RF Exposure Evaluation Report

APPLICANT	:	Nokia Shanghai Bell Co., Ltd.
EQUIPMENT	:	NOK 5G21 GATEWAY GRY KIT
BRAND NAME	:	T-Mobile
MODEL NAME	:	5G21-12W-A
FCC ID	:	2ADZR5G2112WA
STANDARD	:	47 CFR Part 2.1091 FCC KDB 447498 D01 v06

We, Sporton International (Kunshan) Inc., 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 (Kunshan) Inc., the test report shall not be reproduced except in full.

Rose Wang

Reviewed by: Rose Wang / Supervisor

Kat Yin

Approved by: Kat Yin / Manager

ACCREDITED Cert #5145.02

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Revision History

REPORT NO.	VERSION	DESCRIPTION	ISSUED DATE
FA9D2703	Rev. 01	Initial issue of report.	Jul. 31, 2020

1. Administration Data

1.1. Testing Laboratory

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

Testing Laboratory		
Test Firm	Sporton International (Kunshan) Inc.	
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.	**FCC Designation No.**	**FCC Test Firm Registration No.**
	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	NOK 5G21 GATEWAY GRY KIT
Brand Name	T-Mobile
Model Name	5G21-12W-A
FCC ID	2ADZR5G2112WA
Wireless Technology and Frequency Range	LTE Band 2: 1850.7 MHz ~ 1909.3 MHz LTE Band 4: 1710.7 MHz ~ 1754.3 MHz LTE Band 5: 824.7 MHz ~ 848.3 MHz LTE Band 12: 699.7 MHz ~ 715.3 MHz LTE Band 25: 1850.7 MHz ~ 1914.3 MHz LTE Band 26: 814.7 MHz ~ 848.3 MHz LTE Band 41: 2498.5 MHz ~ 2687.5 MHz LTE Band 48: 3552.5 MHz ~ 3697.5 MHz LTE Band 66: 1710.7 MHz ~ 1779.3 MHz LTE Band 71: 665.5 MHz ~695.5 MHz 5G NR n2: 1852.5 MHz ~ 1907.5 MHz 5G NR n25: 1852.5 MHz ~ 1912.5 MHz 5G NR n41: 2506 MHz ~ 2680 MHz 5G NR n66: 1712.5 MHz ~ 1777.5 MHz 5G NR n71: 665.5 MHz ~ 695.5MHz WLAN 2.4GHz Band: 2412 MHz ~ 2462 MHz WLAN 5.2GHz Band: 5180 MHz ~ 5240 MHz WLAN 5.8GHz Band: 5745 MHz ~ 5825 MHz Bluetooth: 2402 MHz ~ 2480 MHz
Mode	LTE: QPSK, 16QAM, 64QAM, 256QAM DFT-s-OFDM (PI/2 BPSK / QPSK / 16QAM / 64QAM / 256QAM) CP-OFDM (QPSK / 16QAM / 64QAM / 256QAM) WLAN 2.4GHz 802.11b/g/n/ax HT20/ HT40/ HE20/ HE40 WLAN 5GHz 802.11a/n HT20/HT40 WLAN 5GHz 802.11ac/ax VHT20/VHT40/VHT80/HE20/HE40/HE80 Bluetooth BR/EDR/LE
Antenna Gain	**<For WWAN/5G NR>** LTE Band 2 : 3.28 dBi LTE Band 4 : 3.28 dBi LTE Band 5 : 1.73 dBi LTE Band 12 : 0.97 dBi LTE Band 25 : 3.28 dBi LTE Band 26 : 1.73 dBi LTE Band 41 : 4.27 dBi LTE Band 48 : 4.10 dBi LTE Band 66 : 3.28 dBi LTE Band 71 : 0.97 dBi n2 / n25: 3.28 dBi n66: 3.28 dBi n41 : 4.27 dBi n71 : 0.85 dBi **<For Bluetooth>** Bluetooth : 4.00 dBi **<For Non-Beamforming>** WLAN 2.4GHz SISO/MIMO: 3.00 dBi WLAN 5GHz SISO/MIMO: 5.00 dBi **<For Beamforming>** WLAN 2.4GHz MIMO: 5.58 dBi WLAN 5.2GHz MIMO: 5.51 dBi WLAN 5.8GHz MIMO: 5.41 dBi
HW Version	3TG00739A

SW Version	HB5GGW_D010000B42T0101E0379.tar
EUT Stage	Identical Prototype

Remark:

1. The above EUT's information was declared by manufacturer. Please refer to the specifications or user's manual for more detailed description.
2. This device supports HPUE for LTE band 41 with class 2 power level, so HPUE has been performed standalone power density calculation.
3. For 11ax, manufacturer declared the EUT does not support OFDMA of Resource unit combination (26 tones, 52 tones, 106 tones, 242 tones…etc).
4. The EUT supports for MIMO mode for 802.11g/n/an/ac/ax mode only.
5. WLAN2.4/5GHz MIMO 802.11 g/n/ac/ax support beamforming mode.
6. For DFT-s-OFDM and CP-OFDM output power measurement reduction, according to maximum power reduction for the CP-OFDM mode will not higher than DFT-s-OFDM mode, therefore, CP-OFDM measurement is unnecessary. We always chose higher power (DFT-s-OFDM mode) to perform MPE analysis.
7. 5GNR supports NSA and SA mode.
8. NSA and SA mode should perform MPE separately. For the maximum power of SA mode is the same as NSA total power level, so SA standalone total power level SAR can represent NSA mode MPE.
9. The device implanted DPS (Dynamic Power Share) function to achieve higher uplink data rate keeping the total power unchanged in 5G NR NSA EN-DC mode according to 3GPP 38.213, when the equipment has a dynamic power sharing capability, it adjusts the LTE or NR transmission power so that the instantaneous total power does not exceed the specified value, when the maximum transmission power of NR (P LTE, P NR) and the specified total power (P total) have been set and the instantaneous calculated total transmission power exceeds P total, the NR transmission power is reduced so that the actual transmission power of the user equipment will not exceed Ptotal power. So if the LTE and NR standalone SAR is testing at total power level, the EN-DC combine MPE(LTE+NR) will not higher than the each standalone LTE and NR MPE, therefore, the simultaneous transmission analysis is used standalone MPE at total power level to show compliance.

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.

3. Maximum RF Tune Up power among production units

<LTE>

Mode		Maximum Average power(dBm)
LTE	Band 2	25.00
	Band 4	25.50
	Band 5	25.00
	Band 12	25.00
	Band 25	25.00
	Band 26	25.00
	Band 41	25.00
	Band 41-HPUE	28.00
	Band 48	18.50
	Band66	25.50
	Band71	25.00

<5G NR>

Mode		Maximum Average power(dBm)
5G NR	n2	25.00
	n25	25.00
	n41	25.00
	n66	25.00
	n71	25.00

<Bluetooth>

Mode		Maximum Average Power (dBm)
Bluetooth	LE	9.00

<WLAN 2.4GHz>

Mode		Maximum Average Power (dBm)
2.4GHz	802.11b SISO	25.00
	802.11g MIMO	29.50
	802.11n-HT20 MIMO	29.50
	802.11n-HT40 MIMO	27.50
	802.11ax-HE20 MIMO	29.50
	802.11ax-HE40 MIMO	27.50

<WLAN 5GHz>

SISO

Mode		Maximum Average Power (dBm)			
		ANT1	ANT2	ANT3	ANT4
5.2GHz	802.11a	28.00	28.00	28.00	28.00
5.8GHz	802.11a	24.00	24.00	24.00	24.00

MIMO

Mode		Maximum Average Power (dBm)
5.2GHz	802.11n-HT20	28.00
	802.11n-HT40	30.00
	802.11ac-VHT20	24.00
	802.11ac-VHT40	25.00
	802.11ac-VHT80	20.00
	802.11ax-HE20	28.00
	802.11ax-HE40	30.00
	802.11ax-HE80	20.00
5.8GHz	802.11n-HT20	30.00
	802.11n-HT40	30.00
	802.11ac-VHT20	30.00
	802.11ac-VHT40	30.00
	802.11ac-VHT80	30.00
	802.11ax-HE20	30.00
	802.11ax-HE40	30.00
	802.11ax-HE80	30.00

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/f2)	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/f2)	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 **31 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)	Antenna Gain (dBi)	Maximum Power (dBm)	Maximum EIRP (dBm)	Maximum EIRP (W)	Average EIRP (mW)	Power Density at 31cm (mW/cm^2)	Limit (mW/cm^2)	Power Density / Limit
LTE Band 2	1850.7	3.28	25.00	28.280	0.673	672.977	0.056	1.000	0.056
LTE Band 4	1710.7	3.28	25.50	28.780	0.755	755.092	0.063	1.000	0.063
LTE Band 5	824.7	1.73	25.00	26.730	0.471	470.977	0.039	0.550	0.071
LTE Band 12	699.7	0.97	25.00	25.970	0.395	395.367	0.033	0.466	0.070
LTE Band 25	1850.7	3.28	25.00	28.280	0.673	672.977	0.056	1.000	0.056
LTE Band 26	814.7	1.73	25.00	26.730	0.471	470.977	0.039	0.543	0.072
LTE Band 41-HPUE	2498.5	4.27	28.00	32.270	1.687	1686.553	0.140	1.000	**0.140**
LTE Band 48	3552.5	4.10	18.50	22.600	0.182	181.970	0.015	1.000	0.015
LTE Band 66	1710.7	3.28	25.50	28.780	0.755	755.092	0.063	1.000	0.063
LTE Band 71	665.5	0.97	25.00	25.970	0.395	395.367	0.033	0.444	0.074
5G NR n2	1852.5	3.28	25.00	28.280	0.673	672.977	0.056	1.000	0.056
5G NR n25	1852.5	3.28	25.00	28.280	0.673	672.977	0.056	1.000	0.056
5G NR n41	2506.0	4.27	25.00	29.270	0.845	845.279	0.070	1.000	0.070
5G NR n66	1712.5	3.28	25.00	28.280	0.673	672.977	0.056	1.000	0.056
5G NR n71	665.5	0.85	25.00	25.850	0.385	384.592	0.032	0.442	**0.072**
2.4GHz WLAN	2412.0	3.00	29.50	32.500	1.778	1778.279	0.147	1.000	0.147
5.2GHz WLAN	5180.0	5.00	30.00	35.000	3.162	3162.278	0.262	1.000	0.262
5.8GHz WLAN	5745.0	5.00	30.00	35.000	3.162	3162.278	0.262	1.000	0.262
Bluetooth	2402.0	4.00	9.00	13.000	0.020	19.953	0.002	1.000	0.002

<For Beamforming mode>

Band	Frequency (MHz)	Antenna Gain (dBi)	Maximum Power (dBm)	Maximum EIRP (dBm)	Maximum EIRP (W)	Average EIRP (mW)	Power Density at 31cm (mW/cm^2)	Limit (mW/cm^2)	Power Density / Limit
2.4GHz WLAN	2412.0	5.58	29.50	35.080	3.221	3221.069	0.267	1.000	**0.267**
5.2GHz WLAN	5180.0	5.51	30.00	35.510	3.556	3556.313	0.295	1.000	**0.295**
5.8GHz WLAN	5745.0	5.41	30.00	35.410	3.475	3475.362	0.288	1.000	**0.288**

Note:
1. For conservativeness, the lowest frequency of each band is used to determine the MPE limit of that band.
2. This device supports HPUE for LTE band 41 with class 2 power level, so HPUE has been performed standalone power density calculation.
3. Chose the maximum power density to do MPE analysis.

5.2. Collocated Power Density Calculation

WWAN Power Density / Limit	WLAN 2.4GHz Power Density / Limit	WLAN 5GHz Low Band Power Density / Limit	WLAN 5GHz High Band Power Density / Limit	Σ(Power Density / Limit) of WWAN + WLAN 2.4GHz+WLAN 5GHz Low Band+ WLAN 5GHz High Band
0.140	0.267	0.295	0.288	0.990

5NR Power Density / Limit	WLAN 2.4GHz Power Density / Limit	WLAN 5GHz−Low Band Power Density / Limit	WLAN 5GHz−High Band Power Density / Limit	Σ(Power Density / Limit) of 5G NR + WLAN 2.4GHz+WLAN 5GHz Low Band+ WLAN 5GHz High Band
0.072	0.267	0.295	0.288	0.922

Note:

1. WLAN 5GHz Low Band means WLAN5G Band5.2GHz.
   WLAN 5GHz High Band means WLAN5G Band5.8GHz.
2. WLAN 5GHz Low Band and WLAN 5GHz High Band can transmit simultaneously.
3. Bluetooth can't transmit with WWAN or WLAN2.4GHz or WLAN5GHz.
4. For colocation analysis, LTE Band41-HPUE is chosen for summation due to the highest (power density/limit) among all WWAN wireless modes.
5. The device implanted DPS (Dynamic Power Share) function to achieve higher uplink data rate keeping the total power unchanged in 5G NR NSA EN-DC mode according to 3GPP 38.213, when the equipment has a dynamic power sharing capability, it adjusts the LTE or NR transmission power so that the instantaneous total power does not exceed the specified value, when the maximum transmission power of NR (P LTE, P NR) and the specified total power (P total) have been set and the instantaneous calculated total transmission power exceeds P total, the NR transmission power is reduced so that the actual transmission power of the user equipment will not exceed Ptotal power. So if the LTE and NR standalone SAR is testing at total power level, the EN-DC combine MPE(LTE+NR) will not higher than the each standalone LTE and NR MPE, therefore, the simultaneous transmission analysis is used standalone MPE at total power level to show compliance.
6. For colocation analysis, 5GNR n71 is chosen for summation due to the highest (power density/limit) among all 5GNR modes.
7. Chose the worst power density among WLAN2.4/5GHz to do co-located.
8. 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 + WLAN 2.4GHz+WLAN 5GHz Low Band + WLAN 5GHz High Band.
9. Σ(Power Density / Limit): This is a summation of [(power density for each transmitter/antenna included in the simultaneous transmission)/ (corresponding MPE limit)], for 5G NR + WLAN 2.4GHz+WLAN 5GHz Low Band + WLAN 5GHz High Band.
10. Considering the WWAN/5GNR module collocation with the WLAN 2.4GHz/WLAN5GHz transmitter of the EIRP performance listed in the table above, the aggregated (power density /limit) is smaller than 1.

Conclusion:

According to 47 CFR §2.1091, the RF exposure analysis concludes that the RF Exposure is FCC compliant.

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