RF Exposure Exhibit

EUT Name: RFID Reader

Model No.: TR-001-44

CFR Part 1.1310 and RSS 102

Prepared for:

Illumina, Inc
5200 Illumina Way
San Diego, CA 92122 USA
Tel: (510) 670-9319
Fax: (510) 670-9302

Prepared by:

TUV Rheinland of North America, Inc.
1279 Quarry Lane
Pleasanton, CA 94566
Tel: (925) 249-9123
Fax: (925) 249-9124
http://www.tuv.com/

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1 Test Methodology

In this document, we evaluate the RF Exposure to human body due the intentional transmission from the transmitter (EUT). The limit for Maximum Permissible Exposure (MPE) specified in FCC 1.1310 is followed. 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.

1.1 RF Exposure Limit

According to FCC 1.1310 table 1: 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				
0.3-1.34	614	1.63	*(100)	6
1.34-30	1842/f	4.89/f	*($900/f^2$)	6
30-300	61.4	0.163	1.0	6
30-1500	…	…	F/300	6
1500-100000	…	…	1.0	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
30-300	27.5	0.073	0.2	30
30-1500	…	…	F(MHz)/1500MHz	30
1500-100000	…	…	1.0	30

F = Frequency in MHz

*=Plane wave equivalent density

According to RSS-102 Issue 5: The criteria listed in the following table shall be used to evaluate the environmental impact of human exposure to radio-frequency (RF) radiation

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)**
0.003-10^{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	$3.142f^{0.3417}$	$0.008335f^{0.3417}$	$0.02619f^{0.6834}$	6
6000-15000	61.4	0.163	10	6
15000-150000	61.4	0.163	10	$616000/f^{1.2}$
150000-300000	$0.158f^{0.5}$	$4.21 \times 10^{-4} f^{0.5}$	$6.67 \times 10^{-5} f$	$616000/f^{1.2}$

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

1.2 EUT Operating Condition

The software provided by Manufacturer enabled the EUT to transmit at the regulated power for RFID; The chipset output power was 200 mW using 9.1.6 FPGA firmware.

1.3 MPE calculation

1.3.1 Antenna Gain

The transmitting antenna was attached. Carrier field strength of each RFID was measured.

1.3.2 Output Power into Antenna & RF Exposure value at distance 20cm

Calculations for this report are based on highest carrier field strength measurement.

Corrected (including cal factors) Measurment:	63.82	dBµV	
The Gain of the antenna:	0.00	dBi	
Type of Measurment:	Radiated		Calculated using the Friis Equations
Impedance:	50.00	Ω	
Measureing Distance:	3.00	m	For calculations using the Friis Equations
Time weighted Duty Cycle:	100.00	%	

The Power Out would be:	0.000000723	Watts
or:	0.00072	mW
or:	0.72	µW
or:	-31.41	dBm

Frequency range from 10 MHz to 40 GHz:

Frequency:	0.01356	GHz	=	13.56 MHz

Power output with DC and antenna Gain (EiRP):

Power (dBm):	-31.41
Power (mW):	0.001
Power (W):	0.000001

R = distance in	20	cm

FCC:

Controlled Exposures - Limit =	4.894666771	mW/cm^2
Uncontrolled Exposures - Limit =	0.978933354	mW/cm^2
Pd =	0.0000001	mW/cm^2
Controlled Margin to Limit =	4.8947	mW/cm^2
Uncontrolled Margin to Limit =	0.9789	mW/cm^2

Note: * = Plane-wave equivalent power density

IC:

Controlled Exposures to Limit =	10	W/m^2
Uncontrolled Exposures Limit =	2	W/m^2
Pd =	0.000001	W/m^2
Controlled Margin to Limit =	10.0000	W/m^2
Uncontrolled Margin to Limit =	2.0000	W/m^2

As originally tested, the EUT was found to be compliant to the requirements of the test standard(s).

1.3.3 Sample Calculation

The Friss 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
$\pi \approx 3.1416$
R = distance between observation point and center of the radiator in cm

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