

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 for the applying WWAN modular device (FCC ID: **VV7-MBMF3507G-L**, IC: **287AG-MBMF3507G**) on October 16, 2008 under the Portable category regarding FCC CFR 47 Section 2.1093.

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
	*1 FCC ID: PD9533ANHU	IC: 1000M-533ANHU
	*1 FCC ID: PD9512ANHU	IC: 1000M-512ANHU
	*1 FCC ID: PD9512ANXMU	N/A
	*1 FCC ID: PD9512ANXHU	N/A
	*1 FCC ID: TX2-RTL8191SE-L	IC: 6317A-RTL8191SE

*1: New co-located WLAN, WiMAX transmitter devices to be added in this Class II application

: additional **SAR/MPE** co-location with WWAN and WLAN/WiMAX transmitter devices in this application

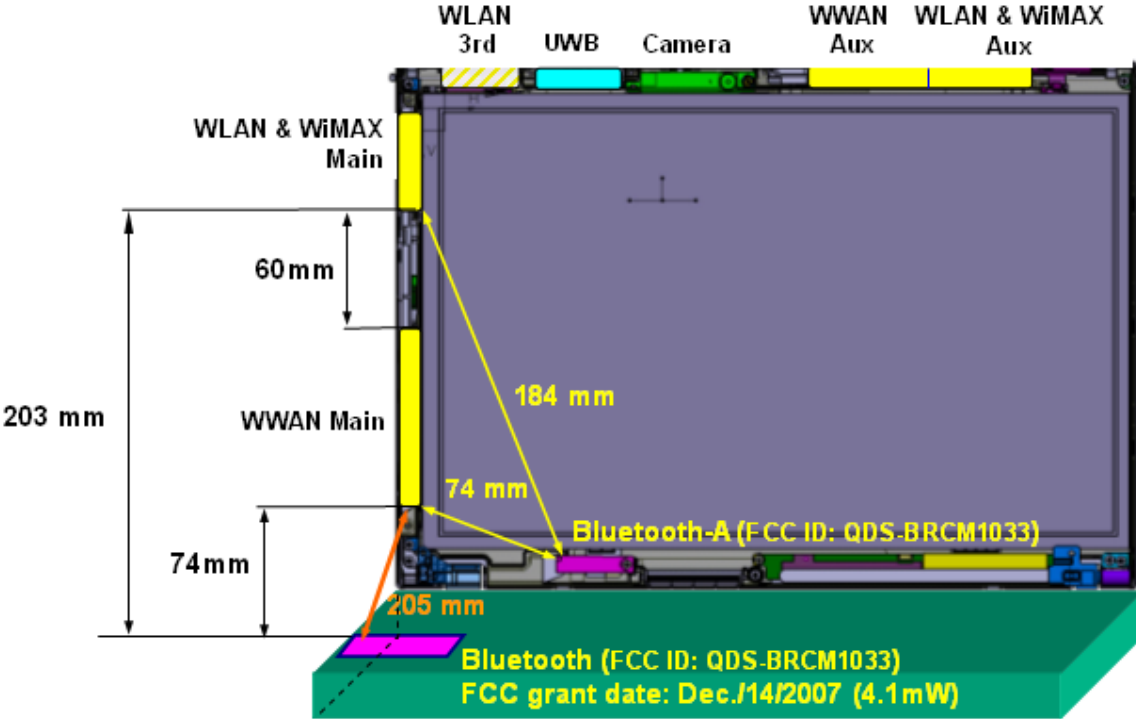
as of April/2009

	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: 02/06/2009
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 *1 IC: 1000M-533ANHU	
FCC ID: PD9512ANHU *1 IC: 1000M-512ANHU	
FCC ID: PD9512ANXMU *1 IC: N/A	
FCC ID: PD9533ANHMU *1 IC: N/A	
FCC ID: TX2-RTL8191SE-L *1 IC: 6317A-RTL8191SE	

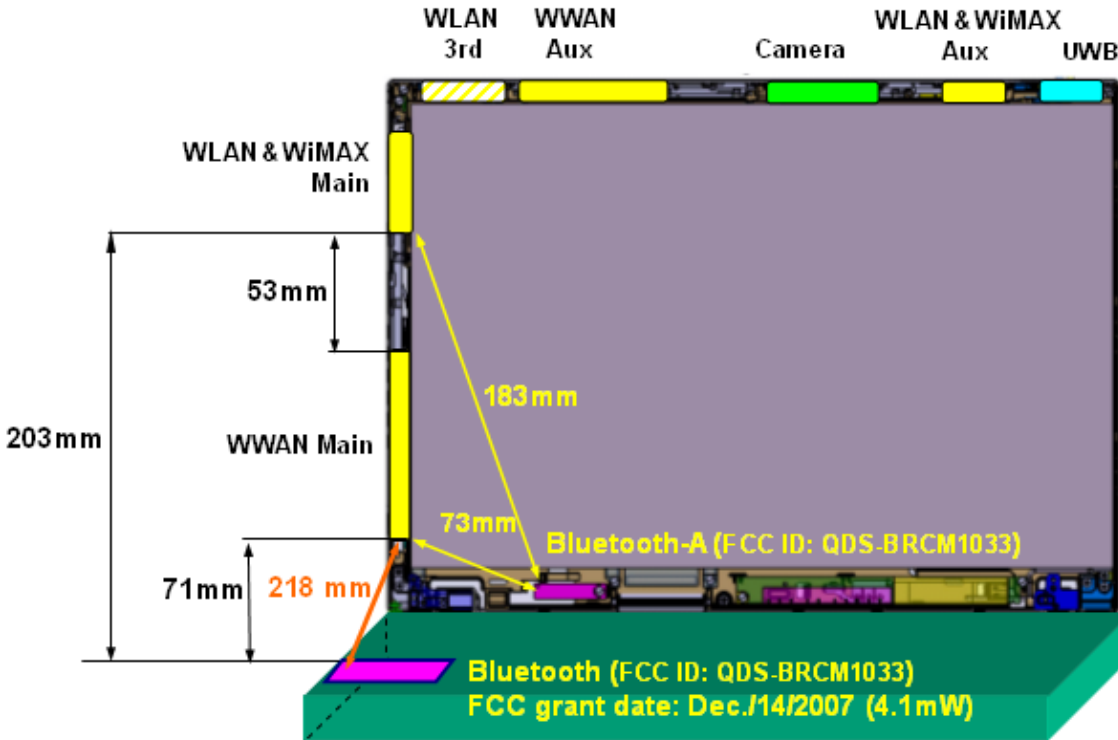
See Annex-1 in more details for the grant history.

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: **F3507G**) 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: VV7-MBMF3507G-L, IC: 287AG-MBMF3507G) 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 7.3 m (> 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 “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 24 cm, and the actual separation distance between WWAN and WLAN/WiMAX antennas is 6 cm or less.

Conclusion: Thus, the FCC [Permit-but-Ask process is required](#) to this application for simultaneous transmission.

See [Table-3](#) for SAR measurement results of the applying WWAN device, and [Table-4](#) for MPE evaluation concerning the co-located WLAN/WiMAX devices.

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

1/2 $\eta_x = 1/2 [P_x / (60/f) - 1]$ (cm) P _x : Conducted power of F3507g			1/2 $\eta_y = 1/2 [P_y / (60/f) - 1]$ (cm) P _y : See Table-2 .			5cm + 1/2 η_x + 1/2 η_y		WLAN to WWAN (cm)	Simul Eval?	
						Duty 100%	Duty 25%			
WWAN: Cellular	Duty=100% (Table-3a) 1/2[1995 /(60/0.836)-1]	14	WLAN 2400MHz	1/2[632/(60/2.45)-1]	13	32	21	5.3 or 6.0	Yes	
			WLAN 5250MHz	1/2[110/(60/5.25)-1]	5	24	13		Yes	
	Duty=25% (Table-3a) 1/2[499 /(60/0.836)-1]	3	WLAN 5600MHz	1/2[110/(60/5.60)-1]	5	24	13		Yes	
			WLAN 5785MHz	1/2[441/(60/5.785)-1]	21	40	29		Yes	
WWAN: PCS	Duty=100% (Table-3b) 1/2[851 /(60/1.880)-1]	13	WLAN 2400MHz	1/2[632/(60/2.45)-1]	13	31	20		Yes	
			WLAN 5250MHz	1/2[110/(60/5.25)-1]	5	23	12		Yes	
	Duty=25% (Table-3b) 1/2[213 /(60/1.880)-1]	2	WLAN 5600MHz	1/2[110/(60/5.60)-1]	5	23	12		Yes	
			WLAN 5785MHz	1/2[441/(60/5.785)-1]	21	39	28		Yes	
				WIMAX 2590MHz	1/2[254/(60/2.59)-1]	5	23		12	Yes

Table-2: 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

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

Table-3: WWAN (Model: F3507G) SAR info.

F3507G Previous Grant date	Host PC model	FCC CFR IC RSS	Max. Conducted power (P)	SAR Distance (D)	SAR (W/Kg)	limit (W/Kg)
FCC 10/16/2008 IC 02/06/2009	ThinkPad T400/R400	Part 22H RSS-132	498.82 mW Table-3a	7.4 cm	0.173	1.6
	ThinkPad T500/W500			7.1 cm	0.161	
(with WLAN/WiMAX co-location)	ThinkPad T400/R400	Part 24E RSS-133	212.78 mW Table-3b	7.4 cm	0.112	1.6
	ThinkPad T500/W500			7.1 cm	0.064	

Table-3a: WWAN Maximum Power consideration at 850MHz frequency band

Mode	Maximum conducted output power (dBm)	Maximum conducted output power (mW)	Duty cycle	Equivalent conducted output power (Maximum conducted output power x duty cycle) (mW)
GPRS	33,00	*2 1995,26	25%	498,82
EDGE	31,00	1258,93	25%	314,73
WCDMA	23,62	230,14	100%	230,14
HSDPA	23,49	223,36	100%	223,36
HSUPA	23,08	203,24	100%	203,24

*2: 2W is the peak output power listed in the original grant (VV7-MBMF3507G). However, based upon the original test report, 1.955W of the peak output power is used here.

Table-3b: WWAN Maximum Power consideration at 1900MHz frequency band

Mode	Maximum conducted output power (dBm)	Maximum conducted output power (mW)	Duty cycle	Equivalent conducted output power (Maximum conducted output power x duty cycle) (mW)
GPRS	29,30	*3 851,14	25%	212,78
EDGE	28,70	741,31	25%	185,33
WCDMA	22,80	190,55	100%	190,55
HSDPA	23,00	199,53	100%	199,53
HSUPA	22,80	190,55	100%	190,55

*3: 871 mW is the peak output power listed in the original test report (VV7-MBMF3507G). However, 851 mW of the burst-averaged output power in the original test report is used here.

Table-4: MPE of WLAN&WiMAX modules

		Max. Conducted power (See Table-2.) (Py)	Max. Host PC antenna gain (See Table-5.) (G)	MPE *4 (mW/cm ²)	limit (mW/cm ²)
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: $MPE = (1000 \times P_y) \times (10^{G/10}) / (4 \times \pi \times 20^2)$

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:VV7-MBMF3507G-L, FCC Regulatory Compliance History

1. Section 2.933 Change in Identification filing based upon VV7-MBMF3507G
 - a. Change in identification grant date:04/30/2008
 - b. Output power : Based upon VV7-MBMF3507G (original device)

FCC Rule Parts	Frequency Range (MHZ)	Output Watts/Peak –Grant entries	Actual Peak Output power based upon the test report	Actual Bust-Averaged Power based upon the test report	Modulation
24E	1850.2 - 1909.8	0.871	0.871	0.851	GPRS/10
24E	1850.2 - 1909.8	0.742	0.742	0.617	EDGE/10
24E	1852.4 - 1907.6	0.387	0.524	0.191(RMS)	HSUPA
22H	824.2 - 848.8	2.0	1.995	1.908	GPRS/10
22H	824.2 - 848.8	1.259	1.259	0.617	EDGE/10
22H	826.4 - 846.6	0.435	0.499	0.203(RMS)	HSUPA

MPE Calculation as documented in VV7-MBMF3507G
 850 MHz frequency band

Maximum output power considerations:

Mode	Maximum conducted output power (dBm)	Maximum conducted output power (mW)	Duty cycle	Equivalent conducted output power (Maximum conducted output power x duty cycle) (mW)
GPRS	33,00	1995,26	25%	498,82
EDGE	31,00	1258,93	25%	314,73
WCDMA	23,62	230,14	100%	230,14
HSDPA	23,49	223,36	100%	223,36
HSUPA	23,08	203,24	100%	203,24

1900 MHz frequency band

Maximum output power considerations:

Mode	Maximum conducted output power (dBm)	Maximum conducted output power (mW)	Duty cycle	Equivalent conducted output power (Maximum conducted output power x duty cycle) (mW)
GPRS	29,30	851,14	25%	212,78
EDGE	28,70	741,31	25%	185,33
WCDMA	22,80	190,55	100%	190,55
HSDPA	23,00	199,53	100%	199,53
HSUPA	22,80	190,55	100%	190,55

2. Class II permissive change, Grant date :05/09/2008
 - 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, 0.173W/kg.; Part 24, 0.112W/kg.

3. Class II permissive change, Grant date: 05/16/2008
 - a. Adding alternate WWAN antenna and co-located with Bluetooth (FCC ID:MCLJ07H081) and WLAN (FCC ID: QDS-BRCM1033) in Mobile Hosts (MP1, KD1, KD2, and BX3)
4. 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, ThinkPad SL310/400 and SL500).
5. Class II permissive change, Grant date:07/29/2008
 - a. Installed WWAN module in Portable Tablet Computer (ThinkPad X200 Tablet) and co-located with Bluetooth (FCC ID: QDS-BRCM1033) and WLAN (FCC ID: PD9LEN512ANMU or FCC ID: PPD-AR5BHB63-L)
 - b. Highest SAR values: Part 22, 0.173W/kg.; Part 24, 0.112W/kg.
6. Class II permissive change, Grant date: 08/05/2008
 - a. Enable Simultaneously WLAN and WWAN simultaneously transmission in hosts (ThinkPad T400/R400 and ThinkPad T500/W500 Laptop Computers).
 - b. and co-located with Bluetooth (FCC ID: QDS-BRCM1033) and WLAN (FCC ID: PD9LEN512ANMU or FCC ID: PPD-AR5BHB63-L)
7. Class II permissive change, Grant date: 09/17/2008
 - a. Add new co-located WLAN/WiMAX module (FCC ID: PD9533ANXMU) in the mobile Hosts ((ThinkPad X200/X200s; ThinkPad X300/X301, ThinkPad SL310/400 and SL500).
8. 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).
9. Class II permissive change, Grant date: 03/20/2009
 - a. Enable simultaneously WLAN/WiMAX/WWAN transmission in Tablet Computer (ThinkPad X200 Tablet) 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:MCLJ07H081).
10. Class II permissive change, application : (April, 2009)
 - a. Enable simultaneously WLAN/WiMAX/WWAN transmission in Mobile Host (ThinkPad T400s) and In portable Host (ThinkPad T400/R400/T500/W500).
 - b. Co-located with FCC ID: PD9533ANHU IC: 1000M-533ANHU, FCC ID: PD9512ANHU, FCC ID: PD9512ANXMU, FCC ID: PD9533ANHMU, FCC ID: TX2-RTL8191SE