

RF Exposure evaluation

1. Product Information

FCC ID	WR4-1081315-01
Product Name	AD-7 Display Terminal
Model/Type reference:	1081315-01
Power supply	Input: DC 9-36V, 1500mA
Applicant	Topcon Positioning Systems, Inc.
Address	7400 National Drive Livermore California United States
Exposure category	General population/uncontrolled environment
EUT Type	Production Unit
Device Type	Mobile Device
The test facility is recognized, certified, or accredited by the following organizations: FCC-Registration No.: 517856 Designation Number: CN1318 Shenzhen CTA Testing Technology Co., Ltd. has been listed on the US Federal Communications Commission list of test facilities recognized to perform electromagnetic emissions measurements. A2LA-Lab Cert. No.: 6534.01 Shenzhen CTA Testing Technology Co., Ltd. has been listed by American Association for Laboratory Accreditation to perform electromagnetic emission measurement. ISED#: 27890 CAB identifier: CN0127 Shenzhen CTA Testing Technology Co., Ltd. has been listed by Innovation, Science and Economic Development Canada to perform electromagnetic emission measurement. The 3m-Semi anechoic test site fulfils CISPR 16-1-4 according to ANSI C63.10 and CISPR 16-1-4:2010.	

2. Reference

According to §1.1307(b)(1), systems operating under the provisions of this 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.

According to §1.1310 and §2.1091 RF exposure is calculated.

KDB 447498 D01v06: Mobile and Portable Devices RF Exposure Procedures and Equipment Authorization Policies

3. 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

Device can only use antennas certificated as follows provided by manufacturer;

Antenna No.	Model No. of antenna:	Type of antenna:	Gain of the antenna (Max.)	Frequency range:
BT	/	PIFA antenna	3.81 dBi for 2400-2500MHz	
2.4GWIFI	/	PIFA antenna	3.81 dBi for 2400-2500MHz	
GSM	/	PIFA antenna	GSM850:-0.29dBi DCS1900: 0.89dBi	
WCDMA	/	PIFA antenna	FDD Band II:0.89dBi FDD Band IV:1.24dBi FDD Band V:-0.29dBi	
LTE	/	PIFA antenna	0.89dBi (max.) For E-UTRA Band 2 1.24dBi (max.) For E-UTRA Band 4 -0.29dBi (max.) For E-UTRA Band 5 2.63dBi (max.) For E-UTRA Band 7 -1.01dBi (max.) For E-UTRA Band 12 -0.45dBi (max.) For E-UTRA Band 13 -1.01dBi (max.) For E-UTRA Band 17 0.89dBi (max.) For E-UTRA Band 25 -1.7dBi (max.) For E-UTRA Band 26 -0.29dBi (max.) For E-UTRA Band 41 -1.67dBi (max.) For E-UTRA Band 66	

6. Conducted Power Results and Manufacturing Tolerance

[BT]

Mode	Channel	Frequency (MHz)	Max Peak Conducted Output Power (dBm)	ANT Max. Tune Up Power (dBm)
GFSK	0	2402	-0.96	0±1.0
	39	2441	-0.75	0±1.0
	78	2480	-1.72	-1.0±1.0
$\pi/4$ DQPSK	0	2402	0.91	0±1.0
	39	2441	1.21	1.0±1.0
	78	2480	0.07	0±1.0
8DPSK	0	2402	1.45	1.0±1.0
	19	2441	1.68	1.0±1.0
	39	2480	0.47	0±1.0

[2.4G WIFI]

Mode	Channel	Frequency (MHz)	Max Peak Conducted Output Power (dBm)	ANT Max. Tune Up Power (dBm)
IEEE 802.11b	1	2412	15.23	15.0±1.0
	6	2437	14.47	14.0±1.0
	11	2462	14.54	14.0±1.0
IEEE 802.11g	1	2412	14.46	14.0±1.0
	6	2437	14.99	14.0±1.0
	11	2462	15.04	15.0±1.0
IEEE 802.11n HT20	1	2412	13.93	13.0±1.0
	6	2437	13.05	13.0±1.0
	11	2462	13.33	13.0±1.0
IEEE 802.11n HT40	3	2422	13.54	13.0±1.0
	6	2437	13.43	13.0±1.0
	9	2452	14.28	14.0±1.0

[GSM Max Average Power]

Test Mode	Channel	Frequency (MHz)	Max Average Power (dBm)	ANT Max. Tune Up Power (dBm)
GSM 850	Low	824.2	30.66	30.0±1.0
	Middle	836.6	30.69	30.0±1.0
	High	848.8	30.70	30.0±1.0
GSM 1900	Low	1850.2	29.66	29.0±1.0
	Middle	1880.0	29.70	29.0±1.0
	High	1909.8	29.68	29.0±1.0

[WCDMA Max Average Power]

Test Mode	Channel	Frequency (MHz)	Max Average Power (dBm)	ANT Max. Tune Up Power (dBm)
WCDMA Band II	Low	1852.4	23.28	23.0±1.0
	Middle	1880	23.31	23.0±1.0
	High	1907.6	23.13	23.0±1.0
WCDMA Band IV	Low	1712.4	23.11	23.0±1.0
	Middle	1732.6	23.28	23.0±1.0
	High	1752.6	23.29	23.0±1.0
WCDMA Band V	Low	826.4	22.76	22.0±1.0
	Middle	836.4	22.82	22.0±1.0
	High	846.6	22.60	22.0±1.0

[LTE Max Average Power]

Test Mode		Channel	Max Average Power (dBm)	ANT Max. Tune Up Power (dBm)
LTE	Band 2	LCH	21.16	21.0±1.0
		MCH	21.55	21.0±1.0
		HCH	22.45	22.0±1.0
	Band 4	LCH	22.36	22.0±1.0
		MCH	22.36	22.0±1.0
		HCH	22.43	22.0±1.0
	Band 5	LCH	23.78	23.0±1.0
		MCH	23.80	23.0±1.0
		HCH	23.41	23.0±1.0
	Band 7	LCH	21.69	21.0±1.0
		MCH	22.04	22.0±1.0
		HCH	21.58	21.0±1.0
	Band 12	LCH	23.81	23.0±1.0
		MCH	23.52	23.0±1.0
		HCH	23.23	23.0±1.0
	Band 13	LCH	24.20	24.0±1.0
		MCH	23.91	23.0±1.0
		HCH	23.64	23.0±1.0
	Band 17	LCH	23.39	23.0±1.0
		MCH	23.26	23.0±1.0
		HCH	23.26	23.0±1.0
	Band 25	LCH	23.79	23.0±1.0
		MCH	22.16	22.0±1.0
		HCH	22.56	22.0±1.0
	Band 26	LCH	23.19	23.0±1.0
		MCH	23.36	23.0±1.0
		HCH	23.02	23.0±1.0
	Band 41	LCH	22.20	22.0±1.0
		MCH	22.36	22.0±1.0
		HCH	21.63	21.0±1.0
	Band 66	LCH	22.56	22.0±1.0
		MCH	22.57	22.0±1.0
		HCH	22.61	22.0±1.0

7. Standalone MPE Result

As declared by the Applicant, the EUT is a wireless device used in a fix application, at least 20 cm from any body part of the user or nearby persons; from the maximum EUT RF output power, the minimum separation distance, $r = 20\text{cm}$, as well as the gain of the used antenna is refer to section 4, the RF power density can be obtained.

[BT]

Modulation Type	Output power		Antenna Gain (dBi)	Antenna Gain (linear)	MPE (mW/cm ²)	MPE Limits (mW/cm ²)	MPE ratios
	dBm	mW					
GFSK	1.0	1.2589	3.81	2.4044	0.0006	1.0000	0.0006
$\pi/4$ -DQPSK	2.0	1.5849	3.81	2.4044	0.0008	1.0000	0.0008
8-DPSK	2.0	1.5849	3.81	2.4044	0.0008	1.0000	0.0008

[2.4G WIFI]

Modulation Type	Output power		Antenna Gain (dBi)	Antenna Gain (linear)	MPE (mW/cm ²)	MPE Limits (mW/cm ²)	MPE ratios
	dBm	mW					
IEEE 802.11b	16.0	39.8107	3.81	2.4044	0.0190	1.0000	0.0190
IEEE 802.11g	16.0	39.8107	3.81	2.4044	0.0190	1.0000	0.0190
IEEE 802.11n HT20	14.0	25.1189	3.81	2.4044	0.0120	1.0000	0.0120
IEEE 802.11n HT40	15.0	31.6228	3.81	2.4044	0.0151	1.0000	0.0151

[GSM/WCDMA/LTE]

Modulation Type	Output power		Antenna Gain (dBi)	Antenna Gain (linear)	MPE (mW/cm ²)	MPE Limits (mW/cm ²)	MPE ratios
	dBm	mW					
GSM 850	31.0	1258.9254	-0.29	0.9354	0.2343	0.5493	0.4265
GSM 1900	30.0	1000.0000	0.89	1.2274	0.2442	1.0000	0.2442
WCDMA Band II	24.0	251.1886	0.89	1.2274	0.0613	1.0000	0.0613
WCDMA Band IV	24.0	251.1886	1.24	1.3305	0.0665	0.5493	0.1211
WCDMA Band V	23.0	199.5262	-0.29	0.9354	0.0371	0.5493	0.0675
Band 2	23.0	199.5262	0.89	1.2274	0.0487	1.0000	0.0487
Band 4	23.0	199.5262	1.24	1.3305	0.0528	1.0000	0.0528
Band 5	24.0	251.1886	-0.29	0.9354	0.0467	0.5493	0.0850
Band 7	23.0	199.5262	2.63	1.8323	0.0727	1.0000	0.0727
Band 12	24.0	251.1886	-1.01	0.7925	0.0396	0.4660	0.0850
Band 13	25.0	316.2278	-0.45	0.9016	0.0567	0.4973	0.1140
Band 17	24.0	251.1886	-1.01	0.7925	0.0396	0.4693	0.0844

Band 25	24.0	251.1886	0.89	1.2274	0.0613	0.5427	0.1130
Band 26	24.0	251.1886	-1.7	0.6761	0.0338	0.5493	0.0615
Band 41	23.0	199.5262	-0.29	0.9354	0.0371	1.0000	0.0371
Band 66	23.0	199.5262	-1.67	0.6808	0.0270	1.0000	0.0270

Remark:

1. Output power (Peak) including turn-up tolerance;
2. MPE evaluate distance is 20cm from user manual provide by manufacturer.

6.1 Simultaneous Transmission MPE Evaluation

The sample support one BT/2.4GWIFI antenna and another one GSM&WCDMA<E transmit antenna, so need consider simultaneous transmission;

According to KDB447498 for Transmitters used in mobile exposure conditions for simultaneous transmission operations;

$$TER = \sum_{k=1}^{N_s} \left(\frac{SAR_k}{SAR_{lim}} \right) + \sum_{k=1}^{N_f} \left(\frac{MPE_{field, k}}{MPE_{field, lim}} \right)^2 + \sum_{k=1}^{N_{PD}} \left(\frac{MPE_{PD, k}}{MPE_{PD, lim}} \right)$$

$\sum \sum$ of MPE ratios ≤ 1.0

WIFI Antenna Max MPE ratios	GSM Antenna Max MPE ratios	$\sum$ MPE ratios	Limit	Results
0.0190	0.4265	0.4455	1.0	Pass

8. Conclusion

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

-----THE END OF REPORT-----