



FCC Part 1 Subpart I
FCC Part 2 Subpart J

RF EXPOSURE REPORT

FOR

802.11 a/b/g/n WLAN, BT 2.1 and RF4CE SATELLITE SETTOP BOX

MODEL NUMBER: ID:075

FCC ID: DKNCB1138

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Prepared for
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Revision History

Rev.	Issue Date	Revisions	Revised By
--	10/14/13	Initial Issue	T. Chan
A	11/05/13	Updated to MPE tables	F. de Anda
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1. ATTESTATION OF TEST RESULTS

COMPANY NAME: ECHOSTAR CORPORATION
90 INVERNESS CIRCLE EAST
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EUT DESCRIPTION: 802.11 a/b/g/n WLAN, BT 2.1 and RF4CE Satellite SetTop Box

MODEL NUMBER: ID:075

SERIAL NUMBER: 200101R01292Y00112H

DATE TESTED: SEPTEMBER 23 – NOVEMBER 15, 2013

APPLICABLE STANDARDS	
STANDARD	TEST RESULTS
FCC PART 1 SUBPART I & PART 2 SUBPART J	Pass

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.

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2. TEST METHODOLOGY

All calculations were made in accordance with FCC OET Bulletin 65 Edition 97-01.

3. REFERENCES

All measurements were made as documented in test report 1, 2, and 3 UL Verification Services Inc. Document 13U16072 for operation in the 2.4 GHz band and 3 and 4 UL Verification Services Inc. Document 13U16072 for operation in the 5 GHz bands.

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

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. EQUATIONS

POWER DENSITY

Power density is given by:

$$S = \text{EIRP} / (4 * \text{Pi} * D^2)$$

Where

S = Power density in mW/cm²

EIRP = Equivalent Isotropic Radiated Power in mW

D = Separation distance in cm

Power density in units of mW/cm² is converted to units of W/m² by multiplying by 10.

DISTANCE

Distance is given by:

$$D = \text{SQRT} (\text{EIRP} / (4 * \text{Pi} * S))$$

Where

D = Separation distance in cm

EIRP = Equivalent Isotropic Radiated Power in mW

S = Power density in mW/cm²

SOURCE-BASED DUTY CYCLE

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

$$\text{Source-based time-averaged EIRP} = (\text{DC} / 100) * \text{EIRP}$$

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.

$$\text{Total EIRP} = (\text{EIRP1}) + (\text{EIRP2}) + \dots + (\text{EIRPn})$$

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.

5.3. 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:

$$824 \text{ MHz} / 1500 = 0.55 \text{ mW/cm}^2 \text{ (FCC)}$$

$$824 \text{ MHz} / 150 = 5.5 \text{ W/m}^2 \text{ (IC).}$$

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 $S = 1.0 \text{ mW/cm}^2$

From IC Safety Code 6, Section 2.2 Table 5 Column 4, $S = 10 \text{ W/m}^2$

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.

Individual Transmitter Analysis

Mode	Separation Distance (cm)	Output Ave. Power	Antenna Gain (dBi)	MFR Tolerance	EIRP (dBm)	Duty Cycle (%)	EIRP (mW)	Power Density (mW/cm ²)	Power Density (W/m ²)	Fraction of Limit
RF4CE	20	4.40	2.00	5.00	11.40	100.0	13.8	0.003	0.03	0.3%
Bluetooth	20	0.74	0.00	2.00	2.74	100.0	1.9	0.000	0.00	0.0%
WLAN	20	19.33	3.10	1.50	23.93	100.0	247.2	0.049	0.49	4.9%
WLAN	20	20.49	3.20	1.50	25.19	100.0	330.4	0.066	0.66	6.6%
WLAN Chain 0 MIMO	20	14.08	3.10	1.50	18.68	100.0	73.8	0.015	0.15	1.5%
WLAN Chain 1 MIMO	20	14.17	2.00	1.50	17.67	100.0	58.5	0.012	0.12	1.2%
WLAN Chain 0 MIMO	20	20.15	3.20	1.50	24.85	100.0	305.5	0.061	0.61	6.1%
WLAN Chain 1 MIMO	20	20.37	1.80	1.50	23.67	100.0	232.8	0.046	0.46	4.6%

To determine the worst case WLAN mode relative to the power density limits for rf exposure:

- The fraction of the limit for 2.4 GHz 1x mode is 4.9%
- The fraction of the limit for 5 GHz 1x mode is 6.6%
- The fraction of the limit for 2.4 GHz 2x mode is the sum of Chain 0 plus chain 1 is 2.7% (1.0% + 0.8%)
- The fraction of the limit for 5 GHz 2x mode is the sum of Chain 0 plus chain 1 is 10.7% (4.3% + 3.3%)

Worst case fraction for WLAN is **10.7%**.

Colocation Analysis

Multiple chain or colocated transmitters

Band	(GHz)	2.4	2.4	2.4	5	2.4	2.4	5	5
Mode		RF4CE	BT	WLAN SISO	WLAN SISO	WLAN MIMO	WLAN MIMO	WLAN MIMO	WLAN MIMO
Transmitter		TX	TX	TX0	TX0	TX0	TX1	TX0	TX1
Separation Distance	(cm)	20	20	20	20	20	20	20	20
Output Power	(dBm)	4.4	0.7	19.3	20.5	14.1	14.2	20.2	20.4
Antenna Gain	(dBi)	2.0	0.0	3.1	3.2	3.1	2.0	3.2	1.8
Tolerance		5.0	2.0	1.5	1.5	1.5	1.5	1.5	1.5
Duty Cycle	(%)	100	100	100	100	100	100	100	100
Source Based EIRP	(mW)	13.8	1.9	247.2	330.4	73.8	58.7	305.5	232.8
FCC Power Density	(mW/cm ²)	0.00	0.00	0.05	0.07	0.01	0.01	0.06	0.05
FCC Power Density Limit	(mW/cm ²)	1	1	1	1	1	1	1	1
IC Power Density	(W/m ²)	0.027	0.004	0.492	0.658	0.147	0.117	0.608	0.463
IC Power Density Limit	(W/m ²)	10	10	10	10	10	10	10	10
Fraction of Limit	(%)	0.3	0.0	4.9	6.6	1.5	1.2	6.1	4.6
Sum of Fractions (%)	11.0	Worst case Scenario. The 2.4 and 5 GHz transmitters can not work simultaneously.							

Collocated transmitters that can operate simultaneously are RF4CE + Bluetooth + WLAN. The total contribution of the power density for each transmitter, as a fraction of the rf exposure limit for each transmitter, is $0.3\% + 0.0\% + 10.7\% = 11\%$. As the sum of the fractions is less than or equal to one (less than or equal to 100%) the device complies with the rf exposure limits for fixed use.

END OF REPORT