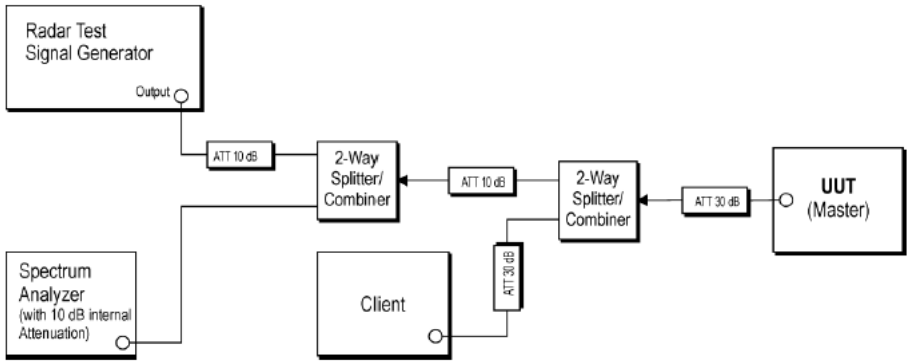
Appendix C: Test Results of DFS

1.1 Measurement

1.1.1 Test set up

This product is a master device and test performed under conducted method.



Test setup as CN22M62P 002 Appendix A.

1.1.2 Operating mode

The equipment operate the frequency band 5250-5350MHz, 5470-5725MHz. We've verified the equipment and chose 5500MHz (20MHz), 5510MHz (40MHz), 5530MHz (80MHz) and 5570MHz (160MHz) for DFS test.

The channel loading of 17% or greater was used for testing, and its data was transferred from the master device to the client device for all test configurations.

WLAN tranfic is generated by the DFS Test tool, from the master to the client in data packets.
Information regarding the parameters of the detected Radar Waveforms is not available to the end user.

1.1.3 Test Requirements

According to Part 15.407(h)(2) and KDB 905462 D02, Radar Detection Function of 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.

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	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 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
Channel Closing Transmission Time	Yes	Yes
Channel Move Time	Yes	Yes
U-NII Detection Bandwidth	Yes	Not required

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

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.	

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.	

Table 5 – Short Pulse Radar Test Waveforms

Radar Type	Pulse Width (µsec)	PRI (µsec)	Number of Pulses	Minimum Percentage of Successful Detection	Minimum Number of Trials
0	1	1428	18	See 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	Roundup $\left\{\left(\frac{1}{360}\right)\cdot\left(\frac{19\cdot10^6}{PRI_{\mu sec}}\right)\right\}$	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.					

Table 6 – Long Pulse Radar Test Waveform

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

Table 7 – Frequency Hopping Radar Test Waveform

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

1.2 DFS Detection Thresholds

1.2.1 Test procedures

Test as per KDB905462 D02 section 7.5, and this product is a master device.
The radar test signal level is set at the Master Device, or the Client Device with In-Service Monitoring, as appropriate for the particular test. This device is known as the Radar Detection Device (RDD). The RDD consists of the applicable device and the device antenna assembly that has the lowest antenna assembly gain of all available antenna assemblies. Depending on the UUT, the following configurations exist:

1) When the Master Device is the UUT, the Master Device is the RDD.
2) When a Client Device without Radar Detection is the UUT, the Master Device is the RDD.
3) When a Client Device with Radar Detection is the UUT, and is tested for response to the Master Device detections, the Master Device is the RDD.
4) When a Client Device with Radar Detection is the UUT, and is tested for independent response to detections by the Client Device, the Client Device is the RDD.

A spectrum analyzer is used to establish the test signal level for each radar type. During this process, there are no transmissions by either the Master Device or Client Device. The spectrum analyzer is switched to the zero span (time domain) mode at the frequency of the Radar Waveform generator. The peak detector function of the spectrum analyzer is utilized. The spectrum analyzer resolution bandwidth (RBW) and video bandwidth (VBW) are set to at least 3 MHz.
The signal generator amplitude and/or step attenuators are set so that the power level measured at the spectrum analyzer is equal to the DFS Detection Threshold that is required for the tests. The signal generator and attenuator settings are recorded for use during the test.
Data demonstrating that the test signal level is correctly set for each radar type (0-6) will be recorded and reported.

1.2.2 Test Result

TestMode	Frequency[dbm]	Radar Type	Result	Verdict
11AC20SISO	5500	Type1	See test Graph	PASS
		Type2	See test Graph	PASS
		Type3	See test Graph	PASS
		Type4	See test Graph	PASS
		Type5	See test Graph	PASS
		Type6	See test Graph	PASS
11AC40SISO	5510	Type0	See test Graph	PASS
		Type1	See test Graph	PASS
		Type2	See test Graph	PASS
		Type3	See test Graph	PASS
		Type4	See test Graph	PASS
		Type5	See test Graph	PASS
		Type6	See test Graph	PASS
11AC80SISO	5530	Type0	See test Graph	PASS
		Type1	See test Graph	PASS
		Type2	See test Graph	PASS
		Type3	See test Graph	PASS
		Type4	See test Graph	PASS
		Type5	See test Graph	PASS
		Type6	See test Graph	PASS
11AC160SISO	5570	Type0	See test Graph	PASS
		Type1	See test Graph	PASS
		Type2	See test Graph	PASS
		Type3	See test Graph	PASS
		Type4	See test Graph	PASS
		Type5	See test Graph	PASS
		Type6	See test Graph	PASS

1.2.3 Test Graphs

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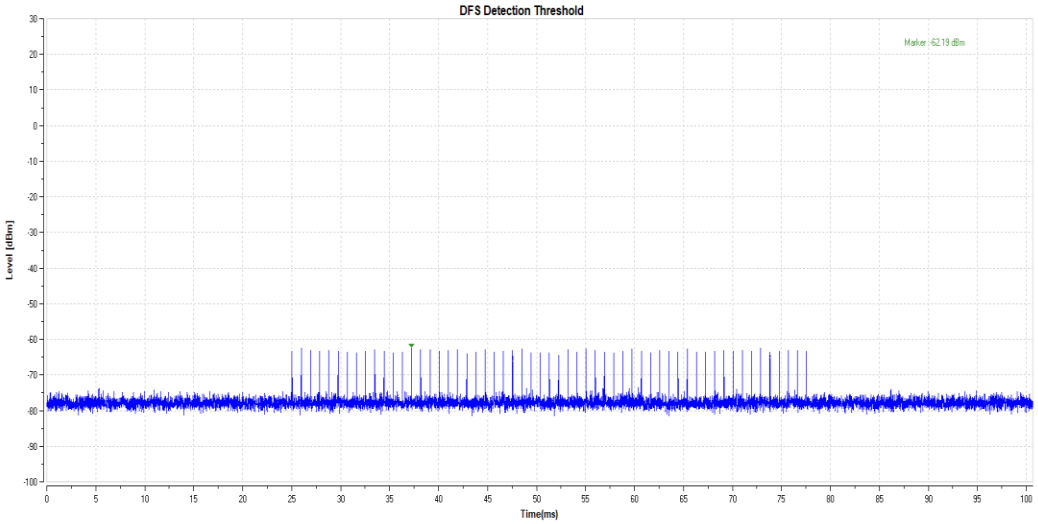

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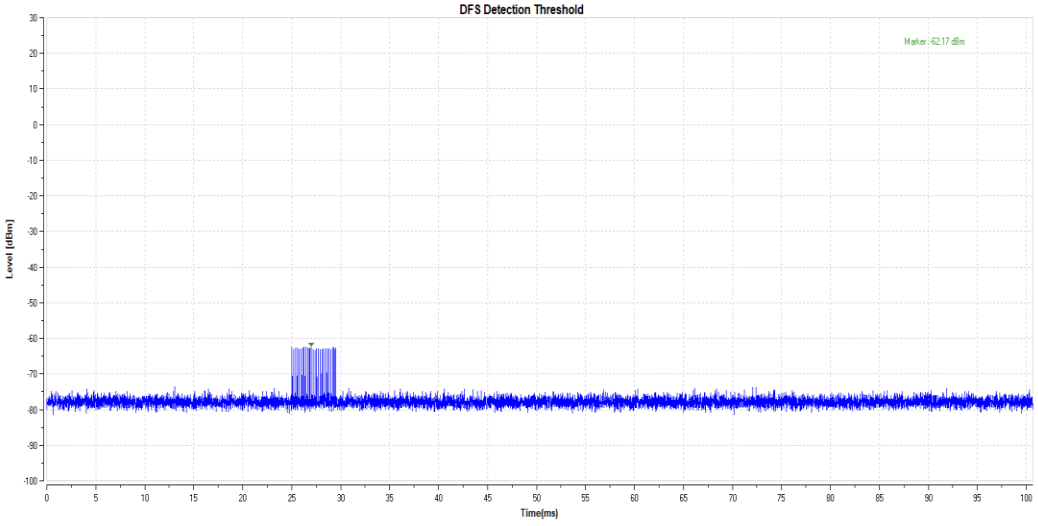

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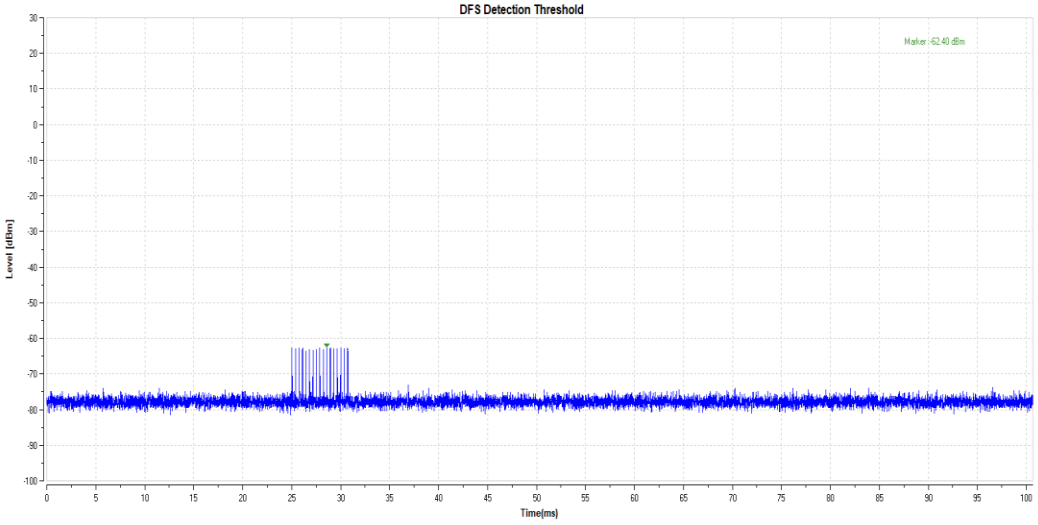

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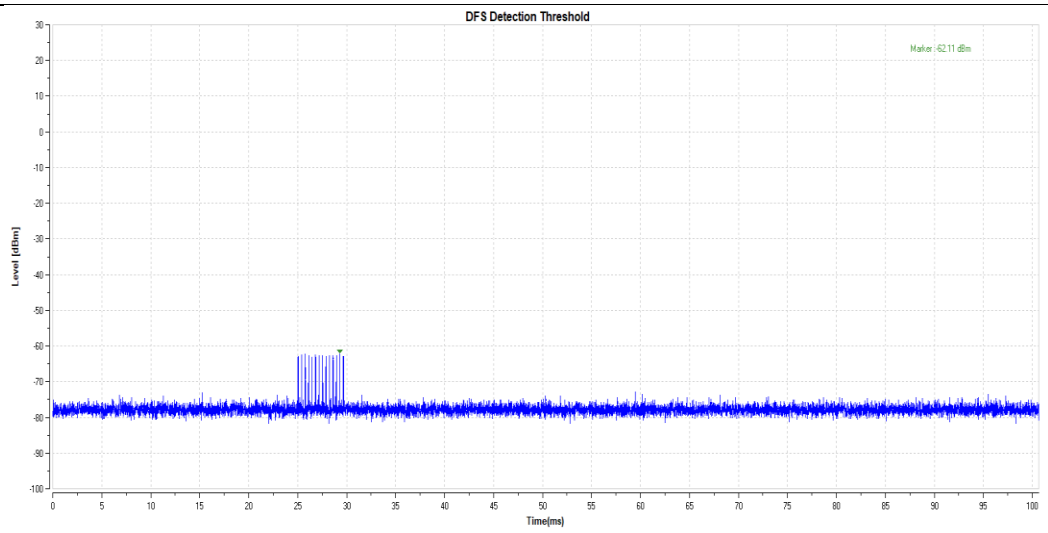

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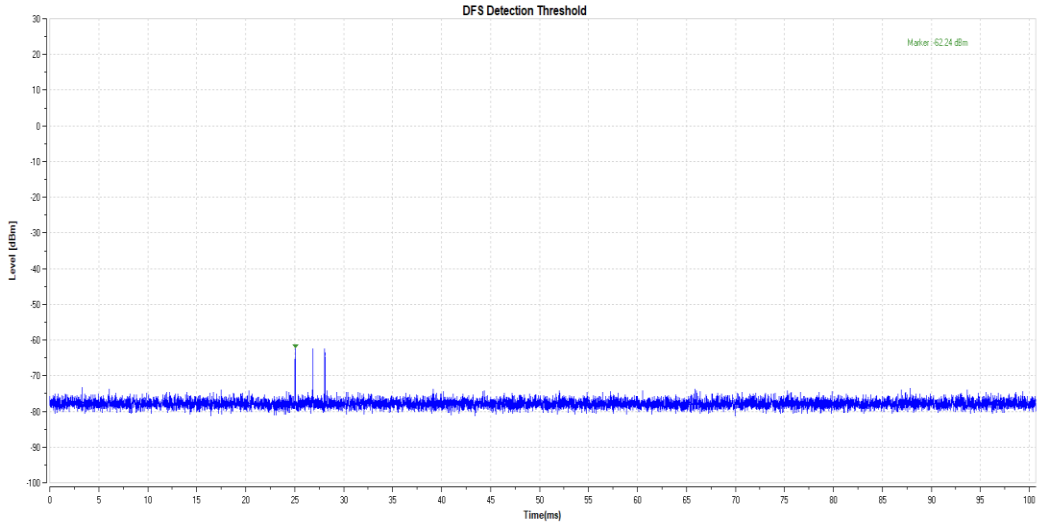

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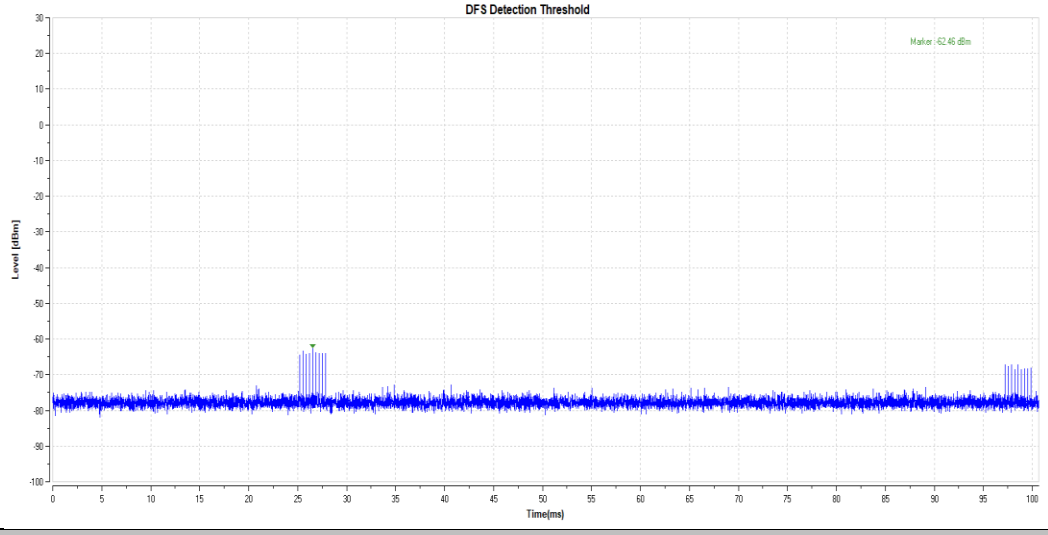

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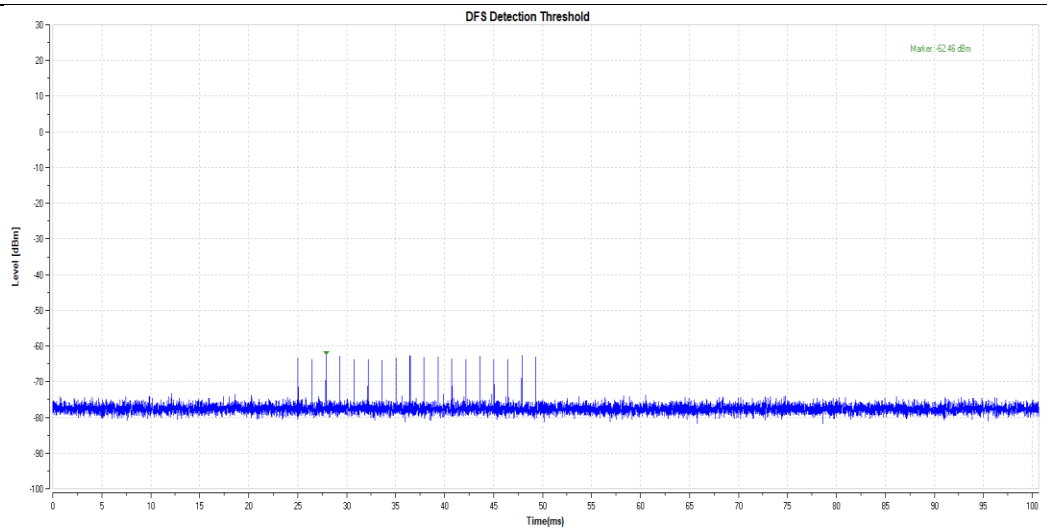

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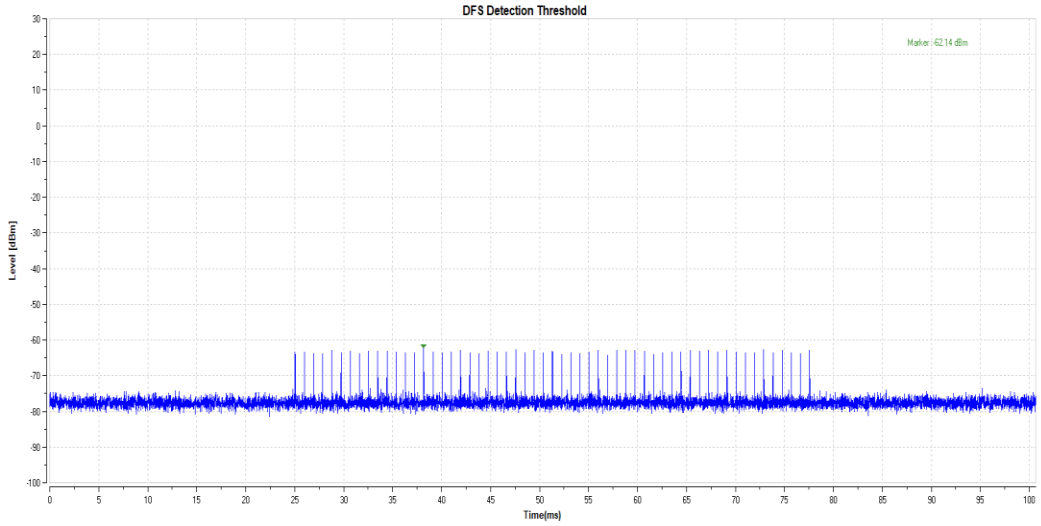

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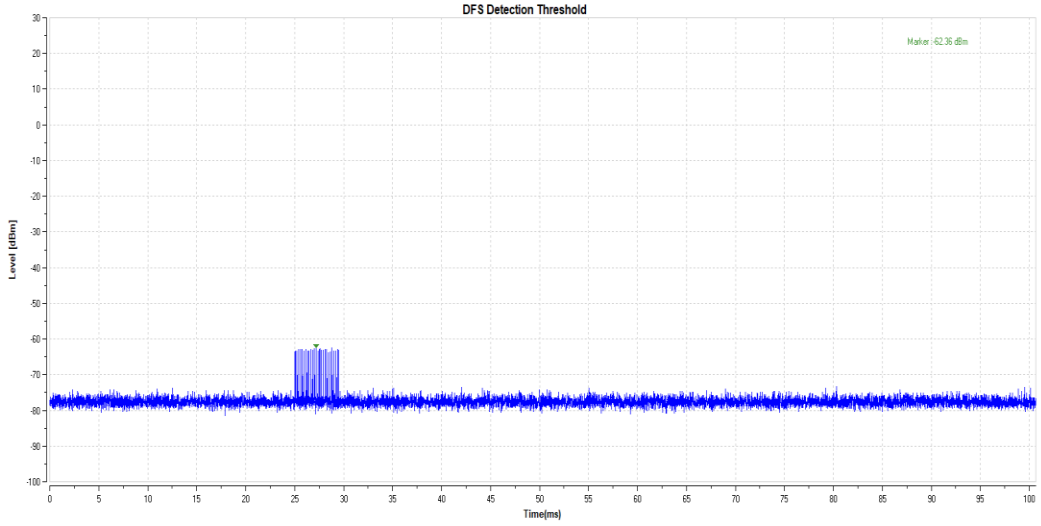

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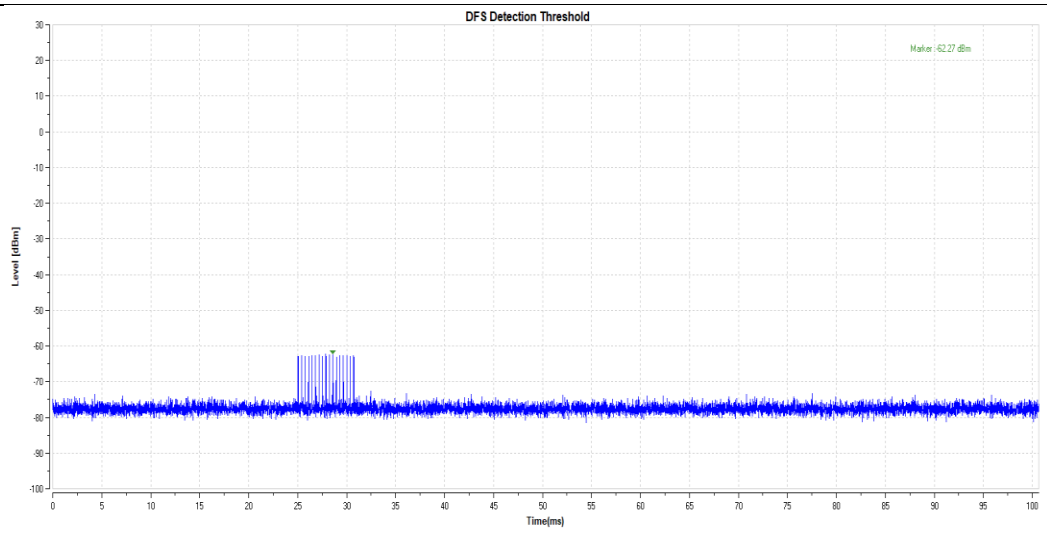

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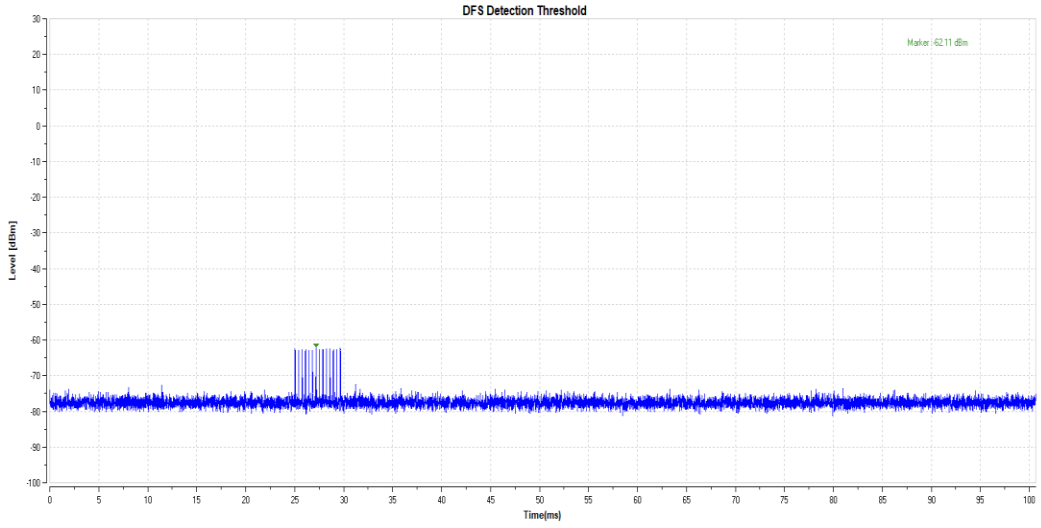

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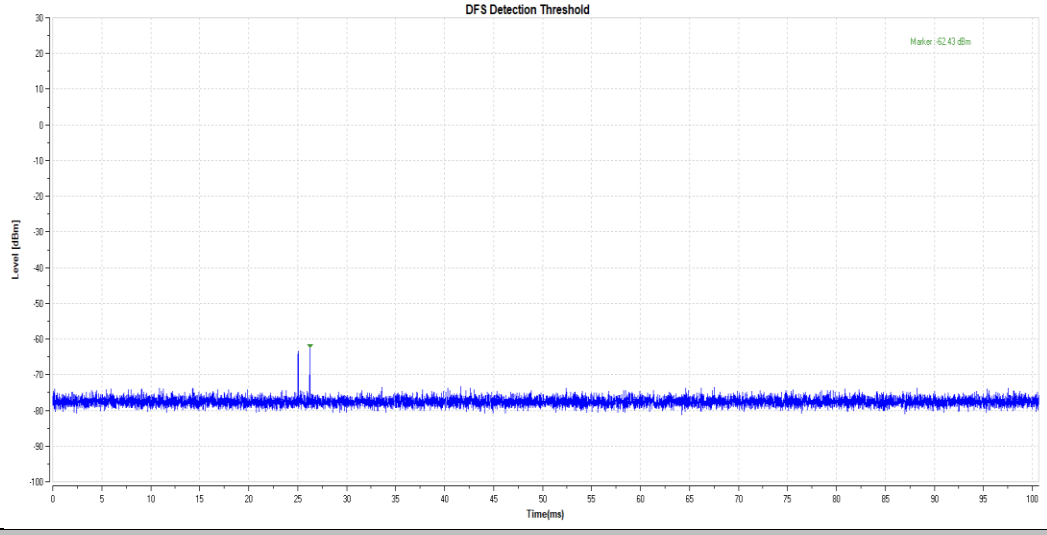

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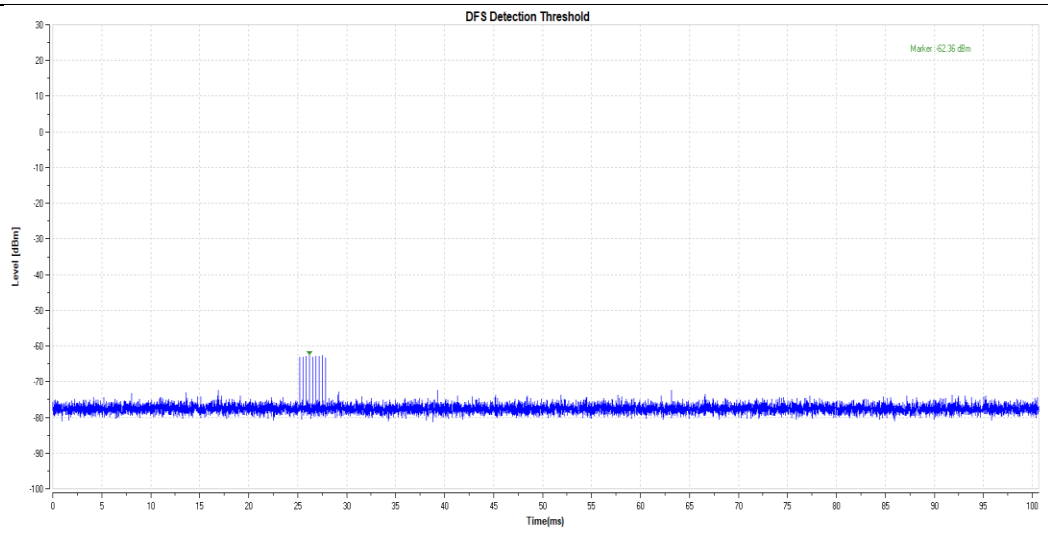

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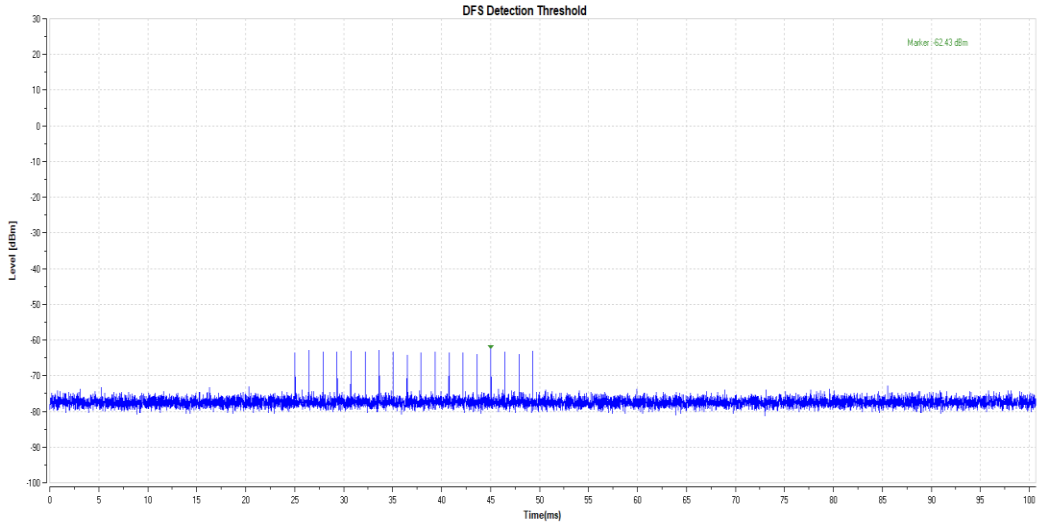

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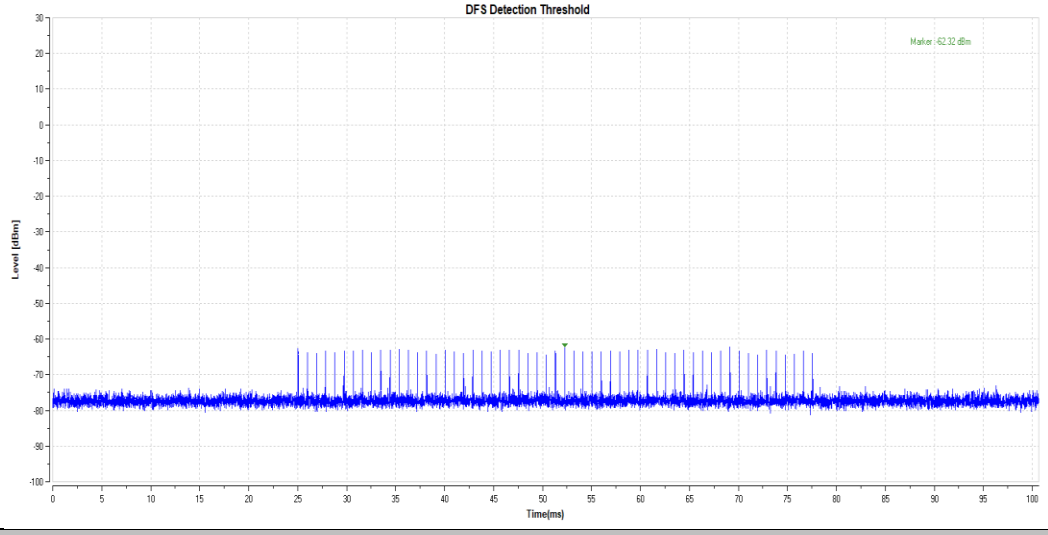

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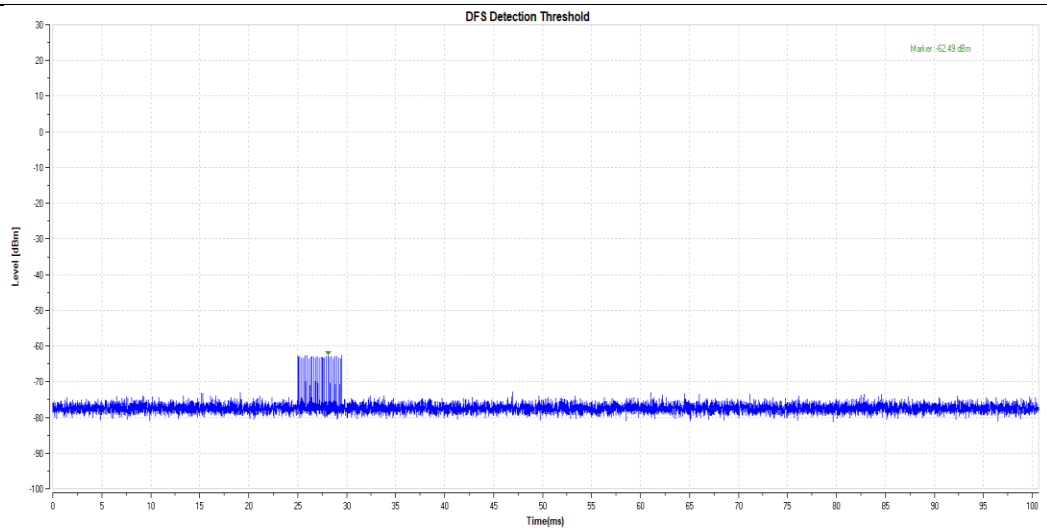

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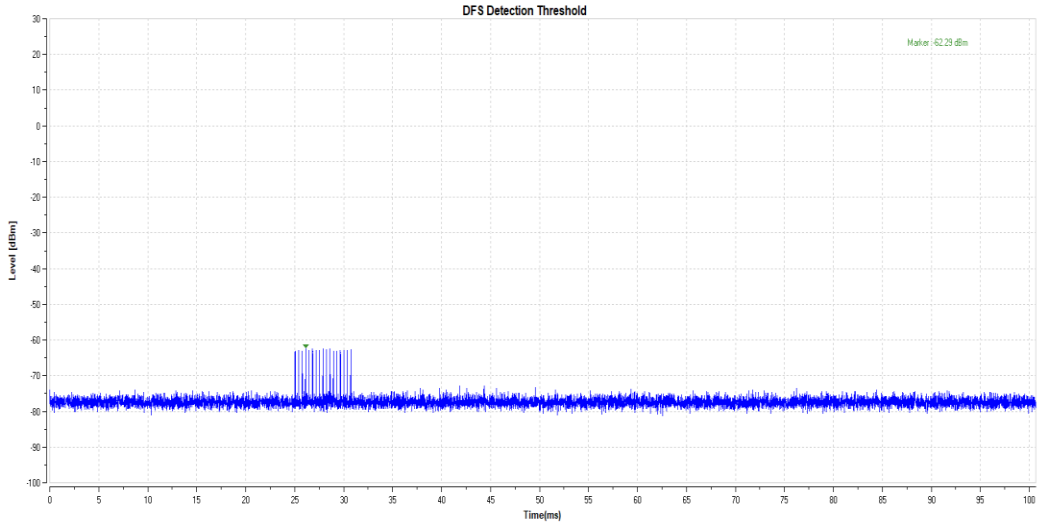

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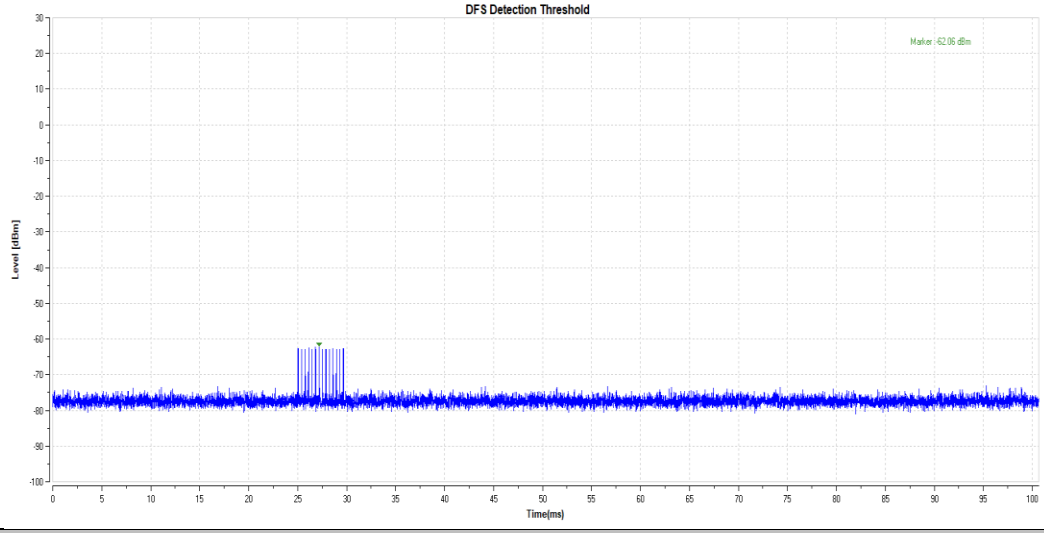

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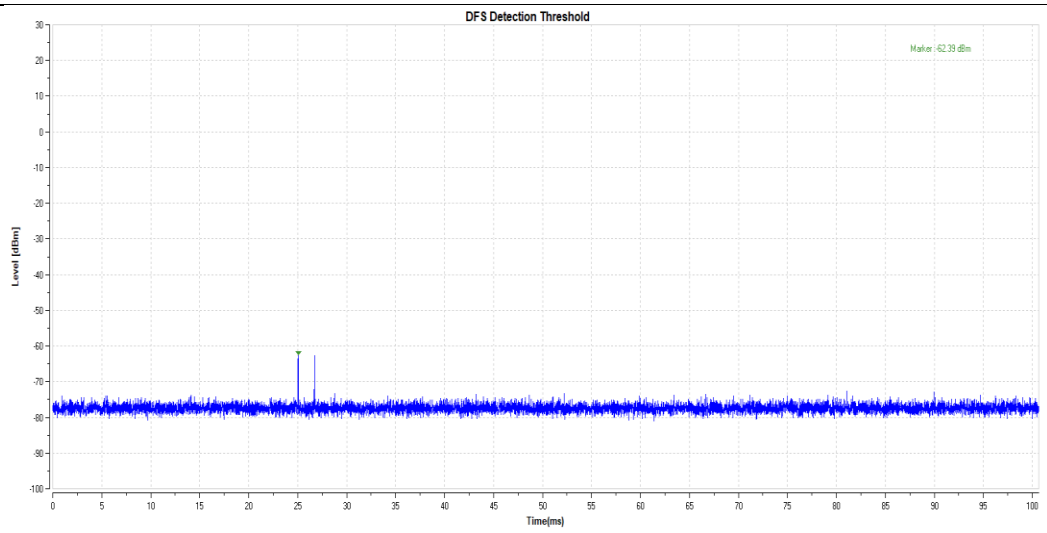

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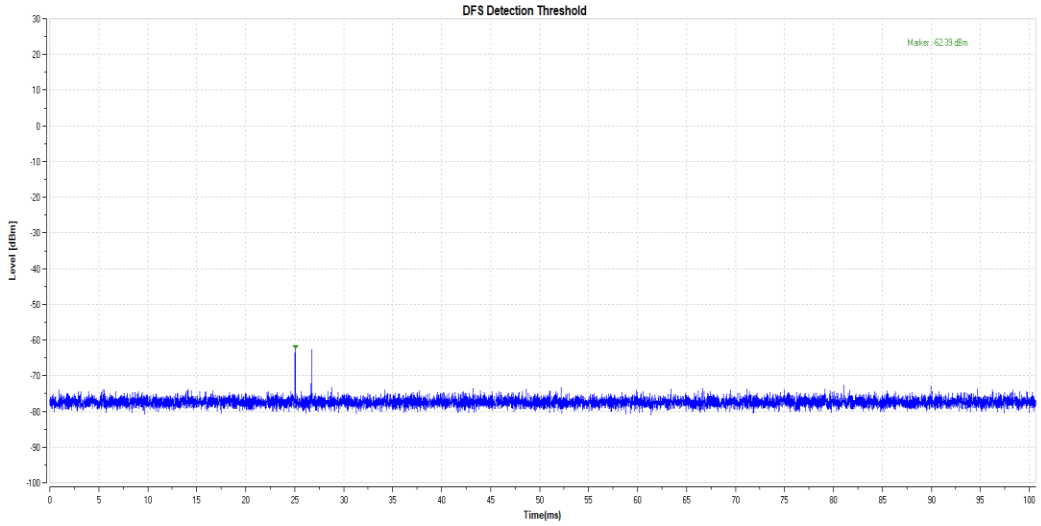

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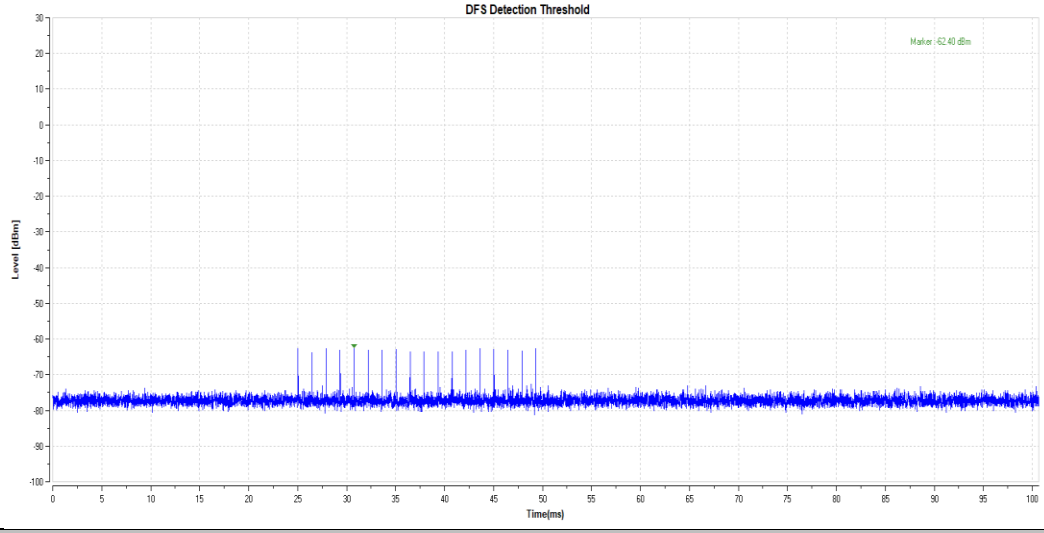

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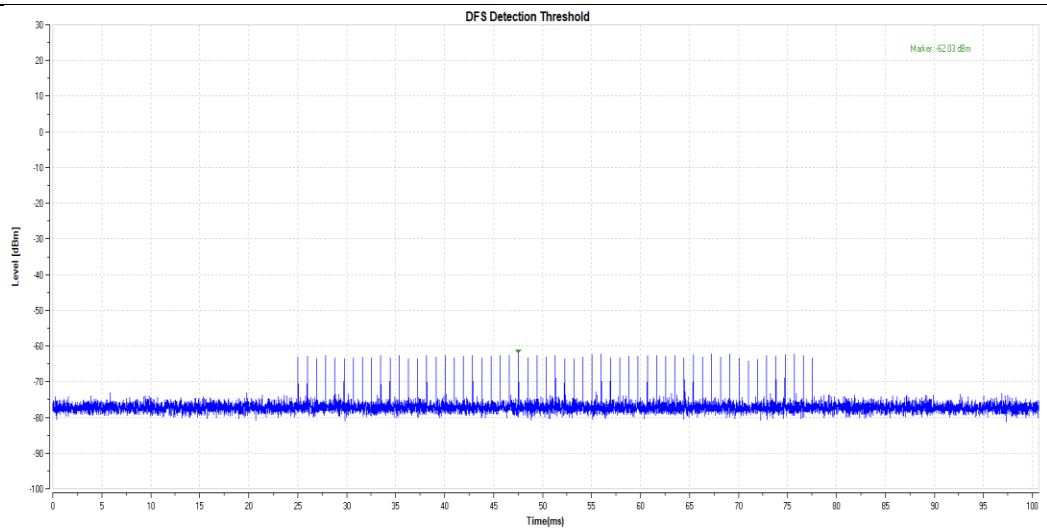

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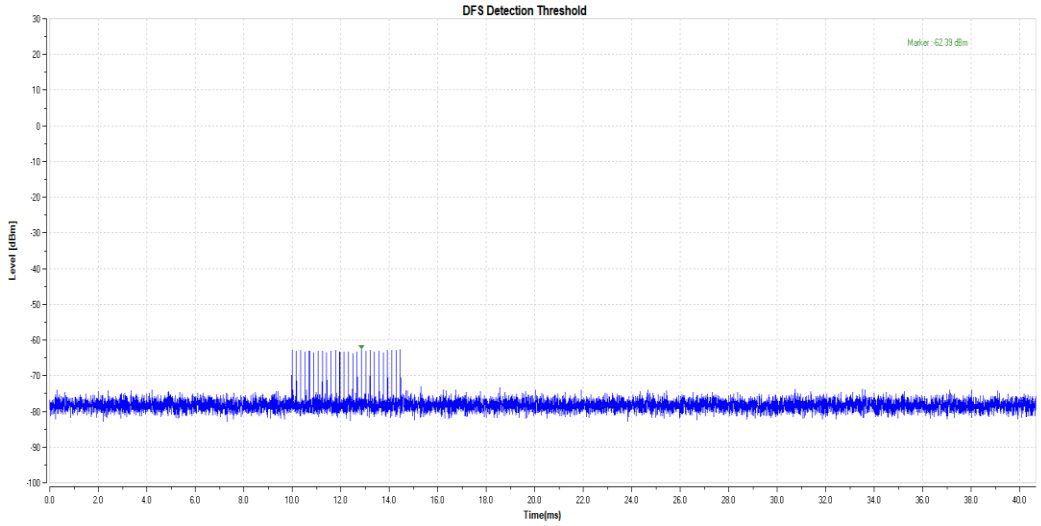

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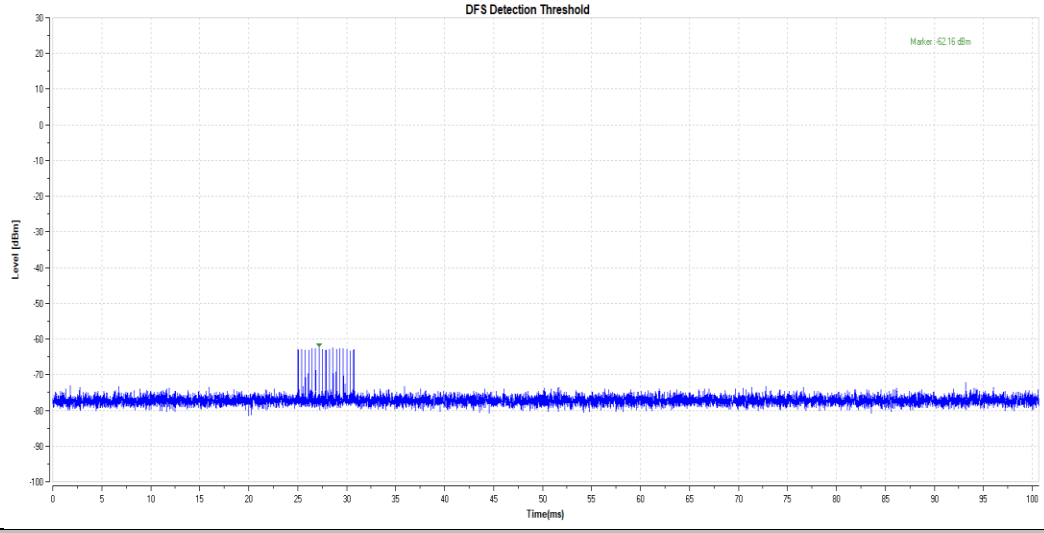

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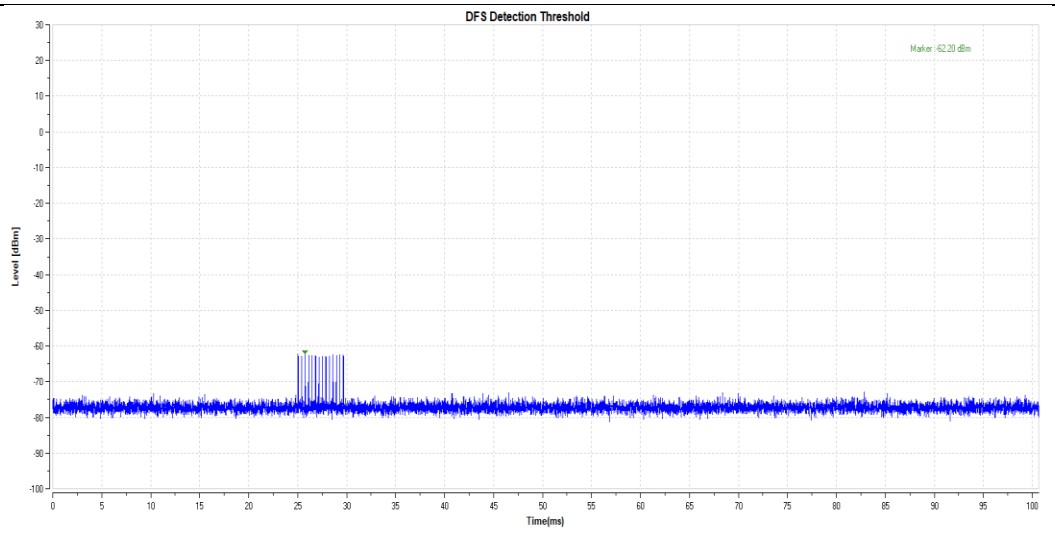

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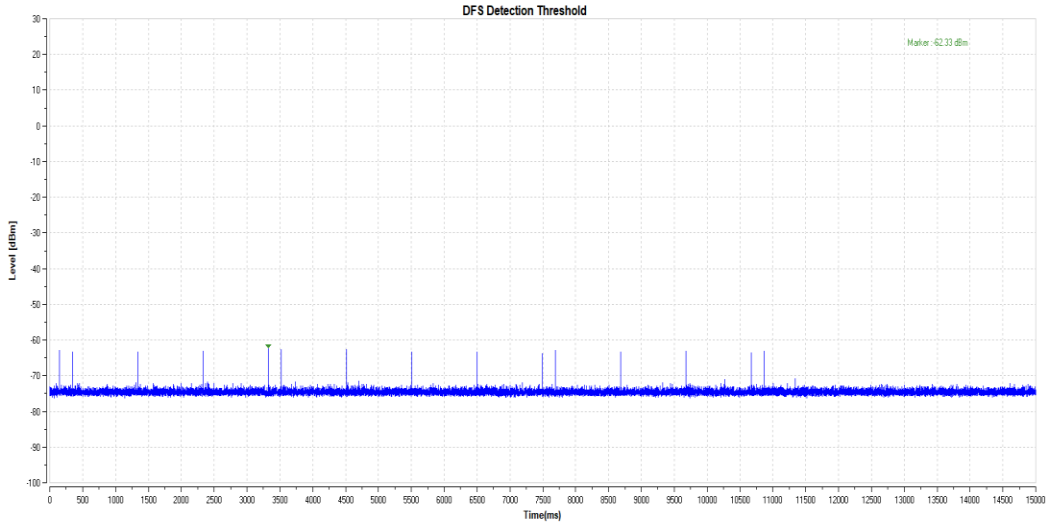

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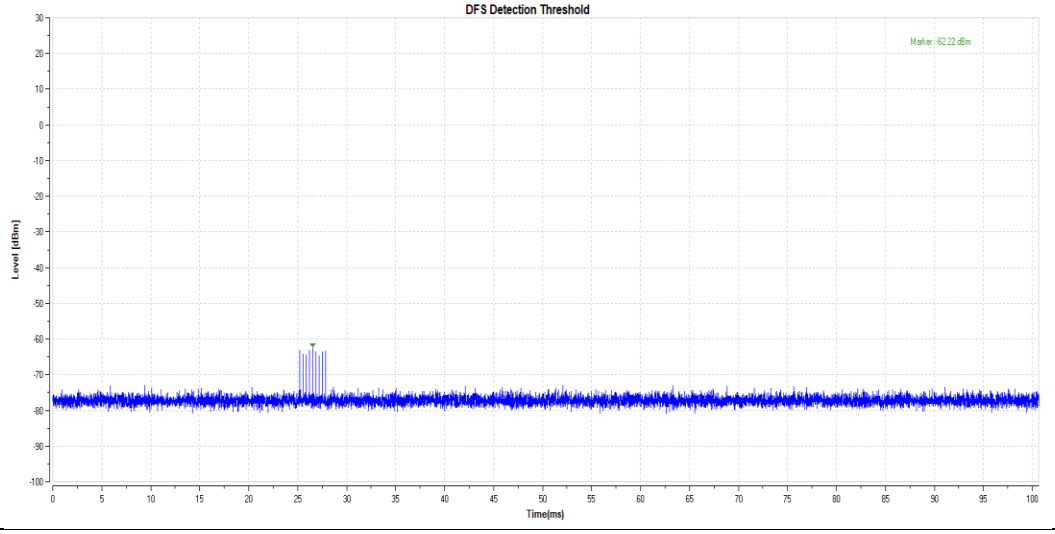


1.3 Channel Availability Check Time

1.3.1 Test Procedures

Test as per KDB905462 D02 section 7.8.2.
The following tests must be performed for U-NII device certification: Initial *Channel Startup Check* with a radar *Burst* at start of *Channel Availability Check* and with a radar *Burst* at end of *Channel Availability Check*; *In-Service Monitoring*; and the 30 minute *Non-Occupancy Period*.

7.8.2.1 Initial Channel Availability Check Time
The Initial *Channel Availability Check Time* tests that the UUT does not emit beacon, control, or data signals on the test *Channel* until the power-up sequence has been completed and the U-NII device checks for *Radar Waveforms* for one minute on the test *Channel*. This test does not use any *Radar Waveforms* and only needs to be performed one time.
a) The U-NII devices will be powered on and be instructed to operate on the appropriate U-NII *Channel* that must incorporate DFS functions. At the same time the UUT is powered on, the spectrum analyzer will be set to zero span mode with a 3 MHz RBW and 3 MHz VBW on the *Channel* occupied by the radar (Ch_r) with a 2.5 minute sweep time. The spectrum analyzer's sweep will be started at the same time power is applied to the U-NII device.

b) The UUT should not transmit any beacon or data transmissions until at least 1 minute after the completion of the power-on cycle.

c) Confirm that the UUT initiates transmission on the channel
This measurement can be used to determine the length of the power-on cycle if it is not supplied by the manufacturer. If the spectrum analyzer sweep is started at the same time the UUT is powered on and the UUT does not begin transmissions until it has completed the cycle, the power-on time can be determined by comparing the two times.

7.8.2.2 Radar Burst at the Beginning of the Channel Availability Check Time
The steps below define the procedure to verify successful radar detection on the test *Channel* during a period equal to the *Channel Availability Check Time* and avoidance of operation on that *Channel* when a radar *Burst* with a level equal to the *DFS Detection Threshold* + 1 dB occurs at the beginning of the *Channel Availability Check Time*. This is illustrated in **Figure 15**.
a) The *Radar Waveform* generator and UUT are connected using the applicable test setup described in the sections on configuration for Conducted Tests (7.2) or Radiated Tests (7.3) and the power of the UUT is switched off.

b) The UUT is powered on at T_0. T_1 denotes the instant when the UUT has completed its power-up sequence (T_{power_up}). The *Channel Availability Check Time* commences on Ch_r at instant T_1 and will end no sooner than $T_1 + T_{ch\_avail\_check}$.

c) A single *Burst* of one of the Short Pulse Radar Types 0-4 will commence within a 6 second window starting at T_1. An additional 1 dB is added to the radar test signal to ensure it is at or above the *DFS Detection Threshold*, accounting for equipment variations/errors.

d) Visual indication or measured results on the UUT of successful detection of the radar *Burst* will be recorded and reported. Observation of Ch_r for UUT emissions will continue for 2.5 minutes after the radar *Burst* has been generated.

e) Verify that during the 2.5 minute measurement window no UUT transmissions occurred on Ch_r. The *Channel Availability Check* results will be recorded.

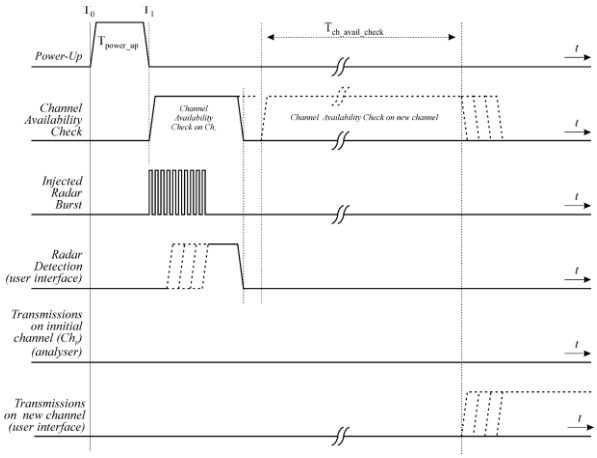


Figure 15: Example of timing for radar testing at the beginning of the Channel Availability Check Time

7.8.2.3 Radar Burst at the End of the Channel Availability Check Time

The steps below define the procedure to verify successful radar detection on the test *Channel* during a period equal to the *Channel Availability Check Time* and avoidance of operation on that *Channel* when a radar *Burst* with a level equal to the *DFS Detection Threshold* + 1dB occurs at the end of the *Channel Availability Check Time*. This is illustrated in **Figure 16**.

a) The *Radar Waveform* generator and UUT are connected using the applicable test setup described in the sections for Conducted Tests (7.2) or Radiated Tests (7.3) and the power of the UUT is switched off.

b) The UUT is powered on at T_0. T_1 denotes the instant when the UUT has completed its power-up sequence (T_{power_up}). The *Channel Availability Check Time* commences on Ch_r at instant T_1 and will end no sooner than $T_1 + T_{ch\_avail\_check}$.

c) A single *Burst* of one of the Short Pulse Radar Types 0-4 will commence within a 6 second window starting at T_1 + 54 seconds. An additional 1 dB is added to the radar test signal to ensure it is at or above the *DFS Detection Threshold*, accounting for equipment variations/errors.

d) Visual indication or measured results on the UUT of successful detection of the radar *Burst* will be recorded and reported. Observation of Ch_r for UUT emissions will continue for 2.5 minutes after the radar *Burst* has been generated.

e) Verify that during the 2.5 minute measurement window no UUT transmissions occurred on Ch_r. The *Channel Availability Check* results will be recorded.

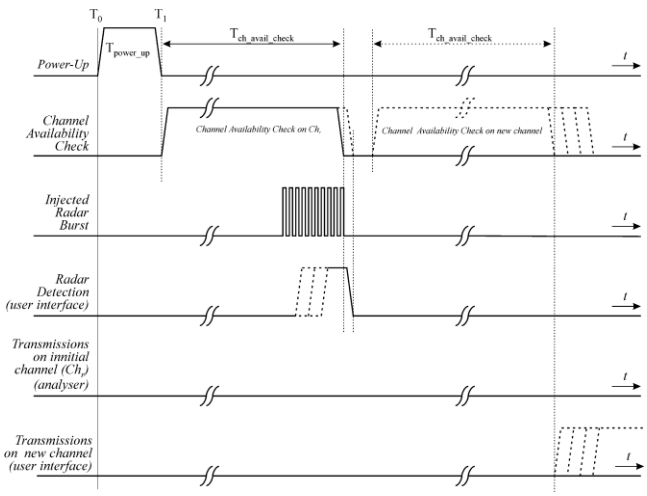


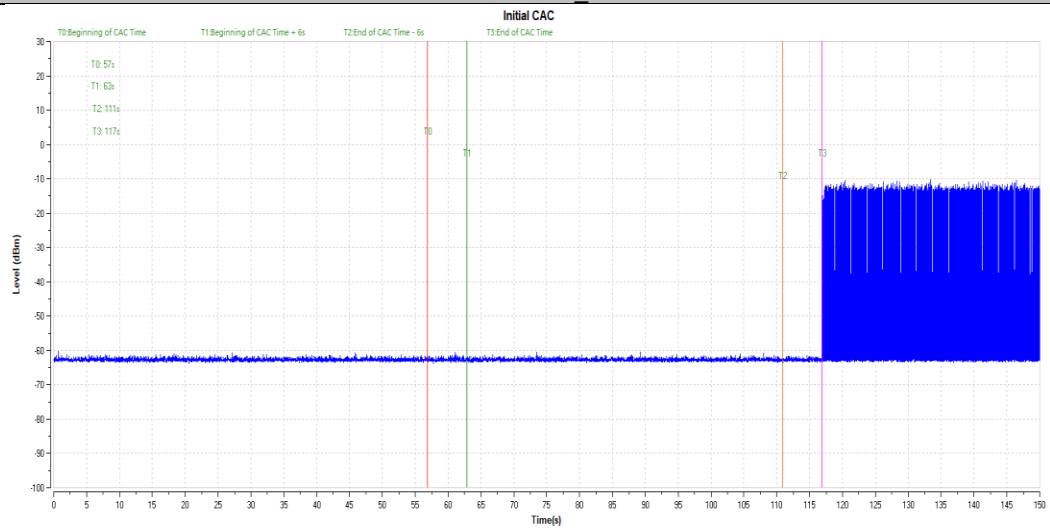
Figure 16: Example of timing for radar testing towards the end of the Channel Availability Check Time

1.3.2 Test Result

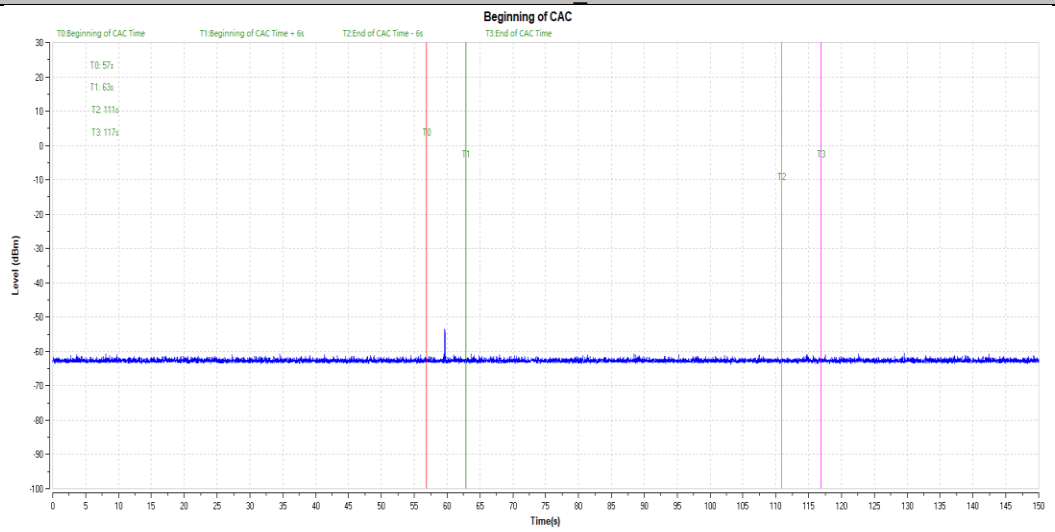
TestMode	Frequency[MHz]	Result	Verdict
11AC160SISO	5570	See test Graph	PASS

1.3.3 Test Graphs

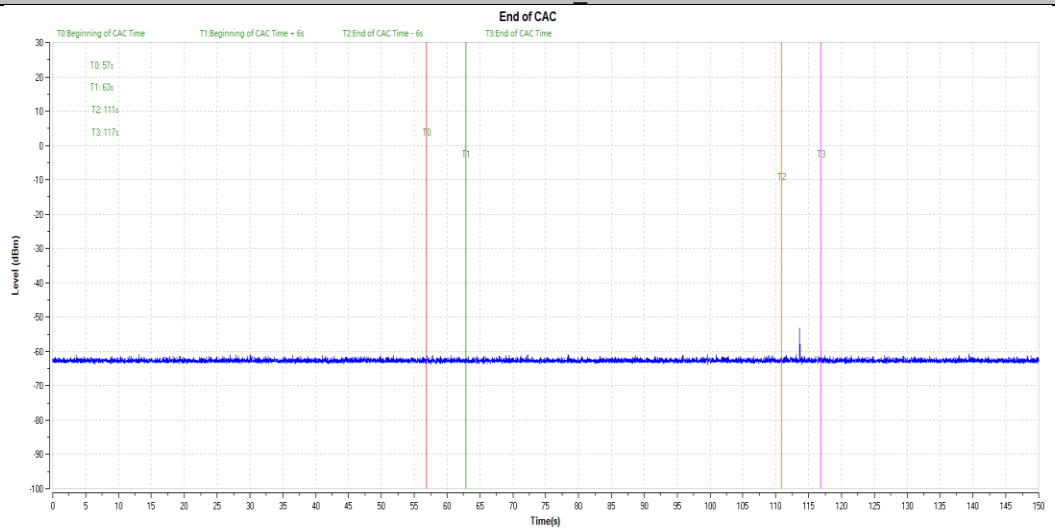
Initial Channel Availability Check Time
11AC160SISO_5570



Beginning of Channel Availability Check Time
11AC160SISO_5570



End of Channel Availability Check Time
11AC160SISO_5570



1.4 Channel Move Time and Channel Closing Transmission Time

1.4.1 Test Procedures

Test as per KDB905462 D02 section 7.8.3.
These tests define how the following DFS parameters are verified during *In-Service Monitoring;*
- Channel Closing Transmission Time; Channel Move Time; Non-Occupancy Period

The steps below define the procedure to determine the above mentioned parameters when a radar *Burst* with a level equal to the *DFS Detection Threshold* + 1dB is generated on the *Operating Channel* of the U-NII device *(In- Service Monitoring).*
a) One frequency will be chosen from the *Operating Channels* of the UUT within the 5250-5350 MHz or 5470-5725 MHz bands. For 802.11 devices, the test frequency must contain control signals. This can be verified by disabling channel loading and monitoring the spectrum analyzer. If no control signals are detected, another frequency must be selected within the emission bandwidth where control signals are detected.

b) In case the UUT is a U-NII device operating as a *Client Device* (with or without DFS), a U-NII device operating as a *Master Device* will be used to allow the UUT (Client device) to *Associate* with the *Master Device*. In case the UUT is a *Master Device*, a U-NII device operating as a *Client Device* will be used and it is assumed that the Client will *Associate* with the UUT (Master). In both cases for conducted tests, the *Radar Waveform* generator will be connected to the *Master Device*. For radiated tests, the emissions of the *Radar Waveform* generator will be directed towards the *Master Device*. If the *Master Device* has antenna gain, the main beam of the antenna will be directed toward the radar emitter. Vertical polarization is used for testing.

c) Stream the channel loading test file from the *Master Device* to the *Client Device* on the test *Channel* for the entire period of the test.

d) At time T_0 the *Radar Waveform* generator sends a *Burst* of pulses for one of the Radar Type 0 in **Table 5** at levels defined in **Table 3**, on the *Operating Channel*. An additional 1 dB is added to the radar test signal to ensure it is at or above the *DFS Detection Threshold*, accounting for equipment variations/errors.

e) Observe the transmissions of the UUT at the end of the radar *Burst* on the *Operating Channel* for duration greater than 10 seconds. Measure and record the transmissions from the UUT during the observation time (*Channel Move Time)*. Measure and record the *Channel Move Time* and *Channel Closing Transmission Time* if radar detection occurs. **Figure 17** illustrates *Channel Closing Transmission Time.*

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

g) In case the UUT is a U-NII device operating as a *Client Device* with *In-Service Monitoring*, perform steps a) to f).

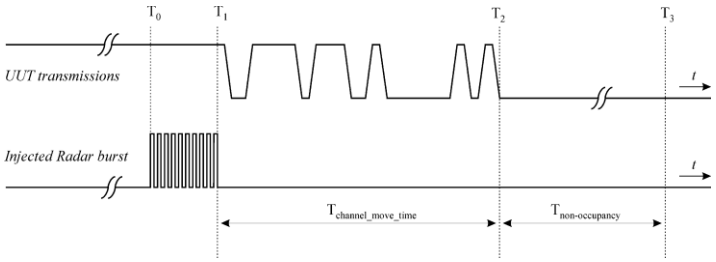


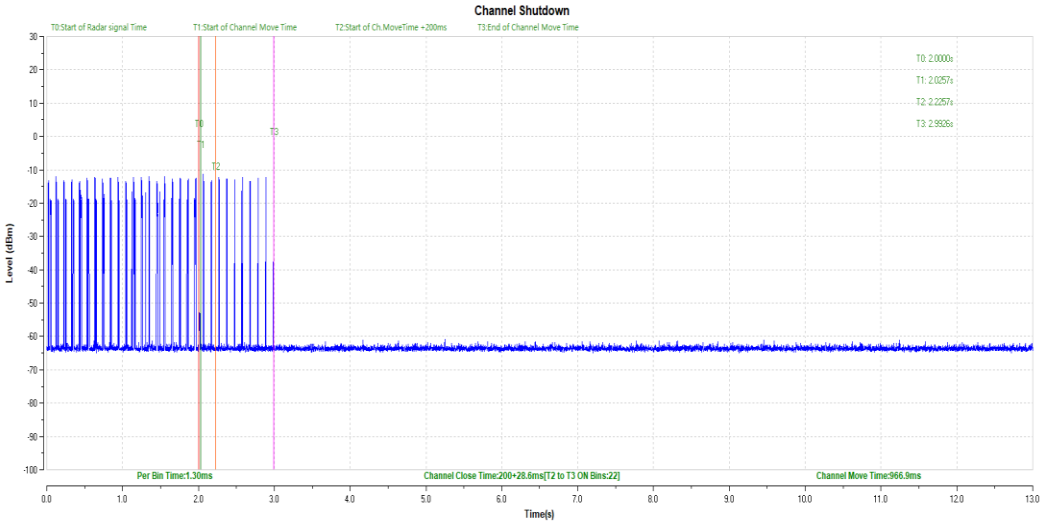
Figure 17: Example of Channel Closing Transmission Time & Channel Closing Time

1.4.2 Results

TestMode	Frequency[MHz]	CCTT[ms]	Limit[ms]	CMT[ms]	Limit[ms]	Verdict
11AC160SISO	5570	200+28.6	200+60	966.9	10000	PASS

1.4.3 Test Graphs

11AC160SISO_5570



1.5 Non-Occupancy Period

1.5.1 Test Procedures

Test as per KDB905462 D02 section 7.8.3.
These tests define how the following DFS parameters are verified during *In-Service Monitoring;*
- Channel Closing Transmission Time; Channel Move Time; Non-Occupancy Period

The steps below define the procedure to determine the above mentioned parameters when a radar *Burst* with a level equal to the *DFS Detection Threshold* + 1dB is generated on the *Operating Channel* of the U-NII device *(In- Service Monitoring).*
a) One frequency will be chosen from the *Operating Channels* of the UUT within the 5250-5350 MHz or 5470-5725 MHz bands. For 802.11 devices, the test frequency must contain control signals. This can be verified by disabling channel loading and monitoring the spectrum analyzer. If no control signals are detected, another frequency must be selected within the emission bandwidth where control signals are detected.

b) In case the UUT is a U-NII device operating as a *Client Device* (with or without DFS), a U-NII device operating as a *Master Device* will be used to allow the UUT (Client device) to *Associate* with the *Master Device*. In case the UUT is a *Master Device*, a U-NII device operating as a *Client Device* will be used and it is assumed that the Client will *Associate* with the UUT (Master). In both cases for conducted tests, the *Radar Waveform* generator will be connected to the *Master Device*. For radiated tests, the emissions of the *Radar Waveform* generator will be directed towards the *Master Device*. If the *Master Device* has antenna gain, the main beam of the antenna will be directed toward the radar emitter. Vertical polarization is used for testing.

c) Stream the channel loading test file from the *Master Device* to the *Client Device* on the test *Channel* for the entire period of the test.

d) At time T_0 the *Radar Waveform* generator sends a *Burst* of pulses for one of the Radar Type 0 in **Table 5** at levels defined in **Table 3**, on the *Operating Channel*. An additional 1 dB is added to the radar test signal to ensure it is at or above the *DFS Detection Threshold*, accounting for equipment variations/errors.

e) Observe the transmissions of the UUT at the end of the radar *Burst* on the *Operating Channel* for duration greater than 10 seconds. Measure and record the transmissions from the UUT during the observation time (*Channel Move Time)*. Measure and record the *Channel Move Time* and *Channel Closing Transmission Time* if radar detection occurs. **Figure 17** illustrates *Channel Closing Transmission Time.*

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

g) In case the UUT is a U-NII device operating as a *Client Device* with *In-Service Monitoring*, perform steps a) to f).

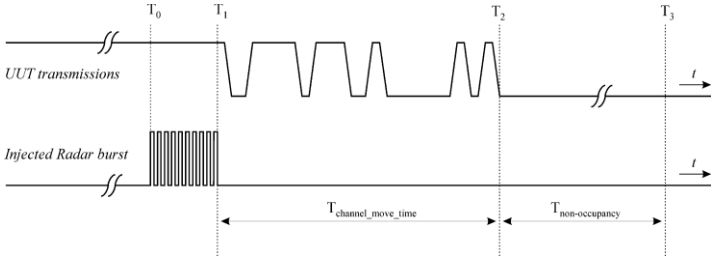
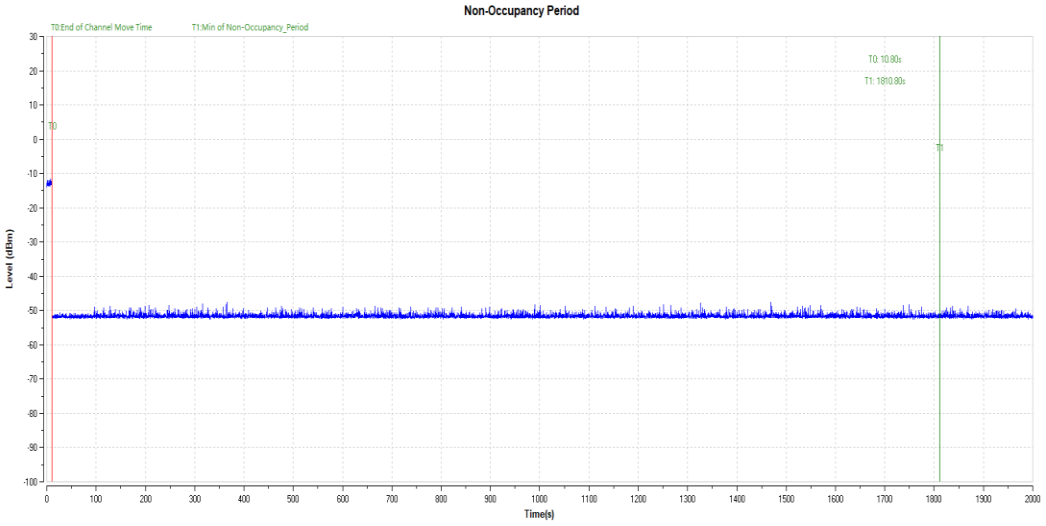


Figure 17: Example of Channel Closing Transmission Time & Channel Closing Time

1.5.2 Test Result

TestMode	Frequency[MHz]	Result	Limit[s]	Verdict
11AC160SISO	5570	see test graph	≥1800	PASS

1.5.3 Test Graphs

11AC160SISO_5570


1.6 U-NII Detection Bandwidth

1.6.1 Test Procedures

Test as per KDB905462 D02 section 7.8.1.

Set up the generating equipment as shown in **Figure 8**, or equivalent. Set up the DFS timing monitoring equipment as shown in **Figure 13** or **Figure 14**. Set up the overall system for either radiated or conducted coupling to the UUT.
Adjust the equipment to produce a single *Burst* of any one of the Short Pulse Radar Types 0 – 4 in **Table 5** at the center frequency of the UUT *Operating Channel* at the specified *DFS Detection Threshold* level found in **Table 3**.
Set the UUT up as a standalone device (no associated Client or Master, as appropriate) and no traffic. Frame based systems will be set to a talk/listen ratio reflecting the worst case (maximum) that is user configurable during this test.
Generate a single radar *Burst*, and note the response of the UUT. Repeat for a minimum of 10 trials. The UUT must detect the *Radar Waveform* within the DFS band using the specified *U-NII Detection Bandwidth* criterion shown in **Table 4**. In cases where the channel bandwidth may exceed past the DFS band edge on specific channels (i.e., 802.11ac or wideband frame based systems) select a channel that has the entire emission bandwidth within the DFS band. If this is not possible, test the detection BW to the DFS band edge.
Starting at the center frequency of the UUT operating *Channel*, increase the radar frequency in 5 MHz steps, repeating the above test sequence, until the detection rate falls below the *U-NII Detection Bandwidth* criterion specified in **Table 4**. Repeat this measurement in 1MHz steps at frequencies 5 MHz below where the detection rate begins to fall. Record the highest frequency (denote as FH) at which detection is greater than or equal to the *U-NII Detection Bandwidth* criterion. Recording the detection rate at frequencies above F_H is not required to demonstrate compliance.
Starting at the center frequency of the UUT operating *Channel*, decrease the radar frequency in 5 MHz steps, repeating the above test sequence, until the detection rate falls below the *U-NII Detection Bandwidth* criterion specified in **Table 4**. Repeat this measurement in 1MHz steps at frequencies 5 MHz above where the detection rate begins to fall. Record the lowest frequency (denote as F_L) at which detection is greater than or equal to the *U-NII Detection Bandwidth* criterion. Recording the detection rate at frequencies below F_L is not required to demonstrate compliance.
The *U-NII Detection Bandwidth* is calculated as follows:
U-NII Detection Bandwidth = $F_H - F_L$
The *U-NII Detection Bandwidth* must meet the *U-NII Detection Bandwidth* criterion specified in **Table 4**. Otherwise, the UUT does not comply with DFS requirements. This is essential to ensure that the UUT is capable of detecting *Radar Waveforms* across the same frequency spectrum that contains the significant energy from the system. In the case that the *U-NII Detection Bandwidth* is greater than or equal to the 99 percent power bandwidth for the measured F_H and F_L, the test can be truncated and the *U-NII Detection Bandwidth* can be reported as the measured F_H and F_L.

1.6.2 Test Result

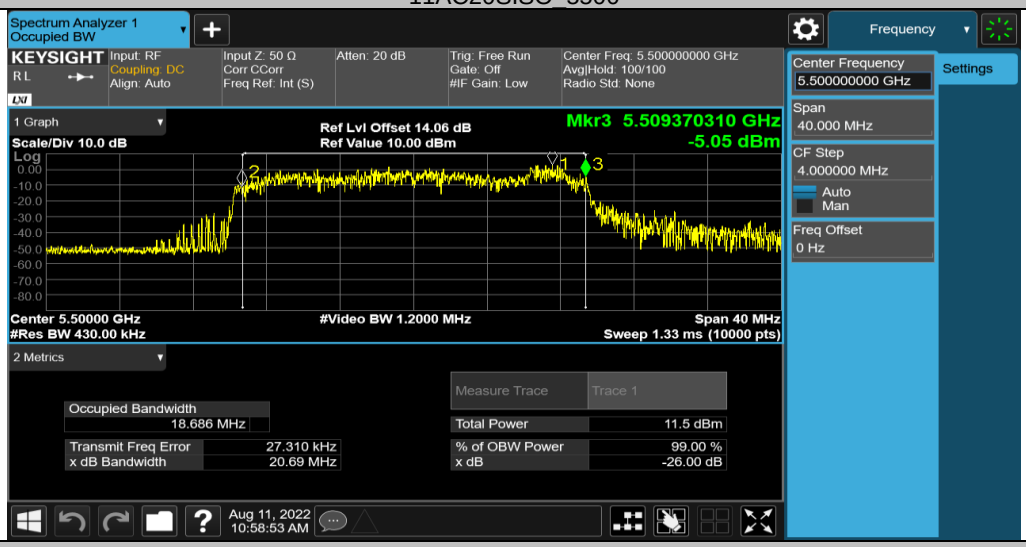
TestMode	Frequency[MHz]	FL[MHz]	FH[MHz]	Detection Bandwidth [MHz]	OCB [MHz]	Ratio [%]	Limit [%]	Verdict
11AC20SISO	5500	5488	5512	24	17.876	134.26	≥100	PASS
11AC40SISO	5510	5486	5535	49	36.308	134.96	≥100	PASS
11AC80SISO	5530	5487	5576	89	76.365	116.55	≥100	PASS
11AC160SISO	5570	5477	5669	192	153.18	125.34	≥100	PASS

Test Mode	Frequency[MHz]	Radar Freq.	Trial 1	Trial 2	Trial 3	Trial 4	Trial 5	Trial 6	Trial 7	Trial 8	Trial 9	Trial 10	Ratio (%)
11AC20 SISO	5500	5485	0	0	0	0	0	0	0	0	0	0	0
		5486	0	0	0	0	0	0	0	0	0	0	0
		5487	0	0	0	0	0	0	0	0	0	0	0
		5488	1	1	1	1	1	1	1	1	1	1	100
		5489	1	1	1	1	1	1	1	1	1	1	100
		5490	1	1	1	1	1	1	1	1	1	1	100
		5495	1	1	1	1	1	1	1	1	1	1	100
		5500	1	1	1	1	1	1	1	1	1	1	100
		5505	1	1	1	1	1	1	1	1	1	1	100
		5510	1	1	1	1	1	1	1	1	1	1	100
		5511	1	1	1	1	1	1	1	1	1	1	100
		5512	1	1	1	1	1	1	1	1	1	1	100
		5513	0	0	0	0	0	0	0	0	0	0	0
		5514	0	0	0	0	0	0	0	0	0	0	0
		5515	0	0	0	0	0	0	0	0	0	0	0
11AC40 SISO	5510	5485	0	1	0	0	0	0	0	0	0	0	10
		5486	1	1	1	1	1	1	1	1	1	1	100
		5487	1	1	1	1	1	1	1	1	1	1	100
		5488	1	1	1	1	1	1	1	1	1	1	100
		5489	1	1	1	1	1	1	1	1	1	1	100
		5490	1	1	1	1	1	1	1	1	1	1	100
		5495	1	1	1	1	1	1	1	1	1	1	100
		5500	1	1	1	1	1	1	1	1	1	1	100
		5505	1	1	1	1	1	1	1	1	1	1	100
		5510	1	1	1	1	1	1	1	1	1	1	100
		5515	1	1	1	1	1	1	1	1	1	1	100
		5520	1	1	1	1	1	1	1	1	1	1	100
		5525	1	1	1	1	1	1	1	1	1	1	100
		5530	1	1	1	1	1	1	1	1	1	1	100
		5535	1	1	1	1	1	1	1	1	1	1	100
		5536	0	0	1	0	0	0	0	0	0	0	10
		5537	0	0	0	0	0	0	0	0	0	0	0
		5538	0	0	0	0	0	0	0	0	0	0	0
		5539	0	0	0	0	0	0	0	0	0	0	0
		5540	0	0	0	0	0	0	0	0	0	0	0
11AC80 SISO	5530	5485	0	0	0	0	0	0	0	0	0	0	0
		5486	1	1	0	0	0	0	0	0	0	0	20
		5487	1	1	1	1	1	1	1	1	1	1	100
		5488	1	1	1	1	1	1	1	1	1	1	100
		5489	1	1	1	1	1	1	1	1	1	1	100
		5490	1	1	1	1	1	1	1	1	1	1	100
		5495	1	1	1	1	1	1	1	1	1	1	100
		5500	1	1	1	1	1	1	1	1	1	1	100
		5505	1	1	1	1	1	1	1	1	1	1	100
		5510	1	1	1	1	1	1	1	1	1	1	100
		5515	1	1	1	1	1	1	1	1	1	1	100
		5520	1	1	1	1	1	1	1	1	1	1	100
		5525	1	1	1	1	1	1	1	1	1	1	100
		5530	1	1	1	1	1	1	1	1	1	1	100
		5535	1	1	1	1	1	1	1	1	1	1	100
		5540	1	1	1	1	1	1	1	1	1	1	100
		5545	1	1	1	1	1	1	1	1	1	1	100
		5550	1	1	1	1	1	1	1	1	1	1	100
		5555	1	1	1	1	1	1	1	1	1	1	100
		5560	1	1	1	1	1	1	1	1	1	1	100
		5565	1	1	1	1	1	1	1	1	1	1	100
		5570	1	1	1	1	1	1	1	1	1	1	100
		5575	1	1	1	1	1	1	1	1	1	1	100
		5576	1	1	1	1	1	1	1	1	1	1	100
		5577	0	0	0	0	0	0	1	0	0	0	10
		5578	0	0	0	0	0	0	0	0	0	0	0
		5579	0	0	0	0	0	0	0	0	0	0	0
		5580	0	0	0	0	0	0	0	0	0	0	0
11AC 160SISO	5570	5475	0	0	0	0	0	0	0	0	0	0	0
		5476	1	1	1	0	0	0	0	0	0	0	30
		5477	1	1	1	1	1	1	1	1	1	1	100

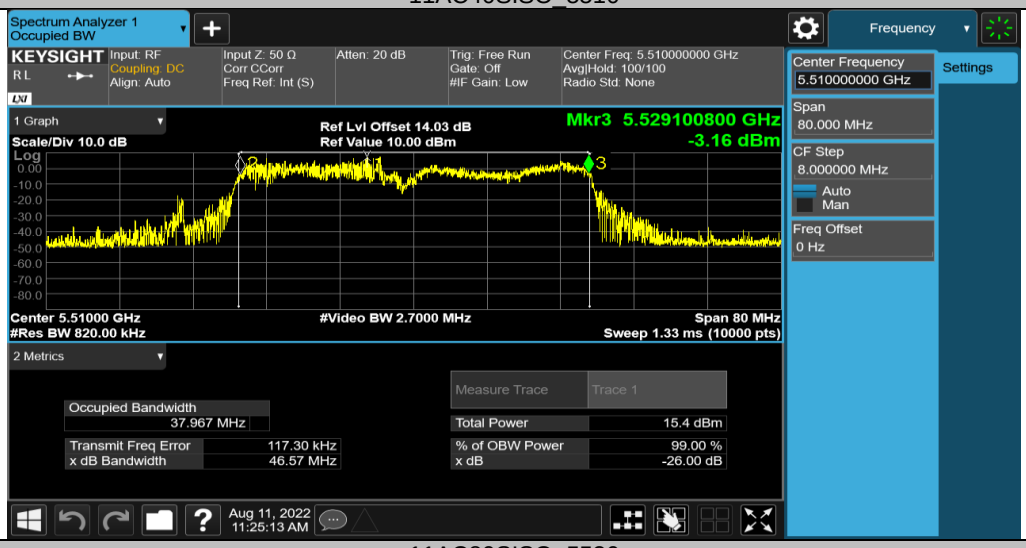
		5478	1	1	1	1	1	1	1	1	1	1	100
		5479	1	1	1	1	1	1	1	1	1	1	100
		5480	1	0	1	1	1	1	1	1	1	1	90
		5485	1	1	1	1	1	1	1	1	1	1	100
		5490	1	1	1	1	1	1	1	1	1	1	100
		5495	1	1	1	1	1	1	1	1	1	1	100
		5500	1	1	1	1	1	1	1	1	1	1	100
		5505	1	1	1	1	1	1	1	1	1	1	100
		5510	1	1	1	1	1	1	1	1	1	1	100
		5515	1	1	1	1	1	1	1	1	1	1	100
		5520	1	1	1	1	1	1	1	1	1	1	100
		5525	1	1	1	1	1	1	1	1	1	1	100
		5530	1	1	1	1	1	1	1	1	1	1	100
		5535	1	1	1	1	1	1	1	1	1	1	100
		5540	1	1	1	1	1	1	1	1	1	1	100
		5545	1	1	1	1	1	1	1	1	1	1	100
		5550	1	1	1	1	1	1	1	1	1	1	100
		5555	1	1	1	1	1	1	1	1	1	1	100
		5560	1	1	1	1	1	1	1	1	1	1	100
		5565	1	1	1	1	1	1	1	1	1	1	100
		5570	1	1	1	1	1	1	1	1	1	1	100
		5575	1	1	1	1	1	1	1	1	1	1	100
		5580	1	1	1	1	1	1	1	1	1	1	100
		5585	1	1	1	1	1	1	1	1	1	1	100
		5590	1	1	1	1	1	1	1	1	1	1	100
		5595	1	1	1	1	1	1	1	1	1	1	100
		5600	1	1	1	1	1	1	1	1	1	1	100
		5605	1	1	1	1	1	1	1	1	1	1	100
		5610	1	1	1	1	1	1	1	1	1	1	100
		5615	1	1	1	1	1	1	1	1	1	1	100
		5620	1	1	1	1	1	1	1	1	1	1	100
		5625	1	1	1	1	1	1	1	1	1	1	100
		5630	1	1	1	1	1	1	1	1	1	1	100
		5635	1	1	1	1	1	1	1	1	1	1	100
		5640	1	1	1	1	1	1	1	1	1	1	100
		5645	1	1	1	1	1	1	1	1	1	1	100
		5650	1	1	1	1	1	1	1	1	1	1	100
		5655	1	1	1	1	1	1	1	1	1	1	100
		5660	1	1	1	1	1	1	1	1	1	1	100
		5665	1	1	1	1	1	1	1	1	1	1	100
		5666	1	1	1	1	1	1	1	1	1	1	100
		5667	1	1	1	1	1	1	1	1	1	1	100
		5668	1	1	1	1	1	1	1	1	1	1	100
		5669	1	1	1	1	1	1	1	1	1	1	100
		5670	1	0	0	0	0	0	0	0	0	0	10

1.6.3 Test Graphs

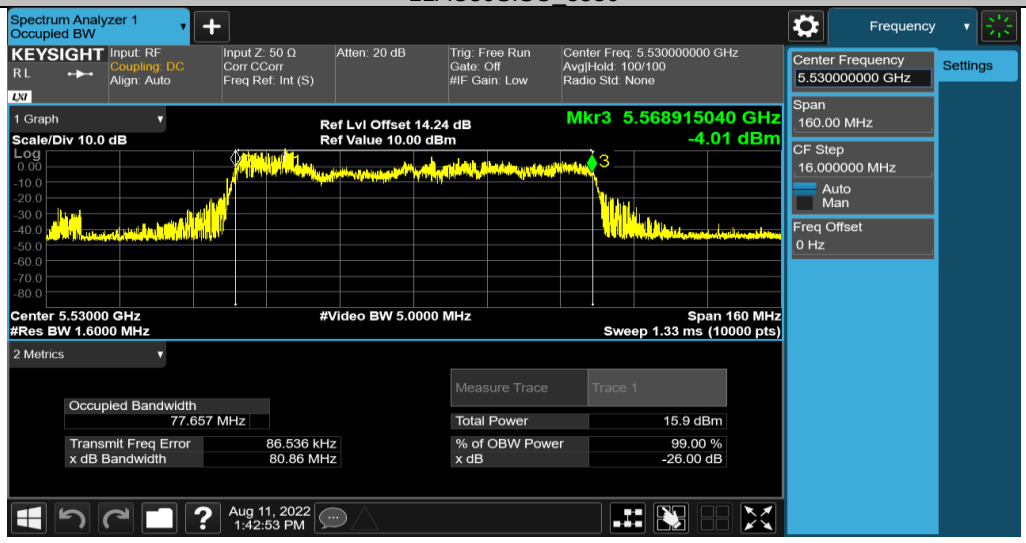
11AC20SISO_5500



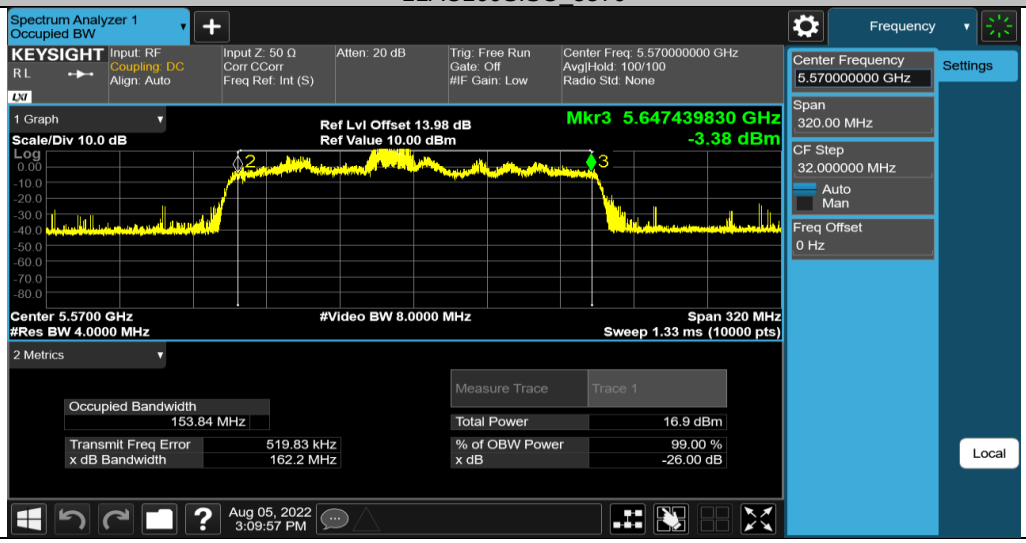
11AC40SISO_5510



11AC80SISO_5530



11AC160SISO_5570



1.7 Statistical Performance check

1.7.1 Test Procedures

Test as per KDB905462 D02 section 7.8.4.

The steps below define the procedure to determine the minimum percentage of successful detection requirements found in **Tables 5-7** when a radar burst with a level equal to the *DFS Detection Threshold* + 1dB is generated on the *Operating Channel* of the U-NII device *(In- Service Monitoring)*.
a) One frequency will be chosen from the *Operating Channels* of the UUT within the 5250-5350 MHz or 5470-5725 MHz bands.

b) In case the UUT is a U-NII device operating as a *Client Device* (with or without Radar Detection), a U-NII device operating as a *Master Device* will be used to allow the UUT (Client device) to *Associate* with the *Master Device*. In case the UUT is a *Master Device*, a U-NII device operating as a *Client Device* will be used and it is assumed that the Client will *Associate* with the UUT (Master). In both cases for conducted tests, the *Radar Waveform* generator will be connected to the *Master Device*. For radiated tests, the emissions of the *Radar Waveform* generator will be directed towards the *Master Device*. If the *Master Device* has antenna gain, the main beam of the antenna will be directed toward the radar emitter. Vertical polarization is used for testing.

c) Stream the channel loading test file from the *Master Device* to the Client Device on the test *Channel* for the entire period of the test.

d) At time T_0 the *Radar Waveform* generator sends the individual waveform for each of the Radar Types 1- 6 in **Tables 5-7**, at levels defined in **Table 3**, on the *Operating Channel*. An additional 1 dB is added to the radar test signal to ensure it is at or above the *DFS Detection Threshold*, accounting for equipment variations/errors.

e) Observe the transmissions of the UUT at the end of the Burst on the *Operating Channel* for duration greater than 10 seconds for Radar Type 0 to ensure detection occurs.

f) Observe the transmissions of the UUT at the end of the Burst on the *Operating Channel* for duration greater than 22 seconds for Long Pulse Radar Type 5 to ensure detection occurs.

g) In case the UUT is a U-NII device operating as a *Client Device* with *In-Service Monitoring*, perform steps a) to f).

7.8.4.1 Short Pulse Radar Test

Once the performance requirements check is complete, statistical data will be gathered, to determine the ability of the device to detect the radar test waveforms (Short Pulse Radar Types 1-4) found in **Table 5**. The device can utilize a test mode to demonstrate when detection occurs to prevent the need to reset the device between trials. The percentage of successful detection is calculated by:

$$\frac{TotalWaveformDetections}{TotalWaveformTrials} \times 100 = \text{Percentage of Successful Detection } \textit{Radar Waveform } N = P_dN$$

In addition an aggregate minimum percentage of successful detection across all Short Pulse Radar Types 1-4 is required and is calculated as follows:

$$\frac{P_d1 + P_d2 + P_d3 + P_d4}{4}$$

The minimum number of trails, minimum percentage of successful detection and the aggregate minimum percentage of successful detection are found in **Table 5**.

7.8.4.2 Long Pulse Radar Test

Statistical data will be gathered to determine the ability of the device to detect the Long Pulse Radar Type 5 found in **Table 6**. The device can utilize a test mode to demonstrate when detection occurs to prevent the need to reset the device between trials.

Three subsets of trials will be performed with a minimum of ten trials per subset. The subset of trials differ in where the Long Pulse Type 5 Signal is tuned in frequency:

a) the *Channel* center frequency (Figure 18);

b) tuned frequencies such that 90% of the Long Pulse Type 5 frequency modulation is within the low edge of the UUT *Occupied Bandwidth* (Figure 19); and

c) tuned frequencies such that 90% of the Long Pulse Type 5 frequency modulation is within the high edge of the UUT *Occupied Bandwidth* (Figure 20).

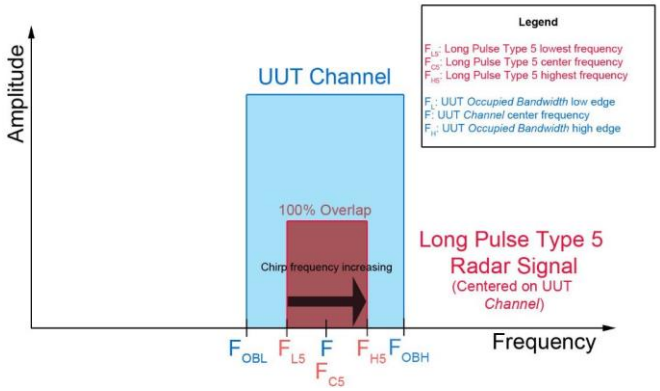


Figure 18: Example of the Relationship Between Long Pulse Type 5 Signal and the U-NII channel when the Signal is Tuned to the UUT Channel Center Frequency

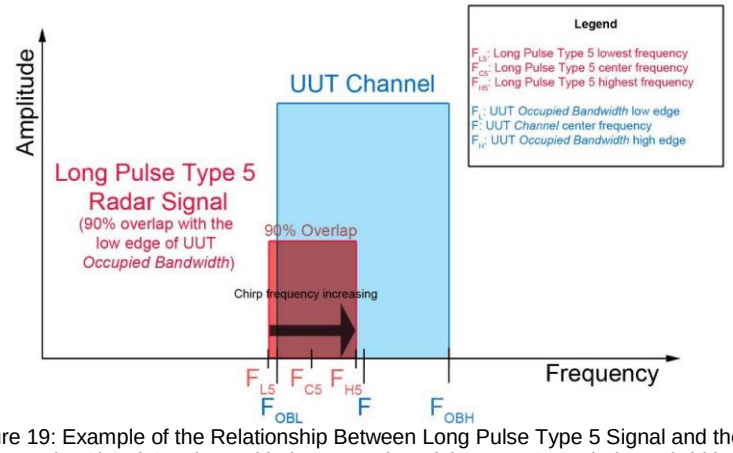


Figure 19: Example of the Relationship Between Long Pulse Type 5 Signal and the U-NII channel when the Signal is Tuned so that 90% of the Radar Signal Overlaps with the Low Edge of the UUT Occupied Bandwidth

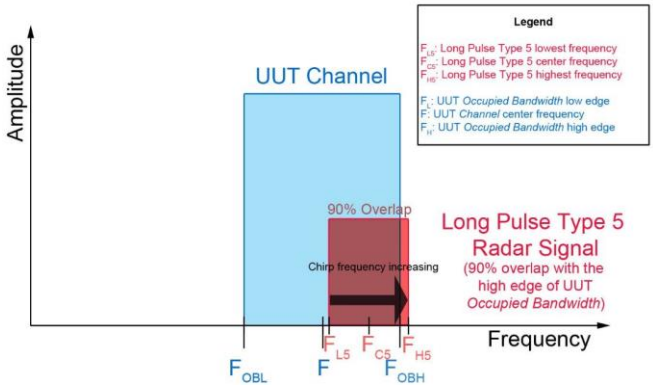


Figure 20: Example of the Relationship Between Long Pulse Type 5 Signal and the U-NII channel when the Signal is Tuned so that 90% of the Radar Signal Overlaps with the High Edge of the UUT Occupied Bandwidth

For subset case 1: the center frequency of the signal generator will remain fixed at the center of the UUT Channel.
For subset case 2: to retain 90% frequency overlap between the radar signal and the UUT Occupied Bandwidth, the center frequency of the signal generator will vary for each of the ten trials in subset case 2. The center frequency of the signal generator for each trial is calculated by:

$F_L + (0.4 * Chirp\ Width\ [in\ MHz])$

For subset case 3: to retain 90% frequency overlap between the radar signal and the UUT Occupied Bandwidth, the center frequency of the signal generator will vary for each of the ten trials in subset case 3. The center frequency of the signal generator for each trial is calculated by:

$F_H - (0.4 * Chirp\ Width\ [in\ MHz])$

The percentage of successful detection is calculated by dividing the sum of the detections for the three subsets by the sum of trials for the three subsets:

$$\frac{TotalWaveformDetections}{TotalWaveformTrials} \times 100$$

7.8.4.3 Frequency Hopping Radar Test

Statistical data will be gathered to determine the ability of the device to detect the Frequency Hopping radar test signal (radar type 6) found in Table 7. The device can utilize a test mode to demonstrate when detection occurs to prevent the need to reset the device between trial runs. The probability of successful detection is calculated by:

$$\frac{TotalWaveformDetections}{TotalWaveformTrials} \times 100$$

1.7.2 Test Result

TestMode	Frequency[MHz]	Radar Type	Pass Times	Fail Times	Probability (%)	Limit (%)	Verdict
11AC20SISO	5500	Type1	26	4	86.67	60	PASS
		Type2	24	6	80.00	60	PASS
		Type3	23	7	76.67	60	PASS
		Type4	24	6	80.00	60	PASS
		Type 1-4	---	---	80.84	80	PASS
		Type5	26	4	86.67	70	PASS
		Type6	30	0	100.00	80	PASS
11AC40SISO	5510	Type1	29	1	96.67	60	PASS
		Type2	22	8	73.33	60	PASS
		Type3	22	8	73.33	60	PASS
		Type4	23	7	76.67	60	PASS
		Type 1-4	---	---	80.00	80	PASS
		Type5	27	3	90.00	70	PASS
		Type6	30	0	100.00	80	PASS
11AC80SISO	5530	Type1	27	3	90.00	60	PASS
		Type2	25	5	83.33	60	PASS
		Type3	21	9	70.00	60	PASS
		Type4	24	6	80.00	60	PASS
		Type 1-4	---	---	80.83	80	PASS
		Type5	29	1	96.67	70	PASS
		Type6	30	0	100.00	80	PASS
11AC160SISO	5570	Type1	28	2	93.33	60	PASS
		Type2	21	9	70.00	60	PASS
		Type3	24	6	80.00	60	PASS
		Type4	25	5	83.33	60	PASS
		Type 1-4	---	---	81.67	80	PASS
		Type5	27	3	90.00	70	PASS
		Type6	30	0	100.00	80	PASS

1.7.2.1 Parameter Data sheet for Radar Types 1

Test Mode	Freq. [MHz]	Trial ID	Pulse Repetition Frequency Number(1 to 23)	Pulse Repetition Frequency (Pulses Per Second)	Pulse Repetition Interval (Microseconds)	Detection (1: Yes; 0: No)
11AC20SISO	5500	0	15	1253.1	798	1
		1	18	1165.6	858	1
		2	7	1567.4	638	1
		3	3	1792.1	558	0
		4	20	1113.6	898	1
		5	4	1730.1	578	1
		6	22	1066.1	938	1
		7	21	1089.3	918	1
		8	13	1319.3	758	1
		9	10	1432.7	698	1
		10	6	1618.1	618	1
		11	19	1139	878	1
		12	2	1858.7	538	1
		13	11	1392.8	718	1
		14	17	1193.3	838	1
		15	-	2536.0	394	1
		16	-	966.0	1035	0
		17	-	827.0	1209	1
		18	-	2501.0	400	1
		19	-	2595.0	385	1
		20	-	1114.0	898	1
		21	-	1302.0	768	1
		22	-	3045.0	328	1
		23	-	1624.0	616	1
		24	-	2878.0	347	1
		25	-	1027.0	974	1
		26	-	2485.0	402	0
		27	-	1600.0	625	1
		28	-	1172.0	853	0
		29	-	1177.0	850	1

Test Mode	Freq. [MHz]	Trial ID	Pulse Repetition Frequency Number(1 to 23)	Pulse Repetition Frequency (Pulses Per Second)	Pulse Repetition Interval (Microseconds)	Detection (1: Yes; 0: No)
11AC40SISO	5510	0	13	1319.3	758	1
		1	2	1858.7	538	1
		2	11	1392.8	718	1
		3	20	1113.6	898	1
		4	23	326.2	3066	1
		5	22	1066.1	938	1
		6	18	1165.6	858	1
		7	3	1792.1	558	1
		8	6	1618.1	618	1
		9	17	1193.3	838	1
		10	21	1089.3	918	1
		11	12	1355	738	1
		12	15	1253.1	798	1
		13	1	1930.5	518	1
		14	8	1519.8	658	1
		15	-	2536.0	394	1
		16	-	966.0	1035	1
		17	-	827.0	1209	1
		18	-	2501.0	400	1
		19	-	2595.0	385	1
		20	-	1114.0	898	1
		21	-	1302.0	768	1
		22	-	3045.0	328	1
		23	-	1624.0	616	1
		24	-	2878.0	347	1
		25	-	1027.0	974	1
		26	-	2485.0	402	0
		27	-	1600.0	625	1
		28	-	1172.0	853	1
		29	-	1177.0	850	1