RF Exposure Evaluation Report

1. Product Information

FCC ID:	2ARZ3FMT1200BT
Product Name	Wireless Charger Car Kit
Model Number	FMT1200BT
Power Supply	Input: DC 12-24V Output: DC 5V, 2.4A(MAX)
Modulation Type	WPT: CW (Continuous Wave) BT: GFSK, π/4-DQPSK FM: FM
Maximum Output Power for WPT	12 W
Frequency Range	WPT: 110 – 205 KHz BT: 2402 – 2480 MHz FM: 88.1 – 107.9 MHz
WPT Operation Frequency	150.0 KHz
Maximum Rated power of WPT	10 W
Antenna Type	WPT: Coil Antenna BT: PCB Antenna FM: Internal Antenna
Hardware version	C61-Qi-v03
Software version	HW-S4903-TX-S10-V2.38
Accessories	IPhone 8 Plus
Exposure category	General population/uncontrolled environment
EUT Type	Production Unit
Device Type	Mobile Device

2. Evaluation Method

Per KDB 680106 D01 Section 3. RF Exposure Requirements;

1) Consumer wireless power transfer devices approved under Part 18 in some cases have to demonstrate compliance with RF exposure requirements. The potential for exposure must be assessed according to the operating configurations of the wireless system and the exposure conditions of users and bystanders. RF exposure must be evaluated with the client device(s) being charged by the primary at maximum output power. The RF exposure requirements must be determined in conjunction with the device operating characteristics, according to the mobile and portable exposure requirements in Section 2.1091 and Section 2.1093 of the rules. SAR and MPE limits do not cover the frequency range for wireless power transfer applications which operate below 100 kHz and 300 kHz respectively; therefore, RF exposure compliance needs to be determined with respect to 1.1307 (c) and (d) of the FCC rules.
2) Based on the design and implementation of the power transfer application, it must be clearly identified if mobile or portable RF exposure conditions apply. Devices that are installed to provide separation of at least 20 cm from users and bystanders may qualify for mobile exposure conditions. For some conditions where users and bystanders may be exposed at closer than 20 cm, section 2.1091(d) (4) of the rules may apply.

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3) For devices designed for typical desktop applications, such a wireless charging pads, RF exposure evaluation should be conducted assuming a user separation distance of 15 cm. E and H field strength measurements or numerical modeling may be used to demonstrate compliance. Measurements should be made from all sides and the top of the primary/client pair, with the 15 cm measured from the center of the probe(s) to the edge of the device. Emissions between 100 kHz to 300 kHz should be assessed versus the limits at 300 kHz in Table 1 of Section 1.1310: 614 V/m and 1.63 A/m. A KDB inquiry is required to determine the applicable exposure limits below 100 kHz
4) Portable exposure conditions from 100 kHz to 6 GHz are determined with respect to SAR requirements. Existing SAR systems and test procedures are generally intended for measurements above 100 MHz. While numerical modeling can be an alternative, the constraints of substantial computational resources at low frequencies could introduce further limitations. Under these circumstances, including operations below 100 kHz, the Commission may consider a combination of analytical analysis, field strength, radiated and conducted power measurements, in conjunction with some limited numerical modeling to assess compliance.
5) Depending on the operating frequency, existing SAR and MPE measurement procedures may be adapted to evaluate wireless power transfer devices for compliance with respect to mobile or portable exposure conditions. If the grantee or its test lab have any questions regarding RF exposure evaluation they should contact the FCC Laboratory with sufficient system operating configuration details to determine if RF exposure evaluation is necessary and, if required, how to apply specific test procedures. Below 100 MHz, when SAR testing is required and the device is operating at close proximity to persons, information on device design, implementation, operating configurations, exposure conditions of users and bystanders are needed to determine the evaluation and testing requirements. In addition, the influence of nearby objects may also need consideration according to the wireless power transfer system implementation; for example, the effects of placing the device, its coils or radiating elements on or near metallic surfaces
6) According to April 2018 TCB Workshop, No need to report E-field measurements. Only H-field required.

Per KDB 447498 D01 Section 4.3.1 Standalone SAR test exclusion considerations;

a) For 100 MHz to 6 GHz and test separation distances ≤ 50 mm, the 1-g and 10-g SAR test exclusion thresholds are determined by the following:

   [(max. power of channel, including tune-up tolerance, mW) / (min. test separation distance, mm)] · [√f(GHz)] ≤ 3.0 for 1-g SAR, and ≤ 7.5 for 10-g extremity SAR, 30 where

   - f(GHz) is the RF channel transmit frequency in GHz
   - Power and distance are rounded to the nearest mW and mm before calculation
   - The result is rounded to one decimal place for comparison
   - The values 3.0 and 7.5 are referred to as numeric thresholds in step b) below

   The test exclusions are applicable only when the minimum test separation distance is ≤ 50 mm, and for transmission frequencies between 100 MHz and 6 GHz. When the minimum test separation distance is < 5 mm, a distance of 5 mm according to 4.1 f) is applied to determine SAR test exclusion.

b) For 100 MHz to 6 GHz and test separation distances > 50 mm, the 1-g and 10-g SAR test exclusion thresholds are determined by the following (also illustrated in Appendix B):

   1) {[Power allowed at numeric threshold for 50 mm in step a)] + [(test separation distance – 50 mm)·(f(MHz)/150)]} mW, for 100 MHz to 1500 MHz
   2) {[Power allowed at numeric threshold for 50 mm in step a)] + [(test separation distance – 50 mm)·10]} mW, for > 1500 MHz and ≤ 6 GHz

c) For frequencies below 100 MHz, the following may be considered for SAR test exclusion (also illustrated in Appendix C):

   1) For test separation distances > 50 mm and < 200 mm, the power threshold at the corresponding test separation distance at 100 MHz in step b) is multiplied by [1 + log(100/f(MHz))]
   2) For test separation distances ≤ 50 mm, the power threshold determined by the equation in c) 1)

for 50 mm and 100 MHz is multiplied by ½

3) SAR measurement procedures are not established below 100 MHz.

When SAR test exclusion cannot be applied, a KDB inquiry is required to determine SAR evaluation requirements for any SAR test results below 100 MHz to be acceptable.

Per KDB 447498 D01 Section 4.3.2 Simultaneous transmission SAR test exclusion considerations;

When an antenna qualifies for the standalone SAR test exclusion of 4.3.1 and also transmits simultaneously with other antennas, the standalone SAR value must be estimated according to the following to determine the simultaneous transmission SAR test exclusion criteria:

1) [(max. power of channel, including tune-up tolerance, mW) / (min. test separation distance, mm)]·[√f(GHz)/x] W/kg, for test separation distances ≤ 50 mm; where x = 7.5 for 1-g SAR and x = 18.75 for 10-g SAR.

2) 0.4 W/kg for 1-g SAR and 1.0 W/kg for 10-g SAR, when the test separation distance is > 50 mm

Per KDB 447498 D01 Section 7.2 Transmitters used in mobile device exposure conditions for simultaneous transmission operations;

When one of the following test exclusion conditions is satisfied for all combinations of simultaneous transmission configurations, further equipment approval is not required to incorporate transmitter modules in host devices that operate in the mixed mobile and portable host platform exposure conditions. The grantee is responsible for documenting this according to Class I permissive change requirements. Antennas that qualify for standalone SAR test exclusion must apply the estimated standalone SAR to determine simultaneous transmission test exclusion.

a) The [∑ of (the highest measured or estimated SAR for each standalone antenna configuration, adjusted for maximum tune-up tolerance) / 1.6 W/kg] + [∑ of MPE ratios] is ≤ 1.0.

b) The SAR to peak location separation ratios of all simultaneously transmitting antenna pairs operating in portable device exposure conditions are all ≤ 0.04, and the [∑ of MPE ratios] is ≤ 1.0.

When RF exposure test exclusion does not apply, simultaneous transmission evaluation is required for mixed mobile device and portable device exposure conditions. For each simultaneous transmission configuration, the sum of the MPE ratios for the simultaneously transmitting antennas operating in mobile device exposure conditions must be determined according to the calculated/estimated, numerically modeled or measured field strengths or power density. For each simultaneous transmission configuration, the enlarged zoom scan measurement and volume scan post-processing procedures in KDB Publication 865664 D01 must be applied to test the simultaneously transmitting antennas operating in portable device exposure conditions. The [(highest measured simultaneous transmission SAR, adjusted for maximum tune-up tolerance) / 1.6 W/kg] + [∑ of MPE ratios] must be ≤ 1.0 for each simultaneous transmission configuration; otherwise, a PAG is required for the FCC to determine compliance on a case-by-case basis, with respect to antenna-to-antenna and antenna-to-user separation, device form factor, operating requirements and exposure conditions, etc.

3. Evaluation 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 680106 D01 RF Exposure Wireless Charging Apps v03: RF Exposure Considerations for Low Power Consumer Wireless Power Transfer Applications

FCC KDB publication 447498 D01 General RF Exposure Guidance v06: RF EXPOSURE PROCEDURES AND EQUIPMENT AUTHORIZATION POLICIES FOR MOBILE AND PORTABLE DEVICES

FCC CFR 47 part1 1.1310: Radiofrequency radiation exposure limits.

FCC CFR 47 part2 2.1091: Radiofrequency radiation exposure evaluation: mobile devices
FCC CFR 47 part 18.107: Indusial, Scientific, and Medical Equipment

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/cm²)	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/f²	6
30-300	61.4	0.163	1.0	6
300-1,500	/	/	f/300	6
1,500-100,000	/	/	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/cm²)	Averaging Time (minute)
Limits for General Population/Uncontrolled Exposure				
0.3-1.34	614	1.63	*100	30
1.34-30	824/f	2.19/f	*180/f²	30
30-300	27.5	0.073	0.2	30
300-1,500	/	/	f/1500	30
1,500-100,000	/	/	1.0	30

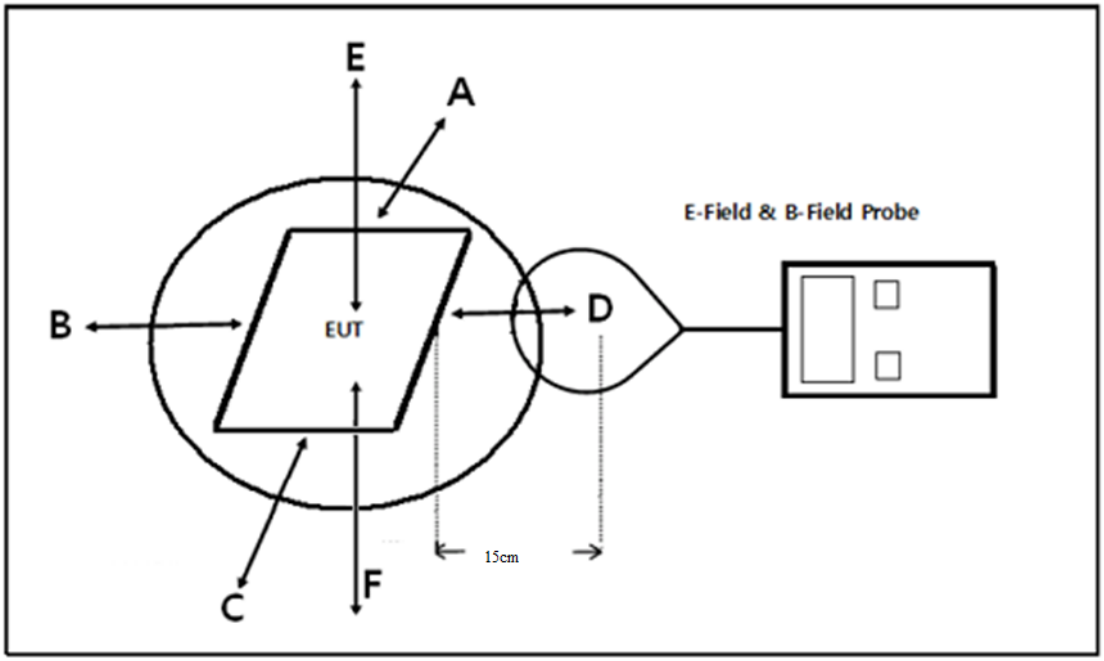
F=frequency in MHz
*=Plane-wave equivalent power density

According to FCC KDB 680106 D01 Section 3. RF Exposure Requirements clause 3 the Emission-Limits in the frequency range from 100 KHz to 300 KHz should be assessed versus the limits at 300 KHz in Table 1 of CFR 47 – Section1.310 as following (measured distance shall be 15cm from the center of the probe to the edge of the device):

	E-filed	H-filed	B-filed
Frequency	V/m	A/m	uT
0.3 MHz – 3.0 MHz	614	1.613	2.0
3.0 MHz – 30 MHz	824/f (=27.5_{30MHz})	2.19/f (=0.073_{30MHz})	--

A KDB inquire was required to determine/confirm the applicable limits below 100 KHz.

4. Test Setup Diagram



For mobile RF exposure condition, due to installation limitations no tests from the underside of the charging device are required.

5. Test Equipment

Equipment	Manufacturer	Model	Serial no.	Calibrated date	Calibrated Due
Exposure Level Tester	Narda	ELT-400	N-0713	2019-04-01	2020-03-31
B-Field Probe	Narda	ELT-400	M-1154	2019-04-01	2020-03-31

6. RF Exposure Evaluation

6.1 Standalone WPT Evaluation

6.1.1 Measurement Procedure

a) The RF exposure test was performed on 360 degree turn table in anechoic chamber.

b) The measurement probe was placed at test distance (15cm) which is between the edge of the charger and the geometric center of probe.

c) The turn table was rotated 360d degree to search of highest strength.

d) The highest emission level was recorded and compared with limit as soon as measurement of each points (A, B, C, D, E) were completed.

e) The EUT were measured according to the dictates of KDB 680106D01v03.

6.1.2 Equipment Approval Considerations

The EUT does comply with item 5.2 of KDB 680106 D01v02 as follows table;

Requirements of KDB 680106 D01	Yes / No	Description
Power transfer frequency is less than 1 MHz	Yes	The device operate in the frequency range 110.0 KHz - 205.0 KHz
Output power from each primary coil is less than 15 watts	Yes	The maximum output power of the primary coil is 10W.
The transfer system includes only single primary and secondary coils. This includes charging systems that may have multiple primary coils and clients that are able to detect and allow coupling only between individual pairs of coils.	Yes	The transfer system includes one primary coils and clients that are able to detect and allow coupling only between individual pairs of coils.
Client device is placed directly in contact with the transmitter.	Yes	Client device is placed directly in contact with the transmitter.
Mobile exposure conditions only (portable exposure conditions are not covered by this exclusion).	Yes	Mobile exposure conditions only
The aggregate H-field strengths at 15 cm surrounding the device and 20 cm above the top surface from all simultaneous transmitting coils are demonstrated to be less than 50% of the MPE limit.	Yes	The aggregate H-field strengths at 15 cm surrounding the device and 20 cm above the top surface from all simultaneous transmitting coils are less than 50% the MPE limit.

In all other cases, unless excluded above, an RF exposure evaluation report must be reviewed and accepted through a KDB or PBA inquiry to enable authorization of the equipment. When evaluation is required to show compliance; for example, using field strength, power density, SAR measurements or computational modeling etc., the specific authorization requirements will be determined based on the results of the RF exposure evaluation.

6.1.3 E and H field Strength

Operate mode:

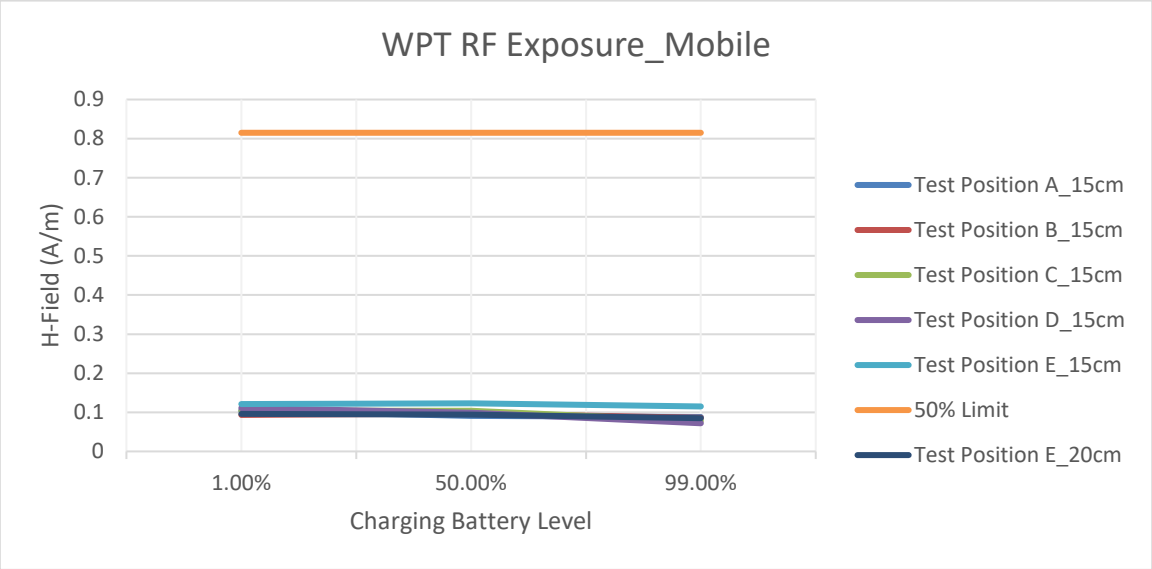
Test Modes		
TM1	Car Charge (5V/2.4A) + EUT + Mobile Phone iPhone 8 Plus (Battery Status: <1%)	Pre-tested
TM2	Car Charge (5V/2.4A) + EUT + Mobile Phone iPhone 8 Plus (Battery Status: <50%)	Pre-tested
TM3	Car Charge (5V/2.4A) + EUT + Mobile Phone iPhone 8 Plus (Battery Status: 100%)	Pre-tested
TM4	Car Charge (5V/2.4A) + EUT + BT Connection + Mobile Phone iPhone 8 Plus (Battery Status: <1%)	Pre-tested
TM5	Car Charge (5V/2.4A) + EUT + BT Connection + Mobile Phone iPhone 8 Plus (Battery Status: <50%)	Pre-tested
TM6	Car Charge (5V/2.4A) + EUT + BT Connection + Mobile Phone iPhone 8 Plus (Battery Status: 100%)	Pre-tested
TM7	Car Charge (5V/2.4A) + EUT + FM TX + Mobile Phone iPhone 8 Plus (Battery Status: <1%)	Pre-tested
TM8	Car Charge (5V/2.4A) + EUT + FM TX + Mobile Phone iPhone 8 Plus (Battery Status: <50%)	Pre-tested
TM9	Car Charge (5V/2.4A) + EUT + FM TX + Mobile Phone iPhone 8 Plus (Battery Status: 100%)	Pre-tested
TM10	Car Charge (5V/2.4A) + EUT + BT Connection + FM TX + Mobile Phone iPhone 8 Plus (Battery Status: <1%)	Recorded
TM11	Car Charge (5V/2.4A) + EUT + BT Connection + FM TX + Mobile Phone iPhone 8 Plus (Battery Status: <50%)	Pre-tested
TM12	Car Charge (5V/2.4A) + EUT + BT Connection + FM TX + Mobile Phone iPhone 8 Plus (Battery Status: 100%)	Pre-tested
TM13	Car Charge (5V/2.4A) + EUT + BT Connection + FM TX	No-tested
TM14	Car Charge (5V/2.4A) + EUT + BT Connection + FM TX	No-tested
TM15	Car Charge (5V/2.4A) + EUT + BT Connection + FM TX	No-tested
Note: All test modes were pre-tested, but we only recorded the worst case in this report.		

H-Field Strength at 15 cm from the edges surrounding the EUT and 15cm from the top surface of the EUT

Charging Battery Level	Frequency Range (MHz)	Measured H-Field Strength Values (A/m)					FCC H-Field Strength 50% Limits (A/m)	FCC H-Field Strength Limits (A/m)
		Test Position A	Test Position B	Test Position C	Test Position D	Test Position E		
1%	0.160	0.104	0.093	0.104	0.111	0.121	0.815	1.63
50%	0.160	0.091	0.097	0.104	0.099	0.123	0.815	1.63
99%	0.160	0.088	0.086	0.078	0.072	0.115	0.815	1.63

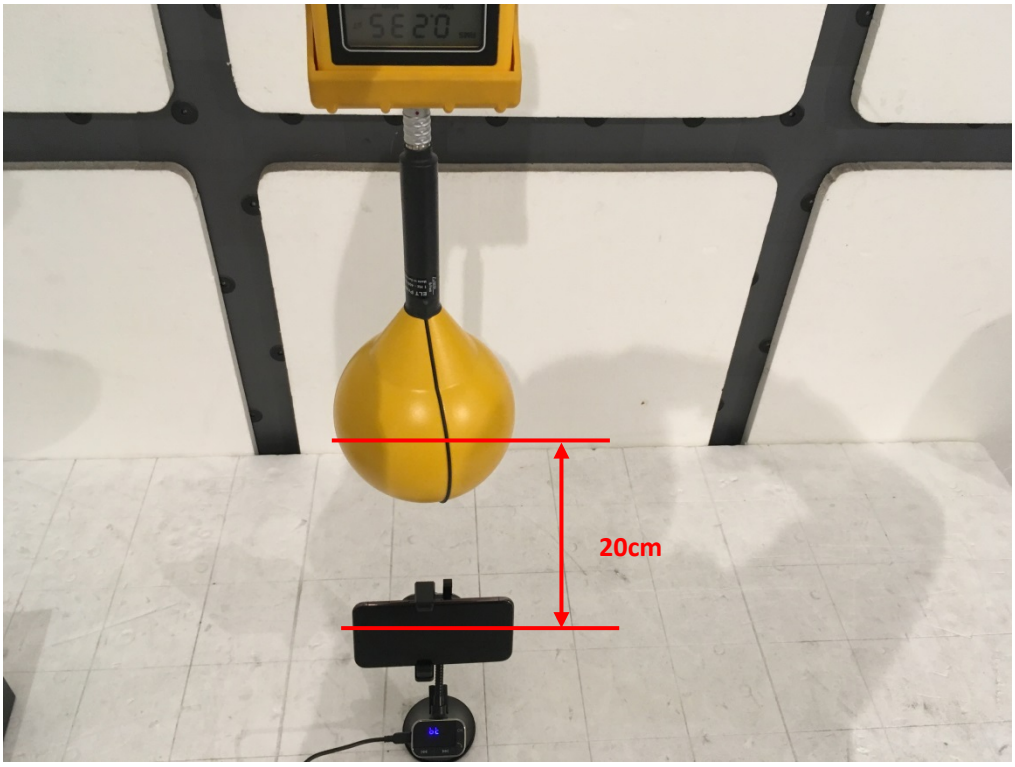
H-Field Strength at 20cm from the top surface of the EUT

Charging Battery Level	Frequency Range (MHz)	Measured H-Field Strength Values (A/m)	FCC H-Field Strength 50% Limits (A/m)	FCC H-Field Strength Limits (A/m)
		Test Position E		
1%	0.160	0.096	0.815	1.63
50%	0.160	0.094	0.815	1.63
99%	0.160	0.085	0.815	1.63



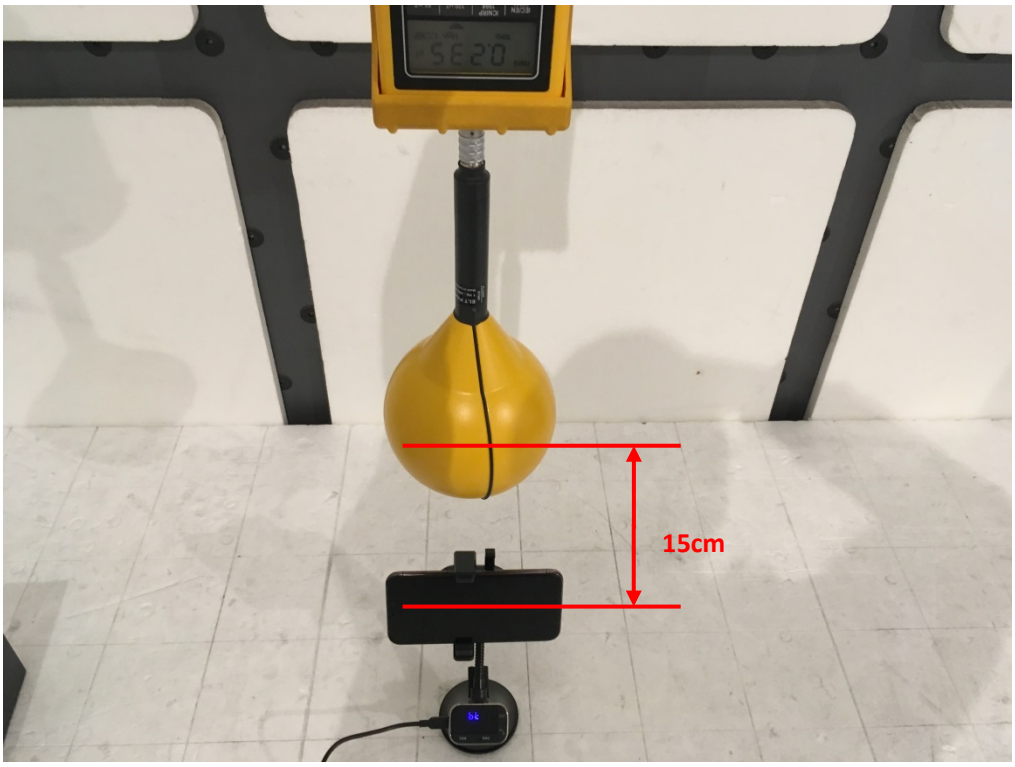
6.1.4 Test Setup Photos

6.1.4.1 Test Position E-Exposure photo from top surface (20cm)



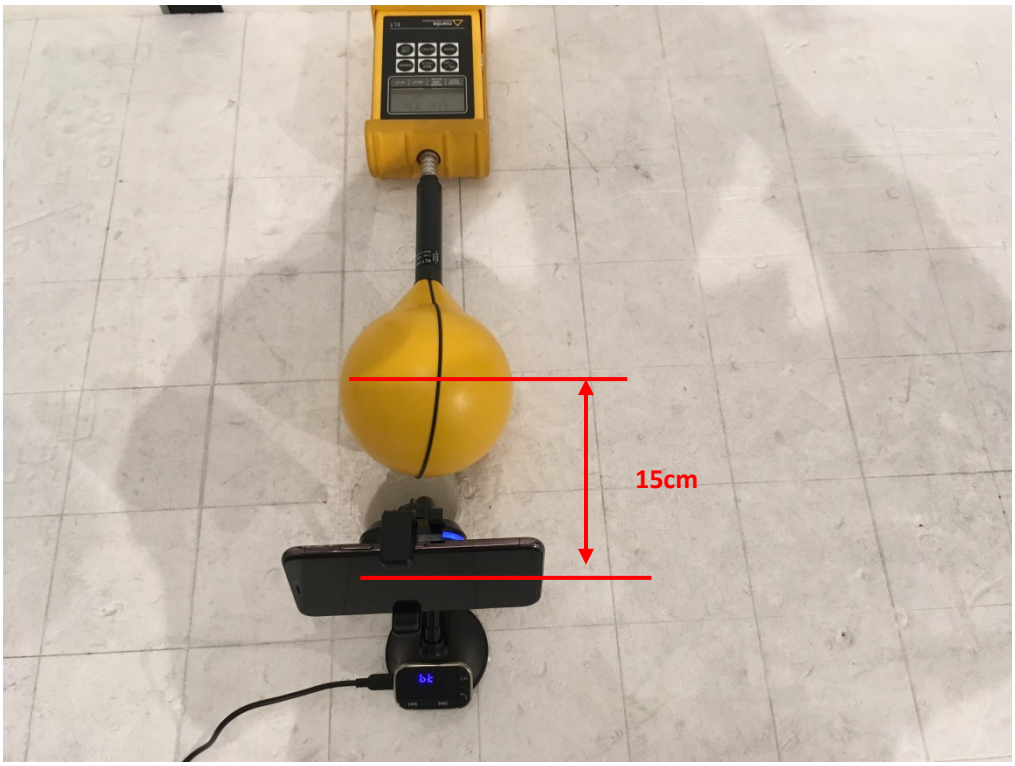
TM10

6.1.4.2 Test Position E-Exposure photo from top surface (15cm)



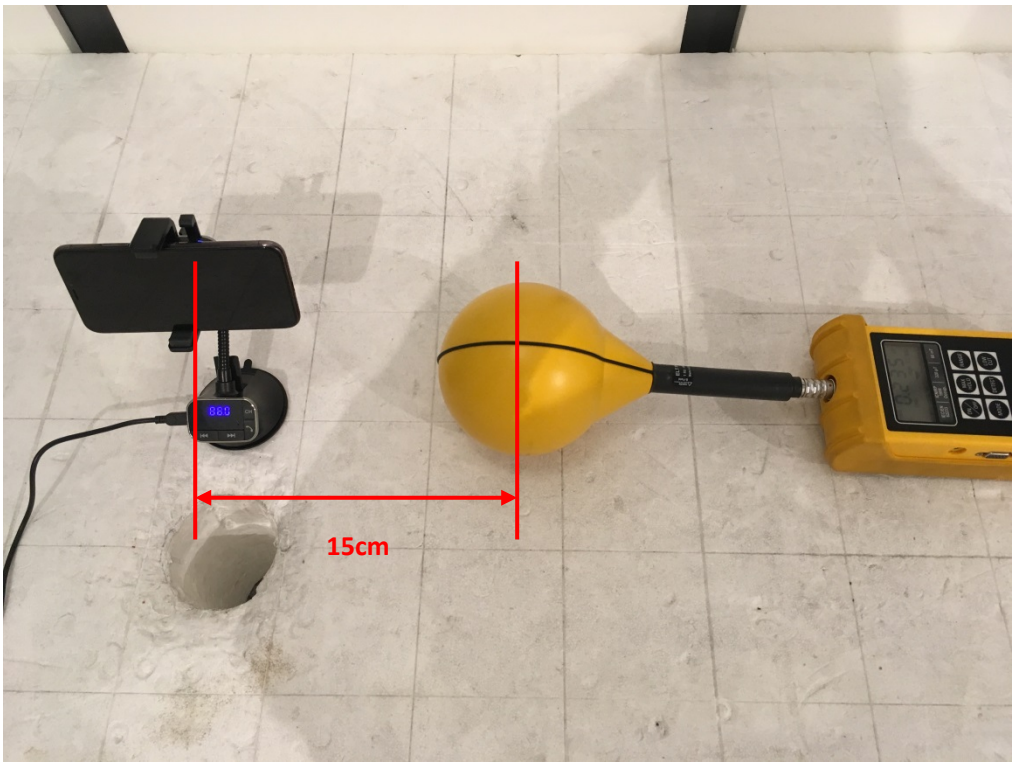
TM10

6.1.4.3 Test Position A - Exposure photo from side edge surface-Rear



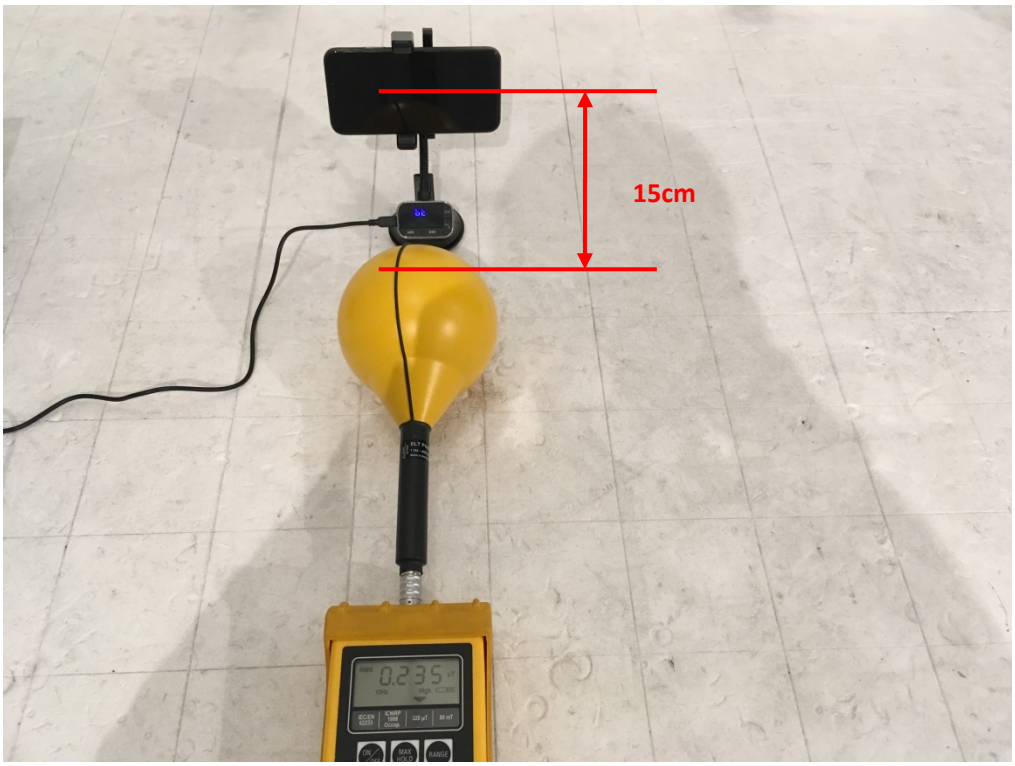
TM10

6.1.4.4 Test Position B-Exposure photo from side edge surface-Left



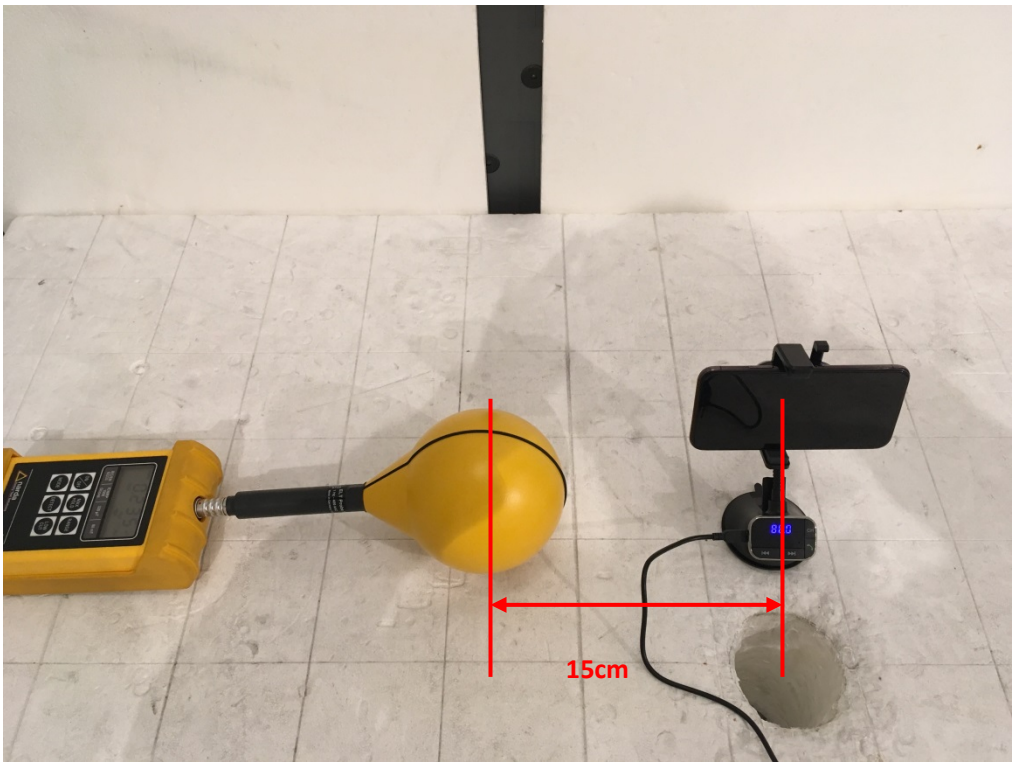
TM10

6.1.4.5 Test Position C-Exposure photo from side edge surface-Front



TM10

6.1.4.6 Test Position D - Exposure photo from side edge surface-Right



TM10

6.2 Standalone BT Evaluation

6.2.1 Conducted Power

Mode	Channel	Frequency (MHz)	Peak Conducted Output Power (dBm)
GFSK	0	2402	2.481
	39	2441	2.034
	78	2480	1.240
π/4DQPSK	0	2402	2.958
	39	2441	2.624
	78	2480	1.865
GFSK (BLE)	0	2402	2.528
	19	2440	2.211
	39	2480	1.573

[FM]

Mode	Frequency (MHz)	Field strength of fundamental @ 3m (dBuv/m)
FM	88.10	34.85
	89.10	39.93
	107.90	40.76

6.2.2 Manufacturing Tolerance

GFSK (Peak)			
Channel	Channel 0	Channel 39	Channel 78
Target (dBm)	3.0	3.0	2.0
Tolerance ±(dB)	1.0	1.0	1.0
π/4-DQPSK (Peak)			
Channel	Channel 0	Channel 39	Channel 78
Target (dBm)	3.0	3.0	2.0
Tolerance ±(dB)	1.0	1.0	1.0
GFSK BT LE (Peak)			
Channel	Channel 0	Channel 19	Channel 39
Target (dBm)	3.0	3.0	2.0
Tolerance ±(dB)	1.0	1.0	1.0

6.2.3 Evaluation Results

Communication Type	f (GHz)	Antenna Distance (mm)	RF output power		SAR Test Exclusion Threshold	SAR Test Exclusion
			dBm	mW		
BT*	2.50	150*	4.00	2.5119	0.03	Yes

Remark:

1. Output power including tune up tolerance;

2. When the minimum test separation distance is < 5 mm, a distance of 5 mm according to f) in section 4.1 is applied to determine SAR test exclusion.

3. Evaluate BT distance at 150mm same as evaluate distance of WPT by KDB inquire.

4. BT - including BT LE and BT Classics.*

[FM]

According to KDB 412172 D01 Determining ERP and EIRP format;

$EIRP = p_t \times g_t = (E \times d)^2/30$

Where:

p_t = transmitter output power in watts,

g_t = numeric gain of the transmitting antenna (unitless),

E = electric field strength in V/m,

d = measurement distance in meters (m).

EIRP = -54.46 dBm

Conducted power = EIRP – Antenna Gain = -54.46 dBm

Band/Mode	f (GHz)	Antenna Distance (mm)	RF output power		SAR Test Exclusion Threshold	SAR Test Exclusion
			dBm	mW		
FM	0.108	150	-54.46	0.0001	0.1 < 3.0	Yes

6.3 Simultaneous Transmission for SAR/MPE Exclusion

The WPT, FM and BT share difference antenna and difference modular, WPT, FM and BT can transmit at the

same, need consider simultaneous transmission.

Maximum Simultaneous transmission SAR/MPE Ratio for BT and WPT.

Maximum SAR Ratio $_{BT}$	Maximum SAR Ratio $_{FM}$	Maximum MPE Ratio $_{WPT}$	$\sum SAR_{ratio}$ + MPE ratios	Limit	Results
0.250	0.001	0.151	< 0.5	1.0	PASS

Remark:

1. *Output power including tune-up tolerance;*
2. *0.4 W/kg for 1-g SAR and 1.0 W/kg for 10-g SAR, when the test separation distance is > 50 mm;*
3. *Evaluate limits for WPT at Field-Strength of 50% Limit.*

7. Conclusion

The detected emissions with a distance of 20 cm from center of probe to the top surface of EUT and 15cm from center of probe to edge of EUT are below the limitations according to FCC KDB 680106 D01 Section 3. RF Exposure Requirement Clause 3.

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

Revision History

Revision	Issue Date	Revisions	Revised By
000	April 15, 2019	Initial Issue	Gavin Liang

.....END OF REPORT.....