

RADIO TEST REPORT

Test Report No. 15234278H-C

Customer	Yamaha Corporation
Description of EUT	Wireless Transmitter
Model Number of EUT	YW10T
FCC ID	A6RYW10T
Test Regulation	FCC Part 15 Subpart C
Test Result	Complied
Issue Date	September 20, 2024
Remarks	-

Representative Test EngineerShousei Hamaguchi
Engineer**Approved By**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".

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- For test report(s) referred in this report, the latest version (including any revisions) is always referred.

REVISION HISTORY

Original Test Report No.: 15234278H-C

Revision	Test Report No.	Date	Page Revised Contents
- (Original)	15234278H-C	September 20, 2024	-

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	Yamaha Corporation
Address	10-1 Nakazawa-cho, Chuo-Ku, Hamamatsu-shi, Shizuoka-ken 430-8650 Japan
Telephone Number	+81-53-460-2240
Contact Person	Kenji Kawasaki

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	YW10T
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	July 8, 2024
Test Date	August 7 to 23, 2024

2.2 Product Description

General Specification

Rating	DC 3.7 V
Operating temperature	10 deg. C to 30 deg. C

Radio Specification

This report contains data provided by the customer which can impact the validity of results. UL Japan, Inc. is only responsible for the validity of results after the integration of the data provided by the customer. The data provided by the customer is marked "a)" in the table below.

Equipment Type	Transmitter
Frequency of Operation	2402 MHz to 2478 MHz
Type of Modulation	FSK
Antenna Gain ^{a)}	-3.1 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

* 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	*1)
6dB Bandwidth	FCC: KDB 558074 D01 15.247 Meas Guidance v05r02 ISED: -	FCC: Section 15.247(a)(2) ISED: RSS-247 5.2(a)	See data.	Complied	Conducted
Maximum Peak Output Power	FCC: KDB 558074 D01 15.247 Meas Guidance v05r02 ISED: RSS-Gen 6.12	FCC: Section 15.247(b)(3) ISED: RSS-247 5.4(d)		Complied	Conducted
Power Density	FCC: KDB 558074 D01 15.247 Meas Guidance v05r02 ISED: -	FCC: Section 15.247(e) ISED: RSS-247 5.2(b)		Complied	Conducted
Spurious Emission Restricted Band Edges	FCC: KDB 558074 D01 15.247 Meas Guidance v05r02 ISED: RSS-Gen 6.13	FCC: Section 15.247(d) ISED: RSS-247 5.5 RSS-Gen 8.9 RSS-Gen 8.10	4.2 dB 7206.0 MHz, AV, Horizontal	Complied	Conducted (below 30 MHz)/ Radiated (above 30 MHz) *2)
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 and does not transmit radio frequency when charging. *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 EUT is a battery-operated device and test was performed with the full-charged battery. 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 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

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

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)

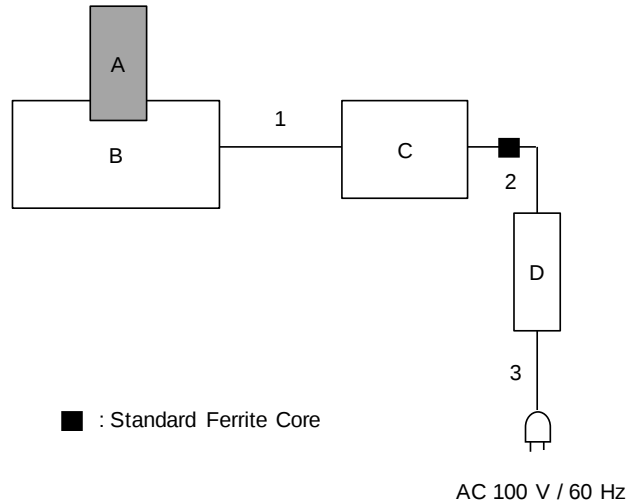
Mode	Remarks*
2.4 GHz Transmitting	-
*Transmitting duty was 100 % on all tests. *The worst condition was determined based on the test result of Maximum Peak Output Power. *Power of the EUT was set by the software as follows; Power Setting: -7 dBm Software: Version; 2.94 (Date: August 7, 2024, Storage 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. Test operating mode was determined as follows according to "Section 1 of 6 802.11 a/b/g/n testing - Managing Complex Regulatory Approvals - " of TCB Council Workshop October 2009.	

*The Details of Operating Mode(s)

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

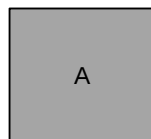
4.2 Configuration and Peripherals

Antenna Terminal conducted test



* Cabling and setup(s) were taken into consideration and test data was taken under worse case conditions.

Radiated Emission test



* Setup was 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	YW10T	T000474SU *1) T000394SU *2)	Yamaha Corporation	EUT
B	Receiver / Charger	RELAY G10	21W1R5M7340000314-1	LINE6	-
C	Laptop PC	X1 Carbon	R9-OH8TU 15/9	LENOVO	-
D	AC Adapter	ADLX45NCC2A	8SSA10E75794C1SG59R0GHF	LENOVO	-

*1) Used for Antenna Terminal conducted test

*2) Used for Radiated Emission test

List of Cables Used

No.	Name	Length (m)	Shield		Remarks
			Cable	Connector	
1	USB Cable	1.5	Shielded	Shielded	-
2	DC Cable	1.7	Unshielded	Unshielded	-
3	AC Cable	1.0	Unshielded	Unshielded	-

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

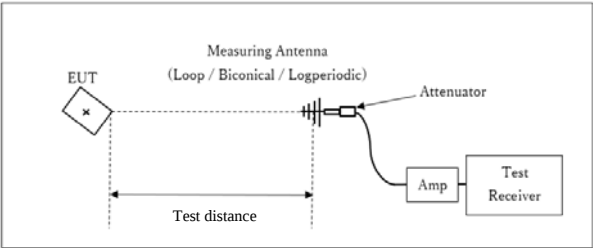
In any 100 kHz bandwidth outside the restricted band in which the spread spectrum intentional radiator is operating, the radio frequency power that is produced by the intentional radiator confirmed 20 dB below that in the 100 kHz bandwidth within the band that contains the highest level of the desired 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	<u>11.12.2.5.1</u> RBW: 1 MHz VBW: 3 MHz Detector: Power Averaging (RMS) Trace: 100 traces <u>11.12.2.5.2</u> 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

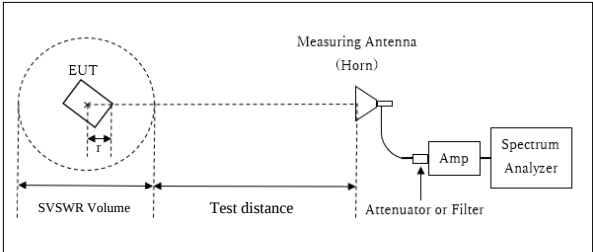
Below 1 GHz



× : 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: $20 \times \log (4.00 \text{ m}^*/3.0 \text{ m}) = 2.50 \text{ dB}$
*(Test Distance + SVSWR Volume /2) - r = 4.00 m

Test Distance: 3 m
SVSWR Volume: 2 m
(SVSWR Volume has been calibrated based on CISPR 16-1-4.)
r: 0.0 m

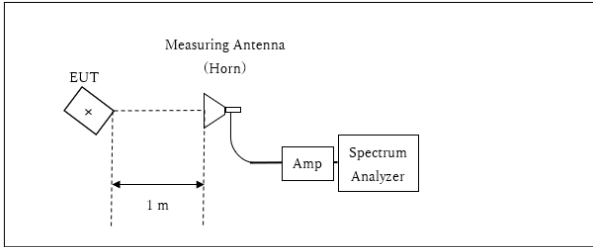
[6 GHz to 10 GHz]

Distance Factor: $20 \times \log (5.00 \text{ m}^*/3.0 \text{ m}) = 4.44 \text{ dB}$
*(Test Distance + SVSWR Volume /2) - r = 5.00 m

Test Distance: 4.3 m
SVSWR Volume: 1.4 m
(SVSWR Volume has been calibrated based on CISPR 16-1-4.)
r: 0.0m

* The test was performed with r = 0.0 m since EUT is small and it was the rather conservative condition.

10 GHz to 26.5 GHz



× : Center of turn table

Distance Factor: $20 \times \log (1.0 \text{ m}^* / 3.0 \text{ m}) = -9.54 \text{ dB}$
*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	5 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 Ohms. For example, the measurement at frequency 9 kHz resulted in a level of 45.5 dBuV/m, which is equivalent to $45.5 - 51.5 = -6.0$ 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

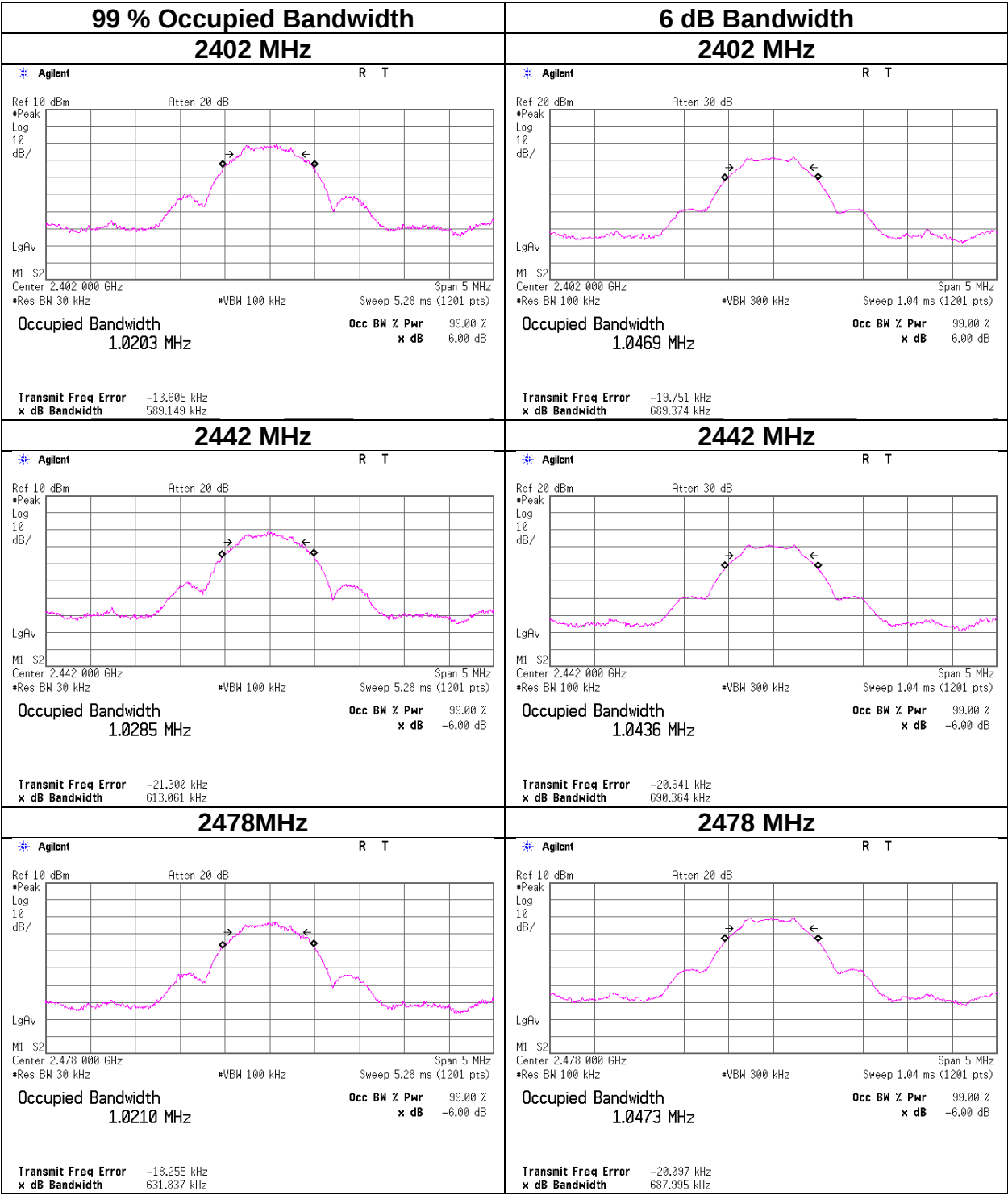
APPENDIX 1: Test Data

99 % Occupied Bandwidth and 6 dB Bandwidth

Test place	Ise EMC Lab. No.2 Measurement Room
Date	August 7, 2024
Temperature / Humidity	25 deg. C / 60 % RH
Engineer	Junya Okuno
Mode	Tx

Frequency [MHz]	99% Occupied Bandwidth [kHz]	6dB Bandwidth [MHz]	Limit for 6dB Bandwidth [MHz]
2402	1020.3	0.689	> 0.5000
2442	1028.5	0.690	> 0.5000
2478	1021.0	0.688	> 0.5000

99 % Occupied Bandwidth and 6 dB Bandwidth



Maximum Peak Output Power

Test place Ise EMC Lab. No.2 Measurement Room
Date August 7, 2024
Temperature / Humidity 25 deg. C / 60 % RH
Engineer Junya Okuno
Mode Tx

Freq.	Reading	Cable Loss	Atten. Loss	Conducted Power					e.i.r.p. for RSS-247					
				Result		Limit		Margin	Antenna Gain	Result		Limit		Margin
				[dBm]	[mW]	[dBm]	[mW]			[dB]	[dBm]	[mW]	[dBm]	
[MHz]	[dBm]	[dB]	[dB]						[dBi]					
2402	-7.31	0.92	10.10	3.71	2.35	30.00	1000	26.29	-3.10	0.61	1.15	36.02	4000	35.41
2442	-8.06	0.93	10.10	2.97	1.98	30.00	1000	27.03	-3.10	-0.13	0.97	36.02	4000	36.15
2478	-9.77	0.94	10.10	1.27	1.34	30.00	1000	28.73	-3.10	-1.83	0.66	36.02	4000	37.85

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.2 Measurement Room
Date	August 7, 2024
Temperature / Humidity	25 deg. C / 60 % RH
Engineer	Junya Okuno
Mode	Tx

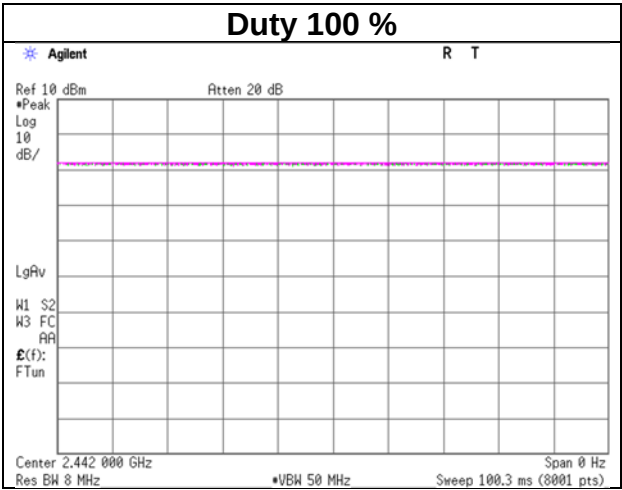
Freq. [MHz]	Reading [dBm]	Cable Loss [dB]	Atten. Loss [dB]	Result (Time average)		Duty factor [dB]	Result (Burst power average)	
				[dBm]	[mW]		[dBm]	[mW]
2402	-8.17	0.92	10.10	2.85	1.93	0.00	2.85	1.93
2442	-9.01	0.93	10.10	2.02	1.59	0.00	2.02	1.59
2478	-10.82	0.94	10.10	0.22	1.05	0.00	0.22	1.05

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

*The equipment and cables were not used for factor 0 dB of the data sheets.

Burst rate confirmation

Test place	Ise EMC Lab. No.2 Measurement Room
Date	August 7, 2024
Temperature / Humidity	25 deg. C / 60 % RH
Engineer	Junya Okuno
Mode	Tx



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

Radiated Spurious Emission

Test place
Semi Anechoic Chamber
Date
Temperature / Humidity
Engineer

Ise EMC Lab.
No.3
August 22, 2024
23 deg. C / 55 % RH
Takumi Nishida
(1 GHz to 10 GHz)

No.3
August 23, 2024
23 deg. C / 67 % RH
Shousei Hamaguchi
(Above 10 GHz)
(Below 1 GHz)

Mode

Tx 2402 MHz

Polarity	Frequency	Reading (QP / PK)	Reading (AV)	Ant. Factor	Loss	Gain	Duty Factor	Result (QP / PK)	Result (AV)	Limit (QP / PK)	Limit (AV)	Margin (QP / PK)	Margin (AV)	Remark
[Hori/Vert]	[MHz]	[dBuV]	[dBuV]	[dBm]	[dB]	[dB]	[dB]	[dBuV/m]	[dBuV/m]	[dBuV/m]	[dBuV/m]	[dB]	[dB]	
Hori.	52.5	23.5	-	10.3	7.3	32.1	-	9.0	-	40.0	-	31.0	-	
Hori.	73.2	21.3	-	6.4	7.6	32.1	-	3.2	-	40.0	-	36.8	-	
Hori.	118.7	21.1	-	12.8	8.0	32.1	-	9.9	-	43.5	-	33.6	-	
Hori.	421.6	20.3	-	16.0	10.2	32.1	-	14.4	-	46.0	-	31.6	-	
Hori.	541.6	20.3	-	17.7	11.0	32.2	-	16.8	-	46.0	-	29.2	-	
Hori.	699.3	20.2	-	19.9	11.6	32.3	-	19.4	-	46.0	-	26.6	-	
Hori.	2390.0	42.5	33.7	27.5	5.5	32.2	-	43.3	34.5	73.9	53.9	30.6	19.4	
Hori.	4804.0	43.3	39.0	31.4	7.6	31.2	-	51.1	46.8	73.9	53.9	22.8	7.1	
Hori.	7206.0	43.5	35.4	35.6	10.7	32.0	-	57.8	49.7	73.9	53.9	16.1	4.2	
Hori.	9608.0	41.6	32.7	35.6	11.2	32.6	-	55.7	46.9	73.9	53.9	18.2	7.0	Floor noise
Vert.	52.5	23.5	-	10.3	7.3	32.1	-	9.0	-	40.0	-	31.0	-	
Vert.	73.2	21.3	-	6.4	7.6	32.1	-	3.2	-	40.0	-	36.8	-	
Vert.	118.7	21.1	-	12.8	8.0	32.1	-	9.9	-	43.5	-	33.6	-	
Vert.	421.6	20.3	-	16.0	10.2	32.1	-	14.4	-	46.0	-	31.6	-	
Vert.	541.6	20.3	-	17.7	11.0	32.2	-	16.8	-	46.0	-	29.2	-	
Vert.	699.3	20.2	-	19.9	11.6	32.3	-	19.4	-	46.0	-	26.6	-	
Vert.	2390.0	42.3	33.3	27.5	5.5	32.2	-	43.1	34.1	73.9	53.9	30.8	19.8	
Vert.	4804.0	44.0	36.9	31.4	7.6	31.2	-	51.8	44.7	73.9	53.9	22.1	9.2	
Vert.	7206.0	43.6	35.3	35.6	10.7	32.0	-	57.9	49.6	73.9	53.9	16.0	4.3	
Vert.	9608.0	41.3	32.9	35.6	11.2	32.6	-	55.5	47.1	73.9	53.9	18.4	6.8	Floor noise

Result (QP / PK) = Reading + Ant Factor + Loss (Cable+Attenuator+Filter+Distance factor(above 1 GHz)) - Gain(Amplifier)

$$\text{Result (AV)} = \text{Reading} + \text{Ant Factor} + \text{Loss (Cable+Attenuator+Filter+Distance factor(above 1 GHz))} - \text{Gain(Amplifier)} + \text{Duty factor}$$

*Other frequency noises omitted in this report were not seen or had enough margin (more than 20 dB).

*OP detector was used up to 1GHz.

20dBc Data Sheet

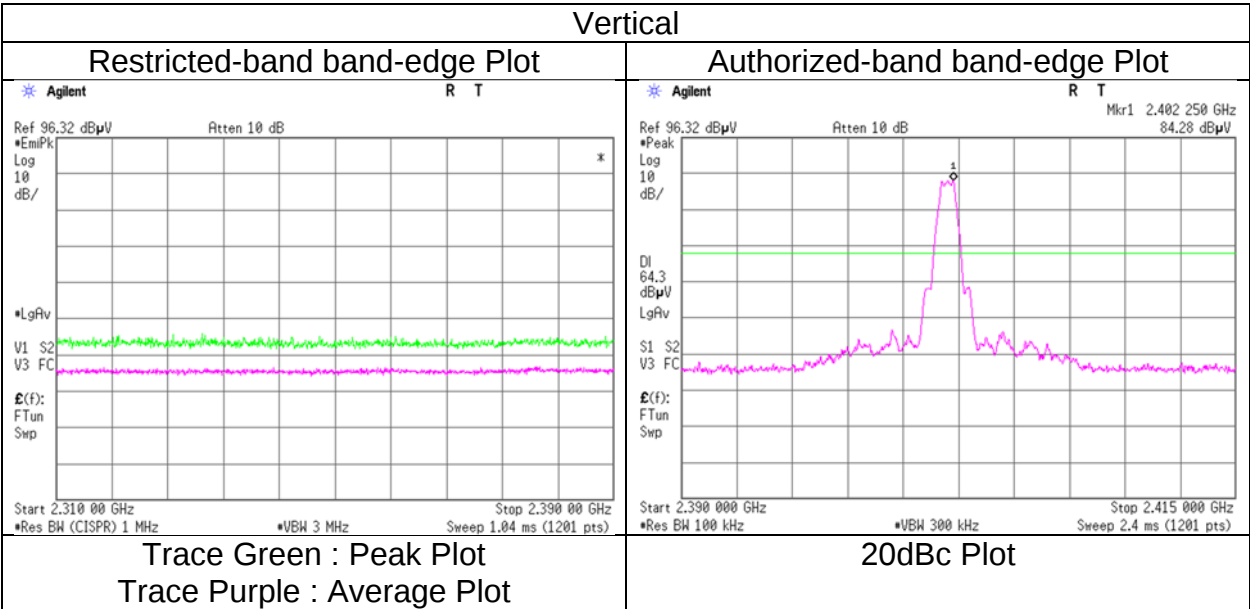
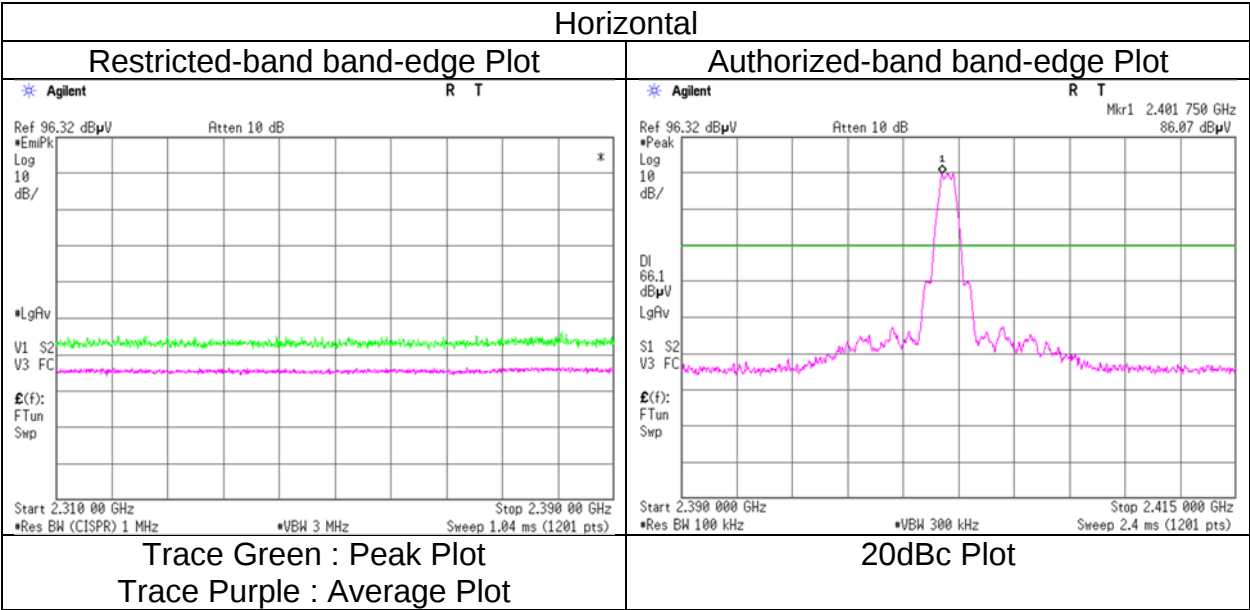
Polarity	Frequency	Reading (PK)	Ant Factor	Loss	Gain	Result	Limit	Margin	Remark
[Hori/Vert]	[MHz]	[dBuV]	[dB/m]	[dB]	[dB]	[dBuV/m]	[dBuV/m]	[dB]	
Hori.	2402.0	86.1	27.5	5.5	32.2	86.9	-	-	Carrier
Hori.	2400.0	40.5	27.5	5.5	32.2	41.3	66.9	25.5	
Vert.	2402.0	84.3	27.5	5.5	32.2	85.1	-	-	Carrier
Vert.	2400.0	40.5	27.5	5.5	32.2	41.2	65.1	23.8	

$$\text{Result} = \text{Reading} + \text{Ant Factor} + \text{Loss (Cable+Attenuator+Filter+Distance factor(above 1 GHz))} - \text{Gain(Amplifier)}$$

Distance factor:	1 GHz - 6 GHz	$20\log(4\text{ m} / 3.0\text{ m}) = 2.5\text{ dB}$
	6 GHz - 10 GHz	$20\log(5\text{ m} / 3.0\text{ m}) = 4.44\text{ dB}$
	10 GHz - 26.5 GHz	$20\log(1.0\text{ m} / 3.0\text{ m}) = -9.5\text{ dB}$

Radiated Spurious Emission
(Reference Plot for band-edge)

Test place Ise EMC Lab.
Semi Anechoic Chamber No.3
Date August 22, 2024
Temperature / Humidity 23 deg. C / 55 % RH
Engineer Takumi Nishida
 (1 GHz to 10 GHz)
Mode Tx 2402 MHz



* 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
Semi Anechoic Chamber
Date
Temperature / Humidity
Engineer

Mode

Ise EMC Lab.
No.3
August 22, 2024
23 deg. C / 55 % RH
Takumi Nishida
(1 GHz to 10 GHz)
Tx 2442 MHz

No.3
August 23, 2024
23 deg. C / 67 % RH
Shousei Hamaguchi
(Above 10 GHz)

Polarity	Frequency	Reading (QP / PK)	Reading (AV)	Ant. Factor	Loss	Gain	Duty Factor	Result (QP / PK)	Result (AV)	Limit (QP / PK)	Limit (AV)	Margin (QP / PK)	Margin (AV)	Remark
[Hori/Vert]	[MHz]	[dBuV]	[dBuV]	[dB/m]	[dB]	[dB]	[dB]	[dBuV/m]	[dBuV/m]	[dBuV/m]	[dBuV/m]	[dB]	[dB]	
Hori.	4884.0	44.1	39.2	31.4	7.6	31.2	-	52.0	47.0	73.9	53.9	21.9	6.9	
Hori.	7326.0	43.0	35.4	35.6	10.7	32.1	-	57.2	49.6	73.9	53.9	16.7	4.3	
Hori.	9768.0	41.2	33.2	35.9	11.3	32.7	-	55.7	47.7	73.9	53.9	18.2	6.2	Floor noise
Vert.	4884.0	44.0	36.7	31.4	7.6	31.2	-	51.9	44.6	73.9	53.9	22.0	9.3	
Vert.	7326.0	42.8	35.2	35.6	10.7	32.1	-	57.0	49.4	73.9	53.9	16.9	4.5	
Vert.	9768.0	41.1	33.0	35.9	11.3	32.7	-	55.6	47.5	73.9	53.9	18.3	6.4	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.

Distance factor:

1 GHz - 6 GHz
6 GHz - 10 GHz
10 GHz - 26.5 GHz

20log (4 m / 3.0 m) = 2.5 dB
20log (5 m / 3.0 m) = 4.44 dB
20log (1.0 m / 3.0 m) = -9.5 dB

Radiated Spurious Emission

Test place
Semi Anechoic Chamber
Date
Temperature / Humidity
Engineer

Mode

Ise EMC Lab.
No.3
August 22, 2024
23 deg. C / 55 % RH
Takumi Nishida
(1 GHz to 10 GHz)
Tx 2478 MHz

No.3
August 23, 2024
23 deg. C / 67 % RH
Shousei Hamaguchi
(Above 10 GHz)

Polarity	Frequency	Reading (QP / PK)	Reading (AV)	Ant. Factor	Loss	Gain	Duty Factor	Result (QP / PK)	Result (AV)	Limit (QP / PK)	Limit (AV)	Margin (QP / PK)	Margin (AV)	Remark
[Hori/Vert]	[MHz]	[dBuV]	[dBuV]	[dB/m]	[dB]	[dB]	[dB]	[dBuV/m]	[dBuV/m]	[dBuV/m]	[dBuV/m]	[dB]	[dB]	
Hori.	2483.5	46.0	37.6	27.4	3.1	32.2	-	44.2	35.9	73.9	53.9	29.7	18.0	
Hori.	4956.0	44.2	39.8	31.6	5.1	31.1	-	49.7	45.3	73.9	53.9	24.2	8.6	
Hori.	7434.0	43.0	34.9	35.5	10.7	32.1	-	57.0	49.0	73.9	53.9	16.9	4.9	
Hori.	9912.0	41.3	33.0	36.1	11.3	32.8	-	56.0	47.7	73.9	53.9	17.9	6.2	Floor noise
Vert.	2483.5	45.8	37.4	27.4	3.1	32.2	-	44.0	35.7	73.9	53.9	29.9	18.2	
Vert.	4956.0	44.2	39.6	31.6	5.1	31.1	-	49.8	45.1	73.9	53.9	24.1	8.8	
Vert.	7434.0	42.7	34.8	35.5	10.7	32.1	-	56.8	48.9	73.9	53.9	17.1	5.1	
Vert.	9912.0	41.2	33.1	36.1	11.3	32.8	-	55.9	47.8	73.9	53.9	18.0	6.1	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.

Distance factor:

1 GHz - 6 GHz
6 GHz - 10 GHz
10 GHz - 26.5 GHz

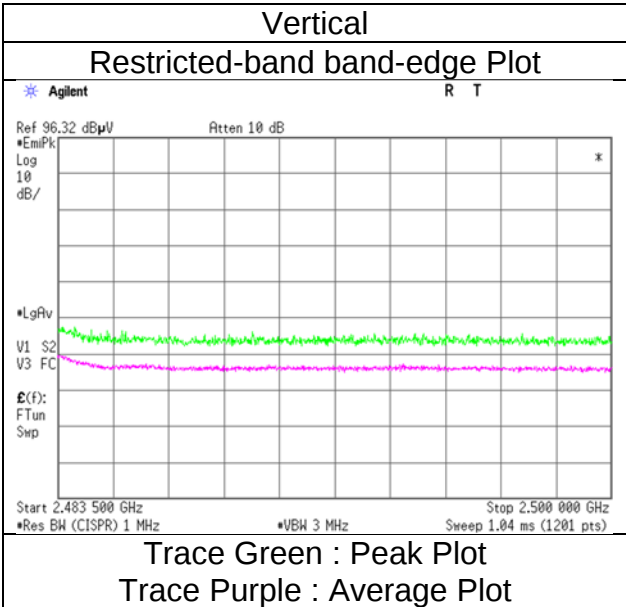
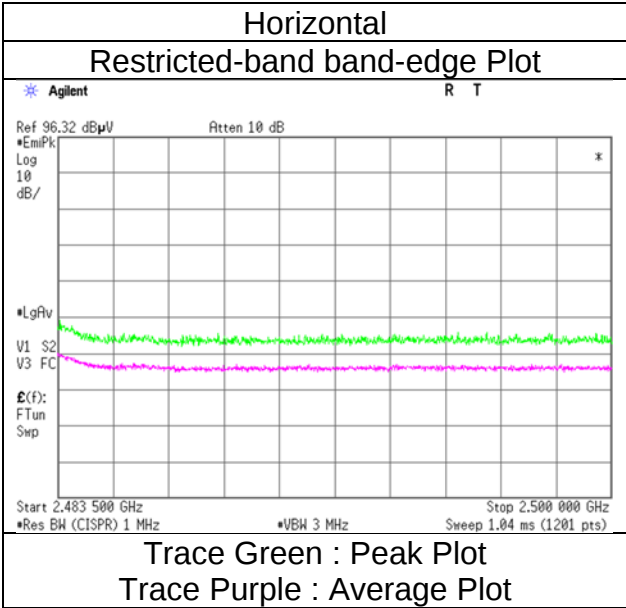
20log (4 m / 3.0 m) = 2.5 dB
20log (5 m / 3.0 m) = 4.44 dB
20log (1.0 m / 3.0 m) = -9.5 dB

Radiated Spurious Emission
(Reference Plot for band-edge)

Test place
Semi Anechoic Chamber
Date
Temperature / Humidity
Engineer

Mode

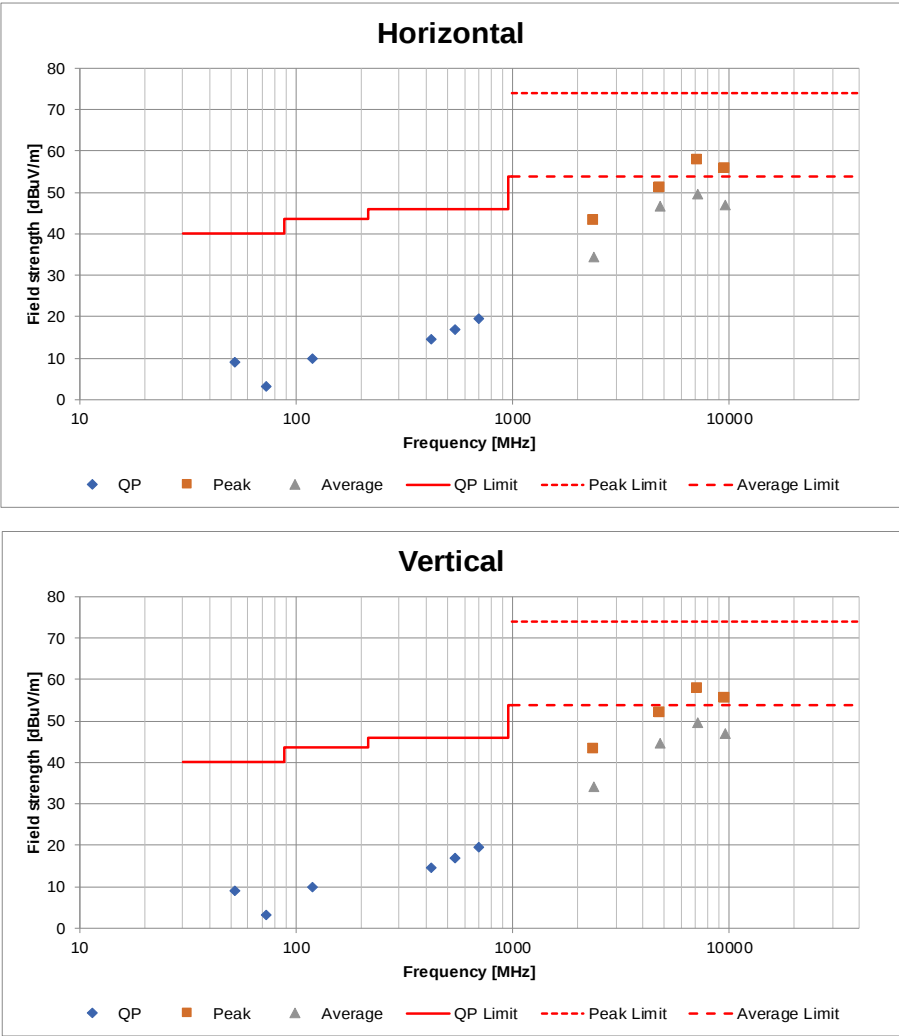
Ise EMC Lab.
No.3
August 22, 2024
23 deg. C / 55 % RH
Takumi Nishida
(1 GHz to 10 GHz)
Tx 2478 MHz



* 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.	No.3
Semi Anechoic Chamber		
Date	August 22, 2024	August 23, 2024
Temperature / Humidity	23 deg. C / 55 % RH	23 deg. C / 67 % RH
Engineer	Takumi Nishida (1 GHz to 10 GHz)	Shousei Hamaguchi (Above 10 GHz) (Below 1 GHz)
Mode	Tx 2402 MHz	

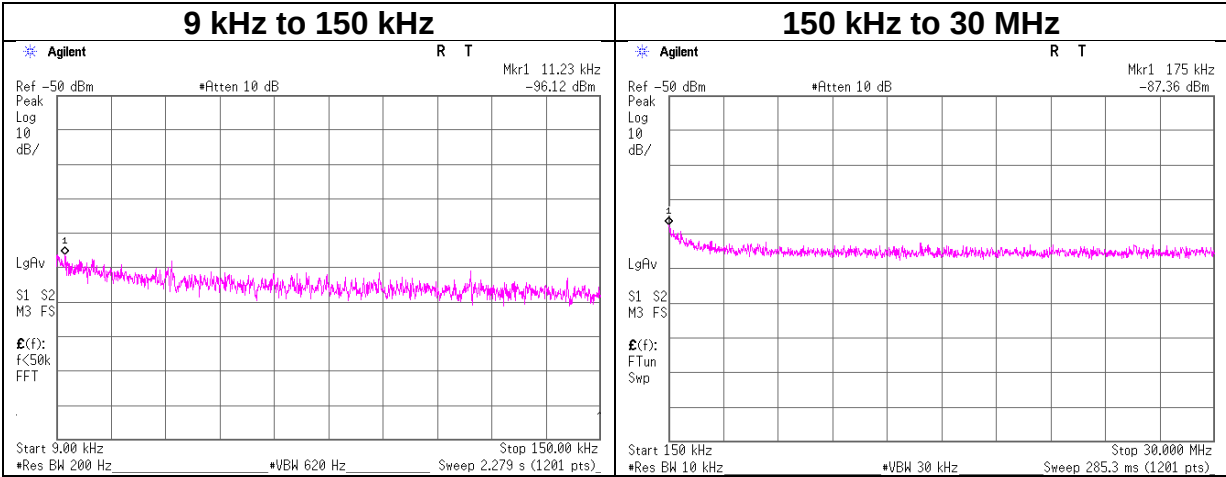


*These plots data contain sufficient number to show the trend of characteristic features for EUT.

Conducted Spurious Emission

Test place
Date
Temperature / Humidity
Engineer
Mode

Ise EMC Lab. No.2 Measurement Room
August 7, 2024
25 deg. C / 60 % RH
Junya Okuno
Tx 2402 MHz



Frequency	Reading	Cable Loss	Attenuator Loss	Antenna Gain*	N	EIRP	Distance	Ground bounce	E	Limit	Margin	Remark
[kHz]	[dBm]	[dB]	[dB]	[dBi]	(Number of Output)	[dBm]	[m]	[dB]	(field strength) [dBuV/m]	[dBuV/m]	[dB]	
11.23	-96.1	0.03	9.8	2.0	1	-84.3	300	6.0	-23.0	46.5	69.5	
175.00	-87.4	0.03	9.8	2.0	1	-75.5	300	6.0	-14.2	22.7	36.9	

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

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

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

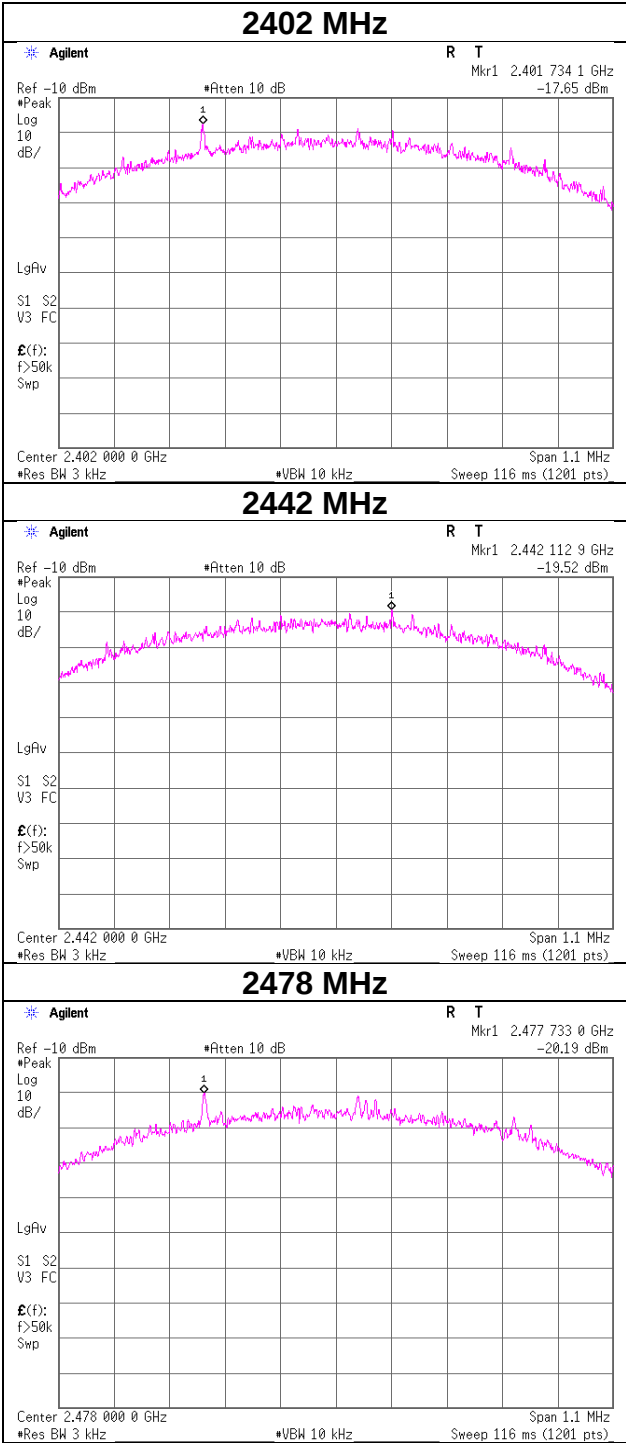
Test place	Ise EMC Lab. No.2 Measurement Room
Date	August 7, 2024
Temperature / Humidity	25 deg. C / 60 % RH
Engineer	Junya Okuno
Mode	Tx

Freq.	Reading	Cable Loss	Atten. Loss	Result	Limit	Margin
[MHz]	[dBm / 3 kHz]	[dB]	[dB]	[dBm / 3 kHz]	[dBm / 3 kHz]	[dB]
2402	-17.65	0.92	10.10	-6.63	8.00	14.63
2442	-19.52	0.93	10.10	-8.49	8.00	16.49
2478	-20.19	0.94	10.10	-9.15	8.00	17.15

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

*The equipment and cables were not used for factor 0 dB of the data sheets.

Power Density



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	141173	Attenuator(10dB) (above1GHz)	HIROSE ELECTRIC CO.,LTD.	AT-110	-	12/11/2023	12
AT	141542	Digital Tester	Fluke Corporation	FLUKE 26-3	78030611	08/06/2024	12
AT	141810	Power Meter	Anritsu Corporation	ML2495A	824014	12/12/2023	12
AT	141832	Power sensor	Anritsu Corporation	MA2411B	738174	12/12/2023	12
AT	141885	Spectrum Analyzer	Keysight Technologies Inc	E4448A	US44300523	11/29/2023	12
AT	195231	Microwave Cable	Huber+Suhner	SF102D/11PC24/ 11PC24/1000mm	537062/126E	02/13/2024	12
AT	197220	Microwave cable	Huber+Suhner	SF126E/11PC35/ 11PC35/2000MM	537003/126E	03/14/2024	12
AT	244707	Thermo-Hygrometer	HIOKI E.E. CORPORATION	LR5001	231202102	01/25/2024	12
RE	141232	High Pass Filter 3.5-18.0GHz	UL Japan	HPF SELECTOR	001	09/04/2023	12
RE	141323	Coaxial cable	UL Japan	-	-	09/10/2023	12
RE	141424	Biconical Antenna	Schwarzbeck Mess- Elektronik OHG	VHA9103+BBA9106	1915	03/15/2024	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	141902	Spectrum Analyzer	Keysight Technologies Inc	E4440A	MY46187105	05/30/2024	12
RE	141951	EMI Test Receiver	Rohde & Schwarz	ESR26	101408	05/17/2024	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	142551	Horn Antenna	AR WORLDWIDE	AT4002A	320010	-	-
RE	242170	Logperiodic Antenna	Schwarzbeck Mess- Elektronik OHG	VUSLP9111B	00728	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