RF EXPOSURE REPORT

REPORT NO.: SA990108H03A

MODEL NO.: DIR-456U

ACCORDING: FCC Guidelines for Human Exposure
IEEE C95.1

APPLICANT: D-Link Corporation

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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

For WLAN:
The software provided by Manufacturer enabled the EUT to transmit and receive data at lowest, middle and highest channel individually.

For 3G/2G
The communication simulator station system controlled a EUT to export maximum output power under transmission mode and specific channel frequency.

FOR WCDMA BAND:
The following procedures were followed according to FCC “SAR Measurement Procedures for 3G Devices”, October, 2007.
Output Power Verification
Maximum output power is verified on the High, Middle and Low channels according to the procedures described in section 5.2 of 3GPP TS 34.121, using the appropriate RMC or AMR with TPC (transmit power control) set to all “1’s” for WCDMA/HSDPA or applying the required inner loop power control procedures to maintain maximum output power while HSUPA is active. Results for all applicable physical channel configurations (DPCCH, DPDCHn and spreading codes, HSDPA, HSPA) should be tabulated in the SAR report. All configurations that are not supported by the DUT or cannot be measured due to technical or equipment limitations should be clearly identified.

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

For WLAN:

Brand No.	Model No.	Net Gain (dBi)	Antenna Type	Connector
WHA YU GROUP	C037-511052-A (SSR-209493)	2.41	PCB Antenna	MHF

For 3G/2G:

Set	Ant.	Manufacturer	ANT Type	ANT Model	Connector
Set 1	Main	Auden Techno Corp.	PCB Antenna	H-0124-1	I-PEX
	Aux	Auden Techno Corp.	PCB Antenna	H-0124-2	I-PEX
Set 2	Main	WHA YU INDUSTRIAL CO., LTD.	PCB Antenna	C037-511090-A	I-PEX
	Aux	WHA YU INDUSTRIAL CO., LTD.	PCB Antenna	C037-511091-A	I-PEX

Antenna Gain (Peak Gain)

Set 1	CELL850 (dBi)	EGSM900 (dBi)	DCS1800 (dBi)	DCS1900 (dBi)	WCDMA2100 (dBi)
Main	0	0.3	1.9	3.0	3.2
Set 1	CELL850 (dBi)	EGSM900 (dBi)	DCS1800 (dBi)	DCS1900 (dBi)	WCDMA2100 (dBi)
Aux (RX only)	0.6	-1.5	0.3	0.1	-1.4
Set 2	CELL850 (dBi)	EGSM900 (dBi)	DCS1800 (dBi)	DCS1900 (dBi)	WCDMA2100 (dBi)
Main	-1	-0.2	1.4	0.8	0.8
Set 2	CELL850 (dBi)	EGSM900 (dBi)	DCS1800 (dBi)	DCS1900 (dBi)	WCDMA2100 (dBi)
Aux (RX only)	-1.3	-1.6	0.1	-0.3	-0.3

From the above antennas, antenna **set 1** was selected as representative antenna for the test and its data was recorded in this report.

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

For Part 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	87.1	0.030	1.0
6	2437	91.2	0.032	1.0
11	2462	85.1	0.029	1.0

For Part 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	275.4	0.095	1.0
6	2437	269.2	0.093	1.0
11	2462	288.4	0.100	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	173.8	0.060	1.0
6	2437	169.8	0.059	1.0
11	2462	182.0	0.063	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	147.9	0.051	1.0
4	2437	138.0	0.048	1.0
7	2452	154.9	0.054	1.0

For 2G function: PCS1900MHz (Gain: 3dBi)

Channel	Channel Frequency (MHz)	Output Power to Antenna (mW) (Peak Conducted)	Power Density (mW/cm^2)	Limit of Power Density (mW/cm^2)
512	1850.2	912.011	0.362	1.0

For 2G function: GSM850MHz (Gain: 0dBi)

Channel	Channel Frequency (MHz)	Output Power to Antenna (mW) (Peak Conducted)	Power Density (mW/cm^2)	Limit of Power Density (mW/cm^2)
251	848.8	1819.701	0.362	0.5659

CONCLUSION:

Both of the WLAN and HSUPA PCI Express Mini Card can transmit simultaneously, the formula of calculated the MPE is:

$CPD_1 / LPD_1 + CPD_2 / LPD_2$ + ……etc. < 1

CPD = Calculation power density

LPD = Limit of power density

For WLAN + 2G: PCS1900MHz

Therefore, the worst-case situation is 0.1 / 1 + 0.362 / 1= 0.462, which is less than “1”. This confirmed that the device comply with FCC 1.1310 MPE limit.

For WLAN + 2G: GSM850MHz

Therefore, the worst-case situation is 0.1 / 1 + 0.362 / 0.5659=0.740, which is less than “1”. This confirmed that the device comply with FCC 1.1310 MPE limit.