

* RF Exposure

FCC ID: TKWBS3-APWB

1. Regulation

This document is prepared to show compliance with the RF Exposure requirements as required in §1.1310 of the FCC rules and Regulations.

The limit for Maximum Permissible Exposure (MPE), specified in FCC §1.1310, is listed in Table 1- According to FCC §1.1310: the criteria listed in the following table shall be used to evaluate the environmental impact of human exposure to radio-frequency (RF) radiation as specified in §1.1307(b).

Table 1 – Limits for Maximum Permissible Exposure (MPE)

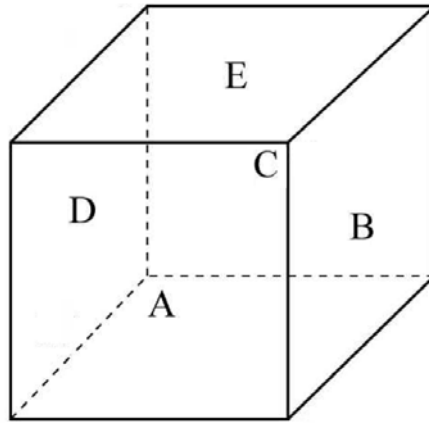
Frequency Range (MHz)	Electric Field Strength [V/m]	Magnetic Field Strength [A/m]	Power Density [mW/cm ²]	Averaging Time [minute]
(A) Limits for Occupational / Controlled Exposure				
0.3 ~ 3.0	614	1.63	*100	6
3.0 ~ 30	1842/f	4.89/f	*900/f ²	6
30 ~ 300	61.4	0.163	1.0	6
300 ~ 1 500	/	/	f/300	6
1 500 ~ 15 000	/	/	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 ~ 1 500	/	/	f/1 500	30
1 500 ~ 15 000	/	/	1.0	30

f=frequency in MHz, * = plane-wave equivalent power density

Per the guidance of KDB 680106, the E-field and H-field limits shown in the table above are extended down to 100 kHz

1.1.1. Isotropic Probe test setup

The measurement probe (EHP-200A) is a regular hexahedron and supports 3-axis (X, Y and Z) isotropic probe.



- A: Front of measurement probe
- B: Right of measurement probe
- C: Rear of measurement probe
- D: Left of measurement probe
- E: Top of measurement probe

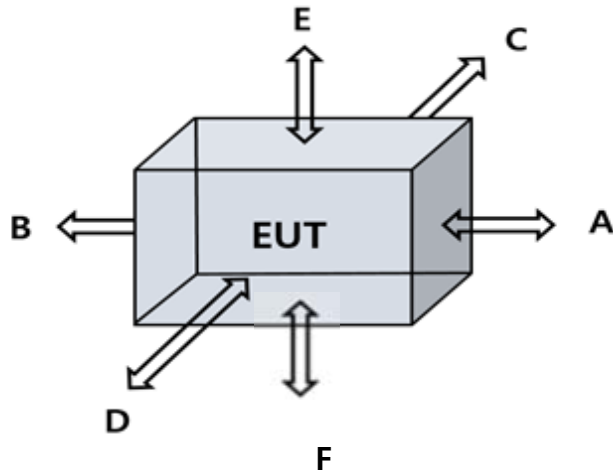
*Bottom of measurement probe is not used to measure RF exposure condition owing to connection with a stick.

At 0 cm distance, measurement isotropic probe was investigated by rotating the probe through various angles for one of the EUT's sides as below.

Measurement Point	A	B	C	D	E
Direction	Front	Right	Rear	Left	Top
Measurement Point	A to B	B to C	C to D	D to A	N/A
Direction	Front to Right	Right to Rear	Rear to Left	Left to Front	-
Measurement Point	A to E	B to E	C to E	D to E	N/A
Direction	Front to Top	Right to Top	Rear to Top	Left to Top	-

When the worst angle among all angles was found, RF exposure measurement should be adjusted from worst angle.

1.1.2. EUT test setup



- 1) Testing was performed with a calibrated field probe.
- 2) Measurement was performed on each side of the EUT as described per below table.
- 3) Test was Performed on 15 cm surrounding the device and 20 cm above the top surface

A	B	C	D	E	F
Front	Rear	Right	Left	Top	Bottom

Measurement Probe	EHP-200A (Manufacturer: Narda)
Measurement Method	Direct measurement
Measurement Distance	Surface of the EUT to the center of the probe.

2.1. Calculation Result of RF Exposure

2.1.1 RFID Result below:

[DC 12V]

E-field Measurements

Frequency [kHz]	Position A (V/m)	Position B (V/m)	Position C (V/m)	Position D (V/m)	Position E (V/m)	Position F (V/m)	Limit (V/m)
122	0.584	0.301	1.203	0.253	0.282	0.372	614

H-field Measurements

Frequency [kHz]	Position A (A/m)	Position B (A/m)	Position C (A/m)	Position D (A/m)	Position E (A/m)	Position F (A/m)	Limit (V/m)
122	0.285	0.050	0.042	0.042	0.097	0.038	1.63

Max. E-field : 1.203 V/m (C: Right), Max. H-field : 0.285 A/m (A: Front)

[DC 24V]

E-field Measurements

Frequency [kHz]	Position A (V/m)	Position B (V/m)	Position C (V/m)	Position D (V/m)	Position E (V/m)	Position F (V/m)	Limit (V/m)
122	0.413	0.365	1.344	0.289	0.237	0.408	614

H-field Measurements

Frequency [kHz]	Position A (A/m)	Position B (A/m)	Position C (A/m)	Position D (A/m)	Position E (A/m)	Position F (A/m)	Limit (V/m)
122	0.291	0.053	0.042	0.045	0.040	0.042	1.63

Max. E-field : 1.344 V/m (C: Right), Max. H-field : 0.291 A/m (A: Front)

[PoE]

E-field Measurements

Frequency [kHz]	Position A (V/m)	Position B (V/m)	Position C (V/m)	Position D (V/m)	Position E (V/m)	Position F (V/m)	Limit (V/m)
122	0.438	0.346	1.445	0.263	0.245	0.438	614

H-field Measurements

Frequency [kHz]	Position A (A/m)	Position B (A/m)	Position C (A/m)	Position D (A/m)	Position E (A/m)	Position F (A/m)	Limit (V/m)
122	0.150	0.051	0.042	0.042	0.042	0.042	1.63

Max. E-field : 1.445 V/m (C: Right), Max. H-field : 0.150 A/m (A: Front)

Note:

- Worst Probe Position: E-field = E side, H-field = E side

2.1.2 WLAN, BLE worst case below:

Mode	Frequency [MHz]	Max tune up power (dBm)	Max tune up power (mW)	ANT Gain [dB i]	ANT Gain (mW)	Power Density at 20 cm [mW/cm ²]	Limit [mW/cm ²]
WLAN	2 437	13.00	19.95	0.63	1.56	0.004 59	1
BLE	2.402	-1.00	0.79	-2.42	0.06	0.000 09	1

2.1.3. NFC, worst case below:

Mode	Frequency [MHz]	Maximum field strength @30m (dB _μ V/m)	Calculated E.I.R.P. (dBm)	Calculated E.I.R.P. (mW)	Min. Test Separation Distance [cm]	Power Density at 20 cm [mW/cm ²]	Limit [mW/cm ²]
NFC	13.56	23.48	-31.75	-0.000 67	20	0.000 000 000 591	0.979

2.1.4. Simultaneous Transmission

Mode	Frequency [MHz]	Max tune up power (dBm)	Max tune up power (mW)	ANT Gain [dB i]	ANT Gain (mW)	Power Density at 20 cm [mW/cm ²]	Limit
802.11b Middle(2 437 MHz) + Bluetooth Low Energy Lowest (2 402 MHz) + NFC(13.56 MHz)						0.004 680 000 591	1

Note.

1. The power density P_d (5th column) at a distance of 20 cm calculated from the friis transmission Formula is far below the limit of 1 mW/cm².
2. Simultaneous transmission of RF Exposure test exclusion for worst case configuration.

2.4G WIFI: the ratio is 0.004 59 / 1
 Bluetooth Low Energy: the ratio is 0.000 09 / 1

2.4G WIFI + Bluetooth Low Energy+ NFC Power density:
 (0.004 59 / 1 + 0.000 09 / 1 + 0.000 000 000591 / 0.979)

2.2. Target power and Tolerance, Max tuneup Power

Mode	Frequency	Target power	Tolerance	Max tune up power	Max tune up power	
	[MHz]	[dB m]	[dB]	[dB m]	[mW]	
BLE	2 402	-2	±1.0	-1.00	0.79	
	2 440	-2	±1.0	-1.00	0.79	
	2 480	-2	±1.0	-1.00	0.79	
2.4G WLAN	b	2 412	9	±1.0	10.00	10.00
		2 437	12	±1.0	13.00	19.95
		2 462	12	±1.0	13.00	19.95
	g	2 412	9	±1.0	10.00	10.00
		2 437	12	±1.0	13.00	19.95
		2 462	12	±1.0	13.00	19.95
	n20	2 412	9	±1.0	10.00	10.00
		2 437	12	±1.0	13.00	19.95
		2 462	12	±1.0	13.00	19.95

Note: Just the worst case mode was shown in report.

3. Conclusion

Therefore, EUT is not required the SAR Evaluation.