Maximum Permissible Exposure Report

1. Product Information

Name of EUT	OVMS (Open Vehicle Monitoring System)
Test Model	OVMS-31-5360A
Modulation Type	GMSK for GSM/GPRS; 8-PSK for EDGE; QPSK for UMTS
Antenna Gain	5.0dBi (max.) For GSM 850; 5.0dBi (max.) For PCS 1900; 5.0dBi for WCDMA Band II; 5.0dBi for WCDMA Band V; 2.0dBi (max.) For BT and WLAN
Hardware version	3.1
Software version	3.2.001
GSM/EDGE/GPRS Operation Frequency Band	GPRS850/GPRS1900/EDGE850/EDGE1900
UMTS Operation Frequency Band	UMTS FDD Band II/V
LTE Operation Frequency Band	Not Supported
GSM/EDGE/GPRS	Supported GPRS/EDGE
GSM Release Version	R99
GSM/EDGE/GPRS Power Class	GSM850:Power Class 4/ PCS1900:Power Class 1
GPRS/EDGE Multislot Class	GPRS/EDGE: Multi-slot Class 12
GPRS operation mode	Class B
WCDMA Release Version	R8
HSDPA Release Version	Release 8
HSUPA Release Version	Release 6
DC-HSUPA Release Version	Not Supported
LTE Release Version	Not Supported
LTE/UMTS Power Class	Class 3
WLAN FCC Modulation Type	IEEE 802.11b: DSSS(CCK,DQPSK,DBPSK) IEEE 802.11g/n: OFDM(64QAM, 16QAM, QPSK, BPSK)
WLAN FCC Operation frequency	IEEE 802.11b/g/n20:2412-2462MHz IEEE 802.11n40:2422-2452MHz
Antenna Type	PCB Antenna
BT Modulation Type	GFSK, π/4-DQPSK, 8-DPSK (BT V4.2)
Extreme temp. Tolerance	-20°C to +55°C
GPS function	Support and only RX
FM function	Not Supported
NFC Function	Not Supported
Extreme vol. Limits	10.8VDC to 13.2VDC (nominal: 12.0VDC)
Exposure category	General population/uncontrolled environment
EUT Type	Production Unit
Device Type	Mobile Device

2. Evaluation Method

Systems operating under the provisions of FCC 47 CFR section shall be operated in a manner that ensures that the public is not exposed to radio frequency energy level in excess of the Commission's guidelines.
In accordance with 47 CFR FCC Part 2 Subpart J, section 2.1091 this device has been defined as mobile device whereby a distance of 0.2m normally can be maintained between the user and the device, and below RF Permissible Exposure limit shall comply with.
In accordance with KDB447498 D01 General RF Exposure Guidance v06 for Simultaneous transmission MPE test exclusion applies when the sum of the MPE ratios for all simultaneous transmitting antennas incorporated in a host device, based on the calculated/estimated, numerically modelled or measured field strengths or power density, is ≤ 1.0. The MPE ratio of each antenna is determined at the minimum test separation distance required by the operating configurations and exposure conditions of the host device, according to the ratio of field strengths or power density to MPE limit, at the test frequency. Either the maximum peak or spatially averaged results from measurements or numerical simulations may be used to determine the MPE ratios. Spatial averaging does not apply when MPE is estimated using simple calculations based on far-field plane-wave equivalent conditions. The antenna installation and operating requirements for the host device must meet the minimum test separation distances required by all antennas, in both standalone and simultaneous transmission operations, to satisfy compliance.

3. Limit

3. 1 Refer Evaluation Method

ANSI C95.1–1999: IEEE Standard for Safety Levels with Respect to Human Exposure to Radio Frequency Electromagnetic Fields, 3 kHz to 300 GHz.
FCC KDB publication 447498 D01 General 1 RF Exposure Guidance v06: Mobile and Portable Devices RF Exposure Procedures and Equipment Authorization Policies.
FCC CFR 47 part1 1.1310: Radiofrequency radiation exposure limits.
FCC CFR 47 part2 2.1091: Radiofrequency radiation exposure evaluation: mobile devices.

3. 2 Limit

Limits for Maximum Permissible Exposure (MPE)/Controlled Exposure

Frequency Range(MHz)	Electric Field Strength(V/m)	Magnetic Field Strength(A/m)	Power Density (mW/cm^2)	Averaging Time (minute)
Limits for Occupational/Controlled Exposure				
0.3 – 3.0	614	1.63	(100) *	6
3.0 – 30	1842/f	4.89/f	($900/f^2$)*	6
30 – 300	61.4	0.163	1.0	6
300 – 1500	/	/	f/300	6
1500 – 100,000	/	/	5	6

Limits for Maximum Permissible Exposure (MPE)/Uncontrolled Exposure

Frequency Range(MHz)	Electric Field Strength(V/m)	Magnetic Field Strength(A/m)	Power Density (mW/cm^2)	Averaging Time (minute)
Limits for Occupational/Controlled Exposure				
0.3 – 3.0	614	1.63	(100) *	30
3.0 – 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
*=Plane-wave equivalent power density

4. MPE Calculation Method

Predication of MPE limit at a given distance
Equation from page 18 of OET Bulletin 65, Edition 97-01

$S=PG/4\pi R^2$

Where: S=power density
P=power input to antenna
G=power gain of the antenna in the direction of interest relative to an isotropic radiator
R=distance to the center of radiation of the antenna

5. Antenna Information

OVMS-31-5360A can only use antennas certificated as follows provided by manufacturer;

Antenna type and antenna number	Operate frequency band	Maximum antenna gain
PCB Antenna	600MHz – 2500MHz	2.0dBi(Max.) for Bluetooth and WLAN
External Stick Antenna	600MHz – 2500MHz	5.0dBi(Max.) for WWAN

6. Conducted Power

General Note: Per KDB 447498 D01v06, the maximum output power channel is used for SAR testing, further SAR test reduction and MPE.

[Bluetooth Max. Conducted Power]

Mode	Channel	Frequency(MHz)	Max. Conducted Output Power (dBm)
GFSK	0	2402	-0.888
	39	2441	0.170
	78	2480	-1.386
π/4DQPSK	0	2402	-1.611
	39	2441	-0.638
	78	2480	-2.232
8-DPSK	0	2402	-1.685
	39	2441	-0.700
	78	2480	-2.234
GFSK BT – LE	0	2402	-0.989
	19	2440	-0.016
	39	2480	-1.487

[2.4GHz WLAN Max. Conducted Power]

Mode	Channel	Frequency(MHz)	Max. Conducted Output Power (dBm)
IEEE 802.11b	1	2412	9.86
	6	2437	10.07
	11	2462	8.80
IEEE 802.11g	1	2412	11.14
	6	2437	13.06
	11	2462	12.11
IEEE 802.11n HT20	1	2412	10.89
	6	2437	13.01
	11	2462	11.90
IEEE 802.11n HT40	3	2422	13.16
	6	2437	12.48
	9	2452	12.51

[GSM Max. Conducted Power]

Mode	Channel	Frequency(MHz)	Max. Conducted Output Power (dBm)
GSM 850 Band	LCH	824.2	32.38
	MCH	836.6	32.44
	HCH	848.8	32.18
PCS 1900 Band	LCH	1850.2	29.31
	MCH	1880.0	29.42
	HCH	1909.8	29.15

[WCDMA Max. Conducted Power]

Mode	Channel	Frequency(MHz)	Max. Conducted Output Power (dBm)
WCDMA Band V	LCH	826.4	22.91
	MCH	836.6	23.32
	HCH	846.6	23.16
WCDMA Band II	LCH	1852.4	23.11
	MCH	1880.0	23.26
	HCH	1907.6	23.14

7. Measurement Results

7.1 Standalone MPE

As declared by the Applicant, the EUT is a wireless device used in a fix application, at least 40cm from any body part of the user or nearby persons; from the maximum EUT RF output power, the minimum separation distance, r =40cm, as well as the gain of the used antenna refer to antenna information, the RF power density can be obtained.

[Bluetooth]

Modulation Type	Max. Tune up Output power		Antenna Gain (dBi)	Antenna Gain (linear)	MPE (mW/cm^2)	MPE Limits (mW/cm^2)
	dBm	mW				
GFSK	1.00	1.2589	2.00	1.5849	0.0001	1.0000
π/4DQPSK	1.00	1.2589	2.00	1.5849	0.0001	1.0000
8-DPSK	1.00	1.2589	2.00	1.5849	0.0001	1.0000
GFSK (BT LE)	1.00	1.2589	2.00	1.5849	0.0001	1.0000

[2.4GHz WLAN]

Modulation Type	Max. Tune up Output power		Antenna Gain (dBi)	Antenna Gain (linear)	MPE (mW/cm^2)	MPE Limits (mW/cm^2)
	dBm	mW				
IEEE 802.11b	11.00	12.5893	2.00	1.5849	0.0010	1.0000
IEEE 802.11g	14.00	25.1189	2.00	1.5849	0.0020	1.0000
IEEE 802.11n HT20	14.00	25.1189	2.00	1.5849	0.0020	1.0000
IEEE 802.11n HT40	14.00	25.1189	2.00	1.5849	0.0020	1.0000

[WWAN]

Modulation Type	Max. Tune up Output power		Antenna Gain (dBi)	Antenna Gain (linear)	MPE (mW/cm^2)	MPE Limits (mW/cm^2)
	dBm	mW				
GSM 850 Band	33.00	1995.2623	5.00	3.1623	0.3138	0.5493
PCS 1900 Band	30.00	1000.0000	5.00	3.1623	0.1573	1.0000
WCDMA Band V	24.00	251.1886	5.00	3.1623	0.0395	0.5493
WCDMA Band II	24.00	251.1886	5.00	3.1623	0.0395	1.0000

Remark:
1.Output power including turn-up tolerance;
2.MPE evaluate distance is 40cm from user manual provide by manufacturer.
3.MPE limits for PCS 1900 and WCDMA Band II refer 1850MHz, GSM 850 and WCDMA Band V refer 824MHz as it is lowest frequency.

7.2 Simultaneous Transmission MPE

The WLAN and BT share same module and same antenna. They cannot transmit at the same time, no need consider simultaneous transmission.
The EUT equiped with one WLAN/BT module and one WWAN module. Each module has its own antenna and they can transmit at the same time. So need consider simultaneous transmission.
According to KDB447498 D01 General RF Exposure Guidance v06 for Transmitters used in mobile exposure conditions for simultaneous transmission operations;
∑ of MPE ratios ≤ 1.0

Simultaneous Transmission MPE			
Mode	∑ MPE ratios (mW/cm2)	Limit (mW/cm2)	Results
BT + GSM 850	0.3139	1.0000	Pass
BT + PCS 1900	0.1574	1.0000	Pass
2.4G WLAN + GSM 850	0.3158	1.0000	Pass
2.4G WLAN + PCS 1900	0.1593	1.0000	Pass
BT + WCDMA Band V	0.0396	1.0000	Pass
BT + WCDMA Band II	0.0396	1.0000	Pass
2.4G WLAN + WCDMA Band V	0.0415	1.0000	Pass
2.4G WLAN + WCDMA Band II	0.0415	1.0000	Pass

8. Conclusion

The measurement results comply with the FCC Limit per 47 CFR 2.1091 for the uncontrolled RF Exposure of mobile device.

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