Korea Testing Certification institute

Test Report

Report No. : CE2023-00008

Company : Olive Union Inc.
Representative : Jayden, Lee
Address : 5F, 24, Banpo-daero 28-gil, Seocho-gu, Seoul, Republic of Korea

1. Product Name : Olive Remote

 -Model Name: OU1P0202

2. FCC ID : 2AOLH-OU1P0202

3. Date of Receipt : 2023-02-03

4. Date of test : 2023-02-03 ~ 2023-03-16

5. Test Method : 47CFR Part15 Subpart C §15.247

6. Test Result : PASS

Tested by : Chang Min, Bae

Approved by : Sung Ryul, Kim

1. This result of the above report are unrelated to KS Q ISO/IEC 17025 and KOLAS recognition and the result of testing with samples and sample names suggested by the client does not guarantee the quality of entire products

2. This report should not be used for advertising, lawsuit, etc. without any official permission of KTC. It is only used for the purpose of the quality test.

3. The authenticity of the report is available on the website (www.ktc.re.kr)

2023. 03. 16.

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1. General Information

1.1. Summary

Testing Laboratory	Korea Testing Certification
Testing location / address	22 Heungan-daero 27 beon-gil, Gunpo-si, Gyeonggi-Do, 15809, Republic of Korea
Applicant	Olive Union Inc.
Address of Applicant	5F, 24, Banpo-daero 28-gil, Seocho-gu, Seoul, Republic of Korea
Contact Person of Applicant	Jayden, Lee
Phone Number of Applicant	+82-2-585-0701
Manufacturer	INTOPS.CO.LTD
Address of Manufacture	7, Saneop-ro, Gwonseon-gu, Suwon-si, Gyeonggi-do, Republic of Korea
Product Name	Olive Remote
Model Name	OU1P0202
Variants Model	-
Power Supply	DC 3.0 V
Frequency Range	2 402 MHz ~ 2480 MHz (BLE)
Modulation	GFSK
Number of Channels	40 channels
Operation Temperature	0 ℃ ~ 40 ℃
Antenna Type / Antenna Gain	Chip Antenna / 1.62 dBi
Hardware Version	V03
Software Version	1.0.0

1.2. Test Information

1.2.1 Supporting Equipment Used During Test

Use	Manufacturer	Model	Comments
EUT	INTOPS.CO.LTD	OU1P0202	-
AE	LG Electronics Inc.	14ZD960	Laptop
Supplementary information EUT = Equipment Under Test, AE = Auxiliary / Associated Equipment, SIM = Simulator (Not Subjected to Test)			

1.2.2 Report revision History

Issue date	Report No.	Reason for issue
2022-03-16	CE2023-00008	First issued.

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1.3. Result Summary

Standard Section	Requirement – Test Standard : FCC Part 15 Subpart C	Result / Comments
15.205(a) 15.209 15.247(d)	Transmitter Radiated Spurious Emissions and Conducted Spurious Emission	Complied with requirement
15.247(a)(2)	6 ㏈ Bandwidth	Complied with requirement
15.247(b)(3)	Maxnimum Peak Conducted Output Power	Complied with requirement
15.247(e)	Peak Power Spectral Density	Complied with requirement
15.207	AC Power Line Conducted Emission	N/A[1)]

Note;
1) Please refer to FCC 15.207 which states, “Measurements to demonstrate compliance with the conducted limits are not required for devices employ Battery for operation and which do not operate from the AC power lines or contain provisions for operation while connected to the AC power lines”. Therefore, for this device, AC Power Line Conducted Emissions investigation is not required.

- All measurements contained in this report were conducted with ANSI C63.10-2013, American National Standard of Procedures for Compliance Testing of Unlicensed Wireless Devices and KDB 558074 D01 15.247 Meas Guidance V05r02.

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1.4. List of Test Equipment

Test Equipment Used					
Equipment	Model	Manufacturer	Serial Number	Last Cal. Date	Cal. Due Date
EMI Test Receiver	N9038A	Agilent	MY53290083	17/08/2021	17/08/2022
Turn Table	DT3000-3t	Innco Systems	-	-	-
Antenna Mast	MA4640-XP-ET-0800	Innco Systems	-	-	-
Loop Antenna	HFH2-Z2E	ROHDE & SCHWARZ	100982	30/11/2021	30/11/2022
Bilog Antenna	VULB9168	Schwarzbeck	01044	09/09/2021	09/09/2023
Horn Antenna	HF907	ROHDE & SCHWARZ	102641	31/03/2021	31/03/2022
Horn Antenna	QSH-SL-18-26-s-20	STEATITE ANTENNA	17871	31/03/2021	31/03/2022
Pre Amplifier	310	SONOMA	340215(4417)	24/01/2022	24/01/2023
Pre Amplifier	SCU-18F	ROHDE & SCHWARZ	180039(5872-13)	30/03/2021	30/03/2022
Pre Amplifier	SCU-26D	ROHDE & SCHWARZ	2030826	31/03/2021	31/03/2022
P-Series dual channel power meter	N1912A	Keysight	MY45100764	10/01/2022	10/01/2023
power sensor	N1921A	Keysight	MA45241181	10/01/2022	10/01/2023
Spectrum Analyzer	FSV30	ROHDE & SCHWARZ	103924	10/05/2021	10/05/2022
DC Power Supply	66319D	Agilent	MY43001744	18/08/2021	18/08/2022
Spectrum Analyzer	FSW43	ROHDE & SCHWARZ	104246	18/08/2021	18/08/2022

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1.5. Measurement uncertainty

Parameter		Uncertainty
RF Output Power		± 0.26 dB
Power Spectral Density		± 0.83 dB
Conducted Spurious Emission		± 0.83 dB
Radiated Emission, 9 kHz to 30 MHz	H	± 3.56 dB
	V	± 3.56 dB
Radiated Emission, below 1 GHz	H	± 3.86 dB
	V	± 4.00 dB
Radiated Emission, above 1 GHz	H	± 4.78 dB
	V	± 4.72 dB

Note;
-This uncertainly represents an expanded uncertainty expressed at approximately 95% confidence level using a coverage factor of k=2.

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1.6. Channel Lists – Bluetooth low energy

Channel	Frequency	Channel	Frequency
0	2402	20	2442
1	2404	21	2444
2	2406	22	2446
3	2408	23	2448
4	2410	24	2450
5	2412	25	2452
6	2414	26	2454
7	2416	27	2456
8	2418	28	2458
9	2420	29	2460
10	2422	30	2462
11	2424	31	2464
12	2426	32	2466
13	2428	33	2468
14	2430	34	2470
15	2432	35	2472
16	2434	36	2474
17	2436	37	2476
18	2438	38	2478
19	2440	39	2480

1.7. Information of test software

-During testing channel & power controlling software provided by the customer was used to control the operating channel as well as the output power level.

- Test software version - nRF_DTM_v0.10.2

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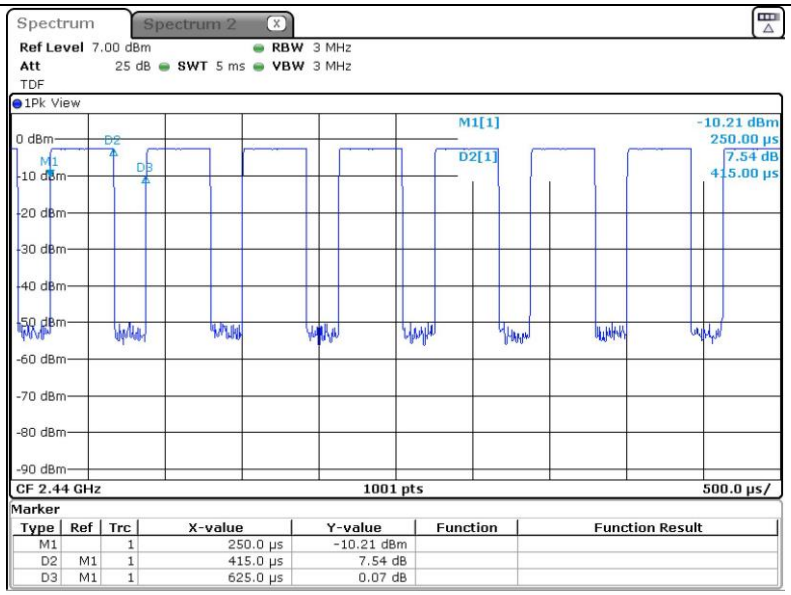
1.8. Duty cycle

Referred to KDB 558074 D01 15.247 Meas Guidance v05r02.
Set RBW ≥ OBW if possible; otherwise, set RBW to the largest available value.
Set detector = peak or average
The zero-span measurement method shall not be used unless both RBW and VBW are >50/T and the number of sweep points across duration T exceeds 100.

Test Mode	Period (㎳)	On time (㎳)	Duty cycle (%)	Duty Cycle Factor (㏈)
1M PHY	0.625	0.415	66	1.8
Duty cycle (%) : (TX on time / (TX on + Tx off) time) x 100 Duty cycle factor(㏈) : 10 log(1/ Duty cycle)				

Test plot
1M PHY



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2. Antenna Requirement

47 CFR § 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. 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.
Antenna of EUT
Antenna used in this product is PCB Embedded Antenna. Gain = 1.62 dBi

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3. Spurious Emissions, Restriced Band Edges

3.1. Limit

47 CFR Part 15

Section § 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 § 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)).

Section § 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 (㎒)	Field Strength (microvolts/meter)	Measurement Distance (Meters)
0.009-0.490	2 400/F(㎑)	300
0.490-1.705	24 000/F(㎑)	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 paragraph (g), fundamental emissions from intentional radiators operating under this section shall not be located in the frequency bands 54-72 ㎒, 76-88 ㎒, 174-216 ㎒ or 470-806 ㎒. However, operation within these frequency bands is permitted under other sections of this part, e.g., §§15.231 and 15.241.

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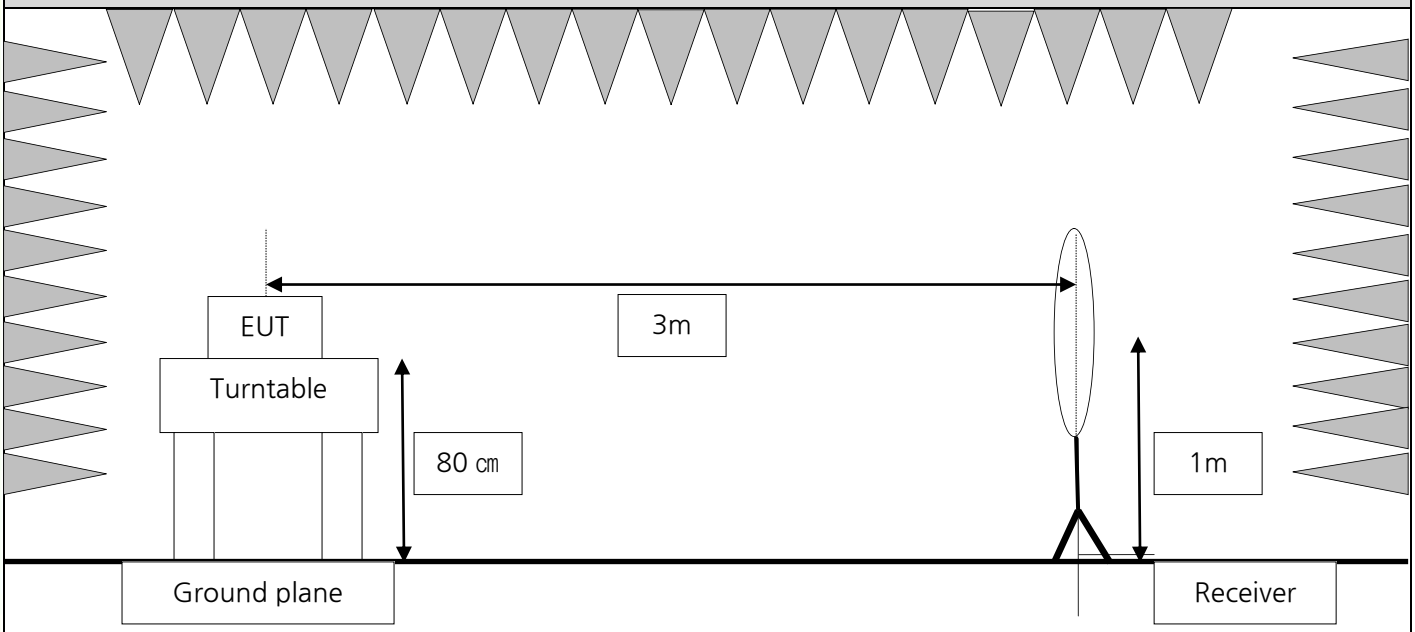
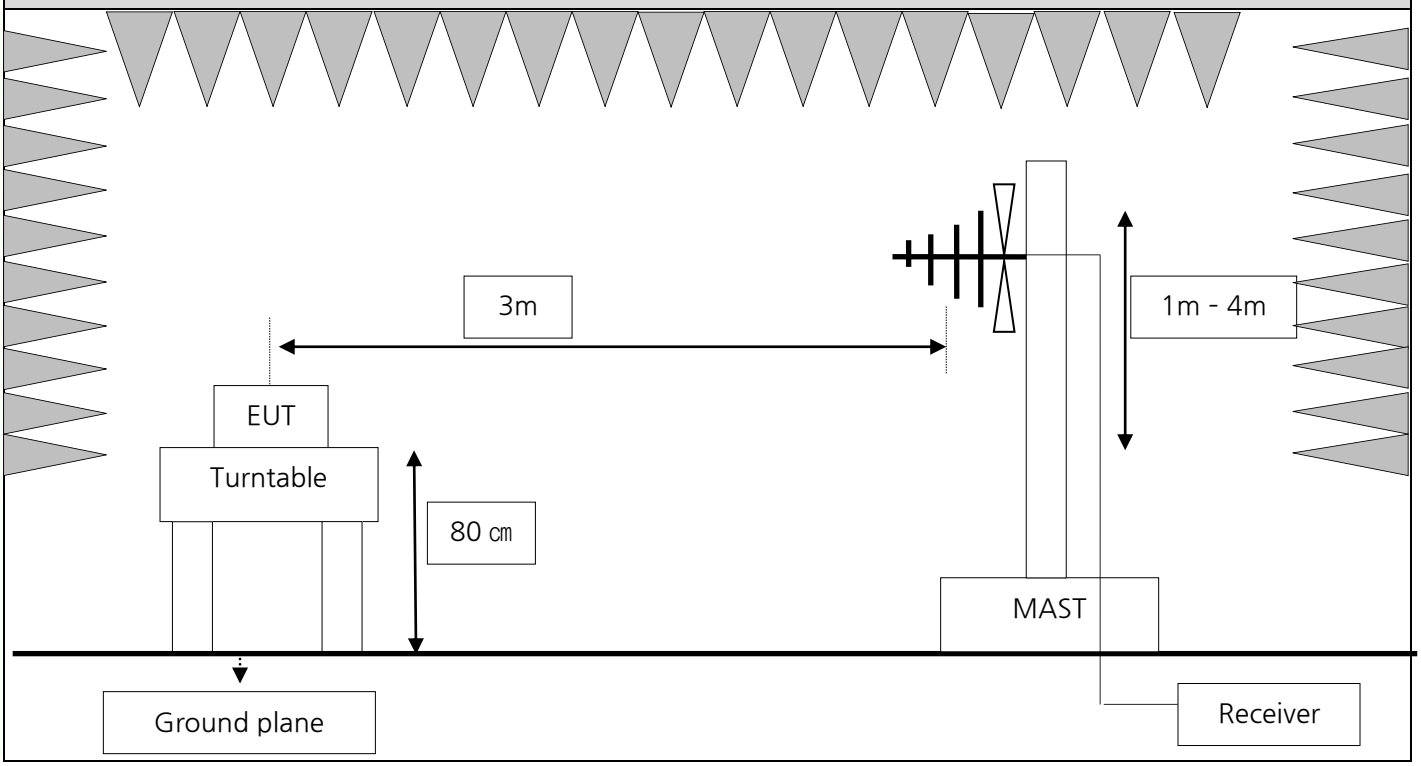
3.2. Test Configuration

Test Setup for radiated test (Below 30 ㎒)



Test Setup for radiated test (30 ㎒ to 1 ㎓)



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Test Result

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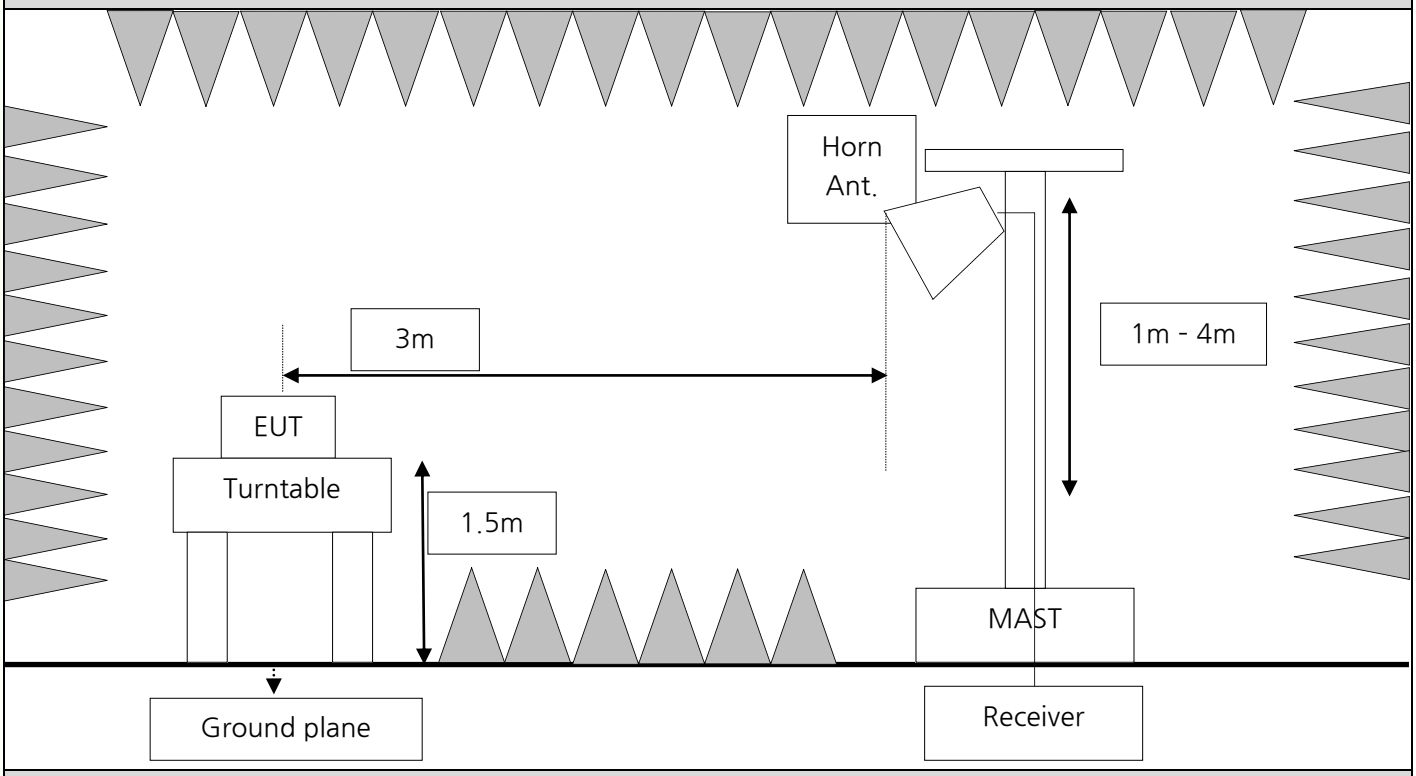
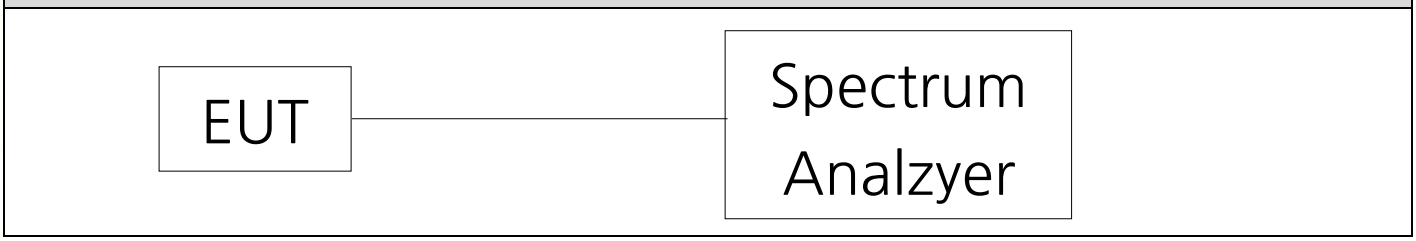
Test Setup for radiated test (Above 1 ㎓)



Test Setup for Conducted test



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3.3. Test Procedure

Radiated emissions from the EUT were measured according to the dictates in section 11.11 & 11.12 of ANSI C63.10-2013.
Test Procedure of Radiated emissions(Below 30 MHz)
1. The EUT was placed on a non-conductive rotating table 0.8 meters above the ground at semi-anechoic chamber. 2. The loop antenna was placed at a location 3 m from the EUT. 3. The loop antenna is fixed at 1 meter above the ground. 4. Find Worst condition on the X-axis, Y-axis, and Z-axis of EUT. 5. Both horizontal and vertical polarization of the antenna are set to make the measurement. 6. The turntable shall be rotated for 360 degrees to determine the position of maximum emission level. . Spectrum Setting - Frequency Range = 9 ㎑ ~ 30 ㎒ - Detector = Peak - Trace = Maxhold - RBW = 9 kHz - VBW ≥ 3 x RBW - Allow sweeps to continue until the trace stabilizes.
Correction Factor for measurement distance at 3m(0.009 MHz – 0.490 MHz) = 40log(3 m/300 m) = - 80 dB Correction Factor for measurement distance at 3m (0.490 MHz – 30 MHz) = 40log(3 m/30 m) = - 40 dB Actual value = Measured Value + Antenna Factor + Cable Loss + Correction Factor(Distance Factor)
Test Procedure of Radiated emissions(Below 1 ㎓)
1. The EUT was placed on a non-conductive rotating table 0.8 meters above the ground at semi-anechoic chamber. 2. Find Worst condition on the X-axis, Y-axis, and Z-axis of EUT. 3. There is a bi-log antenna and a horn antenna, its height are varied from 1m to 4m to determine the maximum value of the field strength. 4. Both horizontal and vertical polarization of the antenna are set to make the measurement. 5. The turntable shall be rotated for 360 degrees to determine the position of maximum emission level. (1) Measurement Type(Peak): - Measured Frequency Range : 30 MHz – 1 GHz - Detector = Peak - Trace = Maxhold - RBW = 100 kHz - VBW ≥ 3 x RBW (2) Measurement Type(Quasi-peak): - Measured Frequency Range : 30 MHz – 1 GHz - Detector = Quasi-Peak - RBW = 120 kHz
Actual value = Measured Value + Antenna Factor + Cable Loss

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Test Procedure of Radiated emissions(Above 1 ㎓)
1. The EUT was placed on a non-conductive rotating table 1.5 meters above the ground at semi-anechoic chamber. 2. Find Worst condition on the X-axis, Y-axis, and Z-axis of EUT. 3. There is a horn antenna, its height is varied from 1m to 4m to determine the maximum value of the field strength. 4. Both horizontal and vertical polarization of the antenna are set to make the measurement. 5. The turntable shall be rotated for 360 degrees to determine the position of maximum emission level. Spectrum Setting (Method 8.6 in KDB 558074 v05r02, Procedure 11.12 in ANSI 63.10-2013) (1) Measurement Type(Peak): - Measured Frequency Range : 1 GHz – 25 GHz - Detector = Peak - Trace = Max hold - RBW = 1 MHz - VBW ≥ 3 x RBW - Allow sweeps to continue until the trace stabilizes. (2) Measurement Type(Average): - Duty cycle < 98 %, duty cycle variations are less than ±2 % - Measured Frequency Range : 1 GHz – 25 GHz - Detector = RMS - Averaging type = power (*i.e.*, RMS) - RBW = 1 MHz - VBW ≥ 3 x RBW - Sweep time = auto. - Trace mode = perfom a trace average of at least 100 traces. - 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. 6. Distance extrapolation factor = 20log (test distance / specific distance) (dB)
Actual value(Peak) = Measured Value + Antenna Factor + Cable Loss + distance extrapolation factor Actual value(Average) = Measured Value + Antenna Factor + Cable Loss + distance extrapolation factor + duty cycle factor Note; If the peak detected amplitude can be shown to comply with the average limit, then it is not necessary to perform a separate average measurement.

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Test Procedure for Radiated Restricted Band Edge
1. The EUT was placed on a non-conductive rotating table 1.5 meters above the ground at semi-anechoic chamber. 2. Find Worst condition on the X-axis, Y-axis, and Z-axis of EUT. 3. There is a horn antenna, its height is varied from 1m to 4m to determine the maximum value of the field strength. 4. Both horizontal and vertical polarization of the antenna are set to make the measurement. 5. The turntable shall be rotated for 360 degrees to determine the position of maximum emission level. Spectrum Setting (Method 8.6 in KDB 558074 v05r02, Procedure 11.12 in ANSI 63.10-2013) (1) Measurement Type(Peak): - Measured Frequency Range : 2310 MHz ~ 2390 MHz/ 2483.5 MHz ~ 2500 MHz - Detector = Peak - Trace = Max hold - RBW = 1 MHz - VBW ≥ 3 x RBW (2) Measurement Type(Average): - Duty cycle < 98 %, duty cycle variations are less than ±2 % - Measured Frequency Range : 2310 MHz ~ 2390 MHz/ 2483.5 MHz ~ 2500 MHz - Detector = RMS - Averaging type = power (*i.e.*, RMS) - RBW = 1 MHz - VBW ≥ 3 x RBW - Sweep time = auto. - Trace mode = perfom a trace average of at least 100 traces. - 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. 6. Distance extrapolation factor = 20log (test distance / specific distance) (dB)
Actual value(Peak) = Measured Value + Antenna Factor + Cable Loss + distance extrapolation factor Actual value(Average) = Measured Value + Antenna Factor + Cable Loss + distance extrapolation factor + duty cycle factor Note; If the peak detected amplitude can be shown to comply with the average limit, then it is not necessary to perform a separate average measurement.

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Test Procedure of Conducted emissions
1. Conducted Emissions at Band Edge Set the center frequency and span to encompass frequency range to be measured. - RBW = 100 ㎑ - VBW ≥ 3 x RBW - Detector = Peak - Sweep time = auto - Trace mode = Max hold - Allow sweeps to continue until the trace stabilizes. 2. Conducted Spurious Emissions Start frequency was set to 9 ㎑ and stop frequency was set to 25 ㎓ - RBW = 1 ㎒, - VBW ≥ 3 x RBW - Detector = Peak - Sweep time = auto - Trace = Max hold - Allow sweeps to continue until the trace stabilizes. 3. TDF function - measure to conducted emissions from 9 ㎑ to 25 ㎓. - path loss of frequency range was compensated to spectrum analyzer as TDF function.

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3.4. Test Results

Ambient Temp.	23 ± 1 ℃
Relative Humidity	43 %
Test Result	PASS (Refer to below)

Note;
- Actual Value(dBμV/m) = Measured Value(dBμV) + Correction Factors(dB/m). - The Actual Value using the peak detector does not include the duty factor. - The measured of emissions are not reporting much lower than the limits by over 20 dB. - Margin Value = Emission level – Limit Value.

Fequency Range : 9 kHz~30 MHz

- 1M PHY

Radiated Emission results (2 480 MHz)								
Measured Frequency (MHz)	**Measured Value (dBμV)**	**Antenna Polarization (H/V)**	**Antenna Factor (dB)**	**(Amp + Cable Loss) (dB)**	**Duty Factor (dB)**	**Actual Value (dBμV/m)**	**Limit (dBμV/m)**	**Margin (dB)**
- 9 kHz~30 MHz have been test and test data more than 20 dB margin.								
Note; - The results of the emissions at frequencies(2 402 MHz, 2 440 MHz, 2 480 MHz) were almost the same.								

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Fequency Range : 30 ㎒ ~ 1 ㎓

- 1M PHY

Radiated Emission results								
Measured Frequency (㎒)	Measured Value (dB㎶)	Detector	Antenna Polarization (H/V)	(Antenna Factor + Amp + Cable Loss) (dB)	Duty Factor (dB)	Actual Value (dB㎶/m)	Limit (dB㎶/m)	Margin (dB)
33.40	38.60	Peak	V	-18.60	-	20.00	40.00	20.00
53.77	40.50	Peak	V	-16.60	-	23.90	40.00	16.10
146.76	29.00	Peak	V	-15.70	-	13.30	43.50	30.20
437.16	30.10	Peak	H	-9.50	-	20.60	46.00	25.40
509.42	30.50	Peak	V	-7.50	-	23.00	46.00	23.00
559.98	31.00	Peak	H	-6.10	-	24.90	46.00	21.10

Note;
-The results of the emissions at frequencies(2 402 ㎒, 2 440 ㎒, 2 480 ㎒) were almost the same.
-Among other frequencies, the worst results were reported (**1M PHY, 2480 ㎒**).

Fequency Range : 1~ 25 ㎓

- 1M PHY – 2 402 ㎒ (0 ch)

Radiated restricted band edge results									
Measured Frequency (㎒)	Measured Value (dB㎶)	Detector	Antenna Polarization (H/V)	Antenna Factor (dB)	(Amp + Cable Loss) (dB)	Duty Factor (dB)	Actual Value (dB㎶/m)	Limit (dB㎶/m)	Margin (dB)
2356.45	50.13	Peak	H	28.61	-33.05	-	45.69	74.00	28.31
2348.55	38.68	Average	H	28.59	-33.07	1.80	36.00	54.00	18.00

Radiated Emission results									
Measured Frequency (㎒)	Measured Value (dB㎶)	Detector	Antenna Polarization (H/V)	Antenna Factor (dB)	(Amp + Cable Loss) (dB)	Duty Factor (dB)	Actual Value (dB㎶/m)	Limit (dB㎶/m)	Margin (dB)
4804.18	48.77	Peak	H	34.22	-28.75	-	54.24	74.00	19.76
4804.28	42.80	Average	H	34.22	-28.75	1.80	50.07	54.00	3.93

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- 1M PHY – 2 440 ㎒ (19 ch)

Radiated Emission results									
Measured Frequency (㎒)	Measured Value (dB㎶)	Detector	Antenna Polarization (H/V)	Antenna Factor (dB)	(Amp + Cable Loss) (dB)	Duty Factor (dB)	Actual Value (dB㎶/m)	Limit (dB㎶/m)	Margin (dB)
4879.52	50.02	Peak	H	34.46	-28.62	-	55.86	74.00	18.14
4879.70	44.08	Average	H	34.46	-28.62	1.80	51.72	54.00	2.28

- 1M PHY – 2 480 ㎒ (39 ch)

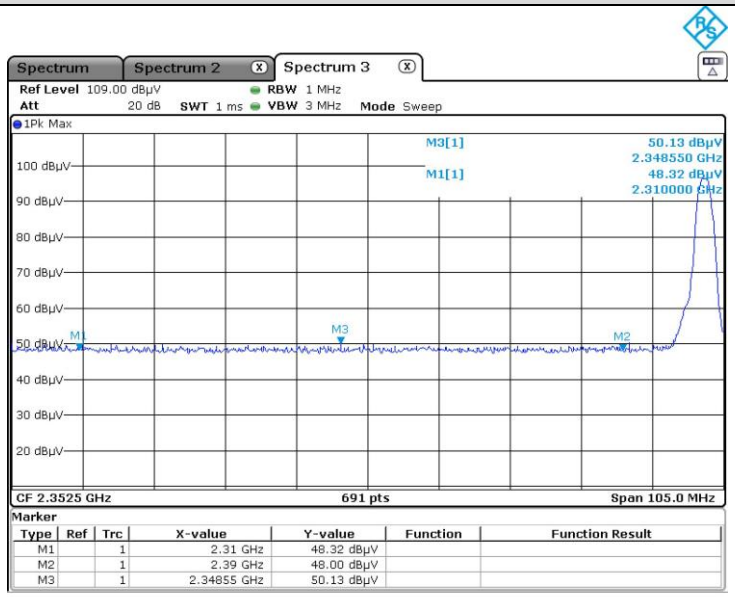
Radiated restricted band edge results									
Measured Frequency (㎒)	Measured Value (dB㎶)	Detector	Antenna Polarization (H/V)	Antenna Factor (dB)	(Amp + Cable Loss) (dB)	Duty Factor (dB)	Actual Value (dB㎶/m)	Limit (dB㎶/m)	Margin (dB)
2493.59	41.50	Peak	H	29.17	-32.84	1.80	33.45	54.00	20.55
2493.59	31.31	Average	H	29.25	-32.83	-	37.92	74.00	36.08

Radiated Emission results									
Measured Frequency (㎒)	Measured Value (dB㎶)	Detector	Antenna Polarization (H/V)	Antenna Factor (dB)	(Amp + Cable Loss) (dB)	Duty Factor (dB)	Actual Value (dB㎶/m)	Limit (dB㎶/m)	Margin (dB)
4959.84	45.10	Peak	H	34.48	-28.48	-	51.10	74.00	22.90
4959.90	38.37	Average	H	34.48	-28.48	1.80	46.17	54.00	7.83

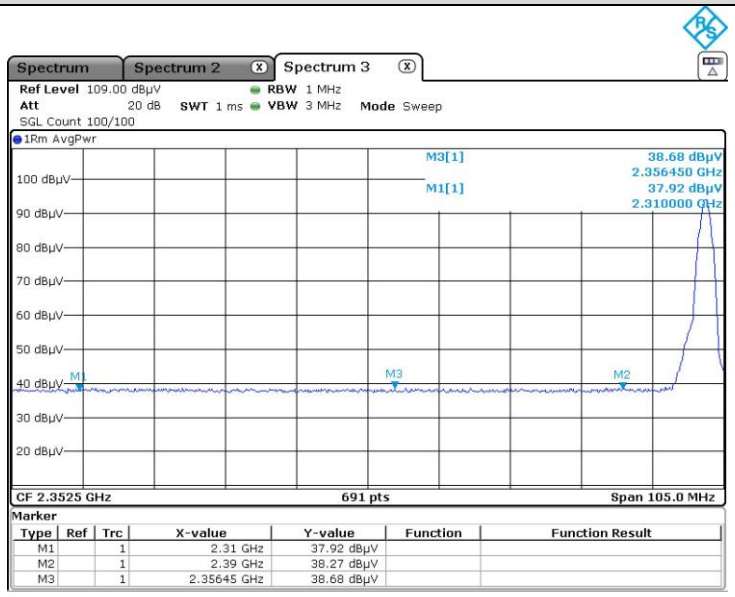
Plots of Radiated Emission

- Test Plot for 1M PHY

Radiated restricted band edge plot - 2 402 ㎒ (Peak)



Radiated restricted band edge plot - 2 402 ㎒ (Average)



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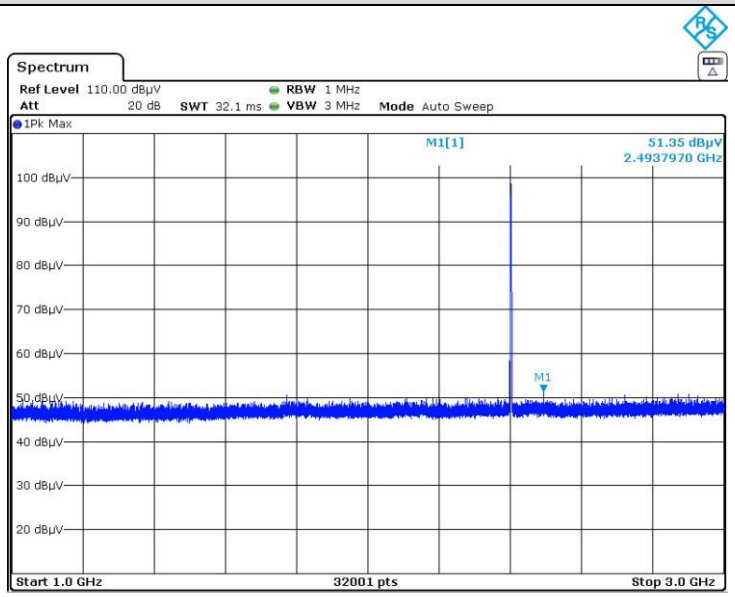
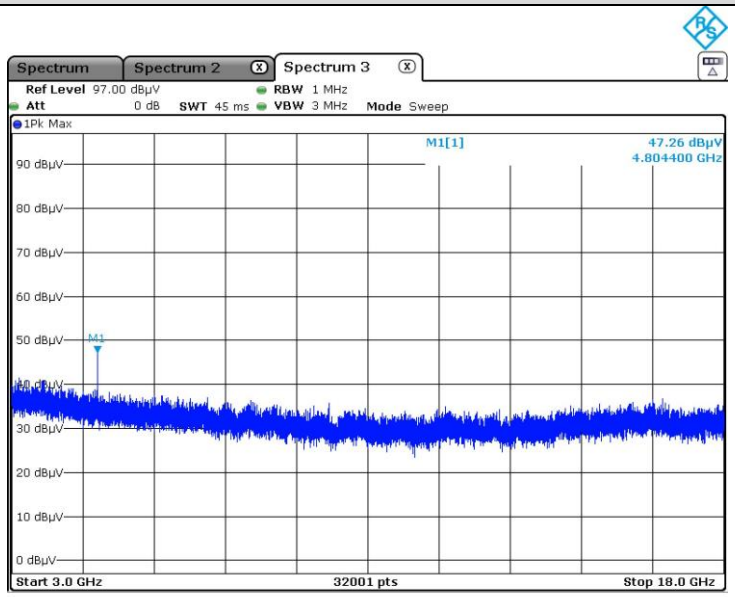
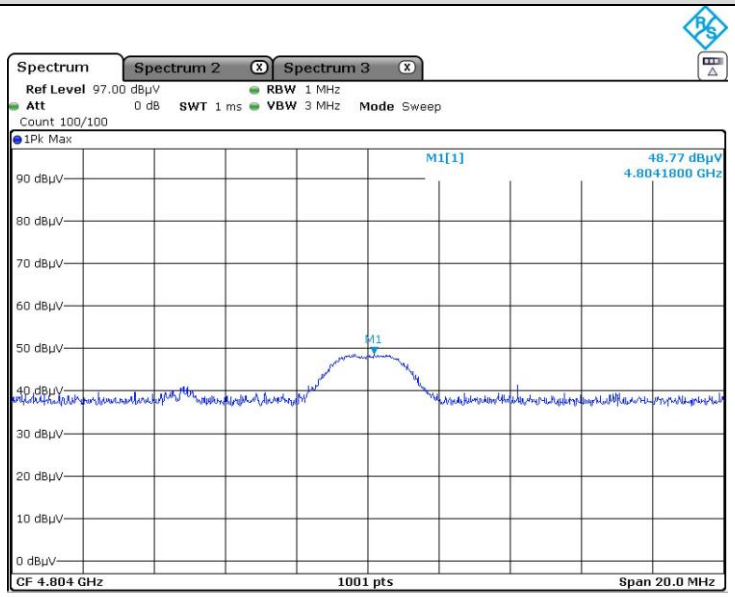
Radiated Emissions 1-3 GHz - 2 402 MHz



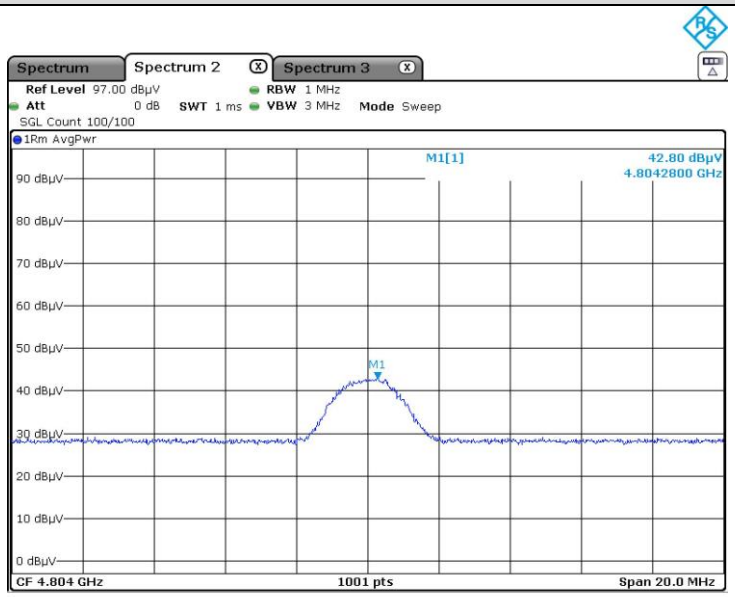
Radiated Emissions 3-18 GHz - 2 402 MHz



Radiated Emissions - 2 402 ㎒ (2nd Harnomic) (Peak)



Radiated Emissions - 2 402 ㎒ (2nd Harnomic) (Average)



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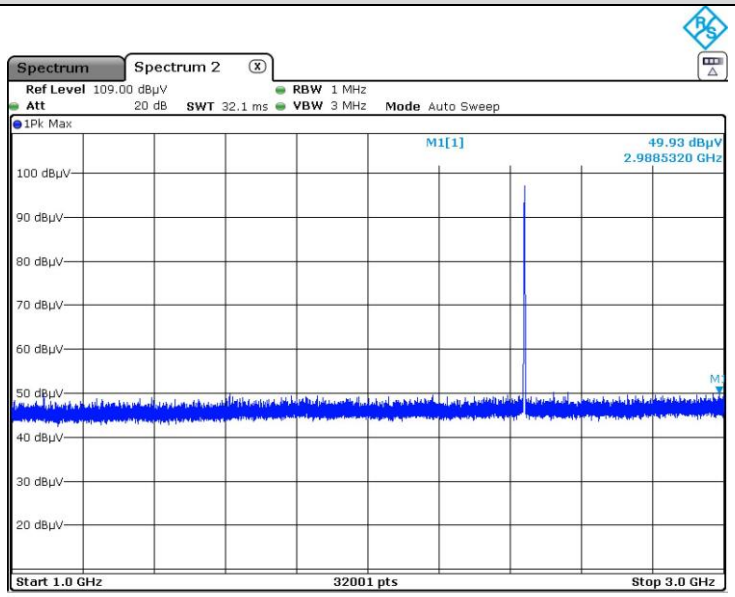
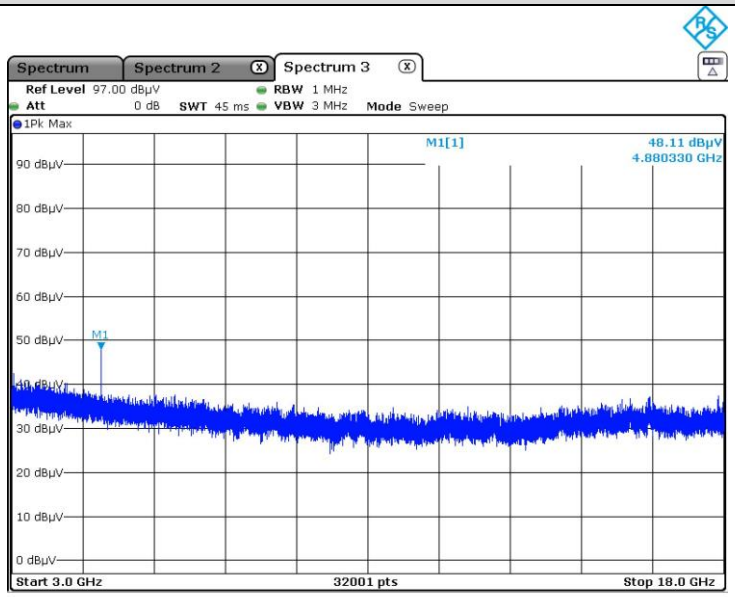
Radiated Emissions 1-3 GHz - 2 440 MHz



Radiated Emissions 3-18 GHz - 2 440 MHz



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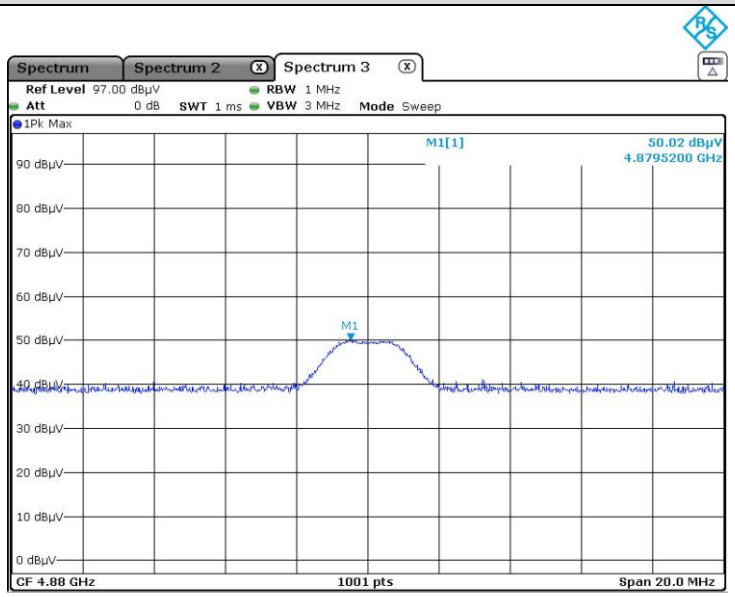
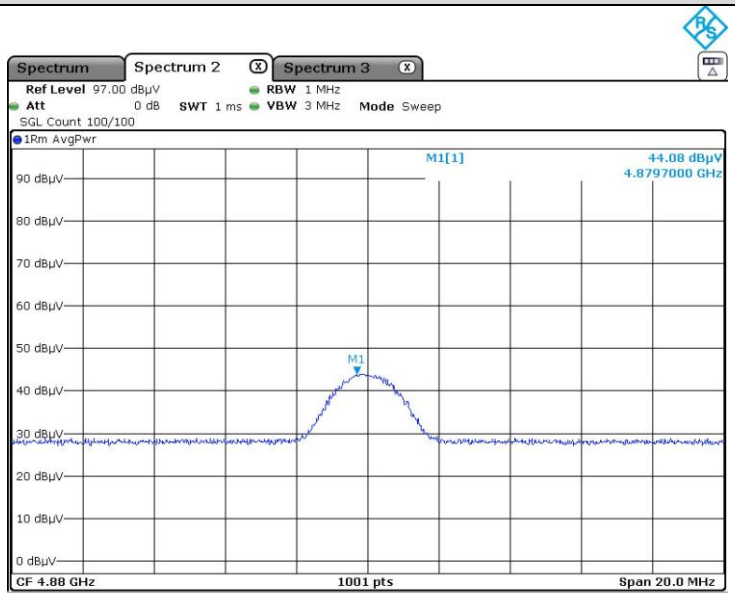
Radiated Emissions - 2 440 ㎒ (2nd Harnomic) (Peak)



Radiated Emissions - 2 440 ㎒ (2nd Harnomic) (Average)



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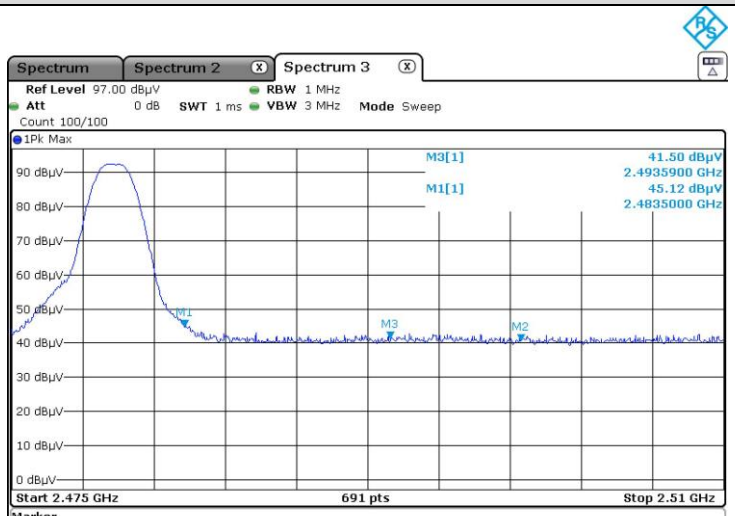
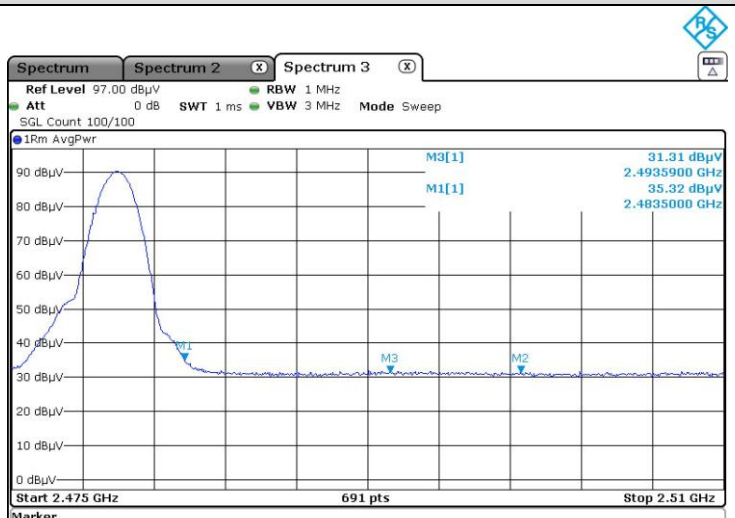
Radiated restricted band edge plot - 2 480 ㎒ (Peak)



Marker

Type	Ref	Trc	X-value	Y-value	Function	Function Result
M1		1	2.4835 GHz	45.12 dBµV		
M2		1	2.5 GHz	40.67 dBµV		
M3		1	2.49359 GHz	41.50 dBµV		

Radiated restricted band edge plot - 2 480 ㎒ (Average)



Marker

Type	Ref	Trc	X-value	Y-value	Function	Function Result
M1		1	2.4835 GHz	35.32 dBµV		
M2		1	2.5 GHz	31.32 dBµV		
M3		1	2.49359 GHz	31.31 dBµV		

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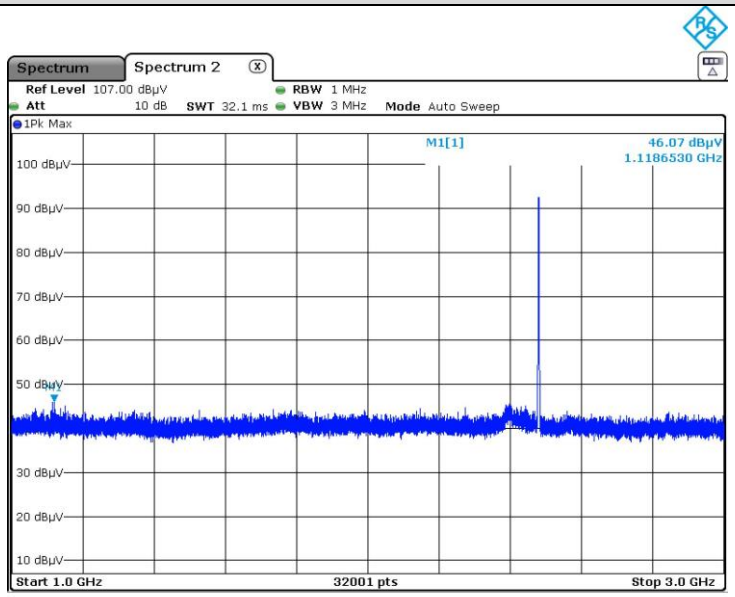
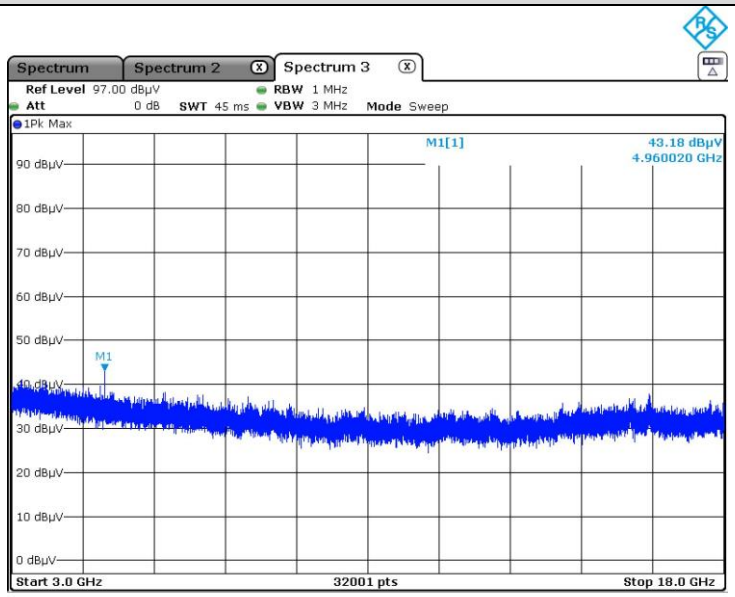
Radiated Emissions 1-3 GHz - 2 480 MHz


Radiated Emissions 3-18 GHz - 2 480 MHz


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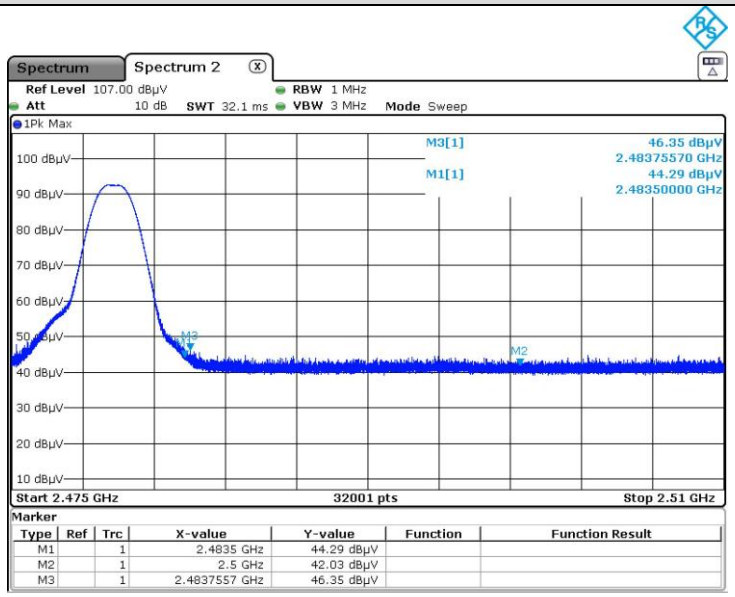
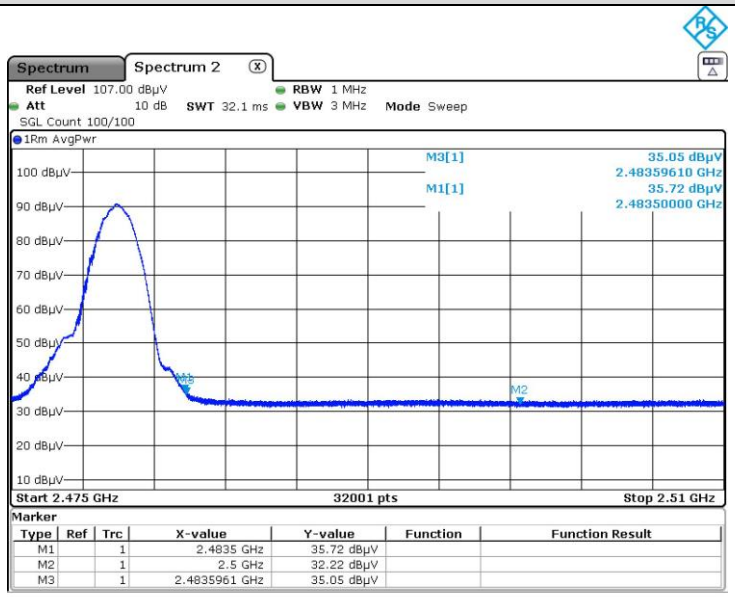
Radiated Emissions - 2 480 ㎒ (2nd Harnomic) (Peak)



Radiated Emissions - 2 480 ㎒ (2nd Harnomic) (Average)



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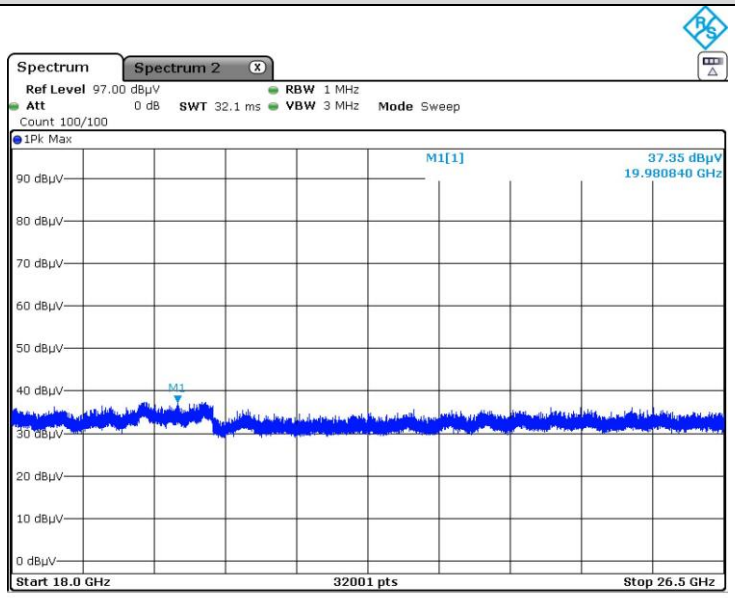
Radiated Emissions 18-25 ㎓ - 1M PHY

-The results of the emissions at frequencies(2 402 ㎒, 2 440 ㎒, 2 480 ㎒) were almost the same. -The worst plot for attached above. (<u>1M PHY, 2480 ㎒</u>).

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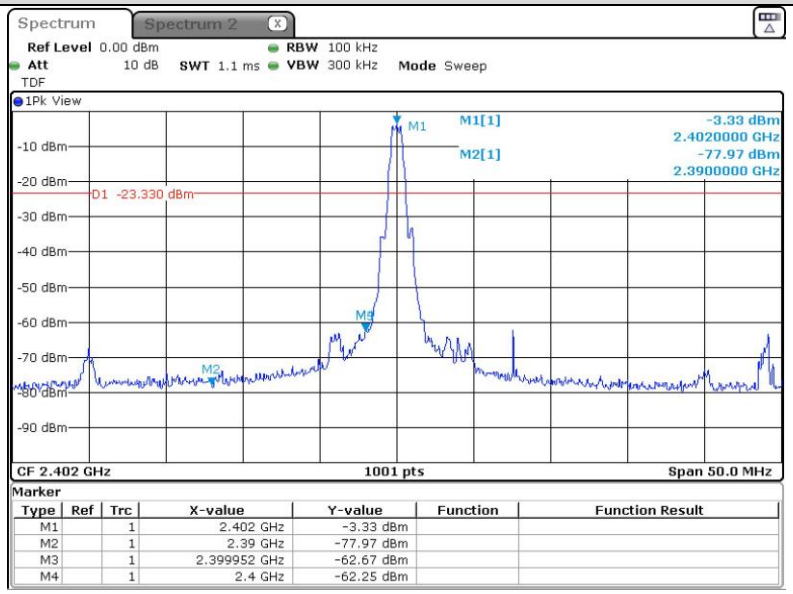
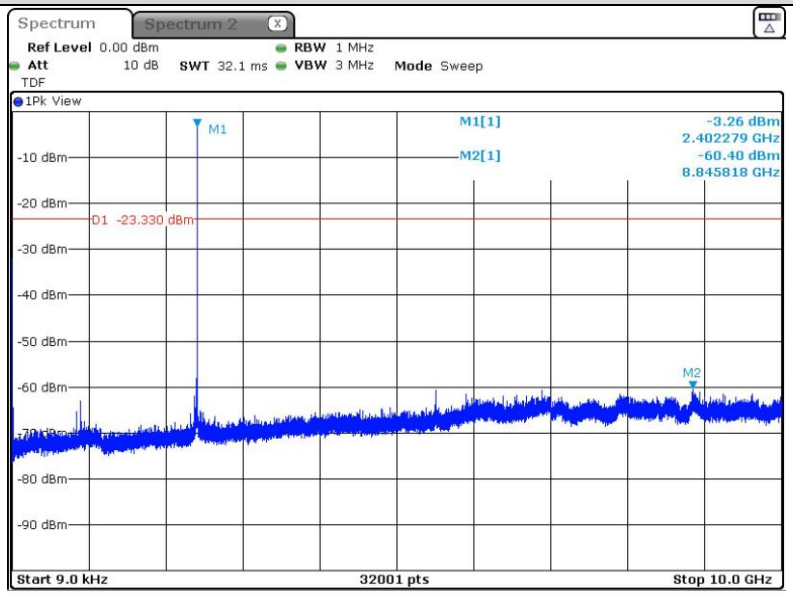
Plots of Conducted Emission

-1M PHY

Conducted band edge plot - 2 402 ㎒ (1M PHY)



Conducted Spurious emission 9 ㎑ ~ 10 ㎓ - 2 402 ㎒ (1M PHY)



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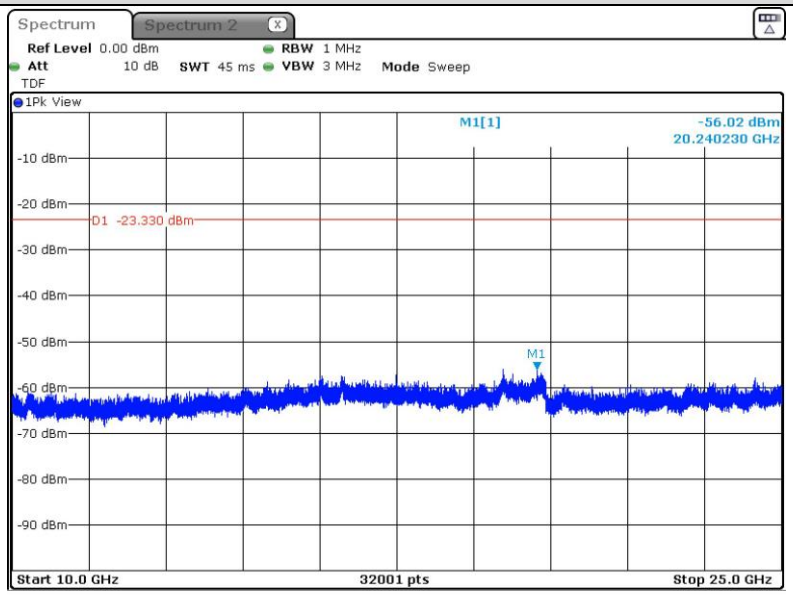
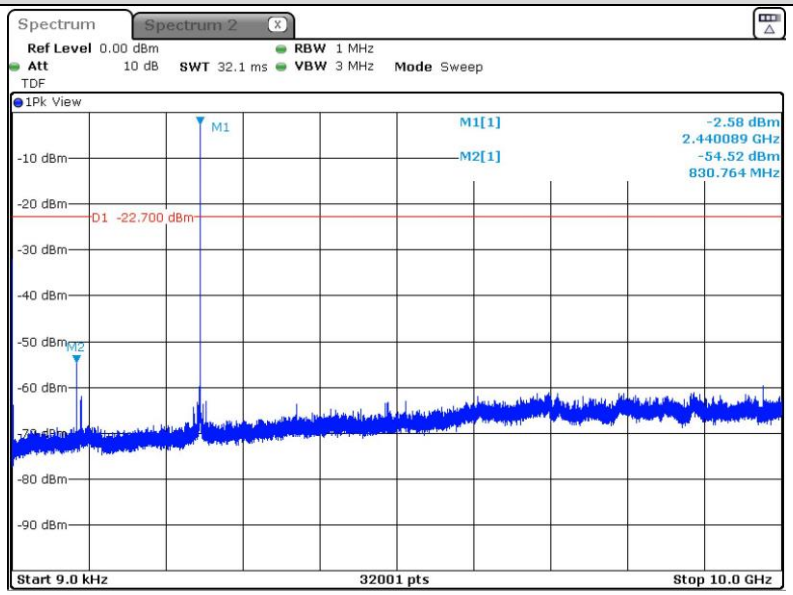
Conducted Spurious emission 10 GHz ~ 25 GHz - 2 402 MHz (1M PHY)



Conducted Spurious emission 9 kHz ~ 10 GHz - 2 440 MHz (1M PHY)



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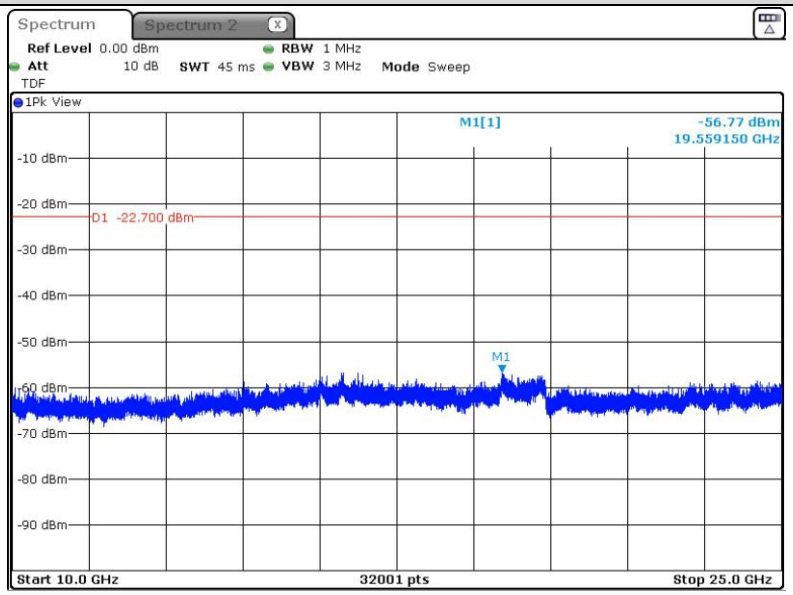
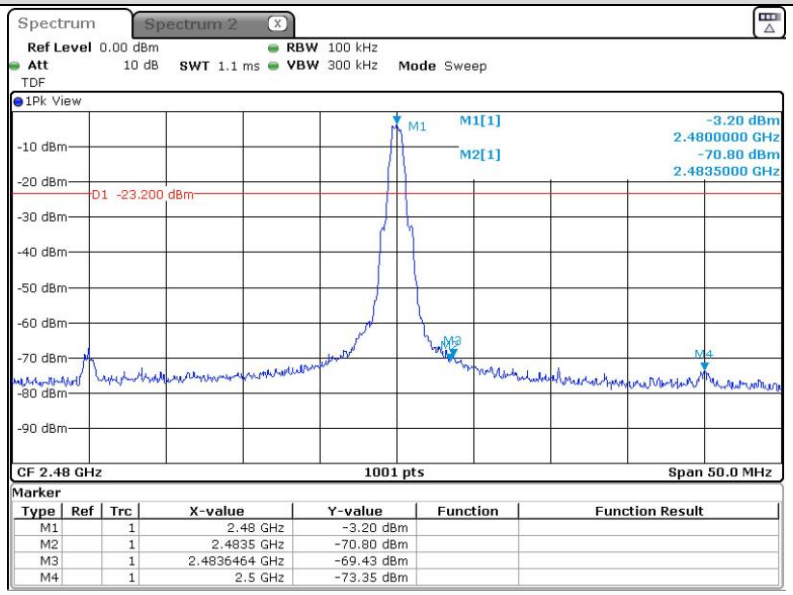
Conducted Spurious emission 10 GHz ~ 25 GHz - 2 440 MHz (1M PHY)

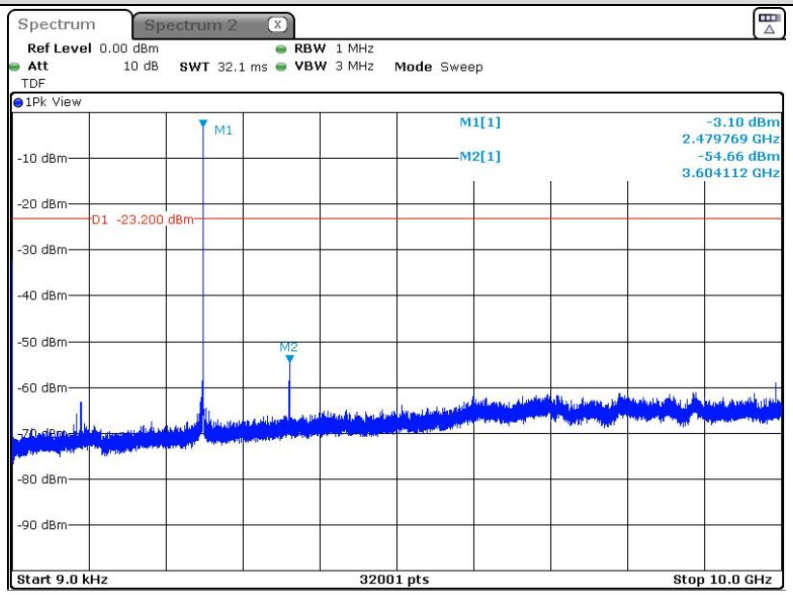


Conducted band edge plot - 2 480 MHz (1M PHY)

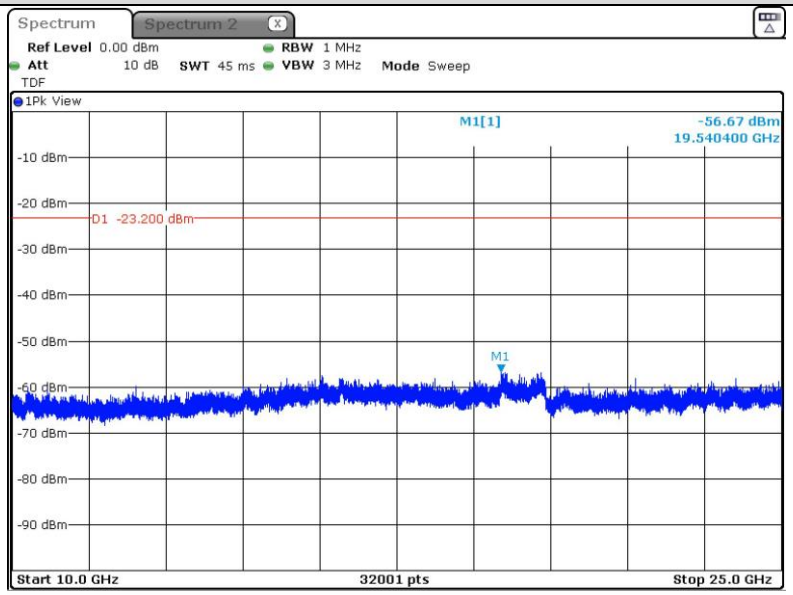


Type	Ref	Trc	X-value	Y-value	Function	Function Result
M1		1	2.48 GHz	-3.20 dBm		
M2		1	2.4835 GHz	-70.80 dBm		
M3		1	2.4836464 GHz	-69.43 dBm		
M4		1	2.5 GHz	-73.35 dBm		

Conducted Spurious emission 9 ㎑ ~ 10 ㎓ - 2 480 ㎒ (1M PHY)



Conducted Spurious emission 10 ㎓ ~ 25 ㎓ - 2 480 ㎒ (1M PHY)



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4. 6 ㏈ Channel Bandwidth & 99% Bandwidth

4.1. Limit

47 CFR Part 15
Section § 15.247(a) systems using digital modulation techniques may operate in the 902-928 ㎒, 2 400-2 483.5 ㎒, and 5 725-5 850 ㎒ bands. The minimum 6 ㏈ bandwidth shall be at least 500 ㎑.

4.2. Test Configuration

Test Setup for Conducted test
EUT — Spectrum Analzyer

4.3. Test procedure

11.8 of ANSI C63.10-2013
The test performed refer to section 11.8.1 Option 1. **Option 1** 1) Set RBW = 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 points (upper and lower frequencies) that are attenuated by 6 ㏈ relative to the maximum level measured in the fundamental emission. **Option 2** The automatic bandwidth measurement capability of an instrument may be employed using the X ㏈ bandwidth mode with X set to 6 ㏈, if the functionality described in 11.8.1 (i.e., RBW = 100 ㎑, VBW ≥ 3 × RBW, and peak detector with maximum hold) is implemented by the instrumentation function. When using this capability, care shall be taken so that the bandwidth measurement is not influenced by any intermediate power nulls in the fundamental emission that might be ≥6 dB.

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99 % Bandwidth

The following conditions shall be observed for measuring the occupied bandwidth and x dB bandwidth:

The transmitter shall be operated at its maximum carrier power measured under normal test condition.

The span of the spectrum analyzer shall be set large enough to capture all products of the modulation process, including the emission skirts, around the carrier frequency, but small enough to avoid having other emissions (e.g. on adjacent channels) within the span.

The detector of the spectrum analyzer shall be set to “Sample”. However, a peak, or peak hold, may be used in place of the sampling detector since this usually produces a wider bandwidth than the actual bandwidth (worst-case measurement). Use of a peak hold (or “Max Hold”) may be necessary to determine the occupied / x dB bandwidth if the device is not transmitting continuously.

The resolution bandwidth (RBW) shall be in the range of 1 % to 5 % of the actual occupied / x dB bandwidth and the video bandwidth (VBW) shall not be smaller than three times the RBW value. Video averaging is not permitted.

Note: It may be necessary to repeat the measurement a few times until the RBW and VBW are in compliance with the above requirement.

For the 99 % emission bandwidth, the trace data points are recovered and 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 difference between the two recorded frequencies is the occupied bandwidth (or the 99 % emission bandwidth).

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4.4. Test Result

Ambient Temp.	23 ± 1 ℃
Relative Humidity	43 %
Test Result	PASS (Refer to below)

-6dB Bandwidth

Channel	Frequency (㎒)	1M PHY	Limit (㎑)
0	2 402	699.30	> 500
19	2 440	709.29	
39	2 480	769.23	

-99% Bandwidth

Channel	Frequency (㎒)	1M PHY
0	2 402	1.03
19	2 440	1.05
39	2 480	1.06

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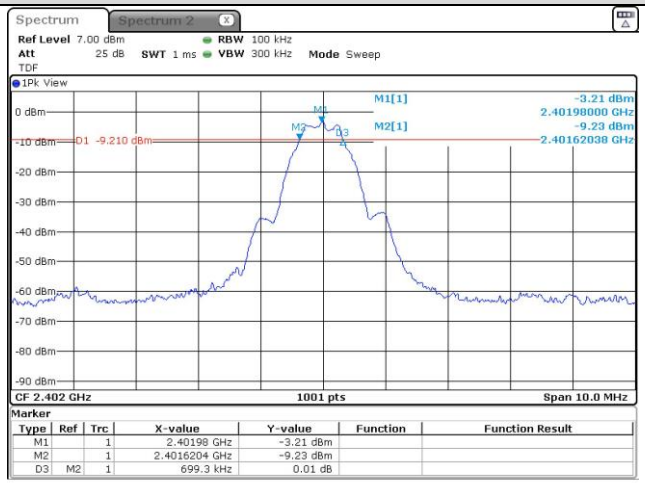
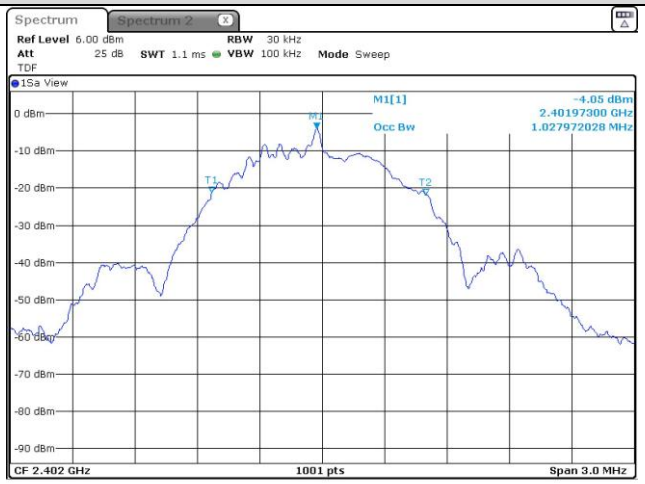
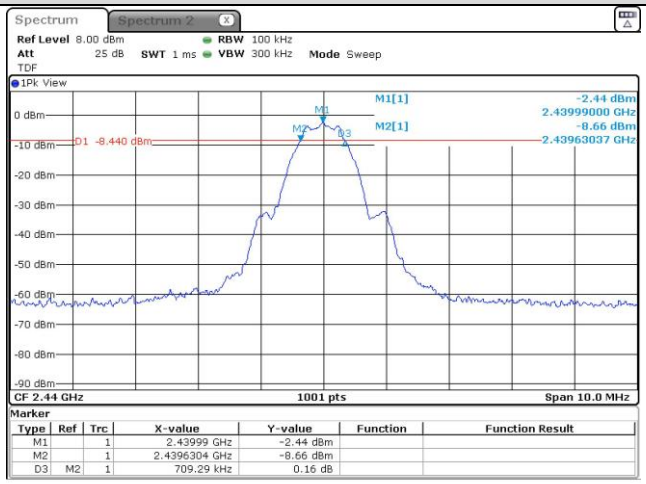
- Test Plot for 1M PHY

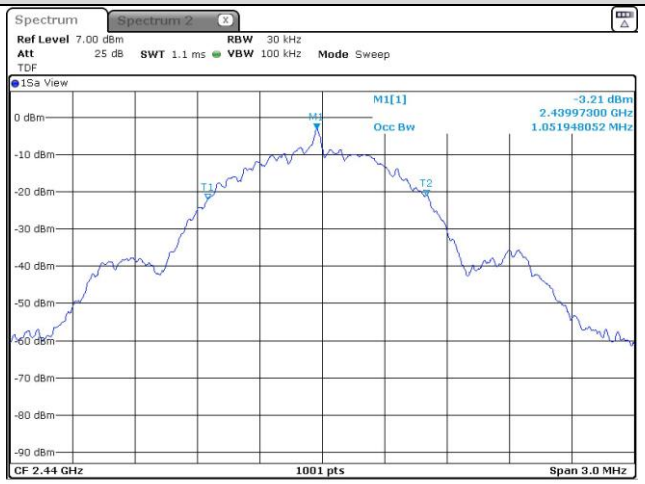
0 ch – 2 402 MHz





19 ch – 2 440 MHz





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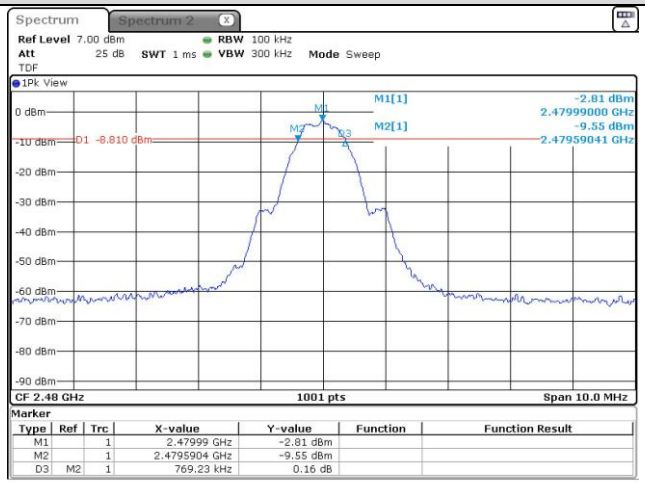
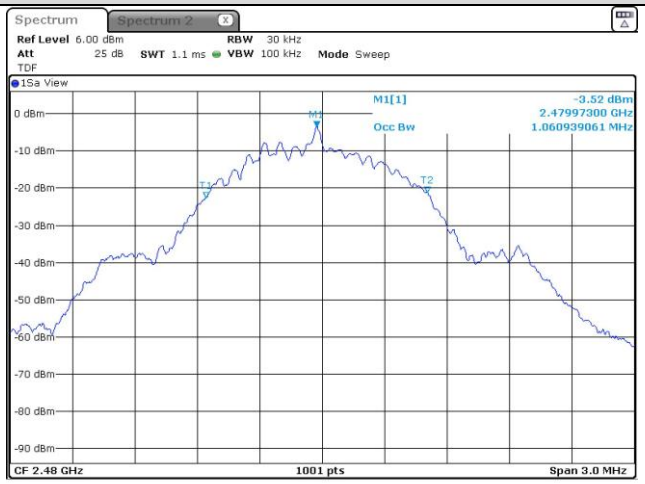
Test Result

Report No. : CE2023-00008

39 ch – 2 480 ㎒





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5. Maximum Peak Output Power

5.1. Limit

47 CFR Part 15
Section § 15.247(b)(3) for systems using digital modulation in the 902-928 ㎒, 2 400-2 483.5 ㎒, and 5 725-5 850 ㎒ bands: 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 antennas and antenna elements. The average must not include any time 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. Section§ 15.247(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 ㏈i. Except as shown in paragraph (c) of this section, if transmitting antennas 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.

5.2. Test configuration

Test Setup for Conducted test

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5.3. Test procedure

11.9 of ANSI C63.10-2013
The test performed refer to section 11.9.1.3. **PKPM1 Peak power meter method** - The maximum peak conducted output power may be measured using a broadband 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. The test performed refer to section 11.9.2.3.2 **Method AVGPM-G (Measurement using a gated RF average-reading power meter)** Method AVGPM-G is a measurement using a gated RF average power meter. Alternatively, measurements may be performed using a wideband gated RF power meter provided that the gate parameters are adjusted such that the power is measured only when the EUT is transmitting at its maximum power control level. Because the measurement is made only during the ON time of the transmitter, no duty cycle correction factor is required.

5.4. Test Results

Ambient Temp.	23 ± 1 ℃
Relative Humidity	43 %
Test Result	PASS (Refer to below)

Channel	Frequency (㎒)	Peak Power Result (dB m)	Average Power Result (dB m)	Limit (dB m)
		1M PHY	1M PHY	
0	2 402	-3.01	-3.16	30
19	2 440	-2.09	-2.25	
39	2 480	-2.93	-3.04	

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6. Power Spectral Density

6.1. Limit

47 CFR Part 15
Section § 15.247(e) for digitally modulated systems, the power spectral density conducted from the intentional radiator to the antenna shall not be greater than 8 ㏈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 paragraph (b) of this section. The same method of determining the conducted output power shall be used to determine the power spectral density.

6.2. Test Configuration

Test Setup for Conducted test

6.3. Test Procedure

11.10 of ANSI C63.10-2013
- 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 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 requirement, then reduce RBW (but no less than 3 ㎑) and repeat.

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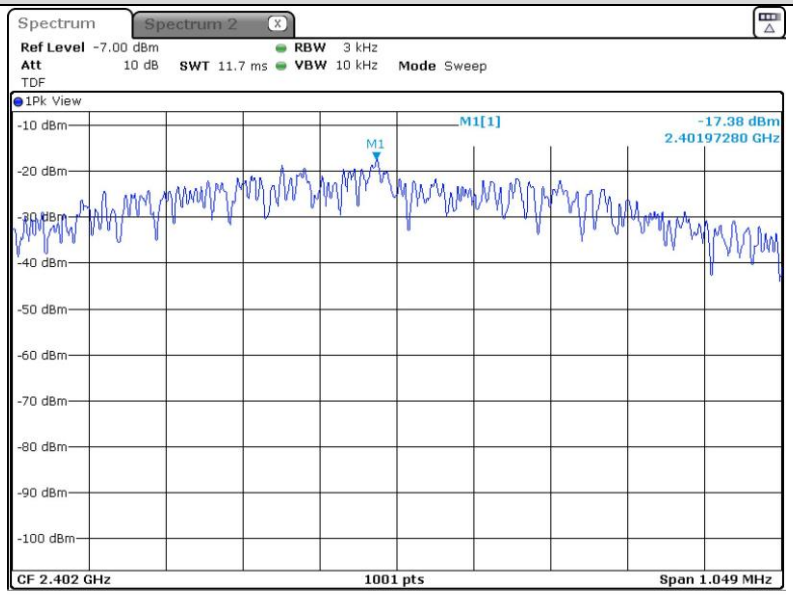
6.4. Test Results

Ambient Temp.	23 ± 1 ℃
Relative Humidity	43 %
Test Result	PASS (Refer to below)

Channel	Frequency (㎒)	Peak Power Result (dB m)	Limit (dB m/3 ㎑)
		1M PHY	
0	2 402	-17.38	8
19	2 440	-16.96	
39	2 480	-16.41	

- Test Plot for 1M PHY

0 ch – 2 402 ㎒



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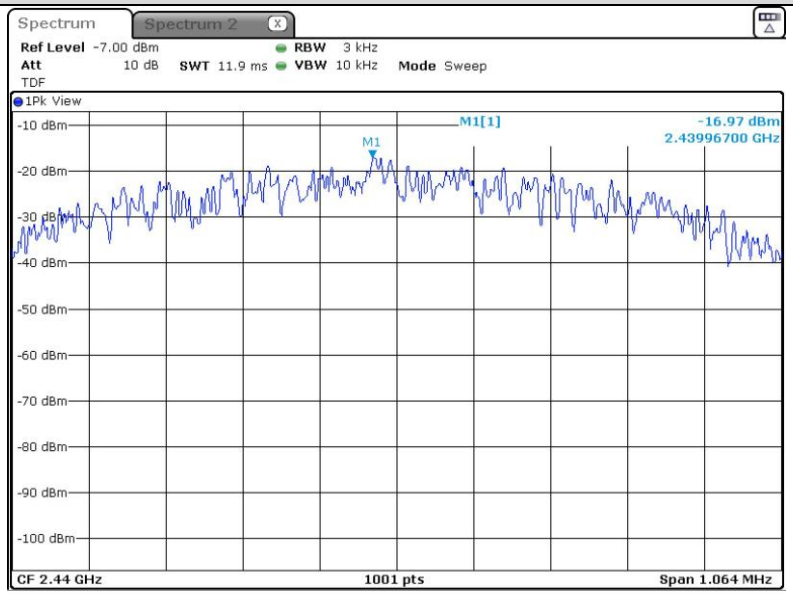
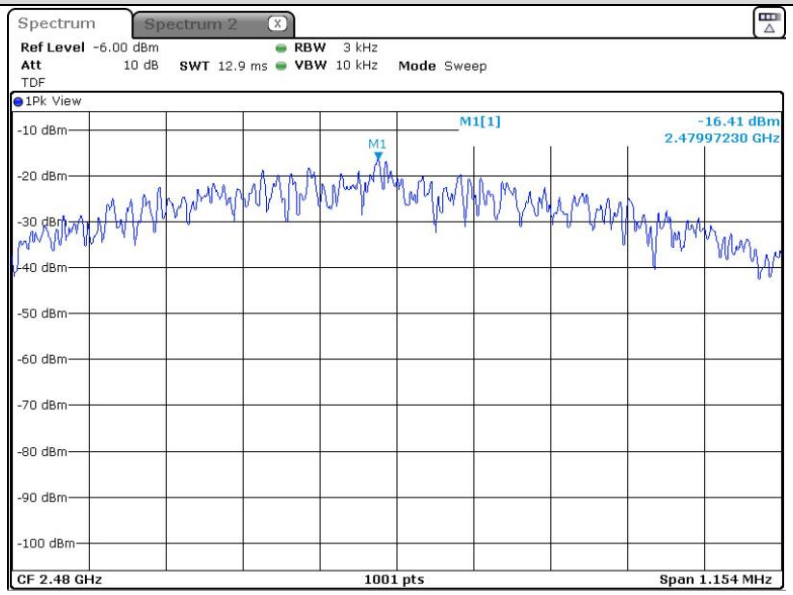
19 ch – 2 440 MHz



39 ch – 2 480 MHz



- End of the Test Report -

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