TEST REPORT

Applicant:	Realtek Semiconductor Corp.
Address:	No. 2, Innovation Road II, Hsinchu Science Park, Hsinchu 300, Taiwan
Equipment Type:	11ax RTL8852CE Combo module
Model Name:	RTL8852CE
Brand Name:	N/A
FCC ID:	TX2-RTL8852CE
Test Standard:	47 CFR Part 15 Subpart E (refer section 3.1)
Sample Arrival Date:	Jan. 29, 2023
Test Date:	Feb. 07, 2023
Date of Issue:	Mar. 17, 2023

ISSUED BY:

Shenzhen BALUN Technology Co., Ltd.

Tested by: Yu Yingyuan **Checked by:** Ye Hongji **Approved by:** Liao Jianming (Technical Director)

Revision History

Version	Issue Date	Revisions
Rev. 01	Mar. 17, 2023	Initial Issue

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1 GENERAL INFORMATION

1.1 Test Laboratory

Name	Shenzhen BALUN Technology Co., Ltd.
Address	Block B, 1/F, Baisha Science and Technology Park, Shahe Xi Road, Nanshan District, Shenzhen, Guangdong Province, P. R. China
Phone Number	+86 755 6685 0100

1.2 Test Location

Name	Shenzhen BALUN Technology Co., Ltd.
Location	☑ Block B, 1/F, Baisha Science and Technology Park, Shahe Xi Road, Nanshan District, Shenzhen, Guangdong Province, P. R. China
	☐ 1/F, Building B, Ganghongji High-tech Intelligent Industrial Park, No. 1008, Songbai Road, Yangguang Community, Xili Sub-district, Nanshan District, Shenzhen, Guangdong Province, P. R. China
Accreditation Certificate	The laboratory is a testing organization accredited by FCC as a accredited testing laboratory. The designation number is CN1196.

2 PRODUCT INFORMATION

2.1 Applicant Information

Applicant	Realtek Semiconductor Corp.
Address	No. 2, Innovation Road II, Hsinchu Science Park, Hsinchu 300, Taiwan

2.2 Manufacturer Information

Manufacturer	Realtek Semiconductor Corp.
Address	No. 2, Innovation Road II, Hsinchu Science Park, Hsinchu 300, Taiwan

2.3 General Description for Equipment under Test (EUT)

EUT Name	11ax RTL8852CE Combo module
Model Name Under Test	RTL8852CE
Series Model Name	N/A
Description of Model name differentiation	N/A
Serial Number	YX055J9W
Hardware Version	N/A
Software Version	N/A
Dimensions (Approx.)	N/A
Weight (Approx.)	N/A

2.3.1 Host Information:

Product Name	Notebook Computer
Model Name	ThinkBook 16 G4+ ARA
Brand Name	Lenovo

2.3.2 Antenna Information:

Antenna Port	Model Name	Antenna Manufacturer	Antenna Type	Antenna Gain (dBi)								
				2.4 GHz	5.15 - 5.25 GHz	5.25 - 5.35 GHz	5.47 - 5.725 GHz	5.725 - 5.895 GHz	5.925 - 6.425 GHz	6.425 - 6.525 GHz	6.525 - 6.875 GHz	6.875 - 7.125 GHz
Main Antenna	F-0G-XZ-0299-000-K0	SPEED	PIFA	2.67	3.51	3.35	4.14	4.14	**4.08**	**4.02**	**4.02**	**4.03**
Auxiliary Antenna	F-0G-XZ-0299-000-K0		PIFA	2.97	3.14	3.02	3.21	3.90	**4.11**	**3.98**	**3.98**	**3.98**
Main Antenna	2.00005169	ZhongTian Xun	PIFA	2.67	3.51	3.35	4.14	4.14	4.08	4.02	4.02	4.03
Auxiliary Antenna	2.00005169		PIFA	2.97	3.14	3.02	3.21	3.90	4.11	3.98	3.98	3.98

2.4 Technical Information

Network and Wireless connectivity	Bluetooth (BR+EDR+BLE) 2.4G WIFI 802.11b, 802.11g, 802.11n(HT20/40), VHT20/40 and 802.11ax(HE20/40) 5G WIFI 802.11a, 802.11n(HT20/40), 802.11ac(VHT20/40/80/160) and 802.11ax(HE20/40/80/160), U-NII-1/2A/2C/3 6G WIFI 802.11ax(HE20/40/80/160), U-NII-5/6/7/8

The requirement for the following technical information of the EUT was tested in this report:

Frequency Range		U-NII-5: 5925 MHz to 6425 MHz U-NII-6: 6425 MHz to 6525 MHz U-NII-7: 6525 MHz to 6875 MHz U-NII-8: 6875 MHz to 7125 MHz
Product Type		☐ Mobile ☒ Portable ☐ Fix Location
Modulation technology		OFDM, OFDMA
Modulation Type		1024QAM, 256QAM, 64QAM, 16QAM, BPSK, QPSK
Product Type		Indoor for IC standard
Transfer Rate (Mbps) (Single RF path)		802.11ax up to 1021 Mbps
Channel Bandwidth		802.11ax: 20 MHz, 40 MHz, 80 MHz, 160MHz
Antenna System (eg., MIMO, Smart Antenna)		Multi Input Multi Output (MIMO) for 802.11ax
Categorization as Correlated or Completely Uncorrelated		Categorization as Uncorrelated for 802.11ax
Antenna Type	Main Antenna	PIFA Antenna
	Aux. Antenna	
Antenna Gain	Main Antenna	U-NII-5: 5925 MHz to 6425 MHz: 4.08 dBi U-NII-6: 6425 MHz to 6525 MHz: 4.02 dBi U-NII-7: 6525 MHz to 6875 MHz: 4.02 dBi U-NII-8: 6875 MHz to 7125 MHz: 4.03 dBi
	Aux. Antenna	U-NII-5: 5925 MHz to 6425 MHz: 4.11 dBi U-NII-6: 6425 MHz to 6525 MHz: 3.98 dBi U-NII-7: 6525 MHz to 6875 MHz: 3.98 dBi U-NII-8: 6875 MHz to 7125 MHz: 3.98 dBi
About the Product		The equipment is 11ax RTL8852CE Combo module, intended for used with information technology equipment.

2.5 Channel List

20 MHz		40 MHz		80 MHz		160 MHz	
Channel Number	Frequency (MHz)	Channel Number	Frequency (MHz)	Channel Number	Frequency (MHz)	Channel Number	Frequency (MHz)
1	5955	3	5965	7	5985	15	6025
5	5975	11	6005	23	6065	**47**	**6185**
9	5995	19	6045	39	6145	79	6345
13	6015	27	6085	55	6225	**111**	**6505**
17	6035	35	6125	71	6305	**143**	**6665**
21	6055	43	6165	87	6385	175	6825
25	6075	51	6205	103	6465	**207**	**6985**
29	6095	59	6245	119	6545		
33	6115	67	6285	135	6625		
37	6135	75	6325	151	6705		
41	6155	83	6365	167	6785		
45	6175	91	6405	183	6865		
49	6195	99	6445	199	6945		
53	**6215**	107	6485	215	7025		
57	6235	115	6525				
61	6255	123	6565				
65	6275	131	6605				
69	6295	139	6645				
73	6315	147	6685				
77	6335	155	6725				
81	6355	163	6765				
85	6375	171	6805				
89	6395	179	6845				
93	6415	187	6885				
97	6435	195	6925				
101	**6455**	203	6965				
105	6475	211	7005				
109	6495	219	7045				
113	6515	227	7085				
117	6535						
121	6555						
125	6575						
129	6595						
133	6615						
137	6635						
141	6655						
145	6675						
149	**6695**						

153	6715						
157	6735						
161	6755						
165	6775						
169	6795						
173	6815						
177	6835						
181	6855						
185	6875						
189	6895						
193	6915						
197	6935						
201	6955						
205	6975						
209	6995						
213	**7015**						
217	7035						
221	7055						
225	7075						
229	7095						
233	7115						

The Lowest frequency, the middle frequency and the highest frequency of channel were selected to perform the test, and the selected channel see below:

For 802.11ax(HE20)

U-NII-5 (5925 - 6425 MHz)			U-NII-6 (6425 - 6525 MHz)		
Channel Number	Channel	Frequency (MHz)	Channel Number	Channel	Frequency (MHz)
53	Mid	6215	101	Mid	6455

U-NII-7 (6425 - 6875 MHz)			U-NII-8 (6875 - 7125 MHz)		
Channel Number	Channel	Frequency (MHz)	Channel Number	Channel	Frequency (MHz)
149	Mid	6695	213	Mid	7015

For 802.11ax(HE160)

U-NII-5 (5925 - 6425 MHz)			U-NII-6 (6425 - 6525 MHz)		
Channel Number	Channel	Frequency (MHz)	Channel Number	Channel	Frequency (MHz)
47	Mid	6185	111	Mid	6505

U-NII-7 (6425 - 6875 MHz)			U-NII-8 (6875 - 7125 MHz)		
Channel Number	Channel	Frequency (MHz)	Channel Number	Channel	Frequency (MHz)
143	Mid	6665	207	Mid	6985

Note: Preliminary tests were performed in different data rate in above table to find the worst radiated emission. The data rate shown in the table below is the worst-case rate with respect to the specific test item. Investigation has been done on all the possible configurations for searching the worst cases. The following table is a list of the test modes shown in this test report.

Test Items	Mode	Data Rate	Modulation Type	U-NII-5	U-NII-6	U-NII-7	U-NII-8
				Channel	Channel	Channel	Channel
Contention Based Protocol	11ax(20 MHz)	4	OFDMA	53	101	149	213
	11ax(160 MHz)	34		47	111	143	207

3 SUMMARY OF TEST RESULTS

3.1 Test Standards

No.	Identity	Document Title
1	47 CFR Part 15 Subpart E	Unlicensed National Information Infrastructure Devices
2	KDB Publication 789033 D02v02r01	Guidelines for Compliance Testing of Unlicensed National Information Infrastructure (U-NII) Devices Part 15, Subpart E
3	KDB Publication 987594 D03v01	Guidelines for Compliance Testing of Unlicensed National Information Infrastructure 6 GHz (U-NII) Devices Part 15, Subpart E
4	KDB Publication 662911 D01v02r01	Emissions Testing of Transmitters with Multiple Outputs in the Same Band (e.g., MIMO, Smart Antenna, etc)
5	ANSI C63.10-2013	American National Standard for Testing Unlicensed Wireless Devices

3.2 Test Verdict

No.	Description	FCC Part No.	Test Result	Verdict
1	Antenna Requirement	15.203	--	Pass[Note1]
2	RF Output Power	15.407(a)	ANNEX A.1	N/A[Note4]
3	Emission Bandwidth & 99% Occupied Bandwidth	15.407(a)	ANNEX A.2	N/A[Note4]
4	6 dB bandwidth	15.407(e)	ANNEX A.3	N/A[Note4]
5	Power Spectral Density	15.407(a)	ANNEX A.4	N/A[Note4]
6	Conducted Emission	15.207	ANNEX A.5	N/A[Note4]
7	Radiated Spurious Emissions and Band Edge (Restricted-band)	15.407(b)	ANNEX A.6	N/A[Note4]
8	Contention Based Protocol	15.407(d)	ANNEX A.7	Pass
9	In-Band Emissions	15.407(b)	ANNEX A.8	N/A[Note4]
10	Receiver Spurious Emissions	--	--	N/A[Note2]

Note [1]: The EUT has a permanently and irreplaceable attached antenna, which complies with the requirement FCC 15.203.

Note [2]: Only radio communication receivers operating in stand-alone mode within the U-NII-30-960 MHz, as well as scanner receivers, are subject to Industry Canada requirements, so this test is not applicable.

Note [3]: Under all normal operating conditions specified in the user manual, frequency stability can keep radiation within the operating frequency band.

Note [4]: This test report applies to class II permissive changes, only test the output power, other test case no need to test.

4 GENERAL TEST CONFIGURATIONS

4.1 Test Environments

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

Relative Humidity	53% to 61%	
Atmospheric Pressure	100 kPa to 102 kPa	
Temperature	NT (Normal Temperature)	+20.1℃ to +20.5℃
Working Voltage of the EUT	NV (Normal Voltage)	15.36 V

4.2 Test Equipment List

Description	Manufacturer	Model	Serial No.	Cal. Date	Cal. Due
Spectrum Analyzer	ROHDE&SCHWARZ	FSV-40	101544	2022.12.28	2023.12.27
Signaling Unit	ROHDE&SCHWARZ	CMW500	171150	2022.06.29	2023.06.28

4.3 Test Software List

Description	Manufacturer	Software Version	Serial No.	Applicable test Setup
BL410R	BALUN	V2.1.1.488	N/A	The section 4.5.1
BL410E	BALUN	V19.8.28.435	N/A	The section 4.5.2&4.5.3&4.5.4&4.5.5

4.4 Measurement Uncertainty

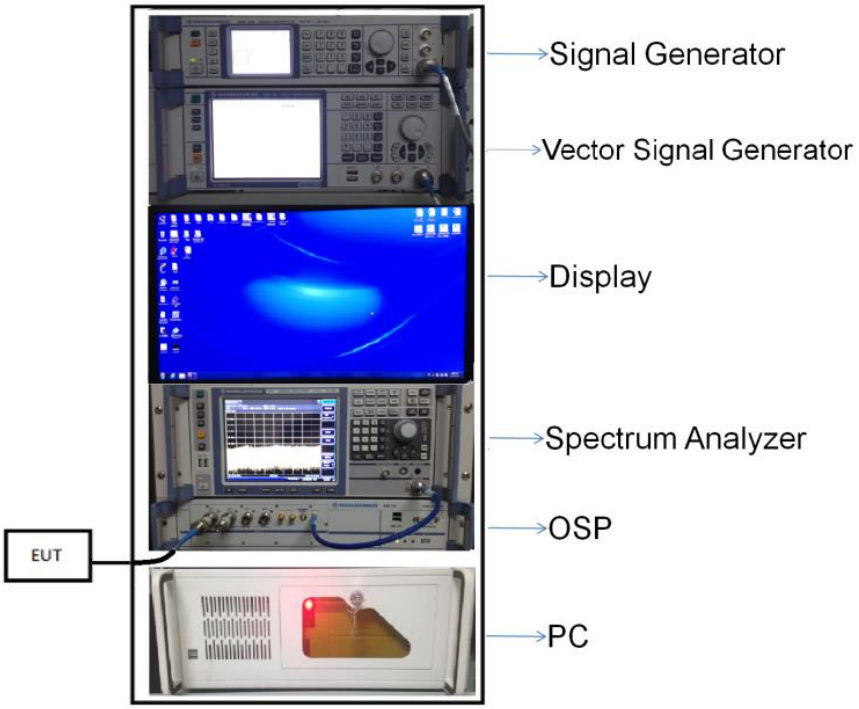
The following measurement uncertainty levels have been estimated for tests performed on the EUT as specified in CISPR 16-4-2.

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

Parameters	Uncertainty
Occupied Channel Bandwidth	2.8%
RF output power, conducted	1.28 dB
Power Spectral Density, conducted	1.30 dB
Unwanted Emissions, conducted	1.84 dB
All emissions, radiated	5.36 dB
Temperature	0.82°C
Humidity	4.1%

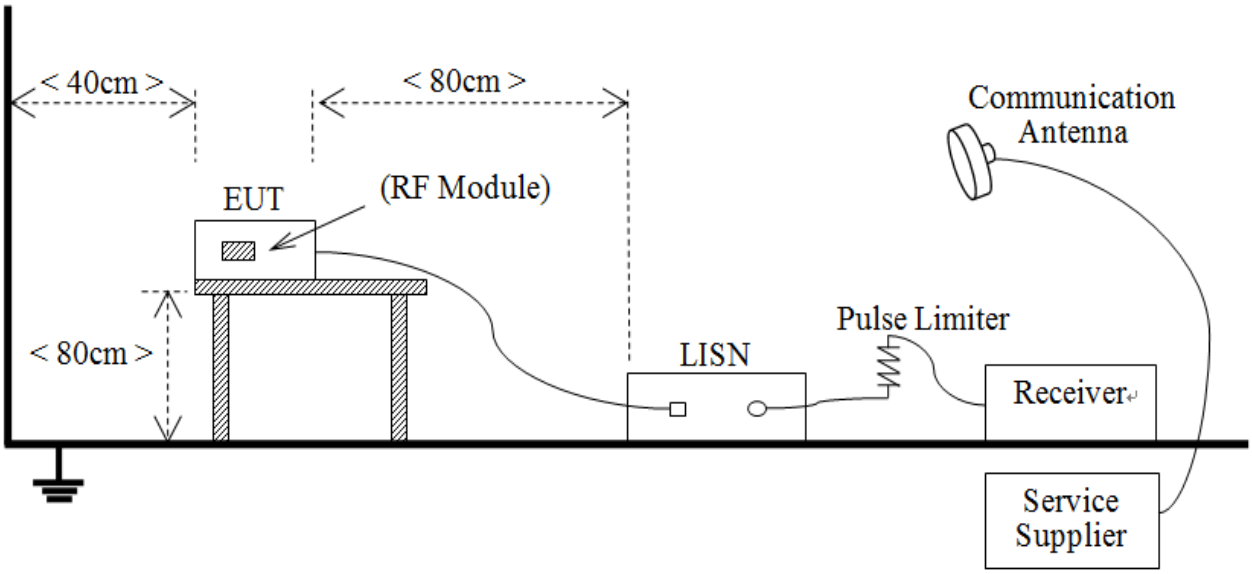
4.5 Description of Test Setup

4.5.1 For Antenna Port Test



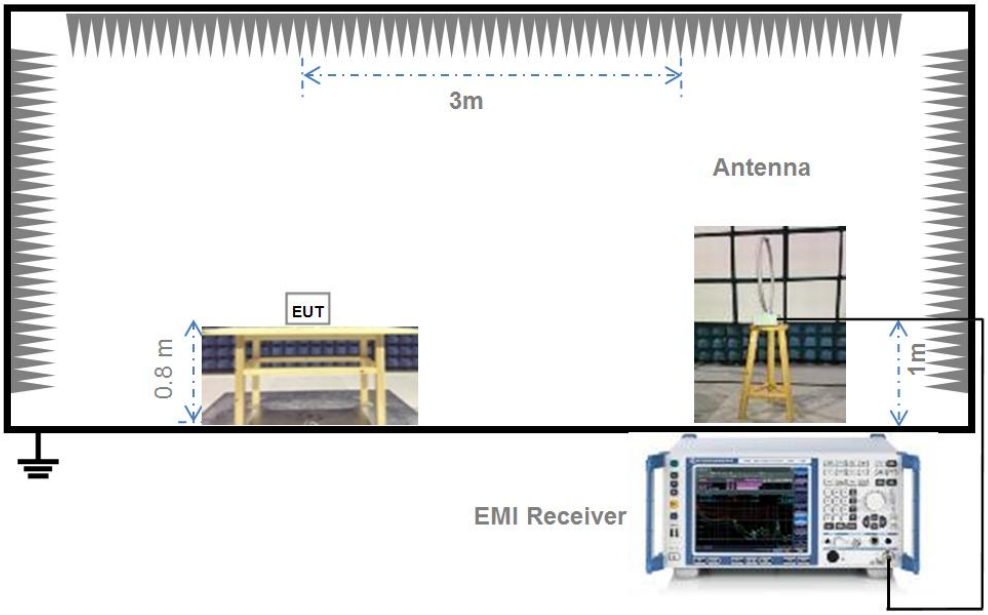
(Diagram 1)

4.5.2 For AC Power Supply Port Test



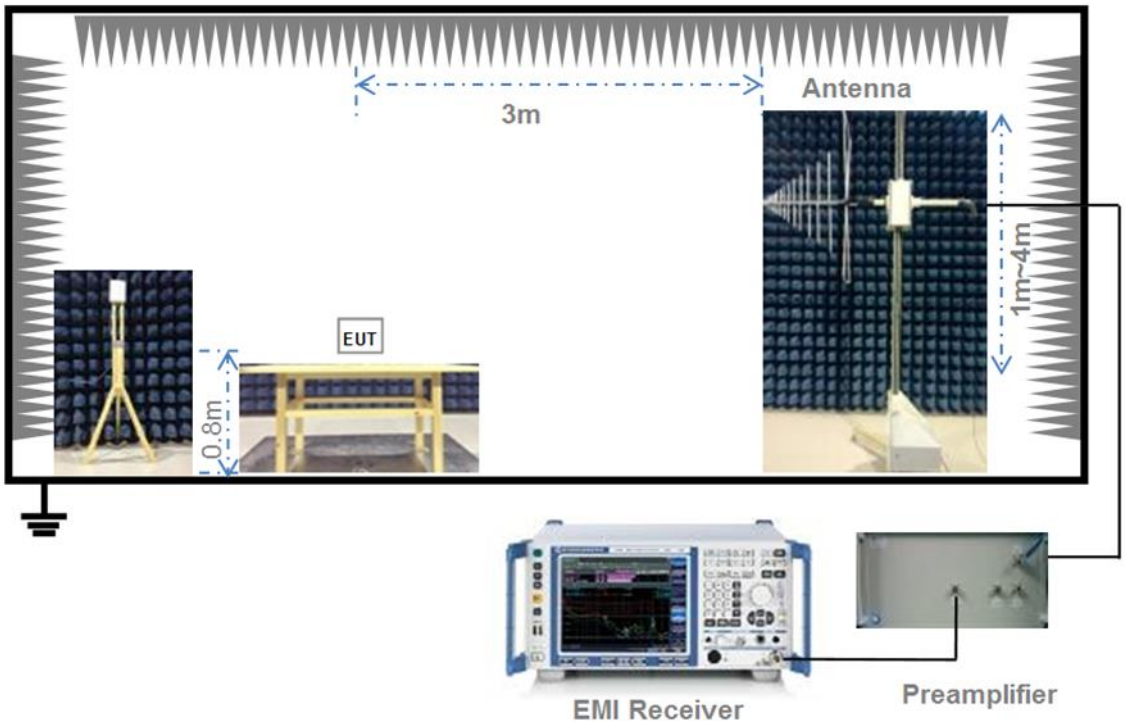
(Diagram 2)

4.5.3 For Radiated Test (Below 30 MHz)



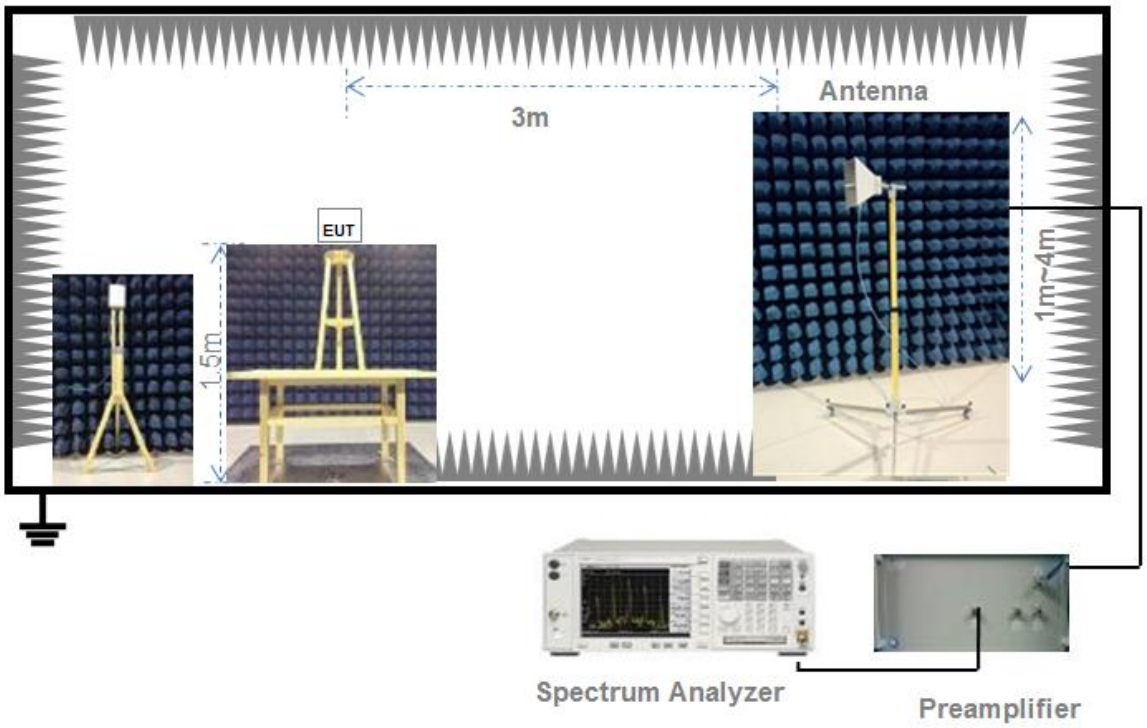
(Diagram 3)

4.5.4 For Radiated Test (30 MHz-1 GHz)



(Diagram 4)

4.5.5 For Radiated Test (Above 1 GHz)



(Diagram 5)

5 TEST ITEMS

5.1 RF Output Power

5.1.1 Test Limit

FCC §15.407(a)

The maximum conducted output power should not exceed:

Frequency Band (MHz)	Limit
5150-5250	250 mW
5250-5350	250 mW or 11 dBm + 10log B, whichever is less.
5470-5725	250 mW or 11 dBm + 10log B, whichever is less.
5725-5850	1 W
5925-7125	24 dBm (e.i.r.p.)
Note: Where “B” is the 26 dB emissions bandwidth in MHz.	

5.1.2 Test Setup

The section 4.5.1 (Diagram 1) test setup description was used for this test. The photo of test setup please refer to ANNEX B.

5.1.3 Test Procedure

The maximum peak conducted output power may be measured using a broadband Average RF power meter. The power meter shall have a video bandwidth that is greater than or equal to the emission bandwidth and utilize a fast-responding diode detector.

The E.I.R.P used radiated test method. At a test site that has been validated using the procedures of ANSI C63.4 or the latest CISPR 16-1-4 for measurements above 1 GHz, so as to simulate a near free-space environment.

5.1.4 Test Result

Please refer to ANNEX A.1.

5.2 Emission Bandwidth and 6 dB Bandwidth

5.2.1 Limit

FCC §15.407(a)

Within the 5.725-5.85 GHz band, the minimum 6 dB bandwidth of U-NII devices shall be at least 500 kHz.

The maximum transmitter channel bandwidth for U-NII devices in the 5.925-7.125 GHz band is 320 megahertz.

5.2.2 Test Setup

The test setup photo please refer to 4.5.1 (Diagram 1) test setup description was used for this test. The photo of test setup please refer to ANNEX B.

5.2.3 Test Procedure

Emission bandwidth

1. Set RBW = approximately 1% of the emission bandwidth.

2. Set VBW ≥ 3*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.

Occupied Bandwidth

1. Set Span = 1.5 times to 5.0 times the OBW

2. Set RBW = 1% to 5% of the OBW.

3. Set VBW ≥ 3*RBW, Detector = Peak.

4. Trace mode = Max hold.

5. Use the 99% power bandwidth function of the instrument.

6 dB bandwidth

1. Set RBW = 100 kHz, VBW = 300 kHz.

2. Detector = Peak.Trace mode = Max hold.

3. Allow the trace to stabilize.

4. Measure the maximum width of the emission that is constrained by the frequencies associated with the two outermost amplitude points (upper and lower frequencies) that are attenuated by 6 dB relative to the maximum level measured in the fundamental emission.

5.2.4 Test Result

Please refer to ANNEX A.2 and ANNEX A.3.

5.3 Power Spectral density (PSD)

5.3.1 Limit

FCC §15.407(a)

The maximum power spectral density should not exceed:

Frequency Band (MHz)	Limit
5150-5250	11 dBm/MHz
5250-5350	11 dBm/MHz
5470-5725	11 dBm/MHz
5725-5850	30 dBm/500kHz
5925-7125	-1 dBm/MHz (e.i.r.p.)

5.3.2 Test Setup

The section 4.5.1 (Diagram 1) test setup description was used for this test. The photo of test setup please refer to ANNEX B.

5.3.3 Test Procedure

Set the spectrum analyzer or EMI receiver span to view the entire emission bandwidth.
1. Set RBW = 510 kHz/1 MHz, VBW ≥ 3*RBW, Sweep time = Auto, Detector = RMS.
2. Allow the sweeps to continue until the trace stabilizes.
3. Use the peak marker function to determine the maximum amplitude level.
4. The E.I.R.P spectral density used radiated test method. At a test site that has been validated using the procedures of ANSI C63.4 or the latest CISPR 16-1-4 for measurements above 1 GHz, so as to simulate a near free-space environment.

5.3.4 Test Result

Please refer to ANNEX A.4.

5.4 Conducted Emission

5.4.1 Limit

FCC §15.207

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 within the U-NII-150 kHz to 30 MHz shall not exceed the limits in the following table, as measured using a 50μH/50Ω line impedance stabilization network (LISN).

Frequency range (MHz)	Conducted Limit (dBμV)	
	Quai-peak	Average
0.15 - 0.50	66 to 56	56 to 46
0.50 - 5	56	46
0.50 - 30	60	50

5.4.2 Test Setup

The section 4.5.2 (Diagram 2) test setup description was used for this test. The photo of test setup please refer to ANNEX B.

5.4.3 Test Procedure

The maximum conducted interference is searched using Peak (PK), if the emission levels more than the AV and QP limits, and that have narrow margins from the AV and QP limits will be re-measured with AV and QP detectors. Tests for both L phase and N phase lines of the power mains connected to the EUT are performed. Refer to recorded points and plots below.

5.4.4 Test Result

Please refer to ANNEX A.5.

5.5 Radiated Spurious Emissions and Band Edge (Restricted-band)

5.5.1 Limit

FCC §15.209 & 15.407(b)

Frequency (MHz)	Field Strength (μV/m)	Measurement Distance (m)
0.009 - 0.490	2400/F(kHz)	300
0.490 - 1.705	24000/F(kHz)	30
1.705 - 30.0	30	30
30 - 88	100	3
88 - 216	150	3
216 - 960	200	3
Above 960	500	3

Note [1]: The Limit for radiated test was performed according to FCC Part 15C
Note [2]: The tighter limit applies at the band edge.

5.5.2 Test Setup

The section 4.5.3-4.5.5 (Diagram 3 - Diagram 5) test setup description was used for this test. The photo of test setup please refer to ANNEX B.

5.5.3 Test Procedure

Since the emission limits are specified in terms of radiated field strength levels, measurements performed to demonstrate compliance have traditionally relied on a radiated test configuration. Radiated measurements remain the principal method for demonstrating compliance to the specified limits; however antenna-port conducted measurements are also now acceptable to demonstrate compliance (see below for details). When radiated measurements are utilized, test site requirements and procedures for maximizing and measuring radiated emissions that are described in ANSI C63.10 shall be followed.

Antenna-port conducted measurements may also be used as an alternative to radiated measurements for demonstrating compliance in the restricted frequency bands. If conducted measurements are performed, then proper impedance matching must be ensured and an additional radiated test for cabinet/case spurious emissions is required.

General Procedure for conducted measurements in restricted bands

a) Measure the conducted output power (in dBm) using the detector specified (see guidance regarding measurement procedures for determining quasi-peak, peak, and average conducted output power, respectively).

b) Add the maximum transmit antenna gain (in dBi) to the measured output power level to determine the EIRP level (see guidance on determining the applicable antenna gain)

c) Add the appropriate maximum ground reflection factor to the EIRP level (6 dB for frequencies ≤ 30 MHz, 4.7 dB for frequencies between 30 MHz and 1000 MHz, inclusive and 0 dB for frequencies > 1000 MHz).

d) For devices with multiple antenna-ports, measure the power of each individual chain and sum the EIRP of all chains in linear terms (e.g., Watts, mW).

e) Convert the resultant EIRP level to an equivalent electric field strength using the following relationship:

E = EIRP – 20log D + 104.8

where:

E = electric field strength in dBμV/m,

EIRP = equivalent isotropic radiated power in dBm

D = specified measurement distance in meters.

f) Compare the resultant electric field strength level to the applicable limit.

g) Perform radiated spurious emission test.

Quasi-Peak measurement procedure

The specifications for measurements using the CISPR quasi-peak detector can be found in Publication 16 of the International Special Committee on Radio Frequency Interference (CISPR) of the International Electrotechnical Commission.

As an alternative to CISPR quasi-peak measurement, compliance can be demonstrated to the applicable emission limits using a peak detector.

Peak power measurement procedure

Peak emission levels are measured by setting the instrument as follows:

a) RBW = as specified in Table 1.

b) VBW ≥ 3 x RBW.

c) Detector = Peak.

d) Sweep time = auto.

e) Trace mode = max hold.

f) Allow sweeps to continue until the trace stabilizes. (Note that the required measurement time may be longer for low duty cycle applications).

Table 1—RBW as a function of frequency

Frequency	RBW
9-150 kHz	200-300 Hz
0.15-30 MHz	9-10 kHz
30-1000 MHz	100-120 kHz
> 1000 MHz	1 MHz

If the peak-detected amplitude can be shown to comply with the average limit, then it is not necessary to perform a separate average measurement.

Trace averaging across on and off times of the EUT transmissions followed by duty cycle correction

If continuous transmission of the EUT (i.e., duty cycle ≥ 98 percent) cannot be achieved and the duty cycle

is constant (i.e., duty cycle variations are less than ± 2 percent), then the following procedure shall be used:

a) The EUT shall be configured to operate at the maximum achievable duty cycle.

b) Measure the duty cycle, x, of the transmitter output signal as described in section 6.0.

c) RBW = 1 MHz (unless otherwise specified).

d) VBW ≥ 3 x RBW.

e) Detector = RMS, if span/(# of points in sweep) ≤ (RBW/2). Satisfying this condition may require increasing the number of points in the sweep or reducing the span. If this condition cannot be satisfied, then the detector mode shall be set to peak.

f) Averaging type = power (i.e., RMS).

1) As an alternative, the detector and averaging type may be set for linear voltage averaging.

2) Some instruments require linear display mode in order to use linear voltage averaging. Log or dB averaging shall not be used.

g) Sweep time = auto.

h) Perform a trace average of at least 100 traces.

i) A correction factor shall be added to the measurement results prior to comparing to the emission limit in order to compute the emission level that would have been measured had the test been performed at 100 percent duty cycle. The correction factor is computed as follows:

1) If power averaging (RMS) mode was used in step f), then the applicable correction factor is 10 log(1/x), where x is the duty cycle.

2) If linear voltage averaging mode was used in step f), then the applicable correction factor is 20 log(1/x), where x is the duty cycle.

3) If a specific emission is demonstrated to be continuous (≥ 98 percent duty cycle) rather than turning on and off with the transmit cycle, then no duty cycle correction is required for that emission.

NOTE: Reduction of the measured emission amplitude levels to account for operational duty factor is not permitted. Compliance is based on emission levels occurring during transmission - not on an average across on and off times of the transmitter.

Determining the applicable transmit antenna gain

A conducted power measurement will determine the maximum output power associated with a restricted band emission; however, in order to determine the associated EIRP level, the gain of the transmitting antenna (in dBi) must be added to the measured output power (in dBm).

Since the out-of-band characteristics of the EUT transmit antenna will often be unknown, the use of a conservative antenna gain value is necessary. Thus, when determining the EIRP based on the measured conducted power, the upper bound on antenna gain for a device with a single RF output shall be selected as the maximum in-band gain of the antenna across all operating bands, or 2 dBi, whichever is greater. However, for devices that operate in multiple frequency bands while using the same transmit antenna, the

highest gain of the antenna within the operating band nearest in frequency to the restricted band emission being measured may be used in lieu of the overall highest gain when the emission is at a frequency that is within 20 percent of the nearest band edge frequency, but in no case shall a value less than 2 dBi be used.

See KDB 662911 for guidance on calculating the additional array gain term when determining the effective antenna gain for a EUT with multiple outputs occupying the same or overlapping frequency ranges in the same band.

Radiated spurious emission test

An additional consideration when performing conducted measurements of restricted band emissions is that unwanted emissions radiating from the EUT cabinet, control circuits, power leads, or intermediate circuit elements will likely go undetected in a conducted measurement configuration. To address this concern, a radiated test shall be performed to ensure that emissions emanating from the EUT cabinet (rather than the antenna port) also comply with the applicable limits.

For these cabinet radiated spurious emission measurements the EUT transmit antenna may be replaced with a termination matching the nominal impedance of the antenna. Procedures for performing radiated measurements are specified in ANSI C63.10. All detected emissions shall comply with the applicable limits.

The measurement frequency range is from 30 MHz to the 10th harmonic of the fundamental frequency. The Turn Table is actuated to turn from 0° to 360°, and both horizontal and vertical polarizations of the Test Antenna are used to find the maximum radiated power. Mid channels on all channel bandwidth verified. Only the worst RB size/offset presented.

The power of the EUT transmitting frequency should be ignored.

All Spurious Emission tests were performed in X, Y, Z axis direction. And only the worst axis test condition was recorded in this test report.

Use the following spectrum analyzer settings:

Span = wide enough to fully capture the emission being measured
RBW = 1 MHz for f ≥ 1 GHz, 100 kHz for f < 1 GHz
VBW ≥ RBW
Sweep = auto
Detector function = peak
Trace = max hold

5.5.4 Test Result

Please refer to ANNEX A.6.

5.6 Contention Based Protocol

5.6.1 Limit

FCC §15.15.407(d)

Indoor access points, subordinate devices and client devices operating in the 5.925-7.125 GHz band (herein referred to as unlicensed devices) are required to use technologies that include a contention-based protocol to avoid co-channel interference with incumbent devices sharing the band. To ensure incumbent co-channel operations are detected in a technology-agnostic manner, unlicensed devices are required to detect co-channel radio frequency energy (energy detect) and avoid simultaneous transmission.

Unlicensed low-power indoor devices must detect co-channel radio frequency power that is at least -62 dBm or lower. Upon detection of energy in the band, unlicensed low power indoor devices must vacate the channel and stay off the channel as long as detected radio frequency power is equal to or greater than the threshold (-62 dBm). The -62 dBm (or lower) threshold is referenced to a 0 dBi antenna gain.

5.6.2 Test Setup

The section 4.5.1 (Diagram 1) test setup description was used for this test. The photo of test setup please refer to ANNEX B.

5.6.3 Test Procedure

The AWGN interference signal level is corrected according to the antenna gain, and the AWGN interference signal is modulated by the vector signal source. When AWGN interference exists, a spectrum analyzer is used to detect whether the EUT recognizes and stops transmission.

5.6.4 Test Result

Please refer to ANNEX A.7.

5.7 In-Band Emissions

5.7.1 Limit

FCC §15.15.407(b)

Using the measuring equipment limit line function, develop the emissions mask based on the following requirements. The emissions power spectral density must be reduced below the peak power spectral density (in dB) as follows:

a. Suppressed by 20 dB at 1 MHz outside of the channel edge. (The channel edge is defined

as the 26-dB point on either side of the carrier center frequency.)

b. Suppressed by 28 dB at one channel bandwidth from the channel center.

c. Suppressed by 40 dB at one- and one-half times the channel bandwidth from the channel center.

5.7.2 Test Setup

The section 4.5.1 (Diagram 1) test setup description was used for this test. The photo of test setup please refer to ANNEX B.

5.7.3 Test Procedure

1. Connect output of the antenna port to a spectrum analyzer or EMI receiver, with appropriate attenuation, as to not damage the instrumentation.
2. Set the reference level of the measuring equipment in accordance with procedure 4.1.5.2 of ANSI C63.10-2013.
3. Measure the 26 dB EBW using the test procedure 12.4.1 of ANSI C63.10-2013. (This will be used to determine the channel edge.)
4. Measure the power spectral density (which will be used for emissions mask reference) using the following procedure:
a) Set the span to encompass the entire 26 dB EBW of the signal.
b) Set RBW = same RBW used for 26 dB EBW measurement.
c) Set VBW $\geqslant$ 3 X RBW
d) Number of points in sweep $\geqslant$ [2 X span / RBW].
e) Sweep time = auto.
f) Detector = RMS (i.e., power averaging)
g) Trace average at least 100 traces in power averaging (rms) mode.
h) Use the peak search function on the instrument to find the peak of the spectrum.
5. For the purposes of developing the emission mask, the channel bandwidth is defined as the 26 dB EBW.
6. Using the measuring equipment limit line function, develop the emissions mask based on the following requirements. The emissions power spectral density must be reduced below the peak power spectral density (in dB) as follows:
a. Suppressed by 20 dB at 1 MHz outside of the channel edge. (The channel edge is defined as the 26-dB point on either side of the carrier center frequency.)
b. Suppressed by 28 dB at one channel bandwidth from the channel center.
c. Suppressed by 40 dB at one- and one-half times the channel bandwidth from the channel

center.

7. Adjust the span to encompass the entire mask as necessary.

8. Clear trace.

9. Trace average at least 100 traces in power averaging (rms) mode.

10. Adjust the reference level as necessary so that the crest of the channel touches the top of the emission mask

5.7.4 Test Result

Please refer to ANNEX A.8.

ANNEX A TEST RESULT

A.1 RF Output Power

Note: Not applicable.

A.2 Emission Bandwidth & 99% Bandwidth

Note: Not applicable.

A.3 6 dB Bandwidth

Note: Not applicable.

A.4 Power Spectral Density

Note: Not applicable.

A.5 Conducted Emissions

Note: Not applicable.

A.6 Radiated Spurious Emissions and Band Edge (Restricted-band)

Note: Not applicable.

A.7 Contention Based Protocol

Interference Signals used for Tests

Interference Signals Type	Bandwidth (MHz)
AWGN	10

Regulated Threshold Level

Test Method	Interference threshold level
☒ Conducted ☐ Radiation	The Regulated Threshold Level = -62 dBm (assumes a 0 dBi receive antenna) and minimum antenna gain is 4.08 dBi. The Regulated Threshold Level = -62 dBm + G (4.08 dBi) = -57.92 dBm

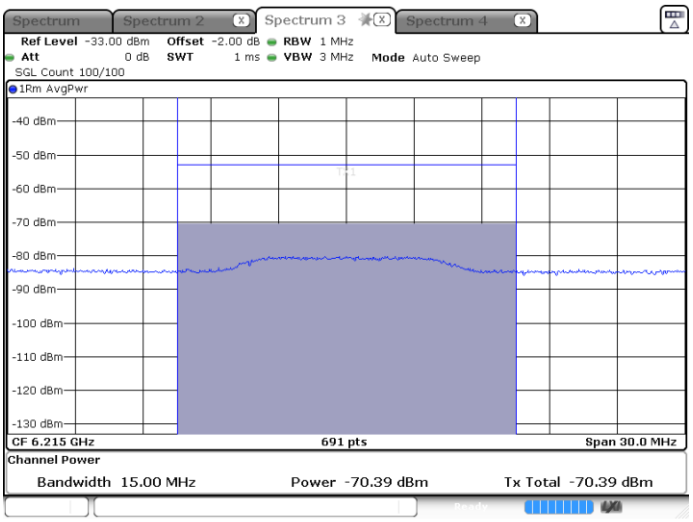
Test Data

U-NII-5 (5925 MHz to 6425 MHz)								
Operation Mode	Channel Number	Channel Frequency (MHz)	AWGN Signal Frequency (MHz)	Measured Detection Level (dBm)	Detection Rate	Regulated Threshold Level (dBm)	Margin (dB)	Verdict
802.11ax (HE20)	53	6215	6215	-70.39	90%	-57.92	-12.47	pass
802.11ax (HE160)	47	6185	6110	-70.96	90%	-57.92	-13.04	pass
			6185	-70.43	90%	-57.92	-12.51	pass
			6260	-70.46	100%	-57.92	-12.54	pass

Test Plots

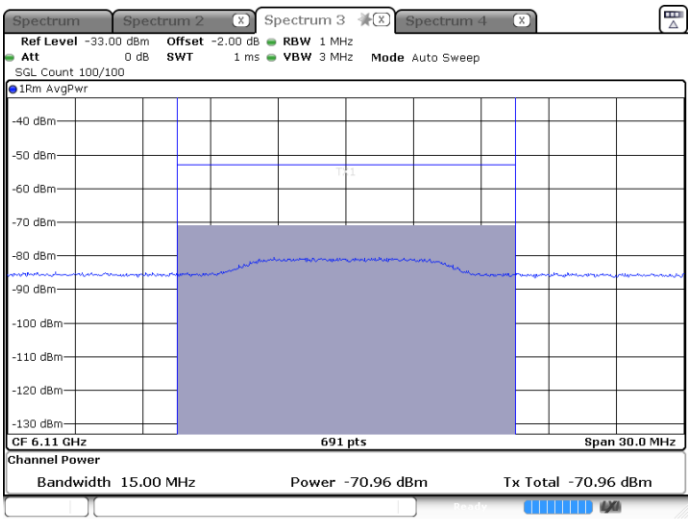
Plots of Incumbent signal(AWGN) Level

802.11ax (HE20)-Channel 53



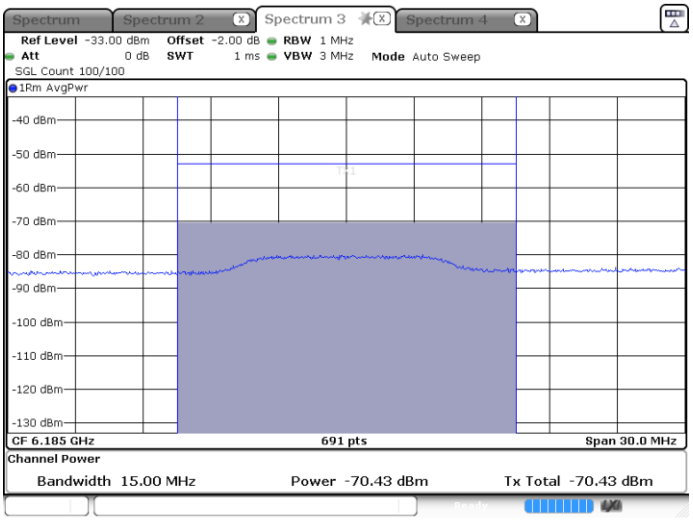
Date: 7.FEB.2023 19:08:36

802.11ax (HE160)-Channel 47 (Low Edge)



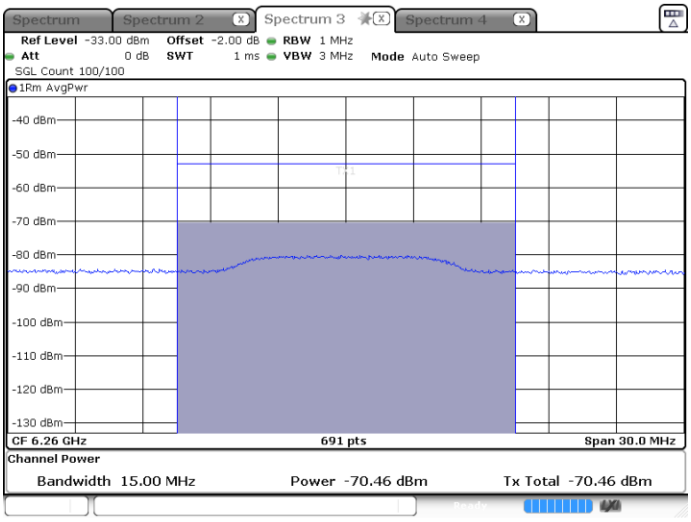
Date: 7.FEB.2023 19:11:05

802.11ax (HE160)-Channel 47 (Middle Edge)



Date: 7.FEB.2023 19:11:33

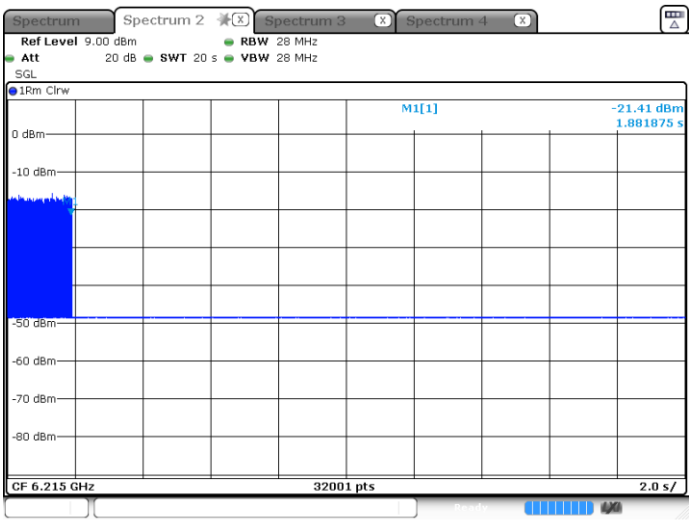
802.11ax (HE160)-Channel 47 (High Edge)



Date: 7.FEB.2023 19:11:59

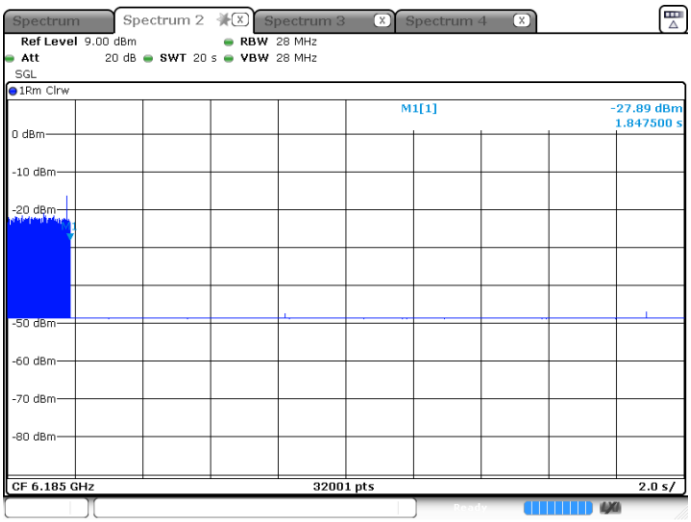
Plots of EUT Tx waveform

802.11ax (HE20)-Channel 53



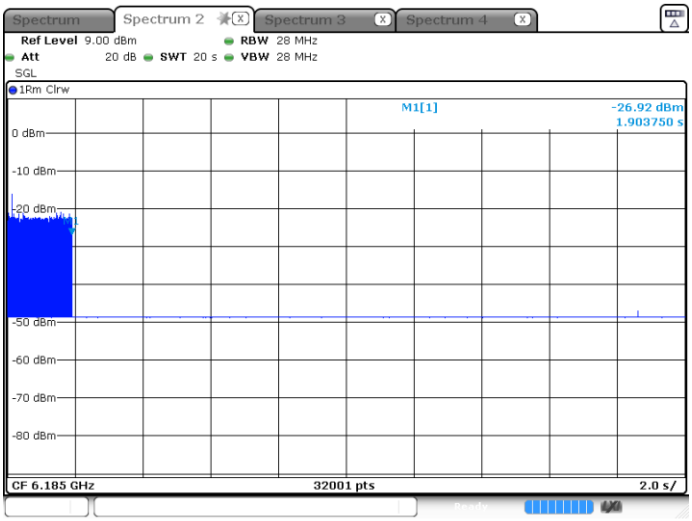
Date: 7.FEB.2023 18:48:04

802.11ax (HE160)-Channel 47 (Low Edge)



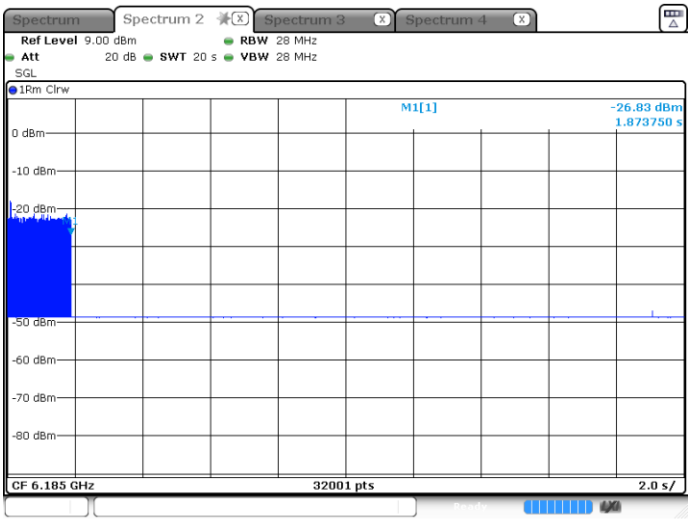
Date: 7.FEB.2023 18:41:53

802.11ax (HE160)-Channel 47 (Middle Edge)



Date: 7.FEB.2023 18:44:07

802.11ax (HE160)-Channel 47 (High Edge)



Date: 7.FEB.2023 18:45:16

Interference Signals used for Tests

Interference Signals Type	Bandwidth (MHz)
AWGN	10

Regulated Threshold Level

Test Method	Interference threshold level
☒ Conducted ☐ Radiation	The Regulated Threshold Level = -62 dBm (assumes a 0 dBi receive antenna) and minimum antenna gain is 3.98 dBi. The Regulated Threshold Level = -62 dBm + G (3.98 dBi) = -58.02 dBm

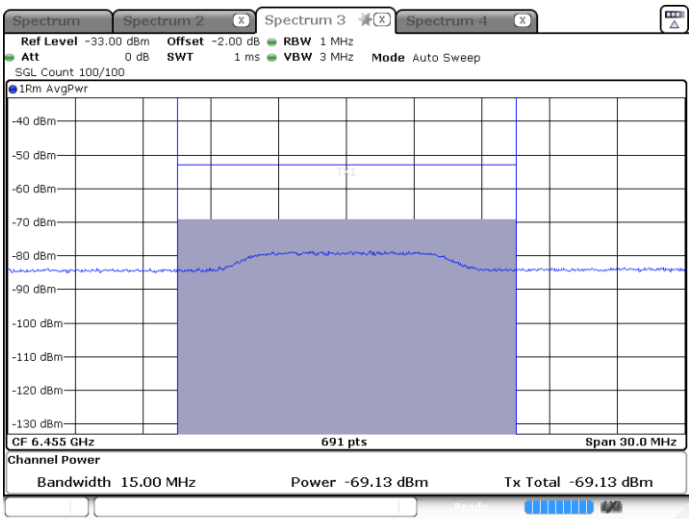
Test Data

U-NII-6 (6425 MHz to 6525 MHz)								
Operation Mode	Channel Number	Channel Frequency (MHz)	AWGN Signal Frequency (MHz)	Measured Detection Level (dBm)	Detection Rate	Regulated Threshold Level (dBm)	Margin (dB)	Verdict
802.11ax (HE20)	101	6455	6455	-69.13	90%	-58.02	-11.11	pass
802.11ax (HE160)	111	6505	6430	-68.82	100%	-58.02	-10.80	pass
			6505	-69.56	90%	-58.02	-11.54	pass
			6580	-70.10	100%	-58.02	-12.08	pass

Test Plots

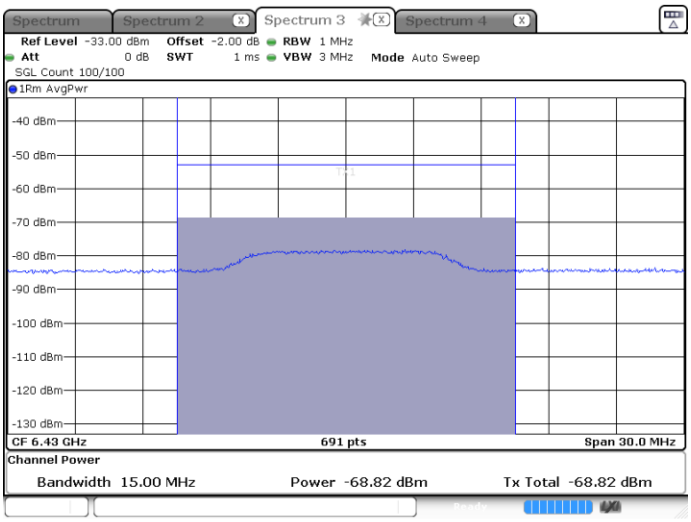
Plots of Incumbent signal(AWGN) Level

802.11ax (HE20)-Channel 101



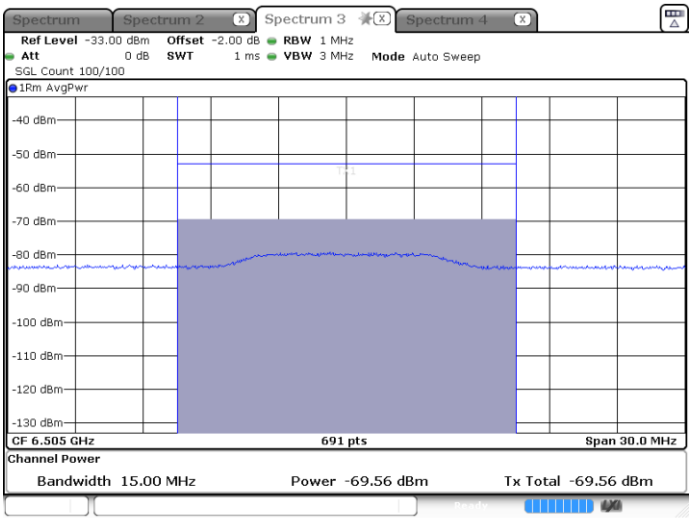
Date: 7.FEB.2023 19:09:11

802.11ax (HE160)-Channel 111 (Low Edge)



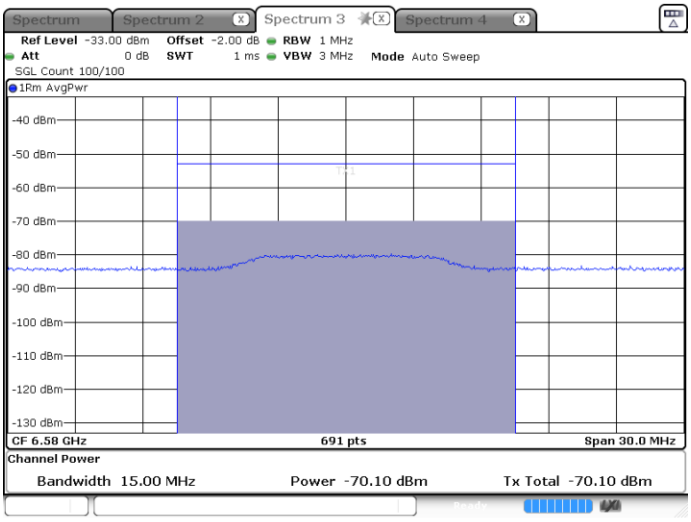
Date: 7.FEB.2023 19:12:30

802.11ax (HE160)-Channel 111 (Middle Edge)



Date: 7.FEB.2023 19:12:59

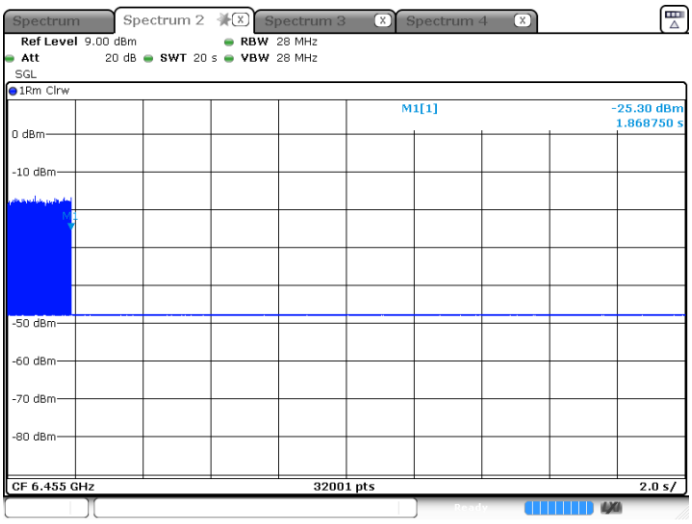
802.11ax (HE160)-Channel 111 (High Edge)



Date: 7.FEB.2023 19:13:24

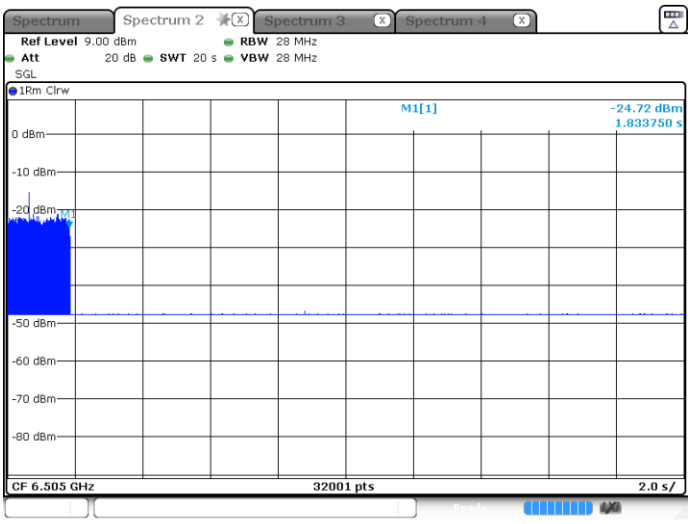
Plots of EUT Tx waveform

802.11ax (HE20)-Channel 101



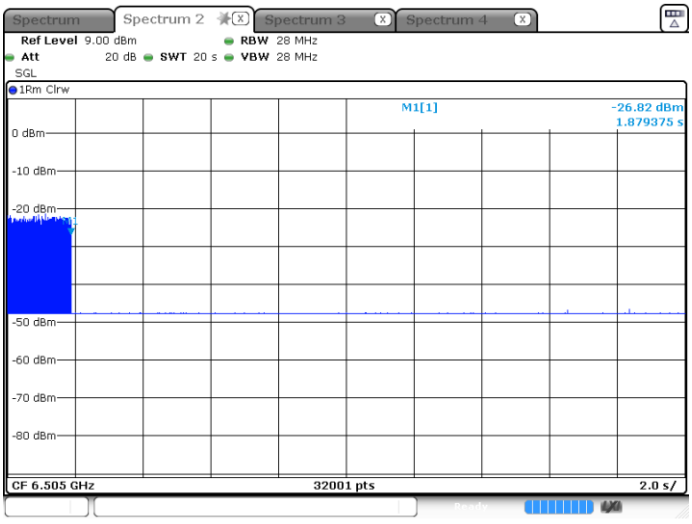
Date: 7.FEB.2023 18:51:45

802.11ax (HE160)-Channel 111 (Low Edge)



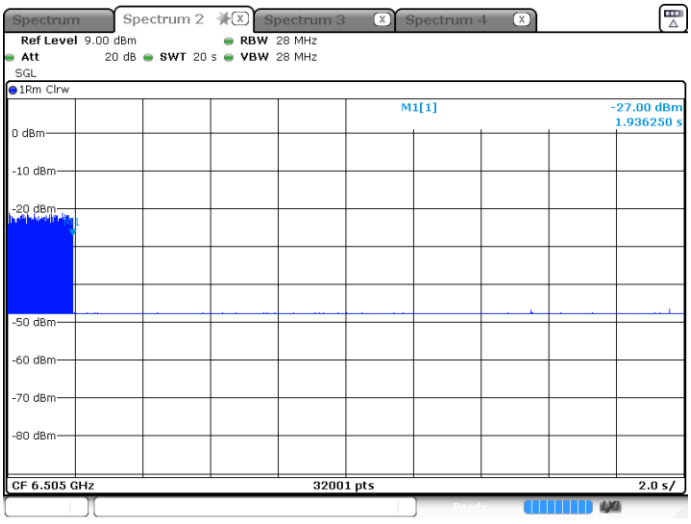
Date: 7.FEB.2023 18:35:31

802.11ax (HE160)-Channel 111 (Middle Edge)



Date: 7.FEB.2023 18:37:21

802.11ax (HE160)-Channel 111 (High Edge)



Date: 7.FEB.2023 18:38:42

Interference Signals used for Tests

Interference Signals Type	Bandwidth (MHz)
AWGN	10

Regulated Threshold Level

Test Method	Interference threshold level
☒ Conducted ☐ Radiation	The Regulated Threshold Level = -62 dBm (assumes a 0 dBi receive antenna) and minimum antenna gain is 3.98 dBi. The Regulated Threshold Level = -62 dBm + G (3.98 dBi) = -58.02 dBm

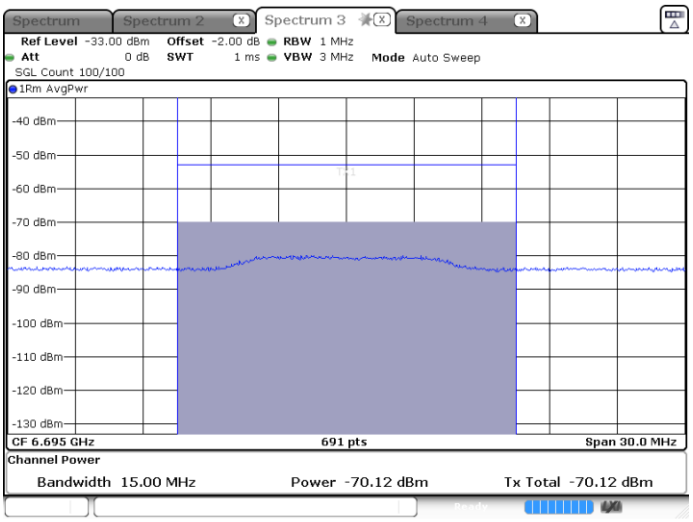
Test Data

U-NII-7 (6425 MHz to 6875 MHz)								
Operation Mode	Channel Number	Channel Frequency (MHz)	AWGN Signal Frequency (MHz)	Measured Detection Level (dBm)	Detection Rate	Regulated Threshold Level (dBm)	Margin (dB)	Verdict
802.11ax (HE20)	149	6695	6695	-70.12	90%	-58.02	-12.10	pass
802.11ax (HE160)	143	6665	6590	-69.66	90%	-58.02	-11.64	pass
			6665	-69.76	100%	-58.02	-11.74	pass
			6740	-69.50	90%	-58.02	-11.48	pass

Test Plots

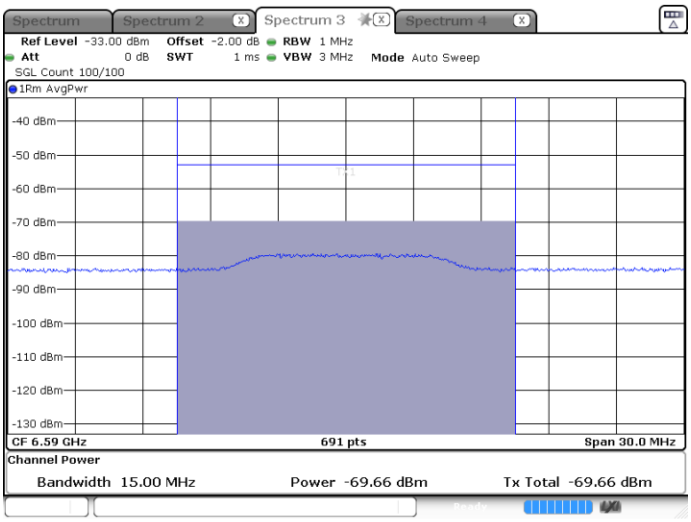
Plots of Incumbent signal(AWGN) Level

802.11ax (HE20)-Channel 149



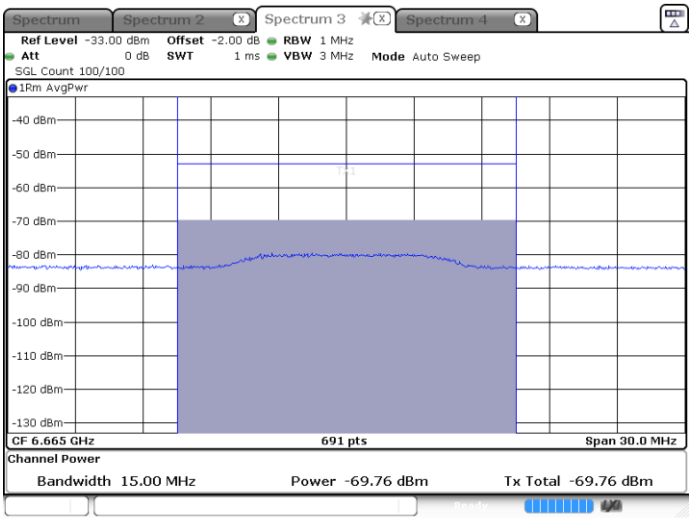
Date: 7.FEB.2023 19:09:50

802.11ax (HE160)-Channel 143 (Low Edge)



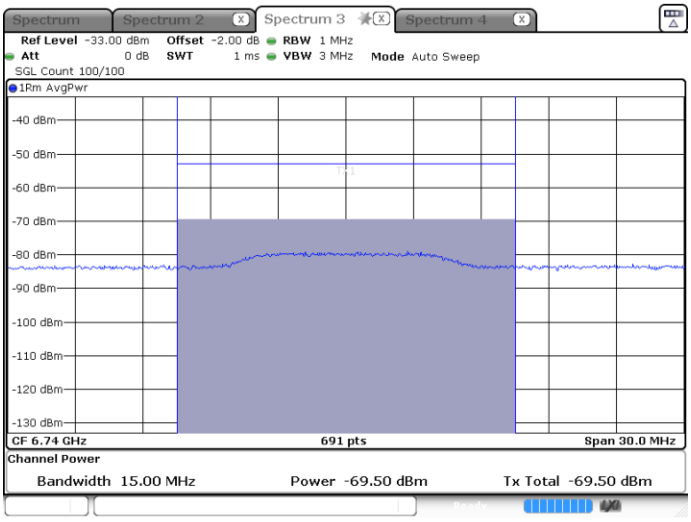
Date: 7.FEB.2023 19:14:01

802.11ax (HE160)-Channel 143 (Middle Edge)



Date: 7.FEB.2023 19:14:28

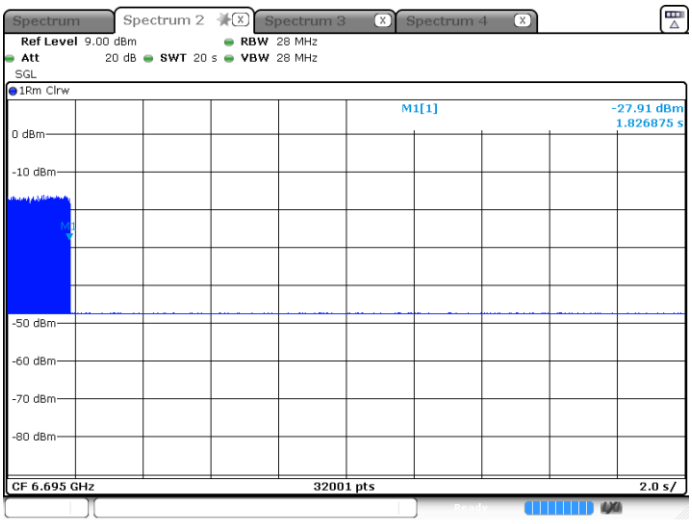
802.11ax (HE160)-Channel 143 (High Edge)



Date: 7.FEB.2023 19:15:00

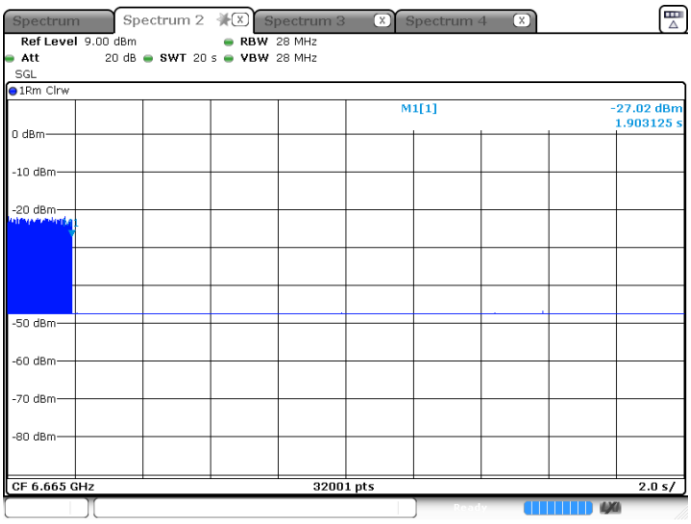
Plots of EUT Tx waveform

802.11ax (HE20)-Channel 149



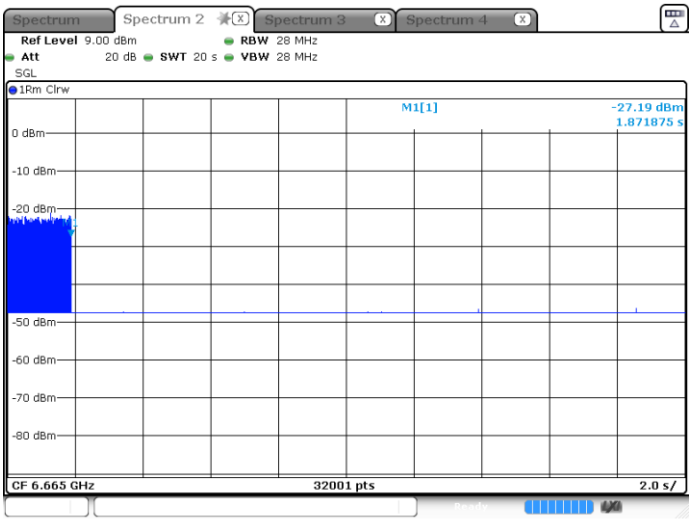
Date: 7.FEB.2023 18:58:47

802.11ax (HE160)-Channel 143 (Low Edge)



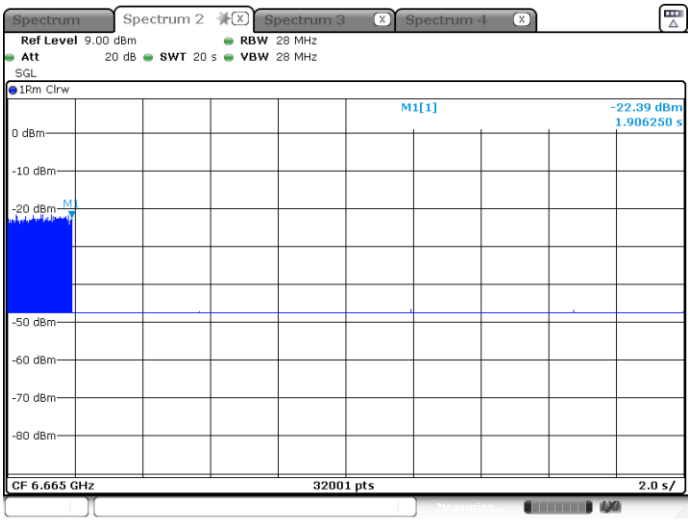
Date: 7.FEB.2023 18:28:57

802.11ax (HE160)-Channel 143 (Middle Edge)



Date: 7.FEB.2023 18:30:41

802.11ax (HE160)-Channel 143 (High Edge)



Date: 7.FEB.2023 18:32:15

Interference Signals used for Tests

Interference Signals Type	Bandwidth (MHz)
AWGN	10

Regulated Threshold Level

Test Method	Interference threshold level
☒ Conducted ☐ Radiation	The Regulated Threshold Level = -62 dBm (assumes a 0 dBi receive antenna) and minimum antenna gain is 3.98 dBi. The Regulated Threshold Level = -62 dBm + G (3.98 dBi) = -58.02 dBm

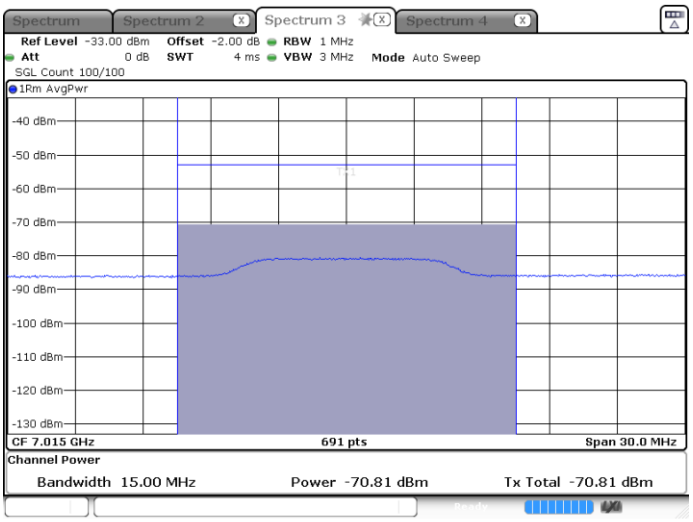
Test Data

U-NII-8 (6875 MHz to 7125 MHz)								
Operation Mode	Channel Number	Channel Frequency (MHz)	AWGN Signal Frequency (MHz)	Measured Detection Level (dBm)	Detection Rate	Regulated Threshold Level (dBm)	Margin (dB)	Verdict
802.11ax (HE20)	213	7015	7015	-70.81	90%	-58.02	-12.79	pass
802.11ax (HE160)	207	6985	6910	-68.86	100%	-58.02	-10.84	pass
			6985	-69.49	90%	-58.02	-11.47	pass
			7060	-70.81	100%	-58.02	-12.79	pass

Test Plots

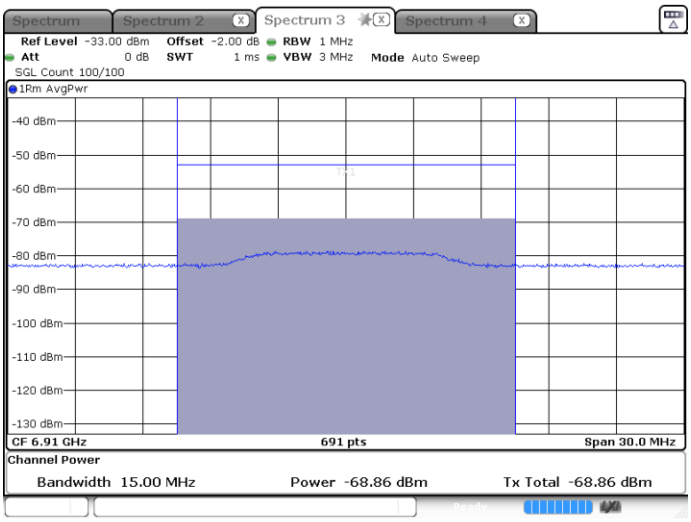
Plots of Incumbent signal(AWGN) Level

802.11ax (HE20)-Channel 213



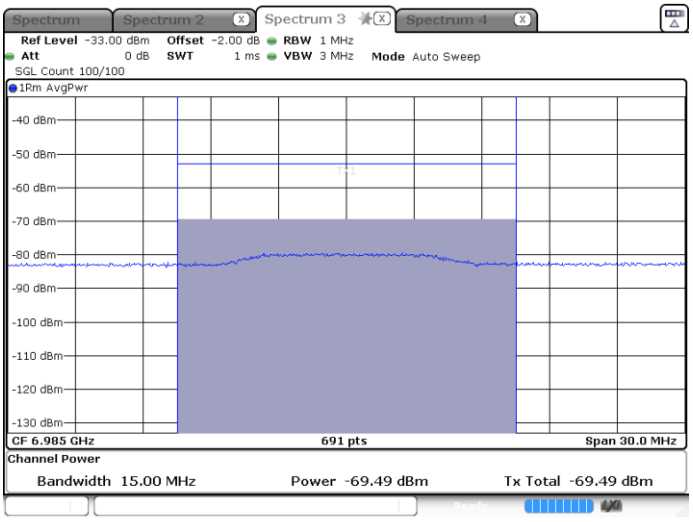
Date: 7.FEB.2023 19:10:33

802.11ax (HE160)-Channel 207 (Low Edge)



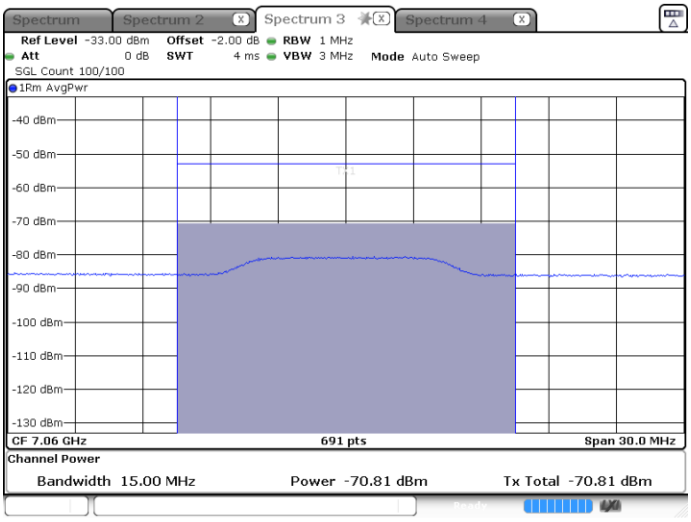
Date: 7.FEB.2023 19:15:29

802.11ax (HE160)-Channel 207 (Middle Edge)



Date: 7.FEB.2023 19:16:14

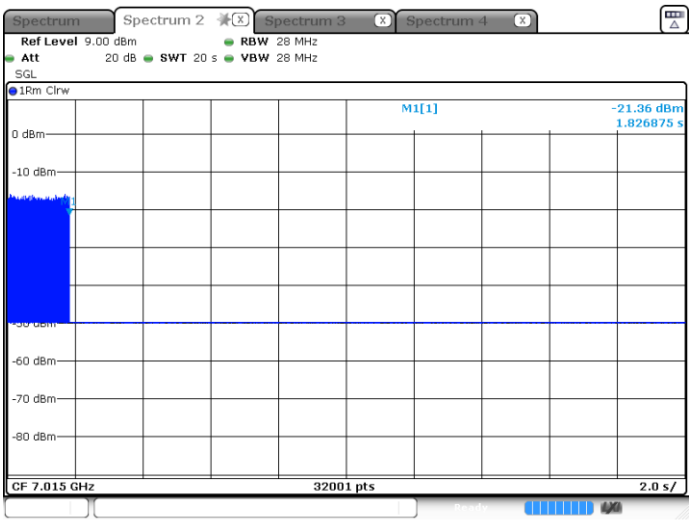
802.11ax (HE160)-Channel 207 (High Edge)



Date: 7.FEB.2023 19:16:34

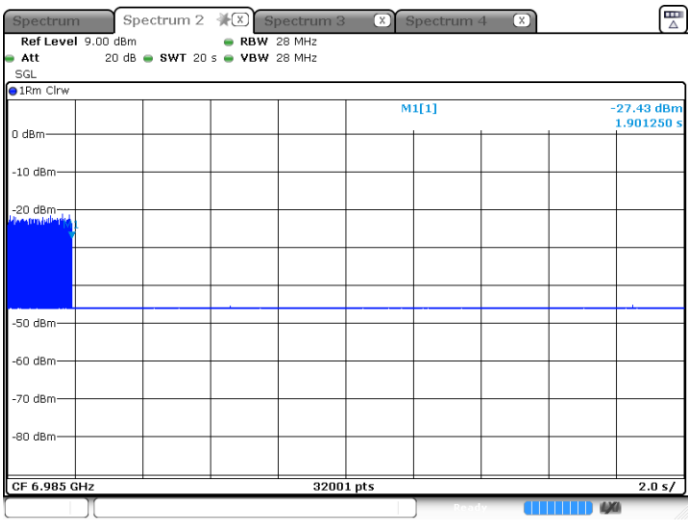
Plots of EUT Tx waveform

802.11ax (HE20)-Channel 213



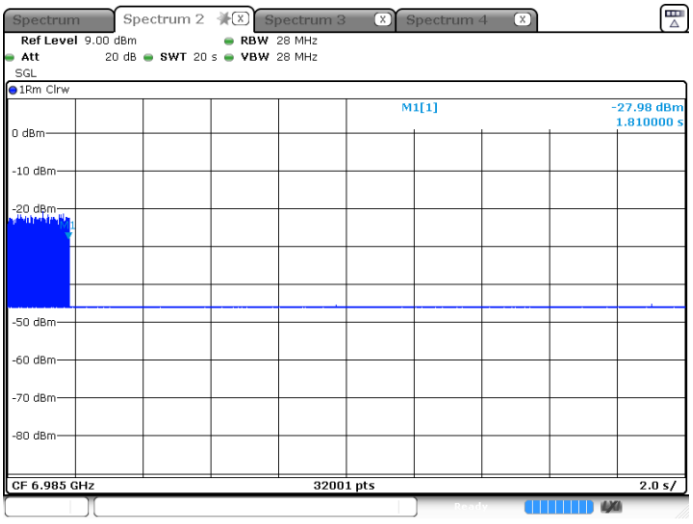
Date: 7.FEB.2023 19:01:26

802.11ax (HE160)-Channel 207 (Low Edge)



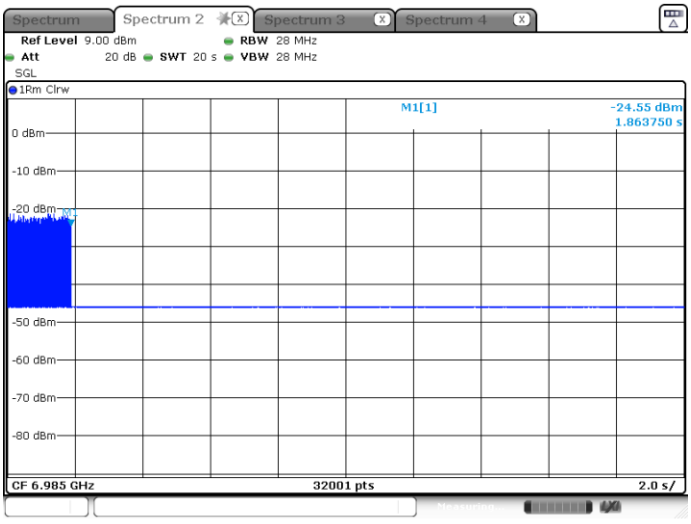
Date: 7.FEB.2023 18:25:45

802.11ax (HE160)-Channel 207 (Middle Edge)



Date: 7.FEB.2023 18:23:01

802.11ax (HE160)-Channel 207 (High Edge)



Date: 7.FEB.2023 18:21:00

A.8 In-Band Emissions

Note: Not applicable.

ANNEX B TEST SETUP PHOTOS

Please refer the document “BL-SZ2310644-AR-2.PDF”.

ANNEX C EUT EXTERNAL PHOTOS

Please refer the document “BL-SZ2310644-AW.PDF”.

ANNEX D EUT INTERNAL PHOTOS

Please refer the document “BL-SZ2310644-AI.PDF”.

Statement

1. The laboratory guarantees the scientificity, accuracy and impartiality of the test, and is responsible for all the information in the report, except the information provided by the customer. The customer is responsible for the impact of the information provided on the validity of the results.
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