Certificate No.: 3745.01

FCC TEST REPORT

Report Number	:	**709502204659-01A**	Date of Issue:	December 28, 2023

Model	:	TS24-U
Product Type	:	Wireless Module
Applicant	:	Hangzhou Tuya Information Technology Co.,Ltd
Address	:	Room701,Building3,More Center,No.87 GuDun Road,Hangzhou,Zhejiang China
Manufacturer	:	Hangzhou Tuya Information Technology Co.,Ltd
Address	:	Room701,Building3,More Center,No.87 GuDun Road,Hangzhou,Zhejiang China
Test Result	:	■ **Positive** ☐ **Negative**
Total pages including Appendices	:	49

TÜV SÜD Certification and Testing (China) Co., Ltd. Shanghai Branch is a subcontractor to TÜV SÜD Product Service GmbH according to the principles outlined in ISO 17025.

TÜV SÜD Certification and Testing (China) Co., Ltd. Shanghai Branch reports apply only to the specific samples tested under stated test conditions. Construction of the actual test samples has been documented. It is the manufacturer's responsibility to assure that additional production units of this model are manufactured with identical electrical and mechanical components. The manufacturer/importer is responsible to the Competent Authorities in Europe for any modifications made to the production units which result in non-compliance to the relevant regulations. TÜV SÜD Certification and Testing (China) Co., Ltd. Shanghai Branch shall have no liability for any deductions, inferences or generalizations drawn by the client or others from TÜV SÜD Certification and Testing (China) Co., Ltd. Shanghai Branch issued reports.

TÜV SÜD Certification and Testing (China) Co., Ltd. Shanghai Branch
3-13, No.151, Heng Tong Road, Shanghai, 200070, P.R. China
Phone: +86 21 61410123, Fax:+86 21 61408600

1 Table of Contents

TÜV SÜD Certification and Testing (China) Co., Ltd. Shanghai Branch
3-13, No.151, Heng Tong Road, Shanghai, 200070, P.R. China
Phone: +86 21 61410123, Fax:+86 21 61408600

2 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, Shanghai 201108, P.R. China
Test Firm FCC Registration Number:	820234
Designation number:	CN1183
IC Company Number:	31688
CAB identifier:	CN0101
Telephone:	+86 21 6141 0123
Fax:	+86 21 6140 8600

3 Description of the Equipment under Test

Description of the Equipment Under Test

Product:	Wireless Module
Model no.:	TS24-U
FCC ID:	2ANDL-TS24-U
Options and accessories:	NA
Rating:	2.0V-3.8V DC
RF Transmission Frequency:	Zigbee:2405~2480MHz; Bluetooth LE:2402~2480MHz;
No. of Operated Channel:	16 for ZigBee; 40 for Bluetooth LE;
Modulation:	Zigbee:16-ary orthogonal modulation, O-QPSK PHY; Bluetooth LE:GFSK

Channel list:

Zigbee			
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

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

TÜV SÜD Certification and Testing (China) Co., Ltd. Shanghai Branch
3-13, No.151, Heng Tong Road, Shanghai, 200070, P.R. China
Phone: +86 21 61410123, Fax:+86 21 61408600

Antenna Type:	PCB antenna
Antenna Gain:	-1.0 dBi
Description of the EUT:	The Equipment Under Test (EUT) is a wireless Module with BLE and Zigbee function. We tested it and listed the worst data in this report.
Test sample no.:	SHA-777946-2 (RF radiated); SHA-777946-1 (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.

TÜV SÜD Certification and Testing (China) Co., Ltd. Shanghai Branch
3-13, No.151, Heng Tong Road, Shanghai, 200070, P.R. China
Phone: +86 21 61410123, Fax:+86 21 61408600

4 Summary of Test Standards

Test Standards	
FCC Part 15 Subpart C	PART 15 - RADIO FREQUENCY DEVICES Subpart C - Intentional Radiators

All the test methods were according to KDB 558074 D01 15.247 Meas Guidance v05r02 Measurement Guidance and ANSI C63.10-2020.

TÜV SÜD Certification and Testing (China) Co., Ltd. Shanghai Branch
3-13, No.151, Heng Tong Road, Shanghai, 200070, P.R. China
Phone: +86 21 61410123, Fax:+86 21 61408600

5 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	13-17	Site 1	☒	☐	☐
§15.247 (b) (1)	Conducted peak output power	18-20	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	21-23	Site 1	☒	☐	☐
§15.247(e)	Power spectral density	24-26	Site 1	☒	☐	☐
§15.247(d)	Spurious RF conducted emissions	27-33	Site 1	☒	☐	☐
§15.247(d)	Band edge	34-38	Site 1	☒	☐	☐
§15.247(d) & §15.209	Spurious radiated emissions for transmitter	39-46	Site 1	☒	☐	☐
§15.203	Antenna requirement	See note 1		☒	☐	☐

Remark 1: N/A – Not Applicable.
Note 1: The EUT uses a PCB antenna, which gain is -1.0dBi. In accordance to §15.203, It is considered sufficiently to comply with the provisions of this section.

TÜV SÜD Certification and Testing (China) Co., Ltd. Shanghai Branch
3-13, No.151, Heng Tong Road, Shanghai, 200070, P.R. China
Phone: +86 21 61410123, Fax:+86 21 61408600

6 General Remarks

Remarks

This submittal(s) (test report) is intended for FCC ID: 2ANDL-TS24-U, complies with Section 15.207,15.209,15.231,15.247 of the FCC Part 15, Subpart C Rules.

Note: The FCC ID: 2ANDL-TS24-U has been granted on 12/09/2022.
The applicant has recently lifted the module chip's restrictions on BLE transmission by modifying the software. The hardware of the module has not undergone any changes.
So, this report is supplemental test for 2.4GHz BLE and 2.4GHz Zigbee test report please refer to 709502204659-00A.

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.

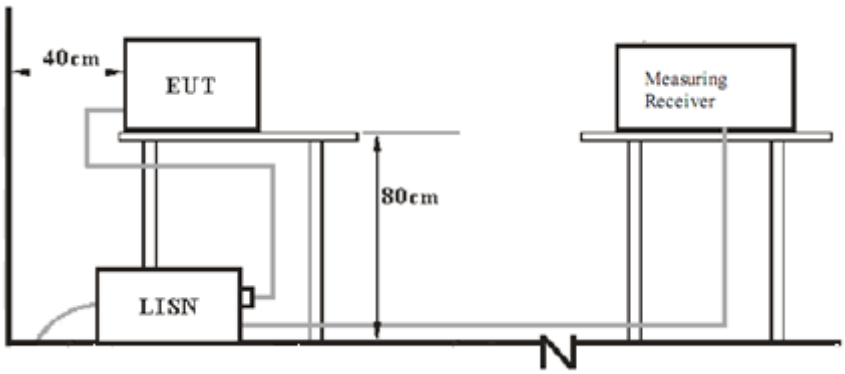
Sample Received Date:	December 6, 2023
Testing Start Date:	December 8, 2023
Testing End Date:	December 22, 2023

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

Reviewed by:	Prepared by:	Tested by:
Hui TONG	Jiaxi XU	Cheng Huali
Review Engineer	Project Engineer	Test Engineer

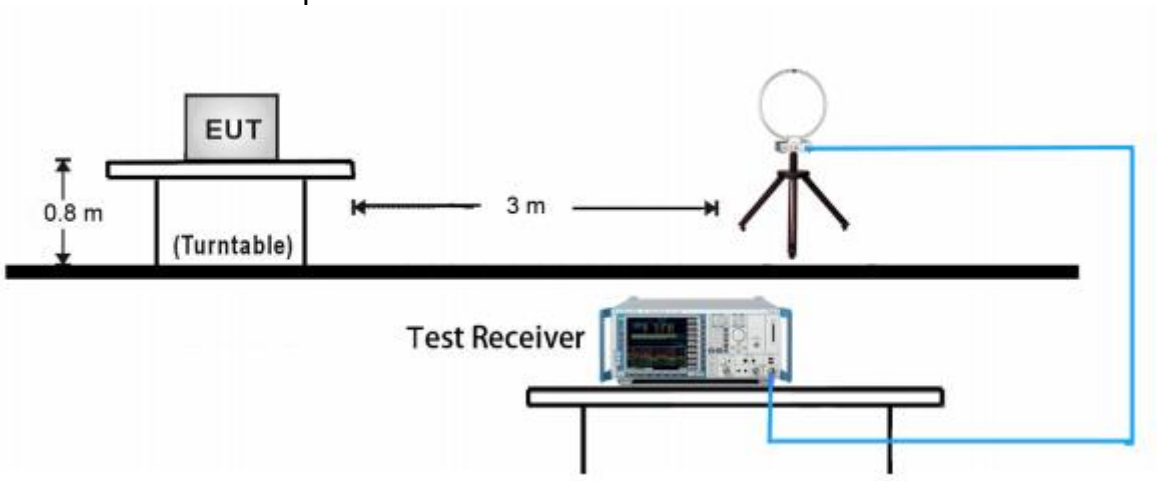
7 Test Setups

7.1 AC Power Line Conducted Emission test setups



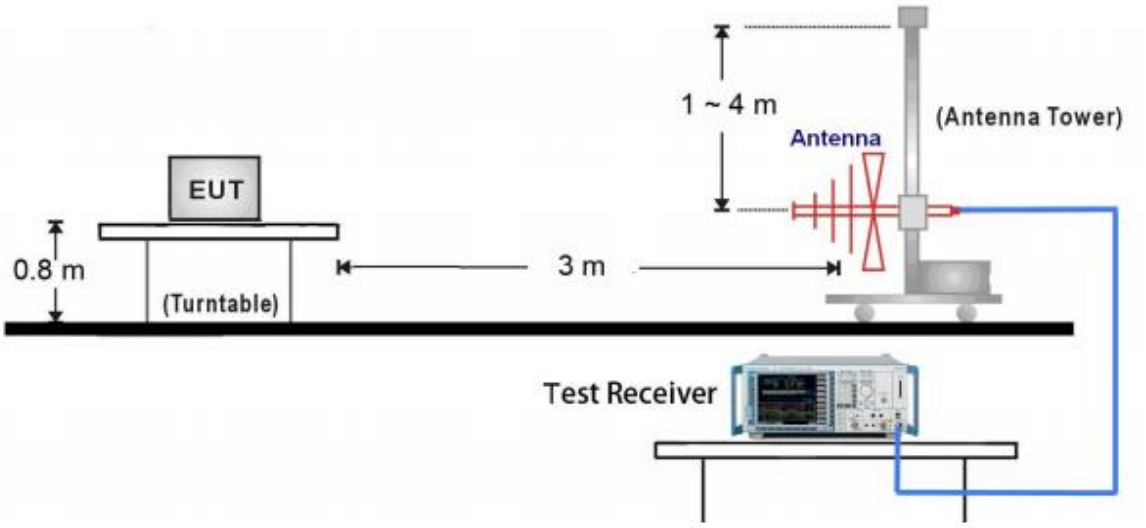
7.2 Radiated test setups

9kHz ~ 30MHz Test Setup:

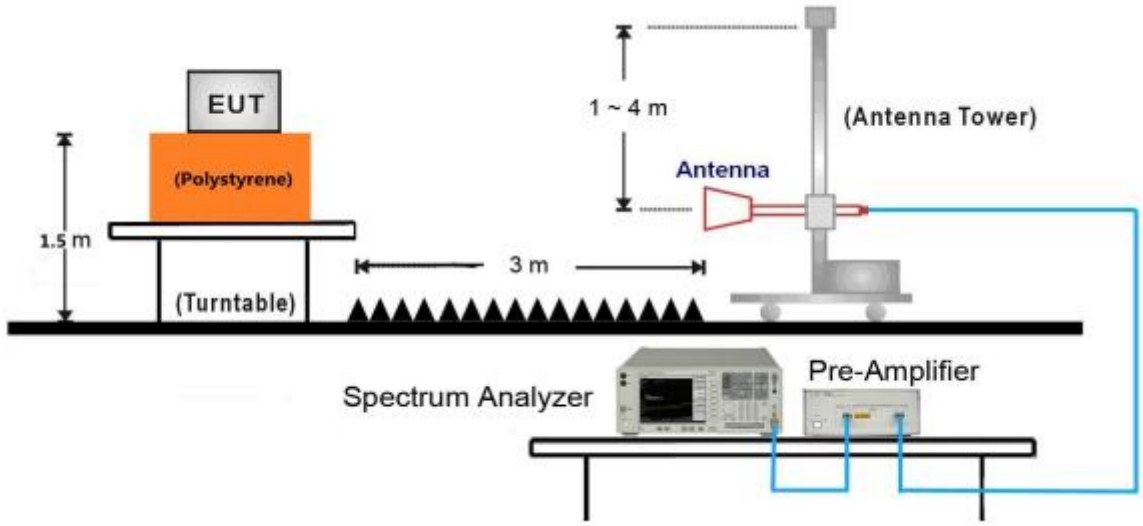


TÜV SÜD Certification and Testing (China) Co., Ltd. Shanghai Branch
3-13, No.151, Heng Tong Road, Shanghai, 200070, P.R. China
Phone: +86 21 61410123, Fax:+86 21 61408600

30MHz ~ 1GHz Test Setup:

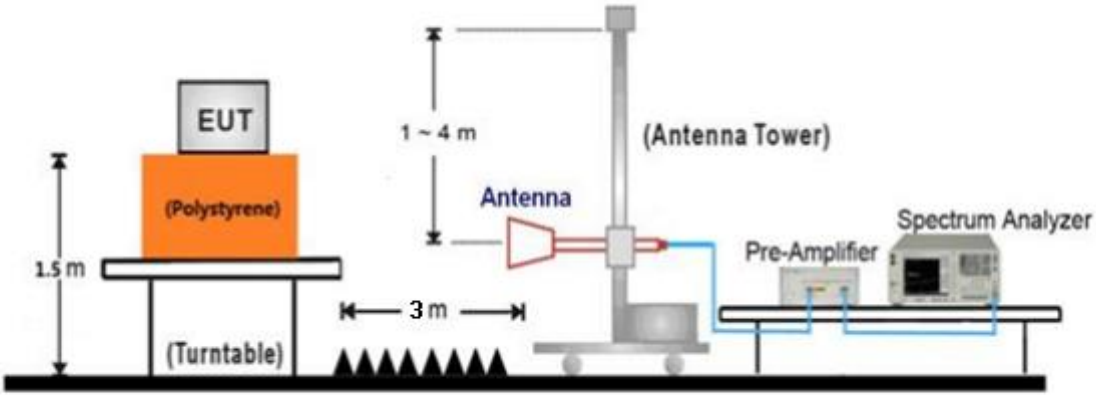


1GHz ~ 18GHz Test Setup:

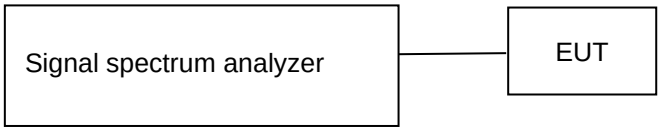


TÜV SÜD Certification and Testing (China) Co., Ltd. Shanghai Branch
3-13, No.151, Heng Tong Road, Shanghai, 200070, P.R. China
Phone: +86 21 61410123, Fax:+86 21 61408600

18GHz ~ 25GHz Test Setup:



7.3 Conducted RF test setups



TÜV SÜD Certification and Testing (China) Co., Ltd. Shanghai Branch
3-13, No.151, Heng Tong Road, Shanghai, 200070, P.R. China
Phone: +86 21 61410123, Fax:+86 21 61408600

8 Systems test configuration

Auxiliary Equipment Used during Test:

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

Test software: ncp_commander

Test Mode Applicability and Tested Channel Detail:

Mode	Tested Channel	Data Rate (Mbps)	Modulation	Power level setting
Bluetooth LE	0	1/2	GFSK	20dBm
	19	1/2	GFSK	20dBm
	39	1/2	GFSK	20dBm

The system was configured to channel 0, 19, and 39 for the test.

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.

9 Technical Requirement

9.1 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

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

Decreasing linearly with logarithm of the frequency

TÜV SÜD Certification and Testing (China) Co., Ltd. Shanghai Branch
3-13, No.151, Heng Tong Road, Shanghai, 200070, P.R. China
Phone: +86 21 61410123, Fax:+86 21 61408600

Conducted Emission

150k-30MHz Conducted Emission Test

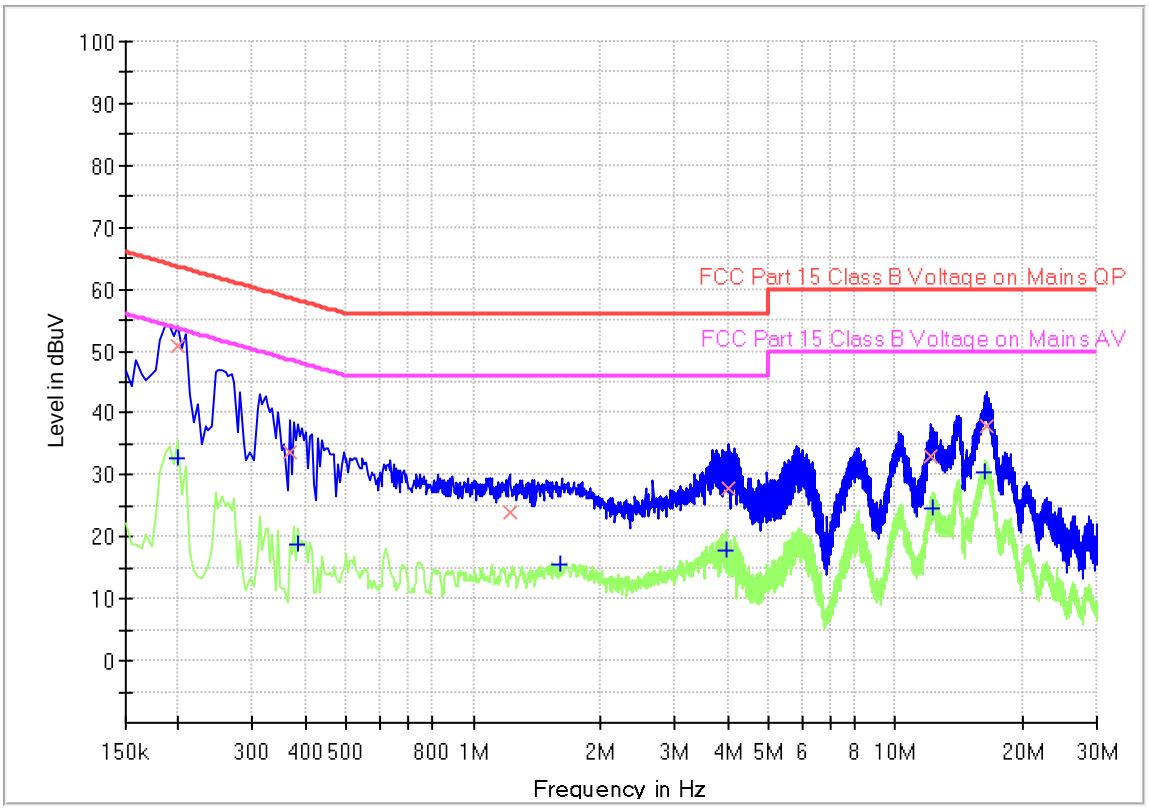
EUT Information

EUT Name:	Wireless Module
Model	TS24-U
Client:	Hangzhou Tuya Information Co.,Ltd
Op Cond	Power on,TX_2402MHz at 1Mbps, AC 120V/560Hz, T24.1, H39.1%, P102.5kPa
Operator:	Cheng Huali
Standard	FCC Part 15.207(a)
Comment:	Phase L
Sample No.:	SHA-777946-3

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



TÜV SÜD Certification and Testing (China) Co., Ltd. Shanghai Branch
3-13, No.151, Heng Tong Road, Shanghai, 200070, P.R. China
Phone: +86 21 61410123, Fax:+86 21 61408600

Final_Result

Frequency (MHz)	QuasiPeak (dBuV)	CAverage (dBuV)	Limit (dBuV)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Line	Corr. (dB)
0.199500	---	32.67	53.63	20.96	1000.0	9.000	L1	19.4
0.199500	50.83	---	63.63	12.80	1000.0	9.000	L1	19.4
0.366000	33.72	---	58.59	24.87	1000.0	9.000	L1	19.5
0.384000	---	18.82	48.19	29.37	1000.0	9.000	L1	19.5
1.216500	24.08	---	56.00	31.92	1000.0	9.000	L1	19.5
1.599000	---	15.52	46.00	30.48	1000.0	9.000	L1	19.5
3.966000	---	17.73	46.00	28.27	1000.0	9.000	L1	19.6
4.002000	27.93	---	56.00	28.07	1000.0	9.000	L1	19.6
12.124500	33.12	---	60.00	26.88	1000.0	9.000	L1	19.9
12.264000	---	24.46	50.00	25.54	1000.0	9.000	L1	19.9
16.354500	---	30.32	50.00	19.68	1000.0	9.000	L1	20.1
16.426500	37.80	---	60.00	22.20	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

TÜV SÜD Certification and Testing (China) Co., Ltd. Shanghai Branch
3-13, No.151, Heng Tong Road, Shanghai, 200070, P.R. China
Phone: +86 21 61410123, Fax:+86 21 61408600

150k-30MHz Conducted Emission Test

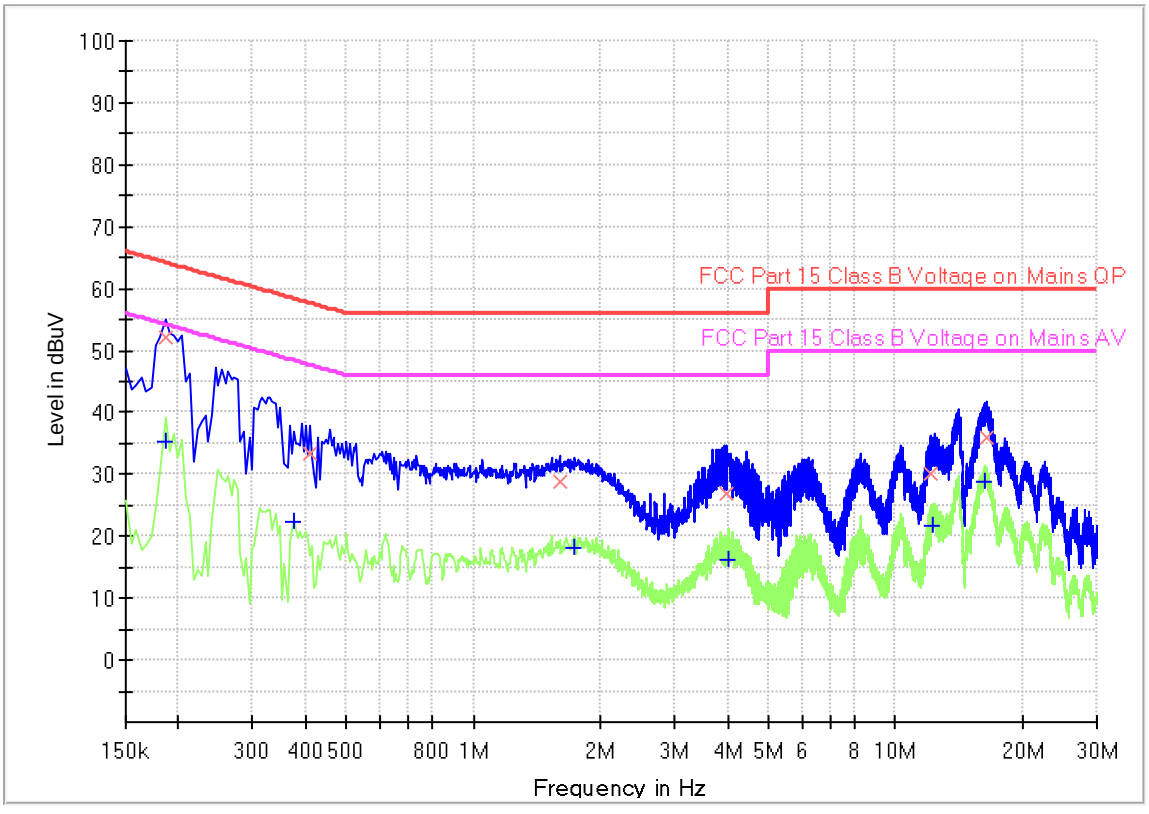
EUT Information

EUT Name:	Wireless Module
Model	TS24-U
Client:	Hangzhou Tuya Information Co.,Ltd
Op Cond	Power on,TX_2402MHz at 1Mbps, AC 120V/60Hz, T24.1, H39.1%, P102.5kPa
Operator:	Cheng Huali
Standard	FCC Part 15.207(a)
Comment:	Phase N
Sample No.:	SHA-777946-3

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



TÜV SÜD Certification and Testing (China) Co., Ltd. Shanghai Branch
3-13, No.151, Heng Tong Road, Shanghai, 200070, P.R. China
Phone: +86 21 61410123, Fax:+86 21 61408600

Final_Result

Frequency (MHz)	QuasiPeak (dBuV)	CAverage (dBuV)	Limit (dBuV)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Line	Corr. (dB)
0.186000	---	35.36	54.21	18.85	1000.0	9.000	N	19.4
0.186000	52.15	---	64.21	12.06	1000.0	9.000	N	19.4
0.375000	---	22.23	48.39	26.16	1000.0	9.000	N	19.5
0.411000	33.33	---	57.63	24.30	1000.0	9.000	N	19.4
1.599000	28.88	---	56.00	27.12	1000.0	9.000	N	19.5
1.734000	---	17.99	46.00	28.01	1000.0	9.000	N	19.5
3.988500	26.74	---	56.00	29.26	1000.0	9.000	N	19.6
4.038000	---	16.15	46.00	29.85	1000.0	9.000	N	19.6
12.160500	29.99	---	60.00	30.01	1000.0	9.000	N	19.8
12.259500	---	21.79	50.00	28.21	1000.0	9.000	N	19.8
16.296000	---	28.87	50.00	21.13	1000.0	9.000	N	20.0
16.390500	36.03	---	60.00	23.97	1000.0	9.000	N	20.0

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

TÜV SÜD Certification and Testing (China) Co., Ltd. Shanghai Branch
3-13, No.151, Heng Tong Road, Shanghai, 200070, P.R. China
Phone: +86 21 61410123, Fax:+86 21 61408600

9.2 Conducted peak output power

Test Method

1. Use the following spectrum analyzer settings:
   RBW > the 6 dB bandwidth of the emission being measured, VBW≥3RBW, Span≥3RBW
   Sweep = auto, Detector function = peak, Trace = max hold.
2. Add a correction factor to the display.
3. Use a power meter to measure the conducted peak output power.

Limits

According to §15.247 (b) (1) conducted peak output power limit as below:

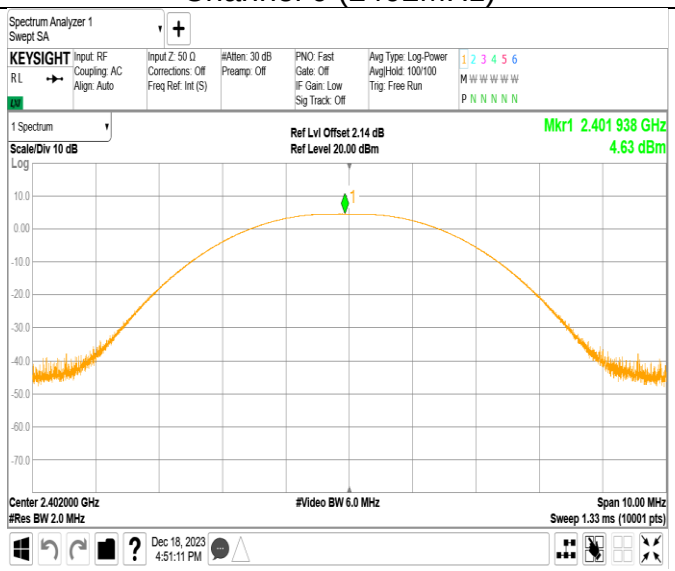
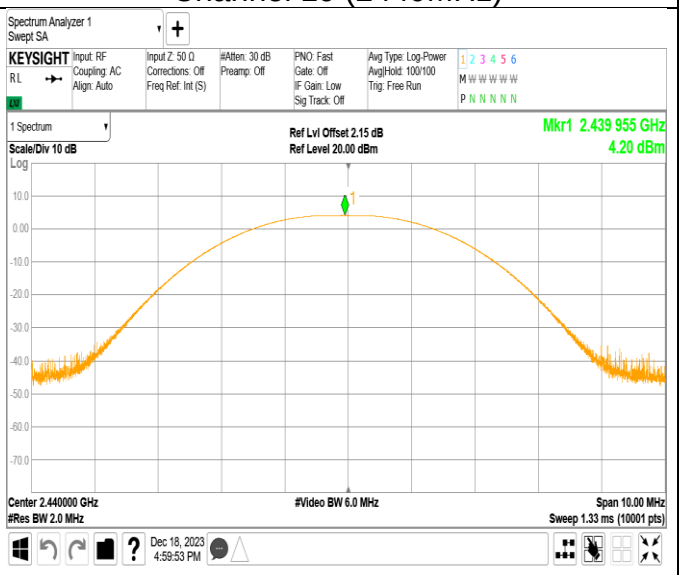
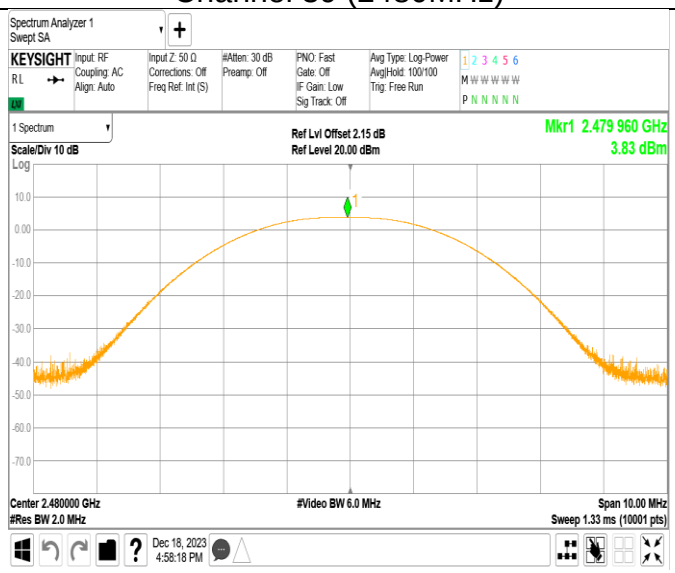
Conducted peak output power

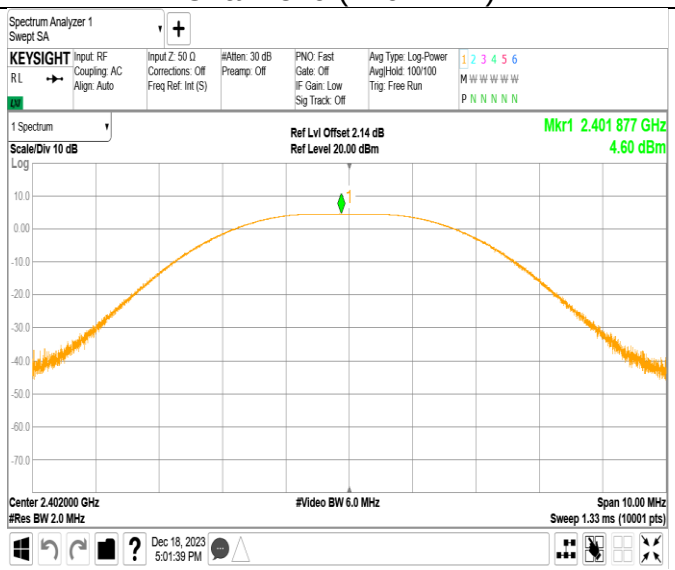
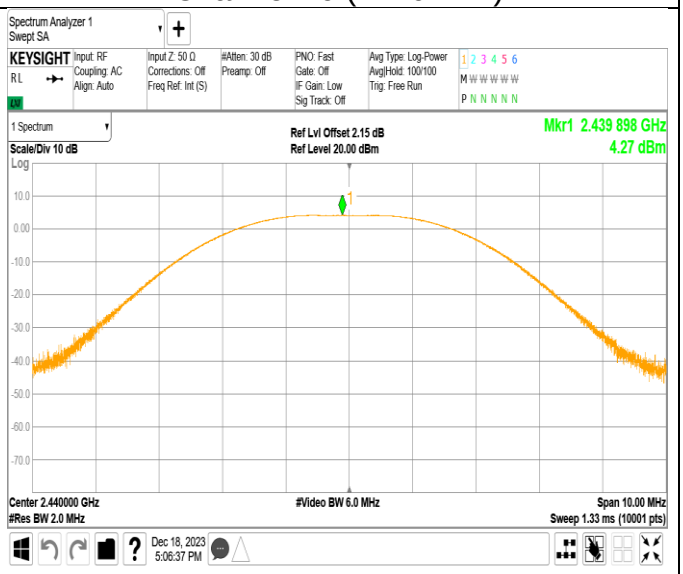
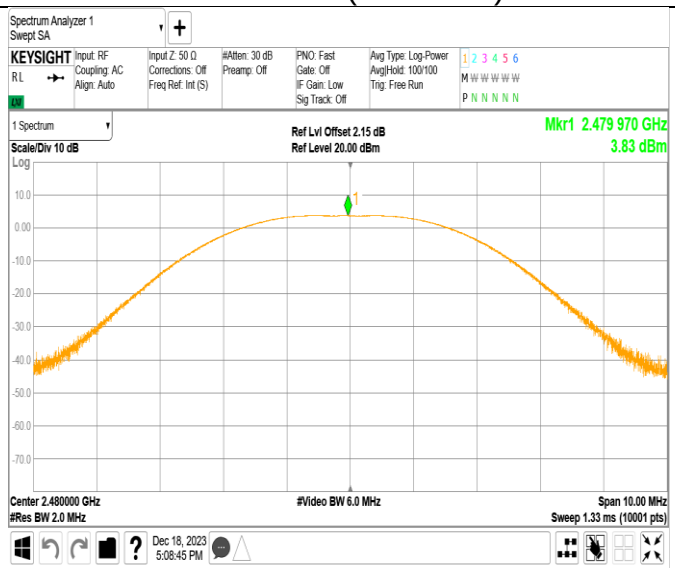
Frequency Range MHz	Limit W	Limit dBm
2400-2483.5	≤1	≤30

Test result as below table

Data transmission Rate	Frequency (MHz)	Conducted Peak Output Power (dBm) §15.247 (b) (1)		
		Result	limit	Verdict
1Mbps	2402MHz	4.63	≤30	Pass
	2440MHz	4.2	≤30	Pass
	2480MHz	3.83	≤30	Pass
2Mbps	2402MHz	4.6	≤30	Pass
	2440MHz	4.28	≤30	Pass
	2480MHz	3.83	≤30	Pass

TÜV SÜD Certification and Testing (China) Co., Ltd. Shanghai Branch
3-13, No.151, Heng Tong Road, Shanghai, 200070, P.R. China
Phone: +86 21 61410123, Fax:+86 21 61408600

Peak output power (1Mbps)	
Channel 0 (2402MHz)	Channel 19 (2440MHz)
	
Channel 39 (2480MHz)	
	

Peak output power (2Mbps)	
Channel 0 (2402MHz)	Channel 19 (2440MHz)
	
Channel 39 (2480MHz)	
	

9.3 6dB 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

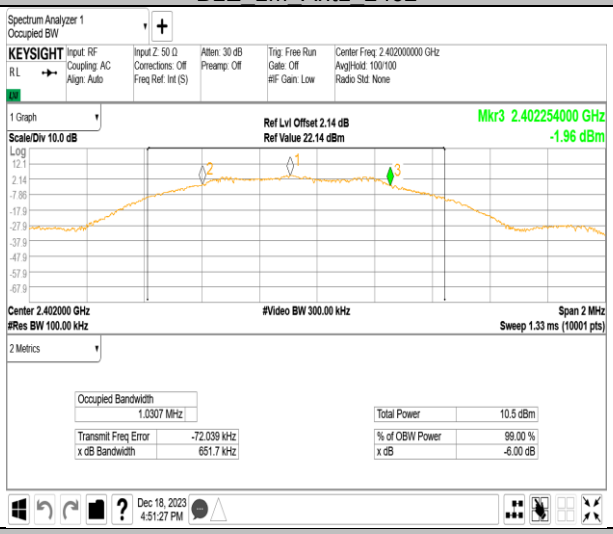
Test result

Data transmission rate	Frequency MHz	6dB bandwidth (MHz)		Result
		result	limit	verdict
1Mbps	2402	0.652	≥0.5	Pass
	2440	0.653	≥0.5	Pass
	2480	0.642	≥0.5	Pass
2Mbps	2402	1.089	≥0.5	Pass
	2440	1.073	≥0.5	Pass
	2480	1.055	≥0.5	Pass

TÜV SÜD Certification and Testing (China) Co., Ltd. Shanghai Branch
3-13, No.151, Heng Tong Road, Shanghai, 200070, P.R. China
Phone: +86 21 61410123, Fax:+86 21 61408600

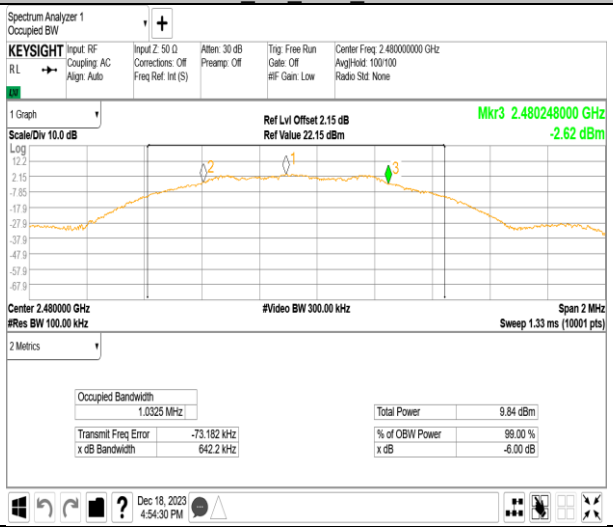
6dB Bandwidth

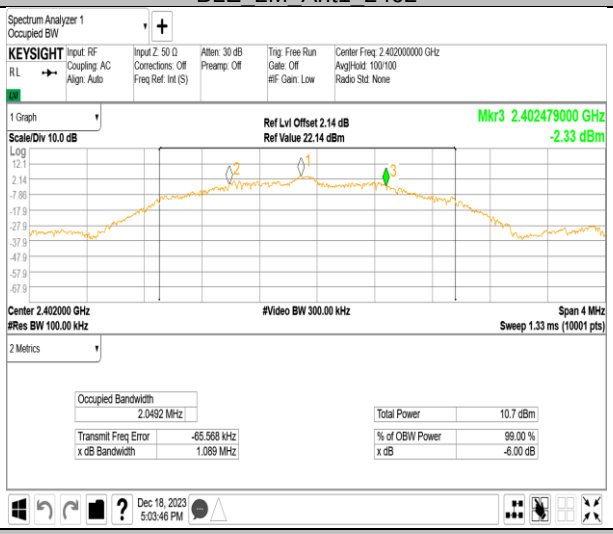
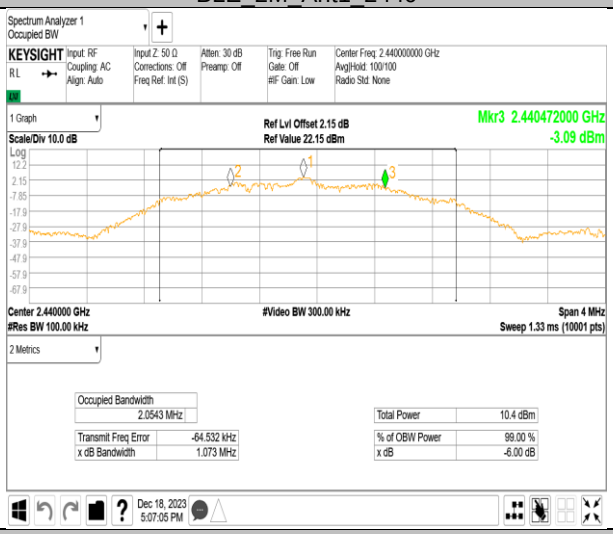
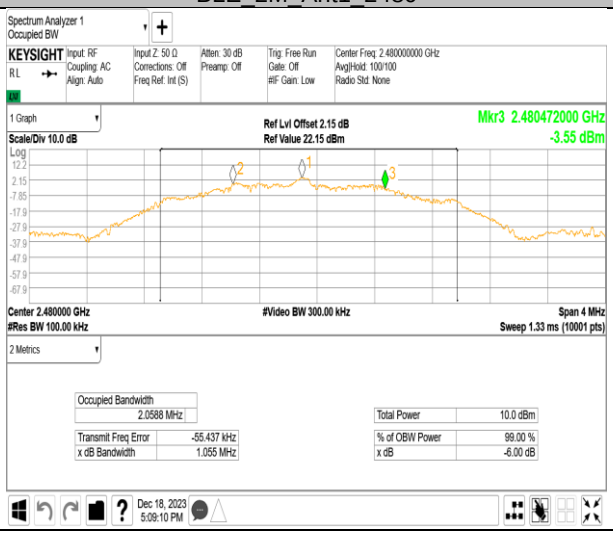
BLE_1M_Ant1_2402



BLE_1M_Ant1_2440

BLE_1M_Ant1_2480



BLE_2M_Ant1_2402

BLE_2M_Ant1_2440

BLE_2M_Ant1_2480


9.4 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.

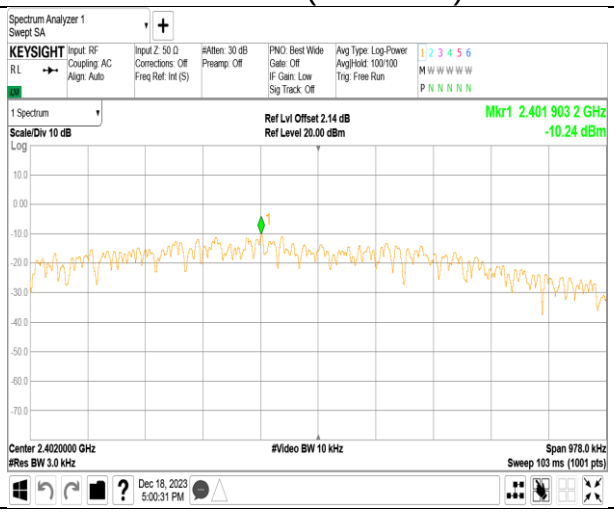
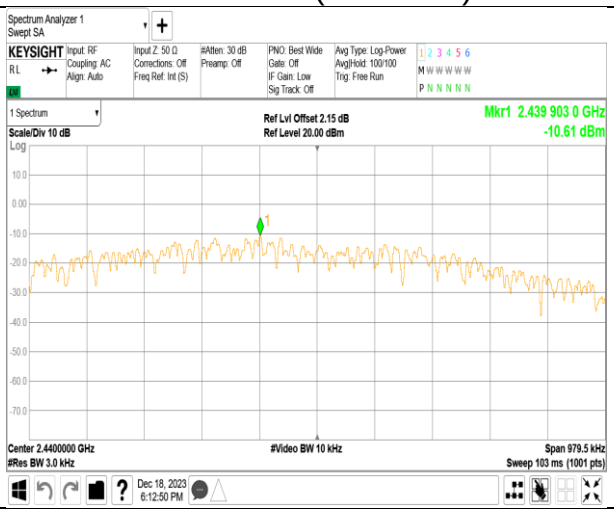
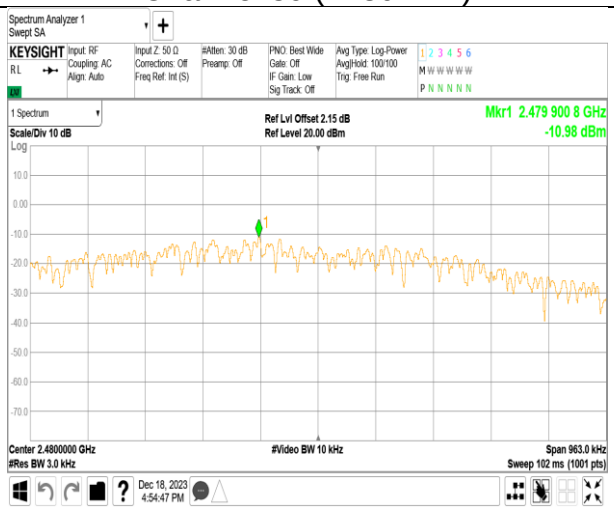
Limit

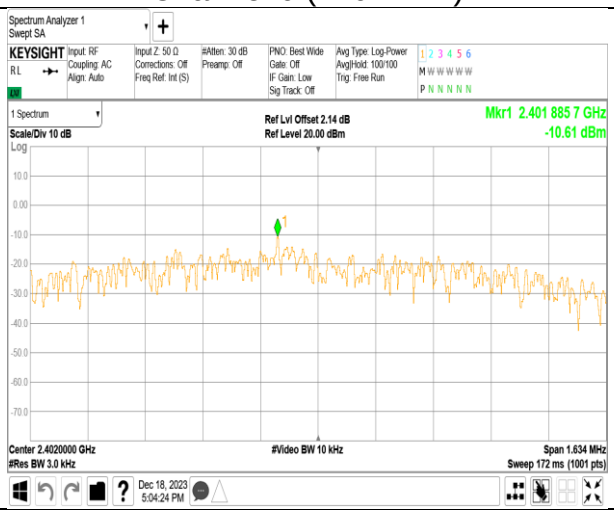
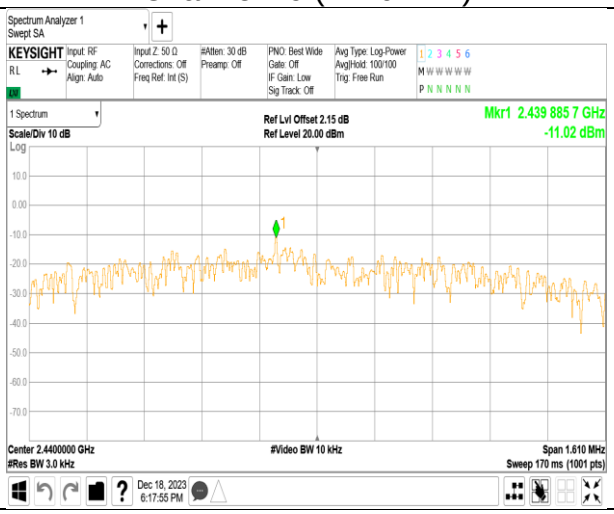
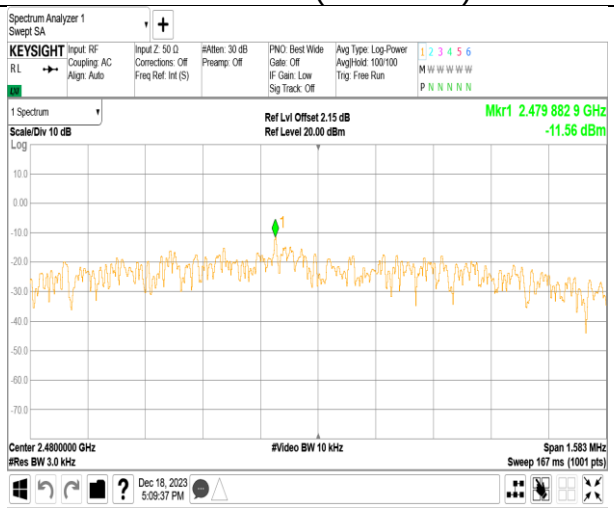
Limit [dBm/3kHz]
⩽8

Test result

Data transmission rate	Frequency	Power spectral density	Result
1Mbps	MHz	dBm/3kHz	
	Top channel 2402MHz	-10.24	Pass
	Middle channel 2440MHz	-10.62	Pass
	Bottom channel 2480MHz	-10.98	Pass
2Mbps	Top channel 2402MHz	-10.61	Pass
	Middle channel 2440MHz	-11.02	Pass
	Bottom channel 2480MHz	-11.56	Pass

TÜV SÜD Certification and Testing (China) Co., Ltd. Shanghai Branch
3-13, No.151, Heng Tong Road, Shanghai, 200070, P.R. China
Phone: +86 21 61410123, Fax:+86 21 61408600

PK PSD (1Mbps)	
Channel 0 (2402MHz)	Channel 19 (2440MHz)
	
Channel 39 (2480MHz)	
	

PK PSD (2Mbps)	
Channel 0 (2402MHz)	Channel 19 (2440MHz)
	
Channel 39 (2480MHz)	
	

9.5 Spurious RF conducted emissions

Test Method

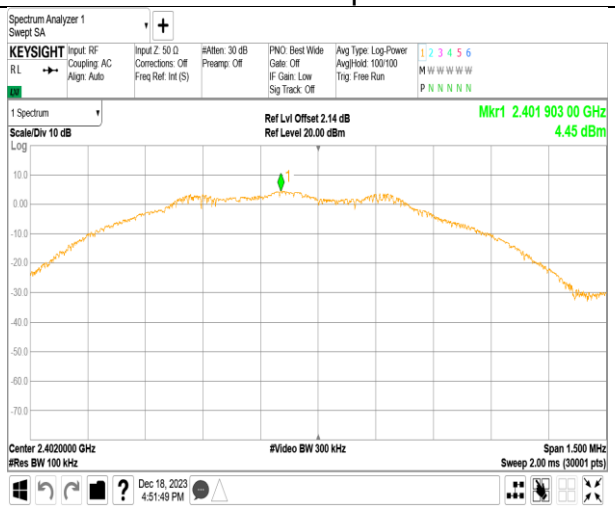
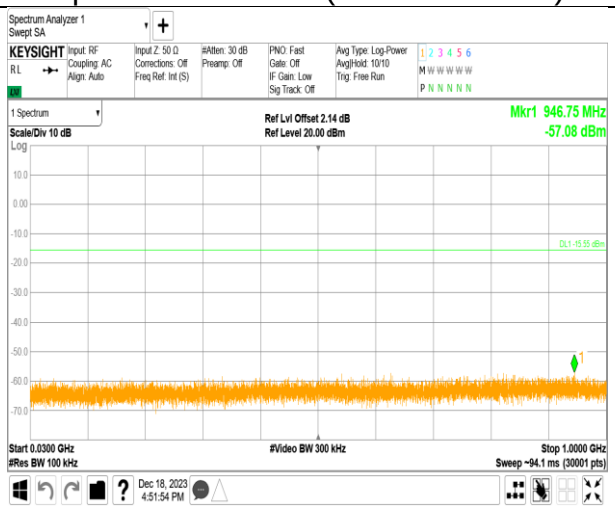
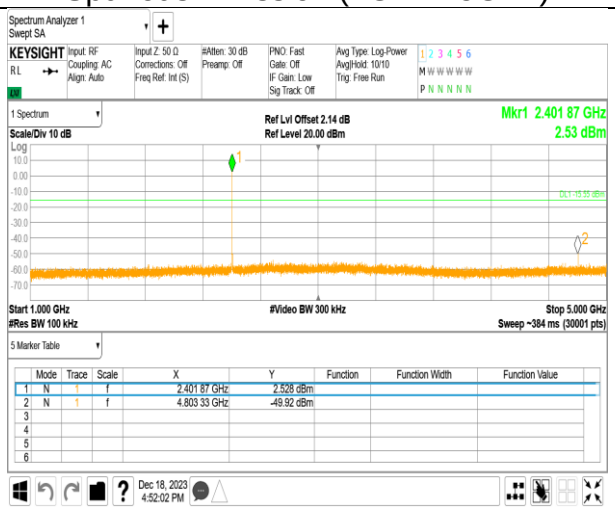
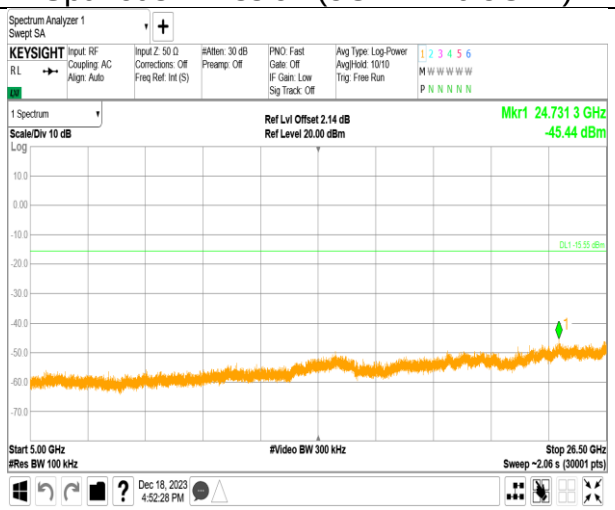
1. The RF output of EUT was connected to the spectrum analyzer by RF cable. The path loss was compensated to the results for each measurement.
2. Set to the maximum power setting, the instrument center frequency is set to the nominal EUT channel center frequency enable the EUT transmit continuously.
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≥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.

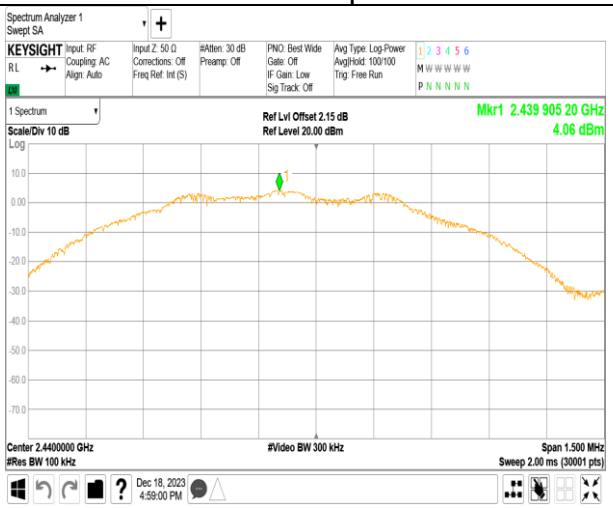
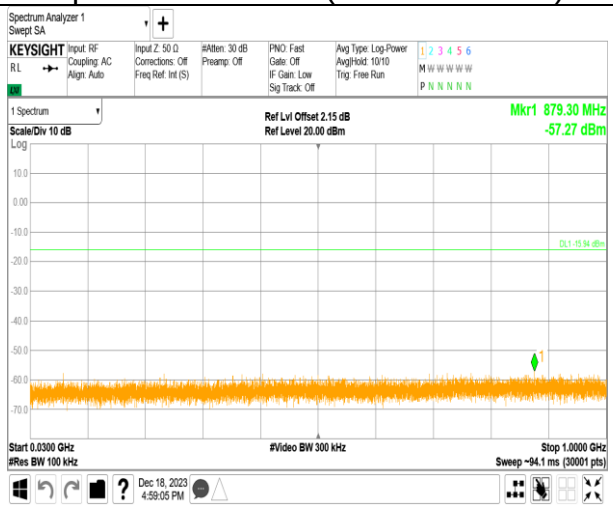
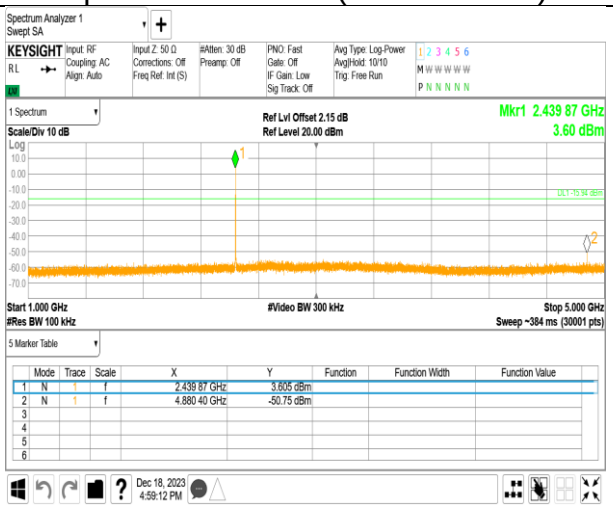
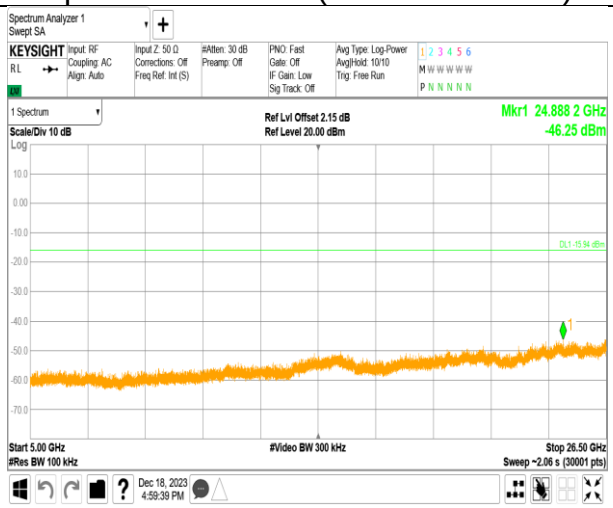
Limit

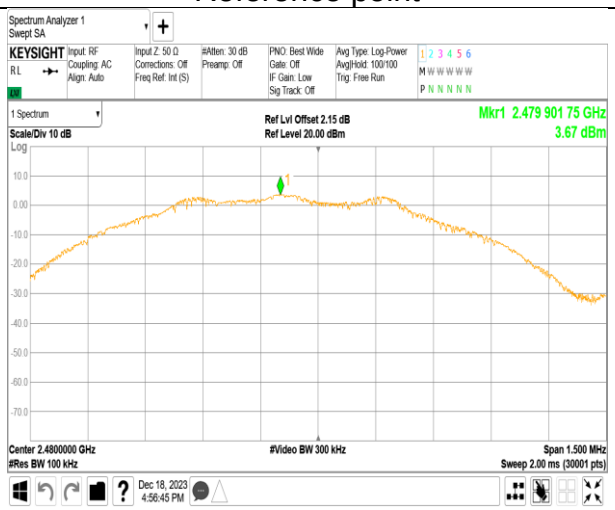
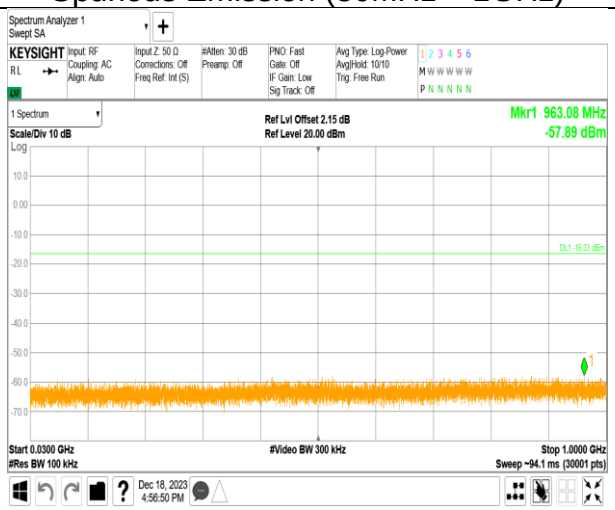
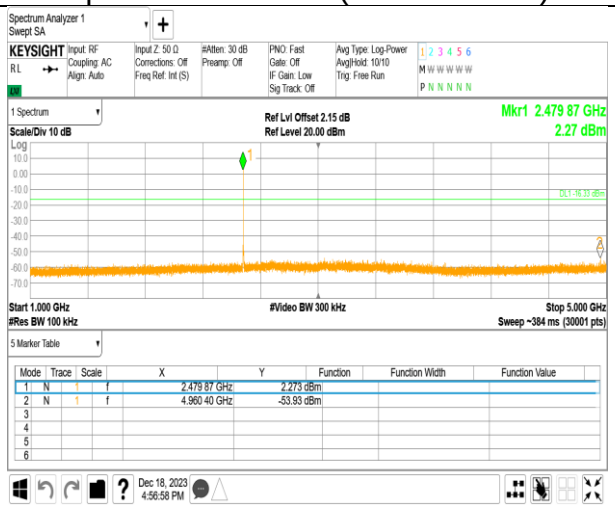
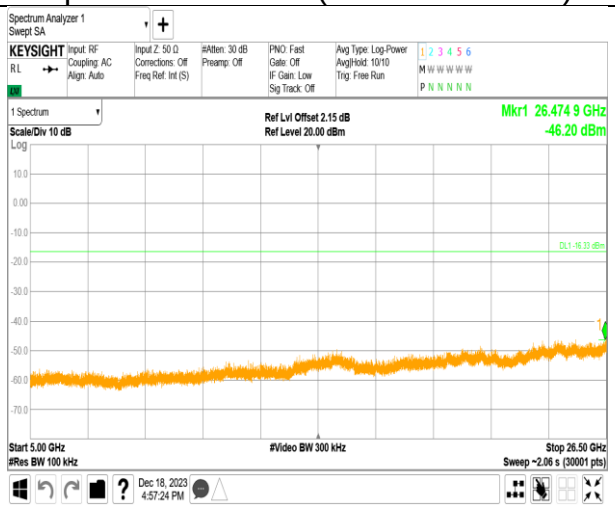
Frequency Range MHz	Limit (dBc)
30-25000	-20

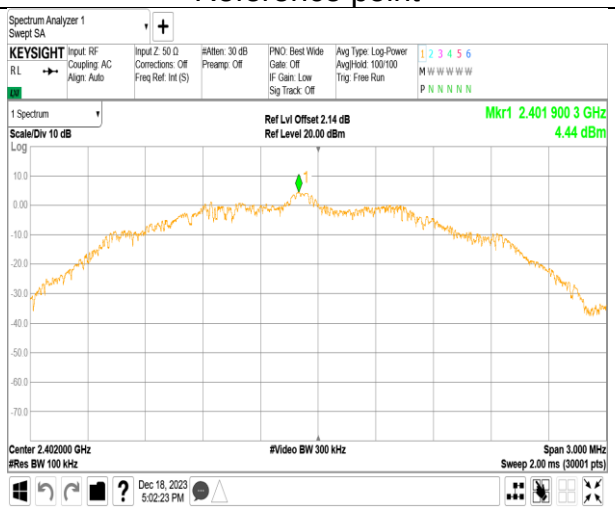
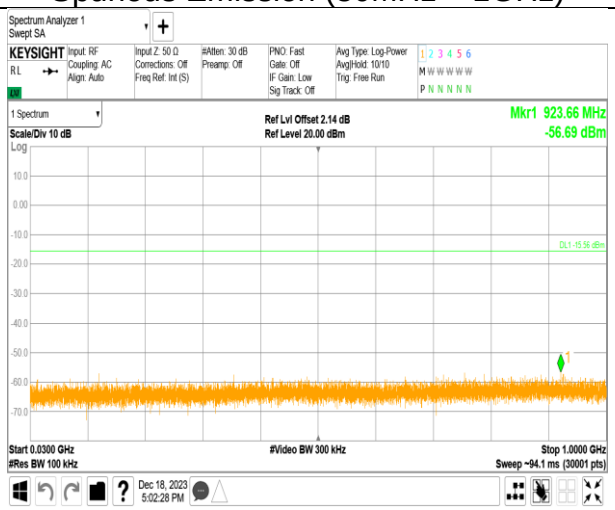
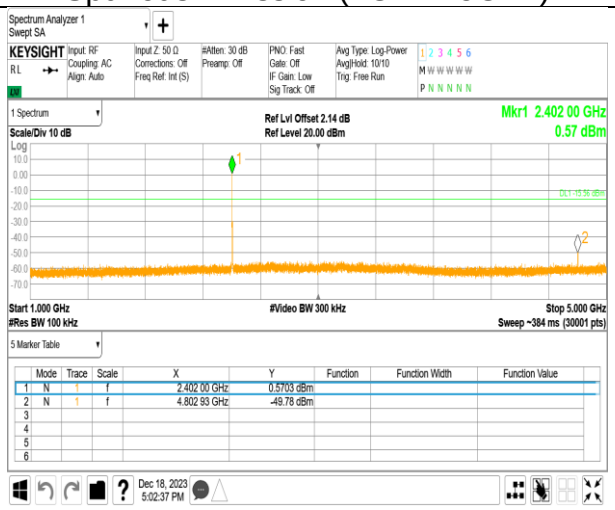
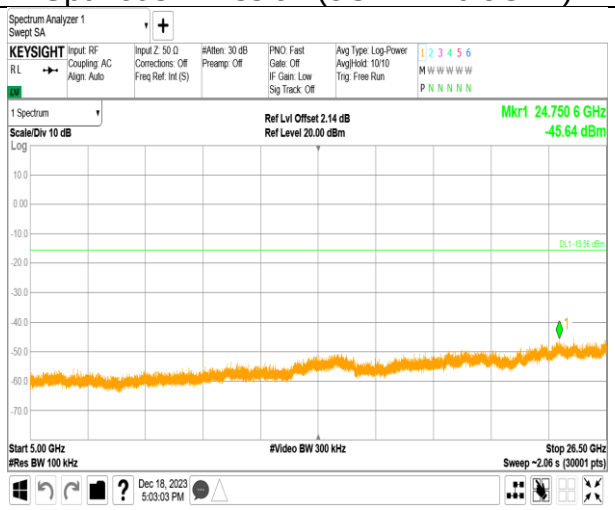
TÜV SÜD Certification and Testing (China) Co., Ltd. Shanghai Branch
3-13, No.151, Heng Tong Road, Shanghai, 200070, P.R. China
Phone: +86 21 61410123, Fax:+86 21 61408600

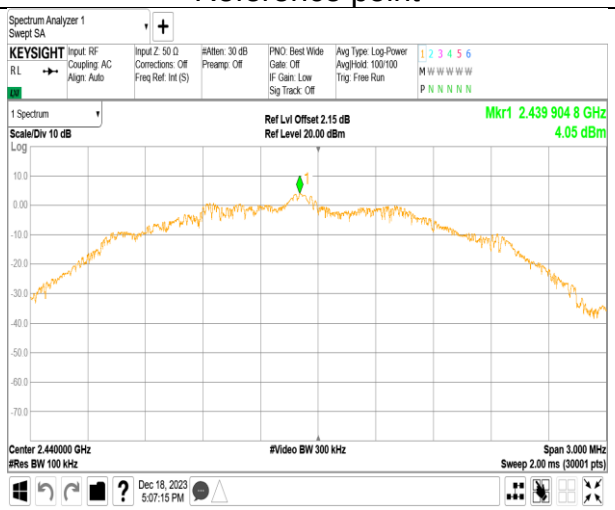
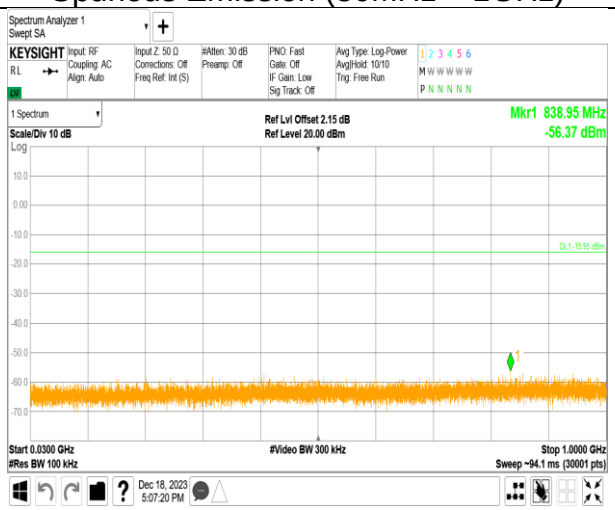
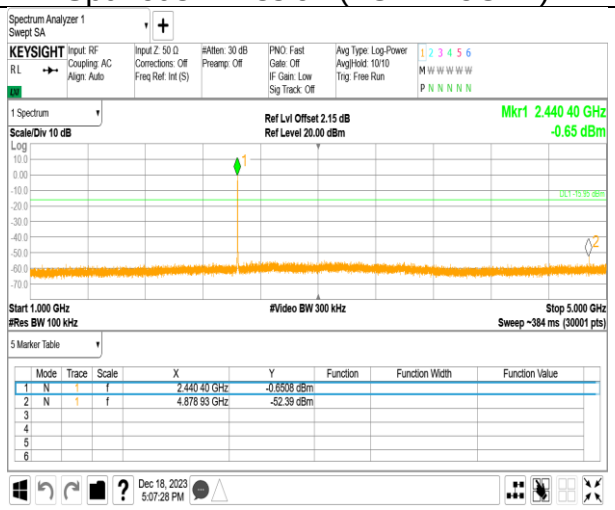
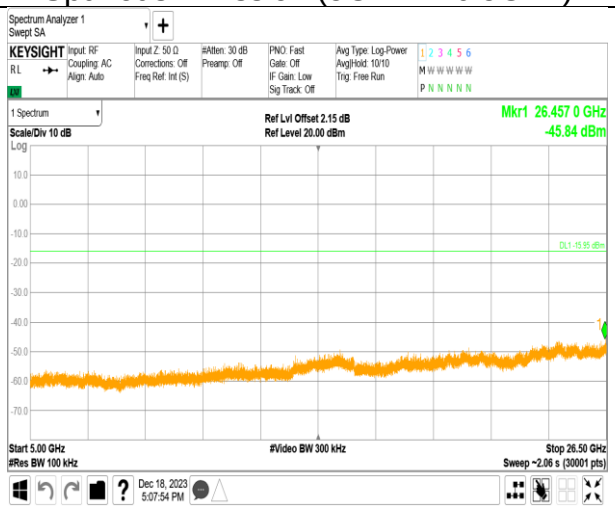
Spurious RF conducted emissions

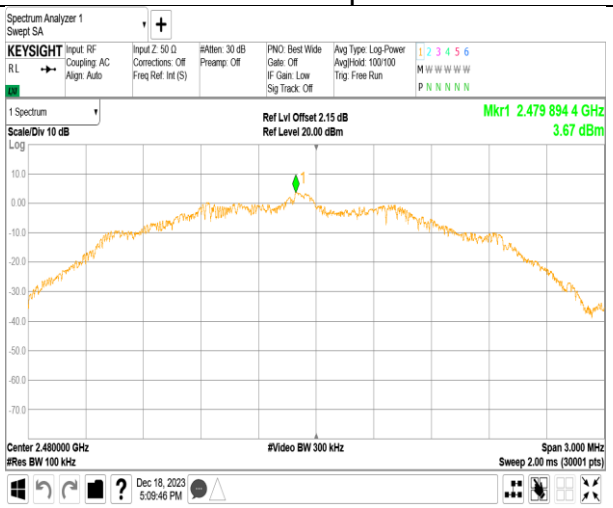
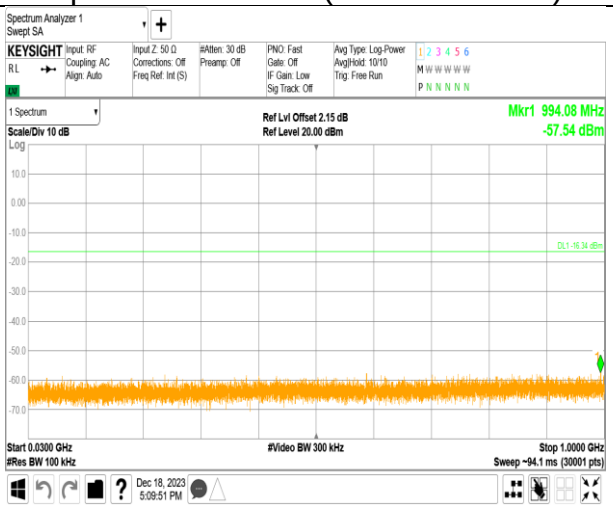
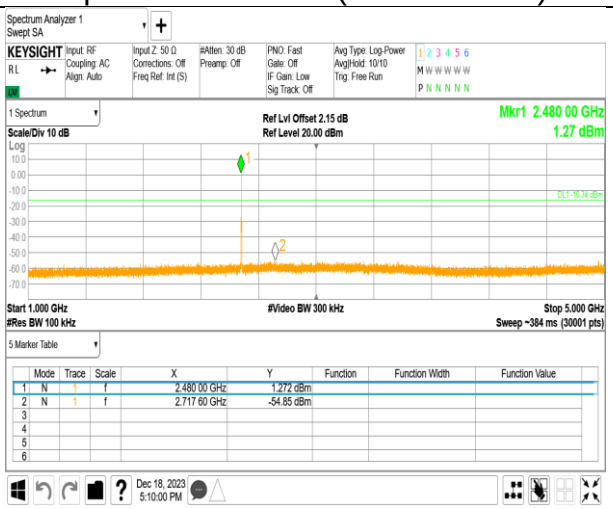
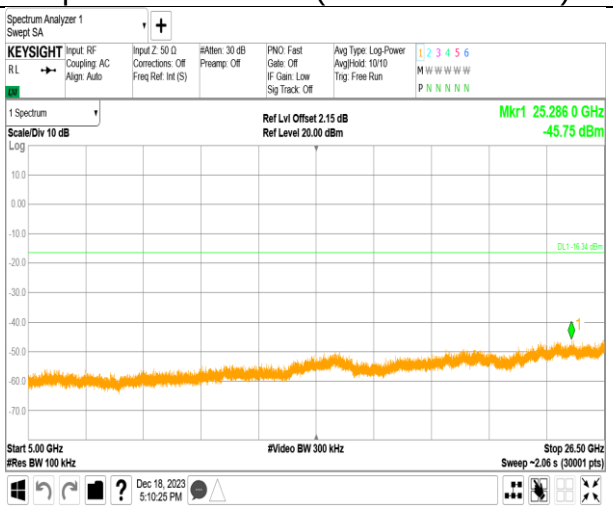
Out-of-Band Emissions (1Mbps)	
Channel 0 (2402MHz)	
Reference point	Spurious Emission (30MHz – 1GHz)
	
Spurious Emission (1GHz –5GHz)	Spurious Emission (5GHz –26.5GHz)
	

Out-of-Band Emissions (1Mbps)	
Channel 19 (2440MHz)	
Reference point	Spurious Emission (30MHz – 1GHz)
	
Spurious Emission (1GHz –5GHz)	Spurious Emission (5GHz –26.5GHz)
	

Out-of-Band Emissions (1Mbps)	
Channel 39 (2480MHz)	
Reference point	Spurious Emission (30MHz – 1GHz)
	
Spurious Emission (1GHz –5GHz)	Spurious Emission (5GHz –26.5GHz)
	

Out-of-Band Emissions (2Mbps)	
Channel 0 (2402MHz)	
Reference point	Spurious Emission (30MHz – 1GHz)
	
Spurious Emission (1GHz –5GHz)	Spurious Emission (5GHz –26.5GHz)
	

Out-of-Band Emissions (2Mbps)	
Channel 19 (2440MHz)	
Reference point	Spurious Emission (30MHz – 1GHz)
	
Spurious Emission (1GHz –5GHz)	Spurious Emission (5GHz –26.5GHz)
	

Out-of-Band Emissions (2Mbps)	
Channel 39 (2480MHz)	
Reference point	Spurious Emission (30MHz – 1GHz)
	
Spurious Emission (1GHz –5GHz)	Spurious Emission (5GHz –26.5GHz)
	

9.6 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≥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

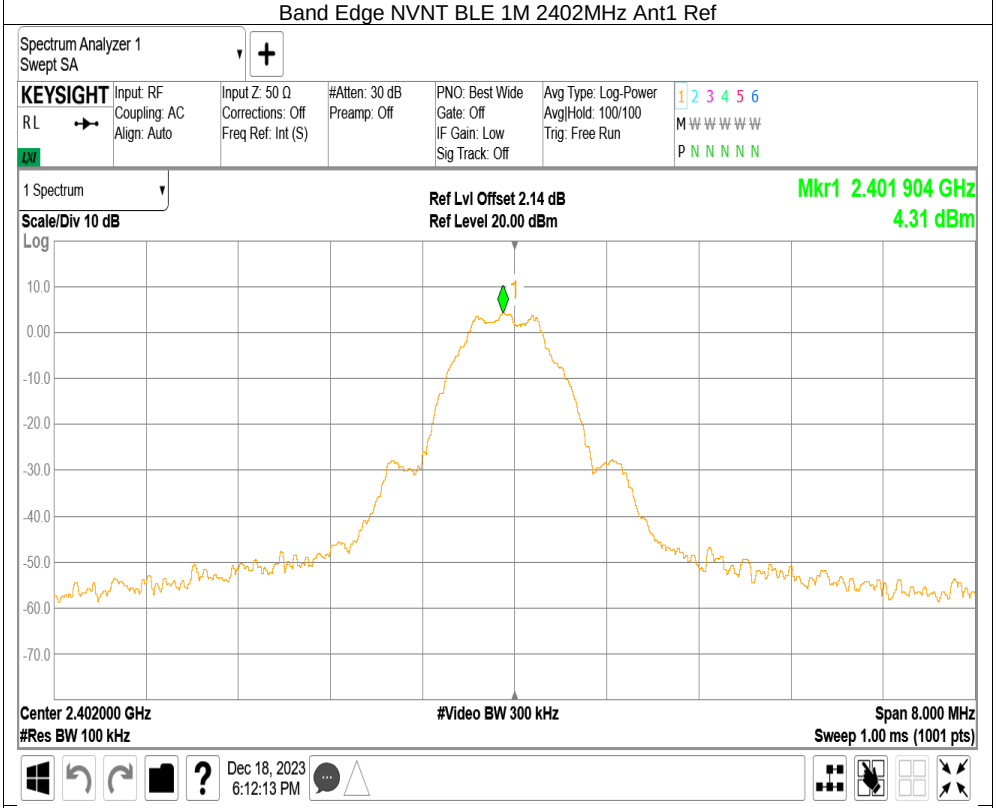
In any 100 kHz bandwidth outside the frequency band in which the spread spectrum or digitally modulated device is operating, the RF power that is produced shall be at least 20 dB below that in the 100 kHz bandwidth within the band that contains the highest level of the desired power, based on either 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

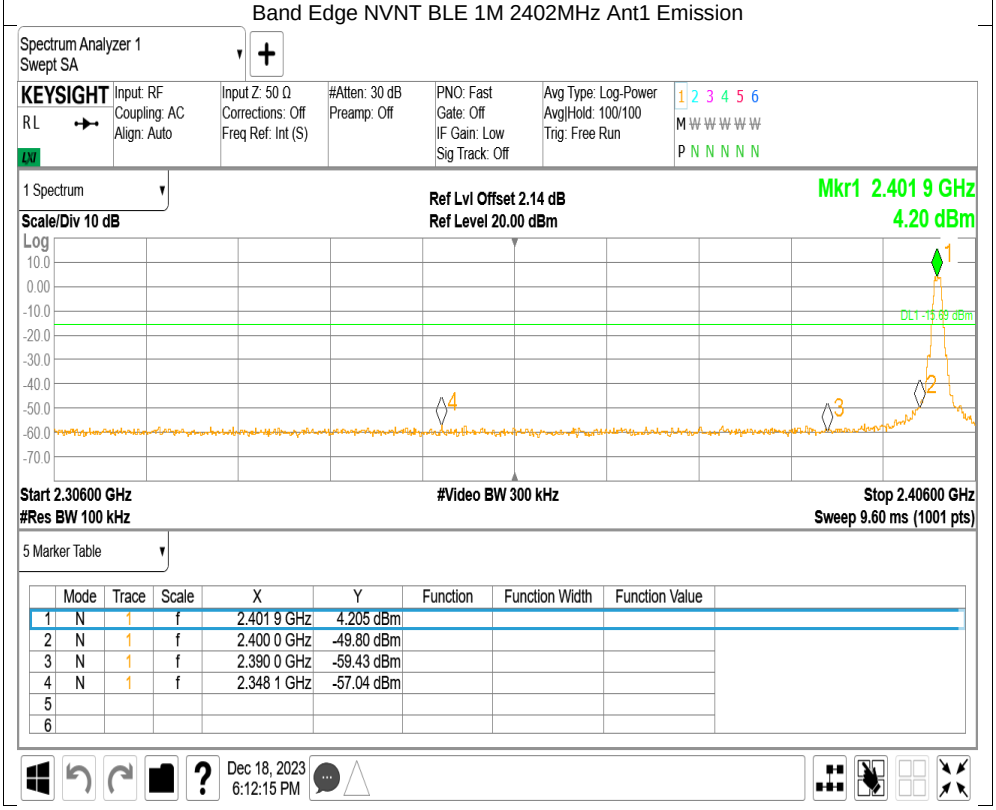
1Mbps

Test Graphs

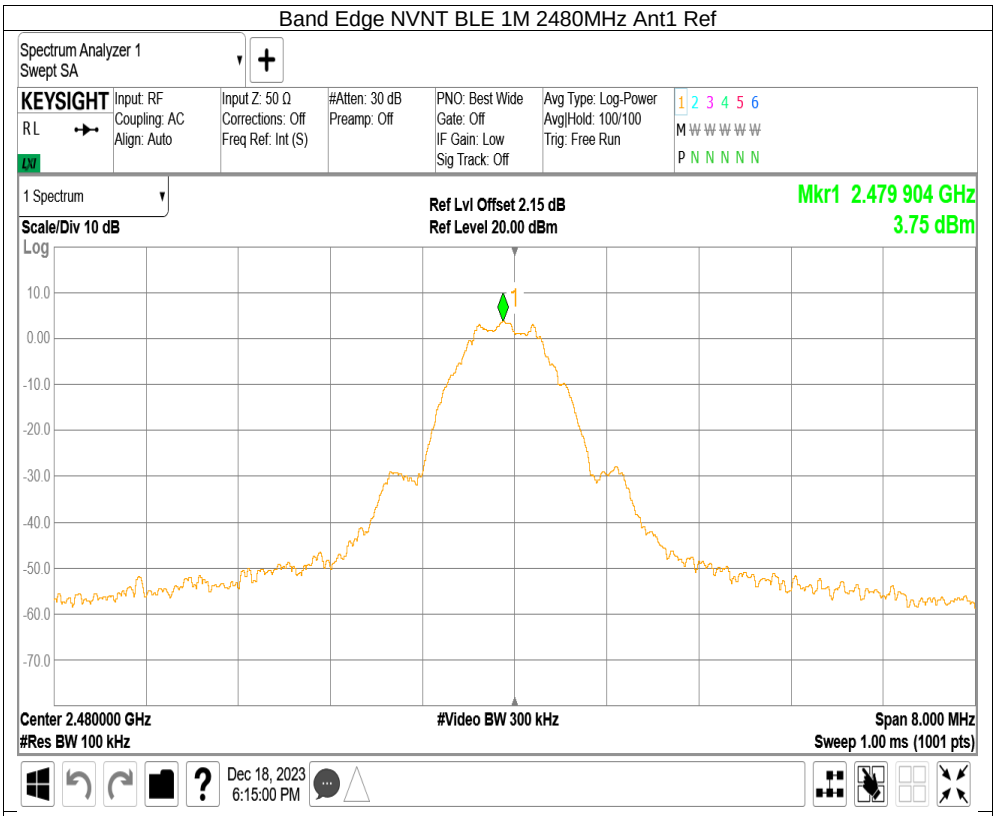
Band Edge NVNT BLE 1M 2402MHz Ant1 Ref



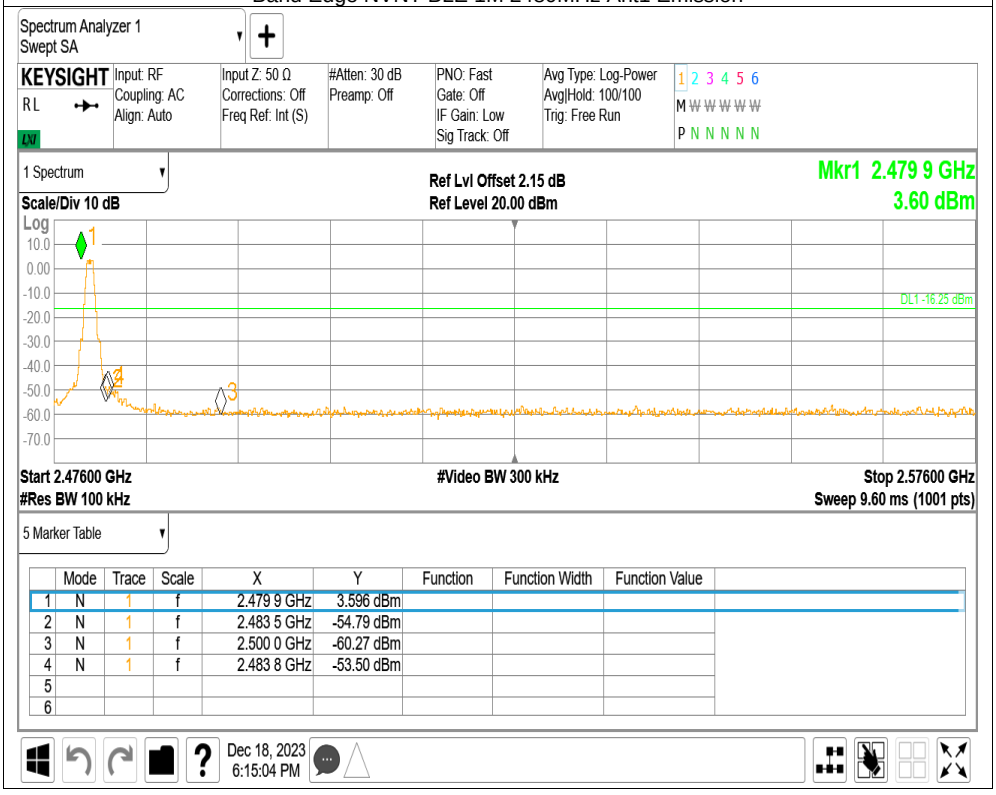
Band Edge NVNT BLE 1M 2402MHz Ant1 Emission



Band Edge NVNT BLE 1M 2480MHz Ant1 Ref

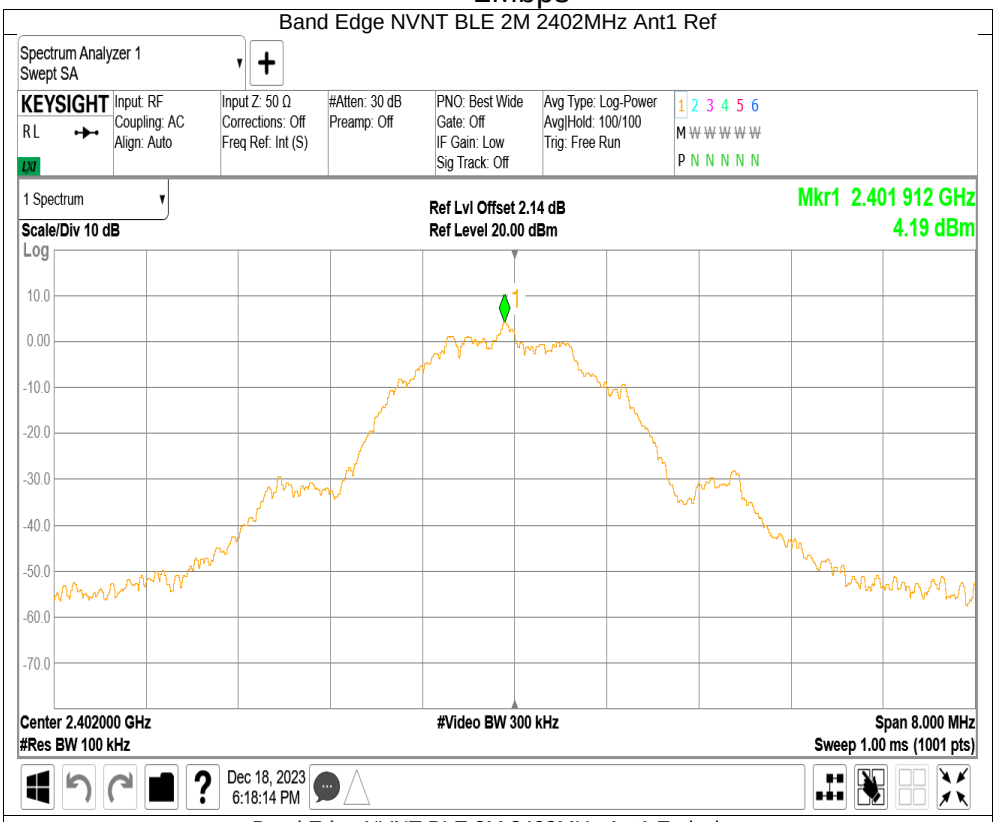


Band Edge NVNT BLE 1M 2480MHz Ant1 Emission

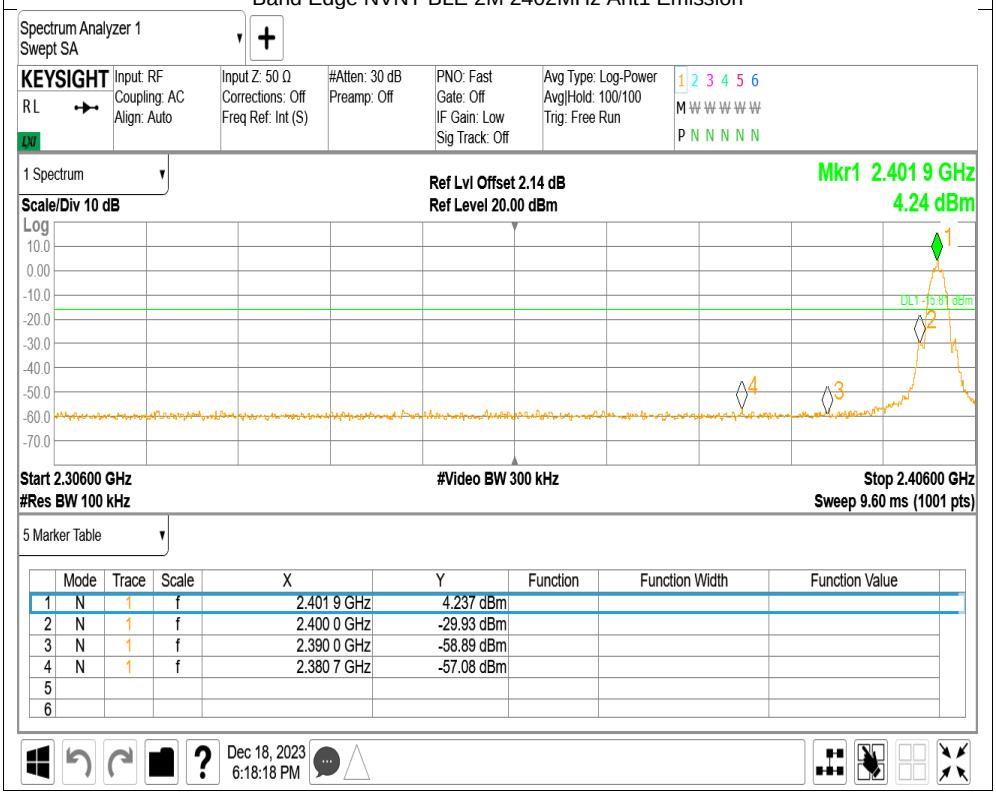


2Mbps

Band Edge NVNT BLE 2M 2402MHz Ant1 Ref

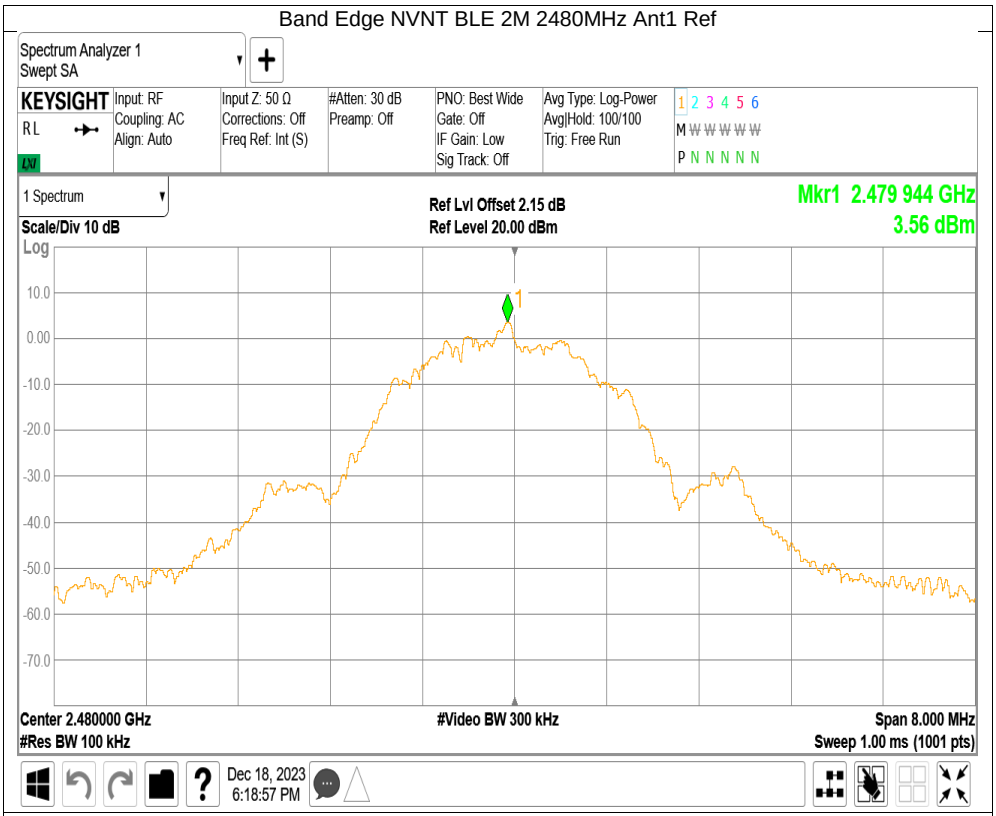


Band Edge NVNT BLE 2M 2402MHz Ant1 Emission

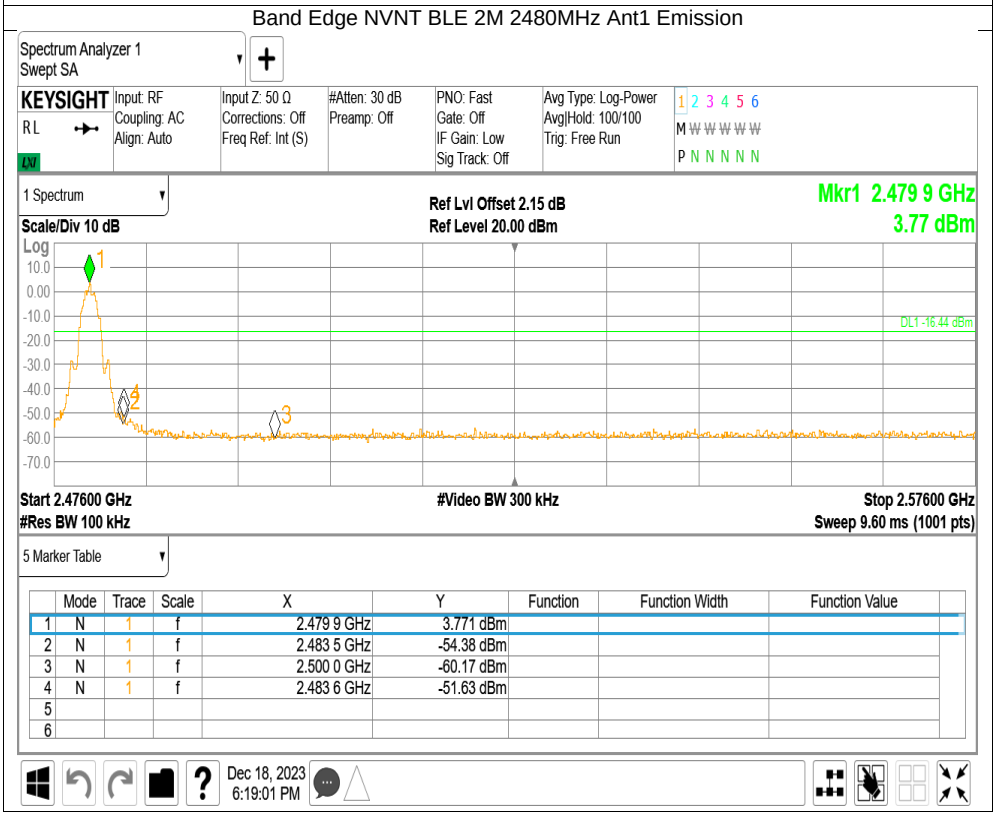


	Mode	Trace	Scale	X	Y	Function	Function Width	Function Value
1	N	1	f	2.401 9 GHz	4.237 dBm			
2	N	1	f	2.400 0 GHz	-29.93 dBm			
3	N	1	f	2.390 0 GHz	-58.89 dBm			
4	N	1	f	2.380 7 GHz	-57.08 dBm			
5								
6								

Band Edge NVNT BLE 2M 2480MHz Ant1 Ref



Band Edge NVNT BLE 2M 2480MHz Ant1 Emission



	Mode	Trace	Scale	X	Y	Function	Function Width	Function Value
1	N	1	f	2.479 9 GHz	3.771 dBm			
2	N	1	f	2.483 5 GHz	-54.38 dBm			
3	N	1	f	2.500 0 GHz	-60.17 dBm			
4	N	1	f	2.483 6 GHz	-51.63 dBm			
5								
6								

TÜV SÜD Certification and Testing (China) Co., Ltd. Shanghai Branch
3-13, No.151, Heng Tong Road, Shanghai, 200070, P.R. China
Phone: +86 21 61410123, Fax:+86 21 61408600

9.7 Spurious radiated emissions for transmitter

Test Method

1. The EUT was place 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 \ [3 × RBW].
   c) Detector = RMS (power averaging), if [span / (# of points in sweep)] \ 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

TÜV SÜD Certification and Testing (China) Co., Ltd. Shanghai Branch
3-13, No.151, Heng Tong Road, Shanghai, 200070, P.R. China
Phone: +86 21 61410123, Fax:+86 21 61408600

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.

The radiation measurements are performed in X, Y, Z axis positioning for Transmitting mode, and found the X axis positioning which it is the worst case.

Test result

Above 1GHz Transmitting spurious emission test result as below:

Test mode:GFSK 1Mbps (2402MHz)					
Frequency MHz	Measure Level (dBuV/m)	Limit (dBuV/M	Margin (dB)	Detector	Polarization
2386.60	44.09	74.00	29.91	PK	Horiznotal
4804.11	41.33	74.00	32.67	PK	Horiznotal
2383.30	44.30	74.00	29.70	PK	Vertical
4802.90	40.00	74.00	34.00	PK	Vertical

Test mode:GFSK 1Mbps (2440MHz)					
Frequency MHz	Measure Level (dBuV/m)	Limit (dBuV/M	Margin (dB)	Detector	Polarization
4879.28	41.18	74.00	32.82	PK	Horiznotal
4879.96	40.49	74.00	33.51	PK	Vertical

Test mode:GFSK 1Mbps (2480MHz)					
Frequency MHz	Measure Level (dBuV/m)	Limit (dBuV/M	Margin (dB)	Detector	Polarization
2483.58	48.30	74.00	25.70	PK	Horiznotal
4959.30	44.39	74.00	29.61	PK	Horiznotal
2483.58	47.03	74.00	26.97	PK	Vertical
4964.40	43.22	74.00	30.78	PK	Vertical

TÜV SÜD Certification and Testing (China) Co., Ltd. Shanghai Branch
3-13, No.151, Heng Tong Road, Shanghai, 200070, P.R. China
Phone: +86 21 61410123, Fax:+86 21 61408600

Test mode:GFSK 2Mbps (2402MHz)					
Frequency MHz	**Measure Level (dBuV/m)**	**Limit (dBuV/M**	**Margin (dB)**	**Detector**	**Polarization**
2384.09	44.68	74.00	29.32	PK	Horiznotal
4803.46	40.61	74.00	33.39	PK	Horiznotal
2383.62	43.62	74.00	30.38	PK	Vertical
4804.33	40.17	74.00	33.83	PK	Vertical

Test mode:GFSK 2Mbps (2440MHz)					
Frequency MHz	**Measure Level (dBuV/m)**	**Limit (dBuV/M**	**Margin (dB)**	**Detector**	**Polarization**
4879.96	40.92	74.00	33.08	PK	Horiznotal
4878.26	41.12	74.00	32.88	PK	Vertical

Test mode:GFSK 2Mbps (2480MHz)					
Frequency MHz	**Measure Level (dBuV/m)**	**Limit (dBuV/M**	**Margin (dB)**	**Detector**	**Polarization**
2483.59	50.52	74.00	23.48	PK	Horiznotal
4959.86	44.04	74.00	29.96	PK	Horiznotal
2483.60	48.04	74.00	25.96	PK	Vertical
4960.43	41.32	74.00	32.68	PK	Vertical

Remark:

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

TÜV SÜD Certification and Testing (China) Co., Ltd. Shanghai Branch
3-13, No.151, Heng Tong Road, Shanghai, 200070, P.R. China
Phone: +86 21 61410123, Fax:+86 21 61408600

The worst case of Radiated Emission below 1GHz:

30-1000MHz Radiated Emission

EUT Information

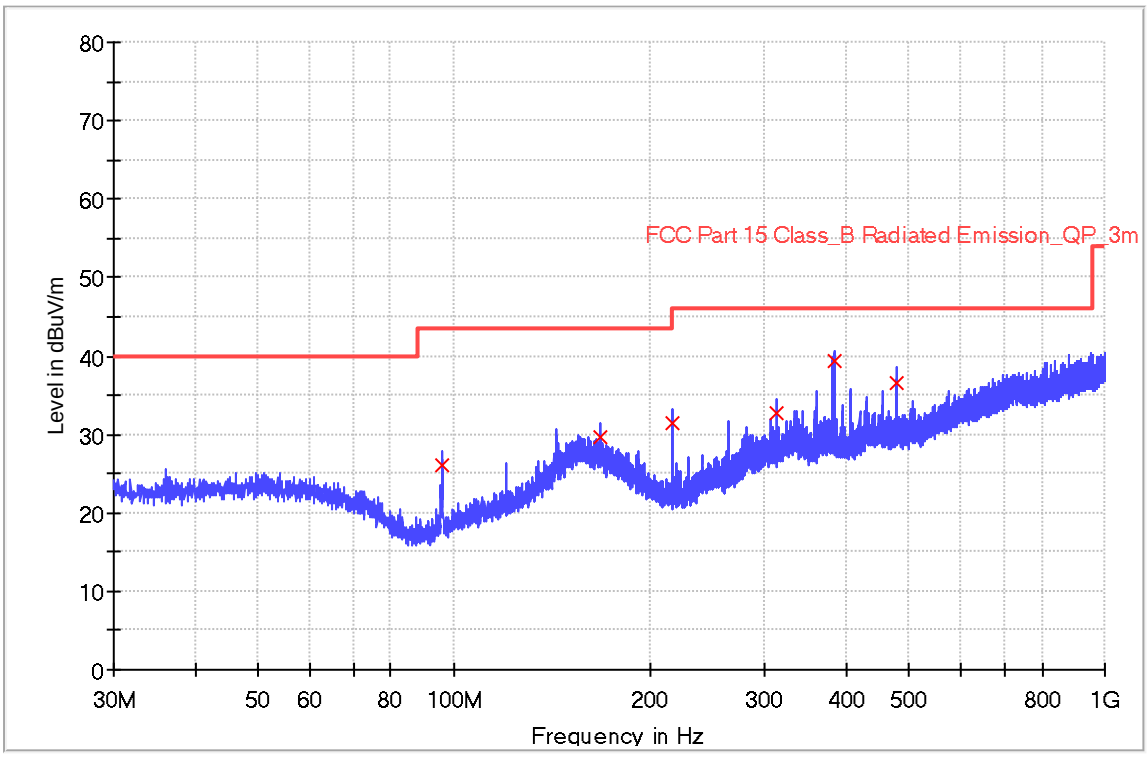
EUT Name:	Wireless Module
Model:	TS24-U
Client:	Hangzhou Tuya Information Technology Co.,Ltd
Op Cond:	Power on,TX_2402MHz at 1Mbps, DC 3.3V, T23.9, 47.4%, P102.5kPa
Operator:	Cheng Huali
Test Spec:	FCC Part 15.209(a)
Comment:	Horizontal
Sample No:	SHA-777946-3

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



TÜV SÜD Certification and Testing (China) Co., Ltd. Shanghai Branch
3-13, No.151, Heng Tong Road, Shanghai, 200070, P.R. China
Phone: +86 21 61410123, Fax:+86 21 61408600

Limit and Margin

Frequency (MHz)	QuasiPeak (dBuV/m)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB/m)	Margin - QPK (dB)	Limit - QPK (dBuV/m)
96.040000	26.2	1000.0	120.000	136.0	H	105.0	15.7	17.4	43.5
168.000000	29.6	1000.0	120.000	174.0	H	221.0	20.4	13.9	43.5
215.960000	31.4	1000.0	120.000	125.0	H	118.0	17.5	12.1	43.5
312.040000	32.8	1000.0	120.000	201.0	H	321.0	21.9	13.2	46.0
384.440000	39.2	1000.0	120.000	152.0	H	36.0	23.8	6.8	46.0
479.400000	36.6	1000.0	120.000	195.0	H	97.0	26.2	9.4	46.0

TÜV SÜD Certification and Testing (China) Co., Ltd. Shanghai Branch
3-13, No.151, Heng Tong Road, Shanghai, 200070, P.R. China
Phone: +86 21 61410123, Fax:+86 21 61408600

30-1000MHz Radiated Emission

EUT Information

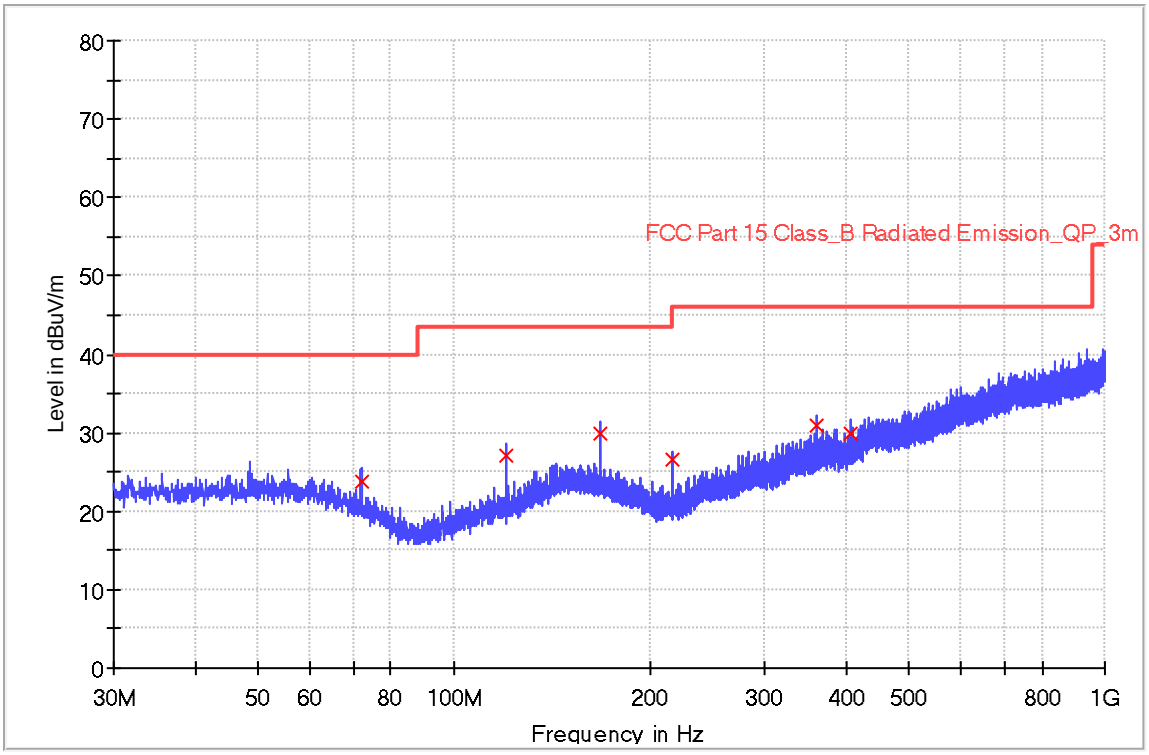
EUT Name:	Wireless Module
Model:	TS24-U
Client:	Hangzhou Tuya Information Technology Co.,Ltd
Op Cond:	Power on,TX_2402MHz at 1Mbps, DC 3.3V, T23.9, 47.4%,
Operator:	Cheng Huali
Test Spec:	FCC Part 15.209(a)
Comment:	Vertical
Sample No:	SHA-777946-3

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



TÜV SÜD Certification and Testing (China) Co., Ltd. Shanghai Branch
3-13, No.151, Heng Tong Road, Shanghai, 200070, P.R. China
Phone: +86 21 61410123, Fax:+86 21 61408600

Limit and Margin

Frequency (MHz)	QuasiPeak (dBuV/m)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB/m)	Margin - QPK (dB)	Limit - QPK (dBuV/m)
71.960000	23.7	1000.0	120.000	130.0	V	64.0	18.2	16.3	40.0
119.960000	27.2	1000.0	120.000	112.0	V	106.0	18.1	16.3	43.5
168.000000	29.9	1000.0	120.000	103.0	V	21.0	20.4	13.6	43.5
216.000000	26.5	1000.0	120.000	126.0	V	325.0	17.5	19.5	46.0
359.960000	30.9	1000.0	120.000	152.0	V	198.0	23.0	15.1	46.0
407.960000	29.9	1000.0	120.000	100.0	V	228.0	24.2	16.1	46.0

Note 1: Measure Level (dBuV/m) = Reading Level (dBuV) + Factor (dB)
Factor (dB) = Cable Loss (dB) + Antenna Factor (dB/m)
Note 2: The test trace is same as the ambient noise and the amplitude of the emissions are attenuated more than 20dB below the permissible (the test frequency range: 9kHz ~ 30MHz, 18GHz ~ 25GHz), therefore no data appear in the report.

TÜV SÜD Certification and Testing (China) Co., Ltd. Shanghai Branch
3-13, No.151, Heng Tong Road, Shanghai, 200070, P.R. China
Phone: +86 21 61410123, Fax:+86 21 61408600

10 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	2023-2-10	2024-2-9
RE	EMI Test Receiver	Rohde & Schwarz	ESR3	101906	2023-8-1	2024-7-31
	Signal Analyzer	Rohde & Schwarz	FSV40	101091	2023-8-1	2024-7-31
	Trilog Super Broadband Test Antenna	Schwarzbeck	VULB 9168	961	2021-9-23	2024-9-22
	Horn Antenna	Rohde & Schwarz	HF907	102393	2021-3-15	2024-3-14
	Pre-amplifier	Rohde & Schwarz	SCU-18D	19006451	2023-8-1	2024-7-31
	Loop antenna	Rohde & Schwarz	HFH2-Z2	100443	2023-6-15	2024-6-14
	DOUBLE-RIDGED WAVEGUIDE HORN WITH PRE-AMPLIFIER (18 GHZ - 40 GHZ)	ETS-Lindgren	3116C	00246076	2023-7-7	2026-7-6
	3m Semi-anechoic chamber	TDK	9X6X6	----	2021-5-8	2024-5-7
CE	EMI Test Receiver	Rohde & Schwarz	ESR3	101907	2023-8-1	2024-7-31
	LISN	Rohde & Schwarz	ENV216	101924	2023-8-1	2024-7-31

Measurement Software Information			
Test Item	Software	Manufacturer	Version
C	MTS 8310	MWRFtest	2.0.0.0
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

11 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: 2021, clause 4.4.3 and 4.5.1.

12 Photographs of Test Set-ups

Refer to the < Test Setup photos >.

13 Photographs of EUT

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

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

TÜV SÜD Certification and Testing (China) Co., Ltd. Shanghai Branch
3-13, No.151, Heng Tong Road, Shanghai, 200070, P.R. China
Phone: +86 21 61410123, Fax:+86 21 61408600