PRADIO TEST REPORT

Test Report No. 14918550S-A-R1

Customer	**CASIO COMPUTER CO., LTD.**
Description of EUT	**Watch**
Model Number of EUT	**GR-B300** (Bluetooth Module: CW5719 is contained.)
FCC ID	**BBQS51W**
Test Regulation	**FCC Part 15 Subpart C**
Test Result	**Complied**
Issue Date	**March 1, 2024**
Remarks	**-**

Representative Test Engineer	Approved By
M. Ikudome	K. Noda
Miku Ikudome Engineer	Kazuya Noda Leader

CERTIFICATE 1266.03

☐ 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".

Report Cover Page - Form-ULID-003532 (DCS:13-EM-F0429) Issue# 22.0

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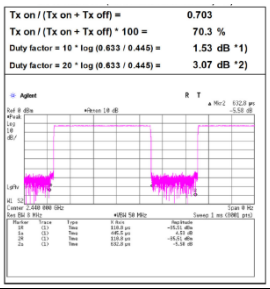
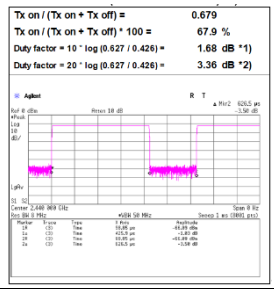
- The information provided from the customer for this report is identified in Section 1.
- For test report(s) referred in this report, the latest version (including any revisions) is always referred.

REVISION HISTORY

Original Test Report No.: 14918550S-A

This report is a revised version of 14918550S-A. 14918550S-A is replaced with this report.

Revision	Test Report No.	Date	Page Revised Contents
- (Original)	14918550S-A	September 27, 2023	-
1	14918550S-A-R1	March 1, 2024	Replace of Burst rate confirmation data, and updated Average output power and Radiated spurious emission data which were affected by this change. From  To 

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

CONTENTS PAGE

SECTION 1: Customer Information

Company Name	CASIO COMPUTER CO., LTD.
Address	2-1, Sakaecho 3 chome, Hamura-shi, Tokyo 205-8555 Japan
Telephone Number	+81-42-579-7282
Contact Person	Shuji Yamashita

The information provided from 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

* The laboratory is exempted from liability of any test results affected from the above information in SECTION 2 and 4.

SECTION 2: Equipment Under Test (EUT)

2.1 Identification of EUT

Description	Watch
Model Number	GR-B300 (Bluetooth Module: CW5719 is contained.)
Alternative Name	R061
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	August 10, 2023
Test Date	August 24 to September 20, 2023

2.2 Product Description

General Specification

Rating	Typical: DC 2.5 V, Min.: DC 1.9 V, Max.: DC 2.7 V
Operating temperature	-10 deg. C to +60 deg. C

Radio Specification

Bluetooth (Low Energy)

Equipment Type	Transceiver
Frequency of Operation	2402 MHz to 2480 MHz
Type of Modulation	GFSK
Antenna Gain	-2.0 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	**FCC:** Section 15.207	-	N/A	*1)
	ISED: RSS-Gen 8.8	**ISED:** RSS-Gen 8.8			
6 dB Bandwidth	**FCC:** KDB 558074 D01 15.247 Meas Guidance v05r02	**FCC:** Section 15.247(a)(2)	See data.	Complied	Conducted
	ISED: -	**ISED:** RSS-247 5.2(a)			
Maximum Peak Output Power	**FCC:** KDB 558074 D01 15.247 Meas Guidance v05r02	**FCC:** Section 15.247(b)(3)		Complied	Conducted
	ISED: RSS-Gen 6.12	**ISED:** RSS-247 5.4(d)			
Power Density	**FCC:** KDB 558074 D01 15.247 Meas Guidance v05r02	**FCC:** Section 15.247(e)		Complied	Conducted
	ISED: -	**ISED:** RSS-247 5.2(b)			
Spurious Emission Restricted Band Edges	**FCC:** KDB 558074 D01 15.247 Meas Guidance v05r02	**FCC:** Section15.247(d)	8.0 dB 2390.000 MHz, AV, Vertical Tx BT LE 2402 MHz	Complied	Conducted (below 30 MHz)/ Radiated (above 30 MHz) *2)
	ISED: RSS-Gen 6.13	**ISED:** RSS-247 5.5 RSS-Gen 8.9 RSS-Gen 8.10			

Note: UL Japan, Inc.'s EMI Work Procedures: Work Instructions-ULID-003591 and Work Instructions-ULID-003593.
* In case any questions arise about test procedure, ANSI C63.10: 2013 is also referred.

*1) The test is not applicable since the EUT does not have AC mains.
*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, 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.

Item	Frequency range	Uncertainty (+/-)
Conducted Emission (AC Mains) LISN	150 kHz-30 MHz	3.1 dB
Radiated Emission (Measurement distance: 3 m)	9 kHz-30 MHz	3.3 dB
	30 MHz-200 MHz	4.8 dB
	200 MHz-1 GHz	6.1 dB
	1 GHz-6 GHz	4.7 dB
	6 GHz-18 GHz	5.3 dB
	18 GHz-40 GHz	5.5 dB
Radiated Emission (Measurement distance: 1 m)	1 GHz-18 GHz	5.6 dB
	18 GHz-40 GHz	5.8 dB

Antenna terminal test	Uncertainty (+/-)
Power Measurement above 1 GHz (Average Detector) SPM-06	1.3 dB
Power Measurement above 1 GHz (Peak Detector) SPM-06	2.1 dB
Power Measurement above 1 GHz (Average Detector) SPM-07	1.1 dB
Power Measurement above 1 GHz (Peak Detector) SPM-07	1.2 dB
Power Measurement above 1 GHz (Average Detector) SPM-13	1.1 dB
Power Measurement above 1 GHz (Peak Detector) SPM-13	1.4 dB
Spurious Emission (Conducted) below 1 GHz	0.84 dB
Conducted Emissions Power Density Measurement 1 GHz-3 GHz	0.86 dB
Conducted Emissions Power Density Measurement 3 GHz-18 GHz	2.4 dB
Spurious Emission (Conducted) 18 GHz-26.5 GHz	2.4 dB
Spurious Emission (Conducted) 26.5 GHz-40 GHz	2.2 dB
Bandwidth Measurement	0.012 %
Duty Cycle and Time Measurement	0.27 %
Temperature_SCH-01	0.87 deg.C.
Humidity_SCH-01	3.5 %
Temperature_SCH-02	2.0 deg.C.
Humidity_SCH-02	6.7 %
Voltage	0.92 %

3.5 Test Location

UL Japan, Inc. Shonan EMC Lab.
1-22-3, Megumigaoka, Hiratsuka-shi, Kanagawa-ken 259-1220 Japan
Telephone: +81-463-50-6400
A2LA Certificate Number: 1266.03
(FCC test firm registration number: 626366, ISED lab company number: 2973D / CAB identifier: JP0001)

Test site	Width x Depth x Height (m)	Size of reference ground plane (m) / horizontal conducting plane	Maximum measurement distance
No.1 Semi-anechoic chamber	20.6 x 11.3 x 7.65	20.6 x 11.3	10 m
No.2 Semi-anechoic chamber	20.6 x 11.3 x 7.65	20.6 x 11.3	10 m
No.3 Semi-anechoic chamber	12.7 x 7.7 x 5.35	12.7 x 7.7	5 m
No.4 Semi-anechoic chamber	8.1 x 5.1 x 3.55	8.1 x 5.1	-
Wireless anechoic chamber 1	9.5 x 6.0 x 5.4	9.5 x 6.0	3 m
Wireless anechoic chamber 2	9.5 x 6.0 x 5.4	9.5 x 6.0	3 m
No.1 Shielded room	6.8 x 4.1 x 2.7	6.8 x 4.1	-
No.2 Shielded room	6.8 x 4.1 x 2.7	6.8 x 4.1	-
No.3 Shielded room	6.3 x 4.7 x 2.7	6.3 x 4.7	-
No.4 Shielded room	4.4 x 4.7 x 2.7	4.4 x 4.7	-
No.5 Shielded room	7.8 x 6.4 x 2.7	7.8 x 6.4	-
No.6 Shielded room	7.8 x 6.4 x 2.7	7.8 x 6.4	-
No.8 Shielded room	3.45 x 5.5 x 2.4	3.45 x 5.5	-
No.1 Measurement room	2.55 x 4.1 x 2.5	-	-

3.6 Test Data, Test Instruments, and Test Set Up

Refer to APPENDIX.

SECTION 4: Operation of EUT during testing

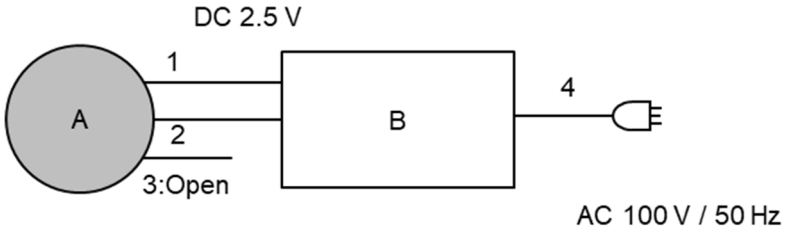
4.1 Operating Mode(s)

Mode	Remarks*
Bluetooth Low Energy (BT LE)	Uncoded 1 M-PHY (1 M-PHY), Maximum Packet Size, PRBS9
*Power of the EUT was set by the software as follows; Power Setting: Fixed Software: BLE RF Test Version: 9.9 (Date: 2023.8.24, 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
Conducted Spurious Emission, Radiated Spurious Emission (Below 1 GHz)	Tx BT LE, 1 M-PHY *1)	2440 MHz
Radiated Spurious Emission (Above 1 GHz), Maximum Peak Output Power, Power Density, 6 dB Bandwidth, 99 % Occupied Bandwidth,	Tx BT LE, 1 M-PHY	2402 MHz 2440 MHz 2480 MHz
*1) Conducted Spurious Emission and 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 and Support Equipment

No.	Item	Model Number	Serial Number	Manufacturer	Remarks
A	Watch	GR-B300	16 *1) 19 *2)	CASIO COMPUTER CO., LTD.	EUT
B	Power Supply (DC)	PAN60-10A	NL002383 *1)	KIKUSUI	-
		PW18-2ATP	19050351 *2)	TEXIO	-

List of Cables Used

No.	Name	Length (m)	Shield		Remarks
			Cable	Connector	
1	DC	0.1 + 1.8 *2) 0.1 + 1.8 + 0.4 *1)	Unshielded	Unshielded	*3)
2	DC	0.1 + 1.8 *2) 0.1 + 1.8 + 0.4 *1)	Unshielded	Unshielded	*3)
3	Signal	0.1	Unshielded	Unshielded	*4)
4	AC	1.8	Unshielded	Unshielded	-

*1) Used for Radiated Emission
*2) Used for Antenna Terminal Conducted test
*3) Cable for test operation
*4) Cable is for system reset during the development, not used for the product

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, 1.0 m by 2.0 m, raised 0.8 m above the conducting ground plane. The Radiated Electric Field Strength has been measured in a Semi Anechoic Chamber with a ground plane.

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

The height of the measuring antenna varied between 1 m and 4 m and EUT was rotated a full revolution in order to obtain the maximum value of the electric field strength.
The measurements were performed for both vertical and horizontal antenna polarization with the Test Receiver, or the Spectrum Analyzer.
The measurements were made with the following detector function of the test receiver and the Spectrum analyzer (in linear mode).
The test was made with the detector (RBW/VBW) in the following table.
When using Spectrum analyzer, the test was made with adjusting span to zero by using peak hold.

Test Antennas are used as below;

Frequency	30 MHz to 200 MHz	200 MHz to 1 GHz	Above 1 GHz
Antenna Type	Biconical	Logperiodic	Horn

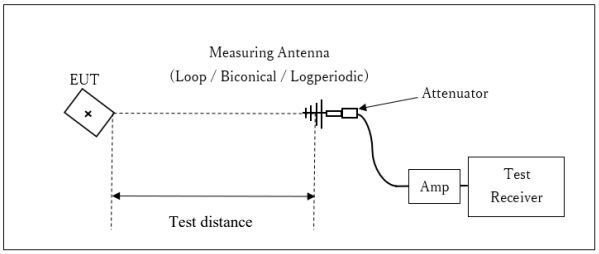
In any 100 kHz bandwidth outside the restricted band in which the spread spectrum intentional radiator is operating, the radio frequency power that is produced by the intentional radiator confirmed 20 dB below that in the 100 kHz bandwidth within the band that contains the highest level of the desired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

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

Frequency	Below 1 GHz	Above 1 GHz		20 dBc
Instrument Used	Test Receiver	Spectrum Analyzer		Spectrum Analyzer
Detector	QP	PK	AV	PK
IF Bandwidth	BW 120 kHz	RBW: 1 MHz VBW: 3 MHz	11.12.2.5.2 RBW: 1 MHz VBW: 3 MHz Detector: Power Averaging (Linear voltage) Trace: 100 traces Duty factor was added to the results.	RBW: 100 kHz VBW: 300 kHz

Figure 2: Test Setup

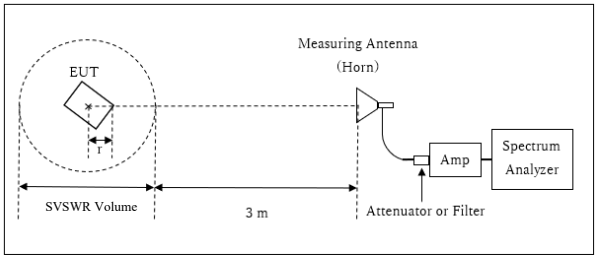
Below 1 GHz



× : Center of turn table

Test Distance: 3 m

1 GHz to 10 GHz

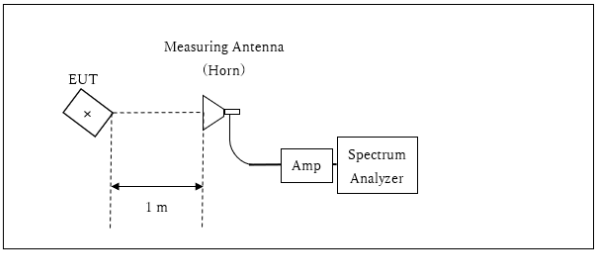


r : Radius of an outer periphery of EUT
× : Center of turn table

Distance Factor: 20 x log (3.95 m / 3.0 m) = 2.39 dB
* Test Distance: (3 + SVSWR Volume /2) - r =3.95 m

SVSWR Volume : 2.0 m
(SVSWR Volume has been calibrated based on CISPR 16-1-4.)
r = 0.05 m

10 GHz to 26.5 GHz



× : Center of turn table

Distance Factor: 20 x log (1.0 m / 3.0 m) = -9.54 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.

Antenna polarization	Carrier	Spurious (30 MHz - 1 GHz)	Spurious (1 GHz - 2.8 GHz)	Spurious (2.8 GHz - 10 GHz)	Spurious (10 GHz - 18 GHz)	Spurious (18 GHz - 26.5 GHz)
Horizontal	X	X	X	X	X	X
Vertical	X	X	X	X	X	X

The test results and limit are rounded off to one decimal place, 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
6 dB Bandwidth	3 MHz	100 kHz	300 kHz	Auto	Peak	Max Hold	Spectrum Analyzer
99 % Occupied Bandwidth *1)	Enough width to display emission skirts	1 to 5 % of OBW	Three times of RBW	Auto	Peak	Max Hold	Spectrum Analyzer
Maximum Peak Output Power	-	-	-	Auto	Peak/ Average *2)	-	Power Meter (Sensor: 160 MHz BW)
Peak Power Density	1.5 times the 6 dB Bandwidth	3 kHz	9.1 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.

The test results and limit are rounded off to two decimals place, 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

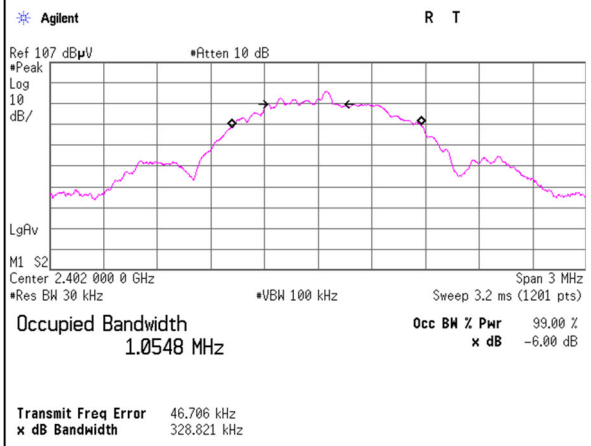
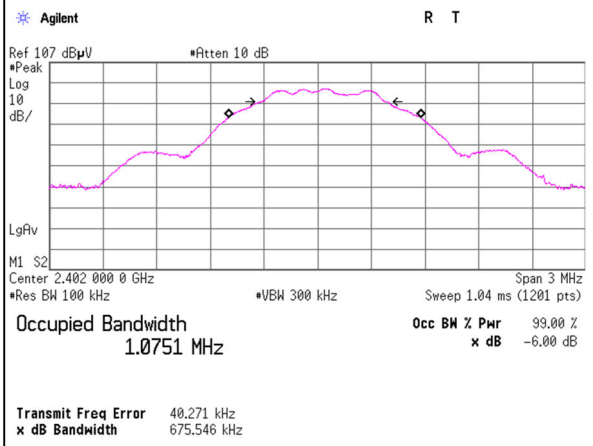
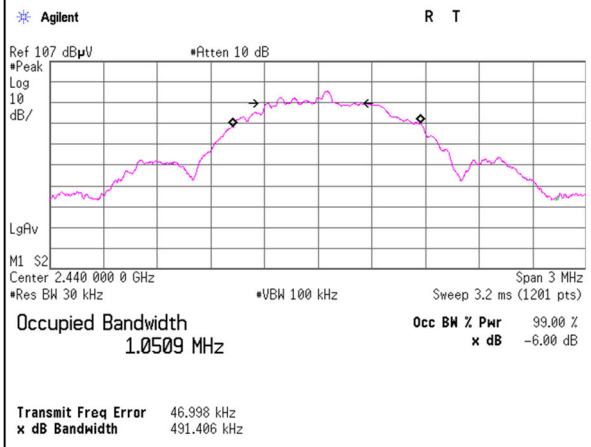
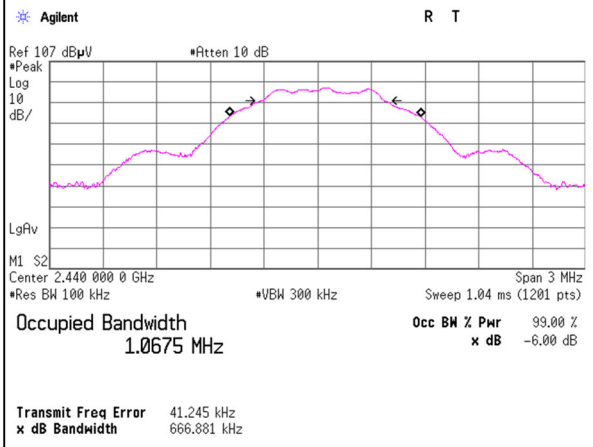
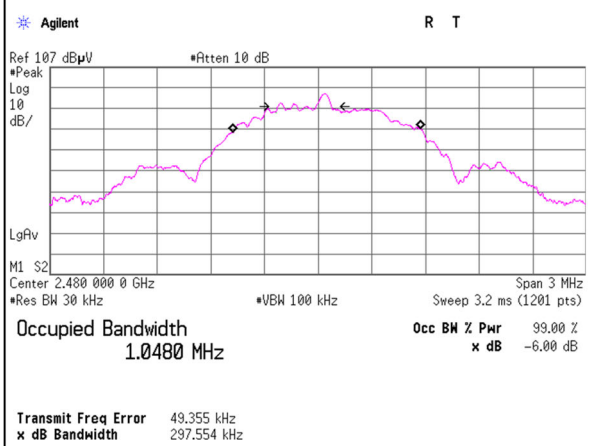
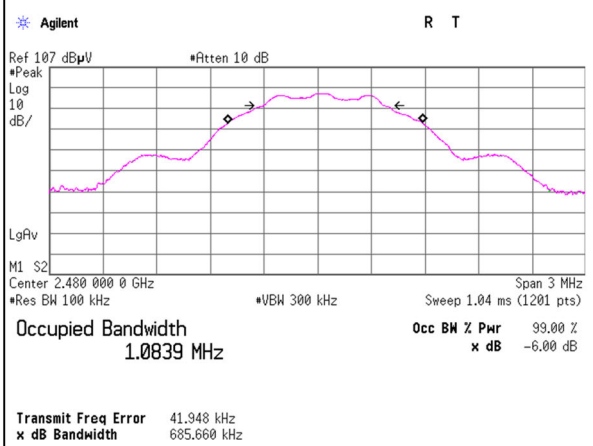
Test place	Shonan EMC Lab. No.5 Shielded Room
Date	September 20, 2023
Temperature / Humidity	24 deg. C / 54 % RH
Engineer	Miku Ikudome
Mode	Tx

BT LE 1M-PHY

Frequency [MHz]	99 % Occupied Bandwidth [kHz]	6 dB Bandwidth [MHz]	Limit for 6 dB Bandwidth [MHz]
2402	1054.8	0.676	> 0.5000
2440	1050.9	0.667	> 0.5000
2480	1048.0	0.686	> 0.5000

99 % Occupied Bandwidth and 6 dB Bandwidth

BT LE 1M-PHY,

99 % Occupied Bandwidth	6 dB Bandwidth
2402 MHz	**2402 MHz**
	
2440 MHz	**2440 MHz**
	
2480 MHz	**2480 MHz**
	

Maximum Peak Output Power

Test place	Shonan EMC Lab. No.5 Shielded Room
Date	September 20, 2023
Temperature / Humidity	24 deg. C / 54 % RH
Engineer	Miku Ikudome
Mode	Tx

BT LE 1M-PHY

Maximum peak output power

				Conducted Power					e.i.r.p. for RSS-247					
Freq.	Reading	Cable Loss	Atten. Loss	Result		Limit		Margin	Antenna Gain	Result		Limit		Margin
[MHz]	[dBm]	[dB]	[dB]	[dBm]	[mW]	[dBm]	[mW]	[dB]	[dBi]	[dBm]	[mW]	[dBm]	[mW]	[dB]
2402	-12.46	1.75	10.18	-0.53	0.89	30.00	1000	30.53	-2.00	-2.53	0.56	36.02	4000	38.55
2440	-12.37	1.76	10.18	-0.43	0.91	30.00	1000	30.43	-2.00	-2.43	0.57	36.02	4000	38.45
2480	-12.49	1.77	10.18	-0.54	0.88	30.00	1000	30.54	-2.00	-2.54	0.56	36.02	4000	38.56

Sample Calculation:
Result = Reading + Cable Loss (including the cable(s) customer supplied) + Attenuator Loss
e.i.r.p. Result = Conducted Power Result + Antenna Gain

Average Output Power
(Reference data for RF Exposure)

Test place	Shonan EMC Lab. No.5 Shielded Room
Date	September 20, 2023
Temperature / Humidity	24 deg. C / 54 % RH
Engineer	Miku Ikudome
Mode	Tx

BT LE 1M-PHY

Average power

Freq.	Reading	Cable Loss	Atten. Loss	Result (Time average)		Duty factor	Result (Burst power average)	
[MHz]	[dBm]	[dB]	[dB]	[dBm]	[mW]	[dB]	[dBm]	[mW]
2402	-14.78	1.75	10.18	-2.85	0.52	1.68	-1.17	0.76
2440	-14.72	1.76	10.18	-2.78	0.53	1.68	-1.10	0.78
2480	-14.77	1.77	10.18	-2.82	0.52	1.68	-1.14	0.77

Sample Calculation:

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

Result (Burst power average) = Result (Time average) + Duty factor

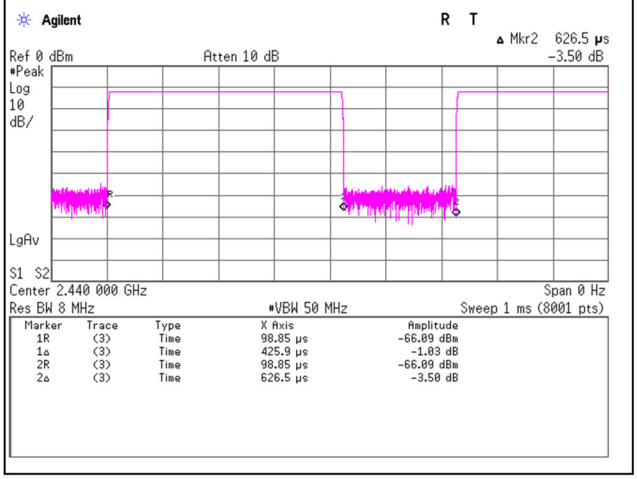
Burst rate confirmation

Test place	Shonan EMC Lab. No.5 Shielded Room
Date	September 20, 2023
Temperature / Humidity	24 deg. C / 54 % RH
Engineer	Miku Ikudome
Mode	Tx

BT LE 1M-PHY (for Average power) *1)

BT LE 1M-PHY (for Radiated emission) *2)

Tx on / (Tx on + Tx off) =	**0.679**
Tx on / (Tx on + Tx off) * 100 =	**67.9 %**
Duty factor = 10 * log (0.627 / 0.426) =	**1.68 dB *1)**
Duty factor = 20 * log (0.627 / 0.426) =	**3.36 dB *2)**



Radiated Spurious Emission

Test place	Shonan EMC Lab.	
Semi Anechoic Chamber	3	3
Date	August 24, 2023	August 25, 2023
Temperature / Humidity	22 deg. C / 47 % RH	22 deg. C / 45% RH
Engineer	Hiromasa Sato	Hiromasa Sato
	(1 GHz to 10 GHz)	(10 GHz to 26.5 GHz)
Mode	Tx BT LE 2402 MHz	

(* PK: Peak, AV: Average, QP: Quasi-Peak)

Polarity	Frequency [MHz]	Detector	Reading [dBuV]	Ant.Fac. [dB/m]	Loss [dB]	Gain [dB]	Distance Factor [dB]	Result [dBuV/m]	Limit [dBuV/m]	Margin [dB]	Height [cm]	Angle [deg]	Remark
Hori.	2390.000	PK	47.28	27.98	14.49	41.61	2.39	50.53	73.9	23.3	246	22	-
Hori.	4804.000	PK	47.95	31.39	7.39	42.87	2.39	46.25	73.9	27.6	164	172	-
Hori.	7206.000	PK	48.12	37.12	8.73	43.34	2.39	53.02	73.9	20.8	150	0	-
Hori.	9608.000	PK	48.31	38.58	9.90	43.12	2.39	56.06	73.9	17.8	150	0	-
Hori.	7206.000	AV	38.61	37.12	8.73	43.34	2.39	43.51	53.9	10.3	150	0	Floor noise
Hori.	9608.000	AV	38.77	38.58	9.90	43.12	2.39	46.52	53.9	**7.3**	150	0	Floor noise
Vert.	2390.000	PK	47.68	27.98	14.49	41.61	2.39	50.93	73.9	22.9	167	284	-
Vert.	4804.000	PK	48.22	31.39	7.39	42.87	2.39	46.52	73.9	27.3	157	77	-
Vert.	7206.000	PK	48.41	37.12	8.73	43.34	2.39	53.31	73.9	20.5	150	0	-
Vert.	9608.000	PK	48.04	38.58	9.90	43.12	2.39	55.79	73.9	18.1	150	0	-
Vert.	7206.000	AV	38.50	37.12	8.73	43.34	2.39	43.40	53.9	10.5	150	0	Floor noise
Vert.	9608.000	AV	38.75	38.58	9.90	43.12	2.39	46.50	53.9	7.4	150	0	Floor noise

Result = Reading + Ant.Fac. + Loss (Cable+(Attenuator or Filter)(below 18 GHz)) - Gain(Amplifier) + Distance factor
Distance factor : 1 GHz - 10 GHz : 20log (3.95 m / 3.0 m) = 2.39 dB
10 GHz - 40 GHz : 20log (1.0 m / 3.0 m) = -9.54 dB

Average measurement value with duty factor

Polarity	Frequency [MHz]	Detector	Reading [dBuV]	Ant.Fac. [dB/m]	Loss [dB]	Gain [dB]	Duty Factor [dB]	Distance Factor [dB]	Result [dBuV/m]	Limit [dBuV/m]	Margin [dB]	Remark
Hori.	2390.000	AV	38.15	27.98	14.49	41.61	3.36	2.39	44.76	53.9	9.1	*1)
Hori.	4804.000	AV	38.36	31.39	7.39	42.87	3.36	2.39	40.02	53.9	13.8	-
Vert.	2390.000	AV	39.29	27.98	14.49	41.61	3.36	2.39	45.90	53.9	8.0	*1)
Vert.	4804.000	AV	38.59	31.39	7.39	42.87	3.36	2.39	40.25	53.9	13.6	-

Result = Reading + Ant.Fac. + Loss (Cable+(Attenuator or Filter)(below 18 GHz)) - Gain(Amplifier) + Duty factor + Distance factor
Distance factor : 1 GHz - 10 GHz : 20log (3.95 m / 3.0 m) = 2.39 dB
10 GHz - 40 GHz : 20log (1.0 m / 3.0 m) = -9.54 dB
Duty factor refer to "Burst rate confirmation" sheet.
*1) Not out of band emission (Leakage Power)

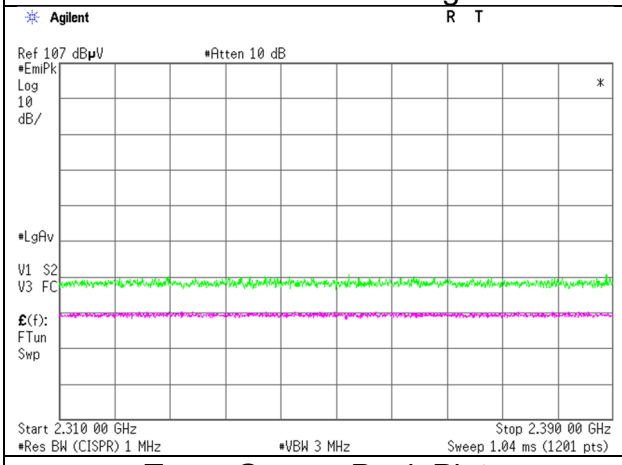
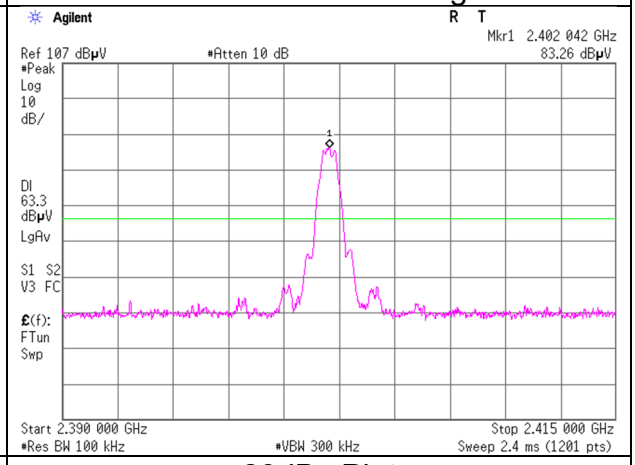
20 dBc Data Sheet (RBW 100 kHz, VBW 300 kHz)

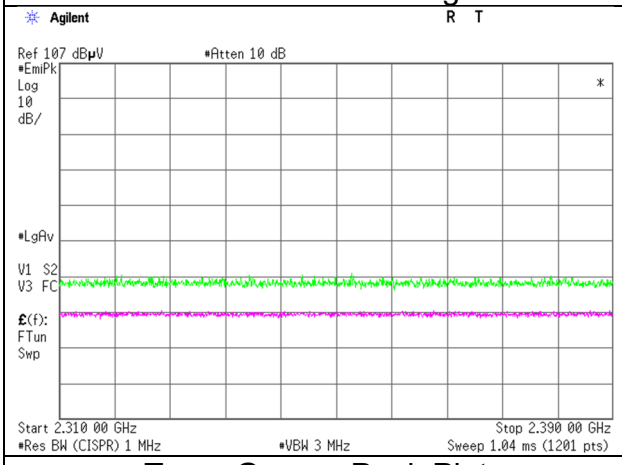
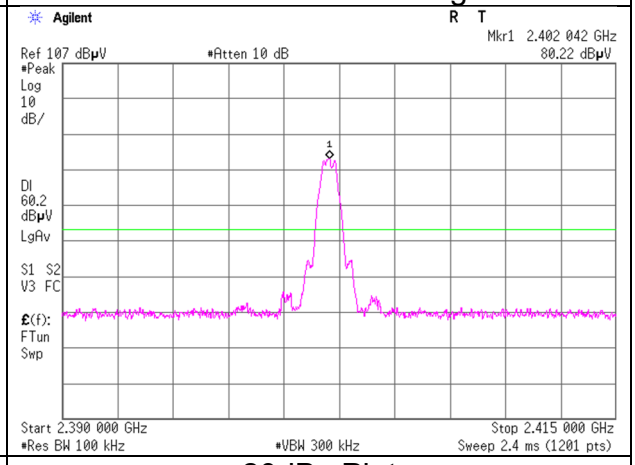
Polarity	Frequency [MHz]	Detector	Reading [dBuV]	Ant.Fac. [dB/m]	Loss [dB]	Gain [dB]	Distance Factor [dB]	Result [dBuV/m]	Limit [dBuV/m]	Margin [dB]	Remark
Hori.	2402.000	PK	82.95	27.97	14.50	41.61	2.39	86.20	-	-	Carrier
Hori.	2400.000	PK	44.95	27.97	14.50	41.61	2.39	48.20	66.2	18.0	-
Vert.	2402.000	PK	79.88	27.97	14.50	41.61	2.39	83.13	-	-	Carrier
Vert.	2400.000	PK	43.34	27.97	14.50	41.61	2.39	46.59	63.1	16.5	-

Result = Reading + Ant.Fac. + Loss (Cable+(Attenuator or Filter)(below 18 GHz)) - Gain(Amplifier) + Distance factor
Distance factor : 1 GHz - 10 GHz : 20log (3.95 m / 3.0 m) = 2.39 dB
10 GHz - 40 GHz : 20log (1.0 m / 3.0 m) = -9.54 dB

Radiated Spurious Emission
(Reference Plot for band-edge)

Test place	Shonan EMC Lab.
Semi Anechoic Chamber	3
Date	August 24, 2023
Temperature / Humidity	22 deg. C / 47 % RH
Engineer	Hiromasa Sato
	(1 GHz to 10 GHz)
Mode	Tx BT LE 2402 MHz

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

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

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

Radiated Spurious Emission

Test place	Shonan EMC Lab.	
Semi Anechoic Chamber	3	3
Date	August 24, 2023	August 25, 2023
Temperature / Humidity	22 deg. C / 47 % RH	22 deg. C / 45% RH
Engineer	Hiromasa Sato	Hiromasa Sato
	(1 GHz to 10 GHz)	(30 MHz to 1 GHz, 10 GHz to 26.5 GHz)
Mode	Tx BT LE 2440 MHz	

(* PK: Peak, AV: Average, QP: Quasi-Peak)

Polarity	Frequency [MHz]	Detector	Reading [dBuV]	Ant.Fac. [dB/m]	Loss [dB]	Gain [dB]	Distance Factor [dB]	Result [dBuV/m]	Limit [dBuV/m]	Margin [dB]	Height [cm]	Angle [deg]	Remark
Hori.	31.371	QP	23.50	18.51	6.51	32.20	0.00	16.32	40.0	23.6	100	0	-
Hori.	223.099	QP	22.80	11.47	8.15	32.04	0.00	10.38	46.0	35.6	100	0	-
Hori.	509.732	QP	22.70	17.86	9.52	31.94	0.00	18.14	46.0	27.8	100	0	-
Hori.	961.114	QP	22.60	21.97	11.16	30.61	0.00	25.12	53.9	28.7	100	0	-
Hori.	4880.000	PK	48.44	31.51	7.43	42.88	2.39	46.89	73.9	27.0	155	47	-
Hori.	7320.000	PK	48.40	37.25	8.79	43.42	2.39	53.41	73.9	20.4	150	0	-
Hori.	9760.000	PK	48.92	39.02	9.99	43.01	2.39	57.31	73.9	16.5	150	0	-
Hori.	7320.000	AV	39.93	37.25	8.79	43.42	2.39	44.94	53.9	8.9	150	0	Floor noise
Hori.	9760.000	AV	38.23	39.02	9.99	43.01	2.39	46.62	53.9	7.2	150	0	Floor noise
Vert.	148.081	QP	23.30	14.75	7.76	32.10	0.00	13.71	43.5	29.7	100	0	-
Vert.	330.047	QP	22.60	14.83	8.74	31.98	0.00	14.19	46.0	31.8	100	0	-
Vert.	618.116	QP	21.40	19.55	9.96	31.94	0.00	18.97	46.0	27.0	100	0	-
Vert.	849.429	QP	22.50	21.56	10.80	31.36	0.00	23.50	46.0	22.5	100	0	-
Vert.	4880.000	PK	48.85	31.51	7.43	42.88	2.39	47.30	73.9	26.6	164	37	-
Vert.	7320.000	PK	48.59	37.25	8.79	43.42	2.39	53.60	73.9	20.3	150	0	-
Vert.	9760.000	PK	48.60	39.02	9.99	43.01	2.39	56.99	73.9	16.9	150	0	-
Vert.	7320.000	AV	38.81	37.25	8.79	43.42	2.39	43.82	53.9	10.0	150	0	Floor noise
Vert.	9760.000	AV	38.55	39.02	9.99	43.01	2.39	46.94	53.9	**6.9**	150	0	Floor noise

Result = Reading + Ant.Fac. + Loss (Cable+(Attenuator or Filter)(below 18 GHz)) - Gain(Amplifier) + Distance factor
Distance factor : 1 GHz - 10 GHz : 20log (3.95 m / 3.0 m) = 2.39 dB
10 GHz - 40 GHz : 20log (1.0 m / 3.0 m) = -9.54 dB

Average measurement value with duty factor

Polarity	Frequency [MHz]	Detector	Reading [dBuV]	Ant.Fac. [dB/m]	Loss [dB]	Gain [dB]	Duty Factor [dB]	Distance Factor [dB]	Result [dBuV/m]	Limit [dBuV/m]	Margin [dB]	Remark
Hori.	4880.000	AV	38.42	31.51	7.43	42.88	3.36	2.39	40.23	53.9	13.6	-
Vert.	4880.000	AV	39.84	31.51	7.43	42.88	3.36	2.39	41.65	53.9	12.2	-

Result = Reading + Ant.Fac. + Loss (Cable+(Attenuator or Filter)(below 18 GHz)) - Gain(Amplifier) + Duty factor + Distance factor
Distance factor : 1 GHz - 10 GHz : 20log (3.95 m / 3.0 m) = 2.39 dB
10 GHz - 40 GHz : 20log (1.0 m / 3.0 m) = -9.54 dB
Duty factor refer to "Burst rate confirmation" sheet.

Radiated Spurious Emission

Test place	Shonan EMC Lab.
Semi Anechoic Chamber	3
Date	August 25, 2023
Temperature / Humidity	22 deg. C / 45 % RH
Engineer	Hiromasa Sato
	(1 GHz to 26.5 GHz)
Mode	Tx BT LE 2480 MHz

(* PK: Peak, AV: Average, QP: Quasi-Peak)

Polarity	Frequency [MHz]	Detector	Reading [dBuV]	Ant.Fac. [dB/m]	Loss [dB]	Gain [dB]	Distance Factor [dB]	Result [dBuV/m]	Limit [dBuV/m]	Margin [dB]	Height [cm]	Angle [deg]	Remark
Hori.	2483.500	PK	47.52	27.89	14.60	41.64	2.39	50.76	73.9	23.1	159	215	-
Hori.	4960.000	PK	48.39	31.73	7.49	42.89	2.39	47.11	73.9	26.7	230	346	-
Hori.	7440.000	PK	48.02	37.42	8.87	43.50	2.39	53.20	73.9	20.7	150	0	-
Hori.	9920.000	PK	47.39	38.95	10.09	42.89	2.39	55.93	73.9	17.9	150	0	-
Hori.	7440.000	AV	39.10	37.42	8.87	43.50	2.39	44.28	53.9	9.6	150	0	Floor noise
Hori.	9920.000	AV	38.61	38.95	10.09	42.89	2.39	47.15	53.9	6.7	150	0	Floor noise
Vert.	2483.500	PK	48.39	27.89	14.60	41.64	2.39	51.63	73.9	22.2	221	99	-
Vert.	4960.000	PK	48.63	31.73	7.49	42.89	2.39	47.35	73.9	26.5	171	62	-
Vert.	7440.000	PK	47.84	37.42	8.87	43.50	2.39	53.02	73.9	20.8	150	0	-
Vert.	9920.000	PK	47.42	38.95	10.09	42.89	2.39	55.96	73.9	17.9	150	0	-
Vert.	7440.000	AV	39.09	37.42	8.87	43.50	2.39	44.27	53.9	9.6	150	0	Floor noise
Vert.	9920.000	AV	38.75	38.95	10.09	42.89	2.39	47.29	53.9	**6.6**	150	0	Floor noise

Result = Reading + Ant.Fac. + Loss (Cable+(Attenuator or Filter)(below 18 GHz)) - Gain(Amplifier) + Distance factor
Distance factor : 1 GHz - 10 GHz : 20log (3.95 m / 3.0 m) = 2.39 dB
10 GHz - 40 GHz : 20log (1.0 m / 3.0 m) = -9.54 dB

Average measurement value with duty factor

Polarity	Frequency [MHz]	Detector	Reading [dBuV]	Ant.Fac. [dB/m]	Loss [dB]	Gain [dB]	Duty Factor [dB]	Distance Factor [dB]	Result [dBuV/m]	Limit [dBuV/m]	Margin [dB]	Remark
Hori.	2483.500	AV	38.24	27.89	14.60	41.64	3.36	2.39	44.84	53.9	9.0	*1)
Hori.	4960.000	AV	38.42	31.73	7.49	42.89	3.36	2.39	40.50	53.9	13.4	-
Vert.	2483.500	AV	38.04	27.89	14.60	41.64	3.36	2.39	44.64	53.9	9.2	*1)
Vert.	4960.000	AV	40.05	31.73	7.49	42.89	3.36	2.39	42.13	53.9	11.7	-

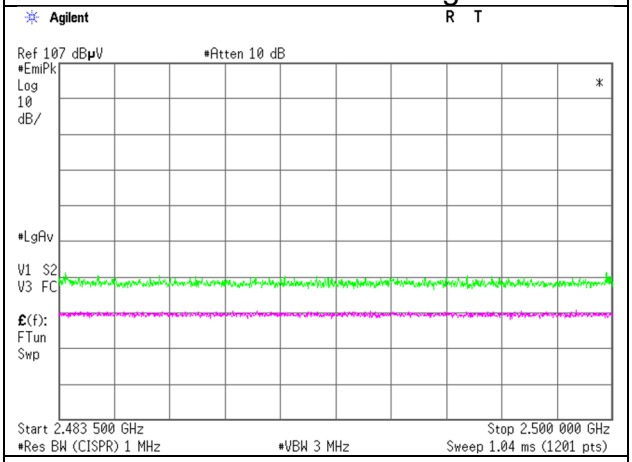
Result = Reading + Ant.Fac. + Loss (Cable+(Attenuator or Filter)(below 18 GHz)) - Gain(Amplifier) + Duty factor + Distance factor
Distance factor : 1 GHz - 10 GHz : 20log (3.95 m / 3.0 m) = 2.39 dB
10 GHz - 40 GHz : 20log (1.0 m / 3.0 m) = -9.54 dB
Duty factor refer to "Burst rate confirmation" sheet.
*1) Not out of band emission (Leakage Power)

Radiated Spurious Emission
(Reference Plot for band-edge)

Test place	Shonan EMC Lab.
Semi Anechoic Chamber	3
Date	August 24, 2023
Temperature / Humidity	22 deg. C / 47 % RH
Engineer	Hiromasa Sato
	(1 GHz to 10 GHz)
Mode	Tx BT LE 2402 MHz

Horizontal

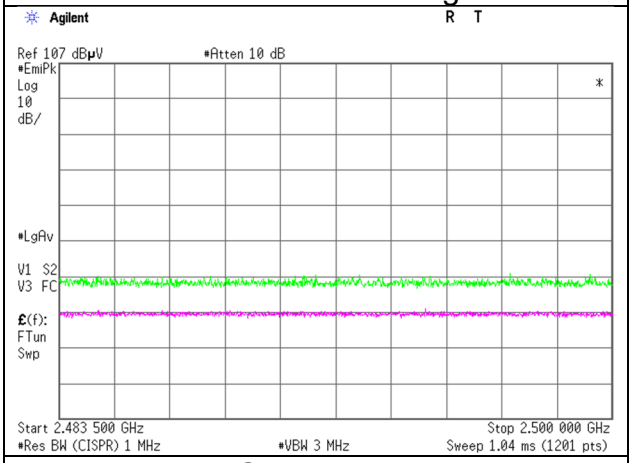
Restricted-band band-edge Plot



Trace Green : Peak Plot
Trace Purple : Average Plot

Vertical

Restricted-band band-edge Plot

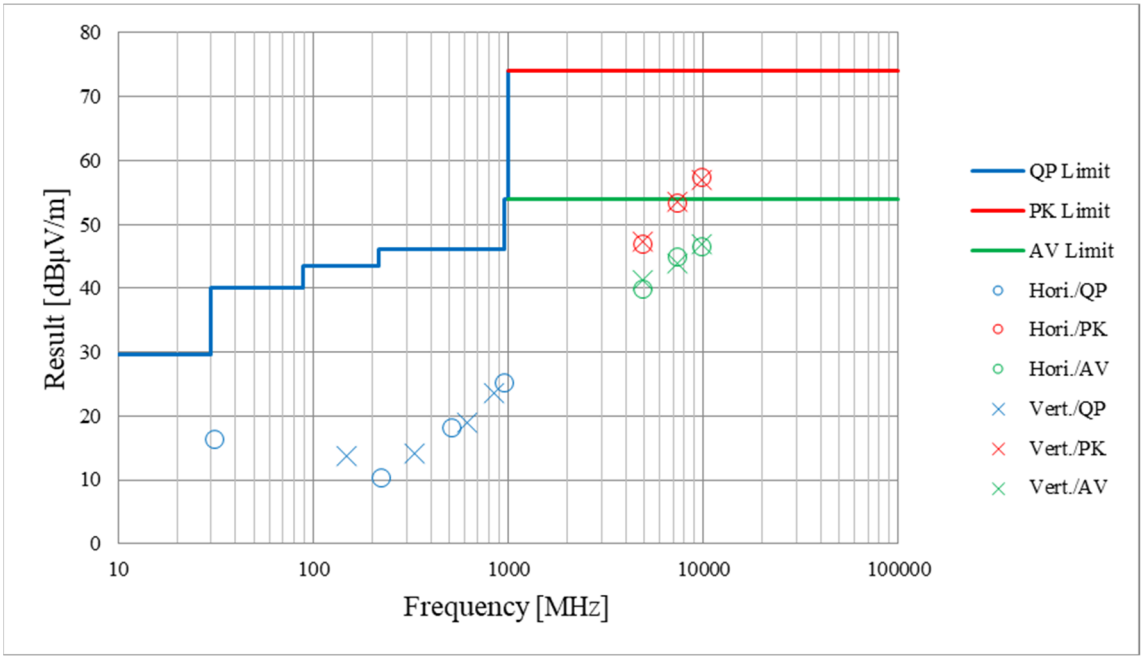


Trace Green : Peak Plot
Trace Purple : Average Plot

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

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

Test place	Shonan EMC Lab.	
Semi Anechoic Chamber	3	3
Date	August 24, 2023	August 25, 2023
Temperature / Humidity	22 deg. C / 47 % RH	22 deg. C / 45% RH
Engineer	Hiromasa Sato	Hiromasa Sato
	(1 GHz to 10 GHz)	(30 MHz to 1 GHz, 10 GHz to 26.5 GHz)
Mode	Tx BT LE 2440 MHz	



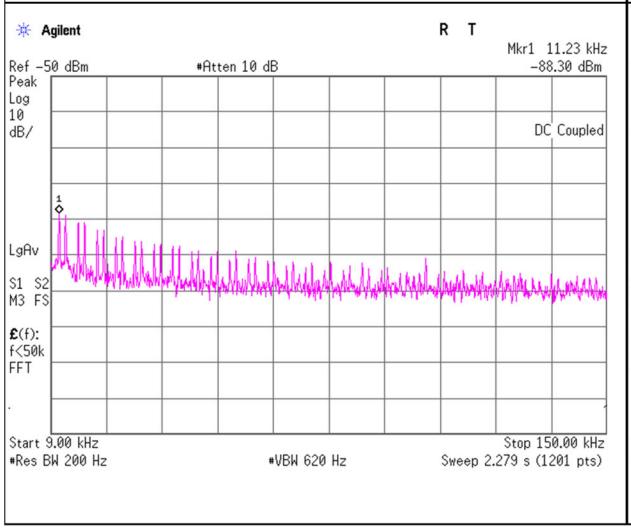
*These plots data contain sufficient number to show the trend of characteristic features for EUT.

Conducted Spurious Emission

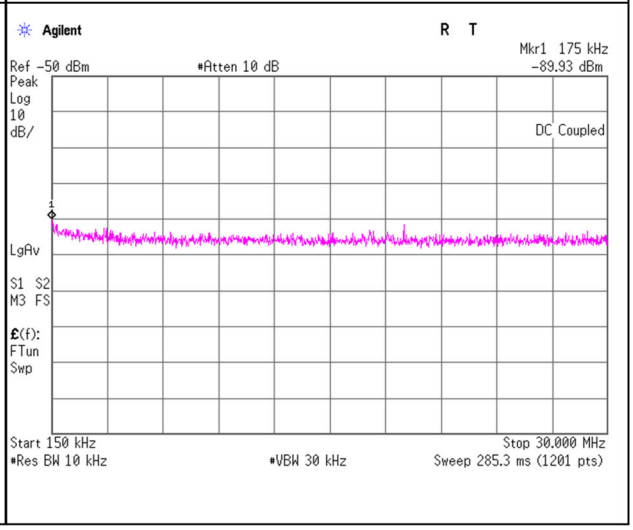
Test place	Shonan EMC Lab. No.5 Shielded Room
Date	September 20, 2023
Temperature / Humidity	24 deg. C / 54 % RH
Engineer	Miku Ikudome
Mode	Tx

Tx, 2440 MHz

9 kHz - 150 kHz



150 kHz - 30 MHz



Frequency [kHz]	Reading [dBm]	Cable Loss [dB]	Attenuator Loss [dB]	Antenna Gain * [dBi]	N (Number of Output)	EIRP [dBm]	Distance [m]	Ground bounce [dB]	E (field strength) [dBuV/m]	Limit [dBuV/m]	Margin [dB]	Remark
11.23	-88.3	0.5	10.1	2.0	1.0	-75.7	300	6.0	-14.4	46.5	60.9	-
175.00	-89.9	0.5	10.1	2.0	1.0	-77.3	300	6.0	-16.0	22.7	38.7	-

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	Shonan EMC Lab. No.5 Shielded Room
Date	September 20, 2023
Temperature / Humidity	24 deg. C / 54 % RH
Engineer	Miku Ikudome
Mode	Tx

BT LE 1M-PHY

Frequency [MHz]	Measured Frequency [MHz]	Reading [dBm/3 kHz]	Cable Loss [dB]	Atten. Loss [dB]	Result [dBm/3 kHz]	Limit [dBm/3 kHz]	Margin [dB]
2402	2402.041	-28.62	1.75	10.18	-16.69	8.00	24.69
2440	2440.020	-27.83	1.76	10.18	-15.89	8.00	23.89
2480	2480.034	-27.47	1.77	10.18	-15.52	8.00	23.52

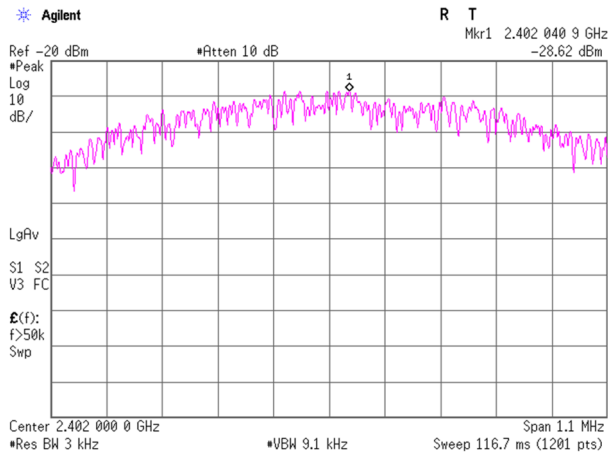
Sample Calculation:
Result = Reading + Cable Loss (including the cable(s) customer supplied) + Attenuator Loss

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

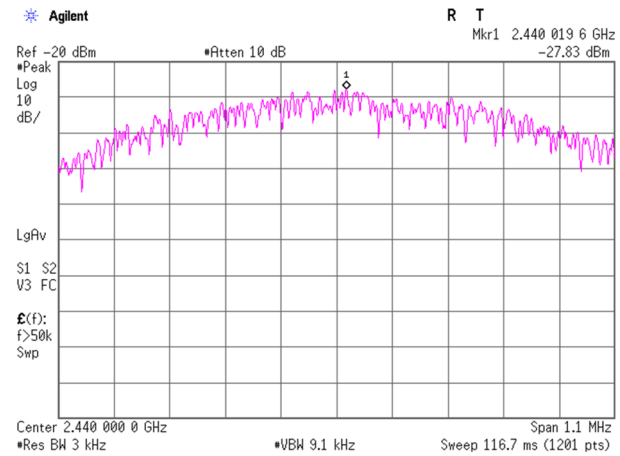
Power Density

BT LE 1M-PHY

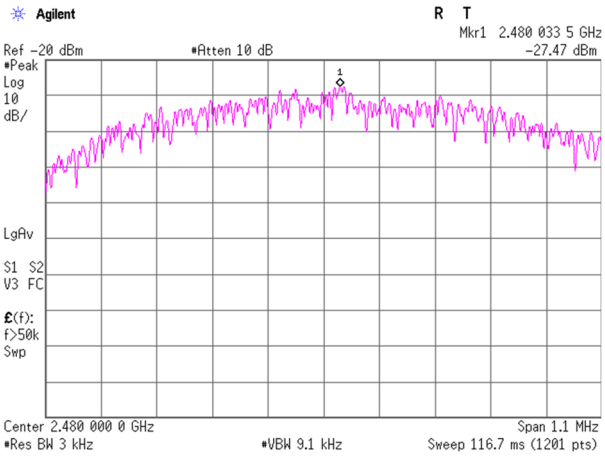
2402 MHz



2440 MHz



2480 MHz



APPENDIX 2: Test Instruments

Test Equipment (1/2)

Test Item	Local ID	LIMS ID	Description	Manufacturer	Model	Serial	Last Calibration Date	Cal Int
AT	KTS-07	145111	Digital Tester	SANWA	PC500	7019232	2022/09/20	12
AT	SAT10-15	160493	Attenuator	Weinschel Corp.	54A-10	83406	2022/12/01	12
AT	SCC-G66	196947	Coaxial Cable	Huber+Suhner	SUCOFLEX 102	803478/2	2023/03/02	12
AT	SOS-19	175823	Thermo-Hygrometer	CUSTOM. Inc	CTH-201	-	2023/08/01	12
AT	SPM-07	146247	Power Meter	Keysight Technologies Inc	8990B	MY51000272	2023/05/29	12
AT	SPSS-04	146310	Power sensor	Keysight Technologies Inc	N1923A	MY5326009	2023/05/29	12
AT	SRENT-30	235604	Spectrum Analyzer	Keysight Technologies Inc	E4440A	MY45300743	2023/05/18	12
RE	COTS-SEMI-5	170932	EMI Software	TSJ (Techno Science Japan)	TEPTO-DV3(RE,CE,ME,PE)	-	-	-
RE	KJM-02	146432	Tape Measure	TAJIMA	GL19-55	-	-	-
RE	SAEC-03(NSA)	145565	Semi-Anechoic Chamber	TDK	SAEC-03(NSA)	3	2023/04/05	12
RE	SAEC-03(SVSWR)	145566	Semi-Anechoic Chamber	TDK	SAEC-03(SVSWR)	3	2023/05/14	12
RE	SAF-03	145126	Pre Amplifier	SONOMA	310N	290213	2023/02/09	12
RE	SAF-06	145005	Pre Amplifier	Toyo Corporation	TPA0118-36	1440491	2023/02/02	12
RE	SAF-08	145007	Pre Amplifier	Toyo Corporation	HAP18-26W	19	2023/03/03	12
RE	SAT10-06	145137	Attenuator	Keysight Technologies Inc	8493C-010	74865	2022/10/20	12
RE	SAT6-13	167094	Attenuator	JFW	50HF-006N	-	2023/02/09	12
RE	SBA-03	145023	Biconical Antenna	Schwarzbeck Mess-Elektronik OHG	BBA9106	91032666	2023/05/16	12
RE	SCC-C1/C2/C3/C4/C5/C10/SRSE-03	145171	Coaxial Cable&RF Selector	Fujikura/Fujikura/Suhner/Suhner/Suhner/Suhner/TOYO	8D2W/12DSFA/141PE/141PE/141PE/141PE/NS4906	-/0901-271(RF Selector)	2023/04/18	12

Test Equipment (2/2)

Test Item	Local ID	LIMS ID	Description	Manufacturer	Model	Serial	Last Calibration Date	Cal Int
RE	SCC-G15	145176	Coaxial Cable	Suhner	SUCOFLEX 102	32703/2	2023/08/23	12
RE	SCC-G40	166491	Coaxial Cable	Junkosha	MWX221-01000NFSNMS/B	1612S005	2023/01/12	12
RE	SCC-G43	156380	Coaxial Cable	Huber+Suhner	SUCOFLEX_104_E	SN MY 13406/4E	2023/05/19	12
RE	SCC-G44	168300	Coaxial Cable	Huber+Suhner	SUCOFLEX 104	800375/4A	2022/11/10	12
RE	SCC-G57	179540	Coaxial Cable	Huber+Suhner	SUCOFLEX 102	802815/2	2023/03/03	12
RE	SCC-G70	200010	Coaxial Cable	Huber+Suhner	SUCOFLEX 104	575618/4	2023/06/06	12
RE	SFL-02	145301	Highpass Filter	Micro-Tronics	HPM50111	51	2022/10/20	12
RE	SHA-03	145501	Horn Antenna	Schwarzbeck Mess-Elektronik OHG	BBHA9120D	9120D-739	2023/03/27	12
RE	SHA-04	145512	Horn Antenna	ETS-Lindgren	3160-09	00094868	2023/06/12	12
RE	SHA-10	194685	Horn Antenna	Schwarzbeck Mess-Elektronik OHG	BBHA 9120 C	711	2023/03/27	12
RE	SLA-07	145529	Logperiodic Antenna	Schwarzbeck Mess-Elektronik OHG	VUSLP9111B	196	2023/05/16	12
RE	SOS-23	191840	Thermo-Hygrometer	CUSTOM. Inc	CTH-201	-	2023/08/03	12
RE	SSA-02	145800	Spectrum Analyzer	Keysight Technologies Inc	E4448A	MY48250106	2023/03/01	12
RE	STR-07	146209	Test Receiver	Rohde & Schwarz	ESU26	100484	2022/09/14	12
RE	STS-03	146210	Digital Hitester	HIOKI E.E. CORPORATION	3805-50	80997823	2022/09/20	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 tests
RE: Radiated Emission