

MEASUREMENT REPORT

FCC PART 15.407 / ISSED RSS-247 DFS

Applicant Name:

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

Date of Testing:

01/09/2019 - 02/01/2019

Test Site/Location:

PCTEST Lab. Morgan Hill, CA, USA

Test Report Serial No.:

1C1811080025-06.BCG

FCC ID:

BCGA2152

IC:

579C-A2152

APPLICANT:

Apple Inc.

Application Type:

Certification

Mode/HVIN:

A2152

EUT Type:

Client Only Device, No Radar Detection Capability

Max. RF Output Power:

84.528 mW (19.27 dBm) Conducted
(802.11n UNII Band 2A)

69.024 mW (18.39 dBm) Conducted
(802.11n UNII Band 2C)

Frequency Range:

5250 – 5350 MHz (UNII-2A Band)

5470 – 5725 MHz (UNII-2C Band)

FCC Classification:

Unlicensed National Information Infrastructure (UNII)

FCC Rule Part(s):

Part 15 Subpart E (15.407)

ISED Specification:

RSS-247 Issue 2

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 KDB 905462 D02 v02 Compliance Measurement Procedures for Unlicensed-National Information Infrastructure Devices Operating in the 5.25 – 5.35 GHz and 5.47 – 5.725 GHz Bands Incorporating Dynamic Frequency Selection. 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.



Randy Ortanez
President



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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 PCTEST Test Location

These measurement tests were radiated at the PCTEST Engineering Laboratory, Inc. 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 v01.

1.3 Test Facility / Accreditations

Measurements were performed at PCTEST Engineering Lab located in Morgan Hill, CA 95037, U.S.A.

- PCTEST is an ISO 17025-2005 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.
- PCTEST 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).
- PCTEST facility is a registered (22831) test laboratory with the site description on file with ISED.

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2.0 PRODUCT INFORMATION

2.1 Equipment Description

The Equipment Under Test (EUT) is the **Apple Tablet Device FCC ID: BCGA2152**. 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)	☒
Client Device with Radar Detection	☐

Test Device Serial No.: DLXXT00QLT5J

2.2 Device Capabilities

This device contains the following capabilities:

802.11b/g/n WLAN, 802.11a/n/ac UNII, Bluetooth (1x, EDR, LE, HDR4, HDR8)

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	149	5745
:	:	:	:	:	:	:	:
42	5210	56	5280	116	5580	157	5785
:	:	:	:	:	:	:	:
48	5240	64	5320	144	5720	165	5825

Table 2-1. 802.11a / 802.11n / 802.11ac (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
				:	:		
				142	5710		

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

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
				:	:		
				138	5690		

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

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2.3 Antenna Description

Following antenna was used for the testing.

Frequency [GHz]	Antenna Gain (dBi)	
	Core 0	Core 1
5.150 - 5.250	1.66	2.65
5.260 - 5.350	2.28	2.81
5.470 - 5.725	3.77	3.10
5.745 - 5.850	3.40	3.18

Table 2-4. 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:
Master	Apple	A1521	Access Point	C86L3BA8FJ1R	BCGA1521
		MacBook Air	Controller	C02P41RZG086	QDS-BRCM1072
Client	Apple	Apple TV	Controller	C0754033HHFP	BCGA1625
		MacBook Air	Controller	C02P41RZG086	QDS-BRCM1072
		Kanzi	Lightning Cable	2092FC	N/A
	Dell	U24177HJ	Monitor Display	0RXP1N-74261-71Q-0APL-A01	N/A

Table 2-5. Test Support Equipment Used

2.5 Master Parameters

Parameters of Master:	
Minimum Antenna Gain	1.4 dBi
EIRP Level:	>23 dBm
Access Point Software Version	7.7.4f0 dev

Table 2-6. Parameters of Master

2.6 Software and Firmware

The test was radiated with firmware version 16E31520i 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 C63.10-2013. 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	$\pm 0.02\%$

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6.0 TEST EQUIPMENT CALIBRATION DATA

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	7/25/2018	Biennial	7/25/2020	302570726
Aeroflex	3035C	PXI RF Digitizer	7/25/2018	Biennial	7/25/2020	303570427
ETS-Lindgren	3117	Horn Antenna	12/5/2018	Annual	12/5/2019	218555
Rohde & Schwarz	ESW44	EMI Test Receiver	11/20/2018	Biennial	11/20/2019	101570
Rohde & Schwarz	TC-TA18	Cross Polarized Vivaldi Antenna	11/21/2018	Annual	11/21/2019	101057

Table 6-1. Annual Test Equipment Calibration Schedule

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.

Requirement	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
Uniform Spreading	Yes	Not required	Not required
U-NII Detection Bandwidth	Yes	Not required	Yes

Table 7-1. DFS Applicability

Requirement	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
Client Beacon Test	N/A	Yes	Yes

Table 7-2. DFS Applicability During Normal Operation

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Requirements

Per KDB 905462 D02 v02 the following are the requirements for 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.

Channel Move Time and Channel Closing Transmission Time requirements 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 Note 1.
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: The instant that the Channel Move Time and the Channel Closing Transmission Time begins is as follows: • For the Short Pulse Radar Test Signals this instant is the end of the Burst. • For the Frequency Hopping radar Test Signal, this instant is the end of the last radar Burst generated. • For the Long Pulse Radar Test Signal this instant is the end of the 12 second period defining the Radar Waveform. 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 is used and for each frequency step the minimum percentage of detection is 90 percent. Measurements are performed with no data traffic.	

Table 7-3: DFS Response Requirements

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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 and 2)
≥ 200 milliwatt	-64 dBm
< 200 milliwatt	-62 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: For this test, the radiated output power of the Master Unit is greater than 23 dBm. Hence, DFS Detection Threshold Value was set to -64dBm.	

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

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7.3 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 7-5 lists the parameters for the Short Pulse Radar Waveforms. A plot of the Radar Pulse Type 0 used for testing is included in Section 7.5 of this report.

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

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	5 – 20	1 - 3	8 - 20	80%	30

Table 7-6. 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 7-7. Parameters for Frequency Hopping Radar Waveforms

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7.4 System Overview and Procedure

KDB 905462 D02 v02 describes a radiated test setup and a conducted test setup. The radiated test setup was used for this testing. Figure 7-1 shows the typical test setup. In Band 2C, one channel selected between 5470 and 5725 MHz was chosen for testing.

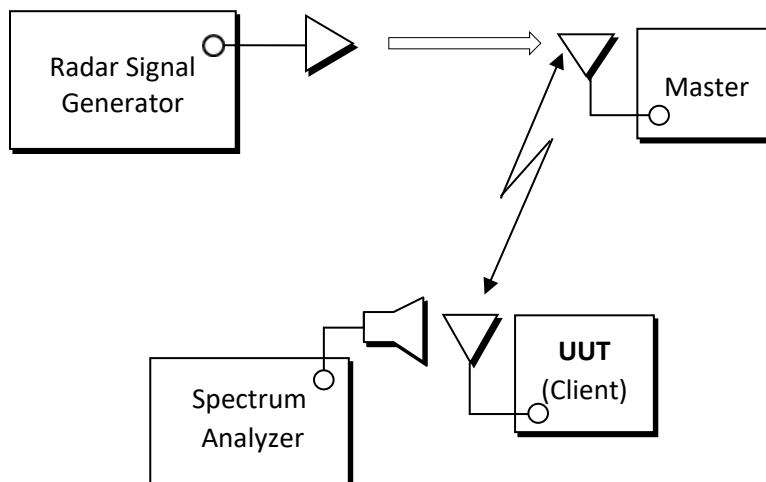


Figure 7-1. Radiated Test Setup for DFS

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 10 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.

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7.5 System Calibration:

Radar pulses that are generated at the PXI RF Synthesizer's Output Port was injected through the Horn antenna. The Vivaldi antenna was connected by a low loss RF cable to the spectrum analyzer. The offset of the spectrum analyzer was calculated based on the loss of the RF cable and gain of the horn antenna.

In the 'PXI DFS Radar Simulator & Analyzer' software, a Radar Type 0 was used to measure the threshold level as described in Section 7.2 on the spectrum analyzer.

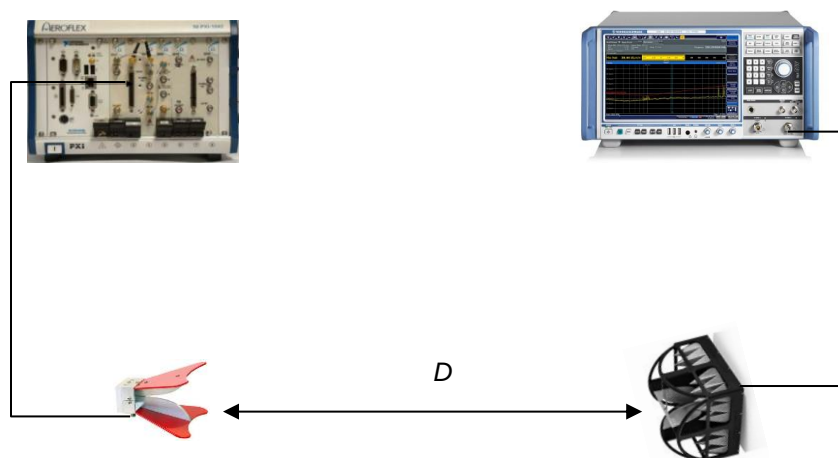


Figure 7-2. Radar Waveform Calibration

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Radar Pulse Notes:

The radiated plots of the RADAR pulse signals (Type 0) are given below after performing the system calibration as described in Section 7.5.

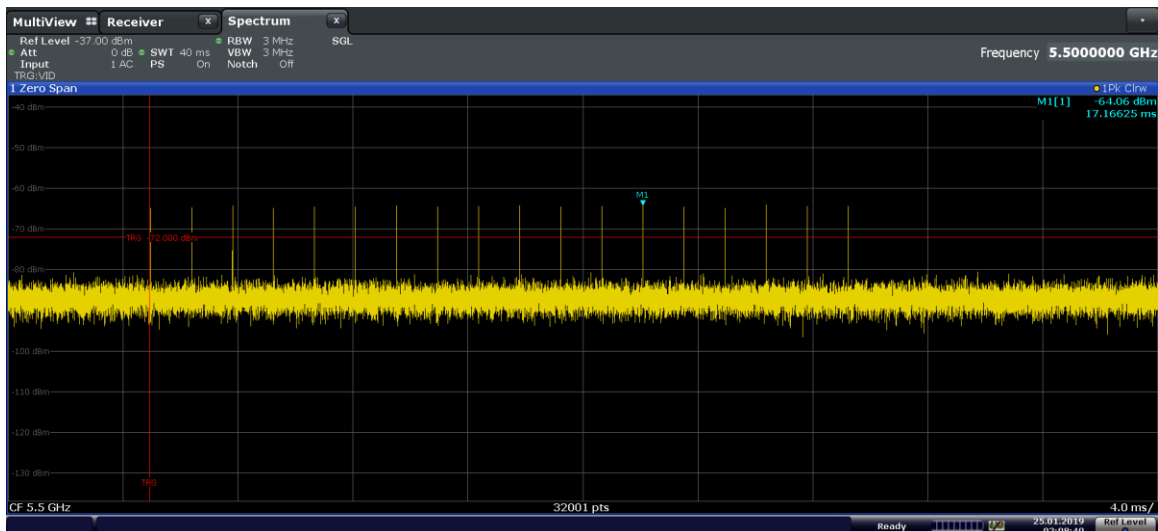


Figure 7-3. 5500MHz – Radar Pulse Type 0 (20MHz)

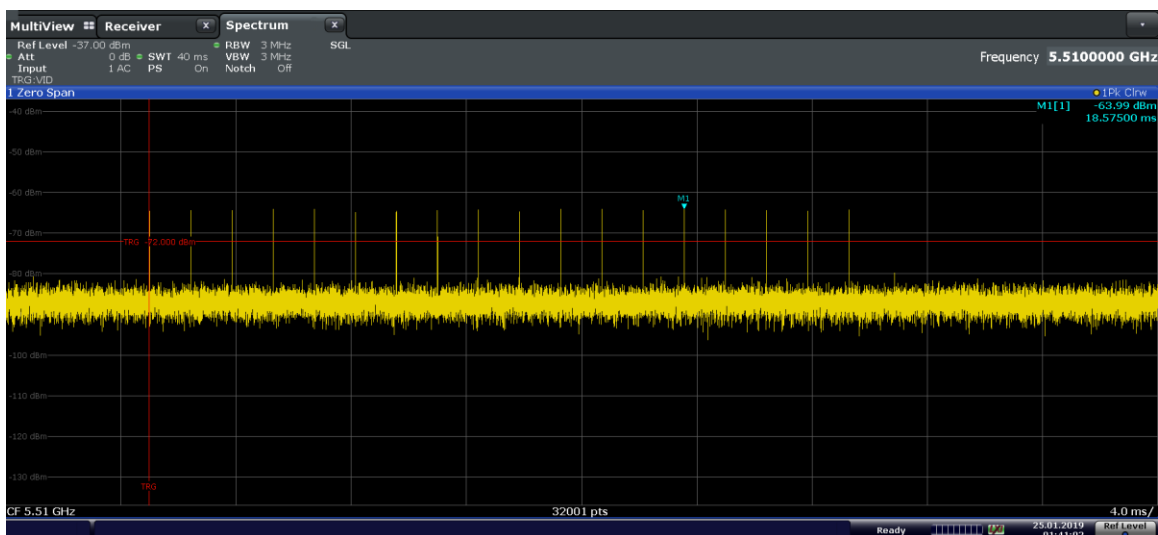


Figure 7-4. 5510MHz – Radar Pulse Type 0 (40MHz)

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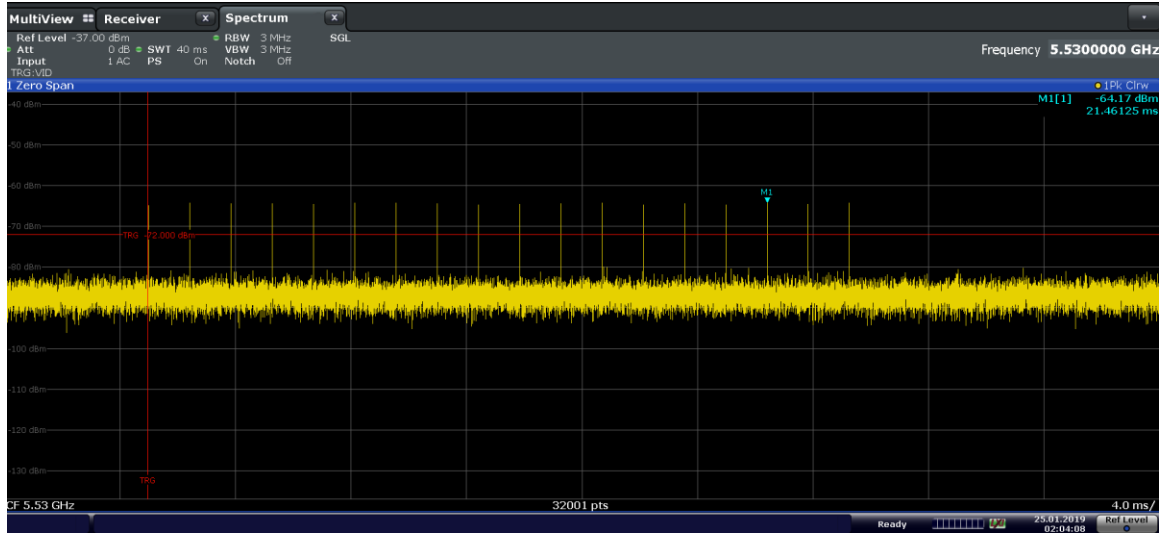


Figure 7-5. 5530MHz – Radar Pulse Type 0 (80MHz)

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8.0 EUT TEST SETUP

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 (MacBook Air). 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.

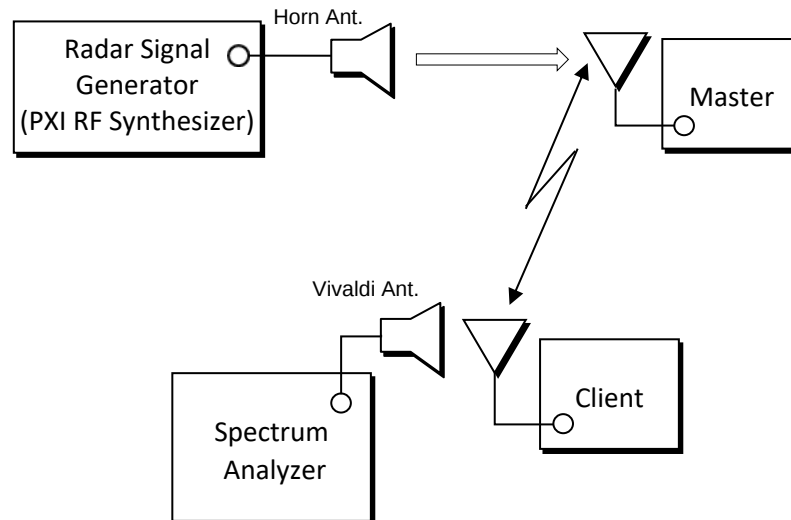


Figure 8-1. Test Setup (Mode 1)

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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.

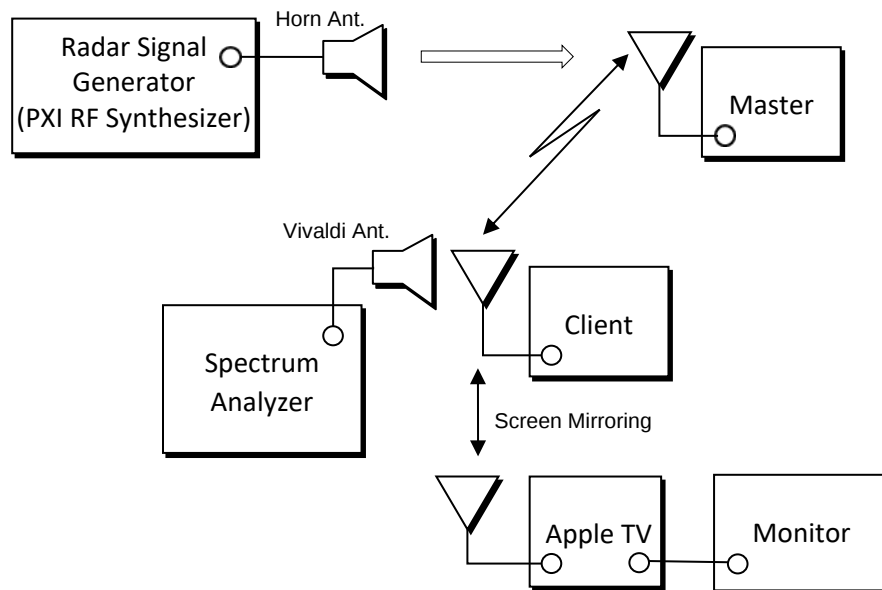


Figure 8-2. Test Setup (Mode 2)

FCC ID: BCGA2152	PCTEST ENGINEERING LABORATORY, INC.	MEASUREMENT REPORT (CERTIFICATION)	Approved by: Quality Manager
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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.

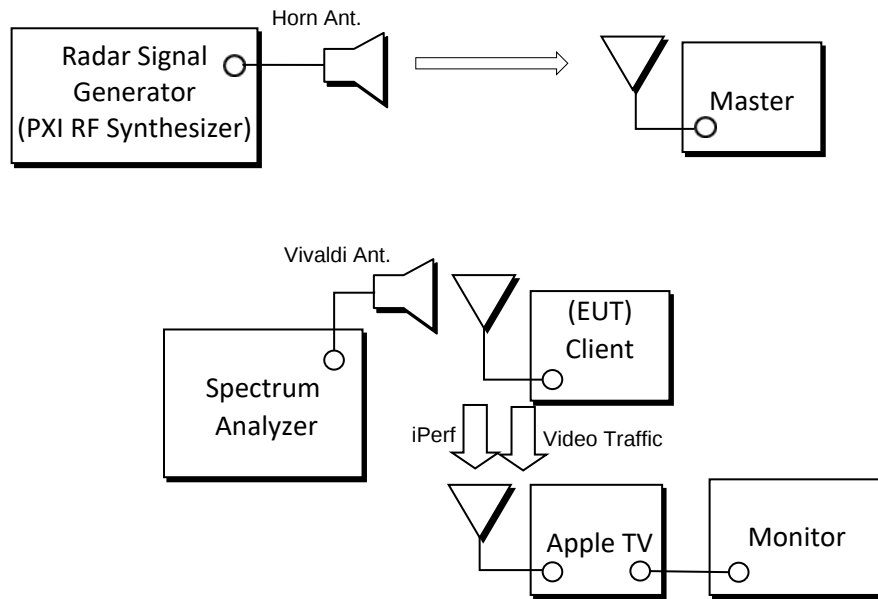


Figure 8-3. Test Setup (Mode 3)

FCC ID: BCGA2152	PCTEST ENGINEERING LABORATORY, INC.		MEASUREMENT REPORT (CERTIFICATION)	Approved by: Quality Manager
Test Report S/N: 1C1811080025-06.BCG	Test Dates: 01/09/2019 - 02/01/2019	EUT Type: Tablet Device		Page 21 of 53

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.

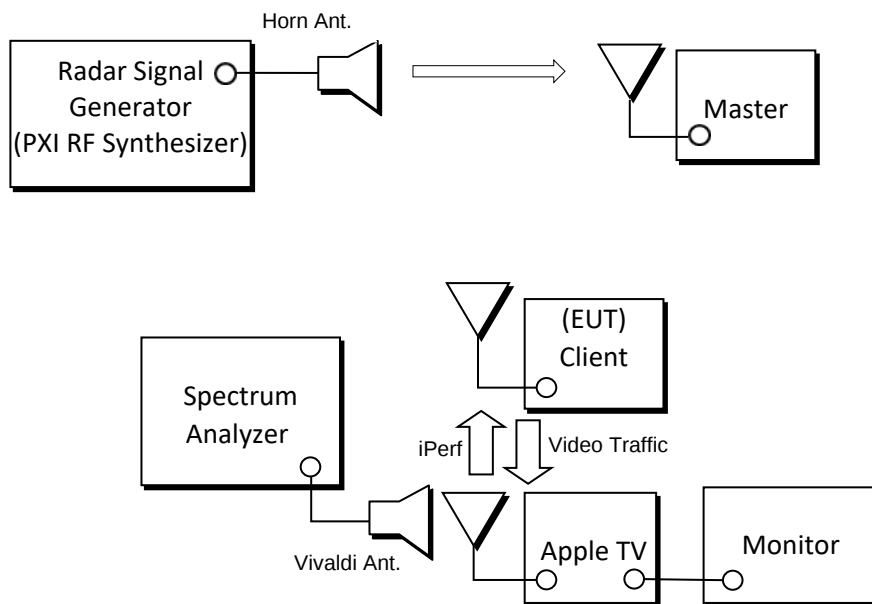


Figure 8-4. Test Setup (Mode 4)

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: BCGA2152	 MEASUREMENT REPORT (CERTIFICATION)		Approved by: Quality Manager
Test Report S/N: 1C1811080025-06.BCG	Test Dates: 01/09/2019 - 02/01/2019	EUT Type: Tablet Device	Page 22 of 53

9.0 TEST RESULTS

9.1 Summary

Company Name: Apple Inc.
 FCC ID: BCGA2152
 FCC Classification: Unlicensed National Information Infrastructure (UNII)

	Mode	Parameter	Measured			Limit	Result
			20MHz Bandwidth	40MHz Bandwidth	80MHz Bandwidth		
5470 – 5725 MHz (excluding 5600-5650MHz for ISSED Canada) UNII – 2C Band	1 Client Mode	Channel Move Time	4.117 s	4.161 s	4.087 s	10 seconds	Pass
		Channel Closing Transmission Time	< 200ms + 17.464 ms (aggregate)	< 200ms + 18.168 ms (aggregate)	< 200ms + 7.912 ms (aggregate)	200 ms + aggregate of 60ms over remaining 10 second period	Pass
		Client beacon test	Monitored for 10 minutes with no client transmission	Monitored for 10 minutes with no client transmission	Monitored for 10 minutes with no client transmission	No client transmission occurred	Pass
	2 Client to Client	Channel Move Time	4.092 s	4.153 s	4.174 s	10 seconds	Pass
		Channel Closing Transmission Time	< 200ms + 17.461 ms (aggregate)	< 200ms + 19.102 ms (aggregate)	< 200ms + 2.368 ms (aggregate)	200 ms + aggregate of 60ms over remaining 10 second period	Pass
		Client beacon test	Monitored for 10 minutes with no client transmission	Monitored for 10 minutes with no client transmission	Monitored for 10 minutes with no client transmission	No client transmission occurred	Pass
	3 Peer to Peer (EUT)	Channel Move Time	4.124 s	4.171 s	4.081 s	10 seconds	Pass
		Channel Closing Transmission Time	< 200ms + 20.165 ms (aggregate)	< 200ms + 18.665 ms (aggregate)	< 200ms + 0.023 ms (aggregate)	200 ms + aggregate of 60ms over remaining 10 second period	Pass
		Client beacon test	Monitored for 10 minutes with no client transmission	Monitored for 10 minutes with no client transmission	Monitored for 10 minutes with no client transmission	No client transmission occurred	Pass
	4 Peer to Peer (Apple TV)	Channel Move Time	4.159 s	4.155 s	4.155 s	10 seconds	Pass
		Channel Closing Transmission Time	< 200ms + 17.904 ms (aggregate)	< 200ms + 18.206 ms (aggregate)	< 200ms + 2.450 ms (aggregate)	200 ms + aggregate of 60ms over remaining 10 second period	Pass
		Client beacon test	Monitored for 10 minutes with no client transmission	Monitored for 10 minutes with no client transmission	Monitored for 10 minutes with no client transmission	No client transmission occurred	Pass

Table 9-1. Summary of Test Results

FCC ID: BCGA2152	 MEASUREMENT REPORT (CERTIFICATION)		Approved by: Quality Manager
Test Report S/N: 1C1811080025-06.BCG	Test Dates: 01/09/2019 - 02/01/2019	EUT Type: Tablet Device	Page 23 of 53

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: BCGA2152	 MEASUREMENT REPORT (CERTIFICATION)		Approved by: Quality Manager
Test Report S/N: 1C1811080025-06.BCG	Test Dates: 01/09/2019 - 02/01/2019	EUT Type: Tablet Device	Page 24 of 53

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. For example, you can zero span the spectrum analyzer and approximate the transmission time.

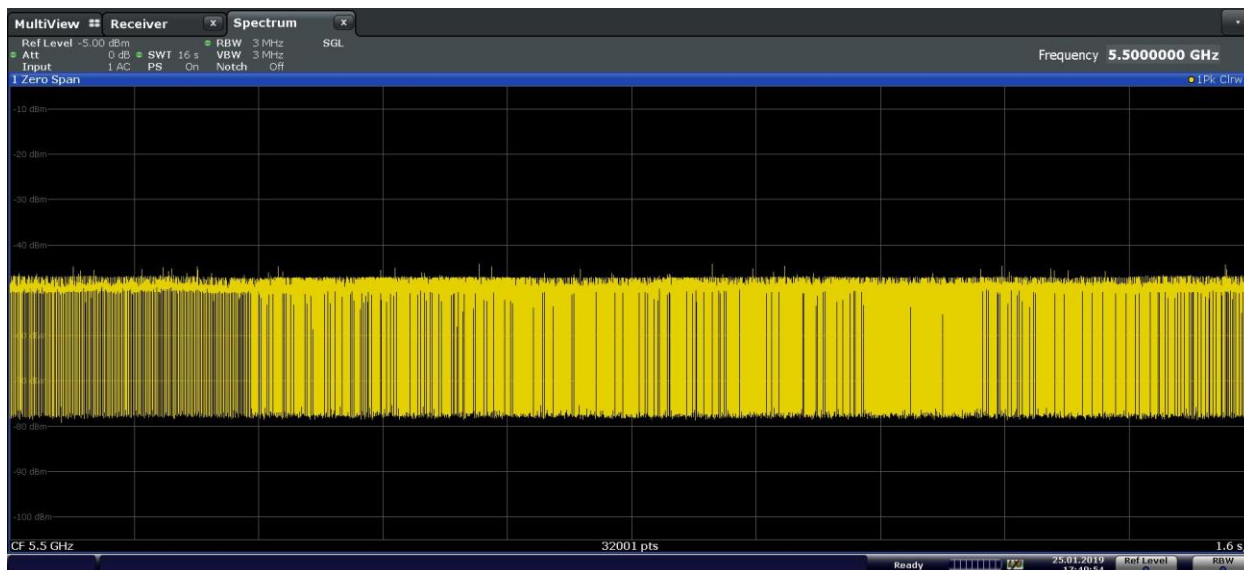


Figure 9-1. 5500MHz - Channel Loading - Mode 1 (20MHz)

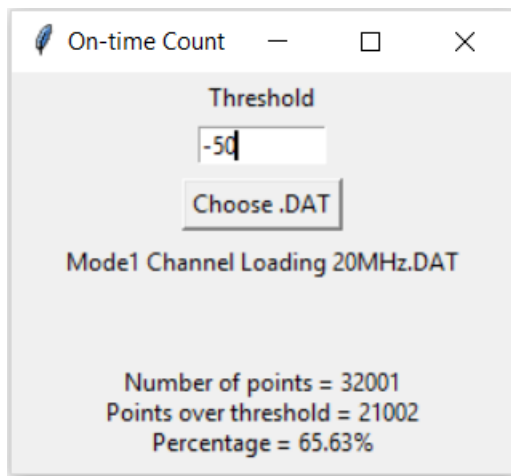


Figure 9-2. 5500MHz - Channel Loading Calculation - Mode 1 (20MHz)

FCC ID: BCGA2152	PCTEST ENGINEERING LABORATORY, INC.	MEASUREMENT REPORT (CERTIFICATION)	Approved by: Quality Manager
Test Report S/N: 1C1811080025-06.BCG	Test Dates: 01/09/2019 - 02/01/2019	EUT Type: Tablet Device	Page 25 of 53

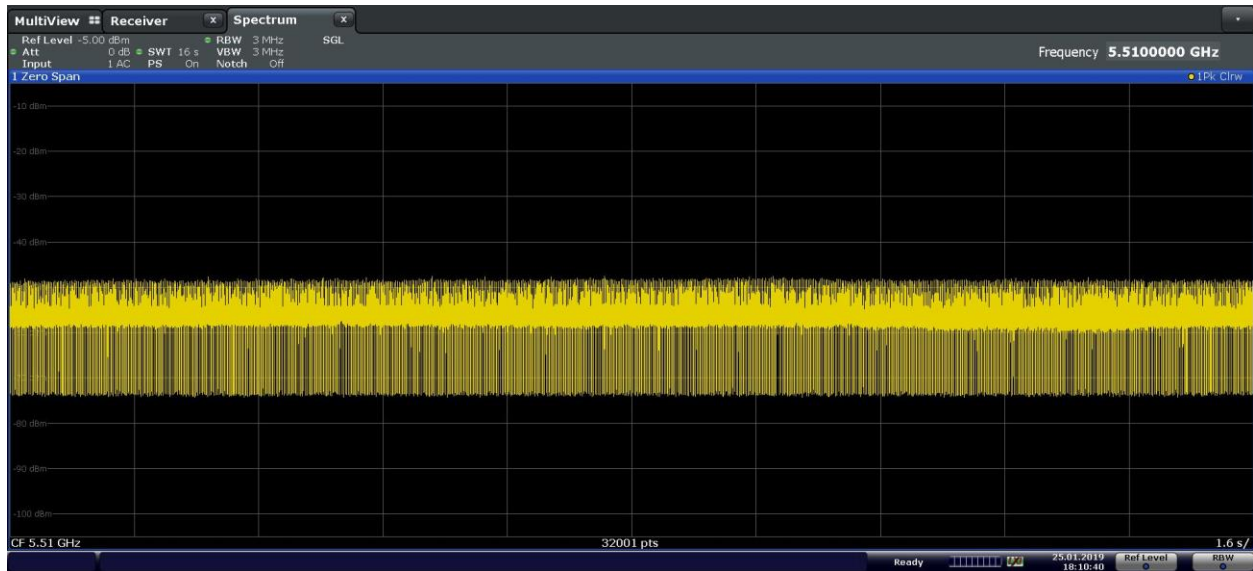


Figure 9-3. 5510MHz - Channel Loading - Mode 1 (40MHz)

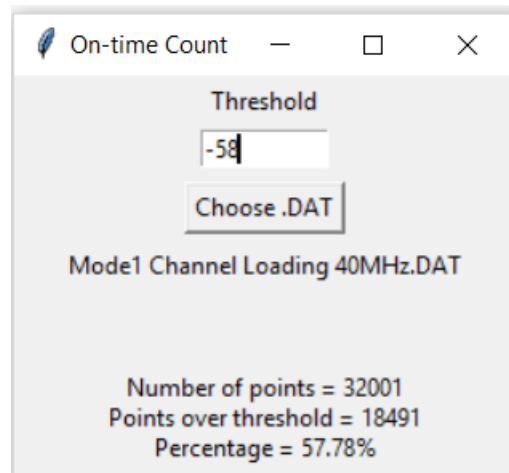


Figure 9-4 5510MHz - Channel Loading Calculation - Mode 1 (40MHz)

FCC ID: BCGA2152	PCTEST ENGINEERING LABORATORY, INC.	MEASUREMENT REPORT (CERTIFICATION)	Approved by: Quality Manager
Test Report S/N: 1C1811080025-06.BCG	Test Dates: 01/09/2019 - 02/01/2019	EUT Type: Tablet Device	Page 26 of 53

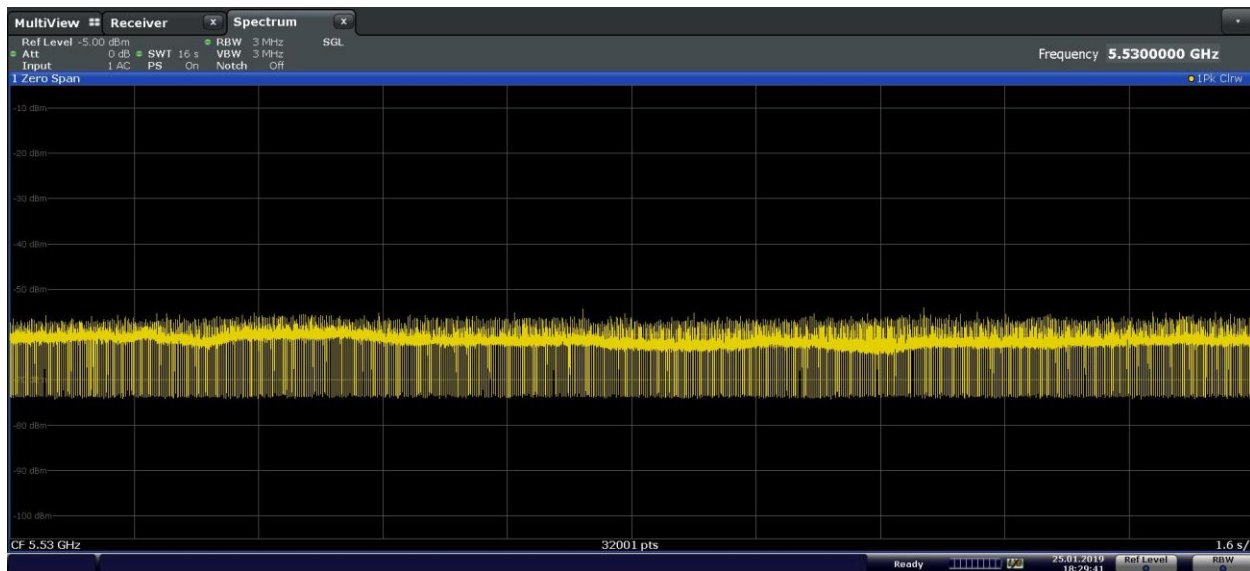


Figure 9-5. 5530MHz - Channel Loading - Mode 1 (80MHz)

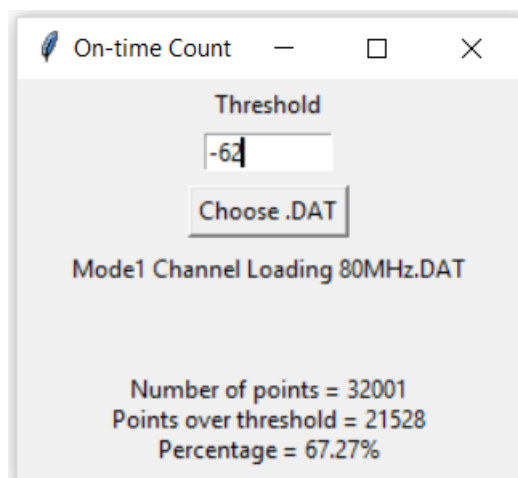


Figure 9-6. 5530MHz - Channel Loading Calculation - Mode 1 (80MHz)

FCC ID: BCGA2152	 MEASUREMENT REPORT (CERTIFICATION)		Approved by: Quality Manager
Test Report S/N: 1C1811080025-06.BCG	Test Dates: 01/09/2019 - 02/01/2019	EUT Type: Tablet Device	Page 27 of 53

9.2.2 Channel Loading Mode 2:

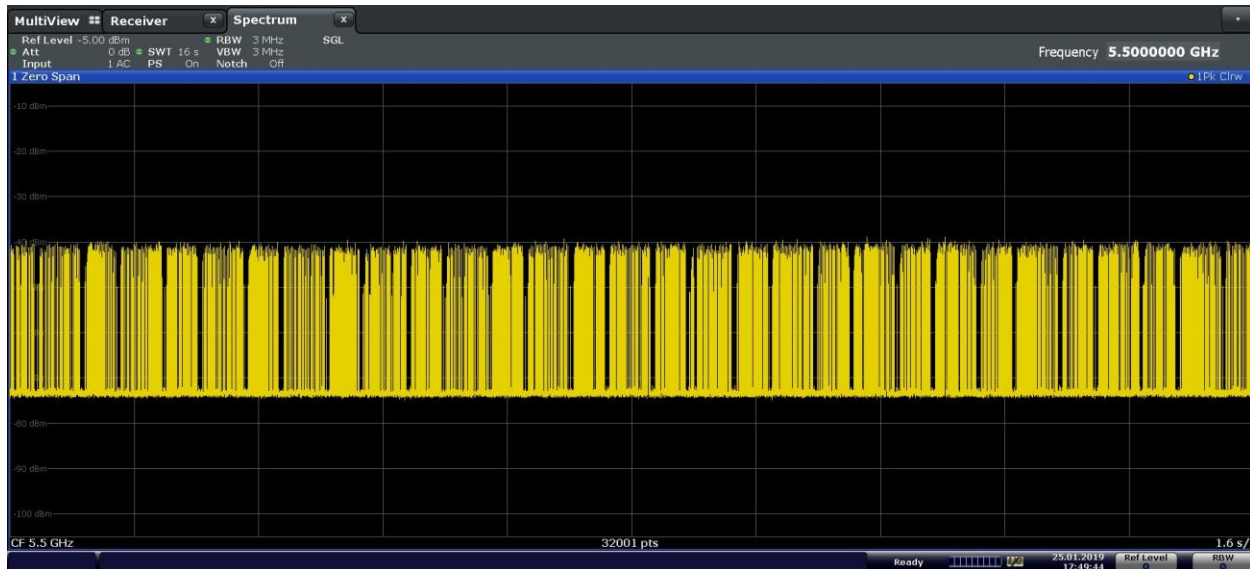


Figure 9-7. 5500MHz - Channel Loading - Mode 2 (20MHz)

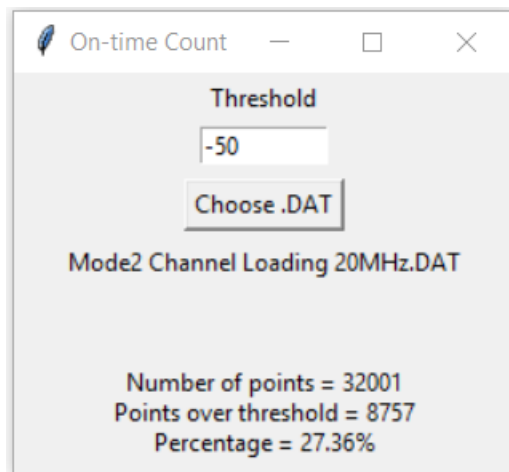


Figure 9-8. 5500MHz - Channel Loading Calculation - Mode 2 (20MHz)

FCC ID: BCGA2152	 MEASUREMENT REPORT (CERTIFICATION)		Approved by: Quality Manager
Test Report S/N: 1C1811080025-06.BCG	Test Dates: 01/09/2019 - 02/01/2019	EUT Type: Tablet Device	Page 28 of 53

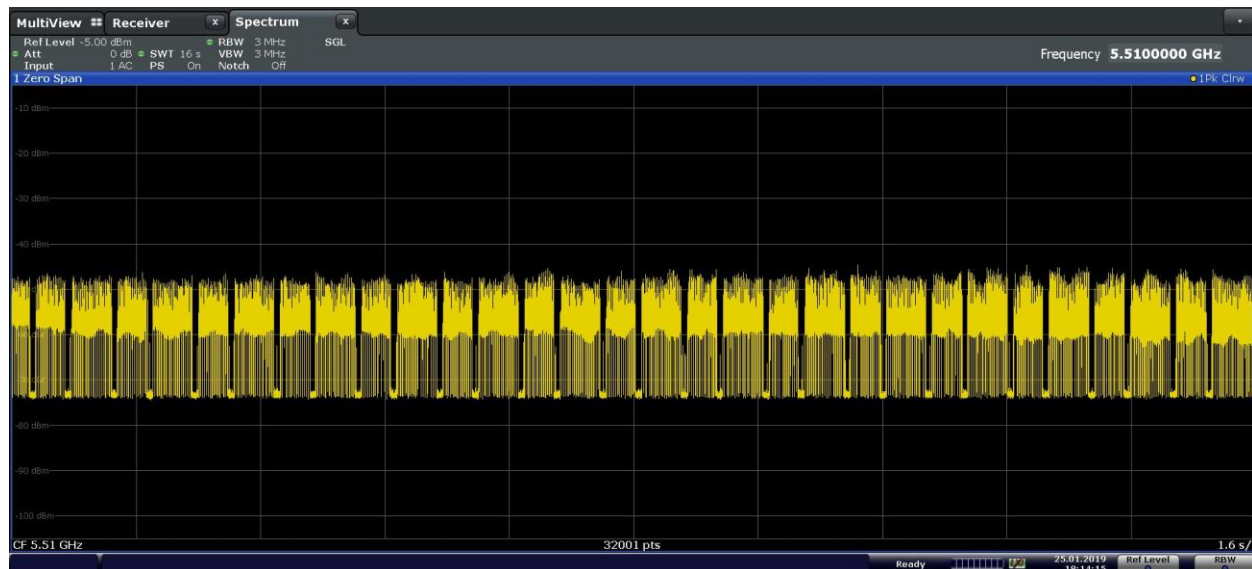


Figure 9-9. 5510MHz - Channel Loading - Mode 2 (40MHz)

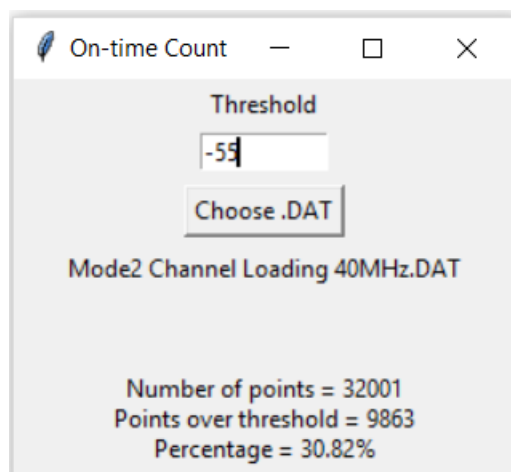


Figure 9-10. 5510MHz - Channel Loading Calculation - Mode 2 (40MHz)

FCC ID: BCGA2152	MEASUREMENT REPORT (CERTIFICATION)		Approved by: Quality Manager
Test Report S/N: 1C1811080025-06.BCG	Test Dates: 01/09/2019 - 02/01/2019	EUT Type: Tablet Device	Page 29 of 53

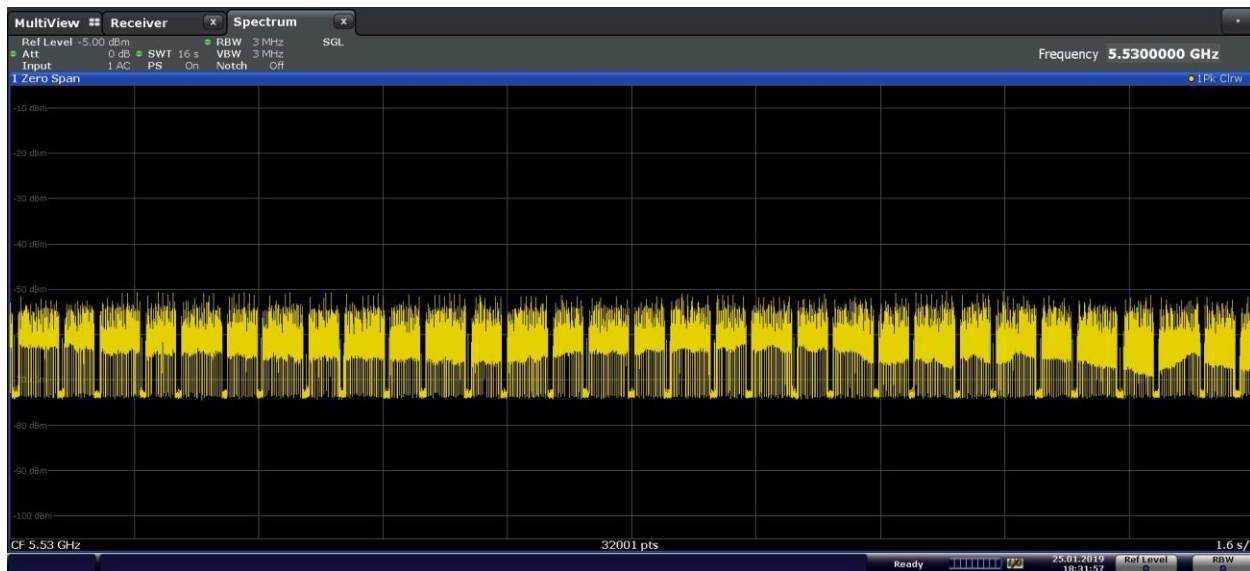


Figure 9-11. 5530MHz - Channel Loading - Mode 2 (80MHz)

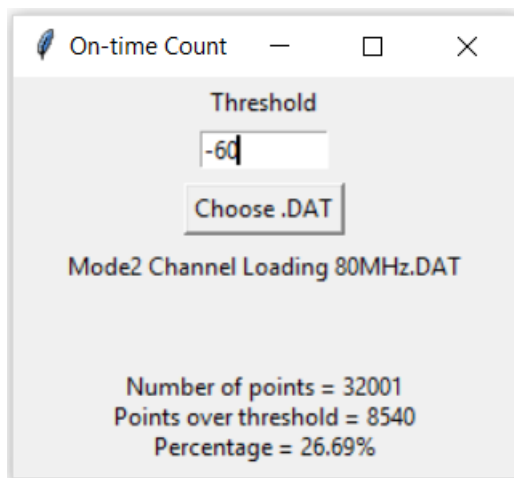


Figure 9-12. 5530MHz - Channel Loading Calculation - Mode 2 (80MHz)

FCC ID: BCGA2152	PCTEST ENGINEERING LABORATORY, INC.	MEASUREMENT REPORT (CERTIFICATION)	Approved by: Quality Manager
Test Report S/N: 1C1811080025-06.BCG	Test Dates: 01/09/2019 - 02/01/2019	EUT Type: Tablet Device	Page 30 of 53

9.2.3 Channel Loading Mode 3:

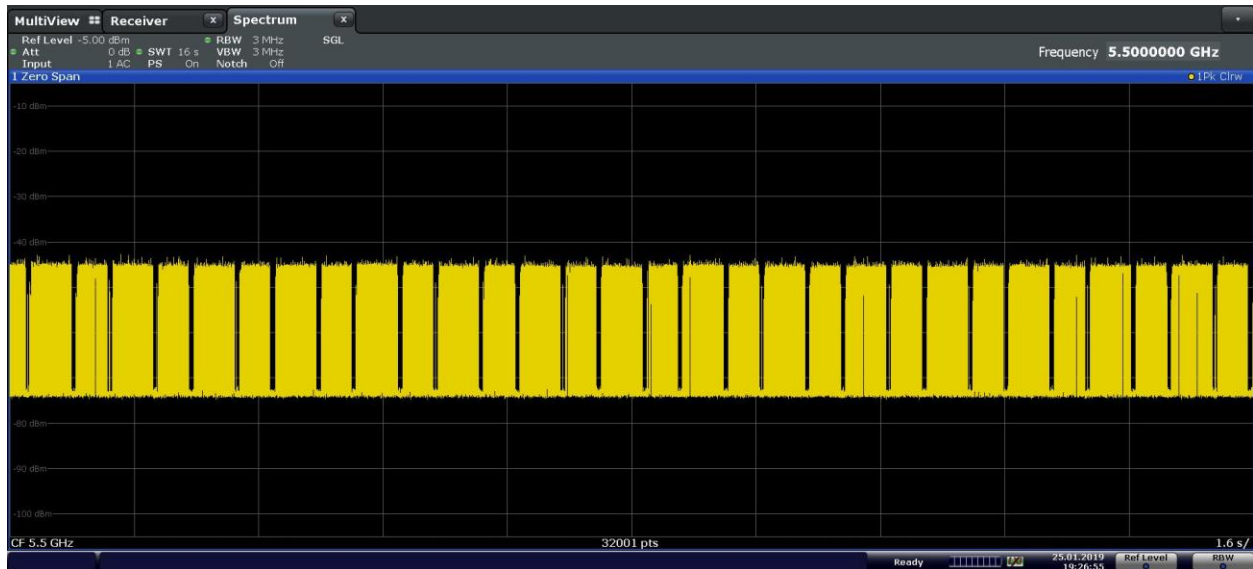


Figure 9-13. 5500MHz - Channel Loading - Mode 3 (20MHz)

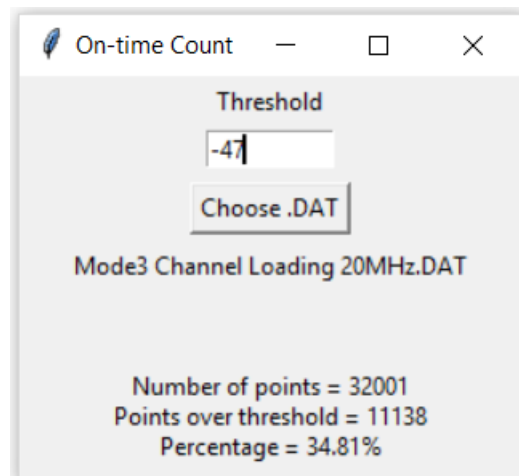


Figure 9-14. 5500MHz - Channel Loading Calculation - Mode 3 (20MHz)

FCC ID: BCGA2152	PCTEST ENGINEERING LABORATORY, INC.	MEASUREMENT REPORT (CERTIFICATION)	Approved by: Quality Manager
Test Report S/N: 1C1811080025-06.BCG	Test Dates: 01/09/2019 - 02/01/2019	EUT Type: Tablet Device	Page 31 of 53

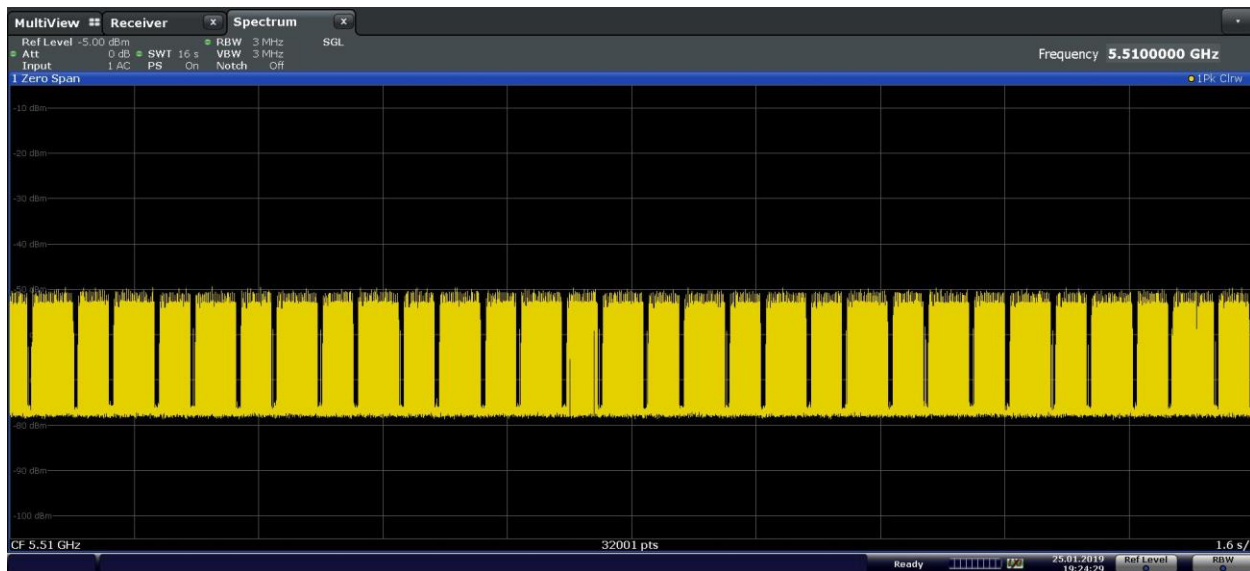


Figure 9-15. 5510MHz - Channel Loading - Mode 3 (40MHz)

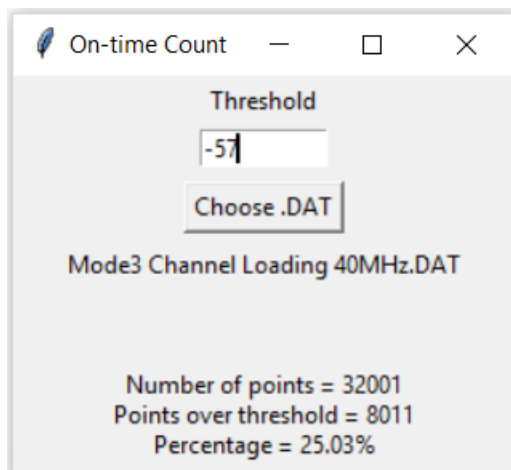


Figure 9-16. 5510MHz - Channel Loading Calculation - Mode 3 (40MHz)

FCC ID: BCGA2152	PCTEST ENGINEERING LABORATORY, INC.	MEASUREMENT REPORT (CERTIFICATION)	Approved by: Quality Manager
Test Report S/N: 1C1811080025-06.BCG	Test Dates: 01/09/2019 - 02/01/2019	EUT Type: Tablet Device	Page 32 of 53

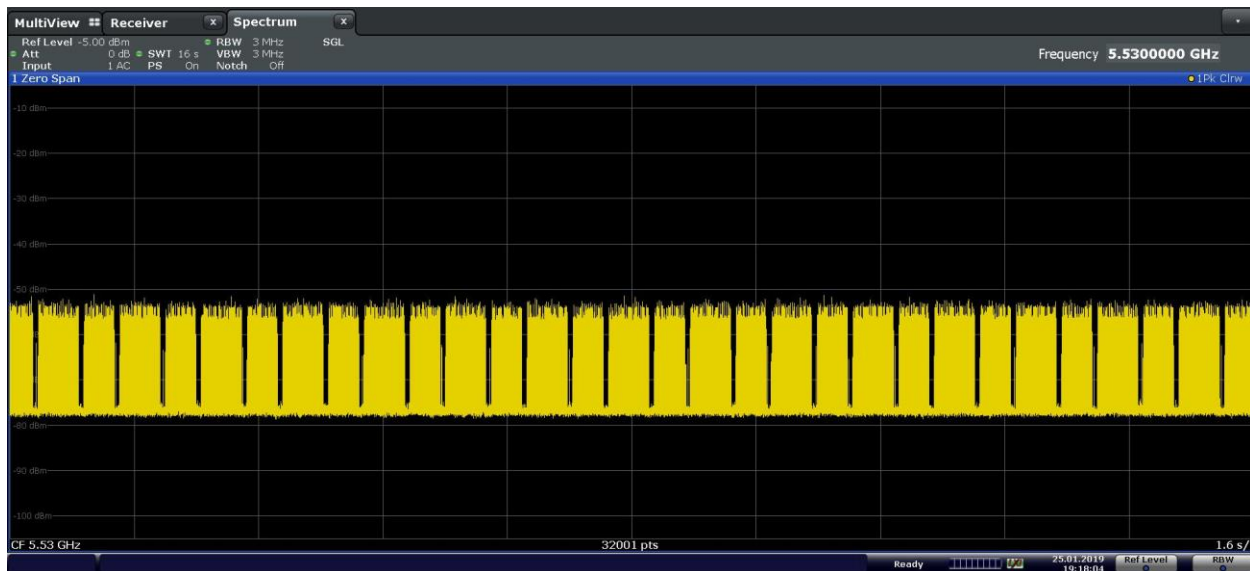


Figure 9-17. 5530MHz - Channel Loading - Mode 3 (80MHz)

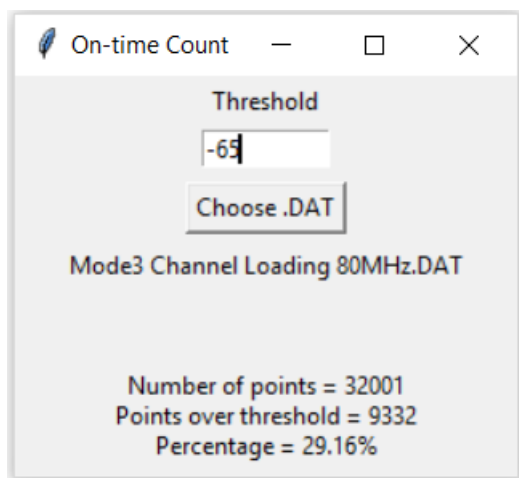


Figure 9-18. 5530MHz - Channel Loading Calculation - Mode 3 (80MHz)

FCC ID: BCGA2152	 MEASUREMENT REPORT (CERTIFICATION)		Approved by: Quality Manager
Test Report S/N: 1C1811080025-06.BCG	Test Dates: 01/09/2019 - 02/01/2019	EUT Type: Tablet Device	Page 33 of 53

9.2.4 Channel Loading Mode 4:

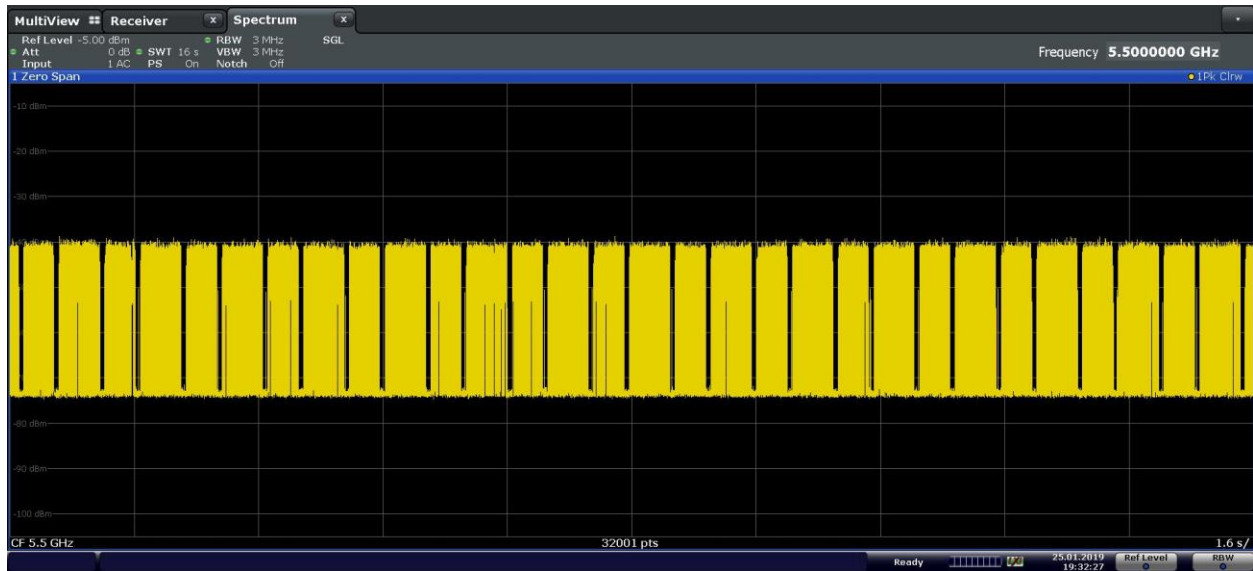


Figure 9-19. 5500 MHz - Channel Loading - Mode 4 (20MHz)

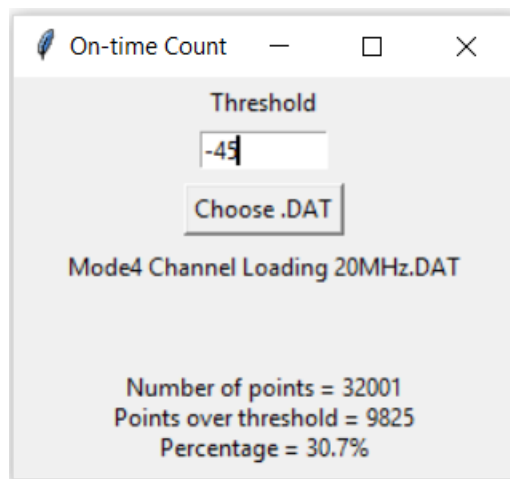


Figure 9-20. 5500MHz - Channel Loading Calculation - Mode 4 (20MHz)

FCC ID: BCGA2152	PCTEST ENGINEERING LABORATORY, INC.	MEASUREMENT REPORT (CERTIFICATION)	Approved by: Quality Manager
Test Report S/N: 1C1811080025-06.BCG	Test Dates: 01/09/2019 - 02/01/2019	EUT Type: Tablet Device	Page 34 of 53

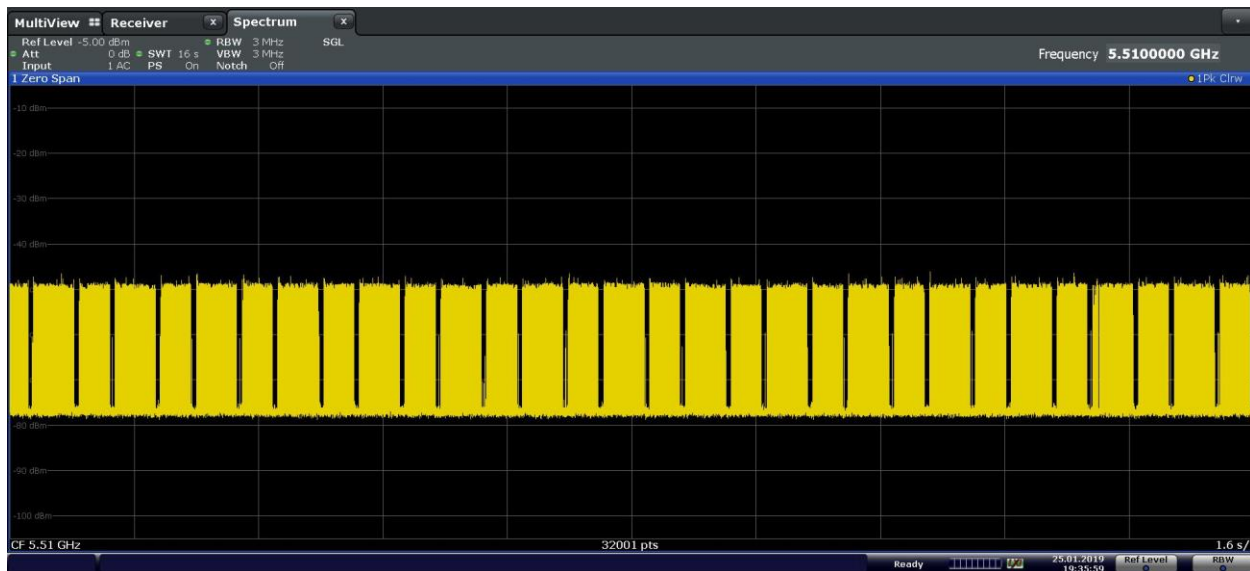


Figure 9-21. 5510MHz - Channel Loading - Mode 4 (40MHz)

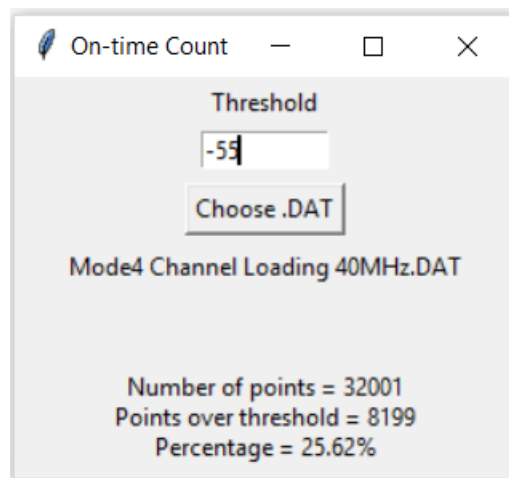


Figure 9-22. 5510MHz - Channel Loading Calculation - Mode 4 (40MHz)

FCC ID: BCGA2152	 MEASUREMENT REPORT (CERTIFICATION)		Approved by: Quality Manager
Test Report S/N: 1C1811080025-06.BCG	Test Dates: 01/09/2019 - 02/01/2019	EUT Type: Tablet Device	Page 35 of 53

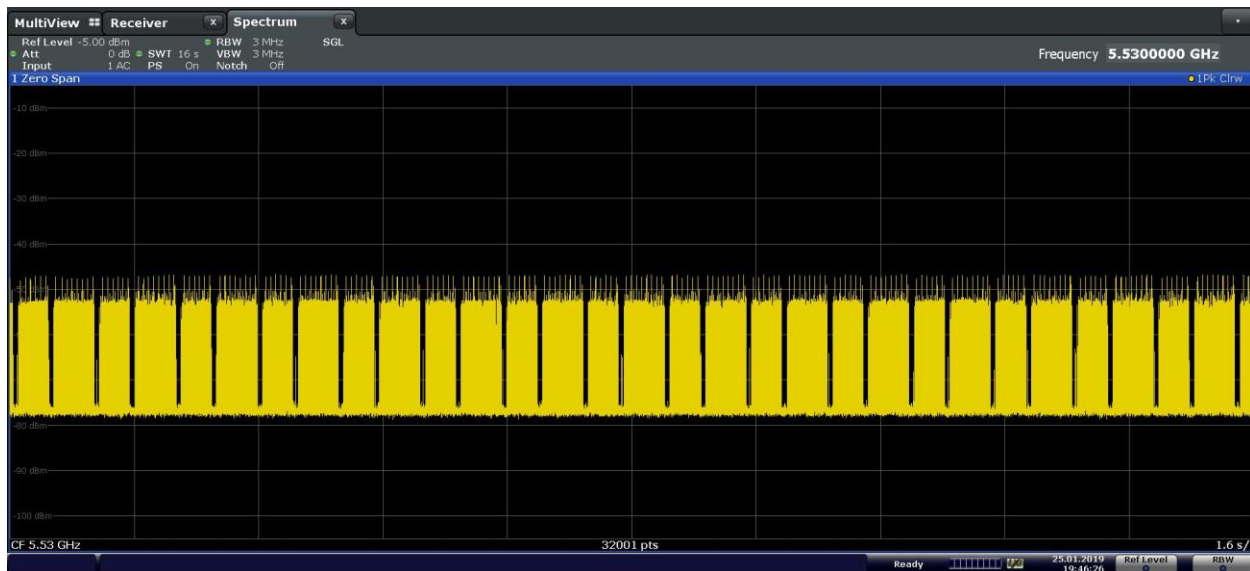


Figure 9-23. 5530MHz - Channel Loading - Mode 4 (80MHz)

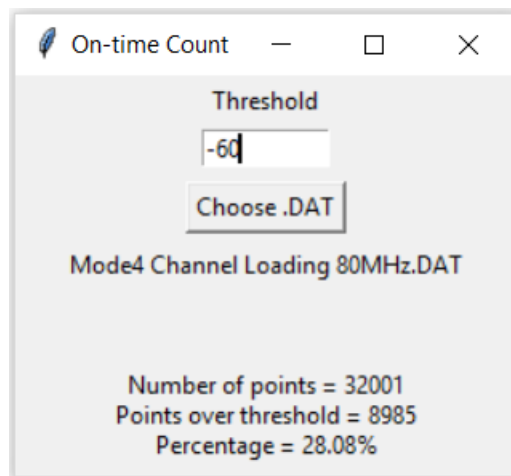


Figure 9-24. 5530MHz - Channel Loading Calculation - Mode 4 (80MHz)

FCC ID: BCGA2152	MEASUREMENT REPORT (CERTIFICATION)		Approved by: Quality Manager
Test Report S/N: 1C1811080025-06.BCG	Test Dates: 01/09/2019 - 02/01/2019	EUT Type: Tablet Device	Page 36 of 53

9.3 Channel Move/ Closing Transmission Time

9.3.1 Channel Move/ Closing Transmission Time Mode 1:

Result

Parameter	Measured			Limit
	20MHz Bandwidth	40MHz Bandwidth	80MHz Bandwidth	
Channel Move Time	4.117 s	4.161 s	4.087 s	10 seconds
Channel Closing Transmission Time	< 200ms + 17.464 ms (aggregate)	< 200ms + 18.168 ms (aggregate)	< 200ms + 7.912 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.

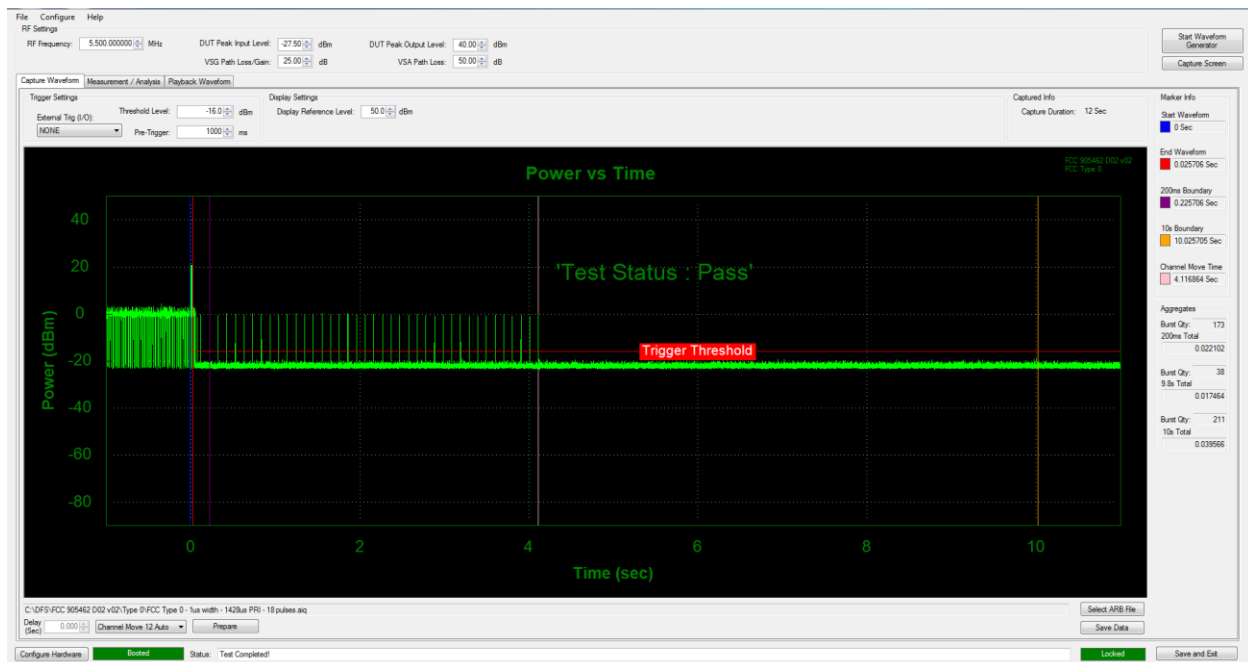


Figure 9-25. 5500MHz - Channel Move/ Closing Transmission Time - Mode 1 (20 MHz)

FCC ID: BCGA2152	MEASUREMENT REPORT (CERTIFICATION)		Approved by: Quality Manager
Test Report S/N: 1C1811080025-06.BCG	Test Dates: 01/09/2019 - 02/01/2019	EUT Type: Tablet Device	Page 37 of 53

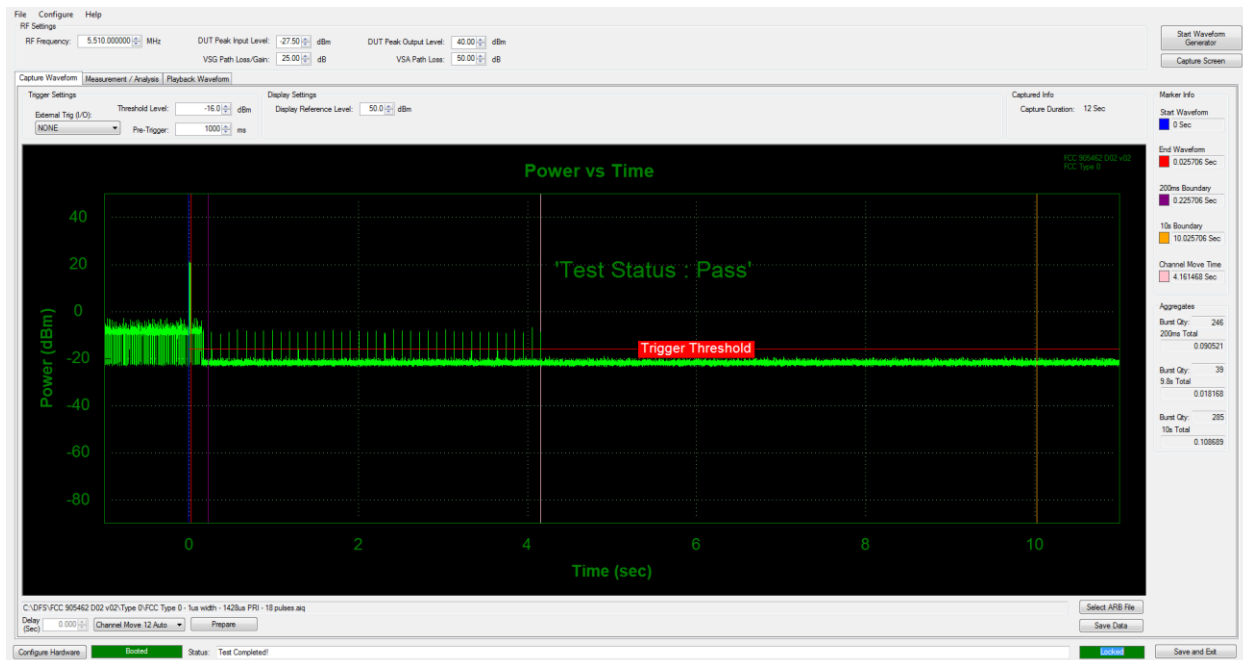


Figure 9-26. 5510MHz - Channel Move/ Closing Transmission Time - Mode 1 (40 MHz)

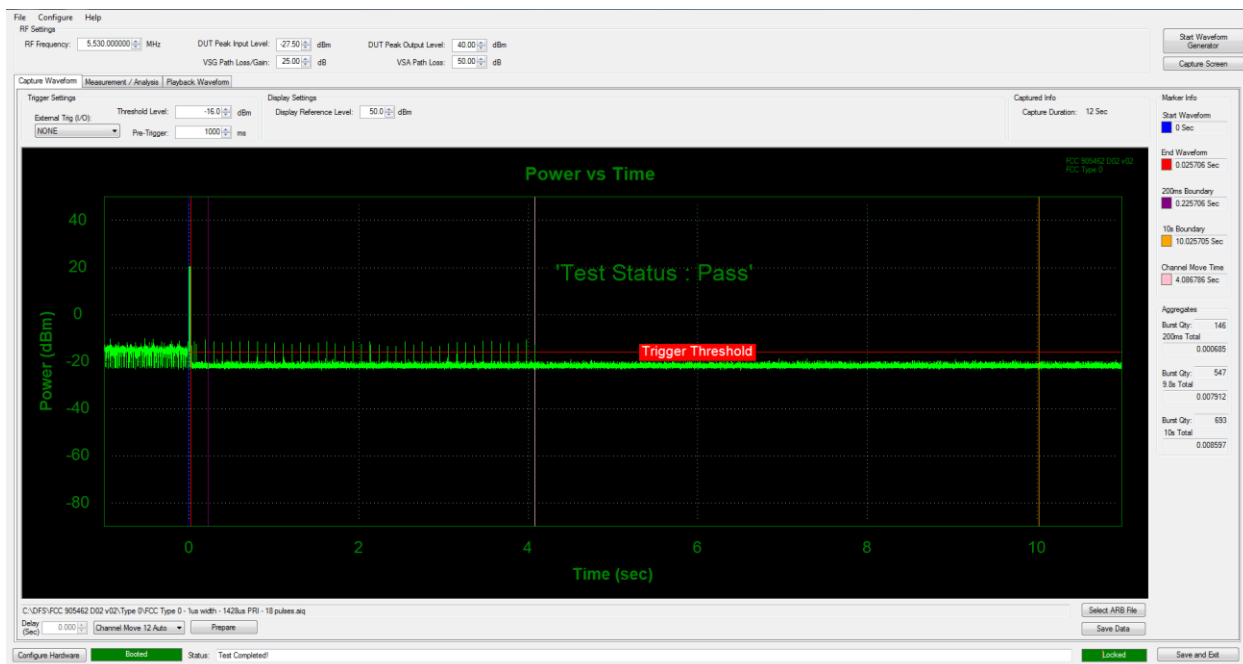


Figure 9-27. 5530MHz - Channel Move/ Closing Transmission Time - Mode 1 (80 MHz)

FCC ID: BCGA2152	PCTEST ENGINEERING LABORATORY, INC.	MEASUREMENT REPORT (CERTIFICATION)	Approved by: Quality Manager
Test Report S/N: 1C1811080025-06.BCG	Test Dates: 01/09/2019 - 02/01/2019	EUT Type: Tablet Device	Page 38 of 53

9.3.2 Channel Move/ Closing Transmission Time Mode 2:

Result:

Parameter	Measured			Limit
	20MHz Bandwidth	40MHz Bandwidth	80MHz Bandwidth	
Channel Move Time	4.092 s	4.153 s	4.174 s	10 seconds
Channel Closing Transmission Time	< 200ms + 17.461 ms (aggregate)	< 200ms + 19.102 ms (aggregate)	< 200ms + 2.368 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.

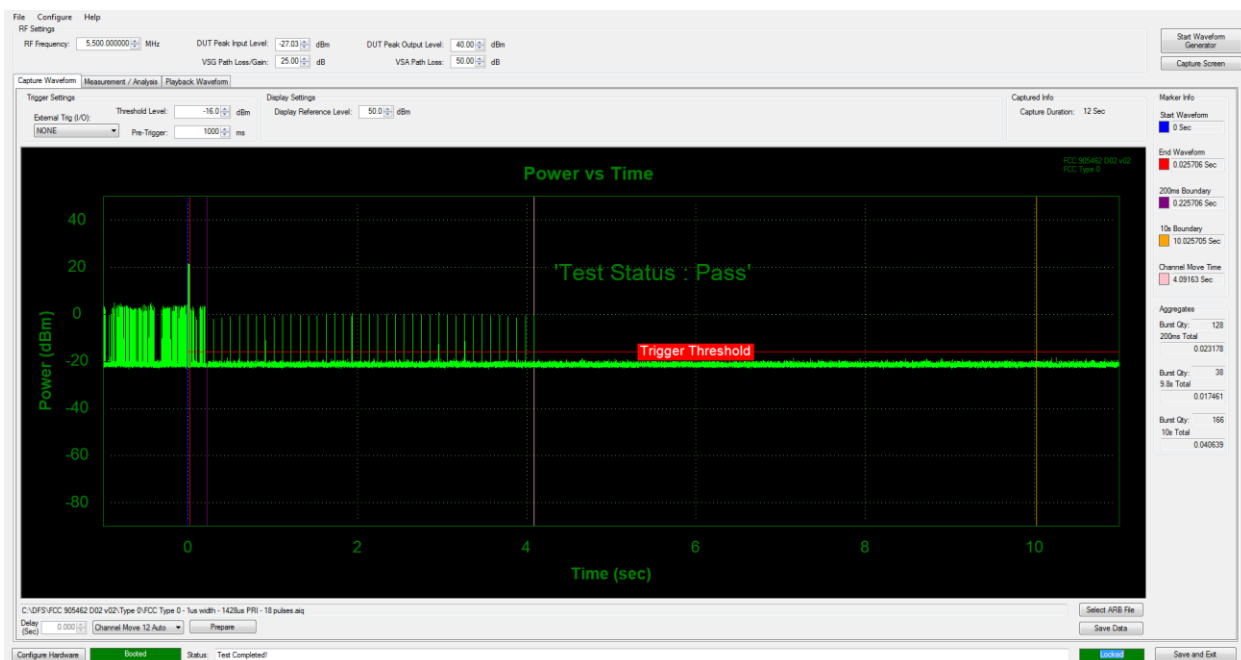


Figure 9-28. 5500MHz - Channel Move/ Closing Transmission Time - Mode 2 (20 MHz)

FCC ID: BCGA2152	PCTEST ENGINEERING LABORATORY, INC.	MEASUREMENT REPORT (CERTIFICATION)	Approved by: Quality Manager
Test Report S/N: 1C1811080025-06.BCG	Test Dates: 01/09/2019 - 02/01/2019	EUT Type: Tablet Device	Page 39 of 53

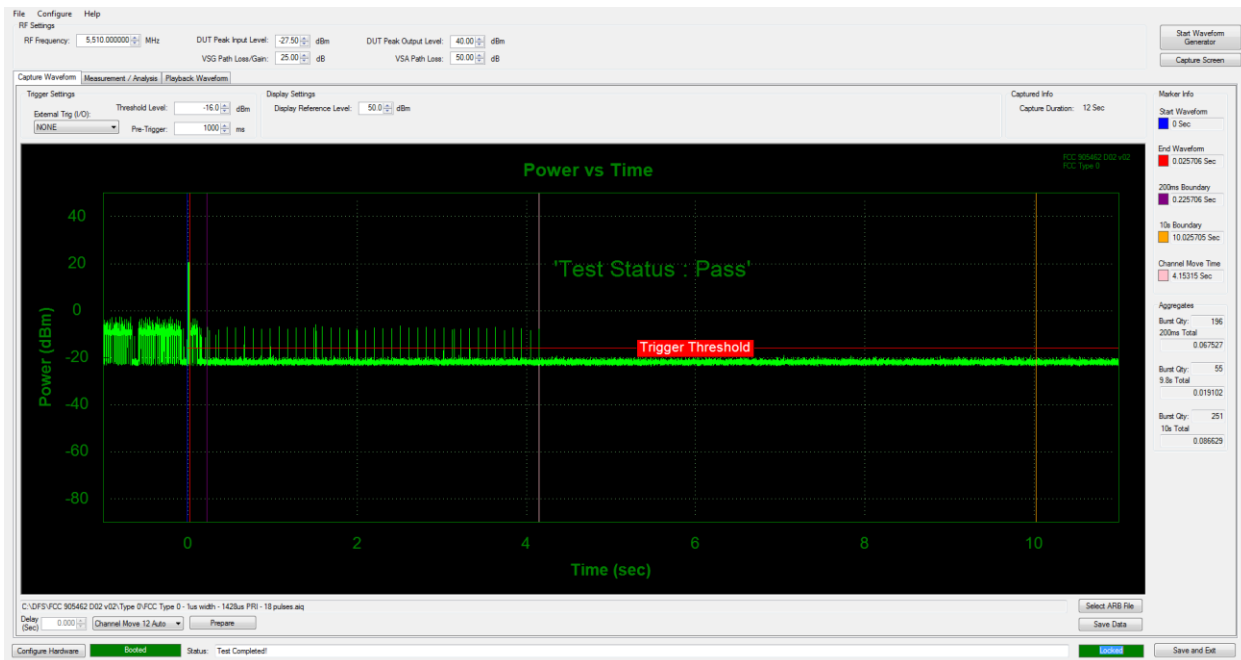


Figure 9-29. 5510MHz - Channel Move/ Closing Transmission Time - Mode 2 (40 MHz)

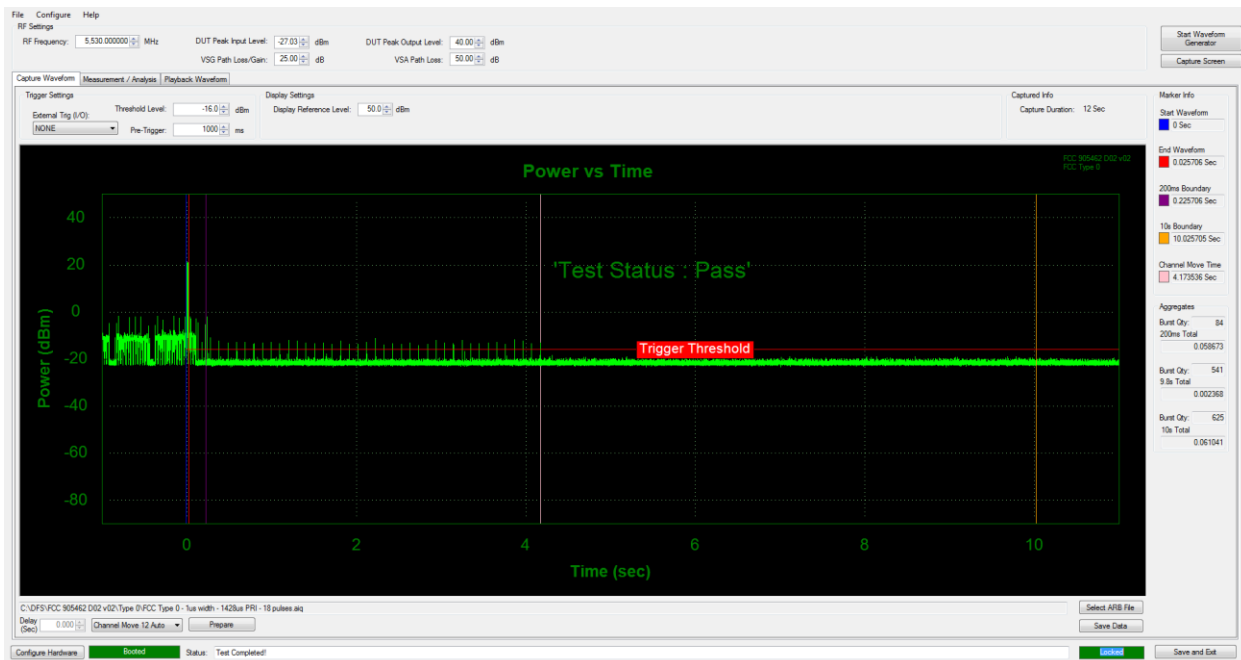


Figure 9-30. 5530MHz - Channel Move/ Closing Transmission Time - Mode 2 (80 MHz)

FCC ID: BCGA2152		MEASUREMENT REPORT (CERTIFICATION)	Approved by: Quality Manager
Test Report S/N: 1C1811080025-06.BCG	Test Dates: 01/09/2019 - 02/01/2019	EUT Type: Tablet Device	Page 40 of 53

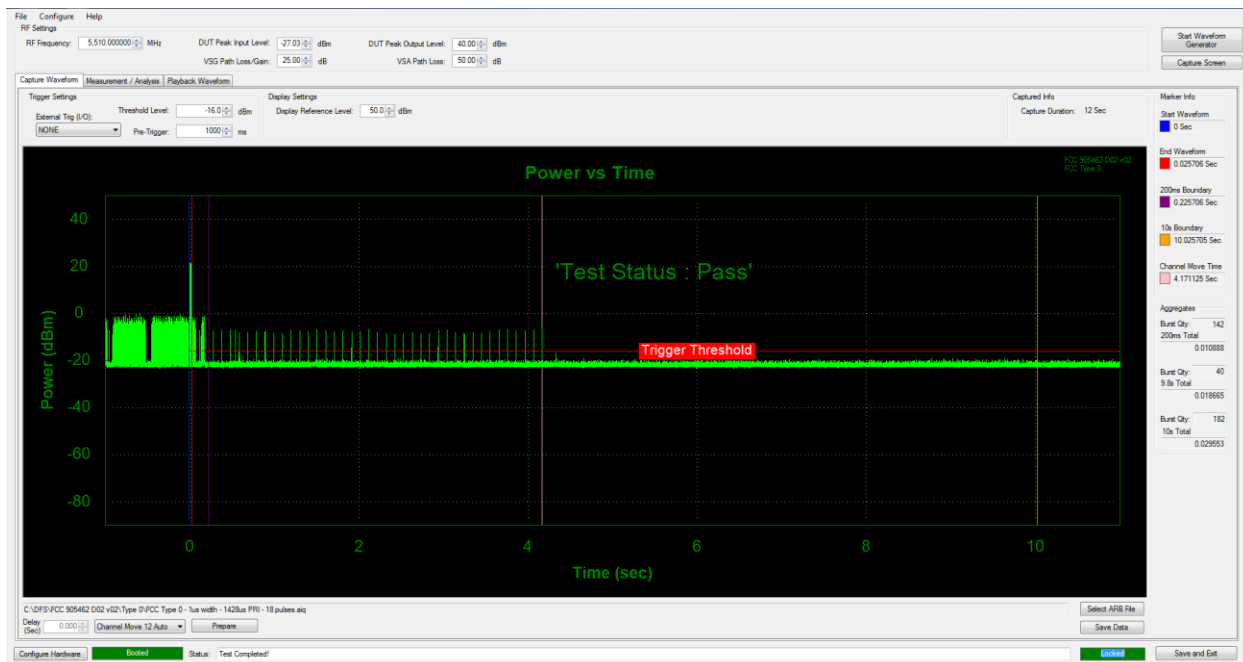


Figure 9-32. 5510MHz - Channel Move/ Closing Transmission Time - Mode 3 (40 MHz)

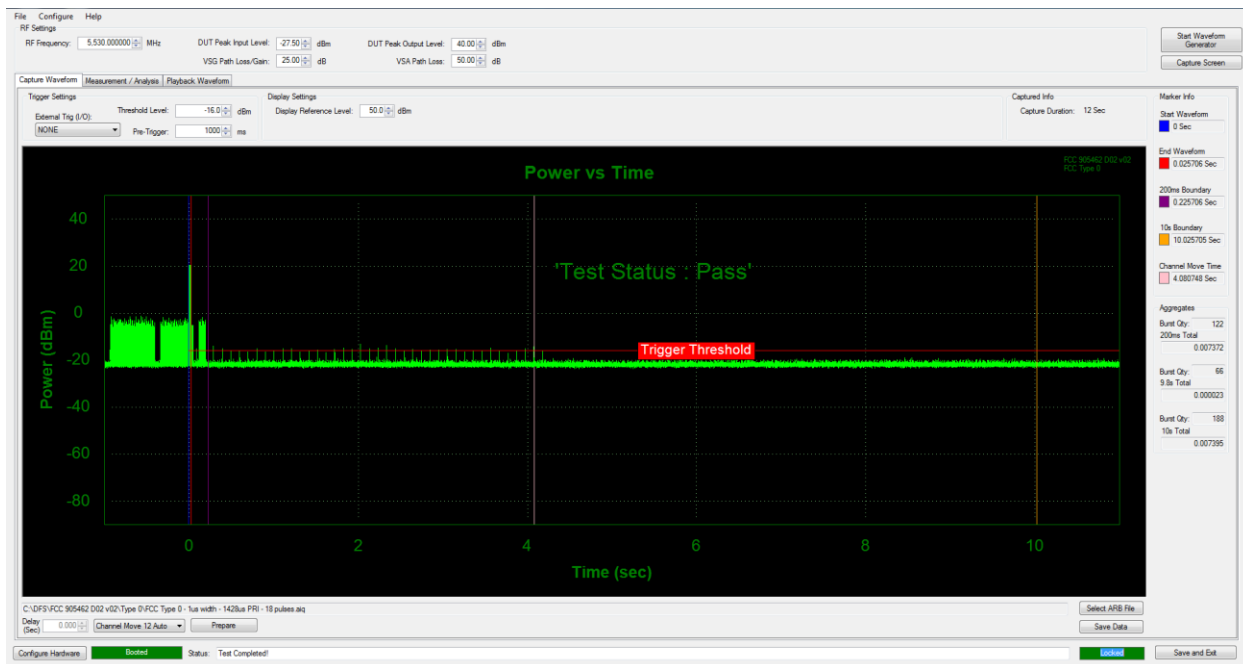


Figure 9-33. 5530MHz - Channel Move/ Closing Transmission Time - Mode 3 (80 MHz)

FCC ID: BCGA2152	PCTEST ENGINEERING LABORATORY, INC.	MEASUREMENT REPORT (CERTIFICATION)	Approved by: Quality Manager
Test Report S/N: 1C1811080025-06.BCG	Test Dates: 01/09/2019 - 02/01/2019	EUT Type: Tablet Device	Page 42 of 53

9.3.4 Channel Move/ Closing Transmission Time Mode 4:

Result:

Parameter	Measured			Limit
	20MHz Bandwidth	40MHz Bandwidth	80MHz Bandwidth	
Channel Move Time	4.159 s	4.155 s	4.155 s	10 seconds
Channel Closing Transmission Time	< 200ms + 17.904 ms (aggregate)	< 200ms + 18.206 ms (aggregate)	< 200ms + 2.450 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.

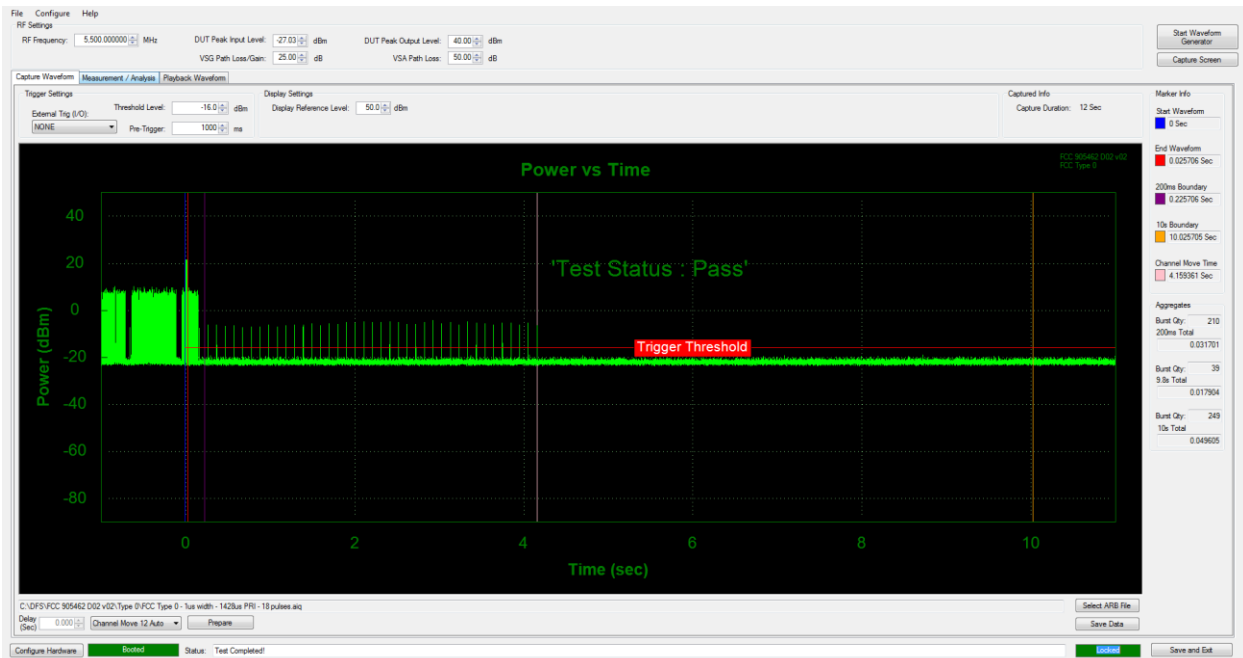


Figure 9-34. 5500MHz - Channel Move/ Closing Transmission Time - Mode 4 (20 MHz)

FCC ID: BCGA2152	MEASUREMENT REPORT (CERTIFICATION)		Approved by: Quality Manager
Test Report S/N: 1C1811080025-06.BCG	Test Dates: 01/09/2019 - 02/01/2019	EUT Type: Tablet Device	Page 43 of 53

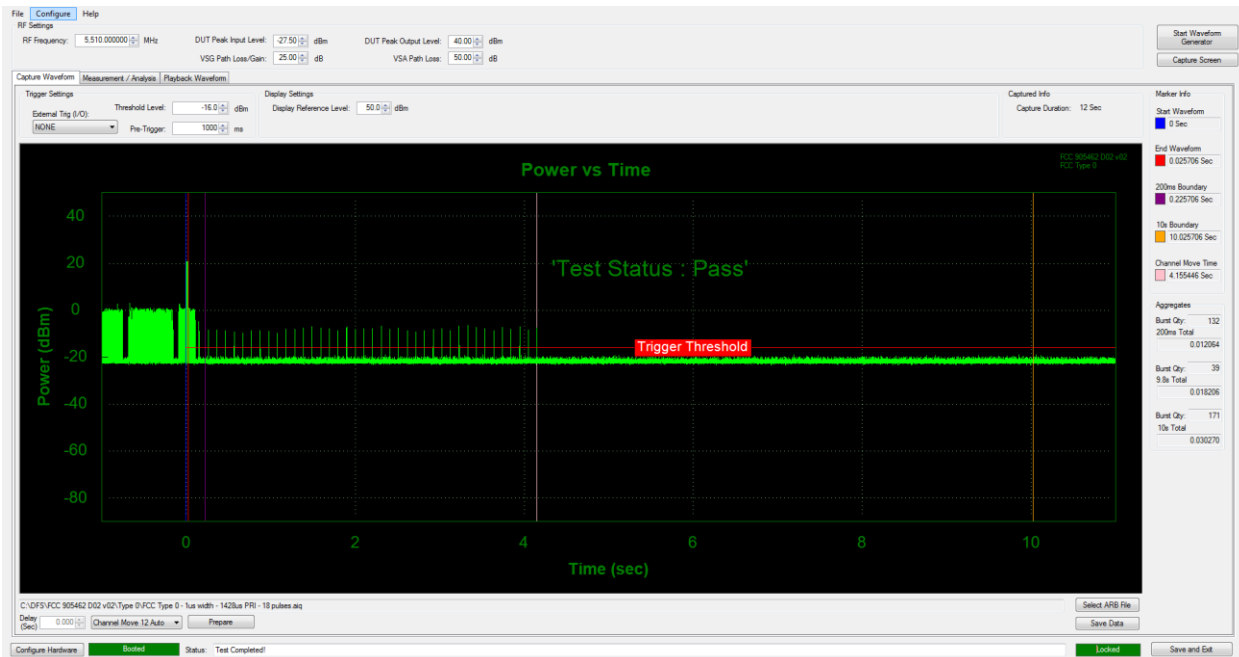


Figure 9-35. 5510MHz - Channel Move/ Closing Transmission Time - Mode 4 (40 MHz)

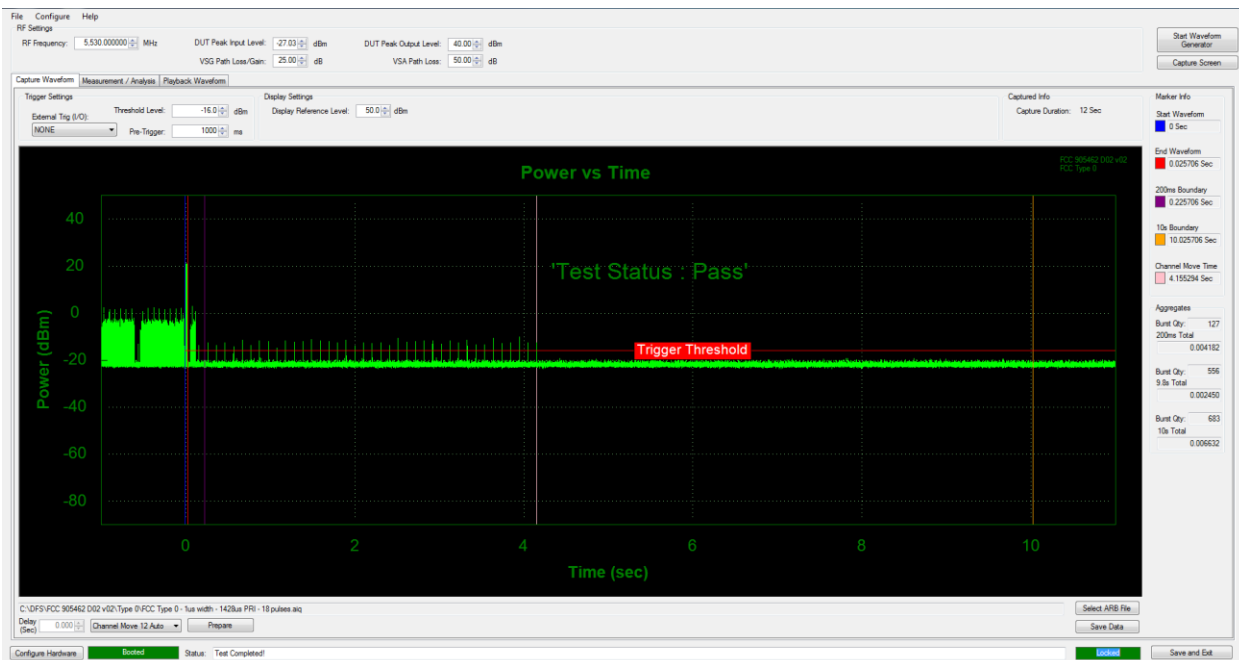


Figure 9-36. 5530MHz - Channel Move/ Closing Transmission Time - Mode 4 (80 MHz)

FCC ID: BCGA2152	MEASUREMENT REPORT (CERTIFICATION)		Approved by: Quality Manager
Test Report S/N: 1C1811080025-06.BCG	Test Dates: 01/09/2019 - 02/01/2019	EUT Type: Tablet Device	Page 44 of 53

9.4 Non-Occupancy Period

9.4.1 Non-Occupancy Period (10 Minutes) Mode 1:

Notes:

1. No frequency transmission detected during the Non-Occupancy Period of 10 minutes monitoring.

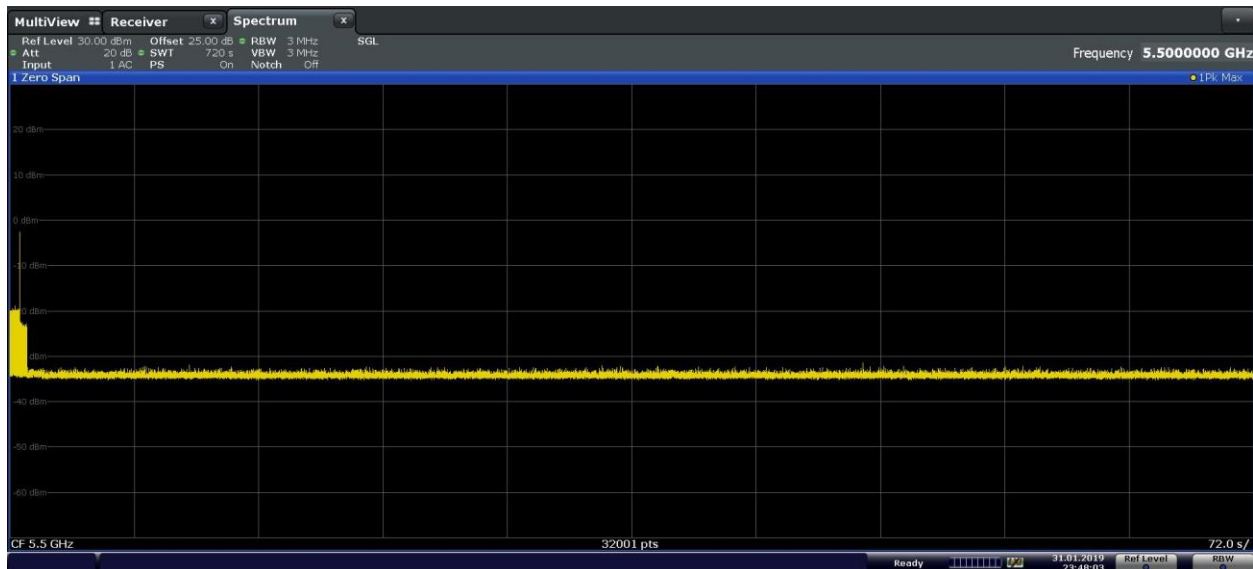


Figure 9-37. 5500MHz - Non-Occupancy Period (10 Minutes) - Mode 1 (20MHz)

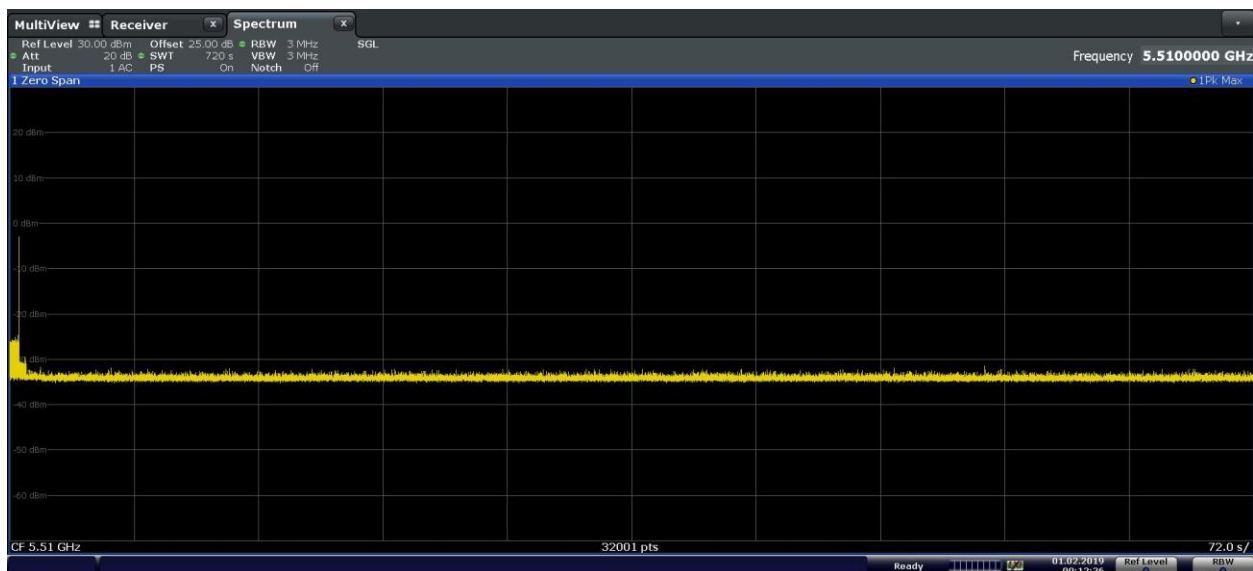


Figure 9-38. 5510MHz - Non-Occupancy Period (10 Minutes) - Mode 1 (40MHz)

FCC ID: BCGA2152	PCTEST ENGINEERING LABORATORY, INC.	MEASUREMENT REPORT (CERTIFICATION)	Approved by: Quality Manager
Test Report S/N: 1C1811080025-06.BCG	Test Dates: 01/09/2019 - 02/01/2019	EUT Type: Tablet Device	Page 45 of 53

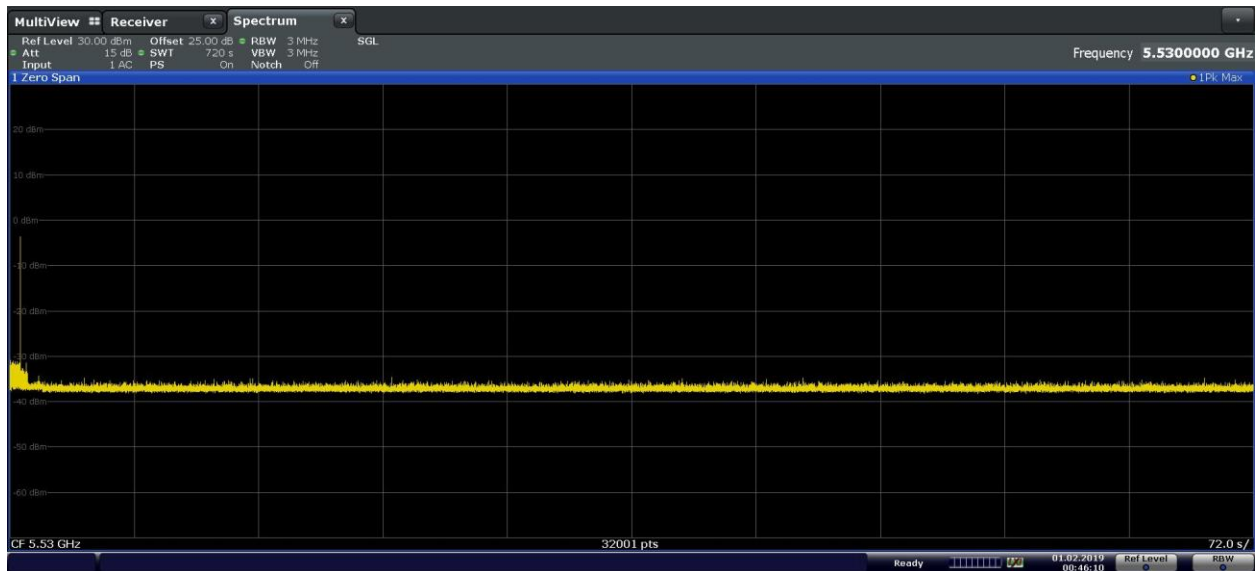


Figure 9-39. 5530MHz - Non-Occupancy Period (10 Minutes) - Mode 1 (80MHz)

FCC ID: BCGA2152	 MEASUREMENT REPORT (CERTIFICATION)		Approved by: Quality Manager
Test Report S/N: 1C1811080025-06.BCG	Test Dates: 01/09/2019 - 02/01/2019	EUT Type: Tablet Device	Page 46 of 53

9.4.2 Non-Occupancy Period (10 Minutes) Mode 2:

Notes:

1. No frequency transmission detected during the Non-Occupancy Period of 10 minutes monitoring.

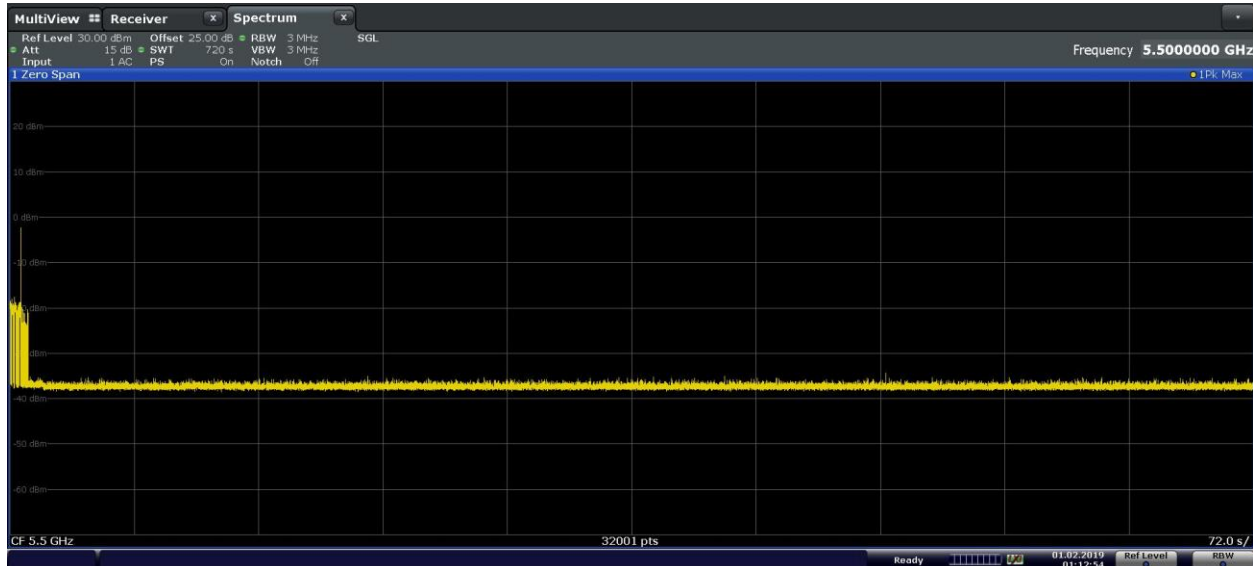


Figure 9-40. 5500MHz - Non-Occupancy Period (10 Minutes) - Mode 2 (20MHz)

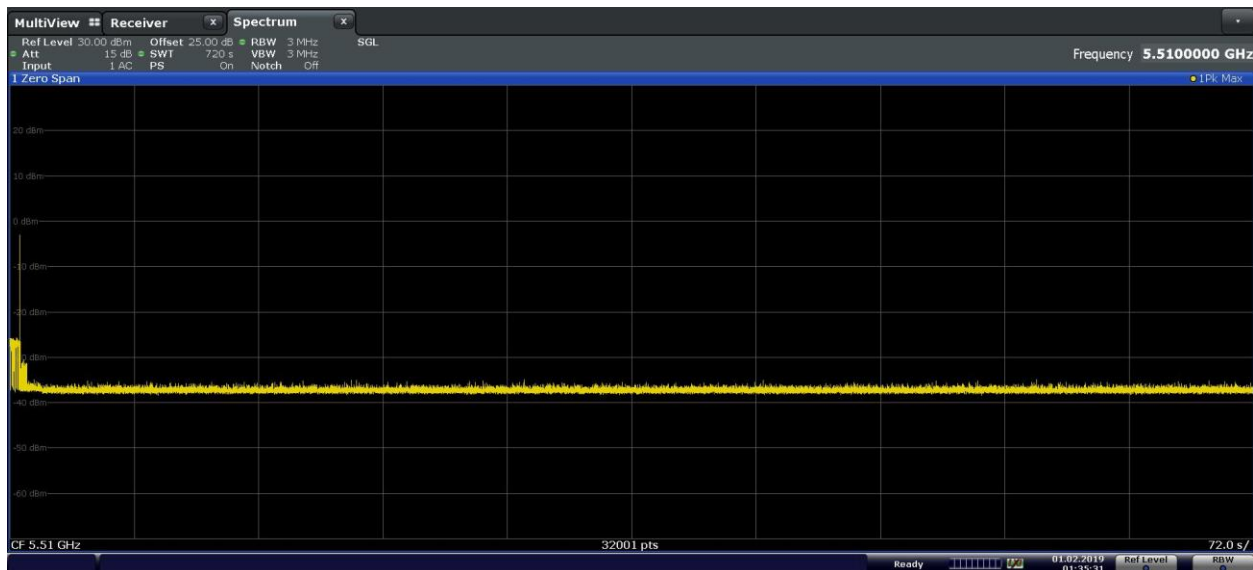


Figure 9-41. 5510MHz - Non-Occupancy Period (10 Minutes) - Mode 2 (40MHz)

FCC ID: BCGA2152	 MEASUREMENT REPORT (CERTIFICATION)		Approved by: Quality Manager
Test Report S/N: 1C1811080025-06.BCG	Test Dates: 01/09/2019 - 02/01/2019	EUT Type: Tablet Device	Page 47 of 53

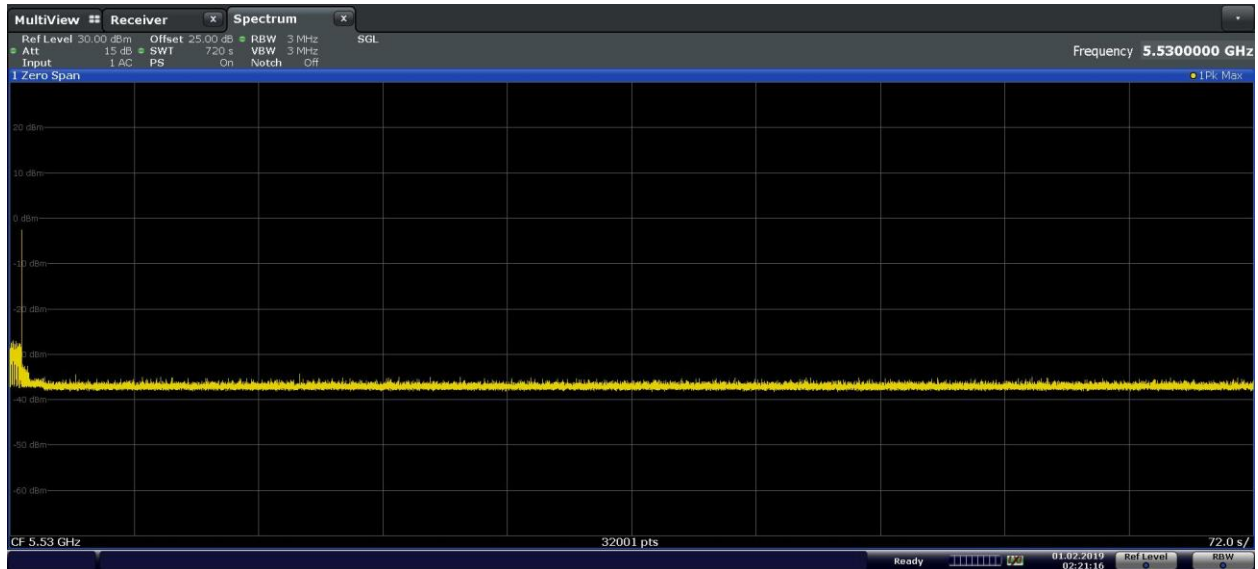


Figure 9-42. 5530MHz - Non-Occupancy Period (10 Minutes) - Mode 2 (80MHz)

FCC ID: BCGA2152	 MEASUREMENT REPORT (CERTIFICATION)		Approved by: Quality Manager
Test Report S/N: 1C1811080025-06.BCG	Test Dates: 01/09/2019 - 02/01/2019	EUT Type: Tablet Device	Page 48 of 53

9.4.3 Non-Occupancy Period (10 Minutes) Mode 3:

Notes:

2. No frequency transmission detected during the Non-Occupancy Period of 10 minutes monitoring.

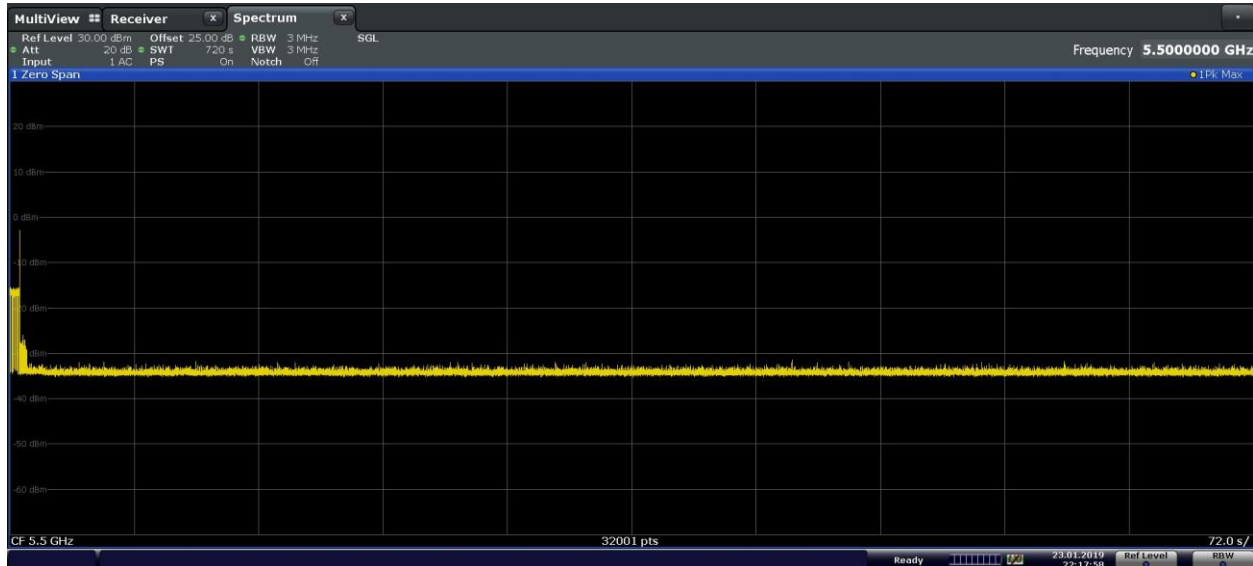


Figure 9-43. 5500MHz - Non-Occupancy Period (10 Minutes) - Mode 3 (20MHz)

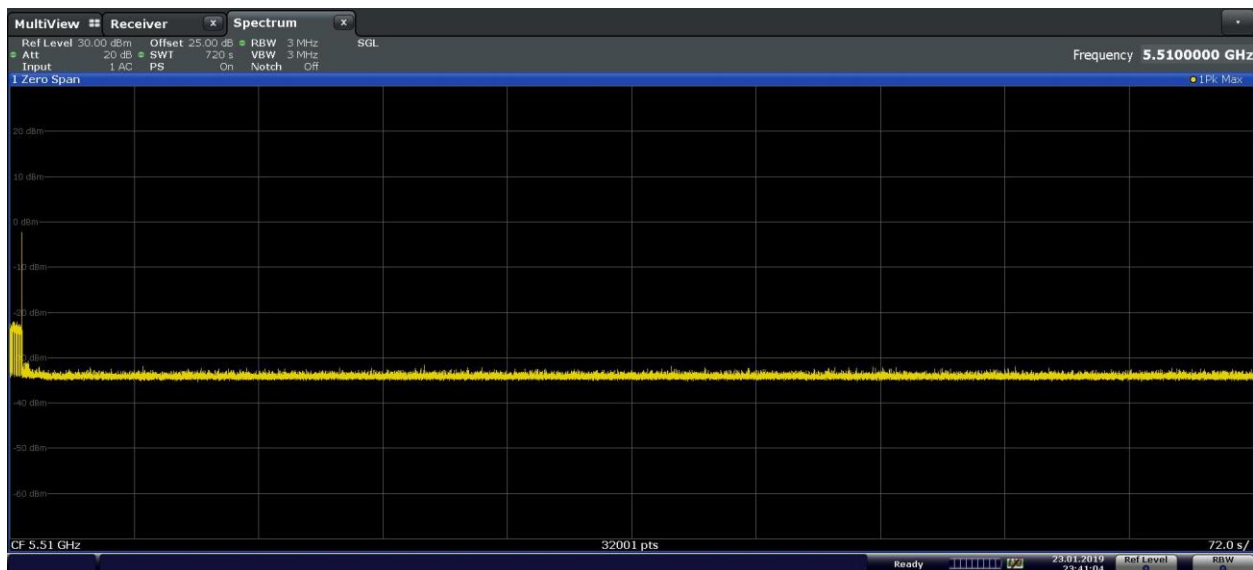


Figure 9-44. 5510MHz - Non-Occupancy Period (10 Minutes) - Mode 3 (40MHz)

FCC ID: BCGA2152	PCTEST ENGINEERING LABORATORY, INC.	MEASUREMENT REPORT (CERTIFICATION)	Approved by: Quality Manager
Test Report S/N: 1C1811080025-06.BCG	Test Dates: 01/09/2019 - 02/01/2019	EUT Type: Tablet Device	Page 49 of 53

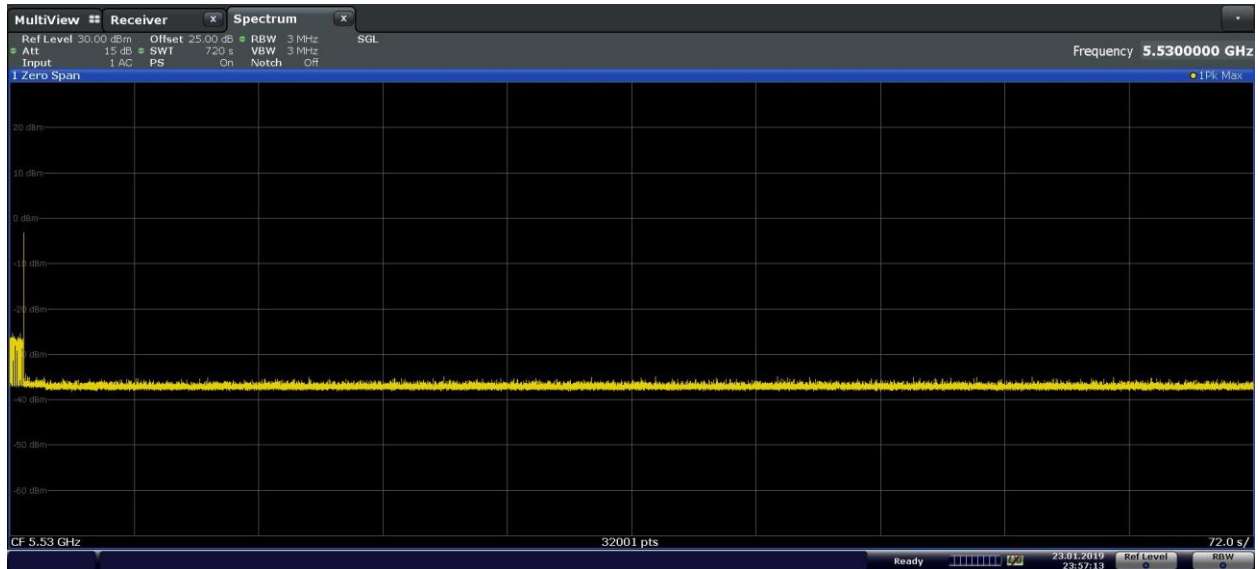


Figure 9-45. 5530MHz - Non-Occupancy Period (10 Minutes) - Mode 3 (80MHz)

FCC ID: BCGA2152	 MEASUREMENT REPORT (CERTIFICATION)		Approved by: Quality Manager
Test Report S/N: 1C1811080025-06.BCG	Test Dates: 01/09/2019 - 02/01/2019	EUT Type: Tablet Device	Page 50 of 53

9.4.4 Non-Occupancy Period (10 Minutes) Mode 4:

Notes:

1. No frequency transmission detected during the Non-Occupancy Period of 10 minutes monitoring.

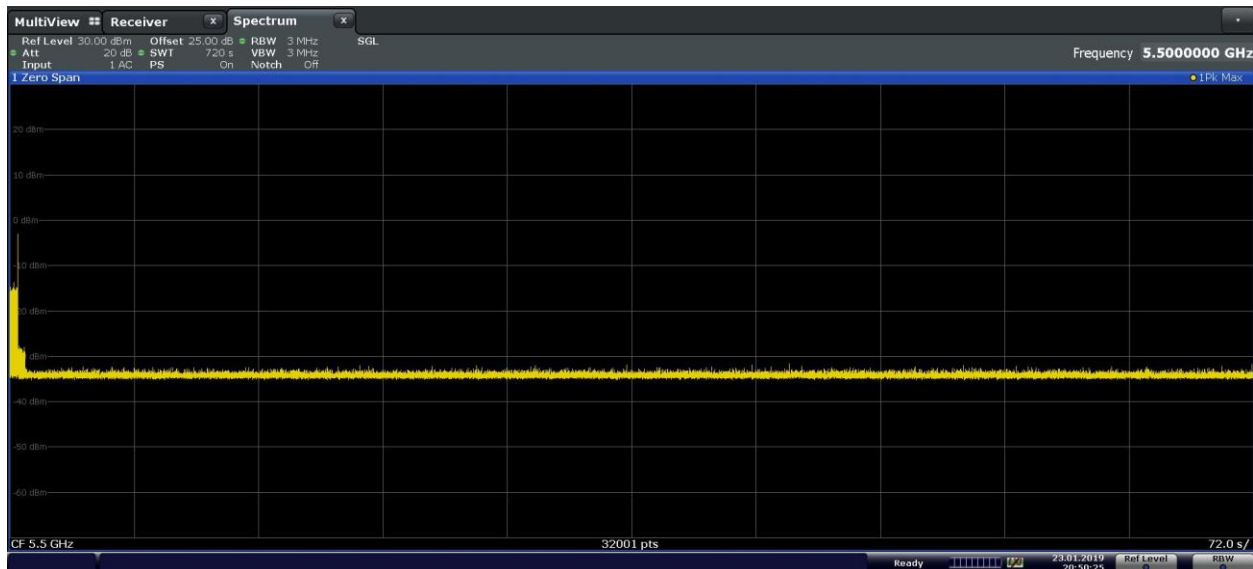


Figure 9-46. 5500MHz - Non-Occupancy Period (10 Minutes) - Mode 4 (20MHz)

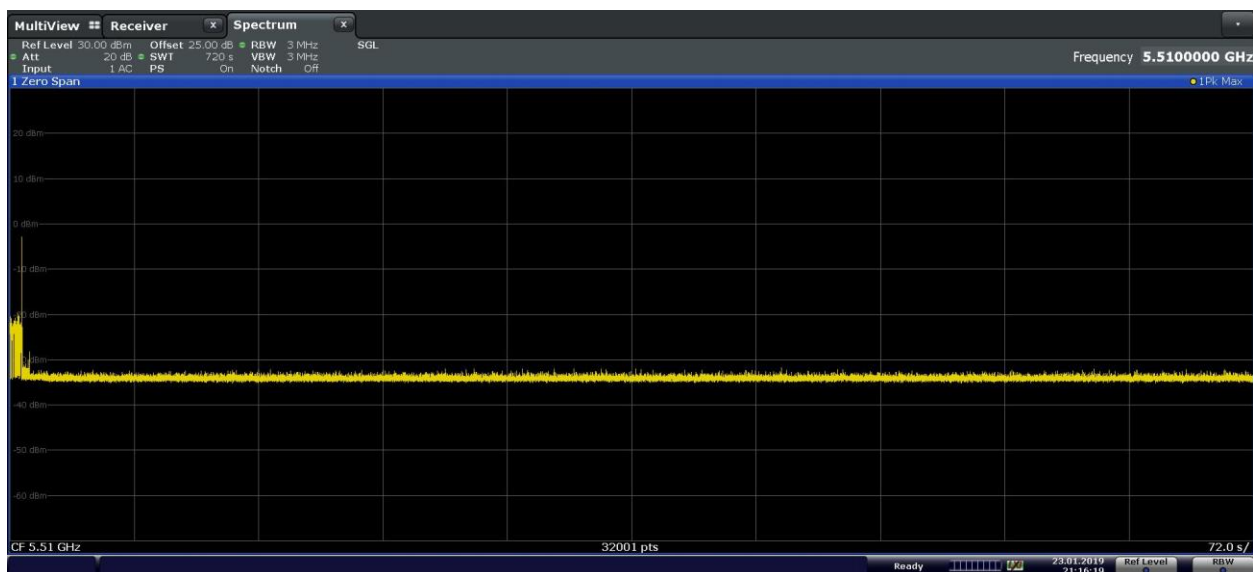


Figure 9-47. 5510MHz - Non-Occupancy Period (10 Minutes) - Mode 4 (40MHz)

FCC ID: BCGA2152	 MEASUREMENT REPORT (CERTIFICATION)		Approved by: Quality Manager
Test Report S/N: 1C1811080025-06.BCG	Test Dates: 01/09/2019 - 02/01/2019	EUT Type: Tablet Device	Page 51 of 53

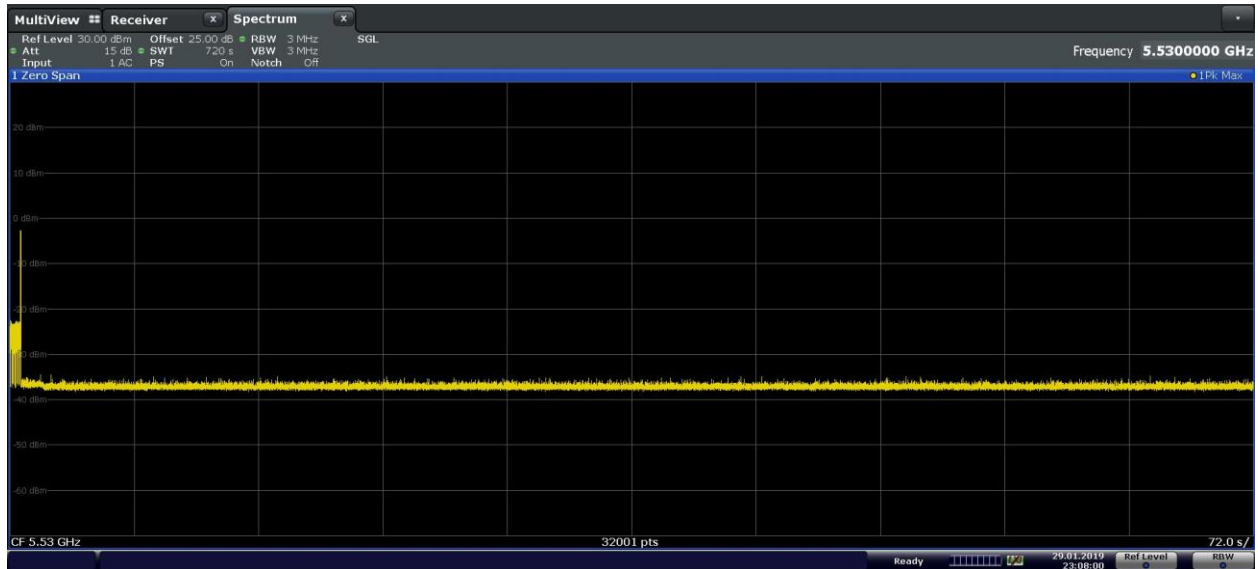


Figure 9-48. 5530MHz - Non-Occupancy Period (10 Minutes) - Mode 4 (80MHz)

FCC ID: BCGA2152	MEASUREMENT REPORT (CERTIFICATION)		Approved by: Quality Manager
Test Report S/N: 1C1811080025-06.BCG	Test Dates: 01/09/2019 - 02/01/2019	EUT Type: Tablet Device	Page 52 of 53

10.0 CONCLUSION

The data collected relate only to the item(s) tested and show that the **Apple Tablet Device FCC ID: BCGA2152** 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: BCGA2152		MEASUREMENT REPORT (CERTIFICATION)	Approved by: Quality Manager
Test Report S/N: 1C1811080025-06.BCG	Test Dates: 01/09/2019 - 02/01/2019	EUT Type: Tablet Device	Page 53 of 53