RADIO TEST REPORT

Test Report No. : 13915330H-A-R1

Applicant	:	**TOYOTA MOTOR CORPORATION**
Type of EUT	:	**Smart LF Oscillator**
Model Number of EUT	:	**TMLF15-4**
FCC ID	:	**NI4TMLF15-4**
Test regulation	:	**FCC Part 15 Subpart C: 2021**
Test Result	:	**Complied (Refer to SECTION 3)**

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2. The results in this report apply only to the sample tested.
3. This sample tested is in compliance with the limits of the above regulation.
4. The test results in this test report are traceable to the national or international standards.
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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 13915330H-A. 13915330H-A is replaced with this report.

Date of test: July 27 and September 1, 2021

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.
☒ There is no testing item of "Non-accreditation".

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REVISION HISTORY

Original Test Report No.: 13915330H-A

Revision	Test report No.	Date	Page revised	Contents
- (Original)	13915330H-A	October 19, 2021	-	-
1	13915330H-A-R1	November 2, 2021	P.6	Correction of FCC Part 15.31 (e) in Clause 3.2; From "The test was performed with the New Battery and DC power supply during the tests. Therefore, the EUT complies with the requirement." to "The EUT provides stable voltage constantly to RF Module regardless of input voltage. Instead of a new battery, DC power supply was used for the test. That does not affect the test result, therefore the EUT complies with the requirement."
1	13915330H-A-R1	November 2, 2021	P.14	Correction of RBW in SECTION 6; From 510 kHz to 510 Hz

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

CONTENTS **PAGE**

SECTION 1: Customer information

Company Name	:	TOYOTA MOTOR CORPORATION
Address	:	1, Toyota-Cho, Toyota, Aichi, 471-8572 Japan
Telephone Number	:	+81-50-3166-3743
Facsimile Number	:	+81-565-94-1161
Contact Person	:	Shinji Suganuma

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)
- 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	:	Smart LF Oscillator
Model Number	:	TMLF15-4
Serial Number	:	Refer to SECTION 4.2
Rating	:	DC 12.0 V (Max 0.5 A)
Receipt Date	:	July 19, 2021
Country of Mass-production	:	Japan
Condition of EUT	:	Production prototype (Not for Sale: This sample is equivalent to mass-produced items.)
Modification	:	No Modification by the test lab.

2.2. Product Description

Smart LF Oscillator, model: TMLF15-4 is a transmitter that is installed in a motor vehicle and is used as part of Smart System.

Radio Specification

Radio Type	:	Transmitter
Frequency of Operation	:	134.2 kHz
Modulation	:	ASK
Antenna type	:	Coil Antenna

Smart LF Oscillator (model: TMLF15-4) consists of the following parts:
- Computer Assy, Smart Key (ECU)
- Door Antenna
- Trunk Antenna
- Room Antenna / Luggage Antenna

SECTION 3: Test specification, procedures & results

3.1 Test Specification

Test Specification : FCC Part 15 Subpart C
FCC Part 15 final revised on May 3, 2021 and effective July 2, 2021

Title : FCC 47CFR Part15 Radio Frequency Device Subpart C Intentional Radiators
Section 15.207 Conducted limits
Section 15.209 Radiated emission limits; general requirements.

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	15.7 dB 134.2 kHz, 0 deg. Peak with Duty factor <Mode 1>	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	16.4 dB 68.845 MHz, Horizontal, QP <Mode 1>	Complied a)
-20 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 -20 dB Bandwidth / 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 EUT provides stable voltage constantly to RF Module regardless of input voltage.
Instead of a new battery, DC power supply was used for the test.
That does not affect the test result, therefore the 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	-

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 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.
Ise EMC Lab.

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
3 m	1 GHz to 6 GHz	4.9 dB
	6 GHz to 18 GHz	5.2 dB
1 m	10 GHz to 26.5 GHz	5.5 dB
	26.5 GHz to 40 GHz	5.5 dB
10 m	1 GHz to 18 GHz	5.2 dB

Antenna Terminal test

Test Item	Uncertainty (+/-)
-20 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: 884919
ISED Lab Company Number: 2973C / CAB identifier: JP0002
4383-326 Asama-cho, Ise-shi, Mie-ken 516-0021 JAPAN
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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	-	-

* 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.

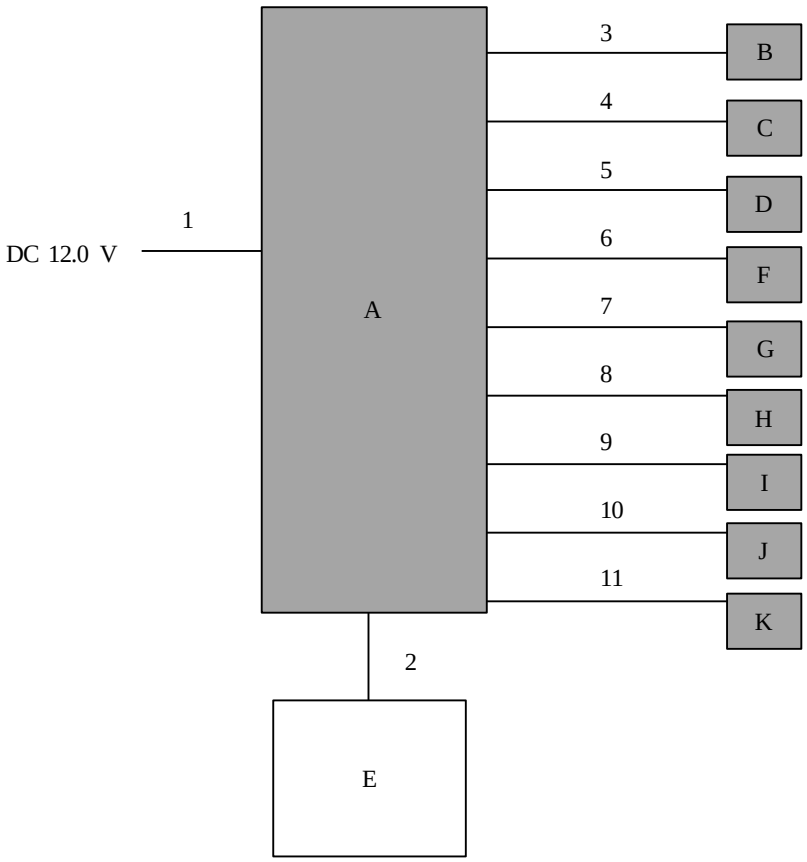
SECTION 4: Operation of EUT during testing

4.1. Operating Mode(s)

Test mode	Remarks
1) Tx 134.2 kHz Door Antenna	-
2) Tx 134.2 kHz Trunk Antenna	
3) Tx 134.2 kHz Room Antenna	
4) Tx 134.2 kHz Room Antenna(Min Power)	
Simultaneous transmission from more than one antenna does not happen. Each antenna will transmit in alternative shift. The test was performed with maximum antenna after the pre-check. * EUT was set by the software as follows; Software: IDT_WAVECHK_V02_Max/ IDT_WAVECHK_V02_Min Version V02 (Date: 2013.06.08, 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 were taken into consideration and test data was taken under worse case conditions.

Description of EUT and Support equipment

No.	Item	Model number	Serial number	Manufacturer	Remarks
A	Computer Assy, Smart Key (ECU)	TMLF15-4(E15V)	001	-	EUT
B	Door Antenna	15DA1	001	-	EUT
C	Room Antenna / Luggage Antenna	8RA	001	-	EUT
D	Trunk Antenna	2TA	001	-	EUT
E	Jig Box	-	-	-	-
F	Door Antenna	15DA1	002	-	EUT
G	Door Antenna	15DA1	003	-	EUT
H	Door Antenna	15DA1	004	-	EUT
I	Room Antenna / Luggage Antenna	8RA	002	-	EUT
J	Room Antenna / Luggage Antenna	8RA	003	-	EUT
K	Trunk Antenna	2TA	002	-	EUT

List of cables used

No.	Name	Length (m)	Shield		Remarks
			Cable	Connector	
1	DC Cable	3.0	Unshielded	Unshielded	-
2	ECU Cable	3.0	Unshielded	Unshielded	-
3	Door Ant Cable	3.0	Unshielded	Unshielded	-
4	Room Ant / Luggage Ant Cable	3.0	Unshielded	Unshielded	-
5	Trunk Ant Cable	3.0	Unshielded	Unshielded	-
6	Door Ant Cable	3.0	Unshielded	Unshielded	-
7	Door Ant Cable	3.0	Unshielded	Unshielded	-
8	Door Ant Cable	3.0	Unshielded	Unshielded	-
9	Room Ant / Luggage Ant Cable	3.0	Unshielded	Unshielded	-
10	Room Ant / Luggage Ant Cable	3.0	Unshielded	Unshielded	-
11	Trunk Ant 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, 1.0 m by 1.5 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

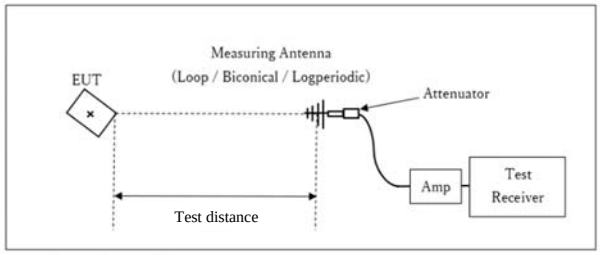
Although these tests were performed other than open field test site, adequate comparison measurements were confirmed against 30 m open field test site. Therefore, sufficient tests were made to demonstrate that the alternative site produces results that correlate with the ones of tests made in an open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

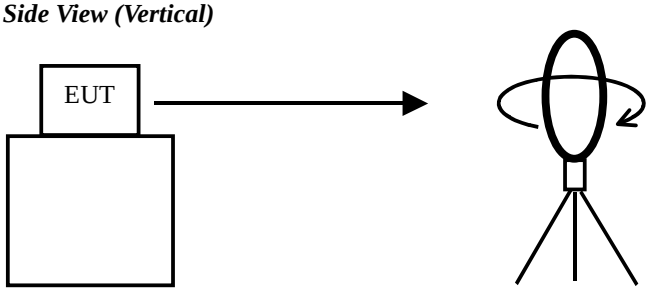
- The carrier level and noise levels were confirmed at each position of X, Y and Z axes of EUT to see the position of maximum noise, and the test was made at the position that has the maximum noise.

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

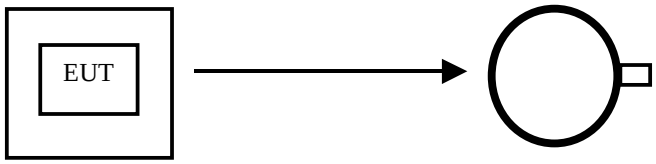
Measurement range : 9 kHz - 1 GHz
Test data : APPENDIX
Test result : Pass

Figure 1: Direction of the Loop Antenna

Side View (Vertical)

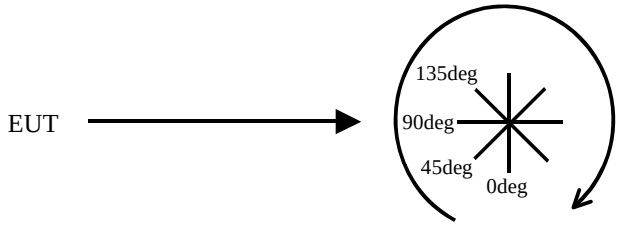


Top View (Horizontal)



Antenna was not rotated.

Top View (Vertical)



Front side: 0 deg.
Forward direction: clockwise

SECTION 6: -20 dB Bandwidth

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

Test	Span	RBW	VBW	Sweep	Detector	Trace	Instrument used
-20 dB Bandwidth	100 kHz	510 Hz	1.6 kHz	Auto	Peak	Max Hold	Spectrum Analyzer

Test data : APPENDIX 1
Test result : Pass

SECTION 7: 99% 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 *)	Max Hold *)	Spectrum Analyzer
*) 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
Test result : Pass

APPENDIX 1: Test data

Radiated Emission (Fundamental and Spurious Emission)

Report No.	13915330H
Test place	Ise EMC Lab.
Semi Anechoic Chamber	No.2
Date	September 1, 2021
Temperature / Humidity	21 deg. C / 41 % RH
Engineer	Hiroki Numata
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	0.13420	PK	96.3	18.9	-73.8	32.1	-	9.3	45.0	35.7	Fundamental
0deg	0.26840	PK	62.9	18.9	-73.8	32.1	-	-24.1	39.0	63.1	
0deg	0.40260	PK	63.3	18.8	-73.8	32.1	-	-23.8	35.5	59.3	
0deg	0.53680	QP	51.8	18.8	-33.8	32.1	-	4.7	33.0	28.3	
0deg	0.67100	QP	50.1	18.8	-33.7	32.1	-	3.1	31.1	28.0	
0deg	0.80520	QP	31.4	18.8	-33.7	32.1	-	-15.6	29.5	45.1	
0deg	0.93940	QP	49.8	18.8	-33.7	32.1	-	2.8	28.1	25.3	
0deg	1.07360	QP	30.8	18.8	-33.7	32.2	-	-16.3	26.9	43.2	
0deg	1.20780	QP	46.0	18.8	-33.7	32.2	-	-1.1	25.9	27.0	
0deg	1.34200	QP	30.7	18.8	-33.7	32.2	-	-16.4	25.0	41.4	
Hori.	38.039	QP	28.7	15.5	7.5	38.7	-	13.0	40.0	27.0	Floor Noise
Hori.	59.736	QP	41.9	7.9	7.9	38.8	-	18.9	40.0	21.1	
Hori.	64.539	QP	39.5	6.9	8.0	38.8	-	15.6	40.0	24.4	
Hori.	68.845	QP	47.8	6.5	8.1	38.8	-	23.6	40.0	16.4	
Hori.	74.035	QP	38.9	6.5	8.1	38.8	-	14.7	40.0	25.3	
Hori.	76.044	QP	40.6	6.6	8.2	38.8	-	16.6	40.0	23.4	
Vert.	38.039	QP	35.8	15.5	7.5	38.7	-	20.1	40.0	19.9	
Vert.	59.736	QP	41.4	7.9	7.9	38.8	-	18.4	40.0	21.6	
Vert.	64.539	QP	34.4	6.9	8.0	38.8	-	10.5	40.0	29.5	
Vert.	68.845	QP	44.4	6.5	8.1	38.8	-	20.2	40.0	19.8	
Vert.	74.035	QP	39.6	6.5	8.1	38.8	-	15.4	40.0	24.6	
Vert.	76.044	QP	42.9	6.6	8.2	38.8	-	18.9	40.0	21.1	

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

PK with Duty factor

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	0.13420	PK	96.3	18.9	-73.8	32.1	0.0	9.3	25.0	15.7	Fundamental
0deg	0.26840	PK	62.9	18.9	-73.8	32.1	0.0	-24.1	19.0	43.1	
0deg	0.40260	PK	63.3	18.8	-73.8	32.1	0.0	-23.8	15.5	39.3	

Result = Reading + Ant Factor + Loss (Cable + Attenuator + 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

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	0.13420	PK	96.3	18.9	6.2	32.1	-	89.3	-	-	Fundamental

Result = Reading + Ant Factor + Loss (Cable+Attenuator) - 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 (Fundamental and Spurious Emission)

Report No.	13915330H
Test place	Ise EMC Lab.
Semi Anechoic Chamber	No.2
Date	September 1, 2021
Temperature / Humidity	21 deg. C / 41 % RH
Engineer	Hiroki Numata
Mode	Mode 2

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	0.13420	PK	95.9	18.9	-73.8	32.1	-	8.9	45.0	36.1	Fundamental
0deg	0.26840	PK	58.4	18.9	-73.8	32.1	-	-28.6	39.0	67.6	
0deg	0.40260	PK	61.6	18.8	-73.8	32.1	-	-25.5	35.5	61.0	
0deg	0.53680	QP	53.1	18.8	-33.8	32.1	-	6.0	33.0	27.0	
0deg	0.67100	QP	48.5	18.8	-33.7	32.1	-	1.5	31.1	29.6	
0deg	0.80520	QP	31.4	18.8	-33.7	32.1	-	-15.6	29.5	45.1	
0deg	0.93940	QP	47.4	18.8	-33.7	32.1	-	0.4	28.1	27.7	
0deg	1.07360	QP	30.8	18.8	-33.7	32.2	-	-16.3	26.9	43.2	
0deg	1.20780	QP	43.5	18.8	-33.7	32.2	-	-3.6	25.9	29.5	
0deg	1.34200	QP	30.7	18.8	-33.7	32.2	-	-16.4	25.0	41.4	
Hori.	32.041	QP	32.6	17.7	7.3	38.7	-	18.9	40.0	21.1	
Hori.	59.754	QP	41.1	7.9	7.9	38.8	-	18.1	40.0	21.9	
Hori.	64.879	QP	37.5	6.8	8.0	38.8	-	13.5	40.0	26.5	
Hori.	69.324	QP	42.9	6.5	8.1	38.8	-	18.7	40.0	21.3	
Hori.	71.261	QP	40.2	6.4	8.1	38.8	-	15.9	40.0	24.1	
Hori.	74.748	QP	32.9	6.5	8.2	38.8	-	8.8	40.0	31.2	Floor Noise
Vert.	32.041	QP	29.7	17.7	7.3	38.7	-	16.0	40.0	24.0	Floor Noise
Vert.	59.754	QP	41.9	7.9	7.9	38.8	-	18.9	40.0	21.1	
Vert.	64.477	QP	40.4	6.9	8.0	38.8	-	16.5	40.0	23.5	
Vert.	68.879	QP	43.2	6.5	8.1	38.8	-	19.0	40.0	21.0	
Vert.	71.261	QP	41.2	6.4	8.1	38.8	-	16.9	40.0	23.1	
Vert.	74.748	QP	45.2	6.5	8.2	38.8	-	21.1	40.0	18.9	

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

PK with Duty factor

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	0.13420	PK	95.9	18.9	-73.8	32.1	0.0	8.9	25.0	16.1	Fundamental
0deg	0.26840	PK	58.4	18.9	-73.8	32.1	0.0	-28.6	19.0	47.6	
0deg	0.40260	PK	61.6	18.8	-73.8	32.1	0.0	-25.5	15.5	41.0	

Result = Reading + Ant Factor + Loss (Cable + Attenuator + 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

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	0.13420	PK	95.9	18.9	6.2	32.1	-	88.9	-	-	Fundamental

Result = Reading + Ant Factor + Loss (Cable+Attenuator) - 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 (Fundamental and Spurious Emission)

Report No.	13915330H
Test place	Ise EMC Lab.
Semi Anechoic Chamber	No.2
Date	September 1, 2021
Temperature / Humidity	21 deg. C / 41 % RH
Engineer	Hiroki Numata
Mode	Mode 3

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	0.13420	PK	95.8	18.9	-73.8	32.1	-	8.8	45.0	36.2	Fundamental
0deg	0.26840	PK	59.0	18.9	-73.8	32.1	-	-28.0	39.0	67.0	
0deg	0.40260	PK	64.2	18.8	-73.8	32.1	-	-22.9	35.5	58.4	
0deg	0.53680	QP	51.7	18.8	-33.8	32.1	-	4.6	33.0	28.4	
0deg	0.67100	QP	49.4	18.8	-33.7	32.1	-	2.4	31.1	28.7	
0deg	0.80520	QP	31.4	18.8	-33.7	32.1	-	-15.6	29.5	45.1	
0deg	0.93940	QP	49.1	18.8	-33.7	32.1	-	2.1	28.1	26.0	
0deg	1.07360	QP	30.8	18.8	-33.7	32.2	-	-16.3	26.9	43.2	
0deg	1.20780	QP	45.4	18.8	-33.7	32.2	-	-1.7	25.9	27.6	
0deg	1.34200	QP	30.7	18.8	-33.7	32.2	-	-16.4	25.0	41.4	
Hori.	45.221	QP	29.6	12.9	7.6	38.7	-	11.4	40.0	28.6	Floor Noise
Hori.	59.755	QP	40.1	7.9	7.9	38.8	-	17.1	40.0	22.9	
Hori.	64.529	QP	39.9	6.9	8.0	38.8	-	16.0	40.0	24.0	
Hori.	68.874	QP	44.5	6.5	8.1	38.8	-	20.3	40.0	19.7	
Hori.	71.155	QP	41.1	6.4	8.1	38.8	-	16.8	40.0	23.2	
Hori.	78.641	QP	35.3	6.8	8.2	38.8	-	11.5	40.0	28.5	
Vert.	45.221	QP	35.3	12.9	7.6	38.7	-	17.1	40.0	22.9	
Vert.	59.755	QP	38.2	7.9	7.9	38.8	-	15.2	40.0	24.8	
Vert.	64.529	QP	35.1	6.9	8.0	38.8	-	11.2	40.0	28.8	
Vert.	68.874	QP	42.8	6.5	8.1	38.8	-	18.6	40.0	21.4	
Vert.	71.155	QP	38.0	6.4	8.1	38.8	-	13.7	40.0	26.3	
Vert.	78.641	QP	36.9	6.8	8.2	38.8	-	13.1	40.0	26.9	

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

PK with Duty factor

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	0.13420	PK	95.8	18.9	-73.8	32.1	0.0	8.8	25.0	16.2	Fundamental
0deg	0.26840	PK	59.0	18.9	-73.8	32.1	0.0	-28.0	19.0	47.0	
0deg	0.40260	PK	64.2	18.8	-73.8	32.1	0.0	-22.9	15.5	38.4	

Result = Reading + Ant Factor + Loss (Cable + Attenuator + 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

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	0.13420	PK	95.8	18.9	6.2	32.1	-	88.8	-	-	Fundamental

Result = Reading + Ant Factor + Loss (Cable+Attenuator) - 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 (Fundamental and Spurious Emission)

Report No.	13915330H
Test place	Ise EMC Lab.
Semi Anechoic Chamber	No.2
Date	September 1, 2021
Temperature / Humidity	21 deg. C / 41 % RH
Engineer	Hiroki Numata
Mode	Mode 4

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	0.13420	PK	81.6	18.9	-73.8	32.1	-	-5.4	45.0	50.4	Fundamental
0deg	0.26840	PK	53.9	18.9	-73.8	32.1	-	-33.1	39.0	72.1	
0deg	0.40260	PK	53.2	18.8	-73.8	32.1	-	-33.9	35.5	69.4	
0deg	0.53680	QP	47.3	18.8	-33.8	32.1	-	0.2	33.0	32.8	
0deg	0.67100	QP	32.9	18.8	-33.7	32.1	-	-14.1	31.1	45.2	
0deg	0.80520	QP	42.0	18.8	-33.7	32.1	-	-5.0	29.5	34.5	
0deg	0.93940	QP	36.3	18.8	-33.7	32.1	-	-10.7	28.1	38.8	
0deg	1.07360	QP	37.4	18.8	-33.7	32.2	-	-9.7	26.9	36.6	
0deg	1.20780	QP	34.4	18.8	-33.7	32.2	-	-12.7	25.9	38.6	
0deg	1.34200	QP	32.7	18.8	-33.7	32.2	-	-14.4	25.0	39.4	
Hori.	36.239	QP	21.1	16.1	7.2	32.0	-	12.4	40.0	27.6	Floor Noise
Hori.	38.657	QP	21.8	15.2	7.3	32.0	-	12.3	40.0	27.7	Floor Noise
Hori.	53.152	QP	21.5	9.9	7.5	32.0	-	6.9	40.0	33.1	Floor Noise
Hori.	70.062	QP	29.3	6.3	7.7	32.0	-	11.3	40.0	28.7	
Hori.	72.479	QP	33.7	6.3	7.7	32.0	-	15.7	40.0	24.3	
Hori.	74.897	QP	31.2	6.4	7.7	32.0	-	13.3	40.0	26.7	
Vert.	36.239	QP	27.6	16.1	7.2	32.0	-	18.9	40.0	21.1	
Vert.	38.657	QP	29.3	15.2	7.3	32.0	-	19.8	40.0	20.2	
Vert.	53.152	QP	27.9	9.9	7.5	32.0	-	13.3	40.0	26.7	
Vert.	70.062	QP	29.1	6.3	7.7	32.0	-	11.1	40.0	28.9	
Vert.	72.479	QP	30.5	6.3	7.7	32.0	-	12.5	40.0	27.5	
Vert.	74.897	QP	29.5	6.4	7.7	32.0	-	11.6	40.0	28.4	

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

PK with Duty factor

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	0.13420	PK	81.6	18.9	-73.8	32.1	0.0	-5.4	25.0	30.4	Fundamental
0deg	0.26840	PK	53.9	18.9	-73.8	32.1	0.0	-33.1	19.0	52.1	
0deg	0.40260	PK	53.2	18.8	-73.8	32.1	0.0	-33.9	15.5	49.4	

Result = Reading + Ant Factor + Loss (Cable + Attenuator + 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

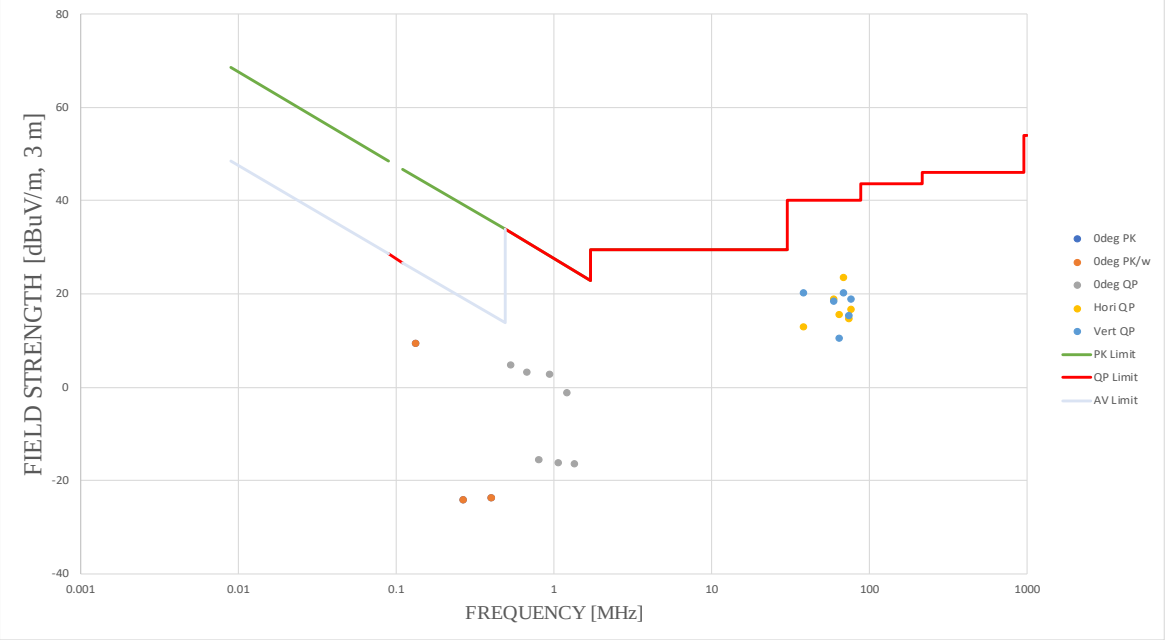
Ant Deg [deg]	Frequency [MHz]	Detector	Reading [dBuV]	Ant Factor [dB/m]	Loss [dB]	Gain [dB]	Duty Factor [dB]	Result [dBuV/m]	Limit [dBuV/m]	Margin [dB]	Remark
0deg	0.13420	PK	81.6	18.9	6.2	32.1	-	74.6	-	-	Fundamental

Result = Reading + Ant Factor + Loss (Cable+Attenuator) - 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
(Plot data, Worst case)

Report No.	13915330H
Test place	Ise EMC Lab.
Semi Anechoic Chamber	No.2
Date	September 1, 2021
Temperature / Humidity	21 deg. C / 41 % RH
Engineer	Hiroki Numata
Mode	Mode 1



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Ise EMC Lab.
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Telephone : +81 596 24 8999
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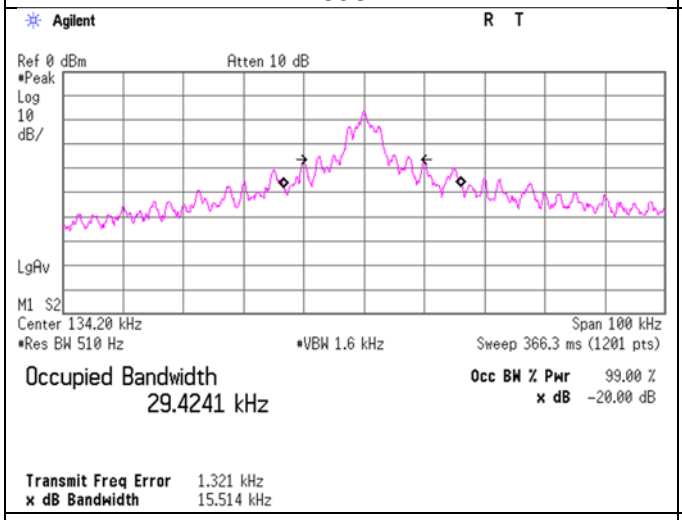
-20 dB Bandwidth / 99 % Occupied Bandwidth

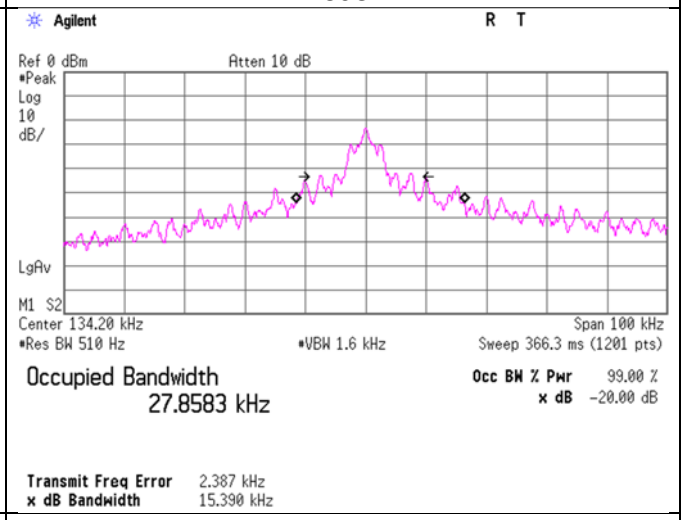
Report No.	13915330H
Test place	Ise EMC Lab.
Semi Anechoic Chamber	No.2
Date	July 27, 2021
Temperature / Humidity	21 deg. C / 41 % RH
Engineer	Akihiko Maeda
Mode	Mode 1 to 4

Mode	-20 dB Bandwidth [kHz]	99 % Occupied Bandwidth [kHz]
Mode 1	15.514	29.4241
Mode 2	15.390	27.8583
Mode 3	15.481	34.0746
Mode 4	15.522	36.9582

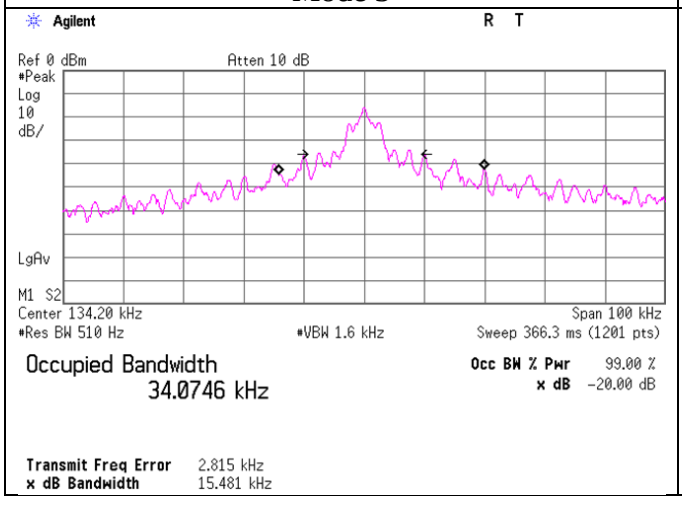
Mode 1



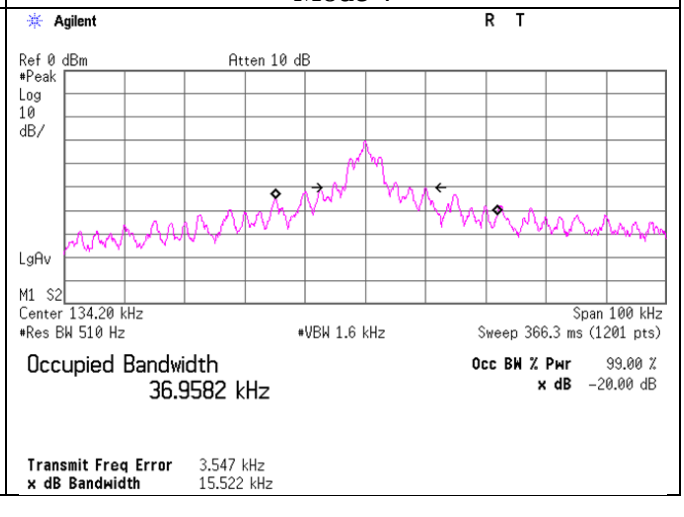
Mode 2



Mode 3



Mode 4



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	12/06/2020	12
RE	MMM-01	141542	Digital Tester	Fluke Corporation	FLUKE 26-3	78030611	08/10/2021	12
RE	MJM-27	142228	Measure	KOMELON	KMC-36	-	-	-
RE	COTS-MEMI-02	178648	EMI measurement program	TSJ (Techno Science Japan)	TEPTO-DV	-	-	-
RE	MPA-19	141585	Pre Amplifier	MITEQ	MLA-10K01-B01-35	1237616	02/18/2021	12
RE	MAT-07	141203	Attenuator(6dB)	Weinschel Corp	2	BK7970	11/13/2020	12
RE	MBA-08	141427	Biconical Antenna	Schwarzbeck Mess-Elektronik OHG	VHA9103B+BBA9106	08031	07/10/2021	12
RE	MCC-12	141317	Coaxial Cable	UL Japan Inc.	-	-	09/06/2021	12
RE	MLA-21	141265	Logperiodic Antenna (200-1000MHz)	Schwarzbeck Mess-Elektronik OHG	VUSLP9111B	9111B-190	07/10/2021	12
RE	MTR-08	141949	Test Receiver	Rohde & Schwarz	ESCI	100767	08/05/2021	12
RE	MCC-255	207745	Coaxial Cable	UL Japan Inc.	-	-	05/17/2021	12
RE	MLPA-02	142152	Loop Antenna	Rohde & Schwarz	HFH2-Z2	836553/009	-	-
RE	MCC-13	141222	Coaxial Cable	Fujikura,HP,Mini-Circits,Fujikura	3D-2W(12m)/5D-2W(5m)/ 5D-2W(0.8m)/5D-2W(1m)	-	02/18/2021	12
RE	MPA-14	141583	Pre Amplifier	SONOMA INSTRUMENT	310	260833	02/18/2021	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 test