

RADIO TEST REPORT

Test Report No. 15274952H-C-R1

Customer	SHIMANO INC.
Description of EUT	Motor Unit
Model Number of EUT	7KX1
FCC ID	WY7-7KX1
Test Regulation	FCC Part 15 Subpart C
Test Result	Complied
Issue Date	June 25, 2024
Remarks	-

Representative Test EngineerTetsuro Yoshida
Engineer**Approved By**Takayuki Shimada
Leader

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.: 15274952H-C

This report is a revised version of 15274952H-C. 15274952H-C is replaced with this report.

Revision	Test Report No.	Date	Page Revised Contents
- (Original)	15274952H-C	June 11, 2024	-
1	15274952H-C-R1	June 25, 2024	SECTION 5: Radiated Spurious Emission Corrected explanatory note *1): “The test was performed that ... which is synchronous the worst duty cycle of ANT+.” ↓ “The test was performed that ... which is synchronous the worst duty cycle of ANT+ and SHIMANO ORIGINAL.”

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	SHIMANO INC.
Address	3-77 Oimatsu-cho, Sakai-ku, Sakai City, Osaka 590-8577, Japan
Telephone Number	+81-72-223-7019
Contact Person	Osamu Kariyama

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	Motor Unit
Model Number	7KX1
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	February 28, 2024 (SHIMANO ORIGINAL) May 8, 2024 (Other than SHIMANO ORIGINAL)
Test Date	March 12 to May 17, 2024

2.2 Product Description

General Specification

Rating	DC 8.3 V to 13.5 V
Operating temperature	-10 deg. C to +50 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.

SHIMANO ORIGINAL

Equipment Type	Transceiver
Frequency of Operation	2478 MHz
Type of Modulation	GFSK
Antenna Type	Monopole Antenna
Antenna Gain	-0.53 dBi

Bluetooth (Low Energy)

Equipment Type	Transceiver
Frequency of Operation	2402 MHz to 2480 MHz
Type of Modulation	GFSK
Antenna Type	Monopole Antenna
Antenna Gain	0.01 dBi

ANT+

Equipment Type	Transceiver
Frequency of Operation	2402 MHz to 2480 MHz
Type of Modulation	GFSK
Antenna Type	Monopole Antenna
Antenna Gain	0.01 dBi

*Bluetooth (Low Energy) and ANT+ do not transmit simultaneously.

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	2.8 dB 2483.5 MHz Horizontal, AV	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 not the device that is designed to be connected to the public utility (AC) power line.
*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)

This EUT provides the stable voltage constantly to RF Module regardless of input voltage. 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	5.0
	6 GHz to 18 GHz		dB	5.2
1 m	10 GHz to 18 GHz		dB	5.3
	18 GHz to 26.5 GHz		dB	5.2
	26.5 GHz to 40 GHz		dB	4.7
0.5 m	26.5 GHz to 40 GHz		dB	4.8

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*
Bluetooth Low Energy (BT LE)	1M-PHY Uncoded PHY (1M), Maximum Packet Size, PRBS9
Bluetooth Low Energy (BT LE)	2M-PHY Uncoded PHY (2M), Maximum Packet Size, PRBS9
ANT+	Maximum Packet Size, PRBS9
SHIMANO ORIGINAL	Maximum Packet Size, SCRAMBLED *1)

*The worst condition was determined based on the test result of RF Output Power.

*1) Transmitting duty was 100 % on all tests

*Power of the EUT was set by the software as follows;

Mode	BT LE	ANT+	SHIMANO ORIGINAL
Power Setting	0 dBm	4 dBm	0 dBm
Software	3KR1.4.15.215.7.bin (Date: May 9, 2024, Storage location: EUT memory)		3KR1.4.15.199.9.bin (Date: March 12, 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.

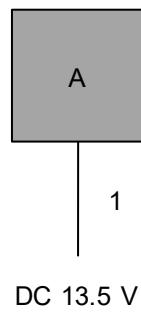
In addition, end users cannot change the settings of the output power of the product.

***The Details of Operating Mode(s)**

Test Item	Operating Mode	Tested Frequency
Radiated Spurious Emission (Below 1 GHz), Conducted Spurious Emission	Tx BT LE 1M	2480 MHz *1)
	Tx BT LE 2M	
	Tx ANT+	2441 MHz *1)
	Tx SHIMANO ORIGINAL	2478 MHz
99% Occupied Bandwidth, 6dB Bandwidth, Maximum Peak Output Power, Radiated Spurious Emission (Above 1 GHz), Power Density	Tx BT LE 1M	2402 MHz
	Tx BT LE 2M	2440 MHz
		2480 MHz
	Tx ANT+	2402 MHz
		2441 MHz
	Tx SHIMANO ORIGINAL	2480 MHz
		2478 MHz

*1) Spurious emissions for frequencies below 1 GHz were limited to the channel that had the highest power during the antenna terminal test, as preliminary testing indicated that changing the operating frequency had no significant impact on the emissions in those frequency bands.

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

No.	Item	Model number	Serial Number	Manufacturer	Remarks
A	Motor Unit	7KX1	7KXVLS30001 *1) 7KXVLS10013 *2) 7KXVLS10003 *3) 7KXVLS10071 *4) 7KXVLS1002E *5)	SHIMANO INC.	EUT

List of Cables Used

No.	Name	Length (m)	Shield		Remarks
			Cable	Connector	
1	DC Cable	2.85 (for RE*) 0.60 (for AT*)	Unshielded	Unshielded	-

1) for RE of Mode BT LE and ANT+

2) for AT of Mode BT LE and ANT+

3) for RE of Mode SHIMANO ORIGINAL

4) for AT of Mode SHIMANO ORIGINAL

*5) for Burst rate confirmation (PK with Duty Factor)

*RE: Radiated Spurious Emission, AT: Antenna Terminal Conducted Tests

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.

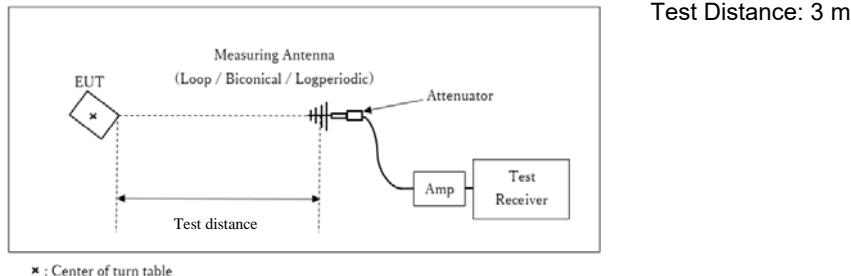
20 dBc was applied to the frequency over the limit of FCC 15.209 / Table 4 of RSS-Gen 8.9(ISED) and outside the restricted band of FCC15.205 / Table 6 of RSS-Gen 8.10 (ISED).

Frequency	Below 1 GHz	Above 1 GHz	20 dBc	
Instrument Used	Test Receiver	Spectrum Analyzer	Spectrum Analyzer	
Detector	QP	PK	AV	
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. <u>15.35(c) Peak with Duty</u> <u>factor *1)</u>	RBW: 100 kHz VBW: 300 kHz

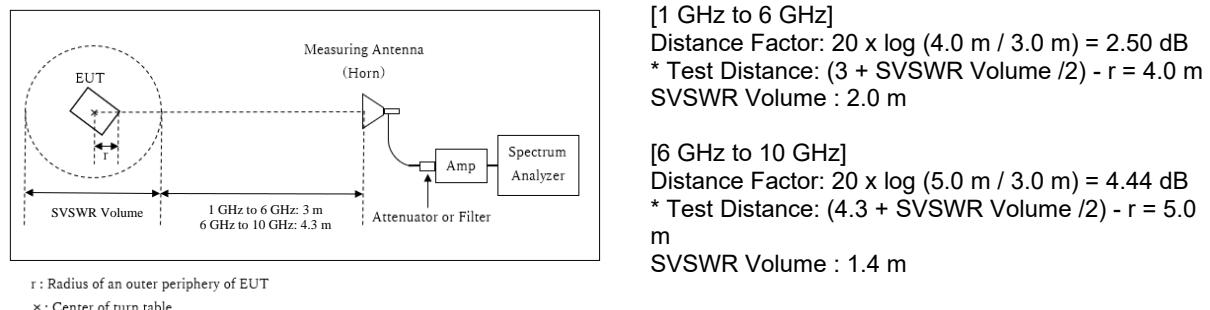
*1) The test was performed that the spurious evaluation as peak with duty factor since the pulse emission which is synchronous the worst duty cycle of ANT+ and SHIMANO ORIGINAL.

Figure 2: Test Setup

Below 1 GHz



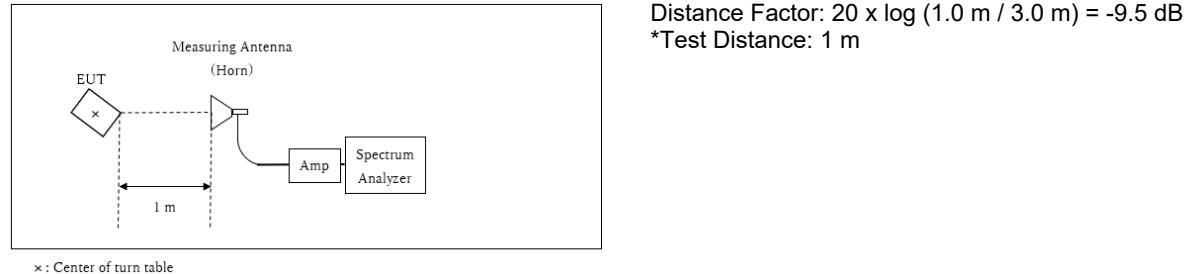
1 GHz to 10 GHz



(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



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	2 MHz / 3 MHz / 5 MHz / 10 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 low enough 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

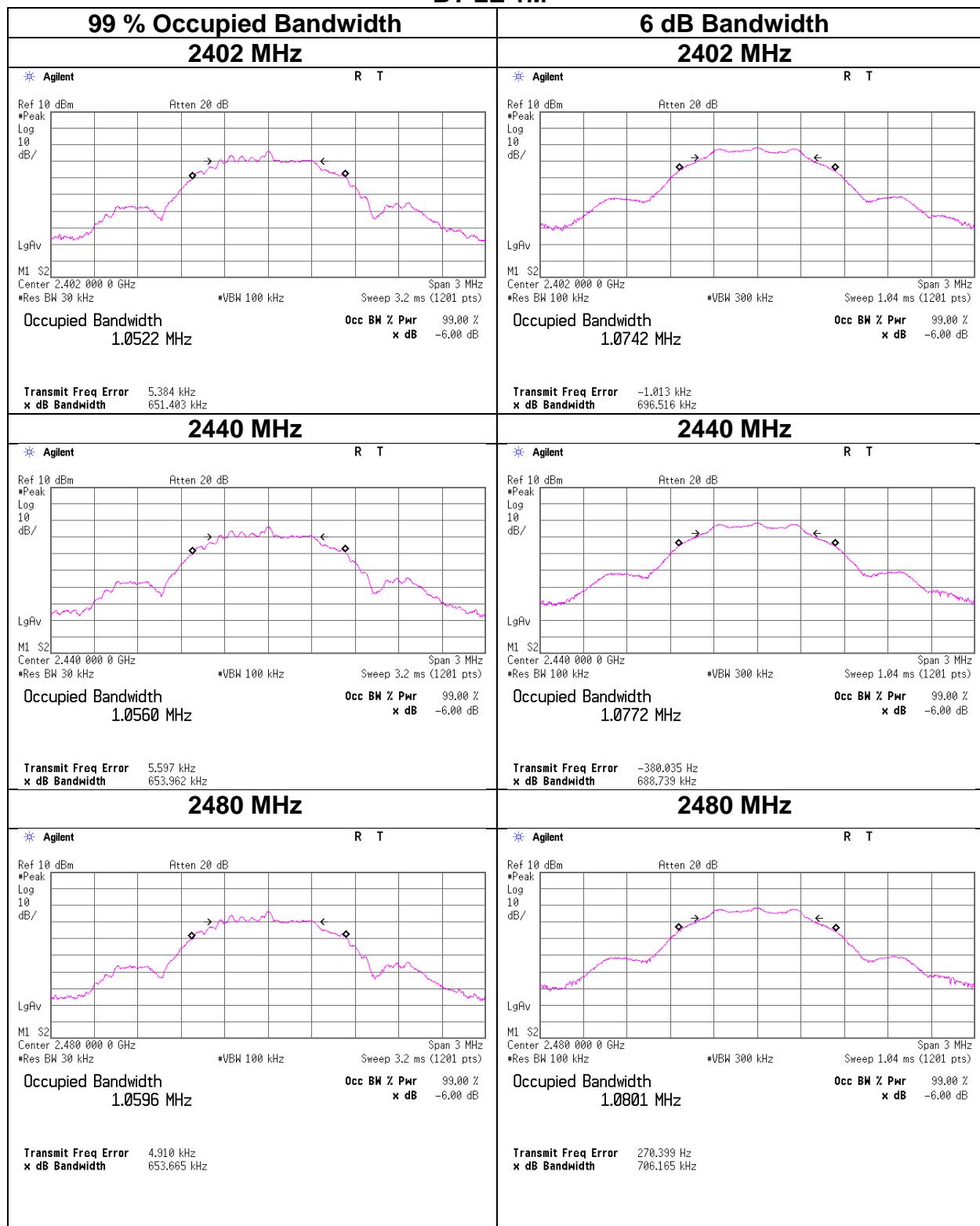
99 % Occupied Bandwidth and 6 dB Bandwidth

Test place	Ise EMC Lab.
Measurement Room	No.10
Date	March 12, 2024
Temperature / Humidity	24 deg. C / 35 % RH
Engineer	Takafumi Noguchi
Mode	Tx
	No.6
	May 15, 2024
	23 deg. C / 48 % RH
	Shousei Hamaguchi

Mode	Frequency [MHz]	99% Occupied Bandwidth [kHz]	6dB Bandwidth [MHz]	Limit for 6dB Bandwidth [MHz]
BT LE 1M	2402	1052.2	0.697	> 0.5000
	2440	1056.0	0.689	> 0.5000
	2480	1059.6	0.706	> 0.5000
BT LE 2M	2402	2059.7	1.129	> 0.5000
	2440	2064.9	1.140	> 0.5000
	2480	2067.7	1.161	> 0.5000
ANT+	2402	845.8	0.501	> 0.5000
	2441	863.7	0.501	> 0.5000
	2480	821.3	0.500	> 0.5000
SHIMANO ORIGINAL	2478	2102.4	1.400	> 0.5000

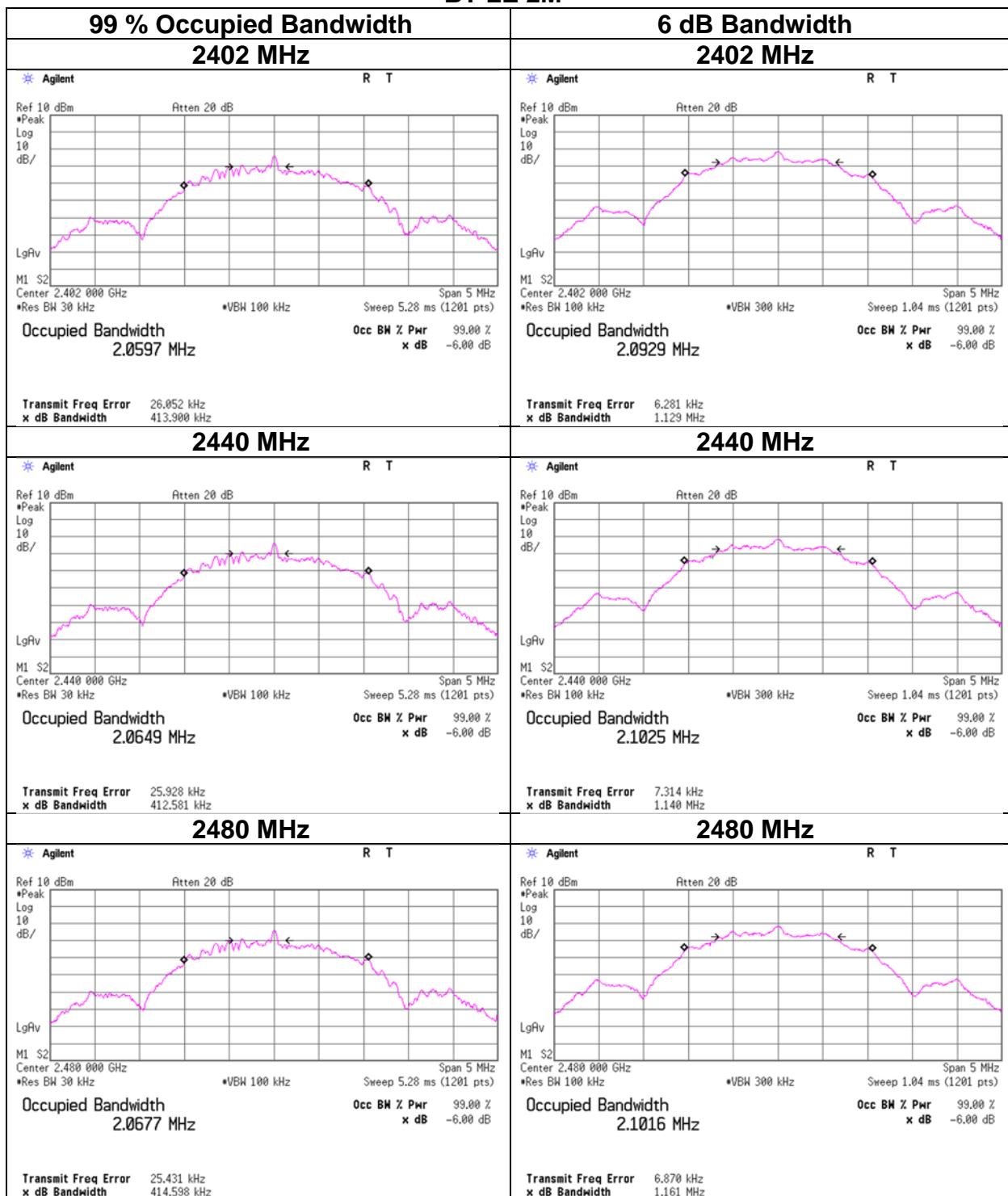
99 % Occupied Bandwidth and 6 dB Bandwidth

BT LE 1M



99 % Occupied Bandwidth and 6 dB Bandwidth

BT LE 2M



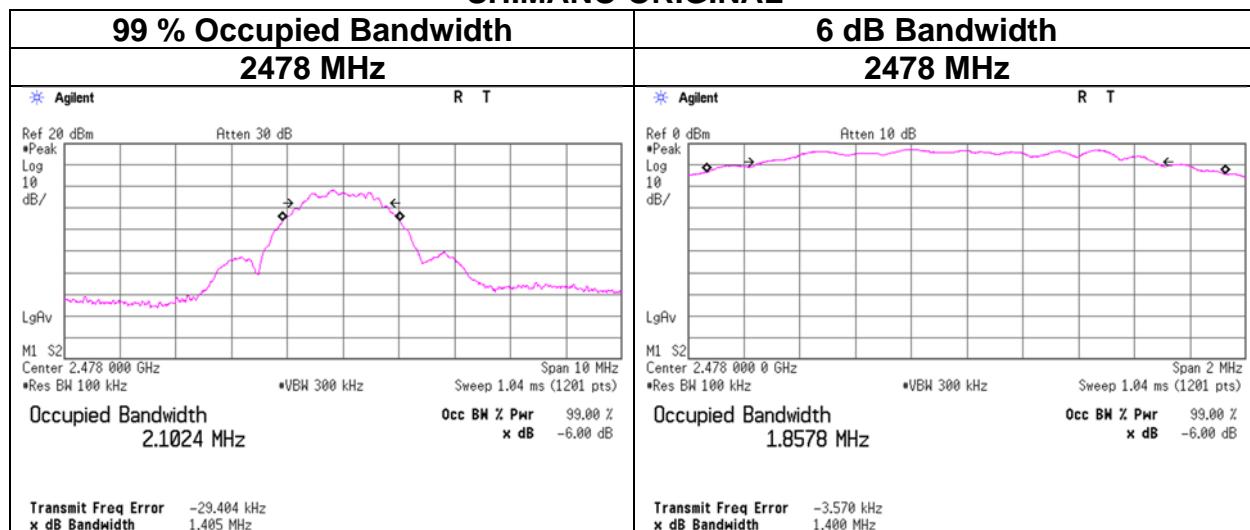
99 % Occupied Bandwidth and 6 dB Bandwidth

ANT+

99 % Occupied Bandwidth		6 dB Bandwidth	
2402 MHz		2402 MHz	
<p>Agilent</p> <p>Ref 20 dBm Atten 30 dB</p> <p>*Peak Log 10 dB/</p> <p>M1 S2</p> <p>Center 2,402,000 GHz *Res BW 30 kHz</p> <p>Occupied Bandwidth 845.8227 kHz</p> <p>Transmit Freq Error 15.101 kHz</p> <p>x dB Bandwidth 336.334 kHz</p>	<p>Agilent</p> <p>Ref 20 dBm Atten 30 dB</p> <p>*Peak Log 10 dB/</p> <p>M1 S2</p> <p>Center 2,402,000 GHz *Res BW 100 kHz</p> <p>Occupied Bandwidth 964.6659 kHz</p> <p>Transmit Freq Error -3.827 kHz</p> <p>x dB Bandwidth 500.786 kHz</p>	<p>Agilent</p> <p>Ref 20 dBm Atten 30 dB</p> <p>*Peak Log 10 dB/</p> <p>M1 S2</p> <p>Center 2,441,000 GHz *Res BW 30 kHz</p> <p>Occupied Bandwidth 863.7110 kHz</p> <p>Transmit Freq Error 2.184 kHz</p> <p>x dB Bandwidth 339.760 kHz</p>	<p>Agilent</p> <p>Ref 20 dBm Atten 30 dB</p> <p>*Peak Log 10 dB/</p> <p>M1 S2</p> <p>Center 2,441,000 GHz *Res BW 100 kHz</p> <p>Occupied Bandwidth 966.1224 kHz</p> <p>Transmit Freq Error -8.475 kHz</p> <p>x dB Bandwidth 500.865 kHz</p>
<p>Agilent</p> <p>Ref 20 dBm Atten 30 dB</p> <p>*Peak Log 10 dB/</p> <p>M1 S2</p> <p>Center 2,480,000 GHz *Res BW 30 kHz</p> <p>Occupied Bandwidth 821.2584 kHz</p> <p>Transmit Freq Error 21.340 kHz</p> <p>x dB Bandwidth 337.463 kHz</p>	<p>Agilent</p> <p>Ref 20 dBm Atten 30 dB</p> <p>*Peak Log 10 dB/</p> <p>M1 S2</p> <p>Center 2,480,000 GHz *Res BW 100 kHz</p> <p>Occupied Bandwidth 912.0519 kHz</p> <p>Transmit Freq Error 12.812 kHz</p> <p>x dB Bandwidth 500.263 kHz</p>	<p>Agilent</p> <p>Ref 20 dBm Atten 30 dB</p> <p>*Peak Log 10 dB/</p> <p>M1 S2</p> <p>Center 2,480,000 GHz *Res BW 30 kHz</p> <p>Occupied Bandwidth 912.0519 kHz</p> <p>Transmit Freq Error 12.812 kHz</p> <p>x dB Bandwidth 500.263 kHz</p>	<p>Agilent</p> <p>Ref 20 dBm Atten 30 dB</p> <p>*Peak Log 10 dB/</p> <p>M1 S2</p> <p>Center 2,480,000 GHz *Res BW 100 kHz</p> <p>Occupied Bandwidth 912.0519 kHz</p> <p>Transmit Freq Error 12.812 kHz</p> <p>x dB Bandwidth 500.263 kHz</p>

99 % Occupied Bandwidth and 6 dB Bandwidth

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Maximum Peak Output Power

Test place Ise EMC Lab. No.6 Measurement Room
 Date May 14, 2024
 Temperature / Humidity 21 deg. C / 47 % RH
 Engineer Shousei Hamaguchi
 Mode Tx BT LE

1M				Conducted Power					e.i.r.p. for RSS-247					
Freq. [MHz]	Reading [dBm]	Cable Loss [dB]	Atten. Loss [dB]	Result		Limit		Margin	Antenna Gain [dBi]	Result		Limit		Margin
				[dBm]	[mW]	[dBm]	[mW]			[dBm]	[mW]	[dBm]	[mW]	
2402	-11.39	1.89	9.74	0.24	1.06	30.00	1000	29.76	0.01	0.25	1.06	36.02	4000	35.77
2440	-11.22	1.90	9.75	0.43	1.10	30.00	1000	29.57	0.01	0.44	1.11	36.02	4000	35.58
2480	-11.20	1.91	9.75	0.46	1.11	30.00	1000	29.54	0.01	0.47	1.11	36.02	4000	35.55

2M				Conducted Power					e.i.r.p. for RSS-247					
Freq. [MHz]	Reading [dBm]	Cable Loss [dB]	Atten. Loss [dB]	Result		Limit		Margin	Antenna Gain [dBi]	Result		Limit		Margin
				[dBm]	[mW]	[dBm]	[mW]			[dBm]	[mW]	[dBm]	[mW]	
2402	-11.44	1.89	9.74	0.19	1.04	30.00	1000	29.81	0.01	0.20	1.05	36.02	4000	35.82
2440	-11.28	1.90	9.75	0.37	1.09	30.00	1000	29.63	0.01	0.38	1.09	36.02	4000	35.64
2480	-11.24	1.91	9.75	0.42	1.10	30.00	1000	29.58	0.01	0.43	1.10	36.02	4000	35.59

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.

Maximum Peak Output Power

Test place Ise EMC Lab. No.6 Measurement Room
Date May 14, 2024
Temperature / Humidity 21 deg. C / 47 % RH
Engineer Shousei Hamaguchi
Mode Tx ANT+

Freq. [MHz]	Reading [dBm]	Cable Loss [dB]	Atten. Loss [dB]	Conducted Power				Antenna Gain [dBi]	e.i.r.p. for RSS-247						
				Result		Limit			Margin	Result		Limit		Margin	
				[dBm]	[mW]	[dBm]	[mW]			[dB]	[dBm]	[mW]	[dBm]	[mW]	
2402	-7.51	1.89	9.74	4.12	2.58	30.00	1000	25.88	0.01	4.13	2.59	36.02	4000	31.89	
2441	-7.52	1.90	9.75	4.13	2.59	30.00	1000	25.87	0.01	4.14	2.59	36.02	4000	31.88	
2480	-7.59	1.91	9.75	4.07	2.55	30.00	1000	25.93	0.01	4.08	2.56	36.02	4000	31.94	

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.

Maximum Peak Output Power

Test place Ise EMC Lab. No.6 Measurement Room
Date May 12, 2024
Temperature / Humidity 24 deg. C / 35 % RH
Engineer Takafumi Noguchi
Mode Tx SHIMANO ORIGINAL

Freq. [MHz]	Reading [dBm]	Cable Loss [dB]	Atten. Loss [dB]	Conducted Power				Antenna Gain [dBi]	e.i.r.p. for RSS-247					
				Result [dBm]	Limit [mW]	Margin [dB]	Result [dBm]		Limit [mW]	Margin [dB]				
2478	0.07	2.38	6.13	8.58	7.21	30.00	1000	21.42	-0.53	8.05	6.38	36.02	4000	27.97

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.						
Measurement Room	No.10						
Date	March 14, 2024						
Temperature / Humidity	22 deg. C / 20 % RH						
Engineer	Takafumi Noguchi						
Mode	Tx						

BT LE 1M

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	-13.82	1.89	9.74	-2.19	0.60	1.97	-0.22	0.95
2440	-13.90	1.90	9.75	-2.25	0.60	1.97	-0.28	0.94
2480	-13.92	1.91	9.75	-2.26	0.59	1.97	-0.29	0.94

BT LE 2M

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	-16.82	1.89	9.74	-5.19	0.30	4.73	-0.46	0.90
2440	-16.70	1.90	9.75	-5.05	0.31	4.73	-0.32	0.93
2480	-16.71	1.91	9.75	-5.05	0.31	4.73	-0.32	0.93

ANT+

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	-30.82	1.89	9.74	-19.19	0.01	23.05	3.86	2.43
2441	-30.89	1.90	9.75	-19.24	0.01	23.05	3.81	2.40
2480	-31.00	1.91	9.75	-19.34	0.01	23.05	3.71	2.35

SHIMANO ORIGINAL

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	-0.13	2.38	6.13	8.38	6.89	0.00	8.38	6.89

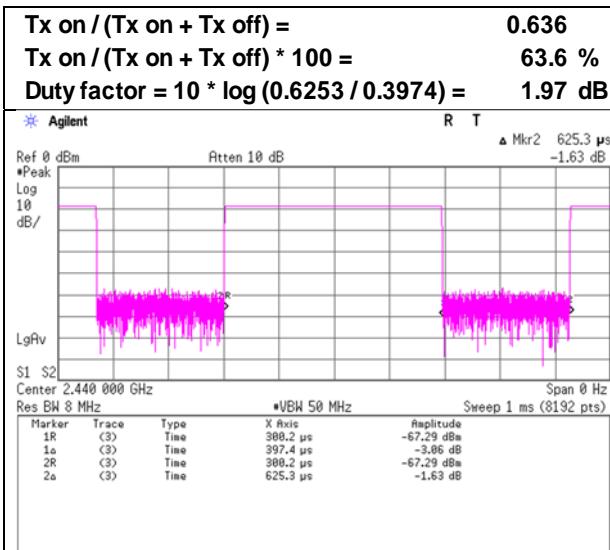
Sample Calculation:

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

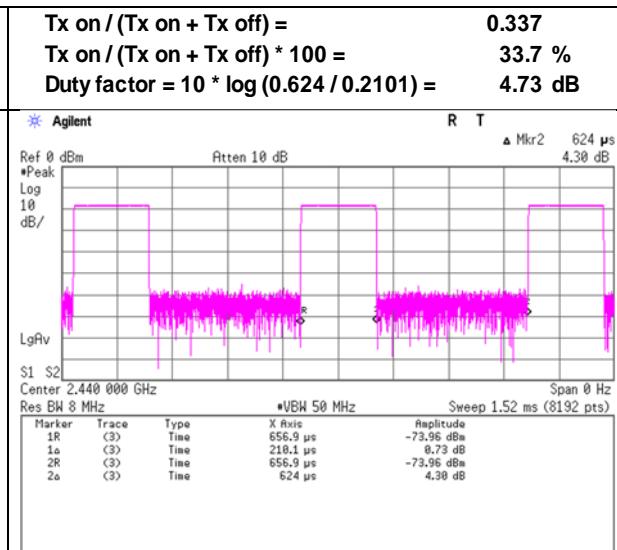
Burst rate confirmation

Test place Ise EMC Lab. No.3 Semi Anechoic Chamber
 Date May 10, 2024
 Temperature / Humidity 23 deg. C / 38 % RH
 Engineer Tomoya Sone
 Mode Tx

BT LE 1M



BT LE 2M

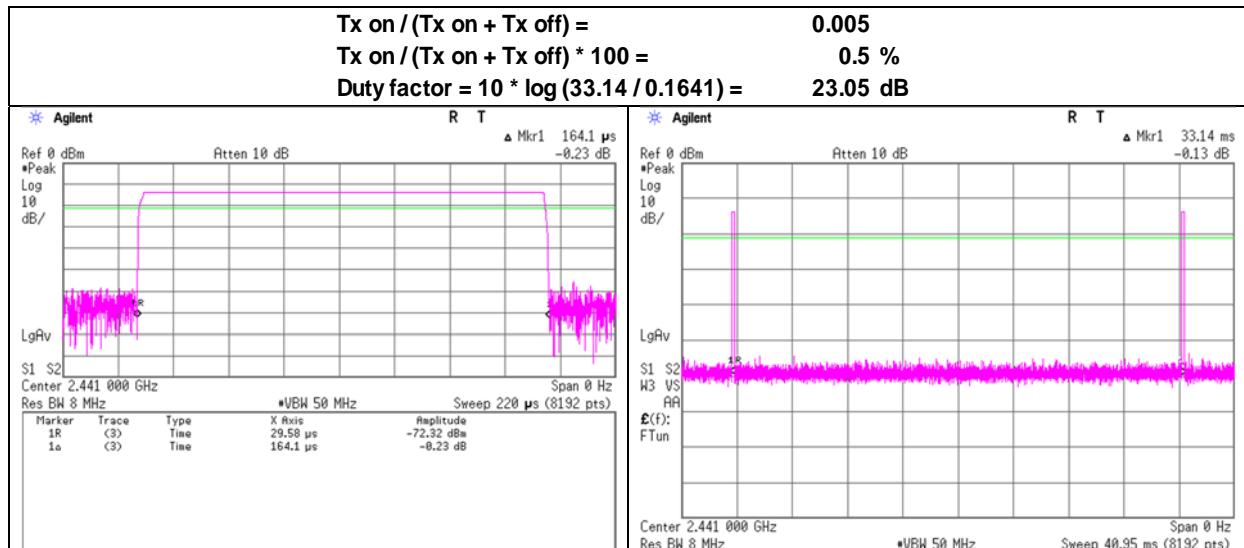


* Since the burst rate is not different between the channels, the data has been obtained on the representative channel.

Burst rate confirmation

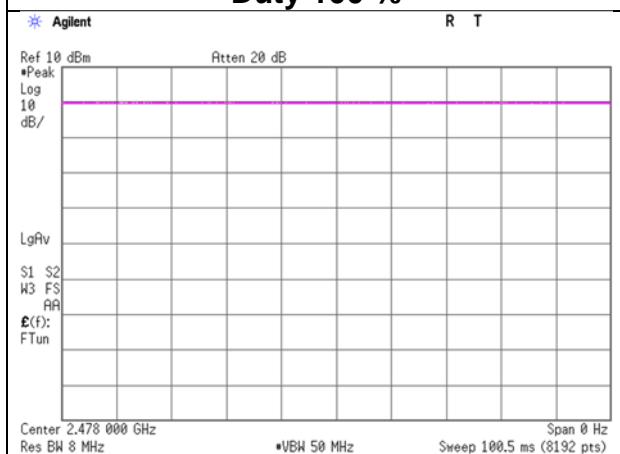
Test place Ise EMC Lab. No.3 Semi Anechoic Chamber
 Date May 10, 2024
 Temperature / Humidity 23 deg. C / 38 % RH
 Engineer Tomoya Sone
 Mode Tx

ANT+



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Duty 100 %

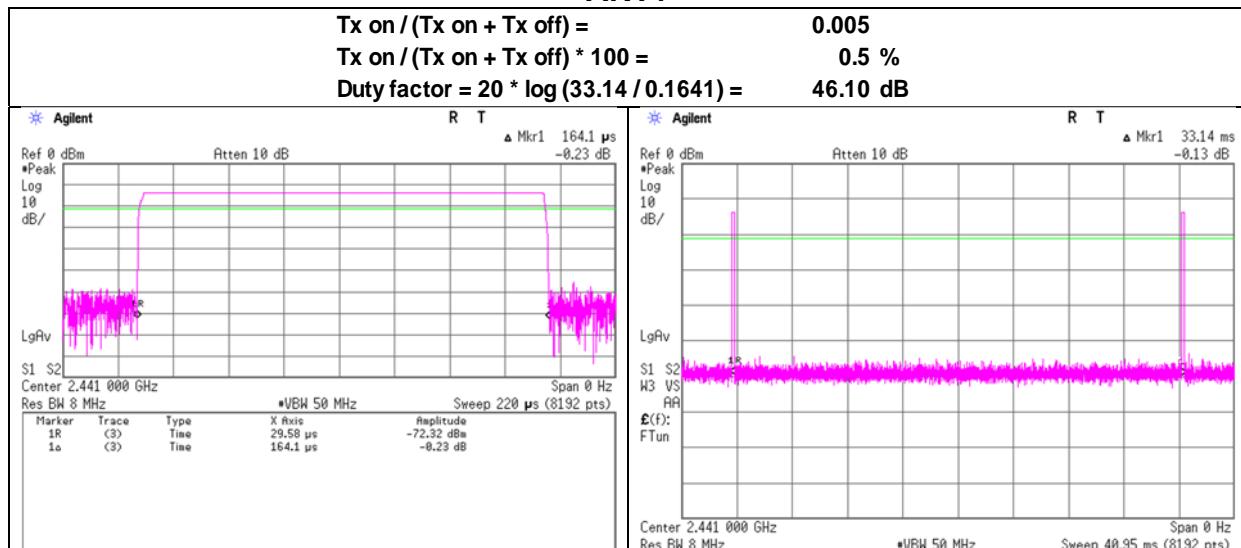


* Since the burst rate is not different between the channels, the data has been obtained on the representative channel.

Burst rate confirmation
(Reference data for Peak with Duty factor)

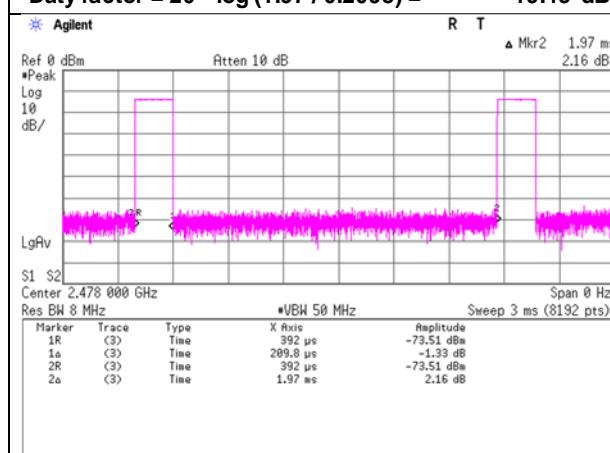
Test place Ise EMC Lab. No.3 Semi Anechoic Chamber
Date May 10, 2024
Temperature / Humidity 23 deg. C / 38 % RH
Engineer Tomoya Sone
Mode Tx

ANT+



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Tx on / (Tx on + Tx off) = **0.106**
Tx on / (Tx on + Tx off) * 100 = **10.6 %**
Duty factor = 20 * log (1.97 / 0.2098) = **19.45 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	No.3	No.2
Date	May 9, 2024	May 10, 2024	May 17, 2024
Temperature / Humidity	20 deg. C / 40 % RH	23 deg. C / 38 % RH	22 deg. C / 48 % RH
Engineer	Tetsuro Yoshida (6 GHz to 10 GHz)	Tomoya Sone (1 GHz to 6 GHz)	Hiroki Numata (Above 10 GHz)
Mode	Tx BT LE 1M 2402 MHz		

Polarity	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.	2390.0	44.7	31.2	27.5	5.5	32.2	2.0	45.5	34.0	73.9	53.9	28.4	19.9	*1)
Hori.	4804.0	40.7	32.5	31.4	7.6	31.2	-	48.5	40.3	73.9	53.9	25.4	13.6	Floor noise
Hori.	7206.0	44.5	33.4	35.6	10.7	32.0	-	58.7	47.7	73.9	53.9	15.2	6.2	Floor noise
Hori.	9608.0	43.6	33.2	35.6	11.2	32.6	-	57.8	47.4	73.9	53.9	16.1	6.5	Floor noise
Vert.	2390.0	42.6	31.6	27.5	5.5	32.2	2.0	43.4	34.4	73.9	53.9	30.5	19.5	*1)
Vert.	4804.0	40.6	32.4	31.4	7.6	31.2	-	48.4	40.2	73.9	53.9	25.5	13.7	Floor noise
Vert.	7206.0	44.3	33.6	35.6	10.7	32.0	-	58.6	47.8	73.9	53.9	15.3	6.1	Floor noise
Vert.	9608.0	43.6	33.1	35.6	11.2	32.6	-	57.8	47.3	73.9	53.9	16.1	6.6	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)

20dBc Data Sheet

Polarity	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	94.2	27.5	5.5	32.2	95.0	-	-	-Carrier
Hori.	2400.0	45.9	27.5	5.5	32.2	46.7	75.0	28.3	
Vert.	2402.0	92.4	27.5	5.5	32.2	93.2	-	-	-Carrier
Vert.	2400.0	44.4	27.5	5.5	32.2	45.1	73.2	28.1	

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

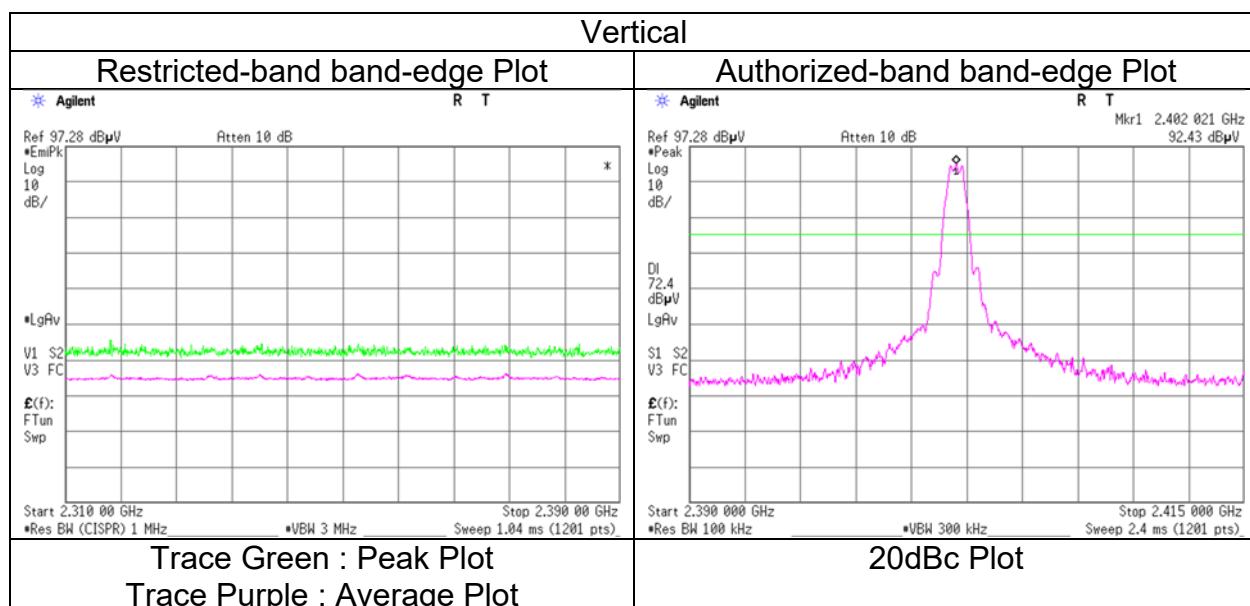
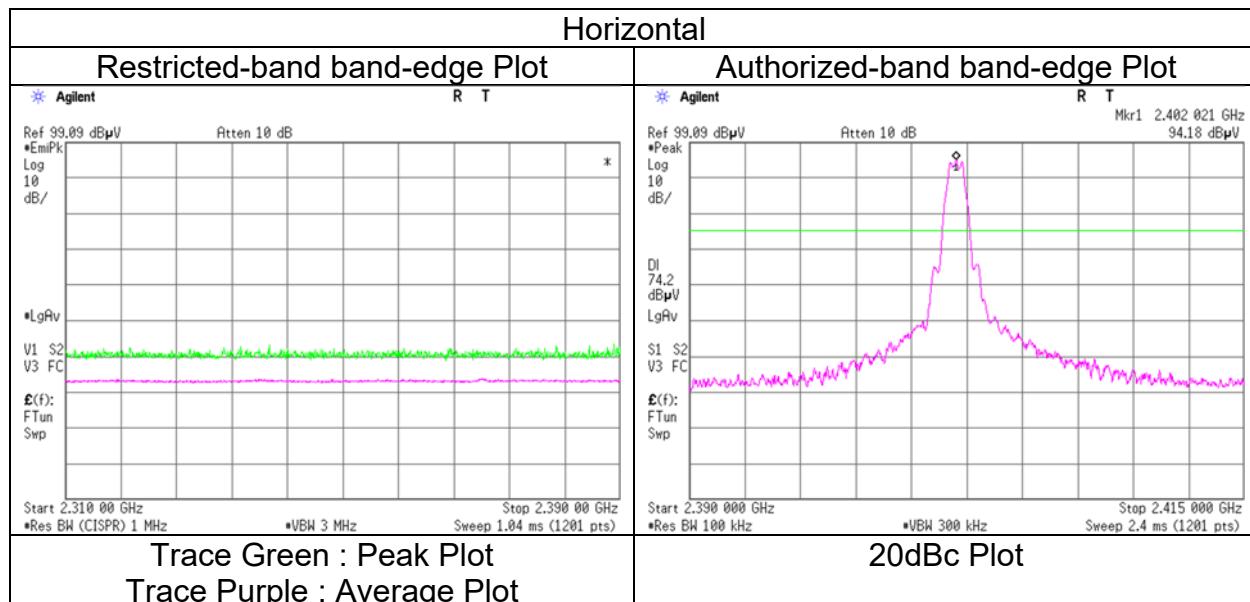
Distance factor: 1 GHz - 6 GHz $20\log(4\text{ m} / 3.0\text{ m}) = 2.5\text{ dB}$

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
Date May 10, 2024
Temperature / Humidity 23 deg. C / 38 % RH
Engineer Tomoya Sone
(1 GHz to 6 GHz)
Mode Tx BT LE 1M 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	Ise EMC Lab.		
Semi Anechoic Chamber	No.3	No.3	No.2
Date	May 9, 2024	May 10, 2024	May 17, 2024
Temperature / Humidity	20 deg. C / 40 % RH	23 deg. C / 38 % RH	22 deg. C / 48 % RH
Engineer	Tetsuro Yoshida (6 GHz to 10 GHz)	Tomoya Sone (1 GHz to 6 GHz)	Hiroki Numata (Above 10 GHz)
Mode	Tx BT LE 1M 2440 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.	4880.0	41.3	31.9	31.4	7.6	31.2	-	49.2	39.7	73.9	53.9	24.7	14.2	Floor noise
Hori.	7320.0	43.6	33.4	35.6	10.7	32.1	-	57.8	47.7	73.9	53.9	16.1	6.2	Floor noise
Hori.	9760.0	43.0	33.1	35.9	11.3	32.7	-	57.5	47.6	73.9	53.9	16.4	6.3	Floor noise
Vert.	4880.0	41.5	31.7	31.4	7.6	31.2	-	49.4	39.6	73.9	53.9	24.6	14.3	Floor noise
Vert.	7320.0	43.6	33.1	35.6	10.7	32.1	-	57.9	47.4	73.9	53.9	16.0	6.5	Floor noise
Vert.	9760.0	43.6	33.3	35.9	11.3	32.7	-	58.1	47.8	73.9	53.9	15.8	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 $20\log(4 \text{ m} / 3.0 \text{ m}) = 2.5 \text{ dB}$
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

Test place	Ise EMC Lab.			
Semi Anechoic Chamber	No.3	No.3	No.2	No.2
Date	May 9, 2024	May 10, 2024	May 16, 2024	May 17, 2024
Temperature / Humidity	20 deg. C / 40 % RH	23 deg. C / 38 % RH	24 deg. C / 58 % RH	22 deg. C / 48 % RH
Engineer	Tetsuro Yoshida (6 GHz to 10 GHz)	Tomoya Sone (1 GHz to 6 GHz)	Hiroyuki Furutaka (Below 1 GHz)	Hiroki Numata (Above 10 GHz)
Mode	Tx BT LE 1M 2480 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.	38.6	20.4	-	15.3	6.7	28.5	-	13.9	-	40.0	-	26.1	-	
Hori.	63.6	21.8	-	7.0	7.0	28.5	-	7.3	-	40.0	-	32.7	-	
Hori.	84.5	22.1	-	7.5	7.2	28.4	-	8.4	-	40.0	-	31.6	-	
Hori.	89.0	22.5	-	8.3	7.3	28.4	-	9.7	-	43.5	-	33.9	-	
Hori.	118.9	21.3	-	12.7	7.5	28.3	-	13.2	-	43.5	-	30.3	-	
Hori.	208.3	20.3	-	11.6	8.2	27.9	-	12.1	-	43.5	-	31.4	-	
Hori.	2483.5	58.9	44.0	27.4	5.6	32.2	2.0	59.7	46.7	73.9	53.9	14.2	7.2	*1)
Hori.	4960.0	41.0	32.3	31.6	7.6	31.1	-	49.0	40.4	73.9	53.9	24.9	13.5	Floor noise
Hori.	7440.0	43.6	33.5	35.5	10.7	32.1	-	57.7	47.6	73.9	53.9	16.2	6.3	Floor noise
Hori.	9920.0	43.9	33.2	36.1	11.3	32.8	-	58.5	47.9	73.9	53.9	15.4	6.0	Floor noise
Vert.	38.6	21.7	-	15.3	6.7	28.5	-	15.2	-	40.0	-	24.8	-	
Vert.	63.6	22.0	-	7.0	7.0	28.5	-	7.5	-	40.0	-	32.5	-	
Vert.	84.5	22.5	-	7.5	7.2	28.4	-	8.8	-	40.0	-	31.2	-	
Vert.	89.0	22.5	-	8.3	7.3	28.4	-	9.7	-	43.5	-	33.9	-	
Vert.	118.9	21.2	-	12.7	7.5	28.3	-	13.1	-	43.5	-	30.4	-	
Vert.	208.3	20.4	-	11.6	8.2	27.9	-	12.2	-	43.5	-	31.3	-	
Vert.	2483.5	56.5	40.6	27.4	5.6	32.2	2.0	57.3	43.3	73.9	53.9	16.6	10.6	*1)
Vert.	4960.0	40.8	32.3	31.6	7.6	31.1	-	48.9	40.3	73.9	53.9	25.0	13.6	Floor noise
Vert.	7440.0	43.6	33.4	35.5	10.7	32.1	-	57.6	47.5	73.9	53.9	16.3	6.4	Floor noise
Vert.	9920.0	43.7	33.2	36.1	11.3	32.8	-	58.4	47.8	73.9	53.9	15.5	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).

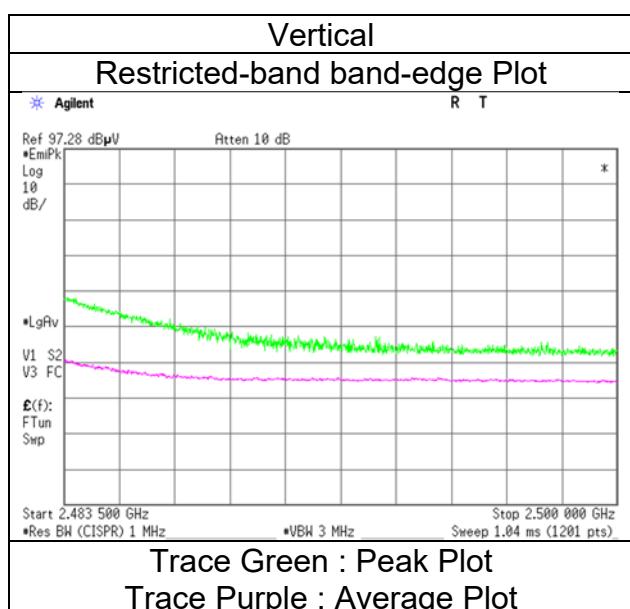
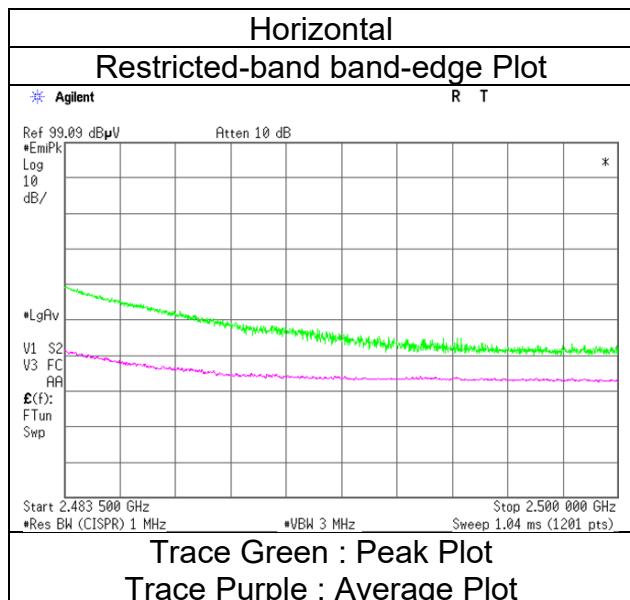
*QP detector was used up to 1GHz

*1) Not Out of Band emission(Leakage Power)

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 May 10, 2024
Temperature / Humidity 23 deg. C / 38 % RH
Engineer Tomoya Sone
(1 GHz to 6 GHz)
Mode Tx BT LE 1M 2480 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

Test place	Ise EMC Lab.		
Semi Anechoic Chamber	No.3	No.3	No.2
Date	May 9, 2024	May 10, 2024	May 17, 2024
Temperature / Humidity	20 deg. C / 40 % RH	23 deg. C / 38 % RH	22 deg. C / 48 % RH
Engineer	Tetsuro Yoshida (6 GHz to 10 GHz)	Tomoya Sone (1 GHz to 6 GHz)	Hiroki Numata (Above 10 GHz)
Mode	Tx BT LE 2M 2402 MHz		

Polarity	Frequency	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/Vert]	[MHz]													
Hori.	2390.0	45.1	31.7	27.5	5.5	32.2	4.7	45.9	37.2	73.9	53.9	28.1	16.7	"1)
Hori.	4804.0	40.8	32.5	31.4	7.6	31.2	-	48.6	40.4	73.9	53.9	25.3	13.6	Floor noise
Hori.	7206.0	44.2	33.3	35.6	10.7	32.0	-	58.5	47.6	73.9	53.9	15.4	6.3	Floor noise
Hori.	9608.0	43.5	33.2	35.6	11.2	32.6	-	57.7	47.3	73.9	53.9	16.2	6.6	Floor noise
Vert.	2390.0	42.9	31.4	27.5	5.5	32.2	4.7	43.7	36.9	73.9	53.9	30.2	17.0	"1)
Vert.	4804.0	40.7	32.7	31.4	7.6	31.2	-	48.5	40.5	73.9	53.9	25.4	13.4	Floor noise
Vert.	7206.0	44.2	33.4	35.6	10.7	32.0	-	58.4	47.7	73.9	53.9	15.5	6.2	Floor noise
Vert.	9608.0	43.7	33.3	35.6	11.2	32.6	-	57.9	47.5	73.9	53.9	16.0	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

*1) Not Out of Band emission(Leakage Power)

20dBc Data Sheet

Polarity	Frequency	Reading (PK) [dBuV]	Ant Factor [dB/m]	Loss [dB]	Gain [dB]	Result [dBuV/m]	Limit [dBuV/m]	Margin [dB]	Remark
[Hori/Vert]	[MHz]								
Hori.	2402.0	93.7	27.5	5.5	32.2	94.5	-	-	Carrier
Hori.	2400.0	62.2	27.5	5.5	32.2	63.0	74.5	11.5	
Vert.	2402.0	91.7	27.5	5.5	32.2	92.5	-	-	Carrier
Vert.	2400.0	60.0	27.5	5.5	32.2	60.8	72.5	11.7	

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

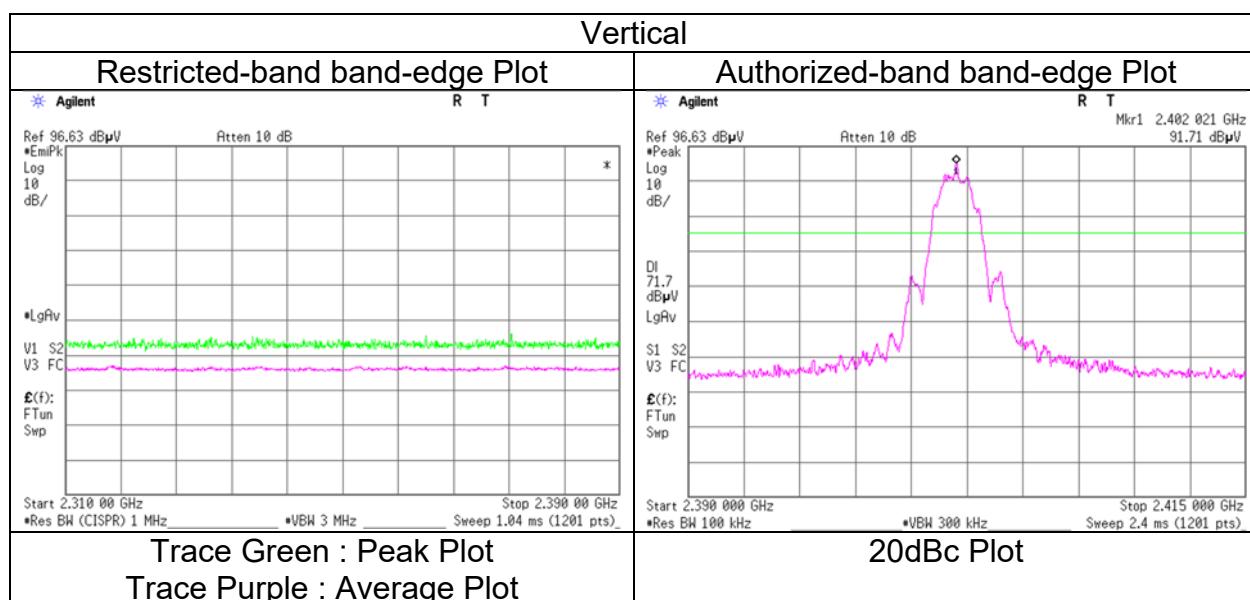
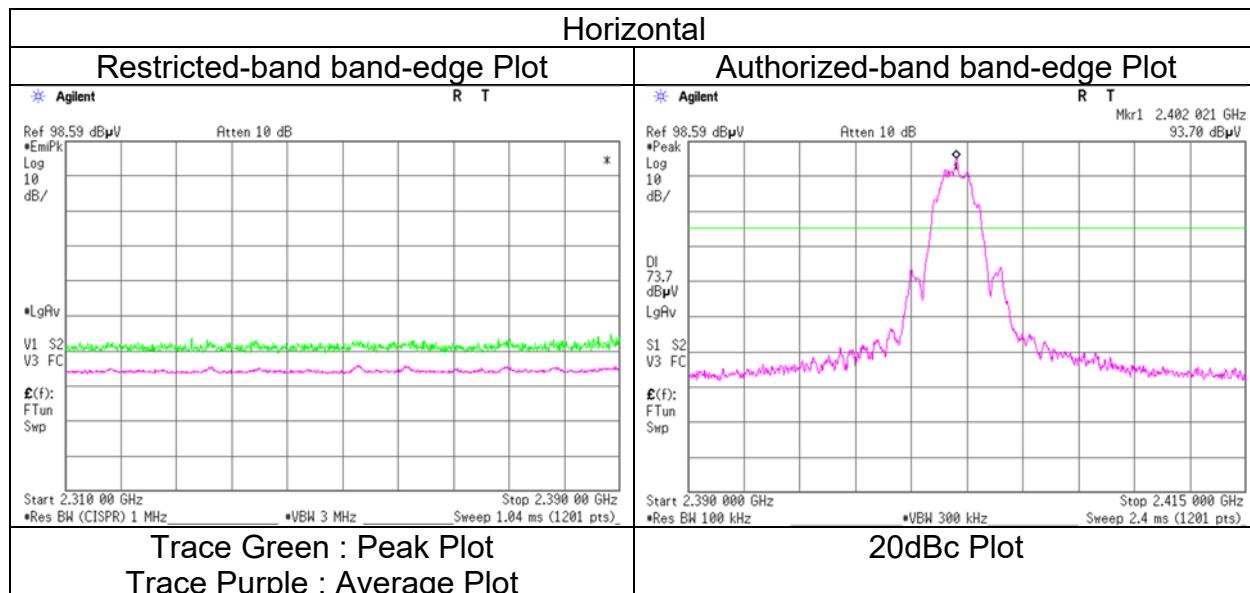
Distance factor: 1 GHz - 6 GHz $20\log(4\text{ m} / 3.0\text{ m}) = 2.5\text{ dB}$

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 May 10, 2024
Temperature / Humidity 23 deg. C / 38 % RH
Engineer Tomoya Sone
(1 GHz to 6 GHz)
Mode Tx BT LE 2M 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	Ise EMC Lab.		
Semi Anechoic Chamber	No.3	No.3	No.2
Date	May 9, 2024	May 10, 2024	May 17, 2024
Temperature / Humidity	20 deg. C / 40 % RH	23 deg. C / 38 % RH	22 deg. C / 48 % RH
Engineer	Tetsuro Yoshida (6 GHz to 10 GHz)	Tomoya Sone (1 GHz to 6 GHz)	Hiroki Numata (Above 10 GHz)
Mode	Tx BT LE 2M 2440 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.	4880.0	41.6	31.8	31.4	7.6	31.2	-	49.4	39.6	73.9	53.9	24.5	14.3	Floor noise
Hori.	7320.0	43.8	33.3	35.6	10.7	32.1	-	58.1	47.5	73.9	53.9	15.8	6.4	Floor noise
Hori.	9760.0	43.5	33.3	35.9	11.3	32.7	-	58.0	47.8	73.9	53.9	15.9	6.1	Floor noise
Vert.	4880.0	41.4	31.6	31.4	7.6	31.2	-	49.3	39.5	73.9	53.9	24.6	14.4	Floor noise
Vert.	7320.0	43.3	33.1	35.6	10.7	32.1	-	57.6	47.3	73.9	53.9	16.3	6.6	Floor noise
Vert.	9760.0	43.7	33.2	35.9	11.3	32.7	-	58.2	47.7	73.9	53.9	15.7	6.2	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 $20\log(4 \text{ m} / 3.0 \text{ m}) = 2.5 \text{ dB}$
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

Test place	Ise EMC Lab.			
Semi Anechoic Chamber	No.3	No.3	No.2	No.2
Date	May 9, 2024	May 10, 2024	May 16, 2024	May 17, 2024
Temperature / Humidity	20 deg. C / 40 % RH	23 deg. C / 38 % RH	24 deg. C / 58 % RH	22 deg. C / 48 % RH
Engineer	Tetsuro Yoshida (6 GHz to 10 GHz)	Tomoya Sone (1 GHz to 6 GHz)	Hiroyuki Furutaka (Below 1 GHz)	Hiroki Numata (Above 10 GHz)
Mode	Tx BT LE 2M 2480 MHz			

Polarity	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
Hor.	38.7	20.5	-	15.3	6.7	28.5	-	14.0	-	40.0	-	26.0	-	-
Hor.	65.0	21.9	-	6.8	7.1	28.5	-	7.2	-	40.0	-	32.8	-	-
Hor.	84.0	22.2	-	7.5	7.2	28.5	-	8.4	-	40.0	-	31.6	-	-
Hor.	89.0	22.5	-	8.3	7.3	28.4	-	9.7	-	43.5	-	33.9	-	-
Hor.	119.0	21.3	-	12.7	7.5	28.3	-	13.2	-	43.5	-	30.3	-	-
Hor.	209.0	20.3	-	11.6	8.2	27.9	-	12.1	-	43.5	-	31.4	-	-
Hor.	2483.5	58.4	34.3	27.4	5.6	32.2	4.7	59.1	39.8	73.9	53.9	14.8	14.2	*1)
Hor.	4960.0	39.8	32.3	31.6	7.6	31.1	-	47.9	40.3	73.9	53.9	26.1	13.6	Floor noise
Hor.	7440.0	43.3	33.2	35.5	10.7	32.1	-	57.3	47.3	73.9	53.9	16.6	6.6	Floor noise
Hor.	9920.0	43.7	33.2	36.1	11.3	32.8	-	58.3	47.8	73.9	53.9	15.6	6.1	Floor noise
Vert.	38.7	21.8	-	15.3	6.7	28.5	-	15.3	-	40.0	-	24.7	-	-
Vert.	65.0	22.1	-	6.8	7.1	28.5	-	7.4	-	40.0	-	32.6	-	-
Vert.	84.0	22.6	-	7.5	7.2	28.5	-	8.8	-	40.0	-	31.2	-	-
Vert.	89.0	22.5	-	8.3	7.3	28.4	-	9.7	-	43.5	-	33.9	-	-
Vert.	119.0	21.2	-	12.7	7.5	28.3	-	13.1	-	43.5	-	30.4	-	-
Vert.	209.0	20.4	-	11.6	8.2	27.9	-	12.2	-	43.5	-	31.3	-	-
Vert.	2483.5	55.1	40.7	27.4	5.6	32.2	4.7	55.8	46.2	73.9	53.9	18.1	7.7	*1)
Vert.	4960.0	39.9	32.4	31.6	7.6	31.1	-	48.0	40.4	73.9	53.9	25.9	13.5	Floor noise
Vert.	7440.0	43.3	33.4	35.5	10.7	32.1	-	57.3	47.4	73.9	53.9	16.6	6.5	Floor noise
Vert.	9920.0	43.3	33.2	36.1	11.3	32.8	-	57.9	47.8	73.9	53.9	16.0	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).

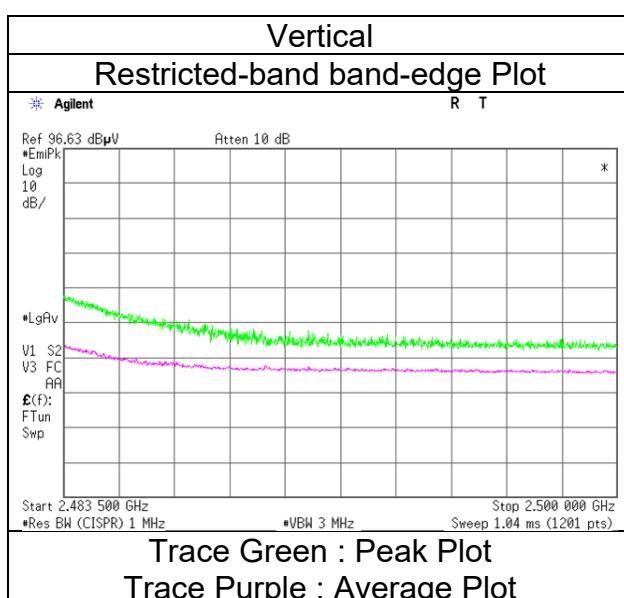
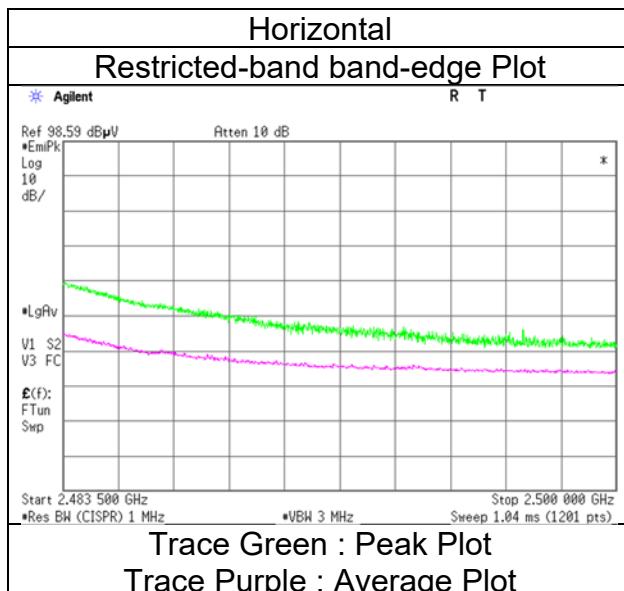
*QP detector was used up to 1GHz.

*1) Not Out of Band emission(Leakage Power)

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
Date May 10, 2024
Temperature / Humidity 23 deg. C / 38 % RH
Engineer Tomoya Sone
(1 GHz to 6 GHz)
Mode Tx BT LE 2M 2480 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

Test place	Ise EMC Lab.			
Semi Anechoic Chamber	No.3		No.3	No.2
Date	May 9, 2024		May 10, 2024	May 17, 2024
Temperature / Humidity	20 deg. C / 40 % RH		23 deg. C / 38 % RH	22 deg. C / 48 % RH
Engineer	Tetsuro Yoshida (6 GHz to 10 GHz)		Tomoya Sone (1 GHz to 6 GHz)	Hiroki Numata (Above 10 GHz)
Mode	Tx ANT+ 2402 MHz			

Polarity	Frequency	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/Vert]	[MHz]													
Hori.	2390.0	51.1	-	27.5	5.5	32.2	-	51.9	-	73.9	-	22.0	-	"1)
Hori.	4804.0	40.6	32.3	31.4	7.6	31.2	-	48.4	40.1	73.9	53.9	25.5	13.8	Floor noise
Hori.	7206.0	44.5	33.4	35.6	10.7	32.0	-	58.8	47.7	73.9	53.9	15.1	6.2	Floor noise
Hori.	9608.0	43.3	33.4	35.6	11.2	32.6	-	57.5	47.5	73.9	53.9	16.4	6.4	Floor noise
Vert.	2390.0	49.5	-	27.5	5.5	32.2	-	50.3	-	73.9	-	23.6	-	"1)
Vert.	4804.0	40.5	32.2	31.4	7.6	31.2	-	48.3	40.0	73.9	53.9	25.6	13.9	Floor noise
Vert.	7206.0	44.3	33.4	35.6	10.7	32.0	-	58.5	47.7	73.9	53.9	15.4	6.2	Floor noise
Vert.	9608.0	43.4	33.3	35.6	11.2	32.6	-	57.6	47.4	73.9	53.9	16.3	6.5	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)

20dBc Data Sheet

Polarity	Frequency	Reading (PK) [dBuV]	Ant Factor [dB/m]	Loss [dB]	Gain [dB]	Result [dBuV/m]	Limit [dBuV/m]	Margin [dB]	Remark
[Hori/Vert]	[MHz]								
Hori.	2402.0	98.4	27.5	5.5	32.2	99.2	-	-	Carrier
Hori.	2400.0	46.3	27.5	5.5	32.2	47.1	79.2	32.1	
Vert.	2402.0	96.8	27.5	5.5	32.2	97.6	-	-	Carrier
Vert.	2400.0	45.1	27.5	5.5	32.2	45.9	77.6	31.6	

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

PK with Duty factor

Polarity	Frequency	Reading (PK) [dBuV]	Ant Factor [dB/m]	Loss [dB]	Gain [dB]	Duty Factor [dB]	Result [dBuV/m]	Limit [dBuV/m]	Margin [dB]	Remark
[Hori/Vert]	[MHz]									
Hori.	2390.000	51.1	27.5	5.5	32.2	-46.1	5.8	53.9	48.1	*
Vert.	2390.000	49.5	27.5	5.5	32.2	-46.1	4.2	53.9	49.7	*

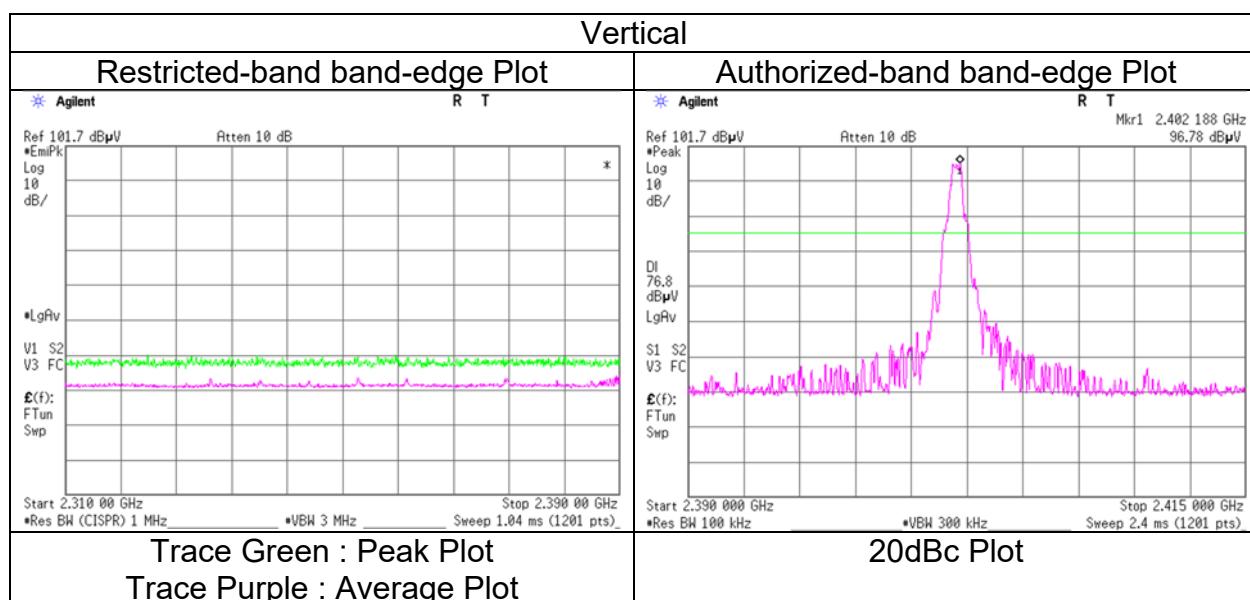
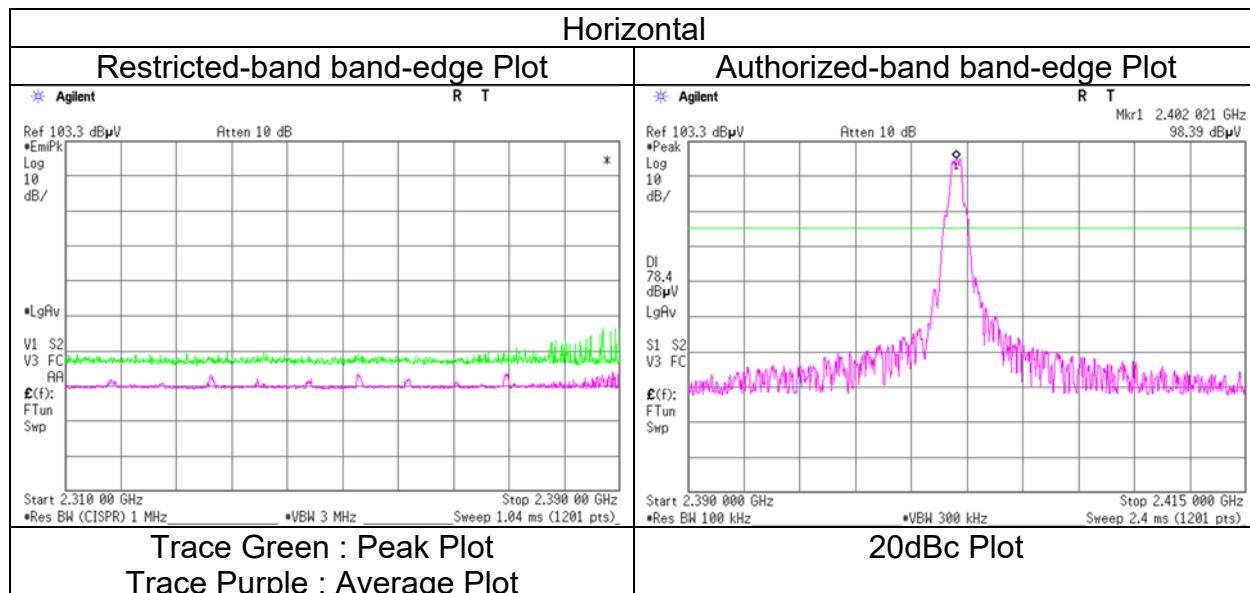
Result = Reading + Ant Factor + Loss (Cable+Attenuator+Filter+Distance factor(above 1 GHz)) - Gain(Amplifier) + Duty factor + Dwell time factor (Refer to dwell time data sheet)

* Above noise was synchronized with carrier frequency.

Distance factor: 1 GHz - 6 GHz 20log (4 m / 3.0 m) = 2.5 dB
6 GHz - 10 GHz 20log (5 m / 3.0 m) = 4.44 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 May 10, 2024
Temperature / Humidity 23 deg. C / 38 % RH
Engineer Tomoya Sone
(1 GHz to 6 GHz)
Mode Tx ANT+ 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	Ise EMC Lab.			
Semi Anechoic Chamber	No.3	No.3	No.2	No.2
Date	May 9, 2024	May 10, 2024	May 16, 2024	May 17, 2024
Temperature / Humidity	20 deg. C / 40 % RH	23 deg. C / 38 % RH	24 deg. C / 58 % RH	22 deg. C / 48 % RH
Engineer	Tetsuro Yoshida (6 GHz to 10 GHz)	Tomoya Sone (1 GHz to 6 GHz)	Hiroyuki Furutaka (Below 1 GHz)	Hiroki Numata (Above 10 GHz)
Mode	Tx ANT+ 2441 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.	55.1	21.5	-	9.3	7.0	28.5	-	9.2	-	40.0	-	30.8	-	
Hori.	64.5	21.6	-	6.8	7.1	28.5	-	7.0	-	40.0	-	33.0	-	
Hori.	93.6	21.9	-	9.0	7.3	28.4	-	9.8	-	43.5	-	33.7	-	
Hori.	103.7	21.4	-	10.7	7.4	28.4	-	11.1	-	43.5	-	32.4	-	
Hori.	212.3	20.3	-	11.5	8.2	27.9	-	12.1	-	43.5	-	31.4	-	
Hori.	223.8	20.6	-	11.6	8.3	27.9	-	12.6	-	46.0	-	33.4	-	
Hori.	4882.0	40.4	31.8	31.4	7.6	31.2	-	48.3	39.7	73.9	53.9	25.6	14.2	Floor noise
Hori.	7323.0	44.1	33.4	35.6	10.7	32.1	-	58.3	47.7	73.9	53.9	15.6	6.2	Floor noise
Hori.	9764.0	43.2	33.1	35.9	11.3	32.7	-	57.7	47.6	73.9	53.9	16.2	6.3	Floor noise
Vert.	55.1	21.5	-	9.3	7.0	28.5	-	9.2	-	40.0	-	30.8	-	
Vert.	64.5	21.7	-	6.8	7.1	28.5	-	7.1	-	40.0	-	32.9	-	
Vert.	93.6	22.0	-	9.0	7.3	28.4	-	9.9	-	43.5	-	33.6	-	
Vert.	103.7	21.5	-	10.7	7.4	28.4	-	11.2	-	43.5	-	32.3	-	
Vert.	212.3	20.4	-	11.5	8.2	27.9	-	12.2	-	43.5	-	31.3	-	
Vert.	223.8	20.7	-	11.6	8.3	27.9	-	12.7	-	46.0	-	33.3	-	
Vert.	4882.0	40.5	31.7	31.4	7.6	31.2	-	48.4	39.6	73.9	53.9	25.5	14.3	Floor noise
Vert.	7323.0	44.2	33.4	35.6	10.7	32.1	-	58.4	47.6	73.9	53.9	15.5	6.3	Floor noise
Vert.	9764.0	43.5	33.1	35.9	11.3	32.7	-	58.0	47.6	73.9	53.9	15.9	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 $20\log(4\text{ m} / 3.0\text{ m}) = 2.5\text{ dB}$
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

Test place	Ise EMC Lab.		
Semi Anechoic Chamber	No.3	No.3	No.2
Date	May 9, 2024	May 10, 2024	May 17, 2024
Temperature / Humidity	20 deg. C / 40 % RH	23 deg. C / 38 % RH	22 deg. C / 48 % RH
Engineer	Tetsuro Yoshida (6 GHz to 10 GHz)	Tomoya Sone (1 GHz to 6 GHz)	Hiroki Numata (Above 10 GHz)
Mode	Tx ANT+ 2480 MHz		

Polarity	Frequency	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/Vert]	[MHz]													
Hori.	2483.5	62.9	-	27.4	5.6	32.2	-	63.6	-	73.9	-	10.3	-	*1)
Hori.	4960.0	40.2	32.2	31.6	7.6	31.1	-	48.3	40.2	73.9	53.9	25.6	13.7	Floor noise
Hori.	7440.0	43.4	33.3	35.5	10.7	32.1	-	57.4	47.4	73.9	53.9	16.5	6.5	Floor noise
Hori.	9920.0	43.6	33.1	36.1	11.3	32.8	-	58.2	47.8	73.9	53.9	15.7	6.1	Floor noise
Vert.	2483.5	60.5	-	27.4	5.6	32.2	-	61.3	-	73.9	-	12.6	-	*1)
Vert.	4960.0	40.2	32.1	31.6	7.6	31.1	-	48.2	40.1	73.9	53.9	25.7	13.8	Floor noise
Vert.	7440.0	43.7	33.3	35.5	10.7	32.1	-	57.8	47.3	73.9	53.9	16.1	6.6	Floor noise
Vert.	9920.0	43.2	33.0	36.1	11.3	32.8	-	57.9	47.7	73.9	53.9	16.0	6.2	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)

PK with Duty factor

Polarity	Frequency	Reading (PK) [dBuV]	Ant Factor [dB/m]	Loss [dB]	Gain [dB]	Duty Factor [dB]	Result [dBuV/m]	Limit [dBuV/m]	Margin [dB]	Remark
[Hori/Vert]	[MHz]									
Hori.	2483.500	62.9	27.4	5.6	32.2	-46.1	17.5	53.9	36.4	*
Vert.	2483.500	60.5	27.4	5.6	32.2	-46.1	15.2	53.9	38.7	*

Result = Reading + Ant Factor + Loss (Cable+Attenuator+Filter+Distance factor(above 1 GHz)) - Gain(Amplifier) + Duty factor + Dwell time factor (Refer to dwell time data sheet)

*Above noise was synchronized with carrier frequency.

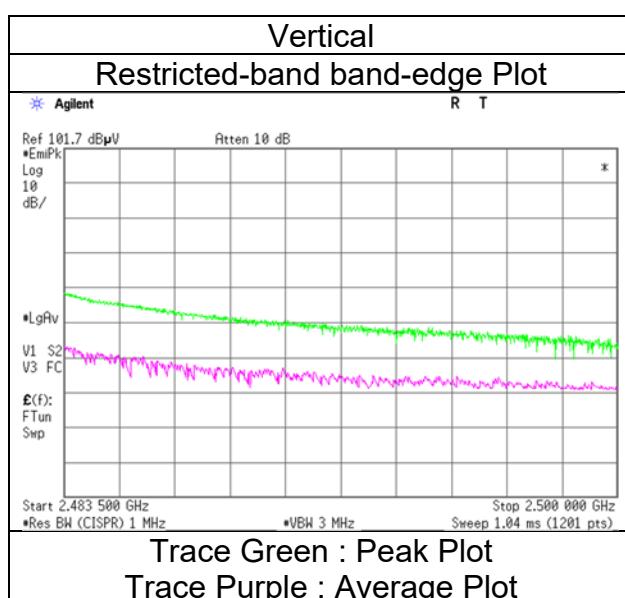
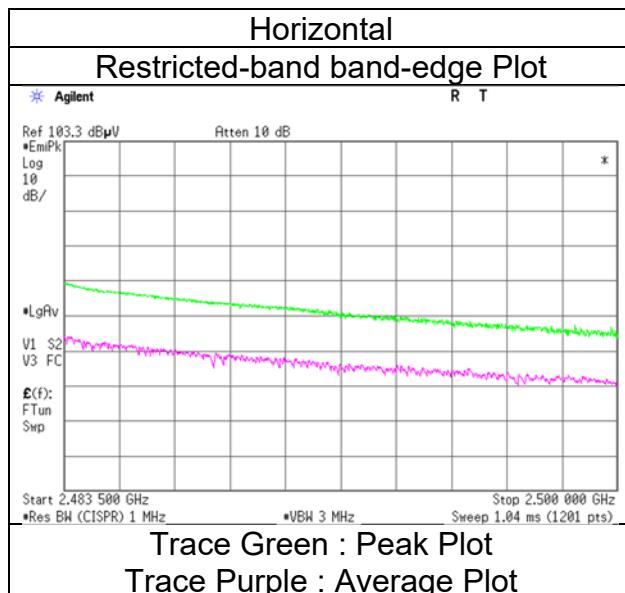
Distance factor: 1 GHz - 6 GHz 20log (4 m / 3.0 m) = 2.5 dB

6 GHz - 10 GHz 20log (5 m / 3.0 m) = 4.44 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
Date May 10, 2024
Temperature / Humidity 23 deg. C / 38 % RH
Engineer Tomoya Sone
(1 GHz to 6 GHz)
Mode Tx ANT+ 2480 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

Test place	Ise EMC Lab.											
Semi Anechoic Chamber	No.3										No.3	
Date	March 12, 2024										March 14, 2024	
Temperature / Humidity	20 deg. C / 41 % RH										21 deg. C / 39 % RH	
Engineer	Tomoya Sone (1 GHz to 6 GHz)										Shousei Hamaguchi (6 GHz to 26.5 GHz)	
Mode	Tx SHIMANO ORIGINAL											

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.	51.4	21.2	-	9.8	7.3	32.2	-	6.0	-	40.0	-	34.0	-	
Hori.	93.5	20.3	-	9.6	7.8	32.2	-	5.6	-	43.5	-	37.9	-	
Hori.	133.5	20.0	-	11.5	8.3	32.1	-	7.6	-	43.5	-	35.9	-	
Hori.	253.4	19.6	-	11.8	9.3	32.0	-	8.6	-	46.0	-	37.4	-	
Hori.	346.9	19.3	-	15.0	10.0	32.0	-	12.3	-	46.0	-	33.7	-	
Hori.	474.8	19.4	-	17.1	10.8	32.0	-	15.2	-	46.0	-	30.8	-	
Hori.	2390.0	42.2	33.8	27.5	5.5	32.2	-	43.0	34.6	73.9	53.9	30.9	19.3	
Hori.	2483.5	58.7	50.3	27.4	5.6	32.2	-	59.4	51.1	73.9	53.9	14.5	2.8	
Hori.	4956.0	50.0	-	31.6	7.6	31.1	-	58.0	-	73.9	-	15.9	-	
Hori.	7434.0	40.1	32.4	35.5	10.7	33.5	-	52.8	45.1	73.9	53.9	21.1	8.8	Floor noise
Hori.	9912.0	42.1	34.2	36.2	11.3	34.1	-	55.5	47.7	73.9	53.9	18.4	6.2	Floor noise
Vert.	51.4	21.2	-	9.8	7.3	32.2	-	6.0	-	40.0	-	34.0	-	
Vert.	93.5	20.3	-	9.6	7.8	32.2	-	5.6	-	43.5	-	37.9	-	
Vert.	133.5	20.0	-	11.5	8.3	32.1	-	7.6	-	43.5	-	35.9	-	
Vert.	253.4	19.6	-	11.8	9.3	32.0	-	8.6	-	46.0	-	37.4	-	
Vert.	346.9	19.3	-	15.0	10.0	32.0	-	12.3	-	46.0	-	33.7	-	
Vert.	474.8	19.4	-	17.1	10.8	32.0	-	15.2	-	46.0	-	30.8	-	
Vert.	2390.0	43.9	33.0	27.5	5.5	32.2	-	44.7	33.8	73.9	53.9	29.2	20.1	
Vert.	2483.5	61.0	50.1	27.4	5.6	32.2	-	61.8	50.8	73.9	53.9	12.2	3.1	
Vert.	4956.0	52.0	-	31.6	7.6	31.1	-	60.1	-	73.9	-	13.8	-	
Vert.	7434.0	40.1	32.4	35.5	10.7	33.5	-	52.8	45.1	73.9	53.9	21.1	8.8	Floor noise
Vert.	9912.0	42.1	34.2	36.2	11.3	34.1	-	55.5	47.7	73.9	53.9	18.4	6.2	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.

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.	2478.0	102.4	27.4	5.6	32.2	103.2	-	-	Carrier
Hori.	2400.0	34.2	27.5	5.5	32.2	35.0	83.2	48.2	
Vert.	2478.0	102.9	27.4	5.6	32.2	103.7	-	-	Carrier
Vert.	2400.0	34.4	27.5	5.5	32.2	35.2	83.7	48.5	

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

PK with Duty Factor

Polarity	Frequency	Reading (PK)	Ant Factor	Loss	Gain	Duty Factor	Result	Limit	Margin	Remark
[Hori/Vert]	[MHz]	[dBuV]	[dB/m]	[dB]	[dB]	[dB]	[dBuV/m]	[dBuV/m]	[dB]	
Hori.	4956.000	50.0	31.6	7.6	31.1	-19.5	38.6	53.9	15.3	*
Vert.	4956.000	52.0	31.6	7.6	31.1	-19.5	40.6	53.9	13.3	*

Result = Reading + Ant Factor + Loss (Cable+Attenuator+Filter+Distance factor(above 1 GHz)) - Gain(Amplifier) + Duty factor (Refer to Burst rate confirmation sheet)

*Above noise was synchronized with carrier frequency.

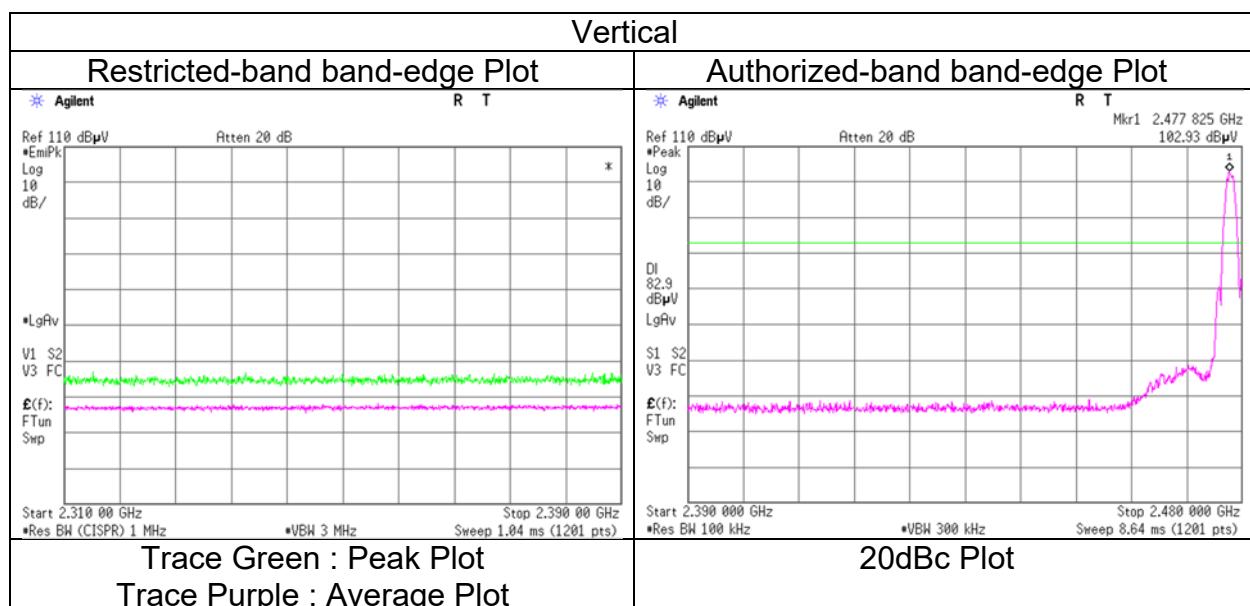
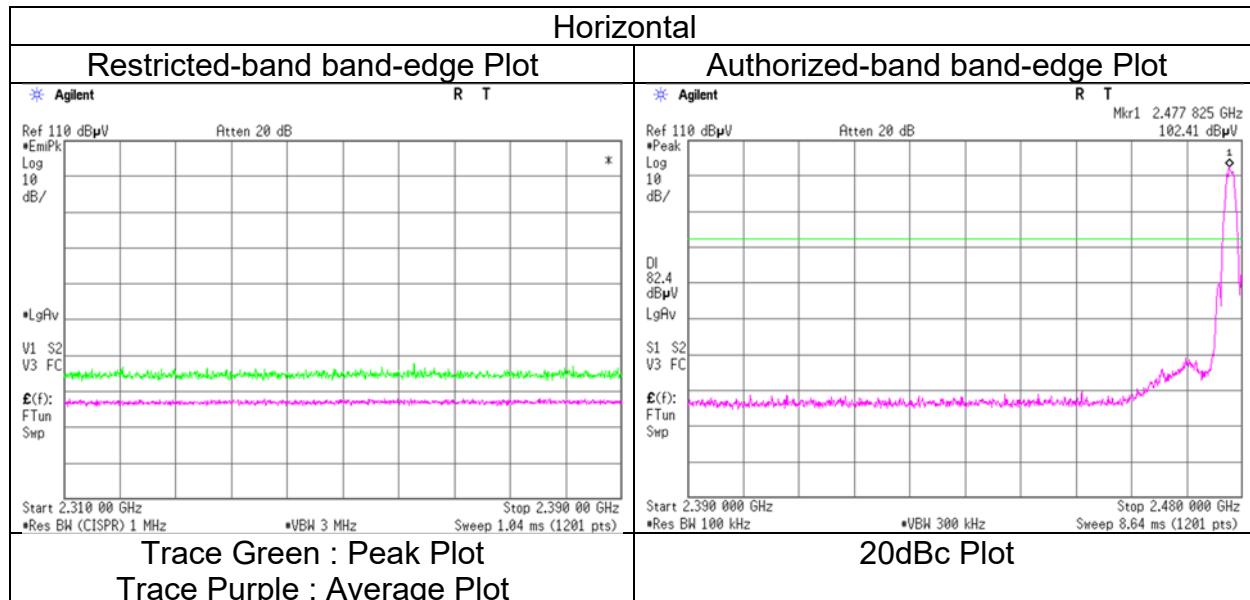
Distance factor: 1 GHz - 6 GHz $20\log(4\text{ m} / 3.0\text{ m}) = 2.50\text{ dB}$

6 GHz - 10 GHz $20\log(5\text{ m} / 3.0\text{ m}) = 4.44\text{ dB}$

10 GHz - 26.5 GHz $20\log(1.0\text{ m} / 3.0\text{ m}) = -9.54\text{ dB}$

Radiated Spurious Emission (Reference Plot for band-edge)

Test place Ise EMC Lab.
Semi Anechoic Chamber
Date March 12, 2024
Temperature / Humidity 20 deg. C / 41 % RH
Engineer Tomoya Sone
(1 GHz to 6 GHz)
Mode Tx SHIMANO ORIGINAL

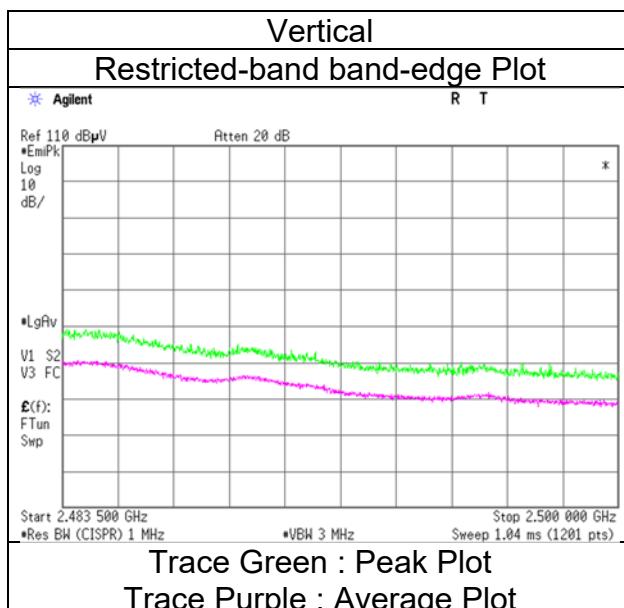
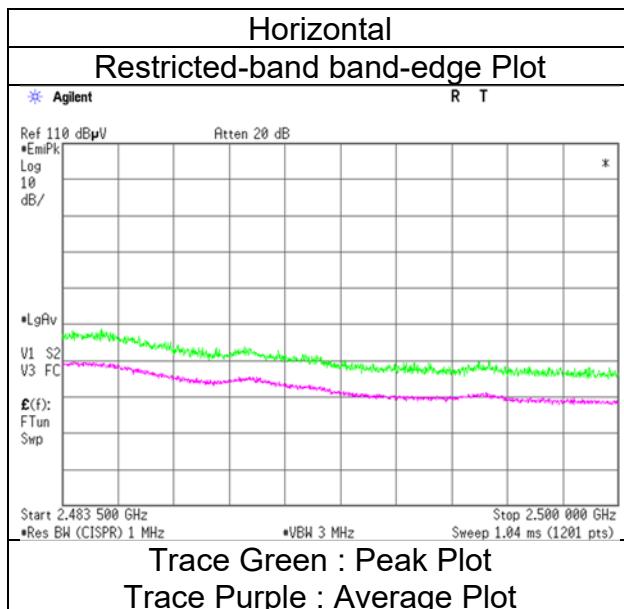


* The measurement was conducted for a sufficiently long enough time to detect any possible spurious emissions.

Final result of restricted band edge and authorized band edge were shown in tabular data.

Radiated Spurious Emission (Reference Plot for band-edge)

Test place Ise EMC Lab.
Semi Anechoic Chamber
Date March 12, 2024
Temperature / Humidity 20 deg. C / 41 % RH
Engineer Tomoya Sone
(1 GHz to 6 GHz)
Mode Tx SHIMANO ORIGINAL

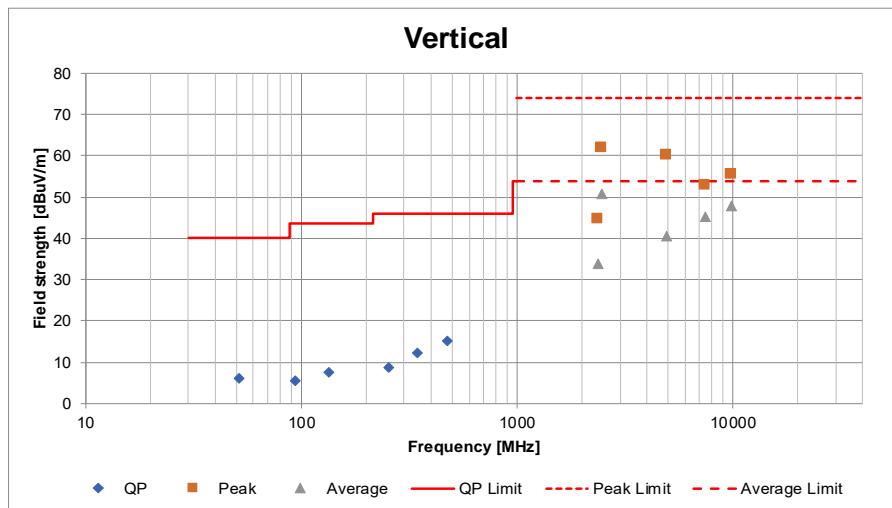
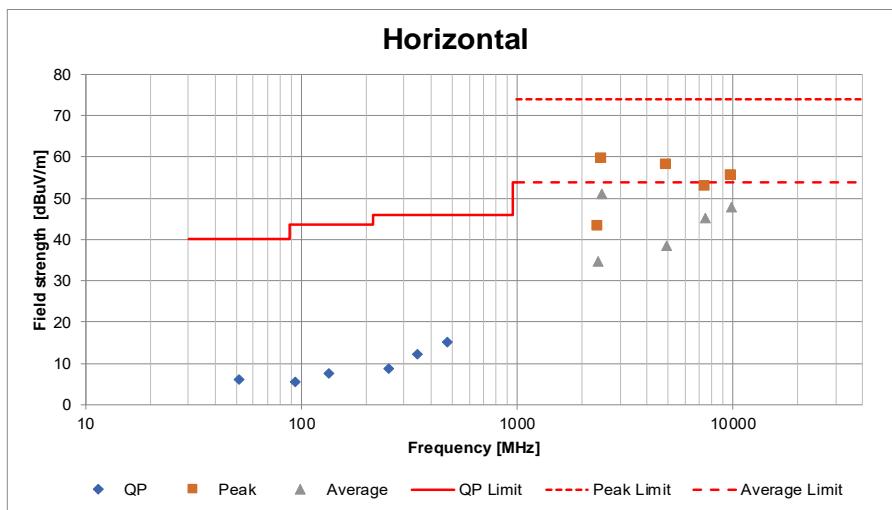


* The measurement was conducted for a sufficiently long enough time to detect any possible spurious emissions.

Final result of restricted band edge was shown in tabular data.

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

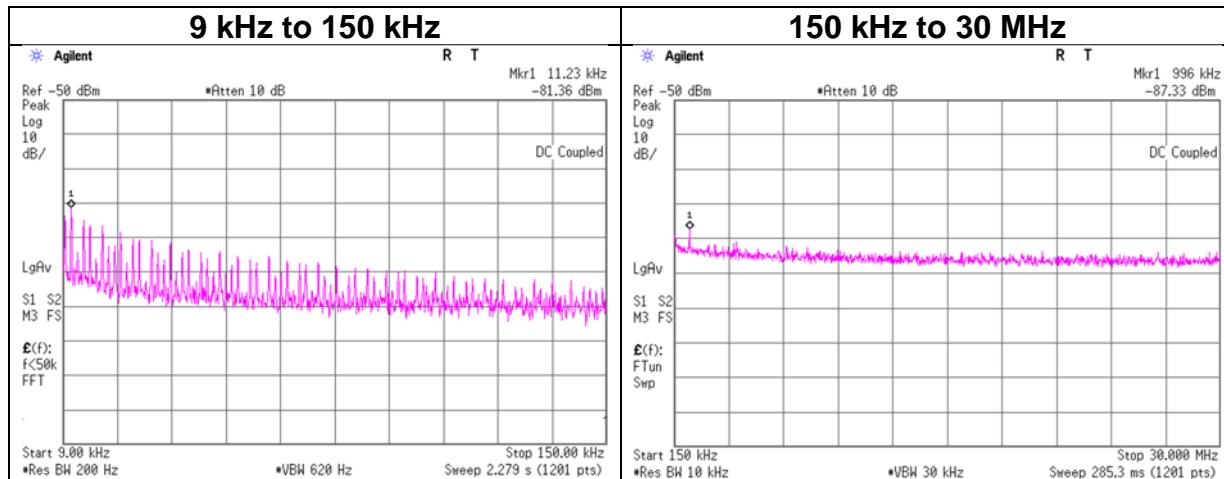
Test place	Ise EMC Lab.		
Semi Anechoic Chamber	No.3	No.3	No.3
Date	March 12, 2024	March 13, 2024	March 14, 2024
Temperature / Humidity	20 deg. C / 41 % RH	23 deg. C / 41 % RH	21 deg. C / 39 % RH
Engineer	Tomoya Sone (1 GHz to 6 GHz)	Shousei Hamaguchi (6 GHz to 26.5 GHz)	Shousei Hamaguchi (Below 1 GHz)
Mode	Tx SHIMANO ORIGINAL		



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

Conducted Spurious Emission

Test place Ise EMC Lab, No.6 Measurement Room
 Date May 15, 2024
 Temperature / Humidity 23 deg. C / 48 % RH
 Engineer Shousei Hamaguchi
 Mode Tx BT LE 1M 2480 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
11.23	-81.4	1.00	9.7	2.0	1	-68.7	300	6.0	-7.4	46.5	53.9	
996.00	-87.3	1.02	9.7	2.0	1	-74.6	30	6.0	6.6	27.6	21.0	

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

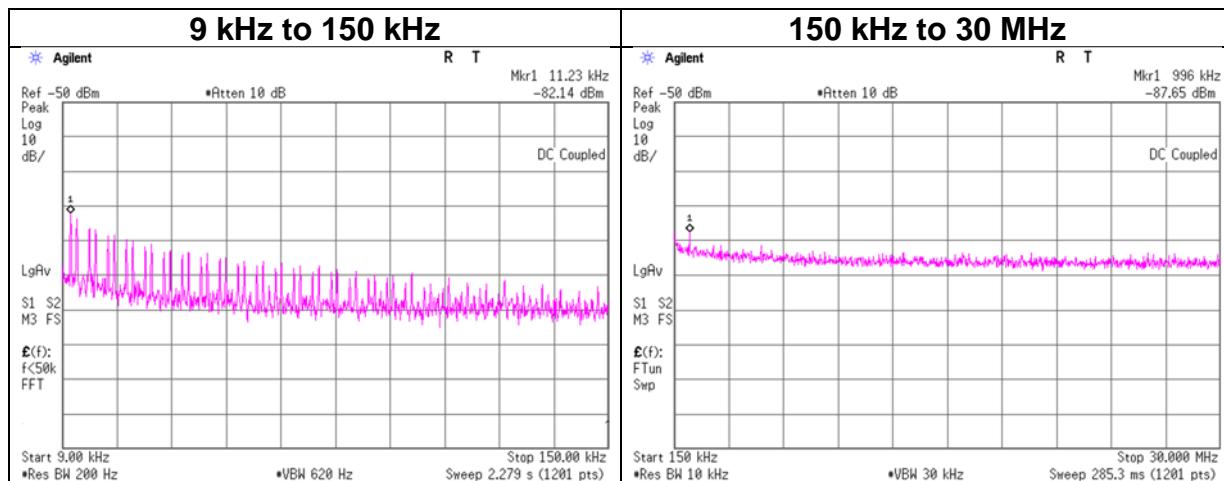
EIRP[dBm] = Reading [dBm] + Cable loss [dB] + Attenuator Loss [dB] + Antenna gain [dBi] + 10 * log (N)

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.

Conducted Spurious Emission

Test place Ise EMC Lab, No.6 Measurement Room
 Date May 15, 2024
 Temperature / Humidity 23 deg. C / 48 % RH
 Engineer Shousei Hamaguchi
 Mode Tx BT LE 2M 2480 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
11.23	-82.1	1.00	9.7	2.0	1	-69.5	300	6.0	-8.2	46.5	54.7	
996.00	-87.7	1.02	9.7	2.0	1	-74.9	30	6.0	6.3	27.6	21.3	

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

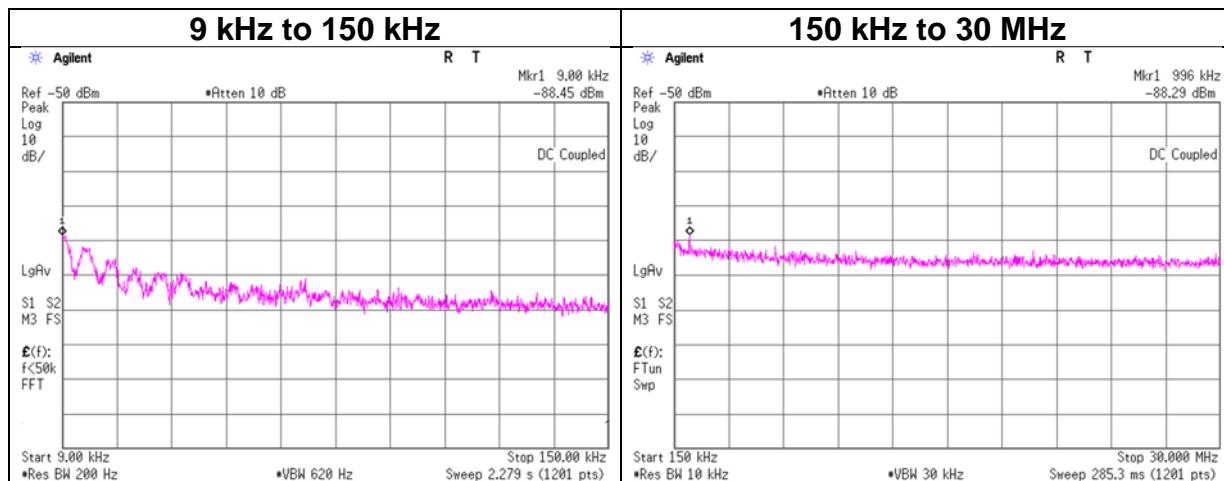
EIRP[dBm] = Reading [dBm] + Cable loss [dB] + Attenuator Loss [dB] + Antenna gain [dBi] + 10 * log (N)

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.

Conducted Spurious Emission

Test place Ise EMC Lab, No.6 Measurement Room
 Date May 15, 2024
 Temperature / Humidity 23 deg. C / 48 % RH
 Engineer Shousei Hamaguchi
 Mode Tx ANT 2441 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
9.00	-88.5	1.00	9.7	2.0	1	-75.8	300	6.0	-14.5	48.5	63.0	
996.00	-88.3	1.02	9.7	2.0	1	-75.6	30	6.0	5.7	27.6	21.9	

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

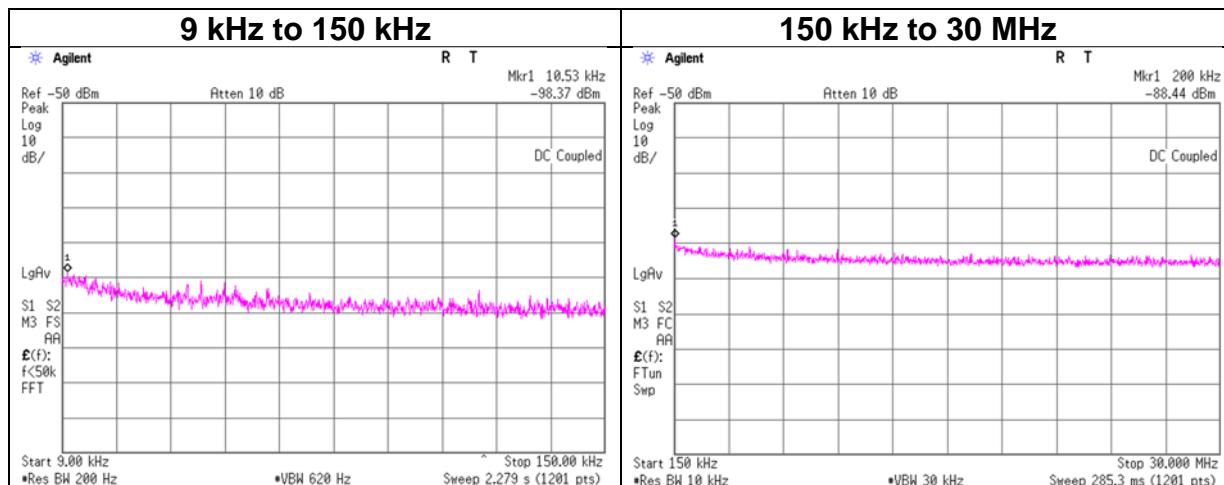
$EIRP [dBm] = \text{Reading [dBm]} + \text{Cable loss [dB]} + \text{Attenuator Loss [dB]} + \text{Antenna gain [dBi]} + 10 * \log (N)$

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.

Conducted Spurious Emission

Test place Ise EMC Lab. No.6 Measurement Room
 Date March 12, 2024
 Temperature / Humidity 24 deg. C / 35 % RH
 Engineer Takafumi Noguchi
 Mode Tx SHIMANO ORIGINAL



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
10.53	-98.4	1.00	9.8	2.0	1	-85.5	300	6.0	-24.3	47.1	71.4	
200.00	-88.4	1.00	9.8	2.0	1	-75.6	300	6.0	-14.3	21.5	35.8	

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.6 Measurement Room
 Date March 12, 2024 May 15, 2024
 Temperature / Humidity 24 deg. C / 35 % RH 23 deg. C / 48 % RH
 Engineer Takafumi Noguchi Shousei Hamaguchi
 Mode Tx

BT LE 1M

Freq. [MHz]	Reading [dBm / 3 kHz]	Cable Loss [dB]	Atten. Loss [dB]	Result		Limit [dBm / 3 kHz]	Margin [dB]
2402	-26.90	1.89	9.74	-15.27	0.03	8.00	23.27
2440	-26.72	1.90	9.75	-15.07	0.03	8.00	23.07
2480	-26.72	1.91	9.75	-15.06	0.03	8.00	23.06

BT LE 2M

Freq. [MHz]	Reading [dBm / 3 kHz]	Cable Loss [dB]	Atten. Loss [dB]	Result		Limit [dBm / 3 kHz]	Margin [dB]
2402	-29.24	1.89	9.74	-17.61	0.02	8.00	25.61
2440	-29.15	1.90	9.75	-17.50	0.02	8.00	25.50
2480	-29.09	1.91	9.75	-17.43	0.02	8.00	25.43

ANT+

Freq. [MHz]	Reading [dBm / 3 kHz]	Cable Loss [dB]	Atten. Loss [dB]	Result		Limit [dBm / 3 kHz]	Margin [dB]
2402	-18.30	1.89	9.74	-6.67	0.22	8.00	14.67
2441	-18.36	1.90	9.75	-6.71	0.21	8.00	14.71
2480	-18.35	1.91	9.75	-6.69	0.21	8.00	14.69

SHIMANO ORIGINAL

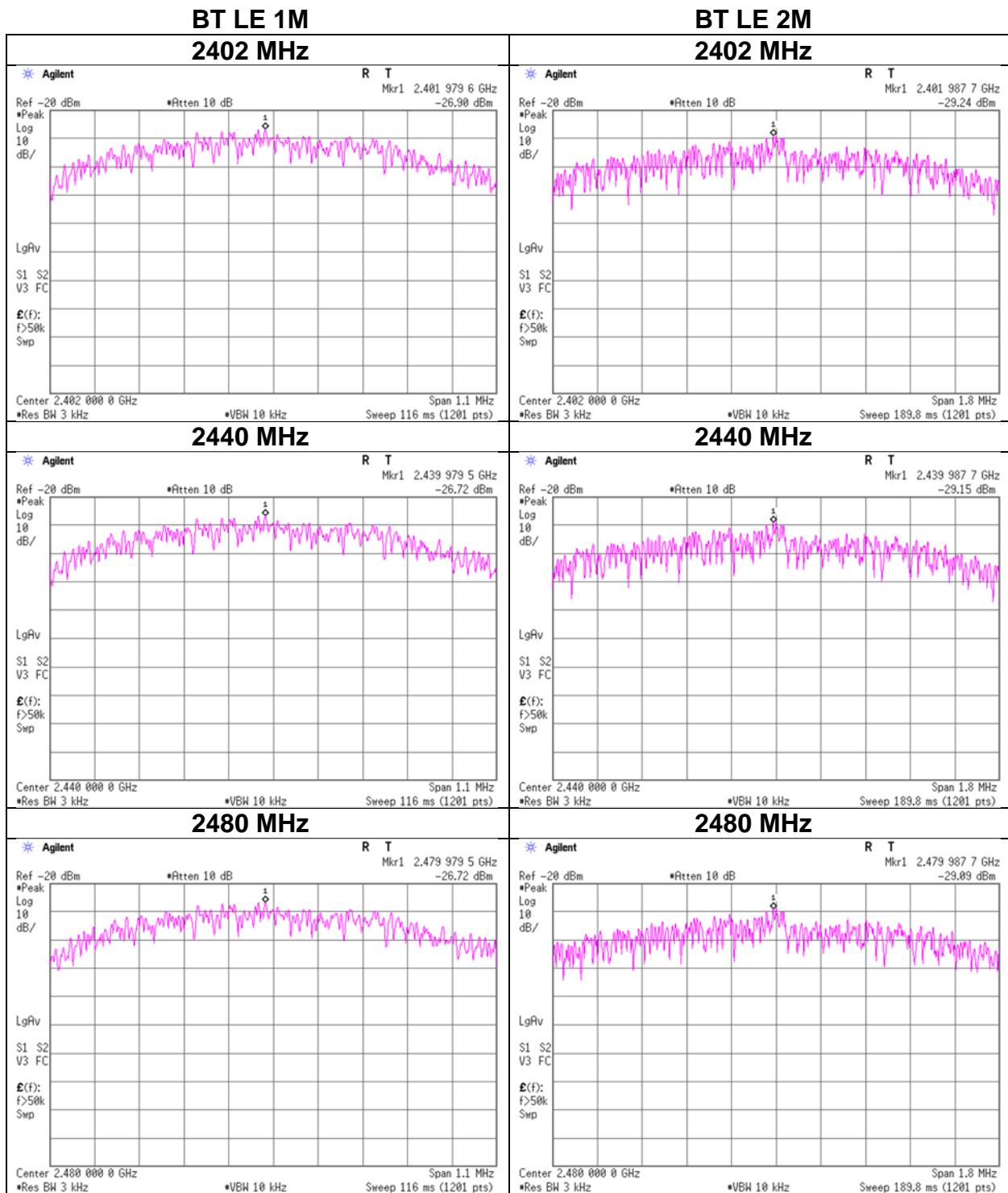
Freq. [MHz]	Reading [dBm / 3 kHz]	Cable Loss [dB]	Atten. Loss [dB]	Result		Limit [dBm / 3 kHz]	Margin [dB]
2478	-20.80	2.38	6.13	-12.29	0.06	8.00	20.29

Sample Calculation:

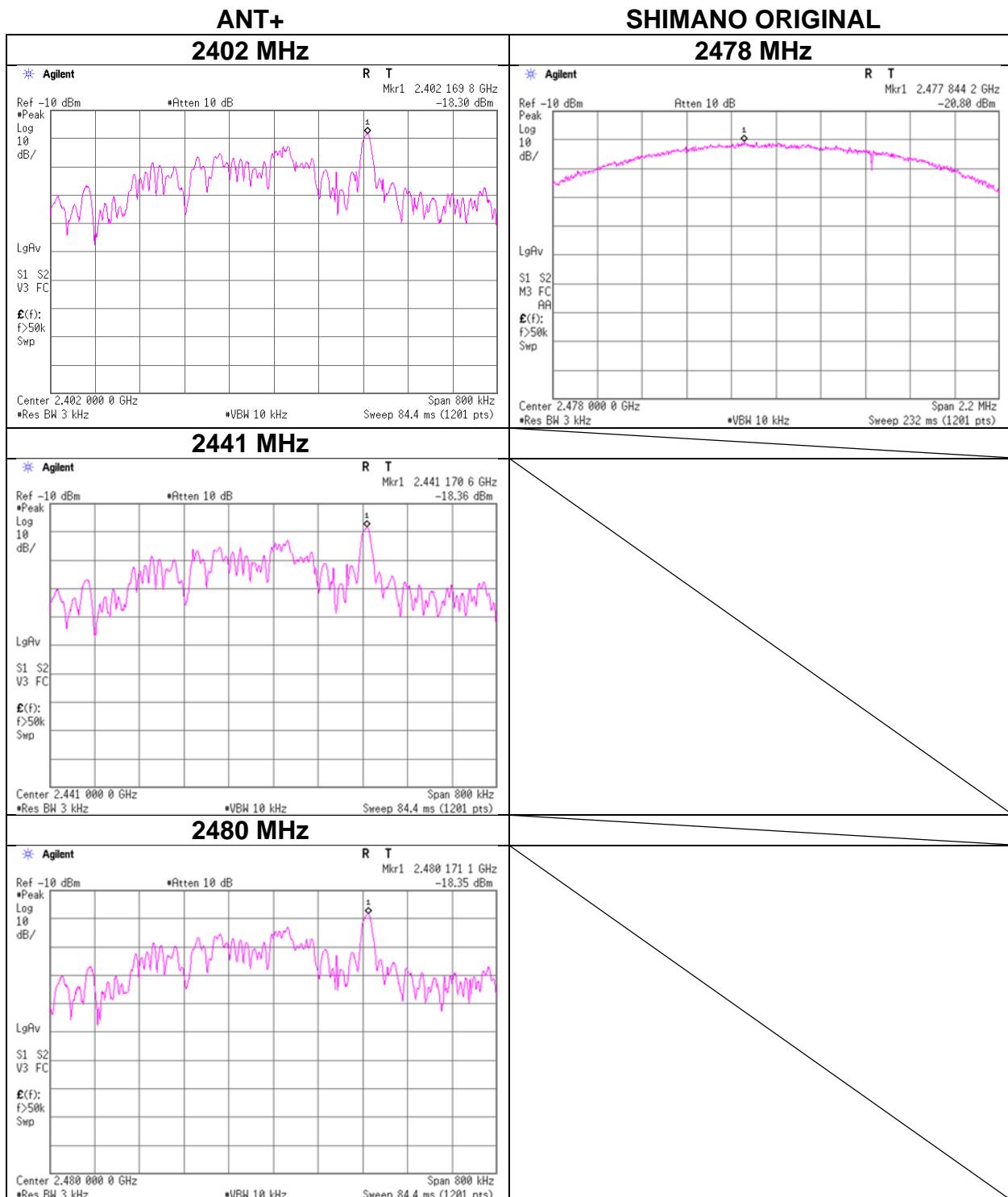
Result = Reading + Cable Loss (including the cable(s) customer supplied) + Attenuator Loss

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

Power Density



Power Density



APPENDIX 2: Test Instruments

Test Equipment used by March 14, 2024

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	141172	Attenuator(6dB)(above 1GHz)	HIROSE ELECTRIC CO.,LTD.	AT-106	-	12/11/2023	12
AT	141328	Microwave Cable 1G-40GHz	Suhner	SUCOFLEX102	28636/2	04/01/2024	12
AT	141558	Digital Tester(TRUE RMS MULTIMETER)	Fluke Corporation	115	17930030	05/17/2024	12
AT	141561	Thermo-Hygrometer	CUSTOM. Inc	CTH-201	1401	-	-
AT	141809	Power Meter	Anritsu Corporation	ML2495A	825002	05/26/2023	12
AT	141900	Spectrum Analyzer	Keysight Technologies Inc	E4440A	MY46185823	06/16/2023	12
AT	196430	Microwave Cable	Huber+Suhner	SF102D/11PC24/11 PC24/1000mm	537059/126EA	02/26/2024	12
RE	141232	High Pass Filter 3.5-18.0GHz	UL Japan	HPF SELECTOR	001	09/04/2023	12
RE	141266	Logperiodic Antenna (200-1000MHz)	Schwarzbeck Mess-Elektronik OHG	VUSLP9111B	9111B-191	08/10/2023	12
RE	141323	Coaxial cable	UL Japan	-	-	09/10/2023	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	07/19/2023	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	141885	Spectrum Analyzer	Keysight Technologies Inc	E4448A	US44300523	11/29/2023	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	142013	AC3_Semi Anechoic Chamber(SVSWR)	TDK	Semi Anechoic Chamber 3m	DA-10005	10/18/2023	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	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	238713	Double Ridge Horn Antenna	Schwarzbeck Mess-Elektronik OHG	BBHA 9120 C	688	08/10/2023	12
RE	244709	Thermo-Hygrometer	HIOKI E.E. CORPORATION	LR5001	231202103	01/25/2024	12
RE	246001	Microwave Cable	Huber+Suhner	SF103/11PC35/11P C35/1000mm / SF126E/5000mm	800673(1m) / 610204(5m)	03/06/2024	12

Test Equipment used on and after May 9, 2024

Test Item	LIMS ID	Description	Manufacturer	Model	Serial	Last Calibration Date	Cal Int
RE	141232	High Pass Filter 3.5-18.0GHz	UL Japan	HPF SELECTOR	001	09/04/2023	12
RE	141265	Logperiodic Antenna (200-1000MHz)	Schwarzbeck Mess-Elektronik OHG	VUSLP9111B	9111B-190	07/11/2023	12
RE	141317	Coaxial Cable	UL Japan	-	-	09/12/2023	12
RE	141427	Biconical Antenna	Schwarzbeck Mess-Elektronik OHG	VHA9103B+ BBA9106	08031	07/11/2023	12
RE	141503	Horn Antenna 18-26.5GHz	EMCO	3160-09	1265	06/23/2023	12
RE	141507	Horn Antenna 1-18GHz	Schwarzbeck Mess-Elektronik OHG	BBHA9120D	258	11/20/2023	12
RE	141532	DIGITAL HiTESTER	HIOKI E.E. CORPORATION	3805	051201197	01/31/2024	12
RE	141542	Digital Tester	Fluke Corporation	FLUKE 26-3	78030611	08/01/2023	12
RE	141579	Pre Amplifier	Keysight Technologies Inc	8449B	3008A02142	02/17/2024	12
RE	141580	Microwave System Amplifier	Keysight Technologies Inc	83017A	MY39500779	03/08/2024	12
RE	141594	Pre Amplifier	Keysight Technologies Inc	8447D	2944A10150	02/17/2024	12
RE	141901	Spectrum Analyzer	Keysight Technologies Inc	E4440A	MY48250080	01/26/2024	12
RE	141903	Spectrum Analyzer	Keysight Technologies Inc	E4440A	MY46186390	01/26/2024	12
RE	141949	Test Receiver	Rohde & Schwarz	ESCI	100767	05/17/2023	12
RE	142004	AC2_Semi Anechoic Chamber (NSA)	TDK	Semi Anechoic Chamber 3m	DA-06902	12/12/2023	24
RE	142006	AC2_Semi Anechoic Chamber (SVSWR)	TDK	Semi Anechoic Chamber 3m	DA-06902	10/20/2023	12
RE	142013	AC3_Semi Anechoic Chamber (SVSWR)	TDK	Semi Anechoic Chamber 3m	DA-10005	10/18/2023	12
RE	142183	Measure	KOMELON	KMC-36	-	10/20/2023	12
RE	142228	Measure, Tape, Steel	KOMELON	KMC-36	-	-	-
RE	178648	EMI measurement program	TSJ (Techno Science Japan)	TEPTO-DV	-	-	-
RE	220646	Attenuator	Huber+Suhner	6806 N-50-1	-	03/12/2024	12
RE	238713	Double Ridge Horn Antenna	Schwarzbeck Mess-Elektronik OHG	BBHA 9120 C	688	08/10/2023	12
RE	244707	Thermo-Hygrometer	HIOKI E.E. CORPORATION	LR5001	231202102	01/25/2024	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
AT	141244	Attenuator (10dB)	Weinschel - API Technologies Corp	WA8-10-34	A198	02/17/2024	12
AT	141327	Coaxial Cable	UL Japan	-	-	02/09/2024	12
AT	141419	Attenuator	Weinschel Associates	WA56-10	56100305	05/18/2023	12
AT	141558	Digital Tester (TRUE RMS MULTIMETER)	Fluke Corporation	115	17930030	05/29/2023	12
AT	141814	Power Meter	Raditeq (Formerly DARE!! Instruments)	RPR3006W	14I00048SNO 082	10/04/2023	12
AT	141900	Spectrum Analyzer	Keysight Technologies Inc	E4440A	MY46185823	06/16/2023	12
AT	197220	Microwave cable	Huber+Suhner	SF126E/11PC35/11PC35/2000MM	537003/126E	03/14/2024	12
AT	244712	Thermo-Hygrometer	HIOKI E.E. CORPORATION	LR5001	231202106	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
AT: Antenna Terminal Conducted test