RADIO TEST REPORT

Test Report No. : 13487459H-A-R1

Applicant	:	**NIDEC MOBILITY CORPORATION**
Type of EUT	:	**ECU of Keyless Operation System**
Model Number of EUT	:	**R328E**
FCC ID	:	**OUCR328E**
Test regulation	:	**FCC Part 15 Subpart C: 2020**
Test Result	:	**Complied (Refer to SECTION 3.2)**

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6. This test report covers Radio technical requirements. It does not cover administrative issues such as Manual or non-Radio test related Requirements. (if applicable)
7. The all test items in this test report are conducted by UL Japan, Inc. Ise EMC Lab.
8. The opinions and the interpretations to the result of the description in this report are outside scopes where UL Japan has been accredited.
9. The information provided from the customer for this report is identified in Section 1.
10. This report is a revised version of 13487459H-A. 13487459H-A is replaced with this report.

Date of test: September 4, 2020

Representative test engineer:
Ken Fujita
Engineer
Consumer Technology Division

Approved by:
Shinichi Miyazono
Engineer
Consumer Technology Division

CERTIFICATE 5107.02

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

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REVISION HISTORY

Original Test Report No.: 13487459H-A

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<tr><td>1</td><td>13487459H-A-R1</td><td>November 26, 2020</td><td>P.11</td><td>Correction of the following table in Clause 4.2;
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<tr><td>A</td><td>ECU</td><td>R328E</td><td>10</td></tr>
<tr><td>B</td><td>LF Antenna DR</td><td>841M-A</td><td>8637A525</td></tr>
<tr><td>C</td><td>LF Antenna AS</td><td>841M-A</td><td>8637A525</td></tr>
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<tr><th>No.</th><th>Item</th><th>Model number</th><th>Serial number</th></tr>
<tr><td>A</td><td>KOS</td><td>R328E</td><td>#10</td></tr>
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<tr><td>D</td><td>LF Antenna INF</td><td>G8D-841M-ANT</td><td>200826-3</td></tr>
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<tr><td>F</td><td>LF Antenna T/G</td><td>G8D-841M-ANT</td><td>200826-5</td></tr>
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Reference: Abbreviations (Including words undescribed in this report)

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

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SECTION 1: Customer information

Company Name	:	NIDEC MOBILITY CORPORATION
Address	:	6368, Nenjo-zaka, Okusa, Komaki-city, Aichi 485-802 Japan
Telephone Number	:	+81-568-78-6159
Facsimile Number	:	+81-568-78-7659
Contact Person	:	Kazushi Yamasaki

The information provided from the customer is as follows;
- Applicant, Type 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
- 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

Type	:	ECU of Keyless Operation System
Model Number	:	R328E
Serial Number	:	Refer to SECTION 4.2
Rating	:	DC 12.0 V
Receipt Date	:	August 28, 2020
Country of Mass-production	:	China
Condition	:	Production model
Modification	:	No Modification by the test lab

2.2 Product Description

Model No: R328E, (referred to as the EUT in this report), is the ECU of Keyless Operation System.
Keyless Operation System has the following radio functions: Immobilizer system and Smart System (LF Transmitting / UHF Receiving).

General Specification

Clock frequency (maximum)	:	UHF: 21.948717 MHz
Operating Temperature	:	-40 deg. C to +85 deg. C

Radio Specification

Immobilizer system function

Equipment Type	:	Transceiver
Frequency of Operation	:	125 kHz
Type of Modulation	:	ASK
Antenna Type	:	Coil Antenna

Smart System: LF Transmitting function

Equipment Type	:	Transmitter
Frequency of Operation	:	125 kHz
Type of Modulation	:	ASK
Antenna Type	:	Coil Antenna

Smart System: UHF Receiving function *

Type of Receiver	:	Super Heterodyne
Receiving Frequency	:	433.92 MHz
Oscillator Frequency	:	21.948717 MHz
Local Oscillator Frequency	:	434.194 MHz
Intermediate Frequency	:	274 kHz
Antenna Type	:	λ/4 Monopole Antenna

*The test of this function was performed separately from this test report, and the conformability is confirmed.

SECTION 3: Test specification, procedures & results

3.1 Test Specification

Test Specification	:	FCC Part 15 Subpart C FCC Part 15 final revised on June 26, 2020 and effective July 27, 2020
Title	:	FCC 47CFR Part15 Radio Frequency Device Subpart C Intentional Radiators Section 15.207 Conducted limits Section 15.209 Radiated emission limits; general requirements.

* Also the EUT complies with FCC Part 15 Subpart B.

3.2 Procedures and results

Item	Test Procedure	Specification	Remarks	Deviation	Worst margin	Results
Conducted Emission	<FCC> ANSI C63.10:2013 6 Standard test methods <ISED> RSS-Gen 8.8	<FCC> Section 15.207 <ISED> RSS-Gen 8.8	-	N/A	N/A	N/A *1)
Electric Field Strength of Fundamental Emission	<FCC> ANSI C63.10:2013 6 Standard test methods <ISED> RSS-Gen 6.5, 6.12	<FCC> Section 15.209 <ISED> RSS-210 7.2 RSS-Gen 8.9	Radiated	N/A	6.0 dB 125 kHz, 0 deg. Peak with Duty factor <LF Antenna DR>	Complied a)
Electric Field Strength of Spurious Emission	<FCC> ANSI C63.10:2013 6 Standard test methods <ISED> RSS-Gen 6.5, 6.6, 6.13	<FCC> Section 15.209 <ISED> RSS-210 7.3 RSS-Gen 8.9	Radiated	N/A	8.0 dB 30.072 MHz, Horizontal, QP <LF Antenna DR>	Complied a)
-26 dB Bandwidth	<FCC> ANSI C63.10:2013 6 Standard test methods <ISED> -	<FCC> Reference data <ISED> -	Radiated	N/A	N/A	Complied b)
Note: UL Japan, Inc.'s EMI Work Procedures No. 13-EM-W0420 and 13-EM-W0422. *1) 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. a) Refer to APPENDIX 1 (data of Radiated emission) b) Refer to APPENDIX 1 (data of -26 dB Bandwidth and 99 % Occupied Bandwidth)						
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.						

FCC Part 15.31 (e)
The test was performed with the New Battery and the EUT constantly provides the stable voltage to RF part through the regulator regardless of input voltage from New Battery. Therefore, this EUT complies with the requirement.

FCC Part 15.203 Antenna requirement
It is impossible for end users to replace the antenna, because the antenna is mounted inside of the vehicle. Therefore, the equipment complies with the antenna requirement of Section 15.203.

3.3 Addition to standard

Item	Test Procedure	Specification	Remarks	Deviation	Worst margin	Results
99 % Occupied Band Width	RSS-Gen 6.7	-	Radiated	N/A	N/A	-
Note: UL Japan, Inc.'s EMI Work Procedures No. 13-EM-W0420 and 13-EM-W0422.						

Other than above, no addition, exclusion nor deviation has been made from the standard.

3.4 Uncertainty

There is no applicable rule of uncertainty in this applied standard. Therefore, the following 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	9 kHz to 30 MHz		3.3 dB
10 m			3.2 dB
3 m	30 MHz to 200 MHz	(Horizontal)	4.8 dB
		(Vertical)	5.0 dB
	200 MHz to 1000 MHz	(Horizontal)	5.2 dB
		(Vertical)	6.3 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

Antenna Terminal test

Test Item	Uncertainty (+/-)
-26 dB Bandwidth / 99 % Occupied Bandwidth	0.96 %

3.5 Test Location

UL Japan, Inc. Ise EMC Lab.
*A2LA Certificate Number: 5107.02 / FCC Test Firm Registration Number: 199967 / ISED Lab Company Number: 2973C
4383-326 Asama-cho, Ise-shi, Mie-ken 516-0021 JAPAN
Telephone: +81 596 24 8999, Facsimile: +81 596 24 8124

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.11 measurement room	6.2 x 4.7 x 3.0	4.8 x 4.6	-	-

* Size of vertical conducting plane (for Conducted Emission test) : 2.0 x 2.0 m for No.1, No.2, No.3, and No.4 semi-anechoic chambers and No.3 and No.4 shielded rooms.

3.6 Test data, Test instruments, and Test set up

Refer to APPENDIX.

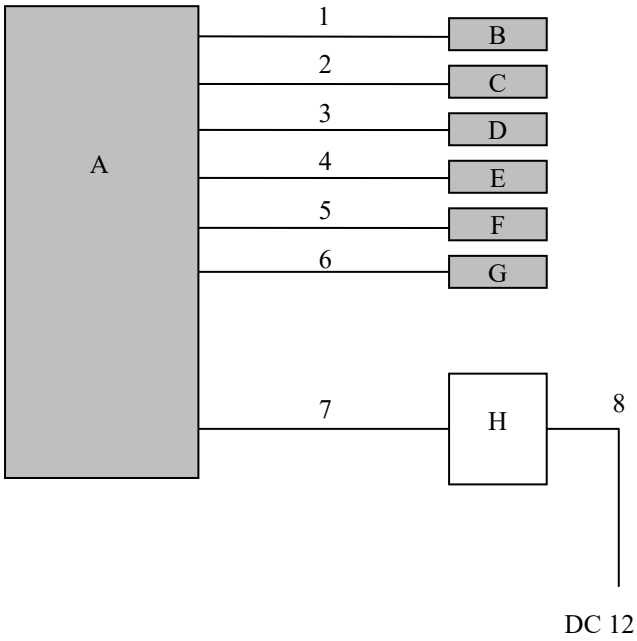
SECTION 4: Operation of EUT during testing

4.1 Operating Modes

Test mode	Remarks
1) Transmitting mode (Tx) 125 kHz	-
* EUT was set by the software as follows; Software: Radio_Law_Certification_EU__kazasi Version 35 FC E2 (Date: 2016/12/02, Storage location: EUT memory) *This setting of software is the worst case. Any conditions under the normal use do not exceed the condition of setting. In addition, end users cannot change the settings of the output power of the product.	

Justification : The system was configured in typical fashion (as a user would normally use it) for testing.

4.2 Configuration and peripherals



* Cabling and setup(s) were taken into consideration and test data was taken under worse case conditions.
* The EUT does not transmit simultaneously from multiple antennas.
* Antenna was evaluated with the worst duty respectively.
* The EUT was set to transmit the data continuously from one antenna as a worst case, not to transmit it randomly from each antenna.
* The each carrier level of the two antennas (DR, AS) and three antennas (INF, INR, T/G) were compared at the pre-check.
  As a result, all the tests were performed with the LF Antenna DR and LF Antenna INF as representative.

Description of EUT and Support equipment

No.	Item	Model number	Serial number	Manufacturer	Remarks
A	KOS	R328E	#10	NIDEC MOBILITY CORPORATION	EUT
B	LF Antenna DR	5716A639WB	200826-1	NIDEC MOBILITY CORPORATION	EUT
C	LF Antenna AS	5716A640WB	200826-2	NIDEC MOBILITY CORPORATION	EUT
D	LF Antenna INF	G8D-841M-ANT	200826-3	NIDEC MOBILITY CORPORATION	EUT
E	LF Antenna INR	G8D-841M-ANT	200826-4	NIDEC MOBILITY CORPORATION	EUT
F	LF Antenna T/G	G8D-841M-ANT	200826-5	NIDEC MOBILITY CORPORATION	EUT
G	Push Start Switch	CFT-M001	2210D1	NIDEC MOBILITY CORPORATION	EUT
H	Jig	-	-	NIDEC MOBILITY CORPORATION	-

List of cables used

No.	Name	Length (m)	Shield		Remark
			Cable	Connector	
1	Antenna Cable	2.3	Unshielded	Unshielded	-
2	Antenna Cable	2.3	Unshielded	Unshielded	-
3	Antenna Cable	2.3	Unshielded	Unshielded	-
4	Antenna Cable	2.3	Unshielded	Unshielded	-
5	Antenna Cable	2.3	Unshielded	Unshielded	-
6	Antenna Cable	2.3	Unshielded	Unshielded	-
7	DC & Signal Cable	3.0	Unshielded	Unshielded	-
8	DC Cable	3.0	Unshielded	Unshielded	-

SECTION 5: Radiated emission (Fundamental and Spurious Emission)

Test Procedure

EUT was placed on a urethane platform of nominal size, 0.5 m by 1.0 m, raised 0.8 m above the conducting ground plane.
The Radiated Electric Field Strength has been measured in a Semi Anechoic Chamber with a ground plane.

Frequency : From 9 kHz to 30 MHz
The EUT was rotated a full revolution in order to obtain the maximum value of the electric field intensity.
The measurements were performed for vertical polarization (antenna angle: 0 deg., 45 deg., 90 deg., and 135 deg.) and horizontal polarization.
*Refer to Figure 1 about Direction of the Loop Antenna.

Frequency: From 30 MHz to 1 GHz
The measuring antenna height varied between 1 and 4 m and EUT was rotated a full revolution in order to obtain the maximum value of the electric field intensity.
The measurements were performed for both vertical and horizontal antenna polarization.

The test was made with the detector (RBW / VBW) in the following table.
When using Spectrum analyzer, the test was made with adjusting span to zero by using peak hold.

Test Antennas are used as below;

Frequency	Below 30 MHz	30 MHz to 200 MHz	200 MHz to 1 GHz
Antenna Type	Loop	Biconical	Logperiodic

Frequency	From 9 kHz to 90 kHz and From 110 kHz to 150 kHz	From 90 kHz to 110 kHz	From 150 kHz to 490 kHz	From 490 kHz to 30 MHz	From 30 MHz to 1 GHz
Instrument used	Test Receiver				
Detector	PK / AV	QP	PK / AV	QP	QP
IF Bandwidth	200 Hz	200 Hz	9 kHz	9 kHz	120 kHz
Test Distance	3 m *1)	3 m *1)	3 m *1)	3 m *2)	3 m

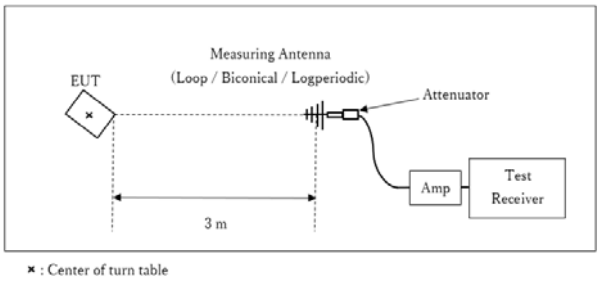
*1) Distance Factor: 40 x log (3 m / 300 m) = -80 dB
*2) Distance Factor: 40 x log (3 m / 30 m) = -40 dB

Although these tests were performed other than open field test site, adequate comparison measurements were confirmed against 30 m open field test site. Therefore sufficient tests were made to demonstrate that the alternative site produces results that correlate with the ones of tests made in an open field based on KDB 414788.

These tests were performed in semi anechoic chamber. Therefore the measured level of emissions may be higher than if measurements were made without a ground plane.
However test results were confirmed to pass against standard limit.

The limits in CFR 47, Part 15, Subpart C, paragraph 15.209(a), are identical to those in RSS-Gen section 8.9, Table 6, since the measurements are performed in terms of magnetic field strength and converted to electric field strength levels (as reported in the table) using the free space impedance of 377 Ohmes. For example, the measurement at frequency 9 kHz resulted in a level of 45.5 dBuV/m, which is equivalent to 45.5 - 51.5 = -6.0 dBuA/m, which has the same margin, 3 dB, to the corresponding RSS-Gen Table 6 limit as it has to 15.209(a) limit.

[Test Setup]
Below 1 GHz



Test Distance: 3 m

- 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.

This EUT has two modes which mechanical key is attached or not. The worst case was confirmed with and without mechanical key, as a result, the test without mechanical key was the worst case. Therefore, the test without mechanical key was performed only.

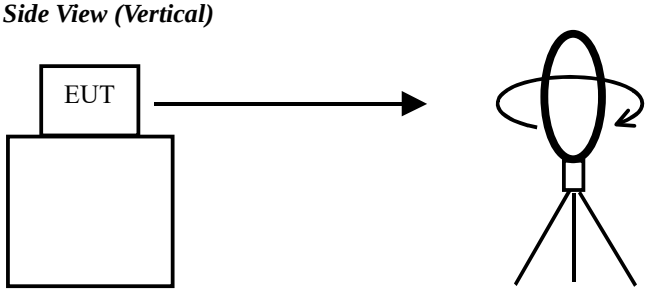
The test results and limit are rounded off to one decimal place, so some differences might be observed.

Measurement range : 9 kHz - 1 GHz
Test data : APPENDIX 1
Test result : Pass

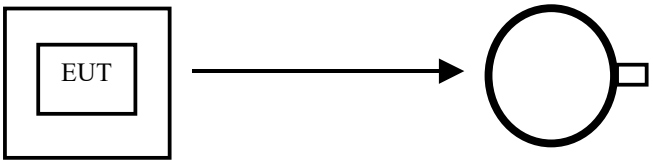
Date: September 4, 2020 Test engineer: Ken Fujita

Figure 1: Direction of the Loop Antenna

Side View (Vertical)

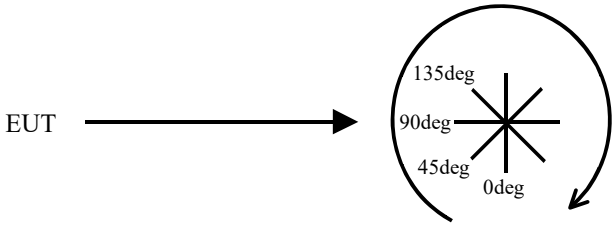


Top View (Horizontal)



Antenna was not rotated.

Top View (Vertical)



Front side: 0 deg.
Forward direction: clockwise

SECTION 6: -26 dB Bandwidth

Test Procedure

The test was measured with a spectrum analyzer using a test fixture.
<LF Antenna>

Test	Span	RBW	VBW	Sweep	Detector	Trace	Instrument used
-26 dB Bandwidth	1 kHz	1 Hz	3 Hz	Auto	Peak	Max Hold	Spectrum Analyzer

<Push Start Switch>

Test	Span	RBW	VBW	Sweep	Detector	Trace	Instrument used
-26 dB Bandwidth	1 kHz	9.1Hz	27 Hz	Auto	Peak	Max Hold	Spectrum Analyzer

Test data : APPENDIX 1
Test result : Pass

SECTION 7: 99 % Occupied Bandwidth

Test Procedure

The test was measured with a spectrum analyzer using a test fixture.

Test	Span	RBW	VBW	Sweep	Detector	Trace	Instrument used
99 % Occupied Bandwidth	Enough width to display emission skirts	1 to 5 % of OBW	Three times of RBW	Auto	Peak *1)	Max Hold *1)	Spectrum Analyzer
*1) The measurement was performed with Peak detector, Max Hold since the duty cycle was not 100 %. Peak hold was applied as Worst-case measurement.							

Test data : APPENDIX 1
Test result : Pass

APPENDIX 1: Test data

Radiated Emission below 30 MHz (Fundamental and Spurious Emission)
<LF Antenna DR>

Report No.	13487459H
Test place	Ise EMC Lab.
Semi Anechoic Chamber	No.2
Date	September 4, 2020
Temperature / Humidity	22 deg. C / 47 % RH
Engineer	Ken Fujita
Mode	Mode 1

PK or QP

Ant Deg [deg] or Polarity [Hori/Vert	Frequency [MHz]	Detector	Reading [dBuV]	Ant Factor [dB/m]	Loss [dB]	Gain [dB]	Duty Factor [dB]	Result [dBuV/m]	Limit [dBuV/m]	Margin [dB]	Remark
0deg	0.12500	PK	106.4	19.4	-74.0	32.3	-	19.6	45.6	26.0	Fundamental
0deg	0.25000	PK	69.9	19.5	-73.9	32.3	-	-16.9	39.6	56.5	
0deg	0.37500	PK	64.8	19.5	-73.9	32.3	-	-21.9	36.1	58.0	
0deg	0.50000	QP	35.3	19.4	-33.9	32.2	-	-11.4	33.6	45.0	
0deg	0.62500	QP	55.0	19.4	-33.9	32.2	-	8.3	31.7	23.4	
0deg	0.75000	QP	31.9	19.4	-33.8	32.2	-	-14.8	30.1	44.9	
0deg	0.87500	QP	48.9	19.4	-33.8	32.2	-	2.3	28.7	26.4	
0deg	1.00000	QP	31.2	19.5	-33.8	32.2	-	-15.4	27.6	43.0	
0deg	1.12500	QP	45.1	19.5	-33.8	32.2	-	-1.5	26.5	28.0	
0deg	1.25000	QP	31.1	19.5	-33.8	32.2	-	-15.4	25.6	41.0	

Result = Reading + Ant Factor + Loss (Cable + Attenuator + Filter + D.Factor) - Gain(Amprifier)

PK with Duty factor

Ant Deg [deg]	Frequency [MHz]	Detector	Reading [dBuV]	Ant Factor [dB/m]	Loss [dB]	Gain [dB]	Duty Factor [dB]	Result [dBuV/m]	Limit [dBuV/m]	Margin [dB]	Remark
0deg	0.12500	PK	106.4	19.4	-74.0	32.3	0.0	19.6	25.6	6.0	
0deg	0.25000	PK	69.9	19.5	-73.9	32.3	0.0	-16.9	19.6	36.5	
0deg	0.37500	PK	64.8	19.5	-73.9	32.3	0.0	-21.9	16.1	38.0	

Result = Reading + Ant Factor + Loss (Cable + Attenuator + Filter + D.Factor) - Gain(Amprifier) + Duty factor *
* Since the peak emission result satisfied the average limit, duty factor was omitted.

Result of the fundamental emission at 3m without Distance factor

PK or QP

Ant Deg [deg]	Frequency [MHz]	Detector	Reading [dBuV]	Ant Factor [dB/m]	Loss [dB]	Gain [dB]	Duty Factor [dB]	Result [dBuV/m]	Limit [dBuV/m]	Margin [dB]	Remark
0deg	0.12500	PK	106.4	19.4	6.0	32.3	-	99.6	-	-	Fundamental

Result = Reading + Ant Factor + Loss (Cable+Attenuator+Filter) - Gain(Amprifier)

* Other frequency noises omitted in this report were not seen or had enough margin (more than 20 dB).

*The test result is rounded off to one or two decimal places, so some differences might be observed.

Radiated Emission below 30 MHz (Fundamental and Spurious Emission)
<LF Antenna INF>

Report No.	13487459H
Test place	Ise EMC Lab.
Semi Anechoic Chamber	No.2
Date	September 4, 2020
Temperature / Humidity	22 deg. C / 47 % RH
Engineer	Ken Fujita
Mode	Mode 1

PK or QP

Ant Deg [deg] or Polarity [Hori/Vert]	Frequency [MHz]	Detector	Reading [dBuV]	Ant Factor [dB/m]	Loss [dB]	Gain [dB]	Duty Factor [dB]	Result [dBuV/m]	Limit [dBuV/m]	Margin [dB]	Remark
0deg	0.12500	PK	104.3	19.4	-74.0	32.3	-	17.5	45.6	28.1	Fundamental
0deg	0.25000	PK	61.7	19.5	-73.9	32.3	-	-25.1	39.6	64.7	
0deg	0.37500	PK	54.1	19.5	-73.9	32.3	-	-32.6	36.1	68.7	
0deg	0.50000	QP	40.6	19.4	-33.9	32.2	-	-6.1	33.6	39.7	
0deg	0.62500	QP	44.2	19.4	-33.9	32.2	-	-2.5	31.7	34.2	
0deg	0.75000	QP	31.4	19.4	-33.8	32.2	-	-15.3	30.1	45.4	
0deg	0.87500	QP	39.2	19.4	-33.8	32.2	-	-7.4	28.7	36.1	
0deg	1.00000	QP	31.1	19.5	-33.8	32.2	-	-15.5	27.6	43.1	
0deg	1.12500	QP	36.3	19.5	-33.8	32.2	-	-10.3	26.5	36.8	
0deg	1.25000	QP	30.9	19.5	-33.8	32.2	-	-15.6	25.6	41.2	

Result = Reading + Ant Factor + Loss (Cable + Attenuator + Filter + D.Factor) - Gain(Amprifier)

PK with Duty factor

Ant Deg [deg]	Frequency [MHz]	Detector	Reading [dBuV]	Ant Factor [dB/m]	Loss [dB]	Gain [dB]	Duty Factor [dB]	Result [dBuV/m]	Limit [dBuV/m]	Margin [dB]	Remark
0deg	0.12500	PK	104.3	19.4	-74.0	32.3	0.0	17.5	25.6	8.1	
0deg	0.25000	PK	61.7	19.5	-73.9	32.3	0.0	-25.1	19.6	44.7	
0deg	0.37500	PK	54.1	19.5	-73.9	32.3	0.0	-32.6	16.1	48.7	

Result = Reading + Ant Factor + Loss (Cable + Attenuator + Filter + D.Factor) - Gain(Amprifier) + Duty factor *
* Since the peak emission result satisfied the average limit, duty factor was omitted.

Result of the fundamental emission at 3m without Distance factor

PK or QP

Ant Deg [deg]	Frequency [MHz]	Detector	Reading [dBuV]	Ant Factor [dB/m]	Loss [dB]	Gain [dB]	Duty Factor [dB]	Result [dBuV/m]	Limit [dBuV/m]	Margin [dB]	Remark
0deg	0.12500	PK	104.3	19.4	6.0	32.3	-	97.5	-	-	Fundamental

Result = Reading + Ant Factor + Loss (Cable+Attenuator+Filter) - Gain(Amprifier)

* Other frequency noises omitted in this report were not seen or had enough margin (more than 20 dB).

*The test result is rounded off to one or two decimal places, so some differences might be observed.

Radiated Emission below 30 MHz (Fundamental and Spurious Emission)
<Push Start Switch>

Report No.	13487459H
Test place	Ise EMC Lab.
Semi Anechoic Chamber	No.2
Date	September 4, 2020
Temperature / Humidity	22 deg. C / 47 % RH
Engineer	Ken Fujita
Mode	Mode 1

PK or QP

Ant Deg [deg] or Polarity [Hori/Vert]	Frequency [MHz]	Detector	Reading [dBuV]	Ant Factor [dB/m]	Loss [dB]	Gain [dB]	Duty Factor [dB]	Result [dBuV/m]	Limit [dBuV/m]	Margin [dB]	Remark
0deg	0.12500	PK	93.9	19.4	-74.0	32.3	-	7.1	45.6	38.5	Fundamental
0deg	0.25000	PK	69.4	19.5	-73.9	32.3	-	-17.4	39.6	57.0	
0deg	0.37500	PK	57.4	19.5	-73.9	32.3	-	-29.3	36.1	65.4	
0deg	0.50000	QP	40.8	19.4	-33.9	32.2	-	-5.9	33.6	39.5	
0deg	0.62500	QP	46.4	19.4	-33.9	32.2	-	-0.3	31.7	32.0	
0deg	0.75000	QP	42.2	19.4	-33.8	32.2	-	-4.5	30.1	34.6	
0deg	0.87500	QP	42.9	19.4	-33.8	32.2	-	-3.7	28.7	32.4	
0deg	1.00000	QP	39.7	19.5	-33.8	32.2	-	-6.9	27.6	34.5	
0deg	1.12500	QP	41.2	19.5	-33.8	32.2	-	-5.3	26.5	31.9	
0deg	1.25000	QP	39.8	19.5	-33.8	32.2	-	-6.7	25.6	32.3	

Result = Reading + Ant Factor + Loss (Cable + Attenuator + Filter + D.Factor) - Gain(Amprifier)

PK with Duty factor

Ant Deg [deg]	Frequency [MHz]	Detector	Reading [dBuV]	Ant Factor [dB/m]	Loss [dB]	Gain [dB]	Duty Factor [dB]	Result [dBuV/m]	Limit [dBuV/m]	Margin [dB]	Remark
0deg	0.12500	PK	93.9	19.4	-74.0	32.3	0.0	7.1	25.6	18.5	
0deg	0.25000	PK	69.4	19.5	-73.9	32.3	0.0	-17.4	19.6	37.0	
0deg	0.37500	PK	57.4	19.5	-73.9	32.3	0.0	-29.3	16.1	45.4	

Result = Reading + Ant Factor + Loss (Cable + Attenuator + Filter + D.Factor) - Gain(Amprifier) + Duty factor *
* Since the peak emission result satisfied the average limit, duty factor was omitted.

Result of the fundamental emission at 3m without Distance factor

PK or QP

Ant Deg [deg]	Frequency [MHz]	Detector	Reading [dBuV]	Ant Factor [dB/m]	Loss [dB]	Gain [dB]	Duty Factor [dB]	Result [dBuV/m]	Limit [dBuV/m]	Margin [dB]	Remark
0	0.12500	PK	93.9	19.4	6.0	32.3	-	87.1	-	-	Fundamental

Result = Reading + Ant Factor + Loss (Cable+Attenuator+Filter) - Gain(Amprifier)

* Other frequency noises omitted in this report were not seen or had enough margin (more than 20 dB).

*The test result is rounded off to one or two decimal places, so some differences might be observed.

Radiated Emission above 30 MHz (Spurious Emission)
<LF Antenna DR>

Report No.	13487459H
Test place	Ise EMC Lab.
Semi Anechoic Chamber	No.2
Date	September 4, 2020
Temperature / Humidity	22 deg. C / 47 % RH
Engineer	Ken Fujita
Mode	Mode 1

Polarity	Frequency [MHz]	Detector	Reading [dBuV]	Ant.Fac. [dB/m]	Loss [dB]	Gain [dB]	Result [dBuV/m]	Limit [dBuV/m]	Margin [dB]	Remark
Hori.	30.072	QP	35.1	18.5	7.0	28.6	32.0	40.0	8.0	
Hori.	35.699	QP	32.7	16.4	7.1	28.6	27.6	40.0	12.5	
Hori.	125.330	QP	23.7	13.2	8.3	28.4	16.8	43.5	26.7	
Hori.	172.508	QP	23.3	15.6	8.7	28.2	19.4	43.5	24.1	
Hori.	211.402	QP	22.6	11.1	9.1	28.0	14.8	43.5	28.7	
Hori.	584.260	QP	21.8	18.9	11.5	29.4	22.8	46.0	23.2	
Vert.	30.072	QP	35.1	18.5	7.0	28.6	32.0	40.0	8.0	
Vert.	35.699	QP	32.5	16.4	7.1	28.6	27.4	40.0	12.7	
Vert.	125.330	QP	23.5	13.2	8.3	28.4	16.6	43.5	26.9	
Vert.	172.508	QP	23.6	15.6	8.7	28.2	19.7	43.5	23.8	
Vert.	211.402	QP	22.1	11.1	9.1	28.0	14.3	43.5	29.2	
Vert.	584.260	QP	21.2	18.9	11.5	29.4	22.2	46.0	23.8	

Result = Reading + Ant Factor + Loss (Cable+Attenuator) - Gain(Amplifier)

*Other frequency noises omitted in this report were not seen or had enough margin (more than 20 dB).

*The test result is rounded off to one or two decimal places, so some differences might be observed.

Radiated Emission above 30 MHz (Spurious Emission)
<LF Antenna INF>

Report No.	13487459H
Test place	Ise EMC Lab.
Semi Anechoic Chamber	No.2
Date	September 4, 2020
Temperature / Humidity	22 deg. C / 47 % RH
Engineer	Ken Fujita
Mode	Mode 1

Polarity	Frequency [MHz]	Detector	Reading [dBuV]	Ant.Fac. [dB/m]	Loss [dB]	Gain [dB]	Result [dBuV/m]	Limit [dBuV/m]	Margin [dB]	Remark
Hori.	30.871	QP	33.8	18.2	7.0	28.6	30.4	40.0	9.6	
Hori.	35.529	QP	31.1	16.5	7.1	28.6	26.0	40.0	14.0	
Hori.	126.471	QP	24.3	13.3	8.3	28.4	17.4	43.5	26.1	
Hori.	140.781	QP	23.4	14.2	8.4	28.4	17.7	43.5	25.8	
Hori.	212.072	QP	23.1	11.1	9.1	28.0	15.3	43.5	28.2	
Hori.	348.070	QP	22.2	15.0	10.2	28.1	19.3	46.0	26.7	
Vert.	30.871	QP	33.1	18.2	7.0	28.6	29.7	40.0	10.3	
Vert.	35.529	QP	31.2	16.5	7.1	28.6	26.1	40.0	13.9	
Vert.	126.471	QP	33.5	13.3	8.3	28.4	26.6	43.5	16.9	
Vert.	140.781	QP	23.5	14.2	8.4	28.4	17.8	43.5	25.7	
Vert.	212.072	QP	23.2	11.1	9.1	28.0	15.4	43.5	28.1	
Vert.	348.070	QP	21.5	15.0	10.2	28.1	18.6	46.0	27.4	

Result = Reading + Ant Factor + Loss (Cable+Attenuator) - Gain(Amplifier)

*Other frequency noises omitted in this report were not seen or had enough margin (more than 20 dB).

*The test result is rounded off to one or two decimal places, so some differences might be observed.

Radiated Emission above 30 MHz (Spurious Emission)
<Push Start Switch>

Report No.	13487459H
Test place	Ise EMC Lab.
Semi Anechoic Chamber	No.2
Date	September 4, 2020
Temperature / Humidity	22 deg. C / 47 % RH
Engineer	Ken Fujita
Mode	Mode 1

Polarity	Frequency [MHz]	Detector	Reading [dBuV]	Ant.Fac. [dB/m]	Loss [dB]	Gain [dB]	Result [dBuV/m]	Limit [dBuV/m]	Margin [dB]	Remark
Hori.	30.019	QP	32.4	18.5	7.0	28.6	29.3	40.0	10.7	
Hori.	31.243	QP	28.7	18.0	7.0	28.6	25.1	40.0	14.9	
Hori.	67.216	QP	23.7	6.4	7.6	28.6	9.1	40.0	30.9	
Hori.	126.918	QP	23.7	13.3	8.3	28.4	16.9	43.5	26.7	
Hori.	211.975	QP	22.3	11.1	9.1	28.0	14.5	43.5	29.0	
Hori.	611.140	QP	21.9	19.4	11.6	29.4	23.6	46.0	22.5	
Vert.	30.019	QP	32.4	18.5	7.0	28.6	29.3	40.0	10.7	
Vert.	31.243	QP	29.7	18.0	7.0	28.6	26.1	40.0	13.9	
Vert.	67.216	QP	24.5	6.4	7.6	28.6	9.9	40.0	30.1	
Vert.	126.918	QP	23.4	13.3	8.3	28.4	16.6	43.5	27.0	
Vert.	211.975	QP	23.3	11.1	9.1	28.0	15.5	43.5	28.0	
Vert.	611.140	QP	21.7	19.4	11.6	29.4	23.4	46.0	22.7	

Result = Reading + Ant Factor + Loss (Cable+Attenuator) - Gain(Amplifier)

*Other frequency noises omitted in this report were not seen or had enough margin (more than 20 dB).

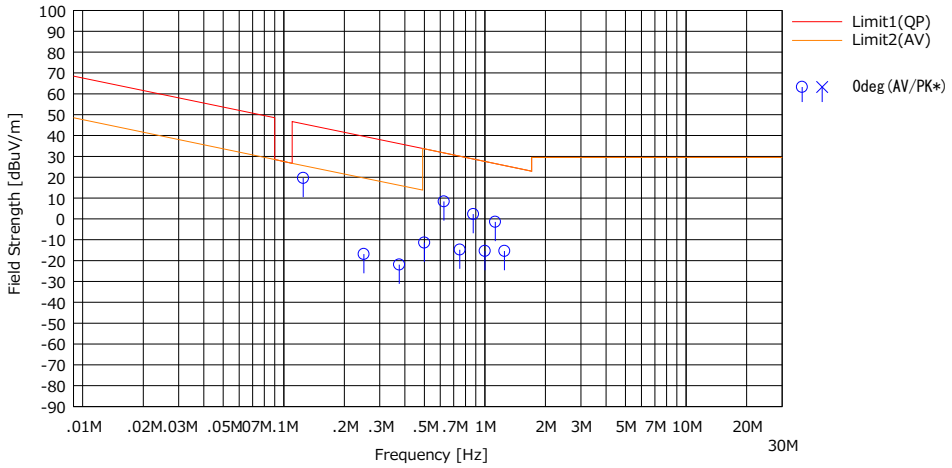
*The test result is rounded off to one or two decimal places, so some differences might be observed.

Radiated Emission Plot data, Worst case
<LF Antenna DR>

Report No.	13487459H
Test place	Ise EMC Lab.
Semi Anechoic Chamber	No.2
Date	September 4, 2020
Temperature / Humidity	22 deg. C / 47 % RH
Engineer	Ken Fujita
Mode	Mode 1

(below 30MHz)

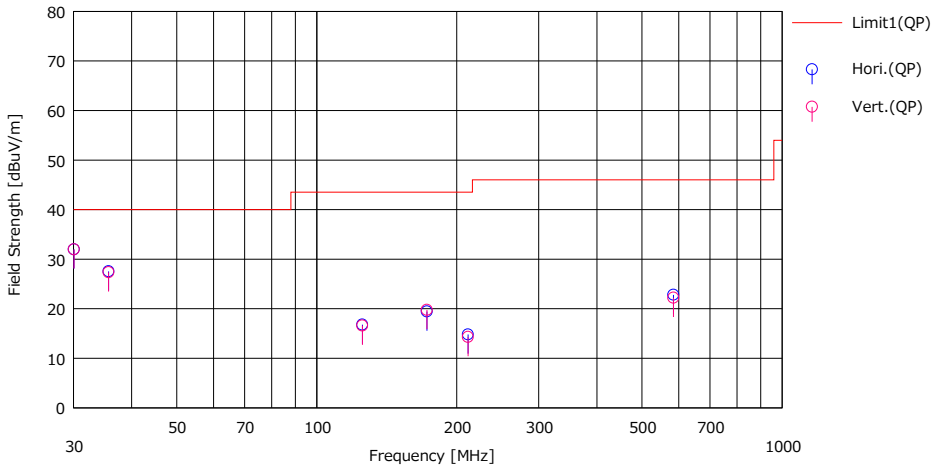
Limit : FCC15.209(a), 9-90kHz:PK, 110-490kHz:PK, other:QP



* Data above 490 kHz were measured using a QP detector.

(above 30MHz)

Limit : FCC15.209 3 m, below 1 GHz:QP, above 1 GHz:AV/PK



*These plots data contains sufficient number to show the trend of characteristic features for EUT.

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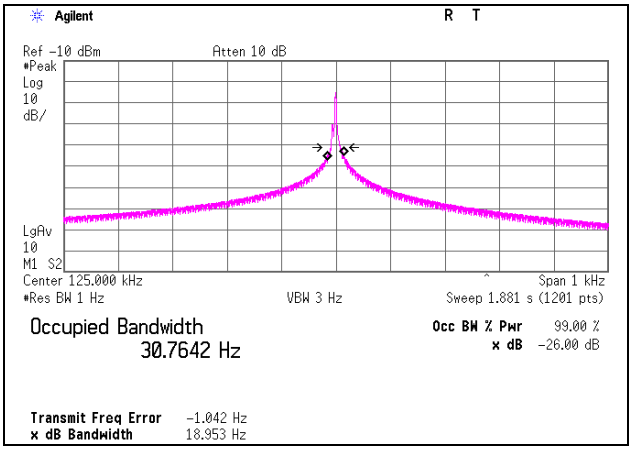
-26 dB Bandwidth and 99 % Occupied Bandwidth

Report No.	13487459H
Test place	Ise EMC Lab.
Semi Anechoic Chamber	No.2
Date	September 4, 2020
Temperature / Humidity	22 deg. C / 47 % RH
Engineer	Ken Fujita
Mode	Mode 1

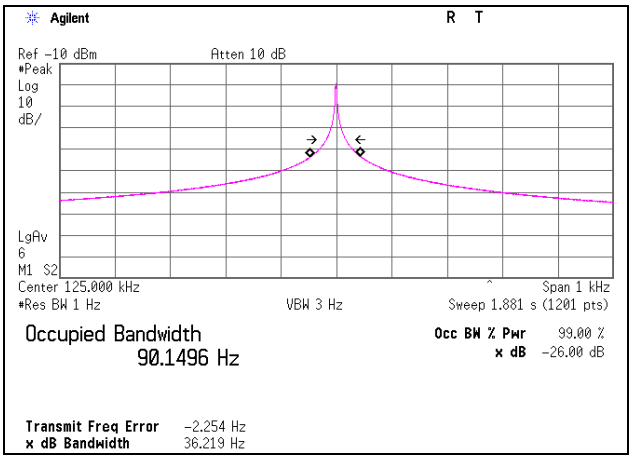
<LF Antenna DR>

-26 dB Bandwidth [Hz]	99 % Occupied Bandwidth [Hz]
18.953	30.7642



<LF Antenna INF>

-26 dB Bandwidth [Hz]	99 % Occupied Bandwidth [Hz]
36.219	90.1496

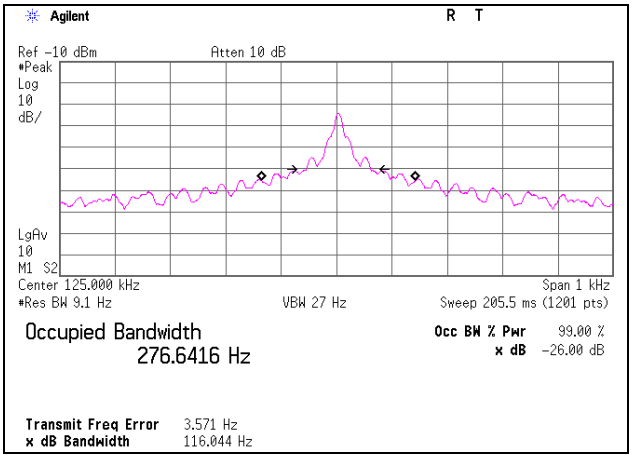


-26 dB Bandwidth and 99 % Occupied Bandwidth

Report No.	13487459H
Test place	Ise EMC Lab.
Semi Anechoic Chamber	No.2
Date	September 4, 2020
Temperature / Humidity	22 deg. C / 47 % RH
Engineer	Ken Fujita
Mode	Mode 1

<Push Start Switch>

-26 dB Bandwidth [Hz]	99 % Occupied Bandwidth [Hz]
116.044	276.6416



APPENDIX 2: Test instruments

Test equipment

Test Item	Local ID	LIMS ID	Description	Manufacturer	Model	Serial	Last Calibration Date	Cal Int
RE	MAEC-02	142004	AC2_Semi Anechoic Chamber(NSA)	TDK	Semi Anechoic Chamber 3m	DA-06902	05/26/2020	24
RE	MOS-41	192300	Thermo-Hygrometer	CUSTOM. Inc	CTH-201	0013	12/19/2019	12
RE	MMM-01	141542	Digital Tester	Fluke Corporation	FLUKE 26-3	78030611	08/18/2020	12
RE	MJM-27	142228	Measure	KOMELON	KMC-36	-	-	-
RE	COTS-MEMI-02	178648	EMI measurement program	TSJ (Techno Science Japan)	TEPTO-DV	-	-	-
RE	MAT-07	141203	Attenuator(6dB)	Weinschel Corp	2	BK7970	11/07/2019	12
RE	MBA-08	141427	Biconical Antenna	Schwarzbeck Mess - Elektronik	VHA9103B+BBA9106	8031	07/29/2020	12
RE	MCC-12	141317	Coaxial Cable	Fujikura/Agilent	-	-	09/03/2019	12
RE	MLA-21	141265	Logperiodic Antenna (200-1000MHz)	Schwarzbeck Mess - Elektronik	VUSLP9111B	9111B-190	07/29/2020	12
RE	MPA-09	141578	Pre Amplifier	Keysight Technologies Inc	8447D	2944A10845	-	-
RE	MTR-03	141942	Test Receiver	Rohde & Schwarz	ESCI	100300	08/18/2020	12
RE	MLPA-01	141254	Loop Antenna	Rohde & Schwarz	HFH2-Z2	100017	10/04/2019	12
RE	MCC-143	141413	Coaxial Cable	UL Japan	-	-	06/18/2020	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