11ax_HE80U_242T (Band 7)

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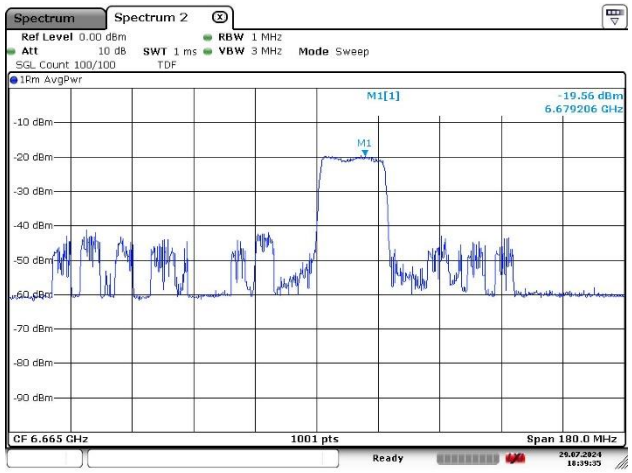	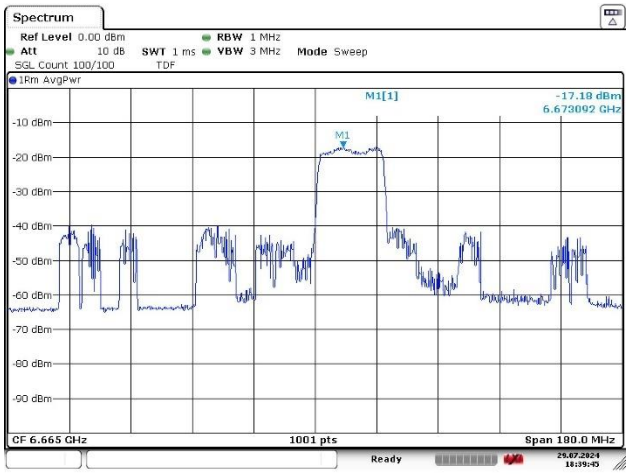
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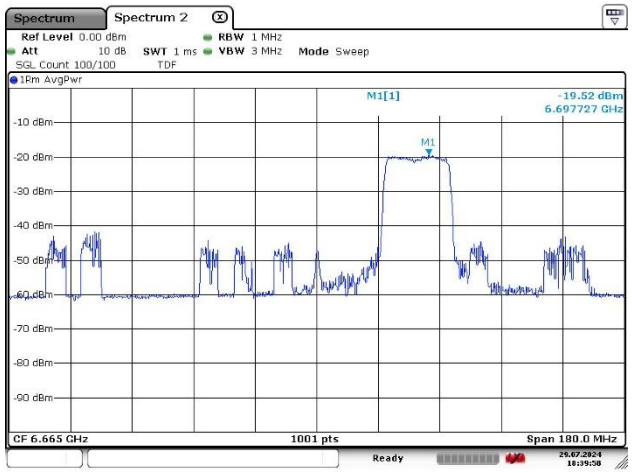	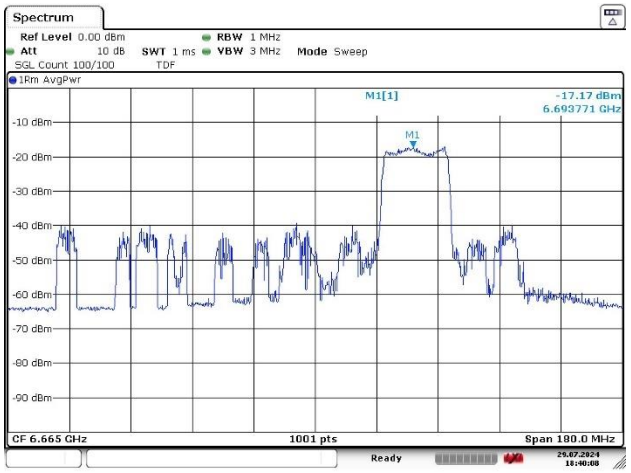
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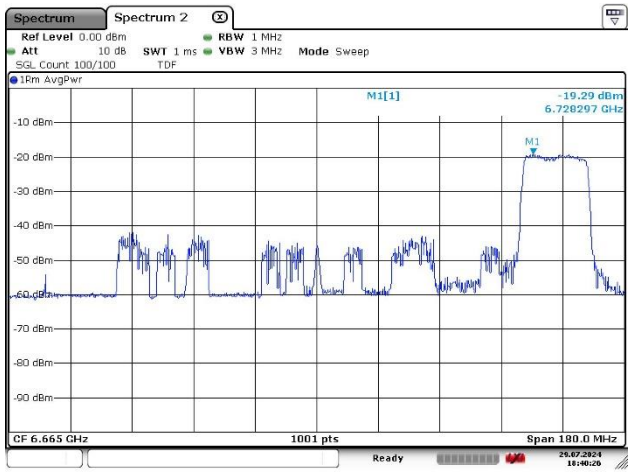	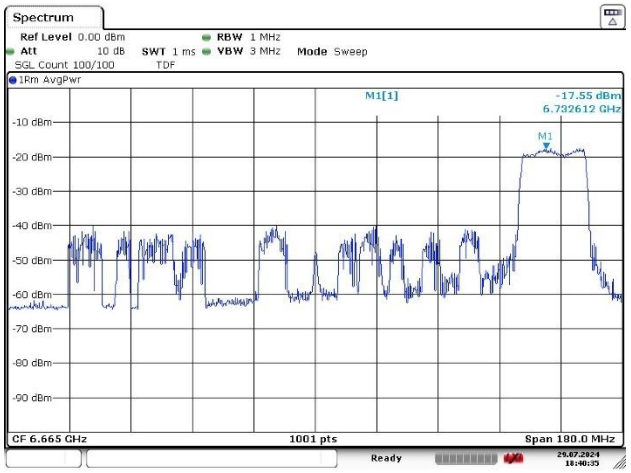

11ax_HE80U_484T (Band 5)

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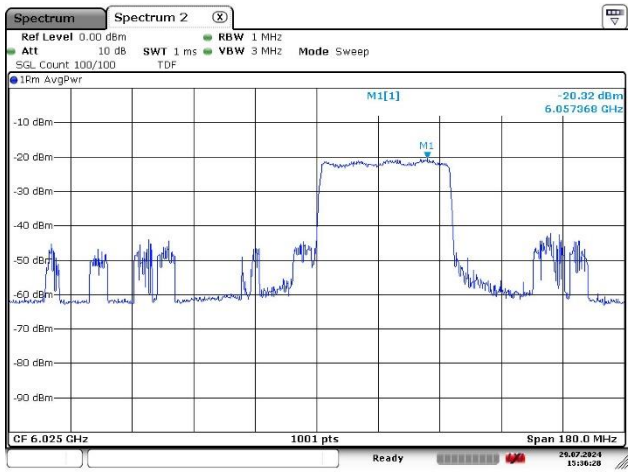	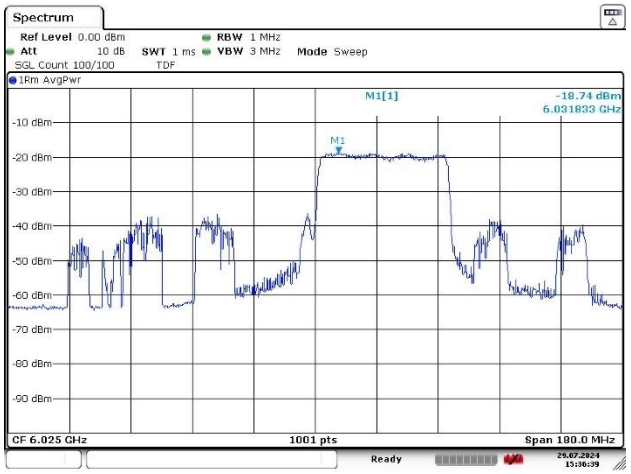
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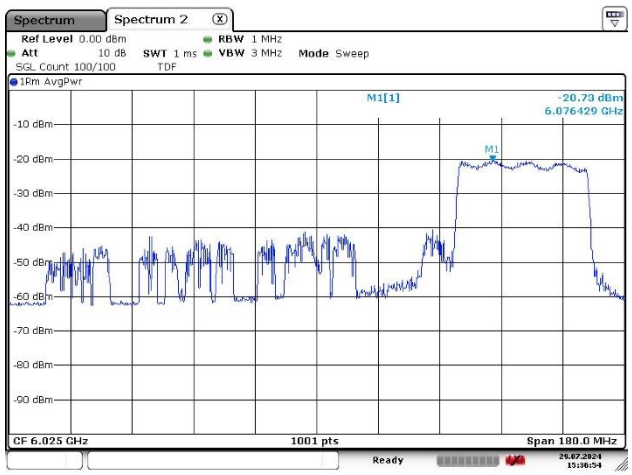	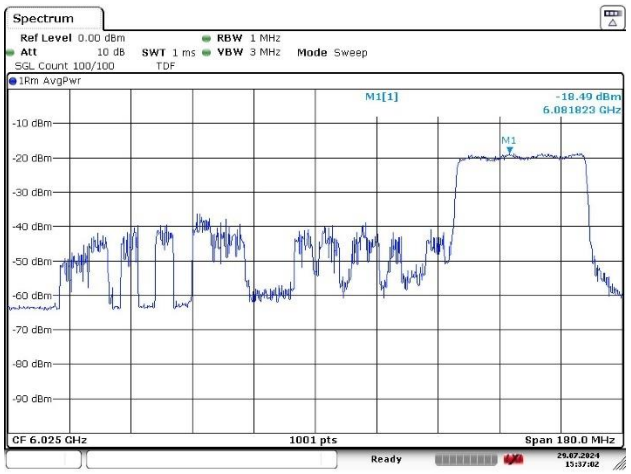

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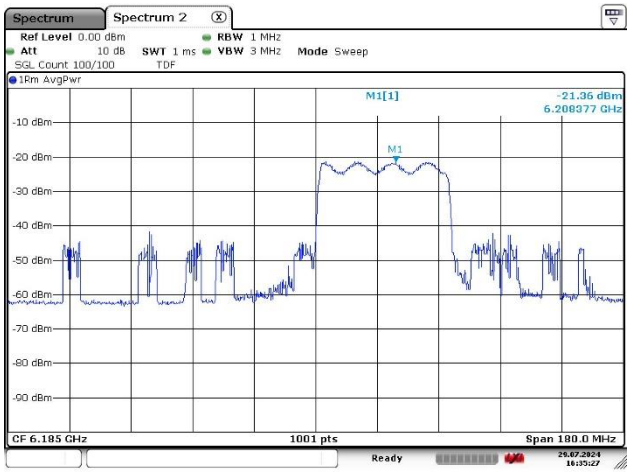	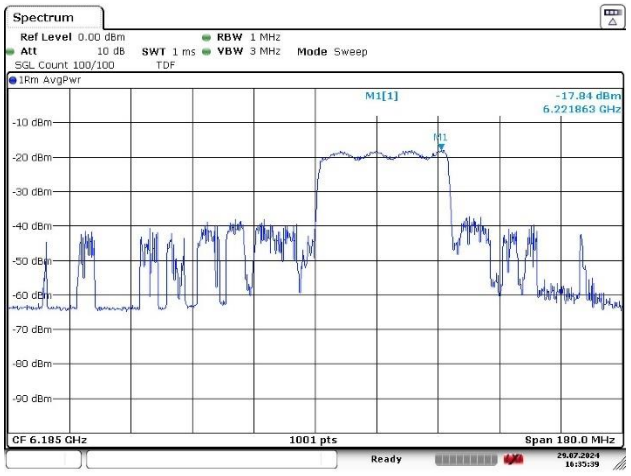
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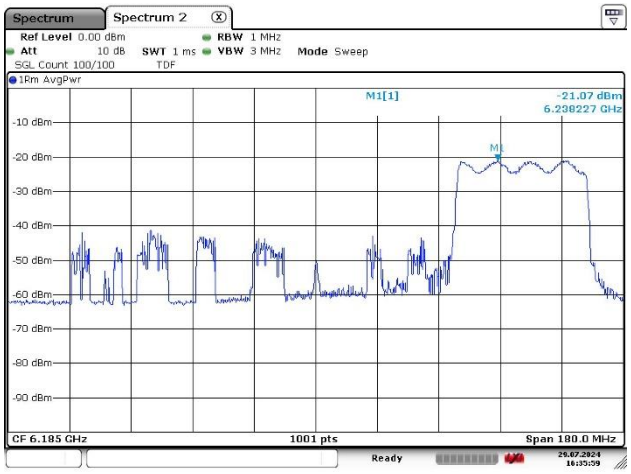	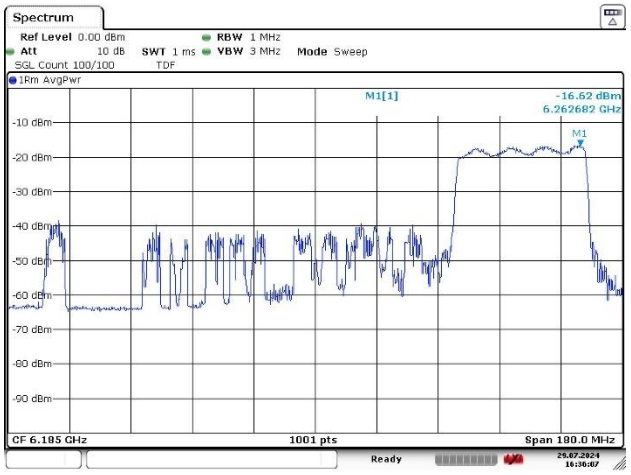

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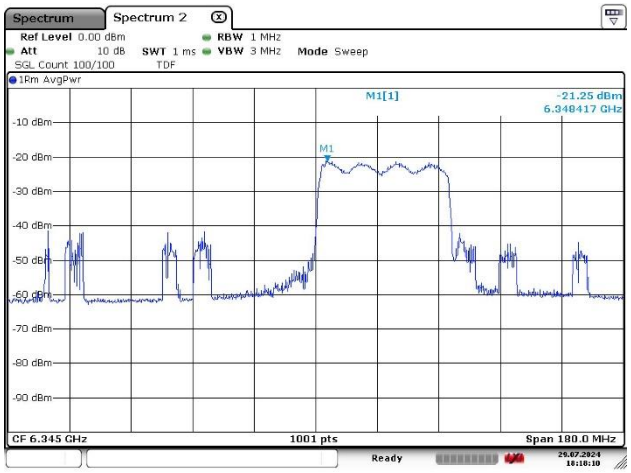	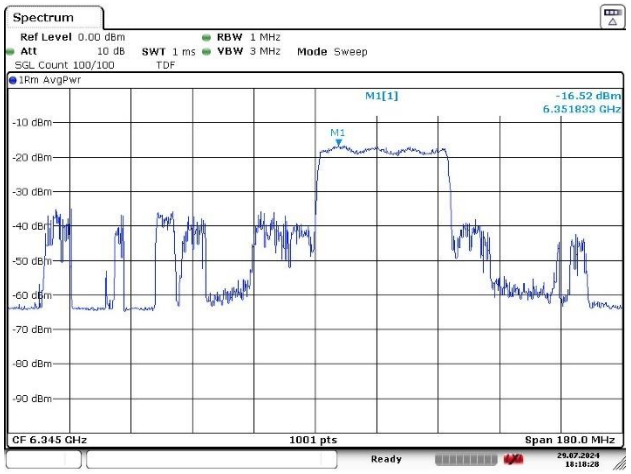
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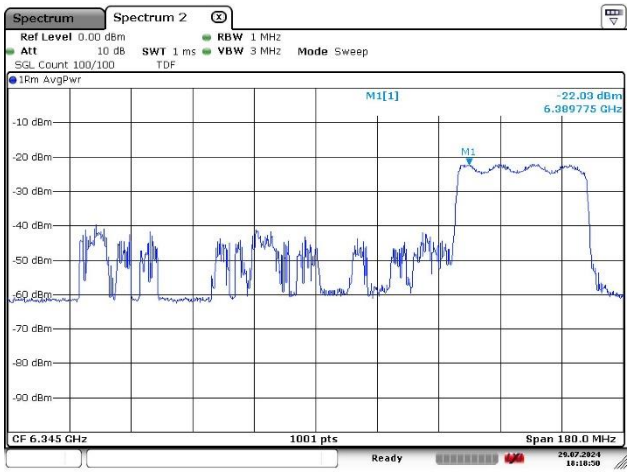	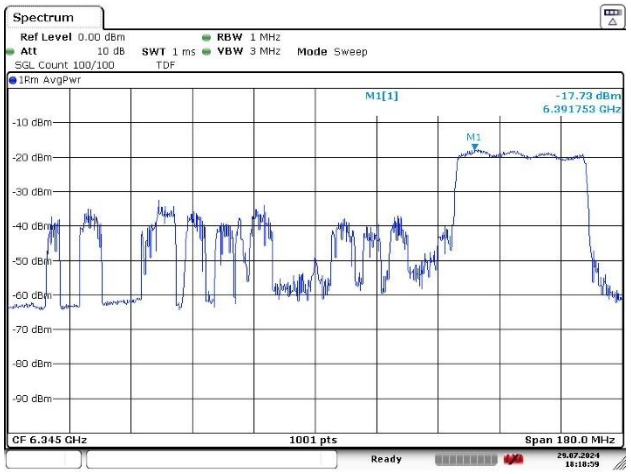

11ax_HE80U_484T (Band 7)

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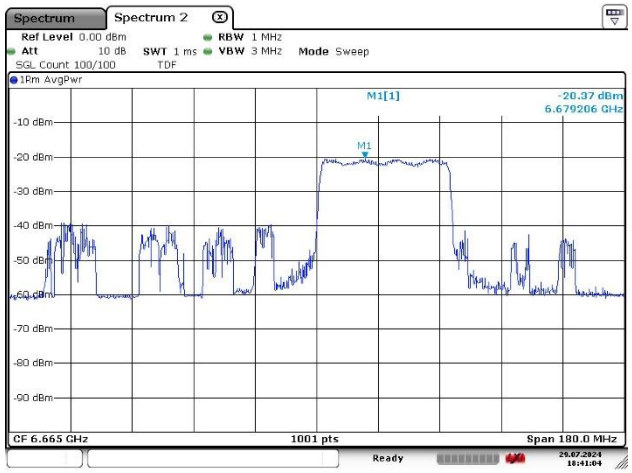	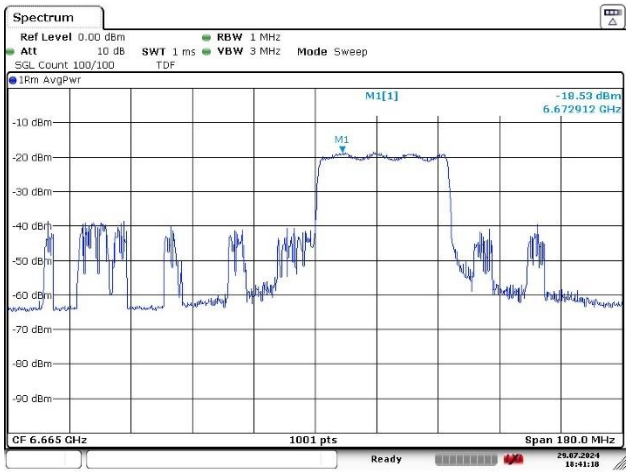
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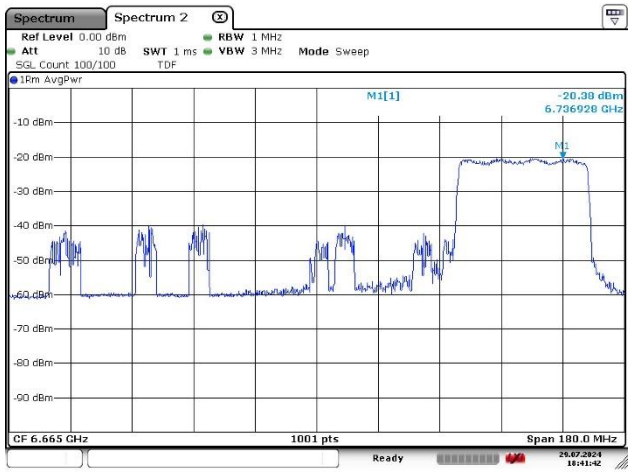	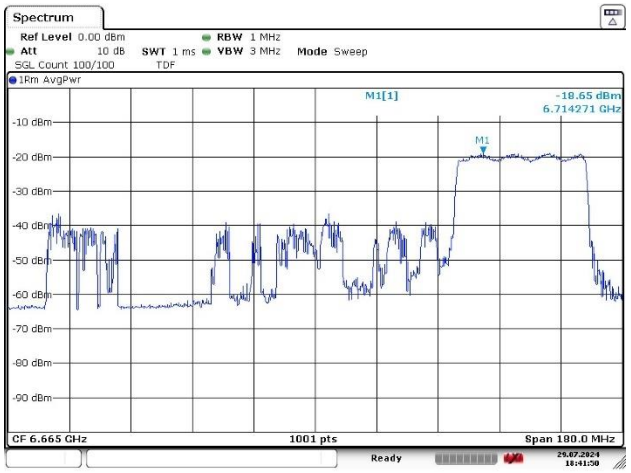

11ax_HE80U_996T (Band 5)

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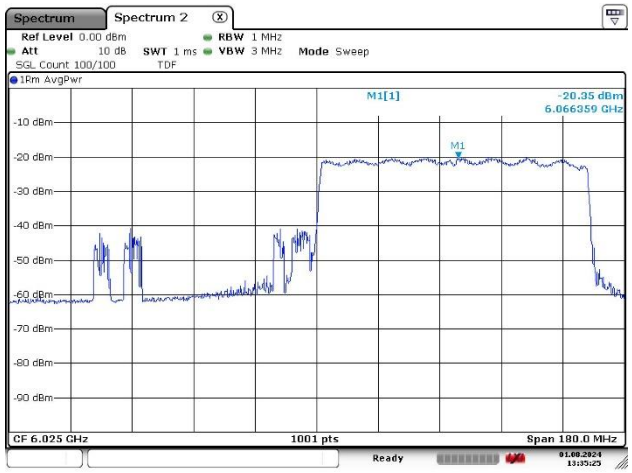	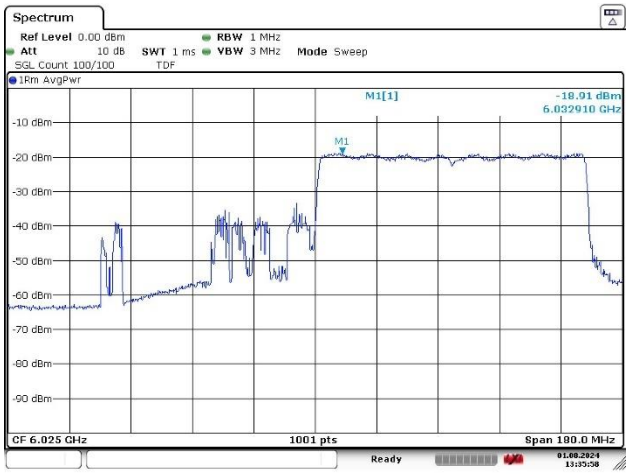
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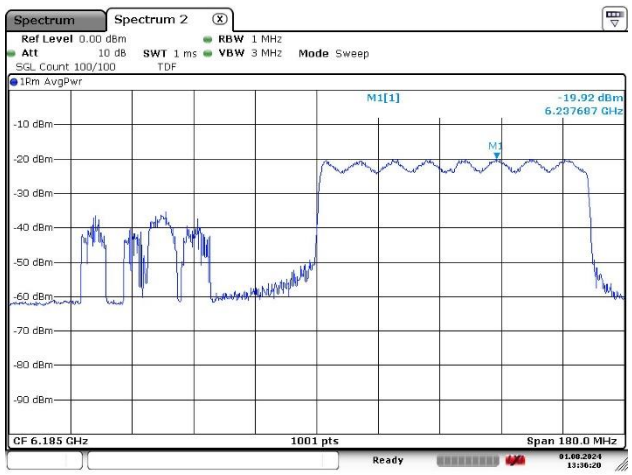	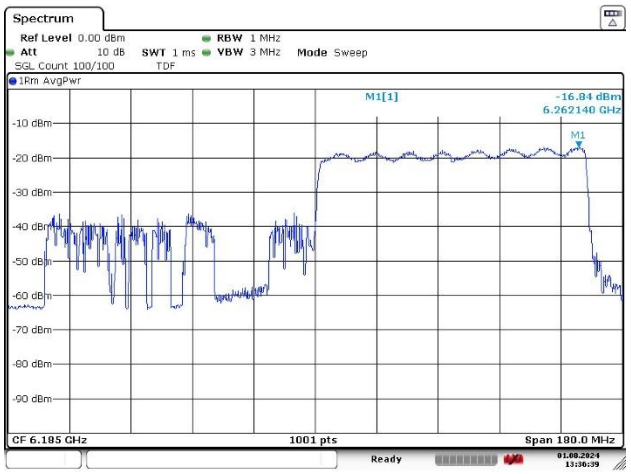
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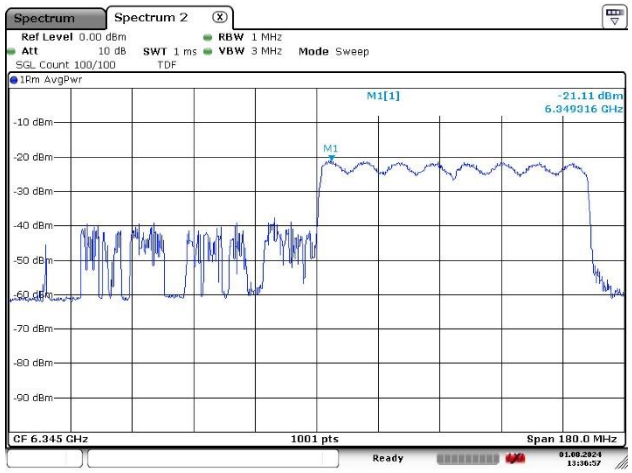	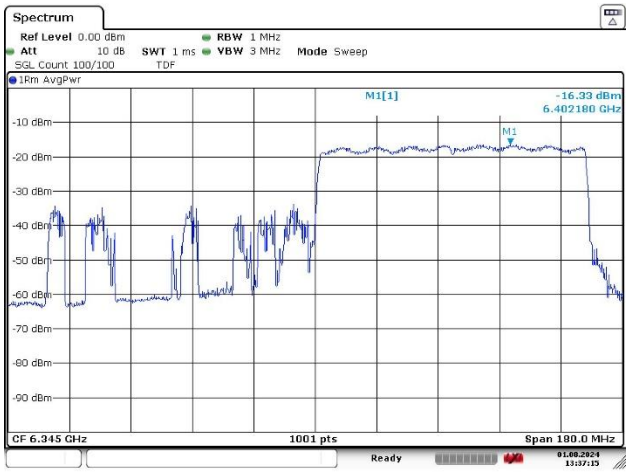

11ax_HE80U_996T (Band 7)

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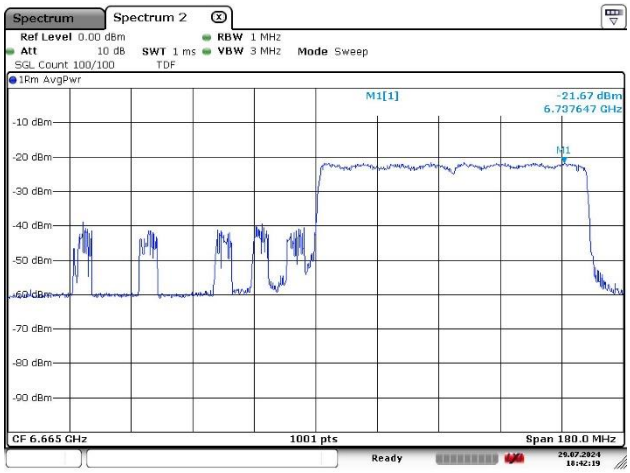	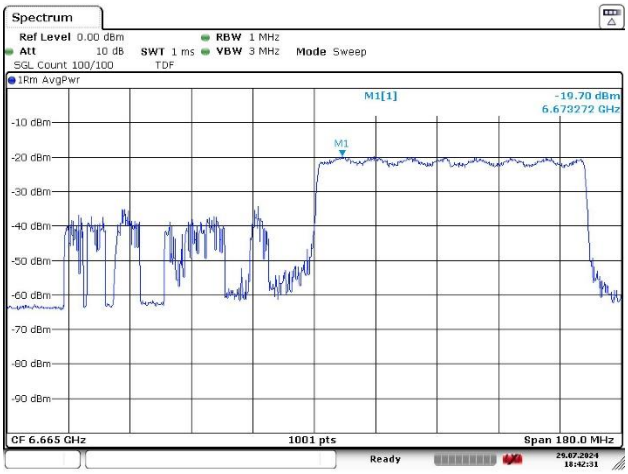

11ax_HE160_2x996T (Band 5)

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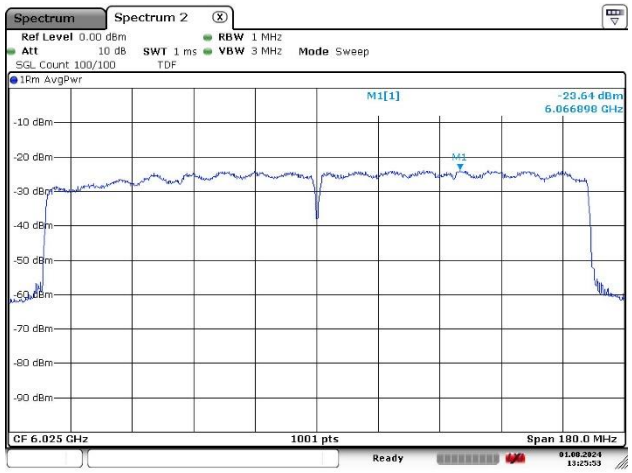	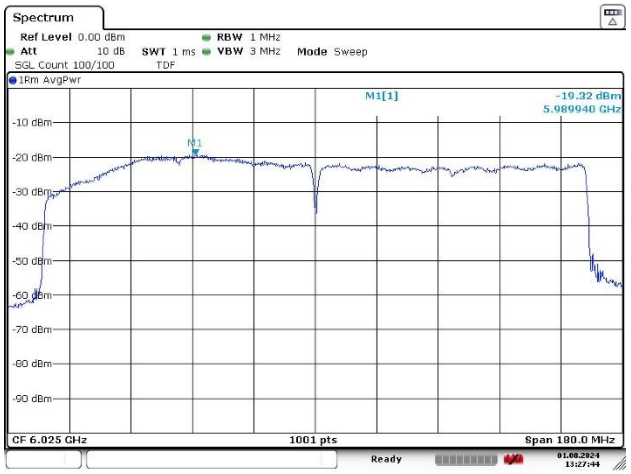
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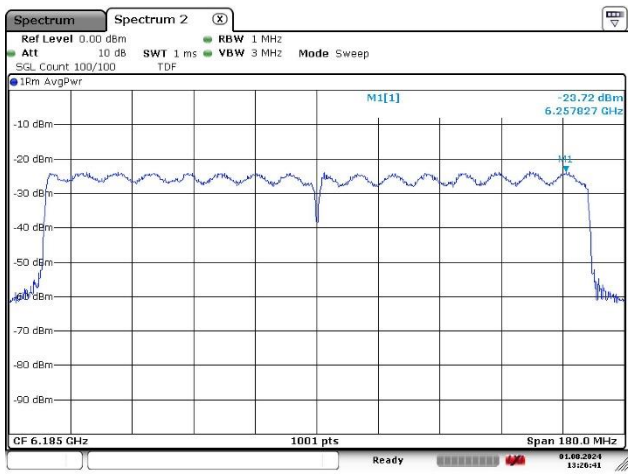	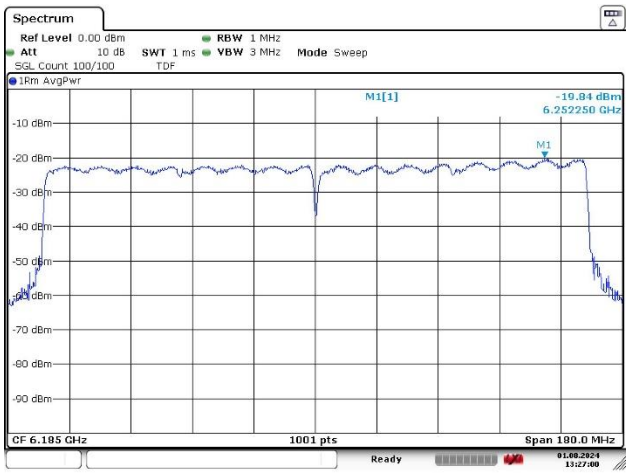
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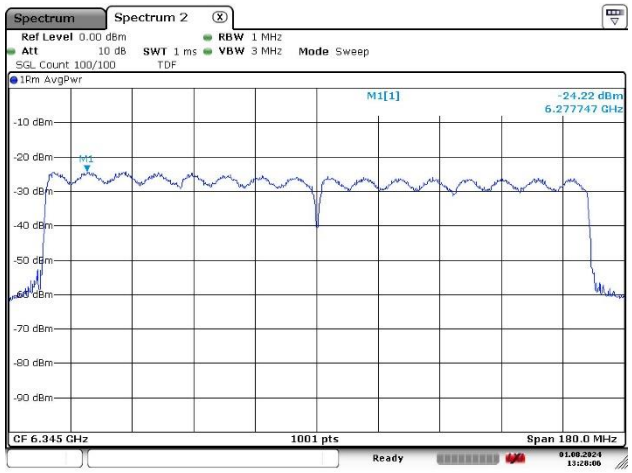	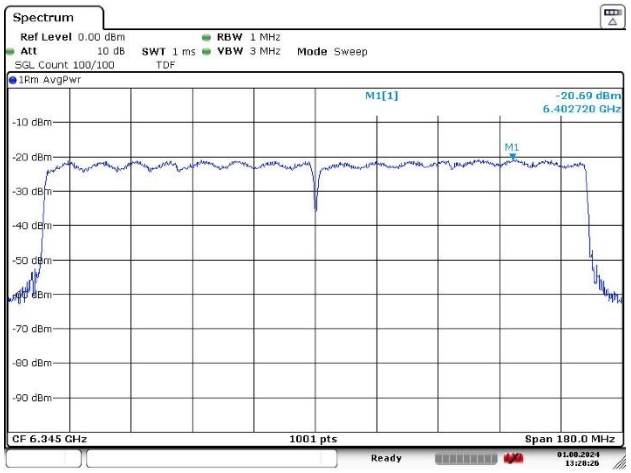

11ax_HE160_2x996T (Band 7)

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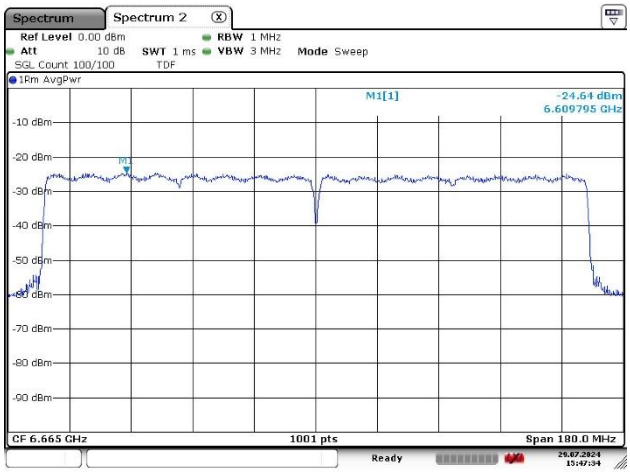	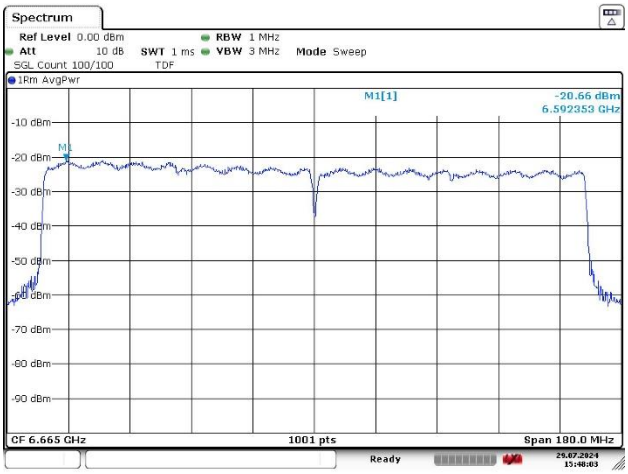

11ax_HE160_SU (Band 5)

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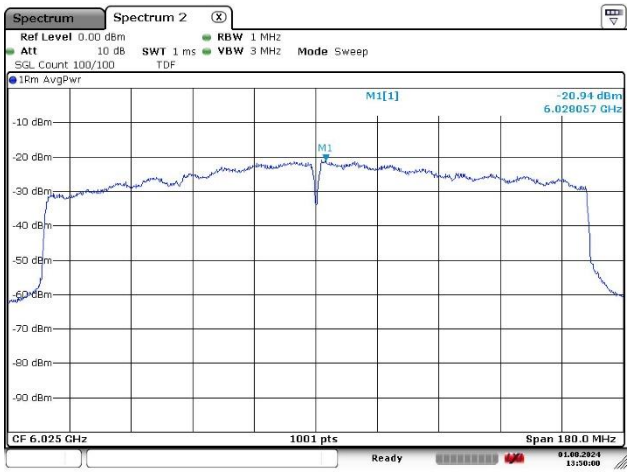	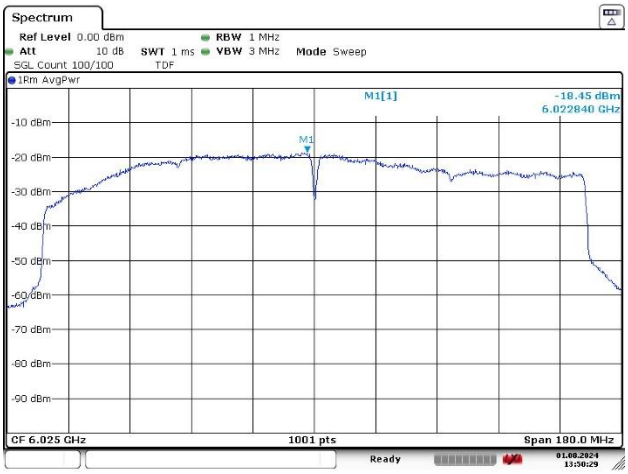
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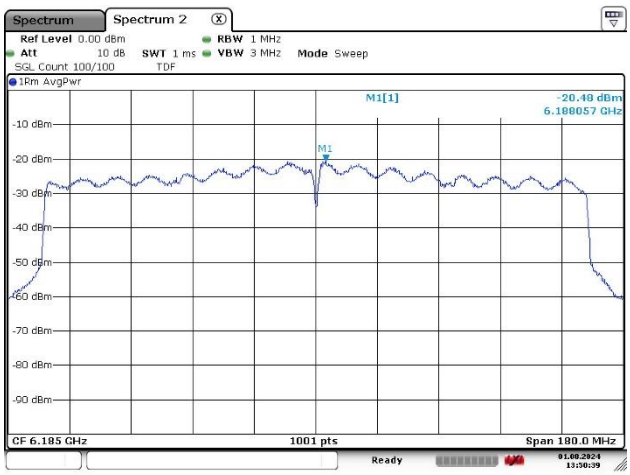
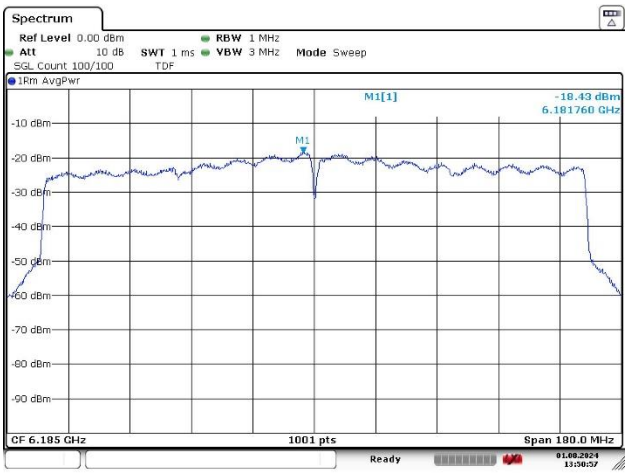
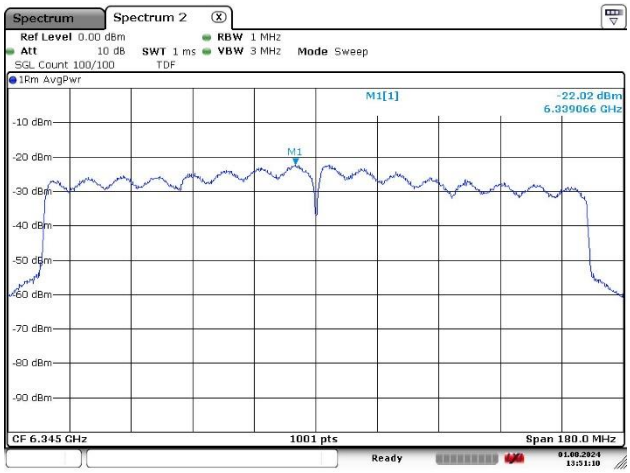
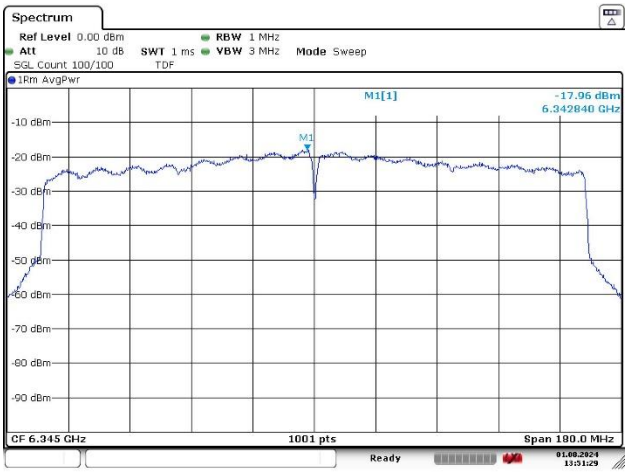
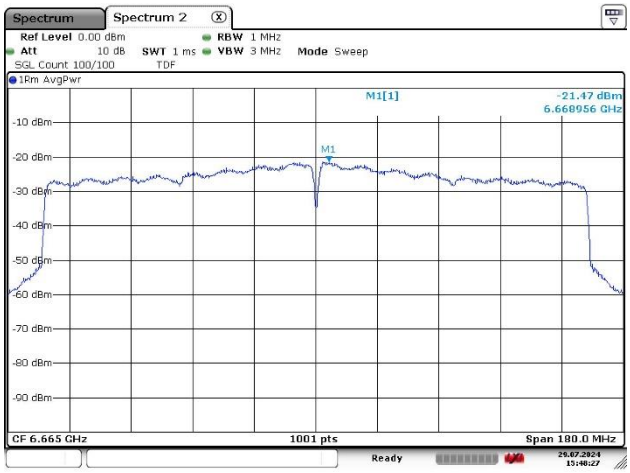
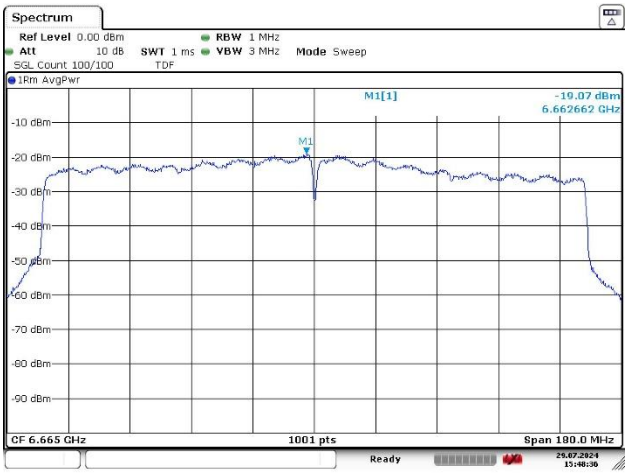
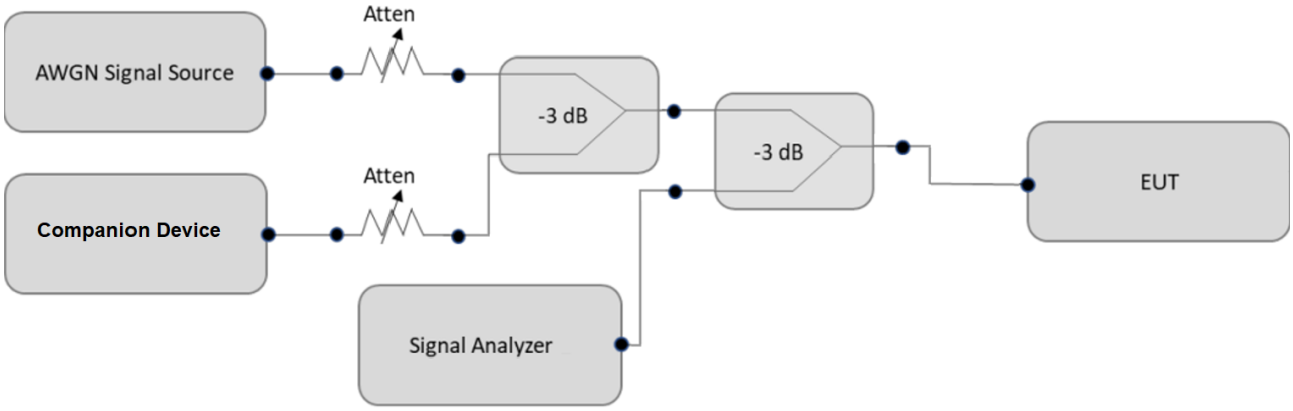
	
Port 1_High Channel (6 345 ㎒)	Port 2_High Channel (6 345 ㎒)
	

11ax_HE160_SU (Band 7)

Port 1_Middle Channel (6 665 ㎒)	Port 2_Middle Channel (6 665 ㎒)
	

7. Contention Based Protocol

7.1. Test Setup



7.2. Limit

Indoor access points, subordinate devices and client devices operating in the 5.925 ㎓ – 7.125 ㎓ 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 ㏈m or lower. Upon detection of energy in the band, unlicensed low power indoor devices must vacate the channel (in which incumbent signal is transmitted) and stay off the incumbent channel as long as detected radio frequency power is equal to or greater than the threshold (-62 ㏈m). The -62 ㏈m (or lower) threshold is referenced to a 0 ㏈i antenna gain.

To ensure incumbent operations are reliably detected in the band, low power indoor devices must detect RF energy throughout their intended operating channel. For example, an 802.11 device that plans to transmit a 40 ㎒ - wide signal (on a primary 20 ㎒ channel and a secondary 20 ㎒ channel) must detect energy throughout the entire 40 ㎒ channel. Additionally, low-power indoor devices must detect co-channel energy with 90 % or greater certainty.

7.3. Test Procedure

1. This measurement settings are specified in section Ⅱ.I of KDB 987594 D02 General UNII Test Procedures New Rules v02r01.

2. Configure the EUT to transmit with a constant duty cycle.

3. Set the operating parameters of the EUT including power level, operating frequency, modulation and bandwidth.

4. Set the signal analyzer center frequency to the nominal EEUT channel center frequency. The span range of the signal analyzer shall be between two times and five times the OBW of the EUT. Connect the output port of the EUT to the signal analyzer 2, as shown in 6.1. Test setup. Ensure that the attenuator 2 provides enough attenuation to not overload the signal analyzer 2 receiver.

5. Monitoring the signal analyzer 2, verify the EUT is operating and transmitting with the parameters set at step two.

6. Using an AWGN signal source, generate (but do not transmit, i.e., RF OFF) a 10 ㎒-wide AWGN signal. Use Table 1 to determine the center frequency of the 10 ㎒ AWGN signal relative to the EUT's channel bandwidth and center frequency.

7. Set the AWGN signal power to an extremely low level (more than 20 ㏈ below the -62 ㏈m threshold). Connect the AWGN signal source, via a 3-㏈ splitter, to the signal analyzer 1 and the EUT as shown in 6.1. Test setup.

8. Transmit the AWGN signal (RF ON) and verify its characteristics on the signal analyzer 1.

9. Monitor the signal analyzer 2 to verify if the AWGN signal has been detected and the EUT has ceased transmission. If the EUT continues to transmit, then incrementally increase the AWGN signal power level until the EUT stops transmitting.

10. (Including all losses in the RF paths) Determine and record the AWGN signal power level (at the EUT's antenna port) at which the EUT ceased transmission. Repeat the procedure at least 10 times to verify the EUT can detect an AWGN signal with 90 % (or better) level of certainty.

11. Refer to Table 1 to determine number of times the detection threshold testing needs to be repeated. If testing is required more than once, then go back to step 5, choose a different center frequency for the AWGN signal and repeat the process.

Table 1. Criteria to determine number of times detection threshold test may be performed

If	Number of Tests	Placement of Incumbent Transmission
$BW_{EUT} \leq BW_{Inc}$	Once	Tune incumbent and EUT transmissions ($f_{c1} = f_{c2}$)
$BW_{Inc} < BW_{EUT} \leq 2BW_{Inc}$	Once	Incumbent transmission is contained within BW_{EUT}
$2BW_{Inc} < BW_{EUT} \leq 4BW_{Inc}$	Twice. Incumbent transmission is contained within BW_{EUT}	Incumbent transmission is located as closely as possible to the lower edge and upper edge, respectively, of the EUT channel
$BW_{EUT} > 4BW_{Inc}$	Three times	Incumbent transmission is located as closely as possible to the lower edge of the EUT channel, in the middle of EUT channel, and as closely as possible to the upper edge of the EUT channel

where:

BW_{EUT}: Transmission bandwidth of EUT signal
BW_{Inc}: Transmission bandwidth of the simulated incumbent signal (10 MHz wide AWGN signal)
f_{c1}: Center frequency of EUT transmission
f_{c2}: Center frequency of simulated incumbent signal

7.4. Test Result

Ambient temperature : (23 ± 1) ℃
Relative humidity : 47 % R.H.

Test mode: 11ax_HE20

Band	Freq. (㎒)	Incumbent Frequency (㎒)	Ch.	Mode	Injected Power (dB m)	Antenna Gain (dB i)	Path Loss (dB)	Adjusted Power (dB m)	Detection Limit (dB m)	Margin (dB)	Number of successes	Total Number of attempts
U-NII 5	6 195	6 195	49	OFF	-96.75	-0.28	20.01	-76.46	-62	14.46	10	10
				Minimal	-97.75	-0.28	20.01	-77.46	-62	15.46	10	10
				On	-98.75	-0.28	20.01	-78.46	-62	16.46	10	10
U-NII 7	6 695	6 695	149	OFF	-99.98	-2.52	25.13	-72.33	-62	10.33	10	10
				Minimal	-100.98	-2.52	25.13	-73.33	-62	11.33	10	10
				On	-101.98	-2.52	25.13	-74.33	-62	12.33	10	10

Remark;

1. Incumbent Signal was an AWGN signal with a bandwidth of 10 ㎒.
2. Adjusted power = Injected Power (dB m) - Antenna Gain (dB i) + Path Loss (dB)
3. Antenna gain is for port 2 as worst case.

*OFF: AWGN level at which no transmission is detected, consistently for a minimum period of 10 seconds

*Minimal: The AWGN level at which the system starts to trigger the transmission switch-off, although it is not kept off consistently.

*ON = AWGN level at which no impact on the transmission is detected, consistently for a minimum period of 10 seconds

Test mode: 11ax_HE160

Band	Freq. (㎒)	Incumbent Frequency (㎒)	Ch.	Mode	Injected Power (dB m)	Antenna Gain (dB i)	Path Loss (dB)	Adjusted Power (dB m)	Detection Limit (dB m)	Margin (dB)	Number of successes	total number of attempts
U-NII 5	6 185	6 110	47	OFF	-87.95	-0.28	19.95	-67.72	-62	5.72	10	10
				Minimal	-88.95	-0.28	19.95	-68.72	-62	6.72	10	10
				On	-89.95	-0.28	19.95	-69.72	-62	7.72	10	10
		6 185		OFF	-86.43	-0.28	20.01	-66.14	-62	4.14	10	10
				Minimal	-88.43	-0.28	20.01	-68.14	-62	6.14	10	10
				On	-90.43	-0.28	20.01	-70.14	-62	8.14	10	10
		6 260		OFF	-97.26	-0.28	22.13	-74.85	-62	12.85	10	10
				Minimal	-99.26	-0.28	22.13	-76.85	-62	14.85	10	10
				On	-100.26	-0.28	22.13	-77.85	-62	15.85	10	10
U-NII 7	6 665	6 590	143	OFF	-93.97	-2.52	24.56	-66.89	-62	4.89	10	10
				Minimal	-94.97	-2.52	24.56	-67.89	-62	5.89	10	10
				On	-95.97	-2.52	24.56	-68.89	-62	6.89	10	10
		6 665		OFF	-90.90	-2.52	25.10	-63.28	-62	1.28	10	10
				Minimal	-92.90	-2.52	25.10	-65.28	-62	3.28	10	10
				On	-93.90	-2.52	25.10	-66.28	-62	4.28	10	10
		6 740		OFF	-98.37	-2.52	26.45	-69.40	-62	7.40	10	10
				Minimal	-100.37	-2.52	26.45	-71.40	-62	9.40	10	10
				On	-101.37	-2.52	26.45	-72.40	-62	10.40	10	10

Remark;

1. Incumbent Signal was an AWGN signal with a bandwidth of 10 ㎒.
2. Adjusted power = Injected Power (㏈m) - Antenna Gain (㏈i) + Path Loss (㏈)
3. Antenna gain is for port 2 as worst case.

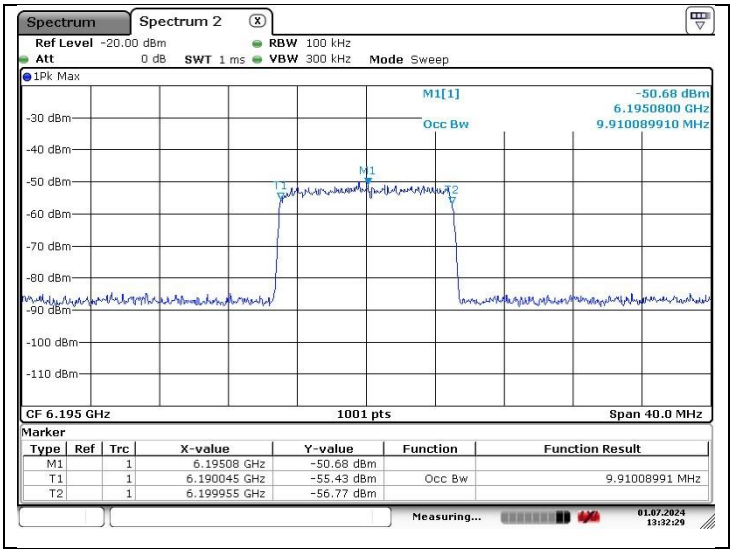
*OFF: AWGN level at which no transmission is detected, consistently for a minimum period of 10 seconds

*Minimal: The AWGN level at which the system starts to trigger the transmission switch-off, although it is not kept off consistently.

*ON = AWGN level at which no impact on the transmission is detected, consistently for a minimum period of 10 seconds

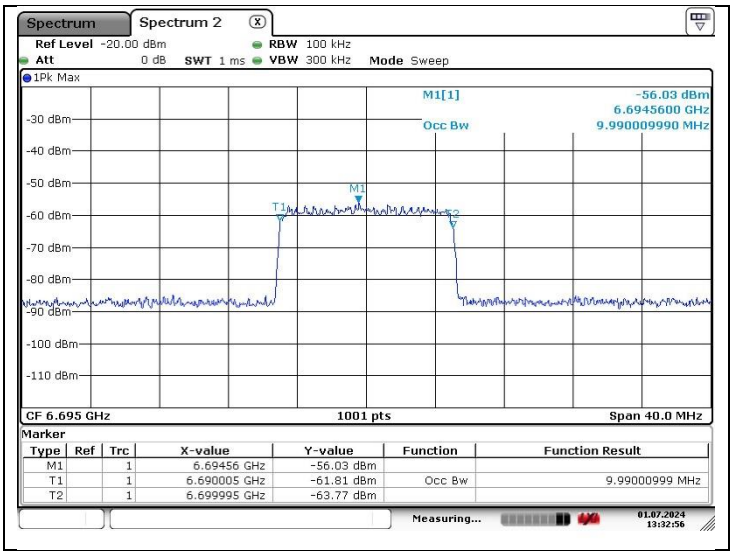
AWGN signal sample

For UNII 5 band



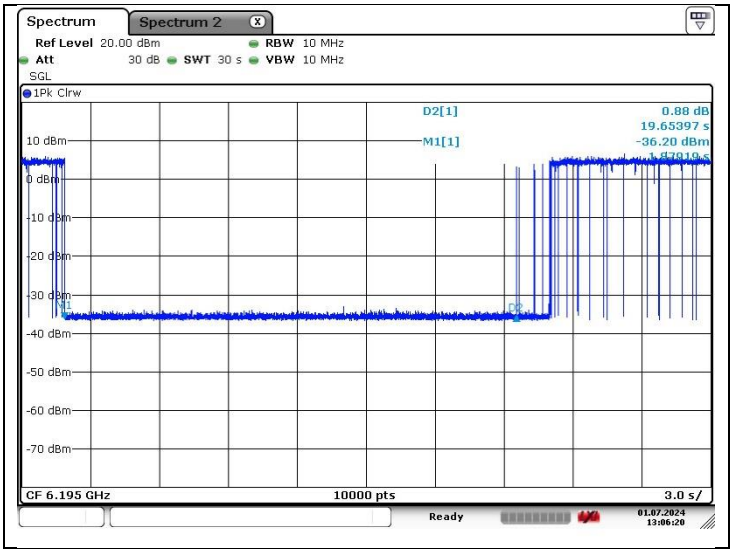
AWGN signal sample

For UNII 7 band

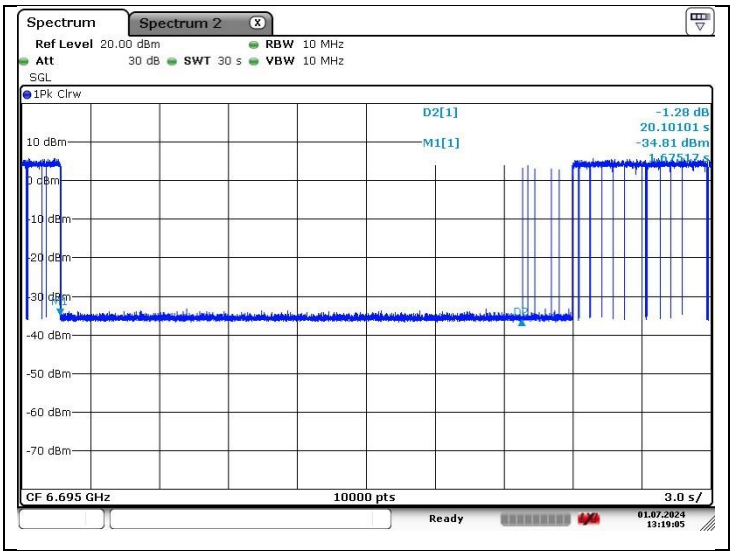


Contention based protocol timing plots

For UNII 5 band 20 ㎒

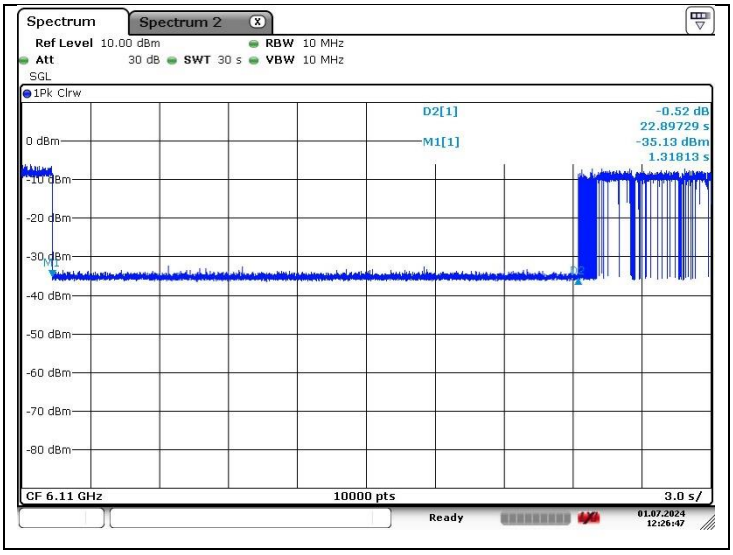


For UNII 7 band 20 ㎒

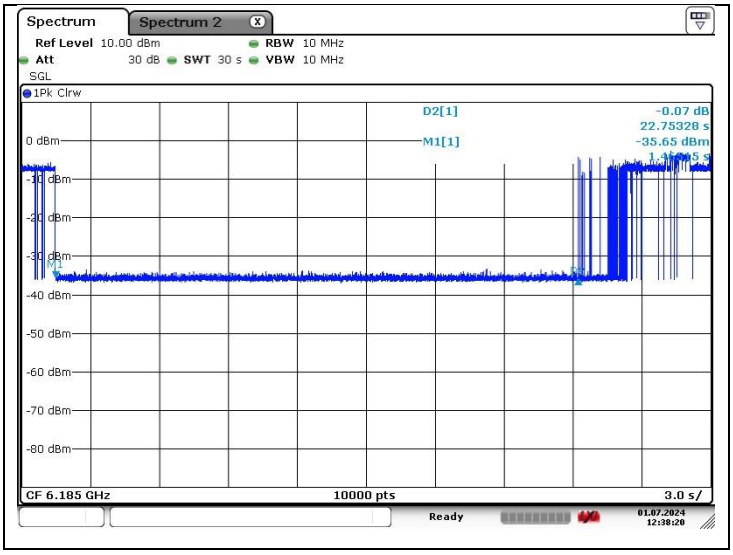


Contention based protocol timing plots

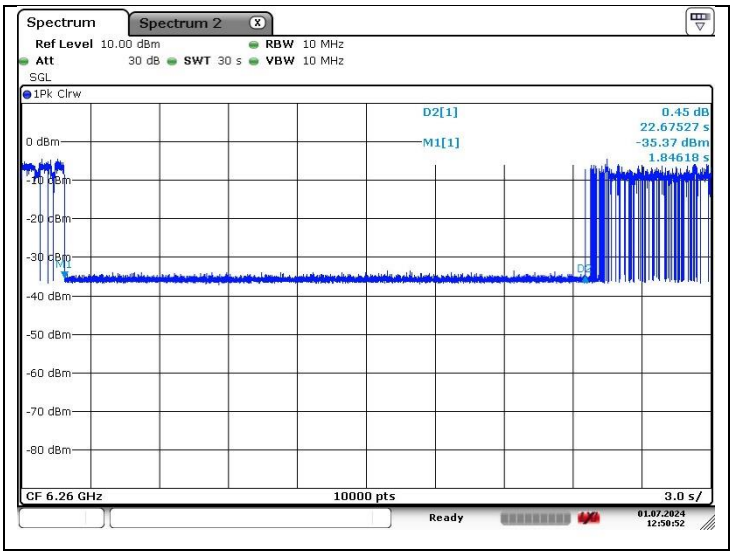
For UNII 5 band 160 ㎒



For UNII 5 band 160 ㎒

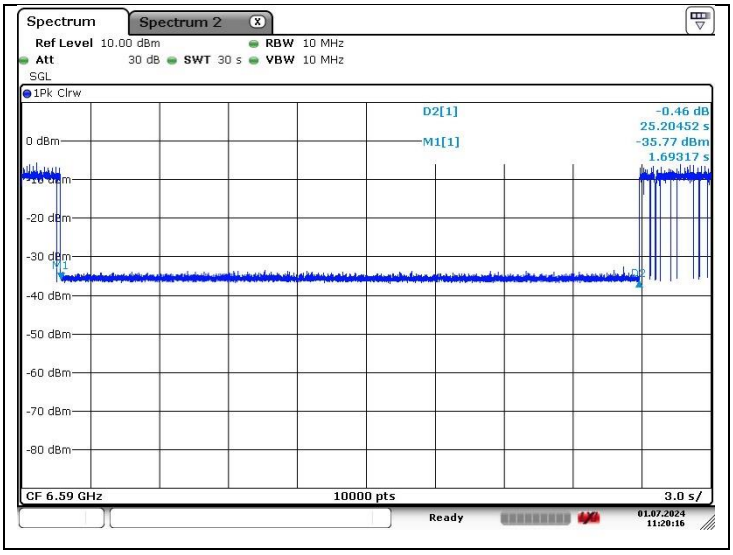


For UNII 5 band 160 ㎒

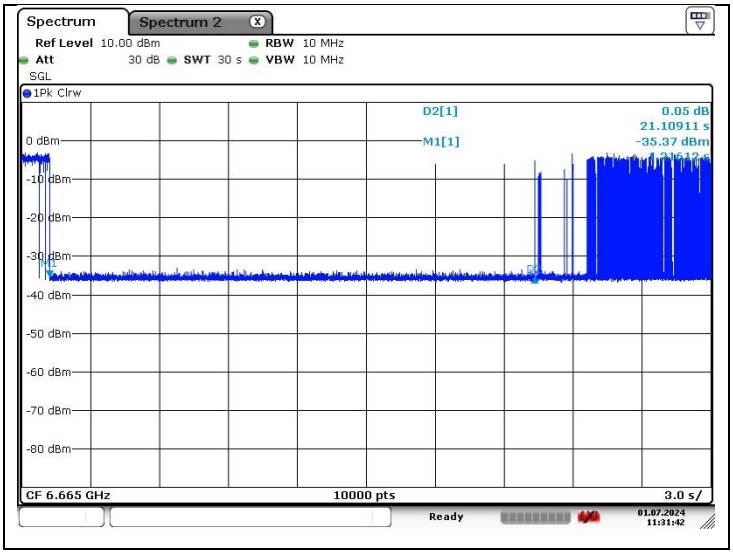


Contention based protocol timing plots

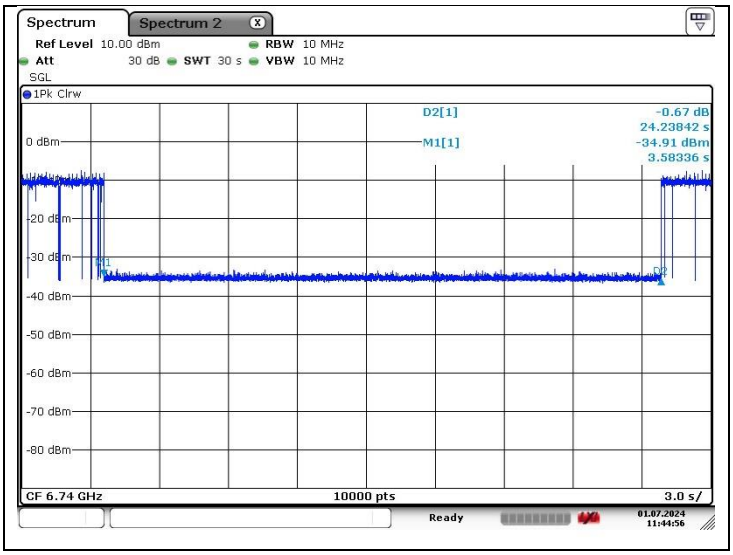
For UNII 7 band 160 ㎒



For UNII 7 band 160 ㎒



For UNII 7 band 160 ㎒



8. Antenna Requirement

8.1. Standard Applicable

For intentional device, according to FCC 47 CFR Section §15.203, 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. The manufacturer may design the unit so that a broken antenna can be replaced by the user, but the use of a standard antenna jack or electrical connector is prohibited. And according to FCC 47 CFR Section §15.247(b) if transmitting antennas of directional gain greater than 6 dBi are used, the power shall be reduced by the amount in dB that the gain of the antenna exceeds 6 dBi.

8.2. Antenna Connected Construction

Antenna used in this product is Pattern antenna and peak max gain of antenna as below.

Band	U-NII 5 5 925 ㎒ ~ 6 425 ㎒	U-NII 7 6 525 ㎒ ~ 6 875 ㎒
Mode	11a, 11ax_HE20, HE40, HE80 and HE160	
Ant. 1 Gain (dBi)	2.86	1.11
Ant. 2 Gain (dBi)	0.77	0.02
Ant. 3 Gain (dBi)	2.40	2.50
Directional Gain (dBi)	5.64	4.84

According to ANSI C63.10-2013 14.4.3, unequal antenna gains with equal transmit powers.
a) If transmit signals are correlated, then
Directional gain = 10 log[$(10^{G1/20} + 10^{G2/20} + \ldots + 10^{GN/20})^2/N_{ANT}$] dBi

Note that the purpose of the factor 20 in the denominator of each exponent and the square of the sum of terms is to combine the signal levels coherently.

In Directional Gain were calculated with worst gain.

- End of the Test Report -