

RF Exposure Evaluation Report

APPLICANT : Nokia Shanghai Bell Co., Ltd.
EQUIPMENT : Nokia FastMile 5G Receiver High Gain
BRAND NAME : Nokia
MODEL NAME : 5G16-A
FCC ID : 2ADZR5G16A
STANDARD : 47 CFR Part 2.1091

The product evaluation date was started from Jun. 07, 2023 and completed on Jun. 07, 2023. We, Sporton International Inc. (Kunshan), would like to declare that the device has been evaluated in accordance with 47 CFR Part 2.1091 and FCC KDB 447498 D01 v06, and pass the limit. Without written approval of Sporton International Inc. (Kunshan), the test report shall not be reproduced except in full.



Approved by: Si Zhang

Sporton International Inc. (Kunshan)

No. 1098, Pengxi North Road, Kunshan Economic Development Zone Jiangsu Province 215300
People's Republic of China



Table of Contents

1. ADMINISTRATION DATA	4
1.1. Testing Laboratory	4
2. DESCRIPTION OF EQUIPMENT UNDER TEST (EUT)	5
3. MAXIMUM RF AVERAGE OUTPUT TUNE UP POWER AMONG PRODUCTION UNITS	7
4. RF EXPOSURE LIMIT INTRODUCTION	9
5. RADIO FREQUENCY RADIATION EXPOSURE EVALUATION	10
5.1. Standalone Power Density Calculation	10
5.2. Collocated Power Density Calculation.....	11



Revision History

REPORT NO.	VERSION	DESCRIPTION	ISSUED DATE
FA341901	Rev. 01	Initial issue of report.	Jun. 21, 2023



1. Administration Data

1.1. Testing Laboratory

Sporton International Inc. (Kunshan) is accredited to ISO/IEC 17025:2017 by American Association for Laboratory Accreditation with Certificate Number 5145.02.

Testing Laboratory			
Test Firm	Sporton International Inc. (Kunshan)		
Test Site Location	No. 1098, Pengxi North Road, Kunshan Economic Development Zone Jiangsu Province 215300 People's Republic of China TEL : +86-512-57900158 FAX : +86-512-57900958		
Test Site No.	Sporton Site No.	FCC Designation No.	FCC Test Firm Registration No.
	SAR01-KS	CN1257	314309

Applicant	
Company Name	Nokia Shanghai Bell Co., Ltd.
Address	388#, Ningqiao Road, China (Shanghai) Pilot Free Trade Zone, Shanghai 201206, China

Manufacturer	
Company Name	Nokia Solutions and Networks Oy
Address	Karakaari 7, 02610 Espoo, Finland



2. Description of Equipment Under Test (EUT)

Product Feature & Specification	
EUT Type	Nokia FastMile 5G Receiver High Gain
Brand Name	Nokia
Model Name	5G16-A
FCC ID	2ADZR5G16A
Wireless Technology and Frequency Range	LTE Band 2 : 1850 MHz ~ 1910 MHz LTE Band 4 : 1710 MHz ~ 1755 MHz LTE Band 5 : 824 MHz ~ 849 MHz LTE Band 7: 2500 MHz ~ 2570 MHz LTE Band 12 : 699 MHz ~ 716 MHz LTE Band 13 : 777 MHz ~ 787 MHz LTE Band 25 : 1850 MHz ~ 1915 MHz LTE Band 26 : 814 MHz ~ 849 MHz LTE Band 38: 2570 MHz ~ 2620 MHz LTE Band 41: 2496 MHz ~ 2690 MHz LTE Band 42: 3450 MHz ~3550 MHz, 3550 MHz ~ 3600 MHz LTE Band 43: 3600 MHz ~ 3700MHz LTE Band 48: 3550 MHz ~ 3700 MHz LTE Band 66 : 1710 MHz ~ 1755 MHz LTE Band 71: 663 MHz ~ 698 MHz 5G NR n2 : 1850 MHz ~ 1910 MHz 5G NR n5 : 824 MHz ~ 849 MHz 5G NR n7 : 2500 MHz ~ 2570 MHz 5G NR n12 : 699 MHz ~ 716 MHz 5G NR n25 : 1850 MHz ~1915 MHz 5G NR n26 : 814 MHz ~ 849 MHz 5G NR n38 : 2570 MHz ~ 2620 MHz 5G NR n41 : 2496 MHz ~ 2690 MHz 5G NR n48 : 3550 MHz ~ 3700 MHz 5G NR n66 : 1710 MHz ~ 1755 MHz 5G NR n71 : 663 MHz ~ 698 MHz 5G NR n77: 3450 MHz ~ 3980 MHz 5G NR n78: 3450 MHz ~ 3800 MHz Bluetooth: 2402 MHz ~ 2480 MHz
Mode	LTE: QPSK, 16QAM, 64QAM, 256QAM 5G NR : CP-OFDM / DFT-s-OFDM, PI/2 BPSK, QPSK, 16QAM, 64QAM, 256QAM Bluetooth LE
Antenna Type	WWAN: Directional Antenna Bluetooth: Dipole Antenna
HW Version	3TG02369Axxx, x:A~Z
SW Version	5GReceiver-HG-2_D230200B31T0001E0147
EUT Stage	Identical Prototype

Remark:

- The above EUT's information was declared by manufacturer. Please refer to the specifications or user's manual for more detailed description.
- 5GNR n2/5/7/12/25/41/48/66/77/78 supports NSA and SA mode, and 5GNR n26/38 supports SA mode only.
- This device supports intra-band ULCA, due to intra-band ULCA and non-CA power is same, so non-CA MPE analysis can represent ULCA MPE analysis.
- The intra-band/inter-band ULCA and EN-DC mode combination could be referred to the product spec.
- This device supports HPUE for LTE Band 38/41 and 5GNR n38/41/77/78 with class 2, so HPUE has been performed to do MPE analysis.
- The device supports HPUE (power class 2) under SISO mode and HPUE (power class 1.5) under UL MIMO mode for 5G NR n41/n77, so HPUE (power class 1.5) has been performed MPE calculation.
- 5GNR n38/41/48/77/78 support SISO/MIMO mode, we only chose MIMO tune up power to perform MPE calculation conservatively for MIMO power is higher.



Comments and Explanations:

1. The declared of product specification for EUT presented in the report are provided by the manufacturer, and the manufacturer takes all the responsibilities for the accuracy of product specification.
2. The maximum RF output tune up power, antenna gain also the safe distance used for evaluate RF exposure were declared by manufacturer.

For Antenna Gain:

Technical	Band	ANT0 Gain (dBi)	ANT1 Gain (dBi)	ANT4 Gain (dBi)	ANT5 Gain (dBi)
4G LTE	Band 2	13.67	13.66	/	/
	Band 4	13.67	12.8	/	/
	Band 5	/	/	2.39	2.23
	Band 7	15.89	16.41	/	/
	Band 12	/	/	1.25	1.28
	Band 13	/	/	1.45	1.78
	Band 25	13.72	13.66	/	/
	Band 26	/	/	2.39	2.23
	Band 38	15.89	16.41	/	/
	Band 41	15.89	16.41	/	/
	Band 42	17.69	17.99	/	/
	Band 43	18.01	17.99	/	/
	Band 48	17.94	17.99	/	/
	Band 66	13.72	12.8	/	/
Band 71	/	/	1.09	1.28	
5G NR	FR1 n2	13.67	13.66	/	/
	FR1 n5	/	/	2.39	2.23
	FR1 n7	15.89	16.41	/	/
	FR1 n12	/	/	1.25	1.28
	FR1 n25	13.72	13.66	/	/
	FR1 n26	/	/	2.39	2.23
	FR1 n66	13.72	/	/	/
	FR1 n71	/	/	1.09	1.28
	FR1 n38	15.89	16.41	/	/
	FR1 n41	15.89	16.41	/	/
	FR1 n48	17.94	17.99	/	/
FR1 n77	18.01	17.99	/	/	
FR1 n78	18.01	17.99	/	/	
BT 4.2	Bluetooth	4.1	/	/	/



3. Maximum RF average output tune up power among production units

<LTE>

Mode	Maximum Average power(dBm)
Band 2	19.0
Band 4	16.0
Band 5	24.0
Band 7	24.0
Band 12	24.0
Band 13	24.0
Band 25	19.0
Band 26	24.0
Band 38 PC3	24.0
Band 38 PC2	27.0
Band 41 PC3	24.0
Band 41 PC2	27.0
Band 42	24.0
Band 43	24.0
Band 48	22.0
Band 66	16.0
Band 71	24.0

<5G NR>

Mode	Maximum Average power(dBm)
n2	19.0
n5	24.0
n7	24.0
n12	24.0
n25	19.0
n26	24.0
n38 PC3	24.0
n38 PC2	27.0
n41 PC3	24.0
n41 PC2	27.0
n48	20.5
n66	16.0
n71	24.0
n77 PC3	24.0
n77 PC2	27.0
n78 PC3	24.0
n78 PC2	27.0



<MIMO>

Mode	Maximum Average power(dBm)
n38	27.00
n41	30.00
n48	24.00
n77	30.00
n78	27.00

Note: WWAN support SISO/MIMO mode, we only chose MIMO tune up power to perform MPE calculation conservatively for MIMO power is higher.

<Bluetooth>

Mode	Maximum Average power(dBm)
Bluetooth LE	5.0



4. RF Exposure Limit Introduction

According to ANSI/IEEE C95.1-1992, the criteria listed in Table 1 shall be used to evaluate the environmental impact of human exposure to radio frequency (RF) radiation as specified in §1.1310.

Frequency range (MHz)	Electric field strength (V/m)	Magnetic field strength (A/m)	Power density (mW/cm ²)	Averaging time (minutes)
(A) Limits for Occupational/Controlled Exposures				
0.3-3.0	614	1.63	*(100)	6
3.0-30	1842/f	4.89/f	*(900/f ²)	6
30-300	61.4	0.163	1.0	6
300-1500			f/300	6
1500-100,000			5	6
(B) Limits for General Population/Uncontrolled Exposure				
0.3-1.34	614	1.63	*(100)	30
1.34-30	824/f	2.19/f	*(180/f ²)	30
30-300	27.5	0.073	0.2	30
300-1500			f/1500	30
1500-100,000			1.0	30

The MPE was calculated at 39 cm to show compliance with the power density limit.

The following formula was used to calculate the Power Density:

$$S = \frac{PG}{4\pi R^2}$$

Where:

S = Power Density

P = Output Power at Antenna Terminals

G = Gain of Transmit Antenna (linear gain)

R = Distance from Transmitting Antenna



5. Radio Frequency Radiation Exposure Evaluation

5.1. Standalone Power Density Calculation

Band	Frequency (MHz)	Duty cycle	Antenna Gain (dBi)	Maximum Power (dBm)	Average EIRP (dBm)	Average EIRP (mW)	Power Density at 39cm (mW/cm ²)	Limit (mW/cm ²)	Power Density / Limit
LTE Band 2	1850.0	100%	13.67	19.00	32.670	1849.269	0.097	1.000	0.097
LTE Band 4	1710.0	100%	13.67	16.00	29.670	926.830	0.049	1.000	0.049
LTE Band 5	824.0	100%	2.39	24.00	26.390	435.512	0.023	0.549	0.041
LTE Band 7	2500.0	100%	16.41	24.00	40.410	10990.058	0.575	1.000	0.575
LTE Band 12	699.0	100%	1.28	24.00	25.280	337.287	0.018	0.466	0.038
LTE Band 13	777.0	100%	1.78	24.00	25.780	378.443	0.020	0.518	0.038
LTE Band 25	1850.0	100%	13.72	19.00	32.720	1870.682	0.098	1.000	0.098
LTE Band 26	814.0	100%	2.39	24.00	26.390	435.512	0.023	0.543	0.042
LTE Band 38	2570.0	25%	16.41	27.00	37.410	5508.077	0.288	1.000	0.288
LTE Band 41	2496.0	25%	16.41	27.00	37.410	5508.077	0.288	1.000	0.288
LTE Band 42	3450.0	25%	17.99	24.00	35.990	3971.915	0.208	1.000	0.208
LTE Band 43	3600.0	25%	18.01	24.00	36.010	3990.249	0.209	1.000	0.209
LTE Band 48	3550.0	25%	17.99	22.00	33.990	2506.109	0.131	1.000	0.131
LTE Band 66	1710.0	100%	13.72	16.00	29.720	937.562	0.049	1.000	0.049
LTE Band 71	663.0	100%	1.28	24.00	25.280	337.287	0.018	0.442	0.040
5G NR n2	1850.00	100%	13.67	19.00	32.670	1849.269	0.097	1.000	0.097
5G NR n5	824.00	100%	2.39	24.00	26.390	435.512	0.023	0.549	0.041
5G NR n7	2500.00	100%	16.41	24.00	40.410	10990.058	0.575	1.000	0.575
5G NR n12	699.00	100%	1.28	24.00	25.280	337.287	0.018	0.466	0.038
5G NR n25	1850.00	100%	13.72	19.00	32.720	1870.682	0.098	1.000	0.098
5G NR n26	814.00	100%	2.39	24.00	26.390	435.512	0.023	0.543	0.042
5G NR n38	2570.00	25%	16.41	27.00	37.410	5508.077	0.288	1.000	0.288
5G NR n41	2496.00	25%	16.41	30.00	40.410	10990.058	0.575	1.000	0.575
5G NR n48	3550.00	25%	17.99	24.00	35.990	3971.915	0.208	1.000	0.208
5G NR n66	1710.00	100%	13.72	16.00	29.720	937.562	0.049	1.000	0.049
5G NR n71	663.00	100%	1.28	24.00	25.280	337.287	0.018	0.442	0.040
5G NR n77	3450.00	25%	18.01	27.00	39.010	7961.594	0.417	1.000	0.417
5G NR n77 MIMO	3450.00	25%	18.01	30.00	42.010	15885.467	0.832	1.000	0.832
5G NR n78	3450.00	25%	18.01	27.00	39.010	7961.594	0.417	1.000	0.417
Bluetooth	2402.0	100%	4.10	5.00	9.100	8.128	0.000	1.000	0.0004

Note:

- For conservativeness, the lowest frequency of each band is used to determine the MPE limit of that band.
- Chose the maximum power to do MPE analysis.
- Chose the maximum RF output tune up power of all antennas among same frequency WWAN bands and the maximum antenna gain to perform MPE calculation conservatively.
- The MIMO mode is completely uncorrelated, so selected the higher SISO gain among all antennas as MIMO gain to perform MPE calculation.
- 5G NR n38/n41/n77/n78 supports MIMO mode, MIMO MPE using single each antenna MPE summed together as MIMO MPE is more conservatively.
- For LTE/NR TDD Bands Evaluation, using perform MPE analysis with default 25% (Declared by Manufacturer) transmission.



5.2. Collocated Power Density Calculation

WWAN Power Density / Limit (n77 MIMO)	Bluetooth Power Density / Limit	Σ (Power Density / Limit) of WWAN + 5G NR + Bluetooth
0.832	0.0004	0.832

LTE Power Density / Limit (LTE Band 7)	LTE Power Density / Limit (LTE Band 41)	Bluetooth Power Density / Limit	Σ (Power Density / Limit) of WWAN + 5G NR + Bluetooth
0.575	0.288	0.0004	0.864

5G NR Power Density / Limit (n77 CA)	5G NR Power Density / Limit (n77 CA)	Bluetooth Power Density / Limit	Σ (Power Density / Limit) of WWAN + 5G NR + Bluetooth
0.417	0.417	0.0004	0.834

LTE Power Density / Limit (LTE Band 7)	5G NR Power Density / Limit (n78)	Bluetooth Power Density / Limit	Σ (Power Density / Limit) of WWAN + 5G NR + Bluetooth
0.575	0.417	0.0004	0.992

Note:

- For colocation analysis, LTE Band 7 is chosen for summation due to the highest (power density/limit) among all LTE Band modes.
- For colocation analysis, 5G NR FR1 n77 is chosen for summation due to the highest (power density/limit) among all 5G NR FR1 modes.
- For 5G NR EN-DC mode, always chose the highest LTE power density and the highest 5G NR power density to sum as EN-DC conservatively.
- Σ (Power Density / Limit): This is a summation of [(power density for each transmitter/antenna included in the simultaneous transmission)/ (corresponding MPE limit)], for WWAN + Bluetooth, LTE + 5G NR + Bluetooth.
- Considering the WWAN and 5G NR module collocation with the Bluetooth transmitter of the EIRP performance listed in the table above, the aggregated (power density /limit) is smaller than 1, and MPE of 3 collocated transmitters is compliant.

Conclusion:

According to 47 CFR §2.1091, the MPE was calculated at 39 cm to show compliance with the power density limit, the RF exposure analysis concludes that the RF Exposure is FCC compliant.

-----THE END-----