FCC 47 CFR § 2.1093
INDUSTRY CANADA RSS 102 ISSUE 5

RF EXPOSURE REPORT

FOR

Multimedia Device with BLE, 2.4Ghz and 5GHz WLAN Radios

MODEL NUMBER: NC2-6A5

FCC ID: A4RNC2-6A5
IC ID: 10395A-NC26A5

REPORT NUMBER: 15U20917-E10

ISSUE DATE: JULY 29, 2015

Prepared for
GOOGLE
1600 AMPHITEATRE PARKWAY
MOUNTAIN VIEW, CA 94043, U.S.A.

Prepared by
UL VERIFICATION SERVICES INC.
47173 BENICIA STREET
FREMONT, CA 94538, U.S.A.
TEL: (510) 771-1000
FAX: (510) 661-0888

NVLAP LAB CODE 200065-0

Revision History

Rev.	Issue Date	Revisions	Revised By
--	7/14/15	Initial Issue	F. de Anda
A	7/29/15	added multiple chain transmitter tables	F. de Anda

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1. ATTESTATION OF TEST RESULTS

COMPANY NAME: GOOGLE
1600 AMPHITEATRE PARKWAY
MOUNTAIN VIEW, CA 94043, U.S.A.

MODEL: NC2-6A5

SERIAL NUMBER: NA

DATE TESTED: NA

APPLICABLE STANDARDS	
STANDARD	**TEST RESULTS**
FCC 47 CFR § 2.1093 Published RF exposure KDB procedures	Exempt from SAR testing
INDUSTRY CANADA RSS 102 ISSUE 5	Exempt from SAR testing

UL Verification Services Inc. calculated the RF Exposure of the above equipment in accordance with the requirements set forth in the above standards, using test results reported in the test report documents referenced below and/or documentation furnished by the applicant. All indications of Pass/Fail in this report are opinions expressed by UL Verification Services Inc. based on interpretations of these calculations. The results show that the equipment is capable of demonstrating compliance with the requirements as documented in this report.

Note: The results documented in this report apply only to the tested sample, under the conditions and modes of operation as described herein. This document may not be altered or revised in any way unless done so by UL Verification Services Inc. and all revisions are duly noted in the revisions section. Any alteration of this document not carried out by UL Verification Services Inc. will constitute fraud and shall nullify the document. This report must not be used by the client to claim product certification, approval, or endorsement by NVLAP, NIST, any agency of the Federal Government, or any agency of any government.

Approved & Released For
UL Verification Services Inc. By:

FRANCISCO DE ANDA
PROJECT LEAD
UL Verification Services Inc.

Tested By:

CHRIS XIONG
EMC ENGINEER
UL Verification Services Inc.

2. TEST METHODOLOGY

All calculations were made in accordance with FCC OET Bulletin 65 Edition 97-01 and IC Safety Code 6.

3. REFERENCES

All measurements were made as documented in test report UL Verification Services Inc. Document 15U20917-E4 FCC_IC BLE Report and 15U20917-E1 FCC_IC DTS WLAN Report for operation in the 2.4 GHz band and UL Verification Services Inc. Document 15U20917-E2 FCC UNII WLAN Report for operation in the 5 GHz bands.

Duty cycle data is excerpted from the applicable test reports.

Output power and Antenna gain data is excerpted from product documentation provided by the applicant.

4. FACILITIES AND ACCREDITATION

The test sites and measurement facilities used to collect data are located at 47173 Benicia Street, Fremont, California, USA.

UL Verification Services Inc. is accredited by NVLAP, Laboratory Code 200065-0. The full scope of accreditation can be viewed at http://ts.nist.gov/standards/scopes/2000650.htm.

5. MAXIMUM PERMISSIBLE RF EXPOSURE

5.1. FCC RULES

§1.1310 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 §1.1307(b), except in the case of portable devices which shall be evaluated according to the provisions of §2.1093 of this chapter.

TABLE 1—LIMITS FOR MAXIMUM PERMISSIBLE EXPOSURE (MPE)

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

TABLE 1—LIMITS FOR MAXIMUM PERMISSIBLE EXPOSURE (MPE)—Continued

Frequency range (MHz)	Electric field strength (V/m)	Magnetic field strength (A/m)	Power density (mW/cm^2)	Averaging time (minutes)
30–300	27.5	0.073	0.2	30
300–1500	.....	.....	f/1500	30
1500–100,000	.....	.....	1.0	30

f = frequency in MHz
* = Plane-wave equivalent power density

NOTE 1 TO TABLE 1: Occupational/controlled limits apply in situations in which persons are exposed as a consequence of their employment provided those persons are fully aware of the potential for exposure and can exercise control over their exposure. Limits for occupational/controlled exposure also apply in situations when an individual is transient through a location where occupational/controlled limits apply provided he or she is made aware of the potential for exposure.

NOTE 2 TO TABLE 1: General population/uncontrolled exposures apply in situations in which the general public may be exposed, or in which persons that are exposed as a consequence of their employment may not be fully aware of the potential for exposure or can not exercise control over their exposure.

5.2. IC RULES

IC Safety Code 6, Section 2.2.1 (a) A person other than an RF and microwave exposed worker shall not be exposed to electromagnetic radiation in a frequency band listed in Column 1 of Table 5, if the field strength exceeds the value given in Column 2 or 3 of Table 5, when averaged spatially and over time, or if the power density exceeds the value given in Column 4 of Table 5, when averaged spatially and over time.

Table 5
Exposure Limits for Persons Not Classed As RF and Microwave Exposed Workers (Including the General Public)

1 Frequency (MHz)	2 Electric Field Strength; rms (V/m)	3 Magnetic Field Strength; rms (A/m)	4 Power Density (W/m^2)	5 Averaging Time (min)
0.003–1	280	2.19		6
1–10	$280/f$	$2.19/f$		6
10–30	28	$2.19/f$		6
30–300	28	0.073	2*	6
300–1 500	$1.585f^{0.5}$	$0.0042f^{0.5}$	$f/150$	6
1 500–15 000	61.4	0.163	10	6
15 000–150 000	61.4	0.163	10	$616\,000/f^{1.2}$
150 000–300 000	$0.158f^{0.5}$	$4.21 \times 10^{-4}f^{0.5}$	$6.67 \times 10^{-5}f$	$616\,000/f^{1.2}$

* Power density limit is applicable at frequencies greater than 100 MHz.

Notes: 1. Frequency, f, is in MHz.
2. A power density of 10 W/m^2 is equivalent to 1 mW/cm^2.
3. A magnetic field strength of 1 A/m corresponds to 1.257 microtesla (μT) or 12.57 milligauss (mG).

5.3. EQUATIONS

POWER DENSITY

Power density is given by:

S = EIRP / (4 * Pi * D^2)

Where

S = Power density in mW/cm^2
EIRP = Equivalent Isotropic Radiated Power in mW
D = Separation distance in cm

Power density in units of mW/cm^2 is converted to units of W/m^2 by multiplying by 10.

DISTANCE

Distance is given by:

D = SQRT (EIRP / (4 * Pi * S))

Where

D = Separation distance in cm
EIRP = Equivalent Isotropic Radiated Power in mW
S = Power density in mW/cm^2

SOURCE-BASED DUTY CYCLE

Where applicable (for example, multi-slot cell phone applications) a duty cycle factor may be applied.

Source-based time-averaged EIRP = (DC / 100) * EIRP

Where

DC = Duty Cycle in %, as applicable
EIRP = Equivalent Isotropic Radiated Power in W

MIMO AND COLOCATED TRANSMITTERS (IDENTICAL LIMIT FOR ALL TRANSMITTERS)

For multiple chain devices, and colocated transmitters operating simultaneously in frequency bands where the limit is identical, the total power density is calculated using the total EIRP obtained by summing the EIRP (in linear units) of each transmitter.

Total EIRP = (EIRP1) + (EIRP2) + ... + (EIRPn)

where

EIRPx = Source-based time-averaged EIRP of chain x or transmitter x

The total EIRP is then used to calculate the Power Density or the Distance as applicable.

MIMO AND COLOCATED TRANSMITTERS

For multiple colocated transmitters operating simultaneously in frequency bands where different limits apply:

The Power Density at the specified separation distance is calculated for each transmitter chain or transmitter.

The fraction of the exposure limit is calculated for each chain or transmitter as
(Power Density of chain or transmitter) / (Limit applicable to that chain or transmitter).

The fractions are summed.

Compliance is established if the sum of the fractions is less than or equal to one.

5.4. LIMITS AND IC EXEMPTION

VARIABLE LIMITS

For mobile radio equipment operating in the cellular phone band, the lowest power density limit is calculated using the lowest frequency:

824 MHz / 1500 = 0.55 mW/cm^2 (FCC)
824 MHz / 150 = 5.5 W/m^2 (IC).

FIXED LIMITS

For operation in the PCS band, the 2.4 GHz band and the 5 GHz bands:

From FCC §1.1310 Table 1 (B), the maximum value of S = 1.0 mW/cm^2
From IC Safety Code 6, Section 2.2 Table 5 Column 4, S = 10 W/m^2

INDUSTRY CANADA EXEMPTION

RSS-102 Clause 2.5.2 RF exposure evaluation is required if the separation distance between the user and the device's radiating element is greater than 20 cm, except when the device operates as follows:

• at or above 300 MHz and below 6 GHz and the source-based, time-averaged maximum e.i.r.p. of the device is equal to or less than 1.31 x 10^-2 f^0.6834 W (adjusted for tune-up tolerance), where f is in MHz;

6. RF EXPOSURE RESULTS

In the table(s) below, Power and Gain are entered in units of dBm and dBi respectively and conversions to linear forms are used for the calculations.

(Single chain transmitters, no colocation, MPE distance > 20 cm)

Band	Mode	FCC Limit (mW/cm^2)	IC Limit (W/m^2)	Output AVG Power (dBm)	Antenna Gain (dBi)	EIRP (dBm)	Duty Cycle (%)	EIRP (mW)	Separation Distance (cm)
2.4 GHz	BLE	1.00	10.0	8.40	3.10	11.50	60.4	8.5	0.82
2.4 GHz	WLAN	1.00	10.0	21.00	3.10	24.10	100.0	257.0	4.52
5 GHz	WLAN	1.00	10.0	18.50	2.10	20.60	100.0	114.8	3.02

Band	@ Distance	FCC Power Density (mW/cm^2)	IC Power Density (mW/cm^2)
2.4 GHz	20.00	0.002	0.017
2.4 GHz		0.051	0.512
5 GHz		0.023	0.229
BLE/2.4GHz WLAN Combined	20.00	0.053	0.529
BLE/5GHz WLAN Combined		0.025	0.246

The device operates above 300 MHz and below 6 GHz with a maximum EIRP less than or equal to 2.7 Watts in 2.4GHz band and 4.9 Watts in the 5GHz bands as a mobile device with a minimum separation distance of 20 cm, therefore it is exempt from routine RF Exposure Evaluation under RSS-102.

(Multiple chain transmitters all with same Power Density limit, MPE distance > 20 cm)

Multiple chain - BLE and 2.4GHZ WLAN

Band	(GHz)	2.4	2.4
Mode		BLE	WLAN
Transmitter		Ant. 2	Ant. 1
Separation Distance	(cm)	20	20
Output Power	(dBm)	8.4	21.0
Antenna Gain	(dBi)	2.3	3.1
Duty Cycle	(%)	60	100
Source Based EIRP	(mW)	7.1	257.0
FCC Power Density	(mW/cm^2)	0.001	0.051
FCC Power Density Limit	(mW/cm^2)	1	1
IC Power Density	(W/m^2)	0.014	0.512
IC Power Density Limit	(W/m^2)	10	10
Fraction of Limit	(%)	0.1	5.1
Sum of Fractions (%)	5.3		

Multiple chain - BLE and 5GHZ WLAN

Band	(GHz)	2.4	5
Mode		BLE	WLAN
Transmitter		Ant. 2	Ant. 3
Separation Distance	(cm)	20	20
Output Power	(dBm)	8.4	18.5
Antenna Gain	(dBi)	3.1	2.1
Duty Cycle	(%)	60	100
Source Based EIRP	(mW)	8.5	114.8
FCC Power Density	(mW/cm^2)	0.002	0.023
FCC Power Density Limit	(mW/cm^2)	1	1
IC Power Density	(W/m^2)	0.017	0.229
IC Power Density Limit	(W/m^2)	10	10
Fraction of Limit	(%)	0.2	2.3
Sum of Fractions (%)	2.5		

Notes:

1) For MPE the new KDB 447498 requires the calculations to use the maximum rated power; that power should be declared by the manufacturer, and should not be lower than the measured power. If the power has a tolerance then we also need to check that the measured power is within the tolerance.

2) A tolerance value of +2 dB was included in the output power values above to cover the output power tolerance of +/-2 dB under extreme conditions in the real filed as declared by the client.

3) The manufacturer configures output power so that the maximum power, after accounting for manufacturing tolerances, will never exceed the maximum power level measured.

4) The output power in the tables above is the maximum power per chain among various channels and various modes within the specific band.

5) The antenna gain in the tables above is the maximum antenna gain among various channels within the specified band.

END OF REPORT