



Maximum Permissible Exposure Report

1. Product Information

FCC ID	2ACHBN6
Name of EUT	GNSS Receiver
Test Model	N6
Modulation Type	GMSK for GSM/GPRS; 8-PSK for EDGE; QPSK for UMTS; QPSK, 16QAM for LTE
Antenna Gain	2.29dBi (max.) For GSM 850; 1.59dBi (max.) For PCS 1900; 1.59dBi for WCDMA Band II; 2.29dBi for WCDMA Band V; 1.59dBi for LTE Band 2; 2.0dBi for LTE Band 4; 2.29dBi for LTE Band 5; 1.59dBi for LTE Band 25; 2.53dBi for LTE Band 26; 3.0dBi for LTE Band 41; 1.0dBi (max.) For BT and WLAN
Hardware version	V2.1
Software version	V1.3.7
GSM/EDGE/GPRS Operation Frequency Band	GPRS850/GPRS1900/EDGE850/EDGE1900
UMTS Operation Frequency Band	UMTS FDD Band II/ V
LTE Operation Frequency Band	LTE FDD band 2, 4, 5, 25, 26, 41
GSM/EDGE/GPRS	Supported GPRS/EDGE
GSM Release Version	R11
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	R11
HSDPA Release Version	Release 8
HSUPA Release Version	Release 7
DC-HSUPA Release Version	Not Supported
LTE Release Version	R11
LTE/UMTS Power Class	Class 3
WLAN FCC Modulation Type	IEEE 802.11b: DSSS(CCK,DQPSK,DBPSK) IEEE 802.11g: OFDM(64QAM, 16QAM, QPSK, BPSK) IEEE 802.11n HT20: OFDM (64QAM, 16QAM, QPSK,BPSK) IEEE 802.11n HT40: OFDM (64QAM, 16QAM, QPSK,BPSK)
WLAN FCC Operation frequency	IEEE 802.11b:2412-2462MHz IEEE 802.11g:2412-2462MHz IEEE 802.11n HT20:2412-2462MHz IEEE 802.11n HT40:2422-2452MHz
Antenna Type	PIFA Antenna For 2G, 3G, 4G PIFA Antenna For BT, WLAN
BT Modulation Type	GFSK, $\pi/4$ -DQPSK, 8-DPSK (BT V4.2)
Operating Frequency	PMR, 410 ~ 470MHz
Channel Separation	12.5KHz & 25KHz
Modulation Type	GMSK
Antenna Type	SMA Antenna, 5.0dBi (max.) for PMR
Extreme temp. Tolerance	-30°C to +50°C
GPS function	Support and only RX
FM function	Not Supported
NFC Function	Not Supported
Extreme vol. Limits	6.12VDC to 8.28VDC (nominal: 7.2VDC)
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 KDB447498D01 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

ES-D4 can only use antennas certificated as follows provided by manufacturer;

Internal Identification	Antenna type and antenna number	Operate frequency band	Maximum antenna gain	Notes
Antenna 0	PIFA Antenna	2000 MHz – 2500 MHz	1 dBi	BT/ WLAN Antenna
Antenna 1	PIFA Antenna	600 MHz – 3000 MHz	2.29dBi (max.) For GSM 850; 1.59dBi (max.) For PCS 1900; 1.59dBi for WCDMA Band II; 2.29dBi for WCDMA Band V; 1.59dBi for LTE Band 2; 2.0dBi for LTE Band 4; 2.29dBi for LTE Band 5; 1.59dBi for LTE Band 25; 2.53dBi for LTE Band 26; 3.0dBi for LTE Band 41;	GSM/WCDMA/LTE Antenna
Antenna 2	SMA Antenna	400 MHz – 500 MHz	5.0dBi (max.) for PMR	PMR Antenna

6. Conducted Power

[BT Max Conducted Power]

Mode	Channel	Frequency(MHz)	Max Conducted Power (dBm)
GFSK	0	2402	1.47
	39	2441	2.74
	78	2480	1.22
$\pi/4$ DQPSK	0	2402	0.59
	39	2441	1.85
	78	2480	0.35
8DPSK	0	2402	0.71
	39	2441	2.00
	78	2480	0.57

<BT LE>

Mode	Channel	Frequency (MHz)	Peak Conducted Output Power (dBm)
GFSK	0	2402	1.11
	19	2440	2.38
	39	2480	0.92

[2.4GWLAN Max Conducted Power]

Mode	Channel	Frequency(MHz)	Max Conducted Power (dBm)
IEEE 802.11b	1	2412	14.24
	6	2437	15.43
	11	2462	14.87
IEEE 802.11g	1	2412	15.13



IEEE 802.11n HT20	6	2437	13.88
	11	2462	14.60
	1	2412	13.30
	6	2437	13.29
	11	2462	13.54
IEEE 802.11n HT40	3	2422	14.06
	6	2437	13.46
	9	2452	12.79

[GSM Max Average Power]

Test Mode	Channel	Frequency (MHz)	Max Average Power (dBm)
GSM 850	Low	824.2	32.37
	Middle	836.6	32.41
	High	848.8	32.37
GSM 1900	Low	1850.2	29.42
	Middle	1880.0	29.43
	High	1909.8	29.47

[WCDMA Max Average Power]

Test Mode	Channel	Frequency (MHz)	Max Average Power (dBm)
WCDMA Band II	Low	1852.4	23.18
	Middle	1880	23.35
	High	1907.6	23.35
WCDMA Band V	Low	826.4	23.03
	Middle	836.4	23.30
	High	846.6	23.30

[LTE Max Average Power]

Test Mode		Channel	Max Average Power (dBm)
LTE	Band 2	LCH	23.03
		MCH	22.94
		HCH	23.31
	Band 4	LCH	23.41
		MCH	23.31
		HCH	23.50
	Band 5	LCH	24.08
		MCH	24.37
		HCH	24.14
	Band 25	LCH	23.76
		MCH	23.93
		HCH	24.35
	Band 26	LCH	23.15
		MCH	23.18
		HCH	23.61
	Band 41	LCH	22.99
		MCH	23.05
		HCH	23.27



7. Manufacturing Tolerance

[BT Max Conducted Power]

Test Mode	Channel	Max Conducted Power (dBm)	ANT Max. Tune Up Power (dBm)
GFSK	LCH	1.47	2.0±1.0
	MCH	2.74	2.0±1.0
	HCH	1.22	2.0±1.0
$\pi/4$ DQPSK	LCH	0.59	1.0±1.0
	MCH	1.85	1.0±1.0
	HCH	0.35	1.0±1.0
8DPSK	LCH	0.71	1.0±1.0
	MCH	2.00	1.0±1.0
	HCH	0.57	1.0±1.0

<BT LE Max Conducted Power >

Mode	Channel	Peak Conducted Output Power (dBm)	ANT Max. Tune Up Power (dBm)
GFSK	LCH	1.11	1.5±1.0
	MCH	2.38	1.5±1.0
	HCH	0.92	1.5±1.0

[2.4GWLAN Max Conducted Power]

Test Mode	Channel	Max Conducted Power (dBm)	ANT Max. Tune Up Power (dBm)
IEEE 802.11b	LCH	14.24	15.0±1.0
	MCH	15.43	15.0±1.0
	HCH	14.87	15.0±1.0
IEEE 802.11g	LCH	15.13	14.5±1.0
	MCH	13.88	14.5±1.0
	HCH	14.60	14.5±1.0
IEEE 802.11n HT20	LCH	13.30	13.0±1.0
	MCH	13.29	13.0±1.0
	HCH	13.54	13.0±1.0
IEEE 802.11n HT40	LCH	14.06	13.5±1.0
	MCH	13.46	13.5±1.0
	HCH	12.79	13.5±1.0

[GSM Max Average Power]

Test Mode	Channel	Max Average Power (dBm)	ANT Max. Tune Up Power (dBm)
GSM 850	LCH	32.37	32.0±1.0
	MCH	32.41	32.0±1.0
	HCH	32.37	32.0±1.0
GSM 1900	LCH	29.42	29.0±1.0
	MCH	29.43	29.0±1.0
	HCH	29.47	29.0±1.0



[WCDMA Max Average Power]

Test Mode		Channel	Max Average Power (dBm)	ANT Max. Tune Up Power (dBm)
WCDMA	Band II	LCH	23.18	23.0±1.0
		MCH	23.35	23.0±1.0
		HCH	23.35	23.0±1.0
	Band V	LCH	23.03	23.0±1.0
		MCH	23.30	23.0±1.0
		HCH	23.30	23.0±1.0

<LTE Max Average Power>

Test Mode		Channel	Max Average Power (dBm)	ANT Max. Tune Up Power (dBm)
LTE	Band 2	LCH	23.03	23.0±1.0
		MCH	22.94	23.0±1.0
		HCH	23.31	23.0±1.0
	Band 4	LCH	23.41	23.0±1.0
		MCH	23.31	23.0±1.0
		HCH	23.5	23.0±1.0
	Band 5	LCH	24.08	24.0±1.0
		MCH	24.37	24.0±1.0
		HCH	24.14	24.0±1.0
	Band 25	LCH	23.76	23.5±1.0
		MCH	23.93	23.5±1.0
		HCH	24.35	23.5±1.0
	Band 26	LCH	23.15	23.0±1.0
		MCH	23.18	23.0±1.0
		HCH	23.61	23.0±1.0
	Band 41	LCH	22.99	23.0±1.0
		MCH	23.05	23.0±1.0
		HCH	23.27	23.0±1.0

<PMR>

Test Mode		Frequency(MHz)	Max Conducted Peak Power (dBm)	Tune Up Power (dBm)
GMSK	12.5KHz	410.125	32.08	33.0±1.0
		453.125	32.35	33.0±1.0
		469.625	31.67	32.0±1.0
		410.125	29.76	30.0±1.0
		453.125	30.41	30.0±1.0
		469.625	30.06	30.0±1.0
	25KHz	410.125	32.21	33.0±1.0
		453.125	32.48	33.0±1.0
		469.625	31.87	32.0±1.0
		410.125	29.87	30.0±1.0
		453.125	30.57	30.0±1.0
		469.625	30.21	30.0±1.0



8. Measurement Results

8.1 Standalone MPE Evaluation

As declared by the Applicant, the EUT is a wireless device used in a fix application, at least 50 cm from any body part of the user or nearby persons; from the maximum EUT RF output power, the minimum separation distance, $r=50\text{cm}$, as well as the gain of the used antenna refer to antenna information, the RF power density can be obtained.

[Antenna 0]

Modulation Type	Output power		Antenna Gain (dBi)	Antenna Gain (linear)	MPE (mW/cm ²)	MPE Limits (mW/cm ²)
	dBm	mW				
GFSK	3.00	1.9953	1.0	1.2589	0.0001	1.0000
$\pi/4$ DQPSK	2.00	1.5849	1.0	1.2589	0.0001	1.0000
8DPSK	2.00	1.5849	1.0	1.2589	0.0001	1.0000
GFSK	2.50	1.7783	1.0	1.2589	0.0001	1.0000
IEEE 802.11b	16.00	39.8107	1.0	1.2589	0.0016	1.0000
IEEE 802.11g	16.00	39.8107	1.0	1.2589	0.0016	1.0000
IEEE 802.11n HT20	14.00	25.1189	1.0	1.2589	0.0010	1.0000
IEEE 802.11n HT40	14.00	25.1189	1.0	1.2589	0.0010	1.0000

[Antenna 1]

Modulation Type	Output power		Antenna Gain (dBi)	Antenna Gain (linear)	MPE (mW/cm ²)	MPE Limits (mW/cm ²)
	dBm	mW				
GSM 850	33.00	1995.2623	2.29	1.6943	0.1076	1.0000
GSM 1900	30.00	1000.0000	1.59	1.4421	0.0459	1.0000
WCDMA Band II	24.00	251.1886	1.59	1.4421	0.0115	0.5493
WCDMA Band V	24.00	251.1886	2.29	1.6943	0.0135	0.4660
LTE Band 2	24.00	251.1886	1.59	1.4421	0.0115	1.0000
LTE Band 4	24.00	251.1886	2.00	1.5849	0.0127	1.0000
LTE Band 5	25.00	316.2278	2.29	1.6943	0.0171	0.5667
LTE Band 25	25.00	316.2278	1.59	1.4421	0.0145	1.0000
LTE Band 26	24.00	251.1886	2.53	1.7906	0.0143	0.5427
LTE Band 41	24.00	251.1886	3.00	1.9953	0.0160	1.0000

[Antenna 2]

Modulation Type	Output power		Antenna Gain (dBi)	Antenna Gain (linear)	MPE (mW/cm ²)	MPE Limits (mW/cm ²)
	dBm	mW				
GMSK 410 ~ 470MHz	34.00	2511.8864	5.0	3.1623	0.2528	0.2733

Remark:

1. Output power including turn-up tolerance;
2. Output power is burst average power;
3. MPE evaluate distance is 20cm from user manual provide by manufacturer;
4. $MPE\ values = PG/4\pi R^2$



8.2 Simultaneous Transmission MPE

The sample support one BT&BLE&2.4GWLAN, another one LTE&WCDMA&GSM and another one PMR transmit antenna, so need consider simultaneous transmission;

PMR cannot work with LTE&WCDMA&GSM at the same time

Simultaneous transmission MPE

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

$\sum$ of MPE ratios ≤ 1.0

BT+GSM			
Mode	$\sum$ MPE ratios	Limit	Results
GFSK+GSM850	0.1077	1.000	Pass
GFSK+GSM1900	0.0460	1.000	Pass
$\pi/4$ DQPSK+GSM850	0.1077	1.000	Pass
$\pi/4$ DQPSK+GSM1900	0.0460	1.000	Pass
8DPSK+GSM850	0.1077	1.000	Pass
8DPSK+GSM1900	0.0460	1.000	Pass

BT+WCDMA			
Mode	$\sum$ MPE ratios	Limit	Results
GFSK+ WCDMA Band II	0.0210	1.000	Pass
GFSK+ WCDMA Band IV	0.0291	1.000	Pass
$\pi/4$ DQPSK+ WCDMA Band II	0.0210	1.000	Pass
$\pi/4$ DQPSK+ WCDMA Band IV	0.0291	1.000	Pass
8DPSK+ WCDMA Band II	0.0210	1.000	Pass
8DPSK+ WCDMA Band IV	0.0291	1.000	Pass

BT+LTE			
Mode	$\sum$ MPE ratios	Limit	Results
GFSK+ LTE Band 2	0.0116	1.000	Pass
GFSK+ LTE Band 4	0.0128	1.000	Pass
GFSK+ LTE Band 5	0.0303	1.000	Pass
GFSK+ LTE Band 25	0.0146	1.000	Pass
GFSK+ LTE Band 26	0.0264	1.000	Pass
GFSK+ LTE Band 41	0.0161	1.000	Pass
$\pi/4$ DQPSK+ LTE Band 2	0.0116	1.000	Pass
$\pi/4$ DQPSK+ LTE Band 4	0.0128	1.000	Pass
$\pi/4$ DQPSK+ LTE Band 5	0.0303	1.000	Pass
$\pi/4$ DQPSK+ LTE Band 25	0.0146	1.000	Pass
$\pi/4$ DQPSK+ LTE Band 26	0.0264	1.000	Pass
$\pi/4$ DQPSK+ LTE Band 41	0.0161	1.000	Pass
8DPSK+ LTE Band 2	0.0116	1.000	Pass
8DPSK+ LTE Band 4	0.0128	1.000	Pass
8DPSK+ LTE Band 5	0.0303	1.000	Pass
8DPSK+ LTE Band 25	0.0146	1.000	Pass
8DPSK+ LTE Band 26	0.0264	1.000	Pass
8DPSK+ LTE Band 41	0.0161	1.000	Pass

BLE+GSM			
Mode	$\sum$ MPE ratios	Limit	Results
GFSK+GSM850	0.1077	1.000	Pass
GFSK+GSM1900	0.0460	1.000	Pass

BLE+WCDMA			
Mode	$\sum$ MPE ratios	Limit	Results
GFSK+ WCDMA Band II	0.0210	1.000	Pass
GFSK+ WCDMA Band IV	0.0291	1.000	Pass



BLE+LTE			
Mode	$\sum$ MPE ratios	Limit	Results
GFSK+ LTE Band 2	0.0116	1.000	Pass
GFSK+ LTE Band 4	0.0128	1.000	Pass
GFSK+ LTE Band 5	0.0303	1.000	Pass
GFSK+ LTE Band 25	0.0146	1.000	Pass
GFSK+ LTE Band 26	0.0264	1.000	Pass
GFSK+ LTE Band 41	0.0161	1.000	Pass

2.4G WLAN+GSM			
Mode	$\sum$ MPE ratios	Limit	Results
IEEE 802.11b +GSM850	0.1092	1.000	Pass
IEEE 802.11b +GSM1900	0.0475	1.000	Pass
IEEE 802.11g +GSM850	0.1092	1.000	Pass
IEEE 802.11g +GSM1900	0.0475	1.000	Pass
IEEE 802.11n20+GSM850	0.1086	1.000	Pass
IEEE 802.11n20+GSM1900	0.0469	1.000	Pass
IEEE 802.11n40+GSM850	0.1086	1.000	Pass
IEEE 802.11n40+GSM1900	0.0469	1.000	Pass

2.4G WLAN+WCDMA			
Mode	$\sum$ MPE ratios	Limit	Results
IEEE 802.11b + WCDMA Band II	0.0225	1.000	Pass
IEEE 802.11b + WCDMA Band V	0.0306	1.000	Pass
IEEE 802.11g + WCDMA Band II	0.0225	1.000	Pass
IEEE 802.11g + WCDMA Band V	0.0306	1.000	Pass
IEEE 802.11n20 + WCDMA Band II	0.0219	1.000	Pass
IEEE 802.11n20 + WCDMA Band V	0.0300	1.000	Pass
IEEE 802.11n40 + WCDMA Band II	0.0219	1.000	Pass
IEEE 802.11n40 + WCDMA Band V	0.0300	1.000	Pass

2.4G WLAN+LTE			
Mode	$\sum$ MPE ratios	Limit	Results
IEEE 802.11b + LTE Band 2	0.0131	1.000	Pass
IEEE 802.11b + LTE Band 4	0.0143	1.000	Pass
IEEE 802.11b + LTE Band 5	0.0318	1.000	Pass
IEEE 802.11b + LTE Band 25	0.0161	1.000	Pass
IEEE 802.11b + LTE Band 26	0.0279	1.000	Pass
IEEE 802.11b + LTE Band 41	0.0176	1.000	Pass
IEEE 802.11g + LTE Band 2	0.0131	1.000	Pass
IEEE 802.11g + LTE Band 4	0.0143	1.000	Pass
IEEE 802.11g + LTE Band 5	0.0318	1.000	Pass
IEEE 802.11g + LTE Band 25	0.0161	1.000	Pass
IEEE 802.11g + LTE Band 26	0.0279	1.000	Pass
IEEE 802.11g + LTE Band 41	0.0176	1.000	Pass
IEEE 802.11n20 + LTE Band 2	0.0125	1.000	Pass
IEEE 802.11n20 + LTE Band 4	0.0137	1.000	Pass
IEEE 802.11n20 + LTE Band 5	0.0312	1.000	Pass
IEEE 802.11n20 + LTE Band 25	0.0155	1.000	Pass
IEEE 802.11n20 + LTE Band 26	0.0273	1.000	Pass
IEEE 802.11n20 + LTE Band 41	0.0170	1.000	Pass
IEEE 802.11n40 + LTE Band 2	0.0125	1.000	Pass
IEEE 802.11n40 + LTE Band 4	0.0137	1.000	Pass
IEEE 802.11n40 + LTE Band 5	0.0312	1.000	Pass
IEEE 802.11n40 + LTE Band 25	0.0155	1.000	Pass
IEEE 802.11n40 + LTE Band 26	0.0273	1.000	Pass
IEEE 802.11n40 + LTE Band 41	0.0170	1.000	Pass



BT+PMR			
Mode	$\sum$ MPE ratios	Limit	Results
GFSK+PMR	0.9250909	1.000	Pass
$\pi/4$ DQPSK+PMR	0.9250909	1.000	Pass
8DPSK+PMR	0.9250909	1.000	Pass

BLE+PMR			
Mode	$\sum$ MPE ratios	Limit	Results
GFSK+ PMR	0.9250909	1.000	Pass

2.4G WLAN+PMR			
Mode	$\sum$ MPE ratios	Limit	Results
IEEE 802.11b + PMR	0.9265909	1.000	Pass
IEEE 802.11g + PMR	0.9265909	1.000	Pass
IEEE 802.11n20 + PMR	0.9259909	1.000	Pass
IEEE 802.11n40 + PMR	0.9259909	1.000	Pass

9. 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-----