RADIO TEST REPORT

Test Report No. 15510563S-A-R4

Customer	**ALPS ALPINE CO., LTD.**
Description of EUT	**Hand Unit**
Model Number of EUT	**TWB1G0636**
FCC ID	**CWTWB1G0636**
Test Regulation	**FCC Part 15 Subpart F**
Test Result	**Complied**
Issue Date	**March 28, 2025**
Remarks	**-**

Representative Test Engineer	Approved By
H. Sato	T.Imamura
Hiromasa Sato Engineer	Toyokazu Imamura Engineer

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# 24.0

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- The opinions and the interpretations to the result of the description in this report are outside scopes where UL Japan, Inc. has been accredited.
- 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. 15510563S-A

This report is a revised version of 15510563S-A-R3. 15510563S-A-R3 is replaced with this report.

Revision	Test Report No.	Date	Revised Contents
- (Original)	15510563S-A	November 27, 2024	-
1	15510563S-A-R1	December 2, 2024	4.1 Software: Correction of storage location "Transmitter timeout test" From: Driven by connected Pc To: EUT memory
2	15510563S-A-R2	March 7, 2025	2.2 Correction of UWB modulation From: BPM-BPSK To: BPM-BPSK and BPSK
			2.2 Replaced of key variation table From: *The EUT has following key variation: TWB1G0636 | 4-button / 5-button To: *The EUT has following key variation: TWB1G0636 | 4-button: 4KEY-1 5-button: 5KEY-1 Add to end of sentence: "(4KEY-1)."
			APPENDIX 1: Deletion of remarks -Radiated emission: * For RF Exposure evaluation Maximum RMS power measured: -48.56 dBm/MHz (refer to upper table value), 10 ^ (-48.56 [dBm/MHz] / 10) = 0.00001393 mW/MHz The bandwidth of this equipment was 619.794 MHz (99 % occupied bandwidth, refer to the data of bandwidth sheet) Total RMS output power was 0.00863373 mW = 0.00001393 mW/MHz x 619.794 MHz - Peak level of the emission: * For RSP-100 Annex B Maximum peak power measured: -6.926 dBm/50 MHz (refer to upper table value) / 10 ^ (-6.926 [dBm/50 MHz]/ 10) = 0.20295511 mW/50 MHz The bandwidth of this equipment was 619.794 MHz (99 % occupied bandwidth, refer to the data of bandwidth sheet) Total peak output power was 2.51580719 mW = 0.20295511 [mW/50 MHz] x 619.794 [MHz] / 50 [MHz] - Transmitter timeout: * Although no transmission signal was seen after the companion device was turned off, the transmitter timeout result was assumed to be the time for one sequence transmission, assuming that the time for one sequence transmission that EUT may transmit. * This EUT was stopped transmit unless there is a second trigger at the Transmitter timeout of the UWB after the Trigger (LF transmission). (Reference data) 1 sequence chart
			APPENDIX 1: - (p.17, p.25) Correction of factor (Tx Ant Gain) of substitution antenna gain value. (mean power) (incorrect): H: 9.84, V: 10.17 -> (correct) H: 12.85, V: 12.85 (peak power) (incorrect) H: 10.21, V: 10.19 -> (correct) J: 12.85, V: 12.85 -(P.28) Correction of Transmitter Timeout (0.00015 s -> less than 1.5 s)
3	15510563S-A-R3	March 25, 2025	Cover page: Deletion of Remarks "UWB part(s)"
			3.2 Procedures and Results Correction of remarks of Transmitter timeout (Conducted -> Radiated)
			Correction of Supplied Voltage Information: "The stable voltage was supplied by the end product which was required to have a power supply regulator." -> "The test was performed with the New Battery during the tests."

Revision	Test Report No.	Date	Revised Contents
3	15510563S-A-R3	March 25, 2025	(p.21) Correction of chart (correction limit line).
			(P.28) Correction of Transmitter Timeout (less than 1.5 s -> less than 10 s)
4	15510563S-A-R4	March 28, 2025	(P.22) Addition of chart (10.6 GHz - 18 GHz).

Reference: Abbreviations (Including words undescribed in this report)

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

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SECTION 1: Customer Information

Company Name	ALPS ALPINE CO., LTD.
Address	6-3-36, Furukawanakazato, Osaki-city, Miyagi-pref, 989-6181, Japan
Telephone Number	+81-229-23-5111
Contact Person	Yuji Ouchi

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	Hand Unit
Model Number	TWB1G0636
Serial Number	Refer to SECTION 4.2
Condition	Engineering prototype (Not for Sale: This sample is equivalent to mass-produced items.)
Modification	No Modification by the test lab
Receipt Date	September 28, 2024
Test Date	October 10 to 26, 2024

2.2 Product Description

General Specification

Rating	DC 3 V
Operating temperature	-20 deg. C to 60 deg. C

Radio Specification

[Transmitter]

Equipment Type	Transmitter
Frequency of Operation	433.92 MHz
Type of Modulation	FSK

[UWB]

Equipment Type	Transceiver
Frequency of Operation	7987.2 MHz (7737.6 MHz to 8236.8 MHz) (ch9)
Type of Modulation	BPM-BPSK and BPSK

[LF receiver]

Equipment Type	Receiver
Frequency of Operation	125 kHz

*The EUT has following key variation:

TWB1G0636	4-button: 4KEY-1 5-button: 5KEY-1

The differences of tested model and variation models are only the number of switch and design.
They are not influence for RF performance.

Therefore the test was performed with the representative 4-button type (4KEY-1).

SECTION 3: Test specification, Procedures & Results

3.1 Test Specification

Test Specification	FCC Part 15 Subpart F The latest version on the first day of the testing period
Title	FCC 47 CFR Part 15 Radio Frequency Device Subpart F Ultra-Wideband Operation Section 15.207 Conducted limits Section 15.503 Definitions Section 15.505 Cross reference Section 15.519 Technical requirements for hand held UWB systems Section 15.521 Technical requirements applicable to all UWB devices

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 Section 15.505(a) Section 15.521(j)	-	N/A	*1)
	ISED: RSS-Gen 8.8	**ISED:** RSS-220 5.2.1(b)			
UWB Bandwidth	**FCC:** Section 15.503(a) ANSI C63.10: 2013 6 Standard test methods, 10 Procedures for measuring ultra-wideband devices	**FCC:** Section 15.503(d) Section 15.519 (b)	See data.	Complied	Radiated
	ISED: RSS-220 Annex 2	**ISED:** RSS-220 2, RSS-220 5.1			
Radiated emission	**FCC:** Section 15.503(a) ANSI C63.10: 2013 6 Standard test methods, 10 Procedures for measuring ultra-wideband devices	**FCC:** Section 15.209, Section 15.505, Section 15.519 (c) (d),Section 521(c)	4.25 dB 8041.990 MHz AV, Horizontal (Transmitting ch9)	Complied	Radiated
	ISED: RSS-Gen 6.5 RSS-220 Annex 4	**ISED:** RSS-220 5.3.1(c)(d)(e)			
Peak level of the Emission	**FCC:** Section 15.521(e)(g) ANSI C63.10: 2013 6 Standard test methods, 10 Procedures for measuring ultra-wideband devices	**FCC:** Section 15.519 (e)	-	Complied	Radiated
	ISED: RSS-220 Annex 4	**ISED:** RSS-220 5.3.1(g)			
Transmitter timeout	**FCC:** Section 15.519(a)(1) ANSI C63.10: 2013 6 Standard test methods, 10 Procedures for measuring ultra-wideband devices	**FCC:** Section 15.519 (a)(1)	-	Complied	Radiated
	ISED: RSS-220 Annex 4	**ISED:** RSS-220 5.3.1(b)			
Note: UL Japan, Inc.'s EMI Work Procedures: Work Instructions-ULID-003591 and Work Instructions-ULID-003593. *1) This test not applicable since the EUT does not have AC Mains.					

FCC Part 15.31 (e)
The test was performed with the New Battery during the tests.
Therefore, the EUT complies with the requirement.

FCC Part 15.203/212 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	-	Radiated

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	3.2 dB
Radiated Emission (Measurement distance: 3 m)	9 kHz-30 MHz	3.3 dB
	30 MHz-200 MHz	4.9 dB
	200 MHz-1 GHz	6.2 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

Radiated Emission (Substitution measurement)

Substitution measurement (EUT height: 1.5 m, Distance: 3 m)	
Frequency range	Uncertainty (+/-)
30 MHz - 200 MHz	4.7 dB
200 MHz - 1000 MHz	3.5 dB
1 GHz - 13 GHz	4.5 dB

Substitution measurement (EUT height: 1.5 m, Distance: 1 m)	
Frequency range	Uncertainty (+/-)
1 GHz - 13 GHz	5.0 dB
13 GHz - 18 GHz	5.5 dB
18 GHz - 26.5 GHz	4.0 dB
26.5 GHz - 40 GHz	4.0 dB

Substitution measurement (EUT height: 1.5 m, Distance: 0.5 m)	
Frequency range	Uncertainty (+/-)
1 GHz - 13 GHz	5.0 dB
13 GHz - 18 GHz	5.4 dB
18 GHz - 26.5 GHz	4.0 dB
26.5 GHz - 40 GHz	4.0 dB

Substitution measurement (EUT height: 1.5 m, Distance: 0.3 m)	
Frequency range	Uncertainty (+/-)
1 GHz - 13 GHz	5.2 dB
13 GHz - 18 GHz	5.4 dB
18 GHz - 26.5 GHz	4.0 dB
26.5 GHz - 40 GHz	4.0 dB

Substitution measurement (EUT height: 1.5 m, Distance: 0.1 m)	
Frequency range	Uncertainty (+/-)
13 GHz - 18 GHz	5.8 dB
18 GHz - 26.5 GHz	4.3 dB
26.5 GHz - 40 GHz	4.3 dB

Antenna terminal test	Uncertainty (+/-)
Spurious Emission (Conducted) below 1 GHz	0.91 dB
Conducted Emissions Power Density Measurement 1 GHz-3 GHz	1.3 dB
Conducted Emissions Power Density Measurement 3 GHz-18 GHz	2.5 dB
Spurious Emission (Conducted) 18 GHz-26.5 GHz	2.8 dB
Spurious Emission (Conducted) 26.5 GHz-40 GHz	2.6 dB
Bandwidth Measurement	0.012 %
Duty Cycle and Time Measurement	0.27 %
Voltage	0.74 %

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 room	Width x Depth x Height (m)	Size of reference ground plane (m) / horizontal conducting plane	Maximum measurement distance
No.1 Semi-anechoic chamber (SAC1)	20.6 x 11.3 x 7.65	20.6 x 11.3	10 m
No.2 Semi-anechoic chamber (SAC2)	20.6 x 11.3 x 7.65	20.6 x 11.3	10 m
No.3 Semi-anechoic chamber (SAC3)	12.7 x 7.7 x 5.35	12.7 x 7.7	5 m
No.4 Semi-anechoic chamber (SAC4)	8.1 x 5.1 x 3.55	8.1 x 5.1	-
Wireless anechoic chamber 1 (WAC1)	9.5 x 6.0 x 5.4	9.5 x 6.0	3 m
Wireless anechoic chamber 2 (WAC2)	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	-	-
No.2 Measurement room	4.5 x 3.5 x 2.5	-	-
Wireless shielded room 1	3.0 x 4.5 x 2.7	3.0 x 4.5	-
Wireless shielded room 2	3.0 x 4.5 x 2.7	3.0 x 4.5	-

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)

Test Item	Operating Mode	Tested frequency
Other than Transmitter timeout test	Transmitting (Tx) ch9 (7987.2 MHz)	7987.2 MHz
Transmitter timeout test	Normal transmitting (Tx) ch9 (7987.2 MHz)	7987.2 MHz

*Power of the EUT was set by the software as follows;
Power Setting: Fixed
Software: Other than Transmitter timeout test:
5AB-01458Z33+5AB-01459Z10
(Date: 2024.09.13, Storage location: EUT memory)

Transmitter timeout test:
5AB-01458A05+5AB-01459A03 (Date: 2024.09.13, 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.

4.2 Configuration and Peripherals

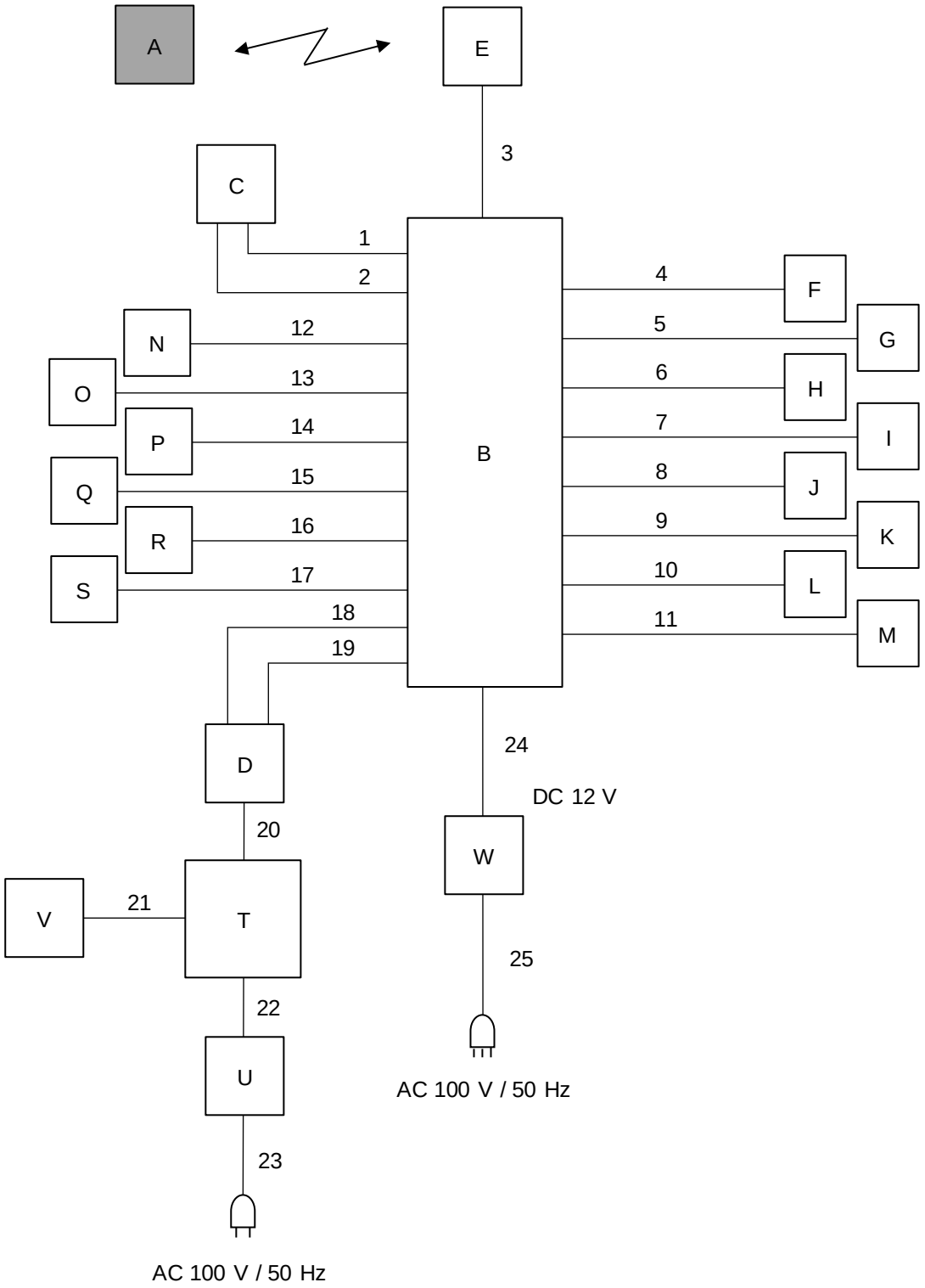
[Other than Transmitter timeout test]

*Test data was taken under worse case conditions.

Description of EUT

No.	Item	Model number	Serial number	Manufacturer	Remarks
A	Hand Unit	TWB1G0636	240927_3	ALPS ALPINE CO.,LTD.	EUT

[Transmitter timeout test]



Description of EUT and Support Equipment

No.	Item	Model number	Serial Number	Manufacturer	Remarks
A	Hand Unit	TWB1G0636	240927_7	ALPS ALPINE CO.,LTD.	EUT
B	CHECKER BOX	-	NO.9	-	-
C	ECU	-	No.123	ALPS ALPINE CO.,LTD.	-
D	CAN_IF	VN1630A	007113-056898	VECTOR	-
E	LF ANT(F)	A0_prototype	-	SUMIDA CORPORATION	-
F	LF_ANT(RES)	T0_prototype	ANT BOARD No.8	SUMIDA CORPORATION	-
G	LF_ANT(TI)	T0_prototype	ANT BOARD No.8	SUMIDA CORPORATION	-
H	LF_ANT(C)	T0_prototype	ANT BOARD No.8	SUMIDA CORPORATION	-
I	LF_ANT(FRAS)	T0_prototype	ANT BOARD No.8	SUMIDA CORPORATION	-
J	LF_ANT(RRAS)	T0_prototype	ANT BOARD No.8	SUMIDA CORPORATION	-
K	LF_ANT(B)	T0_prototype	ANT BOARD No.8	SUMIDA CORPORATION	-
L	LF_ANT(FRDR)	T0_prototype	ANT BOARD No.8	SUMIDA CORPORATION	-
M	LF_ANT(RRDR)	T0_prototype	ANT BOARD No.8	SUMIDA CORPORATION	-
N	UWB ANCHOR	-	R2 8-1	BOSCH	-
O	UWB ANCHOR	-	R2 8-2	BOSCH	-
P	UWB ANCHOR	-	R2 8-3	BOSCH	-
Q	UWB ANCHOR	-	R2 8-4	BOSCH	-
R	UWB ANCHOR	-	R2 8-5	BOSCH	-
S	UWB ANCHOR	-	R2 8-6	BOSCH	-
T	Laptop PC	Latitude 3520	19190242119	DELL	-
U	AC Adaptor	DA65NM191	CN-0WC42G-DES 00-0CQ-GDXT-A02	DELL	-
V	Mouse	MS111-L	CN-09RRC7-44751 -16TOMUE	DELL	-
W	Power Supply(DC)	PAN35-10A	DE001677	Kikusui Electronics Corp.	-

List of Cables Used

No.	Name	Length (m)	Shield		Remarks
			Cable	Connector	
1	Signal	2.5	Unshielded	Unshielded	-
2	Signal	2.5	Unshielded	Unshielded	-
3	Signal	2.0	Unshielded	Unshielded	F
4	Signal	2.1	Unshielded	Unshielded	RES
5	Signal	2.8	Unshielded	Unshielded	TI
6	Signal	1.2	Unshielded	Unshielded	C
7	Signal	1.2	Unshielded	Unshielded	FR-AS
8	Signal	4.4	Unshielded	Unshielded	RR-AS
9	Signal	6.2	Unshielded	Unshielded	B
10	Signal	1.1	Unshielded	Unshielded	FR-DR
11	Signal	6.2	Unshielded	Unshielded	RR-DR
12	Signal	1.7	Unshielded	Unshielded	-
13	Signal	3.0	Unshielded	Unshielded	-
14	Signal	1.4	Unshielded	Unshielded	-
15	Signal	1.6	Unshielded	Unshielded	-
16	Signal	2.4	Unshielded	Unshielded	-
17	Signal	2.8	Unshielded	Unshielded	-
18	Signal	0.5	Shielded	Shielded	-
19	Signal	0.5	Shielded	Shielded	-
20	USB	1.8	Shielded	Shielded	-
21	USB	1.8	Shielded	Shielded	-
22	DC	1.8	Unshielded	Unshielded	-
23	AC	1.0	Unshielded	Unshielded	-
24	DC	1.2	Unshielded	Unshielded	-
25	AC	2.0	Unshielded	Unshielded	-

SECTION 5: Radiated Emission

Test Procedure

[For below 30 MHz]
EUT was placed on a platform of nominal size, 0.15 m by 0.05 m, raised 0.8 m above the conducting ground plane. The table is made of expanded polystyrol and expanded polypropylene and the tabletop is covered with polycarbonate. That has very low permittivity.
The EUT was rotated a full revolution in order to obtain the maximum value of the electric field intensity.
The measurements were performed for vertical polarization (antenna angle: 0 deg., 45 deg., 90 deg., and 135 deg.) and horizontal polarization.
*Refer to Figure 1 about Direction of the Loop Antenna.

[For 30 MHz to 960 MHz]
EUT was placed on a platform of nominal size, 0.15 m by 0.05 m, raised 0.8 m above the conducting ground plane. The table is made of expanded polystyrol and expanded polypropylene and the table top is covered with polycarbonate. That has very low permittivity.

[For 960 MHz to 1000 MHz]
EUT was placed on a urethane platform of nominal size, 0.15 m by 0.05 m, raised 1.5 m above the conducting ground plane.

[For above 1000 MHz]
EUT was placed on a urethane platform of nominal size, 0.15 m by 0.05 m, raised 1.5 m above the conducting ground plane.

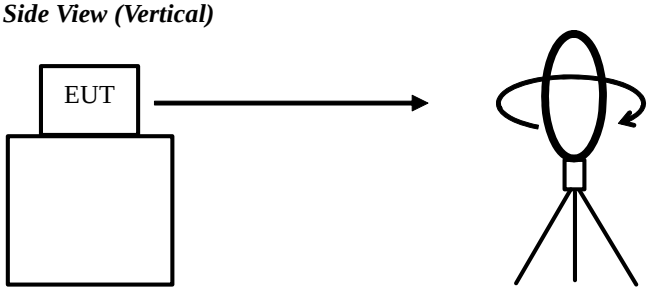
UWB emissions and other emissions:
1) The height of the measuring antenna varied between 1 m and 4 m and EUT was rotated a full revolution in order to obtain the maximum value of the electric field strength.
The measurements were performed for both vertical and horizontal antenna polarization with the 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.

(UWB emissions only) (refer to ANSI C63.10 (reference ANSI C63.26))
2) Exchanged the EUT to the Substitution Antenna, the measurement was set for the same height 1.5 m as the EUT. The frequency below 1 GHz of the Substitution Antenna was used the Half wave dipole Antenna, which was tuned the measured frequency in 1).
The frequency above 1 GHz of the Substitution Antenna was used Horn Antenna.
The Substitution Antenna was connected to the Signal Generator, and the polarized electromagnetic radiation of the Substitution Antenna was matched with the one of the measuring Antenna, which was set with the Signal Generator to the measured frequency in 1). Then, we set with the Output power (CW) of the Signal Generator where the measuring electromagnetic field strength is equal to the measured value in 1) by means of varying the measuring antenna height between 1 to 4 m to obtain maximum receiving level.
Its Output power of Signal Generator was recorded.

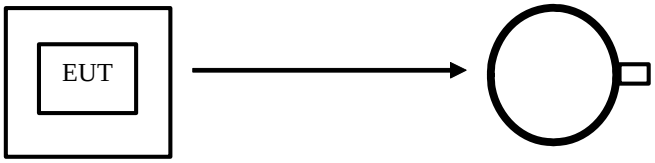
3) Equivalent isotropic radiated power was calculated by subtracting the cable loss and the attenuator loss connected between the signal generator and the substitution antenna from the output power of the signal generator recorded in 2).
For the usage of the antenna (horn antenna) for the substitution antenna, the equivalent isotropic radiated power was calculated by compensating the finite substitution antenna.

Figure 1: Direction of the Loop Antenna

Side View (Vertical)

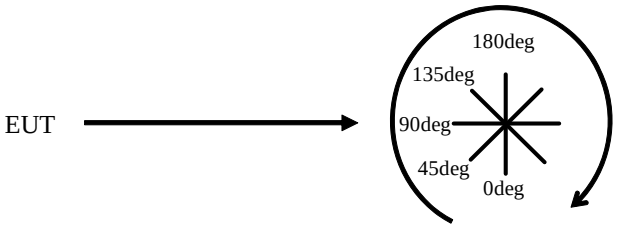


Top View (Horizontal)



Antenna was not rotated.

Top View (Vertical)



Front side: 0 deg.
Forward direction: clockwise

Test Antennas are used as below;

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

Frequency	Below 30 MHz	30 to 960 MHz	Above 960 MHz	
Instrument used	Test Receiver	Test Receiver	Spectrum Analyzer	
Detector	Quasi-Peak	Quasi-Peak	Peak	RMS (AV) *2)
IF Bandwidth	BW 9 kHz	BW 120 kHz	UWB spurious emission: RBW: 1 MHz, VBW: 3 MHz Carrier emission: RBW: 50 MHz, VBW: 80 MHz	UWB spurious emission: RBW: 1 MHz, VBW: 3 MHz GPS band emission: RBW: 1 kHz, VBW: 3 kHz
Test Distance	3 m	3 m	3.0 m (960 MHz to 1 GHz) 0.5 m (1 GHz to 10.6 GHz) *1) 0.3 m (10.6 GHz to 18 GHz) *1) 0.1 m (above 18 GHz) *1)	

*1) For section 10.3.2 of ANSI C63.10: 2013. This measurement was performed at less than 3 m due to the small radiation emission of EUT. In addition, this measurement was performed by the substitution measurement.
Since there are frequencies that are the distance of the near field condition with respect to the measurement distance, we have verified the measurement results in the near field condition and the far field condition and confirmed that there was no difference in the test results.

*2) For section 10.3.7 of ANSI C63.10: 2013. This measurement was set the sweep time so that there is no more than a 1 ms integration period over each measurement bin.

- 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.

Polarity	Frequency [GHz]							
	Below 0.030	0.030 to 0.96	0.96 to 1	1 to 2	2 to 10.6	10.6 to 18	18 to 26.5	26.5 to 40
Horizontal	X	X	X	X	X	X	X	X
Vertical	X	X	X	X	Z	X	X	X

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

Measurement range : 9 kHz to 40 GHz
Test data : APPENDIX
Test result : Pass

SECTION 6: UWB bandwidth and 99 % occupied bandwidth

Test Procedure

The tests were made with below setting by a radiated electric field in semi-anechoic chamber.

Test	Span	RBW	VBW	Sweep	Detector	Trace	Instrument used
UWB Bandwidth, 99 % Occupied Bandwidth	1 GHz	1 MHz or 10 MHz	3 MHz or 40 MHz	Auto	Peak	Max Hold	Spectrum Analyzer

Test data : APPENDIX
Test result : Pass

SECTION 7: Transmitter timeout

Test Procedure
The test was made with spectrum analyzer.

Test Data : APPENDIX
Test Result : Pass

APPENDIX 1: Test Data

Radiated emission

Test place	Shonan EMC Lab. SAC 3
Date	October 26, 2024
Temperature / Humidity	25 deg. C / 44 % RH
Engineer	Shiro Kobayashi
Mode	Transmitting ch9

(UWB emission, RBW 1 MHz)

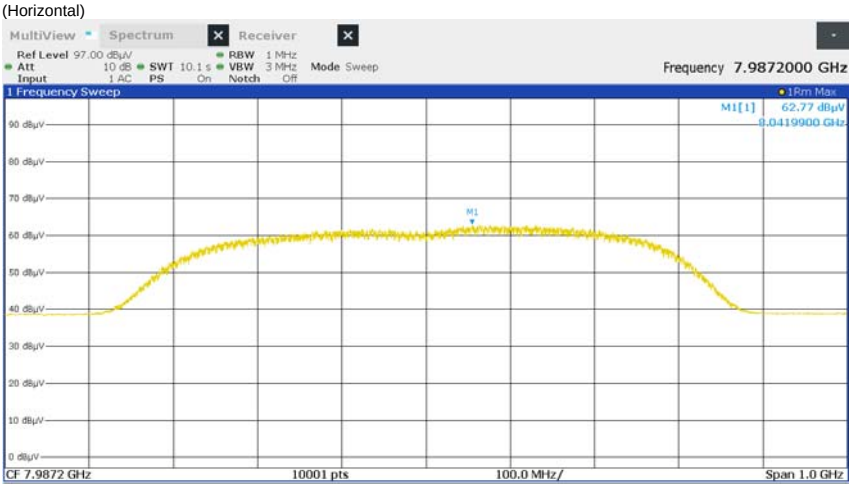
(*SA: Spectrum analyzer, SG: Signal generator, Ant.: substitution antenna)

Band	Pol.	Frequency [MHz]	SA Reading [dBuV/MHz]	SG level [dBm]	Tx Ant.Gain [dBi]	Tx Loss [dB]	-	EIRP Result [dBm/MHz]	EIRP Limit [dBm/MHz]	Margin [dB]	Remarks	Height [cm]	Angle [deg.]
3.1 GHz - 10.6 GHz	Hor.	8041.990	62.77	-47.02	12.85	11.38	-	-45.55	-41.30	4.25	carrier	150	86
3.1 GHz - 10.6 GHz	Ver.	8106.590	61.36	-48.87	12.85	11.43	-	-47.45	-41.30	6.15	carrier	150	141

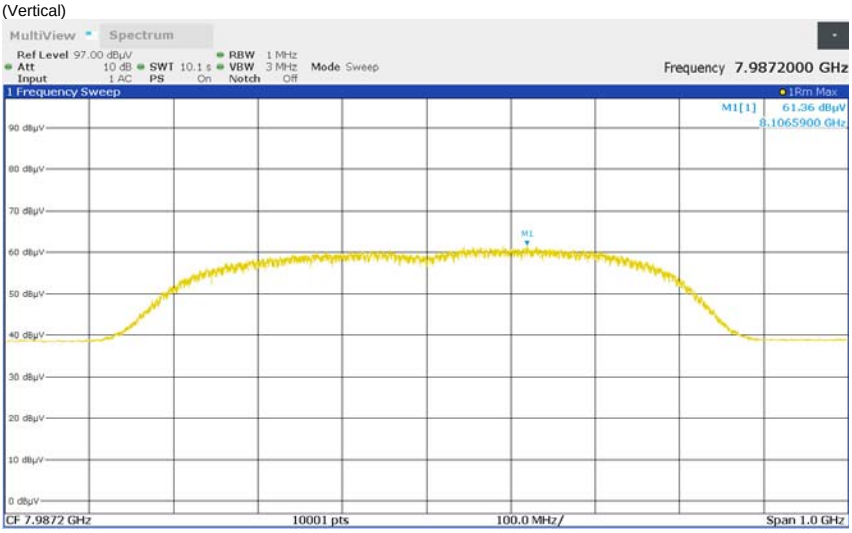
Sample Calculation :

EIRP Result [dBm/MHz] = SG level [dBm] + Tx Ant.Gain [dBi] - Tx Loss [dB]

(Horizontal)



(Vertical)



Radiated emission

Test place	Shonan EMC Lab.			
Semi Anechoic Chamber	SAC 2	SAC 3	SAC 3	SAC 3
Date	October 10, 2024	October 13, 2024	October 26, 2024	October 18, 2024
Temperature / Humidity	22 deg. C / 61 % RH	25 deg. C / 40 % RH	25 deg. C / 44 % RH	23 deg. C / 45 % RH
Engineer	Hiromasa Sato (9 kHz - 1000 MHz)	Yuta Shiba (1 GHz - 2 GHz)	Shiro Kobayashi (1 GHz - 10.6 GHz)	Hiromasa Sato (10.6 GHz - 18 GHz)

Semi Anechoic Chamber	SAC 3	SAC 3
Date	October 13, 2024	October 12, 2024
Temperature / Humidity	25 deg. C / 40 % RH	24 deg. C / 41 % RH
Engineer	Yuta Shiba (18 GHz – 26.5 GHz)	Yosuke Murakami (26.5 GHz - 40 GHz)
Mode	Transmitting ch9	

(UWB emission except carrier emission)

9 kHz to 40 GHz

No.	Freq.	Reading (PK)	SG Level	TX Ant.Gain	TX Loss	EIRP		Margin	Pola.	Height	Angle	TX Ant.Type	Comment
						Result	Limit						
	[MHz]	[dBuV]	[dBm]	[dBi]	[dB]	[dBm]	[dBm]	[dB]		[cm]	[deg]		
1	31948.801	46.61	-60.10	13.01	23.61	-70.70	-61.30	9.4	Hori.	153	142	Horn	RMS
2	31948.801	45.30	-63.72	13.01	23.61	-74.32	-61.30	13.0	Vert.	155	8	Horn	RMS

Calculation:Result [dBm] = SG level [dBm] + Tx Ant Gain [dBi] - Tx Loss (Cable)[dB]
Tx Antenna: Horn(1 GHz-40 GHz) / Rx-Antenna: Horn(1 GHz-40 GHz)

* For below 960 MHz, RBW was set according to FCC 15.209, above 960 MHz, RBW was set to 1 MHz.
(* There were no detect UWB emissions in the range that below 26.5 GHz)

Radiated emission

Test place	Shonan EMC Lab.			
Semi Anechoic Chamber	SAC 2	SAC 3	SAC 3	SAC 3
Date	October 10, 2024	October 13, 2024	October 26, 2024	October 18, 2024
Temperature / Humidity	22 deg. C / 61 % RH	25 deg. C / 40 % RH	25 deg. C / 44 % RH	23 deg. C / 45 % RH
Engineer	Hiromasa Sato (9 kHz - 1000 MHz)	Yuta Shiba (1 GHz - 2 GHz)	Shiro Kobayashi (1 GHz - 10.6 GHz)	Hiromasa Sato (10.6 GHz - 18 GHz)

Semi Anechoic Chamber	SAC 3	SAC 3
Date	October 13, 2024	October 12, 2024
Temperature / Humidity	25 deg. C / 40 % RH	24 deg. C / 41 % RH
Engineer	Yuta Shiba (18 GHz – 26.5 GHz)	Yosuke Murakami (26.5 GHz - 40 GHz)
Mode	Transmitting ch9	

(Other emission)

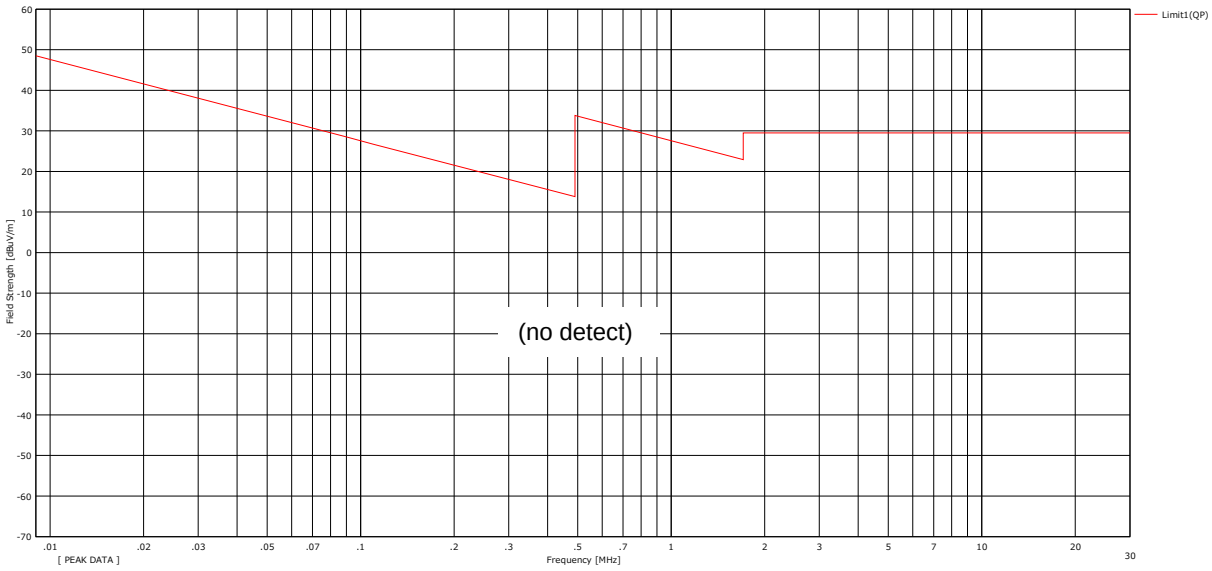
No.	Freq.	Reading (QP)	Ant.Fac	Loss	Gain	Result (QP)	Limit (QP)	Margin (QP)	Pola.	Height	Angle	Ant. Type	Comment
	[MHz]	[dBuV]	[dB/m]	[dB]	[dB]	[dBuV/m]	[dBuV/m]	[dB]	[H/V]	[cm]	[deg.]		
1	97.808	20.86	9.84	8.13	31.90	6.93	43.50	36.5	Hori.	285	163	BC	
2	172.946	21.22	15.83	8.86	31.83	14.08	43.50	29.4	Hori.	149	28	BC	
3	669.187	20.47	20.25	8.89	31.62	17.99	46.00	28.0	Hori.	100	31	LP	
4	76.331	21.23	6.22	7.93	31.91	3.47	40.00	36.5	Vert.	100	12	BC	
5	188.237	20.63	16.32	8.89	31.82	14.02	43.50	29.4	Vert.	100	358	BC	
6	358.781	21.70	14.35	7.06	31.67	11.44	46.00	34.5	Vert.	158	257	LP	
7	856.714	20.33	22.11	9.90	31.14	21.20	46.00	24.8	Vert.	100	204	LP	

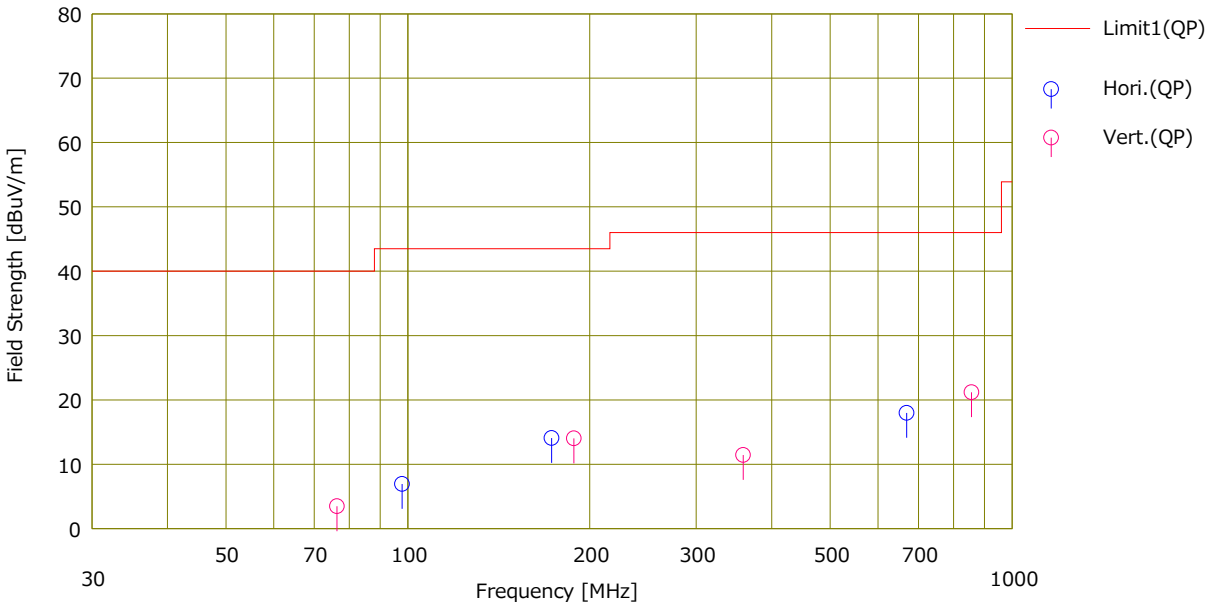
Calculation Result [dBuV/m] = Reading [dBuV/m] + Ant.Fac [dB/m] + Loss (Cable + ATT + ΔAF)[dB] - Gain (AMP)[dB]
Ant.Type = BC: Biconical antenna, LP: Logperiodic antenna, **SH*: Horn antenna

(*There were no detect other emissions in the range that below 30 MHz and above 960 MHz)

Radiated emission

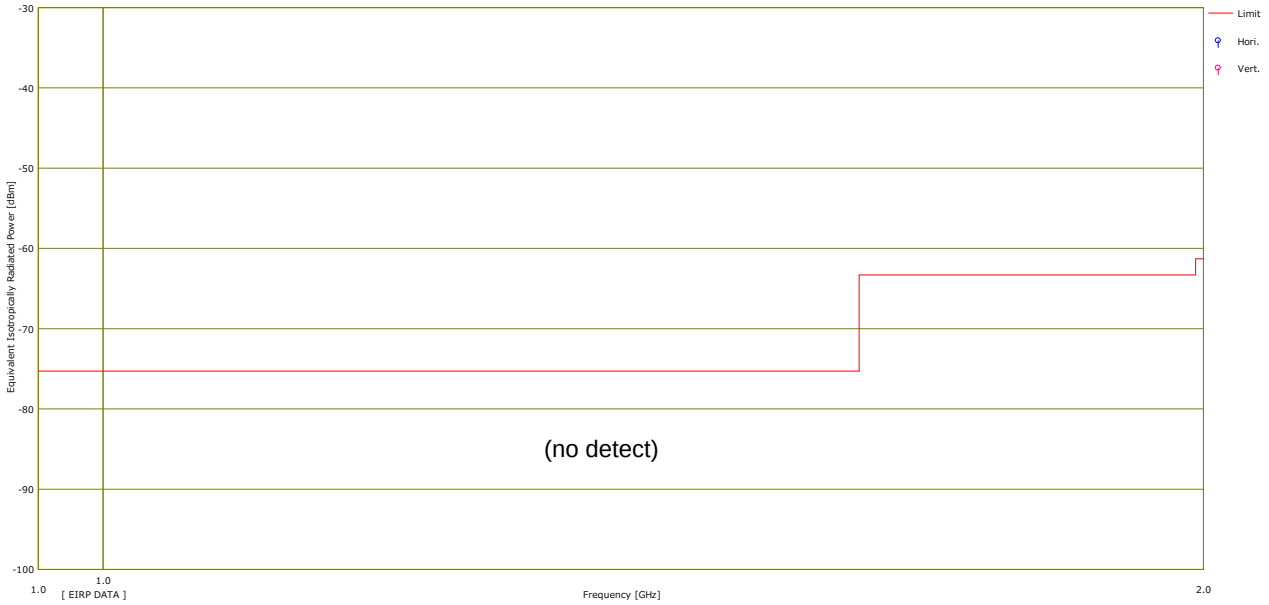
Test place	Shonan EMC Lab.
Semi Anechoic Chamber	SAC 2
Date	October 10, 2024
Temperature / Humidity	22 deg. C / 61 % RH
Engineer	Hiromasa Sato
	(9 kHz - 1000 MHz)
Mode	Transmitting ch9

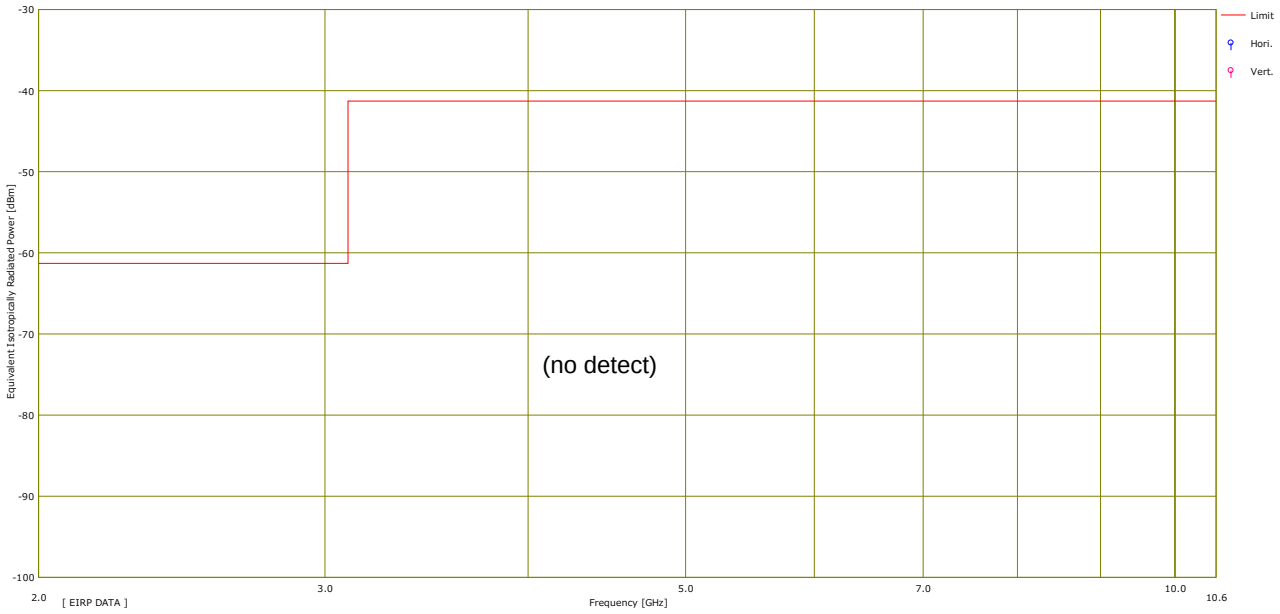




Radiated emission

Test place	Shonan EMC Lab.	
Semi Anechoic Chamber	SAC 3	SAC 3
Date	October 13, 2024	October 26, 2024
Temperature / Humidity	25 deg. C / 40 % RH	25 deg. C / 44 % RH
Engineer	Yuta Shiba (1 GHz - 2 GHz)	Shiro Kobayashi (1 GHz - 10.6 GHz)
Mode	Transmitting ch9	

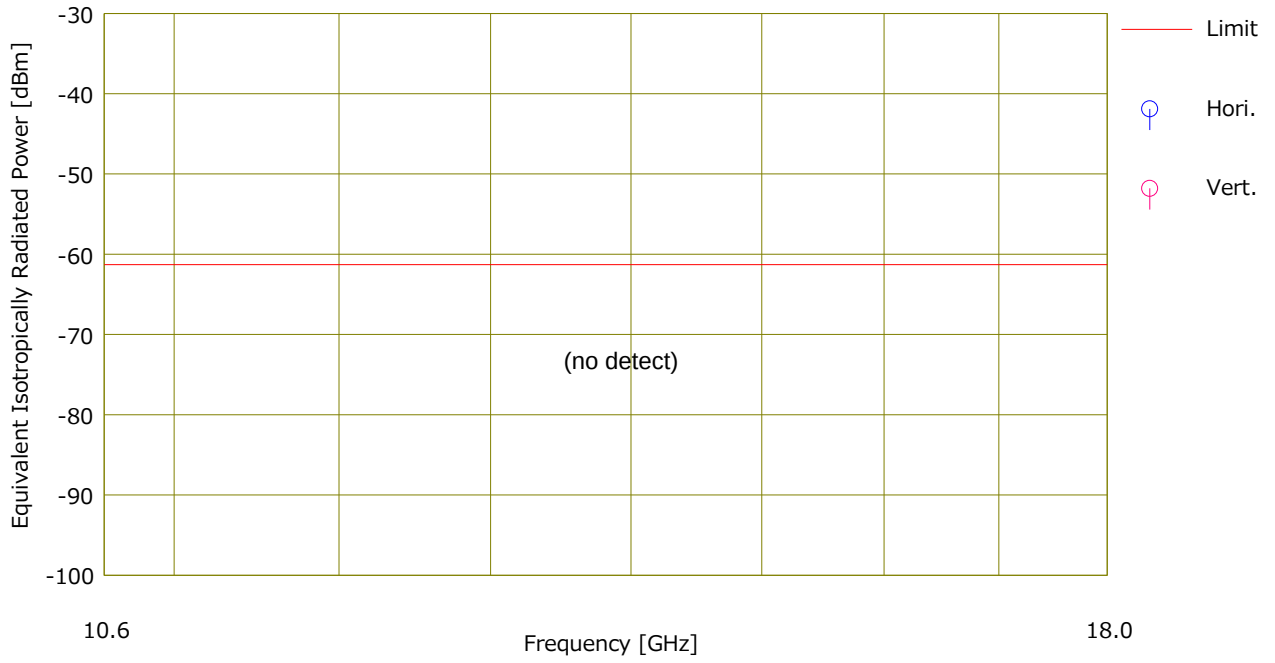


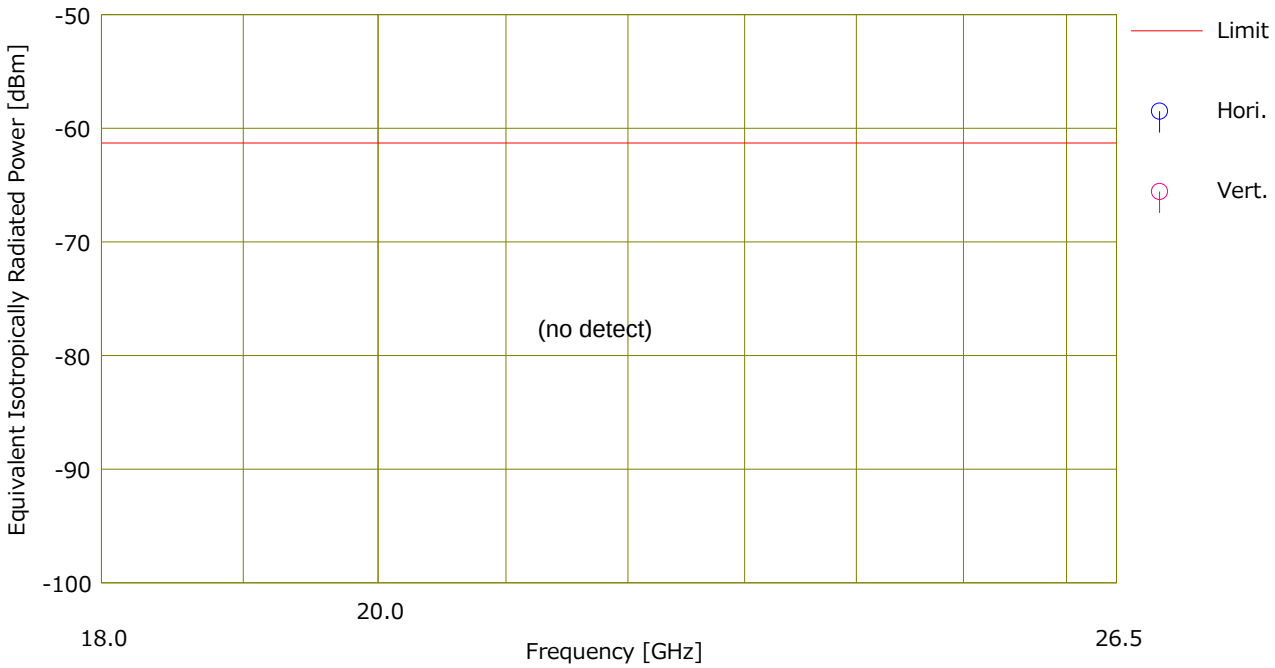


(* except GPS band and carrier emissions)

Radiated emission

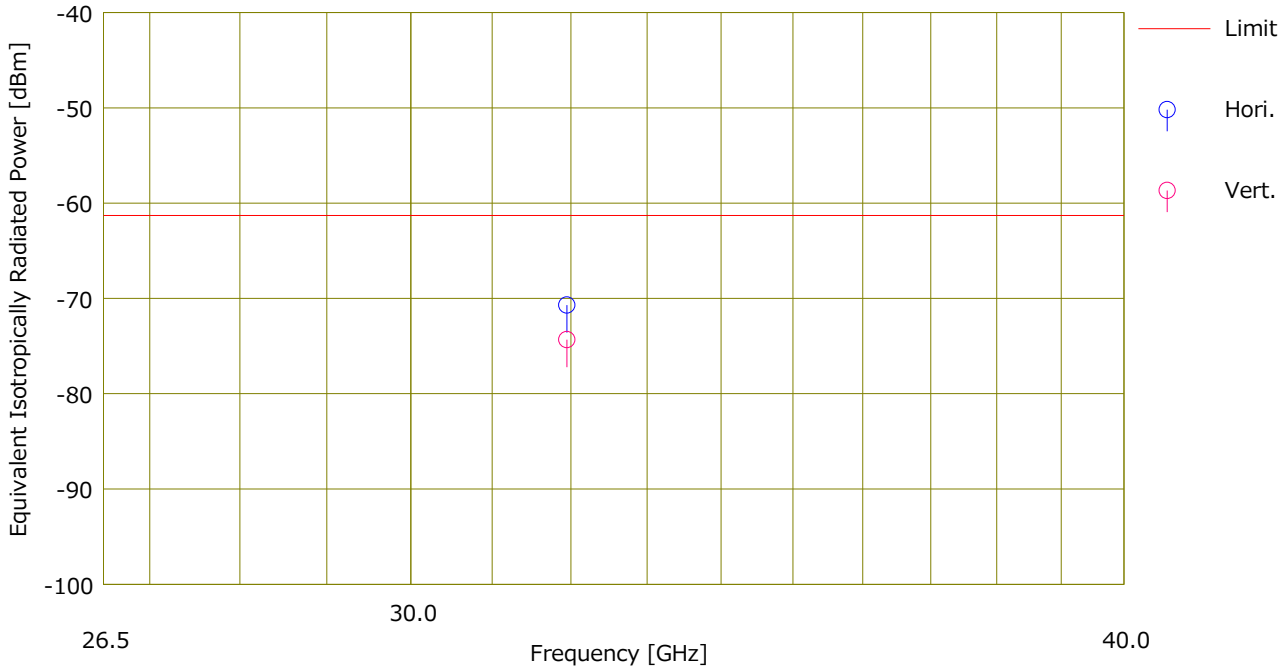
Test place	Shonan EMC Lab.	
Semi Anechoic Chamber	SAC 3	SAC 3
Date	October 18, 2024	October 13, 2024
Temperature / Humidity	23 deg. C / 45 % RH	25 deg. C / 40 % RH
Engineer	Hiromasa Sato (10.6 GHz - 18 GHz)	Yuta Shiba (18 GHz – 26.5 GHz)
Mode	Transmitting ch9	





Radiated emission

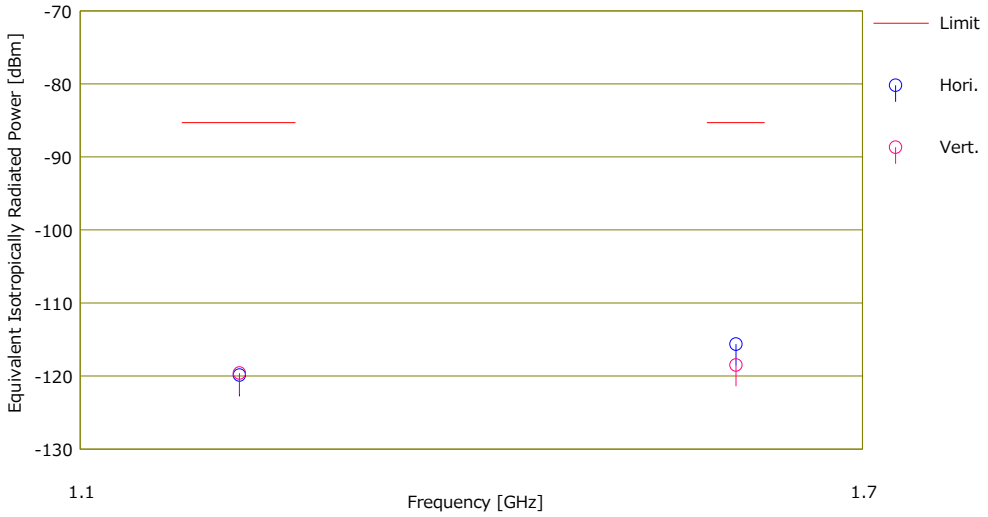
Test place	Shonan EMC Lab.
Semi Anechoic Chamber	SAC 3
Date	October 12, 2024
Temperature / Humidity	24 deg. C / 41 % RH
Engineer	Yosuke Murakami
	(26.5 GHz - 40 GHz)
Mode	Transmitting ch9



Radiated emission (GPS band)

Test place	Shonan EMC Lab. SAC 3
Date	October 13, 2024
Temperature / Humidity	25 deg. C / 40 % RH
Engineer	Yuta Shiba
Mode	Transmitting ch9

(GPS bands emission)



No.	Freq.	Reading (PK)	SG Level	TX Ant.Gain	TX Loss	EIRP Result	EIRP Limit	Margin	Pola.	Height	Angle	TX Ant.Type	Comment
	[MHz]	[dBuV]	[dBm]	[dBi]	[dB]	[dBm]	[dBm]	[dB]		[cm]	[deg]		
1	1202.000	15.68	-122.61	7.00	4.27	-119.88	-85.30	34.5	Hori.	150	0	Horn	RMS, RBW 1 kHz, Floor noise
2	1584.500	15.02	-119.99	9.29	4.94	-115.64	-85.30	30.3	Hori.	150	0	Horn	RMS, RBW 1 kHz, Floor noise
3	1202.000	15.30	-122.33	7.00	4.27	-119.60	-85.30	34.3	Vert.	150	0	Horn	RMS, RBW 1 kHz, Floor noise
4	1584.500	14.80	-122.85	9.29	4.94	-118.50	-85.30	33.2	Vert.	150	0	Horn	RMS, RBW 1 kHz, Floor noise

Calculation:Result [dBm] = SG level [dBm] + Tx Ant Gain [dBi] - Tx Loss (Cable)[dB]
Tx Antenna: Horn(1 GHz-40 GHz) / Rx-Antenna: Horn(1 GHz-40 GHz)

Peak level of the emission

Test place	Shonan EMC Lab. SAC 3
Date	October 26, 2024
Temperature / Humidity	25 deg. C / 44 % RH
Engineer	Shiro Kobayashi
Mode	Transmitting ch9

(Peak level of the emission)

(*SA: Spectrum analyzer, SG: Signal generator, Ant.: substitution antenna)

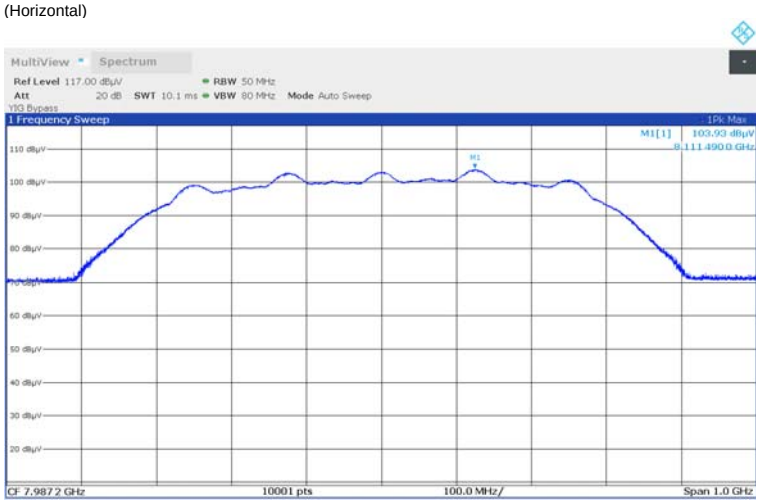
Band	Pol.	Frequency [MHz]	SA Reading [dBuV/50 MHz]	SG level [dBm]	Tx Ant.Gain [dBi]	Tx Loss [dB]	RBW converted factor [dB]	EIRP Result [dBm/50 MHz]	EIRP Limit [dBm/50 MHz]	Margin [dB]	Remarks	Height [cm]	Angle [deg.]
3.1 GHz - 10.6 GHz	Hor.	8111.090	103.93	-5.85	12.85	11.43	0.14	-4.29	0.00	4.29	carrier	150	86
3.1 GHz - 10.6 GHz	Ver.	8109.890	103.52	-6.39	12.85	11.43	0.14	-4.83	0.00	4.83	carrier	150	141

Sample Calculation :

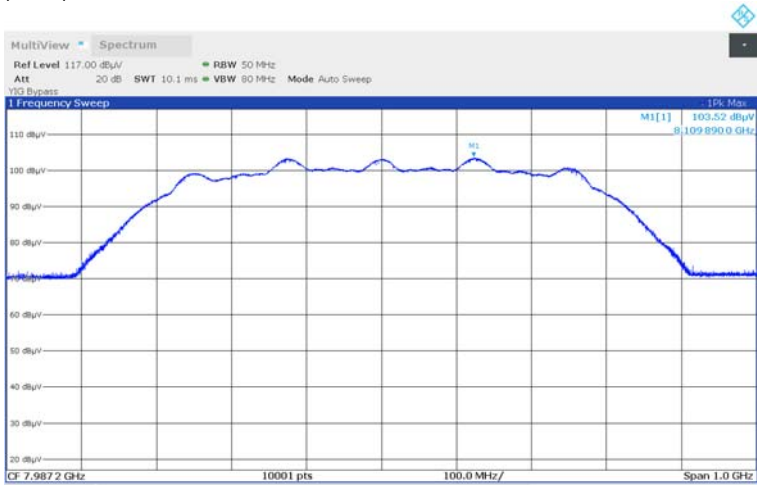
EIRP Result [dBm/MHz] = SG level [dBm] + Tx Ant.Gain [dBi] - Tx Loss [dB] + RBW converted factor [dB]

RBW converted factor [dB] = 20 x log (50 / (3 dB measured bandwidth = 49.1784 [MHz]))

(Horizontal)



(Vertical)



UWB Bandwidth

Test place	Shonan EMC Lab. SAC 3
Date	October 26, 2024
Temperature / Humidity	25 deg. C / 44 % RH
Engineer	Shiro Kobayashi
Mode	Transmitting ch9

10 dB Bandwidth: 580.440 MHz (Limit: >= 500 MHz)

Center Frequency 7992.350 MHz (= (fH + fL) / 2)

(worst: Horizontal)

Start Frequency:	7487.200	**MHz**	**f L:**	7702.130	**MHz**
Stop Frequency:	8487.200	**MHz**	**f H:**	8282.570	**MHz**

UWB Bandwidth

Test place	Shonan EMC Lab. SAC 3
Date	October 26, 2024
Temperature / Humidity	25 deg. C / 44 % RH
Engineer	Shiro Kobayashi
Mode	Transmitting ch9

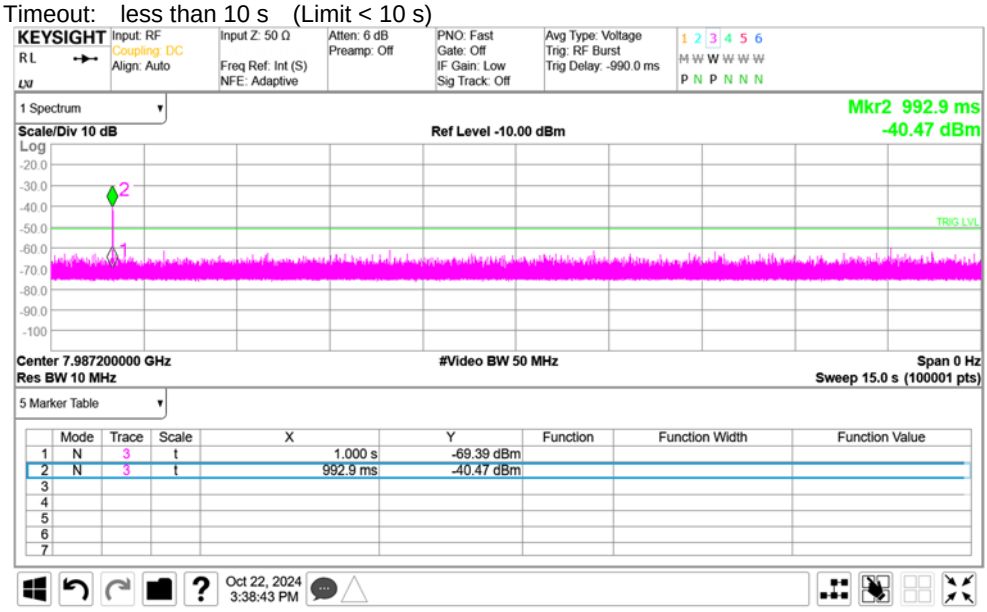
99 % Occupied Bandwidth: 619.794 MHz

(worst: Vertical)

Transmitter timeout

Test place	Shonan EMC Lab. No.3 Shielded Room
Date	October 22, 2024
Temperature / Humidity	25 deg. C / 31 % RH
Engineer	Kenichi Adachi
Mode	Normal Transmitting ch9

Transmitter Timeout: less than 10 s (Limit < 10 s)



* The marker1 was timing point was the companion device power off.

APPENDIX 2: Test instruments

Test Instruments [1/2]

Test Item	LIMS ID	Description	Manufacturer	Model	Serial	Last Calibration Date	Cal Int
RE	144975	Coaxial Cable&RF Selector	Fujikura/Fujikura/Suhner/Suhner/Suhner/TOYO	8D2W/12DSFA/141PE/141PE/141PE/141PE/NS4906	-/0901-270(RF Selector)	2024/04/10	12
RE	144976	Coaxial Cable&RF Selector	Fujikura/Fujikura/Suhner/Suhner/Suhner/TOYO	8D2W/12DSFA/141PE/141PE/141PE/141PE/NS4906	-/0901-270(RF Selector)	2024/04/10	12
RE	145004	Pre Amplifier	SONOMA	310N	290212	2024/02/13	12
RE	145005	Pre Amplifier	Toyo Corporation	TPA0118-36	2046104	2024/02/16	12
RE	145007	Pre Amplifier	Toyo Corporation	HAP18-26W	19	2024/08/21	12
RE	145022	Biconical Antenna	Schwarzbeck Mess-Elektronik OHG	BBA9106	91032665	2024/04/10	12
RE	145129	Pre Amplifier	Toyo Corporation	HAP26-40W	B3208602403-176	2024/05/09	12
RE	145176	Coaxial Cable	Suhner	SUCOFLEX 102	32703/2	2024/08/21	12
RE	145384	Horn Antenna	Schwarzbeck Mess-Elektronik OHG	BBHA9120D	9120D-726	2024/03/11	12
RE	145501	Horn Antenna	Schwarzbeck Mess-Elektronik OHG	BBHA9120D	9120D-739	2024/03/20	12
RE	145512	Horn Antenna	ETS-Lindgren	3160-09	00094868	2024/06/20	12
RE	145514	Horn Antenna	ETS-Lindgren	3160-10	00092383	2024/06/20	12
RE	145515	Horn Antenna	ETS-Lindgren (Cedar Park, Texas)	3116	108256	2024/05/13	12
RE	145536	Loop Antenna	Rohde & Schwarz	HFH2-Z2	100218	2024/04/10	12
RE	145563	Semi-Anechoic Chamber	TDK	SAEC-02(NSA)	2	2024/03/22	12
RE	145565	Semi-Anechoic Chamber	TDK	SAEC-03(NSA)	3	2024/04/03	12
RE	145568	Semi Anechoic Chamber(ME)	TDK	Semi Anechoic Chamber 3m/10m	1, 2, 3	2022/12/24	24
RE	145793	Digital Hitester	HIOKI E.E. CORPORATION	3805-50	80997819	2024/05/29	12
RE	146210	Digital Hitester	HIOKI E.E. CORPORATION	3805-50	80997823	2024/09/24	12
RE	146226	Signal Generator	Keysight Technologies Inc	E8257D-540	MY48051404	2024/01/10	12
RE	146432	Tape Measure	TAJIMA	GL19-55	-	-	-
RE	150463	Test Receiver	Rohde & Schwarz	ESW44	101581	2024/08/06	12
RE	150921	Attenuator	JFW	50HF-003N	-	2024/02/13	12
RE	156380	Coaxial Cable	Huber+Suhner	SUCOFLEX_104_E	SN MY 13406/4E	2024/05/09	12
RE	167095	Attenuator	JFW	50HF-006N	-	2024/02/13	12
RE	167096	Attenuator	JFW	50HF-006N	-	2024/02/13	12
RE	170932	EMI Software	TSJ (Techno Science Japan)	TEPTO-DV3(RE,CE,ME,PE)	Ver 3.1.0546	-	-
RE	179540	Coaxial Cable	Huber+Suhner	SUCOFLEX 102	802815/2	2024/03/05	12
RE	191840	Thermo-Hygrometer	CUSTOM. Inc	CTH-201	-	2024/08/12	12
RE	194601	Coaxial Cable	Fjikura	5D-2W	-	2023/12/08	12
RE	194683	Horn Antenna	Schwarzbeck Mess-Elektronik OHG	BBHA 9120 C	694	2024/03/04	12
RE	194685	Horn Antenna	Schwarzbeck Mess-Elektronik OHG	BBHA 9120 C	711	2024/03/20	12
RE	196937	Coaxial Cable	Huber+Suhner	SUCOFLEX 102	803605/2	2024/03/07	12
RE	196945	Coaxial Cable	Huber+Suhner	SUCOFLEX 102	803414/2	2024/03/12	12
RE	200010	Coaxial Cable	Huber+Suhner	SUCOFLEX 104	575618/4	2024/06/05	12
RE	207277	Tape Measure	ASKUL	-	-	-	-
RE	213530	Test Receiver	Rohde & Schwarz	ESW44	103068	2024/02/22	12
RE	221966	Coaxial Cable	Huber+Suhner	SUCOFLEX 102	2000703/2	2024/06/05	12
RE	236410	Spectrum Analyzer	Keysight Technologies Inc	N9030B	MY63050151	2024/04/26	12

Test Instruments [2/2]

Test Item	LIMS ID	Description	Manufacturer	Model	Serial	Last Calibration Date	Cal Int
RE	236418	Logperiodic Antenna	Schwarzbeck Mess-Elektronik OHG	VULP 9118 B	00975	2024/07/03	12
RE	243214	Coaxial Cable	Hayashi-Repic co., Ltd.	SMS13-13A26-NMS13-9.0m	49306-01-02	2024/06/12	12
RE	243217	Coaxial Cable	Hayashi-Repic co., Ltd.	SMS13-13A26-NMS13-9.0m	49306-01-04	2023/12/20	12
RE	253422	Spectrum Analyzer	Rohde & Schwarz	FSW43	101849	2024/10/21	12

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

***Hyphens for Last Calibration Date, Calibration Due 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.
All equipment is calibrated with valid calibrations. Each measurement data is traceable to the national or international standards.

As for some calibrations performed after the tested dates, those test equipment have been controlled by means of an unbroken chains of calibrations.

Test item: RE: Radiated Emission test