



FCC AND ISED CERTIFICATION TEST REPORT

Applicant	:	Harman International Industries, Inc.
Address of Applicant	:	8500 Balboa Boulevard, Northridge, CA 91329, UNITED STATES
Manufacturer	:	Harman International Industries, Inc.
Address of Manufacturer	:	8500 Balboa Boulevard, Northridge, CA 91329, UNITED STATES
Equipment under Test	:	BLUETOOTH HEADSET
Model No.	:	TUNE FLEX 2
FCC ID	:	APITUNEFLEX2
IC	:	6132A-TUNEFLEX2
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-RE24052314-1E01
Issue Date	:	2024/06/29
Issue By	:	Guangdong Dongdian Testing Service Co., Ltd. Unit 2, Building 1, No. 17, Zongbu 2nd Road, Songshan Lake Park, Dongguan, Guangdong, China, 523808

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Test Report Declare

Applicant	:	Harman International Industries, Inc.
Address of Applicant	:	8500 Balboa Boulevard, Northridge, CA 91329, UNITED STATES
Equipment under Test	:	BLUETOOTH HEADSET
Model No.	:	TUNE FLEX 2
Manufacturer	:	Harman International Industries, Inc.
Address of Manufacturer	:	8500 Balboa Boulevard, Northridge, CA 91329, UNITED STATES

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-RE24052314-1E01		
Date of Receipt:	2024/06/03	Date of Test:	2024/06/03~2024/06/29

Prepared By:

Bobo Chen

Bobo Chen/Engineer

Approved By:



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	2024/06/29	

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	Antenna Requirement	FCC Part 15: 15.203, RSS- Gen Issue 5 clause 6.8	/	Pass
11	Power Line Conducted Emissions	FCC Part 15: 15.207(a), RSS- Gen Issue 5 clause 8.8	/	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	: BLUETOOTH HEADSET
Model Number	: TUNE FLEX 2
EUT Function Description	: Please reference user manual of this device
Power Supply	: CHARGING CASE: DC 5V from USB cable EARBUDS: DC 5V from external charging case CHARGING CASE: DC 3.85V Lithium-ion built-in battery EARBUDS: DC 3.85V Lithium-ion built-in battery

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, $\pi/4$ -DQPSK, 8DPSK

Antenna information	
Antenna Type	: LDS
Left side Max Antenna Gain(dBi)	: -1.94
Right side Max Antenna Gain(dBi)	: -2.67

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		

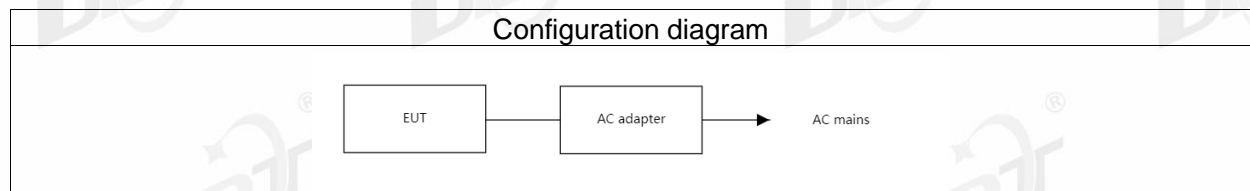
Note: The above EUT information is declared by manufacturer and for more detailed features description please refer to the manufacturer's specifications or User's Manual. The above Antenna information is declared by manufacturer and for more detailed features description please refer to the manufacturer's 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
USB cable	Harman	N/A	Length: 0.2m, unshielded

2.3. Block diagram of EUT configuration for test



2.4. Decision of final test mode

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

Test software: BQB.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	2	CH0 to CH78	2402 to 2480
$\pi/4$ -DQPSK hopping on Tx mode	2	CH0 to CH78	2402 to 2480
8DPSK hopping on Tx mode	2	CH0 to CH78	2402 to 2480
GFSK hopping off Tx mode	2	CH0	2402
	2	CH39	2441
	2	CH78	2480
$\pi/4$ -DQPSK hopping off Tx mode	2	CH0	2402
	2	CH39	2441
	2	CH78	2480
8DPSK hopping off Tx mode	2	CH0	2402
	2	CH39	2441
	2	CH78	2480
Worst-case data rates were: GFSK mode: DH5, $\pi/4$ -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°C to +35 °C
Humidity range:	20% to 75%
Pressure range:	86 kPa to 106 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)	3x10 ⁻⁸
Temperature	0.4 °C
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)

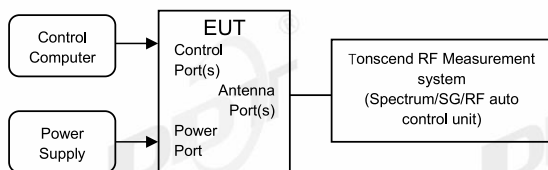
Note: This uncertainty represents an expanded uncertainty expressed at approximately the 95% confidence level using a coverage factor of k=2.

3. Equipment Used During Conductive Test

Equipment	Manufacturer	Model No.	Serial Number	Due Date
<input checked="" type="checkbox"/> RF Connected Test (RF Measurement System 1#)				
SIGNAL ANALYZER	R&S	FSQ26	101272	2025/03/31
Wideband Radio Communication Tester	R&S	CMW500	120259	2024/07/14
MXG Vector Signal Generator	KEYSIGHT	N5182B	MY59100192	2025/03/31
MXG Vector Signal Generator	Agilent	N5182A	MY19060405	2025/03/31
RF Control Unit	Tonsend	JS0806-2	158060010	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

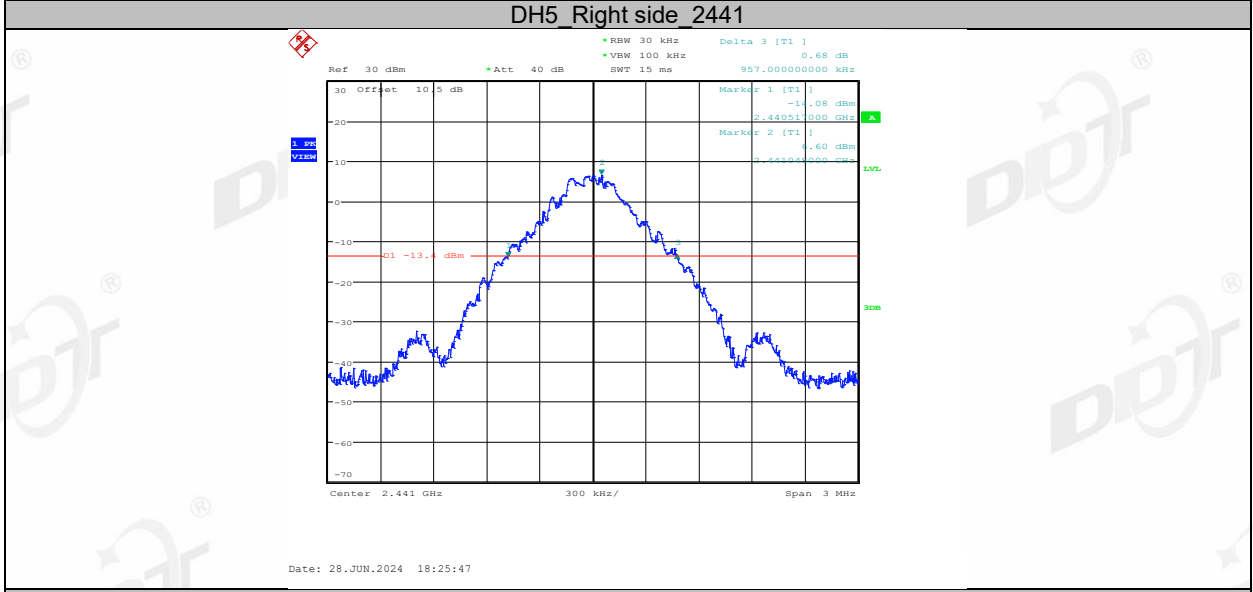
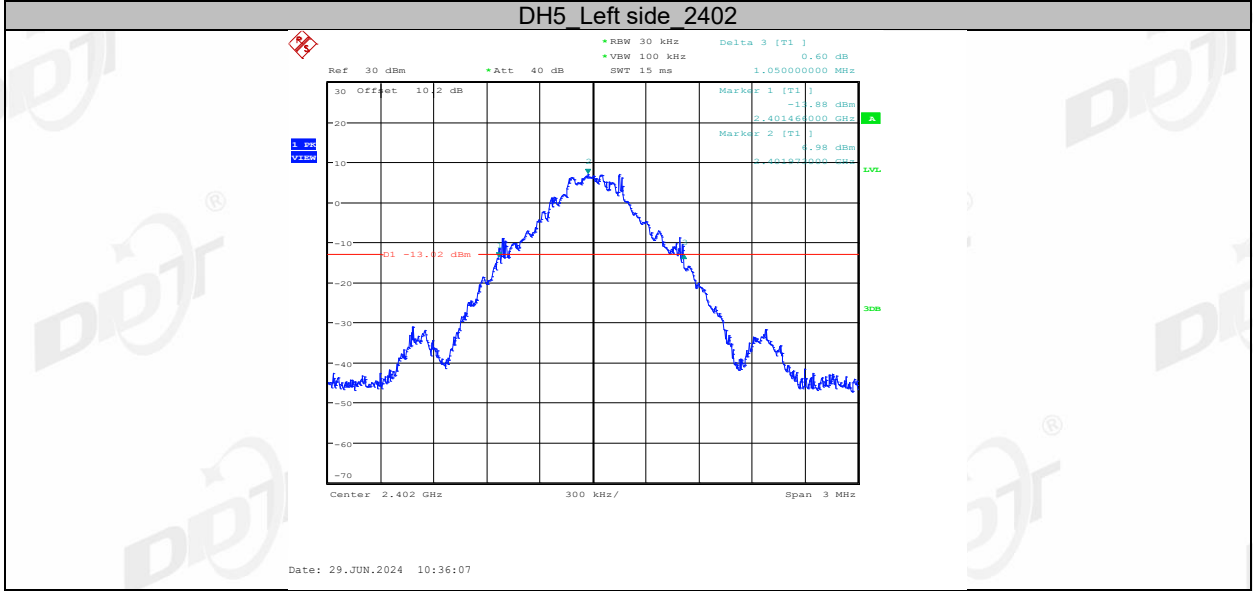
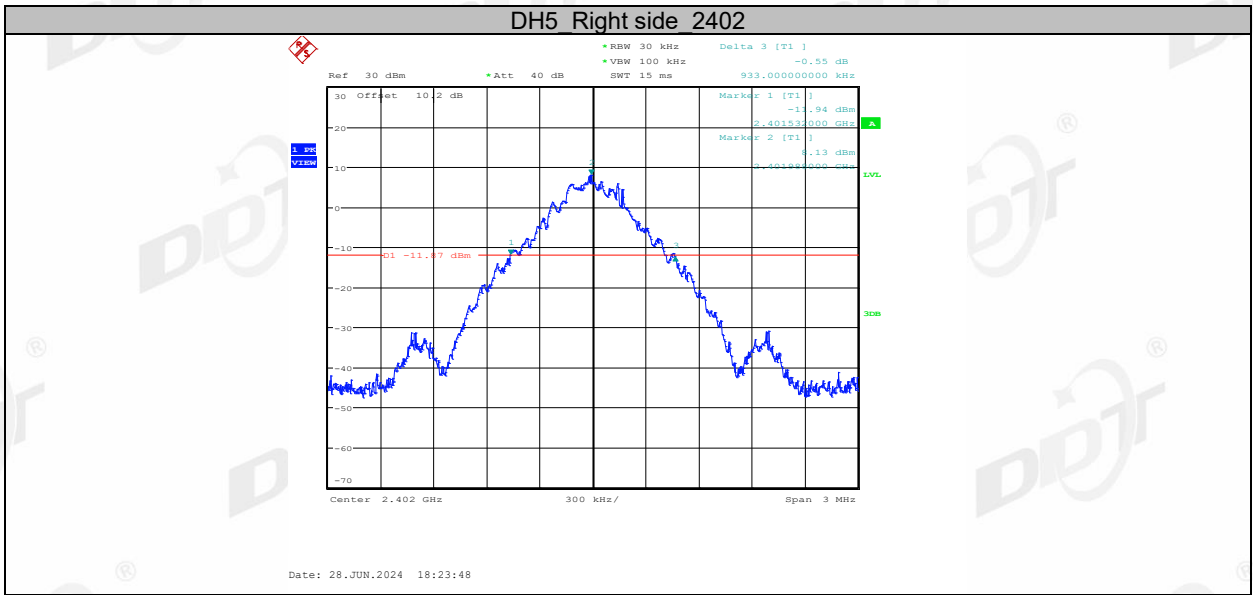
- (5) Measure and record the results in the report.

4.4. Test result

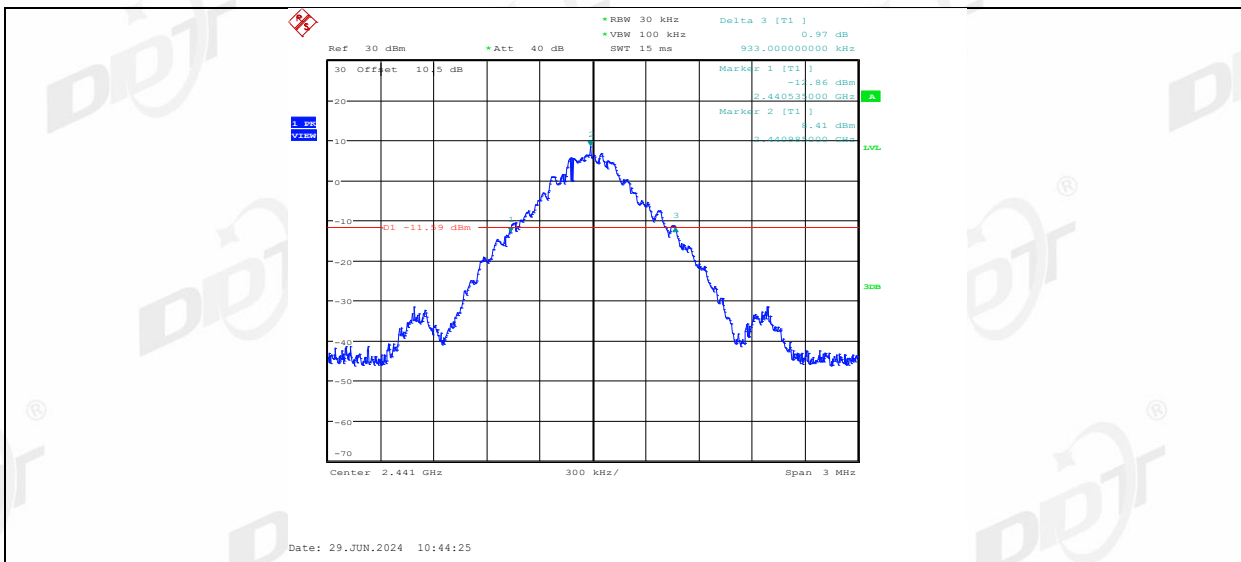
Test Engineer:	Zora Zhang	Test Site:	RF Measurement System 1#
Ambient Condition:	25.3°C,59.4%RH	Test Date:	2024.06.28
Test Power Supply:	Battery	Sample Number:	S24052314-002

Test Mode	Antenna	Frequency [MHz]	20dB EBW[MHz]
DH5	Right side	2402	0.93
	Left side	2402	1.05
	Right side	2441	0.96
	Left side	2441	0.93
	Right side	2480	1.03
	Left side	2480	1.01
2DH5	Right side	2402	1.23
	Left side	2402	1.18
	Right side	2441	1.27
	Left side	2441	1.18
	Right side	2480	1.19
	Left side	2480	1.18
3DH5	Right side	2402	1.25
	Left side	2402	1.20
	Right side	2441	1.26
	Left side	2441	1.20
	Right side	2480	1.29
	Left side	2480	1.25

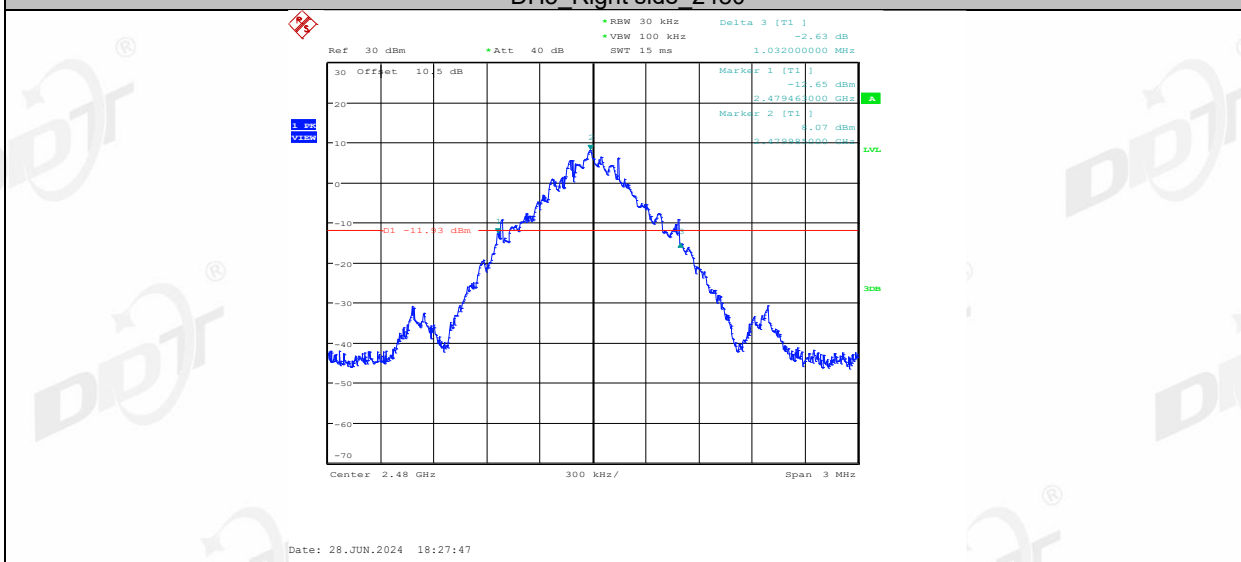
4.5. Test graphs



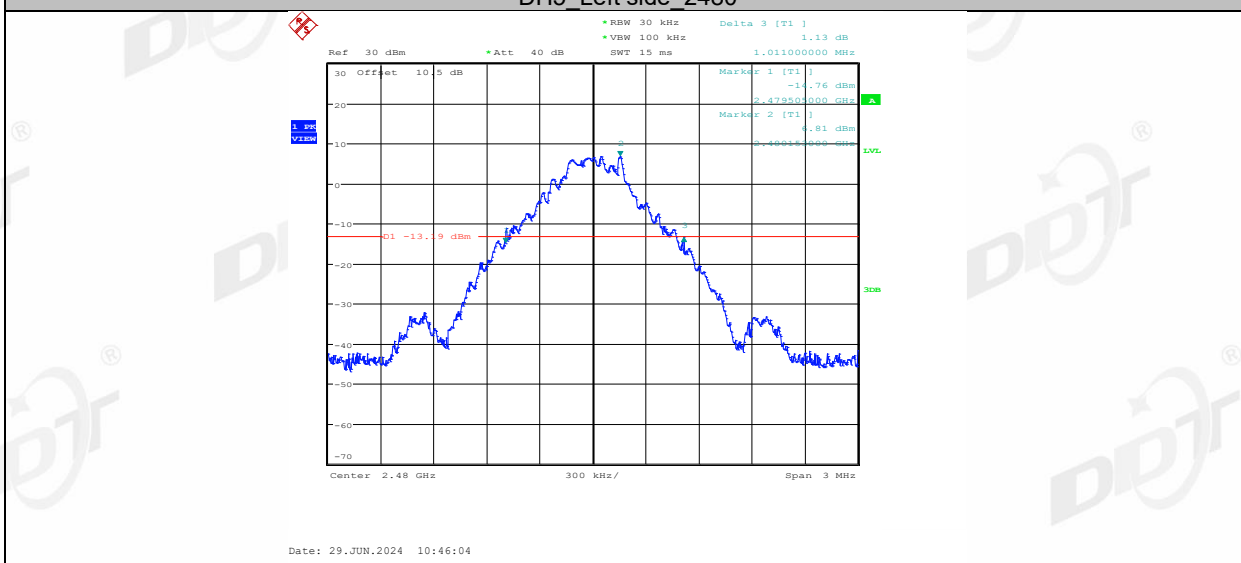
DH5 Left side 2441



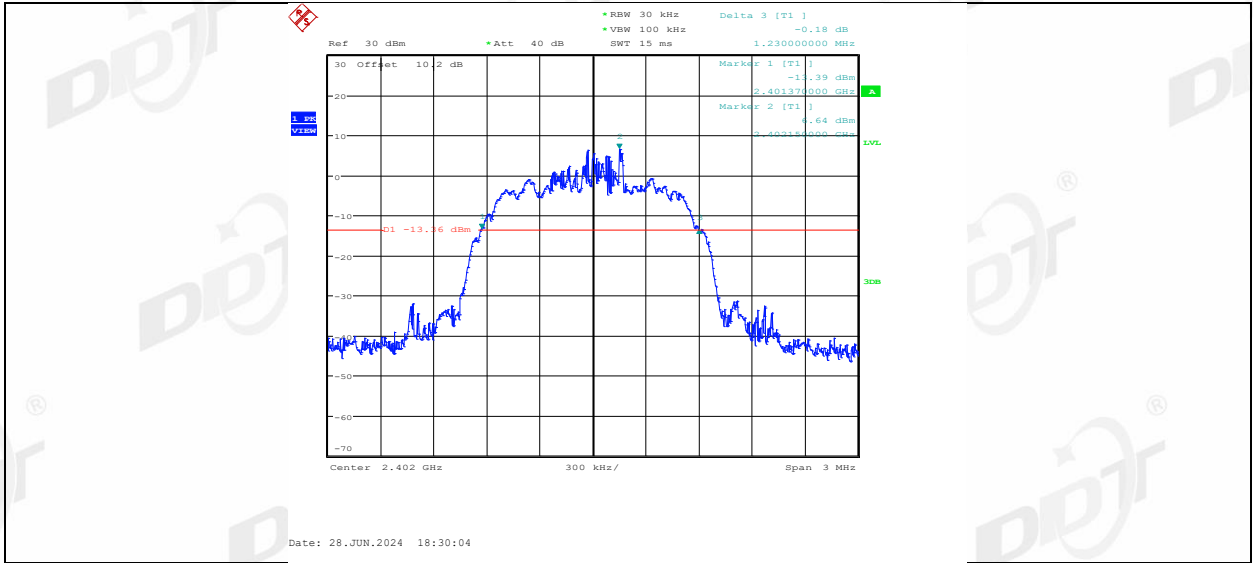
DH5 Right side 2480



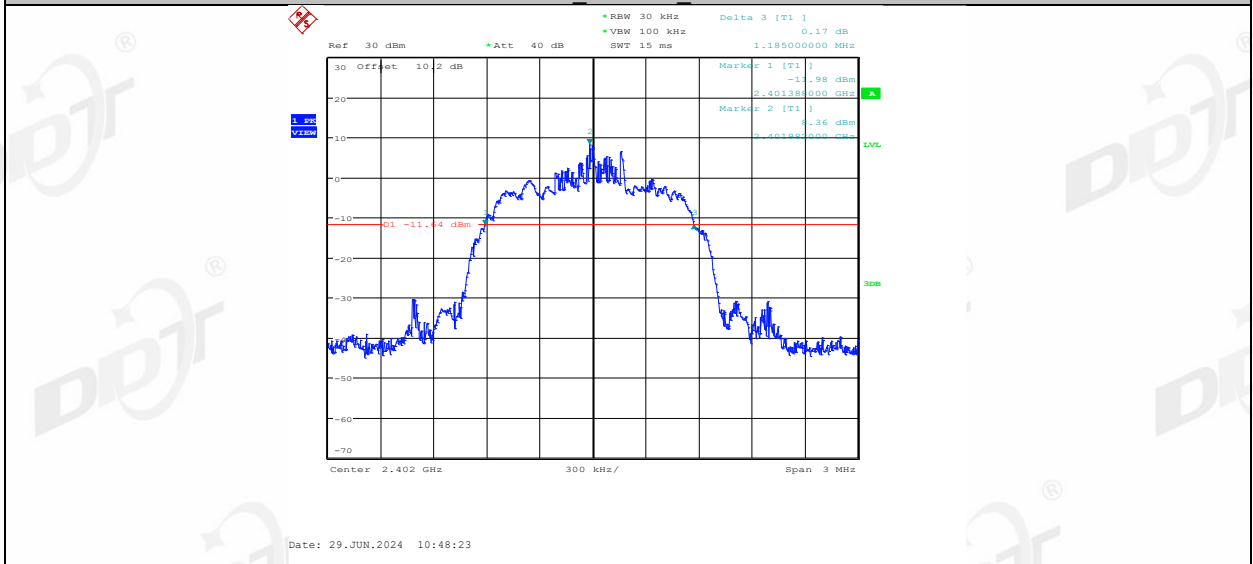
DH5 Left side 2480



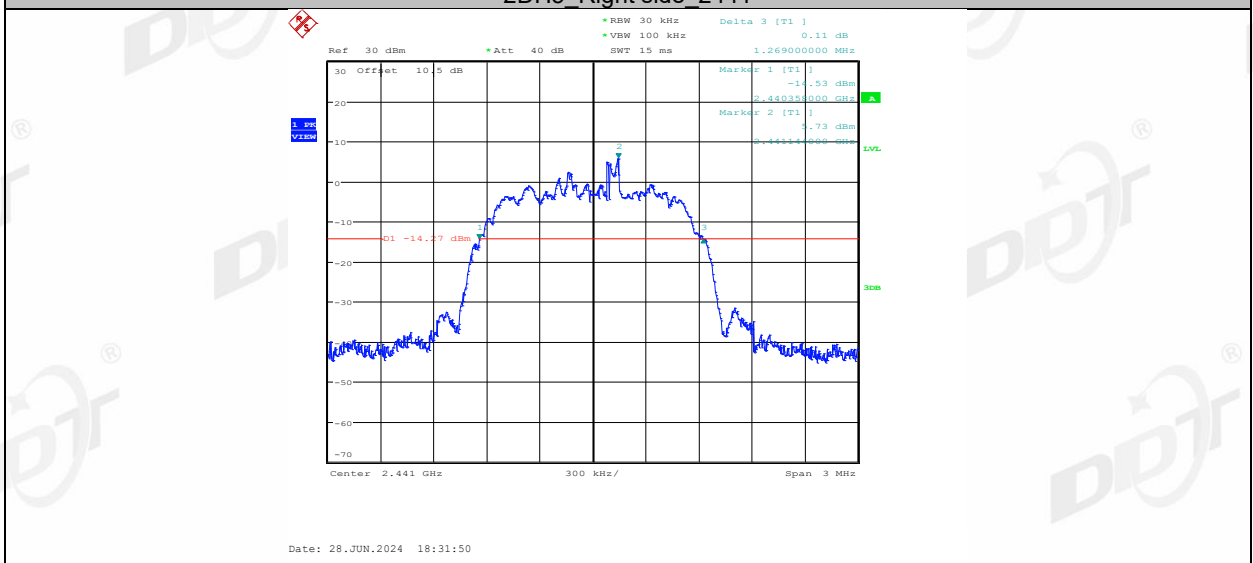
2DH5 Right side 2402



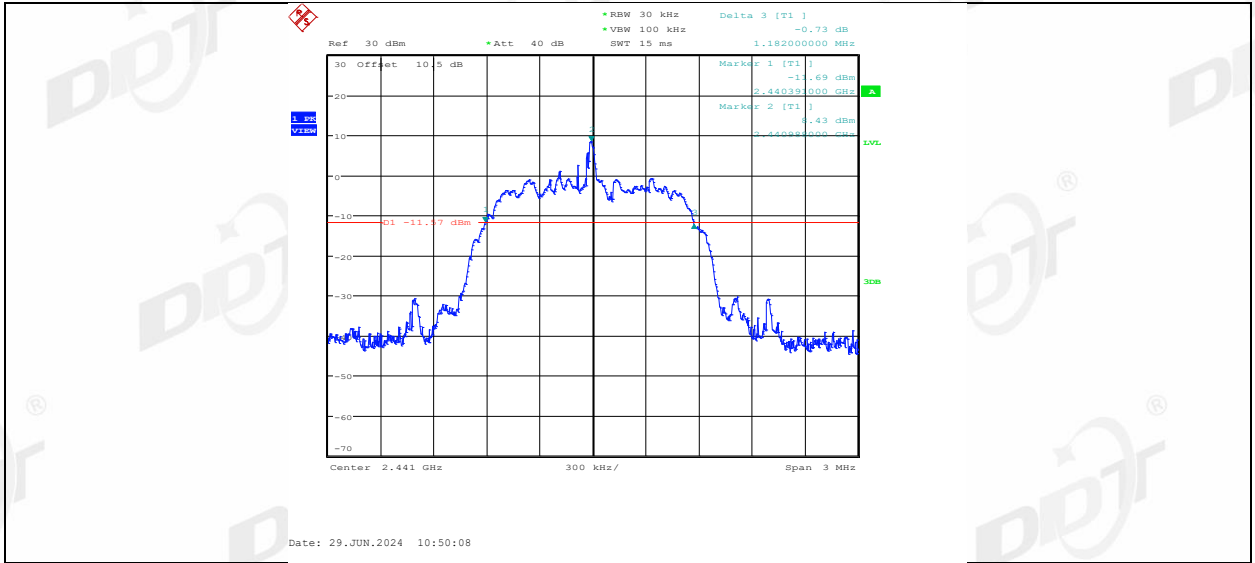
2DH5 Left side 2402



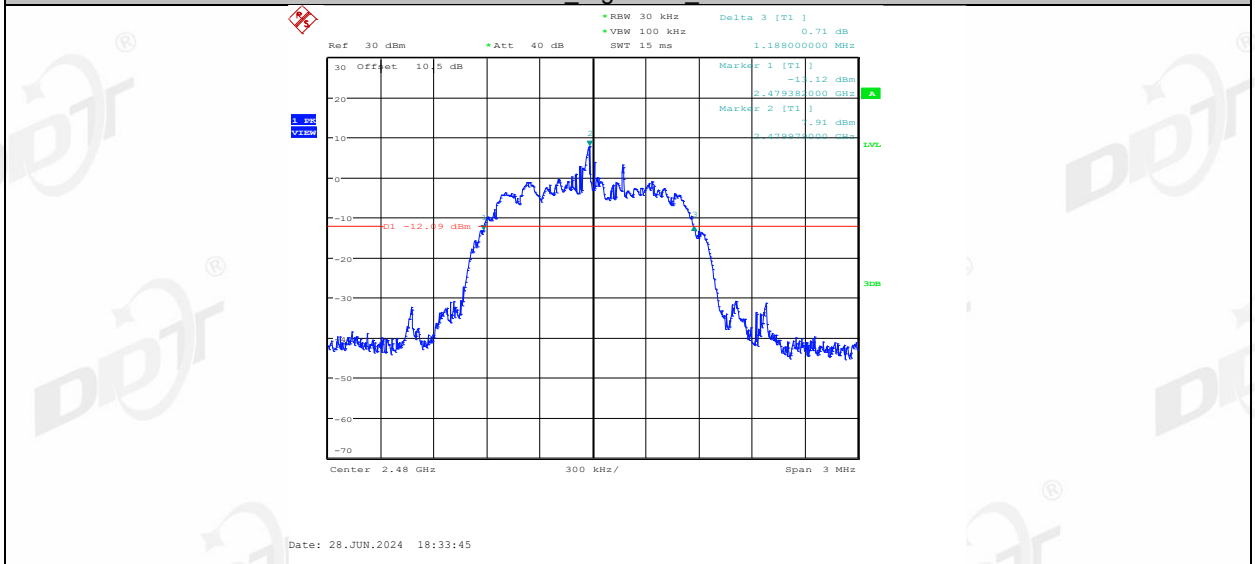
2DH5 Right side 2441



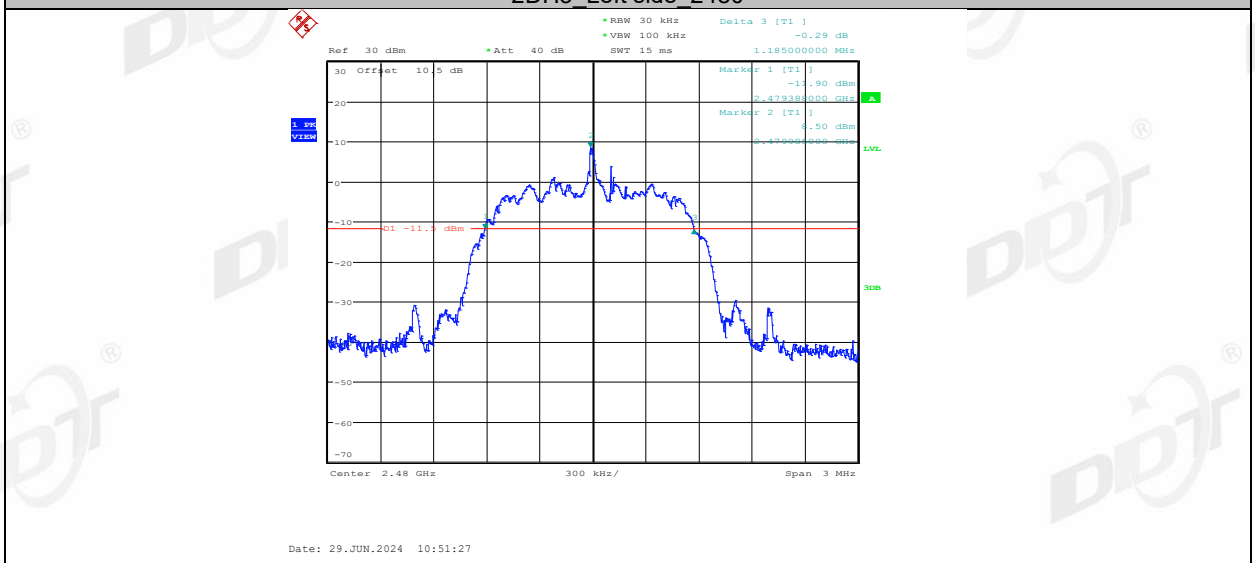
2DH5 Left side 2441



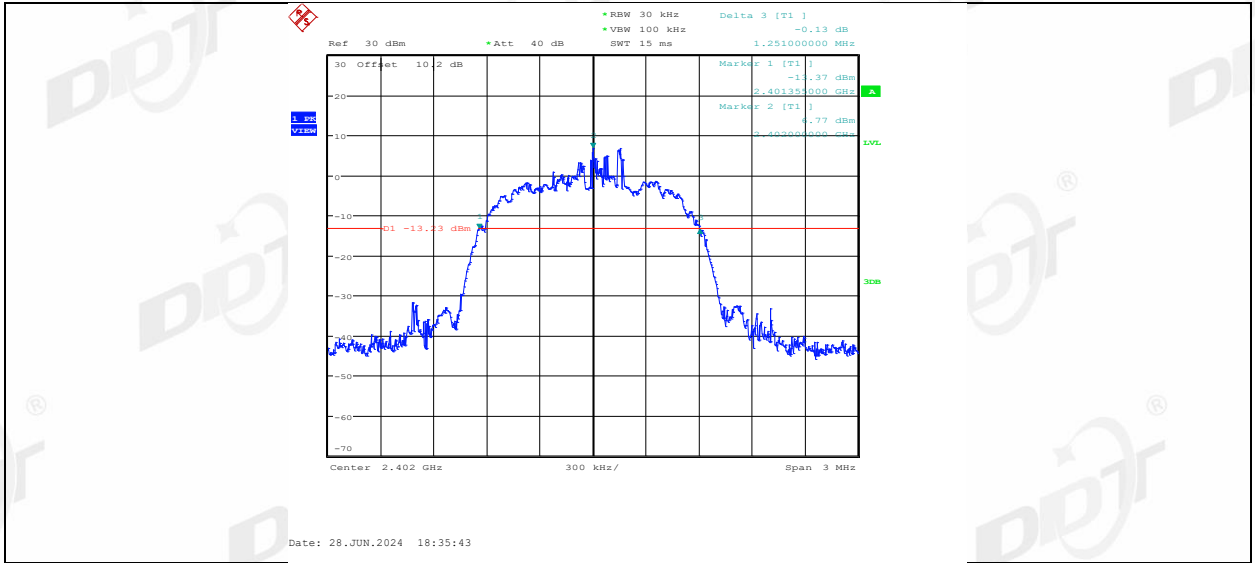
2DH5 Right side 2480



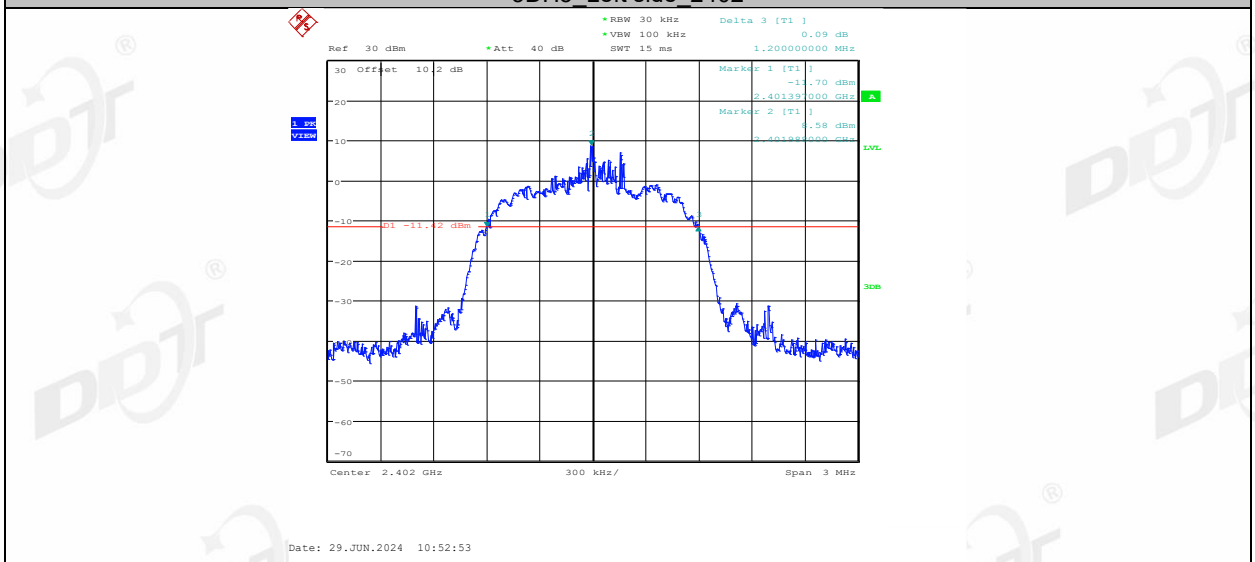
2DH5 Left side 2480



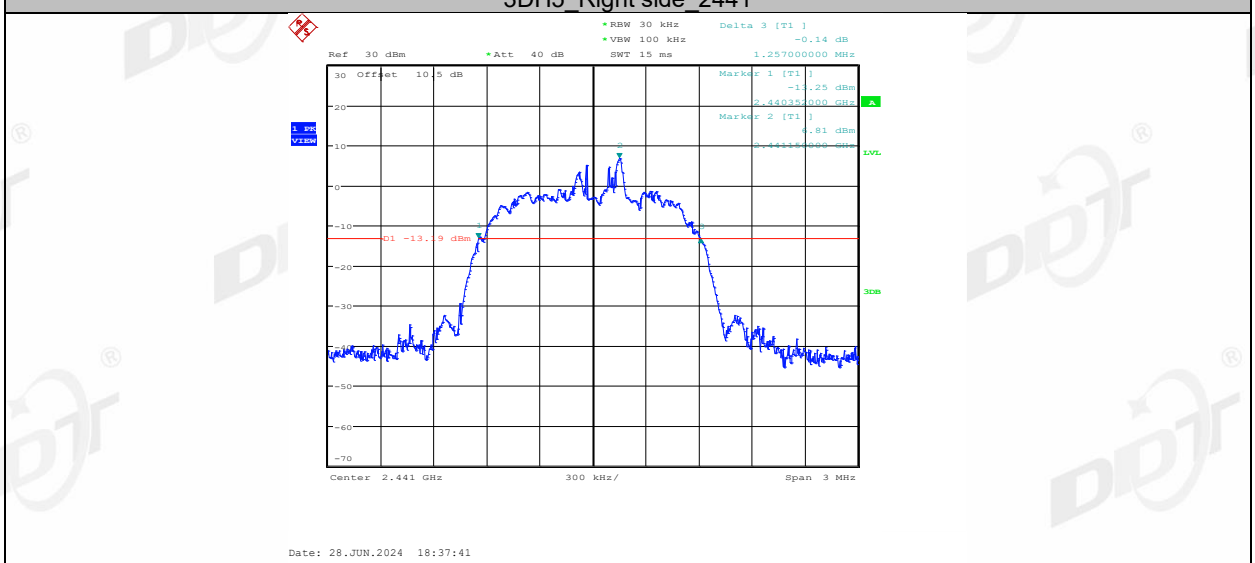
3DH5 Right side 2402



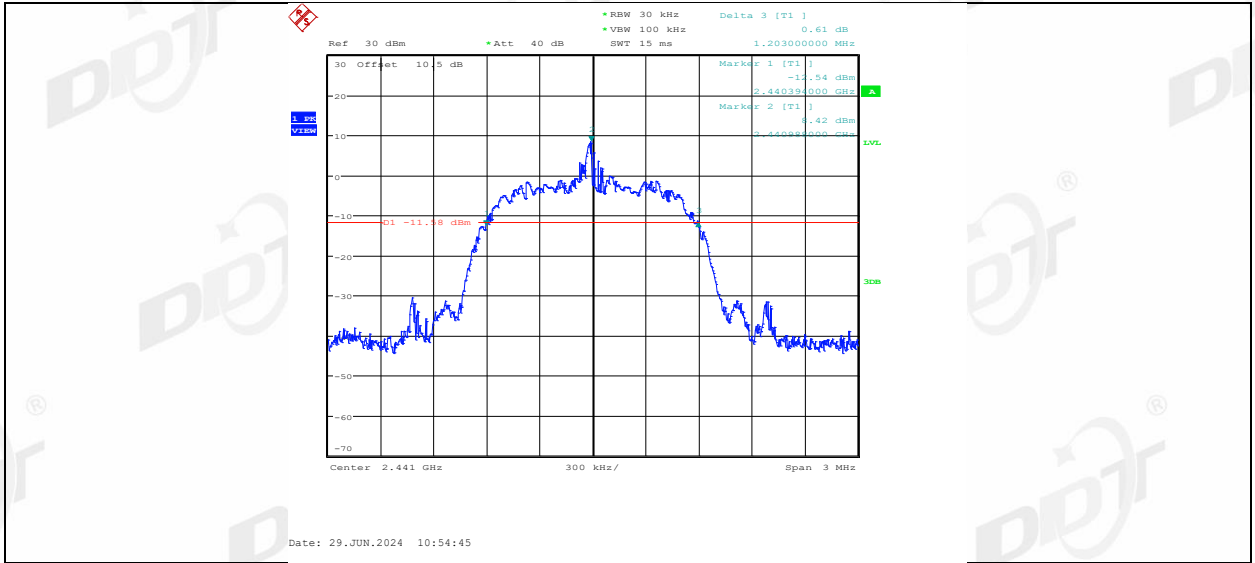
3DH5 Left side 2402



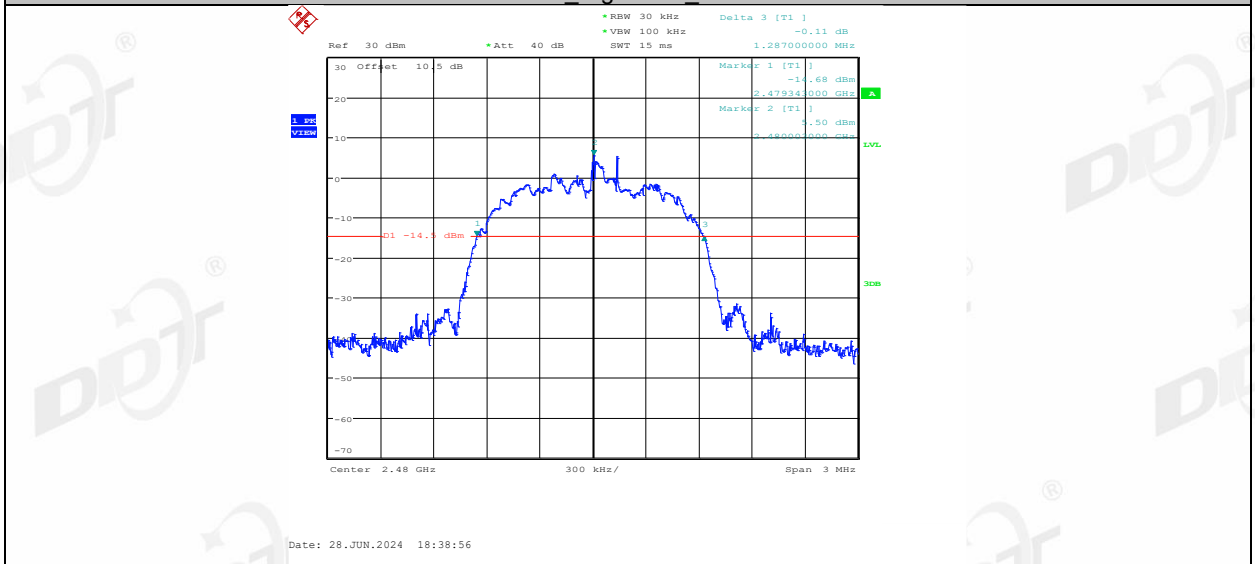
3DH5 Right side 2441



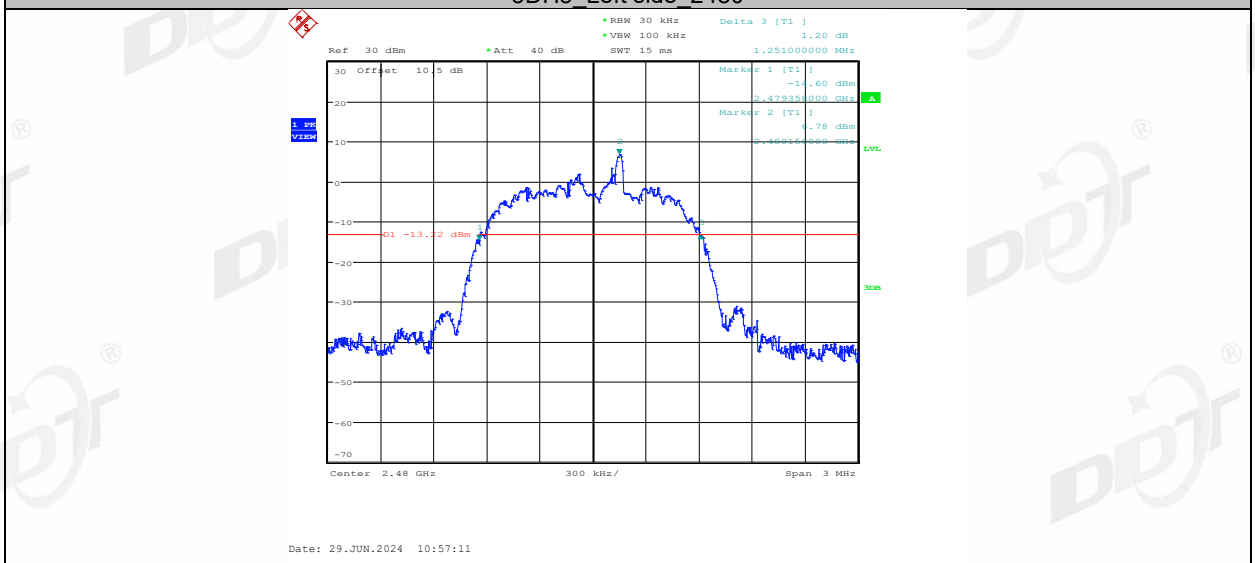
3DH5 Left side 2441



3DH5 Right side 2480

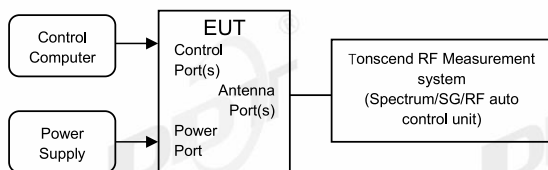


3DH5 Left side 2480



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:

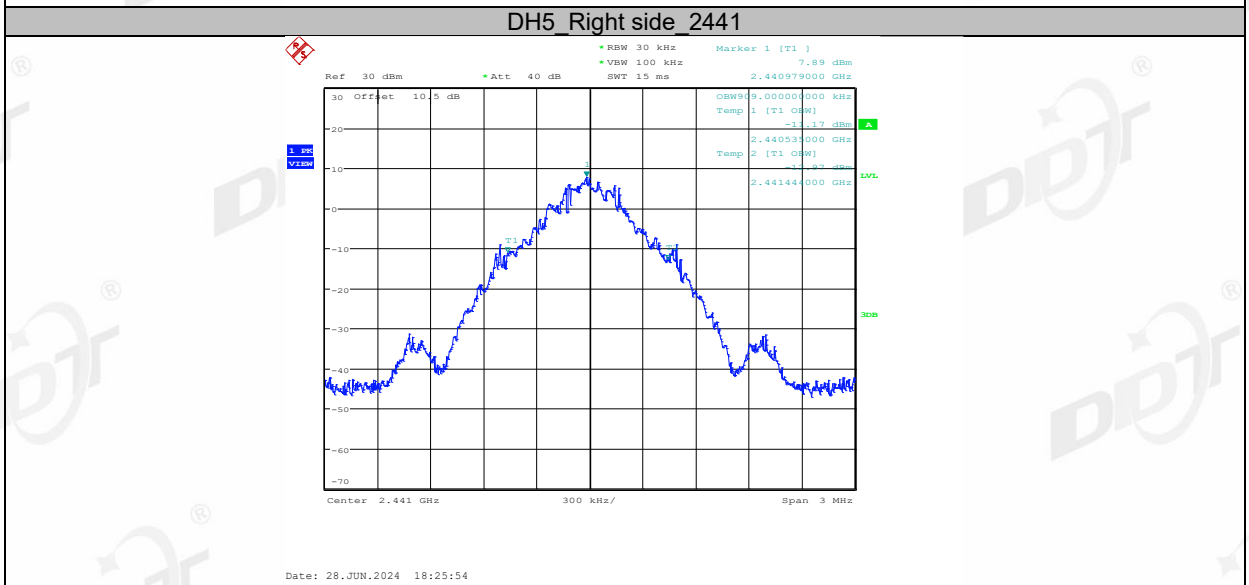
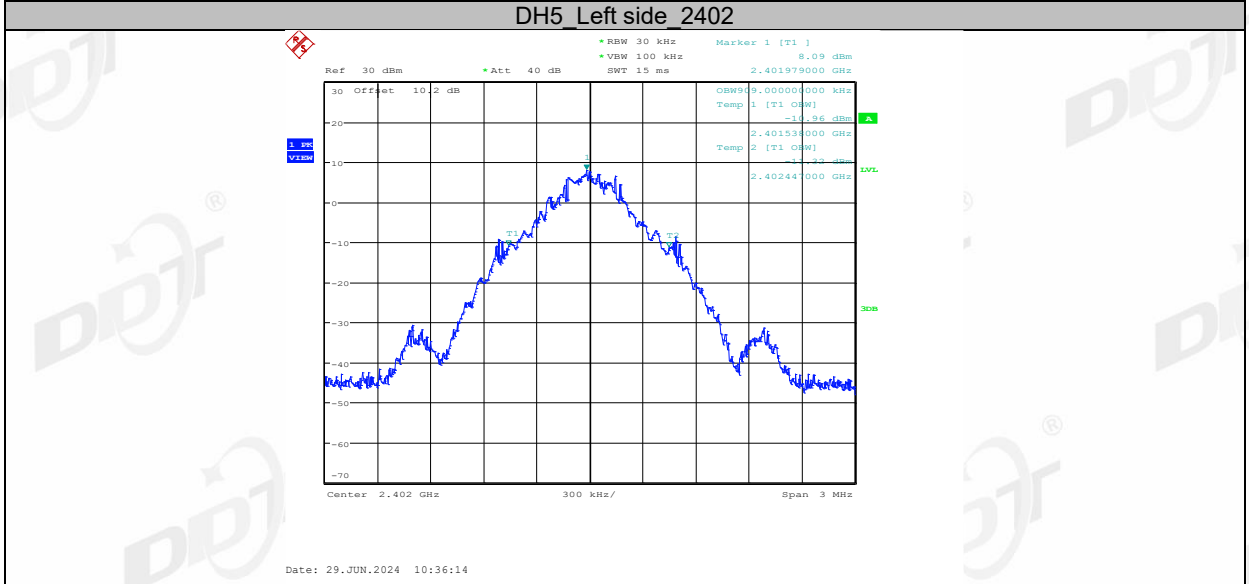
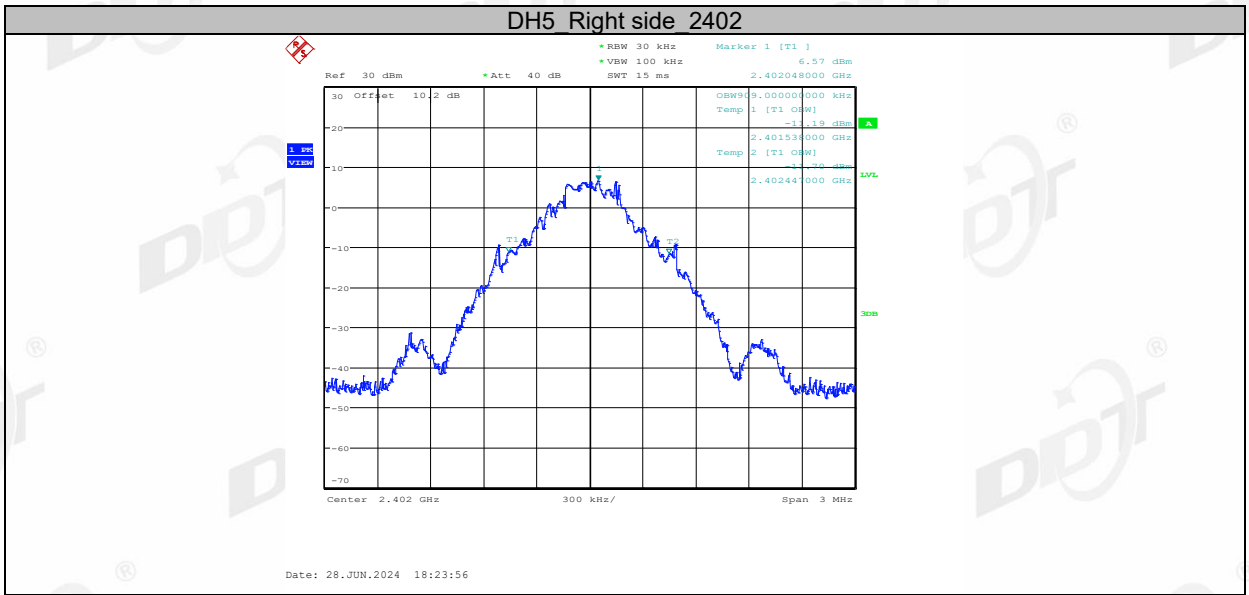
RBW:	1% to 5% of the OBW
VBW:	approximately three times RBW
Span:	between 1.5 times and 5.0 times the OBW
Detector Mode:	Peak
Sweep time:	Auto
Trace mode:	Max hold
- (5) Measure and record the results in the report.

5.4. Test result

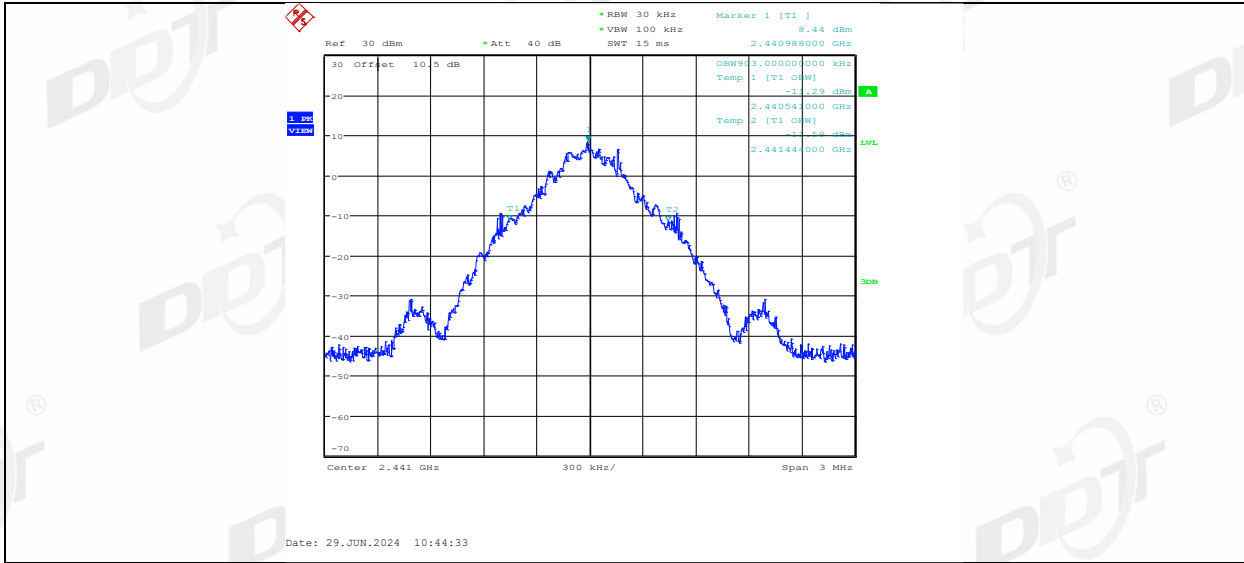
Test Engineer:	Zora Zhang	Test Site:	RF Measurement System 1#
Ambient Condition:	25.3°C,59.4%RH	Test Date:	2024.06.28
Test Power Supply:	Battery	Sample Number:	S24052314-002

Test Mode	Antenna	Frequency [MHz]	OCB [MHz]	FL[MHz]	FH[MHz]
DH5	Right side	2402	0.909	2401.5380	2402.4470
	Left side	2402	0.909	2401.5380	2402.4470
	Right side	2441	0.909	2440.5350	2441.4440
	Left side	2441	0.903	2440.5410	2441.4440
	Right side	2480	0.858	2479.5560	2480.4140
	Left side	2480	0.909	2479.5350	2480.4440
2DH5	Right side	2402	1.155	2401.4060	2402.5610
	Left side	2402	1.155	2401.4090	2402.5640
	Right side	2441	1.161	2440.4030	2441.5640
	Left side	2441	1.155	2440.4090	2441.5640
	Right side	2480	1.155	2479.4060	2480.5610
	Left side	2480	1.152	2479.4090	2480.5610
3DH5	Right side	2402	1.152	2401.4120	2402.5640
	Left side	2402	1.164	2401.4090	2402.5730
	Right side	2441	1.155	2440.4090	2441.5640
	Left side	2441	1.161	2440.4090	2441.5700
	Right side	2480	1.155	2479.4090	2480.5640
	Left side	2480	1.155	2479.4120	2480.5670

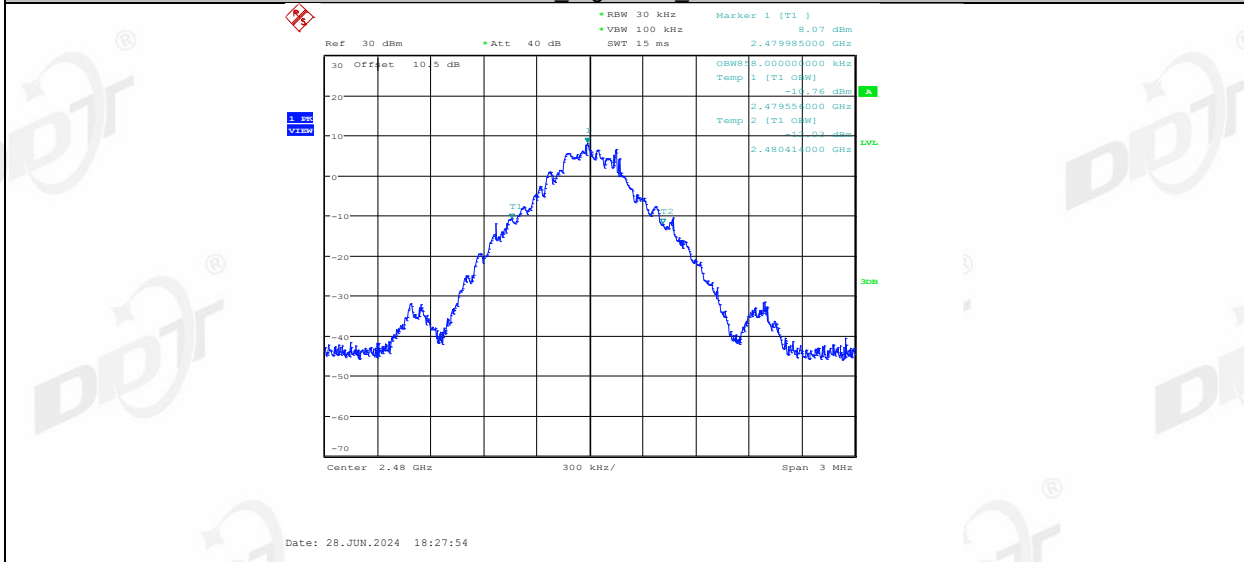
5.5. Test graphs



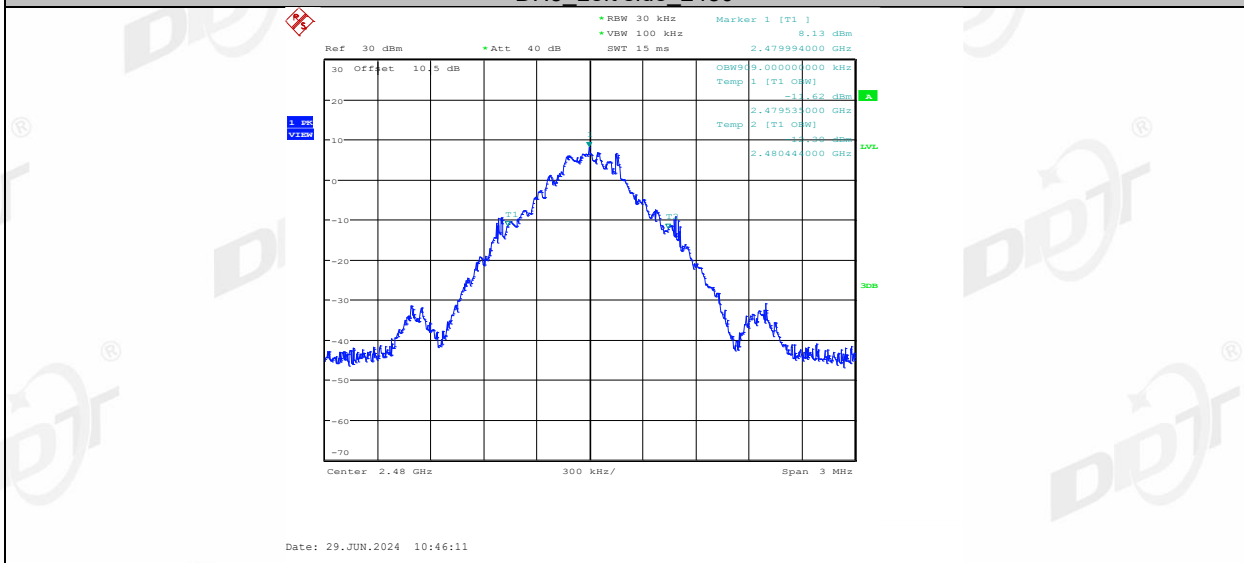
DH5 Left side 2441



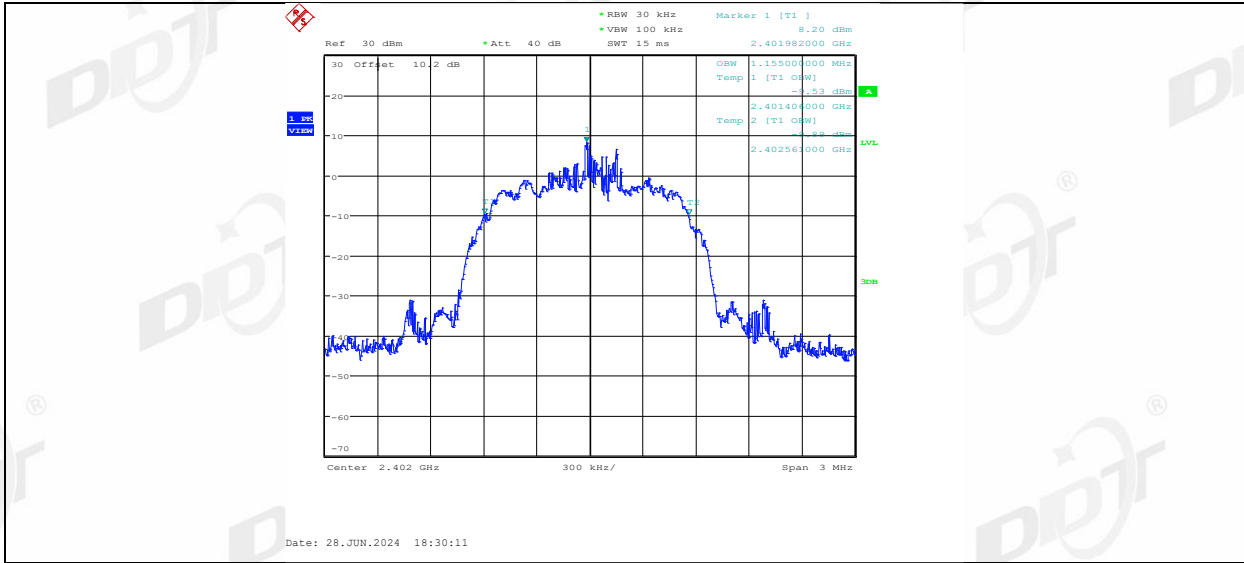
DH5 Right side 2480



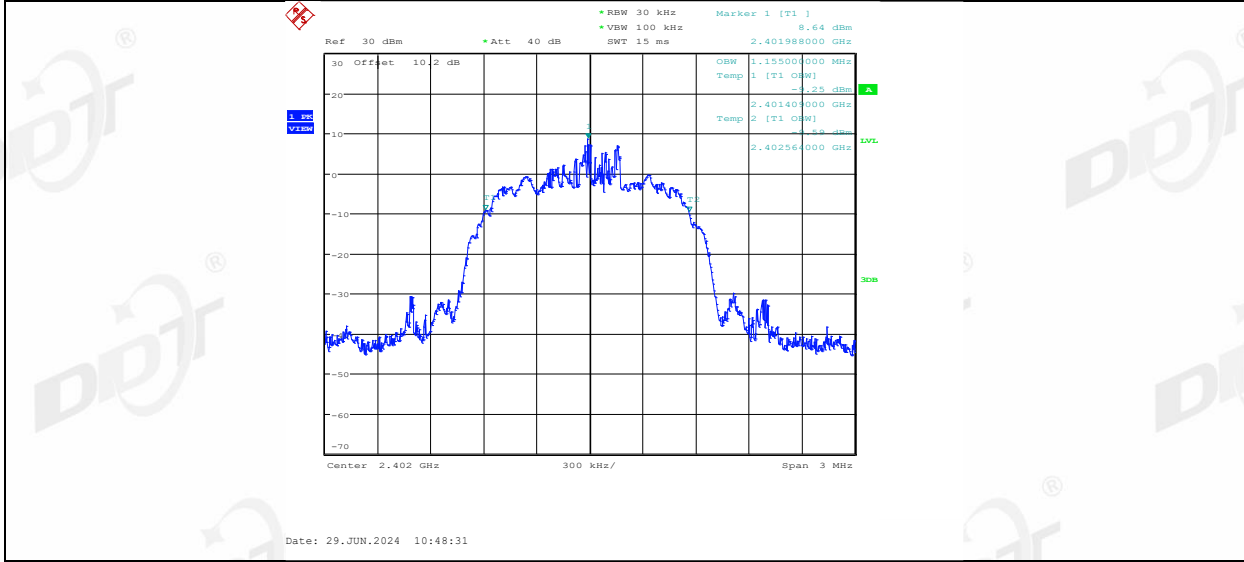
DH5 Left side 2480



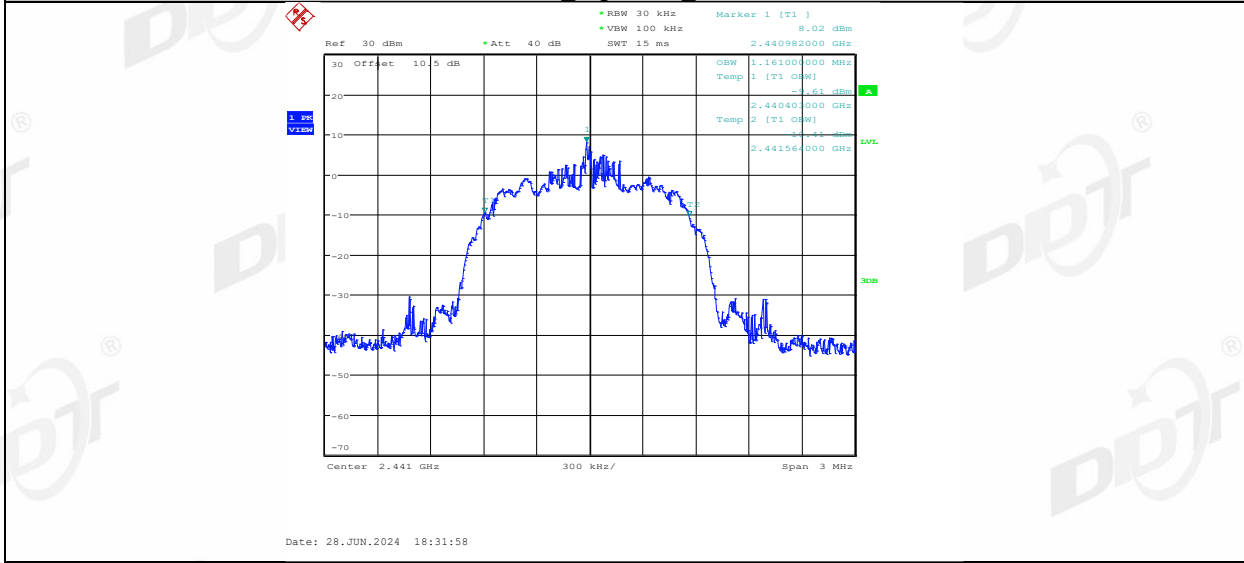
2DH5 Right side 2402



2DH5 Left side 2402



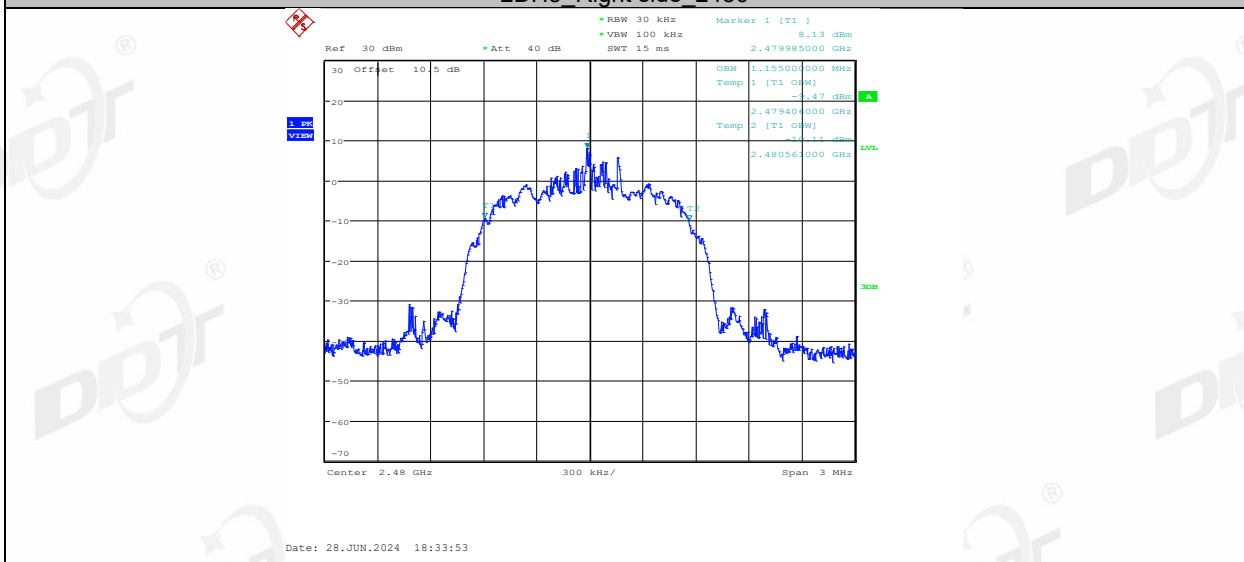
2DH5 Right side 2441



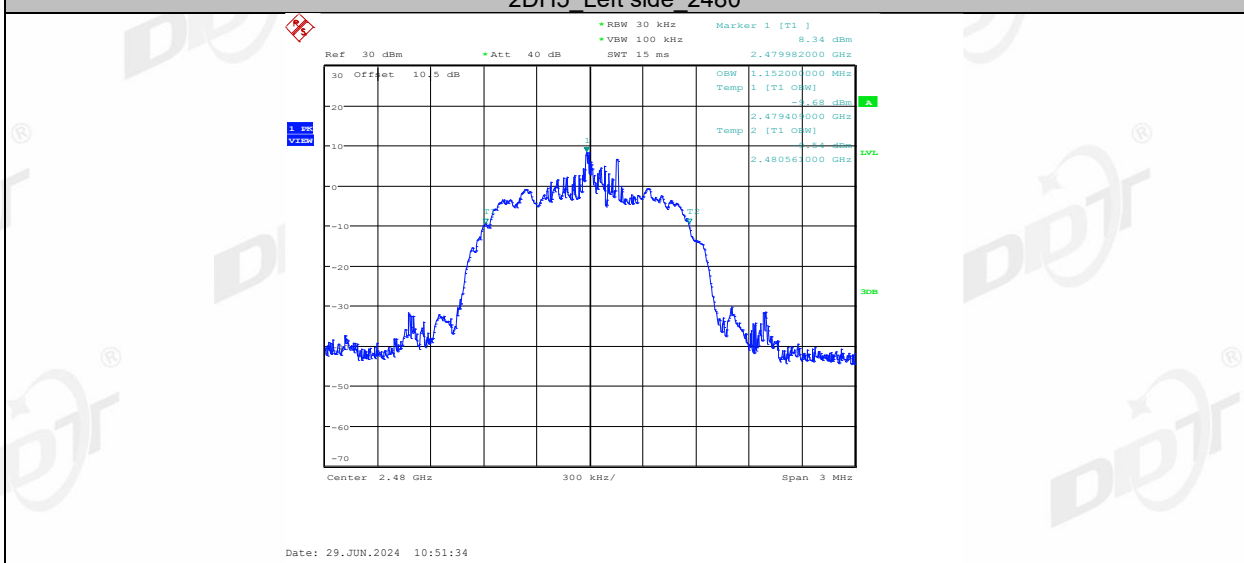
2DH5 Left side 2441



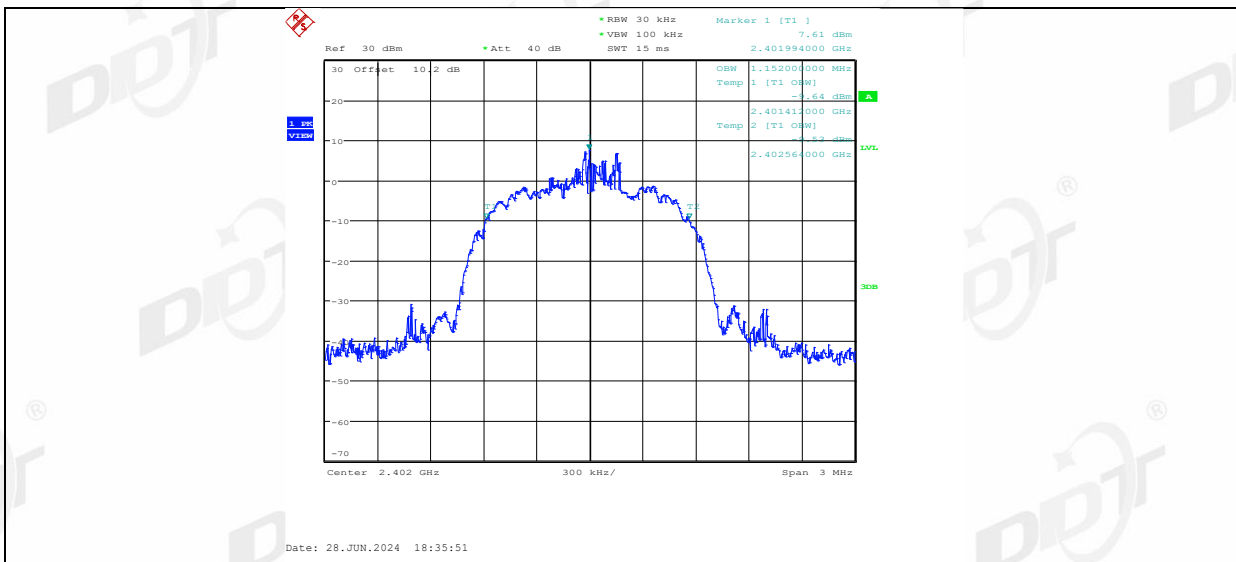
2DH5 Right side 2480



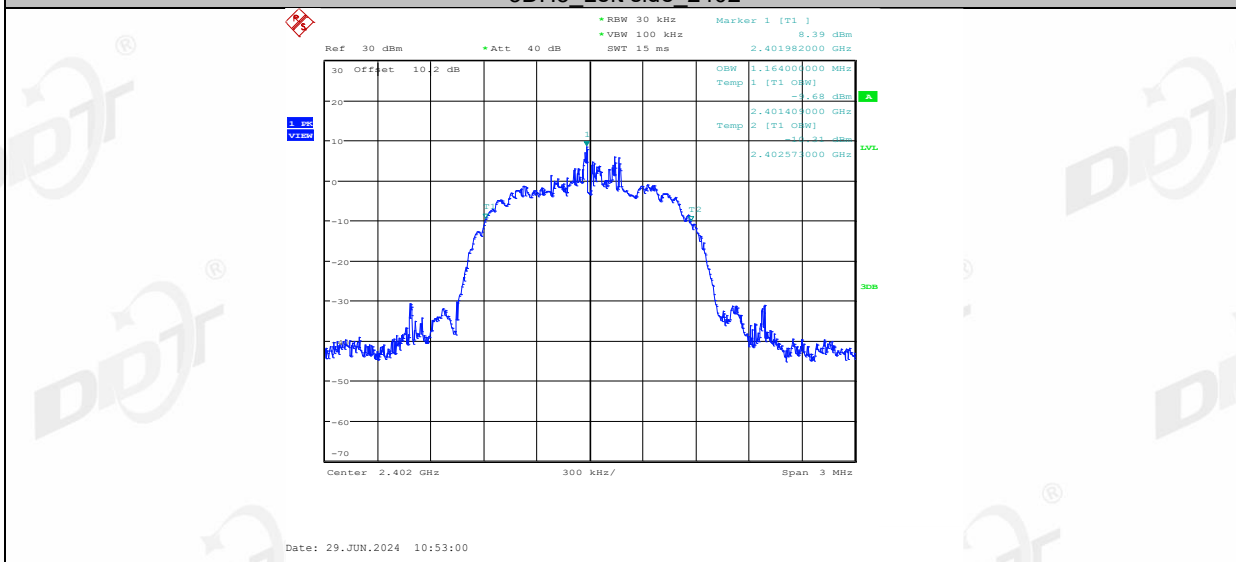
2DH5 Left side 2480



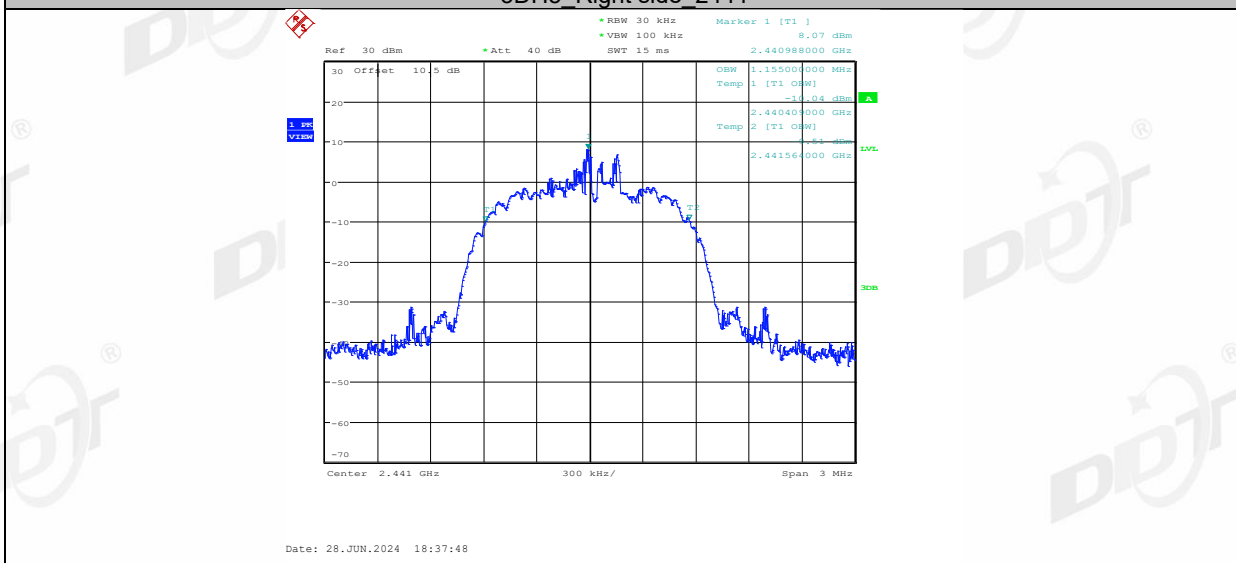
3DH5 Right side 2402



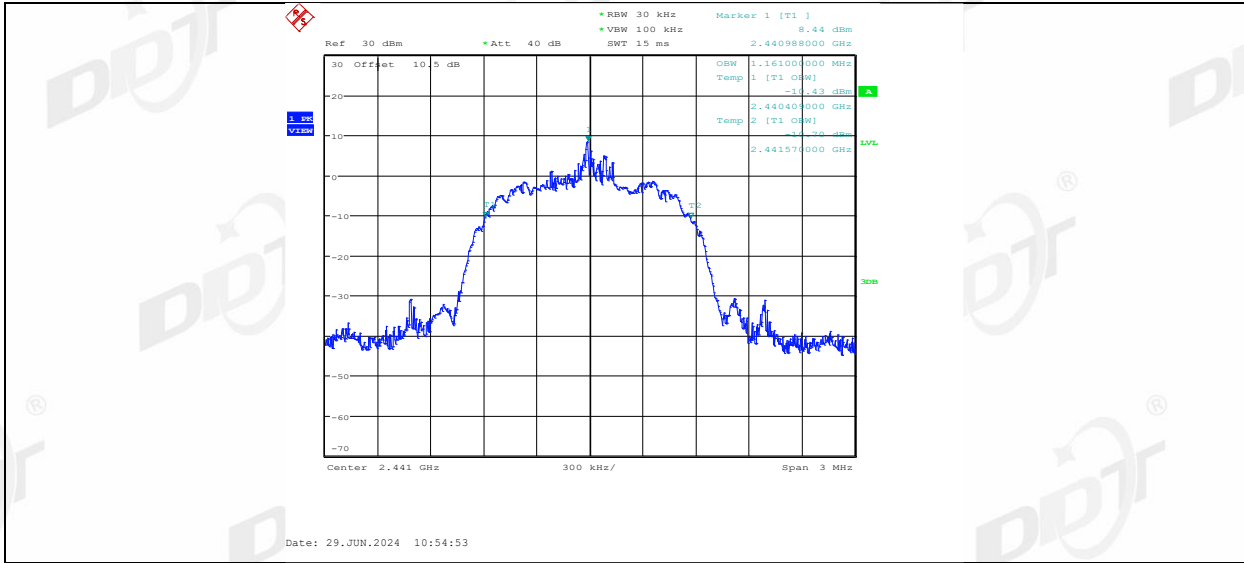
3DH5 Left side 2402



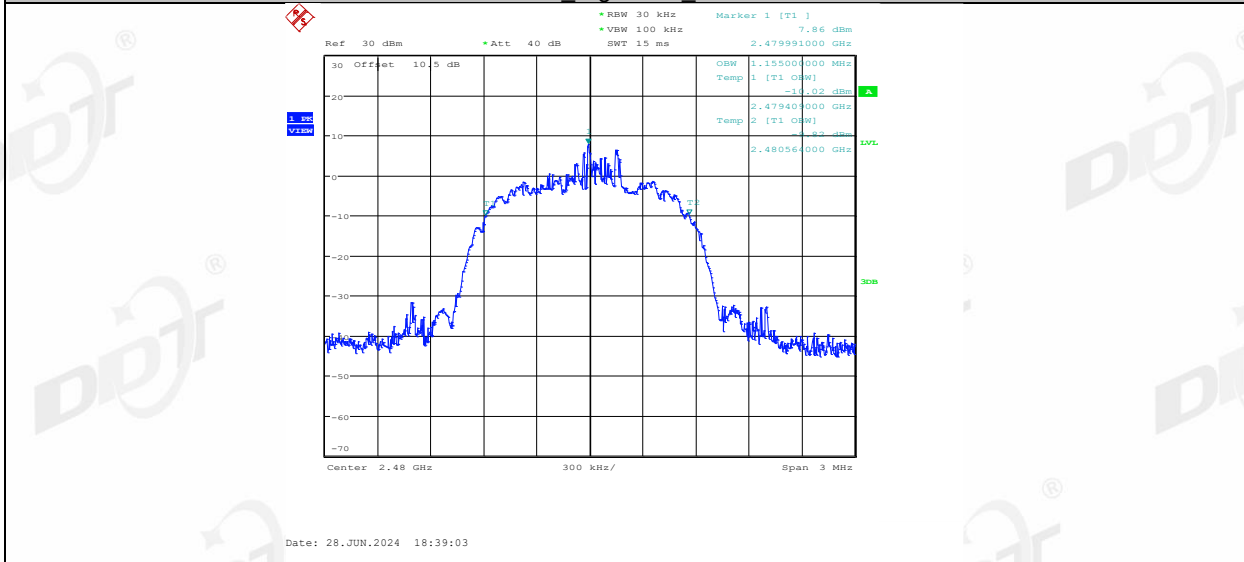
3DH5 Right side 2441



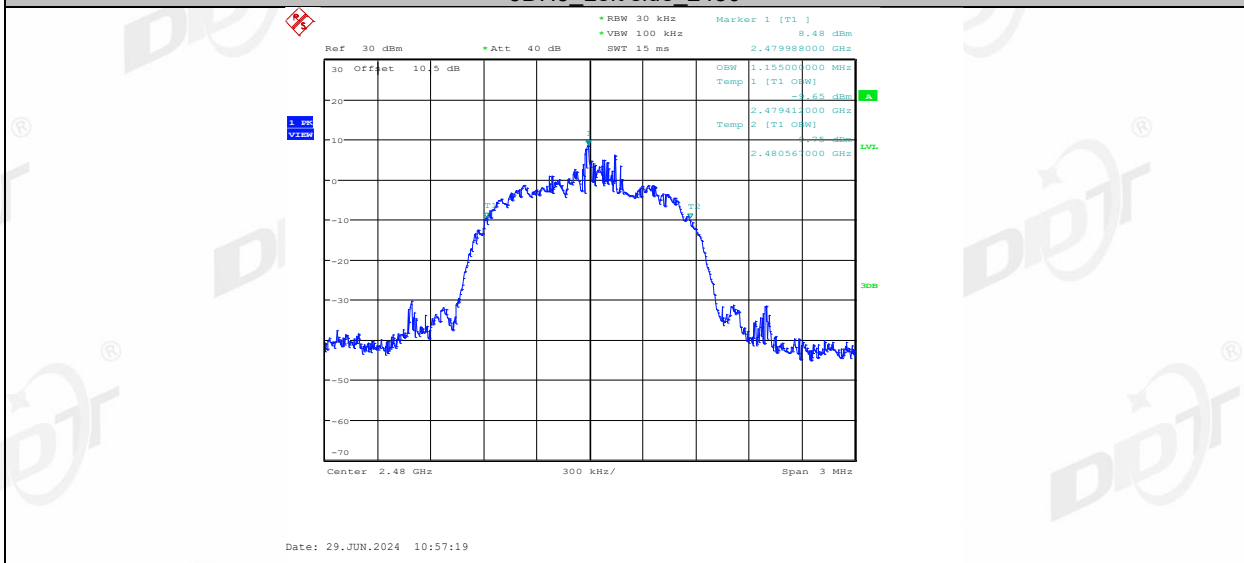
3DH5 Left side 2441



3DH5 Right side 2480

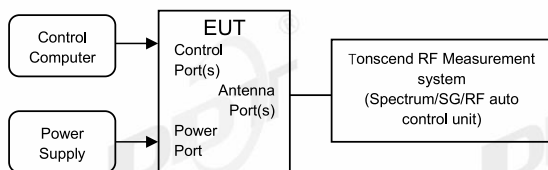


3DH5 Left side 2480



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:

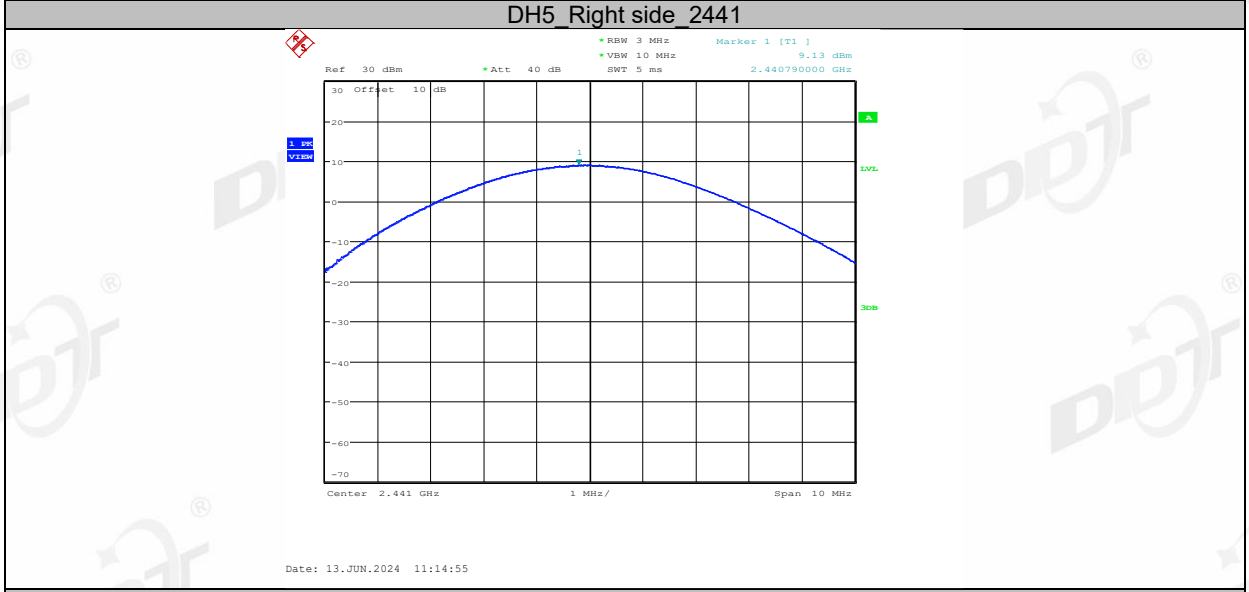
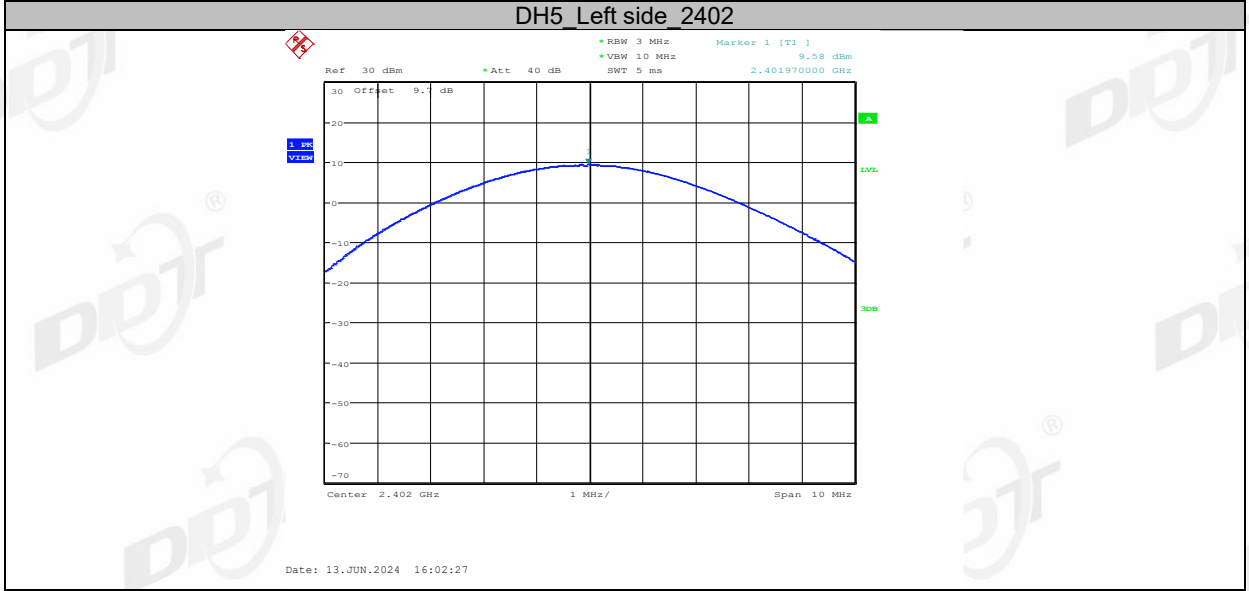
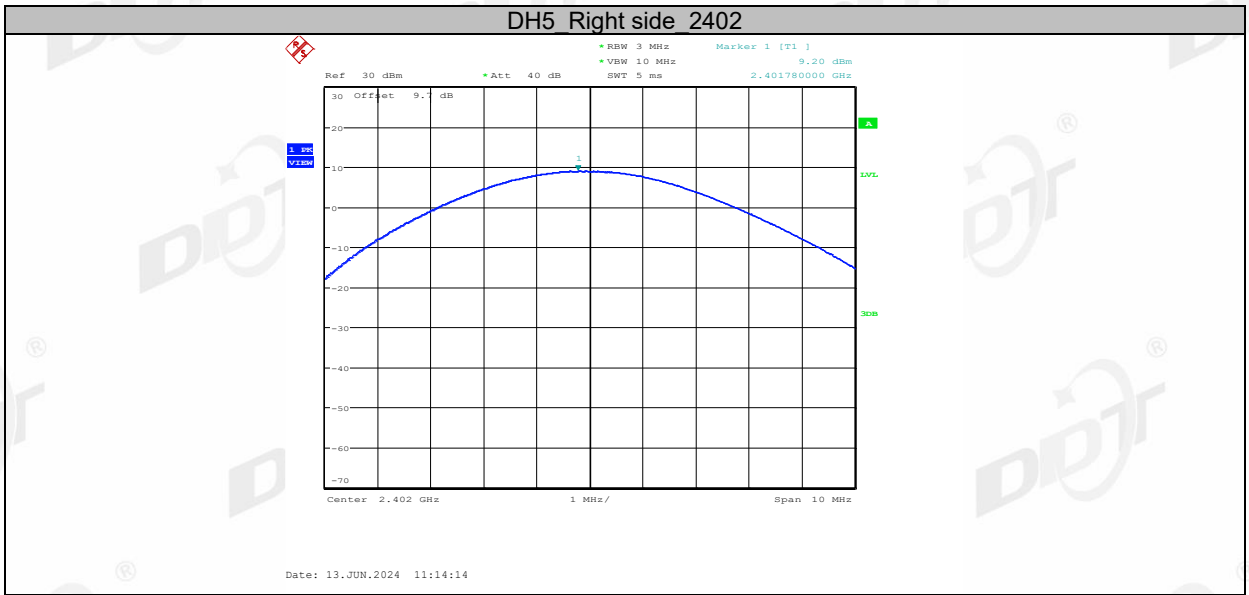
RBW:	> 20 dB bandwidth of the emission being measured.
VBW:	VBW \geq RBW.
Span:	Approximately five times the 20 dB bandwidth, centered on a hopping channel.
Detector Mode:	Peak
Sweep time:	Auto
Trace mode:	Max hold
- (5) Use the marker-to-peak function to set the marker to the peak of the emission and record the results in the report.

6.4. Test result

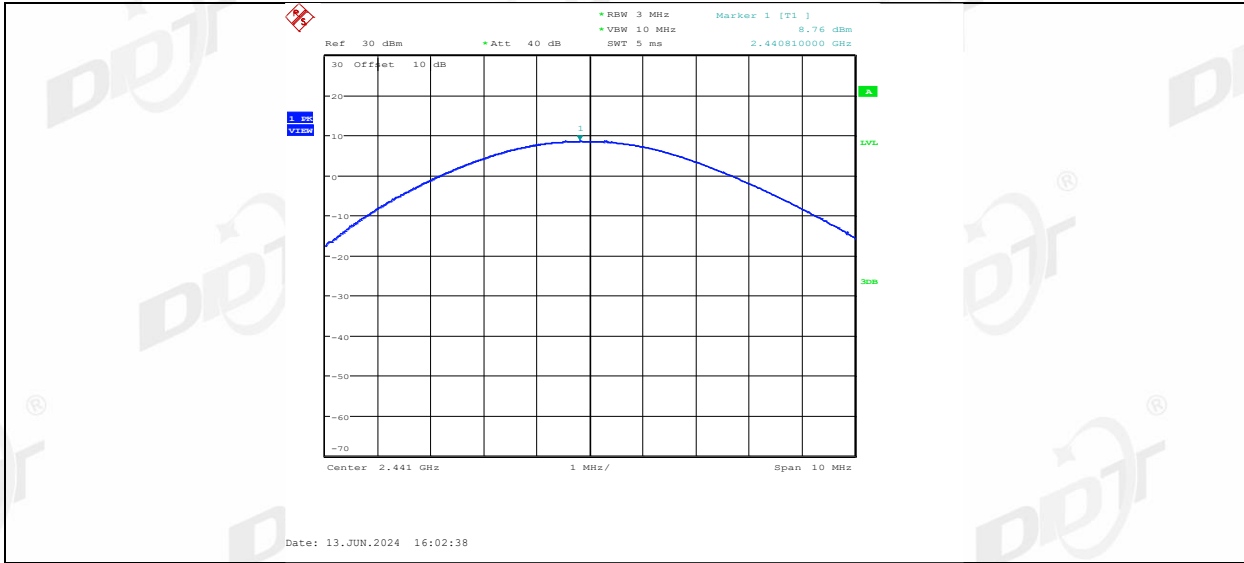
Test Engineer:	Zora Zhang	Test Site:	RF Measurement System 1#
Ambient Condition:	25.3°C,59.4%RH	Test Date:	2024.06.13
Test Power Supply:	Battery	Sample Number:	S24052314-002

Test Mode	Antenna	Frequency [MHz]	Conducted Peak Power [dBm]	Conducted Limit [dBm]	EIRP [dBm]	EIRP Limit [dBm]	Verdict
DH5	Right side	2402	9.20	≤20.97	6.53	≤30	PASS
	Left side	2402	9.58	≤20.97	7.64	≤30	PASS
	Right side	2441	9.13	≤20.97	6.46	≤30	PASS
	Left side	2441	8.76	≤20.97	6.82	≤30	PASS
	Right side	2480	8.87	≤20.97	6.20	≤30	PASS
	Left side	2480	9.24	≤20.97	7.30	≤30	PASS
2DH5	Right side	2402	9.21	≤20.97	6.54	≤30	PASS
	Left side	2402	9.59	≤20.97	7.65	≤30	PASS
	Right side	2441	9.13	≤20.97	6.46	≤30	PASS
	Left side	2441	8.84	≤20.97	6.90	≤30	PASS
	Right side	2480	8.88	≤20.97	6.21	≤30	PASS
	Left side	2480	9.28	≤20.97	7.34	≤30	PASS
3DH5	Right side	2402	9.18	≤20.97	6.51	≤30	PASS
	Left side	2402	9.59	≤20.97	7.65	≤30	PASS
	Right side	2441	9.12	≤20.97	6.45	≤30	PASS
	Left side	2441	8.79	≤20.97	6.85	≤30	PASS
	Right side	2480	8.86	≤20.97	6.19	≤30	PASS
	Left side	2480	9.31	≤20.97	7.37	≤30	PASS

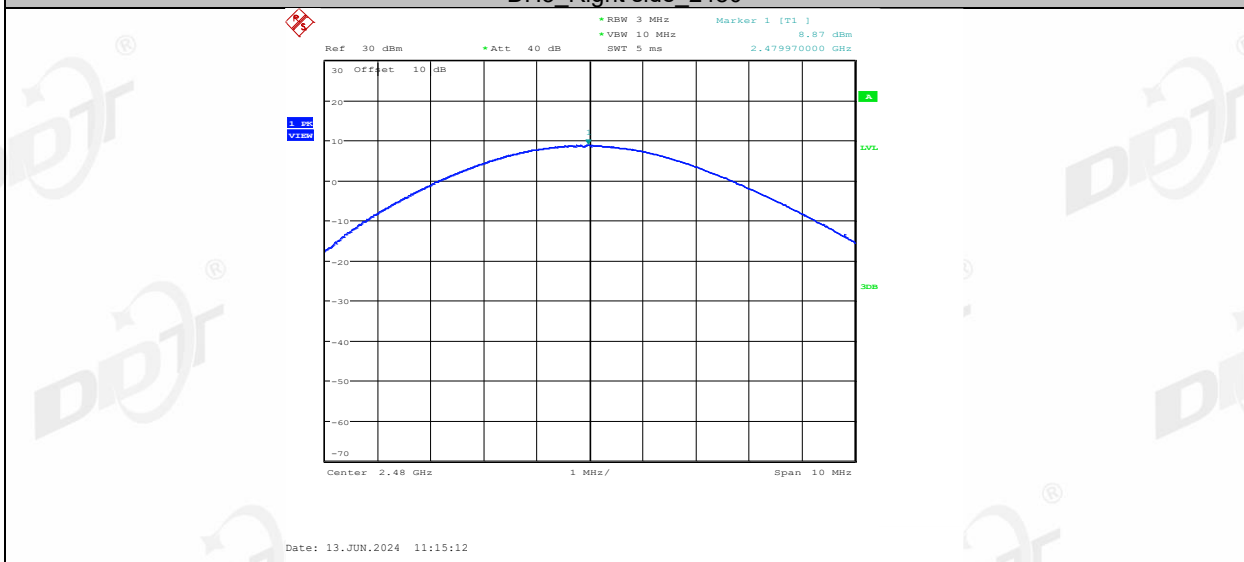
6.5. Test graphs



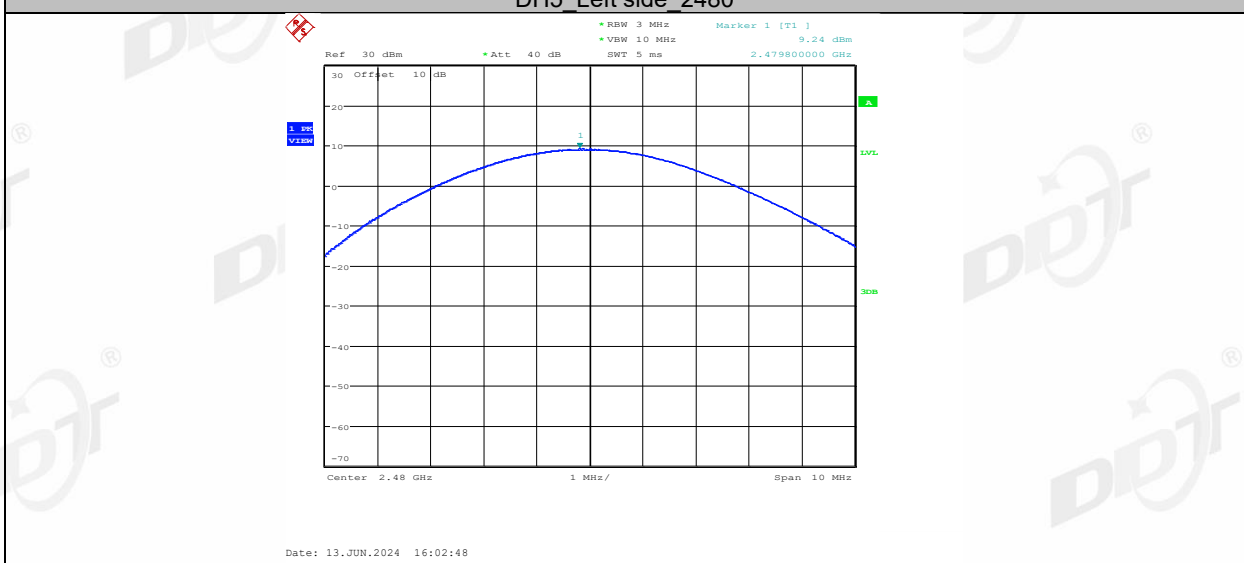
DH5 Left side 2441



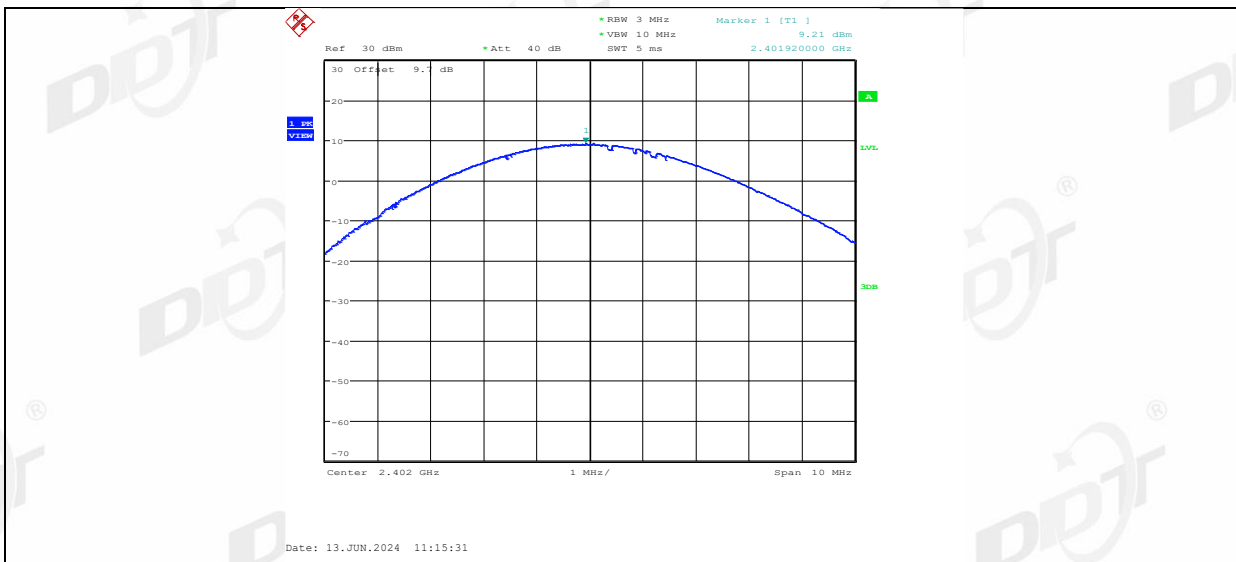
DH5_Right side_2480



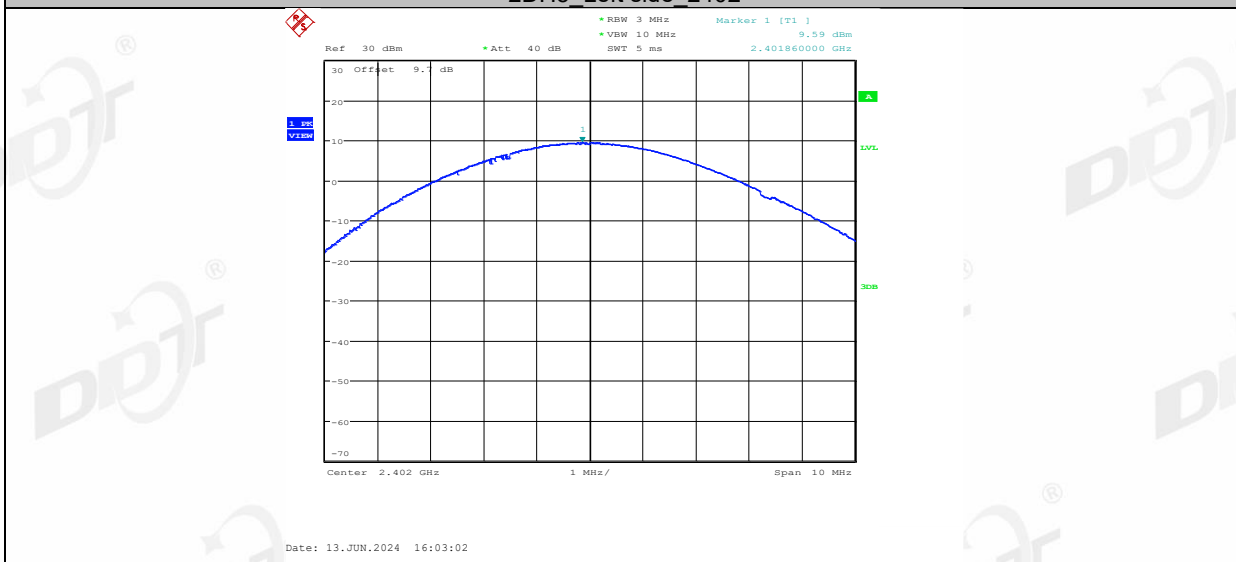
DH5_Left side_2480



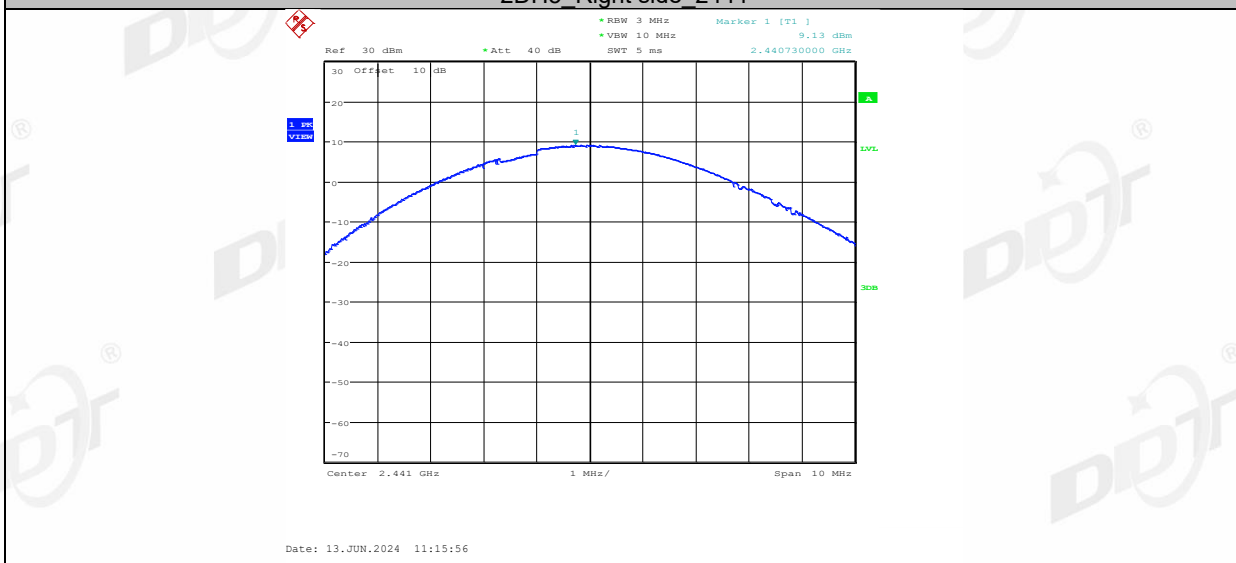
2DH5_Right side_2402



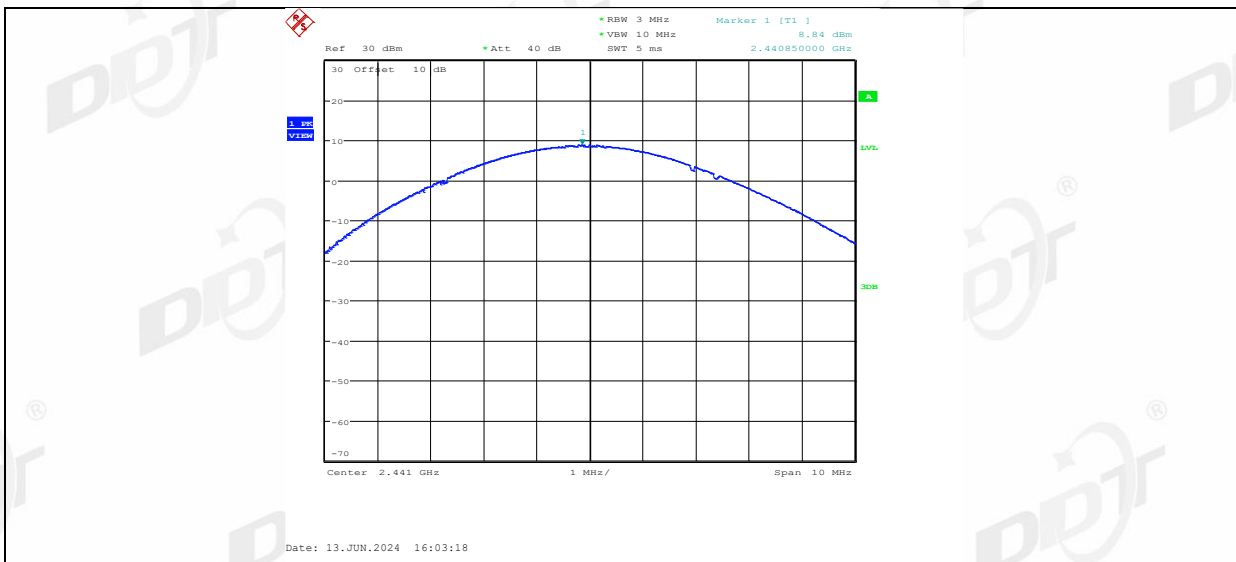
2DH5 Left side 2402



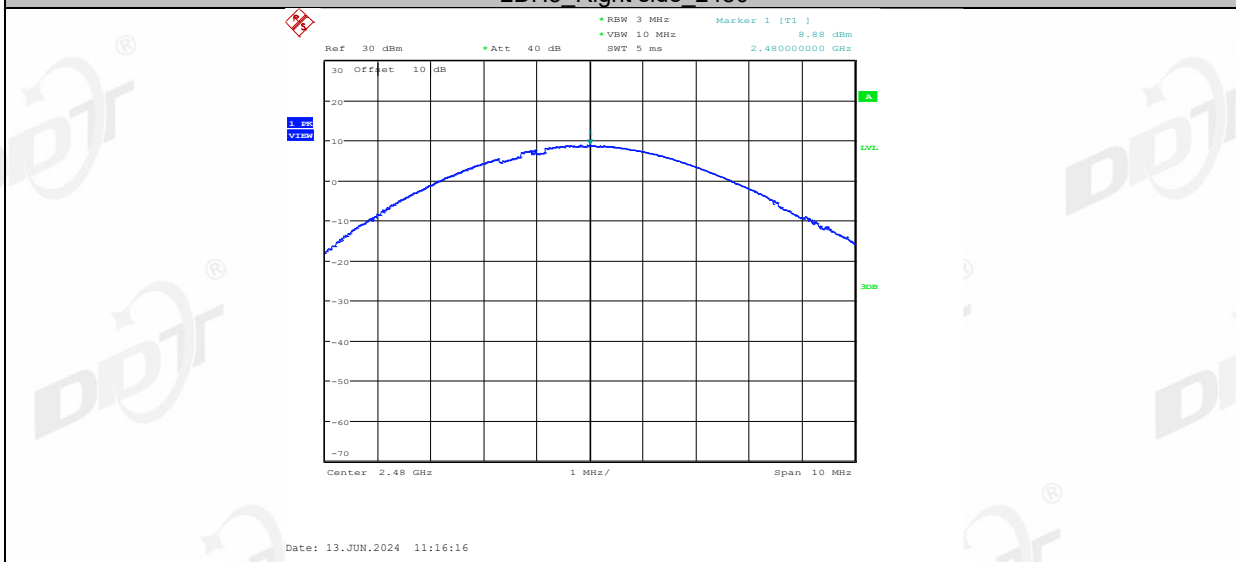
2DH5 Right side 2441



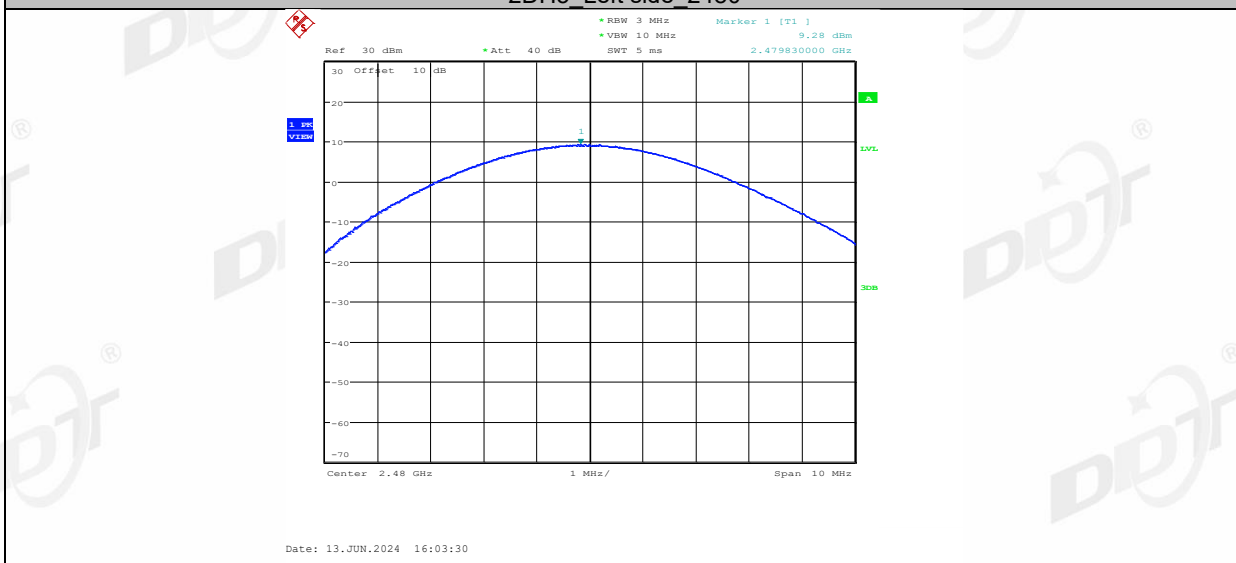
2DH5 Left side 2441



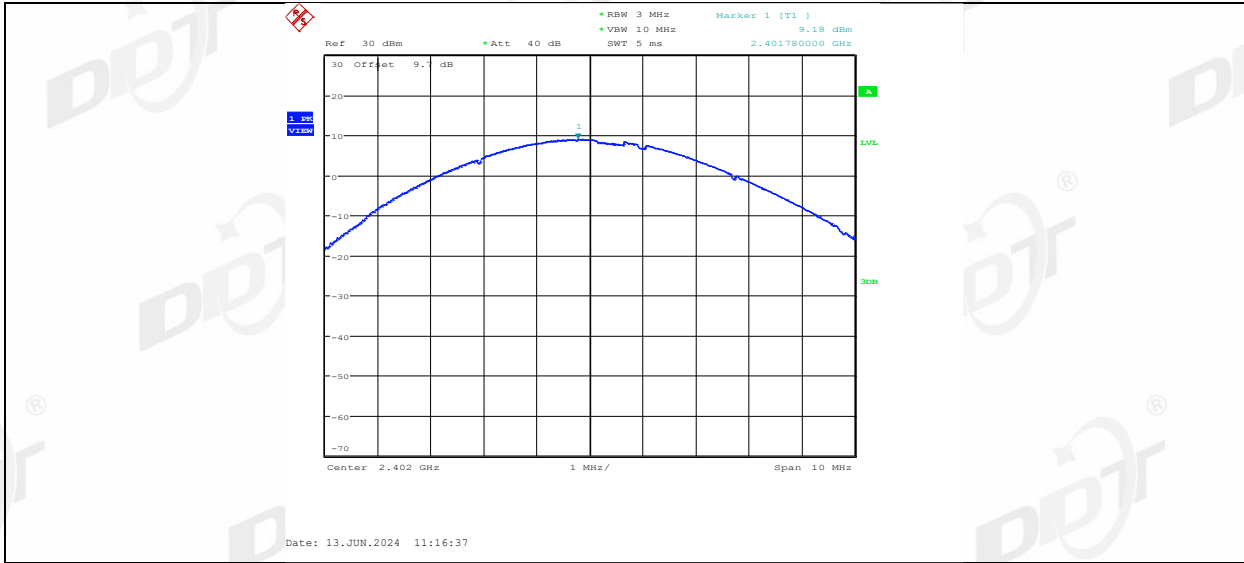
2DH5 Right side 2480



2DH5 Left side 2480



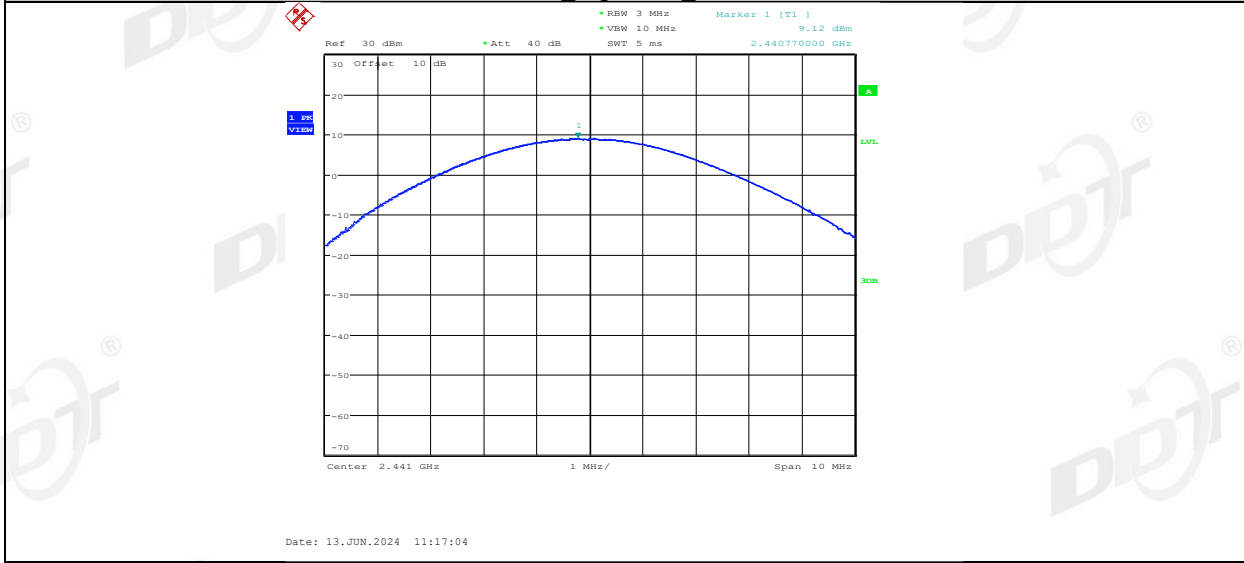
3DH5 Right side 2402



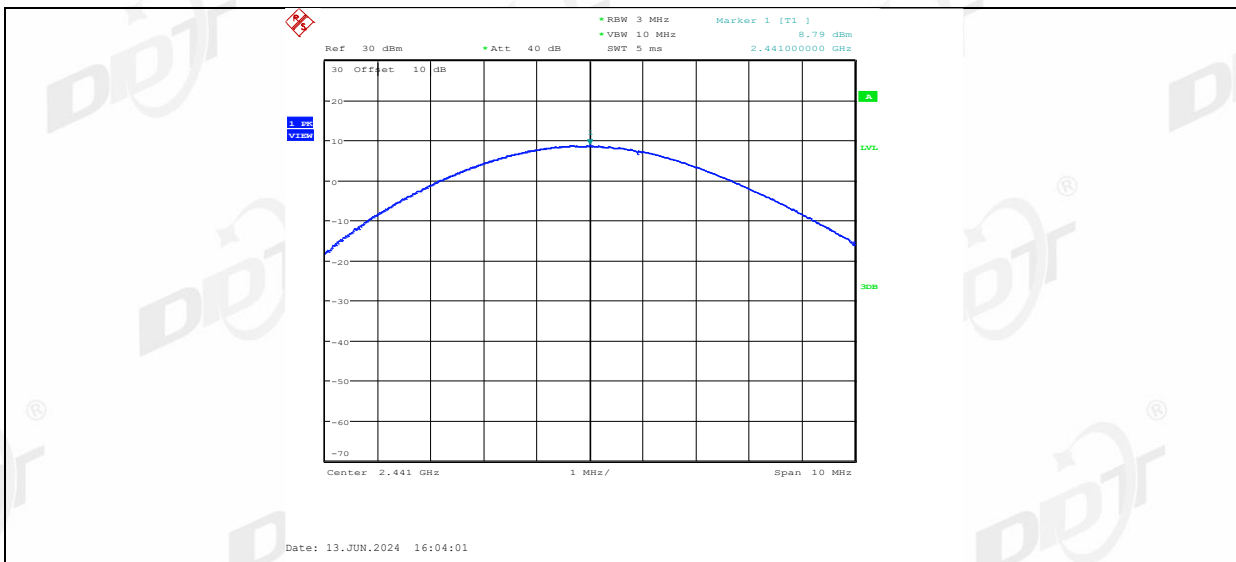
3DH5 Left side 2402



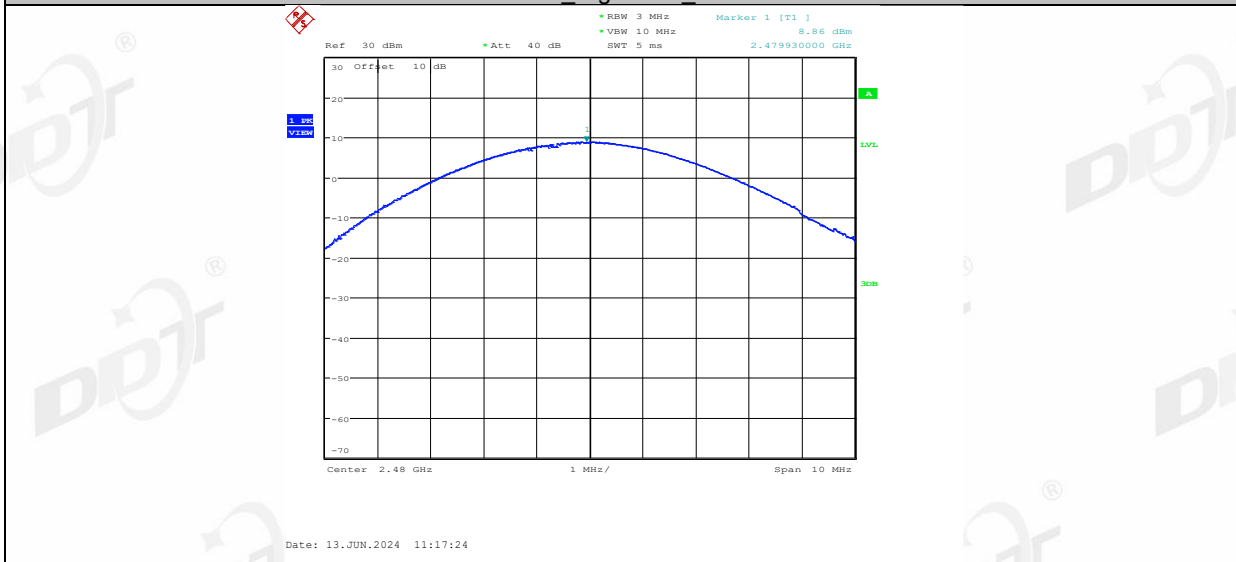
3DH5 Right side 2441



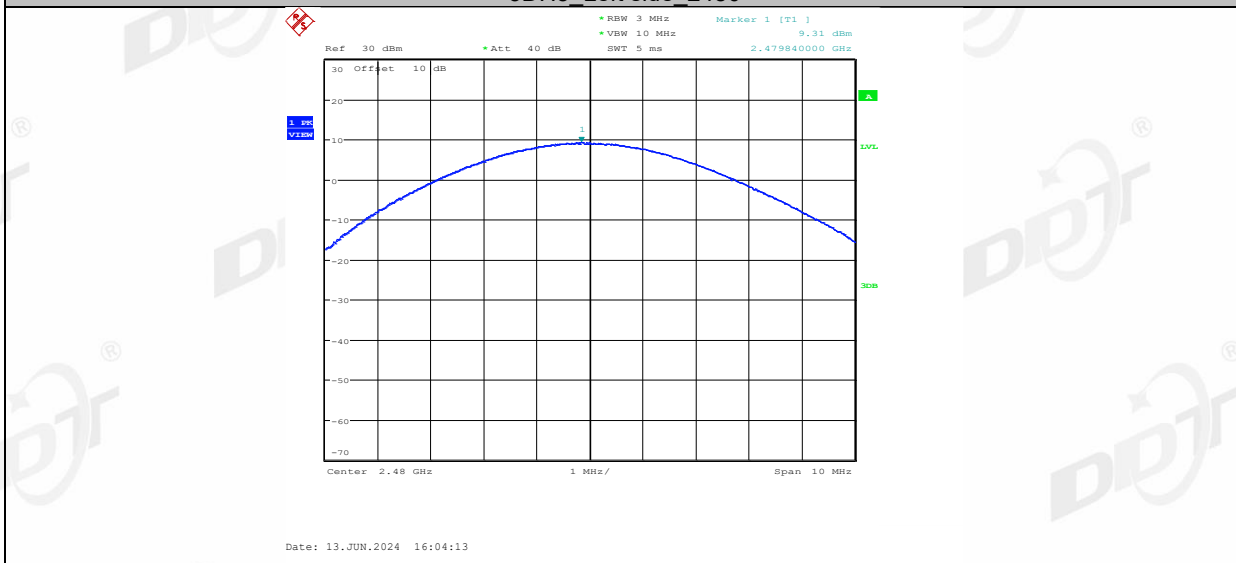
3DH5 Left side 2441



3DH5 Right side 2480

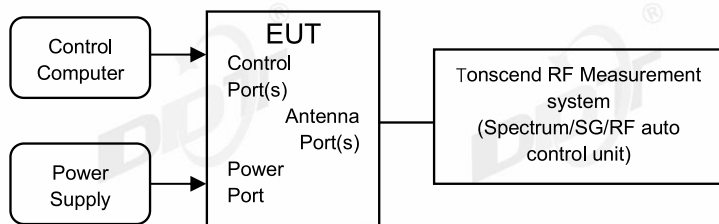


3DH5 Left side 2480



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

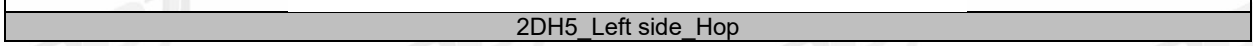
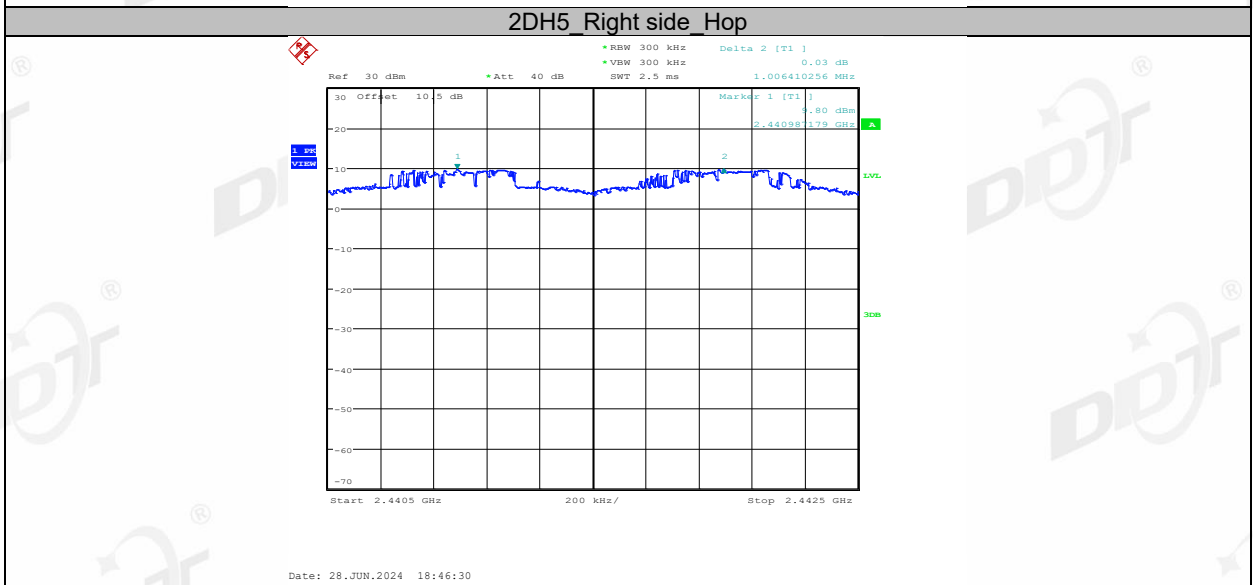
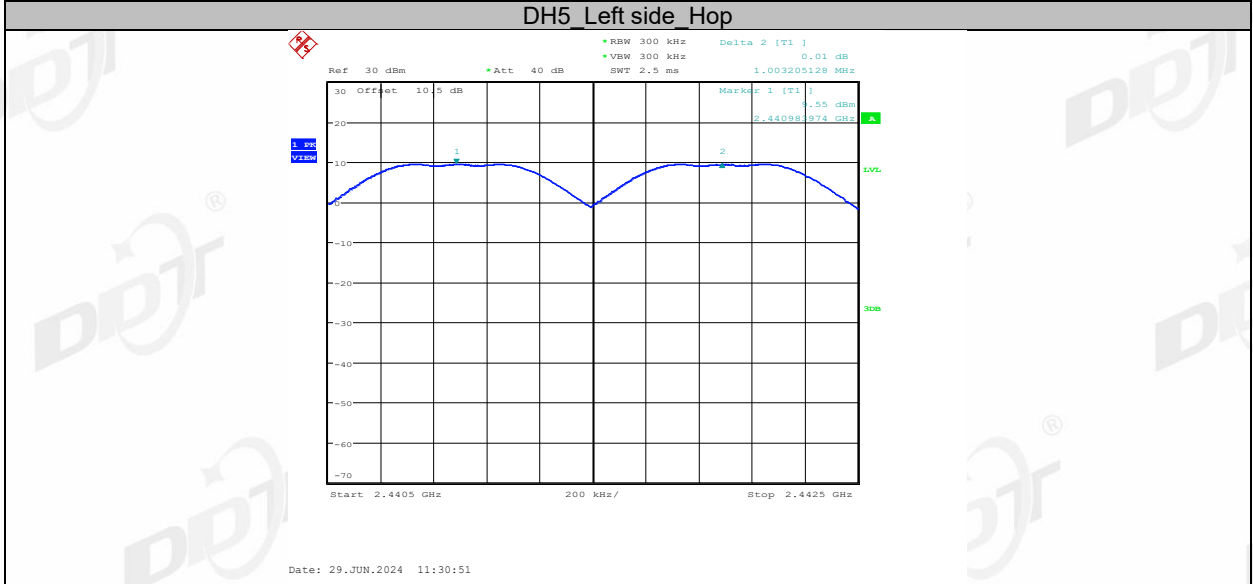
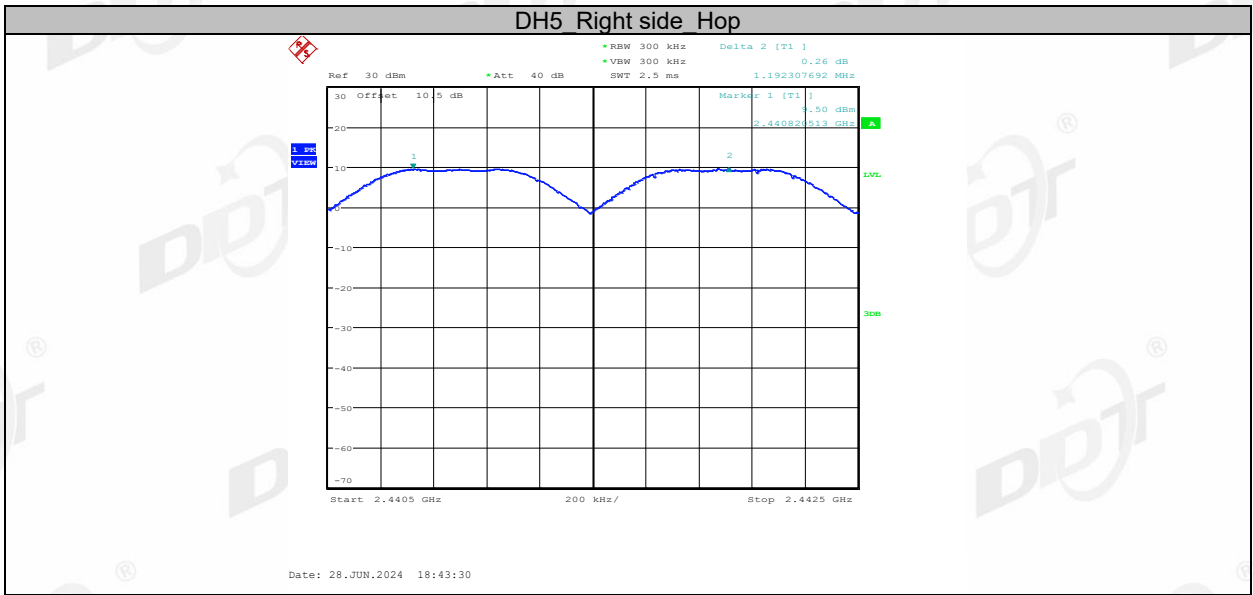
- (1) The test according to ANSI C63.10-2013 clause 7.8.2.
- (2) Connect EUT's antenna output to spectrum analyzer by RF cable, the path loss was compensated to the results.
- (3) Set the EUT as maximum power setting and enable the EUT transmit continuously.
- (4) Use the following spectrum analyzer settings for the maximum peak output power measurement:
 - RBW: approximately 30% of the channel spacing
 - VBW: $VBW \geq RBW$.
 - 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.

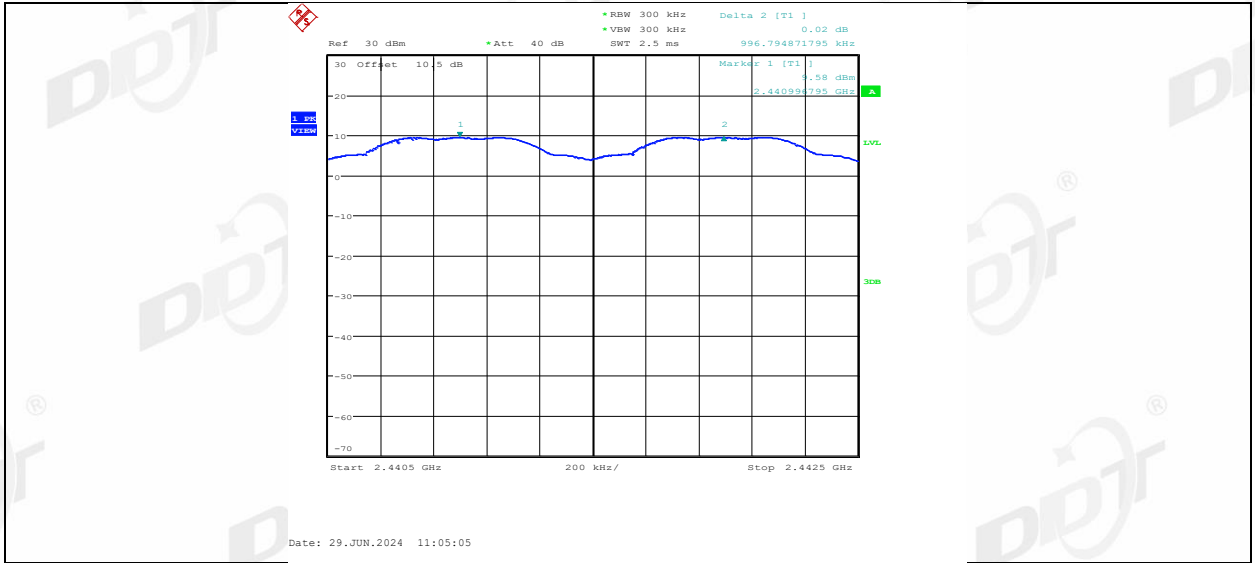
7.4. Test result

Test Engineer:	Zora Zhang	Test Site:	RF Measurement System 1#
Ambient Condition:	25.3°C,59.4%RH	Test Date:	2024.06.28
Test Power Supply:	Battery	Sample Number:	S24052314-002

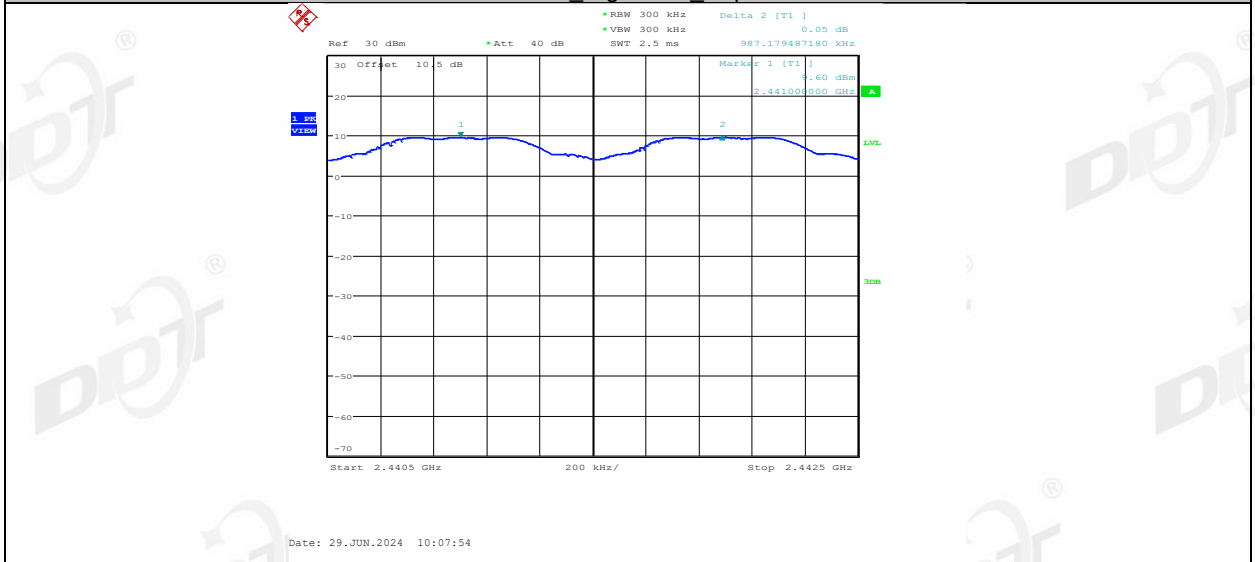
Test Mode	Antenna	Frequency [MHz]	Result [MHz]	Limit [MHz]	Verdict
DH5	Right side	Hop	1.192	≥0.960	PASS
	Left side	Hop	1.003	≥0.960	PASS
2DH5	Right side	Hop	1.006	≥0.853	PASS
	Left side	Hop	0.997	≥0.853	PASS
3DH5	Right side	Hop	0.987	≥0.867	PASS
	Left side	Hop	0.974	≥0.867	PASS

7.5. Test graphs

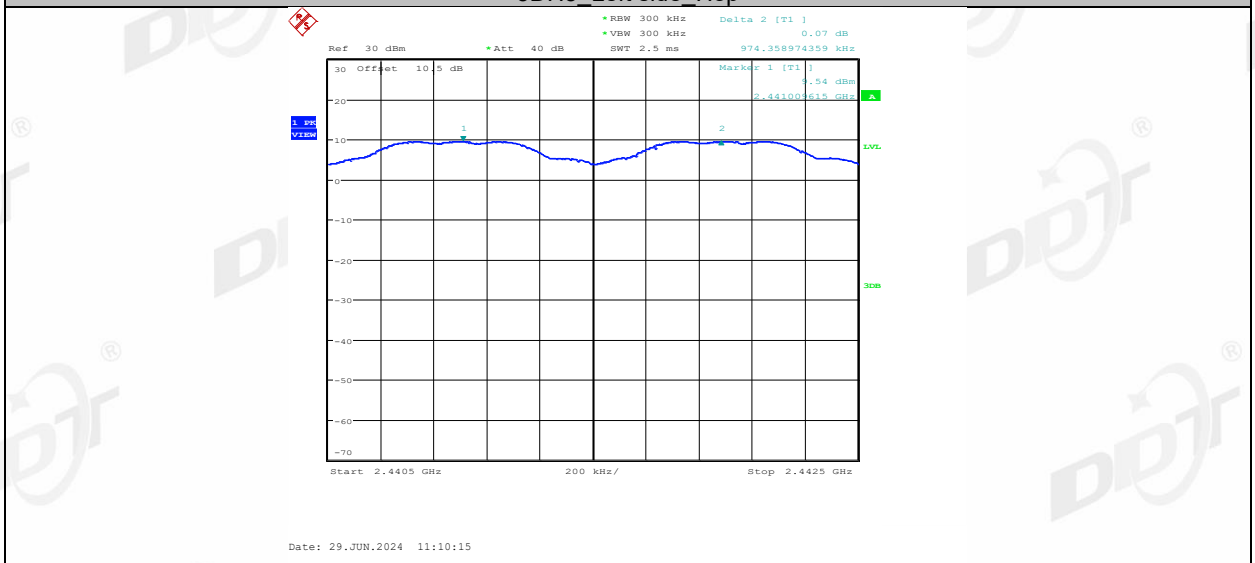




3DH5_Right side_Hop

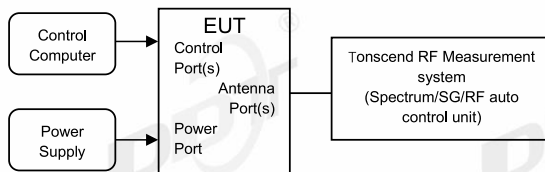


3DH5_Left side_Hop



8. Dwell Time

8.1. Block diagram of test setup



8.2. Limits

The average time of occupancy on any channel shall not be greater than 0.4 seconds within a period of 0.4 seconds multiplied by the number of hopping channels employed.

8.3. Test procedure

- (1) The test according to ANSI C63.10-2013 clause 7.8.4.
- (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:

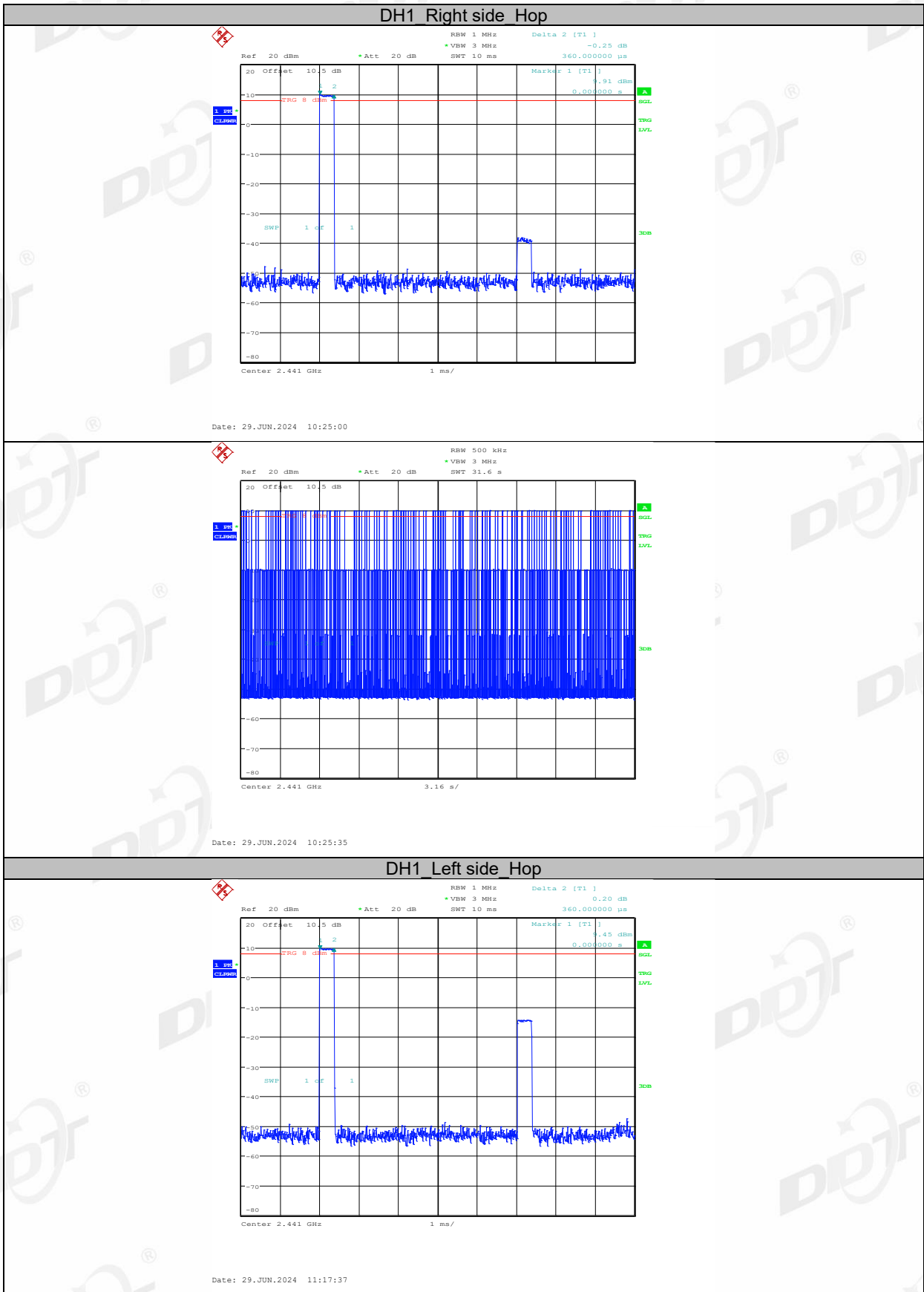
RBW:	≤ channel spacing and where possible RBW should be set $\gg 1 / T$
VBW:	$VBW \geq RBW$.
Span:	Zero span, centered on a hopping channel.
Detector Mode:	Peak
Sweep time:	Auto
Trace mode:	Clear Write.
- (5) The test period: $T = 0.4 \text{ Second/Channel} \times 79 \text{ Channel} = 31.6 \text{ s}$
- (6) Measure the hopping number and on time of each pulse with spectrum analyzer in zero span set, and calculate dwell time with formula Dwell time = total hops * pulse's on time.
- (7) Measure and record the results in the report.

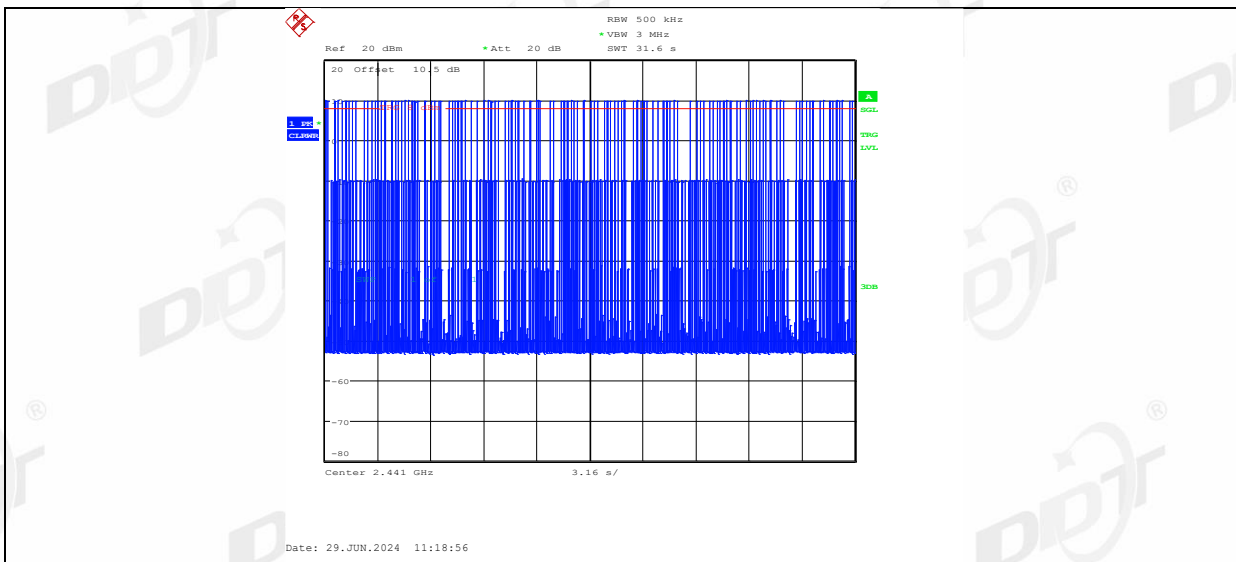
8.4. Test result

Test Engineer:	Zora Zhang	Test Site:	RF Measurement System 1#
Ambient Condition:	25.3°C,59.4%RH	Test Date:	2024.06.29
Test Power Supply:	Battery	Sample Number:	S24052314-002

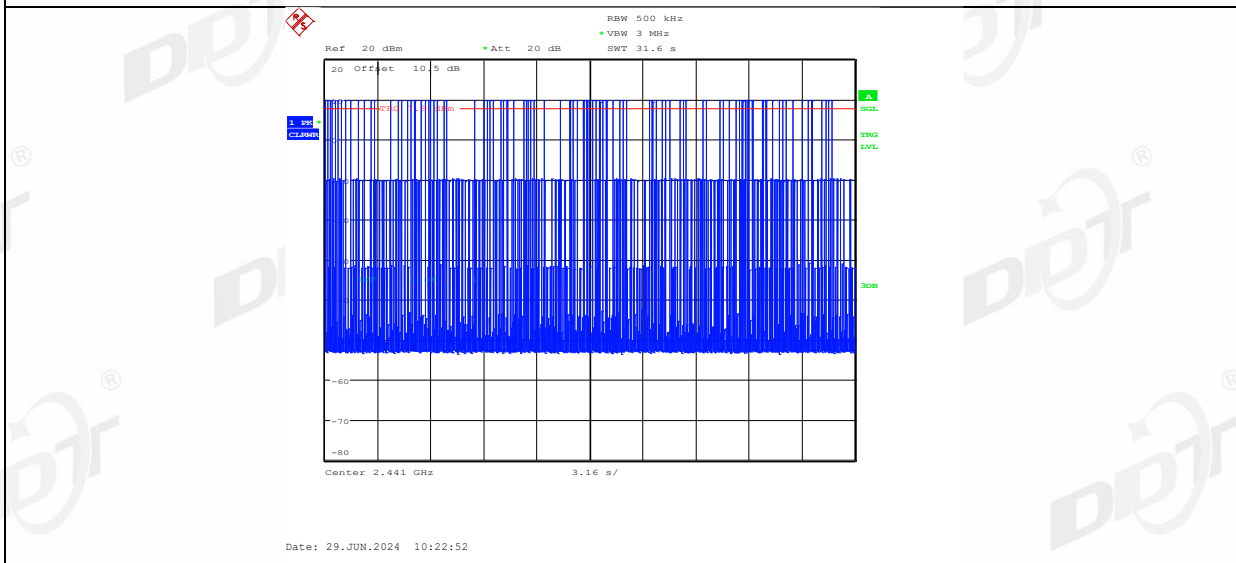
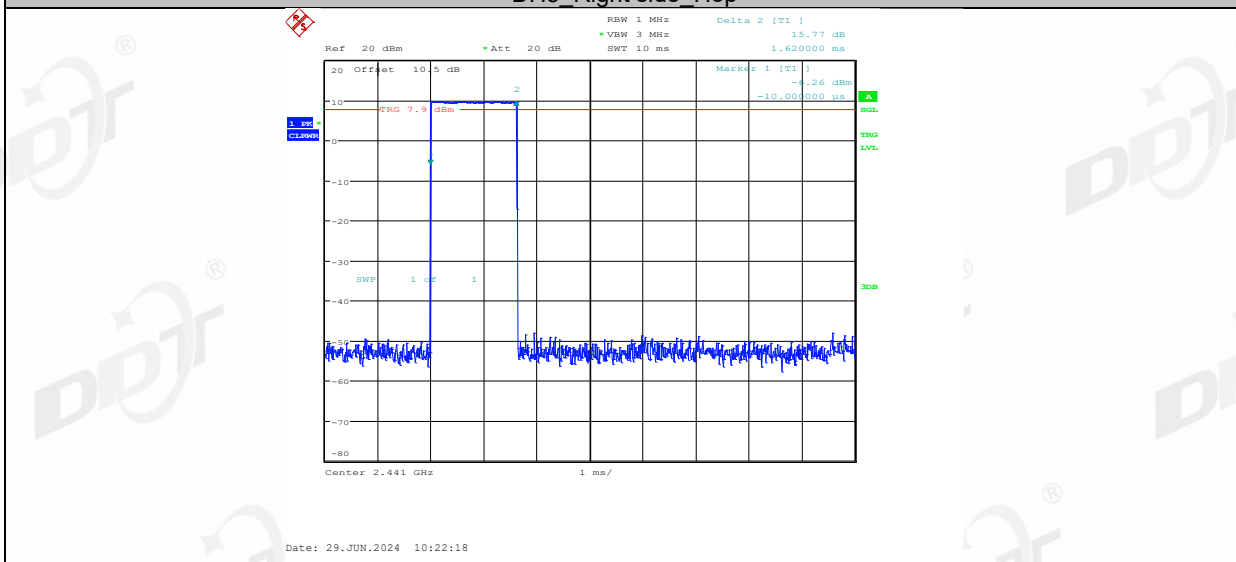
Test Mode	Antenna	Frequency [MHz]	BurstWidth [ms]	TotalHops [Num]	Result[s]	Limit[s]	Verdict
DH1	Right side	Hop	0.360	172	0.062	≤0.4	PASS
	Left side	Hop	0.360	156	0.056	≤0.4	PASS
DH3	Right side	Hop	1.620	103	0.167	≤0.4	PASS
	Left side	Hop	1.620	118	0.191	≤0.4	PASS
DH5	Right side	Hop	2.880	85	0.245	≤0.4	PASS
	Left side	Hop	2.880	81	0.233	≤0.4	PASS
2DH1	Right side	Hop	0.370	158	0.058	≤0.4	PASS
	Left side	Hop	0.370	155	0.057	≤0.4	PASS
2DH3	Right side	Hop	1.620	103	0.167	≤0.4	PASS
	Left side	Hop	1.630	91	0.148	≤0.4	PASS
2DH5	Right side	Hop	2.880	79	0.228	≤0.4	PASS
	Left side	Hop	2.880	74	0.213	≤0.4	PASS
3DH1	Right side	Hop	0.370	160	0.059	≤0.4	PASS
	Left side	Hop	0.370	161	0.060	≤0.4	PASS
3DH3	Right side	Hop	1.630	114	0.186	≤0.4	PASS
	Left side	Hop	1.630	108	0.176	≤0.4	PASS
3DH5	Right side	Hop	2.880	80	0.230	≤0.4	PASS
	Left side	Hop	2.880	86	0.248	≤0.4	PASS

8.5. Test graphs

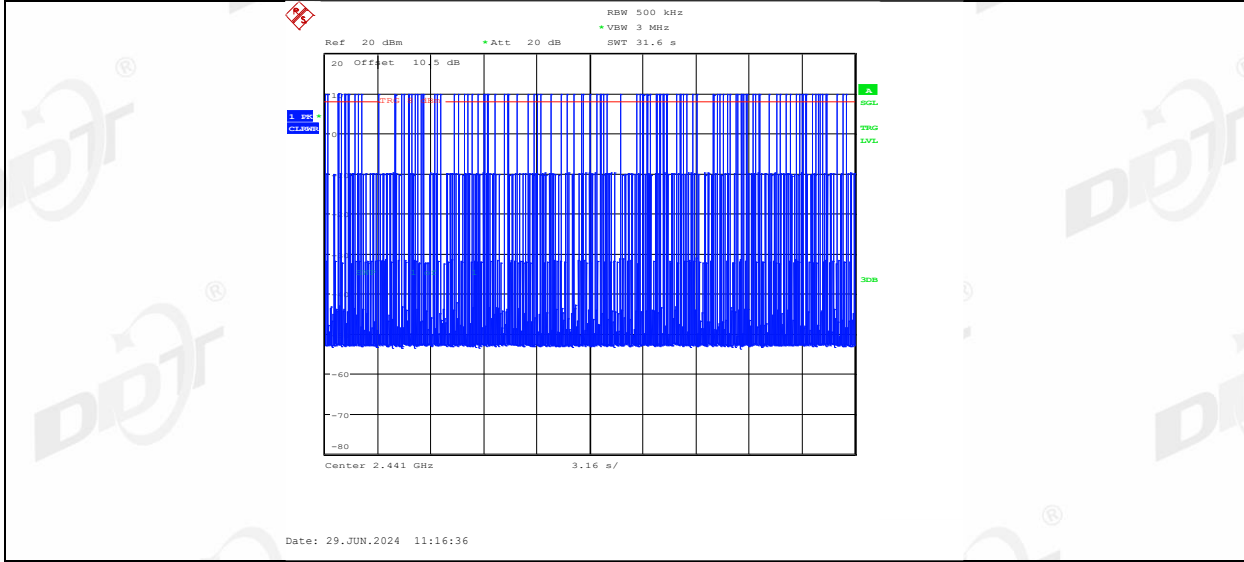
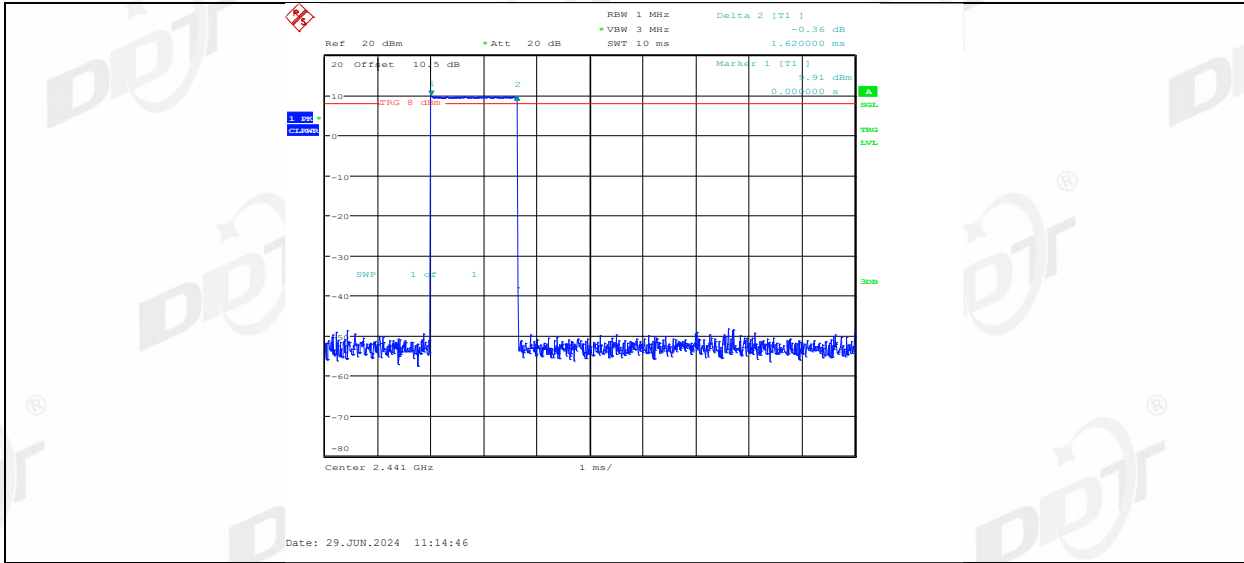




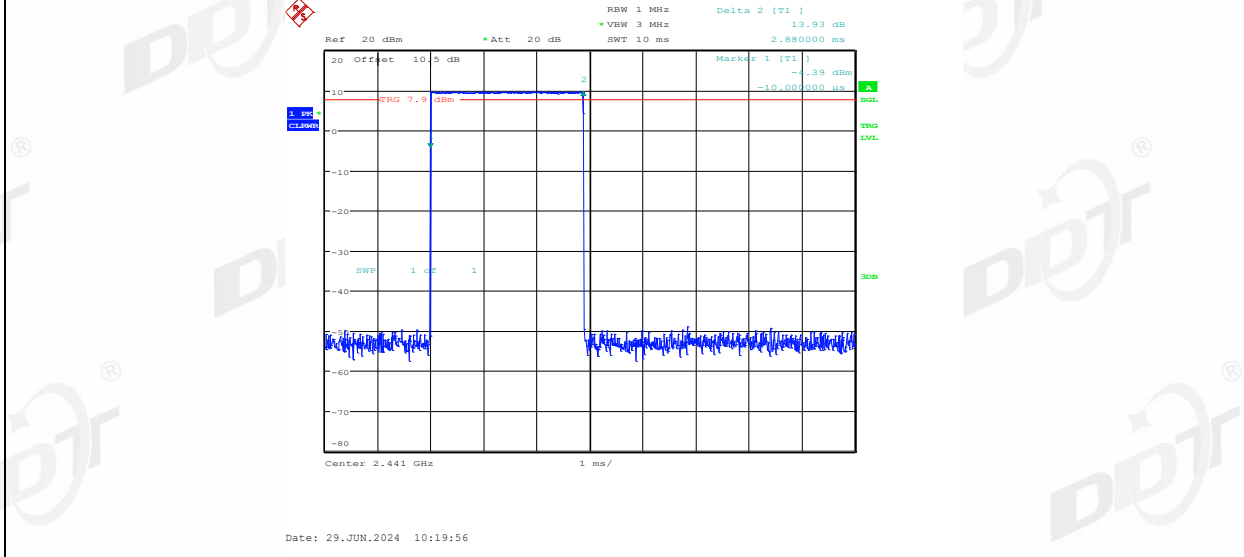
DH3 Right side Hop

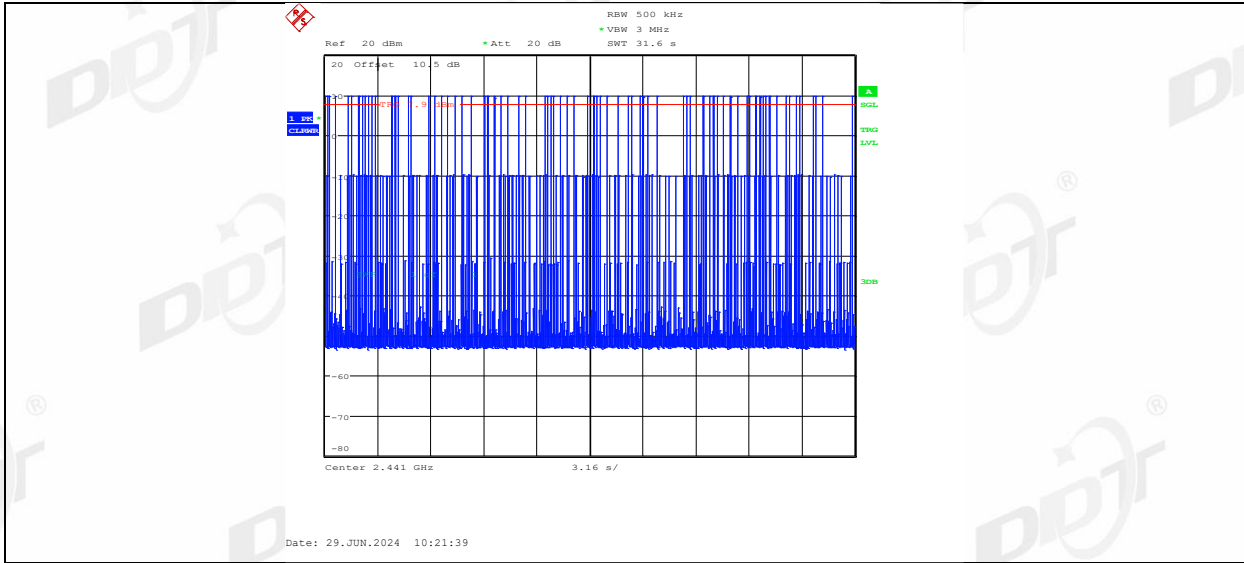


DH3 Left side Hop

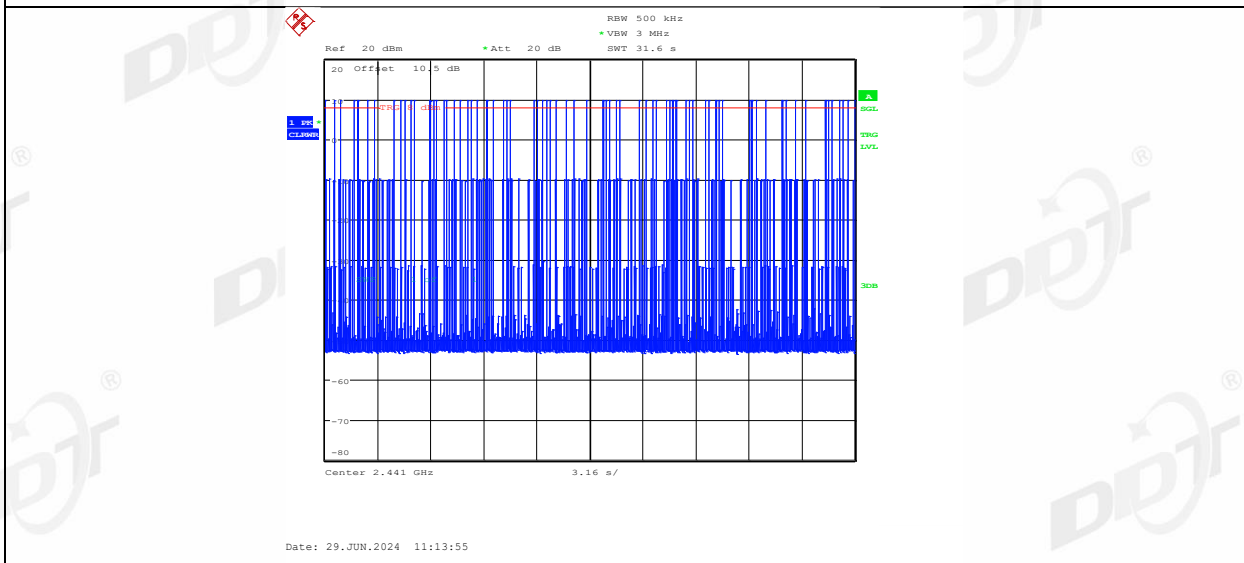
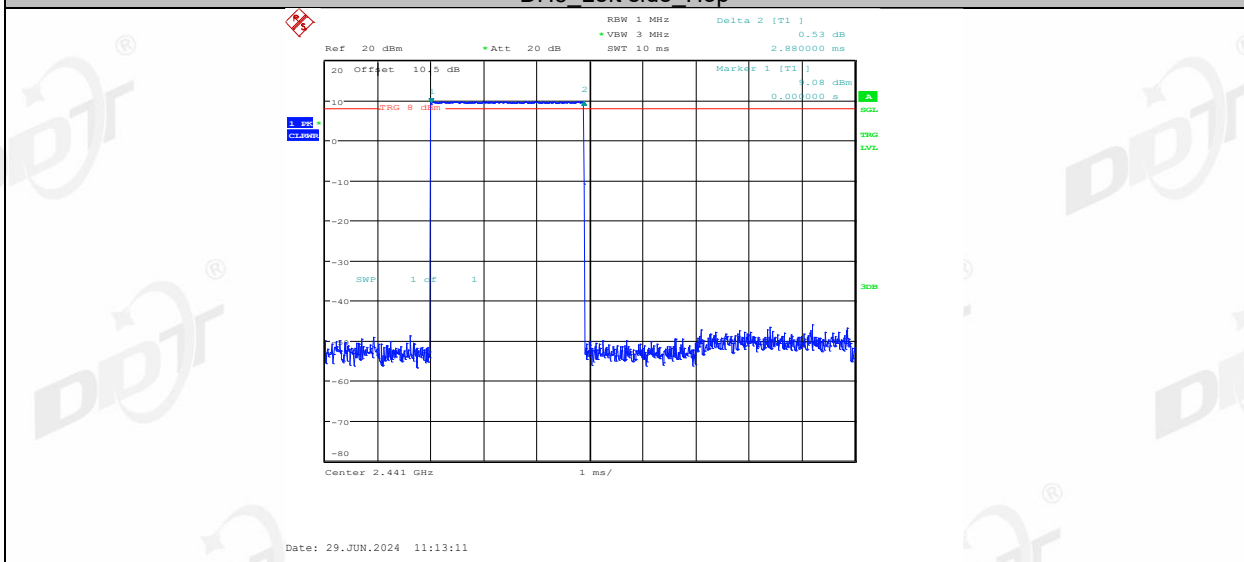


DH5 Right side Hop

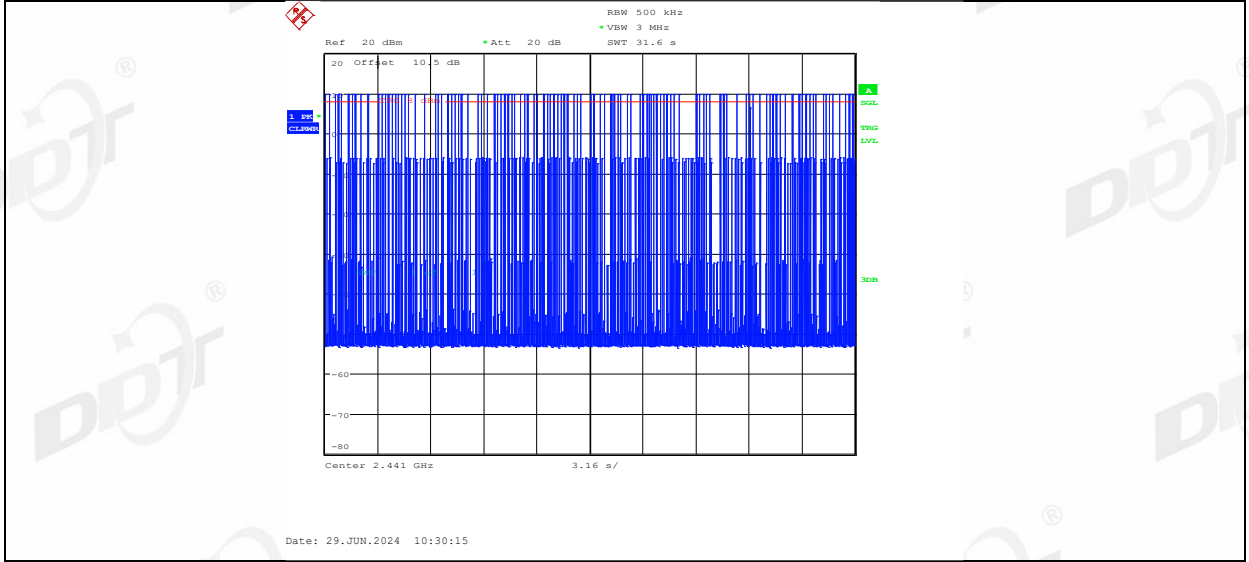
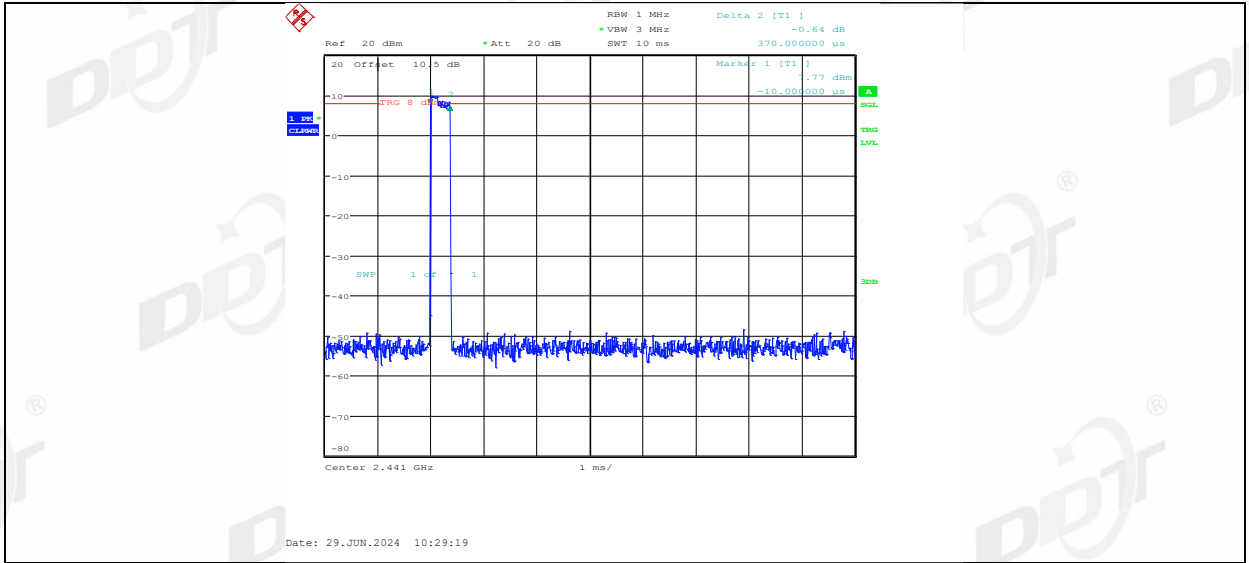




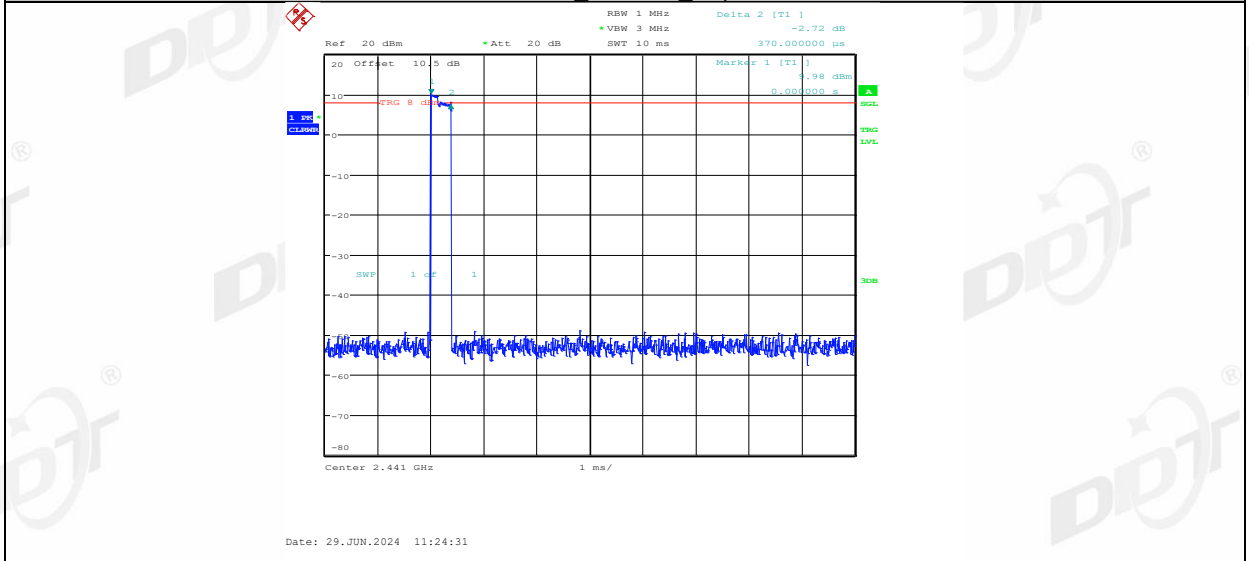
DH5 Left side Hop

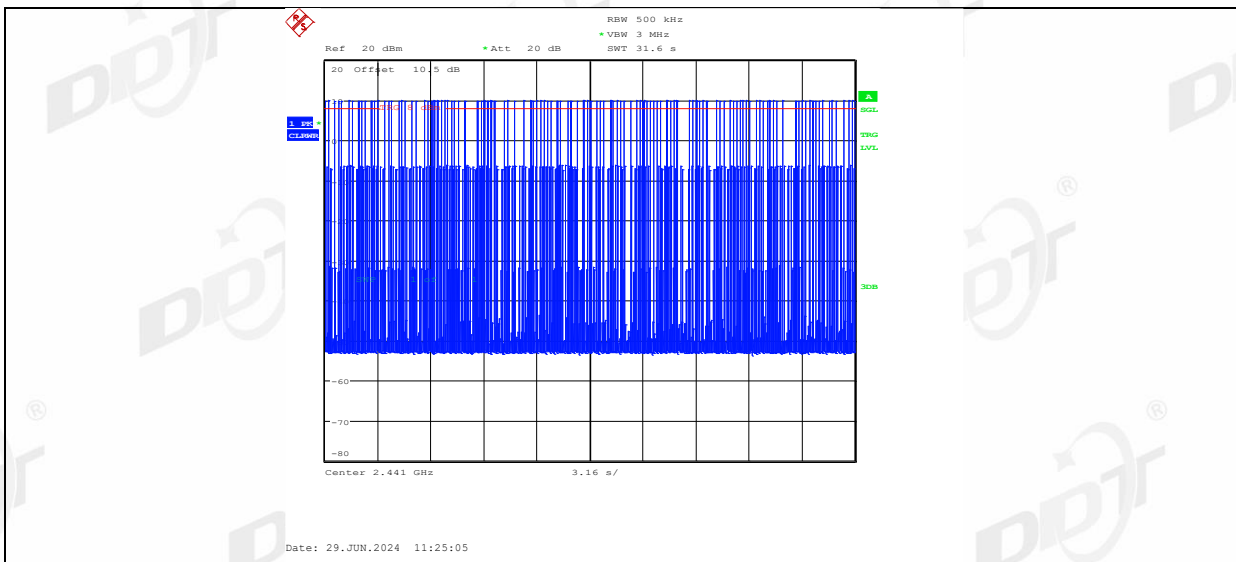


2DH1 Right side Hop

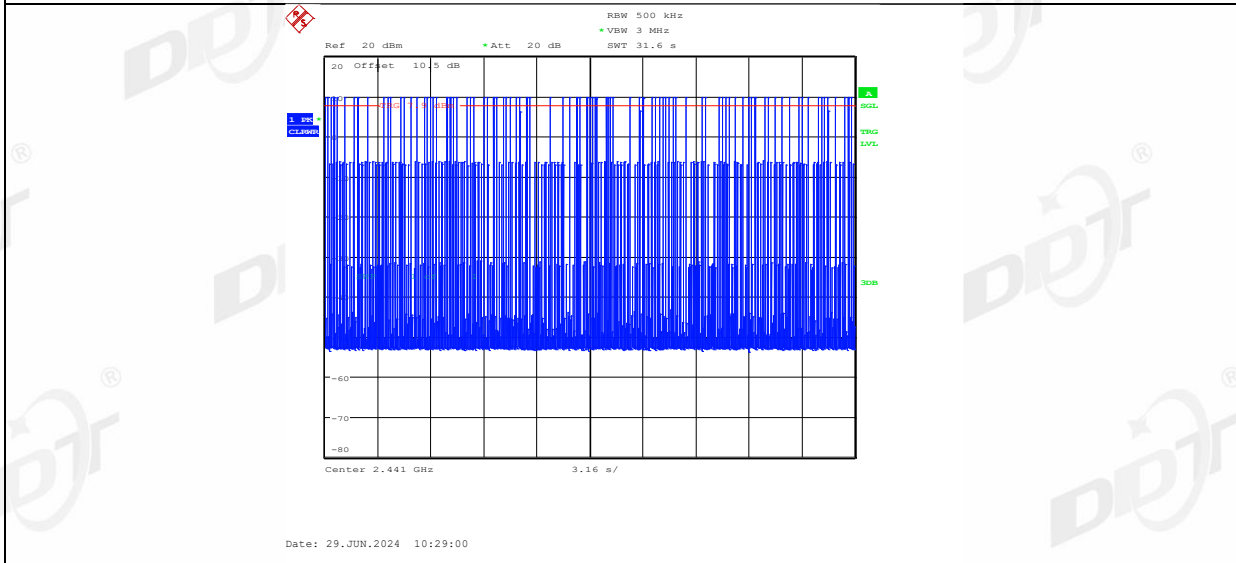
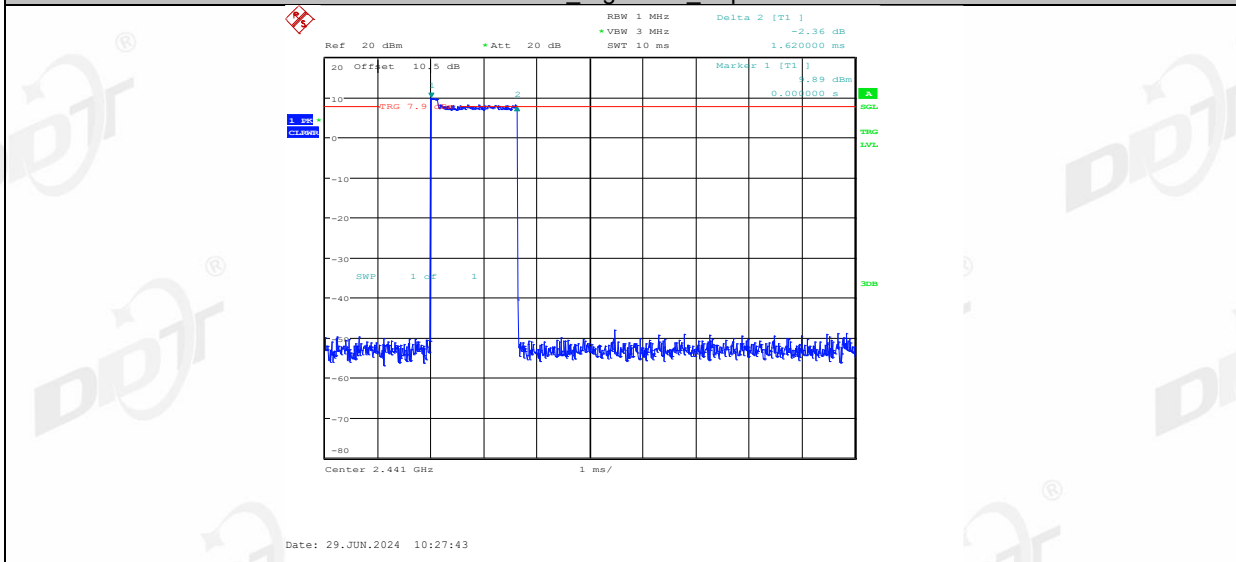


2DH1 Left side Hop

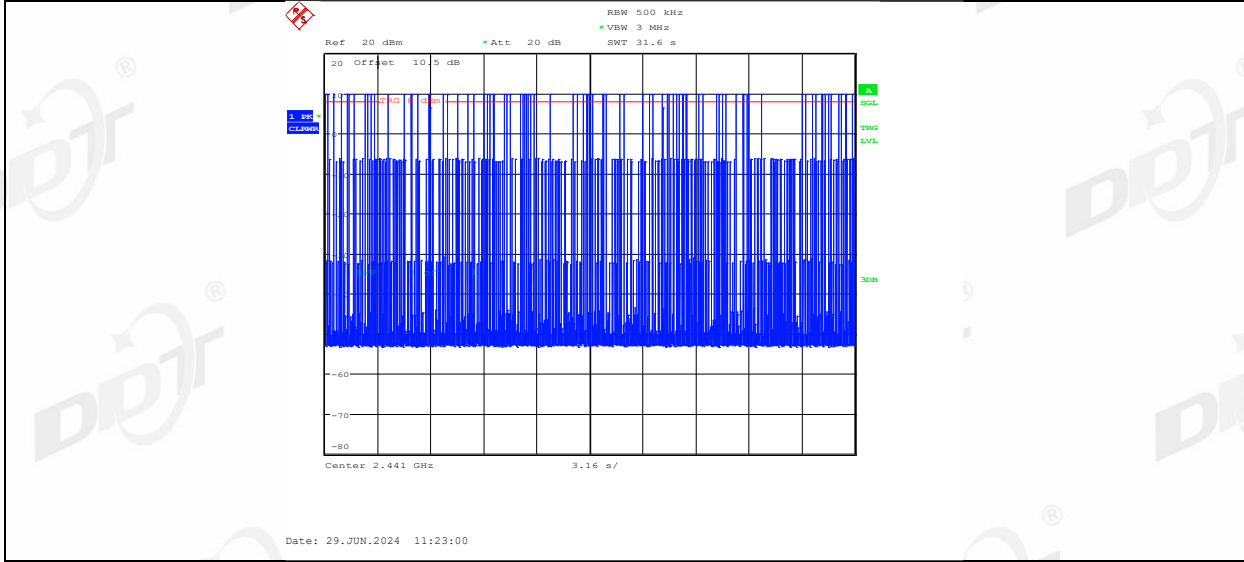
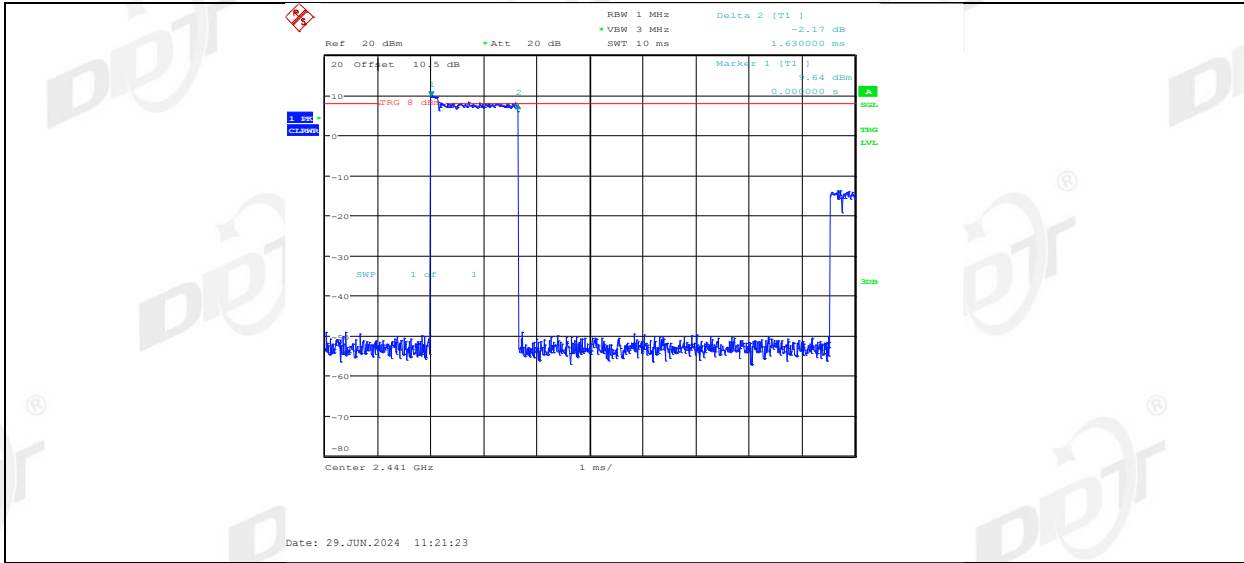




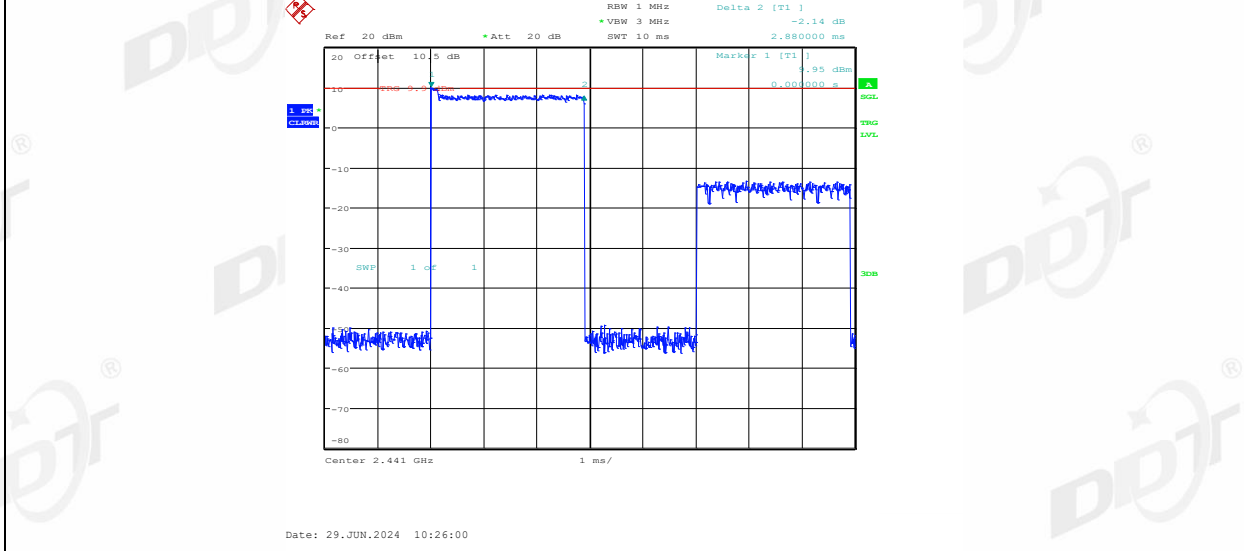
2DH3_Right side Hop

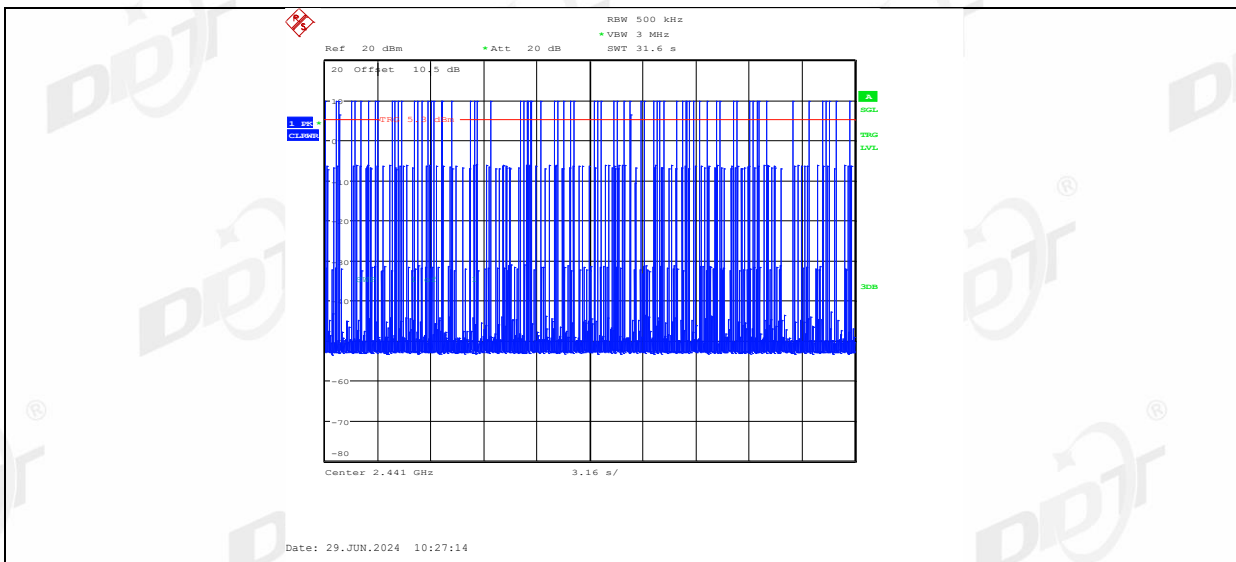


2DH3_Left side Hop

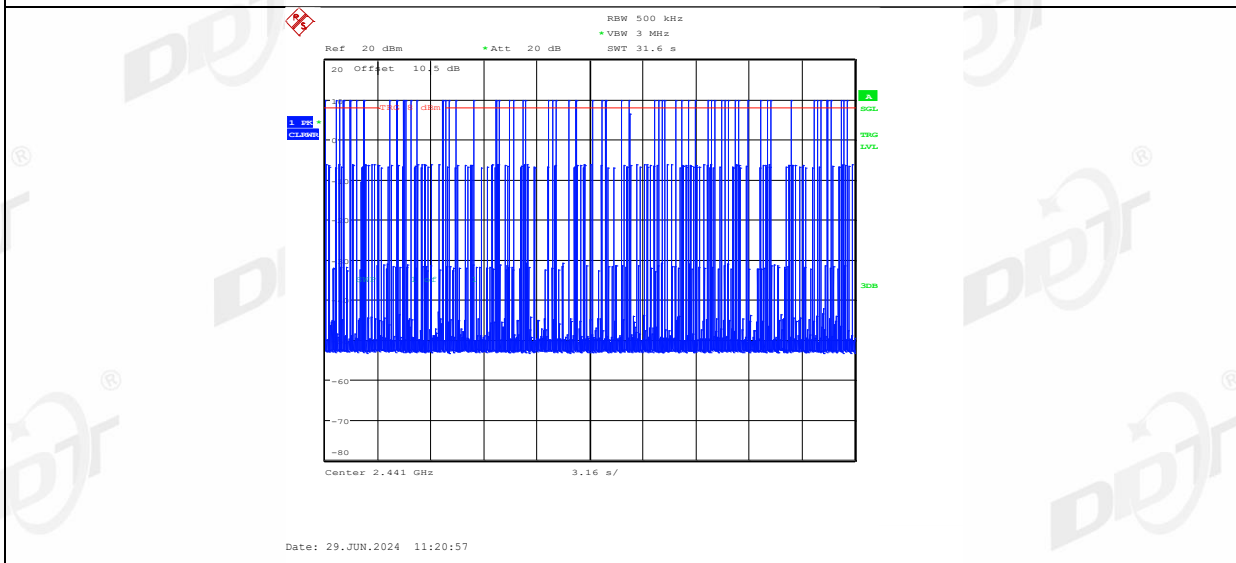
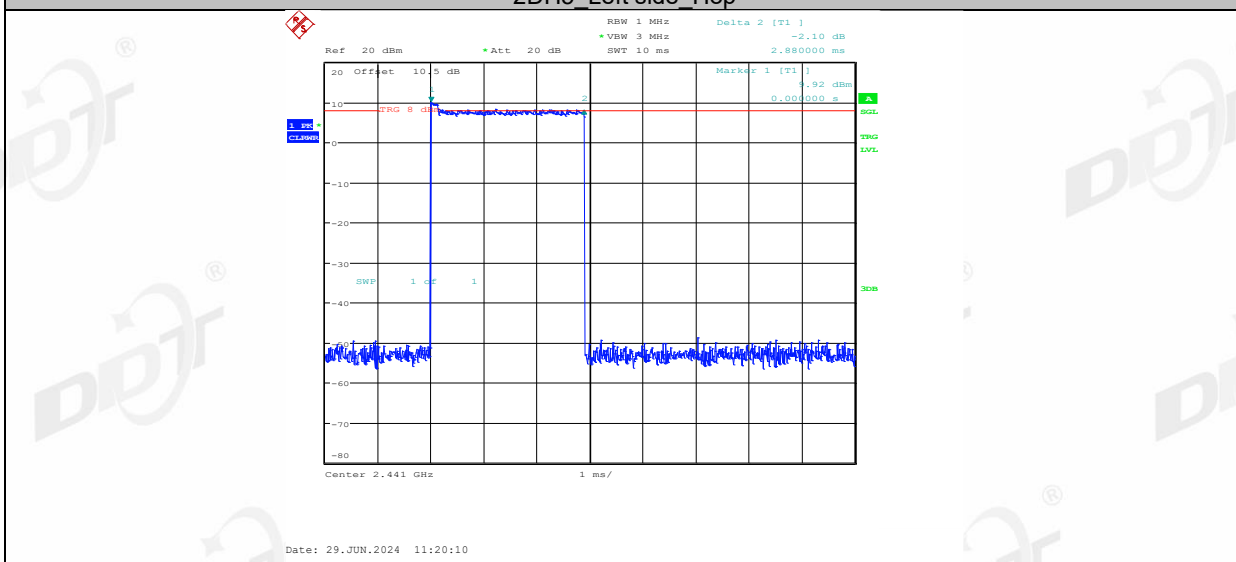


2DH5_Right side_Hop

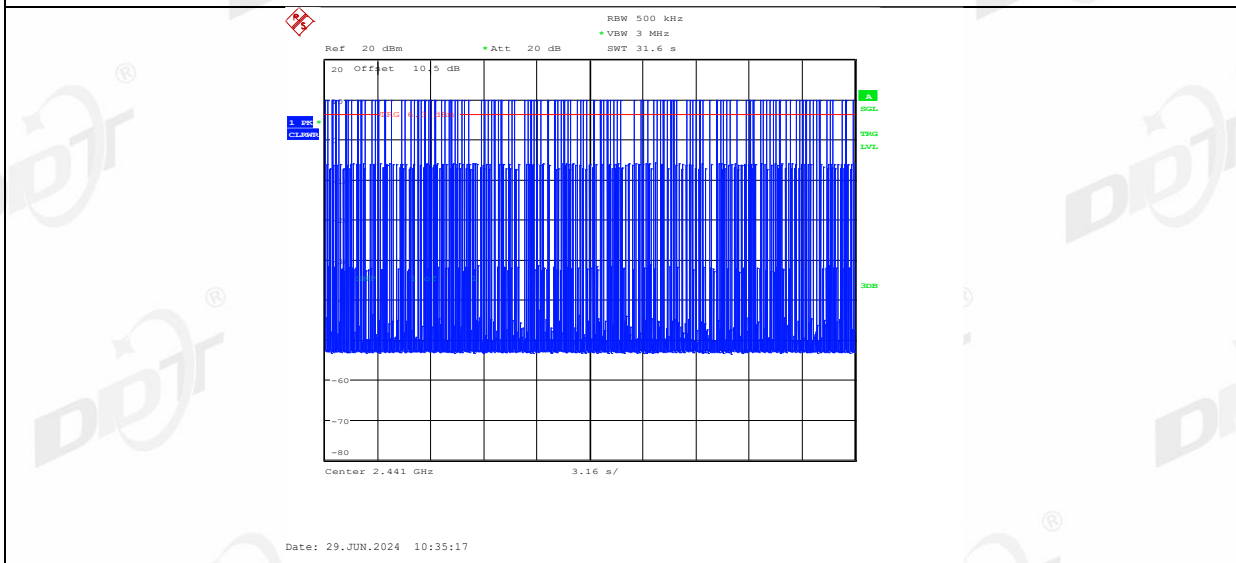
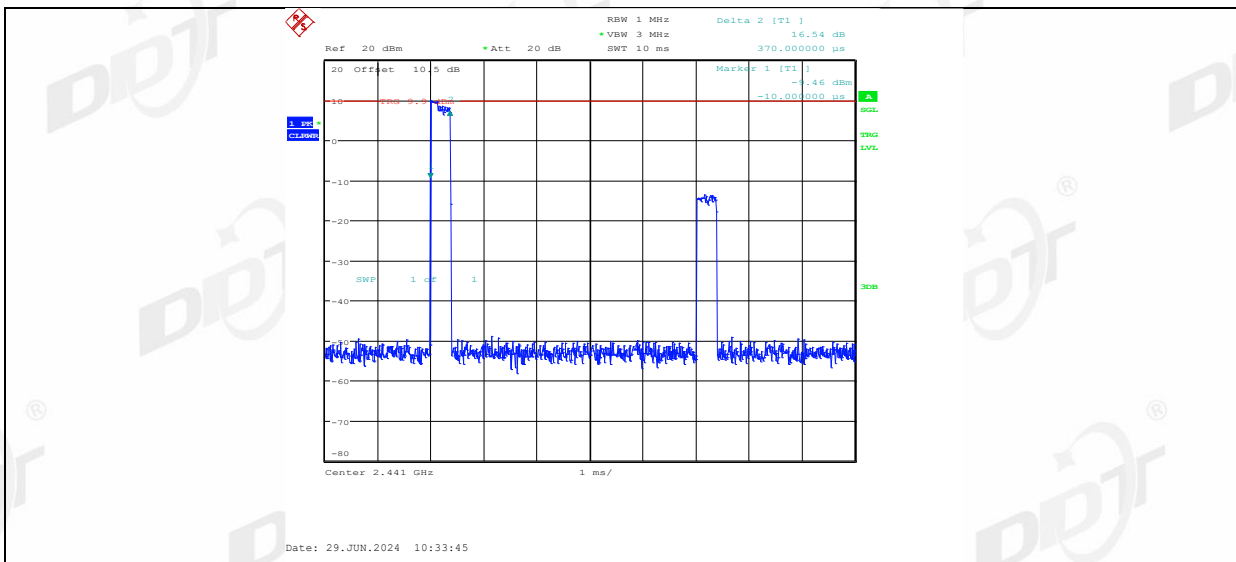




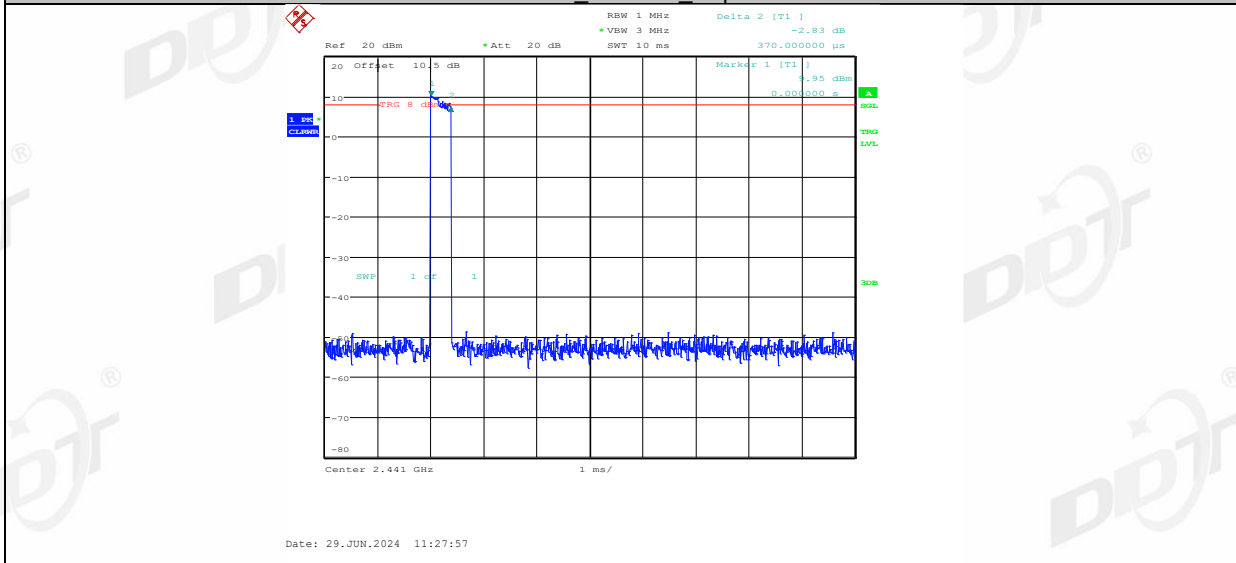
2DH5 Left side Hop

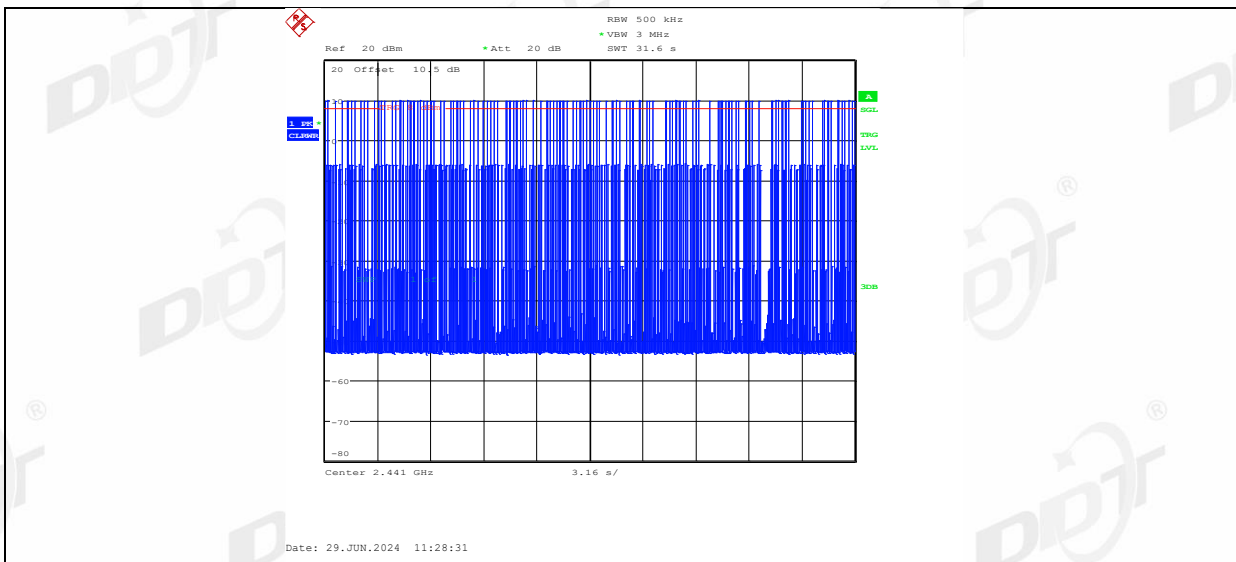


3DH1 Right side Hop

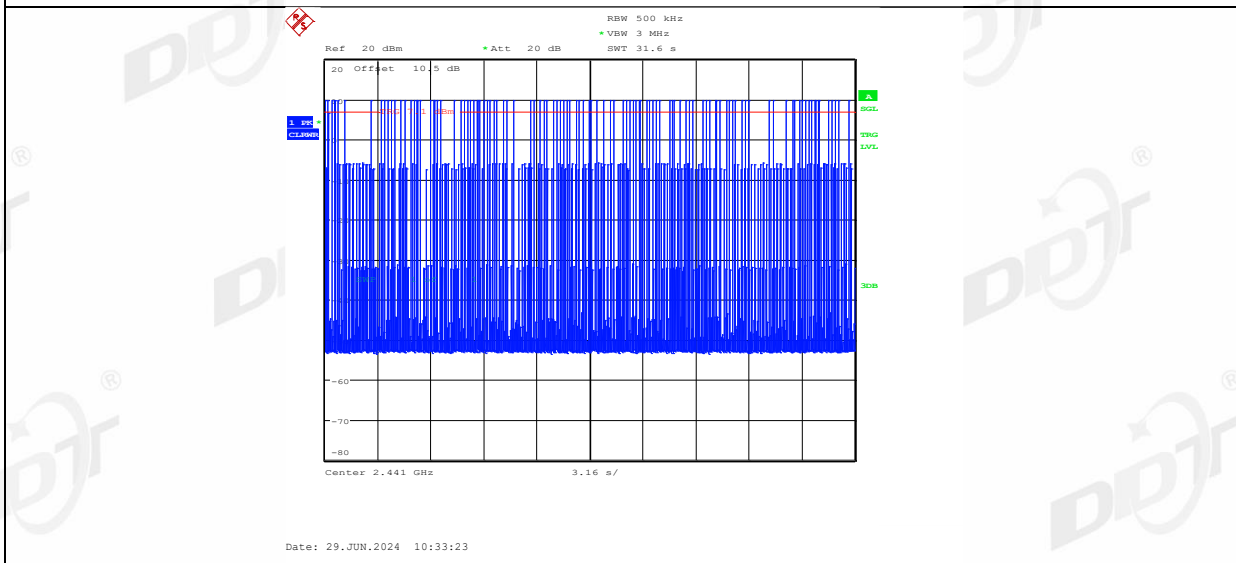
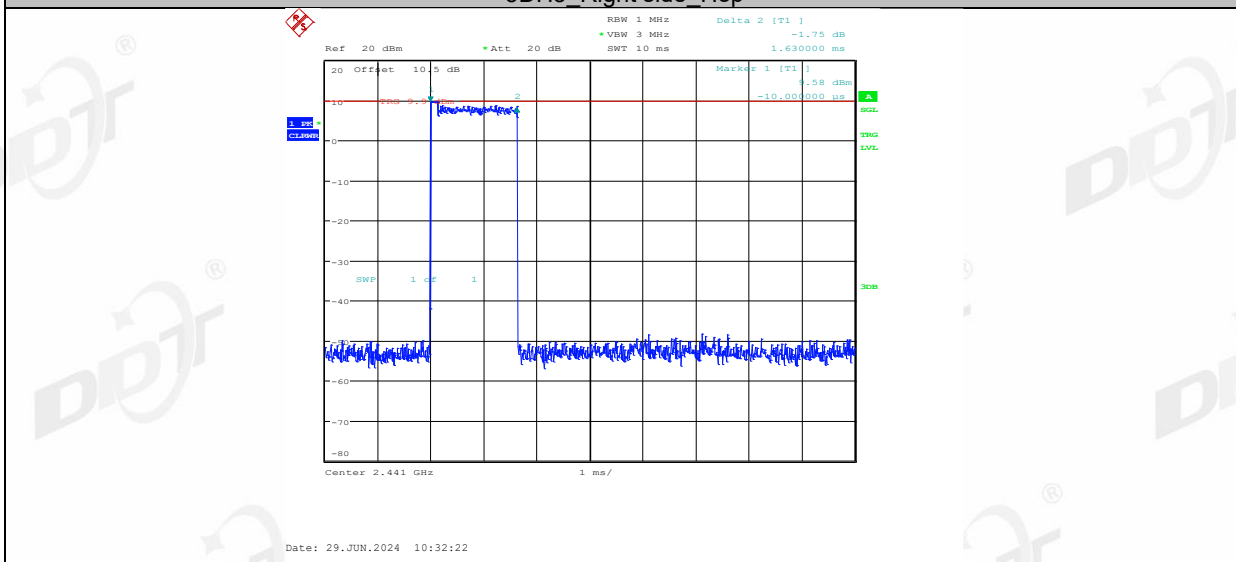


3DH1 Left side Hop

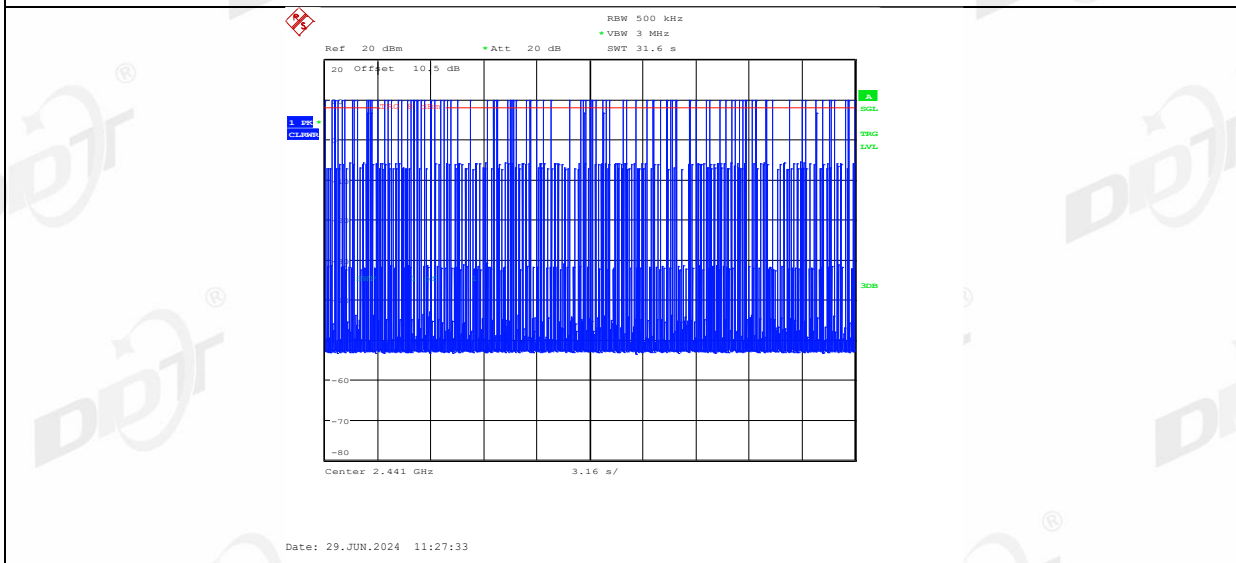
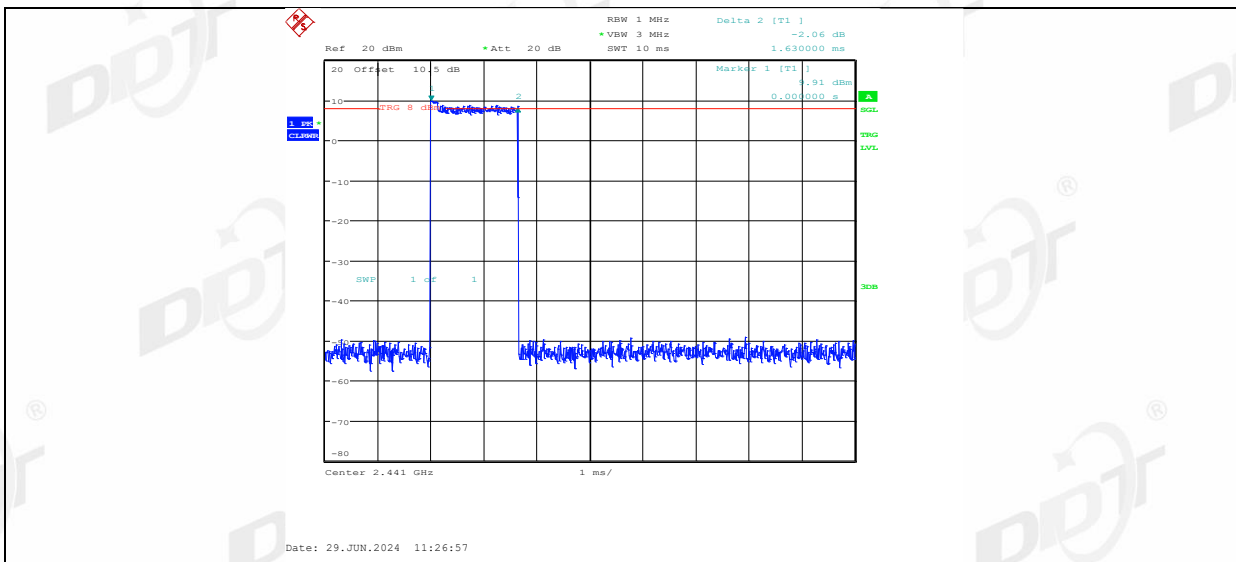




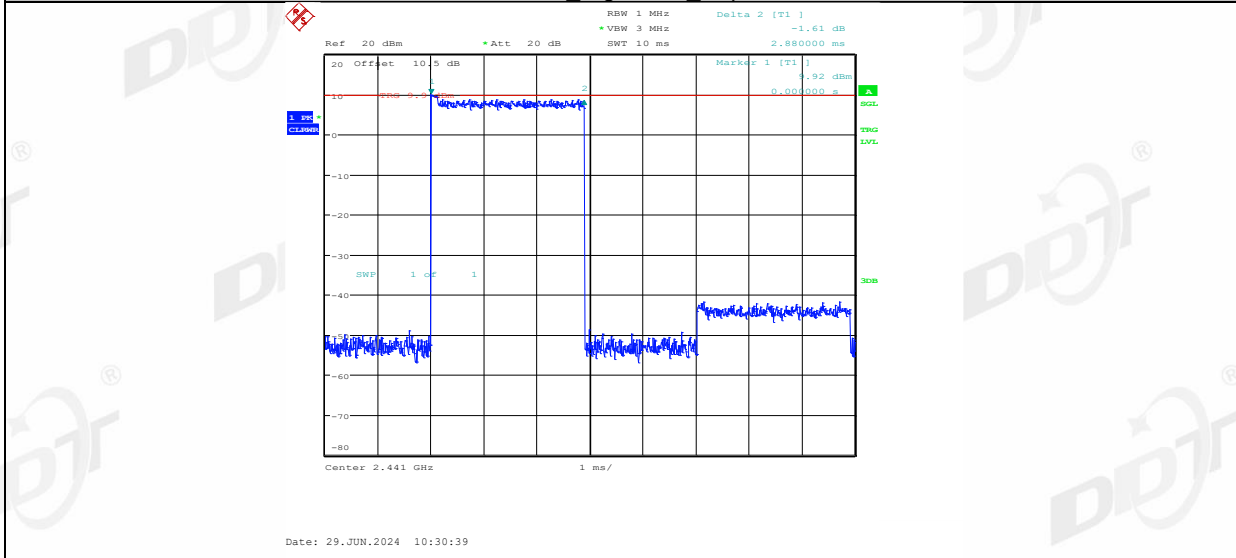
3DH3_Right side Hop

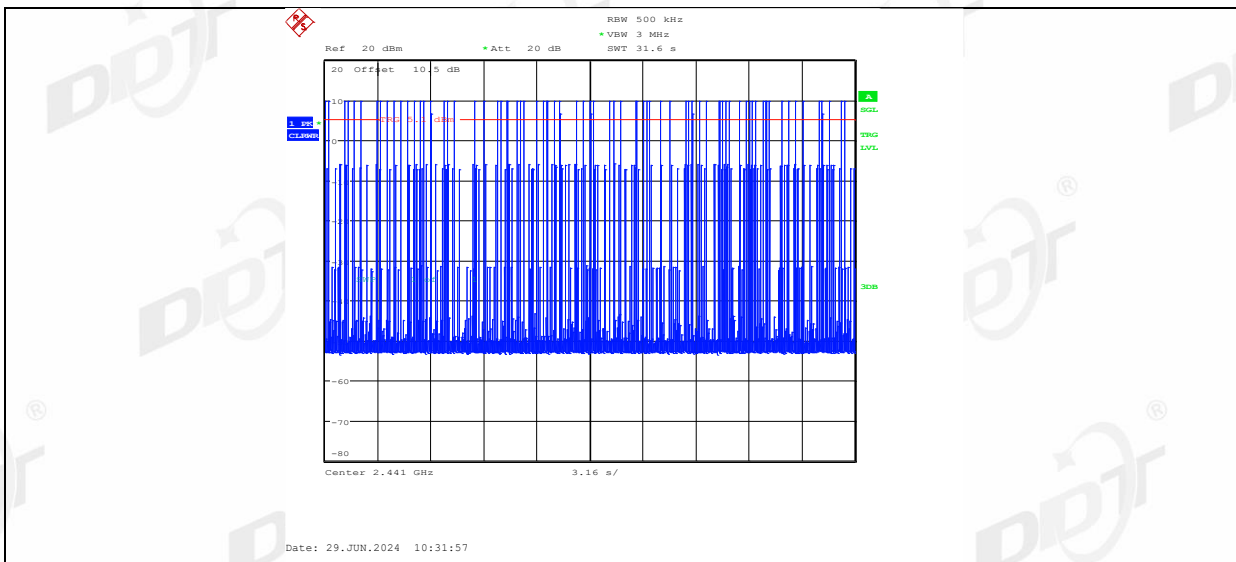


3DH3_Left side Hop

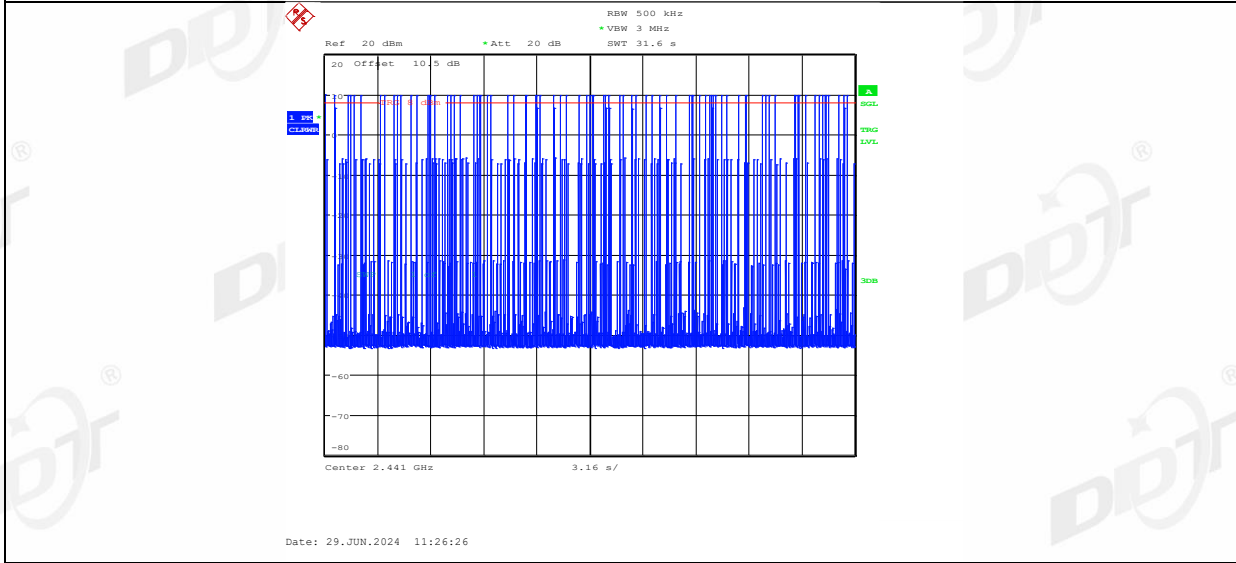
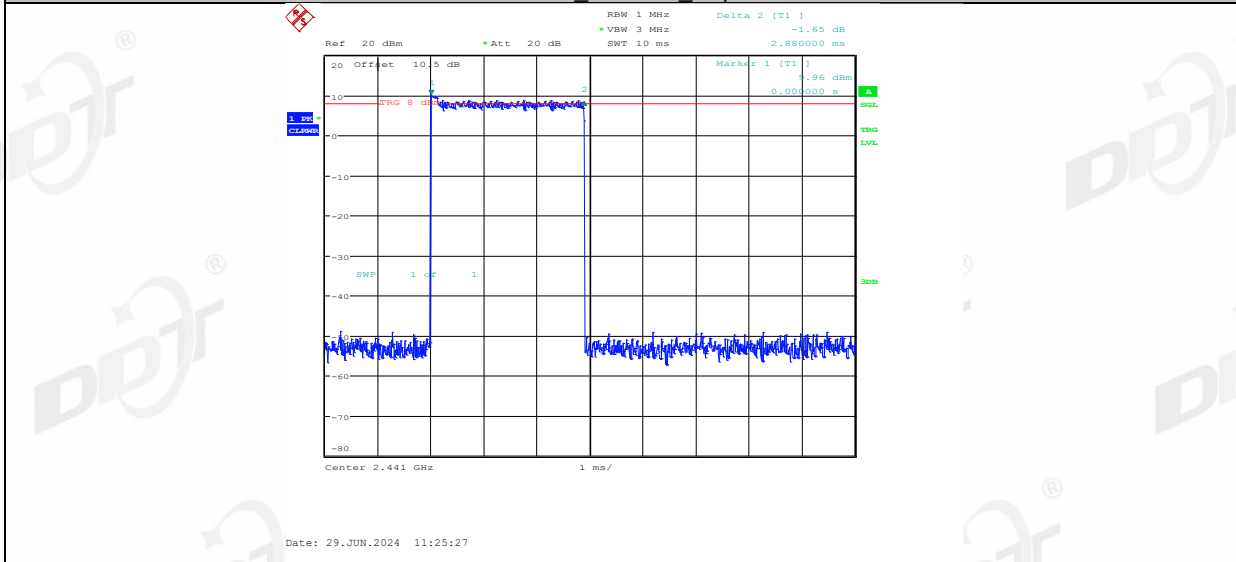


3DH5_Right side_Hop



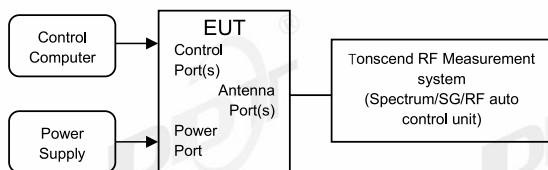


3DH5_Left side_Hop



9. Number of Hopping Channel

9.1. Block diagram of test setup



9.2. Limits

Frequency hopping systems in the 2400-2483.5 MHz band shall use at least 15 channels.

9.3. Test procedure

- (1) The test according to ANSI C63.10-2013 clause 7.8.3.
- (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 maximum peak output power measurement:

RBW:	RBW to less than 30% of the channel spacing or the 20 dB bandwidth, whichever is smaller.
VBW:	VBW \geq RBW.
Span:	The frequency band of operation
Detector Mode:	Peak
Sweep time:	Auto
Trace mode:	Max hold

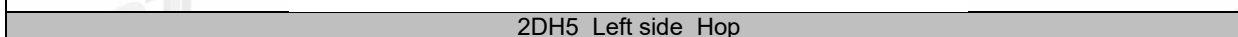
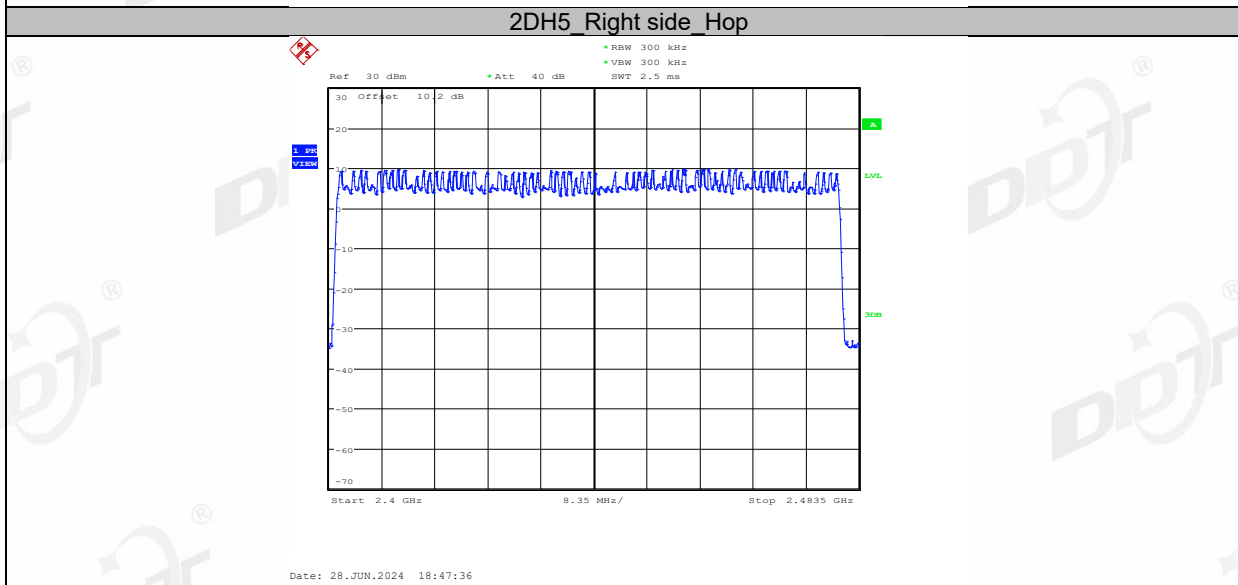
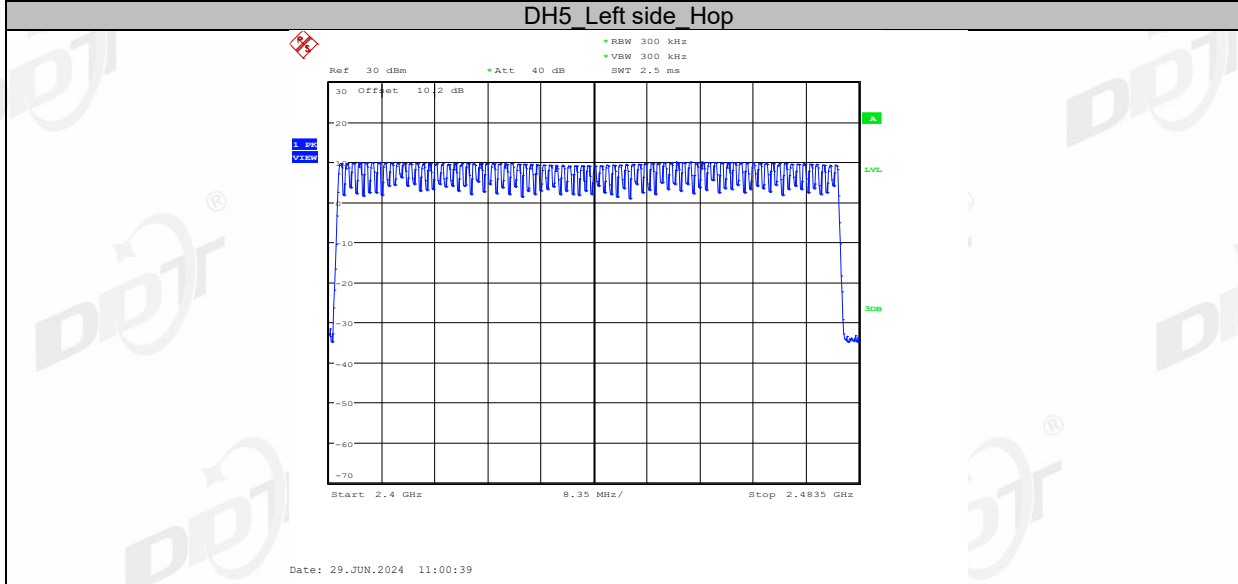
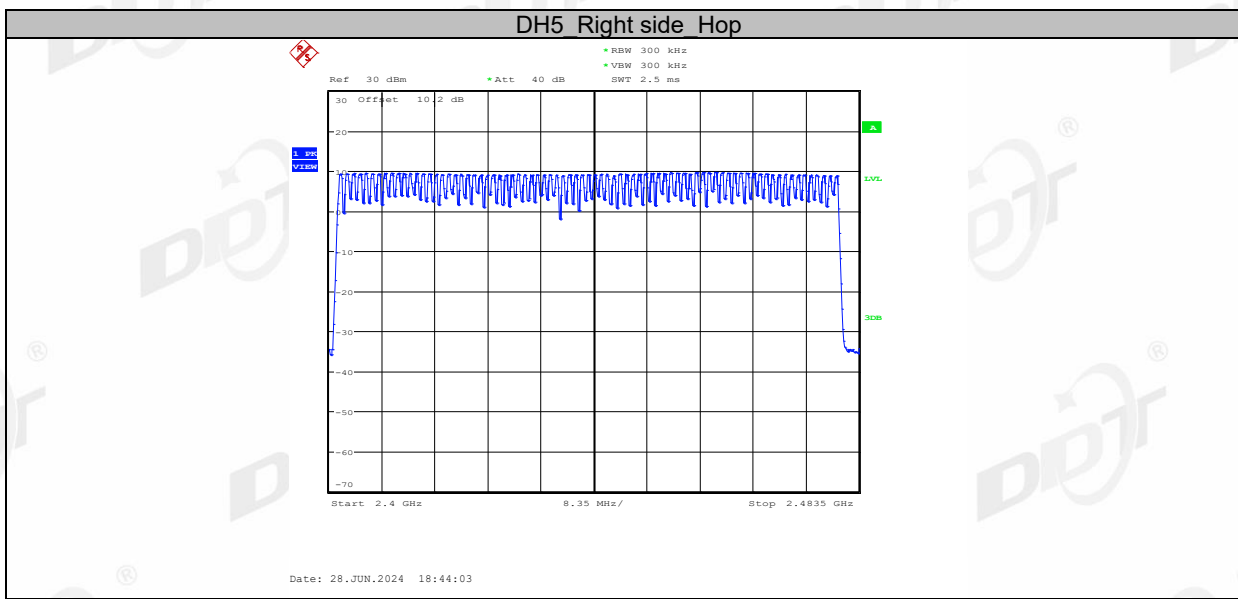
- (5) Measure the hopping number and record the results in the report.
- (6) Measure and record the results in the report.

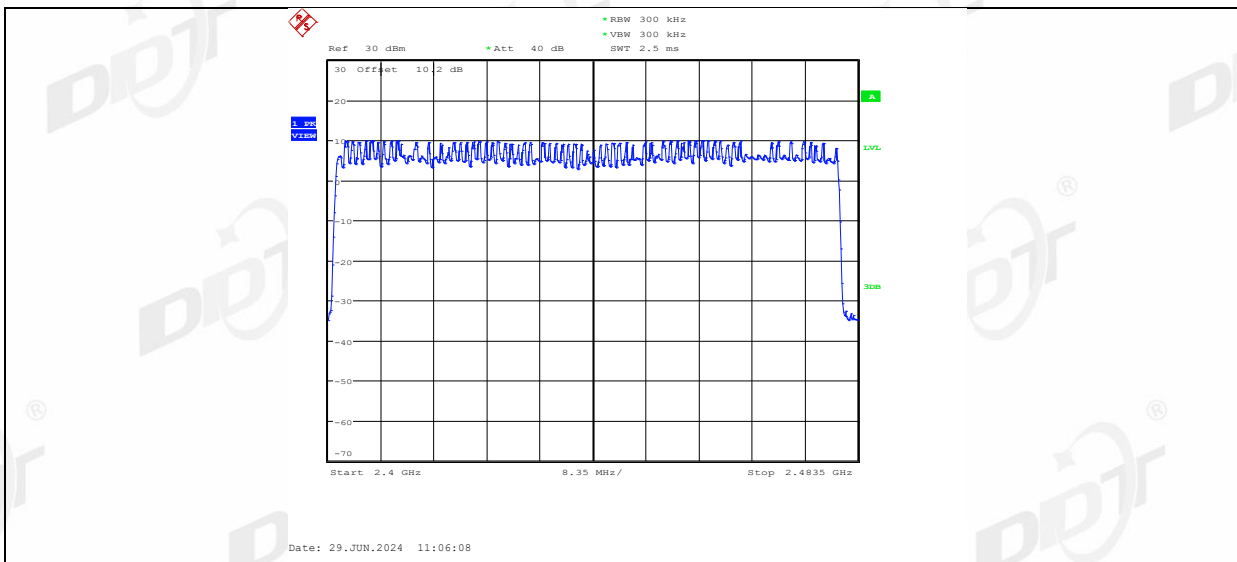
9.4. Test result

Test Engineer:	Zora Zhang	Test Site:	RF Measurement System 1#
Ambient Condition:	25.3°C,59.4%RH	Test Date:	2024.06.28-2024.06.29
Test Power Supply:	Battery	Sample Number:	S24052314-002

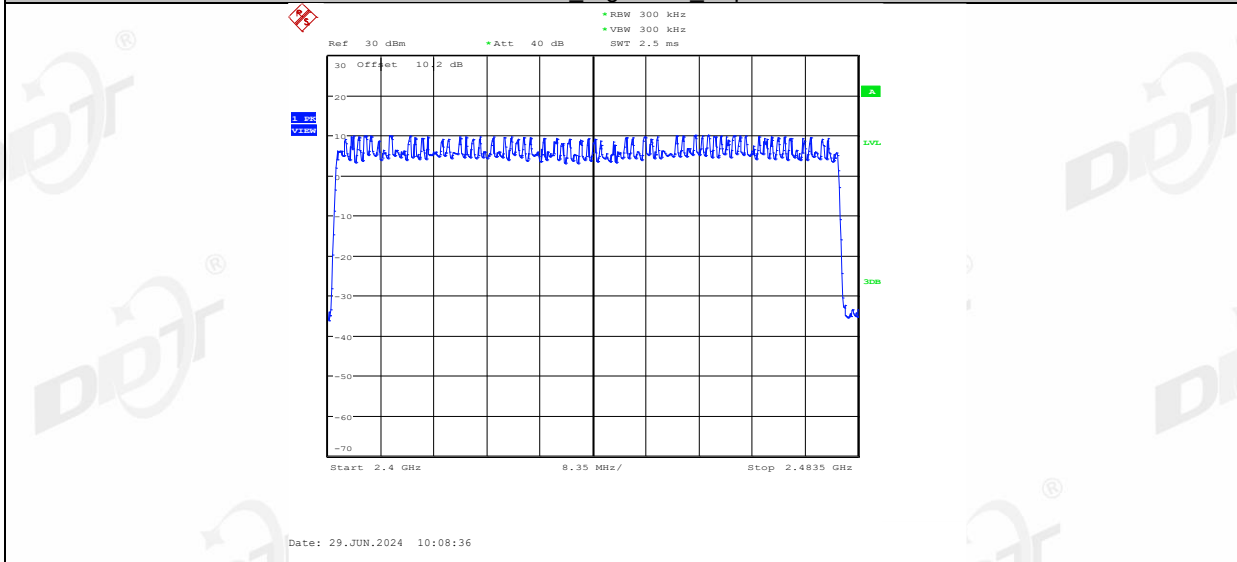
Test Mode	Antenna	Frequency [MHz]	Result [Num]	Limit [Num]	Verdict
DH5	Right side	Hop	79	≥15	PASS
	Left side	Hop	79	≥15	PASS
2DH5	Right side	Hop	79	≥15	PASS
	Left side	Hop	79	≥15	PASS
3DH5	Right side	Hop	79	≥15	PASS
	Left side	Hop	79	≥15	PASS

9.5. Test graphs

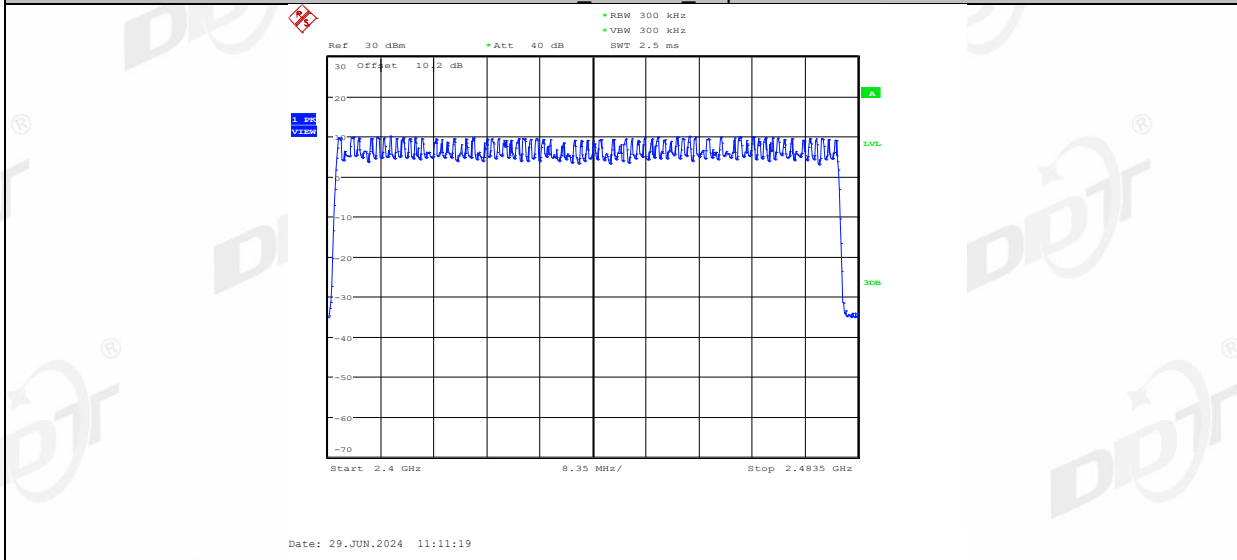




3DH5_Right side_Hop

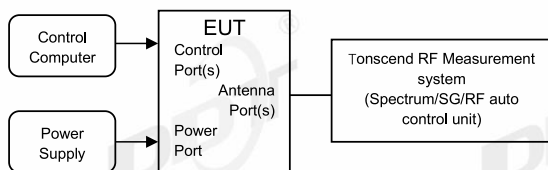


3DH5_Left side_Hop



10. Band Edge Compliance (Conducted Method)

10.1. Block diagram of test setup



10.2. Limit

All restriction band should comply with 15.209, other emission should be at least 20dB below the fundamental.

10.3. Test procedure

- (1) Connect EUT's antenna output to spectrum analyzer by RF cable.
- (2) Establish a reference level by using the following procedure:

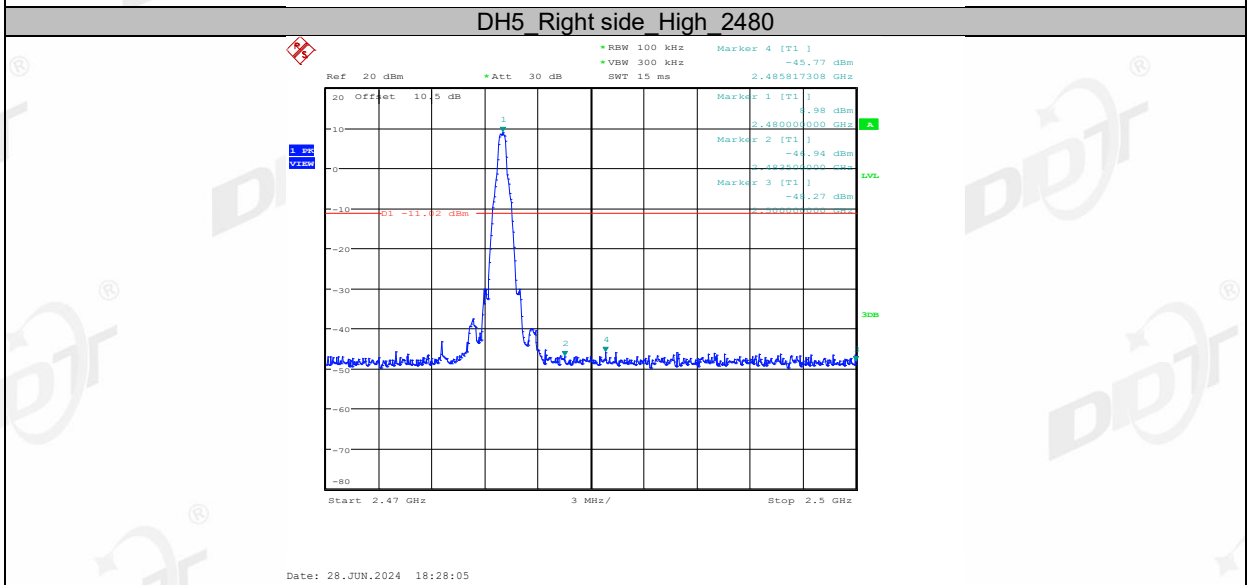
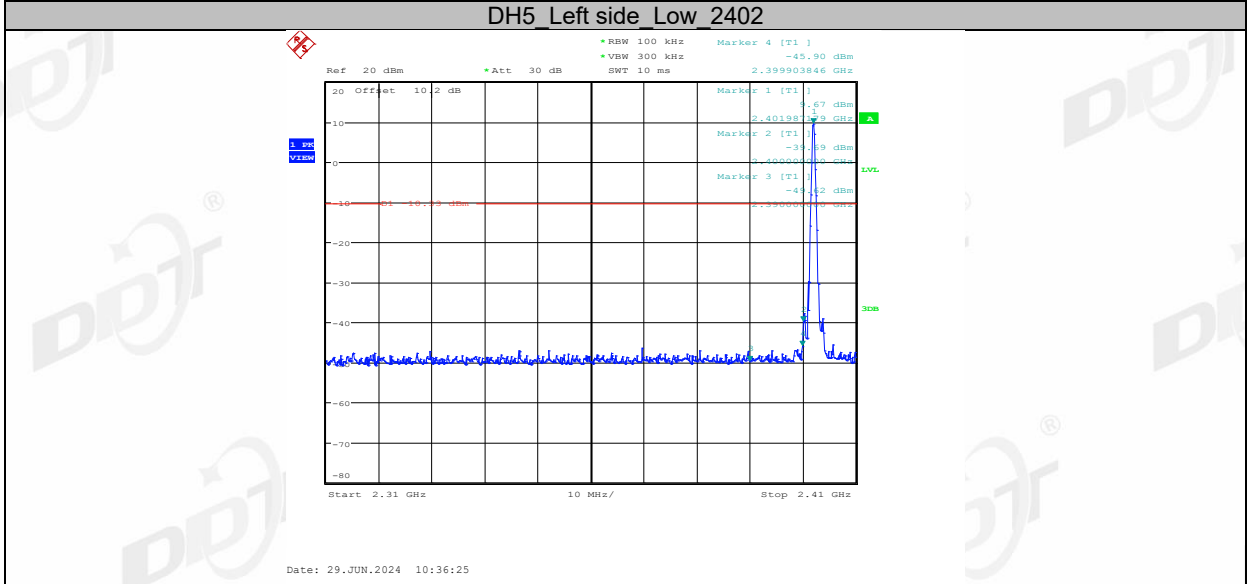
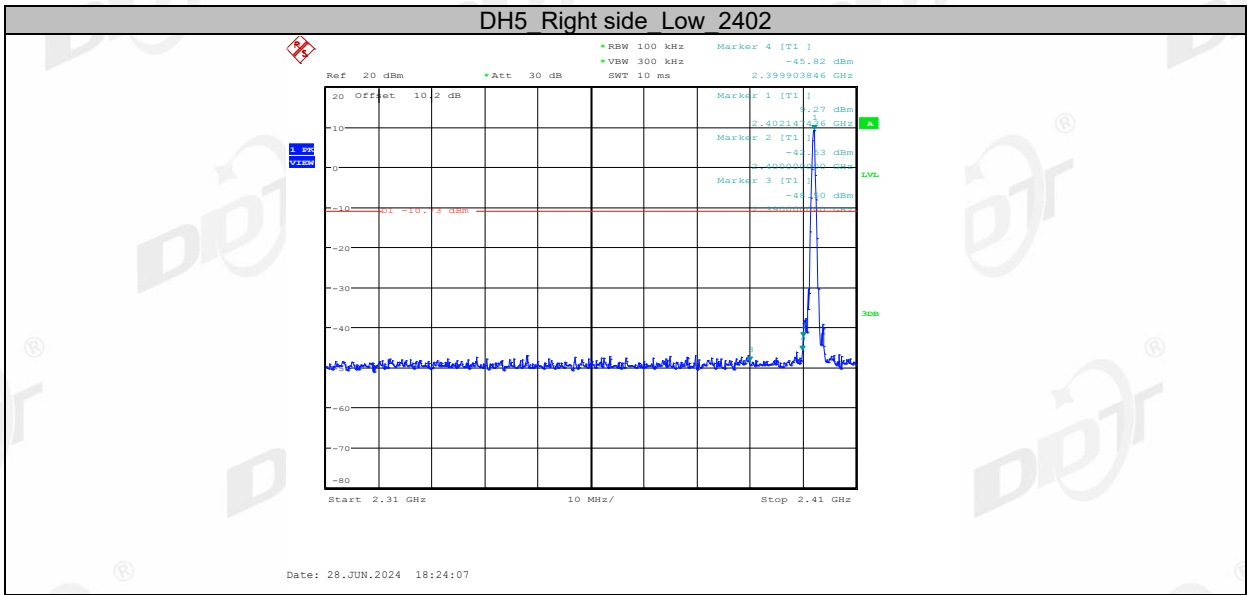
RBW:	100 kHz
VBW:	300 kHz
Span	Encompass frequency range to be measured
Detector Mode:	Peak
Sweep time:	Auto
Trace mode	Max hold
- (3) Allow the trace to stabilize, use the peak marker function to determine the maximum peak power level to establish the reference level.
- (4) Then mark the maximum amplitude of all unwanted emissions outside of the authorized frequency band.

10.4. Test result

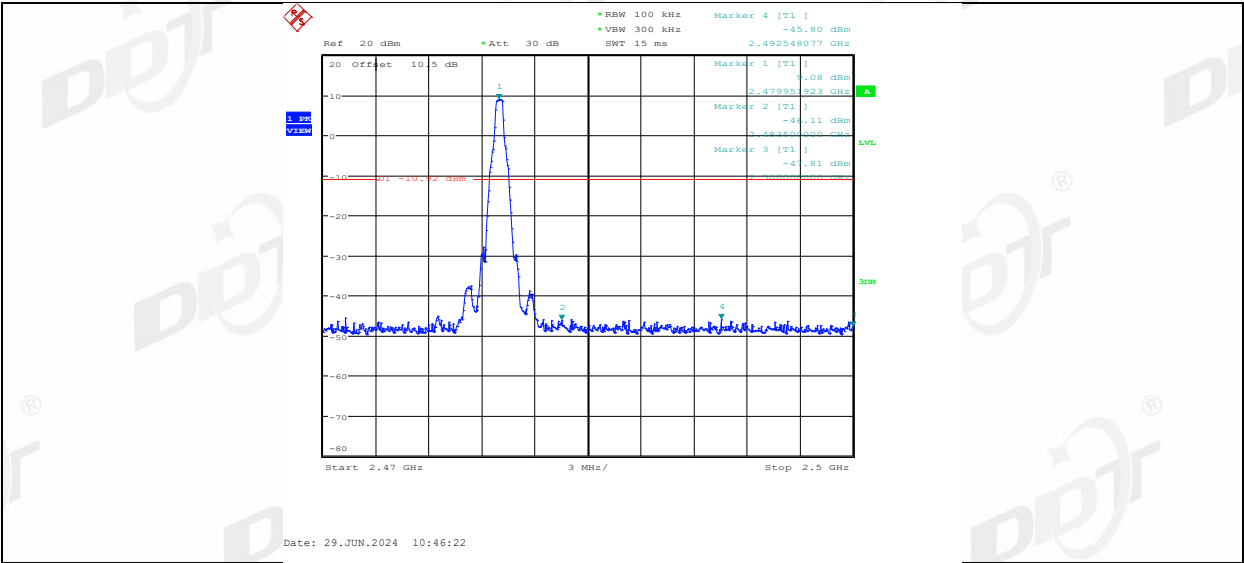
Test Engineer:	Zora Zhang	Test Site:	RF Measurement System 1#
Ambient Condition:	25.3°C, 59.4%RH	Test Date:	2024.06.28-2024.06.29
Test Power Supply:	Battery	Sample Number:	S24052314-002

Mode	Freq. (MHz)	Verdict
GFSK	Hopping off 2402	Pass
	Hopping off 2480	Pass
	Hopping on	Pass
$\pi/4$ -DQPSK	Hopping off 2402	Pass
	Hopping off 2480	Pass
	Hopping on	Pass
8DPSK	Hopping off 2402	Pass
	Hopping off 2480	Pass
	Hopping on	Pass

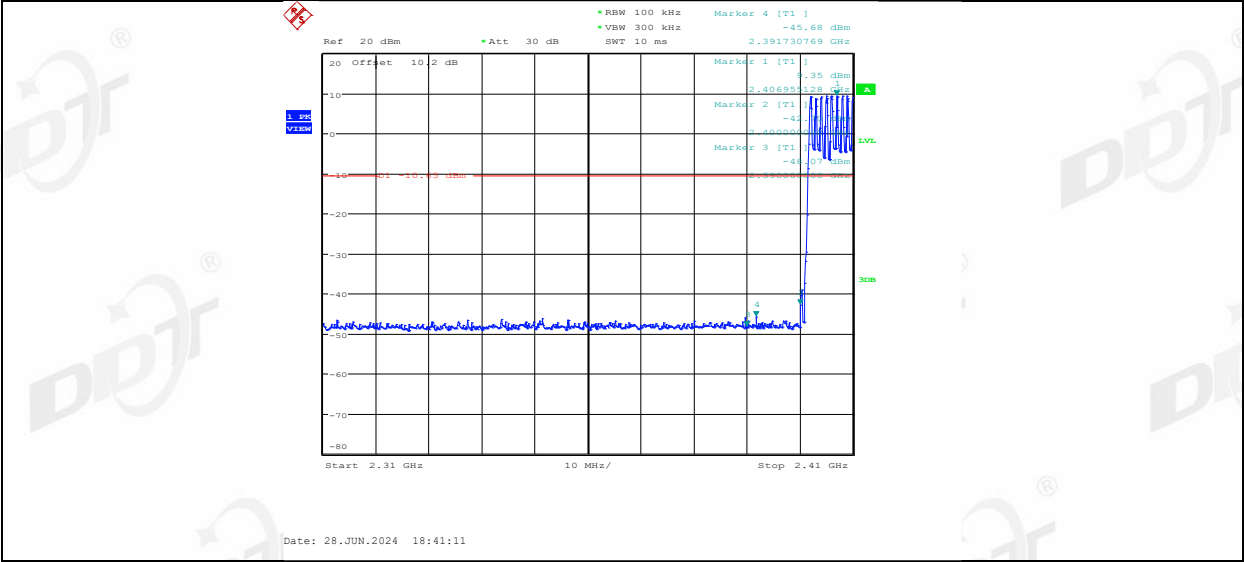
10.5. Test graphs



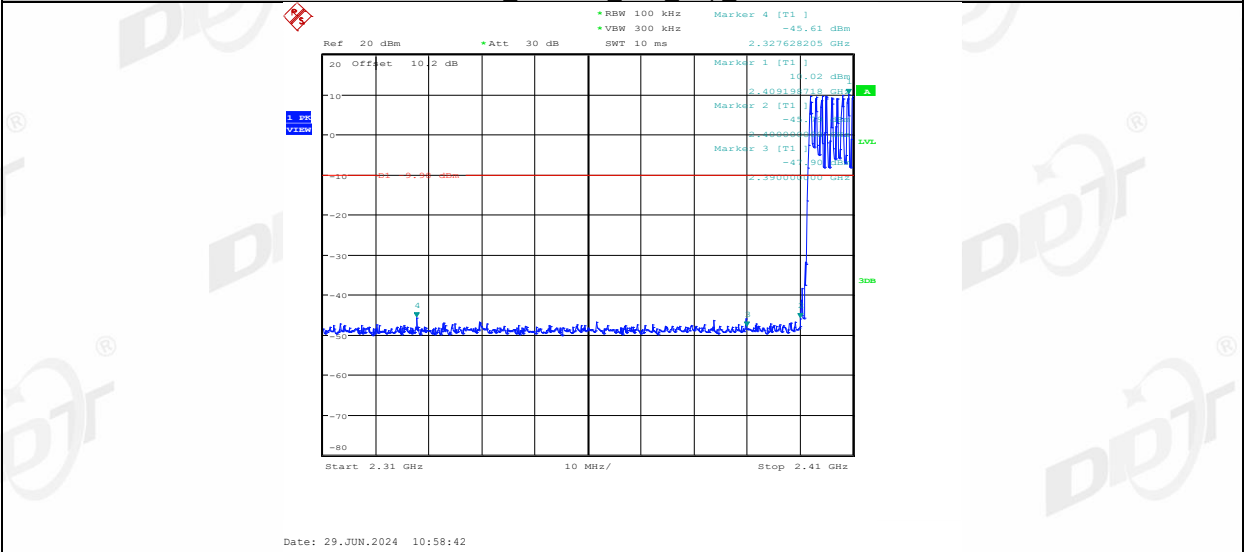
DH5 Left side High 2480



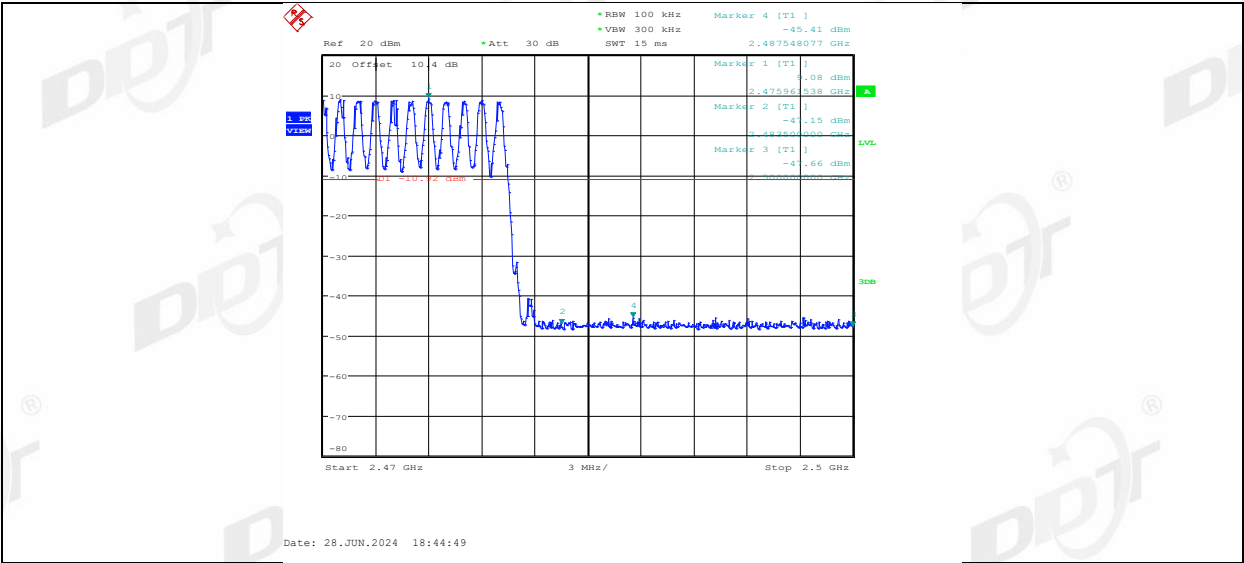
DH5 Right side Low Hop 2402



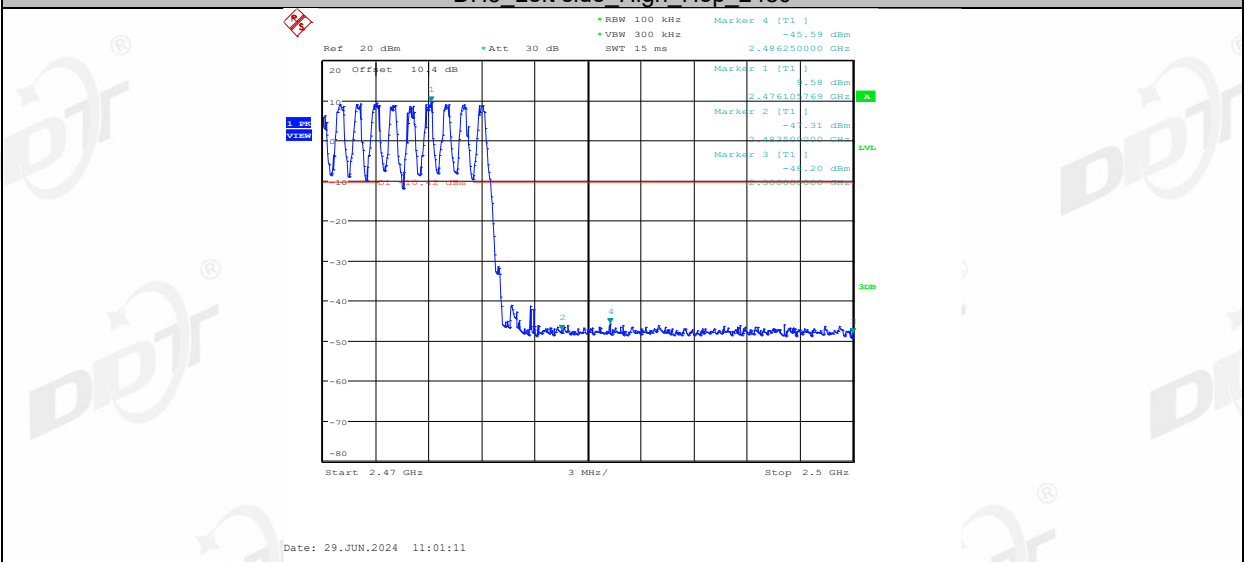
DH5 Left side Low Hop 2402



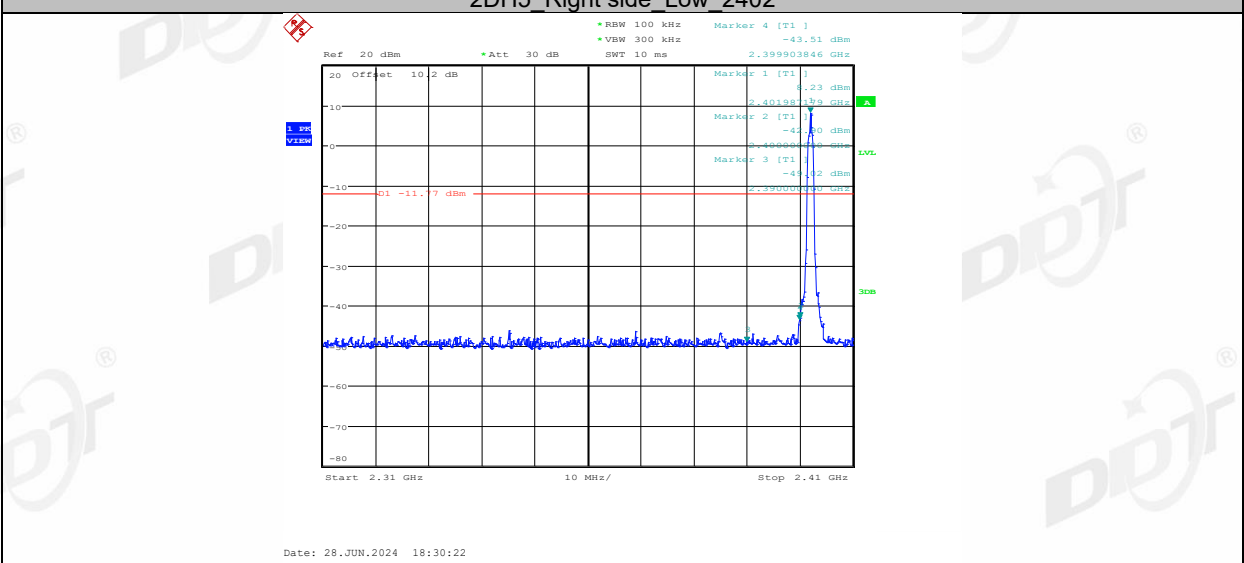
DH5 Right side High Hop 2480



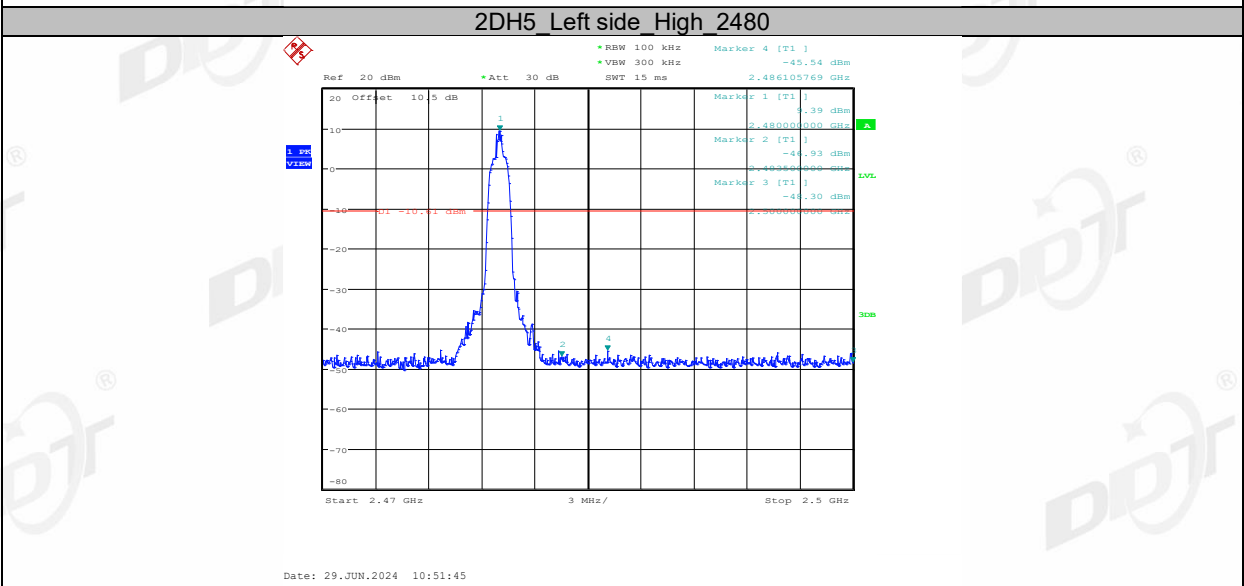
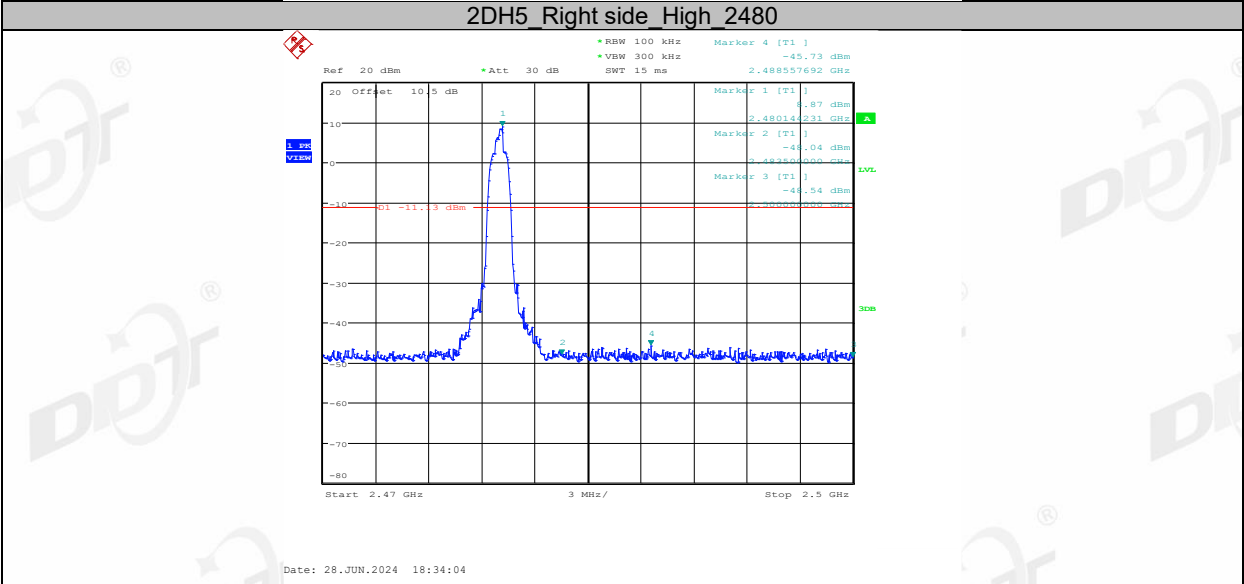
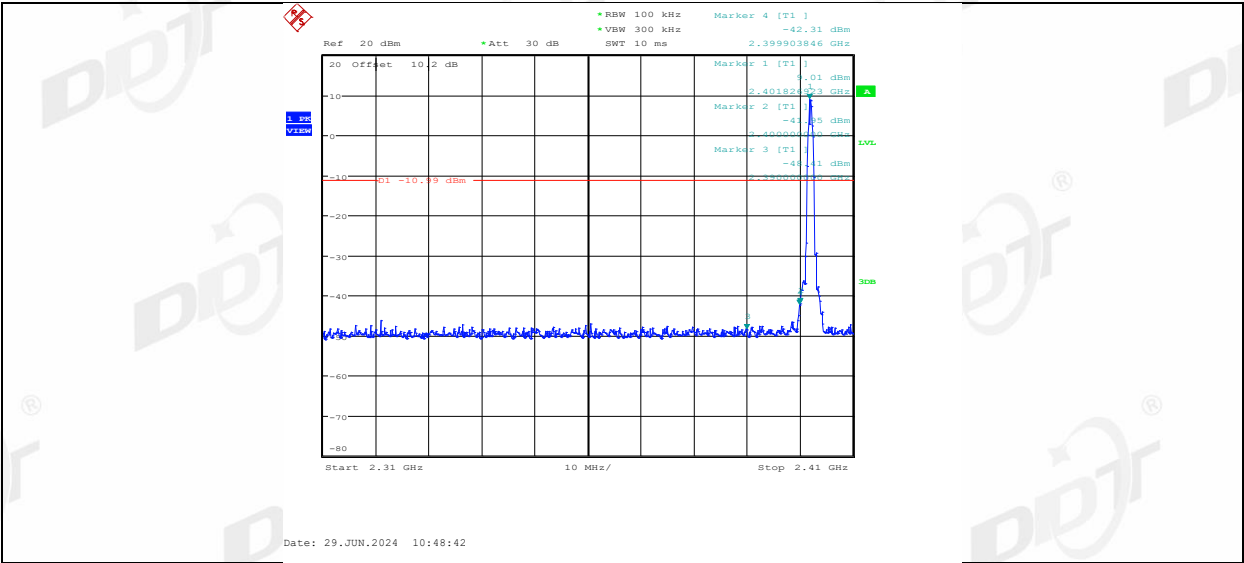
DH5 Left side High Hop 2480



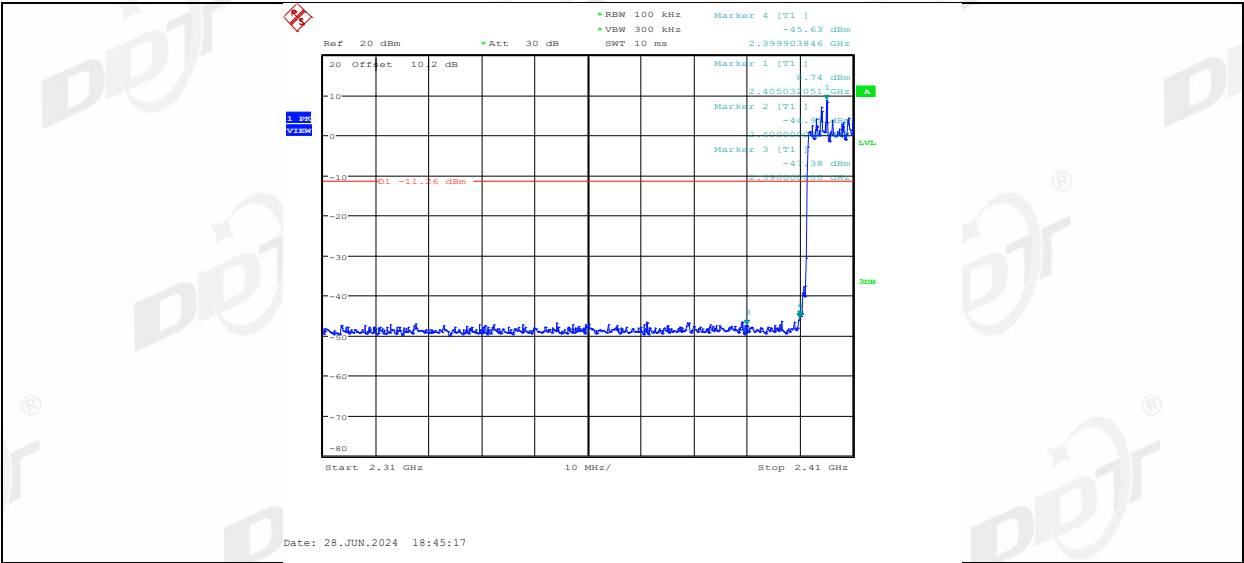
2DH5 Right side Low 2402



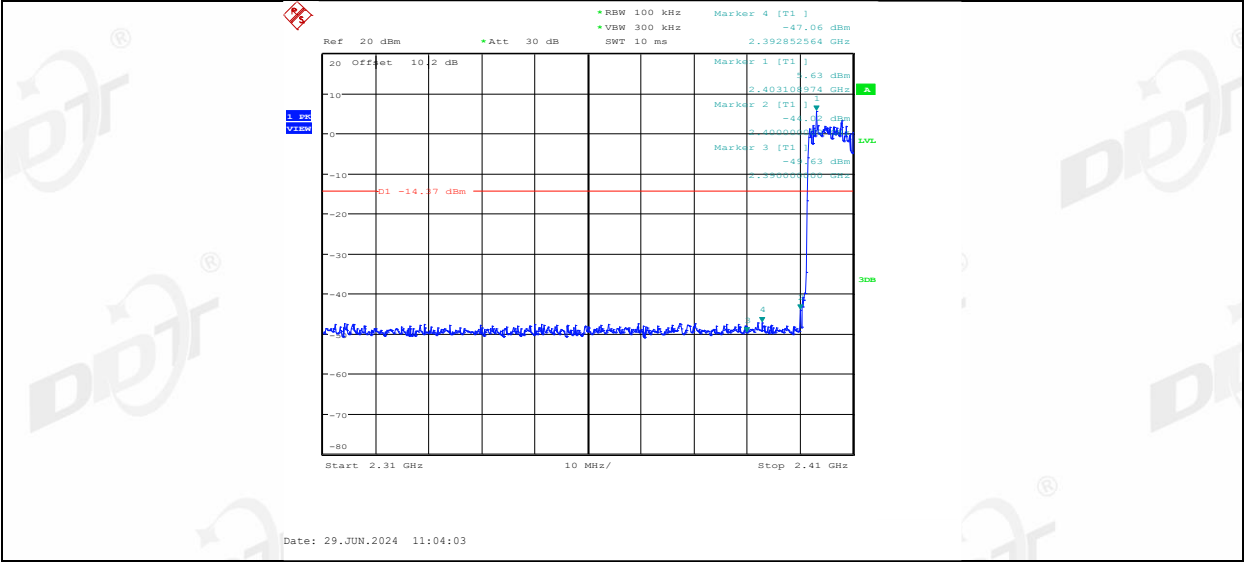
2DH5 Left side Low 2402



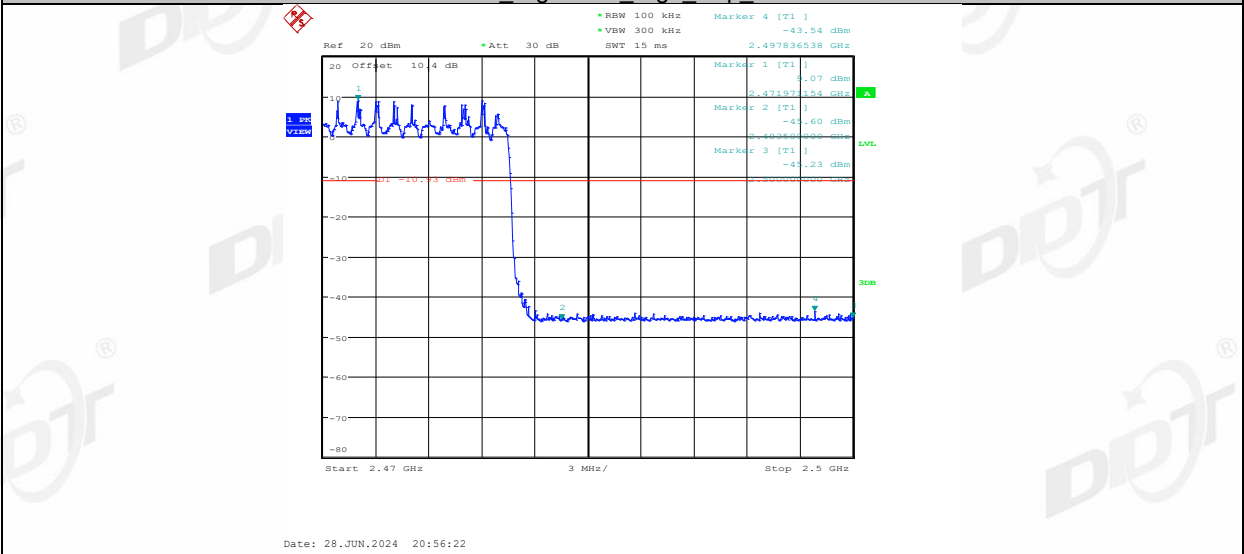
2DH5_Right side_Low_Hop_2402



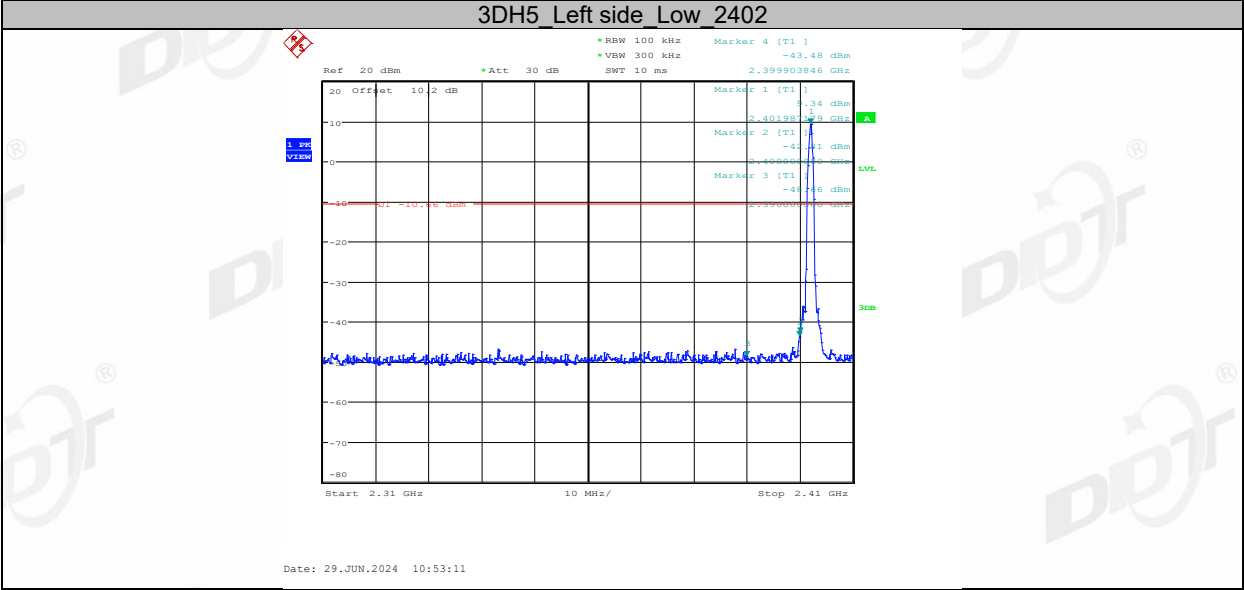
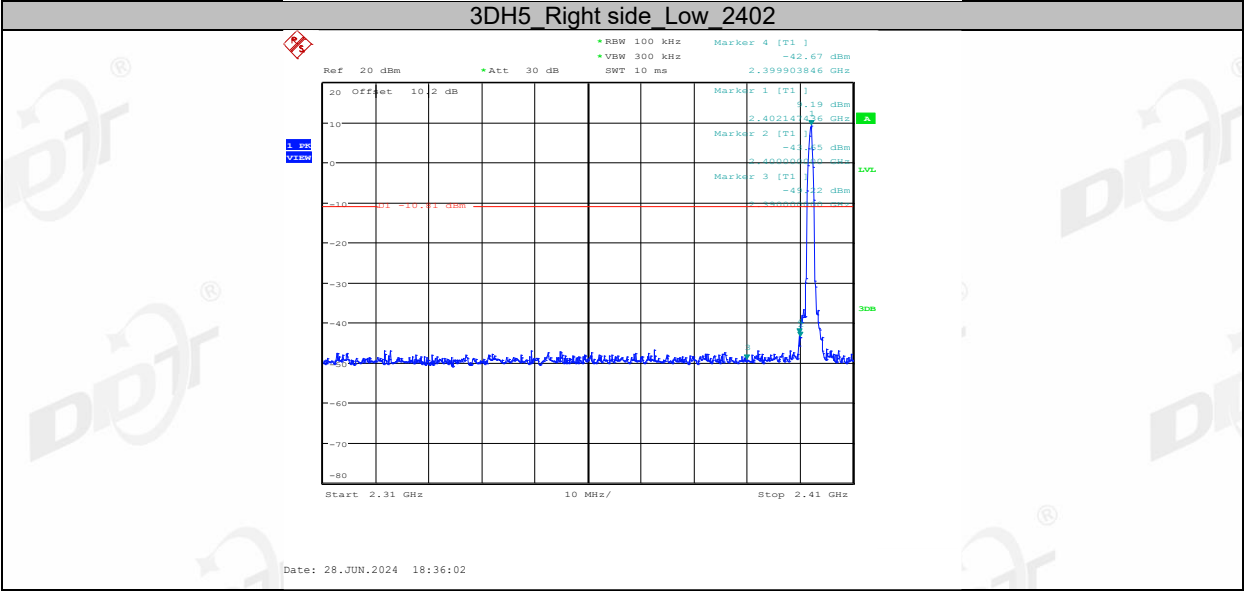
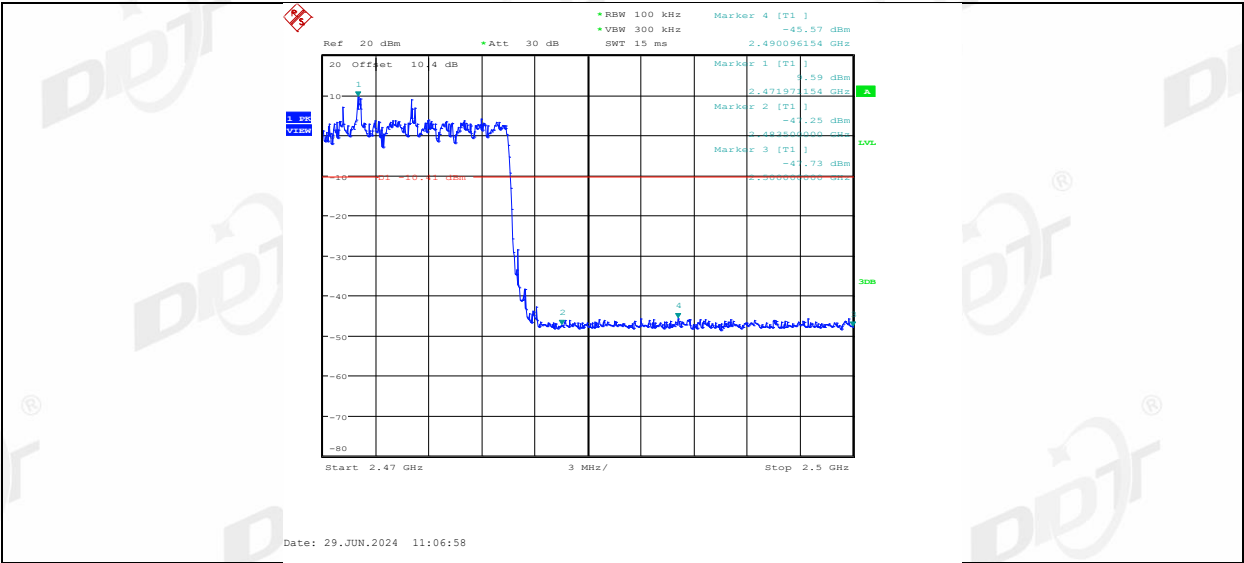
2DH5 Left side Low Hop 2402



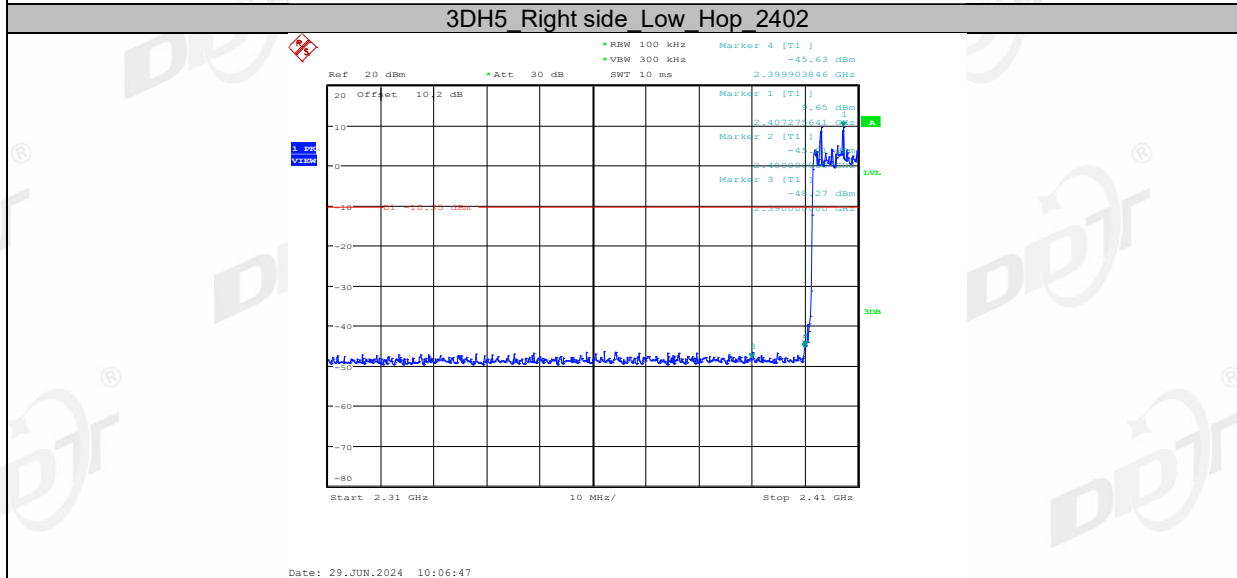
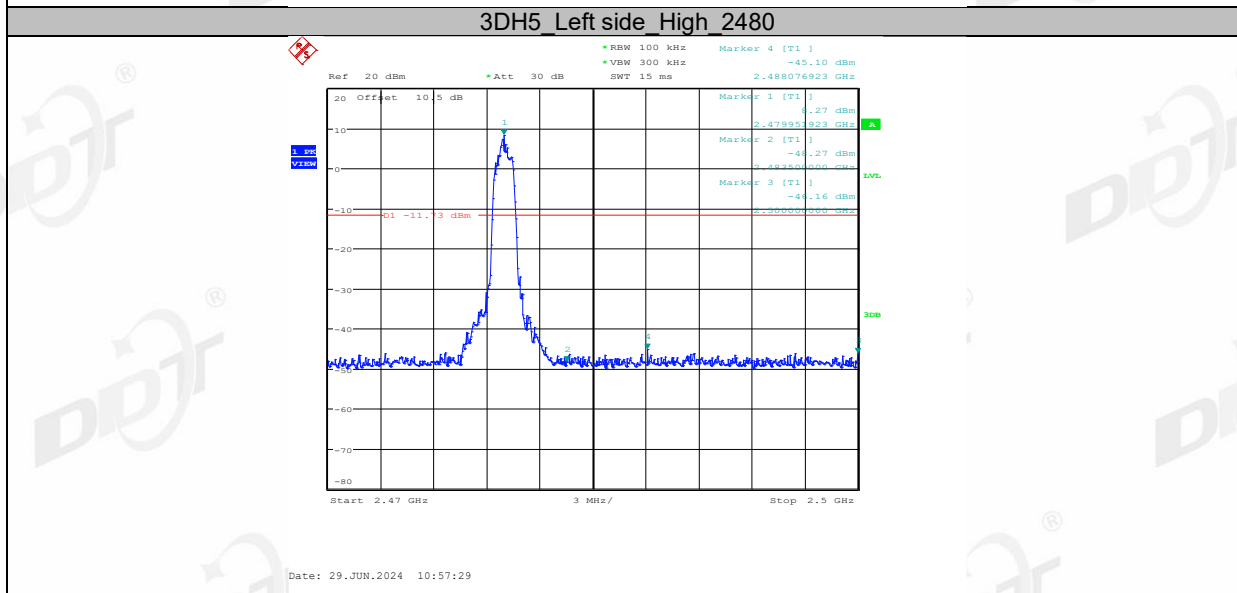
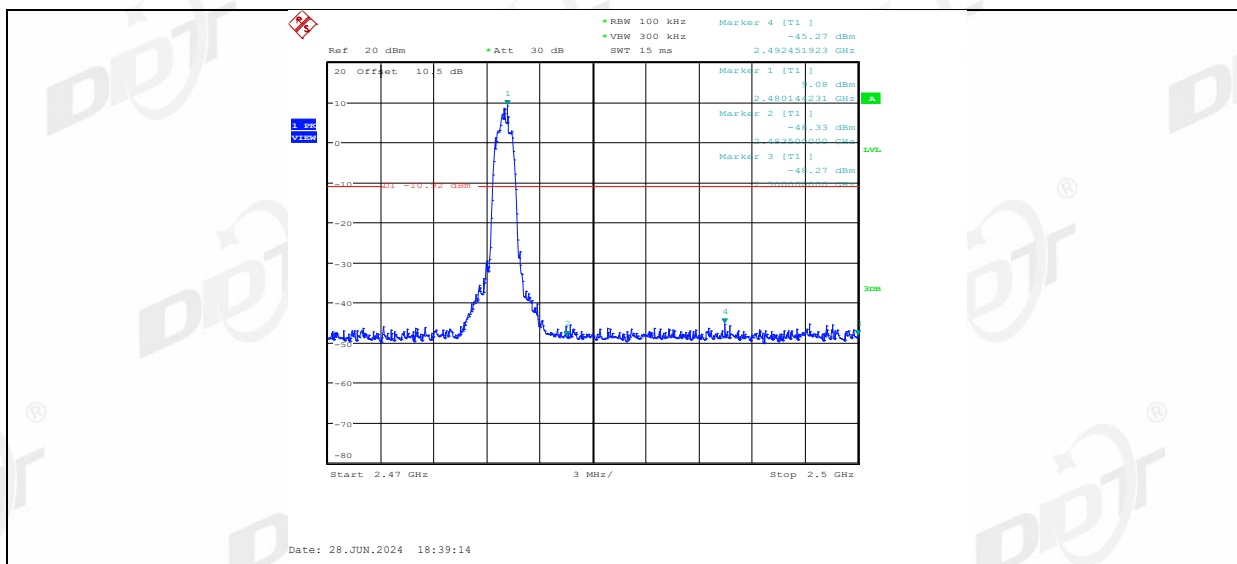
2DH5 Right side High Hop 2480

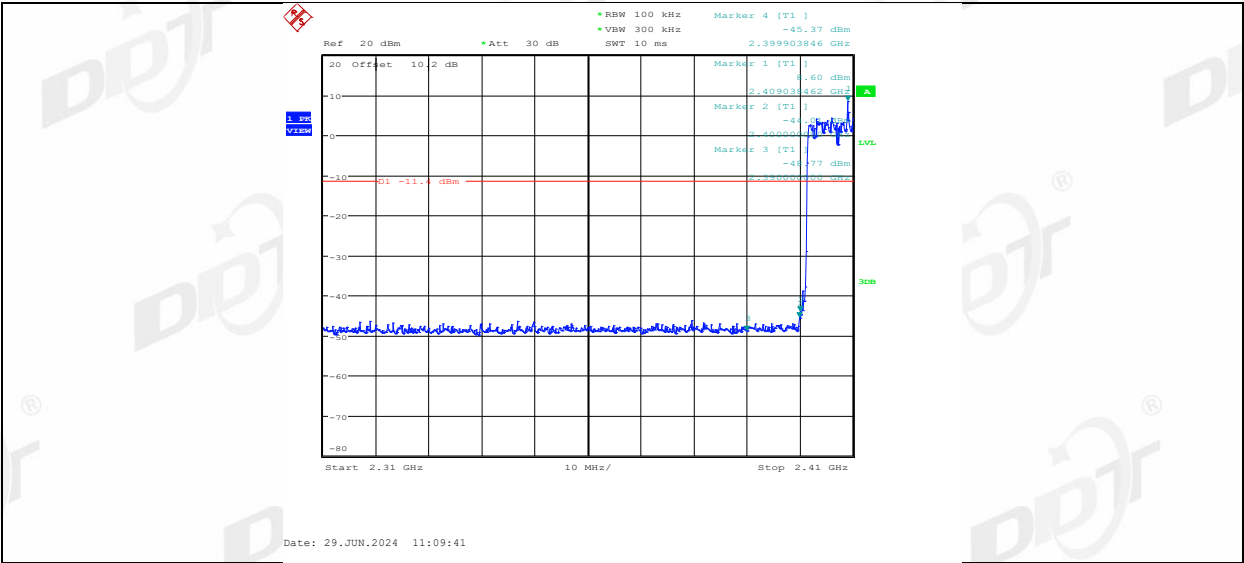


2DH5 Left side High Hop 2480

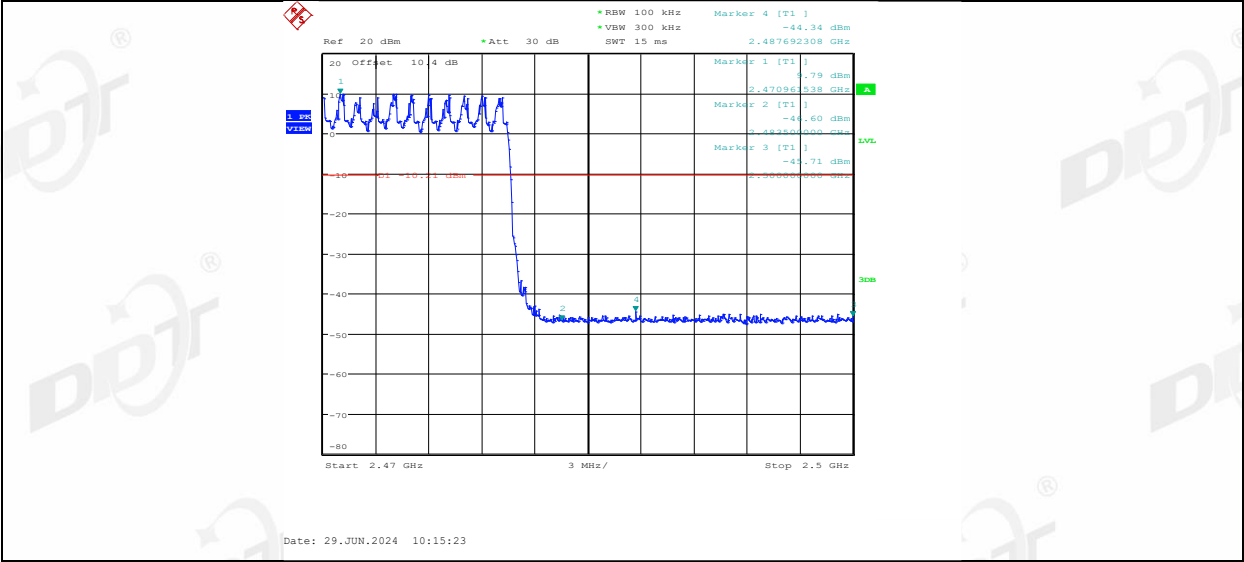


3DH5_Right side_High_2480

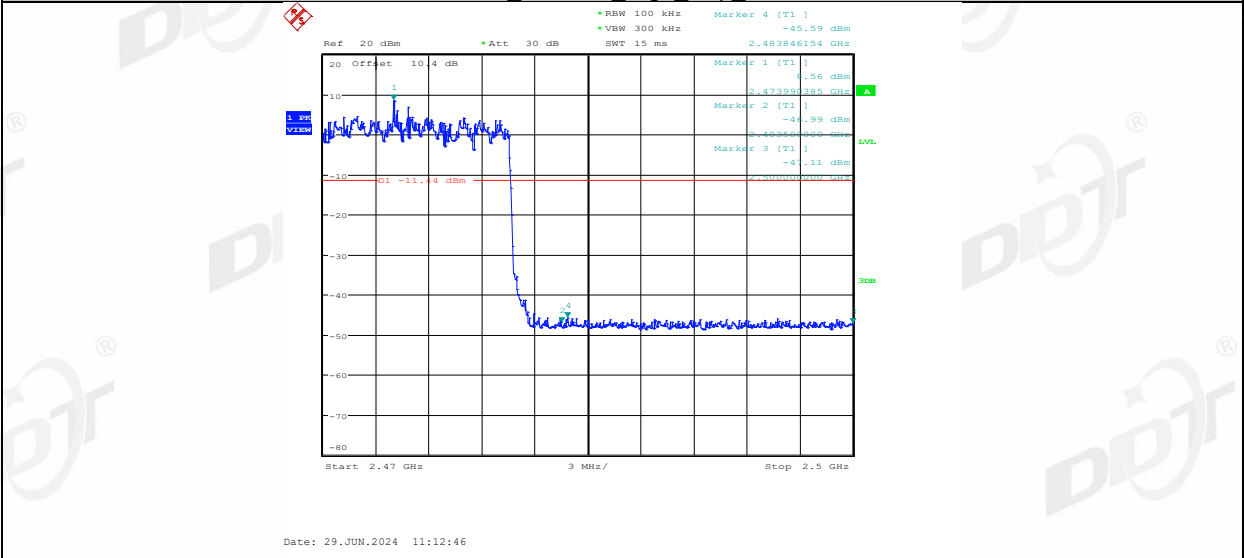




3DH5 Right side High Hop 2480

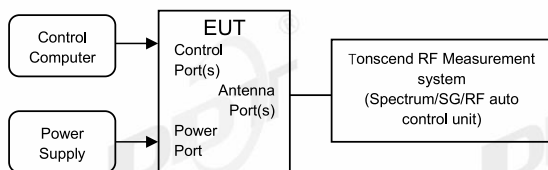


3DH5 Left side High Hop 2480



11. RF Conducted Spurious Emissions

11.1. Block diagram of test setup



11.2. Limits

In any 100 kHz bandwidth outside the frequency bands in which the spread spectrum intentional radiator is operating, the radio frequency power that is produced by the intentional radiator 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.

11.3. Test procedure

(1) Connect EUT's antenna output to spectrum analyzer by RF cable.

(2) Establish a reference level by using the following procedure:

Center frequency	Test frequency
RBW:	100 kHz
VBW:	300 kHz
Span	Wide enough to capture the peak level of the in-band emission
Detector Mode:	Peak
Sweep time:	Auto
Trace mode	Max hold

(3) Allow the trace to stabilize, use the peak marker function to determine the maximum peak power level to establish the reference level.

(4) Set the spectrum analyzer as follows:

RBW:	100 kHz
VBW:	300 kHz
Span	Encompass frequency range to be measured
Number of measurement points	$\geq \text{Span}/\text{RBW}$
Detector Mode:	Peak
Sweep time:	Auto
Trace mode	Max hold

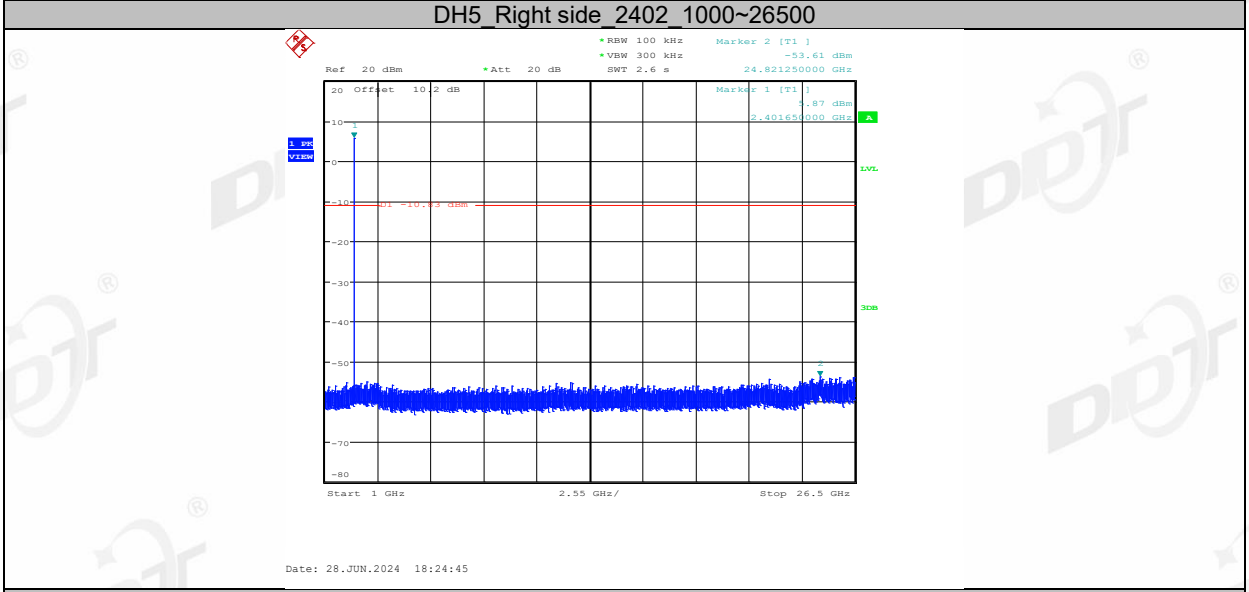
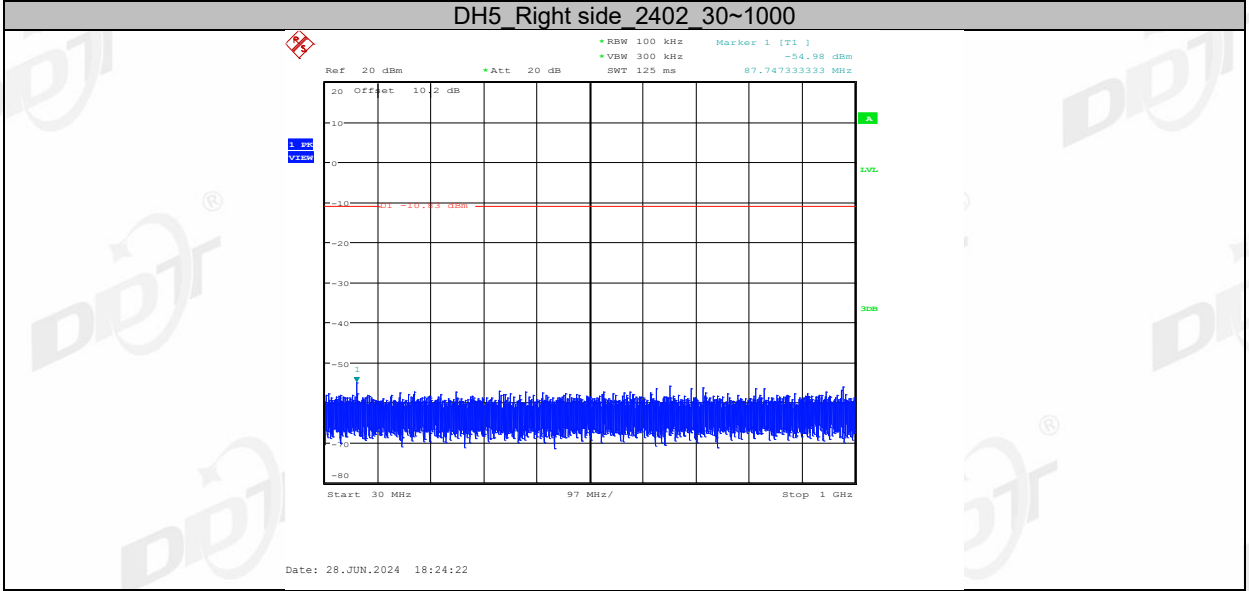
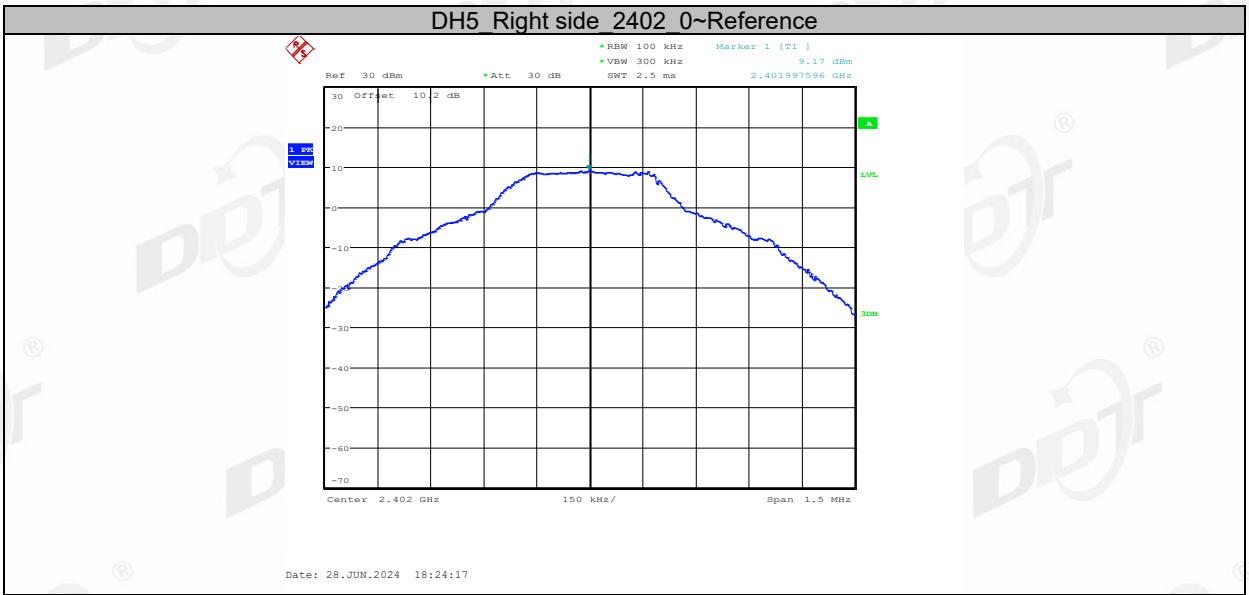
Allow the trace to stabilize, use the peak marker function to determine the maximum amplitude of all unwanted emissions outside of the authorized frequency band

11.4. Test result

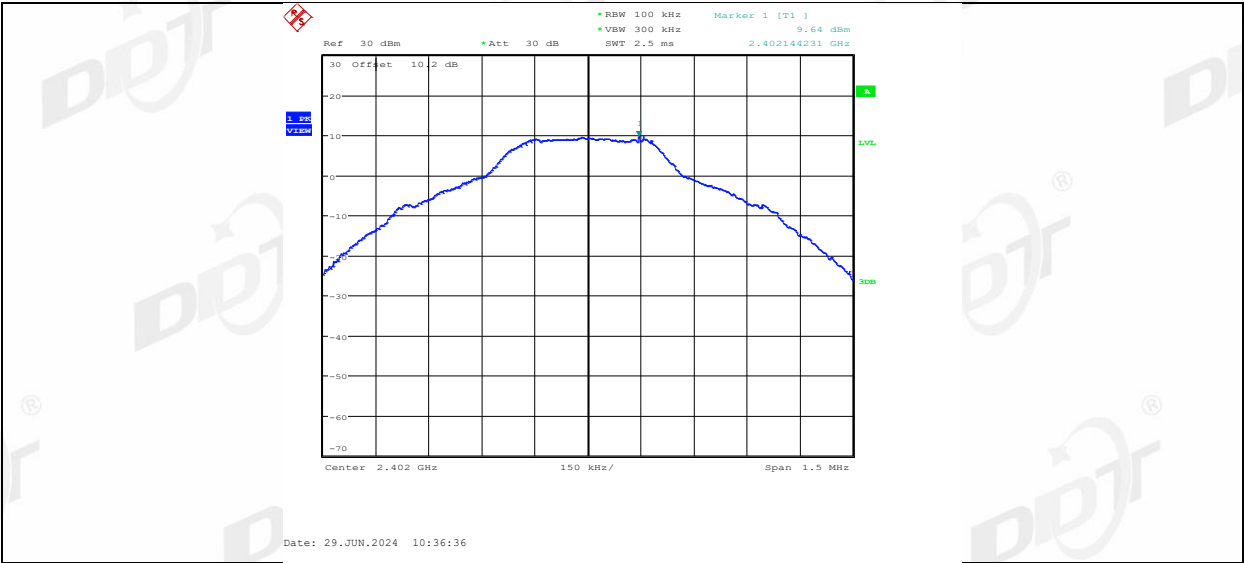
Test Engineer:	Zora Zhang	Test Site:	RF Measurement System 1#
Ambient Condition:	25.3°C, 59.4%RH	Test Date:	2024.06.28-2024.06.29
Test Power Supply:	Battery	Sample Number:	S24052314-002

Mode	Freq. (MHz)	Verdict
GFSK	Hopping off 2402	Pass
	Hopping off 2441	Pass
	Hopping off 2480	Pass
$\pi/4$ -DQPSK	Hopping off 2402	Pass
	Hopping off 2441	Pass
	Hopping off 2480	Pass
8DPSK	Hopping off 2402	Pass
	Hopping off 2441	Pass
	Hopping off 2480	Pass

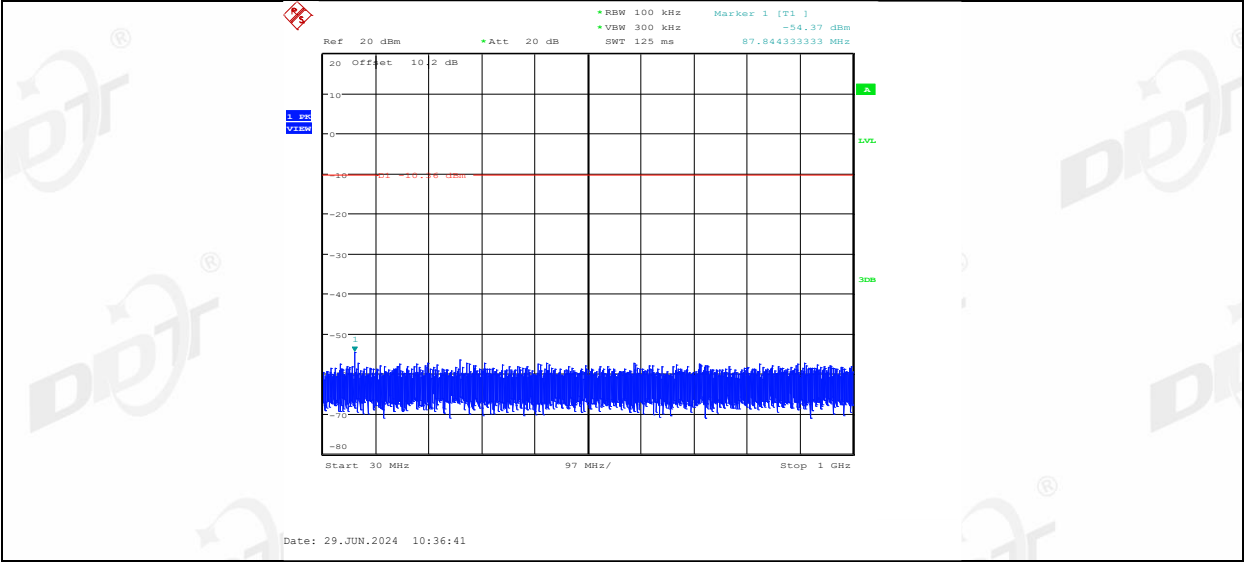
11.5. Test graphs



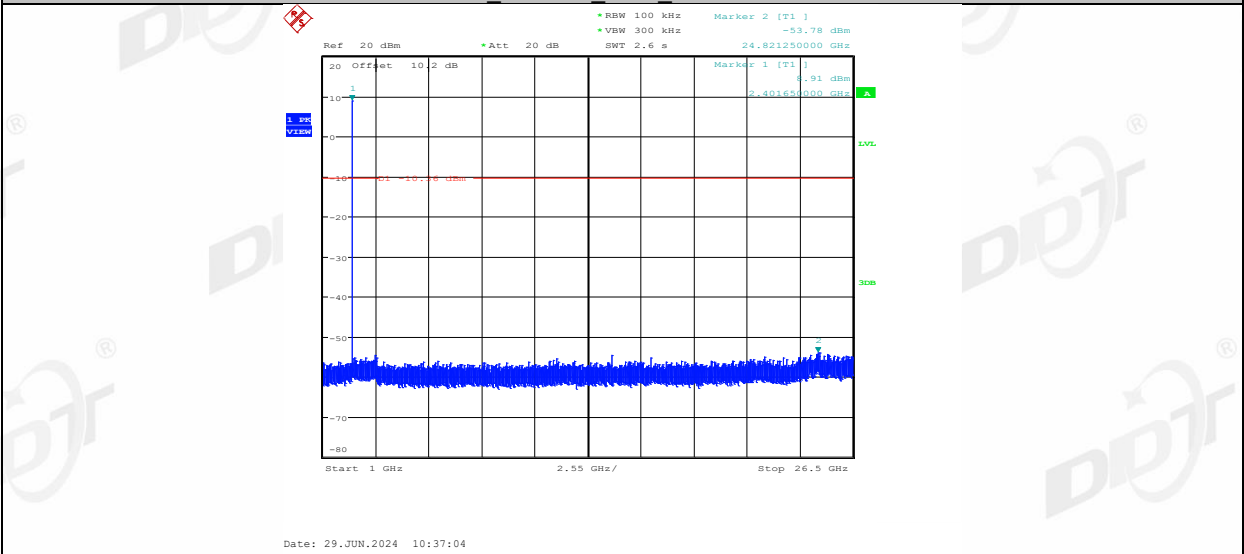
DH5 Left side 2402 0~Reference



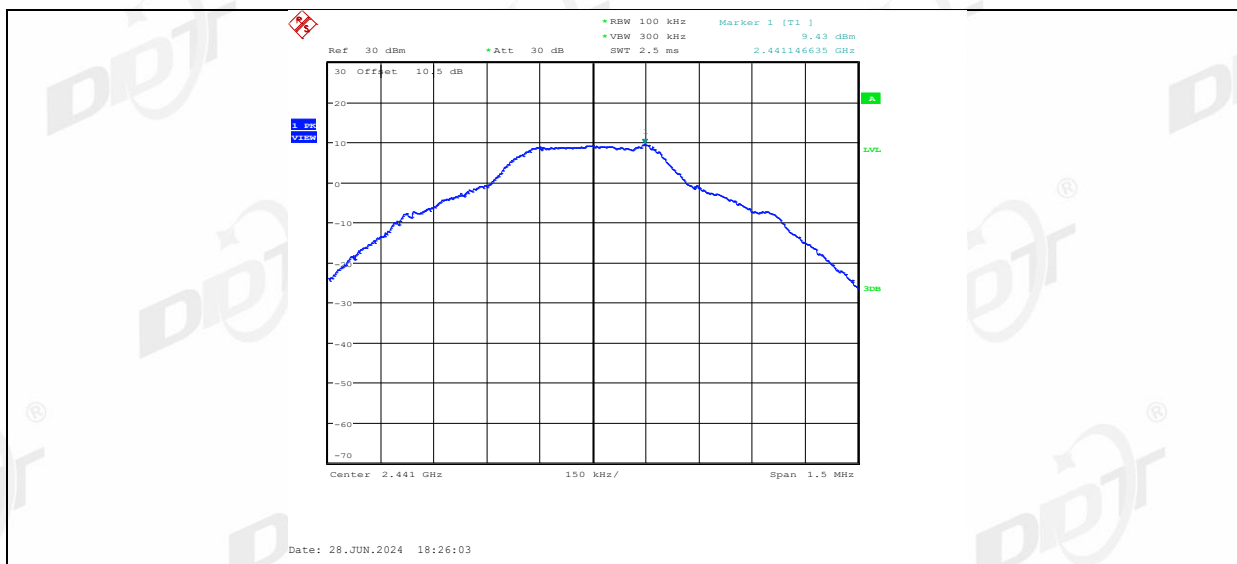
DH5_Left side 2402_30~1000



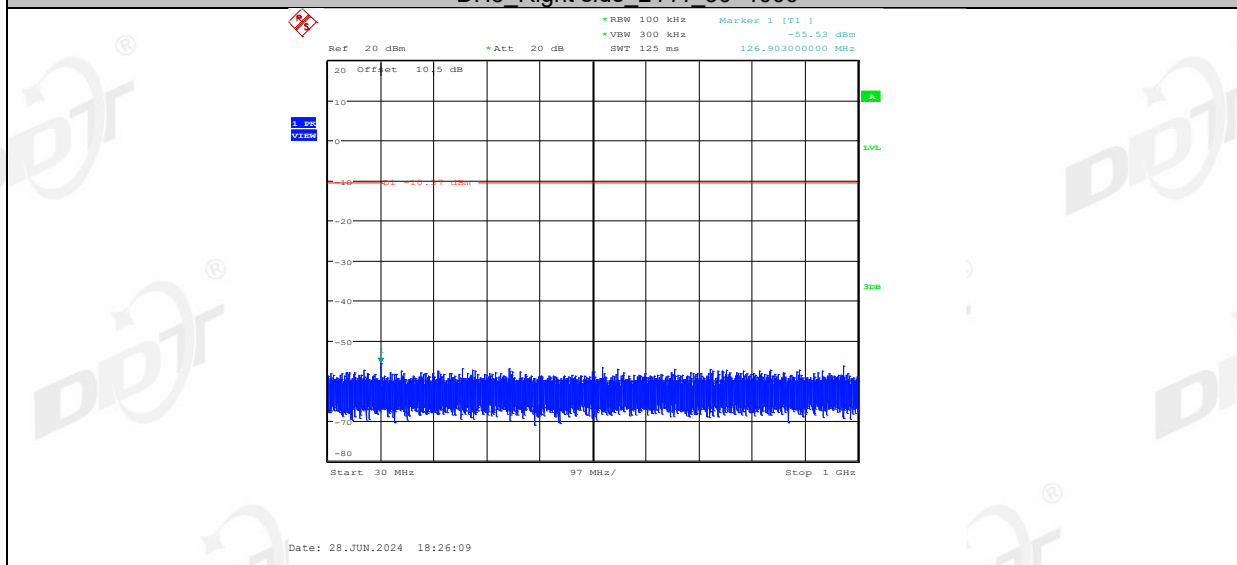
DH5_Left side 2402_1000~26500



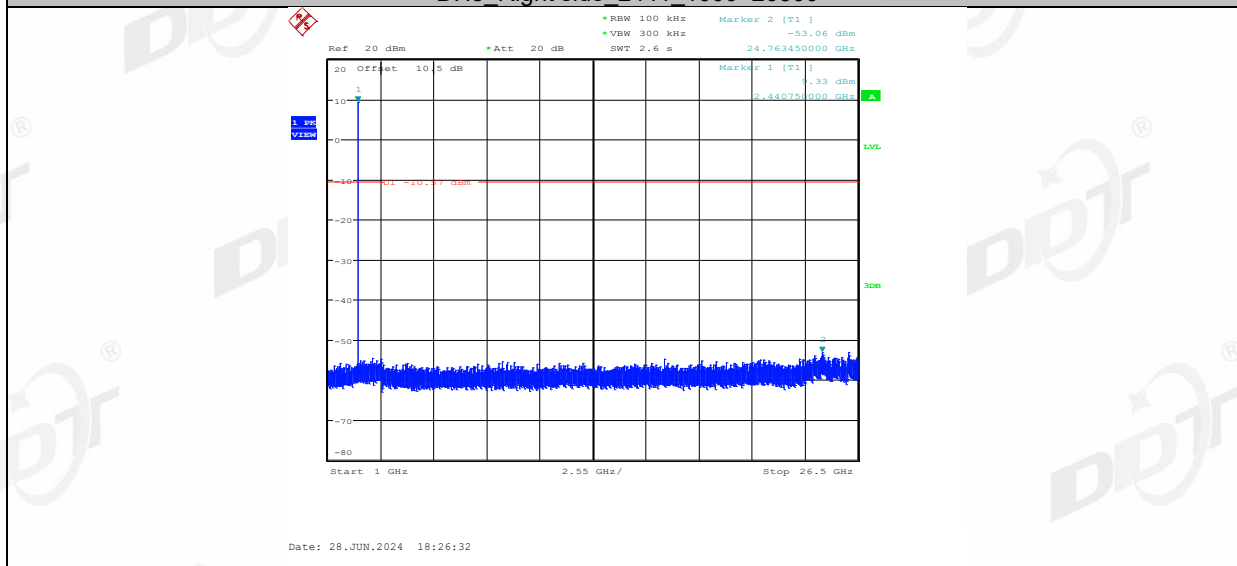
DH5_Right side 2441_0~Reference



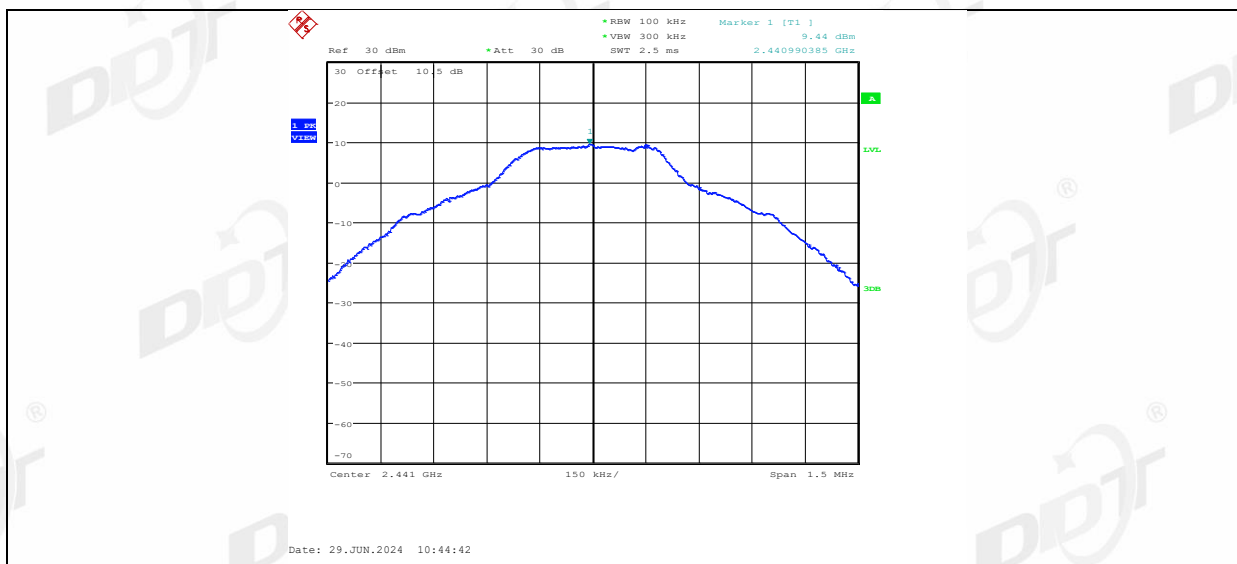
DH5_Right side_2441_30~1000



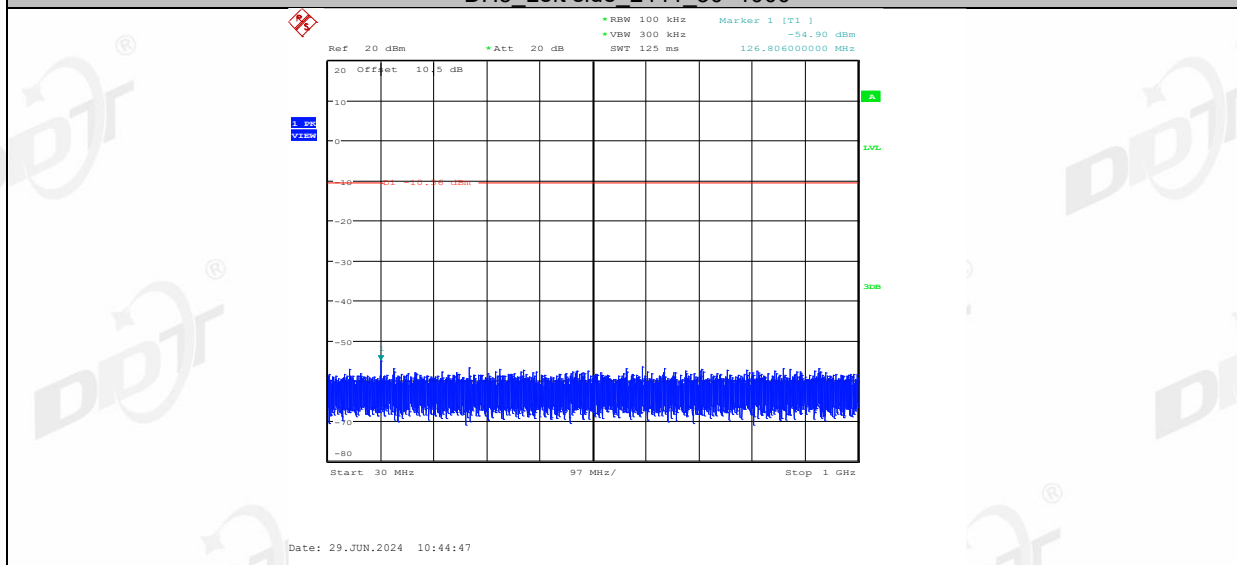
DH5_Right side_2441_1000~26500



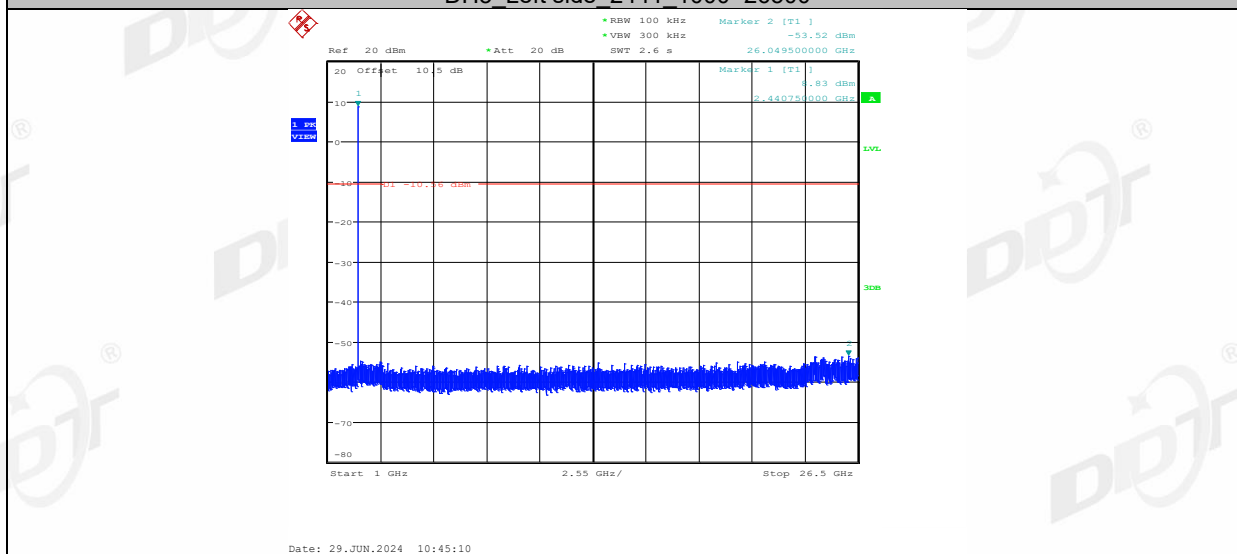
DH5_Left side_2441_0-Reference



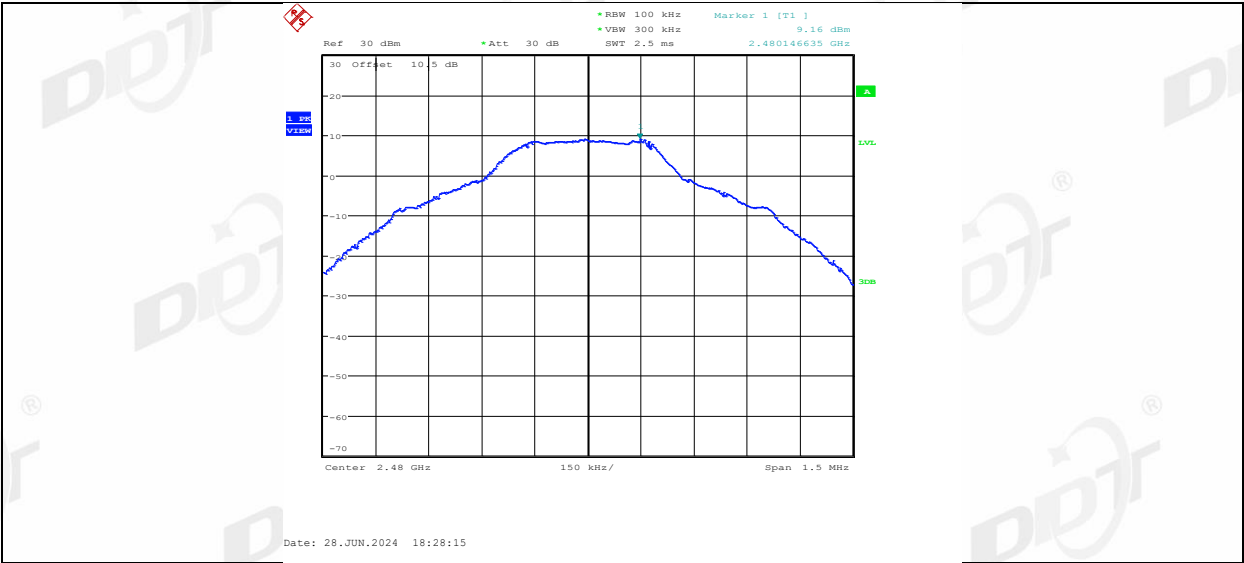
DH5 Left side 2441 30~1000



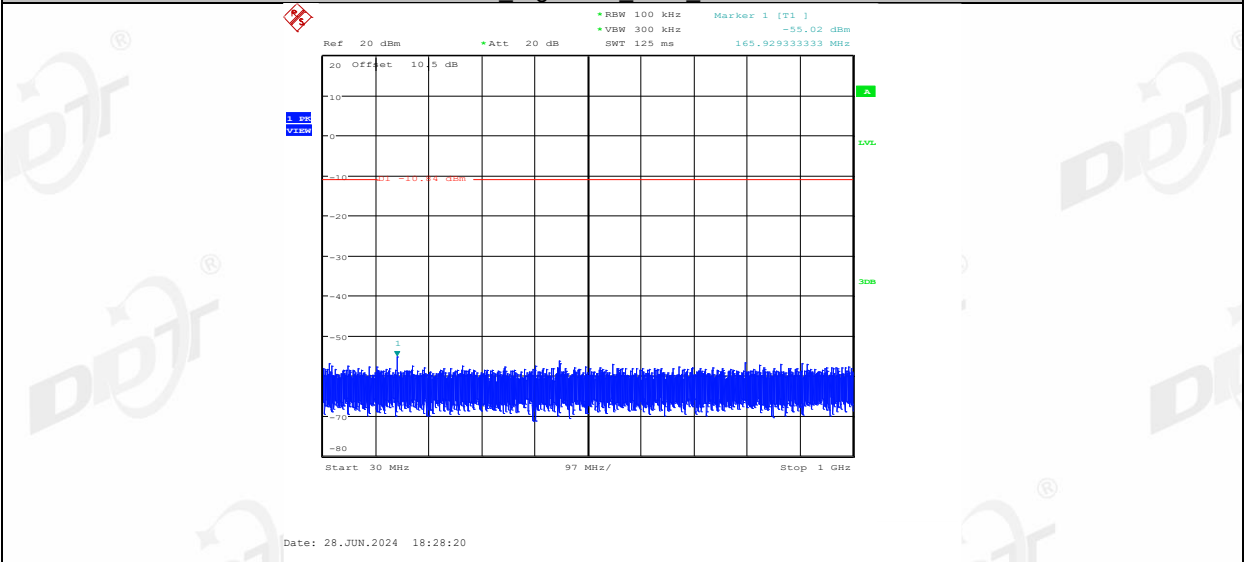
DH5 Left side 2441 1000~26500



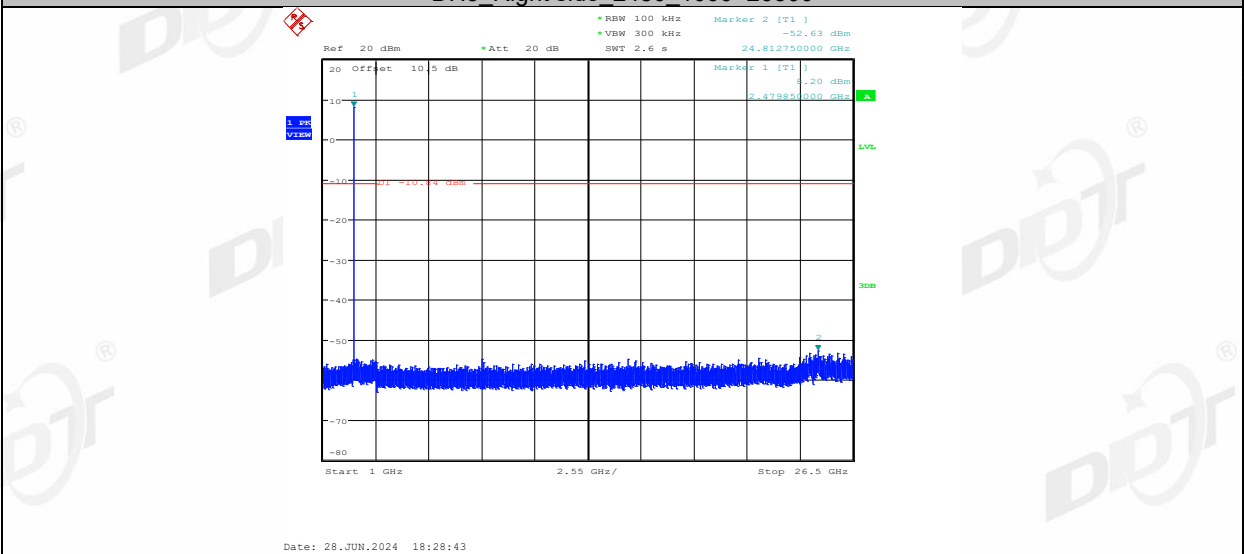
DH5 Right side 2480 0~Reference



DH5_Right side_2480_30~1000



DH5_Right side_2480_1000~26500



DH5_Left side_2480_0-Reference