

Introduction

This document describes a proposed test plan with regards to rf exposure for three modules (WWAN, WLAN and Bluetooth) that are to be installed in the Juniper Systems TK6000 hand-held field computer shown below. This is a follow-up on a previous *KDB 208447* for the same host system with the exception that this enquiry is related to the use of a different cell modem in two slightly different configurations – one is the cell modem on its own, the other with the cell modem and GPS receiver.



The WLAN (FCC ID: VSF19782MX) and Bluetooth (FCC ID: VSF19799AR) modules both have limited modular approvals that include allowance for being co-located in the field computer. RF exposure evaluations were limited to MPE calculations based on the following:

- The host system is for hand-held use with no body-worn accessories;
- The expected operating conditions would ensure at least a 20cm separation from the WLAN and Bluetooth antennas from the body;
- The Bluetooth modules output power and eirp were both below the $(60/f)$ threshold;
- The WLAN output power and eirp were both below the $300 \cdot [f(\text{GHz})]^{-0.5}$ and $1000 \cdot [f(\text{GHz})]^{-0.5}$ thresholds detailed in *KDB 447498* section 4(c);
- The separation distance between WLAN and Bluetooth antennas exceeded 5cm;

The addition of the WWAN module (FCC ID: AU792U09G17826, with change of ID to FCC ID VSF22779 to allow subsequent change in grant notes) will require an additional rf exposure evaluation for the WWAN module that must also consider the co-location with the Bluetooth and WLAN modules. The WWAN module is added to the device through the connection of an expansion pack to the main device, with the expansion pack connecting into a proprietary interface on the rear side of the main unit. Pictures of the two versions of the expansion pack next to the TK6000 are on the next page.

RF Exposure Test Plan v2



Figure 1: TK6000 and Both Versions of Expansion Pack (GSM+GPS on Left, GSM only on Right)

Antenna Separation Distances

The following photographs show the separation distances between WLAN, WWAN and Bluetooth antennas as summarized in the table below. They also show the expected separation distance between the WWAN antenna and the hand.

Expansion pack with cell modem only		
Antenna 1	Antenna 2	Separation (cm)
WWAN	WLAN	6.3
WWAN	Bluetooth	10.0 cm
WLAN	Bluetooth	10.3 cm
WWAN	Hand	> 6.4cm

Expansion pack with cell modem & GPS		
Antenna 1	Antenna 2	Separation (cm)
WWAN	WLAN	9.9
WWAN	Bluetooth	10.0 cm
WLAN	Bluetooth	13.2 cm
WWAN	Hand	> 4" (10cm)

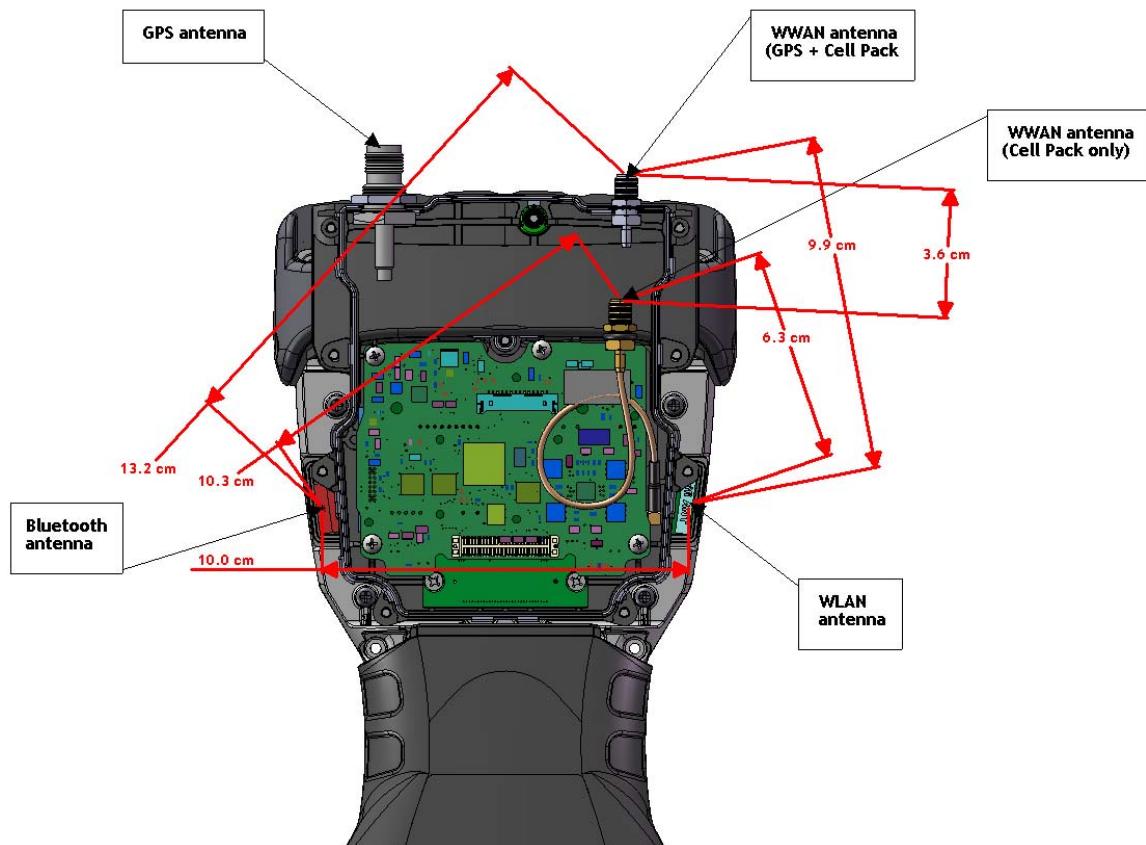


Figure 2: WWAN, WLAN and Bluetooth Antenna Separations For Both Versions of Expansion Pack

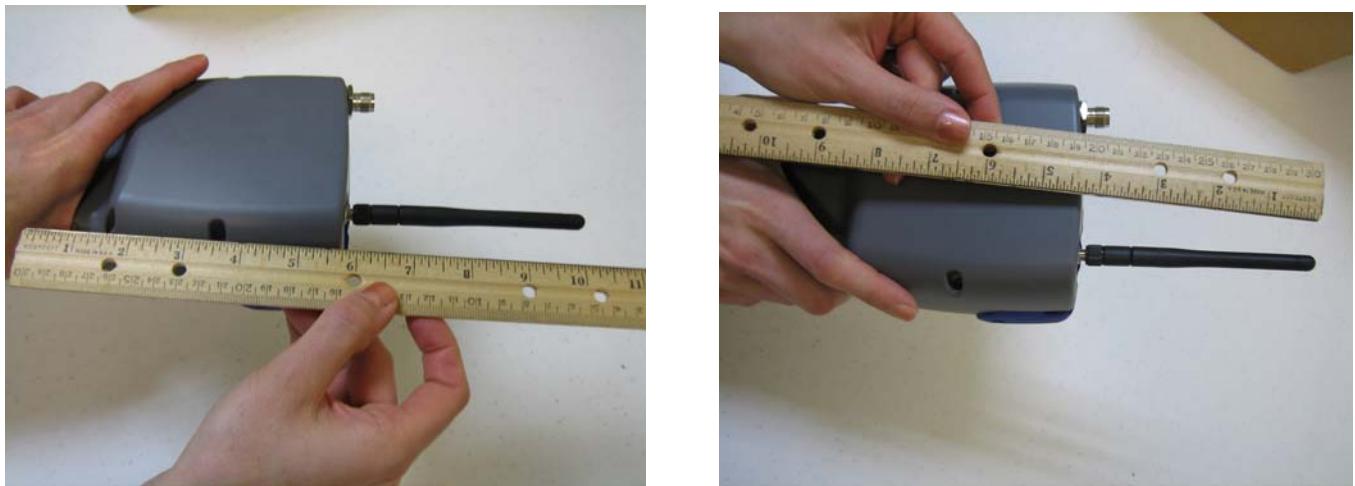


Figure 3: Antenna-to-Hand Separation For Left- and Right-Handed Use (GPS+GSM Pack)

For the GSM-only expansion pack the GSM antenna is located 3.6cm lower so the separation distances are 3cm less than for the GSM+GPS expansion pack (refer to figure 2).

RF Exposure Evaluation

SAR Thresholds

The host is a hand-held device, and has no accessories for the device to be body-worn during operation. Referencing FCC publication KDB447498 SAR is not required for a stand-alone device operating at $P < 60/f$ (GHz) or for devices that operate simultaneously with other transmitters that operate at $P < \frac{1}{2}60/f$ (GHz).

Paragraph 4(c) of KDB447498 states that SAR evaluation is not required for hand-held transmitters that operate closer than 5 cm to the body when they have an output power that is $< 300[f(\text{GHz})]^{-0.5}$ mW. For hand-held and hand-operated devices operating with antenna within 5cm of the hand (but $> 5\text{cm}$ from the body) the threshold increases to $1000 [f(\text{GHz})]^{-0.5}$ mW

The output power, antenna gains and the thresholds for each module are detailed in the tables on the next page. These show that:

- The Bluetooth module is below the $60/f$, and both of the hand-held SAR thresholds.
- The WiFi module is below both of the hand-held SAR thresholds.
- The WWAN module is above the $60/f$ threshold but below the $300[f(\text{GHz})]^{-0.5}$ and $1000 [f(\text{GHz})]^{-0.5}$ thresholds

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Device	Operating Frequency (MHz)		Output power mW	Antenna Gain dBi	SAR threshold (60/f) mW
	From	To			
WWAN Modem ¹	824.2	848.8	217	3.3	70.7
	1850.2	1909.8	106	5.5	31.4
WiFi Module	2412	2462	39.6	0	24.4
Bluetooth Module	2402	2480	10.58	0	24.2

¹ Average output power for WWAN modem based on powers listed in grant (Pmax) and duty cycle. The device is configured using the default radio output power reduction setting 3 (see information below taken from the product documentation).

<ropr> ^{(str)(+CSCS)}	
Radio Output Power Reduction	
According to 3GPP Rel99, output power reduction for multiple TX slots is a mandatory feature. The amount of power reduction is configurable up to 3.0dB for 2TX, 4.8dB for 3Tx to 6dB for 4TX. To optimize heat dissipation, power consumption and SAR values it is recommended to use full power reduction (value "3").	
Parameter is global for all interfaces, volatile and will not be reset by AT&F .	
"1"	Medium Reduction at GMSK (0dB reduction for 1TX and 2TX, 1.8dB for 3TX and 3dB for 4TX) and Full Power at 8PSK
"2"	Maximal Reduction at GMSK (0dB reduction for 1TX, 3dB for 2TX, 4.8dB for 3TX and 6dB for 4TX) and Full Power at 8PSK
"3" ^(P)	Maximal Reduction at GMSK (0dB reduction for 1TX, 3dB for 2TX, 4.8dB for 3TX and 6dB for 4TX) and Maximal Reduction at 8PSK (0dB reduction for 1TX, 3dB for 2TX , 4.8dB for 3TX and 6dB for 4TX)

The average power, based on source-based averaging and use of the maximal reduction when transmitting on multiple time slots, is:

Mode	Operating Band	# of TX time slots	Pout mW	Duty Cycle %	Pout Average mW
GSM (GMSK)	850 MHz	1	1738	12.5%	217
		2	869	25.0%	217
		3	579	37.5%	217
		4	435	50.0%	217
EDGE (8PSK)	850 MHz	1	942	12.5%	118
		2	471	25.0%	118
		3	314	37.5%	118
		4	236	50.0%	118
GSM (GMSK)	1900 MHz	1	850	12.5%	106
		2	425	25.0%	106
		3	283	37.5%	106
		4	213	50.0%	106
EDGE (8PSK)	1900 MHz	1	747	12.5%	93
		2	374	25.0%	93
		3	249	37.5%	93
		4	187	50.0%	93

RF Exposure Test Plan v2

Device	Operating Frequency (MHz)		Output power mW	Hand-held, < 5cm from hand threshold	
	From	To		$1000 \cdot [f(\text{GHz})]^{-0.5}$	Threshold mW
WWAN Modem	824.2	848.8	217	1085.4	20%
WiFi Module	2412	2462	39.6	637.3	6%
Bluetooth Module	2402	2480	10.58	635.0	2%
Aggregate of WWAN, WiFi and Bluetooth power:threshold ratios:					28%

WWAN Modem	1850.2	1909.8	106	723.6	15%
WiFi Module	2412	2462	39.6	637.3	6%
Bluetooth Module	2402	2480	10.58	635.0	2%
Aggregate of WWAN, WiFi and Bluetooth power:threshold ratios:					23%

Device	Operating Frequency (MHz)		Output power mW	Hand-held, < 5cm from body threshold	
	From	To		$300 \cdot [f(\text{GHz})]^{-0.5}$	Threshold mW
WWAN Modem	824.2	848.8	217	325.6	67%
WiFi Module	2412	2462	39.6	191.2	21%
Bluetooth Module	2402	2480	10.58	190.5	6%
Aggregate of WWAN, WiFi and Bluetooth power to threshold ratios:					94%
WWAN Modem	1850.2	1909.8	106	217.1	49%
WiFi Module	2412	2462	39.6	191.2	21%
Bluetooth Module	2402	2480	10.58	190.5	6%
Aggregate of WWAN, WiFi and Bluetooth power to threshold ratios:					76%

Proposed RF Exposure Evaluation

KDB 447498 states that the simultaneous transmission SAR evaluation procedures for cellphones in KDB 648474 may be applied to antennas that are built-in within a PDA or UMPC. The field PC should be considered as an Ultra mobile PC (UMPC).

WWAN Module – Stand Alone

The WWAN module would be subject to routine evaluation when used within 20cm of persons. We believe that because the output power from the device falls below the thresholds detailed in KDB 447498 related to hand-held operation, no SAR testing would be required for use of the module in the TK6000 hand-held device as described in this document.

Bluetooth Module – Stand Alone

Based on both KDB 447498 and KDB 648474 the Bluetooth module does not require a SAR assessment or an MPE assessment.

WiFi Module – Stand Alone

As the WiFi module being well below the *hand-held, within 5cm of the body* $(300[f(\text{GHz})]^{-0.5} \text{ mW})$ and the *hand-held, within 5cm of the hands* $(1000[f(\text{GHz})]^{-0.5} \text{ mW})$ threshold the WiFi module is exempt from a stand-alone SAR assessment.

An MPE assessment is required to demonstrate that the rf exposure hazard 20cm from the device is below the relevant limit.

Co-Located Simultaneous Transmissions

As WWAN, Bluetooth and/or WLAN modules can operate simultaneously; the effects of simultaneous transmissions must also be taken into consideration.

For body exposure an MPE calculation to demonstrate compliance with the limits, based on summing the percentage of the limit for each transmitter and verifying that the total is less than 100%, will be performed and is included at the end of this document.

For localized rf exposure, SAR evaluations are expected. KDB 648474 states: *When stand-alone SAR evaluation is not required and the antenna is 5 cm from other antennas, simultaneous transmission SAR evaluation is also not required for that antenna.* As the individual wireless devices are all below the thresholds that would require SAR evaluations for use in hand-held devices, and as the sum of the ratios of the threshold and output power for each individual transmitter is also less than 100%, no evaluation for simultaneous transmissions are required.

MPE Calculations

The device is a hand-held device that would not be used within 20cm of the body. Hand-held usage and rf exposure is addressed in the first section of this test plan, this MPE calculation is being used to evaluate the rf exposure from the host device at a distance of 20cm from the body with all three transmitters operational.

FCC part 1.1310, Table 1 limits the power density for uncontrolled exposure. The power density, P_d (mW/cm^2) calculated from the maximum EIRP, P_t (mW) and the distance, d (m), between the transmitting antenna and the closest person, can be calculated using:

$$P_d = P_t / (4 \pi d^2)$$

Bluetooth, WWAN (850MHz) and WLAN Modules Operating Simultaneously

Frequency	MPE Limit (mW/cm^2)	Output Power (mW)	Max. Antenna Gain (dBi)	EIRP (mW)	Pd at 20cm (mW/cm^2)	% of limit
2402 to 2480 MHz	1.00	10.6	0.0	10.6	0.002	0.2%
2412 to 2462 MHz	1.00	39.6	0.0	39.6	0.008	0.8%
824 to 849 MHz	0.55			279.8 Note 1	0.06	10.1%
Note 1: EIRP taken from measured value of 31.3dBm erp (=33.5dBm, or 2238.7mW, eirp) corrected for source-based duty cycle (12.5%)						

The total of the rf exposure power density of each device, expressed as a percentage of their respective limits, is 11.1%. As this is below 100% the total power density at 20cm from the device is below the levels permitted for uncontrolled exposure.

Bluetooth, WWAN (1900MHz) and WLAN Modules Operating Simultaneously

Frequency	MPE Limit (mW/cm^2)	Output Power (mW)	Max. Antenna Gain (dBi)	EIRP (mW)	Pd at 20cm (mW/cm^2)	% of limit
2402 to 2480 MHz	1.00	10.6	0.0	10.6	0.002	0.2%
2412 to 2462 MHz	1.00	39.6	0.0	39.6	0.008	0.8%
1850 to 1910 MHz	1.00			238.2 Note 1	0.05	4.7%
Note 1: EIRP taken from measured value of 32.8dBm, or 1905.5mW, eirp) corrected for source-based duty cycle (12.5%)						

The total of the rf exposure power density of each device, expressed as a percentage of their respective limits, is 5.7 %. As this is below 100% the total power density at 20cm from the device is below the levels permitted for uncontrolled exposure.

Revision History

Revision	Date	Comments	Author
1	5/5/2010	Original version set to FCC as part of KDB 222340	Briggs
2	6/7/2010	<p>Modified to account for the following comments from FCC:</p> <p>1) we note fig1 caption "GPS only on Right" appears to be incorrect, i.e. should be GSM only</p> <p>2) we note this wording at pg4 seems a little awkward or misleading: "For devices that could be within 5cm of the hand (but > 5cm from the body) ..." i.e. better to say it like following or similar: "For hand-held and hand-operated devices operating with antenna within 5cm of the hand (but > 5cm from the body) ..."</p> <p>3) concerning WWAN power and transmit slots at pg5, please expand analysis as appropriate to address all modes and consistent with all attachments at KDB pub. 941225 e.g. "... the maximum burst-averaged output power for each mode (GMS/GPRS/EDGE) and the corresponding multi-slot class must be clearly identified in the SAR report for each frequency band."</p> <p>4) at pg6 please change from "For whole-body exposure an MPE ..." to "For body exposure an MPE ..."</p> <p>Modified to update MPE calculation with actual eirp values for Part 22 and Part 24 operation.</p>	Briggs