TEST REPORT

DT&C Co., Ltd.
42, Yurim-ro, 154Beon-gil, Cheoin-gu, Yongin-si, Gyeonggi-do, Korea, 17042
Tel : 031-321-2664, Fax : 031-321-1664

1. Report No : DRTFCC1902-0065
2. Customer
   - Name : COMMAX Co., Ltd.
   - Address : 494 Dunchon-Daero, Jungwon-Gu, Sungnam-Si, Gyeonggi-Do, 13229, South Korea
3. Use of Report : Class II Permissive Change
4. Product Name / Model Name : Zigbee Module / CMX-ZG03
   FCC ID : CCECMX-ZG03
5. Test Method Used : KDB 558074 D01 v05, ANSI C63.10-2013
   Test Specification : FCC Part 15 Subpart C.247
6. Date of Test : 2019.01.21 ~ 2019.02.28
7. Testing Environment : See appended test report.
8. Test Result : Refer to the attached test result.

Affirmation	Tested by	Reviewed by
	Name : SunGeun Lee (Signature)	Name : JaeJin Lee (Signature)

2019 . 02 . 28 .

DT&C Co., Ltd.

If this report is required to confirmation of authenticity, please contact to report@dtnc.net

Test Report Version

Test Report No.	Date	Description
DRTFCC1902-0065	Feb. 28, 2019	Initial issue

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1. General Information

1.1 Testing Laboratory

DT&C Co., Ltd.		
The 3 m test site and conducted measurement facility used to collect the radiated data are located at the 42, Yurim-ro, 154beon-gil, Cheoin-gu, Yongin-si, Gyeonggi-do, Korea 17042. The test site complies with the requirements of § 2.948 according to ANSI C63.4-2014. **- FCC MRA Accredited Test Firm No. : KR0034**		
www.dtnc.net		
Telephone	:	+ 82-31-321-2664
FAX	:	+ 82-31-321-1664

1.2 Details of Applicant

Applicant	:	COMMAX Co., Ltd.
Address	:	494 Dunchon-Daero, Jungwon-Gu, Seongnam-si, Gyeonggi-do, 13229, South Korea
Contact person	:	Ji-Soo KIM

1.3 Description of EUT

EUT	Zigbee Module
Model Name	CMX-ZG03
Software Version	V1.0.0
Model name for host device - 1	CIOT-700M
Model name for host device - 2	CIOT-1020M
Power Supply	DC : 48 V
Frequency Range	2405 ~ 2475MHz (15 channels)
Modulation Technique	O-QPSK
Antenna Type	PCB pattern Antenna
Antenna Gain	PK: 1.70 dBi

1.4 Declaration by the applicant / manufacturer

- N/A

1.5 Test Conditions

Ambient Condition	
▪ Temperature	+20 ℃ ~ +25 ℃
▪ Relative Humidity	40 % ~ 45 %

1.6 Measurement Uncertainty

The measurement uncertainties shown below were calculated in accordance with requirements of ANSI C63.4-2014 and ANSI C63.10-2013. All measurement uncertainty values are shown with a coverage factor of *k* = 2 to indicate a 95 % level of confidence.

Test items	Measurement uncertainty
Transmitter Output Power	0.7 dB (The confidence level is about 95 %, k = 2)
Conducted spurious emission	0.9 dB (The confidence level is about 95 %, k = 2)
AC conducted emission	2.4 dB (The confidence level is about 95 %, k = 2)
Radiated spurious emission (1 GHz Below)	5.1 dB (The confidence level is about 95 %, k = 2)
Radiated spurious emission (1 GHz ~ 18 GHz)	5.4 dB (The confidence level is about 95 %, k = 2)
Radiated spurious emission (18 GHz Above)	5.3 dB (The confidence level is about 95 %, k = 2)

1.7 Support Equipment

Equipment	Manufacturer	Model No.	Serial No.	Note
POE Switch	COMMAX CO., Ltd.	CIOT-H4L2	201705002	-
-	-	-	-	-

Note: The above device was supported by manufacturer.

1.8 Test Equipment List

Type	Manufacturer	Model	Cal.Date (yy/mm/dd)	Next.Cal.Date (yy/mm/dd)	S/N
Spectrum Analyzer	Agilent Technologies	N9020A	18/07/06	19/07/06	US47360812
Spectrum Analyzer	Agilent Technologies	N9020A	18/07/09	19/07/09	MY46471251
Multimeter	FLUKE	17B	18/12/18	19/12/18	26030065WS
DC Power Supply	Agilent Technologies	66332A	18/12/18	19/12/18	US37473833
Signal Generator	Rohde Schwarz	SMBV100A	18/12/19	19/12/19	255571
Signal Generator	ANRITSU	MG3695C	18/12/10	19/12/10	173501
Thermohygrometer	BODYCOM	BJ5478	18/12/27	19/12/27	120612-1
Thermohygrometer	BODYCOM	BJ5478	18/12/27	19/12/27	120612-2
IN/OUT Thermohygrometer	SATO	PC-5000TRH-II	18/07/18	19/07/18	N/A
HYGROMETER	TESTO	608-H1	19/01/31	20/01/31	34862883
Loop Antenna	Schwarzbeck	FMZB1513	18/01/30	20/01/30	1513-128
BILOG ANTENNA	Schwarzbeck	VULB 9160	18/07/13	20/07/13	3359
Horn Antenna	ETS-Lindgren	3117	18/05/10	20/05/10	00140394
Horn Antenna	A.H.Systems Inc.	SAS-574	17/07/31	19/07/31	155
PreAmplifier	Agilent Technologies	8449B	18/07/05	19/07/05	3008A02108
High Pass Filter	Wainwright Instruments	WHKX12-2580-3000-18000-80SS	18/07/05	19/07/05	3
Power Meter & Wide Bandwidth Sensor	Anritsu	ML2495A MA2490A	18/04/17	19/04/17	1306007 1249001
EMI Test Receiver	Rohde Schwarz	ESW44	18/08/06	19/08/06	101645
PreAmplifier	tsj	MLA-10K01-B01-27	18/10/31	19/10/31	2005354
EMI Test Receiver	Rohde Schwarz	ESCI7	19/01/30	20/01/30	100910
PULSE LIMITER	Rohde Schwarz	ESH3-Z2	18/09/27	19/09/27	101333
Cable	HUBER+SUHNER	SUCOFLEX	18/12/22	19/12/22	C-1
Cable	HUBER+SUHNER	SUCOFLEX	18/12/22	19/12/22	C-2
Cable	HUBER+SUHNER	SUCOFLEX	18/12/22	19/12/22	C-3
Cable	HUBER+SUHNER	SUCOFLEX	18/12/22	19/12/22	C-4
Cable	Radiall	TESTPRO3	18/07/06	19/07/06	M-01
Cable	Junkosha	MWX315	18/11/19	19/11/19	M-05
Cable	Junkosha	MWX221	18/11/19	19/11/19	M-06
Cable	HUBER+SUHNER	SUCOFLEX103	18/07/06	19/07/06	M-03
Cable	DT&C	Cable	18/07/05	19/07/05	RF-82
Cable	DT&C	CABLE	18/06/25	19/06/25	RF-55

Note1: The measurement antennas were calibrated in accordance to the requirements of ANSI C63.5-2017
Note2: The cable is not a regular calibration item, so it has been calibrated by DT & C itself.

1.9 Summary of Test Results

FCC Part	RSS Std.	Parameter	Limit	Test Condition	Status Note 1
15.247(a)	RSS-247 [5.2]	6 dB Bandwidth	> 500 kHz	Conducted	C
15.247(b)	RSS-247 [5.4]	Transmitter Output Power	< 1 Watt		C
15.247(d)	RSS-247 [5.5]	Out of Band Emissions / Band Edge	20 dBc in any 100 kHz BW		C
15.247(e)	RSS-247 [5.2]	Transmitter Power Spectral Density	< 8 dBm/3 kHz		C
-	RSS-Gen [6.7]	Occupied Bandwidth (99 %)	RSS-Gen(6.6)		C
15.247(d) 15.205 15.209	RSS-247 [5.5] RSS-Gen [8.9] RSS-Gen [8.10]	General Field Strength Limits (Restricted Bands and Radiated Emission Limits)	FCC 15.209 limits	Radiated	C Note3
15.207	RSS-Gen [8.8]	AC Line Conducted Emissions	FCC 15.207 limits	AC Line Conducted	C
15.203	-	Antenna Requirements	FCC 15.203	-	C

Note 1: **C**=Comply **NC**=Not Comply **NT**=Not Tested **NA**=Not Applicable
Note 2: For radiated emission tests below 30 MHz were performed on semi-anechoic chamber which is correlated with OATS.
Note 3: This test item was performed in each axis and the worst case data was reported.

2. Test Methodology

The measurement procedures described in the ANSI C63.10-2013 and the guidance provided in KDB558074 D01v05 were used in measurement of the EUT.

The EUT was tested per the guidance of KDB558074 D01v05. And ANSI C63.10-2013 was used to reference appropriate EUT setup and maximizing procedures of radiated spurious emission and AC line conducted emission testing.

2.1 EUT Configuration

The EUT configuration for testing is installed on RF field strength measurement to meet the Commissions requirement and operating in a manner that intends to maximize its emission characteristics in a continuous normal application.

2.2 EUT Exercise

The EUT was operated in the test mode to fix the TX frequency that was for the purpose of the measurements. According to its specifications, the EUT must comply with the requirements of the Section 15.207, 15.209 and 15.247 under the FCC Rules Part 15 Subpart C.

2.3 General Test Procedures

Conducted Emissions

The power-line conducted emission test procedure is not described on the KDB558074 D01v05.

So this test was fulfilled with the requirements in Section 6.2 of ANSI C63.10-2013.

The EUT is placed on the wooden table, which is 0.8 m above ground plane and the conducted emissions from the EUT measured in the frequency range between 0.15 MHz and 30 MHz using CISPR Quasi-peak and Average detector.

Radiated Emissions

Basically the radiated tests were performed with KDB558075 D01v05 and ANSI C63.10. Some requirements and procedures like test site requirements, EUT setup and maximizing procedure were fulfilled with the requirements in Section 5 and 6 of the ANSI C63.10.

The EUT is placed on a non-conductive table. For emission measurements at or below 1 GHz, the table height is 80 cm. For emission measurements above 1 GHz, the table height is 1.5 m. The turntable shall rotate 360 degrees to determine the position of maximum emission level. EUT is set 3 m away from the receiving antenna, which varied from 1 m to 4 m to find out the highest emission. And also, each emission was to be maximized by changing the polarization of receiving antenna both horizontal and vertical.

2.4 Description of Test Modes

The EUT has been tested with the operating condition for maximizing the emission characteristics. A test program is used to control the EUT for staying in continuous transmitting. The lowest, middle and highest channels were tested and reported.

Test Mode	Description	Test Frequency [MHz]		
		Lowest channel	Middle channel	Highest channel
TM 1(M/N: CIOT-700M)	ZIGBEE	2405	2440	2475
TM 2(M/N: CIOT-1020M)	ZIGBEE	2405	2440	2475

2.5 Instrument Calibration

The measuring equipment, which was utilized in performing the tests documented herein, has been calibrated in accordance with the manufacturer's recommendations for utilizing calibration equipment, which is traceable to recognized national standards.

3. Test Result

3.1 Maximum Peak Conducted Output Power

▣ Test Requirements and limit, §15.247(b) & RSS-247 [5.4]

A transmitter antenna terminal of EUT is connected to the input of a spectrum analyzer.

Measurement is made while the EUT is operating in transmission mode at the appropriate frequencies.

The maximum permissible conducted output power is 1 Watt.

3.1.1 Test Setup

Refer to the APPENDIX I.

3.1.2 Test Procedures

- **KDB558074 D01v05 - Section 8.3.1.1**
- **ANSI C63.10-2013 – Section 11.9.1.1**

BW ≥ DTS bandwidth

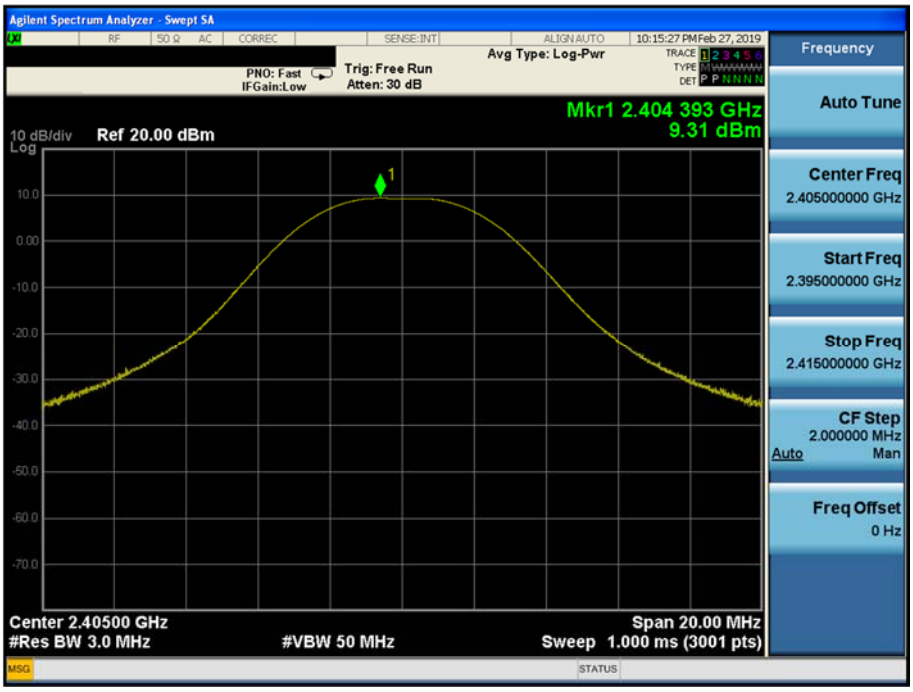
1. Set the RBW ≥ DTS bandwidth
2. Set VBW ≥ 3 x RBW.
3. Set span ≥ 3 x RBW.
4. Sweep time = Auto couple.
5. Detector = Peak.
6. Trace mode = Max hold.
7. Allow the trace to stabilize.

3.1.3 Test Results

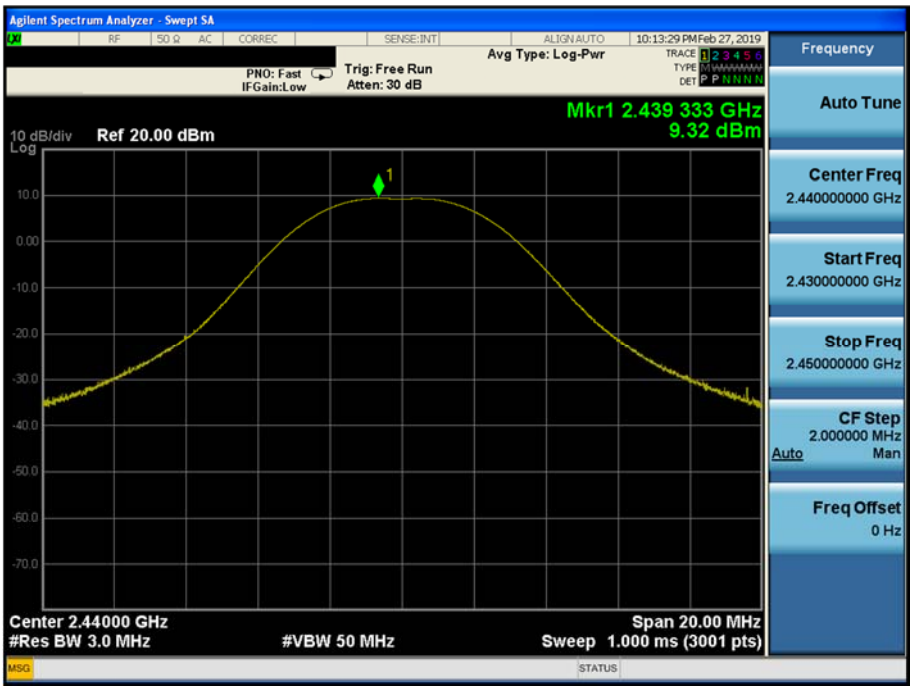
Test mode	Tested Channel	Burst Average Output Power		Peak Output Power	
		dBm	mW	dBm	mW
TM 1	Lowest	9.03	8.00	9.31	8.53
	Middle	9.05	8.04	9.32	8.55
	Highest	**9.11**	**8.15**	**9.41**	**8.73**

Note 1: See next pages for actual measured spectrum plots.

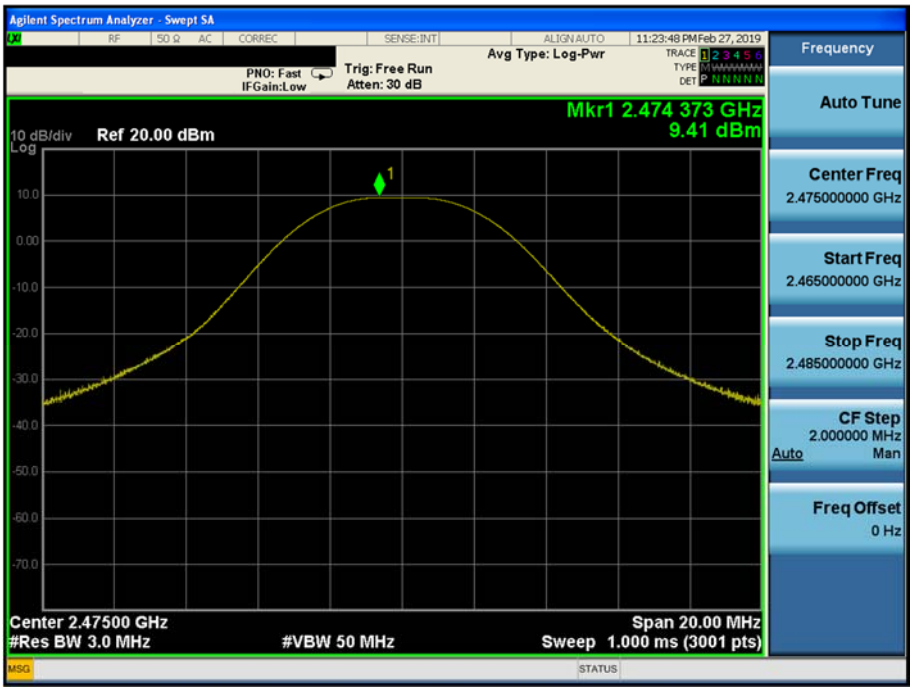
Peak Output Power Test Channel : Lowest



Peak Output Power Test Channel : Middle



Peak Output Power Test Channel : Highest



3.2 6 dB Bandwidth Measurement

▣ Test Requirements and limit, §15.247(a) & RSS-247 [5.2]

The bandwidth at 6 dB down from the highest in-band spectral density is measured with a spectrum analyzer connected to the EUT's antenna terminal while the EUT is operating in transmission mode at the appropriate frequencies.

The minimum permissible 6 dB bandwidth is 500 kHz.

3.2.1 Test Setup

Refer to the APPENDIX I.

3.2.2 Test Procedures

- **KDB558074 D01v05 - Section 8.2**
- **ANSI C63.10-2013 – Section 11.8.2**

Option 2

1. Set resolution bandwidth (RBW) = 100 kHz.
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.

Note: The automatic bandwidth measurement capability of an instrument was used to perform the 6dB bandwidth measurement.

3.2.3 Test Results

Test Mode	Tested Channel	Test Results [MHz]
TM 1	Lowest	1.605
	Middle	**1.651**
	Highest	1.638

6 dB Bandwidth Test Channel : Lowest

6 dB Bandwidth Test Channel : Middle

6 dB Bandwidth Test Channel : Highest

3.3 Maximum Power Spectral Density.

▣ Test requirements and limit, §15.247(e) & RSS-247 [5.2]

The peak power density is measured with a spectrum analyzer connected to the antenna terminal while the EUT is operating in transmission mode at the appropriate frequencies.

Minimum Standard

The 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

3.3.1 Test Setup

Refer to the APPENDIX I.

3.3.2 Test Procedures

- **KDB558074 D01v05 - Section 8.4**
- **ANSI C63.10-2013 – Section 11.10.2**

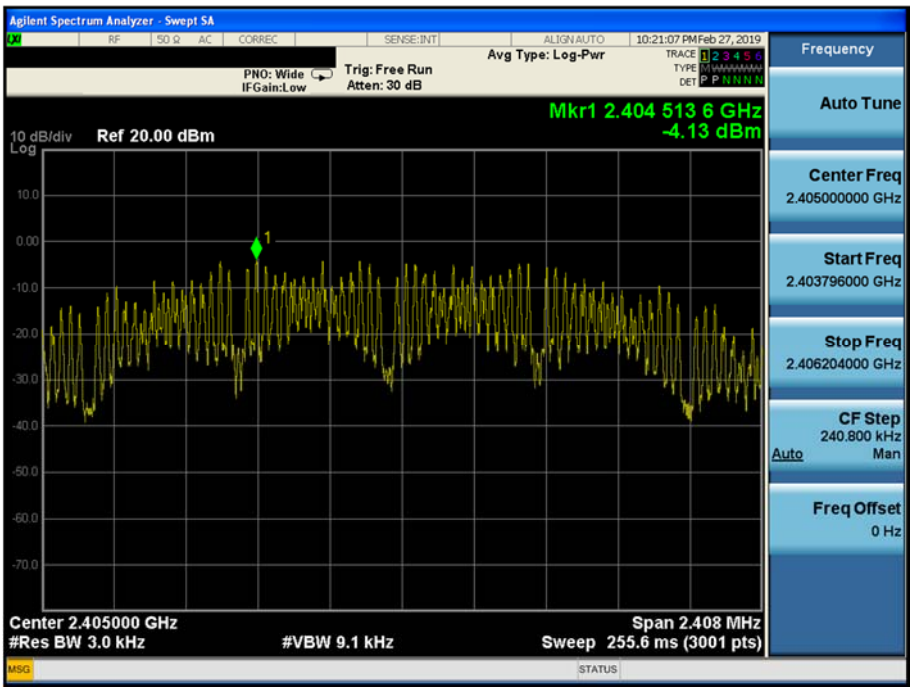
Method PKPSD (peak PSD)

1. Set analyzer center frequency to DTS channel center frequency.
2. Set the span to **1.5 times** the DTS bandwidth.
3. Set the RBW to : **3 kHz** ≤ RBW ≤ **100 kHz**
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 kHz) and repeat.

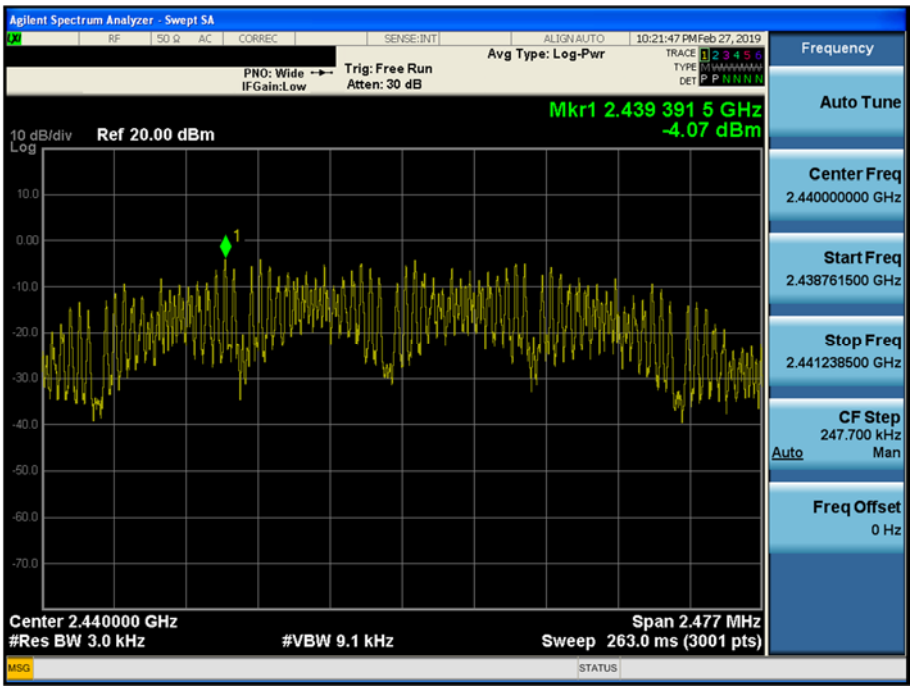
3.3.3 Test Results

Test Mode	Tested Channel	PKPSD [dBm]
TM 1	Lowest	-4.13
	Middle	-4.07
	Highest	**-3.60**

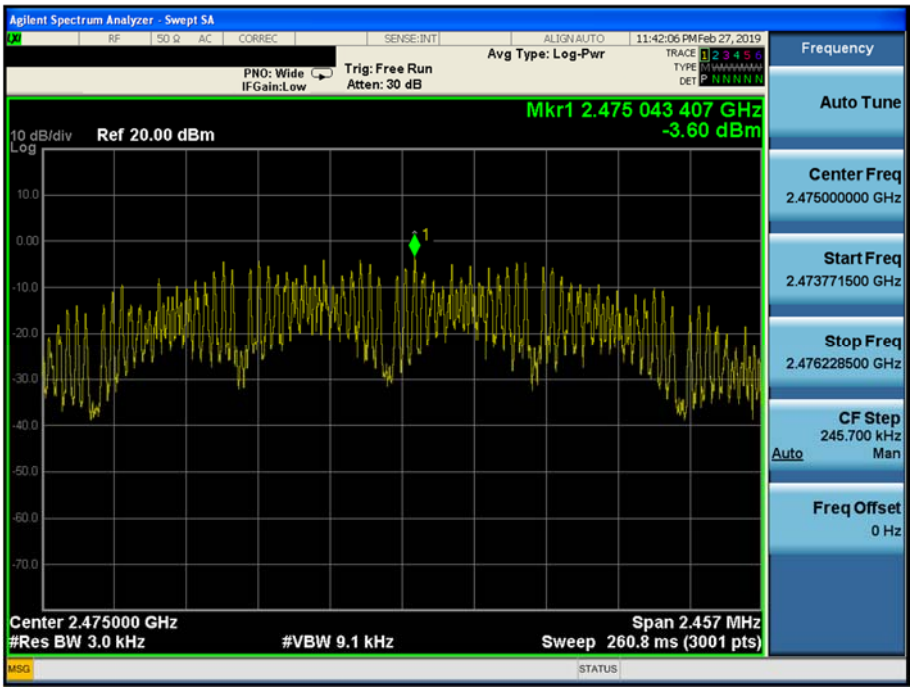
Power Spectral Density Test Channel : Lowest



Power Spectral Density Test Channel : Middle



Power Spectral Density Test Channel : Highest



3.4 Unwanted Emissions (Conducted)

▣ **Test requirements and limit, §15.247(d) & RSS-247 [5.5]**

§15.247(d) specifies that in any 100 kHz bandwidth outside of the authorized frequency band, the power shall be attenuated according to the following conditions :

If **the peak output power procedure** is used to measure the fundamental emission power to demonstrate compliance to **15.247(b)(3)** requirements, then the peak conducted output power measured within any 100 kHz outside the authorized frequency band shall be attenuated **by at least 20 dB** relative to the maximum measured in-band peak PSD level.

If the average output power procedure is used to measure the fundamental emission power to demonstrate compliance to **15.247(b)(3)** requirements, then the power in any 100 kHz outside of the authorized frequency band shall be attenuated by at least 30 dB relative to the maximum measured inband average PSD level.

In either case, attenuation to levels below the general emission limits specified in **§15.209(a)** is not required.

3.4.1 Test Setup

Refer to the APPENDIX I.

3.4.2 Test Procedures

- **KDB558074 D01v05 - Section 8.5**
- **ANSI C63.10-2013 – Section 11.11**

Reference level measurement

1. Set instrument center frequency to DTS channel center frequency.
2. Set the span to ≥ 1.5 times the DTS bandwidth.
3. Set the RBW = **100 kHz.**
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 PSD level.

Emission level measurement

1. Set the center frequency and span to encompass frequency range to be measured.
2. Set the RBW = **100 kHz. (Actual 1 MHz, See below note)**
3. Set the VBW ≥ **3 x RBW. (Actual 3 MHz, See below note)**
4. Detector = **Peak**.
5. Ensure that the number of measurement points ≥ Span / RBW.
6. Sweep time = **Auto couple.**
7. Trace mode = **Max hold.**
8. **Allow the trace to stabilize.** (this may take some time, depending on the extent of the span)
9. Use the peak marker function to determine the maximum amplitude level.

Note: The conducted spurious emission was tested with below settings.

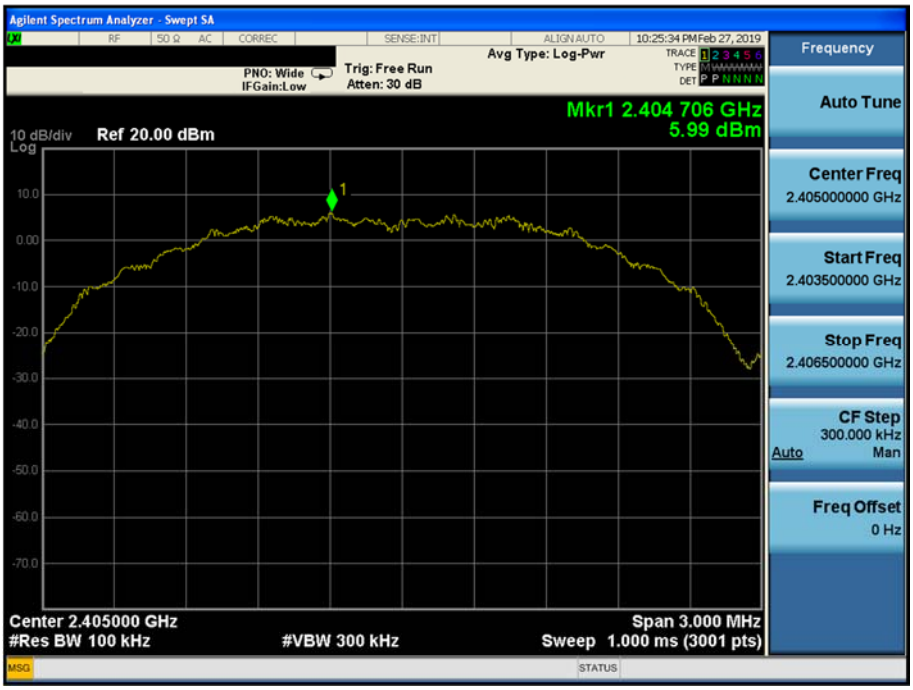
Frequency range	RBW	VBW	Detector	Trace	Sweep Point
9 kHz ~ 30 MHz	100 kHz	300 kHz	Peak	Max Hold	40001
30 MHz ~ 10 GHz	1 MHz	3 MHz			
10 GHz ~ 25 GHz	1 MHz	3 MHz			

LIMIT LINE = 20 dB below of the reference level

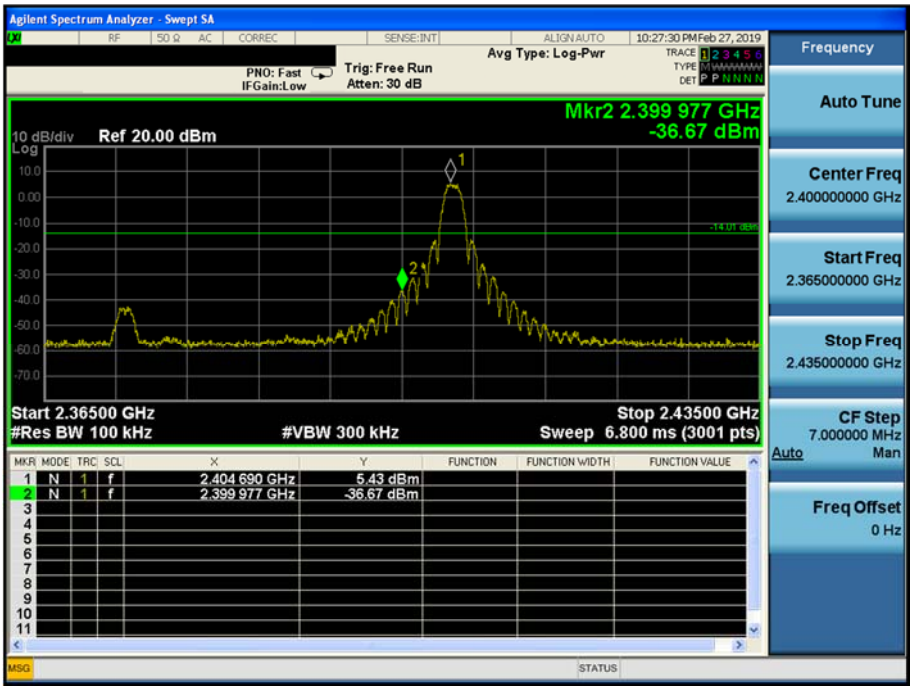
If the emission level with above setting was close to the limit (ie, less than 3 dB margin) then zoom scan is required using RBW = 100 kHz, VBW = 300 kHz, SPAN = 100 MHz and BINS = 2001 to get accurate emission level within 100 kHz BW.

3.4.3 Test Results

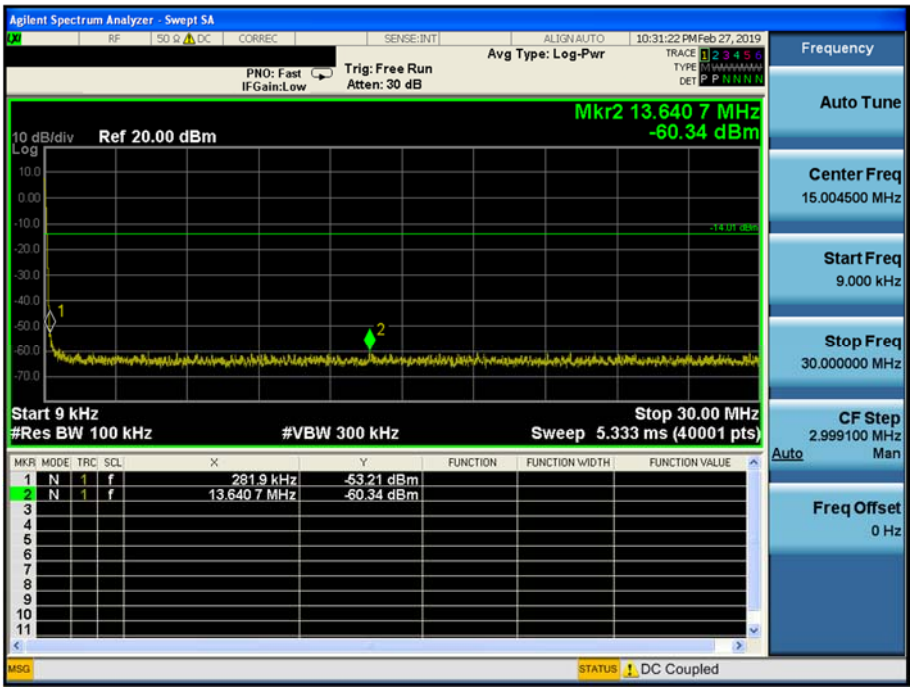
Reference (Test Channel : Lowest)



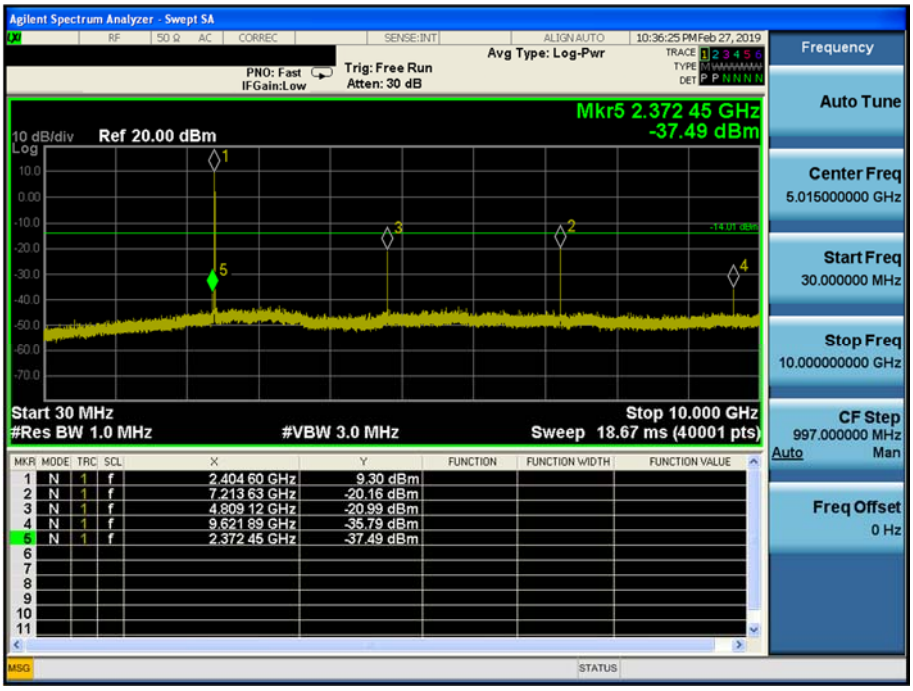
Low Band-edge



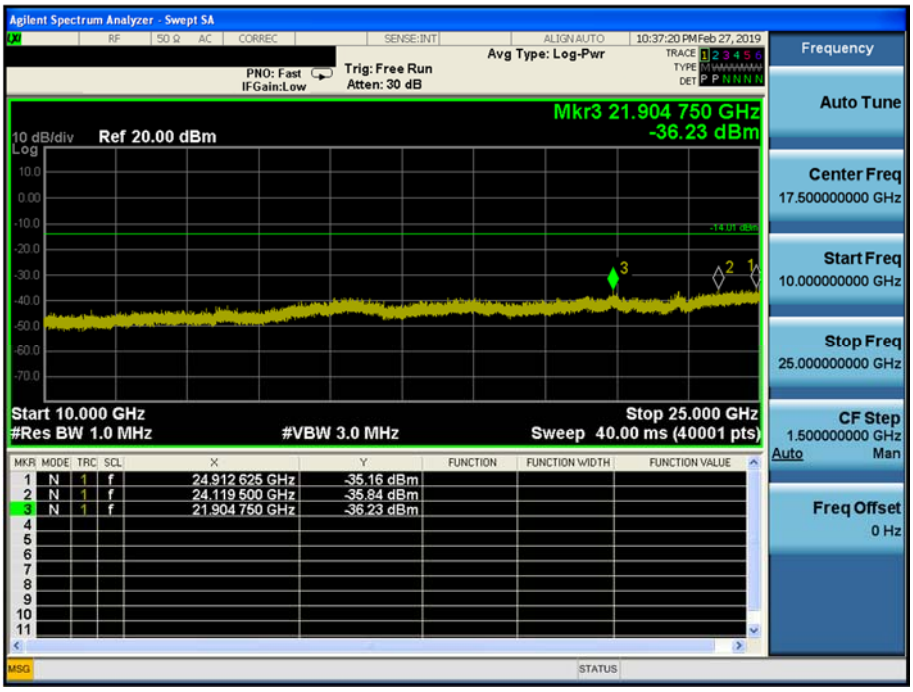
Conducted Spurious Emissions 1 (Test Channel : Lowest)



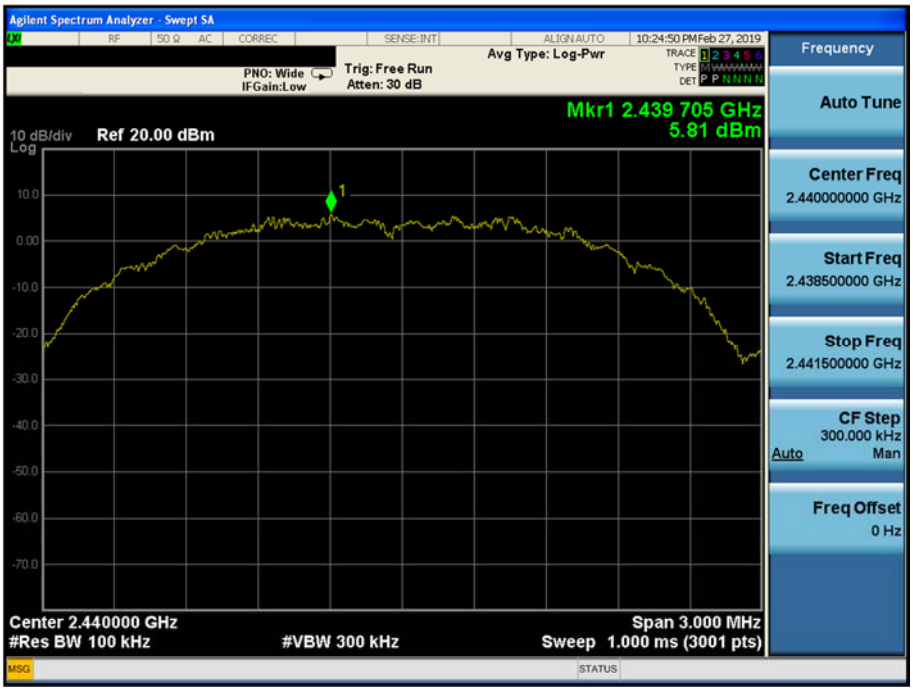
Conducted Spurious Emissions 2 (Test Channel : Lowest)



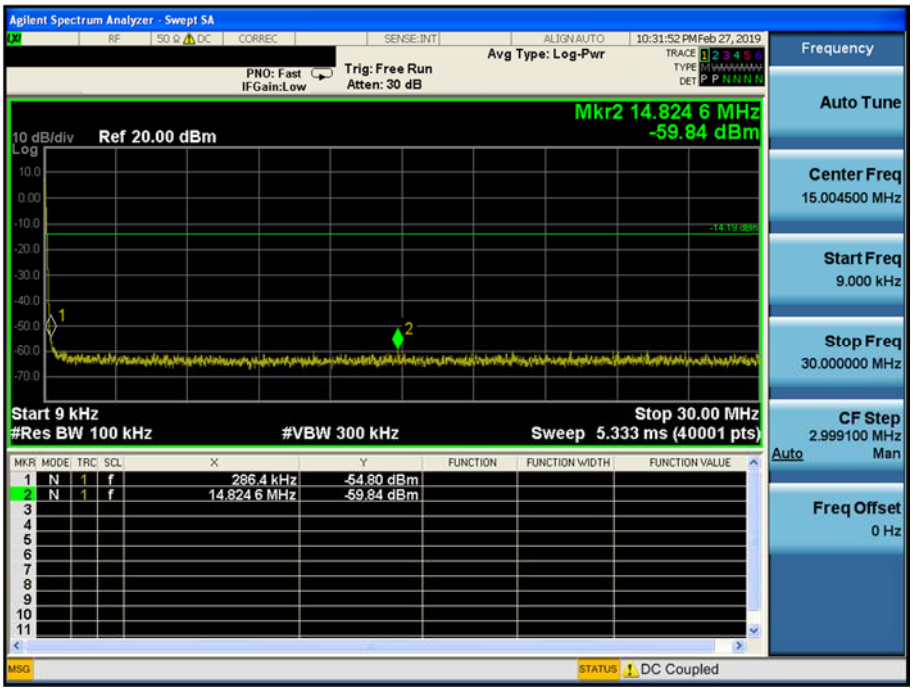
Conducted Spurious Emissions 3 (Test Channel : Lowest)



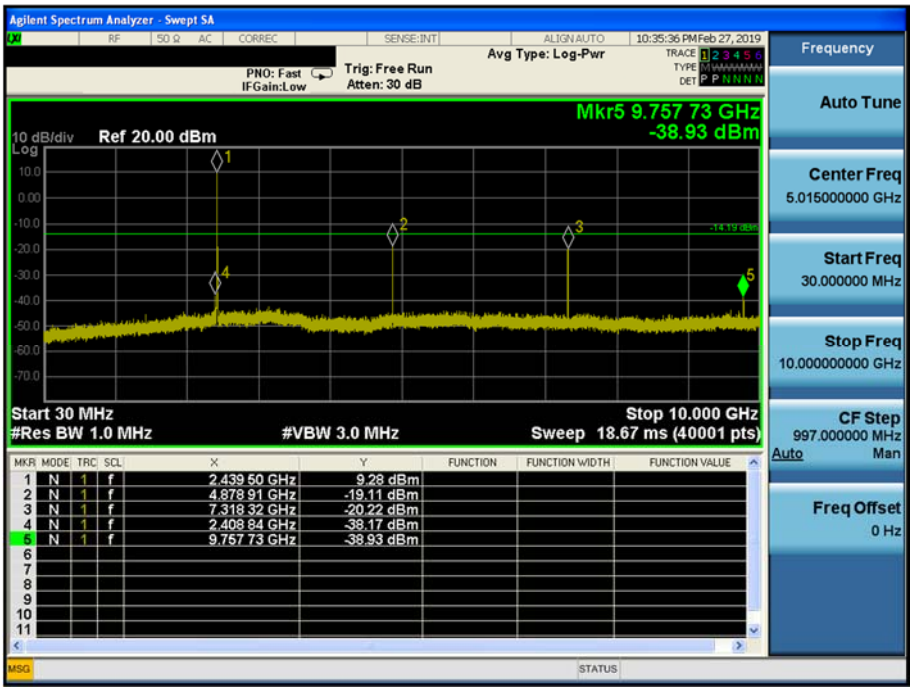
Reference (Test Channel : Middle)



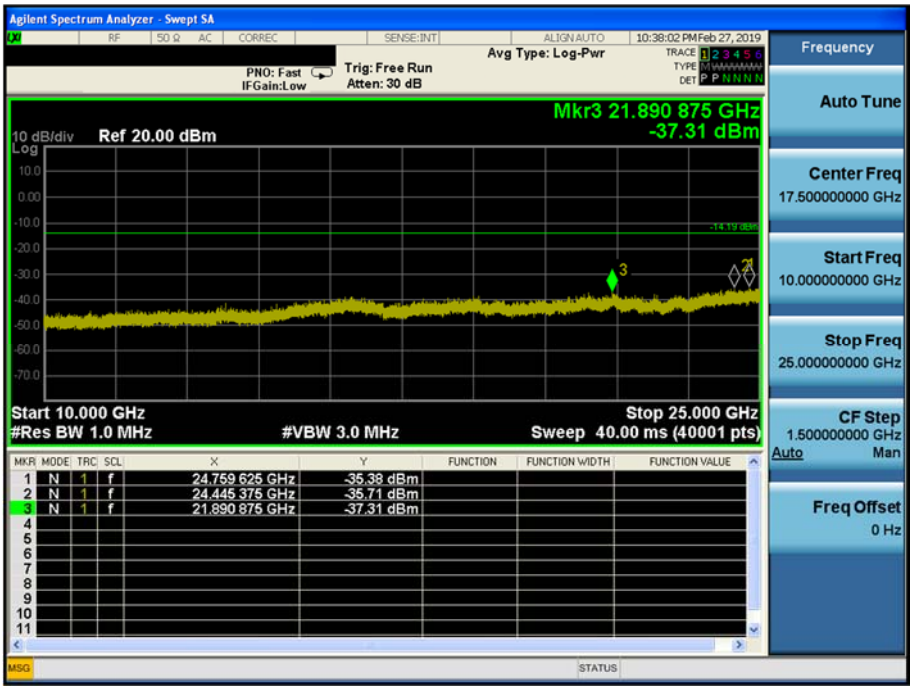
Conducted Spurious Emissions 1 (Test Channel : Middle)



Conducted Spurious Emissions 2 (Test Channel : Middle)

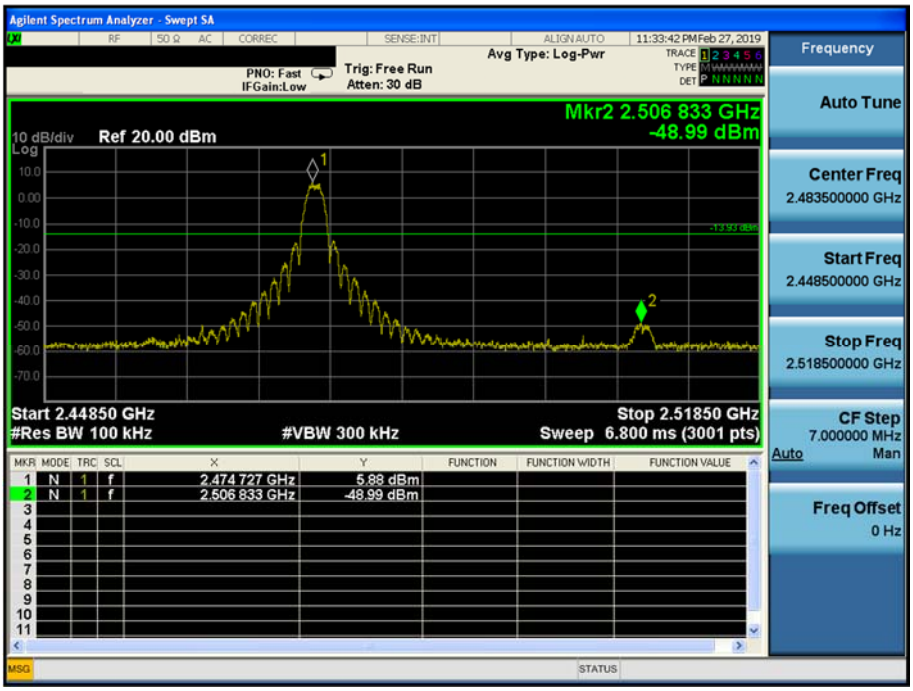


Conducted Spurious Emissions 3 (Test Channel : Middle)

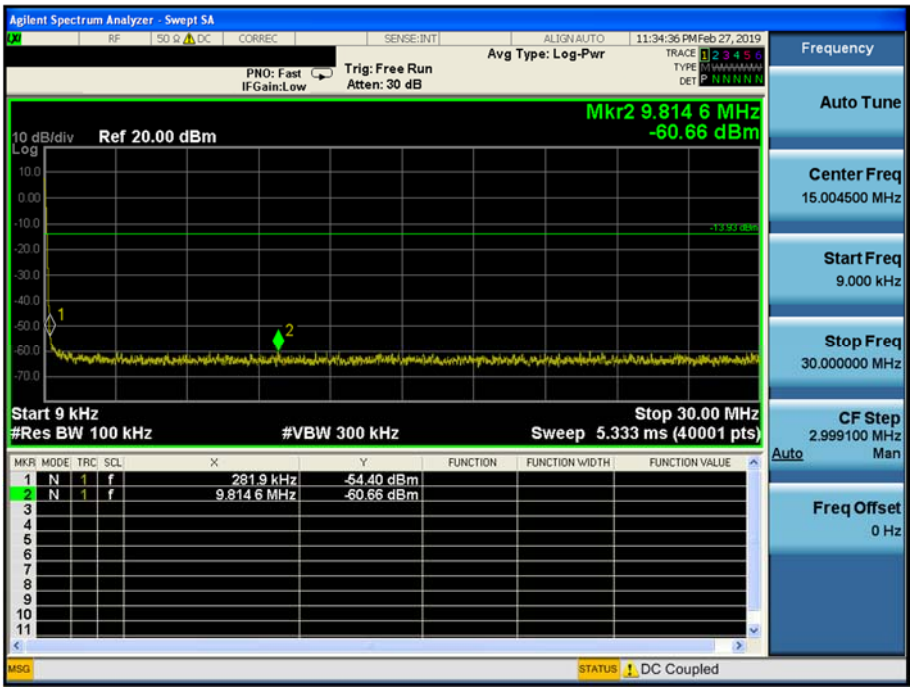


Reference (Test Channel : Highest)

High Band-edge (Test Channel : Highest)



Conducted Spurious Emissions 1 (Test Channel : Highest)



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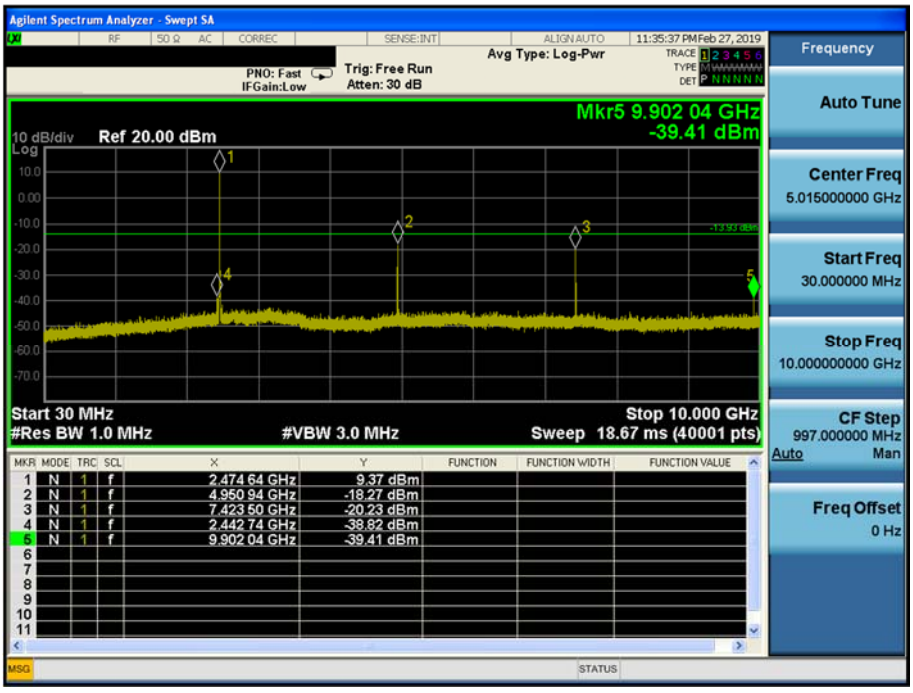
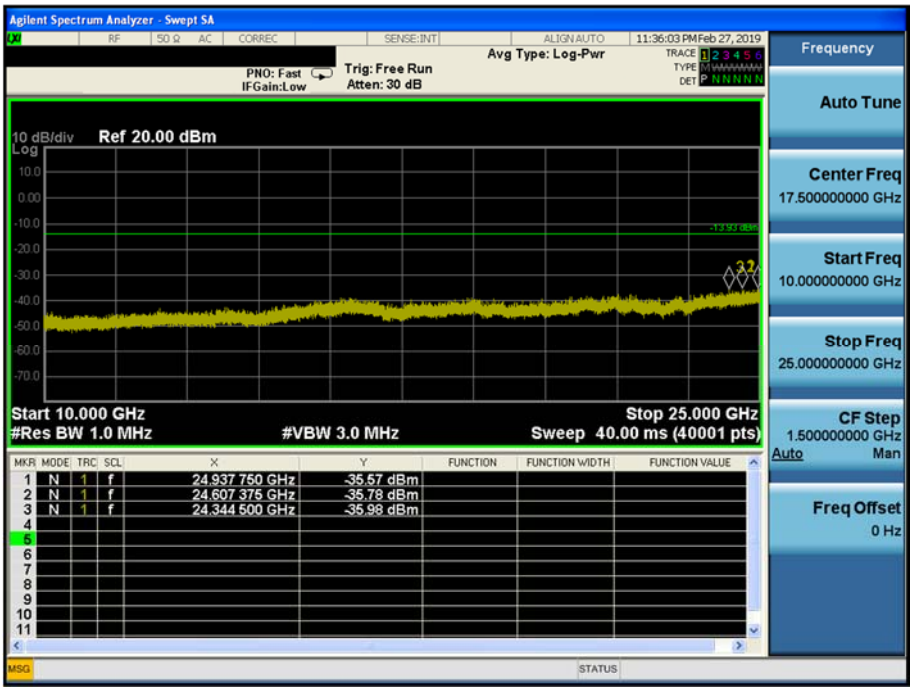


Conducted Spurious Emissions 3 (Test Channel : Highest)



3.5 Unwanted Emissions (Radiated)

▣ **Test Requirements and limit,**

§15.247(d), §15.205, §15.209 & RSS-247 [5.5], RSS-Gen [8.9], RSS-Gen [8.10]

In any 100 kHz bandwidth outside the operating frequency band. In case the emission fall within the restricted band specified on 15.205(a) and (b), then the 15.209(a) limit in the table below has to be followed.

▪ **FCC Part 15.209(a) and (b)**

Frequency (MHz)	Limit (uV/m)	Measurement Distance (meter)
0.009 ~ 0.490	2400/F (kHz)	300
0.490 ~ 1.705	24000/F (kHz)	30
1.705 ~ 30.0	30	30
30 ~ 88	100 **	3
88 ~ 216	150 **	3
216 ~ 960	200 **	3
Above 960	500	3

** Except as provided in 15.209(g), fundamental emissions from intentional radiators operating under this Section shall not be located in the frequency bands 54 ~ 72 MHz, 76 ~ 88 MHz, 174 ~ 216 MHz or 470 ~ 806 MHz. However, operation within these frequency bands is permitted under other sections of this Part, e.g. 15.231 and 15.241.

▪ **FCC Part 15.205 (a) :** Only spurious emissions are permitted in any of the frequency bands listed below :

MHz	MHz	MHz	GHz
0.009 ~ 0.110	16.42 ~ 16.423	399.90 ~ 410	4.5 ~ 5.15
0.495 ~ 0.505	16.69475 ~ 16.69525	608 ~ 614	5.35 ~ 5.46
2.1735 ~ 2.1905	16.80425 ~ 16.80475	960 ~ 1240	7.25 ~ 7.75
4.125 ~ 4.128	25.5 ~ 25.67	1300 ~ 1427	8.025 ~ 8.5
4.17725 ~ 4.17775	37.5 ~ 38.25	1435 ~ 1626.5	9.0 ~ 9.2
4.20725 ~ 4.20775	73 ~ 74.6	1645.5 ~ 1646.5	9.3 ~ 9.5
6.215 ~ 6.218	74.8 ~ 75.2	1660 ~ 1710	10.6 ~ 12.7
6.26775 ~ 6.26825	108 ~ 121.94	1718.8 ~ 1722.2	13.25 ~ 13.4
6.31175 ~ 6.31225	123 ~ 138	2200 ~ 2300	14.47 ~ 14.5
8.291 ~ 8.294	149.9 ~ 150.05	2310 ~ 2390	15.35 ~ 16.2
8.362 ~ 8.366	156.52475 ~ 156.52525	2483.5 ~ 2500	17.7 ~ 21.4
8.37625 ~ 8.38675	156.7 ~ 156.9	2690 ~ 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	Above 38.6
13.36 ~ 13.41			

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

3.5.1 Test Setup

Refer to the APPENDIX I.

3.5.2 Test Procedures

1. The EUT is placed on a non-conductive table. For emission measurements at or below 1 GHz, the table height is 80 cm. For emission measurements above 1 GHz, the table height is 1.5 m.
2. The turntable shall be rotated for 360 degrees to determine the position of maximum emission level.
3. EUT is set 1 or 3 m away from the receiving antenna, which is varied from 1 m to 4 m to find out the highest emissions.
4. Maximum procedure was performed on the six highest emissions to ensure EUT compliance.
5. And also, each emission was to be maximized by changing the polarization of receiving antenna both horizontal and vertical.
6. Repeat above procedures until the measurements for all frequencies are complete.

Note: Measurement Instrument Setting for Radiated Emission Measurements.

1. Frequency Range Below 1 GHz

RBW = 100 or 120 kHz, VBW = 3 x RBW, Detector = Peak or Quasi Peak

2. Frequency Range > 1 GHz

Peak Measurement > 1 GHz

RBW = 1 MHz, VBW = 3 MHz, Detector = Peak, Sweep time = Auto, Trace mode = Max Hold until the trace stabilizes

Average Measurement > 1GHz

The average measurement was determined from the peak field strength after correcting for the worst-case duty cycle. And the worst-case duty cycle was declared by the manufacturer.

3.5.3 Test Results

Frequency Range : 9 kHz ~ 1 GHz, TM 1(M/N: CIOT-700M)

▪ Middle Channel

Frequency (MHz)	ANT Pol	EUT Position (Axis)	Detector Mode	Reading (dBuV)	T.F (dB/m)	D.C.F (dB)	Distance Factor(dB)	Result (dBuV/m)	Limit (dBuV/m)	Margin (dB)
66.74	V	Y	PK	49.00	-16.25	N/A	N/A	32.75	40.00	7.25
94.02	V	Y	PK	57.10	-19.83	N/A	N/A	37.27	43.50	6.23
99.96	H	Y	PK	57.00	-19.21	N/A	N/A	37.79	43.50	5.71
151.85	H	Y	PK	49.00	-13.63	N/A	N/A	35.37	46.00	10.63
450.00	V	Y	PK	47.30	-7.65	N/A	N/A	39.65	46.00	6.35
910.47	V	Y	PK	40.40	2.66	N/A	N/A	43.06	46.00	2.94
-	-	-	-	-	-	-	-	-	-	-

▪ **Note.**

1. Exploratory testing has been performed to determine the emissions characteristic of this EUT.
   And middle channel was selected for final testing and reported.
2. No other spurious and harmonic emissions were found above listed frequencies.
3. Information of Distance Factor

   For finding emissions, the test distance might be reduced from 3 m to 1 m. In this case, the distance factor (-9.54 dB) is applied to the result.

   - Calculation of distance factor = 20 log(applied distance / required distance) = **20 log(1 m / 3 m)** = **-9.54 dB**

   When distance factor is “N/A”, the distance is 3 m and distance factor is not applied.
4. Sample Calculation.

   Margin = Limit – Result / Result = Reading + T.F + D.C.F / T.F = AF + CL – AG

   Where, T.F = Total Factor, AF = Antenna Factor, CL = Cable Loss, AG = Amplifier Gain,

   DCF = Duty Cycle Correction Factor.

Frequency Range : 9 kHz ~ 1 GHz, TM 2(M/N: CIOT-1020M)

▪ Middle Channel

Frequency (MHz)	ANT Pol	EUT Position (Axis)	Detector Mode	Reading (dBuV)	T.F (dB/m)	D.C.F (dB)	Distance Factor(dB)	Result (dBuV/m)	Limit (dBuV/m)	Margin (dB)
38.85	V	Y	PK	49.20	-14.96	N/A	N/A	34.24	40.00	5.76
78.99	H	Y	PK	52.30	-18.55	N/A	N/A	33.75	40.00	6.25
94.50	V	Y	PK	55.80	-19.80	N/A	N/A	36.00	43.50	7.50
99.96	H	Y	PK	56.90	-19.21	N/A	N/A	37.69	43.50	5.81
550.04	V	Y	PK	44.80	-5.80	N/A	N/A	39.00	46.00	7.00
750.02	H	Y	PK	39.20	-0.58	N/A	N/A	38.62	46.00	7.38
-	-	-	-	-	-	-	-	-	-	-

▪ **Note.**

1. Exploratory testing has been performed to determine the emissions characteristic of this EUT.
   And middle channel was selected for final testing and reported.
2. No other spurious and harmonic emissions were found above listed frequencies.
3. Information of Distance Factor

   For finding emissions, the test distance might be reduced from 3 m to 1 m. In this case, the distance factor (-9.54 dB) is applied to the result.

   - Calculation of distance factor = 20 log(applied distance / required distance) = **20 log(1 m / 3 m)** = **-9.54 dB**

   When distance factor is “N/A”, the distance is 3 m and distance factor is not applied.
4. Sample Calculation.

   Margin = Limit – Result / Result = Reading + T.F + D.C.F / T.F = AF + CL – AG

   Where, T.F = Total Factor, AF = Antenna Factor, CL = Cable Loss, AG = Amplifier Gain,

   DCF = Duty Cycle Correction Factor.

Frequency Range : 1 ~ 25 GHz, TM 1(M/N: CIOT-700M)

▪ Lowest Channel

Frequency (MHz)	ANT Pol	EUT Position (Axis)	Detector Mode	Reading (dBuV)	T.F (dB/m)	D.C.F (dB)	Distance Factor(dB)	Result (dBuV/m)	Limit (dBuV/m)	Margin (dB)
2373.60	H	Y	PK	53.23	1.65	N/A	N/A	54.88	74.00	19.12
2372.90	H	Y	AV	53.23	1.64	-20.00	N/A	34.87	54.00	19.13
2389.20	H	Y	PK	46.53	1.70	N/A	N/A	48.23	74.00	25.77
2388.95	H	Y	AV	46.53	1.70	-20.00	N/A	28.23	54.00	25.77
4808.86	V	Y	PK	53.03	5.47	N/A	N/A	58.50	74.00	15.50
4810.90	V	Y	AV	53.03	5.47	-20.00	N/A	38.50	54.00	15.50
7213.38	V	Y	PK	50.05	7.87	N/A	N/A	57.92	74.00	16.08
7216.56	V	Y	AV	50.05	7.88	-20.00	N/A	37.93	54.00	16.07

▪ Middle Channel

Frequency (MHz)	ANT Pol	EUT Position (Axis)	Detector Mode	Reading (dBuV)	T.F (dB/m)	D.C.F (dB)	Distance Factor(dB)	Result (dBuV/m)	Limit (dBuV/m)	Margin (dB)
4880.96	V	Y	PK	53.42	5.63	N/A	N/A	59.05	74.00	14.95
4881.00	V	Y	AV	53.42	5.63	-20.00	N/A	39.05	54.00	14.95
7321.70	V	Y	PK	49.21	8.04	N/A	N/A	57.25	74.00	16.75
7318.38	V	Y	AV	49.21	8.04	-20.00	N/A	37.25	54.00	16.75

▪ Highest Channel

Frequency (MHz)	ANT Pol	EUT Position (Axis)	Detector Mode	Reading (dBuV)	T.F (dB/m)	D.C.F (dB)	Distance Factor(dB)	Result (dBuV/m)	Limit (dBuV/m)	Margin (dB)
2483.55	H	Y	PK	51.25	1.79	N/A	N/A	53.04	74.00	20.96
2483.50	H	Y	AV	51.25	1.79	-20.00	N/A	33.04	54.00	20.96
4951.08	V	Y	PK	56.45	5.74	N/A	N/A	62.19	74.00	11.81
4950.92	V	Y	AV	56.45	5.74	-20.00	N/A	42.19	54.00	11.81
7423.74	V	Y	PK	46.78	7.90	N/A	N/A	54.68	74.00	19.32
7423.44	V	Y	AV	46.78	7.90	-20.00	N/A	34.68	54.00	19.32

▪ **Note.**

1. The radiated emissions were investigated up 25GHz. And no other spurious and harmonic emissions were found above listed frequencies.
2. Information of Distance Factor

   For finding emissions, the test distance might be reduced from 3 m to 1 m. In this case, the distance factor (-9.54 dB) is applied to the result.

   - Calculation of distance factor = 20 log(applied distance / required distance) = **20 log(1 m / 3 m)** = **-9.54 dB**

   When distance factor is “N/A”, the distance is 3 m and distance factor is not applied.
3. Sample Calculation.

   Margin = Limit – Result / Result = Reading + T.F + D.C.F / T.F = AF + CL – AG

   Where, T.F = Total Factor, AF = Antenna Factor, CL = Cable Loss, AG = Amplifier Gain,

   DCF = Duty Cycle Correction Factor.

   Duty cycle Correction factor = 20 x log (10ms/100ms) = -20dB

Frequency Range : 1 ~ 25 GHz, TM 2(M/N: CIOT-1020M)

▪ Lowest Channel

Frequency (MHz)	ANT Pol	EUT Position (Axis)	Detector Mode	Reading (dBuV)	T.F (dB/m)	D.C.F (dB)	Distance Factor(dB)	Result (dBuV/m)	Limit (dBuV/m)	Margin (dB)
2373.25	H	Y	PK	54.01	1.64	N/A	N/A	55.65	74.00	18.35
2373.05	H	Y	AV	54.01	1.64	-20.00	N/A	35.65	54.00	18.35
2387.30	H	Y	PK	50.65	1.70	N/A	N/A	52.35	74.00	21.65
2388.95	H	Y	AV	50.65	1.70	-20.00	N/A	32.35	54.00	21.65
4808.94	V	Y	PK	52.75	5.47	N/A	N/A	58.22	74.00	15.78
4811.04	V	Y	AV	52.75	5.47	-20.00	N/A	38.22	54.00	15.78
7213.40	V	Y	PK	43.47	7.87	N/A	N/A	51.34	74.00	22.66
7216.58	V	Y	AV	43.47	7.88	-20.00	N/A	31.35	54.00	22.65

▪ Middle Channel

Frequency (MHz)	ANT Pol	EUT Position (Axis)	Detector Mode	Reading (dBuV)	T.F (dB/m)	D.C.F (dB)	Distance Factor(dB)	Result (dBuV/m)	Limit (dBuV/m)	Margin (dB)
4880.96	V	Y	PK	52.69	5.63	N/A	N/A	58.32	74.00	15.68
4881.02	V	Y	AV	52.69	5.63	-20.00	N/A	38.32	54.00	15.68
7318.52	V	Y	PK	43.49	8.04	N/A	N/A	51.53	74.00	22.47
7318.74	V	Y	AV	43.49	8.04	-20.00	N/A	31.53	54.00	22.47

▪ Highest Channel

Frequency (MHz)	ANT Pol	EUT Position (Axis)	Detector Mode	Reading (dBuV)	T.F (dB/m)	D.C.F (dB)	Distance Factor(dB)	Result (dBuV/m)	Limit (dBuV/m)	Margin (dB)
2483.58	H	Y	PK	55.06	1.79	N/A	N/A	56.85	74.00	17.15
2483.58	H	Y	AV	55.06	1.79	-20.00	N/A	36.85	54.00	17.15
4951.00	V	Y	PK	53.95	5.74	N/A	N/A	59.69	74.00	14.31
4950.92	V	Y	AV	53.95	5.74	-20.00	N/A	39.69	54.00	14.31
7423.42	V	Y	PK	45.60	7.90	N/A	N/A	53.50	74.00	20.50
7426.52	V	Y	AV	45.60	7.89	-20.00	N/A	33.49	54.00	20.51

▪ **Note.**

1. The radiated emissions were investigated up 25GHz. And no other spurious and harmonic emissions were found above listed frequencies.
2. Information of Distance Factor

   For finding emissions, the test distance might be reduced from 3 m to 1 m. In this case, the distance factor (-9.54 dB) is applied to the result.

   - Calculation of distance factor = 20 log(applied distance / required distance) = **20 log(1 m / 3 m)** = **-9.54 dB**

   When distance factor is “N/A”, the distance is 3 m and distance factor is not applied.
3. Sample Calculation.

   Margin = Limit – Result / Result = Reading + T.F + D.C.F / T.F = AF + CL – AG

   Where, T.F = Total Factor, AF = Antenna Factor, CL = Cable Loss, AG = Amplifier Gain,

   DCF = Duty Cycle Correction Factor.

   Duty cycle Correction factor = 20 x log (10ms/100ms) = -20dB

3.6 Power line Conducted Emissions

▣ **Test Requirements and limit, §15.207 & RSS-Gen [8.8]**

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).

Frequency Range (MHz)	Conducted Limit (dBuV)	
	Quasi-Peak	Average
0.15 ~ 0.5	66 to 56 *	56 to 46 *
0.5 ~ 5	56	46
5 ~ 30	60	50

* Decreases with the logarithm of the frequency

Compliance with this provision shall be based on the measurement of the radio frequency voltage between each power line (LINE and NEUTRAL) and ground at the power terminals.

3.6.1 Test Setup

See test photographs for the actual connections between EUT and support equipment.

3.6.2 Test Procedures

Conducted emissions from the EUT were measured according to the ANSI C63.10.

1. The test procedure is performed in a 6.5 m × 3.5 m × 3.5 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. All peripherals were connected to the second LISN and the chassis ground also bounded to the horizontal ground plane of shielded room.
4. The excess power cable between the EUT and the LISN was bundled. The power cables of peripherals were unbundled. All connecting cables of EUT and peripherals were moved to find the maximum emission.

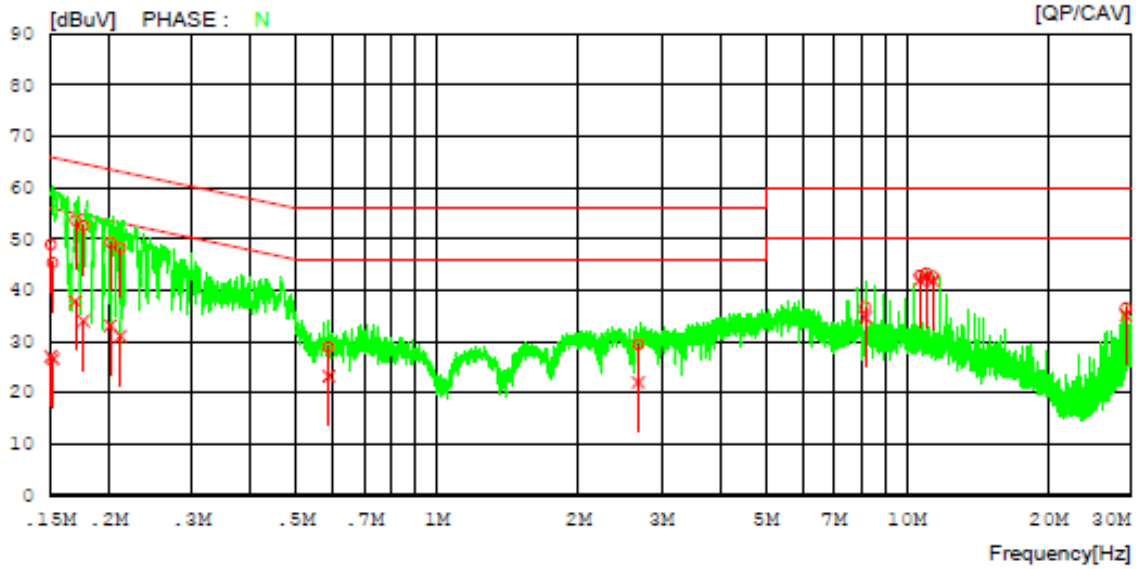
3.6.3 Test Results

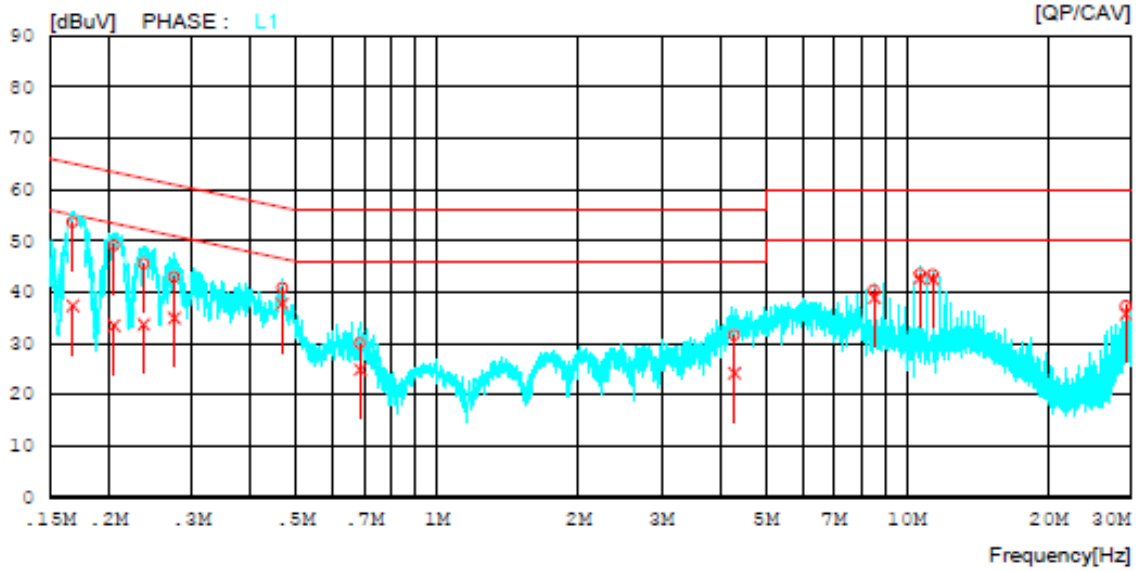
AC Line Conducted Emissions (Graph) : TM 1(M/N: CIOT-700M)

Order No.		Referrence No.	
Model No.	CIOT-700M	Power Supply	120V ,60Hz
Serial No.		Temp/Humi.	23'C , 45%
Test Condition		Operator	

Memo Zigbee

LIMIT : FCC P15.207 QP
FCC P15.207 AV





AC Line Conducted Emissions (List) : TM 1(M/N: CIOT-700M)

Order No.		Referrence No.	
Model No.	CIOT-700M	Power Supply	120V ,60Hz
Serial No.		Temp/Humi.	23'C , 45%
Test Condition		Operator	

Memo Zigbee

LIMIT : FCC P15.207 QP
FCC P15.207 AV

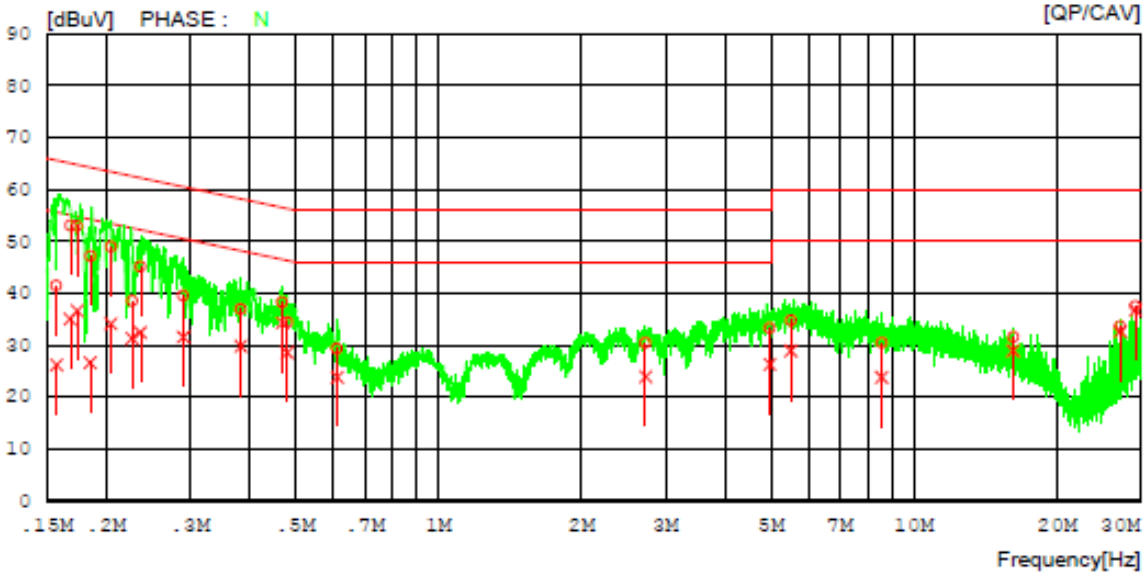
NO	FREQ	READING QP	READING CAV	C.FACTOR	RESULT QP	RESULT CAV	LIMIT QP	LIMIT CAV	MARGIN QP	MARGIN CAV	PHASE
	[MHz]	[dBuV]	[dBuV]	[dB]	[dBuV]	[dBuV]	[dBuV]	[dBuV]	[dBuV]	[dBuV]	
1	0.15071	38.56	16.83	10.29	48.85	27.12	65.96	55.96	17.11	28.84	N
2	0.15230	35.08	16.32	10.28	45.36	26.60	65.87	55.87	20.51	29.27	N
3	0.16985	43.41	27.67	10.18	53.59	37.85	64.97	54.97	11.38	17.12	N
4	0.17691	42.40	23.87	10.14	52.54	34.01	64.63	54.63	12.09	20.62	N
5	0.20167	39.33	23.11	10.00	49.33	33.11	63.54	53.54	14.21	20.43	N
6	0.21191	38.24	21.08	10.00	48.24	31.08	63.13	53.13	14.89	22.05	N
7	0.58815	18.79	13.18	10.04	28.83	23.22	56.00	46.00	27.17	22.78	N
8	2.68360	19.35	11.92	10.13	29.48	22.05	56.00	46.00	26.52	23.95	N
9	8.16480	26.38	24.39	10.32	36.70	34.71	60.00	50.00	23.30	15.29	N
10	10.65380	32.51	31.65	10.38	42.89	42.03	60.00	50.00	17.11	7.97	N
11	11.00740	32.92	32.07	10.40	43.32	42.47	60.00	50.00	16.68	7.53	N
12	11.36400	32.35	31.50	10.41	42.76	41.91	60.00	50.00	17.24	8.09	N
13	29.23660	25.75	24.42	10.71	36.46	35.13	60.00	50.00	23.54	14.87	N
14	0.16772	43.48	27.09	10.16	53.64	37.25	65.07	55.07	11.43	17.82	L1
15	0.20532	39.05	23.46	9.98	49.03	33.44	63.39	53.39	14.36	19.95	L1
16	0.23766	35.56	23.66	9.97	45.53	33.63	62.18	52.18	16.65	18.55	L1
17	0.27576	32.92	24.95	9.98	42.90	34.93	60.94	50.94	18.04	16.01	L1
18	0.46818	30.73	27.69	10.00	40.73	37.69	56.55	46.55	15.82	8.86	L1
19	0.68553	19.96	14.83	10.01	29.97	24.84	56.00	46.00	26.03	21.16	L1
20	4.29420	21.40	14.01	10.16	31.56	24.17	56.00	46.00	24.44	21.83	L1
21	8.52180	30.01	28.62	10.30	40.31	38.92	60.00	50.00	19.69	11.08	L1
22	10.65280	33.10	32.31	10.33	43.43	42.64	60.00	50.00	16.57	7.36	L1
23	11.36300	33.06	32.15	10.36	43.42	42.51	60.00	50.00	16.58	7.49	L1
24	29.23580	26.54	25.03	10.65	37.19	35.68	60.00	50.00	22.81	14.32	L1

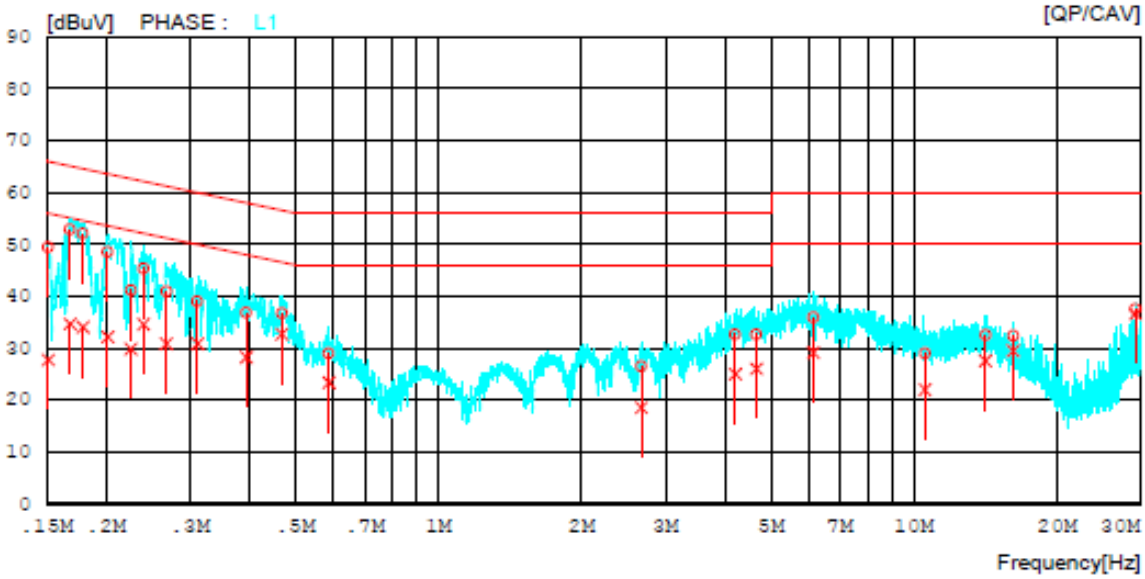
AC Line Conducted Emissions (Graph) : TM 2(M/N: CIOT-1020M)

Order No.		Referrence No.	
Model No.	CIOT-1020M	Power Supply	120V ,60Hz
Serial No.		Temp/Humi.	23'C , 45%
Test Condition		Operator	

Memo Zigbee

LIMIT : FCC P15.207 QP
FCC P15.207 AV





AC Line Conducted Emissions (List) : TM 2(M/N: CIOT-1020M)

Order No.		Referrence No.	
Model No.	CIOT-1020M	Power Supply	120V ,60Hz
Serial No.		Temp/Humi.	23'C , 45%
Test Condition		Operator	

Memo Zigbee

LIMIT : FCC P15.207 QP
FCC P15.207 AV

NO	FREQ	READING QP	READING CAV	C.FACTOR	RESULT QP	RESULT CAV	LIMIT QP	LIMIT CAV	MARGIN QP	MARGIN CAV	PHASE
	[MHz]	[dBuV]	[dBuV]	[dB]	[dBuV]	[dBuV]	[dBuV]	[dBuV]	[dBuV]	[dBuV]	
1	0.15725	31.19	15.98	10.25	41.44	26.23	65.61	55.61	24.17	29.38	N
2	0.16809	42.90	24.90	10.19	53.09	35.09	65.05	55.05	11.96	19.96	N
3	0.17379	42.80	26.47	10.16	52.96	36.63	64.78	54.78	11.82	18.15	N
4	0.18503	37.14	16.58	10.08	47.22	26.66	64.26	54.26	17.04	27.60	N
5	0.20447	38.97	24.15	10.00	48.97	34.15	63.43	53.43	14.46	19.28	N
6	0.22669	28.54	21.31	10.00	38.54	31.31	62.57	52.57	24.03	21.26	N
7	0.23591	35.15	22.46	10.00	45.15	32.46	62.24	52.24	17.09	19.78	N
8	0.29033	29.53	21.59	10.02	39.55	31.61	60.51	50.51	20.96	18.90	N
9	0.38374	26.95	19.83	10.02	36.97	29.85	58.20	48.20	21.23	18.35	N
10	0.46905	28.32	24.30	10.02	38.34	34.32	56.53	46.53	18.19	12.21	N
11	0.48064	24.36	18.59	10.02	34.38	28.61	56.33	46.33	21.95	17.72	N
12	0.61214	19.32	13.80	10.04	29.36	23.84	56.00	46.00	26.64	22.16	N
13	2.72720	20.37	13.85	10.13	30.50	23.98	56.00	46.00	25.50	22.02	N
14	4.97780	23.12	16.08	10.23	33.35	26.31	56.00	46.00	22.65	19.69	N
15	5.50980	24.50	18.64	10.25	34.75	28.89	60.00	50.00	25.25	21.11	N
16	8.55780	20.12	13.45	10.34	30.46	23.79	60.00	50.00	29.54	26.21	N
17	16.16760	21.09	18.44	10.53	31.62	28.97	60.00	50.00	28.38	21.03	N
18	27.15720	23.00	22.02	10.68	33.68	32.70	60.00	50.00	26.32	17.30	N
19	29.23540	26.83	26.08	10.71	37.54	36.79	60.00	50.00	22.46	13.21	N
20	0.15091	39.13	17.43	10.25	49.38	27.68	65.95	55.95	16.57	28.27	L1
21	0.16782	42.68	24.46	10.16	52.84	34.62	65.07	55.07	12.23	20.45	L1
22	0.17882	41.90	23.90	10.10	52.00	34.00	64.54	54.54	12.54	20.54	L1
23	0.20136	38.52	22.14	9.98	48.50	32.12	63.55	53.55	15.05	21.43	L1
24	0.22536	31.10	19.77	9.97	41.07	29.74	62.62	52.62	21.55	22.88	L1
25	0.23954	35.36	24.60	9.97	45.33	34.57	62.11	52.11	16.78	17.54	L1
26	0.26757	30.93	20.84	9.98	40.91	30.82	61.19	51.19	20.28	20.37	L1
27	0.31095	28.94	20.87	9.98	38.92	30.85	59.95	49.95	21.03	19.10	L1
28	0.39400	26.75	18.24	9.99	36.74	28.23	57.98	47.98	21.24	19.75	L1
29	0.46821	26.68	22.66	10.00	36.68	32.66	56.55	46.55	19.87	13.89	L1
30	0.58768	18.89	13.29	10.01	28.90	23.30	56.00	46.00	27.10	22.70	L1
31	2.66960	16.33	8.38	10.10	26.43	18.48	56.00	46.00	29.57	27.52	L1
32	4.20660	22.44	14.80	10.16	32.60	24.96	56.00	46.00	23.40	21.04	L1
33	4.66460	22.41	15.79	10.18	32.59	25.97	56.00	46.00	23.41	20.03	L1
34	6.14800	25.64	18.90	10.23	35.87	29.13	60.00	50.00	24.13	20.87	L1
35	10.54760	18.61	11.59	10.33	28.94	21.92	60.00	50.00	31.06	28.08	L1
36	14.15180	22.00	17.09	10.45	32.45	27.54	60.00	50.00	27.55	22.46	L1
37	16.16600	21.87	18.94	10.48	32.35	29.42	60.00	50.00	27.65	20.58	L1
38	29.23420	26.84	25.90	10.65	37.49	36.55	60.00	50.00	22.51	13.45	L1

3.7 Occupied Bandwidth

▣ **Test Requirements, RSS-Gen [6.7]**

When an occupied bandwidth value is not specified in the applicable RSS, the transmitted signal bandwidth to be reported is to be its 99 % emission bandwidth, as calculated or measured.

3.7.1 Test Setup

NA

3.7.2 Test Procedures

The 99 % power bandwidth was measured with a calibrated spectrum analyzer.

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 3 × RBW.

Spectrum analyzer plots are included on the following pages.

3.7.3 Test Results

NA

4. ANTENNA REQUIREMENTS

▣ **According to FCC 47 CFR §15.203**

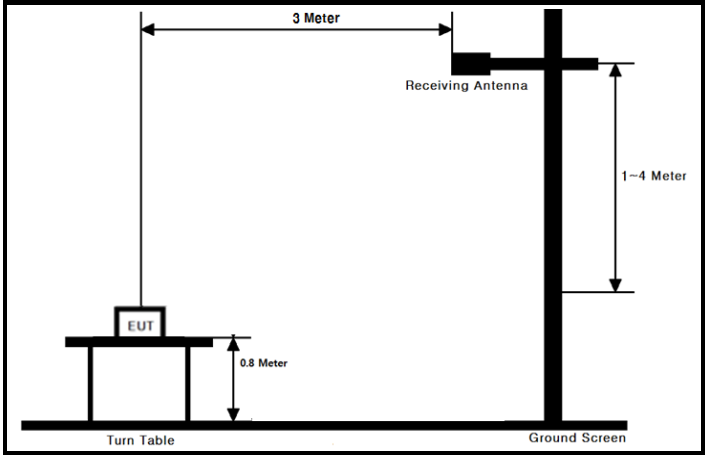
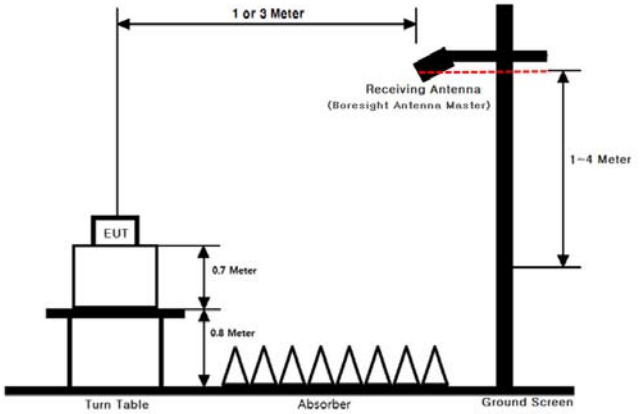
"An intentional radiator antenna shall be designed to ensure that no antenna other than that furnished by the responsible party can be used with the device. The use of a permanently attached antenna or of an antenna that uses a unique coupling to the intentional radiator shall be considered sufficient to comply with the provisions of this section."

The Antenna is permanently attached.
Therefore this E.U.T Complies with the requirement of §15.203

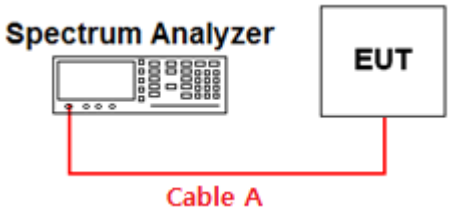
APPENDIX I

Test set up diagrams

- **Radiated Measurement**

Below 1GHz	Above 1GHz
	

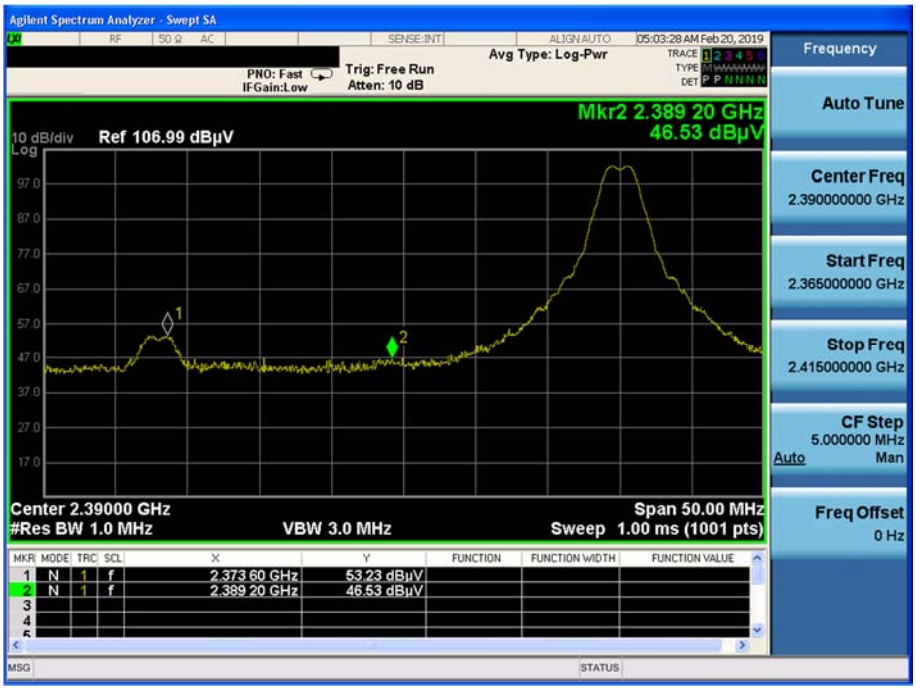
- **Conducted Measurement**



APPENDIX II

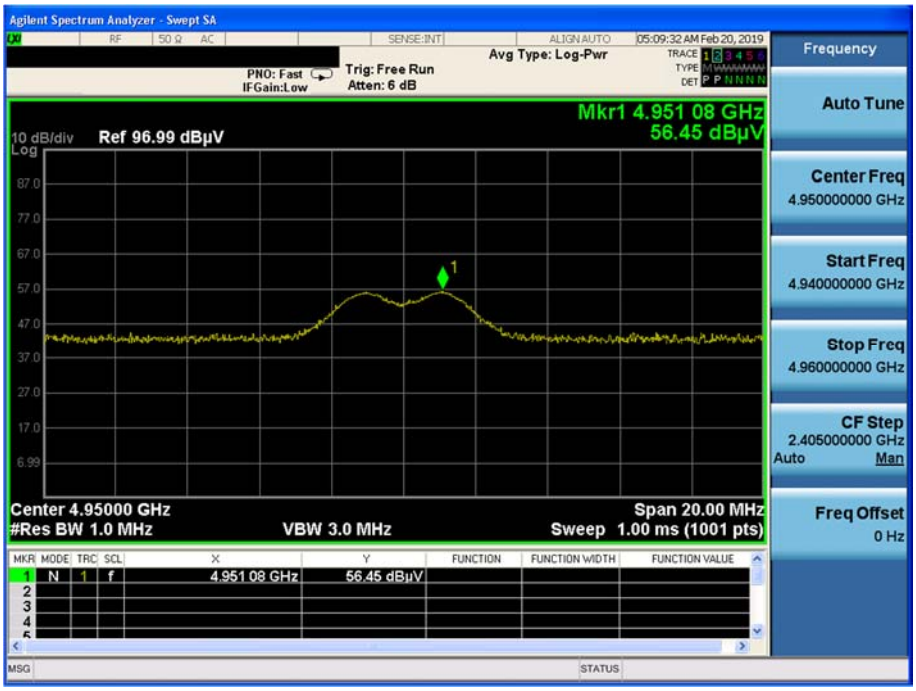
Unwanted Emissions (Radiated) Test Plot, TM 1(M/N: CIOT-700M)

TM1 & Lowest & Y & Hor **Detector Mode : PK**



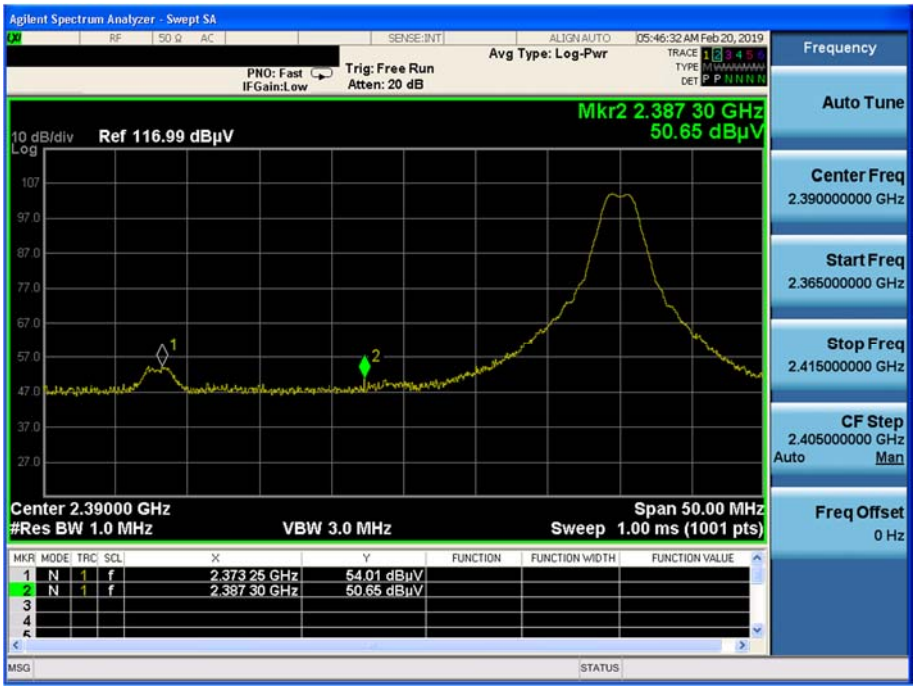
TM1 & Highest & Y & Hor **Detector Mode : PK**

TM1 & Highest & Y & Ver **Detector Mode : PK**



Unwanted Emissions (Radiated), TM 2(M/N: CIOT-700M)

TM1 & Lowest & Y & Hor **Detector Mode : PK**



TM1 & Highest & Y & Hor **Detector Mode : PK**

TM1 & Highest & Y & Ver **Detector Mode : PK**