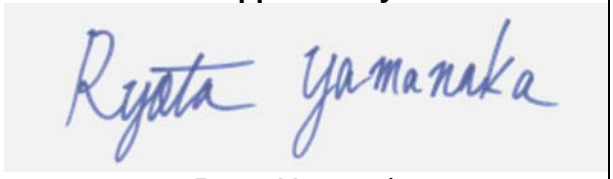
RADIO TEST REPORT

Test Report No. 14689576H-A-R1

Customer	**Dartslive International Ltd.**
Description of EUT	**DARTSLIVE3**
Model Number of EUT	**DL3-0000**
FCC ID	**2ARUU-DL30000**
Test Regulation	**FCC Part 15 Subpart C**
Test Result	**Complied**
Issue Date	**June 15, 2023**
Remarks	**-**

Representative test engineer	Approved by
	
Yuichiro Yamazaki Engineer	Ryota Yamanaka Engineer

CERTIFICATE 5107.02

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

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- The information provided from the customer for this report is identified in Section 1.
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REVISION HISTORY

Original Test Report No. 14689576H-A

This report is a revised version of 14689576H-A. 14689576H-A is replaced with this report.

Revision	Test Report No.	Date	Page Revised Contents
- (Original)	14689576H-A	June 1, 2023	-
1	14689576H-A-R1	June 15, 2023	Correction of the dimensions of the receiving antenna in SECTION 6 (page 17) From 0.035 m to 0.020 m

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	Dartslive International Ltd.
Address	12/F, Linkchart Centre, 2 Tai Yip Street, Kwun Tong, Kowloon, Hong Kong
Telephone Number	+852-3568-6302
Contact Person	Kengo Tsoi

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	DARTSLIVE3
Model Number	DL3-0000
Serial Number	Refer to SECTION 4.2
Condition	Production prototype (Not for Sale: This sample is equivalent to mass-produced items.)
Modification	No Modification by the test lab
Receipt Date	April 25, 2023
Test Date	April 26 to May 14, 2023

2.2 Product Description

General Specification

Rating	AC 100 V to 240 V, 2.3 A, 50 / 60 Hz
Operating temperature	5 deg. C to 30 deg. C

Radio Specification

[24 GHz Sensor]

Radio Type	Transceiver
Frequency of Operation	24.075 GHz to 24.175 GHz
Modulation	Unmodulation
Antenna Gain	7.8 dBi (max)
Steerable Antenna	None
Usage location	Fixed use

[RFID] *1)
[Module: DLI-00524-B]

Radio Type	Transceiver
Frequency of Operation	13.56 MHz
Type of Modulation	ASK

[Module: ME-MR23M4-B-SG]

Radio Type	Transceiver
Frequency of Operation	13.56 MHz
Type of Modulation	ASK

*1) This is a FCC certificated module.
Model number: DLI-00524-B (FCC ID: 2ARUU-DLI00524B)
ME-MR23M4-B-SG (FCC ID: UOEME-M23B)

2.3 Variant model(s)

Tested model: DL3-0000 has a variant model: D3E-0000 (Description: DARTSLIVE3 SE).
The difference of these models is follows;

	DL3-0000 (Tested model)	D3E-0000
Cabinet structure	With stainless steel exterior, Caster: 4 pcs	No stainless steel exterior, Caster: 2 pcs
Sound unit	2.1 ch, With Woofer	2.0 ch, No Woofer
LED decorations	With LED decorations, With 2 pcs pwb for 4 slots	No Upper side LEDs (L/R), No Lower door LEDs (L/R), No Lower door LEDs (L/R)
Coin acceptor	DP-2	VN-5 (Lower cost)

SECTION 3: Test specification, procedures & results

3.1 Test Specification

Test Specification	FCC Part 15 Subpart C The latest version on the first day of the testing period
Title	CC 47CFR Part15 Radio Frequency Device Subpart C Intentional Radiators Section 15.245 Operation within the bands 902 - 928MHz, 2435 - 2465MHz, 5785 - 5815MHz, 10500 - 10550MHz, and 24075 - 24175MHz. Remarks: The full port test filled all available ports was performed at the FCC part 15B. (Verification)

*Also the EUT complies with FCC Part 15 Subpart B.

3.2 Procedures and results

No.	Item	Test Procedure	Specification	Worst margin	Results	Remarks
1	Conducted Emission	ANSI C63.10-2013 6. Standard test methods	Section 15.207(a)	5.92 dB, 2.86833 MHz, AV, Phase N	Complied	-
2	Electric Field Strength of Fundamental Emission	ANSI C63.10-2013 6. Standard test methods	Section 15.245(b)	23.1 dB 24113.3 MHz Vertivcal, AV	Complied	Radiated
3	Electric Field Strength of Spurious Emission	ANSI C63.10-2013 6. Standard test methods 9. Procedures for testing millimeter-wave systems	Section 15.205 Section 15.209 Section 15.245(b)	0.9 dB 96462.6 MHz Horizontal / Vertical, AV	Complied	Radiated
4	-20dB Bandwidth	ANSI C63.4:2009 13. Measurement of intentional radiators	Section 15.215(c)	-	Complied	Radiated
*Note: UL Japan, Inc.'s EMI Work Procedures: Work Instructions-ULID-003591 and Work Instructions-ULID-003593.						

FCC Part 15.31 (e)

This EUT provides the stable voltage constantly to RF part 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 Band Width	RSS-Gen 4.6.1	RSS-Gen 4.6.1	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.

Conducted emission

Using Item	Frequency range	Uncertainty (+/-)
AMN (LISN)	0.009 MHz to 0.15 MHz	3.7 dB
	0.15 MHz to 30 MHz	3.3 dB

Radiated emission

Measurement distance	Frequency range		Uncertainty (+/-)
3 m	9 kHz to 30 MHz		3.3 dB
10 m			3.1 dB
3 m	30 MHz to 200 MHz	Horizontal	4.8 dB
		Vertical	5.0 dB
	200 MHz to 1000 MHz	Horizontal	5.1 dB
		Vertical	6.2 dB
10 m	30 MHz to 200 MHz	Horizontal	4.8 dB
		Vertical	4.8 dB
	200 MHz to 1000 MHz	Horizontal	4.9 dB
		Vertical	5.0 dB
3 m	1 GHz to 6 GHz	Test Receiver	5.0 dB
		Spectrum analyzer	4.9 dB
	6 GHz to 18 GHz	Test Receiver	5.3 dB
		Spectrum analyzer	5.2 dB
1 m	10 GHz to 26.5 GHz	Spectrum analyzer	5.5 dB
	26.5 GHz to 40 GHz	Spectrum analyzer	5.4 dB
0.5 m	26.5 GHz to 40 GHz	Spectrum analyzer	5.4 dB
10 m	1 GHz to 18 GHz	Test Receiver	5.3 dB
>= 0.5 m	40 GHz to 50 GHz		4.2 dB
>= 0.5 m	50 GHz to 75 GHz		5.9 dB
>= 0.5 m	75 GHz to 110 GHz		5.5 dB

Antenna Terminal test

Test Item	Uncertainty (+/-)
Antenna terminal conducted emission / Power density	2.7 dB

3.5 Test Location

UL Japan, Inc. Ise EMC Lab.
4383-326 Asama-cho, Ise-shi, Mie-ken 516-0021 Japan
Telephone: +81-596-24-8999
*A2LA Certificate Number: 5107.02 / FCC Test Firm Registration Number: 884919
ISED Lab Company Number: 2973C / CAB identifier: JP0002

Test site	Width x Depth x Height (m)	Size of reference ground plane (m) / horizontal conducting plane	Other rooms	Maximum measurement distance
No.1 semi-anechoic chamber	19.2 x 11.2 x 7.7	7.0 x 6.0	No.1 Power source room	10 m
No.2 semi-anechoic chamber	7.5 x 5.8 x 5.2	4.0 x 4.0	-	3 m
No.3 semi-anechoic chamber	12.0 x 8.5 x 5.9	6.8 x 5.75	No.3 Preparation room	3 m
No.3 shielded room	4.0 x 6.0 x 2.7	N/A	-	-
No.4 semi-anechoic chamber	12.0 x 8.5 x 5.9	6.8 x 5.75	No.4 Preparation room	3 m
No.4 shielded room	4.0 x 6.0 x 2.7	N/A	-	-
No.5 semi-anechoic chamber	6.0 x 6.0 x 3.9	6.0 x 6.0	-	-
No.5 measurement room	6.4 x 6.4 x 3.0	6.4 x 6.4	-	-
No.6 shielded room	4.0 x 4.5 x 2.7	4.0 x 4.5	-	-
No.6 measurement room	4.75 x 5.4 x 3.0	4.75 x 4.15	-	-
No.7 shielded room	4.7 x 7.5 x 2.7	4.7 x 7.5	-	-
No.8 measurement room	3.1 x 5.0 x 2.7	3.1 x 5.0	-	-
No.9 measurement room	8.8 x 4.6 x 2.8	2.4 x 2.4	-	-
No.10 shielded room	3.8 x 2.8 x 2.8	3.8 x 2.8	-	-
No.11 measurement room	4.0 x 3.4 x 2.5	N/A	-	-
No.12 measurement room	2.6 x 3.4 x 2.5	N/A	-	-
Large Chamber	16.9 x 22.1 x 10.17	16.9 x 22.1	-	10 m
Small Chamber	5.3 x 6.69 x 3.59	5.3 x 6.69	-	-

* 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

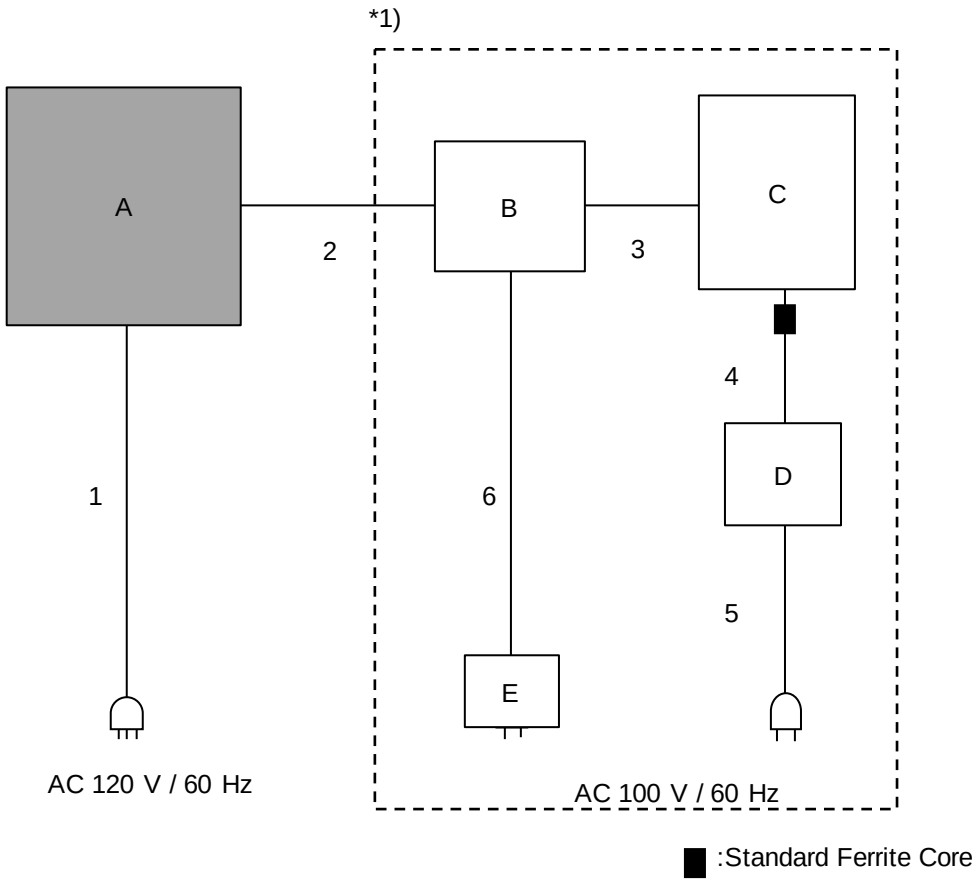
Refer to APPENDIX.

SECTION 4: Operation of EUT during testing

4.1 Operating Modes

Mode	Test Item
1) Full output mode	- Conducted Emission - Radiated Emission (Electric Field Strength of Fundamental Emission and Spurious Emission) - 20 dB Bandwidth, 99 % Occupied Bandwidth - Duty Cycle
The system was configured in typical fashion (as a customer would normally use it) for testing.	
*Power of the EUT was set by the software as follows; Power Setting: 4.8 dBm Software Version No. c8492cd42c540a5efba30c455d3f9bb68dbaa54d Firmware Version; - Speed sensor (=GZV-D01-C2): GZV-D01_A0 Aug 28 2018 - Main I/O board: 1.0.2.0 - Membrane I/O board: 1.0.1.4 - Target sensor, M: 0x0041 - Target sensor, S: 0x0041 (Date: 2023.04 24, Storage location: EUT memory) *This setting of software is the worst case. Any conditions under the normal use do not exceed the condition of setting. In addition, end users cannot change the settings of the output power of the product.	

4.2 Configuration and peripherals



*1) For Radiated Emission test, these items were placed under the reference ground plane.

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

*As a result of comparing AC 120 V and AC 240 V at pre-check, conducted emission test was performed with AC 240 V of the worst voltage as representative.

Description of EUT and Support Equipment

No.	Item	Model number	Serial Number	Manufacturer	Remarks
A	DARTSLIVE3	DL3-0000	WAE212527	Dartslive International Ltd.	EUT
B	HUB	WN-G380R3	BBE262188091	I/O DATA	-
C	PC	NJ5500E	775001638	EPSON DIRECT CORP.	-
D	AC Adapter	ADP-65JH CB	671W11B049X	DELTA ELECTRONICS INC.	-
E	AC Adapter	UC-105-0510	J05-0134309	UNIFIVE	-

List of Cables Used

No.	Name	Length (m)	Shield		Remarks
			Cable	Connector	
1	AC Cable	2.0	Unshielded	Unshielded	-
2	LAN Cable	2.0	Unshielded	Unshielded	-
3	LAN Cable	10.0	Unshielded	Unshielded	-
4	DC Cable	1.8	Unshielded	Unshielded	-
5	AC Cable	0.8	Unshielded	Unshielded	-
6	DC Cable	1.7	Unshielded	Unshielded	-

SECTION 5: Conducted Emission

Test Procedure and conditions

EUT was placed on a carpet for insulation above a reference ground plane.
EUT was set up typical spacing (1.2 m) for the other equipment. EUT was located 80 cm from LISN 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. Each EUT current-carrying power lead, except the ground (safety) lead, was individually connected through the LISN/AMN to the input power source. All unused 50 ohm connectors of the LISN/AMN were resistivity terminated in 50 ohm when not connected to the measuring equipment.

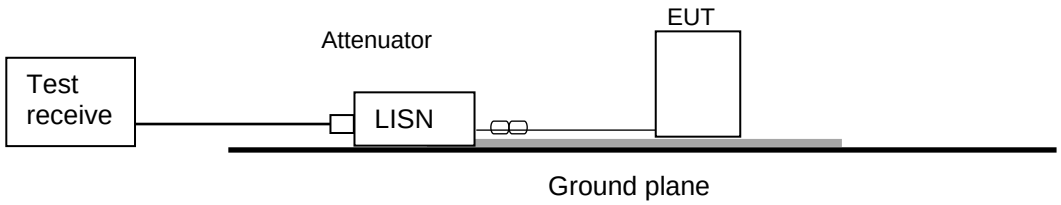
For the tests on EUT with other peripherals (as a whole system)
I/O cable and AC cables that were connected to the peripherals were bundled in center. They were folded back and forth forming a bundle 30 cm to 40 cm long and were hanged at a 40 cm height to the ground plane.

The AC Mains Terminal Continuous disturbance Voltage has been measured with the EUT in a Semi Anechoic Chamber or a Measurement Room.
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 to 30 MHz
Test data : APPENDIX
Test result : Pass

Figure 1: Test Setup



SECTION 6: Radiated emission (Electric Field Strength of Fundamental and Spurious Emission)

Test Procedure and conditions

[For below 30 MHz]
EUT was placed on a carpet for insulation above a reference ground plane. EUT was set up typical spacing for the other equipment.
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., 135 deg and 180 deg.) and horizontal polarization.
*Refer to Figure 3 about Direction of the Loop Antenna.

[For below 1 GHz]
EUT was placed on a carpet for insulation above a reference ground plane. EUT was set up typical spacing for the other equipment.
The Radiated Electric Field Strength has been measured in a Semi Anechoic Chamber with a ground plane.

[For above 1 GHz, up to 40 GHz]
EUT was placed on a carpet for insulation above a reference ground plane. EUT was set up typical spacing for the other equipment.

For 1 GHz to 10 GHz
The Radiated Electric Field Strength has been measured in a Semi Anechoic Chamber with absorbent materials lined on a ground plane.

For 10 GHz to 40 GHz
The Radiated Electric Field Strength has been measured in a Semi Anechoic Chamber with a ground plane.

The height of the measuring antenna varied between 1 m and 4 m (frequency range 9 kHz to 30 MHz: loop antenna was fixed height at 1.0 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 voltage average 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;

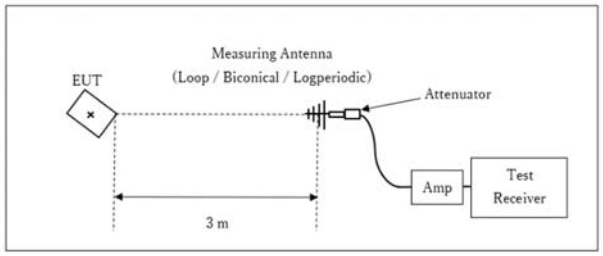
Frequency	Below 30 MHz	30 MHz to 200 MHz	200 MHz to 1 GHz	Above 1 GHz
Antenna Type	Loop	Biconical	Logperiodic	Horn

Frequency	9 kHz to 150 kHz	150 kHz to 30 MHz	30 MHz to 1 GHz	1 GHz to 40 GHz	
Instrument used	Test Receiver	Test Receiver	Test Receiver	Spectrum Analyzer	
Detector	QP, Average *1)	QP, Average *1)	QP	Peak	Average
IF Bandwidth	BW 200 Hz	BW 9 kHz	BW 120 kHz	RBW: 1 MHz VBW: 3 MHz	RBW: 1 MHz VBW: 10 Hz Voltage avg.

*1) Although these tests were performed other than open field test site, adequate comparison measurements were confirmed against 30 m open field test site. Therefore sufficient tests were made to demonstrate that the alternative site produces results that correlate with the ones of tests made in an open field based on KDB 414788.

Figure 2: Test Setup (9 kHz to 40 GHz)

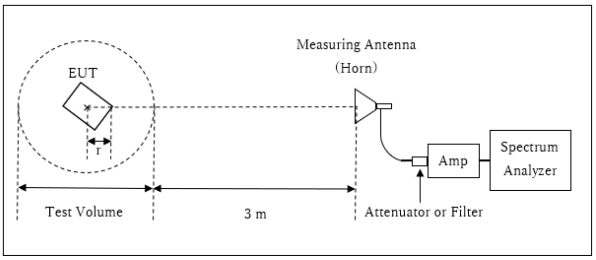
Below 1 GHz



× : Center of turn table

Test Distance: 3 m

1 GHz to 10 GHz

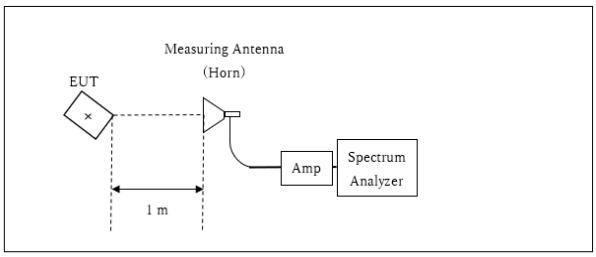


r : Radius of an outer periphery of EUT
× : Center of turn table

Distance Factor: 20 x log (3.60 m*/3.00 m) = 1.6 dB
* Test Distance: (3 + SVSWR Volume /2) - r = 3.60 m

SVSWR Volume: 2 m
(SVSWR Volume has been calibrated based on CISPR 16-1-4.)
r = 0.4 m

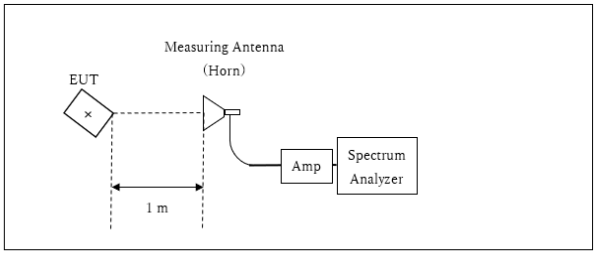
10 GHz to 26.5 GHz



× : Center of turn table

Distance Factor: 20 x log (1.00 m * / 3.00 m) = -9.5 dB
*Test Distance: 1.0 m

26.5 GHz to 40 GHz

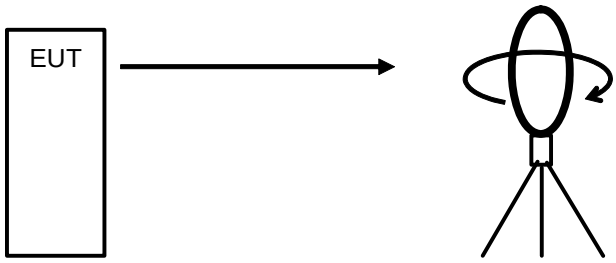


× : Center of turn table

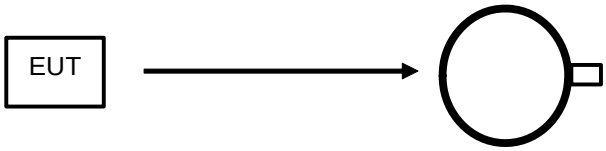
Distance Factor: 20 x log (0.50 * / 3.00 m) = -15.5 dB
*Test Distance: 0.5 m

Figure 3: Direction of the Loop Antenna

Side View (Vertical)

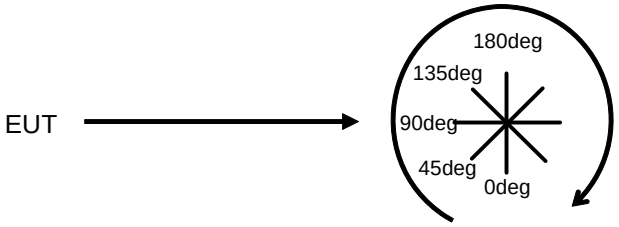


Top View (Horizontal)



Antenna was not rotated.

Top View (Vertical)



Front side: 0 deg.
Forward direction: clockwise

[About fundamental measurement]
The carrier levels were confirmed at maximum direction of transmission. The maximum direction was searched under carefully since beam-widths are narrow.

The carrier levels were measured in the far field. The distance of the far field was calculated from follow equation.

$$r = \frac{2D^2}{\lambda}$$

where

r is the distance from the radiating element of the EUT to the edge of the far field, in m
D is the largest dimension of both the radiating element and the test antenna (horn), in m
(The antenna aperture size of test antenna was used for this caluculation.)
Lambda is the wavelength of the emission under investigation [300 / *f* (MHz) * 10^3], in millimeter

Frequency	Wavelength	Maximum Aperture Dimention			Far Field
		EUT	Test Antenna (MHA-02)	Maximum	Boundary
	Lambda			*D*	*r*
[GHz]	[mm]	[m]	[m]	[m]	[m]
24.175	12.4	0.020	0.038	0.038	0.233

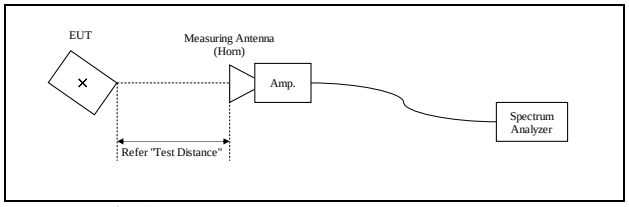
[Above 40 GHz]
The test was performed based on “Procedures for testing millimeter-wave systems” of ANSI C63.10-2013.
EUT was placed on a carpet for insulation above a reference ground plane. EUT was set up typical spacing for the other equipment.

Set spectrum analyzer RBW, VBW, span, etc., to the proper values. Note these values. Enable two traces—one set to “clear write,” and the other set to “max hold.” Begin hand-held measurements with the test antenna (horn) at a distance of 1 m from the EUT in a horizontally polarized position. Slowly adjust its position, entirely covering the plane 1 m from the EUT. Observation of the two active traces on the spectrum analyzer will allow refined horn positioning at the point(s) of maximum field intensity. Repeat with the horn in a vertically polarized position. If the emission cannot be detected at 1 m, reduce the RBW to increase system sensitivity. Note the value. If the emission still cannot be detected, move the horn closer to the EUT, noting the distance at which a measurement is made.

Detector	Peak	Average
IF Bandwidth	RBW: 1 MHz VBW: 3 MHz	RBW: 1 MHz VBW: 10 Hz Voltage avg.

Figure 4: Test Setup (40 GHz to 100 GHz)

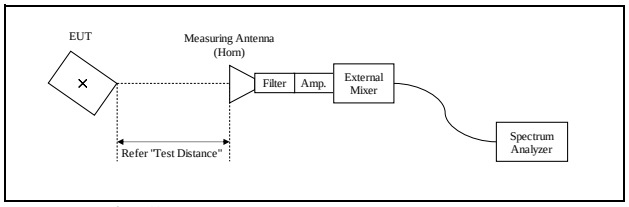
40 GHz to 50 GHz



×: Center of turn table

Distance Factor: 20 x log (0.75 m* / 3.0 m) = -12.0 dB
*Test Distance: 0.75 m

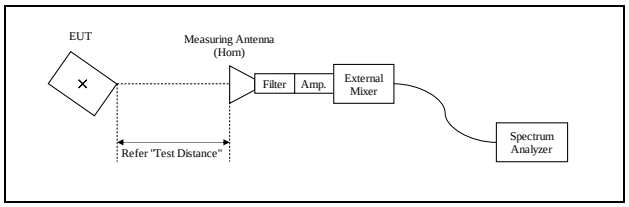
50 GHz to 75 GHz



×: Center of turn table

Distance Factor: 20 x log (0.75 m* / 3.0 m) = -12.0 dB
*Test Distance: 0.75 m

75 GHz to 100 GHz



×: Center of turn table

Distance Factor: 20 x log (0.5 m* / 3.0 m) = -15.5 dB
*Test Distance: 0.5 m

The test was made on EUT at the normal use position.

*The result is rounded off to the second decimal place, so some differences might be observed.

Measurement range : 9 kHz to 100 GHz
Test data : APPENDIX 1
Test result : Pass

SECTION 7: 20 dB Bandwidth, 99 % Occupied Bandwidth and Duty Cycle

Test Procedure

The measurement was performed in the antenna height to gain the maximum of Electric field strength.

Test	Span	RBW	VBW	Sweep	Detector	Trace	Instrument used
20 dB Bandwidth	1 MHz	5.1 kHz 1 % to 5 % of OBW	15 kHz Three times of RBW	Auto	Peak	Max Hold	Spectrum Analyzer
99 % Occupied Bandwidth	1 MHz, Enough width to display emission skirts	5.1 kHz 1 % to 5 % of OBW	15 kHz Three times of RBW	Auto	Peak *1)	Max Hold	Spectrum Analyzer
Duty Cycle	Zero	8 MHz	50 MHz	101 msec	Peak	Single	Spectrum Analyzer
*1) Peak detector was applied as Worst-case measurement.							

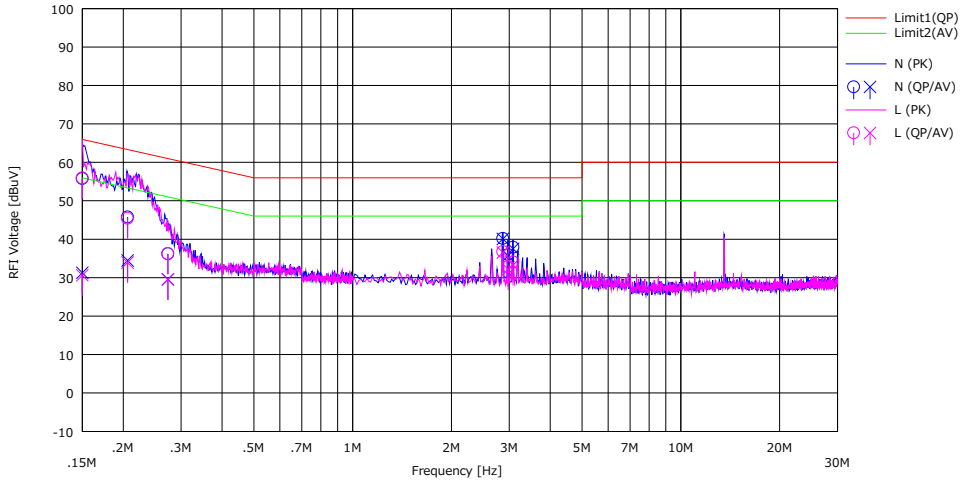
Test data : APPENDIX
Test result : Pass

APPENDIX 1: Test data

Conducted Emission

Test place	Ise EMC Lab.
Semi Anechoic Chamber	No.1
Date	May 14, 2023
Temperature / Humidity	24 deg. C / 50 % RH
Engineer	Takafumi Noguchi
Mode	Mode 1

Limit : FCC_Part 15 Subpart C(15.207)



No.	Freq.	Reading		LISN	LOSS	Results		Limit		Margin		Phase	Comment
		〈QP〉	〈AV〉			〈QP〉	〈AV〉	〈QP〉	〈AV〉	〈QP〉	〈AV〉		
	[MHz]	[dBuV]	[dBuV]	[dB]	[dB]	[dBuV]	[dBuV]	[dBuV]	[dBuV]	[dB]	[dB]		
1	0.15000	42.60	18.10	0.09	13.05	55.74	31.24	66.00	56.00	10.26	24.76	N	
2	0.20629	32.60	21.30	0.09	13.07	45.76	34.46	63.35	53.35	17.59	18.89	N	
3	0.27370	23.00	16.40	0.09	13.08	36.17	29.57	61.00	51.00	24.83	21.43	N	
4	2.86833	26.60	26.50	0.13	13.45	40.18	40.08	56.00	46.00	15.82	5.92	N	
5	2.97483	22.40	22.10	0.13	13.46	35.99	35.69	56.00	46.00	20.01	10.31	N	
6	3.08103	24.30	23.90	0.13	13.47	37.90	37.50	56.00	46.00	18.10	8.50	N	
7	0.15000	42.80	17.50	0.07	13.05	55.92	30.62	66.00	56.00	10.08	25.38	L	
8	0.20611	32.30	20.80	0.06	13.07	45.43	33.93	63.36	53.36	17.93	19.43	L	
9	0.27339	23.10	16.40	0.06	13.08	36.24	29.54	61.01	51.01	24.77	21.47	L	
10	2.86872	23.20	23.00	0.10	13.45	36.75	36.55	56.00	46.00	19.25	9.45	L	
11	2.97493	19.30	18.60	0.10	13.46	32.86	32.16	56.00	46.00	23.14	13.84	L	
12	3.08109	20.50	19.70	0.10	13.47	34.07	33.27	56.00	46.00	21.93	12.73	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.

Radiated Emission (Electric Field Strength of Fundamental and Unwanted Emission)

Test place	Ise EMC Lab.			
Semi Anechoic Chamber	No.4	No.4	No.4	No.4
Date	April 26, 2023	April 27, 2023	April 27, 2023	April 28, 2023
Temperature / Humidity	22 deg. C / 61 % RH	21 deg. C / 46 % RH	21 deg. C / 44 % RH	21 deg. C / 44 % RH
Engineer	Junki Nagatomi (18 GHz to 26.5 GHz)	Junki Nagatomi (26.5 GHz to 40 GHz) (Above 50 GHz)	Yuichiro Yamazaki (1 GHz to 18 GHz) (40 GHz to 50 GHz)	Junki Nagatomi (Below 1 GHz)
Mode	Mode 1			

[18 GHz to 26.5 GHz (Fundamental and Band-edge)]

Polarity [Hori/Vert]	Frequency [MHz]	Reading (QP / PK) [dBuV]	Reading (AV) [dBuV]	Ant. Factor [dB/m]	Loss [dB]	Gain [dB]	Result (QP / PK) [dBuV/m]	Result (AV) [dBuV/m]	Limit (QP / PK) [dBuV/m]	Limit (AV) [dBuV/m]	Margin (QP / PK) [dB]	Margin (AV) [dB]	Remark
Hori.	24000.0	47.8	34.3	40.4	-1.5	33.1	53.6	40.1	73.9	53.9	20.4	13.9	Floor noise
Hori.	24075.0	42.0	34.7	40.4	-1.5	33.1	47.8	40.5	73.9	53.9	26.1	13.5	Floor noise
Hori.	24113.3	87.6	87.6	40.4	-1.5	33.1	93.4	93.4	147.9	127.9	54.5	34.6	
Hori.	24175.0	46.2	34.4	40.4	-1.5	33.1	52.0	40.2	73.9	53.9	21.9	13.7	Floor noise
Hori.	24250.0	46.8	34.3	40.3	-1.5	33.0	52.6	40.2	73.9	53.9	21.3	13.7	Floor noise
Vert.	24000.0	47.7	34.3	40.4	-1.5	33.1	53.5	40.1	73.9	53.9	20.5	13.9	Floor noise
Vert.	24075.0	47.1	34.7	40.4	-1.5	33.1	52.9	40.4	73.9	53.9	21.0	13.5	Floor noise
Vert.	24113.3	99.1	99.0	40.4	-1.5	33.1	104.9	104.8	147.9	127.9	43.0	23.1	
Vert.	24175.0	47.8	34.4	40.4	-1.5	33.1	53.7	40.2	73.9	53.9	20.3	13.7	Floor noise
Vert.	24250.0	46.6	34.3	40.3	-1.5	33.0	52.5	40.2	73.9	53.9	21.4	13.7	Floor noise

Result = Reading + Ant Factor + Loss (Cable + Attenuator + Filter + Mixer (above 50 GHz) + Distance factor (above 1 GHz)) - Gain(Amplifier)

*Other frequency noises omitted in this report were not seen or had enough margin (more than 20 dB).
*QP detector was used up to 1GHz.

Distance factor: 18 GHz to 26.5 GHz 20log (1.00 m / 3.00 m) = -9.5 dB

[Spurious emissions other than above]
Below 1 GHz

Polarity [Hori/Vert]	Frequency [MHz]	Reading (QP / PK) [dBuV]	Reading (AV) [dBuV]	Ant. Factor [dB/m]	Loss [dB]	Gain [dB]	Result (QP / PK) [dBuV/m]	Result (AV) [dBuV/m]	Limit (QP / PK) [dBuV/m]	Limit (AV) [dBuV/m]	Margin (QP / PK) [dB]	Margin (AV) [dB]	Remark
Hori.	36.0	22.5	-	16.4	7.1	32.1	13.9	-	40.0	-	26.1	-	
Hori.	51.2	38.7	-	10.8	7.4	32.1	24.7	-	40.0	-	15.3	-	
Hori.	181.0	32.8	-	16.2	8.6	32.0	25.6	-	43.5	-	17.9	-	
Hori.	182.8	32.8	-	16.2	8.6	32.0	25.6	-	43.5	-	17.9	-	
Hori.	232.5	38.5	-	11.5	9.1	32.0	27.0	-	46.0	-	19.0	-	
Hori.	368.4	29.4	-	15.2	10.0	32.1	22.5	-	46.0	-	23.5	-	
Hori.	554.0	30.2	-	18.0	11.1	32.2	27.1	-	46.0	-	18.9	-	
Hori.	626.2	30.9	-	19.6	11.4	32.3	29.6	-	46.0	-	16.4	-	
Hori.	761.6	24.5	-	20.3	11.8	31.9	24.8	-	46.0	-	21.3	-	
Hori.	952.5	25.8	-	22.2	12.6	30.8	29.7	-	46.0	-	16.3	-	
Vert.	36.0	30.4	-	16.4	7.1	32.1	21.8	-	40.0	-	18.2	-	
Vert.	51.2	34.7	-	10.8	7.4	32.1	20.7	-	40.0	-	19.3	-	
Vert.	181.0	27.3	-	16.2	8.6	32.0	20.1	-	43.5	-	23.4	-	
Vert.	182.7	27.5	-	16.2	8.6	32.0	20.3	-	43.5	-	23.2	-	
Vert.	232.5	39.6	-	11.5	9.1	32.0	28.1	-	46.0	-	17.9	-	
Vert.	368.6	34.0	-	15.2	10.0	32.1	27.1	-	46.0	-	18.9	-	
Vert.	554.0	30.5	-	18.0	11.1	32.2	27.4	-	46.0	-	18.6	-	
Vert.	626.3	28.5	-	19.6	11.4	32.3	27.2	-	46.0	-	18.8	-	
Vert.	761.7	21.8	-	20.3	11.8	31.9	22.0	-	46.0	-	24.0	-	
Vert.	952.8	28.6	-	22.2	12.6	30.8	32.6	-	46.0	-	13.5	-	

Result = Reading + Ant Factor + Loss (Cable + Attenuator + Filter + Mixer (above 50 GHz) + Distance factor (above 1 GHz)) - Gain(Amplifier)

*Other frequency noises omitted in this report were not seen or had enough margin (more than 20 dB).
*QP detector was used up to 1GHz.

Radiated Emission (Electric Field Strength of Fundamental and Unwanted Emission)

Test place	Ise EMC Lab.			
Semi Anechoic Chamber	No.4	No.4	No.4	No.4
Date	April 26, 2023	April 27, 2023	April 27, 2023	April 28, 2023
Temperature / Humidity	22 deg. C / 61 % RH	21 deg. C / 46 % RH	21 deg. C / 44 % RH	21 deg. C / 44 % RH
Engineer	Junki Nagatomi (18 GHz to 26.5 GHz)	Junki Nagatomi (26.5 GHz to 40 GHz) (Above 50 GHz)	Yuichiro Yamazaki (1 GHz to 18 GHz) (40 GHz to 50 GHz)	Junki Nagatomi (Below 1 GHz)
Mode	Mode 1			

Above 1 GHz

Polarity [Hori/Vert]	Frequency [MHz]	Reading (QP / PK) [dBuV]	Reading (AV) [dBuV]	Ant. Factor [dB/m]	Loss [dB]	Gain [dB]	Result (QP / PK) [dBuV/m]	Result (AV) [dBuV/m]	Limit (QP / PK) [dBuV/m]	Limit (AV) [dBuV/m]	Margin (QP / PK) [dB]	Margin (AV) [dB]	Remark
Hori.	1057.7	52.0	49.1	24.3	3.1	34.7	44.7	41.9	73.9	53.9	29.2	12.1	
Hori.	1193.4	55.1	52.8	24.9	3.2	34.4	48.8	46.6	73.9	53.9	25.1	7.3	
Hori.	1220.4	56.0	54.5	25.1	3.2	34.3	50.1	48.5	73.9	53.9	23.8	5.4	
Hori.	1545.9	49.2	45.9	25.0	3.4	33.4	44.2	40.9	73.9	53.9	29.7	13.0	
Hori.	1800.6	50.8	42.8	25.2	3.6	32.8	46.9	38.8	73.9	53.9	27.0	15.1	
Hori.	2078.0	50.5	41.3	26.9	3.8	32.2	49.0	39.8	73.9	53.9	24.9	14.1	
Hori.	2216.1	50.1	39.6	28.2	3.9	32.1	50.0	39.5	73.9	53.9	23.9	14.4	
Hori.	2354.6	49.6	44.2	27.9	3.9	32.0	49.4	44.0	73.9	53.9	24.5	9.9	
Hori.	3462.6	46.1	36.7	28.7	4.4	31.5	47.7	38.4	73.9	53.9	26.2	15.6	
Hori.	5197.2	42.3	33.1	32.1	5.2	31.2	48.4	39.2	73.9	53.9	25.6	14.7	
Hori.	48228.3	56.6	53.1	41.7	-3.9	32.8	61.6	58.1	108.0	88.0	46.3	29.9	
Hori.	72345.0	37.1	23.9	43.1	6.0	21.2	65.0	51.8	108.0	88.0	43.0	36.1	
Hori.	96462.6	53.1	46.6	45.7	-4.4	34.9	59.5	53.0	73.9	53.9	14.4	0.9	
Vert.	1057.7	52.6	49.2	24.3	3.1	34.7	45.4	42.0	73.9	53.9	28.6	12.0	
Vert.	1193.4	53.1	50.7	24.9	3.2	34.4	46.8	44.5	73.9	53.9	27.1	9.5	
Vert.	1220.4	54.2	52.1	25.1	3.2	34.3	48.2	46.2	73.9	53.9	25.7	7.7	
Vert.	1545.9	47.8	44.7	25.0	3.4	33.4	42.8	39.7	73.9	53.9	31.1	14.2	
Vert.	1800.6	55.0	48.6	25.2	3.6	32.8	51.1	44.7	73.9	53.9	22.9	9.2	
Vert.	2078.0	53.1	44.6	26.9	3.8	32.2	51.6	43.1	73.9	53.9	22.3	10.8	
Vert.	2216.1	48.7	37.0	28.2	3.9	32.1	48.6	36.9	73.9	53.9	25.3	17.0	
Vert.	2354.6	49.1	43.1	27.9	3.9	32.0	48.9	42.9	73.9	53.9	25.0	11.0	
Vert.	3462.6	50.0	40.1	28.7	4.4	31.5	51.7	41.7	73.9	53.9	22.3	12.2	
Vert.	5197.2	45.4	34.4	32.1	5.2	31.2	51.5	40.5	73.9	53.9	22.4	13.5	
Vert.	48228.3	54.2	50.7	41.7	-3.9	32.8	59.3	55.7	108.0	88.0	48.7	32.2	
Vert.	72345.0	36.8	23.8	43.1	6.0	21.2	64.7	51.7	108.0	88.0	43.2	36.2	
Vert.	96462.6	53.8	46.6	45.7	-4.4	34.9	60.2	53.0	73.9	53.9	13.7	0.9	

Result = Reading + Ant Factor + Loss (Cable + Attenuator + Filter + Mixer (above 50 GHz) + Distance factor (above 1 GHz)) - Gain(Amplifier)

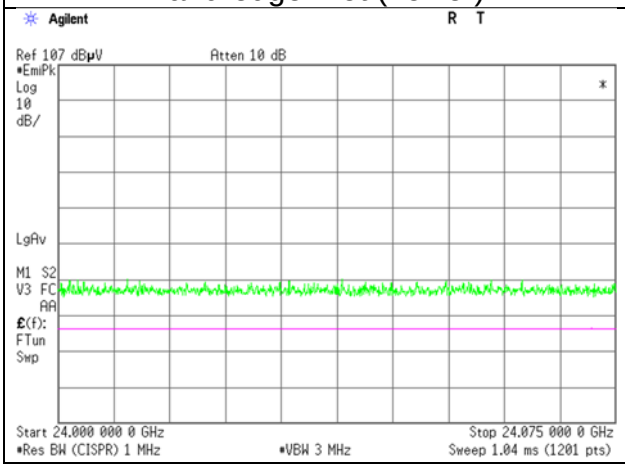
*Other frequency noises omitted in this report were not seen or had enough margin (more than 20 dB).
*QP detector was used up to 1GHz.

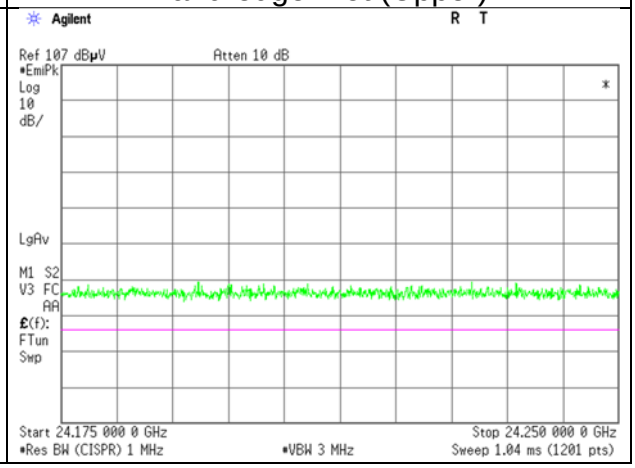
Distance factor:	1 GHz to 10 GHz	20log (3.60 m / 3.00 m) = 1.6 dB
	10 GHz to 18 GHz	20log (1.00 m / 3.00 m) = -9.5 dB
	26.5 GHz to 40 GHz	20log (0.50 m / 3.00 m) = -15.5 dB
	40 GHz to 75 GHz	20log (0.75 m / 3.00 m) = -12.0 dB
	75 GHz to 100 GHz	20log (0.50 m / 3.00 m) = -15.5 dB

Radiated Emission (Electric Field Strength of Fundamental and Unwanted Emission)
(Reference Plot for band-edge)

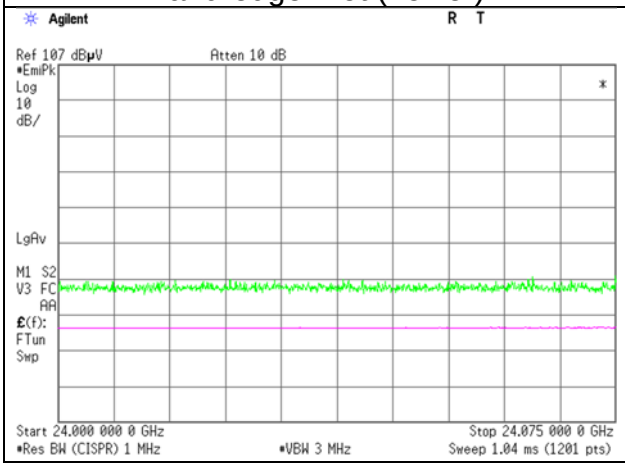
Test place	Ise EMC Lab.
Semi Anechoic Chamber	No.4
Date	April 26, 2023
Temperature / Humidity	22 deg. C / 61% RH
Engineer	Junki Nagatomi
Mode	Mode 1

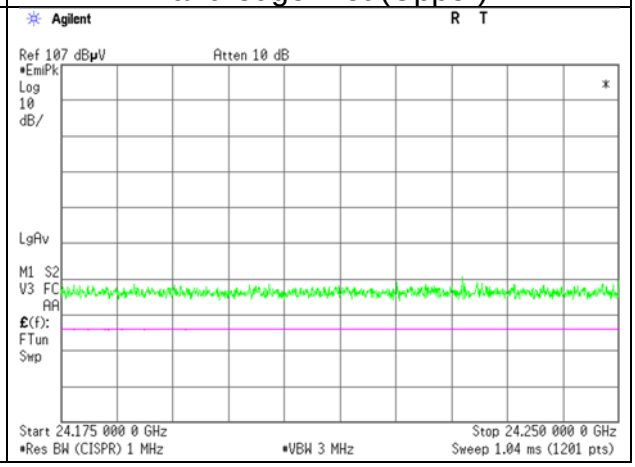
Horizontal	
Band-edge Plot (Lower)	Band-edge Plot (Upper)





Vertical	
Band-edge Plot (Lower)	Band-edge Plot (Upper)

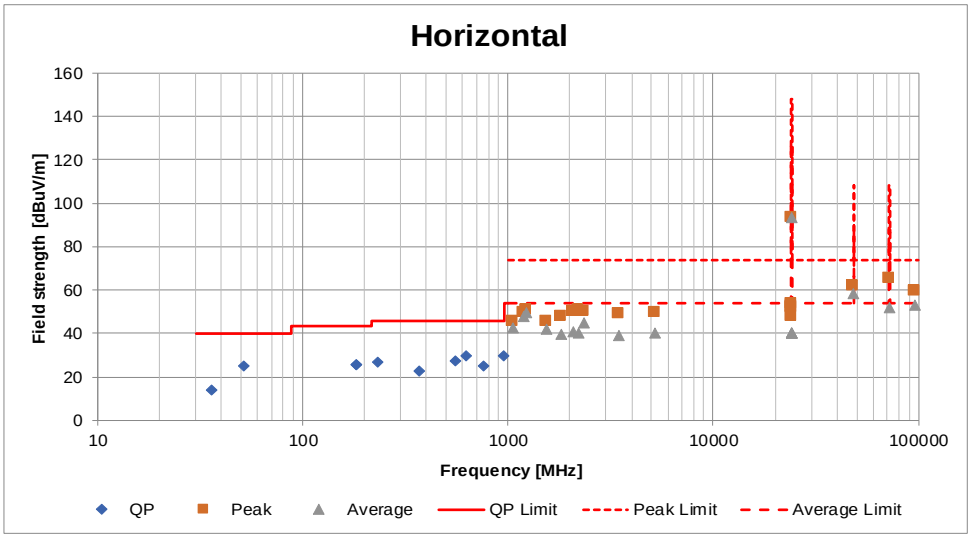


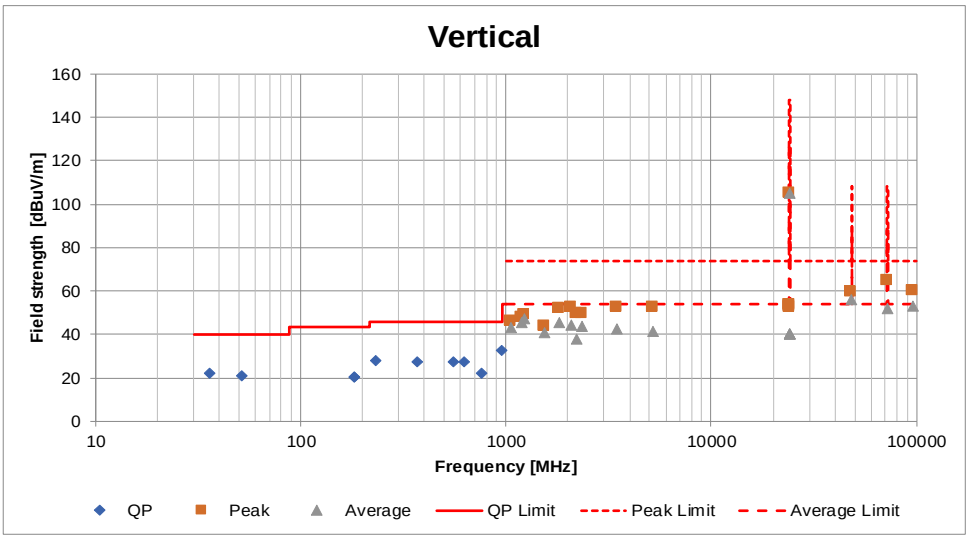


* Final result was shown in tabular data.

Radiated Emission (Electric Field Strength of Fundamental and Spurious Emission)
(Plot data, Worst case)

Test place	Ise EMC Lab.			
Semi Anechoic Chamber	No.4	No.4	No.4	No.4
Date	April 26, 2023	April 27, 2023	April 27, 2023	April 28, 2023
Temperature / Humidity	22 deg. C / 61 % RH	21 deg. C / 46 % RH	21 deg. C / 44 % RH	21 deg. C / 44 % RH
Engineer	Junki Nagatomi (18 GHz to 26.5 GHz)	Junki Nagatomi (26.5 GHz to 40 GHz) (Above 50 GHz)	Yuichiro Yamazaki (1 GHz to 18 GHz) (40 GHz to 50 GHz)	Junki Nagatomi (Below 1 GHz)
Mode	Mode 1			

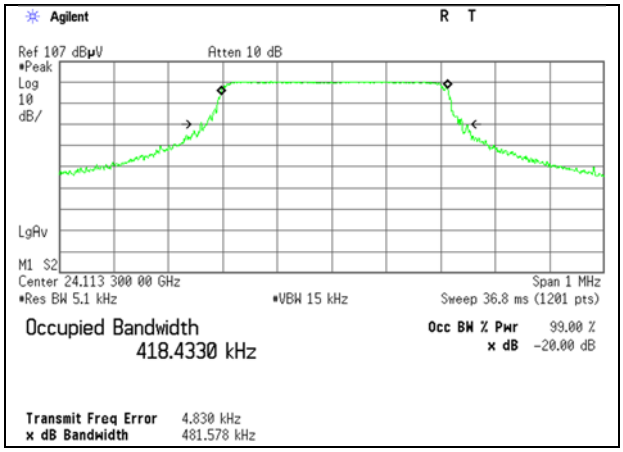




20 dB Bandwidth, 99 % Occupied Bandwidth

Test place	Ise EMC Lab.
Semi Anechoic Chamber	No.4
Date	April 26, 2023
Temperature / Humidity	22 deg. C / 61% RH
Engineer	Junki Nagatomi
Mode	Mode 1

20dB Bandwidth [kHz]	99 % Occupied Bandwidth [kHz]
481.58	418.43

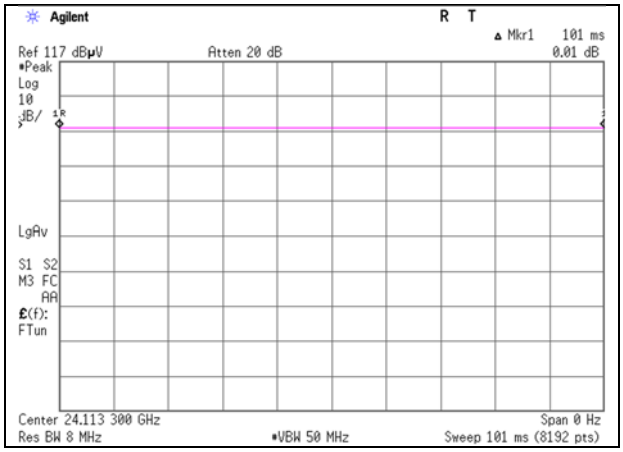


Duty Cycle

Test place	Ise EMC Lab.
Semi Anechoic Chamber	No.4
Date	April 26, 2023
Temperature / Humidity	22 deg. C / 61 % RH
Engineer	Junki Nagatomi
Mode	Mode 1

Tx On time [ms]	Tx On + Off time [ms]	Duty factor [dB]
101.000	101.000	0.00

Duty factor = 20 * log (Tx On time / Tx On + Off time)



APPENDIX 2: Test instruments

Test Equipment (1/2)

Test Item	Local ID	LIMS ID	Description	Manufacturer	Model	Serial	Last Calibration Date	Cal Int
CE	COTS-MEMI-02	178648	EMI measurement program	TSJ (Techno Science Japan)	TEPTO-DV	-	-	-
CE	MAEC-01	141998	AC1_Semi Anechoic Chamber(NSA)	TDK	Semi Anechoic Chamber 10m	DA-06881	06/28/2022	24
CE	MAT-64	141290	Attenuator(13dB)	JFW Industries, Inc.	50FP-013H2 N	-	12/22/2022	12
CE	MCC-03	141215	Coaxial Cable	Fujikura/Suhner/ TSJ	5D-2W/ 3D-2W/RG400u/ RFM-E421(SW)	-/01068(Switcher)	06/11/2022	12
CE	MJM-25	142226	Measure,Tape,Steel	KOMELON	KMC-36	-	-	-
CE	MLS-25	141537	LISN(AMN)	Schwarzbeck Mess-Elektronik OHG	NSLK8127	8127-731	07/25/2022	12
CE	MLS-26	141538	LISN(AMN)	Schwarzbeck Mess-Elektronik OHG	NSLK8127	8127-732	07/25/2022	12
CE	MMM-09	141533	DIGITAL HiTESTER	HIOKI E.E. CORPORATION	3805	51201195	01/18/2023	12
CE	MOS-27	141566	Thermo-Hygrometer	CUSTOM. Inc	CTH-201	A08Q26	01/13/2023	12
CE	MTA-55	141937	Terminator	TME	CT-01BP	-	12/14/2022	12
CE	MTR-09	141950	EMI Test Receiver	Rohde & Schwarz	ESU26	100412	10/11/2022	12
RE	COTS-MEMI-02	178648	EMI measurement program	TSJ (Techno Science Japan)	TEPTO-DV	-	-	-
RE	MAEC-04	142011	AC4_Semi Anechoic Chamber(NSA)	TDK	Semi Anechoic Chamber 3m	DA-10005	05/22/2022	24
RE	MAEC-04-SVSWR	142017	AC4_Semi Anechoic Chamber(SVSWR)	TDK	Semi Anechoic Chamber 3m	DA-10005	04/14/2023	24
RE	MAT-34	141331	Attenuator(6dB)	TME	UFA-01	-	02/01/2023	12
RE	MBA-05	141425	Biconical Antenna	Schwarzbeck Mess-Elektronik OHG	VHA9103+ BBA9106	VHA 91031302	08/26/2022	12
RE	MCC-113	141217	Coaxial cable	Fujikura/Suhner/TSJ	5D-2W/ SFM141/421010/ sucoform141-PE/ RFM-E121(SW)	-/04178	06/11/2022	12
RE	MCC-135	142032	Microwave Cable	Huber+Suhner	SUCOFLEX102	37511/2	09/28/2022	12
RE	MCC-136	142033	Microwave Cable	Huber+Suhner	SUCOFLEX102	37512/2	09/28/2022	12
RE	MCC-178	141227	Microwave Cable	Junkosha	MMX221-00500DMSDMS	1502S305	03/03/2023	12
RE	MCC-220	151897	Microwave Cable	Huber+Suhner	SF101EA/11PC24/ 11PC24/2.5M	SN MY1726/1EA	04/11/2023	12
RE	MCC-224	160324	Coaxial Cable	Huber+Suhner	SUCOFLEX 102A	MY009/2A	10/19/2022	12
RE	MCC-255	207745	Coaxial Cable	UL Japan	-	-	05/17/2022	12
RE	MCC-265	234602	Microwave Cable	Huber+Suhner	SF126E/11PC35/ 11PC35/ 1000M,5000M	537063/126E / 537074/126E	03/16/2023	12
RE	MCC-50	141397	Coaxial Cable	UL Japan	-	-	11/18/2022	12
RE	MHA-02	141503	Horn Antenna 18-26.5GHz	EMCO	3160-09	1265	06/22/2022	12
RE	MHA-21	141508	Horn Antenna 1-18GHz	Schwarzbeck Mess-Elektronik OHG	BBHA9120D	557	05/20/2022	12
RE	MHA-29	141517	Horn Antenna 26.5-40GHz	ETS-Lindgren	3160-10	152399	11/14/2022	12
RE	MHA-31	142041	Horn Antenna	Oshima Prototype Engineering Co.	A16-187	1	09/01/2022	12
RE	MHA-33	180634	Horn Antenna	SAGE Millimeter, Inc.	SAZ-2410-15-S1	17343-01	06/09/2022	12
RE	MHA-35	180544	Horn Antenna	SAGE Millimeter, Inc.	SAZ-2410-10-S1	17343-01	06/27/2022	12
RE	MJM-29	142230	Measure,Tape,Steel	KOMELON	KMC-36	-	-	-
RE	MLA-23	141267	Logperiodic Antenna (200-1000MHz)	Schwarzbeck Mess-Elektronik OHG	VUSLP9111B	9111B-192	09/21/2022	12
RE	MLPA-01	141254	Loop Antenna	Rohde & Schwarz	HFH2-Z2	100017	05/31/2022	12
RE	MMM-10	141545	DIGITAL HiTESTER	HIOKI E.E. CORPORATION	3805	51201148	01/18/2023	12
RE	MMX-01	142047	Preselected Millimeter Mixer	Keysight Technologies Inc	11974V-E01	3001A00412	11/25/2022	12

Test Equipment (2/2)

Test Item	Local ID	LIMS ID	Description	Manufacturer	Model	Serial	Last Calibration Date	Cal Int
RE	MMX-02	142048	Harmonic Mixer	Keysight Technologies Inc	11970W	2521 A01909	10/06/2022	12
RE	MOS-15	141562	Thermo-Hygrometer	CUSTOM. Inc	CTH-201	0010	01/13/2023	12
RE	MPA-12	141581	MicroWave System Amplifier	Keysight Technologies Inc	83017A	00650	10/05/2022	12
RE	MPA-14	141583	Pre Amplifier	SONOMA INSTRUMENT	310	260833	04/05/2023	12
RE	MPA-22	141588	Pre Amplifier	L3 Narda-MITEQ	AMF-6F-2600400-33-8P / AMF-4F-2600400-33-8P	1871355 / 1871328	01/24/2023	12
RE	MPA-23	142055	Power Amplifier	SAGE Millimeter, Inc.	SBP-5037532015-1515-N1	11599-01	03/22/2023	12
RE	MPA-25	159919	Power Amplifier	SAGE Millimeter, Inc.	SBP-4035033018-2F2F-S1	12559-01	06/10/2022	12
RE	MPA-31	180607	Power Amplifier	SAGE Millimeter, Inc.	SBP-7531142515-1010-E1	17343-01	10/07/2022	12
RE	MSA-10	141899	Spectrum Analyzer	Keysight Technologies Inc	E4448A	MY46180655	02/20/2023	12
RE	MTR-10	141951	EMI Test Receiver	Rohde & Schwarz	ESR26	101408	07/25/2022	12

***Hyphens for Last Calibration Date and Cal Int (month) are instruments that Calibration is not required (e.g. software), or instruments checked in advance before use.**

The expiration date of the calibration is the end of the expired month.
As for some calibrations performed after the tested dates, those test equipment have been controlled by means of an unbroken chains of calibrations.

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

Test item:

CE: Conducted Emission
RE: Radiated Emission