DEKRA Certification, Inc.
405 Glenn Dr. Suite 12,
Sterling, VA 20164
United States of America

Test report No:
4465ERM.007

Assessment report
RF EXPOSURE REPORT ACCORDING TO
IEEE Std C95.3-2002
FCC 47 CFR Part 2.1093

(*) Identification of item tested	Wireless Charging Module
(*) Trademark	Aptiv
(*) Model and /or type reference tested	WCM_tx1
Other identification of the product	FCC: L2C0091TR IC ID: 3432A-0091TR HVIN: 1356 4197
(*) Features	NFC, PLA FOD
Manufacturer	APTIV SERVICES US, LLC. 13085 Hamilton Crossing Blvd, Carmel, Indiana, 46032, USA
Test method requested, standard	IEEE Std C95.3-2002: "IEEE Recommended Practice for Measurements and Computations of Radio Frequency Electromagnetic Fields With Respect to Human Exposure to Such Fields, 100 kHz–300 GHz". FCC 47 CFR Part 2.1093. Radiofrequency radiation exposure evaluation: portable devices. FCC 47 CFR Part 1.1307: Actions that may have a significant environmental effect, for which Environmental Assessments (EAs) must be prepared.
Summary	IN COMPLIANCE
Approved by (name / position & signature)	Domingo Galvez EMC&RF Lab Manager  Digitally signed by Domingo Galvez DN: cn=Domingo Galvez, o=Dekra Certification Inc., ou=Regulatory Lab Manager, email=domingo.galvez@dekra.com, c=US
Date of issue	04-02-2024
Report template No	FERMUSA_199 (*) "Data provided by the client"

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In order to assure the traceability to other national and international laboratories, DEKRA Certification Inc. has a calibration and maintenance program for its measurement equipment.

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Uncertainties

Uncertainty (factor k=2) was calculated according to the DEKRA Certification internal document PODT000**.**

Frequency (MHz)	Uncertainty (dB)	Uncertainty	Field
0.03 – 0.09	3.87	1.56	Electric (V/m)
0.03 – 0.09	2.60	1.34	Magnetic (A/m)
0.09 - 10	0.85	1.10	Electric (V/m)
0.09 - 10	0.71	1.09	Magnetic (A/m)

Data provided by the client

The following data has been provided by the client:

1. Information relating to the description of the sample ("Identification of the item tested", "Trademark", "Model and/or type reference tested").

2. The sample consists of the Wireless Charging Module version 3.1 (WCM3.1), Model A & B charges consumer electronics (CE) devices wirelessly by supplying power under the Wireless Power Consortium (WPC) Qi v1.3 charging standard. The power source to the WCM is 12V vehicle battery. CAN bus is the communication interface to the vehicle. WCM3.1 is a non-terminating CAN node with output pins provisioned for a daisy-chain connection to additional downstream CAN nodes. The WCM supports functionality for detecting foreign objects, such as coins, keys, or RFID tags; and halting or prohibiting charging while the foreign object remains present on the interface surface. The WCM is capable of delivering up to 15W to the compatible CE device.

3. Applicant's declaration letter shown below for model similarity.

APTIV

February 22, 2024

John Gettel
Systems Engineering Manager
Aptiv
5725 Innovation Drive
Troy, MI 48098

RE

To whom it may concern,

The GM Wireless Charging Module **WCM_tx1** includes four variants.

The four variants include the hardware versions / HVIN;

1356 4197
1356 4198
1356 4199
1356 4200

The funtional behavoir (RF, EMC, Qi, NFC) of all four hardware versions is identical.

The material of all four hardware versions, plastic resin, PCB and components, is eaxctly the same. The pinouts of all four hardware versions, is eaxctly the same.

The differences between the hardware versions is associated with the mounting location within the vehicle.

These differences are;

1) Housing Locating Notches
    a. Each separate hardware version has a different housing locating notch which allows only the individual wireless chargers to be installed in a specific location within the vehicle.

2) Vehicle Hareness Connetor Keying
    a. Each separate hardware version has a different vehicle connector key which allows only the wireless charger designed for that location to be connected to the vehicle harness at that location.

Sincerely,

John Gettel

5725 Innovation Drive | Troy | Michigan | United States

DEKRA declines any responsibility with respect to the information provided by the client and that may affect the validity of results.

Usage of samples

Samples undergoing test have been selected by the client

Sample S/01 is composed of the following elements:

Control Nº	Description	Model	Serial Nº	Date of reception
4465/08	GM WCM PV2 - model A	WCM_tx1	-	2/12/2024
4030/14	Harness	-	-	11/29/2023
4030/07	Load	-	-	11/29/2023

1. Sample S/01 has undergone the test(s) specified in subclause “Test method requested”.

Identification of the client

APTIV SERVICES US, LLC.
5725 Innovation Drive,
Troy, Michigan 48098,
USA

Testing period and place

Test Location	DEKRA Certification Inc.
Date (start)	02-19-2024
Date (finish)	02-20-2024

Document history

Report number	Date	Description
4465ERM.007	04-02-2024	First release

General description of the device under evaluation

The test sample consist of the Wireless Charging Module version 3.1 (WCM3.1), Model A & B charges consumer electronics (CE) devices wirelessly by supplying power under the Wireless Power Consortium (WPC) Qi v1.3 charging standard. The power source to the WCM is 12V vehicle battery. CAN bus is the communication interface to the vehicle. WCM3.1 is a non-terminating CAN node with output pins provisioned for a daisy-chain connection to additional downstream CAN nodes. The WCM supports functionality for detecting foreign objects, such as coins, keys, or RFID tags; and halting or prohibiting charging while the foreign object remains present on the interface surface. The WCM is capable of delivering up to 15W to the compatible CE device.

In order to perform the assessment for the Qi wireless technology a conservative evaluation distance <=10cm has been used.

Environmental conditions

In the control chamber, the following limits were not exceeded during the test:

Temperature	Min. = 15 ºC Max. = 35 ºC
Relative humidity	Min. = 30 % Max. = 75 %
Air pressure	Min. = 860 mbar Max. = 1060 mbar

Remarks and comments

The tests have been performed by the technical personnel: Ivy Yousuf Moutushi, Prudhvi Kothapalli and Koji Nishimoto.

Testing verdicts

Not applicable :	N/A
Pass :	P
Fail :	F
Not measured :	N/M

FCC 47 CFR § 2.1093 & ISED RSS 102 ISSUE 5 AMD 1 & ISED RSS 102-SPR-002 ISSUE 2	VERDICT			
	N/A	P	F	NM
NFC				NM(1)
Qi Wireless Charger		P		

1: Technology not subject to testing. Verdict has been determined through RF Exposure assessment (see Appendix A).

List of equipment used during the test

CONTROL NUMBER	DESCRIPTION	MANUFACTURER	MODEL	LAST CALIBRATION	NEXT CALIBRATION
1107	ETHERNET SNMP THERMOMETER	HW GROUP	HWg-STE Plain	2022/08	2024/08
1324	Narda EHP-200A E and H Field Analyzer	NARDA	EHP-200A	2020/09	2024/09

Appendix A: FCC RF Exposure Evaluation

RF Exposure Assessment result and verdict

According to the manufacturer, the device is installed in a vehicle and during its normal use, the separation distance between the radiating structures of the device and nearby users will be greater than 30 mm as the evaluated distance is 22mm, based on the 8mm distance is from the sensor of the probe to the edge. In order to perform the assessment a conservative evaluation distance of 2 cm has been used.

RF Exposure evaluation for the Qi wireless technology has been conducted through field measurements (see Qi Wireless Charger Evaluation section below).

NFC technology is not subjected to testing and verdict can be determined through RF Exposure assessment (see NFC RF Exposure Assessment section below).

Technology	Frequency (MHz)	Max. H-field (A/m)	Max. E-field (V/m)	Maximum Power (mW)	H-Field Limit (A/m)	E-Field Limit (V/m)	§1.1307(b)(3).i.(A) Exposure Limit (mW)	Verdict
NFC	13.56	-	-	0.0003	-	-	1.00	PASS
Qi Charger	0.128	1.40	4.91	-	1.63	614	-	PASS

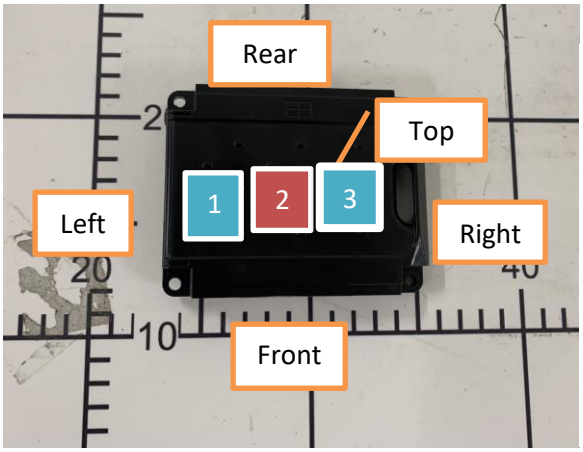
Table 1: Assessment result and Verdict

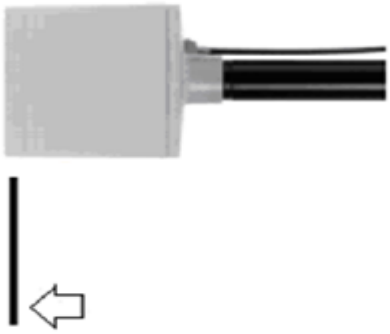
Qi Wireless Charger Evaluation

For low-power (<15W), in-vehicle applications perform H-field measurements for each edge/top surface of the host/client pair at every 2 cm, starting from as close as possible out to 10 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 <=10 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

According to “FCC 47 CFR Part 2.1093”, portable devices that transmit at frequencies above 6 GHz are to be evaluated in terms of the MPE limits specified in §1.1310 of this chapter. Measurements and calculations to demonstrate compliance with MPE field strength or power density limits for devices operating above 6 GHz should be made at a minimum distance of 5 cm from the radiating source.

Limits for Maximum Permissible Exposure (MPE) to comply with FCC 47 CFR § 2.1091 are defined in “FCC 47 CFR Part 1.1310 Radiation Exposure limits, paragraph €”:





E Field = 0cm to 10 cm

H Field = 0cm to 10 cm

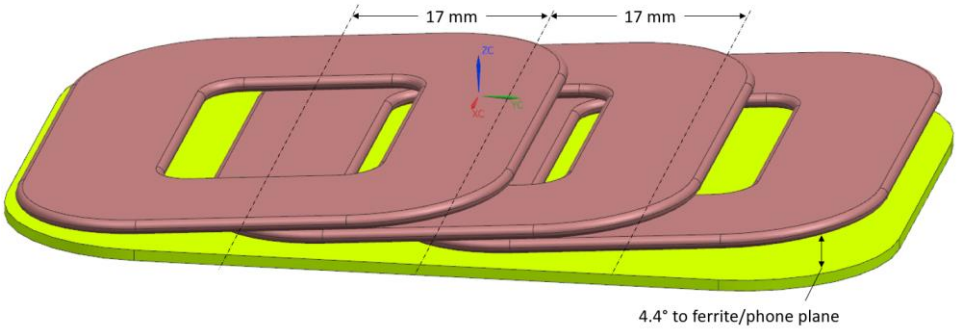


Figure 1: WPT measurement setup

The test sample Primary Coil is one from a linear array of partially overlapping Primary Coils, as appropriate for the position of the Power Receiver relative to the Primary Coils. Selection of the Primary Coil proceeds by the Power Transmitter attempting to establish communication with a Power Receiver using any of the Primary Coils. The array may consist of a single Primary Coil only.

The WPT device consists of different coils but the load is placed on top of all the coils position for which all the coils will transmit.

The below testing setup has been measured in order to assess compliance for the device.

- Setup 1 – Charging setup with a Load

For the normal charging setup, measurements at every 2 cm starting from 0cm to 10 cm distance have been performed for all device sides, at different battery charge levels. With the customer provided load, measurements were performed by placing the load on all three different coils at different charging levels.

99% Battery Charge level

Test Side	Distance to DUT (cm)	Frequency (kHz)	H- Field (A/m)	Limit (A/m)	% Limit	Verdict
Front	0	128	0.72	1.63	44.04	Pass
	2		0.47		28.81	Pass
	4		1.13		69.40	Pass
	6		0.58		35.88	Pass
	8		0.27		16.67	Pass
	10		0.18		10.86	Pass
Rear	0		1.18		72.28	Pass
	2		0.58		35.36	Pass
	4		1.33		81.40	Pass
	6		0.84		51.48	Pass
	8		0.51		31.37	Pass
	10		0.29		17.80	Pass
Left	0		0.25		15.64	Pass
	2		0.38		23.56	Pass
	4		0.96		58.83	Pass
	6		0.50		30.90	Pass
	8		0.30		18.60	Pass
	10		0.18		11.23	Pass
Right	0		0.31		18.71	Pass
	2		0.25		15.23	Pass
	4		0.19		11.75	Pass
	6		0.13		8.04	Pass
	8		0.11		6.47	Pass
	10		0.07		4.31	Pass
Top	0		1.36		83.15	Pass
	2		0.69		42.05	Pass
	4		0.37		22.92	Pass
	6		1.37		84.07	Pass
	8		0.82		50.28	Pass
	10		0.52		31.99	Pass

Table 2: H-field measurement values

Test Side	Distance to DUT (cm)	Frequency (kHz)	E- Field (V/m)	Limit (V/m)	% Limit	Verdict
Front	0	128	2.75	614	0.45	Pass
	2		1.57		0.26	Pass
	4		0.93		0.15	Pass
	6		0.62		0.10	Pass
	8		0.42		0.07	Pass
	10		0.51		0.08	Pass
Rear	0		3.40		0.55	Pass
	2		1.72		0.28	Pass
	4		0.82		0.13	Pass
	6		0.74		0.12	Pass
	8		0.56		0.09	Pass
	10		0.56		0.09	Pass
Left	0		2.99		0.49	Pass
	2		2.55		0.41	Pass
	4		2.21		0.36	Pass
	6		1.41		0.23	Pass
	8		1.51		0.25	Pass
	10		1.39		0.23	Pass
Right	0		2.34		0.38	Pass
	2		1.65		0.27	Pass
	4		1.05		0.17	Pass
	6		0.96		0.16	Pass
	8		0.77		0.12	Pass
	10		0.54		0.09	Pass
Top	0		4.77		0.78	Pass
	2		3.98		0.65	Pass
	4		2.39		0.39	Pass
	6		1.58		0.26	Pass
	8		1.11		0.18	Pass
	10		0.71		0.12	Pass

Table 3: E-field measurement values

50% Battery Charge level

Test Side	Distance to DUT (cm)	Frequency (kHz)	H- Field (A/m)	Limit (A/m)	% Limit	Verdict
Front	0	128	0.74	1.63	45.63	Pass
	2		0.46		28.25	Pass
	4		0.77		47.52	Pass
	6		0.38		23.36	Pass
	8		0.21		12.60	Pass
	10		0.11		6.59	Pass
Rear	0		1.13		69.60	Pass
	2		0.58		35.36	Pass
	4		1.22		74.56	Pass
	6		0.91		55.64	Pass
	8		0.49		30.33	Pass
	10		0.32		19.36	Pass
Left	0		1.40		85.89	Pass
	2		0.23		14.11	Pass
	4		0.83		50.97	Pass
	6		0.40		24.29	Pass
	8		0.25		15.27	Pass
	10		0.14		8.31	Pass
Right	0		0.58		35.42	Pass
	2		0.39		23.77	Pass
	4		0.23		14.21	Pass
	6		0.19		11.85	Pass
	8		0.12		7.53	Pass
	10		0.07		4.31	Pass
Top	0		1.27		78.20	Pass
	2		0.68		41.50	Pass
	4		0.35		21.49	Pass
	6		1.34		82.49	Pass
	8		0.75		46.15	Pass
	10		0.44		27.16	Pass

Table 4: H-field measurement values

Test Side	Distance to DUT (cm)	Frequency (kHz)	E- Field (V/m)	Limit (V/m)	% Limit	Verdict
Front	0	128	2.84	614	0.46	Pass
	2		1.28		0.21	Pass
	4		0.65		0.11	Pass
	6		0.48		0.08	Pass
	8		0.39		0.06	Pass
	10		0.41		0.07	Pass
Rear	0		4.35		0.71	Pass
	2		1.44		0.23	Pass
	4		0.76		0.12	Pass
	6		0.86		0.14	Pass
	8		0.59		0.10	Pass
	10		0.47		0.08	Pass
Left	0		4.91		0.80	Pass
	2		3.00		0.49	Pass
	4		1.89		0.31	Pass
	6		1.22		0.20	Pass
	8		1.17		0.19	Pass
	10		0.91		0.15	Pass
Right	0		1.97		0.32	Pass
	2		1.93		0.31	Pass
	4		1.40		0.23	Pass
	6		1.15		0.19	Pass
	8		1.06		0.17	Pass
	10		1.01		0.16	Pass
Top	0		4.84		0.79	Pass
	2		3.37		0.55	Pass
	4		1.81		0.29	Pass
	6		1.23		0.20	Pass
	8		0.79		0.13	Pass
	10		0.73		0.12	Pass

Table 5: E-field measurement values

1% Battery Charge level

Test Side	Distance to DUT (cm)	Frequency (kHz)	H- Field (A/m)	Limit (A/m)	% Limit	Verdict
Front	0	128	0.83	1.63	50.86	Pass
	2		0.47		28.92	Pass
	4		1.20		73.77	Pass
	6		0.54		33.06	Pass
	8		0.26		16.06	Pass
	10		0.15		8.90	Pass
Rear	0		1.12		68.56	Pass
	2		0.68		41.80	Pass
	4		0.31		18.87	Pass
	6		0.92		56.54	Pass
	8		0.51		31.20	Pass
	10		0.27		16.69	Pass
Left	0		0.34		20.74	Pass
	2		1.22		74.55	Pass
	4		0.72		44.37	Pass
	6		0.41		24.98	Pass
	8		0.33		20.44	Pass
	10		0.02		0.93	Pass
Right	0		0.98		60.07	Pass
	2		0.61		37.26	Pass
	4		0.37		22.67	Pass
	6		0.23		13.91	Pass
	8		0.15		9.12	Pass
	10		0.09		5.75	Pass
Top	0		1.34		82.45	Pass
	2		0.72		43.96	Pass
	4		0.39		23.71	Pass
	6		1.38		84.47	Pass
	8		0.76		46.92	Pass
	10		0.48		29.33	Pass

Table 6: H-field measurement values

Test Side	Distance to DUT (cm)	Frequency (kHz)	E- Field (V/m)	Limit (V/m)	% Limit	Verdict
Front	0	128	2.43	614	0.40	Pass
	2		1.53		0.25	Pass
	4		1.26		0.21	Pass
	6		0.85		0.14	Pass
	8		0.81		0.13	Pass
	10		0.79		0.13	Pass
Rear	0		3.86		0.63	Pass
	2		2.16		0.35	Pass
	4		1.74		0.28	Pass
	6		1.75		0.29	Pass
	8		2.09		0.34	Pass
	10		2.36		0.38	Pass
Left	0		4.77		0.78	Pass
	2		3.38		0.55	Pass
	4		3.15		0.51	Pass
	6		3.48		0.57	Pass
	8		3.53		0.58	Pass
	10		3.13		0.51	Pass
Right	0		2.64		0.43	Pass
	2		2.20		0.36	Pass
	4		1.87		0.30	Pass
	6		1.46		0.24	Pass
	8		1.26		0.20	Pass
	10		1.29		0.21	Pass
Top	0		2.72		0.44	Pass
	2		2.39		0.39	Pass
	4		1.48		0.24	Pass
	6		1.24		0.20	Pass
	8		0.91		0.15	Pass
	10		0.82		0.13	Pass

Table 7: E-field measurement values

All E-Field and H-Field values are in compliance to values shown into “Table 1: Limits for Maximum Permissible Exposure (MPE)” for the frequency range used by the device.

Simultaneous transmission assessment:

The device under evaluation is able to transmit simultaneously using NFC and WPT transmitters, therefore the most conservative approach for the evaluation of the simultaneous transmission will be:

Simultaneous technologies and modes	Result (∑ of Pout/Pmax ratios)	Verdict (∑ ≤ 1)
Qi Wireless Charging (H-Field + E-Field) + NFC	0.87	Pass

NFC output power calculation

As stated into DEKRA Certification Inc. test report num. 4465ERM.006, the maximum measured field strength value for each technology at the operating frequency is:

Operation Mode	Frequency (MHz)	Maximum E-field strength (dBµV/m) measured at 3 m
NFC	13.56	60.0

Table 4: Measurement Results

Using Field Strength Approach formula (linear terms):
$E.I.R.P = Pt \times Gt = (E \times d)^2 / 30$

Where:
Pt = transmitter output power in watts
Gt = numeric gain of the transmitting antenna (unitless)
E = electric field strength in V/m = $10^{((dB\mu V/m)/20)}/10^6$.
d = measurement distance in meters (m) = 3
So, $P_t = (E \times d)^2 / (30 \times G_t)$ = -35.23 dBm

Appendix B: **FCC RF Exposure information**

FCC RF Exposure evaluation

When a device qualifies for the categorical exclusion provision of § 2.1091(c), the minimum test separation distance may be estimated, when applicable, by simple calculations according to plane-wave equivalent conditions, to ensure the transmitter and its antenna(s) can operate in manners that meet or exceed the estimated distance. The source-based time-averaged maximum radiated power, according to the maximum antenna gain, must be applied to calculate the field strength and power density required to establish the minimum test separation distance. When the estimated test separation distance becomes overly conservative and does not support compliance, MPE measurement or computational modeling may be used to determine the required minimum separation distance.

According to §1.1310 Radiofrequency radiation exposure limits, paragraph (e), the limits for Maximum Permissible Exposure (MPE) to radiofrequency electromagnetic fields are:

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 (minutes)
(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
1,500–100,000	.....	.....	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
300–1,500	.....	.....	f/1500	30
1,500–100,000	.....	.....	1.0	30

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

FCC MPE Evaluation

Limits for Maximum Permissible Exposure (MPE) for RF sources are defined in FCC 47 CFR "§1.1310 Radiation Exposure limits, paragraph (e)":

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)	Averaging time (minutes)
(i) 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
1,500-100,000			5	<6
(ii) 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/1500	<30
1,500-100,000			1.0	<30

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

Each supported transmission technology will be evaluated to determine if it is in compliance with limits for Maximum Permissible Exposure (MPE) to radiofrequency electromagnetic fields.

In order to perform the assessment, the following equations have been used for the calculations; these equations are accurate in the far-field of an antenna and will over-predict power density in the near field, where they could be used for making a "worst-case" or conservative prediction:

Power density: $S[mW/cm^2] = \frac{P_{E.I.R.P.}[mW]}{4\Pi R[cm]^2}$

Where:

S = power density

$P_{E.I.R.P.}$ = Equivalent isotropically radiated power

R = distance to the center of radiation of the antenna (evaluation distance)

$P_{E.I.R.P.}$ = $P_T + G_T - L_C$

Where:

P_T= transmitter time-averaged output power (including Duty Cycle and tune-up tolerance, if applicable)

G_T= gain of the transmitting antenna

L_C = signal attenuation in the connecting cable between the transmitter and the antenna if applicable

Simultaneous transmission assessment:

When multiple sources are introduced into an environment, it becomes necessary to address the sources interdependently, since each source will contribute some percentage of the maximum exposure toward the total exposure. The sum of the ratios of the exposure from each source to the corresponding maximum exposure for the frequency of each source must be evaluated.

The exposure complies with the maximum permissible exposure if the sum of the ratios is less than unity:

$$\sum_{i=1}^{n} \frac{Exp_i}{Limit_i} < 1$$

Where
Exp_i is the measured/calculated exposure value of each source;
$Limit_i$ is the applicable limit of each source.

Appendix C: Photographs

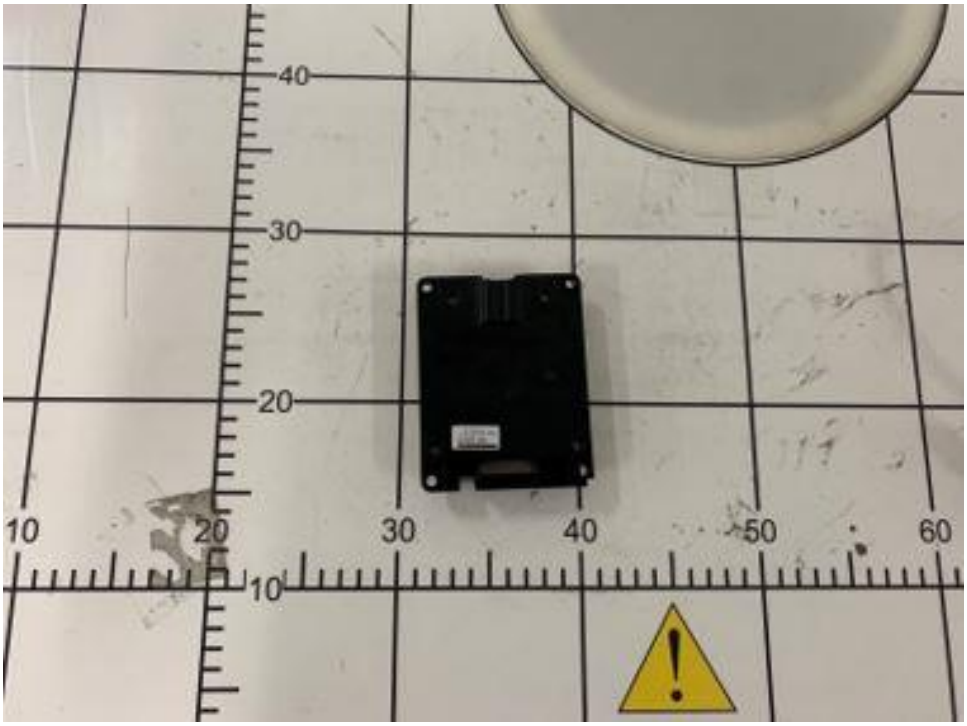


Figure C1. DUT Top view

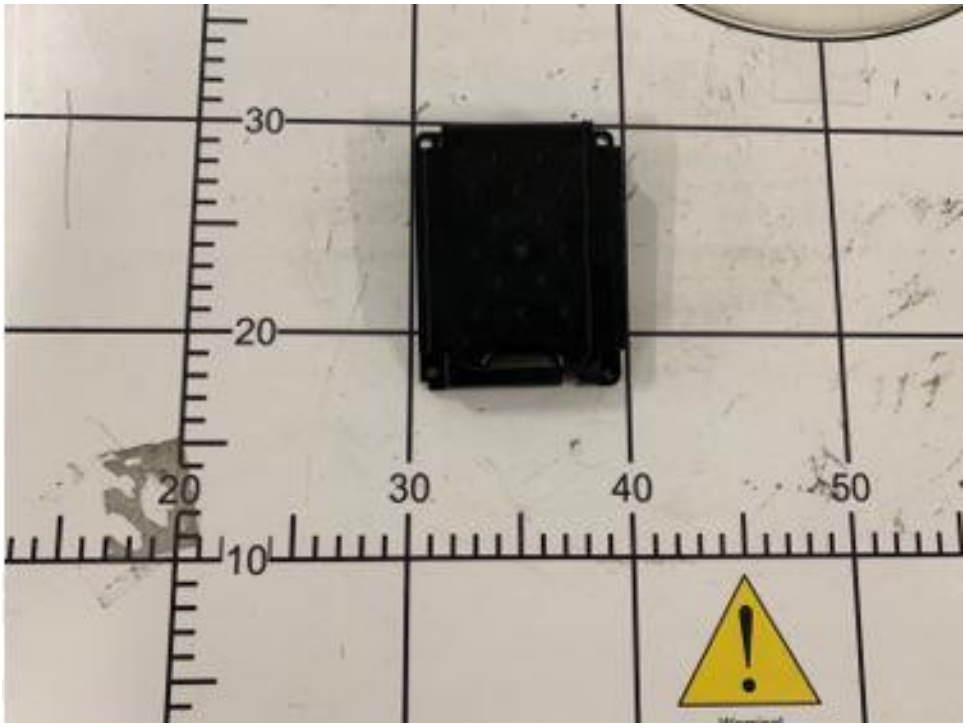


Figure C2. DUT rear view

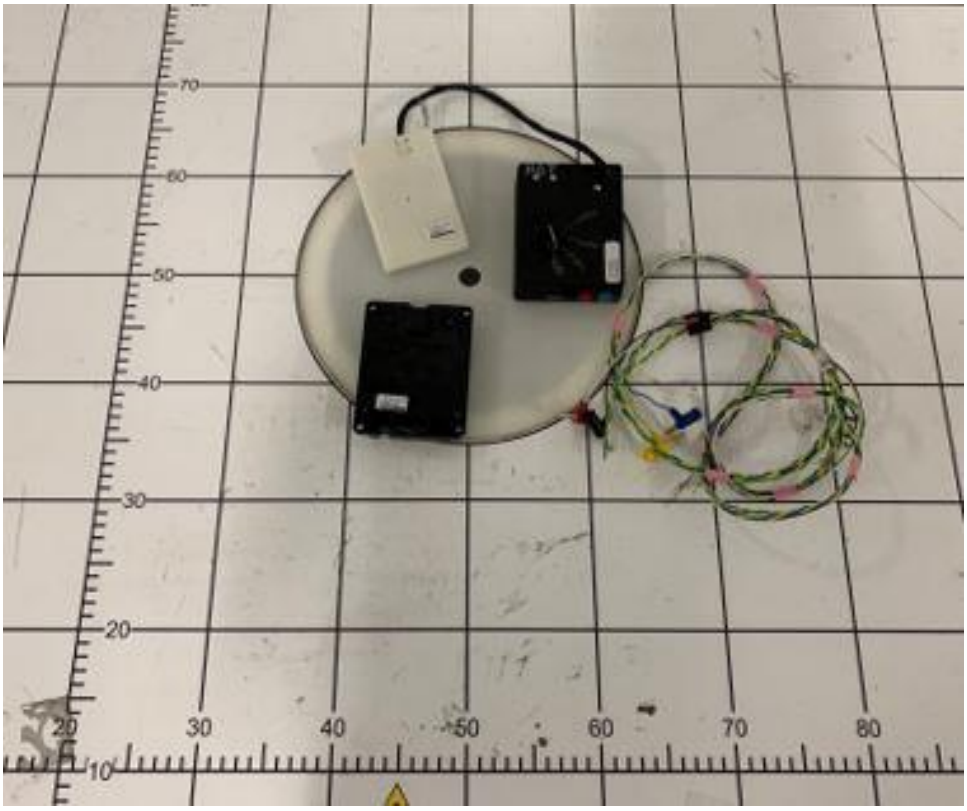


Figure C3. DUT with Accessories

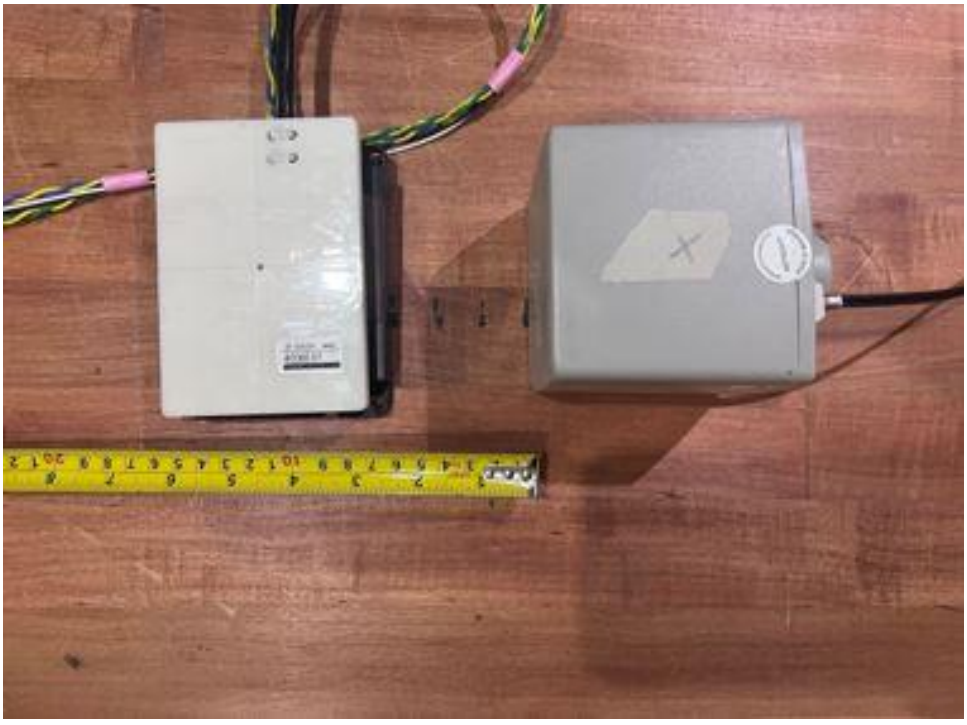


Figure C4. DUT Test setup 1

Figure C5. DUT Test setup 2

Figure C6. DUT Test setup 3

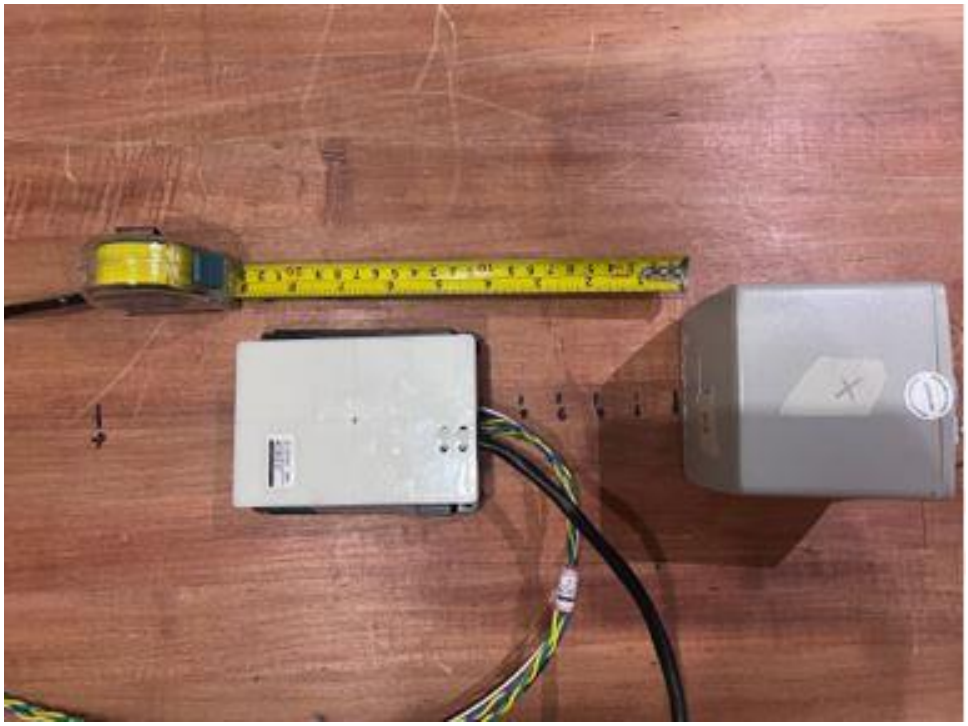


Figure C7. DUT Test setup 4

Figure C8. DUT Test setup 5