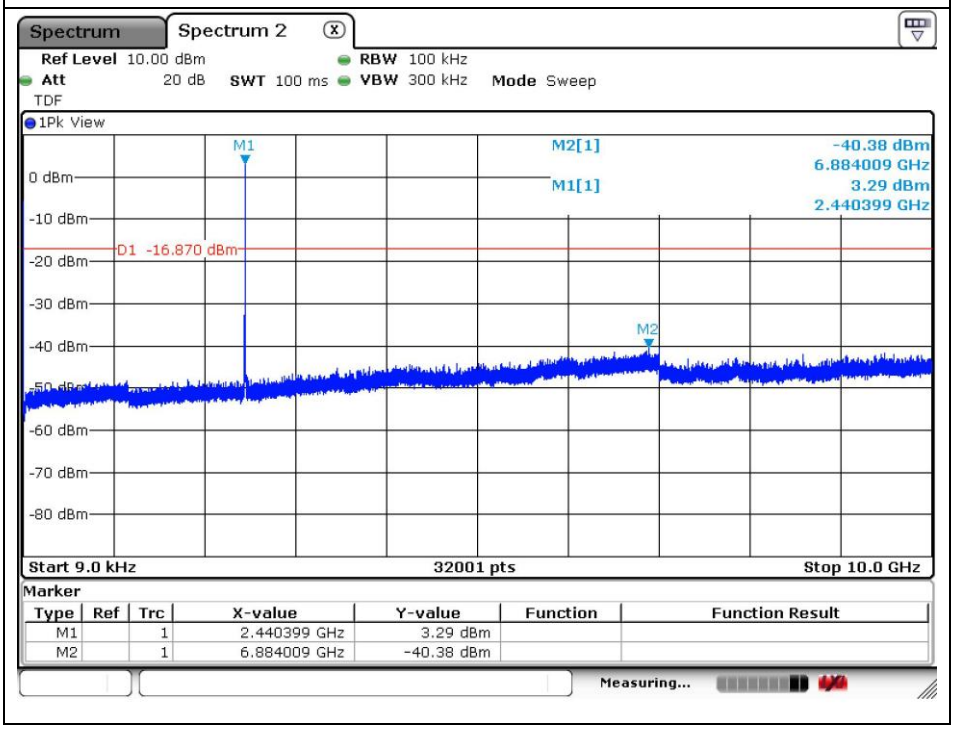
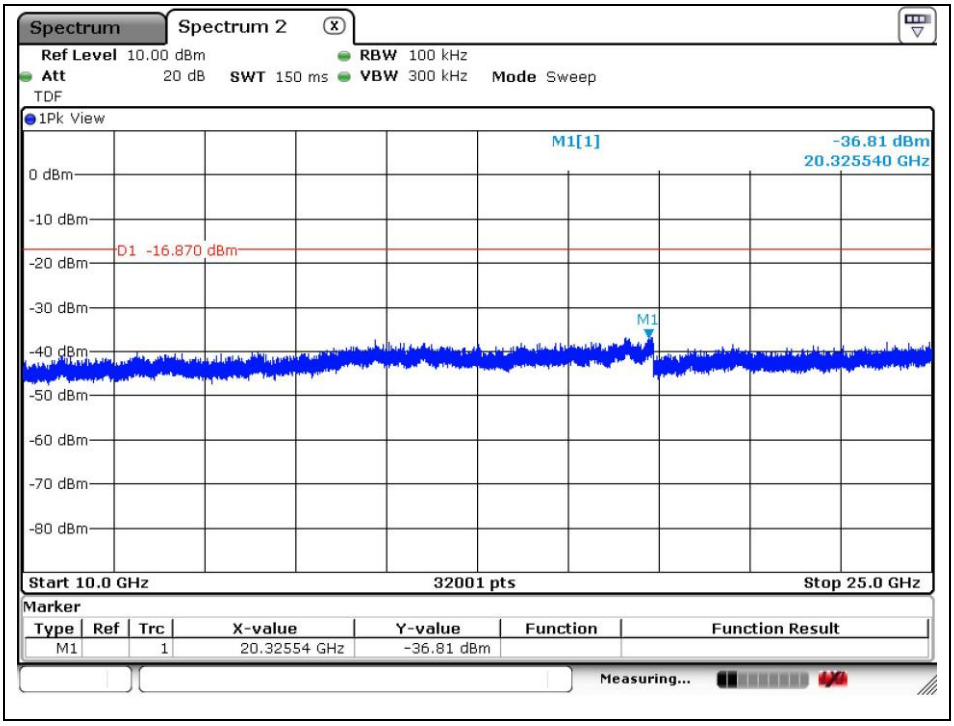

Spectrum
Spectrum 2
Ref Level 10.00 dBm
RBW 100 kHz
Att 20 dB
SWT 150 ms
VBW 300 kHz
Mode Sweep
TDF
1Pk View
M1[1]
-36.32 dBm
20.367720 GHz
0 dBm
-10 dBm
D1 -17.090 dBm
-20 dBm
-30 dBm
M1
-40 dBm
-50 dBm
-60 dBm
-70 dBm
-80 dBm
Start 10.0 GHz
32001 pts
Stop 25.0 GHz
Marker
Type Ref Trc X-value Y-value Function Function Result
M1 1 20.36772 GHz -36.32 dBm
Measuring...

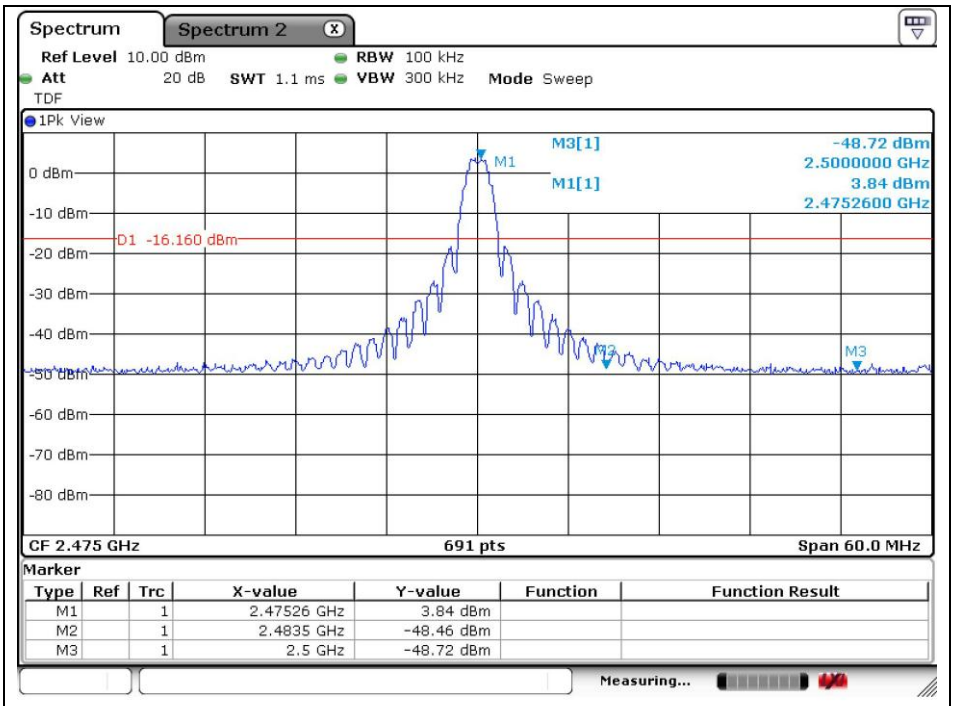
Middle channel

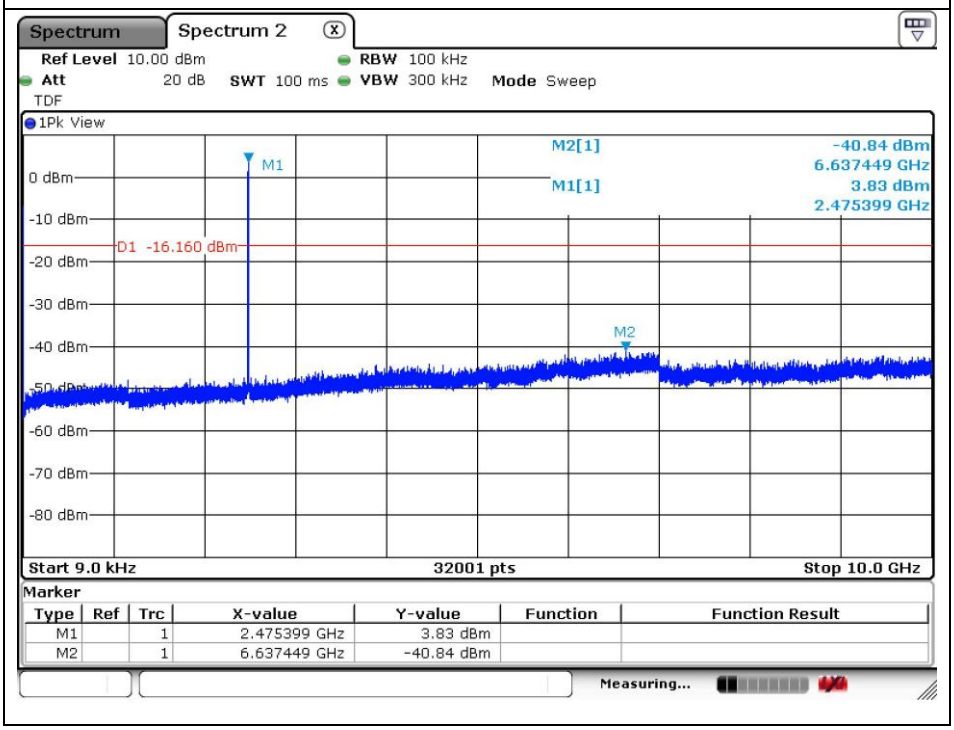





Spectrum
Spectrum 2
Ref Level 10.00 dBm
RBW 100 kHz
Att 20 dB
SWT 150 ms
VBW 300 kHz
Mode Sweep
TDF
1Pk View
M1[1]
-36.81 dBm
20.325540 GHz
0 dBm
-10 dBm
D1 -16.870 dBm
-20 dBm
-30 dBm
M1
-40 dBm
-50 dBm
-60 dBm
-70 dBm
-80 dBm
Start 10.0 GHz
32001 pts
Stop 25.0 GHz
Marker
Type Ref Trc X-value Y-value Function Function Result
M1 1 20.32554 GHz -36.81 dBm
Measuring...

High channel





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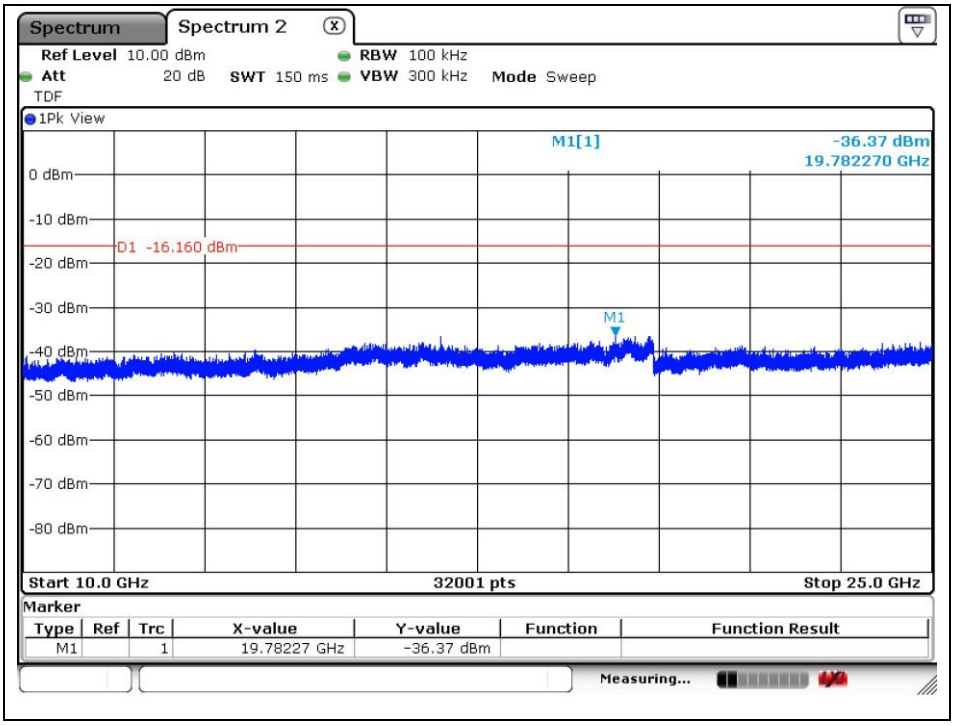
Spectrum
Spectrum 2
Ref Level 10.00 dBm
RBW 100 kHz
Att 20 dB
SWT 150 ms
VBW 300 kHz
Mode Sweep
TDF
1Pk View
M1[1]
-36.37 dBm
19.782270 GHz
0 dBm
-10 dBm
D1 -16.160 dBm
-20 dBm
-30 dBm
M1
-40 dBm
-50 dBm
-60 dBm
-70 dBm
-80 dBm
Start 10.0 GHz
32001 pts
Stop 25.0 GHz
Marker
Type Ref Trc X-value Y-value Function Function Result
M1 1 19.78227 GHz -36.37 dBm
Measuring...

3. 6 ㏈ Bandwidth & 99 % Bandwidth

3.1. Test Setup

3.2. Limit

FCC

§15.247(a)(2), systems using digital modulation techniques may operate in the 902-928 ㎒, 2 400-2 483.5 ㎒, and 5 725-5 825 ㎒ bands. The minimum of 6 ㏈ Bandwidth shall be at least 500 ㎑.

IC

RSS-247 Issue 1, 5.2 (1), the minimum -6 ㏈ Bandwidth shall be 500 ㎑.

3.3. Test Procedure

3.3.1. 6 ㏈ Bandwidth

The test follows section 8.0 DTS bandwidth of FCC KDB Publication 558074_v03r05.

Tests performed using section 8.1 Option 1.

- Option 1:
1. Set RBW to = 100 ㎑.
2. Set the video bandwidth(VBW) ≥ 3 x RBW.
3. Detector = Peak.
4. Trace mode = max hold.
5. Sweep = auto couple.
6. Allow the trace to stabilize.
7. Measure the maximum width of the emission that is constrained by the frequencies associated with the two outermost amplitude point (upper and lower frequencies) that are attenuated by 6 ㏈ relative to the maximum level measured in the fundamental emission.

3.3.2. 99 % Bandwidth

The span of the analyzer shall be set to capture all products of the modulation process, including the emission skirts.
The resolution bandwidth (RBW) shall be in the range of 1 % to 5 % of the occupied bandwidth (OBW) and video bandwidth (VBW) shall be approximately 3x RBW. Detector = sampling, Trace mode = max hold.
The trace data points are recovered and are directly summed in linear power level 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 (starting at the highest frequency, at the right side of the span, and going down in frequency).
This frequency is then recorded.

The results shown in this test report refer only to the sample(s) tested unless otherwise stated. This test report cannot be reproduced, except in full, without prior written permission of the Company.

3.4. Test Results

Ambient temperature : (23 ± 1) ℃
Relative humidity : 47 % R.H.

Mode	Channel	Frequency (MHz)	6 dB Bandwidth (MHz)	99 % Bandwidth (MHz)
DSSS	Low	2 405	1.621	2.460
	Middle	2 440	1.635	2.460
	High	2 475	1.606	2.460

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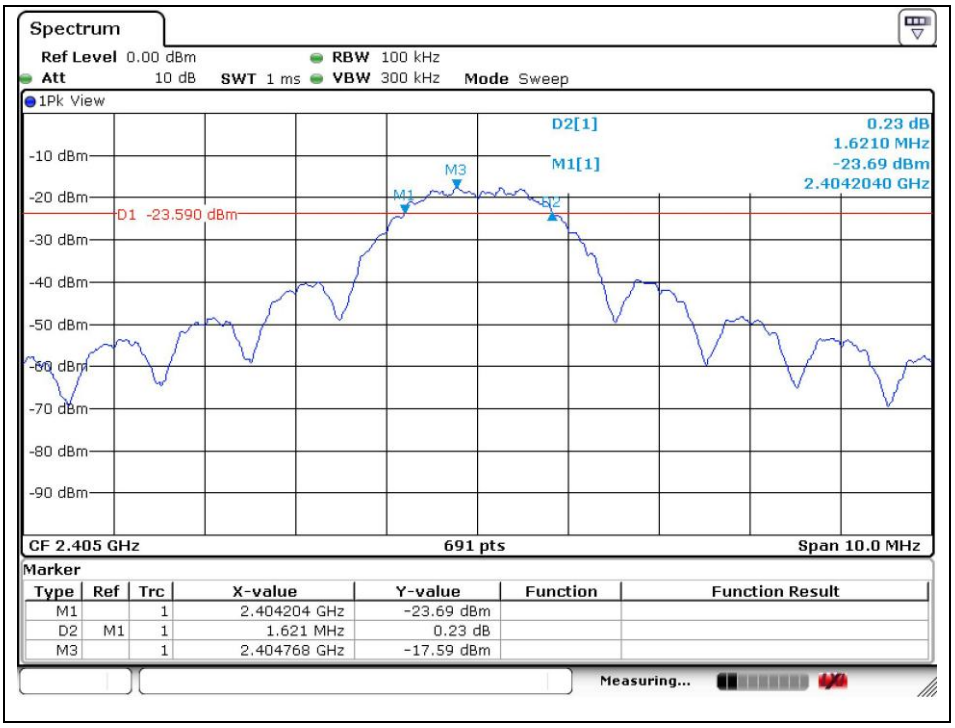
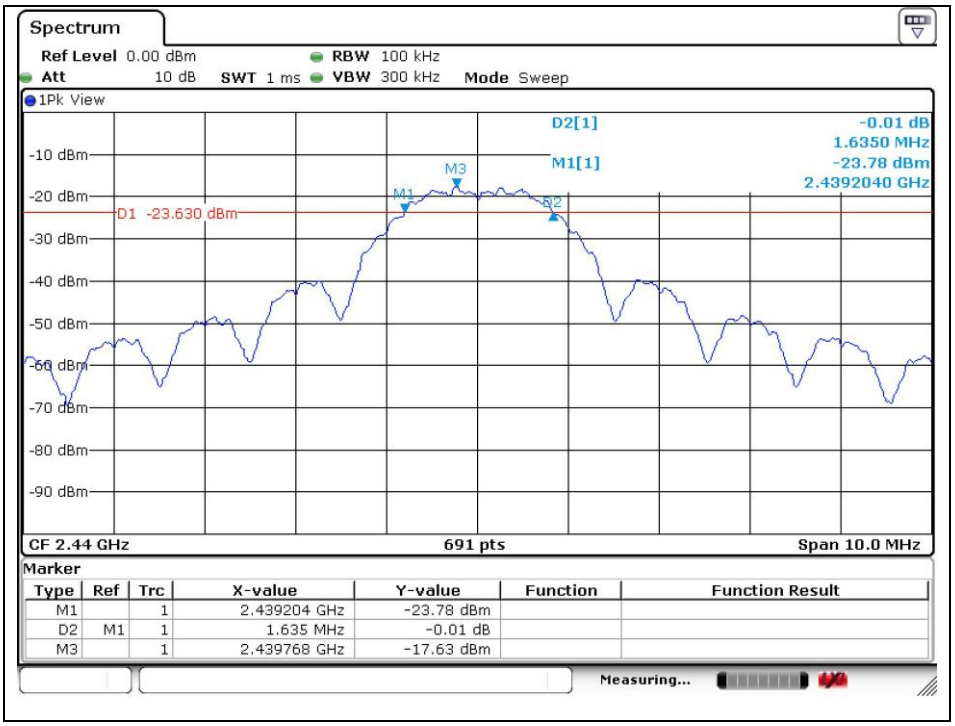
6 dB Bandwidth

Low channel



Middle channel



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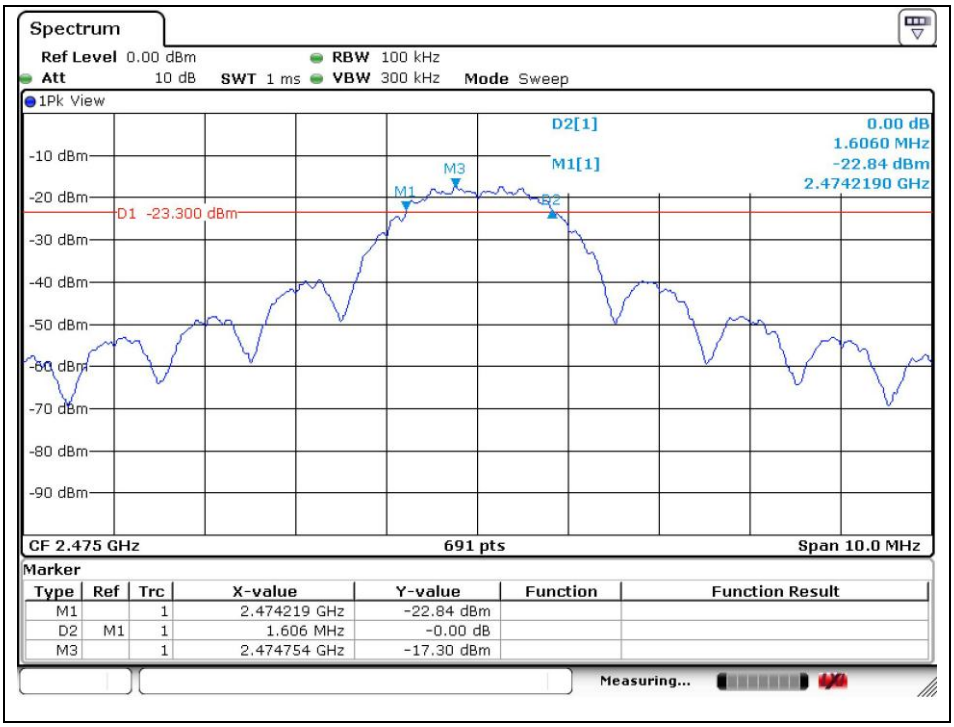
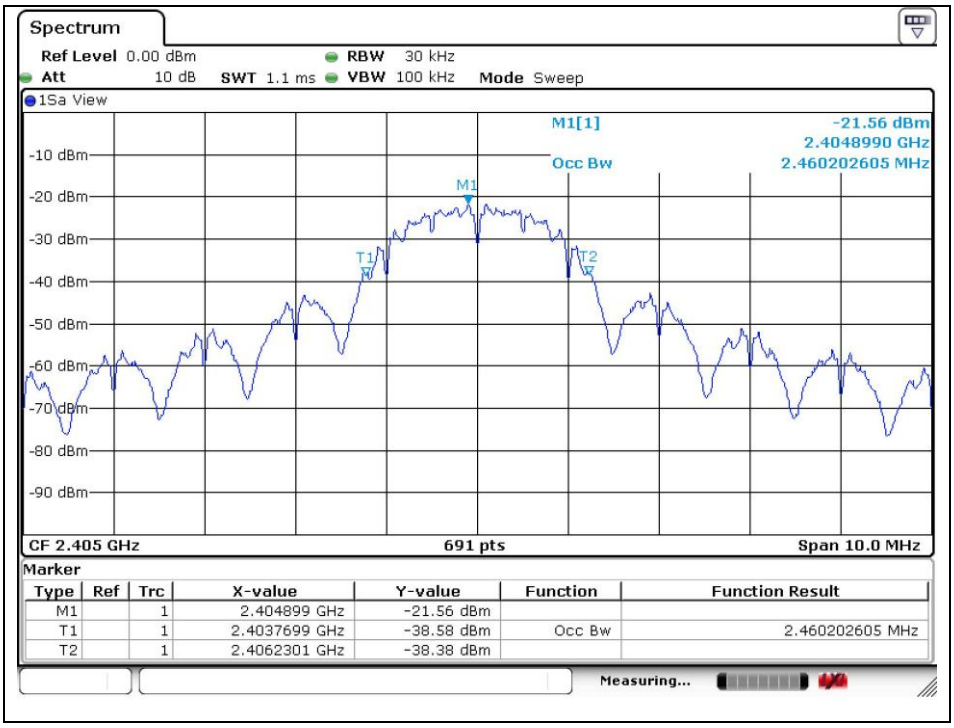
High channel



99 % Bandwidth

Low channel



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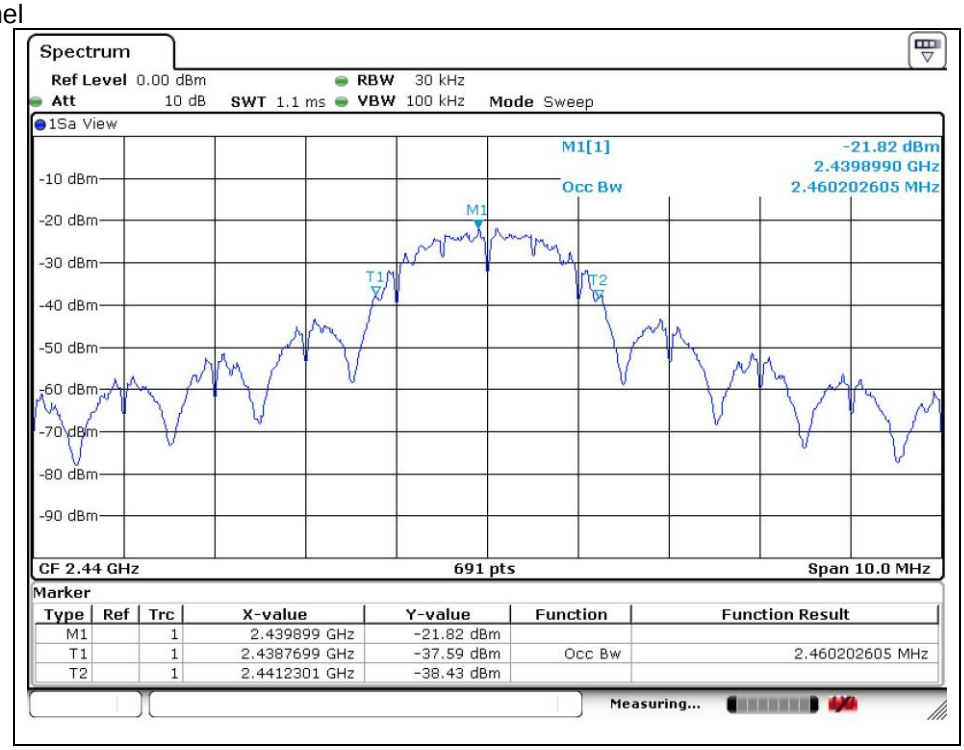
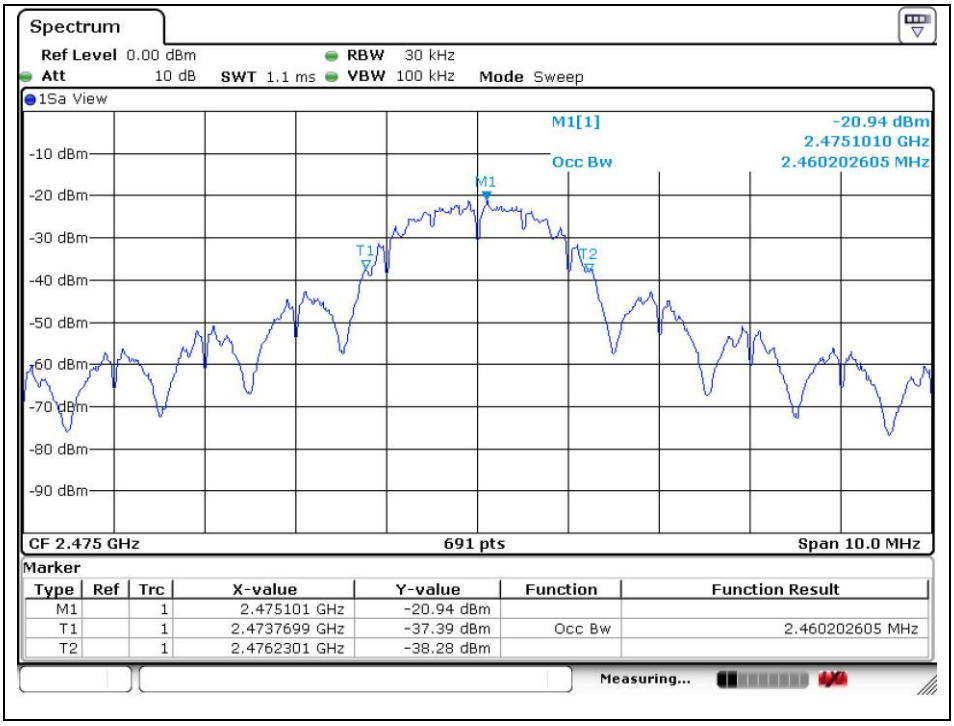
Middle channel



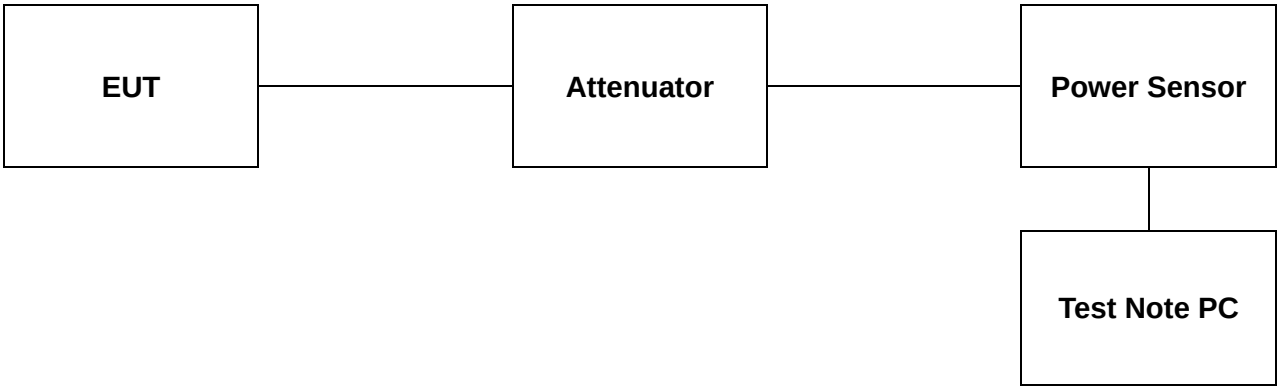
High channel



The results shown in this test report refer only to the sample(s) tested unless otherwise stated. This test report cannot be reproduced, except in full, without prior written permission of the Company.

4. Maximum Peak Conducted Output Power

4.1. Test Setup



4.2. Limit

FCC

§15.247(b)(3), for systems using digital modulation in the 902-928 ㎒, 2 400-2 483.5 ㎒, and 5 725-5 850 ㎒ band : 1 Watt. As an alternative to a peak power measurement, compliance with the one watt limit can be based on a measurement of the maximum conducted output power. Maximum Conducted output Power is defined as the total transmit power delivered to all antennas and antenna elements averaged across all symbols in the signaling alphabet when the transmitter is operating at its maximum power control level. Power must be summed across all antenna elements. The average must not include any intervals during which the transmitter is off or is transmitting at a reduced power level. If multiple modes of operation are possible (e.g., alternative modulation methods), the maximum conducted output power is the highest total transmit power occurring in any mode.

According to §15.247(b)(4), the conducted output power limit specified in paragraph(b) of this section is based on the use of antenna with directional gains that do not exceed 6 ㏈i. Except as shown in paragraph(c) of this section, if transmitting antenna of directional gain greater than 6 ㏈i are used, the conducted output power from the intentional radiator shall be reduced below the stated values in paragraph (b)(1), (b)(2), and (b)(3) of this section, as appropriate, by the amount in ㏈ that the directional gain of the antenna exceeds 6 ㏈i.

IC

RSS-247 Issue 1, 5.4 (4), for DTSs employing digital modulation techniques operating in the bands 902-928 ㎒ and 2 400-2 483.5 ㎒ the maximum peak conducted output power shall not exceed 1 W. Except as provided in Section 5.4 (5), the e.i.r.p shall not exceed 4 W.

As an alternative to a peak measurement, compliance can be based on a measurement of the maximum conducted output power. The maximum conducted output power is the total transmit power delivered to all antennas and antenna elements, averaged across all symbols in the signalling alphabet when the transmitter is operating at its maximum power control level. Power must be summed across all antennas and antenna elements. The average must not include any time intervals during which the transmitter is off or transmitting at a reduced power level. If multiple modes of operation are implemented, the maximum conducted output power is the highest total transmit power occurring in any mode.

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4.3. Test Procedure

The test follows section 9.1.2 of FCC KDB Publication 558074_v03r05.

- Peak power meter method

-The maximum peak conducted output power can be measured using a broad band peak RF power meter. The power meter shall have a video bandwidth that is greater than or equal to the DTS bandwidth and shall utilize a fast-responding diode detector.

Test program: (S/W name : R&S Power Viewer, Version : 3.2.0)

1. Initially overall offset for attenuator and cable loss is measured per frequency.
2. Measured offset is inserted in test program in advance of measurement for output power.
3. Power for each frequency (channel) of device is investigated as final result.
4. Final result reported on this section from R&S power viewer program includes with several factors and test program shows only final result.

The results shown in this test report refer only to the sample(s) tested unless otherwise stated. This test report cannot be reproduced, except in full, without prior written permission of the Company.

4.4. Test Results

Ambient temperature : (23 ± 1) ℃
Relative humidity : 47 % R.H.

Mode	Channel	Frequency (㎒)	Attenuator + Cable offset (㏈)	Peak Power Result (㏈ m)	Peak Power Limit (㏈ m)
DSSS	Low	2 405	21.88	6.82	30
	Middle	2 440	21.98	6.74	
	High	2 475	21.90	**7.63**	

Remark;

Attenuator and cable offset was compensated in test program (R&S Power Viewer) before measuring.

The results shown in this test report refer only to the sample(s) tested unless otherwise stated. This test report cannot be reproduced, except in full, without prior written permission of the Company.

5. Power Spectral Density

5.1. Test Setup

5.2. Limit

FCC
§15.247(e) For digitally modulated system, the power spectral density conducted from the intentional radiator to the antenna shall not be greater than 8 �dB m in any 3 ㎑ band any time interval of continuous transmission. This power spectral density shall be determined in accordance with the provisions of paragraph (b) of this section. The same method of determining the conducted output power shall be used to determine the power spectral density.

IC
RSS-247 Issue 1, 5.2 (2), the transmitter power spectral density conducted from the transmitter to the antenna shall not be greater than 8 ㎡B m in any 3 ㎑ band during any time interval of continuous transmission. This power spectral density shall be determined in accordance with the provisions of Section 5.4 (4), (i.e. the power spectral density shall be determined using the same method as is used to determine the conducted output power).

5.3. Test Procedure

The measurements are recorded using the PKPSD measurement procedure in section 10.2 of KDB 558074_v03r05.

- This procedure shall be used if maximum peak conducted output power was used to demonstrate compliance, and is optional if the maximum conducted (average) output power was used to demonstrate compliance.

1. Set analyzer center frequency to DTS channel center frequency.
2. Set the span to at least 1.5 times the DTS bandwidth.
3. Set the RBW to : 3 ㎑ ≤ RBW ≤ 100 ㎑.
4. Set the VBW ≥ 3 x RBW.
5. Detector = Peak.
6. Sweep time = auto couple.
7. Trace mode = max hold.
8. Allow trace to fully stabilize.
9. Use the peak marker function to determine the maximum amplitude level within the RBW.
10. If measured value exceeds limit, reduce RBW (no less than 3 ㎑) and repeat.

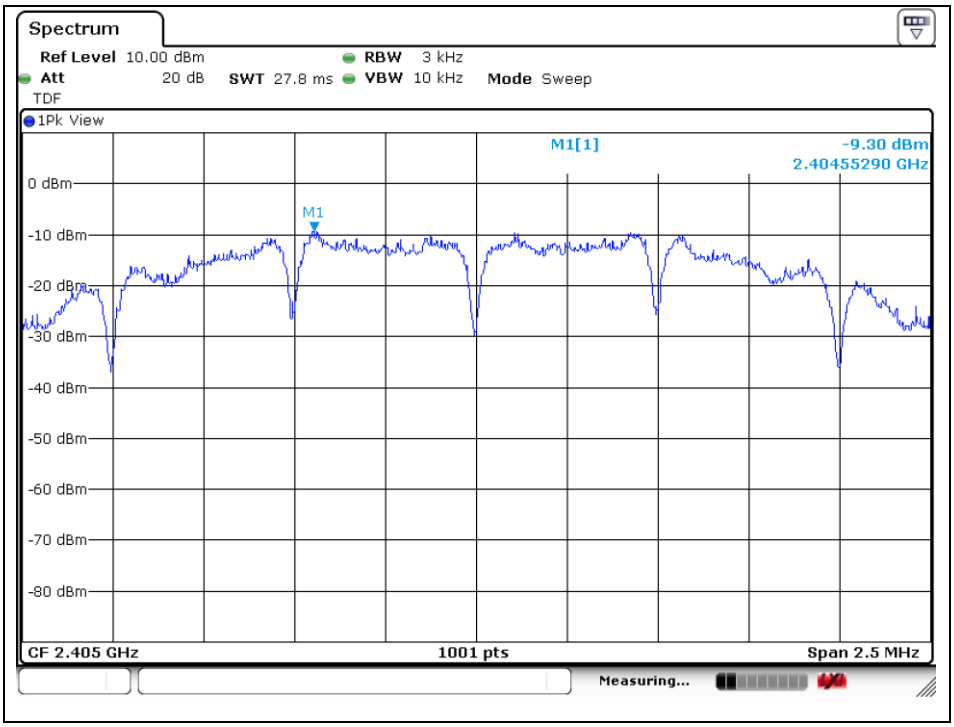
The results shown in this test report refer only to the sample(s) tested unless otherwise stated. This test report cannot be reproduced, except in full, without prior written permission of the Company.

5.4. Test Results

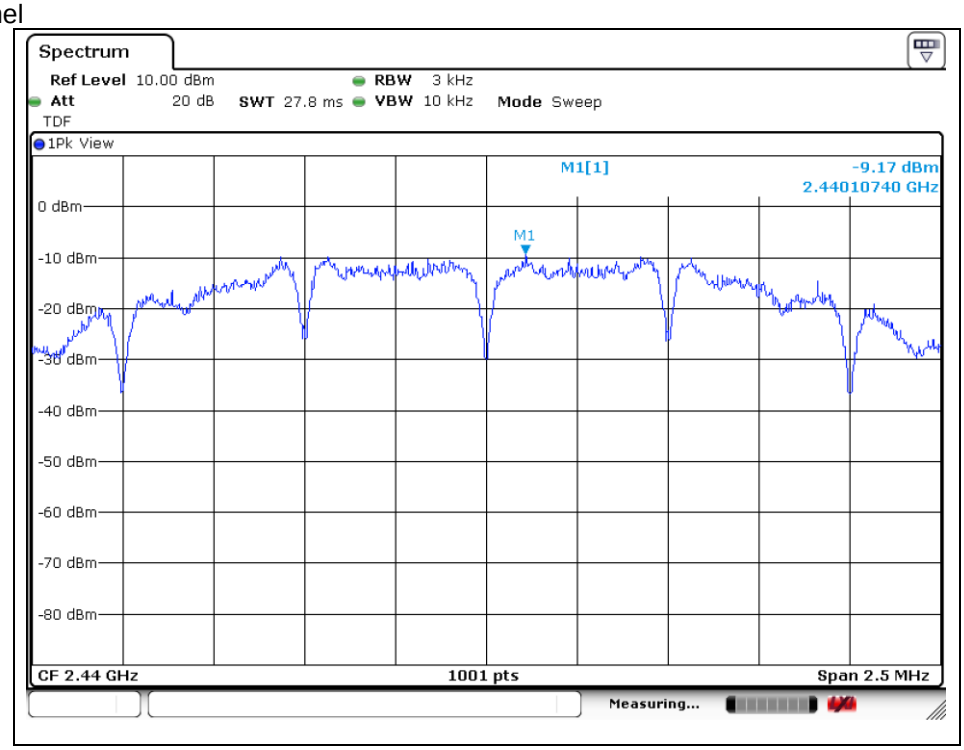
Ambient temperature : (23 ± 1) ℃
Relative humidity : 47 % R.H.

Mode	Channel	Frequency (㎒)	Measured PSD (㏈ m)	Maximum Limit (㏈ m)
DSSS	Low	2 405	-9.30	8
	Middle	2 440	-9.17	
	High	2 475	-7.63	

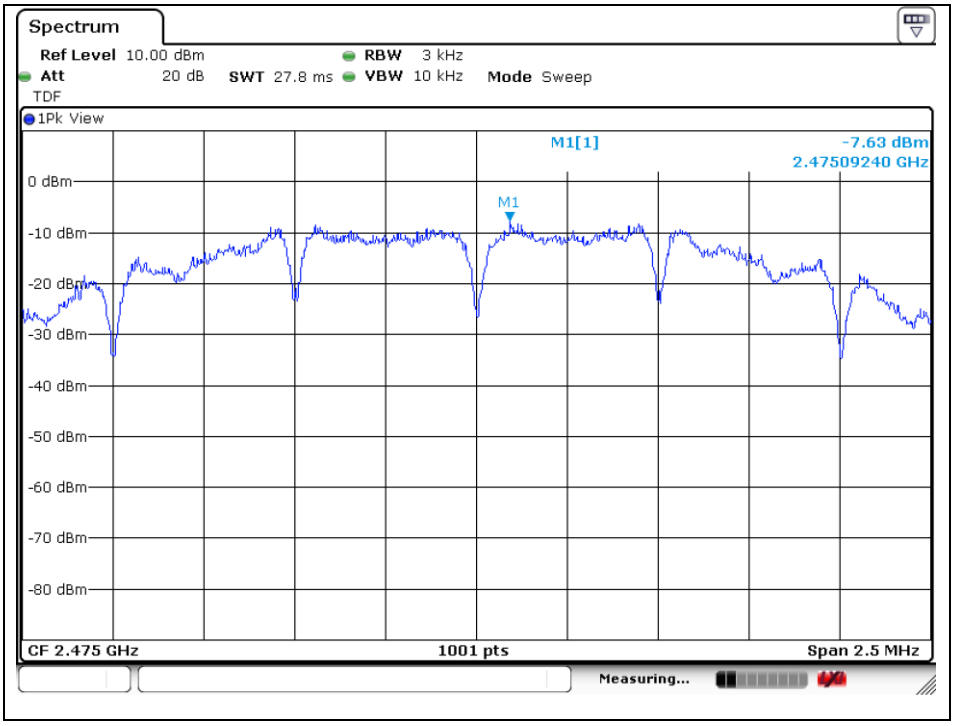
Low channel



Middle channel



High channel



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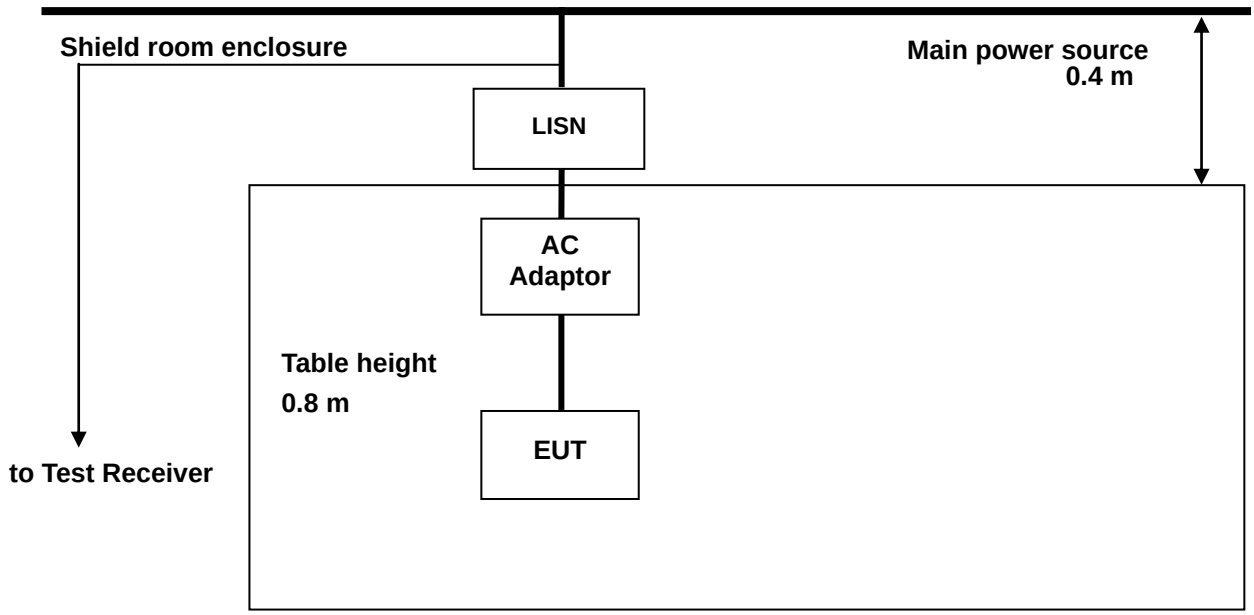
6. AC Power Line Conducted Emission

6.1. Test Setup



6.2. Limit

FCC

§15.207(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 line on any frequency or frequencies, within the band 150 ㎑ to 30 ㎒, shall not exceed the limits in the following table, as measured using a 50 ㎕H /50 ohm line impedance stabilization network(LISN).

Compliance with the provision of this paragraph shall on the measurement of the radio frequency voltage between each power line and ground at the power terminal. The lower applies at the boundary between the frequency ranges.

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

* Decreases with the logarithm of the frequency.

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IC

RSS-Gen Issue 4, 8.8, A radio apparatus that is designed to be connected to the public utility (AC) power line shall ensure that the radio frequency voltage, which is conducted back onto the AC power line on any frequency or frequencies, within the band 150 ㎑ to 30 ㎒, shall not exceed the limits in Table 3.

Unless the requirements applicable to a given device state otherwise, for any radio apparatus equipped to operate from the public utility AC power supply either directly or indirectly (such as with a battery charger), the radio frequency voltage of emissions conducted back onto the AC power lines in the frequency range of 0.15 ㎒ to 30 ㎒ shall not exceed the limits shown in Table 3 below. The more stringent limit applies at the frequency range boundaries.

The conducted emissions shall be measured in accordance with the reference publication mentioned in Section 3.

Table 3 – AC Power Line Conducted Emissions Limits

Frequency (㎒)	Conducted limit (dBμV)	
	Quasi-peak	Average**
0.15 - 0.50	66 - 56*	56 - 46*
0.50 - 5.00	56	46
5.00 - 30.0	60	50

* Decreases with the logarithm of the frequency.
** A linear average detector is required.

6.3. Test Procedures

All data rates and modes were investigated for this test. The full data for the worst case data rate are reported in this section.

AC line conducted emissions from the EUT were measured according to the dictates of ANSI C63.10-2013

1. The test procedure is performed in a 6.5 m × 3.6 m × 3.6 m (L × W × H) shielded room. The EUT along with its peripherals were placed on a 1.0 m (W) × 1.5 m (L) and 0.8 m in height wooden table and the EUT was adjusted to maintain a 0.4 meter space from a vertical reference plane.
2. The EUT was connected to power mains through a line impedance stabilization network (LISN) which provides 50 ohm coupling impedance for measuring instrument and the chassis ground was bounded to the horizontal ground plane of shielded room.
3. The excess power cable between the EUT and the LISN was bundled. All connecting cables of EUT were moved to find the maximum emission.

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6.4. Test Results

The following table shows the highest levels of conducted emissions on both phase of Hot and Neutral line

Ambient temperature : (23 ± 1) ℃
Relative humidity : 47 % R.H.

Frequency range : 0.15 ㎒ - 30 ㎒
Measured Bandwidth : 9 ㎑

FREQ.	LEVEL(dBμV)		LINE	LIMIT(dBμV)		MARGIN(dB)	
(㎒)	Q-Peak	Average		Q-Peak	Average	Q-Peak	Average
0.47	31.00	23.70	N	56.51	46.51	25.51	22.81
0.63	18.60	13.20	N	56.00	46.00	37.40	32.80
1.00	16.70	12.00	N	56.00	46.00	39.30	34.00
1.76	16.60	12.00	N	56.00	46.00	39.40	34.00
2.52	15.60	10.40	N	56.00	46.00	40.40	35.60
18.55	16.00	11.70	N	60.00	50.00	44.00	38.30
0.47	29.40	23.10	H	56.51	46.51	27.11	23.41
0.61	15.70	10.30	H	56.00	46.00	40.30	35.70
1.04	15.30	10.40	H	56.00	46.00	40.70	35.60
1.41	15.20	10.80	H	56.00	46.00	40.80	35.20
1.80	15.40	10.90	H	56.00	46.00	40.60	35.10
13.56	15.00	10.10	H	60.00	50.00	45.00	39.90

Remark;

1. Line (H): Hot, Line (N): Neutral.
2. All channel of operation were investigated and the worst-case emissions were reported using High channel.
3. Traces shown in plot mad using a peak detector and average detector.
4. The limit for Class B device(s) from 150 ㎑ to 30 ㎒ are specified in Section of the Title 47 CFR.
5. Deviations to the Specifications: None.

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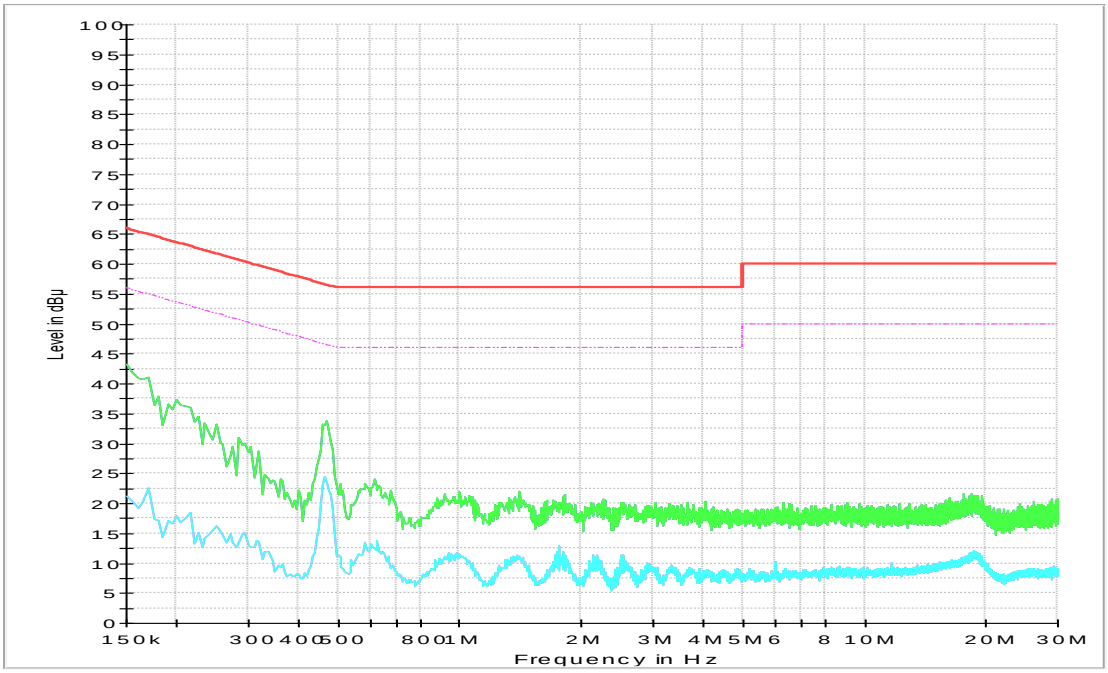
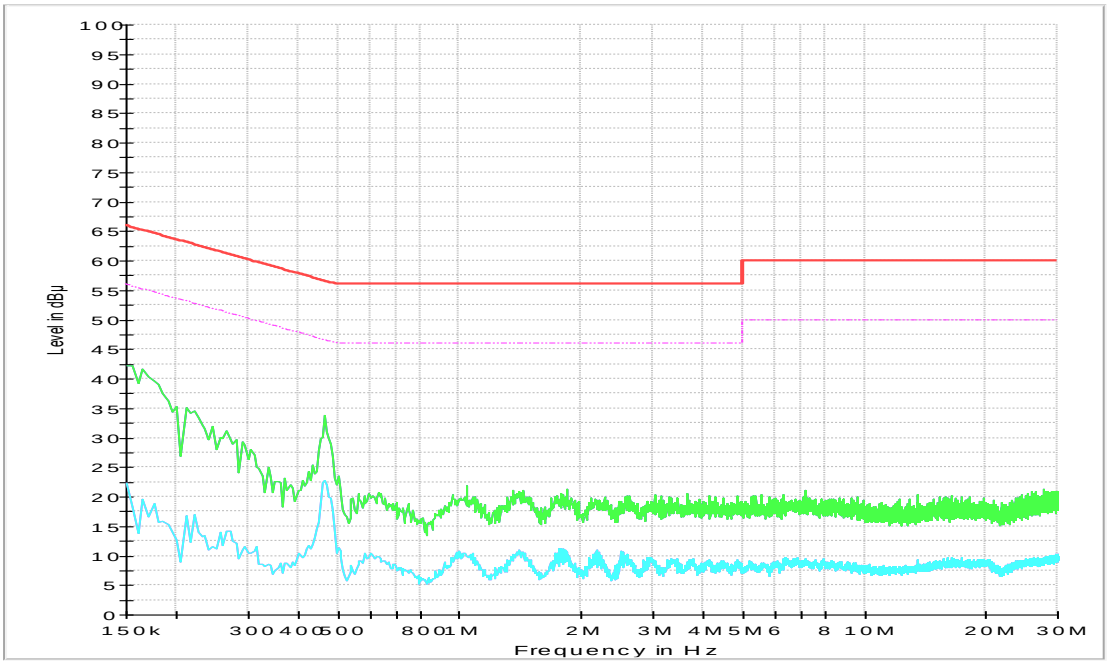
Plots of Conducted Power line

Test mode: (Neutral)



Test mode: (Hot)



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7. Antenna Requirement

7.1. Standard Applicable

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

7.2. Antenna Connected Construction

Antenna used in this product is Dipole type with gain of 1.10 dBi.

- End of the Test Report -

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