



RADIO TEST REPORT

Test Report No. : 13392309H

Applicant : **Marelli Corporation**
Type of EUT : **Keyless Start System (LF Transmitter)**
Model Number of EUT : **K63T0**
FCC ID : **KBRK63T0**
Test regulation : **FCC Part 15 Subpart C: 2020**
Test Result : **Complied (Refer to SECTION 3.2)**

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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.

Date of test: July 2 to 10, 2020

Representative test engineer:

A. Maeda
Akihiko Maeda
Engineer
Consumer Technology Division

Approved by:

S. Miyazono
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".

UL Japan, Inc.
Ise EMC Lab.

4383-326 Asama-cho, Ise-shi, Mie-ken 516-0021 JAPAN
Telephone : +81 596 24 8999
Facsimile : +81 596 24 8124

REVISION HISTORY

Original Test Report No.: 13392309H

Revision	Test report No.	Date	Page revised	Contents
- (Original)	13392309H	July 20, 2020	-	-

UL Japan, Inc.

Ise EMC Lab.

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

Telephone : +81 596 24 8999

Facsimile : +81 596 24 8124

Reference: Abbreviations (Including words undescribed in this report)

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

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Ise EMC Lab.

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

Telephone : +81 596 24 8999

Facsimile : +81 596 24 8124

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SECTION 1: Customer information

Company Name	:	Marelli Corporation
Address	:	2-1917 Nisshin-cho kita-ku, Saitama-city, Saitama 331-8501 SAITAMA SAITAMA
Telephone Number	:	+81-48-661-0580
Contact Person	:	Takaichiro Ishida

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	:	Keyless Start System (LF Transmitter)
Model Number	:	K63T0
Serial Number	:	Refer to SECTION 4.2
Rating	:	DC 12.0 V
Receipt Date	:	June 26, 2020
Country of Mass-production	:	Thailand
Condition	:	Engineering prototype (Not for Sale: This sample is equivalent to mass-produced items.)
Modification	:	No Modification by the test lab

2.2 Product Description

Model No: K63T0, (referred to as the EUT in this report), is the Keyless Start System (LF Transmitter).

Radio Specification

Radio Type	:	Transmitter
Frequency of Operation	:	125 kHz
Modulation	:	ASK
Antenna type	:	Ferrite bar Antenna
Clock frequency (Maximum)	:	40 MHz

SECTION 3: Test specification, procedures & results

3.1 Test Specification

Test Specification : FCC Part 15 Subpart C
FCC Part 15 final revised on May 26, 2020 and effective July 27, 2020 except 15.258

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

* The revision does not affect the test result conducted before its effective date.

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 4.4 RSS-Gen 8.9	Radiated	N/A	9.2 dB 123.6 kHz, 0 deg. Peak with Duty factor <Mode 4>	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 4.4 RSS-Gen 8.9	Radiated	N/A	2.7 dB 33.759 MHz, Horizontal, QP <Mode 2>	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) 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 the wireless transmitter 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.

UL Japan, Inc.

Ise EMC Lab.

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

Telephone : +81 596 24 8999

Facsimile : +81 596 24 8124

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
		5.0 dB
	200 MHz to 1000 MHz (Horizontal)	5.2 dB
		6.3 dB
10 m	30 MHz to 200 MHz (Horizontal)	4.8 dB
		4.8 dB
	200 MHz to 1000 MHz (Horizontal)	5.0 dB
		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 (+/-)
-26 dB Bandwidth / 99 % Occupied Bandwidth	0.96 %

3.5 Test Location

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*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.

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

Telephone : +81 596 24 8999

Facsimile : +81 596 24 8124

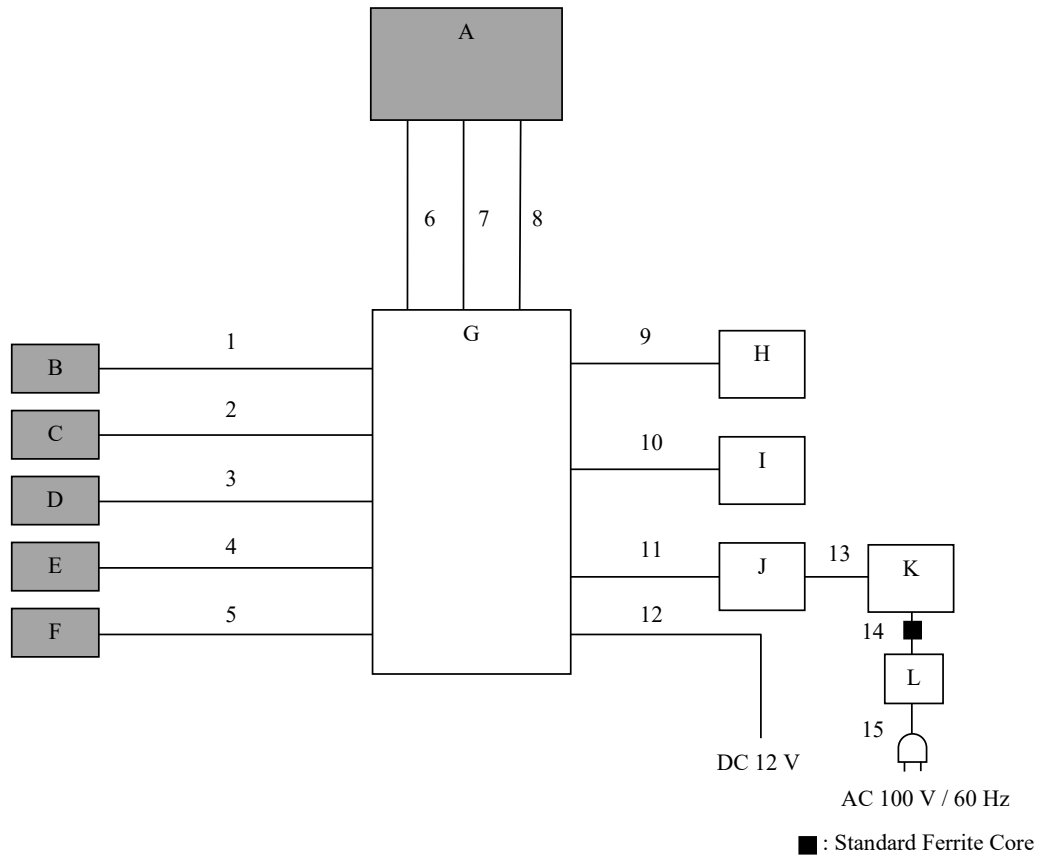
SECTION 4: Operation of EUT during testing

4.1 Operating Modes

Test mode	Remarks
1) Transmitting mode (Tx) 125 kHz Bk ANT (Room Center Port) 2) Transmitting mode (Tx) 125 kHz Dr ANT (Room Rear Port) 3) Transmitting mode (Tx) 125 kHz Dr ANT (Dr ANT Port) 4) Transmitting mode (Tx) 125 kHz Bk ANT (Bk ANT Port)	-
* EUT was set by the software as follows; Software: AS0701 Version 0701 (Date: 2020/3/10, 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.
- *According to the result of pre-check to LF Antenna (Dr) and LF Antenna (As), it was confirmed that there was no difference in RF characteristics among antennas. So the test was performed with one antenna D (LF Antenna (Dr)) as a representative.

Description of EUT and Support equipment

No.	Item	Model number	Serial number	Manufacturer	Remarks
A	Keyless Start System (LF Transmitter)	K63T0	001	Marelli Corporation	EUT
B	LF Antenna (Room Center)	37175-57L00	001	Murata Manufacturing Co., Ltd	EUT
C	LF Antenna (Room Rear)	37175-61M00	002	Murata Manufacturing Co., Ltd	EUT
D	LF Antenna(Dr)	37174-57L00	003	Murata Manufacturing Co., Ltd	EUT
E	LF Antenna(As)	37174-57L00	004	Murata Manufacturing Co., Ltd	EUT
F	LF Antenna(Bk)	37175-57L00	005	Murata Manufacturing Co., Ltd	EUT
G	Checker Box	008	008-1	Murata Manufacturing Co., Ltd	-
H	Push Switch	TWK1A001	001	ALPS ALPINE CO., LTD.	-
I	Receiver	R57L1	001	Marelli Corporation	-
J	CANalyzer	VN1630A	007113-520351	VECTOR	-
K	Laptop PC	SCF-S93WEJDS	1AKSA39499	Panasonic Corporation	-
L	AC Adaptor	CF-AA63772B_M6	38201E	Panasonic Corporation	-

List of cables used

No.	Name	Length (m)	Shield		Remark
			Cable	Connector	
1	Antenna Cable	2.5	Unshielded	Unshielded	-
2	Antenna Cable	2.5	Unshielded	Unshielded	-
3	Antenna Cable	2.5	Unshielded	Unshielded	-
4	Antenna Cable	2.5	Unshielded	Unshielded	-
5	Antenna Cable	2.5	Unshielded	Unshielded	-
6	Signal Cable	1.5	Unshielded	Unshielded	-
7	Signal Cable	1.5	Unshielded	Unshielded	-
8	Signal Cable	1.5	Unshielded	Unshielded	-
9	Signal Cable	0.6	Unshielded	Unshielded	-
10	Signal Cable	0.6	Unshielded	Unshielded	-
11	Signal Cable	1.8	Unshielded	Unshielded	-
12	DC Cable	2.0	Unshielded	Unshielded	-
13	USB Cable	1.7	Shielded	Shielded	-
14	DC Cable	1.0	Unshielded	Unshielded	-
15	AC Cable	0.8	Unshielded	Unshielded	-

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Ise EMC Lab.

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

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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., 135 deg., and 180 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: $40 \times \log(3 \text{ m} / 300 \text{ m}) = -80 \text{ dB}$

*2) Distance Factor: $40 \times \log(3 \text{ m} / 30 \text{ m}) = -40 \text{ dB}$

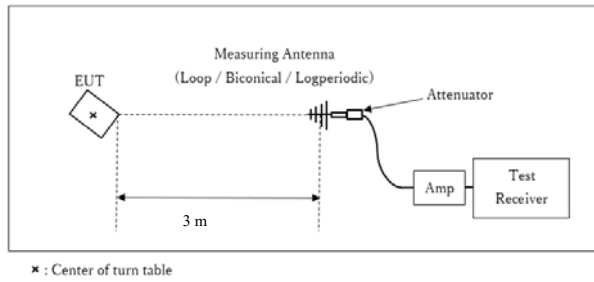
Although these tests were performed other than open field test site, adequate comparison measurements were confirmed against 30 m open field test site. Therefore sufficient tests were made to demonstrate that the alternative site produces results that correlate with the ones of tests made in an open 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 Ohms. For example, the measurement at frequency 9 kHz resulted in a level of 45.5 dBuV/m, which is equivalent to $45.5 - 51.5 = -6.0 \text{ dBuA/m}$, 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.

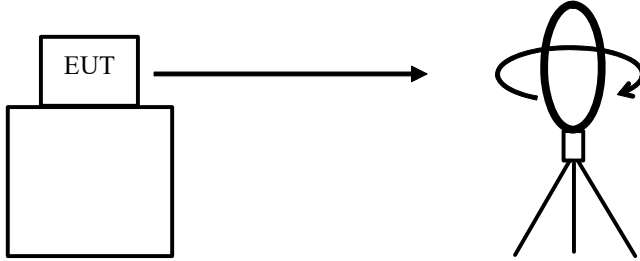
Measurement range : 9 kHz - 1 GHz
Test data : APPENDIX 1
Test result : Pass

Date: July 2 and 10, 2020
July 3, 2020
July 9, 2020

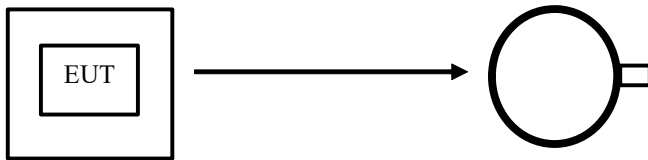
Test engineer: Akihiko Maeda
Yuta Moriya
Hiroyuki Furutaka

Figure 1: Direction of the Loop Antenna

Side View (Vertical)

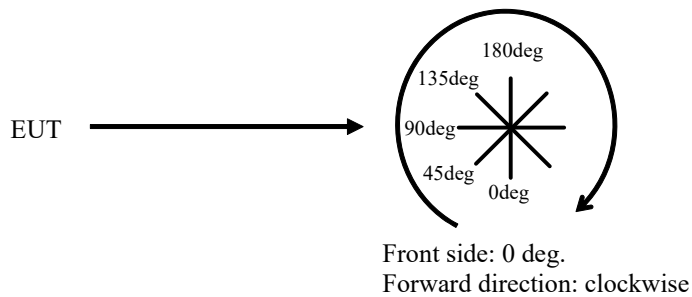


Top View (Horizontal)



Antenna was not rotated.

Top View (Vertical)



SECTION 6: -26 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
-26 dB Bandwidth	70 kHz 100 kHz 220 kHz	510 Hz 1.5 kHz	1.6 kHz 5 kHz	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)

Report No. 13392309H
Test place Ise EMC Lab.
Semi Anechoic Chamber No.3
Date July 9, 2020
Temperature / Humidity 22 deg. C / 68 % RH
Engineer Hiroyuki Furutaka
Mode Mode 1, Bk ANT (Room Center Port)

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	0.11000	QP	47.9	20.0	-74.0	32.2	-	-38.4	26.7	65.1	
0deg	0.12360	PK	94.7	19.9	-74.0	32.3	-	8.4	45.7	37.3	Fundamental
0deg	0.24720	PK	66.3	19.9	-74.0	32.3	-	-20.1	39.7	59.8	
0deg	0.37080	PK	56.7	19.9	-73.9	32.3	-	-29.7	36.2	65.9	
0deg	0.49440	QP	40.2	19.8	-33.9	32.2	-	-6.2	33.7	39.9	
0deg	0.61800	QP	39.6	19.8	-33.9	32.2	-	-6.8	31.8	38.6	
0deg	0.74160	QP	33.5	19.8	-33.9	32.2	-	-12.8	30.2	43.0	
0deg	0.86520	QP	41.8	19.8	-33.9	32.2	-	-4.5	28.8	33.3	
0deg	0.98880	QP	33.0	19.8	-33.9	32.2	-	-13.3	27.7	41.0	
0deg	1.11240	QP	38.1	19.8	-33.9	32.2	-	-8.2	26.6	34.8	
0deg	1.23600	QP	32.2	19.8	-33.9	32.2	-	-14.1	25.7	39.8	

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

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	0.12360	PK	94.7	19.9	-74.0	32.3	0.0	8.4	25.7	17.3	
0deg	0.24720	PK	66.3	19.9	-74.0	32.3	0.0	-20.1	19.7	39.8	
0deg	0.37080	PK	56.7	19.9	-73.9	32.3	0.0	-29.7	16.2	45.9	

Result = Reading + Ant Factor + Loss (Cable + Attenuator + Filter + D.Factor) - Gain(Amplifier) + 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	0.12360	PK	94.7	19.9	6.0	32.3	-	88.4	-	-	Fundamental

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

UL Japan, Inc.

Ise EMC Lab.

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

Telephone : +81 596 24 8999

Facsimile : +81 596 24 8124

Radiated Emission below 30 MHz (Fundamental and Spurious Emission)

Report No. 13392309H
Test place Ise EMC Lab.
Semi Anechoic Chamber No.1
Date July 10, 2020
Temperature / Humidity 22 deg. C / 74 % RH
Engineer Akihiko Maeda
Mode Mode 2, Dr ANT (Room Rear Port)

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	0.11000	QP	34.6	20.0	-74.0	32.2	-	-51.7	26.7	78.4	
0deg	0.12360	PK	80.0	19.9	-74.0	32.3	-	-6.3	45.7	52.0	Fundamental
0deg	0.24720	PK	57.7	19.9	-73.9	32.3	-	-28.6	39.7	68.3	
0deg	0.37080	PK	56.7	19.9	-73.9	32.3	-	-29.6	36.2	65.8	
0deg	0.49440	QP	45.7	19.8	-33.9	32.2	-	-0.6	33.7	34.3	
0deg	0.61800	QP	37.3	19.8	-33.9	32.2	-	-9.0	31.8	40.8	
0deg	0.74160	QP	40.0	19.8	-33.9	32.2	-	-6.3	30.2	36.5	
0deg	0.86520	QP	38.8	19.8	-33.8	32.2	-	-7.5	28.8	36.3	
0deg	0.98880	QP	32.8	19.8	-33.8	32.2	-	-13.5	27.7	41.2	
0deg	1.11240	QP	35.2	19.8	-33.8	32.2	-	-11.1	26.6	37.7	
0deg	1.23600	QP	32.3	19.8	-33.8	32.2	-	-13.9	25.7	39.6	

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

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	0.12360	PK	80.0	19.9	-74.0	32.3	0.0	-6.3	25.7	32.0	
0deg	0.24720	PK	57.7	19.9	-73.9	32.3	0.0	-28.6	19.7	48.3	
0deg	0.37080	PK	56.7	19.9	-73.9	32.3	0.0	-29.6	16.2	45.8	

Result = Reading + Ant Factor + Loss (Cable + Attenuator + Filter + D.Factor) - Gain(Amplifier) + 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	0.12360	PK	80.0	19.9	6.0	32.3	-	73.7	-	-	Fundamental

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

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Ise EMC Lab.

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

Telephone : +81 596 24 8999

Facsimile : +81 596 24 8124

Radiated Emission below 30 MHz (Fundamental and Spurious Emission)

Report No. 13392309H
Test place Ise EMC Lab.
Semi Anechoic Chamber No.2
Date July 2, 2020
Temperature / Humidity 22 deg. C / 65 % RH
Engineer Akihiko Maeda
Mode Mode 3, Dr ANT (Dr ANT Port)

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	0.11000	QP	49.9	20.0	-74.0	32.2	-	-36.4	26.7	63.1	
0deg	0.12360	PK	98.8	19.9	-74.0	32.3	-	12.5	45.7	33.2	Fundamental
0deg	0.24720	PK	62.9	19.9	-73.9	32.3	-	-23.4	39.7	63.1	
0deg	0.37080	PK	71.8	19.9	-73.9	32.3	-	-14.5	36.2	50.7	
0deg	0.49440	QP	42.1	19.8	-33.9	32.2	-	-4.2	33.7	37.9	
0deg	0.61800	QP	54.0	19.8	-33.9	32.2	-	7.7	31.8	24.1	
0deg	0.74160	QP	37.4	19.8	-33.9	32.2	-	-8.9	30.2	39.1	
0deg	0.86520	QP	47.1	19.8	-33.8	32.2	-	0.8	28.8	28.0	
0deg	0.98880	QP	35.6	19.8	-33.8	32.2	-	-10.7	27.7	38.4	
0deg	1.11240	QP	41.3	19.8	-33.8	32.2	-	-5.0	26.6	31.6	
0deg	1.23600	QP	34.1	19.8	-33.8	32.2	-	-12.1	25.7	37.8	

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

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	0.12360	PK	98.8	19.9	-74.0	32.3	0.0	12.5	25.7	13.2	
0deg	0.24720	PK	62.9	19.9	-73.9	32.3	0.0	-23.4	19.7	43.1	
0deg	0.37080	PK	71.8	19.9	-73.9	32.3	0.0	-14.5	16.2	30.7	

Result = Reading + Ant Factor + Loss (Cable + Attenuator + Filter + D.Factor) - Gain(Amplifier) + 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	0.12360	PK	98.8	19.9	6.0	32.3	-	92.5	-	-	Fundamental

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

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Ise EMC Lab.

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

Telephone : +81 596 24 8999

Facsimile : +81 596 24 8124

Radiated Emission below 30 MHz (Fundamental and Spurious Emission)

Report No. 13392309H
Test place Ise EMC Lab.
Semi Anechoic Chamber No.2
Date July 2, 2020
Temperature / Humidity 22 deg. C / 65 % RH
Engineer Akihiko Maeda
Mode Mode 4, Bk ANT (Bk ANT Port)

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	0.11000	QP	62.0	20.0	-74.0	32.2	-	-24.3	26.7	51.0	
0deg	0.12360	PK	102.8	19.9	-74.0	32.3	-	16.5	45.7	29.2	Fundamental
0deg	0.24720	PK	70.3	19.9	-73.9	32.3	-	-16.0	39.7	55.7	
0deg	0.37080	PK	72.1	19.9	-73.9	32.3	-	-14.2	36.2	50.4	
0deg	0.49440	QP	40.6	19.8	-33.9	32.2	-	-5.7	33.7	39.4	
0deg	0.61800	QP	55.0	19.8	-33.9	32.2	-	8.7	31.8	23.1	
0deg	0.74160	QP	36.7	19.8	-33.9	32.2	-	-9.6	30.2	39.8	
0deg	0.86520	QP	48.2	19.8	-33.8	32.2	-	1.9	28.8	26.9	
0deg	0.98880	QP	35.0	19.8	-33.8	32.2	-	-11.3	27.7	39.0	
0deg	1.11240	QP	42.5	19.8	-33.8	32.2	-	-3.8	26.6	30.4	
0deg	1.23600	QP	33.7	19.8	-33.8	32.2	-	-12.5	25.7	38.2	

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

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	0.12360	PK	102.8	19.9	-74.0	32.3	0.0	16.5	25.7	9.2	
0deg	0.24720	PK	70.3	19.9	-73.9	32.3	0.0	-16.0	19.7	35.7	
0deg	0.37080	PK	72.1	19.9	-73.9	32.3	0.0	-14.2	16.2	30.4	

Result = Reading + Ant Factor + Loss (Cable + Attenuator + Filter + D.Factor) - Gain(Amplifier) + 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	0.12360	PK	102.8	19.9	6.0	32.3	-	96.5	-	-	Fundamental

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

UL Japan, Inc.

Ise EMC Lab.

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

Telephone : +81 596 24 8999

Facsimile : +81 596 24 8124

Radiated Emission above 30 MHz (Spurious Emission)

Report No. 13392309H
Test place Ise EMC Lab.
Semi Anechoic Chamber No.2
Date July 3, 2020
Temperature / Humidity 23 deg. C / 62 % RH
Engineer Yuta Moriya
Mode Mode 1, Bk ANT (Room Center Port)

Polarity	Frequency [MHz]	Detector	Reading [dBuV]	Ant.Fac. [dB/m]	Loss [dB]	Gain [dB]	Result [dBuV/m]	Limit [dBuV/m]	Margin [dB]	Remark
Hori.	30.445	QP	28.2	18.4	7.0	28.6	25.0	40.0	15.0	
Hori.	35.613	QP	28.4	16.5	7.1	28.6	23.4	40.0	16.6	
Hori.	42.782	QP	30.9	13.9	7.2	28.6	23.4	40.0	16.6	
Hori.	61.878	QP	33.8	7.4	7.5	28.6	20.2	40.0	19.9	
Hori.	84.449	QP	45.5	7.4	7.8	28.5	32.2	40.0	7.8	
Hori.	331.666	QP	22.5	14.5	10.0	28.0	19.1	46.0	27.0	
Vert.	30.445	QP	37.9	18.4	7.0	28.6	34.7	40.0	5.3	
Vert.	36.003	QP	36.3	16.4	7.1	28.6	31.2	40.0	8.8	
Vert.	42.892	QP	34.8	13.9	7.2	28.6	27.3	40.0	12.7	
Vert.	61.489	QP	42.0	7.5	7.5	28.6	28.4	40.0	11.6	
Vert.	85.431	QP	33.0	7.7	7.8	28.5	20.0	40.0	20.0	
Vert.	331.666	QP	22.8	14.5	10.0	28.0	19.4	46.0	26.7	

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.

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Radiated Emission above 30 MHz (Spurious Emission)

Report No. 13392309H
Test place Ise EMC Lab.
Semi Anechoic Chamber No.2
Date July 3, 2020
Temperature / Humidity 23 deg. C / 62 % RH
Engineer Yuta Moriya
Mode Mode 2, Dr ANT (Room Rear Port)

Polarity	Frequency [MHz]	Detector	Reading [dBuV]	Ant.Fac. [dB/m]	Loss [dB]	Gain [dB]	Result [dBuV/m]	Limit [dBuV/m]	Margin [dB]	Remark
Hori.	33.759	QP	41.6	17.2	7.1	28.6	37.3	40.0	2.7	
Hori.	42.170	QP	41.2	14.2	7.2	28.6	34.0	40.0	6.0	
Hori.	48.619	QP	36.9	11.8	7.3	28.6	27.4	40.0	12.6	
Hori.	61.679	QP	49.4	7.5	7.5	28.6	35.8	40.0	4.2	
Hori.	80.081	QP	50.3	6.8	7.8	28.6	36.3	40.0	3.7	
Hori.	362.517	QP	20.5	15.0	10.3	28.2	17.6	46.0	28.4	
Vert.	33.132	QP	35.0	17.5	7.1	28.6	30.9	40.0	9.1	
Vert.	42.765	QP	36.1	13.9	7.2	28.6	28.6	40.0	11.4	
Vert.	48.629	QP	42.4	11.8	7.3	28.6	32.9	40.0	7.1	
Vert.	60.859	QP	49.7	7.7	7.5	28.6	36.3	40.0	3.7	
Vert.	80.081	QP	42.5	6.8	7.8	28.6	28.5	40.0	11.5	
Vert.	366.456	QP	21.1	15.0	10.3	28.2	18.2	46.0	27.8	

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.

UL Japan, Inc.

Ise EMC Lab.

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

Telephone : +81 596 24 8999

Facsimile : +81 596 24 8124

Radiated Emission above 30 MHz (Spurious Emission)

Report No. 13392309H
Test place Ise EMC Lab.
Semi Anechoic Chamber No.2
Date July 3, 2020
Temperature / Humidity 23 deg. C / 62 % RH
Engineer Yuta Moriya
Mode Mode 3, Dr ANT (Dr ANT Port)

Polarity	Frequency [MHz]	Detector	Reading [dBuV]	Ant.Fac. [dB/m]	Loss [dB]	Gain [dB]	Result [dBuV/m]	Limit [dBuV/m]	Margin [dB]	Remark
Hori.	42.947	QP	28.1	13.8	7.2	28.6	20.6	40.0	19.5	
Hori.	54.555	QP	36.6	9.7	7.4	28.6	25.1	40.0	14.9	
Hori.	57.825	QP	40.0	8.6	7.5	28.6	27.4	40.0	12.6	
Hori.	60.125	QP	43.1	7.9	7.5	28.6	29.9	40.0	10.1	
Hori.	78.297	QP	43.5	6.6	7.7	28.6	29.3	40.0	10.7	
Hori.	336.532	QP	21.6	14.7	10.1	28.0	18.4	46.0	27.7	
Vert.	44.273	QP	34.3	13.4	7.2	28.6	26.4	40.0	13.6	
Vert.	55.296	QP	43.4	9.4	7.4	28.6	31.6	40.0	8.4	
Vert.	57.825	QP	39.3	8.6	7.5	28.6	26.7	40.0	13.3	
Vert.	60.371	QP	41.0	7.8	7.5	28.6	27.7	40.0	12.3	
Vert.	78.297	QP	37.1	6.6	7.7	28.6	22.9	40.0	17.1	
Vert.	336.532	QP	22.1	14.7	10.1	28.0	18.9	46.0	27.2	

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.

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Radiated Emission above 30 MHz (Spurious Emission)

Report No. 13392309H
Test place Ise EMC Lab.
Semi Anechoic Chamber No.2
Date July 3, 2020
Temperature / Humidity 23 deg. C / 62 % RH
Engineer Yuta Moriya
Mode Mode 4, Bk ANT (Bk ANT Port)

Polarity	Frequency [MHz]	Detector	Reading [dBuV]	Ant.Fac. [dB/m]	Loss [dB]	Gain [dB]	Result [dBuV/m]	Limit [dBuV/m]	Margin [dB]	Remark
Hori.	36.661	QP	25.5	16.2	7.1	28.6	20.2	40.0	19.8	
Hori.	44.927	QP	24.4	13.1	7.3	28.6	16.2	40.0	23.8	
Hori.	55.073	QP	35.7	9.5	7.4	28.6	24.0	40.0	16.0	
Hori.	60.297	QP	34.6	7.8	7.5	28.6	21.3	40.0	18.7	
Hori.	79.190	QP	34.2	6.7	7.7	28.6	20.1	40.0	19.9	
Hori.	336.532	QP	21.6	14.7	10.1	28.0	18.4	46.0	27.7	
Vert.	34.948	QP	27.7	16.8	7.1	28.6	22.9	40.0	17.1	
Vert.	43.824	QP	28.1	13.6	7.2	28.6	20.3	40.0	19.7	
Vert.	54.466	QP	34.9	9.7	7.4	28.6	23.4	40.0	16.6	
Vert.	61.605	QP	34.0	7.5	7.5	28.6	20.4	40.0	19.6	
Vert.	79.007	QP	33.2	6.7	7.7	28.6	19.1	40.0	20.9	
Vert.	333.636	QP	21.8	14.6	10.1	28.0	18.4	46.0	27.6	

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.

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Ise EMC Lab.

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

Telephone : +81 596 24 8999

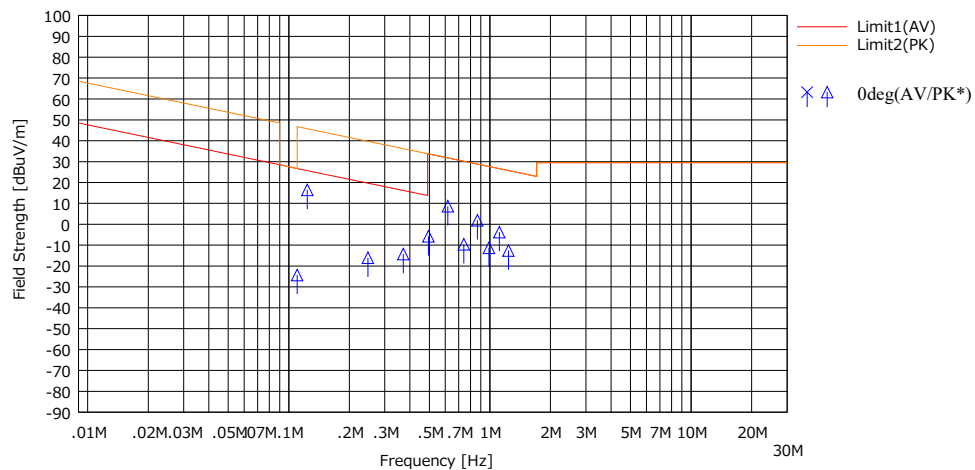
Facsimile : +81 596 24 8124

Radiated Emission Plot data, Worst case

Report No.	13392309H	
Test place	Ise EMC Lab.	
Semi Anechoic Chamber	No.2	No.2
Date	July 2, 2020	July 3, 2020
Temperature / Humidity	22 deg. C / 65 % RH	23 deg. C / 62 % RH
Engineer	Akihiko Maeda (Below 30 MHz)	Yuta Moriya (Above 30 MHz)
Mode	Mode 4, Bk ANT	Mode 2, Room Rear ANT

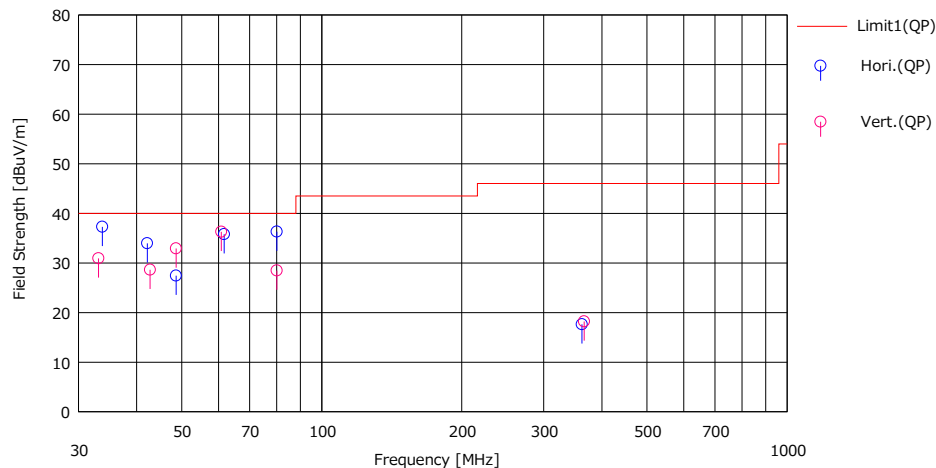
(Below 30MHz)

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



* Data of 90 kHz to 110 kHz and above 490 kHz were measured using a QP detector.

(Above 30MHz)



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

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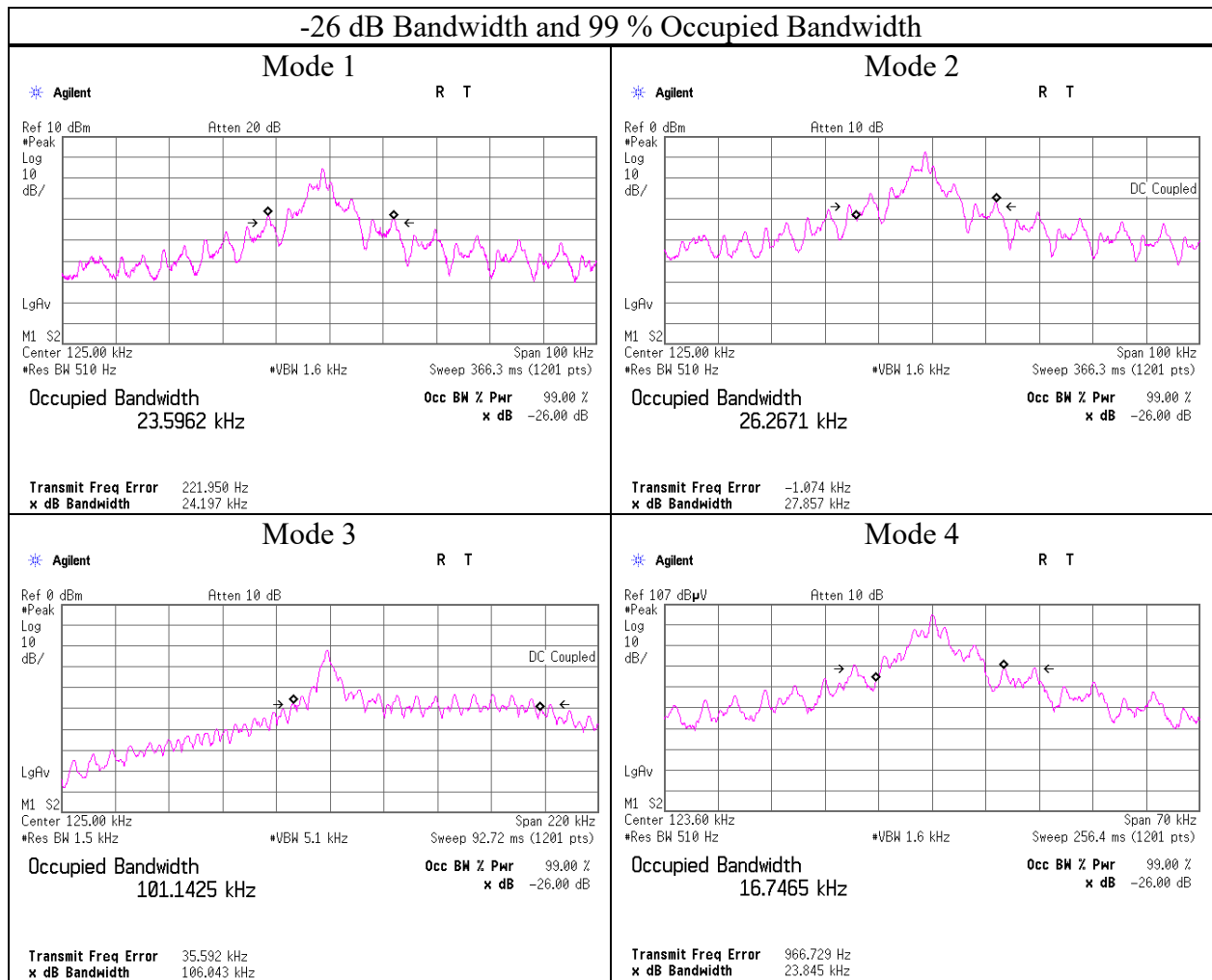
Telephone : +81 596 24 8999

Facsimile : +81 596 24 8124

-26 dB Bandwidth and 99 % Occupied Bandwidth

Report No.	13392309H	No.1
Test place	Ise EMC Lab.	
Semi Anechoic Chamber	No.3	
Date	July 9, 2020	July 10, 2020
Temperature / Humidity	22 deg. C / 68 % RH	22 deg. C / 74 % RH
Engineer	Hiroyuki Furutaka	Akihiko Maeda
Mode	Mode 1 to 4	

Mode	-26 dB Bandwidth [kHz]	99 % Occupied Bandwidth [kHz]
Mode 1	24.197	23.5962
Mode 2	27.857	26.2671
Mode 3	106.043	101.1425
Mode 4	23.845	16.7465



UL Japan, Inc.

Ise EMC Lab.

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

Telephone : +81 596 24 8999

Facsimile : +81 596 24 8124

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	CTH-201	0013	12/19/2019	12
RE	MMM-01	141542	Digital Tester	Fluke Corporation	FLUKE 26-3	78030611	08/20/2019	12
RE	MJM-27	142228	Measure	KOMELON	KMC-36	-	-	-
RE	COTS-MEMI-02	178648	EMI measurement program	TSJ (Techno Science Japan)	TEPTO-DV	-	-	-
RE	MTR-10	141951	EMI Test Receiver	Rohde & Schwarz	ESR26	101408	03/10/2020	12
RE	MSA-10	141899	Spectrum Analyzer	Keysight Technologies Inc	E4448A	MY46180655	08/07/2019	12
RE	MAT-07	141203	Attenuator(6dB)	Weinschel Corp	2	BK7970	11/07/2019	12
RE	MCC-13	141222	Coaxial Cable	Fujikura,HP,Mini-Circuits,Fujikura	3D-2W(12m)/ 5D-2W(5m)/ 5D-2W(0.8m)/ 5D-2W(1m)	-	02/25/2020	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
RE	MPA-13	141582	Pre Amplifier	SONOMA INSTRUMENT	310	260834	02/10/2020	12
RE	MBA-08	141427	Biconical Antenna	Schwarzbeck Mess - Elektronik	VHA9103B+BBA9106	8031	08/23/2019	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	08/23/2019	12
RE	MPA-24	141594	Pre Amplifier	Keysight Technologies Inc	8447D	2944A10150	02/10/2020	12
RE	MAEC-03	142008	AC3_Semi Anechoic Chamber(NSA)	TDK	Semi Anechoic Chamber 3m	DA-10005	05/22/2020	24
RE	MOS-13	141554	Thermo-Hygrometer	CUSTOM	CTH-201	1301	01/07/2020	12
RE	MMM-08	141532	DIGITAL HiTESTER	Hioki	3805	51201197	01/06/2020	12
RE	MJM-16	142183	Measure	KOMELON	KMC-36	-	-	-
RE	MAT-95	142314	Attenuator	Pasternack	PE7390-6	D/C 1504	06/17/2020	12
RE	MBA-03	141424	Biconical Antenna	Schwarzbeck Mess - Elektronik	VHA9103+BBA9106	1915	08/24/2019	12
RE	MCC-51	141323	Coaxial cable	UL Japan	-	-	07/06/2020	12
RE	MLA-22	141266	Logperiodic Antenna(200-1000MHz)	Schwarzbeck Mess - Elektronik	VUSLP9111B	9111B-191	08/24/2019	12
RE	MTR-08	141949	Test Receiver	Rohde & Schwarz	ESCI	100767	08/02/2019	12
RE	MCC-112	141216	Coaxial cable	Fujikura/Suhner/TSJ	5D-2W/SFM14/ suciform141-PE/ 421-010/ RFM-E321(SW)	-/00640	07/06/2020	12
RE	MSA-15	141902	Spectrum Analyzer	Keysight Technologies Inc	E4440A	MY46187105	10/09/2019	12
RE	MAEC-01	141998	AC1_Semi Anechoic Chamber(NSA)	TDK	Semi Anechoic Chamber 10m	DA-06881	06/08/2020	24
RE	MOS-27	141566	Thermo-Hygrometer	CUSTOM	CTH-201	A08Q26	01/07/2020	12
RE	MMM-03	141530	Digital Tester	Fluke Corporation	FLUKE 26-3	78030621	08/20/2019	12
RE	MJM-25	142226	Measure	KOMELON	KMC-36	-	-	-
RE	MAT-08	141213	Attenuator(6dB)	Weinschel Corp	2	BK7971	11/14/2019	12
RE	MCC-03	141215	Coaxial Cable	Fujikura/Suhner/TSJ	5D-2W/3D-2W/ RG400u/ RFM-E421(SW)	-/01068 (Switcher)	06/25/2020	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.

UL Japan, Inc.

Ise EMC Lab.

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

Telephone : +81 596 24 8999

Facsimile : +81 596 24 8124

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

Test item:

RE: Spurious emission