FCC - DFS TEST REPORT

Report Number	:	**4842024420600E** Date of Issue: 2025.04.07
Model	:	THP23-ZB-X, THP23-ZB-P, THP23-ZB-X-Vx, THP23-ZB-Vx, THP23-M-X, THP23-M-Vx (“x” represents 1, 2, 3……)
Product Type	:	Smart M Gateway
Applicant	:	Zhejiang Lingzhu Technology Co., Ltd.
Address	:	Room 302, No 1 Building Huace Center, Xihu District 310000, Hangzhou City, Zhejiang Province, PEOPLE'S REPUBLIC OF CHINA
Manufacturer	:	Zhejiang Lingzhu Technology Co., Ltd.
Address	:	Room 302, No 1 Building Huace Center, Xihu District 310000, Hangzhou City, Zhejiang Province, PEOPLE'S REPUBLIC OF CHINA
Test Result	:	■ **Positive** ☐ **Negative**
Total pages including Appendices	:	**24**

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1 Table of Contents

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2 Report Modification Record

Alterations and additions to this report will be issued to the holders of each copy in the form of a complete document.

Issue	Description of Change	Date of Issue
1	First Issue	2025.04.07

3 Details about the Test Laboratory

Details about the Test Laboratory
Test Site 1

Company name:	TÜV SÜD Certification and Testing (China) Co., Ltd.
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4 Description of the Equipment under Test

Product:	Smart M Gateway
Model no.:	THP23-ZB-X
FCC ID:	2BEWXTHP23
Rating:	Gateway Input: DC 5V, 2A (Type C Port); DC 48V, 0.35A (PoE Port) Adapter Input:100-240V~,50/60Hz, 0.4A (for model KA12H-0502000US); 100-240V~,50/60Hz, 0.3A (for model TPA-10D050200UU01) Adapter Output: DC 5.0V, 2.0A, 10W
RF Transmission Frequency(DFS band):	5G Wi-Fi: 5260~5320 MHz (U-NII-2A) 5500~5700 MHz (U-NII-2C)
Modulation:	802.11a: BPSK, QPSK, 16QAM, 64QAM 802.11n: BPSK, QPSK, 16QAM, 64QAM
Hardware Version:	V1.3.0
Software Version:	V1.0.4
Antenna Type:	Built-in Antenna
Antenna Gain:	5.15-5.25GHz: 1.64dBi, 5.25-5.35GHz:1.89dBi, 5.47-5.725GHz: 2.35dBi, 5.725-5.85GHz:2.44dBi
Max EIRP:	14.75dBm
Description of the EUT:	The Equipment Under Test (EUT) is a Smart M Gateway which support 2.4GHz & 5GHz Wi-Fi, Low Energy Bluetooth (1Mbps date rate) and Zigbee function.
Test sample no.:	WUX-0877560-006

The sample's mentioned in this report is/are submitted/ supplied/ manufactured by client. The laboratory therefore assumes no responsibility for accuracy of information on the brand name, model number, origin of manufacture, consignment, antenna gain or any information supplied

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5 Summary of Test Standards

Test Standards	
FCC Part 15 Subpart E 15.407(h)	PART 15 - RADIO FREQUENCY DEVICES Subpart E - Unlicensed National Information Infrastructure Devices

Test Method:
KDB 905462 D02 UNII DFS Compliance Procedures New Rules v02
KDB 905462 D03 UNII Clients Without Radar Detection New Rules v01r02
ANSI C63.10-2020, American National Standard for Testing Unlicensed Wireless Devices

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6 Summary of Test Results

Technical Requirements				
FCC Part 15 Subpart E; KDB 905462 D02				
Clause	Test	Test Result		
		Pass	Fail	N/A
15.407(h)(2); 7.8.1	UNII Detection Bandwidth	☐	☐	☒
15.407(h)(2); 7.8.2 Performance Requirement Check	Initial Channel Availability Check Time (CAC)	☐	☐	☒
	Radar Burst at the Beginning of the CAC	☐	☐	☒
	Radar Burst at the End of the CAC	☐	☐	☒
15.407(h)(2); 7.8.3 In-Service Monitoring	Channel Move Time	☒	☐	☐
	Channel Closing Transmission Time	☒	☐	☐
	Non-Occupancy Period	☒	☐	☐
15.407; 7.8.4	Statistical Performance Check	☐	☐	☒

Remark: The EUT is Clients Device without Radar Detection.

7 General Remarks

Remarks

This submittal(s) (test report) is intended for FCC ID: 2BEWXTHP23, complies with DFS requirement in FCC Part 15 Subpart E.

SUMMARY:

All tests according to the regulations cited on page 5 were

■ - Performed

☐ - **Not** Performed

The Equipment Under Test

■ - **Fulfills** the general approval requirements.

☐ - **Does not** fulfill the general approval requirements.

Sample Received Date:	2025.01.02
Testing Start Date:	2025.02.18
Testing End Date:	2025.02.19

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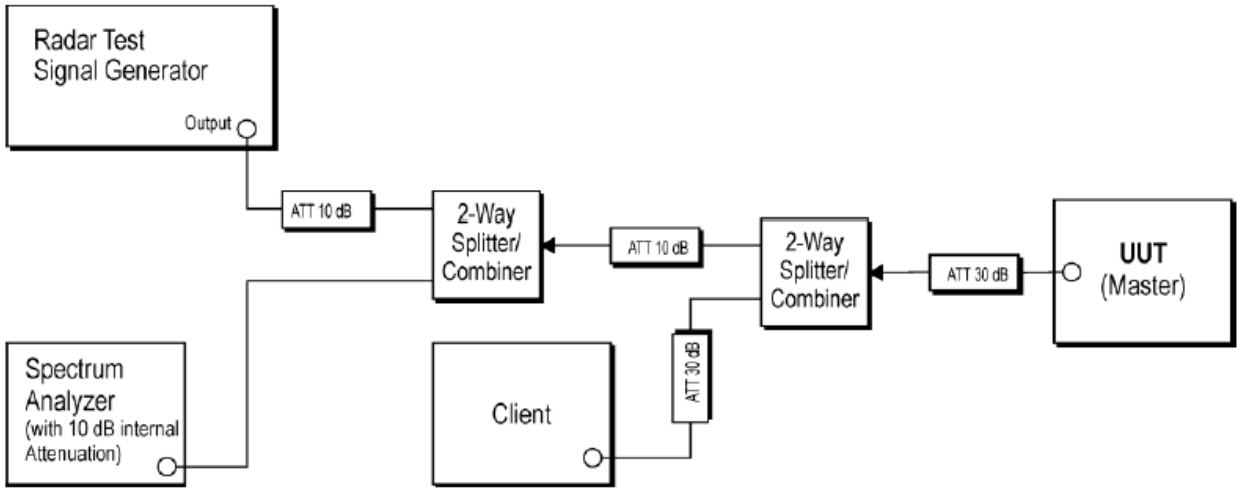
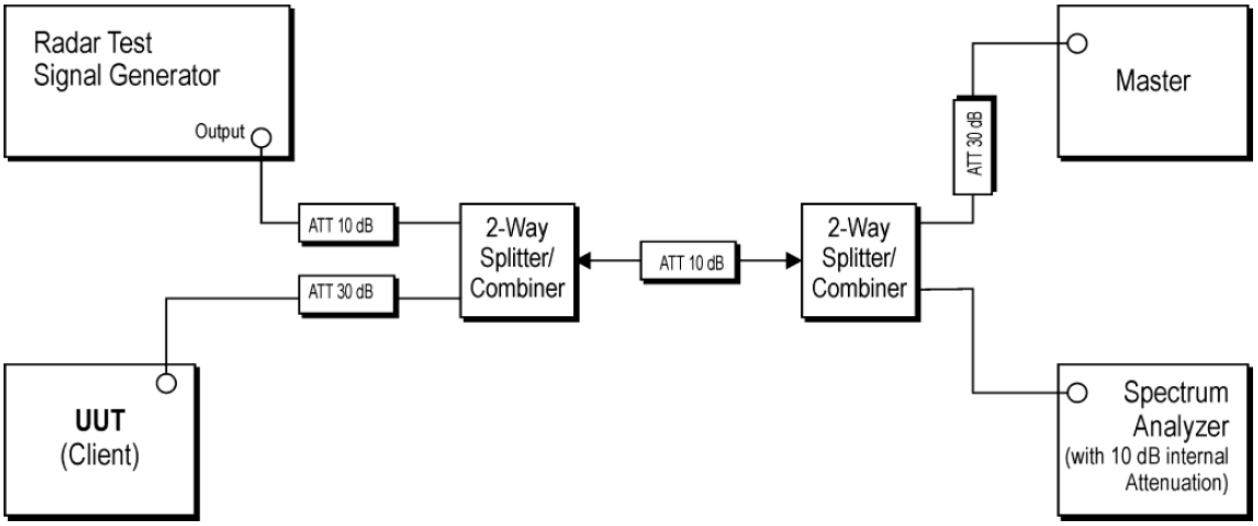
Reviewed by:	Prepared by:	Tested by:
Zhilan Xue	Xin Feng	Xu Zheng
Reviewer Engineer	Project Engineer	Test Engineer

8 Test setups

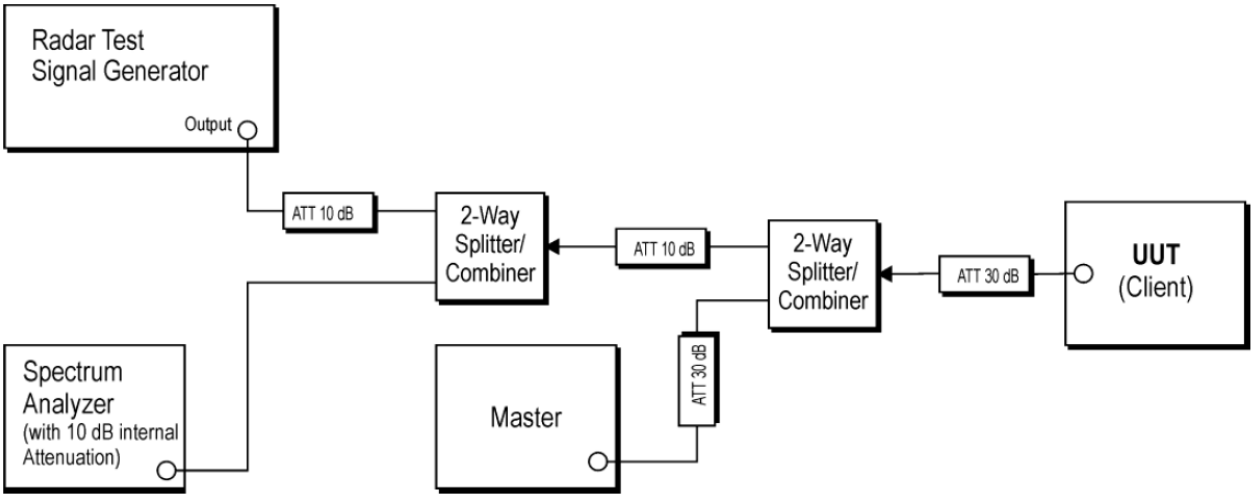
8.1 Setup for Master with injection at the Master



8.2 Setup for Client with injection at the Master



8.3 Setup for Client with injection at the Client



9 Systems test configuration

9.1 Auxiliary Equipment and software Used during Test:

DESCRIPTION	MANUFACTURER	MODEL NO.(SHIELD)	S/N(LENGTH)
Notebook	Huawei	VLT-W50	2018AP1231
Dual Band Wi-Fi Router (FCC ID: MSQ-RTAXJ300)	ASUS	RT-AX82U	M7ICI4000151

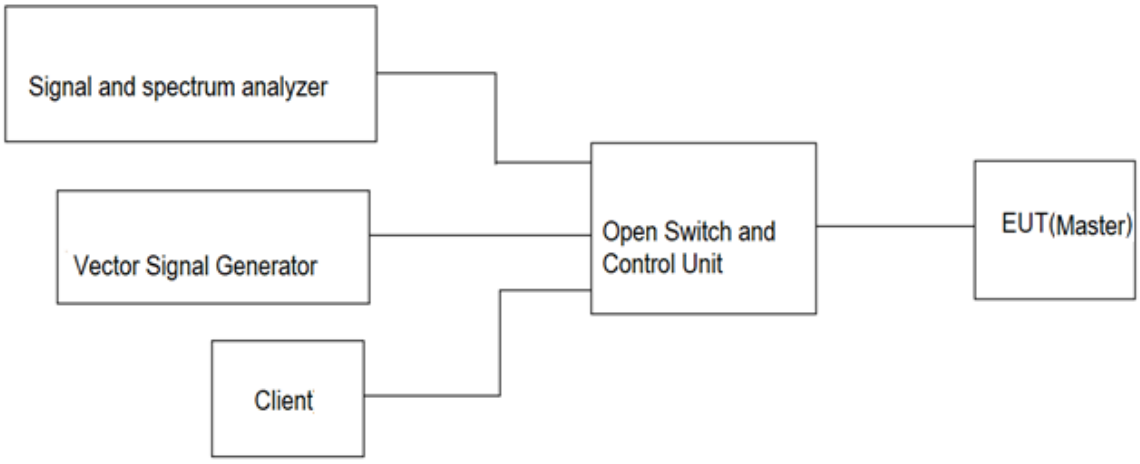
Test software: MTS 8310

The system was configured to channel:

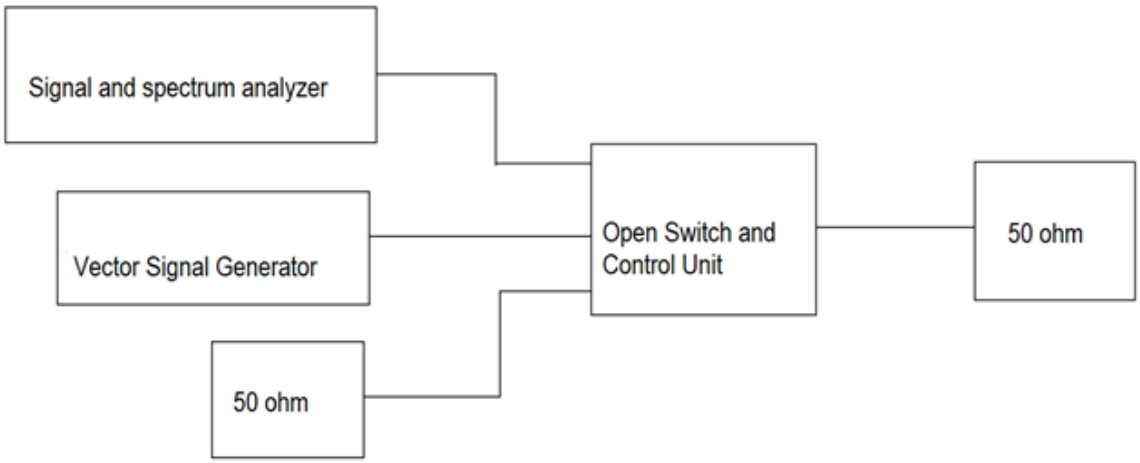
Test Mode	Channel (MHz)
802.11a	5G WIFI-Band 2
	CH64 (5320MHz)
	5G WIFI-Band 3
	CH100 (5500MHz)
802.11n HT20	5G WIFI-Band 2
	CH64 (5320MHz)
	5G WIFI-Band 3
	CH100 (5500MHz)

9.2 MWRF test system configuration

Conducted Test



Radar waveform calibration



9.3 Channel Loading

System testing will be performed with channel-loading using means appropriate to the data types that are used by the unlicensed device. The following requirements apply:

☐	a) The data file must be of a type that is typical for the device (i.e., MPEG-2, MPEG-4, WAV, MP3, MP4, AVI, etc.) and must generally be transmitting in a streaming mode.
☒	b) Software to ping the client is permitted to simulate data transfer but must have random ping intervals.
☒	c) Timing plots are required with calculations demonstrating a minimum channel loading of approximately 17% or greater. For example, channel loading can be estimated by setting the spectrum analyzer for zero span and approximate the Time On/ (Time On + Off Time). This can be done with any appropriate channel BW and modulation type.
☐	d) Unicast or Multicast protocols are preferable but other protocols may be used. The appropriate protocol used must be described in the test procedures.

10 Dynamic Frequency Selection (DFS) Requirement

10.1 DFS Overview

The following table from KDB 905462 lists the applicable requirements for the DFS testing.

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.		

10.2 DFS Detection Thresholds

Table 3 below provides the *DFS Detection Thresholds* for *Master Devices* as well as *Client Devices* incorporating *In-Service Monitoring*

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.	

10.3 Response Requirements

Table 4 provides the response requirements for *Master* and *Client Devices* incorporating DFS.

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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10.4 RADAR TEST WAVEFORMS

This section provides the parameters for required test waveforms, minimum percentage of successful detections, and the minimum number of trials that must be used for determining DFS conformance. Step intervals of 0.1 microsecond for Pulse Width, 1 microsecond for PRI, 1 MHz for chirp width and 1 for the number of pulses will be utilized for the random determination of specific test waveforms.

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	$\text{Roundup}\left\{\left(\frac{1}{360}\right)\cdot\left(\frac{19\cdot10^6}{\text{PRI}_{\mu\text{sec}}}\right)\right\}$	60%	30
		Test B: 15 unique PRI values randomly selected within the range of 518-3066 µsec, with a minimum increment of 1 µsec, excluding PRI values selected in Test A			
2	1-5	150-230	23-29	60%	30
3	6-10	200-500	16-18	60%	30
4	11-20	200-500	12-16	60%	30
Aggregate (Radar Types 1-4)				80%	120
Note 1: Short Pulse Radar Type 0 should be used for the detection bandwidth test, channel move time, and channel closing time tests.					

A minimum of 30 unique waveforms are required for each of the Short Pulse Radar Types 2 through 4. If more than 30 waveforms are used for Short Pulse Radar Types 2 through 4, then each additional waveform must also be unique and not repeated from the previous waveforms. If more than 30 waveforms are used for Short Pulse Radar Type 1, then each additional waveform is generated with Test B and must also be unique and not repeated from the previous waveforms in Tests A or B.

For example if in Short Pulse Radar Type 1 Test B a PRI of 3066 µsec is selected, the number of pulses would be

$$\text{Roundup}\left\{\left(\frac{1}{360}\right)\cdot\left(\frac{19\cdot10^6}{3066}\right)\right\} = \text{Round up } \{17.2\} = 18.$$

Table 5a - Pulse Repetition Intervals Values for Test A

Pulse Repetition Frequency Number	Pulse Repetition Frequency (Pulses Per Second)	Pulse Repetition Interval (Microseconds)
1	1930.5	518
2	1858.7	538
3	1792.1	558
4	1730.1	578
5	1672.2	598
6	1618.1	618
7	1567.4	638
8	1519.8	658
9	1474.9	678
10	1432.7	698
11	1392.8	718
12	1355	738
13	1319.3	758
14	1285.3	778
15	1253.1	798
16	1222.5	818
17	1193.3	838
18	1165.6	858
19	1139	878
20	1113.6	898
21	1089.3	918
22	1066.1	938
23	326.2	3066

The aggregate is the average of the percentage of successful detections of Short Pulse Radar Types 1-4. For example, the following table indicates how to compute the aggregate of percentage of successful detections.

Radar Type	Number of Trials	Number of Successful Detections	Minimum Percentage of Successful Detection
1	35	29	82.9%
2	30	18	60%
3	30	27	90%
4	50	44	88%
Aggregate (82.9% + 60% + 90% + 88%)/4 = 80.2%			

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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

The parameters for this waveform are randomly chosen. Thirty unique waveforms are required for the Long Pulse Radar Type waveforms. If more than 30 waveforms are used for the Long Pulse Radar Type waveforms, then each additional waveform must also be unique and not repeated from the previous waveforms.

Each waveform is defined as follows:
1) The transmission period for the Long Pulse Radar test signal is 12 seconds.
2) There are a total of 8 to 20 *Bursts* in the 12 second period, with the number of *Bursts* being randomly chosen. This number is *Burst Count*.
3) Each *Burst* consists of 1 to 3 pulses, with the number of pulses being randomly chosen. Each *Burst* within the 12 second sequence may have a different number of pulses.
4) The pulse width is between 50 and 100 microseconds, with the pulse width being randomly chosen. Each pulse within a *Burst* will have the same pulse width. Pulses in different *Bursts* may have different pulse widths.
5) Each pulse has a linear frequency modulated chirp between 5 and 20 MHz, with the chirp width being randomly chosen. Each pulse within a *transmission period* will have the same chirp width. The chirp is centered on the pulse. For example, with a radar frequency of 5300 MHz and a 20 MHz chirped signal, the chirp starts at 5290 MHz and ends at 5310 MHz.
6) If more than one pulse is present in a *Burst*, the time between the pulses will be between 1000 and 2000 microseconds, with the time being randomly chosen. If three pulses are present in a *Burst*, the random time interval between the first and second pulses is chosen independently of the random time interval between the second and third pulses.
7) The 12 second transmission period is divided into even intervals. The number of intervals is equal to *Burst Count*. Each interval is of length (12,000,000 / *Burst Count*) microseconds. Each interval contains one *Burst*. The start time for the *Burst*, relative to the beginning of the interval, is between 1 and [(12,000,000 / *Burst Count*) – (Total *Burst* Length) + (One Random PRI Interval)] microseconds, with the start time being randomly chosen. The step interval for the start time is 1 microsecond. The start time for each *Burst* is chosen randomly.

A representative example of a Long Pulse Radar Type waveform:
1) The total test waveform length is 12 seconds.
2) Eight (8) *Bursts* are randomly generated for the *Burst Count*.
3) *Burst* 1 has 2 randomly generated pulses.
4) The pulse width (for both pulses) is randomly selected to be 75 microseconds.
5) The PRI is randomly selected to be at 1213 microseconds.
6) *Bursts* 2 through 8 are generated using steps 3 – 5.
7) Each *Burst* is contained in even intervals of 1,500,000 microseconds. The starting location for Pulse 1, *Burst* 1 is randomly generated (1 to 1,500,000 minus the total *Burst* 1 length + 1 random PRI interval) at the 325,001 microsecond step. *Bursts* 2 through 8 randomly fall in successive 1,500,000 microsecond intervals (i.e. *Burst* 2 falls in the 1,500,001 – 3,000,000 microsecond range).

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

For the Frequency Hopping Radar Type, the same *Burst* parameters are used for each waveform. The hopping sequence is different for each waveform and a 100-length segment is selected from the hopping sequence defined by the following algorithm:
The first frequency in a hopping sequence is selected randomly from the group of 475 integer frequencies from 5250 – 5724 MHz. Next, the frequency that was just chosen is removed from the group and a frequency is randomly selected from the remaining 474 frequencies in the group. This process continues until all 475 frequencies are chosen for the set. For selection of a random frequency, the frequencies remaining within the group are always treated as equally likely.

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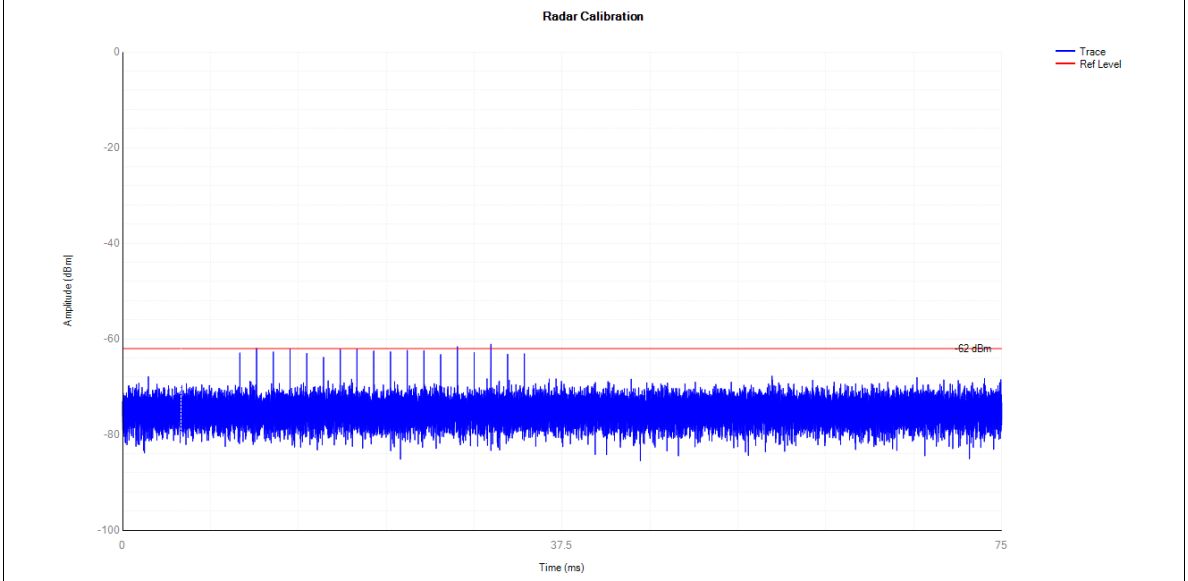
11 Test Result

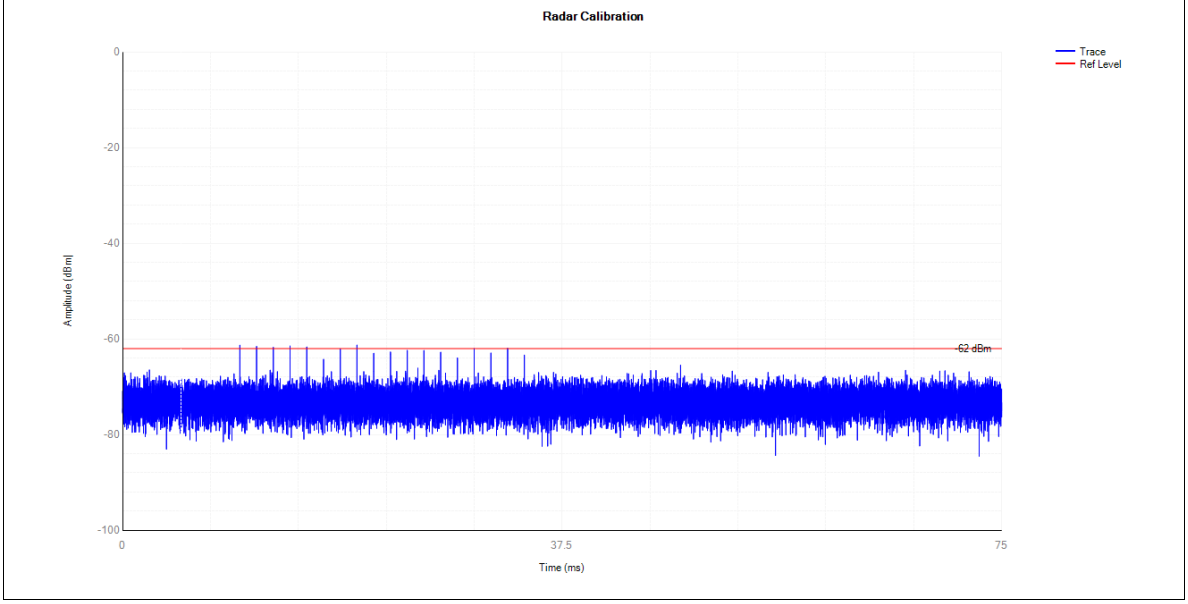
Calibration

Frequency (MHz)	Type	Result	Verdict
5320	DFS_FCC_T0	See test Graph	Pass
5500	DFS_FCC_T0	See test Graph	Pass

5320MHz DFS_FCC_T0



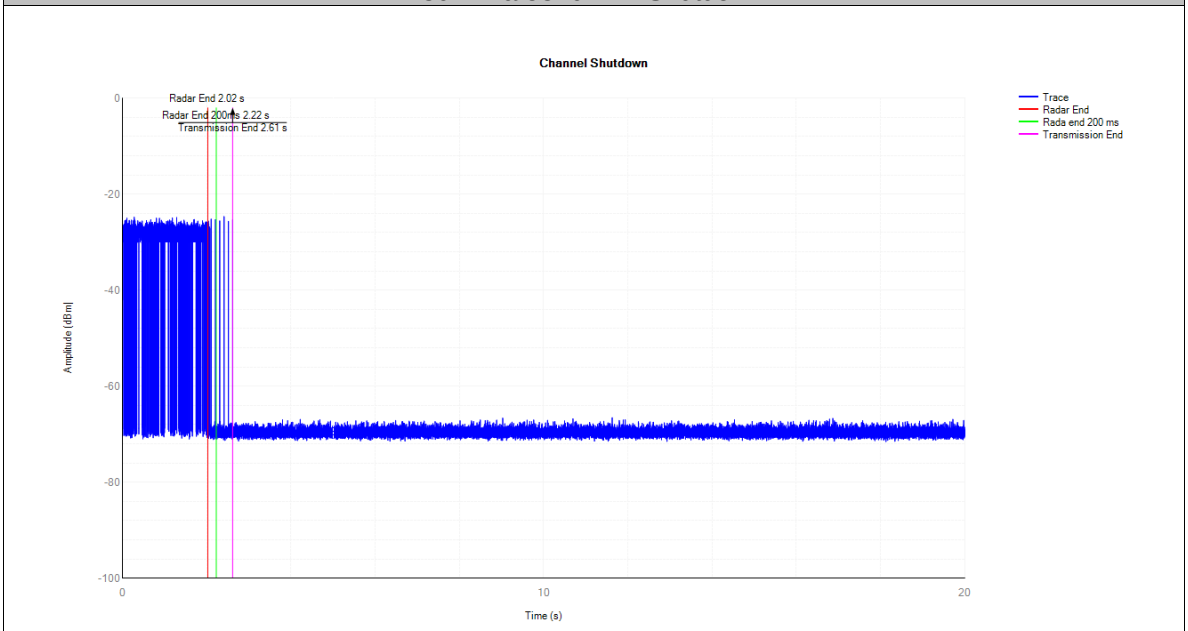
5500MHz DFS_FCC_T0



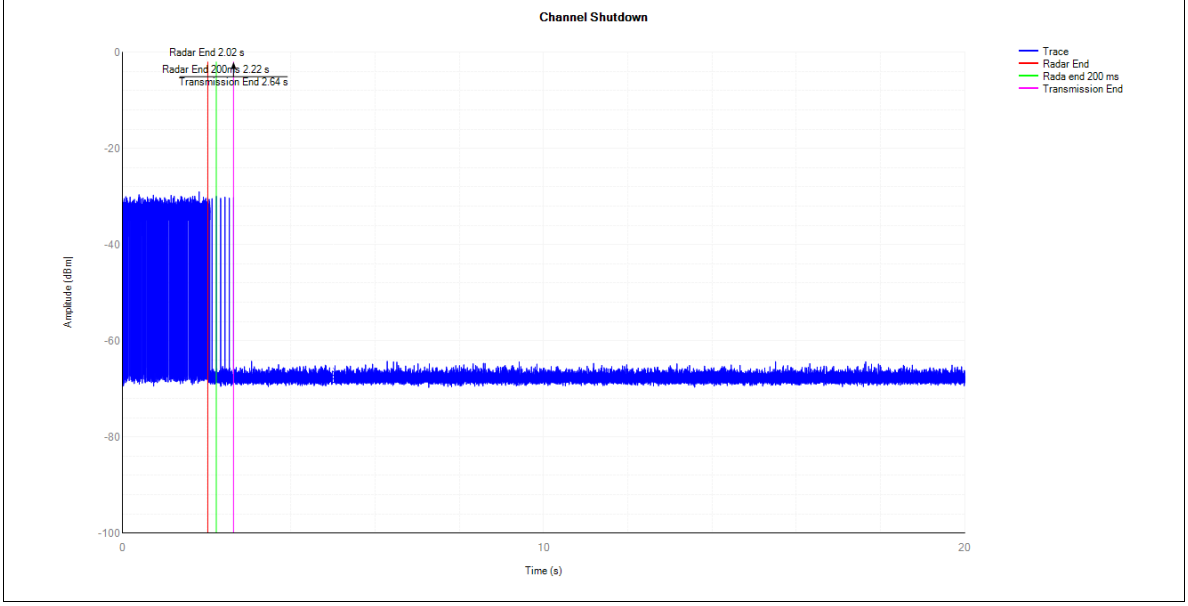
Shutdown Time

Mode	Frequency (MHz)	Channel Move Time (s)	Limit Channel Move Time (s)	Close Transmission Time (s)	Limit Close Transmission Time (s)	Close Transmission Time after 200ms(s)	Limit Close Transmission Time after 200ms (s)	Verdict
802.11a	5320	0.59	10	0.036	0.26	0.003	0.06	Pass
802.11a	5500	0.612	10	0.043	0.26	0.004	0.06	Pass
802.11n HT20	5320	0.64	10	0.025	0.26	0.005	0.06	Pass
802.11n HT20	5500	0.55	10	0.027	0.26	0.004	0.06	Pass

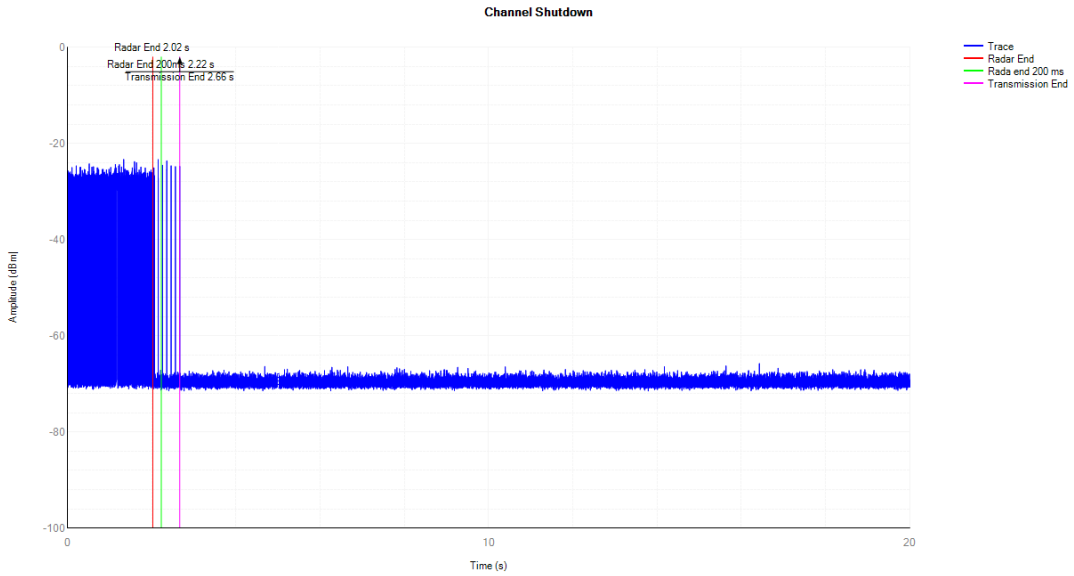
802.11a 5320MHz Shutdown



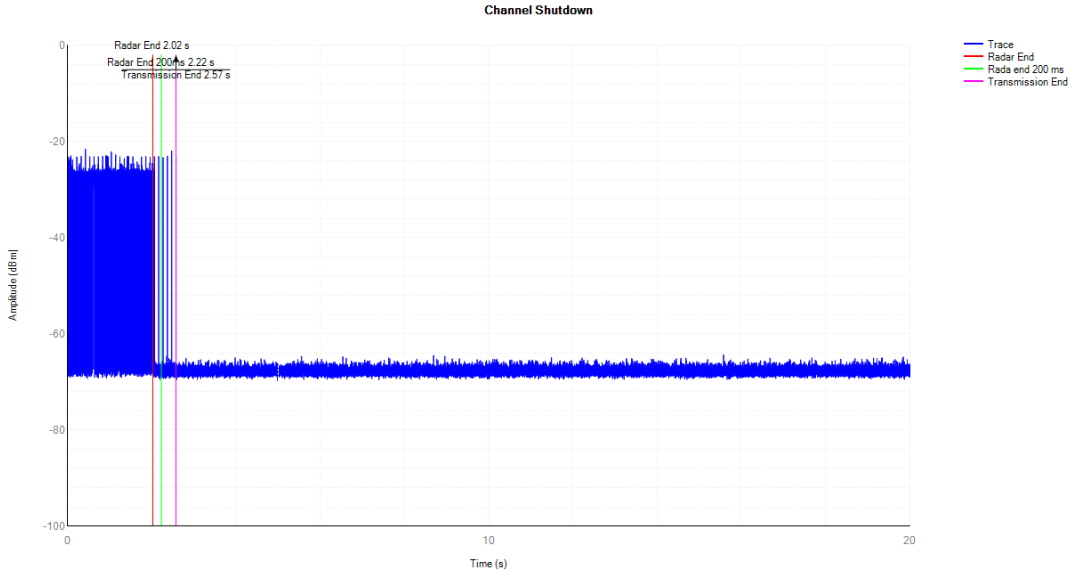
802.11a 5500MHz Shutdown



802.11n HT20 5320MHz Shutdown



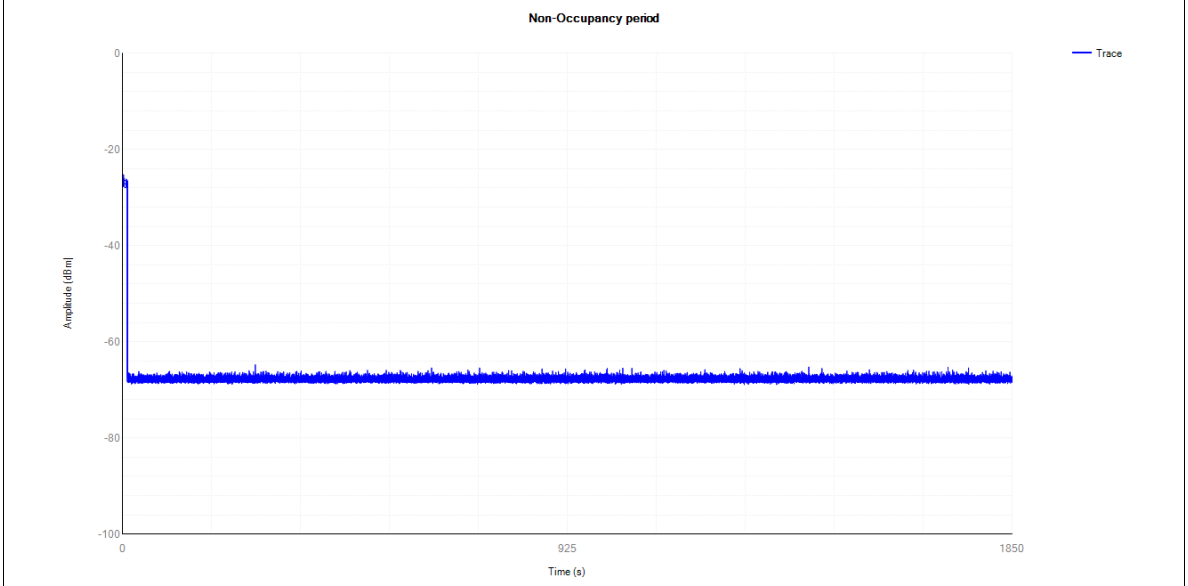
802.11n HT20 5500MHz Shutdown



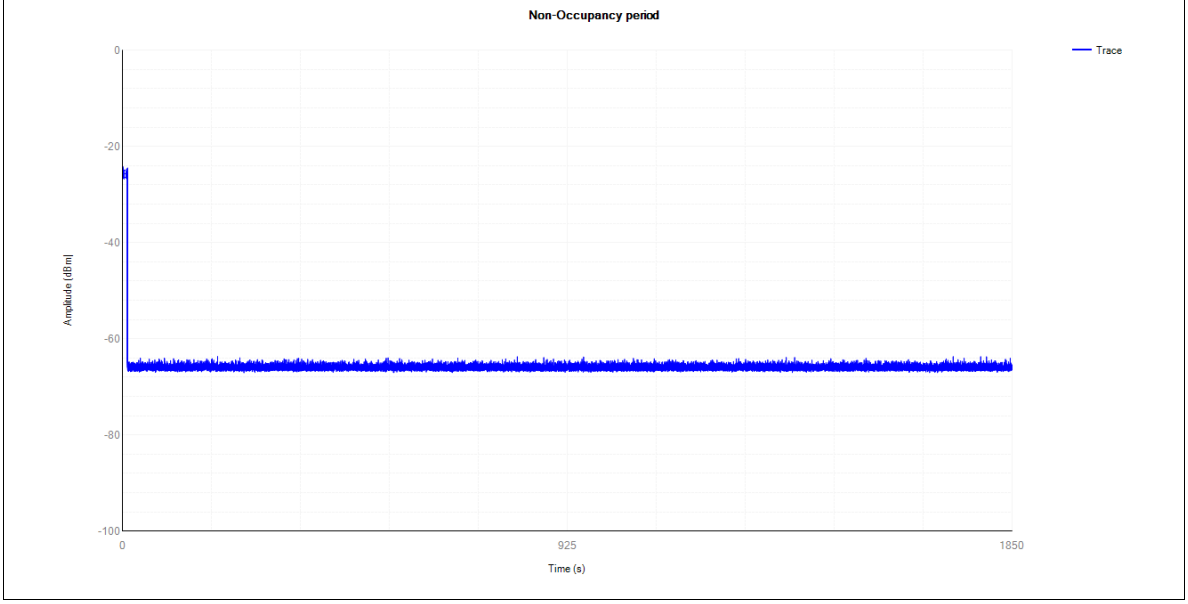
Non-Occupancy

Mode	Frequency (MHz)	Result	Verdict
802.11a	5320	See test Graph	Pass
802.11a	5500	See test Graph	Pass
802.11n HT20	5320	See test Graph	Pass
802.11n HT20	5500	See test Graph	Pass

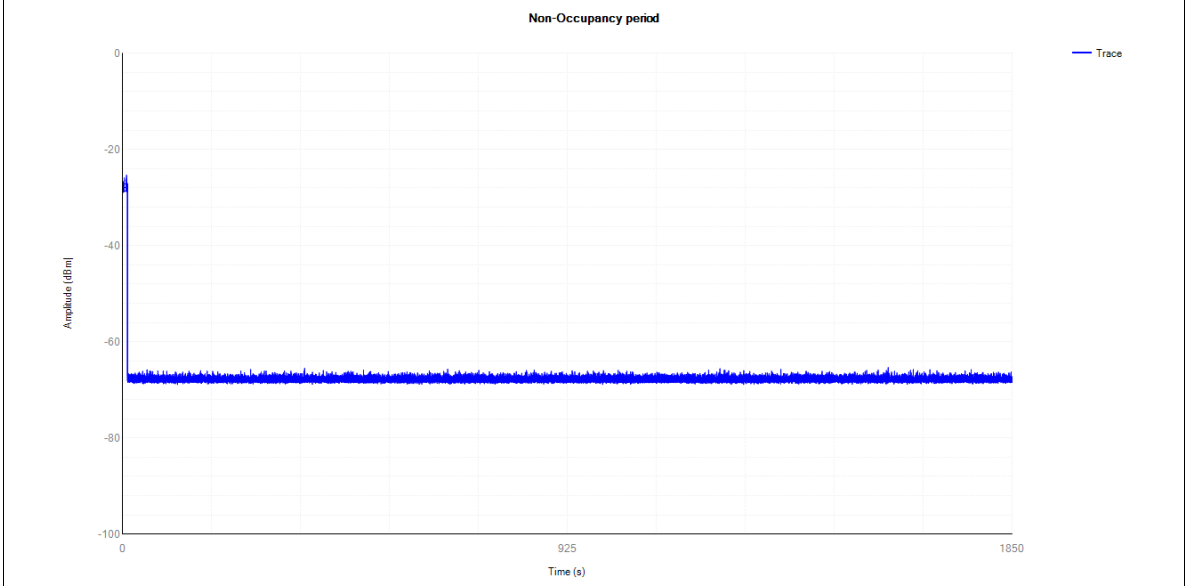
802.11a 5320MHz Non-Occupancy



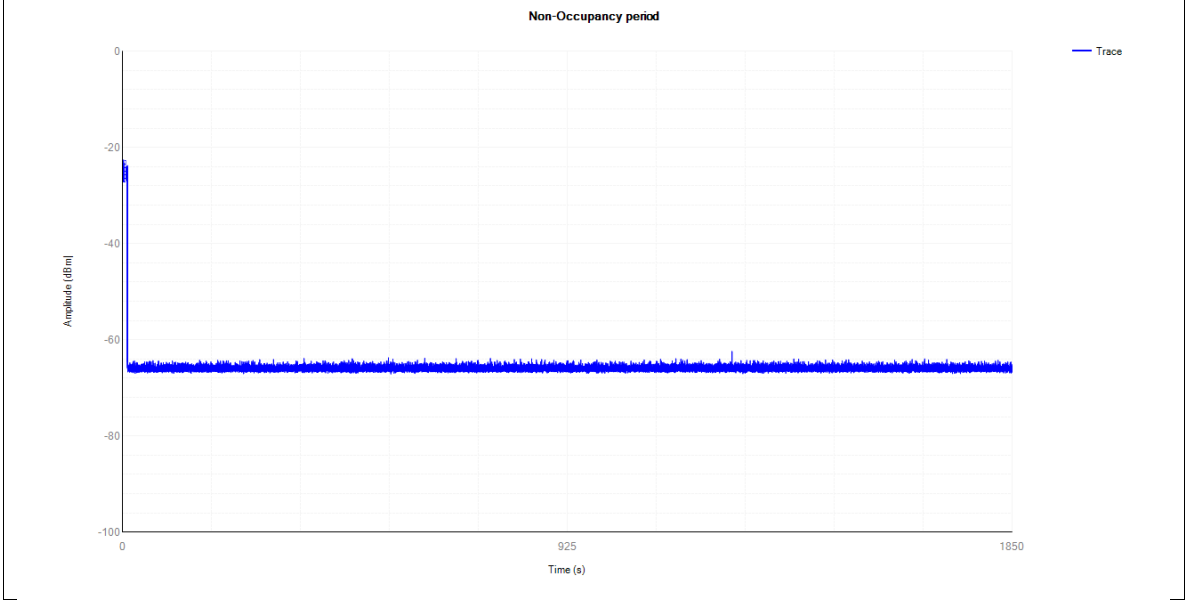
802.11a 5500MHz Non-Occupancy



802.11n HT20 5320MHz Non-Occupancy



802.11n HT20 5500MHz Non-Occupancy



12 Test Equipment List

DESCRIPTION	MANUFACTURER	MODEL NO.	SERIAL NO.	CAL. DATE	CAL. DUE DATE
Signal Analyzer	Rohde & Schwarz	FSV40	487/641405	2024-4-8	2025-4-7
Open Switch and Control Platform	Rohde & Schwarz	OSP-B157W8	487/391835-2	2024-11-23	2025-11-22
Signal generator	Rohde & Schwarz	SMB100A	487/391835-3	2024-11-23	2025-11-22
Vector signal generator	Rohde & Schwarz	SMBV100A	487/391835-4	2024-11-23	2025-11-22

Measurement Software Information		
Software	Manufacturer	Version
MTS 8310	MAXWELL	2.0.0.0

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13 System Measurement Uncertainly

For a 95% confidence level, the measurement expanded uncertainties for defined systems, in accordance with the recommendations of ISO 17025 were:

System Measurement Uncertainty	
Test Items	Extended Uncertainty
Uncertainty for Conducted RF test	RF Power Conducted: 1.32dB Frequency test involved:1%

Measurement Uncertainty Decision Rule:

Determination of conformity with the specification limits is based on the decision rule according to IEC Guide 115: 2023, clause 4.3.3.

----------End of Test Report----------

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