FCC Part 1 Subpart I
FCC Part 2 Subpart J
INDUSTRY CANADA RSS 102 ISSUE 5

RF EXPOSURE REPORT

FOR

HOME AUTOMATION GATEWAY PRODUCT: 802.11a/b/g/n 2x2 MIMO, BLUETOOTH, BLUETOOTH LOW ENERGY, ZigBee and Z-WAVE

MODEL NUMBER: ID: 087

FCC ID: DKNCS08
IC: 1707A-CS08

REPORT NUMBER: R10526502-RF7

ISSUE DATE: 2015-06-01

Prepared for
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Revision History

Rev.	Issue Date	Revisions	Revised By
--	2015-05-15	Initial Issue	Jeff Moser
1	2015-05-28	Revised rule references on page 5, revised Exposure limit table on page 7, revised IC Exemption levels on page 10 and revised power levels to include 0.5 dBm tune up.	Jeff Moser
2	2015-06-01	Revised RF Exposure Limits on page 10 and revised data tables to include limits.	Jeff Moser

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1. ATTESTATION OF TEST RESULTS

COMPANY NAME:　　　　ECHOSTAR TECHNOLOGIES LLC
　　　　　　　　　　　　　90 INVERNESS CIRCLE EAST
　　　　　　　　　　　　　ENGLEWOOD CO, 80112, USA

EUT DESCRIPTION:　　　HOME AUTOMATION GATEWAY PRODUCT

MODEL:　　　　　　　　ID: 087

SERIAL NUMBER:　　　　FCC1 – FCC6

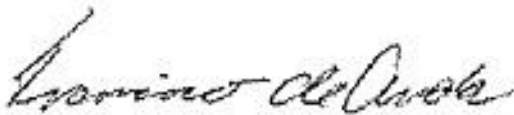**DATE TESTED:**　　　　　February 23, 2015 to May 4, 2015

APPLICABLE STANDARDS	
STANDARD	TEST RESULTS
FCC PART 1 SUBPART I & PART 2 SUBPART J	PASS
INDUSTRY CANADA RSS 102 ISSUE 5	PASS

UL LLC tested the above equipment in accordance with the requirements set forth in the above standards. All indications of Pass/Fail in this report are opinions expressed by UL LLC based on interpretations and/or observations of test results. Measurement Uncertainties were not taken into account and are published for informational purposes only. The test results show that the equipment tested 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 LLC and all revisions are duly noted in the revisions section. Any alteration of this document not carried out by UL LLC 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　　　　　　　　Prepared By:
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EMC Project Lead　　　　　　　　　　　EMC Program Manager
UL Verification Services　　　　　　　　UL LLC – Consumer Technology Division

2. TEST METHODOLOGY

All calculations were made in accordance with FCC Parts 2.1091, 2.1093 and KDB 447498 D01 v05r02 and IC Safety Code 6, RSS 102 Issue 5.

3. REFERENCES

All measurements were made as documented in test report UL LLC R10526502-RF6 for operation in the 900 MHz bands, UL LLC R10526502-RF1, R10526502-RF3, R10526502-RF4, R10526502-RF6 for operation in the 2.4 GHz band and UL LLC R10526502-RF2 for operation in the 5 GHz bands.

Output power, Duty cycle and Antenna gain data is excerpted from the applicable test reports.

4. FACILITIES AND ACCREDITATION

The test sites and measurement facilities used to collect data are located at 12 Laboratory Dr., Research Triangle Park, NC 27709, USA.

12 Laboratory Dr., RTP, NC 27709
☐ Chamber A
☒ Chamber C

The onsite chambers (A & C) are covered under Industry Canada company address code 2180C with site numbers 2180C -1 through 2180C-2, respectively.

UL LLC (RTP) is accredited by NVLAP, Laboratory Code 200246-0. The full scope of accreditation can be viewed at http://ts.nist.gov/standards/scopes/2002460.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/cm²)	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

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/cm²)	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.

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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 the below table, if the field strength exceeds the value given in Column 2 or 3 of the below table, when averaged spatially and over time, or if the power density exceeds the value given in Column 4 of the below table, when averaged spatially and over time.

Table 4: RF Field Strength Limits for Devices Used by the General Public (Uncontrolled Environment)

Frequency Range (MHz)	Electric Field (V/m rms)	Magnetic Field (A/m rms)	Power Density (W/m^2)	Reference Period (minutes)
$0.003\text{-}10^{21}$	83	90	-	Instantaneous*
0.1-10	-	$0.73/f$	-	6**
1.1-10	$87/f^{0.5}$	-	-	6**
10-20	27.46	0.0728	2	6
20-48	$58.07/f^{0.25}$	$0.1540/f^{0.25}$	$8.944/f^{0.5}$	6
48-300	22.06	0.05852	1.291	6
300-6000	$3.142\,f^{0.3417}$	$0.008335\,f^{0.3417}$	$0.02619 f^{0.6834}$	6
6000-15000	61.4	0.163	10	6
15000-150000	61.4	0.163	10	$616000/f^{1.2}$
150000-300000	$0.158\,f^{0.5}$	$4.21 \times 10^{-4}\,f^{0.5}$	$6.67 \times 10^{-5}\,f$	$616000/f^{1.2}$

Note: f is frequency in MHz.
*Based on nerve stimulation (NS).
** Based on specific absorption rate (SAR).

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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

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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

RF EXPOSURE LIMITS – GENERAL PUBLIC (UNCONTROLLED ENVIRONMENTS)

FCC:
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

IC:
For operation in the 300-6000 MHz band:

Power Density = $0.02619f^{0.6834}$

$$\text{Power Density (2.4 GHz)} = 0.02619(2400)^{0.6834} = 4.4 \text{ W/m}^2$$
$$\text{Power Density (5 GHz)} = 0.02619(5150)^{0.6834} = 9.01 \text{ W/m}^2$$
Note – Lowest frequency that would yield the lowest limit was used.

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:

- below 20 MHz[6] and the source-based, time-averaged maximum e.i.r.p. of the device is equal to or less than 1 W (adjusted for tune-up tolerance);
- at or above 20 MHz and below 48 MHz and the source-based, time-averaged maximum e.i.r.p. of the device is equal to or less than $4.49/f^{0.5}$ W (adjusted for tune-up tolerance), where f is in MHz;
- at or above 48 MHz and below 300 MHz and the source-based, time-averaged maximum e.i.r.p. of the device is equal to or less than 0.6 W (adjusted for tune-up tolerance);
- 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 $1.31 \times 10^{-2} f^{0.6834}$ W (adjusted for tune-up tolerance), where f is in MHz;
- at or above 6 GHz and the source-based, time-averaged maximum e.i.r.p. of the device is equal to or less than 5 W (adjusted for tune-up tolerance).

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[6] Transmitters operating between 0.003-10 MHz, meeting the exemption from routine RF Exposure evaluation, shall demonstrate compliance to the instantaneous limits in Section 4.

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, 20 cm MPE distance)

Single Chain and non-colocated transmitters								
Band	Mode	Separation Distance (cm)	Output AVG Power (dBm)	Antenna Gain (dBi)	Duty Cycle (%)	EIRP (mW)	FCC Power Density (mW/cm^2)	IC Power Density (W/m^2)
2.4 GHz	Bluetooth	20	6.64	3.30	100.0	9.9	0.0019631	0.0196314
2.4 GHz	ZigBee	20	18.70	3.30	100.0	158.5	0.0315464	0.3154644
2.4 GHz	WLAN	20	21.58	3.10	100.0	293.8	0.0584723	0.5847233
5 GHz	WLAN	20	17.06	2.50	100.0	90.4	0.0179867	0.1798665

Note - FCC Power Density Limit = 1 mW/cm^2. IC Power Density Limit = 4W/m^2 (2.4 GHz) and 9W/m^2 (5GHz).

- IC Power Density is worst-case for both 2.4 GHz band and 5 GHz band.

-Bluetooth worst-case power = GFSK

-2.4 GHz WLAN Worst-case power = 802.11n HT20

-5 GHz WLAN worst-case power = 802.11a

-Power values include +/-0.5 dBm tolerance.

(MIMO and/or Colocated transmitters all with same Power Density limit, 20 cm MPE distance)

Multiple chain or colocated transmitters

Band	Mode	Chain for MIMO	Separation Distance (cm)	Output AVG Power (dBm)	Antenna Gain (dBi)	EIRP (dBm)	Duty Cycle (%)	EIRP (mW)	FCC Power Density (mW/cm^2)	IC Power Density (W/m^2)
2.4 GHz	Bluetooth	N/A		6.64	3.00	9.64	100.0	9.2		
2.4 GHz	ZigBee	N/A		18.70	3.00	21.70	100.0	147.9		
2.4 GHz	WLAN	2		24.23	3.10	27.33	100.0	540.8		
5 GHz	WLAN	2		18.64	2.50	21.14	100.0	130.0		
Combined			20					827.9	0.165	1.65

Note - FCC Power Density Limit = 1 mW/cm^2. IC Power Density Limit = 4W/m^2 (2.4 GHz)

and 9W/m^2 (5GHz).

-Bluetooth worst-case power = GFSK

- 2.4 GHz WLAN Worst-case power = 802.11n HT20

- 5 GHz WLAN Worst-case power = FCC 5.2G 802.11n HT20. Note IC 5.2G 802.11n HT20 power is 14.72 dBm.

Worst-case IC is 5.8 GHz 802.11nHT20 = 18.11 dBm

Note - Power values include +/- 0.5 dBm tolerance.

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

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

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

END OF REPORT