RADIO TEST REPORT

Test Report No. 15324662H-A

Customer	**Tokai Rika Co Ltd**
Description of EUT	**Smart LF Oscillator with Receiver**
Model Number of EUT	**K58U0**
FCC ID	**MOZK58U0**
Test Regulation	**FCC Part 15 Subpart C**
Test Result	**Complied**
Issue Date	**July 26, 2024**
Remarks	**-**

Representative test engineer	**Approved by**
Shousei Hamaguchi Engineer	Akihiko Maeda Leader

CERTIFICATE 5107.02

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REVISION HISTORY

Original Test Report No. 15324662H-A

Revision	Test Report No.	Date	Page Revised Contents
- (Original)	15324662H-A	July 26, 2024	-

Reference: Abbreviations (Including words undescribed in this report)

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

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SECTION 1: Customer Information

Company Name	Tokai Rika Co Ltd
Address	3-260 Toyota, Oguchi-cho, Niwa-gun, Aichi 480-0195, Japan
Telephone Number	+81-587-95-0093
Contact Person	Tetsuhiro Okuoka

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

SECTION 2: Equipment Under Test (EUT)

2.1 Identification of EUT

Description	Smart LF Oscillator with Receiver
Model Number	K58U0
Serial Number	Refer to SECTION 4.2
Condition	Engineering prototype (Not for Sale: This sample is equivalent to mass-produced items.)
Modification	No Modification by the test lab
Receipt Date	June 10, 2024
Test Date	June 18 to July 16, 2024

2.2 Product Description

General Specification

Rating	DC 12.0 V (Max 0.5 A (ave.))
Operating temperature	-40 deg. C to 85 deg. C

Radio Specification

Equipment Type	Transmitter
Frequency of Operation	125 kHz
Type of Modulation	ASK

Equipment Type	Receiver
Frequency of Operation	433.92 MHz
Local Oscillator Frequency	433.72 MHz

Smart LF Oscillator with Receiver (model: K58U0) consists of the following parts:
- Controller assy, WIU
- D seat Antenna
- P seat Antenna
- Indoor1 Antenna
- Indoor2 Antenna
- Luggage Antenna
- B/D Antenna
- Extra Antenna

SECTION 3: Test specification, procedures & results

3.1 Test Specification

Test Specification	FCC Part 15 Subpart C The latest version on the first day of the testing period
Title	FCC 47CFR Part15 Radio Frequency Device Subpart C Intentional Radiators Section 15.207 Conducted limits Section 15.209 Radiated emission limits; general requirements.
*Also the EUT complies with FCC Part 15 Subpart B.	

3.2 Procedures and results

Item	Test Procedure	Specification	Worst margin	Results	Remarks
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	*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	2.9 dB 125 kHz, 0 deg. Peak with Duty factor (Mode 4)	Complied	Radiated
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	7.3 dB 0.5000 MHz, 0 deg., QP (Mode 4)	Complied	Radiated
-20 dB Bandwidth	<FCC> ANSI C63.10:2013 6 Standard test methods <ISED> -	<FCC> Reference data <ISED> -	N/A	Complied	Radiated
Note: UL Japan, Inc.'s EMI Work Procedures: Work Instructions-ULID-003591 and Work Instructions-ULID-003593. *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.					

FCC Part 15.31 (e)

Input voltage to RF part does not go through the regulator.
So the test was performed with the supply voltage varied between 85 % and 115 % of the nominal rated supply voltage (DC 12 V) and the variation of the input power 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	Worst margin	Results	Remarks
99 % emission bandwidth	RSS-Gen 6.7	-	N/A	-	Radiated

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

3.4 Uncertainty

Measurement uncertainty is not taken into account when stating conformity with a specified requirement. Note: When margins obtained from test results are less than the measurement uncertainty, the test results may exceed the limit.

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		Unit	Calculated Uncertainty (+/-)
3 m	9 kHz to 30 MHz		dB	3.3
10 m			dB	3.1
3 m	30 MHz to 200 MHz	Horizontal	dB	4.7
		Vertical	dB	4.7
	200 MHz to 1000 MHz	Horizontal	dB	4.8
		Vertical	dB	6.0
10 m	30 MHz to 200 MHz	Horizontal	dB	5.2
		Vertical	dB	5.1
	200 MHz to 1000 MHz	Horizontal	dB	5.2
		Vertical	dB	5.2
3 m	1 GHz to 6 GHz		dB	5.0
	6 GHz to 18 GHz		dB	5.2
1 m	10 GHz to 18 GHz		dB	5.3
	18 GHz to 26.5 GHz		dB	5.2
	26.5 GHz to 40 GHz		dB	4.7
0.5 m	26.5 GHz to 40 GHz		dB	4.8

-20 dB Bandwidth and 99% Occupied Bandwidth

Item	Unit	Calculated Uncertainty (+/-)
Bandwidth (OBW)	%	0.96

3.5 Test Location

UL Japan, Inc. Ise EMC Lab.
4383-326 Asama-cho, Ise-shi, Mie-ken 516-0021 Japan
Telephone: +81-596-24-8999
*A2LA Certificate Number: 5107.02 / FCC Test Firm Registration Number: 884919
ISED Lab Company Number: 2973C / CAB identifier: JP0002

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	-	-
Large Chamber	16.9 x 22.1 x 10.17	16.9 x 22.1	-	10 m
Small Chamber	5.3 x 6.69 x 3.59	5.3 x 6.69	-	-

3.6 Test data, Test instruments, and Test set up

Refer to APPENDIX.

SECTION 4: Operation of EUT during testing

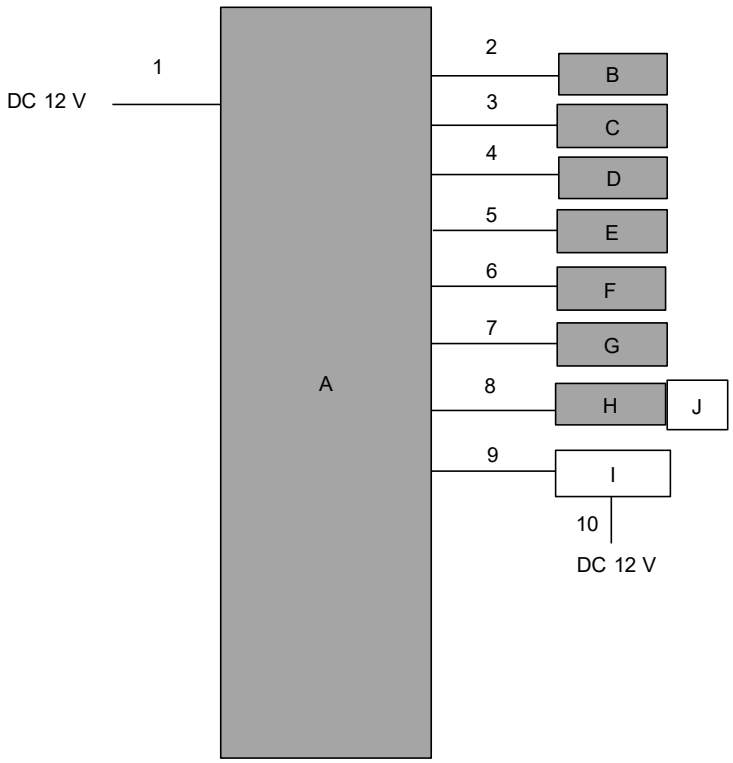
4.1. Operating Mode(s)

Test mode	Remarks
1) Transmitting mode (Tx), D seat Antenna	*1)
2) Transmitting mode (Tx), Extra Antenna	-
3) Transmitting mode (Tx), Simultaneous transmission (D seat Antenna, P seat Antenna, B/D Antenna)	-
4) Transmitting mode (Tx), Simultaneous transmission (Indoor 2 Antenna, Luggage Antenna)	*1)
*Power of the EUT was set by the software as follows; Software: K58U0_max V2.00 (Date: 2024.06.06, 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.	

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

* 1) Representative antenna(s) comparing D seat, P seat, B/D, Indoor 1, Indoor 2 and Luggage antenna.

4.2 Configuration and Peripherals



* Cabling and setup(s) 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	Remark
A	Controller assy, WIU	K58U0	2	-	EUT
B	D seat Antenna	T-2FD28	40	-	EUT
C	P seat Antenna	T-2FD28	43	-	EUT
D	Indoor1 Antenna	T-2FD28	3	-	EUT
E	Indoor2 Antenna	T-2FD28	39	-	EUT
F	Luggage Antenna	T-2FD28	42	-	EUT
G	B/D Antenna	T-2FD28	60	-	EUT
H	Extra Antenna	T-3AA31	1	-	EUT
I	LED & Switch Jig	-	-	-	-
J	Smart Key	R58U0	32	-	-

List of Cables Used

No.	Name	Length (m)	Shield		Remark
			Cable	Connector	
1	DC Cable	1.9	Unshielded	Unshielded	-
2	Antenna Cable	2.0	Unshielded	Unshielded	-
3	Antenna Cable	2.0	Unshielded	Unshielded	-
4	Antenna Cable	2.0	Unshielded	Unshielded	-
5	Antenna Cable	2.0	Unshielded	Unshielded	-
6	Antenna Cable	2.0	Unshielded	Unshielded	-
7	Antenna Cable	2.0	Unshielded	Unshielded	-
8	Antenna Cable	2.0	Unshielded	Unshielded	-
9	Signal Cable	2.0	Unshielded	Unshielded	-
10	DC Cable	2.8	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.

[Limit conversion]
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.

[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., 180 deg.) and horizontal polarization.
*Refer to Figure 2 about Direction of the Loop Antenna.

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.

[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.

[Test instruments and test settings]

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

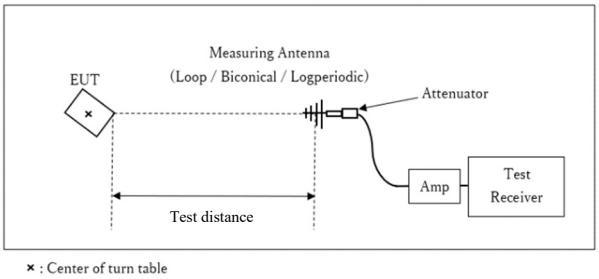
The test was made with the detector (RBW/VBW) in the following table.
When using Spectrum analyzer, the test was made with adjusting span to zero by using peak hold.

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

Figure 1: Test Setup

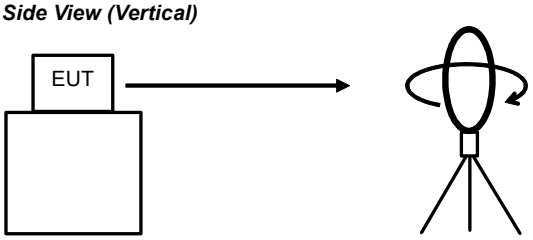
Below 1 GHz



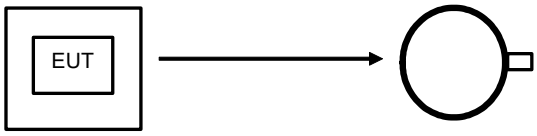
Test Distance: 3 m

Figure 2: Direction of the Loop Antenna

Side View (Vertical)

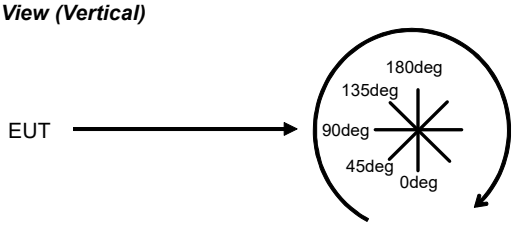


Top View (Horizontal)



Antenna was not rotated.

Top View (Vertical)



Front side: 0 deg.
Forward direction: clockwise

- 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 to 1 GHz
Test data : APPENDIX
Test result : Pass

SECTION 6: -20 dB Bandwidth

Test Procedure

The test was measured with a spectrum analyzer.

Test	Span	RBW	VBW	Sweep	Detector	Trace	Instrument used
-20 dB Bandwidth	Enough width to display emission skirts	1 to 5 % of OBW	Three times of RBW	Auto	Peak	Max Hold	Spectrum Analyzer

Test data : APPENDIX
Test result : Pass

SECTION 7: 99 % emission bandwidth

Test Procedure

The test was measured with a spectrum analyzer.

Test	Span	RBW	VBW	Sweep	Detector	Trace	Instrument used
99 % emission bandwidth	Enough width to display emission skirts	1 to 5 % of OBW	Three times of RBW	Auto	Peak	Max Hold	Spectrum Analyzer
Peak hold was applied as Worst-case measurement.							

Test data : APPENDIX
Test result : Pass

APPENDIX 1: Test data

Radiated Emission (Fundamental and Spurious Emission)

Test place	Ise EMC Lab.
Semi Anechoic Chamber	No.1
Date	June 18, 2024
Temperature / Humidity	20 deg. C / 47 % RH
Engineer	Ken Fujita
Mode	Mode 1

PK or QP

Ant Deg [deg] or Polarity [Hori/Vert]	Frequency [MHz]	Detector	Reading [dBuV]	Ant Factor [dB/m]	Loss [dB]	Gain [dB]	Duty Factor [dB]	Result [dBuV/m]	Limit [dBuV/m]	Margin [dB]	Remark
0deg	0.12500	PK	98.8	19.5	-74.0	32.2	-	12.1	45.6	33.5	Fundamental(DC 10.2 V)
0deg	0.12500	PK	98.8	19.5	-74.0	32.2	-	12.1	45.6	33.5	Fundamental(DC 12.0 V)
0deg	0.12500	PK	98.8	19.5	-74.0	32.2	-	12.1	45.6	33.5	Fundamental(DC 13.8 V)
0deg	0.25000	PK	81.5	19.6	-74.0	32.2	-	-5.1	39.6	44.7	
0deg	0.37500	PK	63.7	19.7	-73.9	32.2	-	-22.7	36.1	58.8	
0deg	0.50000	QP	63.9	19.7	-33.9	32.2	-	17.5	33.6	16.1	
0deg	0.62500	QP	62.7	19.7	-33.9	32.2	-	16.3	31.7	15.4	
0deg	0.75000	QP	52.7	19.7	-33.9	32.2	-	6.3	30.1	23.8	
0deg	0.87500	QP	51.5	19.7	-33.8	32.2	-	5.2	28.7	23.5	
0deg	1.00000	QP	54.4	19.7	-33.8	32.2	-	8.1	27.6	19.5	
0deg	1.12500	QP	48.6	19.7	-33.8	32.2	-	2.3	26.5	24.2	
0deg	1.25000	QP	42.6	19.7	-33.8	32.2	-	-3.7	25.6	29.3	
Hori.	68.729	QP	41.9	6.5	8.0	38.9	-	17.5	40.0	22.5	
Hori.	85.745	QP	36.3	7.9	8.3	38.9	-	13.6	40.0	26.4	
Hori.	184.292	QP	28.6	16.2	9.4	39.0	-	15.2	43.5	28.3	
Hori.	258.622	QP	27.9	12.2	10.1	38.9	-	11.3	46.0	34.7	
Hori.	615.050	QP	27.0	19.6	12.7	38.2	-	21.1	46.0	24.9	
Hori.	922.160	QP	26.7	22.0	14.4	37.9	-	25.2	46.0	20.8	
Vert.	68.729	QP	39.1	6.5	8.0	38.9	-	14.7	40.0	25.3	
Vert.	85.745	QP	32.6	7.9	8.3	38.9	-	9.9	40.0	30.1	
Vert.	184.292	QP	33.1	16.2	9.4	39.0	-	19.7	43.5	23.8	
Vert.	258.622	QP	27.5	12.2	10.1	38.9	-	10.9	46.0	35.1	

Result = Reading + Ant Factor + Loss (Cable + Attenuator + Filter + 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	0.12500	PK	98.8	19.5	-74.0	32.2	0.0	12.1	25.6	***13.5***	Fundamental(DC 10.2 V)
0deg	0.12500	PK	98.8	19.5	-74.0	32.2	0.0	12.1	25.6	***13.5***	Fundamental(DC 12.0 V)
0deg	0.12500	PK	98.8	19.5	-74.0	32.2	0.0	12.1	25.6	***13.5***	Fundamental(DC 13.8 V)
0deg	0.25000	PK	81.5	19.6	-74.0	32.2	0.0	-5.1	19.6	24.7	
0deg	0.37500	PK	63.7	19.7	-73.9	32.2	0.0	-22.7	16.1	38.8	

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

Result of the fundamental emission at 3 m 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	98.8	19.5	6.0	32.2	-	92.1	-	-	Fundamental

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

If Gain 0.0dB shown in the above table, pre-amplifier was not used to avoid the influence of carrier power. The pre-amplifier used for carrier frequency measurement was not saturated.
Other frequency noises omitted in this report were not seen or had enough margin (more than 20 dB).

*It was confirmed that there were no differences in the spurious emission due to the input voltage.

Radiated Emission (Fundamental and Spurious Emission)

Test place	Ise EMC Lab.
Semi Anechoic Chamber	No.1
Date	June 24, 2024
Temperature / Humidity	20 deg. C / 47 % RH
Engineer	Shousei Hamaguchi
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	100.0	19.5	-74.0	32.2	-	13.3	45.6	32.3	Fundamental(DC 10.2 V)
0deg	0.12500	PK	100.0	19.5	-74.0	32.2	-	13.3	45.6	32.3	Fundamental(DC 12.0 V)
0deg	0.12500	PK	99.9	19.5	-74.0	32.2	-	13.2	45.6	32.4	Fundamental(DC 13.8 V)
0deg	0.25000	PK	64.4	19.6	-74.0	32.2	-	-22.2	39.6	61.8	
0deg	0.37500	PK	61.1	19.7	-73.9	32.2	-	-25.3	36.1	61.4	
0deg	0.50000	QP	55.9	19.7	-33.9	32.2	-	9.5	33.6	24.1	
0deg	0.62500	QP	47.4	19.7	-33.9	32.2	-	1.0	31.7	30.7	
0deg	0.75000	QP	49.2	19.7	-33.9	32.2	-	2.8	30.1	27.3	
0deg	0.87500	QP	42.4	19.7	-33.8	32.2	-	-3.9	28.7	32.6	
0deg	1.00000	QP	44.5	19.7	-33.8	32.2	-	-1.8	27.6	29.4	
0deg	1.12500	QP	40.6	19.7	-33.8	32.2	-	-5.7	26.5	32.2	
0deg	1.25000	QP	40.2	19.7	-33.8	32.2	-	-6.1	25.6	31.7	
Hori.	42.981	QP	38.4	13.8	7.5	38.9	-	20.8	40.0	19.2	
Hori.	78.336	QP	44.7	6.9	8.1	38.9	-	20.8	40.0	19.2	
Hori.	102.449	QP	30.7	10.4	8.5	38.9	-	10.7	43.5	32.8	
Hori.	192.135	QP	32.8	16.5	9.5	39.0	-	19.8	43.5	23.7	
Hori.	215.644	QP	34.6	11.2	9.7	38.9	-	16.6	43.5	26.9	
Hori.	410.332	QP	27.6	16.1	11.3	38.5	-	16.5	46.0	29.5	
Vert.	42.981	QP	49.6	13.8	7.5	38.9	-	32.0	40.0	***8.0***	
Vert.	78.336	QP	34.6	6.9	8.1	38.9	-	10.7	40.0	29.3	
Vert.	102.449	QP	36.0	10.4	8.5	38.9	-	16.0	43.5	27.5	
Vert.	192.135	QP	40.4	16.5	9.5	39.0	-	27.4	43.5	16.1	
Vert.	215.644	QP	37.2	11.2	9.7	38.9	-	19.2	43.5	24.3	
Vert.	410.332	QP	27.5	16.1	11.3	38.5	-	16.4	46.0	29.6	

Result = Reading + Ant Factor + Loss (Cable + Attenuator + Filter + 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	0.12500	PK	100.0	19.5	-74.0	32.2	0.0	13.3	25.6	12.3	Fundamental(DC 10.2 V)
0deg	0.12500	PK	100.0	19.5	-74.0	32.2	0.0	13.3	25.6	12.3	Fundamental(DC 12.0 V)
0deg	0.12500	PK	99.9	19.5	-74.0	32.2	0.0	13.2	25.6	12.4	Fundamental(DC 13.8 V)
0deg	0.25000	PK	64.4	19.6	-74.0	32.2	0.0	-22.2	19.6	41.8	
0deg	0.37500	PK	61.1	19.7	-73.9	32.2	0.0	-25.3	16.1	41.4	

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

Result of the fundamental emission at 3 m 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	100.0	19.5	6.0	32.2	-	93.3	-	-	Fundamental

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

If Gain 0.0dB shown in the above table, pre-amplifier was not used to avoid the influence of carrier power. The pre-amplifier used for carrier frequency measurement was not saturated.
Other frequency noises omitted in this report were not seen or had enough margin (more than 20 dB).

*It was confirmed that there were no differences in the spurious emission due to the input voltage.

Radiated Emission (Fundamental and Spurious Emission)

Test place	Ise EMC Lab.
Semi Anechoic Chamber	No.1
Date	June 18, 2024
Temperature / Humidity	20 deg. C / 47 % RH
Engineer	Ken Fujita
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	99.9	19.5	-74.0	32.2	-	13.2	45.6	32.4	Fundamental(DC 10.2 V)
0deg	0.12500	PK	99.9	19.5	-74.0	32.2	-	13.2	45.6	32.4	Fundamental(DC 12.0 V)
0deg	0.12500	PK	99.9	19.5	-74.0	32.2	-	13.2	45.6	32.4	Fundamental(DC 13.8 V)
0deg	0.25000	PK	82.1	19.6	-74.0	32.2	-	-4.5	39.6	44.1	
0deg	0.37500	PK	73.9	19.7	-73.9	32.2	-	-12.5	36.1	48.6	
0deg	0.50000	QP	53.8	19.7	-33.9	32.2	-	7.4	33.6	26.2	
0deg	0.62500	QP	40.5	19.7	-33.9	32.2	-	-5.9	31.7	37.6	
0deg	0.75000	QP	37.1	19.7	-33.9	32.2	-	-9.3	30.1	39.4	
0deg	0.87500	QP	41.0	19.7	-33.8	32.2	-	-5.3	28.7	34.0	
0deg	1.00000	QP	43.2	19.7	-33.8	32.2	-	-3.1	27.6	30.7	
0deg	1.12500	QP	43.3	19.7	-33.8	32.2	-	-3.0	26.5	29.5	
0deg	1.25000	QP	42.1	19.7	-33.8	32.2	-	-4.2	25.6	29.8	
Hori.	47.725	QP	29.9	12.0	7.6	38.9	-	10.6	40.0	29.4	
Hori.	164.284	QP	34.6	15.5	9.2	39.0	-	20.3	43.5	23.2	
Hori.	186.413	QP	33.3	16.3	9.4	39.0	-	20.0	43.5	23.5	
Hori.	250.387	QP	27.8	11.9	10.1	38.9	-	10.9	46.0	35.1	
Hori.	600.566	QP	27.4	19.4	12.6	38.2	-	21.2	46.0	24.8	
Hori.	883.101	QP	26.9	22.0	14.2	38.1	-	25.0	46.0	21.0	
Vert.	47.725	QP	34.2	12.0	7.6	38.9	-	14.9	40.0	25.1	
Vert.	164.284	QP	32.3	15.5	9.2	39.0	-	18.0	43.5	25.5	
Vert.	186.413	QP	35.6	16.3	9.4	39.0	-	22.3	43.5	21.2	
Vert.	250.387	QP	27.8	11.9	10.1	38.9	-	10.9	46.0	35.1	
Vert.	600.566	QP	27.3	19.4	12.6	38.2	-	21.1	46.0	24.9	
Vert.	883.101	QP	26.8	22.0	14.2	38.1	-	24.9	46.0	21.1	

Result = Reading + Ant Factor + Loss (Cable + Attenuator + Filter + 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	0.12500	PK	99.9	19.5	-74.0	32.2	0.0	13.2	25.6	***12.4***	Fundamental(DC 10.2 V)
0deg	0.12500	PK	99.9	19.5	-74.0	32.2	0.0	13.2	25.6	***12.4***	Fundamental(DC 12.0 V)
0deg	0.12500	PK	99.9	19.5	-74.0	32.2	0.0	13.2	25.6	***12.4***	Fundamental(DC 13.8 V)
0deg	0.25000	PK	82.1	19.6	-74.0	32.2	0.0	-4.5	19.6	24.1	
0deg	0.37500	PK	73.9	19.7	-73.9	32.2	0.0	-12.5	16.1	28.6	

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

Result of the fundamental emission at 3 m 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	99.9	19.5	6.0	32.2	-	93.2	-	-	Fundamental

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

If Gain 0.0dB shown in the above table, pre-amplifier was not used to avoid the influence of carrier power. The pre-amplifier used for carrier frequency measurement was not saturated.
Other frequency noises omitted in this report were not seen or had enough margin (more than 20 dB).

*It was confirmed that there were no differences in the spurious emission due to the input voltage.

Radiated Emission (Fundamental and Spurious Emission)

Test place	Ise EMC Lab.
Semi Anechoic Chamber	No.1
Date	June 24, 2024
Temperature / Humidity	20 deg. C / 47 % RH
Engineer	Shousei Hamaguchi
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	109.3	19.5	-74.0	32.2	-	22.6	45.6	23.0	Fundamental(DC 10.2 V)
0deg	0.12500	PK	109.4	19.5	-74.0	32.2	-	22.7	45.6	22.9	Fundamental(DC 12.0 V)
0deg	0.12500	PK	109.3	19.5	-74.0	32.2	-	22.6	45.6	23.0	Fundamental(DC 13.8 V)
0deg	0.25000	PK	88.3	19.6	-74.0	32.2	-	1.7	39.6	37.9	
0deg	0.37500	PK	79.9	19.7	-73.9	32.2	-	-6.5	36.1	42.6	
0deg	0.50000	QP	72.7	19.7	-33.9	32.2	-	26.3	33.6	7.3	
0deg	0.62500	QP	62.0	19.7	-33.9	32.2	-	15.6	31.7	16.1	
0deg	0.75000	QP	52.5	19.7	-33.9	32.2	-	6.1	30.1	24.0	
0deg	0.87500	QP	60.7	19.7	-33.8	32.2	-	14.4	28.7	14.3	
0deg	1.00000	QP	61.5	19.7	-33.8	32.2	-	15.2	27.6	12.4	
0deg	1.12500	QP	59.5	19.7	-33.8	32.2	-	13.2	26.5	13.3	
0deg	1.25000	QP	54.9	19.7	-33.8	32.2	-	8.6	25.6	17.0	
Hori.	43.121	QP	30.9	13.7	7.5	38.9	-	13.2	40.0	26.8	
Hori.	78.310	QP	44.6	6.9	8.1	38.9	-	20.7	40.0	19.3	
Hori.	102.633	QP	34.9	10.4	8.5	38.9	-	14.9	43.5	28.6	
Hori.	192.014	QP	32.9	16.5	9.5	39.0	-	19.9	43.5	23.6	
Hori.	215.648	QP	34.8	11.2	9.7	38.9	-	16.8	43.5	26.7	
Hori.	410.332	QP	27.6	16.1	11.3	38.5	-	16.5	46.0	29.5	
Vert.	43.121	QP	42.7	13.7	7.5	38.9	-	25.0	40.0	15.0	
Vert.	78.310	QP	34.7	6.9	8.1	38.9	-	10.8	40.0	29.2	
Vert.	102.633	QP	40.1	10.4	8.5	38.9	-	20.1	43.5	23.4	
Vert.	192.014	QP	40.2	16.5	9.5	39.0	-	27.2	43.5	16.3	
Vert.	215.648	QP	37.1	11.2	9.7	38.9	-	19.1	43.5	24.4	
Vert.	410.332	QP	27.5	16.1	11.3	38.5	-	16.4	46.0	29.6	

Result = Reading + Ant Factor + Loss (Cable + Attenuator + Filter + 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	0.12500	PK	109.3	19.5	-74.0	32.2	0.0	22.6	25.6	3.0	Fundamental(DC 10.2 V)
0deg	0.12500	PK	109.4	19.5	-74.0	32.2	0.0	22.7	25.6	***2.9***	Fundamental(DC 12.0 V)
0deg	0.12500	PK	109.3	19.5	-74.0	32.2	0.0	22.6	25.6	3.0	Fundamental(DC 13.8 V)
0deg	0.25000	PK	88.3	19.6	-74.0	32.2	0.0	1.7	19.6	17.9	
0deg	0.37500	PK	79.9	19.7	-73.9	32.2	0.0	-6.5	16.1	22.6	

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

Result of the fundamental emission at 3 m 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	109.3	19.5	6.0	32.2	-	102.6	-	-	Fundamental

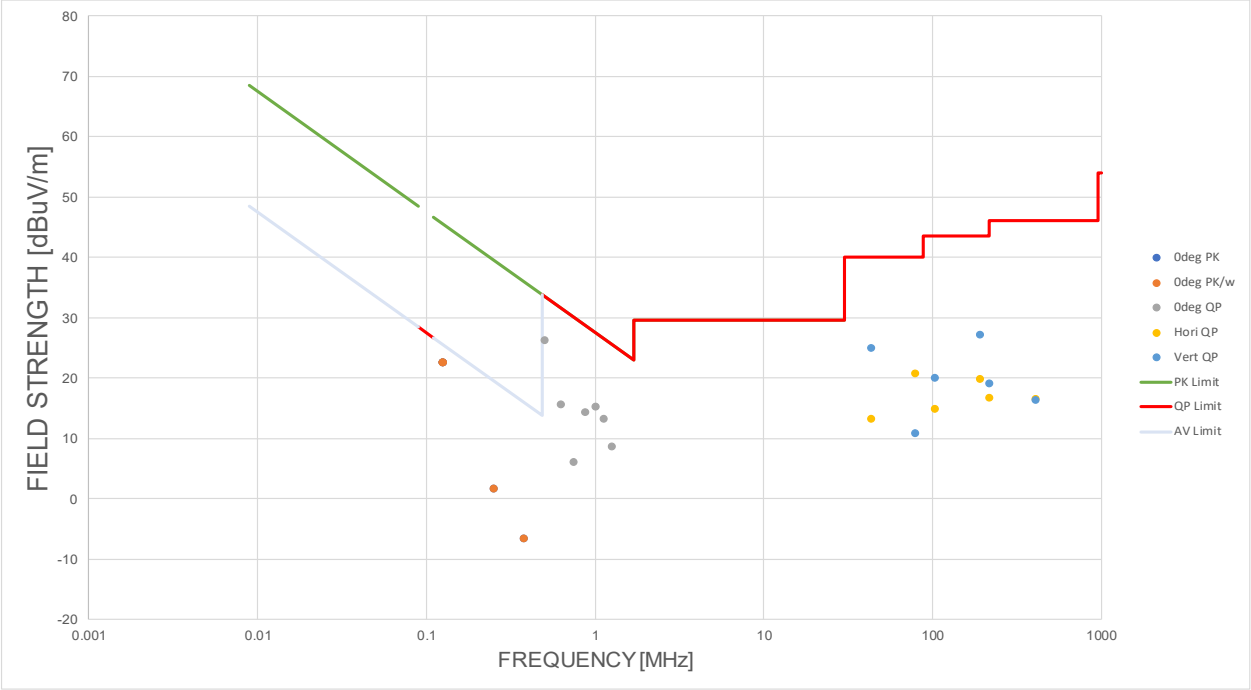
Result = Reading + Ant Factor + Loss (Cable+Attenuator) - Gain(Amprifier)

If Gain 0.0dB shown in the above table, pre-amplifier was not used to avoid the influence of carrier power. The pre-amplifier used for carrier frequency measurement was not saturated.
Other frequency noises omitted in this report were not seen or had enough margin (more than 20 dB).

*It was confirmed that there were no differences in the spurious emission due to the input voltage.

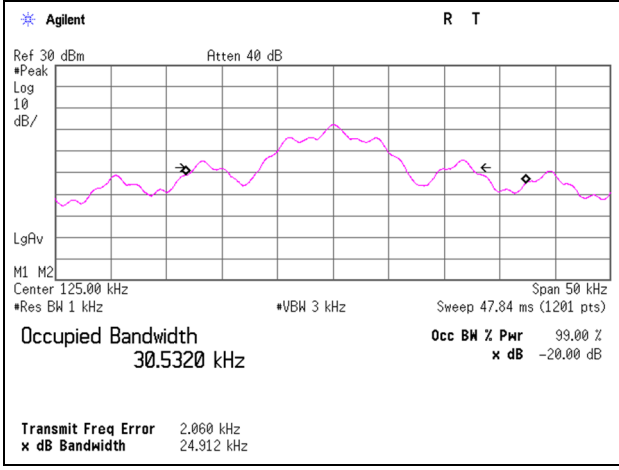
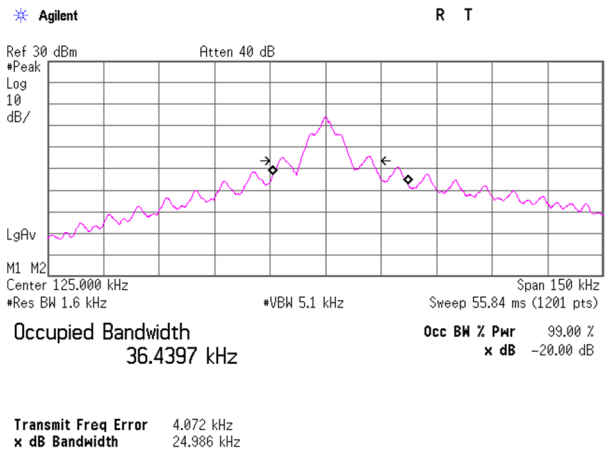
Radiated Spurious Emission
(Plot data, Worst case for Fundamental Emission)

Test place	Ise EMC Lab.
Semi Anechoic Chamber	No.1
Date	June 24, 2024
Temperature / Humidity	20 deg. C / 47 % RH
Engineer	Shousei Hamaguchi
Mode	Mode 4



-20 dB Bandwidth / 99 % emission bandwidth

Test place	Ise EMC Lab.
Measurement Room	No.4
Date	July 16, 2024
Temperature / Humidity	23 deg. C / 52 % RH
Engineer	Shousei Hamaguchi
Mode	Mode 1

-20 dB Bandwidth [kHz]	99 % emission bandwidth [kHz]
24.912	36.4397
	

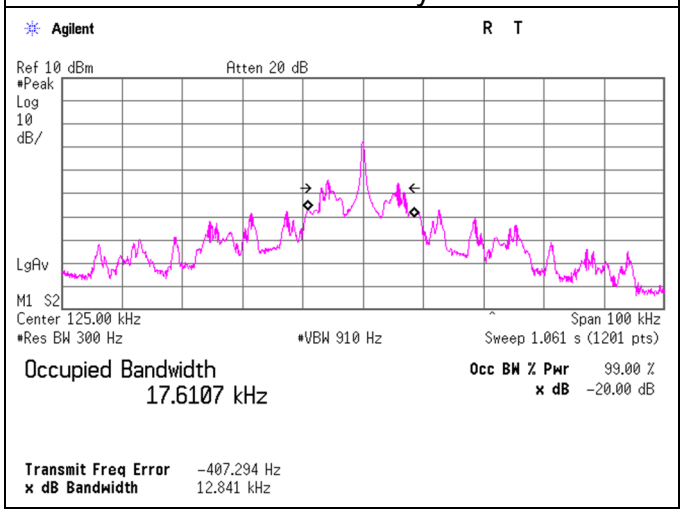
*It was confirmed that there were no differences in the bandwidth due to the input voltage.

-20 dB Bandwidth / 99 % emission bandwidth

Test place	Ise EMC Lab.
Measurement Room	No.4
Date	July 16, 2024
Temperature / Humidity	23 deg. C / 52 % RH
Engineer	Shousei Hamaguchi
Mode	Mode 2

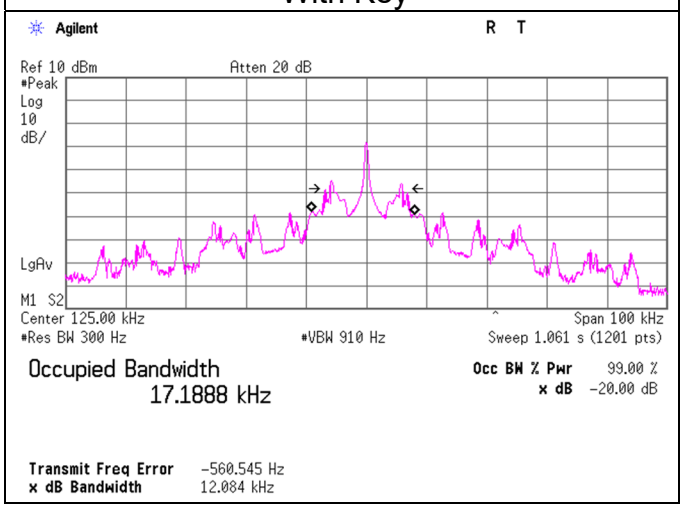
-20 dB Bandwidth [kHz]	99 % emission bandwidth [kHz]
12.841	17.6107

Without Key



-20 dB Bandwidth [kHz]	99 % emission bandwidth [kHz]
12.084	17.1888

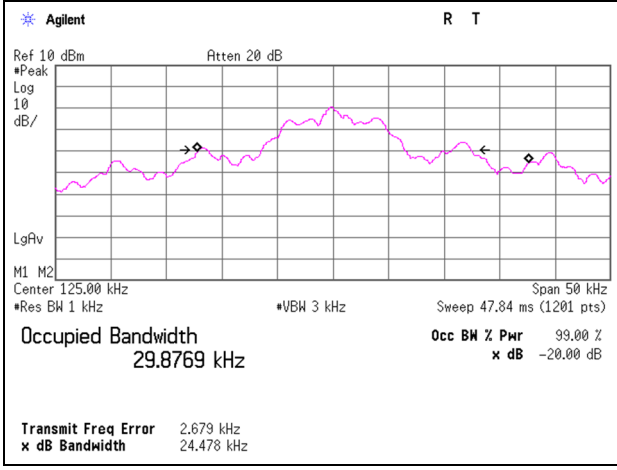
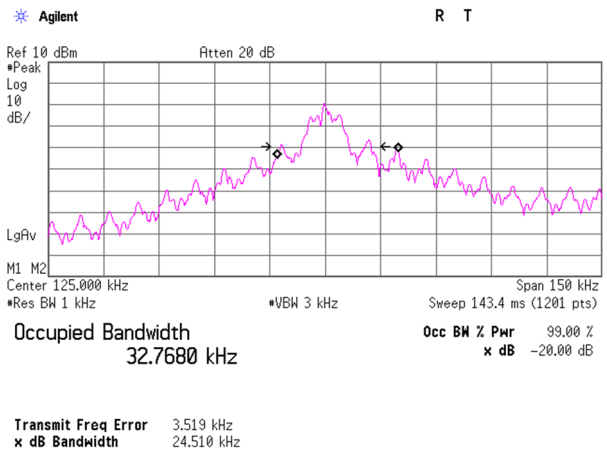
With Key



*It was confirmed that there were no differences in the bandwidth due to the input voltage.

-20 dB Bandwidth / 99 % emission bandwidth

Test place	Ise EMC Lab.
Measurement Room	No.4
Date	July 16, 2024
Temperature / Humidity	23 deg. C / 52 % RH
Engineer	Shousei Hamaguchi
Mode	Mode 3

-20 dB Bandwidth [kHz]	99 % emission bandwidth [kHz]
24.478	32.7680
	

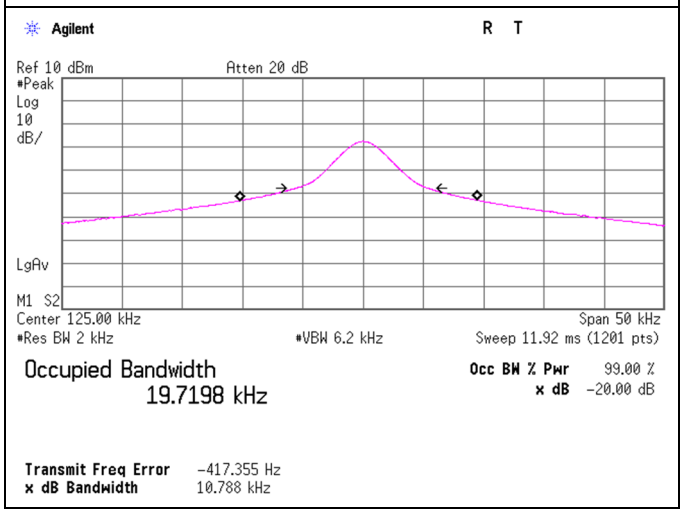
*It was confirmed that there were no differences in the bandwidth due to the input voltage.

-20 dB Bandwidth / 99 % emission bandwidth

Test place	Ise EMC Lab.
Measurement Room	No.4
Date	July 16, 2024
Temperature / Humidity	23 deg. C / 52 % RH
Engineer	Shousei Hamaguchi
Mode	Mode 4

-20 dB Bandwidth [kHz]	99 % emission bandwidth [kHz]
10.788	19.7198

Mode 4



*It was confirmed that there were no differences in the bandwidth due to the input voltage.

Since the transmitter signal is CW-like it is impractical to use a RBW setting of 1 % - 5 % of the emission bandwidth since the emission bandwidth will be proportional to the RBW.

APPENDIX 2: Test instruments

Test Equipment

Test Item	LIMS ID	Description	Manufacturer	Model	Serial	Last Calibration Date	Cal Int
RE	141198	Biconical Antenna	Schwarzbeck Mess-Elektronik OHG	VHA9103+ BBA9106	2513	06/06/2023	12
RE	141213	Attenuator (6dB)	Weinschel Corp	2	BK7971	11/16/2023	12
RE	141215	Coaxial Cable	Fujikura/Suhner/TSJ	5D-2W/3D-2W/ RG400u/ RFM-E421(SW)	-/01068 (Switcher)	06/24/2024	12
RE	141350	Coaxial Cable	Suhner/storm/Agilent/TSJ	-	-	03/05/2024	12
RE	141557	DIGIITAL HiTESTER	HIOKI E.E. CORPORATION	3805	070900530	01/31/2024	12
RE	141583	Pre Amplifier	SONOMA INSTRUMENT	310	260833	04/04/2024	12
RE	141585	Pre Amplifier	L3 Narda-MITEQ	MLA-10K01-B01-35	1237616	02/17/2024	12
RE	141884	Spectrum Analyzer	Keysight Technologies Inc	E4448A	MY44020357	05/09/2024	12
RE	141950	EMI Test Receiver	Rohde & Schwarz	ESU26	100412	11/20/2023	12
RE	142152	Loop Antenna	Rohde & Schwarz	HFH2-Z2	836553/009	10/17/2023	12
RE	142645	Loop Antenna	UL Japan	-	-	-	-
RE	159670	Coaxial Cable	UL Japan	-	-	11/21/2023	12
RE	160924	Logperiodic Antenna	Schwarzbeck Mess-Elektronik OHG	VUSLP9111B	225	11/29/2023	12
RE	244711	Thermo-Hygrometer	HIOKI E.E. CORPORATION	LR5001	231202105	01/25/2024	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