

FCC - TEST REPORT

Report Number : **68.940.23.0027.01** Date of Issue: **2023-07-13**

Model : **060-ROT-16**

Product Type : **360 Rotation Bumper Car (12V) 2 Speed (Kidzone App)**

Applicant : **ALIGN INC.**

Address : **19301 E Walnut dr. N. City of industry CA91748 United States**

Manufacturer : **ALIGN INC.**

Address : **19301 E Walnut dr. N. City of industry CA91748 United States**

Test Result : ☒ **Positive** ☐ **Negative**

Total pages including Appendices : **66**

Any use for advertising purposes must be granted in writing. This technical report may only be quoted in full. This report is the result of a single examination of the object in question and is not generally applicable evaluation of the quality of other products in regular production. For further details, please see testing and certification regulation, chapter A-3.4.

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2 Details about the Test Laboratory

Details about the Test Laboratory

Test Site 1

Company name: TÜV SÜD Certification and Testing (China) Co., Ltd. Shenzhen Branch
Building 12&13, Zhiheng Wisdomland Business Park, Guankou Erlu,
Nantou, Nanshan District, Shenzhen City, 518052, P. R. China

Telephone: 86 755 8828 6998

Fax: 86 755 8828 5299

FCC Registration No.: 514049

FCC Designation Number: CN5009

IC Registration No.: 10320A

3 Description of the Equipment Under Test

Product:	360 Rotation Bumper Car (12V) 2 Speed (Kidzone App)
Model no.:	060-ROT-16
FCC ID:	2BBEC060-ROT-16
Options and accessories:	Adapter
Rating:	Supplied by 12VDC Li-ion Rechargeable Battery 4.5Ah Charged by 12.0Vdc, 0.5A external adapter
Adapter information:	Adapter Model: SL12-04-01 Input: 120Vac, 60Hz; 0.25A Output: 12.0Vdc, 0.5A
RF Transmission Frequency:	2402MHz-2480MHz
No. of Operated Channel:	79
Modulation:	GFSK, $\pi/4$ -DQPSK, 8DPSK
Antenna Type:	PCB Antenna
Antenna Gain:	-0.58dBi
Description of the EUT:	EUT is a 360 Rotation Bumper Car with Bluetooth and 2.4G Hopping function which operated at 2.4GHz.

4 Summary of Test Standards

Test Standards	
FCC Part 15 Subpart C 10-1-2021 Edition	PART 15 - RADIO FREQUENCY DEVICES Subpart C - Intentional Radiators

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

5 Summary of Test Results

Technical Requirements						
FCC Part 15 Subpart C						
Test Condition		Pages	Test Site	Test Result		
				Pass	Fail	N/A
§15.207	Conducted emission AC power port	10	Site 1	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
§15.247 (b) (1)	Conducted peak output power	13	Site 1	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
§15.247(a)(1)	20dB bandwidth	19	Site 1	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
§15.247(a)(1)	Carrier frequency separation	30	Site 1	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
§15.247(a)(1)(iii)	Number of hopping frequencies	33	Site 1	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
§15.247(a)(1)(iii)	Dwell Time	36	Site 1	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
§15.247(e)	Power spectral density	---	---	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>
§15.247(d)	Spurious RF conducted emissions	46	Site 1	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
§15.247(d)	Band edge	61	Site 1	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
§15.247(d)	Spurious radiated emissions for transmitter	69	Site 1	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
§15.203	Antenna requirement	See note 2		<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

Note 1: N/A=Not Applicable.

Note 2: The EUT uses a PCB antenna, which gain is -0.58dBi. In accordance to §15.203, it is considered sufficiently to comply with the provisions of this section.

6 General Remarks

Remarks

This submittal(s) (test report) is intended for FCC ID: 2BBEC060-ROT-16 complies with Section 15.207, 15.209, 15.247 of the FCC Part 15, Subpart C rules.

SUMMARY:

All tests according to the regulations cited on page 5 were

■ - Performed

□ - **Not** Performed

The Equipment Under Test

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

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

Sample Received Date: 2023-05-18

Testing Start Date: 2023-05-18

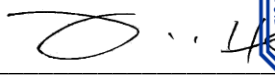
Testing End Date: 2023-05-24

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


Reviewed by:

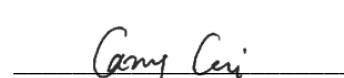
Prepared by:

Tested by:


Jessie He
Project Manager

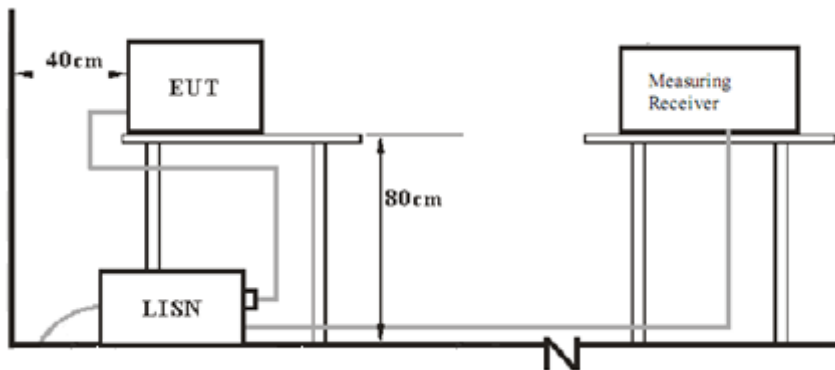



Richard He
Project Engineer


Garry Cai
Test Engineer

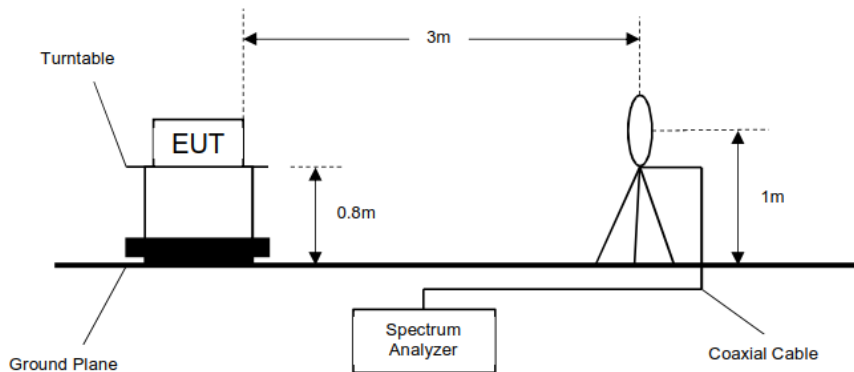
7 Test Setups

7.1 AC Power Line Conducted Emission test setups

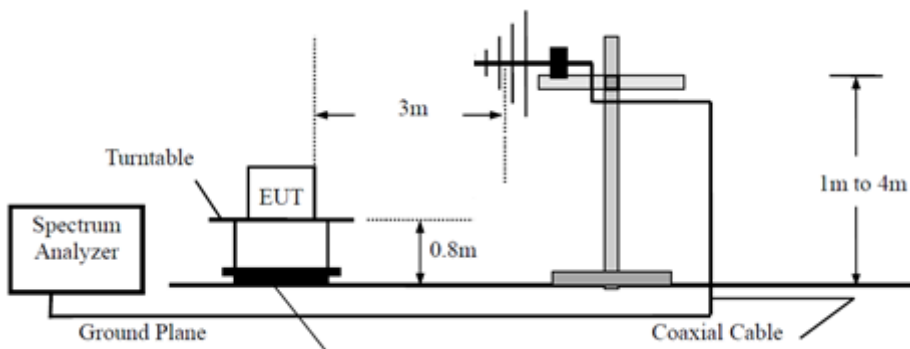


7.2 Radiated test setups

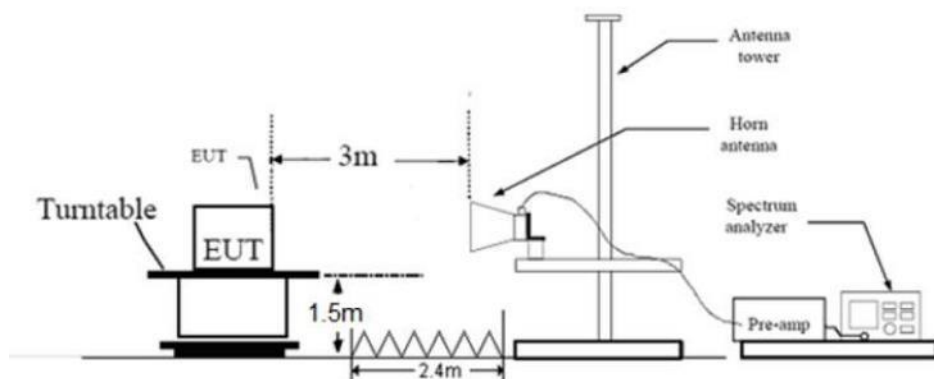
9KHz - 30MHz



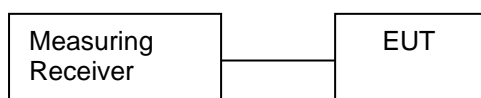
30MHz - 1GHz



Above 1GHz



7.3 Conducted RF test setups



8 Systems test configuration

Auxiliary Equipment Used during Test:

DESCRIPTION	MANUFACTURER	MODEL NO.	S/N
Notebook	Lenovo	X240	---

Test software information:

Test Software Version	1.0.2.2	
Modulation	Setting TX Power	Packet Type
GFSK	0	PRBS9
$\pi/4$ -DQPSK	0	PRBS9
8DPSK	0	PRBS9

The system was configured to hopping mode and non-hopping mode.

Hopping mode: typical working mode (normal hopping status)

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

9 Technical Requirement

9.1 Conducted Emission

Test Method

1. The EUT was placed 0.4 meter from the conducting wall of the shielding room was kept at least 80 centimeters from any other grounded conducting surface.
2. Connect EUT to the power mains through a line impedance stabilization network (LISN).
3. All the support units are connecting to the other LISN.
4. The LISN provides 50 ohm coupling impedance for the measuring instrument.
5. Both sides of AC line were checked for maximum conducted interference.
6. The frequency range from 150 kHz to 30 MHz was searched.
7. Set the test-receiver system to Peak Detect Function and specified bandwidth (IF Bandwidth = 9kHz) with Maximum Hold Mode. Then measurement is also conducted by Average Detector and Quasi-Peak Detector Function respectively.

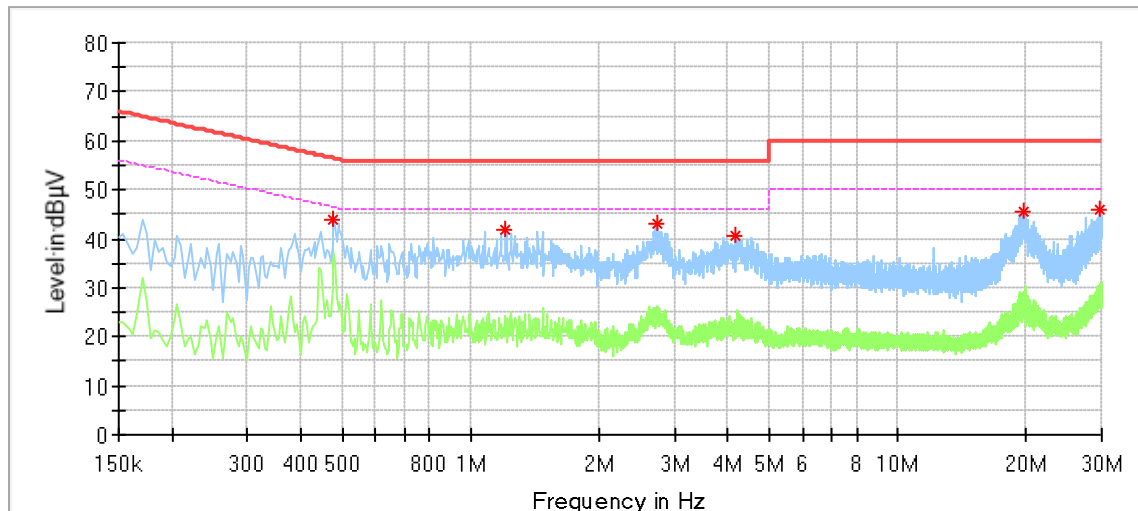
Limit

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

*Decreases with the logarithm of the frequency.

Conducted Emission

Model : 060-ROT-16
 Test Mode : Charging
 Test Voltage : 120VAC, 60Hz (for external adapter)
 Remark : Power Line, Live



Critical Freqs

Frequency (MHz)	MaxPeak (dBμV)	Average (dBμV)	Limit (dBμV)	Margin (dB)	Line	Corr. (dB)
0.478000	43.90	---	56.37	12.48	L1	9.62
1.210000	41.81	---	56.00	14.19	L1	9.64
2.742000	42.94	---	56.00	13.06	L1	9.68
4.154000	40.72	---	56.00	15.28	L1	9.74
19.670000	45.48	---	60.00	14.52	L1	10.06
29.810000	46.13	---	60.00	13.87	L1	10.02

Final Result

Frequency (MHz)	QuasiPeak (dBμV)	Average (dBμV)	Limit (dBμV)	Margin (dB)	Line	Corr. (dB)
---	---	---	---	---		---

Remark:

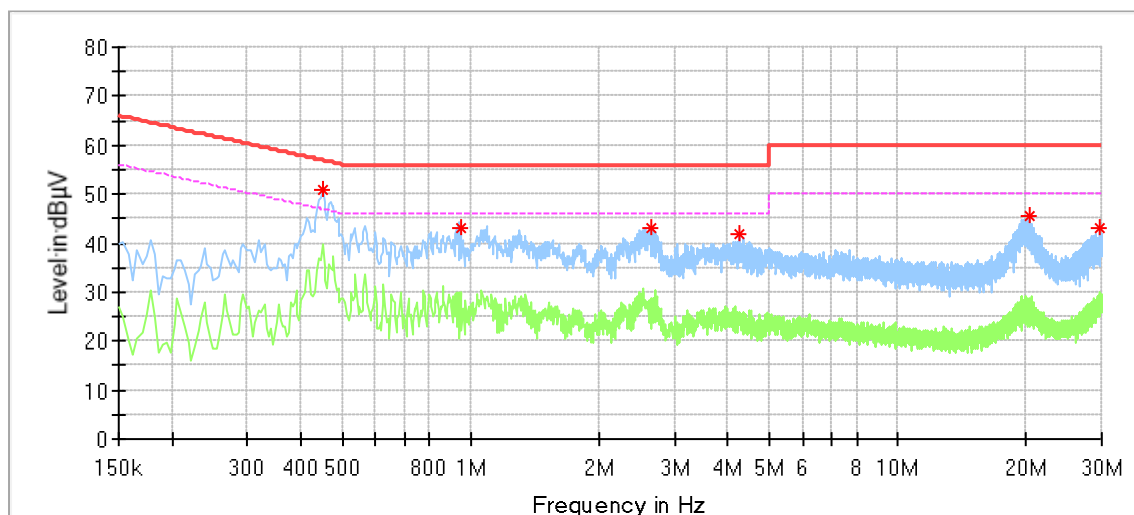
Level=Reading Level + Correction Factor

Correction Factor=LISN Factor + Cable Loss

(The Reading Level is recorded by software which is not shown in the sheet)

Conducted Emission

Model : 060-ROT-16
 Test Mode : Charging
 Test Voltage : 120VAC, 60Hz (for external adapter)
 Remark : Power Line, Neutral



Critical_Freqs

Frequency (MHz)	MaxPeak (dBμV)	Average (dBμV)	Limit (dBμV)	Margin (dB)	Line	Corr. (dB)
0.450000	50.70	---	56.88	6.18	N	9.62
0.946000	43.14	---	56.00	12.86	N	9.64
2.650000	43.01	---	56.00	12.99	N	9.68
4.246000	41.75	---	56.00	14.25	N	9.74
20.322000	45.58	---	60.00	14.42	N	10.09
29.794000	42.93	---	60.00	17.07	N	10.06

Final_Result

Frequency (MHz)	QuasiPeak (dBμV)	Average (dBμV)	Limit (dBμV)	Margin (dB)	Line	Corr. (dB)
---	---	---	---	---	---	---

Remark:

Level=Reading Level + Correction Factor

Correction Factor=LISN Factor + Cable Loss

(The Reading Level is recorded by software which is not shown in the sheet)

9.2 Conducted peak output power

Test Method

1. The RF output of EUT was connected to the test spectrum analyzer by RF cable. The path loss was compensated to the results for each measurement.
2. Set to the maximum power setting and enable the EUT transmit continuously
3. Use the following test receiver settings:
Span = approximately 5 times the 20dB bandwidth, centered on a hopping channel
RBW > the 20dB bandwidth of the emission being measured, VBW ≥ RBW,
Sweep = auto, Detector function = peak, Trace = max hold
4. Allow the trace to stabilize. Use the marker-to-peak function to set the marker to the peak of the emission. The indicated level is the peak output power and record the results in the test report.
5. Repeat above procedures until all frequencies measured were completed.

Limits

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

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

Conducted Peak Output Power

Test result as below table

Bluetooth Mode GFSK modulation Test Result

Frequency MHz	Conducted Peak Output Power dBm	Result
Low channel 2402MHz	-9.31	Pass
Middle channel 2441MHz	-9.1	Pass
High channel 2480MHz	-9.27	Pass

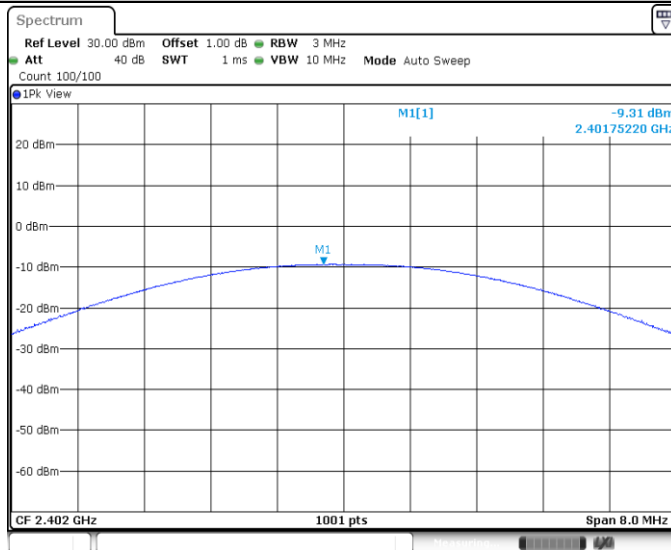
Bluetooth Mode $\pi/4$ -DQPSK modulation Test Result

Frequency MHz	Conducted Peak Output Power dBm	Result
Low channel 2402MHz	-8.43	Pass
Middle channel 2441MHz	-8.33	Pass
High channel 2480MHz	-8.42	Pass

Bluetooth Mode 8DPSK modulation Test Result

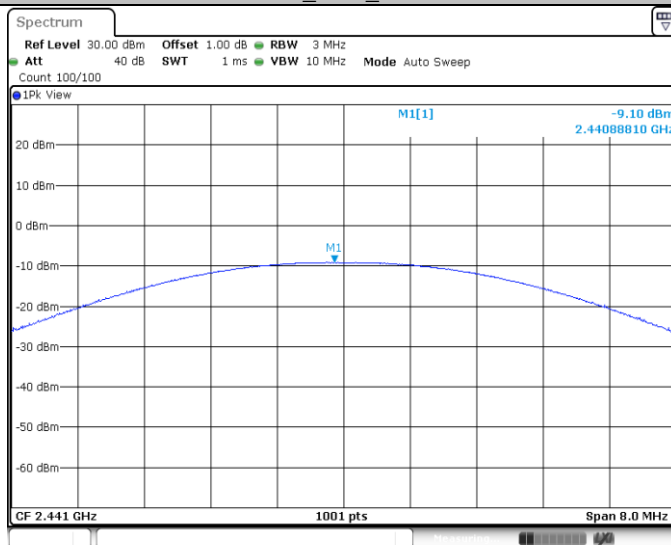
Frequency MHz	Conducted Peak Output Power dBm	Result
Low channel 2402MHz	-8.03	Pass
Middle channel 2441MHz	-7.86	Pass
High channel 2480MHz	-7.97	Pass

DH5_Ant1_2402



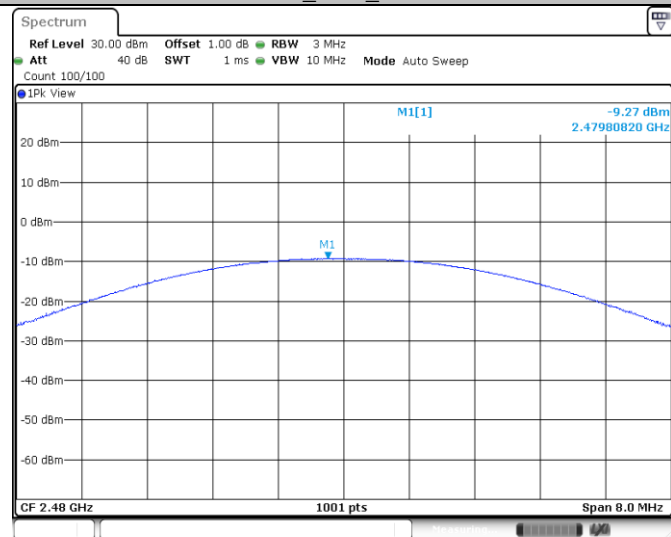
Date: 22 MAY 2023 17:33:11

DH5_Ant1_2441



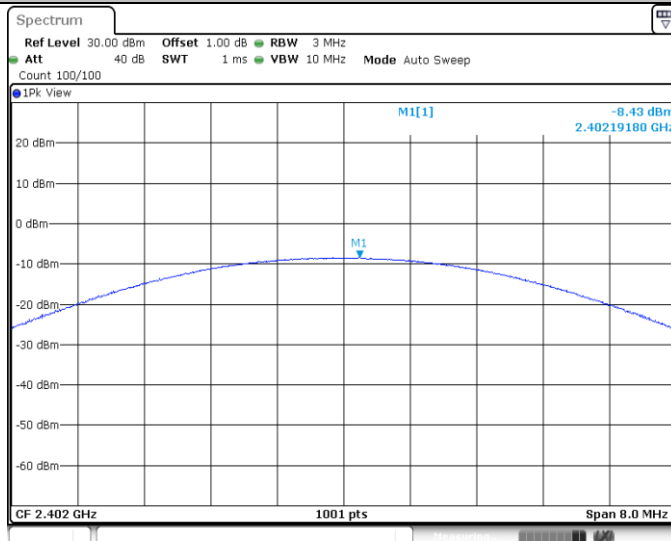
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DH5_Ant1_2480



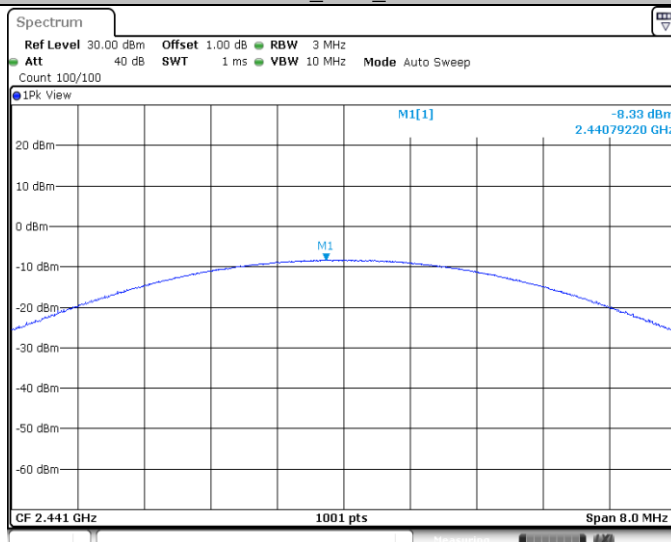
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2DH5_Ant1_2402



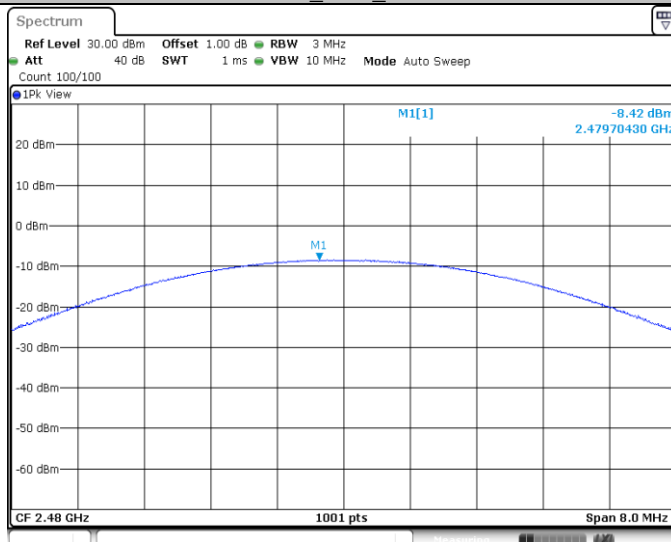
Date: 22 MAY 2023 17:34:17

2DH5_Ant1_2441



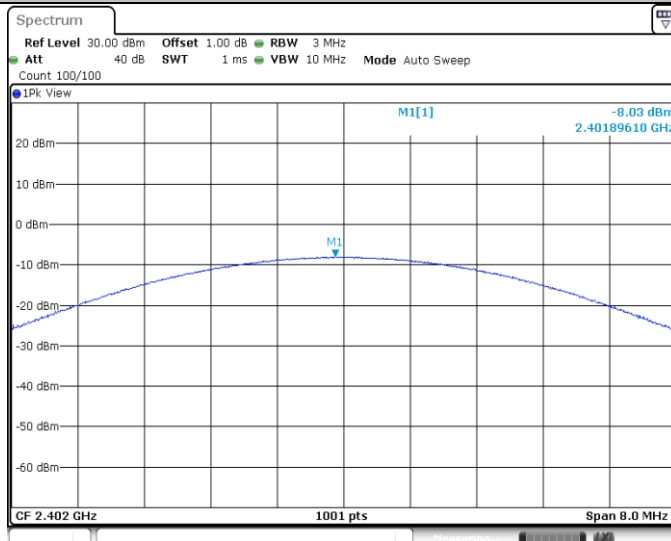
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2DH5_Ant1_2480



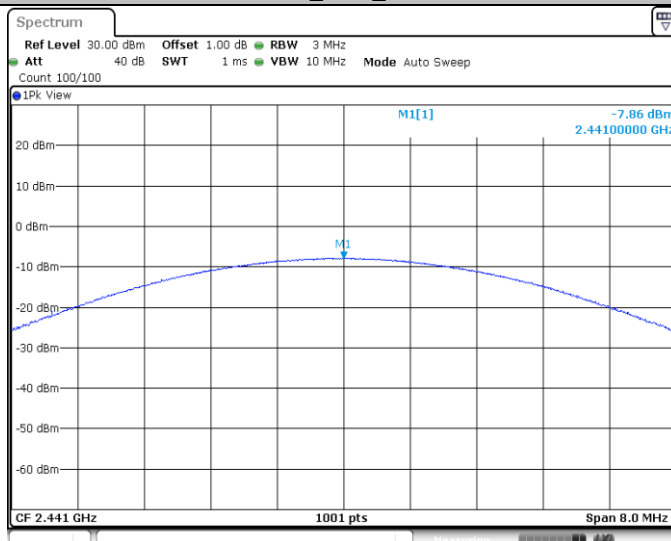
Date: 22 MAY 2023 17:34:47

3DH5_Ant1_2402



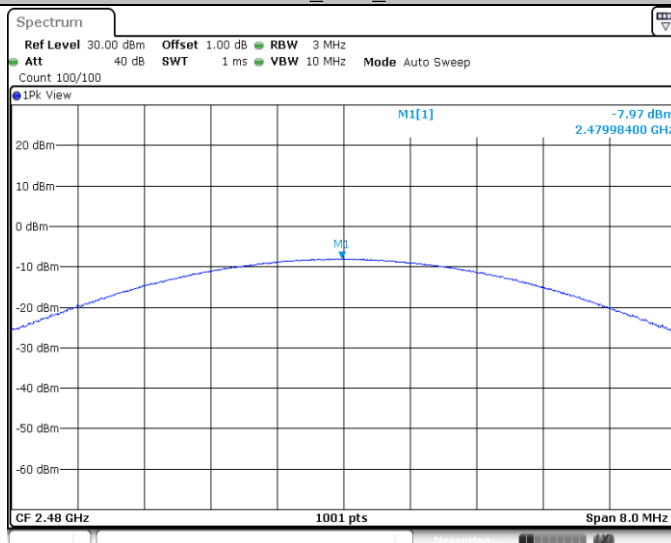
Date: 22 MAY 2023 17:35:05

3DH5_Ant1_2441



Date: 22 MAY 2023 17:35:24

3DH5_Ant1_2480



Date: 22 MAY 2023 17:35:43

9.3 20 dB bandwidth

Test Method

1. The RF output of EUT was connected to the test receiver by RF cable. The path loss was compensated to the results for each measurement.
2. Set to the maximum power setting and enable the EUT transmit continuously.
3. Use the following test receiver settings:
Span = approximately 5 times the 20dB bandwidth, centered on a hopping channel
RBW > the 20dB bandwidth of the emission being measured, VBW \geq RBW,
Sweep = auto, Detector function = peak, Trace = max hold
4. Allow the trace to stabilize. Use the marker-to-peak function to set the marker to the peak of the emission. Measure the frequency difference of two frequencies that were attenuated 20 dB from the reference level. Record the frequency difference as the emission bandwidth. Record the results.
5. Repeat above procedures until all frequencies measured were complete.

Limit

Limit [kHz]

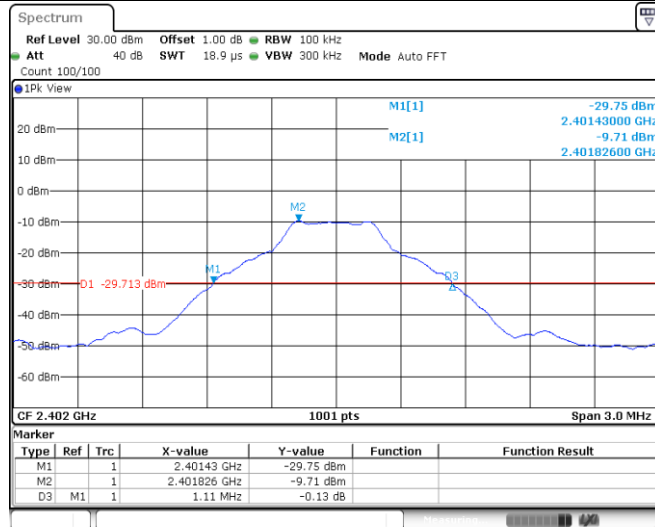
N/A

20 dB bandwidth

Bluetooth Mode GFSK Modulation test result

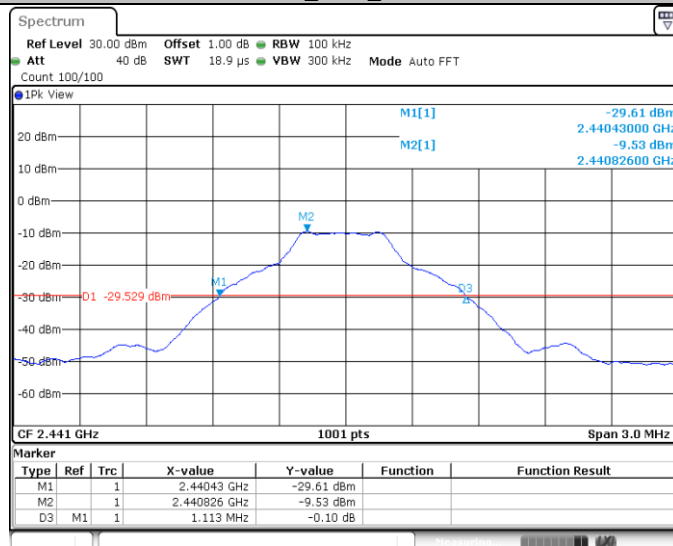
Test Mode	Antenna	Channel [MHz]	20db EBW[MHz]	FL[MHz]	FH[MHz]	Limit [MHz]	Verdict
DH5	Ant1	2402	1.110	2401.430	2402.540	---	PASS
		2441	1.113	2440.430	2441.543	---	PASS
		2480	1.113	2479.427	2480.540	---	PASS
2DH5	Ant1	2402	1.380	2401.292	2402.672	---	PASS
		2441	1.380	2440.292	2441.672	---	PASS
		2480	1.383	2479.289	2480.672	---	PASS
3DH5	Ant1	2402	1.383	2401.301	2402.684	---	PASS
		2441	1.383	2440.298	2441.681	---	PASS
		2480	1.383	2479.298	2480.681	---	PASS

DH5_Ant1_2402



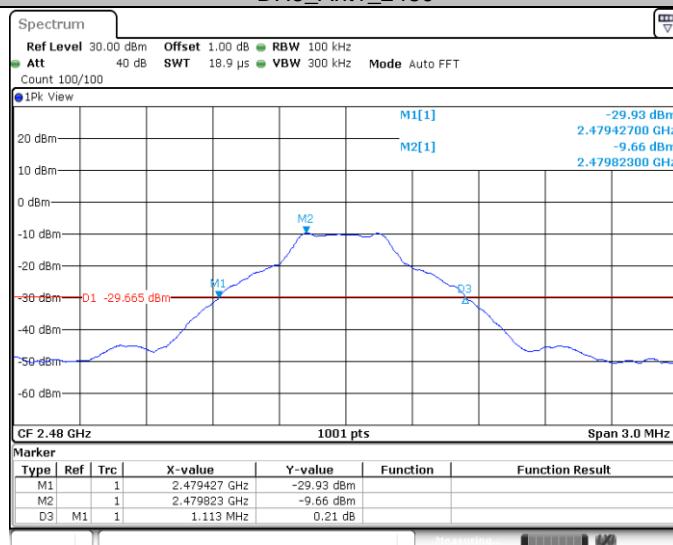
Date: 22 MAY 2023 17:08:16

DH5_Ant1_2441



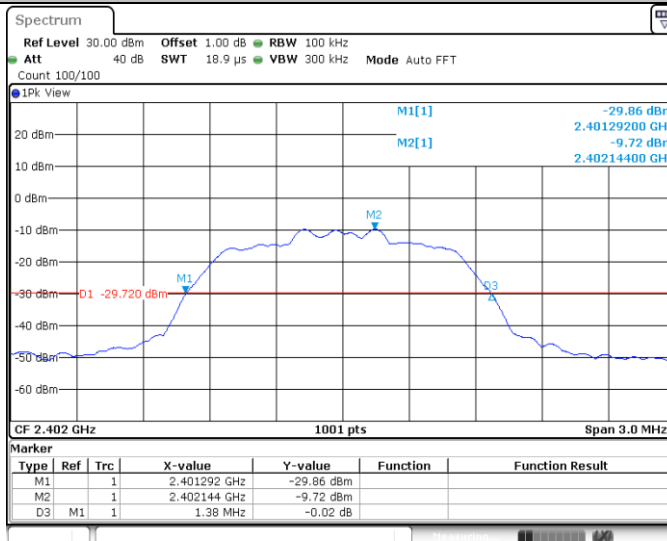
Date: 22 MAY 2023 17:10:06

DH5_Ant1_2480



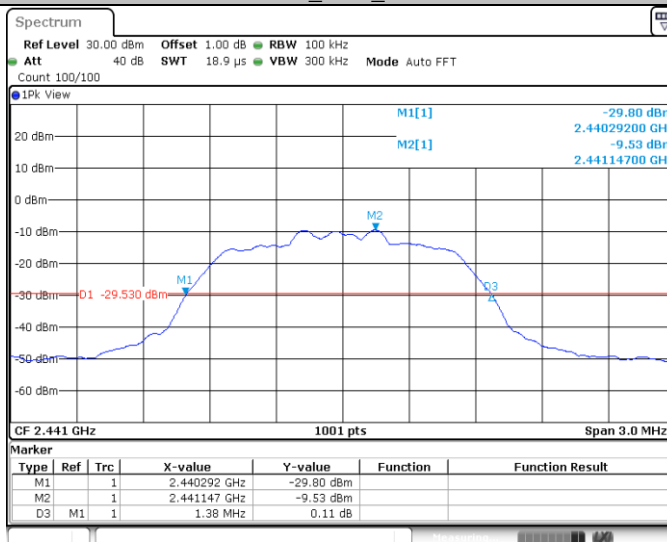
Date: 22 MAY 2023 17:11:41

2DH5_Ant1_2402



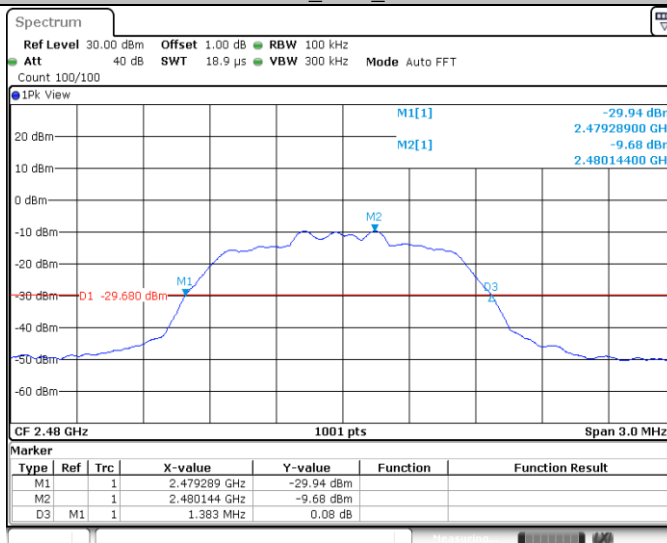
Date: 22 MAY 2023 17:13:15

2DH5_Ant1_2441



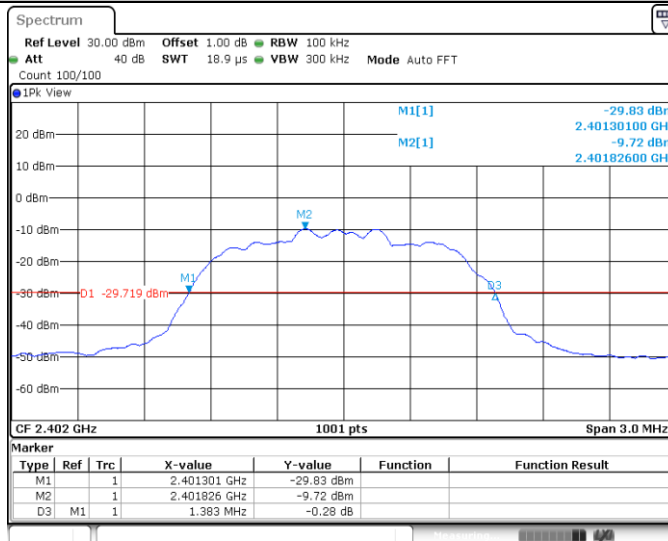
Date: 22 MAY 2023 17:14:47

2DH5_Ant1_2480



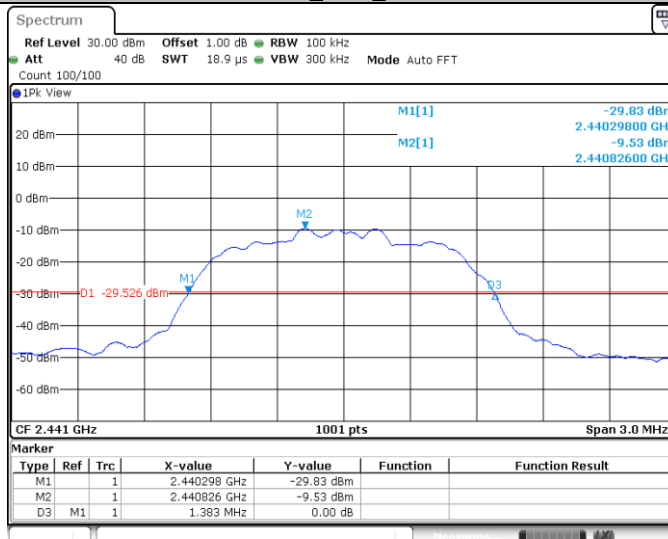
Date: 22 MAY 2023 17:16:08

3DH5_Ant1_2402



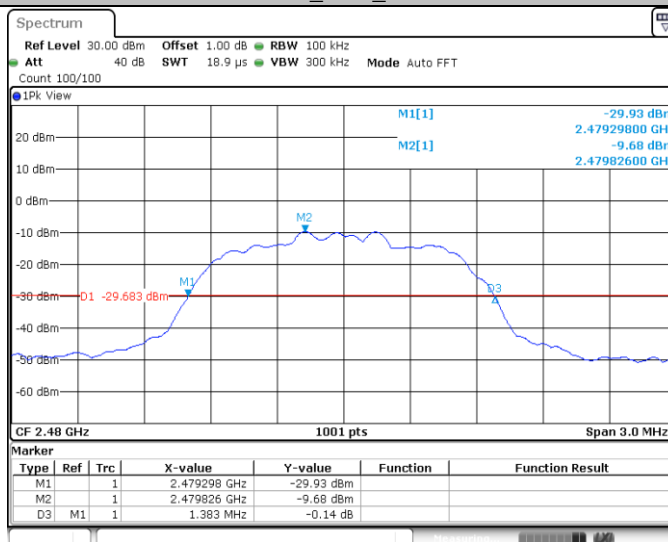
Date: 22 MAY 2023 17:17:47

3DH5_Ant1_2441



Date: 22 MAY 2023 17:19:20

3DH5_Ant1_2480



Date: 22 MAY 2023 17:20:45

9.4 Carrier Frequency Separation

Test Method

1. The RF output of EUT was connected to the test receiver by RF cable the path loss was compensated to the results for each measurement.
2. Set to the maximum power setting and enable the EUT transmit to hopping mode.
3. Use the following spectrum analyzer settings:
Span = wide enough to capture the peaks of two adjacent channels, $RBW \geq 1\%$ of the span, $VBW \geq RBW$, Sweep = auto, Detector function = peak
4. By using the Max-Hold function record the separation of two adjacent channels.
5. Measure the frequency difference of these two adjacent channels by spectrum analyzer marker function. Record the results.
6. Repeat above procedures until all frequencies measured were complete.

Limit

Limit
kHz

$\geq 25\text{kHz}$ or $2/3$ of the 20 dB bandwidth which is greater

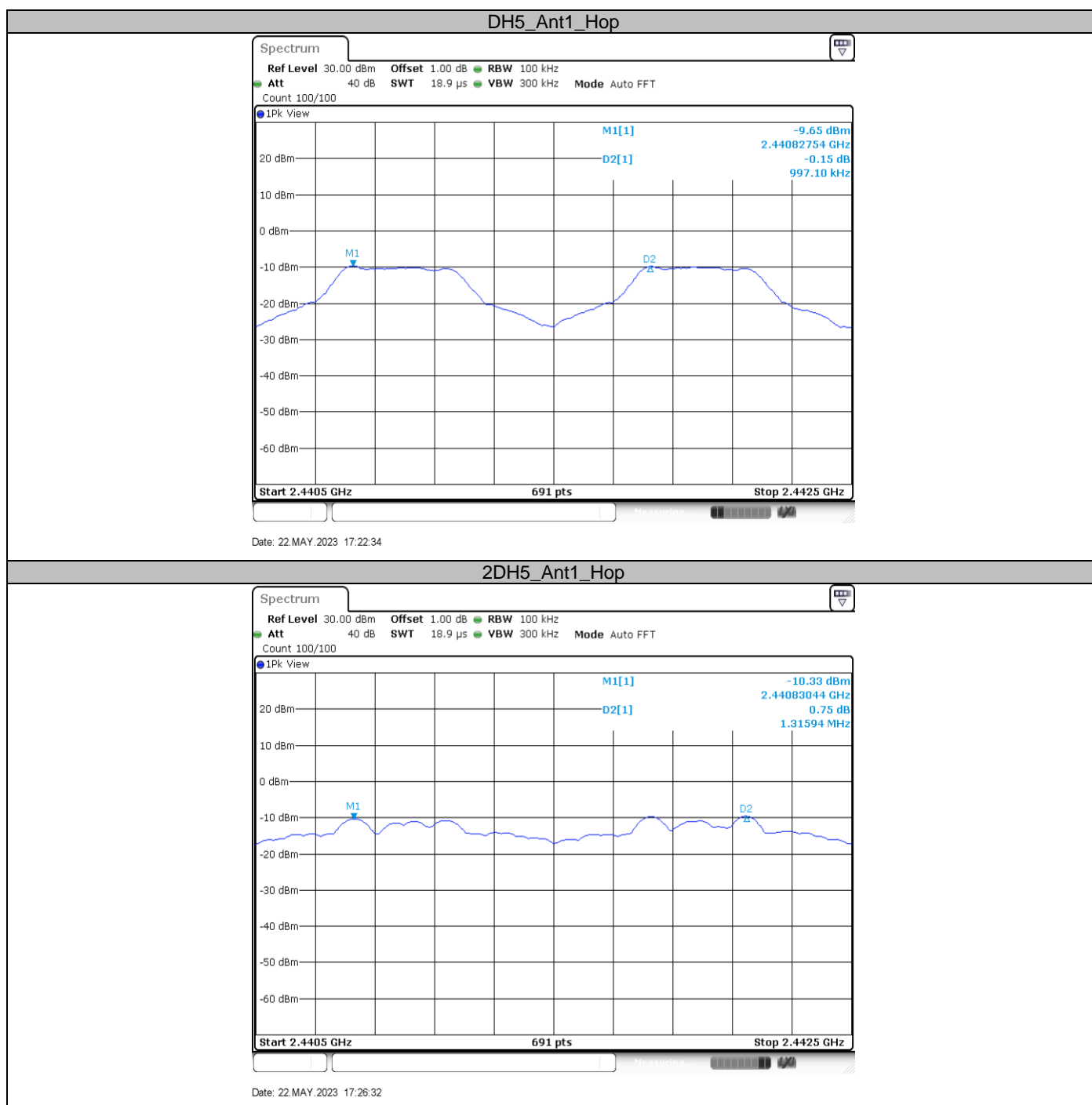
Limit

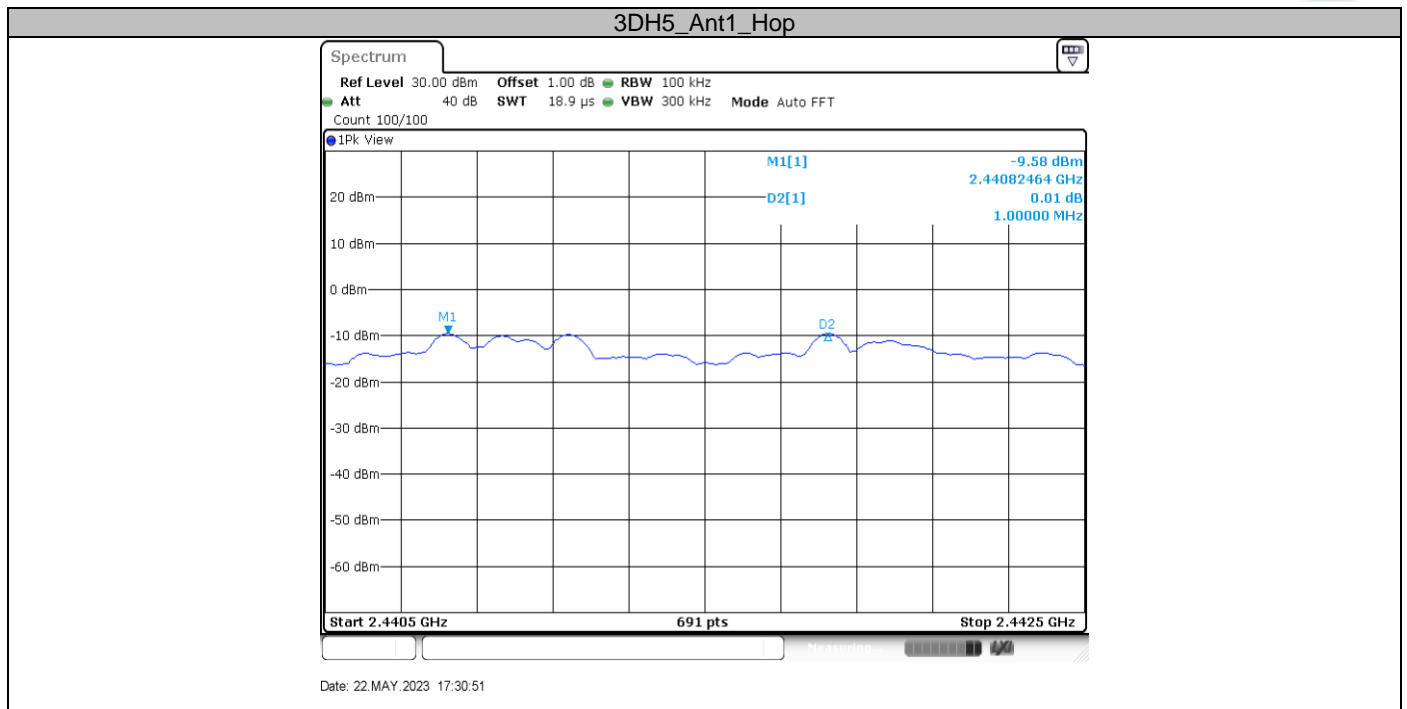
Modulation	Frequency MHz	2/3 of 20 dB Bandwidth kHz
GFSK	2441	742
$\pi/4$ -DQPSK	2441	922
8DPSK	2441	922

Carrier Frequency Separation

Test result: The measurement was performed with the typical configuration (normal hopping status).

Modulation	Frequency MHz	Carrier Frequency Separation kHz	Result
GFSK	2441	997	Pass
$\pi/4$ -DQPSK	2441	1316	Pass
8DPSK	2441	1000	Pass





9.5 Number of hopping frequencies

Test Method

1. The RF output of EUT was connected to the spectrum analyzer by RF cable. The path loss was compensated to the results for each measurement.
2. Set to the maximum power setting and enable the EUT transmit to hopping mode.
3. Use the following spectrum analyzer settings:
Span = the frequency band of operation, $RBW \geq 1\%$ of the span, $VBW \geq RBW$,
Sweep = auto, Detector function = peak
4. Set the spectrum analyzer on Trace = max hold
5. Allow the trace to stabilize. It may prove necessary to break the span up to sections, in order to clearly show all of the hopping frequencies. The limit is specified in one of the subparagraphs of this Section. Submit this plot(s).

Limit

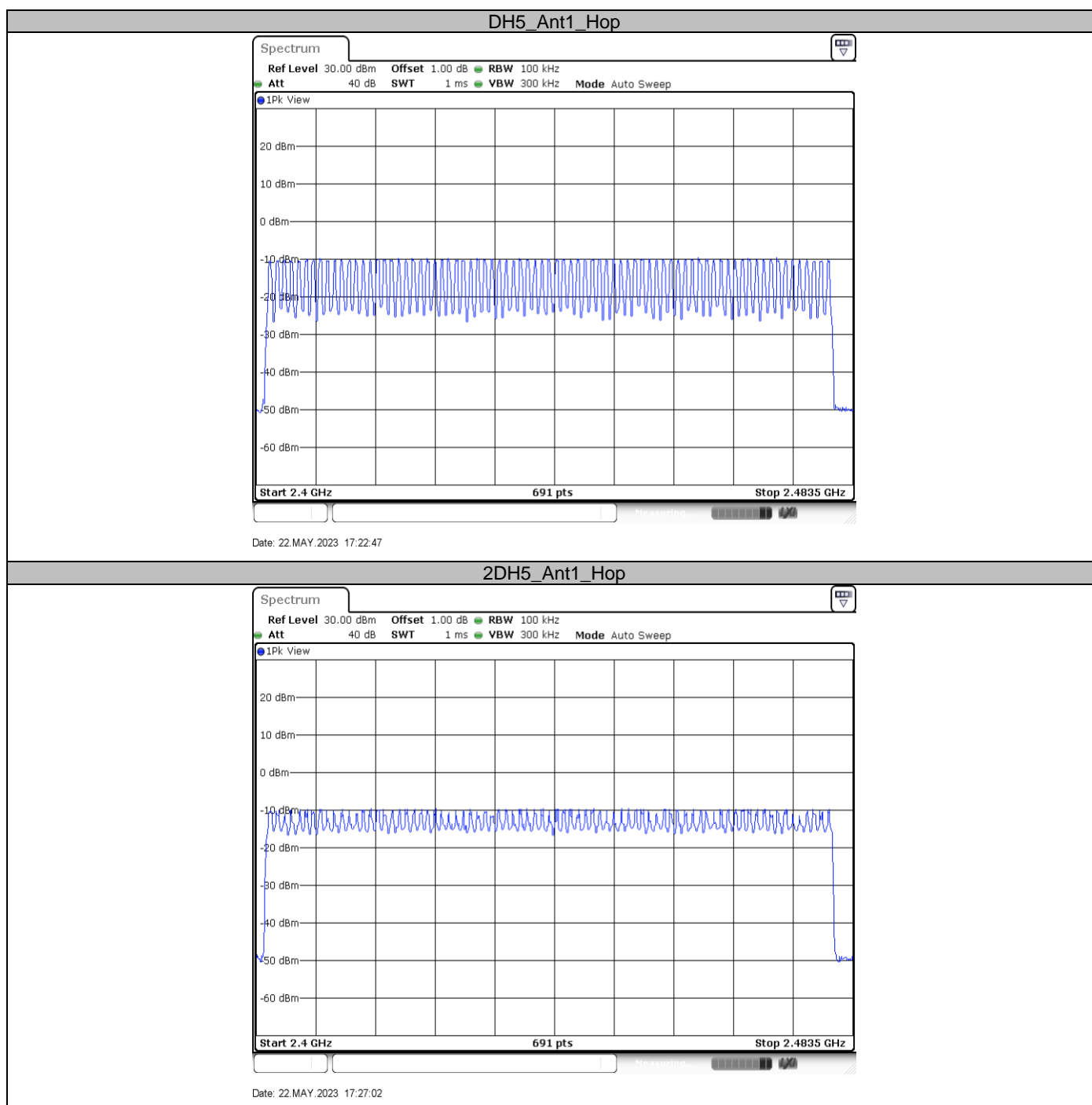
Limit
number

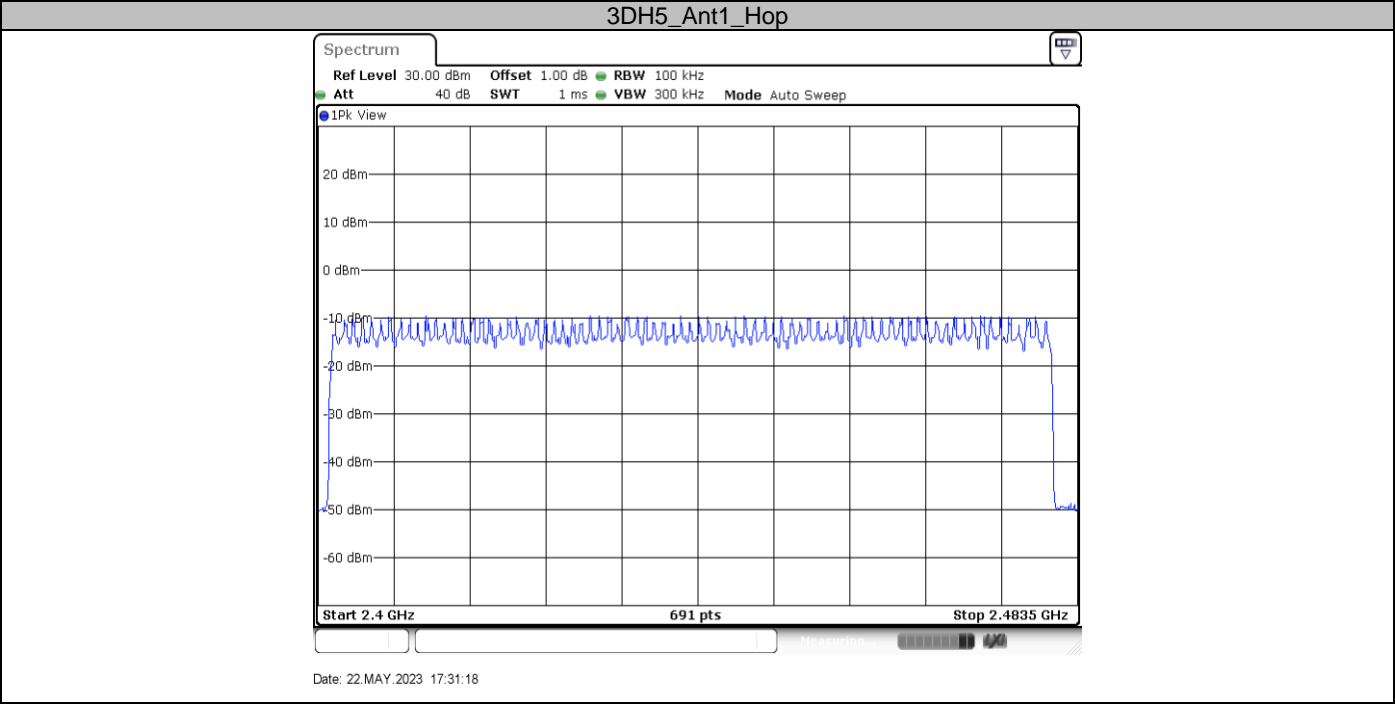
≥ 15

Number of hopping frequencies

Test result: The measurement was performed with the typical configuration (normal hopping status), and the total hopping channels is constant for the all modulation mode according with the Bluetooth Core Specification.

TestMode	Antenna	Channel	Result	Limit	Verdict
DH5	Ant1	Hop	79	≥ 15	PASS
2DH5	Ant1	Hop	79	≥ 15	PASS
3DH5	Ant1	Hop	79	≥ 15	PASS





9.6 Dwell Time

Test Method

1. The RF output of EUT was connected to the spectrum analyzer by RF cable. The path loss was compensated to the results for each measurement.
2. Set to the maximum power setting and enable the EUT transmit to hopping mode.
3. Span: Zero span, centered on a hopping channel.
4. RBW shall be \ channel spacing and where possible RBW should be set $\gg 1 / T$, where T is the expected dwell time per channel.
5. Sweep: As necessary to capture the entire dwell time per hopping channel; where possible use a video trigger and trigger delay so that the transmitted signal starts a little to the right of the start of the plot. The trigger level might need slight adjustment to prevent triggering when the system hops on an adjacent channel; a second plot might be needed with a longer sweep time to show two successive hops on a channel.
6. Detector function: Peak.
7. Trace: Max hold. Use the marker-delta function to determine the transmit time per hop. If this value varies with different modes of operation (data rate, modulation format, number of hopping channels, etc.), then repeat this test for each variation in transmit time.

Limit

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

Dwell Time

Dwell time

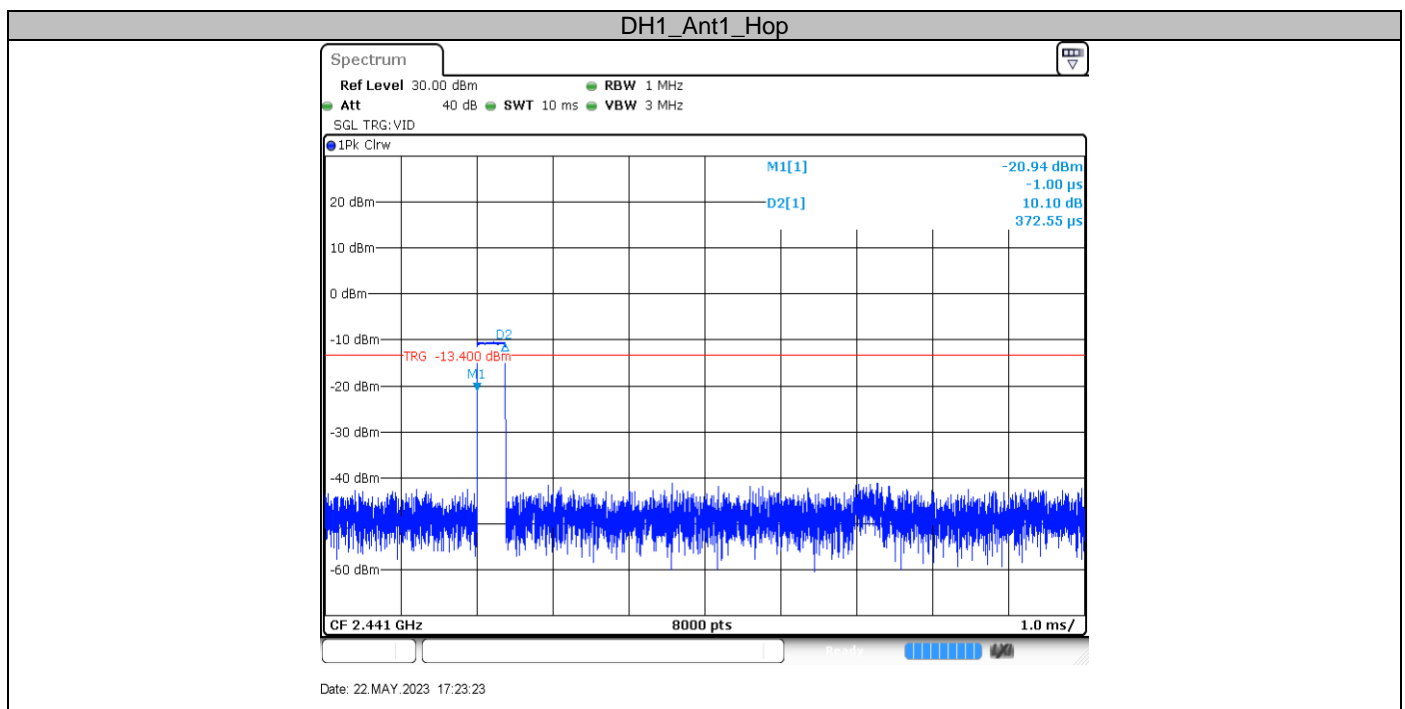
The maximum dwell time shall be 0.4 s.

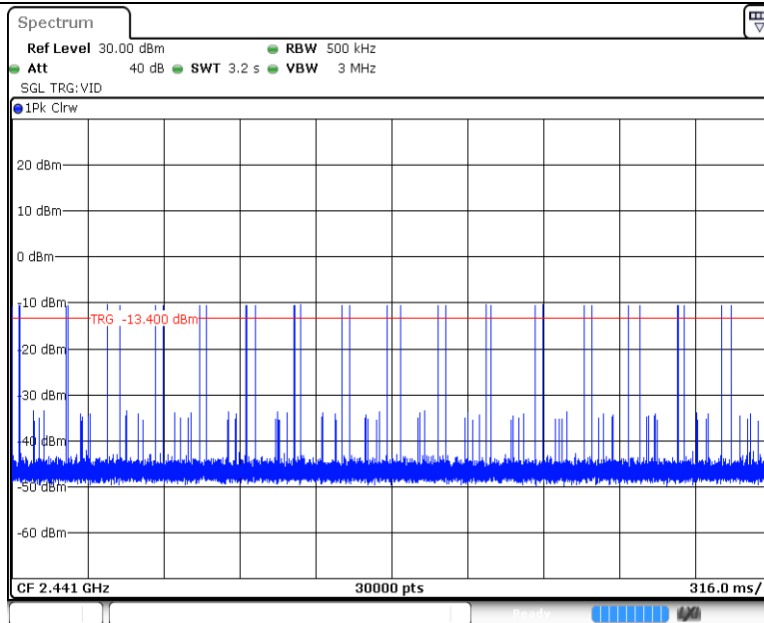
The Dwell Time = Burst Width * Total Hops. The detailed calculations are showed as follows:

The duration for dwell time calculation: 0.4 [s] * hopping number = 0.4 [s] * 79 [ch] = 31.6 [s*ch];

Test result as below:

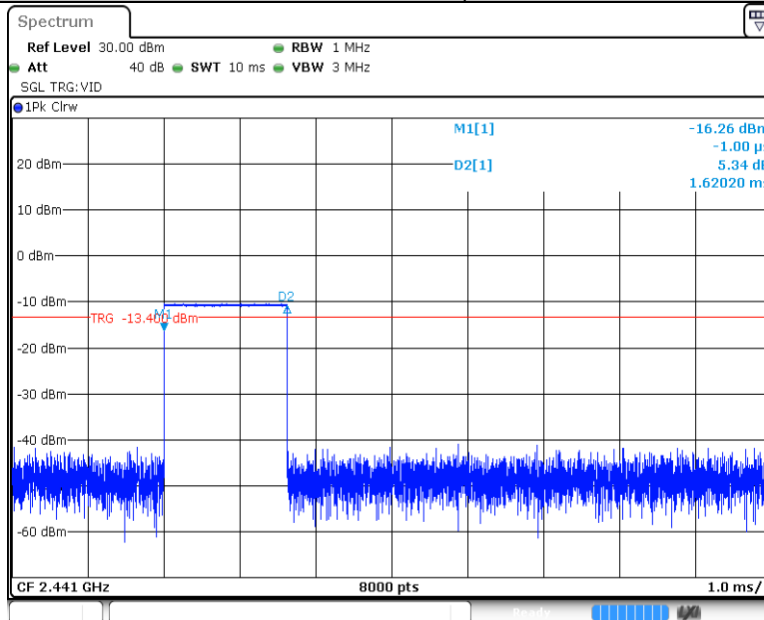
TestMode	Antenna	Channel	BurstWidth (ms)	TotalHops	Result (s)	Limit (s)	Verdict
DH1	Ant1	Hop	0.37	330	0.123	<=0.4	PASS
DH3	Ant1	Hop	1.62	180	0.292	<=0.4	PASS
DH5	Ant1	Hop	1.83	90	0.164	<=0.4	PASS
2DH1	Ant1	Hop	0.38	320	0.122	<=0.4	PASS
2DH3	Ant1	Hop	1.63	170	0.276	<=0.4	PASS
2DH5	Ant1	Hop	2.87	130	0.373	<=0.4	PASS
3DH1	Ant1	Hop	0.38	330	0.127	<=0.4	PASS
3DH3	Ant1	Hop	1.63	160	0.26	<=0.4	PASS
3DH5	Ant1	Hop	2.87	70	0.201	<=0.4	PASS



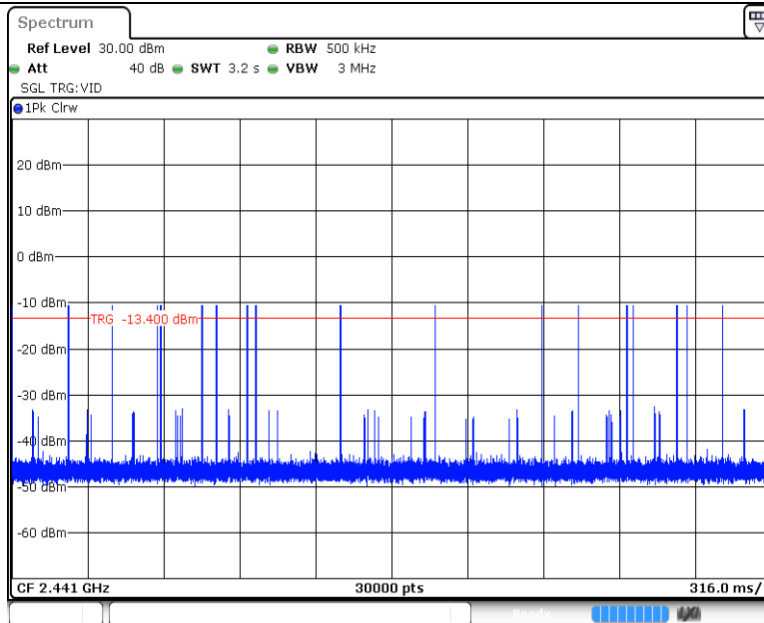


Date: 22 MAY 2023 17:23:28

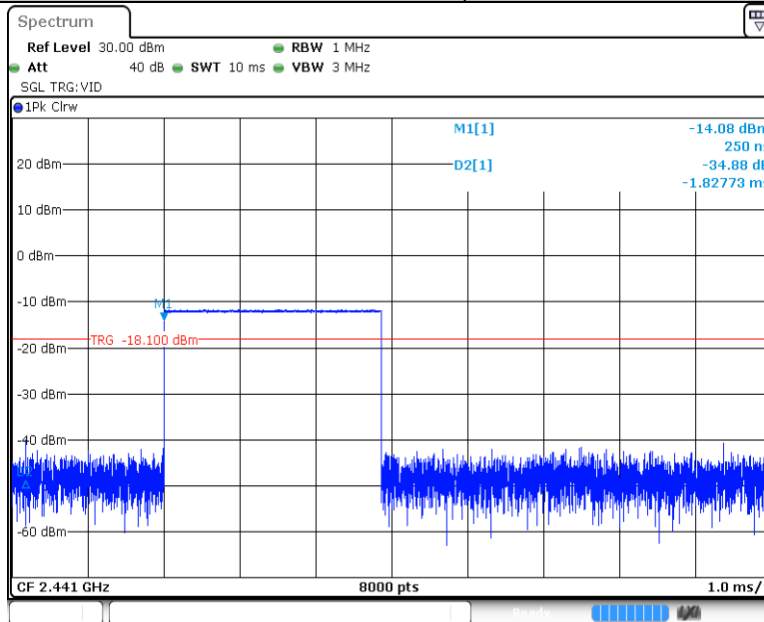
DH3_Ant1_Hop

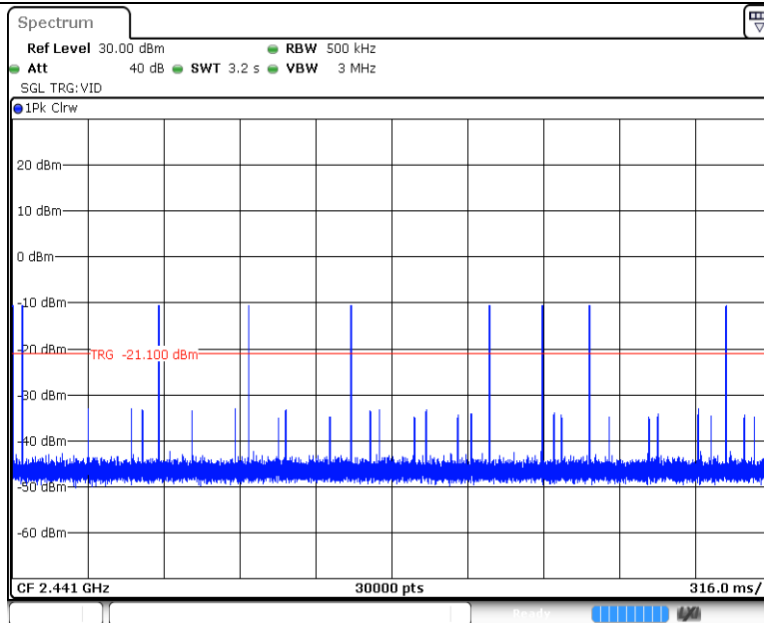


Date: 22 MAY 2023 17:23:51



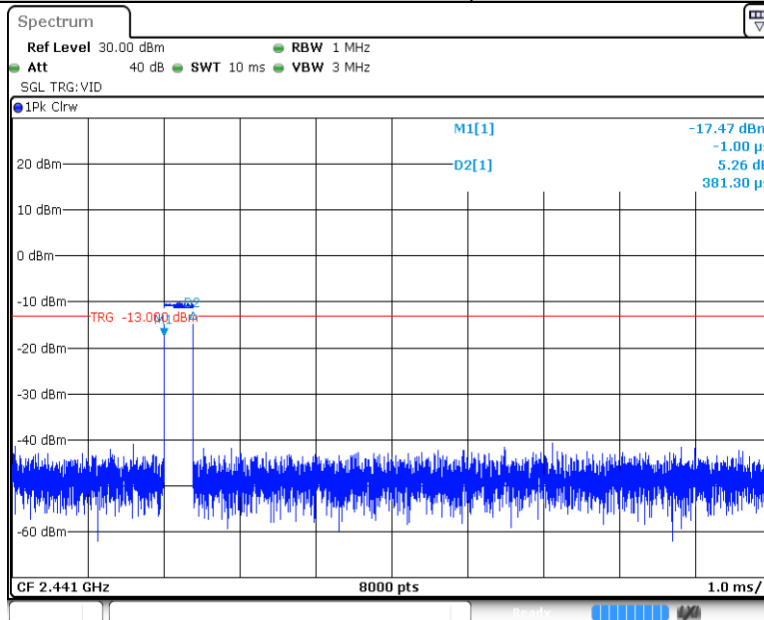
DH5_Ant1_Hop



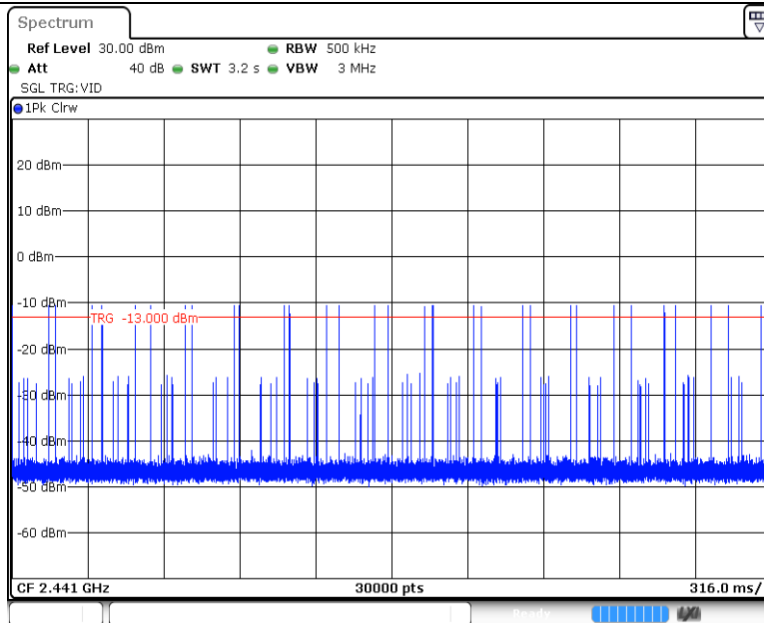


Date: 22 MAY 2023 17:23:01

2DH1_Ant1_Hop

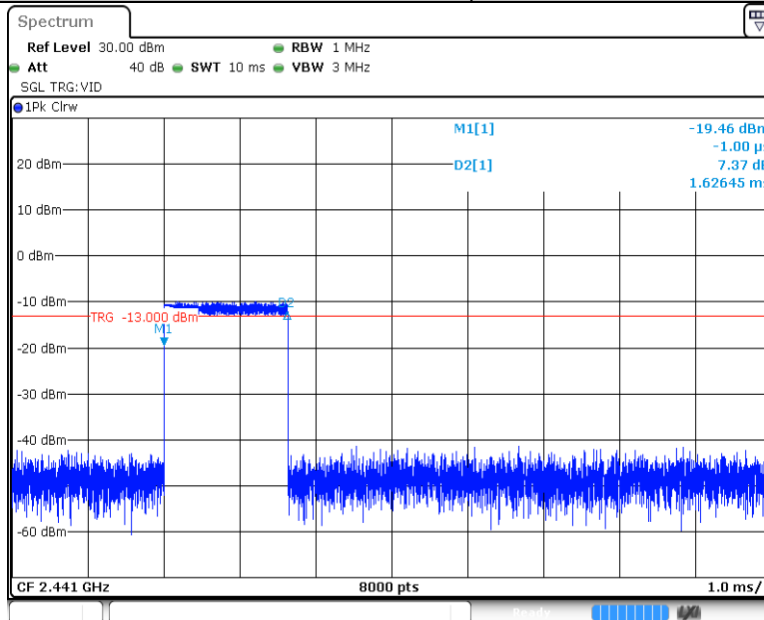


Date: 22 MAY 2023 17:28:08

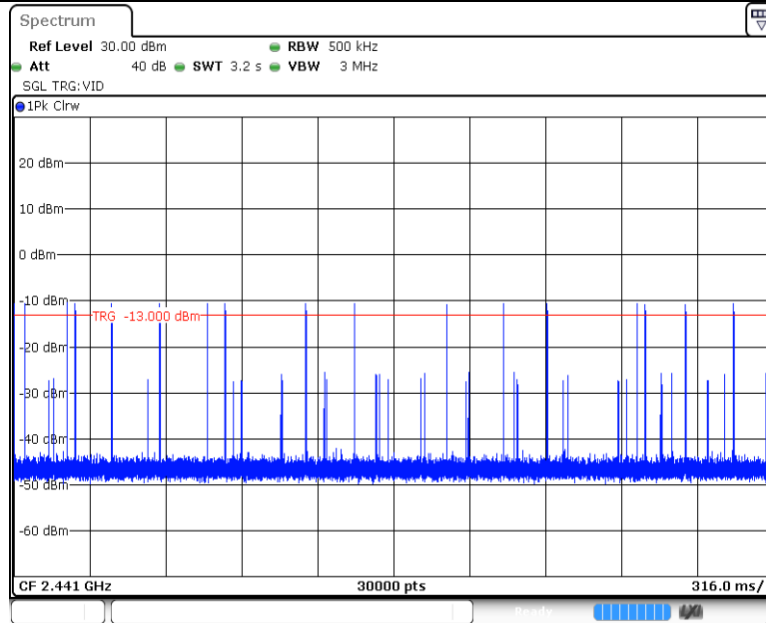


Date: 22.MAY.2023 17:28:13

2DH3_Ant1_Hop

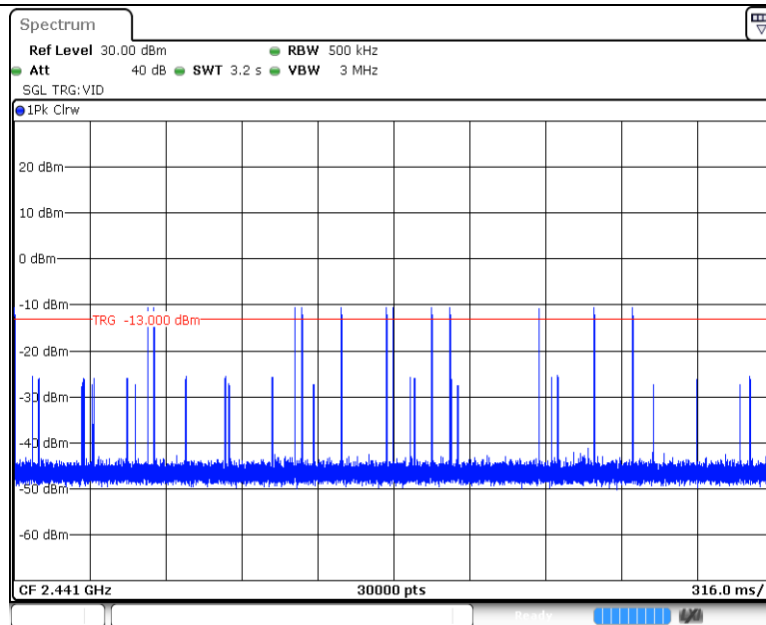


Date: 22.MAY.2023 17:28:34



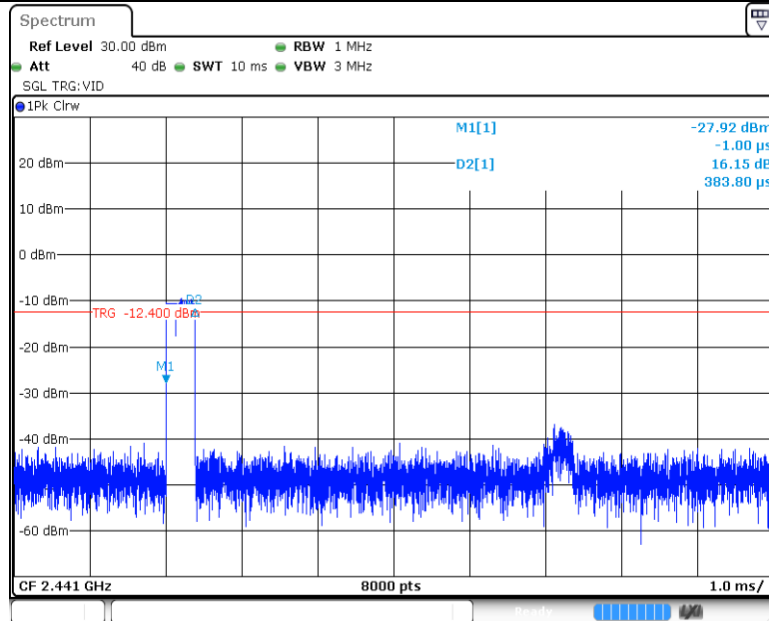
Date: 22.MAY.2023 17:28:40

2DH5_Ant1_Hop

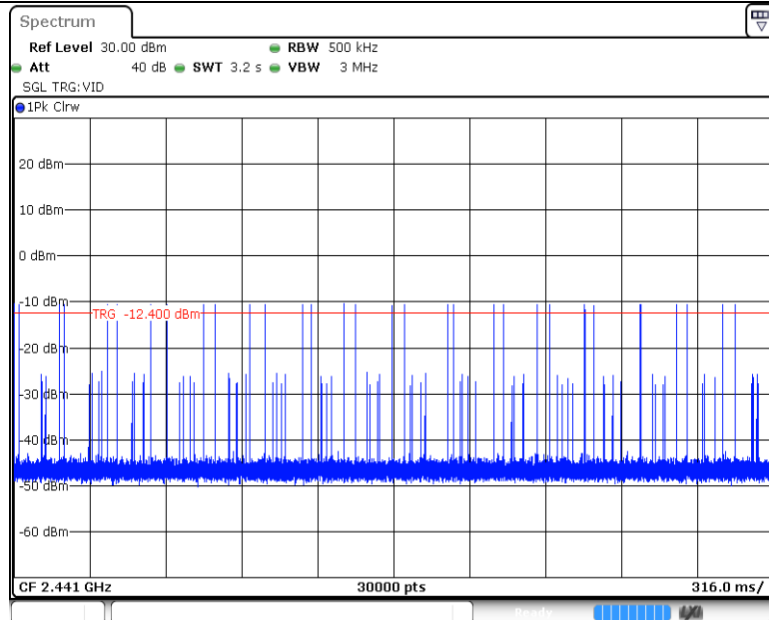


Date: 22.MAY.2023 17:27:46

3DH1_Ant1_Hop

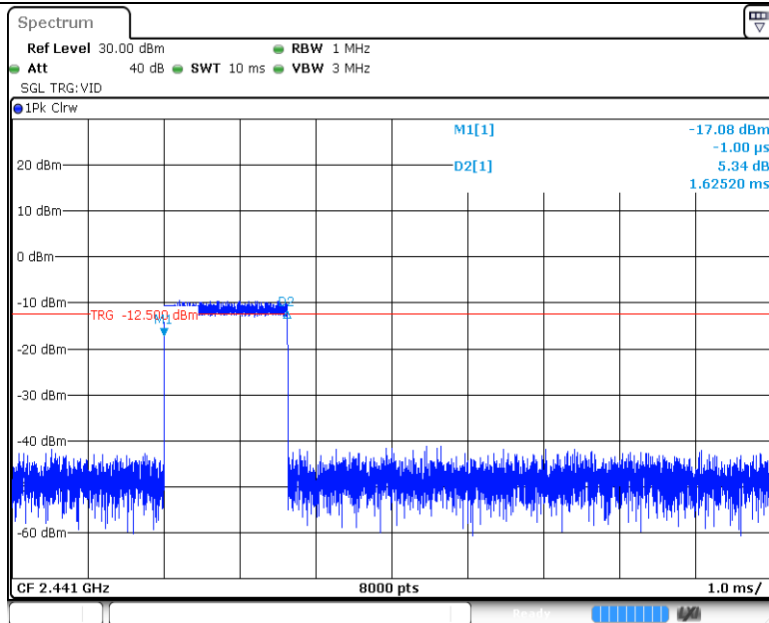


Date: 22.MAY.2023 17:32:00

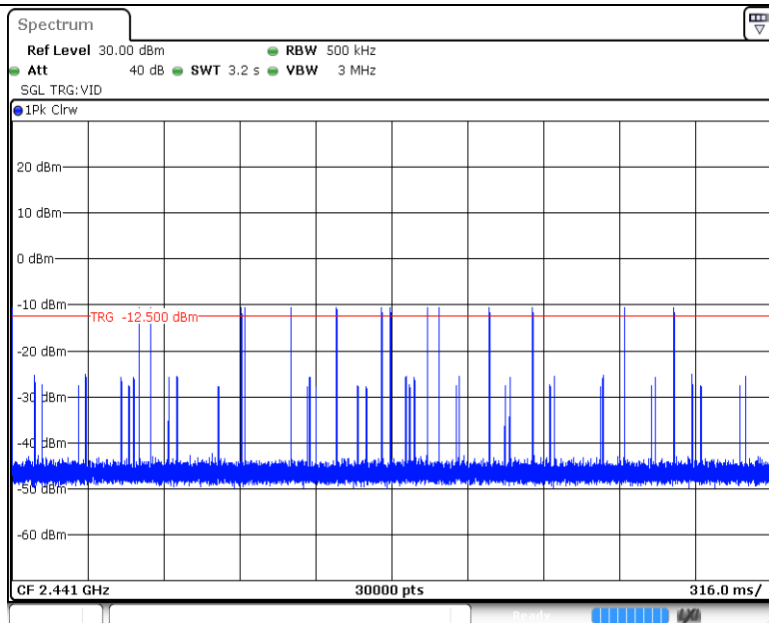


Date: 22.MAY.2023 17:32:05

3DH3_Ant1_Hop

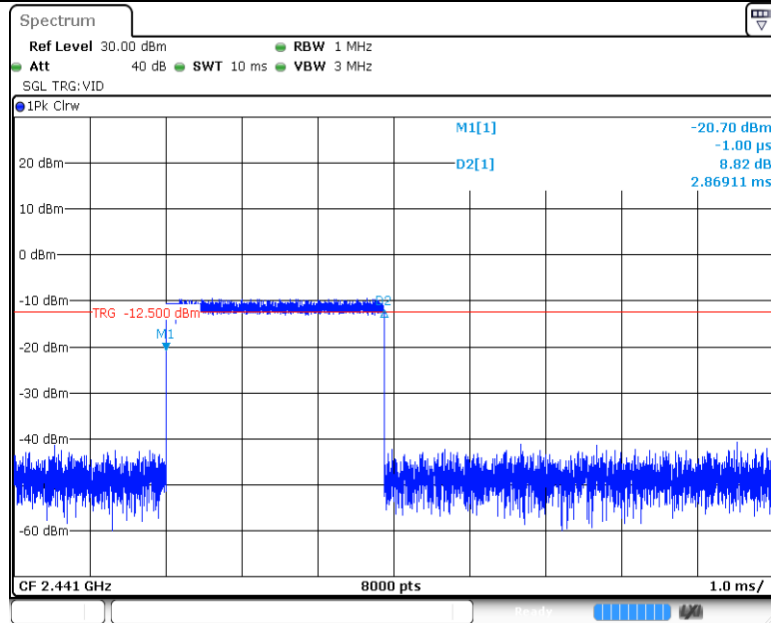


Date: 22.MAY.2023 17:32:25

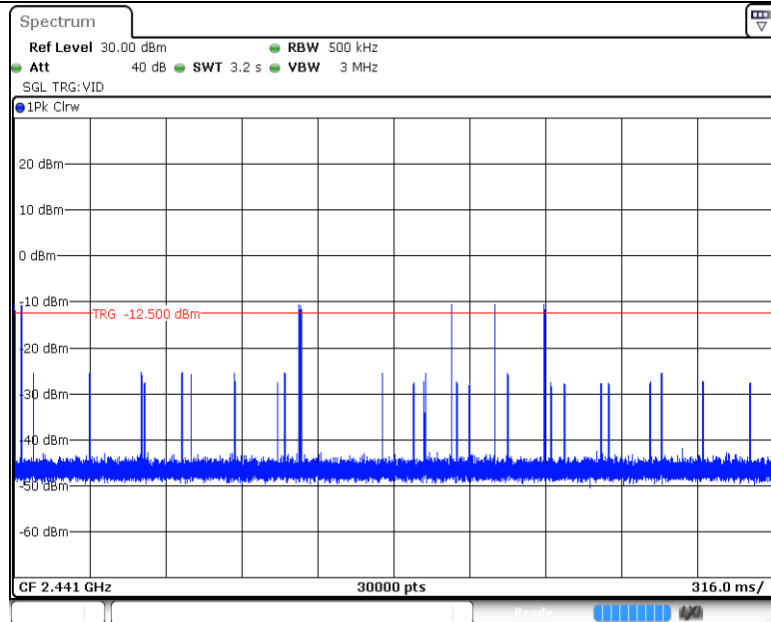


Date: 22.MAY.2023 17:32:30

3DH5_Ant1_Hop



Date: 22.MAY.2023 17:31:31



Date: 22.MAY.2023 17:31:36

9.7 Spurious RF conducted emissions

Test Method

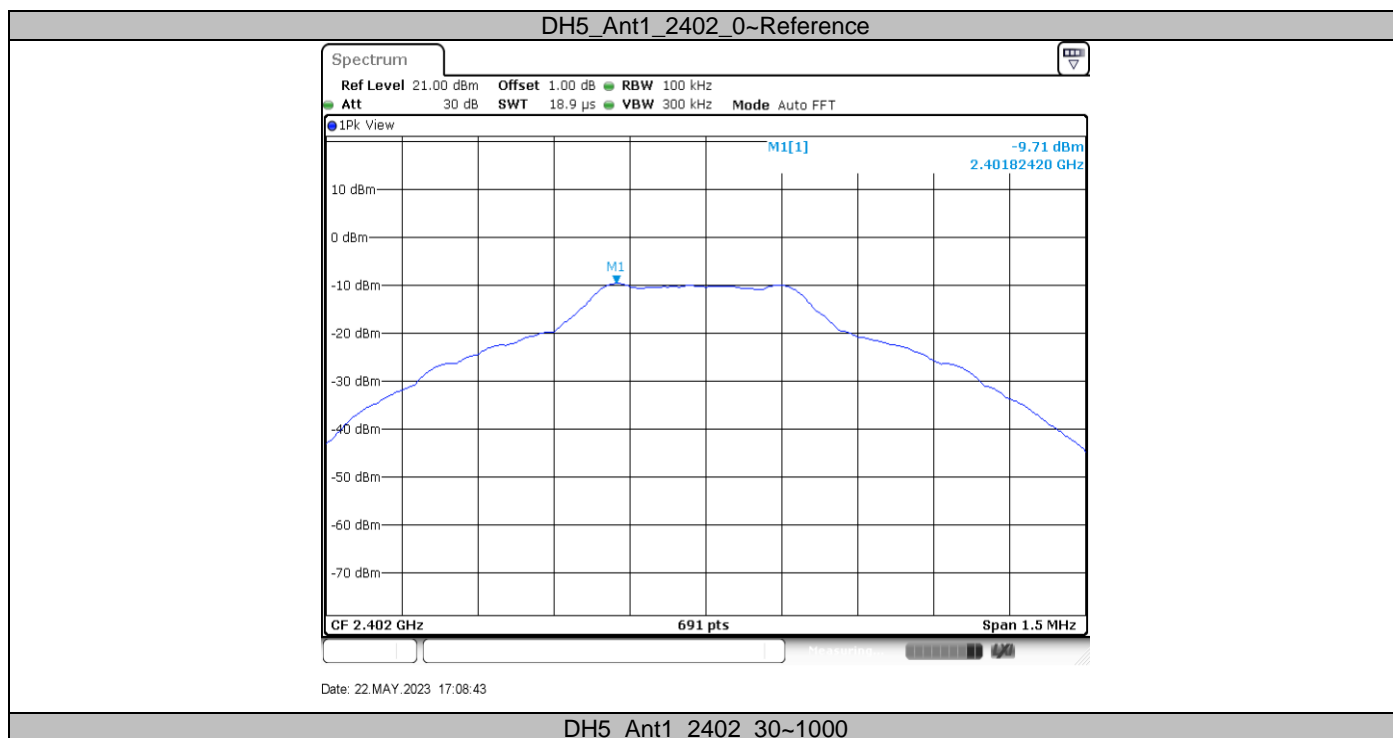
1. The RF output of EUT was connected to the spectrum analyzer by RF cable. The path loss was compensated to the results for each measurement.
2. Set to the maximum power setting and enable the EUT transmit continuously.
3. Set RBW = 100 kHz, VBW=300 kHz, Peak Detector. Unwanted Emissions measured in any 100 kHz bandwidth outside of the authorized frequency band shall be attenuated by at least 20 dB relative to the maximum in-band peak PSD level in 100 kHz when maximum peak conducted output power procedure is used. If the transmitter complies with the conducted power limits based on the use of RMS averaging over a time interval, the attenuation required under this paragraph shall be 30 dB instead of 20 dB.
4. Measure and record the results in the test report.
5. The RF fundamental frequency should be excluded against the limit line in the operating frequency

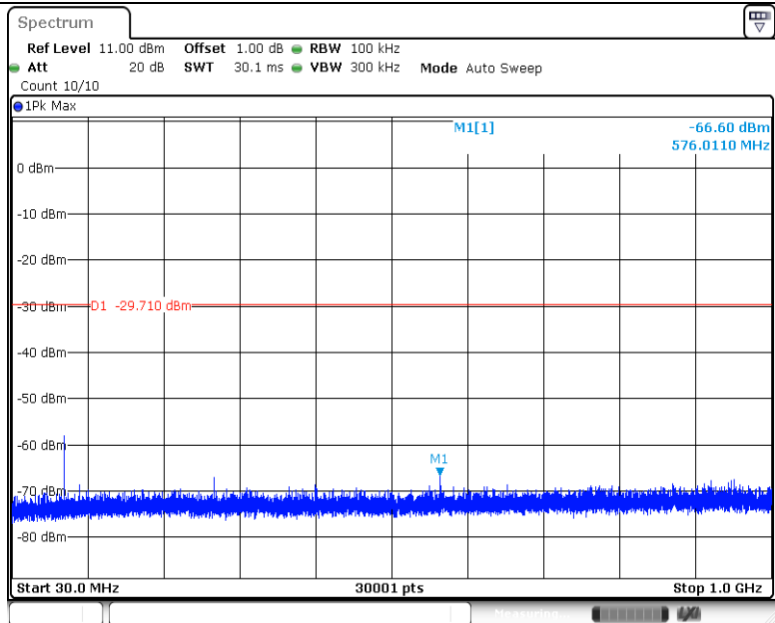
Limit

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

Spurious RF conducted emissions

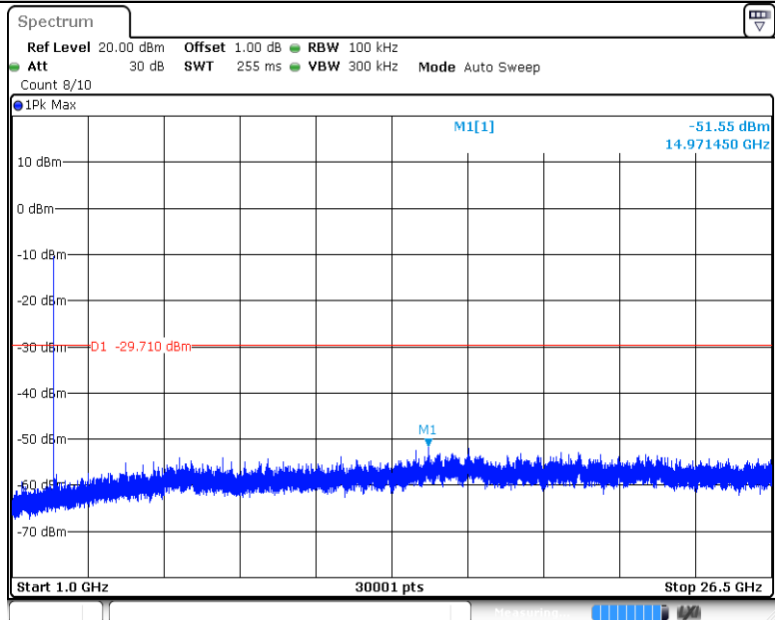
Test Mode	Antenna	Channel (MHz)	Frequency Range (MHz)	Reference Level	Result (dBm)	Limit (dBm)	Verdict
DH5	Ant1	2402	Reference	-9.71	-9.71	---	PASS
			30~1000	30~1000	-66.6	<=-29.71	PASS
			1000~26500	1000~26500	-51.55	<=-29.71	PASS
		2441	Reference	-9.54	-9.54	---	PASS
			30~1000	30~1000	-57.85	<=-29.54	PASS
			1000~26500	1000~26500	-51.14	<=-29.54	PASS
		2480	Reference	-9.71	-9.71	---	PASS
			30~1000	30~1000	-60.07	<=-29.71	PASS
			1000~26500	1000~26500	-52.76	<=-29.71	PASS
2DH5	Ant1	2402	Reference	-9.70	-9.70	---	PASS
			30~1000	30~1000	-64.78	<=-29.7	PASS
			1000~26500	1000~26500	-51.63	<=-29.7	PASS
		2441	Reference	-9.61	-9.61	---	PASS
			30~1000	30~1000	-58.35	<=-29.61	PASS
			1000~26500	1000~26500	-52.2	<=-29.61	PASS
		2480	Reference	-9.72	-9.72	---	PASS
			30~1000	30~1000	-57.95	<=-29.72	PASS
			1000~26500	1000~26500	-52.42	<=-29.72	PASS
3DH5	Ant1	2402	Reference	-9.70	-9.70	---	PASS
			30~1000	30~1000	-63.08	<=-29.7	PASS
			1000~26500	1000~26500	-52.16	<=-29.7	PASS
		2441	Reference	-9.56	-9.56	---	PASS
			30~1000	30~1000	-58.2	<=-29.56	PASS
			1000~26500	1000~26500	-52.48	<=-29.56	PASS
		2480	Reference	-9.68	-9.68	---	PASS
			30~1000	30~1000	-58.86	<=-29.68	PASS
			1000~26500	1000~26500	-52.17	<=-29.68	PASS





Date: 22.MAY.2023 17:08:49

DH5_Ant1_2402_1000~26500



Date: 22.MAY.2023 17:08:57

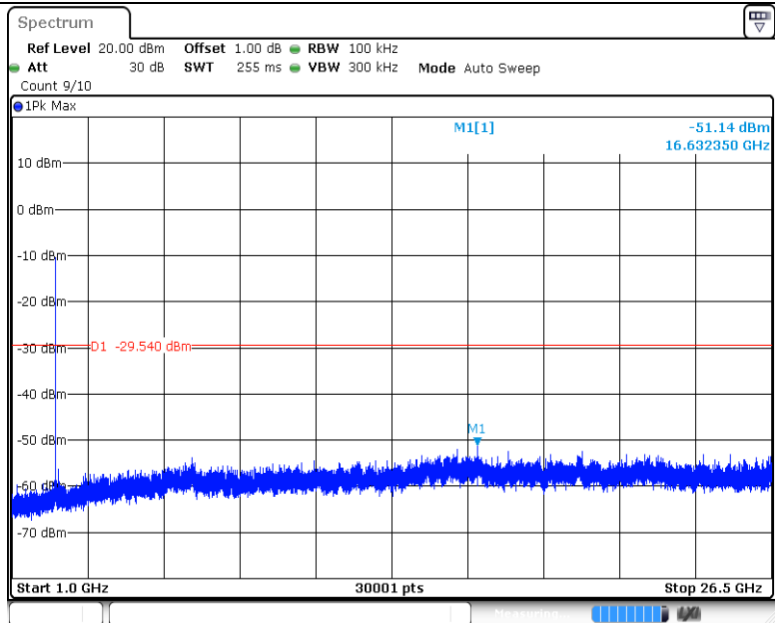
DH5_Ant1_2441_0~Reference



DH5_Ant1_2441_30~1000

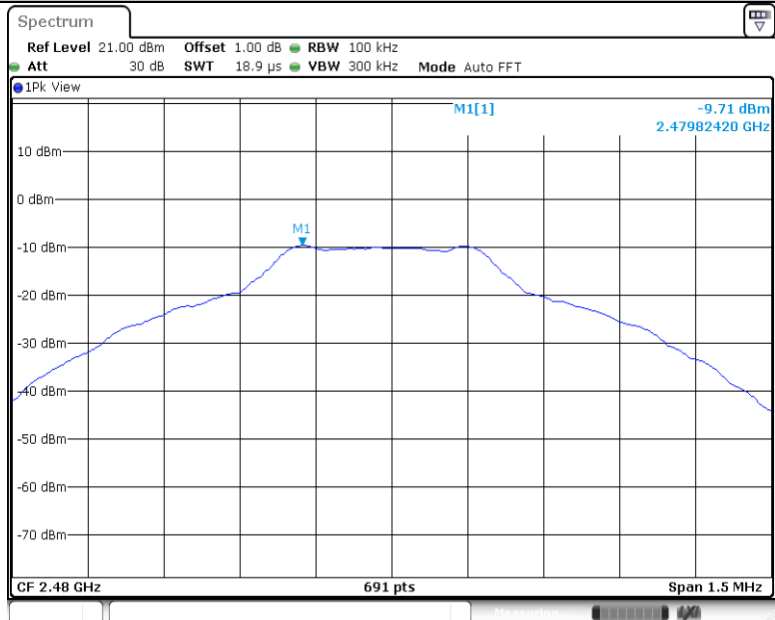


DH5_Ant1_2441_1000~26500



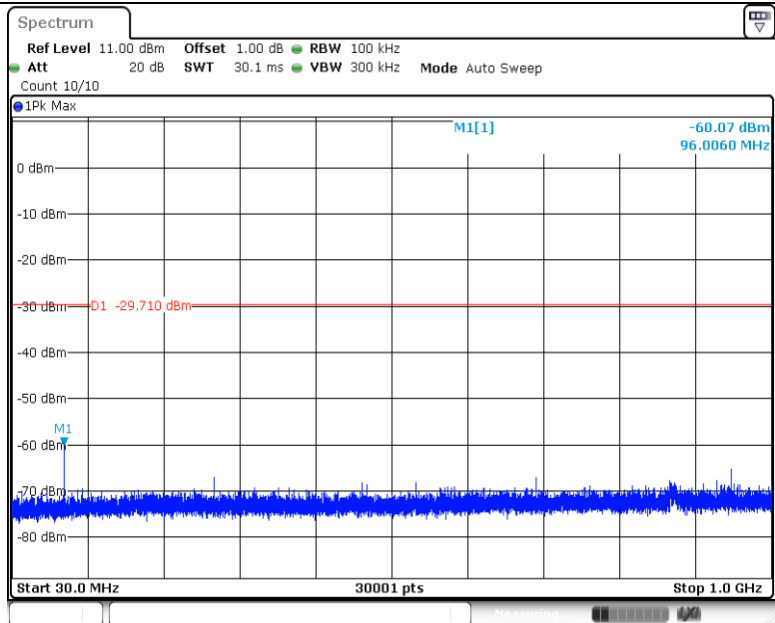
Date: 22.MAY.2023 17:10:37

DH5_Ant1_2480_0~Reference



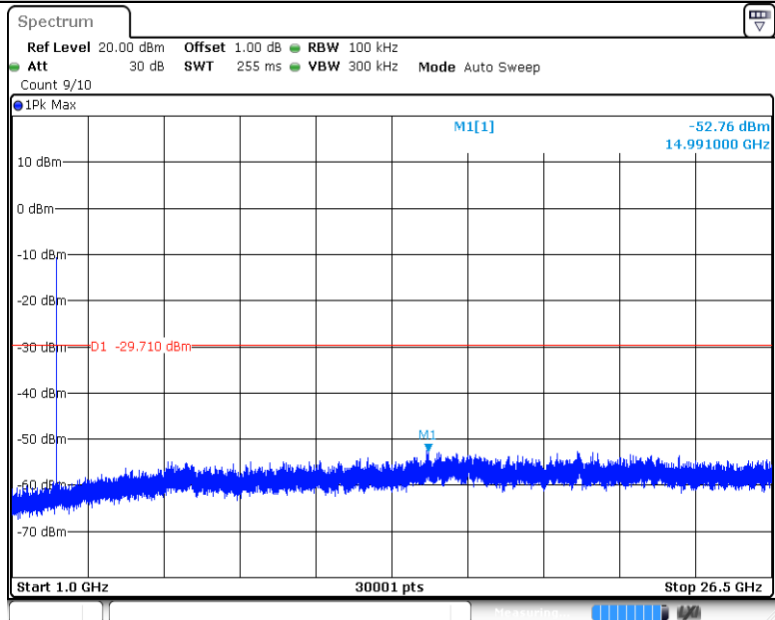
Date: 22.MAY.2023 17:12:06

DH5_Ant1_2480_30~1000



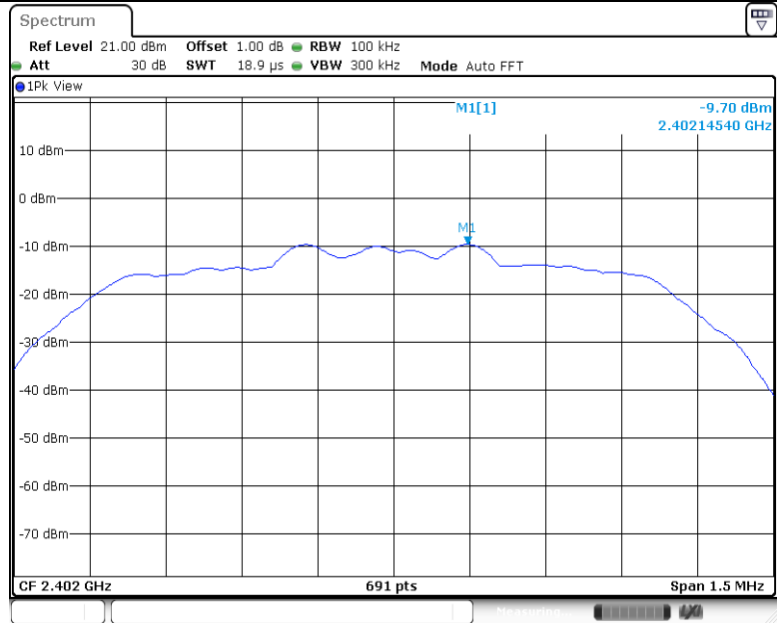
Date: 22 MAY.2023 17:12:12

DH5_Ant1_2480_1000~26500



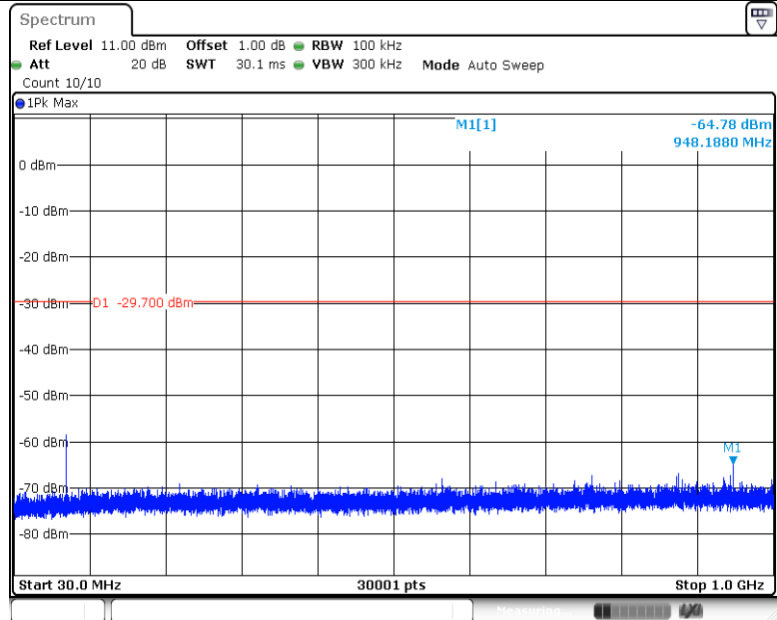
Date: 22 MAY.2023 17:12:20

2DH5_Ant1_2402_0~Reference



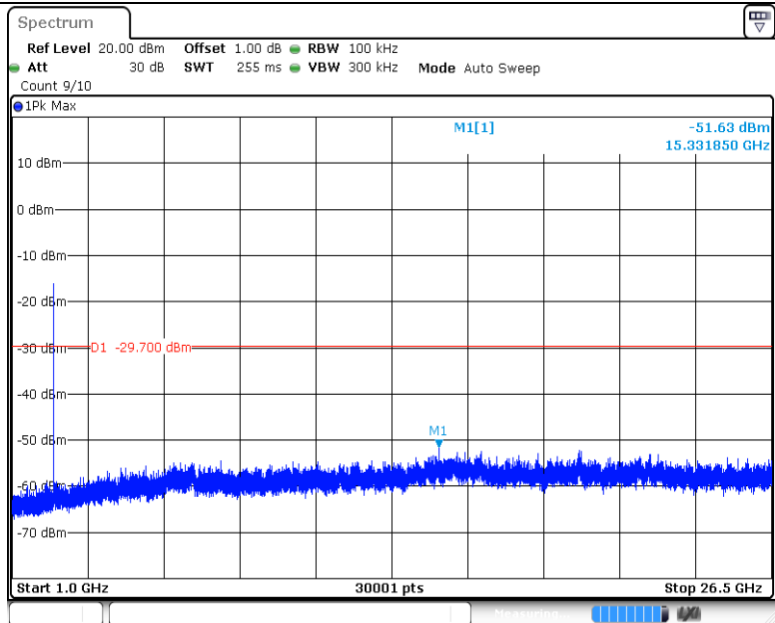
Date: 22.MAY.2023 17:13:41

2DH5_Ant1_2402_30~1000



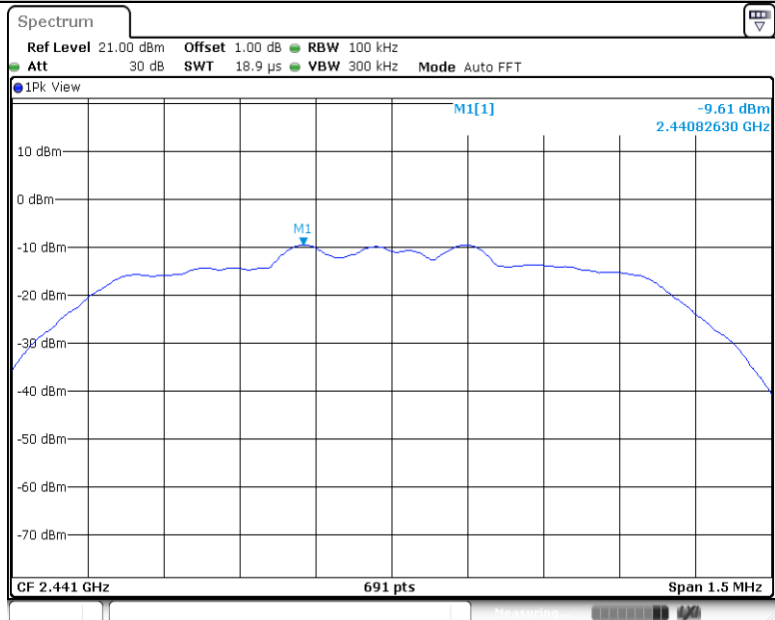
Date: 22.MAY.2023 17:13:47

2DH5_Ant1_2402_1000~26500



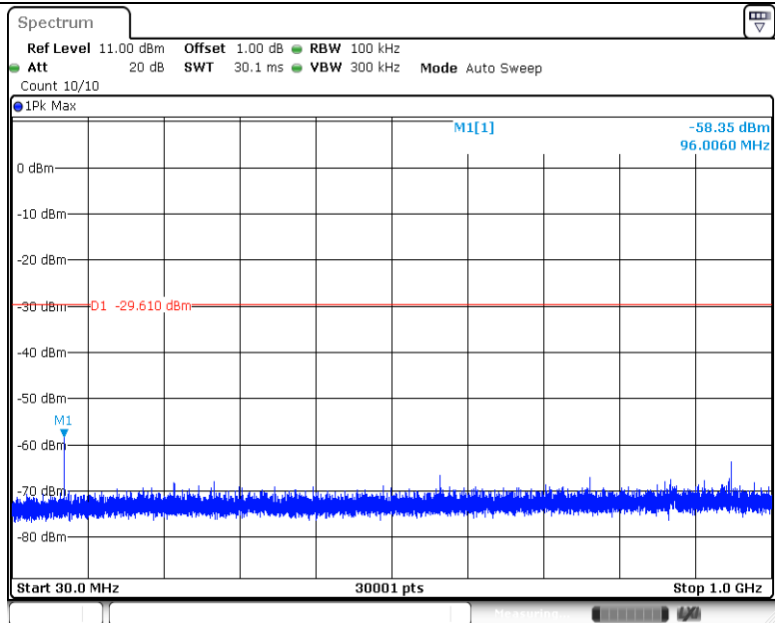
Date: 22.MAY.2023 17:13:55

2DH5_Ant1_2441_0~Reference



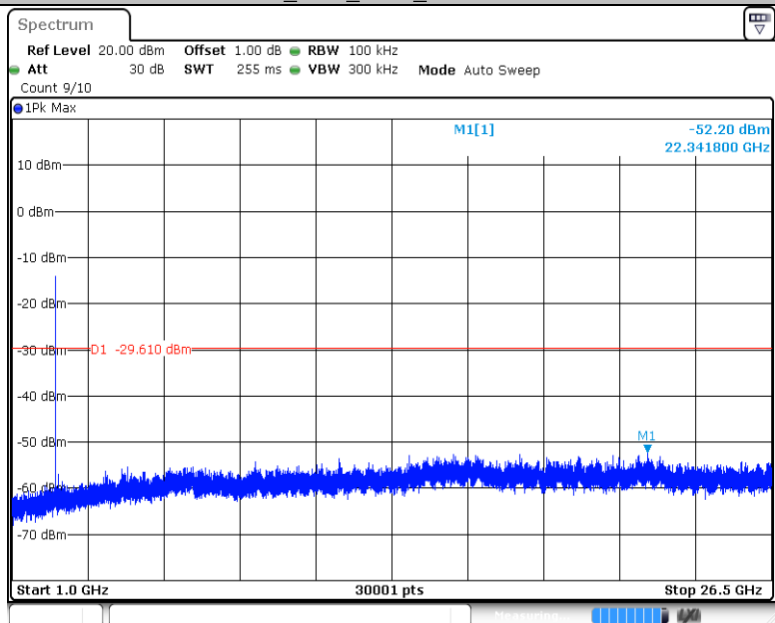
Date: 22.MAY.2023 17:15:04

2DH5_Ant1_2441_30~1000



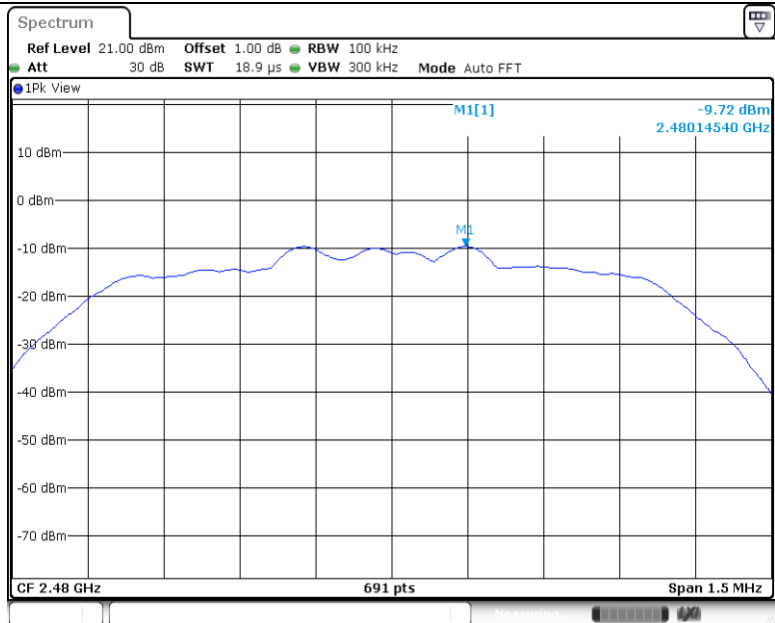
Date: 22.MAY.2023 17:15:10

2DH5_Ant1_2441_1000~26500



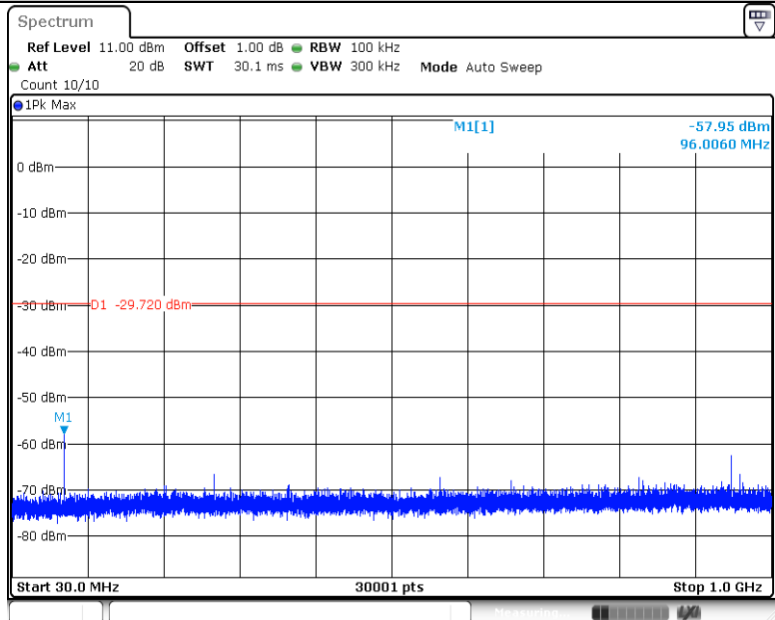
Date: 22.MAY.2023 17:15:18

2DH5_Ant1_2480_0~Reference



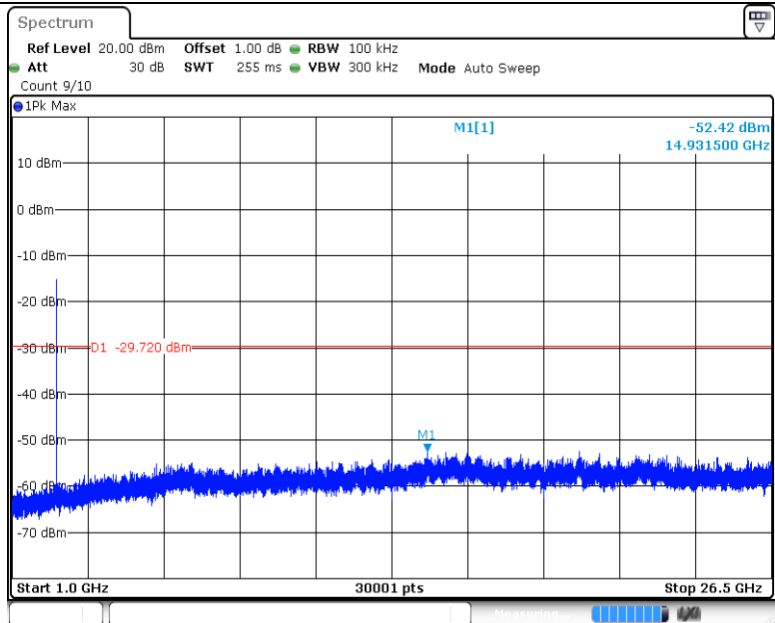
Date: 22.MAY.2023 17:16:34

2DH5_Ant1_2480_30~1000



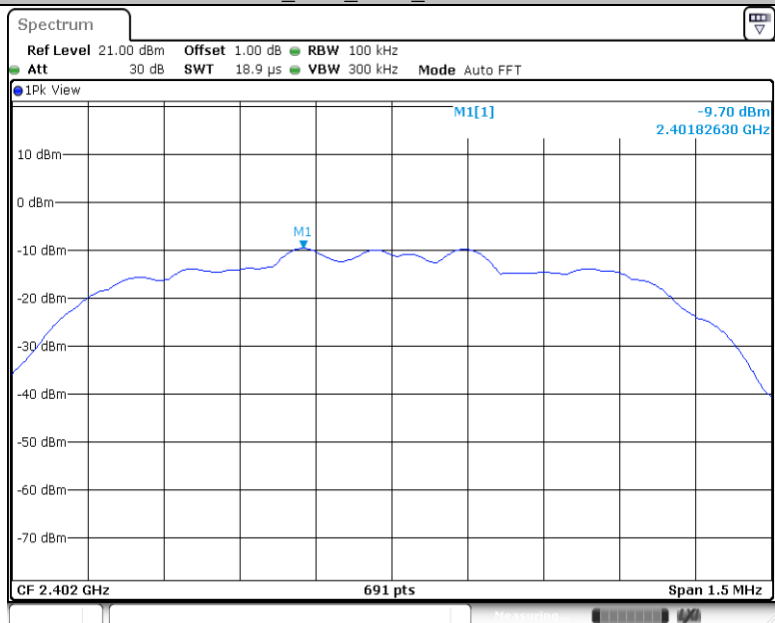
Date: 22.MAY.2023 17:16:40

2DH5_Ant1_2480_1000~26500



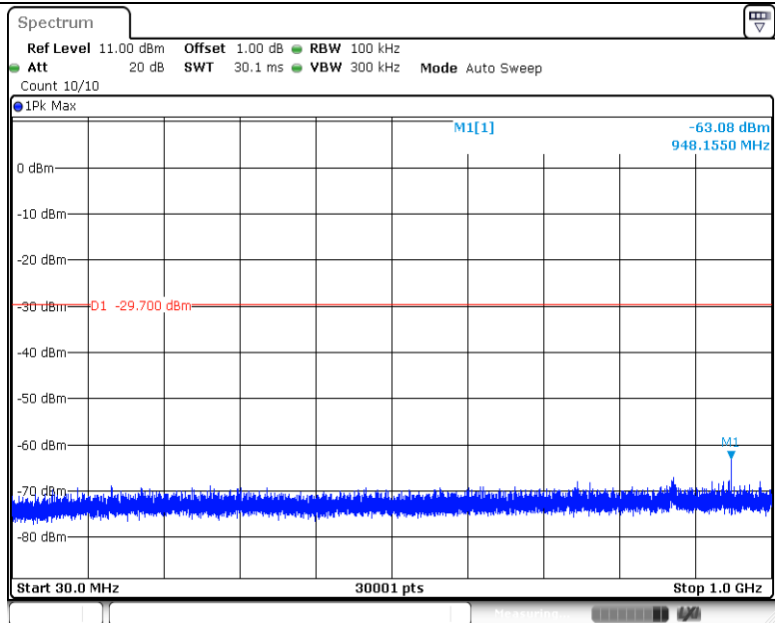
Date: 22.MAY.2023 17:16:48

3DH5_Ant1_2402_0~Reference



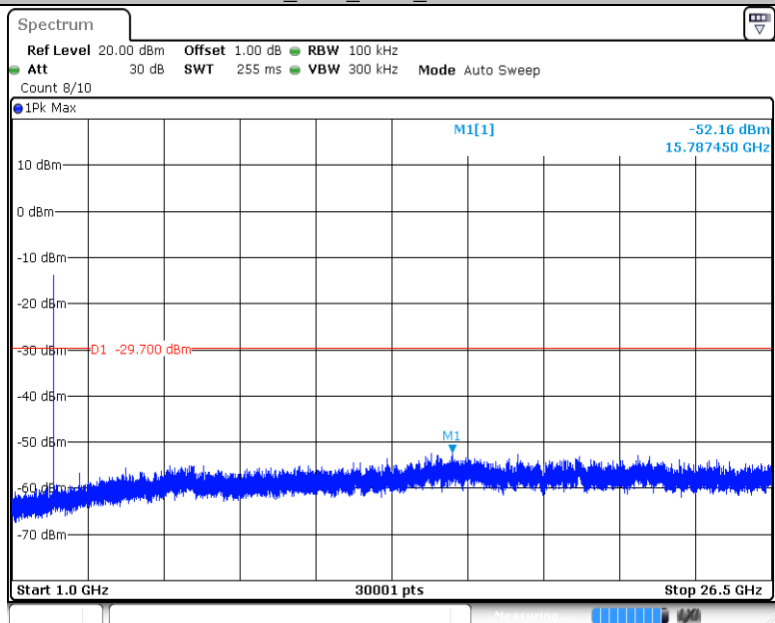
Date: 22.MAY.2023 17:18:13

3DH5_Ant1_2402_30~1000



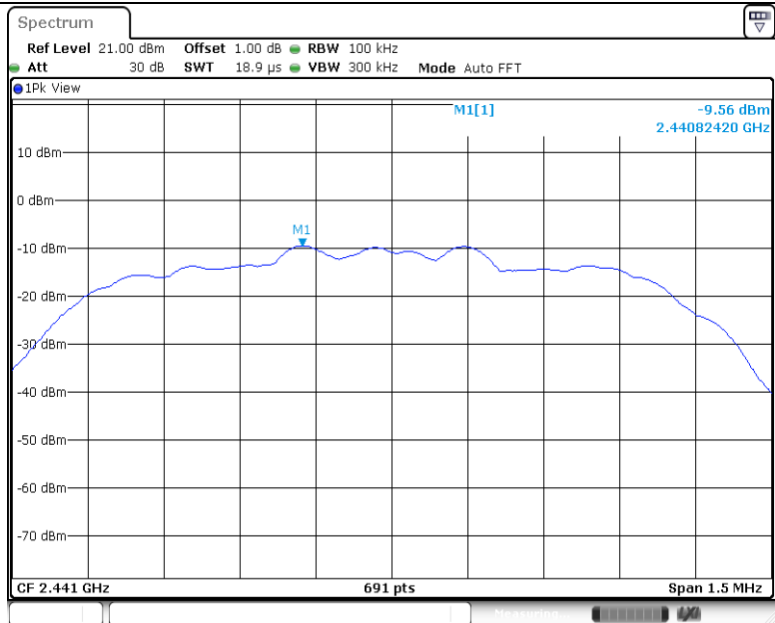
Date: 22.MAY.2023 17:18:19

3DH5_Ant1_2402_1000~26500



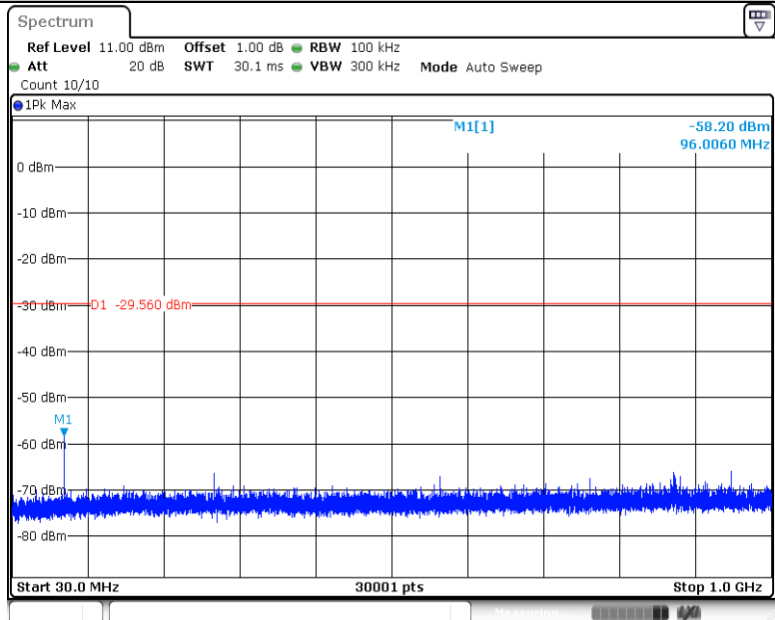
Date: 22.MAY.2023 17:18:27

3DH5_Ant1_2441_0~Reference



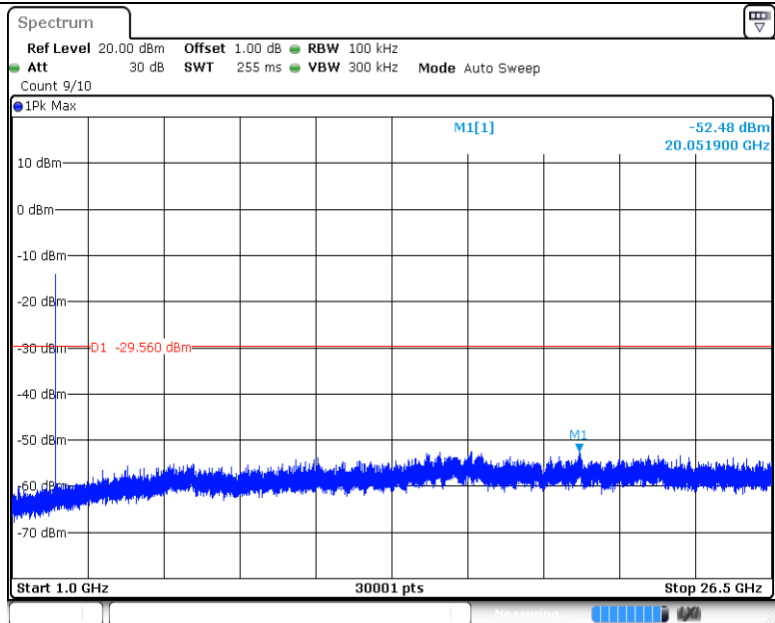
Date: 22.MAY.2023 17:19:36

3DH5_Ant1_2441_30~1000



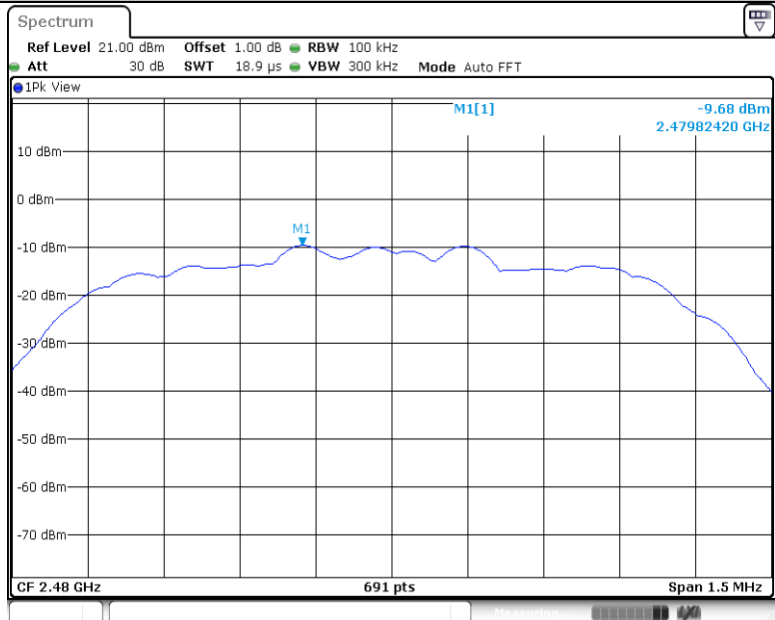
Date: 22.MAY.2023 17:19:42

3DH5_Ant1_2441_1000~26500



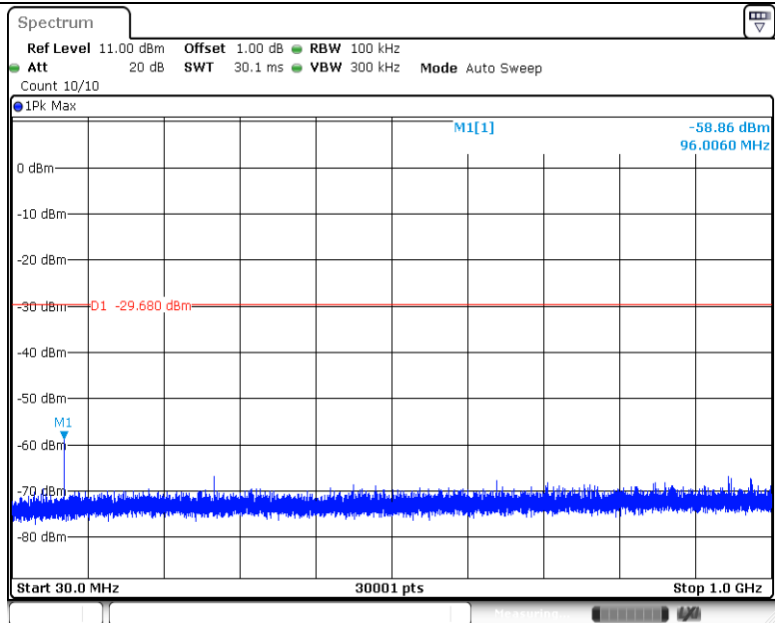
Date: 22.MAY.2023 17:19:50

3DH5_Ant1_2480_0~Reference



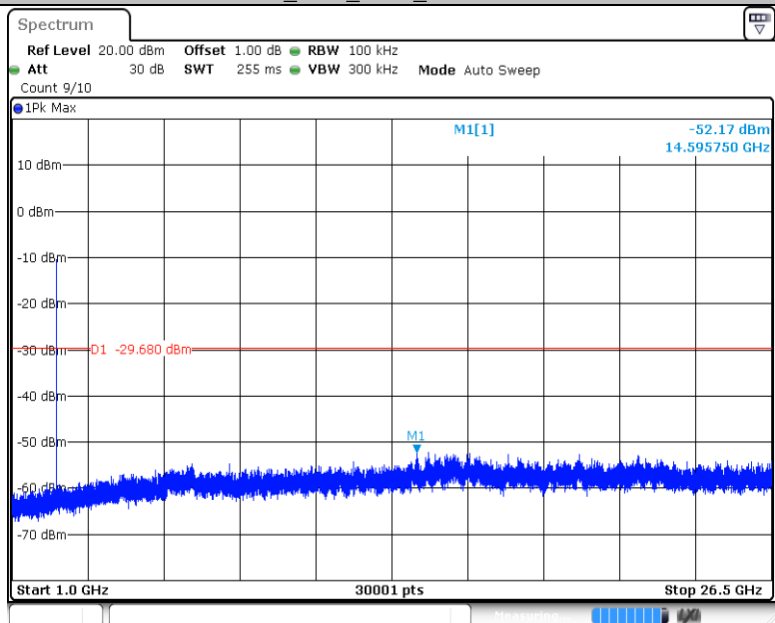
Date: 22.MAY.2023 17:21:11

3DH5_Ant1_2480_30~1000



Date: 22.MAY.2023 17:21:17

3DH5_Ant1_2480_1000~26500



Date: 22.MAY.2023 17:21:25

9.8 Band edge testing

Test Method

1. The RF output of EUT was connected to the test receiver by RF cable. The path loss was compensated to the results for each measurement.
2. Set to the maximum power setting and enable the EUT transmit continuously.
3. Set RBW = 100 kHz, VBW=300 kHz, Peak Detector. Unwanted Emissions measured in any 100 kHz bandwidth outside of the authorized frequency band shall be attenuated by at least 20 dB relative to the maximum in-band peak PSD level in 100 kHz when maximum peak conducted output power procedure is used. If the transmitter complies with the conducted power limits based on the use of RMS averaging over a time interval, the attenuation required under this paragraph shall be 30 dB instead of 20 dB.
4. Measure and record the results in the test report.
5. The RF fundamental frequency should be excluded against the limit line in the operating frequency
6. Set to the maximum power setting and enable the EUT hopping mode, repeat the test.

Limit:

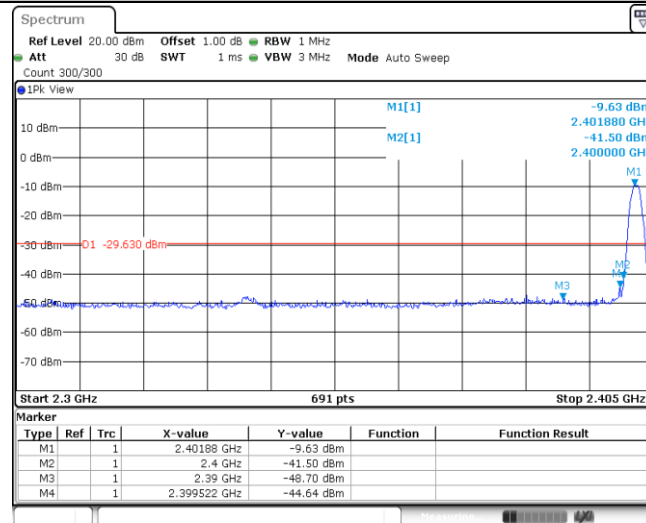
In any 100kHz bandwidth outside the frequency band in which the spread spectrum or digitally modulated device is operating, the RF power that is produced shall be at least 20 dB below that in the 100 kHz bandwidth within the band that contains the highest level of the desired power, based on either an RF conducted or a radiated measurement, provided that the transmitter demonstrates compliance with the peak conducted power limits.

Band edge

Test Result as below:

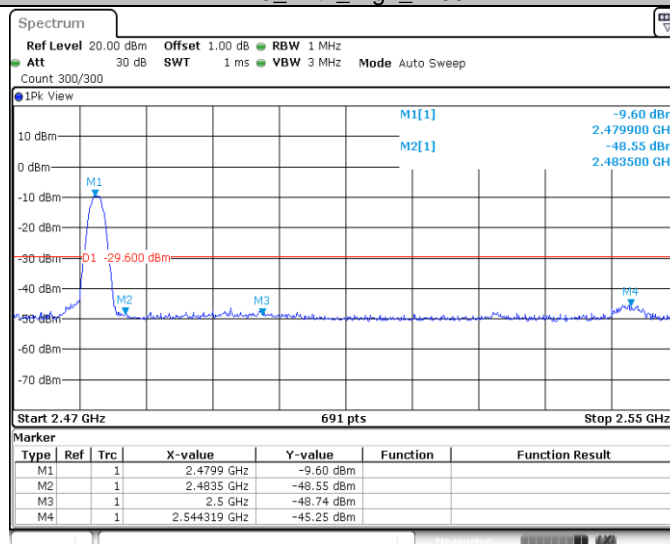
Test Mode	Antenna	Channel	Channel (MHz)	Reference Level (dBm)	Result (dBm)	Limit (dBm)	Verdict
DH5	Ant1	Low	2402	-9.63	-44.64	<=-29.63	PASS
		High	2480	-9.60	-45.25	<=-29.6	PASS
		Low	Hop_2402	-9.63	-47.3	-29.63	PASS
		High	Hop_2480	-9.59	-44.18	-29.59	PASS
2DH5	Ant1	Low	2402	-9.00	-40	<=-29	PASS
		High	2480	-8.97	-45.22	<=-28.97	PASS
		Low	Hop_2402	-9.05	-47.4	-29.05	PASS
		High	Hop_2480	-9.00	-45.34	-29	PASS
3DH5	Ant1	Low	2402	-8.72	-40.09	<=-28.72	PASS
		High	2480	-8.68	-45.4	<=-28.68	PASS
		Low	Hop_2402	-8.96	-47.08	-28.96	PASS
		High	Hop_2480	-8.62	-45.47	-28.62	PASS

DH5_Ant1_Low_2402



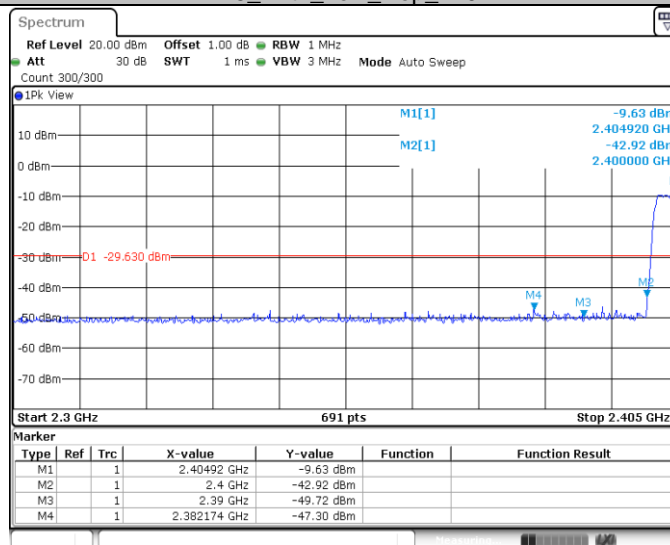
Date: 22 MAY 2023 17:08:36

DH5_Ant1_High_2480



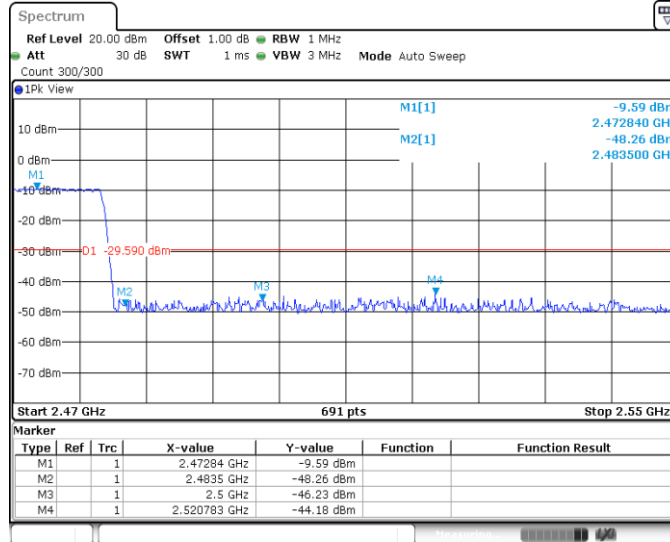
Date: 22 MAY 2023 17:12:01

DH5_Ant1_Low Hop_2402



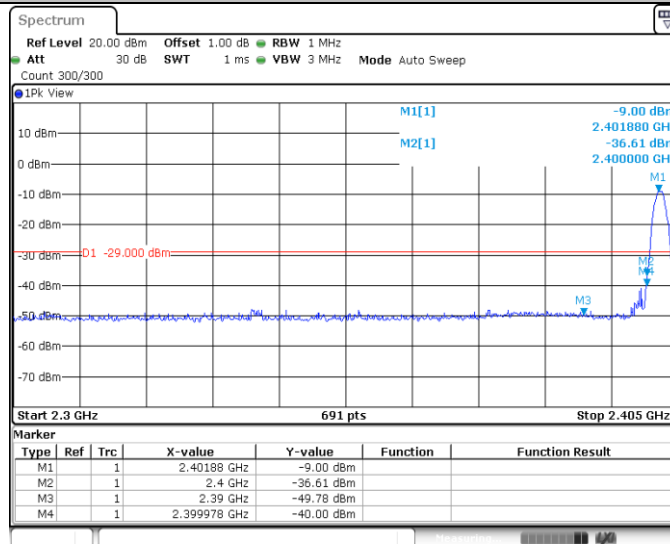
Date: 22 MAY 2023 17:21:49

DH5_Ant1_High_Hop_2480



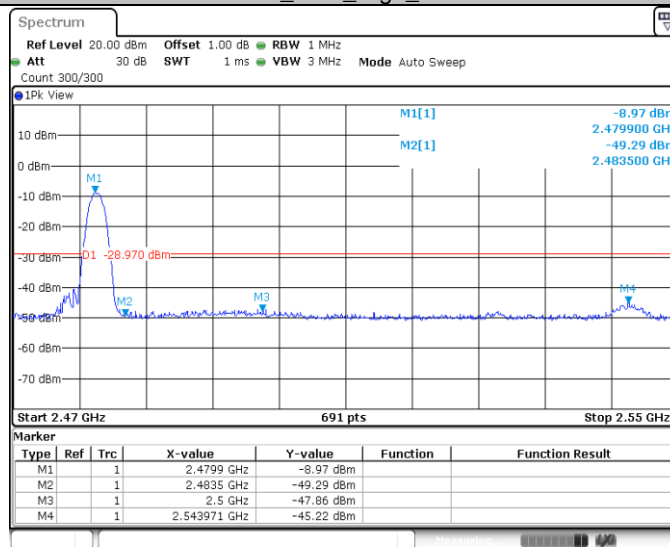
Date: 22 MAY 2023 17:24:18

2DH5_Ant1_Low_2402



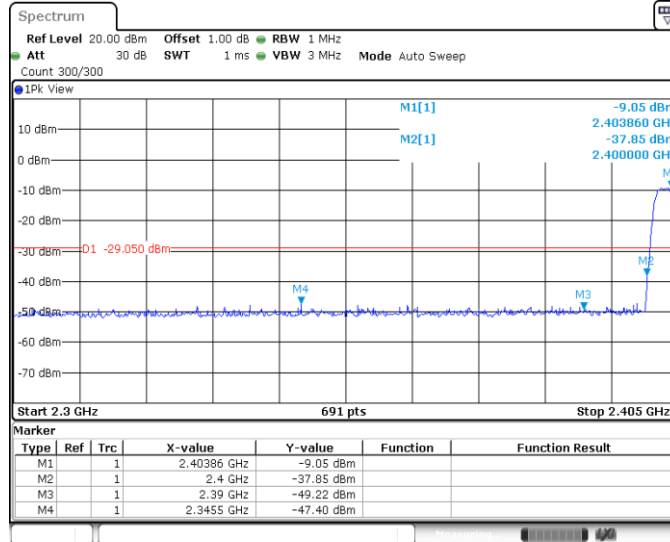
Date: 22 MAY 2023 17:13:35

2DH5_Ant1_High_2480



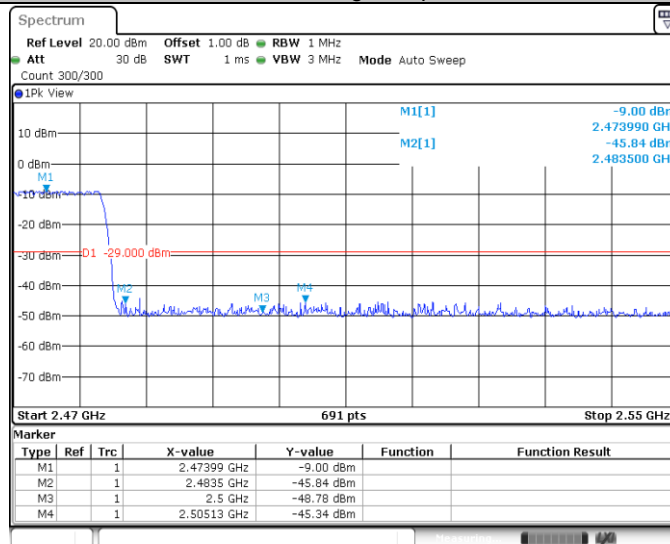
Date: 22 MAY 2023 17:16:28

2DH5_Ant1_Low_Hop_2402



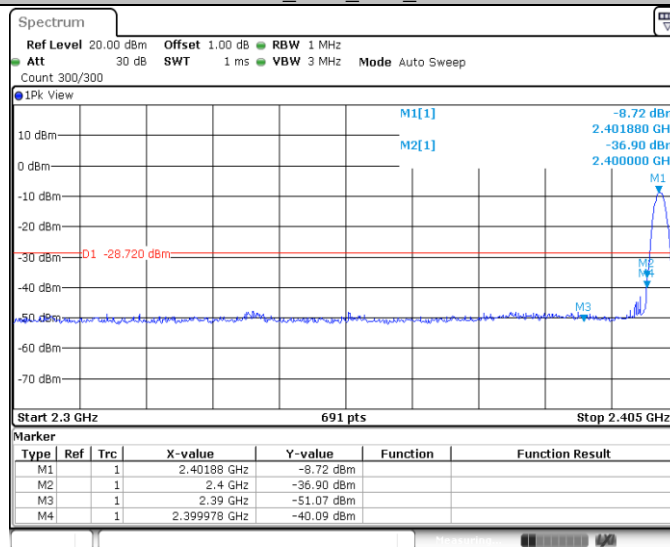
Date: 22 MAY 2023 17:24:39

2DH5_Ant1_High_Hop_2480



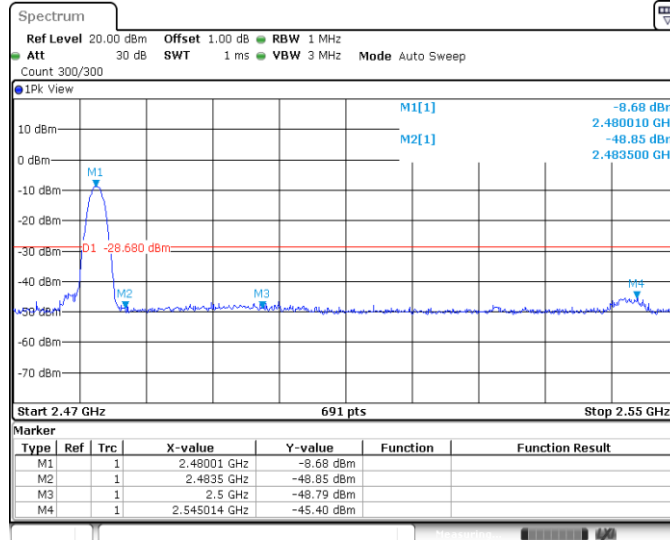
Date: 22 MAY 2023 17:28:57

3DH5_Ant1_Low_2402



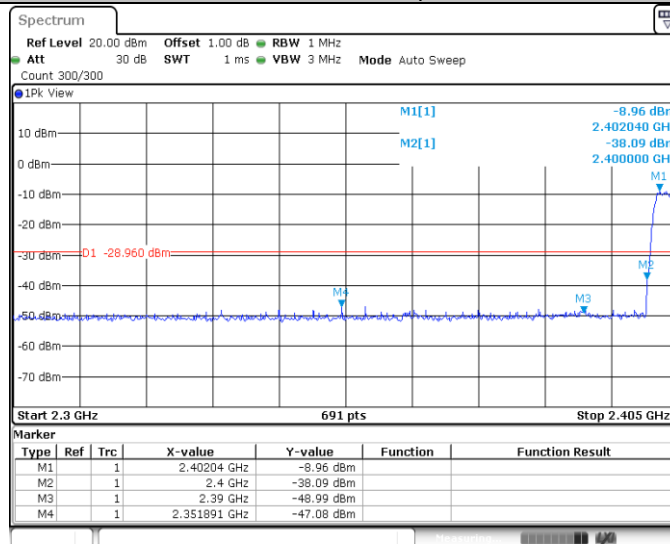
Date: 22 MAY 2023 17:18:07

3DH5_Ant1_High_2480



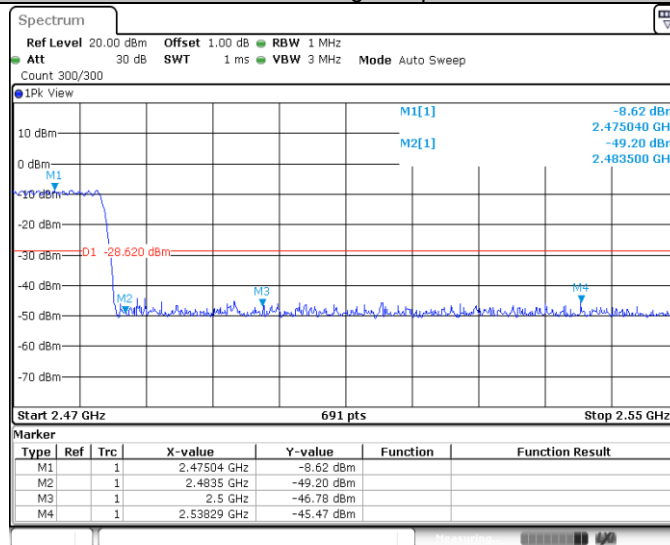
Date: 22 MAY 2023 17:21:05

3DH5_Ant1_Low_Hop_2402



Date: 22 MAY 2023 17:29:16

3DH5_Ant1_High_Hop_2480



Date: 22 MAY 2023 17:32:47

9.9 Spurious radiated emissions for transmitter

Test Method

1. The EUT was placed on a turn table which is 1.5m above ground plane for above 1GHz and 0.8m above ground for below 1GHz at 3 meters chamber room for test. The table was rotated 360 degrees to determine the position of the highest radiation.
2. Set to the maximum power setting and enable the EUT transmit continuously
3. The EUT was set 3 meters away from the interference – receiving antenna, which was mounted on the top of a variable – height antenna tower.
4. The height of antenna is varied from one meter to four meters above the ground to determine the maximum value of the field strength. Both horizontal and vertical polarizations of the antenna are set to make the measurement.
5. For each suspected emission, the EUT was arranged to its worst case and then the antenna was tuned to heights from 1 meter to 4 meters and the rotatable table was turned from 0 degrees to 360 degrees to find the maximum reading.
6. Use the following spectrum analyzer settings According to C63.10:
 - (1) Span shall wide enough to fully capture the emission being measured;
 - (2) Set RBW=100 kHz for $f < 1$ GHz; VBW RBW; Sweep = auto; Detector function = peak; Trace = max hold;
 - (3) Set RBW = 1 MHz, VBW= 3MHz for $f \geq 1$ GHz for peak measurement.For average measurement:
VBW = 10 Hz, when duty cycle is no less than 98 percent.
VBW $\geq 1/T$, when duty cycle is less than 98 percent where T is the minimum transmission duration over which the transmitter is on and is transmitting at its maximum power control level for the tested mode of operation.
7. Repeat above procedures until all frequencies measured were complete.

Note:

- 1: The resolution bandwidth and video bandwidth of test receiver/spectrum analyzer is 120 KHz for Quasi-peak detection (QP) at frequency below 1GHz.
- 2: The resolution bandwidth of test receiver/spectrum analyzer is 1MHz and the video bandwidth is 3MHz for peak detection (PK) at frequency above 1GHz.
- 3: The resolution bandwidth of test receiver/spectrum analyzer is 1MHz and the video bandwidth is 3MHz for RMS Average ((duty cycle < 98%) for Average detection (AV) at frequency above 1GHz, then the measurement results was added to a correction factor ($20\log(1/\text{duty cycle})$).
- 4: The resolution bandwidth of test receiver/spectrum analyzer is 1MHz and the video bandwidth is 10Hz (duty cycle > 98%) for Average detection (AV) at frequency above 1GHz.

Spurious radiated emissions for transmitter

Limit

The radio emission outside the operating frequency band 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. Radiated emissions which fall in the restricted bands, as defined in section 15.205 & RSS-GEN 8.10, must comply with the radiated emission limits specified in section 15.209 & RSS-Gen 6.13.

Frequency MHz	Field Strength $\mu\text{V/m}$	Field Strength $\text{dB}\mu\text{V/m}$	Detector	Measurement distance meters
0.009-0.490	2400/F(kHz)	48.5-13.8	AV	300
0.490-1.705	24000/F(kHz)	33.8-23.0	QP	30
1.705-30	30	29.5	QP	30
30-88	100	40	QP	3
88-216	150	43.5	QP	3
216-960	200	46	QP	3
960-1000	500	54	QP	3
Above 1000	500	54	AV	3
Above 1000	5000	74	PK	3

Note 1: $\text{Limit } 3\text{m}(\text{dB}\mu\text{V/m}) = \text{Limit } 300\text{m}(\text{dB}\mu\text{V/m}) + 40\text{Log}(300\text{m}/3\text{m})$ (Below 30MHz)

Note 2: $\text{Limit } 3\text{m}(\text{dB}\mu\text{V/m}) = \text{Limit } 30\text{m}(\text{dB}\mu\text{V/m}) + 40\text{Log}(30\text{m}/3\text{m})$ (Below 30MHz)

Spurious radiated emissions for transmitter

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

The only worse case (which is subject to the maximum EIRP, GFSK mode) test result is listed in the report.

Transmitting spurious emission test result as below:

Frequency Band	Frequency MHz	Emission Level dB μ V/m	Polarization	Limit dB μ V/m	Detector	Margin dB μ V/m	Correct factor (dB)	Result
30-1000MHz	179.986250	22.46	H	43.50	QP	21.04	16.89	Pass
	391.264375	29.51	H	46.00	QP	16.49	23.89	Pass
	617.395625	33.88	H	46.00	QP	12.12	28.05	Pass
	883.357500	38.58	H	46.00	QP	7.42	32.10	Pass
	Other Frequencies	--	H	--	QP	--	--	Pass
	195.263750	22.56	V	43.50	QP	20.94	18.93	Pass
	467.955000	29.89	V	46.00	QP	16.11	25.05	Pass
	599.511250	33.95	V	46.00	QP	12.05	27.92	Pass
	920.096250	39.01	V	46.00	QP	6.99	32.50	Pass
	Other Frequencies	--	V	--	QP	--	--	Pass

GFSK Modulation 2402MHz Test Result

Frequency Band	Frequency MHz	Emission Level dB μ V/m	Polarization	Limit dB μ V/m	Detector	Margin dB μ V/m	Correct factor (dB)	Result
1000-25000MHz	3912.000000	48.38	H	74	PK	25.62	2.91	Pass
	9602.000000	45.87	H	74	PK	28.13	12.61	Pass
	14516.000000	47.99	H	74	PK	26.01	18.43	Pass
	Other Frequencies	--	H	--	PK	--	--	Pass
	1991.500000	43.67	V	74	PK	30.33	-6.48	Pass
	9752.000000	43.43	V	74	PK	30.57	12.65	Pass
	14685.500000	47.48	V	74	PK	26.52	18.84	Pass
	Other Frequencies	--	V	--	PK	--	--	Pass

GFSK Modulation 2441MHz Test Result

Frequency Band	Frequency MHz	Emission Level dBμV/m	Polarization	Limit dBμV/m	Detector	Margin dBμV/m	Correct factor (dB)	Result
1000-25000MHz	4496.500000	49.10	H	74	PK	24.90	4.74	Pass
	9758.000000	45.33	H	74	PK	28.67	12.67	Pass
	14513.500000	47.27	H	74	PK	26.73	18.42	Pass
	Other Frequencies	--	H	--	PK	--	--	Pass
	1994.500000	43.14	V	74	PK	30.86	-6.42	Pass
	10663.500000	44.36	V	74	PK	29.64	13.38	Pass
	14573.000000	47.41	V	74	PK	26.59	18.67	Pass
	Other Frequencies	--	V	--	PK	--	--	Pass

GFSK Modulation 2480MHz Test Result

Frequency Band	Frequency MHz	Emission Level dBμV/m	Polarization	Limit dBμV/m	Detector	Margin dBμV/m	Correct factor (dB)	Result
1000-25000MHz	4957.000000	50.43	H	74	PK	23.57	6.25	Pass
	9914.000000	47.51	H	74	PK	26.49	12.71	Pass
	14568.000000	47.47	H	74	PK	26.54	18.65	Pass
	Other Frequencies	--	H	--	PK	--	--	Pass
	1991.500000	43.93	V	74	PK	30.07	-6.48	Pass
	8981.000000	43.63	V	74	PK	30.37	12.48	Pass
	15149.500000	49.31	V	74	PK	24.69	19.55	Pass
	Other Frequencies	--	V	--	PK	--	--	Pass

Remark:

- (1) Data of measurement within frequency range 9kHz-30MHz is the noise floor or attenuated more than 20dB below the permissible limits or the field strength is too small to be measured, so test data does not present in this report.
- (2) Data of measurement within this frequency range shown "--" in the table above means the reading of emissions are the noise floor or attenuated more than 10dB below the permissible limits or the field strength is too small to be measured.
- (3) Level=Reading Level + Correction Factor
 Above 1GHz: Corrector factor = Antenna Factor + Cable Loss- Amplifier Gain
 Below 1GHz: Corrector factor = Antenna Factor + Cable Loss
 (The Reading Level is recorded by software which is not shown in the sheet)

10 Test Equipment List

List of Test Instruments

Conducted Emission 2# Test

DESCRIPTION	MANUFACTURER	MODEL NO.	EQUIPMENT ID	SERIAL NO.	CAL INTERVAL (YEAR)	CAL. DUE DATE
EMI Test Receiver	Rohde & Schwarz	ESR 3	68-4-74-19-002	102590	1	2024-5-19
LISN	Rohde & Schwarz	ENV216	68-4-87-19-001	102472	1	2024-5-20
Attenuator	Shanghai Huaxiang	TS2-26-3	68-4-81-16-003	080928189	1	2024-5-19
Test software	Rohde & Schwarz	EMC32	68-4-90-19-005-A01	Version10.35.02	N/A	N/A
Shielding Room	TDK	CSR #2	68-4-90-19-005	----	3	2025-10-15

Radiated Emission Test 1# Test

DESCRIPTION	MANUFACTURER	MODEL NO.	EQUIPMENT ID	SERIAL NO.	CAL INTERVAL (YEAR)	CAL. DUE DATE
EMI Test Receiver	Rohde & Schwarz	ESR 7	68-4-74-19-001	102176	1	2024-5-20
Trilog Super Broadband Test Antenna	Schwarzbeck	VULB 9163	68-4-80-14-002	707	1	2024-7-18
Loop Antenna	Rohde & Schwarz	HFH2-Z2	68-4-80-14-006	100398	1	2023-8-17
Pre-amplifier	Rohde & Schwarz	SCU 18	68-4-29-14-001	102230	1	2024-5-19
Attenuator	Mini-circuits	UNAT-6+	68-4-81-21-001	15542	1	2024-5-19
3m Semi-anechoic chamber	TDK	SAC-3 #1	68-4-90-14-001	----	3	2024-5-28
Test software	Rohde & Schwarz	EMC32	68-4-90-14-001-A10	Version10.35.02	N/A	N/A

Radiated Emission 2# Test

DESCRIPTION	MANUFACTURER	MODEL NO.	EQUIPMENT ID	SERIAL NO.	CAL INTERVAL (YEAR)	CAL. DUE DATE
EMI Test Receiver	Rohde & Schwarz	ESR 26	68-4-74-14-002	101269	1	2024-5-20
Wave Guide Antenna	ETS	3117	68-4-80-19-001	00218954	1	2024-4-26
Pre-amplifier	Rohde & Schwarz	SCU 18F	68-4-29-19-001	100745	1	2024-5-19
Pre-amplifier	Rohde & Schwarz	SCU 18F	68-4-29-19-002	100746	1	2024-5-19
Sideband Horn Antenna	Q-PAR	QWH-SL-18-40-K-SG	68-4-80-14-008	12827	1	2024-7-11
Pre-amplifier	Rohde & Schwarz	SCU 40A	68-4-29-14-002	100432	1	2024-8-1
Attenuator	Mini-circuits	UNAT-6+	68-4-81-21-002	15542	1	2024-5-19
3m Semi-anechoic chamber	TDK	SAC-3 #2	68-4-90-19-006	----	2	2024-5-28
Test software	Rohde & Schwarz	EMC32	68-4-90-19-006-A01	Version10.35.02	N/A	N/A

RF conducted test

DESCRIPTION	MANUFACTURER	MODEL NO.	EQUIPMENT ID	SERIAL NO.	CAL INTERVAL (YEAR)	CAL. DUE DATE
Signal Analyzer	Rohde & Schwarz	FSV40	68-4-74-14-004	101030	1	2024-5-19
RF Switch Module	Rohde & Schwarz	OSP120/OSP-B157W	68-4-93-14-003	101226/100929	1	2024-5-20
Test software	Rohde & Schwarz	EMC32	68-4-48-14-003-A10	Version 10.60.10	N/A	N/A
Test software	Tonscend	System for BT/WIFI	68-4-74-14-006-A13	Version 2.6.77.0518	N/A	N/A
Shielding Room	TDK	TS8997	68-4-90-19-003	----	3	2025-10-15

11 System Measurement Uncertainty

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

System Measurement Uncertainty	
Test Items	Extended Uncertainty
Uncertainty for Conducted Emission in new shielding room (68-4-90-19-005) 150kHz-30MHz (for test using AMN ENV216)	3.33dB
Uncertainty for Radiated Emission in 3m chamber (68-4-90-14-001) 9kHz-30MHz	4.70dB
Uncertainty for Radiated Emission in 3m chamber (68-4-90-14-001) 30MHz-1000MHz	Horizontal: 4.64dB; Vertical: 4.79dB;
Uncertainty for Radiated Emission in new 3m chamber (68-4-90-19-006) 1000MHz-18000MHz	Horizontal: 5.08dB; Vertical: 5.09dB;
Uncertainty for Radiated Emission in new 3m chamber (68-4-90-19-006) 18GHz-40GHz	Horizontal: 3.14dB; Vertical: 3.12dB;
Uncertainty for Conducted RF test with TS 8997	RF Power Conducted: 1.31dB Frequency test involved: 0.6×10 ⁻⁸ or 1%

Measurement Uncertainty Decision Rule

Determination of conformity with the specification limits is based on the decision rule according to IEC Guide 115: 2021, clause 4.4.3 and 4.5.1.

---The End---