ELECTROMAGNETIC EMISSIONS COMPLIANCE REPORT

Applicant:	Microsoft Corporation One Microsoft Way Redmond, WA 98052-6399, U.S.A
Product Name:	Portable Computing Device
Brand Name:	Microsoft
Model No.:	1979
Model Difference:	N/A
Report Number:	E2/2020/90088
FCC ID:	C3K1979
FCC Rule Part:	§15.407, Cat: U-NII
Issue Date:	Feb. 24, 2021
Date of Test:	Sep. 22, 2020 ~ Jan. 29, 2021
Date of EUT Received:	Sep. 22, 2020

We hereby certify that:

The above equipment was tested by SGS Taiwan Ltd. Central RF Lab The test data, data evaluation, test procedures, and equipment configurations shown in this report were made in accordance with the procedures given in ANSI C63.10: 2013 and the energy emitted by the sample EUT tested as described in this report is in compliance with conducted and radiated emission limits.

The test results of this report relate only to the tested sample identified in this report.

Approved By: Jay. Lin

Jay Lin / Asst. Supervisor

Testing Laboratory
3702

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Revision History

Report Number	Revision	Description	Issue Date	Remark
E2/2020/90088	Rev.00	Original.	Feb. 24, 2021	Revised By: Violetta Tang

Note:

1、Disclaimer
Antenna information is provided by the applicant, the test results of this report are applicable to the sample EUT received.

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Table of Contents

1 GENERAL INFORMATION 4
2 SUMMARY OF TEST RESULT 7
3 MEASUREMENT UNCERTAINTY 7
4 TPC and DFS MEASUREMENT 8

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1 GENERAL INFORMATION

1.1 Product Description

Product Name:	Portable Computing Device
Brand Name:	Microsoft
Model No.:	1979
Model Difference:	N/A
HW Version (Product):	EV2
SW Version (Product):	4.89.137
HW Version (Radio):	N/A
SW Version (Radio):	21.80.2.1
Radio Test Tool & Version:	DRTU: 21.21080.0.0-10722
Power Supply:	From Rechargeable Lithium-Ion Polymer Battery or from AC/DC Adapter
Modulation type	64QAM, 16QAM, QPSK, BPSK for OFDM 256QAM for OFDM in 802.11ac only 1024QAM for OFDMA in 802.11ax only
Transition Rate:	802.11 a: 6/9/12/18/24/36/48/54 Mbps 802.11 n_20MHz: 6.5 – 144.4Mbps 802.11 n_40MHz: 13.5 – 300.0Mbps 802.11 ac_20MHz: 6.5 –173.3Mbps 802.11 ac_40MHz: 13.5 –400.0Mbps 802.11 ac_80MHz: 29.3 – 866.7Mbps 802.11 ac_160MHz: 58.5 – 1733.4Mbps 802.11 ax_20MHz: 8.6 –286.8 Mbps 802.11 ax_40MHz: 17.2 -573.5 Mbps 802.11 ax_80MHz: 36.0 – 1201 Mbps 802.11 ax_160MHz: 68 – 2402 Mbps

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1.2 Antenna Designation

Antenna Type	Chain A / Chain B	Freq. (MHz)	Peak Antenna Gain (dBi)	Worst Antenna Gain
PIFA	Chain A	5150~5250	6.10	V
		5250~5350	5.90	V
		5470~5725	5.70	V
		5725~5850	5.90	V
	Chain B	5150~5250	4.80	
		5250~5350	4.50	
		5470~5725	3.10	
		5725~5850	2.80	
Note: Investigation has been done to determine the worst case scenario for the above antennas demonstrated with measurements in this report.				

Below directional gain is used in measurement due to the worst case scenario determined in section 4 of this report designate below antennas for transmissions.

Transmission Chain	Freq. (MHz)	Peak Antenna Gain (dBi)	Directional Gain in the worst case scenario (dBi)
Chain A	5150~5250	6.10	5.50
Chain B		4.80	
Chain A	5250~5350	5.90	5.26
Chain B		4.50	
Chain A	5470~5725	5.70	4.59
Chain B		3.10	
Chain A	5725~5850	5.90	4.62
Chain B		2.80	

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1.3 Test Methodology of Applied Standards

FCC Part 15, Subpart E §15.407

FCC KDB 905462 D02 UNII DFS Compliance Procedures New Rules v02

FCC KDB 905462 D03 UNII Clients Without Radar Detection New Rules v01r02

1.4 Test Facility

SGS Taiwan Ltd. Central RF Lab (TAF code 3702)
No.2, Keji 1st Rd., Guishan District, Taoyuan City, Taiwan 333
FCC Designation number: TW0028

1.5 Special Accessories

There are no special accessories used while test was conducted.

1.6 Equipment Modifications

There was no modification incorporated into the EUT.

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2 SUMMARY OF TEST RESULT

FCC Rules	Description Of Test	Result
§15.407(h)	TPC and DFS Measurement	Compliant

3 MEASUREMENT UNCERTAINTY

Test Items	Uncertainty
TPC and DFS Measurement	+/- 123.36 Hz
Temperature	+/- 0.65 °C
Humidity	+/- 4.6 %
DC / AC Power Source	DC= +/- 0.13%, AC=+/- 0.2%

This uncertainty represents an expanded uncertainty expressed at approximately the 95% confidence level using a coverage factor of k=2.

The conformity assessment statement in this report is based solely on the test results, measurement uncertainty is excluded.

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4 TPC AND DFS MEASUREMENT

4.1 TPC: Standard Applicable

According to §15.407(h)(1), Transmit power control (TPC). U-NII devices operating in the 5.25-5.35 GHz band and the 5.47-5.725 GHz band shall employ a TPC mechanism. The U-NII device is required to have the capability to operate at least 6 dB below the mean EIRP value of 30 dBm. A TPC mechanism is not required for systems with an e.i.r.p. of less than 500 mW.

Result: N/A, The output power is less than 500mW.

4.2 DFS: Standard Applicable

According to §15.407(h)(2) and FCC KDB 905462 D02 , Radar Detection Function of Dynamic Frequency Selection (DFS).

Radar Detection Function of Dynamic Frequency Selection (DFS). U-NII devices operating with any part of its 26 dB emission bandwidth in the 5.25-5.35 GHz and 5.47-5.725 GHz bands shall employ a DFS radar detection mechanism to detect the presence of radar systems and to avoid co-channel operation with radar systems. Operators shall only use equipment with a DFS mechanism that is turned on when operating in these bands. The device must sense for radar signals at 100 percent of its emission bandwidth. The minimum DFS detection threshold for devices with a maximum e.i.r.p. of 200 mW to 1 W is −64 dBm. For devices that operate with less than 200 mW e.i.r.p. and a power spectral density of less than 10 dBm in a 1 MHz band, the minimum detection threshold is −62 dBm. The detection threshold is the received power averaged over 1 microsecond referenced to a 0 dBi antenna. For the initial channel setting, the manufacturers shall be permitted to provide for either random channel selection or manual channel selection.

(i) Operational Modes. The DFS requirement applies to the following operational modes:
  (a) The requirement for channel availability check time applies in the master operational mode.
  (b) The requirement for channel move time applies in both the master and slave operational modes.

(ii) Channel Availability Check Time. A U-NII device shall check if there is a radar system already operating on the channel before it can initiate a transmission on a channel and when it has to move to a new channel. The U-NII device may start using the channel if no radar signal with a power level greater than the interference threshold values listed in paragraph (h)(2) of this section, is detected within 60 seconds.

(iii) Channel Move Time. After a radar's presence is detected, all transmissions shall cease on the operating channel within 10 seconds. Transmissions during this period shall consist of normal traffic for a maximum of 200 ms after detection of the radar signal. In addition, intermittent management and control signals can be sent during the remaining time to facilitate vacating the operating channel.

(iv) Non-occupancy Period. A channel that has been flagged as containing a radar system, either by a channel availability check or in-service monitoring, is subject to a non-occupancy period of at least 30 minutes. The non-occupancy period starts at the time when the radar system is detected.

EUT	Serial Number	Note
Portable Computing Device	3978103657	

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4.2.1 Limit

Table 1: Applicability of DFS requirements prior to use of a channel

Requirement	Operational Mode		
	Master	Client(without radar detection)	Client(with radar detection)
Non-occupancy Period	Yes	Yes	Yes
DFS Detection Thresh-old	Yes	Not required	Yes
Channel Availability Check Time	Yes	Not required	Not required
U-NII Detection Bandwidth	Yes	Not required	Yes

Table 2: Applicability of DFS requirements during normal operation

Requirement	Operational Mode	
	Master Device or Client with Radar Detection	Client Without Radar Detection
DFS Detection Threshold	Yes	Not required
Cannel Closing Transmission time	Yes	Yes
Channel Move time	Yes	Yes
U-NII Detection Bandwidth	Yes	Not required

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Additional requirements for devices with multiple bandwidth mode	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 3: Interference Threshold values, Master or Client incorporating In-Service Monitoring

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. **Note3:** EIRP is based on the highest antenna gain. For MIMO devices refer to KDB Publication 662911 D01.	

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Table 4: DFS Response requirement values

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 Notes 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.
Note 3: During the *U-NII Detection Bandwidth* detection test, radar type 0 should be used. For each frequency step the minimum percentage of detection is 90 percent. Measurements are performed with no data traffic.

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Table 5: Radar Test Waveforms

Short Pulse Radar

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	$\text{Roundup}\left\{\left(\frac{1}{360}\right)\cdot\left(\frac{19\cdot 10^6}{PRI_{\mu sec}}\right)\right\}$	60%	30
		Test B: 15 unique PRI values randomly selected within the range of 518-3066 µsec, with a minimum increment of 1 µsec, excluding PRI values selected in Test A			
2	1-5	150-230	23-29	60%	30
3	6-10	200-500	16-18	60%	30
4	11-20	200-500	12-16	60%	30
Aggregate (Radar Types 1-4)				80%	120
Note 1: Short Pulse Radar Type 0 should be used for the detection bandwidth test, channel move time, and channel closing time tests.					

Long Pulse Radar

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

Frequency Hopping Radar

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

The applicant of this given application confirms that information regarding the parameters of the detected Radar Waveforms is not available to the end user.

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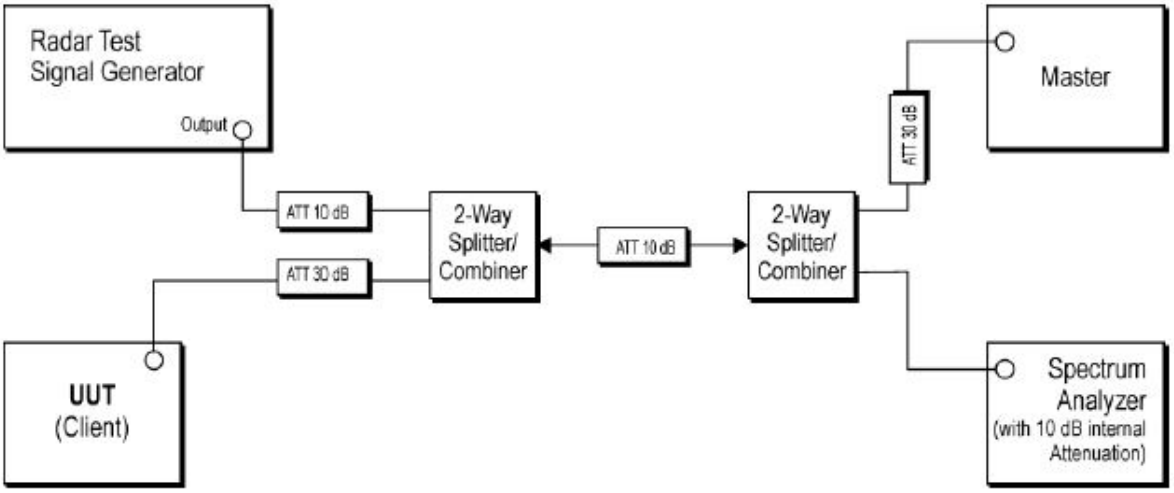
4.2.2 Test Setup

Setup for Client with injection at the Master



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4.2.3 Test Equipment Used:

Conducted Emission Test Site					
EQUIPMENT TYPE	MFR	MODEL NUMBER	SERIAL NUMBER	LAST CAL.	CAL DUE.
EMI Receiver	KEYSIGHT	N9038A	MY52260216	12/01/2020	11/30/2021
Signal Generator	KEYSIGHT	N5182B	MY59100873	06/26/2020	06/25/2021
Power Splitter	Mini-Circuits	ZN2PD-9G-S+	N/A	01/02/2020	01/01/2021
Power Splitter	Mini-Circuits	ZN2PD-9G-S+	N/A	01/02/2020	01/01/2021
Attenuator	Woken	WRF53AYM2B7	RF08	11/19/2020	11/18/2021
Power Splitter	Agilent	11636B	56355	01/02/2020	01/01/2021
Power Splitter	Agilent	11636B	59355	01/02/2020	01/01/2021
AP	ASUS	RT-AX88U	2019/K2ITHP000148 FCC ID: MSQ-RTAXHP00	N/A	N/A

Conducted Emission Test Site					
EQUIPMENT TYPE	MFR	MODEL NUMBER	SERIAL NUMBER	LAST CAL.	CAL DUE.
Splitter	Woken	DOM35LW1E1	RF251	11/19/2020	11/18/2021
Splitter	Woken	DOM35LW1A2	RF255	11/19/2020	11/18/2021
Attenuator	Woken	WRF53AYM2B7	RF08	11/19/2020	11/18/2021
Splitter	Marvelous Microwave	MVE8576	RF257	11/19/2020	11/18/2021
Splitter	Woken	DOM35LW1A2	RF258	11/19/2020	11/18/2021

Note: The measurement was taken place with the long duration of the time, and additional equipment list as shown above indicate those equipment of which has been subject to undertake the calibration in intermediate period of time of the measurement.

equipment) w/o radar detection and DFS capability.

EUT has no TPC mechanism implemented with no adjustment of lowest, and highest power, but the level of power emission stays at fixed level.

WLAN traffic is generated by streaming the mpeg file from the master to slave in full monitor video mode using the media player.

The rated output power of the master unit is >23dBm(EIRP).therefore the required interference threshold level is -64dBm.after correction for antenna gain and procedural adjustments, the required conducted threshold at the antenna port is -64dBm.

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While calibrate the path on antenna port of DFS test equipment (master), measurements equipments (spectrum) is ensured to be 50 Ohms, and therefore verification on antenna gain measurement can be ignored.

Conducted test was performed with appropriate adjustment, and calibration to ensure power from DFS simulator injects to antenna port of DFS test equipment (DFS) is -64dBm

Message or files that is used for communication between Master and Client:

IP based system:

For the required channel loading, the full motion, 30 frames per second MPEG video file from http://ntiacsd.ntia.doc.gov/dfs/ was streamed from a network on a test bench (server of the storage to download the mandatory format of Video file), via the DFS Master device, to the UE (mobile phone).

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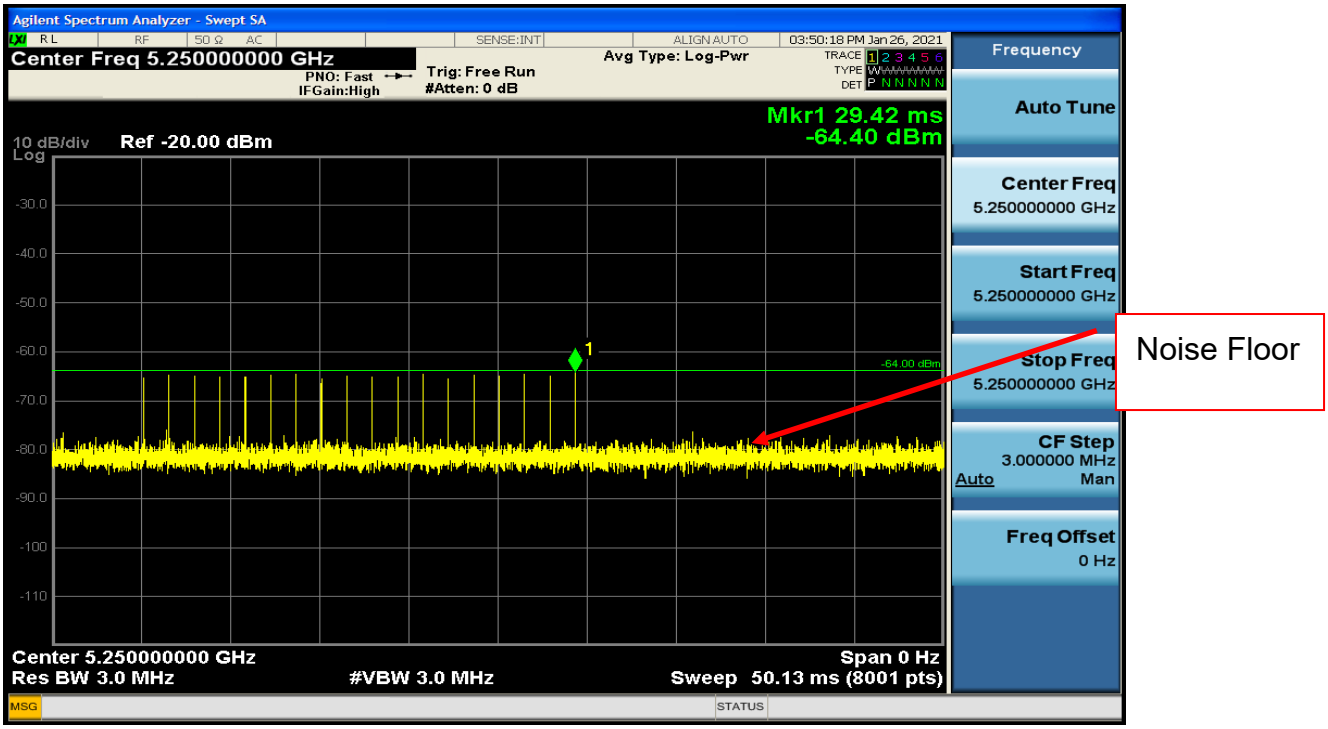
4.2.4 Test results

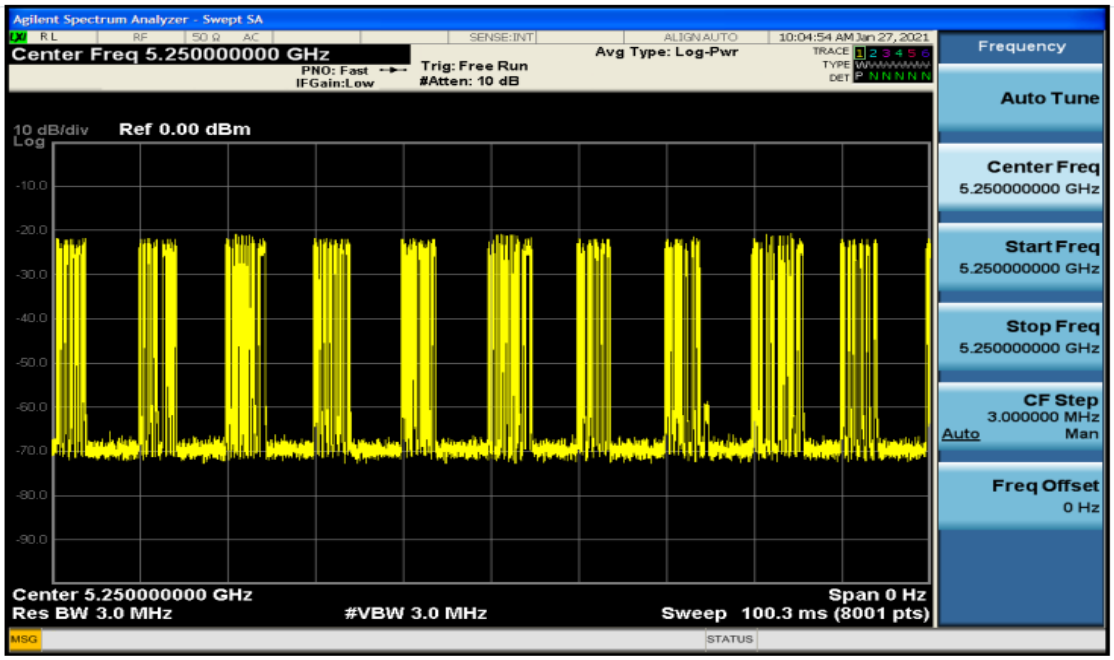
Calibration plots for each of the required radar waveforms

802.11 ax HE160 CH 5250

Radar type 0



WLAN traffic



Duty Cycle: 24.87189 %

** The Channel Loading must be more than 17%*

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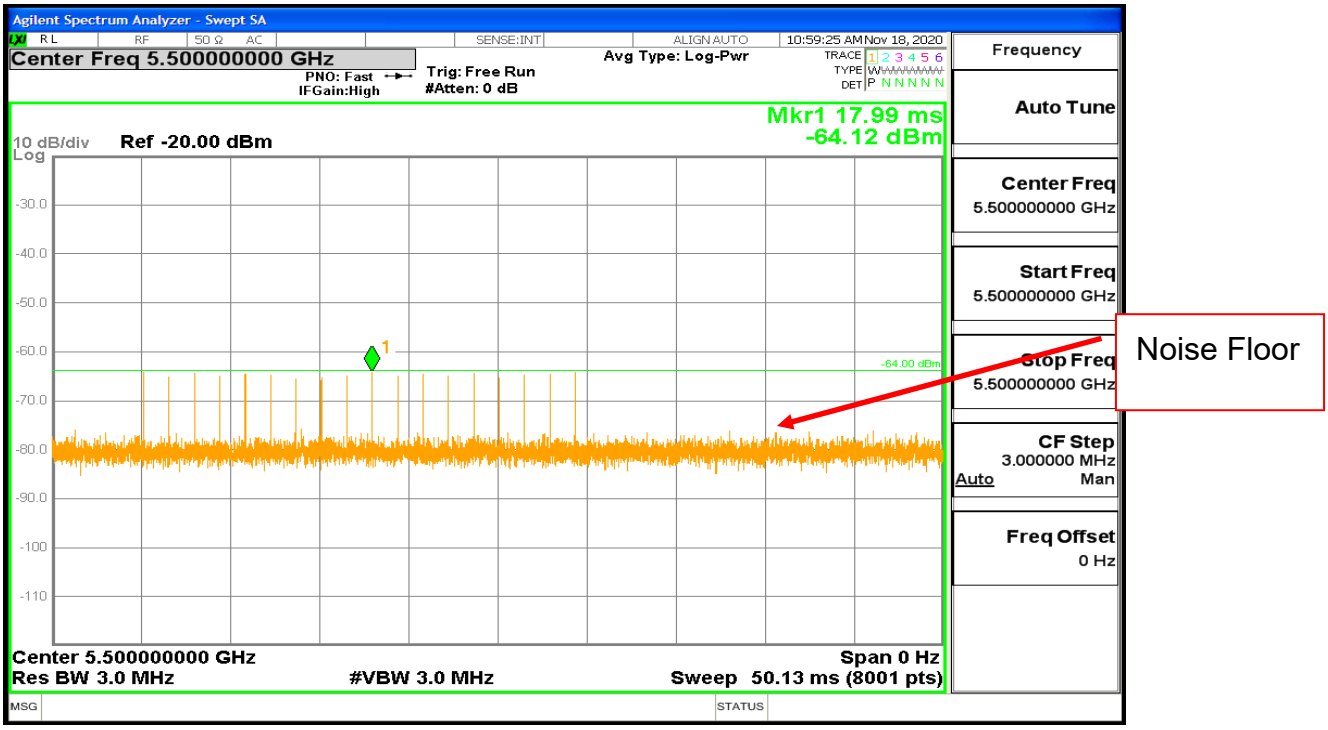
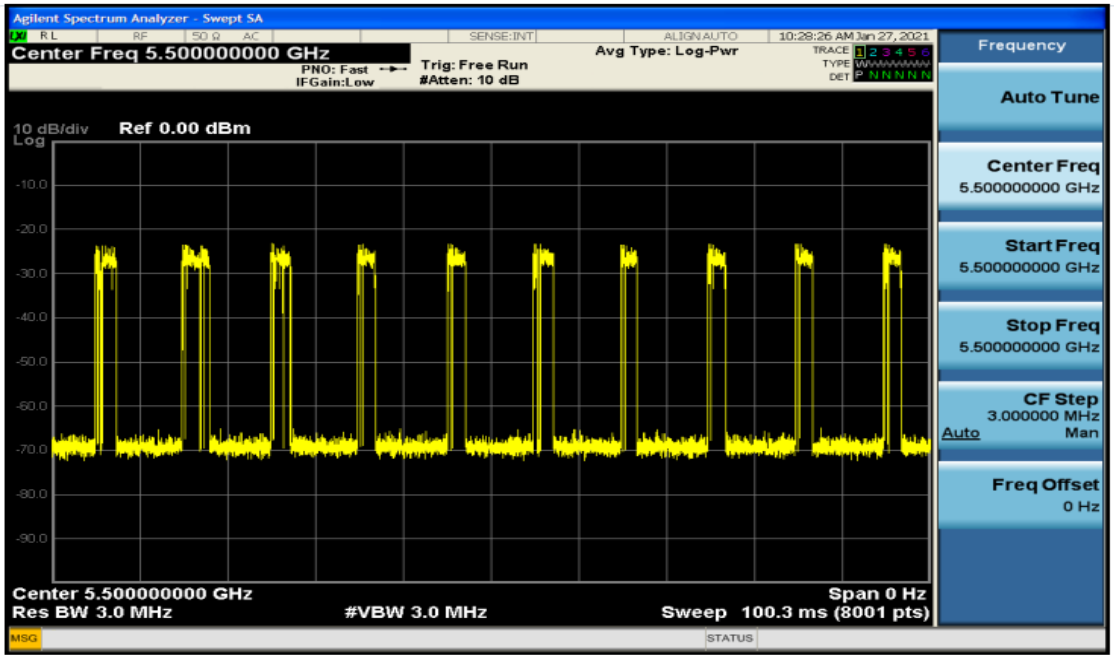
802.11 ax HE20 CH 5500
Radar type 0



WLAN traffic



Duty Cycle: 21.40982 %

** The Channel Loading must be more than 17%*

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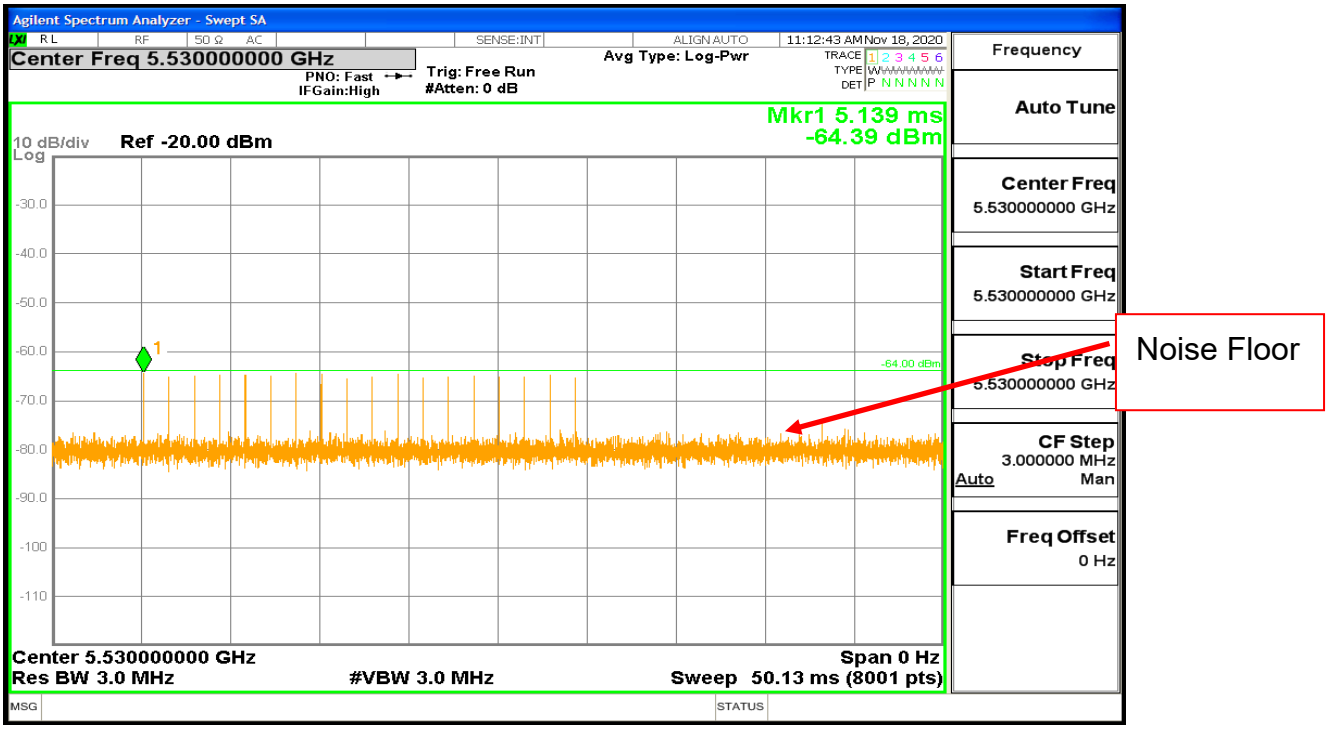
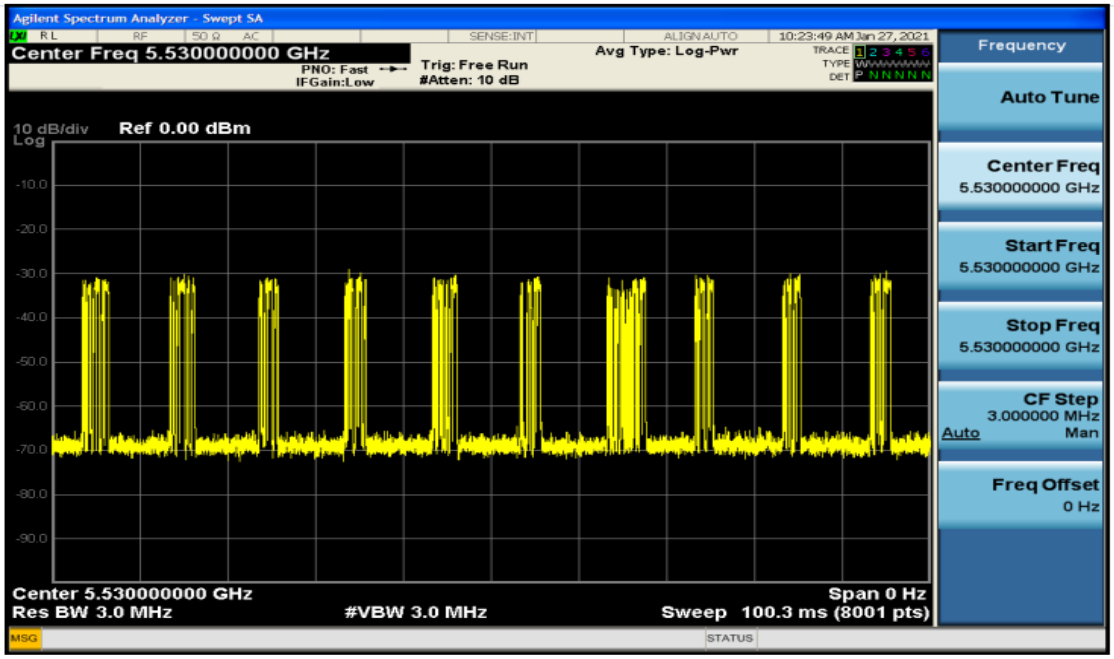
802.11 ax HE80 CH 5530
Radar type 0



WLAN traffic



Duty Cycle: 18.86014 %

** The Channel Loading must be more than 17%*

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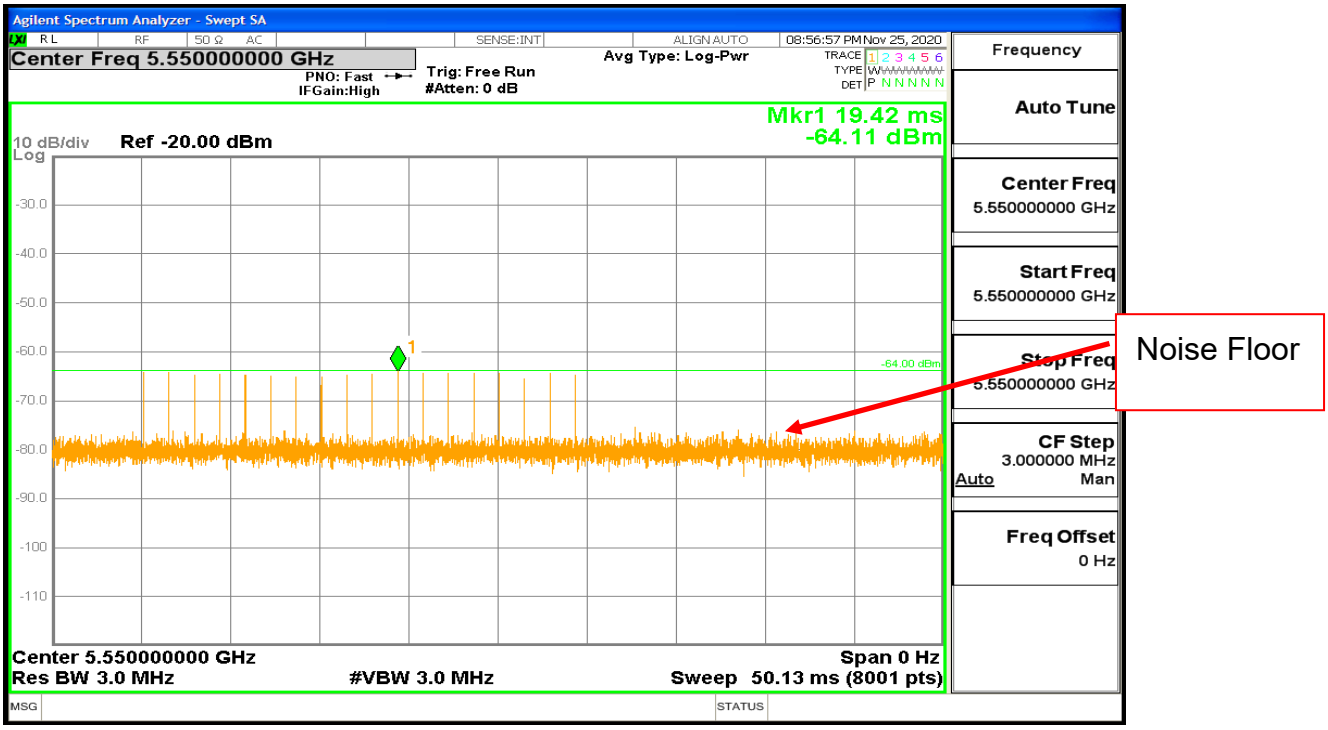
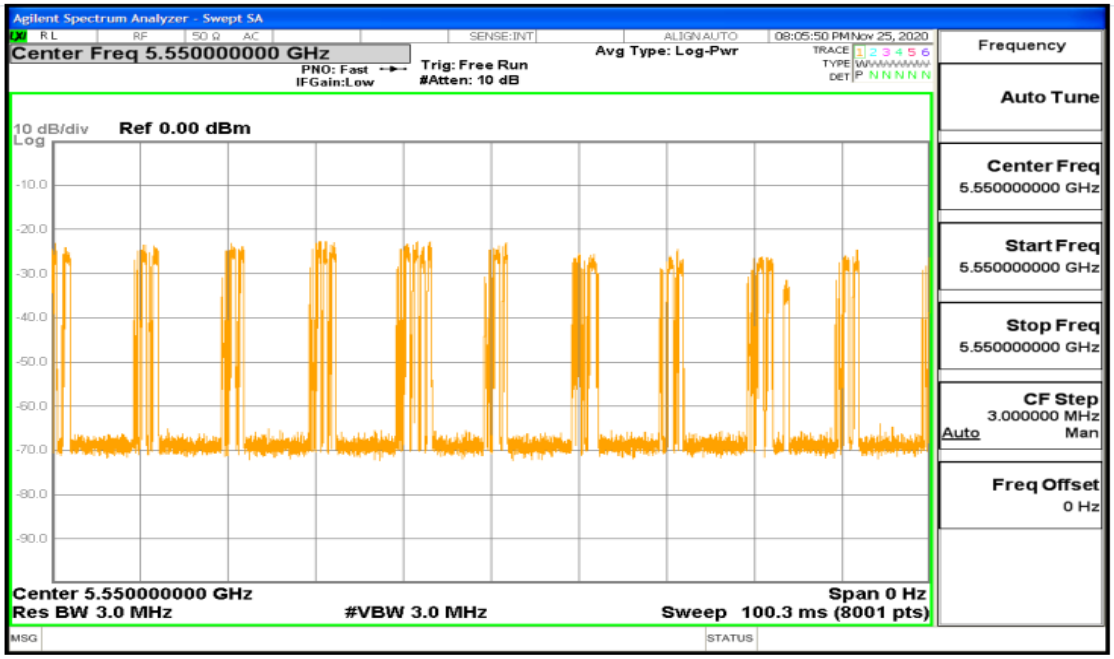
802.11 ax HE40 CH 5550
Radar type 0



WLAN traffic



Duty Cycle: 17.69779 %

** The Channel Loading must be more than 17%*

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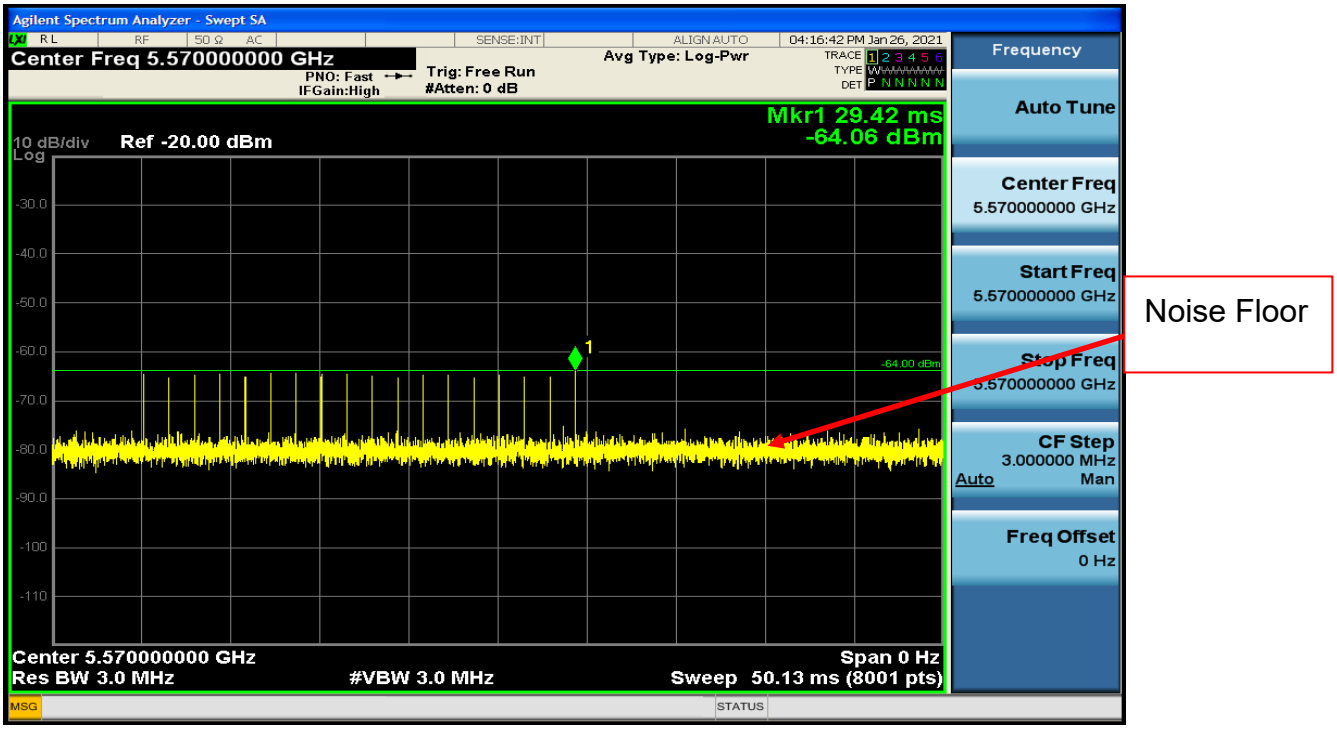
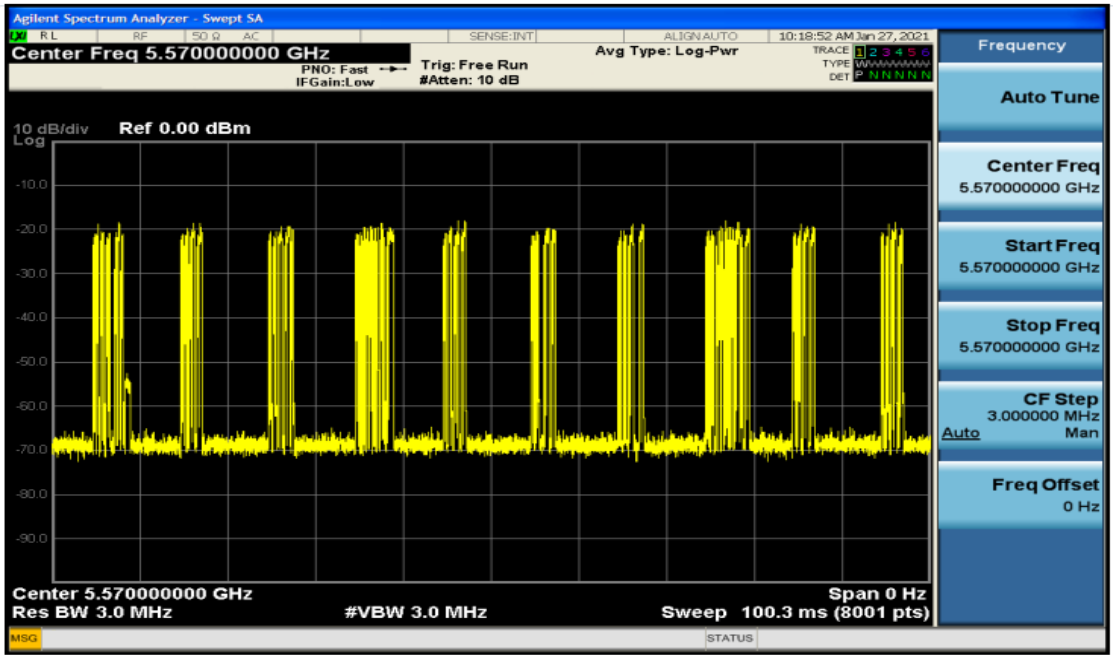
802.11 ax HE160 CH 5570
Radar type 0



WLAN traffic



Duty Cycle: 19.02262 %

** The Channel Loading must be more than 17%*

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Test Result of Channel closing Transmission Time and Channel Move Time

Channel Shutdown Result					
Detection Threshold Level (dBm)			-64		
Modulation Mode	Freq. (MHz)	Radar Test Signal	Channel Closing Transmission Time(ms) 200ms~10sec		Channel Move Time(s)
HE20	5500	Type 0	218	18	0.812
HE40	5550	Type 0	202	2	0.878
HE80	5530	Type 0	216	16	0.858
HE160	5250	Type 0	222	22	0.912
HE160	5570	Type 0	218	18	0.864
Limit			**260 ms**	60 ms	10 sec
Result			Complied		

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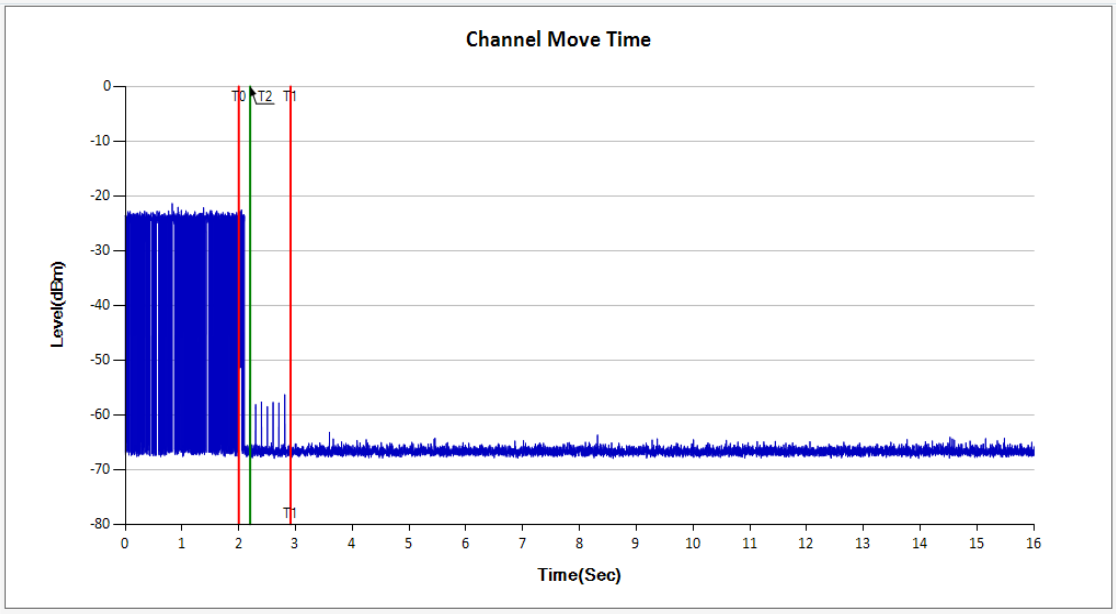
Radar Type 0 Channel Move and Closing Transmission Time – 1
802.11 ax HE160 CH 5250

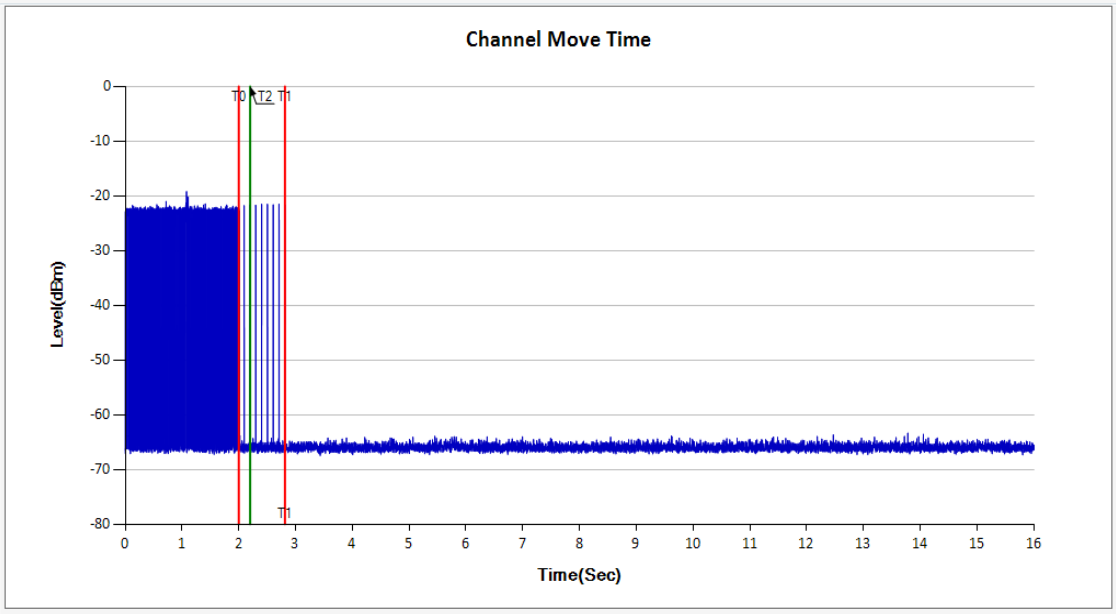


T0: 2 Sec(Radar Injection)
T1: 2.912 Sec(Eut Move Time)
T2: 2.2 Sec(200ms Interval)

Channel Move Time: 0.912 Sec
Channel Closing Transmission Time: 0.022 Sec

Note for Setting: RBW: 3MHz, VBW: 3MHz, Span: 0Hz, Sweep time: 16s

802.11 ax HE20 CH 5500



T0: 2 Sec(Radar Injection)
T1: 2.812 Sec(Eut Move Time)
T2: 2.2 Sec(200ms Interval)

Channel Move Time: 0.812 Sec
Channel Closing Transmission Time: 0.018 Sec

Note for Setting: RBW: 3MHz, VBW: 3MHz, Span: 0Hz, Sweep time: 16s

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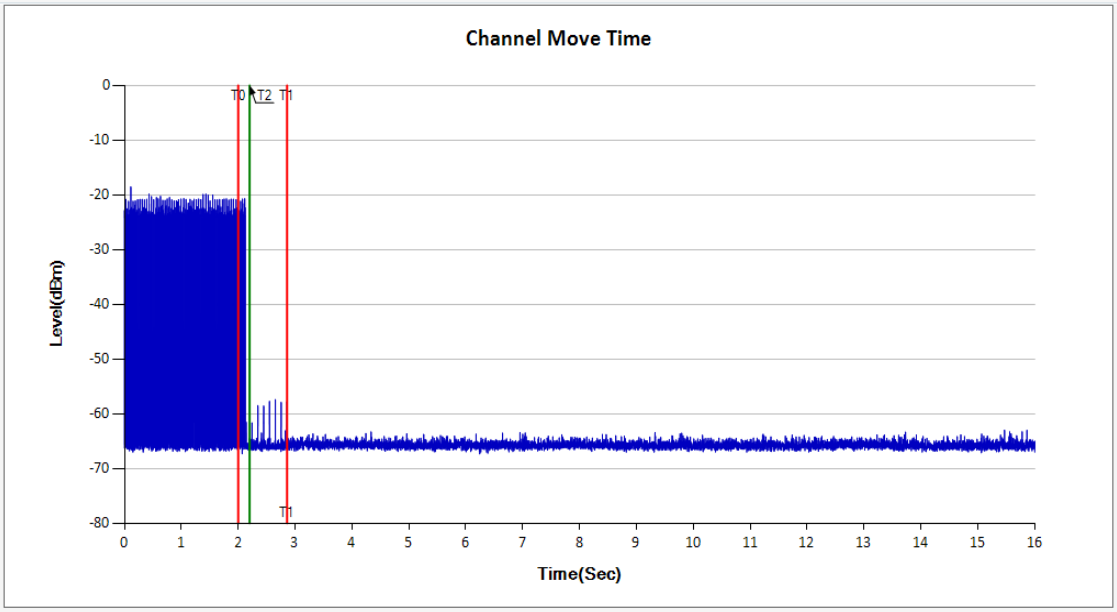
802.11 ax HE80 CH 5530

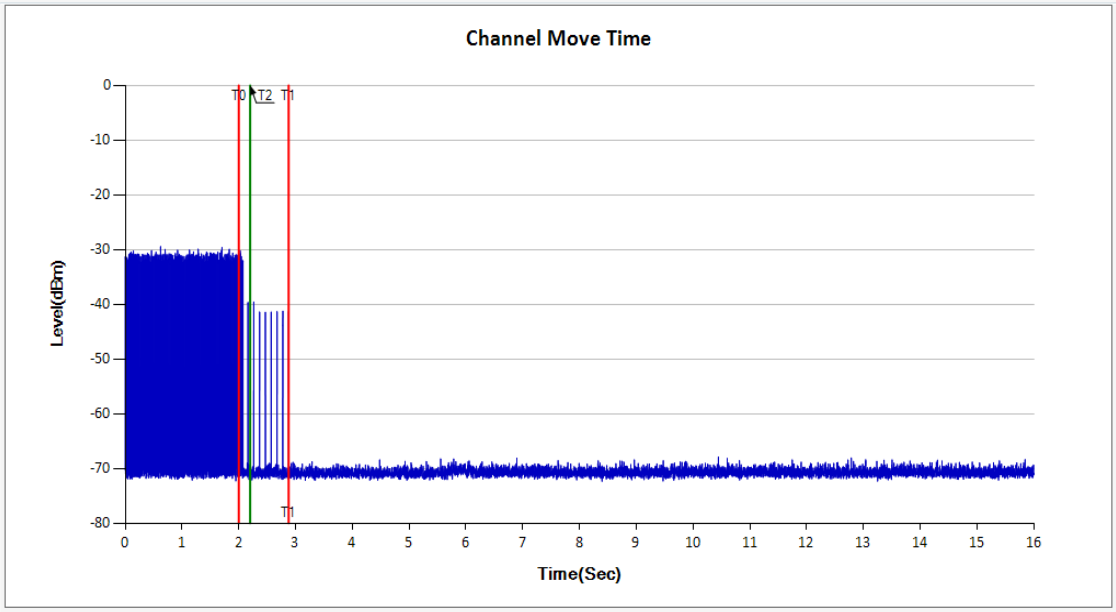


T0: 2 Sec(Radar Injection)
T1: 2.858 Sec(Eut Move Time)
T2: 2.2 Sec(200ms Interval)

Channel Move Time: 0.858 Sec
Channel Closing Transmission Time: 0.016 Sec

Note for Setting: RBW: 3MHz, VBW: 3MHz, Span: 0Hz, Sweep time: 16s

802.11 ax HE40 CH 5550



T0: 2 Sec(Radar Injection)
T1: 2.878 Sec(Eut Move Time)
T2: 2.2 Sec(200ms Interval)

Channel Move Time: 0.878 Sec
Channel Closing Transmission Time: 0.02 Sec

Note for Setting: RBW: 3MHz, VBW: 3MHz, Span: 0Hz, Sweep time: 16s

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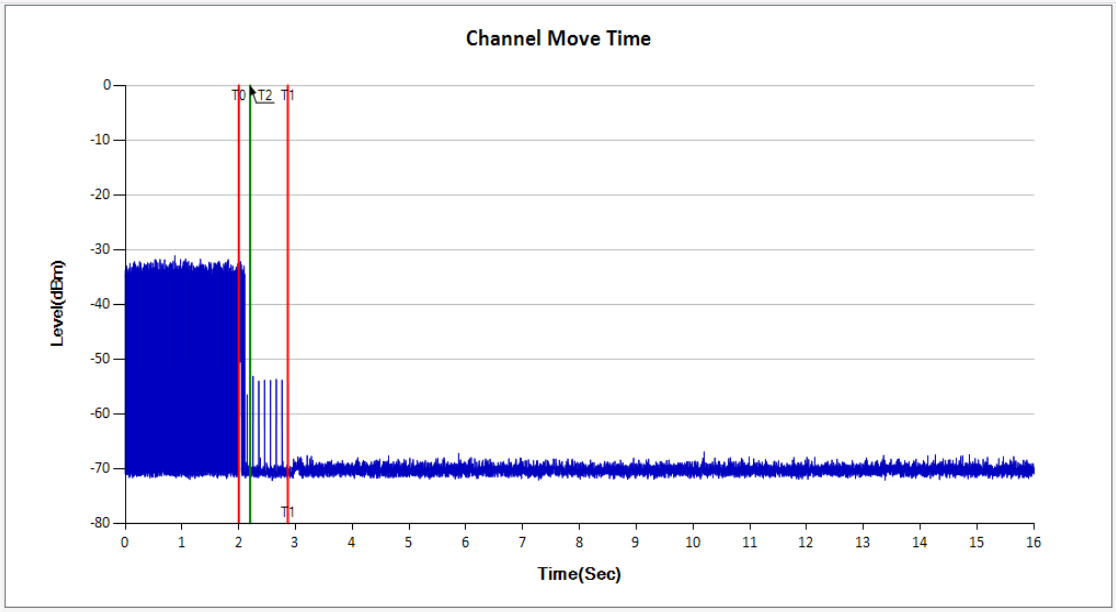
802.11 ax HE160 CH 5570



T0: 2 Sec(Radar Injection)
T1: 2.864 Sec(Eut Move Time)
T2: 2.2 Sec(200ms Interval)

Channel Move Time: 0.864 Sec

Channel Closing Transmission Time: 0.018 Sec

Note for Setting: RBW: 3MHz, VBW: 3MHz, Span: 0Hz, Sweep time: 16s

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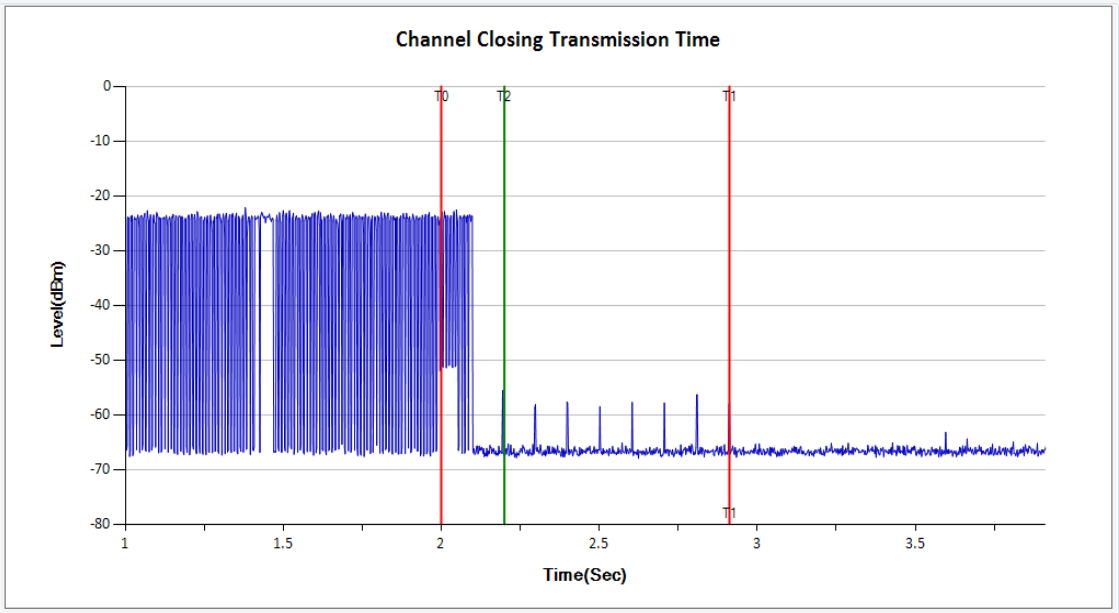
Radar Type 0 Channel Move and Closing Transmission Time - 2

802.11 ax HE160 CH 5250

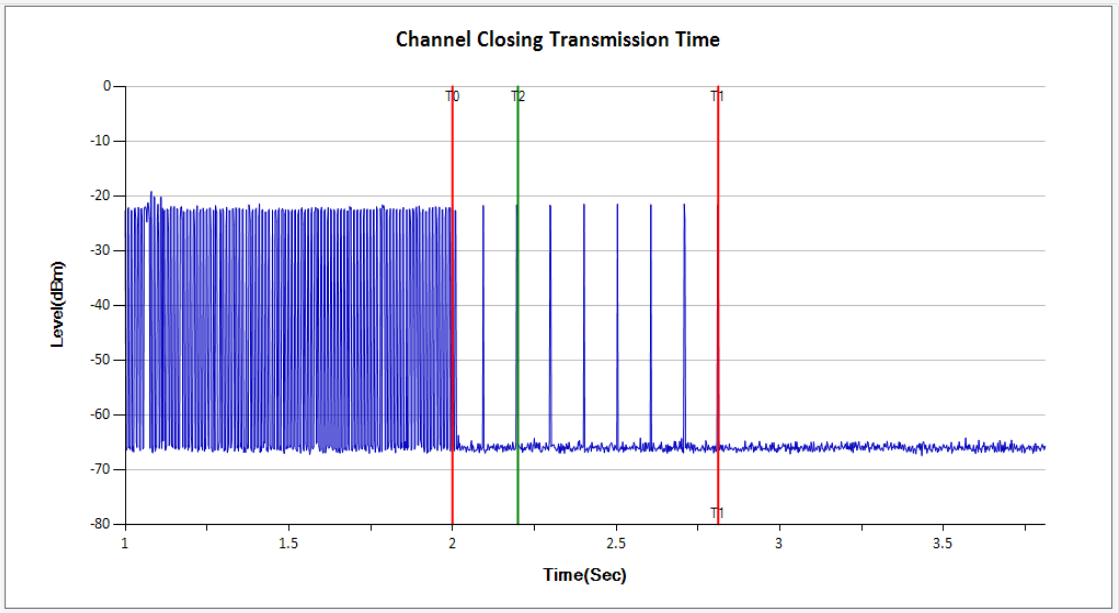


T0: 2 Sec(Radar Injection)
T1: 2.912 Sec(Eut Move Time)
T2: 2.2 Sec(200ms Interval)

Channel Move Time: 0.912 Sec
Channel Closing Transmission Time: 0.022 Sec

Note for Setting: RBW: 3MHz, VBW: 3MHz, Span: 0Hz, Sweep time: 16s

802.11 ax HE20 CH 5500



T0: 2 Sec(Radar Injection)
T1: 2.812 Sec(Eut Move Time)
T2: 2.2 Sec(200ms Interval)

Channel Move Time: 0.812 Sec
Channel Closing Transmission Time: 0.018 Sec

Note for Setting: RBW: 3MHz, VBW: 3MHz, Span: 0Hz, Sweep time: 16s

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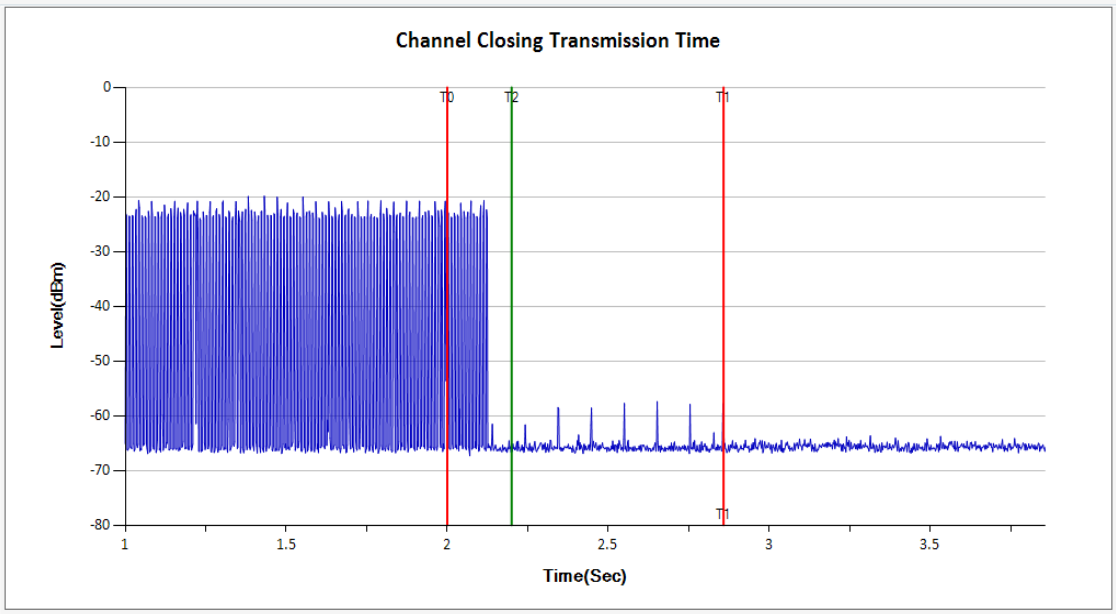
802.11 ax HE80 CH 5530

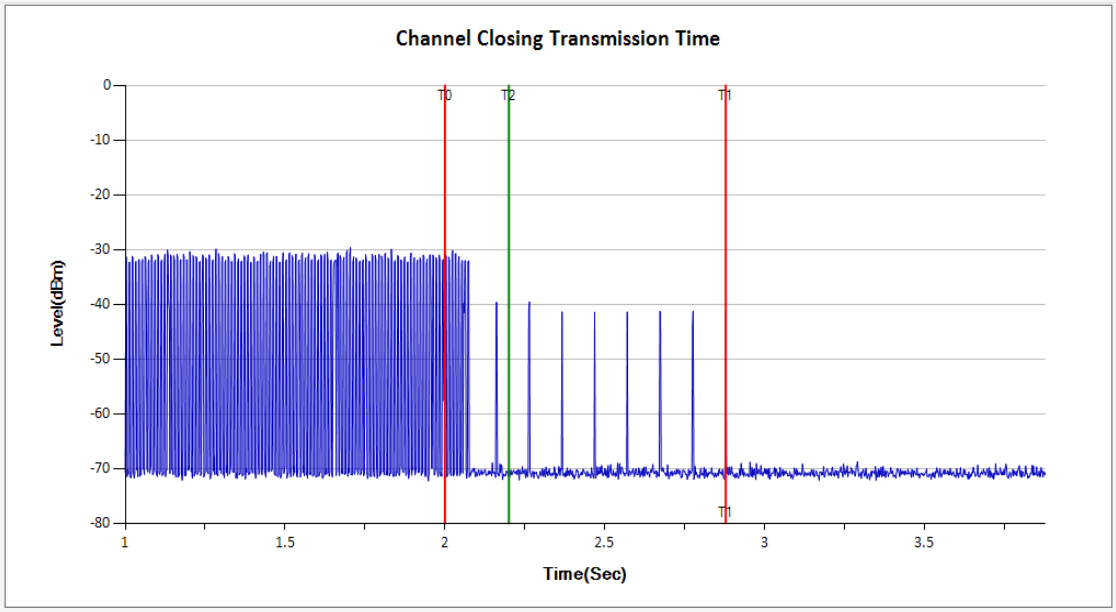


T0: 2 Sec(Radar Injection)
T1: 2.858 Sec(Eut Move Time)
T2: 2.2 Sec(200ms Interval)

Channel Move Time: 0.858 Sec
Channel Closing Transmission Time: 0.016 Sec

Note for Setting: RBW: 3MHz, VBW: 3MHz, Span: 0Hz, Sweep time: 16s

802.11 ax HE40 CH 5550



T0: 2 Sec(Radar Injection)
T1: 2.878 Sec(Eut Move Time)
T2: 2.2 Sec(200ms Interval)

Channel Move Time: 0.878 Sec
Channel Closing Transmission Time: 0.02 Sec

Note for Setting: RBW: 3MHz, VBW: 3MHz, Span: 0Hz, Sweep time: 16s

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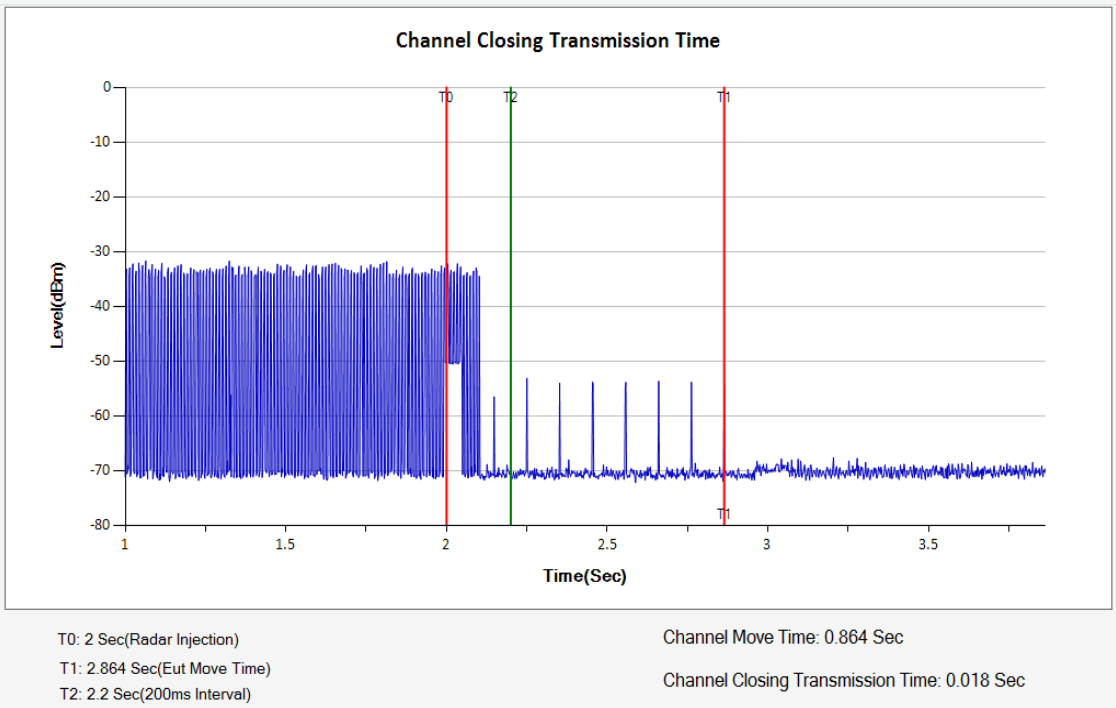

Note for Setting: RBW: 3MHz, VBW: 3MHz, Span: 0Hz, Sweep time: 16s

Verdict: *Note: narrowing the sweep time as the good engineering process for the verification of transmission closing in 200ms*

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Non-occupancy Period (without radar detection)

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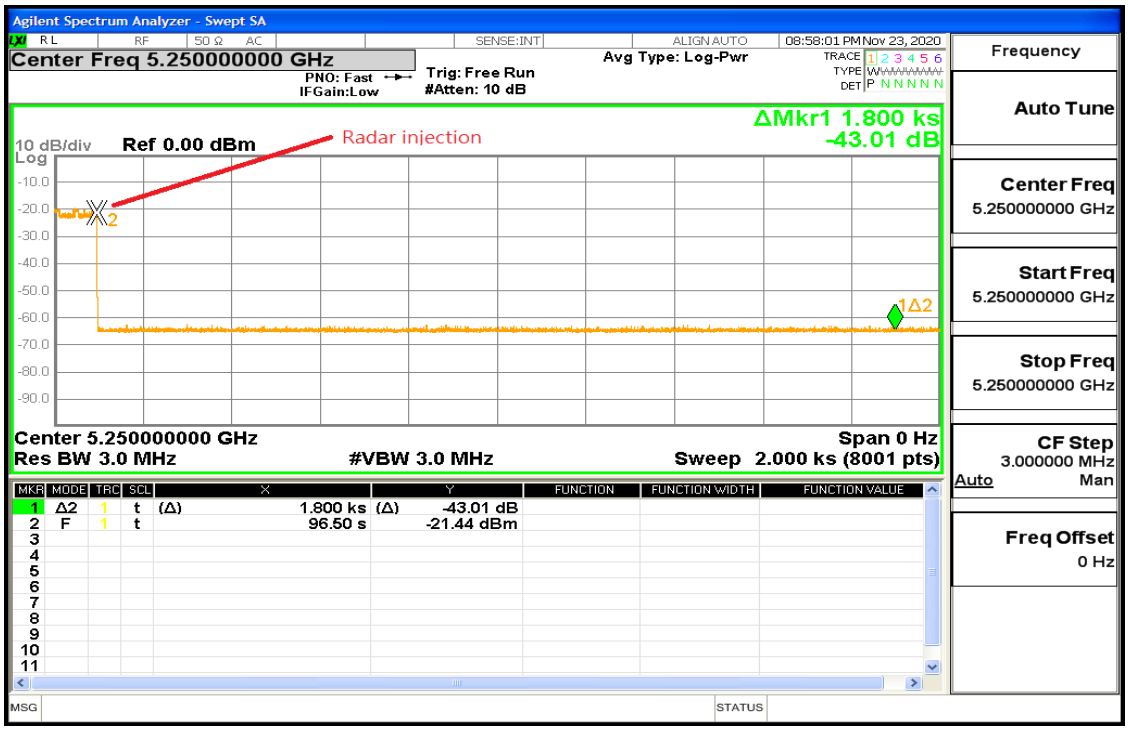
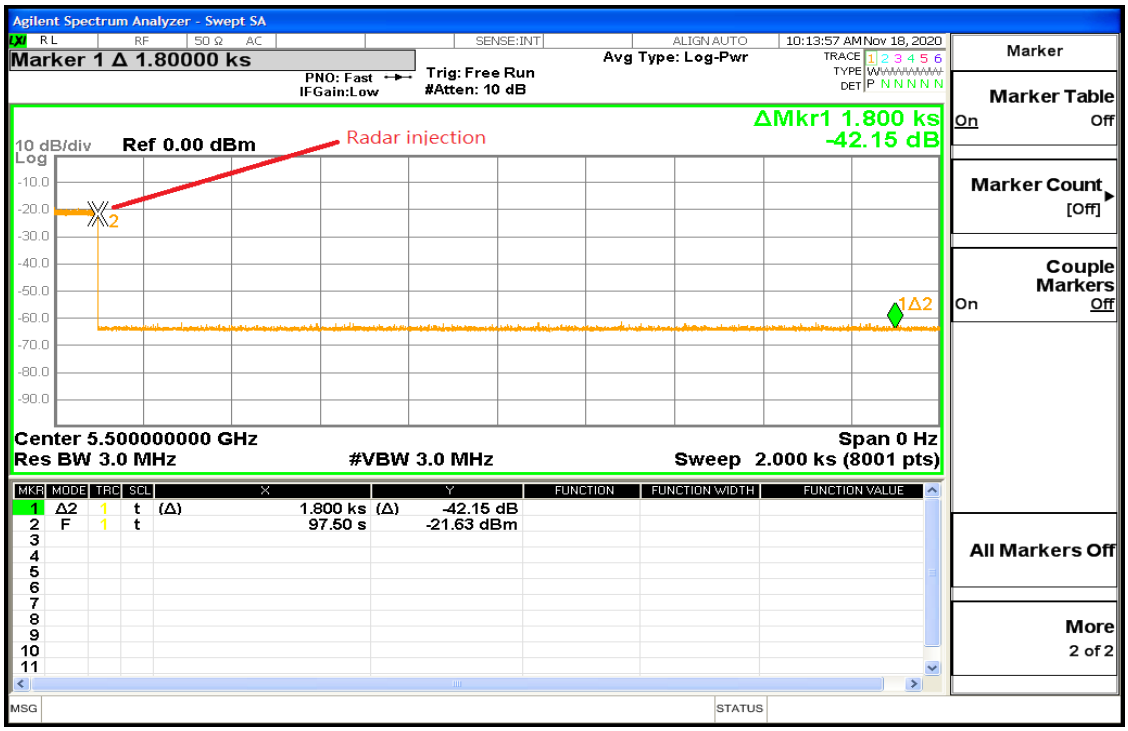


802.11 ax HE20 CH 5500



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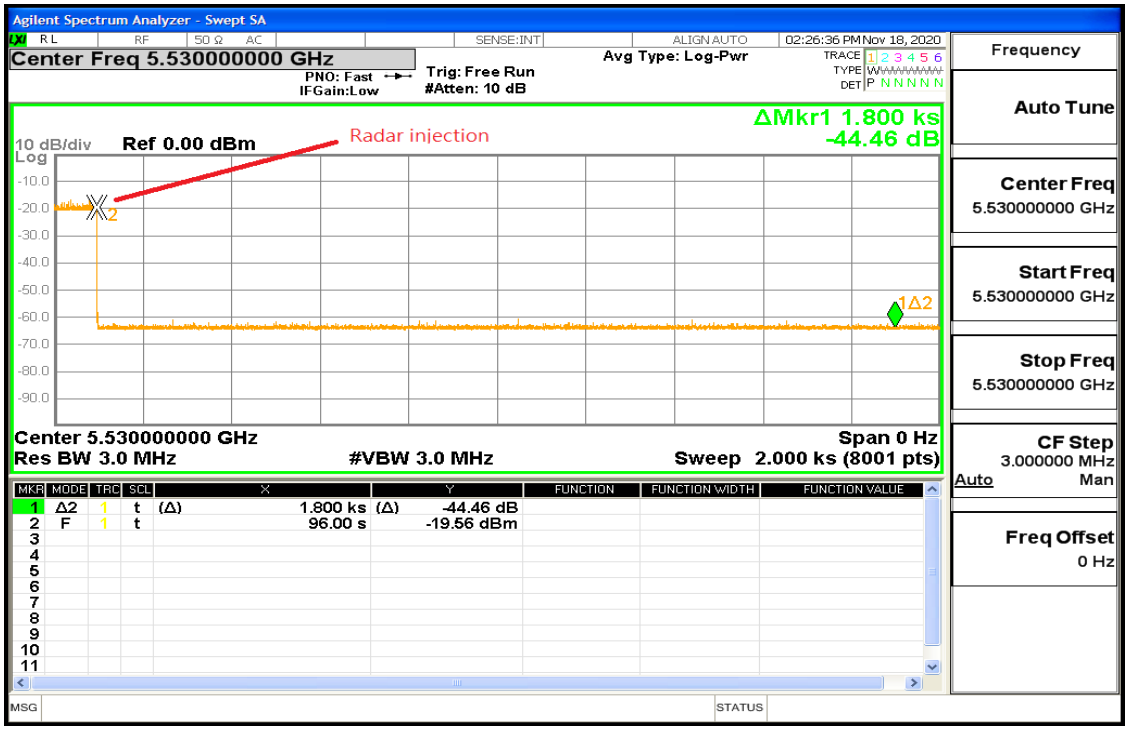
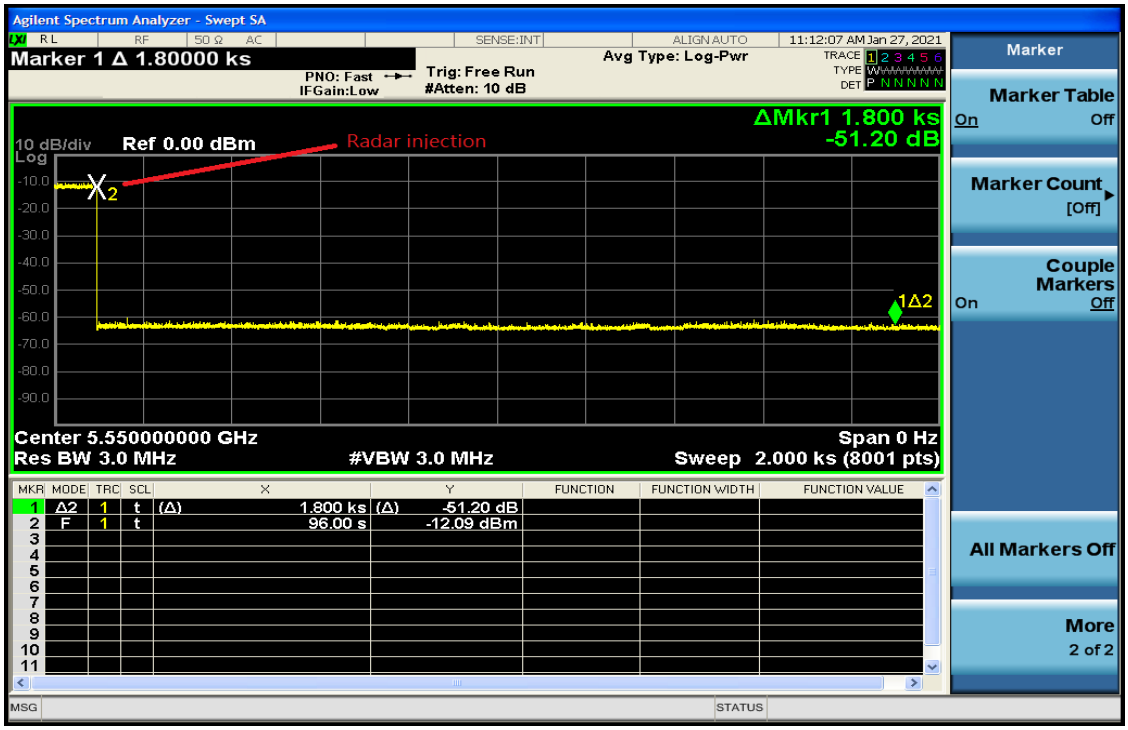


802.11 ax HE40 CH 5550



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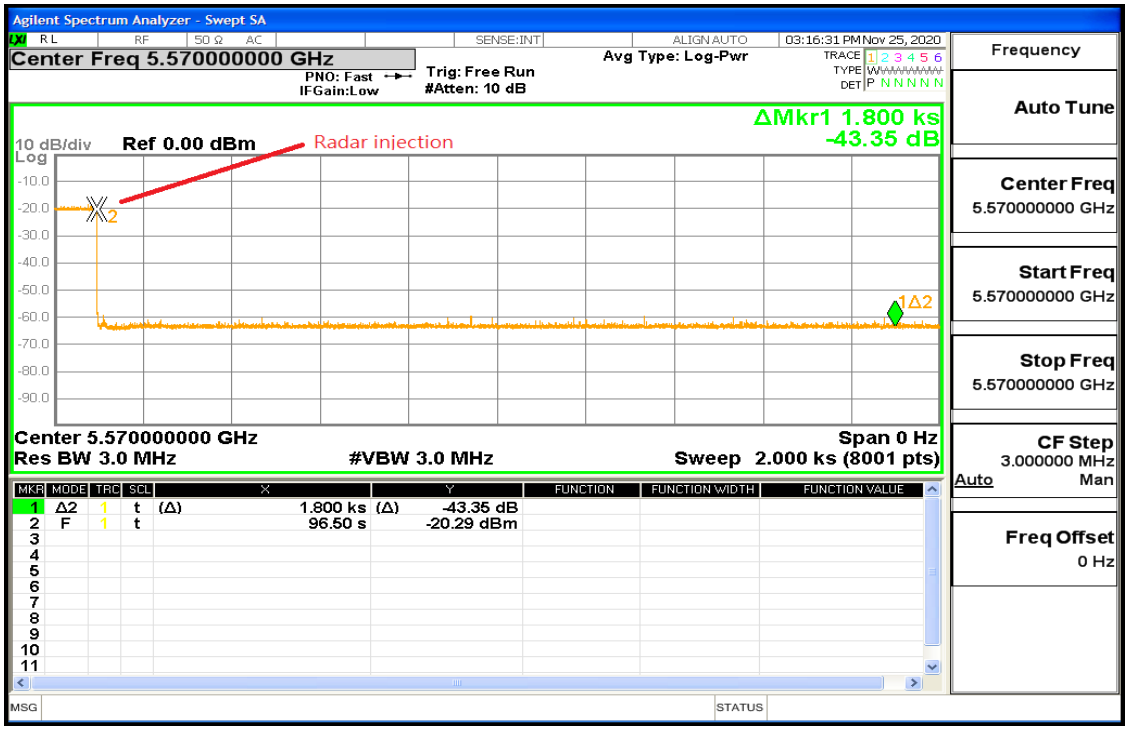

Verdict: *To verify whether channel is unavailable to be operated in 30 minutes.*
1.8ks = 1800s = 1800 s/min /60 = 30minute

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PRI
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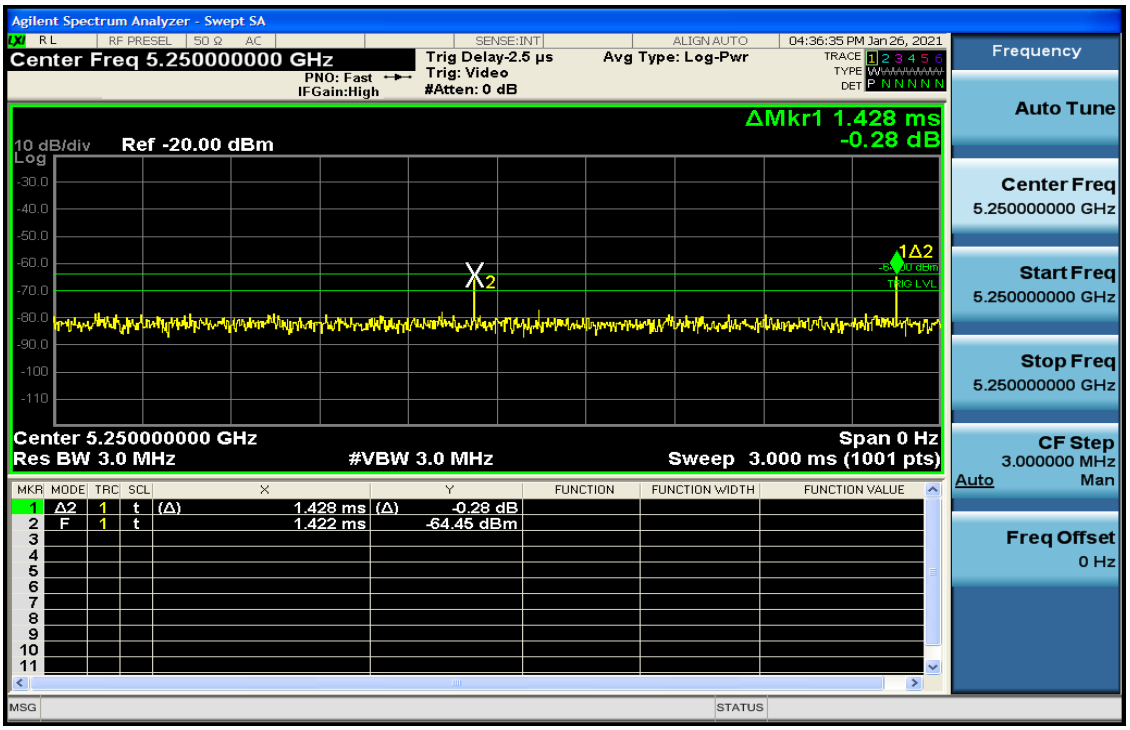
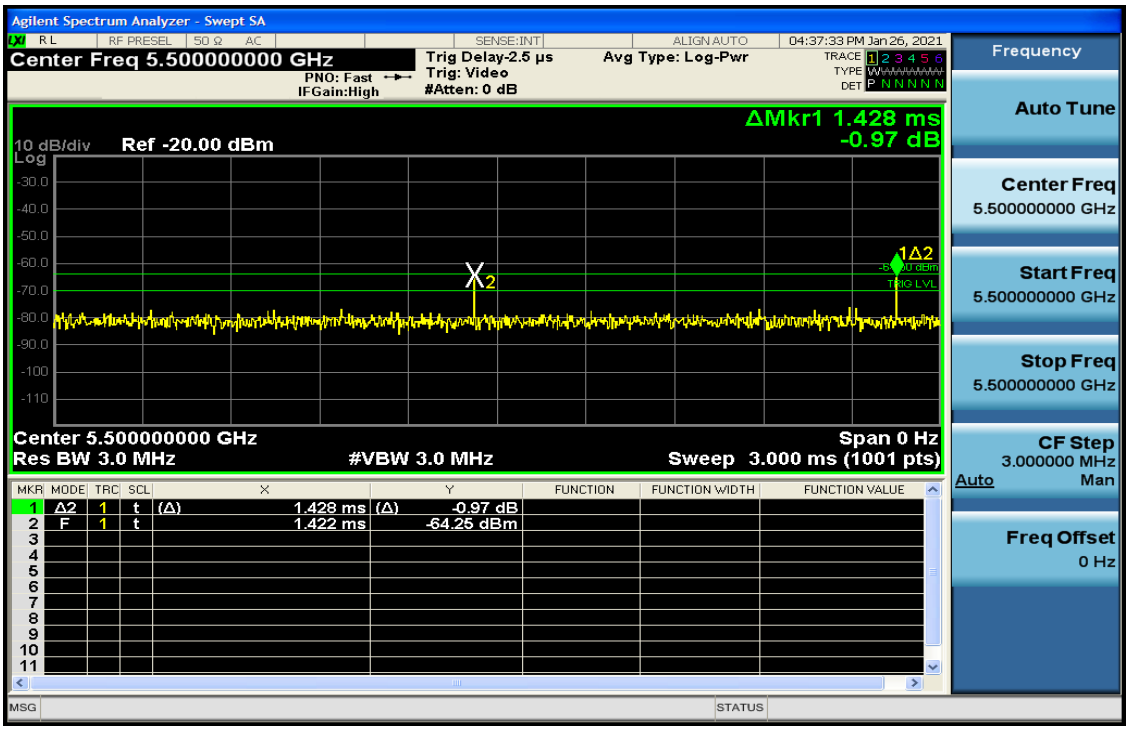


802.11 ax HE20 CH 5500



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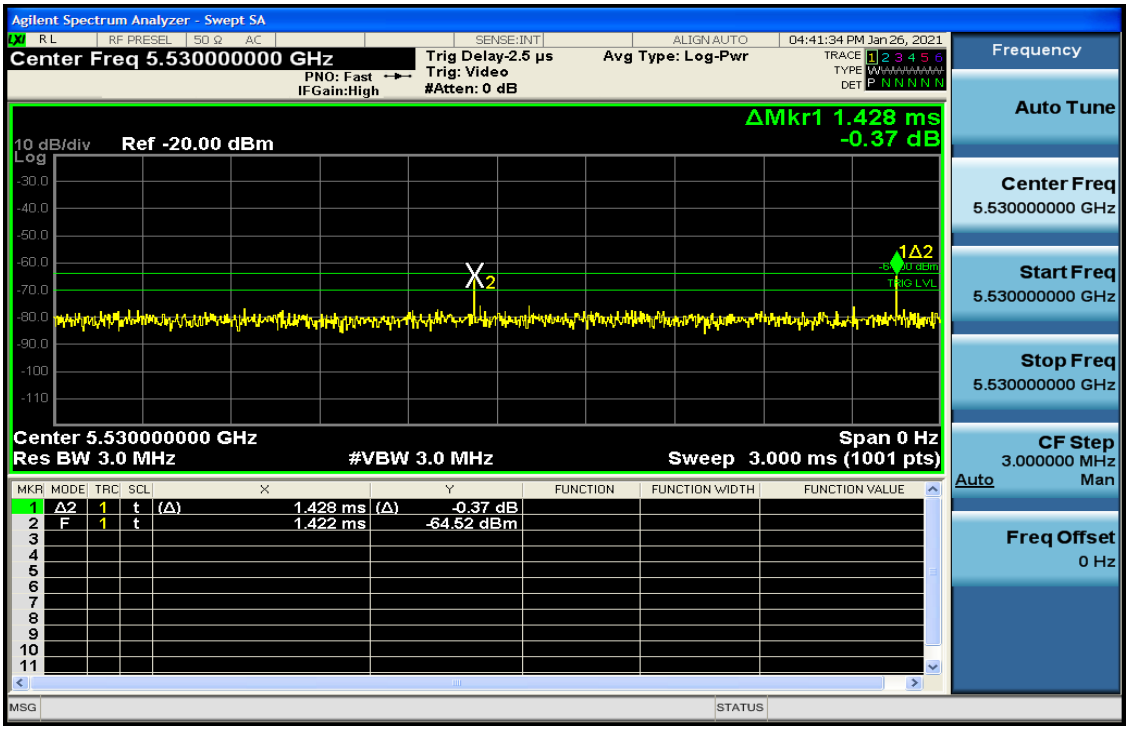
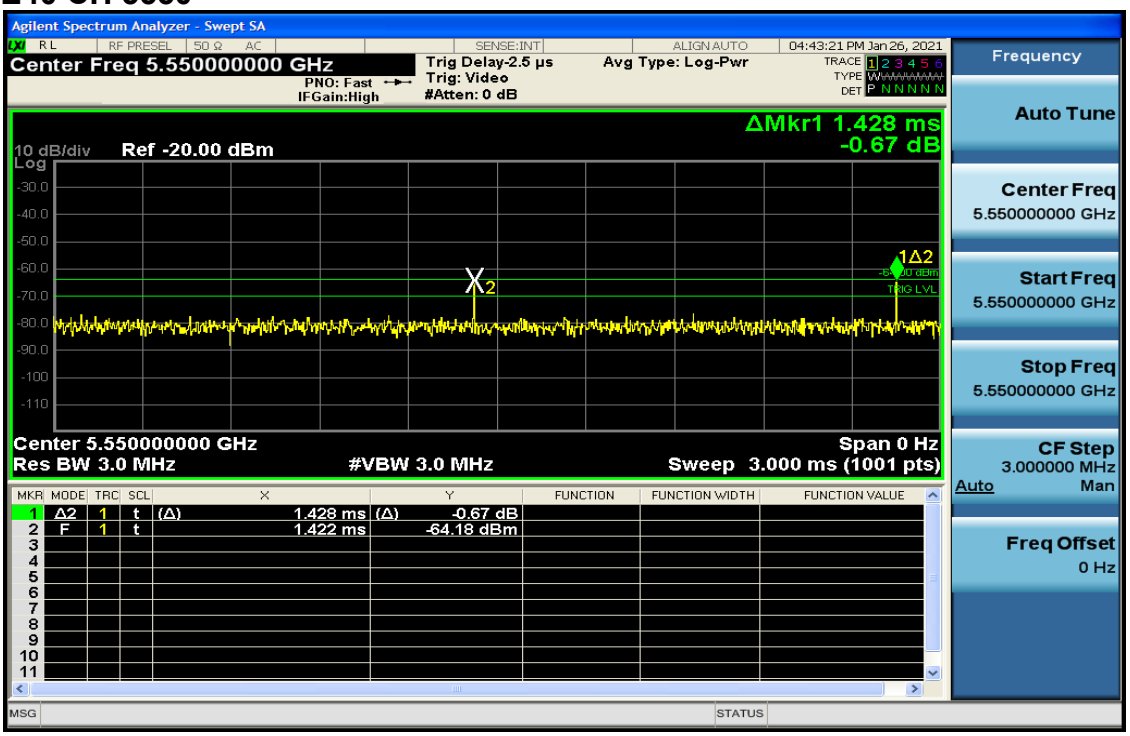


802.11 ax HE40 CH 5550



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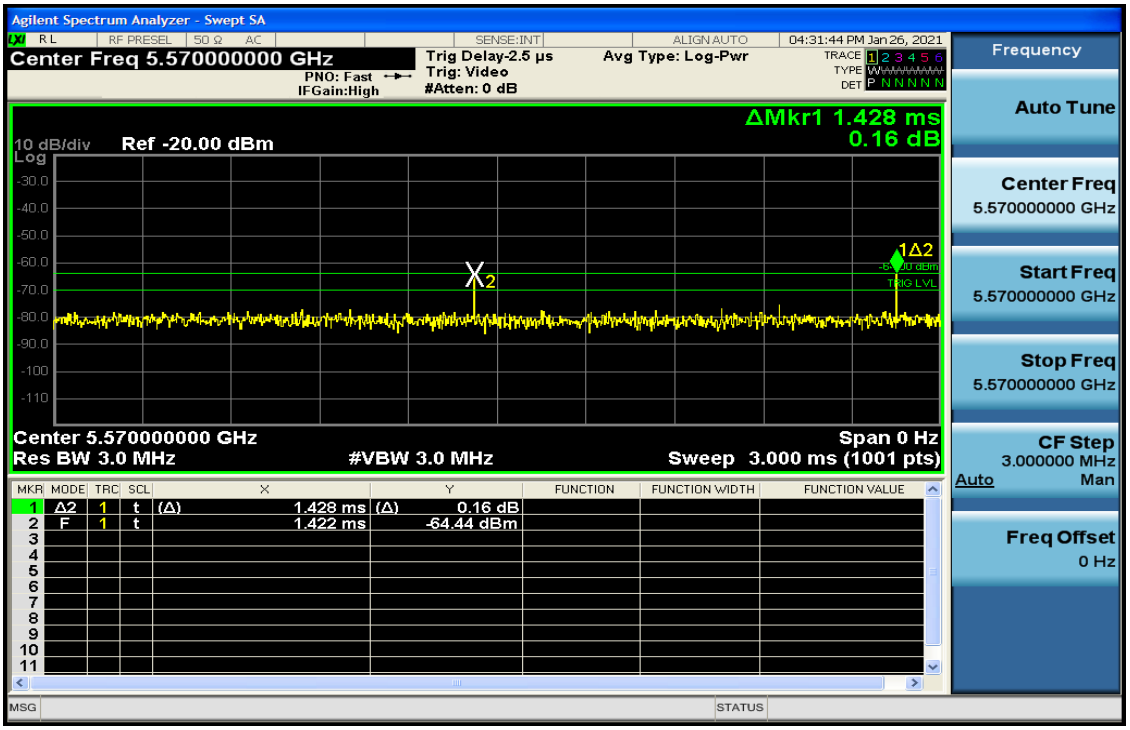

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Pulse width

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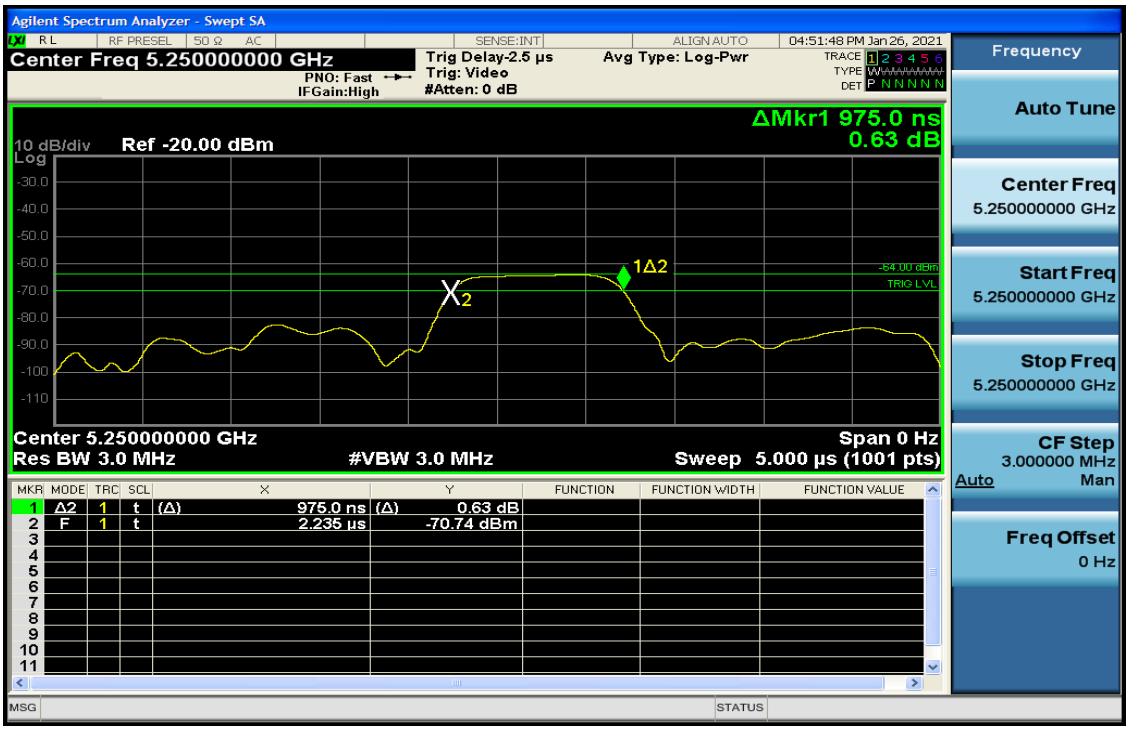

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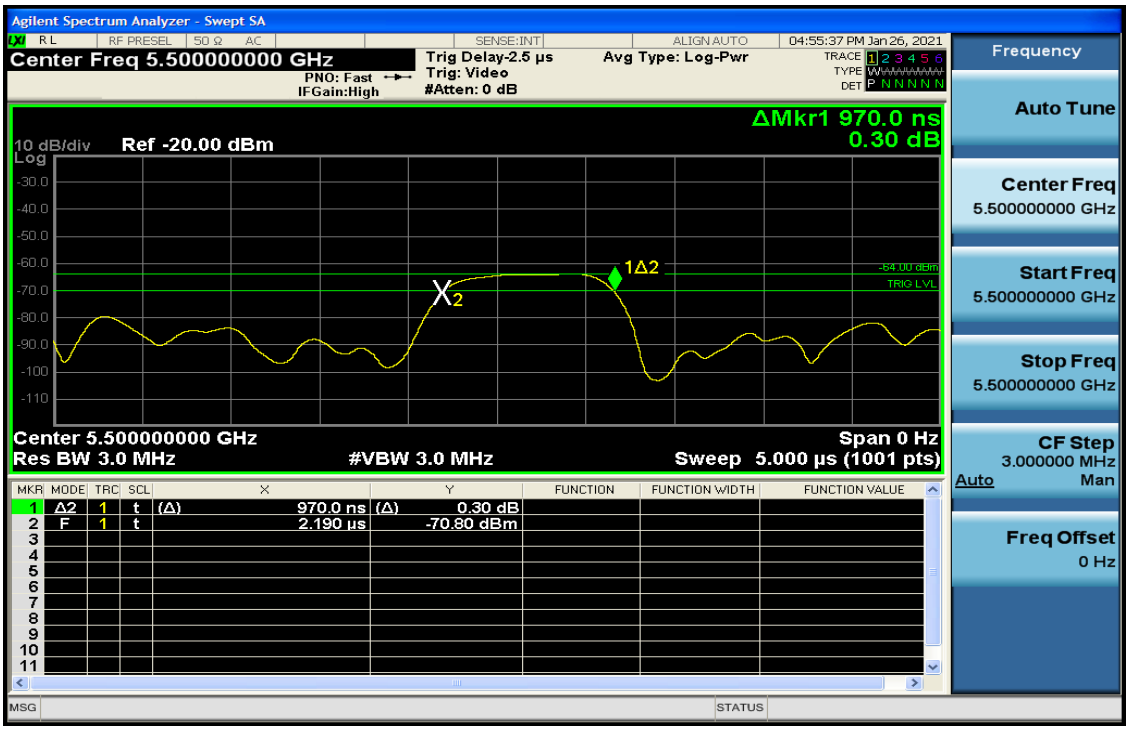

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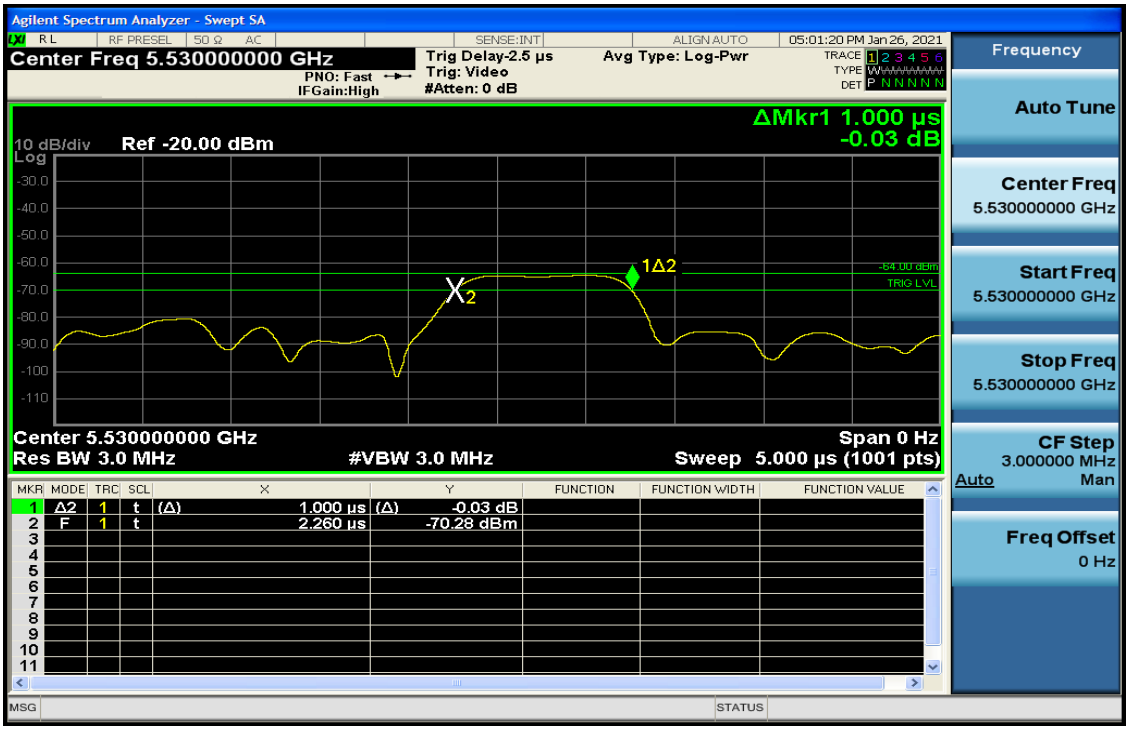

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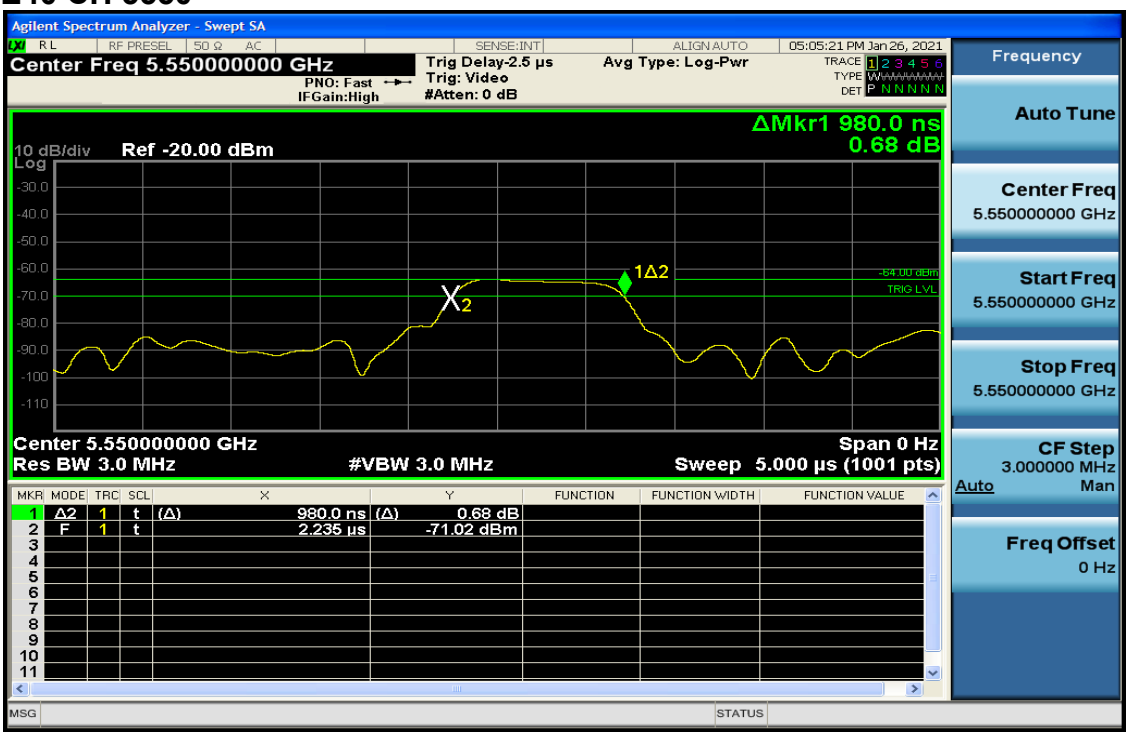

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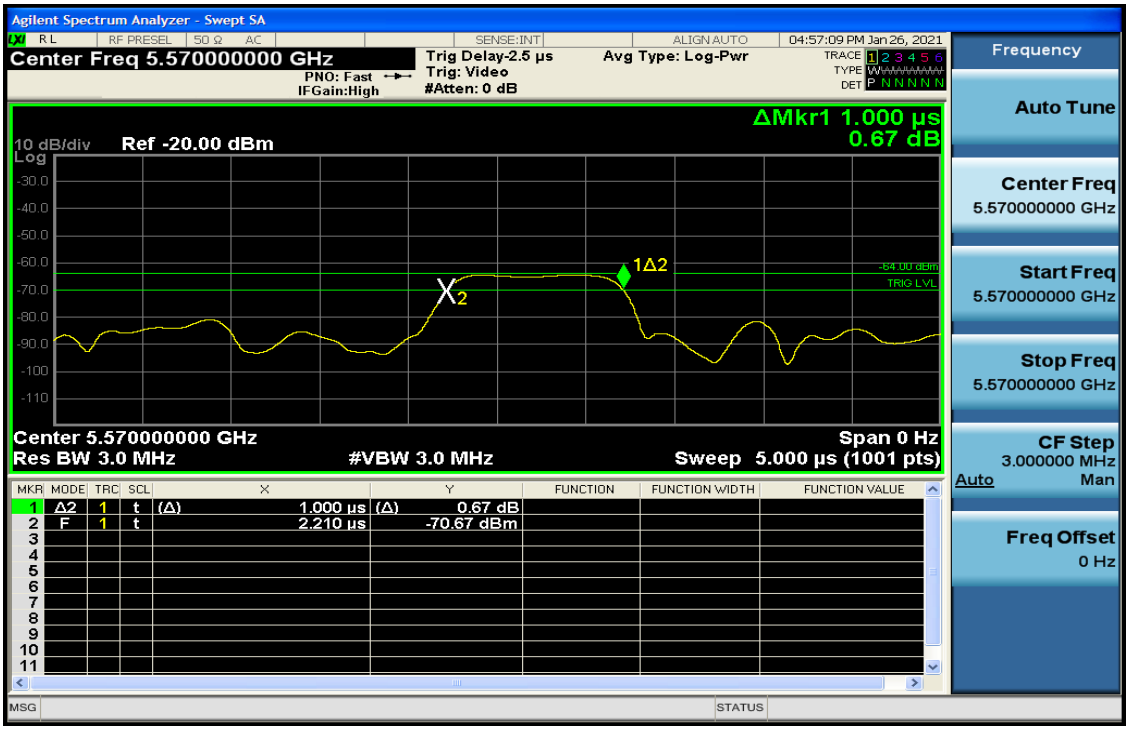

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