




RADIO TEST REPORT


Test Report No. : 13760081H-A-R2

Applicant : Marelli Corporation
Type of EUT : CONTROLLER ASSY, BCM
Model Number of EUT : K67T0
FCC ID : KBRK67T0
Test regulation : FCC Part 15 Subpart C: 2021
Test Result : Complied (Refer to SECTION 3)

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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 13760081H-A-R1. 13760081H-A-R1 is replaced with this report.

Date of test: August 27 and October 20, 2021

Representative test engineer: 
Kiyoshiro Okazaki
Engineer

Approved by: 
Shinichi Miyazono
Engineer



CERTIFICATE 5107.02

- ☐ The testing in which "Non-accreditation" is displayed is outside the accreditation scopes in UL Japan.
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REVISION HISTORY

Original Test Report No.: 13760081H-A

Revision	Test report No.	Date	Page revised	Contents
- (Original)	13760081H-A	September 10, 2021	-	-
1	13760081H-A-R1	October 29, 2021	P.1	Correction of the test date in cover page
1	13760081H-A-R1	October 29, 2021	P.5	Correction of Local Oscillator Frequency in Receiver part for Radio Specification of Clause 2.2; From 24.305 MHz to 433.669 MHz
1	13760081H-A-R1	October 29, 2021	P.9	Addition of the description of simultaneous transmission in Clause 4.2
1	13760081H-A-R1	October 29, 2021	P.14	Addition of the test date
2	13760081H-A-R2	November 9, 2021	P.24	Addition of test equipment used for October 20, 2021 test.
2	13760081H-A-R2	November 9, 2021	all	Change the total number of pages

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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SECTION 1: Customer information

Company Name	:	Marelli Corporation
Address	:	2-1917 Nisshin-cho, Kita-ku, Saitama-shi, Saitama 331-8501 JAPAN
Telephone Number	:	+81-48-660-2111
Contact Person	:	DAISUKE MORI

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	:	CONTROLLER ASSY, BCM
Model Number	:	K67T0
Serial Number	:	Refer to SECTION 4.2
Rating	:	DC 12.0 V
Receipt Date	:	August 16, 2021
Country of Mass-production	:	India
Condition	:	Production prototype (Not for Sale: This sample is equivalent to mass-produced items.)
Modification	:	No Modification by the test lab.

2.2. Product Description

Model: K67T0 (referred to as the EUT in this report) is a CONTROLLER ASSY, BCM.

Radio Specification

[Transmitter part]

Radio Type	:	Transmitter
Frequency of Operation	:	125 kHz
Modulation	:	ASK
Antenna type	:	Ferrite bar Antenna
Clock frequency (Maximum)	:	8 MHz

[Receiver part]

Type of Receiver	:	Super Heterodyne
Receiving Frequency	:	433.92 MHz
Local Oscillator Frequency	:	433.669 MHz
Intermediate Frequency	:	0.251 MHz
Antenna Type	:	Internal antenna (Independent antenna)

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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	<FCC> Section 15.207	-	N/A	N/A	N/A *1)
Electric Field Strength of Fundamental Emission	<FCC> ANSI C63.10:2013 6 Standard test methods	<FCC> Section 15.209	Radiated	N/A	6.4 dB 125 kHz, 0 deg. Peak with Duty factor <Mode 2>	Complied a)
Electric Field Strength of Spurious Emission	<FCC> ANSI C63.10:2013 6 Standard test methods	<FCC> Section 15.209	Radiated	N/A	9.6 dB 31.726 MHz, Vertical, QP <Mode 1>	Complied a)
-20 dB Bandwidth	<FCC> ANSI C63.10:2013 6 Standard test methods	<FCC> Reference data	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 / 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 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 .

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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 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 $k=2$.

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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) (Vertical)	4.8 dB
		5.0 dB
	200 MHz to 1000 MHz (Horizontal) (Vertical)	5.2 dB
		6.3 dB
10 m	30 MHz to 200 MHz (Horizontal) (Vertical)	4.8 dB
		4.8 dB
	200 MHz to 1000 MHz (Horizontal) (Vertical)	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 (+/-)
-20 dB Bandwidth / 99 % Occupied Bandwidth	0.96 %

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3.5 Test Location

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*A2LA Certificate Number: 5107.02 / FCC Test Firm Registration Number: 199967

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

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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.

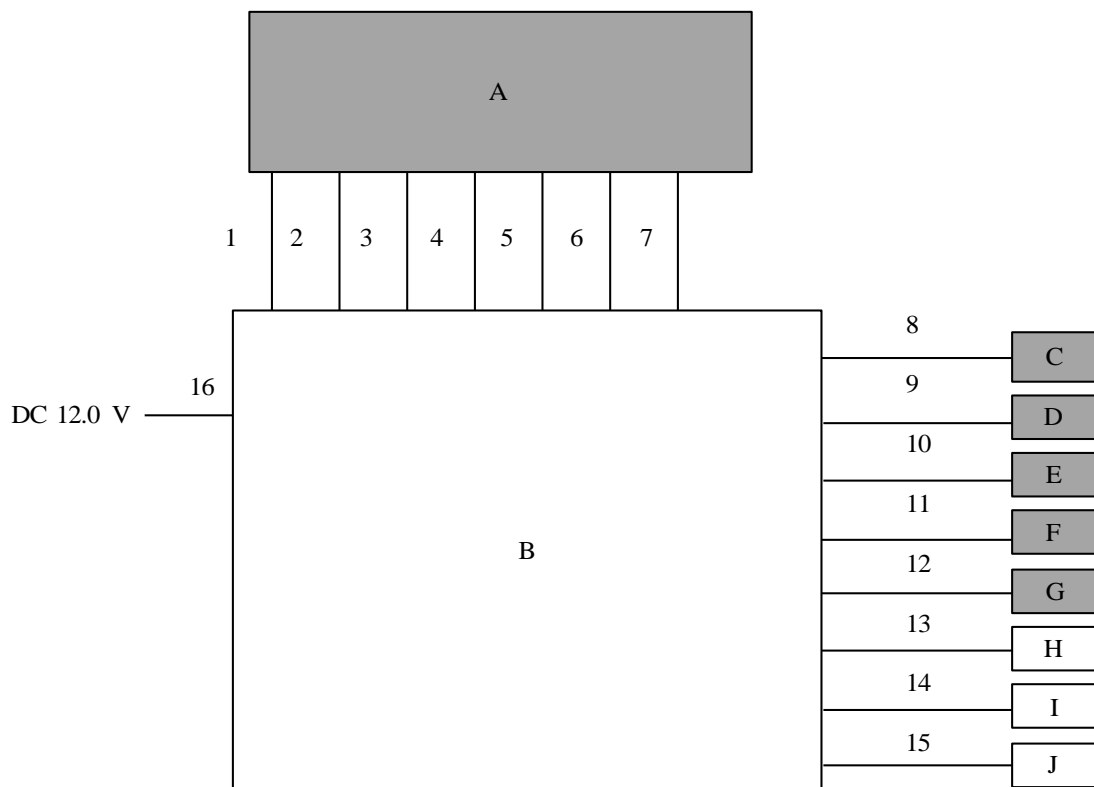
SECTION 4: Operation of EUT during testing

4.1. Operating Mode(s)

Test mode	Remarks
1) Mode 1	Tx 125kHz ANT ASSY-KLS, BACK
2) Mode 2	Tx 125kHz ANT ASSY-KLS, INNER FRONT
3) Mode 3	Tx 125kHz ANT ASSY-KLS, INNER BACK
4) Mode 4	Tx 125kHz ANT ASSY-KLS, DR DOOR
* EUT was set by the software as follows; Software: 4SX Version LF003 (Date: 2021.08.26, 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.

* As a result of comparing DR DOOR Antenna and AS DOOR Antenna at pre-check, there was no difference in Radio characteristics.

Therefore the test was performed with DR DOOR Antenna as representative.

* EUT has the simultaneous transmission specifications of DR DOOR Antenna and AS DOOR Antenna.

After the test results between this simultaneous transmission and the DR DOOR Antenna single transmission were compared, it was confirmed that the single transmission was the worst.

Therefore, the test was performed with the DR DOOR Antenna.

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Description of EUT and Support equipment

No.	Item	Model number	Serial number	Manufacturer	Remarks
A	CONTROLLER ASSY, BCM	K67T0	045	Marelli Corporation	EUT
B	Checker Box	-	-	Marelli Corporation	-
C	ANT ASSY-KLS, DR DOOR	MSAS0913-01	0010	Murata Manufacturing Co.,Ltd.	EUT
D	ANT ASSY-KLS, AS DOOR	MSAS0913-01	0009	Murata Manufacturing Co.,Ltd.	EUT
E	ANT ASSY-KLS, INNER FRONT	MSAS0909-01	0198	Murata Manufacturing Co.,Ltd.	EUT
F	ANT ASSY-KLS, INNER BACK	MSAS0909-01	0113	Murata Manufacturing Co.,Ltd.	EUT
G	ANT ASSY-KLS, BACK	MSAS0912-01	0026	Murata Manufacturing Co.,Ltd.	EUT
H	SWITCH ASSY, ENGINE START	P55T0	0054	Marelli Corporation	-
I	Jig	-	-	-	-
J	Steering lock	-	-	-	-

List of cables used

No.	Name	Length (m)	Shield		Remarks
			Cable	Connector	
1	Signal Cable	1.7	Unshielded	Unshielded	-
2	Signal Cable	1.7	Unshielded	Unshielded	-
3	Signal Cable	1.7	Unshielded	Unshielded	-
4	Signal Cable	1.7	Unshielded	Unshielded	-
5	Signal Cable	1.7	Unshielded	Unshielded	-
6	Signal Cable	1.7	Unshielded	Unshielded	-
7	Signal Cable	1.7	Unshielded	Unshielded	-
8	Antenna Cable	5.6	Unshielded	Unshielded	-
9	Antenna Cable	5.6	Unshielded	Unshielded	-
10	Antenna Cable	2.0	Unshielded	Unshielded	-
11	Antenna Cable	2.0	Unshielded	Unshielded	-
12	Antenna Cable	2.0	Unshielded	Unshielded	-
13	Signal and DC Cable	1.5	Unshielded	Unshielded	-
14	Signal Cable	0.4	Unshielded	Unshielded	-
15	Signal Cable	1.5	Unshielded	Unshielded	-
16	DC Cable	1.0	Unshielded	Unshielded	-

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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: $40 \times \log(3 \text{ m} / 300 \text{ m}) = -80 \text{ dB}$

*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.

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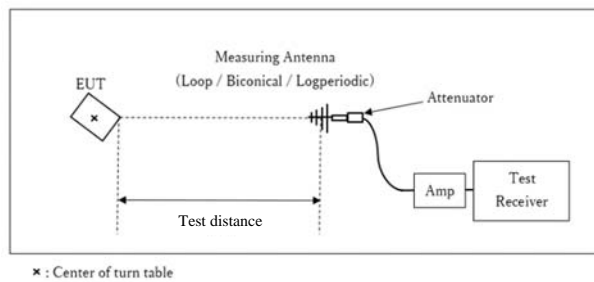
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[Test Setup]
Below 1 GHz



Test Distance: 3 m

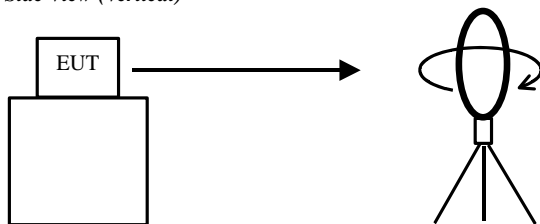
- The carrier level and noise levels were confirmed at each position of X, Y and Z axes of EUT to see the position of maximum noise, and the test was made at the position that has the maximum noise.

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

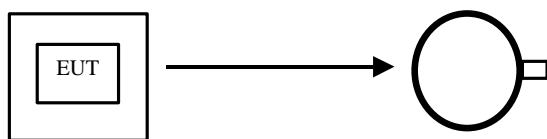
Measurement range : 9 kHz - 1 GHz
Test data : APPENDIX
Test result : Pass

Figure 1: Direction of the Loop Antenna

Side View (Vertical)

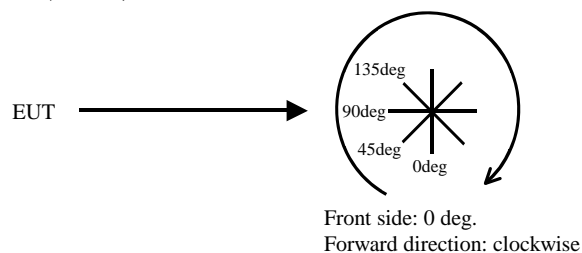


Top View (Horizontal)



Antenna was not rotated.

Top View (Vertical)



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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	75 kHz	300 Hz	910 Hz	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.	13760081H	No.2
Test place	Ise EMC Lab.	
Semi Anechoic Chamber	No.2	
Date	August 27, 2021	October 20, 2021
Temperature / Humidity	23 deg. C / 65 % RH	22 deg. C / 45 % RH
Engineer	Kiyoshiro Okazaki	Junya Okuno
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	105.8	18.9	-74.0	32.3	-	18.4	45.6	27.2	Fundamental
0deg	0.25000	PK	77.2	18.9	-73.9	32.3	-	-10.1	39.6	49.7	
0deg	0.37500	PK	80.6	18.8	-73.9	32.3	-	-6.8	36.1	42.9	
0deg	0.50000	QP	55.9	18.8	-33.9	32.3	-	8.5	33.6	25.1	
0deg	0.62500	QP	46.2	18.8	-33.9	32.4	-	-1.3	31.7	33.0	
0deg	0.75000	QP	39.9	18.8	-33.8	32.4	-	-7.5	30.1	37.6	
0deg	0.87500	QP	31.8	18.8	-33.8	32.4	-	-15.6	28.7	44.3	
0deg	1.00000	QP	34.3	18.8	-33.8	32.4	-	-13.1	27.6	40.7	
0deg	1.12500	QP	32.7	18.8	-33.8	32.4	-	-14.7	26.5	41.2	
0deg	1.25000	QP	31.3	18.8	-33.8	32.4	-	-16.1	25.6	41.7	
Hori.	34.816	QP	34.0	17.0	6.8	28.5	-	29.3	40.0	10.7	
Hori.	44.309	QP	24.9	13.5	6.9	28.4	-	16.9	40.0	23.1	
Hori.	75.194	QP	28.6	6.5	7.3	28.4	-	14.0	40.0	26.0	
Hori.	107.985	QP	23.3	11.5	7.5	28.3	-	14.0	43.5	29.5	
Hori.	187.959	QP	22.6	16.3	8.1	28.0	-	19.0	43.5	24.5	
Hori.	242.657	QP	41.7	12.4	8.5	27.7	-	34.9	46.0	11.1	
Hori.	358.637	QP	23.3	15.4	9.3	28.0	-	20.0	46.0	26.0	
Hori.	454.347	QP	22.5	16.9	9.7	28.8	-	20.3	46.0	25.7	
Vert.	31.726	QP	33.9	18.2	6.8	28.5	-	30.4	40.0	9.6	
Vert.	34.816	QP	29.9	17.0	6.8	28.5	-	25.2	40.0	14.8	
Vert.	37.476	QP	33.0	16.0	6.8	28.5	-	27.3	40.0	12.7	
Vert.	44.309	QP	30.1	13.5	6.9	28.4	-	22.1	40.0	17.9	
Vert.	75.194	QP	42.6	6.5	7.3	28.4	-	28.0	40.0	12.0	
Vert.	120.103	QP	28.5	12.9	7.6	28.3	-	20.7	43.5	22.8	
Vert.	187.959	QP	25.3	16.3	8.1	28.0	-	21.7	43.5	21.8	
Vert.	233.800	QP	37.8	12.5	8.4	27.7	-	31.0	46.0	15.0	
Vert.	454.347	QP	22.7	16.9	9.7	28.8	-	20.5	46.0	25.5	

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

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	0.12500	PK	105.8	18.9	-74.0	32.3	0.0	18.4	25.6	7.2	Fundamental
0deg	0.25000	PK	77.2	18.9	-73.9	32.3	0.0	-10.1	19.6	29.7	
0deg	0.37500	PK	80.6	18.8	-73.9	32.3	0.0	-6.8	16.1	22.9	

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

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	105.8	18.9	6.0	32.3	-	98.4	-	-	Fundamental

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).

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Radiated Emission (Fundamental and Spurious Emission)

Report No. 13760081H
Test place Ise EMC Lab.
Semi Anechoic Chamber No.2
Date August 27, 2021
Temperature / Humidity 23 deg. C / 65 % RH
Engineer Kiyoshiro Okazaki
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	0.12500	PK	106.6	18.9	-74.0	32.3	-	19.2	45.6	26.4	Fundamental
0deg	0.25000	PK	76.5	18.9	-73.9	32.3	-	-10.8	39.6	50.4	
0deg	0.37500	PK	82.6	18.8	-73.9	32.3	-	-4.8	36.1	40.9	
0deg	0.50000	QP	47.2	18.8	-33.9	32.3	-	-0.2	33.6	33.8	
0deg	0.62500	QP	41.0	18.8	-33.9	32.4	-	-6.5	31.7	38.2	
0deg	0.75000	QP	35.8	18.8	-33.8	32.4	-	-11.6	30.1	41.7	
0deg	0.87500	QP	32.4	18.8	-33.8	32.4	-	-15.0	28.7	43.7	
0deg	1.00000	QP	34.5	18.8	-33.8	32.4	-	-12.9	27.6	40.5	
0deg	1.12500	QP	31.4	18.8	-33.8	32.4	-	-16.0	26.5	42.5	
0deg	1.25000	QP	31.1	18.8	-33.8	32.4	-	-16.3	25.6	41.9	
Hori.	35.780	QP	33.6	16.6	6.8	28.5	-	28.5	40.0	11.5	
Hori.	73.012	QP	28.6	6.4	7.2	28.4	-	13.8	40.0	26.2	
Hori.	100.043	QP	23.4	10.3	7.5	28.3	-	12.9	43.5	30.6	
Hori.	119.425	QP	22.5	12.8	7.6	28.3	-	14.6	43.5	28.9	
Hori.	153.761	QP	22.6	15.2	7.9	28.1	-	17.6	43.5	25.9	
Hori.	233.601	QP	41.5	12.5	8.4	27.7	-	34.7	46.0	11.3	
Hori.	321.605	QP	23.5	14.9	9.0	27.8	-	19.6	46.0	26.4	
Vert.	31.871	QP	33.8	18.1	6.8	28.5	-	30.2	40.0	9.8	
Vert.	35.780	QP	28.9	16.6	6.8	28.5	-	23.8	40.0	16.2	
Vert.	73.012	QP	43.3	6.4	7.2	28.4	-	28.5	40.0	11.5	
Vert.	100.043	QP	27.9	10.3	7.5	28.3	-	17.4	43.5	26.1	
Vert.	119.425	QP	28.6	12.8	7.6	28.3	-	20.7	43.5	22.8	
Vert.	153.761	QP	24.6	15.2	7.9	28.1	-	19.6	43.5	23.9	
Vert.	233.601	QP	37.6	12.5	8.4	27.7	-	30.8	46.0	15.2	
Vert.	321.605	QP	22.5	14.9	9.0	27.8	-	18.6	46.0	27.4	

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

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	0.12500	PK	106.6	18.9	-74.0	32.3	0.0	19.2	25.6	6.4	Fundamental
0deg	0.25000	PK	76.5	18.9	-73.9	32.3	0.0	-10.8	19.6	30.4	
0deg	0.37500	PK	82.6	18.8	-73.9	32.3	0.0	-4.8	16.1	20.9	

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

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	106.6	18.9	6.0	32.3	-	99.2	-	-	Fundamental

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).

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Radiated Emission (Fundamental and Spurious Emission)

Report No. 13760081H
Test place Ise EMC Lab.
Semi Anechoic Chamber No.2
Date August 27, 2021
Temperature / Humidity 23 deg. C / 65 % RH
Engineer Kiyoshiro Okazaki
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	0.12500	PK	106.4	18.9	-74.0	32.3	-	19.0	45.6	26.6	Fundamental
0deg	0.25000	PK	76.3	18.9	-73.9	32.3	-	-11.0	39.6	50.6	
0deg	0.37500	PK	80.8	18.8	-73.9	32.3	-	-6.6	36.1	42.7	
0deg	0.50000	QP	49.5	18.8	-33.9	32.3	-	2.1	33.6	31.5	
0deg	0.62500	QP	40.0	18.8	-33.9	32.4	-	-7.5	31.7	39.2	
0deg	0.75000	QP	36.9	18.8	-33.8	32.4	-	-10.5	30.1	40.6	
0deg	0.87500	QP	33.4	18.8	-33.8	32.4	-	-14.0	28.7	42.7	
0deg	1.00000	QP	34.6	18.8	-33.8	32.4	-	-12.8	27.6	40.4	
0deg	1.12500	QP	31.0	18.8	-33.8	32.4	-	-16.4	26.5	42.9	
0deg	1.25000	QP	31.2	18.8	-33.8	32.4	-	-16.2	25.6	41.8	
Hori.	33.230	QP	33.7	17.6	6.8	28.5	-	29.6	40.0	10.4	
Hori.	44.109	QP	24.5	13.6	6.9	28.4	-	16.6	40.0	23.4	
Hori.	53.120	QP	25.5	10.2	7.0	28.4	-	14.3	40.0	25.7	
Hori.	82.529	QP	28.0	7.3	7.3	28.4	-	14.2	40.0	25.8	
Hori.	102.759	QP	23.1	10.7	7.5	28.3	-	13.0	43.5	30.5	
Hori.	126.771	QP	22.5	13.5	7.7	28.2	-	15.5	43.5	28.0	
Hori.	251.202	QP	42.2	12.3	8.5	27.7	-	35.3	46.0	10.7	
Hori.	432.017	QP	22.4	16.5	9.6	28.6	-	19.9	46.0	26.1	
Vert.	33.230	QP	33.9	17.6	6.8	28.5	-	29.8	40.0	10.2	
Vert.	44.109	QP	29.7	13.6	6.9	28.4	-	21.8	40.0	18.2	
Vert.	53.120	QP	29.8	10.2	7.0	28.4	-	18.6	40.0	21.4	
Vert.	82.529	QP	40.5	7.3	7.3	28.4	-	26.7	40.0	13.3	
Vert.	102.759	QP	27.6	10.7	7.5	28.3	-	17.5	43.5	26.0	
Vert.	126.771	QP	28.4	13.5	7.7	28.2	-	21.4	43.5	22.1	
Vert.	251.202	QP	38.4	12.3	8.5	27.7	-	31.5	46.0	14.5	
Vert.	432.017	QP	22.6	16.5	9.6	28.6	-	20.1	46.0	25.9	

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

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	0.12500	PK	106.4	18.9	-74.0	32.3	0.0	19.0	25.6	6.6	Fundamental
0deg	0.25000	PK	76.3	18.9	-73.9	32.3	0.0	-11.0	19.6	30.6	
0deg	0.37500	PK	80.8	18.8	-73.9	32.3	0.0	-6.6	16.1	22.7	

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

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	18.9	6.0	32.3	-	99.0	-	-	Fundamental

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).

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Radiated Emission (Fundamental and Spurious Emission)

Report No. 13760081H
Test place Ise EMC Lab.
Semi Anechoic Chamber No.2
Date August 27, 2021
Temperature / Humidity 23 deg. C / 65 % RH
Engineer Kiyoshiro Okazaki
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	0.12500	PK	104.6	18.9	-74.0	32.3	-	17.2	45.6	28.4	Fundamental
0deg	0.25000	PK	77.0	18.9	-73.9	32.3	-	-10.3	39.6	49.9	
0deg	0.37500	PK	71.5	18.8	-73.9	32.3	-	-15.9	36.1	52.0	
0deg	0.50000	QP	48.9	18.8	-33.9	32.3	-	1.5	33.6	32.1	
0deg	0.62500	QP	42.0	18.8	-33.9	32.4	-	-5.5	31.7	37.2	
0deg	0.75000	QP	36.6	18.8	-33.8	32.4	-	-10.8	30.1	40.9	
0deg	0.87500	QP	33.1	18.8	-33.8	32.4	-	-14.3	28.7	43.0	
0deg	1.00000	QP	33.9	18.8	-33.8	32.4	-	-13.5	27.6	41.1	
0deg	1.12500	QP	31.1	18.8	-33.8	32.4	-	-16.3	26.5	42.8	
0deg	1.25000	QP	30.9	18.8	-33.8	32.4	-	-16.5	25.6	42.1	
Hori.	34.081	QP	33.5	17.3	6.8	28.5	-	29.1	40.0	10.9	
Hori.	39.520	QP	24.3	15.2	6.9	28.5	-	17.9	40.0	22.1	
Hori.	44.111	QP	25.0	13.6	6.9	28.4	-	17.1	40.0	22.9	
Hori.	69.101	QP	27.8	6.4	7.2	28.4	-	13.0	40.0	27.0	
Hori.	125.713	QP	23.5	13.5	7.7	28.2	-	16.5	43.5	27.0	
Hori.	174.842	QP	22.4	15.8	8.0	28.0	-	18.2	43.5	25.3	
Hori.	233.608	QP	41.6	12.5	8.4	27.7	-	34.8	46.0	11.2	
Vert.	31.700	QP	33.7	18.2	6.8	28.5	-	30.2	40.0	9.8	
Vert.	34.081	QP	29.5	17.3	6.8	28.5	-	25.1	40.0	14.9	
Vert.	39.520	QP	33.2	15.2	6.9	28.5	-	26.8	40.0	13.2	
Vert.	44.111	QP	30.1	13.6	6.9	28.4	-	22.2	40.0	17.8	
Vert.	69.101	QP	41.6	6.4	7.2	28.4	-	26.8	40.0	13.2	
Vert.	125.713	QP	28.4	13.5	7.7	28.2	-	21.4	43.5	22.1	
Vert.	174.842	QP	25.4	15.8	8.0	28.0	-	21.2	43.5	22.3	
Vert.	233.608	QP	37.9	12.5	8.4	27.7	-	31.1	46.0	14.9	

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

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	0.12500	PK	104.6	18.9	-74.0	32.3	0.0	17.2	25.6	8.4	Fundamental
0deg	0.25000	PK	77.0	18.9	-73.9	32.3	0.0	-10.3	19.6	29.9	
0deg	0.37500	PK	71.5	18.8	-73.9	32.3	0.0	-15.9	16.1	32.0	

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

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	104.6	18.9	6.0	32.3	-	97.2	-	-	Fundamental

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).

UL Japan, Inc.

Ise EMC Lab.

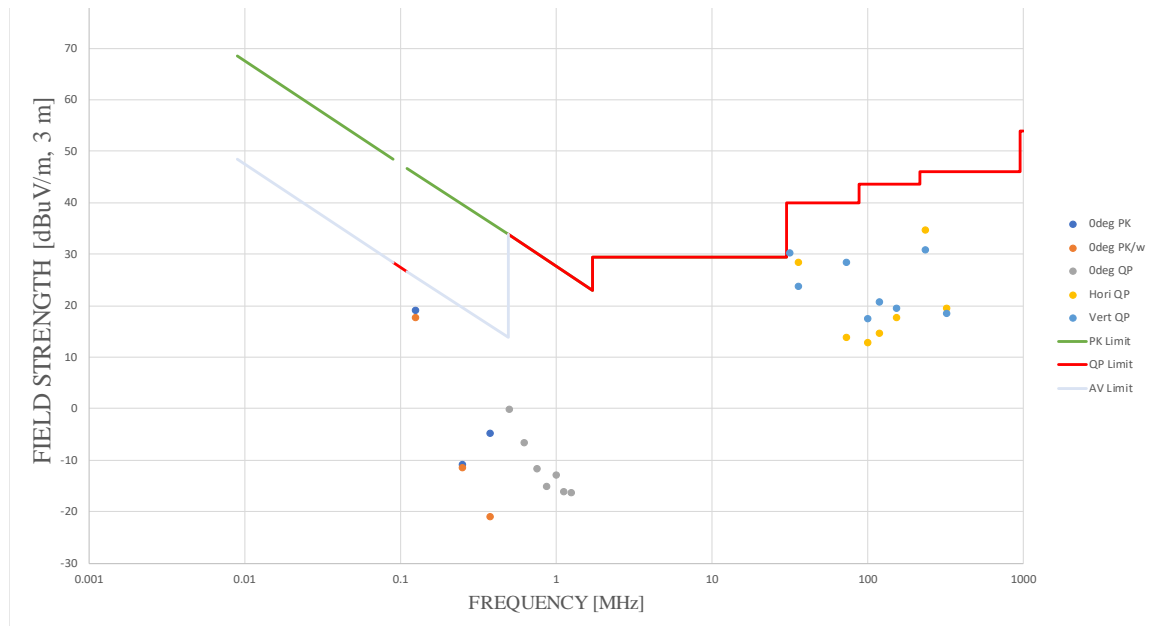
4383-326 Asama-cho, Ise-shi, Mie-ken 516-0021 JAPAN

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Radiated Spurious Emission (Plot data, Worst case)

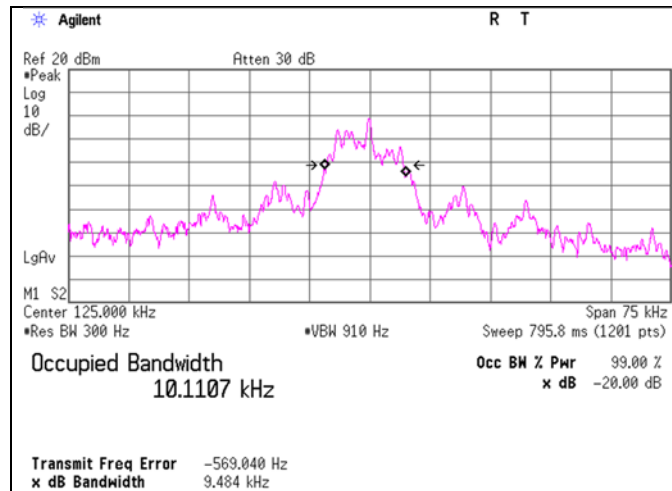
Report No. 13760081H
Test place Ise EMC Lab.
Semi Anechoic Chamber No.2
Date August 27, 2021
Temperature / Humidity 23 deg. C / 65 % RH
Engineer Kiyoshiro Okazaki
Mode Mode 2



-20 dB Bandwidth / 99 % Occupied Bandwidth

Report No.	13760081H
Test place	Ise EMC Lab.
Semi Anechoic Chamber	No.2
Date	August 27, 2021
Temperature / Humidity	23 deg. C / 65 % RH
Engineer	Kiyoshiro Okazaki
Mode	Mode 1

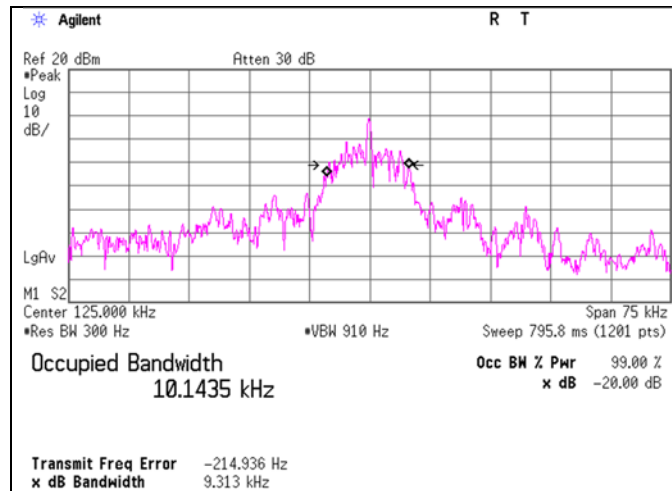
-20 dB Bandwidth [kHz]	99 % Occupied Bandwidth [kHz]
9.484	10.1107



-20 dB Bandwidth / 99 % Occupied Bandwidth

Report No.	13760081H
Test place	Ise EMC Lab.
Semi Anechoic Chamber	No.2
Date	August 27, 2021
Temperature / Humidity	23 deg. C / 65 % RH
Engineer	Kiyoshiro Okazaki
Mode	Mode 2

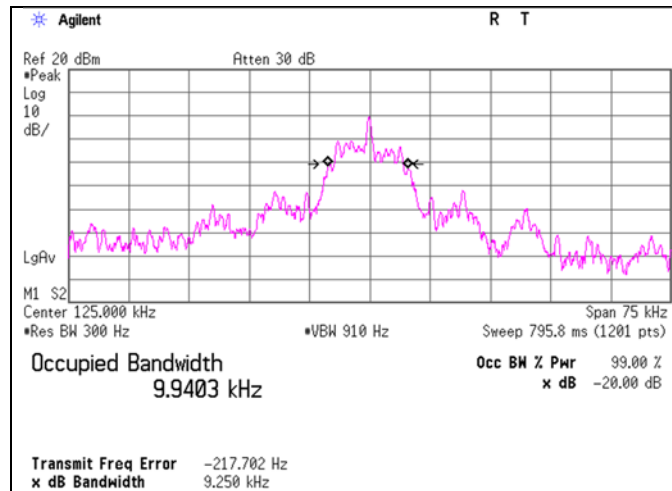
-20 dB Bandwidth [kHz]	99 % Occupied Bandwidth [kHz]
9.313	10.1435



-20 dB Bandwidth / 99 % Occupied Bandwidth

Report No.	13760081H
Test place	Ise EMC Lab.
Semi Anechoic Chamber	No.2
Date	August 27, 2021
Temperature / Humidity	23 deg. C / 65 % RH
Engineer	Kiyoshiro Okazaki
Mode	Mode 3

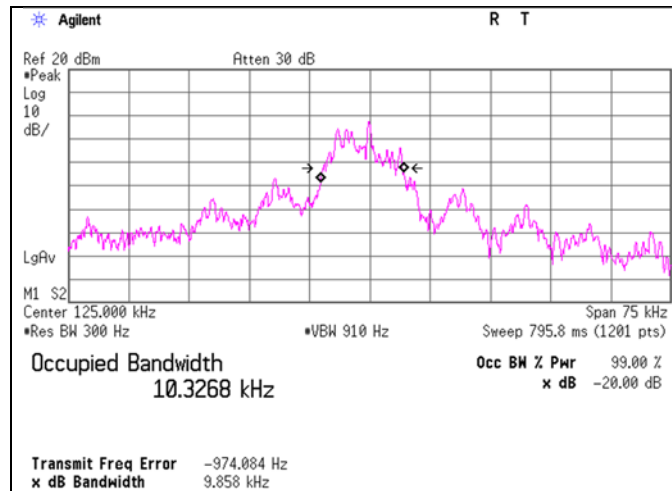
-20 dB Bandwidth [kHz]	99 % Occupied Bandwidth [kHz]
9.250	9.9403



-20 dB Bandwidth / 99 % Occupied Bandwidth

Report No.	13760081H
Test place	Ise EMC Lab.
Semi Anechoic Chamber	No.2
Date	August 27, 2021
Temperature / Humidity	23 deg. C / 65 % RH
Engineer	Kiyoshiro Okazaki
Mode	Mode 4

-20 dB Bandwidth [kHz]	99 % Occupied Bandwidth [kHz]
9.858	10.3268



APPENDIX 2: Test instruments

Test equipment (Test date: August 27, 2021)

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	MTR-10	141951	EMI Test Receiver	Rohde & Schwarz	ESR26	101408	03/09/2021	12
RE	MSA-03	141884	Spectrum Analyzer	Keysight Technologies Inc	E4448A	MY44020357	03/10/2021	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.	-	-	09/25/2020	12
RE	MLA-21	141265	Logperiodic Antenna (200-1000MHz)	Schwarzbeck Mess-Elektronik OHG	VUSLP9111B	9111B-190	07/10/2021	12
RE	MPA-24	141594	Pre Amplifier	Keysight Technologies Inc	8447D	2944A10150	02/18/2021	12
RE	MPA-13	141582	Pre Amplifier	SONOMA INSTRUMENT	310	260834	02/18/2021	12
RE	MLPA-02	142152	Loop Antenna	Rohde & Schwarz	HFH2-Z2	836553/009	12/04/2020	12
RE	MCC-219	159670	Coaxial Cable	UL Japan Inc.	-	-	11/17/2020	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)	-	02/18/2021	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

Test equipment (Test date : October 20, 2021)

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	MTR-10	141951	EMI Test Receiver	Rohde & Schwarz	ESR26	101408	03/09/2021	12
RE	MSA-03	141884	Spectrum Analyzer	Keysight Technologies Inc	E4448A	MY44020357	03/10/2021	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	MPA-24	141594	Pre Amplifier	Keysight Technologies Inc	8447D	2944A10150	02/18/2021	12
RE	MPA-13	141582	Pre Amplifier	SONOMA INSTRUMENT	310	260834	02/18/2021	12
RE	MLPA-02	142152	Loop Antenna	Rohde & Schwarz	HFH2-Z2	836553/009	12/04/2020	12
RE	MCC-219	159670	Coaxial Cable	UL Japan Inc.	-	-	11/17/2020	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)	-	02/18/2021	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.

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Test item: RE: Radiated Emission test