RF Exposure Justification
in co-locating with other transmitters

1. Outline

As shown by the Figure-1 through Figure-6 in this exhibit, the applying host PC device (Lenovo ThinkPad X200 Tablet Series) incorporates the four kinds of transmitters listed below.

WWAN:	FCC ID: **VV7-MBMF3507G-L**
Bluetooth:	FCC ID: QDS-BRCM1033
UWB:	FCC ID: TZQWQ110HMC
WLAN/WiMAX:	FCC ID: PD9533ANMU
	FCC ID: PD9533ANXMU
	FCC ID: PD9LEN512ANMU
	FCC ID: PPD-AR5BHB63-L

The minimum separation distance between human body and the WWAN Tx antenna of the host PC device is **13mm** (in Figure-6). Therefore the applying WWAN transmitter module (Model: **F3507G**) and the antenna system is subjected to SAR evaluation pursuant to FCC CFR 47 Section 2.1093.

The applying WWAN transmitter module has been tested for the host PC device and was already certified by the Commission on July 29, 2008 without co-location with WLAN / WiMAX devices.

This document is to clarify the RF exposure compliance for co-location with the above WLAN / WiMAX devices.

With the evaluation hereafter, the applying modular transmitter (FCC ID: **VV7-MBMF3507G-L**) has found to comply with the SAR limit pursuant to FCC CFR 47 section 2.1093 for general Population/ Uncontrolled exposure and KDB 447498 issued on July/27/2008, even if the co-located WLAN (or WiMAX) devices transmit radio frequencies simultaneously.

Summary of RF Exposure evaluation

Operation mode	Antenna combination	Clause number	Category	Result	note
Notebook, Primary Landscape	WWAN Main and WLAN/WiMAX Aux	5.1.1	MPE / MPE	Pass	Sum of MPE: 0.292 mW/cm^2
	WWAN Main and WLAN/WiMAX Main & 3rd	5.1.2	MPE / SAR	Permit-but-Ask	
Primary Portrait	WWAN Main and WLAN/WiMAX Main & 3rd	5.2.1	MPE / MPE	Pass	Sum of MPE: below 0.292
	WWAN Main and WLAN/WiMAX Aux	5.2.2	MPE / SAR	Permit-but-Ask	
Lap Held	WWAN and WLAN/WiMAX Main	5.3.1	SAR / SAR	Pass	SAR to peak location separation ratio 0.125 (< 0.3)
	WWAN and WLAN/WiMAX Aux	5.3.2	SAR / SAR	Pass	Sum of SAR: 22H: 0.217 W/Kg 24E: 0.457 W/Kg
Secondary Landscape	WWAN Main and WLAN/WiMAX Main & 3rd	5.4	N/A / SAR	Pass	Max. SAR: 0.222 W/Kg
Secondary Portrait	WWAN Main and WLAN/WiMAX Aux	5.5	SAR / SAR	Pass	Sum of SAR: 22H: 0.407 W/Kg 24E: 1.344 W/Kg

2. Configuration of EUT

Figure-1: Notebook mode

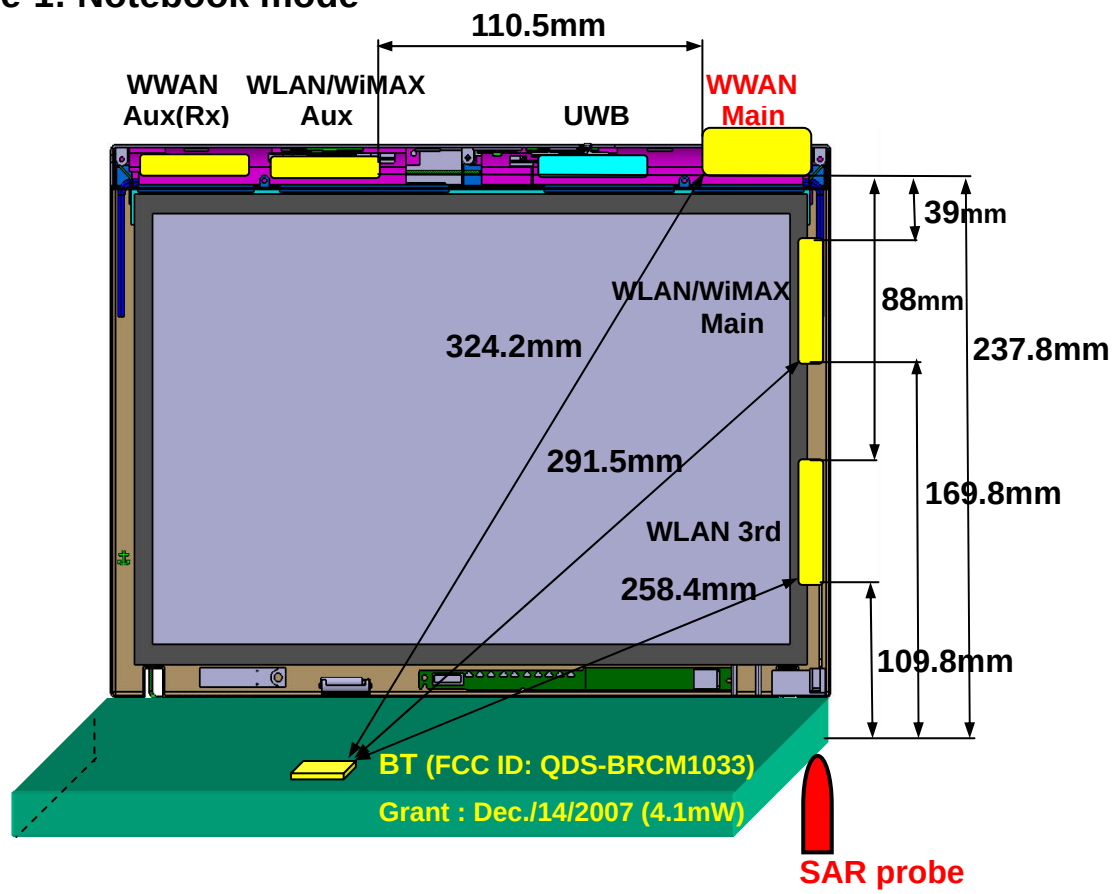


Figure-2: Lap Held

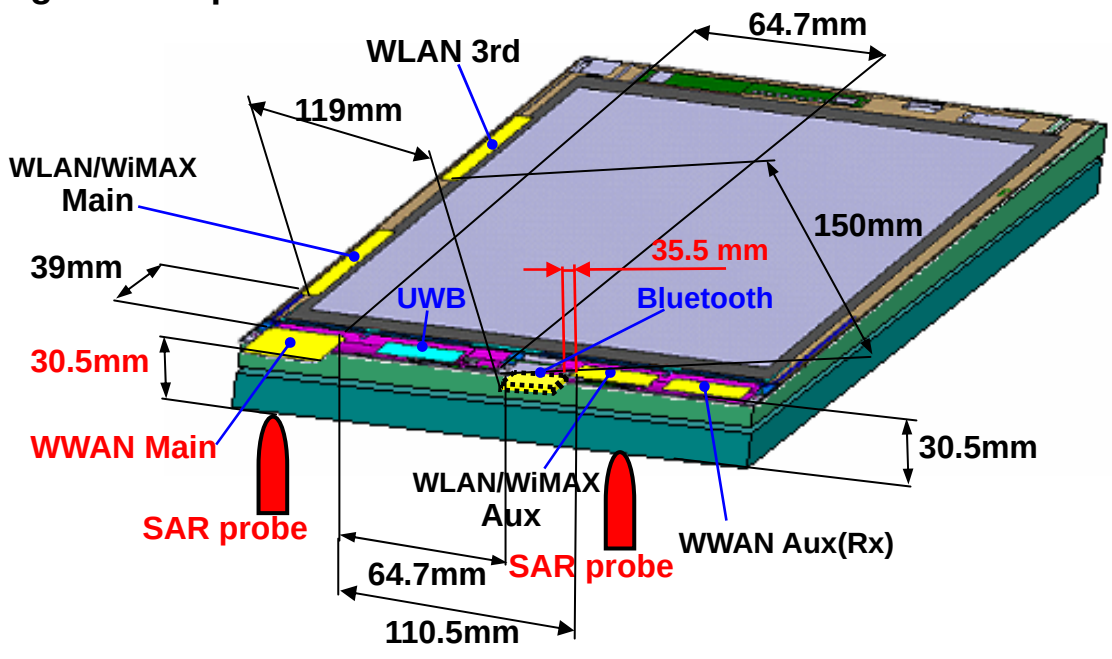


Figure-3:
Tablet PL (Primary Landscape)

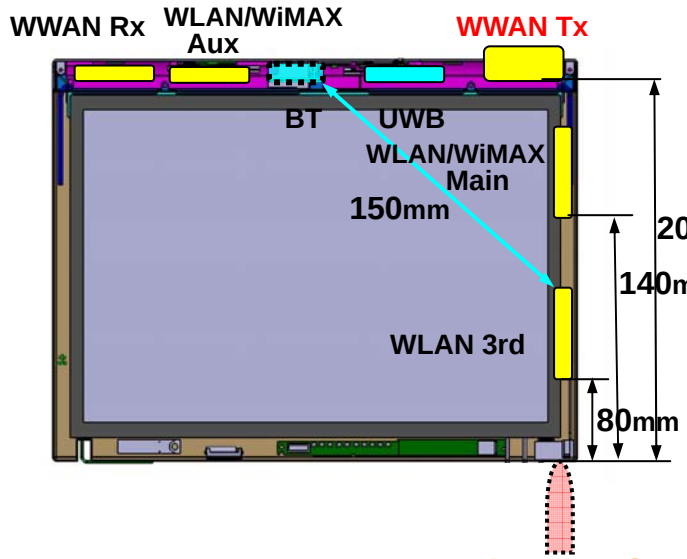


Figure-4:
Tablet PP (Primary Portrait)

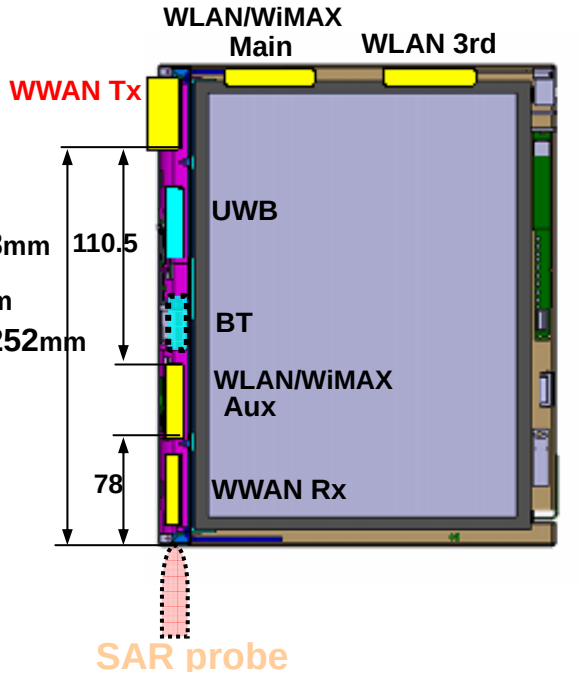


Figure-5:
Tablet SL (Secondary Landscape)

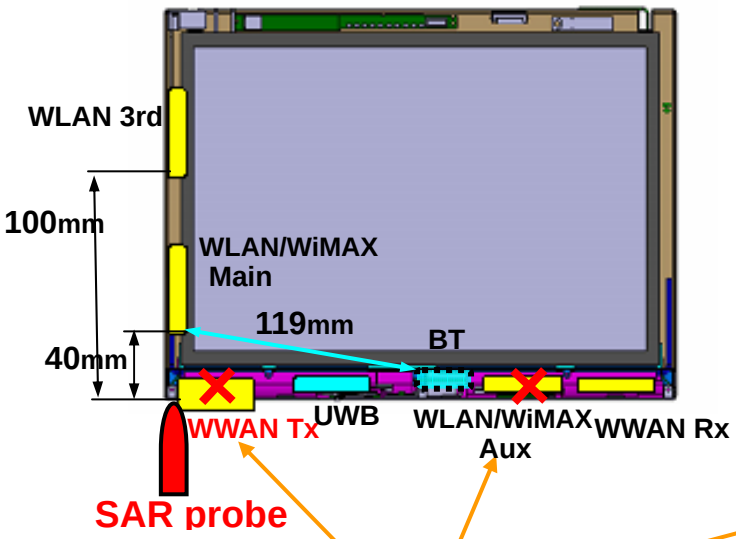
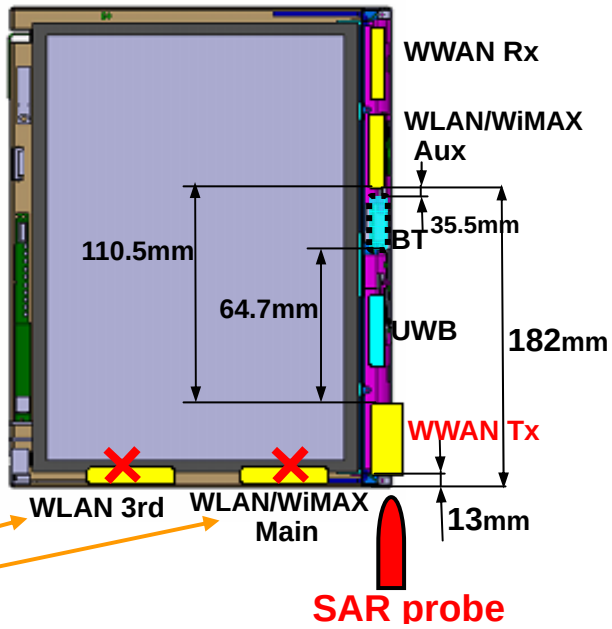


Figure-6:
Tablet SP (Secondary Portrait)



✕ **Tx antennas in these rotary screen positions do not transmit RF (Rx only).**

See separate exhibit “Tablet Tx control logic” in more details.

3. RF Exposure justification regarding Bluetooth co-location

WWAN - Bluetooth

The co-location evaluation between the applying WWAN (Model: **F3507G**) and Bluetooth device is not required because of the sufficient antenna separation distance (64.7mm or more).

WLAN – Bluetooth

The Bluetooth antenna separation distance from human body in Figure-2 is 30.5mm. And the antenna to antenna separation distance between the WLAN/WiMAX **Aux** and Bluetooth is 35.5mm. Therefore, the WLAN/WiMAX **Aux** antenna in Figure-2 requires a RF Exposure evaluation for co-location with Bluetooth device (**FCC ID: QDS-BRCM1033**).

The all specified WLAN/WiMAX devices listed in page 1 were already certified with co-location with the Bluetooth device at each Grant of Equipment Authorization.

4. RF Exposure justification regarding UWB co-location

UWB transmitter is not mentioned in FCC CFR 47 Section 2.1091 and 2.1093, so it does not subject to RF exposure requirement. Therefore, no additional SAR testing or RF Exposure evaluation is required for any combination with UWB transmitter.

5. RF Exposure evaluation regarding WWAN & WLAN co-location

5.1 Notebook & Primary Landscape modes

The Notebook and Primary Landscape modes are similar test configurations with or without the thickness of keyboard section, and Landscape mode represents for evaluation as the worse case.

5.1.1 WWAN Main and WLAN/WiMAX Aux antennas

These antennas fall in Mobile category and co-locate with 110.5 mm of antenna to antenna separation distance. Therefore, the summation of the highest MPE of WWAN and WLAN (or WiMAX) devices is required. The MPE summation is calculated as below.

1) Part 22H (Cellular) & Part 15C/E or Part 27:
Per OET Bulletin 65, Section 3 for frequency bands with different limits, the MPEs are calculated separately for each band, then divided by the limit for the band and the results are summed. The summation must be less than 1.
i.e. 0.417 / 0.533 (Table-1) + 0.117 / 1.0 (Table-2) = 0.899 < 1.0 …… Pass

2) Part 24E (PCM) & Part 15C/E or Part 27:
0.175 (Table-1) + 0.117 (Table-2) = 0.292 mW/cm^2 (Limit=1.0) …… Pass

Table-1: WWAN (Model: F3507g) MPE info.

F3507G Grant date	Host PC model	FCC CFR	Max. Conducted power (**Px**)	Max. Host PC antenna gain (**G**)	Distance (**D**)	**MPE *1** (mW/cm^2)	limit (mW/cm^2)
07/29/2008 without WLAN co-location	ThinkPad X200 Tablet	Part 22H	2.000 W	0.54 dBi	20.8 cm	**0.417**	0.533 (=800/1500)
		Part 24E	0.871 W	0.38 dBi	20.8 cm	**0.175**	1.0

***1**: MPE= (1000 x **Px**)x(10 $^{G/10}$) / (4 x π x **D**^{2})

Table-2: WLAN&WiMAX MPE info.

		Max. Conducted power (See **Table-3**.) (**Py**)	Max. Host PC antenna gain (**G**)	**MPE *2** (mW/cm^2)	limit (mW/cm^2)
Part 15C	2.4GHz band	0.470 W	1.32 dBi	**0.117**	1.0
Part 15E	5.18– 5.32GHz	0.110 W	1.45 dBi	0.028	
Part 15E	5.50 – 5.70GHz	0.110 W	1.47 dBi	0.028	
Part 15C	5.745 – 5.825GHz	0.436 W	1.13 dBi	0.104	
Part 27	2.496 – 2.690GHz	0.211 W	0.16 dBi	0.040	

***2** MPE= (1000x**Py**)x(10 $^{G/10}$) / (4 x π x 20.8^2)

Table-3: Conducted peak power of WLAN&WiMAX modules

Grant date ***3**	FCC ID	WLAN				WiMAX
		Part 15C 2.4GHz band	Part 15E 5.18 – 5.32GHz	Part 15E 5.50 – 5.70GHz	Part 15C 5.745 – 5.825GHz	Part 27 2.496 – 2.690GHz
09/03/2008	PPD-AR5BHB63-L	0.1977W	N/A	N/A	N/A	N/A
09/17/2008	PD9LEN512ANMU	0.091 W	0.028 W	0.054 W	0.021 W	N/A
09/22/2008	PD9533ANMU	0.130 W	0.110 W	0.110 W	0.068 W	N/A
02/10/2009	PD9533ANXMU	0.470 W	0.048 W	0.048 W	0.436 W	0.211 W

***3**: Grant dates with ThinkPad X200 Tablet Series

5.1.2 WWAN Main and WLAN/WiMAX Main & 3rd antennas

The WWAN Main antenna falls in Mobile category. On the other hand, the WLAN/WiMAX Main and 3rd antennas are Portable category.

The antenna-to-antenna separation distance between WWAN and WLAN/WiMAX regarding KDB 616217 is calculated as below.

Table-4: Antenna to Antenna separation distance of WWAN & WLAN/WiMAX modules

$1/2\ n_x = 1/2\ [P_x/(60/f)-1]$ (cm) P_x: See Table-1.			$1/2\ n_y = 1/2\ [P_y/(60/f)-1]$ (cm) P_y: See Table-2.			5cm + $1/2\ n_x$ + $1/2\ n_y$	WLAN to WWAN (cm)	Simul Eval?
WWAN: Cellular	1/2[2000/(60/0.836)-1]	14	WLAN 2400MHz	1/2[470/(60/2.45)-1]	9	28	3.9 or 8.8	Yes
			WLAN 5250MHz	1/2[110/(60/5.25)-1]	5	24		Yes
			WLAN 5600MHz	1/2[110/(60/5.60)-1]	5	24		Yes
			WLAN 5785MHz	1/2[436/(60/5.785)-1]	21	40		Yes
			WIMAX 2590MHz	1/2[211/(60/2.59)-1]	4	23		Yes
WWAN: PCS	1/2[871/(60/1.880)-1]	14	WLAN 2400MHz	1/2[470/(60/2.45)-1]	9	28		Yes
			WLAN 5250MHz	1/2[110/(60/5.25)-1]	5	24		Yes
			WLAN 5600MHz	1/2[110/(60/5.60)-1]	5	24		Yes
			WLAN 5785MHz	1/2[436/(60/5.785)-1]	21	40		Yes
			WIMAX 2590MHz	1/2[211/(60/2.59)-1]	4	23		Yes

Conclusion: ….. Requires Permit-but-Ask.
The configuration of clause 5.1.2 requires the FCC evaluation for simultaneous transmission. See Table-1 for WWAN MPE and Table-5 WLAN/WiMAX SAR.

Table-5: WLAN/WiMAX SAR test results at Primary Landscape mode

Grant date ***3**	FCC ID	Device type	FCC CFR	Conducted Max. power	**SAR** (W/Kg)	
					Main	**3rd**
02/10/2009	PD9533ANXMU	WLAN / WiMAX	Part 15C (2.4G)	0.470 W	***5**	**0.064 *4**
			Part 15C (5.8G)	0.436 W	***5**	**0.084 *4**
			Part 15E	0.048 W	***5**	**0.126 *4**
			Part 27	0.211 W	**0.026 *9** **0.069*10**	Not used
09/22/2008	PD9533ANMU	WLAN	Part 15C (2.4G)	0.130 W	***5**	**0.025 *4**
			Part 15C (5.8G)	0.068 W	***5**	**0.098 *4**
			Part 15E	0.110 W	***5**	**0.095 *4**
09/17/2008	PD9LEN512ANMU	WLAN	Part 15C (2.4G)	0.091 W	**0.015**	Not used
			Part 15C (5.8G)	0.021 W	**0.005**	Not used
			Part 15E	0.054 W	**0.005**	Not used
09/03/2008	PPD-AR5BHB63-L	WLAN	Part 15C (2.4G)	0.1977 W	**0.080**	Not used

***3:** Grant dates for ThinkPad X200 Tablet Series
***4**: (Main + 3rd) or (Main + Aux + 3rd) 802.11n MIMO simultaneous
***5:** Measurement was omitted because the result of *4 is surely worse than *5.
***9:** Notebook mode ***10:** Primary Landscape mode

5.2 Primary Portrait mode

5.2.1 WWAN Main and WLAN/WiMAX Main & 3rd antennas

These antennas fall in Mobile category, and co-locate with 39 mm of antenna to antenna separation distance. Therefore, the summation of the highest MPE of WWAN and WLAN (or WiMAX) devices is applied.
The results of MPE summation are lower than Primary Landscape mode (Clause 5.1.1) thanks to the longer anterra separation distance from human body.

Therefore, conclusion of the RF Exposure evaluation is: …… Pass

5.2.2 WWAN Main and WLAN/WiMAX Aux antennas

The WWAN Main antenna falls in Mobile category. On the other hand, the WLAN/WiMAX Aux antenna is Portable category.

The antenna-to-antenna separation distance between WWAN and WLAN/WiMAX regarding KDB 616217 is shown by Table-4 (i.e. Min. 23cm), and the distance between the both antennas is 11.05 cm.

Conclusion: ….. Requires Permit-but-Ask.
The configuration of clause 5.2.2 requires the FCC evaluation for simultaneous transmission. See Table-1 for WWAN MPE and Table-6 WLAN/WiMAX SAR.

Table-6: WLAN/WiMAX SAR test results at Primary Portrait mode

Grant date ***3**	FCC ID	Device type	FCC CFR	Conducted Max. power	**SAR** (W/Kg) **Aux**
02/10/2009	PD9533ANXMU	WLAN / WiMAX	Part 15C (2.4G)	0.470 W	**0.017**
			Part 15C (5.8G)	0.436 W	**0.026**
			Part 15E	0.048 W	**0.136**
			Part 27	0.211 W	Not used
09/22/2008	PD9533ANMU	WLAN	Part 15C (2.4G)	0.130 W	**0.014**
			Part 15C (5.8G)	0.068 W	**0.037**
			Part 15E	0.110 W	**0.110**
09/17/2008	PD9LEN512ANMU	WLAN	Part 15C (2.4G)	0.091 W	***6**
			Part 15C (5.8G)	0.021 W	***6**
			Part 15E	0.054 W	***6**
09/03/2008	PPD-AR5BHB63-L	WLAN	Part 15C (2.4G)	0.1977 W	**0.068**

***3:** Grant dates for ThinkPad X200 Tablet Series
***6:** Measurement was omitted because of the lower power than others.

5.3 Lap held mode

The SAR results of the all WWAN and WLAN/WiMAX devices at Lap held mode are shown as below.

Table-7: SAR test results at Lap held mode

Grant date *3	FCC ID	Device type	FCC CFR	Conducted Max. power	SAR (W/Kg)
07/29/2008	**VV7-MBM F3507G-L**	WWAN	Part 22H	2.000 W	**0.168**
			Part 24E	0.871 W	**0.408**

Grant date *3	FCC ID	Device type	FCC CFR	Conducted Max. power	SAR (W/Kg)	
					Main	**Aux *7**
02/10/2009	PD9533ANXMU	WLAN / WiMAX	Part 15C (2.4G)	0.470 W	**0.023 *4**	**0.023**
			Part 15C (5.8G)	0.436 W	**0.023 *4**	**0.029**
			Part 15E	0.048 W	**0.053 *4**	**0.028**
			Part 27	0.211 W	**0.022 *4**	Rx only
09/22/2008	PD9533ANMU	WLAN	Part 15C (2.4G)	0.130 W	**0.021 *4**	**0.019**
			Part 15C (5.8G)	0.068 W	**0.037 *4**	**0.034**
			Part 15E	0.110 W	**0.051 *4**	**0.038**
09/17/2008	PD9LEN512ANMU	WLAN	Part 15C (2.4G)	0.091 W	**0.015**	Rx only
			Part 15C (5.8G)	0.021 W	**0.005**	Rx only
			Part 15E	0.054 W	**0.005**	Rx only
09/03/2008	PPD-AR5BHB63-L	WLAN	Part 15C (2.4G)	0.1977 W	**0.081**	**0.049**

***3**: Grant dates for ThinkPad X200 Tablet Series
***4**: (Main + 3rd) or (Main + Aux + 3rd) 802.11n MIMO simultaneous
***7:** Bluetooth co-location evaluation was taken into account for Aux antenna. Refer to Clause 3.

5.3.1 WWAN Main and WLAN/WiMAX Main antennas

The antenna separation distance between WWAN **Main** and WLAN/WiMAX **Main** is 39mm (<5cm). Therefore **SAR to peak location separation ratio** is applied in accordance with the FCC KDB 447498, 07/27/2008.

The SAR to peak location separation ratio is calculated by using the highest SAR results of each WWAN and WLAN/WiMAX devices as follows.

(0.408 + 0.081)/ 3.9 = 0.125 (< 0.3) …….. Pass

5.3.2 WWAN Main and WLAN/WiMAX Aux antennas

The antenna separation distance between WWAN **Main** and WLAN/WiMAX **Aux** is 110.5mm. Therefore summation of SAR is applicable for RF Exposure evaluation.

Sum of SAR = 0.168 + 0.049 = 0.217 (< 1.6) …… Pass (Cellular band)
= 0.408 + 0.049 = 0.457 (< 1.6) …… Pass (PCS band)

5.4 Secondary Landscape mode

The applying WWAN transmitter does not function at Secondary Landscape mode, so the co-location evaluation for WWAN and WLAN/WiMAX devices is not necessary.

The all subjected WLAN/WiMAX transmitters have found to comply with the SAR limit as below.

…... … Pass

Table-8: SAR test results at Secondary Landscape mode

Grant date *3	FCC ID	Device type	FCC CFR	Conducted Max. power	**SAR** (W/Kg)
07/29/2008	**VV7-MBM F3507G-L**	WWAN	Part 22H	N/A	not used
			Part 24E	N/A	not used

Grant date *3	FCC ID	Device type	FCC CFR	Conducted Max. power	**SAR** (W/Kg)	
					Main	**Aux**
02/10/2009	PD9533ANXMU	WLAN / WiMAX	Part 15C (2.4G)	0.470 W	**0.179 *4**	Rx only
			Part 15C (5.8G)	0.436 W	**0.091 *4**	Rx only
			Part 15E	0.048 W	**0.177 *4**	Rx only
			Part 27	0.211 W	**0.222**	Rx only
09/22/2008	PD9533ANMU	WLAN	Part 15C (2.4G)	0.130 W	**0.133 *4**	Rx only
			Part 15C (5.8G)	0.068 W	**0.036**	Rx only
			Part 15E	0.110 W	**0.043**	Rx only
09/17/2008	PD9LEN512ANMU	WLAN	Part 15C (2.4G)	0.091 W	**0.040**	Rx only
			Part 15C (5.8G)	0.021 W	**0.039**	Rx only
			Part 15E	0.054 W	**0.091**	Rx only
09/03/2008	PPD-AR5BHB63-L	WLAN	Part 15C (2.4G)	0.1977 W	**0.089**	Rx only

***3**: Grant dates for ThinkPad X200 Tablet Series
***4**: Main + 3rd antenna 802.11n 40MHz simultaneous

5.5 Secondary Portrait mode

The antenna separation distance between WWAN **Main** and WLAN/WiMAX **Aux** is 110.5mm. Therefore summation of SAR is applicable for RF Exposure evaluation.

Sum of SAR = 0.243 + 0.164 = 0.407 (< 1.6) …… Pass (Cellular band)
= 1.180 + 0.164 = 1.344 (< 1.6) …… Pass (PCS band)

Table-3: SAR test results at Secondary Portrait mode

Grant date *3	FCC ID	Device type	FCC CFR	Conducted Max. Power	**SAR** (W/Kg)
07/29/2008	**VV7-MBM F3507G-L**	WWAN	Part 22H	2.000 W	**0.243**
			Part 24E	0.885 W	**1.180**

Grant date *3	FCC ID	Device type	FCC CFR	Conducted Max. Power	**SAR** (W/Kg)	
					Main	**Aux**
02/10/2009	PD9533ANXMU	WLAN / WiMAX	Part 15C (2.4G)	0.470 W	Rx only	**0.083**
			Part 15C (5.8G)	0.436 W	Rx only	**0.062**
			Part 15E	0.048 W	Rx only	**0.155**
			Part 27	0.211 W	not used *8	not used *8
09/22/2008	PD9533ANMU	WLAN	Part 15C (2.4G)	0.130 W	Rx only	**0.086**
			Part 15C (5.8G)	0.068 W	Rx only	**0.088**
			Part 15E	0.110 W	Rx only	**0.164**
09/17/2008	PD9LEN512ANMU	WLAN	Part 15C (2.4G)	0.091 W	not used *8	not used *8
			Part 15C (5.8G)	0.021 W		
			Part 15E	0.054 W		
09/03/2008	PPD-AR5BHB63-L	WLAN	Part 15C (2.4G)	0.1977 W	Rx only	**0.027**

***3**: Grant dates for ThinkPad X200 Tablet Series
***8**: WiMAX and PD9LEN512ANMU do not function at Secondary Portrait mode.