Testing Laboratory 3787

DFS TEST REPORT

FCC ID	:	TLZ-CU5XX
Equipment	:	Wireless MCU with Integrated Tri-radio Wi-Fi 6 + BLE 5.3/802.15.4 LGA module, Wireless MCU with Integrated Wi Fi 6 and Bluetooth Low Energy 5. 3 Module
Brand Name	:	AzureWave
Model Name	:	AW-CU570, AW-CU598
Applicant	:	AzureWave Technologies, Inc. 8F., No.94, Baozhong Rd. , Xindian Dist., New Taipei City , Taiwan 231
Manufacturer	:	AzureWave Technologies, Inc. 8F., No.94, Baozhong Rd. , Xindian Dist., New Taipei City , Taiwan 231
Standard	:	47 CFR FCC Part 15.407

The product was received on Dec. 12, 2023, and testing was started from Feb. 23, 2024 and completed on Feb. 27, 2024. We, Sporton International Inc. Hsinchu Laboratory, would like to declare that the tested sample has been evaluated in accordance with the procedures given in FCC KDB 905462 D02 UNII DFS Compliance Procedures New Rules v02 and shown compliance with the applicable technical standards.

The test results in this report apply exclusively to the tested model / sample. Without written approval of Sporton International Inc. Hsinchu Laboratory, the test report shall not be reproduced except in full.

Approved by: Rex Liao

Sporton International Inc. Hsinchu Laboratory
No.8, Ln. 724, Bo'ai St., Zhubei City, Hsinchu County 302010, Taiwan (R.O.C.)

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History of this test report

Report No.	Version	Description	Issued Date
FZ3N2709	01	Initial issue of report	Jun. 28, 2024

Summary of Test Result

Report Clause	Ref Std. Clause	Test Items	Result (PASS/FAIL)	Remark
-	FCC KDB 905462 7.8.1	DFS: UNII Detection Bandwidth Measurement	N/A	-
-	FCC KDB 905462 7.8.2.1	DFS: Initial Channel Availability Check Time	N/A	-
-	FCC KDB 905462 7.8.2.2	DFS: Radar Burst at the Beginning of the Channel Availability Check Time	N/A	-
-	FCC KDB 905462 7.8.2.3	DFS: Radar Burst at the End of the Channel Availability Check Time	N/A	-
3.3	FCC KDB 905462 7.8.3	DFS: In-Service Monitoring for Channel Move Time (CMT)	PASS	-
3.3	FCC KDB 905462 7.8.3	DFS: In-Service Monitoring for Channel Closing Transmission Time (CCTT)	PASS	-
3.3	FCC KDB 905462 7.8.3	DFS: In-Service Monitoring for Non-Occupancy Period (NOP)	PASS	-
-	FCC KDB 905462 7.8.4	DFS: Statistical Performance Check	N/A	-
Note: Since the product is client without radar detection function, only Channel Move Time, Channel Closing Transmission Time and Non-Occupancy Period are required to perform.				

Conformity Assessment Condition:

1. The test results (PASS/FAIL) with all measurement uncertainty excluded are presented against the regulation limits or in accordance with the requirements stipulated by the applicant/manufacturer who shall bear all the risks of non-compliance that may potentially occur if measurement uncertainty is taken into account.
2. The measurement uncertainty please refer to each test result in the chapter "Measurement Uncertainty".

Disclaimer:

The product specifications of the EUT presented in the test report that may affect the test assessments are declared by the manufacturer who shall take full responsibility for the authenticity.

Reviewed by: Sam Chen
Report Producer: Sophia Shiung

1 General Description

1.1 Information

1.1.1 RF General Information

Specification Items	Description			
Frequency Range	5250 MHz – 5350 MHz 5470 MHz – 5725 MHz			
Power Type	From host system			
Channel Bandwidth	20 MHz operating channel bandwidth			
Operating Mode	☐	Master		
	☐	Client with radar detection		
	☒	Client without radar detection		
Communication Mode	☒	IP Based (Load Based)	☐	Frame Based
TPC Function	☒	With TPC	☐	Without TPC
Weather Band (5600~5650MHz)	☒	With 5600~5650MHz	☐	Without 5600~5650MHz
Power-on cycle	NA (No Channel Availability Check Function)			
Firmware Number	18.80.6.p7.1			

- 11a and HT20 use a combination of OFDM-BPSK, QPSK, 16QAM, 64QAM modulation.
- VHT20 use a combination of OFDM-BPSK, QPSK, 16QAM, 64QAM, 256QAM modulation.
- HEW20 use a combination of OFDMA-BPSK, QPSK, 16QAM, 64QAM, 256QAM, 1024QAM modulation.
- EUT employ a TPC mechanism and TPC have the capability to operate at least 6 dB below highest RF output power.

Note: The above information was declared by manufacturer.

TPC Power Result

Mode	Min Power (dBm)	Max Power (dBm)	Min EIRP (dBm)	Max EIRP (dBm)
802.11a_Nss1,(6Mbps)_1TX	-	-	-	-
5.25-5.35GHz	11.87	17.87	16.87	22.87
5.47-5.725GHz	13.39	19.39	18.39	24.39
802.11ax HEW20_Nss1,(MCS0)_1TX	-	-	-	-
5.25-5.35GHz	11.94	17.94	16.94	22.94
5.47-5.725GHz	12.68	18.68	17.68	23.68

Note: The manufacturer declared that TPC is applied to this equipment. The test result of TPC is equal to RF output power minus 6dBm which is recorded as a reference for the manufacturer.

1.1.2 Antenna Information

Ant.	Brand	Model Name	Antenna Type	Connector	Gain (dBi)
1	ARISTOTLE	RFA-27-C38H1-C198	Dipole	u.FL	Note 1
2	Molex	2128600011	Dipole	u.FL	
3	LYNwave	2570	PCB	N/A	

Note 1:

Ant.	Port				Gain (dBi)			
	WLAN 2.4GHz	WLAN 5GHz	Bluetooth	Thread	WLAN 2.4GHz	WLAN 5GHz	Bluetooth	Thread
1	-	1	-	-	3	5	3	3
2	1	-	1	1	Note 2			
3	1	1	1	1	2.2	4.4	2.2	2.2

Note 2: The Ant. 2 has one RF cable (Brand: TE Connectivity / Model Name: Linx Connectivity / Remark: 11.5cm), and its gains are listed below.

Ant.	Gain (dBi)				
		WLAN 2.4GHz	WLAN 5GHz	Bluetooth	Thread
2	Max Peak Gain	5.3	4.5	5.3	5.3
	Cable Loss	0.34	0.34	0.34	0.34
	Net Gain	4.96	4.16	4.96	4.96

Note 3: The above information was declared by manufacturer.

Note 4: **For 2.4GHz function:**

For IEEE 802.11 b/g/n/VHT/ax (1TX/1RX):

Only Port 1 can be used as transmitting/receiving antenna.

For 5GHz function:

For IEEE 802.11a/n/ac/ax (1TX/1RX):

Only Port 1 can be used as transmitting/receiving antenna.

For bluetooth function (1TX/1RX):

Only Port 1 can be used as transmitting/receiving antenna.

For Thread function (1TX/1RX):

Only Port 1 can be used as transmitting/receiving antenna.

1.1.3 DFS Band Carrier Frequencies

There are one bandwidth systems.

For 20MHz bandwidth systems, use Channel 52, 56, 60, 64, 100, 104, 108, 112, 116, 120, 124, 128, 132, 136, 140, 144.

Frequency Band	Channel No.	Frequency	Channel No.	Frequency
5250~5350 MHz Band 2	52	5260 MHz	60	5300 MHz
	56	5280 MHz	64	5320 MHz
5470~5725 MHz Band 3	100	5500 MHz	124	5620 MHz
	104	5520 MHz	128	5640 MHz
	108	5540 MHz	132	5660 MHz
	112	5560 MHz	136	5680 MHz
	116	5580 MHz	140	5700 MHz
	120	5600 MHz	144	5720 MHz

1.1.4 Table for Multiple Listing

The two EUTs are identical except for the difference listed below:

EUT	Equipment Name	Model Name	Thread Function
1	Wireless MCU with Integrated Tri-radio Wi-Fi 6 + BLE 5.3/802.15.4 LGA module	AW-CU570	V
2	Wireless MCU with Integrated Wi Fi 6 and Bluetooth Low Energy 5. 3 Module	AW-CU598	X

Note 1: From the above EUTs, EUT 2 (AW-CU598) was selected as representative EUT for the test and its data was recorded in this report.

Note 2: The above information was declared by manufacturer.

1.2 Accessories

N/A

1.3 Support Equipment

Support Equipment				
No.	**Equipment**	**Brand Name**	**Model Name**	**FCC ID**
A	Notebook	DELL	E6230	N/A
B	Notebook	Lenovo	L440	N/A
C	WLAN AP	ASUS	RT-AX88U	MSQ-RTAXHP00
D	Fixture	Azurewave	2570-i4	N/A

1.4 Applicable Standards

According to the specifications of the manufacturer, the EUT must comply with the requirements of the following standards:

- 47 CFR FCC Part 15.407
- FCC KDB 905462 D02 UNII DFS Compliance Procedures New Rules v02

1.5 Testing Location Information

Testing Location Information	
Test Lab.：Sporton International Inc. Hsinchu Laboratory	
Hsinchu (TAF: 3787)	ADD: No.8, Ln. 724, Bo'ai St., Zhubei City, Hsinchu County 302010, Taiwan (R.O.C.) TEL: 886-3-656-9065 FAX: 886-3-656-9085 Test site Designation No. TW3787 with FCC. Conformity Assessment Body Identifier (CABID) TW3787 with ISED.

Test Condition	Test Site No.	Test Engineer	Test Environment (°C / %)	Test Date
DFS	DF01-CB	Jack Teng	21.9~22.9 / 66~69	Feb. 23, 2024~ Feb. 27, 2024

2 Test Configuration of EUT

2.1 Test Channel Frequencies Configuration

Test Channel Frequencies Configuration	
IEEE Std.	**Test Channel Freq. (MHz)**
802.11ax (HEW20)	5300 MHz

2.2 The Worst Case Measurement Configuration

The Worst Case Mode for Following Conformance Tests	
Tests Item	Dynamic Frequency Selection (DFS)
Test Condition	Conducted measurement at transmit chains
Modulation Mode	802.11ax (HEW20)
1	EUT 2

3 Dynamic Frequency Selection (DFS) Test Result

3.1 General DFS Information

3.1.1 DFS Parameters

Table D.1: DFS requirement values	
Parameter	**Value**
Non-occupancy period	Minimum 30 minutes
Channel Availability Check Time	60 seconds
Channel Move Time	10 seconds (Note 1).
Channel Closing Transmission Time	200 milliseconds + an aggregate of 60 milliseconds over remaining 10 second periods. (Notes 1 and 2).
U-NII Detection Bandwidth	Minimum 100% of the 99% power bandwidth (Note 3).
Note 1: Channel Move Time and the Channel Closing Transmission Time should be performed with Radar Type 0. The measurement timing begins at the end of the Radar Type 0 burst. Note 2: The Channel Closing Transmission Time is comprised of 200 milliseconds starting at the beginning of the Channel Move Time plus any additional intermittent control signals required to facilitate Channel changes (an aggregate of 60 milliseconds) during the remainder of the 10 second period. The aggregate duration of control signals will not count quiet periods in between transmissions. Note 3: During the U-NII Detection Bandwidth detection test, radar type 0 is used and for each frequency step the minimum percentage of detection is 90%. Measurements are performed with no data traffic.	

Table D.2: Interference threshold values	
Maximum Transmit Power	**Value (see note)**
EIRP ≥ 200 mW	-64 dBm
EIRP < 200 mW and PSD < 10dBm/MHz	-62 dBm
EIRP < 200 mW and PSD >= 10dBm/MHz	-64 dBm
Note 1: This is the level at the input of the receiver assuming a 0 dBi receive antenna. Note 2: Throughout these test procedures an additional 1 dB has been added to the amplitude of the test transmission waveforms to account for variations in measurement equipment. This will ensure that the test signal is at or above the detection threshold level to trigger a DFS response. Note3: EIRP is based on the highest antenna gain. For MIMO devices refer to KDB Publication 662911D01.	

3.1.2 Applicability of DFS Requirements Prior to Use of a Channel

Requirement	DFS Operational mode		
	Master	Client without radar detection	Client with radar detection
Non-Occupancy Period	Yes	Not required	Yes
DFS Detection Threshold	Yes	Not required	Yes
Channel Availability Check Time	Yes	Not required	Not required
U-NII Detection Bandwidth	Yes	Not required	Yes

3.1.3 Applicability of DFS Requirements during Normal Operation

Requirement	DFS Operational mode		
	Master	Client without radar detection	Client with radar detection
DFS Detection Threshold	Yes	Not required	Yes
Channel Closing Transmission Time	Yes	Yes	Yes
Channel Move Time	Yes	Yes	Yes
U-NII Detection Bandwidth	Yes	Not required	Yes

Additional requirements for devices with multiple bandwidth modes	Master Device or Client with Radar Detection	Client Without Radar Detection
U-NII Detection Bandwidth and Statistical Performance Check	All BW modes must be tested	Not required
Channel Move Time and Channel Closing Transmission Time	Test using widest BW mode available	Test using the widest BW mode available for the link
All other tests	Any single BW mode	Not required
Note: Frequencies selected for statistical performance check (Section 7.8.4) should include several frequencies within the radar detection bandwidth and frequencies near the edge of the radar detection bandwidth. For 802.11 devices it is suggested to select frequencies in each of the bonded 20 MHz channels and the channel center frequency.		

3.1.4 Channel Loading/Data Streaming

☐	The data file (MPEG-4) has been transmitting in a streaming mode.
☒	Software to ping the client is permitted to simulate data transfer with random ping intervals.
☒	Minimum channel loading of approximately 17%.
☐	Unicast protocol has been used.

3.2 Radar Test Waveform Calibration

3.2.1 Short Pulse Radar Test Waveforms

Radar Type	Pulse Width (µsec)	PRI (µsec)	Number of Pulses	Minimum Percentage of Successful Detection	Minimum Trials
0	1	1428	18	See Note 1	See Note 1
1A	1	15 unique PRI in KDB 905462 D02 Table 5a	$Roundup\left\{\left(\frac{1}{360}\right)\times\left(\frac{19\times10^6}{PRI}\right)\right\}$	60%	15
1B	1	15 unique PRI within 518-3066, Excluding 1A PRI		60%	15
2	1-5	150-230	23-29	60%	30
3	6-10	200-500	16-18	60%	30
4	11-20	200-500	12-16	60%	30
Aggregate (Radar Types 1-4)				80%	120
Note 1: Short Pulse Radar Type 0 should be used for the detection bandwidth test, channel move time, and channel closing time tests.					

A minimum of 30 unique waveforms are required for each of the short pulse radar types 1 through 4. If more than 30 waveforms are used for short pulse radar types 1 through 4, then each additional waveform must also be unique and not repeated from the previous waveforms. The aggregate is the average of the percentage of successful detections of short pulse radar types 1-4.

3.2.2 Long Pulse Radar Test Waveform

Radar Type	Pulse Width (µsec)	Chirp Width (MHz)	PRI (µsec)	Number of Pulses per *Burst*	Number of *Bursts*	Minimum Percentage of Successful Detection	Minimum Trials
5	50-100	5-20	1000-2000	1-3	8-20	80%	30

Each waveform is defined as follows:

- The transmission period for the Long Pulse Radar test signal is 12 seconds.
- There are a total of 8 to 20 Bursts in the 12 second period, with the number of Bursts being randomly chosen. This number is Burst Count.
- Each Burst consists of 1 to 3 pulses, with the number of pulses being randomly chosen. Each Burst within the 12 second sequence may have a different number of pulses.
- The pulse width is between 50 and 100 microseconds, with the pulse width being randomly chosen. Each pulse within a Burst will have the same pulse width. Pulses in different Bursts may have different pulse widths.
- Each pulse has a linear FM chirp between 5 and 20 MHz, with the chirp width being randomly chosen. Each pulse within a transmission period will have the same chirp width. The chirp is centered on the pulse. For example, with a radar frequency of 5300 MHz and a 20 MHz chirped signal, the chirp starts at 5290 MHz and

ends at 5310 MHz.

- If more than one pulse is present in a Burst, the time between the pulses will be between 1000 and 2000 microseconds, with the time being randomly chosen. If three pulses are present in a Burst, the time between the first and second pulses is chosen independently of the time between the second and third pulses.
- The 12 second transmission period is divided into even intervals. The number of intervals is equal to Burst Count. Each interval is of length (12,000,000 / Burst Count) microseconds. Each interval contains one Burst. The start time for the Burst, relative to the beginning of the interval, is between 1 and [(12,000,000 / Burst Count) – (Total Burst Length) + (One Random PRI Interval)] microseconds, with the start time being randomly chosen. The step interval for the start time is 1 microsecond. The start time for each Burst is chosen independently.

3.2.3 Frequency Hopping Radar Test Waveform

Radar Type	Pulse Width (μsec)	PRI (μsec)	Pulses per Hop	Hopping Rate (kHz)	Hopping Sequence Length (ms)	Minimum Percentage of Successful Detection	Minimum Trials
6	1	333	9	0.333	300	70%	30

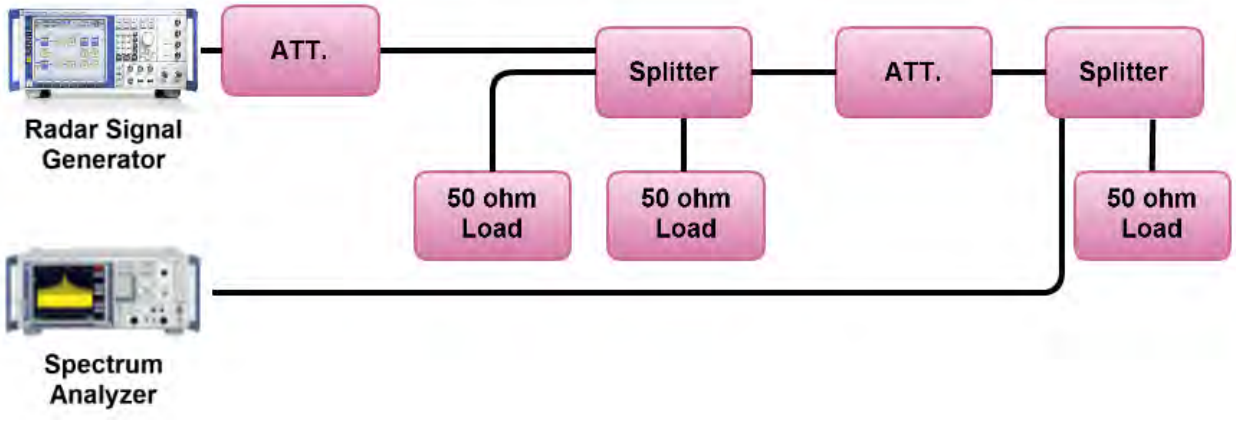
For the Frequency Hopping Radar Type, the same Burst parameters are used for each waveform. The hopping sequence is different for each waveform and a 100-length segment is selected from the hopping sequence defined by the following algorithm:
The first frequency in a hopping sequence is selected randomly from the group of 475 integer frequencies from 5250 – 5724 MHz. Next, the frequency that was just chosen is removed from the group and a frequency is randomly selected from the remaining 474 frequencies in the group.

3.2.4 DFS Threshold Level

DFS Threshold Level	
DFS Threshold level: -63 dBm	☒ at the antenna connector
	☐ in front of the antenna
The Interference **Radar Detection Threshold Level** is *-64 dBm + 0 [dBi] + 1 dB* = -63 dBm. That had been taken into account the output power range and antenna gain.	

3.2.5 Calibration Setup

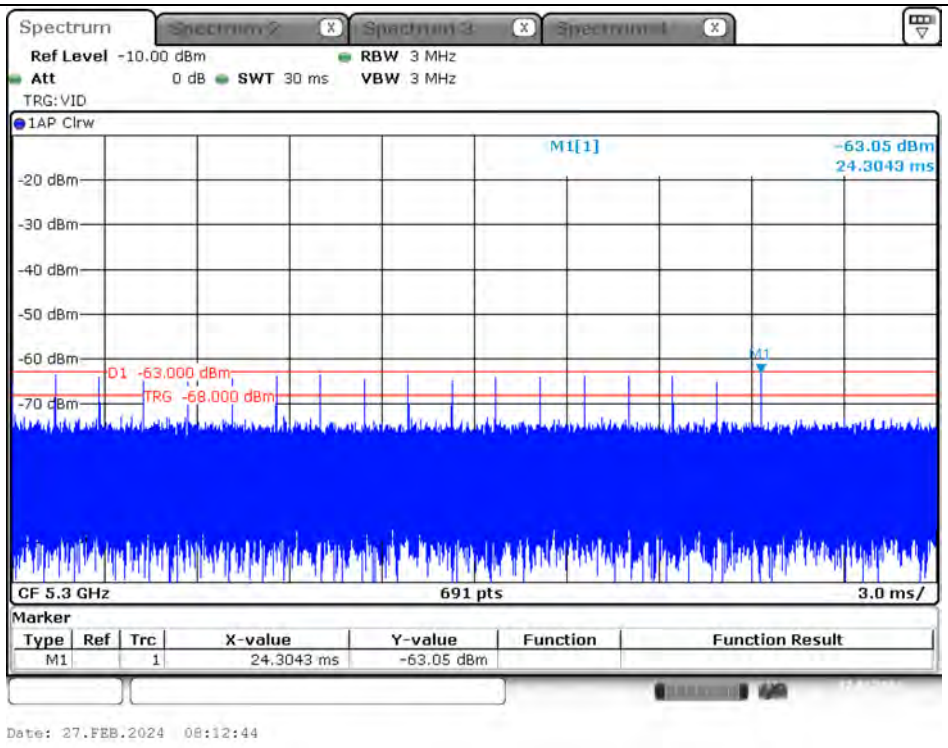
Client Conducted Calibration Setup



3.2.6 Radar Waveform calibration Plot

Test Frequency: 5300 MHz

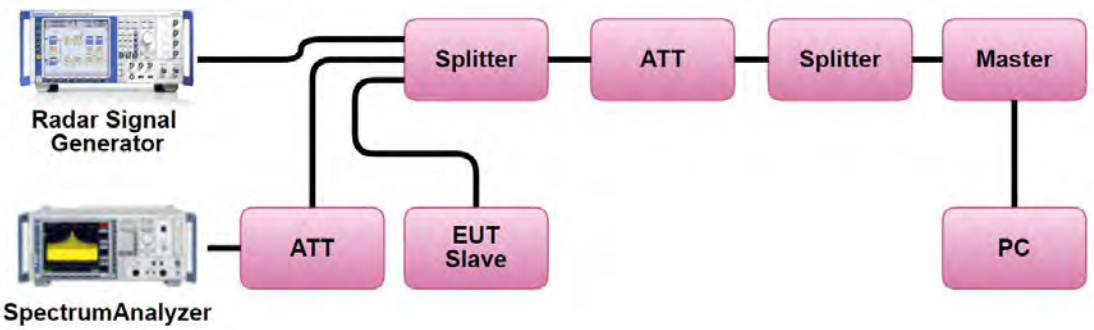
Radar #0 DFS detection threshold level



3.2.7 Test Setup

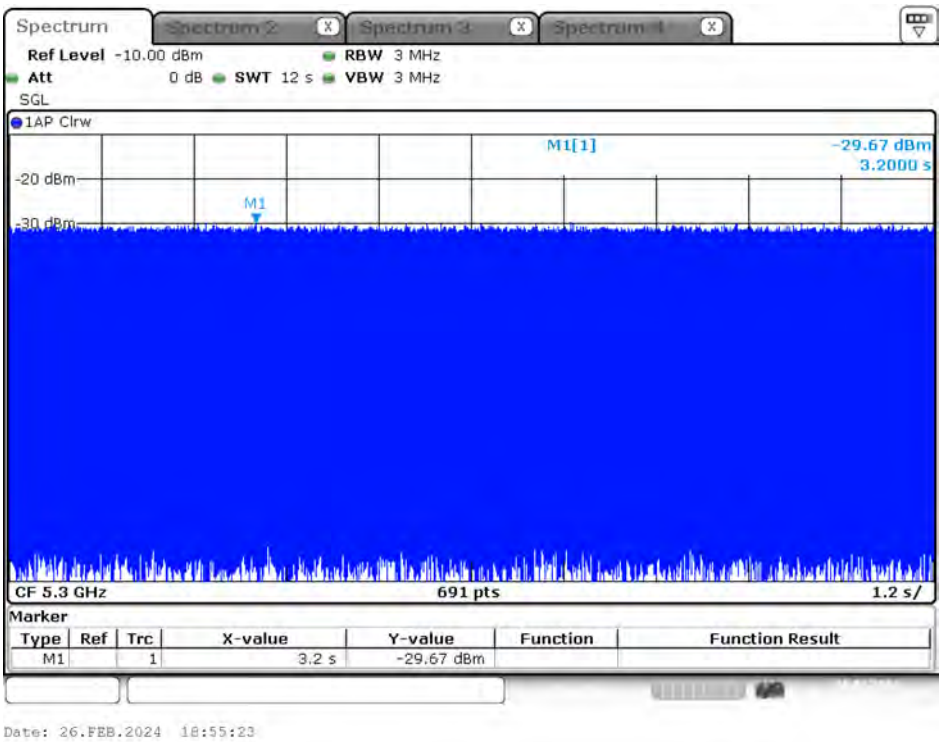
A spectrum analyzer is used as a monitor to verify that the EUT has vacated the Channel within the (Channel Closing Transmission Time and Channel Move Time, and does not transmit on a Channel during the Non-Occupancy Period after the detection and Channel move.

Client without Radar Detect Conducted Measurement

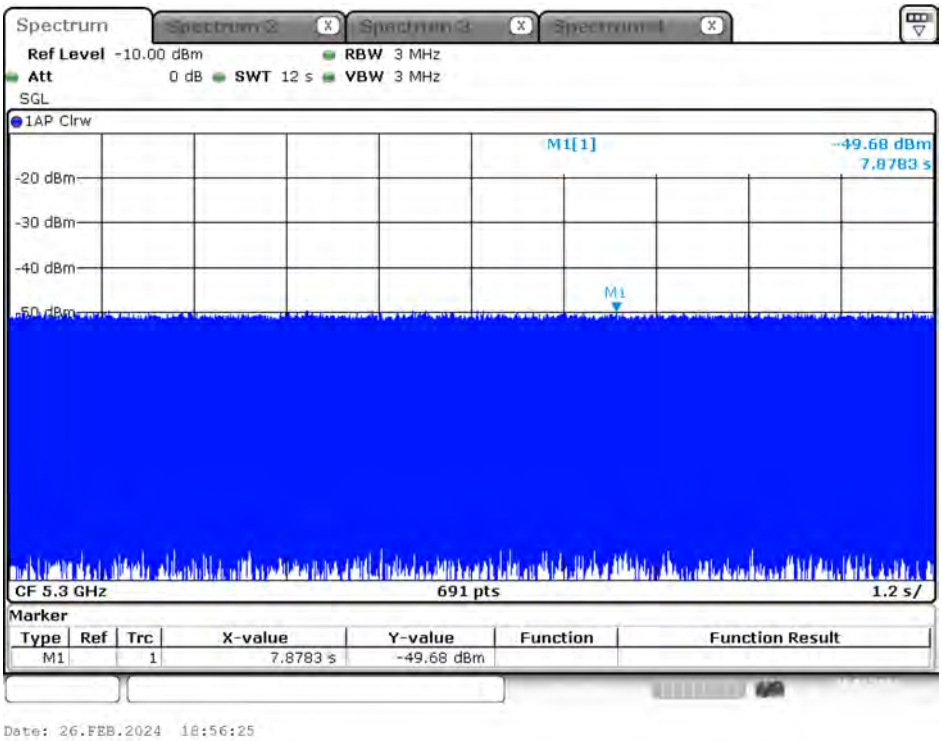


3.2.8 Data traffic Plot

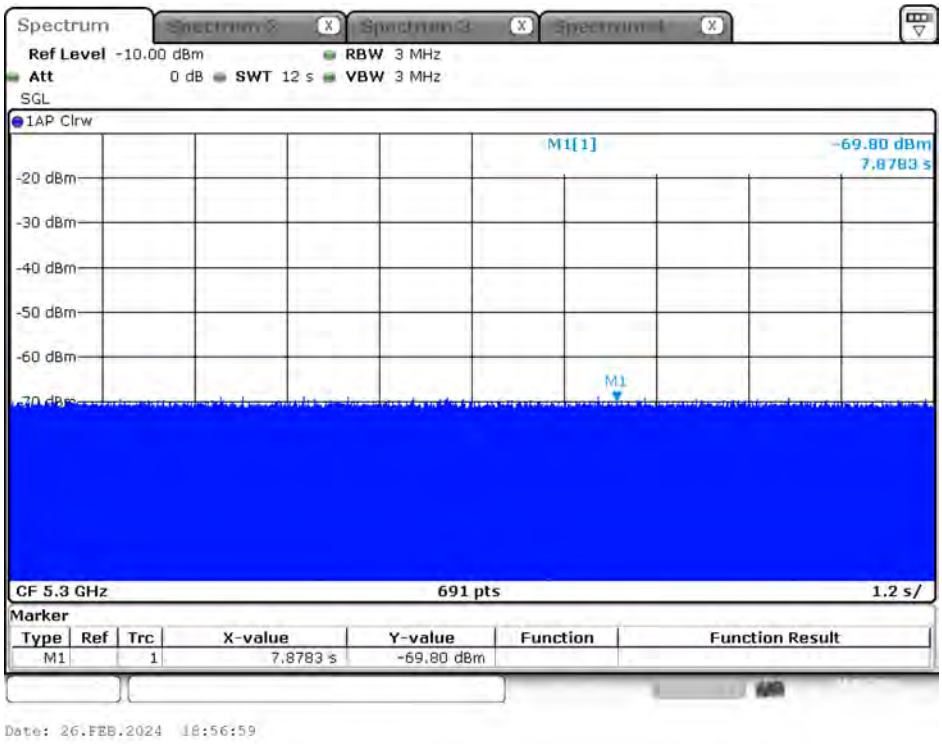
EUT Data traffic Plot	Modulation Mode: 802.11ax (HEW20)	Test Frequency: 5300 MHz



Master Data Traffic Plot	Modulation Mode: 802.11ax (HEW20)	Test Frequency: 5300 MHz



Without Data Traffic Plot	Modulation Mode: 802.11ax (HEW20)	Test Frequency: 5300 MHz



3.3 In-service Monitoring

3.3.1 In-service Monitoring Limit

In-service Monitoring Limit	
Channel Move Time	10 sec
Channel Closing Transmission Time	200 ms + an aggregate of 60 ms over remaining 10 sec periods.
Non-occupancy period	Minimum 30 minutes

3.3.2 Measuring Instruments

Refer a test equipment and calibration data table in this test report.

3.3.3 Test Procedures

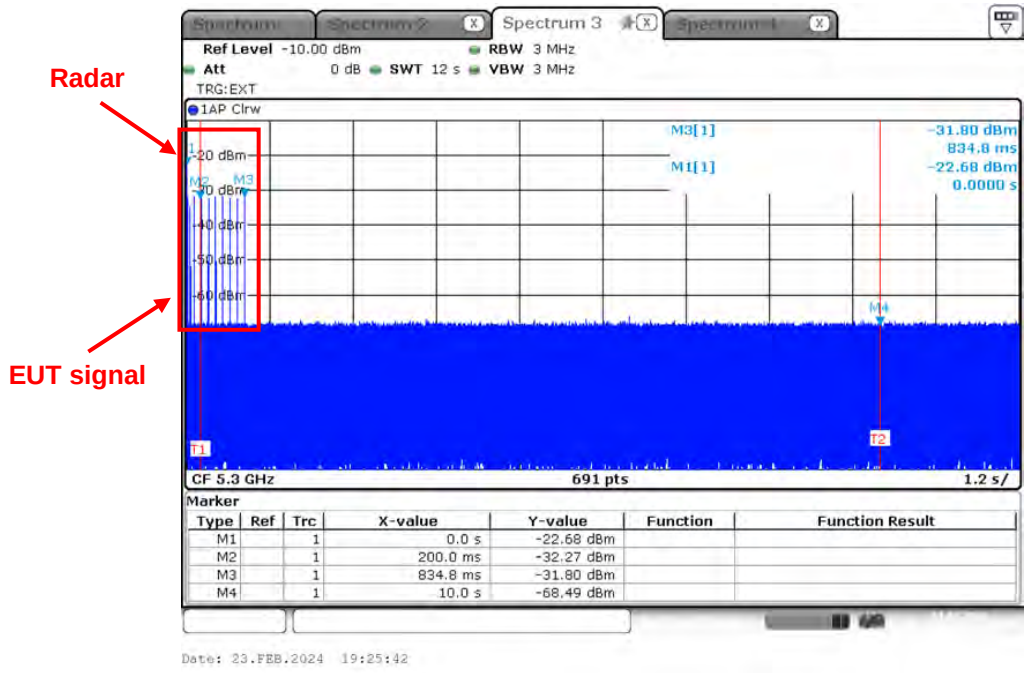
Test Method	
☒	Verified during In-Service Monitoring; Channel Closing Transmission Time, Channel Move Time. Client Device will associate with the EUT. Observe the transmissions of the EUT at the end of the radar Burst on the Operating Channel for duration greater than 10 seconds. Measure and record the transmissions from the EUT during the observation time (Channel Move Time). Compare the Channel Move Time and Channel Closing Transmission Time limits.
☒	Verified during In-Service Monitoring; Channel Closing Transmission Time, Channel Move Time. One 12 sec plot needs to be reported for the Short Pulse Radar Types 0. And zoom-in a 60 ms plot verified channel closing time for the aggregate transmission time starting from 200ms after the end of the radar signal to the completion of the channel move.
☒	Verified during In-Service Monitoring; Non-Occupancy Period. Client Device will associate with the EUT. Observe the transmissions of the EUT at the end of the radar Burst on the Operating Channel for duration greater than 10 seconds. Measure and record the transmissions from the EUT during the observation time (Non-Occupancy Period). Compare the Non-Occupancy Period limits.

3.3.4 Test Result of Channel Move Time

Modulation Mode: 802.11ax (HEW20)

Parameter	Test Result	Limit
	Type 0	
Test Channel (MHz)	5300 MHz	-
Channel Move Time (sec.)	0.834	< 10s

Modulation Mode	Freq.	Radar Type
802.11ax (HEW20)	5300 MHz	0



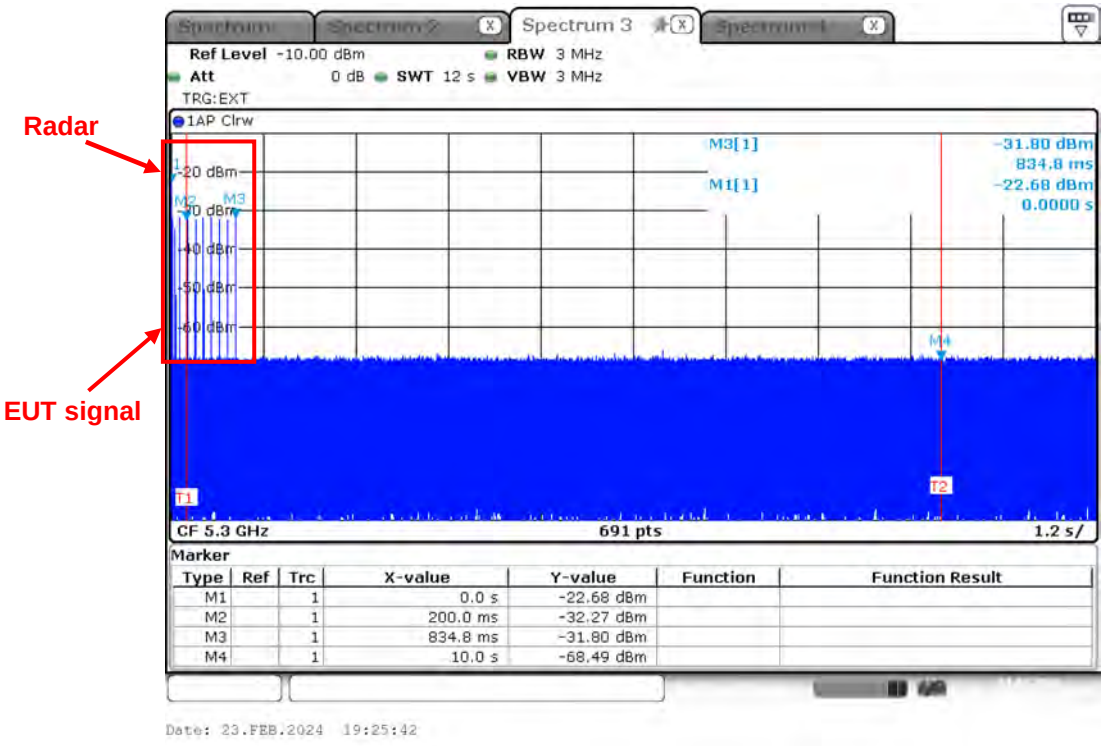
3.3.5 Test Result of Channel Closing Transmission Time

Modulation Mode: 802.11ax (HEW20)

Parameter	Test Result	Limit
	Type 0	
Test Channel (MHz)	5300 MHz	-
Channel Closing Transmission Time (ms) (Note)	26.086	＜ 60ms

Note: The Channel Closing Transmission Time is comprised of 200 milliseconds starting at the beginning of the Channel Move Time plus any additional intermittent control signals required to facilitate a Channel move (an aggregate of 60 milliseconds) during the remainder of the 10 seconds period. The aggregate duration of control signals will not count quiet periods in between transmissions.

Modulation Mode	Freq.	Radar Type
802.11ax (HEW20)	5300 MHz	0
Channel Closing Transmission Time is comprised of 200 ms starting at the beginning of the Channel Move Time plus 60ms additional intermittent control signals		



Dwell is the dwell time per spectrum analyzer sampling bin.

S is the sweep time

B is the number of spectrum analyzer sampling bins

C is the intermittent control signals of Channel Closing Transmission Time

N is the number of spectrum analyzer sampling bins (intermittent control signals) showing a U-NII transmission

Dwell (2.899 ms)= S (2000 ms) / B (690)
C (26.086 ms) = N (9) X Dwell (2.899 ms)

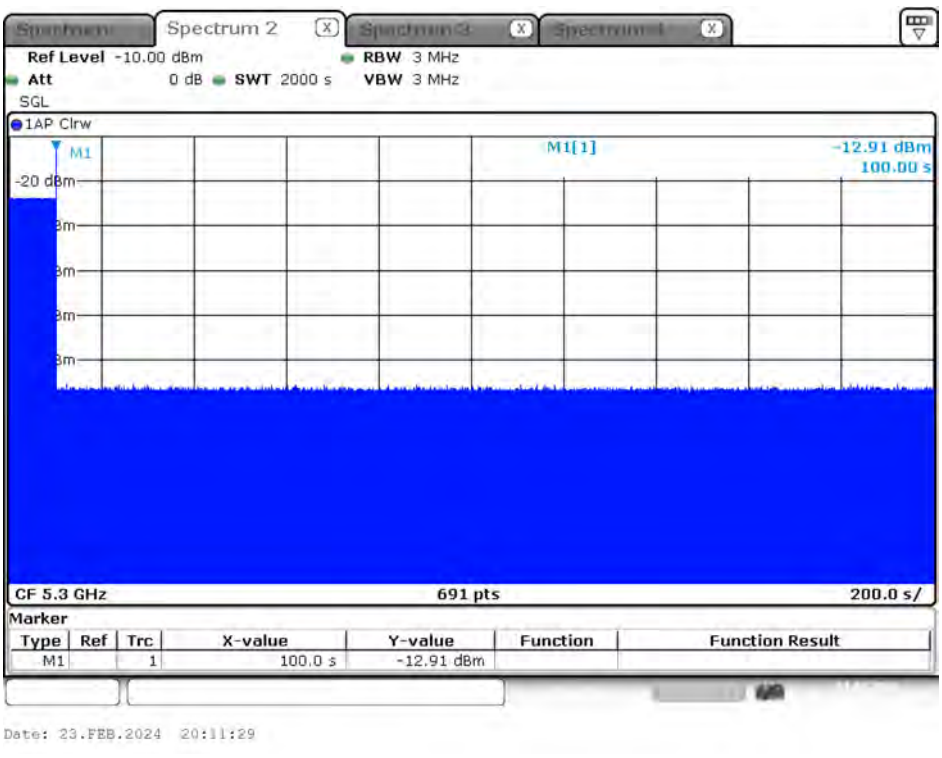
3.3.6 Test Result of Non-Occupancy Period

Modulation Mode: 802.11ax (HEW20)

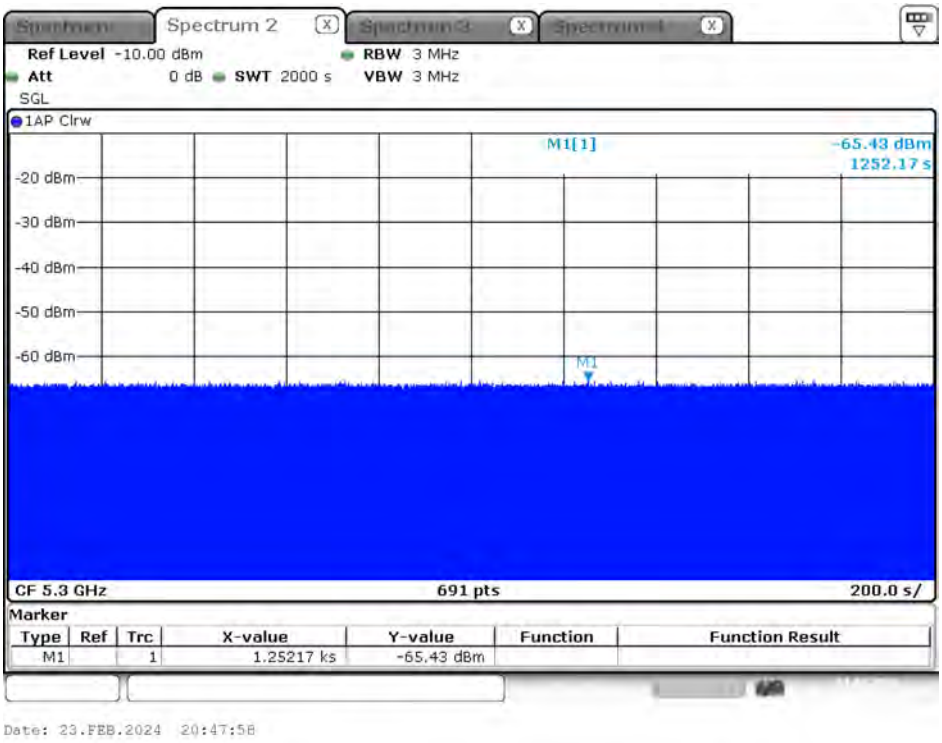
Parameter	Test Result	Limit
	Type 0	
Test Channel (MHz)	5300 MHz	-
Non-Occupancy Period (min.)	≧30	≧ 30 min

Modulation Mode	Freq.
802.11ax (HEW20)	5300 MHz

Non-Occupancy Period
During the 30 minutes observation time, UUT did not make any transmissions on a channel after a radar signal was detected on that channel by either the Channel Availability Check or the In-Service Monitoring.



Non-associated test
Master was off.
During the 30 minutes observation time, The UUT did not make any transmissions in the DFS band after UUT power up.



4 Test Equipment and Calibration Data

Instrument	Brand	Model No.	Serial No.	Characteristics	Calibration Date	Calibration Due Date	Remark
Spectrum Analyzer	R&S	FSV40	101026	9kHz~40GHz	Nov. 21, 2023	Nov. 20, 2024	Conducted (DF01-CB)
Vector Signal generator	R&S	SMU200A	102782	100kHz-6GHz	Sep. 07, 2023	Sep. 06, 2024	Conducted (DF01-CB)
RF Power Divider	MTJ	2 Way	DF01-DV03	1GHz ~ 8GHz	Oct. 03, 2023	Oct. 02, 2024	Conducted (DF01-CB)
RF Power Divider	MTJ	2 Way	DF01-DV02	1GHz ~ 8GHz	Oct. 03, 2023	Oct. 02, 2024	Conducted (DF01-CB)
RF Power Divider	MTJ	4 Way	DF01-DV01	1GHz ~ 6GHz	Oct. 03, 2023	Oct. 02, 2024	Conducted (DF01-CB)
RF Cable-high	Woken	RG402	High Cable-52	1GHz –18GHz	Oct. 02, 2023	Oct. 01, 2024	Conducted (DF01-CB)
RF Cable-high	Woken	RG402	High Cable-53	1GHz –18GHz	Oct. 02, 2023	Oct. 01, 2024	Conducted (DF01-CB)
RF Cable-high	Woken	RG402	High Cable-54	1GHz –18GHz	Oct. 02, 2023	Oct. 01, 2024	Conducted (DF01-CB)
RF Cable-high	Woken	RG402	High Cable-56	1GHz –18GHz	Oct. 02, 2023	Oct. 01, 2024	Conducted (DF01-CB)

Note: Calibration Interval of instruments listed above is one year.

5 Measurement Uncertainty

Test Items	Uncertainty	Remark
Conducted Emission	3.1 dB	Confidence levels of 95%