

## RF Exposure evaluation for SAR/MPE configuration in co-locating with other transmitters

### 1. Outline

The Figure-1 indicates the specific host PC devices in this application which were previously certified by the Commission and IC for the applying WWAN modular device (FCC ID: **J9CUNDP-1L**, IC: **2723A-UNDP1**) on March 20, 2009 under the Portable category regarding FCC CFR 47 Section 2.1093, and on May 04, 2009 under the "SAR Evaluation" category pursuant to IC RSS-102e clause 2.5.1.

The applying WWAN modular device transmits RF simultaneously with the three kinds of transmitters listed below.

- |                       |                           |                     |
|-----------------------|---------------------------|---------------------|
| 1. Bluetooth:         | FCC ID: QDS-BRCM1033      | IC: 4324A-BRCM1033  |
| 2. UWB:               | FCC ID: TX2RTU7305BG13HMC | N/A                 |
| 3. one of WLAN/WiMAX: | FCC ID: PD9533ANMU        | IC: 1000M-533ANMU   |
|                       | FCC ID: PD9533ANXMU       | N/A                 |
|                       | FCC ID: PD9LEN512ANMU     | IC: 1000M-L512ANMU  |
|                       | FCC ID: PPD-AR5BHB63-L    | IC: 4104A-ARBHB63L  |
|                       | FCC ID: PD9533ANHU        | IC: 1000M-533ANHU   |
|                       | FCC ID: PD9512ANHU        | IC: 1000M-512ANHU   |
|                       | FCC ID: PD9512ANXMU       | N/A                 |
|                       | FCC ID: PD9512ANXHU       | N/A                 |
|                       | FCC ID: TX2-RTL8191SE-L   | IC: 6317A-RTL8191SE |
|                       | *1 FCC ID: PD9112BNHU     | IC: 1000M-112BNHU   |

\*1: New co-located WLAN transmitter device to be added in this Class II application

\*2 : additional **SAR/MPE** co-location with WWAN and WLAN transmitter device in this application

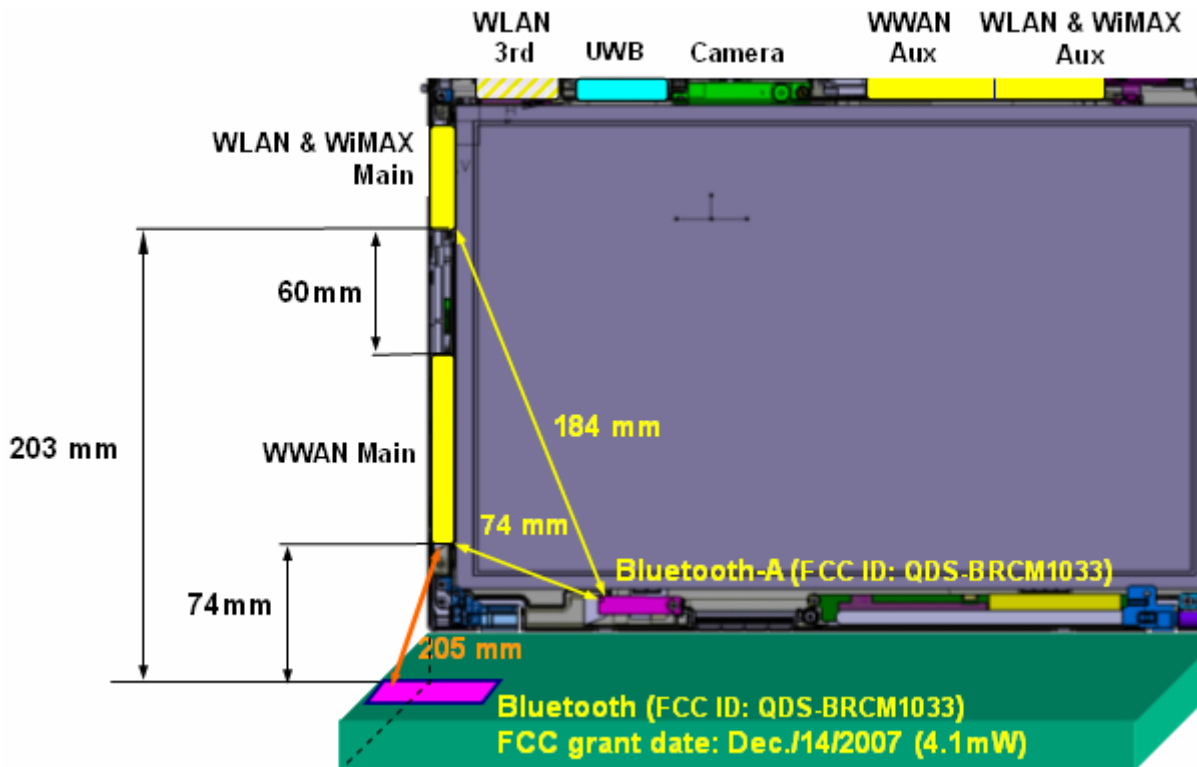
as of June/2009

	SAR / MPE config.
Co-located WLAN/WiMAX modules	ThinkPad T400/R400/T500/W500
FCC ID: PD9533ANMU IC: 1000M-533ANMU	granted FCC: 08/05/2008 IC: 05/13/2008
FCC ID: PD9LEN512ANMU IC: 1000M-L512ANMU	
FCC ID: PPD-AR5BHB63-L IC: 4104A-ARBHB63L	
FCC ID: PD9533ANXMU IC: N/A	granted FCC: 10/16/2008
FCC ID: PD9533ANHU IC: 1000M-533ANHU	granted FCC: 03/20/2009 IC: 05/04/2009
FCC ID: PD9512ANHU IC: 1000M-512ANHU	
FCC ID: PD9512ANXMU IC: N/A	
FCC ID: PD9533ANHMU IC: N/A	
FCC ID: TX2-RTL8191SE-L IC: 6317A-RTL8191SE	
FCC ID: PD9112BNHU IC: 1000M-112BNHU	*2

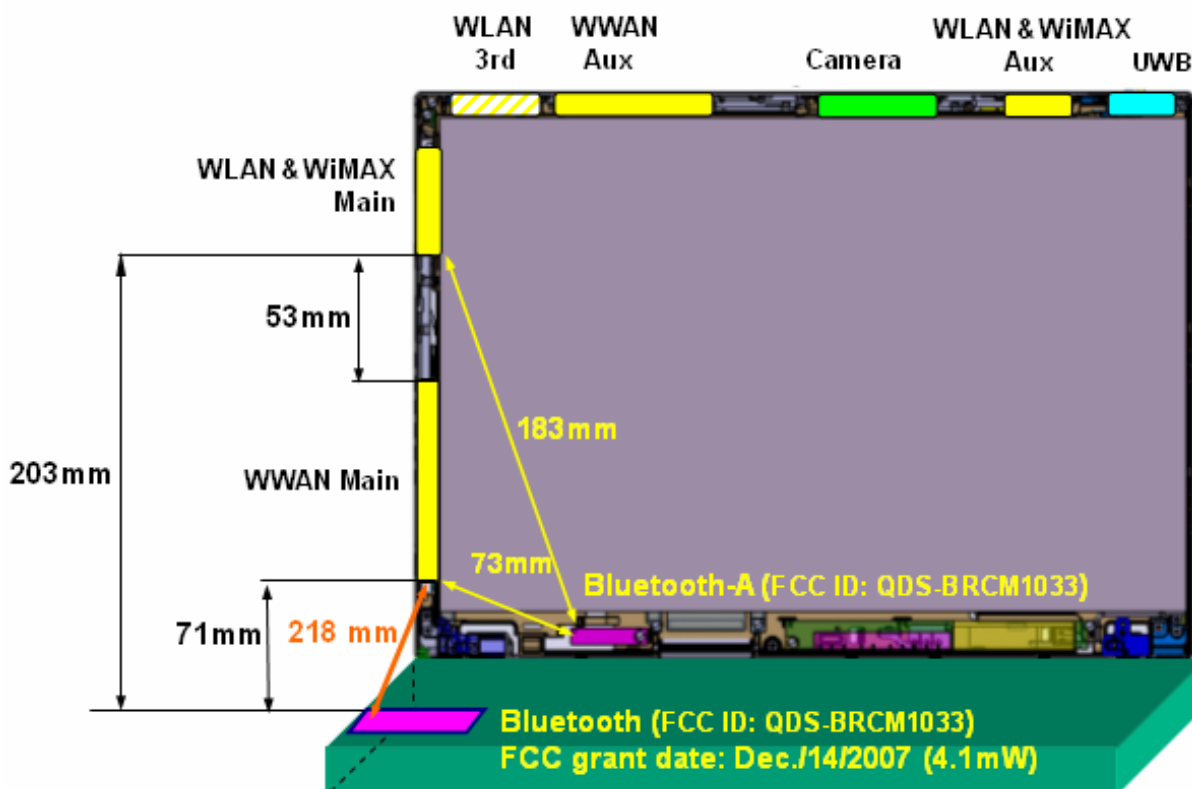
See Annex-1 in more details for the grant history.

Figure-1: Exterior views of the host PC devices

**ThinkPad T400/R400 Series**



**ThinkPad T500/W500 Series**



The separation distance between human body and the WWAN Tx antenna of the host PC devices is 74mm or less. Therefore the applying WWAN transmitter module (Model: **UNDP-1**) and the antenna systems are subjected to “Portable device” pursuant to FCC CFR 47 Section 2.1093 and “SAR Evaluation” category pursuant to IC RSS-102e clause 2.5.1.

With the evaluation hereafter, the applying modular transmitter (FCC ID: J9CUNDP-1L, IC: 2723A-UNDP1) has found to comply with the SAR limit pursuant to FCC CFR 47 section 2.1093 for general Population/Uncontrolled exposure and IC RSS-102e clause 4.1.

## **2. RF Exposure justification regarding Bluetooth co-location**

The separation distance between the WWAN and Bluetooth antennas is 73 mm (> 5cm) and the transmission power of Bluetooth is 4.1mW ( $< 60/f_{\text{GHz}}$ ), therefore the co-location evaluation for the Bluetooth device is not required pursuant to FCC KDB 616217 and 447498.

## **3. 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.

#### 4. RF Exposure evaluation regarding WWAN & WLAN co-location

The WWAN Main antenna falls in “**Portable**” category. On the other hand, the WLAN/WiMAX antennas are “**Mobile**” category.

Therefore, the assessment of “antenna-to-antenna separation distance” between the WWAN and WLAN/WiMAX antennas is required for the RF Exposure co-location evaluation pursuant to KDB 616217.

As shown by Table-1, the “antenna-to-antenna separation distance” is calculated as minimum 17 cm, and the actual separation distance between WWAN and WLAN/WiMAX antennas is 6 cm or less.

**Conclusion:** ..... **Consultation with FCC is required** to this application for simultaneous transmission.

See [Table-2](#) for SAR measurement results of the applying WWAN device, and [Table-3](#) for MPE evaluation concerning the co-located WLAN/WiMAX devices.

**Table-1:** Antenna to Antenna separation distance of WWAN & WLAN/WiMAX modules

1/2 n <sub>x</sub> =1/2 [ P <sub>x</sub> /(60/f)-1] (cm) P <sub>x</sub> : Conducted power of F3507g See <a href="#">Table-2a</a> .			1/2 n <sub>y</sub> =1/2 [ P <sub>y</sub> /(60/f)-1] (cm) P <sub>y</sub> : WLAN/WiMAX conducted power See <a href="#">Table-4</a> .			5cm + 1/2 n <sub>x</sub> + 1/2 n <sub>y</sub> P <sub>x</sub> Duty 100% 50%	WLAN to WWAN (cm)	Simul Eval?
WWAN: Cellular	Duty=100% 1/2[ <b>1986</b> /(60/0.836)-1]	14	WLAN 2400MHz	1/2[ <b>632</b> /(60/2.45)-1]	13	32 25	5.3 or 6.0	Yes
		14	WLAN 5250MHz	1/2[ <b>110</b> /(60/5.25)-1]	5	24 <b>17</b>		Yes
	Duty=50% 1/2[ <b>993</b> /(60/0.836)-1]	7	WLAN 5600MHz	1/2[ <b>110</b> /(60/5.60)-1]	5	24 <b>17</b>		Yes
		7	WLAN 5785MHz	1/2[ <b>441</b> /(60/5.785)-1]	21	40 33		Yes
		7	WIMAX 2590MHz	1/2[ <b>254</b> /(60/2.59)-1]	5	24 <b>17</b>		Yes
WWAN: PCS	Duty=100% 1/2[ <b>885</b> /(60/1.880)-1]	14	WLAN 2400MHz	1/2[ <b>632</b> /(60/2.45)-1]	13	32 25		Yes
		14	WLAN 5250MHz	1/2[ <b>110</b> /(60/5.25)-1]	5	24 <b>17</b>		Yes
	Duty=50% 1/2[ <b>443</b> /(60/1.880)-1]	7	WLAN 5600MHz	1/2[ <b>110</b> /(60/5.60)-1]	5	24 <b>17</b>		Yes
		7	WLAN 5785MHz	1/2[ <b>441</b> /(60/5.785)-1]	21	40 33		Yes
		7	WIMAX 2590MHz	1/2[ <b>254</b> /(60/2.59)-1]	5	24 <b>17</b>		Yes

**Table-2:** WWAN (Model: UNDP-1) SAR info.

SAR measurement results: Based upon J9CUNDP-1L (grant date: 03/05/2008)

Host PC model	Initial Grant of the Host PC	FCC CFR IC RSS	Max. Conducted power (P)	SAR Distance (D)	Stand alone SAR (W/Kg)	limit (W/Kg)
ThinkPad T400/R400 ThinkPad T500/W500	FCC 03/05/2008	Part 22H RSS-132	0.993 W (Table-2a)	7.4 cm	<b>0.081</b>	1.6
				7.1 cm	<b>0.094</b>	
	IC 05/13/2008	Part 24E RSS-133	0.443 W (Table-2a)	7.4 cm	<b>0.056</b>	1.6
				7.1 cm	<b>0.049</b>	

**Table-2a: WWAN Maximum Power consideration**

Output power: Based upon J9CUNDP-1 (original device: 01/18/2008)

FCC Rule Parts	Frequency Range (MHZ)	Peak Output Watts Grant entries	Source-based Averaging	Output Power Watts	Modulation
22H	824.2 - 848.8	1.986	50%	0.993	GPRS/Class 12
	824.2 - 848.8	0.607	50%	0.304	EDGE/12
	826.4 - 846.6	0.277	100%	0.277	UMTS
	824.7 - 848.31	0.31	100%	0.31	CDMA
24E	1850.2 - 1909.8	0.885	50%	0.443	GPRS/12
	1850.2 - 1909.8	0.48	50%	0.24	EDGE/12
	1852.4 - 1907.6	0.286	100%	0.286	UMTS
	1851.25 - 1908.75	0.289	100%	0.289	CDMA

**Table-3: MPE of WLAN&WiMAX modules**

		Max. Conducted power (See Table-4.) (Py)	Max. Host PC antenna gain (See Table-5.) (G)	MPE *4 (mW/cm <sup>2</sup> )	limit (mW/cm <sup>2</sup> )
Part 15C	2.4GHz band	0.632 W	1.99 dBi	0.199	1.0
Part 15E	5.18-5.32GHz	0.110 W	2.59 dBi	0.040	
Part 15E	5.50 - 5.70GHz	0.110 W	2.79 dBi	0.042	
Part 15C	5.745 - 5.825GHz	0.441 W	2.46 dBi	0.155	
Part 27	2.496 - 2.690GHz	0.254 W	1.94 dBi	0.079	

$$*4: MPE = (1000 \times Py) \times (10^{G/10}) / (4 \times \pi \times 20^2)$$

**Table-4: Conducted peak power of WLAN&WiMAX modules**

FCC ID	Original Grant date	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
PPD-AR5BHB63-L	03 / 24 /2008	0.1977W	N/A	N/A	N/A	N/A
PD9LEN512ANMU	06 / 24 /2008	0.091 W	0.028 W	0.054 W	0.021 W	N/A
PD9533ANMU	07 / 07 /2008	0.130 W	0.110 W	0.110 W	0.068 W	N/A
PD9533ANXMU	07 / 18 /2008	0.470 W	0.048 W	0.048 W	0.436 W	0.211 W
PD9512ANHU	12 / 11 /2008	0.072 W	0.045 W	0.071 W	0.062 W	N/A
PD9533ANHU	12 / 04 /2008	0.438 W	0.045 W	0.045 W	0.441 W	N/A
PD9512ANXMU	11 / 03 /2008	0.632 W	0.048 W	0.047 W	0.338 W	0.242 W
PD9512ANXHU	12 / 09 /2008	0.585 W	0.047 W	0.048 W	0.328 W	0.254 W
TX2-RTL8191SE-L	02 / 25 /2009	0.0667W	N/A	N/A	N/A	N/A
PD9112BNHU	06 / 04 /2009	0.048 W	N/A	N/A	N/A	N/A

  New co-located WLAN/WiMAX transmitter devices to be added in this Class II application

**Table-5: WLAN & WiMAX Antenna Gains of new host PC devices**

	Antenna Manufacturer	Main Antenna					Auxiliary antenna				3rd antenna			
		Frequency band (GHz)					Frequency band (GHz)				Frequency band (GHz)			
		2.4 -2.5	5.15 -5.35	5.47 -5.725	5.725 -5.85	WiMAX 2.49-2.69	2.4 -2.5	5.15 -5.35	5.47 -5.725	5.725 -5.85	2.4 -2.5	5.15 -5.35	5.47 -5.725	5.725 -5.85
T400/R400	NISSEI	0.54	0.90	1.93	1.47	0.67	1.80	-0.17	0.46	0.46	1.99	0.97	0.67	1.29
	Amphenol	1.47	0.26	-0.36	-0.30	1.94	1.68	1.65	1.58	1.08	-0.60	1.78	2.79	2.46
	FOXCONN	-0.40	2.59	1.62	1.38	N/A	1.10	1.22	0.00	-0.69	1.85	0.70	0.20	-0.42
T500/W500	NISSEI	1.35	1.76	0.09	-1.66	1.55	1.99	0.77	2.04	2.42	1.97	0.20	0.82	-1.01
	Amphenol	1.61	0.75	1.75	1.75	1.32	1.57	1.47	1.73	2.33	1.18	1.53	0.84	0.67

**Annex-1:** FCC ID: J9CUNDP-1L, FCC Regulatory Compliance History

1. Section 2.933 Change in Identification filing based upon J9CUNDP-1
  - a. Change in identification grant date:01/23/2008
  - b. Output power : Based upon J9CUNDP-1 (original device)

FCC Rule Parts	Frequency Range (MHZ)	Output Watts/Peak –Grant entries	Source-based Averaging	Modulation
24E	1850.2 - 1909.8	0.885	50%	GPRS/12
24E	1850.2 - 1909.8	0.48	50%	EDGE/12
24E	1852.4 - 1907.6	0.286	100%	UMTS
24E	1851.25 – 1908.75	0.289	100%	CDMA
22H	824.2 - 848.8	1.986	50%	GPRS/Class 12
22H	824.2 - 848.8	0.607	50%	EDGE/12
22H	826.4 - 846.6	0.277	100%	UMTS
22H	824.7 – 848.31	0.31	100%	CDMA

MPE Calculation as documented in J9CUNDP-1

Technology	Band	Frequency (MHz)	Duty Cycle	Measured Max Conducted Power (dBm)	Antenna Gain (dBi)	Peak EIRP		Average EIRP Adjusted For Duty Cycle		Distance (cm)	Resulted Power Density (mW/cm <sup>2</sup> )	FCC MPE Limit (mW/cm <sup>2</sup> )
						EIRP (dBm)	EIRP (W)	EIRP (dBm)	EIRP (W)			
GPRS Class 12	Cell	824	0.5	32.98	4.00	36.98	4.99	33.97	2.49	20.00	0.496	0.549
GPRS Class 12	PCS	1850	0.5	29.41	3.50	32.91	1.95	29.90	0.98	20.00	0.194	1.000
CDMA2000	Cell	824	1.00	24.92	4.00	28.92	0.78	28.92	0.78	20.00	0.155	0.549
CDMA2000	PCS	1850	1.00	24.61	3.50	28.11	0.65	28.11	0.65	20.00	0.129	1.000
UMTS	Cell	824	1.00	24.42	4.00	28.42	0.70	28.42	0.70	20.00	0.138	0.549
UMTS	PCS	1850	1.00	24.57	3.50	28.07	0.64	28.07	0.64	20.00	0.128	1.000

As submitted in the separate RF exposure exhibits, while assessing RF exposure for mobile configuration, Source-based time averaging power are used. Source-based time averaging power is calculated by using peak output power x source-based time averaging duty cycle.

2. Class II permissive change, Grant date :03/05/2008
  - a. Implementing Two-Way bios lock logic and qualified for portable hosts / (ThinkPad T400/R400 and ThinkPad T500/W500 Laptop Computers).
  - b. Highest SAR values: Part 22, 0.081W/kg.; Part 24, 0.094 W/kg.
  - c. No co-located WLAN or Bluetooth modules.
3. Class II permissive change, Grant date: 05/14/2008
  - a. Adding alternate WWAN antenna and co-located with Bluetooth (FCC ID:MCLJ07H081) and FCC ID: QDS-BRCM1033) in Mobile Hosts (ThinkPad X200/X200s, X300/X301)

4. Class II permissive change, Grant date:07/10/2008
  - a. Installed WWAN module in Portable Tablet Computer (ThinkPad X200 Tablet w/12.1 inches diagonal screen size) and co-located with Bluetooth (FCC ID: QDS-BRCM1033)
  - b. Highest SAR values: Part 22, 0.373W/kg.; Part 24, 0.561 W/kg.
5. Class II permissive change, Grant date: 07/18/2008
  - a. Enabling WWAN and WLAN to transmit simultaneously
  - b. Co-located with WLAN modules (FCC ID:PPD-AR5BHB63-L; PD9LEN512ANMU; and PD9533ANMU) in Mobile Hosts (ThinkPad X200/X200s; ThinkPad X300/X301).
6. Class II permissive change, Grant date: 08/05/2008
  - a. Adding alternate WWAN antenna and co-located with WLAN (FCC ID: PPD-AR5BHB63-L, PD9LEN512ANMU, or PD9533ANMU) and Bluetooth (FCC ID: QDS-BRCM1033) in Portable Hosts (T400/R400, X500/W500)
7. Class II permissive change, Grant date: 09/16/2008
  - a. Add new co-located WLAN/WiMAX module (FCC ID: PD9533ANXMU) in the mobile Hosts (Thinkpad X200/X200s; ThinkPad X300/X301).
8. Class II permissive change, Grant date: 09/19/2008
  - a. Add new ACON Antenna in ThinkPad X200 Tablet w/12.1 inches diagonal screen size PC
  - b. Highest SAR values: Part 22, 0.390 W/kg; Part 24, 0.671 W/kg.
9. Class II permissive change, Grant date: 10/16/2008
  - a. Add new co-located WLAN/WiMAX module (FCC ID:PD9533ANXMU) in the portable host (ThinkPad T400/R400 and ThinkPad T500/W500 Laptop Computers).
10. Class II permissive change, Grant date: 10/28/2008
  - a. Add WNC antenna is ThinkPad X200 Tablet w/12.1 inches diagonal screen size PC
  - b. Highest SAR values: Part 22, 0.643 W/kg; Part 24, 0.976 W/kg.
11. Class II permissive change, Grant date: 03/20/2009
  - a. Enable simultaneously WLAN/WiMAX/WWAN transmission in Tablet Computer (ThinkPad X200 Tablet w/12.1 inches diagonal screen size) and co-located with WLAN/WiMAX module (FCC ID:PD9533ANXMU), WLAN modules (FCC ID:PD9LEN512ANMU, FCC ID: PD9533ANMU or FCC ID: PPD-AR5BHB63-L) and Bluetooth Module (FCC ID: QDS-BRCM1033)
  - b. Enable simultaneously WLAN/WiMAX/WWAN transmission in Mobile computer (ThinkPad SL300/SL400/T400S/SL500) and co-located with WLAN/WiMAX module (FCC ID:PD9533ANXMU), WLAN modules (FCC ID:PD9LEN512ANMU, FCC ID: PD9533ANMU, TX2-RTL8191SE-L or FCC ID: PPD-AR5BHB63-L) and Bluetooth Module (FCC ID: QDS-BRCM1033)
  - c. Enable simultaneously WLAN/WiMAX/WWAN transmission in Portable computer (ThinkPad T400/R400 and X500/W500) and co-located with WLAN/WiMAX module (FCC ID:PD9533ANXMU), WLAN modules (FCC ID:PD9LEN512ANMU, FCC ID: PD9533ANMU, TX2-RTL8191SE-L or FCC ID: PPD-AR5BHB63-L) and Bluetooth Module (FCC ID: QDS-BRCM1033)



12. Class II permissive change, , Grant date: 05/22/2009

- a. Enable simultaneously WLAN/WiMAX/WWAN transmission in Tablet Host (ThinkPad X200 Tablet w/12.1 inches diagonal screen size)
- b. Adding new Co-located WLAN modules (FCC ID: TX2-RTL8191SE-L) with previous certified WiMAX/WLAN (FCC ID: PD9533ANHU, FCC ID: PD9512ANHU, FCC ID: PD9512ANXMU, FCC ID: PD9533ANHMU and Bluetooth Modules(FCC ID: QDS-BRCM1033).

13. Class II permissive change, Pending application : (June, 2009)

- a. Adding alternate WWAN antenna and co-located with Bluetooth (FCC ID: QDS-BRCM 1046) in Mobile Hosts (L410, SL410, L510, SL510).
- b. Add new co-located WLAN module (FCC ID: PD9112BNHU) in the Portable host (ThinkPad T400/R400 and ThinkPad T500/W500 Laptop Computers) and the Mobile host (ThinkPad X200/X200s, ThinkPad X300/X301, ThinkPad T400s, ThinkPad SL300/SL400/SL500, ThinkPad L410/SL410/L500 and SL510 Laptop Computers).