

Element Materials Technology

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MEASUREMENT REPORT FCC PART 15.407 / ISED RSS-247 DFS

Applicant Name:

Apple Inc. One Apple Park Way Cupertino, CA 95014 United States

Date of Testing: 11/29/2023 - 1/15/2024 **Test Report Issue Date:** 3/25/2024 **Test Site/Location:** Element Materials Technology, Morgan Hill, CA, USA **Test Report Serial No.:** 1C2311270063-10.BCG

BCGA2902

579C-A2902

Apple Inc.

Certification

A2902

APPLICANT:

FCC ID:

IC:

Application Type:

Model/HVIN: **EUT Type:** Max. RF Output Power:

Frequency Range: FCC Classification: FCC Rule Part(s): **ISED Specification:**

Client Only Device, No Radar Detection Capability 177.828 mW (22.50 dBm) Conducted (802.11n UNII Band 2A) 198.153 mW (22.97 dBm) Conducted (802.11n UNII Band 2C) 5250 - 5350 MHz (UNII-2A Band) 5470 - 5725 MHz (UNII-2C Band) Unlicensed National Information Infrastructure (UNII) Part 15 Subpart E (15.407) RSS-247 Issue 3 **Test Procedure(s):** KDB 905462 D02 v02

This equipment has been shown to be capable of compliance with the applicable technical standards as indicated in the measurement report and was tested in accordance with the measurement procedures specified in ANSI C63.10-2013. Test results reported herein relate only to the item(s) tested.

I attest to the accuracy of data. All measurements reported herein were performed by me or were made under my supervision and are correct to the best of my knowledge and belief. I assume full responsibility for the completeness of these measurements and vouch for the qualifications of all persons taking them.

R] Ortanez **Executive Vice President**

Prepared by: WKR0000010733

Reviewed by: WKR0000005913



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1.0 INTRODUCTION

1.1 Scope

This report has been prepared to demonstrate compliance with the requirements for Dynamic Frequency Selection (DFS) as stated in KDB 905462 D02 v02. As of July 20, 2007, all devices operating in the 5250 – 5350 MHz and/or the 5470 – 5725 MHz bands (excluding 5600-5650MHz for ISED Canada) must comply with the DFS requirements.

1.2 Element Test Location

These measurement tests were conducted at the Element Materials Technology facility located at 18855 Adams Court, Morgan Hill, CA 95037. The measurement facility is compliant with the test site requirements specified in ANSI C63.4-2014 and KDB 414788 D01 v01r01.

1.3 Test Facility / Accreditations

Measurements were performed at Element Materials Technology located in Morgan Hill, CA 95037, U.S.A.

- Element Materials Technology is an ISO 17025-2017 accredited test facility under the American Association for Laboratory Accreditation (A2LA) with Certificate number 2041.02 for Specific Absorption Rate (SAR), Hearing Aid Compatibility (HAC) testing, where applicable, and Electromagnetic Compatibility (EMC) testing for FCC and Innovation, Science, and Economic Development Canada rules.
- Element Washington DC LLC TCB is a Telecommunication Certification Body (TCB) accredited to ISO/IEC 17065-2012 by A2LA (Certificate number 2041.03) in all scopes of FCC Rules and ISED Standards (RSS).
- Element Materials Technology facility is a registered (22831) test laboratory with the site description on file with ISED.
- Element Washington DC LLC is a Recognized U.S. Certification Assessment Body (CAB # US0110) for ISED Canada as designated by NIST under the U.S. and Canada Mutual Recognition Agreements (MRAs).

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PRODUCT INFORMATION 2.0

2.1 **Equipment Description**

The Equipment Under Test (EUT) is the Apple Tablet Device FCC ID: BCGA2902, IC: 579C-A2902. The test data contained in this report pertains only to the emissions due to the EUT's UNII transmitter. As the EUT does not have radar detection capability it was evaluated as a Client Only Device. All test results reported herein are applicable to the sample selected for testing.

Mode of Operation:

Master Device	
Client Device (No radar detection)	\square
Client Device with Radar Detection	

Test Device Serial No.: Y464T6JJHY

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2.2 **Device Capabilities**

This device contains the following capabilities:

802.11b/g/n/ax WLAN, 802.11a/n/ac/ax UNII, 802.15.4, Bluetooth (1x, EDR, LE1M, LE2M, HDR4, HDR8) 802.11a/ax WIFI 6E, NB UNII (1x, HDR4, HDR8), WPT

This device supports BT Beamforming.

Channel puncturing function is not supported for this device.

	Band 1			Band 2A			Band 2C			Band 3
Ch.	Frequency (MHz)		Ch.	Frequency (MHz)		Ch.	Frequency (MHz)		Ch.	Frequency (MHz)
36	5180		52	5260		100	5500	Γ	149	5745
:	:		:	:		:	:	Γ	:	:
42	5210		56	5280		116	5580	Γ	157	5785
:	:		:	:		:	:	Γ	:	:
48	5240		64	5320		144	5720	Γ	165	5825
	Table 2-1, 802 11a / 802 11a / 802 11ac / 802 11ax (20MHz) Frequency / Channel Operations									

Table 2-1. 802.11a / 802.11n / 802.11ac / 802.11ax (20MHz) Frequency / Channel Operations

	Band 1		Band 2A		Band 2C		Band 3
Ch.	Frequency (MHz)	Ch.	Frequency (MHz)	Ch.	Frequency (MHz)	Ch.	Frequency (MHz)
38	5190	54	5270	102	5510	151	5755
:	:		:	:	:	:	:
46	5230	62	5310	110	5550	159	5795

Table 2-2. 802.11n / 802.11ac / 802.11ax (40MHz BW) Frequency / Channel Operations

142

138

5710

5690

	Band 1	_	Band 2A			Band 2C			Band 3			
Ch.	Frequency (MHz)	Ch.	Frequency (MHz)		Ch.	Frequency (MHz)		Ch.	Frequency (MHz)			
42	5210	58	5290		106	5530		155	5775			
					:							

Table 2-3. 802.11ac / 802.11ax (80MHz BW) Frequency / Channel Operations

	Band 1	 Band 2A				Band 2C
Ch.	Frequency (MHz)	Ch.	Frequency (MHz)		Ch.	Frequency (MHz)
50	5250	50	5250		114	5570

Table 2-4. 802.11ac / 802.11ax (160MHz BW) Frequency / Channel Operations

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2.3 Antenna Description

Frequency	Antenna Gain (dBi)					
[GHz]	Antenna WF8	Antenna WF7a				
5.150 – 5.250	1.3	2.9				
5.250 - 5.350	1.6	2.7				
5.470 – 5.725	4.4	2.5				
5.725 – 5.850	5.0	2.1				

Following antenna gains provided by manufacturer were used for the testing.

Table 2-5. Highest Antenna Gain

2.4 Test Support Equipment

The following equipment was used in support of the DFS testing.

Device	Manufacturer	Model	Description	S/N:	FCC ID:
		A1521	Access Point	C86L3BA8FJ1R	BCGA1521
Master	Apple	MacBook Air	Controller	C02P41RZG086	QDS- BRCM1072
	Netgear	RAXE500	Access Point	6JX215GA10A5	PY320300508
		Apple TV	Controller	C0754033HHFP	BCGA1625
Client	Apple	MacBook Air	Controller	C02P41RZG086	QDS- BRCM1072
Client		Spartan	USB-C Cable 000MKTR02U		N/A
	Dell	U24177HJ	Monitor Display	0RXP1N-74261- 71Q-0APL-A01	N/A

Table 2-6. Test Support Equipment List

2.5 Master Parameters

Parameters of Master:				
Minimum Antenna Gain	1.4 dBi			
EIRP Level:	>23 dBm			
Access Point Software Version	7.7.9			

Table 2-7. Parameters of Master

2.6 Software and Firmware

The test was done with firmware version 21E8197 installed on the EUT.

2.7 EMI Suppression Device(s)/Modifications

No EMI suppression device(s) were added and/or no modifications were made during testing.

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3.0 **DESCRIPTION OF TESTS**

3.1 Evaluation Procedure

The measurement procedures described in KDB 905462 D02 v02 were used in the measurement of the EUT. Radiated test methodology was used for the DFS evaluation procedure of the EUT. No deviations to the test procedure and test methods occurred during the evaluation of the EUT.

Deviation from measurement procedure.....None

3.2 Environmental Conditions

The temperature is controlled within range of 15°C to 35°C. The relative humidity is controlled within range of 10% to 75%. The atmospheric pressure is monitored within the range 86-106kPa (860-1060mbar).

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4.0 ANTENNA REQUIREMENTS

Excerpt from §15.203 of the FCC Rules/Regulations:

"An intentional radiator antenna shall be designed to ensure that no antenna other than that furnished by the responsible party can 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 antennas of the EUT are permanently attached.
- There are no provisions for connection to an external antenna.

Conclusion:

The EUT complies with the requirement of §15.203.

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5.0 MEASUREMENT UNCERTAINTY

The measurement uncertainties shown below were calculated in accordance with the requirements of ANSI C63.23-2012. All measurement uncertainty values are shown with a coverage factor of k = 2 to indicate a 95% level of confidence. The measurement uncertainty shown below meets or exceeds the U_{CISPR} measurement uncertainty values specified in CISPR 16-4-2 and, thus, can be compared directly to specified limits to determine compliance.

Parameter	Expanded Uncertainty	
Time	± 0.02%	

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TEST EQUIPMENT CALIBRATION DATA 6.0

Test Equipment Calibration is traceable to the National Institute of Standards and Technology (NIST). Measurements antennas used during testing were calibrated in accordance to the requirements of ANSI C63.5-2017.

Manufacturer	Model	Description	Cal. Date	Cal. Interval	Cal. Due Date	Serial No.
Aeroflex	3025C	PXI RF Synthesizer	03/06/2023	Biennial	03/06/2025	302570726
Aeroflex	3035C	PXI RF Digitizer	03/06/2023	Biennial	03/06/2025	303570427
ETS-Lindgren	3117	Double Ridged Guide Antenna (1-18 GHz)	03/30/2023	Annual	03/30/2024	00218555
Keysight Technology	N9040B	UXA Signal Analyzer	03/10/2023	Annual	03/10/2024	MY57212015
Rohde & Schwarz	TC-TA18	Vivaldi Antenna	8/02/2023	Annual	8/02/2024	101063

Table 6-1. Test Equipment List

Note:

For equipment listed above that has a calibration date or calibration due date that falls within the test date range, care was taken to ensure that this equipment was used after the calibration date and before the calibration due date.

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7.0 DESCRIPTION OF DYNAMIC FREQUENCY SELECTION TEST

7.1 Applicability

The following table from KDB 905462 D02 v02 lists the applicable requirements for the DFS testing. The device evaluated in this report is considered a client device without radar detection capability.

		Operational Mode			
Requirement	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		

Table 7-1. DFS Applicability

		Operational Mode			
Requirement	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		

Table 7-2. DFS Applicability During Normal Operation

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.

Table 7-3. Additional Requirement for Devices with Multiple Bandwidth Modes

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Per KDB 905462 D02 v02 the operational behavior and individual DFS requirements associated with these modes are as follows:

7.1.1 Master Devices:

- a) The Master Device will use DFS in order to detect Radar Waveforms with received signal strength above the DFS Detection Threshold in the 5250 – 5350 MHz and 5470 – 5725 MHz bands. DFS is not required in the 5150 – 5250 MHz or 5725 – 5850 MHz bands.
- b) Before initiating a network on a Channel, the Master Device will perform a Channel Availability Check for a specified time duration (Channel Availability Check Time) to ensure that there is no radar system operating on the Channel, using DFS described under subsection a) above.
- c) The Master Device initiates a U-NII network by transmitting control signals that will enable other U-NII devices to Associate with the Master Device.
- d) During normal operation, the Master Device will monitor the Channel (In-Service Monitoring) to ensure that there is no radar system operating on the Channel, using DFS described under a).
- e) If the Master Device has detected a Radar Waveform during In-Service Monitoring as described under d), the Operating Channel of the U-NII network is no longer an Available Channel. The Master Device will instruct all associated Client Device(s) to stop transmitting on this Channel within the Channel Move Time. The transmissions during the Channel Move Time will be limited to the Channel Closing Transmission Time.
- f) Once the Master Device has detected a Radar Waveform it will not utilize the Channel for the duration of the Non-Occupancy Period.
- g) If the Master Device delegates the In-Service Monitoring to a Client Device, then the combination will be tested to the requirements described under d) through f) above.

7.1.2 Client Devices:

- a) A Client Device will not transmit before having received appropriate control signals from a Master Device.
- b) A Client Device will stop all its transmissions whenever instructed by a Master Device to which it is associated and will meet the Channel Move Time and Channel Closing Transmission Time requirements. The Client Device will not resume any transmissions until it has again received control signals from a Master Device.
- c) If a Client Device is performing In-Service Monitoring and detects a Radar Waveform above the DFS Detection Threshold, it will inform the Master Device. This is equivalent to the Master Device detecting the Radar Waveform and d) through f) of section 5.1.1 apply.
- d) Irrespective of Client Device or Master Device detection the Channel Move Time and Channel Closing Transmission Time requirements remain the same.
- e) The client test frequency must be monitored to ensure no transmission of any type has occurred for 30 minutes. Note: If the client moves with the master, the device is considered compliant if nothing appears in the client nonoccupancy period test. For devices that shutdown (rather than moving channels), no beacons should appear.

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7.2 DFS Detection Threshold Values

The DFS detection thresholds are defined for Master devices and Client Devices with In-service monitoring. These detection thresholds are listed in the following table.

Maximum Transmit Power	Value (See Notes 1, 2, and 3)		
EIRP ≥ 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.

Note 3: EIRP is based on the highest antenna gain. For MIMO devices refer to KDB Publication 662911 D01.

Table 7-4: Detection Thresholds for Master Devices and Client Devices with Radar Detection

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7.3 DFS Response Requirements

DFS response requirements for Master and Client Devices are listed in the following table.

Parameter	Value
Non-occupancy period	Minimum 30 minutes
Channel Availability Check Time	60 seconds
Channel Move Time	10 seconds See Note1
Channel Closing Transmission Time	200 milliseconds + an aggregate of 60 milliseconds over remaining 10 second period. See Note 1 and 2.
U-NII Detection Bandwidth	Minimum 100% of the U- NII 99% transmission 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.

control signals will not count quiet periods in between transmissions.

frequency step the minimum percentage of detection is 90 percent. Measurements are performed with no data traffic.

Table 7-5: DFS Response Requirements

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7.4 Parameters of DFS Test Signals

As the EUT is a Client Device with no Radar Detection only one type radar pulse is required for the testing. Radar Pulse type 0 was used in the evaluation of the Client device for the purpose of measuring the Channel Move Time and the Channel Closing Transmission Time. Table 7-6 lists the parameters for the Short Pulse Radar Waveforms. A plot of the Radar Pulse Type 0 used for testing is included in Section 7.7 of this report.

Radar Type	Pulse Width (µsec)	PRI Number of Pulses (µsec)		Minimum Percentage of Successful Detection	Minimum Number of Trials
0	1	1428	18	See Note 1	See Note 1
		Test A: 15 unique PRI values randomly selected from the list of 23 PRI values in Table 5a	$Roundup\left\{\frac{1}{360},\frac{19.10^6}{PRI_{\mu sec}}\right\}$		
1	1	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		60%	30
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
Aggrega	Aggregate (Radar Types 1-4)				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 7-6: Parameters for Short Pulse Radar Waveforms

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

Table 7-7. Parameters for Long Pulse Radar Waveforms

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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

Table 7-8. Parameters for Frequency Hopping Radar Waveforms

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7.5 System Overview and Procedure

DFS Test Setup per KDB 905462 D02 V02:

Radiated DFS Test Setup	\square
Conducted DFS Test Setup	

KDB 905462 D02 v02 describes radiated test setup and conducted test setup. DFS testing was performed using radiated test setup, as seen in Figure 7-1 below. One channel was selected in Band UNII-2C, between 5470-5725 MHz, for testing.

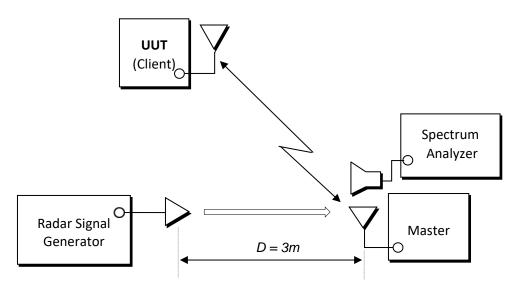


Figure 7-1. Radiated Test Setup for DFS

- 1. The "Aeroflex PXI DFS Radar Simulator and Analyzer Test Suite" is setup to provide a simulated radar pulse at the frequency that the Master and Client are operating. A Type 0 radar pulse was used.
- 2. The Client Device (EUT) is set up per the diagram in Figure 7-1 and communications between the Master device and the Client is established.
- 3. The FCC video test file is streamed from the Master to the Client to properly load the network.
- 4. The "Aeroflex PXI DFS Radar Simulator and Analyzer Test Suite" is set to record and display 12 seconds of time, starting from where the simulated radar is generated. This time domain plot captures any transmissions occurring up to and after 10 seconds. Aggregate time is computed to ensure compliance. (Note: the channel may be different since the Master and Client have changed channels due to the detection of the initial radar pulse.)
- 5. After the initial radar burst the channel is monitored for 30 minutes to ensure no transmissions or beacons occur. A second monitoring setup is used to verify that the Master and Client have both moved to different channels.

Test Report S/N: Test Dates: EUT Type:	FCC ID: BCGA2902 IC: 579C-A2902	element MEASUREMENT REPORT (CERTIFICATION)		Approved by: Technical Manager	
	Test Report S/N:	Test Dates:	EUT Type:	Dogo 17 of 42	
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7.6 **System Calibration:**

The following equipment setup was used to calibrate the Radar Waveform. A spectrum analyzer was used to establish the test signal level for each radar type. During this process, there were no transmissions by either the Master or Client Device. The spectrum analyzer was switched to the zero span (Time Domain) mode at the frequency of the Radar Waveform generator. Peak detection was utilized. The spectrum analyzer resolution bandwidth (RBW) and video bandwidth (VBW) were set to 3MHz.

The signal generator amplitude is adjusted so that the power level measured at the spectrum analyzer is equal to the DFS detection threshold -64 dBm. The required radiated threshold at the antenna port is -64dBm + 0dBi + 1dB = -63 dBm (Section 7.2).

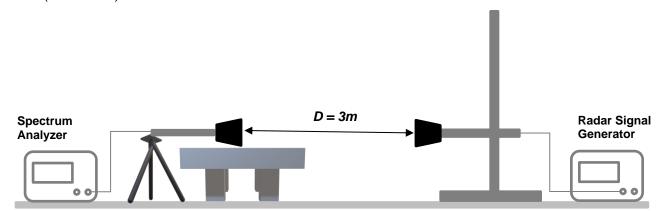


Figure 7-2. Radar Waveform Calibration

FCC ID: BCGA2902 IC: 579C-A2902	element	MEASUREMENT REPORT (CERTIFICATION)	Approved by: Technical Manager
Test Report S/N:	Test Dates:	EUT Type:	Dage 19 of 10
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Radar Waveform Calibration Plot:

The radiated plots of the Radar Pulse Signals (Type 0) are given below after performing the system calibration as described in Section 7.7.

Short Pulse Radar Type 0:

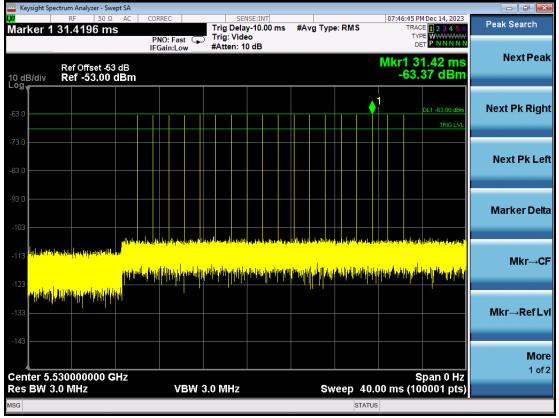


Figure 7-3. 5530MHz – Radar Pulse Type 0 (80MHz)

Test Report S/N: Test Dates: EUT Type: Page 19 of 42	FCC ID: BCGA2902 IC: 579C-A2902	element	element MEASUREMENT REPORT (CERTIFICATION)	
Page 19 01 42	Test Report S/N:	Test Dates:	EUT Type:	Dage 10 of 12
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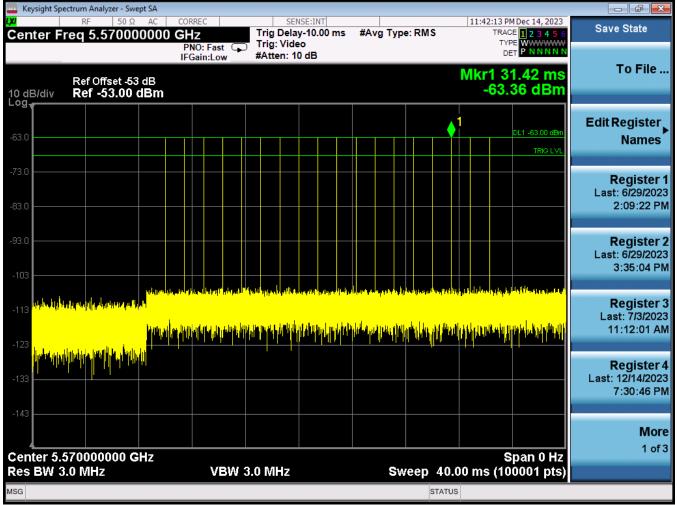


Figure 7-4. 5570MHz – Radar Pulse Type 0 (160MHz)

FCC ID: BCGA2902 IC: 579C-A2902	element	MEASUREMENT REPORT (CERTIFICATION)	Approved by: Technical Manager
Test Report S/N:	Test Dates:	EUT Type:	Dage 20 of 42
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8.0 EUT COMMUNICATION MODES

The EUT was tested in 4 different test configurations,

Mode 1: Client Mode

Mode 2: Client to Client

Mode 3: Peer to Peer (EUT)

Mode 4: Peer to Peer (Apple TV)

Mode 1: Client Mode

Client is connected to Master (AP) via WLAN network and plays a video test file "6 ½ Magic Hours" in a Server (Laptop). This Server is connected to the Master (AP) via ethernet cable. The Vivaldi antenna is adjusted so that the WLAN traffic level, as displayed on the spectrum analyzer, is at lower amplitude than the radar detection threshold.

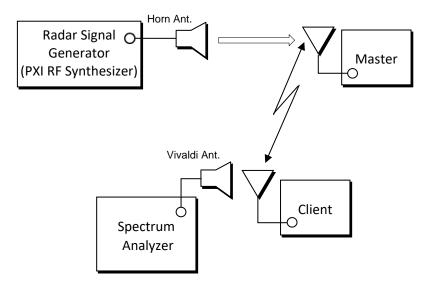


Figure 8-1. Test Setup (Mode 1)

FCC ID: BCGA2902 IC: 579C-A2902	element	MEASUREMENT REPORT (CERTIFICATION)	Approved by: Technical Manager
Test Report S/N:	Test Dates:	EUT Type:	Dage 01 of 40
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Mode 2: Client-to-Client Communications Mode

Client plays the video test file that is streamed to generate WLAN while linked to Master and streamed the video through Apple TV to Monitor display. The Vivaldi antenna is adjusted so that the WLAN traffic level, as displayed on the spectrum analyzer, is at lower amplitude than the radar detection threshold.

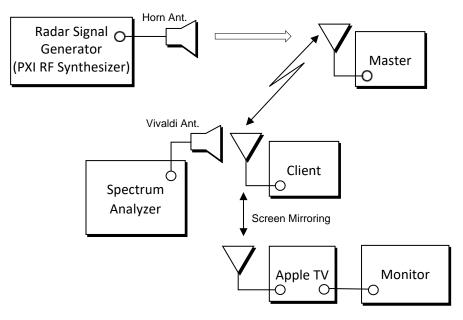


Figure 8-2. Test Setup (Mode 2)

FCC ID: BCGA2902 IC: 579C-A2902	element MEASUREMENT REPORT (CERTIFICATION)		Approved by: Technical Manager
Test Report S/N:	Test Dates:	EUT Type:	Dogo 22 of 42
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Mode 3: Peer-to-Peer (EUT) Communications Mode

Generate and inject additional transmission:

- 1. Client and Apple TV must be linked to the Master.
- 2. Client plays video that is saved within its internal storage and begin mirroring screen via Apple TV.
- 3. Connect the Apple TV and Client to the support laptop and initiate additional transmission using iPerf.
- 4. After the additional transmission is injected, the Client must be disconnected to the Master.
- 5. Client stops and re-start mirroring screen.

Client plays video that is saved within its internal storage and streamed through Apple TV to the Monitor display. The receive antenna/ monitoring antenna is placed near the EUT. Additional data traffic was sent from the EUT (Client) to Apple TV (Server) using iPerf. The Vivaldi antenna is adjusted so that the WLAN traffic level, as displayed on the spectrum analyzer, is at lower amplitude than the radar detection threshold.

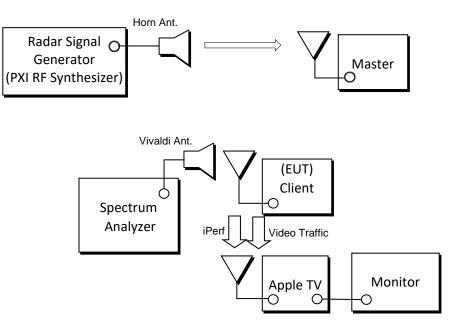


Figure 8-3. Test Setup (Mode 3)

FCC ID: BCGA2902 IC: 579C-A2902	element	MEASUREMENT REPORT (CERTIFICATION)	Approved by: Technical Manager
Test Report S/N:	Test Dates:	EUT Type:	Dage 22 of 42
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Mode 4: Peer-to-Peer (Apple TV) Communications Mode

Generate and inject additional transmission:

- 1. Client and Apple TV must be linked to the Master.
- 2. Client plays video that is saved within its internal storage and begin mirroring screen via Apple TV.
- 3. Connect the Apple TV and Client to the support laptop and initiate additional transmission using iPerf.
- 4. After the additional transmission is injected, the Client must be disconnected to the Master.
- 5. Client stops and re-start mirroring screen.

Client plays video that is saved within its internal storage and streamed through Apple TV to the Monitor display. The receive antenna/ monitoring antenna is placed near the Apple TV. Additional data traffic was sent from the Apple TV (Client) to the EUT (Server) using iPerf. The Vivaldi antenna is adjusted so that the WLAN traffic level, as displayed on the spectrum analyzer, is at lower amplitude than the radar detection threshold.

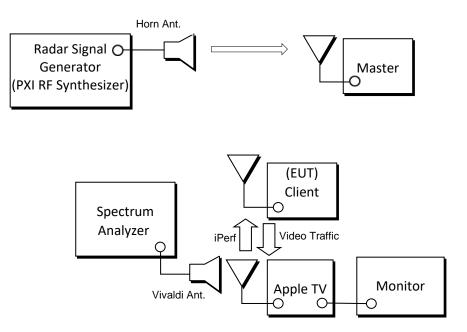


Figure 8-4. Test Setup (Mode 4)

In summary, for Modes 1 and Mode 2, Client is linked to the Master, and for Modes 3 and Mode 4, Client is not linked to the Master.

FCC ID: BCGA2902 IC: 579C-A2902	element	MEASUREMENT REPORT (CERTIFICATION)	Approved by: Technical Manager
Test Report S/N:	Test Dates:	EUT Type:	Dage 24 of 42
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9.0 TEST RESULTS

9.1 Summary

Company Name:	Apple Inc.
FCC ID:	BCGA2902
IC:	<u>579C-A2902</u>
FCC Classification:	Unlicensed National Information Infrastructure (UNII)

			Меа	sured		
	Mode	Parameter	80MHz Bandwidth	160MHz Bandwidth	Limit	Result
		Channel Move Time	0.907 s	0.115 s	10 seconds	Pass
	1 Client Mode	Channel Closing Transmission Time	< 200ms + 0.000 ms (aggregate)	< 200ms + 0.000 ms (aggregate)	200 ms + aggregate of 60ms over remaining 10 second period	Pass
ada)		Non- Occupancy Period	Monitored for 30 minutes with no client transmission	Monitored for 30 minutes with no client transmission	30 Minutes	Pass
Cana		Channel Move Time	0.804 s	N/A	10 seconds	Pass
6xcluding 5600-5725 MHz (excluding 5600-5650MHz for ISED Canada) UNII – 2C Band Client to tueic to tueic Cinut client	Channel Closing Transmission Time	< 200ms + 0.595 ms (aggregate)	N/A	200 ms + aggregate of 60ms over remaining 10 second period	Pass	
	Non- Occupancy Period	Monitored for 30 minutes with no client transmission	N/A	30 Minutes	Pass	
- 5 6501 1 - 2		Channel Move Time	0.123 s	N/A	10 seconds	Pass
5470 – 5600-565 UNII –	3 Peer to Peer	Channel Closing Transmission Time	< 200ms + 0.000 ms (aggregate)	N/A	200 ms + aggregate of 60ms over remaining 10 second period	Pass
luding	(EUT)	Non- Occupancy Period	Monitored for 30 minutes with no client transmission	N/A	30 Minutes	Pass
(exc		Channel Move Time	0.137 s	N/A	10 seconds	Pass
	4 Peer to Peer	Channel Closing Transmission Time	< 200ms + 0.000 ms (aggregate)	N/A	200 ms + aggregate of 60ms over remaining 10 second period	Pass
	(Apple TV)	Non- Occupancy Period	Monitored for 30 minutes with no client transmission	N/A	30 Minutes	Pass

Table 9-1. Summary of Test Results

FCC ID: BCGA2902 IC: 579C-A2902	element	MEASUREMENT REPORT (CERTIFICATION)	Approved by: Technical Manager
Test Report S/N:	Test Dates:	EUT Type:	Dage OF of 40
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Notes:

- 1) The EUT was found to be compliant with the requirements for DFS as required for a Client Device per Part 15.407(h), RSS-247 and KDB 905462 D02 v02.
- 2) Automated test software was used to measure emissions and capture the corresponding plots necessary to show compliance. The list is given below,
 - DFS threshold count v1.1 •
 - DFS Radar Simulator and Analyzer v2.8 (Aeroflex Inc.) •
 - iPerf Software

FCC ID: BCGA2902 IC: 579C-A2902	element	MEASUREMENT REPORT (CERTIFICATION)	Approved by: Technical Manager
Test Report S/N:	Test Dates:	EUT Type:	Dogo 26 of 42
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9.2 Channel Loading

9.2.1 Channel Loading Mode 1:

Channel Loading Notes:

Per KDB 905462 D02 v02, timing plots are required with calculations demonstrating a minimum channel loading of approximately 17% or greater. Channel loading can be estimated by setting the spectrum analyzer for zero span and approximate the transmission time.

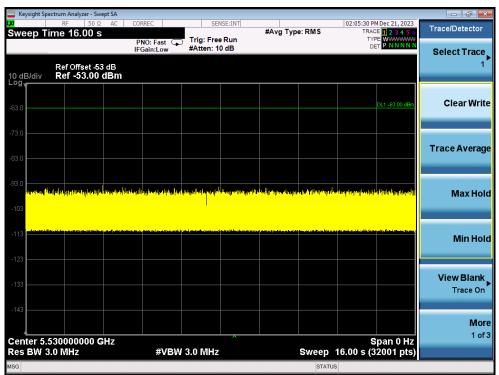


Figure 9-1. 5530MHz - Channel Loading - Mode 1 (80MHz)

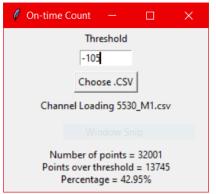


Figure 9-2. 5530MHz - Channel Loading Calculation - Mode 1 (80MHz)

FCC ID: BCGA2902 IC: 579C-A2902	element MEASUREMENT REPORT (CERTIFICATION)		Approved by: Technical Manager
Test Report S/N:	Test Dates:	EUT Type:	Dage 07 of 40
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							STATU			
enter 5. es BW 3	570000000 3.0 MHz	GHZ	#VBM	/ 3.0 MHz			Sweep	Span 0 Hz 16.00 s (32001 pts		L
143										Scale Typ
										01
133										Freq Offs
123									Auto	IVIO
113			dia siddada yiki dhasisidad bir sasa ny sara da						3 Auto	8.000000 MI M
		the second of	a contractor de contractor				1	and the second		CF Ste
103 4. 4. 4	unterstation of the state of	tur and an	hudin henry literation	da mata kubilas	dia akalenta	Ling the strength	n malina ika da	a dealer and an an and the second state and the	5.57	0000000 G
3.0										Stop Fr
3.0									0.01	
									5.57	Start Fr 0000000 G
3.0										
3.0								DL1 -63.00 dBm	5.57	0000000 G
										Center Fr
) dB/div	Ref -53.0	0 dBm								
	Ref Offset -	52 AD	IFGam:Low	WAtten. 1	U U D					Auto Tu
enter F	req 5.5700	00000	PNO: Fast IFGain:Low	Trig: Free #Atten: 1		#Avg iyp	e: RIVIS	TRACE 1 2 3 4 5 (TYPE WWWWWW DET P N N N N		
		Ω AC	CORREC	SEN	NSE:INT	#Avg Typ	- DMC	02:11:57 PM Dec 21, 2023	Er	equency

Figure 9-3. 5570MHz - Channel Loading - Mode 1 (160MHz)

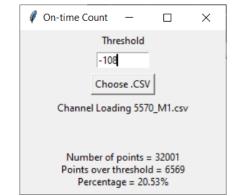


Figure 9-4. 5570MHz - Channel Loading Calculation - Mode 1 (160MHz)

FCC ID: BCGA2902 IC: 579C-A2902	element	MEASUREMENT REPORT (CERTIFICATION)	Approved by: Technical Manager
Test Report S/N:	Test Dates:	EUT Type:	Dage 20 of 42
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9.2.2 Channel Loading Mode 2:

🔤 Keysight S	pectrum Analyzer - Swept SA					- ē 🔀
Center	RF 50 Ω AC Freq 5.530000000	CORREC	SENSE:INT	#Avg Type: RMS	10:32:18 PM Dec 22, 2023 TRACE 2 3 4 5 6	Frequency
	Ref Offset -53 dB	PNO: Fast	rig: Free Run Atten: 10 dB		TYPE WWWWWW DET P NNNN	Auto Tune
10 dB/div Log	Ref -53.00 dBm				DL1 -63.00 dBm	Center Freq 5.530000000 GHz
-73.0						Start Freq 5.530000000 GHz
-93.0	414) aver (1997) 144) (1997) 144 (1997) 	14 11	Your Charles the second se	na ar daar yn di fyr far yn radio	handanan an	Stop Freq 5.530000000 GHz
-113					ere a monte d'autor de la composition d	CF Step 3.000000 MHz <u>Auto</u> Man
-133						Freq Offset 0 Hz
						Scale Type
Center 5 Res BW	.530000000 GHz	#VBW 3.		Sween	Span 0 Hz 16.00 s (32001 pts)	Log <u>Lin</u>
Kes DW	3.0 WHZ	#VBW 3.		sweep		
maa				STAT	03	

Figure 9-5. 5530MHz - Channel Loading - Mode 2 (80MHz)

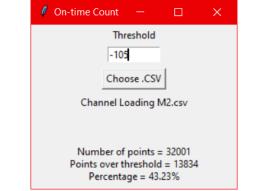


Figure 9-6. 5530MHz - Channel Loading Calculation - Mode 2 (80MHz)

FCC ID: BCGA2902 IC: 579C-A2902	element	MEASUREMENT REPORT (CERTIFICATION)	Approved by: Technical Manager
Test Report S/N:	Test Dates:	EUT Type:	Dage 20 of 42
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9.2.3 Channel Loading Mode 3:

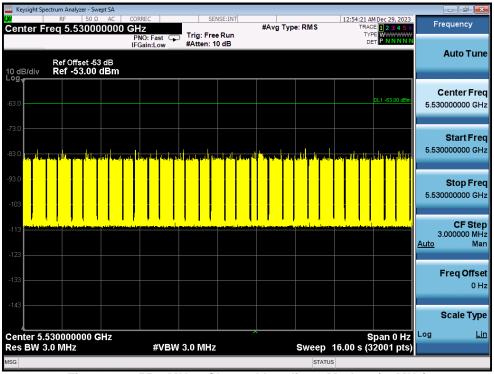


Figure 9-7. 5530MHz - Channel Loading - Mode 3 (80MHz)

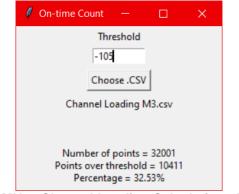


Figure 9-8. 5530MHz - Channel Loading Calculation - Mode 3 (80MHz)

FCC ID: BCGA2902 IC: 579C-A2902	element MEASUREMENT REPORT (CERTIFICATION)		Approved by: Technical Manager
Test Report S/N:	Test Dates:	EUT Type:	Dage 20 of 42
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9.2.4 Channel Loading Mode 4:

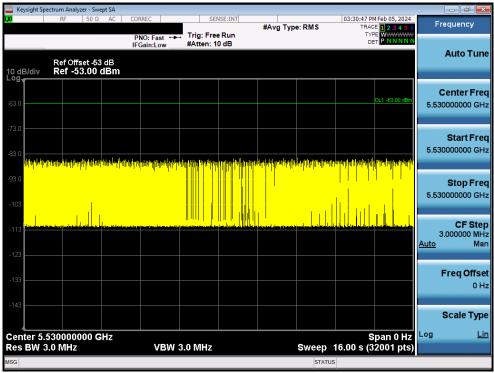


Figure 9-9. 5530 MHz - Channel Loading - Mode 4 (80MHz)

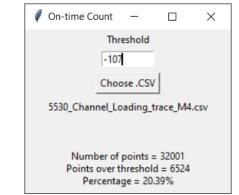


Figure 9-10. 5530MHz - Channel Loading Calculation - Mode 4 (80MHz)

FCC ID: BCGA2902 IC: 579C-A2902	element	MEASUREMENT REPORT (CERTIFICATION)	Approved by: Technical Manager
Test Report S/N:	Test Dates:	EUT Type:	Dage 21 of 42
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9.3 Channel Move/ Closing Transmission Time

9.3.1 Channel Move/ Closing Transmission Time Mode 1:

<u>Result</u>

Parameter	Measu	Limits	
	80MHz Bandwidth	160MHz Bandwidth	
Channel Move Time	.907 s	.115 s	10 seconds
Channel Closing Transmission Time	< 200ms + 0.000 ms (aggregate)	< 200ms + 0.000 ms (aggregate)	200 ms + aggregate of 60ms over remaining 10 second period

Notes:

- 1. The pulses shown in the plots below have been determined to be from the Master AP.
- 2. Marker Info and Aggregate time results are shown on the right side of the plots below.

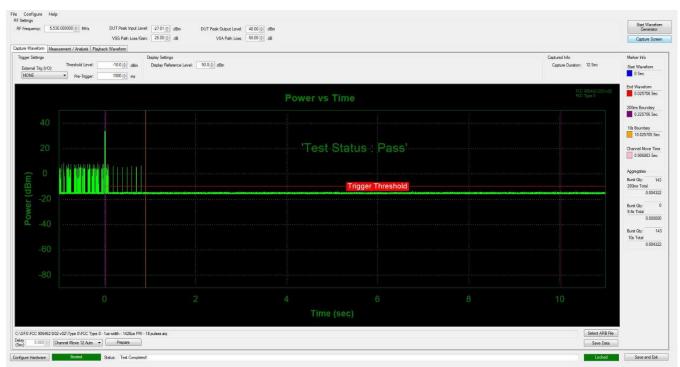


Figure 9-11. 5530MHz - Channel Move/ Closing Transmission Time - Mode 1 (80 MHz)

FCC ID: BCGA2902 IC: 579C-A2902	element	element MEASUREMENT REPORT (CERTIFICATION)	
Test Report S/N:	Test Dates:	EUT Type:	Dage 22 of 42
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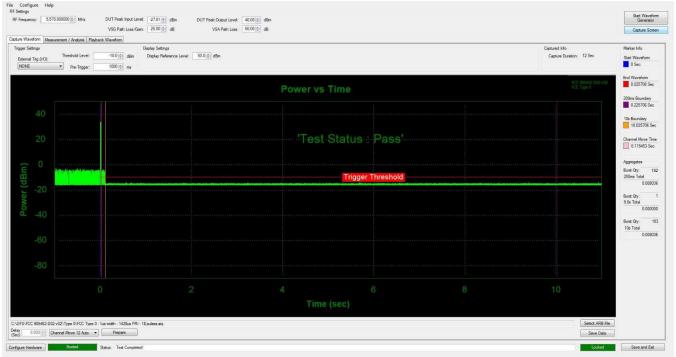


Figure 9-12. 5570MHz - Channel Move/ Closing Transmission Time - Mode 1 (160 MHz)

FCC ID: BCGA2902 IC: 579C-A2902	element	MEASUREMENT REPORT (CERTIFICATION)	Approved by: Technical Manager
Test Report S/N:	Test Dates:	EUT Type:	Dogo 22 of 42
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9.3.2 Channel Move/ Closing Transmission Time Mode 2:

Result:

Parameter	Measurement 80MHz Bandwidth	Limits
Channel Move Time	.804 s	10 seconds
Channel Closing Transmission Time	< 200ms + 0.595 ms (aggregate)	200 ms + aggregate of 60ms over remaining 10 second period

Notes:

- 1. The pulses shown in the plots below have been determined to be from the Master AP.
- 2. Marker Info and Aggregate time results are shown on the right side of the plots below.

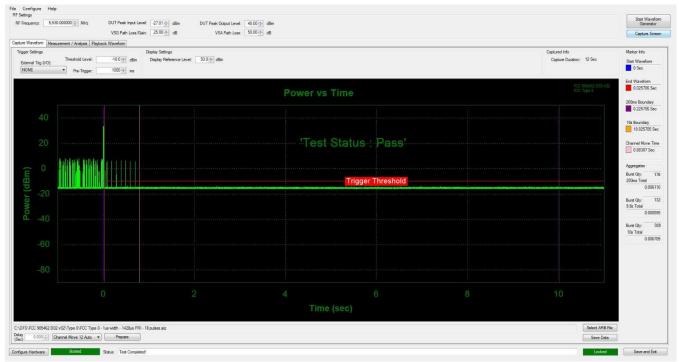


Figure 9-13. 5530MHz - Channel Move/ Closing Transmission Time - Mode 2 (80 MHz)

FCC ID: BCGA2902 IC: 579C-A2902	element MEASUREMENT REPORT (CERTIFICATION)		Approved by: Technical Manager
Test Report S/N:	Test Dates:	EUT Type:	Dage 24 of 42
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9.3.3 Channel Move/ Closing Transmission Time Mode 3:

Result:

Parameter	Measurement 80MHz Bandwidth	Limits
Channel Move Time	.123 s	10 seconds
Channel Closing Transmission Time	< 200ms + 0.000 ms (aggregate)	200 ms + aggregate of 60ms over remaining 10 second period

Notes:

- 1. The pulses shown in the plots below have been determined to be from the Master AP.
- 2. Marker Info and Aggregate time results are shown on the right side of the plots below.

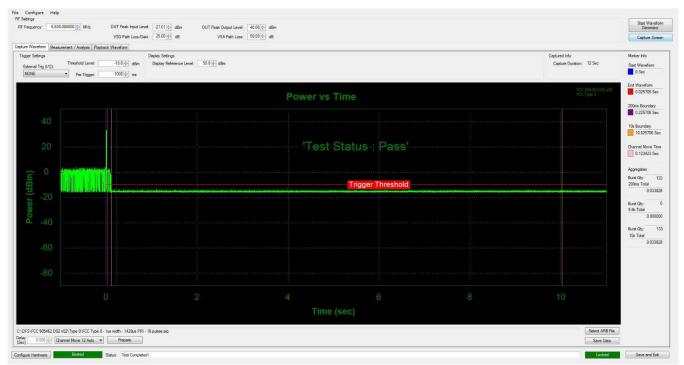


Figure 9-14. 5530MHz - Channel Move/ Closing Transmission Time - Mode 3 (80 MHz)

FCC ID: BCGA2902 IC: 579C-A2902	element	Approved by: Technical Manager	
Test Report S/N:	Test Dates:	EUT Type:	Dage 25 of 42
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9.3.4 Channel Move/ Closing Transmission Time Mode 4:

Result:

Parameter	Measurement 80MHz Bandwidth	Limits
Channel Move Time	.137 s	10 seconds
Channel Closing Transmission Time	< 200ms + 0.000 ms (aggregate)	200 ms + aggregate of 60ms over remaining 10 second period

Notes:

- 1. The pulses shown in the plots below have been determined to be from the Master AP.
- 2. Marker Info and Aggregate time results are shown on the right side of the plots below.

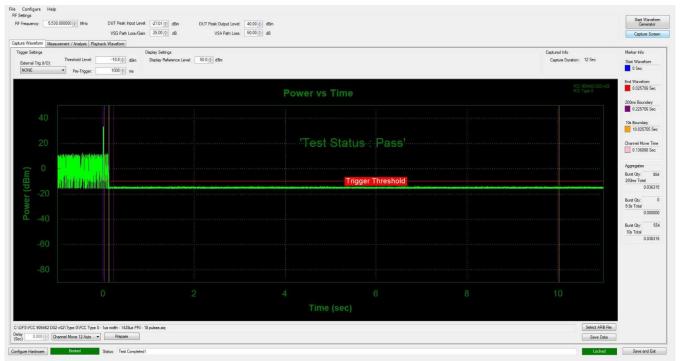


Figure 9-15. 5530MHz - Channel Move/ Closing Transmission Time - Mode 4 (80 MHz)

FCC ID: BCGA2902 IC: 579C-A2902	element MEASUREMENT REPORT (CERTIFICATION)		Approved by: Technical Manager
Test Report S/N:	Test Dates:	EUT Type:	Dage 26 of 42
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9.4 Non-Occupancy Period

9.4.1 Non-Occupancy Period (30 Minutes) Mode 1:

Notes:

1. No frequency transmission detected during the Non-Occupancy Period of 30 minutes monitoring.

🛄 Keysight Sp	ectrum Analyzer	•						
<mark>IXI</mark> Contor E	_R ⊧ req 5.530	50 Ω AC	CORREC	SENSE:I	#Avg Type	02:53:0	1 PM Dec 21, 2023 RACE 1 2 3 4 5 6	Frequency
Centerr	1eq 5.55	000000	PNO: Fast H IFGain:Low	Trig: Free Ru #Atten: 10 dB	n Avg Hold:	1/1		Auto Tune
10 dB/div Log	Ref Offse Ref -53 .	t -53 dB 00 dBm						Auto Tune
-63.0							DL1 -63.00 dBm	Center Freq 5.530000000 GHz
-73.0								Start Freq
-83.0								5.530000000 GHz
-103	, Lat. aballance	to the distribution of the	late a way will be also			- the stand of the standard		Stop Freq 5.530000000 GHz
-113								CF Step 3.000000 MHz <u>Auto</u> Man
-123								Freq Offset 0 Hz
-143								Scale Type
Center 5. Res BW 3	53000000 3.0 MHz	0 GHz	#VBV	V 3.0 MHz	s	weep 2.000 ks	Opan v nz j	Log <u>Lin</u>
MSG						STATUS		

Figure 9-16. 5530MHz - Non-Occupancy Period (30 Minutes) - Mode 1 (80MHz)

FCC ID: BCGA2902 IC: 579C-A2902	element MEASUREMENT REPORT (CERTIFICATION)		Approved by: Technical Manager
Test Report S/N:	Test Dates:	EUT Type:	Dega 27 of 42
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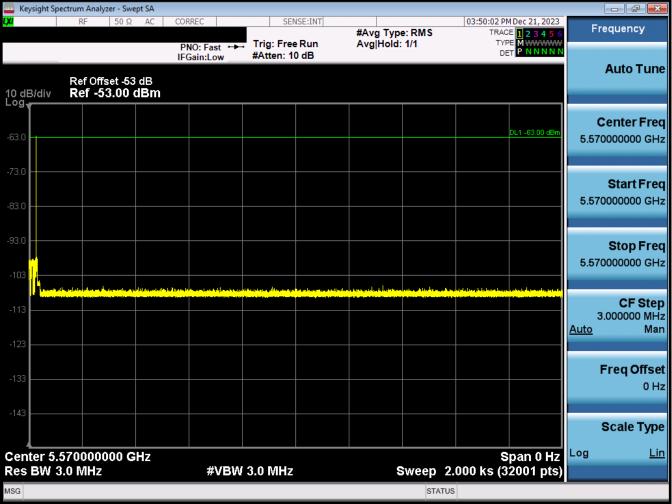


Figure 9-17. 5570MHz - Non-Occupancy Period (30 Minutes) - Mode 1 (160MHz)

FCC ID: BCGA2902 IC: 579C-A2902	element	element MEASUREMENT REPORT (CERTIFICATION)	
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9.4.2 Non-Occupancy Period (30 Minutes) Mode 2:

Notes:

1. No frequency transmission detected during the Non-Occupancy Period of 30 minutes monitoring.

🔤 Keysight Sp	ectrum Analyzer - Swept SA					
LXI Contor F	RF 50 Ω AC Freq 5.53000000		SENSE:INT	#Avg Type: RMS	11:29:49 PM Dec 22, 2023 TRACE 1 2 3 4 5 6	Frequency
Centerr	1eq 5.55000000	PNO: Fast IFGain:Low	Trig: Free Run #Atten: 10 dB	Avg Hold: 1/1		Auto Tune
10 dB/div Log _y	Ref Offset -53 dB Ref -53.00 dBm	1				
-63.0					DL1 -63.00 dBm	Center Freq 5.53000000 GHz
-73.0						5.55000000 GH2
-73.0						Start Freq
-83.0						5.530000000 GHz
-93.0						Stop Freq
-103						5.53000000 GHz
		a dalla de alla tinà al la divisiona alla divisi di	en dia mandra dia 1990 and and a second	in the two ends of a place in and an type in a boot in the test	a delaktor pel lingua a such y statk per dieta da da de	CF Step
-113						3.000000 MHz Auto Man
-123						Auto Marr
-133						Freq Offset
						0 Hz
-143						Scale Type
Center 5	530000000 GHz				Span 0 Hz	Log <u>Lin</u>
Res BW		#VBW	3.0 MHz	Sweep 2	.000 ks (32001 pts)	
MSG				STATU	S	

Figure 9-18. 5530MHz - Non-Occupancy Period (30 Minutes) - Mode 2 (80MHz)

FCC ID: BCGA2902 IC: 579C-A2902	element MEASUREMENT REPORT (CERTIFICATION)		Approved by: Technical Manager
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9.4.3 Non-Occupancy Period (30 Minutes) Mode 3:

Notes:

1. No frequency transmission detected during the Non-Occupancy Period of 30 minutes monitoring.

🛄 Keysight Sp	ectrum Analyzer - Swept SA					
L <mark>XI</mark> Contor E	RF 50 Ω AC req 5.530000000		SENSE:INT	#Avg Type: RMS	01:30:14 AM Dec 23, 2023 TRACE 1 2 3 4 5 6	Frequency
Center F	Teq 3.33000000	PNO: Fast IFGain:Low	Trig: Free Run #Atten: 10 dB	Avg Hold: 1/1		Auto Tune
10 dB/div Log	Ref Offset -53 dB Ref -53.00 dBm					Auto Tune
-63.0					DL1 -63.00 dBm	Center Freq
						5.530000000 GHz
-73.0						Start Freq
-83.0						5.530000000 GHz
-93.0						Stop Freq
-103		1	Sector chates and some soft amount	ally and an I due on a late of the sound	distance to construct on a	5.530000000 GHz
-113						CF Step 3.000000 MHz
-123						<u>Auto</u> Man
-133						Freq Offset
-143						0 Hz
						Scale Type
Center 5. Res BW 3	530000000 GHz 3.0 MHz	#VBW	3.0 MHz	Sweep 2	Span 0 Hz .000 ks (32001 pts)	Log <u>Lin</u>
MSG				STATU		
	E laura 0.40	5520MUL N		Daria d (20 Minut		

Figure 9-19. 5530MHz - Non-Occupancy Period (30 Minutes) - Mode 3 (80MHz)

FCC ID: BCGA2902 IC: 579C-A2902	element MEASUREMENT REPORT (CERTIFICATION)		Approved by: Technical Manager
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9.4.4 Non-Occupancy Period (30 Minutes) Mode 4:

Notes:

1. No frequency transmission detected during the Non-Occupancy Period of 30 minutes monitoring.

🛄 Keysight Spe	ctrum Analyzer - Swept SA					- F X
Center Fr	RF 50 Ω AC Teq 5.53000000		SENSE:INT	#Avg Type: RMS	01:33:02 AM Dec 29, 2023 TRACE 1 2 3 4 5 6	Frequency
Genter I	04 0.00000000	PNO: Fast 🔾	Trig: Free Run #Atten: 10 dB	Avg Hold: 1/1	TYPE MWWWW DET PNNNN	
		IFGain:Low	#Atten: To db			Auto Tune
10 dB/div	Ref Offset -53 dB Ref -53.00 dBn	n				
Log						
-63.0					DL1 -63.00 dBm	Center Freq
-03.0						5.530000000 GHz
-73.0						
						Start Freq
-83.0						5.530000000 GHz
-93.0						Stop Freq
a a star a st						5.530000000 GHz
-103	الالاستقار والمعرف والمتعادين	والمراجعة والمراجعة والمراجع والمراجعة والمراجع	and the state of t	and the second design of the	ald a distantial to some contractors of basis	
-113						CF Step
						3.000000 MHz <u>Auto</u> Man
-123						Addo Marr
						Erog Offect
-133						Freq Offset 0 Hz
						0112
-143						Scale Type
Center 5.5	30000000 GHz				Span 0 Hz	Log <u>Lin</u>
Res BW 3	.0 MHz	#VBW	3.0 MHz	Sweep 2	2.000 ks (32001 pts)	
MSG	Figure 0.0			STATU	IS	

Figure 9-20. 5530MHz - Non-Occupancy Period (30 Minutes) - Mode 4 (80MHz)

FCC ID: BCGA2902 IC: 579C-A2902	element	MEASUREMENT REPORT (CERTIFICATION)	Approved by: Technical Manager
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10.0 CONCLUSION

The data collected relate only to the item(s) tested and show that the **Apple Tablet Device FCC ID: BCGA2902**, **IC: 579C-A2902** is in compliance with the DFS requirements for a Client Device without radar detection in accordance with Part 15.407 of the FCC Rules and RSS-247 of the Innovation, Science and Economic Development Canada Rules.

FCC ID: BCGA2902 IC: 579C-A2902	element	MEASUREMENT REPORT (CERTIFICATION)	Approved by: Technical Manager
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