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FCC CFR47 PART 15 SUBPART C & IC RSS-210

TEST REPORT

For

2.4GHz DTS Transmitter Module
(for 2.4GHz Band Transmission)

Model Number: CEN-8B

FCC ID: ST2-CEN8B
IC: 6012A-CEN8B

Report Number: 0048-130114-03

Prepared for
Centrak, Inc.
5 Caufield Place, Ste 102
Newtown, PA 18940
USA

Prepared by
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Date: 01/25/2013

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1. TEST RESULT CERTIFICATION

COMPANY NAME: Centrak, Inc.
5 Caufield Place, Ste 102
Newtown, PA 18940, USA

EUT DESCRIPTION: 2.4GHz DTS Transmitter Module

MODEL: CEN-8B

DATE TESTED: 01/14/2013 to 01/25/2013

APPLICABLE STANDARDS	
STANDARD	**TEST RESULTS**
FCC Part 15.247 & IC RSS-210:Issue 8	NO NON-COMPLIANCE NOTED

Advanced Compliance Laboratory, Inc. tested the above equipment in accordance with the requirements set forth in the above standards. The test results show that the equipment tested is capable of demonstrating compliance with the requirements as documented in this report.

Note: This document reports conditions under which testing was conducted and results of tests performed. This document may not be altered or revised in any way unless done so by Advanced Compliance Laboratory, Inc. (ACL) and all revisions are duly noted in the revisions section. Any alteration of this document not carried out by ACL, Advanced Compliance Laboratory, Inc. will constitute fraud and shall nullify the document.

Approved & Released For ACL By:

Wei Li
Manager
Advanced Compliance Laboratory, Inc.

Tested By:

Edward Lee
EMC Engineer

2. EUT DESCRIPTION

The EUT is a low power transmitter, using digital modulation & operating in the 2400-2483.5 MHz band.

The transmitter has a maximum peak conducted output power as follows:

Frequency Range (MHz)	Rated Power		Tested Peak Power (dBm/W)
2412-2462	8dBm		7.41 /0.006

The EUT can use a surface mount antenna:

1. Johanson Technology, Inc., P/N 2450AT42A100, 2.4GHz Band, 0 dBi, typ. (XZ-Vertical Polarization)

3. TEST METHODOLOGY

The tests documented in this report were performed in accordance with ANSI C63.4-2003/C63.10-2009, FCC CFR 47Part 2 & 15 and IC RSS-210. Test procedure described in FCC "KDB 558074 D02 DTS Measurement Guidance" is used in this report.

4. FACILITIES AND ACCREDITATION

The test sites and measurement facilities used to collect data are located at Hillsborough, New Jersey, USA The sites are constructed in conformance with the requirements of ANSI C63.4-2003, ANSI C63.7-2005 and CISPR Publication 22. All receiving equipment conforms to CISPR Publication 16-1, "Radio Interference Measuring Apparatus and Measurement Methods."

ACL is accredited by NVLAP, Laboratory Code 200101-0. The full accreditation can be viewed at http://www.ac-lab.com

NVLAP Lab Code: 200101-0

No part of this report may be used to claim or imply product endorsement by NVLAP or any agency of the US Government.

5. CALIBRATION AND UNCERTAINTY

5.1. MEASURING INSTRUMENT CALIBRATION

The measuring equipment utilized to perform the tests documented in this report has been calibrated in accordance with the manufacturer's recommendations, and is traceable to recognized national standards.

5.2. MEASUREMENT UNCERTAINTY

The estimated uncertainty of the test result is given as following. The method of uncertainty calculation is provided in Advanced Compliance Lab. Doc. No. 0048-01-01.

	Prob. Dist.	Uncertainty(dB)	Uncertainty(dB)	Uncertainty(dB)
		30-1000MHz	1-6.5GHz	Conducted
Combined Std. Uncertainty u_c	norm.	±2.36	±2.99	±1.83

5.3. TEST AND MEASUREMENT EQUIPMENT

The following test and measurement equipment was utilized for the tests documented in this report:

Manufacture	Model	Serial No.	Description	Last Cal dd/mm/ yy	Cal Due dd/mm/ yy
Agilent	E4440A	US40420700	3Hz-26.5GHz Spec. Analyzer	25/08/12	25/08/13
R &S	ESPI7	6001	9KHz-7GHz EMI Receiver	17/06/12	17/06/13
EMCO	3104C	9307-4396	20-300MHz Biconical Antenna	15/01/12	15/01/14
EMCO	3146	9008-2860	200-1000MHz Log-Periodic Antenna	15/01/12	15/01/14
EMCO	6502	2665	10KHz-30MHz Active Loop Antenna	28/05/12	28/05/13
EMCO	3115	4945	Double Ridge Guide Horn Antenna	22/01/12	22/01/14
HP	E8254A	US42110367	Signal Generator	23/03/12	23/03/13
Scientific-Atlanta	12A-18	441	Wave Guide Horn Antenna	04/08/12	04/08/13
Agilent	E4448A	MY45300108	3Hz-50GHz Spectrum Analyzer	05/09/12	05/09/13
Agilent	83650B	3844A01114	50G Swept Signal Generator	27/01/11	27/01/14
HP	5361B	3023A01322	20G Pulse/CW Microwave Counter	10/06/12	10/06/13
HP	4419A	US37292112	RF Power Meter w/ Sensor Probe	29/06/12	29/06/13
EMCO	3116	4943	Double Ridge Guide Horn Antenna	11/01/12	11/01/14
ARA	MWH-1826/ B	1013	18-26GHZ Horn Antena	10/02/12	10/2/2013
Fischer Custom	LISN-1	900-4-0008	Line Impedance Stabilization Networks	18/03/12	18/03/13
Fischer Custom	LISN-2	900-4-0009	Line Impedance Stabilization Networks	24/03/12	24/03/13
SUNSYS	EC127	96025	Temperature Test Chamber	30/06/12	30/06/13
Lorch Microwave	5NF-800/1000-S	AC3	Notch Filter		
Lorch Microwave	5NF-1800/2200-S	AE10	Notch Filter		
RES-NET	RFA500NFF30	0108	30dB in-line Power Attenuator		
Narda	3022	80986	Directional Coupler		

All Test Equipment Used are Calibrated Traceable to NIST Standards.

6. SETUP OF EQUIPMENT UNDER TEST

SUPPORT EQUIPMENT

n/a

TEST SETUP

Testing Frequency/Channel/Port Selection:

- Conducted measurement performed at EUT's antenna connector.
- Using internal continuous testing signal source. Fresh batteries as DC power source.
- Modulation: DSSS
- Signal BW: 18.6MHz. Emission Designator: 18M6G1D
- L(owest), M(iddle), H(ighest) Channels of 2.4G Band were selected:
  L=2412MHz, M=2438MHz, H=2462MHz

7. APPLICABLE LIMITS AND TEST RESULTS

7.1. 6dB &99% BANDWIDTH

LIMIT

§15.247 (a) (2) & RSS-210 A8.2(1): Min. 6dB bandwidth should be no less than 500KHz.

TEST PROCEDURE ***per FCC KDB 558074D02***

Measurement Procedure for Emission Bandwidth (DTS Bandwidth)	Applicable to this EUT
7.1 DTS BW Measurement Procedure: Option 1	☐
7.2 DTS BW Measurement Procedure: Option 2	☒

RESULTS

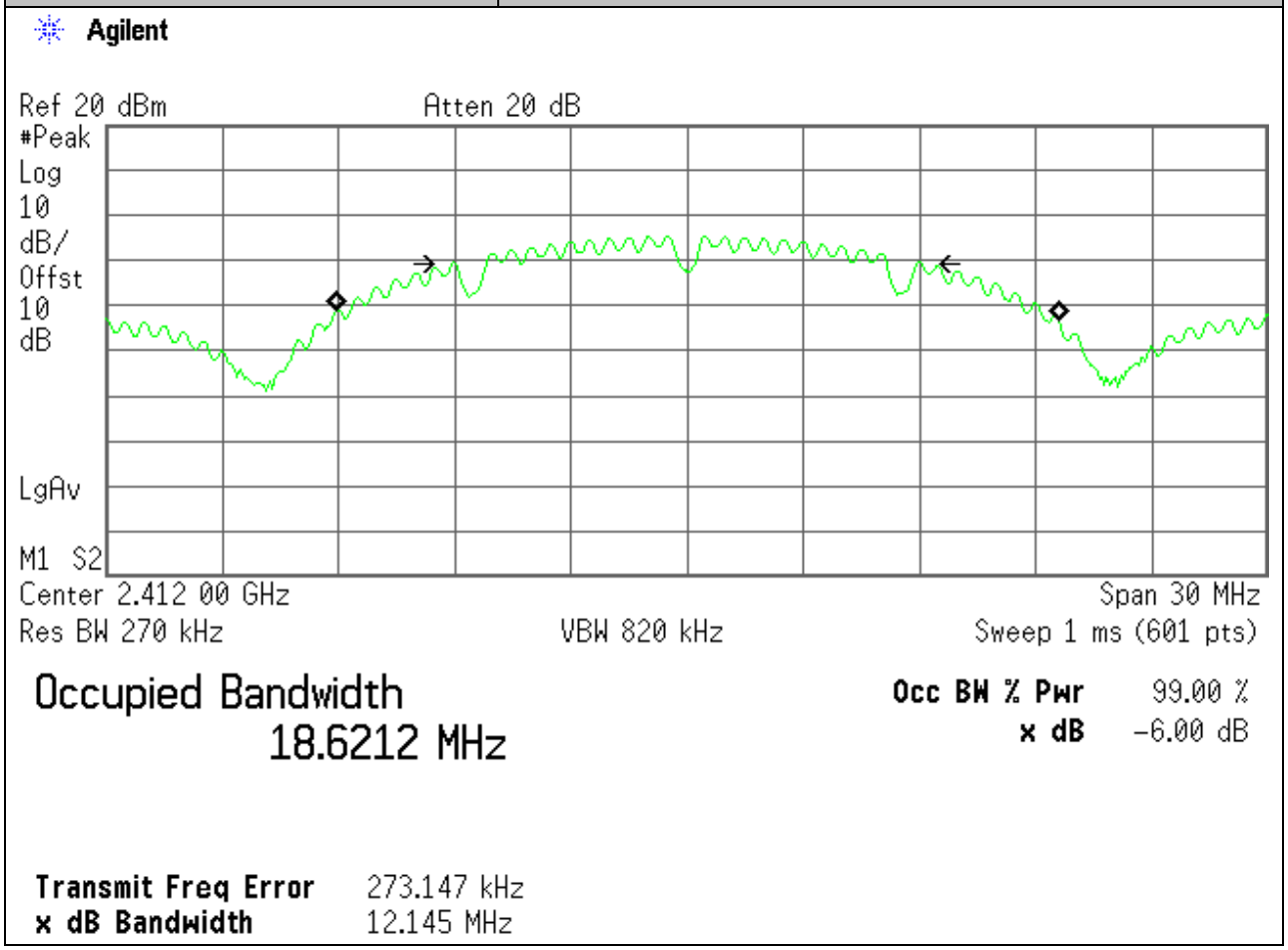
No non-compliance noted.

Summary of Bandwidth Testing Data

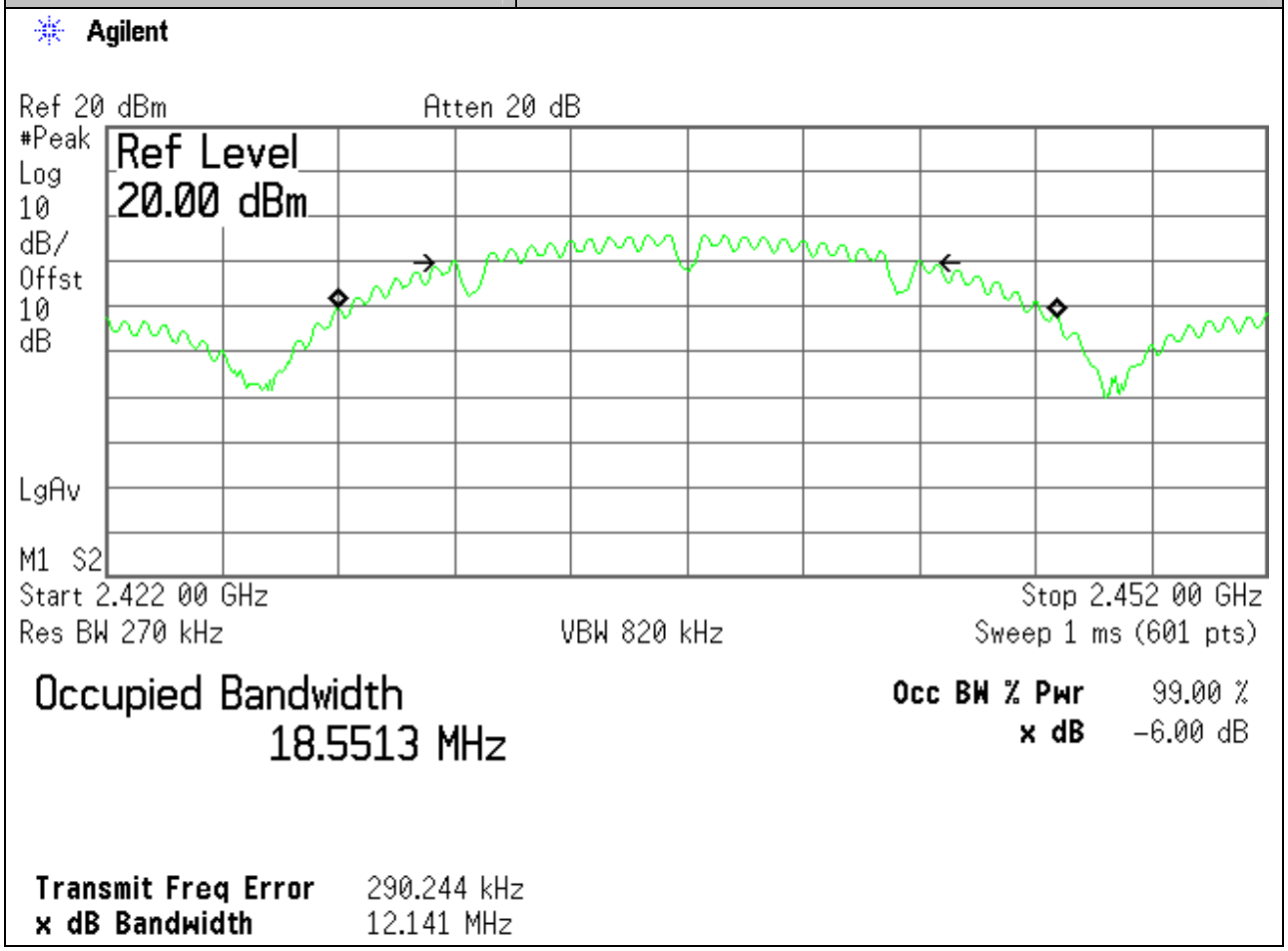
	Channel	6dB Bandwidth (KHz)	99% Bandwidth (KHz)
	L	12145	18625
	M	12141	18556
	H	12138	18470

6dB & 99% BANDWIDTH

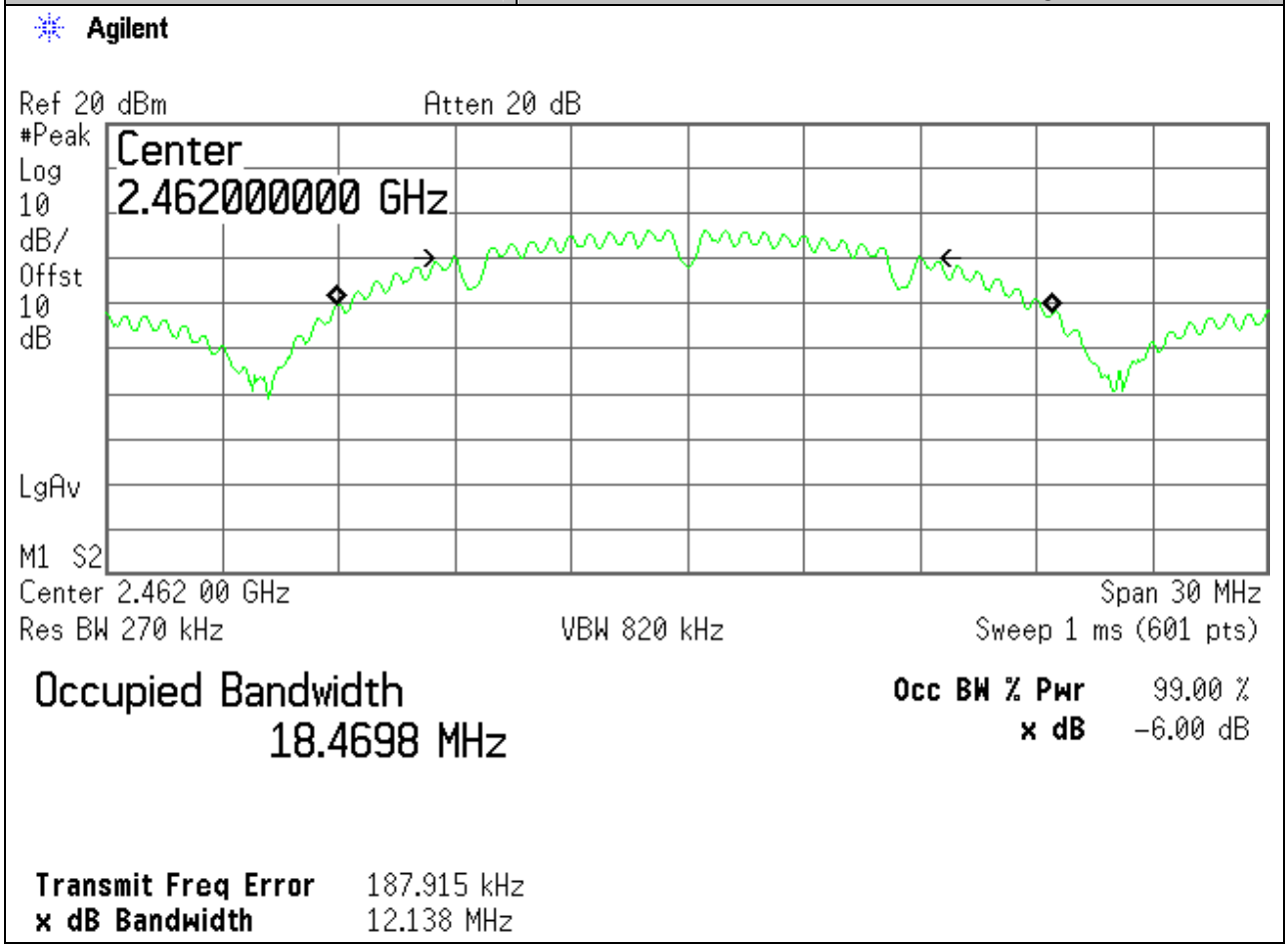
Plot Name:	6dB &99% Bandwidth, Low CH



Plot Name:	6dB & 99% Bandwidth Mid CH



Plot Name:	6dB & 99% Bandwidth High CH



7.2. PEAK OUTPUT POWER

PEAK POWER LIMIT

§15.247 (b)(3) & RSS-210 A8.4(4)

The maximum peak conducted output power of the intentional radiator shall not exceed the following: For systems using digital modulation in the 902-928 MHz, 2400-2483.5 MHz, and 5725-5850 MHz bands: 1 Watt.

The conducted output power limit specified in paragraph (b) of this section is based on the use of antennas with directional gains that do not exceed 6 dBi.

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

Therefore, the applicable output power limit shall be calculated as follows:

Pout = 30 -(Gtx-6) for antenna gain ≤6dBi or
Pout = 30 -Floor[(Gtx-6)/3]
G_{Tx} = the maximum transmitting antenna directional gain in dBi.

TEST PROCEDURE ***per FCC KDB 558074D02***

Measurement Procedure for Fundamental Emission Output Power	Applicable to this EUT
8.1.1 Maximum Peak Conducted Output Power Level Measurement Procedure Option 1 (RBW≥DTS BW)	☐ **preferred**
8.1.2 Maximum Peak Conducted Output Power Level Measurement Procedure Option 2 (RBW<DTS BW)	☒
8.1.3 Maximum Peak Conducted Output Power Level Measurement Procedure Option 3 (Peak Power Meter Method)	☐
8.2.1 Maximum Conducted Output Power Level * Measurement Procedure Option 1 (RMS/Sample Detector with Band Power measurement)	☐
8.2.2 Maximum Conducted Output Power Level * Measurement Procedure Option 2 (RMS Power Averaging Detector with single slow sweep)	☐
8.2.3 Maximum Conducted Output Power Level * Measurement Procedure Option 2 (using a broadband RF average power meter)	☐
8.2.4 Maximum Conducted Output Power Level Measurement Procedure Alternative 1 (adding 10log (1/DT), using SA or PM)	☐

* Alternative method. EUT shall be configured to transmit continuously (min. 98% duty cycle at full power). The spectrum analyzer shall be set for bin-to-bin spacing ≤RBW/2.

RESULTS

No non-compliance noted:

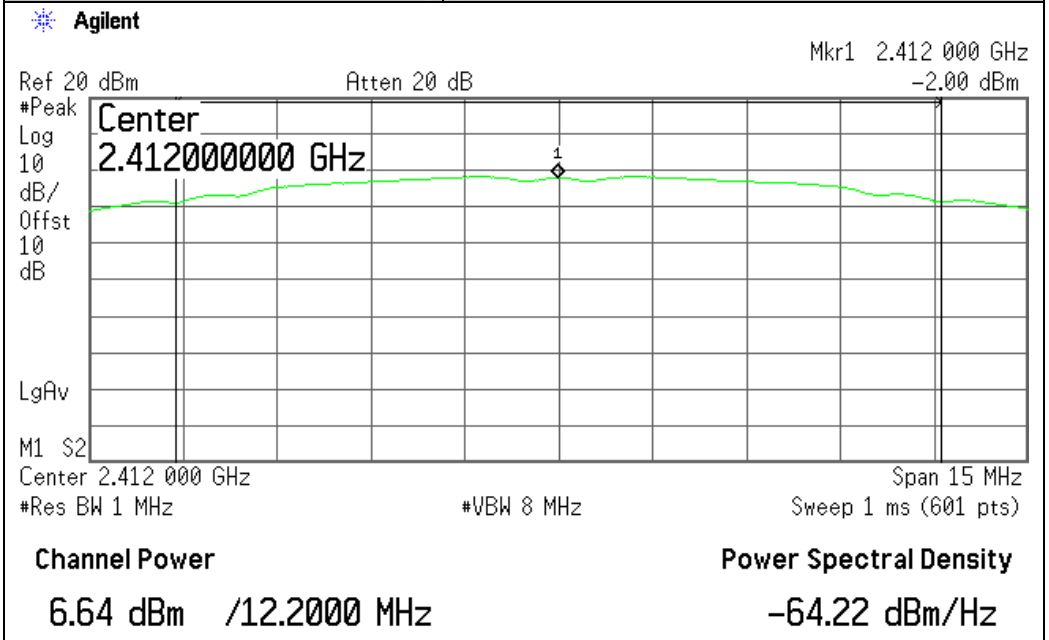
OUTPUT PEAK POWER

	Channel	Peak Power (dBm)	Limit (dBm)	Margin
	L	6.64	30	-23.36
	M	7.04	30	-22.96
	H	7.41	30	-22.59

Therefore, the max. measured peak power is +7.41dBm , which is under FCC allowed power limit.

PLOTS for Peak Output Power

Plot Name:	Output Peak Power @ Low CH



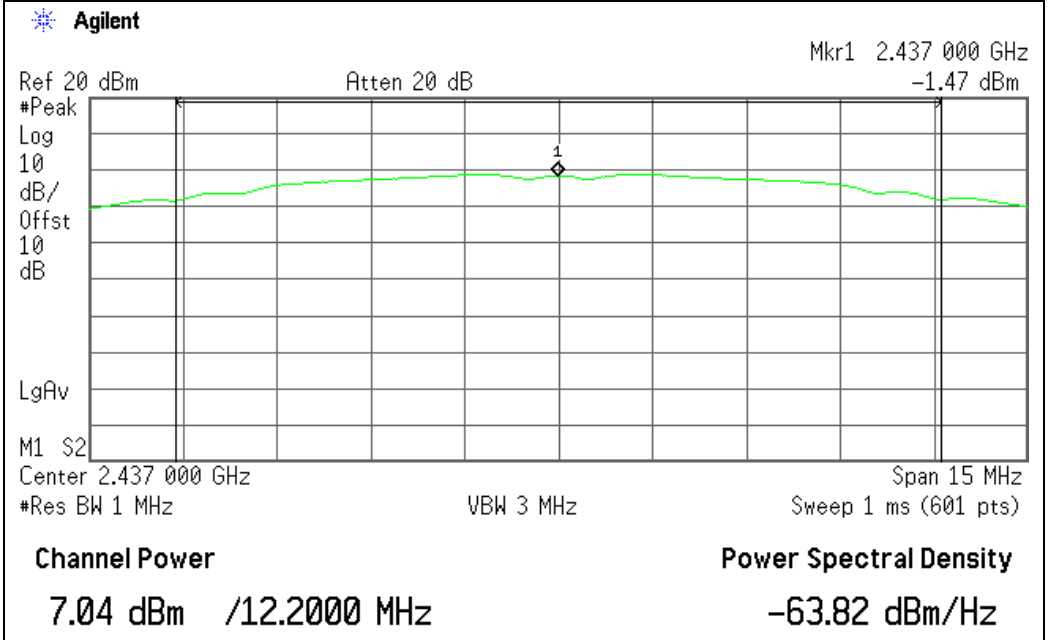
Channel Power

6.64 dBm /12.2000 MHz

Power Spectral Density

-64.22 dBm/Hz

Plot Name:	Output Peak Power @ Mid CH



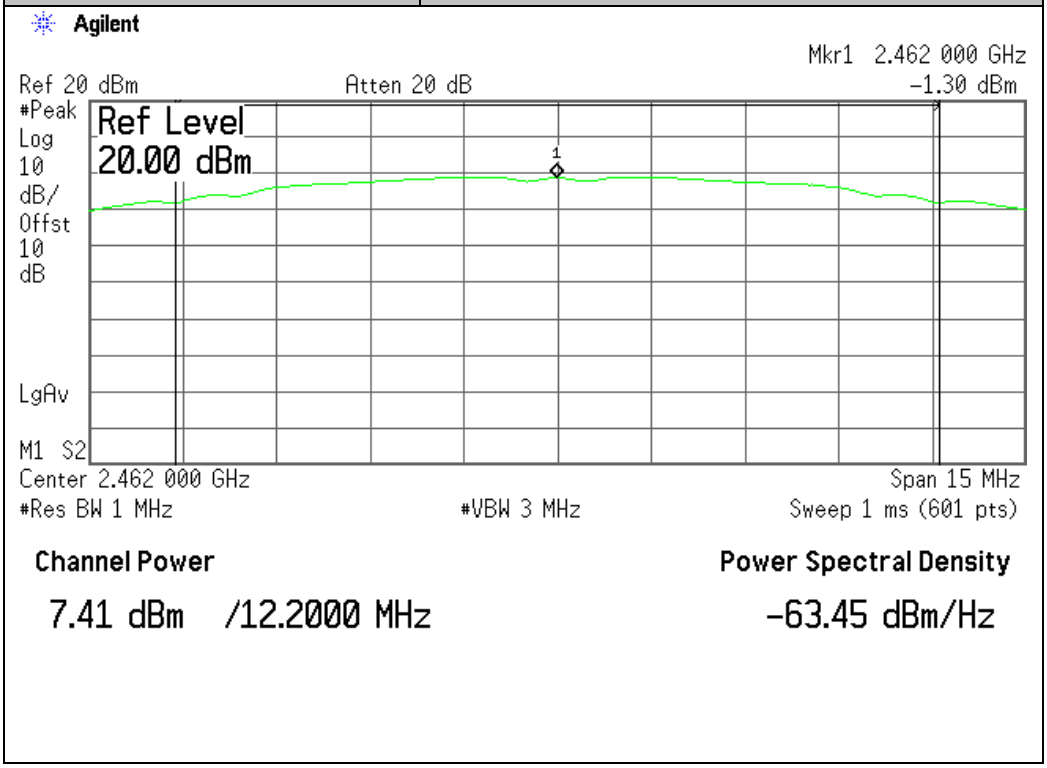
Channel Power

7.04 dBm /12.2000 MHz

Power Spectral Density

-63.82 dBm/Hz

Plot Name:	Output Peak Power @ High CH



7.3. MAXIMUM PERMISSIBLE EXPOSURE

LIMITS & RSS-102

§1.1310 The criteria listed in Table 1 shall be used to evaluate the environmental impact of human exposure to radio-frequency (RF) radiation as specified in §1.1307(b), except in the case of portable devices which shall be evaluated according to the provisions of §2.1093 of this chapter.

TABLE 1—LIMITS FOR MAXIMUM PERMISSIBLE EXPOSURE (MPE)

Frequency range (MHz)	Electric field strength (V/m)	Magnetic field strength (A/m)	Power density (mW/cm^2)	Averaging time (minutes)
(A) Limits for Occupational/Controlled Exposures				
0.3–3.0	614	1.63	*(100)	6
3.0–30	1842/f	4.89/f	*($900/f^2$)	6
30–300	61.4	0.163	1.0	6
300–1500			f/300	6
1500–100,000			5	6
(B) Limits for General Population/Uncontrolled Exposure				
0.3–1.34	614	1.63	*(100)	30
1.34–30	824/f	2.19/f	*($180/f^2$)	30

TABLE 1—LIMITS FOR MAXIMUM PERMISSIBLE EXPOSURE (MPE)—Continued

Frequency range (MHz)	Electric field strength (V/m)	Magnetic field strength (A/m)	Power density (mW/cm^2)	Averaging time (minutes)
30–300	27.5	0.073	0.2	30
300–1500			f/1500	30
1500–100,000			1.0	30

f = frequency in MHz
* = Plane-wave equivalent power density

NOTE 1 TO TABLE 1: Occupational/controlled limits apply in situations in which persons are exposed as a consequence of their employment provided those persons are fully aware of the potential for exposure and can exercise control over their exposure. Limits for occupational/controlled exposure also apply in situations when an individual is transient through a location where occupational/controlled limits apply provided he or she is made aware of the potential for exposure.

NOTE 2 TO TABLE 1: General population/uncontrolled exposures apply in situations in which the general public may be exposed, or in which persons that are exposed as a consequence of their employment may not be fully aware of the potential for exposure or can not exercise control over their exposure.

CALCULATIONS

Given

$E = \sqrt{(30 * P * G)} / d$

and

$S = E \wedge 2 / 3770$

where

E = Field Strength in Volts/meter
P = Power in Watts
G = Numeric antenna gain
d = Distance in meters
S = Power Density in milliwatts/square centimeter

Combining equations and rearranging the terms to express the distance as a function of the remaining variables yields:

$d = \sqrt{((30 * P * G) / (3770 * S))}$

Changing to units of Power to mW and Distance to cm, using: P (mW) = P (W) / 1000 and
d (cm) =100 * d (m)

yields

$d = 100 * \sqrt{((30 * (P / 1000) * G) / (3770 * S))}$

$d = 0.282 * \sqrt{(P * G / S)}$

where

d = distance in cm
P = Power in mW
G = Numeric antenna gain
S = Power Density in mW/cm^2

Substituting the logarithmic form of power and gain using: P (mW) = 10 ^ (P (dBm) / 10) and
G (numeric) = 10 ^ (G (dBi) / 10)

yields

$d = 0.282 * 10 \wedge ((P + G) / 20) / \sqrt{S}$ Equation (1)

$S = 0.0795 * 10 \wedge ((P + G)/10)/ d\wedge 2$ Equation (2)

where

d = MPE distance in cm
P = Power in dBm
G = Antenna Gain in dBi
S = Power Density Limit in mW/cm^2

Equation (1) and the measured peak power is used to calculate the MPE distance.
Equation (2) and the measured peak power is used to calculate the Power density.

LIMITS

From §1.1310 Table 1 (B),
for Public S = 1.0 mW/cm^2
for Professional, S = 5.0 mW/cm^2

RESULTS

No non-compliance noted:

For this EUT, Max. P (pk)= 7.41 dBm, Max G= 0.0 dBi, and d=20cm

Plug all three items into equation (2), and yields,

Power Density Limit (mW/cm^2)	Output Power (dBm)	Antenna Gain (dBi)	Power Density (mW/cm^2)
1.0/5.0	7.41	0.0	0.001

NOTE: For mobile or fixed location transmitters, the minimum separation distance is 20 cm, even if calculations indicate that the MPE distance would be less.

7.4. AVERAGE POWER

AVERAGE POWER LIMIT

None; for reporting purposes only.

TEST PROCEDURE

The transmitter output is connected to a power meter.

RESULTS

NA.

OUTPUT AVERAGE POWER

Channel BW (MHz)	Channel	Average Power (dBm)

7.5. PEAK POWER SPECTRAL DENSITY

LIMIT

§15.247 (e) & RSS-210 A8.2(2)
For direct sequence systems, the peak power spectral density conducted from the intentional radiator to the antenna shall not be greater than 8 dBm in any 3 kHz band during any time interval of continuous transmission.

TEST PROCEDURE ***per FCC KDB 558074D02***

Measurement Procedure for Maximum Power Spectral Density in the Fundamental Emission*	**Applicable to this EUT**
9.1 Measurement Procedure Option 1 for Peak PSD	☒**preferred**
9.2 Measurement Procedure Option 2 for Average PSD**	☐
9.3 Measurement Procedure Option 3 for Average PSD** (RMS Power Averaging Detector with single slow sweep)	☐
9.4 Measurement Procedure Alternative 1 for Average PSD (Adding 10log (1/DT))	☐

* same method as used to determine fundamental power.
** EUT shall be configured to transmit continuously (min. 98% duty cycle at full power) or use video trigging/signal gating. The spectrum analyzer shall be set for bin-to-bin spacing ≤RBW/2.

RESULTS

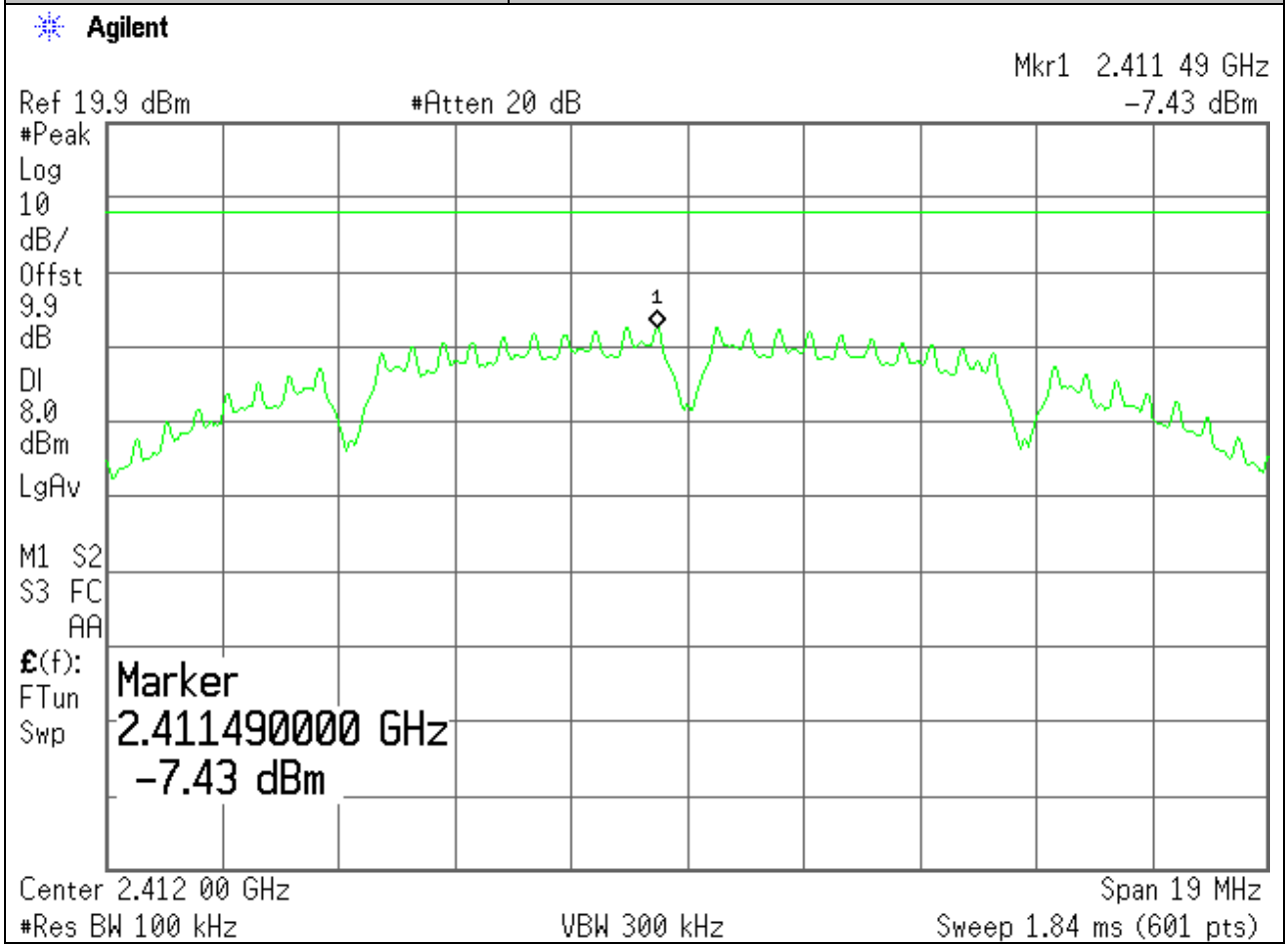
No non-compliance noted:

Summary of PPSD Testing Data:

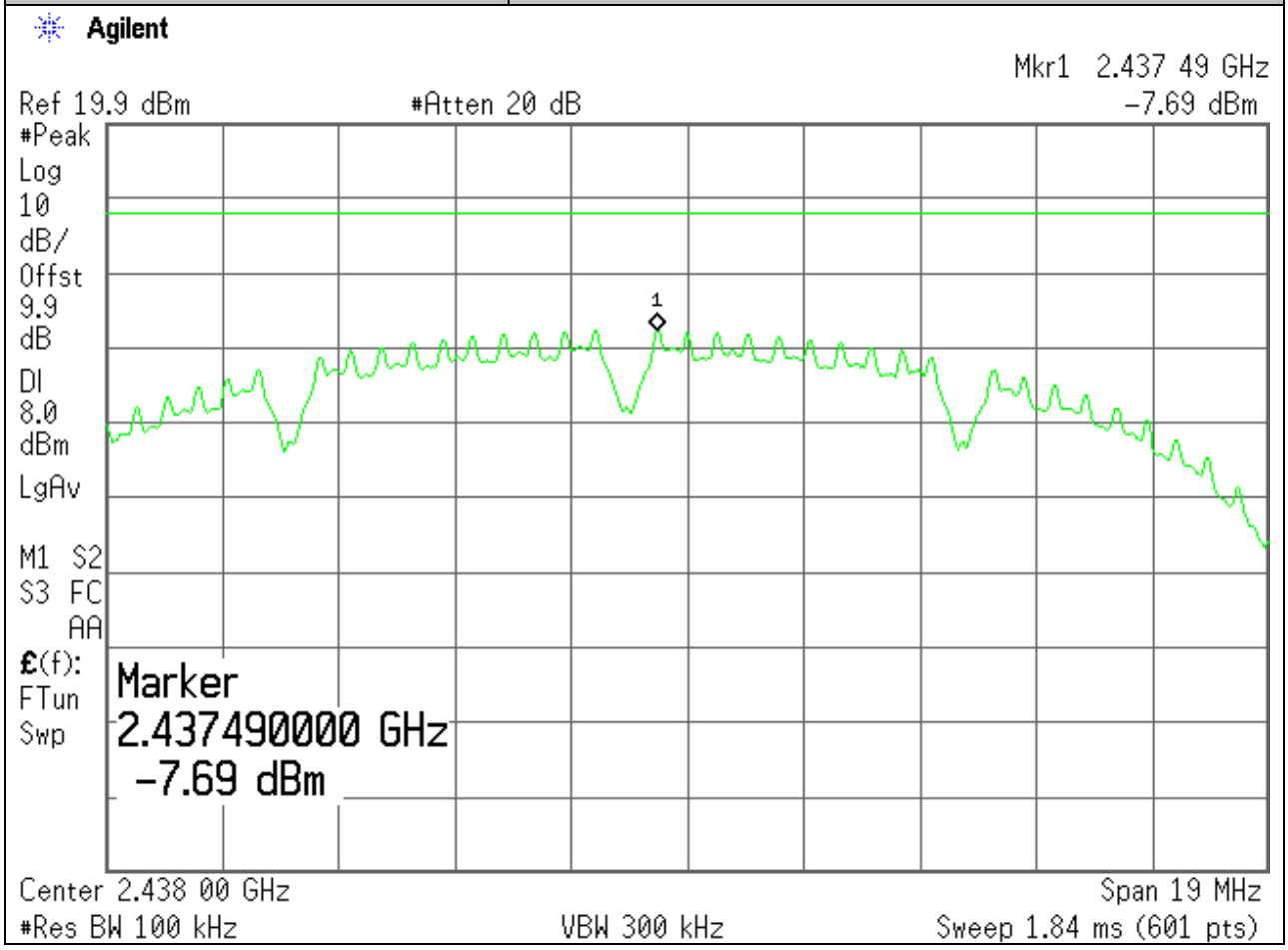
Channel	PPSD (dBm/100KHz BW)	Equivalent PPSD (dBm/3KHz BW)	Limit (dBm/3KHz BW)
Low	-7.43	-19.93	8
Middle	-7.69	-19.62	8
High	-8.25	-19.34	8

PEAK POWER SPECTRAL DENSITY

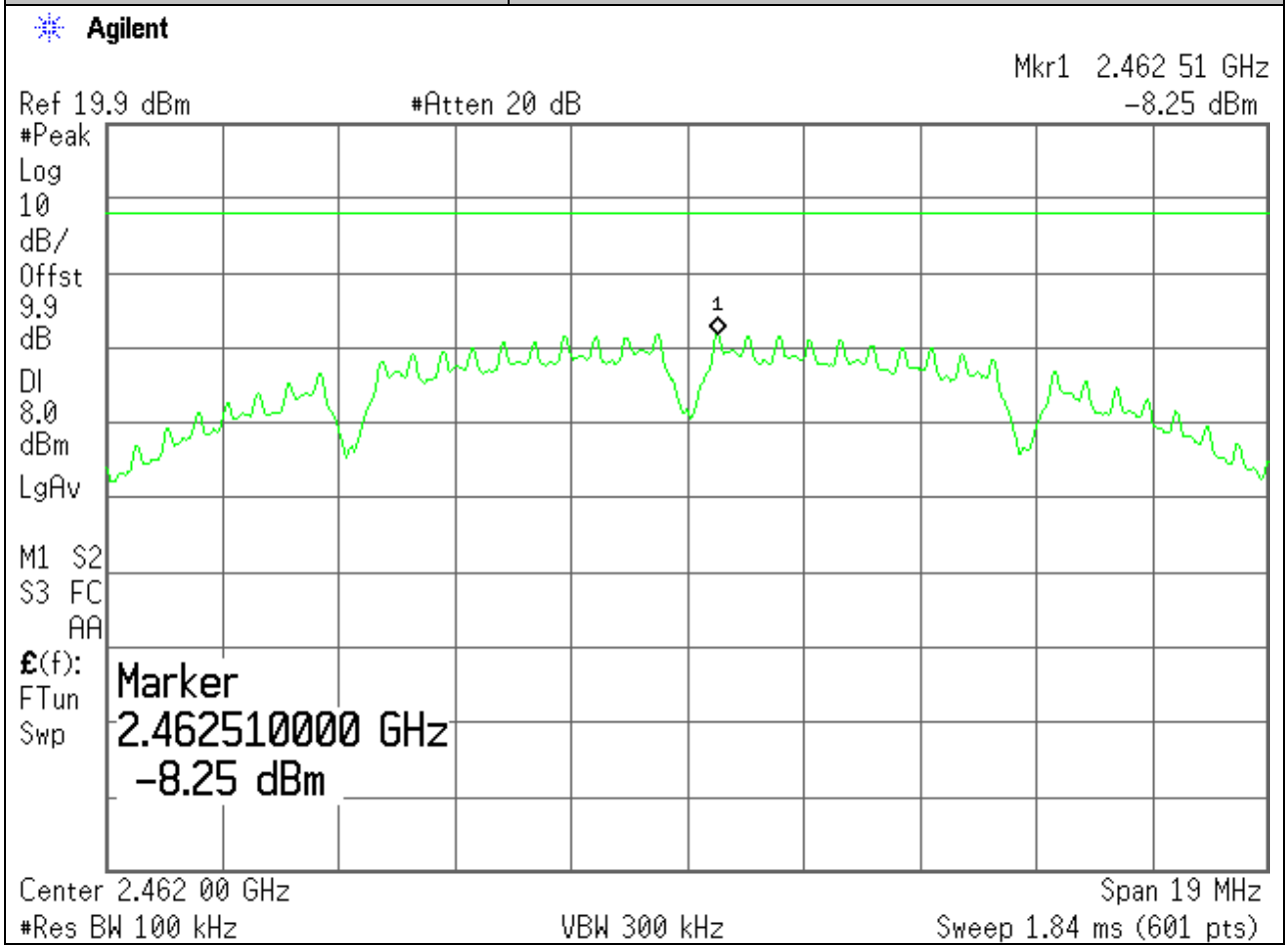
Plot Name:	PPSD (dBm/Hz BW) @ Low CH



Plot Name:	PPSD (dBm/Hz BW) @ Mid CH



Plot Name:	PPSD (dBm/Hz BW) @ High CH



7.6. CONDUCTED SPURIOUS EMISSIONS

LIMITS

§15.247 (d) & RSS- 210 A8.5
In any 100 kHz bandwidth outside the frequency band in which the spread spectrum or digitally modulated intentional radiator is operating, the radio frequency power that is produced by the intentional radiator shall be at least 20 dB below that in the 100 kHz bandwidth within the band that contains the highest level of the desired power, based on either an RF conducted or a radiated measurement, provided the transmitter demonstrates compliance with the peak conducted power limits. If the transmitter complies with the conducted power limits based on the use of RMS averaging over a time interval, as permitted under paragraph (b)(3) of this section, the attenuation required under this paragraph shall be 30 dB instead of 20 dB. Attenuation below the general limits specified in §15.209(a) is not required. 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 in §15.209(a) (see §15.205(c)).

TEST PROCEDURE ***per FCC KDB 558074D02***

(Report the three highest emissions relative to the limit)

Conducted Measurement Procedure for Maximum Unwanted Emissions into Non-Restricted Frequency Bands	**Applicable to this EUT**	
	Peak Power limit: (-20dB)	**Average Power Limit: (-30dB)**
10.1.1 Measurement Procedure-Reference Level (using Sec.9.1 peak PSD procedure with RBW=100KHz, VBW=300KHz)	☒	
10.1.2 Measurement Procedure-Unwanted Emissions*	☒ **preferred**	☐

* Different attenuation limit shall be used based on the measurement method of fundamental emission power and PSD.

Antenna-Port Conducted Measurement Procedure for Maximum Unwanted Emissions into Restricted Frequency Bands**	**Applicable to this EUT**
10.2.3.1 CISPR Quasi-Peak Measurement (CISPR 16)	☐
10.2.3.2 Peak Power Measurement (Sec.8.1.1 procedure with RBW=1MHz)	☐
10.2.3.3 Average Power Measurement (Sec.8.2 procedure with RBW=1MHz)	☐
10.2.4 Antenna-Port Conducted Measurement Procedure	☐
10.2.5.1 Band-Edge Marker-Delta Method (KDB913591)	☐
10.2.5.2 Band-Edge Integrated Power Measurement	☐

** To use this conducted testing method, the followings shall be taken as consideration:

1. Proper RBW and detector, per 15.35 a/b, shall be chosen in different frequency ranges;
2. **Maximum transmitter antenna gain (no less than 2dBi), G, shall be added to the measured power level to determine the EIRP;**
3. **Appropriate factor, A, shall be added to model worst case ground reflections: 6.0dB (f≤30MHz) and 4.7dB (f≤30 to 1000MHz)**
4. **Electric field strength can be obtained from the equation: E= EIRP-20log(d)+104.8+G (or 2.0) +A; Then compare to applicable limit;**
5. Unwanted emissions from EUT cabinet or casing shall be measured via radiated emission test method per C63.10 (in this case, the antenna port may be terminated properly).
6. Absolute peak power limit of -21.2dBm within the unwanted emission bandwidth shall be used for meeting 15.35(b) requirement;
7. Per 15.35(c), for pulse operation, Duty Cycle factor reduction can be applied for unwanted emissions that have the same pulse characteristics as does the fundamental emissions (such as harmonics) pulse operation

*** EUT shall be configured to transmit continuously (min. 98% duty cycle at full power). The spectrum analyzer shall be set for bin-to-bin spacing ≤RBW/2.

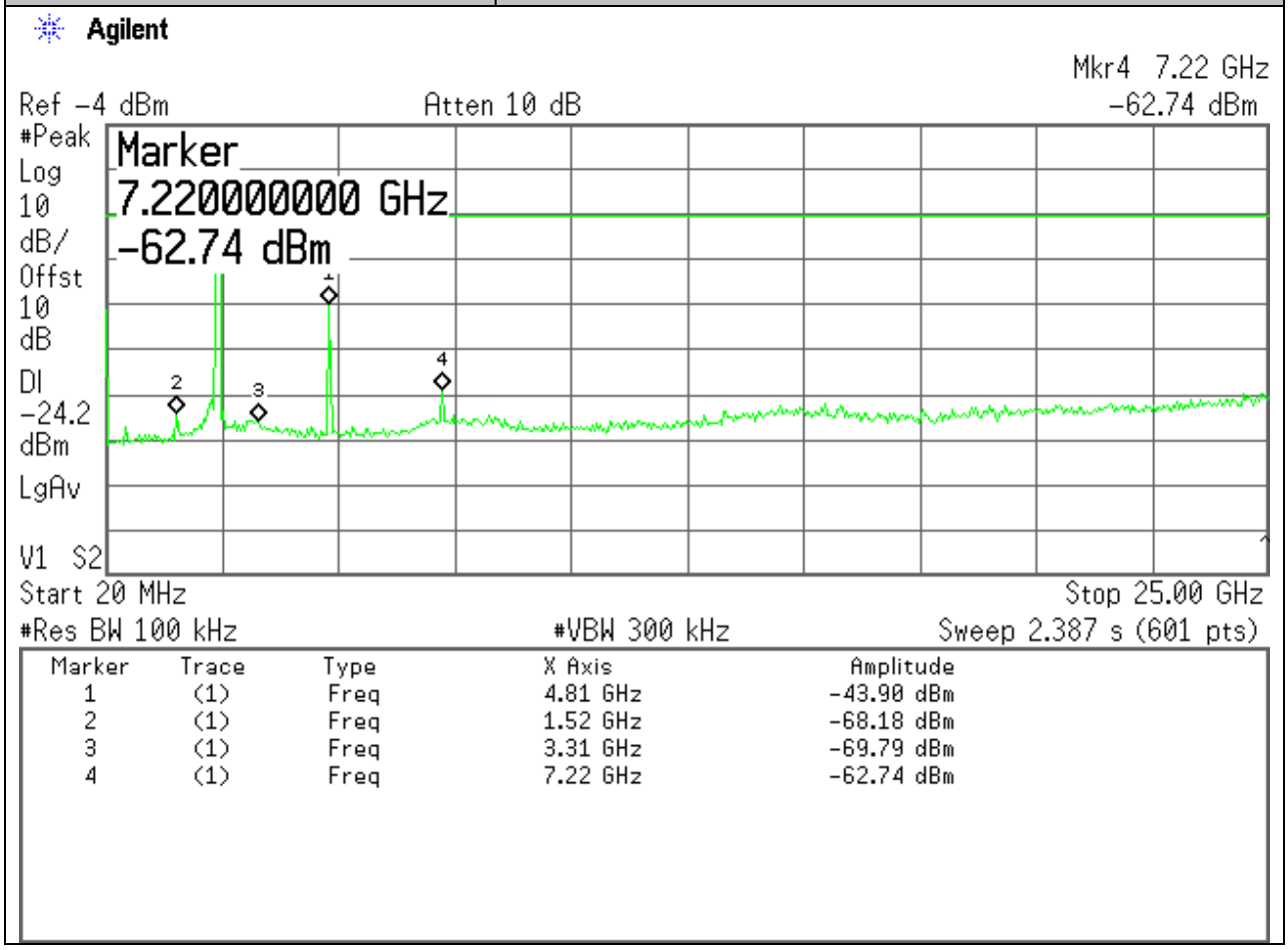
RESULTS

No non-compliance noted.

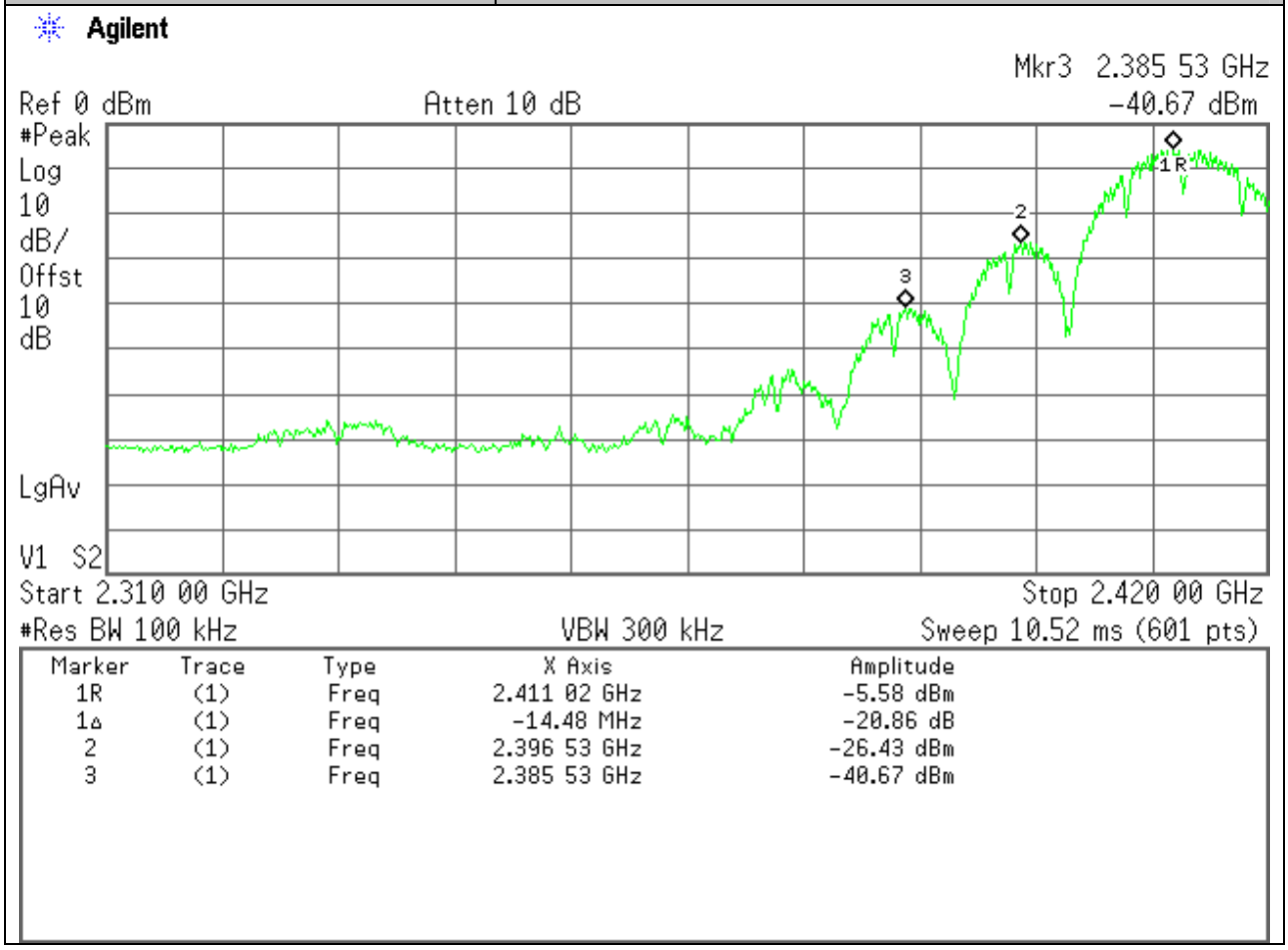
. **CONDUCTED SPURIOUS EMISSIONS (in non-restricted frequency Bands)**

Based on PSD measurement result, set reference level as -4dBm.

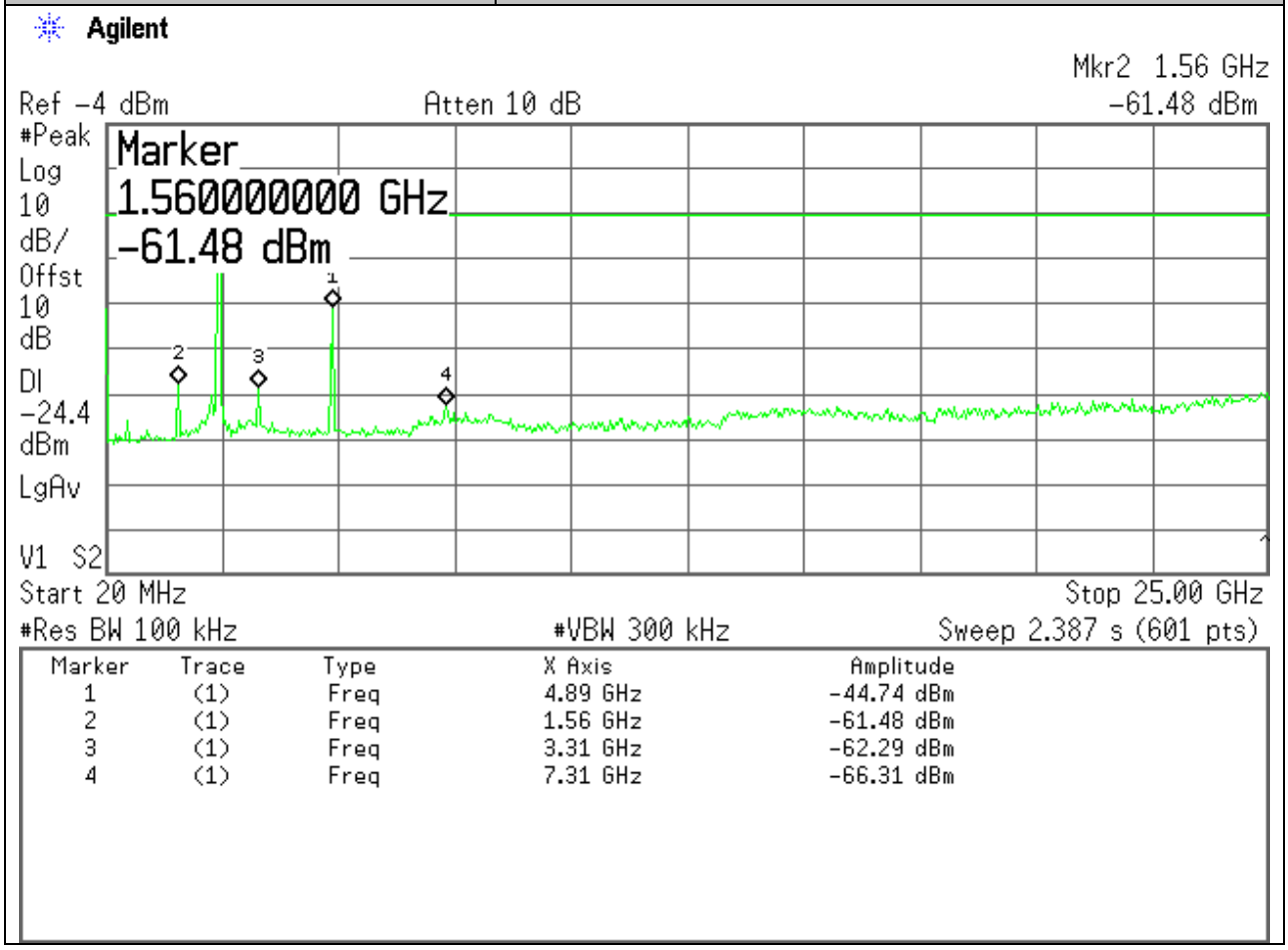
Plot Name:	Conducted Spurious Emissions @ Low CH



Plot Name:	Conducted Spurious Emissions @ Low Band Edge Low CH

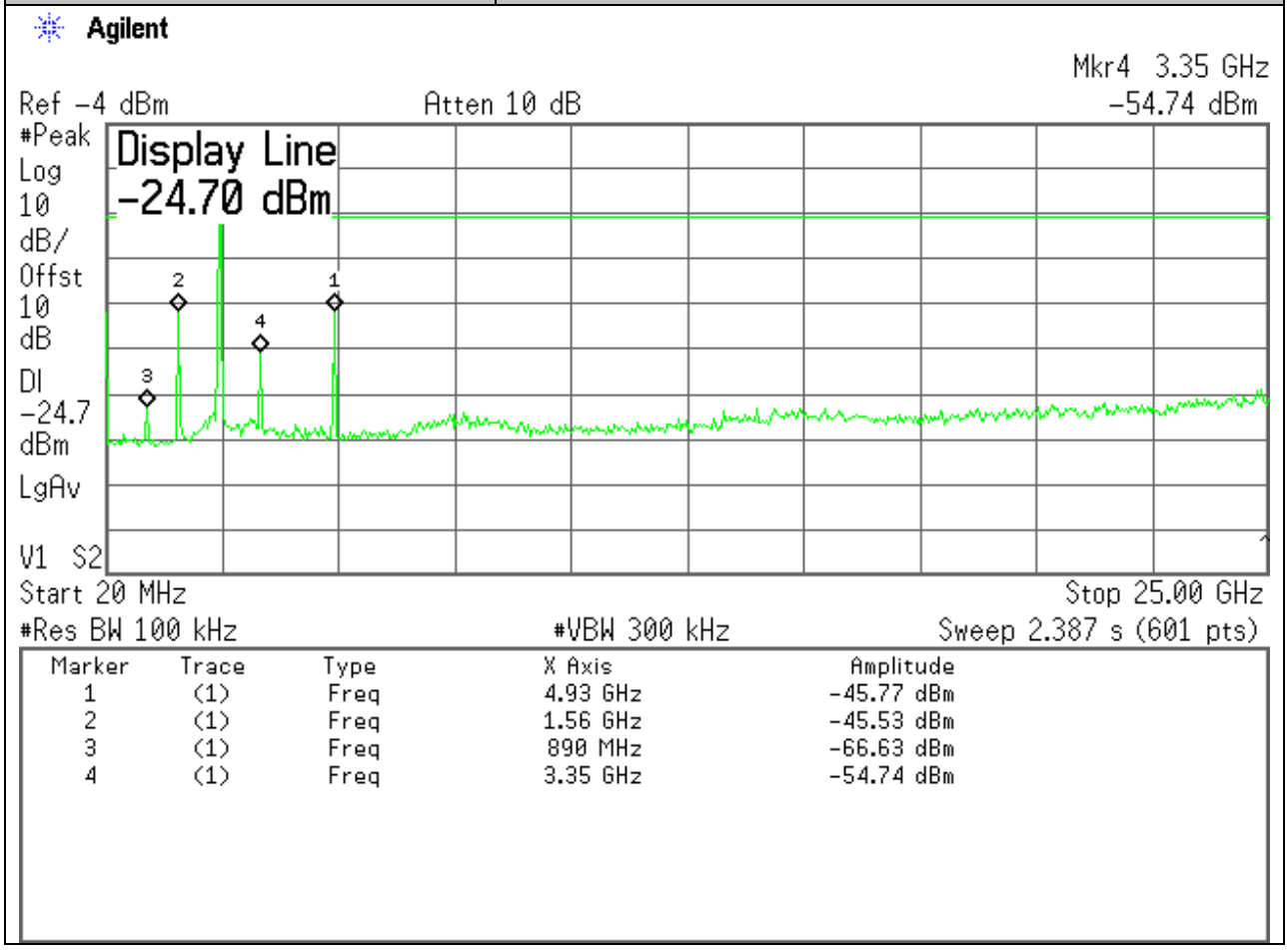


Plot Name:	Conducted Spurious Emissions @ Mid CH

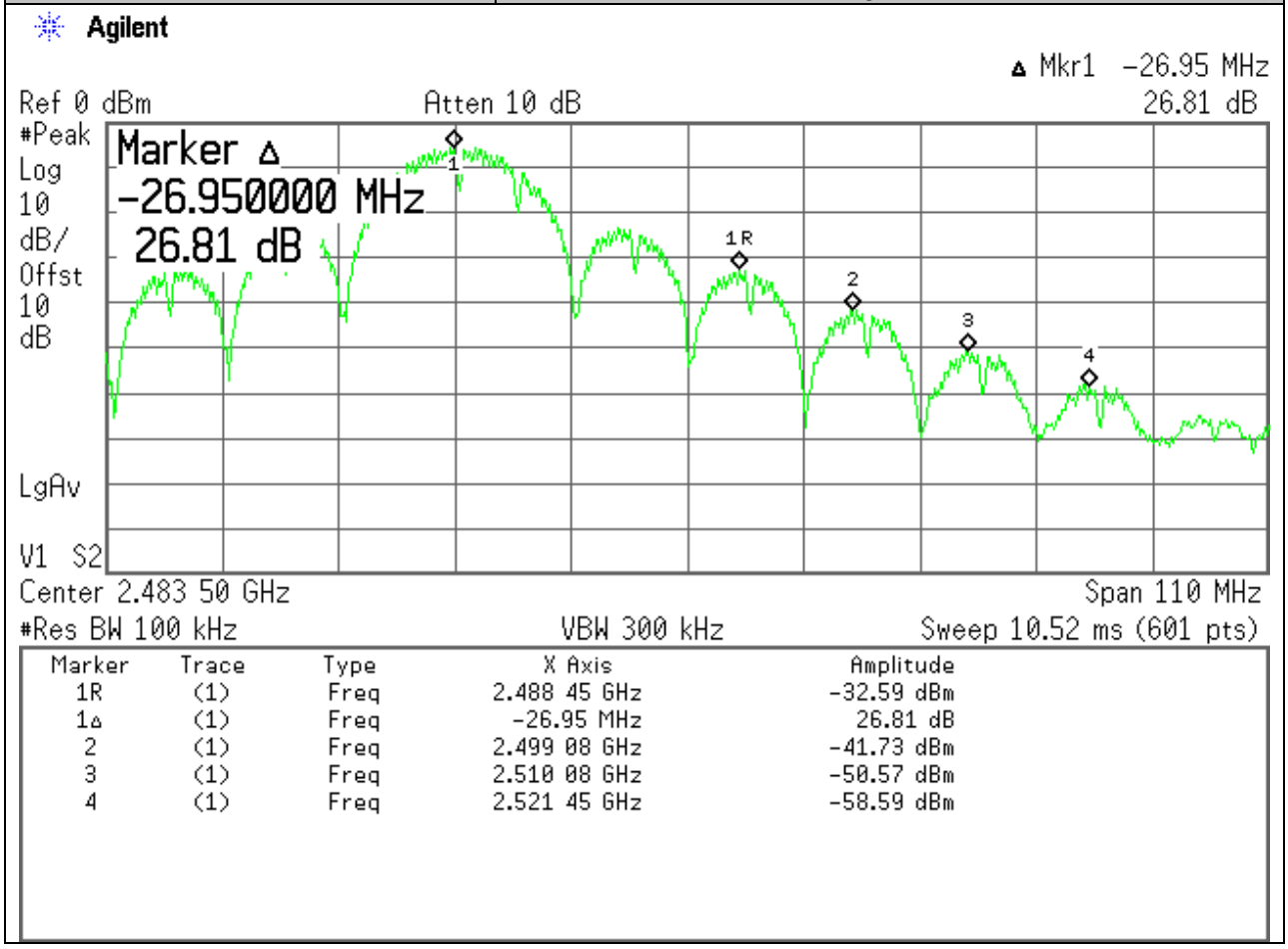


Marker	Trace	Type	X Axis	Amplitude
1	(1)	Freq	4.89 GHz	-44.74 dBm
2	(1)	Freq	1.56 GHz	-61.48 dBm
3	(1)	Freq	3.31 GHz	-62.29 dBm
4	(1)	Freq	7.31 GHz	-66.31 dBm

Plot Name:	Conducted Spurious Emissions @ High CH



Plot Name:	Conducted Spurious Emissions @ High Band Edge High CH



Marker	Trace	Type	X Axis	Amplitude
1R	(1)	Freq	2.488 45 GHz	-32.59 dBm
1Δ	(1)	Freq	-26.95 MHz	26.81 dB
2	(1)	Freq	2.499 08 GHz	-41.73 dBm
3	(1)	Freq	2.510 08 GHz	-50.57 dBm
4	(1)	Freq	2.521 45 GHz	-58.59 dBm

7.7. **RADIATED EMISSIONS** into Restricted Frequency Bands

7.7.1. TRANSMITTER RADIATED SPURIOUS EMISSIONS

LIMITS

§15.205 (a) RSS-102 Except as shown in paragraph (d) of this section, only spurious emissions are permitted in any of the frequency bands listed below:

MHz	MHz	MHz	GHz
0.090 - 0.110	16.42 - 16.423	399.9 - 410	4.5 - 5.15
[1]0.495 - 0.505	16.69475 - 16.69525	608 - 614	5.35 - 5.46
2.1735 - 2.1905	16.80425 - 16.80475	960 - 1240	7.25 - 7.75
4.125 - 4.128	25.5 - 25.67	1300 - 1427	8.025 - 8.5
4.17725 - 4.17775	37.5 - 38.25	1435 - 1626.5	9.0 - 9.2
4.20725 - 4.20775	73 - 74.6	1645.5 - 1646.5	9.3 - 9.5
6.215 - 6.218	74.8 - 75.2	1660 - 1710	10.6 - 12.7
6.26775 - 6.26825	108 - 121.94	1718.8 - 1722.2	13.25 - 13.4
6.31175 - 6.31225	123 - 138	2200 - 2300	14.47 - 14.5
8.291 - 8.294	149.9 - 150.05	2310 - 2390	15.35 - 16.2
8.362 - 8.366	156.52475 - 156.52525	2483.5 - 2500	17.7 - 21.4
8.37625 - 8.38675	156.7 - 156.9	2655 - 2900	22.01 - 23.12
8.41425 - 8.41475	162.0125 - 167.17	3260 - 3267	23.6 - 24.0
12.29 - 12.293	167.72 - 173.2	3332 - 3339	31.2 - 31.8
12.51975 - 12.52025	240 - 285	3345.8 - 3358	36.43 - 36.5
12.57675 - 12.57725	322 - 335.4	3600 - 4400	([2])
13.36 - 13.41			

[1] Until February 1, 1999, this restricted band shall be 0.490-0.510 MHz.
[2] Above 38.6

§15.205 (b) Except as provided in paragraphs (d) and (e), the field strength of emissions appearing within these frequency bands shall not exceed the limits shown in Section 15.209. At frequencies equal to or less than 1000 MHz, compliance with the limits in Section 15.209 shall be demonstrated using measurement instrumentation employing a CISPR quasi-peak detector. Above 1000 MHz, compliance with the emission limits in Section 15.209 shall be demonstrated based on the average value of the measured emissions. The provisions in Section 15.35 apply to these measurements.

§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 (MHz)	Field Strength (microvolts/meter)	Measurement Distance (meters)
30 - 88	100 **	3
88 - 216	150 **	3
216 - 960	200 **	3
Above 960	500	3

§15.209 (b) In the emission table above, the tighter limit applies at the band edges.

TEST PROCEDURE

The EUT is placed on a non-conducting table 80 cm above the ground plane. The antenna to EUT distance is 3 meters. The EUT is configured in accordance with ANSI C63.4. The EUT is set to transmit in a continuous mode. Established procedures in C63.10 for performing radiated measurements shall be used. For cabinet emission measurements, the EUT transmit antenna may be replaced with a termination matching the nominal impedance of the antenna. For portable devices, the EUT was tested in three orthogonal planes.

For measurements below 1 GHz the resolution bandwidth is set to 100 kHz for peak detection measurements or 120 kHz for quasi-peak detection measurements. Peak detection is used unless otherwise noted as quasi-peak. For measurements above 1 GHz the resolution bandwidth is set to 1 MHz, and then the video bandwidth is set to 1 MHz for peak measurements and 10 Hz for average measurements.

The radio spectrum was investigated from the lowest frequency generated within the device (without going below 9 kHz) up to the 10^{th} harmonic of the rated transmitted emission. The emissions are investigated with the transmitter set to the lowest, middle, and highest channels.

The emissions are investigated with the transmitter set to the lowest, middle, and highest channels.
The frequency range of interest is monitored at a fixed antenna height and EUT azimuth. The EUT is rotated through 360 degrees to maximize emissions received. The antenna is scanned from 1 to 4 meters above the ground plane to further maximize the emission. Measurements are made with the antenna polarized in both the vertical and the horizontal positions.

RESULTS

No non-compliance noted:

7.7.2. TRANSMITTER RADIATED EMISSIONS DATA
(HARMONICS & SPURIOUS falling in the restricted bands listed in Sec.15.205)

A. Data for RF Module with 0dBi surface mount antenna

A1. EUT at X Orientation

Low Channel Harmonics/Spurious

Freq. (MHz)	Worst H/V	Dist. (m)	DT Corr (dB)	Peak@3m (dBuV/m)	Cal Avg @3m (dBuV/m)	PK Lim (dBuV/m)	QP /Avg. Lim (dBuV/m)	PK Mar (dBuV/m)	QP /Avg.Mar. (dBuV/m)
4824	H	3	-28	53.8	25.8	74	54	-20.2	-28.2
7236	H	3	-28	50.1	22.1	74	54	-23.9	-31.9
4824	V	3	-28	54.9	26.9	74	54	-19.1	-27.1
7236	V	3	-28	51.3	23.3	74	54	-22.7	-30.7

Middle Channel Harmonics/Spurious

Freq. (MHz)	Worst H/V	Dist. (m)	DT Corr (dB)	Peak@3m (dBuV/m)	Cal Avg @3m (dBuV/m)	PK Lim (dBuV/m)	QP /Avg. Lim (dBuV/m)	PK Mar (dBuV/m)	QP /Avg.Mar. (dBuV/m)
4874	H	3	-28	58.2	30.2	74	54	-15.8	-23.8
7311	H	3	-28	51.5	23.5	74	54	-22.5	-30.5
4874	V	3	-28	55.7	27.7	74	54	-18.3	-26.3
7311	v	3	-28	52.3	24.3	74	54	-21.7	-29.7

High Channel Harmonics/Spurious

Freq. (MHz)	Worst H/V	Dist. (m)	DT Corr (dB)	Peak@3m (dBuV/m)	Cal Avg @3m (dBuV/m)	PK Lim (dBuV/m)	QP /Avg. Lim (dBuV/m)	PK Mar (dBuV/m)	QP /Avg.Mar. (dBuV/m)
4924	H	3	-28	59.5	31.5	74	54	-14.5	-22.5
7386	H	3	-28	51.4	23.4	74	54	-22.6	-30.6
4924	V	3	-28	59.4	31.4	74	54	-14.6	-22.6
7386	v	3	-28	52.8	24.8	74	54	-21.2	-29.2

The system was configured for testing in a typical fashion (as a customer would normally use it. No other harmonics or spurious emissions were detected in the rest band above system noise floor.

THE “DUTY CYCLE CORRECTION FACTOR” FOR SPURIOUS RADIATED EMISSIONS IS; 20 log * (4 ms / 100 ms) = -28 dB, WHICH WAS USED TO CORRECT THE AVERAGE RADIATED EMISSION READINGS.

A2. EUT at Y Orientation

Low Channel Harmonics/Spurious

Freq. (MHz)	Worst H/V	Dist. (m)	DT Corr (dB)	Peak@3m (dBuV/m)	Cal Avg @3m (dBuV/m)	PK Lim (dBuV/m)	QP /Avg. Lim (dBuV/m)	PK Mar (dBuV/m)	QP /Avg.Mar. (dBuV/m)
4824	H	3	-28	58.0	30	74	54	-16.0	-24.0
7236	H	3	-28	50.5	22.5	74	54	-23.5	-31.5
4824	V	3	-28	53.7	25.7	74	54	-20.3	-28.3
7236	V	3	-28	51.2	23.2	74	54	-22.8	-30.8

Middle Channel Harmonics/Spurious

Freq. (MHz)	Worst H/V	Dist. (m)	DT Corr (dB)	Peak@3m (dBuV/m)	Cal Avg @3m (dBuV/m)	PK Lim (dBuV/m)	QP /Avg. Lim (dBuV/m)	PK Mar (dBuV/m)	QP /Avg.Mar. (dBuV/m)
4874	H	3	-28	59.4	31.4	74	54	-14.6	-22.6
7311	H	3	-28	50.9	22.9	74	54	-23.1	-31.1
4874	V	3	-28	57.6	29.6	74	54	-16.4	-24.4
7311	v	3	-28	49.9	21.9	74	54	-24.1	-32.1

High Channel Harmonics/Spurious

Freq. (MHz)	Worst H/V	Dist. (m)	DT Corr (dB)	Peak@3m (dBuV/m)	Cal Avg @3m (dBuV/m)	PK Lim (dBuV/m)	QP /Avg. Lim (dBuV/m)	PK Mar (dBuV/m)	QP /Avg.Mar. (dBuV/m)
4924	H	3	-28	59.8	31.8	74	54	-14.2	-22.2
7386	H	3	-28	51.1	23.1	74	54	-22.9	-30.9
4924	V	3	-28	59.7	31.7	74	54	-14.3	-22.3
7386	v	3	-28	52.8	24.8	74	54	-21.2	-29.2

The system was configured for testing in a typical fashion (as a customer would normally use it. No other harmonics or spurious emissions were detected in the rest band above system noise floor.

THE “DUTY CYCLE CORRECTION FACTOR” FOR SPURIOUS RADIATED EMISSIONS IS; 20 log * (4 ms / 100 ms) = -28 dB, WHICH WAS USED TO CORRECT THE AVERAGE RADIATED EMISSION READINGS.

A3. EUT at Z Orientation

Low Channel Harmonics/Spurious

Freq. (MHz)	Worst H/V	Dist. (m)	DT Corr (dB)	Peak@3m (dBuV/m)	Cal Avg @3m (dBuV/m)	PK Lim (dBuV/m)	QP /Avg. Lim (dBuV/m)	PK Mar (dBuV/m)	QP /Avg.Mar. (dBuV/m)
4824	H	3	-28	55.5	27.5	74	54	-18.5	-26.5
7236	H	3	-28	49.7	21.7	74	54	-24.3	-32.3
4824	V	3	-28	55.1	27.1	74	54	-18.9	-26.9
7236	V	3	-28	50.5	22.5	74	54	-23.5	-31.5

Middle Channel Harmonics/Spurious

Freq. (MHz)	Worst H/V	Dist. (m)	DT Corr (dB)	Peak@3m (dBuV/m)	Cal Avg @3m (dBuV/m)	PK Lim (dBuV/m)	QP /Avg. Lim (dBuV/m)	PK Mar (dBuV/m)	QP /Avg.Mar. (dBuV/m)
4874	H	3	-28	57.4	29.4	74	54	-16.6	-24.6
7311	H	3	-28	51.2	23.2	74	54	-22.8	-30.8
4874	V	3	-28	57.8	29.8	74	54	-16.2	-24.2
7311	v	3	-28	50.9	22.9	74	54	-23.1	-31.1

High Channel Harmonics/Spurious

Freq. (MHz)	Worst H/V	Dist. (m)	DT Corr (dB)	Peak@3m (dBuV/m)	Cal Avg @3m (dBuV/m)	PK Lim (dBuV/m)	QP /Avg. Lim (dBuV/m)	PK Mar (dBuV/m)	QP /Avg.Mar. (dBuV/m)
4924	H	3	-28	57.4	29.4	74	54	-16.6	-24.6
7386	H	3	-28	51.2	23.2	74	54	-22.8	-30.8
4924	V	3	-28	57.8	29.8	74	54	-16.2	-24.2
7386	v	3	-28	50.9	22.9	74	54	-23.1	-31.1

The system was configured for testing in a typical fashion (as a customer would normally use it. No other harmonics or spurious emissions were detected in the rest band above system noise floor.

THE “DUTY CYCLE CORRECTION FACTOR” FOR SPURIOUS RADIATED EMISSIONS IS; 20 log * (4 ms / 100 ms) = -28 dB, WHICH WAS USED TO CORRECT THE AVERAGE RADIATED EMISSION READINGS.

B. Data for RF Module in Hosting Devices

B1. RF module in Hosting Device I: VW

Low Channel Harmonics/Spurious

Freq. (MHz)	Worst H/V	Dist. (m)	DT Corr (dB)	Peak@3m (dBuV/m)	Cal Avg @3m (dBuV/m)	PK Lim (dBuV/m)	QP /Avg. Lim (dBuV/m)	PK Mar (dBuV/m)	QP /Avg.Mar. (dBuV/m)
4824	H	3	-28	53.5	25.5	74	54	-20.5	-28.5
7236	H	3	-28	46.0	18.0	74	54	-28.0	-36.0
4824	V	3	-28	49.2	21.2	74	54	-24.8	-32.8
7236	V	3	-28	46.7	18.7	74	54	-27.3	-35.3

Middle Channel Harmonics/Spurious

Freq. (MHz)	Worst H/V	Dist. (m)	DT Corr (dB)	Peak@3m (dBuV/m)	Cal Avg @3m (dBuV/m)	PK Lim (dBuV/m)	QP /Avg. Lim (dBuV/m)	PK Mar (dBuV/m)	QP /Avg.Mar. (dBuV/m)
4874	H	3	-28	58.9	30.9	74	54	-15.1	-23.1
7311	H	3	-28	47.4	19.4	74	54	-26.6	-34.6
4874	V	3	-28	54.1	26.1	74	54	-19.9	-27.9
7311	v	3	-28	46.4	18.4	74	54	-27.6	-35.6

High Channel Harmonics/Spurious

Freq. (MHz)	Worst H/V	Dist. (m)	DT Corr (dB)	Peak@3m (dBuV/m)	Cal Avg @3m (dBuV/m)	PK Lim (dBuV/m)	QP /Avg. Lim (dBuV/m)	PK Mar (dBuV/m)	QP /Avg.Mar. (dBuV/m)
4924	H	3	-28	58.9	30.9	74	54	-13.5	-23.1
7386	H	3	-28	47.4	19.4	74	54	-25.9	-34.6
4924	V	3	-28	54.1	26.1	74	54	-17.3	-27.9
7386	v	3	-28	46.4	18.4	74	54	-24.2	-35.6

The system was configured for testing in a typical fashion (as a customer would normally use it. No other harmonics or spurious emissions were detected in the rest band above system noise floor.

THE "DUTY CYCLE CORRECTION FACTOR" FOR SPURIOUS RADIATED EMISSIONS IS; 20 log * (4 ms / 100 ms) = -28 dB, WHICH WAS USED TO CORRECT THE AVERAGE RADIATED EMISSION READINGS.

B2. RF module in Hosting Device II: Monitor

Low Channel Harmonics/Spurious

Freq. (MHz)	Worst H/V	Dist. (m)	DT Corr (dB)	Peak@3m (dBuV/m)	Cal Avg @3m (dBuV/m)	PK Lim (dBuV/m)	QP /Avg. Lim (dBuV/m)	PK Mar (dBuV/m)	QP /Avg.Mar. (dBuV/m)
4824	H	3	-28	52.8	24.8	74	54	-21.2	-29.2
7236	H	3	-28	45.3	17.3	74	54	-28.7	-36.7
4824	V	3	-28	48.5	20.5	74	54	-25.5	-33.5
7236	V	3	-28	46	18.0	74	54	-28.0	-36.0

Middle Channel Harmonics/Spurious

Freq. (MHz)	Worst H/V	Dist. (m)	DT Corr (dB)	Peak@3m (dBuV/m)	Cal Avg @3m (dBuV/m)	PK Lim (dBuV/m)	QP /Avg. Lim (dBuV/m)	PK Mar (dBuV/m)	QP /Avg.Mar. (dBuV/m)
4874	H	3	-28	56.7	28.7	74	54	-17.3	-25.3
7311	H	3	-28	45.2	17.2	74	54	-28.8	-36.8
4874	V	3	-28	51.9	23.9	74	54	-22.1	-30.1
7311	v	3	-28	44.2	16.2	74	54	-29.8	-37.8

High Channel Harmonics/Spurious

Freq. (MHz)	Worst H/V	Dist. (m)	DT Corr (dB)	Peak@3m (dBuV/m)	Cal Avg @3m (dBuV/m)	PK Lim (dBuV/m)	QP /Avg. Lim (dBuV/m)	PK Mar (dBuV/m)	QP /Avg.Mar. (dBuV/m)
4924	H	3	-28	58.5	30.5	74	54	-15.5	-23.5
7386	H	3	-28	46.1	18.1	74	54	-27.9	-35.9
4924	V	3	-28	54.7	26.7	74	54	-19.3	-27.3
7386	v	3	-28	47.8	19.8	74	54	-26.2	-34.2

The system was configured for testing in a typical fashion (as a customer would normally use it. No other harmonics or spurious emissions were detected in the rest band above system noise floor.

THE “DUTY CYCLE CORRECTION FACTOR” FOR SPURIOUS RADIATED EMISSIONS IS; 20 log * (4 ms / 100 ms) = -28 dB, WHICH WAS USED TO CORRECT THE AVERAGE RADIATED EMISSION READINGS.

C. Band Edge Data for EUT

In addition, the band-edge requirements are also verified.

Testing procedure per KDB 558074D02:

The measurement of unwanted emissions at the edge of the authorized frequency bands can be complicated by the capture of RF energy from the fundamental emission within the RBW passband. The following techniques are permitted for use in performing a measurement of the unwanted emission level at the band edges.

10.2.5.1 Marker-Delta Method

The marker-delta method, as described in KDB 913591 and in C63.10, can be used to perform measurements of the unwanted emissions level at the band-edges.

10.2.5.2 Integrated Power Measurement

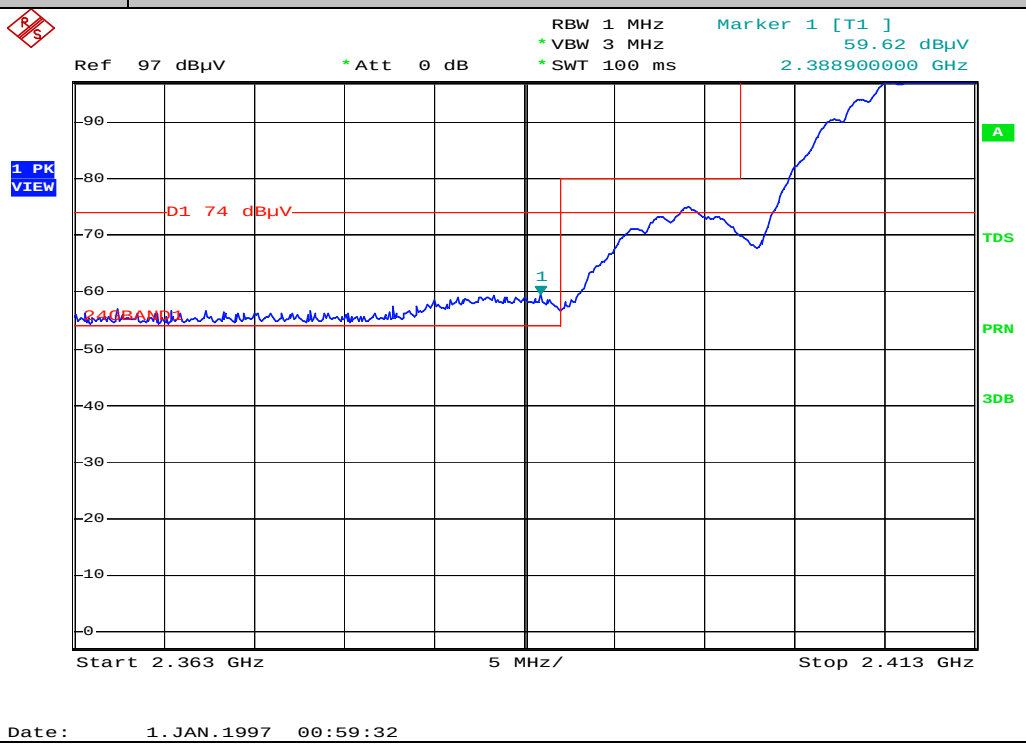
A narrower resolution bandwidth can be used at the band edge to improve the measurement accuracy provided that the measurement is subsequently integrated to the relevant bandwidth specification (e.g., 100 kHz within non-restricted bands and 1 MHz within restricted frequency bands).

Results:

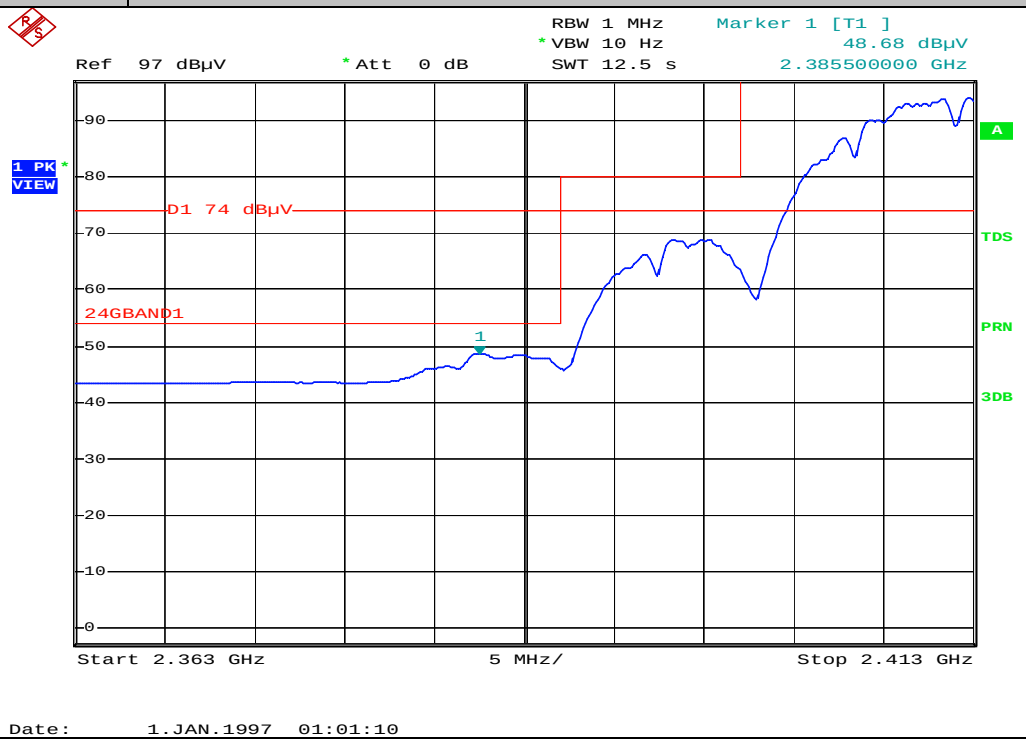
The testing results for worst case based on pretesting results are shown as following and comply with the band-edge requirements for 2400-2483.5MHz DTS per FCC Part 15.247. EUT antenna with max gain was used for this testing.

- H=Measurement antenna horizontal position
- V= Measurement antenna vertical position
- Using conventional manner for measuring the radiated emissions that are removed by more than two measurement bandwidths from band-edge, such as the emissions in the restricted band 2310-2390MHz & 2483.5-2500MHz, etc.
- Using conventional manner or if needed, using “delta” measurement technique for measuring the radiated emissions that are up to two measurement bandwidths removed from band-edge, such as the restricted band that begins at 2483.5MHz.

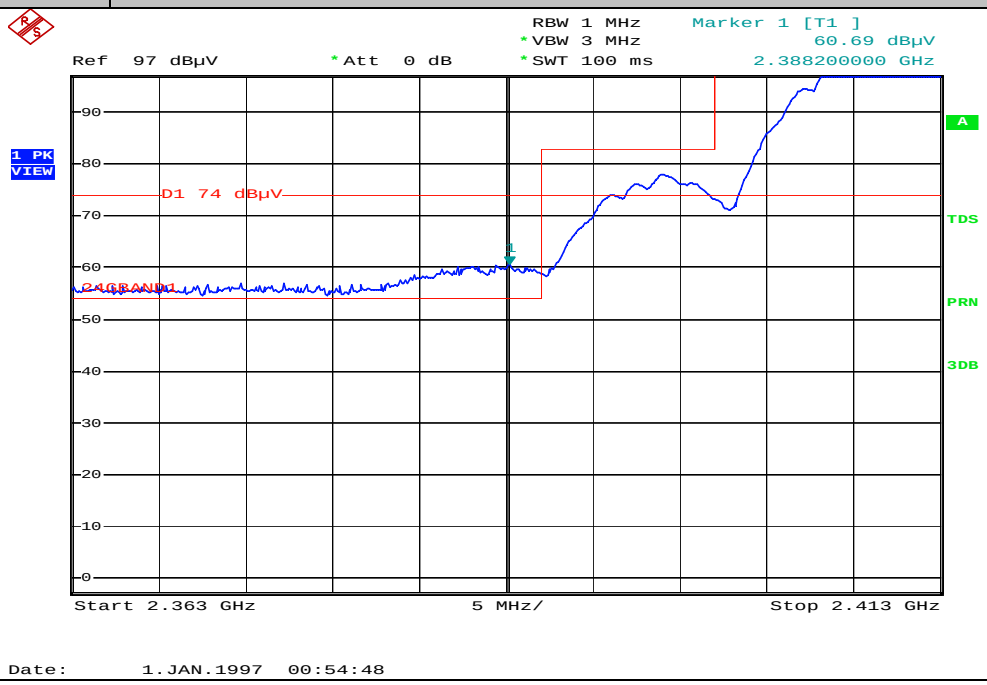
Plot Name:	Peak Reading for Band-Edge Radiated Emissions @ Low End, H



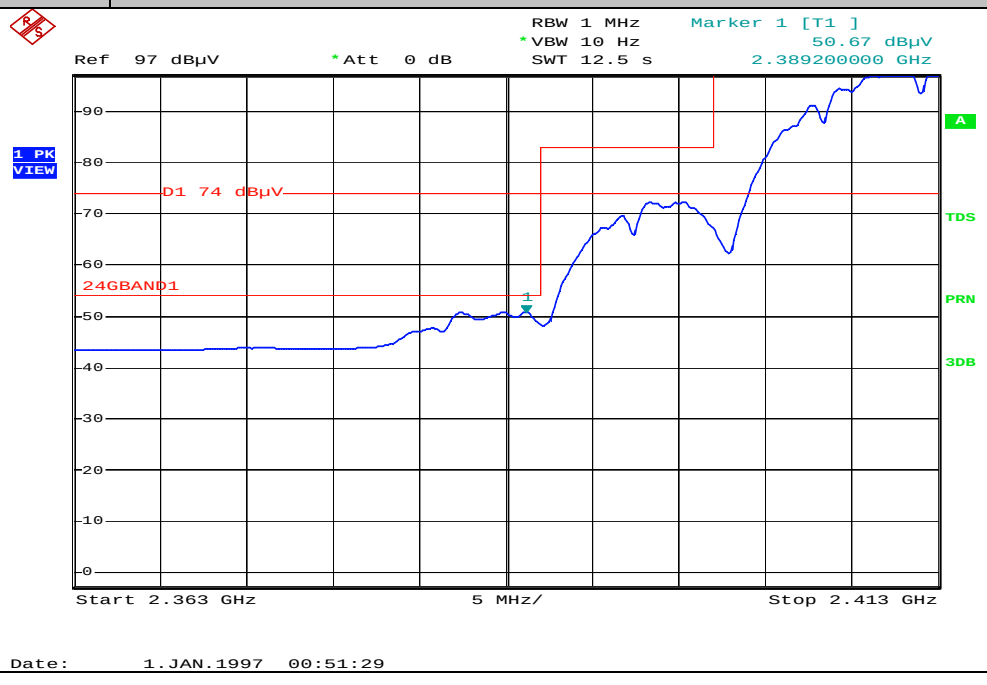
Plot Name:	Average Reading for Band-Edge Radiated Emissions @ Low End, H



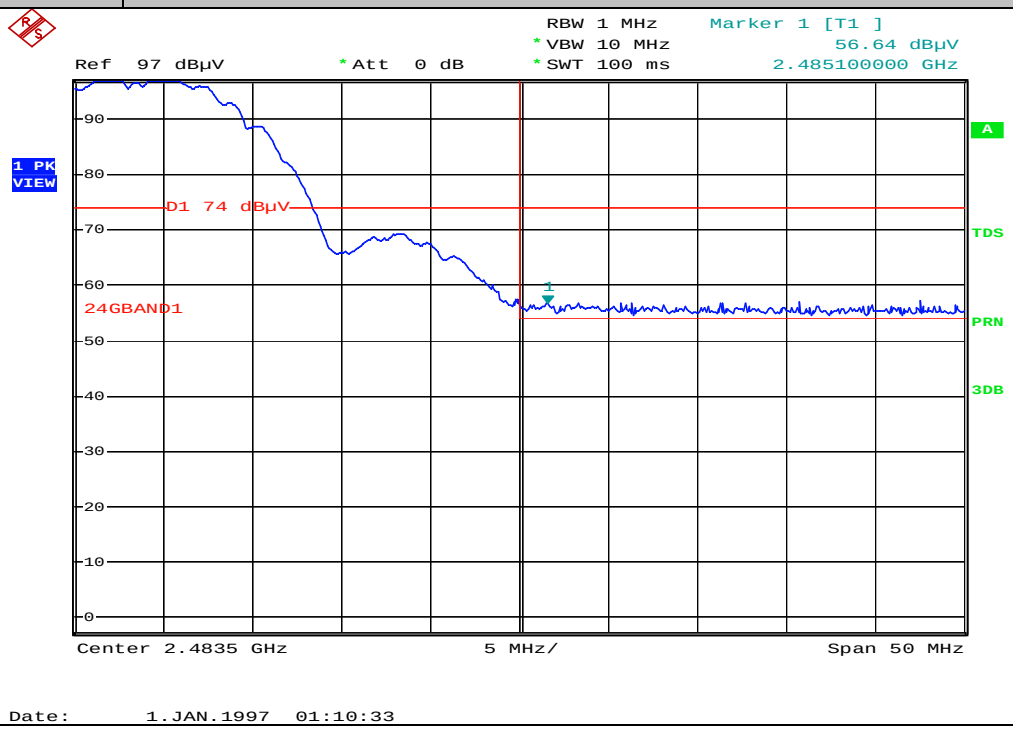
Plot Name:	Peak Reading for Band-Edge Radiated Emissions @ Low End, V



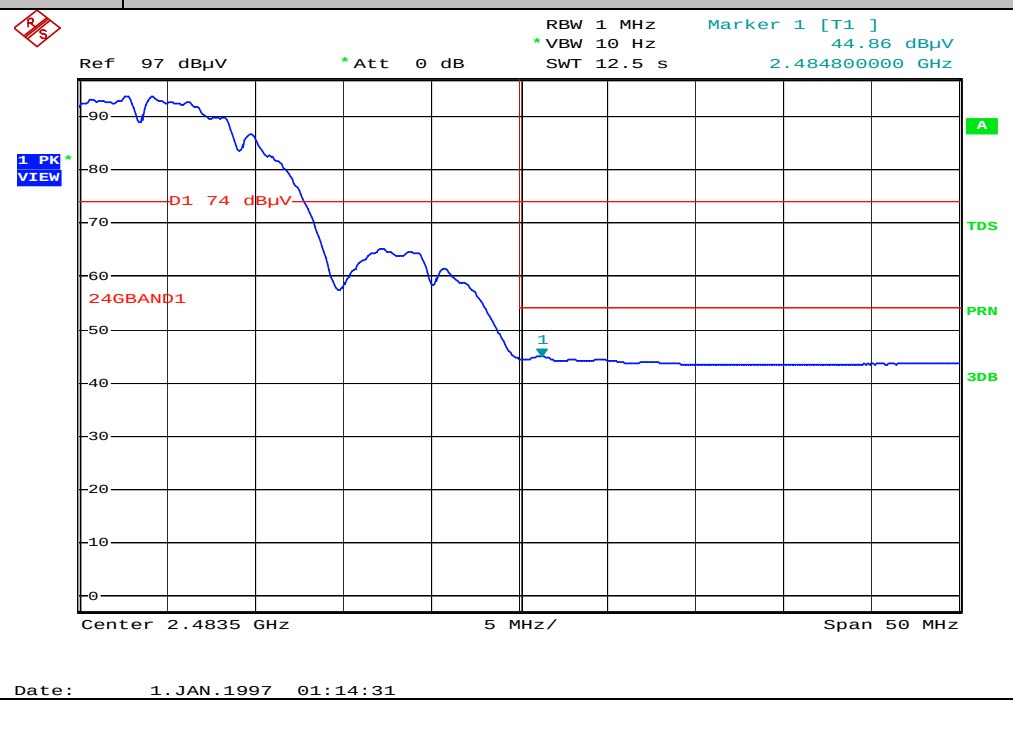
Plot Name:	Average Reading for Band-Edge Radiated Emissions @ Low End, V



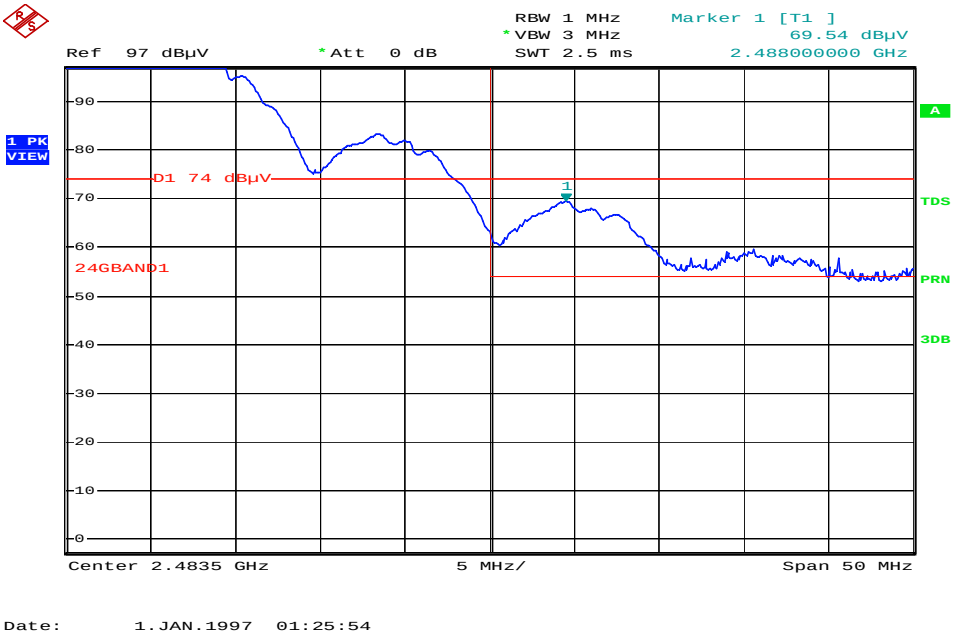
Plot Name:	Peak Reading for Band-Edge Radiated Emissions @ High End, H



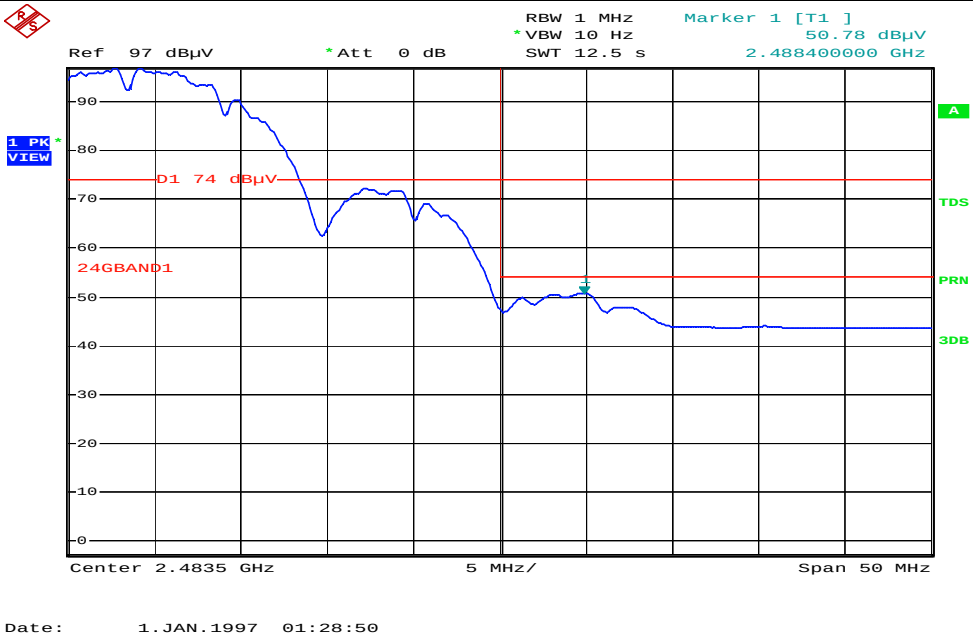
Plot Name:	Average Reading for Band-Edge Radiated Emissions @ High End, H



Plot Name:	Peak Reading for Band-Edge Radiated Emissions @ High End, V



Plot Name:	Average Reading for Band-Edge Radiated Emissions @ High End, V



7.8. AC CONDUCTED EMISSIONS for RF Module in Hosting Device

The EUT was setup and located so that the distance between the boundary of the EUT and the closest surface to the LISN was 0.8m or more.

EUT test configuration was according to CISPR22 and Section 7 of ANSI C63.4-2003.

Conducted disturbance was measured between the phase lead and the ground, and between the neutral lead and the ground. The frequency 0.150 - 30 MHz was investigated.

The EMI receiver was set to PEAK detector setting, and swept continuously over the frequency range to be investigated. The resolution bandwidth was set to 9KHz minimum. The EMI receiver input cable was connected to LINE 1 RF measurement connection on the LISN. A 50ohm terminator was connected to the unused RF port on the LISN. For each mode of EUT operation, emissions readings were maximized by manipulating cable and wire positions. The configuration for each EUT power cord which produced emissions closest to the limit was recorded. The same procedure was repeated for LINE 2 of each EUT power cord.

Instrument Settings

Frequency Range	Peak	Quasi-Peak	Average
0.15 – 30 MHz	9 kHz	9 kHz	30 kHz

Limit: FCC Part 15 / CISPR22 Class B

Testing Data

The following plots show the neutral and line conducted emissions for the typical operation condition. The conducted test data shows the worst case emissions still below the FCC Part 15/CISPR22 Class B limits.

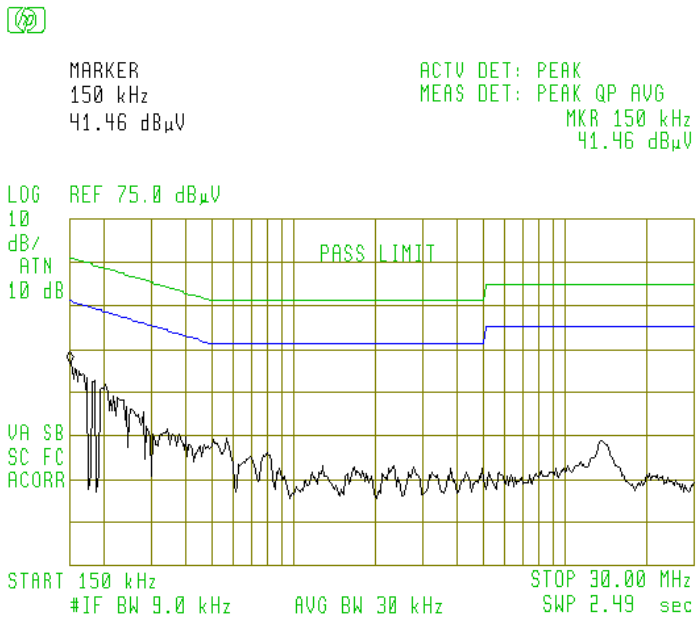
Highest Data for AC Main Conducted Emissions (w/ PC Connected)						
Frequency (MHz)	0.15	0.16	0.18	0.20	1.57	13.7
Peak Reading (dBuV) from Line*	41.5	39.8	37.4	36.7	24.4	23.5
Frequency (MHz)	0.15	0.16	.018	0.25	0.58	13.7
Peak Reading(dBuV) from Neutral *	43.5	39.8	37.9	31.5	24.6	23.6

* No QP reading is needed since the peak reading is already below QP limit.

Result: : No non-compliance noted

Line Conducted Emission

Frequency: 150kHz to 30MHz



Neutral Conducted Emission

Frequency: 150kHz to 30MHz