

Prüfbericht-Nr.: Test report no.:	SE23N0FX-004	Auftrags-Nr.: Order no.:	0290100214	Seite 1 von 18 Page 1 of 18
Kunden-Referenz-Nr.: Client reference no.:	2458172	Auftragsdatum: Order date:	2022.09.29	
Auftraggeber: Client:	Nomono AS			
Prüfgegenstand: Test item:	Central hub of recording device			
Bezeichnung / Typ-Nr.: Identification / Type no.:	Space Recorder / FCC ID: 2A9CX-REC1			
Auftrags-Inhalt: Order content:	Accredited Testing			
Prüfgrundlage: Test specification:	FCC 47 CFR Part 15.407 with KDB 905462 D02 v02 ANSI C63.10: 2013			
Wareneingangsdatum: Date of sample receipt:	2022.11.09			
Prüfmuster-Nr.: Test sample no.:	See section 2.3			
Prüfzeitraum: Testing period:	2023.04.10 - 2023.04.27			
Ort der Prüfung: Place of testing:	Lund, Sweden			
Prüflaboratorium: Testing laboratory:	TÜV Rheinland Sweden			
Prüfergebnis*: Test result*:	Pass			
überprüft von: reviewed by:		genehmigt von: authorized by:		
Datum: 2023.05.17 Date:	Signed by: Niall Forrester	Datum: 2023.05.17 Date:	Signed by: Hakan Ahlberg	
Stellung / Position:	Senior Technical Expert	Stellung / Position:	Lab Manager	
Sonstiges / Other:	The device contains multiple radio transmitters. Please see section 2.1 for details and section 3.7 for notes about the configurations tested.			
Zustand des Prüfgegenstandes bei Anlieferung: Condition of the test item at delivery:	Prüfmuster vollständig und unbeschädigt Test item complete and undamaged			
* Legende:	1 = sehr gut P(ass) = entspricht o.g. Prüfgrundlage(n)	2 = gut F(ail) = entspricht nicht o.g. Prüfgrundlage(n)	3 = befriedigend N/A = nicht anwendbar	4 = ausreichend N/T = nicht getestet
* Legend:	1 = very good P(ass) = passed a.m. test specification(s)	2 = good F(ail) = failed a.m. test specification(s)	3 = satisfactory N/A = not applicable	4 = sufficient N/T = not tested
Dieser Prüfbericht bezieht sich nur auf das o.g. Prüfmuster und darf ohne Genehmigung der Prüfstelle nicht auszugsweise vervielfältigt werden. Dieser Bericht berechtigt nicht zur Verwendung eines Prüfzeichens. This test report only relates to the a. m. test sample. Without permission of the test center this test report is not permitted to be duplicated in extracts.				

Revision History

REVISION	DATE	REMARKS	AUTHOR
001	2023.04.20	First release	Niall Forrester
002	2023.04.21	Corrected error in wireless frequencies	Niall Forrester
003	2023.04.27	Added “non-occupancy” results	Niall Forrester
004	2023.05.17	Updated module text	Niall Forrester
Note: Latest revision report will replace all previous reports			
This report based on FCC Part 15.407 DFS Template version 1.0			

Summary of Test Results

FCC 47 CFR (KDB 905462 D02) Rule Part	Test Description	Applicability	Report Section	RESULT	REMARKS
15.407 h(2) (7.8.1)	U-NII Detection Bandwidth (Prior to use of a channel)	NO	4.1	N/A	Client without radar detection
15.407 h(2) (7.8.1)	U-NII Detection Bandwidth (During normal Operation)	NO		N/A	Client without radar detection
15.407 h(2) (7.8.2)	Channel Availability Check Time (Prior to use of a channel)	NO	4.2	N/A	Client without radar detection
15.407 h(2)(iv) (7.8.3)	“Operational Requirements” Non-Occupancy Period (Prior to use of a channel)	YES	4.3	PASS	
15.407 h(2) (7.8.3)	“Operational Requirements” DFS Detection Threshold (Prior to use of a channel)	NO		N/A	Client without radar detection
15.407 h(2) (7.8.3)	“Operational Requirements” DFS Detection Threshold (During normal Operation)	NO		N/A	Client without radar detection
15.407 h(2)(ii) (7.8.3)	“Operational Requirements” Channel Move Time (During normal Operation)	YES		PASS	
15.407 h(2)(iii) (7.8.3)	“Operational Requirements” Channel Closing Trans. Time (During normal Operation)	YES		PASS	
15.407 h(2)(ii) (7.8.3)	“Operational Requirements” Channel Move Time: Aggregate (During normal Operation)	YES		PASS	
15.407 h(2) (7.8.4)	Statistical Performance Check	NO	4.4	N/A	Client without radar detection

Possible test case verdicts:

- | | |
|--|-----------------------|
| - Test case does not apply to the test object: | N/A |
| - Test object complies with the requirement: | PASS or COMPLIANT |
| - Test object does not meet the requirement: | FAIL or NOT COMPLIANT |
| - Test case not performed on the test object: | N.P. |

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1. GENERAL INFORMATION

1.1 Test Site

Test Facility:	TÜV Rheinland Sweden AB
Address:	Mobilvägen 10
	223 62 Lund
	Sweden
Swedac Registration Number:	10325
FCC Test Firm Registration Number:	517458
ISED Test Site Registration Number:	24753

1.2 Client Information

Company Name:	Nomono AS
Address:	Strandveien 43
	7067 Trondheim
	Norway
Contact Person:	Kristine Snyder / Sindre Georgsen
Contact e-Mail / Telephone	compliance@nomono.co +47 40 44 00 40 / +47 93 42 48 42

2. PRODUCT INFORMATION

2.1 General Description

Model name:	Space Recorder
Manufacturer:	Nomono
Model number / Marketing name:	Space Recorder
FCC ID:	2A9CX-REC1
Description:	Central hub of recording device
Ancillary Equipment:	See section 2.9

The device incorporates five separate radio transmitters:

A "Main" module for WLAN 2.4 GHz 802.11 b/g/n, WLAN 5GHz 802.11 a/n/ac and Bluetooth Low Energy. This module uses its own SMT antenna

4 x "Microphone" modules (labelled "Tx0" "Tx3" below) for communicating with a wireless microphone via Bluetooth Low Energy. Each of these modules is connected to its own PCB antenna

2.2 Device Characteristics

Device Class for 47 CFR Part 15 B	Class B
Type of Power Supply	Internal battery Charging via dedicated charging base or Charging via USB C (No dedicated AC/DC adapter supplied with device)
Nominal Supply Voltage	3.6V DC (Battery) 5.0V DC (From charging base) 5.0V DC (USB)
Supply Voltage Range	2.75V – 4.2V (Battery) 4.9V – 5.1V (From charging base) 5.0V – 12.0V DC (USB)
Operating Temperature Range	0 to 45 °C
Operating Air Humidity Range	-
Highest Internal Frequency Source	5825 MHz

2.3 Test Samples

EUT #	EUT ID	Description	Used For:
1	A003418772-001	Modified with Semi-Rigid Hardware: 830-00002 rev. 4 Firmware: nRF radio: v0.8.0 CPU: v0.6.1	All tests

2.4 Wireless Technologies and Bands Supported by the EUT

Technology	Band	Frequency Range (Tx)	Evaluation Performed*
WLAN 802.11b/g/n (Main)	2.4 GHz	2412 MHz - 2462 MHz	NO
WLAN 802.11a/n/ac (Main)	5 GHz	5180 MHz – 5825 MHz	YES
Bluetooth Low Energy (Main)	2.4 GHz	2402 MHz - 2480 MHz	NO
Bluetooth Low Energy (Microphone Tx0)	2.4 GHz	2402 MHz - 2480 MHz	NO
Bluetooth Low Energy (Microphone Tx1)	2.4 GHz	2402 MHz - 2480 MHz	NO
Bluetooth Low Energy (Microphone Tx2)	2.4 GHz	2402 MHz - 2480 MHz	NO
Bluetooth Low Energy (Microphone Tx3)	2.4 GHz	2402 MHz - 2480 MHz	NO

*This statement refers only to this report. Other wireless technologies may be covered by other reports.

2.5 Antenna Information

Technology	Band	Number of Antennas	Antenna Type(s)	Gain (dBi)
WLAN 802.11b/g/n (Main) & Bluetooth Low Energy (Main)	2.4 GHz	1	SMT Chip Antenna	4.20
WLAN 802.11a/n/ac (Main)	5 GHz	1	SMT Chip Antenna	4.50
Bluetooth Low Energy (Microphone Tx0)	2.4 GHz	1	PCB Antenna	2.05
Bluetooth Low Energy (Microphone Tx1)	2.4 GHz	1	PCB Antenna	1.99
Bluetooth Low Energy (Microphone Tx2)	2.4 GHz	1	PCB Antenna	2.58
Bluetooth Low Energy (Microphone Tx3)	2.4 GHz	1	PCB Antenna	1.16

2.6 Simultaneous Transmission Capabilities

Active Technologies	Bands	Active Modules
WLAN 802.11 b/g/n Bluetooth Low Energy Bluetooth Low Energy Bluetooth Low Energy Bluetooth Low Energy (All active simultaneously)	2.4 GHz 2.4 GHz 2.4 GHz 2.4 GHz 2.4 GHz	Main Microphone Tx0 Microphone Tx1 Microphone Tx2 Microphone Tx3 (All active simultaneously)
Bluetooth Low Energy Bluetooth Low Energy Bluetooth Low Energy Bluetooth Low Energy Bluetooth Low Energy (All active simultaneously)	2.4 GHz 2.4 GHz 2.4 GHz 2.4 GHz 2.4 GHz	Main Microphone Tx0 Microphone Tx1 Microphone Tx2 Microphone Tx3 (All active simultaneously)
WLAN 802.11 a/n/ac Bluetooth Low Energy Bluetooth Low Energy Bluetooth Low Energy Bluetooth Low Energy (All active simultaneously)	5 GHz 2.4 GHz 2.4 GHz 2.4 GHz 2.4 GHz	Main Microphone Tx0 Microphone Tx1 Microphone Tx2 Microphone Tx3 (All active simultaneously)

The configurations listed above represent the worst cases. Variations of these configurations where one or more radio transmitters is not active are also possible. The “Microphone” modules operate independent of each other and independent of the “Main” module. The “Main” module is not capable of transmitting WLAN 2.4GHz and WLAN 5GHz simultaneously, neither can it transmit Bluetooth Low Energy and WLAN simultaneously.

2.7 Wireless Technology Details

Technology	Band	Modulation Type(s)	No. of Channels	Channel Spacing	Adaptivity
WLAN 802.11b/g/n (Main)	2.4 GHz	CCK, BPSK, QPSK, 16-QAM, 64-QAM	As per 802.11 Spec	As per 802.11 Spec	N/A
WLAN 802.11a/n/ac (Main)	5 GHz	CCK, BPSK, QPSK, 16-QAM, 64-QAM	As per 802.11 Spec	As per 802.11 Spec	N/A
Bluetooth Low Energy (Main)	2.4 GHz	GFSK	40	2 MHz	N/A
Bluetooth Low Energy (Microphone Tx0)	2.4 GHz	GFSK	40	2 MHz	N/A
Bluetooth Low Energy (Microphone Tx1)	2.4 GHz	GFSK	40	2 MHz	N/A
Bluetooth Low Energy (Microphone Tx2)	2.4 GHz	GFSK	40	2 MHz	N/A
Bluetooth Low Energy (Microphone Tx3)	2.4 GHz	GFSK	40	2 MHz	N/A

2.8 DFS Support Details

Technology	U-NII bands	Device Type	Radar Detection
WLAN 802.11a/n/ac (Main)	U-NII-1 U-NII-2A U-NII-2C U-NII-3	Client	Not Supported

2.9 Ancillary Equipment

None

2.10 EUT Diagrams

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3. TEST METHODS

3.1 Test Standards

Testing was performed according to the following standards / references

Standard	Version	Description
FCC 47 CFR 15.407	-	Unlicensed National Information Infrastructure Devices – General technical requirements
KDB 905462 D02 v02	v02	UNII DFS Compliance Procedures New Rules

3.2 Additional references

The following standards / references were also considered for the testing

Standard	Version	Description
ANSI C63.10	2013	American National Standard of Procedures for Compliance Testing of Unlicensed Wireless Devices
KDB 789033 D02	V02r01	Guidelines for compliance testing of Unlicensed National information Infrastructure (U-NII) devices. Part 15, Subpart E

3.3 Limits

FCC 47 CFR (KDB 905462 D02) Rule Part	Test Description	Limit Reference FCC 47 CFR Reference (KDB 905462 Reference)
15.407 h(2) (7.8.1)	U-NII Detection Bandwidth (Prior to use of a channel)	N/A
15.407 h(2) (7.8.1)	U-NII Detection Bandwidth (During normal Operation)	N/A
15.407 h(2) (7.8.2)	Channel Availability Check Time (Prior to use of a channel)	N/A
15.407 h(2)(iv) (7.8.3)	“Operational Requirements” Non-Occupancy Period (Prior to use of a channel)	15.407 h(2) KDB 905462 D02 5.3
15.407 h(2) (7.8.3)	“Operational Requirements” DFS Detection Threshold (Prior to use of a channel)	N/A
15.407 h(2) (7.8.3)	“Operational Requirements” DFS Detection Threshold (During normal Operation)	N/A
15.407 h(2)(ii) (7.8.3)	“Operational Requirements” Channel Move Time (During normal Operation)	15.407 h(2) KDB 905462 D02 5.3
15.407 h(2)(iii) (7.8.3)	“Operational Requirements” Channel Closing Trans. Time (During normal Operation)	15.407 h(2) KDB 905462 D02 5.3
15.407 h(2)(ii) (7.8.3)	“Operational Requirements” Channel Move Time: Aggregate (During normal Operation)	15.407 h(2) KDB 905462 D02 5.3
15.407 h(2) (7.8.4)	Statistical Performance Check	N/A

Interpretation of the measurement results has been performed in accordance with ANSI C63.10 section 1.3

Compliance with the requirements has been based on the results of the measurements compared to the specified limits, not taking into account measurement instrumentation uncertainty.

Measurement Uncertainty figures are stated in section 6

3.4 Description of Test Methods and Equipment Setup

3.4.1 General Description

Testing was performed in accordance with the various requirements of ANSI C63.10. Any deviations from the test methods are described in section 3.7

Where different arrangements of equipment were used for different types of measurements, these are tabulated in section 3.4.2 and details of each arrangement are included in subsequent sections

3.4.2 Test Equipment Setup Used by Test Type

FCC 47 CFR (KDB 905462 D02) Rule Part	Test Description	Test Equipment Used
15.407 h(2) (7.8.1)	U-NII Detection Bandwidth (Prior to use of a channel)	N/A
15.407 h(2) (7.8.1)	U-NII Detection Bandwidth (During normal Operation)	N/A
15.407 h(2) (7.8.2)	Channel Availability Check Time (Prior to use of a channel)	N/A
15.407 h(2)(iv) (7.8.3)	“Operational Requirements” Non-Occupancy Period (Prior to use of a channel)	CTE
15.407 h(2) (7.8.3)	“Operational Requirements” DFS Detection Threshold (Prior to use of a channel)	N/A
15.407 h(2) (7.8.3)	“Operational Requirements” DFS Detection Threshold (During normal Operation)	N/A
15.407 h(2)(ii) (7.8.3)	“Operational Requirements” Channel Move Time (During normal Operation)	CTE
15.407 h(2)(iii) (7.8.3)	“Operational Requirements” Channel Closing Trans. Time (During normal Operation)	CTE
15.407 h(2)(ii) (7.8.3)	“Operational Requirements” Channel Move Time: Aggregate (During normal Operation)	CTE
15.407 h(2) (7.8.4)	Statistical Performance Check	N/A

3.4.3 Test Equipment Setup – CTE System

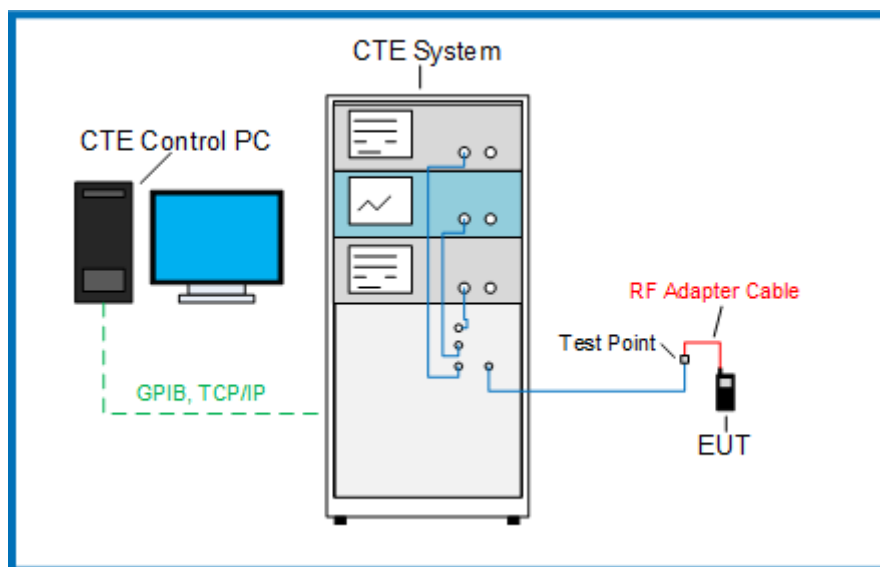
The Comprehensive Test Environment (CTE) system consists of a number of instruments (see section 5.1.1) mounted in a rack together with automated relays and interconnecting hardware. The instruments and other equipment are controlled from a standard PC running software provided by the manufacturer. The RF output of the EUT is connected to the test system via a coaxial cable.

Tests are in the form of pre-defined scripts that can be loaded on the PC. The scripts, as well as the hardware setup, have been verified for conformance with the relevant test specifications.

Losses in the cables and interconnects have been measured using the system's own automated routines and are compensated for automatically. Any additional loss in RF adapter cables supplied together with the EUT can be compensated for using the known characteristics of that adapter.

For DFS testing of client devices and some receiver testing, a wireless access point with appropriate certifications is used as the WLAN master device, with the DUT as a client.

CTE Block Diagram



3.5 EUT Configuration During Test

An ASUS RT-AX88U (FCC ID: MSQ-RTAXHP00) was connected to the CTE system, acting as the WLAN master device. The other parts of the CTE system allow for control of the level of wanted signals as well as the disturbance signals generated by the system, and measurements using a Spectrum Analyser.

The DUT was connected via an RF cable and a semi-rigid adapter in place of the antenna to allow for conducted radio testing. The DUT was operating in its normal 'signalling' mode, thus being controlled by the Asus Router

3.6 EUT Operation Modes

Operation mode	Description
Rec – Cond - SIG	Space Recorder only in “stand-alone” configuration. Antenna replaced by semi-rigid cable for conducted measurements Device not charging – DC power from lab power supply Radio transmitter(s) in normal ‘signalling’ mode where channel assignments, modes etc. are controlled by the access point. Details about which transmitters, channels etc. listed under “Wireless Configuration”

3.7 Deviations from the Test Standard

None

3.8 Environmental Conditions

3.8.1 Environmental Conditions – CTE

Date	Time	Temperature (°C)	Relative Humidity (%)
2023.04.10	07:35	19.8	32
2023.04.27	11:00	18.9	28

4. TEST RESULTS

4.1 Test Results – U-NII Detection Bandwidth

4.1.1 U-NII Detection Bandwidth – Test Summary

This requirement is not applicable for a Client device without Radar Detection

4.2 Test Results – Channel Availability Check Time

4.2.1 Channel Availability Check Time – Test Summary

This requirement is not applicable for a Client device without Radar Detection

4.3 Test Results – Operational Requirements

4.3.1 Operational Requirements – Test Summary

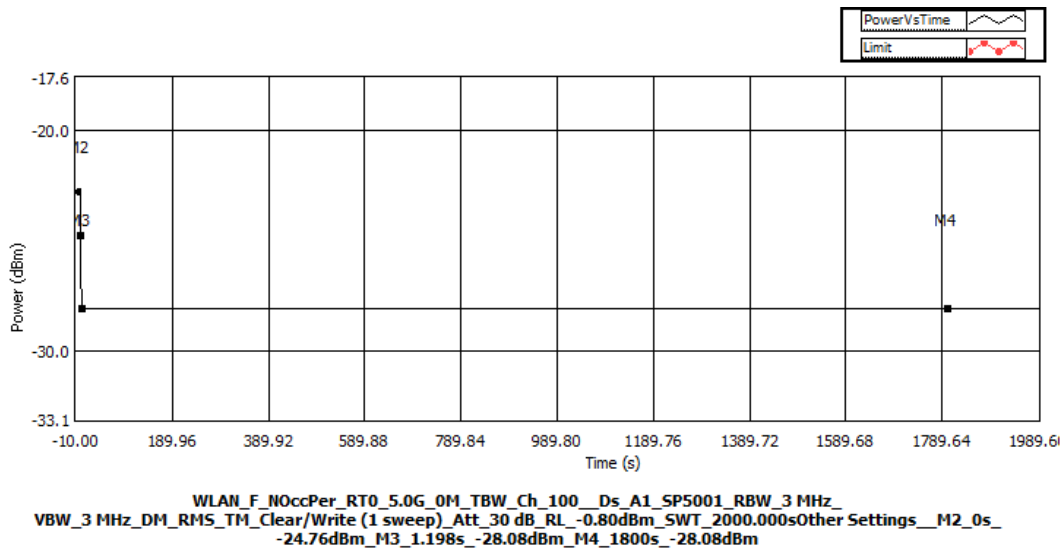
Test Specification	47 CFR 15.407 h(2), KDB 905462 D02 7.8.3			
Test Engineer & Date	Niall Forrester		2023.04.10 – 2023.04.27	
EUT and Ancillary Equipment IDs	A003418772_001		N/A	
EUT Operation Mode(s)	Rec – Cond - SIG			
EUT Wireless Configuration(s)	WLAN 802.11n 5 GHz (see details below)			
EUT Hardware Configuration(s)	Stand-alone (Space Recorder)			
Overall Result	PASS			

Test Parameter	Wireless Configuration	Measured	Limit	Result
“Operational Requirements” Non-Occupancy Period (Prior to use of a channel)	WLAN 802.11n 20MHz MCS7 CH 64 (64-QAM 5320 MHz)	No Tx	No Tx	PASS
“Operational Requirements” Non-Occupancy Period (Prior to use of a channel)	WLAN 802.11n 20MHz MCS7 CH 100 (64-QAM 5500 MHz)	No Tx	No Tx	PASS
“Operational Requirements” DFS Detection Threshold (Prior to use of a channel)	-	-	-	N/A
“Operational Requirements” DFS Detection Threshold (During normal Operation)	-	-	-	N/A
“Operational Requirements” Channel Move Time (During normal Operation)	WLAN 802.11n 20MHz MCS7 CH 64 (64-QAM 5320 MHz)	0.80 s	10 s	PASS
Operational Requirements” Channel Move Time (During normal Operation)	WLAN 802.11n 20MHz MCS7 CH 100 (64-QAM 5500 MHz)	0.86 s	10 s	PASS
“Operational Requirements” Channel Closing Trans. Time (During normal Operation)	WLAN 802.11n 20MHz MCS7 CH 64 (64-QAM 5320 MHz)	83.06 ms	200 ms	PASS
Operational Requirements” Channel Closing Trans. Time (During normal Operation)	WLAN 802.11n 20MHz MCS7 CH 100 (64-QAM 5500 MHz)	24.73 ms	200 ms	PASS
“Operational Requirements” Channel Move Time: Aggregate (During normal Operation)	WLAN 802.11n 20MHz MCS7 CH 64 (64-QAM 5320 MHz)	86.66 ms	260 ms	PASS
Operational Requirements” Channel Move Time: Aggregate (During normal Operation)	WLAN 802.11n 20MHz MCS7 CH 100 (64-QAM 5500 MHz)	28.36 ms	260 ms	PASS
“Operational Requirements” Non-Occupancy Period (Prior to use of a channel)	-	-	-	N/A

* For detailed measurements, see tables and graphs in sections below

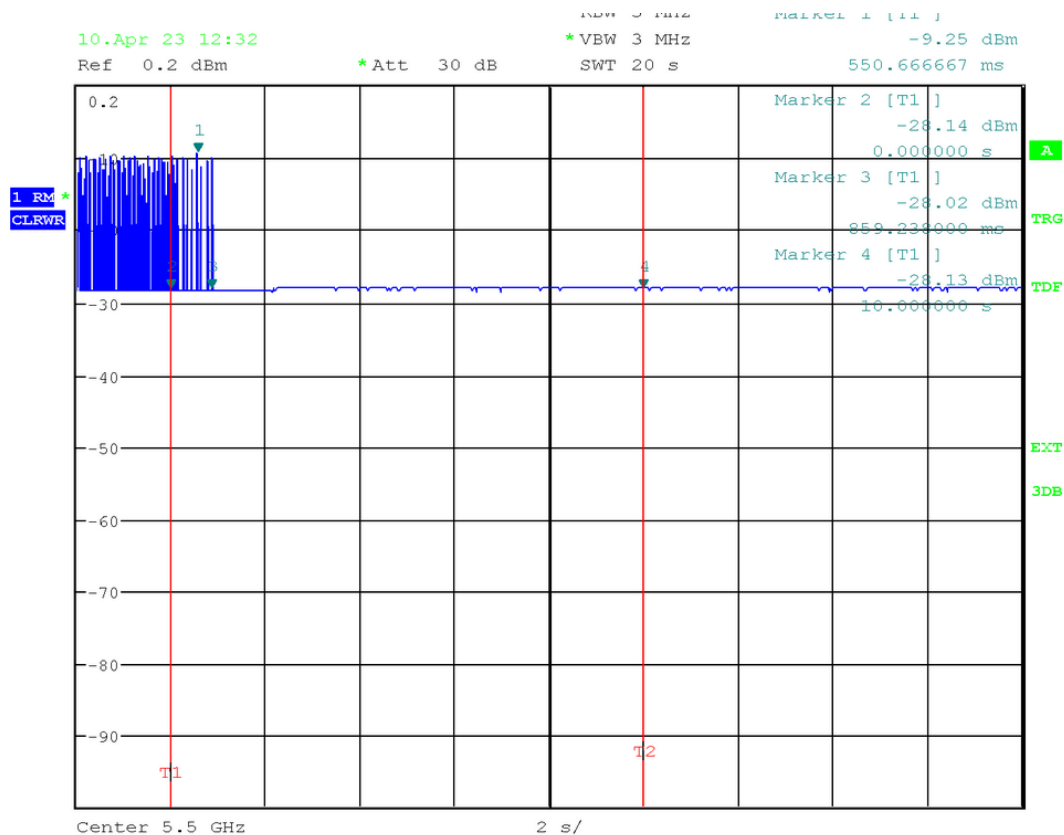
4.3.2 Operational Requirements – Test Details (Worst case graphs):

Non- Occupancy Period: WLAN 802.11n 20MHz MCS7 CH100



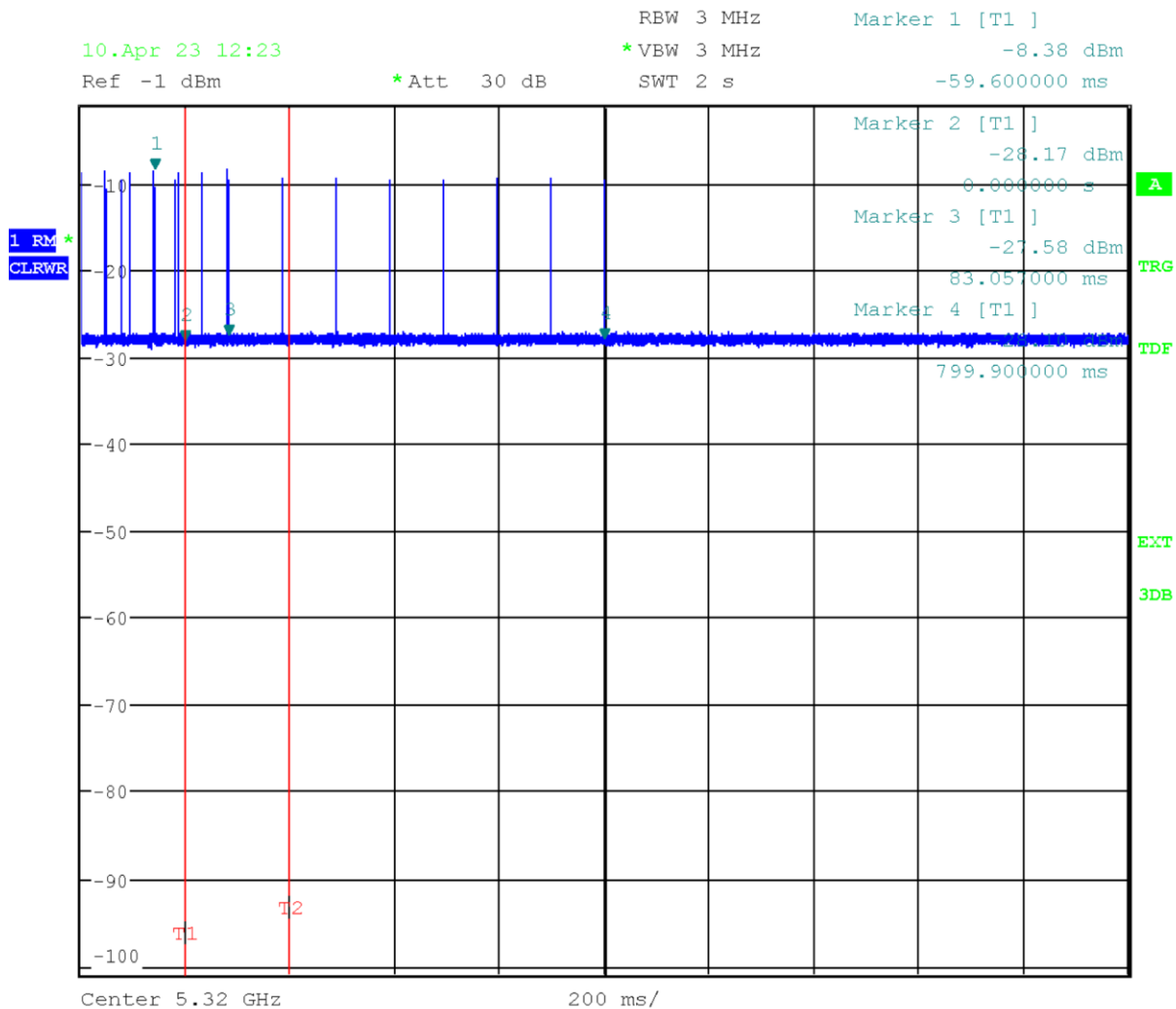
4.3.3 Operational Requirements – Test Details (Worst case graphs):

Channel Move Time: WLAN 802.11n 20MHz MCS7 CH100



Date: 10.APR.2023 12:32:31

Channel Closing Time: WLAN 802.11n 20MHz MCS7 CH64



Date: 10.APR.2023 12:23:25

4.4 Test Results – Statistical Performance Check

4.4.1 Statistical Performance Check – Test Summary

This requirement is not applicable for a Client device without Radar Detection

5. TEST EQUIPMENT STATUS

5.1 List of Hardware with Calibration Dates

5.1.1 Hardware List – CTE System

Type	Manufacturer	Model	Serial Number / ID	Calibration Date	Calibration Due
Comprehensive Testing Environment	TÜV Rheinland LGA Products	HWE 6000	00139	N/A	N/A
WLAN Signaling Unit	ASUS	RT-AX88U MSQ-RTAXHP00	L6IMHP000811	N/A	N/A
Spectrum Analyzer	Rohde & Schwarz	FSU26	101603	2022.07.13	2023.07.13
Vector Signal Generator	Rohde & Schwarz	SMBV100B	101584 2704111	N/A	N/A
Power Supply	Keithley	2303	1198722 2717714	2022.08.22	2023.08.22
Multimeter	Keithley	2700	1035251 2704115	2022.07.06	2023.07.06
Average Power Sensor	Rohde & Schwarz	NRP-Z31	102145 2704104	2022.07.14	2023.07.14
Temperature Chamber	Vötsch	VT4002	58566081940010 2717693	N/A	N/A
Single Input Thermometer	Fluke	Fluke-51-2	41410362WS 2807523	2022.07.02	2023.07.02
Temperature probe	Fluke	80PK-1	WPL26041802 2807528	2022.07.02	2023.07.02
Digital Multimeter	Fluke	87	61320241 2744110	2022.07.05	2023.07.05
Humidity Temperature Probe	Lufft	OPUS 20	146.0216.0802.030 2703980	2022.07.27	2024.07.27

5.2 Software / Firmware Versions

Equipment	Software / Firmware Name	Version
Comprehensive Testing Environment (CTE)	CTE – TMF	V51.0
	CTE – BT	V44.0

6. MEASUREMENT UNCERTAINTY

6.1 Measurement Uncertainty for CTE

Parameter	Uncertainty (Coverage Factor $k=2$)
Maximum Output Power (15.247b)	± 0.51 dB
Maximum Output Power (15.407a)	± 1.98 dB
Frequency Tolerance (15.249b2)	< 10 ppm

7. PHOTOGRAPHS

For photographs, see Appendix 1