



# EMI TEST REPORT

Test Report No.: 14325756H-A-R1

Customer	DENSO CORPORATION
Description of EUT	Radio Frequency Key (RFK)
Model Number of EUT	YBN00
FCC ID	HYQYBN00
Test Regulation	FCC Part 18
Test Result	Complied (Refer to SECTION 3)
Issue Date	September 27, 2022
Remarks	For Permissive change

Representative Test Engineer

Hiroki Numata  
Engineer

Approved By

Tsubasa Takayama  
Leader



CERTIFICATE 5107.02

- The testing in which "Non-accreditation" is displayed is outside the accreditation scopes in UL Japan, Inc.  
 There is no testing item of "Non-accreditation".

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- The information provided from the customer for this report is identified in Section 1.
- For test report(s) referred in this report, the latest version (including any revisions) is always referred.

## **REVISION HISTORY**

### **Original Test Report No.: 14325756H-A**

This report is a revised version of 14325756H-A. 14325756H-A is replaced with this report.

Revision	Test Report No.	Date	Page Revised Contents
- (Original)	14325756H-A	July 15, 2022	-
1	14325756H-A-R1	September 27, 2022	Correction of the Model number and Serial number for Item B in Clause 4.2; - Model number: from “BQ5002AEVM-607” to “BQ50002AEVM-607” - Serial number: from “3404146WBG151417HH1” to “3404146WBG1514117HH1”

**Reference: Abbreviations (Including words undescribed in this report)**

A2LA	The American Association for Laboratory Accreditation	ICES	Interference-Causing Equipment Standard
AC	Alternating Current	IEC	International Electrotechnical Commission
AFH	Adaptive Frequency Hopping	IEEE	Institute of Electrical and Electronics Engineers
AM	Amplitude Modulation	IF	Intermediate Frequency
Amp, AMP	Amplifier	ILAC	International Laboratory Accreditation Conference
ANSI	American National Standards Institute	ISED	Innovation, Science and Economic Development Canada
Ant, ANT	Antenna	ISO	International Organization for Standardization
AP	Access Point	JAB	Japan Accreditation Board
ASK	Amplitude Shift Keying	LAN	Local Area Network
Atten., ATT	Attenuator	LIMS	Laboratory Information Management System
AV	Average	MCS	Modulation and Coding Scheme
BPSK	Binary Phase-Shift Keying	MRA	Mutual Recognition Arrangement
BR	Bluetooth Basic Rate	N/A	Not Applicable
BT	Bluetooth	NIST	National Institute of Standards and Technology
BT LE	Bluetooth Low Energy	NS	No signal detect.
BW	BandWidth	NSA	Normalized Site Attenuation
Cal Int	Calibration Interval	NVLAP	National Voluntary Laboratory Accreditation Program
CCK	Complementary Code Keying	OBW	Occupied Band Width
Ch., CH	Channel	OFDM	Orthogonal Frequency Division Multiplexing
CISPR	Comite International Special des Perturbations Radioelectriques	P/M	Power meter
CW	Continuous Wave	PCB	Printed Circuit Board
DBPSK	Differential BPSK	PER	Packet Error Rate
DC	Direct Current	PHY	Physical Layer
D-factor	Distance factor	PK	Peak
DFS	Dynamic Frequency Selection	PN	Pseudo random Noise
DQPSK	Differential QPSK	PRBS	Pseudo-Random Bit Sequence
DSSS	Direct Sequence Spread Spectrum	PSD	Power Spectral Density
EDR	Enhanced Data Rate	QAM	Quadrature Amplitude Modulation
EIRP, e.i.r.p.	Equivalent Isotropically Radiated Power	QP	Quasi-Peak
EMC	ElectroMagnetic Compatibility	QPSK	Quadri-Phase Shift Keying
EMI	ElectroMagnetic Interference	RBW	Resolution Band Width
EN	European Norm	RDS	Radio Data System
ERP, e.r.p.	Effective Radiated Power	RE	Radio Equipment
EU	European Union	RF	Radio Frequency
EUT	Equipment Under Test	RMS	Root Mean Square
Fac.	Factor	RSS	Radio Standards Specifications
FCC	Federal Communications Commission	Rx	Receiving
FHSS	Frequency Hopping Spread Spectrum	SA, S/A	Spectrum Analyzer
FM	Frequency Modulation	SG	Signal Generator
Freq.	Frequency	SVSWR	Site-Voltage Standing Wave Ratio
FSK	Frequency Shift Keying	TR	Test Receiver
GFSK	Gaussian Frequency-Shift Keying	Tx	Transmitting
GNSS	Global Navigation Satellite System	VBW	Video BandWidth
GPS	Global Positioning System	Vert.	Vertical
Hori.	Horizontal	WLAN	Wireless LAN

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<b>CONTENTS</b>	<b>PAGE</b>
<b>SECTION 1: Customer Information.....</b>	<b>5</b>
<b>SECTION 2: Equipment Under Test (EUT) .....</b>	<b>5</b>
<b>SECTION 3: Test specification, procedures &amp; results .....</b>	<b>7</b>
<b>SECTION 4: Operation of EUT during testing.....</b>	<b>9</b>
<b>SECTION 5: Radiated Emission .....</b>	<b>10</b>
<b>APPENDIX 1: Test data .....</b>	<b>13</b>
<b>Radiated Emission .....</b>	<b>13</b>
<b>APPENDIX 2: Test instruments .....</b>	<b>15</b>
<b>APPENDIX 3: Photographs of test setup.....</b>	<b>16</b>
<b>Radiated Emission .....</b>	<b>16</b>
<b>Worst Case Position.....</b>	<b>18</b>

## **SECTION 1: Customer Information**

Company Name	DENSO CORPORATION
Address	1-1, Showa-cho, Kariya-shi, Aichi-ken, 448-8661 Japan
Telephone Number	+81-566-61-5789
Contact Person	Toshiaki Saito

The information provided from the customer is as follows;

- Customer, Description of EUT, Model Number of EUT, FCC ID on the cover and other relevant pages
- Operating/Test Mode(s) (Mode(s)) on all the relevant pages
- SECTION 1: Customer Information
- SECTION 2: Equipment Under Test (EUT) other than the Receipt Date and Test Date
- SECTION 4: Operation of EUT during testing

\* The laboratory is exempted from liability of any test results affected from the above information in SECTION 2 and 4.

## **SECTION 2: Equipment Under Test (EUT)**

### **2.1 Identification of EUT**

Description	Radio Frequency Key (RFK)
Model Number	YBN00
Serial Number	Refer to SECTION 4.2
Condition	Production prototype (Not for Sale: This sample is equivalent to mass-produced items.)
Modification	No Modification by the test lab
Receipt Date	May 13, 2022
Test Date	May 13 and June 19, 2022

### **2.2 Product Description**

#### **General Specification**

Rating	DC 3.7 V typical (DC 3.0 V to 4.2 V)
Operating frequency	-30 deg. C to +60 deg. C

## Radio Specification

### [UWB]

Radio Type	Transceiver
Frequency of Operation	(CH5): 6489.6 MHz (6240.0 to 6739.2 MHz), (CH9): 7987.2 MHz (7737.6 to 8236.8 MHz)
Modulation	BPM-BPSK
Antenna Gain	(CH5): 6.78 dBi (max), (CH9): 2.83 dBi (max)

### [Bluetooth Low Energy]

Radio Type	Transceiver
Frequency of Operation	2402 MHz to 2480 MHz
Modulation	GFSK
Antenna Gain	-1.69 dBi (max)

### [NFC (Passive)]

Radio Type	Receiver (Passive TAG)
Frequency of Operation	13.56 MHz
Modulation	ASK

### [WPC1.2 (5W BPP)] \*1)

Equipment Type	Receiver
Operating Frequency	110 kHz to 205 kHz
Rated Receive Output Power	5 W (BPP)
Charging distance	Contact

\*1) This test report applies to WPC1.2 (5W BPP).

<Contents of the change from original model>

Original test report number of this report is 14082125H-A-R2.

The EUT specification was changed from the original model as below;

- Change Qi/NFC antenna size and matching component.

## **SECTION 3: Test specification, procedures & results**

### **3.1 Test specification**

Test Specification	FCC Part 18 2020, final revised on June 26, 2020 and effective July 27, 2020
Title	FCC 47CFR Part18 Industrial, scientific, and medical equipment

### **3.2 Procedures and results**

Item	Test Procedure & Limits	Deviation	Worst margin	Result
Radiated emission	Section 18.305 FCC/OET MP-5	N/A	22.2 dB 37.740 MHz, Vertical	Complied *1)
Conducted emission	Section 18.307 FCC/OET MP-5	N/A	N/A	N/A *2)

\* Note: UL Japan, Inc.'s EMI Work Procedure: Work Instructions-ULID-003591.

\*1) The result is rounded off to the second decimal place. Therefore, there may be 0.1 difference for the result.

\*2) The test is not applicable since the EUT is not the device that is designed to be connected to the public utility (AC) power line.

Symbols:

Complied           The data of this test item has enough margin, more than the measurement uncertainty.

Complied#         The data of this test item meets the limits unless the measurement uncertainty is taken into consideration

### **3.3 Addition to standard**

No addition, exclusion nor deviation has been made from the standard.

### **3.4 Uncertainty**

#### **EMI**

There is no applicable rule of uncertainty in this applied standard. Therefore, the results are derived depending on whether or not laboratory uncertainty is applied.

The following uncertainties have been calculated to provide a confidence level of 95 % using a coverage factor  $k = 2$ .

#### **Radiated emission**

Measurement distance	Frequency range		Uncertainty (+/-)
3 m	30 MHz to 200 MHz	Horizontal	4.8 dB
		Vertical	5.0 dB
	200 MHz to 1000 MHz	Horizontal	5.1 dB
		Vertical	6.2 dB
10 m	30 MHz to 200 MHz	Horizontal	4.8 dB
		Vertical	4.8 dB
	200 MHz to 1000 MHz	Horizontal	5.0 dB
		Vertical	5.0 dB

### 3.5 Test Location

UL Japan, Inc. Ise EMC Lab.

\*A2LA Certificate Number: 5107.02 / FCC Test Firm Registration Number: 884919

ISED Lab Company Number: 2973C / CAB identifier: JP0002

4383-326 Asama-cho, Ise-shi, Mie-ken 516-0021 Japan

Telephone: +81-596-24-8999

Test site	Width x Depth x Height (m)	Size of reference ground plane (m) / horizontal conducting plane	Other rooms	Maximum measurement distance
No.1 semi-anechoic chamber	19.2 x 11.2 x 7.7	7.0 x 6.0	No.1 Power source room	10 m
No.2 semi-anechoic chamber	7.5 x 5.8 x 5.2	4.0 x 4.0	-	3 m
No.3 semi-anechoic chamber	12.0 x 8.5 x 5.9	6.8 x 5.75	No.3 Preparation room	3 m
No.3 shielded room	4.0 x 6.0 x 2.7	N/A	-	-
No.4 semi-anechoic chamber	12.0 x 8.5 x 5.9	6.8 x 5.75	No.4 Preparation room	3 m
No.4 shielded room	4.0 x 6.0 x 2.7	N/A	-	-
No.5 semi-anechoic chamber	6.0 x 6.0 x 3.9	6.0 x 6.0	-	-
No.5 measurement room	6.4 x 6.4 x 3.0	6.4 x 6.4	-	-
No.6 shielded room	4.0 x 4.5 x 2.7	4.0 x 4.5	-	-
No.6 measurement room	4.75 x 5.4 x 3.0	4.75 x 4.15	-	-
No.7 shielded room	4.7 x 7.5 x 2.7	4.7 x 7.5	-	-
No.8 measurement room	3.1 x 5.0 x 2.7	3.1 x 5.0	-	-
No.9 measurement room	8.8 x 4.6 x 2.8	2.4 x 2.4	-	-
No.10 shielded room	3.8 x 2.8 x 2.8	3.8 x 2.8	-	-
No.11 measurement room	4.0 x 3.4 x 2.5	N/A	-	-
No.12 measurement room	2.6 x 3.4 x 2.5	N/A	-	-

### 3.6 Test data, Test instruments, and Test set up

Refer to APPENDIX.



**SECTION 4: Operation of EUT during testing**

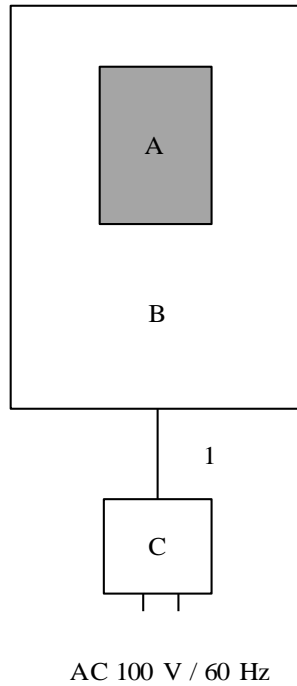
**4.1 Operating mode(s)**

The mode is used :

Test mode	Remarks
Charging mode	Mode 1

\*The test was performed with the points designated by the customer and worst frequencies.

**4.2 Configuration and peripherals**



- \* Cabling and setup were taken into consideration and test data was taken under worse case conditions.
  - \* The test was performed together with a representative transmitter.
  - \* EUT was arranged so that the emission level becomes a maximum.
  - \* EUT was set up to receive maximum power from the WPT source.
- To receive maximum power, the test was performed with the batteries fully discharged.

**Description of EUT and Support equipment**

No.	Item	Model number	Serial number	Manufacturer	Remarks
A	Radio Frequency Key (RFK)	YBN00	No.52	DENSO CORPORATION	EUT
B	Wireless Power Tx	BQ50002AEVM-607	3404146WBG1514117H H1	Texas Instruments	-
C	AC Adaptor	ACA-IP528K	J04-0256319	SANWA SUPPLY	-

**List of cables used**

No.	Name	Length (m)	Shield		Remark
			Cable	Connector	
1	USB Cable	1.5	Shielded	Shielded	-

## **SECTION 5: Radiated Emission**

### **5.1 Operating environment**

Test place : No.1 semi anechoic chamber  
Temperature : See data  
Humidity : See data

### **5.2 Test configuration**

EUT was placed on a urethane platform of nominal size, 1.5 m by 1.0 m, raised 1.0 m above the conducting ground plane. The EUT was set on the center of the table top.  
Test was made with the antenna positioned in 0 deg., 45 deg., 90 deg., 135deg., and 180 deg., and Horizontal.  
The measurement antenna was varied in height above the conducting ground plane to obtain the maximum signal strength. Photographs of the set up are shown in Appendix 3.  
\*Refer to Figure 1 about Direction of the Loop Antenna.

### **5.3 Test conditions**

Frequency range : 9 kHz - 30 MHz (Loop antenna)  
30 MHz - 200 MHz (Biconical antenna)  
200 MHz - 400 MHz (Logperiodic antenna)  
Test distance : 3 m / 10 m  
EUT position : Table top  
EUT operation mode : See Clause 4.1

### **5.4 Test procedure**

#### **Below 30 MHz**

The height of antenna was fixed in 2 m.  
EUT was rotated a full revolution in order to obtain the maximum value of the electric field intensity.  
The measurements were performed in 0 deg., 45 deg., 90 deg., 135deg., and 180 deg. with the Test Receiver.  
The electric field intensity at a distance of 300 m was calculated from the measurement results at distances of 3 m and 10 m.

#### **Above 30 MHz**

Maximum electric field intensity was confirmed with the measurements at distances of 3 m and 10 m.  
The electric field intensity at a distance of 300 m was calculated from the measurement results at distances of 3 m and 10 m.  
The radiated emission measurements were made with the following detector function of the test receiver.

The test was made with the detector (RBW) in the following table.

Frequency	9 kHz - 150 kHz	150 kHz - 30 MHz	30 MHz - 400 MHz
Instrument used	Test Receiver		
IF Bandwidth	AV: 200 Hz	AV: 9 kHz	AV: 120 kHz

The measurement result was calculated by the following formula:

[Frequency at which the signal was confirmed at both 10 m and 3 m]

Result = Reading + ANT Factor + Cable loss + Atten loss + Extrapolation Factor - AMP gain

Extrapolation Factor = decade \* Log (Test distance (3 m) / Separate distance (300 m))

decade = (10 m reading - 3 m reading) / (log 3 m - log 10 m)

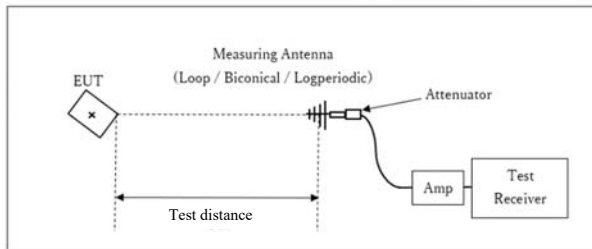
\*Refer to Part 18 Section 305 Notes 2 and KDB 629601.

[Other Frequency]

Result = Reading + ANT Factor + Cable loss + Atten loss + Extrapolation Factor - AMP gain  
Extrapolation Factor =  $20 * \log(\text{Test distance (3 m)} / \text{Separate distance (300 m)})$

<Test Setup>

Below 1 GHz



Test Distance: 3 m / 10 m

\* : Center of turn table

- The carrier level and noise levels were confirmed at each position of X, Y and Z axes of EUT to see the position of maximum noise, and the test was made at the position that has the maximum noise.

The test results and limit are rounded off to one decimal place, so some differences might be observed.

## 5.5 Test result

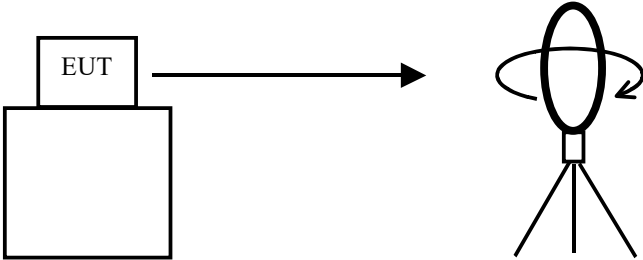
Summary of the test results: Pass

Date: May 15, 2022  
Date: June 19, 2022

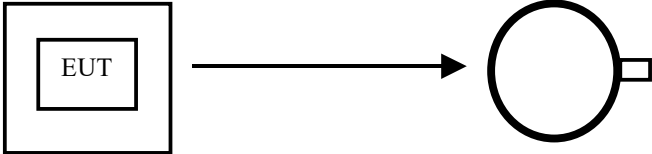
Test engineer: Hiroki Numata  
Test engineer: Hiroyuki Furutaka

Figure 1: Direction of the Loop Antenna

Side View (Vertical)

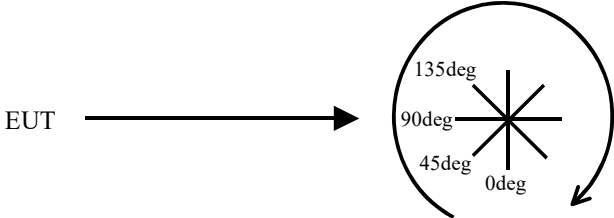


Top View (Horizontal)



Antenna was not rotated.

Top View (Vertical)



Front side: 0 deg.  
Forward direction: clockwise

**APPENDIX 1: Test data**

**Radiated Emission**  
**(Below 30 MHz)**

Test place                    Ise EMC Lab.  
Semi Anechoic Chamber    No.1  
Date                            May 15, 2022  
Temperature / Humidity    22 deg. C / 54% RH  
Engineer                      Hiroki Numata  
Mode                            Mode 1

FREQ [MHz]	Reading (3m) [dBμV]	Reading (10m) [dBμV]	ANT Factor [dB/m]	Atten + Cable loss [dB]	AMP Gain [dB]	Extrapolation Factor [dB]	Result (300 m) [dBμV/m]	Limit (300 m) [dBμV/m]	Margin [dB]	Antenna [deg]	Remarks
0.1459	89.8	58.7	19.6	6.0	32.2	-119.0	-35.7	23.5	59.2	0	
0.1459	87.5	58.3	19.6	6.0	32.2	-111.7	-30.8	23.5	54.3	45	
0.1459	85.7	58.0	19.6	6.0	32.2	-106.0	-26.8	23.5	50.3	90	
0.1459	87.1	58.4	19.6	6.0	32.2	-109.8	-29.3	23.5	52.8	135	
0.1459	89.6	58.5	19.6	6.0	32.2	-119.0	-35.9	23.5	59.4	180	
0.1459	83.4	49.5	19.6	6.0	32.2	-129.7	-52.8	23.5	76.3	Horizontal	
0.2917	39.0	29.5	19.5	6.0	32.2	-40.0	-7.6	23.5	31.1	0	Reading(10m) is Floor Noise *1)
0.4376	62.5	35.2	19.5	6.1	32.1	-74.2	-18.3	23.5	41.8	0	
0.5834	25.8	26.6	19.4	6.1	32.1	-40.0	-20.8	23.5	44.3	0	Reading(10m) is Floor Noise *1)
0.7293	52.7	33.3	19.4	6.1	32.2	-74.2	-28.1	23.5	51.6	0	
0.8752	22.6	25.5	19.4	6.2	32.2	-40.0	-24.0	23.5	47.5	0	Reading(10m) is Floor Noise *1)
1.0210	44.7	26.1	19.4	6.2	32.2	-40.0	-1.9	23.5	25.4	0	Reading(10m) is Floor Noise *1)
1.1669	19.1	25.0	19.4	6.2	32.2	-40.0	-27.5	23.5	51.0	0	Reading(10m) is Floor Noise *1)
1.3127	41.0	25.2	19.4	6.2	32.2	-40.0	-5.5	23.5	31.0	0	Reading(10m) is Floor Noise *1)
1.4586	17.0	24.8	19.4	6.2	32.2	-40.0	-29.5	23.5	53.0	0	Reading(10m) is Floor Noise *1)

CALCULATION(Result) : Reading + ANT Factor + Cable loss + Atten loss + Extrapolation Factor - AMP gain  
 Extrapolation Factor = decade \* Log (Test distance(3m) / Separate distance(300m))  
 decade = (10m reading - 3m reading) / (log 3m - log 10m)

\*1) Used for the square of an inverse linear distance extrapolation factor (20 dB/decade)  
 Except for the above table : adequate margin data below the limits.

-Worst direction of EUT was decided by test result performed on test distance at 3 m, and test distance at 10 m was performed worst direction.

**Radiated emission**  
**(Above 30 MHz)**

Test place                    Ise EMC Lab.  
Semi Anechoic Chamber    No.1  
Date                            June 19, 2022  
Temperature / Humidity    22 deg. C / 68% RH  
Engineer                      Hiroyuki Furutaka  
Mode                            Mode 1

FREQ [MHz]	Reading (3m) [dBμV]	Reading (10m) [dBμV]	ANT Factor [dB/m]	Atten + loss [dB]	AMP gain [dB]	Extrapolatio Factor [dB]	Result (300 m) [dBμV/m]	Limit (300 m) [dBμV/m]	Margin [dB]	Antenna Polarization	Remarks
73.610	42.7	29.9	6.5	8.0	39.0	-49.0	-30.8	23.5	54.3	Horizontal	
86.221	40.7	26.4	7.9	8.2	39.1	-54.7	-37.0	23.5	60.5	Horizontal	
127.743	39.2	28.7	13.5	8.7	39.1	-40.2	-17.9	23.5	41.4	Horizontal	
141.745	42.3	29.3	14.5	8.9	39.1	-49.7	-23.2	23.5	46.7	Horizontal	
212.075	36.9	23.5	12.4	9.6	39.1	-51.3	-31.4	23.5	54.9	Horizontal	
248.282	28.6	21.8	12.7	10.0	39.0	-26.0	-13.8	23.5	37.3	Horizontal	
37.740	26.9	24.4	15.6	7.4	39.0	-9.6	1.3	23.5	22.2	Vertical	
74.090	40.3	35.2	6.5	8.0	39.0	-19.5	-3.7	23.5	27.2	Vertical	
86.000	48.1	40.5	7.8	8.2	39.1	-29.1	-4.0	23.5	27.5	Vertical	
128.843	48.4	39.1	13.6	8.7	39.1	-35.6	-3.9	23.5	27.4	Vertical	
146.187	52.3	42.3	14.7	9.0	39.1	-38.2	-1.4	23.5	24.9	Vertical	
157.402	41.6	33.6	15.3	9.1	39.1	-30.6	-3.8	23.5	27.3	Vertical	

CALCULATION(Result) : Reading + ANT Factor + Cable loss + Atten loss - AMP gain + Extrapolation Factor  
 Extrapolation Factor = decade \* Log (Test distance(3m) / Separate distance(300m))  
 decade = (10m reading - 3m reading) / (log 3m - log 10m)

Except for the above table : adequate margin data below the limits.

-Worst direction of EUT was decided by test result performed on test distance at 3 m, and test distance at 10 m was performed worst direction.

## APPENDIX 2: Test instruments

### Test equipment

Test Item	Local ID	LIMS ID	Description	Manufacturer	Model	Serial	Last Calibration Date	Cal Int
RE	APANT08	146613	Loop Antenna	Rohde & Schwarz	HFH2-Z2	842906/011	10/06/2021	12
RE	COTS-MEMI-02	178648	EMI measurement program	TSJ (Techno Science Japan)	TEPTO-DV	-	-	-
RE	KBA-05	141198	Biconical Antenna	Schwarzbeck Mess-Elektronik OHG	VHA9103+BBA9106	2513	05/14/2022	12
RE	MAEC-01	141998	AC1_Semi Anechoic Chamber(NSA)	TDK	Semi Anechoic Chamber 10m	DA-06881	06/08/2020	24
RE	MAT-08	141213	Attenuator(6dB)	Weinschel Corp	2	BK7971	11/09/2021	12
RE	MCC-02	141350	Coaxial Cable	Suhner/storm/Agilent/TSJ	-	-	03/08/2022	12
RE	MCC-03	141215	Coaxial Cable	Fujikura/Suhner/TSJ	5D-2W/3D-2W/RG400u/RFM-E421(SW)	-/01068 (Switcher)	06/11/2022	12
RE	MCC-64	141327	Coaxial Cable	UL Japan	-	-	02/28/2022	12
RE	MJM-25	142226	Measure	KOMELON	KMC-36	-	-	-
RE	MLA-20	141264	Logperiodic Antenna (200-1000MHz)	Schwarzbeck Mess-Elektronik OHG	VUSLP9111B	189	05/14/2022	12
RE	MMM-09	141533	DIGITAL HiTESTER	HIOKI E.E. CORPORATION	3805	51201195	01/16/2022	12
RE	MOS-27	141566	Thermo-Hygrometer	CUSTOM. Inc	CTH-201	A08Q26	01/10/2022	12
RE	MPA-14	141583	Pre Amplifier	SONOMA INSTRUMENT	310	260833	04/04/2022	12
RE	MPA-19	141585	Pre Amplifier	MITEQ	MLA-10K01-B01-35	1237616	02/28/2022	12
RE	MTR-09	141950	EMI Test Receiver	Rohde & Schwarz	ESU26	100412	10/14/2021	12

\*Hyphens for Last Calibration Date and Cal Int (month) are instruments that Calibration is not required (e.g. software), or instruments checked in advance before use.

The expiration date of the calibration is the end of the expired month.

As for some calibrations performed after the tested dates, those test equipment have been controlled by means of an unbroken chains of calibrations.

All equipment is calibrated with valid calibrations. Each measurement data is traceable to the national or international standards.

Test item:

**RE: Radiated emission**