FCC AND ISED CERTIFICATION TEST REPORT

Applicant	:	Klein Tools Inc.
Address of Applicant	:	450 Bond Street Lincolnshire IL, 60069 USA
Manufacturer	:	Klein Tools Inc.
Address of Manufacturer	:	450 Bond Street Lincolnshire IL, 60069 USA
Equipment under Test	:	Hardhat Bluetooth Speaker
Model No.	:	AEPHS1
FCC ID	:	2AI28-AEPHS1
IC	:	21655-AEPHS1
Test Standard(s)	:	FCC Rules and Regulations Part 15 Subpart C, RSS-247 Issue 3 August 2023, ANSI C63.10:2013, RSS-Gen Issue 5, Apr. 2018, Amendment 2 (February 2021)
Report No.	:	DDT-RE24053007-1E01
Issue Date	:	2024/07/19
Issue By	:	Guangdong Dongdian Testing Service Co., Ltd. Unit 2, Building 1, No. 17, Zongbu 2nd Road, Songshan Lake Park, Dongguan, Guangdong, China, 523808

REPORT

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Test Report Declare

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Equipment under Test	:	Hardhat Bluetooth Speaker
Model No.	:	AEPHS1
Manufacturer	:	Klein Tools Inc.
Address of Manufacturer	:	450 Bond Street Lincolnshire IL, 60069 USA

Test Standard Used:

FCC Rules and Regulations Part 15 Subpart C,
RSS-247 Issue 3 August 2023,
ANSI C63.10:2013,
RSS-Gen Issue 5, Apr. 2018, Amendment 2 (February 2021)

We Declare:

The equipment described above is tested by Guangdong Dongdian Testing Service Co., Ltd. and in the configuration tested the equipment complied with the standards specified above. The test results are contained in this test report and Guangdong Dongdian Testing Service Co., Ltd. is assumed of full responsibility for the accuracy and completeness of these tests.

Report No.:	DDT-RE24053007-1E01		
Date of Receipt:	2024/06/17	**Date of Test:**	2024/06/17~2024/07/19

Prepared By: **Approved By:**

Ziqin Chen Damon Hu

Ziqin Chen/Engineer **Damon Hu/EMC Manager**

Note: This report applies to above tested sample only. This report shall not be reproduced in parts without written approval of Guangdong Dongdian Testing Service Co., Ltd.

Revision History

Rev.	Revisions	Issue Date	Revised By
---	Initial issue	2024/07/19	

1. Summary of Test Results

No.	Test Parameter	Clause No.	Condition	Result
1	Maximum Peak Output Power	FCC Part 15: 15.247(b)(1), RSS-247 Issue 3 clause 5.4(b)	/	Pass
2	20 dB Bandwidth	FCC Part 15: 15.247(a)(1), RSS-247 Issue 3 clause 5.1(a)	/	Pass
3	99% Bandwidth	RSS-Gen Issue 5 clause 6.7	/	Pass
4	Carrier Frequency Separation	FCC Part 15: 15.247(a)(1), RSS-247 Issue 3 clause 5.1(b)	/	Pass
5	Number of Hopping Channel	FCC Part 15: 15.247(a)(1)(iii), RSS-247 Issue 3 clause 5.1(d)	/	Pass
6	Dwell Time	FCC Part 15: 15.247(a)(1)(iii), RSS-247 Issue 3 clause 5.1(d)	/	Pass
7	RF Conducted Spurious Emissions	FCC Part 15: 15.247(d), RSS-247 Issue 3 clause 5.5	/	Pass
8	Radiated Emission	FCC Part 15: 15.205, FCC Part 15: 15.209, FCC Part 15: 15.247(d), RSS-247 Issue 3 clause 5.5, RSS-Gen Issue 5 clause 8.9, RSS-Gen Issue 5 clause 8.10	/	Pass
9	Band Edge Compliance	FCC Part 15: 15.205, FCC Part 15: 15.209, FCC Part 15: 15.247(d), RSS-247 Issue 3 clause 5.5, RSS-Gen Issue 5 clause 8.9, RSS-Gen Issue 5 clause 8.10	/	Pass
10	Power Line Conducted Emissions	FCC Part 15: 15.207(a), RSS-Gen Issue 5 clause 8.8	/	Pass
11	Antenna Requirement	FCC Part 15: 15.203, RSS-Gen Issue 5 clause 6.8	/	Pass
Note: N/A is an abbreviation for Not Applicable, and means this item is not applicable for this device or no need to test according to standard.				

2. General Test Information

2.1. Description of EUT

EUT Name	:	Hardhat Bluetooth Speaker
Model Number	:	AEPHS1
Difference of model number	:	/
EUT Function Description	:	Please reference user manual of this device
Power Supply	:	Input: 5V ⎓ 1A (via type-C port) Internal Li-ion Polymer battery: 3.8Vdc, 250mAh, 0.95Wh
Hardware Version	:	V1.3
Software Version	:	V1.0.0.7

Note: This EUT support Bluetooth BR/EDR/LE, this report only for Bluetooth BR/EDR.

Radio Specification	:	Bluetooth BR/EDR
Operation Frequency	:	2402 MHz-2480 MHz
Modulation	:	GFSK, π/4-DQPSK, 8DPSK

Antenna information		
Antenna Type	:	Chip Antenna
Max Antenna Gain(dBi)	:	1.24

Channel information

Channel	Frequency (MHz)	Channel	Frequency (MHz)	Channel	Frequency (MHz)
0	2402	27	2429	54	2456
1	2403	28	2430	55	2457
2	2404	29	2431	56	2458
3	2405	30	2432	57	2459
4	2406	31	2433	58	2460
5	2407	32	2434	59	2461
6	2408	33	2435	60	2462
7	2409	34	2436	61	2463
8	2410	35	2437	62	2464
9	2411	36	2438	63	2465
10	2412	37	2439	64	2466
11	2413	38	2440	65	2467
12	2414	39	2441	66	2468
13	2415	40	2442	67	2469
14	2416	41	2443	68	2470
15	2417	42	2444	69	2471
16	2418	43	2445	70	2472
17	2419	44	2446	71	2473

18	2420	45	2447	72	2474
19	2421	46	2448	73	2475
20	2422	47	2449	74	2476
21	2423	48	2450	75	2477
22	2424	49	2451	76	2478
23	2425	50	2452	77	2479
24	2426	51	2453	78	2480
25	2427	52	2454		
26	2428	53	2455		

Note: The above EUT information is declared by manufacturer and for more detailed features description please refer to the manufacturer's specifications or User's Manual. The above Antenna information is declared by manufacturer and for more detailed features description please refer to the manufacturer's specifications, the laboratory shall not be held responsible.

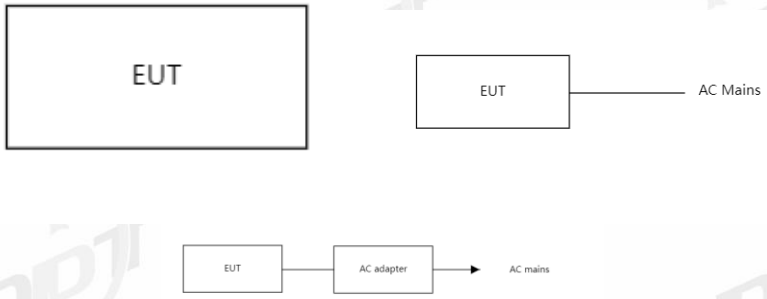
“☒” means to be chosen or applicable; “□” means don’t to be chosen or not applicable; This note applies to entire report.

2.2. Accessories of EUT

Accessories	Manufacturer	Model number	Description
/	/	/	/

2.3. Block diagram of EUT configuration for test

Configuration diagram



2.4. Decision of final test mode

According pre-test, the worst test modes were reported as below:

Test software: BK32xx RF Test_V1.8.2.exe

The test software was used to control EUT work in Continuous Tx mode, and select test channel, wireless mode as below table.

The pathloss of external cable: 0.5 dB (According to the manufacturer's claims)

Tested mode, channel, information			
Mode	Setting Tx Power	Channel	Frequency (MHz)
GFSK hopping on Tx mode	1	CH0 to CH78	2402 to 2480
π/4-DQPSK hopping on Tx mode	1	CH0 to CH78	2402 to 2480
8DPSK hopping on Tx mode	1	CH0 to CH78	2402 to 2480
GFSK hopping off Tx mode	1	CH0	2402
	1	CH39	2441
	1	CH78	2480
π/4-DQPSK hopping off Tx mode	1	CH0	2402
	1	CH39	2441
	1	CH78	2480
8DPSK hopping off Tx mode	1	CH0	2402
	1	CH39	2441
	1	CH78	2480
Worst-case data rates were: GFSK mode: DH5, π/4-DQPSK mode: 2DH5, 8DPSK mode: 3DH5			

2.5. Deviations of test standard

No deviation.

2.6. Test environment conditions

During the measurement the environmental conditions were within the listed ranges:

Temperature range:	+15℃ to +35 ℃
Humidity range:	20% to 75%
Pressure range:	86 kPa to106 kPa

Note: The specific temperature and humidity information of each test item refers to the temperature and humidity record in the corresponding test data.

2.7. Test laboratory

Guangdong Dongdian Testing Service Co., Ltd.
Add.: Unit 2, Building 1, No. 17, Zongbu 2nd Road, Songshan Lake Park, Dongguan, Guangdong, China, 523808.
Tel.: +86-0769-38826678, http://www.dgddt.com, Email: ddt@dgddt.com.

CNAS Accreditation No. L6451; A2LA Accreditation Number: 3870.01
FCC Designation Number: CN1182, Test Firm Registration Number: 540522
Innovation, Science and Economic Development Canada Site Registration Number: 10288A
Conformity Assessment Body identifier: CN0048
VCCI facility registration number: C-20087, T-20088, R-20123, R-20155, G-20118

2.8. Measurement uncertainty

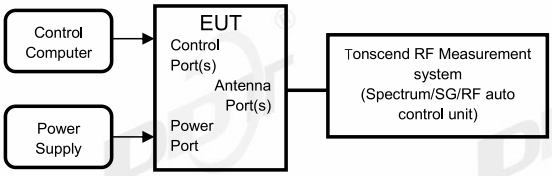
Test Item	Uncertainty
Bandwidth	1.1%
Peak Output Power (Conducted) (Spectrum analyzer)	0.86 dB (10 MHz ≤ f < 3.6 GHz);
	1.38 dB (3.6 GHz ≤ f < 8 GHz)
Peak Output Power (Conducted) (Power Sensor)	0.74 dB
Power Spectral Density	0.74 dB (10 MHz ≤ f < 3.6 GHz);
	1.38 dB (3.6 GHz ≤ f < 8 GHz)
Frequencies Stability	6.7 x 10^{-8} (Antenna couple method)
	5.5 x 10^{-8} (Conducted method)
Conducted spurious emissions	0.86 dB (10 MHz ≤ f < 3.6 GHz);
	1.40 dB (3.6 GHz ≤ f < 8 GHz)
	1.66 dB (8 GHz ≤ f < 26.5 GHz)
Uncertainty for radio frequency (RBW < 20 kHz)	3×10^{-8}
Temperature	0.4 ℃
Humidity	2 %
Uncertainty for Radiation Emission test (9 kHz – 30 MHz)	3.44 dB
Uncertainty for Radiation Emission test (30 MHz - 1 GHz)	4.70 dB (Antenna Polarize: V)
	4.84 dB (Antenna Polarize: H)
Uncertainty for Radiation Emission test (1 GHz - 40 GHz)	4.10 dB (1 - 6 GHz)
	4.40 dB (6 GHz - 18 GHz)
	3.54 dB (18 GHz - 26 GHz)
	4.30 dB (26 GHz - 40 GHz)
Uncertainty for Power line conduction emission test	3.34dB (150KHz-30MHz)
	3.72dB (9KHz-150KHz)
Note: This uncertainty represents an expanded uncertainty expressed at approximately the 95% confidence level using a coverage factor of k=2.	

3. Equipment Used During Conductive Test

Equipment	Manufacturer	Model No.	Serial Number	Due Date
☒RF Connected Test (RF Measurement System 4#)				
Signal &Spectrum Analyzer	R&S	FSV3044	101173	2025/03/31
Wideband Radio Communication Tester	R&S	CMW500	168801	2025/03/31
MXG Vector Signal Generator	Agilent	N5182A	MY48180737	2025/03/31
PSG Vector Signal Generator	Agilent	E8267D	US49060192	2024/09/05
RF Control Unit	Tonsend	JS0806-2	21I8060485	2025/03/31
TEMP&HUMI Programmable Chamber	ZHIXIANG	ZXGDJS-150L	ZX170110-A	2025/04/22
Test Software	Tonscend	JS1120-3	Ver.3.2.22	N/A

4. 20 dB Bandwidth

4.1. Block diagram of test setup



4.2. Limits

Intentional radiators operating under the alternative provisions to the general emission limits, as contained in § 15.217 through 15.257 and in Subpart E of this part, must be designed to ensure that the 20 dB bandwidth of the emission, or whatever bandwidth may otherwise be specified in the specific rule section under which the equipment operates, is contained within the frequency band designated in the rule section under which the equipment is operated.

4.3. Test procedure

(1) The test according to ANSI C63.10-2013 clause 6.9.2.
(2) Connect EUT's antenna output to spectrum analyzer by RF cable, the path loss was compensated to the results
(3) Set the EUT as maximum power setting and enable the EUT transmit continuously
(4) Use the following spectrum analyzer settings for the 20 dB bandwidth measurement:

RBW:	1% to 5% of the OBW
VBW:	approximately three times RBW
Span:	between 2 times and 5 times the OBW
Detector Mode:	Peak
Sweep time:	Auto
Trace mode:	Max hold

(5) Measure and record the results in the report.

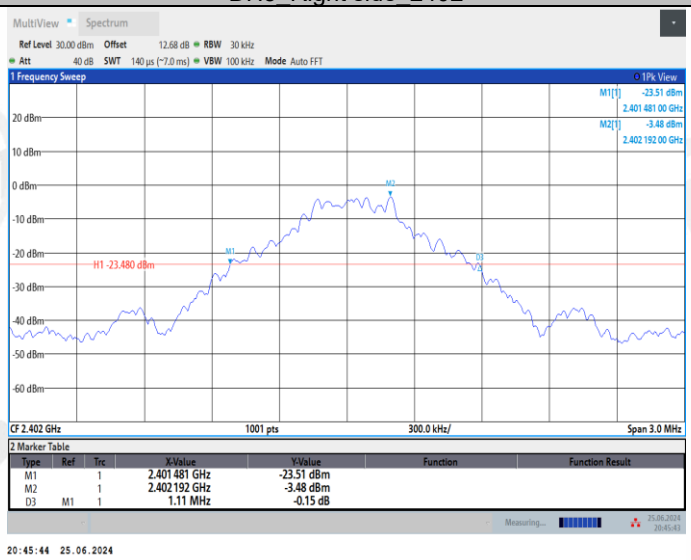
4.4. Test result

Test Engineer:	Zoe	Test Site:	RF Measurement System 4#
Ambient Condition:	25.6-26.1℃,41.8-45.3%RH	Test Date:	2024.06.25-2024.06.26
Test Power Supply:	Battery	Sample Number:	S24053007-001

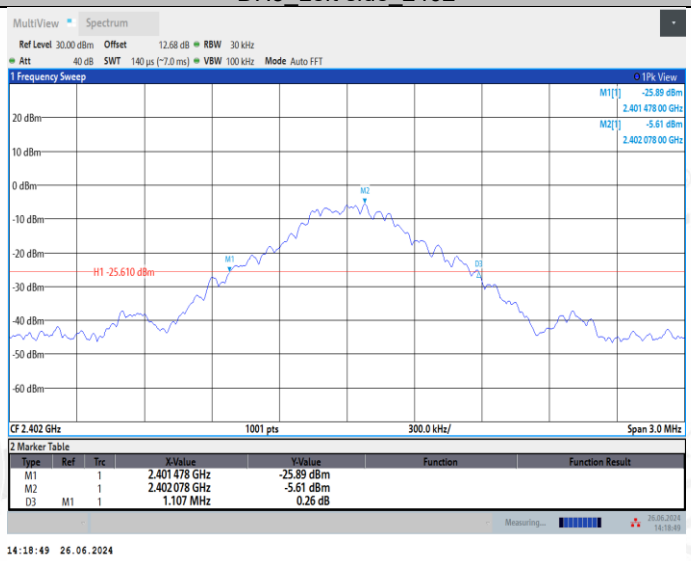
Test Mode	Antenna	Frequency [MHz]	20dB EBW[MHz]
DH5	Right side	2402	1.11
	Left side	2402	1.11
	Right side	2441	1.01
	Left side	2441	1.11
	Right side	2480	1.11
	Left side	2480	1.11
2DH5	Right side	2402	1.32
	Left side	2402	1.35
	Right side	2441	1.32
	Left side	2441	1.33
	Right side	2480	1.28
	Left side	2480	1.33
3DH5	Right side	2402	1.32
	Left side	2402	1.31
	Right side	2441	1.28
	Left side	2441	1.34
	Right side	2480	1.30
	Left side	2480	1.28

4.5. Test graphs

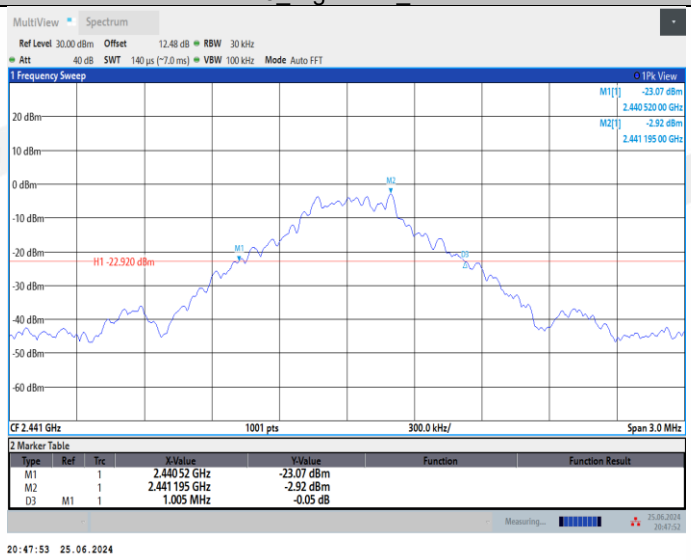
DH5_Right side_2402



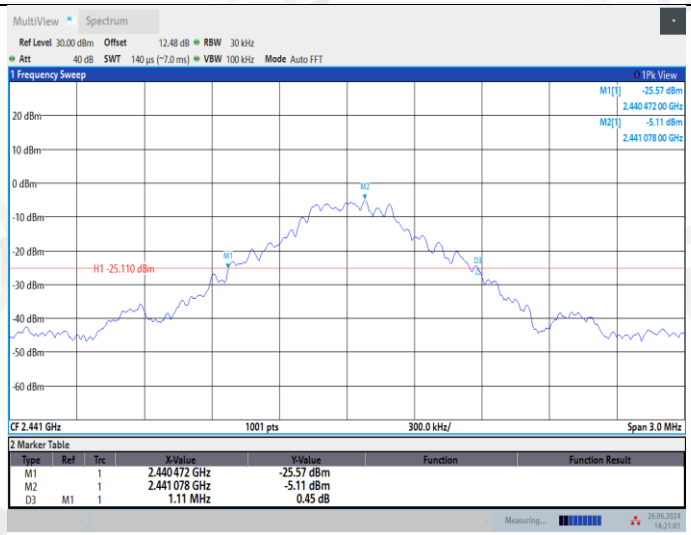
DH5_Left side_2402



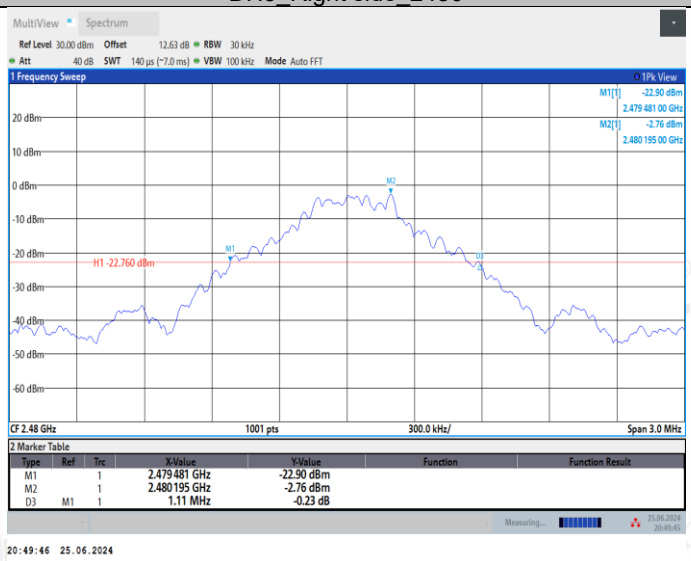
DH5_Right side_2441



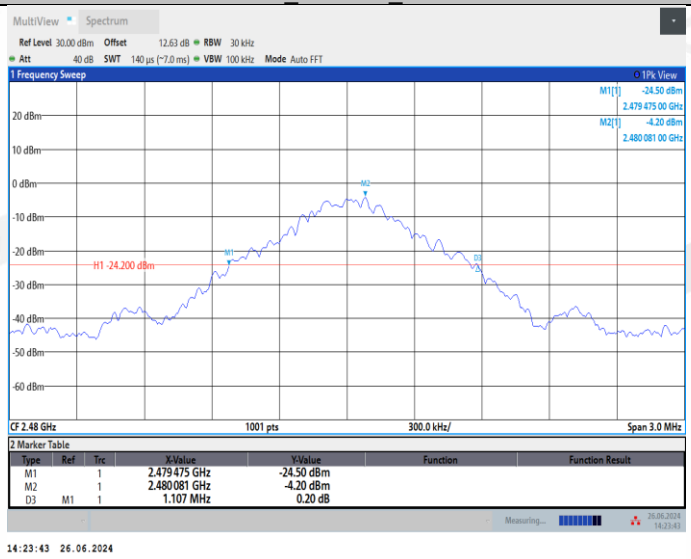
DH5_Left side_2441



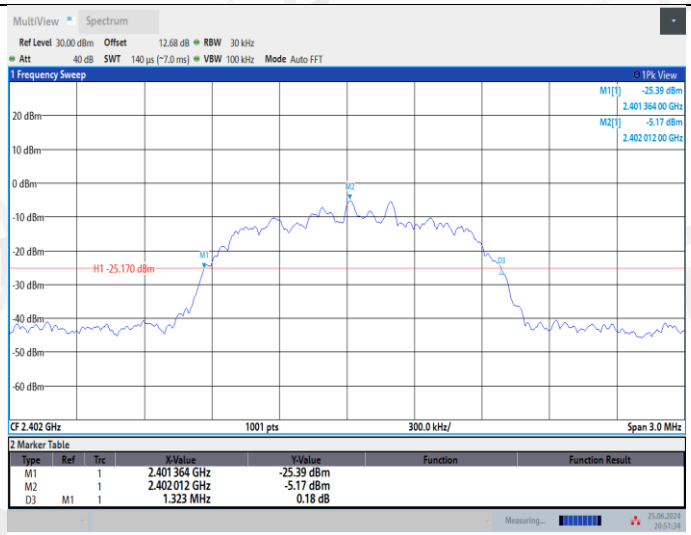
DH5_Right side_2480



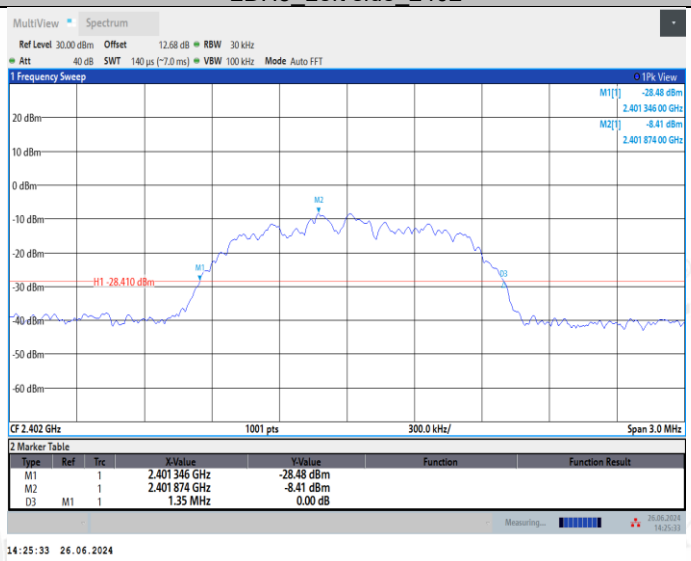
DH5_Left side_2480



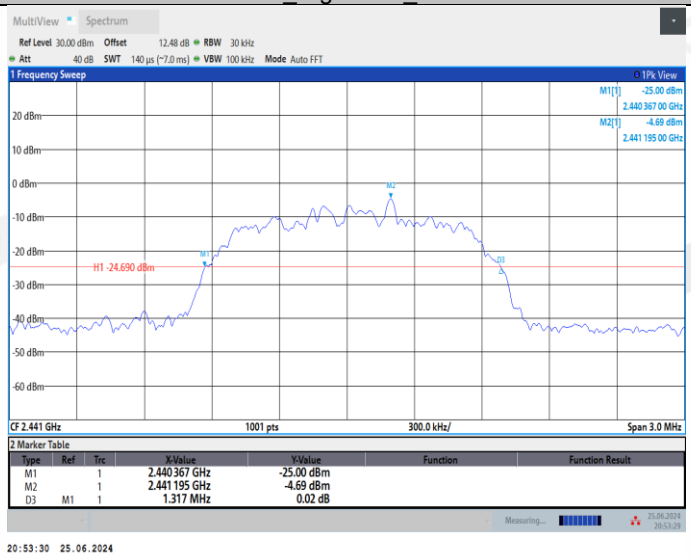
2DH5_Right side_2402



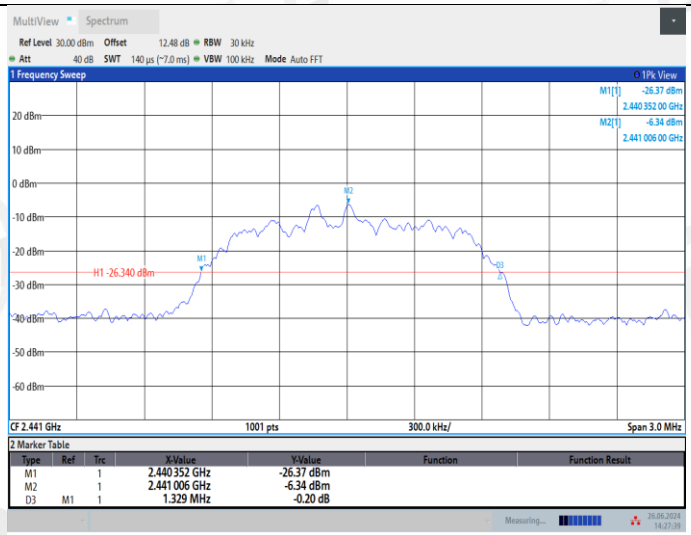
2DH5_Left side_2402



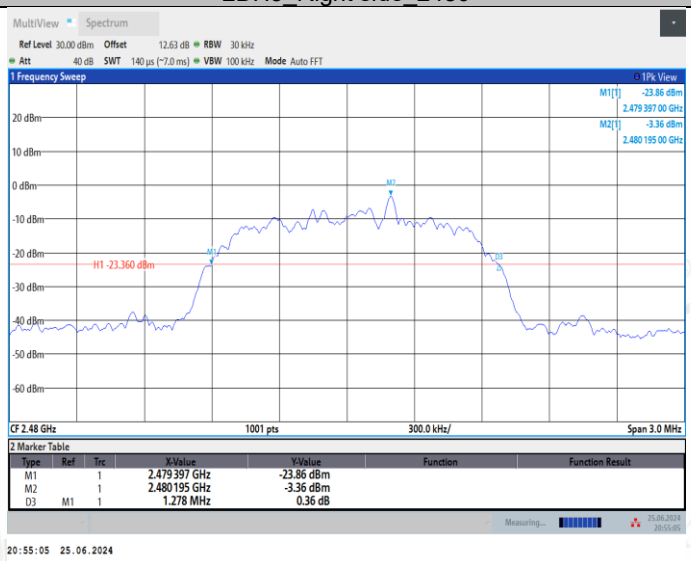
2DH5_Right side_2441



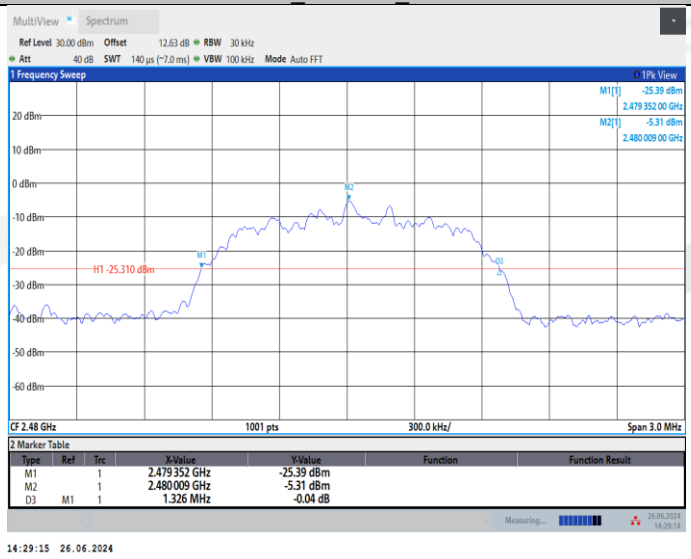
2DH5_Left side_2441



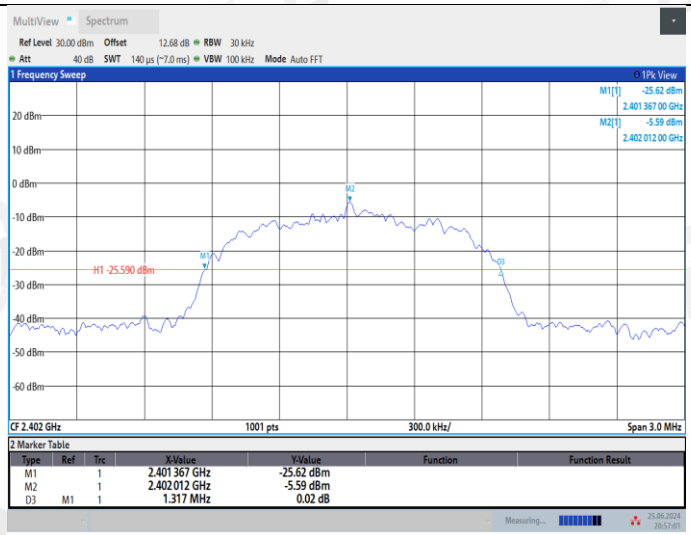
2DH5_Right side_2480



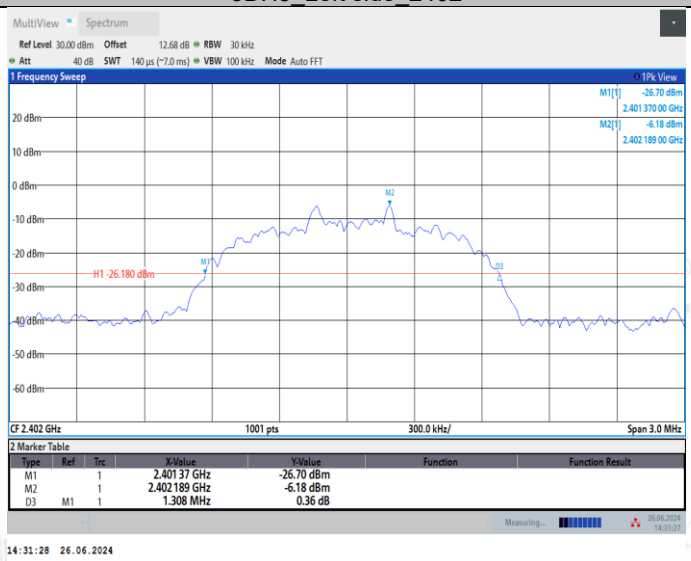
2DH5_Left side_2480



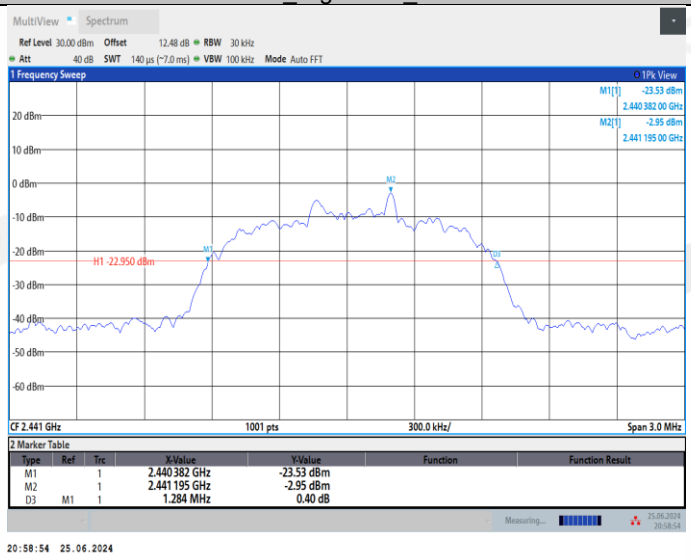
3DH5_Right side_2402



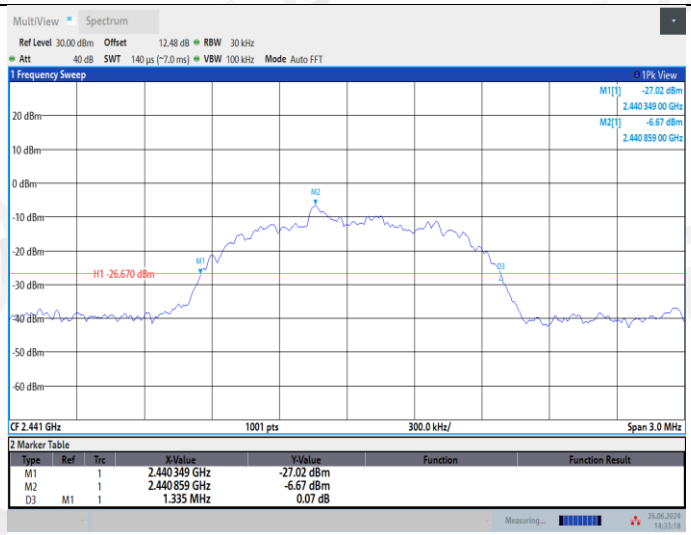
3DH5_Left side_2402



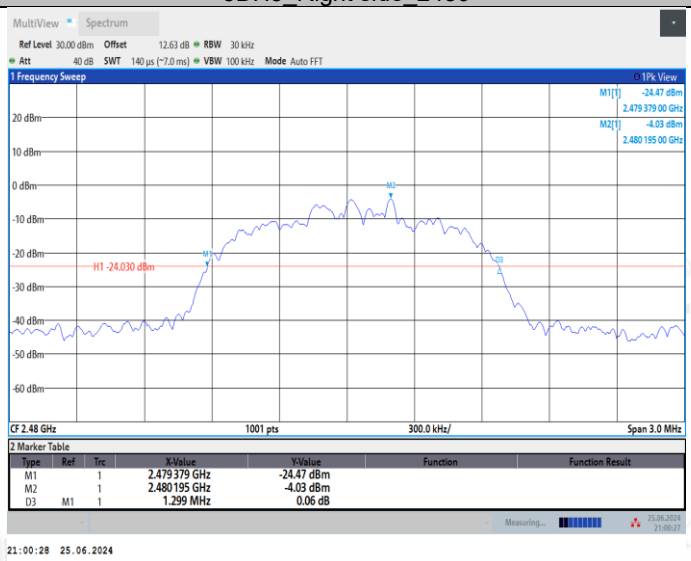
3DH5_Right side_2441



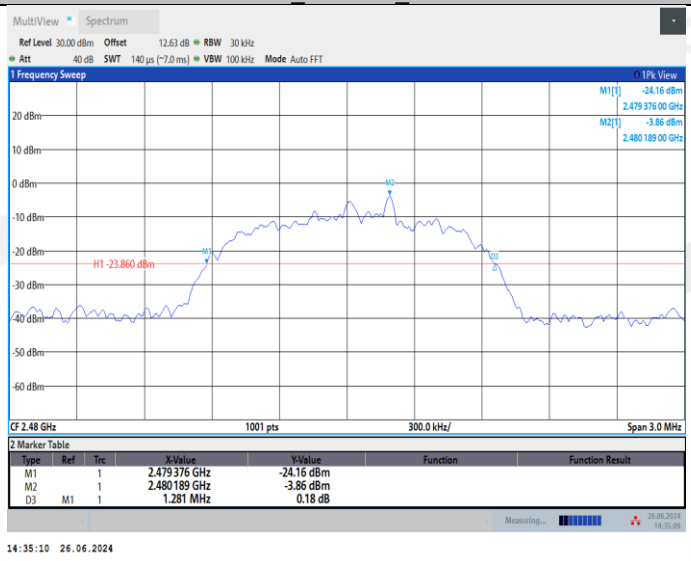
3DH5_Left side_2441



3DH5_Right side_2480

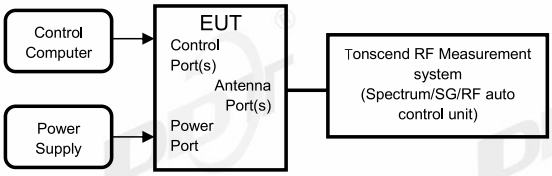


3DH5_Left side_2480



5. 99% Bandwidth

5.1. Block diagram of test setup



5.2. Limits

Just for Report.

5.3. Test procedure

(1) The test according to ANSI C63.10-2013 clause 6.9.3.
(2) Connect EUT's antenna output to spectrum analyzer by RF cable, the path loss was compensated to the results
(3) Set the EUT as maximum power setting and enable the EUT transmit continuously
(4) Use the following spectrum analyzer settings for the 99% bandwidth measurement:

RBW:	1% to 5% of the OBW
VBW:	approximately three times RBW
Span:	between 1.5 times and 5.0 times the OBW
Detector Mode:	Peak
Sweep time:	Auto
Trace mode:	Max hold

(5) Measure and record the results in the report.

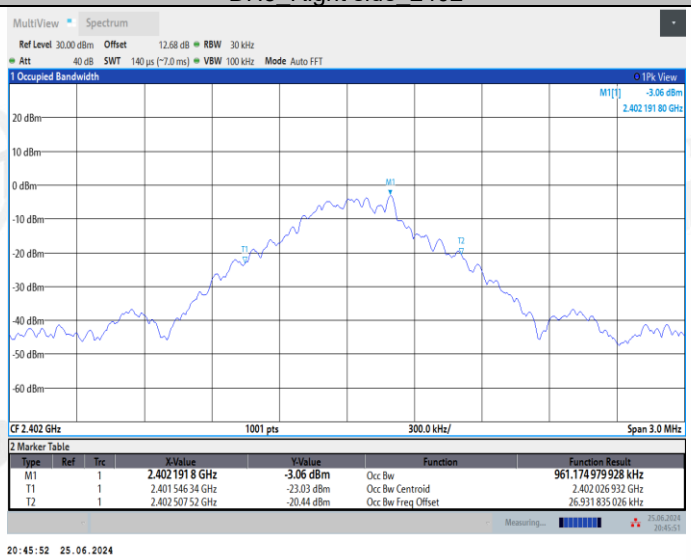
5.4. Test result

Test Engineer:	Zoe	Test Site:	RF Measurement System 4#
Ambient Condition:	25.6-26.1℃,41.8-45.3%RH	Test Date:	2024.06.25-2024.06.26
Test Power Supply:	Battery	Sample Number:	S24053007-001

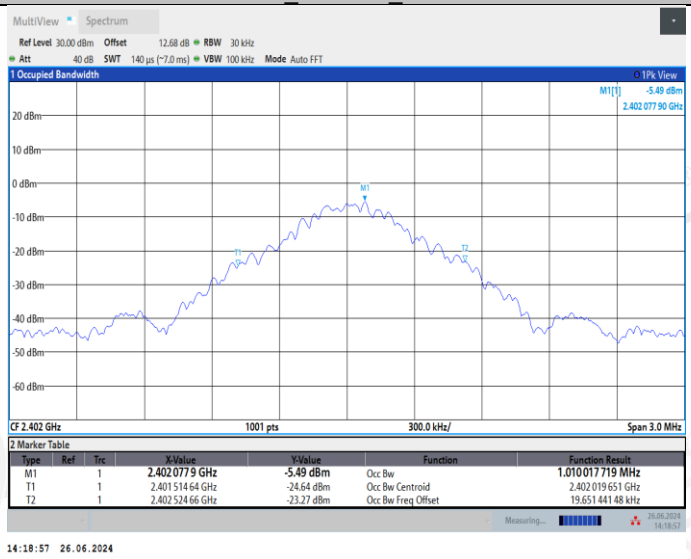
Test Mode	Antenna	Frequency [MHz]	OCB [MHz]	FL[MHz]	FH[MHz]
DH5	Right side	2402	0.961	2401.5463	2402.5075
	Left side	2402	1.01	2401.5146	2402.5247
	Right side	2441	0.991	2440.5231	2441.5142
	Left side	2441	1.009	2440.5072	2441.5165
	Right side	2480	0.987	2479.5293	2480.5162
	Left side	2480	1.003	2479.5176	2480.5208
2DH5	Right side	2402	1.2	2401.4270	2402.6273
	Left side	2402	1.206	2401.4139	2402.6201
	Right side	2441	1.183	2440.4346	2441.6173
	Left side	2441	1.223	2440.4045	2441.6270
	Right side	2480	1.193	2479.4303	2480.6230
	Left side	2480	1.212	2479.4124	2480.6248
3DH5	Right side	2402	1.187	2401.4337	2402.6205
	Left side	2402	1.213	2401.4057	2402.6187
	Right side	2441	1.199	2440.4232	2441.6219
	Left side	2441	1.226	2440.4008	2441.6272
	Right side	2480	1.195	2479.4274	2480.6227
	Left side	2480	1.214	2479.4043	2480.6185

5.5. Test graphs

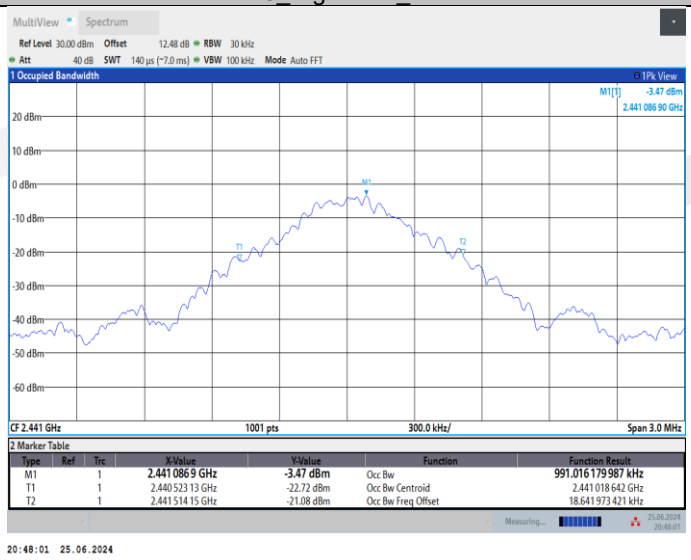
DH5_Right side_2402



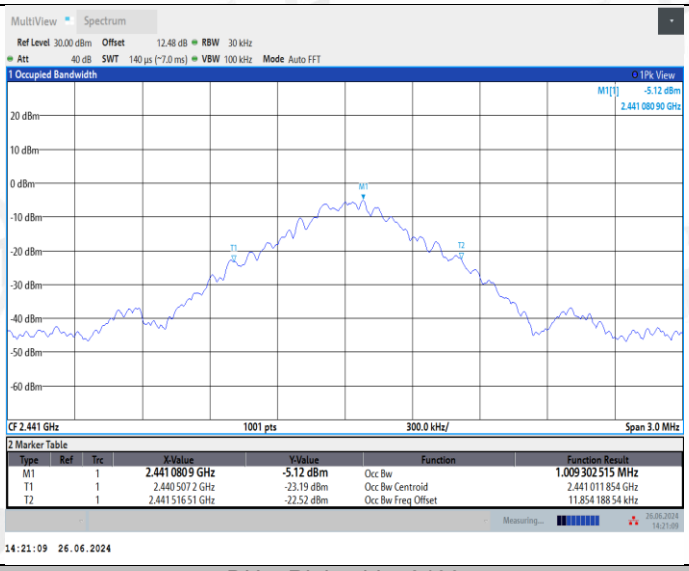
DH5_Left side_2402



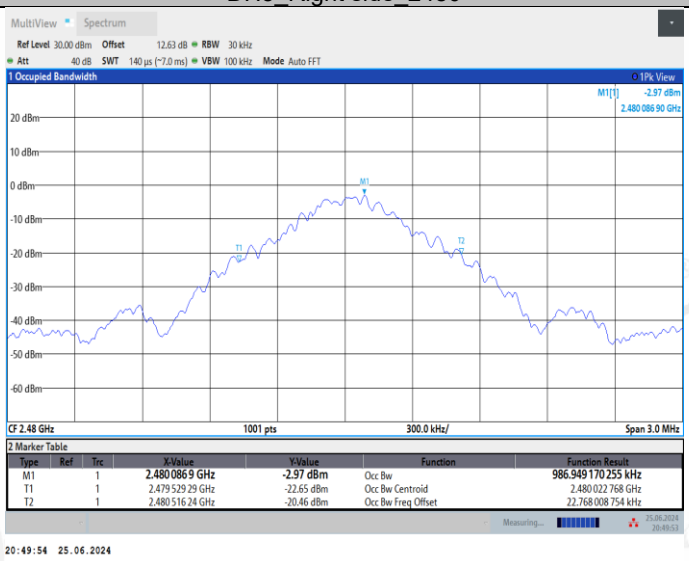
DH5_Right side_2441



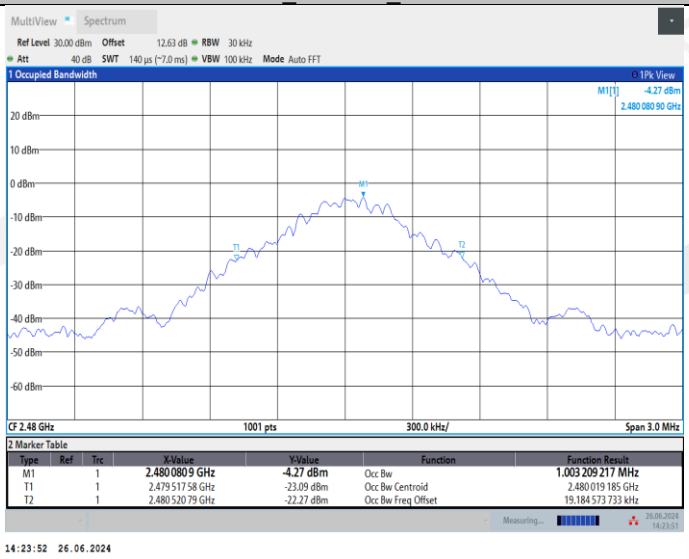
DH5_Left side_2441



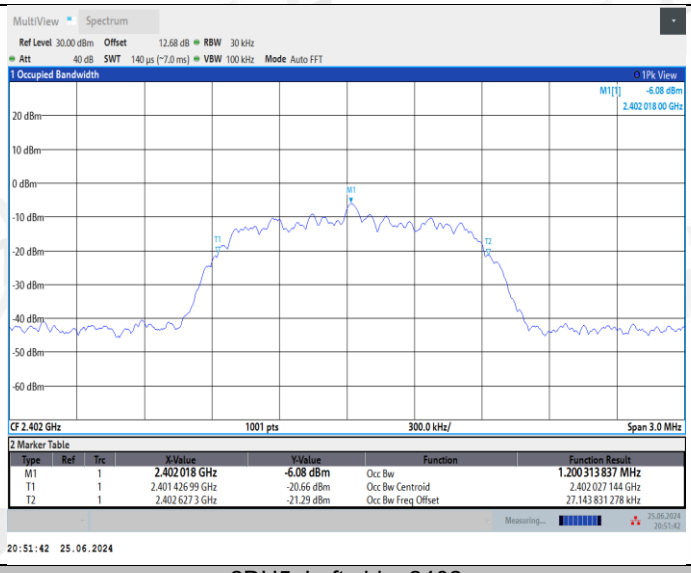
DH5_Right side_2480



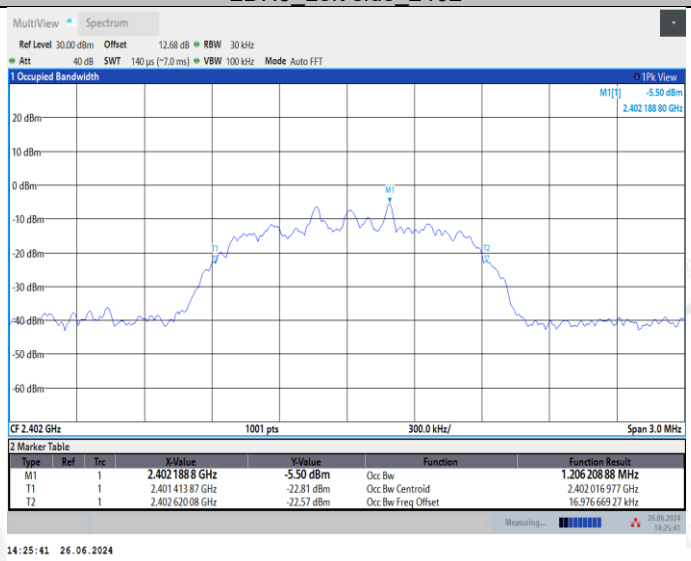
DH5_Left side_2480



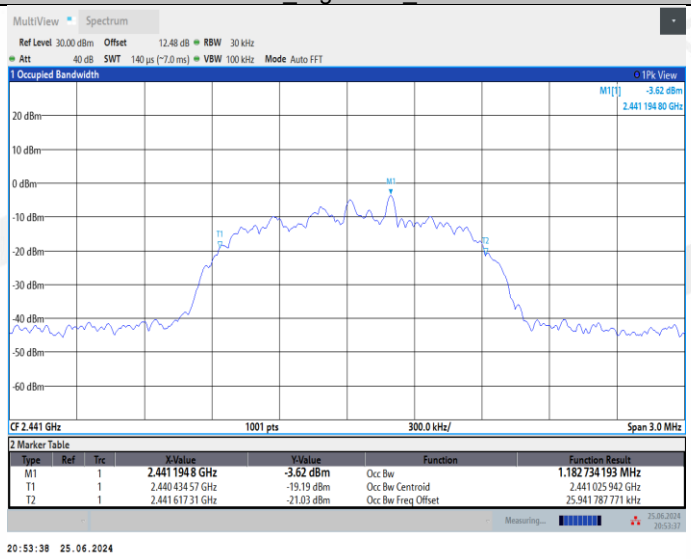
2DH5_Right side_2402



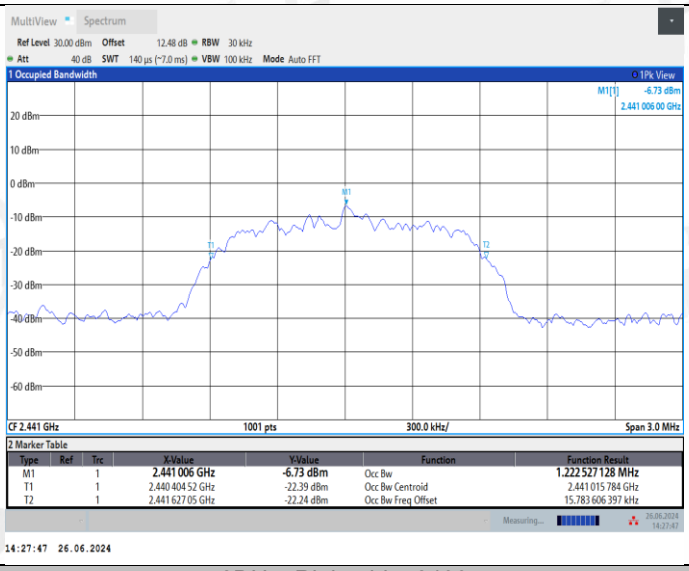
2DH5_Left side_2402



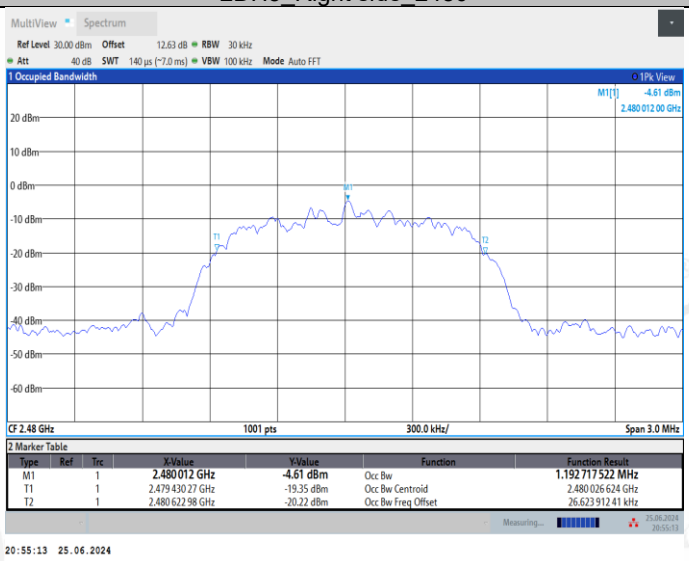
2DH5_Right side_2441



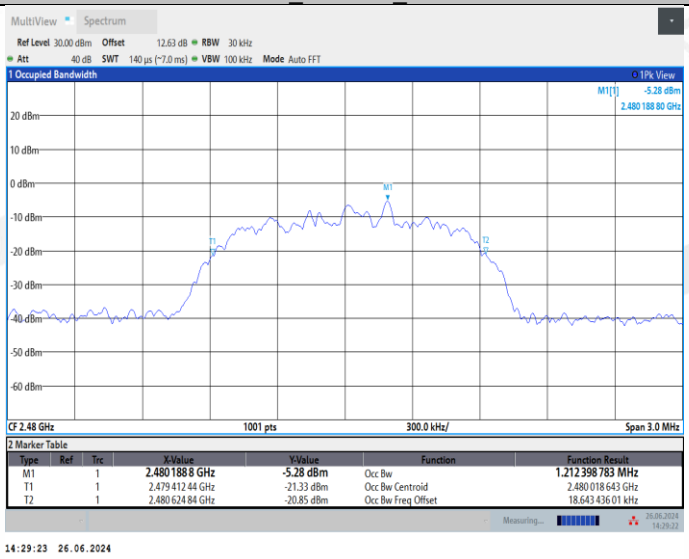
2DH5_Left side_2441



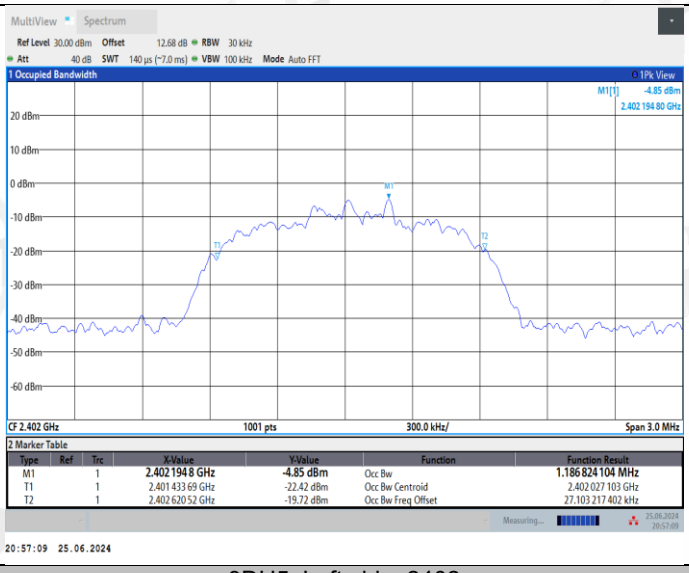
2DH5_Right side_2480



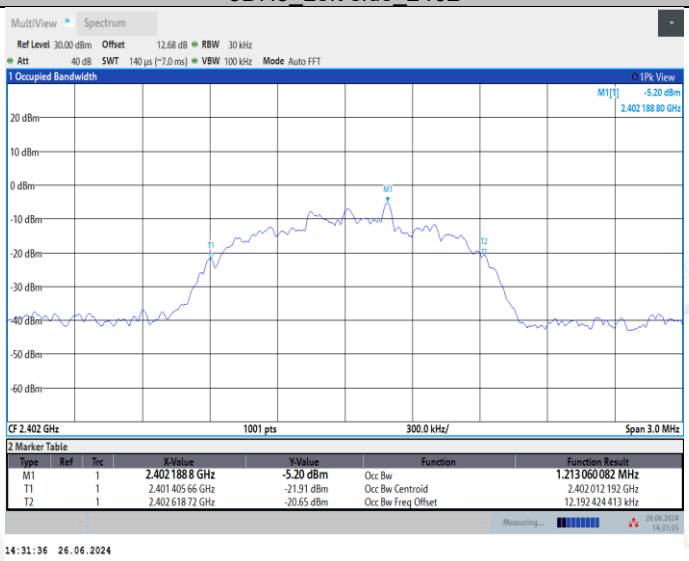
2DH5_Left side_2480



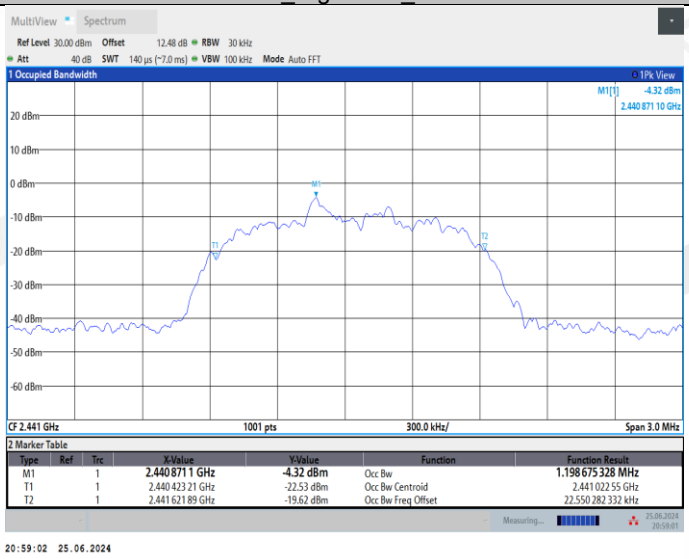
3DH5_Right side_2402



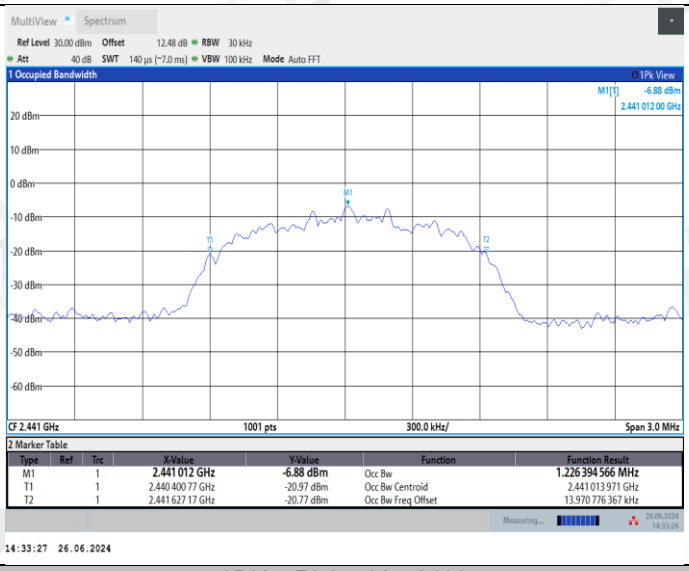
3DH5_Left side_2402



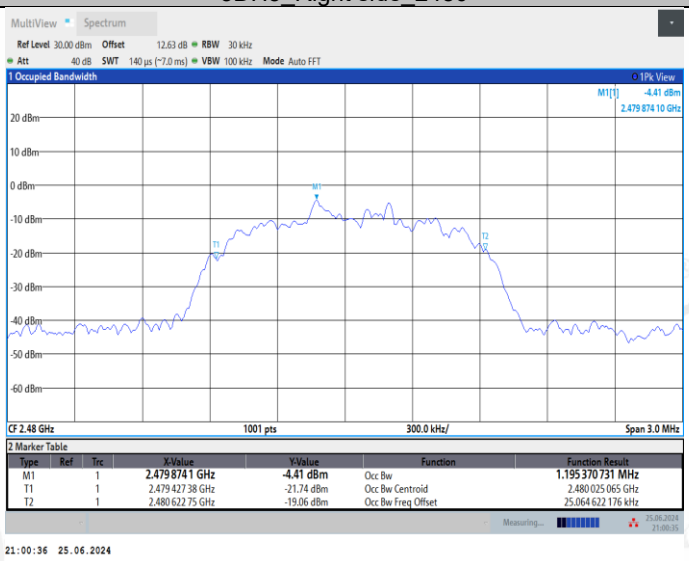
3DH5_Right side_2441



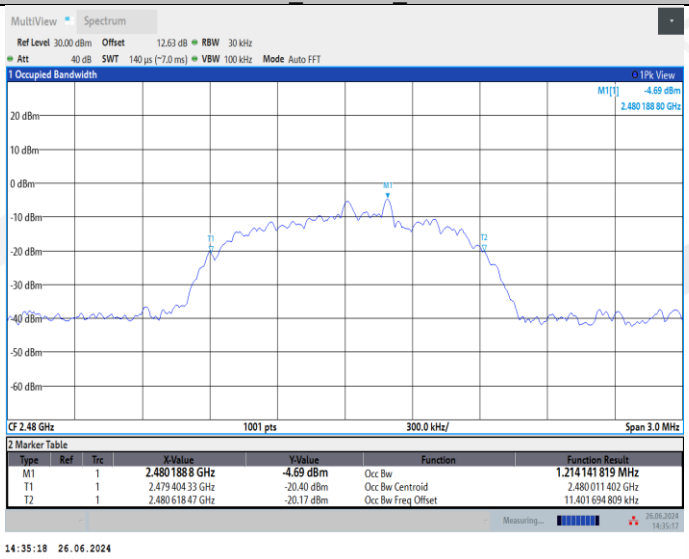
3DH5_Left side_2441



3DH5_Right side_2480

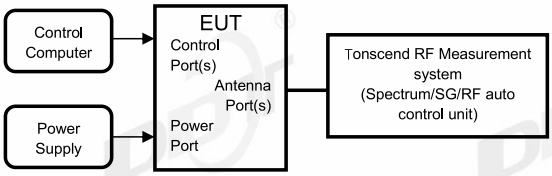


3DH5_Left side_2480



6. Maximum Peak Output Power

6.1. Block diagram of test setup



6.2. Limits

For frequency hopping systems operating in the 2400-2483.5 MHz band employing at least 75 non-overlapping hopping channels, and all frequency hopping systems in the 5725-5850 MHz band: 1 watt. For all other frequency hopping systems in the 2400-2483.5 MHz band: 0.125 watts, the e.i.r.p shall not exceed 4W.

6.3. Test procedure

(1) The test according to ANSI C63.10-2013 clause 7.8.5.
(2) Connect EUT's antenna output to spectrum analyzer by RF cable, the path loss was compensated to the results.
(3) Set the EUT as maximum power setting and enable the EUT transmit continuously.
(4) Use the following spectrum analyzer settings for the maximum peak output power measurement:

RBW:	> 20 dB bandwidth of the emission being measured.
VBW:	VBW ≥ RBW.
Span:	Approximately five times the 20 dB bandwidth, centered on a hopping channel.
Detector Mode:	Peak
Sweep time:	Auto
Trace mode:	Max hold

(5) Use the marker-to-peak function to set the marker to the peak of the emission and record the results in the report.

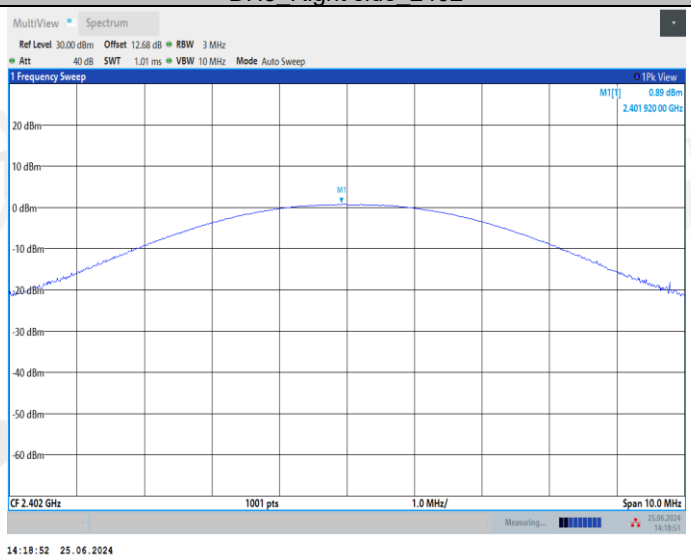
6.4. Test result

Test Engineer:	Zoe	Test Site:	RF Measurement System 4#
Ambient Condition:	25.6-26.1℃,41.8-45.3%RH	Test Date:	2024.06.25-2024.06.26
Test Power Supply:	Battery	Sample Number:	S24053007-001

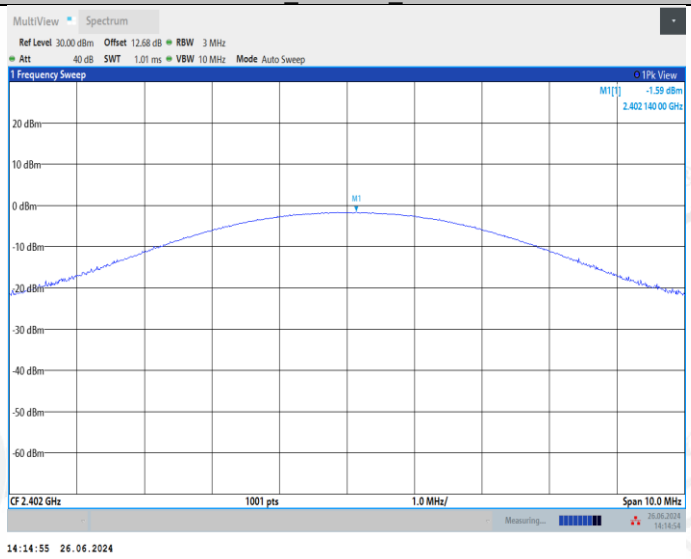
Test Mode	Antenna	Frequency [MHz]	Conducted Peak Power[dBm]	Conducted Limit[dBm]	EIRP[dBm]	EIRP Limit[dBm]	Verdict
DH5	Right side	2402	0.89	≤20.97	2.13	≤30	PASS
	Left side	2402	-1.59	≤20.97	-0.35	≤30	PASS
	Right side	2441	0.23	≤20.97	1.47	≤30	PASS
	Left side	2441	-1.20	≤20.97	0.04	≤30	PASS
	Right side	2480	0.40	≤20.97	1.64	≤30	PASS
	Left side	2480	-0.46	≤20.97	0.78	≤30	PASS
2DH5	Right side	2402	0.64	≤20.97	1.88	≤30	PASS
	Left side	2402	-1.80	≤20.97	-0.56	≤30	PASS
	Right side	2441	0.06	≤20.97	1.30	≤30	PASS
	Left side	2441	-1.34	≤20.97	-0.10	≤30	PASS
	Right side	2480	0.29	≤20.97	1.53	≤30	PASS
	Left side	2480	-0.47	≤20.97	0.77	≤30	PASS
3DH5	Right side	2402	0.70	≤20.97	1.94	≤30	PASS
	Left side	2402	-1.67	≤20.97	-0.43	≤30	PASS
	Right side	2441	0.13	≤20.97	1.37	≤30	PASS
	Left side	2441	-1.27	≤20.97	-0.03	≤30	PASS
	Right side	2480	0.30	≤20.97	1.54	≤30	PASS
	Left side	2480	-0.56	≤20.97	0.68	≤30	PASS

6.5. Test graphs

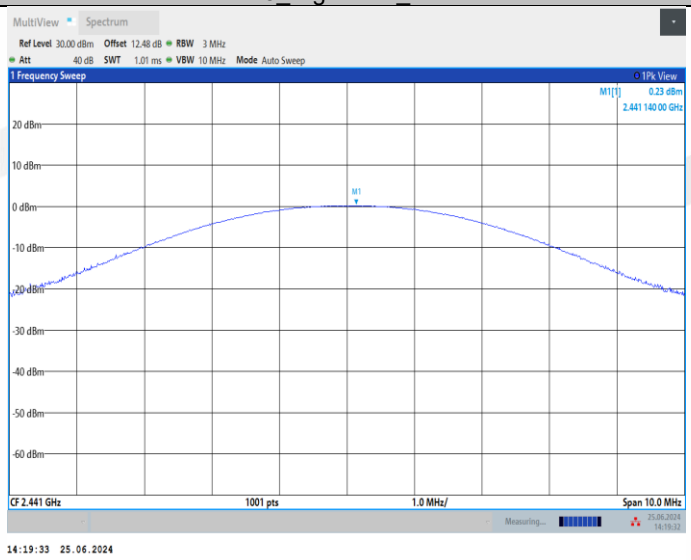
DH5_Right side_2402



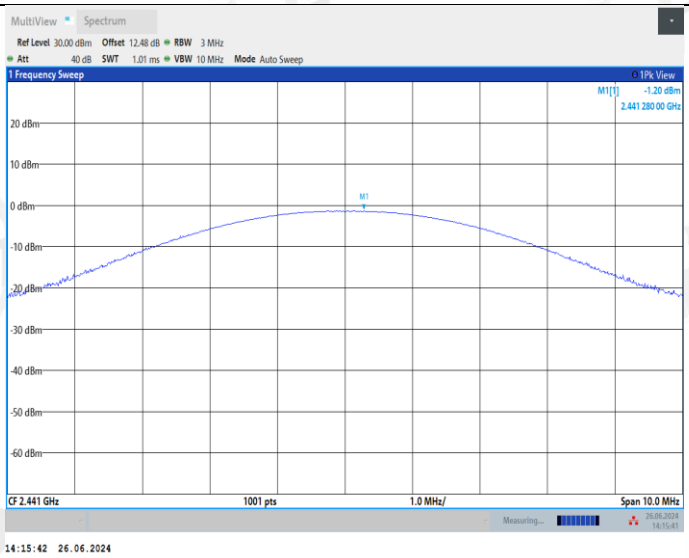
DH5_Left side_2402



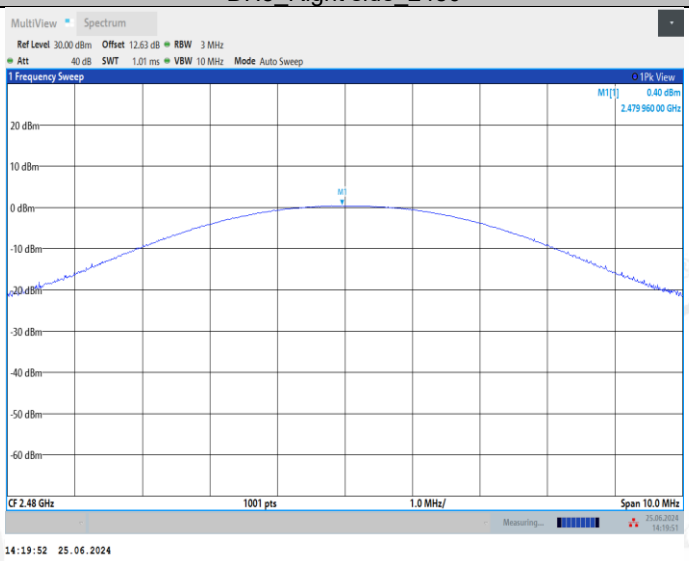
DH5_Right side_2441



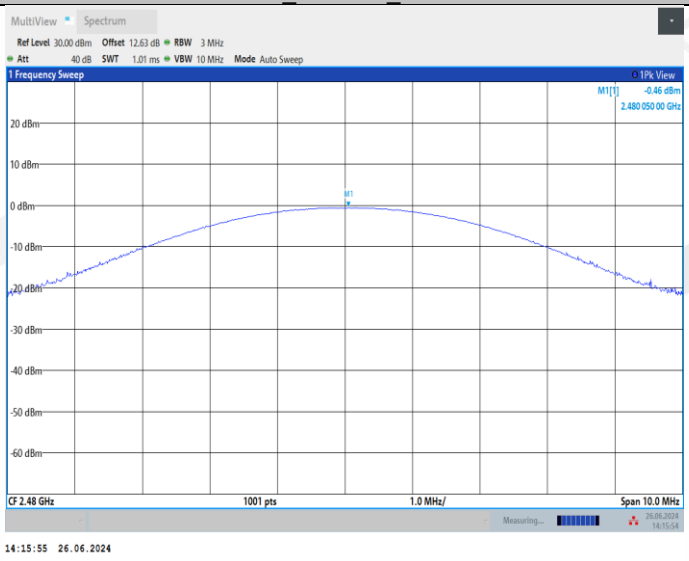
DH5_Left side_2441



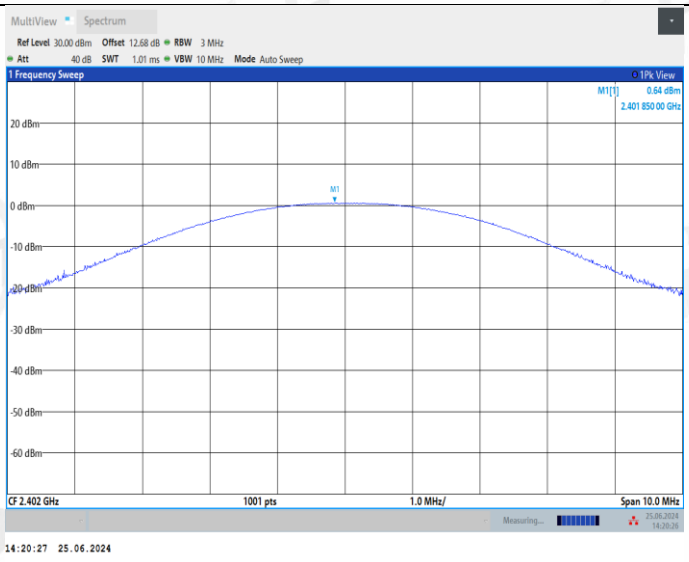
DH5_Right side_2480



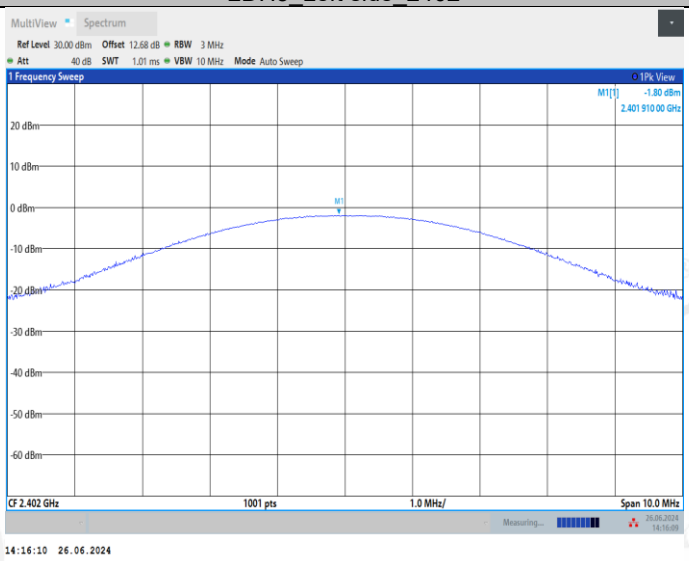
DH5_Left side_2480



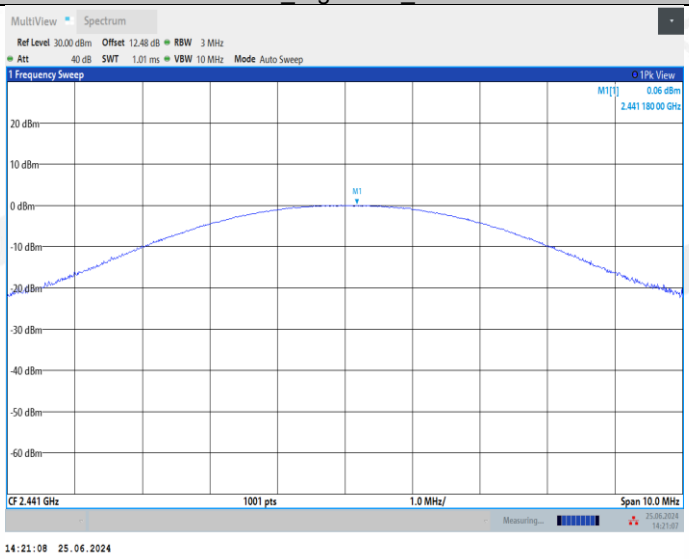
2DH5_Right side_2402



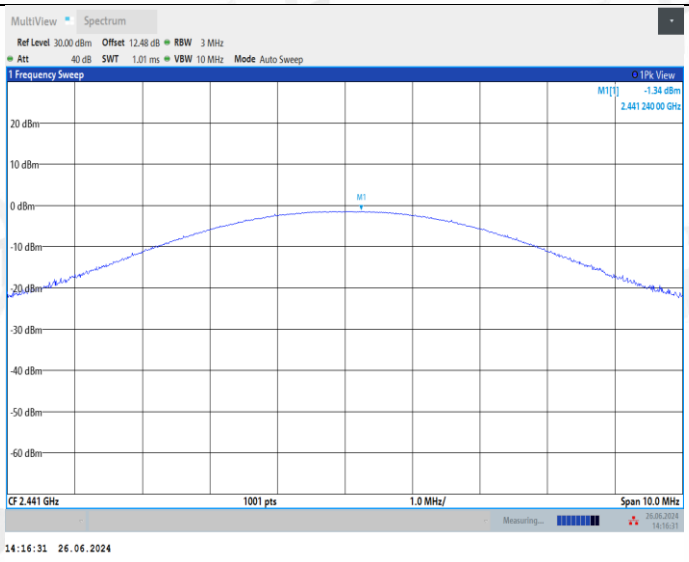
2DH5_Left side_2402



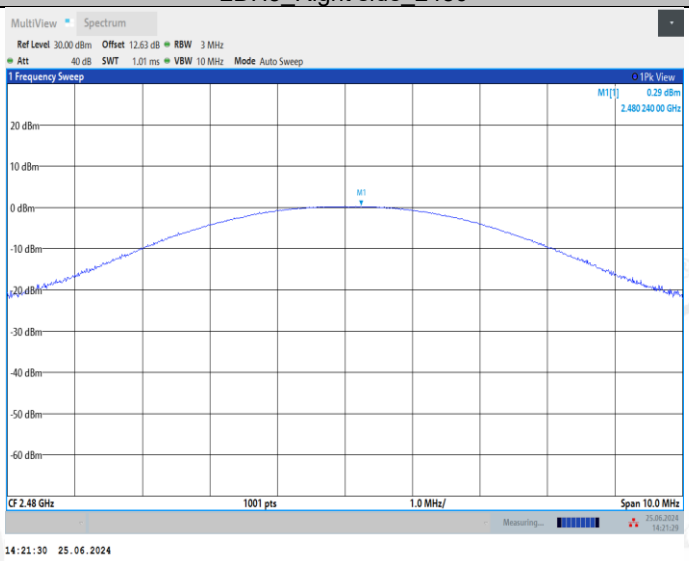
2DH5_Right side_2441



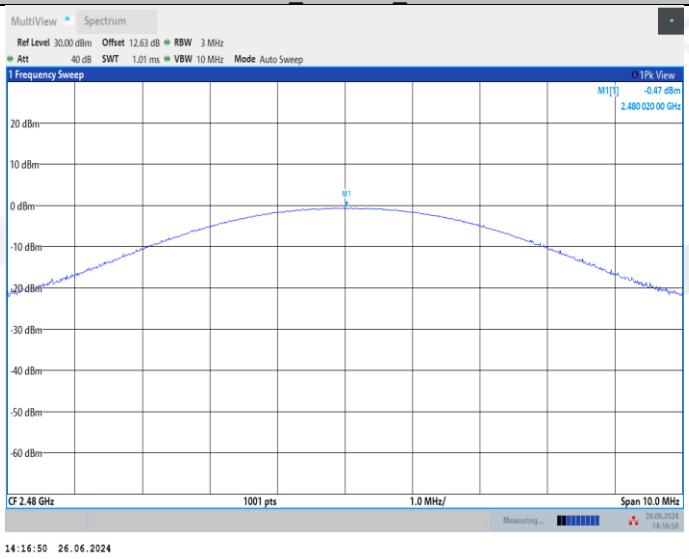
2DH5_Left side_2441



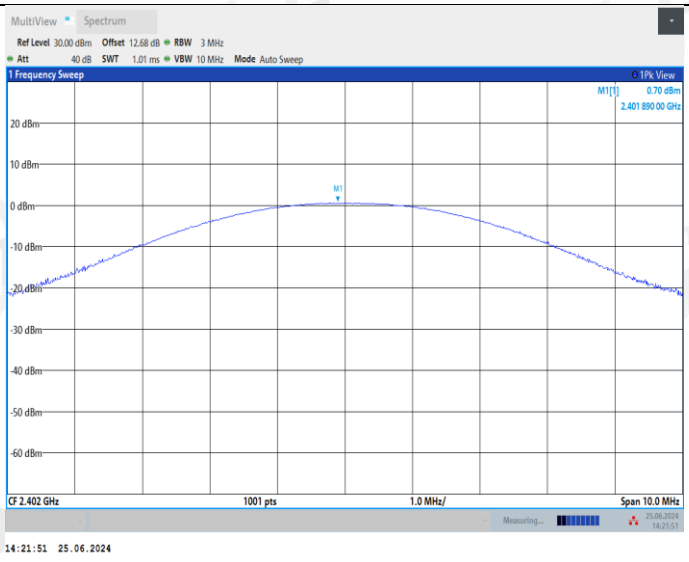
2DH5_Right side_2480



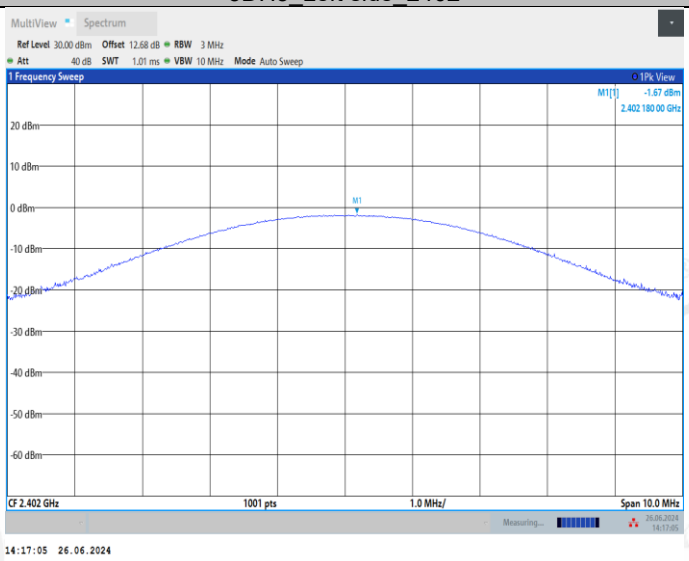
2DH5_Left side_2480



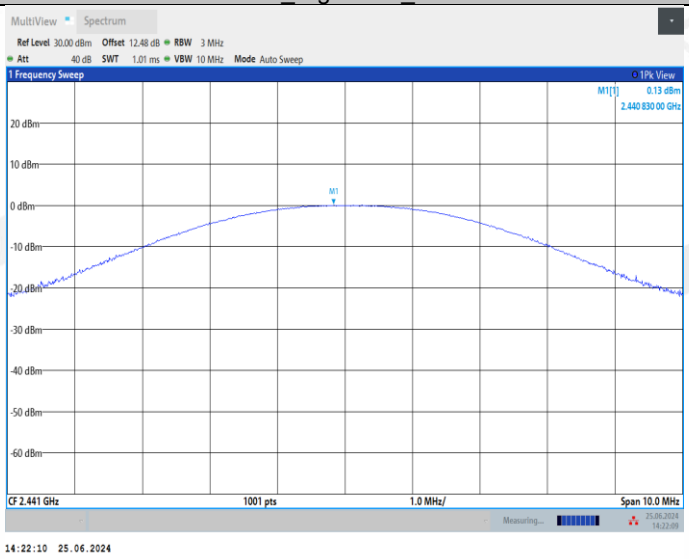
3DH5_Right side_2402



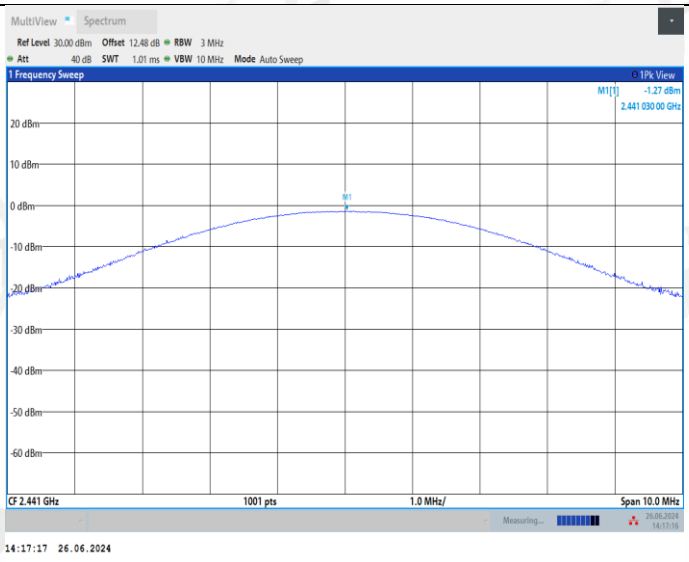
3DH5_Left side_2402



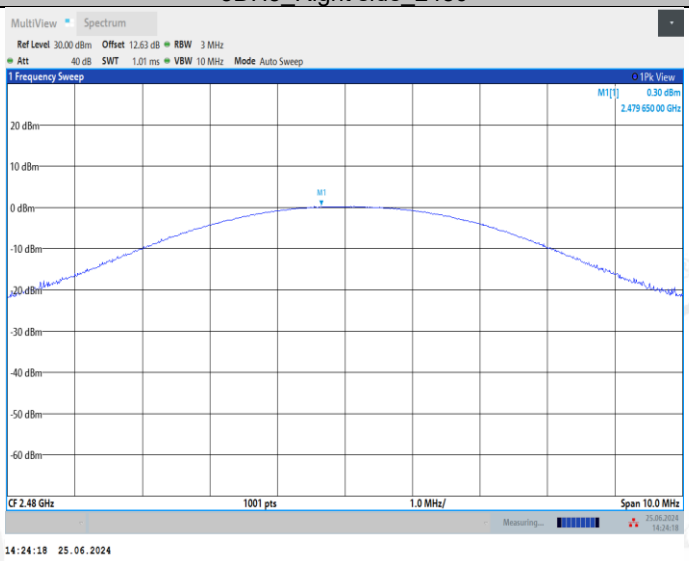
3DH5_Right side_2441



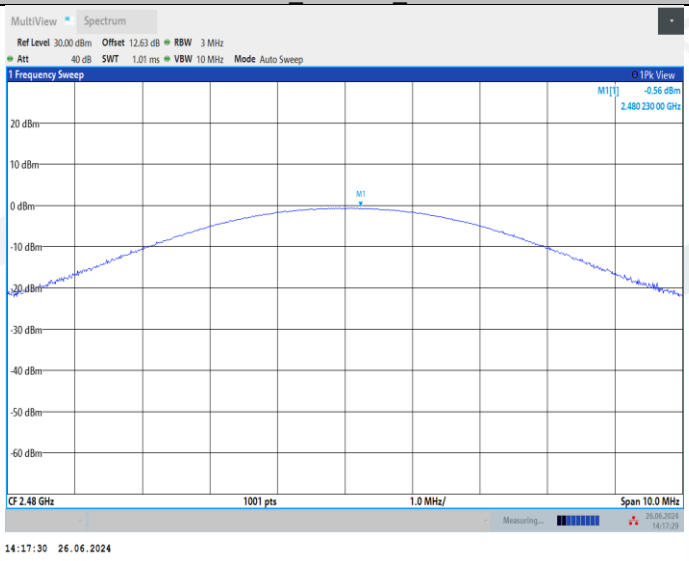
3DH5_Left side_2441



3DH5_Right side_2480

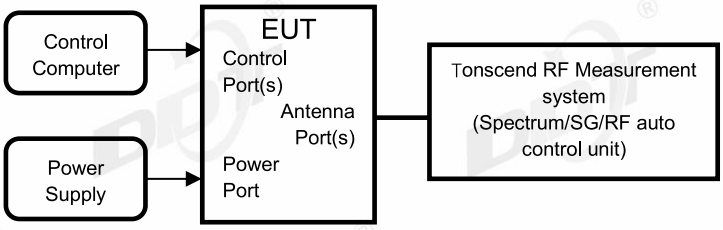


3DH5_Left side_2480



7. Carrier Frequency Separation

7.1. Block diagram of test setup



7.2. Limits

Frequency hopping systems shall have hopping channel carrier frequencies separated by a minimum of 25 kHz or the 20 dB bandwidth of the hopping channel, whichever is greater. Alternatively, frequency hopping systems operating in the 2400-2483.5 MHz band may have hopping channel carrier frequencies that are separated by 25 kHz or two-thirds of the 20 dB bandwidth of the hopping channel, whichever is greater, provided the systems operate with an output power no greater than 125 mW.

7.3. Test procedure

(1) The test according to ANSI C63.10-2013 clause 7.8.2.
(2) Connect EUT's antenna output to spectrum analyzer by RF cable, the path loss was compensated to the results.
(3) Set the EUT as maximum power setting and enable the EUT transmit continuously.
(4) Use the following spectrum analyzer settings for the maximum peak output power measurement:

RBW:	approximately 30% of the channel spacing
VBW:	VBW ≥ RBW.
Span:	Wide enough to capture the peaks of two adjacent channels.
Detector Mode:	Peak
Sweep time:	Auto
Trace mode:	Max hold

(5) Use the marker-delta function to determine the separation between the peaks of the adjacent channels and record the results in the report.

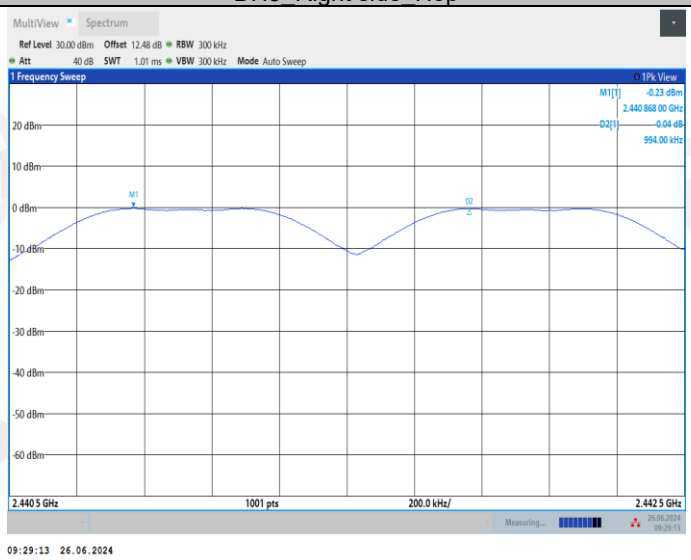
7.4. Test result

Test Engineer:	Zoe	Test Site:	RF Measurement System 4#
Ambient Condition:	25.6-26.1℃,41.8-45.3%RH	Test Date:	2024.06.25-2024.06.26
Test Power Supply:	Battery	Sample Number:	S24053007-001

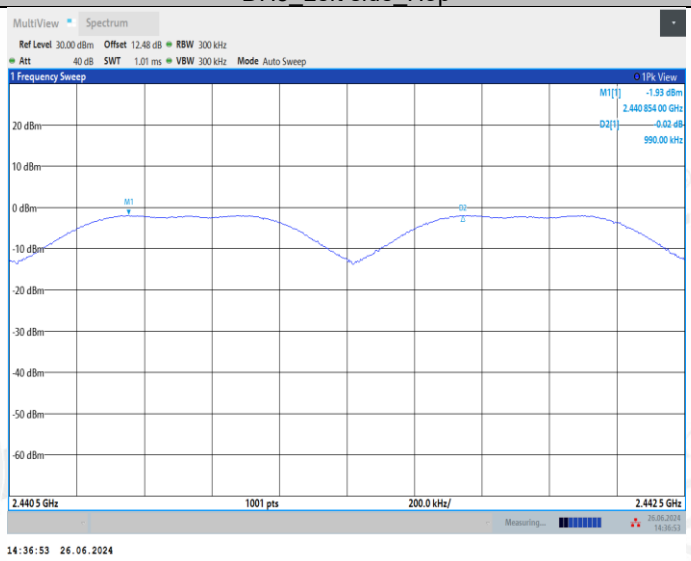
Test Mode	Antenna	Frequency [MHz]	Result [MHz]	Limit [MHz]	Verdict
DH5	Right side	Hop	0.994	≥0.740	PASS
	Left side	Hop	0.99	≥0.740	PASS
2DH5	Right side	Hop	1.000	≥0.880	PASS
	Left side	Hop	1.006	≥0.880	PASS
3DH5	Right side	Hop	1.008	≥0.880	PASS
	Left side	Hop	1.008	≥0.880	PASS

7.5. Test graphs

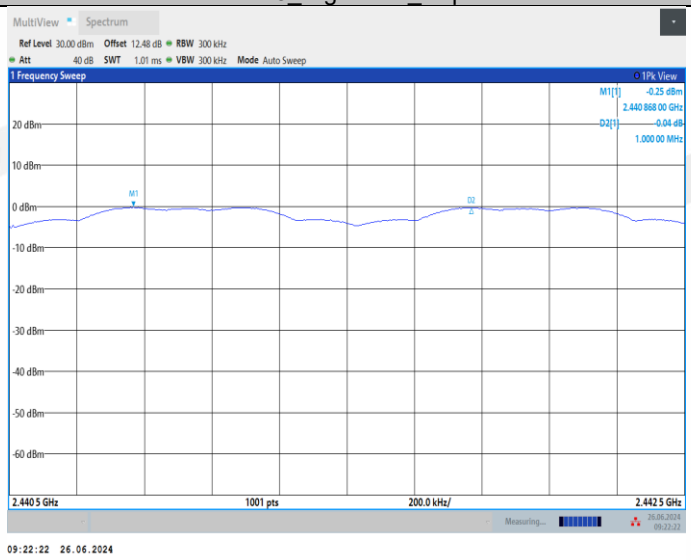
DH5_Right side_Hop



DH5_Left side_Hop



2DH5_Right side_Hop



2DH5_Left side_Hop