RF Exposure Evaluation

FCC ID: 2A9Q9-EPB-MQ25

Product Name:	Marquis 5000mAh 20W PD Power Bank w/Charger & Cables
Product Model No.:	EPB-MQ25 M2256Q
Test Auxiliary:	AC/DC Adapter, Phone
Test Auxiliary Model No.:	HW200450CP0, iPhone13 Pro
Operation Frequency:	115kHz-205kHz
Modulation Type:	ASK
Antenna Type:	Loop Coil Antenna
Power Supply:	Battery capacity: 3.7V, 5000mAh, 18.5Wh Wireless Output：5W/7.5W/10W/15W TYPE-C INPUT: 5V⎓ 3A, 9V⎓ 2A, 12V⎓ 1.5A, 18W MAX TYPE-C LINE INPUT: 5V⎓ 3A, 9V⎓ 2A, 12V⎓ 1.5A, 18W MAX TYPE-C LINE OUTPUT: 5V⎓ 3A, 9V⎓ 2.2A, 12V⎓ 1.67A, 20W, 10V⎓ 2.25A 22.5W MAX LITHTING LINE OUTPUT: 5V⎓ 3A, 9V⎓ 2.2A, 12V⎓ 1.67A, 20W MAX USBA OUTPUT: 5V⎓ 3A, 9V⎓ 2A, 12V⎓ 1.5A, 18W
Battery Capacity:	5000mAh(DC 3.85V/19.25Wh)
Transmitting Mode	Keep the EUT in continuously wireless charging mode

a. EUT mode of adapter input + wireless charge output:

Test Modes:	Test Coil	Description:
Mode 1	ANT 1	AC/DC Adapter + EUT + Phone (Battery Status: <1%)
Mode 2		AC/DC Adapter + EUT + Phone (Battery Status: 50%)
Mode 3		AC/DC Adapter + EUT + Phone (Battery Status: >98%)

b. EUT mode of wireless charge output:

Test Modes:	Test Coil	Description:
Mode 1a	ANT 1	EUT + Phone (Battery Status: <1%)
Mode 2a		EUT + Phone (Battery Status: 50%)
Mode 3a		EUT + Phone (Battery Status: >98%)

Note: Both a and b were tested, and only the test data for b was recorded.

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1 Measuring Standard

1.1 KDB 680106 D01 Wireless Power Transfer v04

1.2 Measurement Uncertainty

The reported uncertainty of measurement y ±U, where expended uncertainty U is based on a standard uncertainty multiplied by a coverage factor of k=2, providing a level of confidence of approximately 95 %.

No.	Item	Uncertainly
1	H-filed	±0.93dB
2	E-filed	±0.51dB

2 Requirements

2.1 According to the item 5.2 of KDB 680106 D01v04:

Inductive wireless power transfer applications that meet all of the following requirements are excluded from submitting an RF exposure evaluation.

a) The power transfer frequency is below 1 MHz.

Yes.The device operates in the frequency from 115kHz to 205kHz.

b) The output power from each transmitting element (e.g., coil) is less than or equal to 15 watts.

Yes,The maximum output power of the primary coil is 15watts.

c) A client device providing the maximum permitted load is placed in physical contact with the transmitter (i.e., the surfaces of the transmitter and client device enclosures need to be in physical contact).

Yes. Client device is placed directly in contact with the transmitter.

d) Only § 2.1091-Mobile exposure conditions apply (i.e., this provision does not cover § 2.1093-Portable exposure conditions).

NO. The EUT is a portable wireless charger.

e) The E-field and H-field strengths, at and beyond 20 cm surrounding the device surface, are demonstrated to be less than 50% of the applicable MPE limit, per KDB 447498, Table 1. These measurements shall be taken along the principal axes of the device, with one axis oriented along the direction of the estimated maximum field strength, and for three points per axis or until a 1/d (inverse distance from the emitter structure) field strength decay is observed. Symmetry considerations may be used for test reduction purposes.
The device shall be operated in documented worst-case compliance scenarios (i.e., the ones that lead to the maximum field components), and while all the radiating structures

Yes. The EUT coil is evaluated at maximum output power and the test results are less than 50% of the limit.

f) For systems with more than one radiating structure, the conditions specified in (5) must be met when the system is fully loaded (i.e., clients absorbing maximum power available), and with all the radiating structures operating at maximum power at the same time, as per design conditions. If the design allows one or more radiating structures to be powered at a higher level while other radiating structures are not powered, then those cases must be tested as well.

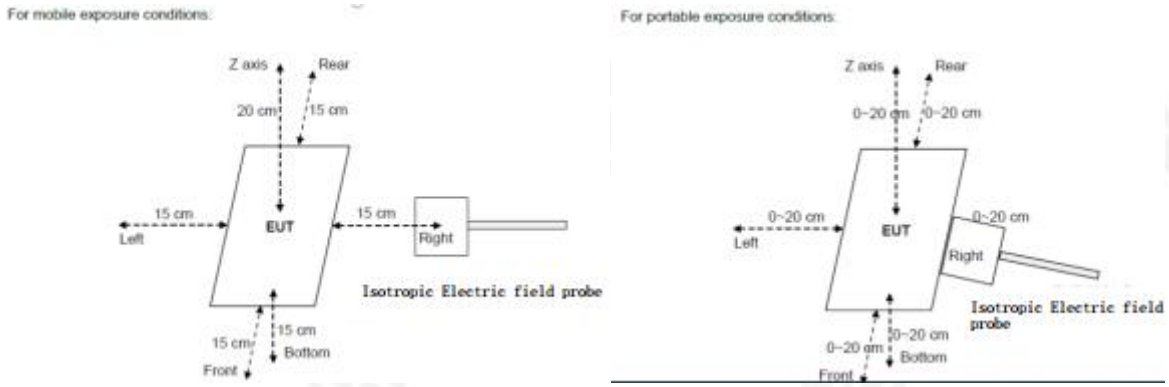
NO, The EUT has one coil.

3 Method Of Measurement

3.1 Applicable Standard

According to S1.1307(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 §2.1093 RF exposure is calculated. According KDB 680106 D01 Wireless Power Transfer v04.

3.2 Block diagram of Test Setup



Note: Measurements should be made from all sides and the top of the primary/client pair, with the 20 cm-0cm measured from the center of the top, and 20cm-0cm measured from the center of the rest.

3.3 For mobile exposure conditions:

a. The RF exposure test was performed in an echoic chamber

b. E and H-field measurements should be made with the center of the probe at a distance of 15 cm surrounding the EUT and 20 cm above the top surface of the primarv/client pair

c. The highest emission level was recorded and compared with limit

d. The EUT was measured according to the dictates of KDB 680106 D01v04

3.4 For portable exposure conditions:

a. The RF exposure test was performed in an echoic chamber

b. E and H-field measurements should be made with the probe at 0 cm for all side of the EUT.

c. The highest emission level was recorded and compared with limit.

For portable exposure conditions:

Perform H-field measurements for each edge/top surface of the host/client pair at every 2 cm startino from as close as possible out to10cm

3.5 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 (minutes)
(A) Limits for Occupational/Controlled Exposures				
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
(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
300-1500	/	/	f/1500	30
1500-100,000	/	/	1.0	30

F=frequency in MHz
*=Plane-wave equivalent power density
RF exposure compliance will need to be determined with respect to 1.1307(c) and (d) of the FCC rules. The emissions should be within the limits at 300kHz in Table 1 of 1.1310(use the 300kHz limits for 150kHz:614V/m,1.63A/m).

3.6 Test Procedure:

1) The RF exposure test was performed on 360 degree turn table in an echoic chamber.

2) 20 cm-0cm measured from the center of the top, and 20cm-0cm measured from the center of the rest sides.

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

4) The highest emission level was recorded and compared with limit as soon as measurement of each points were completed.

5) The EUT were measured according to the dictates of KDB 680106 D01v04.

4 Test Instruments list

Test Equipment	Manufacturer	Model No.	SN.	Cal.Date (mm-dd-yy)	Cal.Due date (mm-dd-yy)
Exposure Level Tester	Narda	ELT-400	180ZX10220	Nov. 16, 2023	Nov. 15, 2024
Magnetic field probe 100cEPB-RO25	Narda	ELT probe 100cEPB-RO25	M0675	Nov. 16, 2023	Nov. 15, 2024

5 Test Result

H-Filed Strength at (distance from 6cm to 20cm at 2cm iteration) surrounding the EUT (A/m):

distance (cm)	Battery Level:	Position Left (uT)	Position Right (uT)	Position Rear (uT)	Position Front (uT)	Position Top (uT)	Position BOTTOM (uT)
20	<1%	0.0174	0.0176	0.0173	0.0175	0.0171	0.0170
18	<1%	0.0233	0.0236	0.0231	0.0234	0.0229	0.0228
16	<1%	0.0320	0.0325	0.0318	0.0322	0.0316	0.0313
14	<1%	0.0456	0.0462	0.0452	0.0459	0.0449	0.0446
12	<1%	0.0674	0.0684	0.0669	0.0679	0.0664	0.0660
10	<1%	0.1043	0.1058	0.1036	0.1051	0.1028	0.1021
8	<1%	0.1695	0.1719	0.1682	0.1707	0.1670	0.1658
6	<1%	0.2876	0.2917	0.2855	0.2896	0.2834	0.2814

distance (cm)	Battery Level:	Position Left (A/m)	Position Right (A/m)	Position Rear (A/m)	Position Front (A/m)	Position Top (A/m)	Position BOTTOM (A/m)	50% Limits (A/m)	Limits (A/m)
20	<1%	0.0139	0.0141	0.0138	0.0140	0.0137	0.0136	0.815	1.63
18	<1%	0.0186	0.0189	0.0185	0.0187	0.0183	0.0182	0.815	1.63
16	<1%	0.0256	0.0260	0.0254	0.0258	0.0252	0.0251	0.815	1.63
14	<1%	0.0365	0.0370	0.0362	0.0367	0.0359	0.0357	0.815	1.63
12	<1%	0.0539	0.0547	0.0535	0.0543	0.0532	0.0528	0.815	1.63
10	<1%	0.0835	0.0847	0.0829	0.0841	0.0822	0.0816	0.815	1.63
8	<1%	0.1357	0.1375	0.1346	0.1365	0.1336	0.1326	0.815	1.63
6	<1%	0.2302	0.2334	0.2284	0.2317	0.2267	0.2251	0.815	1.63

H-Filed Strength at (distance from 6cm to 20cm at 2cm iteration) surrounding the EUT (A/m):

distance (cm)	Battery Level:	Position Left (uT)	Position Right (uT)	Position Rear (uT)	Position Front (uT)	Position Top (uT)	Position Bottom (uT)
20	50%	0.0170	0.0173	0.0171	0.0168	0.0165	0.0166
18	50%	0.0228	0.0231	0.0229	0.0224	0.0221	0.0223
16	50%	0.0313	0.0318	0.0316	0.0309	0.0304	0.0306
14	50%	0.0446	0.0452	0.0449	0.0439	0.0433	0.0436
12	50%	0.0660	0.0669	0.0664	0.0650	0.0640	0.0645
10	50%	0.1021	0.1036	0.1028	0.1006	0.0991	0.0998
8	50%	0.1658	0.1682	0.1670	0.1634	0.1609	0.1622
6	50%	0.2814	0.2855	0.2834	0.2772	0.2731	0.2751

distance (cm)	Battery Level:	Position Left (A/m)	Position Right (A/m)	Position Rear (A/m)	Position Front (A/m)	Position Top (A/m)	Position Bottom (A/m)	50% Limits (A/m)	Limits (A/m)
20	50%	0.0136	0.0138	0.0137	0.0134	0.0132	0.0133	0.815	1.63
18	50%	0.0182	0.0185	0.0183	0.0179	0.0177	0.0178	0.815	1.63
16	50%	0.0251	0.0254	0.0252	0.0247	0.0243	0.0245	0.815	1.63
14	50%	0.0357	0.0362	0.0359	0.0351	0.0346	0.0349	0.815	1.63
12	50%	0.0528	0.0535	0.0532	0.0520	0.0512	0.0516	0.815	1.63
10	50%	0.0816	0.0829	0.0822	0.0804	0.0792	0.0798	0.815	1.63
8	50%	0.1326	0.1346	0.1336	0.1307	0.1287	0.1297	0.815	1.63
6	50%	0.2251	0.2284	0.2267	0.2218	0.2185	0.2201	0.815	1.63

H-Filed Strength at (distance from 6cm to 20cm at 2cm iteration) surrounding the EUT (A/m):

distance (cm)	Battery Level:	Position Left (uT)	Position Right (uT)	Position Rear (uT)	Position Front (uT)	Position Top (uT)	Position Bottom (uT)
20	>98%	0.0168	0.0169	0.0170	0.0161	0.0163	0.0164
18	>98%	0.0224	0.0226	0.0228	0.0216	0.0218	0.0219
16	>98%	0.0309	0.0311	0.0313	0.0297	0.0299	0.0302
14	>98%	0.0439	0.0443	0.0446	0.0423	0.0426	0.0429
12	>98%	0.0650	0.0655	0.0660	0.0626	0.0630	0.0635
10	>98%	0.1006	0.1013	0.1021	0.0968	0.0976	0.0983
8	>98%	0.1634	0.1646	0.1658	0.1573	0.1585	0.1597
6	>98%	0.2772	0.2793	0.2814	0.2669	0.2689	0.2710

distance (cm)	Battery Level:	Position Left (A/m)	Position Right (A/m)	Position Rear (A/m)	Position Front (A/m)	Position Top (A/m)	Position Bottom (A/m)	50% Limits (A/m)	Limits (A/m)
20	>98%	0.0134	0.0135	0.0136	0.0129	0.0130	0.0131	0.815	1.63
18	>98%	0.0179	0.0181	0.0182	0.0173	0.0174	0.0175	0.815	1.63
16	>98%	0.0247	0.0249	0.0251	0.0238	0.0240	0.0241	0.815	1.63
14	>98%	0.0351	0.0354	0.0357	0.0338	0.0341	0.0344	0.815	1.63
12	>98%	0.0520	0.0524	0.0528	0.0501	0.0504	0.0508	0.815	1.63
10	>98%	0.0804	0.0810	0.0816	0.0774	0.0780	0.0786	0.815	1.63
8	>98%	0.1307	0.1317	0.1326	0.1258	0.1268	0.1278	0.815	1.63
6	>98%	0.2218	0.2234	0.2251	0.2135	0.2152	0.2168	0.815	1.63

Note: A/m = uT/1.25

H-Filed Strength at (distance from 4cm to 0cm) surrounding the EUT (A/m):

distance (cm)	Battery Level:	Position Left (A/m)	Position Right (A/m)	Position Rear (A/m)	Position Front (A/m)	Position Top (A/m)	Position Bottom (A/m)	50% Limits (A/m)	Limits (A/m)
4	<1%	0.3944	0.4001	0.3916	0.3972	0.3887	0.3859	0.815	1.63
4	50%	0.3859	0.3916	0.3887	0.3802	0.3745	0.3774	0.815	1.63
4	>98%	0.3802	0.3830	0.3859	0.3660	0.3689	0.3717	0.815	1.63
2	<1%	0.6192	0.6278	0.6144	0.6233	0.6100	0.6055	0.815	1.63
2	50%	0.6055	0.6144	0.6100	0.5966	0.5877	0.5922	0.815	1.63
2	>98%	0.5966	0.6011	0.6055	0.5744	0.5788	0.5833	0.815	1.63
0	<1%	0.7460	0.7563	0.7402	0.7510	0.7349	0.7295	0.815	1.63
0	50%	0.7295	0.7402	0.7349	0.7188	0.7081	0.7134	0.815	1.63
0	>98%	0.7188	0.7241	0.7295	0.6920	0.6973	0.7027	0.815	1.63

Note: Biot-Savar law:

1. Magnetic field on the axis of a current-carrying circle coil:

$$B = \frac{u_0 I R^2}{2(R^2+X^2)^{\frac{3}{2}}}$$

R is the coil outside diameter radius.

X is the distance from the test point to the center of the coil circle.

B is the magnetic magnetic field.

2. According to the KDB 680106, the model needs to be validated by probe measurements at the two points closest to the surface of the device, in 2cm increments, and if there is a 30% agreement between the model and the (E-field and/or h-field) probe measurements, the validation is considered sufficient.

3. We derived the field strengths at 10cm to 8cm and 8cm to 6cm, respectively, which are close to the actual test values, based on the field strength at 6 cm, the field strength at 4cm and 2cm and 0 cm can be deduced.

4. A table of error data between the assessed and measured values:

distance (cm)	Measurements (A/m)	distance (cm)	Assessed (A/m)	Error (%)	Limit (%)
10	0.0829	\	\	\	\
8	0.1342	10 to 8	0.1307	2.61	<30
6	0.2289	8 to 6	0.2218	3.10	<30

5. Calculation process:

distance (cm)	Battery Level:	Position Left (A/m)
8	<1%	0.1357
6	<1%	0.2302
4	<1%	0.3944
2	<1%	0.6192
0	<1%	0.7460

8cm: $u_0IR^2 = B * 2(R^2 + X^2)^{\frac{3}{2}} = 0.1357 * 2(0.055^2 + 0.08^2)^{\frac{3}{2}} = 0.000248246$

To 6cm: $B = \frac{u_0IR^2}{2(R^2+X^2)^{\frac{3}{2}}} = \frac{0.000248246}{2(0.055^2+0.06^2)^{\frac{3}{2}}} = 0.2302$

6cm: $u_0IR^2 = B * 2(R^2 + X^2)^{\frac{3}{2}} = 0.2302 * 2(0.055^2 + 0.06^2)^{\frac{3}{2}} = 0.000248246$

To 4cm: $B = \frac{u_0IR^2}{2(R^2+X^2)^{\frac{3}{2}}} = \frac{0.000248246}{2(0.055^2+0.04^2)^{\frac{3}{2}}} = 0.3944$

4cm: $u_0IR^2 = B * 2(R^2 + X^2)^{\frac{3}{2}} = 0.3944 * 2(0.055^2 + 0.04^2)^{\frac{3}{2}} = 0.000248246$

To 2cm: $B = \frac{u_0IR^2}{2(R^2+X^2)^{\frac{3}{2}}} = \frac{0.000248246}{2(0.055^2+0.02^2)^{\frac{3}{2}}} = 0.6192$

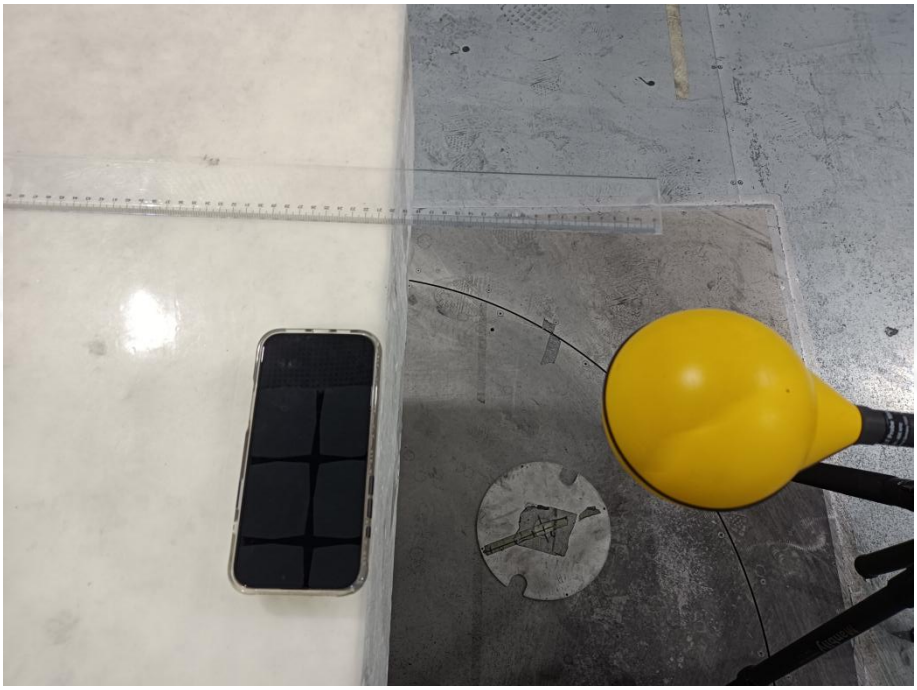
2cm: $u_0IR^2 = B * 2(R^2 + X^2)^{\frac{3}{2}} = 0.6189 * 2(0.055^2 + 0.02^2)^{\frac{3}{2}} = 0.000248246$

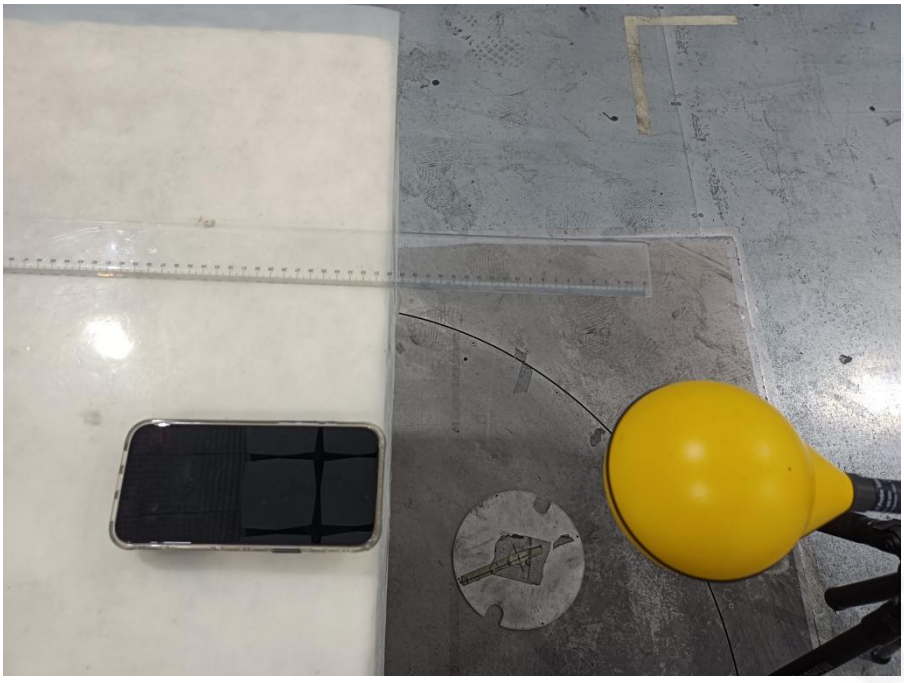
To 0cm: $B = \frac{u_0IR^2}{2(R^2+X^2)^{\frac{3}{2}}} = \frac{0.000248246}{2(0.055^2+0^2)^{\frac{3}{2}}} = 0.7460$

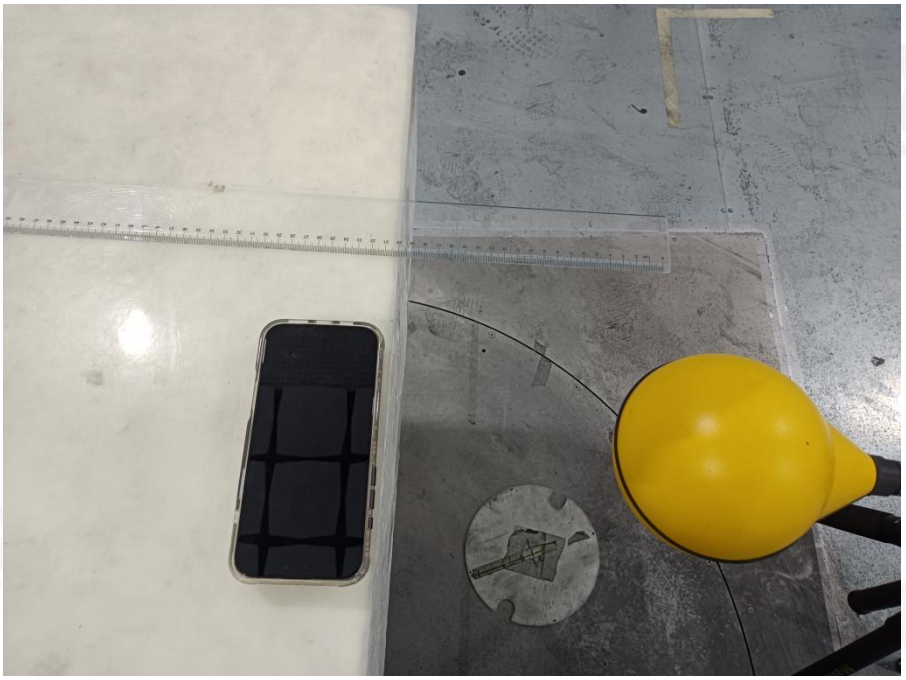
6 Test Set-up Photo

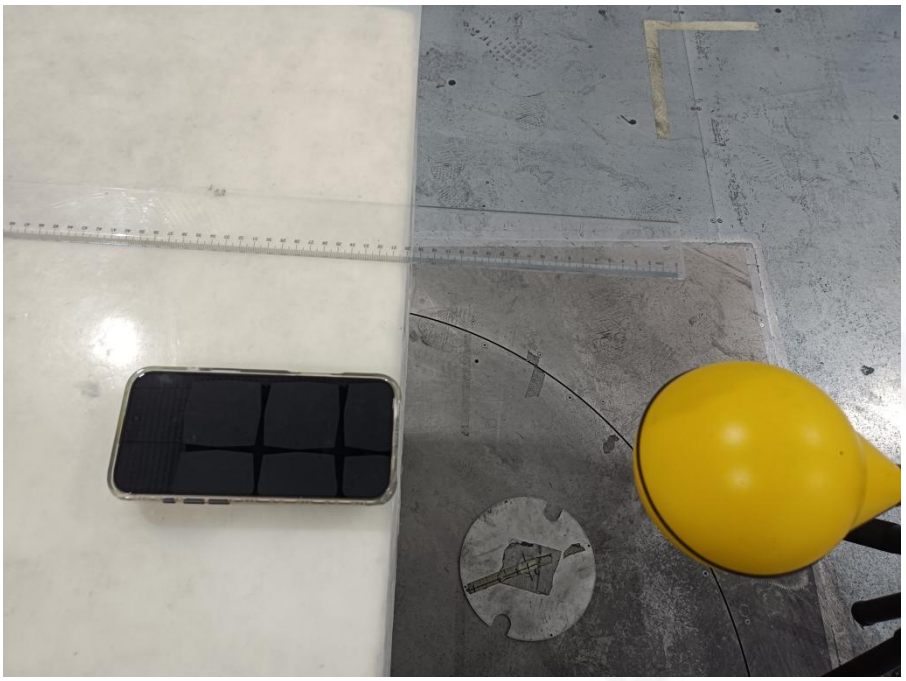
Probe	Length	Width	Radius
	11cm	11cm	5.5cm

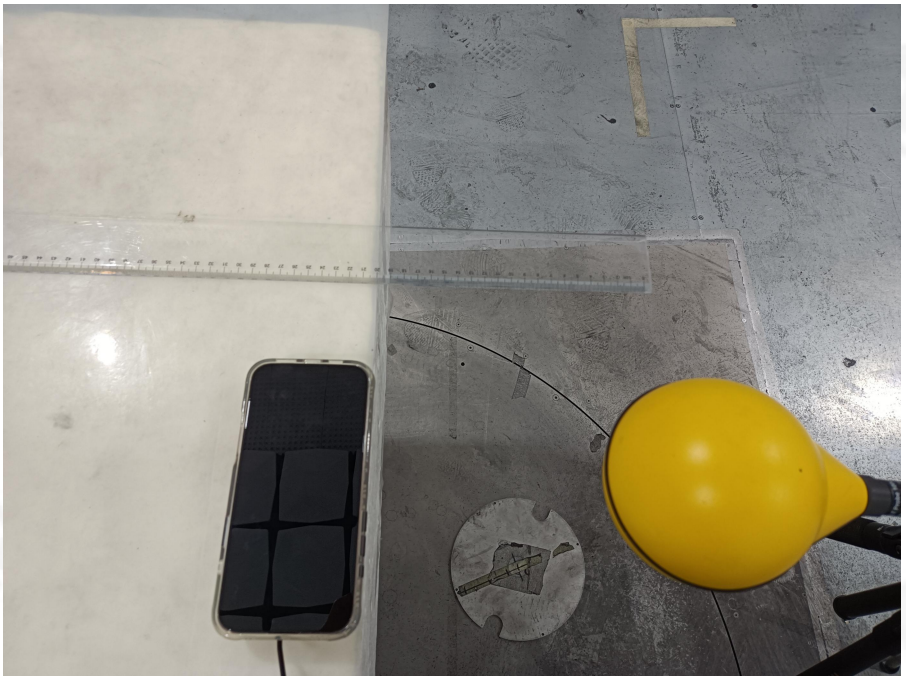
Test distance: 20cm

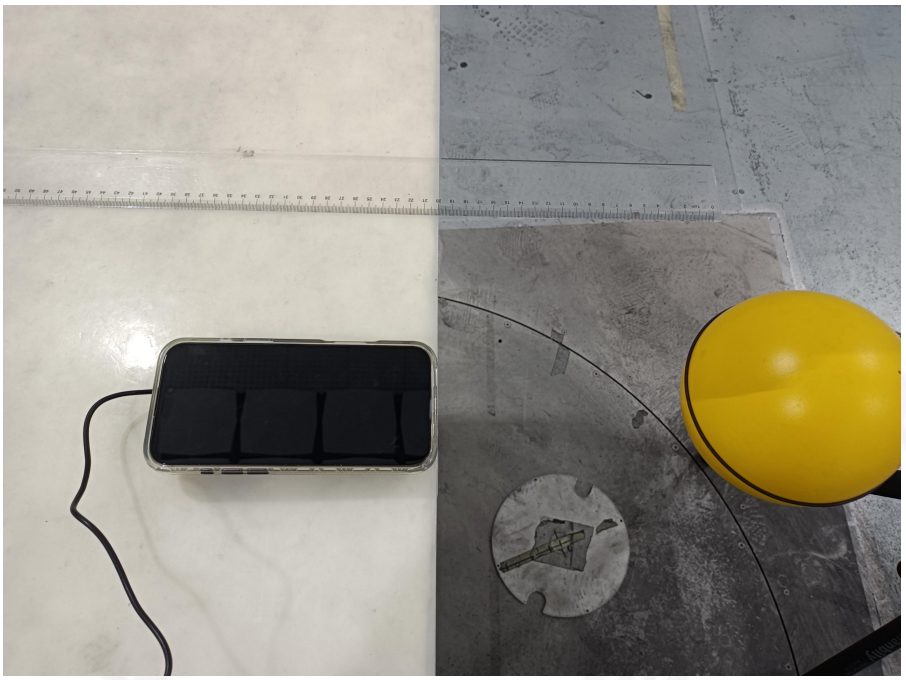


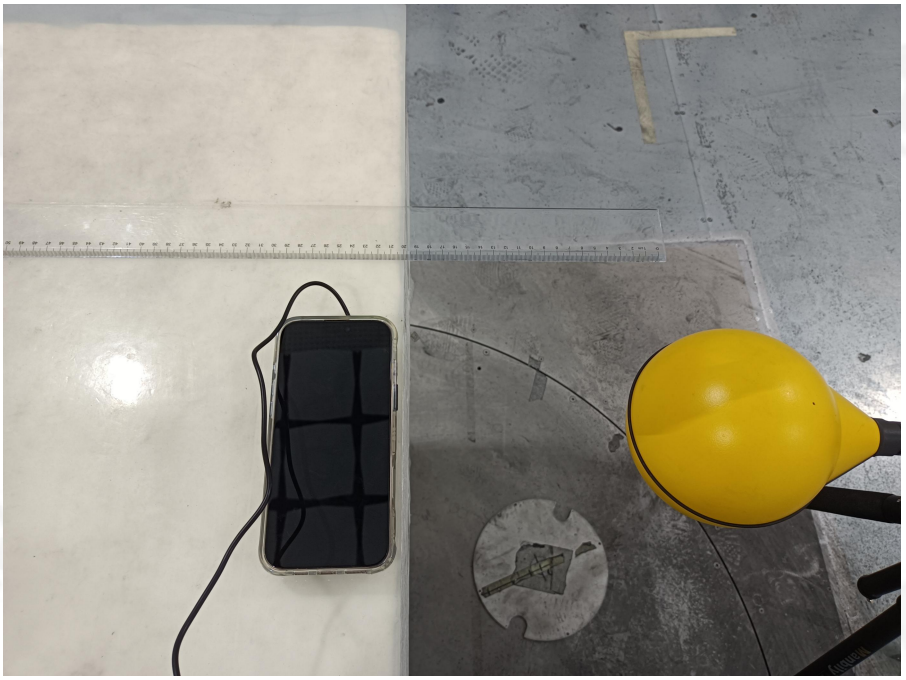


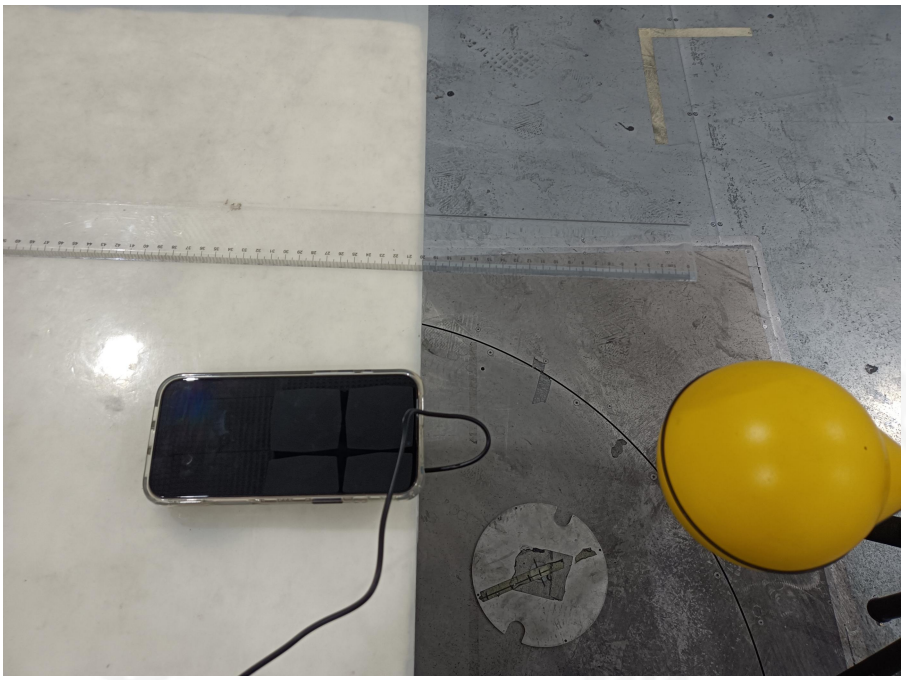


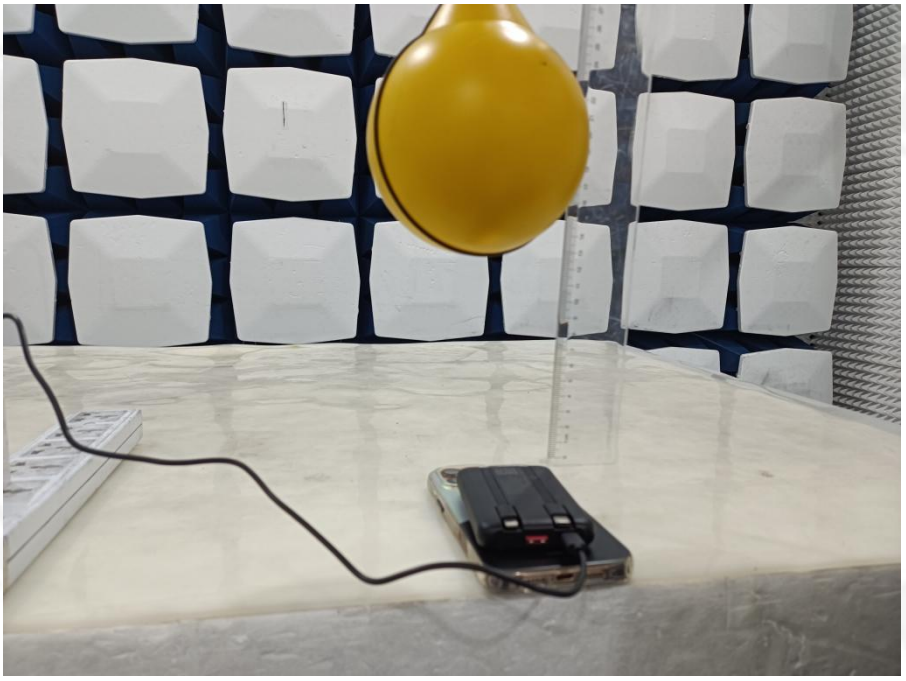


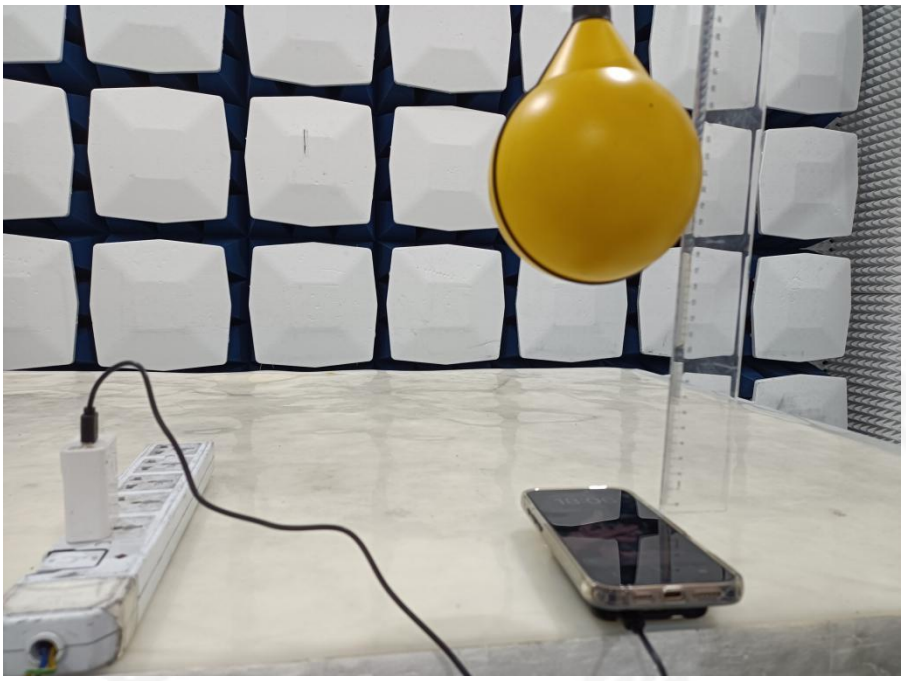












Test distance: 6cm