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

1. Outline

The Figure-1 shows the new host PC device to be added in this application. And the applying WWAN modular device (FCC ID: **VV7-MBMF3507G-L**, IC: **287AG-MBMF3507G**) transmits RF with the three kinds of transmitters listed below simultaneously.

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: PD9533ANHMU	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
*2: additional 'Mobile' Host PC devices (See Figure-1.)

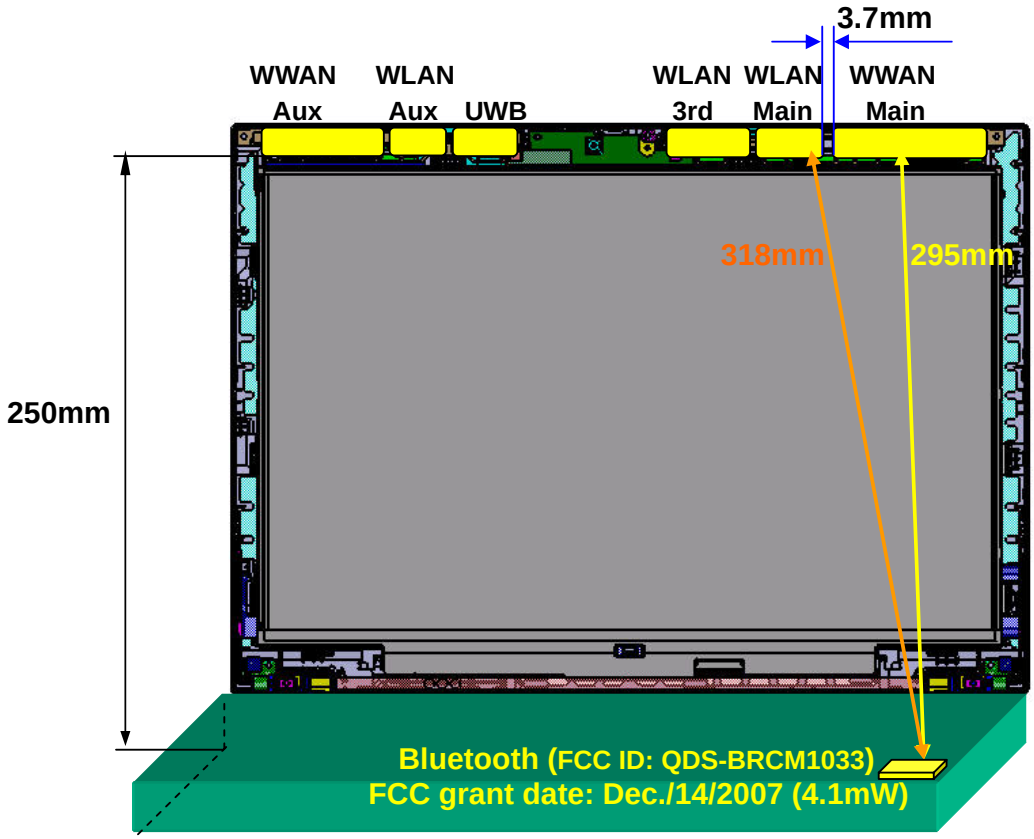
: additional **MPE/MPE** co-location with WWAN and WLAN/WiMAX transmitter devices in this application

as of April/2009

	MPE / MPE config.	
Co-located WLAN/WiMAX modules	ThinkPad X200/X200s X300/X301 SL300/SL400/SL500	ThinkPad T400s *2
FCC ID: PD9533ANMU IC: 1000M-533ANMU	granted FCC: 07/18/2008 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: 09/17/2008	
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: the new host PC device (T400s)



The separation distance between human body and the WWAN Tx antenna of the host PC device is 250mm. Therefore the applying WWAN transmitter module (Model: **F3507G**) and the antenna system are subjected to "Mobile device" pursuant to FCC CFR 47 Section 2.1091 and "RF Exposure Evaluation" category pursuant to IC RSS-102e clause 2.5.2.

With the evaluation hereafter, the applying modular transmitter (Model: **F3507G**) has found to comply with the MPE limit (1.0 mW/cm^2) pursuant to FCC CFR 47 section 1.1310 for general Population/Uncontrolled exposure, and IC RSS-102e clause 4.2.

2. RF Exposure justification regarding Bluetooth co-location

The co-location evaluation with the Bluetooth device is not required because of the sufficient antenna separation distance (295 mm or more) and its low power (4.1mW) 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 both WWAN and WLAN (or WiMAX) antennas fall in Mobile category and co-locate with 3.7mm 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.

0.071 / 0.533 (Table-1) + 0.197 / 1.0 (Table-2) = 0.330 < 1.0 …… Pass

2) Part 24E (PCM) & Part 15C/E or Part 27:
0.076 (Table-1) + 0.197 (Table-2) = 0.273 mW/cm^2 (Limit=1.0) …… Pass

Table-1: MPE of WWAN (Model: **F3507G**) MPE

Host PC model	Grant date	FCC CFR	Max. Conducted power (**P**) (mW)	Max. Host PC antenna gain (**G**)	Distance (**D**)	**MPE *3** (mW/cm^2)	limit (mW/cm^2)
ThinkPad 200/X200s	FCC: 09/17/2008 IC: 02/06/2009	Part 22H RSS -132	498.82 Table-1a	-1.17 dBi	21.1 cm	**0.068**	0.533 (=800/1500)
ThinkPad 300/X301				-0.04 dBi	23.5 cm	**0.071**	
ThinkPad SL300				-1.97 dBi	24.3 cm	**0.043**	
ThinkPad SL400				-1.08 dBi	26.5 cm	**0.044**	
ThinkPad SL500				-0.52 dBi	27.7 cm	**0.046**	
ThinkPad T400s	New host PC			-0.10 dBi	25.0 cm	**0.062**	
ThinkPad 200/X200s	FCC: 09/17/2008 IC: 02/06/2009	Part 24E RSS -133	212.78 Table-1b	1.34 dBi	21.1 cm	**0.052**	1.0
ThinkPad 300/X301				3.92 dBi	23.5 cm	**0.076**	
ThinkPad SL300				0.12 dBi	24.3 cm	**0.029**	
ThinkPad SL400				-1.16 dBi	26.5 cm	**0.018**	
ThinkPad SL500				2.10 dBi	27.7 cm	**0.036**	
ThinkPad T400s	New host PC			1.91 dBi	25.0 cm	**0.042**	

***3**: MPE= (**P**x1000)x(10 $^{G/10}$) / (4 x π x **D**^{2})

Table-1a: 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	***4** 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

***4: 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-1b: 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	*5 851,14	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

***5: 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-2: MPE of WLAN&WiMAX modules

		Max. Conducted power (See **Table-3**) (**Py**)	Max. Host PC antenna gain (See **Table-4**.) (**G**)	**MPE *6** (mW/cm^2)	limit (mW/cm^2)
Part 15C	2.4GHz band	0.632 W	1.94 dBi	**0.197**	1.0
Part 15E	5.18– 5.32GHz	0.110 W	2.61 dBi	0.040	
Part 15E	5.50 – 5.70GHz	0.110 W	2.98 dBi	0.043	
Part 15C	5.745 – 5.825GHz	0.441 W	2.93 dBi	0.172	
Part 27	2.496 – 2.690GHz	0.254 W	1.72 dBi	0.075	

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

Table-3: 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-4: WLAN & WiMAX Antenna Gains of new host PC devices

additional 'Mobile' Host PC device in this Class II application

		Main Antenna					Auxiliary antenna				3rd antenna			
		Frequency band (GHz)					Frequency band (GHz)				Frequency band (GHz)			
	Antenna Manufacturer	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
T400s	NISSEI	-0.83	1.19	1.81	1.63	-1.43	-0.61	2.27	2.98	2.64	1.22	2.61	2.95	2.93
	FOXCONN	1.16	0.65	1.01	-0.25	1.19	-0.88	1.63	0.67	-0.17	1.83	1.84	0.98	0.43
X300	NISSEI	1.88	2.12	2.34	2.31	1.72	1.26	-0.14	1.44	1.47	0.90	-0.14	-0.50	-0.64
X301														
SL300	ACON	0.96	-0.05	-1.73	-2.27	-0.96	-0.86	-2.97	-0.85	-0.69	–	–	–	–
	Amphenol	-1.85	0.96	0.56	-0.02	-2.01	-1.60	1.35	0.52	0.52	–	–	–	–
SL400	ACON	-1.32	-0.88	-3.22	-2.97	-3.61	-0.23	-1.77	-2.57	-2.74	–	–	–	–
	TYCO	-2.39	-0.55	-2.48	-2.66	-2.20	1.52	-0.96	-1.93	-1.93	–	–	–	–
SL500	ACON	-1.16	-1.83	-2.00	-2.00	-1.65	-0.74	-3.11	-2.68	-2.51	–	–	–	–
	TYCO	-0.58	-0.68	-2.08	-1.69	-0.67	-0.11	-1.50	-2.40	-3.11	–	–	–	–
X200	ACON	1.17	-1.19	-2.38	-2.36	1.51	1.04	-0.11	0.33	-1.06	-1.05	-1.39	-3.47	-4.61
	Wistron NW	1.94	0.16	0.61	0.29	0.90	0.59	-1.27	-0.33	-0.77	0.44	-1.77	-1.06	-1.01
X200s	ACON	-0.42	-1.06	-1.43	-2.08	-0.12	-0.13	-0.85	-1.36	-2.52	-0.81	-1.72	-2.56	-2.56
	Wistron NW	-0.52	-0.42	-0.31	-0.49	-0.72	0.31	-0.65	-0.24	-0.24	0.24	-0.71	-0.23	-0.37

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