RF REPORT

FCC ID: 2AZFE-AN1

On Behalf of

Shenzhen Shadow Crown Technology Co.,Ltd.

LED Projector

Model No.: An1, An2, An3, E88, LU-1, An2 Pro, E88 Pro, NX-2, NS-1, NS-1 PRO

Prepared for	:	Shenzhen Shadow Crown Technology Co.,Ltd.
Address	:	A9 East 5th Floor, Industrial Building,Longwang Miao, Fuyong District , Shenzhen, Guangdong, P.R.China.

Prepared By	:	Shenzhen Alpha Product Testing Co., Ltd
Address	:	Building i, No.2, Lixin Road, Fuyong Street, Bao'an District, 518103, Shenzhen, Guangdong, China

Report Number	:	A2303044-C01-R01
Date of Receipt	:	March 23, 2023
Date of Test	:	March 23, 2023 to April 13, 2023
Date of Report	:	April 13, 2023
Version Number	:	V0

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TEST REPORT DECLARATION

Applicant	:	Shenzhen Shadow Crown Technology Co.,Ltd.
Address	:	A9 East 5th Floor, Industrial Building,Longwang Miao, Fuyong District , Shenzhen, Guangdong, P.R.China.
Manufacturer	:	Shenzhen Shadow Crown Technology Co.,Ltd.
Address	:	A9 East 5th Floor, Industrial Building,Longwang Miao, Fuyong District , Shenzhen, Guangdong, P.R.China.
EUT Description	:	LED Projector
(A) Model No.	:	An1, An2, An3, E88, LU-1, An2 Pro, E88 Pro, NX-2, NS-1, NS-1 PRO
(B) Trademark	:	N/A

Measurement Standard Used:

FCC Rules and Regulations Part 15 Subpart C Section 15.247

The device described above is tested by Shenzhen Alpha Product Testing Co., Ltd. to determine the maximum emission levels emanating from the device and the severe levels of the device can endure and its performance criterion. The test results are contained in this test report and Shenzhen Alpha Product Testing Co., Ltd. is assumed full responsibility for the accuracy and completeness of test. Also, this report shows that the EUT is technically compliant with above listed standard(s) requirements.

This report applies to above tested sample only. This report shall not be reproduced in parts without written approval of Shenzhen Alpha Product Testing Co., Ltd.

Tested by (name + signature)	:	Yannis Wen Project Engineer
Approved by (name + signature)	:	Reak Yang Project Manager
Date of issue	:	April 13, 2023

Revision History

Revision	Issue Date	Revisions	Revised By
V0	April 13, 2023	Initial released Issue	Yannis Wen

1 General Information

1.1 Description of Device (EUT)

Product Name	:	LED Projector
Trademark	:	N/A
Model Number	:	An1, An2, An3, E88, LU-1, An2 Pro, E88 Pro, NX-2, NS-1, NS-1 PRO
DIFF	:	There is no difference between the models except the appearance color. So all the test were performed on the model An1.
Power Supply	:	AC 120/60Hz
Operation Frequency	:	2402MHz to 2480MHz
Number of Channels	:	79
Modulation Type	:	GFSK, π/4 DQPSK, 8DPSK
Antenna Type	:	PCB antenna
Antenna Gain	:	-0.58dBi（Max）

1.2 Test Lab information

Shenzhen Alpha Product Testing Co., Ltd Building i, No.2, Lixin Road, Fuyong Street, Bao'an District, 518103, Shenzhen, Guangdong, China
June 21, 2018 File on Federal Communication Commission Registration Number: 293961 Designation Number: CN1236 July 15, 2019 Certificated by IC Registration Number: CN0085

2 Summary of test

2.1 Test Standard description:

The tests were performed according to following standards:

FCC Part 15.247: Operation within the bands 902-928 MHz, 2400-2483.5 MHz, and 5725-5850 MHz

2.2 Summary of test

Item	Requirement	Method	Result
Antenna requirement	Part 15.203		Pass
Conducted Emission at AC power line	FCC Part 15.207(a)	ANSI C63.10-2013 section 6.2	Pass
Occupied Bandwidth	FCC Part 15.215(c)	ANSI C63.10-2013, section 6.9.2	Pass
Maximum Conducted Output Power	FCC Part 15.247(b)(1)	ANSI C63.10-2013, section 7.8.5	Pass
Channel Separation	FCC Part 15.247(a)(1)	ANSI C63.10-2013, section 7.8.2	Pass
Number of Hopping Frequencies	FCC Part 15.247(a)(1)(iii)	ANSI C63.10-2013, section 7.8.3	Pass
Dwell Time	FCC Part 15.247(a)(1)(iii)	ANSI C63.10-2013, section 7.8.4	Pass
Emissions in non-restricted frequency bands	FCC Part 15.247(d)	7.8.8	Pass
Band edge emissions (Radiated)	FCC Part 15.247(d)	ANSI C63.10-2013 section 6.6.4	Pass
Emissions in restricted frequency bands (below 1GHz)	FCC Part 15.247(d)	ANSI C63.10-2013 section 6.6.4	Pass
Emissions in restricted frequency bands (above 1GHz)	FCC Part 15.247(d)	ANSI C63.10-2013 section 6.6.4	Pass

2.3 Test Mode Description

Tested mode, channel, and data rate information		
Mode	Channel	Frequency (MHz)
Carrier Tx Mode	L: CH0	2402
	M: CH39	2441
	H: CH78	2480
GFSK / Pi/4-DQPSK / 8-DPSK hopping on Tx Mode	CH0 to CH78	2402 to 2480
GFSK / Pi/4-DQPSK / 8-DPSK hopping off Tx Mode	L: CH0	2402
	M: CH39	2441
	H: CH78	2480

2.4 Measurement Uncertainty (95% confidence levels, k=2)

Item	Uncertainty
Uncertainty for Power point Conducted Emissions Test	1.63dB
Uncertainty for Radiation Emission test in 3m chamber (below 30MHz)	3.5dB
Uncertainty for Radiation Emission test in 3m chamber (30MHz to 1GHz)	3.74dB(Polarize: V)
	3.76dB(Polarize: H)
Uncertainty for Radiation Emission test in 3m chamber (1GHz to 25GHz)	3.77dB(Polarize: V)
	3.80dB(Polarize: H)
Uncertainty for radio frequency	5.06×10^{-8}GHz
Uncertainty for conducted RF Power	0.40dB
Uncertainty for temperature	0.2℃
Uncertainty for humidity	1%
Uncertainty for DC and low frequency voltages	0.06%

2.5 Test Equipment

Equipment	Manufacture	Model No.	Firmware version	Serial No.	Last cal.	Cal Interval
9*6*6 anechoic chamber	CHENYU	9*6*6	/	N/A	2022.05.17	3Year
Spectrum analyzer	ROHDE&SCHWARZ	FSV40-N	2.3	102137	2022.08.22	1Year
Spectrum analyzer	Agilent	N9020A	A.14.16	MY499100060	2022.08.22	1Year
Receiver	ROHDE&SCHWARZ	ESR	2.28 SP1	1316.3003K03-102082-Wa	2022.08.22	1Year
Receiver	R&S	ESCI	4.42 SP1	101165	2022.08.22	1Year
Bilog Antenna	Schwarzbeck	VULB 9168	/	VULB 9168#627	2021.08.30	2Year
Horn Antenna	SCHWARZBECK	BBHA 9120 D	/	2106	2021.08.30	2Year
Active Loop Antenna	SCHWARZBECK	FMZB 1519B	/	00059	2021.08.30	2Year
RF Cable	Resenberger	Cable 1	/	RE1	2022.08.22	1Year
RF Cable	Resenberger	Cable 2	/	RE2	2022.08.22	1Year
RF Cable	Resenberger	Cable 3	/	CE1	2022.08.22	1Year
Pre-amplifier	HP	HP8347A	/	2834A00455	2022.08.22	1Year
Pre-amplifier	Agilent	8449B	/	3008A02664	2022.08.22	1Year
L.I.S.N.#1	Schwarzbeck	NSLK8126	/	8126-466	2022.08.22	1Year
L.I.S.N.#2	ROHDE&SCHWARZ	ENV216	/	101043	2022.08.23	1 Year
Horn Antenna	SCHWARZBECK	BBHA9170	/	00946	2021.08.30	2 Year
Preamplifier	SKET	LNPA_1840-50	/	SK2018101801	2022.08.22	1 Year
Power Meter	Agilent	E9300A	/	MY41496628	2022.08.22	1 Year
Power Sensor	DARE	RPR3006W	/	15100041SNO91	2022.08.22	1 Year
Temp. & Humid. Chamber	Weihuang	WHTH-1000-40-880	/	100631	2022.08.22	1 Year
Switching Mode Power Supply	JUNKE	JK12010S	/	20140927-6	2022.08.22	1 Year
Adjustable attenuator	MWRFtest	N/A	/	N/A	N/A	N/A
10dB Attenuator	Mini-Circuits	DC-6G	/	N/A	N/A	N/A

Software Information			
Test Item	Software Name	Manufacturer	Version
RE	EZ-EMC	farad	Alpha-3A1
CE	EZ-EMC	farad	Alpha-3A1
RF-CE	MTS 8310	MWRFtest	2.0.0.0

3 Evaluation Results (Evaluation)

3.1 Antenna requirement

Test Requirement:	An intentional radiator shall be designed to ensure that no antenna other than that furnished by the responsible party shall be used with the device. The use of a permanently attached antenna or of an antenna that uses a unique coupling to the intentional radiator shall be considered sufficient to comply with the provisions of this section.

3.1.1 Conclusion:

The EUT antenna is PCB antenna. It complies with the standard requirement.

4 Radio Spectrum Matter Test Results (RF)

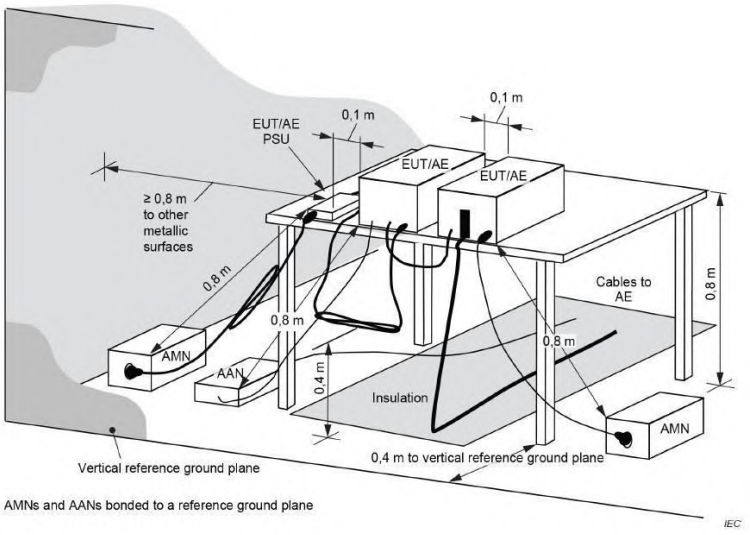
4.1 Conducted Emission at AC power line

Test Requirement:	Except as shown in paragraphs (b)and (c)of this section, for an intentional radiator that is designed to be connected to the public utility (AC) power line, the radio frequency voltage that is conducted back onto the AC power line on any frequency or frequencies, within the band 150 kHz to 30 MHz, shall not exceed the limits in the following table, as measured using a 50 μH/50 ohms line impedance stabilization network (LISN).
Test Limit:	Frequency of emission (MHz) / Conducted limit (dBμV): Quasi-peak / Average 0.15-0.5: 66 to 56* / 56 to 46* 0.5-5: 56 / 46 5-30: 60 / 50 *Decreases with the logarithm of the frequency.
Test Method:	Refer to ANSI C63.10-2013 section 6.2, standard test method for ac power-line conducted emissions from unlicensed wireless devices

4.1.1 E.U.T. Operation:

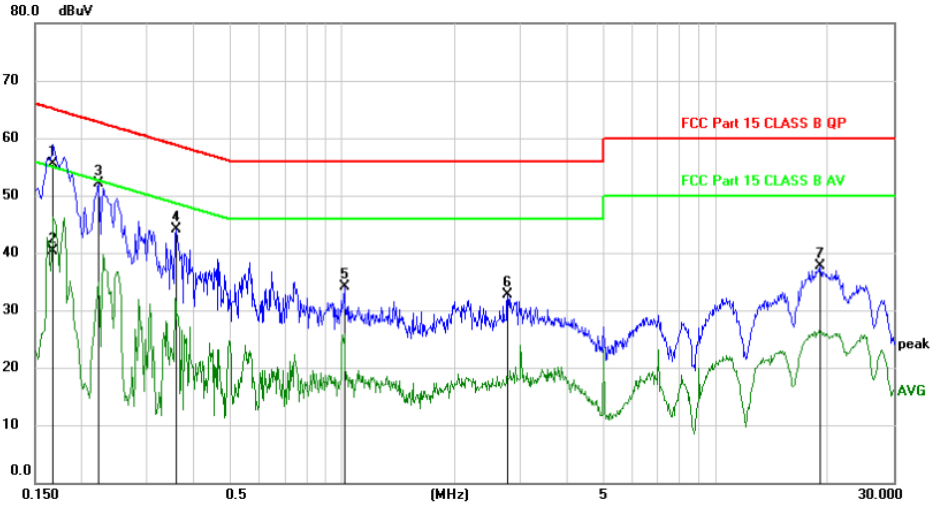
Operating Environment:					
Temperature:	23.8 °C	Humidity:	54.2 %	Atmospheric Pressure:	101.6 kPa
Pre test mode:	All modes				
Final test mode:	TX-GFSK (hopping off)				

4.1.2 Test Setup Diagram:



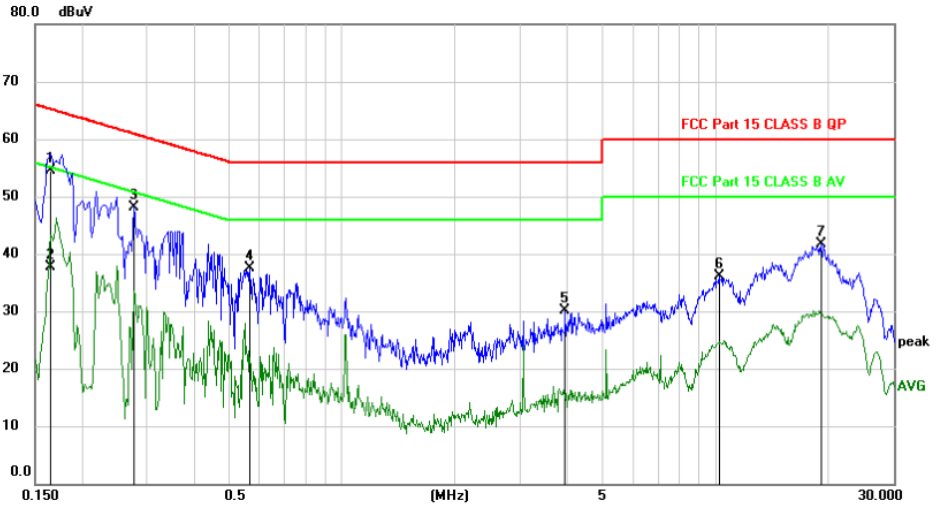
4.1.3 Test Result:

TX-GFSK (hopping ff) / Line: Line /CH: L



No.	Mk.	Freq.	Reading Level	Correct Factor	Measure-ment	Limit	Margin		
		MHz	dBuV	dB	dBuV	dBuV	dB	Detector	Comment
1	*	0.1680	45.57	9.93	55.50	65.06	-9.56	QP	
2		0.1680	30.31	9.93	40.24	55.06	-14.82	AVG	
3		0.2220	42.21	9.94	52.15	62.74	-10.59	peak	
4		0.3600	34.12	9.95	44.07	58.73	-14.66	peak	
5		1.0140	24.14	9.92	34.06	56.00	-21.94	peak	
6		2.7780	22.84	9.94	32.78	56.00	-23.22	peak	
7		19.0920	27.21	10.44	37.65	60.00	-22.35	peak	

TX-GFSK (hopping on) / Line: Neutral



No.	Mk.	Freq.	Reading Level	Correct Factor	Measure-ment	Limit	Margin		
		MHz	dBuV	dB	dBuV	dBuV	dB	Detector	Comment
1	*	0.1650	44.63	9.93	54.56	65.21	-10.65	QP	
2		0.1650	27.69	9.93	37.62	55.21	-17.59	AVG	
3		0.2760	38.26	9.94	48.20	60.94	-12.74	peak	
4		0.5670	27.63	9.93	37.56	56.00	-18.44	peak	
5		3.9540	20.05	9.97	30.02	56.00	-25.98	peak	
6		10.1940	25.94	10.21	36.15	60.00	-23.85	peak	
7		19.1490	31.21	10.45	41.66	60.00	-18.34	peak	

Note: All modes have been tested, and only worst data was listed in this report.

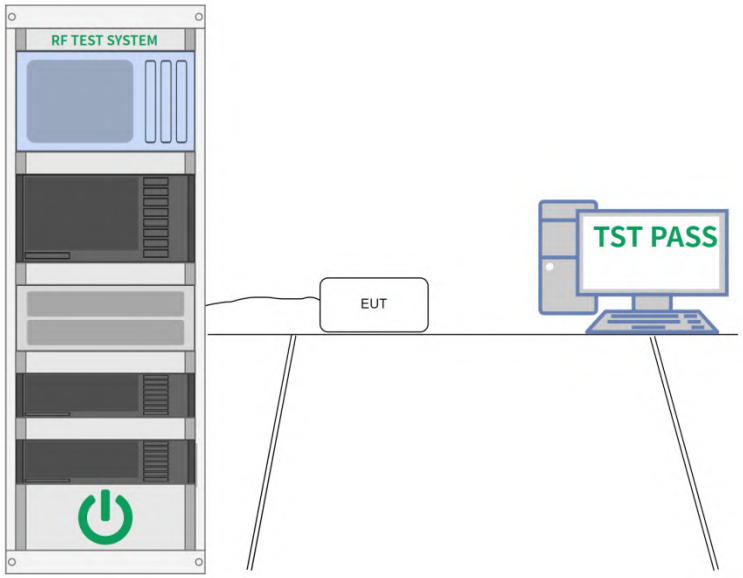
4.2 Occupied Bandwidth

Test Requirement:	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.
Test Limit:	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.
Test Method:	Occupied bandwidth—relative measurement procedure
Procedure:	a) The spectrum analyzer center frequency is set to the nominal EUT channel center frequency. The span range for the EMI receiver or spectrum analyzer shall be between two times and five times the OBW. b) The nominal IF filter bandwidth (3 dB RBW) shall be in the range of 1% to 5% of the OBW and video bandwidth (VBW) shall be approximately three times RBW, unless otherwise specified by the applicable requirement. c) Set the reference level of the instrument as required, keeping the signal from exceeding the maximum input mixer level for linear operation. In general, the peak of the spectral envelope shall be more than [10 log (OBW/RBW)] below the reference level. Specific guidance is given in 4.1.5.2. d) Steps a) through c) might require iteration to adjust within the specified tolerances. e) The dynamic range of the instrument at the selected RBW shall be more than 10 dB below the target “−xx dB down” requirement; that is, if the requirement calls for measuring the −20 dB OBW, the instrument noise floor at the selected RBW shall be at least 30 dB below the reference value. f) Set detection mode to peak and trace mode to max hold. g) Determine the reference value: Set the EUT to transmit an unmodulated carrier or modulated signal, as applicable. Allow the trace to stabilize. Set the spectrum analyzer marker to the highest level of the displayed trace (this is the reference value). h) Determine the “−xx dB down amplitude” using [(reference value) − xx]. Alternatively, this calculation may be made by using the marker-delta function of the instrument. i) If the reference value is determined by an unmodulated carrier, then turn the EUT modulation ON, and either clear the existing trace or start a new trace on the spectrum analyzer and allow the new trace to stabilize. Otherwise, the trace from step g) shall be used for step j). j) Place two markers, one at the lowest frequency and the other at the highest frequency of the envelope of the spectral display, such that each marker is at or slightly below the “-xx dB down amplitude” determined in step h). If a marker is below this “−xx dB down amplitude” value, then it shall be as close as possible to this value. The occupied bandwidth is the frequency difference between the two markers. Alternatively, set a marker at the lowest frequency of the envelope of the spectral display, such that the marker is at or slightly below the “-xx dB down amplitude” determined in step h). Reset the marker-delta function and move the marker to the other side of the emission until the delta marker amplitude is at the same level as the reference marker amplitude. The marker-delta frequency reading at this point is the specified emission bandwidth. k) The occupied bandwidth shall be reported by providing plot(s) of the measuring instrument display; the plot axes and the scale units per division shall be clearly labeled. Tabular data may be reported in addition to the plot(s).

4.2.1 E.U.T. Operation:

Operating Environment:					
Temperature:	22.5 °C	Humidity:	51.5 %	Atmospheric Pressure:	102 kPa
Pre test mode:	TX-GFSK(hopping off), TX-Pi/4DQPSK (hopping off), TX-8DPSK (hopping off)				
Final test mode:	TX-GFSK(hopping off), TX-Pi/4DQPSK (hopping off), TX-8DPSK (hopping off)				

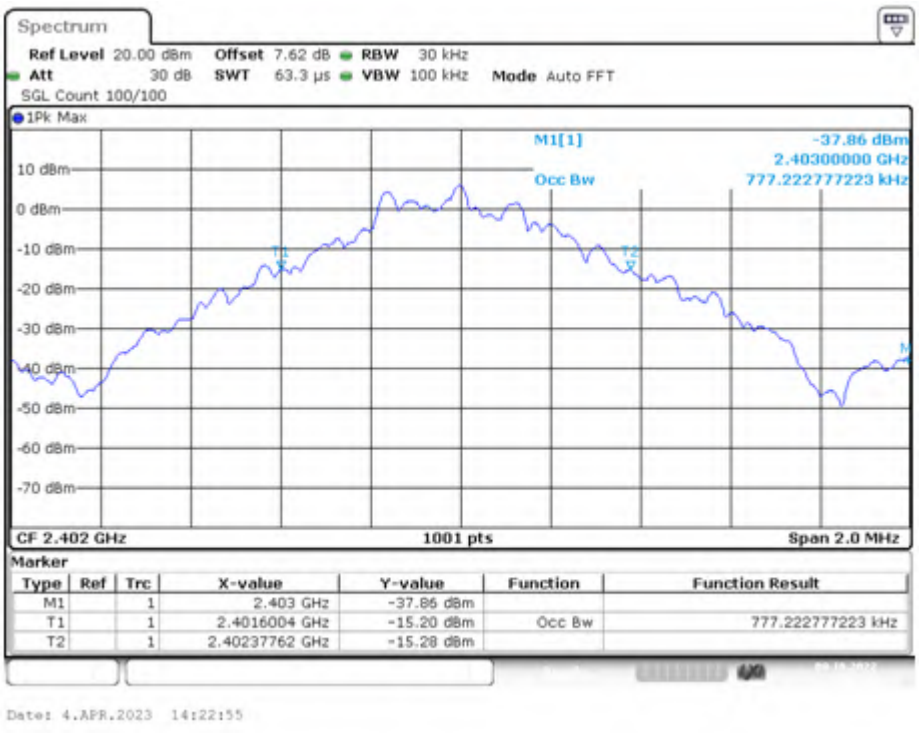
4.2.2 Test Setup Diagram:



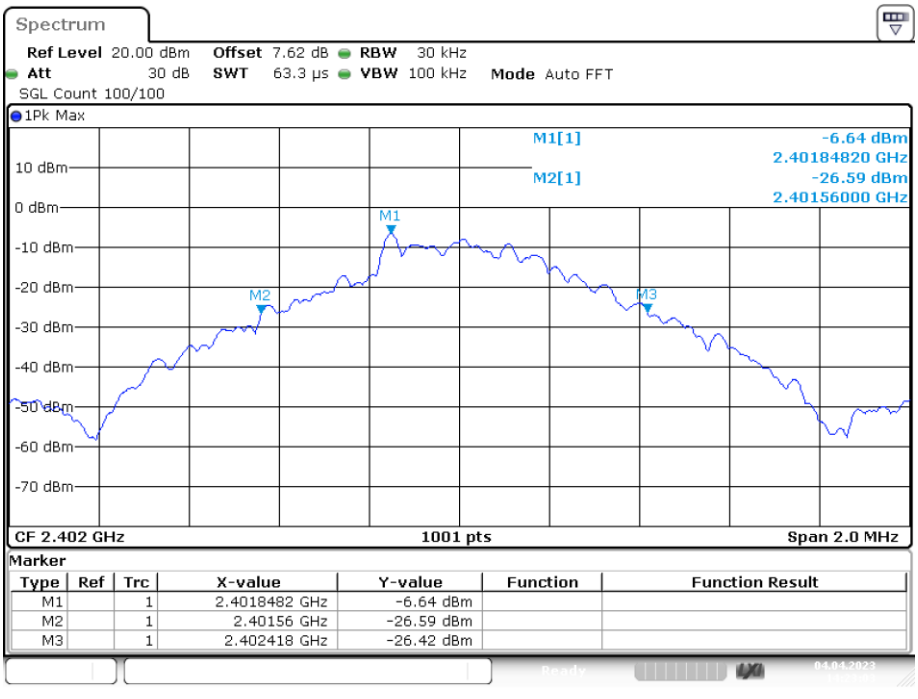
4.2.3 Test Result:

Condition	Mode	Frequency (MHz)	Antenna	99% OBW (MHz)	-20 dB Bandwidth (MHz)	Limit -20 dB Bandwidth (MHz)	Verdict
NVNT	1-DH1	2402	Ant 1	0.777	0.858	/	Pass
NVNT	1-DH1	2441	Ant 1	0.823	0.884	/	Pass
NVNT	1-DH1	2480	Ant 1	0.821	0.882	/	Pass
NVNT	2-DH1	2402	Ant 1	1.163	1.234	/	Pass
NVNT	2-DH1	2441	Ant 1	1.167	1.236	/	Pass
NVNT	2-DH1	2480	Ant 1	1.159	1.198	/	Pass
NVNT	3-DH1	2402	Ant 1	1.153	1.21	/	Pass
NVNT	3-DH1	2441	Ant 1	1.143	1.208	/	Pass
NVNT	3-DH1	2480	Ant 1	1.157	1.206	/	Pass

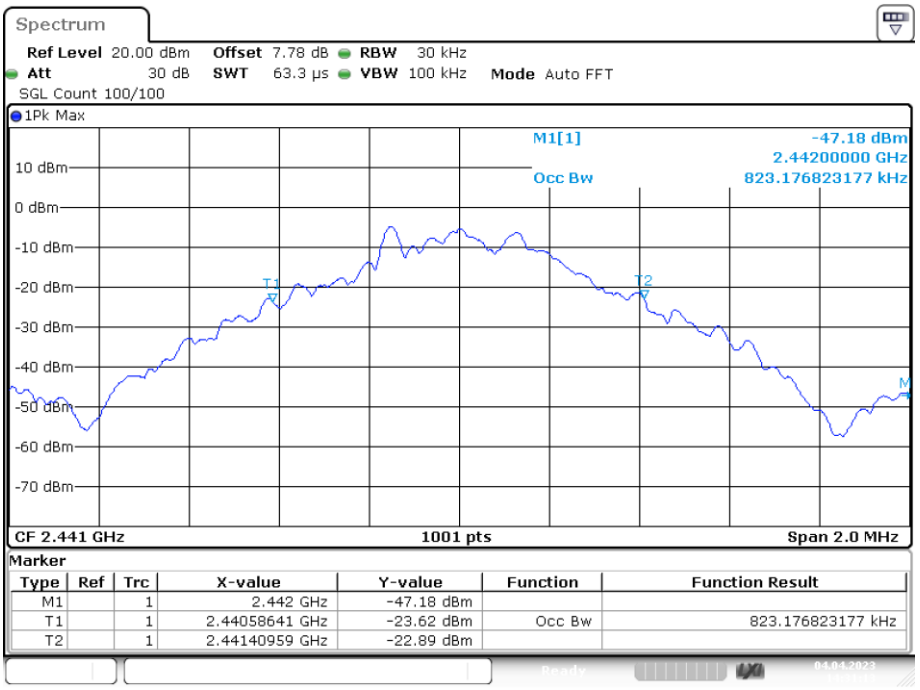
OBW NVNT 1-DH1 2402MHz Ant1



-20dB Bandwidth NVNT 1-DH1 2402MHz Ant1



OBW NVNT 1-DH1 2441MHz Ant1



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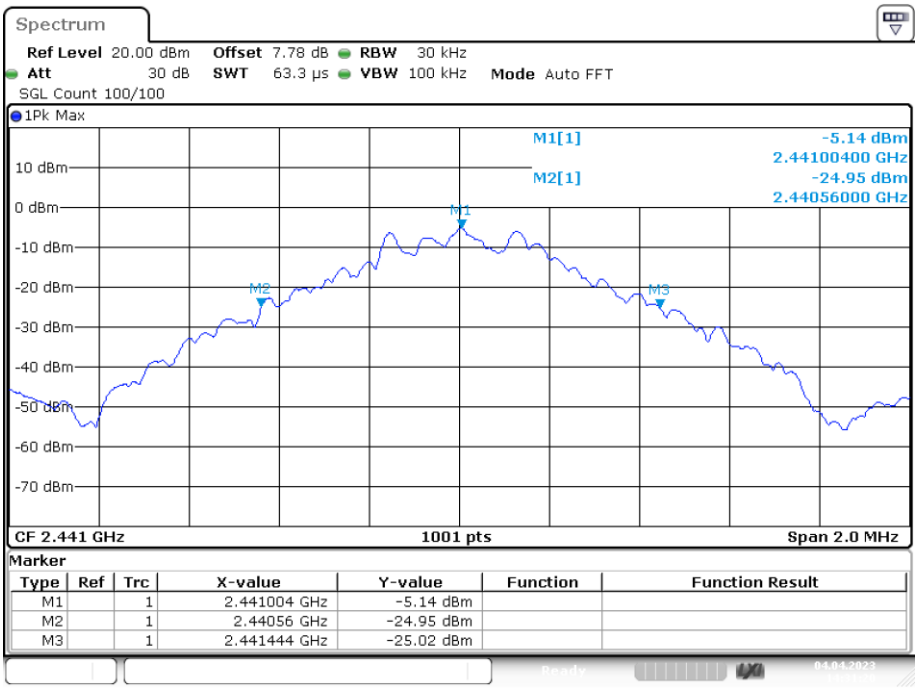

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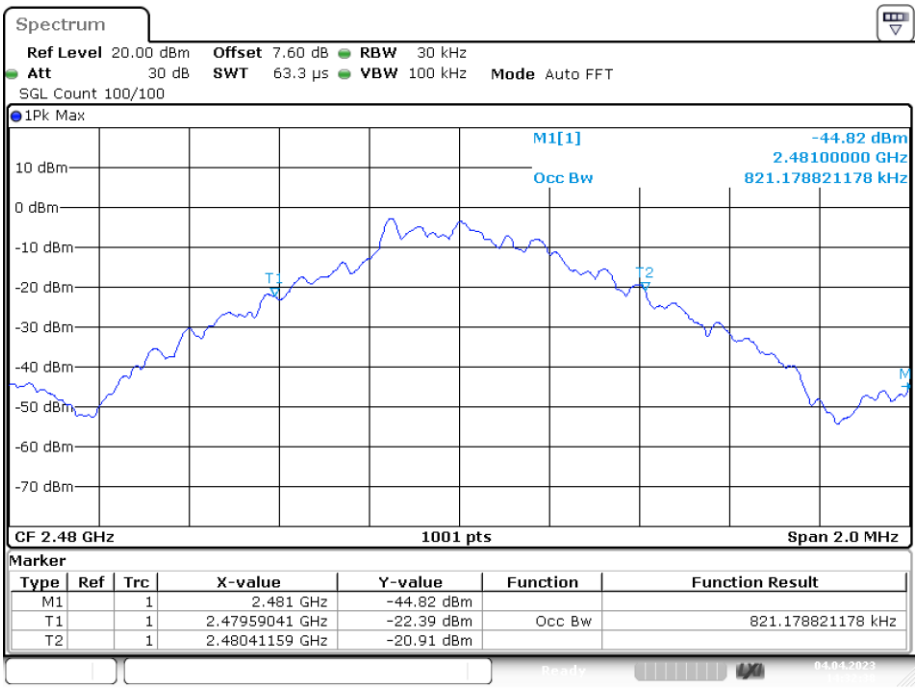

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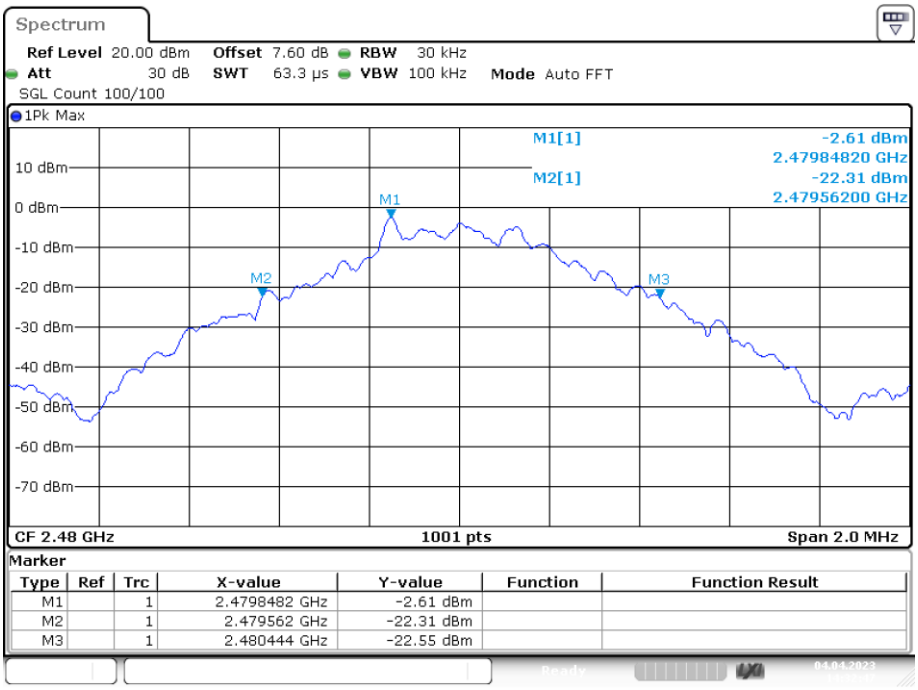

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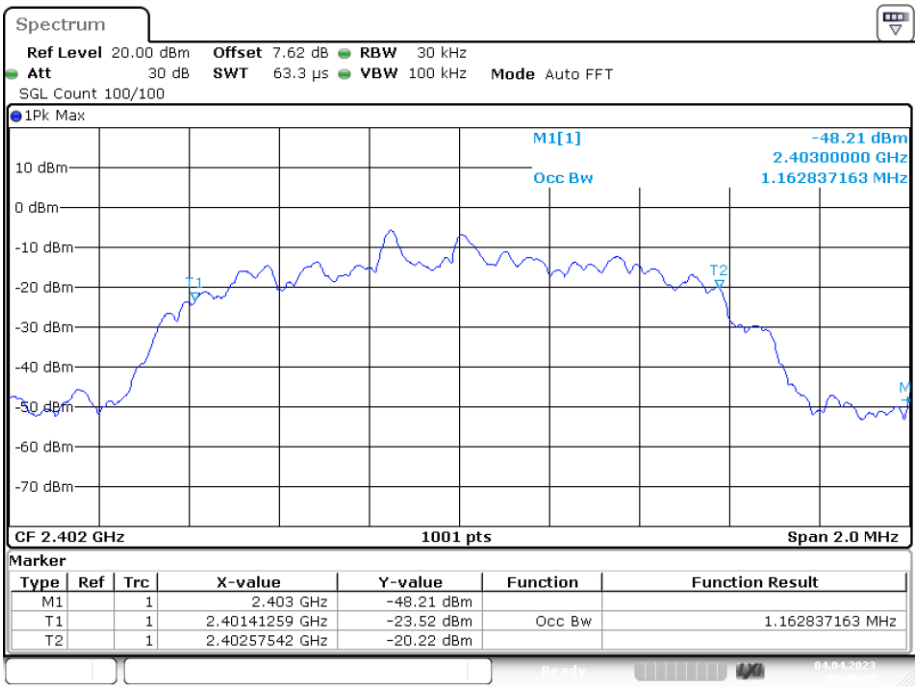

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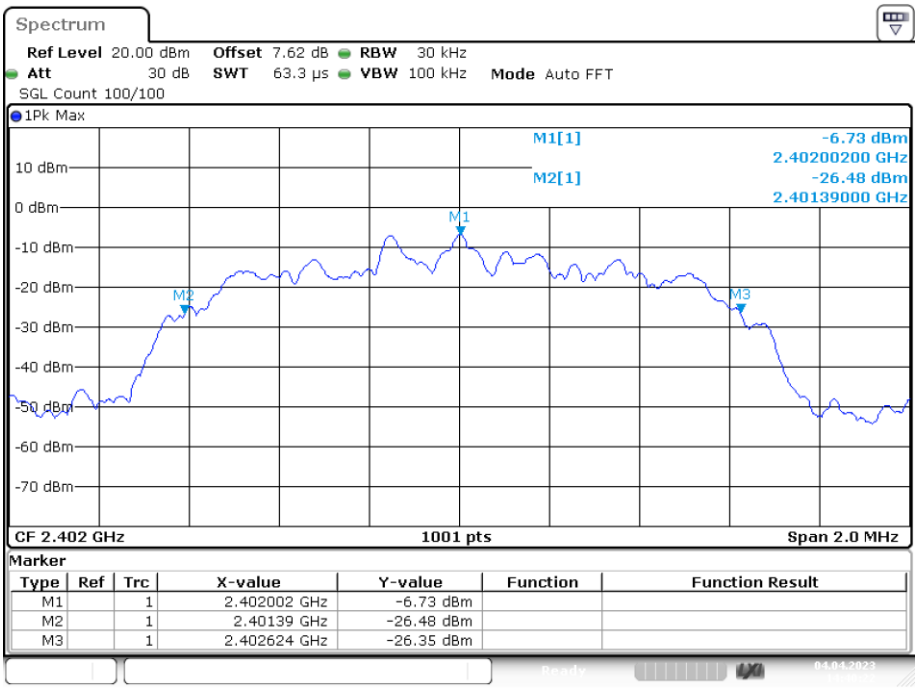

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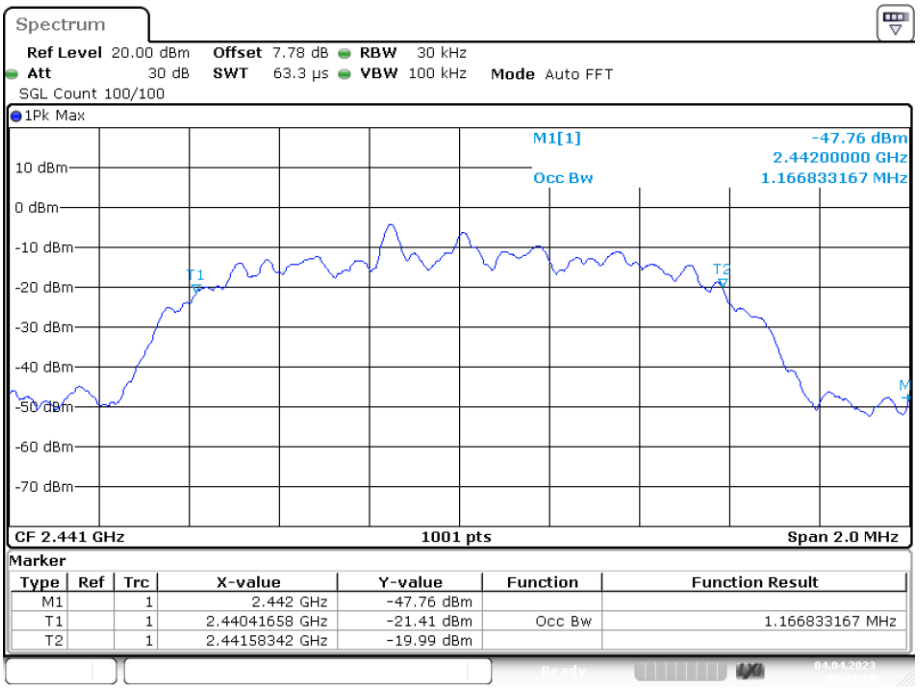

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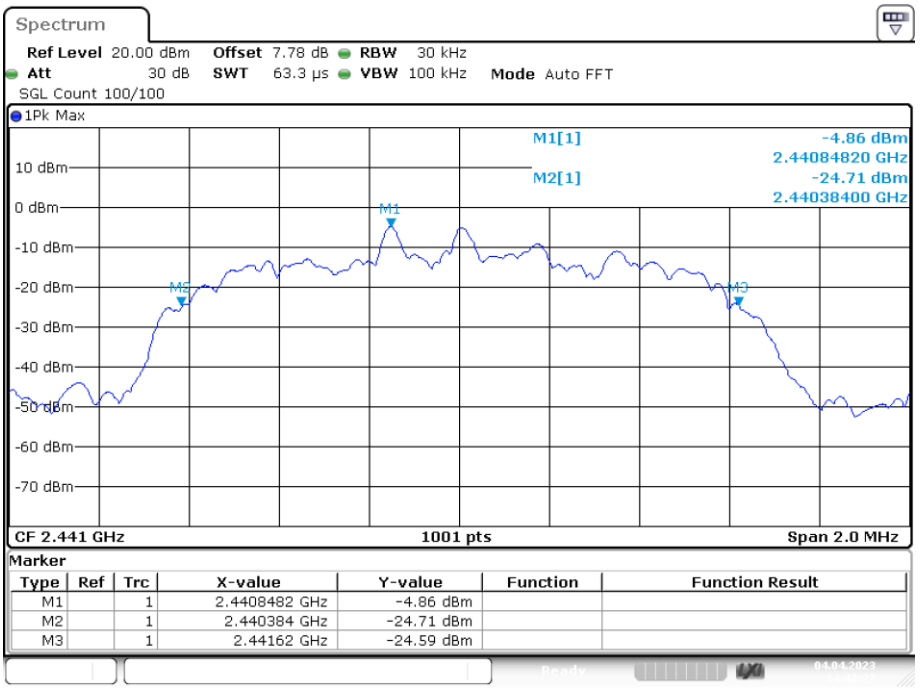
-20dB Bandwidth NVNT 2-DH1 2441MHz Ant1



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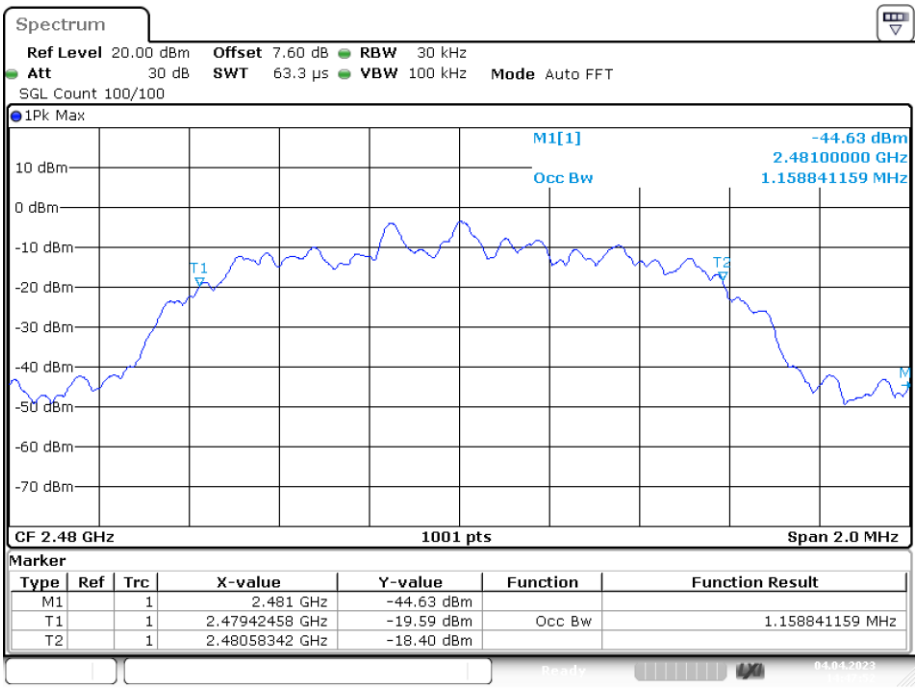

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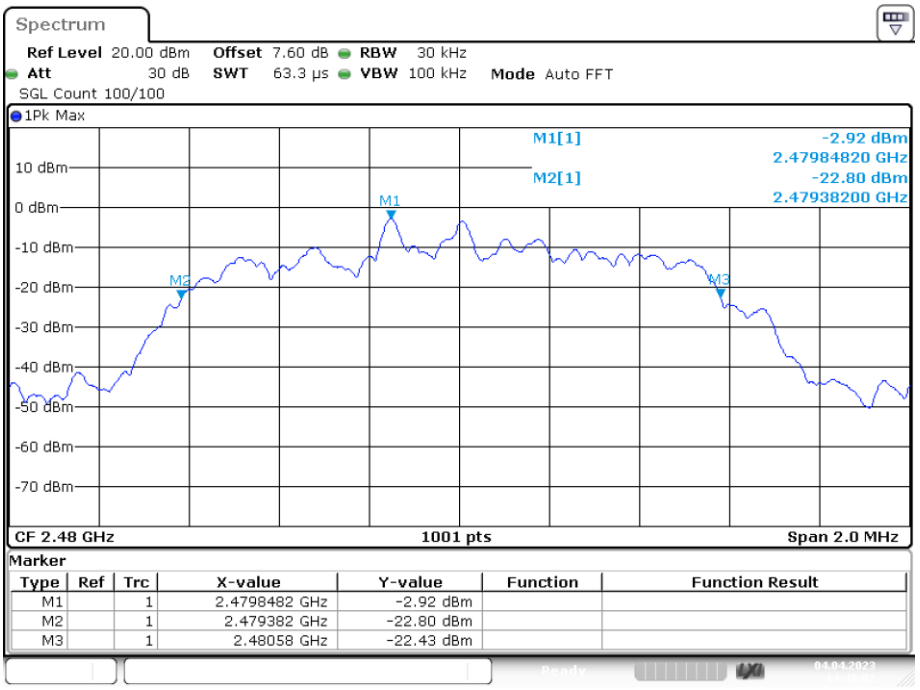

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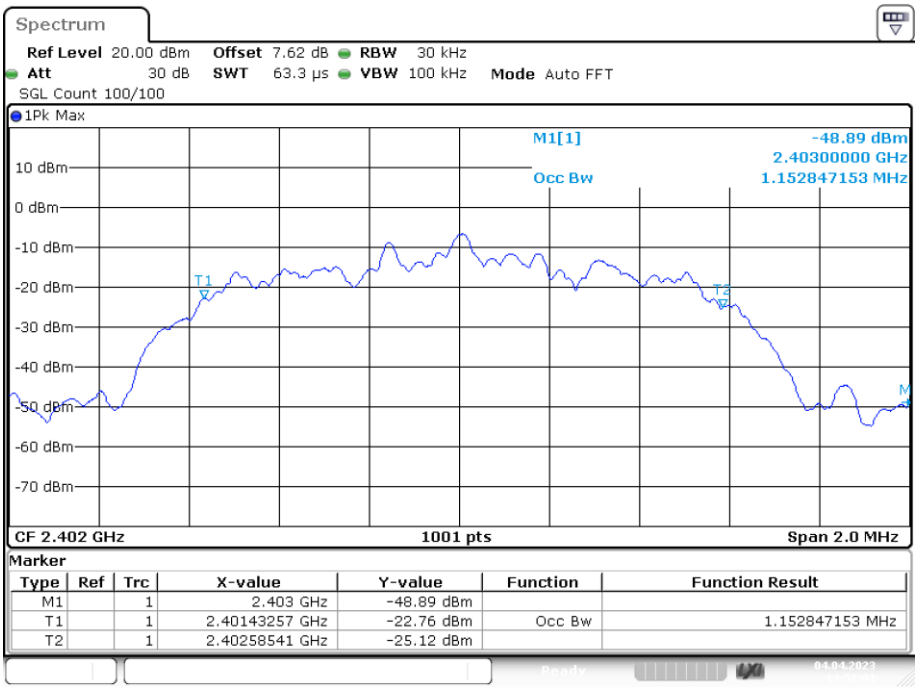

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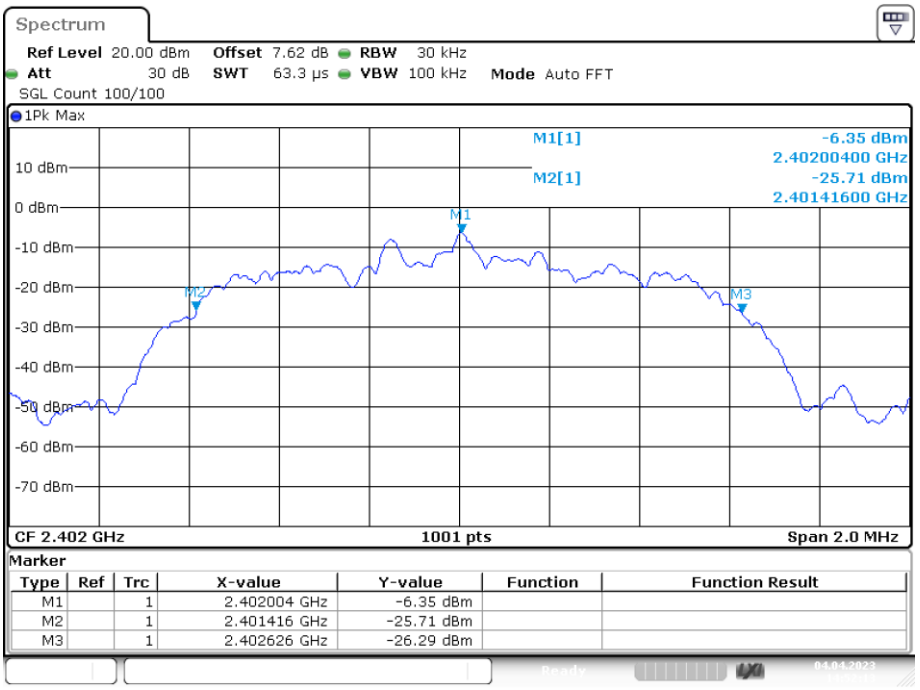

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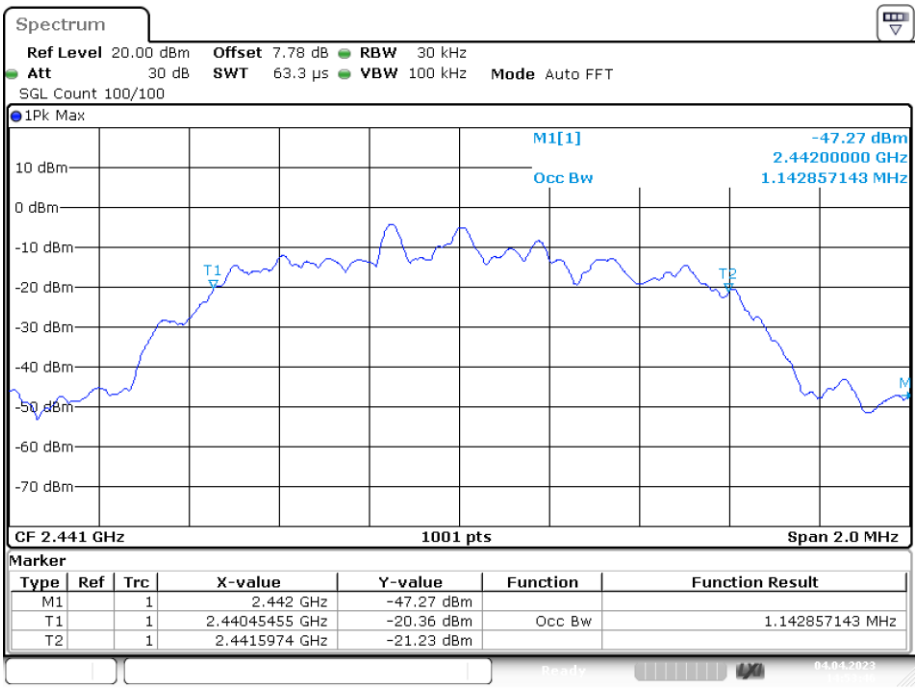

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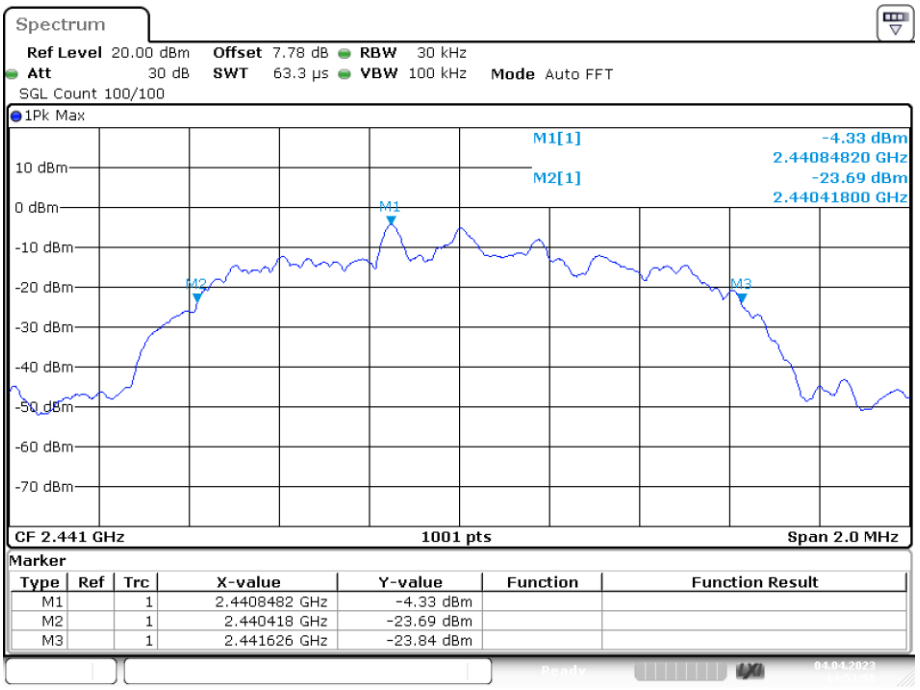
-20dB Bandwidth NVNT 3-DH1 2441MHz Ant1



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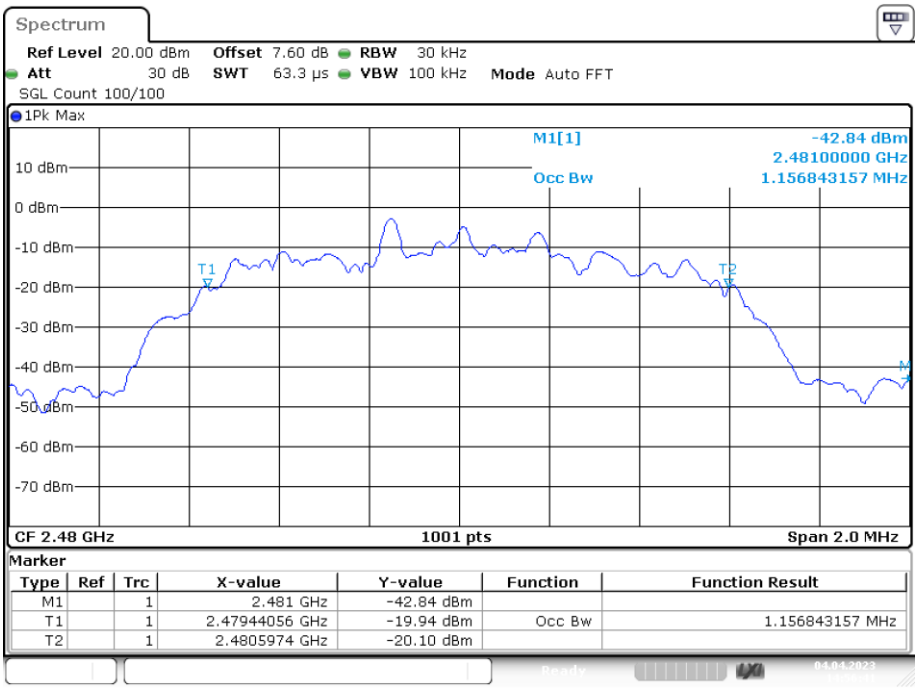
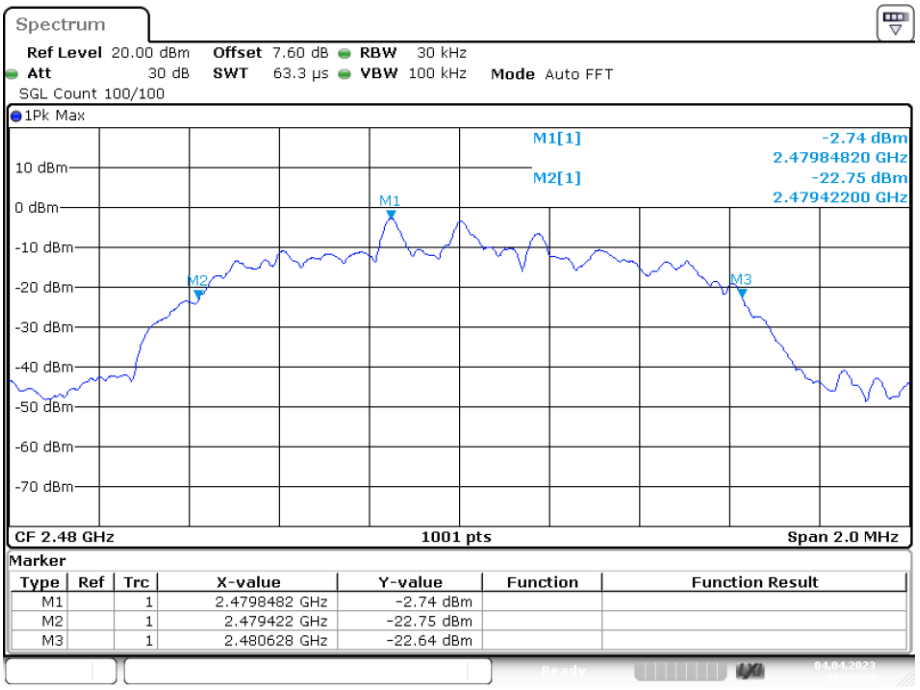
OBW NVNT 3-DH1 2480MHz Ant1



Date: 4.APR.2023 14:56:41

-20dB Bandwidth NVNT 3-DH1 2480MHz Ant1



Date: 4.APR.2023 14:56:53

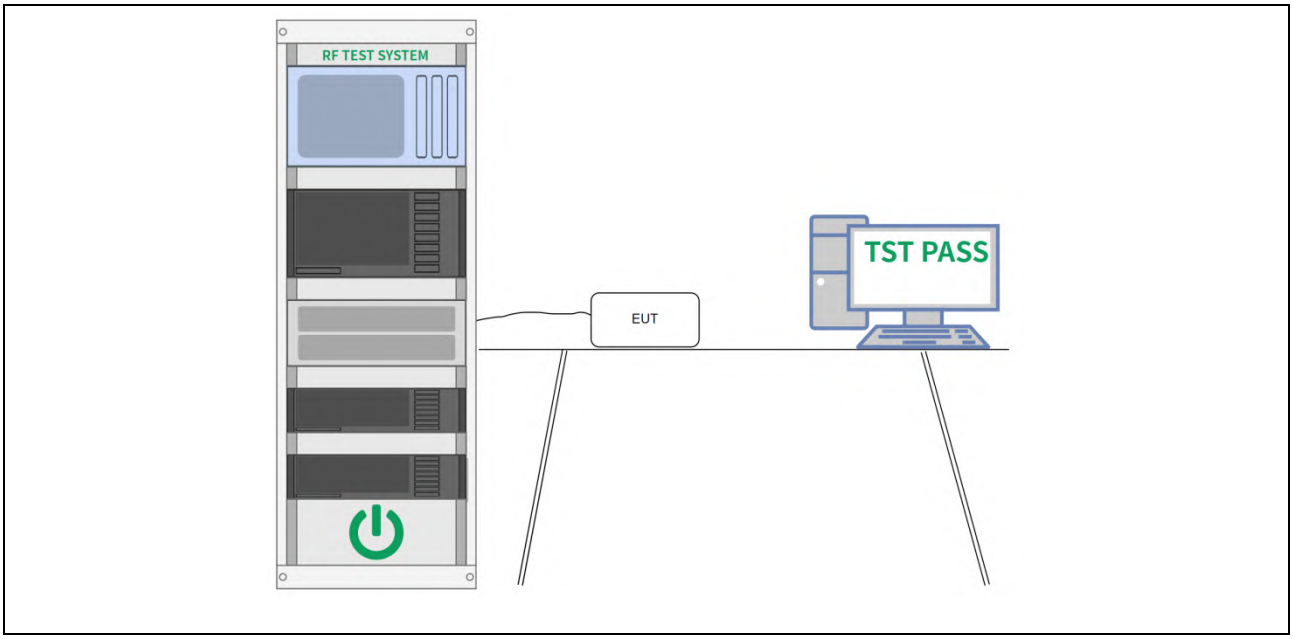
4.3 Maximum Conducted Output Power

Test Requirement:	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.
Test Limit:	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.
Test Method:	Output power test procedure for frequency-hopping spread-spectrum (FHSS) devices
Procedure:	This is an RF-conducted test to evaluate maximum peak output power. Use a direct connection between the antenna port of the unlicensed wireless device and the spectrum analyzer, through suitable attenuation. The hopping shall be disabled for this test: a) Use the following spectrum analyzer settings: 1) Span: Approximately five times the 20 dB bandwidth, centered on a hopping channel. 2) RBW > 20 dB bandwidth of the emission being measured. 3) VBW >= RBW. 4) Sweep: Auto. 5) Detector function: Peak. 6) Trace: Max hold. b) Allow trace to stabilize. c) Use the marker-to-peak function to set the marker to the peak of the emission. d) The indicated level is the peak output power, after any corrections for external attenuators and cables. e) A plot of the test results and setup description shall be included in the test report. NOTE—A peak responding power meter may be used, where the power meter and sensor system video bandwidth is greater than the occupied bandwidth of the unlicensed wireless device, rather than a spectrum analyzer.

4.3.1 E.U.T. Operation:

Operating Environment:					
Temperature:	23.8 °C	Humidity:	54.2 %	Atmospheric Pressure:	101.6 kPa
Pre test mode:	TX-GFSK(hopping off), TX-Pi/4DQPSK (hopping off), TX-8DPSK (hopping off)				
Final test mode:	TX-GFSK(hopping off), TX-Pi/4DQPSK (hopping off), TX-8DPSK (hopping off)				

4.3.2 Test Setup Diagram:



4.3.3 Test Result:

Condition	Mode	Frequency (MHz)	Antenna	Conducted Power (dBm)	Duty Factor (dB)	Limit (dBm)	Verdict
NVNT	1-DH1	2402	Ant1	-3.825	0	21	Pass
NVNT	1-DH1	2441	Ant1	-2.596	0	21	Pass
NVNT	1-DH1	2480	Ant1	-0.847	0	21	Pass
NVNT	1-DH3	2441	Ant1	-2.493	0	21	Pass
NVNT	1-DH5	2441	Ant1	-2.537	0	21	Pass
NVNT	2-DH1	2402	Ant1	-3.389	0	21	Pass
NVNT	2-DH1	2441	Ant1	-2.363	0	21	Pass
NVNT	2-DH1	2480	Ant1	-0.377	0	21	Pass
NVNT	2-DH3	2441	Ant1	-1.986	0	21	Pass
NVNT	2-DH5	2441	Ant1	-1.912	0	21	Pass
NVNT	3-DH1	2402	Ant1	-3.11	0	21	Pass
NVNT	3-DH1	2441	Ant1	-2.149	0	21	Pass
NVNT	3-DH1	2480	Ant1	-0.325	0	21	Pass
NVNT	3-DH3	2441	Ant1	-1.84	0	21	Pass
NVNT	3-DH5	2441	Ant1	-1.657	0	21	Pass

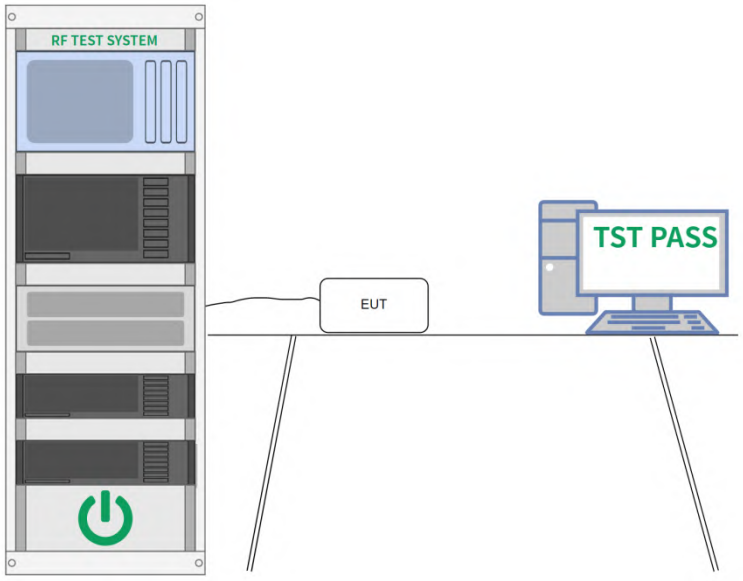
4.4 Channel Separation

Test Requirement:	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.
Test Limit:	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.
Test Method:	Carrier frequency separation
Procedure:	The EUT shall have its hopping function enabled. Use the following spectrum analyzer settings: a) Span: Wide enough to capture the peaks of two adjacent channels. b) RBW: Start with the RBW set to approximately 30% of the channel spacing; adjust as necessary to best identify the center of each individual channel. c) Video (or average) bandwidth (VBW) ≥ RBW. d) Sweep: Auto. e) Detector function: Peak. f) Trace: Max hold. g) Allow the trace to stabilize. Use the marker-delta function to determine the separation between the peaks of the adjacent channels. Compliance of an EUT with the appropriate regulatory limit shall be determined. A plot of the data shall be included in the test report.

4.4.1 E.U.T. Operation:

Operating Environment:					
Temperature:	23.8 °C	Humidity:	54.2 %	Atmospheric Pressure:	101.6 kPa
Pre test mode:	TX-GFSK(hopping on), TX-Pi/4DQPSK (hopping on), TX-8DPSK (hopping on)				
Final test mode:	TX-GFSK(hopping on), TX-Pi/4DQPSK (hopping on), TX-8DPSK (hopping on)				

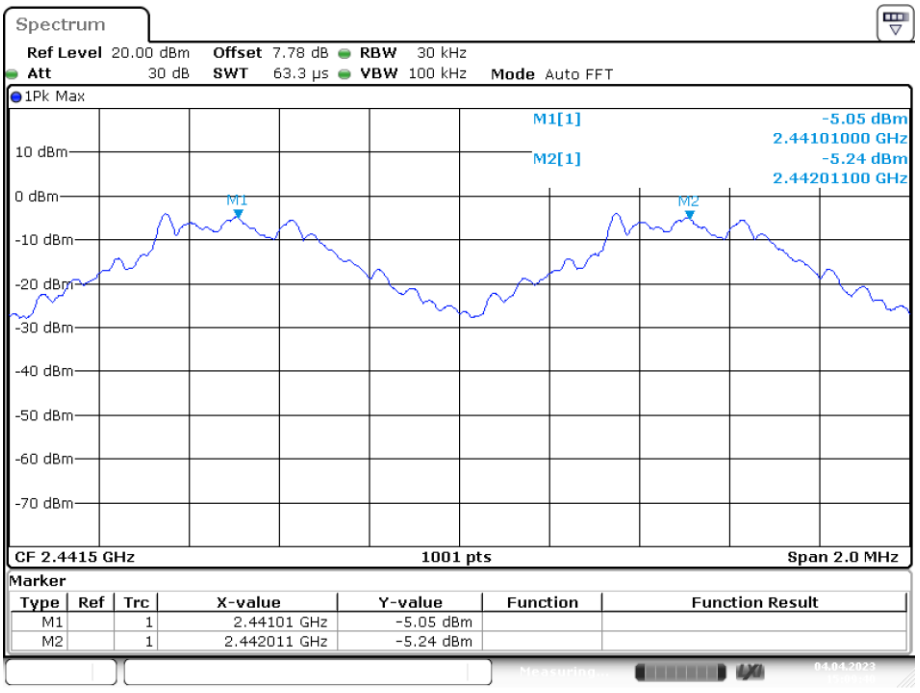
4.4.2 Test Setup Diagram:



4.4.3 Test Result:

Condition	Mode	Antenna	Hopping Freq1 (MHz)	Hopping Freq2 (MHz)	HFS (MHz)	Limit (MHz)	Verdict
NVNT	1-DH1	Ant1	2441.01	2442.011	1.001	0.884	Pass
NVNT	2-DH1	Ant1	2440.848	2441.848	1	0.824	Pass
NVNT	3-DH1	Ant1	2440.848	2441.848	1	0.805	Pass

CFS NVNT 1-DH1 2441MHz Ant1



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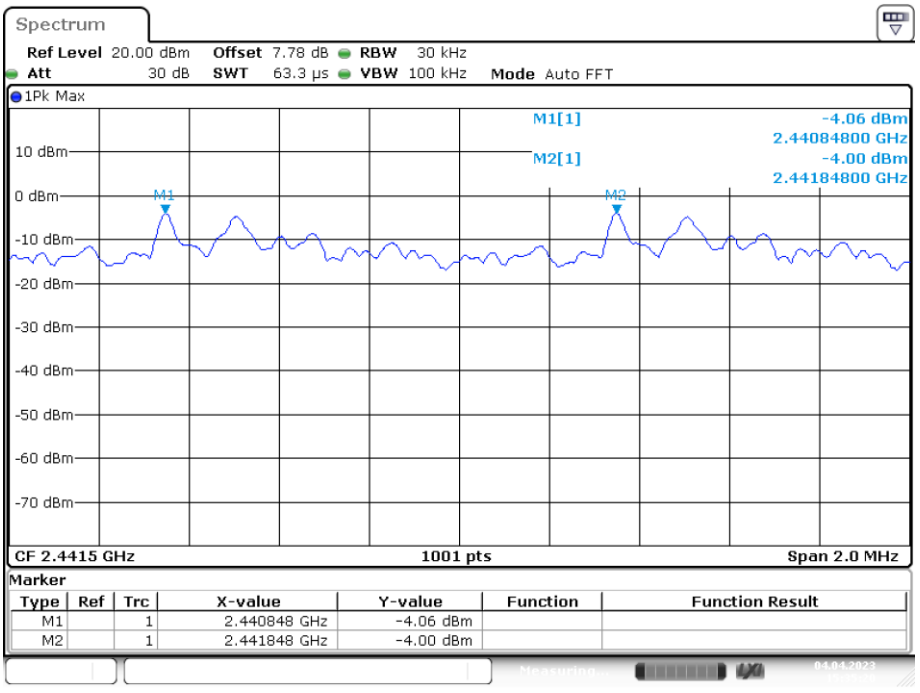
CFS NVNT 2-DH1 2441MHz Ant1



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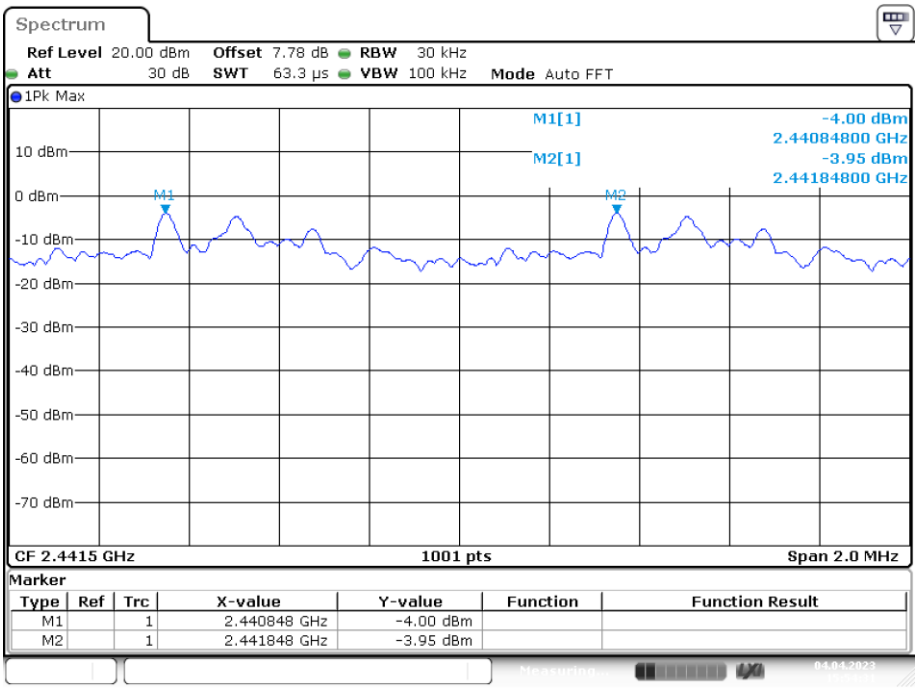
CFS NVNT 3-DH1 2441MHz Ant1



Date: 4.APR.2023 15:54:30

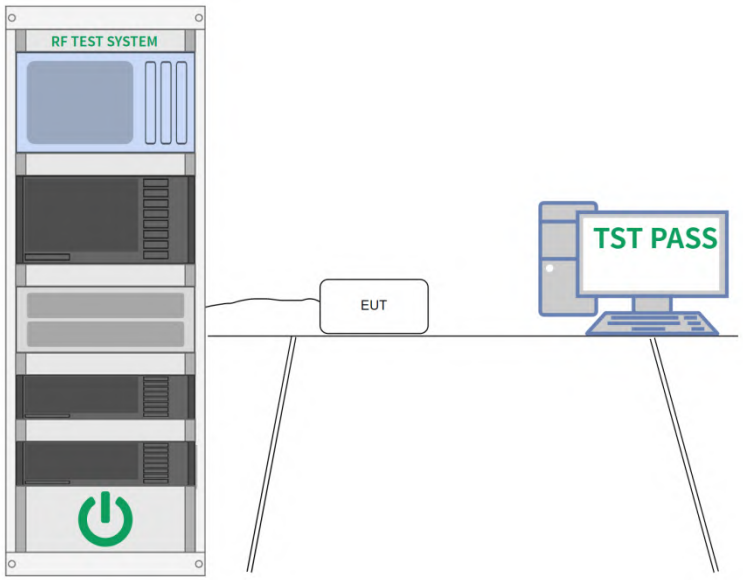
4.5 Number of Hopping Frequencies

Test Requirement:	Fequency hopping systems in the 2400-2483.5 MHz band shall use at least 15 channels. 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. Frequency hopping systems may avoid or suppress transmissions on a particular hopping frequency provided that a minimum of 15 channels are used.
Test Limit:	Fequency hopping systems in the 2400-2483.5 MHz band shall use at least 15 channels. 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. Frequency hopping systems may avoid or suppress transmissions on a particular hopping frequency provided that a minimum of 15 channels are used.
Test Method:	Number of hopping frequencies
Procedure:	The EUT shall have its hopping function enabled. Use the following spectrum analyzer settings: a) Span: The frequency band of operation. Depending on the number of channels the device supports, it may be necessary to divide the frequency range of operation across multiple spans, to allow the individual channels to be clearly seen. b) RBW: To identify clearly the individual channels, set the RBW to less than 30% of the channel spacing or the 20 dB bandwidth, whichever is smaller. c) VBW ≥ RBW. d) Sweep: Auto. e) Detector function: Peak. f) Trace: Max hold. g) Allow the trace to stabilize. It might prove necessary to break the span up into subranges to show clearly all of the hopping frequencies. Compliance of an EUT with the appropriate regulatory limit shall be determined for the number of hopping channels. A plot of the data shall be included in the test report.

4.5.1 E.U.T. Operation:

Operating Environment:					
Temperature:	23.8 °C	Humidity:	54.2 %	Atmospheric Pressure:	101.6 kPa
Pre test mode:	TX-GFSK(hopping on), TX-Pi/4DQPSK (hopping on), TX-8DPSK (hopping on)				
Final test mode:	TX-GFSK(hopping on), TX-Pi/4DQPSK (hopping on), TX-8DPSK (hopping on)				

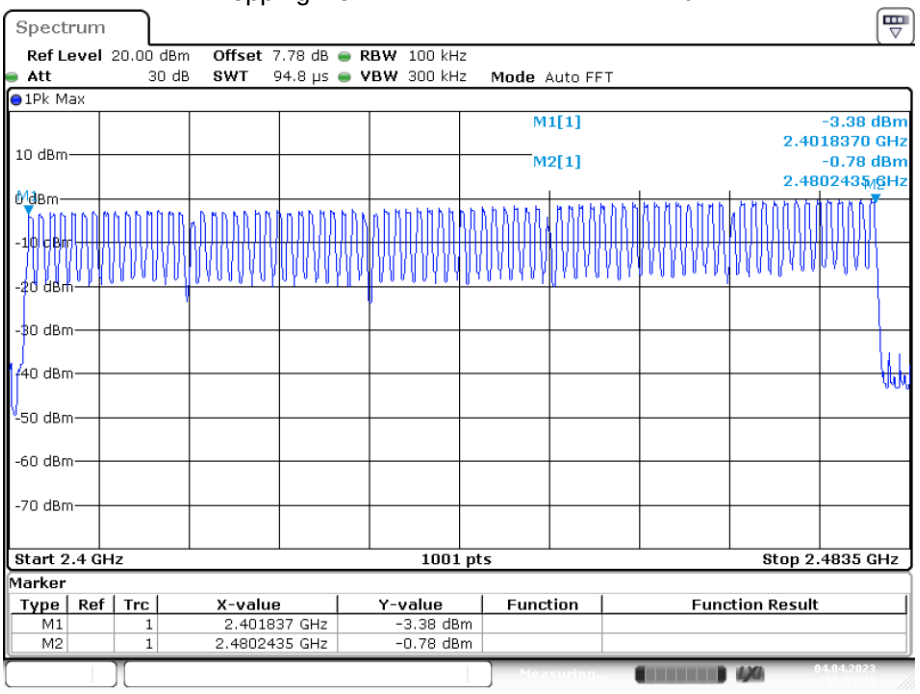
4.5.2 Test Setup Diagram:



4.5.3 Test Result:

Condition	Mode	Antenna	Hopping Number	Limit	Verdict
NVNT	1-DH1	Ant1	79	15	Pass
NVNT	2-DH1	Ant1	79	15	Pass
NVNT	3-DH1	Ant1	79	15	Pass

Hopping No. NVNT 1-DH1 2441MHz Ant1



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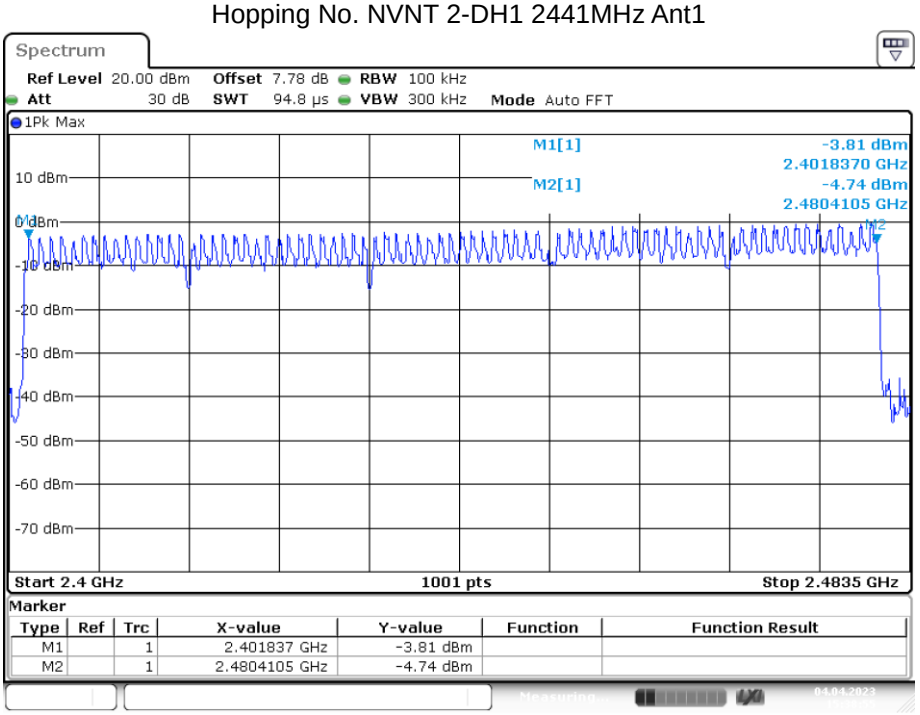
Hopping No. NVNT 2-DH1 2441MHz Ant1



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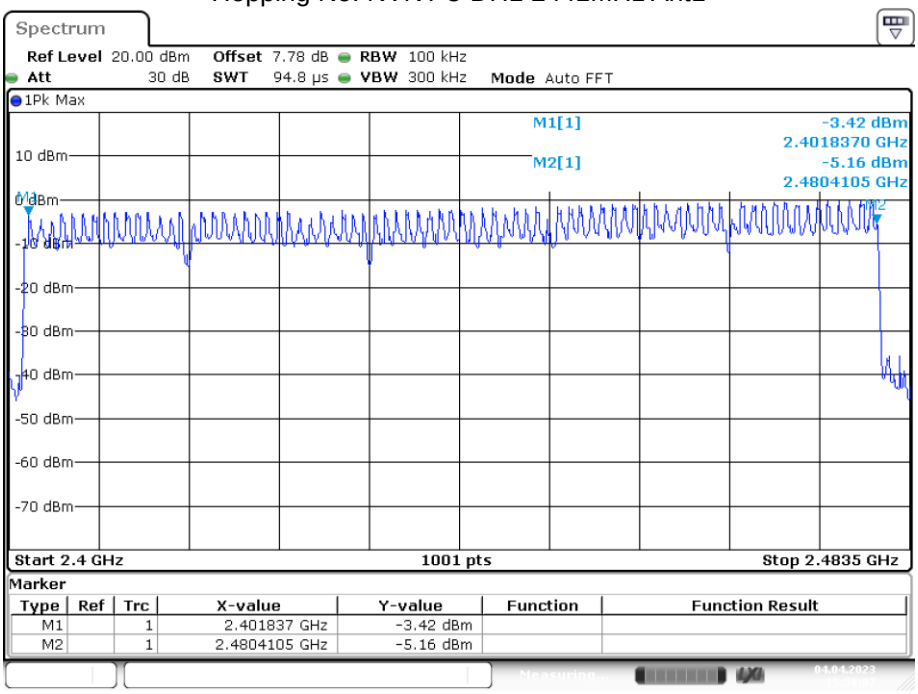
Hopping No. NVNT 3-DH1 2441MHz Ant1



Date: 4.APR.2023 15:58:07

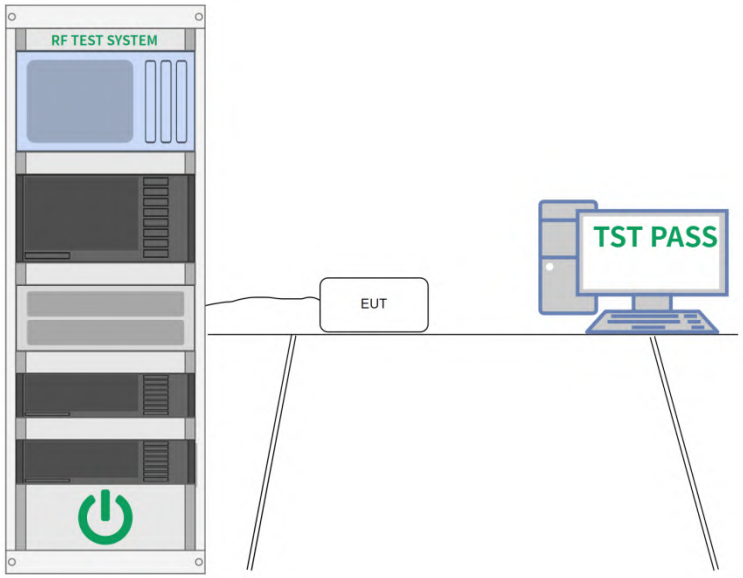
4.6 Dwell Time

Test Requirement:	Fequency hopping systems in the 2400-2483.5 MHz band shall use at least 15 channels. 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. Frequency hopping systems may avoid or suppress transmissions on a particular hopping frequency provided that a minimum of 15 channels are used.
Test Limit:	Fequency hopping systems in the 2400-2483.5 MHz band shall use at least 15 channels. 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. Frequency hopping systems may avoid or suppress transmissions on a particular hopping frequency provided that a minimum of 15 channels are used.
Test Method:	Time of occupancy (dwell time)
Procedure:	The EUT shall have its hopping function enabled. Use the following spectrum analyzer settings: a) Span: Zero span, centered on a hopping channel. b) RBW shall be <= channel spacing and where possible RBW should be set >> 1 / T, where T is the expected dwell time per channel. c) 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. d) Detector function: Peak. e) 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. Repeat the measurement using a longer sweep time to determine the number of hops over the period specified in the requirements. The sweep time shall be equal to, or less than, the period specified in the requirements. Determine the number of hops over the sweep time and calculate the total number of hops in the period specified in the requirements, using the following equation: (Number of hops in the period specified in the requirements) = (number of hops on spectrum analyzer) × (period specified in the requirements / analyzer sweep time) The average time of occupancy is calculated from the transmit time per hop multiplied by the number of hops in the period specified in the requirements. If the number of hops in a specific time varies with different modes of operation (data rate, modulation format, number of hopping channels, etc.), then repeat this test for each variation. The measured transmit time and time between hops shall be consistent with the values described in the operational description for the EUT.

4.6.1 E.U.T. Operation:

Operating Environment:					
Temperature:	23.8 °C	Humidity:	54.2 %	Atmospheric Pressure:	101.6 kPa
Pre test mode:	TX-GFSK(hopping on), TX-Pi/4DQPSK (hopping on), TX-8DPSK (hopping on)				
Final test mode:	TX-GFSK(hopping on), TX-Pi/4DQPSK (hopping on), TX-8DPSK (hopping on)				

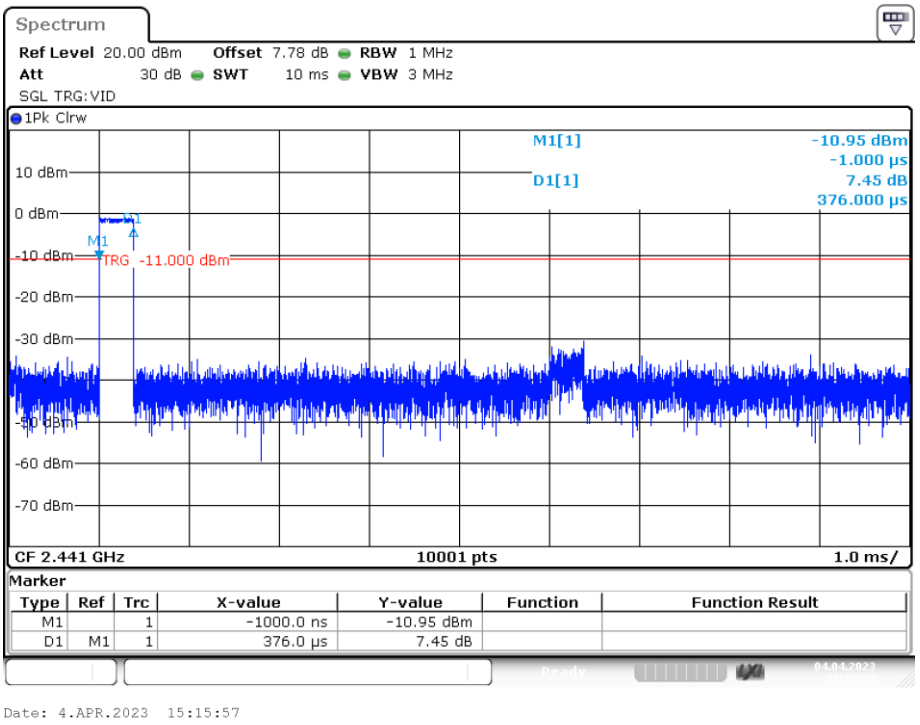
4.6.2 Test Setup Diagram:



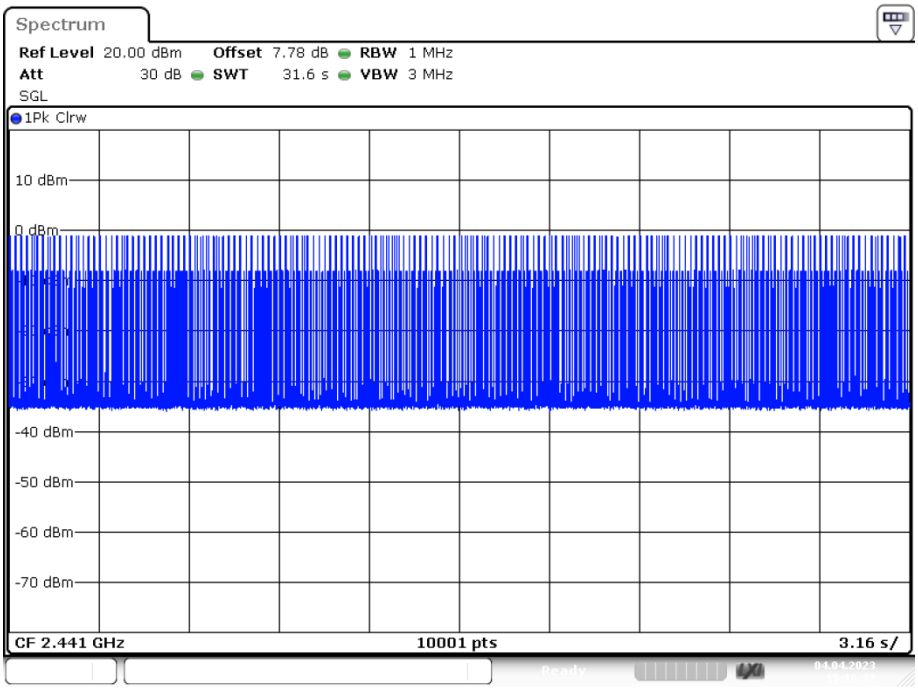
4.6.3 Test Result:

Condition	Mode	Frequency (MHz)	Antenna	Pulse Time (ms)	Total Dwell Time (ms)	Period Time (ms)	Limit (ms)	Verdict
NVNT	1-DH1	2441	Ant1	0.376	120.320	31600	400	Pass
NVNT	1-DH3	2441	Ant1	1.631	260.960	31600	400	Pass
NVNT	1-DH5	2441	Ant1	2.879	307.093	31600	400	Pass
NVNT	2-DH1	2441	Ant1	0.385	123.200	31600	400	Pass
NVNT	2-DH3	2441	Ant1	1.637	261.920	31600	400	Pass
NVNT	2-DH5	2441	Ant1	2.878	306.987	31600	400	Pass
NVNT	3-DH1	2441	Ant1	0.387	123.840	31600	400	Pass
NVNT	3-DH3	2441	Ant1	1.637	261.920	31600	400	Pass
NVNT	3-DH5	2441	Ant1	2.886	307.840	31600	400	Pass

Dwell NVNT 1-DH1 2441MHz Ant1 One Burst



Dwell NVNT 1-DH1 2441MHz Ant1 Accumulated



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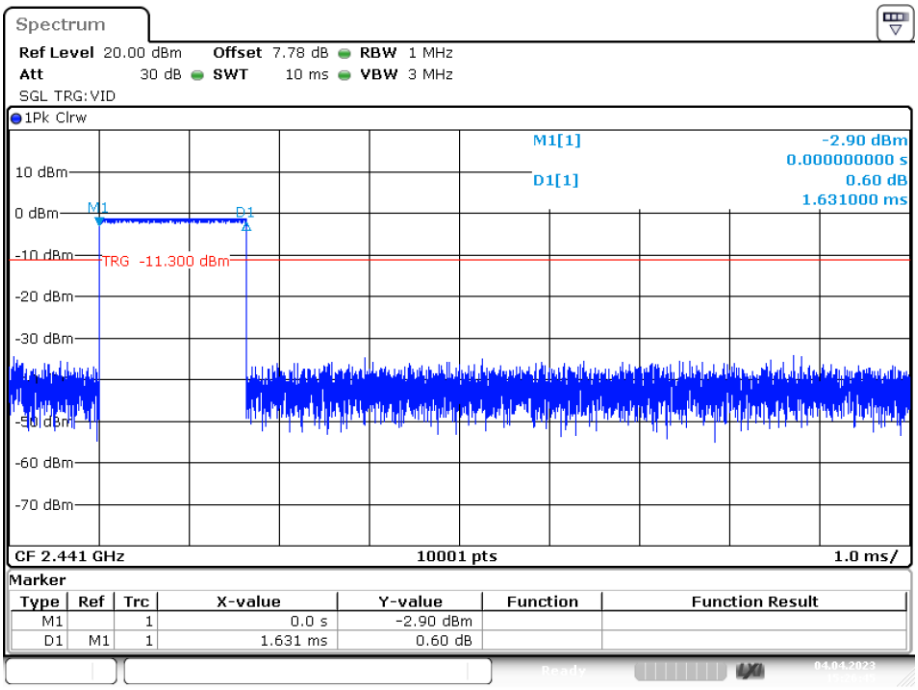
Dwell NVNT 1-DH3 2441MHz Ant1 One Burst



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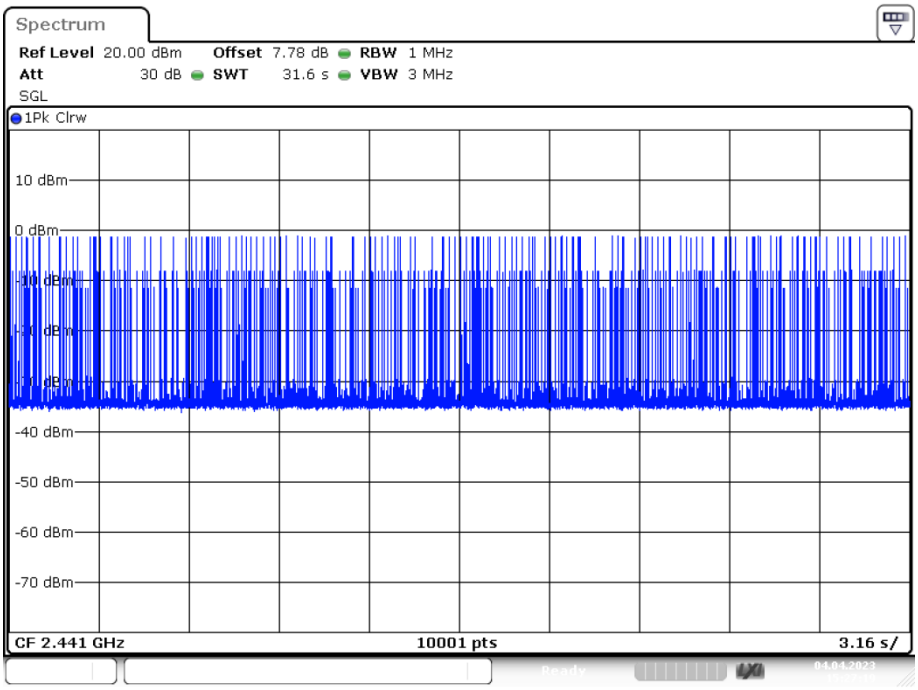
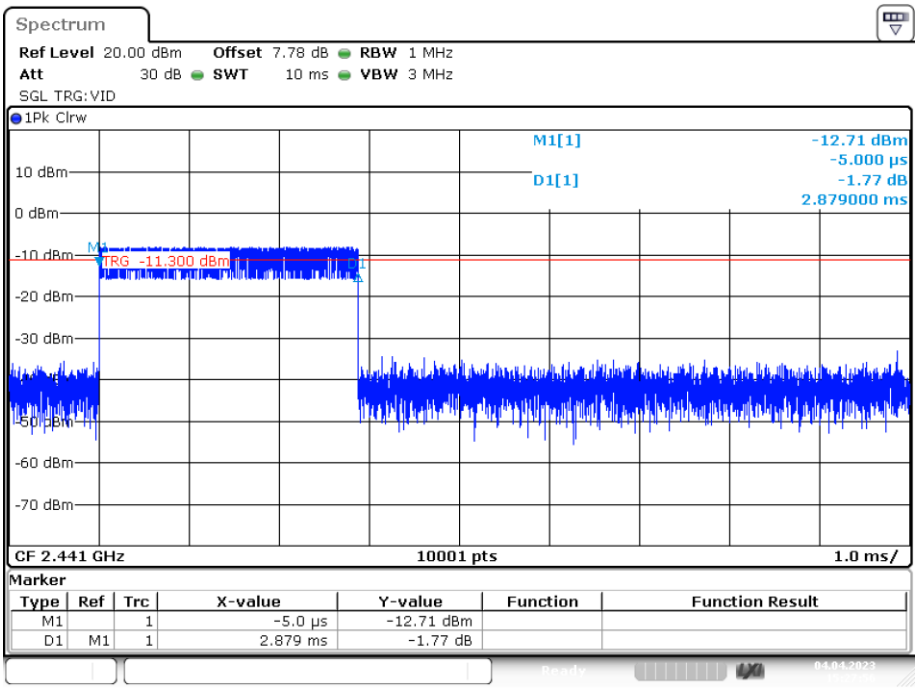
Dwell NVNT 1-DH3 2441MHz Ant1 Accumulated



Date: 4.APR.2023 15:27:19

Dwell NVNT 1-DH5 2441MHz Ant1 One Burst



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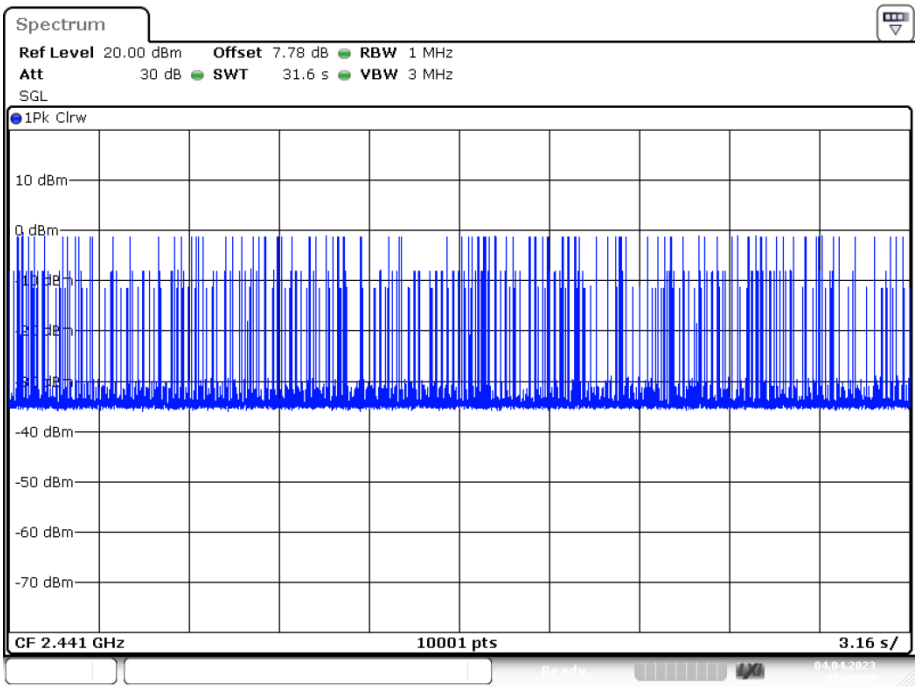
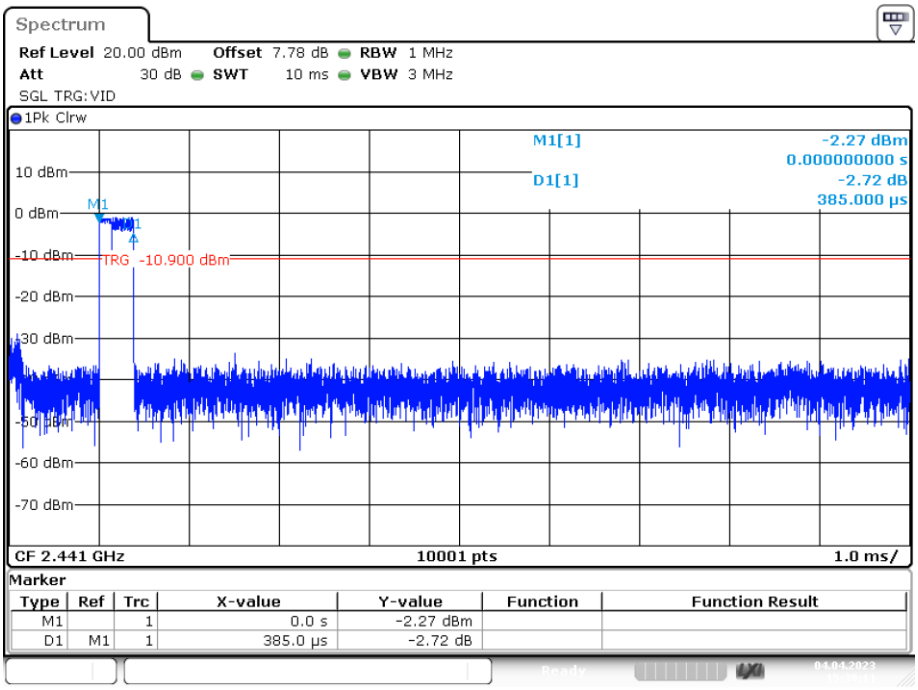
Dwell NVNT 1-DH5 2441MHz Ant1 Accumulated



Date: 4.APR.2023 15:28:30

Dwell NVNT 2-DH1 2441MHz Ant1 One Burst

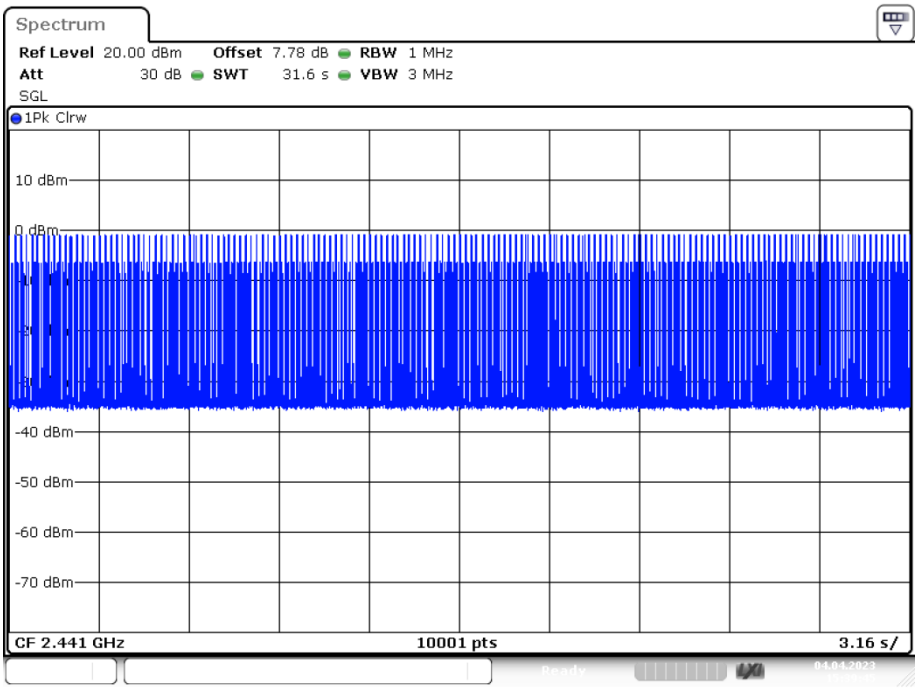


Marker

Type	Ref	Trc	X-value	Y-value	Function	Function Result
M1		1	0.0 s	-2.27 dBm		
D1	M1	1	385.0 µs	-2.72 dB		

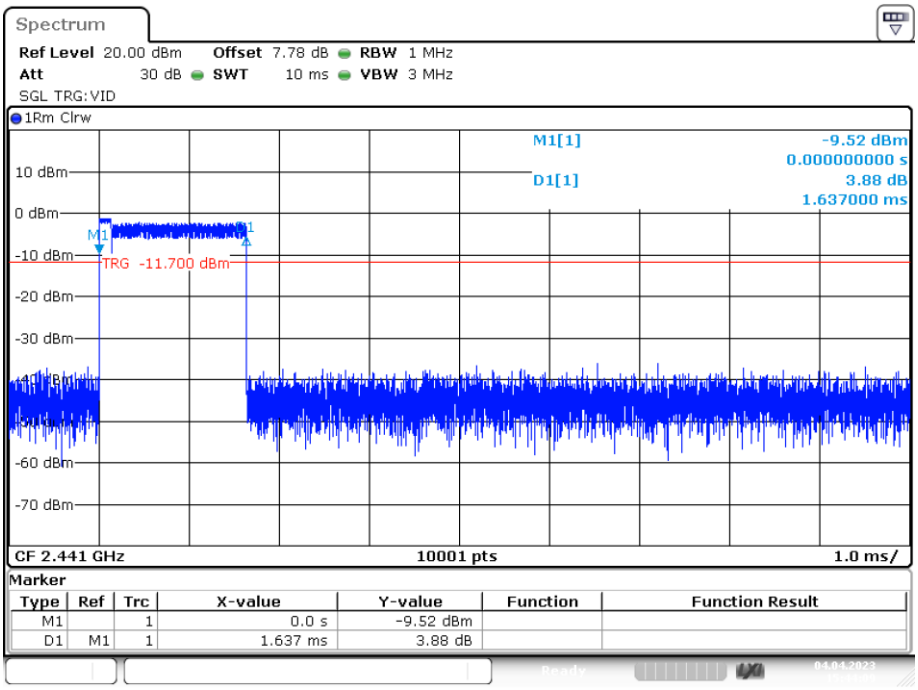
Date: 4.APR.2023 15:39:10

Dwell NVNT 2-DH1 2441MHz Ant1 Accumulated



Date: 4.APR.2023 15:39:45

Dwell NVNT 2-DH3 2441MHz Ant1 One Burst



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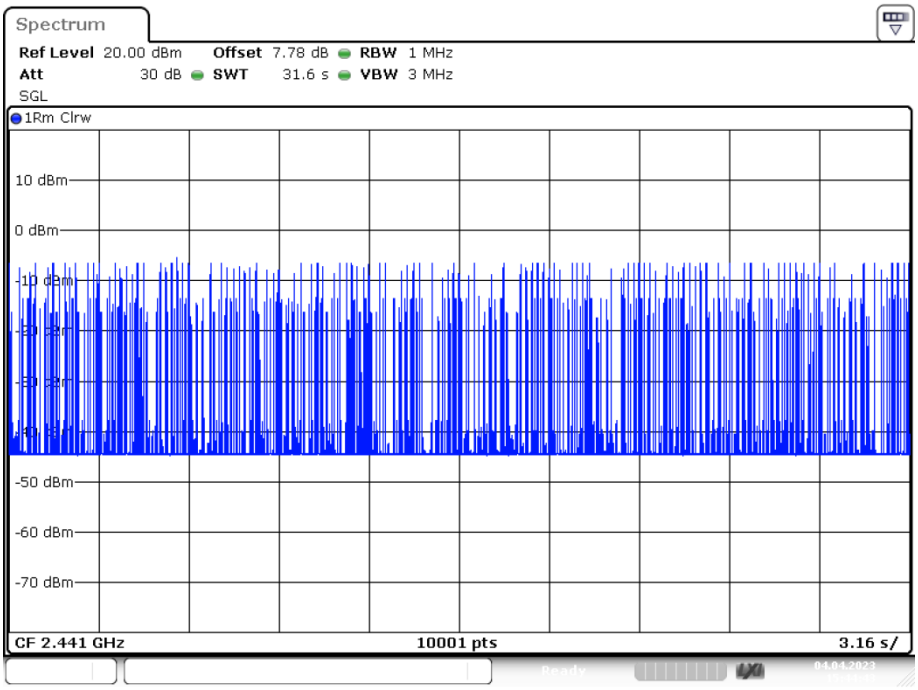
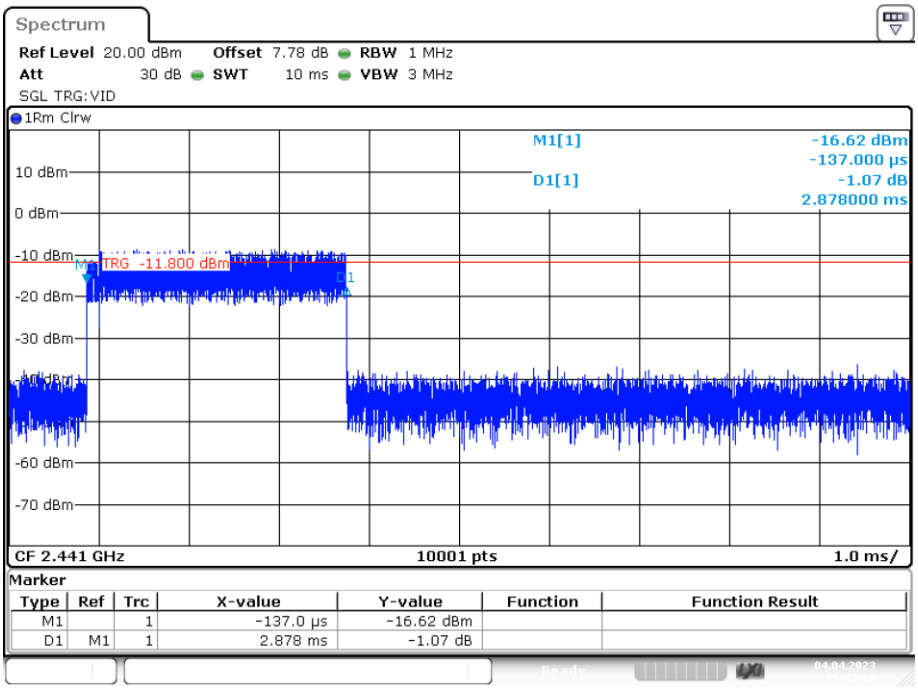
Dwell NVNT 2-DH3 2441MHz Ant1 Accumulated



Date: 4.APR.2023 15:44:43

Dwell NVNT 2-DH5 2441MHz Ant1 One Burst



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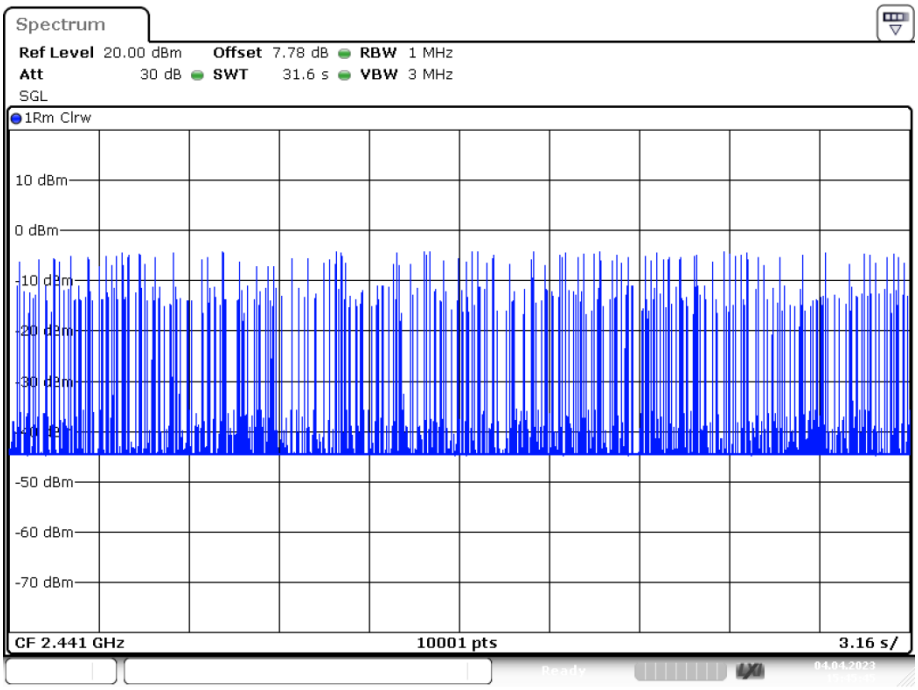
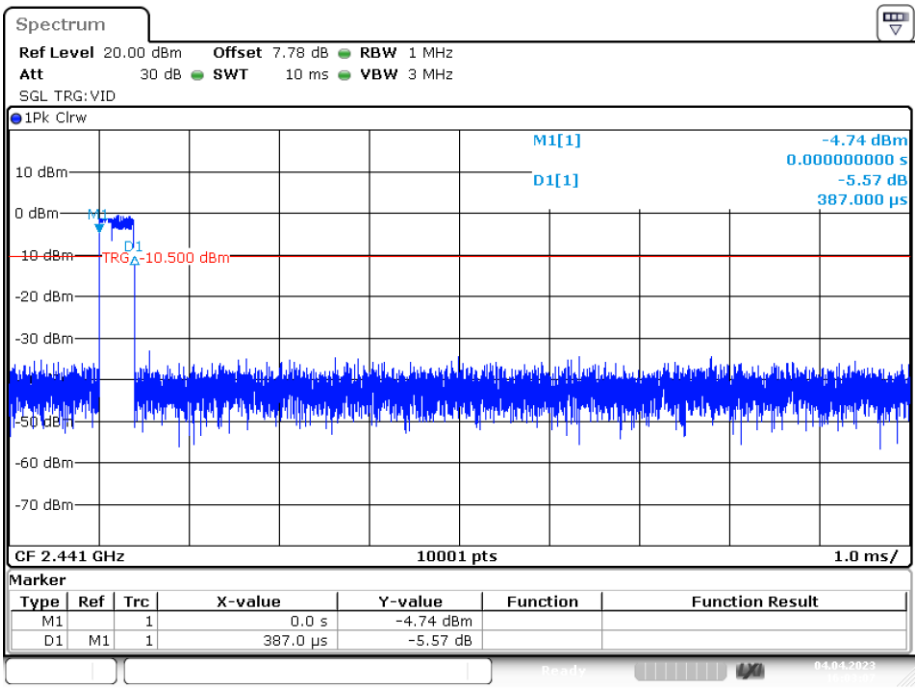
Dwell NVNT 2-DH5 2441MHz Ant1 Accumulated



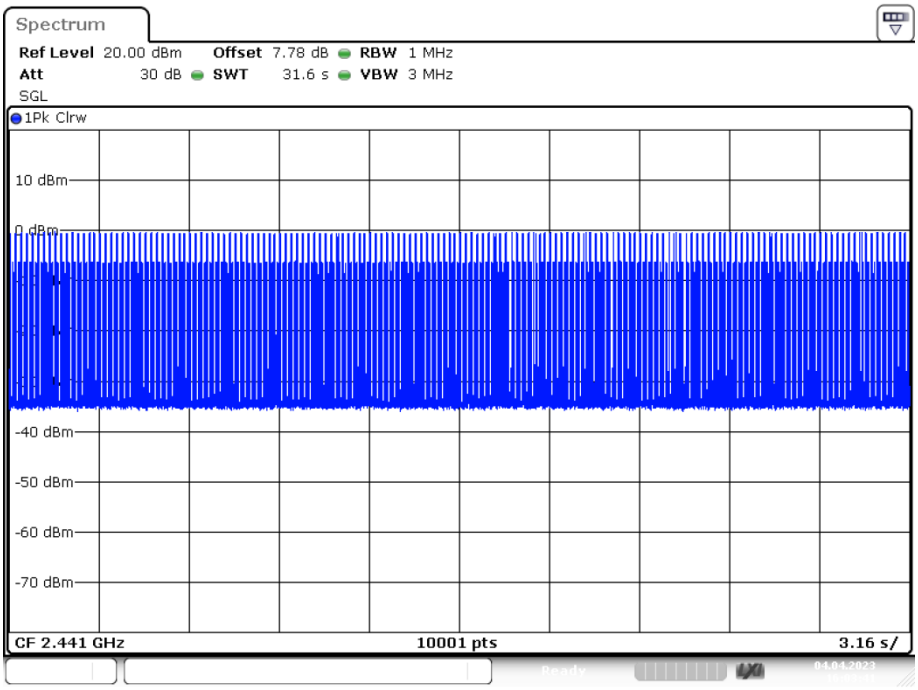
Date: 4.APR.2023 15:45:45

Dwell NVNT 3-DH1 2441MHz Ant1 One Burst



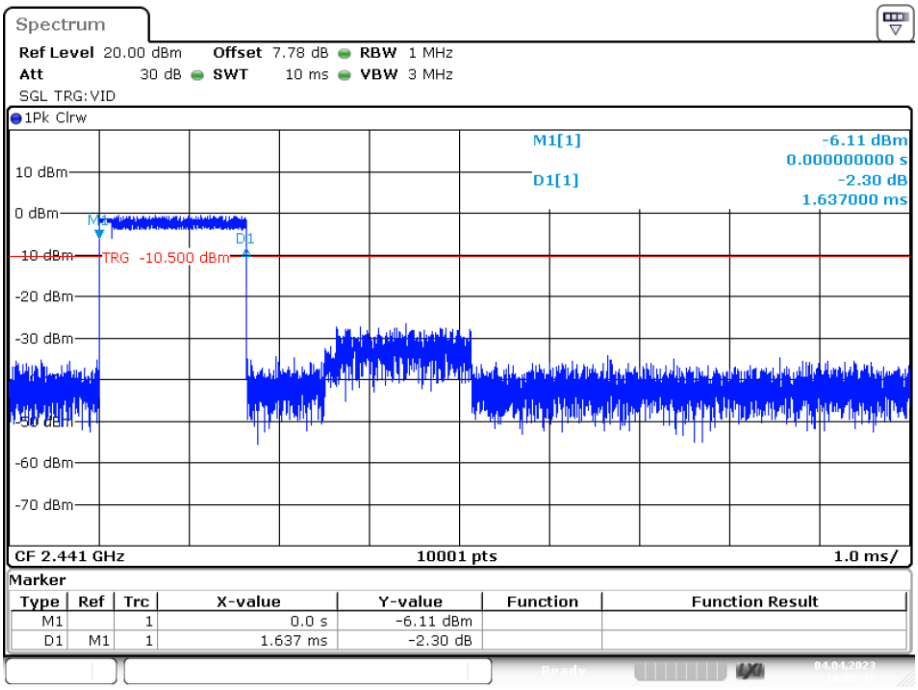
Date: 4.APR.2023 16:03:07

Dwell NVNT 3-DH1 2441MHz Ant1 Accumulated



Date: 4.APR.2023 16:03:41

Dwell NVNT 3-DH3 2441MHz Ant1 One Burst



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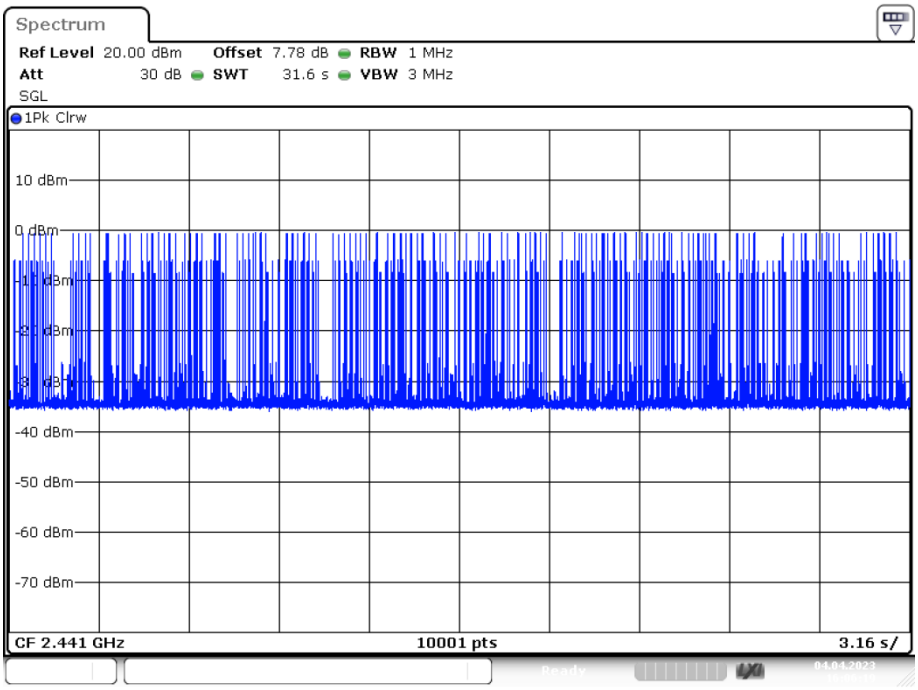
Dwell NVNT 3-DH3 2441MHz Ant1 Accumulated



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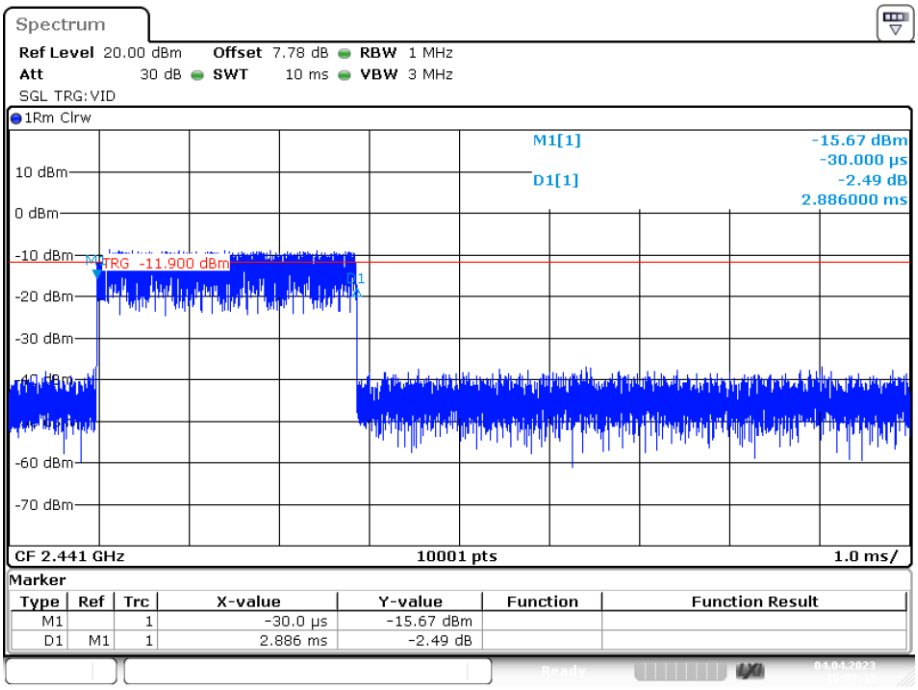
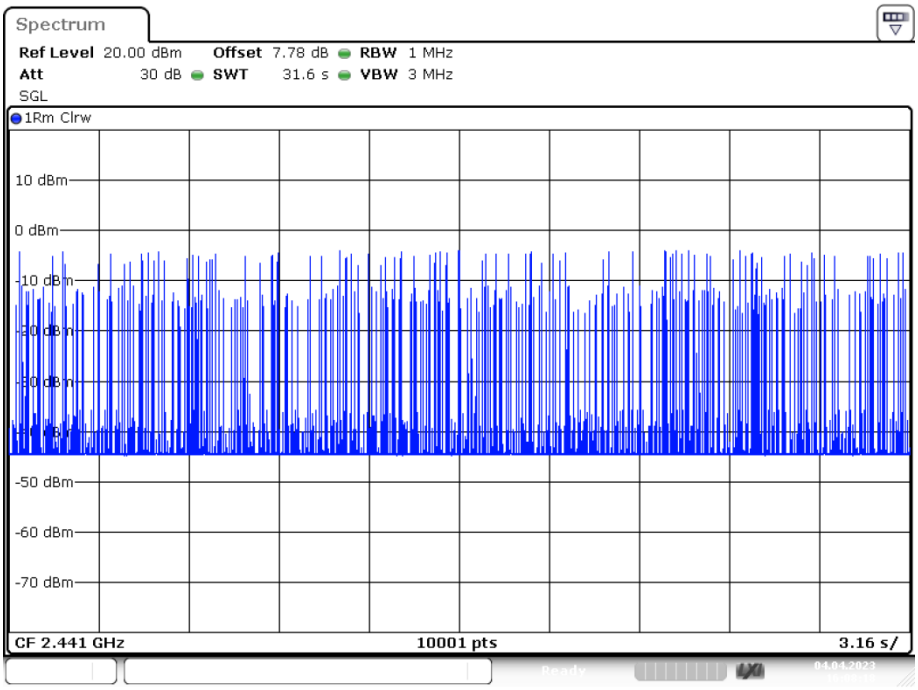
Dwell NVNT 3-DH5 2441MHz Ant1 One Burst



Date: 4.APR.2023 16:07:44

Dwell NVNT 3-DH5 2441MHz Ant1 Accumulated



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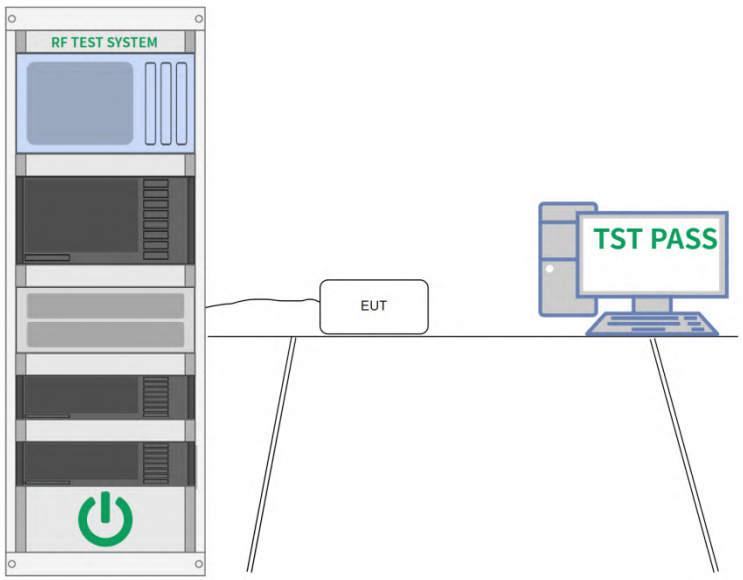
4.7 Emissions in non-restricted frequency bands

Test Requirement:	In any 100 kHz bandwidth outside the frequency band in which the spread spectrum or digitally modulated 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, based on either an RF conducted or a radiated measurement, provided the transmitter demonstrates compliance with the peak conducted power limits. If the transmitter complies with the conducted power limits based on the use of RMS averaging over a time interval, as permitted under paragraph (b)(3) of this section, the attenuation required under this paragraph shall be 30 dB instead of 20 dB. Attenuation below the general limits specified in § 15.209(a) is not required.
Test Limit:	In any 100 kHz bandwidth outside the frequency band in which the spread spectrum or digitally modulated 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, based on either an RF conducted or a radiated measurement, provided the transmitter demonstrates compliance with the peak conducted power limits. If the transmitter complies with the conducted power limits based on the use of RMS averaging over a time interval, as permitted under paragraph (b)(3) of this section, the attenuation required under this paragraph shall be 30 dB instead of 20 dB. Attenuation below the general limits specified in § 15.209(a) is not required.
Test Method:	Conducted spurious emissions test methodology
Procedure:	Conducted spurious emissions shall be measured for the transmit frequency, per 5.5 and 5.6, and at the maximum transmit powers. Connect the primary antenna port through an attenuator to the spectrum analyzer input; in the results, account for all losses between the unlicensed wireless device output and the spectrum analyzer. The instrument shall span 30 MHz to 10 times the operating frequency in GHz, with a resolution bandwidth of 100 kHz, video bandwidth of 300 kHz, and a coupled sweep time with a peak detector. The band 30 MHz to the highest frequency may be split into smaller spans, as long as the entire spectrum is covered.

4.7.1 E.U.T. Operation:

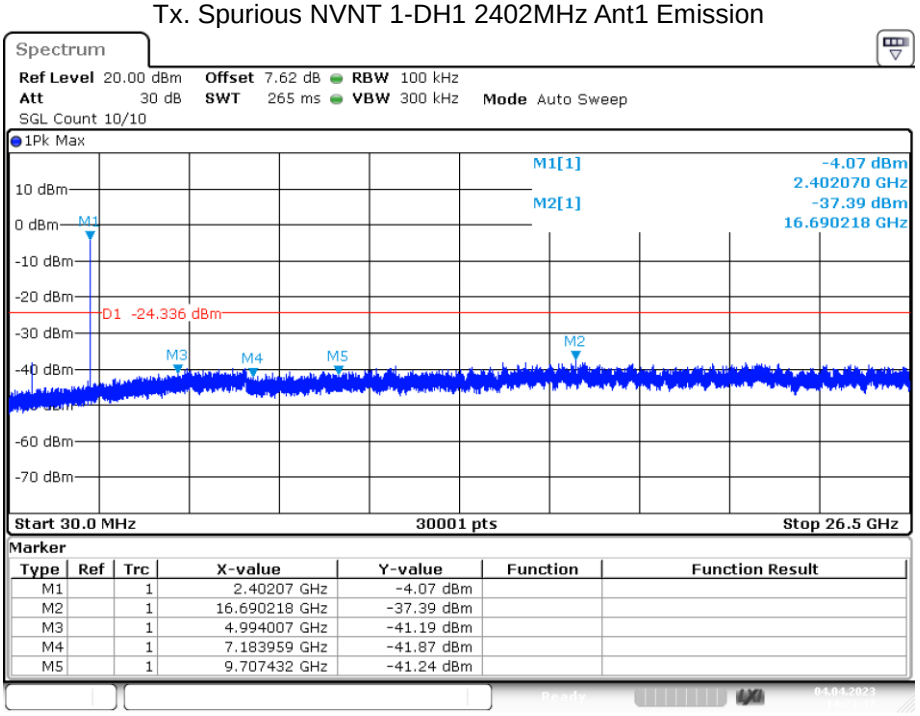
Operating Environment:					
Temperature:	23.8 °C	Humidity:	54.2 %	Atmospheric Pressure:	101.6 kPa
Pre test mode:	TX-GFSK(hopping off), TX-Pi/4DQPSK (hopping off), TX-8DPSK (hopping off)				
Final test mode:	TX-GFSK(hopping off), TX-Pi/4DQPSK (hopping off), TX-8DPSK (hopping off)				

4.7.2 Test Setup Diagram:



4.7.3 Test Result:

Tx. Spurious NVNT 1-DH1 2402MHz Ant1 Emission



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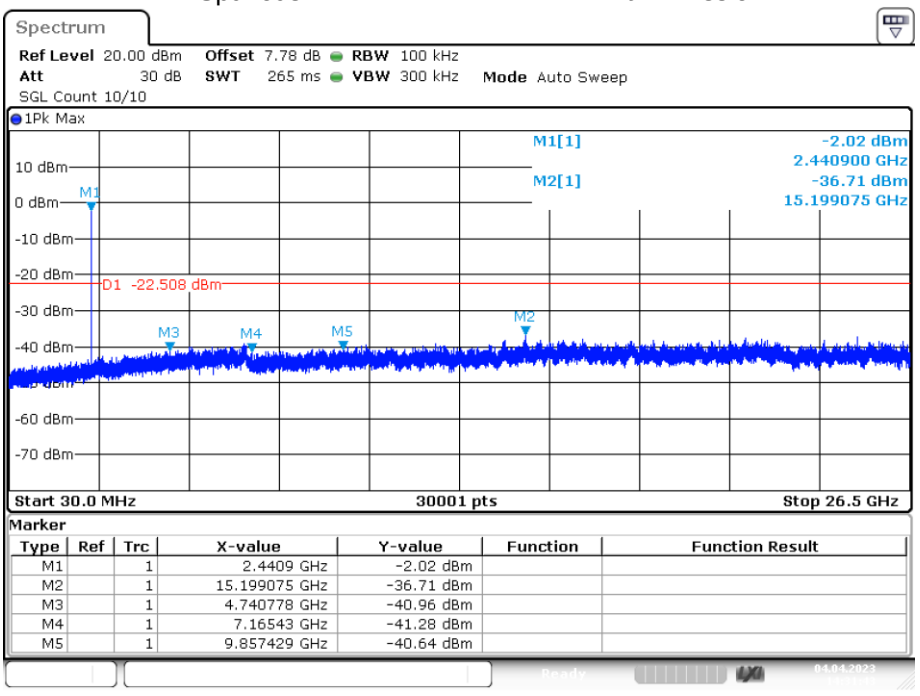
Tx. Spurious NVNT 1-DH1 2441MHz Ant1 Emission



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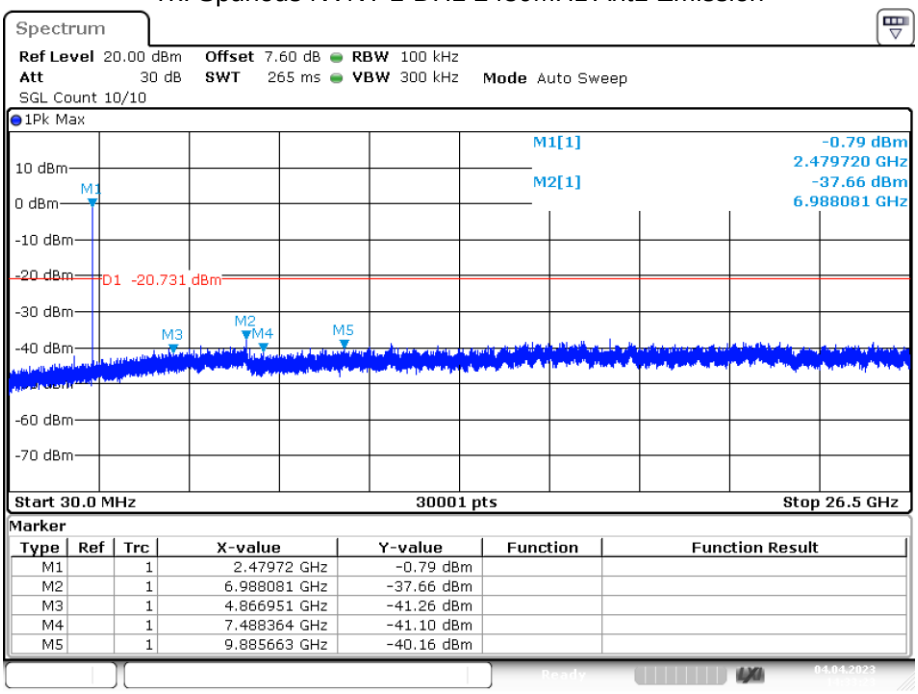
Tx. Spurious NVNT 1-DH1 2480MHz Ant1 Emission



Marker

Type	Ref	Trc	X-value	Y-value	Function	Function Result
M1		1	2.47972 GHz	-0.79 dBm		
M2		1	6.988081 GHz	-37.66 dBm		
M3		1	4.866951 GHz	-41.26 dBm		
M4		1	7.488364 GHz	-41.10 dBm		
M5		1	9.885663 GHz	-40.16 dBm		

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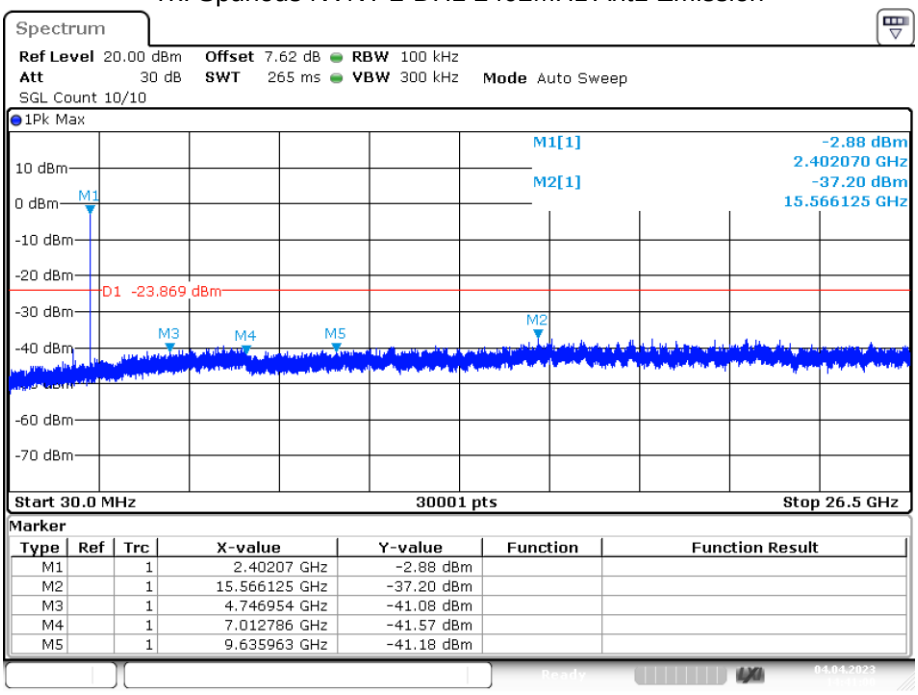
Tx. Spurious NVNT 2-DH1 2402MHz Ant1 Emission



Marker

Type	Ref	Trc	X-value	Y-value	Function	Function Result
M1		1	2.40207 GHz	-2.88 dBm		
M2		1	15.566125 GHz	-37.20 dBm		
M3		1	4.746954 GHz	-41.08 dBm		
M4		1	7.012786 GHz	-41.57 dBm		
M5		1	9.635963 GHz	-41.18 dBm		

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