





EMI TEST REPORT

Test Report No. 14839031H-D-R2

Customer	DENSO CORPORATION
Description of EUT	Cockpit Control Unit
Model Number of EUT	DNNS137
FCC ID	HYQDNNS137
Test Regulation	FCC Part 15 Subpart B, Class B
Test Result	Complied
Issue Date	June 24, 2024
Remarks	-

Representative test engineer	Approved by
	
Ken Fujita Engineer	Ryota Yamanaka Engineer
 	
CERTIFICATE 5107.02	
<input type="checkbox"/> The testing in which "Non-accreditation" is displayed is outside the accreditation scopes in UL Japan, Inc. <input checked="" type="checkbox"/> There is no testing item of "Non-accreditation".	

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REVISION HISTORY

Original Test Report No. 14839031H-D

This report is a revised version of 14839031H-D-R1. 14839031H-D-R1 is replaced with this report.

Revision	Test Report No.	Date	Page Revised Contents
- (Original)	14839031H-D	April 23, 2024	-
1	14839031H-D-R1	June 4, 2024	Correction of the following items in Radio Specification for Clause 2.2; - Antenna gain for WLAN - FM frequency for Broadcast
1	14839031H-D-R1	June 4, 2024	Addition of the Test Setup diagram for 10 GHz to 40 GHz in Figure 1 of SECTION 5.
1	14839031H-D-R1	June 4, 2024	Correction of the frequency (Mode 1 Local) for Radiated Emission test in APPENDIX 1; from 87.7 MHz to 87.75 MHz
1	14839031H-D-R1	June 4, 2024	Addition of the following sentence in Radiated Emission (Above 1 GHz) test data; “* No signal was detected above 10 GHz.”
2	14839031H-D-R2	June 24, 2024	Correction of the RBDS frequency for Broadcast in Radio Specification for Clause 2.2

Reference: Abbreviations (Including words undescribed in this report)

A2LA	The American Association for Laboratory Accreditation	Hori.	Horizontal
AAN	Asymmetric Artificial Network	ICES	Interference-Causing Equipment Standard
AC	Alternating Current	I/O	Input/Output
AE	Auxiliary equipment	IEC	International Electrotechnical Commission
AM	Amplitude Modulation	IEEE	Institute of Electrical and Electronics Engineers
AMN	Artificial Mains Network	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	ISN	Impedance Stabilization Network
AP	Access Point	ISO	International Organization for Standardization
ASK	Amplitude Shift Keying	JAB	Japan Accreditation Board
Atten., ATT	Attenuator	LAN	Local Area Network
AV	Average	LCL	Longitudinal Conversion Loss
BPSK	Binary Phase-Shift Keying	LIMS	Laboratory Information Management System
BR	Bluetooth Basic Rate	LISN	Line Impedance Stabilization Network
BT	Bluetooth	MRA	Mutual Recognition Arrangement
BT LE	Bluetooth Low Energy	N/A	Not Applicable
BW	BandWidth	NIST	National Institute of Standards and Technology
C.F	Correction Factor	NS	No signal detect.
Cal Int	Calibration Interval	NSA	Normalized Site Attenuation
CAV	CISPR AV	OBW	Occupied BandWidth
CCK	Complementary Code Keying	OFDM	Orthogonal Frequency Division Multiplexing
CDN	Coupling Decoupling Network	PER	Packet Error Rate
Ch., CH	Channel	PK	Peak
CISPR	Comite International Special des Perturbations Radioelectriques	P _{LT}	long-term flicker severity
Corr.	Correction	POHC(A)	Partial Odd Harmonic Current
CPE	Customer premise equipment	Pol., Pola.	Polarization
CW	Continuous Wave	PR-ASK	Phase Reversal ASK
DBPSK	Differential BPSK	P _{ST}	short-term flicker severity
DC	Direct Current	QAM	Quadrature Amplitude Modulation
DET	Detector	QP	Quasi-Peak
D-factor, D.fac.	Distance factor	QPSK	Quadrature Phase Shift Keying
Dmax	maximum absolute voltage change during an observation period	r.m.s., RMS	Root Mean Square
DQPSK	Differential QPSK	RBW	Resolution BandWidth
DSSS	Direct Sequence Spread Spectrum	RE	Radio Equipment
DUT	Device Under Test	REV	Reverse
EDR	Enhanced Data Rate	RF	Radio Frequency
e.i.r.p., EIRP	Equivalent Isotropically Radiated Power	RFID	Radio Frequency Identifier
EM clamp	Electromagnetic clamp	RNSS	Radio Navigation Satellite Service
EMC	ElectroMagnetic Compatibility	RSS	Radio Standards Specifications
EMI	ElectroMagnetic Interference	Rx	Receiving
EMS	ElectroMagnetic Susceptibility	S.fac.	Site factor
EN	European Norm	SINAD	Ratio of (Signal + Noise + Distortion) to (Noise + Distortion)
e.r.p., ERP	Effective Radiated Power	S/N	Signal to Noise ratio
ETSI	European Telecommunications Standards Institute	SA, S/A	Spectrum Analyzer
EU	European Union	SABS	South African Bureau of Standards
EUT	Equipment Under Test	SANS	South African National Standards
Fac.	Factor	SG	Signal Generator
FCC	Federal Communications Commission	SVSWR	Site-Voltage Standing Wave Ratio
FHSS	Frequency Hopping Spread Spectrum	THC(A)	Total Harmonic Current
FM	Frequency Modulation	THD(%)	Total Harmonic Distortion
Freq.	Frequency	TR, T/R	Test Receiver
FSK	Frequency Shift Keying	Tx	Transmitting
Fund	Fundamental	UFA	Uniform field area
FWD	Forward	VBW	Video BandWidth
GFSK	Gaussian Frequency-Shift Keying	Vert.	Vertical
GNSS	Global Navigation Satellite System	WLAN	Wireless LAN
GPS	Global Positioning System	xDSL	Generic term for all types of DSL technology (DSL: Digital Subscriber Line)

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SECTION 1: Customer information

Company Name	DENSO CORPORATION
Address	1-1, Showa-cho, Kariya-shi, Aichi-ken, 448-8661, Japan
Telephone Number	+81-566-26-5879
Contact Person	Takehiro Abeta

The information provided by the customer is as follows;

- Customer, Description of EUT, Model Number of EUT on the cover and other relevant pages
- Operating/Test Mode(s) (Mode(s)) on all the relevant pages
- SECTION 1: Customer Information
- SECTION 2: Equipment Under Test (EUT) other than the Receipt Date and Test Date
- SECTION 4: Operation of EUT during testing

SECTION 2: Equipment under test (EUT)

2.1 Identification of EUT

Description	Cockpit Control Unit
Model Number	DNNS137
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	March 14, 2024
Test Date	March 31 to April 4, 2024

2.2 Product Description

General Specification

Rating	DC 13.2 V VDD DC 1.8 V, 3.3 V, 2.2 V
Clock frequency (ies) in the system	9.6 GHz

Radio Specification

WLAN (IEEE802.11b/11g/11n-20/n-40)

Equipment Type	Transceiver	
Frequency of Operation	20 MHz Band: 2412 MHz to 2462 MHz 40 MHz Band: 2432 MHz to 2452 MHz	
Type of Modulation	DSSS (CCK, DQPSK, DBPSK) OFDM (64QAM, 16QAM, QPSK, BPSK, 256QAM)	
Antenna Type	Inverted F Antenna	
Antenna Gain	Antenna 0:	0.71 dBi (Peak) (for Right)
	Antenna 1:	2.19 dBi (Peak) (for Left)

Bluetooth (BR / EDR)

Equipment Type	Transceiver	
Frequency of Operation	2402 MHz to 2480 MHz	
Type of Modulation	FHSS (GFSK, $\pi/4$ DQPSK, 8 DPSK)	
Antenna Type	Inverted F Antenna	
Antenna Gain	0.71 dBi (Peak) (for Right)	

WLAN (IEEE802.11a/11n-20/11ac-20/11n-40/11ac-40/11ac-80)

Equipment Type	Transceiver	
Frequency of Operation	20 MHz Band	5180 MHz to 5240 MHz 5745 MHz to 5825 MHz
	40 MHz Band	5190 MHz to 5230 MHz 5755 MHz to 5795 MHz
	80 MHz Band	5210 MHz 5775 MHz
Type of Modulation	OFDM (64QAM, 16QAM, QPSK, BPSK, 256QAM)	
Antenna Type	Inverted F Antenna	
Antenna Gain	Antenna 0:	1.66 dBi (Peak) (for Right)
	Antenna 1:	4.04 dBi (Peak) (for Left)

GNSS

Equipment Type	Receiver	
Frequency of Operation	GPS: 1575.42MHz GLONASS: 1598.0625 MHz to 1605.375 MHz	
Type of Modulation	BPSK	

Broadcast

Equipment Type	Receiver	
Frequency of Operation	AM: 522 kHz to 1710 kHz FM: 87.75 MHz to 107.9 MHz RBDS: 87.75 MHz to 107.9 MHz XM: 2333.465 MHz to 2344.045 MHz	

SECTION 3: Test specification, procedures & results

3.1 Test Specification

Test Specification	FCC Part 15 Subpart B The latest version on the first day of the testing period
Title	FCC 47CFR Part15 Radio Frequency Device Subpart B Unintentional Radiators

3.2 Procedures and results

Item	Test Procedure	Limits	Worst margin	Result	Remarks
Conducted emission	ANSI C63.4: 2014 + C63.4a: 2017 7. AC power - line conducted emission measurements	Class B	-	N/A	*1)
Radiated emission	ANSI C63.4: 2014 C63.4a: 2017 8. Radiated emission measurements	Class B	13.71 dB 759,005 MHz, Vertical, QP (Mode 2)	Complied	-
Antenna Terminal	ANSI C63.4: 2014 + C63.4a: 2017 12. Measurement of unintentional radiators other than ITE	Class B	12.78 dB 1643.403 MHz (Mode 3)	Complied	-

* Note: UL Japan, Inc.'s EMI Work Procedure: Work Instructions-ULID-003591.

*1) The test is not applicable since the EUT is not the device that is designed to be connected to the public utility (AC) power line.

3.3 Addition to standard

No addition, exclusion nor deviation has been made from the standard.

3.4 Uncertainty

Measurement uncertainty is not taken into account when stating conformity with a specified requirement. Note: When margins obtained from test results are less than the measurement uncertainty, the test results may exceed the limit.

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

Radiated emission

Measurement distance	Frequency range		Unit	Calculated Uncertainty (+/-)
3 m	9 kHz to 30 MHz		dB	3.3
10 m			dB	3.1
3 m	30 MHz to 200 MHz	Horizontal	dB	4.7
		Vertical	dB	4.7
	200 MHz to 1000 MHz	Horizontal	dB	4.8
		Vertical	dB	6.0
10 m	30 MHz to 200 MHz	Horizontal	dB	5.2
		Vertical	dB	5.1
	200 MHz to 1000 MHz	Horizontal	dB	5.2
		Vertical	dB	5.2
3 m	1 GHz to 6 GHz		dB	5.0
	6 GHz to 18 GHz		dB	5.2
1 m	10 GHz to 18 GHz		dB	5.3
	18 GHz to 26.5 GHz		dB	5.2
	26.5 GHz to 40 GHz		dB	4.7
0.5 m	26.5 GHz to 40 GHz		dB	4.8

Antenna Terminal test

Item	Unit	Calculated Uncertainty (+/-)
Antenna terminal conducted emission	dB	3.1

3.5 Test Location

UL Japan, Inc. Ise EMC Lab.

4383-326 Asama-cho, Ise-shi, Mie-ken 516-0021 Japan

Telephone: +81-596-24-8999

A2LA Certificate Number: 5107.02 / FCC Test Firm Registration Number: 884919

ISED Lab Company Number: 2973C / CAB identifier: JP0002

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

3.6 Test data, Test instruments, and Test set up

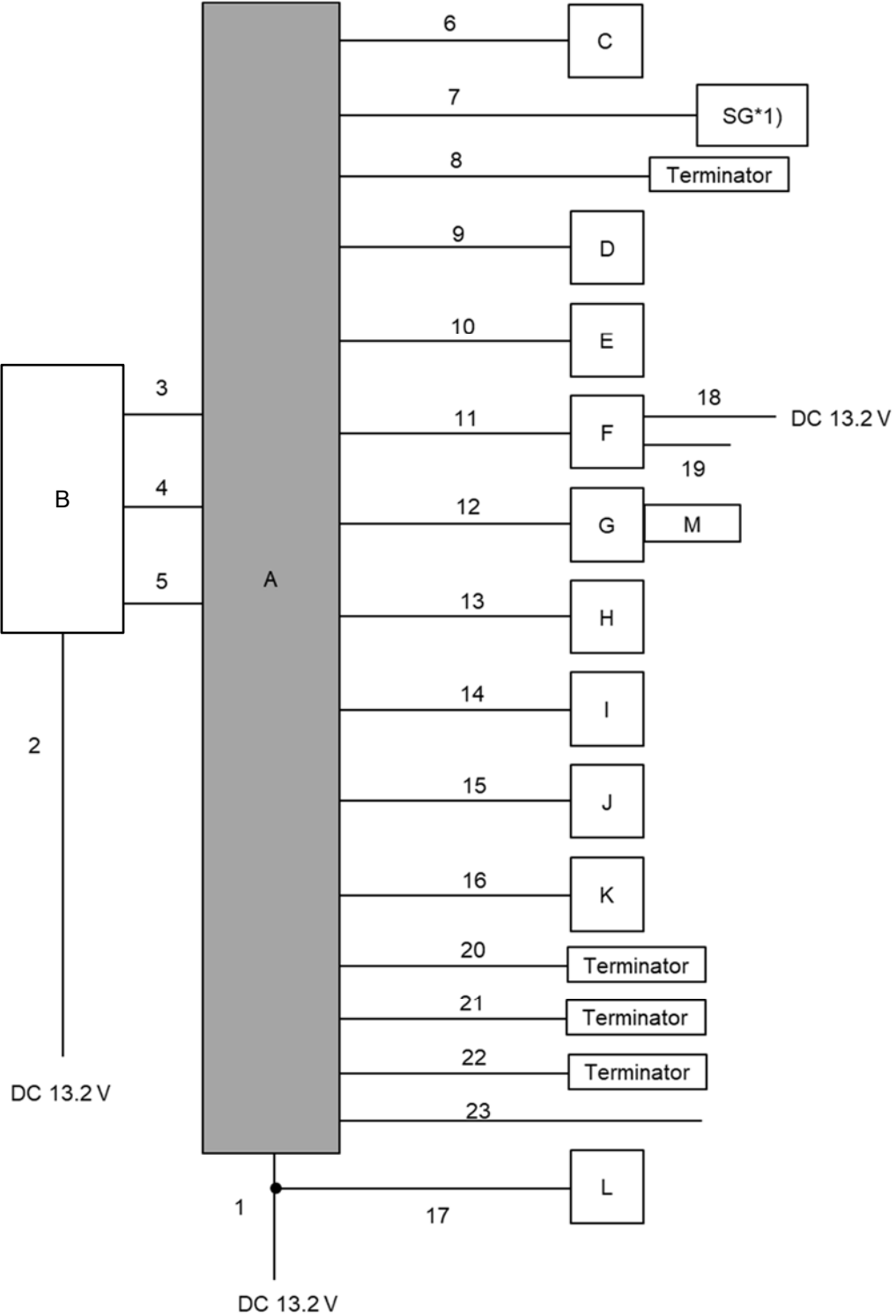
Refer to APPENDIX.

SECTION 4: Operation of EUT during testing

4.1 Operating Mode(s)

Mode	<ol style="list-style-type: none">1. FM Receiving (Local) mode (Radiated Emission test)2. FM Receiving (Other) mode (Radiated Emission test)3. Antenna terminal mode (Antenna Terminal Conducted Emission test)
Software(s)	CCU TEST Program Soc: Version: S01NSM005-011 VCPU: Version: S01NSV005-011

4.2 Configuration and peripherals



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

Description of EUT and Support Equipment

No.	Item	Model number	Serial Number	Manufacturer	Remarks
A	Cockpit Control Unit	DNNS137	4687260010000 00000000005	DENSO CORPORATION	EUT
B	Display (CID)	137000-15890001	No.1	DENSO TEN CORPORATION	-
C	GPS Antenna	86277AL000	29550172	SUBARU CORPORATION	-
D	Camera Dummy	MAX96778COAXE VKIT	-	Maxim integrated	-
E	Ether Dummy	EtherBoard	-	DENSO CORPORATION	-
F	METER	5-157500-186	No.S44	DENSO CORPORATION	-
G	USB BOX	TAP8006 cable	No.12	HOSHIDEN	-
H	Speaker	AK-122	-	archill	-
I	Speaker	AK-122	-	archill	-
J	Speaker	AK-122	-	archill	-
K	Speaker	AK-122	-	archill	-
L	HEATER CONTROL Panel	137000-15990005	No.1	DENSO TEN CORPORATION	-
M	USB Memory	RUF3-K16GB	P10416	BUFFALO INC.	-

List of Cables Used

No.	Name	Length (m)	Shield		Remarks
			Cable	Connector	
1	DC Cable	4.20	Unshielded	Unshielded	-
2	DC Cable	4.30	Unshielded	Unshielded	-
3	Antenna Cable	0.57	Shielded	Shielded	-
4	Antenna Cable	0.57	Shielded	Shielded	-
5	Display Signal Cable	0.57	Shielded	Shielded	-
6	GPS Antenna Cable	1.00	Shielded	Shielded	-
7	Radio Antenna Cable (AM/FM)	2.00	Shielded	Shielded	-
8	Radio Antenna Cable (XM)	2.00	Shielded	Shielded	-
9	Camera Cable	2.00	Shielded	Shielded	-
10	Ether Cable	2.00	Shielded	Shielded	-
11	METER Signal Cable	2.00	Unshielded	Unshielded	-
12	USB BOX Cable	2.00	Shielded	Shielded	-
13	Speaker Cable	6.30	Unshielded	Unshielded	-
14	Speaker Cable	6.30	Unshielded	Unshielded	-
15	Speaker Cable	6.30	Unshielded	Unshielded	-
16	Speaker Cable	6.30	Unshielded	Unshielded	-
17	DC Cable	4.60	Unshielded	Unshielded	-
18	DC Cable	4.60	Unshielded	Unshielded	-
19	Signal Cable	2.00	Unshielded	Unshielded	-
20	Signal Cable	2.00	Unshielded	Unshielded	-
21	Signal Cable	2.00	Unshielded	Unshielded	-
22	Signal Cable	2.00	Unshielded	Unshielded	-
23	Signal Cable	2.00	Unshielded	Unshielded	-

SECTION 5: Radiated Emission

5.1 Operating environment

Date : See data
Test place : See data
Temperature : See data
Humidity : See data
Test engineer : See data

5.2 Test configuration

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 EUT was set on the edge of the tabletop.

Test was made with the antenna positioned in both the horizontal and vertical planes of polarization. The measurement antenna was varied in height above the conducting ground plane to obtain the maximum signal strength.

Photographs of the set up are shown in APPENDIX 3.

5.3 Test conditions

Frequency range : 30 MHz to 200 MHz (Biconical antenna)
200 MHz to 1000 MHz (Logperiodic antenna)
1000 MHz to 40000 MHz (Horn antenna)
Test distance : 3 m
EUT position : Table top
EUT operation mode : See Clause 4.1

5.4 Test procedure

The height of the measuring antenna varied between 1 and 4 m and EUT was rotated a full revolution in order to obtain the maximum value of the electric field intensity.

The measurements were performed for both vertical and horizontal antenna polarization with the Test Receiver.

The radiated emission measurements were made with the following detector function of the Test Receiver. The test of Local oscillator spurious has been measured up to appropriate frequency based on the result of the antenna terminal test.

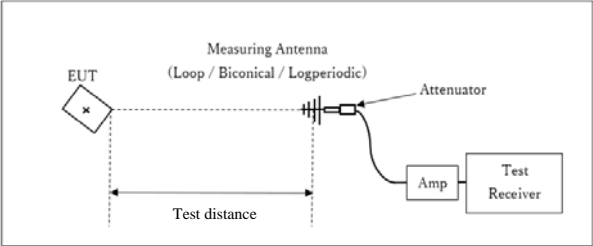
Test antenna was aimed at the emission source for receiving the maximum signal and always kept. (Above 1 GHz)

Frequency	Below 1 GHz	Above 1 GHz *1)
Instrument used	Test Receiver	Test Receiver
IF Bandwidth	QP: BW 120 kHz	PK: BW 1 MHz, CAV: BW 1 MHz

*1) The measurement data was adjusted to a 3 m distance using the following Distance Factor.
Distance Factor: See Figure 1.

Figure 1: Test Setup

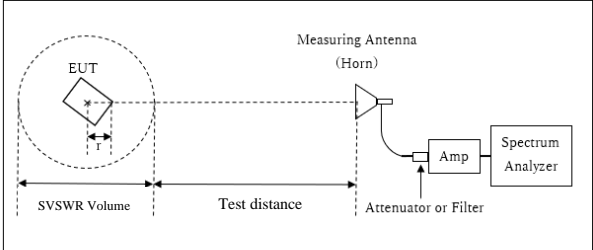
Below 1 GHz



x : Center of turn table

Test Distance: 3 m

1 GHz to 10 GHz

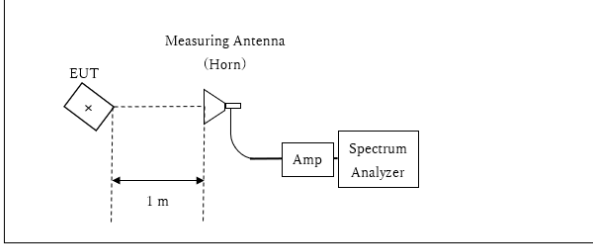


r : Radius of an outer periphery of EUT
 x : Center of turn table

Distance Factor: $20 \times \log(3.3 \text{ m}^*/3.0 \text{ m}) = 0.83 \text{ dB}$
 * Test Distance: $(3 + \text{SVSWR Volume} / 2) - r = 3.3 \text{ m}$

SVSWR Volume: 2 m
 (SVSWR Volume has been calibrated based on CISPR 16-1-4.)
 $r = 0.7 \text{ m}$

10 GHz to 40 GHz



x : Center of turn table

Distance Factor: $20 \times \log(1.0 \text{ m}^* / 3.0 \text{ m}) = -9.54 \text{ dB}$
 *Test Distance: 1 m

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

5.5 Test result

Summary of the test results: Pass

The limit is rounded down to one decimal place.
 The test result is rounded off, so some differences might be observed.

SECTION 6: Antenna Terminal

6.1 Operating environment

Date : See data
Test place : See data
Temperature : See data
Humidity : See data
Test engineer : See data

6.2 Test configuration

EUT was placed on a wooden table of nominal size, 1.0 m by 1.5 m, raised 0.8 m from the ground. Photographs of the set up are shown in APPENDIX 3.

6.3 Test conditions

Frequency range : 30 MHz to 1000 MHz / 1000 MHz to 2000 MHz
Test distance : N/A
EUT position : Table top
EUT operation mode : See Clause 4.1

6.4 Test procedure

The Antenna Terminal was measured with a spectrum analyzer connected to the antenna port.

Frequency	Below 1 GHz	Above 1 GHz
Instrument used	Spectrum Analyzer	Spectrum Analyzer *1)
IF Bandwidth	PK: RBW: 100 kHz / VBW: 300 kHz	PK: RBW: 1 MHz / VBW: 3 MHz

*1) The Spectrum Analyzer was used in 3 dB resolution bandwidth.

6.5 Test result

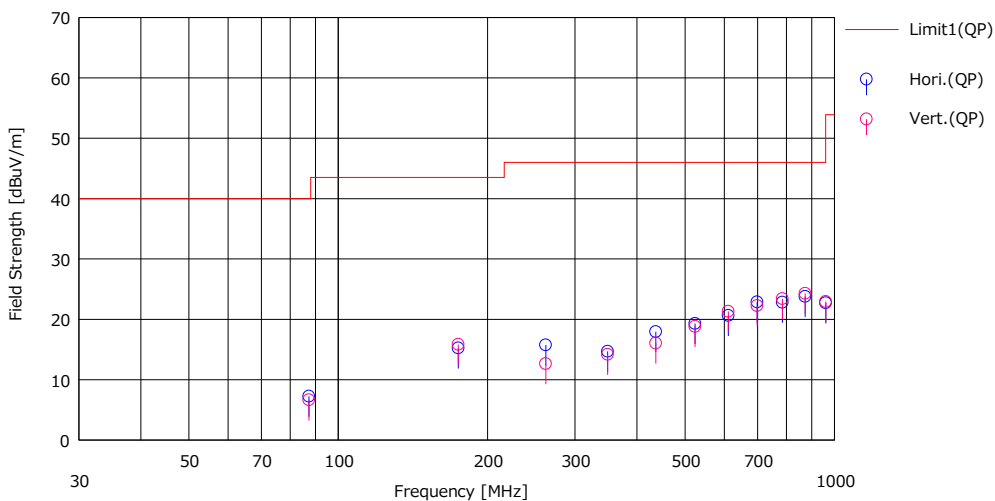
Summary of the test results: Pass

APPENDIX 1: Test data

Radiated Emission

Test place Ise EMC Lab.
Semi Anechoic Chamber No.4
Date April 4, 2024
Temperature / Humidity 23 deg. C / 39 % RH
Engineer Ken Fujita
(Below 1 GHz)
Mode Mode 1 Local (87.75 MHz)

Limit : FCC_Part 15 Subpart B(15.109)_Class B



No.	Freq. [MHz]	Reading	Ant.Fac	Loss	Gain	Result	Limit	Margin	Pola.	Height	Angle	Ant. Type	Comment
		(QP)				[dBm]	[dB]	[dBuV/m]					
1	87.300	23.50	8.12	7.71	32.07	7.26	40.00	32.74	Hori.	300	323	BA	
2	174.600	22.70	16.06	8.50	32.02	15.24	43.50	28.26	Hori.	100	359	BA	
3	261.900	26.20	12.30	9.26	32.01	15.75	46.00	30.25	Hori.	100	359	LA23	
4	349.200	21.90	15.01	9.82	32.05	14.68	46.00	31.32	Hori.	100	359	LA23	
5	436.500	23.60	16.17	10.31	32.13	17.95	46.00	28.05	Hori.	100	359	LA23	
6	523.800	23.10	17.58	10.83	32.20	19.31	46.00	26.69	Hori.	100	359	LA23	
7	611.100	22.20	19.38	11.30	32.25	20.63	46.00	25.37	Hori.	100	359	LA23	
8	698.400	23.70	19.84	11.61	32.29	22.86	46.00	23.14	Hori.	100	359	LA23	
9	785.700	22.10	20.63	11.87	31.79	22.81	46.00	23.19	Hori.	100	359	LA23	
10	873.000	21.00	21.89	12.17	31.28	23.78	46.00	22.22	Hori.	100	359	LA23	
11	960.300	18.70	22.25	12.54	30.76	22.73	53.90	31.17	Hori.	100	359	LA23	
12	87.300	22.90	8.12	7.71	32.07	6.66	40.00	33.34	Vert.	100	26	BA	
13	174.600	23.30	16.06	8.50	32.02	15.84	43.50	27.66	Vert.	100	32	BA	
14	261.900	23.10	12.30	9.26	32.01	12.65	46.00	33.35	Vert.	100	0	LA23	
15	349.200	21.40	15.01	9.82	32.05	14.18	46.00	31.82	Vert.	100	0	LA23	
16	436.500	21.70	16.17	10.31	32.13	16.05	46.00	29.95	Vert.	100	0	LA23	
17	523.800	22.60	17.58	10.83	32.20	18.81	46.00	27.19	Vert.	100	0	LA23	
18	611.100	22.90	19.38	11.30	32.25	21.33	46.00	24.67	Vert.	100	0	LA23	
19	698.400	23.10	19.84	11.61	32.29	22.26	46.00	23.74	Vert.	100	0	LA23	
20	785.700	22.70	20.63	11.87	31.79	23.41	46.00	22.59	Vert.	100	0	LA23	
21	873.000	21.50	21.89	12.17	31.28	24.28	46.00	21.72	Vert.	100	0	LA23	
22	960.300	18.90	22.25	12.54	30.76	22.93	53.90	30.97	Vert.	100	0	LA23	

CHART: WITH FACTOR

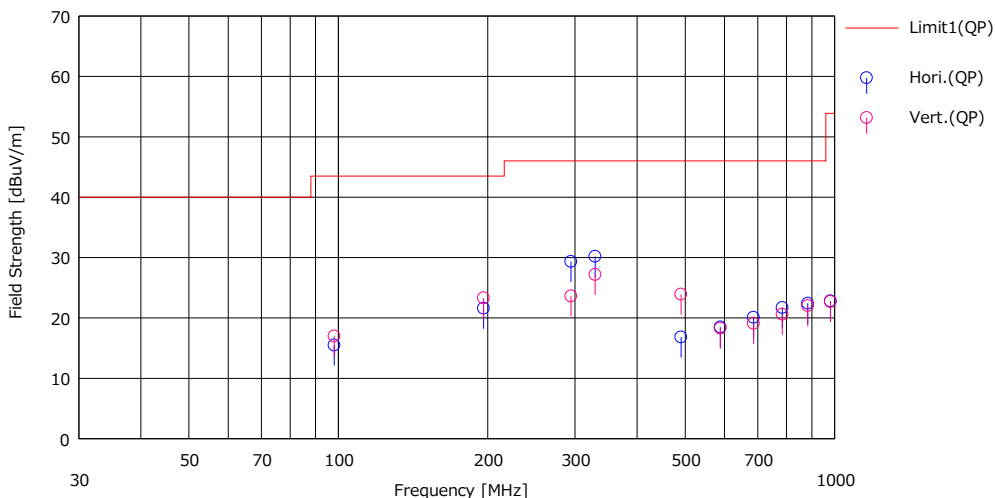
ANT TYPE: - 30 MHz: LOOP, 30 MHz - 200 MHz: BICONICAL, 200 MHz - 1000 MHz: LOGPERIODIC, 1000 MHz -: HORN
CALCULATION: RESULT = READING + ANT FACTOR + LOSS(CABLE + ATT) - GAIN(AMP)

Except for the above table: adequate margin data below the limits.

Radiated Emission

Test place	Ise EMC Lab.
Semi Anechoic Chamber	No.4
Date	April 4, 2024
Temperature / Humidity	23 deg. C / 39 % RH
Engineer	Ken Fujita
	(Below 1 GHz)
Mode	Mode 1 Local (97.7 MHz)

Limit : FCC_Part 15 Subpart B(15.109)_Class B



No.	Freq. [MHz]	Reading	AntFoc [dB/m]	Loss [dB]	Gain [dB]	Result	Limit	Margin	Pola. [H/V]	Height [cm]	Angle [deg]	Ant. Type	Comment
		(QP)				(QP)	(QP)	(QP)					
1	98.103	29.70	10.01	7.81	32.04	15.48	43.50	28.02	Hori.	300	323	BA	
2	196.206	28.40	16.53	8.68	32.01	21.60	43.50	21.90	Hori.	300	323	BA	
3	294.309	38.20	13.62	9.52	32.01	29.33	46.00	16.67	Hori.	100	359	LA23	
4	329.130	38.00	14.50	9.71	32.04	30.17	46.00	15.83	Hori.	100	359	LA23	
5	490.515	20.80	17.58	10.62	32.18	16.82	46.00	29.18	Hori.	100	359	LA23	
6	588.618	20.50	19.01	11.19	32.23	18.47	46.00	27.53	Hori.	100	359	LA23	
7	686.721	21.10	19.70	11.57	32.28	20.09	46.00	25.91	Hori.	100	359	LA23	
8	784.824	21.00	20.61	11.87	31.79	21.69	46.00	24.31	Hori.	100	359	LA23	
9	882.927	19.50	21.93	12.21	31.22	22.42	46.00	23.58	Hori.	100	359	LA23	
10	981.030	18.50	22.30	12.63	30.64	22.79	53.90	31.11	Hori.	100	359	LA23	
11	98.103	31.20	10.01	7.81	32.04	16.98	43.50	26.52	Vert.	100	26	BA	
12	196.206	30.10	16.53	8.68	32.01	23.30	43.50	20.20	Vert.	157	16	BA	
13	294.309	32.50	13.62	9.52	32.01	23.63	46.00	22.37	Vert.	100	0	LA23	
14	329.392	35.00	14.51	9.71	32.04	27.18	46.00	18.82	Vert.	100	0	LA23	
15	490.515	27.90	17.58	10.62	32.18	23.92	46.00	22.08	Vert.	100	0	LA23	
16	588.618	20.30	19.01	11.19	32.23	18.27	46.00	27.73	Vert.	100	0	LA23	
17	686.721	20.10	19.70	11.57	32.28	19.09	46.00	26.91	Vert.	100	0	LA23	
18	784.824	19.90	20.61	11.87	31.79	20.59	46.00	25.41	Vert.	100	0	LA23	
19	882.927	19.10	21.93	12.21	31.22	22.02	46.00	23.98	Vert.	100	0	LA23	
20	981.030	18.40	22.30	12.63	30.64	22.69	53.90	31.21	Vert.	100	0	LA23	

CHART: WITH FACTOR

ANT TYPE: - 30 MHz: LOOP, 30 MHz - 200 MHz: BICONICAL, 200 MHz - 1000 MHz: LOGPERIODIC, 1000 MHz -: HORN

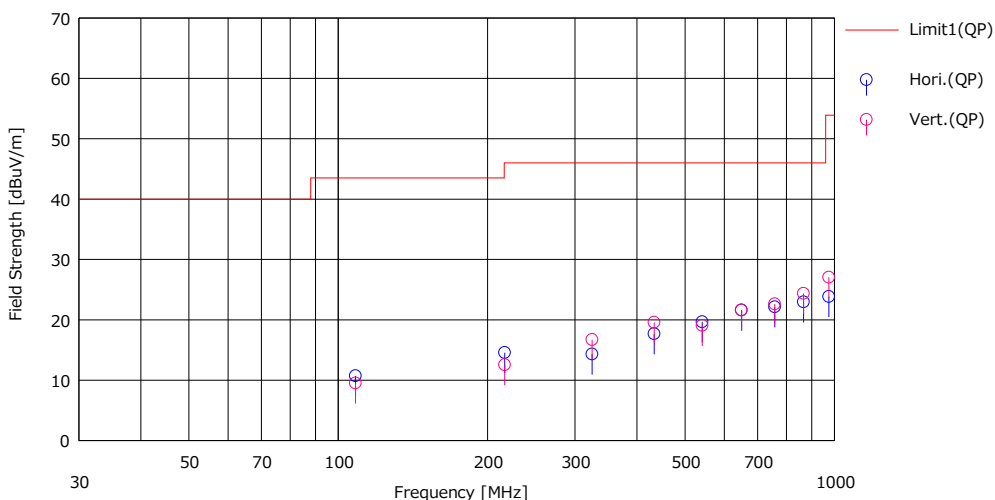
CALCULATION: RESULT = READING + ANT FACTOR + LOSS(CABLE + ATT) - GAIN(AMP)

Except for the above table: adequate margin data below the limits.

Radiated Emission

Test place Ise EMC Lab.
Semi Anechoic Chamber No.4
Date April 4, 2024
Temperature / Humidity 23 deg. C / 39 % RH
Engineer Ken Fujita
(Below 1 GHz)
Mode Mode 1 Local (107.9 MHz)

Limit : FCC_Part 15 Subpart B(15.109)_Class B



No.	Freq. [MHz]	Reading	Ant.Fac [dB/m]	Loss [dB]	Gain [dB]	Result	Limit	Margin	Pola [H/V]	Height [cm]	Angle [deg]	Ant. Type	Comment
		(QP) [dBuV]				(QP) [dBuV/m]	(QP) [dB]						
1	108.304	23.30	11.55	7.91	32.04	10.72	43.50	32.78	Hori.	300	323	BA	
2	216.608	26.50	11.20	8.87	32.01	14.56	46.00	31.44	Hori.	100	359	LA23	
3	324.912	22.30	14.36	9.69	32.03	14.32	46.00	31.68	Hori.	100	359	LA23	
4	433.216	23.40	16.12	10.29	32.13	17.68	46.00	28.32	Hori.	100	359	LA23	
5	541.520	23.20	17.73	10.95	32.21	19.67	46.00	26.33	Hori.	100	359	LA23	
6	649.824	23.10	19.30	11.47	32.26	21.61	46.00	24.39	Hori.	100	359	LA23	
7	758.128	22.10	20.19	11.79	31.95	22.13	46.00	23.87	Hori.	100	359	LA23	
8	866.432	20.30	21.83	12.15	31.31	22.97	46.00	23.03	Hori.	100	359	LA23	
9	974.736	19.60	22.32	12.60	30.68	23.84	53.90	30.06	Hori.	100	359	LA23	
10	108.304	22.10	11.55	7.91	32.04	9.52	43.50	33.98	Vert.	100	26	BA	
11	216.608	24.50	11.20	8.87	32.01	12.56	46.00	33.44	Vert.	100	0	LA23	
12	324.912	24.70	14.36	9.69	32.03	16.72	46.00	29.28	Vert.	100	0	LA23	
13	433.216	25.30	16.12	10.29	32.13	19.58	46.00	26.42	Vert.	100	0	LA23	
14	541.520	22.60	17.73	10.95	32.21	19.07	46.00	26.93	Vert.	100	0	LA23	
15	649.824	23.10	19.30	11.47	32.26	21.61	46.00	24.39	Vert.	100	0	LA23	
16	758.128	22.60	20.19	11.79	31.95	22.63	46.00	23.37	Vert.	100	0	LA23	
17	866.432	21.70	21.83	12.15	31.31	24.37	46.00	21.63	Vert.	100	0	LA23	
18	974.736	22.80	22.32	12.60	30.68	27.04	53.90	26.86	Vert.	100	0	LA23	

CHART: WITH FACTOR

ANT TYPE: - 30 MHz: LOOP, 30 MHz - 200 MHz: BICONICAL, 200 MHz - 1000 MHz: LOGPERIODIC, 1000 MHz -: HORN

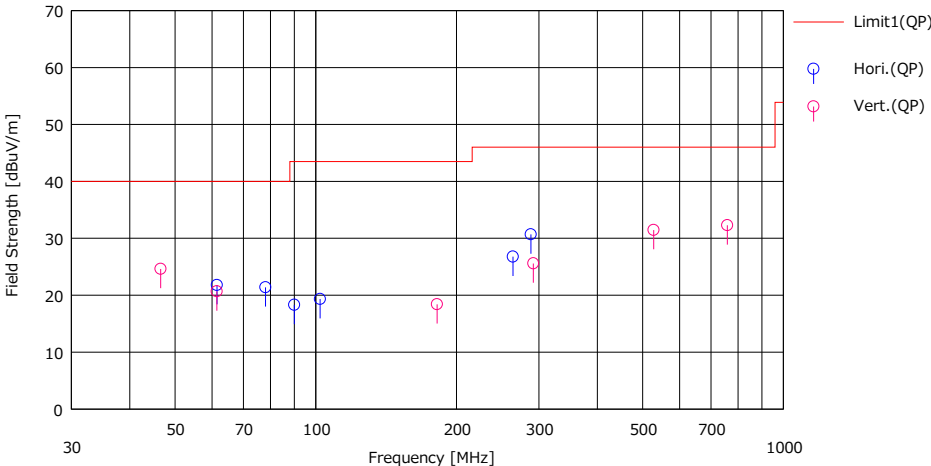
CALCULATION: RESULT = READING + ANT FACTOR + LOSS(CABLE + ATT) - GAIN(AMP)

Except for the above table: adequate margin data below the limits.

Radiated Emission

Test place Ise EMC Lab.
Semi Anechoic Chamber No.2
Date April 3, 2024
Temperature / Humidity 20 deg. C / 50 % RH
Engineer Junki Nagatomi
(Below 1 GHz)
Mode Mode 2

Limit : FCC_Part 15 Subpart B(15.109)_Class B



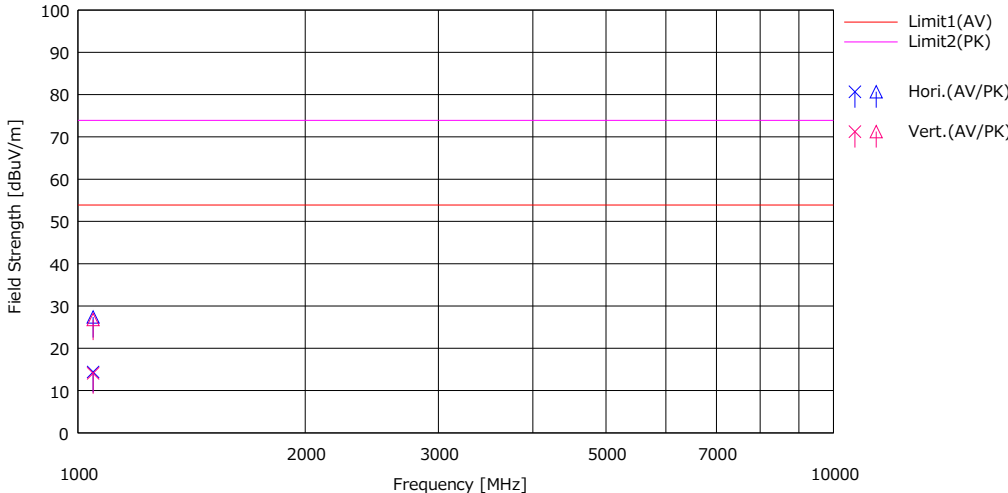
No.	Freq. [MHz]	Reading	AntFac [dB/m]	Loss [dB]	Gain [dB]	Result	Limit	Margin	Pola [H/V]	Height [cm]	Angle [deg]	Ant. Type	Comment
		[QP]				[QP]	[QP]	[QP]					
1	61.446	34.10	9.16	7.01	28.49	21.78	40.00	18.22	Hori.	400	0	BA	
2	78.065	33.60	9.08	7.17	28.46	21.39	40.00	18.61	Hori.	190	236	BA	
3	89.965	30.00	9.46	7.28	28.43	18.31	43.50	25.19	Hori.	256	52	BA	
4	102.177	30.30	10.04	7.39	28.40	19.33	43.50	24.17	Hori.	279	91	BA	
5	264.004	33.30	12.73	8.49	27.74	26.78	46.00	19.22	Hori.	100	76	LA21	
6	288.482	36.00	13.78	8.64	27.73	30.69	46.00	15.31	Hori.	100	173	LA21	
7	46.588	36.00	10.31	6.85	28.53	24.63	40.00	15.37	Vert.	100	312	BA	
8	61.420	33.00	9.16	7.01	28.49	20.68	40.00	19.32	Vert.	200	258	BA	
9	181.727	24.80	13.70	7.98	28.07	18.41	43.50	25.09	Vert.	100	279	BA	
10	291.932	30.90	13.76	8.66	27.73	25.59	46.00	20.41	Vert.	157	16	LA21	
11	527.984	33.00	17.76	9.89	29.19	31.46	46.00	14.54	Vert.	164	12	LA21	
12	759.005	30.40	20.33	10.70	29.14	32.29	46.00	13.71	Vert.	100	117	LA21	

CHART: WITH FACTOR
ANT TYPE: - 30 MHz: LOOP, 30 MHz - 200 MHz: BICONICAL, 200 MHz - 1000 MHz: LOGPERIODIC, 1000 MHz -: HORN
CALCULATION: RESULT = READING + ANT FACTOR + LOSS(CABLE + ATT) - GAIN(AMP)
Except for the above table: adequate margin data below the limits.

Radiated Emission

Test place Ise EMC Lab.
Semi Anechoic Chamber No.4
Date April 4, 2024
Temperature / Humidity 23 deg. C / 39 % RH
Engineer Ken Fujita
(Above 1 GHz)
Mode Mode 1 Local (87.75 MHz)

Limit : FCC_Part 15 Subpart B(15.109)_Class B



No.	Freq. [MHz]	Reading		Ant.Fac [dB/m]	Loss [dB]	Gain [dB]	Result		Limit		Margin		Pola. [H/V]	Height [cm]	Angle [deg]	Ant. Type	Comment
		(AV) [dBuV]	(PK) [dBuV]				(AV) [dBuV/m]	(PK) [dBuV/m]	(AV) [dBuV/m]	(PK) [dBuV/m]	(AV) [dB]	(PK) [dB]					
1	1047.600	22.90	35.90	24.28	1.72	34.51	14.39	27.39	53.90	73.90	39.51	46.51	Hori.	100	0	H21	
2	1047.600	22.60	35.30	24.28	1.72	34.51	14.09	26.79	53.90	73.90	39.81	47.11	Vert.	100	0	H21	

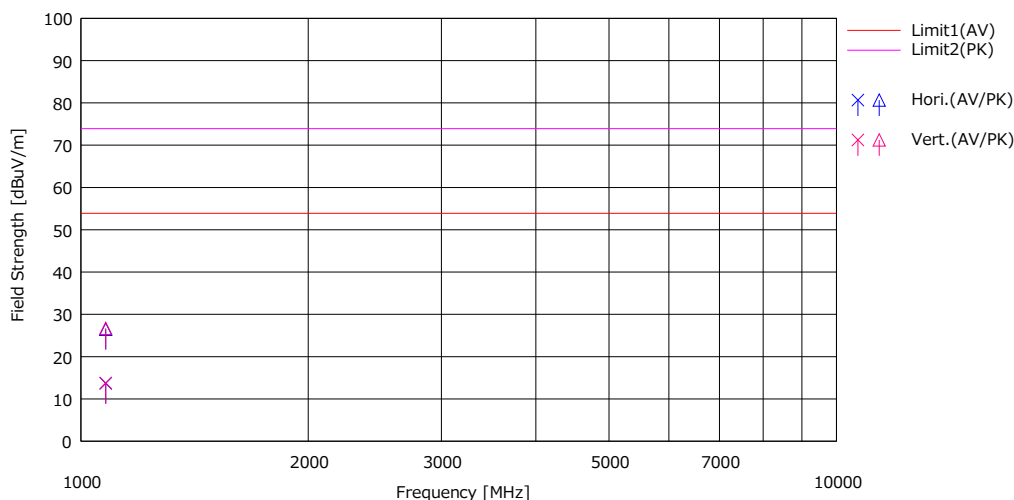
CHART: WITH FACTOR
ANT TYPE: - 30 MHz: LOOP, 30 MHz - 200 MHz: BICONICAL, 200 MHz - 1000 MHz: LOGPERIODIC, 1000 MHz -: HORN
CALCULATION: RESULT = READING + ANT FACTOR + LOSS(CABLE + ATT) - GAIN(AMP)
Except for the above table: adequate margin data below the limits.

* No signal was detected above 10 GHz.

Radiated Emission

Test place	Ise EMC Lab.
Semi Anechoic Chamber	No.4
Date	April 4, 2024
Temperature / Humidity	23 deg. C / 39 % RH
Engineer	Ken Fujita
	(Above 1 GHz)
Mode	Mode 1 Local (97.7 MHz)

Limit : FCC_Part 15 Subpart B(15.109)_Class B



No.	Freq. [MHz]	Reading		Ant.Fac [dB/m]	Loss [dB]	Gain [dB]	Result		Limit		Margin		Pola. [H/V]	Height [cm]	Angle [deg]	Ant. Type	Comment
		(AV) [dBuV]	(PK) [dBuV]				(AV) [dBuV/m]	(PK) [dBuV/m]	(AV) [dB]	(PK) [dB]	(AV) [dB]	(PK) [dB]					
1	1079.133	21.90	34.70	24.45	1.75	34.42	13.68	26.48	53.90	73.90	40.22	47.42	Hori.	100	0	H2.1	
2	1079.133	22.00	34.90	24.45	1.75	34.42	13.78	26.68	53.90	73.90	40.12	47.22	Vert.	100	0	H2.1	

CHART: WITH FACTOR

ANT TYPE: - 30 MHz: LOOP, 30 MHz - 200 MHz: BICONICAL, 200 MHz - 1000 MHz: LOGPERIODIC, 1000 MHz -: HORN
CALCULATION: RESULT = READING + ANT FACTOR + LOSS(CABLE + ATT) - GAIN(AMP)

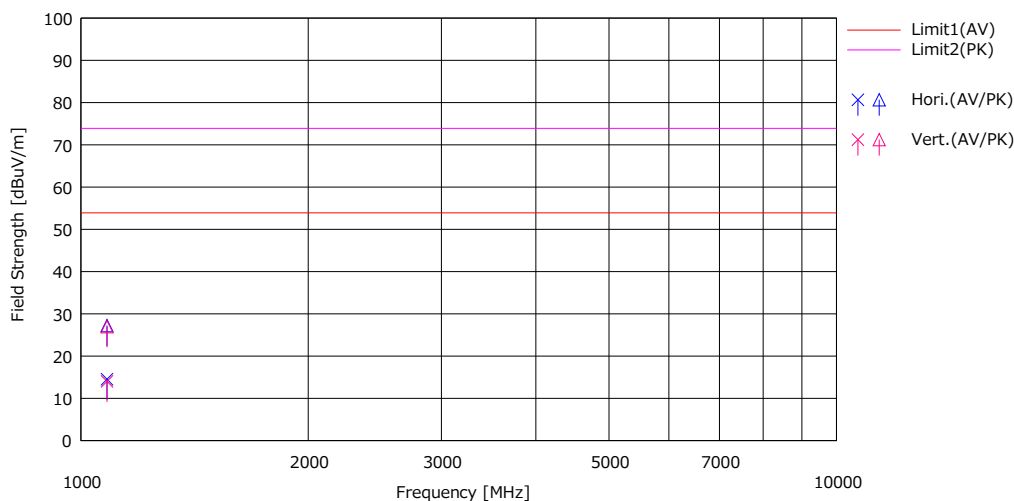
Except for the above table: adequate margin data below the limits.

* No signal was detected above 10 GHz.

Radiated Emission

Test place	Ise EMC Lab.
Semi Anechoic Chamber	No.4
Date	April 4, 2024
Temperature / Humidity	23 deg. C / 39 % RH
Engineer	Ken Fujita
	(Above 1 GHz)
Mode	Mode 1 Local (107.9 MHz)

Limit : FCC_Part 15 Subpart B(15.109)_Class B



No.	Freq. [MHz]	Reading		Ant.Fac [dB/m]	Loss [dB]	Gain [dB]	Result		Limit		Margin		Pola. [H/V]	Height [cm]	Angle [deg]	Ant. Type	Comment
		(AV) [dBuV]	(PK) [dBuV]				(AV) [dBuV/m]	(PK) [dBuV/m]	(AV) [dBuV/m]	(PK) [dBuV/m]	(AV) [dB]	(PK) [dB]					
1	1083.040	22.70	35.40	24.48	1.75	34.41	14.52	27.22	53.90	73.90	39.38	46.68	Hori.	100	0	H21	
2	1083.040	22.20	35.10	24.48	1.75	34.41	14.02	26.92	53.90	73.90	39.88	46.98	Vert.	100	0	H21	

CHART: WITH FACTOR

ANT TYPE: - 30 MHz: LOOP, 30 MHz - 200 MHz: BICONICAL, 200 MHz - 1000 MHz: LOGPERIODIC, 1000 MHz -: HORN

CALCULATION: RESULT = READING + ANT FACTOR + LOSS(CABLE + ATT) - GAIN(AMP)

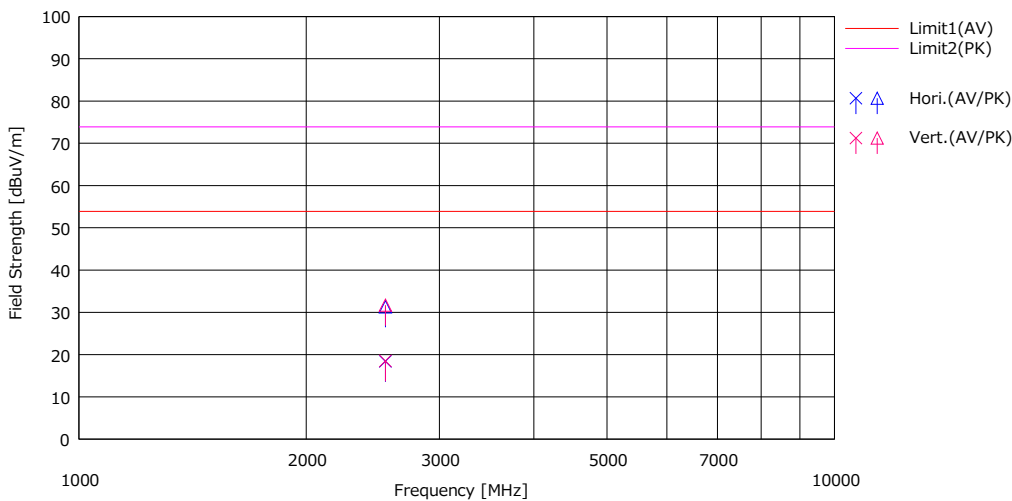
Except for the above table: adequate margin data below the limits.

* No signal was detected above 10 GHz.

Radiated Emission

Test place	Ise EMC Lab.
Semi Anechoic Chamber	No.4
Date	April 4, 2024
Temperature / Humidity	23 deg. C / 39 % RH
Engineer	Ken Fujita
	(Above 1 GHz)
Mode	Mode 2

Limit : FCC_Part 15 Subpart B(15.109)_Class B



No.	Freq. [MHz]	Reading		Ant.Fac [dB/m]	Loss [dB]	Gain [dB]	Result		Limit		Margin		Pola. [H/V]	Height [cm]	Angle [deg]	Ant. Type	Comment
		(AV) [dBuV]	(PK) [dBuV]				(AV) [dBuV/m]	(PK) [dBuV/m]	(AV) [dBuV/m]	(PK) [dBuV/m]	(AV) [dB]	(PK) [dB]					
1	2544.978	19.60	32.50	27.77	2.72	31.70	18.39	31.29	53.90	73.90	35.51	42.61	Hori.	100	0	H21	
2	2544.978	19.70	32.90	27.77	2.72	31.70	18.49	31.69	53.90	73.90	35.41	42.21	Vert.	100	0	H21	

CHART: WITH FACTOR

ANT TYPE: - 30 MHz: LOOP, 30 MHz - 200 MHz: BICONICAL, 200 MHz - 1000 MHz: LOGPERIODIC, 1000 MHz -: HORN

CALCULATION: RESULT = READING + ANT FACTOR + LOSS(CABLE + ATT) - GAIN(AMP)

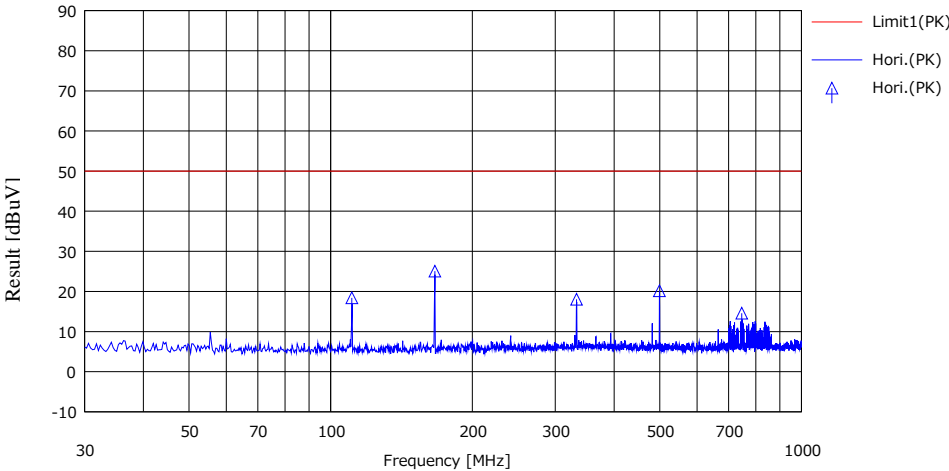
Except for the above table: adequate margin data below the limits.

* No signal was detected above 10 GHz.

Antenna Terminal Conducted Emission

Test place Ise EMC Lab.
Semi Anechoic Chamber No.2
Date March 31, 2024
Temperature / Humidity 20 deg. C / 56 % RH
Engineer Junki Nagatomi
Mode Mode 3

Limit : FCC15.111 Antenna terminal measurement



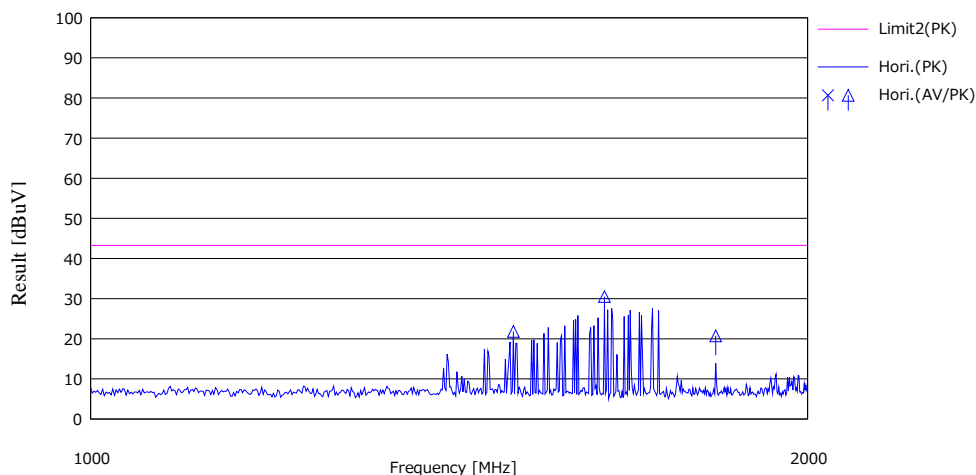
No.	Freq. [MHz]	Reading	Ant.Fac [dB/m]	Loss [dB]	Gain [dB]	Result	Limit *1)	Margin	Pola. [H/V]	Height [cm]	Angle [deg]	Ant. Type	Comment
		[dBuV]				[dBuV]	[dB]						
1	110.925	40.61	0.00	6.17	28.37	18.41	50.00	31.59	Hori.	0	0	---	
2	166.397	47.01	0.00	6.19	28.15	25.05	50.00	24.95	Hori.	0	0	---	
3	332.798	39.72	0.00	6.25	27.93	18.04	50.00	31.96	Hori.	0	0	---	
4	499.194	42.97	0.00	6.32	29.11	20.18	50.00	29.82	Hori.	0	0	---	
5	746.404	37.36	0.00	6.39	29.17	14.58	50.00	35.42	Hori.	0	0	---	Local 92.9 MHz

* 2 nW = -57 dBm = 50 dBuV
CHART: WITH FACTOR
CALCULATION: RESULT = READING + LOSS (CABLE + Matching Pad) – GAIN (AMP)
Except for the above table: adequate margin data below the limits.

Antenna Terminal Conducted Emission

Test place	Ise EMC Lab.
Semi Anechoic Chamber	No.2
Date	March 31, 2024
Temperature / Humidity	20 deg. C / 56 % RH
Engineer	Junki Nagatomi
Mode	Mode 3

Limit : FCC_Part 15 Subpart B(15.109)_Class B



No.	Freq. [MHz]	Reading		Ant.Fac [dB/m]	Loss [dB]	Gain [dB]	Result		Limit *1)		Margin [dB]	Pola. [H/V]	Height [cm]	Angle [deg]	Ant. Type	Comment
		(AV) [dBuV]	(PK) [dBuV]				(AV) [dBuV]	(PK) [dBuV]	(PK) [dBuV/m]							
1	1504.998	---	50.35	0.00	6.53	35.06	---	21.82	43.28	21.46	Hori.	0	0	---		
2	1643.403	---	58.89	0.00	6.53	34.92	---	30.50	43.28	12.78	Hori.	0	0	---	Local 103.1 MHz	
3	1830.002	---	48.90	0.00	6.55	34.73	---	20.72	43.28	22.56	Hori.	0	0	---		

* 2 nW = -57 dBm = 50 dBuV

CHART: WITH FACTOR

CALCULATION: RESULT = READING + LOSS (CABLE + Matching Pad) – GAIN (AMP)

Except for the above table: adequate margin data below the limits.

APPENDIX 2: Test instruments

Test equipment

Test Item	LIMS ID	Description	Manufacturer	Model	Serial	Last Calibration Date	Cal Int
AT	141279	Microwave Cable	Junkosha	MMX221-00500DMSDMS	1502S303	03/04/2024	12
AT	141542	Digital Tester	Fluke Corporation	FLUKE 26-3	78030611	08/01/2023	12
AT	141550	Matching Pad Anritsu	Anritsu Corporation	MB-009	40063	07/26/2023	12
AT	141579	Pre Amplifier	Keysight Technologies Inc	8449B	3008A02142	02/17/2024	12
AT	141594	Pre Amplifier	Keysight Technologies Inc	8447D	2944A10150	02/17/2024	12
AT	141901	Spectrum Analyzer	Keysight Technologies Inc	E4440A	MY48250080	01/26/2024	12
AT	156190	DC Block	EMC Instruments Corporation	N9398C	MY46457635	07/05/2023	12
AT	244707	Thermo-Hygrometer	HIOKI E.E. CORPORATION	LR5001	231202102	01/25/2024	12
RE	141265	Logperiodic Antenna (200-1000MHz)	Schwarzbeck Mess-Elektronik OHG	VUSLP9111B	9111B-190	07/11/2023	12
RE	141267	Logperiodic Antenna (200-1000MHz)	Schwarzbeck Mess-Elektronik OHG	VUSLP9111B	9111B-192	09/21/2023	12
RE	141317	Coaxial Cable	UL Japan	-	-	09/12/2023	12
RE	141331	Attenuator(6dB)	TME	UFA-01	-	02/17/2024	12
RE	141397	Coaxial Cable	UL Japan	-	-	11/22/2023	12
RE	141425	Biconical Antenna	Schwarzbeck Mess-Elektronik OHG	VHA9103+BBA9106	VHA 91031302	08/10/2023	12
RE	141508	Horn Antenna 1-18GHz	Schwarzbeck Mess-Elektronik OHG	BBHA9120D	557	05/17/2023	12
RE	141542	Digital Tester	Fluke Corporation	FLUKE 26-3	78030611	08/01/2023	12
RE	141545	DIGITAL HiTESTER	HIOKI E.E. CORPORATION	3805	51201148	02/01/2024	12
RE	141550	Matching Pad Anritsu	Anritsu Corporation	MB-009	40063	07/26/2023	12
RE	141581	MicroWave System Amplifier	Keysight Technologies Inc	83017A	00650	10/05/2023	12
RE	141583	Pre Amplifier	SONOMA INSTRUMENT	310	260833	04/04/2024	12
RE	141594	Pre Amplifier	Keysight Technologies Inc	8447D	2944A10150	02/17/2024	12
RE	141892	Signal Generator	Keysight Technologies Inc	E8257D	US49280311	11/24/2023	12
RE	141950	EMI Test Receiver	Rohde & Schwarz	ESU26	100412	11/20/2023	12
RE	141951	EMI Test Receiver	Rohde & Schwarz	ESR26	101408	04/10/2023	12
RE	142004	AC2_Semi Anechoic Chamber(NSA)	TDK	Semi Anechoic Chamber 3m	DA-06902	12/12/2023	24
RE	142011	AC4_Semi Anechoic Chamber(NSA)	TDK	Semi Anechoic Chamber 3m	DA-10005	12/13/2023	24
RE	142017	AC4_Semi Anechoic Chamber(SVSWR)	TDK	Semi Anechoic Chamber 3m	DA-10005	10/11/2023	12
RE	142228	Measure, Tape, Steel	KOMELON	KMC-36	-	-	-
RE	142230	Measure, Tape, Steel	KOMELON	KMC-36	-	-	-
RE	156190	DC Block	EMC Instruments Corporation	N9398C	MY46457635	07/05/2023	12
RE	178648	EMI measurement program	TSJ (Techno Science Japan)	TEPTO-DV	-	-	-
RE	197990	Biconical Antenna	Schwarzbeck Mess-Elektronik OHG	VHBB 9124 + BBA 9106	01365	11/29/2023	12
RE	220646	Attenuator	Huber+Suhner	6806_N-50-1	-	03/12/2024	12
RE	234602	Microwave Cable	Huber+Suhner	SF126E/11PC35/11PC35/1000M,5000M	537063/126E / 537074/126E	03/08/2024	12
RE	244707	Thermo-Hygrometer	HIOKI E.E. CORPORATION	LR5001	231202102	01/25/2024	12
RE	244710	Thermo-Hygrometer	HIOKI E.E. CORPORATION	LR5001	231202104	01/25/2024	12

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

The expiration date of the calibration is the end of the expired month.

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

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

Test item:

AT: Antenna Terminal Conducted

RE: Radiated emission