RADIO TEST REPORT

Test Report No. : 13753617H-A-R1

Applicant	:	**T&D Corporation**
Type of EUT	:	**Data Logger**
Model Number of EUT	:	**TR71A**
FCC ID	:	**SRD50110**
Test regulation	:	**FCC Part 15 Subpart C: 2021** *** Bluetooth Low Energy parts**
Test Result	:	**Complied (Refer to SECTION 3)**

1. This test report shall not be reproduced in full or partial, without the written approval of UL Japan, Inc.
2. The results in this report apply only to the sample tested.
3. This sample tested is in compliance with the limits of the above regulation.
4. The test results in this test report are traceable to the national or international standards.
5. This test report must not be used by the customer to claim product certification, approval, or endorsement by the A2LA accreditation body.
6. This test report covers Radio technical requirements.
   It does not cover administrative issues such as Manual or non-Radio test related Requirements. (if applicable)
7. The all test items in this test report are conducted by UL Japan, Inc. Ise EMC Lab.
8. The opinions and the interpretations to the result of the description in this report are outside scopes where UL Japan has been accredited.
9. The information provided from the customer for this report is identified in Section 1.
10. This report is a revised version of 13753617H-A. 13753617H-A is replaced with this report.

Date of test: April 12 to June 30, 2021

Representative test engineer:
Kiyoshiro Okazaki
Engineer

Approved by:
Takumi Shimada
Engineer

CERTIFICATE 5107.02

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

REVISION HISTORY

Original Test Report No.: 13753617H-A

Revision	Test report No.	Date	Page revised	Contents
- (Original)	13753617H-A	June 30, 2021	-	-
1	13753617H-A-R1	July 9, 2021	P.13	Correction of title from Radiated emission test to Conducted and Radiated emission tests
1	13753617H-A-R1	July 9, 2021	P.14	Correction of page layout
1	13753617H-A-R1	July 9, 2021	P.16	Correction of IF Bandwidth: AV of Above 1 GHz
1	13753617H-A-R1	July 9, 2021	P.25	Deletion of notes below the table.
1	13753617H-A-R1	July 9, 2021	P.27	Correction of the sentence below the waveform.
1	13753617H-A-R1	July 9, 2021	P.28, 30, 31	Addition of AV detection data of 4th harmonics frequency. Deletion of data of 4th harmonics frequency from table of Peak measurement value with duty cycle correction factor.
1	13753617H-A-R1	July 9, 2021	P.33	Addition of AV detection point
1	13753617H-A-R1	July 9, 2021	P.39, 40	Addition of *1) to MHA-21, and addition of notes *1)

Reference: Abbreviations (Including words undescribed in this report)

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

CONTENTS **PAGE**

SECTION 1: Customer information

Company Name	:	T&D Corporation
Address	:	817-1 Shimadachi, Matsumoto, Nagano, 390-0852 Japan
Telephone Number	:	+81-263-40-0131
Facsimile Number	:	+81-263-40-3152
Contact Person	:	Chiaki Segi

The information provided from the customer is as follows;
- Applicant, Type 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
- 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

Type	:	Data Logger
Model Number	:	TR71A
Serial Number	:	Refer to SECTION 4.2
Rating	:	DC 2.6 V - 3.0 V (Battery) DC 5.0 V (USB)
Receipt Date	:	April 8, 2021
Country of Mass-production	:	Japan
Condition	:	Engineering prototype (Not for Sale: This sample is equivalent to mass-produced items.)
Modification	:	No Modification by the test lab.

2.2 Product Description

Model: TR71A (referred to as the EUT in this report) is a Data Logger.

*Model No. TR71A has a similar model: TR72A.
The difference between TR71A and TR72A is only sensor.
(Same radio module is embedded in these models)
The test was performed with TR71A as a representative because it has the worst result.

General Specification

Clock frequency(ies) in the system : WLAN CPU:40 MHz, BLE CPU:24 MHz

Radio Specification

Type of radio	IEEE802.11b *1)	IEEE802.11g *1)	IEEE802.11n *1) (20 M band)	Bluetooth Low Energy
Radio Type	Transceiver			Transceiver
Frequency of operation	2412MHz - 2462 MHz			2402 MHz - 2480 MHz
Type of modulation	DSSS (CCK, DQPSK, DBPSK)	OFDM-CCK (64QAM, 16QAM, QPSK, BPSK)	OFDM (64QAM, 16QAM, QPSK, BPSK)	GFSK
Channel spacing	5 MHz			2 MHz
Antenna type	Internal Antenna (ceramic chip antenna)			Pattern Antenna
Antenna Gain	3.35 dBi			1.6 dBi

*1) The Wireless LAN module installed in the EUT has already been approved by the FCC (FCC ID: YOPGS2200M).
Therefore, this test report only concerns Bluetooth Low Energy.

SECTION 3: Test specification, procedures & results

3.1 Test Specification

Test Specification	:	FCC Part 15 Subpart C FCC Part 15 final revised on January 12, 2021 and effective February 11, 2021
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	16.08 dB (0.66595 MHz, N, AV)	Complied a)	-
	ISED: RSS-Gen 8.8	**ISED:** RSS-Gen 8.8			
6dB Bandwidth	**FCC:** KDB 558074 D01 15.247 Meas Guidance v05r02	**FCC:** Section 15.247(a)(2)	See data.	Complied b)	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 c)	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 d)	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)	6.6 dB (671.957 MHz, QP, Hori.)	Complied e), f)	Conducted (below 30 MHz)/ Radiated (above 30 MHz) *1)
	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 No. 13-EM-W0420 and 13-EM-W0422.
*1) 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.

a) Refer to APPENDIX 1 (data of Conducted Emission)
b) Refer to APPENDIX 1 (data of 6 dB Bandwidth and 99 % Occupied Bandwidth)
c) Refer to APPENDIX 1 (data of Maximum Peak Output Power)
d) Refer to APPENDIX 1 (data of Power Density)
e) Refer to APPENDIX 1 (data of Conducted Spurious Emission)
f) Refer to APPENDIX 1 (data of Radiated Spurious Emission)

Symbols:

Complied	The data of this test item has enough margin, more than the measurement uncertainty.
Complied#	The data of this test item meets the limits unless the measurement uncertainty is taken into consideration.

* In case any questions arise about test procedure, ANSI C63.10: 2013 is also referred.

FCC Part 15.31 (e)
This EUT provides stable voltage constantly to RF Module regardless of input voltage.
Therefore, this EUT complies with the requirement.

FCC Part 15.203 Antenna requirement
It is impossible for end users to replace the antenna, because the antenna is mounted inside of the 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	- a)	Conducted

a) Refer to APPENDIX 1 (data of 6 dB Bandwidth and 99 % Occupied Bandwidth)

Other than above, no addition, exclusion nor deviation has been made from the standard.

3.4 Uncertainty

There is no applicable rule of uncertainty in this applied standard. Therefore, the results are derived depending on whether or not laboratory uncertainty is applied.

The following uncertainties have been calculated to provide a confidence level of 95 % using a coverage factor *k*=2.
Ise EMC Lab.

Antenna Terminal test

Test Item	Uncertainty (+/-)
20 dB Bandwidth / 99 % Occupied Bandwidth	0.96 %
Maximum Peak Output Power / Average Output Power	1.4 dB
Carrier Frequency Separation	0.42 %
Dwell time / Burst rate	0.10 %
Conducted Spurious Emission	2.6 dB

Conducted emission

using Item	Frequency range	Uncertainty (+/-)
AMN (LISN)	0.009 MHz to 0.15 MHz	3.4 dB
	0.15 MHz to 30 MHz	2.9 dB

Radiated emission

Measurement distance	Frequency range	Uncertainty (+/-)
3 m	9 kHz to 30 MHz	3.3 dB
10 m		3.2 dB
3 m	30 MHz to 200 MHz (Horizontal)	4.8 dB
	(Vertical)	5.0 dB
	200 MHz to 1000 MHz (Horizontal)	5.2 dB
	(Vertical)	6.3 dB
10 m	30 MHz to 200 MHz (Horizontal)	4.8 dB
	(Vertical)	4.8 dB
	200 MHz to 1000 MHz (Horizontal)	5.0 dB
	(Vertical)	5.0 dB
3 m	1 GHz to 6 GHz	4.9 dB
	6 GHz to 18 GHz	5.2 dB
1 m	10 GHz to 26.5 GHz	5.5 dB
	26.5 GHz to 40 GHz	5.5 dB
10 m	1 GHz to 18 GHz	5.2 dB

3.5 Test Location

UL Japan, Inc. Ise EMC Lab.
*A2LA Certificate Number: 5107.02 / FCC Test Firm Registration Number: 199967
ISED Lab Company Number: 2973C / CAB identifier: JP0002
4383-326 Asama-cho, Ise-shi, Mie-ken 516-0021 JAPAN
Telephone: +81 596 24 8999, Facsimile: +81 596 24 8124

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.11 measurement room	6.2 x 4.7 x 3.0	4.8 x 4.6	-	-

* Size of vertical conducting plane (for Conducted Emission test) : 2.0 x 2.0 m for No.1, No.2, No.3, and No.4 semi-anechoic chambers and No.3 and No.4 shielded rooms.

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)

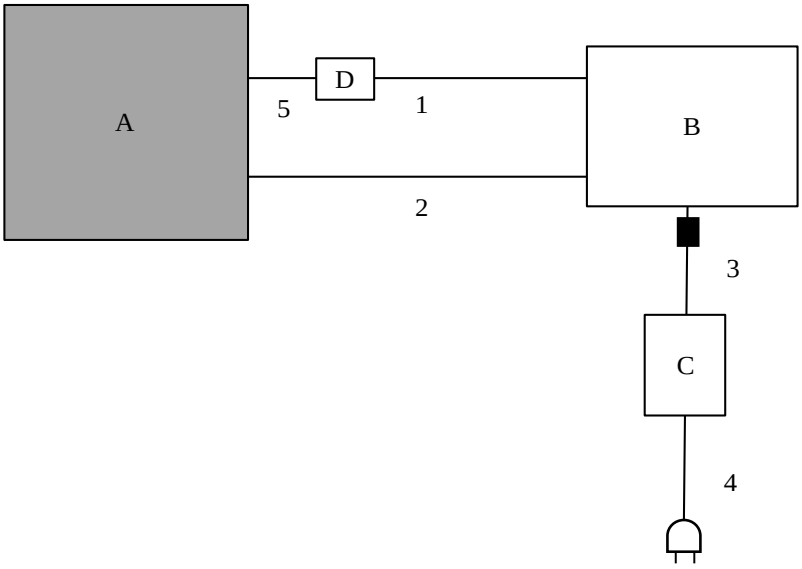
Mode	Remarks*
BT LE	Maximum Packet Size, PRBS9
*Power of the EUT was set by the software as follows; Power settings: 3 dBm Software: PSoC4 BLE Radio Examination Version 0.67 (Date: April 12, 2021 Storage location: Driven by connected PC) *This setting of software is the worst case. Any conditions under 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 Emission Spurious Emission 6dB Bandwidth Maximum Peak Output Power Power Density 99% Occupied Bandwidth	BT LE Tx	2402 MHz 2440 MHz 2480 MHz

4.2 Configuration and peripherals

Antenna terminal test



AC 100 V / 60 Hz

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

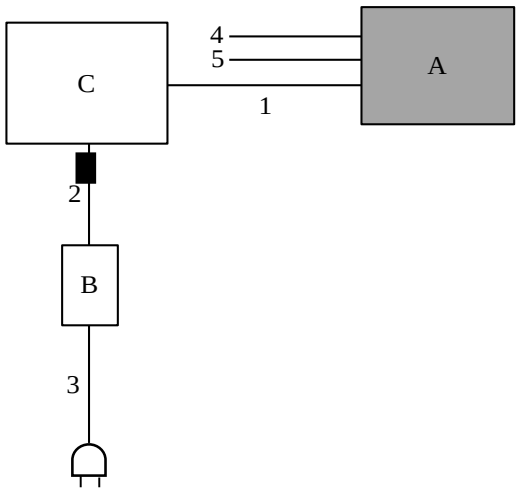
Description of EUT and Support equipment

No.	Item	Model number	Serial number	Manufacturer	Remarks
A	Data Logger	TR71A	107	T&D Corporation	EUT
B	Laptop PC	NJ3900E	845031007	EPSON	-
C	AC adaptor	ADP-650H CB	671W38G00SD	DELTA ELECTRONICS, INC.	-
D	jig	-	-	-	-

List of cables used

No.	Name	Length (m)	Shield		Remarks
			Cable	Connector	
1	USB Cable	2.0	Shielded	Shielded	-
2	USB Cable	1.5	Shielded	Shielded	-
3	DC Cable	1.7	Unshielded	Unshielded	-
4	AC Cable	2.0	Unshielded	Unshielded	-
5	Signal Cable	0.2	Unshielded	Unshielded	-

Conducted and Radiated emission tests



AC 120 V / 60 Hz

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

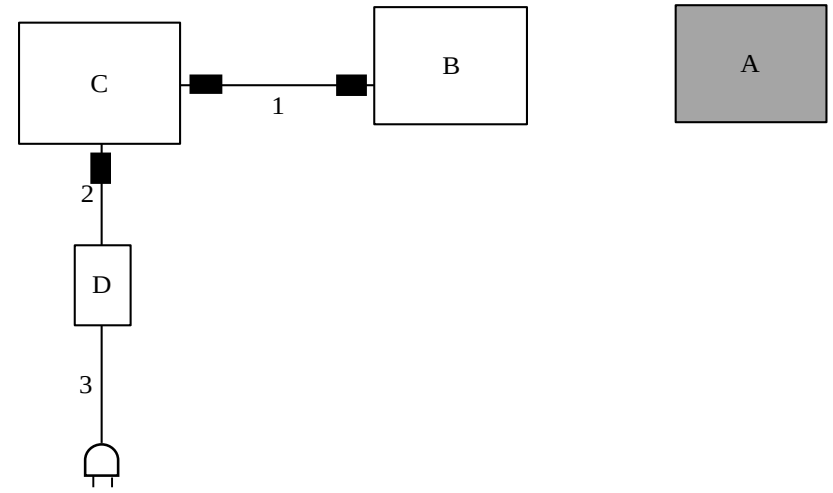
Description of EUT and Support equipment

No.	Item	Model number	Serial number	Manufacturer	Remarks
A	Data Logger	TR71A	107	T&D Corporation	EUT
B	AC adaptor	ADP-650H CB	671W38G00SD	DELTA ELECTRONICS, INC.	-
C	Laptop PC	NJ3900E	845031007	EPSON	-

List of cables used

No.	Name	Length (m)	Shield		Remarks
			Cable	Connector	
1	USB Cable	2.0	Shielded	Shielded	-
2	DC Cable	1.7	Unshielded	Unshielded	-
3	AC Cable	2.0	Unshielded	Unshielded	-
4	Signal Cable	0.6	Unshielded	Unshielded	-
5	Signal Cable	0.6	Unshielded	Unshielded	-

Duty cycle correction factor



AC 100 V / 60 Hz

* 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	Data Logger	TR71A	5F3A030C	T&D Corporation	EUT
B	Wireless Base Station	RTR500BC	5856078B	T&D Corporation	-
C	Laptop PC	CF-MX4	5FKSA17959	Panasonic	-
D	AC Adaptor	CF-AA62J2C	62J2CM2152251436SB	Panasonic	-

List of cables used

No.	Name	Length (m)	Shield		Remarks
			Cable	Connector	
1	USB Cable	1.5	Shielded	Shielded	-
2	DC Cable	1.6	Unshielded	Unshielded	-
3	AC Cable	0.8	Unshielded	Unshielded	-

SECTION 5: Conducted Emission

Test Procedure and conditions

EUT was placed on a urethane platform of nominal size, 1.0 m by 1.5 m, raised 0.8 m above the conducting ground plane. The rear of tabletop was located 40 cm to the vertical conducting plane. The rear of EUT, including peripherals aligned and flushed with rear of tabletop. All other surfaces of tabletop were at least 80cm from any other grounded conducting surface. EUT was located 80 cm from a Line Impedance Stabilization Network (LISN) / Artificial mains Network (AMN) and excess AC cable was bundled in center.

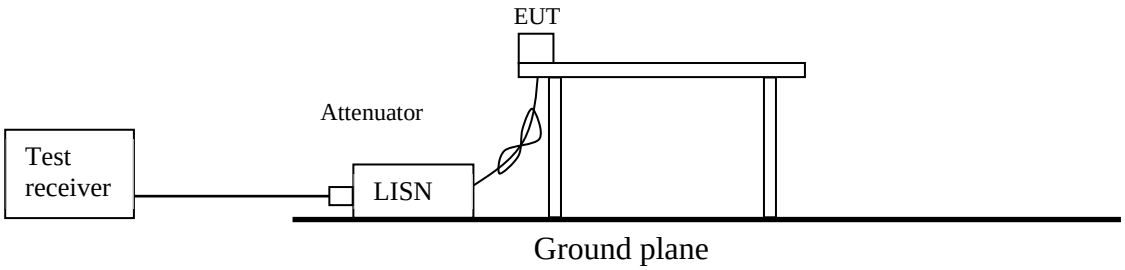
I/O cables that were connected to the peripherals were bundled in center. They were folded back and forth forming a bundle 30 cm to 40 cm long and were hanged at a 40 cm height to the ground plane. All unused 50ohm connectors of the LISN (AMN) were resistivity terminated in 50 ohm when not connected to the measuring equipment.

The AC Mains Terminal Continuous disturbance Voltage has been measured with the EUT in a Semi Anechoic Chamber. The EUT was connected to a LISN (AMN).
An overview sweep with peak detection has been performed.

The test results and limit are rounded off to one decimal place, so some differences might be observed.

Detector **: QP and CISPR AV**
Measurement range **: 0.15 MHz - 30 MHz**
Test data **: APPENDIX**
Test result **: Pass**

Figure 1: Test Setup



SECTION 6: 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.

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.
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 measurements were performed for both vertical and horizontal antenna polarization with the Test Receiver, or the Spectrum Analyzer.
The measurements were made with the following detector function of the test receiver and the Spectrum analyzer (in linear mode).
The test was made with the detector (RBW/VBW) in the following table.
When using Spectrum analyzer, the test was made with adjusting span to zero by using peak hold.

Test Antennas are used as below;

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

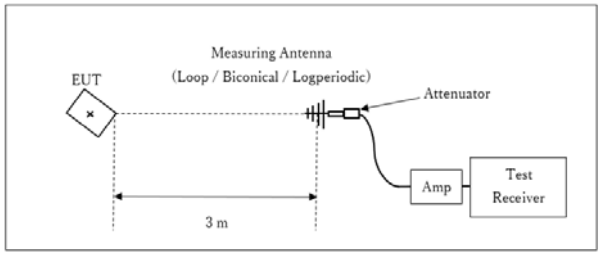
In any 100 kHz bandwidth outside the restricted band in which the spread spectrum intentional radiator is operating, the radio frequency power that is produced by the intentional radiator confirmed 20 dB below that in the 100 kHz bandwidth within the band that contains the highest level of the desired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

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

Frequency	Below 1 GHz	Above 1 GHz		20 dBc
Instrument used	Test Receiver	Spectrum Analyzer		Spectrum Analyzer
Detector	QP	PK	AV	PK
IF Bandwidth	BW 120 kHz	RBW: 1 MHz VBW: 3 MHz	11.12.2.5.1 RBW: 1 MHz VBW: 3 MHz Detector: Power Averaging (RMS) Trace: 100 traces 11.12.2.5.2 The duty cycle was less than 98% for detected noise, a duty factor was added to the 11.12.2.5.1 results. or The limit for Average detector is applied to the measurement value with Peak detector used Duty cycle correction factor (DCCF).	RBW: 100 kHz VBW: 300 kHz

Figure 2: Test Setup

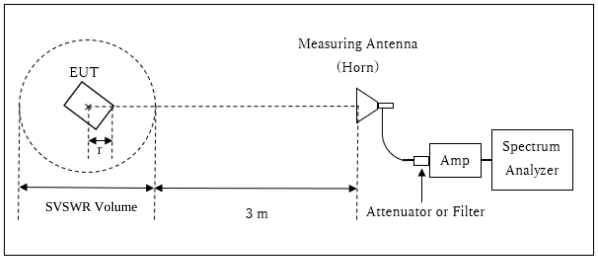
Below 1 GHz



× : Center of turn table

Test Distance: 3 m

1 GHz - 10 GHz



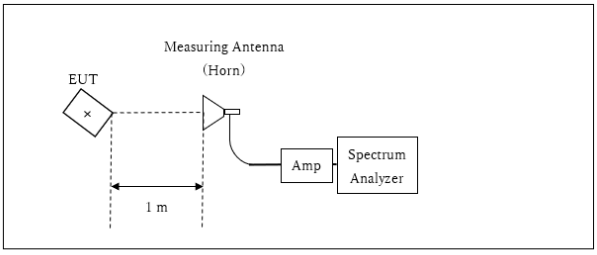
r : Radius of an outer periphery of EUT
× : Center of turn table

Distance Factor: 20 x log (4.0 m / 3.0 m) = 2.5 dB
* Test Distance: (3 + SVSWR Volume /2) - r = 4.0 m

SVSWR Volume : 2.0 m
(SVSWR Volume has been calibrated based on CISPR 16-1-4.)
r = 0.0 m

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

10 GHz – 26.5 GHz



× : Center of turn table

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

- The carrier level and noise levels were confirmed at each position of X, Y and Z axes of EUT to see the position of maximum noise, and the test was made at the position that has the maximum noise.

The test results and limit are rounded off to one decimal place, so some differences might be observed.

Measurement range : 30 MHz - 26.5 GHz
Test data : APPENDIX
Test result : Pass

SECTION 7: Antenna Terminal Conducted Tests

Test Procedure

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

Test	Span	RBW	VBW	Sweep time	Detector	Trace	Instrument used
6dB Bandwidth	3 MHz	30 kHz	100 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)	9kHz to 150kHz	200 Hz	620 Hz	Auto	Peak	Max Hold	Spectrum Analyzer
	150kHz to 30MHz	9.1 kHz	27 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 = 9.1 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.

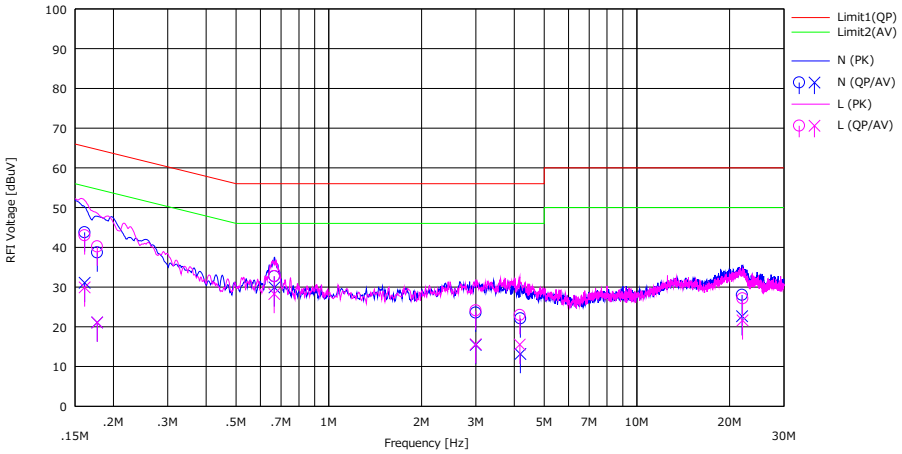
Test data : APPENDIX
Test result : Pass

APPENDIX 1: Test data

Conducted Emission

Report No.	13753617H
Test place	Ise EMC Lab. No.4 Semi Anechoic Chamber
Date	April 20, 2021
Temperature / Humidity	20 deg. C / 40 % RH
Engineer	Yuta Moriya
Mode	Tx BT LE 2402MHz

Limit : FCC_Part 15 Subpart C(15.207)



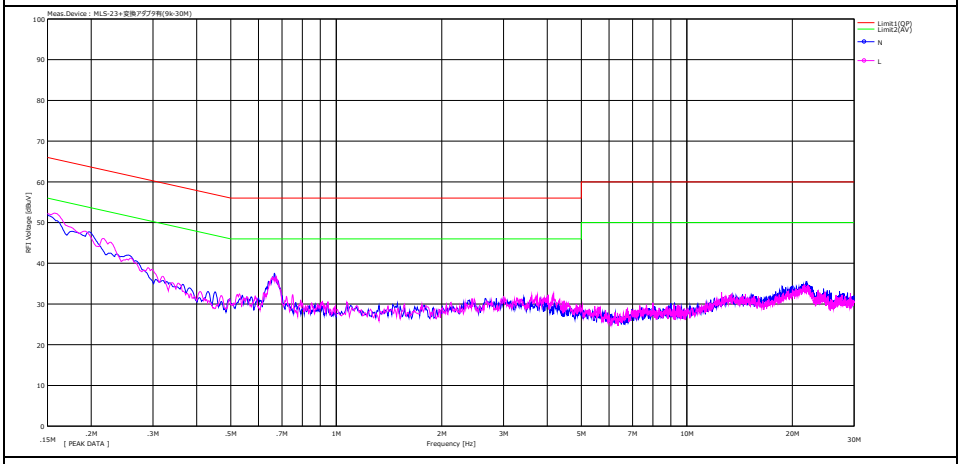
No.	Freq.	Reading ⟨QP⟩	Reading ⟨AV⟩	LISN	LOSS	Results ⟨QP⟩	Results ⟨AV⟩	Limit ⟨QP⟩	Limit ⟨AV⟩	Margin ⟨QP⟩	Margin ⟨AV⟩	Phase	Comment
	[MHz]	[dBuV]	[dBuV]	[dB]	[dB]	[dBuV]	[dBuV]	[dBuV]	[dBuV]	[dB]	[dB]		
1	0.16130	30.50	17.80	0.07	13.20	43.77	31.07	65.40	55.40	21.63	24.33	N	
2	0.17720	25.40	7.82	0.06	13.21	38.67	21.09	64.62	54.62	25.95	33.53	N	
3	0.66595	19.40	16.60	0.06	13.26	32.72	29.92	56.00	46.00	23.28	16.08	N	
4	2.99800	10.01	1.92	0.10	13.43	23.54	15.45	56.00	46.00	32.46	30.55	N	
5	4.18600	8.49	-0.47	0.12	13.49	22.10	13.14	56.00	46.00	33.90	32.86	N	
6	21.94000	13.60	8.22	0.44	13.98	28.02	22.64	60.00	50.00	31.98	27.36	N	
7	0.16130	29.70	16.60	0.10	13.20	43.00	29.90	65.40	55.40	22.40	25.50	L	
8	0.17720	26.90	7.80	0.10	13.21	40.21	21.11	64.62	54.62	24.41	33.51	L	
9	0.66510	19.37	14.90	0.11	13.26	32.74	28.27	56.00	46.00	23.26	17.73	L	
10	2.99800	10.55	2.03	0.15	13.43	24.13	15.61	56.00	46.00	31.87	30.39	L	
11	4.16800	9.30	1.85	0.17	13.49	22.96	15.51	56.00	46.00	33.04	30.49	L	
12	22.02000	12.60	7.10	0.54	13.98	27.12	21.62	60.00	50.00	32.88	28.38	L	

CHART: WITH FACTOR Peak hold data. CALCULATION : RESULT = READING + LISN + LOSS (CABLE + ATT)
Except for the above table: adequate margin data below the limits.

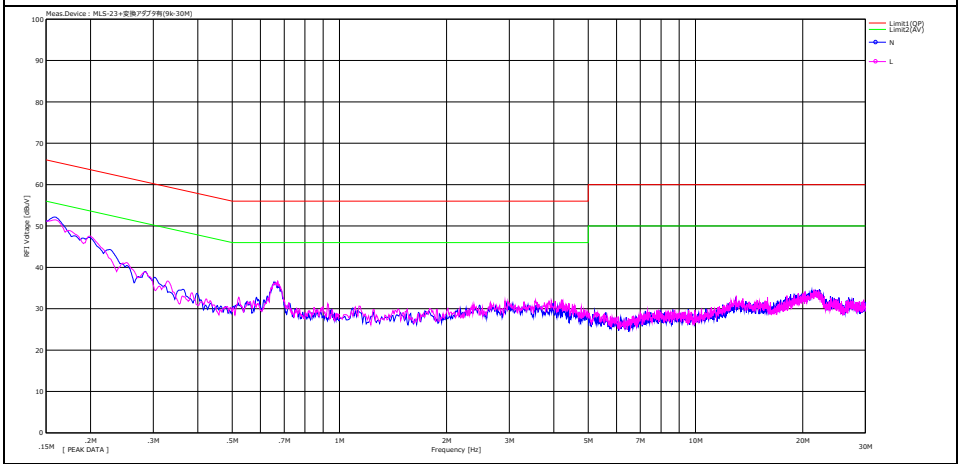
Conducted Emission

Report No.	13753617H
Test place	Ise EMC Lab. No.4 Semi Anechoic Chamber
Date	April 20, 2021
Temperature / Humidity	20 deg. C / 40 % RH
Engineer	Yuta Moriya
Mode	Tx BT LE

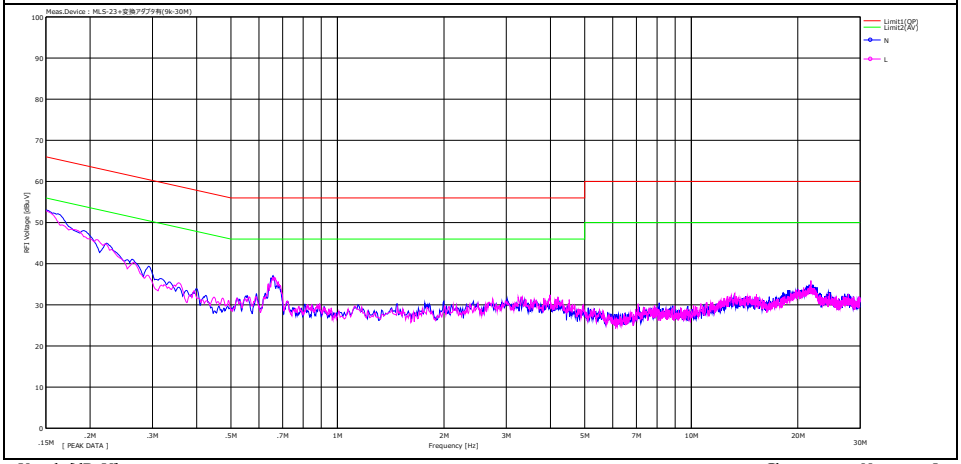
2402 MHz



2440 MHz



2480 MHz



Y scale [dBuV] Chart — N — L

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6 dB Bandwidth and 99 % Occupied Bandwidth

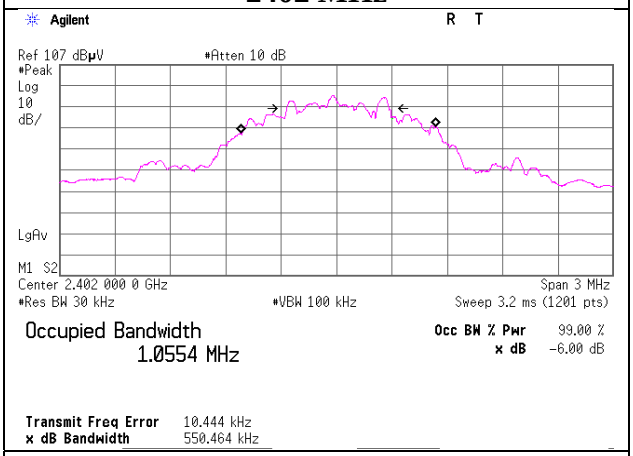
Report No.	13753617H
Test place	Ise EMC Lab. No.6 Measurement Room
Date	April 12, 2021
Temperature / Humidity	23 deg. C / 50 % RH
Engineer	Yuta Moriya
Mode	Tx

Mode	Frequency [MHz]	99% Occupied Bandwidth [kHz]	6dB Bandwidth [MHz]	Limit for 6dB Bandwidth [MHz]
BT LE	2402	1055.4	0.663	> 0.5000
	2440	1054.6	0.666	> 0.5000
	2480	1051.6	0.657	> 0.5000

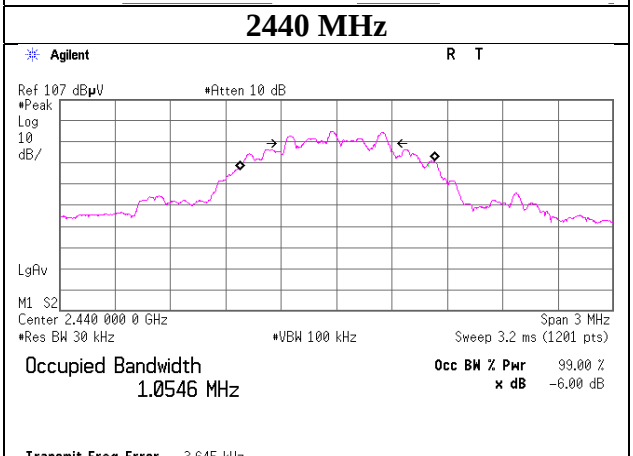
99%Occupied Bandwidth

BT LE

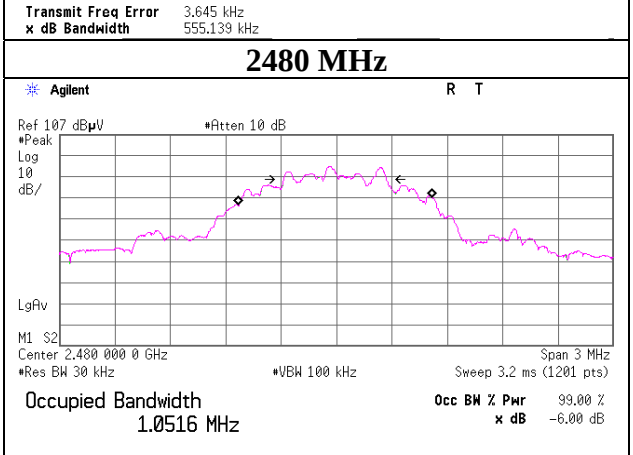
2402 MHz



2440 MHz



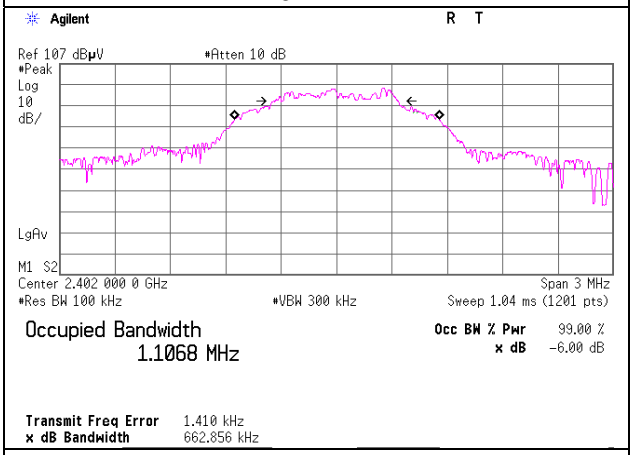
2480 MHz



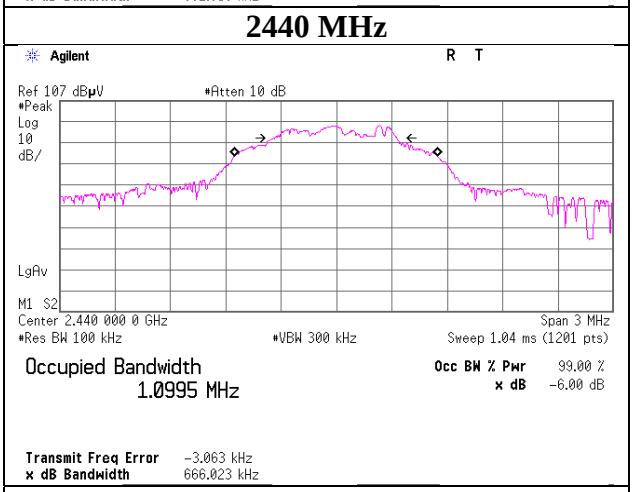
6dB Bandwidth

BT LE

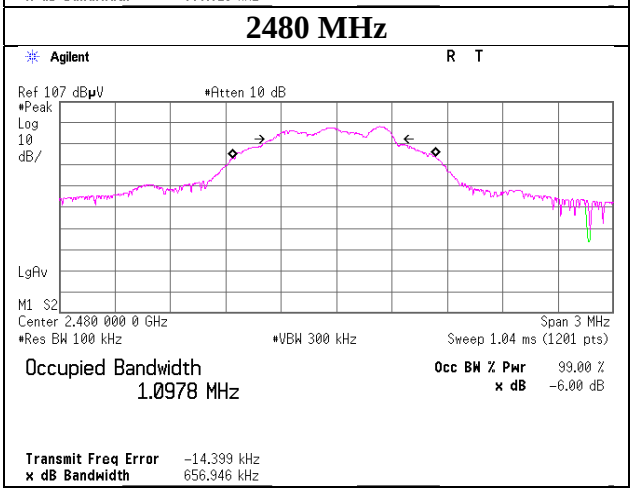
2402 MHz



2440 MHz



2480 MHz



Maximum Peak Output Power

Report No.	13753617H
Test place	Ise EMC Lab. No.6 Measurement Room
Date	April 12, 2021
Temperature / Humidity	23 deg. C / 50 % RH
Engineer	Yuta Moriya
Mode	Tx BT LE

				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	-11.32	0.70	10.02	-0.60	0.87	30.00	1000	30.60	1.60	1.00	1.26	36.02	4000	35.02
2440	-11.46	0.70	10.02	-0.74	0.84	30.00	1000	30.74	1.60	0.86	1.22	36.02	4000	35.16
2480	-11.45	0.70	10.02	-0.73	0.85	30.00	1000	30.73	1.60	0.87	1.22	36.02	4000	35.15

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)

Report No.	13753617H
Test place	Ise EMC Lab. No.6 Measurement Room
Date	April 12, 2021
Temperature / Humidity	23 deg. C / 50 % RH
Engineer	Yuta Moriya
Mode	Tx BT LE

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	-12.28	0.70	10.02	-1.56	0.70	0.70	-0.86	0.82
2440	-12.39	0.70	10.02	-1.67	0.68	0.70	-0.97	0.80
2480	-12.58	0.70	10.02	-1.86	0.65	0.70	-1.16	0.77

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

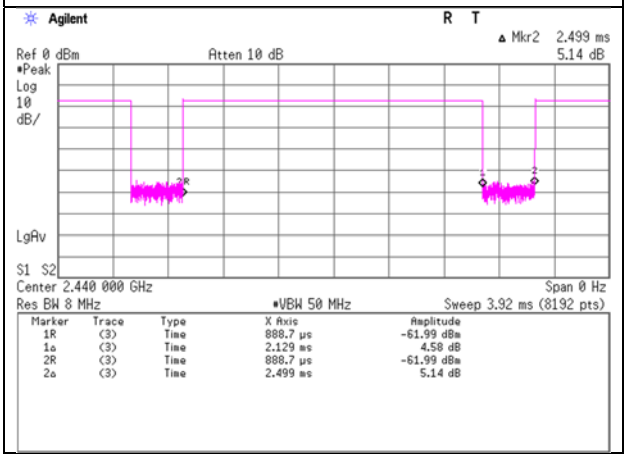
*The equipment and cables were not used for factor 0 dB of the data sheets.

Burst rate confirmation

Report No.	13753617H
Test place	Ise EMC Lab. No.4 Semi Anechoic Chamber
Date	April 17, 2021
Temperature / Humidity	21 deg. C / 40 % RH
Engineer	Kiyoshiro Okazaki
Mode	Tx

BT LE

Tx on / (Tx on + Tx off) =	**0.852**
Tx on / (Tx on + Tx off) * 100 =	**85.2 %**
Duty factor = 10 * log (2.499 / 2.129) =	**0.70 dB**

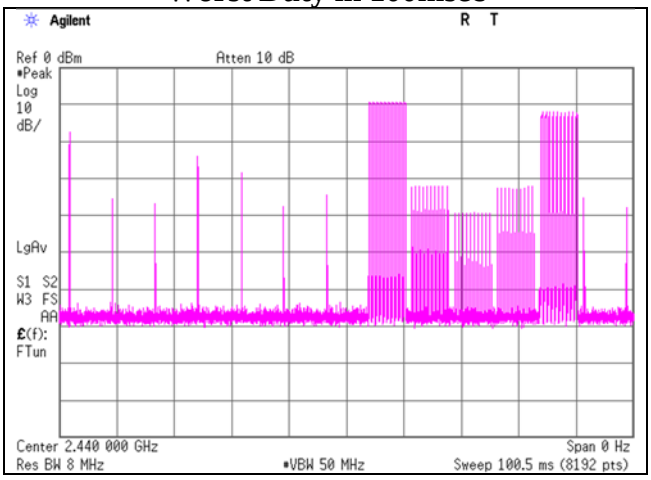


* Since the burst rate is not different between the channels, the data has been obtained on the representative channel.

Duty cycle correction factor

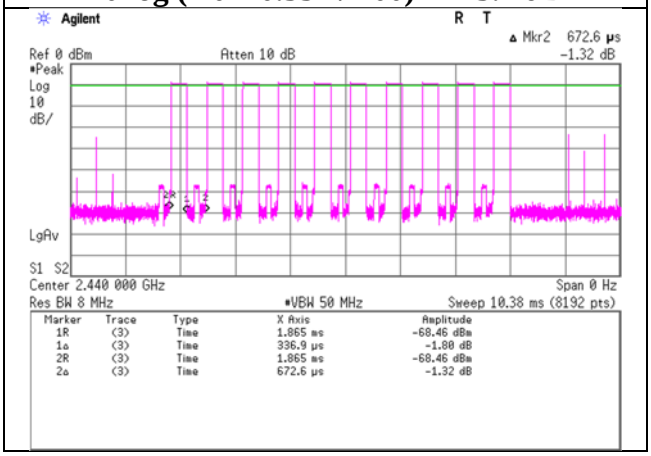
Report No.	13753617H
Test place	Ise EMC Lab. No.6 Measurement Room
Date	June 30, 2021
Temperature / Humidity	23 deg. C / 48 % RH
Engineer	Nachi Konegawa
Mode	Data Communication

Worst Duty in 100msec



Worst Duty cycle

Averaging factor (Duty factor) =
20 log (20 x 0.337 / 100) = -23.4 dB



*Since the burst rate is not different by the channel and advertising mode, the data has been obtained on the representative channel.
The ON time (0.337 ms) appears 20 times in 100 ms.
The actual measurement value was applied as Averaging factor (Duty factor).

Radiated Spurious Emission

Report No.	13753617H		
Test place	Ise EMC Lab.		
Semi Anechoic Chamber	No.4	No.4	No.4
Date	April 17, 2021	April 18, 2021	April 18, 2021
Temperature / Humidity	21 deg. C / 40 % RH	22 deg. C / 41 % RH	22 deg. C / 41 % RH
Engineer	Kiyoshiro Okazaki	Kiyoshiro Okazaki	Kiyoshiro Okazaki
	(1 GHz - 10 GHz)	(10 GHz - 26.5 GHz)	(30 MHz - 1 GHz)
Mode	Tx BT LE 2402 MHz		

Polarity	Frequency [MHz]	Detector	Reading [dBuV]	Ant.Fac. [dB/m]	Loss [dB]	Gain [dB]	Duty Factor [dB]	Result [dBuV/m]	Limit [dBuV/m]	Margin [dB]	Remark
Hori.	100.720	QP	20.3	10.2	8.0	31.5	-	7.0	43.5	36.5	
Hori.	318.407	QP	38.3	14.1	9.7	31.3	-	30.8	46.0	15.2	
Hori.	353.478	QP	37.2	15.2	9.9	31.3	-	31.0	46.0	15.0	
Hori.	453.100	QP	32.9	16.5	10.5	31.3	-	28.6	46.0	17.4	
Hori.	671.957	QP	40.0	19.6	11.5	31.6	-	39.5	46.0	6.6	
Hori.	707.012	QP	39.0	19.8	11.6	31.6	-	38.8	46.0	7.2	
Hori.	2390.000	PK	54.6	27.8	5.5	31.8	-	56.1	73.9	17.8	
Hori.	4804.000	PK	50.3	31.6	7.7	31.2	-	58.3	73.9	15.6	
Hori.	7206.000	PK	44.9	36.5	8.9	32.4	-	57.9	73.9	16.0	
Hori.	9608.000	PK	41.7	38.0	9.6	32.6	-	56.7	73.9	17.2	Floor noise
Hori.	9608.000	AV	30.7	38.0	9.6	32.6	-	45.7	53.9	8.2	Floor noise
Vert.	100.321	QP	29.3	10.2	8.0	31.5	-	16.0	43.5	27.6	
Vert.	318.132	QP	37.6	14.1	9.7	31.3	-	30.1	46.0	15.9	
Vert.	353.328	QP	38.9	15.2	9.9	31.3	-	32.7	46.0	13.3	
Vert.	453.488	QP	37.7	16.5	10.5	31.3	-	33.4	46.0	12.6	
Vert.	671.606	QP	37.8	19.6	11.5	31.6	-	37.3	46.0	8.8	
Vert.	707.278	QP	35.9	19.8	11.6	31.6	-	35.7	46.0	10.3	
Vert.	2390.000	PK	52.9	27.8	5.5	31.8	-	54.4	73.9	19.6	
Vert.	4804.000	PK	51.3	31.6	7.7	31.2	-	59.4	73.9	14.5	
Vert.	7206.000	PK	42.3	36.5	8.9	32.4	-	55.4	73.9	18.5	
Vert.	9608.000	PK	41.6	38.0	9.6	32.6	-	56.6	73.9	17.3	Floor noise
Vert.	9608.000	AV	30.1	38.0	9.6	32.6	-	45.1	53.9	8.8	Floor noise

Result = 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).

Distance factor: 1 GHz - 10 GHz 20log (4.0 m / 3.0 m) = 2.5 dB
10 GHz - 26.5 GHz 20log (1.0 m / 3.0 m) = -9.5 dB

Peak measurement value with duty cycle correction factor

Frequency [MHz]	Detector	Reading [dBuV] Hor	Reading [dBuV] Ver	Ant Factor [dB/m]	Loss [dB]	Gain [dB]	DCCF [dB]	Result [dBuV/m] Hor	Result [dBuV/m] Ver	Limit [dBuV/m]	Margin [dB] Hor	Margin [dB] Ver	Remark
2390.000	PK	54.6	52.9	27.8	5.5	31.8	-23.4	32.7	31.0	53.9	21.2	23.0	*1)
4804.000	PK	50.3	51.3	31.6	7.7	31.2	-23.4	34.9	36.0	53.9	19.0	17.9	
7206.000	PK	44.9	42.3	36.5	8.9	32.4	-23.4	34.5	32.0	53.9	19.4	21.9	

Result = Reading + Ant Factor + Loss (Cable+Attenuator+Filter+Distance factor(above 1 GHz)) - Gain(Amplifier) + DCCF
*Other frequency noises omitted in this report were not seen or had enough margin (more than 20 dB).

Distance factor: 1 GHz - 10 GHz 20log (4.0 m / 3.0 m) = 2.5 dB
10 GHz - 26.5 GHz 20log (1.0 m / 3.0 m) = -9.5 dB
Duty cycle correction factor (DCCF) refer to "Duty cycle correction factor" sheet.
*1) Not Out of Band emission(Leakage Power)

20dBc Data Sheet

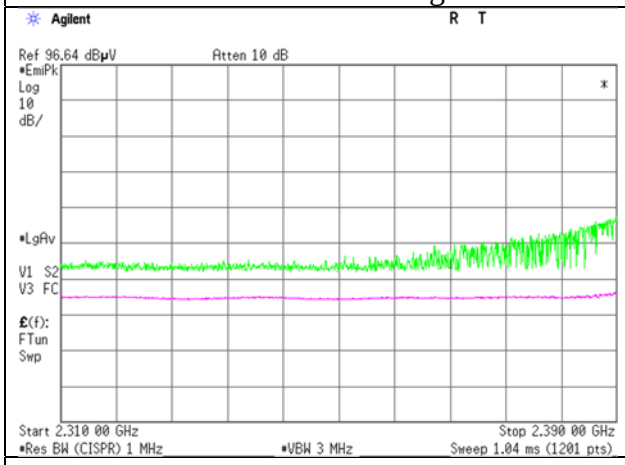
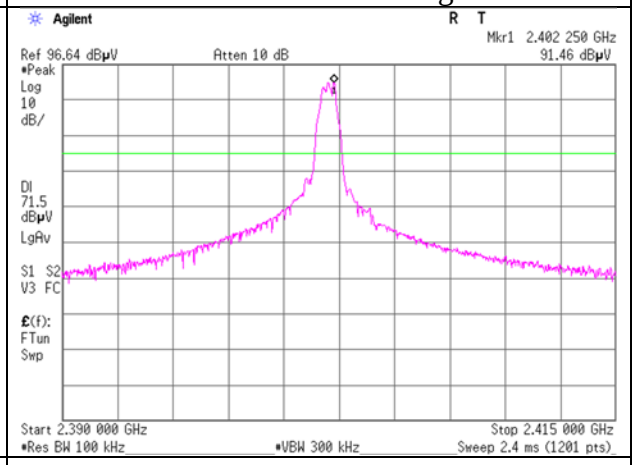
Polarity	Frequency [MHz]	Detector	Reading [dBuV]	Ant Factor [dB/m]	Loss [dB]	Gain [dB]	Result [dBuV/m]	Limit [dBuV/m]	Margin [dB]	Remark
Hori.	2402.000	PK	91.5	27.8	5.5	31.8	93.0	-	-	Carrier
Hori.	2400.000	PK	55.5	27.8	5.5	31.8	57.0	73.0	15.9	
Vert.	2402.000	PK	88.5	27.8	5.5	31.8	90.0	-	-	Carrier
Vert.	2400.000	PK	52.6	27.8	5.5	31.8	54.1	70.0	15.9	

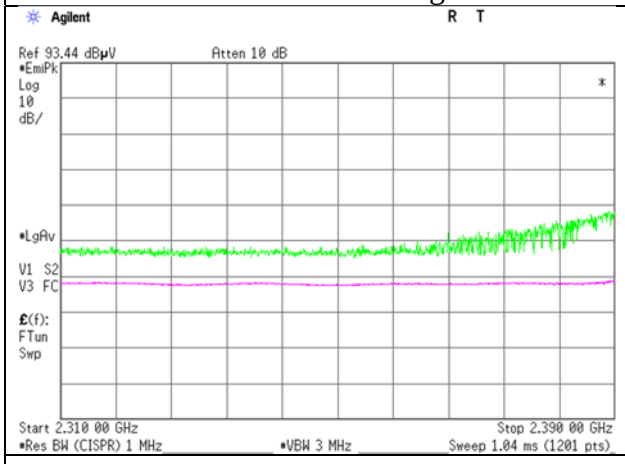
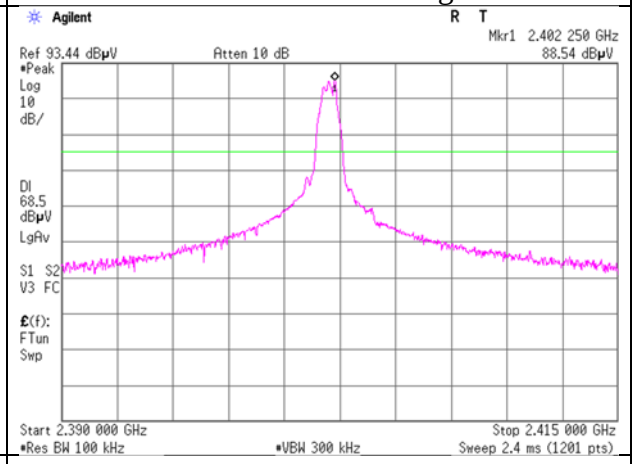
Result = Reading + Ant Factor + Loss (Cable+Attenuator+Filter+Distance factor(above 1 GHz)) - Gain(Amprifier)

Distance factor: 1 GHz - 10 GHz 20log (4.0 m / 3.0 m) = 2.5 dB
10 GHz - 26.5 GHz 20log (1.0 m / 3.0 m) = -9.5dB

Radiated Spurious Emission
(Reference Plot for band-edge)

Report No.	13753617H
Test place	Ise EMC Lab.
Semi Anechoic Chamber	No.4
Date	April 17, 2021
Temperature / Humidity	21 deg. C / 40 % RH
Engineer	Kiyoshiro Okazaki
	(1 GHz - 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 was shown in tabular data.

Radiated Spurious Emission

Report No.	13753617H
Test place	Ise EMC Lab.
Semi Anechoic Chamber	No.4
Date	April 18, 2021
Temperature / Humidity	22 deg. C / 41 % RH
Engineer	Kiyoshiro Okazaki
	(30 MHz - 26.5 GHz)
Mode	Tx BT LE 2440 MHz

Polarity	Frequency [MHz]	Detector	Reading [dBuV]	Ant.Fac. [dB/m]	Loss [dB]	Gain [dB]	Duty Factor [dB]	Result [dBuV/m]	Limit [dBuV/m]	Margin [dB]	Remark
Hori.	101.062	QP	20.4	10.3	8.0	31.5	-	7.2	43.5	36.3	
Hori.	282.765	QP	38.2	13.4	9.5	31.3	-	29.8	46.0	16.2	
Hori.	353.336	QP	34.5	15.2	9.9	31.3	-	28.3	46.0	17.7	
Hori.	452.328	QP	37.4	16.5	10.5	31.3	-	33.0	46.0	13.0	
Hori.	672.338	QP	39.6	19.6	11.5	31.6	-	39.1	46.0	7.0	
Hori.	707.349	QP	39.0	19.8	11.6	31.6	-	38.8	46.0	7.2	
Hori.	4880.000	PK	49.4	31.6	7.7	31.2	-	57.5	73.9	16.4	
Hori.	7320.000	PK	45.7	36.6	8.9	32.4	-	58.8	73.9	15.1	
Hori.	9760.000	PK	40.2	38.4	9.6	32.7	-	55.6	73.9	18.3	Floor noise
Hori.	9760.000	AV	30.8	38.4	9.6	32.7	-	46.3	53.9	7.6	Floor noise
Vert.	101.938	QP	29.2	10.5	8.0	31.5	-	16.2	43.5	27.3	
Vert.	282.284	QP	38.5	13.4	9.5	31.3	-	30.1	46.0	15.9	
Vert.	353.372	QP	38.7	15.2	9.9	31.3	-	32.5	46.0	13.5	
Vert.	452.316	QP	37.6	16.5	10.5	31.3	-	33.2	46.0	12.8	
Vert.	672.348	QP	37.6	19.6	11.5	31.6	-	37.1	46.0	9.0	
Vert.	707.313	QP	35.8	19.8	11.6	31.6	-	35.6	46.0	10.4	
Vert.	4880.000	PK	51.1	31.6	7.7	31.2	-	59.2	73.9	14.7	
Vert.	7320.000	PK	44.3	36.6	8.9	32.4	-	57.4	73.9	16.5	
Vert.	9760.000	PK	40.2	38.4	9.6	32.7	-	55.6	73.9	18.3	Floor noise
Vert.	9760.000	AV	30.8	38.4	9.6	32.7	-	46.2	53.9	7.7	Floor noise

Result = 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).

Distance factor: 1 GHz - 10 GHz 20log (4.0 m / 3.0 m) = 2.5 dB
10 GHz - 26.5 GHz 20log (1.0 m / 3.0 m) = -9.5 dB

Peak measurement value with duty cycle correction factor

Frequency [MHz]	Detector	Reading [dBuV] Hor	Reading [dBuV] Ver	Ant Factor [dB/m]	Loss [dB]	Gain [dB]	DCCF [dB]	Result [dBuV/m] Hor	Result [dBuV/m] Ver	Limit [dBuV/m]	Margin [dB] Hor	Margin [dB] Ver	Remark
4880.000	PK	49.4	51.1	31.6	7.7	31.2	-23.4	34.1	35.8	53.9	19.8	18.1	
7320.000	PK	45.7	44.3	36.6	8.9	32.4	-23.4	35.4	34.0	53.9	18.5	19.9	

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

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

Distance factor: 1 GHz - 10 GHz 20log (4.0 m / 3.0 m) = 2.5 dB
10 GHz - 26.5 GHz 20log (1.0 m / 3.0 m) = -9.5 dB

Duty cycle correction factor (DCCF) refer to "Duty cycle correction factor" sheet.

Radiated Spurious Emission

Report No.	13753617H
Test place	Ise EMC Lab.
Semi Anechoic Chamber	No.4
Date	April 18, 2021
Temperature / Humidity	22 deg. C / 41 % RH
Engineer	Kiyoshiro Okazaki
	(30 MHz - 26.5 GHz)
Mode	Tx BT LE 2480 MHz

Polarity	Frequency [MHz]	Detector	Reading [dBuV]	Ant.Fac. [dB/m]	Loss [dB]	Gain [dB]	Duty Factor [dB]	Result [dBuV/m]	Limit [dBuV/m]	Margin [dB]	Remark
Hori.	101.060	QP	20.3	10.3	8.0	31.5	-	7.1	43.5	36.4	
Hori.	317.820	QP	38.4	14.1	9.7	31.3	-	30.9	46.0	15.1	
Hori.	353.889	QP	34.2	15.2	9.9	31.3	-	28.0	46.0	18.0	
Hori.	453.584	QP	37.5	16.5	10.5	31.3	-	33.2	46.0	12.8	
Hori.	671.845	QP	39.5	19.6	11.5	31.6	-	39.0	46.0	7.1	
Hori.	707.265	QP	35.0	19.8	11.6	31.6	-	34.8	46.0	11.2	
Hori.	2483.500	PK	63.2	27.7	5.6	31.8	-	64.7	73.9	9.3	
Hori.	4960.000	PK	49.9	31.6	7.7	31.2	-	58.0	73.9	15.9	
Hori.	7440.000	PK	44.8	36.7	8.9	32.5	-	58.0	73.9	16.0	
Hori.	9920.000	PK	40.3	38.6	9.7	32.7	-	55.9	73.9	18.0	Floor noise
Hori.	9920.000	AV	30.7	38.6	9.7	32.7	-	46.2	53.9	7.7	Floor noise
Vert.	101.082	QP	29.3	10.3	8.0	31.5	-	16.1	43.5	27.4	
Vert.	317.193	QP	37.5	14.0	9.7	31.3	-	30.0	46.0	16.1	
Vert.	353.849	QP	38.2	15.2	9.9	31.3	-	32.0	46.0	14.0	
Vert.	453.483	QP	37.6	16.5	10.5	31.3	-	33.3	46.0	12.7	
Vert.	671.854	QP	37.6	19.6	11.5	31.6	-	37.1	46.0	9.0	
Vert.	707.241	QP	35.1	19.8	11.6	31.6	-	34.9	46.0	11.1	
Vert.	2483.500	PK	62.8	27.7	5.6	31.8	-	64.2	73.9	9.7	
Vert.	4960.000	PK	51.2	31.6	7.7	31.2	-	59.3	73.9	14.6	
Vert.	7440.000	PK	43.5	36.7	8.9	32.5	-	56.6	73.9	17.3	
Vert.	9920.000	PK	40.1	38.6	9.7	32.7	-	55.7	73.9	18.3	Floor noise
Vert.	9920.000	AV	30.5	38.6	9.7	32.7	-	46.0	53.9	7.9	Floor noise

Result = 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).

Distance factor: 1 GHz - 10 GHz 20log (4.0 m / 3.0 m) = 2.5 dB
10 GHz - 26.5 GHz 20log (1.0 m / 3.0 m) = -9.5 dB

Peak measurement value with duty cycle correction factor

Frequency [MHz]	Detector	Reading [dBuV] Hor	Reading [dBuV] Ver	Ant Factor [dB/m]	Loss [dB]	Gain [dB]	DCCF [dB]	Result [dBuV/m] Hor	Result [dBuV/m] Ver	Limit [dBuV/m]	Margin [dB] Hor	Margin [dB] Ver	Remark
2483.500	PK	63.2	62.8	27.7	5.6	31.8	-23.4	41.3	40.8	53.9	12.7	13.1	*1)
4960.000	PK	49.9	51.2	31.6	7.7	31.2	-23.4	34.6	35.9	53.9	19.3	18.0	
7440.000	PK	44.8	43.5	36.7	8.9	32.5	-23.4	34.6	33.2	53.9	19.4	20.7	

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

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

Distance factor: 1 GHz - 10 GHz 20log (4.0 m / 3.0 m) = 2.5 dB
10 GHz - 26.5 GHz 20log (1.0 m / 3.0 m) = -9.5 dB

Duty cycle correction factor (DCCF) refer to "Duty cycle correction factor" sheet.

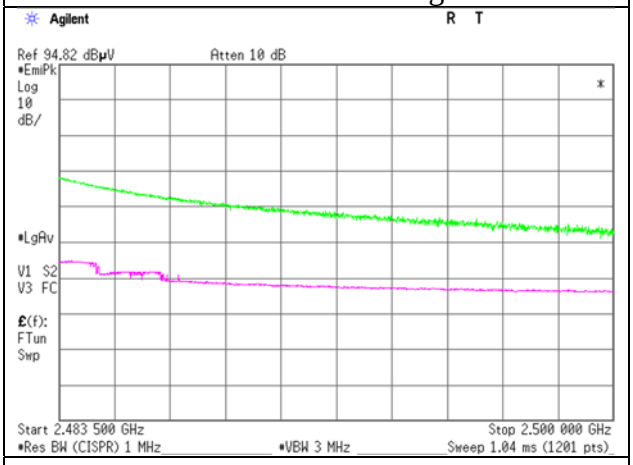
*1) Not Out of Band emission(Leakage Power)

Radiated Spurious Emission
(Reference Plot for band-edge)

Report No.	13753617H
Test place	Ise EMC Lab.
Semi Anechoic Chamber	No.4
Date	April 18, 2021
Temperature / Humidity	22 deg. C / 41 % RH
Engineer	Kiyoshiro Okazaki (1 GHz - 10 GHz)
Mode	Tx BT LE 2480 MHz

Horizontal

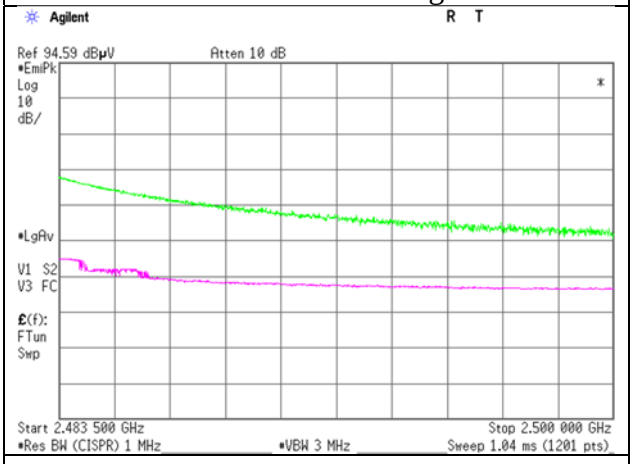
Restricted-band band-edge Plot



Trace Green : Peak Plot
Trace Purple : Average Plot

Vertical

Restricted-band band-edge Plot

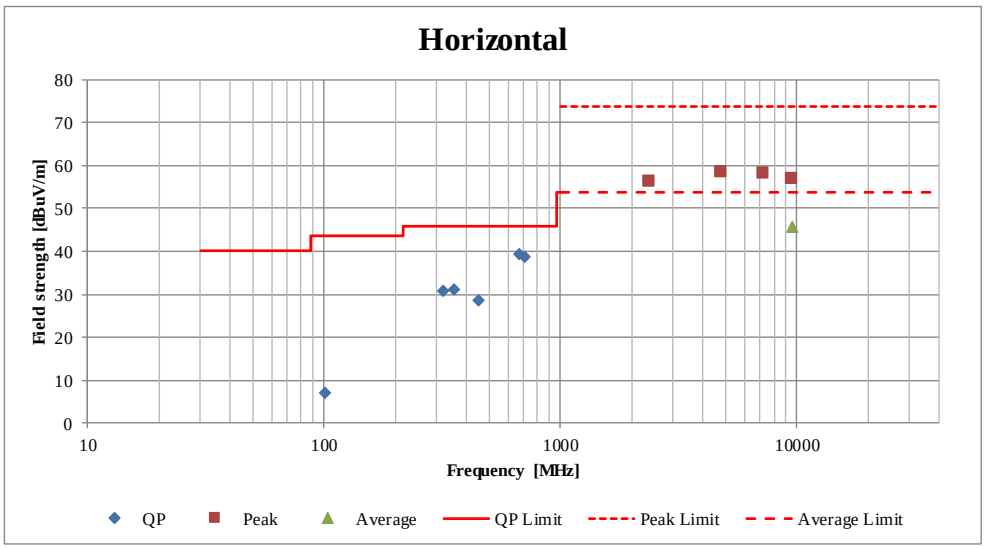


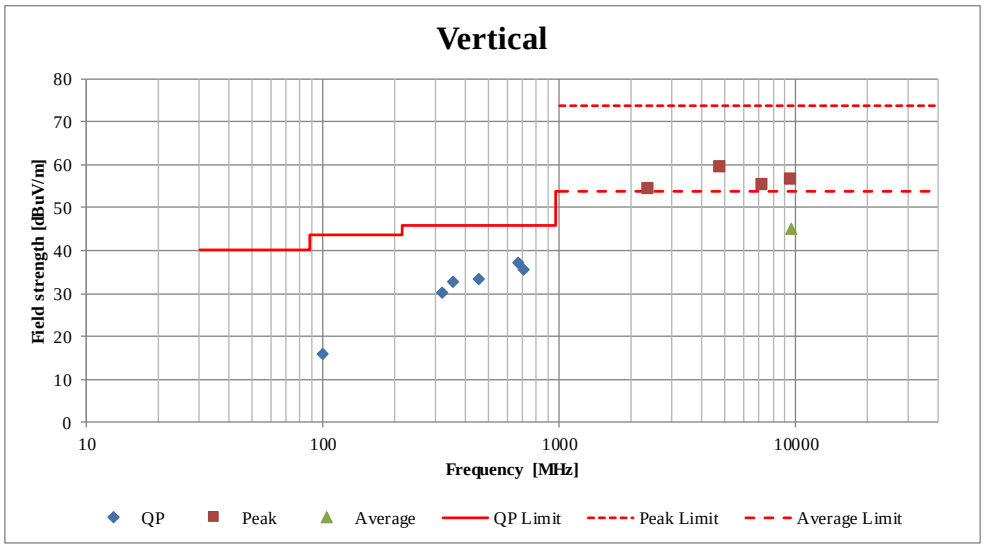
Trace Green : Peak Plot
Trace Purple : Average Plot

* 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)

Report No.	13753617H		
Test place	Ise EMC Lab.		
Semi Anechoic Chamber	No.4	No.4	No.4
Date	April 17, 2021	April 18, 2021	April 18, 2021
Temperature / Humidity	21 deg. C / 40 % RH	22 deg. C / 41 % RH	22 deg. C / 41 % RH
Engineer	Kiyoshiro Okazaki	Kiyoshiro Okazaki	Kiyoshiro Okazaki
	(1 GHz - 10 GHz)	(10 GHz - 26.5 GHz)	(30 MHz - 1 GHz)
Mode	Tx BT LE 2402 MHz		



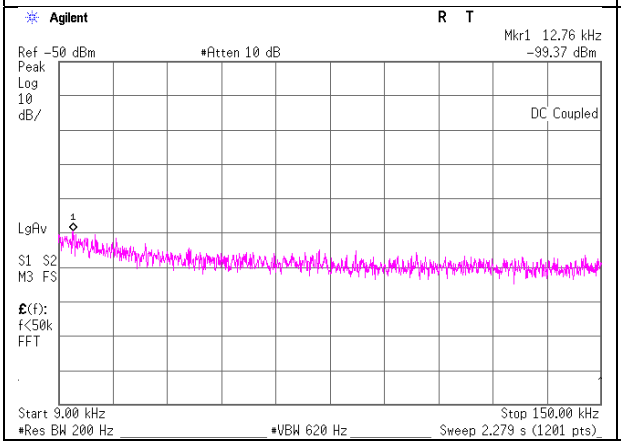


*These plots data contains sufficient number to show the trend of characteristic features for EUT.

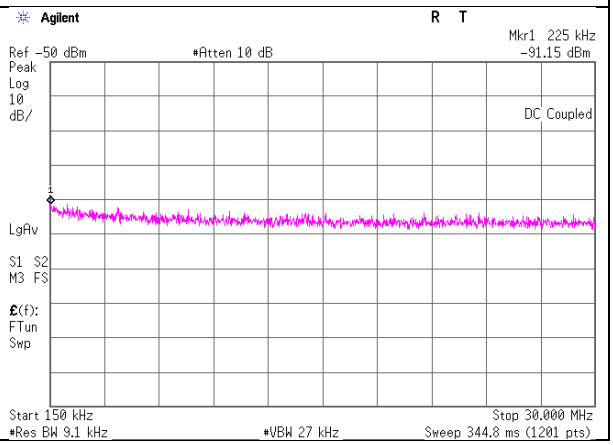
Conducted Spurious Emission

Report No.	13753617H
Test place	Ise EMC Lab. No.6 Measurement Room
Date	April 12, 2021
Temperature / Humidity	23 deg. C / 50 % RH
Engineer	Yuta Moriya
Mode	Tx BT LE 2402 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
12.67	-99.4	0.70	9.8	2.0	1	-86.8	300	6.0	-25.6	45.5	71.1	
225.00	-91.2	0.70	9.8	2.0	1	-78.6	300	6.0	-17.4	20.5	37.9	

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)

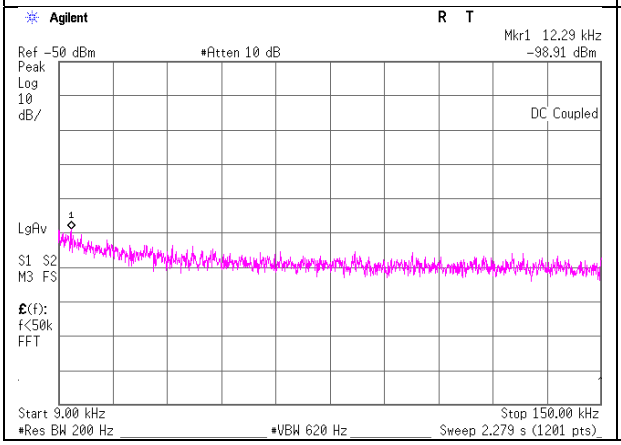
N: Number of output

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

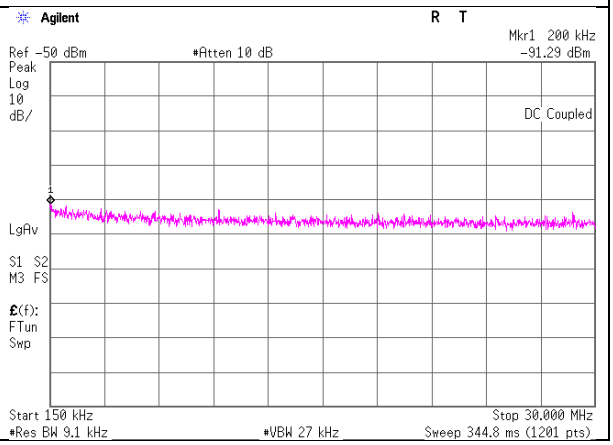
Conducted Spurious Emission

Report No.	13753617H
Test place	Ise EMC Lab. No.6 Measurement Room
Date	April 12, 2021
Temperature / Humidity	23 deg. C / 50 % RH
Engineer	Yuta Moriya
Mode	Tx BT LE 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
12.29	-98.9	0.70	9.8	2.0	1	-86.4	300	6.0	-25.1	45.8	70.9	
200.00	-91.3	0.70	9.8	2.0	1	-78.8	300	6.0	-17.5	21.5	39.0	

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)

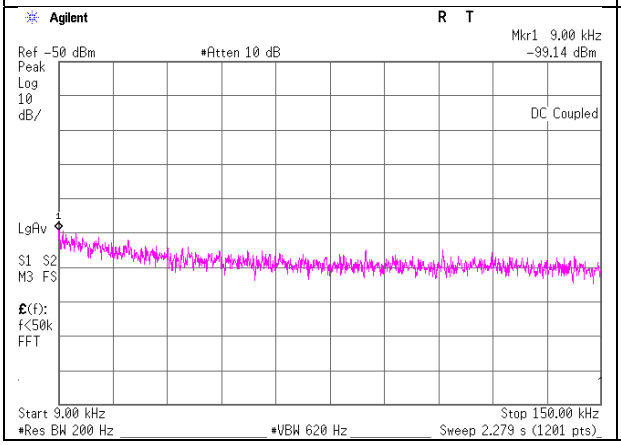
N: Number of output

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

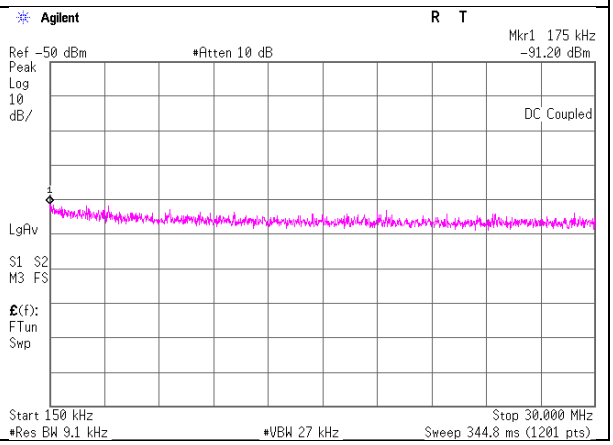
Conducted Spurious Emission

Report No.	13753617H
Test place	Ise EMC Lab. No.6 Measurement Room
Date	April 12, 2021
Temperature / Humidity	23 deg. C / 50 % RH
Engineer	Yuta Moriya
Mode	Tx BT LE 2480 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
9.00	-99.1	0.70	9.8	2.0	1	-86.6	300	6.0	-25.3	48.5	73.8	
175.00	-91.2	0.70	9.8	2.0	1	-78.7	300	6.0	-17.4	22.7	40.1	

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

Report No.	13753617H
Test place	Ise EMC Lab. No.6 Measurement Room
Date	April 12, 2021
Temperature / Humidity	23 deg. C / 50 % RH
Engineer	Yuta Moriya
Mode	Tx

Freq. [MHz]	Reading [dBm / 3 kHz]	Cable Loss [dB]	Atten. Loss [dB]	Result [dBm / 3 kHz]	Limit [dBm / 3 kHz]	Margin [dB]
2412	-17.14	0.70	10.02	-6.42	8.00	14.42
2437	-17.32	0.70	10.02	-6.60	8.00	14.60
2462	-17.50	0.70	10.02	-6.78	8.00	14.78

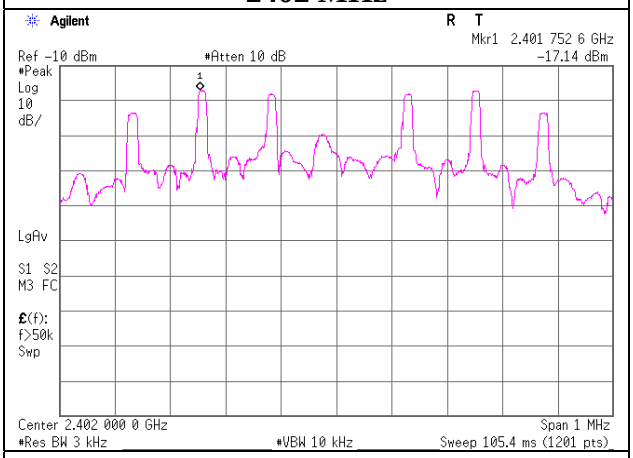
Sample Calculation:
Result = Reading + Cable Loss (including the cable(s) customer supplied) + Attenuator Loss

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

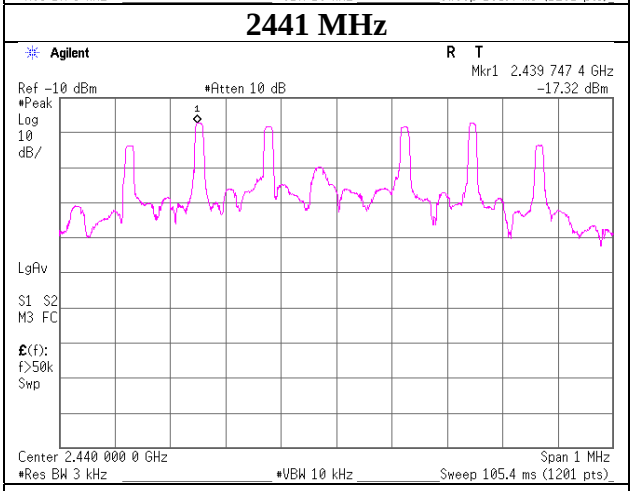
Power Density

BT LE

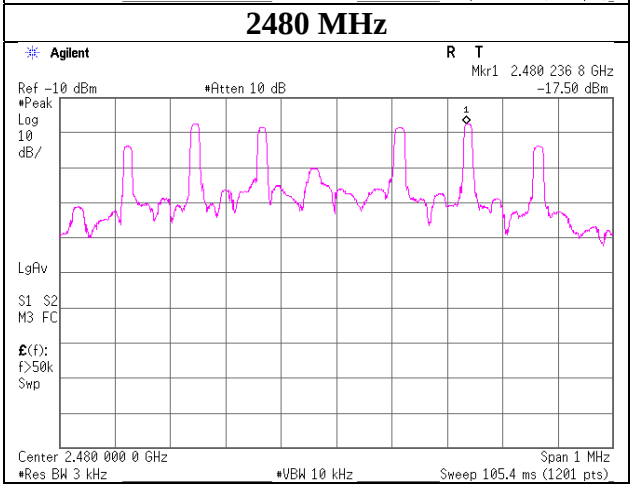
2402 MHz



2441 MHz



2480 MHz



APPENDIX 2: Test instruments

Test equipment

Test Item	Local ID	LIMS ID	Description	Manufacturer	Model	Serial	Last Calibration Date	Cal Int
AT	MOS-24	90289	Thermo-Hygrometer	CUSTOM. Inc	CTH-201	0005	01/15/2021	12
AT	MMM-12	141547	DIGITAL HiTESTER	HIOKI E.E. CORPORATION	3805	60500120	02/01/2021	12
AT	MRENT-130	141855	Spectrum Analyzer	Keysight Technologies Inc	E4440A	MY46187750	11/18/2020	12
AT	MPM-13	141810	Power Meter	Anritsu Corporation	ML2495A	824014	12/14/2020	12
AT	MPSE-18	141832	Power sensor	Anritsu Corporation	MA2411B	738174	12/14/2020	12
AT	MAT-57	141333	Attenuator(10dB)	Suhner	6810.19.A	-	12/07/2020	12
AT	MAT-10	141156	Attenuator(10dB)	Weinschel Corp	2	BL1173	11/13/2020	12
RE	MAEC-04	142011	AC4_Semi Anechoic Chamber(NSA)	TDK	Semi Anechoic Chamber 3m	DA-10005	05/25/2020	24
RE	MOS-15	141562	Thermo-Hygrometer	CUSTOM. Inc	CTH-201	0010	01/15/2021	12
RE	MMM-10	141545	DIGITAL HiTESTER	HIOKI E.E. CORPORATION	3805	51201148	01/07/2021	12
RE	MJM-29	142230	Measure	KOMELON	KMC-36	-	-	-
RE	COTS-MEMI-02	178648	EMI measurement program	TSJ (Techno Science Japan)	TEPTO-DV	-	-	-
RE	MAEC-04-SVSWR	142017	AC4_Semi Anechoic Chamber(SVSWR)	TDK	Semi Anechoic Chamber 3m	DA-10005	04/12/2021	24
RE	MHA-21	141508	Horn Antenna 1-18GHz	Schwarzbeck Mess-Elektronik OHG	BBHA9120D	557	05/22/2020	12 *1)
RE	MPA-12	141581	MicroWave System Amplifier	Keysight Technologies Inc	83017A	00650	10/19/2020	12
RE	MCC-246	199563	Microwave Cable	Huber+Suhner	SF126E/11PC35/11PC35/1000M,5000M	537061/126E / 537072/126E	06/11/2020	12
RE	MHF-26	141296	High Pass Filter 3.5-18.0GHz	UL Japan	HPF SELECTOR	002	09/23/2020	12
RE	MSA-15	141902	Spectrum Analyzer	Keysight Technologies Inc	E4440A	MY46187105	10/15/2020	12
RE	MAT-34	141331	Attenuator(6dB)	TME	UFA-01	-	02/02/2021	12
RE	MBA-05	141425	Biconical Antenna	Schwarzbeck Mess-Elektronik OHG	VHA9103+BBA9106	VHA 91031302	08/31/2020	12
RE	MCC-50	141397	Coaxial Cable	UL Japan	-	-	11/06/2020	12
RE	MLA-23	141267	Logperiodic Antenna (200-1000MHz)	Schwarzbeck Mess-Elektronik OHG	VUSLP9111B	9111B-192	09/02/2020	12
RE	MPA-14	141583	Pre Amplifier	SONOMA INSTRUMENT	310	260833	02/18/2021	12
RE	MTR-03	141942	Test Receiver	Rohde & Schwarz	ESCI	100300	08/18/2020	12
RE	MHA-17	141506	Horn Antenna 15-40GHz	Schwarzbeck Mess-Elektronik OHG	BBHA9170	BBHA9170307	07/16/2020	12
CE	MAEC-04	142011	AC4_Semi Anechoic Chamber(NSA)	TDK	Semi Anechoic Chamber 3m	DA-10005	05/25/2020	24
CE	MOS-15	141562	Thermo-Hygrometer	CUSTOM. Inc	CTH-201	0010	01/15/2021	12
CE	MMM-10	141545	DIGITAL HiTESTER	HIOKI E.E. CORPORATION	3805	51201148	01/07/2021	12
CE	MJM-29	142230	Measure	KOMELON	KMC-36	-	-	-
CE	COTS-MEMI-02	178648	EMI measurement program	TSJ (Techno Science Japan)	TEPTO-DV	-	-	-
CE	MLS-23	141357	LISN(AMN)	Schwarzbeck Mess-Elektronik OHG	NSLK8127	8127-729	07/22/2020	12
CE	MAT-67	141248	Attenuator	JFW Industries, Inc.	50FP-013H2 N	-	12/07/2020	12
CE	MCC-113	141217	Coaxial cable	Fujikura/Suhner/TSJ	5D-2W/SFM141/ 421-010/ sucoform141-PE/ RFM-E121(SW)	-/04178	06/18/2020	12
CE	MTR-10	141951	EMI Test Receiver	Rohde & Schwarz	ESR26	101408	03/09/2021	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.

The expiration*1) This test equipment was used for the tests before the expiration date of the calibration.

All equipment is calibrated with valid calibrations. Each measurement data is traceable to the national or international standards.

Test item: **CE: Conducted Emission test**
RE: Radiated Emission test
AT: Antenna Terminal Conducted test