RADIO TEST REPORT

Test Report No. 15477512H-A-R1

Customer	**Roland Corporation**
Description of EUT	**Wireless Transmitter**
Model Number of EUT	**WL-60T(2)**
FCC ID	**SOP421721B**
Test Regulation	**FCC Part 15 Subpart C**
Test Result	**Complied**
Issue Date	**December 4, 2024**
Remarks	**-**

Representative Test Engineer	Approved By
Takumi Nishida Engineer	Takumi Shimada 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".

UL Japan, Inc. Ise EMC Lab.
4383-326 Asama-cho, Ise-shi, Mie-ken 516-0021 Japan / +81-596-24-8999

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REVISION HISTORY

Original Test Report No.: 15477512H-A

This report is a revised version of 15477512H-A. 15477512H-A is replaced with this report.

Revision	Test Report No.	Date	Page Revised Contents
- (Original)	15477512H-A	November 15, 2024	-
1	15477512H-A-R1	December 4, 2024	APPENDIX 2: Test Instruments Deleted LIMS ID: 142011.

Reference: Abbreviations (Including words undescribed in this report)

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

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SECTION 1: Customer Information

Company Name	Roland Corporation
Address	1-5-3 Shinmiyakoda, Hamana-ku, Hamamatsu, Shizuoka 431-1304 Japan
Telephone Number	+81-53-428-5101
Contact Person	Hideaki Koyama

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	Wireless Transmitter
Model Number	WL-60T(2)
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	September 20, 2024
Test Date	September 24 to October 7, 2024

2.2 Product Description

General Specificatio

Rating	DC 3.0 V
Operating temperature	0 deg. C to 40 deg. C

Radio Specification

Equipment Type	Transmitter
Frequency of Operation	2402 MHz to 2478 MHz
Type of Modulation	GFSK
Antenna Gain	-0.19 dBi

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 47 CFR Part 15 Radio Frequency Device Subpart C Intentional Radiators Section 15.207 Conducted limits Section 15.247 Operation within the bands 902-928 MHz, 2400-2483.5 MHz, and 5725-5850 MHz

*The customer has declared that the EUT has complies with FCC Part 15 Subpart B as SDoC.

3.2 Procedures and Results

Item	Test Procedure	Specification	Worst Margin	Results	Remarks
Conducted Emission	**FCC:** ANSI C63.10-2013 6. Standard test methods	**FCC:** Section 15.207	-	N/A	*1)
	ISED: RSS-Gen 8.8	**ISED:** RSS-Gen 8.8			
6dB Bandwidth	**FCC:** KDB 558074 D01 15.247 Meas Guidance v05r02	**FCC:** Section 15.247(a)(2)	See data.	Complied	Conducted
	ISED: -	**ISED:** RSS-247 5.2(a)			
Maximum Peak Output Power	**FCC:** KDB 558074 D01 15.247 Meas Guidance v05r02	**FCC:** Section 15.247(b)(3)		Complied	Conducted
	ISED: RSS-Gen 6.12	**ISED:** RSS-247 5.4(d)			
Power Density	**FCC:** KDB 558074 D01 15.247 Meas Guidance v05r02	**FCC:** Section 15.247(e)		Complied	Conducted
	ISED: -	**ISED:** RSS-247 5.2(b)			
Spurious Emission Restricted Band Edges	**FCC:** KDB 558074 D01 15.247 Meas Guidance v05r02	**FCC:** Section15.247(d)	7.5 dB 2350.1 MHz, AV, Horizontal	Complied	Conducted (below 30 MHz)/ Radiated (above 30 MHz) *2)
	ISED: RSS-Gen 6.13	**ISED:** RSS-247 5.5 RSS-Gen 8.9 RSS-Gen 8.10			

Note: UL Japan, Inc.'s EMI Work Procedures: Work Instructions-ULID-003591 and Work Instructions-ULID-003593.
* In case any questions arise about test procedure, ANSI C63.10: 2013 is also referred.
*1) The test is not applicable since the EUT is a battery operated device.
*2) Radiated test was selected over 30 MHz based on section 15.247(d) and KDB 558074 D01 15.247 Meas Guidance v05r02 8.5 and 8.6.

FCC Part 15.31 (e)

The test was performed with the New Battery and the stable voltage was supplied to the EUT during the tests. 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 EUT. 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% Occupied Bandwidth	**ISED:** RSS-Gen 6.7	**ISED:** -	N/A	-	Conducted

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	5.1
	6 GHz to 18 GHz		dB	5.4
1 m	10 GHz to 18 GHz		dB	5.4
	18 GHz to 26.5 GHz		dB	5.3
	26.5 GHz to 40 GHz		dB	4.8
0.5 m	26.5 GHz to 40 GHz		dB	5.0

Antenna Terminal Conducted

Item	Unit	Calculated Uncertainty (+/-)
Antenna terminated conducted emission / Power density / Burst power	dB	3.47
Adjacent channel power (ACP)	dB	2.28
Bandwidth (OBW)	%	0.96
Time readout (time span upto 100 msec)	%	0.11
Time readout (time span upto 1000 msec)	%	0.11
Time readout (time span upto 60 sec)	%	0.02
Power measurement (Power meter < 8 GHz)	dB	1.46
Power measurement (Call box < 6 GHz)	dB	1.69
Frequency readout (Frequency counter)	ppm	0.67
Frequency readout (Spectrum analyzer frequency readout function)	ppm	2.13
Temperature (constant temperature bath)	deg. C	0.69
Humidity (constant temperature bath)	%RH	2.98
Modulation characteristics	%	6.93
Frequency for mobile	ppm	0.08
Contention-based protocol	dB	2.26

3.5 Test Location

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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

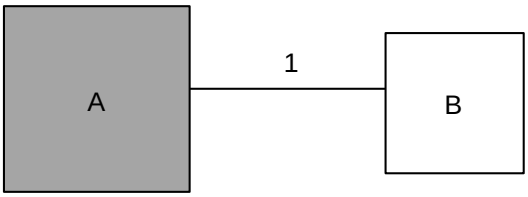
4.1 Operating Mode(s)

Mode	Remarks*
Tx GFSK	PN9
*The worst condition was determined based on the test result of Maximum Peak Output Power (Mid Channel)	
*Power of the EUT was set by the software as follows; Power Setting: -8 dBm Software: _rom_img_bg749_N8_2 (Date: July 30, 2024, 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.	

*The Details of Operating Mode(s)

Test Item	Operating Mode	Tested Frequency
Radiated Spurious Emission (Below 1 GHz)	Tx GFSK	2478 MHz *1)
99% Occupied Bandwidth, 6dB Bandwidth, Maximum Peak Output Power, Radiated Spurious Emission (Above 1 GHz), Conducted Spurious Emission, Power Density	Tx GFSK	2402 MHz 2442 MHz 2478 MHz
*1) The Frequency was tested as a representative, because it had the highest power at antenna terminal test.		

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	Remarks
A	Wireless Transmitter	WL-60T(2)	11 (For RE*) 3 (For AT*)	Roland Corporation	EUT
B	iPod touch	PVHW2J/A	F0THN24DM93D	Apple	-

List of Cables Used

No.	Name	Length (m)	Shield		Remarks
			Cable	Connector	
1	Audio Cable	0.8	Shielded	Shielded	-

*AT: Antenna Terminal Conducted test, RE: Radiated Emission

SECTION 5: Radiated Spurious Emission

Test Procedure

It was measured based on "8.5 and 8.6 of KDB 558074 D01 15.247 Meas Guidance v05r02".

[For below 1 GHz]
EUT was placed on a urethane platform of nominal size, 0.5 m by 1.0 m, raised 0.8 m above the conducting ground plane. The Radiated Electric Field Strength has been measured in a Semi Anechoic Chamber with a ground plane.

[For above 1 GHz]
EUT was placed on a urethane platform of nominal size, 0.5 m by 0.5 m, raised 1.5 m above the conducting ground plane. The Radiated Electric Field Strength has been measured in a Semi Anechoic Chamber with absorbent materials lined on a ground plane. Test antenna was aimed at the EUT for receiving the maximum signal and always kept within the illumination area of the 3 dB beamwidth of the antenna.

The height of the measuring antenna varied between 1 m and 4 m and EUT was rotated a full revolution in order to obtain the maximum value of the electric field strength.
The measurements were performed for both vertical and horizontal antenna polarization with the Test Receiver, or the Spectrum Analyzer.
The measurements were made with the following detector function of the test receiver and the Spectrum analyzer (in linear mode).
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	30 MHz to 200 MHz	200 MHz to 1 GHz	Above 1 GHz
Antenna Type	Biconical	Logperiodic	Horn

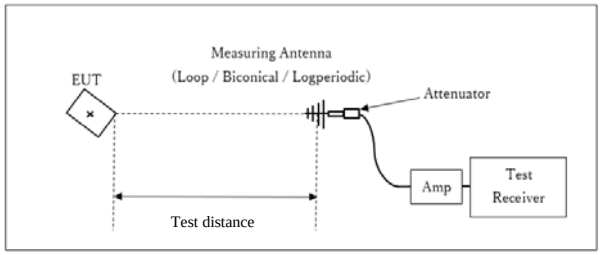
In any 100 kHz bandwidth outside the restricted band in which the spread spectrum intentional radiator is operating, the radio frequency power that is produced by the intentional radiator confirmed 20 dB below that in the 100 kHz bandwidth within the band that contains the highest level of the desired power, based on a radiated measurement.

20 dBc was applied to the frequency over the limit of FCC 15.209 / Table 4 of RSS-Gen 8.9(ISED) and outside the restricted band of FCC15.205 / Table 6 of RSS-Gen 8.10 (ISED).

Frequency	Below 1 GHz	Above 1 GHz		20 dBc
Instrument Used	Test Receiver	Spectrum Analyzer		Spectrum Analyzer
Detector	QP	PK	AV	PK
IF Bandwidth	BW 120 kHz	RBW: 1 MHz VBW: 3 MHz	11.12.2.5.1 RBW: 1 MHz VBW: 3 MHz Detector: Power Averaging (RMS) Trace: 100 traces 11.12.2.5.2 The duty cycle was less than 98% for detected noise, a duty factor was added to the 11.12.2.5.1 results.	RBW: 100 kHz VBW: 300 kHz

Figure 2: Test Setup

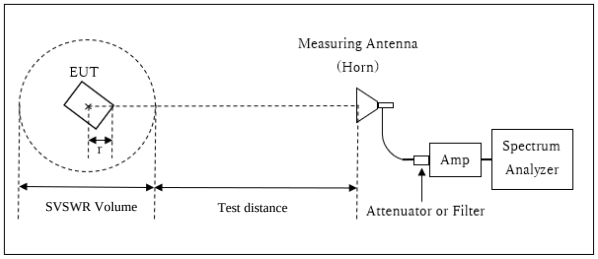
Below 1 GHz



× : Center of turn table

Test Distance: 3 m

1 GHz to 10 GHz



r : Radius of an outer periphery of EUT
× : Center of turn table

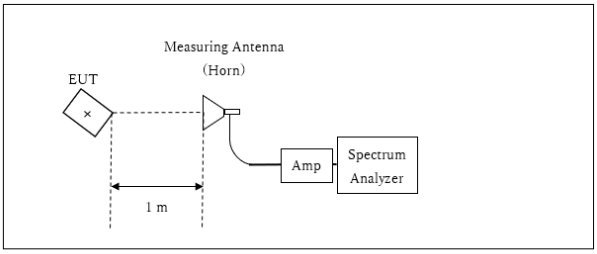
[1 GHz to 6 GHz]
Distance Factor: 20 x log (3.95 m* / 3.0 m) = 2.39 dB
*(Test Distance + SVSWR Volume /2) - r = 3.95 m

Test Distance: 3 m
SVSWR Volume: 2 m
(SVSWR Volume has been calibrated based on CISPR 16-1-4.)
r: 0.05 m

[6 GHz to 10 GHz]
Distance Factor: 20 x log (4.95 m* / 3.0 m) = 4.35 dB
*(Test Distance + SVSWR Volume /2) - r = 4.95 m

Test Distance: 4.3 m
SVSWR Volume: 1.4 m
(SVSWR Volume has been calibrated based on CISPR 16-1-4.)
r: 0.05 m

10 GHz to 26.5 GHz



× : Center of turn table

Distance Factor: 20 x log (1.0 m / 3.0 m) = -9.5 dB
*Test Distance: 1 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.

Test results are rounded off and limit are rounded down, so some differences might be observed.

Measurement Range : 30 MHz to 26.5 GHz
Test Data : APPENDIX
Test Result : Pass

SECTION 6: Antenna Terminal Conducted Tests

Test Procedure

The tests were made with below setting connected to the antenna port.

Test	Span	RBW	VBW	Sweep time	Detector	Trace	Instrument Used
6dB Bandwidth	3 MHz	100 kHz	300 kHz	Auto	Peak	Max Hold	Spectrum Analyzer
99% Occupied Bandwidth *1)	Enough width to display emission skirts	1 to 5 % of OBW	Three times of RBW	Auto	Peak	Max Hold	Spectrum Analyzer
Maximum Peak Output Power	-	-	-	Auto	Peak/ Average *2)	-	Power Meter (Sensor: 50 MHz BW)
Peak Power Density	1.5 times the 6dB Bandwidth	3 kHz	10 kHz	Auto	Peak	Max Hold	Spectrum Analyzer *3)
Conducted Spurious Emission *4) *5)	9 kHz to 150 kHz	200 Hz	620 Hz	Auto	Peak	Max Hold	Spectrum Analyzer
	150 kHz to 30 MHz	10 kHz	30 kHz				

*1) Peak hold was applied as Worst-case measurement.
*2) Reference data
*3) Section 11.10.2 Method PKPSD (peak PSD) of "ANSI C63.10-2013".
*4) In the frequency range below 30MHz, RBW was narrowed to separate the noise contents.
Then, wide-band noise near the limit was checked separately, however the noise was not detected as shown in the chart.
(9 kHz - 150 kHz: RBW = 200 Hz, 150 kHz - 30 MHz: RBW = 10 kHz)
*5) The limits in CFR 47, Part 15, Subpart C, paragraph 15.209(a), are identical to those in RSS-Gen section 8.9, Table 6, since the measurements are performed in terms of magnetic field strength and converted to electric field strength levels (as reported in the table) using the free space impedance of 377 Ohmes. For example, the measurement at frequency 9 kHz resulted in a level of 45.5 dBuV/m, which is equivalent to 45.5 - 51.5 = -6.0 dBuA/m, which has the same margin, 3 dB, to the corresponding RSS-Gen Table 6 limit as it has to 15.209(a) limit.

Test results are rounded off and limit are rounded down, so some differences might be observed.
The equipment and cables were not used for factor 0 dB of the data sheets.

Test Data : APPENDIX
Test Result : Pass

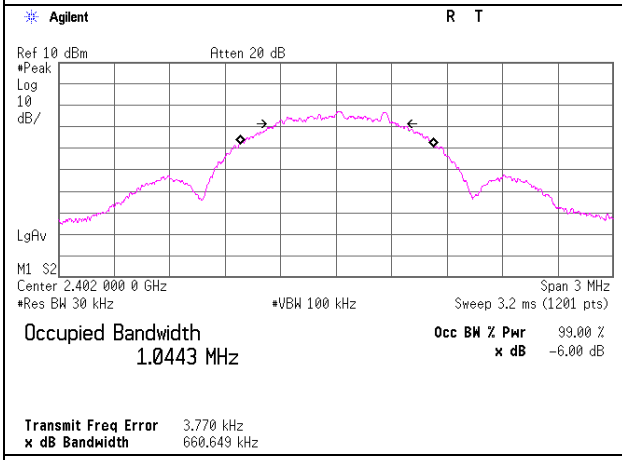
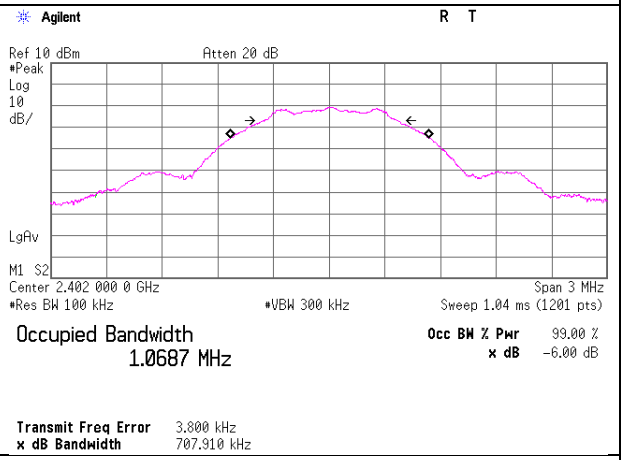
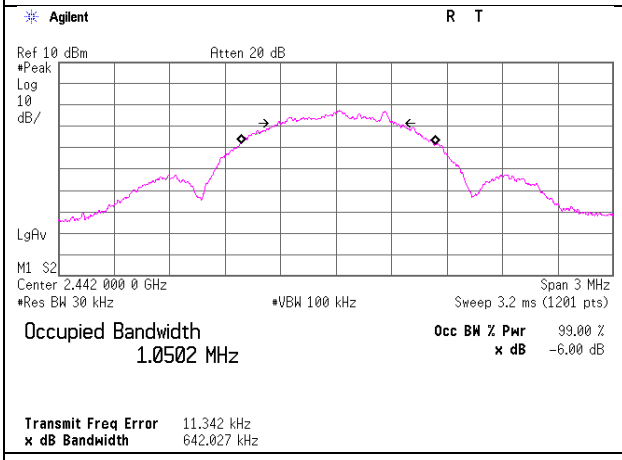
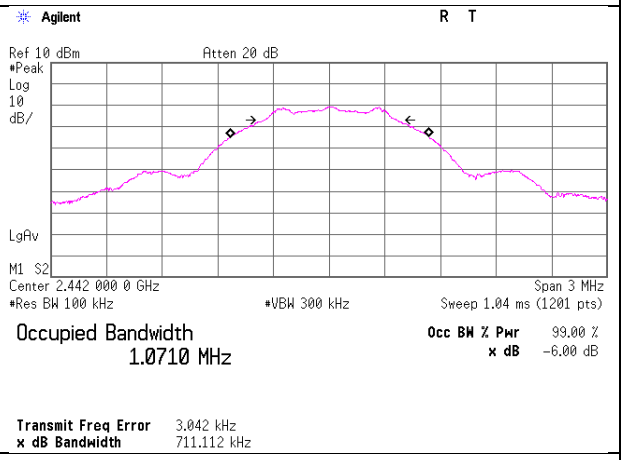
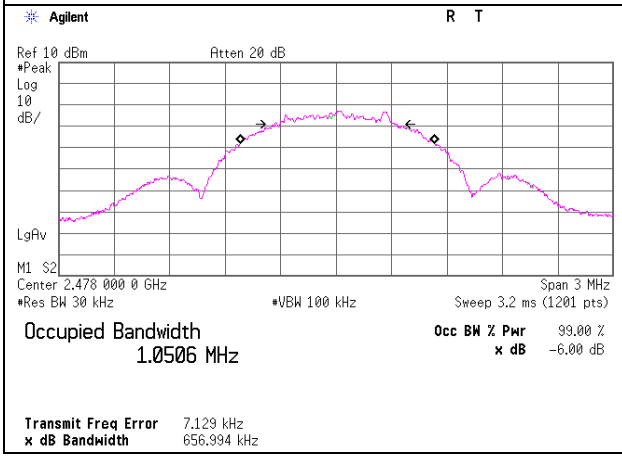
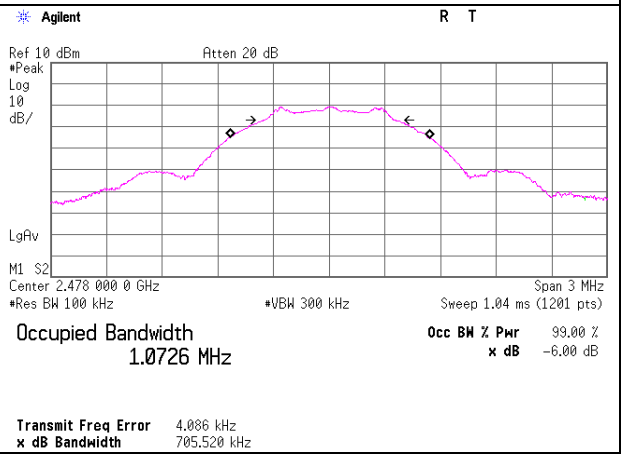
APPENDIX 1: Test Data

99 % Occupied Bandwidth and 6 dB Bandwidth

Test place	Ise EMC Lab. No.4 Measurement Room
Date	September 24, 2024
Temperature / Humidity	23 deg. C / 55 % RH
Engineer	Takumi Nishida
Mode	Tx

Frequency [MHz]	99% Occupied Bandwidth [kHz]	6dB Bandwidth [MHz]	Limit for 6dB Bandwidth [MHz]
2402	1044.3	0.708	> 0.5000
2442	1050.2	0.711	> 0.5000
2478	***1050.6***	0.706	> 0.5000

99 % Occupied Bandwidth and 6 dB Bandwidth

99 % Occupied Bandwidth	6 dB Bandwidth
2402 MHz	**2402 MHz**
	
2442 MHz	**2442 MHz**
	
2478 MHz	**2478 MHz**
	

Maximum Peak Output Power

Test place	Ise EMC Lab. No.4 Measurement Room
Date	September 24, 2024
Temperature / Humidity	23 deg. C / 55 % RH
Engineer	Takumi Nishida
Mode	Tx

				Conducted Power					e.i.r.p. for RSS-247					
Freq.	Reading	Cable Loss	Atten. Loss	Result		Limit		Margin	Antenna Gain	Result		Limit		Margin
[MHz]	[dBm]	[dB]	[dB]	[dBm]	[mW]	[dBm]	[mW]	[dB]	[dBi]	[dBm]	[mW]	[dBm]	[mW]	[dB]
2402	-10.48	1.45	9.73	0.70	1.17	30.00	1000	29.31	-0.19	0.51	1.12	36.02	4000	35.52
2442	-10.38	1.48	9.73	0.83	1.21	30.00	1000	29.17	-0.19	0.64	1.16	36.02	4000	35.38
2478	-10.37	1.50	9.73	***0.86***	***1.22***	30.00	1000	29.14	-0.19	***0.67***	***1.17***	36.02	4000	35.35

Sample Calculation:
Result = Reading + Cable Loss (including the cable(s) customer supplied) + Attenuator Loss
e.i.r.p. Result = Conducted Power Result + Antenna Gain
*The equipment and cables were not used for factor 0 dB of the data sheets.

Average Output Power
(Reference data for RF Exposure)

Test place	Ise EMC Lab. No.4 Measurement Room
Date	September 24, 2024
Temperature / Humidity	23 deg. C / 55 % RH
Engineer	Takumi Nishida
Mode	Tx

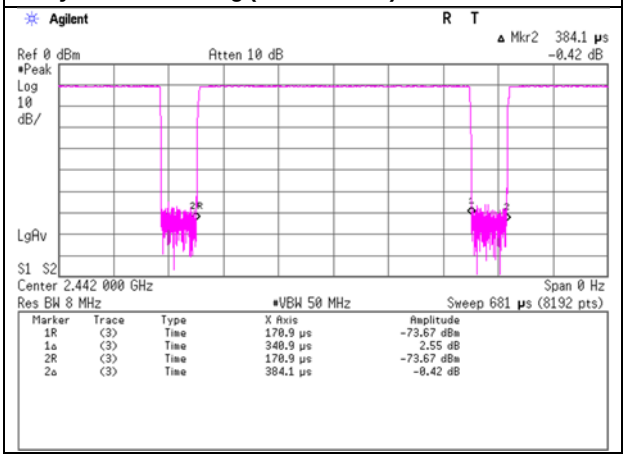
Freq.	Reading	Cable Loss	Atten. Loss	Result (Time average)		Duty factor	Result (Burst power average)	
[MHz]	[dBm]	[dB]	[dB]	[dBm]	[mW]	[dB]	[dBm]	[mW]
2402	-11.21	1.45	9.73	-0.03	0.99	0.52	0.49	1.12
2442	-11.12	1.48	9.73	0.09	1.02	0.52	0.61	1.15
2478	-11.10	1.50	9.73	***0.13***	***1.03***	0.52	***0.65***	***1.16***

Sample Calculation:
Result (Time average) = Reading + Cable Loss (including the cable(s) customer supplied) + Attenuator Loss
Result (Burst power average) = Time average + Duty factor

Burst rate confirmation

Test place	Ise EMC Lab. No.4 Measurement Room
Date	September 24, 2024
Temperature / Humidity	23 deg. C / 55 % RH
Engineer	Takumi Nishida
Mode	Tx

Tx on / (Tx on + Tx off) =	**0.888**
Tx on / (Tx on + Tx off) * 100 =	**88.8 %**
Duty factor = 10 * log (384.1 / 340.9) =	**0.52 dB**



* Since the burst rate is not different between the channels, the data has been obtained on the representative channel.

Radiated Spurious Emission

Test place	Ise EMC Lab.
Semi Anechoic Chamber	No.3
Date	October 2, 2024
Temperature / Humidity	23 deg. C / 65 % RH
Engineer	Tomoya Sone
	(1 GHz to 10 GHz)
Mode	Tx GFSK 2402 MHz

Polarity [Hori/Vert]	Frequency [MHz]	Reading (QP / PK) [dBuV]	Reading (AV) [dBuV]	Ant. Factor [dB/m]	Loss [dB]	Gain [dB]	Duty Factor [dB]	Result (QP / PK) [dBuV/m]	Result (AV) [dBuV/m]	Limit (QP / PK) [dBuV/m]	Limit (AV) [dBuV/m]	Margin (QP / PK) [dB]	Margin (AV) [dB]	Remark
Hori.	2338.0	46.3	37.7	27.7	5.4	32.2	0.5	47.3	39.1	73.9	53.9	26.6	14.8	*2)
Hori.	2390.0	42.8	32.2	27.5	5.5	32.2	0.5	43.6	33.5	73.9	53.9	30.3	20.4	*1)
Hori.	2530.1	52.1	44.1	27.4	5.6	32.2	0.5	53.0	45.4	73.9	53.9	21.0	8.5	*2)
Hori.	4804.0	39.9	32.4	31.4	7.7	31.2	-	47.7	40.3	73.9	53.9	26.2	13.6	Floor noise
Hori.	7206.0	42.3	31.7	35.6	8.8	32.0	-	54.7	44.0	73.9	53.9	19.2	9.9	Floor noise
Hori.	9608.0	40.5	34.5	35.6	9.2	32.6	-	52.7	46.7	73.9	53.9	21.2	7.3	Floor noise
Vert.	2338.0	46.8	37.6	27.7	5.4	32.2	0.5	47.8	39.1	73.9	53.9	26.2	14.9	*2)
Vert.	2390.0	42.6	32.4	27.5	5.5	32.2	0.5	43.4	33.7	73.9	53.9	30.5	20.2	*1)
Vert.	2530.1	51.5	43.4	27.4	5.6	32.2	0.5	52.3	44.7	73.9	53.9	21.6	9.2	*2)
Vert.	4804.0	39.9	32.4	31.4	7.7	31.2	-	47.7	40.3	73.9	53.9	26.2	13.6	Floor noise
Vert.	7206.0	42.3	31.7	35.6	8.8	32.0	-	54.7	44.0	73.9	53.9	19.2	9.9	Floor noise
Vert.	9608.0	40.5	34.5	35.6	9.2	32.6	-	52.7	46.7	73.9	53.9	21.2	7.3	Floor noise

Result (QP / PK) = Reading + Ant Factor + Loss (Cable+Attenuator+Filter+Distance factor(above 1 GHz)) - Gain(Amplifier)
Result (AV)= Reading + Ant Factor + Loss (Cable+Attenuator+Filter+Distance factor(above 1 GHz)) - Gain(Amplifier) + Duty factor
*Other frequency noises omitted in this report were not seen or had enough margin (more than 20 dB).
*QP detector was used up to 1GHz.
*1) Not Out of Band emission(Leakage Power)
*2) Noise synchronized with duty of carrier freqency

20dBc Data Sheet

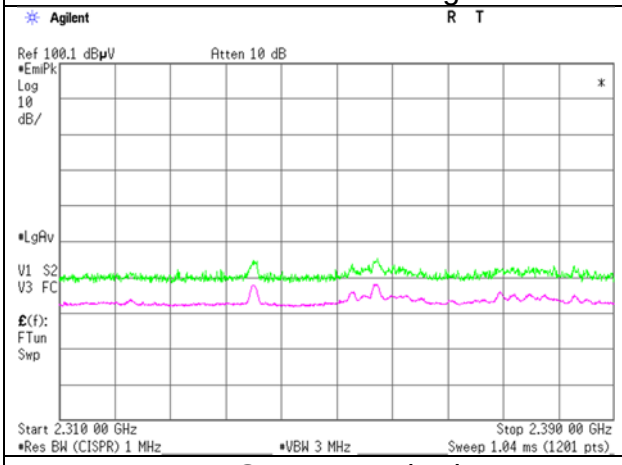
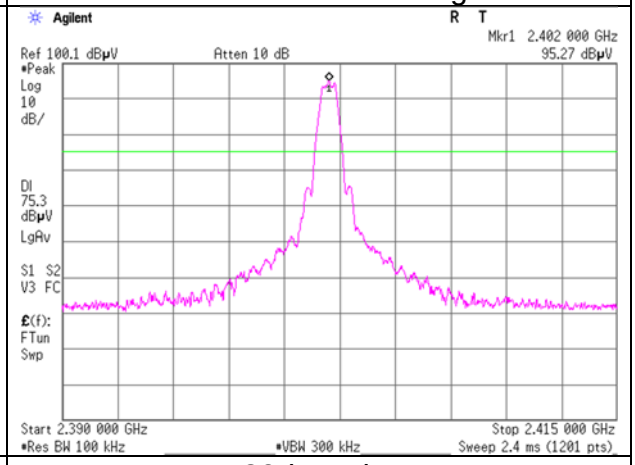
Polarity [Hori/Vert]	Frequency [MHz]	Reading (PK) [dBuV]	Ant Factor [dB/m]	Loss [dB]	Gain [dB]	Result [dBuV/m]	Limit [dBuV/m]	Margin [dB]	Remark
Hori.	2402.0	95.3	27.5	5.5	32.2	96.1	-	-	Carrier
Hori.	2400.0	47.9	27.5	5.5	32.2	48.7	76.1	27.3	
Vert.	2402.0	95.8	27.5	5.5	32.2	96.6	-	-	Carrier
Vert.	2400.0	48.3	27.5	5.5	32.2	49.0	76.6	27.6	

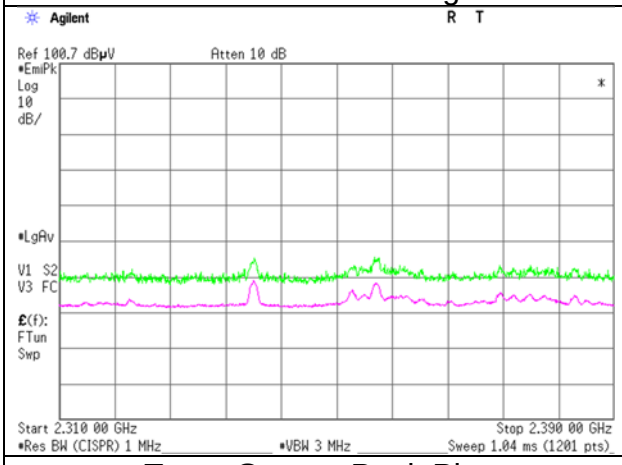
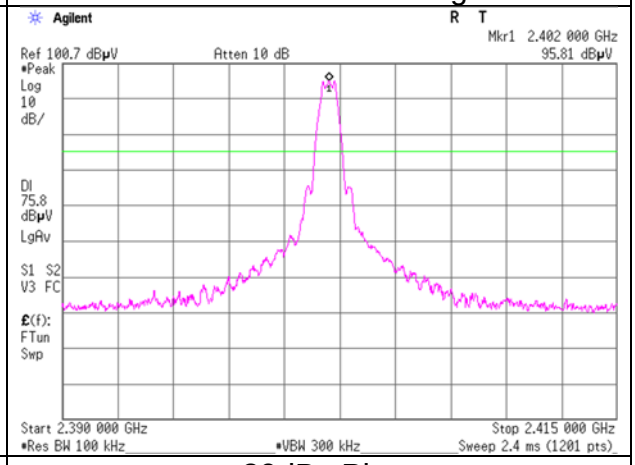
Result = Reading + Ant Factor + Loss (Cable+Attenuator+Filter+Distance factor(above 1 GHz)) - Gain(Amprifier)

Distance factor:	1 GHz - 6 GHz	20log (3.95 m / 3.0 m) = 2.39 dB
	6 GHz - 10 GHz	20log (4.95 m / 3.0 m) = 4.35 dB
	10 GHz - 26.5 GHz	20log (1.0 m / 3.0 m) = -9.5 dB

Radiated Spurious Emission
(Reference Plot for band-edge)

Test place	Ise EMC Lab.
Semi Anechoic Chamber	No.3
Date	October 2, 2024
Temperature / Humidity	23 deg. C / 65 % RH
Engineer	Tomoya Sone
	(1 GHz to 6 GHz)
Mode	Tx GFSK 2402 MHz

Horizontal	
Restricted-band band-edge Plot	Authorized-band band-edge Plot
	
Trace Green : Peak Plot Trace Purple : Average Plot	20dBc Plot

Vertical	
Restricted-band band-edge Plot	Authorized-band band-edge Plot
	
Trace Green : Peak Plot Trace Purple : Average Plot	20dBc Plot

* The measurement was conducted for a sufficiently long enough time to detect any possible spurious emissions.
Final result of restricted band edge and authorized band edge were shown in tabular data.

Radiated Spurious Emission

Test place	Ise EMC Lab.
Semi Anechoic Chamber	No.3
Date	October 2, 2024
Temperature / Humidity	23 deg. C / 65 % RH
Engineer	Tomoya Sone
	(1 GHz to 10 GHz)
Mode	Tx GFSK 2442 MHz

Polarity [Hori/Vert]	Frequency [MHz]	Reading (QP / PK) [dBuV]	Reading (AV) [dBuV]	Ant. Factor [dB/m]	Loss [dB]	Gain [dB]	Duty Factor [dB]	Result (QP / PK) [dBuV/m]	Result (AV) [dBuV/m]	Limit (QP / PK) [dBuV/m]	Limit (AV) [dBuV/m]	Margin (QP / PK) [dB]	Margin (AV) [dB]	Remark
Hori.	2378.0	49.0	42.2	27.6	5.4	32.2	0.5	49.8	43.4	73.9	53.9	24.2	10.5	*2)
Hori.	2570.0	52.9	44.8	27.5	5.5	32.1	0.5	53.7	46.2	73.9	53.9	20.2	7.8	*2)
Hori.	4884.0	40.1	32.1	31.4	7.6	31.2	-	47.9	39.9	73.9	53.9	26.0	14.0	Floor noise
Hori.	7326.0	42.2	31.6	35.6	8.8	32.1	-	54.5	43.9	73.9	53.9	19.4	10.0	Floor noise
Hori.	9768.0	39.2	34.0	35.9	9.3	32.7	-	51.7	46.5	73.9	53.9	22.2	7.4	Floor noise
Vert.	2378.0	48.9	41.9	27.6	5.4	32.2	0.5	49.6	43.1	73.9	53.9	24.3	10.8	*2)
Vert.	2570.0	52.1	44.1	27.5	5.5	32.1	0.5	53.0	45.5	73.9	53.9	20.9	8.5	*2)
Vert.	4884.0	40.1	32.1	31.4	7.6	31.2	-	47.9	39.9	73.9	53.9	26.0	14.0	Floor noise
Vert.	7326.0	42.2	31.6	35.6	8.8	32.1	-	54.5	43.9	73.9	53.9	19.4	10.0	Floor noise
Vert.	9768.0	39.2	34.0	35.9	9.3	32.7	-	51.7	46.5	73.9	53.9	22.2	7.4	Floor noise

Result (QP / PK) = Reading + Ant Factor + Loss (Cable+Attenuator+Filter+Distance factor(above 1 GHz)) - Gain(Amplifier)
Result (AV)= Reading + Ant Factor + Loss (Cable+Attenuator+Filter+Distance factor(above 1 GHz)) - Gain(Amplifier) + Duty factor
*Other frequency noises omitted in this report were not seen or had enough margin (more than 20 dB).
*QP detector was used up to 1GHz.

*2) Noise synchronized with duty of carrier freqency

Distance factor:	1 GHz - 6 GHz	20log (3.95 m / 3.0 m) = 2.39 dB
	6 GHz - 10 GHz	20log (4.95 m / 3.0 m) = 4.35 dB
	10 GHz - 26.5 GHz	20log (1.0 m / 3.0 m) = -9.5 dB

Radiated Spurious Emission

Test place	Ise EMC Lab.	
Semi Anechoic Chamber	No.3	No.3
Date	October 2, 2024	October 7, 2024
Temperature / Humidity	23 deg. C / 65 % RH	23 deg. C / 68 % RH
Engineer	Tomoya Sone	Takumi Nishida
	(1 GHz to 10 GHz)	(below 1GHz)
Mode	Tx GFSK 2478 MHz	

Polarity [Hori/Vert]	Frequency [MHz]	Reading (QP / PK) [dBuV]	Reading (AV) [dBuV]	Ant. Factor [dB/m]	Loss [dB]	Gain [dB]	Duty Factor [dB]	Result (QP / PK) [dBuV/m]	Result (AV) [dBuV/m]	Limit (QP / PK) [dBuV/m]	Limit (AV) [dBuV/m]	Margin (QP / PK) [dB]	Margin (AV) [dB]	Remark
Hori.	32.7	28.2	-	17.5	7.0	32.2	-	20.5	-	40.0	-	19.5	-	
Hori.	52.4	28.9	-	10.4	7.3	32.2	-	14.4	-	40.0	-	25.6	-	
Hori.	66.7	25.9	-	6.7	7.5	32.2	-	7.9	-	40.0	-	32.1	-	
Hori.	80.0	26.5	-	6.8	7.7	32.2	-	8.8	-	40.0	-	31.2	-	
Hori.	285.1	22.4	-	13.6	9.6	32.0	-	13.5	-	46.0	-	32.5	-	
Hori.	591.7	22.6	-	19.0	11.5	32.1	-	21.0	-	46.0	-	25.0	-	
Hori.	2350.1	50.9	45.1	27.7	5.3	32.2	0.5	51.7	46.4	73.9	53.9	22.2	7.5	*2)
Hori.	2483.5	51.1	37.8	27.4	5.4	32.2	0.5	51.7	39.0	73.9	53.9	22.2	14.9	*1)
Hori.	2606.0	51.6	43.6	27.6	5.5	32.1	0.5	52.6	45.1	73.9	53.9	21.3	8.8	*2)
Hori.	4956.0	40.9	32.1	31.6	7.6	31.1	-	48.9	40.1	73.9	53.9	25.0	13.8	Floor noise
Hori.	7434.0	41.9	31.5	35.5	8.8	32.1	-	54.0	43.6	73.9	53.9	19.9	10.3	Floor noise
Hori.	9912.0	40.3	33.7	36.1	9.4	32.8	-	53.0	46.4	73.9	53.9	20.9	7.5	Floor noise
Vert.	32.7	26.9	-	17.5	7.0	32.2	-	19.2	-	40.0	-	20.8	-	
Vert.	52.4	28.5	-	10.4	7.3	32.2	-	14.0	-	40.0	-	26.0	-	
Vert.	66.7	25.1	-	6.7	7.5	32.2	-	7.1	-	40.0	-	32.9	-	
Vert.	80.0	26.5	-	6.8	7.7	32.2	-	8.8	-	40.0	-	31.2	-	
Vert.	285.1	22.4	-	13.6	9.6	32.0	-	13.5	-	46.0	-	32.5	-	
Vert.	591.7	22.6	-	19.0	11.5	32.1	-	21.0	-	46.0	-	25.0	-	
Vert.	2350.1	50.4	44.1	27.7	5.3	32.2	0.5	51.2	45.4	73.9	53.9	22.7	8.5	*2)
Vert.	2483.5	50.5	32.4	27.4	5.4	32.2	0.5	51.1	33.5	73.9	53.9	22.8	20.4	*1)
Vert.	2606.0	51.7	43.7	27.6	5.5	32.1	0.5	52.7	45.2	73.9	53.9	21.2	8.7	*2)
Vert.	4956.0	40.9	32.1	31.6	7.6	31.1	-	48.9	40.1	73.9	53.9	25.0	13.8	Floor noise
Vert.	7434.0	41.9	31.5	35.5	8.8	32.1	-	54.0	43.6	73.9	53.9	19.9	10.3	Floor noise
Vert.	9912.0	40.3	33.7	36.1	9.4	32.8	-	53.0	46.4	73.9	53.9	20.9	7.5	Floor noise

Result (QP / PK) = Reading + Ant Factor + Loss (Cable+Attenuator+Filter+Distance factor(above 1 GHz)) - Gain(Amplifier)
Result (AV)= Reading + Ant Factor + Loss (Cable+Attenuator+Filter+Distance factor(above 1 GHz)) - Gain(Amplifier) + Duty factor
*Other frequency noises omitted in this report were not seen or had enough margin (more than 20 dB).
*QP detector was used up to 1GHz.
*1) Not Out of Band emission(Leakage Power)
*2) Noise synchronized with duty of carrier freqency

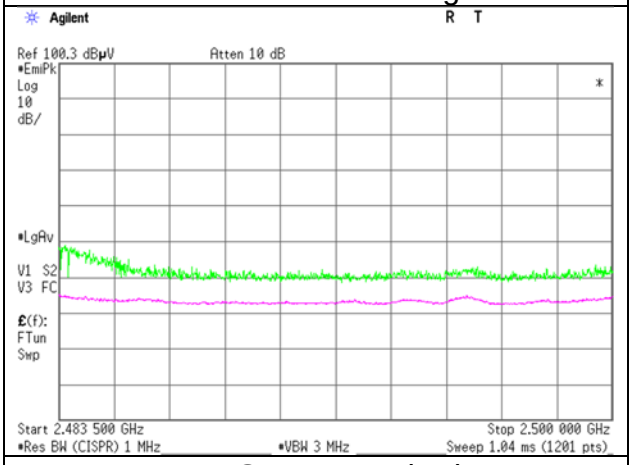
Distance factor:	1 GHz - 6 GHz	20log (3.95 m / 3.0 m) = 2.39 dB
	6 GHz - 10 GHz	20log (4.95 m / 3.0 m) = 4.35 dB
	10 GHz - 26.5 GHz	20log (1.0 m / 3.0 m) = -9.5 dB

Radiated Spurious Emission
(Reference Plot for band-edge)

Test place	Ise EMC Lab.
Semi Anechoic Chamber	No.3
Date	October 2, 2024
Temperature / Humidity	23 deg. C / 65 % RH
Engineer	Tomoya Sone
	(1 GHz to 6 GHz)
Mode	Tx GFSK 2478 MHz

Horizontal

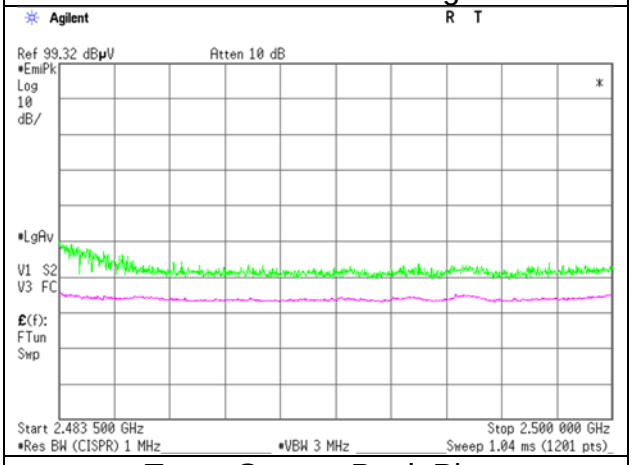
Restricted-band band-edge Plot



Trace Green : Peak Plot
Trace Purple : Average Plot

Vertical

Restricted-band band-edge Plot

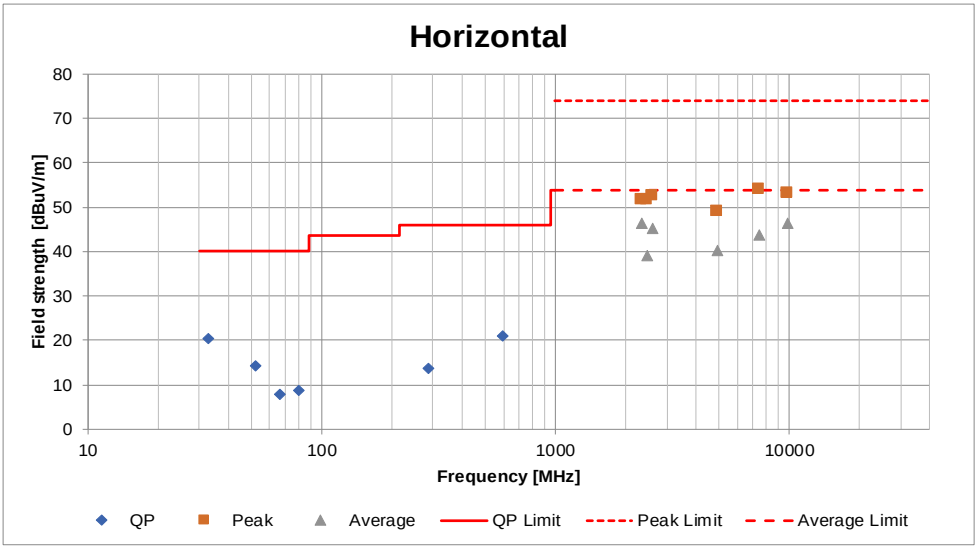


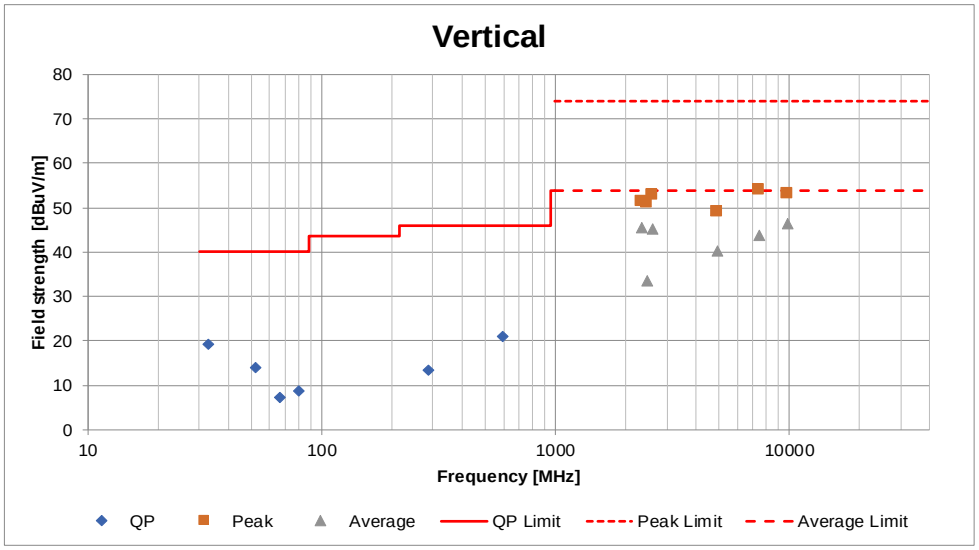
Trace Green : Peak Plot
Trace Purple : Average Plot

* The measurement was conducted for a sufficiently long enough time to detect any possible spurious emissions.
Final result of restricted band edge was shown in tabular data.

Radiated Spurious Emission
(Plot data, Worst case mode for Maximum Peak Output Power)

Test place	Ise EMC Lab.	
Semi Anechoic Chamber	No.3	No.3
Date	October 2, 2024	October 7, 2024
Temperature / Humidity	23 deg. C / 65 % RH	23 deg. C / 68 % RH
Engineer	Tomoya Sone	Takumi Nishida
	(1 GHz to 10 GHz)	(below 1GHz)
Mode	Tx GFSK 2478 MHz	



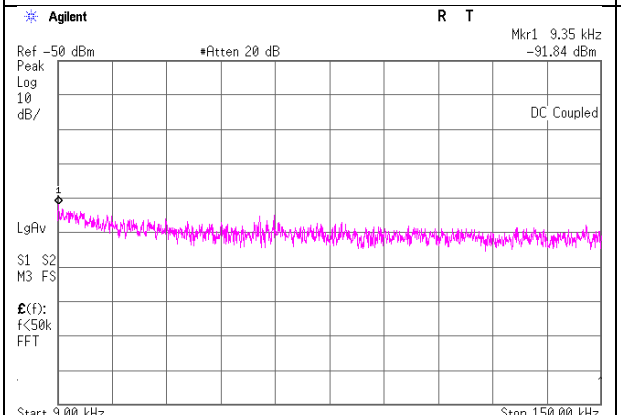


*These plots data contain sufficient number to show the trend of characteristic features for EUT.

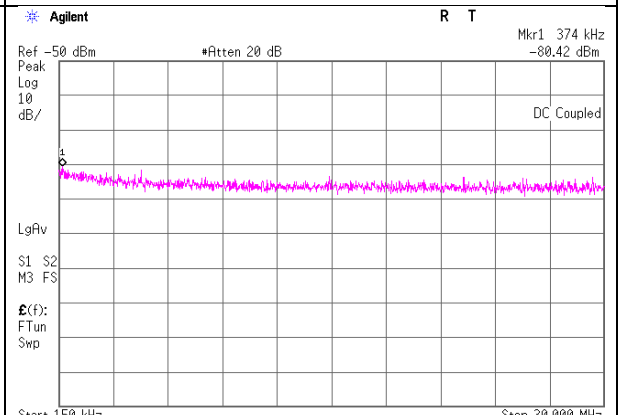
Conducted Spurious Emission

Test place	Ise EMC Lab. No.4 Measurement Room
Date	September 26, 2024
Temperature / Humidity	23 deg. C / 55 % RH
Engineer	Takumi Nishida
Mode	Tx 2478 MHz

9 kHz to 150 kHz



150 kHz to 30 MHz



Frequency [kHz]	Reading [dBm]	Cable Loss [dB]	Attenuator Loss [dB]	Antenna Gain* [dBi]	N (Number of Output)	EIRP [dBm]	Distance [m]	Ground bounce [dB]	E (field strength) [dBuV/m]	Limit [dBuV/m]	Margin [dB]	Remark
9.35	-91.8	0.00	9.8	2.0	1	-80.0	300	6.0	-18.7	48.1	66.8	
374.00	-80.4	0.01	9.8	2.0	1	-68.6	300	6.0	-7.3	16.1	23.4	

E [dBuV/m] = EIRP [dBm] - 20 log (Distance [m]) + Ground bounce [dB] + 104.8 [dBuV/m]

EIRP[dBm] = Reading [dBm] + Cable loss [dB] + Attenuator Loss [dB] + Antenna gain [dBi] + 10 * log (N)

N: Number of output

*2.0 dBi was applied to the test result based on ANSI C63.10 since antenna gain was less than 2.0 dBi.

Power Density

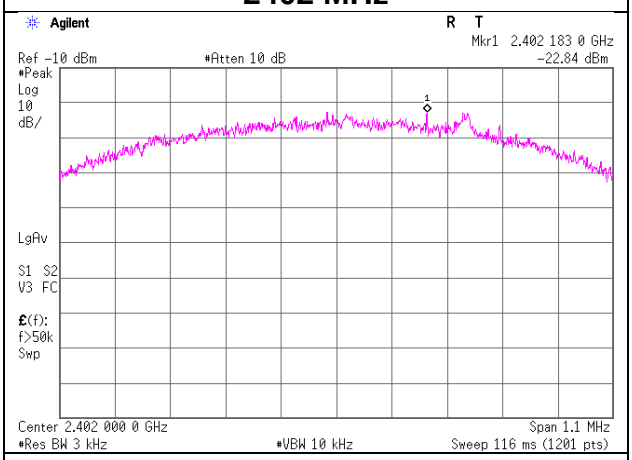
Test place	Ise EMC Lab. No.4 Measurement Room
Date	September 24, 2024
Temperature / Humidity	23 deg. C / 55 % RH
Engineer	Takumi Nishida
Mode	Tx

Freq. [MHz]	Reading [dBm / 3 kHz]	Cable Loss [dB]	Atten. Loss [dB]	Result [dBm / 3 kHz]	Limit [dBm / 3 kHz]	Margin [dB]
2402	-22.84	1.45	9.73	***-11.67***	8.00	19.67
2442	-22.90	1.48	9.73	-11.69	8.00	19.69
2478	-23.07	1.50	9.73	-11.84	8.00	19.84

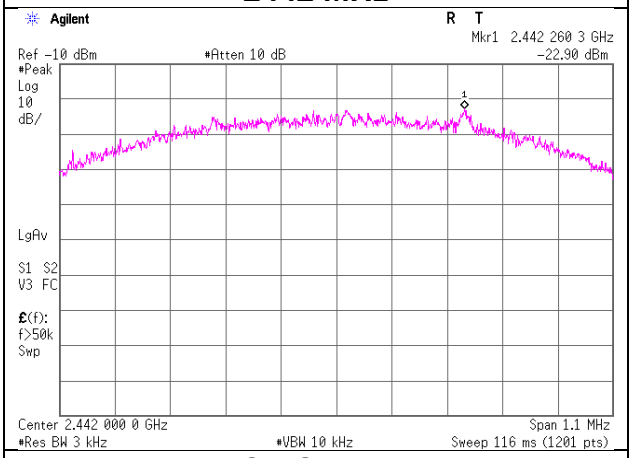
Sample Calculation:
Result = Reading + Cable Loss (including the cable(s) customer supplied) + Attenuator Loss

Power Density

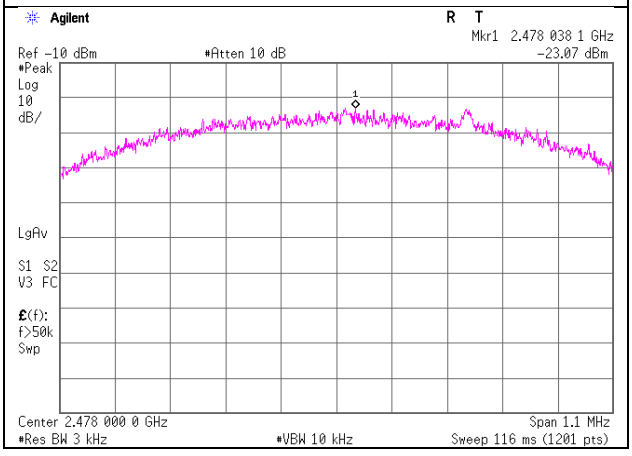
2402 MHz



2442 MHz



2478 MHz



APPENDIX 2: Test Instruments

Test Equipment

Test Item	LIMS ID	Description	Manufacturer	Model	Serial	Last Calibration Date	Cal Int
AT	141156	Attenuator (10dB)	Weinschel Corp	2	BL1173	11/17/2023	12
AT	141327	Coaxial Cable	UL Japan	-	-	02/09/2024	12
AT	141414	Microwave Cable	Junkosha	MWX221	1207S407	07/06/2024	12
AT	141419	Attenuator	Weinschel Associates	WA56-10	56100305	05/22/2024	12
AT	141545	DIGITAL HiTESTER	HIOKI E.E. CORPORATION	3805	51201148	02/01/2024	12
AT	141809	Power Meter	Anritsu Corporation	ML2495A	825002	05/22/2024	12
AT	141830	Power sensor	Anritsu Corporation	MA2411B	738285	05/22/2024	12
AT	141901	Spectrum Analyzer	Keysight Technologies Inc	E4440A	MY48250080	01/26/2024	12
AT	244710	Thermo-Hygrometer	HIOKI E.E. CORPORATION	LR5001	231202104	01/25/2024	12
RE	141232	High Pass Filter 3.5-18.0GHz	UL Japan	HPF SELECTOR	001	09/13/2024	12
RE	141266	Logperiodic Antenna (200-1000MHz)	Schwarzbeck Mess-Elektronik OHG	VUSLP9111B	9111B-191	08/23/2024	12
RE	141323	Coaxial cable	UL Japan	-	-	09/13/2024	12
RE	141507	Horn Antenna 1-18GHz	Schwarzbeck Mess-Elektronik OHG	BBHA9120D	258	11/20/2023	12
RE	141513	Horn Antenna 15-40GHz	Schwarzbeck Mess-Elektronik OHG	BBHA9170	BBHA9170306	07/19/2024	12
RE	141532	DIGITAL HiTESTER	HIOKI E.E. CORPORATION	3805	051201197	01/31/2024	12
RE	141580	Microwave System Amplifier	Keysight Technologies Inc	83017A	MY39500779	03/08/2024	12
RE	141582	Pre Amplifier	SONOMA INSTRUMENT	310	260834	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	142008	AC3_Semi Anechoic Chamber (NSA)	TDK	Semi Anechoic Chamber 3m	DA-10005	12/11/2023	24
RE	142013	AC3_Semi Anechoic Chamber (SVSWR)	TDK	Semi Anechoic Chamber 3m	DA-10005	04/12/2023	24
RE	142183	Measure	KOMELON	KMC-36	-	10/20/2023	12
RE	142314	Attenuator	Pasternack Enterprises	PE7390-6	D/C 1504	06/06/2024	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
RE	245787	Double Ridge Horn Antenna	Schwarzbeck Mess-Elektronik OHG	BBHA 9120 C	689	03/06/2024	12
RE	246001	Microwave Cable	Huber+Suhner	SF103/11PC35/ 11PC35/1000mm / SF126E/5000mm	800673(1m) / 610204(5m)	03/06/2024	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:

AT: Antenna Terminal Conducted test
RE: Radiated Emission