

US Tech Test Report:
FCC ID:
IC:
Test Report Number:
Issue Date:
Customer:
Model:

FCC Part 15 Certification
2AHPM-TITAN
21163-TITAN
16-0054
March 18, 2016
HDJ WIRELESS ENTERPRISE LLC
VERSA ROUTER 1100 TITAN

MPE and SAR Threshold Requirements

This exhibit is provided to show the MPE and SAR Threshold requirements for the Versa Router 1100 TITAN meets the exemption limits for Routine Evaluation of RF Exposure (FCC Part 2.1091, Part 2.1093, RSS 102 section 2.5.2).

This document covers the VN1100, 900 MHz band radio module.

Additional data which covers the co-located 3G module is provided in a separate exhibit. Although both radios can transmit simultaneously, the radios do not transmit on overlapping frequencies. The VN1100 transmits only at the following frequencies, 902.4 – 927.6 MHz. The 3G module with FCC and IC id: FCC ID: XPYLISAU230, IC: 8595A-LISAU230, transmits at: 824.2-848.8 MHz, 1712.4-1752.6 MHz, and 1850.2-1909.8 MHz. See the attached exhibit for the 3G module MPE calculations.

The antenna used with this 3G module in this configuration is a 2.2 dBi gain antenna which is less than the lowest approved antenna gain to be used with the 3G module.

NOTE: During the RF Exposure evaluation all antennas were ON and transmitting. The conducted output measurements were deemed to provide worst case figures therefore the RF Exposure calculation are performed using the conducted output measurement.

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VN1100, 900 MHz band radio:

Maximum Public Exposure to RF (MPE) CFR 1.1310(e)

The maximum exposure level to the public from the RF power of the EUT shall not exceed a power density, **S**, of 1 mW/cm² at a distance, **d**, of 20 cm from the EUT.

Therefore, for:

Highest Antenna = 3.0 dBi

Peak Power (Watts) = 0.417 (from UST Test Report 16-0054)

Gain of Transmit Antenna = 3.0 dBi = 2.0, numeric (from UST Test Report 16-0054)

d = Distance = 20 cm = 0.2 m

$$\begin{aligned} S &= (PG / 4\pi d^2) = EIRP / 4A = 0.417(2.0) / 4 * \pi * 0.2 * 0.2 \\ &= 0.8340 / 0.503 = 1.6581 \text{ W/m}^2 \\ &= (\text{W/m}^2) (1\text{m}^2/\text{W}) (0.1 \text{ mW/cm}^2) \\ &= 0.1658 \text{ mW/cm}^2 \end{aligned}$$

which is << less than 0.61 mW/cm²

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SAR Threshold Requirements Based on RSS 102 Issue section 2.5.2

Highest Gain Antenna = 3.0 dBi

Peak Power (dBm) = 26.2 (highest measured output power level)

Gain of Transmit Antenna = 3.0 dBi

Distance = > 20 cm

time based average = Duty Cycle = 50% (see test report)

Total source based time average = (Pwr dBm) + (Ant gain dBi) * time based average

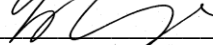
$$26.2 \text{ dBm} + 3.0 \text{ dBi} = 29.2 \text{ dBm (832 mW)} * 0.50 = 415 \text{ mW}$$

which is << less than 1.38 W for IC (per RSS 102, 2.5.2)

All calculations performed by:

George Yang

Date: 4/19/2016

Signature: 

Note: validation of output power levels and antenna gain information please see the referenced test reports for this submittal.

5. Radio Frequency Exposure Evaluation

§2.1091, RSS-102

5.1.References

FCC: §1.1310, § 2.1091

IC: RSS-102, Issue 4

The criteria used for the evaluation of human exposure to radio frequency radiation is table 1 according FCC §1.1310 and table chapter 4.2 of RSS-102 standard.

As the mobile equipment is authorized under Part 22 (Subpart H), Part 24 and Part 27 of the FCC Rules, it is subject for evaluation of the RF exposure prior to equipment authorization.

§2.1091: Further information on evaluating compliance with these limits can be found in the FCC's OST/OET Bulletin Number 65, "Evaluating Compliance with FCC-Specified Guidelines for Human Exposure to Radiofrequency Radiation."

1)For purposes of analyzing mobile transmitting devices under the occupational/controlled criteria specified in Sec. 1.1310 of this chapter, time-averaging provisions of the guidelines may be used in conjunction with typical maximum duty factors to determine maximum likely exposure levels.

For purposes of these requirements mobile devices are defined by the FCC as transmitters designed to be used in other than fixed locations and to generally be used in such a way that a separation distance of at least 20 centimeters is normally maintained between radiating structures and the body of the user or nearby persons. These devices are normally evaluated for exposure potential with relation to the MPE limits given in Table 1 of Appendix A.

TABLE 1—LIMITS FOR MAXIMUM PERMISSIBLE EXPOSURE (MPE)—Continued

Frequency range (MHz)	Electric field strength (V/m)	Magnetic field strength (A/m)	Power density (mW/cm ²)	Averaging time (minutes)
30–300	61.4	0.163	1.0	6
300–1500 .....	.....	.....	f/300	6
1500–100,000 .....	.....	.....	5	6
(B) Limits for General Population/Uncontrolled Exposure				
0.3–1.34	614	1.63	*(100)	30
1.34–30	824/f	2.19/f	*(180/f ²)	30
30–300	27.5	0.073	0.2	30
300–1500 .....	.....	.....	f/1500	30
1500–100,000 .....	.....	.....	1.0	30

f = frequency in MHz

Table 1: LIMITS FOR MAXIMUM PERMISSIBLE EXPOSURE (MPE)

The used equation to predict the power density in the far-field of one single radiating antenna can be made by following equation:

$$S = \frac{EIRP}{4\pi R^2} = \frac{P * G}{4\pi R^2}$$

Abbreviations:

S: Power density (mW/cm²)
P: Power Input measured conducted on RF-port (mW)
G: Numeric gain of the antenna relative to an isotropic radiator
R: distance from the surface or antenna of the EUT (cm)

For given power density limit at a single frequency (accord. Table 1 Limits) the maximum antenna gain can be calculated:

$$G_{NUMERIC} = \frac{S * 4\pi R^2}{P}$$

5.2.General Limits

§1.1307

Cellular Radiotelephone Service (subpart H of part 22)

Non-building-mounted antennas: height above ground level to lowest point of antenna < 10 m and total power of all channels > 1000 W ERP (1640 W EIRP)

§1.1307

Personal Communications Services (part 24)

Broadband PCS (subpart E): non-building-mounted antennas: height above ground level to lowest point of antenna < 10 m and total power of all channels > 2000 W ERP (3280 W EIRP)

§1.1310 LIMITS FOR MAXIMUM PERMISSIBLE EXPOSURE (MPE)

Table 1(B) Limits for General Population/Uncontrolled Exposure

300–1500 MHz: $f/1500$ mW/cm² (f in MHz)

1500–100,000 MHz: 1.0 mW/cm²

§2.1091

Subject to routine evaluation is required when the device operate at frequencies of 1.5 GHz or below and their effective radiated power (ERP) is 1.5 watts or more, or if they operate at frequencies above 1.5 GHz and their ERP is 3 watts or more.

§24.232

(a) Base stations are limited to 1640 watts peak equivalent isotropically radiated power (e.i.r.p.) with an antenna height up to 300 meters HAAT.

c) Mobile/portable stations are limited to 2 watts EIRP...

§22.913

(a)Maximum ERP. The effective radiated power (ERP) of base transmitters and cellular repeaters must not exceed 500 Watts.

(2)... The ERP of mobile transmitters and auxiliary test transmitters must not exceed 7 Watts.

§27.50

(4) Fixed, mobile, and portable (hand-held) stations operating in the 1710–1755 MHz band are limited to 1 watt EIRP. Fixed stations operating in this band are limited to a maximum antenna height of 10 meters above ground. Mobile and portable stations operating in this band must employ a means for limiting power to the minimum necessary for successful communications

Canadian RSS-102 standard for uncontrolled environment requires the RF-exposure value in W/m^2 unit, therefore the MPE limit value determined in mW/cm^2 unit, should be multiplied by 10 to have the required unit. The MPE limits are the same like on FCC §1.1301 at table 1.

5.3.Methods

Valid for GSM/GPRS/EDGE mode:

- The power was checked on 3 frequencies (lowest/middle/highest) within each operable bands.
- Average burst power (slot power) and peak were measured.
- Only one uplink slot (1 TX) was measured. 4 TX slots are maximum possible for this device and calculated as worst-case.
- A duty-cycle correction factor of $10 \cdot \log_{10}(\text{max. number of possible active slots} / 8 \text{ slots})$ were applied

Please find in the following tables the calculations. Also the maximum admissible allowed antenna gain is calculated which is not exceeding the MPE limit for fixed and mobile operations.

Valid for FDD/W-CDMA Mode:

- The power was checked on 3 frequencies (lowest/middle/highest) within each operable FDD-band. RMS and Peak detector was used.
- No duty-cycle correction factor is applicable

5.4. Results

850 MHz frequency band

Maximum output power considerations

Mode	Measured freq. (MHz)	Measured maximum conducted output power (dBm)	Duty cycle	Measured Maximum conducted output power (W)	Equivalent conducted output power (maximum conducted output power x duty cycle) (mW)
GSM/GPRS (PK)	824.2	32.20	50%	1.658	829
	837	32.24		1.675	838
	848.8	32.33		1.711	855
GSM/GPRS (Avg. Burst Power)	824.2	32.01	50%	1.589	795
	837	32.08		1.616	808
	848.8	32.14		1.636	818
EDGE (PK)	824.2	29.22	50%	0.835	417
	837	29.23		0.838	419
	848.8	29.26		0.844	422
EDGE (Avg. Burst Power)	824.2	26.32	50%	0.429	214
	837	26.39		0.436	218
	848.8	26.48		0.445	222
WCDMA (PK)	826.4	26.12	100%	0.409	409
	836.4	26.11		0.408	408
	846.6	25.86		0.385	385
WCDMA (RMS)	826.4	22.01	100%	0.159	159
	836.4	22.82		0.192	192
	846.6	22.72		0.187	187

Antenna gains considerations of 850 MHz band:

P	Selected the highest maximum power input to the antenna incl. Duty cycle (mW): (Avg. Burst Power or RMS)	818
R	Distance (cm):	20
S	Power density MPE limit acc. §1.1310 and RSS-102 for uncontrolled exposure (mW/cm ²): (FCC use mW/cm ² & IC use W/m ²)	0.55
G ₁	Maximum Antenna gain to comply with MPE limit (dBi):	5.28

(For G₁ selected the lowest measured channel to reach minimum ant. gain)

	ERP power limit according to §2.1091 (W ERP): (Avg. Burst Power or RMS)	1.50
G ₂	Max. Antenna gain to comply with limit incl. Duty cycle (dBi):	4.78

(For G₂ selected the highest max. Avg. Burst Power or RMS value incl. Duty cycle)

	ERP power limit according to §22.913 (W ERP):	7.00
G ₃	Max. Antenna gain to comply with limit (dBi):	8.46

(For G₃ selected the highest Average burst power value excluded Duty cycle)

G_{850 MHz band}	Min (G₁, G₂, G₃) (dBi)	4.78
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The max. ant. gain for mobile operation at 850 MHz band to comply with MPE and ERP limits incl. path loss shall not exceed (dBi):	4.78
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RF Exposure Evaluation acc. RSS-102 allowed maximum antenna gain in a distance of 20 cm is for RF Field strength (W/m ²): 4.90
(Exemption from Routine Evaluation Limits – RF Exposure Evaluation is not required, if the device below 1.5 GHz and the maximum e.i.r.p. is equal to or less than 2.5 W. However, if the device in question meets the exemption from routine evaluation limits of sections 2.5.1 or 2.5.2 (RSS-102) only a signed declaration of compliance needs to be submitted (see Annex C))

1700 MHz frequency band

Maximum output power considerations:

Mode	Measured freq. (MHz)	Measured maximum conducted output power (dBm)	Duty cycle	Measured Maximum conducted output power (W)	Equivalent conducted output power (maximum conducted output power x duty cycle) (mW)
WCDMA (PK)	1712.4	25.55	100%	0.359	359
	1732.6	25.49		0.354	354
	1752.6	25.65		0.367	367
WCDMA (RMS)	1712.4	22.35	100%	0.172	172
	1732.6	22.32		0.171	171
	1752.6	22.45		0.176	176

Antenna gains considerations:

P	Selected the maximum power input to the antenna incl. Duty cycle (mW): (RMS)	176
R	Distance (cm):	20
S	Power density MPE limit acc. §1.1310 and RSS-102 for uncontrolled exposure (mW/cm ²): (note: FCC use mW/cm ² & IC use W/m ²)	1.00
G ₁	Maximum Antenna gain to comply with MPE limit (dBi):	14.56

	ERP power limit according to §2.1091 (W ERP): (RMS)	3.00
G ₂	Max. Antenna gain to comply with limit incl. Duty cycle (dBi):	14.47

	EIRP power limit according to §27.50(d) (W EIRP):	1.00
G ₃	Max. Antenna gain to comply with limit (dBi):	7.55

(For G3 selected the max. RMS value excluded Duty cycle)

G_{1700 MHz band}	Min (G₁, G₂, G₃) (dBi)	7.55
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The max. ant. gain for mobile operation at 1700 MHz band to comply with MPE and EIRP limits incl. path loss shall not exceed (dBi):	7.55
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RF Exposure Evaluation acc. RSS-102 allowed maximum antenna gain in a distance of 20 cm is for RF Field strength (W/m ²): 1.99
(Exemption from Routine Evaluation Limits – RF Exposure Evaluation is not required, if the device above 1.5 GHz and the maximum e.i.r.p. of the device is equal to or less than 5 W. However, if the device in question meets the exemption from routine evaluation limits of sections 2.5.1 or 2.5.2 (RSS-102) only a signed declaration of compliance needs to be submitted (see Annex C))

1900 MHz frequency band

Maximum output power considerations:

Mode	Measured freq. (MHz)	Measured maximum conducted output power (dBm)	Duty cycle	Measured Maximum conducted output power (W)	Equivalent conducted output power (maximum conducted output power x duty cycle) (mW)
GSM/GPRS (PK)	1850.2	29.18	50%	0.828	414
	1880.0	29.24		0.839	419
	1909.8	29.11		0.814	407
GSM/GPRS (Avg. Burst Power)	1850.2	29.02	50%	0.799	399
	1880.0	29.06		0.806	403
	1909.8	28.97		0.789	394
EDGE (PK)	1850.2	28.04	50%	0.636	0.318
	1880.0	28.06		0.640	0.320
	1909.8	27.93		0.621	0.310
EDGE (Avg. Burst Power)	1850.2	25.24	50%	0.334	0.167
	1880.0	25.29		0.338	0.169
	1909.8	25.19		0.330	0.165
WCDMA (PK)	1852.4	25.74	100%	0.375	0.375
	1880.0	25.86		0.385	0.385
	1907.6	25.41		0.348	0.348
WCDMA (RMS)	1852.4	22.69	100%	0.186	0.186
	1880.0	22.72		0.187	0.187
	1907.6	22.51		0.178	0.178

Antenna gains considerations of 1900 MHz band:

P	Selected the maximum power input to the antenna incl. Duty cycle (mW): (Avg. Burst Power or RMS)	403
R	Distance (cm):	20
S	Power density MPE limit acc. §1.1310 and RSS-102 for uncontrolled exposure (mW/cm ²): (FCC use mW/cm ² & IC use W/m ²)	1.00
G ₁	Maximum Antenna gain to comply with MPE limit (dBi):	10.96

	ERP power limit according to §2.1091 (W ERP): (Avg. Burst Power or RMS)	3.00
G ₂	Max. Antenna gain to comply with limit incl. Duty cycle (dBi): (For G ₂ selected the max. Avg. Burst Power or RMS value incl. Duty cycle)	10.87

	EIRP power limit according to §24.232 (W EIRP):	2.00
G ₃	Max. Antenna gain to comply with limit (dBi): (For G ₃ selected the max. Average burst power value excluded Duty cycle)	3.95

G_{1900 MHz band}	Min (G₁, G₂, G₃) (dBi)	3.95
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The max. ant. gain for mobile operation at 1900 MHz band to comply with MPE and EIRP limits incl. path loss shall not exceed (dBi):	3.95
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RF Exposure Evaluation acc. RSS-102 allowed maximum antenna gain in a distance of 20 cm is for RF Field strength (W/m ²): 1.99
(Exemption from Routine Evaluation Limits – RF Exposure Evaluation is not required, if the device above 1.5 GHz and the maximum e.i.r.p. of the device is equal to or less than 5 W. However, if the device in question meets the exemption from routine evaluation limits of sections 2.5.1 or 2.5.2 (RSS-102) only a signed declaration of compliance needs to be submitted (see Annex C))