

TEST REPORT

of

FCC CFR 47 part1, 1.1307(b), 1.1310

FCC ID: 2AV76-NMOK-351W

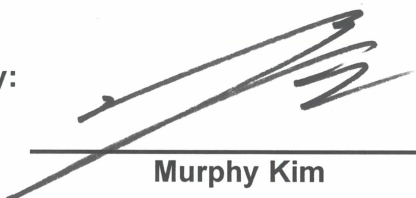
Equipment Under Test : WIRELESS POWER CHARGING SYSTEM
Model Name : NMOK-351W
Variant Model Name(s) : -
Applicant : NIDEC MOBILITY KOREA CORPORATION
Manufacturer : NIDEC MOBILITY KOREA CORPORATION
Date of Receipt : 2023.05.02
Date of Test(s) : 2023.05.03 ~ 2023.11.14
Date of Issue : 2023.11.14

In the configuration tested, the EUT complied with the standards specified above. This test report does not assure KOLAS accreditation.

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- 2) The SGS Korea is not responsible for the sampling, the results of this test report apply to the sample as received.
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- 4) The data marked ※ in this report was provided by the customer and may affect the validity of the test results.

We are responsible for all the information of this test report except for the data(※) provided by the customer.

Tested by:


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Report Number: F690501-RF-RTL004557

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1. General Information

1.1. Testing Laboratory

SGS Korea Co., Ltd. (Gunpo Laboratory)

- 10-2, LS-ro 182beon-gil, Gunpo-si, Gyeonggi-do, Korea, 15807
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- Designation number: KR0150

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1.2. Details of Applicant

Applicant : NIDEC MOBILITY KOREA CORPORATION

Address : 790-12, Bogaewonsam-ro, Bogae-myeon, Anseong-si, Gyeonggi-do, South Korea, 17507

Contact Person : Nam, Sang-il

Phone No. : +82 2 850 5789

1.3. Details of Manufacturer

Company : Same as applicant

Address : Same as applicant

1.4. Description of EUT

Kind of Product	WIRELESS POWER CHARGING SYSTEM	
Model Name	NMOK-351W	
Serial Number	0001	
Power Supply	DC 12 V	
Operation Mode	5 W, 10 W, Idle	
Frequency Range	5 W	127 ~ 129 kHz
	10 W	127 ~ 129 kHz
	Idle	127 ~ 129 kHz
Antenna Type	Coil Antenna	
Antenna Part Number	N/A	
H/W Version	1.00	
S/W Version	1.00	

1.5. Test Equipment List

Equipment	Manufacturer	Model	S/N	Cal. Date	Cal. Interval	Cal. Due
Electric and Magnetic field Probe analyzer	NARDA	EHP 200AC	170WX91017	Dec. 19, 2022	Annual	Dec. 19, 2023
DC Power Supply	Agilent	U8002A	MY50020026	Nov. 30, 2022	Annual	Nov. 30, 2023
Anechoic Chamber	SY Corporation	L × W × H (9.6 m × 6.4 m × 6.6 m)	N/A	N.C.R.	N/A	N.C.R.

► Support Equipment

Description	Manufacturer	Model	FCC ID
SAMSUNG Mobile Phone	Samsung Electronics Co., Ltd.	SM-N975U	A3LSMN975U
Lap top	Dell	Latitude 3510	-

1.6. Summary of Test Results

The EUT has been tested according to the following specifications:

APPLIED STANDARD: FCC Part 1 Subpart I		
Section	Test Item(s)	Result
1.1307(b) 1.1310(e)(1)	Electronic Field, Magnetic Field	Complied

1.7. Test Report Revision

Revision	Report Number	Date of Issue	Description
0	F690501-RF-RTL004557	2023.11.14	Initial

1.8. Measurement Uncertainty

Where relevant, the following measurement uncertainty levels have been estimated for tests performed on the apparatus:

Parameter	Uncertainty
Electric Field	19.44 %
Magnetic Field	19.86 %

All measurement uncertainty values are shown with a coverage factor of $k=2$ to indicate a 95 % level of confidence.

1.9. Worst Case of Test Configurations

In order to check all kinds of possible configurations, EUT was evaluated with appropriate client and under each charging condition as below table.

Charging mode with client device	Mode		Description
Model: SM-N975U FCC ID: A3LSMN975U	5 W	10 W	1 % of battery 50 % of battery 99 % of battery
	127 ~ 129 kHz	127 ~ 129 kHz	

Mode	Battery	Frequency (kHz)	E-field Strength (V/m)	H-field Strength (A/m)
5 W	1 %	127 ~ 129	<u>69.632</u>	<u>1.216</u>
	50 %		69.307	1.207
	99 %		68.126	1.193
10 W	1 %	127 ~ 129	<u>68.398</u>	<u>1.226</u>
	50 %		68.193	1.203
	99 %		67.493	1.188

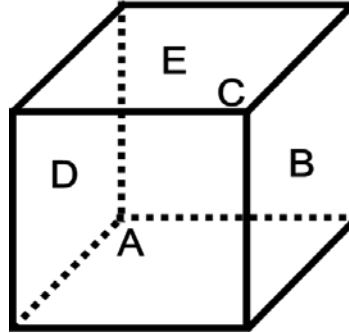
Note;

- EUT was investigated with client device under normal charging condition as above then worst value was only reported.

2. Test Result

2.1. Isotropic Probe Test Setup

The measurement probe (EHP-200AC) is a regular hexahedron and supports 3-axis 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.

- 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	-

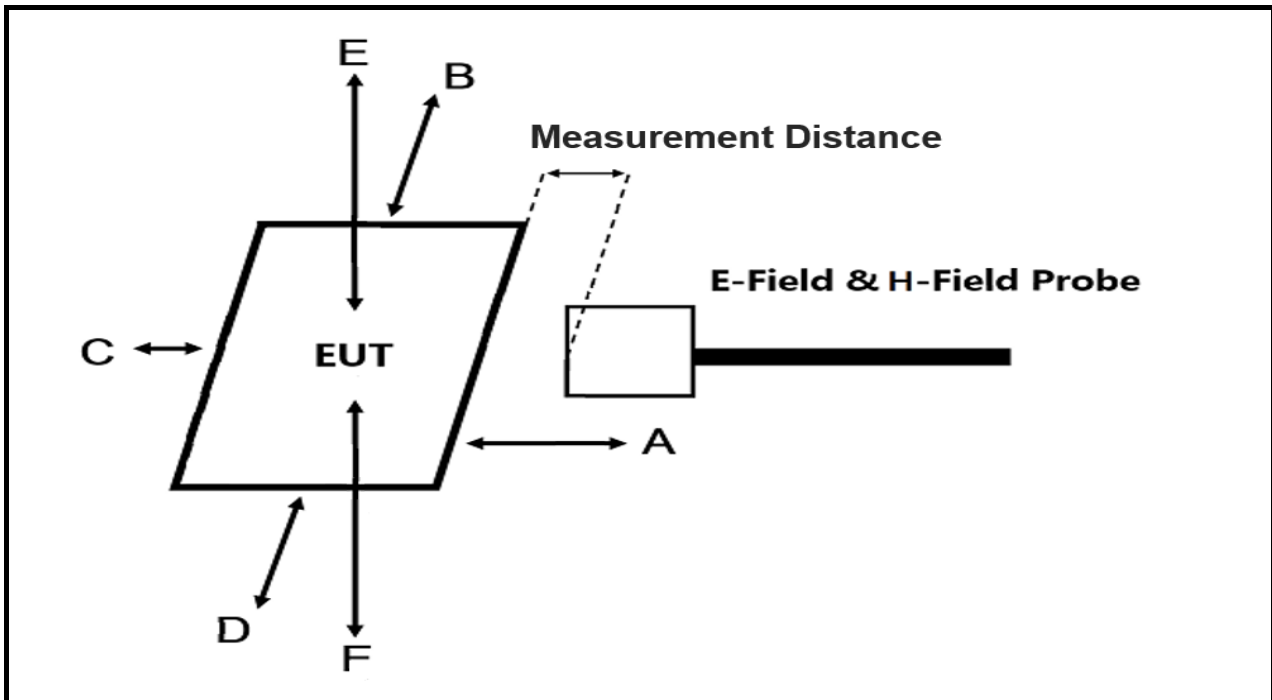
- When the worst angle among all angles was found, RF exposure measurement should be adjusted from worst angle.

- Worst Case

E-field: One of the several angles was found as Side D of isotropic probe.

H-field: One of the several angles was found as Side C of isotropic probe.

2.2. EUT Test Setup



2.3. Measurement procedure

- The RF exposure test was performed in anechoic chamber.
- The measurement probe was placed at test distance (0, 2, 4, 6, 8, 10, 15 cm) which is between the edge of the charger and the edge of probe.
- Measurement was performed on each side of the EUT as described above picture (A, B, C, D, E, F).
- The EUT was measured according to the dictates of KDB 680106 D01 Wireless Power Transfer v 04.

Note;

- Each sensing element of probe is located 8 mm below the external surface.

2.4. Environmental evaluation and exposure limit according to FCC CFR 47 part 1, 1.1307(b), 1.1310.

§1.1310: The criteria listed in the following table shall be used to evaluate the environment impact of human exposure to radio frequency (RF) radiation as specified in §1.1307(b), except in the case of portable devices which shall be evaluated according to the provisions of FCC part 2.1093 of this chapter.

Table 1 to § 1.1310(e)(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)	Average Time (minutes)
(i) Limits for Occupational /Control 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
300-1 500	-	-	f/300	<6
1 500-100 000	-	-	5	<6
(ii) Limits for General Population/Uncontrolled Exposures				
<u>0.3-1.34</u>	<u>614</u>	<u>1.63</u>	*(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
1 500-100 000	-	-	1.0	<30

f = frequency in MHz. * = Plane wave equivalent power density.

2.5. E and H field strength

Ambient temperature : (23 ± 1) °C
Relative humidity : 47 % R.H.

2.5.1. E-Field Strength at from the edges surrounding the EUT

Test Condition: 5 W Operating mode with client device (1 % battery status of client device)

Frequency (kHz)	Distance (cm)	EUT Sides						Limits (V/m)
		A (V/m)	B (V/m)	C (V/m)	D (V/m)	E (V/m)	F (V/m)	
127 ~ 129	15	2.582	1.785	2.134	1.519	4.326	0.596	614
	10	4.776	3.138	4.529	2.505	7.810	0.825	
	8	5.989	4.168	5.905	3.651	13.155	1.134	
	6	8.103	5.522	8.590	5.844	18.304	1.329	
	4	13.734	7.648	13.283	8.456	24.236	1.827	
	2	18.699	15.278	21.824	12.565	41.371	2.699	
	Contact	25.075	21.870	28.081	16.337	69.632	3.460	

Test Condition: 10 W Operating mode with client device (1 % battery status of client device)

Frequency (kHz)	Distance (cm)	EUT Sides						Limits (V/m)
		A (V/m)	B (V/m)	C (V/m)	D (V/m)	E (V/m)	F (V/m)	
127 ~ 129	15	2.551	2.323	2.484	1.765	5.043	0.976	614
	10	4.839	4.449	5.057	3.339	9.050	1.434	
	8	7.213	5.899	6.880	4.452	11.626	1.374	
	6	9.262	7.591	10.254	6.020	19.453	1.541	
	4	13.395	11.506	16.683	10.456	32.523	1.723	
	2	20.276	16.225	23.616	14.046	43.920	2.478	
	Contact	31.321	25.821	35.675	17.030	68.398	3.116	

Test Condition: Idle

Frequency (kHz)	Distance (cm)	EUT Sides						Limits (V/m)
		A (V/m)	B (V/m)	C (V/m)	D (V/m)	E (V/m)	F (V/m)	
127 ~ 129	15	0.380	0.380	0.380	0.415	0.362	0.850	614
	10	0.391	0.374	0.371	0.362	0.391	1.392	
	8	0.362	0.389	0.370	0.362	0.380	1.474	
	6	0.371	1.203	0.364	0.373	0.407	1.874	
	4	0.429	4.008	0.404	0.366	5.740	2.174	
	2	7.149	5.101	0.953	0.389	33.470	1.828	
	Contact	13.877	6.864	3.602	0.543	<u>56.469</u>	2.413	

2.5.2. H-Field Strength at from the edges surrounding the EUT

Test Condition: 5 W Operating mode with client device (1 % battery status of client device)

Frequency (kHz)	Distance (cm)	EUT Sides						Limits (A/m)
		A (A/m)	B (A/m)	C (A/m)	D (A/m)	E (A/m)	F (A/m)	
127 ~ 129	15	0.171	0.166	0.178	0.161	0.171	0.158	1.63
	10	0.234	0.261	0.279	0.220	0.228	0.184	
	8	0.293	0.278	0.304	0.289	0.231	0.274	
	6	0.497	0.426	0.589	0.390	0.345	0.339	
	4	0.770	0.590	0.824	0.484	0.476	0.508	
	2	0.994	0.898	1.140	0.663	0.758	0.762	
	Contact	1.100	1.186	<u>1.216</u>	0.843	1.015	1.158	

Test Condition: 10 W Operating mode with client device (1 % battery status of client device)

Frequency (kHz)	Distance (cm)	EUT Sides						Limits (A/m)
		A (A/m)	B (A/m)	C (A/m)	D (A/m)	E (A/m)	F (A/m)	
127 ~ 129	15	0.164	0.166	0.164	0.166	0.166	0.166	1.63
	10	0.260	0.207	0.264	0.224	0.159	0.234	
	8	0.330	0.203	0.380	0.236	0.164	0.212	
	6	0.407	0.302	0.408	0.385	0.164	0.346	
	4	0.643	0.466	0.671	0.564	0.201	0.467	
	2	0.981	0.858	1.033	0.836	0.280	0.855	
	Contact	1.089	1.119	1.160	1.099	0.404	<u>1.226</u>	

Test Condition: Idle

Frequency (kHz)	Distance (cm)	EUT Sides						Limits (A/m)
		A (A/m)	B (A/m)	C (A/m)	D (A/m)	E (A/m)	F (A/m)	
127 ~ 129	15	0.158	0.159	0.159	0.161	0.157	0.159	1.63
	10	0.159	0.158	0.166	0.156	0.159	0.168	
	8	0.156	0.166	0.183	0.191	0.197	0.163	
	6	0.159	0.171	0.194	0.242	0.173	0.178	
	4	0.360	0.434	0.248	0.330	0.274	0.234	
	2	0.571	0.961	0.566	0.535	0.766	0.335	
	Contact	0.649	<u>1.235</u>	0.625	0.551	1.150	0.350	

2.6. H-Field Strength Calculation of the EUT

2.6.1. Calculation of μ_r (relative permeability)

According to the self-inductance formula, μ_r (relative permeability) can be obtained.

$$x = \sqrt{1 + \left(\frac{d}{2l}\right)^2}$$

$$L = 2l \left[\ln \left\{ \left(\frac{2l}{d} \right) (1 + x) \right\} - x + \frac{\mu_r}{4} + \frac{d}{2l} \right]$$

$$\mu_r = 4 \left[\frac{L}{2l} - \ln \left\{ \left(\frac{2l}{d} \right) (1 + x) \right\} + x - \frac{d}{2l} \right]$$

Where;

L: self inductance [nH], Qi specification of WIRELESS POWER CONSORTIUM

d: diameter of the wire [cm]

l: length of the wire in [cm]

μ_r : relative permeability

L [nH]	d [cm]	l [cm]	μ_r
11 500	0.115	153	120.01

2.6.2. Calculation of theoretical H-field strength with Biot-Savart's law

According to Biot-Savart law, the value of the B-field at the distance z from the coil is expressed as follows.

$$B_z = \frac{\mu_0 I R^2}{2(R^2 + z^2)^{3/2}}$$

Convert the value of the B-field to the H-field.

$$B_z = \mu_0 \times H_z,$$

$$H_z = \frac{I R^2}{2(R^2 + z^2)^{3/2}}$$

Considering the number of turns and relative permeability of coil, it is expressed as follows.

$$H_z = \frac{I R^2}{2(R^2 + z^2)^{3/2}} \times \frac{N}{\mu_r}$$

Where;

I: the maximum current to the EUT during charging can be obtained from the power supply equipment [A]

R: the radial of EUT's coil antenna [m]

z: the distance from the coil antenna to the point to be measured [m]

N: the number of turns in the coil

μ_r : relative permeability

Test Condition	I [A]	R [m]	μ_r	N	z [m]	Actual measuring distance ³⁾ [m]	Theoretical H-field value [A/m]
5 W	1	0.027	120.01	12	0.020 ¹⁾	0.008	0.961
					0.012 ²⁾	0	1.413
10 W	1	0.027	120.01	12	0.020 ¹⁾	0.008	0.961
					0.012 ²⁾	0	1.413

Note;

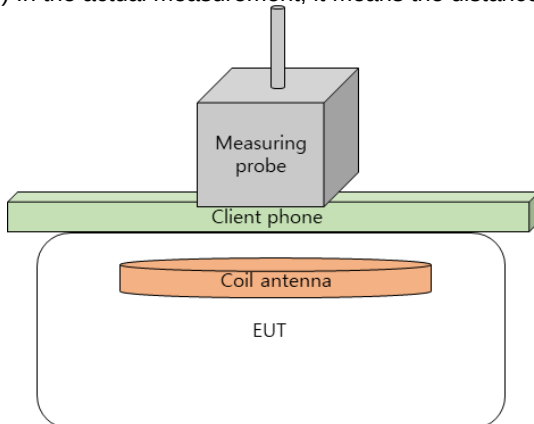
1) Distance z is from the EUT's coil antenna to the measurement point and includes all of the following.

- 4 mm, the gap from EUT's coil antenna to edge of the EUT
- 8 mm, the client phone thickness
- 8 mm, the gap from edge of measuring probe to sensing elements of measuring probe

2) Distance z is from the EUT's coil antenna to the measurement point and includes all of the following.

- 4 mm, the gap from EUT's coil antenna to edge of the EUT
- 8 mm, the client phone thickness

3) In the actual measurement, it means the distance between the EUT and the sensing elements of the probe.



8 mm, the gap from edge of measuring probe to sensing material

8 mm, the client phone thickness

4 mm, the gap from EUT's coil antenna to edge of the EUT

2.6.3. The validation of H-field strength

Frequency (kHz)	Test Condition	Distance (cm)	Theoretical H-field value [A/m]	30 % tolerance of theoretical H-field value [A/m]		Measured value [A/m]	Limits [A/m]
				Min.	Max		
127 ~ 129	5 W (1 % battery status of client device)	Contact ¹⁾	0.961	0.673	1.249	1.216	1.63
127 ~ 129	10 W (1 % battery status of client device)	Contact ¹⁾	0.961	0.673	1.249	1.226	

Note;

- 1) Probe has 4 mm radius enclosure but each sensing element is located 8 mm from the probe edge.
Therefore, actual distance in measurement is 8 mm.

2.6.4. The estimation of H-field strength

Frequency (kHz)	Test Condition	Distance (cm)	EUT Sides E	Limits [A/m]
			Theoretical H-field value [A/m]	
127 ~ 129	5 W (1 % battery status of client device)	0	1.413	1.63
127 ~ 129	10 W (1 % battery status of client device)	0	1.413	

Estimation formula and theoretical value have 30% agreement with actual measurement. Estimation for 0mm field strength with validated formula complies limit.

- End of the Test Report -