RADIO TEST REPORT

Test Report No. 15200257H-A-R1

Customer	**SUBARU CORPORATION**
Description of EUT	**Keyless Access with Push-Button Start System**
Model Number of EUT	**SU23S-1**
FCC ID	**Y8PSU23S-1**
Test Regulation	**FCC Part 15 Subpart C**
Test Result	**Complied**
Issue Date	**April 23, 2024**
Remarks	**-**

Representative test engineer	Approved by
	
Takafumi Noguchi Engineer	Shinichi Miyazono Engineer

CERTIFICATE 5107.02

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

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REVISION HISTORY

Original Test Report No. 15200257H-A

This report is a revised version of 15200257H-A. 15200257H-A is replaced with this report.

Revision	Test Report No.	Date	Page Revised Contents
- (Original)	15200257H-A	April 16, 2024	-
1	15200257H-A-R1	April 23, 2024	Deletion of the Operating temperature from SECTION 2.2
1	15200257H-A-R1	April 23, 2024	Correction of the Antenna name for Clause 4.1 and 4.2; from “OUTSIDE” to “LUGGAGE”

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	SUBARU CORPORATION
Address	1-1, Subaru-cho, ota-shi, Gunma-ken, 373-8555, Japan
Telephone Number	+81-80-7737-7297
Contact Person	Junichi Motoyama

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	Keyless Access with Push-Button Start System
Model Number	SU23S-1
Serial Number	Refer to SECTION 4.2
Condition	Production prototype (Not for Sale: This sample is equivalent to mass-produced items.)
Modification	No Modification by the test lab
Receipt Date	March 19, 2024
Test Date	March 27, 2024

2.2 Product Description

General Specification

Rating	DC 12.0 V

Radio Specification

[Transmitter]

Radio Type	Transmitter
Frequency of Operation	134.2 kHz
Type of Modulation	OOK (A1D)
Antenna	Antenna (TYPE 1) *1), *3) / (TYPE 2) *2)
Antenna Specification	Ferrite antenna coil
Oscillator frequency	4.2944 MHz (Crystal)

*1) Maximum number of this antenna is 2.
*2) Maximum number of this antenna is 4.
*3) The Antennas (TYPE 1) of this system have variations of model 1 and model 2.
The difference of these variations is only the outer shell, and the test was performed with the representative model 1.

[Receiver]

Radio Type	Receiver
Frequency of Operation	433.92 MHz
Oscillator frequency	30.265 MHz (Crystal)
Intermediate frequency	280 kHz
Type of Modulation	FSK
Type of receiving system	Super-heterodyne
Antenna Type	Internal antenna (Inverted F antenna)
Voltage Controlled Oscillator	1734.540 MHz (Maximum)

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	0.7 dB 134.2 kHz, 0 deg. Peak with Duty factor (Mode 3)	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	12.7 dB 0.67100 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)

This EUT provides stable voltage constantly to RF Module regardless of input voltage.
Therefore, this EUT complies with the requirement.

FCC Part 15.203 Antenna requirement

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

3.3 Addition to standard

Item	Test Procedure	Specification	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

-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

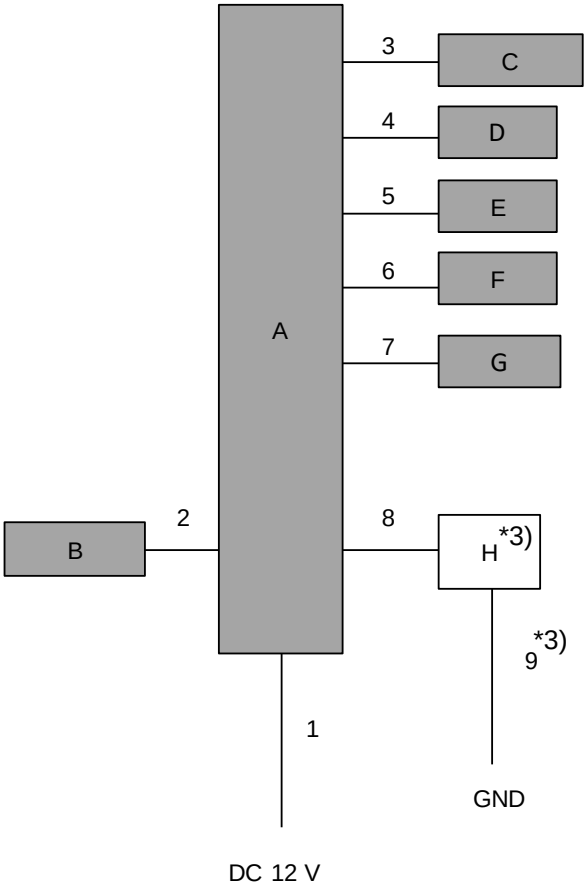
Refer to APPENDIX.

SECTION 4: Operation of EUT during testing

4.1. Operating Mode(s)

Test mode	Remarks
1) Tx 134.2 kHz Antenna (TYPE1)	-
2) Tx 134.2 kHz Antenna (TYPE2 INSIDE)	-
3) Tx 134.2 kHz Antenna (TYPE2 LUGGAGE)	-
4) Tx 134.2 kHz Antenna (TYPE1 (No.1)) + Antenna (TYPE 1 (No.2))	simultaneous transmission
*Power of the EUT was set by the software as follows; Software: SMT_ROMUP_WAVETEST_001 Version: 01 (Date: 2023.09.29, 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.

*This system has two kinds of antenna types.
- Two ports where Antenna (TYPE 1) are connected.
- Four ports where Antenna (3 for TYPE 2 INSIDE and 1 for TYPE 2 LUGGAGE) are connected.
- The difference between INSIDE Antenna and LUGGAGE Antenna is output power only.

The test was performed with each representative one of above three kinds of antenna ports.
* Antenna (Type 1) and Antenna (Type 2) were evaluated with the worst duty respectively.

Worst duty does not change due to the difference in number of connected antennas.

Description of EUT and Support Equipment

No.	Item	Model number	Serial Number	Manufacturer	Remark
A	Keyless Access with Push-Button Start System	SU23S-1	SU23S-1-1 *1) SU23S-1-K1 *2)	SUBARU CORPORATION	EUT
B	Antenna	TYPE1 (No.1)	J2142019	SUBARU CORPORATION	EUT
C	Antenna	TYPE1 (No.2)	J2142008	SUBARU CORPORATION	EUT
D	Antenna	TYPE2 INSIDE (No.1)	D33151 000161	SUBARU CORPORATION	EUT
E	Antenna	TYPE2 INSIDE (No.2)	D33151 000163	SUBARU CORPORATION	EUT
F	Antenna	TYPE2 INSIDE (No.3)	D33151 000164	SUBARU CORPORATION	EUT
G	Antenna	TYPE2 LUGGAGE (No.4)	D33151 000135	SUBARU CORPORATION	EUT
H	Low Frequency & Radio Frequency Bench (TYPE1)	-	No.1	SUBARU CORPORATION	*3)

List of Cables Used

No.	Name	Length (m)	Shield		Remark
			Cable	Connector	
1	DC Cable	3.0	Unshielded	Unshielded	-
2	Antenna Cable	3.0	Unshielded	Unshielded	-
3	Antenna Cable	3.0	Unshielded	Unshielded	-
4	Antenna Cable	3.0	Unshielded	Unshielded	-
5	Antenna Cable	3.0	Unshielded	Unshielded	-
6	Antenna Cable	3.0	Unshielded	Unshielded	-
7	Antenna Cable	3.0	Unshielded	Unshielded	-
8	Signal Cable	3.0	Unshielded	Unshielded	-
9	GND Cable	6.0	Unshielded	Unshielded	*3)

*1) for Mode 1, 2, 3
*2) for Mode 4
*3) Mode 4 excluded

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

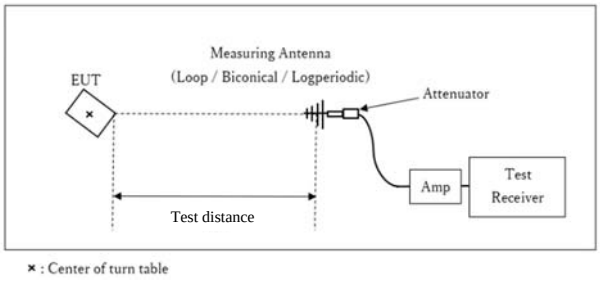
The test was made with the detector (RBW/VBW) in the following table.
When using Spectrum analyzer, the test was made with adjusting span to zero by using peak hold.

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

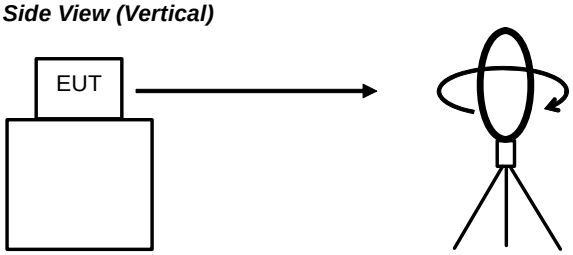
Below 1 GHz



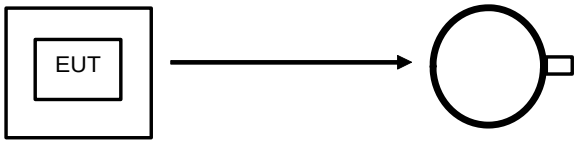
Test Distance: 3 m

Figure 2: Direction of the Loop Antenna

Side View (Vertical)

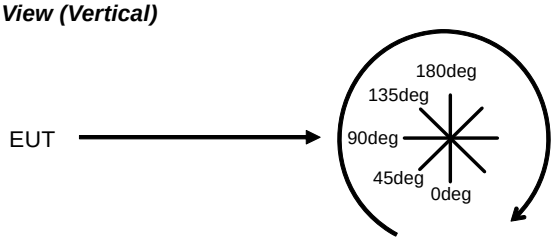


Top View (Horizontal)



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

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

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.3
Date	March 27, 2024
Temperature / Humidity	22 deg. C / 40 % RH
Engineer	Takafumi Noguchi
Mode	Mode 1

PK or QP

Ant Deg [deg] or Polarity [Hori/Vert]	Frequency [MHz]	Detector	Reading [dBuV]	Ant Factor [dB/m]	Loss [dB]	Gain [dB]	Duty Factor [dB]	Result [dBuV/m]	Limit [dBuV/m]	Margin [dB]	Remark
0deg	0.13420	PK	100.7	19.5	-74.1	32.2	-	13.9	45.0	31.1	Fundamental
0deg	0.26840	PK	47.9	19.6	-64.3	32.2	-	-29.0	39.0	68.0	
0deg	0.40260	PK	65.9	19.7	-64.4	32.2	-	-11.0	35.5	46.5	
0deg	0.53680	QP	28.6	19.7	-24.4	32.2	-	-8.3	33.0	41.3	
0deg	0.67100	QP	53.5	19.7	-24.4	32.2	-	16.6	31.1	14.5	
0deg	0.80520	QP	26.5	19.7	-24.3	32.2	-	-10.3	29.5	39.8	
0deg	0.93940	QP	42.4	19.7	-24.3	32.1	-	5.7	28.1	22.4	
0deg	1.07360	QP	22.4	19.7	-24.3	32.1	-	-14.3	26.9	41.2	
0deg	1.20780	QP	32.7	19.7	-24.3	32.1	-	-4.0	25.9	29.9	
0deg	1.34200	QP	22.1	19.7	-24.3	32.1	-	-14.6	25.0	39.6	
Hori.	42.848	QP	22.9	10.9	7.1	32.2	-	8.7	40.0	31.3	
Hori.	45.226	QP	22.6	10.5	7.2	32.2	-	8.1	40.0	31.9	
Hori.	64.265	QP	22.3	9.1	7.5	32.2	-	6.7	40.0	33.3	
Hori.	67.997	QP	28.4	9.0	7.5	32.2	-	12.7	40.0	27.3	
Hori.	85.689	QP	24.1	9.3	7.7	32.2	-	8.9	40.0	31.1	
Hori.	400.000	QP	21.6	15.8	10.3	32.0	-	15.7	46.0	30.3	
Vert.	42.848	QP	35.2	10.9	7.1	32.2	-	21.0	40.0	19.0	
Vert.	45.226	QP	29.0	10.5	7.2	32.2	-	14.5	40.0	25.5	
Vert.	64.265	QP	29.6	9.1	7.5	32.2	-	14.0	40.0	26.0	
Vert.	67.997	QP	31.6	9.0	7.5	32.2	-	15.9	40.0	24.1	
Vert.	85.689	QP	30.0	9.3	7.7	32.2	-	14.8	40.0	25.2	
Vert.	400.000	QP	21.6	15.8	10.3	32.0	-	15.7	46.0	30.3	

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	0.13420	PK	100.7	19.5	-74.1	32.2	0.0	13.9	25.0	***11.1***	Fundamental
0deg	0.26840	PK	47.9	19.6	-64.3	32.2	0.0	-29.0	19.0	48.0	
0deg	0.40260	PK	65.9	19.7	-64.4	32.2	0.0	-11.0	15.5	26.5	

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	0.13420	PK	100.7	19.5	5.9	32.2	-	93.9	-	-	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).

Radiated Emission (Fundamental and Spurious Emission)

Test place	Ise EMC Lab.
Semi Anechoic Chamber	No.3
Date	March 27, 2024
Temperature / Humidity	22 deg. C / 40 % RH
Engineer	Takafumi Noguchi
Mode	Mode 2

PK or QP

Ant Deg [deg] or Polarity [Hori/Vert]	Frequency [MHz]	Detector	Reading [dBuV]	Ant Factor [dB/m]	Loss [dB]	Gain [dB]	Duty Factor [dB]	Result [dBuV/m]	Limit [dBuV/m]	Margin [dB]	Remark
0deg	0.13420	PK	101.6	19.5	-74.1	32.2	-	14.8	45.0	30.2	Fundamental
0deg	0.26840	PK	66.1	19.6	-64.3	32.2	-	-10.8	39.0	49.8	
0deg	0.40260	PK	55.9	19.7	-64.4	32.2	-	-21.0	35.5	56.5	
0deg	0.53680	QP	23.1	19.7	-24.4	32.2	-	-13.8	33.0	46.8	
0deg	0.67100	QP	33.6	19.7	-24.4	32.2	-	-3.3	31.1	34.4	
0deg	0.80520	QP	22.2	19.7	-24.3	32.2	-	-14.6	29.5	44.1	
0deg	0.93940	QP	37.0	19.7	-24.3	32.2	-	0.2	28.1	27.9	
0deg	1.07360	QP	21.9	19.7	-24.3	32.2	-	-14.9	26.9	41.8	
0deg	1.20780	QP	33.4	19.7	-24.3	32.2	-	-3.4	25.9	29.3	
0deg	1.34200	QP	21.9	19.7	-24.3	32.2	-	-14.9	25.0	39.9	
Hori.	42.848	QP	22.8	10.9	7.1	32.2	-	8.6	40.0	31.4	
Hori.	45.226	QP	22.6	10.5	7.2	32.2	-	8.1	40.0	31.9	
Hori.	64.265	QP	22.4	9.1	7.5	32.2	-	6.8	40.0	33.2	
Hori.	67.997	QP	27.1	9.0	7.5	32.2	-	11.4	40.0	28.6	
Hori.	85.689	QP	23.9	9.3	7.7	32.2	-	8.7	40.0	31.3	
Hori.	400.000	QP	21.6	15.8	10.3	32.0	-	15.7	46.0	30.3	
Vert.	42.848	QP	34.4	10.9	7.1	32.2	-	20.2	40.0	19.8	
Vert.	45.226	QP	30.0	10.5	7.2	32.2	-	15.5	40.0	24.5	
Vert.	64.265	QP	28.3	9.1	7.5	32.2	-	12.7	40.0	27.3	
Vert.	67.997	QP	31.2	9.0	7.5	32.2	-	15.5	40.0	24.5	
Vert.	85.689	QP	30.0	9.3	7.7	32.2	-	14.8	40.0	25.2	
Vert.	400.000	QP	21.6	15.8	10.3	32.0	-	15.7	46.0	30.3	

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	0.13420	PK	101.6	19.5	-74.1	32.2	0.0	14.8	25.0	***10.2***	Fundamental
0deg	0.26840	PK	66.1	19.6	-64.3	32.2	0.0	-10.8	19.0	29.8	
0deg	0.40260	PK	55.9	19.7	-64.4	32.2	0.0	-21.0	15.5	36.5	

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	0.13420	PK	101.6	19.5	5.9	32.2	-	94.8	-	-	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).

Radiated Emission (Fundamental and Spurious Emission)

Test place	Ise EMC Lab.
Semi Anechoic Chamber	No.3
Date	March 27, 2024
Temperature / Humidity	22 deg. C / 40 % RH
Engineer	Takafumi Noguchi
Mode	Mode 3

PK or QP

Ant Deg [deg] or Polarity [Hori/Vert]	Frequency [MHz]	Detector	Reading [dBuV]	Ant Factor [dB/m]	Loss [dB]	Gain [dB]	Duty Factor [dB]	Result [dBuV/m]	Limit [dBuV/m]	Margin [dB]	Remark
0deg	0.13420	PK	111.1	19.5	-74.1	32.2	-	24.3	45.0	20.7	Fundamental
0deg	0.26840	PK	66.4	19.6	-64.3	32.2	-	-10.5	39.0	49.5	
0deg	0.40260	PK	56.4	19.7	-64.4	32.2	-	-20.5	35.5	56.0	
0deg	0.53680	QP	23.9	19.7	-24.4	32.2	-	-13.0	33.0	46.0	
0deg	0.67100	QP	44.3	19.7	-24.4	32.2	-	7.4	31.1	23.7	
0deg	0.80520	QP	22.2	19.7	-24.3	32.2	-	-14.6	29.5	44.1	
0deg	0.93940	QP	41.9	19.7	-24.3	32.2	-	5.1	28.1	23.0	
0deg	1.07360	QP	22.0	19.7	-24.3	32.2	-	-14.8	26.9	41.7	
0deg	1.20780	QP	38.8	19.7	-24.3	32.2	-	2.0	25.9	23.9	
0deg	1.34200	QP	21.9	19.7	-24.3	32.2	-	-14.9	25.0	39.9	
Hori.	42.848	QP	22.8	10.9	7.1	32.2	-	8.6	40.0	31.4	
Hori.	45.226	QP	22.7	10.5	7.2	32.2	-	8.2	40.0	31.8	
Hori.	64.265	QP	22.4	9.1	7.5	32.2	-	6.8	40.0	33.2	
Hori.	67.997	QP	26.9	9.0	7.5	32.2	-	11.2	40.0	28.8	
Hori.	85.689	QP	24.0	9.3	7.7	32.2	-	8.8	40.0	31.2	
Hori.	400.000	QP	21.6	15.8	10.3	32.0	-	15.7	46.0	30.3	
Vert.	42.848	QP	34.4	10.9	7.1	32.2	-	20.2	40.0	19.8	
Vert.	45.226	QP	29.8	10.5	7.2	32.2	-	15.3	40.0	24.7	
Vert.	64.265	QP	29.6	9.1	7.5	32.2	-	14.0	40.0	26.0	
Vert.	67.997	QP	29.2	9.0	7.5	32.2	-	13.5	40.0	26.5	
Vert.	85.689	QP	29.7	9.3	7.7	32.2	-	14.5	40.0	25.5	
Vert.	400.000	QP	21.6	15.8	10.3	32.0	-	15.7	46.0	30.3	

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	0.13420	PK	111.1	19.5	-74.1	32.2	0.0	24.3	25.0	***0.7***	Fundamental
0deg	0.26840	PK	66.4	19.6	-64.3	32.2	0.0	-10.5	19.0	29.5	
0deg	0.40260	PK	56.4	19.7	-64.4	32.2	0.0	-20.5	15.5	36.0	

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

Result of the fundamental emission at 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	0.13420	PK	111.1	19.5	5.9	32.2	-	104.3	-	-	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).

Radiated Emission (Fundamental and Spurious Emission)

Test place	Ise EMC Lab.
Semi Anechoic Chamber	No.3
Date	March 27, 2024
Temperature / Humidity	22 deg. C / 40 % RH
Engineer	Takafumi Noguchi
Mode	Mode 4

PK or QP

Ant Deg [deg] or Polarity [Hori/Vert]	Frequency [MHz]	Detector	Reading [dBuV]	Ant Factor [dB/m]	Loss [dB]	Gain [dB]	Duty Factor [dB]	Result [dBuV/m]	Limit [dBuV/m]	Margin [dB]	Remark
0deg	0.13420	PK	100.9	19.5	-74.1	32.2	-	14.1	45.0	30.9	Fundamental
0deg	0.26840	PK	53.4	19.6	-64.3	32.2	-	-23.5	39.0	62.5	
0deg	0.40260	PK	71.7	19.7	-64.4	32.2	-	-5.2	35.5	40.7	
0deg	0.53680	QP	32.8	19.7	-24.4	32.2	-	-4.1	33.0	37.1	
0deg	0.67100	QP	55.3	19.7	-24.4	32.2	-	18.4	31.1	12.7	
0deg	0.80520	QP	29.7	19.7	-24.3	32.2	-	-7.1	29.5	36.6	
0deg	0.93940	QP	44.3	19.7	-24.3	32.2	-	7.5	28.1	20.6	
0deg	1.07360	QP	22.2	19.7	-24.3	32.2	-	-14.6	26.9	41.5	
0deg	1.20780	QP	34.7	19.7	-24.3	32.2	-	-2.1	25.9	28.0	
0deg	1.34200	QP	22.1	19.7	-24.3	32.2	-	-14.7	25.0	39.7	
Hori.	40.399	QP	22.6	11.3	7.1	32.2	-	8.8	40.0	31.2	
Hori.	41.596	QP	22.8	11.1	7.1	32.2	-	8.8	40.0	31.2	
Hori.	42.761	QP	22.5	10.9	7.1	32.2	-	8.3	40.0	31.7	
Hori.	54.651	QP	22.4	9.5	7.3	32.2	-	7.0	40.0	33.0	
Hori.	129.504	QP	22.2	11.4	8.2	32.1	-	9.7	43.5	33.8	
Hori.	400.000	QP	21.6	15.8	10.3	32.0	-	15.7	46.0	30.3	
Vert.	40.399	QP	27.6	11.3	7.1	32.2	-	13.8	40.0	26.2	
Vert.	41.596	QP	24.2	11.1	7.1	32.2	-	10.2	40.0	29.8	
Vert.	42.761	QP	29.3	10.9	7.1	32.2	-	15.1	40.0	24.9	
Vert.	54.651	QP	28.7	9.5	7.3	32.2	-	13.3	40.0	26.7	
Vert.	129.504	QP	26.1	11.4	8.2	32.1	-	13.6	43.5	29.9	
Vert.	400.000	QP	21.6	15.8	10.3	32.0	-	15.7	46.0	30.3	

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	0.13420	PK	100.9	19.5	-74.1	32.2	0.0	14.1	25.0	***10.9***	Fundamental
0deg	0.26840	PK	53.4	19.6	-64.3	32.2	0.0	-23.5	19.0	42.5	
0deg	0.40260	PK	71.7	19.7	-64.4	32.2	0.0	-5.2	15.5	20.7	

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

Result of the fundamental emission at 3 m without Distance factor

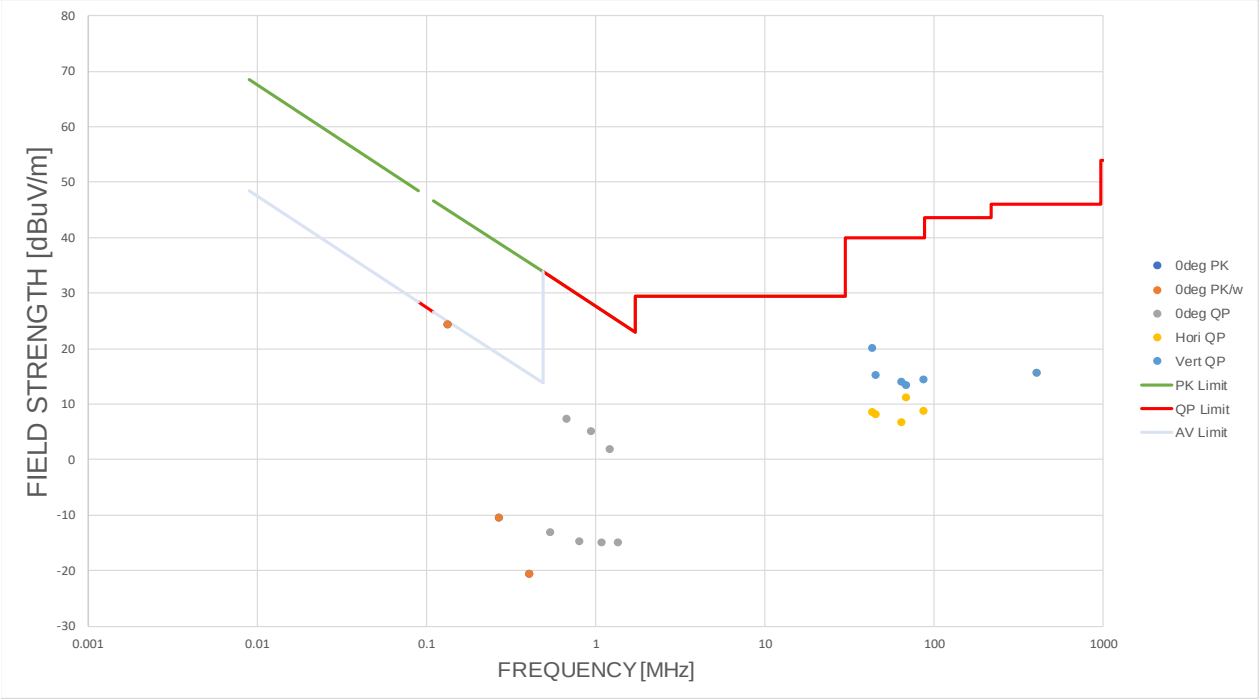
Ant Deg [deg]	Frequency [MHz]	Detector	Reading [dBuV]	Ant Factor [dB/m]	Loss [dB]	Gain [dB]	Duty Factor [dB]	Result [dBuV/m]	Limit [dBuV/m]	Margin [dB]	Remark
0deg	0.13420	PK	100.9	19.5	5.9	32.2	-	94.1	-	-	Fundamental

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).

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

Test place	Ise EMC Lab.
Semi Anechoic Chamber	No.3
Date	March 27, 2024
Temperature / Humidity	22 deg. C / 40 % RH
Engineer	Takafumi Noguchi
Mode	Mode 3

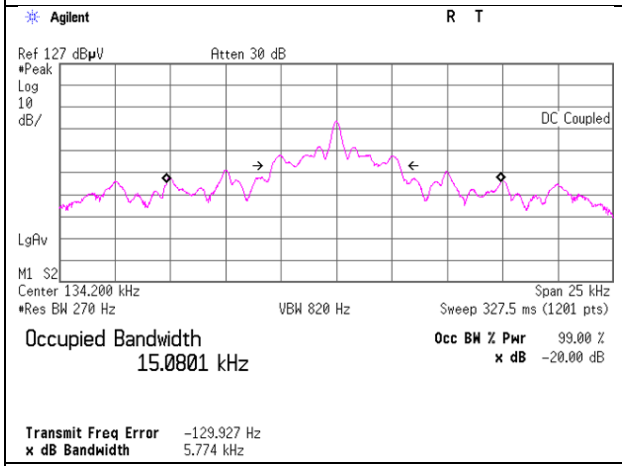


-20 dB Bandwidth / 99 % emission bandwidth

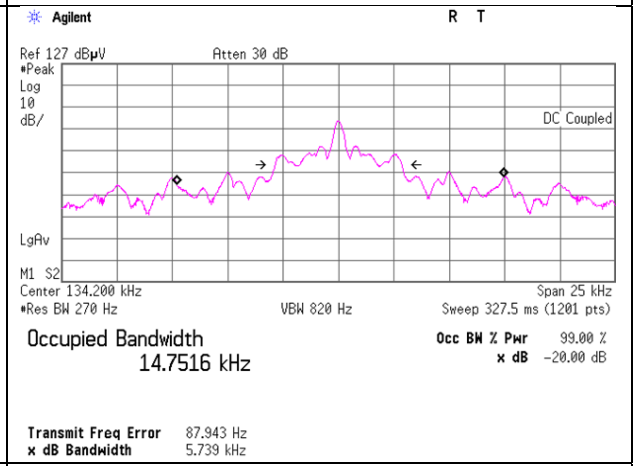
Test place	Ise EMC Lab.
Semi Anechoic Chamber	No.3
Date	March 27, 2024
Temperature / Humidity	22 deg. C / 40 % RH
Engineer	Takafumi Noguchi
Mode	Tx

Mode	-20 dB Bandwidth [kHz]	99 % emission bandwidth [kHz]
1	5.774	15.0801
2	5.739	14.7516
3	5.723	12.4247
4	10.282	22.2038

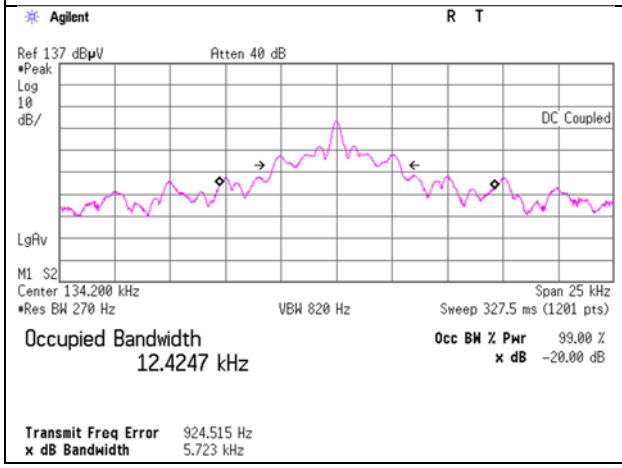
Mode 1



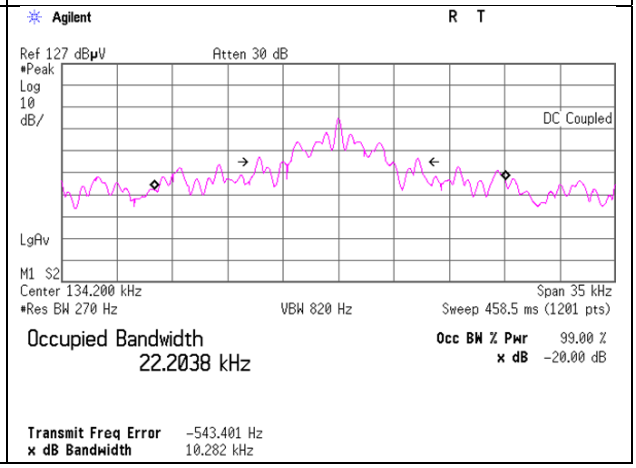
Mode 2



Mode 3



Mode 4



APPENDIX 2: Test instruments

Test Equipment

Test Item	LIMS ID	Description	Manufacturer	Model	Serial	Last Calibration Date	Cal Int
RE	141216	Coaxial cable	Fujikura/Suhner/TSJ	5D-2W/SFM14/ sucoform141-PE/ 421-010/RFM-E321(SW)	-/00640	07/25/2023	12
RE	141266	Logperiodic Antenna (200-1000MHz)	Schwarzbeck Mess-Elektronik OHG	VUSLP9111B	9111B-191	08/10/2023	12
RE	141295	High Pass Filter 0.15-30MHz	Rohde & Schwarz	EZ-25/3	100041	02/14/2024	12
RE	141323	Coaxial cable	UL Japan	-	-	09/10/2023	12
RE	141532	DIGITAL HiTESTER	HIOKI E.E. CORPORATION	3805	051201197	01/31/2024	12
RE	141582	Pre Amplifier	SONOMA INSTRUMENT	310	260834	02/17/2024	12
RE	141902	Spectrum Analyzer	Keysight Technologies Inc	E4440A	MY46187105	05/23/2023	12
RE	141951	EMI Test Receiver	Rohde & Schwarz	ESR26	101408	04/10/2023	12
RE	142008	AC3_Semi Anechoic Chamber(NSA)	TDK	Semi Anechoic Chamber 3m	DA-10005	12/11/2023	24
RE	142152	Loop Antenna	Rohde & Schwarz	HFH2-Z2	836553/009	10/17/2023	12
RE	142183	Measure	KOMELON	KMC-36	-	10/20/2023	12
RE	142314	Attenuator	Pasternack Enterprises	PE7390-6	D/C 1504	06/23/2023	12
RE	159670	Coaxial Cable	UL Japan	-	-	11/21/2023	12
RE	178648	EMI measurement program	TSJ (Techno Science Japan)	TEPTO-DV	-	-	-
RE	197990	Biconical Antenna	Schwarzbeck Mess-Elektronik OHG	VHBB 9124 + BBA 9106	01365	11/29/2023	12
RE	244709	Thermo-Hygrometer	HIOKI E.E. CORPORATION	LR5001	231202103	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