

FCC Radio Test Report

FCC ID: 2BDWL2417321

Report No. : BTL-FCCP-1-2303E003
Equipment : TELUS SmartHome+ Hub
Brand Name : TELUS
Test Model : HUF
Series Model : N/A
Applicant : TELUS Communications Inc.
Address : 7th Floor, 510 West Georgia Street, Vancouver, BC, V6B0M3 Canada

Radio Function : Bluetooth Low Energy (5.1)

FCC Rule Part(s) : FCC CFR Title 47, Part 15, Subpart C (15.247)
Measurement Procedure(s) : ANSI C63.10-2013

Date of Receipt : 2024/3/5
Date of Test : 2024/3/5 ~ 2024/6/15
Issued Date : 2025/1/23

The above equipment has been tested and found in compliance with the requirement of the above standards by BTL Inc.

Poken Huang

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Declaration

BTL represents to the client that testing is done in accordance with standard procedures as applicable and that test instruments used has been calibrated with standards traceable to international standard(s) and/or national standard(s).

BTL's reports apply only to the specific samples tested under conditions. It is manufacture's responsibility to ensure that additional production units of this model are manufactured with the identical electrical and mechanical components. **BTL** assumes no responsibility for the data provided by the Customer, any statements, inferences or generalizations drawn by the customer or others from the reports issued by **BTL**.

This report is the confidential property of the client. As a mutual protection to the clients, the public and ourselves, the test report shall not be reproduced, except in full, without our written approval.

BTL's laboratory quality assurance procedures are in compliance with the **ISO/IEC 17025** requirements, and accredited by the conformity assessment authorities listed in this test report.

BTL is not responsible for the sampling stage, so the results only apply to the sample as received.

The information, data and test plan are provided by manufacturer which may affect the validity of results, so it is manufacturer's responsibility to ensure that the apparatus meets the essential requirements of applied standards and in all the possible configurations as representative of its intended use.

Limitation

For the use of the authority's logo is limited unless the Test Standard(s)/Scope(s)/Item(s) mentioned in this test report is (are) included in the conformity assessment authorities acceptance respective.

Please note that the measurement uncertainty is provided for informational purpose only and are not use in determining the Pass/Fail results.

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REVISION HISTORY

Report No.	Version	Description	Issued Date	Note
BTL-FCCP-1-2303E003	R00	Original Report.	2024/7/24	Invalid
BTL-FCCP-1-2303E003	R01	Corrected the Hardware Version.	2024/10/10	Invalid
BTL-FCCP-1-2303E003	R02	Corrected the Output Power.	2025/1/23	Valid

1 SUMMARY OF TEST RESULTS

Test procedures according to the technical standard(s):

FCC CFR Title 47, Part 15, Subpart C				
Standard(s) Section	Test Item	Test Result	Judgment	Remark
15.207	AC Power Line Conducted Emissions	APPENDIX A	PASS	-----
15.247(d) 15.205(a) 15.209(a)	Radiated Emissions	APPENDIX B APPENDIX C	PASS	-----
15.247(a)(2)	Bandwidth	APPENDIX D	PASS	-----
15.247(b)(3)	Maximum Output Power	APPENDIX E	PASS	-----
15.247(d)	Power Spectral Density	APPENDIX F	PASS	-----
15.247(e)	Antenna conducted Spurious Emission	APPENDIX G	PASS	-----
15.203	Antenna Requirement	-----	PASS	-----

Note:

(1) "N/A" denotes test is not applicable to this device.

1.1 TEST FACILITY

The test locations stated below are under the TAF Accreditation Number 0659.

The test location(s) used to collect the test data in this report are:

No. 72, Ln. 169, Sec. 2, Datong Rd., Xizhi Dist., New Taipei City 221, Taiwan
(FCC DN: TW0659)

☒ C06 ☒ CB21

1.2 MEASUREMENT UNCERTAINTY

The reported uncertainty of measurement $y \pm U$, where expanded uncertainty U is based on a standard uncertainty multiplied by a coverage factor of $k = 2$, providing a level of confidence of approximately **95 %**.

The measurement instrumentation uncertainty considerations contained in CISPR 16-4-2. The eLab measurement uncertainty is less than the CISPR 16-4-2 U_{cispr} requirement.

A. AC power line conducted emissions test:

Test Site	Method	Measurement Frequency Range	U (dB)
C06	CISPR	150 kHz ~ 30MHz	2.4498

B. Radiated emissions test:

Test Site	Measurement Frequency Range	U,(dB)
CB21	0.03 GHz ~ 0.2 GHz	4.17
	0.2 GHz ~ 1 GHz	4.72
	1 GHz ~ 6 GHz	5.20
	6 GHz ~ 18 GHz	5.50
	18 GHz ~ 26 GHz	3.69
	26 GHz ~ 40 GHz	4.23

C. Conducted test:

Test Item	U,(dB)
Occupied Bandwidth	0.53
Maximum Output Power	0.37
Power Spectral Density	0.66
Conducted Spurious emissions	0.54
Conducted Band edges	0.53

NOTE:

Unless specifically mentioned, the uncertainty of measurement has not been taken into account to declare the compliance or non-compliance to the specification.

1.3 TABLE OF PARAMETERS OF TEXT SOFTWARE SETTING

Test Software	NB-03A1-01			
Modulation Mode	2402 MHz	2440 MHz	2480 MHz	Data Rate
BLE 5.1	default	default	default	1 Mbps
BLE 5.1	default	default	default	2 Mbps

1.4 TABLE OF PARAMETERS OF TEXT SOFTWARE SETTING

Test Item	Environment Condition	Test Voltage	Tested by
AC Power Line Conducted Emissions	25°C, 45%	AC 120V	Ken Hsieh
Radiated Emissions	24°C, 62%	DC 5V	Ken Hsieh
Bandwidth	25°C, 64%	DC 5V	Ken Hsieh
Maximum Output Power	25°C, 64%	DC 5V	Ken Hsieh
Power Spectral Density	25°C, 64%	DC 5V	Ken Hsieh
Antenna conducted Spurious Emission	25°C, 64%	DC 5V	Ken Hsieh

2 GENERAL INFORMATION

2.1 DESCRIPTION OF EUT

Equipment	TELUS SmartHome+ Hub
Brand Name	TELUS
Test Model	HUF
Series Model	N/A
Model Difference(s)	N/A
Software Version	v0.8.13
Hardware Version	DVT
Power Source	DC Voltage supplied from AC adapter. Model: DSA-12PF11-05 FUS 050200
Power Rating	I/P:100-240V ~ 50/60Hz 0.5A O/P:+5.0V --- 2.0A
Operation Frequency	2402 MHz ~ 2480 MHz
Modulation Type	GFSK
Bit Rate of Transmitter	1Mbps, 2Mbps
Max. Output Power	1Mbps: 6.82 dBm (0.0048 W) 2Mbps: 6.17 dBm (0.0041 W)

NOTE:

1. The above EUT information is declared by manufacturer and for more detailed features description, please refers to the manufacturer's specifications or user's manual.

2. Channel List:

Channel	Frequency (MHz)	Channel	Frequency (MHz)
00	2402	20	2442
01	2404	21	2444
02	2406	22	2446
03	2408	23	2448
04	2410	24	2450
05	2412	25	2452
06	2414	26	2454
07	2416	27	2456
08	2418	28	2458
09	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

3. Table for Filed Antenna:

Ant.	Brand	Model Name	Antenna Type	Connector	Gain (dBi)
1		N/A	PIFA	N/A	2.74

Note:

The above Antenna information are derived from the antenna data sheet provided by manufacturer and for more detailed features description, please refer to the manufacturer's specifications, the laboratory shall not be held responsible.

2.2 TEST MODES

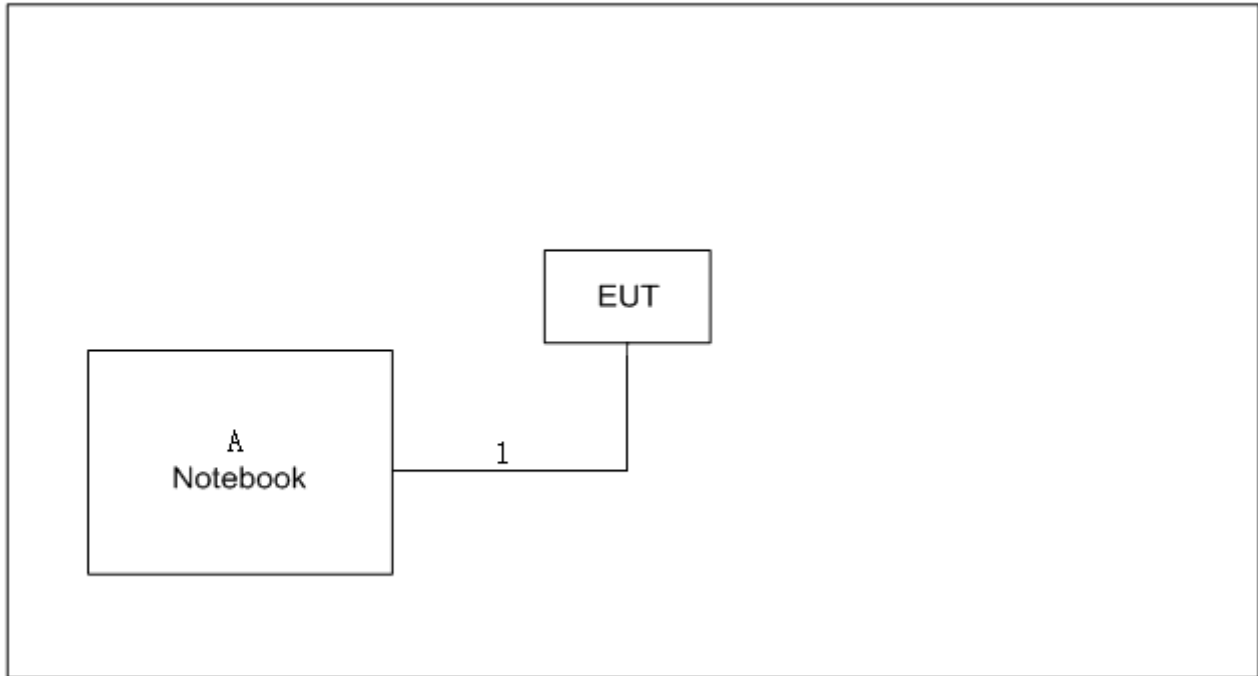
Test Items	Test mode	Channel	Note
AC power line conducted emissions	Normal	-	-
Transmitter Radiated Emissions (below 1GHz)	2 Mbps	19	-
Transmitter Radiated Emissions (above 1GHz)	1/2 Mbps	00/39	Bandedge
	1/2 Mbps	00/19/39	Harmonic
Bandwidth	1/2 Mbps	00/19/39	-
Output Power	1/2 Mbps	00/19/39	-
Power Spectral Density	1/2 Mbps	00/19/39	-
Antenna conducted Spurious Emission	1/2 Mbps	00/19/39	-

NOTE:

- (1) For radiated emission above 1 GHz test, the spurious points of 1GHz~26.5GHz have been pre-tested and in this report only recorded the worst case. The remaining spurious points are all below the limit value of 20dB.
- (2) For radiated emissions below 1 GHz test, the 1Mbps channel 19 is found to be the worst case and recorded.
- (3) For radiated emission band edge test, both Vertical and Horizontal are evaluated, but only the worst case (Horizontal) is recorded.
- (4) The test sample with two adapters, only the cable is different. For radiated spurious emissions below 1 GHz test, two adapters had been pre-tested and in this report only recorded the worst case

2.3 BLOCK DIAGRAM SHOWING THE CONFIGURATION OF SYSTEM TESTED

Equipment letters and Cable numbers refer to item numbers described in the tables of clause 2.4.



2.4 SUPPORT UNITS

Item	Equipment	Brand	Model No.	Remarks
A	Notebook	tinkpad	ThinkBook16+	Furnished by test lab.

Item	Cable Type	Ferrite Core	Length	Shielded	Remarks
1	USB Cable	NO	1m	NO	Furnished by test lab.

3 AC POWER LINE CONDUCTED EMISSIONS TEST

3.1 LIMIT

Frequency (MHz)	Limit (dB μ V)	
	Quasi-peak	Average
0.15 - 0.5	66 - 56 *	56 - 46 *
0.50 - 5.0	56	46
5.0 - 30.0	60	50

NOTE:

- (1) The tighter limit applies at the band edges.
- (2) The limit of " * " marked band means the limitation decreases linearly with the logarithm of the frequency in the range.
- (3) The test result calculated as following:
Measurement Value = Reading Level + Correct Factor
Correct Factor = Insertion Loss + Cable Loss + Attenuator Factor (if use)
Margin Level = Measurement Value – Limit Value

Calculation example:

Reading Level		Correct Factor		Measurement Value
38.22	+	3.45	=	41.67

Measurement Value		Limit Value		Margin Level
41.67	-	60	=	-18.33

The following table is the setting of the receiver.

Receiver Parameter	Setting
Attenuation	10 dB
Start Frequency	0.15 MHz
Stop Frequency	30 MHz
IF Bandwidth	9 KHz

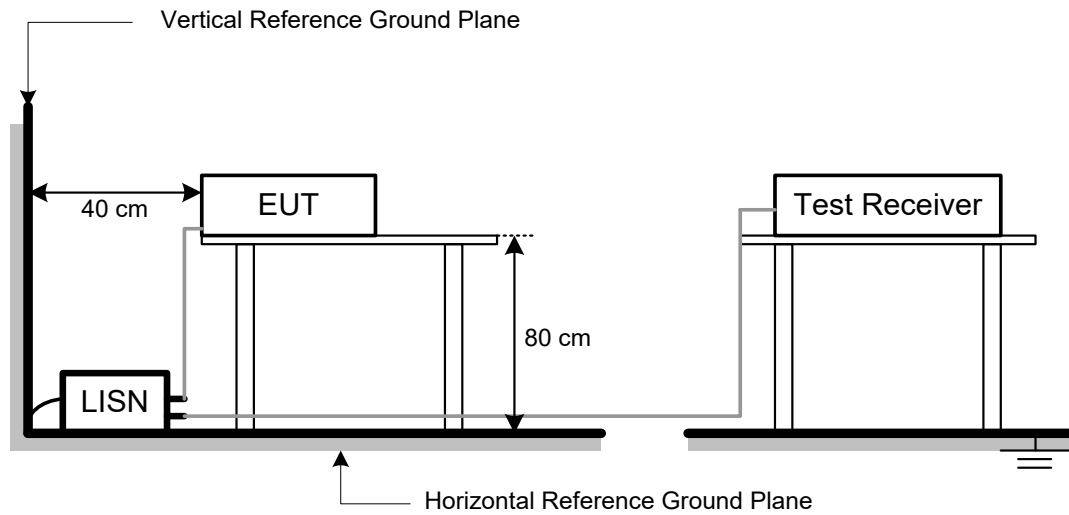
3.2 TEST PROCEDURE

- a. The EUT was placed 0.8 m above the horizontal ground plane with the EUT being connected to the power mains through a line impedance stabilization network (LISN).
All other support equipment were powered from an additional LISN(s).
The LISN provides 50 Ohm/50uH of impedance for the measuring instrument.
- b. Interconnecting cables that hang closer than 40 cm to the ground plane shall be folded back and forth in the center forming a bundle to keep the cable above 40 cm.
- c. Excess I/O cables that are not connected to a peripheral shall be bundled in the center.
The end of the cable will be terminated, using the correct terminating impedance.
The overall length shall not exceed 1 m.
- d. The LISN is spaced at least 80 cm from the nearest part of the EUT chassis.
- e. For the actual test configuration, please refer to the related Item – EUT TEST PHOTO.

NOTE:

- (1) In the results, each reading is marked as Peak, QP or AVG per the detector used.
BW=9 kHz (6 dB Bandwidth)
- (2) All readings are Peak unless otherwise stated QP or AVG in column of Note. Both the QP and the AVG readings must be less than the limit for compliance.

3.3 TEST SETUP



3.4 TEST RESULT

Please refer to the APPENDIX A.

4 RADIATED EMISSIONS TEST

4.1 LIMIT

In case the emission falls within the restricted band specified on 15.205, then the 15.209 limit in the table below has to be followed.

LIMITS OF RADIATED EMISSIONS MEASUREMENT (9 kHz to 1000 MHz)

Frequency (MHz)	Field Strength (microvolts/meter)	Measurement Distance (meters)
0.009~0.490	2400/F(KHz)	300
0.490~1.705	24000/F(KHz)	30
1.705~30.0	30	30
30~88	100	3
88~216	150	3
216~960	200	3
960~1000	500	3

LIMITS OF RADIATED EMISSIONS MEASUREMENT (Above 1000 MHz)

Frequency (MHz)	Radiated Emissions (dBuV/m)		Measurement Distance (meters)
	Peak	Average	
Above 1000	74	54	3

NOTE:

- (1) The limit for radiated test was performed according to FCC CFR Title 47, Part 15, Subpart C.
- (2) The tighter limit applies at the band edges.
- (3) Emission level (dBuV/m)=20log Emission level (uV/m).
- (4) The test result calculated as following:

Measurement Value = Reading Level + Correct Factor

Correct Factor = Antenna Factor + Cable Loss - Amplifier Gain(if use)

Margin Level = Measurement Value - Limit Value

Calculation example:

Reading Level		Correct Factor		Measurement Value
41.91	+	-8.36	=	33.55

Measurement Value		Limit Value		Margin Level
33.55	-	43.50	=	-9.95

Spectrum Parameter	Setting
Attenuation	Auto
Start Frequency	1000 MHz
Stop Frequency	10th carrier harmonic
RBW / VBW (Emission in restricted band)	1MHz / 3MHz for Peak, 1MHz / 1/T for Average

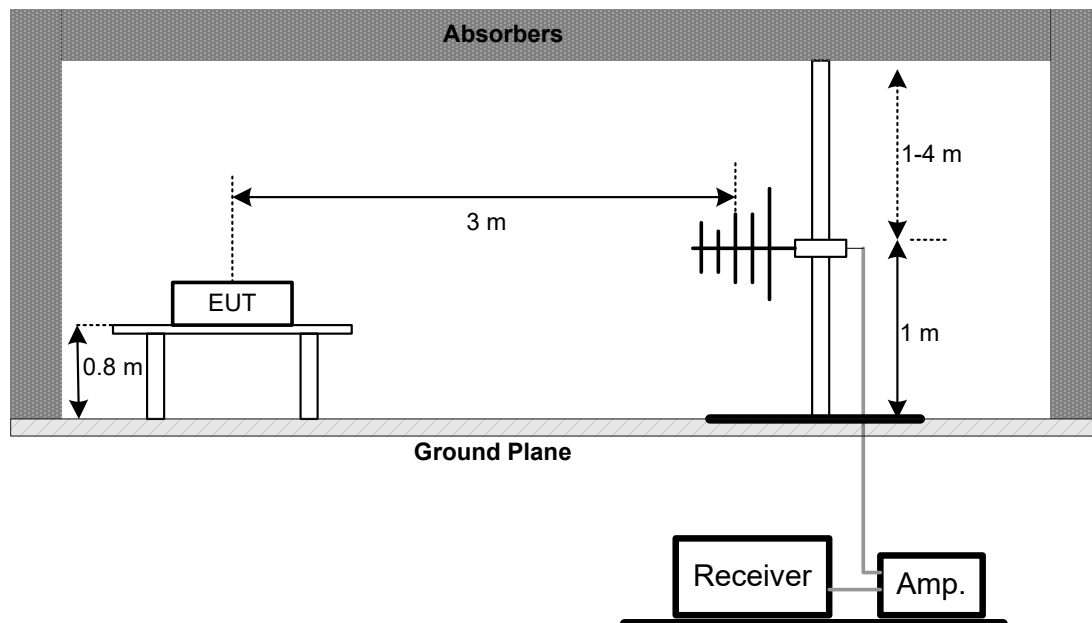
Spectrum Parameter	Setting
Attenuation	Auto
Start ~ Stop Frequency	9KHz~90KHz for PK/AVG detector
Start ~ Stop Frequency	90KHz~110KHz for QP detector
Start ~ Stop Frequency	110KHz~490KHz for PK/AVG detector
Start ~ Stop Frequency	490KHz~30MHz for QP detector
Start ~ Stop Frequency	30MHz~1000MHz for QP detector

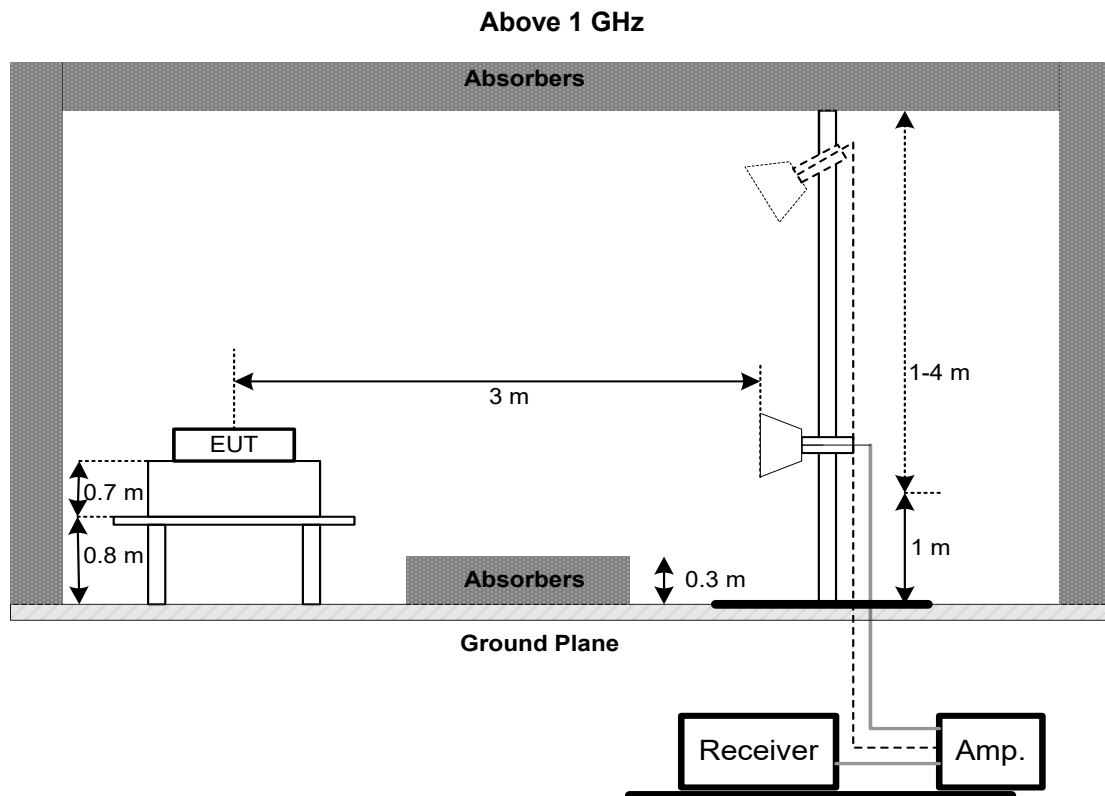
4.2 TEST PROCEDURE

- The measuring distance of 3 m shall be used for measurements. The EUT was placed on the top of a rotating table 0.8 meter above the ground at a 3 meter semi-anechoic chamber. The table was rotated 360 degrees to determine the position of the highest radiation.(below 1GHz)
- The measuring distance of 3 m shall be used for measurements. The EUT was placed on the top of a rotating table 1.5 meter above the ground at a 3 meter semi-anechoic chamber. The table was rotated 360 degrees to determine the position of the highest radiation.(above 1GHz)
- The height of the equipment or of the substitution antenna shall be 0.8 m or 1.5 m, the height of the test antenna shall vary between 1 m to 4 m. Both horizontal and vertical polarizations of the antenna are set to make the measurement.
- For each suspected emission, the EUT was arranged to its worst case and then the antenna was tuned to heights find the maximum reading (used Bore sight function).
- The receiver system was set to peak and average detect function and specified bandwidth with maximum hold mode when the test frequency is above 1GHz.
- The initial step in collecting radiated emission data is a receiver peak detector mode pre-scanning the measurement frequency range. Significant peaks are then marked and then Quasi Peak detector mode re-measured.
- All readings are Peak unless otherwise stated QP in column of Note. Peak denotes that the Peak reading compliance with the QP Limits and then QP Mode measurement didn't perform. (below 1GHz)
- All readings are Peak Mode value unless otherwise stated AVG in column of Note. If the Peak Mode Measured value compliance with the Peak Limits and lower than AVG Limits, the EUT shall be deemed to meet both Peak & AVG Limits and then only Peak Mode was measured, but AVG Mode didn't perform. (above 1GHz)
- For the actual test configuration, please refer to the related Item – EUT TEST PHOTO.

4.3 TEST SETUP

30 MHz to 1 GHz





4.4 EUT OPERATING CONDITIONS

The EUT was programmed to be in continuously transmitting mode.

4.5 TEST RESULT – BELOW 30 MHZ

There were no emissions found below 30 MHz within 20 dB of the limit.

4.6 TEST RESULT – 30 MHZ TO 1 GHZ

Please refer to the APPENDIX B.

4.7 TEST RESULT – ABOVE 1 GHZ

Please refer to the APPENDIX C.

NOTE:

- (1) No limit: This is fundamental signal, the judgment is not applicable.
For fundamental signal judgment was referred to Peak output test.

5 BANDWIDTH TEST

5.1 APPLIED PROCEDURES / LIMIT

Section	Test Item	Limit
15.247(a)(2)	6 dB Bandwidth	500 kHz

5.2 TEST PROCEDURE

- The EUT was directly connected to the spectrum analyzer and antenna output port as show in the block diagram below,
- Spectrum Setting : RBW= 100KHz, VBW=300KHz, Sweep time = 2.5 ms.

5.3 TEST SETUP



5.4 EUT OPERATION CONDITIONS

The EUT was programmed to be in continuously transmitting mode.

5.5 TEST RESULTS

Please refer to the APPENDIX D.

6 OUTPUT POWER TEST

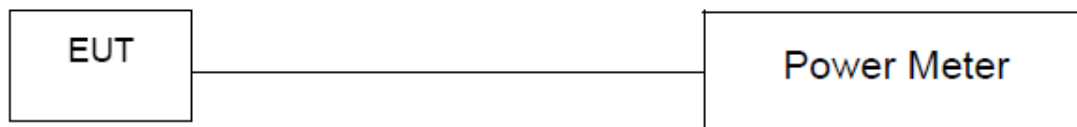
6.1 APPLIED PROCEDURES / LIMIT

Section	Test Item	Limit
15.247(b)(3)	Maximum Output Power	1 Watt or 30dBm

6.2 TEST PROCEDURE

- The EUT was directly connected to the power meter and antenna output port as show in the block diagram below,
- The maximum peak conducted output power was performed in accordance with FCC KDB 558074 D01 15.247 Meas Guidance.

6.3 TEST SETUP



6.4 EUT OPERATION CONDITIONS

The EUT was programmed to be in continuously transmitting mode.

6.5 TEST RESULTS

Please refer to the APPENDIX E.

7 POWER SPECTRAL DENSITY TEST

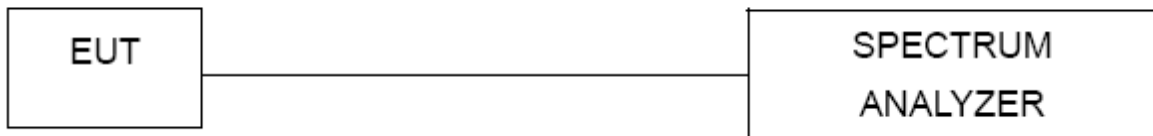
7.1 APPLIED PROCEDURES / LIMIT

Section	Test Item	Limit
15.247(e)	Power Spectral Density	8 dBm (in any 3 kHz)

7.2 TEST PROCEDURE

- The EUT was directly connected to the spectrum analyzer and antenna output port as show in the block diagram below,
- Spectrum Setting: RBW=3KHz, VBW=10 KHz, Sweep time = auto.

7.3 TEST SETUP



7.4 EUT OPERATION CONDITIONS

The EUT was programmed to be in continuously transmitting mode.

7.5 TEST RESULTS

Please refer to the APPENDIX F.

8 ANTENNA CONDUCTED SPURIOUS EMISSION

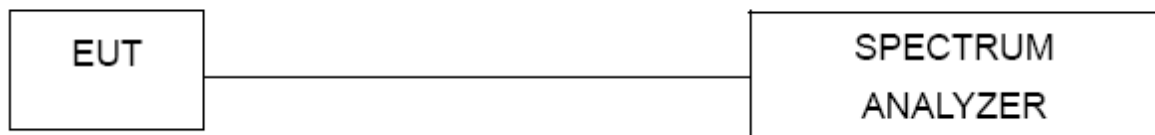
8.1 APPLIED PROCEDURES / LIMIT

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.

8.2 TEST PROCEDURE

- a. The EUT was directly connected to the spectrum analyzer and antenna output port as show in the block diagram below,
- b. Spectrum Setting : RBW= 100KHz, VBW=300KHz, Sweep time = 10 ms.

8.3 TEST SETUP



8.4 EUT OPERATION CONDITIONS

The EUT was programmed to be in continuously transmitting mode.

8.5 TEST RESULTS

Please refer to the APPENDIX G.

9 LIST OF MEASURING EQUIPMENTS

AC Power Line Conducted Emissions

Item	Kind of Equipment	Manufacturer	Type No.	Serial No.	Calibrated Date	Calibrated Until
1	Reciver	MXE EMI Reciver	Agilent Technologies	N9038A	2023/6/26	2024/6/25
2	LISN	Two-Line V-Network	R&S	ENV216	2023/7/21	2024/7/20

Radiated Emissions_ Below 1G

Item	Kind of Equipment	Manufacturer	Type No.	Serial No.	Calibrated Date	Calibrated Until
1	Trilog-Broadband Antenna	Schwarzbeck	VULB 9168	01207	2023/12/18	2024/12/17
2	EMI Test Receiver	Keysight	N9038A	MY54130009	2023/6/26	2024/6/25
3	Pre-Amplifier	EMCI	EMC001330-202 01222	980807	2023/12/11	2024/12/10
4	Test Cable	EMCI	EMC-8D-NM-NM -5000	150106	2023/12/11	2024/12/10
5	Test Cable	EMCI	EMC-CFD-400-N M-NM-8000	200348	2023/12/11	2024/12/10

Radiated Emissions_ Above 1G

Item	Kind of Equipment	Manufacturer	Type No.	Serial No.	Calibrated Date	Calibrated Until
1	Broad-Band Horn Antenna	RFSPIN	DRH18-E	210109A18E	2024/1/10	2025/1/9
2	Pre-Amplifier	EMCI	EMC051845SE	980779	2023/12/11	2024/12/10
3	Test Cable	EMCI	EMC105-SM-SM-1000	210119	2023/12/11	2024/12/10
4	Test Cable	EMCI	EMC105-SM-SM-3000	210118	2023/12/11	2024/12/10
5	Test Cable	EMCI	EMC105-SM-SM-7000	210117	2023/12/11	2024/12/10
6	EXA Spectrum Analyzer	keysight	N9010A	MY56480554	2023/9/12	2024/9/11

Bandwidth & Maximum Output Power & Power Spectral Density & Antenna conducted Spurious Emission

Item	Kind of Equipment	Manufacturer	Type No.	Serial No.	Calibrated Date	Calibrated Until
1	Spectrum Analyzer	R&S	FSP 30	100854	2023/6/26	2024/6/25

Remark: "N/A" denotes no model name, no serial no. or no calibration specified.
All calibration period of equipment list is one year.

10 EUT TEST PHOTO

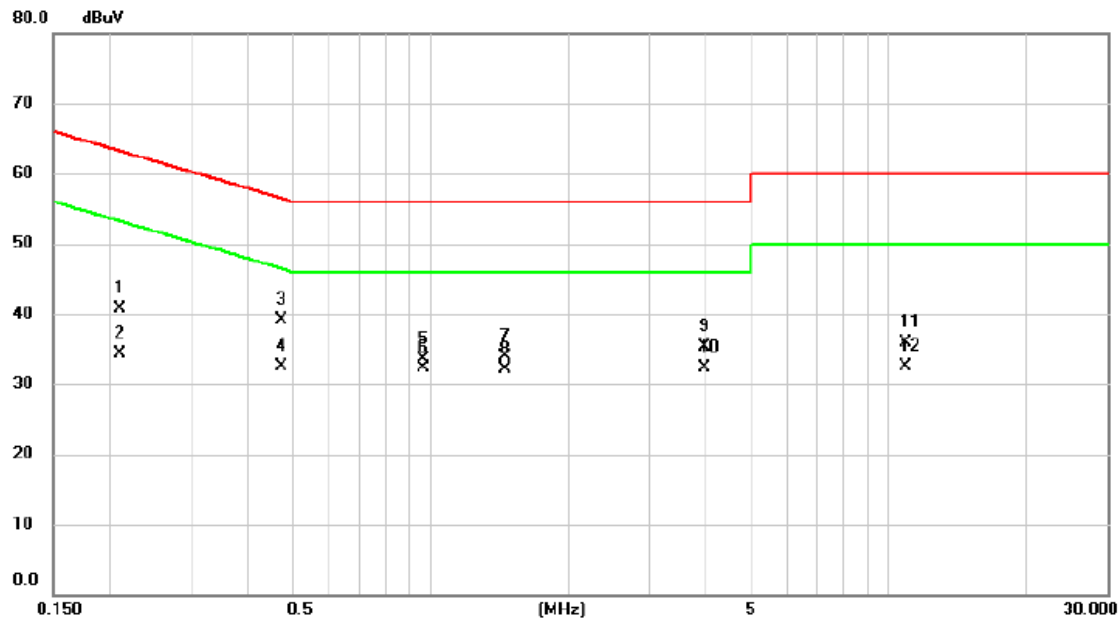
Please refer to APPENDIX-TEST PHOTOS.

11 EUT PHOTOS

Please refer to APPENDIX-EUT PHOTOS.

APPENDIX A AC POWER LINE CONDUCTED EMISSIONS

Test Mode	Normal	Tested Date	2024/4/16
Phase	Line		

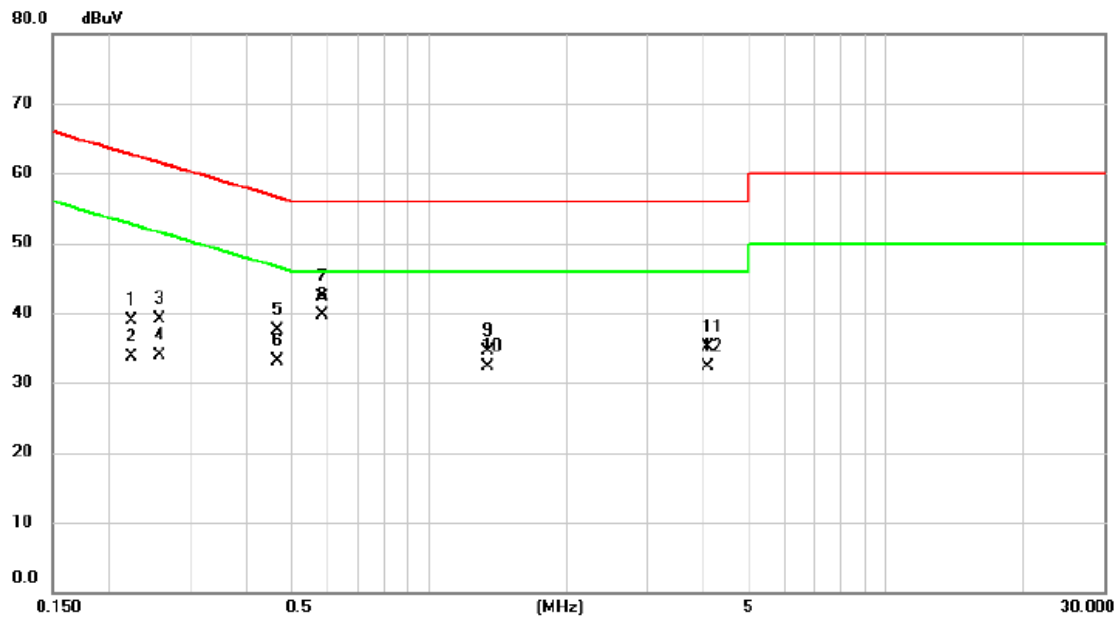


No.	Mk.	Freq. MHz	Reading Level dBuV	Correct Factor dB	Measure- ment dBuV	Limit dBuV	Margin dB	Detector	Comment
1		0.2091	31.12	9.67	40.79	63.24	-22.45	QP	
2		0.2091	24.60	9.67	34.27	53.24	-18.97	AVG	
3		0.4713	29.37	9.68	39.05	56.49	-17.44	QP	
4		0.4713	22.88	9.68	32.56	46.49	-13.93	AVG	
5		0.9680	23.86	9.73	33.59	56.00	-22.41	QP	
6	*	0.9680	22.61	9.73	32.34	46.00	-13.66	AVG	
7		1.4585	24.21	9.76	33.97	56.00	-22.03	QP	
8		1.4585	22.41	9.76	32.17	46.00	-13.83	AVG	
9		3.9740	25.42	9.87	35.29	56.00	-20.71	QP	
10		3.9740	22.35	9.87	32.22	46.00	-13.78	AVG	
11		10.8750	25.84	10.07	35.91	60.00	-24.09	QP	
12		10.8750	22.39	10.07	32.46	50.00	-17.54	AVG	

REMARKS:

- (1) Measurement Value = Reading Level + Correct Factor.
- (2) Margin Level = Measurement Value - Limit Value.

Test Mode	Normal	Tested Date	2024/4/16
Phase	Neutral		



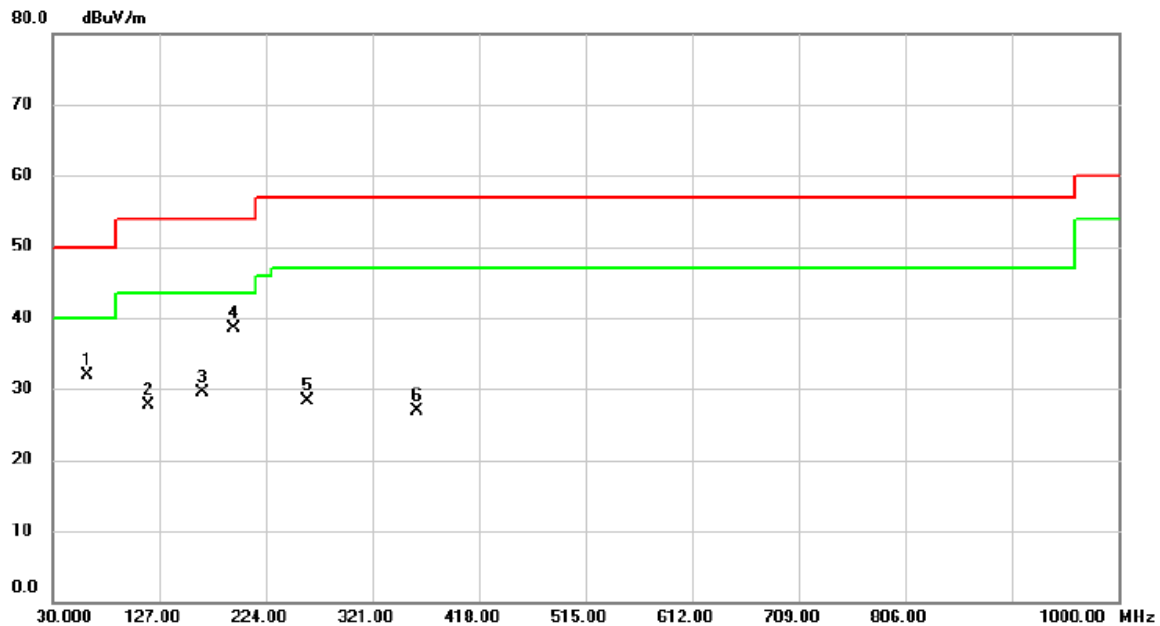
No.	Mk.	Freq. MHz	Reading Level dBuV	Correct Factor dB	Measure- ment dBuV	Limit dBuV	Margin dB	Detector	Comment
1		0.2235	29.18	9.66	38.84	62.69	-23.85	QP	
2		0.2235	24.12	9.66	33.78	52.69	-18.91	AVG	
3		0.2567	29.47	9.65	39.12	61.54	-22.42	QP	
4		0.2567	24.27	9.65	33.92	51.54	-17.62	AVG	
5		0.4661	27.82	9.68	37.50	56.58	-19.08	QP	
6		0.4661	23.47	9.68	33.15	46.58	-13.43	AVG	
7		0.5855	32.60	9.70	42.30	56.00	-13.70	QP	
8	*	0.5855	30.07	9.70	39.77	46.00	-6.23	AVG	
9		1.3460	24.66	9.75	34.41	56.00	-21.59	QP	
10		1.3460	22.58	9.75	32.33	46.00	-13.67	AVG	
11		4.0865	25.19	9.88	35.07	56.00	-20.93	QP	
12		4.0865	22.39	9.88	32.27	46.00	-13.73	AVG	

REMARKS:

- (1) Measurement Value = Reading Level + Correct Factor.
- (2) Margin Level = Measurement Value - Limit Value.

APPENDIX B RADIATED EMISSIONS - 30 MHZ TO 1 GHZ

Test Mode	BLE 5.1 (1 Mbps)	Test Date	2024/4/11
Test Frequency	2440MHz	Polarization	Vertical



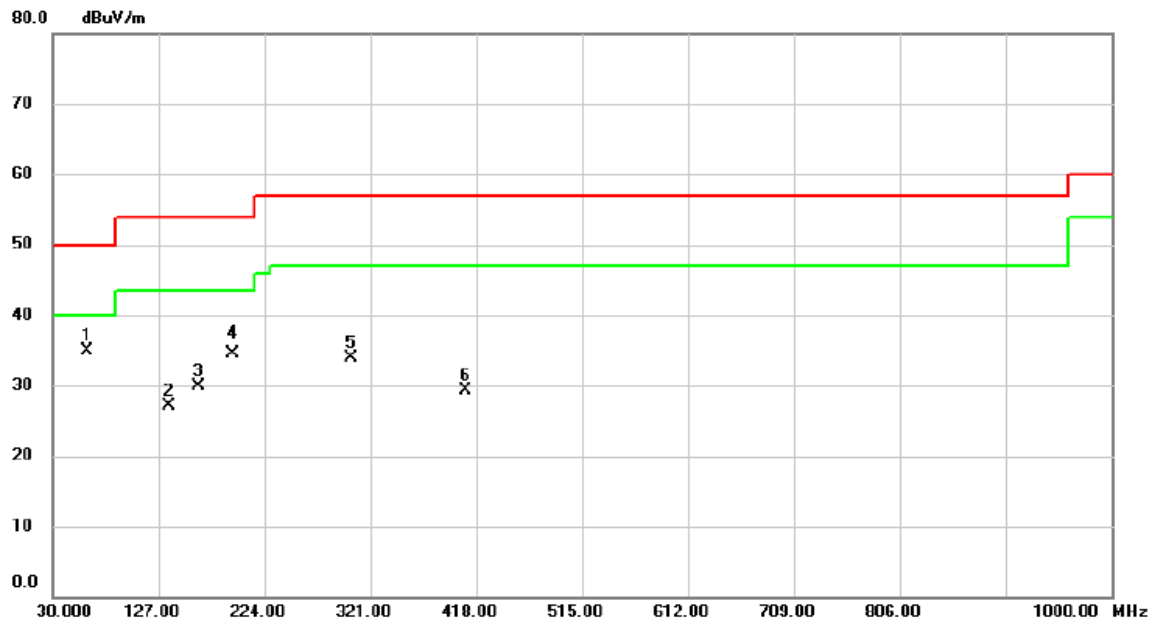
No. Mk.	Freq. MHz	Reading Level dBuV	Correct Factor dB	Measure- ment dBuV/m	Limit dBuV/m	Margin dB	Antenna Height cm	Table Degree	Comment
1	62.0100	44.01	-12.19	31.82	50.00	-18.18	peak	100	249
2	117.3000	41.88	-14.18	27.70	54.00	-26.30	peak	100	197
3	165.8000	41.06	-11.48	29.58	54.00	-24.42	peak	100	193
4 *	194.9000	52.46	-13.99	38.47	54.00	-15.53	peak	200	183
5	261.8300	40.02	-11.62	28.40	57.00	-28.60	peak	100	197
6	361.7400	35.54	-8.58	26.96	57.00	-30.04	peak	100	197

REMARKS:

(1) Measurement Value = Reading Level + Correct Factor.

(2) Margin Level = Measurement Value - Limit Value.

Test Mode	BLE 5.1 (1 Mbps)	Test Date	2024/4/11
Test Frequency	2440MHz	Polarization	Horizontal



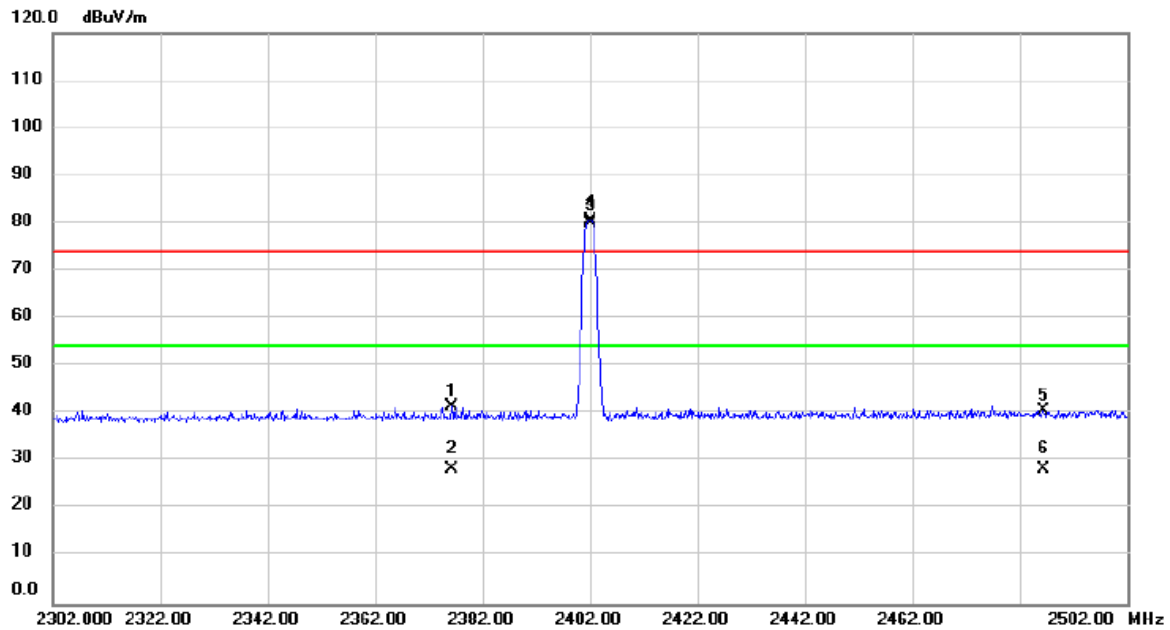
No.	Mk.	Freq.	Reading Level	Correct Factor	Measurement	Limit	Margin	Antenna Height	Table Degree	
		MHz	dBuV	dB	dBuV/m	dBuV/m	dB	Detector	cm	degree
1	*	62.0100	47.00	-12.19	34.81	50.00	-15.19	peak	200	0
2		136.7000	39.40	-12.31	27.09	54.00	-26.91	peak	200	100
3		163.8600	41.34	-11.34	30.00	54.00	-24.00	peak	200	100
4		194.9000	48.49	-13.99	34.50	54.00	-19.50	QP	100	234
5		303.5400	44.01	-10.16	33.85	57.00	-23.15	peak	100	323
6		408.3000	36.57	-7.23	29.34	57.00	-27.66	peak	100	146

REMARKS:

- (1) Measurement Value = Reading Level + Correct Factor.
- (2) Margin Level = Measurement Value - Limit Value.

APPENDIX C RADIATED EMISSIONS - ABOVE 1 GHZ

Test Mode	BLE 5.1 (1 Mbps)	Test Date	2024/4/12
Test Frequency	2402MHz	Polarization	Vertical

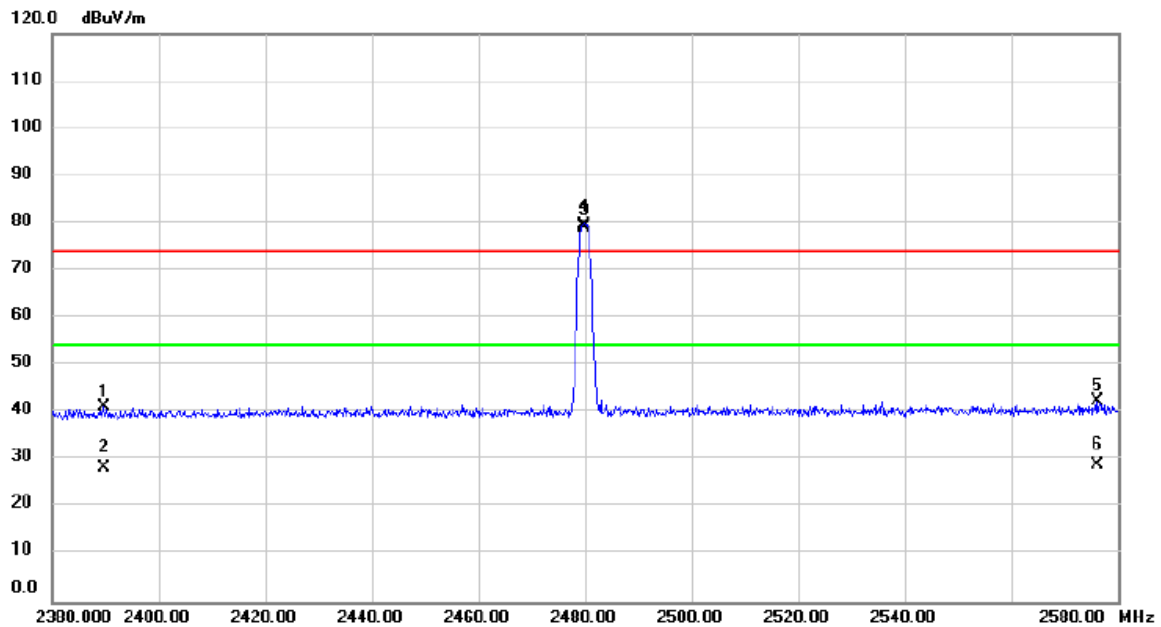


No.	Mk.	Freq. MHz	Reading Level dBuV	Correct Factor dB	Measure- ment dBuV/m	Limit dBuV/m	Margin dB	Antenna Height cm	Table Degree degree	Comment
1		2376.200	38.50	2.97	41.47	74.00	-32.53	peak		
2		2376.200	25.32	2.97	28.29	54.00	-25.71	AVG		
3	X	2402.200	77.59	3.01	80.60	74.00	6.60	peak		No Limit
4	*	2402.200	76.87	3.01	79.88	54.00	25.88	AVG		No Limit
5		2486.400	37.64	3.12	40.76	74.00	-33.24	peak		
6		2486.400	25.37	3.12	28.49	54.00	-25.51	AVG		

REMARKS:

- (1) Measurement Value = Reading Level + Correct Factor.
- (2) Margin Level = Measurement Value - Limit Value.

Test Mode	BLE 5.1 (1 Mbps)	Test Date	2024/4/12
Test Frequency	2480MHz	Polarization	Vertical

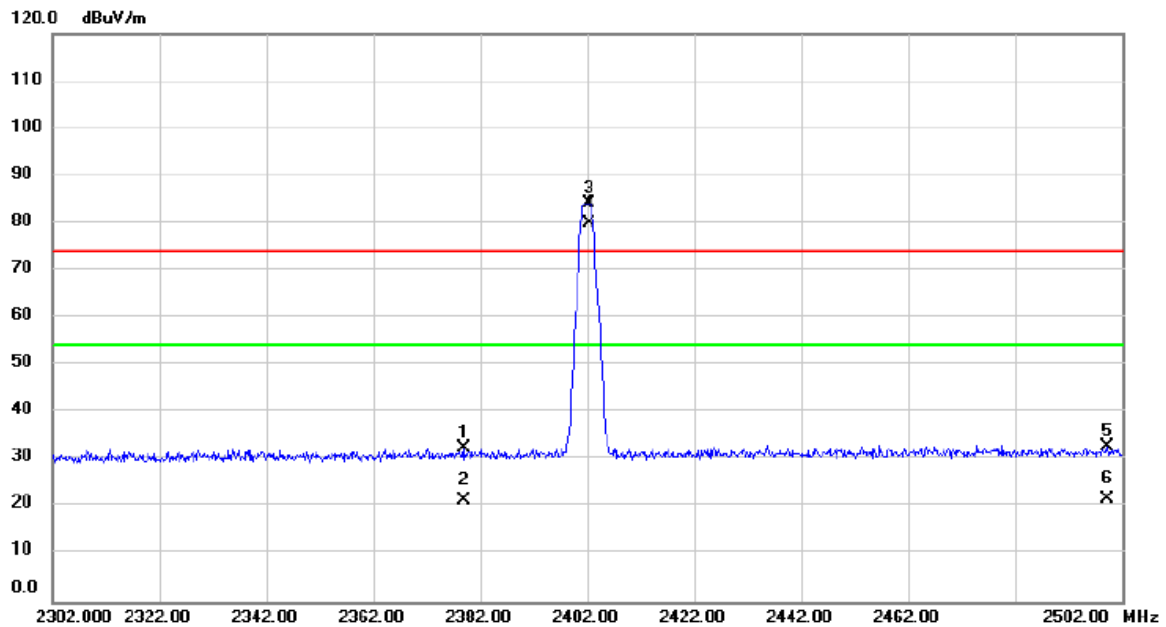


No.	Mk.	Freq. MHz	Reading Level dBuV	Correct Factor dB	Measure- ment dBuV/m	Limit dBuV/m	Margin dB	Detector	Antenna Height cm	Table Degree degree	Comment
1		2389.800	38.20	2.99	41.19	74.00	-32.81	peak			
2		2389.800	25.45	2.99	28.44	54.00	-25.56	AVG			
3	X	2479.800	76.68	3.12	79.80	74.00	5.80	peak			No Limit
4	*	2479.800	75.98	3.12	79.10	54.00	25.10	AVG			No Limit
5		2576.000	39.14	3.41	42.55	74.00	-31.45	peak			
6		2576.000	25.42	3.41	28.83	54.00	-25.17	AVG			

REMARKS:

- (1) Measurement Value = Reading Level + Correct Factor.
- (2) Margin Level = Measurement Value - Limit Value.

Test Mode	BLE 5.1 (2 Mbps)	Test Date	2024/4/12
Test Frequency	2402MHz	Polarization	Vertical

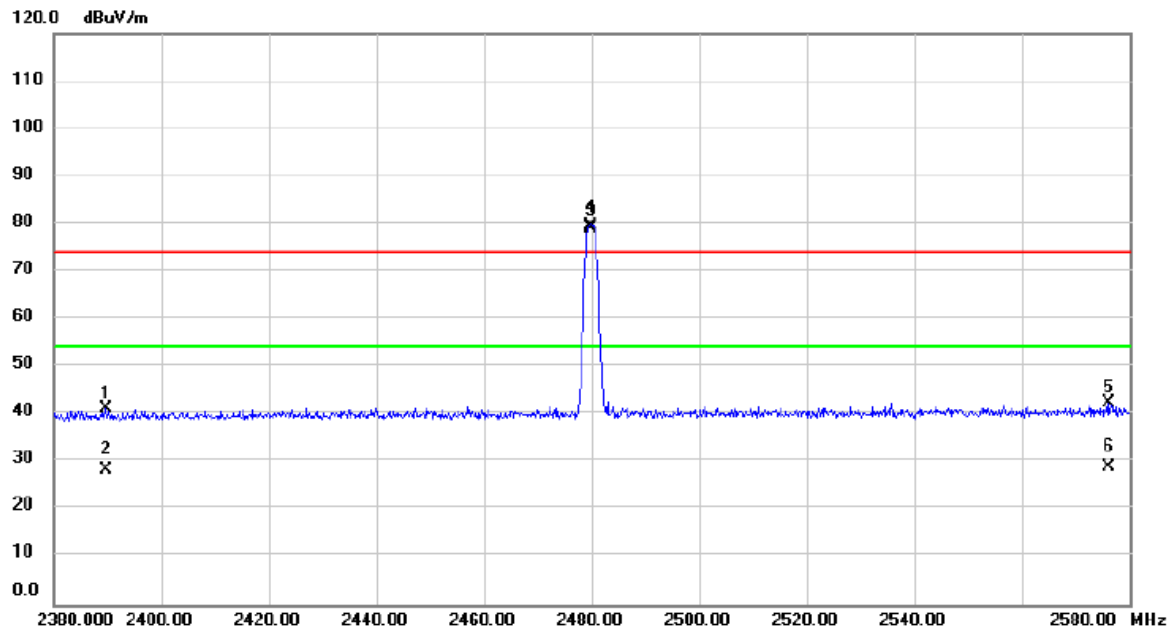


No.	Mk.	Freq.	Reading Level	Correct Factor	Measurement	Limit	Margin	Antenna Height	Table Degree	
		MHz	dBuV	dB	dBuV/m	dBuV/m	dB	cm	degree	Comment
1		2378.800	38.67	-6.15	32.52	74.00	-41.48			peak
2		2378.800	27.67	-6.15	21.52	54.00	-32.48			AVG
3	X	2402.400	90.35	-6.09	84.26	74.00	10.26			No Limit
4	*	2402.400	86.08	-6.09	79.99	54.00	25.99			No Limit
5		2499.200	38.74	-5.88	32.86	74.00	-41.14			peak
6		2499.200	27.72	-5.88	21.84	54.00	-32.16			AVG

REMARKS:

- (1) Measurement Value = Reading Level + Correct Factor.
- (2) Margin Level = Measurement Value - Limit Value.

Test Mode	BLE 5.1 (2 Mbps)	Test Date	2024/4/12
Test Frequency	2480MHz	Polarization	Vertical

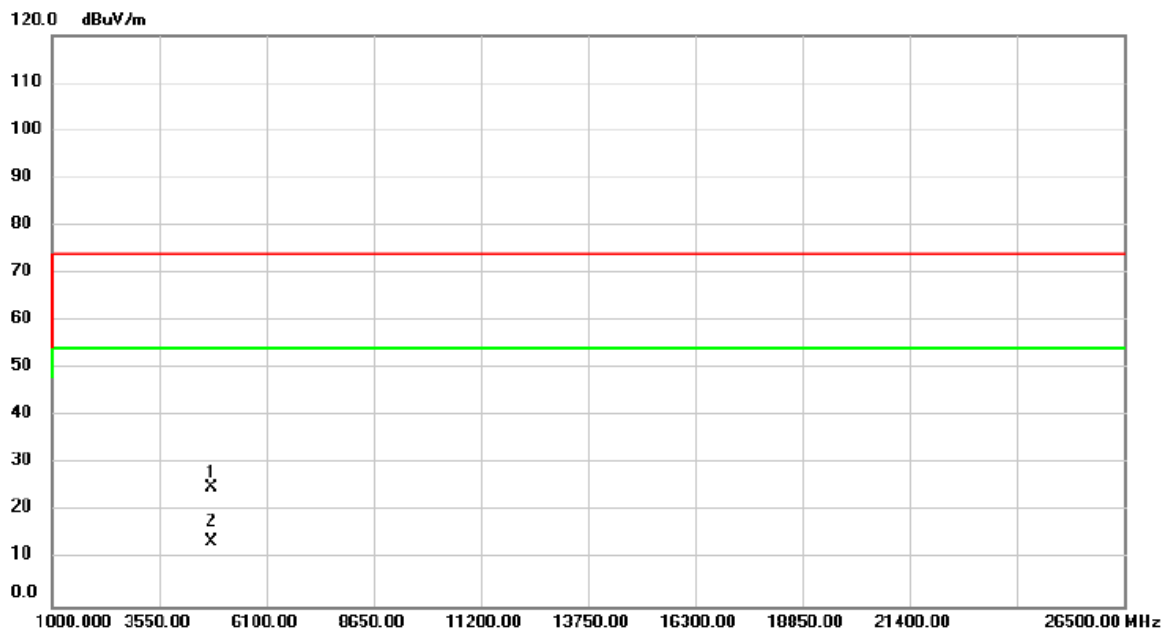


No.	Mk.	Freq. MHz	Reading Level dBuV	Correct Factor dB	Measure- ment dBuV/m	Limit dBuV/m	Margin dB	Antenna Height cm	Table Degree	Comment
1		2389.800	38.20	2.99	41.19	74.00	-32.81	peak		
2		2389.800	25.45	2.99	28.44	54.00	-25.56	AVG		
3	X	2479.800	76.68	3.12	79.80	74.00	5.80	peak		No Limit
4	*	2479.800	75.98	3.12	79.10	54.00	25.10	AVG		No Limit
5		2576.000	39.14	3.41	42.55	74.00	-31.45	peak		
6		2576.000	25.42	3.41	28.83	54.00	-25.17	AVG		

REMARKS:

- (1) Measurement Value = Reading Level + Correct Factor.
- (2) Margin Level = Measurement Value - Limit Value.

Test Mode	BLE 5.1 (1 Mbps)	Test Date	2023/12/28
Test Frequency	2402MHz	Polarization	Vertical

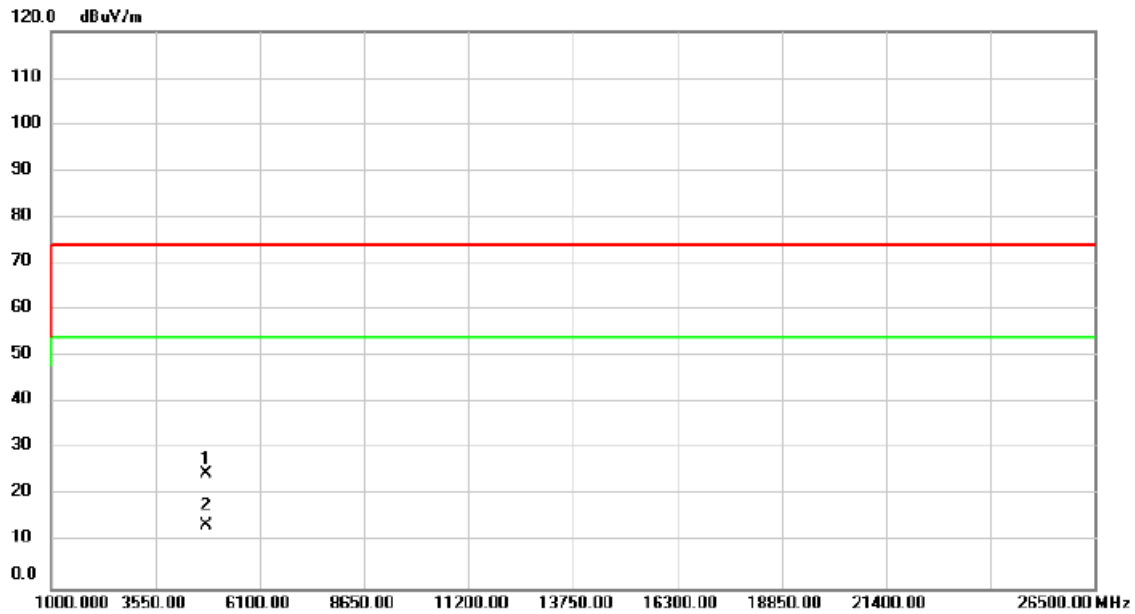


No.	Mk.	Freq.	Reading Level	Correct Factor	Measurement	Limit	Margin	Antenna Height	Table Degree	
		MHz	dBuV	dB	dBuV/m	dBuV/m	dB	cm	degree	Comment
1		4804.000	33.57	-8.62	24.95	74.00	-49.05	peak		
2	*	4804.000	22.14	-8.62	13.52	54.00	-40.48	AVG		

REMARKS:

- (1) Measurement Value = Reading Level + Correct Factor.
- (2) Margin Level = Measurement Value - Limit Value.

Test Mode	BLE 5.1 (1 Mbps)	Test Date	2023/12/28
Test Frequency	2402MHz	Polarization	Horizontal

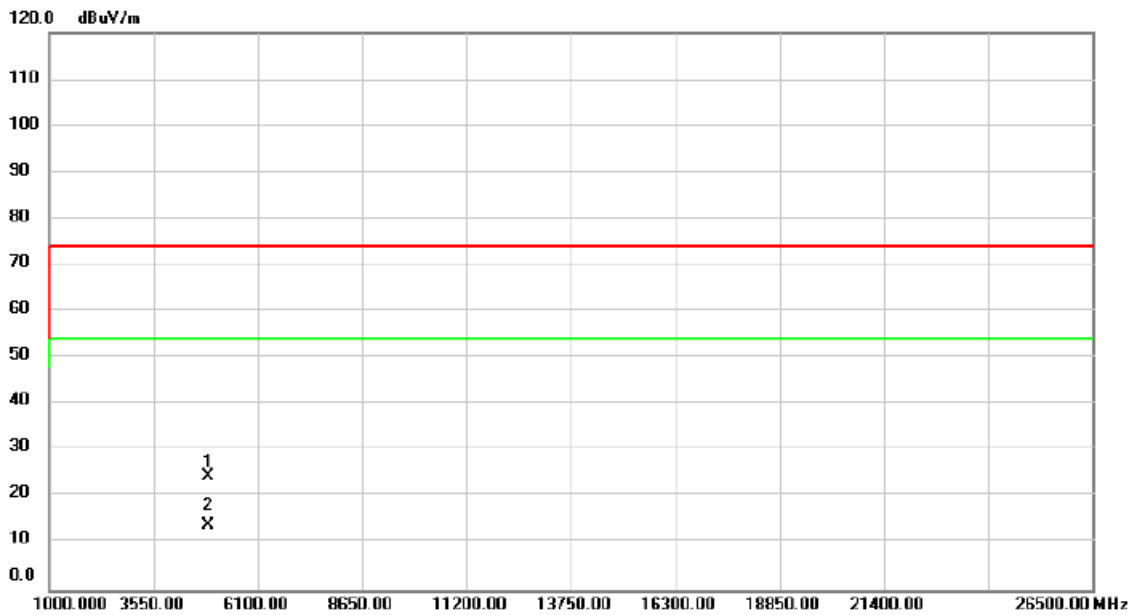


No.	Mk.	Freq.	Reading Level	Correct Factor	Measurement	Limit	Margin	Antenna Height	Table Degree	
		MHz	dBuV	dB	dBuV/m	dBuV/m	dB	Detector	cm	degree
1		4804.000	33.33	-8.62	24.71	74.00	-49.29	peak		
2	*	4804.000	22.15	-8.62	13.53	54.00	-40.47	AVG		

REMARKS:

- (1) Measurement Value = Reading Level + Correct Factor.
- (2) Margin Level = Measurement Value - Limit Value.

Test Mode	BLE 5.1 (1 Mbps)	Test Date	2023/12/28
Test Frequency	2440MHz	Polarization	Vertical

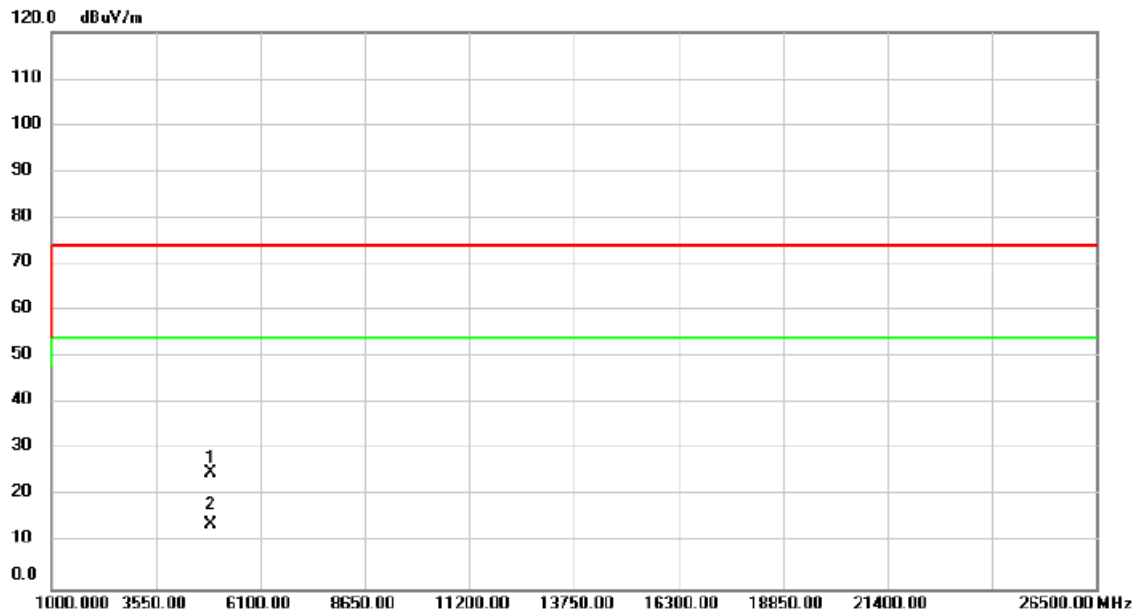


No.	Mk.	Freq.	Reading Level	Correct Factor	Measurement	Limit	Margin	Antenna Height	Table Degree	
		MHz	dBuV	dB	dBuV/m	dBuV/m	dB	Detector	cm	degree
1		4880.000	32.74	-8.43	24.31	74.00	-49.69	peak		
2	*	4880.000	22.31	-8.43	13.88	54.00	-40.12	AVG		

REMARKS:

- (1) Measurement Value = Reading Level + Correct Factor.
- (2) Margin Level = Measurement Value - Limit Value.

Test Mode	BLE 5.1 (1 Mbps)	Test Date	2023/12/28
Test Frequency	2440MHz	Polarization	Horizontal

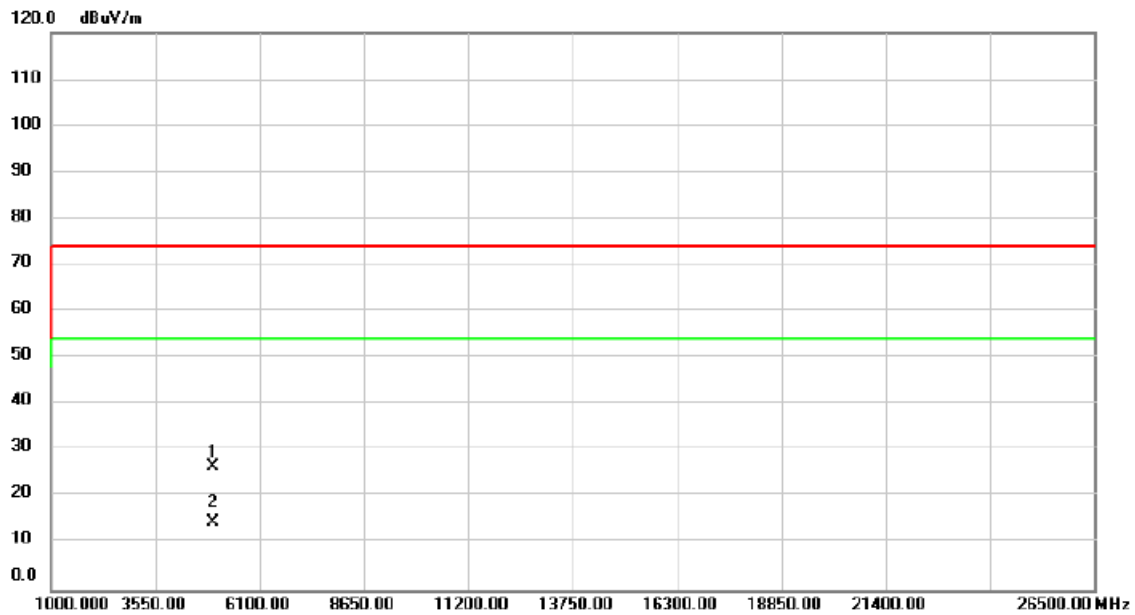


No.	Mk.	Freq.	Reading Level	Correct Factor	Measurement	Limit	Margin	Antenna Height	Table Degree	
		MHz	dBuV	dB	dBuV/m	dBuV/m	dB	Detector	cm	degree
1		4880.000	33.46	-8.43	25.03	74.00	-48.97	peak		
2	*	4880.000	22.45	-8.43	14.02	54.00	-39.98	AVG		

REMARKS:

- (1) Measurement Value = Reading Level + Correct Factor.
- (2) Margin Level = Measurement Value - Limit Value.

Test Mode	BLE 5.1 (1 Mbps)	Test Date	2023/12/28
Test Frequency	2480MHz	Polarization	Vertical

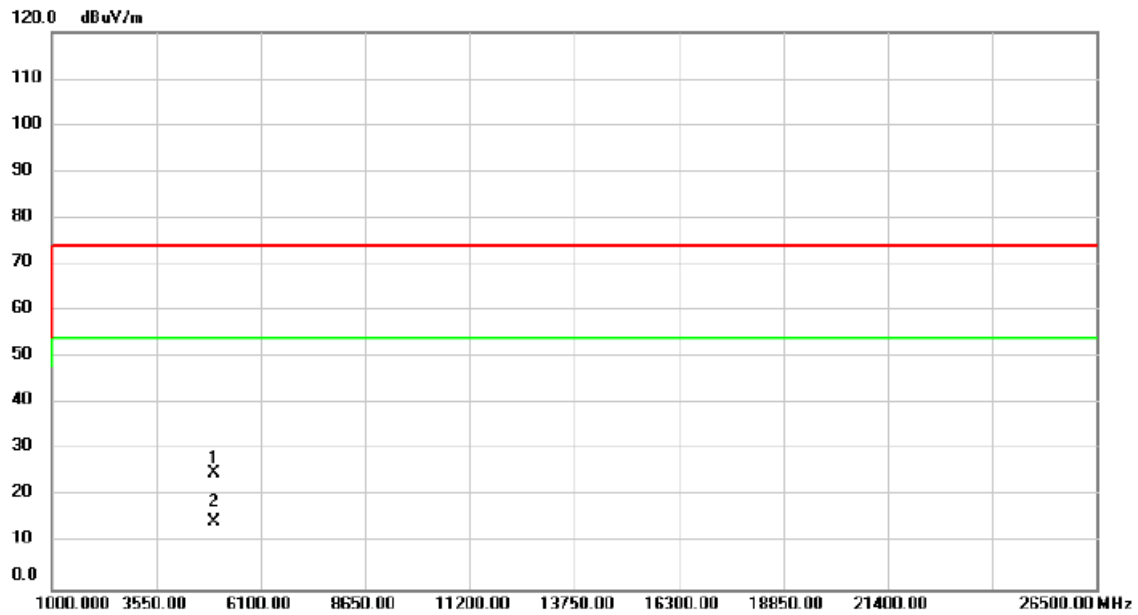


No.	Mk.	Freq.	Reading Level	Correct Factor	Measurement	Limit	Margin	Antenna Height	Table Degree	
		MHz	dBuV	dB	dBuV/m	dBuV/m	dB	Detector	cm	degree
1		4960.000	34.77	-8.23	26.54	74.00	-47.46	peak		
2	*	4960.000	22.76	-8.23	14.53	54.00	-39.47	AVG		

REMARKS:

- (1) Measurement Value = Reading Level + Correct Factor.
- (2) Margin Level = Measurement Value - Limit Value.

Test Mode	BLE 5.1 (1 Mbps)	Test Date	2023/12/28
Test Frequency	2480MHz	Polarization	Horizontal

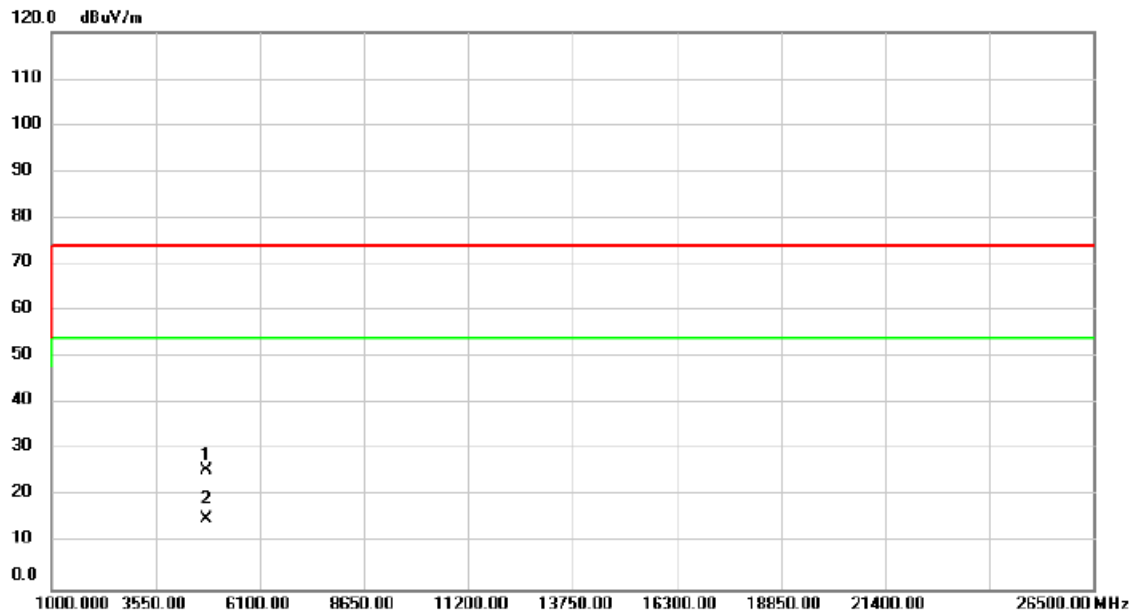


No.	Mk.	Freq.	Reading Level	Correct Factor	Measure-ment	Limit	Margin	Antenna Height	Table Degree	
		MHz	dBuV	dB	dBuV/m	dBuV/m	dB	Detector	cm	degree
1		4960.000	33.29	-8.23	25.06	74.00	-48.94	peak		
2	*	4960.000	22.83	-8.23	14.60	54.00	-39.40	AVG		

REMARKS:

- (1) Measurement Value = Reading Level + Correct Factor.
- (2) Margin Level = Measurement Value - Limit Value.

Test Mode	BLE 5.1 (2 Mbps)	Test Date	2023/12/28
Test Frequency	2402MHz	Polarization	Vertical

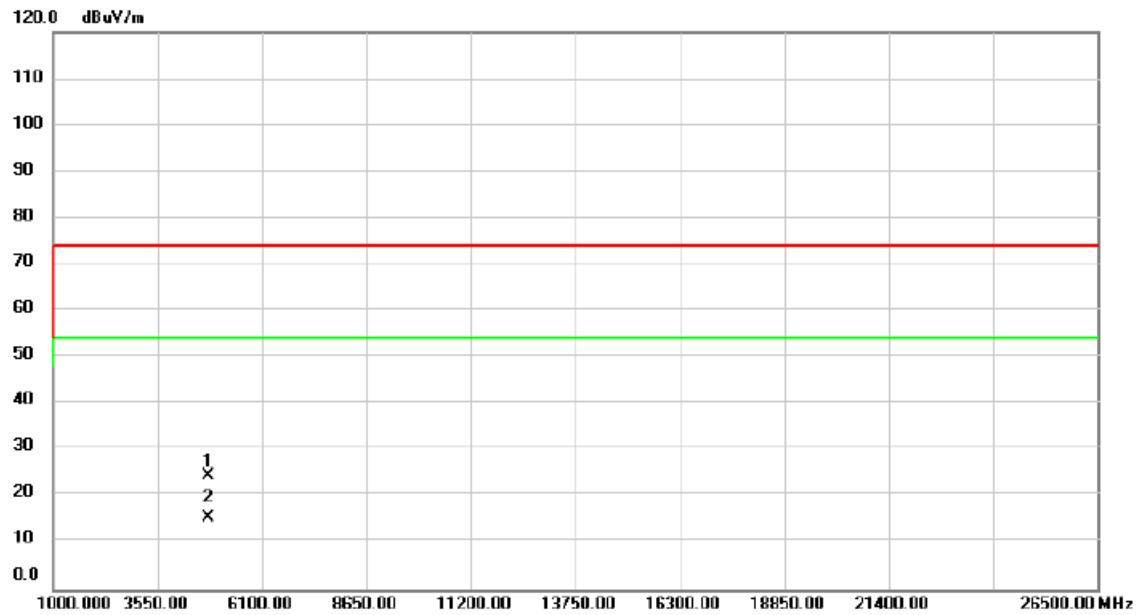


No.	Mk.	Freq.	Reading Level	Correct Factor	Measurement	Limit	Margin	Antenna Height	Table Degree	
		MHz	dBuV	dB	dBuV/m	dBuV/m	dB	Detector	cm	degree
1		4804.000	34.41	-8.62	25.79	74.00	-48.21	peak		
2	*	4804.000	23.65	-8.62	15.03	54.00	-38.97	AVG		

REMARKS:

- (1) Measurement Value = Reading Level + Correct Factor.
- (2) Margin Level = Measurement Value - Limit Value.

Test Mode	BLE 5.1 (2 Mbps)	Test Date	2023/12/28
Test Frequency	2402MHz	Polarization	Horizontal

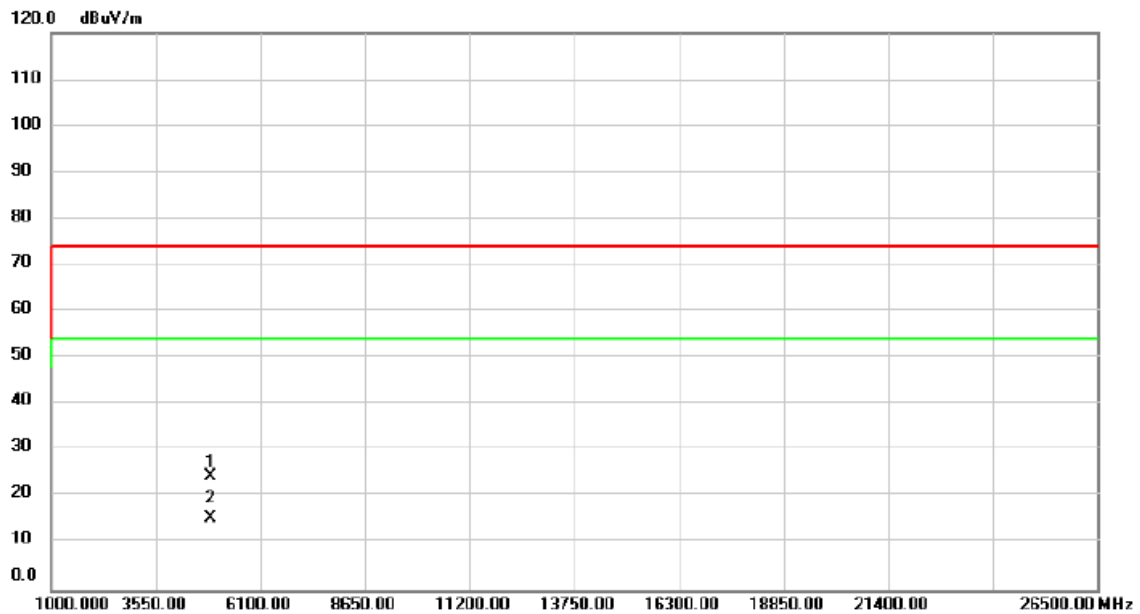


No.	Mk.	Freq.	Reading Level	Correct Factor	Measurement	Limit	Margin	Antenna Height	Table Degree	
		MHz	dBuV	dB	dBuV/m	dBuV/m	dB	Detector	cm	degree
1		4804.000	33.05	-8.62	24.43	74.00	-49.57	peak		
2	*	4804.000	23.99	-8.62	15.37	54.00	-38.63	AVG		

REMARKS:

- (1) Measurement Value = Reading Level + Correct Factor.
- (2) Margin Level = Measurement Value - Limit Value.

Test Mode	BLE 5.1 (2 Mbps)	Test Date	2023/12/28
Test Frequency	2440MHz	Polarization	Vertical

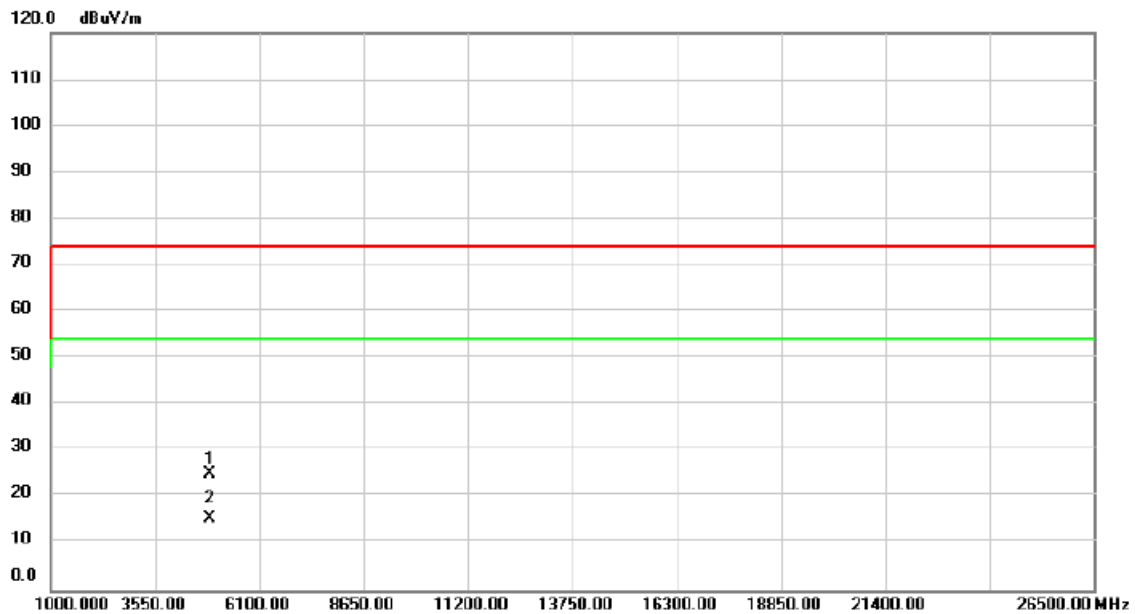


No.	Mk.	Freq.	Reading Level	Correct Factor	Measurement	Limit	Margin	Antenna Height	Table Degree	
		MHz	dBuV	dB	dBuV/m	dBuV/m	dB	Detector	cm	degree
1		4880.000	32.78	-8.43	24.35	74.00	-49.65	peak		
2	*	4880.000	23.82	-8.43	15.39	54.00	-38.61	AVG		

REMARKS:

- (1) Measurement Value = Reading Level + Correct Factor.
- (2) Margin Level = Measurement Value - Limit Value.

Test Mode	BLE 5.1 (2 Mbps)	Test Date	2023/12/28
Test Frequency	2440MHz	Polarization	Horizontal

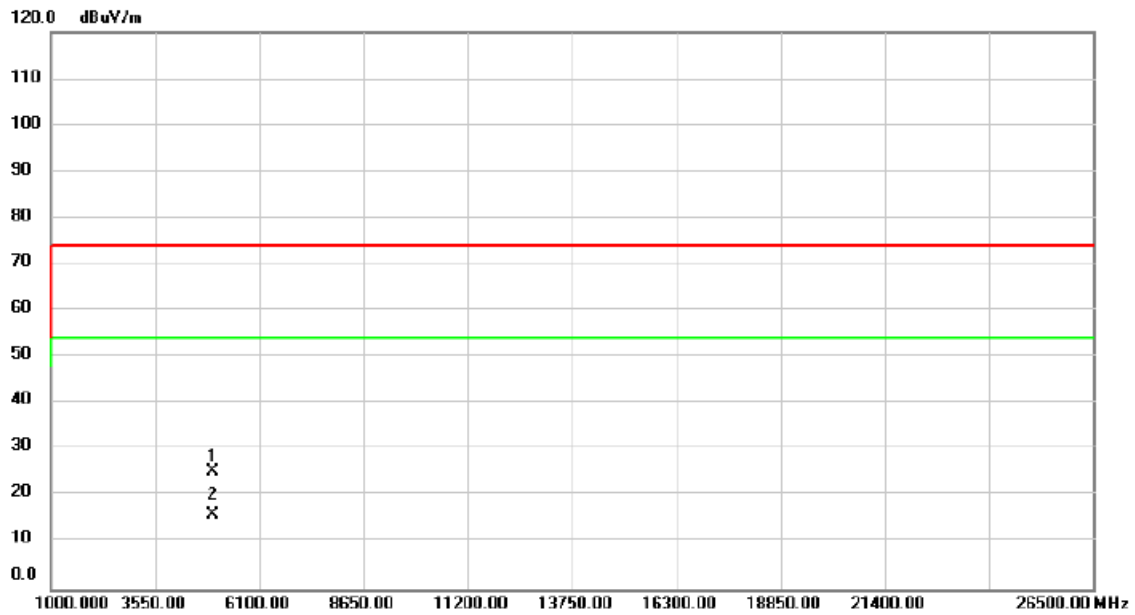


No.	Mk.	Freq.	Reading Level	Correct Factor	Measurement	Limit	Margin	Antenna Height	Table Degree	
		MHz	dBuV	dB	dBuV/m	dBuV/m	dB	Detector	cm	degree
1		4880.000	33.52	-8.43	25.09	74.00	-48.91	peak		
2	*	4880.000	23.99	-8.43	15.56	54.00	-38.44	AVG		

REMARKS:

- (1) Measurement Value = Reading Level + Correct Factor.
- (2) Margin Level = Measurement Value - Limit Value.

Test Mode	BLE 5.1 (2 Mbps)	Test Date	2023/12/28
Test Frequency	2480MHz	Polarization	Vertical

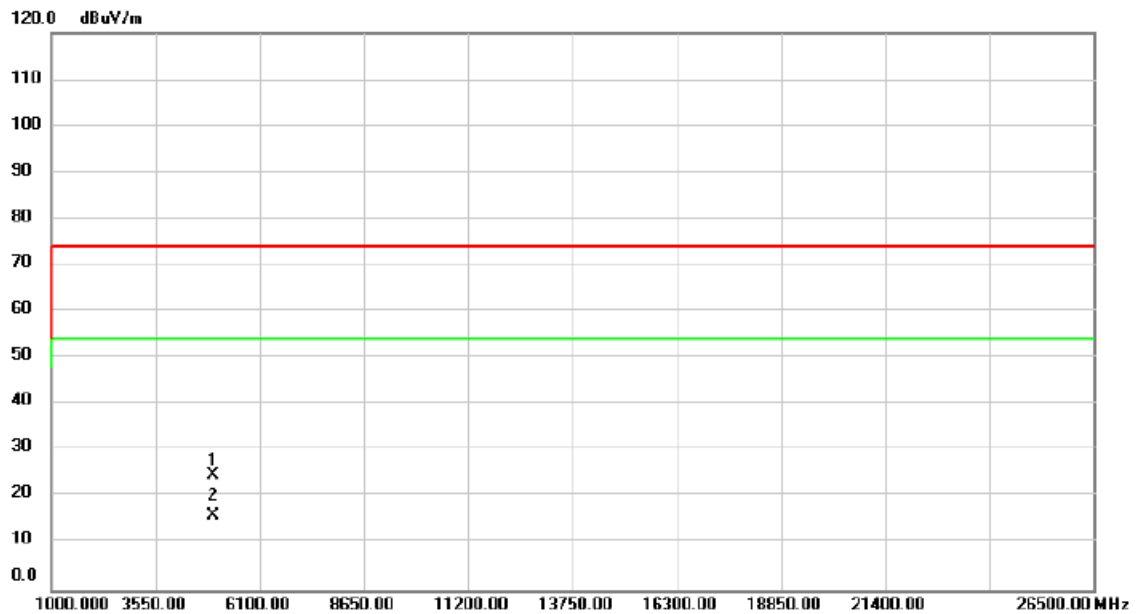


No.	Mk.	Freq.	Reading Level	Correct Factor	Measurement	Limit	Margin	Antenna Height	Table Degree	
		MHz	dBuV	dB	dBuV/m	dBuV/m	dB	Detector	cm	degree
1		4960.000	33.44	-8.23	25.21	74.00	-48.79	peak		
2	*	4960.000	24.43	-8.23	16.20	54.00	-37.80	AVG		

REMARKS:

- (1) Measurement Value = Reading Level + Correct Factor.
- (2) Margin Level = Measurement Value - Limit Value.

Test Mode	BLE 5.1 (2 Mbps)	Test Date	2023/12/28
Test Frequency	2480MHz	Polarization	Horizontal



No.	Mk.	Freq.	Reading Level	Correct Factor	Measurement	Limit	Margin	Antenna Height	Table Degree	
		MHz	dBuV	dB	dBuV/m	dBuV/m	dB	Detector	cm	degree
1		4960.000	32.98	-8.23	24.75	74.00	-49.25	peak		
2	*	4960.000	24.38	-8.23	16.15	54.00	-37.85	AVG		

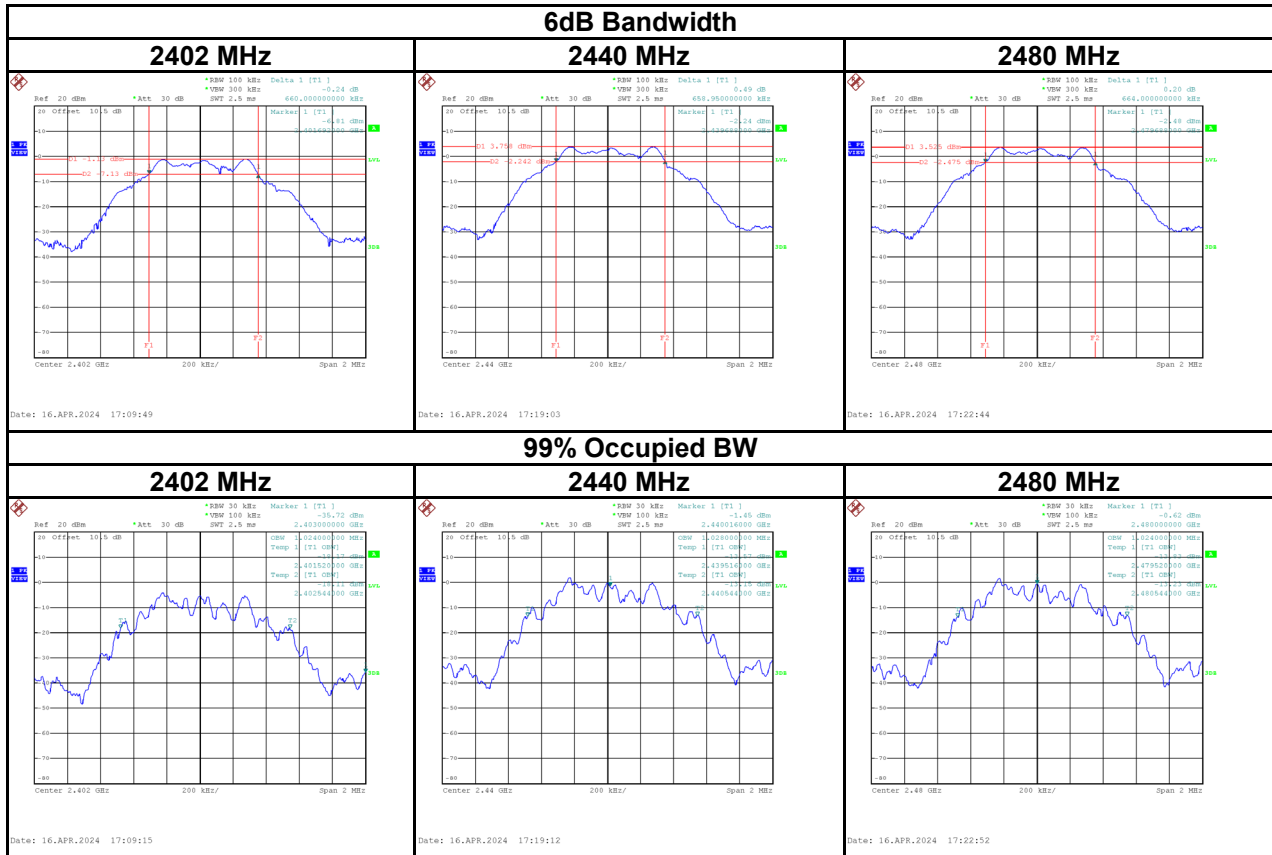
REMARKS:

- (1) Measurement Value = Reading Level + Correct Factor.
- (2) Margin Level = Measurement Value - Limit Value.

APPENDIX D BANDWIDTH

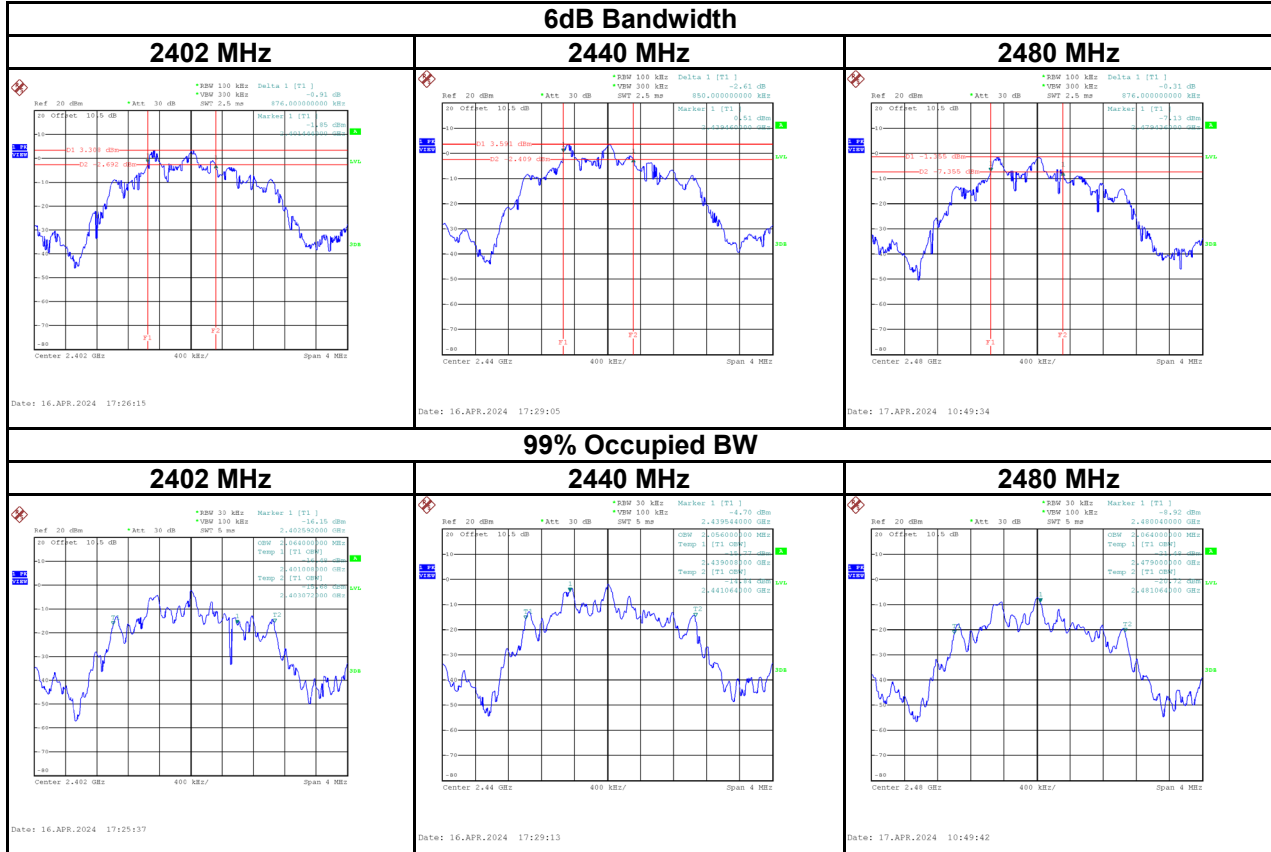
Test Mode:	1Mbps
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Frequency (MHz)	6dB Bandwidth (MHz)	99% Occupied BW (MHz)	Min. Limit (kHz)	Test Result
2402	0.660	1.024	500	Pass
2440	0.659	1.028	500	Pass
2480	0.664	1.024	500	Pass



Test Mode:	2Mbps
------------	-------

Frequency (MHz)	6dB Bandwidth (MHz)	99% Occupied BW (MHz)	Min. Limit (kHz)	Test Result
2402	0.876	2.064	500	Pass
2440	0.850	2.056	500	Pass
2480	0.876	2.064	500	Pass



APPENDIX E MAXIMUM OUTPUT POWER

Test Mode :	1Mbps	Tested Date	2024/4/16
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Frequency (MHz)	Conducted Power (dBm)	Conducted Power (W)	Max. Limit (dBm)	Max. Limit (W)	Test Result
2402	5.54	0.0036	30.00	1.0000	Pass
2440	6.82	0.0048	30.00	1.0000	Pass
2480	3.30	0.0021	30.00	1.0000	Pass

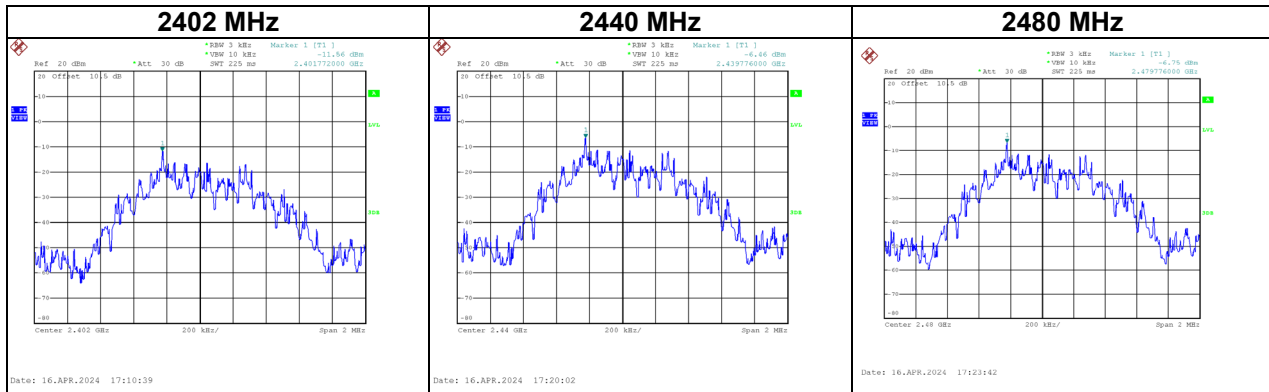
Test Mode :	2Mbps	Tested Date	2024/4/16
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Frequency (MHz)	Conducted Power (dBm)	Conducted Power (W)	Max. Limit (dBm)	Max. Limit (W)	Test Result
2402	4.81	0.0030	30.00	1.0000	Pass
2440	6.17	0.0041	30.00	1.0000	Pass
2480	2.71	0.0019	30.00	1.0000	Pass

APPENDIX F POWER SPECTRAL DENSITY TEST

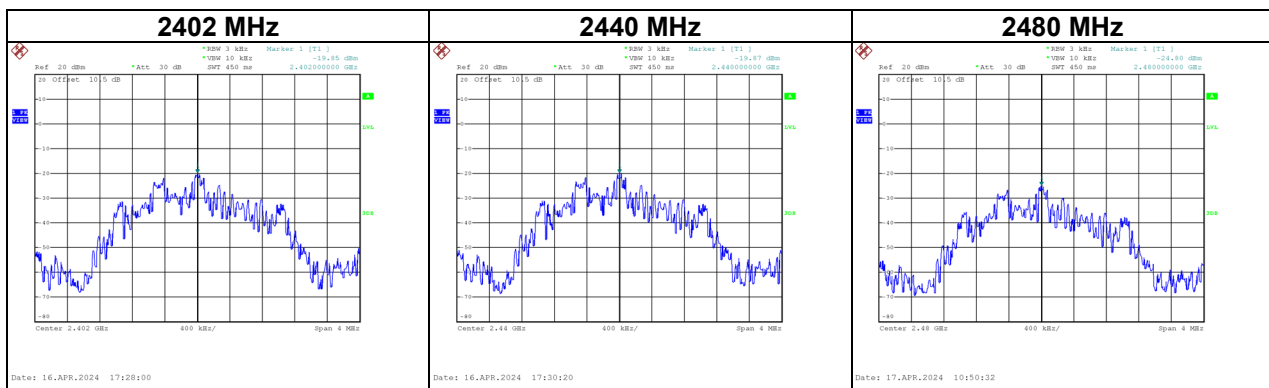
Test Mode :	1Mbps
-------------	-------

Frequency (MHz)	Power Density (dBm/3kHz)	Max. Limit (dBm/3kHz)	Test Result
2402	-11.56	8	Pass
2440	-6.46	8	Pass
2480	-6.75	8	Pass



Test Mode :	2Mbps
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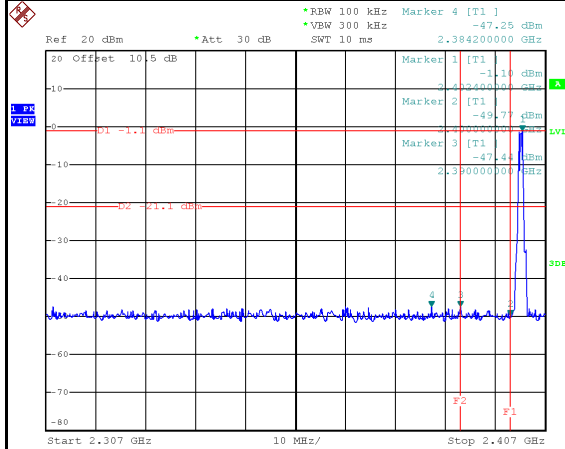
Frequency (MHz)	Power Density (dBm/3kHz)	Max. Limit (dBm/3kHz)	Test Result
2402	-19.85	8	Pass
2440	-19.87	8	Pass
2480	-24.80	8	Pass



APPENDIX G ANTENNA CONDUCTED SPURIOUS EMISSION

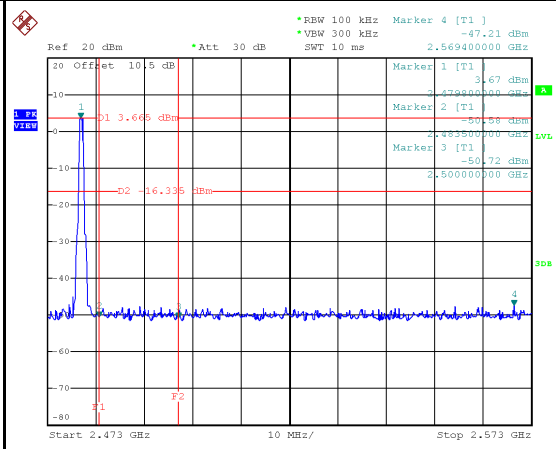
Test Mode : 1Mbps

Low Bandedge-2402 MHz



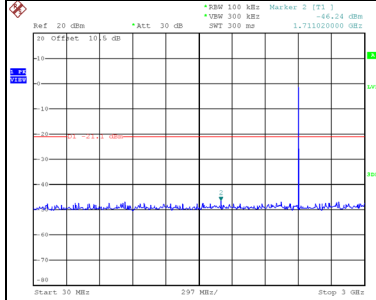
Date: 16.APR.2024 17:09:58

High Bandedge-2480 MHz

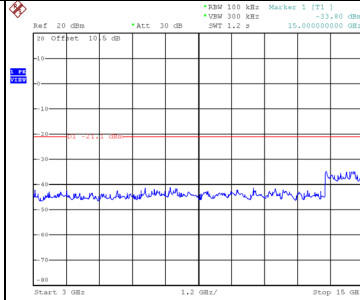


Date: 16.APR.2024 17:23:01

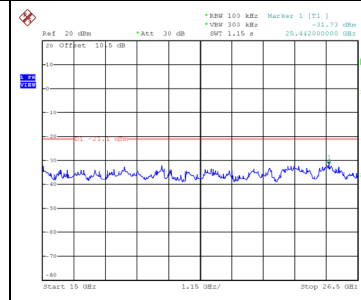
2402 MHz – 10th Harmonics



Date: 16.APR.2024 17:10:13

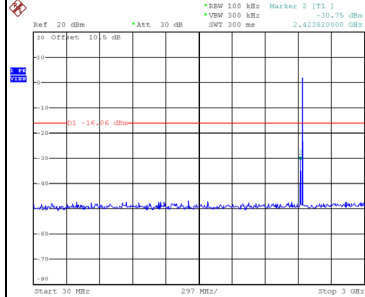


Date: 16.APR.2024 17:10:22

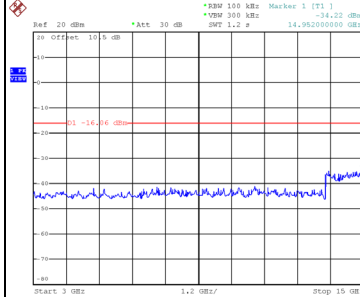


Date: 16.APR.2024 17:10:32

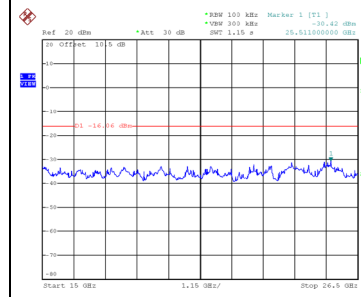
2440 MHz – 10th Harmonics



Date: 16.APR.2024 17:19:36

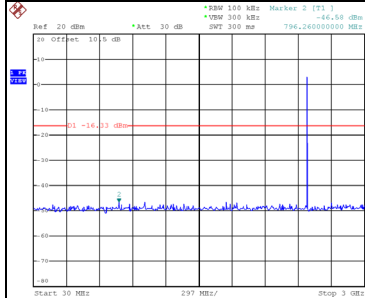


Date: 16.APR.2024 17:19:45

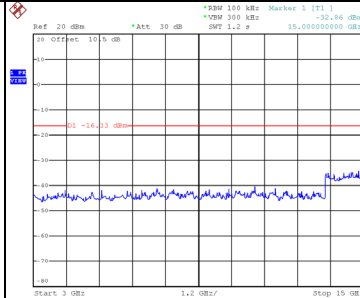


Date: 16.APR.2024 17:19:54

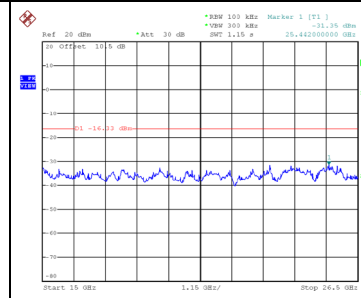
2480 MHz – 10th Harmonics



Date: 16.APR.2024 17:23:16



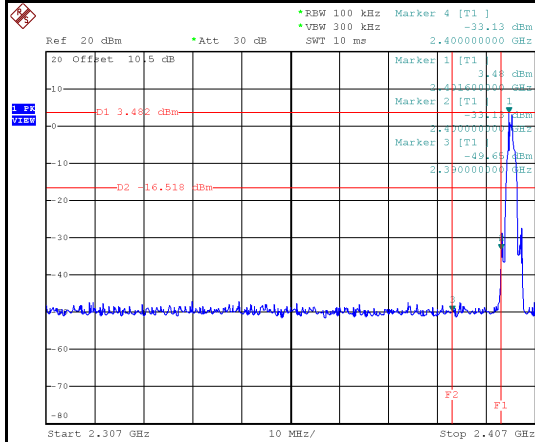
Date: 16.APR.2024 17:23:26



Date: 16.APR.2024 17:23:35

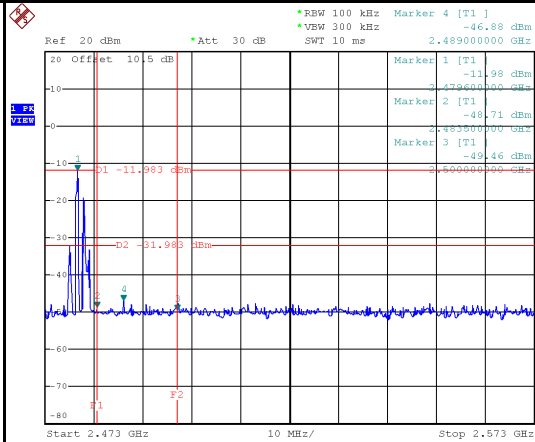
Test Mode : 2Mbps

Low Bandedge-2402 MHz



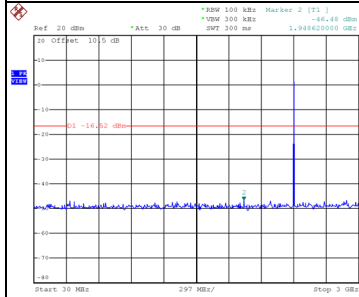
Date: 16.APR.2024 17:26:24

High Bandedge-2480 MHz

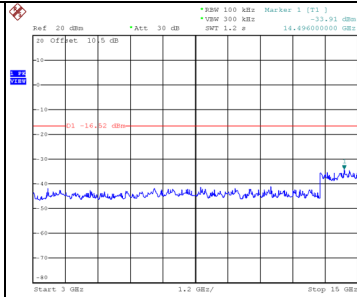


Date: 17.APR.2024 10:49:51

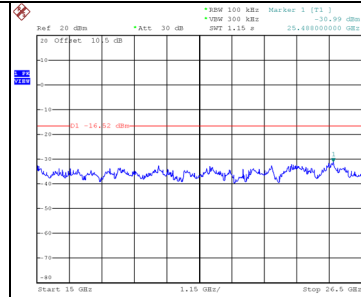
2402 MHz – 10th Harmonics



Date: 16.APR.2024 17:26:40

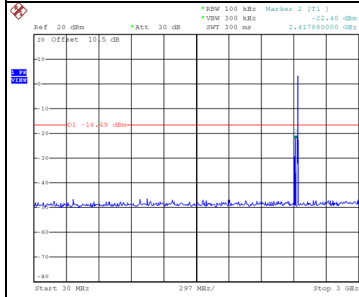


Date: 16.APR.2024 17:26:49

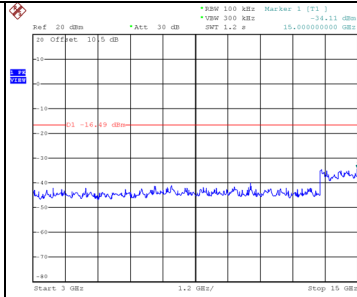


Date: 16.APR.2024 17:26:58

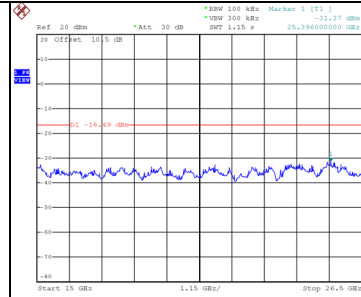
2440 MHz – 10th Harmonics



Date: 16.APR.2024 17:29:53

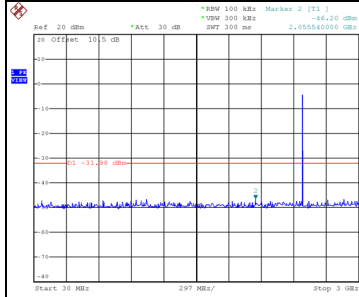


Date: 16.APR.2024 17:30:03

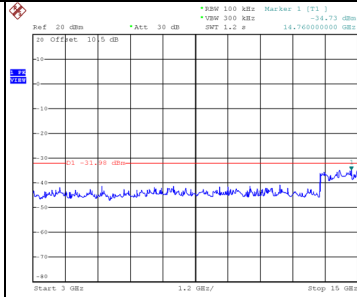


Date: 16.APR.2024 17:30:12

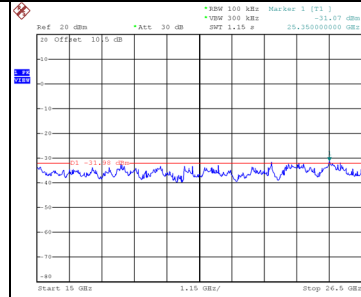
2480 MHz – 10th Harmonics



Date: 17.APR.2024 10:50:06



Date: 17.APR.2024 10:50:15



Date: 17.APR.2024 10:50:24

End of Test Report