

Prüfbericht-Nr.: Test report no.:	SE23D05H-003	Auftrags-Nr.: Order no.:	0290100214	Seite 1 von 10 Page 1 of 10	
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:	RF Exposure Evaluation				
Prüfgrundlage: Test specification:	FCC 47 CFR 2.1091				
Wareneingangsdatum: Date of sample receipt:	N/A				
Prüfmuster-Nr.: Test sample no.:	N/A				
Prüfzeitraum: Testing period:	N/A -				
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:	Datum: 2023.05.17 Date:				
Stellung / Position: Senior Technical Expert	Stellung / Position: Lab Manager				
Sonstiges / Other:					
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 F(ail) = entspricht nicht o.g. Prüfgrundlage(n)	4 = ausreichend N/A = nicht anwendbar	5 = mangelhaft 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 F(ail) = failed a.m. test specification(s)	4 = sufficient N/A = not applicable	5 = poor 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. <i>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.</i>					

V05

Revision History

Revision	Date	Remarks	Author
001	2023.04.21	First release	Niall Forrester
002	2023.04.21	Corrected error in wireless frequencies	Niall Forrester
003	2023.05.17	Updated module text	Niall Forrester
Note: Latest revision report will replace all previous reports			
This report based on RF Exposure FCC 47CFR 2-1091 IEEE C95 Template version 1.1			

Statement of Compliance

Evaluation was performed based on FCC 47 CFR 2.1091 for mobile devices.

The calculations below show that the Space Recorder / FCC ID: 2A9CX-REC1 device is compliant with these requirements at a distance of 20cm for all supported combinations of wireless transmitter technologies.

Table of Contents

1. GENERAL INFORMATION	3
1.1 Test Site	3
1.2 Client Information	3
2. PRODUCT INFORMATION	4
2.1 General Description	4
2.2 Device Usage and Evaluation Distance	4
2.3 Wireless Technologies and Bands Supported by the EUT	4
2.4 Simultaneous Transmission Configurations	5
2.5 Conducted Power and Antenna Gain	5
3. TEST METHODS	6
3.1 Test Standards	6
3.2 Additional references	6
3.3 Limits	7
4. EVALUATION DETAILS	9
4.1 Power Density (S) at 20cm Distance for Each Band and Technology	9
4.2 Simultaneous Transmission Calculations	10

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

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 Usage and Evaluation Distance

The device is a hub for wireless communication with multiple Bluetooth wireless microphones, also featuring wireless cloud access over WLAN. A separation distance of 20cm has been applied.

2.3 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	YES
WLAN 802.11a/n/ac (Main)	5 GHz	5180 MHz – 5825 MHz	YES
Bluetooth Low Energy (Main)	2.4 GHz	2402 MHz - 2480 MHz	YES
Bluetooth Low Energy (Microphone Tx0)	2.4 GHz	2402 MHz - 2480 MHz	YES
Bluetooth Low Energy (Microphone Tx1)	2.4 GHz	2402 MHz - 2480 MHz	YES
Bluetooth Low Energy (Microphone Tx2)	2.4 GHz	2402 MHz - 2480 MHz	YES
Bluetooth Low Energy (Microphone Tx3)	2.4 GHz	2402 MHz - 2480 MHz	YES

2.4 Simultaneous Transmission Configurations

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

2.5 Conducted Power and Antenna Gain

Technology	Band	Max. Conducted Output Power (dBm)	Max. Time-Averaged Output Power (dBm)*	Antenna Gain (dBi)	Max. e.r.p. (mW)
WLAN 802.11b/g/n (Main)	2.4 GHz	18.16	18.16	4.20	104.95
WLAN 802.11a/n/ac (Main)	5 GHz	13.80	13.80	4.50	41.21
Bluetooth Low Energy (Main)	2.4 GHz	5.40	5.40	4.20	5.56
Bluetooth Low Energy (Microphone Tx0)	2.4 GHz	4.87	4.87	2.05	3.00
Bluetooth Low Energy (Microphone Tx1)	2.4 GHz	4.78	4.78	1.99	2.90
Bluetooth Low Energy (Microphone Tx2)	2.4 GHz	5.26	5.26	2.58	3.71
Bluetooth Low Energy (Microphone Tx3)	2.4 GHz	5.27	5.27	1.16	2.68

3. TEST METHODS

3.1 Test Standards

Testing was performed according to the following standards / references

Standard	Version	Description
47 CFR 2.1091	-	Radiofrequency radiation exposure evaluation: mobile devices.

3.2 Additional references

Standard	Version	Description
47 CFR 1.1307	-	Actions that may have a significant environmental effect, for which Environmental Assessments (EAs) must be prepared
KDB 447498 D01	v06	RF Exposure Procedures and Equipment Authorization Policies for Mobile and Portable Devices
KDB 447498 D04	v01	RF Exposure Procedures and Equipment Authorization Policies for Mobile and Portable Devices

3.3 Limits

Extract from FCC 47 CFR 2.1093 (c)

- (1) Evaluation of compliance with the exposure limits in 1.1310 of this chapter, and preparation of an EA if the limits are exceeded, is necessary for mobile devices with single RF sources having either more than an available maximum time-averaged power of 1 mW or more than the ERP listed in Table 1 to 1.1307(b)(3)(i)(C), whichever is greater. For mobile devices not exempt by 1.1307(b)(3)(i)(C) at distances from 20 centimeters to 40 centimeters and frequencies from 0.3 GHz to 6 GHz, evaluation of compliance with the exposure limits in 1.1310 of this chapter is necessary if the ERP of the device is greater than ERP_{20cm} in the formula below. If the ERP of a single RF source at distances from 20 centimeters to 40 centimeters and frequencies from 0.3 GHz to 6 GHz is not easily obtained, then the available maximum time-averaged power may be used (i.e., without consideration of ERP) in comparison with the following formula only if the physical dimensions of the radiating structure(s) do not exceed the electrical length of $\lambda/4$ or if the antenna gain is less than that of a half-wave dipole (1.64 linear value).

$$P_{th}(mW) = ERP_{20cm}(mW) = 2040f \quad \text{for } 0.3 \text{ GHz} \leq f \leq 1.5 \text{ GHz}$$

$$P_{th}(mW) = ERP_{20cm}(mW) = 3060 \quad \text{for } 1.5 \text{ GHz} \leq f \leq 6 \text{ GHz}$$

Table 1 from 1.1307(b)(3)(i)(C),

RF Source Frequency (MHz)	Threshold ERP (W)
0.3 – 1.34	$1,920 R^2$
1.34 – 30	$3,450 R^2/f^2$
30 – 300	$3.83 R^2$
300 – 1,500	$0.0128 R^2 f$
1,500 – 100,000	$19.2 R^2$

Where
R = separation distance in m
f = frequency in MHz

- (2) For multiple mobile or portable RF sources within a device operating in the same time averaging period, routine environmental evaluation is required if the formula in 1.1307(b)(3)(ii)(B) of this chapter is applied to determine the exemption ratio and the result is greater than 1.

Equation from FCC 47 CFR 1.1307(b)(3)(ii)(B):

$$\sum_{i=1}^a \frac{P_i}{P_{th,i}} + \sum_{j=1}^b \frac{ERP_j}{ERP_{th,j}} + \sum_{k=1}^c \frac{Evaluated_k}{Exposure Limit_k} \leq 1$$

Where:

a = number of fixed, mobile, or portable RF sources claiming exemption using paragraph (b)(3)(i)(B) of this section for P_{th} , including existing exempt transmitters and those being added.

b = number of fixed, mobile, or portable RF sources claiming exemption using paragraph (b)(3)(i)(C) of this section for Threshold ERP, including existing exempt transmitters and those being added.

c = number of existing fixed, mobile, or portable RF sources with known evaluation for the specified minimum distance including existing evaluated transmitters.

P_i = the available maximum time-averaged power or the ERP, whichever is greater, for fixed, mobile, or portable RF source i at a distance between 0.5 cm and 40 cm (inclusive).

$P_{th,i}$ = the exemption threshold power (P_{th}) according to paragraph (b)(3)(i)(B) of this section for fixed, mobile, or portable RF source i.

ERP_j = the ERP of fixed, mobile, or portable RF source j.

$ERP_{th,j}$ = exemption threshold ERP for fixed, mobile, or portable RF source j, at a distance of at least $\lambda/2\pi$ according to the applicable formula of paragraph (b)(3)(i)(C) of this section.

$Evaluated_k$ = the maximum reported SAR or MPE of fixed, mobile, or portable RF source k either in the device or at the transmitter site from an existing evaluation at the location of exposure.

$Exposure Limit_k$ = either the general population/uncontrolled maximum permissible exposure (MPE) or specific absorption rate (SAR) limit for each fixed, mobile, or portable RF source k, as applicable from 1.1310 of this chapter.

- (3) Unless otherwise specified in this chapter, any other single mobile or multiple mobile and portable RF source(s) associated with a device is exempt from routine environmental evaluation for RF exposure prior to equipment authorization or use, except as specified in 1.1307(c) and (d) of this chapter.

4. EVALUATION DETAILS

4.1 Power Density (S) at 20cm Distance for Each Band and Technology

The maximum e.r.p of each of the transmitters in the device is >1mW, so the ERP threshold is calculated:

Based on Table 1 from 1.1307(b)(3)(i)(C) above, the threshold ERP for each transmitter would be:

$$19.2 \times (0.2)^2 = 0.768W = 768mW$$

Technology	Band	Freq* (GHz)	Min.** Separation (cm)	Max. Conducted Power (dBm)	Max . Conducted Power (mW)	Antenna Gain (dBi)	Max e.r.p (mW)	Threshold P _{th} (mW)
WLAN 802.11b/g/n (Main)	2.4 GHz	2.12	20	18.16	65.46	4.2	104.95	768
WLAN 802.11a/n/ac (Main)	5 GHz	5.18	20	13.80	23.99	4.5	41.21	768
Bluetooth Low Energy (Main)	2.4 GHz	2.40	20	5.40	3.47	4.2	5.56	768
Bluetooth Low Energy (Microphone Tx0)	2.4 GHz	2.40	20	4.87	3.07	2.05	3.00	768
Bluetooth Low Energy (Microphone Tx1)	2.4 GHz	2.40	20	4.78	3.01	1.99	2.90	768
Bluetooth Low Energy (Microphone Tx2)	2.4 GHz	2.40	20	5.26	3.36	2.58	3.71	768
Bluetooth Low Energy (Microphone Tx3)	2.4 GHz	2.40	20	5.27	3.37	1.16	2.68	768

* The lowest frequency in each band has been chosen, to give the most conservative limit

Based on this calculation, the maximum conducted power and maximum effective radiated power are both below the threshold P_{th} for each individual transmitter. A calculation for the supported combinations of simultaneous transmissions is performed below.

4.2 Simultaneous Transmission Calculations

Based on the equation from FCC 47 CFR 1.1307(b)(3)(ii)(B). In this case all of the ratio calculations are in the form of $P_i/P_{th,i}$, so the equation simplifies to:

$$\sum_{i=1}^a \frac{P_i}{P_{th,i}} \leq 1$$

Calculation of Ratio $P_i/P_{th,i}$ for Supported Transmitter Technologies and bands

Technology	Band	P_i^* (mW)	Limit $P_{th,i}$ (mW)	$P_i/P_{th,i}$
WLAN 802.11b/g/n (Main)	2.4 GHz	104.95	768	0.137
WLAN 802.11a/n/ac (Main)	5 GHz	41.21	768	0.054
Bluetooth Low Energy (Main)	2.4 GHz	5.56	768	0.007
Bluetooth Low Energy (Microphone Tx0)	2.4 GHz	3.07	768	0.004
Bluetooth Low Energy (Microphone Tx1)	2.4 GHz	3.01	768	0.004
Bluetooth Low Energy (Microphone Tx2)	2.4 GHz	3.71	768	0.005
Bluetooth Low Energy (Microphone Tx3)	2.4 GHz	3.37	768	0.004

*Where P_i is the higher value from conducted power or e.r.p. for each transmitter

Evaluation of Compliance for Supported Combinations of Transmitters

Main Tech.	Main Band	Main $P_i/P_{th,i}$	Microphone Tech.	Microphone Band	Microphone $P_i/P_{th,i}$	Sum $P_i/P_{th,i}$	Compliant?
WLAN 802.11b/g/n	2.4 GHz	0.137	Bluetooth Low Energy	2.4 GHz Tx0-Tx3	0.004+0.004+0.005+0.004	0.154	YES
WLAN 802.11a/n/ac	5 GHz	0.054	Bluetooth Low Energy	2.4 GHz Tx0-Tx3	0.004+0.004+0.005+0.004	0.071	YES
Bluetooth Low Energy	2.4 GHz	0.007	Bluetooth Low Energy	2.4 GHz Tx0-Tx3	0.004+0.004+0.005+0.004	0.024	YES

The table above shows the compliance evaluation for all supported combinations of transmitters