TEST REPORT

Part 15 Subpart E 15.407

Equipment under test	NUGU candle SE
Model name	NU110
FCC ID	2A9KPNU110SE
Applicant	LISMA CO., LTD.
Manufacturer	DongGuan Hajen Electro-mechanics Co., Ltd.
Date of test(s)	2022.12.01 ~ 2023.01.03
Date of issue	2023.01.12

Issued to
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Test and report completed by :	**Report approval by :**
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This test report is not related to KS Q ISO/IEC 17025 and KOLAS

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Revision history

Revision	Date of issue	Test report No.	Description
-	2023.01.12	KES-RF-23T0015	Initial

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1. General information

Applicant:	LISMA CO., LTD.
Applicant address:	358, Samil-daero, Jung-gu, Seoul, Republic of Korea
Test site:	KES Co., Ltd.
Test site address:	☐3701, 40, Simin-daero 365beon-gil, Dongan-gu, Anyang-si, Gyeonggi-do, 14057, Korea ☒473-21, Gayeo-ro, Yeoju-si, Gyeonggi-do, Korea
Test Facility	FCC Accreditation Designation No.: KR0100, Registration No.: 444148
FCC rule part(s):	15.407
FCC ID:	2A9KPNU110SE
Test device serial No.:	☒ Production ☐ Pre-production ☐ Engineering

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1.1. EUT description

Equipment under test	NUGU candle SE
Frequency range	2 402 ㎒ ~ 2 480 ㎒ (BDR / EDR)
	2 402 ㎒ ~ 2 480 ㎒ (LE 1 Mbps)
	2 412 ㎒ ~ 2 462 ㎒ (802.11b/g/n_HT20)
	2 422 ㎒ ~ 2 452 ㎒ (802.11n_HT40)
	UNII-1 5 180 ㎒ ~ 5 240 ㎒ (802.11a/n_HT20)
	5 190 ㎒ ~ 5 230 ㎒ (802.11n_HT40)
	UNII-2A 5 260 ㎒ ~ 5 320 ㎒ (802.11a/n_HT20)
	5 270 ㎒ ~ 5 310 ㎒ (802.11n_HT40)
	UNII-2C 5 500 ㎒ ~ 5 720 ㎒ (802.11a/n_HT20)
	5 510 ㎒ ~ 5 710 ㎒ (802.11n_HT40)
	UNII-3 5 745 ㎒ ~ 5 825 ㎒ (802.11a/n_HT20)
	5 755 ㎒ ~ 5 795 ㎒ (802.11n_HT40)
Model	NU110
Modulation technique	GFSK, π/4DQPSK, 8DPSK, **DSSS, OFDM**
Number of channels	2 402 ㎒ ~ 2 480 ㎒ (BDR / EDR) : 79 ch
	2 402 ㎒ ~ 2 480 ㎒ (LE 1 Mbps) : 40 ch
	2 412 ㎒ ~ 2 462 ㎒ (802.11b/g/n_HT20) : 11 ch
	2 422 ㎒ ~ 2 452 ㎒ (802.11n_HT40) : 7 ch
	UNII-1 5 180 ㎒ ~ 5 240 ㎒ (802.11a/n_HT20) : 4 ch
	5 190 ㎒ ~ 5 230 ㎒ (802.11n_HT40) : 2 ch
	UNII-2A 5 260 ㎒ ~ 5 320 ㎒ (802.11a/n_HT20) : 4 ch
	5 270 ㎒ ~ 5 310 ㎒ (802.11n_HT40) : 2 ch
	UNII-2C 5 500 ㎒ ~ 5 720 ㎒ (802.11a/n_HT20) : 12 ch
	5 510 ㎒ ~ 5 710 ㎒ (802.11n_HT40) : 6 ch
	UNII-3 5 745 ㎒ ~ 5 825 ㎒ (802.11a/n_HT20) : 5 ch
	5 755 ㎒ ~ 5 795 ㎒ (802.11n_HT40) : 2 ch
Antenna specification	BDR/EDR : Chip Antenna // Peak gain: 3.0 ㏈i
	LE 1 Mbps : Chip Antenna // Peak gain: 3.0 ㏈i
	WLAN 2.4 ㎓ : Chip Antenna // Peak gain: 3.0 ㏈i
	WLAN 5 ㎓ : Chip Antenna // Peak gain: 3.3 ㏈i
Power source	AC 120 V (AC/DC adapter output 15 V)
H/W version	V0.2
S/W version	130020312

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1.2. Test configuration

The **LISMA CO., LTD. // NUGU candle SE // NU110 // FCC ID: 2A9KPNU110SE** was tested according to the specification of EUT, the EUT must comply with following standards and KDB documents.

FCC Part 15.407
KDB 789033 D02 v02r01
ANSI C63.10-2013

1.3. Information about derivative model

N/A

1.4. Accessory information

Equipment	Manufacturer	Model	Serial No.	Power source
AC/DC adapter	Dongguan RuiHeng Electronic Technology Co.,LTD	RH-150200US	221010000111	AC 120 V input, DC 15 V, 2.0 A output

1.5. Sample calculation

Where relevant, the following sample calculation is provided
For all conducted test items :

The offset level is set in the spectrum analyzer to compensate the RF cable loss and attenuator factor between EUT conducted output port and spectrum analyzer. With the offset compensation, the spectrum analyzer reading level is exactly the EUT RF output level.

Offset(dB) = RF cable loss(dB) + attenuator factor(dB).
= 1.83 + 10 = 11.83 (dB)

For Radiation test :
Field strength level (dBμV/m) = Measured level (dBμV) + Antenna factor (dB) + Cable loss (dB) – Amplifier gain (dB)

1.6. Measurement Uncertainty

Test Item		Uncertainty
Uncertainty for Conduction emission test		2.38 dB (SHIELD ROOM #6)
Uncertainty for Radiation emission test (include Fundamental emission)	Below 1㎓	4.50 dB (SAC #6)
	Above 1㎓	4.90 dB (SAC #5)
Note. This uncertainty represents an expanded uncertainty expressed at approximately the 95% confidence level using a coverage factor of k=2.		

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1.7. Frequency/channel operations

Ch.	Frequency (㎒)	Rate(Mbps)
00	2 402	BDR 1 Mbps, EDR 2 Mbps, EDR 3 Mbps
. .	. .	. .
40	2 442	BDR 1 Mbps, EDR 2 Mbps, EDR 3 Mbps
. .	. .	. .
78	2 480	BDR 1 Mbps, EDR 2 Mbps, EDR 3 Mbps

Ch.	Frequency (㎒)	Rate(Mbps)
00	2 402	LE 1 Mbps
. .	. .	. .
20	2 442	LE 1 Mbps
. .	. .	. .
39	2 480	LE 1 Mbps

Ch.	Frequency (㎒)	Rate(Mbps)
01	2 412	802.11b/g/n_HT20
. .	. .	. .
06	2 437	802.11b/g/n_HT20
. .	. .	. .
11	2 462	802.11b/g/n_HT20

Ch.	Frequency (㎒)	Rate(Mbps)
03	2 422	802.11n_HT40
. .	. .	. .
06	2 437	802.11n_HT40
. .	. .	. .
09	2 452	802.11n_HT40

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UNII-1

Ch.	Frequency (㎒)
36	5 180
44	5 220
48	5 240

UNII-2A

Ch.	Frequency (㎒)
52	5 260
56	5 280
64	5 320

UNII-2C

Ch.	Frequency (㎒)
100	5 500
120	5 600
144	5 720

UNII-3

Ch.	Frequency (㎒)
149	5 745
157	5 785
165	5 825

802.11a/n_HT20 mode

UNII-1

Ch.	Frequency (㎒)
38	5 190
46	5 230

UNII-2A

Ch.	Frequency (㎒)
54	5 270
62	5 310

UNII-2C

Ch.	Frequency (㎒)
102	5 510
118	5 590
142	5 710

UNII-3

Ch.	Frequency (㎒)
151	5 755
159	5 795

802.11n_HT40 mode

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2. Summary of tests

Section in FCC Part 15	Parameter	Test results
15.407(a)	26 dB bandwidth & 99 % bandwidth	Pass
15.407(a)	6 dB bandwidth	Pass
15.407(a)	Maximum conducted output power	Pass
15.407(a)	Power spectral density	Pass
15.407(g)	Frequency stability	Pass
15.205, 15.209, 15.407(b)	Radiated restricted band and emission	Pass
15.207(a)	AC power line conducted emissions	Pass
15.203	Antenna Requirement	Pass

Note.

1. Except for the list below, all tests were conducted with default output power.

2.4 GHz WLAN		
Mode	**Frequency (MHz)**	**Setting value**
802.11n_HT40	2 422	10
	2 437	10
	2 452	10
UNII-1		
802.11n_HT40	5 190	10
UNII-2A		
802.11n_HT40	5 310	10
UNII-2C		
802.11a	5 700	10
802.11n_HT20	5 700	10
802.11n_HT40	5 510	10
	5 670	10

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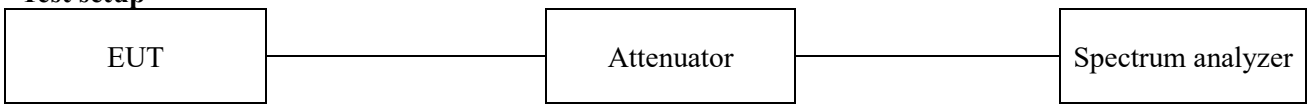
3. Test results

3.1. 26 dB bandwidth & 99% Occupied Bandwidth

Test setup



Test procedure

<u>26 dB bandwidth</u>
KDB 789033 D02 v02r01– Section C.1

1. Set RBW = approximately 1% of the emission bandwidth.
2. Set the VBW > RBW.
3. Detector = Peak.
4. Trace mode = max hold.
5. Measure the maximum width of the emission that is 26 dB down from the peak of the emission. Compare this with the RBW setting of the analyzer. Readjust RBW and repeat measurement as needed until the RBW/EBW ratio is approximately 1%.

<u>99 % bandwidth</u>
KDB 789033 D02 v02r01– Section D

1. Set span = 1.5 times to 5.0 times the OBW.
2. Set RBW = 1% to 5% of the OBW
3. Set the VBW > 3 x RBW.
4. Video averaging is not permitted. Where practical, a sample detection and single sweep mode shall be used. Otherwise, peak bandwidth function of the instrument (if available).
5. Use the 99% power bandwidth function of the instrument (if available).
6. If the instrument does not have a 99% power bandwidth function, the trace data points are recovered and directly summed in power units. The recovered amplitude data points, beginning at the lowest frequency, are placed in a running sum until 0.5% of the total is reached; that frequency is recorded as the lower frequency. The process is repeated until 99.5% of the total is reached; that frequency is recorded as the upper frequency. The 99% occupied bandwidth is the difference between these two frequencies.

Limit
N/A

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Test results

Band	Frequency(㎒)	Mode	26 dB bandwidth(㎒)	99 % bandwidth(㎒)
UNII-1	5 180	802.11 a	21.52	18.85
	5 220		21.60	19.02
	5 240		21.18	18.97
UNII-2A	5 260		21.84	19.12
	5 280		21.33	18.75
	5 320		21.54	18.83
UNII-2C	5 500		20.96	18.64
	5 600		21.14	18.62
	5 720		21.08	18.83
UNII-3	5 745		21.04	18.83
	5 785		21.27	18.72
	5 825		21.09	18.86
UNII-1	5 180	802.11 n_HT20	21.51	19.77
	5 220		21.47	19.95
	5 240		21.50	19.92
UNII-2A	5 260		21.63	19.77
	5 280		21.81	19.90
	5 320		21.22	19.77
UNII-2C	5 500		21.36	19.71
	5 600		20.73	19.59
	5 720		21.68	19.88
UNII-3	5 745		20.92	19.72
	5 785		21.41	19.84
	5 825		21.33	19.71
UNII-2C (Band-crossing channels)	5 720	802.11 a	16.22	N/A
	5 720	802.11 n_HT20	16.87	N/A

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Band	Frequency(㎒)	Mode	26 dB bandwidth(㎒)	99 % bandwidth(㎒)
UNII-1	5 190	802.11 n_HT40	46.37	41.04
	5 230		48.32	41.07
UNII-2A	5 270		43.87	39.93
	5 310		43.72	40.21
UNII-2C	5 510		44.75	40.06
	5 590		45.10	40.24
	5 710		46.88	40.13
UNII-3	5 755		43.40	40.13
	5 795		44.84	39.99
UNII-2C (Band-crossing channels)	5 710	802.11 n_HT40	37.66	N/A

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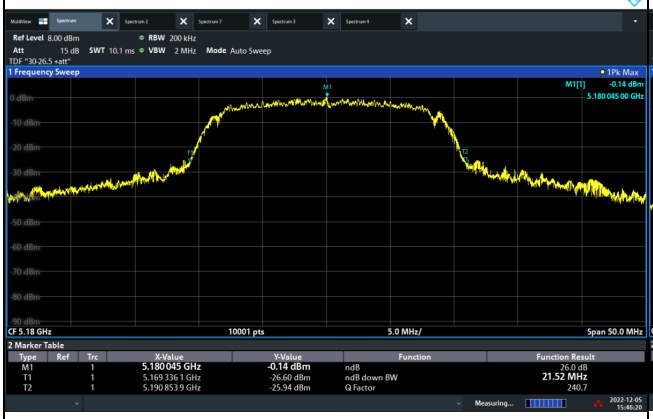
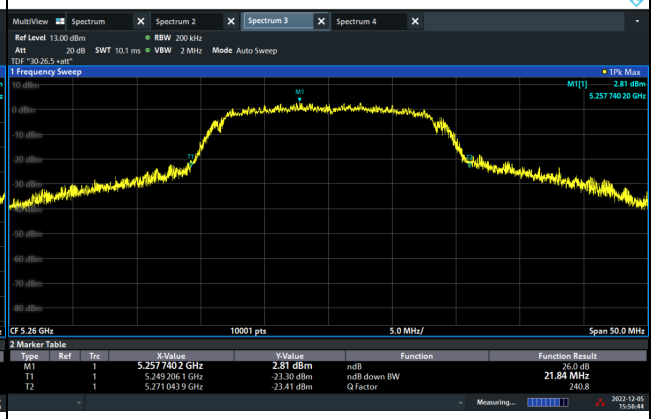
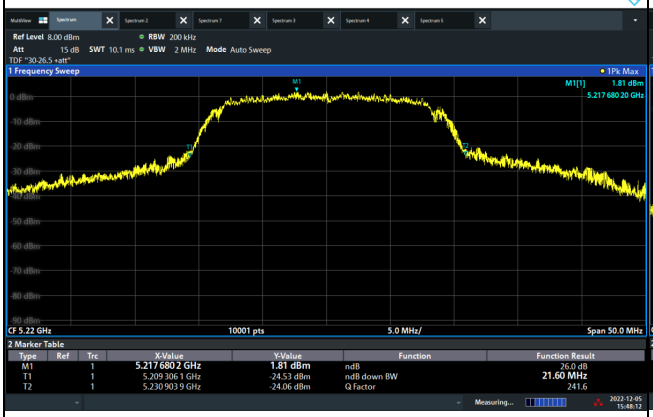
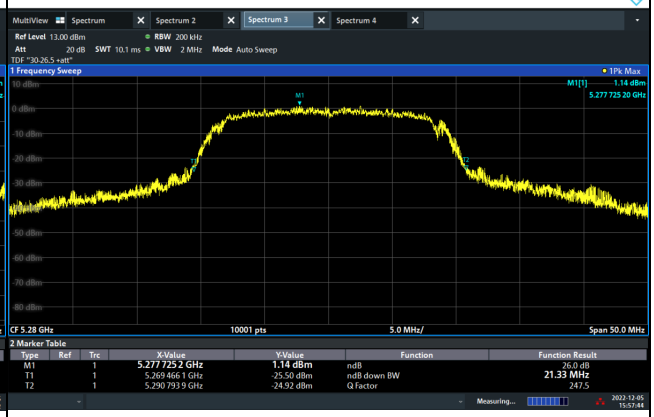
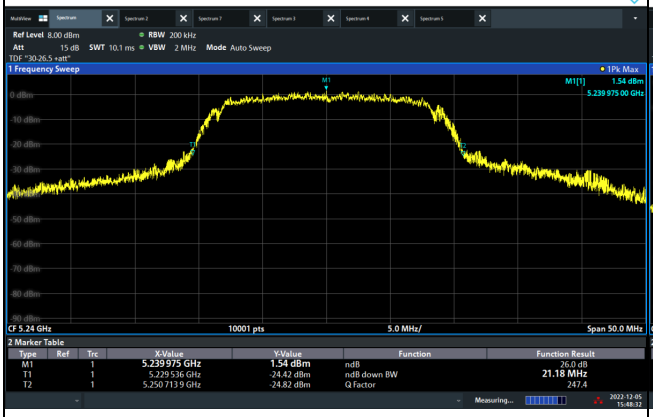
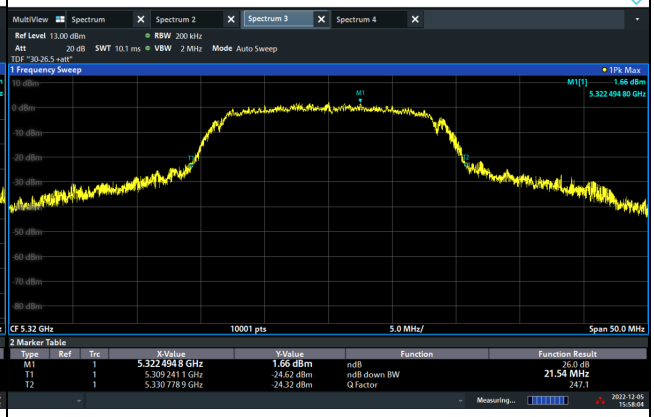
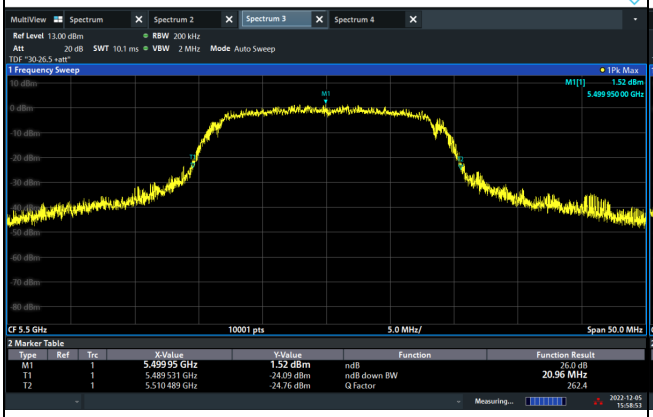
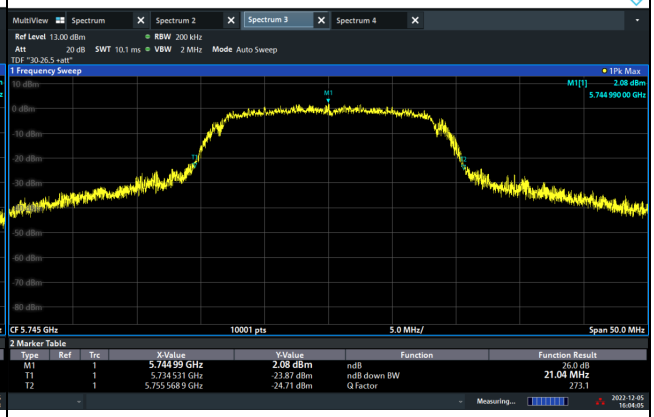
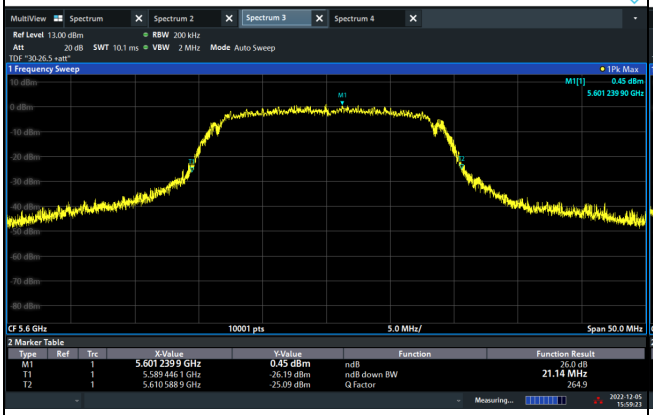
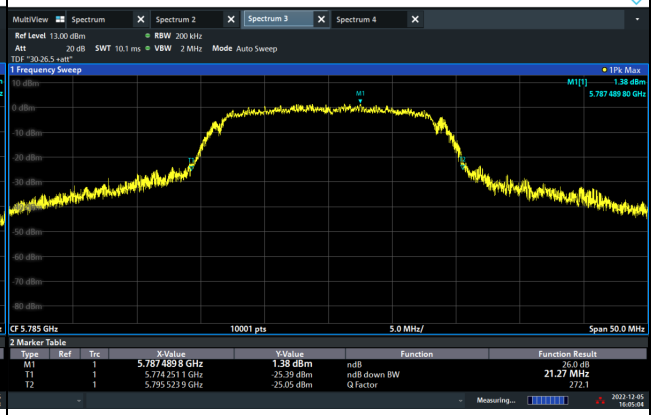
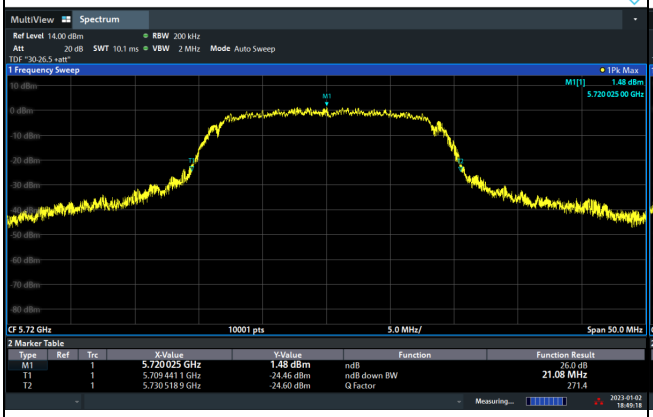
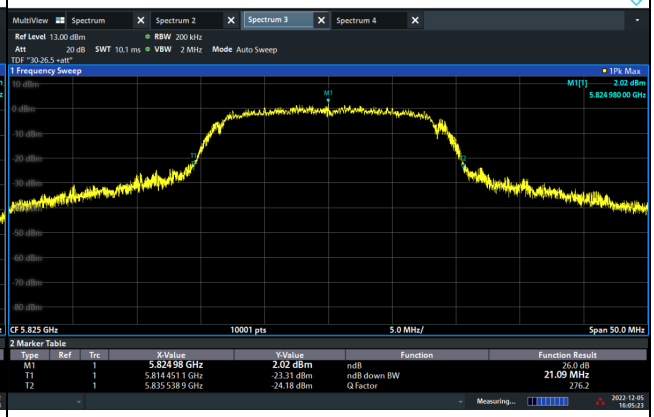
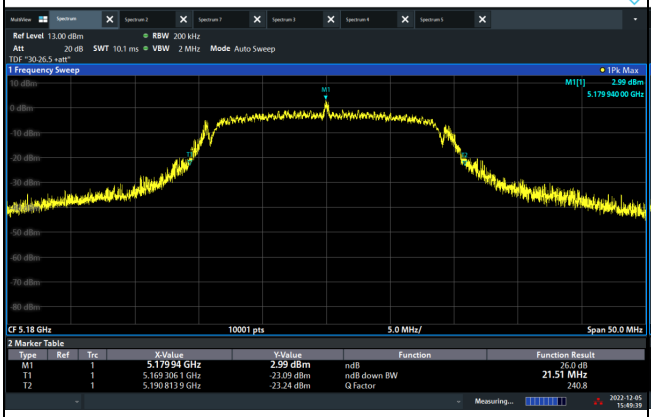
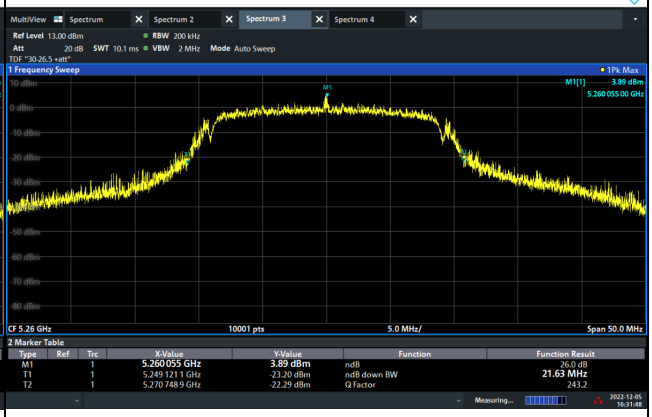
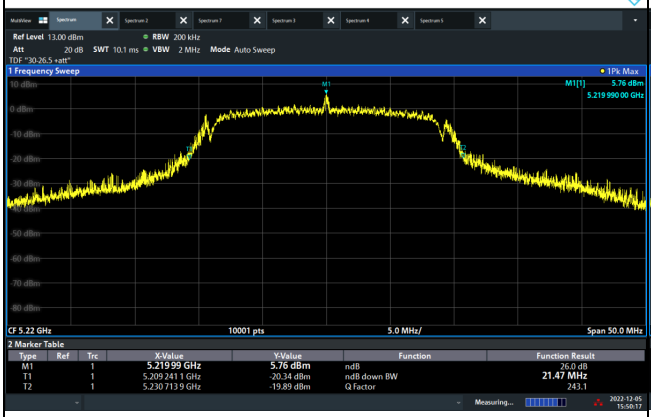
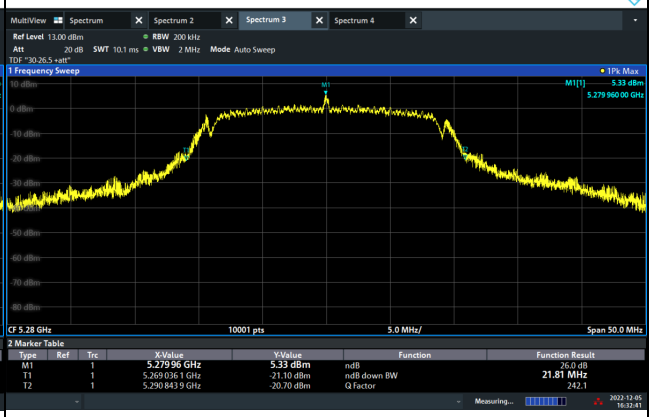
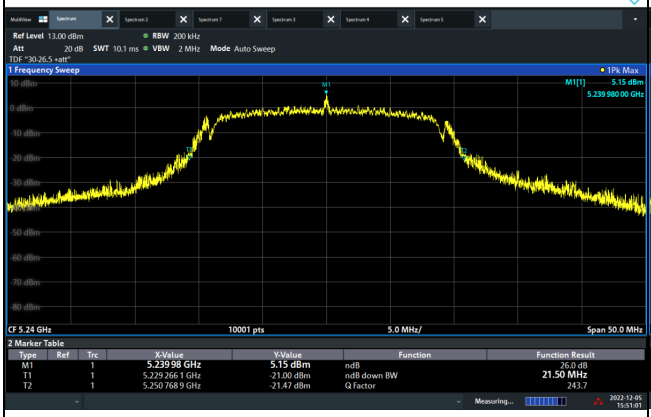
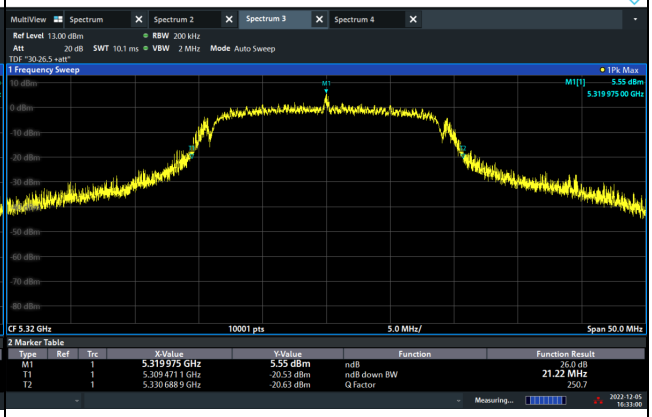
26 dB bandwidth

Mode : 802.11a

UNII-1	UNII-2A
	
	
	

UNII-2C	UNII-3
	
	
	

Mode : 802.11n_HT20

UNII-1	UNII-2A
	
	
	

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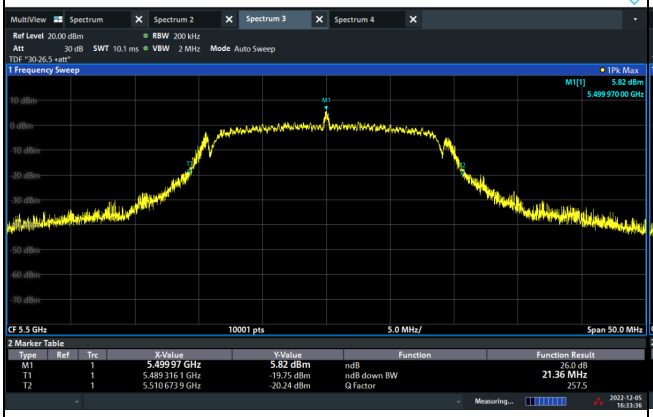	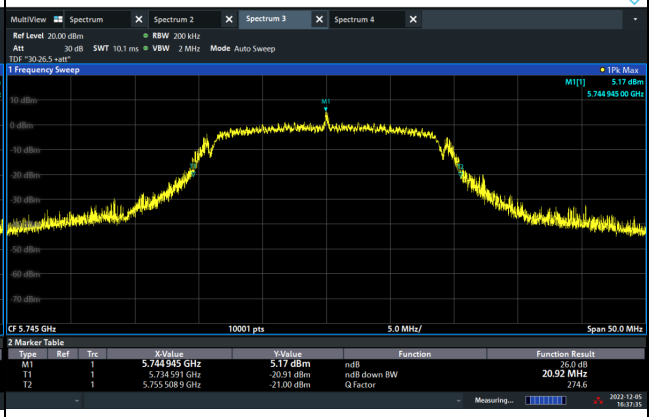
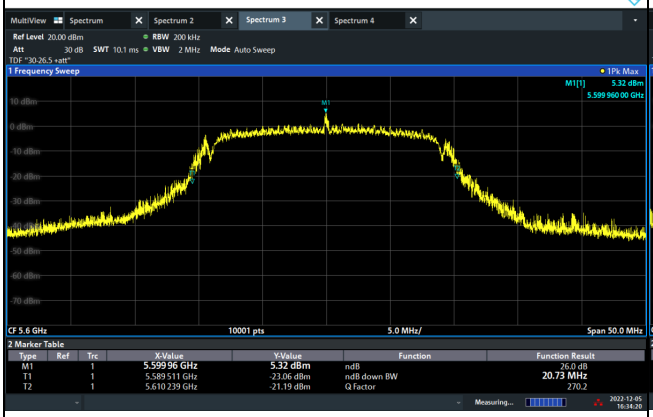	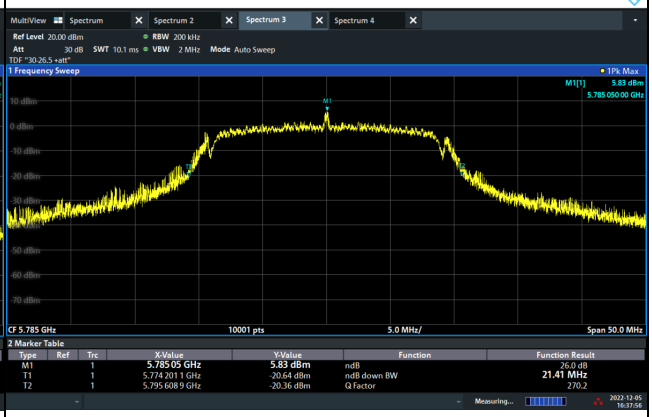
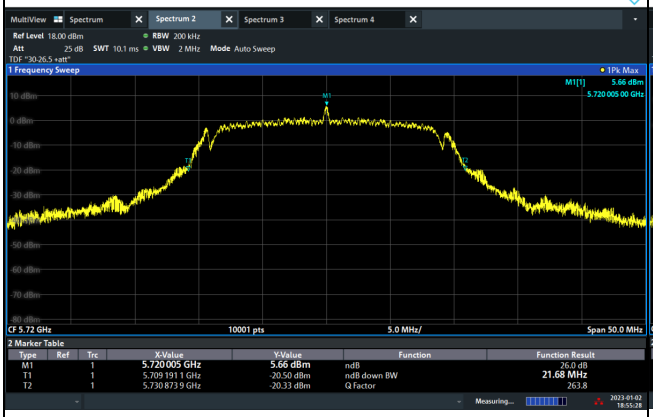	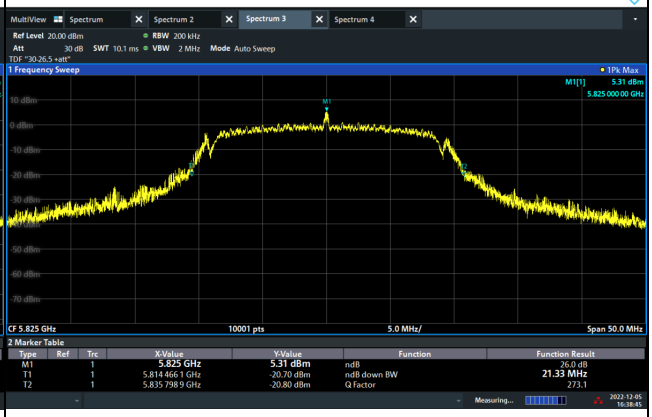

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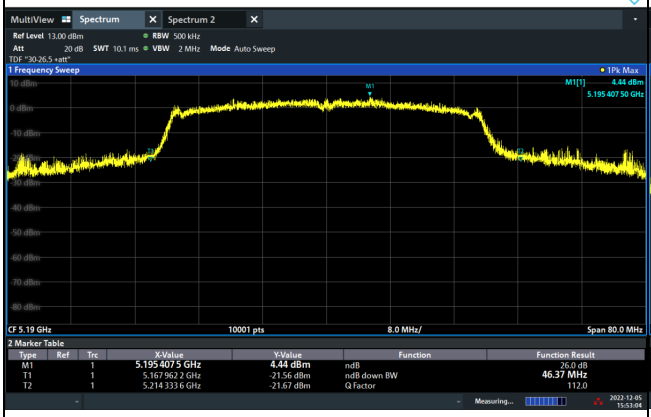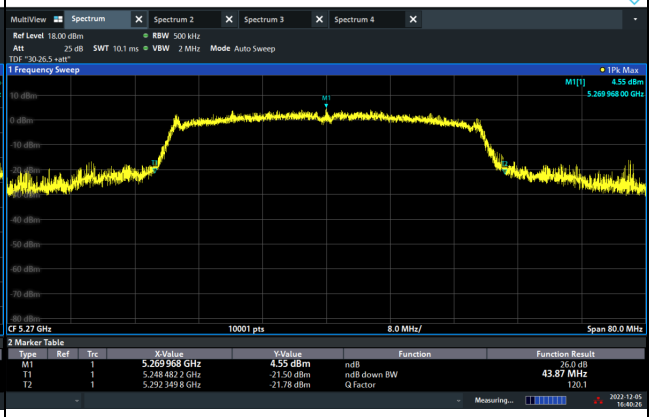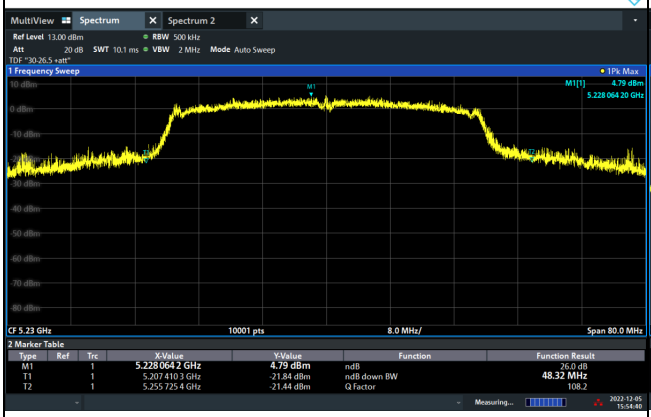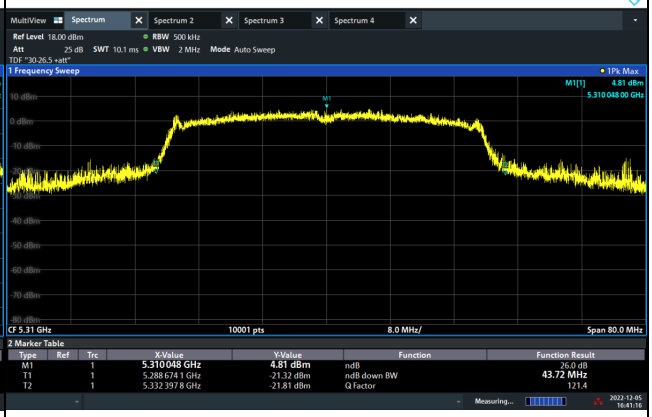
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