DFS Testing of the Comma.ai, Inc. 2.4/5 GHz WiFi Module Model: LightningHard SOM

In accordance with FCC Part 15 Subpart H §15.407 and IC RSS-247 Issue 3 August 2023

America

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Comma.ai, Inc.
3900 Harney St.
San Diego, CA 92110
USA

COMMERCIAL-IN-CONFIDENCE

Date: May 2024
Document Number: 72198710 Issue 01 | Version Number: 01

RESPONSIBLE FOR	NAME	DATE	SIGNATURE
Authorized Signatory	Omar Castillo	May 13, 2024	

Signatures in this approval box have checked this document in line with the requirements of TÜV SÜD document control rules.

EXECUTIVE SUMMARY
A sample of this product was tested and found to be in compliance with FCC Part 15 Subpart H §15.407 and IC RSS-247 Issue 3 August 2023.

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TÜV SÜD America, Inc.
10040 Mesa Rim Road
San Diego, CA 92121-2912

TÜV SÜD America, Inc.
Rancho Bernardo Facility
16936 Via Del Campo
San Diego, CA 92127

Phone: 858 678 1400
www.TÜV-sud-america.com

REPORT ON	DFS Testing of the Comma.ai, Inc. Model: LightningHard SOM
TEST REPORT NUMBER	72198710
TEST REPORT DATE	May 2024
PREPARED FOR	Comma.ai, Inc. 3900 Harney St. San Diego, CA 92110 USA
CONTACT PERSON	Alex Matzner Chief Operating Officer alex.matzner@comma.ai +1 (858) 779-4335
PREPARED BY	Ferdinand S. Custodio **Name** Authorized Signatory Title: Senior EMC Test Engineer / Wireless Team Lead
APPROVED BY	Omar Castillo **Name** Authorized Signatory Title: Senior EMC/Wireless Test Engineer
DATED	May 13, 2024

Revision History

72198710 Comma.ai, Inc. Model: LightningHard SOM					
DATE	OLD REVISION	NEW REVISION	REASON	PAGES AFFECTED	APPROVED BY
05/13/2024	—	Initial Release			Omar Castillo

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SECTION 1

REPORT SUMMARY

DFS Testing of the
Comma.ai, Inc.
LightningHard SOM

1.1 INTRODUCTION

The information contained in this report is intended to show verification of the LightningHard SOM 2.4/5 GHz WiFi Module to the requirements of FCC Part 15 Subpart H §15.407 and IC RSS-247 Issue 3 August 2023.

Objective	To perform DFS Testing to determine the Equipment Under Test's (EUT's) compliance with the Test Specification, for the series of tests carried out.
Manufacturer	Comma.ai, Inc.
EUT	2.4/5 GHz WiFi Module
Model Number	LightningHard SOM
FCC ID	2BFC6-LIGHTNINGH
ISED/IC Number	32232-LIGHTNINGH
Operational Mode	Client Without Radar Detector
Serial Number(s)	N/A
Number of Samples Tested	1
Test Specification/Issue/Date	• FCC Part 15 Subpart H §15.407 (October 1, 2023). • RSS-247–Digital Transmission Systems (DTS), Frequency Hopping Systems (FHSS) and Licence-Exempt Local Area Network (LE-LAN) Devices (Issue 3, August 2023). • RSS-Gen - General Requirements for Compliance of Radio Apparatus (Issue 5, Amendment 2 February 2021).
Start of Test	April 05, 2024
Finish of Test	April 05, 2024
Name of Engineer(s)	Ferdinand Custodio
Related Document(s)	• 905462 D02 UNII DFS Compliance Procedures New Rules v02. • 905462 D03 Client Without DFS New Rules v01r02.

1.2 TEST REQUIREMENTS

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

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.

1.3 BRIEF SUMMARY OF RESULTS

A brief summary of the tests carried out in accordance with FCC Part 15 Subpart H §15.407 with cross-reference to the corresponding IC RSS standard are shown below.

Section	§15.407 Spec Clause	RSS	Test Description	Result
2.1	§15.407(h) and KDB 905462	RSS-247 6.3	In-Service Monitoring (U-NII-2A)	
			Channel Move Time	Compliant
			Channel Closing Transmission Time	Compliant
			Non-occupancy period	Compliant
2.2	§15.407(h) and KDB 905462	RSS-247 6.3	In-Service Monitoring (U-NII-2C)	
			Channel Move Time	Compliant
			Channel Closing Transmission Time	Compliant
			Non-occupancy period	Compliant

1.4 PRODUCT INFORMATION

1.4.1 Technical Description

The Equipment Under Test (EUT) is a Comma.ai, Inc. LightningHard SOM. It is a 2.4/5 GHz WiFi Module with 2x2 MIMO WLAN functionality, spatial MIMO functionality, 2x2, implemented physically by means of two independent antenna connectors. It operates in both the 2.4GHz (DSSS and OFDM) and 5GHz (OFDM) bands (802.11a/b/g/n/ac). The EUT is mounted on a test board when verified.

Equipment Under Test

1.4.2 EUT General Description

EUT Description	2.4/5 GHz WiFi Module
Model Name	LightningHard SOM
Model Number(s)	LightningHard SOM
Rated Voltage	12VDC (TMEZON Adaptor Model: MZ-12V2A-2.4M Input: 100-240V, 50/60Hz 1A Output: 12VDC, 2A)
Mode Verified	Wi-Fi 802.11a/n/ac (Master device default setting for 5GHz)
Capability	Wi-Fi 802.11a/b/g/n/ac
Primary Unit (EUT)	☐ Production ☐ Pre-Production ☒ Engineering
Operational Mode	Client without radar detection
Operating Modes	802.11 a (20MHz), n20, n40, ac20, ac40, ac80
Maximum Conducted Output Power	WLAN 5GHz U-NII-1: 17.29 dBm WLAN 5GHz U-NII-2A: 17.15 dBm WLAN 5GHz U-NII-2C: 16.56 dBm WLAN 5GHz U-NII-3: 13.01 dBm
Channel Plan	

Mode	Frequency Range (MHz)
802.11a, 802.11n (HT20), 802.11n (HT40), 802.11ac (20 MHz), 802.11ac (40 MHz) and 802.11ac (80 MHz)	U-NII-1
	U-NII-2A
	U-NII-2C
	U-NII-3

TPC Support	☐ Yes ☒ No
System Architecture	☒ IP Based ☐ Frame Based
FCC ID of Master Device (if EUT is a Client Device)	MSQ-RTAX6800
EUT Unintentional Radiator Compliance	The EUT was evaluated for unintentional emissions and was found to be compliant. Compliance for unintentional emissions was verified by SGS North America , Inc. and is documented under report number 208726-2 with issue date of 05/10/2024.
Master Device Power-On Cycle	48.261 seconds

	Antenna	
	WLAN 0 (Primary)	**WLAN 1 (Secondary)**
Type	PCB Omnidirectional	PCB Omnidirectional
Manufacturer	TE Connectivity	TE Connectivity
Part Number	TE 2344654-7	TE 2344654-7
Dimensions	30mm x 9.5mm x 1mm	30mm x 9.5mm x 1mm
Peak Gain 5GHz	5.7 dBi	5.7 dBi

Test Configuration	☐ Radiated ☒ Conducted
Antenna Port Tested (if Conducted)	Both (WLAN 0 and 1), combined using 2-way power divider/combiner
Channel Loading Configuration	Simulated server using iPerf3. Data loading kept at >17%.

1.5 EUT TEST CONFIGURATION

1.5.1 Test Configuration Description

Test Configuration	Description
Default	EUT associated with the Master device on channel 52 (U-NII-2A) or channel 116 (U-NII-2C). A support laptop on the same network running iPerf3 is used to create data transfer with the EUT. Channel loading is kept at >17%.

Note: Channel selection is based on representing both U-NII-2A and U-NII-2C bands and the widest BW mode available for the link at the time of testing (Master device dependent).

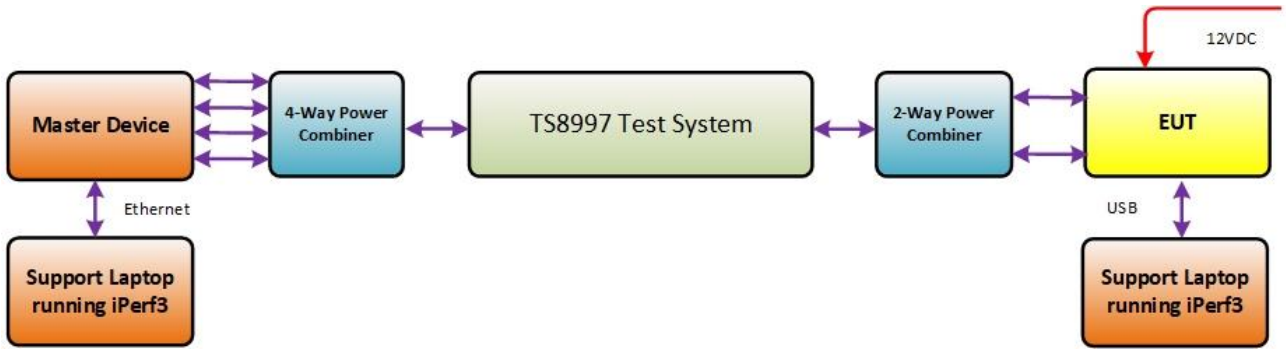
1.5.2 EUT Exercise Software

iPerf 3.1.3

1.5.3 Support Equipment and I/O cables

Manufacturer	Equipment/Cable	Description
Asus	Master device	Model RT-AX88U Pro S/N R1IG68203295ZMD FCC ID MSQ-RTAX6800
Lenovo	Laptop for EUT	Thinkpad T440S S/N PC-03BBGR
Lenovo	Laptop for Master device	Thinkpad P17 S/N PF-30AAHS
Weinschel	Power Divider/Splitter	Model 93459 S/N 1515 Broadband DC to 18GHz
MCLI	4 Way Power Divider	Model PS4-109 S/N 177 0.3 to 3GHz, verified up to 6GHz

1.5.1 Simplified Test Configuration Diagram



1.6 DEVIATIONS FROM THE STANDARD

No deviations from the applicable test standards or test plan were made during testing.

1.7 MODIFICATION RECORD

Description of Modification	Modification Fitted By	Date Modification Fitted
Serial Number: No modifications		
N/A	-	-

The table above details modifications made to the EUT during the test programme. The modifications incorporated during each test (if relevant) are recorded on the appropriate test pages.

1.8 TEST METHODOLOGY

All measurements contained in this report were conducted as per KDB905462 D02 UNII DFS Compliance Procedures New Rules v02. Compliance Measurement Procedures For Unlicensed-National Information Infrastructure Devices Operating In The 5250-5350 MHz And 5470-5725 MHz Bands Incorporating Dynamic Frequency Selection (April 08, 2016).

1.9 TEST FACILITY LOCATION

1.9.1 TÜV SÜD America Inc. (Mira Mesa)

10040 Mesa Rim Road, San Diego, CA 92121-2912 (32.901268,-117.177681). Phone: (858) 678-1400 FAX: (858) 546-0364

1.9.2 TÜV SÜD America Inc. (Rancho Bernardo)

16936 Via Del Campo, San Diego, CA 92127-1708 (33.018644,-117.092409). Phone: (858) 678-1400 FAX: (858) 546-0364.

1.10 TEST FACILITY REGISTRATION

1.10.1 FCC – Designation No.: US1146

TÜV SÜD America Inc. (San Diego), is an accredited test facility with the site description report on file and has met all the requirements specified in §2.948 of the FCC rules. The acceptance letter from the FCC is maintained in our files and the Designation is US1146.

1.10.2 Innovation, Science and Economic Development Canada (ISED) Registration No.: 3067A-1 & 22806-1

The 10m Semi-anechoic chamber of TÜV SÜD America Inc. (San Diego Rancho Bernardo) has been registered by Certification and Engineering Bureau of Innovation, Science and Economic Development Canada for radio equipment testing with Registration No. 3067A-1.

The 3m Semi-anechoic chamber of TÜV SÜD America Inc. (San Diego Mira Mesa) has been registered by Certification and Engineering Bureau of Innovation, Science and Economic Development Canada for radio equipment testing with Registration No. 22806-1.

1.11 DFS Test System

The DFS system consists of hardware and software. The R&S®TS8997 is a wireless measurement system for regulatory testing in line with FCC §15.407.

1.11.1 Short Pulse Radar Test Waveforms (Types 0-4)

The short pulse radar simulation is a conventional amplitude pulse with varying pulse widths, pulse rate intervals (PRI) and number of pulses. General characteristics for these types and number of repetitions required by the standard are as follows:

Radar Type	Pulse Width (µsec)	PRI (µsec)	Number of Pulses
0	1	1428	18
1	1	**Test A**: 15 unique PRI values randomly selected	Roundup((1/360)x(19x10 ^{6}/PRI$_{\mu sec}$)
		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
3	6-10	200-500	16-18
4	11-20	200-500	12-16

1.11.2 Long Pulse Radar Test Waveforms (Types 5)

The long pulse radar simulation is a 12 second concatenated series of chirps, chosen randomly. The general characteristics for Type 5 and number of repetitions required by the standard are as follows:

Radar Type	Pulse Width (µsec)	Chirp Width (MHz)	PRI (µsec)	Number of Pulses
5	50-100	5-20	1000-2000	1-3

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 Burst will have the same chirp width. Pulses in different Bursts may have different chirp widths. 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.

1.11.3 Frequency Hopping Radar Test Waveform (Types 6)

Radar Type	Pulse Width (µsec)	PRI (µsec)	Pulse per Hop	Hopping Rate (kHz)	Hopping Sequence Length (msec)
6	1	333	9	0.333	300

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.

SECTION 2

TEST DETAILS

DFS Testing of the
Comma.ai, Inc.
LightningHard SOM

2.1 DFS In-Service Monitoring (5260 MHz)

2.1.1 Specification Reference

FCC title 47 part 15 §15.407(h), KDB 905462 D02 U-NII DFS Compliance Procedures New Rules v02
RSS-247, Clause 6.3

2.1.2 Measurement Summary

DUT Frequency (MHz)	Radar Type No.	Type of Measurement value	Overall Result	Overall Comment
5260.000000	0	First of all Transmitt Test	---	not performed / not finished
5260.000000	0	Channel Move Time	PASS	
5260.000000	0	Channel Closing Transmission Time	PASS	
5260.000000	0	Non-occupancy period	PASS	Overall Comment

2.1.3 Channel Move Time Detailed Result

DUT Frequency (MHz)	Radar Type No.	CMT Tx Time (s)	CMT Limit (s)	CMT Result	CMT Comment
5260.000000	0	0.819	10.000	PASS	Tx Time value is last trailing edge found within sweep. See Note 1.

2.1.4 Channel Closing Transmission Time Detailed Results

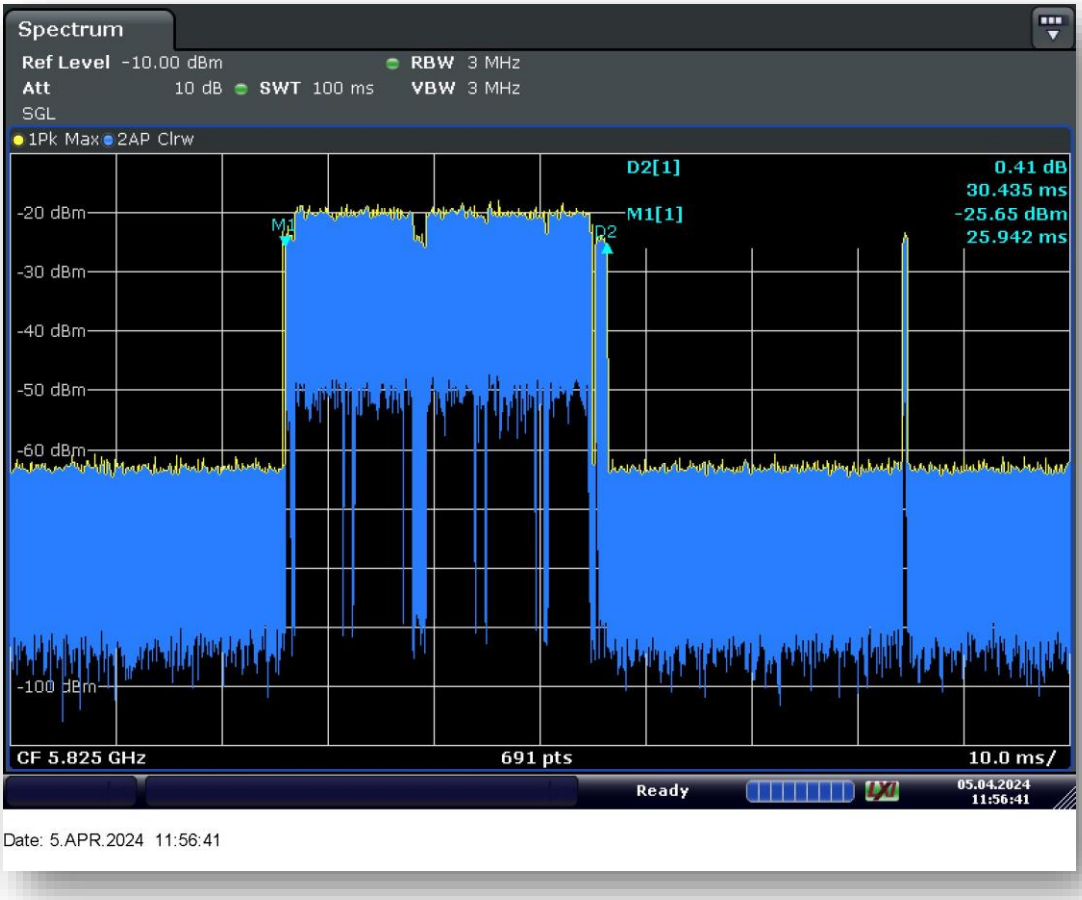
DUT Frequency (MHz)	Radar Type No.	CCTT Type of Value	CCTT No. of Pulses found	CCTT Tx Time (ms)	CCTT Tx Time Limit (ms)	CCTT Result	CCTT Comment
5260.0000	0	first 200 ms	50	15.820	200.000	PASS	See Note 1.
5260.0000	0	remaining 10.0	16	3.632	60.000	PASS	See Note 1.

2.1.5 Non-occupancy period Detailed Results

DUT Frequency (MHz)	Radar Type No.	NOP No. of Pulses found	NOP No. of Pulses Limit	NOP Tx Time (s)	NOP Tx Time Limit (s)	NOP Result
5260.00000	0	0	0	0.000	0.000	PASS

2.1.6 Transmitting Test Detailed Results

DUT Frequency (MHz)	Tx-Test Duty Cycle (%)	Tx-Test Duty Cycle Limit	TX-Test Result
Representative (plot presented is when EUT moved with Master)	30.435%	≥ 17%	PASS

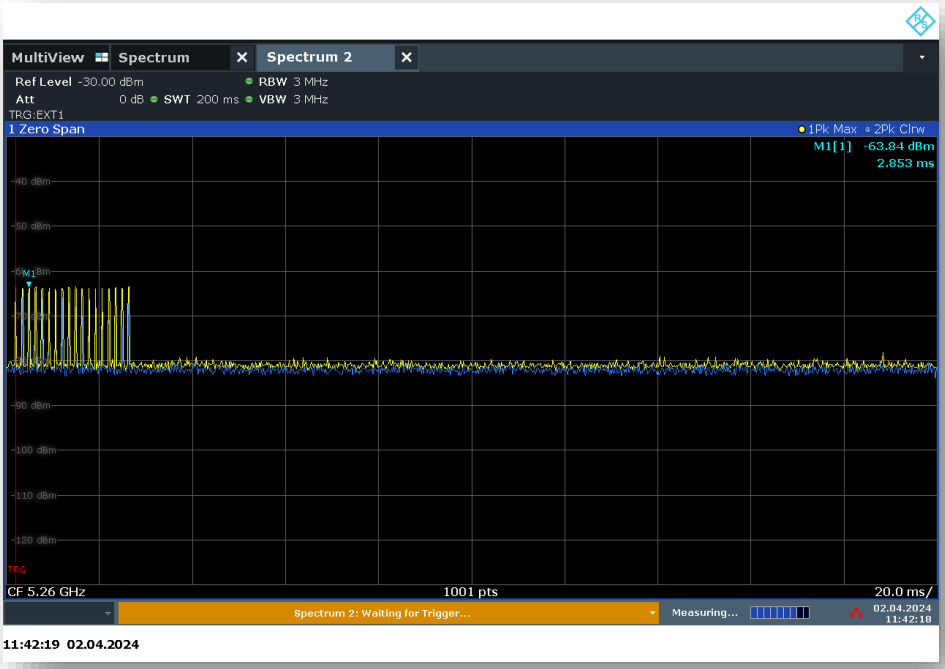


Note: The plot is taken when the EUT moved with the Master to another channel during testing but the loading is identical.

2.1.7 Radar level verification

Description / Formula	Value	Unit
IF(({DFS Mode(0/1/2)}=0)or({DFS Mode(0/1/2)}=1) , IF((dBm2W({Nominal Power[dBm]})>0.2) , -64 , IF(({Configured PSD[dBm]}<10) , -62 , -64))+ {Attenuation Vector Generator to DUT[dB]} , -50+ {Attenuation Vector Generator to COMP[dB]})+ {Radar Signal Level Offset[dB]}	Given setting / formula to calculate Vector Generator level	--

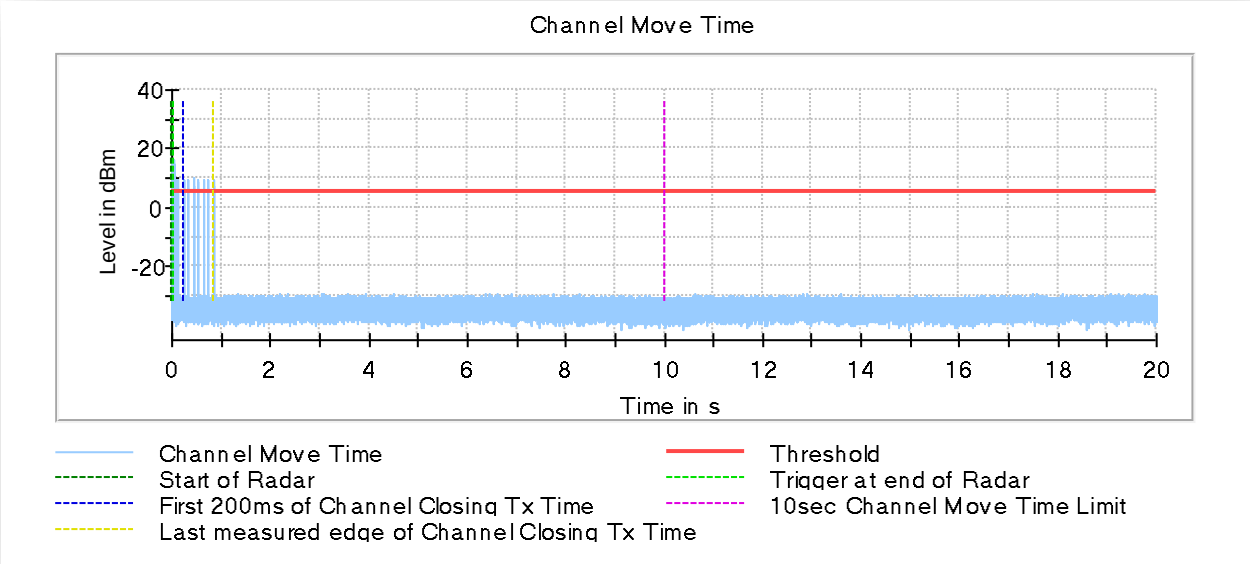
Configured DUT EIRP:	19.95	mW
Configured DUT PSD:	3.00	dBm/MHz
Requirement of the Detection threshold value for this given values acc. to FCC clause 5.2 / Table 3	-62	dBm
Vector Generator level setting	13.77	dBm
Configured overall pathloss from Vector Generator RF out to DUT connector of 'DUT to OSP'-cable	42.95	dB
Given additional level added to the amplitude of the waveform to account for variations in measurement equipment acc. to FCC clause 5.2 / Table 3 / Note 2	1.00	dB
This results in the following radar signal level at the DUT	-29.19	dBm

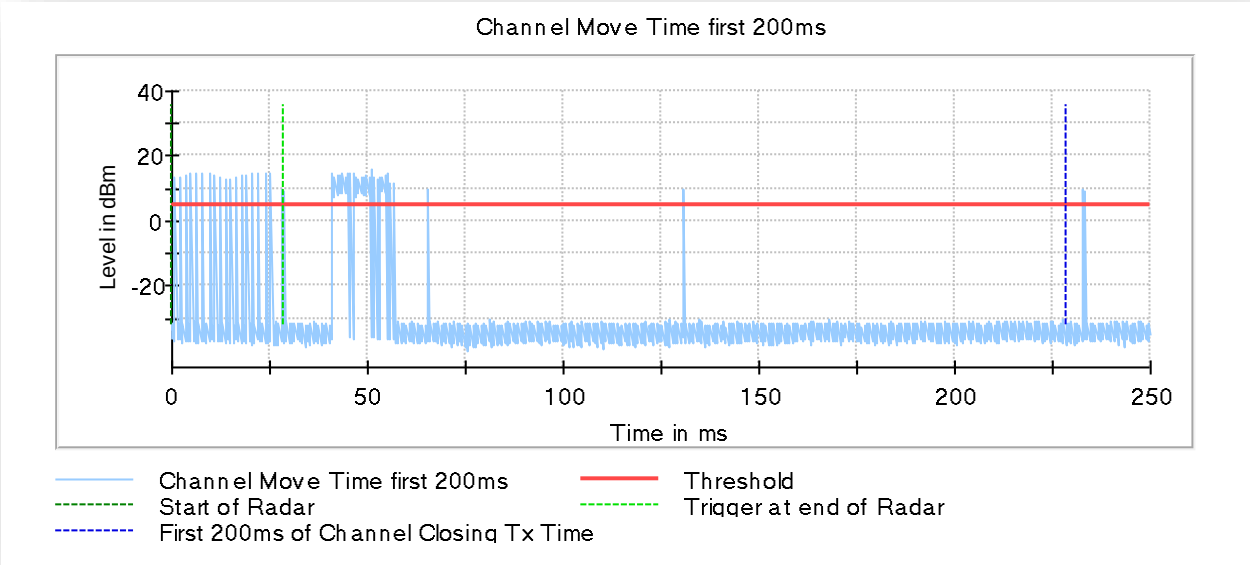


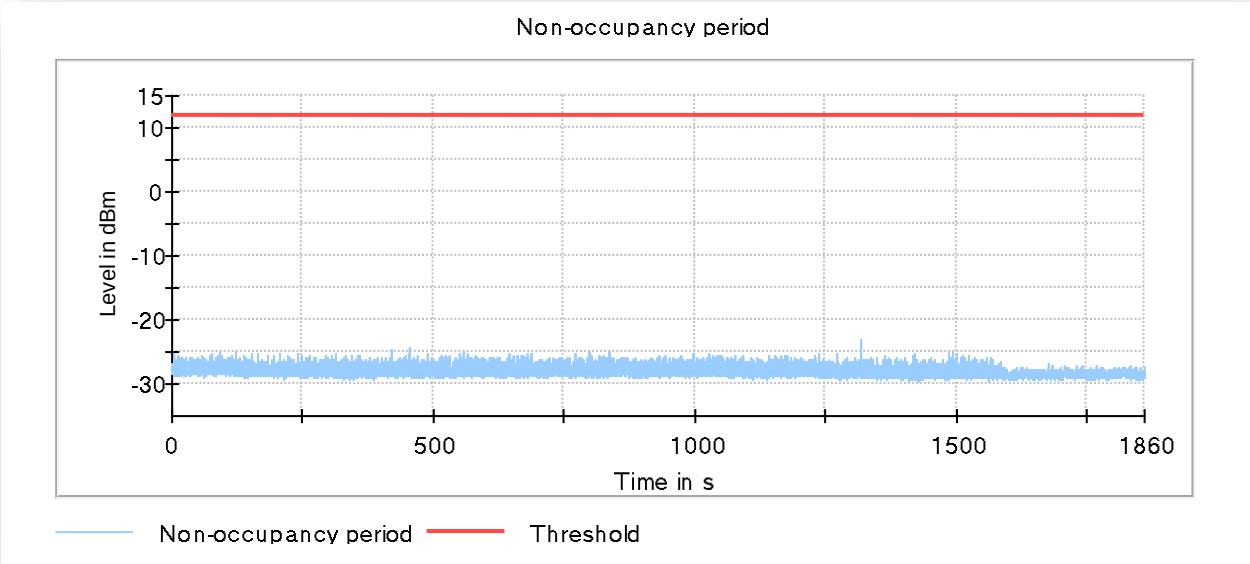
Note: For reference only, the final radar signal level applied to the EUT is dependent on the overall pathloss of the test system including the declared antenna gain of the EUT.

2.1.8 Additional Information

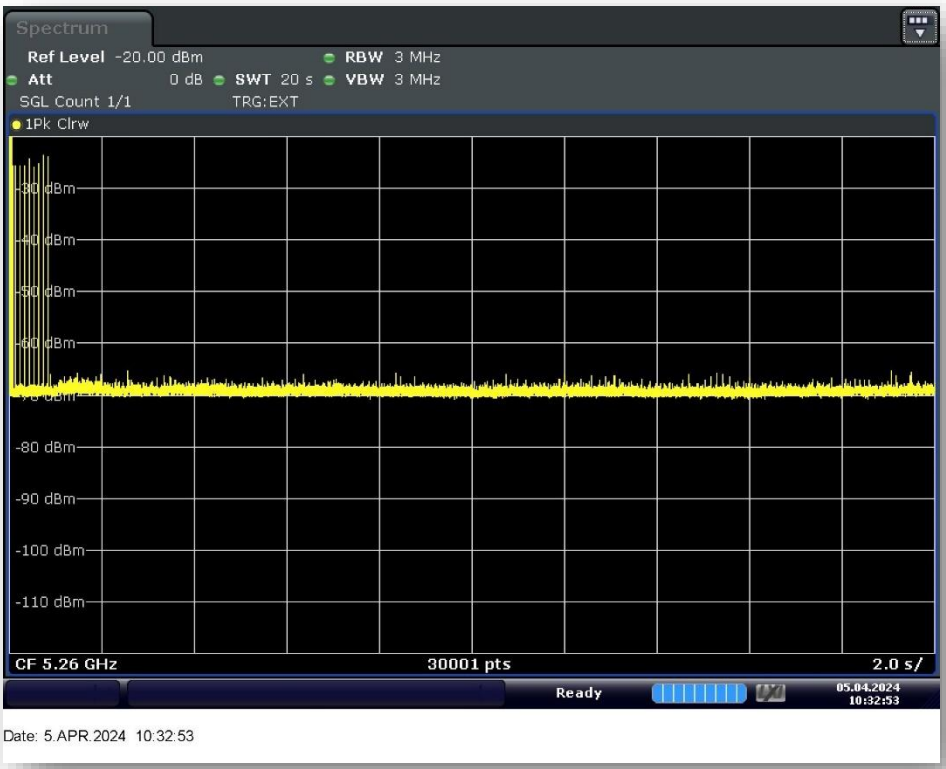
Note	Description
Note 1:	Because of the radar pulse event at the beginning, the investigation of the trace begins with an offset of 28.7 ms conforming to the end of the Radar burst.
Note 2:	Channel move time (CMT) / channel closing transmission time (CCTT) measurement was made with hi resolution video sweep using OSP DAQ channel
Note 3:	Because of the substantially higher sampling rate of the video signal the results for CCTT and CMT are more accurate than in the graphics visible. Reached timing accuracy of the video trace: approx 4 µs
Note 4:	The Non-Occupancy Period trace starts at the end of the Channel move time trace (20.000 secs.) Labeling of the x-axis (time) is relative to its beginning (0 secs.)


Channel Move Time
Level in dBm
40
20
0
-20
0
2
4
6
8
10
12
14
16
18
20
Time in s
Channel Move Time
Start of Radar
First 200ms of Channel Closing Tx Time
Last measured edge of Channel Closing Tx Time
Threshold
Trigger at end of Radar
10sec Channel Move Time Limit

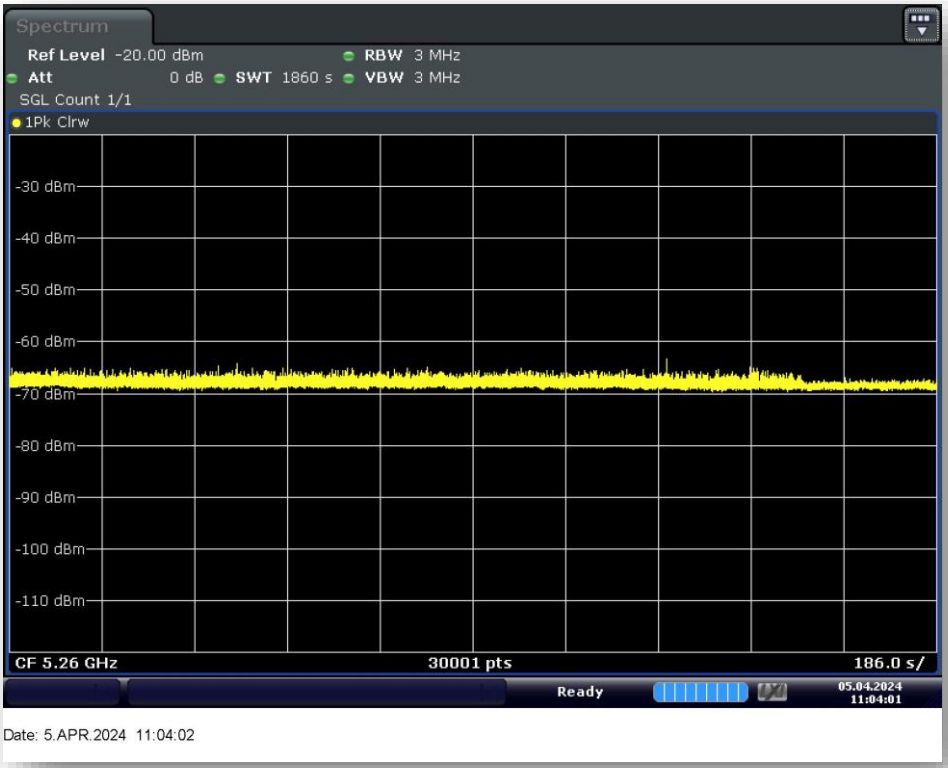

Channel Move Time first 200ms
Level in dBm
40
20
0
-20
0
50
100
150
200
250
Time in ms
Channel Move Time first 200ms
Start of Radar
First 200ms of Channel Closing Tx Time
Threshold
Trigger at end of Radar



Channel Move Time



Non-occupancy period



2.1.9 Channel Move Time; Channel Closing Transmission Time

Setting	Instrument Value	Target Value
Center Frequency	5.26000 GHz	5.26000 GHz
Span	ZeroSpan	ZeroSpan
RBW	3.000 MHz	>= 3.000 MHz
VBW	3.000 MHz	>= 3.000 MHz
SweepPoints	30001	~ 30001
Sweeptime	20.000 s	20.000 s
Reference Level	-20.000 dBm	-20.000 dBm
Attenuation	0.000 dB	0.000 dB
Detector	MaxPeak	MaxPeak
SweepCount	1	1
Filter	3 dB	3 dB
Trace Mode	Clear Write	Clear Write
Sweeptype	Sweep	AUTO
Preamp	off	off
Trigger	External	External
Trigger Offset	0.000 s	0.000 s

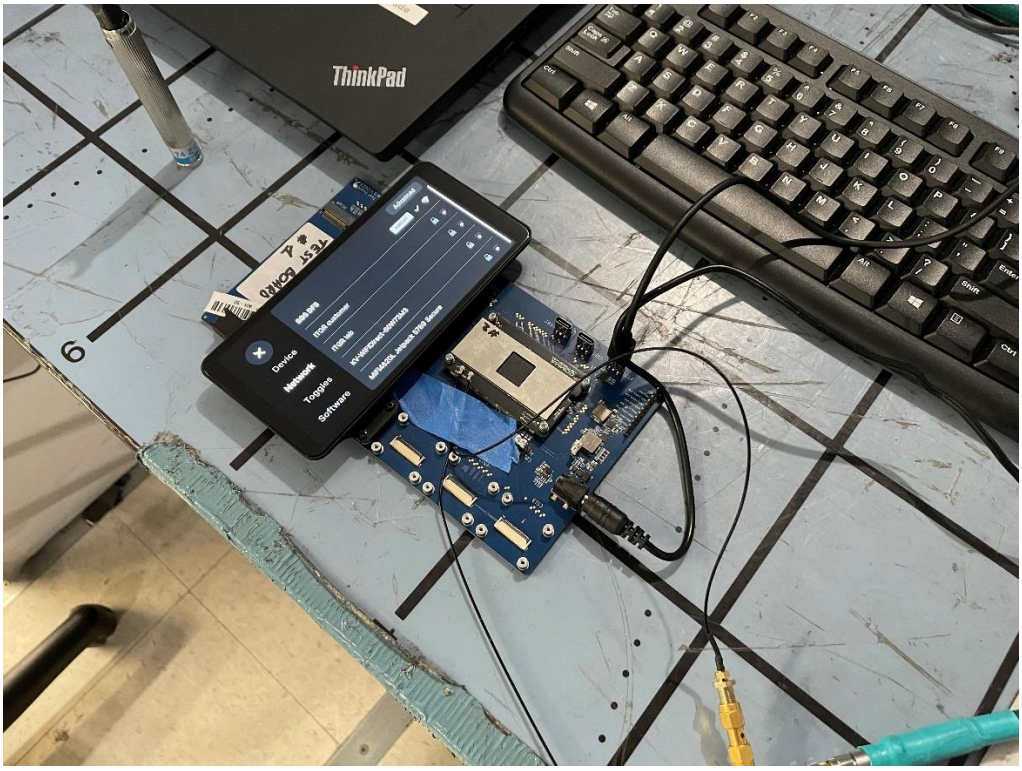
2.1.10 Non-occupancy period

Setting	Instrument Value	Target Value
Center Frequency	5.26000 GHz	5.26000 GHz
Span	ZeroSpan	ZeroSpan
RBW	3.000 MHz	>= 3.000 MHz
VBW	3.000 MHz	>= 3.000 MHz
SweepPoints	30001	~ 30001
Sweeptime	1.860 ks	1.860 ks
Reference Level	-20.000 dBm	-20.000 dBm
Attenuation	0.000 dB	0.000 dB
Detector	MaxPeak	MaxPeak
SweepCount	1	1
Filter	3 dB	3 dB
Trace Mode	Clear Write	Clear Write
Sweeptype	Sweep	AUTO
Preamp	off	off

2.1.11 OSP Video Detector

Setting	Instrument Value	Target Value
Measurement Time	20.000 s	20.000 s
Samplerate	2500 kHz	2500 kHz
Tracepoints	50000000	50000000
Time resolution	4.000 µs	4.000 µs
Detector	Peak	Peak

2.1.12 Test Setup Photos



2.2 DFS In-Service Monitoring (5580 MHz)

2.2.1 Specification Reference

FCC title 47 part 15 §15.407(h), KDB 905462 D02 U-NII DFS Compliance Procedures New Rules v02
RSS-247, Clause 6.3

2.2.2 Measurement Summary

DUT Frequency (MHz)	Radar Type No.	Type of Measurement value	Overall Result	Overall Comment
5580.000000	0	First of all Transmitt Test	---	not performed / not finished
5580.000000	0	Channel Move Time	PASS	
5580.000000	0	Channel Closing Transmission Time	PASS	
5580.000000	0	Non-occupancy period	PASS	Overall Comment

2.2.3 Channel Move Time Detailed Result

DUT Frequency (MHz)	Radar Type No.	CMT Tx Time (s)	CMT Limit (s)	CMT Result	CMT Comment
5580.000000	0	0.819	10.000	PASS	Tx Time value is last trailing edge found within sweep. See Note 1.

2.2.4 Channel Closing Transmission Time Detailed Results

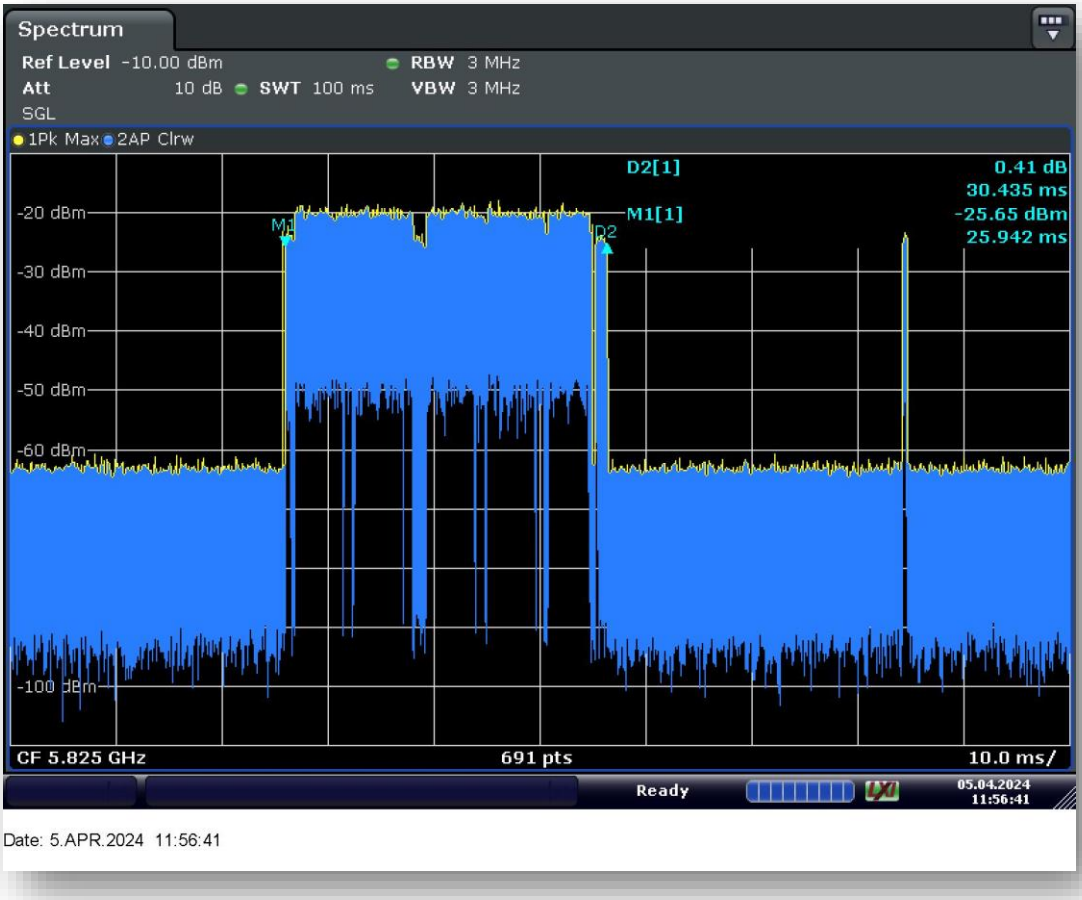
DUT Frequency (MHz)	Radar Type No.	CCTT Type of Value	CCTT No. of Pulses found	CCTT Tx Time (ms)	CCTT Tx Time Limit (ms)	CCTT Result	CCTT Comment
5580.0000	0	first 200 ms	26	14.776	200.000	PASS	See Note 1.
5580.0000	0	remaining 10.0	0	0.000	60.000	PASS	See Note 1.

2.2.5 Non-occupancy period Detailed Results

DUT Frequency (MHz)	Radar Type No.	NOP No. of Pulses found	NOP No. of Pulses Limit	NOP Tx Time (s)	NOP Tx Time Limit (s)	NOP Result
5580.00000	0	0	0	0.000	0.000	PASS

2.2.6 Transmitting Test Detailed Results

DUT Frequency (MHz)	Tx-Test Duty Cycle (%)	Tx-Test Duty Cycle Limit	TX-Test Result
Representative (plot presented is when EUT moved with Master)	30.435%	≥ 17%	PASS

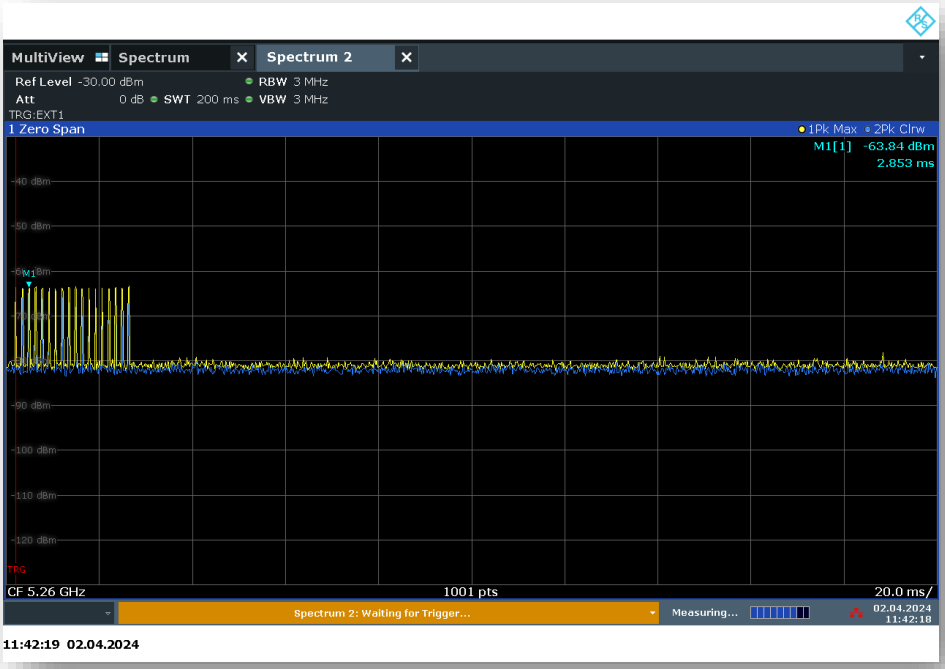


Note: The plot is taken when the EUT moved with the Master to another channel during testing but the loading is identical.

2.2.7 Radar level verification

Description / Formula	Value	Unit
IF(({DFS Mode(0/1/2)}=0)or({DFS Mode(0/1/2)}=1) , IF((dBm2W({Nominal Power[dBm]})>0.2) , -64 , IF(({Configured PSD[dBm]}<10) , -62 , -64))+ {Attenuation Vector Generator to DUT[dB]} , -50+ {Attenuation Vector Generator to COMP[dB]})+ {Radar Signal Level Offset[dB]}	Given setting / formula to calculate Vector Generator level	--

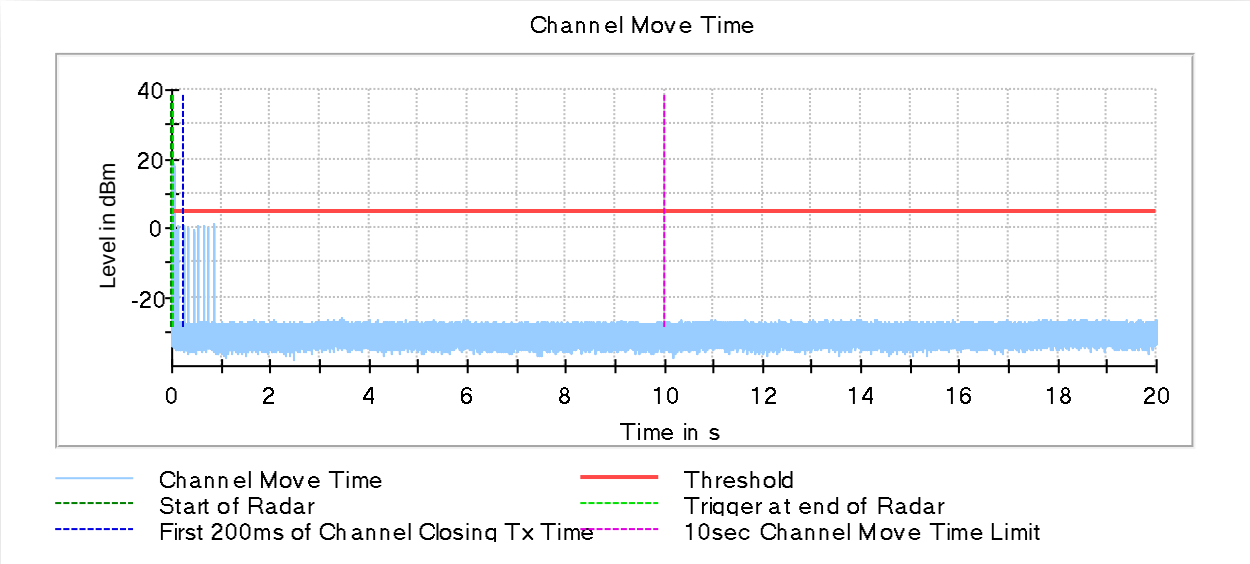
Configured DUT EIRP:	19.95	mW
Configured DUT PSD:	3.00	dBm/MHz
Requirement of the Detection threshold value for this given values acc. to FCC clause 5.2 / Table 3	-62	dBm
Vector Generator level setting	15.61	dBm
Configured overall pathloss from Vector Generator RF out to DUT connector of 'DUT to OSP'-cable	44.28	dB
Given additional level added to the amplitude of the waveform to account for variations in measurement equipment acc. to FCC clause 5.2 / Table 3 / Note 2	1.00	dB
This results in the following radar signal level at the DUT	-28.66	dBm

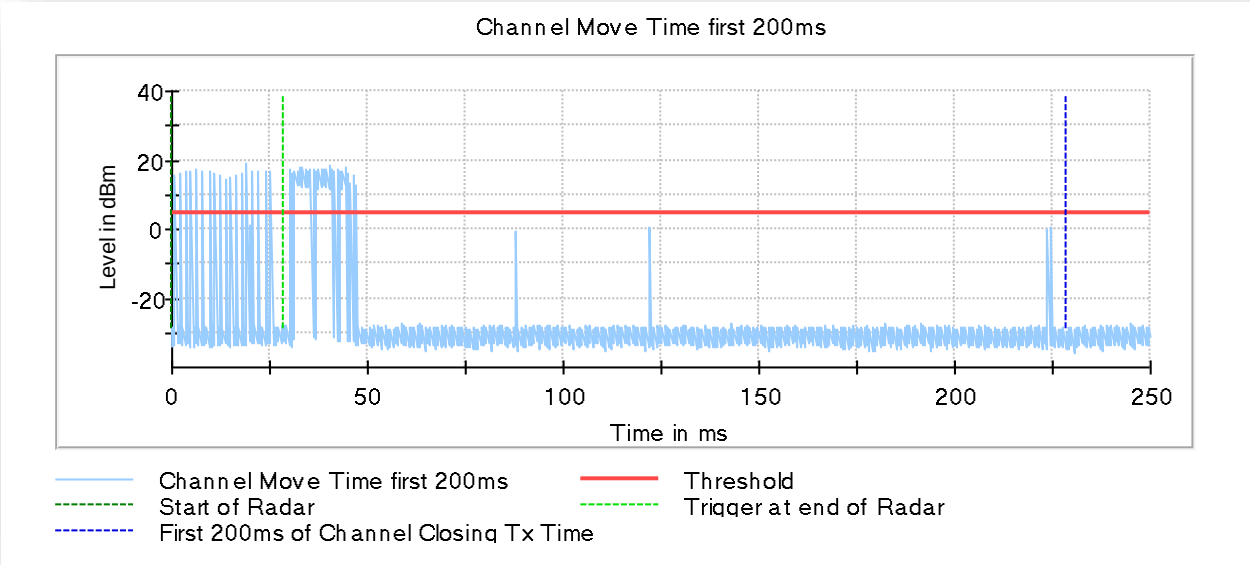


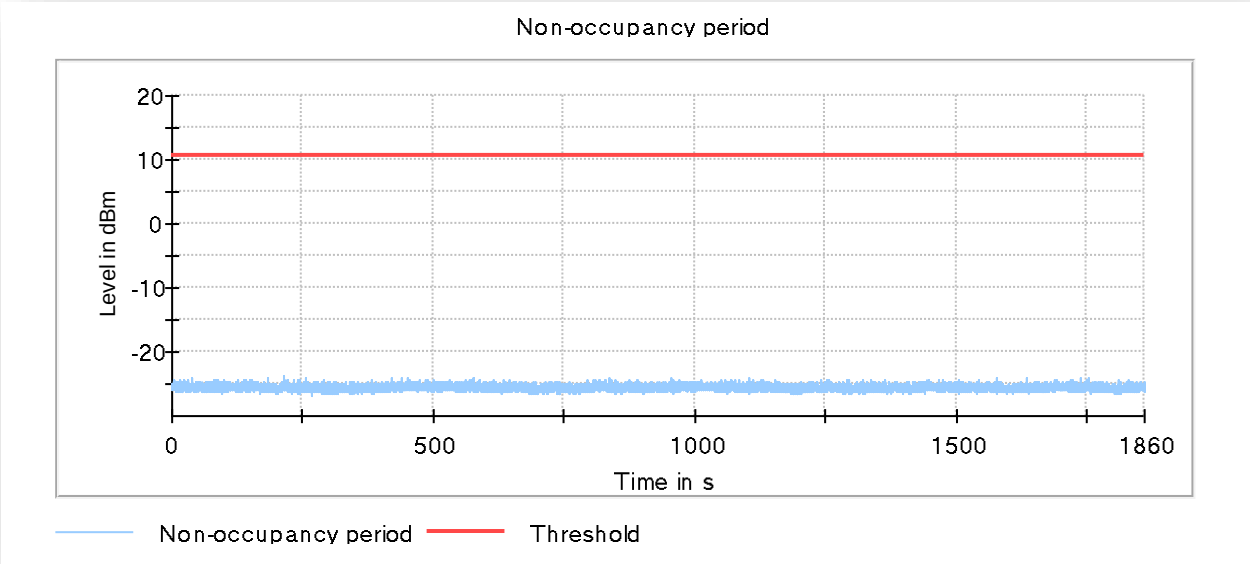
Note: For reference only, the final radar signal level applied to the EUT is dependent on the overall pathloss of the test system including the declared antenna gain of the EUT.

2.2.8 Additional Information

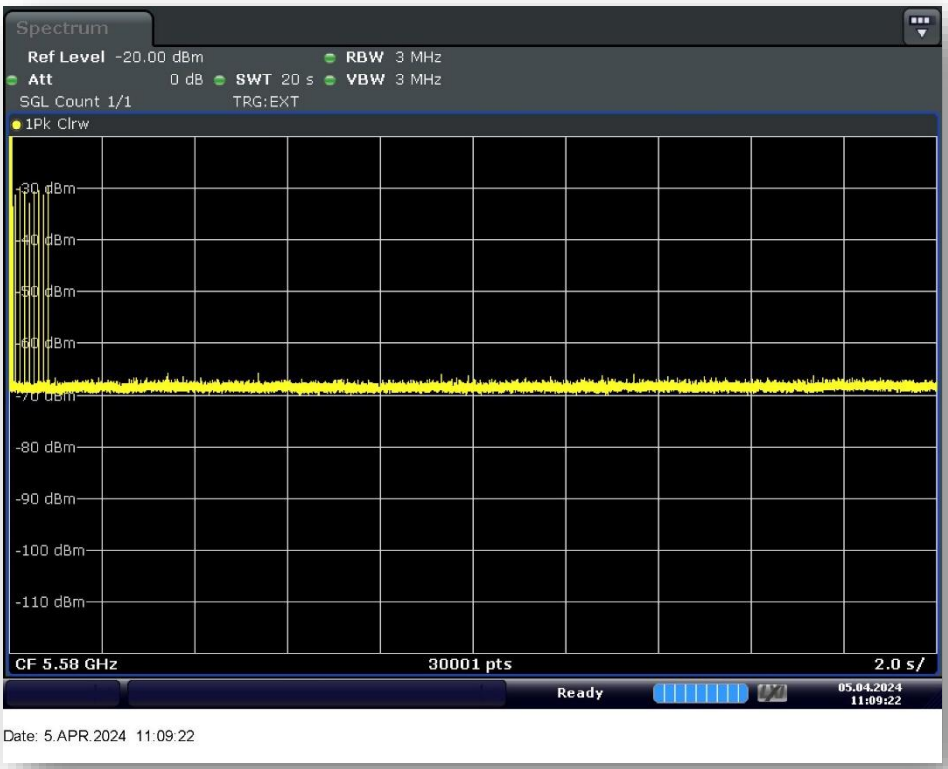
Note	Description
Note 1:	Because of the radar pulse event at the beginning, the investigation of the trace begins with an offset of 28.7 ms conforming to the end of the Radar burst.
Note 2:	Channel move time (CMT) / channel closing transmission time (CCTT) measurement was made with hi resolution video sweep using OSP DAQ channel
Note 3:	Because of the substantially higher sampling rate of the video signal the results for CCTT and CMT are more accurate than in the graphics visible. Reached timing accuracy of the video trace: approx 4 µs
Note 4:	The Non-Occupancy Period trace starts at the end of the Channel move time trace (20.000 secs.) Labeling of the x-axis (time) is relative to its beginning (0 secs.)


Channel Move Time
Level in dBm
40
20
0
-20
0
2
4
6
8
10
12
14
16
18
20
Time in s
Channel Move Time
Start of Radar
First 200ms of Channel Closing Tx Time
Threshold
Trigger at end of Radar
10sec Channel Move Time Limit

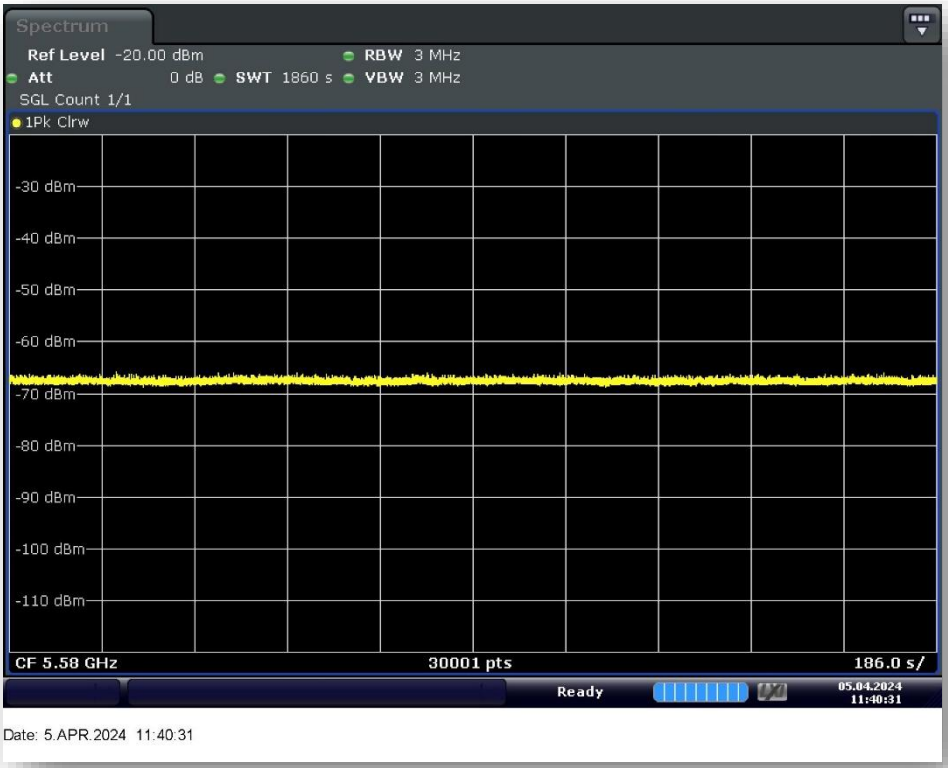

Channel Move Time first 200ms
Level in dBm
40
20
0
-20
0
50
100
150
200
250
Time in ms
Channel Move Time first 200ms
Start of Radar
First 200ms of Channel Closing Tx Time
Threshold
Trigger at end of Radar



Channel Move Time



Non-occupancy period



2.2.9 Channel Move Time; Channel Closing Transmission Time

Setting	Instrument Value	Target Value
Center Frequency	5.58000 GHz	5.58000 GHz
Span	ZeroSpan	ZeroSpan
RBW	3.000 MHz	>= 3.000 MHz
VBW	3.000 MHz	>= 3.000 MHz
SweepPoints	30001	~ 30001
Sweeptime	20.000 s	20.000 s
Reference Level	-20.000 dBm	-20.000 dBm
Attenuation	0.000 dB	0.000 dB
Detector	MaxPeak	MaxPeak
SweepCount	1	1
Filter	3 dB	3 dB
Trace Mode	Clear Write	Clear Write
Sweeptype	Sweep	AUTO
Preamp	off	off
Trigger	External	External
Trigger Offset	0.000 s	0.000 s

2.2.10 Non-occupancy period

Setting	Instrument Value	Target Value
Center Frequency	5.58000 GHz	5.58000 GHz
Span	ZeroSpan	ZeroSpan
RBW	3.000 MHz	>= 3.000 MHz
VBW	3.000 MHz	>= 3.000 MHz
SweepPoints	30001	~ 30001
Sweeptime	1.860 ks	1.860 ks
Reference Level	-20.000 dBm	-20.000 dBm
Attenuation	0.000 dB	0.000 dB
Detector	MaxPeak	MaxPeak
SweepCount	1	1
Filter	3 dB	3 dB
Trace Mode	Clear Write	Clear Write
Sweeptype	Sweep	AUTO
Preamp	off	off

2.2.11 OSP Video Detector

Setting	Instrument Value	Target Value
Measurement Time	20.000 s	20.000 s
Samplerate	2500 kHz	2500 kHz
Tracepoints	50000000	50000000
Time resolution	4.000 µs	4.000 µs
Detector	Peak	Peak

2.2.12 Test Setup Photos

Identical to Section 2.1.12 of this test report.

SECTION 3

TEST EQUIPMENT USED

3.1 Hardware Setup: WMS Measurements\TS8997

TS8997	
Spectrum Analyzer:	SA FSV 30 (SA FSV 30) @ VISA (ADR TCPIP::169.254.2.21::inst0::instr), SN 1321.3008K30/103166, FW 3.70, CAL 1/24/2025
Vector Generator:	VG SMBV100A (VG SMBV100A) @ VISA (ADR TCPIP::169.254.2.23::inst0::instr), SN 260734, FW 3.1.19.15-3.50.082.47, CAL 1/25/2025
Generator:	SMB100A (SMB100A) @ VISA (ADR TCPIP::169.254.2.22::inst0::instr), SN 175750, FW 3.1.18.2-3.01.203.44 / Drv:5.8.0, CAL 1/24/2025
OSP:	OSP-B157W (OSP-B157W) @ VISA (ADR TCPIP::169.254.2.20::inst0::instr), SN 1527.1144. /, FW 1.27.0.0, CAL 1/25/2025
Test performed with WMS32 Version:	11.70.00
Miscellaneous	
True RMS Multimeter	Fluke 85 III S/N 69880143 CAL 10/02/2024
Barometer/Temperature/Humidity	Omega iBTHX-W S/N 15050268 CAL 06/15/2024

3.2 Measurement Uncertainty / general calculation

Inherent Errors	Specified Error	Standard Uncertainty
Frequency Response	0.2	0.12
Input Attenuator Switching	0.2	0.12
Display Linearity	0.1	0.06
VSWR of OSP-B157W (path correction)	1.8	0.42
VSWR of SigGen	1.6	
VSWR of EUT	1.6	0.42
VSWR of OSP-B157W (source mismatch)	1.8	
Uncertainty of SigGen	0.5	0.29
Combined Standard Uncertainty		1.43 dB

SECTION 4

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4.1 ACCREDITATION, DISCLAIMERS AND COPYRIGHT

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