

FCC - TEST REPORT

Report Number : **709502404854-00A** Date of Issue: September 10, 2024Model : ZPU-ProProduct Type : Zigbee ModuleApplicant : Hangzhou Tuya Information Technology Co.,Ltd.Address : Room 301,Building 1,Huace Center,Xihu District,
Hangzhou,Zhejiang, ChinaManufacturer : Hangzhou Tuya Information Technology Co.,Ltd.Address : Room 301,Building 1,Huace Center,Xihu District,
Hangzhou,Zhejiang, ChinaTest Result : ☒ **Positive** ☐ **Negative**Total pages including
Appendices : 47

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2 Report Modification Record

Alterations and additions to this report will be issued to the holders of each copy in the form of a complete document.

Issue	Description of Change	Date of Issue
709502404854-00A	First Issue	09/10/2024

3 Details about the Test Laboratory

Test Site 1

Company name: TÜV SÜD Certification and Testing (China) Co., Ltd. Shanghai Branch
No.16 Lane, 1951 Du Hui Road,
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FCC Registration No.: 820234

FCC Designation Number: CN1183

ISED CAB identifier CN0101

IC Registration No.: 31668

4 Description of the Equipment under Test

Product: Zigbee Module

Model no.: ZPU-Pro

FCC ID: 2ANDL-ZPUPRO

Rating: 3.0-3.6V DC

RF Transmission Frequency: 2405~2480MHz

No. of Operated Channel: 16

Modulation: 16-ary orthogonal modulation, O-QPSK PHY

Channel list:

Operation Frequency each of channel			
Channel	Frequency	Channel	Frequency
11	2405 MHz	19	2445 MHz
12	2410 MHz	20	2450 MHz
13	2415 MHz	21	2455 MHz
14	2420 MHz	22	2460 MHz
15	2425 MHz	23	2465 MHz
16	2430 MHz	24	2470 MHz
17	2435 MHz	25	2475 MHz
18	2440 MHz	26	2480 MHz

Antenna type: Onboard PCB antenna

Antenna Gain: 0.56dBi

Description of the EUT: The Equipment Under Test (EUT) is a Zigbee Module.
We tested it and listed the worst data in this report.

Test sample no.: SHA-822439-1 (RF radiated); SHA-822439-2 (RF conducted)

The sample's mentioned in this report is/are submitted/ supplied/ manufactured by client. The laboratory therefore assumes no responsibility for accuracy of information on the brand name, model number, origin of manufacture, consignment or any information supplied.



5 Summary of Test Standards

Test Standards	
FCC Part 15 Subpart C 10-1-2023 Edition	PART 15 - RADIO FREQUENCY DEVICES Subpart C - Intentional Radiators

All the test methods were according to KDB 558074 D01 15.247 Meas Guidance v05r02 and ANSI C63.10 (2013).

6 Summary of Test Results

Technical Requirements						
FCC Part 15 Subpart C						
Test Condition		Pages	Test Site	Test Result		
				Pass	Fail	N/A
§15.207	Conducted emission AC power port	12-16	Site 1	☒	☐	☐
§15.247 (b) (3)	Conducted peak output power	17-18	Site 1	☒	☐	☐
§15.247(a)(1)	20dB bandwidth	---	---	☐	☐	☒
§15.247(a)(1)	Carrier frequency separation	---	---	☐	☐	☒
§15.247(a)(1)(iii)	Number of hopping frequencies	---	---	☐	☐	☒
§15.247(a)(1)(iii)	Dwell Time	---	---	☐	☐	☒
§15.247(a)(2)	6dB bandwidth	19-20	Site 1	☒	☐	☐
§15.247(e)	Power spectral density	21-22	Site 1	☒	☐	☐
§15.247(d)	Spurious RF conducted emissions	23-26	Site 1	☒	☐	☐
§15.247(d)	Band edge	27-29	Site 1	☒	☐	☐
§15.247(d) & §15.209	Spurious radiated emissions for transmitter	30-43	Site 1	☒	☐	☐
§15.203	Antenna requirement	See note 1		☒	☐	☐

Remark 1: N/A – Not Applicable.

Note 1: The EUT uses PCB antenna, which gain is 0.56dBi. In accordance to §15.203, It is considered sufficiently to comply with the provisions of this section.



7 General Remarks

Remarks

This submittal(s) (test report) is intended for FCC ID: 2ANDL-ZPUPRO complies with Section 15.207, 15.209, 15.247 of the FCC Part 15, Subpart C rules.

SUMMARY:

All tests according to the regulations cited on page 5 were

■ - Performed

□ - **Not** Performed

The Equipment under Test

■ - **Fulfills** the general approval requirements.

□ - **Does not** fulfill the general approval requirements.

Sample Received Date: August 26, 2024

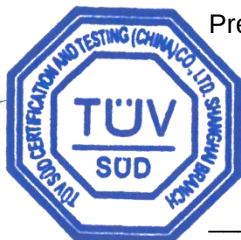
Testing Start Date: August 26, 2024

Testing End Date: September 3, 2024

-TÜV SÜD Certification and Testing (China) Co., Ltd. Shanghai Branch

Reviewed by:

Hui TONG
Review Engineer



Prepared by:

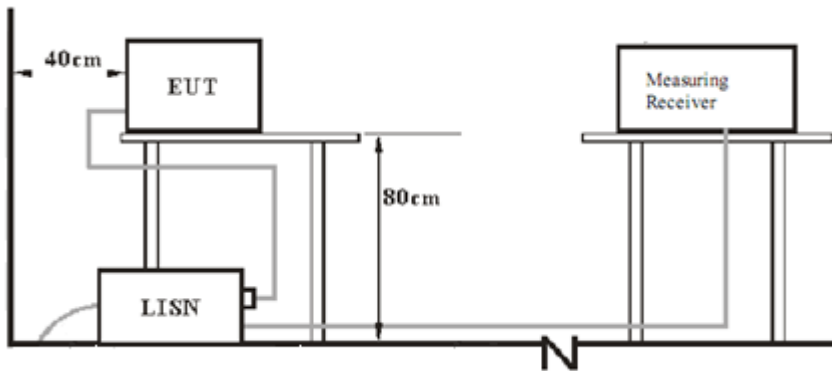
Jiaxi XU
Project Engineer

Tested by:

Tianji XU
Test Engineer

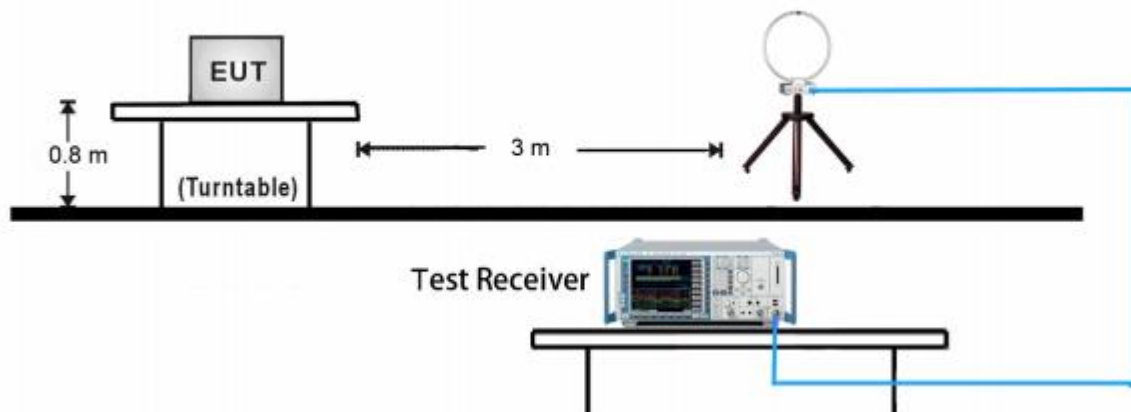
8 Test Setups

7.1 AC Power Line Conducted Emission test setups

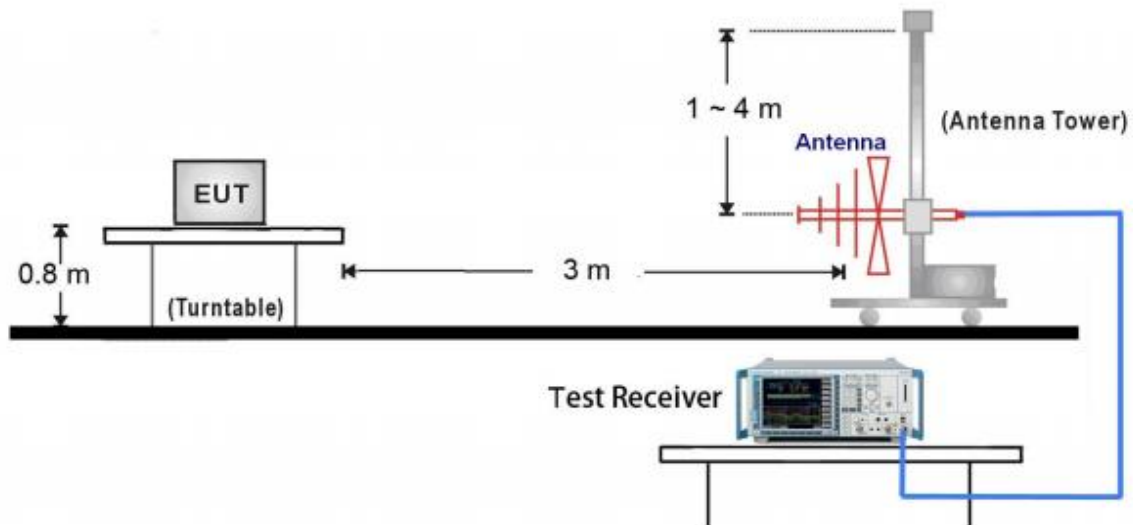


7.2 Radiated test setups

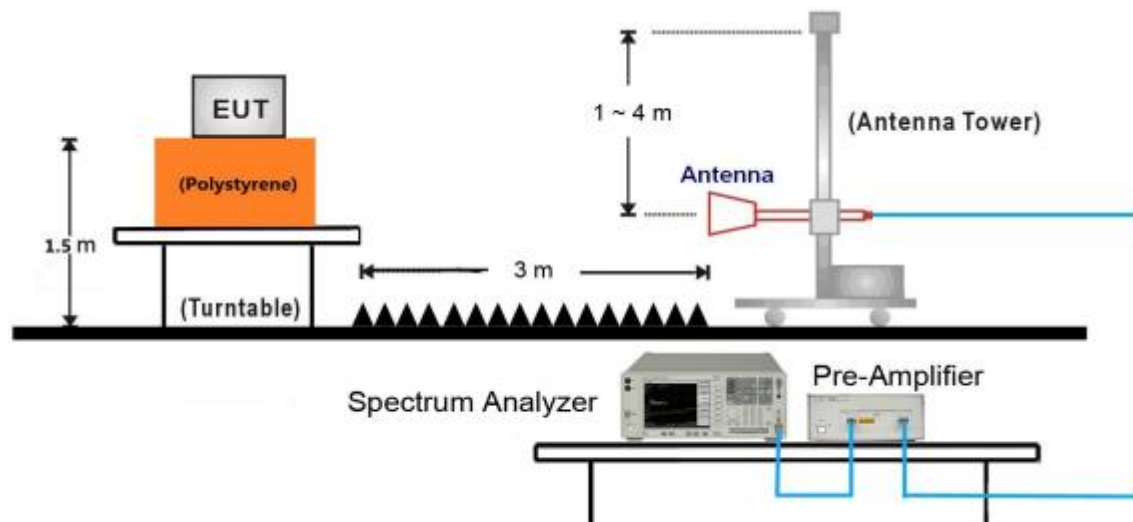
9kHz ~ 30MHz Test Setup:



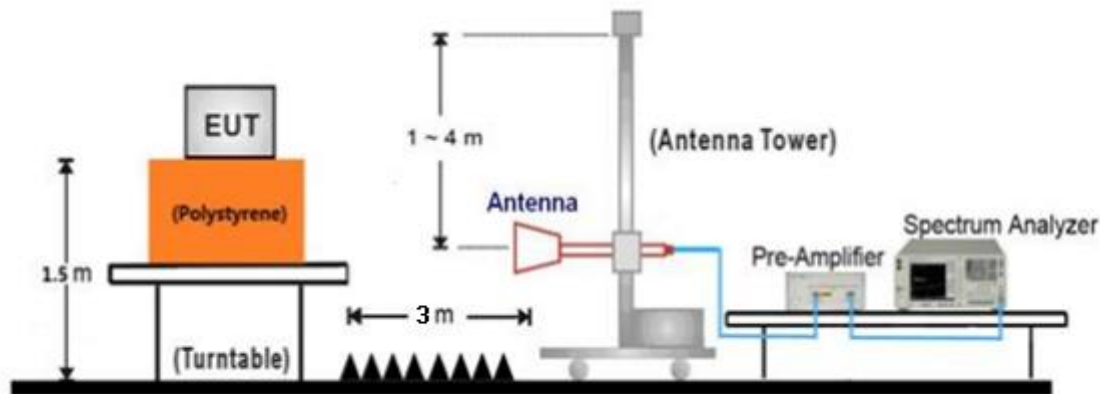
30MHz ~ 1GHz Test Setup:



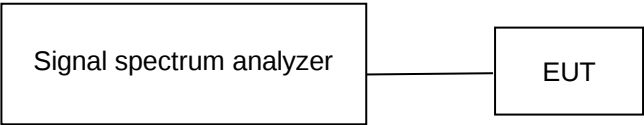
1GHz ~ 18GHz Test Setup:



18GHz ~ 25GHz Test Setup:



7.3 Conducted RF test setups



9 Systems test configuration

Auxiliary Equipment Used during Test:

DESCRIPTION	MANUFACTURER	MODEL NO.(SHIELD)	S/N(LENGTH)
Notebook	Lenovo	E470	PF-OU5TS7 17/09

Test software: Test software: PhyPlusKit.exe

The system was configured to channel 11, 19, and 26 for the test.

Test Mode Applicability and Tested Channel Detail:

Tested Channel	Data Rate	Modulation	Index Value (Power level setting)
11	250 kbit/s	O-QPSK	1
19	250 kbit/s	O-QPSK	1
26	250 kbit/s	O-QPSK	1

Non-hopping mode: The system was configured to operate at a signal channel transmitting. The test software allows the configuration and operation at the worst-case duty and the highest transmit power.

10 Technical Requirement

10.1 Conducted Emission

Test Method

1. The EUT was placed on a table, which is 0.8m above ground plane
2. The power line of the EUT is connected to the AC mains through a Artificial Mains Network (A.M.N.).
3. Maximum procedure was performed to ensure EUT compliance
4. A EMI test receiver is used to test the emissions from both sides of AC line

Limit

According to §15.207, conducted emissions limit as below:

Frequency MHz	QP Limit dB μ V	AV Limit dB μ V
0.150-0.500	66-56*	56-46*
0.500-5	56	46
5-30	60	50

Decreasing linearly with logarithm of the frequency

Conducted Emission

150k-30MHz Conducted Emission Test

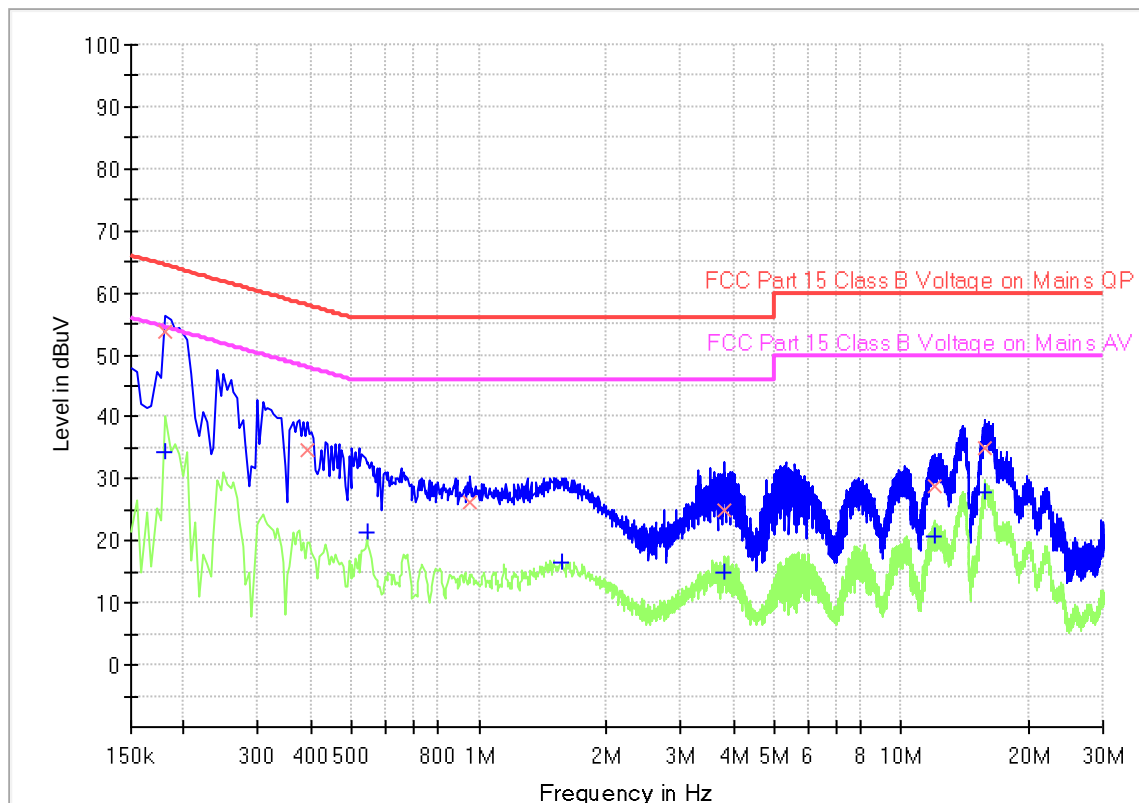
EUT Information

EUT Name:	Zigbee Module
Model	ZPU-Pro
Client:	Hangzhou Tuya Information Technology Co., Ltd.
Op Cond	Power on and TX_2480MHz
Operator:	Tianji XU
Standard	FCC Part 15.207(a)
Sample No.:	SHA-822439-1

Scan Setup: Voltage with 2-Line-LISN pre [EMI conducted]

Hardware Setup:	Voltage with 2-Line-LISN
Receiver:	[ESR 3]
Level Unit:	dBuV

Subrange	Step Size	Detectors	IF BW	Meas. Time	Preamp
9 kHz - 150 kHz	100 Hz	PK+	200 Hz	0.02 s	0 dB
150 kHz - 30 MHz	4.5 kHz	PK+; AVG	9 kHz	0.01 s	0 dB





Final_Result

Frequency (MHz)	QuasiPeak (dBuV)	CAverage (dBuV)	Limit (dBuV)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Line	Corr. (dB)
0.181500	---	34.46	54.42	19.96	1000.0	9.000	L1	19.4
0.181500	53.64	---	64.42	10.78	1000.0	9.000	L1	19.4
0.393000	34.67	---	58.00	23.33	1000.0	9.000	L1	19.5
0.541500	---	21.24	46.00	24.76	1000.0	9.000	L1	19.4
0.955500	26.29	---	56.00	29.71	1000.0	9.000	L1	19.5
1.563000	---	16.69	46.00	29.31	1000.0	9.000	L1	19.5
3.808500	24.96	---	56.00	31.04	1000.0	9.000	L1	19.6
3.826500	---	14.80	46.00	31.20	1000.0	9.000	L1	19.6
11.922000	28.93	---	60.00	31.07	1000.0	9.000	L1	19.9
11.922000	---	20.81	50.00	29.19	1000.0	9.000	L1	19.9
15.787500	35.00	---	60.00	25.00	1000.0	9.000	L1	20.1
15.828000	---	27.97	50.00	22.03	1000.0	9.000	L1	20.1

Note 1: Measure Level (dBuV/m) = Reading Level (dBuV) + Factor (dB)

Factor (dB) = Cable Loss (dB) + LISN Factor (dB) + 10dB Attenuator

150k-30MHz Conducted Emission Test

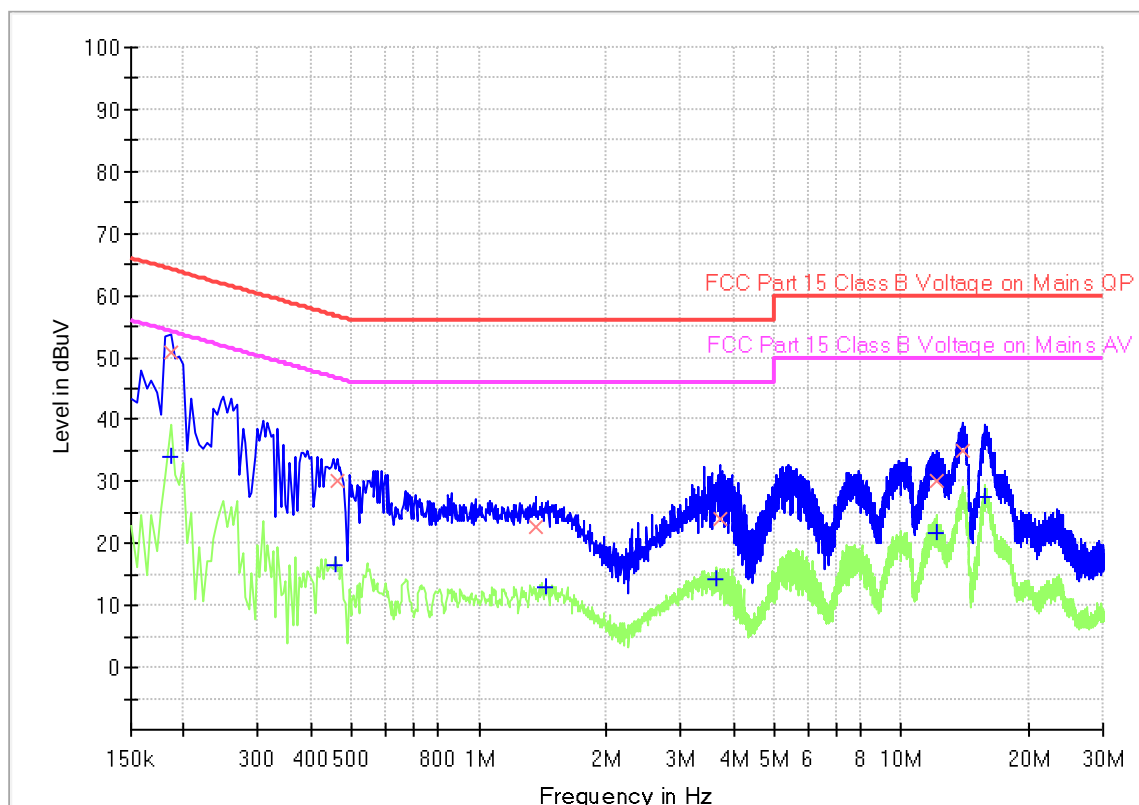
EUT Information

EUT Name:	Zigbee Module
Model	ZPU-Pro
Client:	Hangzhou Tuya Information Technology Co., Ltd.
Op Cond	Power on and TX_2480MHz
Operator:	Tianji XU
Standard	FCC Part 15.207(a)
Sample No.:	SHA-822439-1

Scan Setup: Voltage with 2-Line-LISN pre [EMI conducted]

Hardware Setup:	Voltage with 2-Line-LISN
Receiver:	[ESR 3]
Level Unit:	dBuV

Subrange	Step Size	Detectors	IF BW	Meas. Time	Preamplifier
9 kHz - 150 kHz	100 Hz	PK+	200 Hz	0.02 s	0 dB
150 kHz - 30 MHz	4.5 kHz	PK+; AVG	9 kHz	0.01 s	0 dB





Final_Result

Frequency (MHz)	QuasiPeak (dBuV)	CAverage (dBuV)	Limit (dBuV)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Line	Corr. (dB)
0.186000	---	34.03	54.21	20.18	1000.0	9.000	N	19.4
0.186000	50.73	---	64.21	13.48	1000.0	9.000	N	19.4
0.456000	---	16.47	46.77	30.30	1000.0	9.000	N	19.5
0.460500	30.09	---	56.68	26.59	1000.0	9.000	N	19.5
1.365000	22.66	---	56.00	33.34	1000.0	9.000	N	19.5
1.432500	---	12.96	46.00	33.04	1000.0	9.000	N	19.5
3.624000	---	14.14	46.00	31.86	1000.0	9.000	N	19.5
3.705000	23.98	---	56.00	32.02	1000.0	9.000	N	19.6
12.084000	30.01	---	60.00	29.99	1000.0	9.000	N	19.8
12.093000	---	21.80	50.00	28.20	1000.0	9.000	N	19.8
13.947000	35.00	---	60.00	25.00	1000.0	9.000	N	19.9
15.742500	---	27.39	50.00	22.61	1000.0	9.000	N	19.9

Note 1: Measure Level (dBuV/m) = Reading Level (dBuV) + Factor (dB)
 Factor (dB) = Cable Loss (dB) + LISN Factor (dB) + 10dB Attenuator

10.2 Conducted peak output power

Test Method

1. Use the following spectrum analyzer settings:
RBW > the 6 dB bandwidth of the emission being measured, VBW $\geq$ 3RBW, Span $\geq$ 3RBW
Sweep = auto, Detector function = peak, Trace = max hold.
2. Add a correction factor to the display.
3. Allow the trace to stabilize. Use the marker-to-peak function to set the marker to the peak of the emission. The indicated level is the peak output power.

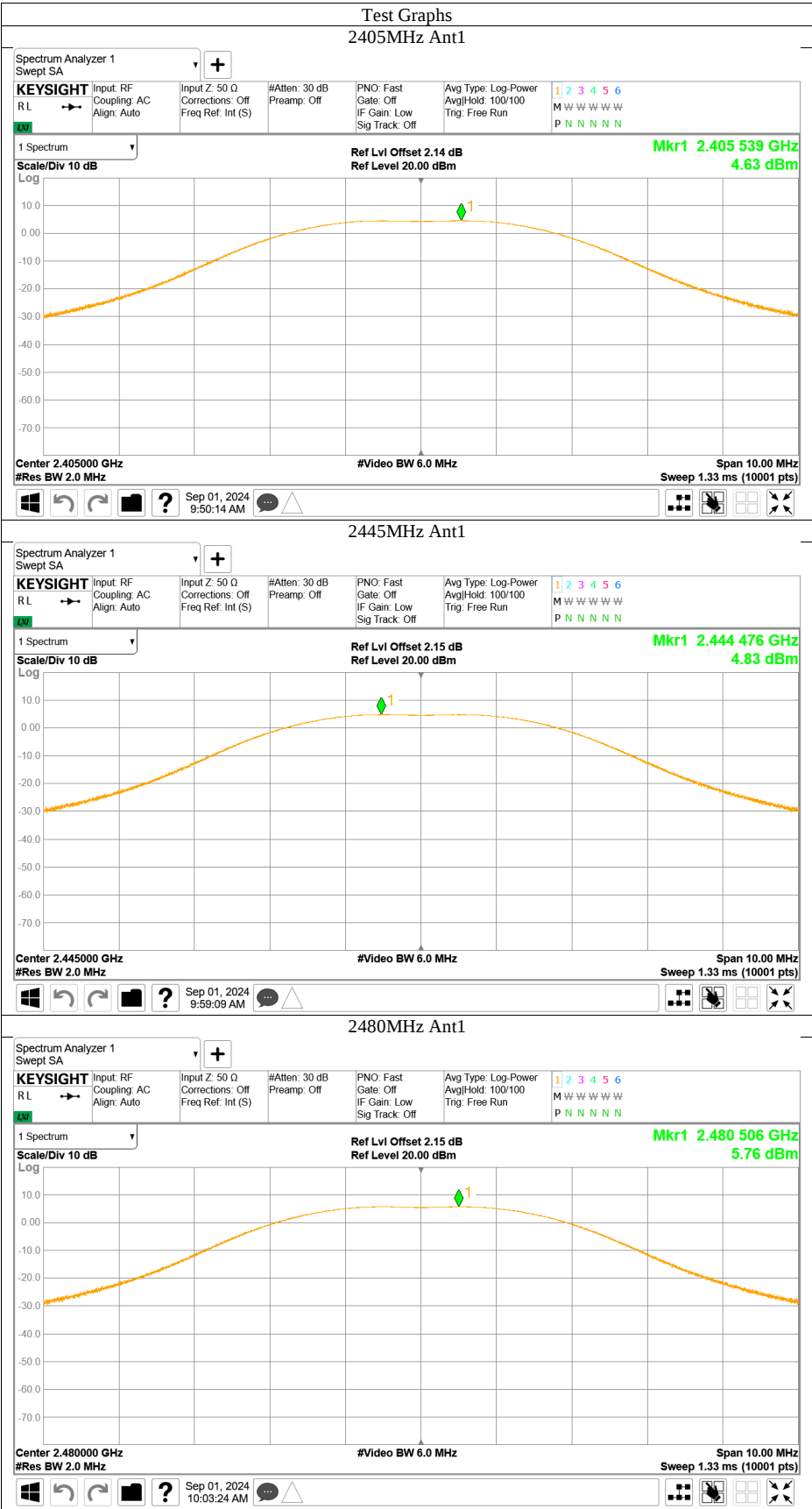
Limits

According to §15.247 (b) (3), conducted peak output power limit as below:

Frequency Range MHz	Limit W	Limit dBm
2400-2483.5	≤ 1	≤ 30

Test result as below table

Frequency MHz	Conducted Peak Output Power dBm	Result
Low channel 2405MHz	4.63	Pass
Middle channel 2440MHz	4.83	Pass
High channel 2480MHz	5.76	Pass





10.36dB bandwidth

Test Method

- 1. The RF output of EUT was connected to the spectrum analyzer. The path loss was compensated to the results for each measurement.
- 2. Set to the maximum power setting, the instrument center frequency is set to the nominal EUT channel center frequency enable the EUT transmit continuously.
- 3. Use the following spectrum analyzer settings:
RBW=100KHz, VBW≥3RBW, Sweep = auto, Detector function = peak, Trace = max hold
- 4. Use the automatic bandwidth measurement capability of an instrument, use the X dB bandwidth mode with X set to 6 dB.
- 5. Allow the trace to stabilize, record the 6 dB Bandwidth value.

Limit

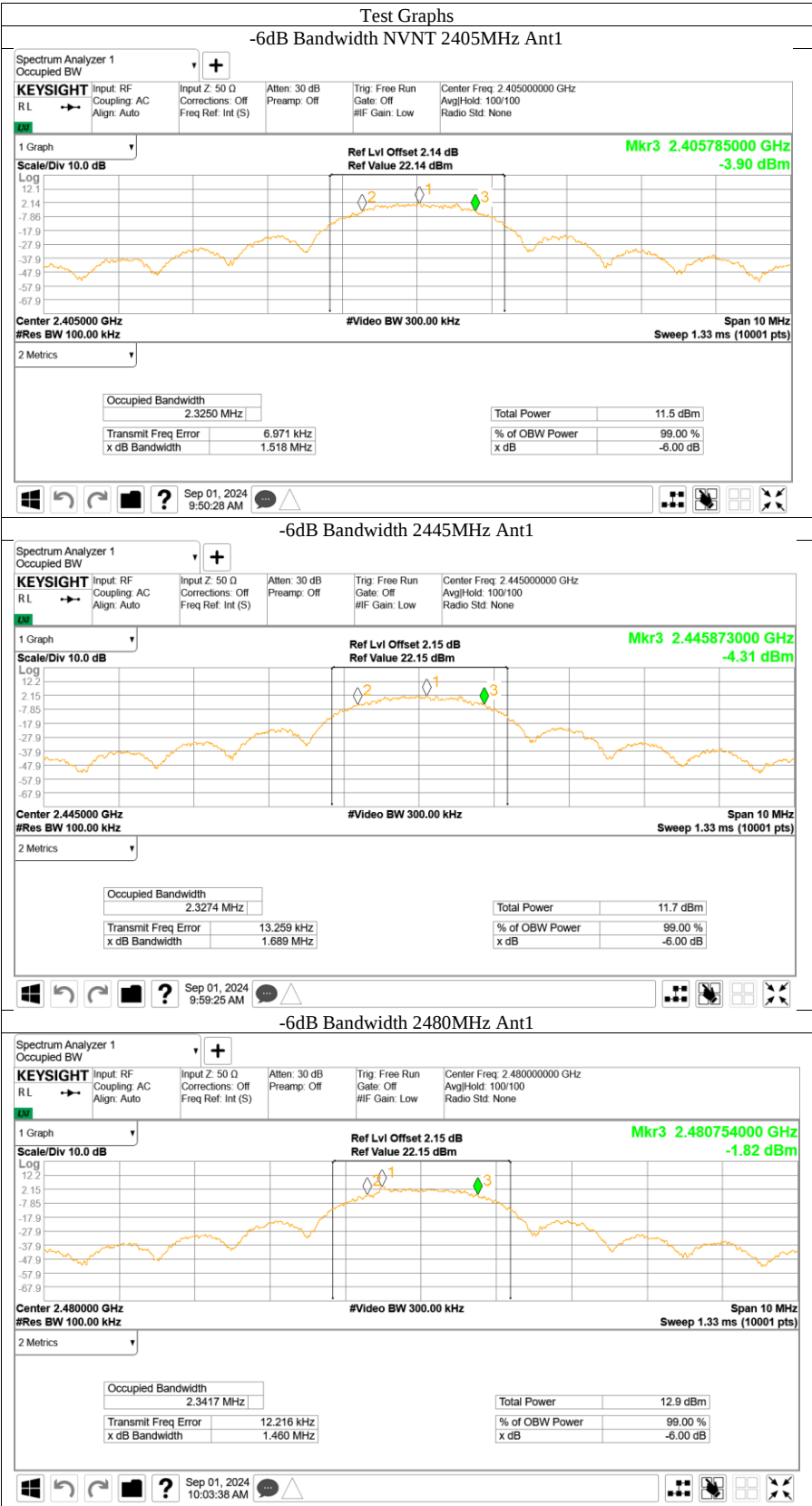
Limit [kHz]
≥500

Test result

Frequency MHz	6dB bandwidth kHz	Result
Top channel 2405MHz	1518	Pass
Middle channel 2440MHz	1689	Pass
Bottom channel 2480MHz	1460	Pass



6dB Bandwidth





10.4 Power spectral density

Test Method

This procedure shall be used if maximum peak conducted output power was used to demonstrate compliance:

- 1. The RF output of EUT was connected to the spectrum analyzer. The path loss was compensated to the results for each measurement.
- 2. Set to the maximum power setting, the instrument center frequency is set to the nominal EUT channel center frequency enable the EUT transmit continuously.
- 3. Use the following spectrum analyzer settings:
- 4. Set analyzer center frequency to DTS channel center frequency. RBW=3kHz, VBW≥3RBW, Span=1.5 times DTS bandwidth, Detector=Peak, Sweep=auto, Trace= max hold.
- 5. Allow trace to fully stabilize, use the peak marker function to determine the maximum amplitude level within the RBW.
- 6. Repeat above procedures until other frequencies measured were completed.

Limit

Limit [dBm/3kHz]

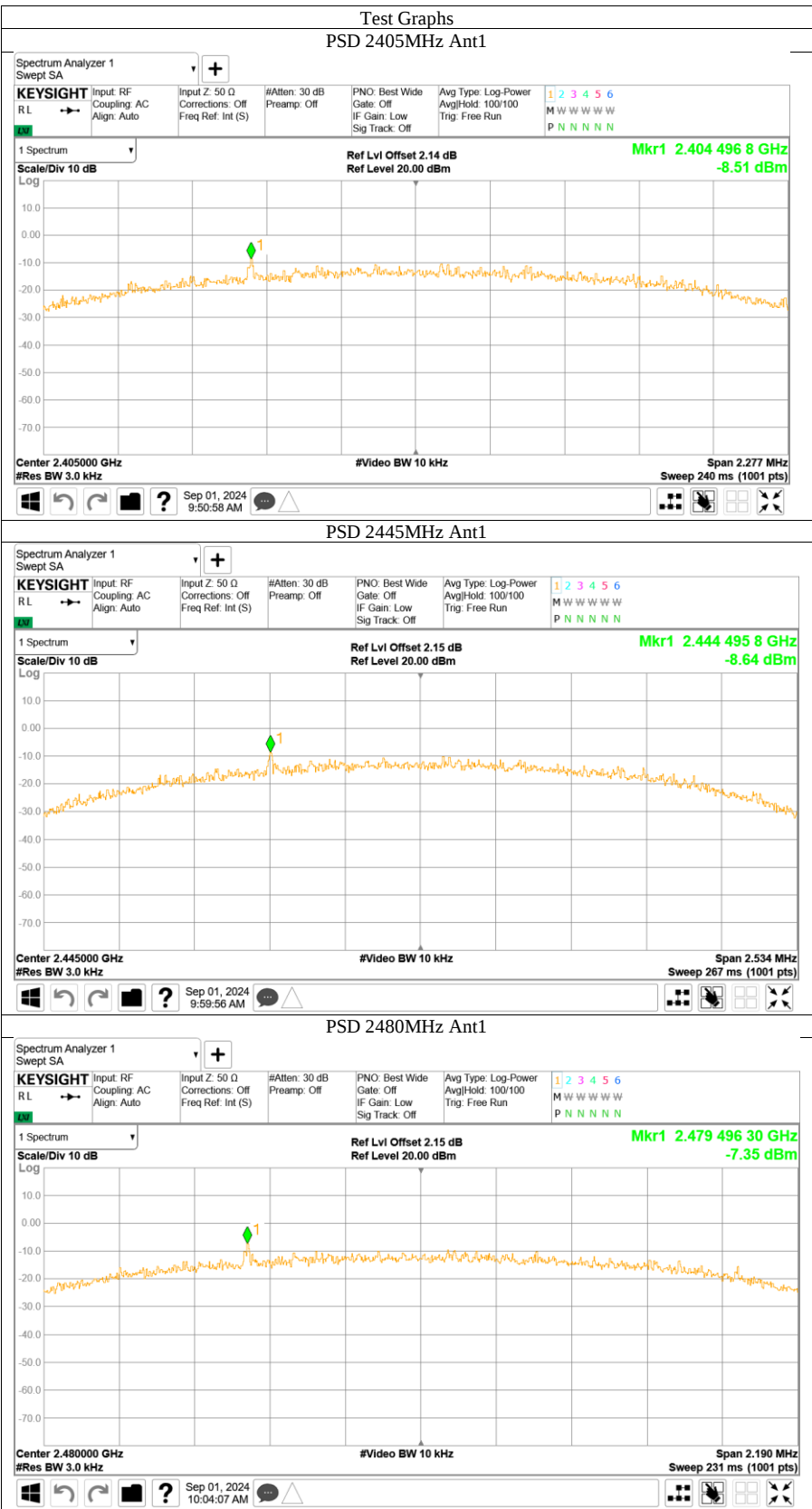
≤8

Test result

Frequency MHz	Power spectral density dBm/3KHz	Result
Top channel 2405MHz	-8.51	Pass
Middle channel 2440MHz	-8.64	Pass
Bottom channel 2480MHz	-7.35	Pass



Power spectral density



10.5 Spurious RF conducted emissions

Test Method

1. The RF output of EUT was connected to the spectrum analyzer by RF cable. The path loss was compensated to the results for each measurement.
2. Set to the maximum power setting, the instrument center frequency is set to the nominal EUT channel center frequency enable the EUT transmit continuously.
3. Use the following spectrum analyzer settings:
Span = wide enough to capture the peak level of the in-band emission and all spurious emissions (e.g., harmonics) from the lowest frequency generated in the EUT up through the 10th harmonic. Typically, several plots are required to cover this entire span.
RBW = 100 kHz, VBW $\geq$ 3RBW, Sweep = auto, Detector function = peak, Trace = max hold
4. Allow the trace to stabilize. Set the marker on the peak of any spurious emission recorded.
5. The level displayed must comply with the limit specified in this Section. Submit these plots.
6. Repeat above procedures until all frequencies measured were complete.

Limit

Frequency Range MHz	Limit (dBc)
30-25000	-20

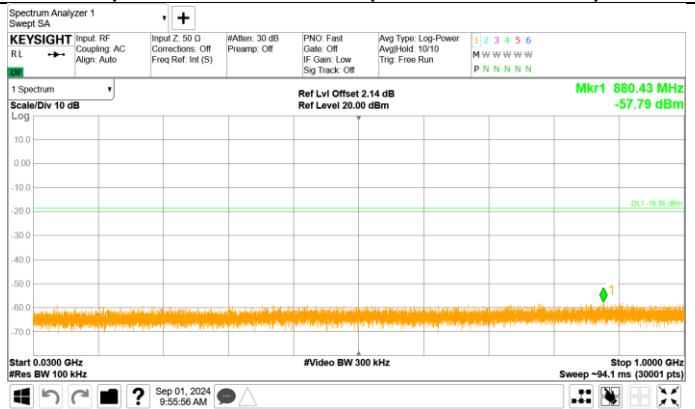
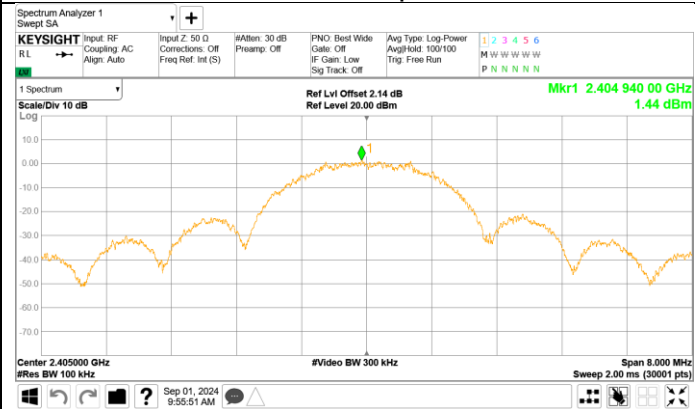


Spurious RF conducted emissions

Out-of-Band Emissions
Channel 11 (2405MHz)

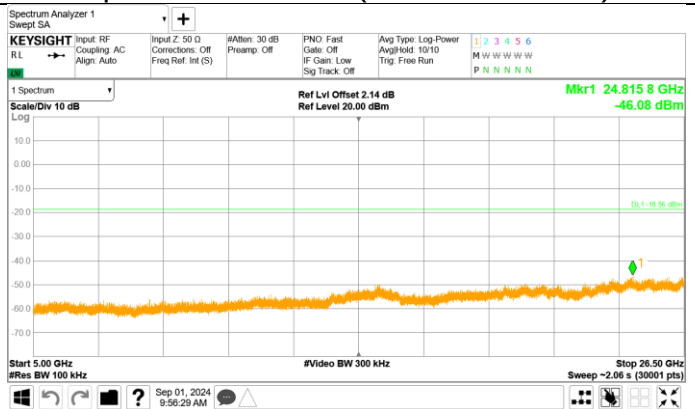
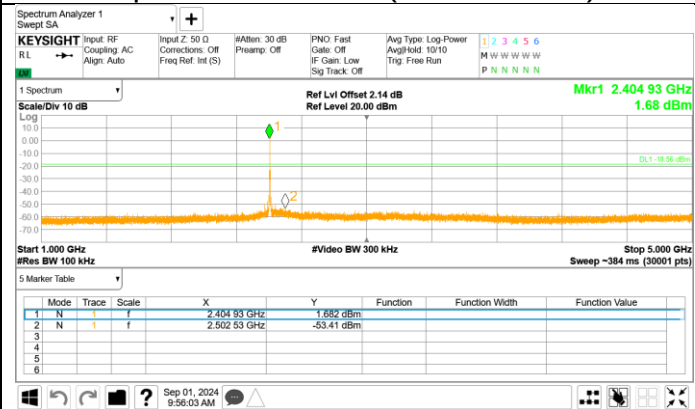
Reference point

Spurious Emission (30MHz – 1GHz)



Spurious Emission (1GHz – 5GHz)

Spurious Emission (5GHz – 26.5GHz)

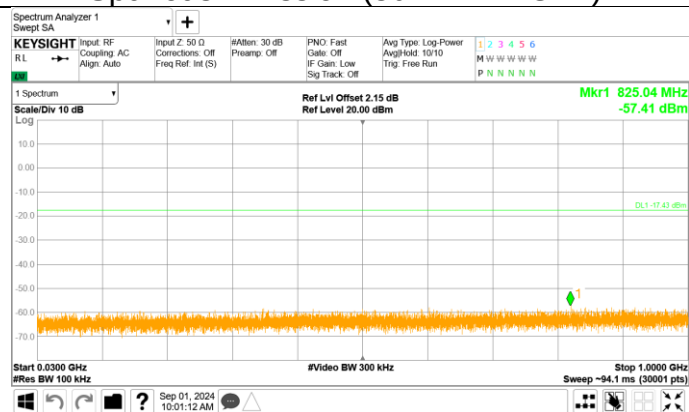
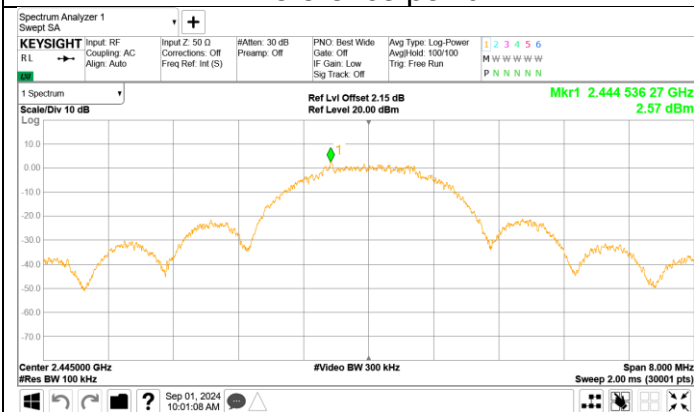




Out-of-Band Emissions Channel 19 (2445MHz)

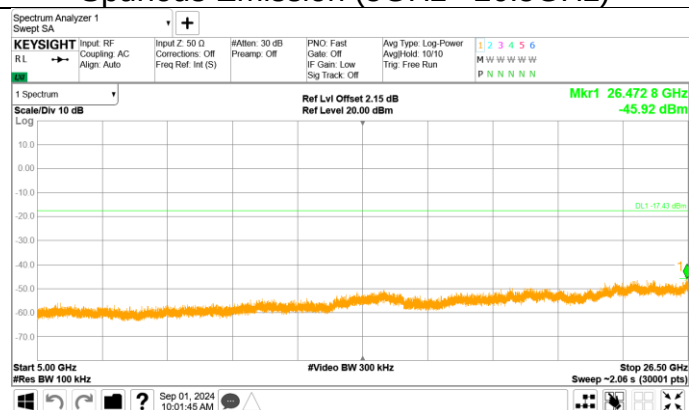
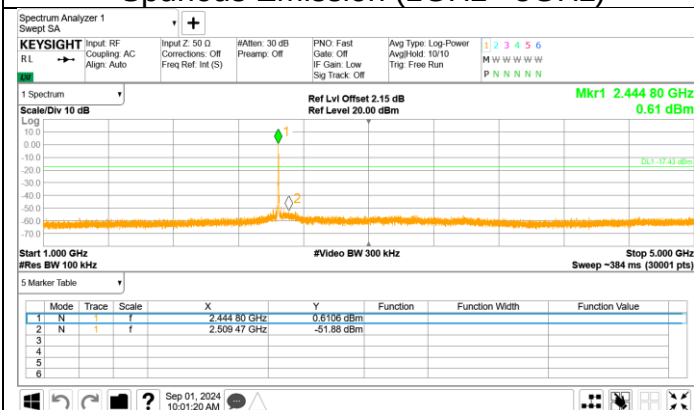
Reference point

Spurious Emission (30MHz – 1GHz)

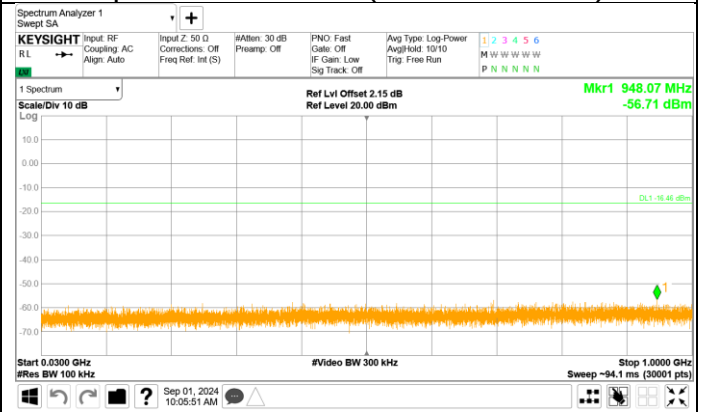


Spurious Emission (1GHz – 5GHz)

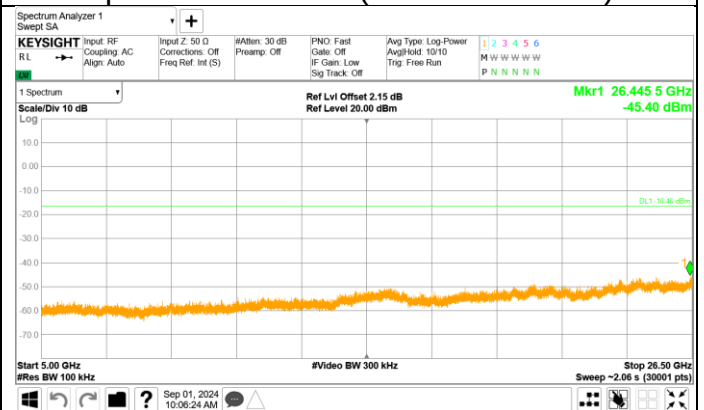
Spurious Emission (5GHz – 26.5GHz)



Spurious Emission (30MHz – 1GHz)



Spurious Emission (5GHz –26.5GHz)



10.6 Band edge

Test Method

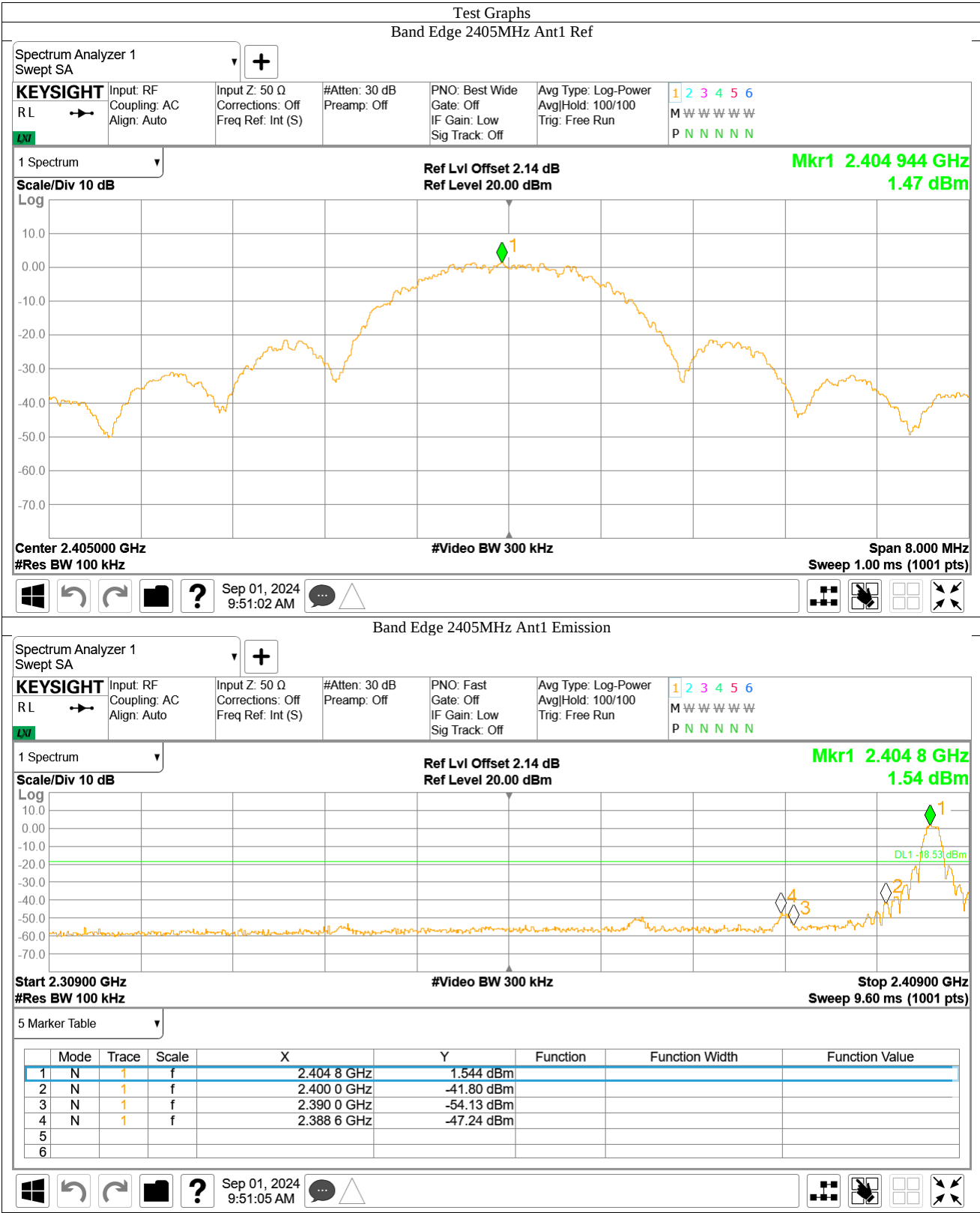
1. The RF output of EUT was connected to the spectrum analyzer by RF cable. The path loss was compensated to the results for each measurement.
2. Set to the maximum power setting, the instrument center frequency is set to the nominal EUT channel center frequency enable the EUT transmit continuously.
3. Use the following spectrum analyzer settings:
Span = wide enough to capture the peak level of the in-band emission and all spurious
RBW = 100 kHz, VBW $\geq$ 3RBW, Sweep = auto, Detector function = peak, Trace = max hold
4. Allow the trace to stabilize, use the peak and delta measurement to record the result.
5. The level displayed must comply with the limit specified in this Section.
6. Repeat above procedures until all frequencies measured were complete and submit all the plots.

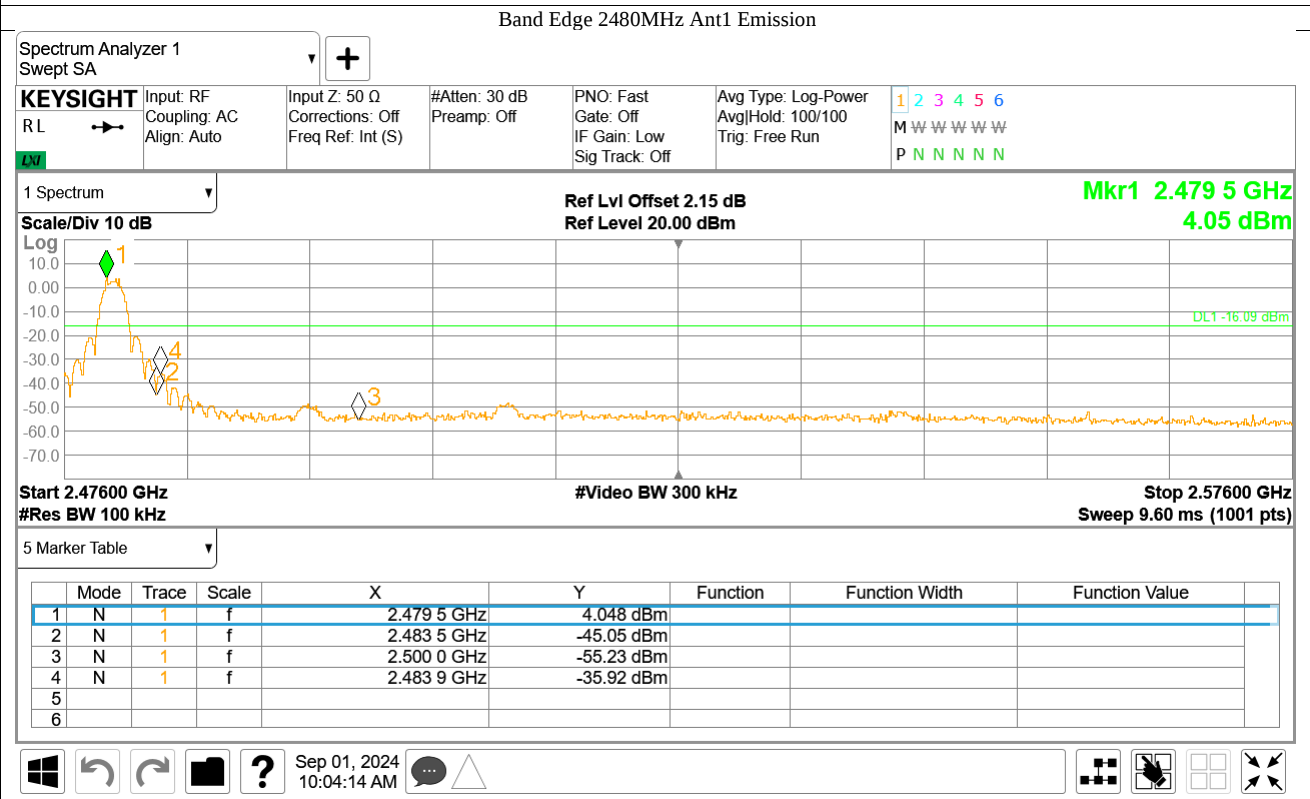
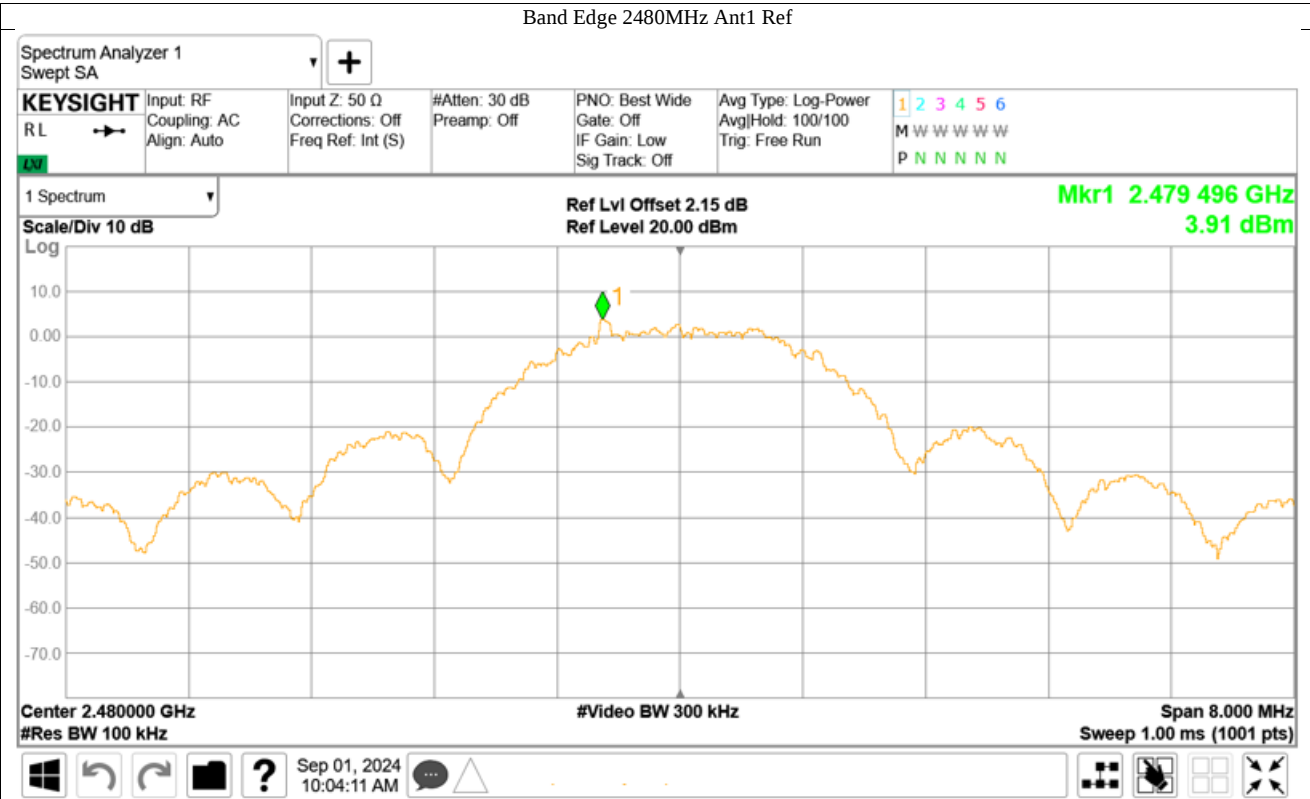
Limit

In any 100 kHz bandwidth outside the frequency band in which the spread spectrum or digitally modulated device is operating, the RF power that is produced shall be at least 20 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 that the transmitter demonstrates compliance with the peak conducted power limits. If the transmitter complies with the conducted power limits based on the use of RMS averaging over a time interval, as permitted under § 15.247(b)(3), the attenuation required shall be 30 dB instead of 20 dB.



Test result





10.7 Spurious radiated emissions for transmitter

Test Method

1. The EUT was placed on a turn table which is 1.5m above ground plane for above 1GHz and 0.8m above ground for below 1GHz at 3 meter chamber room for test. The table was rotated 360 degrees to determine the position of the highest radiation.
2. The EUT was set 3 meters away from the interference – receiving antenna, which was mounted on the top of a variable – height antenna tower.
3. The height of antenna is varied from one meter to four meters above the ground to determine the maximum value of the field strength. Both horizontal and vertical polarizations of the antenna are set to make the measurement.
4. For each suspected emission, the EUT was arranged to its worst case and then the antenna was tuned to heights from 1 meter to 4 meters and the rotatable table was turned from 0 degrees to 360 degrees to find the maximum reading.
5. Use the following spectrum analyzer settings According to C63.10
 - 1) Procedure for Unwanted Emissions Measurements Below 1000 MHz
Span = wide enough to capture the peak level of the in-band emission and all spurious
RBW = 100 kHz to 120kHz, VBW ≥ RBW for peak measurement, Sweep = auto, Detector function = peak, Trace = max hold.
 - 2) For Peak unwanted emissions Above 1GHz:
Span = wide enough to capture the peak level of the in-band emission and all spurious
RBW = 1MHz, VBW ≥ RBW for peak measurement, Sweep = auto, Detector function = peak, Trace = max hold.

Procedures for average unwanted emissions measurements above 1GHz

 - a) RBW = 1MHz.
 - b) $VBW \leq [3 \times RBW]$.
 - c) Detector = RMS (power averaging), if $[span / (\# \text{ of points in sweep})] \leq RBW / 2$.
Satisfying this condition can require increasing the number of points in the sweep or reducing the span. If the condition is not satisfied, then the detector mode shall be set to peak.
 - d) Averaging type = power (i.e., rms) (As an alternative, the detector and averaging type may be set for linear voltage averaging. Some instruments require linear display mode to use linear voltage averaging. Log or dB averaging shall not be used.)
 - e) Sweep time = auto.
 - f) Perform a trace average of at least 100 traces if the transmission is continuous. If the transmission is not continuous, then the number of traces shall be increased by a factor of $1 / D$, where D is the duty cycle. For example, with 50% duty cycle, at least 200 traces shall be averaged. (If a specific emission is demonstrated to be continuous—i.e., 100% duty cycle—then rather than turning ON and OFF with the transmit cycle, at least 100 traces shall be averaged.)
 - g) If tests are performed with the EUT transmitting at a duty cycle less than 98%, then a correction factor shall be added to the measurement results prior to comparing with the emission limit, to compute the emission level that would have been measured had the test been performed at 100% duty cycle. The correction factor is computed as follows:
 - 1) If power averaging (rms) mode was used in the preceding step e), then the correction factor is $[10 \log (1 / D)]$, where D is the duty cycle. For example, if the transmit duty cycle was 50%, then 3 dB shall be added to the measured emission levels.



2) If linear voltage averaging mode was used in the preceding step e), then the correction factor is $[20 \log (1 / D)]$, where D is the duty cycle. For example, if the transmit duty cycle was 50%, then 6 dB shall be added to the measured emission levels.

3) If a specific emission is demonstrated to be continuous (100% duty cycle) rather than turning ON and OFF with the transmit cycle, then no duty cycle correction is required for that emission (AV) at frequency above 1GHz.

Limit

In any 100 kHz bandwidth outside the frequency band in which the spread spectrum or digitally modulated device is operating, the RF power that is produced shall be at least 20 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 that the transmitter demonstrates compliance with the peak conducted power limits. If the transmitter complies with the conducted power limits based on the use of RMS averaging over a time interval, as permitted under § 15.247(b)(3), the attenuation required shall be 30 dB instead of 20 dB. Attenuation below the general field strength 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).

Frequency MHz	Field Strength uV/m	Measured Distance Meters
0.009~0.490	2400/F (kHz)	300
0.490~1.705	24000/F (kHz)	30
1.705~30	30	30

Frequency MHz	Field Strength uV/m	Field Strength dBµV/m	Detector
30-88	100	40	QP
88-216	150	43.5	QP
216-960	200	46	QP
960-1000	500	54	QP
Above 1000	500	54	AV
Above 1000	5000	74	PK

Spurious radiated emissions for transmitter

According to C63.10, if the peak (or quasi-peak) measured value complies with the average limit, it is unnecessary to perform an average measurement, so AV emission value did not show in below table if the peak value complies with average limit.

Data of measurement within frequency range 9kHz-30MHz is the noise floor or attenuated more than 20dB below the permissible limits or the field strength is too small to be measured, so test data does not present in this report.

Test result

The worst case of Radiated Emission below 1GHz: Only the worst case listed as below.

30-1000MHz Radiated Emission

EUT Information

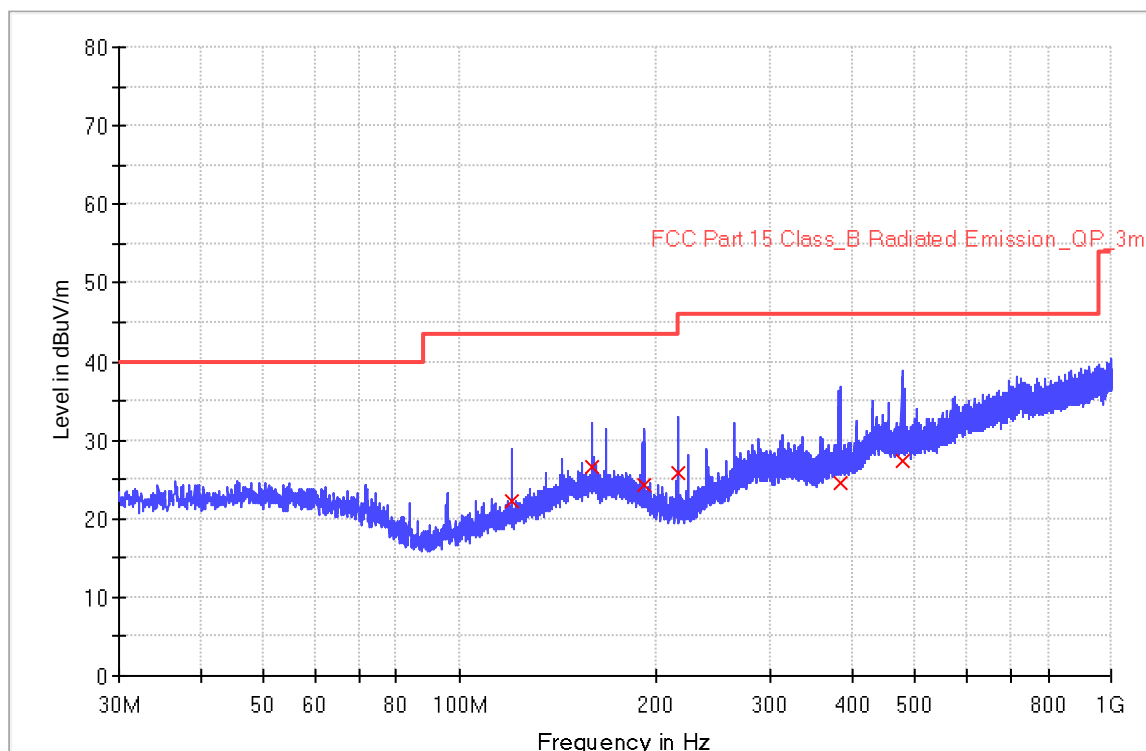
EUT Name:	Zigbee Module
Model:	ZPU-Pro
Client:	Hangzhou Tuya Information Technology Co., Ltd.
Op Cond:	Power on and TX at 2480MHz
Operator:	Tianji XU
Test Spec:	FCC Part 15.209(a)
Sample No:	SHA-822439-1

Sweep Setup: RE_VULB9168_pre_Cont_30-1000 [EMI radiated]

Hardware Setup:	RE_VULB9168
Receiver:	[ESR 3]
Level Unit:	dBuV/m

Subrange	Step Size	Detectors	Bandwidth	Sweep Time	Preamp
30 MHz - 1 GHz	48.5 kHz	PK+	120 kHz	0.2 s	20 dB

RE_VULB9168_pre_Cont_30-1000



Limit and Margin

Frequency (MHz)	QuasiPeak (dBuV/m)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB/m)	Margin - QPK (dB)
119.960000	22.2	1000.0	120.000	150.0	H	322.0	18.1	21.3
159.960000	26.5	1000.0	120.000	125.0	H	186.0	20.9	17.0
191.680000	24.3	1000.0	120.000	200.0	H	25.0	18.4	19.2
216.000000	25.8	1000.0	120.000	100.0	H	116.0	17.5	20.2
383.400000	24.5	1000.0	120.000	152.0	H	263.0	23.8	21.5
478.320000	27.4	1000.0	120.000	260.0	H	27.0	26.1	18.6

(continuation of the "Limit and Margin" table from column 16 ...)

Frequency (MHz)	Limit - QPK (dBuV/m)
119.960000	43.5
159.960000	43.5
191.680000	43.5
216.000000	46.0
383.400000	46.0
478.320000	46.0

Note 1: Measure Level (dBuV/m) = Reading Level (dBuV) + Factor (dB)

Factor (dB) = Cable Loss (dB) + Antenna Factor (dB/m)

30-1000MHz Radiated Emission

EUT Information

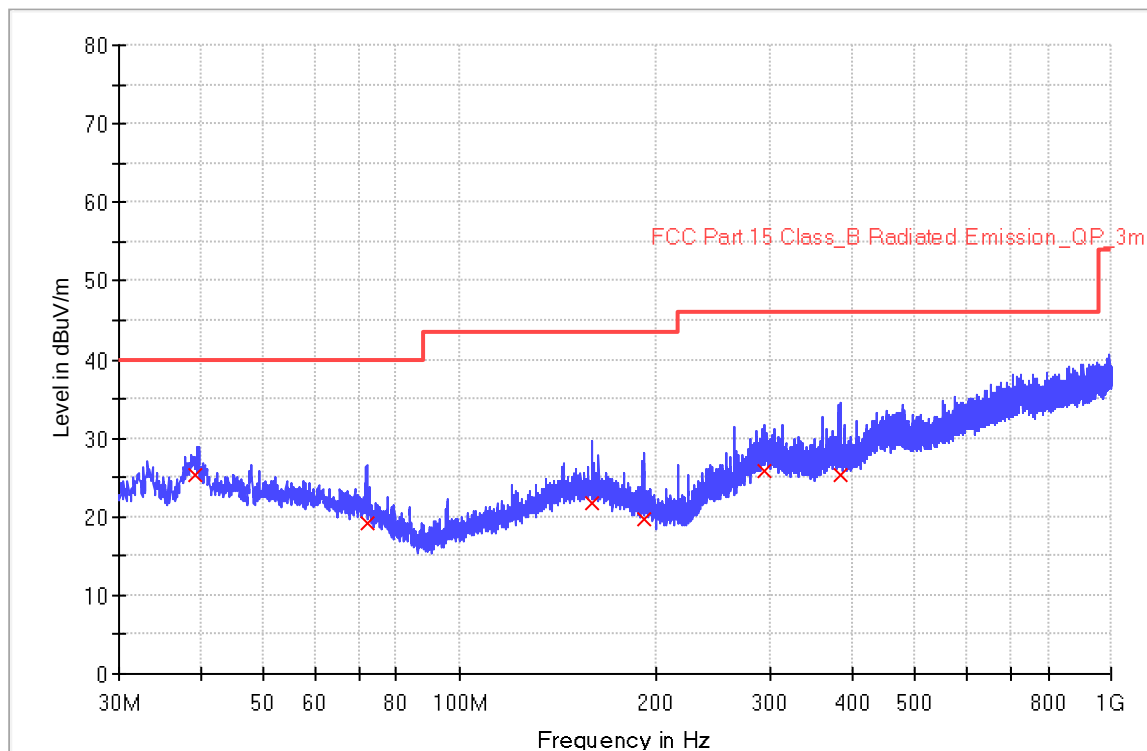
EUT Name:	Zigbee Module
Model:	ZPU-Pro
Client:	Hangzhou Tuya Information Technology Co., Ltd.
Op Cond:	Power on and TX at 2480MHz
Operator:	Tianji XU
Test Spec:	FCC Part 15.209(a)
Sample No:	SHA-822439-1

Sweep Setup: RE_VULB9168_pre_Cont_30-1000 [EMI radiated]

Hardware Setup:	RE_VULB9168
Receiver:	[ESR 3]
Level Unit:	dBuV/m

Subrange	Step Size	Detectors	Bandwidth	Sweep Time	Preamp
30 MHz - 1 GHz	48.5 kHz	PK+	120 kHz	0.2 s	20 dB

RE_VULB9168_pre_Cont_30-1000





Limit and Margin

Frequency (MHz)	QuasiPeak (dBuV/m)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB/m)	Margin - QPK (dB)
39.300000	25.4	1000.0	120.000	150.0	V	133.0	20.0	14.6
72.000000	19.2	1000.0	120.000	120.0	V	214.0	18.2	20.8
159.960000	21.7	1000.0	120.000	112.0	V	16.0	20.9	21.8
191.640000	19.6	1000.0	120.000	225.0	V	253.0	18.4	23.9
293.240000	25.8	1000.0	120.000	200.0	V	228.0	21.3	20.2
384.280000	25.2	1000.0	120.000	100.0	V	305.0	23.8	20.8

(continuation of the "Limit and Margin" table from column 16 ...)

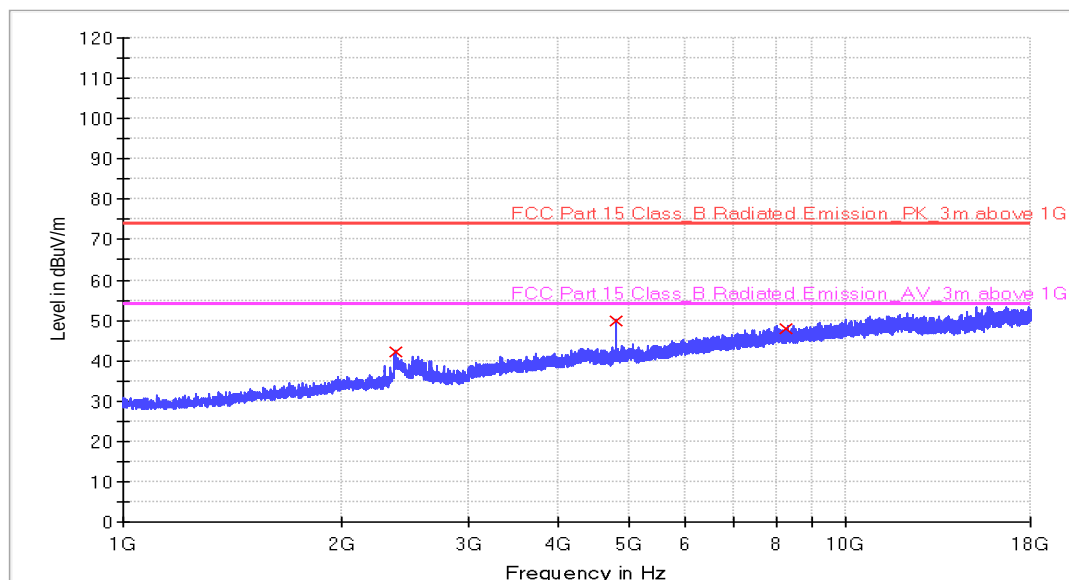
Frequency (MHz)	Limit - QPK (dBuV/m)
39.300000	40.0
72.000000	40.0
159.960000	43.5
191.640000	43.5
293.240000	46.0
384.280000	46.0

Note 1: Measure Level (dBuV/m) = Reading Level (dBuV) + Factor (dB)
 Factor (dB) = Cable Loss (dB) + Antenna Factor (dB/m)

Radiated Emission 1-18GHz

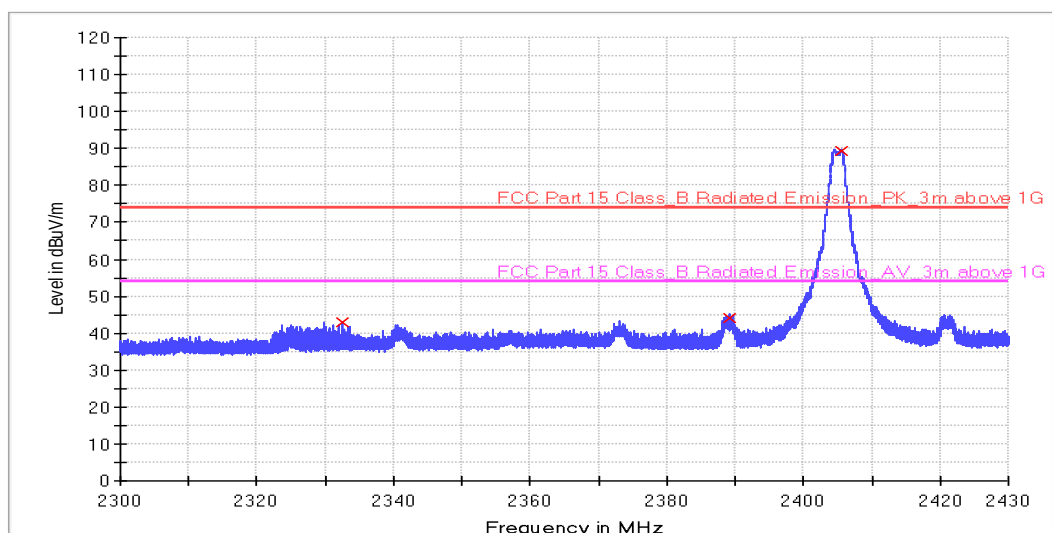
Frequency:2405MHz

RE_HF907_BRF_Pre



Frequency (MHz)	MaxPeak (dBuV/m)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB/m)	Limit (dBuV/m)	Margin (dB)
2384.500000	42.3	150.0	H	19.0	-4.7	74.0	31.7
4809.700000	49.8	160.0	H	269.0	-2.2	74.0	24.2
8248.900000	47.9	250.0	H	359.0	2.2	74.0	26.1

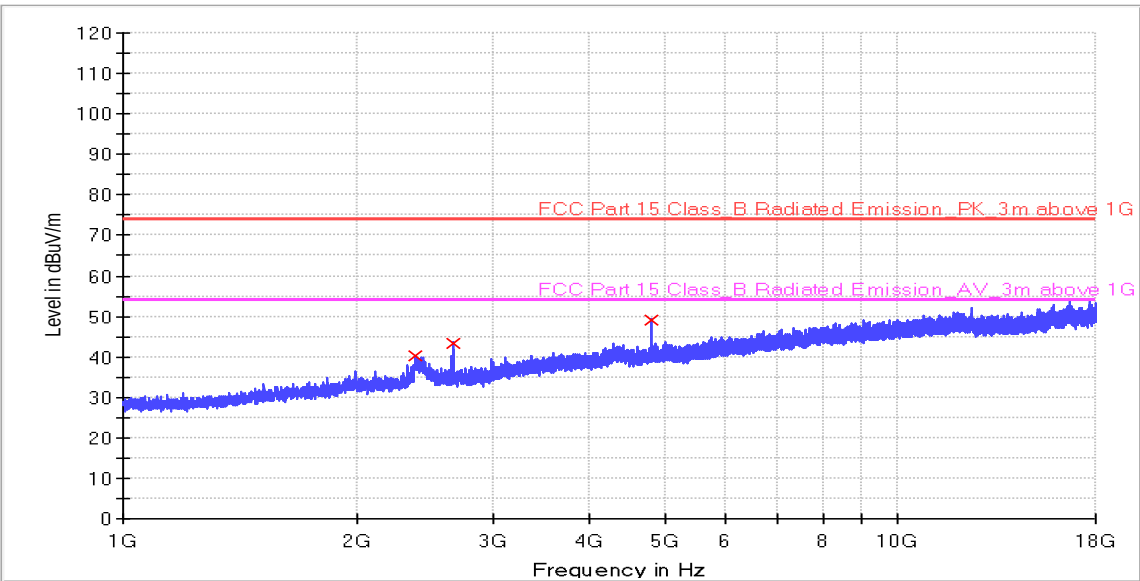
RE_HF907_BRF_Pre



Frequency (MHz)	MaxPeak (dBuV/m)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB/m)	Limit (dBuV/m)	Margin (dB)
2332.600000	43.1	148.0	H	196.4	-11.1	74.0	30.9
2389.300000	44.2	160.0	H	276.9	-10.8	74.0	29.8
2405.500000	89.3	150.0	H	136.8	-10.8	/	/

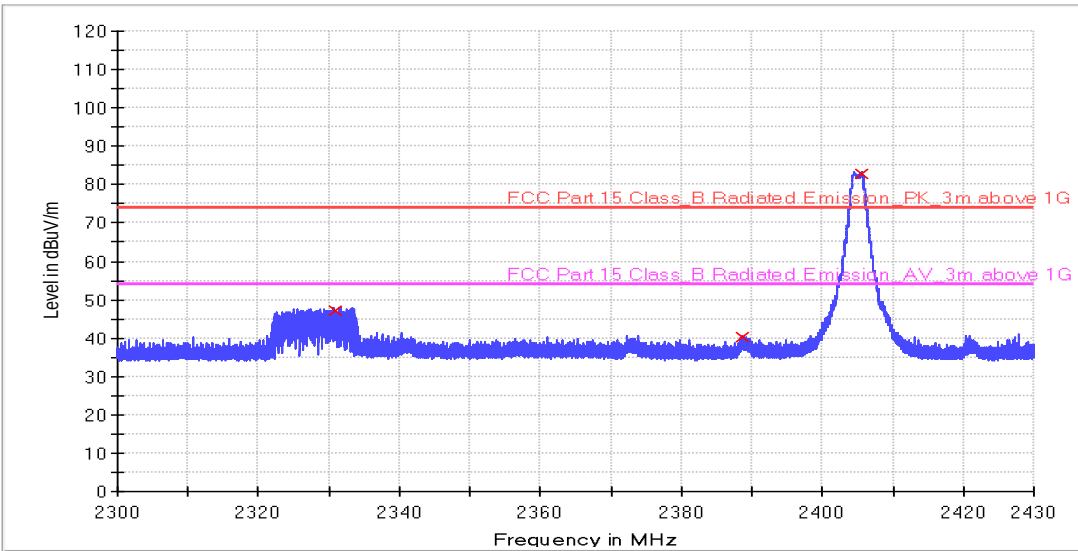


RE_HF907_BRF_Pre



Frequency (MHz)	MaxPeak (dBuV/m)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB/m)	Limit (dBuV/m)	Margin (dB)
2383.200000	40.1	140.0	V	210.5	-6.1	74.0	33.9
2661.100000	43.5	180.0	V	165.5	-9.5	74.0	30.5
4809.100000	49.1	150.0	V	295.3	-2.2	74.0	24.9

RE_HF907_BRF_Pre

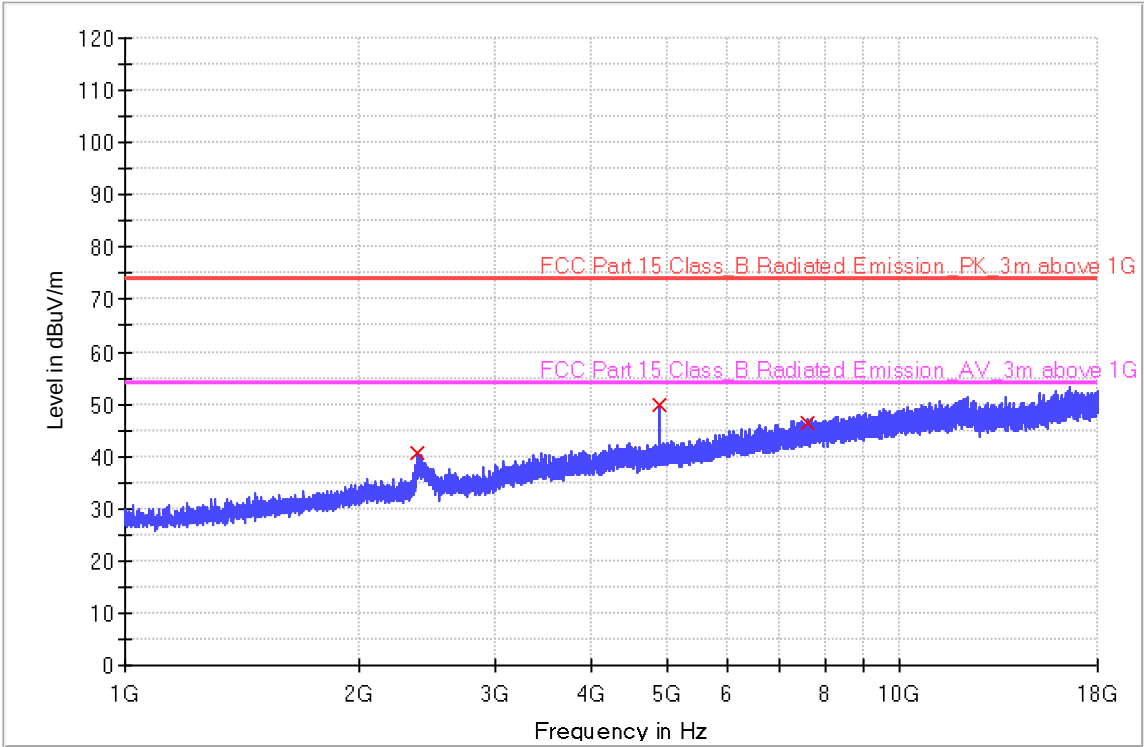


Frequency (MHz)	MaxPeak (dBuV/m)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB/m)	Limit (dBuV/m)	Margin (dB)
2330.800000	47.2	160.0	V	134.3	-11.1	74.0	26.8
2388.700000	40.1	150.0	V	269.3	-10.8	74.0	33.9
2405.500000	83.0	200.0	V	190.6	-10.8	/	/



Frequency:2445MHz

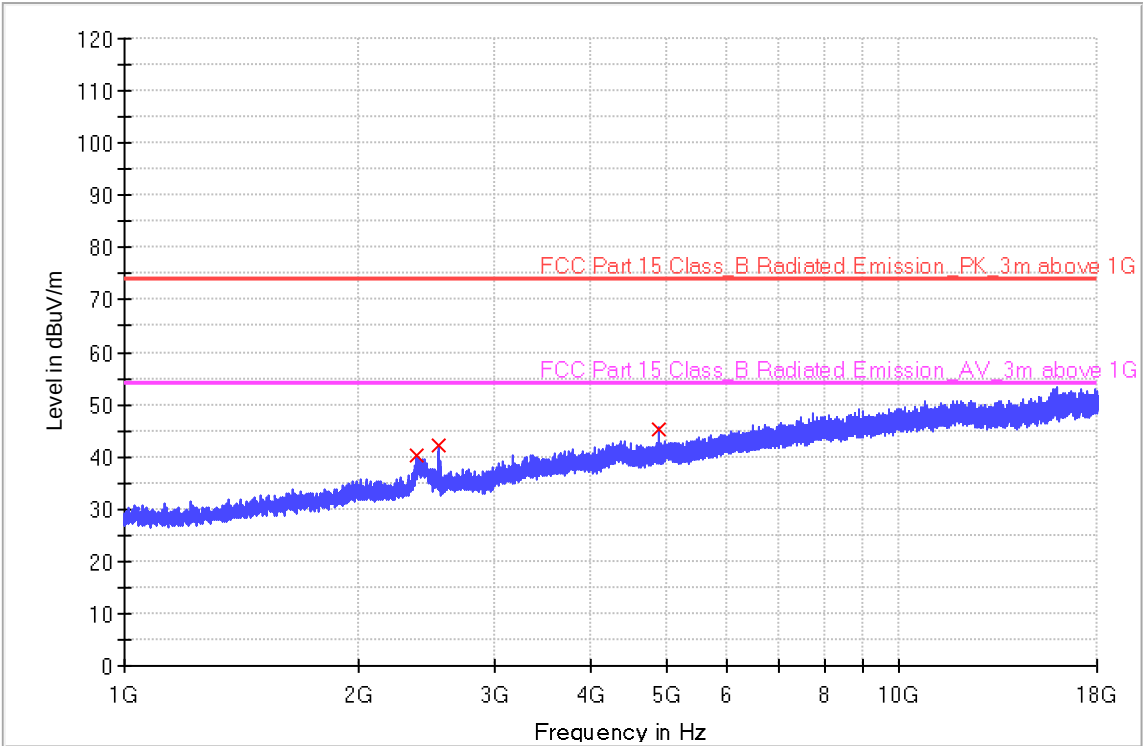
RE_HF907_BRF_Pre



Frequency (MHz)	MaxPeak (dBuV/m)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB/m)	Limit (dBuV/m)	Margin (dB)
2380.600000	40.5	150.0	H	210.5	-5.3	74.0	33.5
4890.400000	49.8	180.0	H	165.5	-2.0	74.0	24.2
7593.400000	46.5	270.0	H	295.3	1.7	74.0	27.5



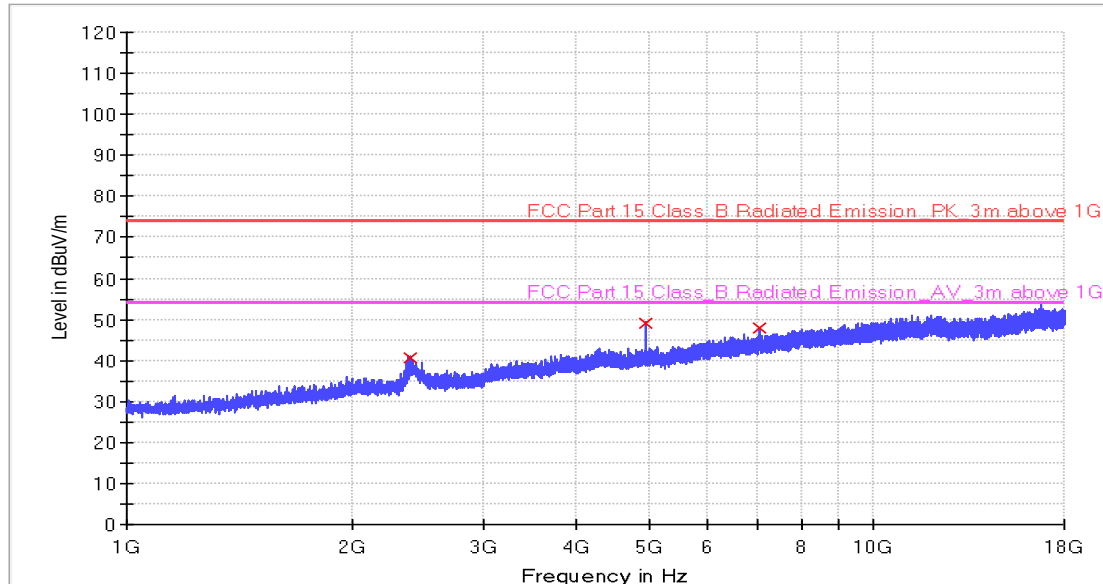
RE_HF907_BRF_Pre



Frequency (MHz)	MaxPeak (dBuV/m)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB/m)	Limit (dBuV/m)	Margin (dB)
2380.300000	40.2	160.0	V	92.6	-5.4	74.0	33.8
2543.200000	42.1	250.0	V	100.3	-9.6	74.0	31.9
4891.000000	45.1	144.0	V	265.4	-2.0	74.0	28.9

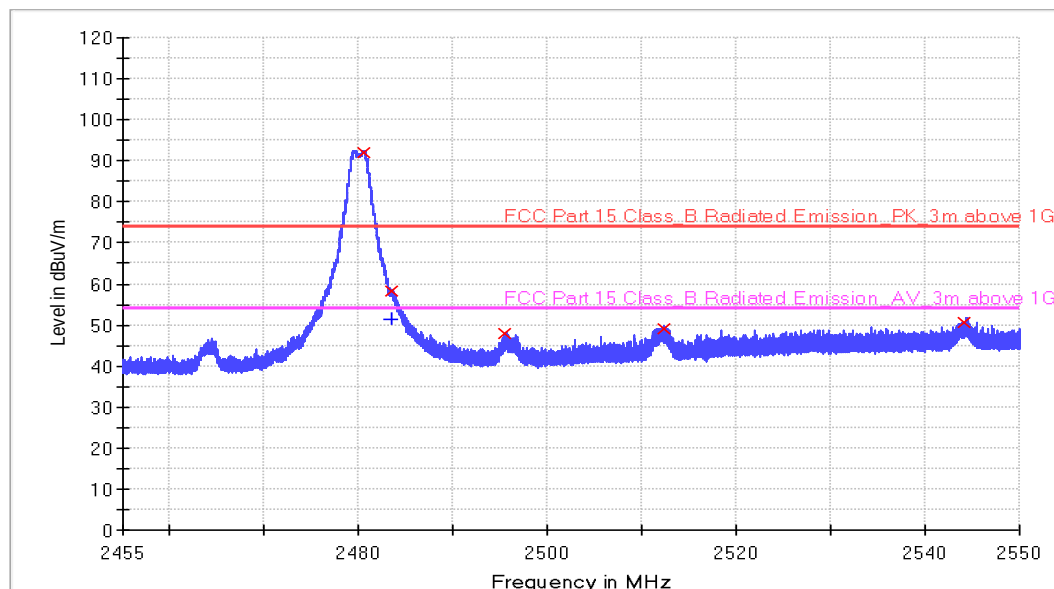
Frequency: 2480MHz

RE_HF907_BRF_Pre



Frequency (MHz)	MaxPeak (dBuV/m)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB/m)	Limit (dBuV/m)	Margin (dB)
2392.000000	40.5	250.0	H	131.8	-5.6	74.0	33.5
4960.600000	48.9	150.0	H	269.8	-1.9	74.0	25.1
7049.800000	47.8	150.0	H	182.1	1.2	74.0	26.2

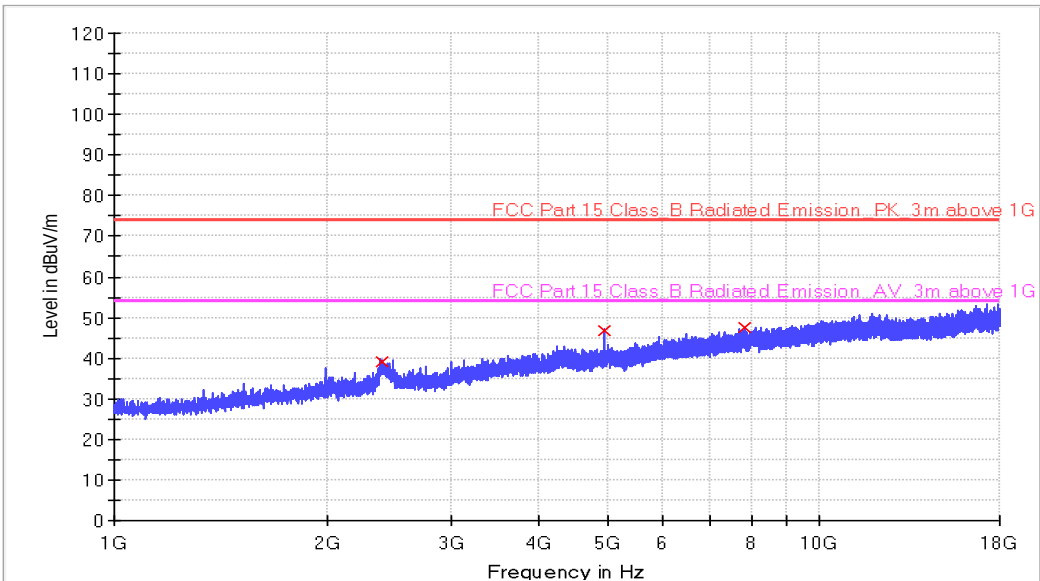
RE_HF907_BRF_Pre



Frequency (MHz)	MaxPeak (dBuV/m)	AV (dBuV/m)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB/m)	Margin - PK+	Limit - PK+	Margin - AV	Limit - AV
2480.50	92.1	---	250.0	H	185.4	-10.3	-18.1	/	/	/
2483.50	58.1	51.2	140.0	H	164.5	-8.2	15.9	74.0	2.8	54.0
2495.50	48.1	---	150.0	H	103.9	-10.3	25.9	74.0	---	---
2512.30	48.9	---	160.0	H	209.5	-10.2	25.1	74.0	---	---
2544.10	50.7	---	150.0	H	237.0	-9.6	23.3	74.0	---	---

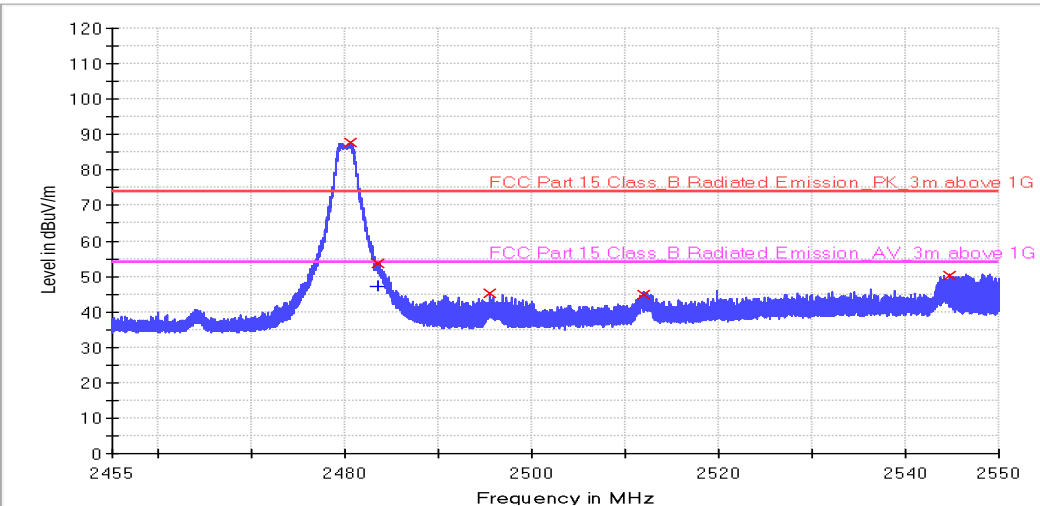


RE_HF907_BRF_Pre



Frequency (MHz)	MaxPeak (dBuV/m)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB/m)	Limit (dBuV/m)	Margin (dB)
2392.000000	39.1	160.0	V	100.8	-5.6	74.0	34.9
4958.800000	46.7	140.0	V	153.3	-1.9	74.0	27.3
7813.300000	47.4	150.0	V	202.4	1.9	74.0	26.6

RE_HF907_BRF_Pre

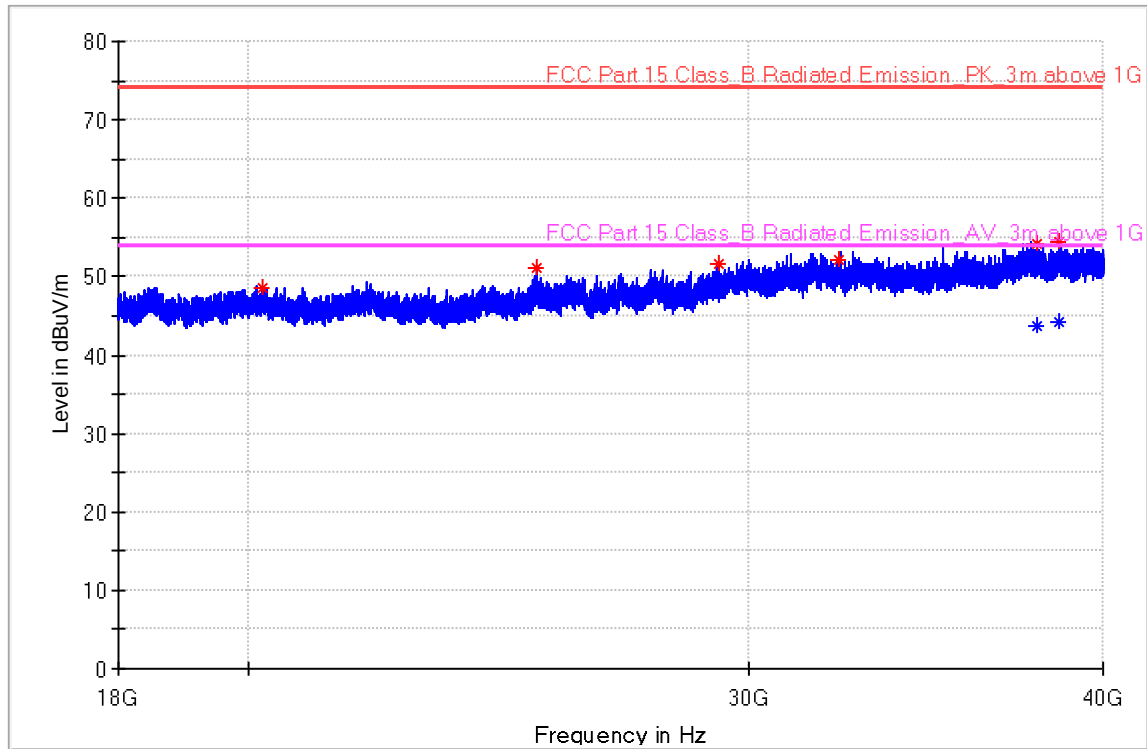


Frequency (MHz)	MaxPeak (dBuV/m)	AV (dBuV/m)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB/m)	Margin - PK+ (dB)	Limit - PK+ (dBuV/m)	Margin - AV (dB)	Limit - AV (dBuV/m)
2480.5	87.7	---	199.4	V	136.6	-10.3	/	/	/	/
2483.5	53.5	47.2	178.8	V	121.1	-8.2	20.5	74.0	6.8	54.0
2495.45	45.2	---	101.1	V	211.2	-10.3	28.8	74.0	---	---
2512.0	44.9	---	272.2	V	222.5	-10.2	29.1	74.0	---	---
2544.70	50.1	---	186.5	V	174.0	-9.9	23.9	74.0	---	---

The worst case of Radiated Emission Above 18GHz

Frequency:2480MHz

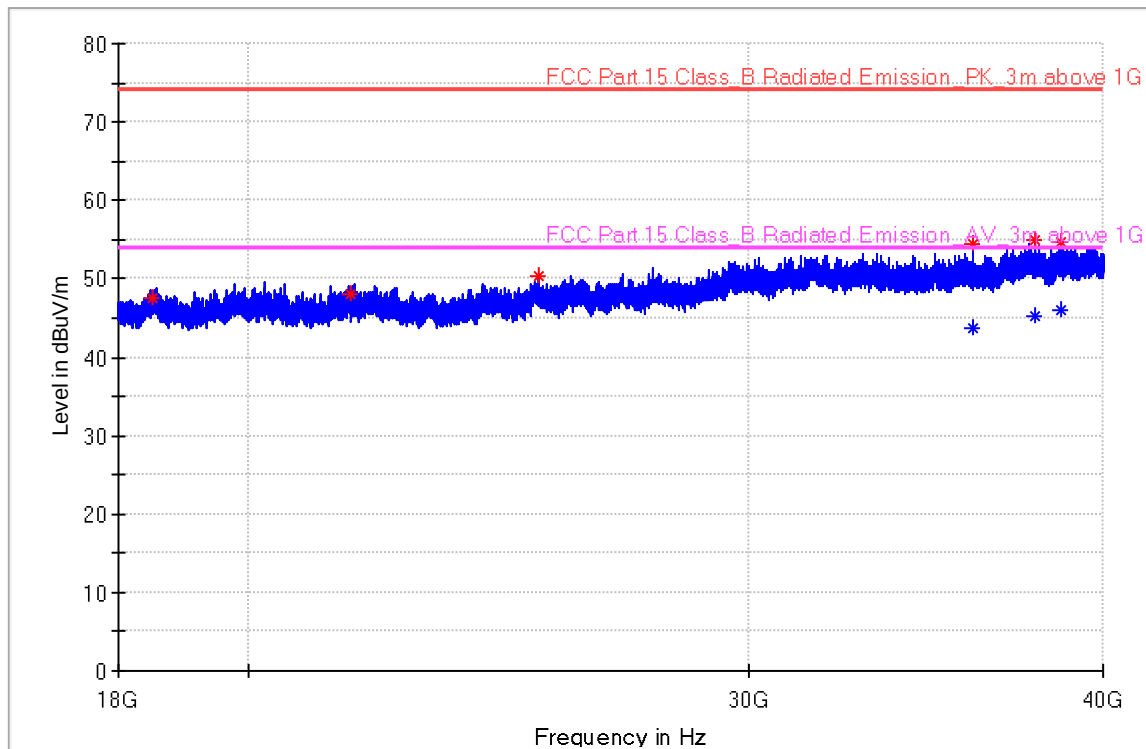
Full Spectrum



Limit and Margin

Frequency (MHz)	MaxPeak (dBuV/m)	Average (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB/m)
20231.625000	48.60	---	74.00	25.40	193	H	166.0	12.6
25266.187500	51.20	---	74.00	22.80	275	H	231.0	13.2
29292.875000	51.65	---	74.00	22.35	194	H	346.0	19.3
32298.625000	52.16	---	74.00	21.84	224	H	324.0	18.9
37915.500000	---	43.82	54.00	10.18	159	H	346.0	18.1
37915.500000	54.24	---	74.00	19.76	178	H	217.0	19.6
38585.125000	---	44.33	54.00	9.67	113	H	346.0	18.1
38585.125000	54.56	---	74.00	19.44	193	H	339.0	18.1

Full Spectrum



Limit and Margin

Frequency (MHz)	MaxPeak (dBuV/m)	Average (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB/m)
18515.625000	47.47	---	74.00	26.53	184	V	126.0	9.7
21741.375000	48.14	---	74.00	25.86	230	V	81.0	15.4
25303.312500	50.33	---	74.00	23.67	240	V	300.0	13.8
36022.150000	54.55	---	74.00	19.45	196	V	227.0	17.5
36022.150000	---	43.75	54.00	10.25	177	V	307.0	17.5
37882.500000	---	45.24	54.00	8.76	129	V	220.0	19.7
37882.500000	54.91	---	74.00	19.09	287	V	198.0	19.6
38655.250000	---	46.17	54.00	7.83	184	V	88.0	15.6
38655.250000	54.65	---	74.00	19.35	230	V	103.0	17.9

Remark:

- (1) Emission level= Original Receiver Reading + Correct Factor
- (2) Correct Factor = Antenna Factor + Cable Loss -Amplifier gain
- (3) Margin = limit – Corrected Reading

11 Test Equipment List

List of Test Instruments
Test Site1

	DESCRIPTION	MANUFACTURER	MODEL NO.	SERIAL NO.	CAL. DATE	CAL. DUE DATE
C	Signal spectrum analyzer	Agilent	N9020B	MY59050168	2024-2-19	2025-2-18
RE	EMI Test Receiver	Rohde & Schwarz	ESR3	101906	2024-8-1	2025-7-31
	Signal Analyzer	Rohde & Schwarz	FSV40	101091	2024-8-1	2025-7-31
	Trilog Super Broadband Test Antenna	Schwarzbeck	VULB 9168	961	2021-9-23	2024-9-22
	Horn Antenna	Rohde & Schwarz	HF907	102393	2024-4-14	2027-4-13
	Pre-amplifier	Shenzhen HzEMC	HPA-081843	HYP A23026	2024-4-16	2025-4-15
	Loop antenna	Rohde & Schwarz	HFH2-Z2	100443	2024-6-26	2025-6-25
	Double Ridged Horn Antenna	ETS-Lindgren	3116C	00246076	2023-7-7	2026-7-6
	3m Semi-anechoic chamber	TDK	9X6X6	----	2024-5-8	2027-5-7
CE	EMI Test Receiver	Rohde & Schwarz	ESR3	101907	2024-8-1	2025-7-31
	LISN	Rohde & Schwarz	ENV216	101924	2024-8-1	2025-7-31

Measurement Software Information			
Test Item	Software	Manufacturer	Version
C	MTS 8310	MWRFTtest	3.0.0.0
RE	EMC 32	Rohde & Schwarz	V10.50.40
CE	EMC 32	Rohde & Schwarz	V9.15.03

C - Conducted RF tests

- Conducted peak output power
- 6dB bandwidth and 99% Occupied Bandwidth
- Power spectral density*
- Spurious RF conducted emissions
- Band edge



12 System Measurement Uncertainty

For a 95% confidence level, the measurement expanded uncertainties for defined systems, in accordance with the recommendations of ISO 17025 were:

Items	Extended Uncertainty
Conducted Disturbance at Mains Terminals	150kHz to 30MHz, LISN, 3.16dB
Radiated Disturbance	9kHz to 30MHz, 3.52dB 30MHz to 1GHz, 5.03dB (Horizontal) 5.12dB (Vertical) 1GHz to 18GHz, 5.49dB 18GHz to 40GHz, 5.63dB
RF Conducted Measurement	Power related: 1.16dB Frequency related: 6.00×10^{-8}

Measurement Uncertainty Decision Rule:

Determination of conformity with the specification limits is based on the decision rule according to IEC Guide 115: 2023, clause 4.3.3.



13 Photographs of Test Set-ups

Refer to the < Test Setup photos >.



14 Photographs of EUT

Refer to the < External Photos > & < Internal Photos >.

-----End of Test Report-----