1. MAXIMUM PERMISSIBLE EXPOSURE (MPE)

1.1 Standard Applicable

According to §1.1307(b)(1), system operating under the provisions of this section shall be operating in a manner that the public is not exposed to radio frequency energy level in excess limit for maximum permissible exposure.

(a) Limits for Occupational / Controlled Exposure

Frequency range (MHz)	Electric Field Strength (E) (V/m)	Magnetic Field Strength (H) (A/m)	Power Density (S) (mW/cm^2)	Averaging Times $\mid E \mid^2$, $\mid H \mid^2$ or S (minutes)
0.3-3.0	614	1.63	(100)*	6
3.0-30	1842/f	4.89/f	(900/f)*	6
30-300	61.4	0.163	1.0	6
300-1500	/	/	F/300	6
1500-100000	/	/	5	6

(b) Limits for General Population / Uncontrolled Exposure

Frequency range (MHz)	Electric Field Strength (E) (V/m)	Magnetic Field Strength (H) (A/m)	Power Density (S) (mW/cm^2)	Averaging Times $\mid E \mid^2$, $\mid H \mid^2$ or S (minutes)
0.3-1.34	614	1.63	(100)*	30
1.34-30	824/f	2.19/f	(180/f)*	30
30-300	27.5	0.073	0.2	30
300-1500	/	/	F/1500	30
1500-100000	/	/	1	30

Note: f = frequency in MHz: * = Plane-wave equivalents power density

1.2 MPE Calculation Method

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

S = power density (in appropriate units, e.g., mw/cm^2)

P = power input to the antenna (in appropriate units, e.g., mw)

G = power gain of the antenna in the direction of interest relative to an isotropic radiator, the power gain factor is normally numeric gain.

R = distance to the center of radiation of the antenna (in appropriate units, e.g., cm)

1.3 MPE Calculation Result
1.3.1 Result for operational ISM Band

For WiFi function, operating at 2412-2462MHz for 802.11b/g/n-HT20, 11 channels with 5MHz channel spacing and 2422-2452MHz for 802.11n-HT40, 9 channels with 5MHz channel spacing.

Modulation Type: BPSK, QPSK, 16QAM, 64QAM for OFDM. CCK, DQPSK, DBPSK for DSSS.

Antenna Type: sucker antenna

Antenna Gain: 2.0dBi

The nominal conducted averaged output power specified: 18 dBm (Tolerance: +/-1dB)

The maximum conducted averaged output power for the EUT is 17.77 dBm in the frequency 2.437GHz 802.11b mode which is within the production variation.

In STBC, Chain 1+ Chain 2 Directional gain = G_{ANT} + 10 log(N) dBi = 2 + 10 log(2) = 5dBi

The maximum EIRP= 18 + 1 + 5 = 24 dBm = 251.1886mW

The worst case is power density at prediction frequency at 20cm: **0.05 (mw/cm^2)**

MPE limit for general population exposure at prediction frequency: 1 (mw/cm^2)

0.05 (mw/cm^2) < 1 (mw/cm^2)

Result: Pass

1.3.2 Result for lower operational Band: LTE Band 5 and LTE Band 17, GSM850 and WCDMA Band 5

Operating Mode	Frequency on channel	Declared maximum conducted output power	Max. positive tolerance according manufacturer	Antenna Gain	Calculated maximum EIRP (declared + Tune-up + antenna Gain)	Duty cycle	Declared maximum EIRP	Equivalent EIRP (maximum EIRP x duty cycle)	MPE Limit	MPE-Value	Margin to limit:
	(MHz)	(dBm)	(dBm)	(dBm)	(dBm)	(%)	(W)	(mW)	(mw/cm^2)	(mw/cm^2)	(mw/cm^2)
GSM/GPRS (Peak)	824.2	33	0.5	2.15	35.65		3.673	1836	0.5495	0.3653	0.1842
	837	33	0.5	2.15	35.65	50	3.673	1836	0.5580	0.3653	0.1927
	848.8	33	0.5	2.15	35.65		3.673	1836	0.5659	0.3653	0.2006
GSM/GPRS (Avg.Burst Power)	824.2	33	0.5	2.15	35.65		3.673	1836	0.5495	0.3653	0.1842
	837	33	0.5	2.15	35.65	50	3.673	1836	0.5580	0.3653	0.1927
	848.8	33	0.5	2.15	35.65		3.673	1836	0.5659	0.3653	0.2006
EDGE (Peak)	824.2	27	0.5	2.15	29.65		0.923	461	0.5495	0.0918	0.4577
	837	27	0.5	2.15	29.65	50	0.923	461	0.5580	0.0918	0.4662
	848.8	27	0.5	2.15	29.65		0.923	461	0.5659	0.0918	0.4741
EDGE	824.2	27	0.5	2.15	29.65	50	0.923	461	0.5495	0.0918	0.4577

(Avg.Burst Power)	837	27	0.5	2.15	29.65		0.923	461	0.5580	0.0918	0.4662
	848.8	27	0.5	2.15	29.65		0.923	461	0.5659	0.0918	0.4741
WCDMA FDD Band 5 (RMS-Value)	826.4	24	0.5	2.15	26.65	100	0.462	462	0.5509	0.0920	0.4589
	836.4	24	0.5	2.15	26.65		0.462	462	0.5576	0.0920	0.4656
	846.6	24	0.5	2.15	26.65		0.462	462	0.5644	0.0920	0.4724
LTE Band 17 (QPSK,#RB=1,RMS-Value)	706.5	23	0.5	2.15	25.65	100	0.367	367	0.4710	0.0731	0.3979
	710	23	0.5	2.15	25.65		0.367	367	0.4733	0.0731	0.4002
	713.5	23	0.5	2.15	25.65		0.367	367	0.4757	0.0731	0.4026
LTE Band 17 (16QAM,#RB=1,RMS-Value)	706.5	22	0.5	2.15	24.65	100	0.292	292	0.4710	0.0580	0.4130
	710	22	0.5	2.15	24.65		0.292	292	0.4733	0.0580	0.4153
	713.5	22	0.5	2.15	24.65		0.292	292	0.4757	0.0580	0.4177
LTE Band 5 (QPSK,#RB=1,RMS-Value)	824.7	23	0.5	2.15	25.65	100	0.367	367	0.5498	0.0731	0.4767
	836.5	23	0.5	2.15	25.65		0.367	367	0.5577	0.0731	0.4846
	836.5	23	0.5	2.15	25.65		0.367	367	0.5655	0.0731	0.4924
LTE Band 5 (16QAM,#RB=1,RMS-Value)	824.7	22	0.5	2.15	24.65	100	0.292	292	0.5498	0.0580	0.4918
	836.5	22	0.5	2.15	24.65		0.292	292	0.5577	0.0580	0.4997
	836.5	22	0.5	2.15	24.65		0.292	292	0.5655	0.0580	0.5075
LTE Band 13 (QPSK,#RB=1,RMS-Value)	779.5	23	0.5	2.15	25.65	100	0.367	367	0.5197	0.0731	0.4466
	782	23	0.5	2.15	25.65		0.367	367	0.5213	0.0731	0.4482
	784.5	23	0.5	2.15	25.65		0.367	367	0.5230	0.0731	0.4499
LTE Band 13 (16QAM,#RB=1,RMS-Value)	779.5	22	0.5	2.15	24.65	100	0.292	292	0.5197	0.0580	0.4617
	782	22	0.5	2.15	24.65		0.292	292	0.5213	0.0580	0.4633
	784.5	22	0.5	2.15	24.65		0.292	292	0.5230	0.0580	0.4650

Result: Pass

1.3.3 Result for upper operational Band: LTE Band 4 and WCDMA Band 4

Operating Mode	Frequency on channel	Declared maximum conducted output power	Max. positive tolerance according manufacturer	Antenna Gain	Calculated maximum EIRP (declared + Tune-up + antenna Gain)	Duty cycle	Declared maximum EIRP	Equivalent EIRP (maximum EIRP x duty cycle)	MPE Limit	MPE-Value	Margin to limit:
	(MHz)	(dBm)	(dBm)	(dBm)	(dBm)	(%)	(W)	(mW)	(mw/cm^2)	(mw/cm^2)	(mw/cm^2)
WCDMA FDD Band 4 (RMS-Value)	1712.4	24	0.5	2.15	26.65	100	0.462	462	1.0000	0.0920	0.9080
	1740.0	24	0.5	2.15	26.65		0.462	462	1.0000	0.0920	0.9080
	1752.6	24	0.5	2.15	26.65		0.462	462	1.0000	0.0920	0.9080
LTE Band 4 (QPSK,#RB=1,RMS-Value)	1710.7	23	0.5	2.15	25.65	100	0.367	367	1.0000	0.0731	0.9269
	1732.5	23	0.5	2.15	25.65		0.367	367	1.0000	0.0731	0.9269
	1754.3	23	0.5	2.15	25.65		0.367	367	1.0000	0.0731	0.9269
LTE Band 4 (16QAM,#RB=1,RMS- Value)	1710.7	22	0.5	2.15	24.65	100	0.292	292	1.0000	0.0580	0.9420
	1732.5	22	0.5	2.15	24.65		0.292	292	1.0000	0.0580	0.9420
	1754.3	22	0.5	2.15	24.65		0.292	292	1.0000	0.0580	0.9420

Result: Pass

1.3.4 Result for upper operational Band: GSM 1900 LTE Band 2 and WCDMA Band 2

Operating Mode	Frequency on channel	Declared maximum conducted output power	Max. positive tolerance according manufacturer	Antenna Gain	Calculated maximum EIRP (declared + Tune-up + antenna Gain)	Duty cycle	Declared maximum EIRP	Equivalent EIRP (maximum EIRP x duty cycle)	MPE Limit	MPE-Value	Margin to limit:
	(MHz)	(dBm)	(dBm)	(dBm)	(dBm)	(%)	(W)	(mW)	(mw/cm²)	(mw/cm²)	(mw/cm²)
GSM/GPRS (Peak)	824.2	33	0.5	2.15	32.65	50	1.841	920	1.0	0.1831	0.8169
	837	33	0.5	2.15	32.65		1.841	920	1.0	0.1831	0.8169
	848.8	33	0.5	2.15	32.65		1.841	920	1.0	0.1831	0.8169
GSM/GPRS (Avg.Burst Power)	824.2	33	0.5	2.15	32.65	50	1.841	920	1.0	0.1831	0.8169
	837	33	0.5	2.15	32.65		1.841	920	1.0	0.1831	0.8169
	848.8	33	0.5	2.15	32.65		1.841	920	1.0	0.1831	0.8169
EDGE (Peak)	824.2	27	0.5	2.15	28.65	50	0.733	366	1.0	0.0729	0.9271
	837	27	0.5	2.15	28.65		0.733	366	1.0	0.0729	0.9271
	848.8	27	0.5	2.15	28.65		0.733	366	1.0	0.0729	0.9271
EDGE (Avg.Burst Power)	824.2	27	0.5	2.15	28.65	50	0.733	366	1.0	0.0729	0.9271
	837	27	0.5	2.15	28.65		0.733	366	1.0	0.0729	0.9271
	848.8	27	0.5	2.15	28.65		0.733	366	1.0	0.0729	0.9271
WCDMA FDD Band 4 (RMS-Value)	1712.4	24	0.5	2.15	26.65	100	0.462	462	1.0	0.0920	0.9080
	1740.0	24	0.5	2.15	26.65		0.462	462	1.0	0.0920	0.9080
	1752.6	24	0.5	2.15	26.65		0.462	462	1.0	0.0920	0.9080
LTE Band 4 (QPSK,#RB=1,RMS-Value)	1710.7	23	0.5	2.15	25.65	100	0.367	367	1.0	0.0731	0.9269
	1732.5	23	0.5	2.15	25.65		0.367	367	1.0	0.0731	0.9269
	1754.3	23	0.5	2.15	25.65		0.367	367	1.0	0.0731	0.9269
LTE Band 4 (16QAM,#RB=1,RMS- Value)	1710.7	22	0.5	2.15	24.65	100	0.292	292	1.0	0.0580	0.9420
	1732.5	22	0.5	2.15	24.65		0.292	292	1.0	0.0580	0.9420
	1754.3	22	0.5	2.15	24.65		0.292	292	1.0	0.0580	0.9420

Result: Pass

1.3.5 Simultaneous Multi-band Transmission MPE Analysis

List of Mode for Simultaneous Multi-band Transmission

No.	Configurations	Hotspot SAR
1	**GSM + WLAN**	Yes
2	**WCDMA + WLAN**	Yes
3	**LTE + WLAN**	Yes

Remark: GSM and WCDMA and LTE share the same antenna, and cannot transmit simultaneously.

No.	Configurations	Maximum MPE- Value (mw/cm^2)			WWAN Limit (mw/cm^2)	Margin to limit (mw/cm^2)
		WWAN	**WLAN**	**Transmit Simultaneously**		
1	GPRS/EDGE 850	0.3653	0.05	0.4153	0.5495	0.1342
2	WCDMA FDD Band 5	0.0920	0.05	0.1420	0.5509	0.4089
3	LTE Band 17	0.0731	0.05	0.1231	0.4710	0.3479
4	LTE Band 5	0.0731	0.05	0.1231	0.5498	0.4267
5	LTE Band 13	0.0731	0.05	0.1231	0.5197	0.3966
6	WCDMA FDD Band 4	0.0920	0.05	0.1420	1.0	0.8580
7	LTE Band 4	0.0731	0.05	0.1231	1.0	0.8769
8	GPRS/EDGE 1900	0.1831	0.05	0.2331	1.0	0.7669
9	WCDMA FDD Band 2	0.0920	0.05	0.1420	1.0	0.8580
10	LTE Band 2	0.0731	0.05	0.1231	1.0	0.8769

Result: Pass