

CONTENTS

Page








1. TEST SUMMARY	4
1.1 REGULATIONS AND RESULTS.....	4
1.2 TEST METHODOLOGY.....	4
1.3 ADDITIONS, DEVIATIONS, EXCLUSIONS FROM STANDARDS	4
1.4 PURPOSE OF THE TEST	4
2. EUT (EQUIPMENT UNDER TEST) INFORMATION.....	6
2.1 GENERAL DESCRIPTION	6
2.2 ADDITIONAL MODEL	7
3. TEST CONDITION.....	8
3.1 EQUIPMENT USED DURING TEST	8
3.2 MODE OF OPERATION DURING THE TEST	8
3.3 TEST SETUP DRAWING.....	8
3.4 EUT MODIFICATIONS	8
4. TEST RESULT	9
4.1 DYAMIC FREQUENCY SELECTION (DFS).....	9
APPENDIX I – TEST INSTRUMENTATION	18

Release Control Record

Issue Report No.	Issued Date	Details/Revisions
TR-W2006-025	2020-06-30	Initial Release
-	-	-

1.5 Test Facility

The measurement facilities are located at 135-60 Gyeongchung-daero, Gonjam-eup, Gwangju-si, Gyeonggi-do 12813, Korea. Our test facilities are accredited as a Conformity Assessment Body (CAB) by the FCC and ISED Canada, designated by the RRA (National Radio Research Agency), and accredited by KOLAS (Korea Laboratory Accreditation Scheme) in Korea and approved by TUV Rheinland, TUV SÜD and Korean Register of Shipping according to the requirement of ISO/IEC 17025.

Laboratory Qualification	Registration No.	Mark
FCC	KR0160	
ISED Canada	12721A	
RRA	KR0160	 National Radio Research Agency
TUV Rheinland	UA 50314109-0002	
TUV SÜD	CARAT 094465 0004 Rev.00	
Korean Agency for Technology and Standards	KT733	
KOREAN REGISTER OF SHIPPING	PCT40841-TL001	

Remark. This report is not related to KOLAS accreditation and relevant regulation.

2. EUT (Equipment Under Test) INFORMATION

2.1 General Description

The Aroot Co., Ltd., Model SBW-M3 (referred to as the EUT in this report) is a WiFi/BT Combo Module. which has 3 Equipment Class, DSS, DTS, and NII. This test report covers NII portion only and other functions are covered by other test report. The product specification described herein was obtained from product data sheet or user's manual.

Equipment Class		NII – Unlicensed National Information Instructure TX	
Operating Frequency	Bluetooth LE	2 402 MHz – 2 480 MHz	
	Bluetooth	2 402 MHz – 2 480 MHz	
	WLAN 2.4 GHz	2 412 MHz – 2 462 MHz (802.11b/g/n HT20)	
		2 422 MHz – 2 452 MHz (802.11n HT40)	
	UNII 1 band 5 150 MHz – 5 250 MHz	5 180 MHz – 5 240 MHz (802.11a/n HT20/ac VHT20)	
		5 190 MHz – 5 230 MHz (802.11n HT40/ac VHT40)	
		5 210 MHz (802.11ac VHT80)	
	UNII 2-A band 5 250 MHz – 5 350 MHz	5 260 MHz – 5 320 MHz (802.11a/n HT20/ac VHT20)	
		5 270 MHz – 5 310 MHz (802.11n HT40/ac VHT40)	
		5 290 MHz (802.11ac VHT80)	
	UNII 2-C band 5 470 MHz – 5 725 MHz	5 500 MHz – 5 700 MHz (802.11a/n HT20/ac VHT20)	
		5 510 MHz – 5 670 MHz (802.11n HT40/ac VHT40)	
		5 530 MHz – 5 610 MHz (802.11ac VHT80)	
	UNII 3 band 5 725 MHz – 5 850 MHz	5 745 MHz – 5 825 MHz (802.11a/n HT20/ac VHT20)	
		5 755 MHz – 5 795 MHz (802.11n HT40/ac VHT40)	
		5 775 MHz (802.11ac VHT80)	
Straddle channel UNII 2-C to 3 band	5 720 MHz (802.11a/n HT20/ac VHT20)		
	5 710 MHz (802.11n HT40/ac VHT40)		
	5 690 MHz (802.11ac VHT80)		
Generated or used Freq. in EUT		32.768 kHz, 37.4 MHz	
Type of Antenna		<input type="checkbox"/> Integrated Type <input checked="" type="checkbox"/> Dedicated Type	
Antenna Gain		4.61 dBi	
Operating Temperature		- 20 °C ~ + 55 °C	
Normal Test Voltage		DC 3.3 V	
Electrical Rating		DC 3.3 V	
Test SW Version		DBGMon version: unknown	
Software Version		Ver 1.0	
Hardware Version		Ver 1.0	

2.2 Additional Model

None

3. TEST CONDITION

3.1 Equipment Used During Test

The following peripheral devices and/or interface cables were connected during the measurement:

Description	Model No.	Serial No.	Manufacturer.
WiFi/BT Combo Module (EUT)	SBW-M3	N/A	Aroot Co., Ltd.
Notebook PC	15s-du0069TU	CND9503W22	HP
Adapter for Notebook PC	TPN-CA14	N/A	Chicony Power Technology (Chongqing) Co., Ltd.
Wireless Access Point	WA730	4D7689EP000FB (FCC ID: PY315300320) (IC: 4054A-15300320)	NETGEAR

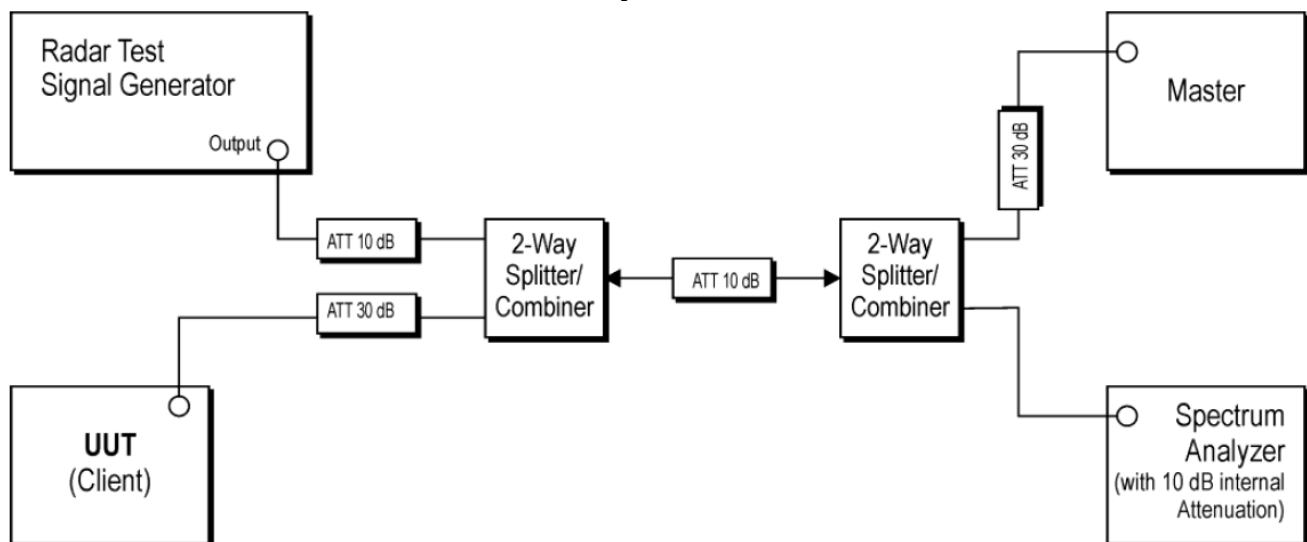
3.2 Mode of operation during the test

Software used to control the EUT for staying in continuous transmitting mode is programmed.

The used modulation type for the testing is OFDM

3.3 Test Setup Drawing

UUT is a Client and Radar Test Waveforms are injected into the Master



3.4 EUT Modifications

- No EMC Relevant Modifications were performed by this test laboratory.

4. TEST RESULT

4.1 Dynamic Frequency Selection (DFS)

4.1.1 Limit

Acc. to KDB 905462 D02 UNII DFS compliance Procedures New Rules v02, following tables shall be applied.

Table 1: Applicability of DFS Requirement Prior to Use of a Channel

Requirement	Operational Mode		
	Master	Client Without Radar Detection	Client With Radar Detection
<i>Non-Occupancy Period</i>	Yes	Not Required	Yes
<i>DFS Detection Threshold</i>	Yes	Not Required	Yes
<i>Channel Availability Check Time</i>	Yes	Not Required	Not Required
<i>U-NII Detection Bandwidth</i>	Yes	Not Required	Yes

Table 2: Applicability of DFS Requirement Prior to Use of a Channel

Requirement	Operational Mode	
	Master Device or Client with Radar Detection	Client With Radar Detection
<i>DFS Detection Threshold</i>	Yes	Not Required
<i>Channel Closing Transmission Time</i>	Yes	Yes
<i>Channel Move Time</i>	Yes	Yes
<i>U-NII Detection Bandwidth</i>	Yes	Not Required

Additional requirements for devices with multiple bandwidth modes	Master Device or Client with Radar Detection	Client With Radar Detection
<i>U-NII Detection Bandwidth and Statistical Performance Check</i>	All BW modes must be tested	Not Required
<i>Channel Move Time and Channel Closing Transmission Time</i>	Test using widest BW mode available	Test using the widest BW mode available for the link
<i>All other tests</i>	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.

Table 3: DFS Detection Thresholds for Master Devices and Client Devices with Radar Detection

Maximum Transmit Power	Value (See Notes 1, 2, and 3)
EIRP \geq 200 milliwatt	-64 dBm
EIRP < 200 milliwatt and power spectral density < 10 dBm/MHz	-62 dBm
EIRP < 200 milliwatt that do not meet the power spectral density requirement	-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 662911 D01.

Table 4: DFS Response Requirement Values

Parameter	Value
<i>Non-occupancy period</i>	Minimum 30 minutes
<i>Channel Available Check Time</i>	60 seconds
<i>Channel Move Time</i>	10 seconds See Note1.
<i>Channel Closing Transmission Time</i>	200 milliseconds + an aggregate of 60 milliseconds over remaining 10 second period. See Notes 1 and 2.
<i>U-NII Detection Bandwidth</i>	Minimum 100 % of the U-NII 99 % transmissions power bandwidth. See 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 a *Channel* move (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 should be used. For each frequency step the minimum percentage of detection is 90 percent. Measurements are performed with no data traffic.

4.1.2 DFS Test Signals

Table 5: Short Pulse Radar Test Waveforms

Radar Type	Pulse Width (μsec)	PRI (μsec)	Number of Pulses	Minimum Percentage of Successful Detection	Minimum Number of Trials
0	1	1428	18	See Note1	See Note1
1	1	Test A: 15 unique PRI values randomly selected from the list of 23 PRI values in Table 5a	$\text{Roundup}\left\{\left(\frac{1}{360}\right) \cdot \left(\frac{19 \cdot 10^6}{PRI_{\mu\text{sec}}}\right)\right\}$	60 %	30
		Test B: 15 unique PRI values randomly selected within the range of 518-3066 μsec, with a minimum increment of 1 μsec, excluding PRI values selected in Test A			
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.					

Table 6: 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 Number of Trials
5	50-100	5-20	1000-2000	1-3	8-20	80 %	30

Table 7: Frequency Hopping Radar Test Waveform

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

4.1.3 Method of Measurement

Acc. to KDB 905462 D02 UNII DFS compliance Procedures New Rules v02, figure 3 describes a conducted test setup.

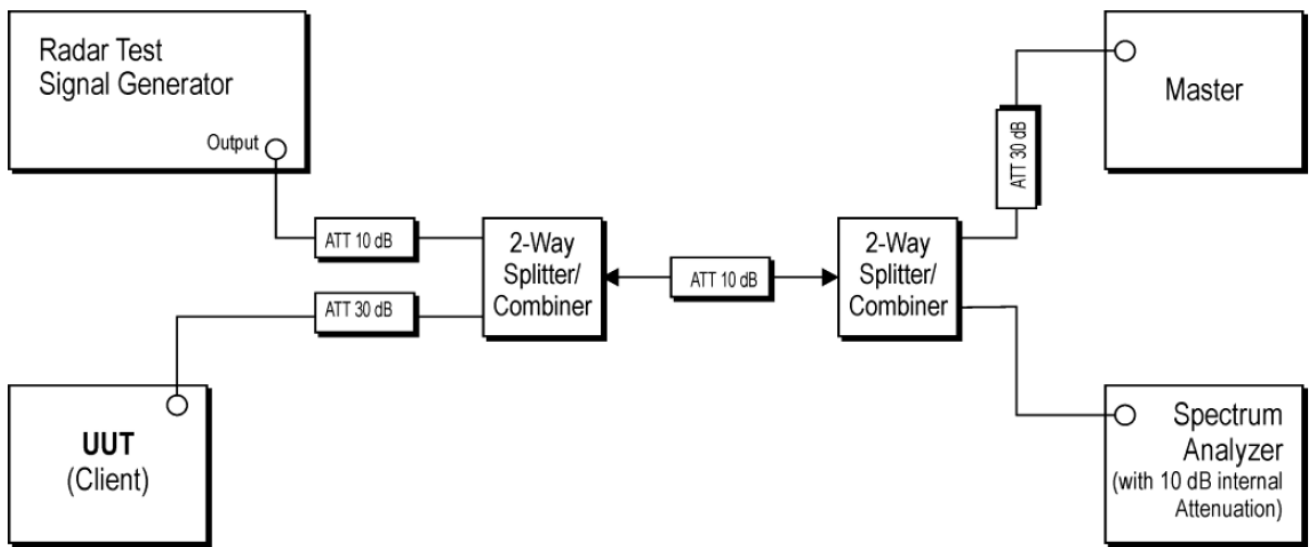


Figure 3: Example Conducted Setup where UUT is a Client and Radar Test Waveforms are injected into the Master

The steps below define the procedure to determine the above mentioned parameters when a radar *Burst* with a level equal to the *DFS Detection Threshold* + 1dB is generated on the *Operating Channel* of the U-NII device (*In- Service Monitoring*).

- One frequency will be chosen from the *Operating Channels* of the UUT within the 5250-5350 MHz or 5470-5725 MHz bands.
- In case the UUT is a U-NII device operating as a *Client Device* (with or without DFS), a U-NII device operating as a *Master Device* will be used to allow the UUT (Client device) to *Associate* with the *Master Device*.
- Stream the channel loading test file from the *Master Device* to the *Client Device* on the test *Channel* for the entire period of the test.
- At time T_0 the *Radar Waveform* generator sends a *Burst* of pulses for one of the Radar Type 0 in **Table 5** at levels defined in **Table 3**, on the *Operating Channel*. An additional 1 dB is added to the radar test signal to ensure it is at or above the *DFS Detection Threshold*, accounting for equipment variations/errors.
- Observe the transmissions of the UUT at the end of the radar *Burst* on the *Operating Channel* for duration

greater than 10 seconds. Measure and record the transmissions from the UUT during the observation time (*Channel Move Time*). Measure and record the *Channel Move Time* and *Channel Closing Transmission Time* if radar detection occurs. **Figure 17** illustrates *Channel Closing Transmission Time*.

f) When operating as a *Master Device*, monitor the UUT for more than 30 minutes following instant T_2 to verify that the UUT does not resume any transmissions on this *Channel*. Perform this test once and record the measurement result.

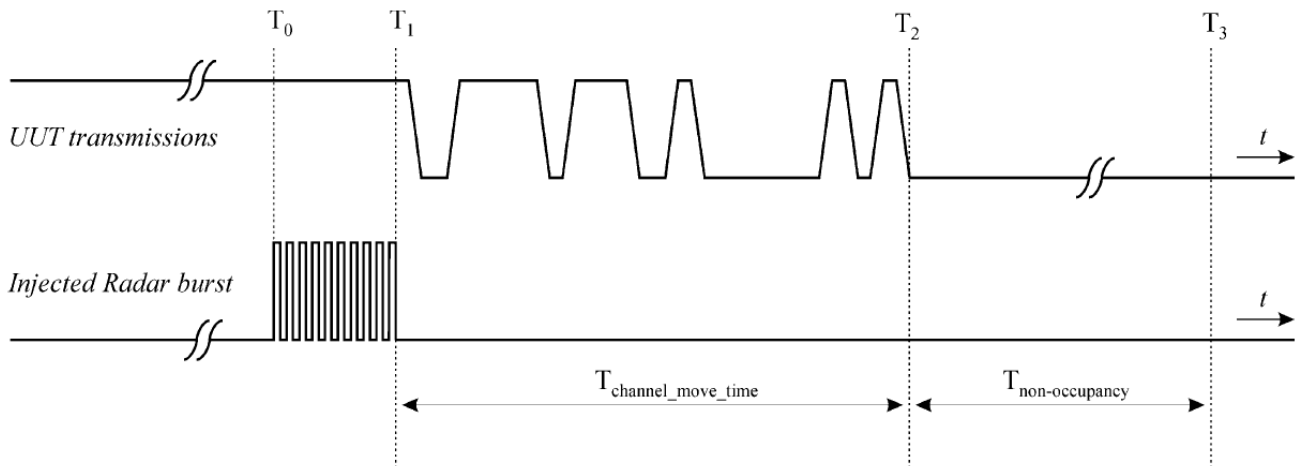


Figure 17: Example of Channel Closing Transmission Time & Channel Closing Time

4.1.4 Test Data

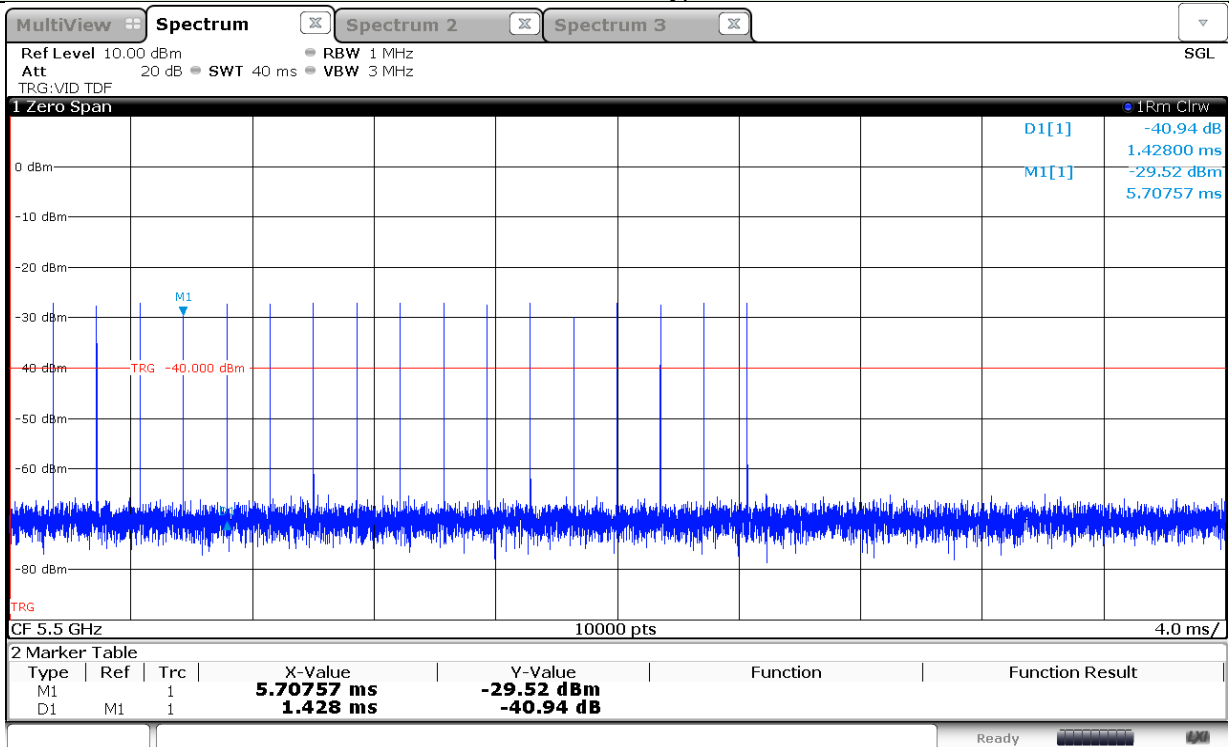
Date of Test	2020-06-01	Temperature	(26.8 ± 1.4) °C
		Relative humidity	(47.3 ± 7.4) % R.H.
Measurement Frequency		5 500 MHz at 20 MHz BW / 5 530 MHz at 80 MHz BW	
Test Result	PASS	Tested By	Do-heon Kim

Parameter	Test Data	Limit	Test Result
	Type 0		
Test Frequency (MHz)	5 500	-	-
Channel Move Time (Sec)	0.012	< 10 Sec.	PASS
Channel Closing Transmission Time (ms)	0.012	< 60 ms	PASS
Non-Occupancy Period (Min.)	≥ 30	≥ 30	PASS

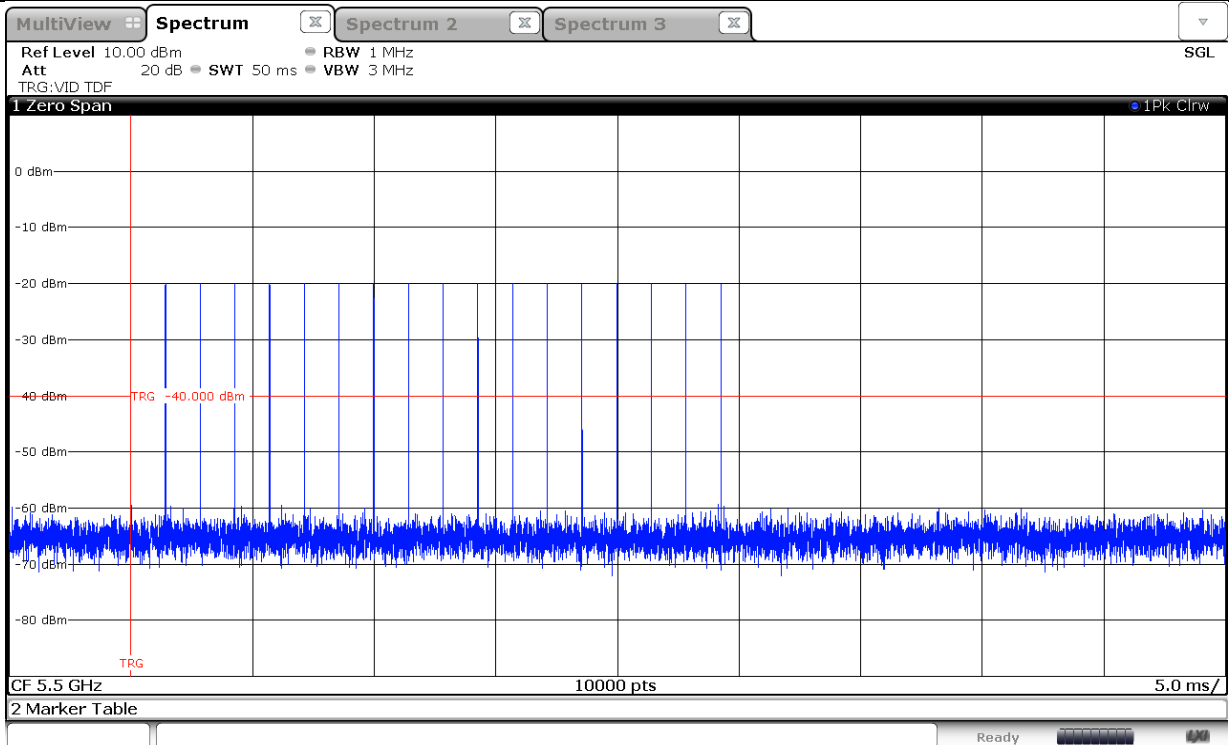
Parameter	Test Data	Limit	Test Result
	Type 0		
Test Frequency (MHz)	5 530	-	-
Channel Move Time (Sec)	0.034	< 10 Sec.	PASS
Channel Closing Transmission Time (ms)	0.034	< 60 ms	PASS
Non-Occupancy Period (Min.)	≥ 30	≥ 30	PASS

Remark. The EUT is a client device without radar detecting

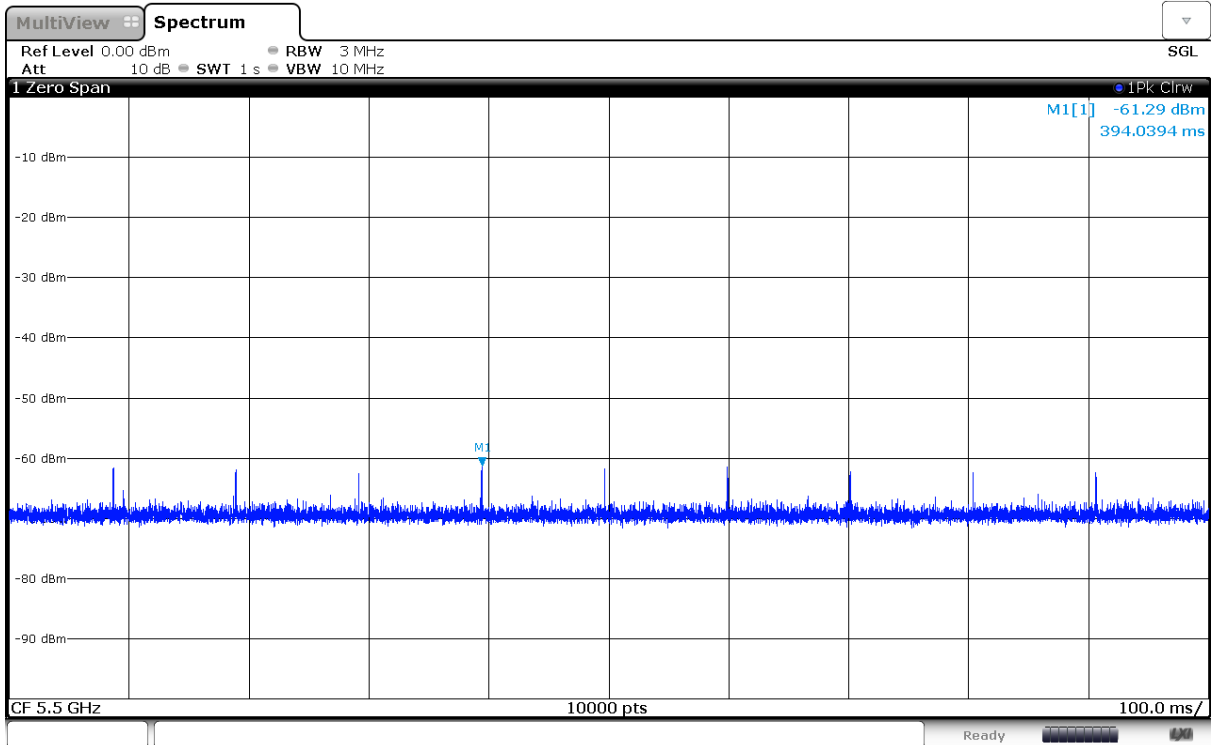
Radar Waveform Type 0: PRI



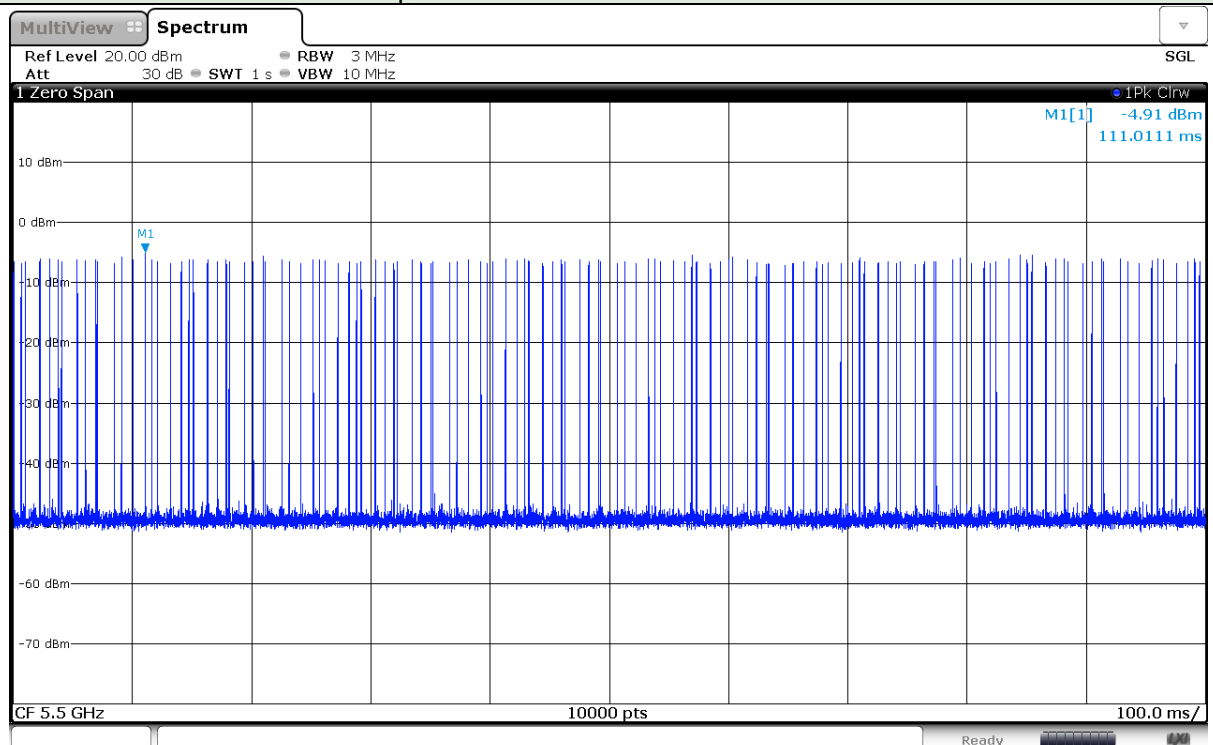
Radar Waveform Type 0: Number of Pulses



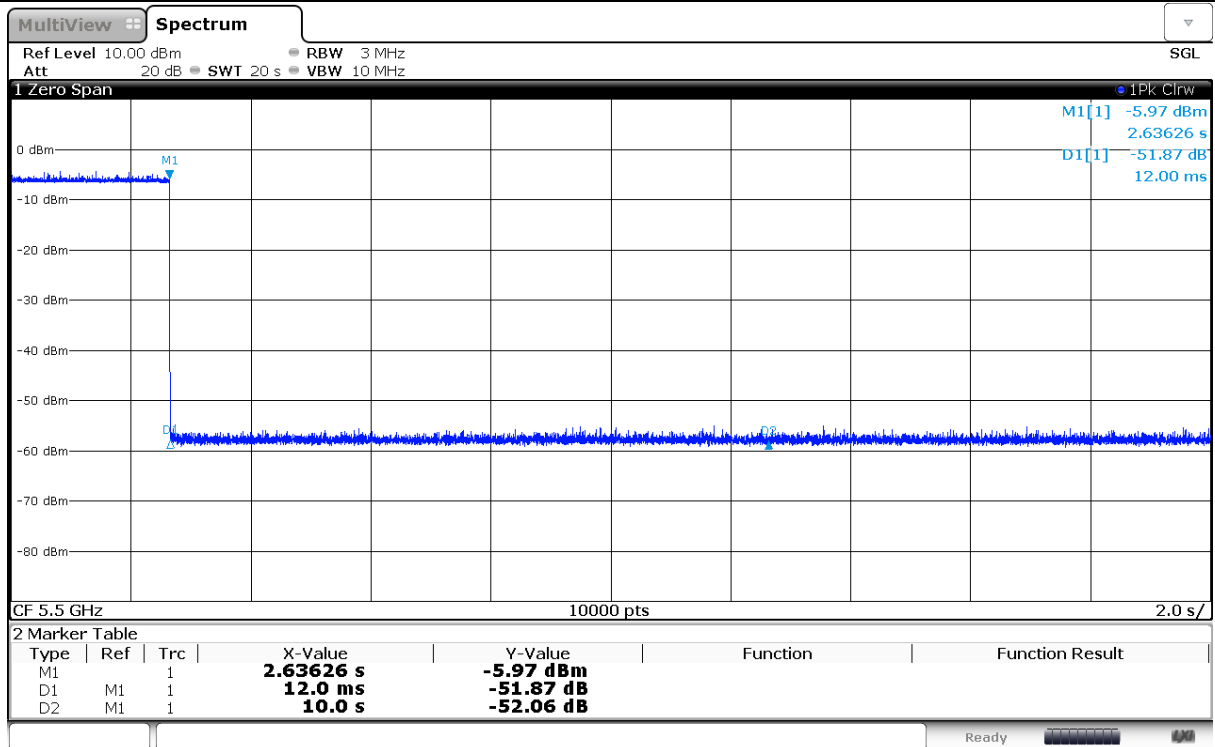
Operational WLAN Channel without Traffic



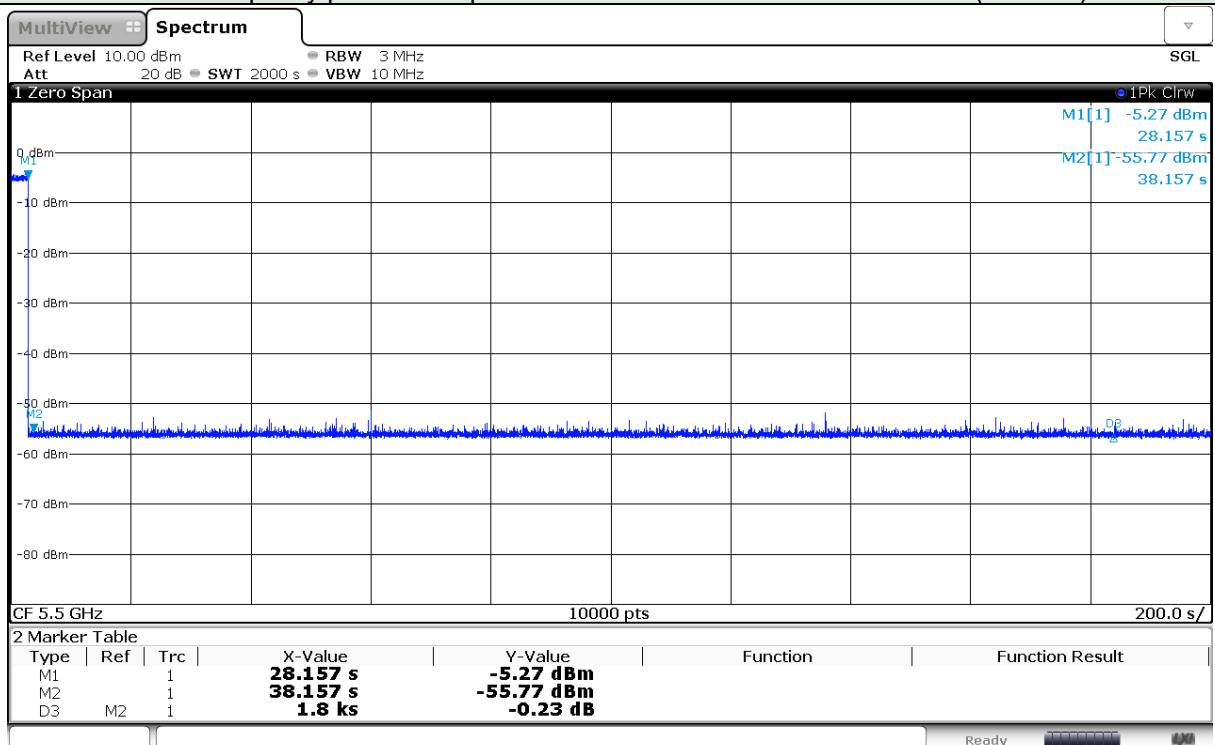
Operational WLAN Channel with Traffic



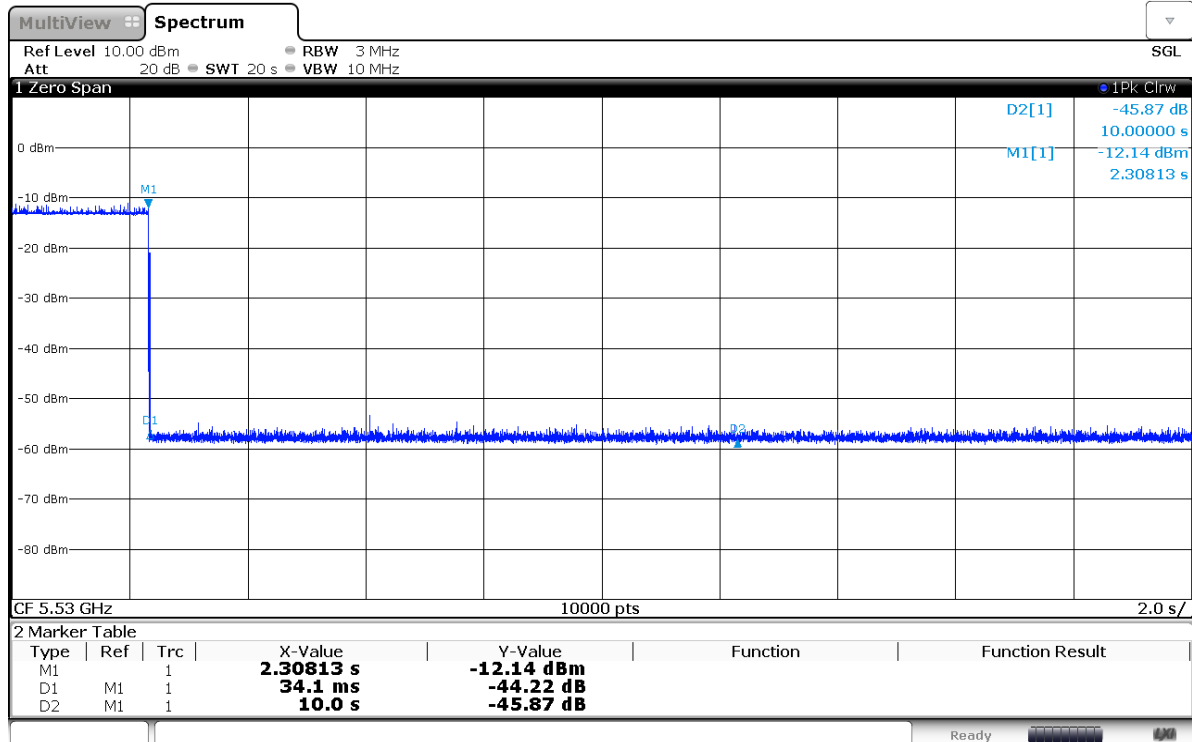
Channel move time and Channel closing transmission time at 20 MHz bandwidth (802.11a)



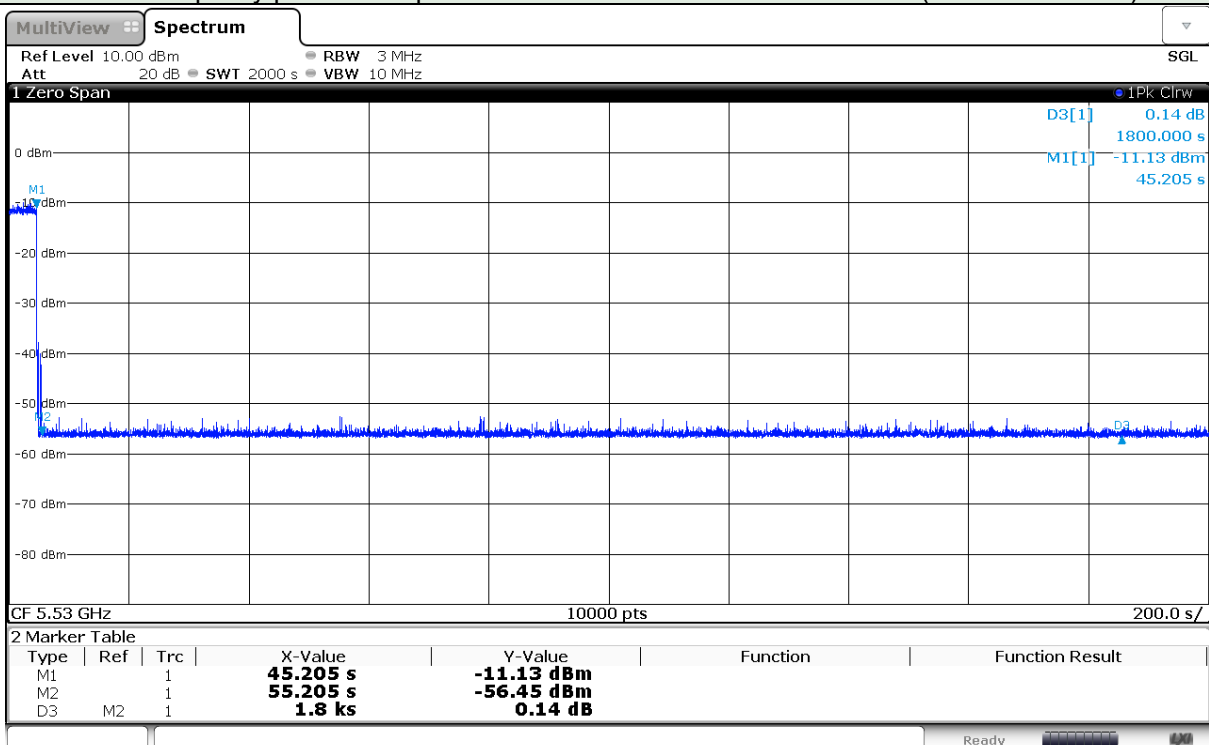
Non-occupancy period – Elapse time 30 minutes at 20 MHz bandwidth (802.11a)



Channel move time and Channel closing transmission time at 80 MHz bandwidth (802.11ac VHT80)



Non-occupancy period – Elapse time 30 minutes at 80 MHz bandwidth (802.11ac VHT80)



Appendix I – Test Instrumentation

Description	Model No.	Serial No.	Manufacturer.	Due for Cal. Date	Cal. Interval
Signal & Spectrum Analyzer	FSW 43	100578	Rohde & Schwarz	2021-04-20	1 Y
Vector Signal Generator	SMBV100A	101441	Rohde & Schwarz	2021-01-26	1 Y
Attenuator	56-10	58769	WEINSCHTEL	2021-01-20	1 Y
Attenuator	10 dB	ENG-1	Rohde & Schwarz	2021-01-16	1 Y
DC Power Supply	6032A	SG41000637	Agilent	2021-03-25	1 Y
Directional Coupler	AAMCS-UDC-0.5G-18G-SF	000757	AAMCS	2021-01-17	1 Y
Splitter	1580	SC321	WEINSCHTEL	2021-01-20	1 Y
Attenuator	8496A	3308A3798S	HP	2021-01-16	1 Y
Attenuator	8494B	3308a38821	HP	2021-01-16	1 Y
Wireless Access Point	WAC720	4D7689EP000FB	NETGEAR	-	N/A

The measuring equipment utilized to perform the tests documented in this test report has been calibrated in accordance with manufacturer's recommendations, and is traceable to recognized national standards.