RF EXPOSURE REPORT

REPORT NO.: SA990810E06

MODEL NO.: 2100X

FCC ID: TC22100X

ACCORDING: FCC Guidelines for Human Exposure
IEEE C95.1

APPLICANT: Roku, LLC

ADDRESS: 19352 Hilton Rd Springdale, AR 72764

ISSUED BY: Bureau Veritas Consumer Products Services
(H.K.) Ltd., Taoyuan Branch Hsin Chu Laboratory

LAB ADDRESS: No. 81-1, Lu Liao Keng, 9th Ling,Wu Lung Tsuen,
Chiung Lin Hsiang, Hsin Chu Hsien 307, Taiwan

RF Exposure Measurement

1. Introduction

In this document, we try to prove the safety of radiation harmfulness to the human body for our product. The limit for Maximum Permissible Exposure (MPE) specified in FCC 1.1310 is followed. The Gain of the antenna used in this product is measured in a Fully Anechoic Chamber (FAC) calibrated for antenna measurement in our lab, and also the maximum total power input to the antenna is measured. Through the Friis transmission formula and the maximum gain of the antenna, we can calculate the distance, away from the product, where the limit of MPE is reached.

Although the Friis transmission formula is a far field assumption, the calculated result of that is an over-prediction for near field power density. We will take that as the worst case to specify the safety range.

2. RF Exposure Limit

According to FCC 1.1310: The criteria listed in the following table shall be used to evaluate the environmental impact of human exposure to radio-frequency (RF) radiation as specified in 1.1307(b)

LIMITS FOR MAXIMUM PERMISSIBLE EXPOSURE (MPE)

Frequency Range (MHz)	Electric Field Strength (V/m)	Magnetic Field Strength (A/m)	Power Density (mW/cm^2)	Average Time (minutes)
(A)Limits For Occupational / Control Exposures				
300-1500	…	…	F/300	6
1500-100,000	…	…	5	6
(B)Limits For General Population / Uncontrolled Exposure				
300-1500	…	…	F/1500	30
1500-100,000	…	…	1.0	30

F = Frequency in MHz

3. Friis Formula

Friis transmission formula : $Pd = (Pout * G) / (4 * pi * r^2)$

where
Pd = power density in mW/cm^2
Pout = output power to antenna in mW
G = gain of antenna in linear scale
Pi = 3.1416
R = distance between observation point and center of the radiator in cm

Pd is the limit of MPE, 1 mW/cm^2. If we know the maximum Gain of the antenna and the total power input to the antenna, through the calculation, we will know the MPE value at distance 20cm.

Ref. : David K. Cheng, *Field and Wave Electromagnetics*, Second Edition,
      Page 640, Eq. (11-133).

4. EUT Operating condition
The software provided by Manufacturer enabled the EUT to transmit and receive data at lowest, middle and highest channel individually.

5. Classification
The antenna of this product, under normal use condition, is at least 20cm away from the body of the user. So, this device is classified as **Mobile Device**.

6. TEST RESULTS

6.1 Antenna Gain

There are two antennas provided to this EUT, please refer to the following table:

Chain	Antenna Type	Antenna Connector	Antenna Gain (dBi)	Frequency range (MHz to MHz)
Chain (0)	PCB Printed(Main)	NA	-1.51	2400 to 2483.5
	PCB Printed(Main)	NA	3.88	5150 to 5750
Chain (1)	PCB Printed(Aux)	NA	0.34	2400 to 2483.5
	PCB Printed(Aux)	NA	3.03	5150 to 5750

6.2 Output Power Into Antenna & RF Exposure value at distance 20cm:

For 15.247(2.4GHz):

802.11b:

Channel	Channel Frequency (MHz)	Output Power to Antenna (mW)	Power Density (mW/cm^2)	Limit of Power Density (mW/cm^2)
1	2412	91.2	0.020	1.0
6	2437	234.4	0.050	1.0
11	2462	75.9	0.016	1.0

802.11g:

Channel	Channel Frequency (MHz)	Output Power to Antenna (mW)	Power Density (mW/cm^2)	Limit of Power Density (mW/cm^2)
1	2412	450.7	0.097	1.0
6	2437	883.7	0.190	1.0
11	2462	221.9	0.048	1.0

802.11n (20MHz):

Channel	Channel Frequency (MHz)	Output Power to Antenna (mW)	Power Density (mW/cm^2)	Limit of Power Density (mW/cm^2)
1	2412	247.7	0.053	1.0
6	2437	873.3	0.188	1.0
11	2462	203.0	0.044	1.0

802.11n (40MHz):

Channel	Channel Frequency (MHz)	Output Power to Antenna (mW)	Power Density (mW/cm^2)	Limit of Power Density (mW/cm^2)
1	2422	127.7	0.027	1.0
4	2437	317.1	0.068	1.0
7	2452	132.2	0.028	1.0

For 15.247(5GHz):

802.11a:

Channel	Channel Frequency (MHz)	Output Power to Antenna (mW)	Power Density (mW/cm^2)	Limit of Power Density (mW/cm^2)
149	5745	199.5	0.097	1.0
157	5785	177.8	0.086	1.0
165	5825	173.8	0.084	1.0

802.11n (20MHz):

Channel	Channel Frequency (MHz)	Output Power to Antenna (mW)	Power Density (mW/cm^2)	Limit of Power Density (mW/cm^2)
149	5745	413.1	0.201	1.0
157	5785	381.2	0.185	1.0
165	5825	343.8	0.167	1.0

802.11n (40MHz):

Channel	Channel Frequency (MHz)	Output Power to Antenna (mW)	Power Density (mW/cm^2)	Limit of Power Density (mW/cm^2)
151	5755	376.8	0.183	1.0
159	5795	372.5	0.181	1.0

For 15.407(5GHz):

802.11a:

Channel	Channel Frequency (MHz)	Output Power to Antenna (mW)	Power Density (mW/cm^2)	Limit of Power Density (mW/cm^2)
36	5180	28.8	0.014	1.0
40	5200	28.8	0.014	1.0
48	5240	29.5	0.014	1.0
52	5260	147.9	0.072	1.0
60	5300	147.9	0.072	1.0
64	5320	67.6	0.033	1.0
100	5500	41.7	0.020	1.0
120	5600	138.0	0.067	1.0
140	5700	28.2	0.014	1.0

802.11n (20MHz):

Channel	Channel Frequency (MHz)	Output Power to Antenna (mW)	Power Density (mW/cm^2)	Limit of Power Density (mW/cm^2)
36	5180	29.4	0.014	1.0
40	5200	31.6	0.015	1.0
48	5240	31.1	0.015	1.0
52	5260	119.1	0.058	1.0
60	5300	117.8	0.057	1.0
64	5320	109.9	0.053	1.0
100	5500	57.0	0.028	1.0
120	5600	119.1	0.058	1.0
140	5700	44.0	0.021	1.0

802.11n (40MHz):

Channel	Channel Frequency (MHz)	Output Power to Antenna (mW)	Power Density (mW/cm^2)	Limit of Power Density (mW/cm^2)
38	5190	31.5	0.015	1.0
46	5230	47.0	0.023	1.0
54	5270	188.8	0.092	1.0
62	5310	41.9	0.020	1.0
102	5510	32.1	0.016	1.0
118	5590	178.4	0.087	1.0
134	5670	74.3	0.036	1.0

--- END ---