RADIO TEST REPORT

Test Report No. 15106472S-A-R2

Customer	**NITTOKU CO., LTD.**
Description of EUT	**HF Band RFID Reader/Writer**
Model Number of EUT	**ITS-HRW110**
FCC ID	**2A29TITSHRW110S2404**
Test Regulation	**FCC Part 15 Subpart C**
Test Result	**Complied**
Issue Date	**September 11, 2024**
Remarks	**-**

Representative test engineer	Approved by
Y. Tanikawara	K. Takeyama
Yusuke Tanikawara Engineer	Kazutaka Takeyama Leader

CERTIFICATE 1266.03

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

UL Japan, Inc. Shonan EMC Lab.
1-22-3 Megumigaoka, Hiratsuka-shi, Kanagawa-ken, 259-1220 Japan / +81-463-50-6400

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REVISION HISTORY

Original Test Report No. 15106472S-A

This report is a revised version of 15106472S-A-R1. 15106472S-A-R1 is replaced with this report.

Revision	Test Report No.	Date	Page Revised Contents
- (Original)	15106472S-A	April 22, 2024	-
1	15106472S-A-R1	September 3, 2024	P.5 The current value of Rating was corrected from 0.2 A to 0.15 A. P.6 “The stable voltage was supplied by the end product which was required to have a power supply regulator. “The RF Part has its own regulator. The RF Part is constantly provided with voltage through the regulator regardless of input voltage. P.9 Correction of Voltage. Maximum: From DC 10.8 V To DC 13.8 V Minimum: From DC 13.8 V To DC 10.2 V Tag combination descriptions were added for each test item. P.10 The description of “form” was corrected to “from”. P.19 12.931 MHz and 14.185 MHz were moved to the Spurious emission section. P.27 TF is now listed as FT: Frequency Tolerance and BW: 20 dB Bandwidth and 99% Occupied Bandwidth, and the equipment list has been revised. P.30 Addition of “Front” and “Rear”
2	15106472S-A-R2	September 11, 2024	P.9 An explanation of tag combinations has been added to each test item. Test Items with the same Operating mode have been combined. Unnecessary "*" characters have been removed. P.18, P.19 Deleted of remarks “<Carrier>” and “<Spurious> Horizontal: With ISO15693 Tag 1 / Vertical: With ISO15693 Tag 1”

Reference: Abbreviations (Including words undescribed in this report)

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

CONTENTS PAGE

SECTION 1: Customer Information

Company Name	NITTOKU CO., LTD.
Address	2-292-1 Azuma-cho, Omiya-ku, Saitama-city, Saitama-pref 330-0841 Japan
Telephone Number	+81-48-615-2117
Contact Person	Takamasa Shirako

The information provided by 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

SECTION 2: Equipment Under Test (EUT)

2.1 Identification of EUT

Description	HF Band RFID Reader/Writer
Model Number	ITS-HRW110
Serial Number	Refer to SECTION 4.2
Condition	Production model
Modification	No Modification by the test lab
Receipt Date	December 9 and 25, 2023 and February 27, 2024
Test Date	December 22, 2023 to March 1, 2024

Radio Specification

2.2 Product Description

General Specification

Rating	DC 12 V, 0.15 A
Operating Temperature	0 deg. C to +60 deg. C (Mounted on metal surface when used above +55 deg. C)

Radio Specification

This report contains data provided by the customer which can impact the validity of results. UL Japan, Inc. is only responsible for the validity of results after the integration of the data provided by the customer. The data provided by the customer is marked “a)” in the table below.

Equipment Type	Transceiver
Frequency of Operation	13.56 MHz
Type of Modulation	ASK
Antenna type	Loop

SECTION 3: Test specification, procedures & results

3.1 Test Specification

Test Specification	FCC Part 15 Subpart C The latest version on the first day of the testing period
Title	FCC 47CFR Part15 Radio Frequency Device Subpart C Intentional Radiators Section 15.207 Conducted limits Section 15.225 Operation within the band 13.110-14.010 MHz.

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

3.2 Procedures and results

Item	Test Procedure	Specification	Worst margin	Results	Remarks
Conducted Emission	<FCC> ANSI C63.10:2013 6 Standard test methods	<FCC> Section 15.207	3.5 dB, 27.12000 MHz, AV, L1 Remarks: With ISO 15693 Tag 1, Antenna: ITS-HAN10R	Complied	-
	<ISED> RSS-Gen 8.8	<ISED> RSS-Gen 8.8			
Electric Field Strength of Fundamental Emission	<FCC> ANSI C63.10:2013 6 Standard test methods	<FCC> Section 15.225(a)	53.4 dB, 13.560 MHz, Vertical Antenna: ITS-HAN60S	Complied	Radiated
	<ISED> RSS-Gen 6.4, 6.12	<ISED> RSS-210 B.6			
Spectrum Mask	<FCC> ANSI C63.10:2013 6 Standard test methods	<FCC> Section 15.225(b)(c)	33.0 dB, 13.770 MHz, Vertical Antenna: ITS-HAN60S	Complied	Radiated
	<ISED> RSS-Gen 6.4, 6.13	<ISED> RSS-210 B.6			
20 dB Bandwidth	<FCC> ANSI C63.10:2013 6 Standard test methods	<FCC> Section15.215(c)	See data	Complied	Radiated
	<ISED> -	<ISED> -			
Electric Field Strength of Spurious Emission	<FCC> ANSI C63.10:2013 6 Standard test methods	<FCC> Section 15.209, Section 15.225 (d)	0.8 dB 447.480 MHz, Horizontal, QP Antenna: ITS-HAN10R	Complied	Radiated
	<ISED> RSS-Gen 6.4, 6.13	<ISED> RSS-210 B.6 RSS-Gen 8.9			
Frequency Tolerance	<FCC> ANSI C63.10:2013 6 Standard test methods	<FCC> Section 15.225(e)	See data	Complied	Radiated
	<ISED> RSS-Gen 6.11, 8.11	<ISED> RSS-210 B.6			
Note: UL Japan, Inc.'s EMI Work Procedures: Work Instructions-ULID-003591 and Work Instructions-ULID-003593.					

FCC Part 15.31 (e)

The RF Part has its own regulator.
The RF Part is constantly provided with voltage through the regulator regardless of input voltage.
Therefore, the EUT complies with the requirement.
However, the supply voltage was varied and tested at 85 % and 115 % of the nominal rated supply voltage during frequency tolerance test according to Section 15.225(e).

FCC Part 15.203 Antenna requirement

The EUT has an external antenna connector, but it is installed by the professionals.
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% emission bandwidth	<ISED>RSS-Gen 6.7	-	N/A	-	Radiated
Note: UL Japan, Inc.'s EMI Work Procedures: Work Instructions-ULID-003591 and Work Instructions-ULID-003593.					

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

SAC=Semi-Anechoic Chamber
SR= Shielded Room is applied besides radiated emission

Other test	Uncertainty (+/-)
Bandwidth Measurement	0.012 %
Temperature_SCH-01	0.96 deg.C.
Humidity_SCH-01	4.0 %
Temperature_SCH-02	2.2 deg.C.
Voltage	0.74 %
Frequency Measurement (Spectrum Analyzer)	1.7 x 10^-7
Frequency Measurement (Frequency Counter)	8.3 x 10^-8

3.5 Test Location

UL Japan, Inc. Shonan EMC Lab.
1-22-3 Megumigaoka, Hiratsuka-shi, Kanagawa-ken, 259-1220 Japan
Telephone number : +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)

The mode is used:

Test mode	Remarks
Transmitting mode (Tx)	The EUT Transmits and Receives at the same time and there is no receiving mode.
The EUT was operated in a manner similar to typical use during the tests.	
*Power of the EUT was set by the software as follows; Firmware: Ver 1.54 (Date: 2023/12/22, 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.	
Justification: The system was configured in typical fashion (as a user would normally use it) for testing.	

Test Item	Operating mode
Conducted Emission 20 dB Bandwidth and 99 % Occupied Bandwidth Frequency Tolerance	Tx, With ISO15693 Tag 1
Electric Field Strength of Fundamental Emission Spectrum Mask	Antenna: ITS-HAN10R Tx, With ISO15693 Tag 1 Antenna: ITS-HAN60S Horizontal: Tx, With ISO15693 Tag 2 Vertical: Tx, Without Tag
Electric Field Strength of Spurious Emission	Antenna: ITS-HAN10R (Below 30 MHz) Tx, With ISO15693 Tag 1 (Above 30 MHz) Tx, Without Tag Antenna: ITS-HAN60S (Below 30 MHz) Horizontal: Tx, With ISO15693 Tag 2 Vertical: Tx, With ISO15693 Tag 1 (Above 30 MHz) Tx, Without Tag

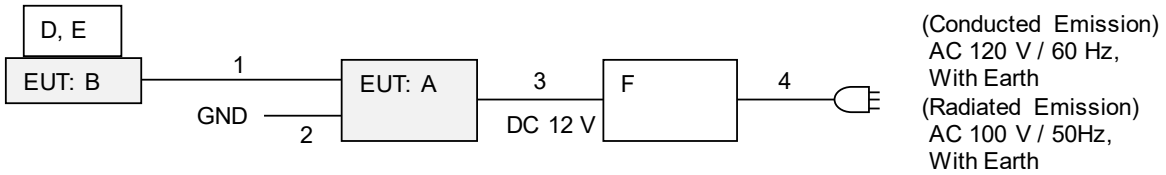
Frequency Tolerance	
Temperature	-20 deg. C to +50 deg. C Step 10 deg. C
Voltage	Normal Voltage DC 12 V Maximum Voltage DC 13.8 V (DC 12 V +15 %) Minimum Voltage DC 10.2 V (DC 12 V -15 %)
*This EUT provides stable voltage constantly to RF Part regardless of input voltage	

The carrier level and noise levels were confirmed Low bit rate and High bit rate, and the test was made with the condition that has the maximum noise.
Combinations of the worst case:

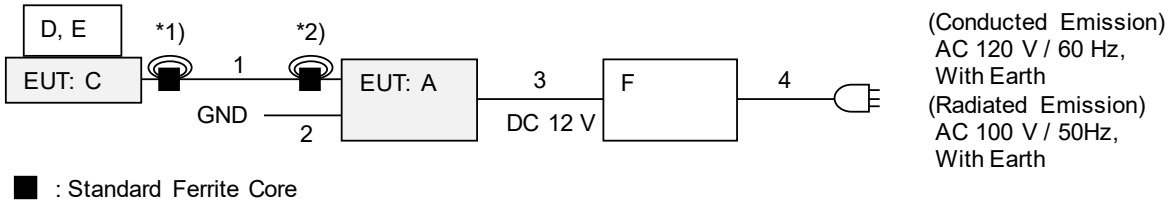
Antenna	Conducted Emission	Radiated Emission (Carrier)	Radiated Emission (Below 30MHz)	Radiated Emission (Above 30MHz)
ITS-HAN10R	Low bit rate	High bit rate	High bit rate	High bit rate
ITS-HAN60S	Low bit rate	High bit rate	High bit rate	High bit rate

4.2 Configuration and peripherals

Antenna : ITS-HAN10R



Antenna : ITS-HAN60S



*1) Ferrite core Model No. TFN 081610 (Manufacture: TKK) 2 cm from Item A, 3 turns
*2) Ferrite core Model No. TFN 081610 (Manufacture: TKK) 2 cm from Item C, 3 turns

* Cabling and setup 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	Remark
A	HF Band RFID Reader/Writer	ITS-HRW110	2000000292 *1) 2000000346 *2)	NITTOKU	EUT
B	Antenna	ITS-HAN10R	10R243	NITTOKU	EUT
C	Antenna	ITS-HAN60S	60S243	NITTOKU	EUT
D	ISO15693 Tag 1	ITS HTG21F52K	212243	NITTOKU	-
E	ISO15693 Tag 2	ITS HTG61F52K	612243	NITTOKU	-
F	Power Supply (DC)	PAN35-10A	DE001677	KIKUSUI	*3)
		PAN60-10A	NL002383	KIKUSUI	*4)
		PAN55-20A	DD000084	KIKUSUI	*5)
		PAN35-10A	NA000955	KIKUSUI	*6)

*1) Used for Low bit rate.
*2) Used for High bit rate.
*3) Used for Radiated emission test ITS-HAN10R antenna (Below 30 MHz).
*4) Used for Radiated emission test ITS-HAN10R antenna (Above 30 MHz).
*5) Used for Radiated emission test for ITS-HAN60S antenna.
*6) Used for Conducted emission test and Antenna terminal test for ITS-HAN60S antenna.

List of Cables Used

No.	Name	Length (m)	Shield		Remark
			Cable	Connector	
1	Antenna	2.0	Shielded	Shielded	-
2	Earth	3.0	Unshielded	Unshielded	-
3	DC	3.0	Unshielded	Unshielded	-
4	AC	2.0	Unshielded	Unshielded	-

SECTION 5: Conducted Emission

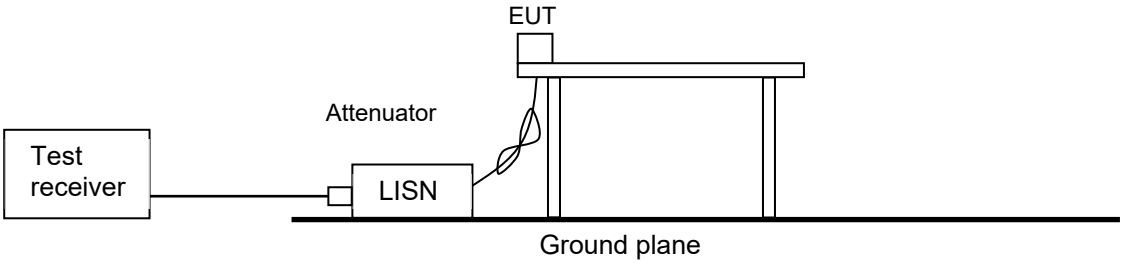
Test Procedure and conditions

EUT was placed on a urethane platform of nominal size, 1.0 m by 2.0 m and 1.0 m by 1.5 m, raised 0.8 m above the conducting ground plane.
The rear of tabletop was located 40 cm to the vertical conducting plane. The rear of EUT, including peripherals aligned and flushed with rear of tabletop. All other surfaces of tabletop were at least 80 cm from any other grounded conducting surface. EUT was located 80 cm from a Line Impedance Stabilization Network (LISN)/ Artificial mains Network (AMN) and excess AC cable was bundled in center.

I/O cables that were connected to the peripherals were bundled in center. They were folded back and forth forming a bundle 30 cm to 40 cm long and were hanged at a 40 cm height to the ground plane.

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

Figure 1: Test Setup



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

SECTION 6: Radiated Emission (Fundamental, Spurious Emission and Spectrum Mask)

Test Procedure

EUT was placed on a urethane platform of nominal size, 1.0 m by 2.0 m, raised 0.8 m above the conducting ground plane. The Radiated Electric Field Strength has been measured in a Semi Anechoic Chamber with a ground plane.

[Limit conversion]

The limits in CFR 47, Part 15, Subpart C, paragraph 15.209(a), are identical to those in RSS-Gen section 8.9, Table 6, since the measurements are performed in terms of magnetic field strength and converted to electric field strength levels (as reported in the table) using the free space impedance of 377 Ohmes. For example, the measurement at frequency 9 kHz resulted in a level of 45.5 dBuV/m, which is equivalent to 45.5 - 51.5 = -6.0 dBuA/m, which has the same margin, 3 dB, to the corresponding RSS-Gen Table 6 limit as it has to 15.209(a) limit.

[Frequency: From 9 kHz to 30 MHz]

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: 90 deg.) and horizontal polarization.
*Refer to Figure 3 about Direction of the Loop Antenna.

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.

These tests were performed in semi anechoic chamber. Therefore the measured level of emissions may be higher than if measurements were made without a ground plane. However test results were confirmed to pass against standard limit.

[Frequency: From 30 MHz to 1 GHz]

The measuring antenna height 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.

[Test instruments and test settings]

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

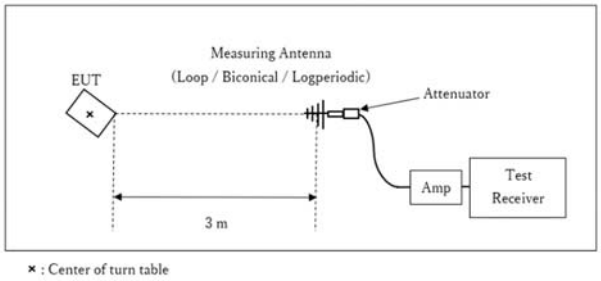
The test was made with the detector (RBW/VBW) in the following table.
When using Spectrum analyzer, the test was made with adjusting span to zero by using peak hold.

Frequency	From 9 kHz to 90 kHz and From 110 kHz to 150 kHz	From 90 kHz to 110 kHz	From 150 kHz to 490 kHz	From 490 kHz to 30 MHz	From 30 MHz to 1 GHz
Instrument used	Test Receiver				
Detector	PK / AV	QP	PK / AV	QP	QP
IF Bandwidth	200 Hz	200 Hz	9 kHz	9 kHz	120 kHz
Test Distance	3 m *1)	3 m *1)	3 m *1)	3 m *2)	3 m

*1) Distance Factor: 40 x log (3 m / 300 m) = -80 dB
*2) Distance Factor: 40 x log (3 m / 30 m) = -40 dB

Figure 2: Test Setup

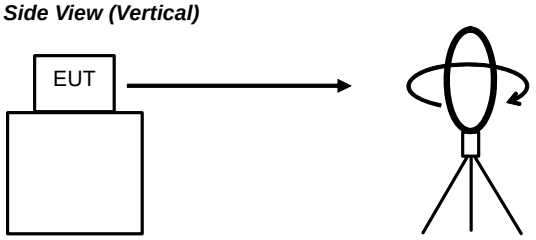
Below 1 GHz



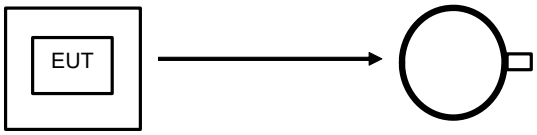
Test Distance: 3 m

Figure 3: Direction of the Loop Antenna

Side View (Vertical)

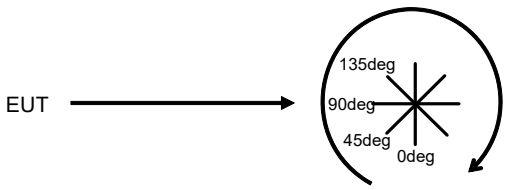


Top View (Horizontal)



Antenna was not rotated.

Top View (Vertical)



Front side: 0 deg.
Forward direction: clockwise

- 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.

		Frequency / Antenna polarization	Below 30 MHz (Carrier)	Below 30 MHz	Above 30 MHz
Module		Horizontal	X	X	X
		Vertical	X	X	X
Antenna	ITS-HAN10R	Horizontal	Z	Z	X
		Vertical	Y	Z	X
	ITS-HAN60S	Horizontal	Z	Z	X
		Vertical	Y	Z	X

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

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

SECTION 7: Other tests

Test	Span	RBW	VBW	Sweep	Detector	Trace	Instrument used
20 dB Bandwidth	100 kHz	1 kHz	3 kHz	Auto	Peak	Max Hold	Spectrum Analyzer
99 % Occupied Bandwidth	Enough width to display emission skirts	1 to 5 % of OBW	Three times of RBW	Auto	Peak *1)	Max Hold *1)	Spectrum Analyzer
Frequency Tolerance	-	-	-	-	-	-	Spectrum Analyzer *2)
*1) The measurement was performed with Peak detector, Max Hold since the duty cycle was not 100 %. *2) The measurement was performed with Marker Frequency Counter Function.							

Test data : APPENDIX
Test result : Pass

APPENDIX 1: Test data

Conducted Emission

DATA OF CONDUCTED EMISSION TEST

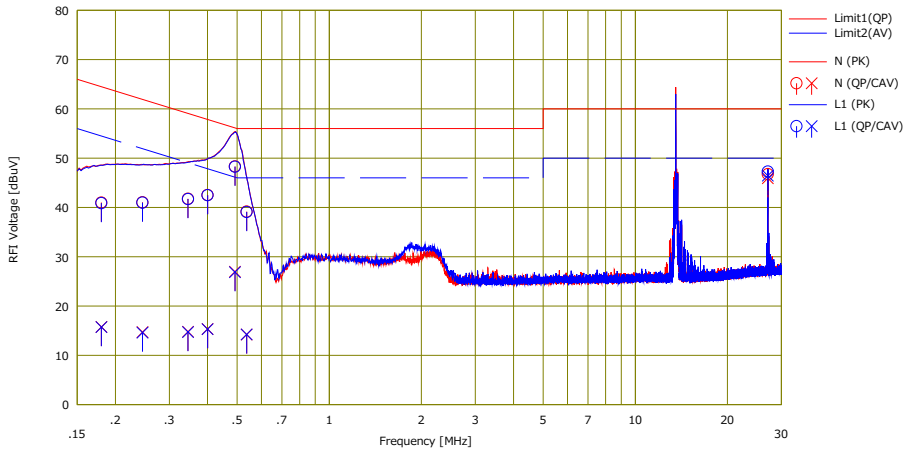
UL Japan,Inc. Shonan EMC Lab. No.2 Shielded Room
Date : 2023/12/26

Power : DC 12 V(AC 120 V / 60 Hz)
Temp./Humi. : 21 deg.C / 24 %RH

Remarks : With ISO15693 Tag 1, Antenna : ITS-HAN10R

Limit : FCC_Part 15 Subpart C(15.207)

Engineer : Yusuke Tanikawara



No.	Freq.	Reading		C.Fac	Results		Limit		Margin		Phase	Comment
		〈QP〉	〈CAV〉		〈QP〉	〈CAV〉	〈QP〉	〈AV〉	〈QP〉	〈AV〉		
	[MHz]	[dBuV]	[dBuV]	[dB]	[dBuV]	[dBuV]	[dBuV]	[dBuV]	[dB]	[dB]		
1	0.18002	28.55	3.32	12.43	40.98	15.75	64.48	54.48	23.5	38.7	N	
2	0.24521	28.58	2.25	12.44	41.02	14.69	61.92	51.92	20.9	37.2	N	
3	0.34526	29.31	2.33	12.44	41.75	14.77	59.08	49.08	17.3	34.3	N	
4	0.40025	30.05	2.87	12.46	42.51	15.33	57.85	47.85	15.3	32.5	N	
5	0.49198	35.85	14.50	12.46	48.31	26.96	56.13	46.13	7.8	19.1	N	
6	0.53686	26.68	1.75	12.46	39.14	14.21	56.00	46.00	16.8	31.7	N	
7	27.12000	32.97	32.13	13.79	46.76	45.92	60.00	50.00	13.2	4.0	N	
8	0.18002	28.46	3.29	12.42	40.88	15.71	64.48	54.48	23.6	38.7	L1	
9	0.24521	28.52	2.15	12.44	40.96	14.59	61.92	51.92	20.9	37.3	L1	
10	0.34526	29.27	2.28	12.43	41.70	14.71	59.08	49.08	17.3	34.3	L1	
11	0.40025	30.02	2.84	12.45	42.47	15.29	57.85	47.85	15.3	32.5	L1	
12	0.49198	35.79	14.40	12.47	48.26	26.87	56.13	46.13	7.8	19.2	L1	
13	0.53686	26.62	1.77	12.46	39.08	14.23	56.00	46.00	16.9	31.7	L1	
14	27.12000	33.26	32.42	14.02	47.28	46.44	60.00	50.00	12.7	3.5	L1	

Calculation:Result[dBuV]=Reading[dBuV]+C.Fac(LISN(AMN)+Cable+ATT)[dB]
LISN(AMN): 145539

Conducted Emission

DATA OF CONDUCTED EMISSION TEST

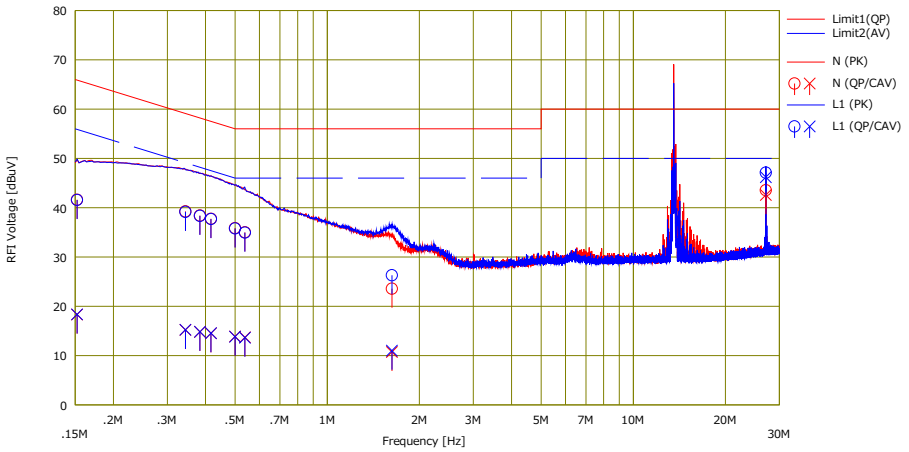
UL Japan,Inc. Shonan EMC Lab. No.2 Shielded Room
Date : 2024/03/01

Power : DC 12 V(AC 120 V / 60 Hz)
Temp./Humi. : 23 deg.C / 33 %RH

Remarks : With ISO15693 Tag 1, Antenna : ITS-HAN60S

Limit : FCC_Part 15 Subpart C(15.207)

Engineer : Yusuke Tanikawara



No.	Freq.	Reading		C.Fac	Results		Limit		Margin		Phase	Comment
		(QP)	(CAV)		(QP)	(CAV)	(QP)	(AV)	(QP)	(AV)		
	[MHz]	[dBuV]	[dBuV]	[dB]	[dBuV]	[dBuV]	[dBuV]	[dBuV]	[dB]	[dB]		
1	0.15217	26.11	2.82	15.50	41.61	18.32	65.88	55.88	24.2	37.5	N	
2	0.34401	23.72	-0.32	15.52	39.24	15.20	59.11	49.11	19.8	33.9	N	
3	0.38366	22.87	-0.72	15.52	38.39	14.80	58.20	48.20	19.8	33.4	N	
4	0.41690	22.22	-1.00	15.52	37.74	14.52	57.51	47.51	19.7	32.9	N	
5	0.49977	20.30	-1.68	15.55	35.85	13.87	56.00	46.00	20.1	32.1	N	
6	0.53828	19.45	-1.86	15.56	35.01	13.70	56.00	46.00	20.9	32.3	N	
7	1.62628	7.91	-4.93	15.65	23.56	10.73	56.00	46.00	32.4	35.2	N	
8	27.12000	26.20	25.22	17.35	43.55	42.57	60.00	50.00	16.4	7.4	N	
9	0.15217	26.06	2.86	15.50	41.56	18.36	65.88	55.88	24.3	37.5	L1	
10	0.34401	23.63	-0.27	15.51	39.14	15.24	59.11	49.11	19.9	33.8	L1	
11	0.38366	22.81	-0.70	15.52	38.33	14.82	58.20	48.20	19.8	33.3	L1	
12	0.41690	22.17	-0.99	15.52	37.69	14.53	57.51	47.51	19.8	32.9	L1	
13	0.49977	20.26	-1.69	15.52	35.78	13.83	56.00	46.00	20.2	32.1	L1	
14	0.53828	19.42	-1.89	15.52	34.94	13.63	56.00	46.00	21.0	32.3	L1	
15	1.62628	10.66	-4.62	15.62	26.28	11.00	56.00	46.00	29.7	35.0	L1	
16	27.12000	30.07	29.16	17.04	47.11	46.20	60.00	50.00	12.8	3.8	L1	

Calculation:Result[dBuV]=Reading[dBuV]+C.Fac(LISN(AMN)+Cable+ATT)[dB]
LISN(AMN): 145539

Conducted Emission

DATA OF CONDUCTED EMISSION TEST

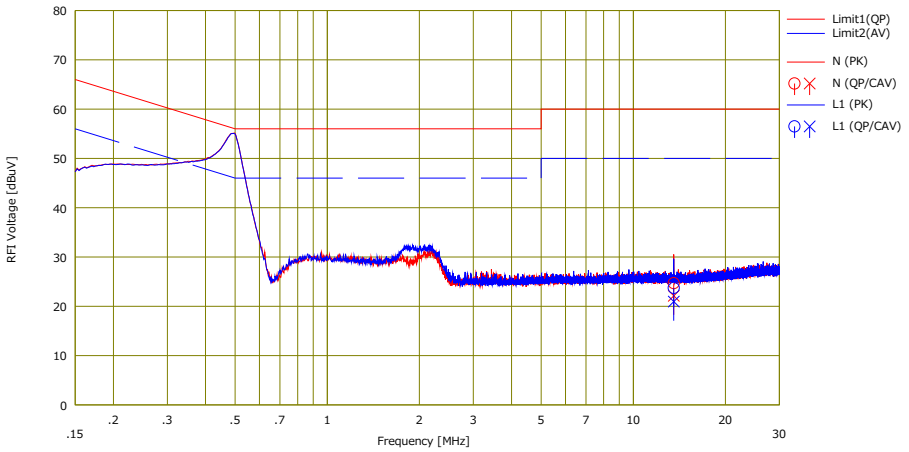
UL Japan,Inc. Shonan EMC Lab. No.2 Shielded Room
Date : 2023/12/26

Power : DC 12 V(AC 120 V / 60 Hz)
Temp./Humi. : 21 deg.C / 24 %RH

Remarks : Antenna terminated

Limit : FCC_Part 15 Subpart C(15.207)

Engineer : Yusuke Tanikawara



No.	Freq.	Reading		C.Fac	Results		Limit		Margin		Phase	Comment
		〈QP〉	〈CAV〉		〈QP〉	〈CAV〉	〈QP〉	〈AV〉	〈QP〉	〈AV〉		
	[MHz]	[dBuV]	[dBuV]	[dB]	[dBuV]	[dBuV]	[dBuV]	[dBuV]	[dB]	[dB]		
1	13.56000	11.51	8.96	13.16	24.67	22.12	60.00	50.00	35.3	27.8	N	
2	13.56000	10.49	7.72	13.22	23.71	20.94	60.00	50.00	36.2	29.0	L1	

Calculation:Result[dBuV]=Reading[dBuV]+C.Fac(LISN(AMN)+Cable+ATT)[dB]
LISN(AMN): 145539

Fundamental Emission and Spectrum Mask

Test place	Shonan EMC Lab.
Semi Anechoic Chamber	SAC1
Date	December 27, 2023
Temperature / Humidity	20 deg. C / 28 % RH
Engineer	Yuta Shiba
Remarks	Antenna: ITS-HAN10R, Vertical Antenna degree: 90 deg. (Worst) Horizontal: With ISO15693 Tag 1 / Vertical: With ISO15693 Tag 1

Fundamental emission

No.	FREQ	Test Receiver Reading		Antenna Factor	Loss	AMP GAIN	Distance factor	RESULT		LIMIT (30m)	MARGIN	
		Hor	Ver					Hor	Ver		Hor	Ver
	[MHz]	[dBuV]	[dBuV]	[dB/m]	[dB]	[dB]	[dB]	[dBuV/m]	[dBuV/m]	[dBuV/m]	[dB]	[dB]
1	13.560	64.90	67.90	19.35	6.56	31.85	-40.00	18.96	21.96	83.90	64.9	61.9

Calculation:Result[dBuV/m]=Reading[dBuV]+Ant.Fac[dB/m]+Loss(Cable+ATT)[dB]-Gain(AMP)[dB]+Distance factor[dB]

Distance factor: 40 x log (3 m/30 m) = -40 dB

Limits (30 m)

・13.553 MHz to 13.567 MHz : 83.9 dBuV/m (FCC 15.225(a))

Spurious emission within the band

No.	FREQ	Test Receiver Reading		Antenna Factor	Loss	AMP GAIN	Distance factor	RESULT		LIMIT (30m)	MARGIN	
		Hor	Ver					Hor	Ver		Hor	Ver
	[MHz]	[dBuV]	[dBuV]	[dB/m]	[dB]	[dB]	[dB]	[dBuV/m]	[dBuV/m]	[dBuV/m]	[dB]	[dB]
1	13.110	29.80	29.90	19.32	6.55	31.85	-40.00	-16.18	-16.08	29.50	45.7	45.6
2	13.351	41.00	44.10	19.34	6.55	31.85	-40.00	-4.96	-1.86	40.50	45.5	42.4
3	13.410	33.30	36.10	19.34	6.56	31.85	-40.00	-12.65	-9.85	40.50	53.2	50.4
4	13.454	39.90	31.40	19.35	6.56	31.85	-40.00	-6.04	-14.54	50.40	56.4	64.9
5	13.553	50.40	54.00	19.35	6.56	31.85	-40.00	4.46	8.06	50.40	45.9	42.3
6	13.567	49.60	53.20	19.36	6.56	31.85	-40.00	3.67	7.27	50.40	46.7	43.1
7	13.653	34.60	31.40	19.36	6.56	31.85	-40.00	-11.33	-14.53	50.40	61.7	64.9
8	13.710	32.90	35.40	19.37	6.56	31.85	-40.00	-13.02	-10.52	40.50	53.5	51.0
9	13.764	41.40	40.60	19.37	6.56	31.85	-40.00	-4.52	-5.32	40.50	45.0	45.8
10	14.010	29.80	29.70	19.39	6.57	31.85	-40.00	-16.09	-16.19	29.50	45.6	45.7

Calculation:Result[dBuV/m]=Reading[dBuV]+Ant.Fac[dB/m]+Loss(Cable+ATT)[dB]-Gain(AMP)[dB]+Distance factor[dB]

Outside filed strength frequencies

・Fc±7 kHz:13.553 MHz to 13.567 MHz

・Fc±150 kHz:13.410 MHz to 13.710 MHz

・Fc±450 kHz:13.110 MHz to 14.010 MHz

Fc = 13.56 MHz

Limits (30 m)

・13.410 MHz to 13.553 MHz and 13.567 MHz to 13.710 MHz : 50.4 dBuV/m (FCC 15.225(b))

・13.110 MHz to 13.410 MHz and 13.710 MHz to 14.010 MHz : 40.5 dBuV/m (FCC 15.225(c))

・Below 13.110 MHz and Above 14.010 MHz : 29.5 dBuV/m (FCC 15.225(d)and FCC 15.209)

Fundamental Emission and Spectrum Mask

Test place	Shonan EMC Lab.
Semi Anechoic Chamber	SAC2
Date	February 29, 2024
Temperature / Humidity	23 deg. C / 30 % RH
Engineer	Yusuke Tanikawara
Remarks	Antenna: ITS-HAN60S, Vertical Antenna degree: 90 deg. (Worst) Horizontal: With ISO15693 Tag 2 / Vertical: Without Tag

Fundamental emission

No.	FREQ	Test Receiver Reading		Antenna Factor	Loss	AMP GAIN	Distance factor	RESULT		LIMIT (30m)	MARGIN	
		Hor	Ver					Hor	Ver		Hor	Ver
	[MHz]	[dBuV]	[dBuV]	[dB/m]	[dB]	[dB]	[dB]	[dBuV/m]	[dBuV/m]	[dBuV/m]	[dB]	[dB]
1	13.560	63.00	76.60	19.35	6.55	31.96	-40.00	16.94	30.54	83.90	67.0	53.4

Calculation:Result[dBuV/m]=Reading[dBuV]+Ant.Fac[dB/m]+Loss(Cable+ATT)[dB]-Gain(AMP)[dB]+Distance factor[dB]

Distance factor: 40 x log (3 m/30 m) = -40 dB

Limits (30 m)

・13.553 MHz to 13.567 MHz : 83.9 dBuV/m (FCC 15.225(a))

Spurious emission within the band

No.	FREQ	Test Receiver Reading		Antenna Factor	Loss	AMP GAIN	Distance factor	RESULT		LIMIT (30m)	MARGIN	
		Hor	Ver					Hor	Ver		Hor	Ver
	[MHz]	[dBuV]	[dBuV]	[dB/m]	[dB]	[dB]	[dB]	[dBuV/m]	[dBuV/m]	[dBuV/m]	[dB]	[dB]
1	13.110	30.30	30.10	19.32	6.54	31.96	-40.00	-15.80	-16.00	29.50	45.3	45.5
2	13.350	39.50	51.50	19.34	6.54	31.96	-40.00	-6.58	5.42	40.50	47.1	35.1
3	13.410	32.00	43.20	19.34	6.55	31.96	-40.00	-14.07	-2.87	40.50	54.6	43.4
4	13.462	38.30	50.50	19.35	6.55	31.96	-40.00	-7.76	4.44	50.40	58.2	46.0
5	13.553	49.30	63.00	19.35	6.55	31.96	-40.00	3.24	16.94	50.40	47.2	33.5
6	13.567	48.10	61.90	19.36	6.55	31.96	-40.00	2.05	15.85	50.40	48.4	34.6
7	13.665	35.60	48.50	19.36	6.55	31.96	-40.00	-10.45	2.45	50.40	60.9	48.0
8	13.699	31.80	44.60	19.37	6.55	31.96	-40.00	-14.24	-1.44	50.40	64.6	51.8
9	13.710	32.20	44.60	19.37	6.55	31.96	-40.00	-13.84	-1.44	40.50	54.3	41.9
10	13.770	38.60	53.50	19.37	6.55	31.96	-40.00	-7.44	7.46	40.50	47.9	33.0
11	13.882	30.30	40.00	19.38	6.56	31.96	-40.00	-15.72	-6.02	40.50	56.2	46.5
12	14.010	30.20	30.20	19.39	6.56	31.96	-40.00	-15.81	-15.81	29.50	45.3	45.3

Calculation:Result[dBuV/m]=Reading[dBuV]+Ant.Fac[dB/m]+Loss(Cable+ATT)[dB]-Gain(AMP)[dB]+Distance factor[dB]

Outside filed strength frequencies

・Fc±7 kHz:13.553 MHz to 13.567 MHz

・Fc±150 kHz:13.410 MHz to 13.710 MHz

・Fc±450 kHz:13.110 MHz to 14.010 MHz

Fc = 13.56 MHz

Limits (30 m)

・13.410 MHz to 13.553 MHz and 13.567 MHz to 13.710 MHz : 50.4 dBuV/m (FCC 15.225(b))

・13.110 MHz to 13.410 MHz and 13.710 MHz to 14.010 MHz : 40.5 dBuV/m (FCC 15.225(c))

・Below 13.110 MHz and Above 14.010 MHz : 29.5 dBuV/m (FCC 15.225(d)and FCC 15.209)

Spurious Emission

Test place	Shonan EMC Lab.	
Semi Anechoic Chamber	SAC1	SAC1
Date	December 27, 2023	December 25, 2023
Temperature / Humidity	20 deg. C / 28 % RH	25 deg. C / 31 % RH
Engineer	Yuta Shiba	Hiromasa Sato
	(Below 30 MHz)	(Above 30 MHz)
Mode	(Below 30 MHz) Antenna: ITS-HAN10R, With ISO15693 Tag 1	
	(Above 30 MHz) Antenna: ITS-HAN10R, Without Tag	

Polarity	Frequency [MHz]	Detector	Reading [dBuV]	Ant.Fac. [dB/m]	Loss [dB]	Gain [dB]	Distance Factor [dB]	Result [dBuV/m]	Limit [dBuV/m]	Margin [dB]	Height [cm]	Angle [deg.]	Remark
Hori.	27.120	QP	29.00	20.66	6.89	31.83	-40.00	-15.28	29.5	44.8	-	260	* Limit: 30m
Hori.	393.240	QP	50.18	15.29	7.20	31.78	-	40.89	46.0	5.1	100	137	-
Hori.	420.360	QP	45.39	15.80	7.37	31.80	-	36.76	46.0	9.2	100	225	-
Hori.	447.480	QP	52.69	16.82	7.53	31.84	-	45.20	46.0	**0.8**	100	125	-
Hori.	461.040	QP	45.44	17.03	7.62	31.84	-	38.25	46.0	7.8	100	130	-
Hori.	474.600	QP	44.88	17.21	7.70	31.84	-	37.95	46.0	8.1	193	302	-
Hori.	488.160	QP	42.67	17.35	7.77	31.84	-	35.95	46.0	10.1	183	23	-
Hori.	501.720	QP	44.38	17.46	7.85	31.84	-	37.85	46.0	8.2	100	204	-
Vert.	27.120	QP	36.40	20.66	6.89	31.83	-40.00	-7.88	29.50	37.4	-	140	* Limit: 30m
Vert.	40.680	QP	43.33	14.57	7.29	31.83	-	33.36	40.00	6.6	100	345	
Vert.	393.240	QP	45.77	15.29	7.20	31.78	-	36.48	46.00	9.5	100	88	
Vert.	420.360	QP	48.95	15.80	7.37	31.80	-	40.32	46.00	5.7	100	56	
Vert.	447.480	QP	49.75	16.82	7.53	31.84	-	42.26	46.00	3.7	100	164	
Vert.	461.040	QP	47.39	17.03	7.62	31.84	-	40.20	46.00	5.8	100	154	
Vert.	474.600	QP	46.66	17.21	7.70	31.84	-	39.73	46.00	6.3	100	307	
Vert.	488.160	QP	45.70	17.35	7.77	31.84	-	38.98	46.00	7.0	100	183	
Vert.	501.720	QP	46.00	17.46	7.85	31.84	-	39.47	46.00	6.5	100	179	

Result = Reading + Ant Factor + Loss (Cable+ATT+ΔAF(above 30 MHz)) - Gain(Amprifier) + Distance factor(below 30 MHz)

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

* Carrier level (Result at 3m): Hor= 59 dBuV/m, Ver= 62 dBuV/m

Spurious Emission

Test place	Shonan EMC Lab.
Semi Anechoic Chamber	SAC2
Date	February 29, 2024
Temperature / Humidity	23 deg. C / 30 % RH
Engineer	Yusuke Tanikawara
Remarks	(Below 30 MHz) Antenna: ITS-HAN60S, Horizontal: With ISO15693 Tag 2 Vertical: With ISO15693 Tag 1 (Above 30 MHz) Antenna: ITS-HAN60S, Without Tag

Polarity	Frequency [MHz]	Detector	Reading [dBuV]	Ant.Fac. [dB/m]	Loss [dB]	Gain [dB]	Distance Factor [dB]	Result [dBuV/m]	Limit [dBuV/m]	Margin [dB]	Height [cm]	Angle [deg.]	Remark
Hori.	12.931	QP	30.90	19.31	6.53	31.96	-40.00	-15.22	29.50	44.7	-	241	* Limit: 30m
Hori.	14.185	QP	30.60	19.41	6.56	31.96	-40.00	-15.39	29.50	44.9	-	241	* Limit: 30m
Hori.	27.120	QP	29.40	20.66	6.88	31.95	-40.00	-15.01	29.50	44.5	-	5	* Limit: 30m
Hori.	420.357	QP	50.40	15.85	7.48	31.68	-	42.05	46.00	4.0	100	341	-
Hori.	433.917	QP	52.80	16.27	7.58	31.68	-	44.97	46.00	**1.0**	199	262	-
Hori.	447.479	QP	52.00	16.66	7.68	31.68	-	44.66	46.00	1.3	212	271	-
Hori.	461.037	QP	48.90	16.92	7.76	31.68	-	41.90	46.00	4.1	198	242	-
Hori.	542.396	QP	45.10	18.30	8.20	31.69	-	39.91	46.00	6.1	148	261	-
Hori.	623.756	QP	44.20	18.73	8.64	31.64	-	39.93	46.00	6.1	100	259	-
Hori.	650.877	QP	42.40	20.02	8.78	31.65	-	39.55	46.00	6.5	100	238	-
Hori.	677.995	QP	45.10	20.23	8.94	31.61	-	42.66	46.00	3.3	122	135	-
Vert.	12.931	QP	39.00	19.31	6.53	31.96	-40.00	-7.12	29.50	36.6	-	249	* Limit: 30m
Vert.	14.185	QP	42.30	19.41	6.56	31.96	-40.00	-3.69	29.50	33.2	-	249	* Limit: 30m
Vert.	27.120	QP	39.10	20.66	6.88	31.95	-40.00	-5.31	29.50	34.8	-	136	* Limit: 30m
Vert.	420.359	QP	50.90	15.85	7.48	31.68	-	42.55	46.00	3.5	120	256	-
Vert.	433.919	QP	51.40	16.27	7.58	31.68	-	43.57	46.00	2.4	150	352	-
Vert.	447.479	QP	48.90	16.66	7.68	31.68	-	41.56	46.00	4.4	115	3	-
Vert.	461.039	QP	49.20	16.92	7.76	31.68	-	42.20	46.00	3.8	100	225	-
Vert.	542.398	QP	47.00	18.30	8.20	31.69	-	41.81	46.00	4.2	100	25	-
Vert.	650.875	QP	43.00	20.02	8.78	31.65	-	40.15	46.00	5.9	180	352	-

Result = Reading + Ant Factor + Loss (Cable+ATT+ΔAF(above 30 MHz)) - Gain(Amprifier) + Distance factor(below 30 MHz)

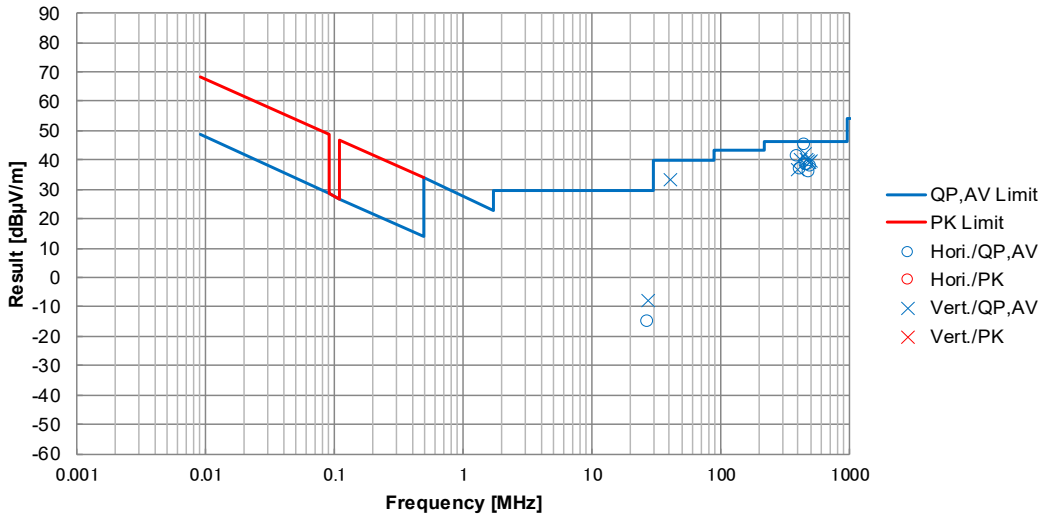
* Other frequency noises omitted in this report were not seen or have enough margin (more than 20 dB).

* Carrier level (Result at 3m): Hor= 56.9 dBuV/m, Ver= 70.5 dBuV/m

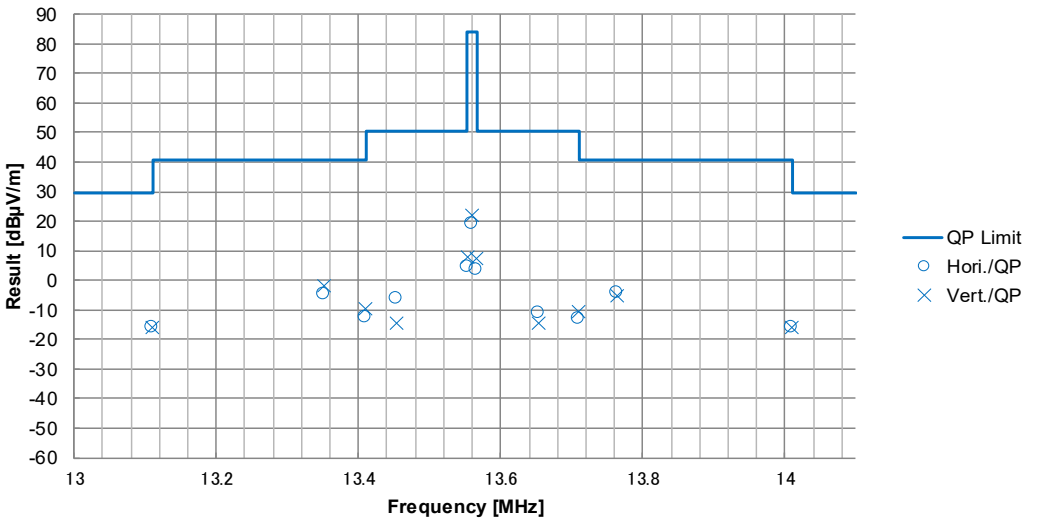
Radiated Spurious Emission

Test place	Shonan EMC Lab.	
Semi Anechoic Chamber	SAC1	SAC1
Date	December 27, 2023	December 25, 2023
Temperature / Humidity	20 deg. C / 28 % RH	25 deg. C / 31 % RH
Engineer	Yuta Shiba	Hiromasa Sato
	(Below 30 MHz)	(Above 30 MHz)
Remarks	Antenna: ITS-HAN10R	

Spurious emission plot



Within band plot

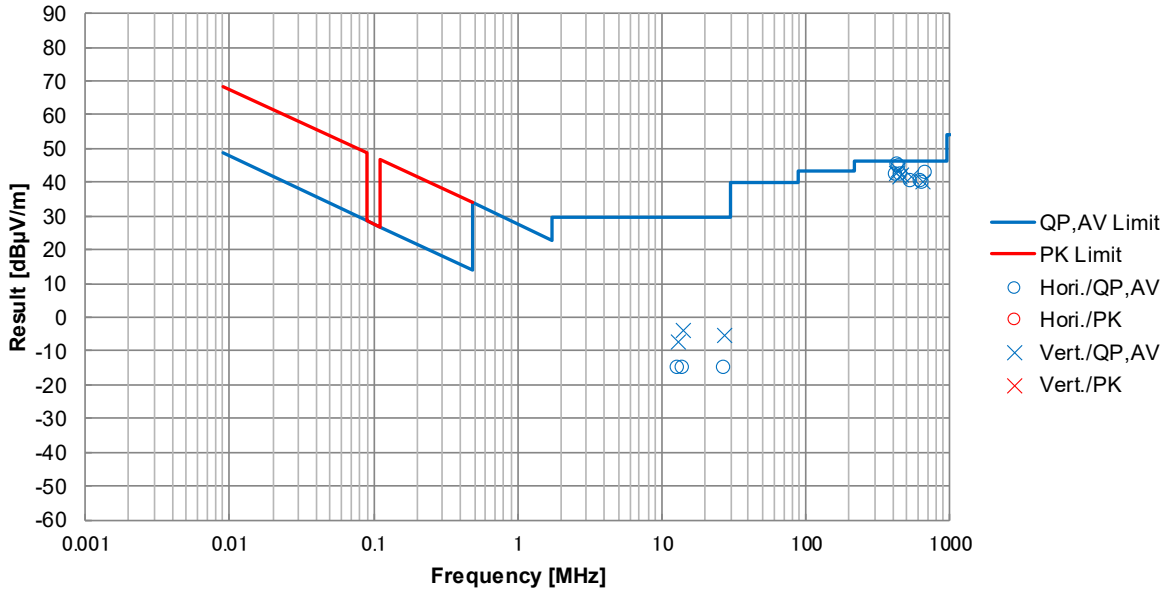


*These plots data contains sufficient number to show the trend of characteristic features for EUT.

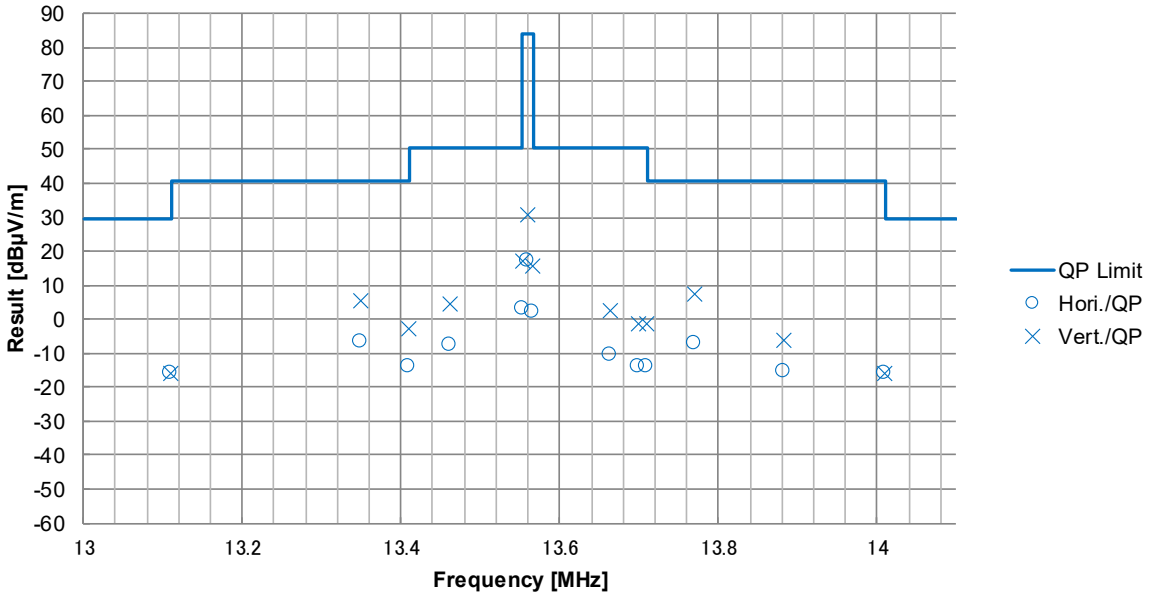
Radiated Spurious Emission

Test place	Shonan EMC Lab.
Semi Anechoic Chamber	SAC2
Date	February 29, 2024
Temperature / Humidity	23 deg. C / 30 % RH
Engineer	Yusuke Tanikawara
Remarks	Antenna: ITS-HAN60S

Spurious emission plot



Within band plot



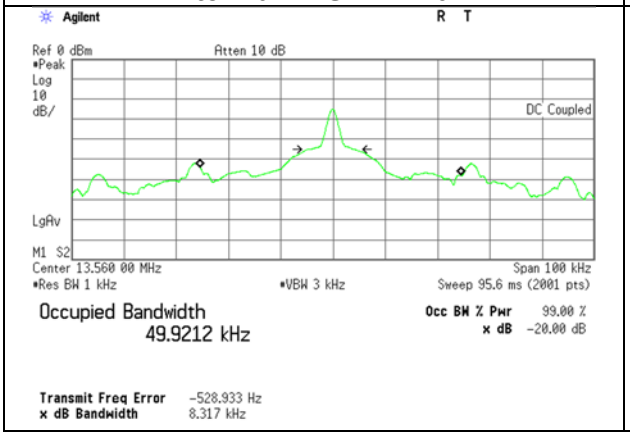
*These plots data contains sufficient number to show the trend of characteristic features for EUT.

20 dB Bandwidth and 99% Occupied Bandwidth

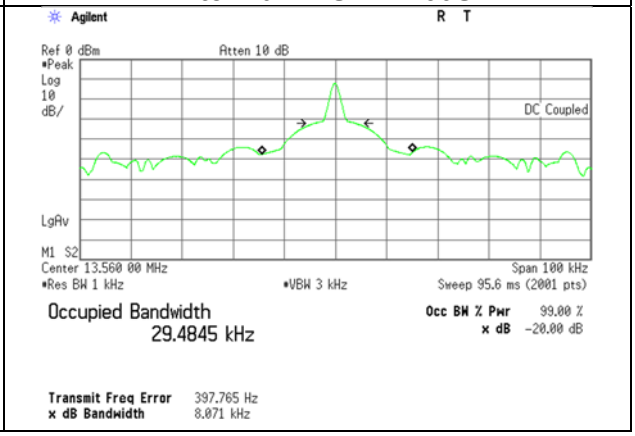
Test place	Shonan EMC Lab.	
Semi Anechoic Chamber	No.5 Shielded Room	No.5 Shielded Room
Date	December 22, 2023	March 1, 2024
Temperature / Humidity	20 deg. C / 33 % RH	21 deg. C / 36 % RH
Engineer	Kouki Yamada	Yusuke Tanikawara
Remarks	Antenna: ITS-HAN10R, With ISO15693 Tag 1	Antenna: ITS-HAN60S, With ISO15693 Tag 1

Antenn	FREQ [MHz]	20dB Bandwidth [kHz]	99% Occupied Bandwidth [kHz]
ITS-HAN10R	13.56	8.317	49.9212
ITS-HAN60S	13.56	8.071	29.4845

Antenna : ITS-HAN10R



Antenna : ITS-HAN60S



Frequency Tolerance

Test place	Shonan EMC Lab.
Semi Anechoic Chamber	No.5 Shielded Room
Date	December 22, 2023
Temperature / Humidity	20 deg. C / 33 % RH
Engineer	Kouki Yamada
Remarks	Antenna: ITS-HAN10R, With ISO15693 Tag 1

Test condition		Tested	Measured	Frequency	Result		Limit
Temp.	Voltage	timing	frequency	error			
[deg. C]	[V]		[MHz]	[MHz]	[%]	[ppm]	[+/- %]
50	12	Power on	13.559807	-0.000193	-0.00143	-14.3	0.01
		+ 2 min.	13.559856	-0.000144	-0.00106	-10.6	0.01
		+ 5 min.	13.559830	-0.000170	-0.00125	-12.5	0.01
		+ 10 min.	13.559866	-0.000134	-0.00099	-9.9	0.01
40	12	Power on	13.559883	-0.000117	-0.00086	-8.6	0.01
		+ 2 min.	13.559892	-0.000108	-0.00080	-8.0	0.01
		+ 5 min.	13.559851	-0.000149	-0.00110	-11.0	0.01
		+ 10 min.	13.559910	-0.000090	-0.00067	-6.7	0.01
30	12	Power on	13.559912	-0.000088	-0.00065	-6.5	0.01
		+ 2 min.	13.559926	-0.000074	-0.00054	-5.4	0.01
		+ 5 min.	13.559976	-0.000024	-0.00018	-1.8	0.01
		+ 10 min.	13.559926	-0.000074	-0.00055	-5.5	0.01
20	12	Power on	13.559918	-0.000082	-0.00061	-6.1	0.01
		+ 2 min.	13.559949	-0.000051	-0.00038	-3.8	0.01
		+ 5 min.	13.559898	-0.000102	-0.00075	-7.5	0.01
		+ 10 min.	13.559927	-0.000073	-0.00054	-5.4	0.01
20	10.2	Power on	13.559912	-0.000088	-0.00065	-6.5	0.01
	(12V -15 %)	+ 2 min.	13.559948	-0.000052	-0.00038	-3.8	0.01
		+ 5 min.	13.559973	-0.000027	-0.00020	-2.0	0.01
		+ 10 min.	13.559999	-0.000001	0.00000	0.0	0.01
20	13.8	Power on	13.559933	-0.000067	-0.00049	-4.9	0.01
	(12V +15 %)	+ 2 min.	13.559919	-0.000081	-0.00060	-6.0	0.01
		+ 5 min.	13.560011	0.000011	0.00008	0.8	0.01
		+ 10 min.	13.560007	0.000007	0.00005	0.5	0.01
10	12	Power on	13.560027	0.000027	0.00020	2.0	0.01
		+ 2 min.	13.559958	-0.000042	-0.00031	-3.1	0.01
		+ 5 min.	13.560007	0.000007	0.00005	0.5	0.01
		+ 10 min.	13.559947	-0.000053	-0.00039	-3.9	0.01
0	12	Power on	13.560054	0.000054	0.00040	4.0	0.01
		+ 2 min.	13.560053	0.000053	0.00039	3.9	0.01
		+ 5 min.	13.560042	0.000042	0.00031	3.1	0.01
		+ 10 min.	13.560073	0.000073	0.00054	5.4	0.01
-10	12	Power on	13.560014	0.000014	0.00010	1.0	0.01
		+ 2 min.	13.560013	0.000013	0.00010	1.0	0.01
		+ 5 min.	13.559964	-0.000036	-0.00027	-2.7	0.01
		+ 10 min.	13.560015	0.000015	0.00011	1.1	0.01
-20	12	Power on	13.560026	0.000026	0.00019	1.9	0.01
		+ 2 min.	13.559866	-0.000134	-0.00099	-9.9	0.01
		+ 5 min.	13.560027	0.000027	0.00020	2.0	0.01
		+ 10 min.	13.559998	-0.000002	-0.00001	-0.1	0.01

Calculation formula: Frequency error = Measured frequency - Tested frequency (13.56 MHz)
Result [%] = Frequency error / Tested frequency * 100

*The test was begun from 50 deg. C and the temperature was lowered each 10 deg. C.

Frequency Tolerance

Test place	Shonan EMC Lab.
Semi Anechoic Chamber	No.5 Shielded Room
Date	March 1, 2024
Temperature / Humidity	21 deg. C / 36 % RH
Engineer	Yusuke Tanikawara
Remarks	Antenna: ITS-HAN60S, With ISO15693 Tag 1

Test condition		Tested	Measured	Frequency	Result		Limit
Temp.	Voltage	timing	frequency	error			
[deg. C]	[V]		[MHz]	[MHz]	[%]	[ppm]	[+/- %]
50	12	Power on	13.559853	-0.000147	-0.00108	-10.8	0.01
		+ 2 min.	13.559848	-0.000152	-0.00112	-11.2	0.01
		+ 5 min.	13.559866	-0.000134	-0.00099	-9.9	0.01
		+ 10 min.	13.559866	-0.000134	-0.00099	-9.9	0.01
40	12	Power on	13.559921	-0.000079	-0.00058	-5.8	0.01
		+ 2 min.	13.559916	-0.000084	-0.00062	-6.2	0.01
		+ 5 min.	13.559896	-0.000104	-0.00077	-7.7	0.01
		+ 10 min.	13.559897	-0.000103	-0.00076	-7.6	0.01
30	12	Power on	13.559211	-0.000789	-0.00582	-58.2	0.01
		+ 2 min.	13.559966	-0.000034	-0.00025	-2.5	0.01
		+ 5 min.	13.559935	-0.000065	-0.00048	-4.8	0.01
		+ 10 min.	13.559914	-0.000086	-0.00063	-6.3	0.01
20	12	Power on	13.559965	-0.000035	-0.00026	-2.6	0.01
		+ 2 min.	13.559954	-0.000046	-0.00034	-3.4	0.01
		+ 5 min.	13.559943	-0.000057	-0.00042	-4.2	0.01
		+ 10 min.	13.559902	-0.000098	-0.00072	-7.2	0.01
20	10.2	Power on	13.559946	-0.000054	-0.00040	-4.0	0.01
	(12V -15 %)	+ 2 min.	13.560002	0.000002	0.00002	0.2	0.01
		+ 5 min.	13.559990	-0.000010	-0.00007	-0.7	0.01
		+ 10 min.	13.559950	-0.000050	-0.00037	-3.7	0.01
20	13.8	Power on	13.559972	-0.000028	-0.00021	-2.1	0.01
	(12V +15 %)	+ 2 min.	13.559891	-0.000109	-0.00080	-8.0	0.01
		+ 5 min.	13.559830	-0.000170	-0.00125	-12.5	0.01
		+ 10 min.	13.559949	-0.000051	-0.00038	-3.8	0.01
10	12	Power on	13.560026	0.000026	0.00019	1.9	0.01
		+ 2 min.	13.560015	0.000015	0.00011	1.1	0.01
		+ 5 min.	13.560003	0.000003	0.00002	0.2	0.01
		+ 10 min.	13.559983	-0.000017	-0.00013	-1.3	0.01
0	12	Power on	13.560034	0.000034	0.00025	2.5	0.01
		+ 2 min.	13.559955	-0.000045	-0.00033	-3.3	0.01
		+ 5 min.	13.559974	-0.000026	-0.00019	-1.9	0.01
		+ 10 min.	13.560014	0.000014	0.00011	1.1	0.01
-10	12	Power on	13.559992	-0.000008	-0.00006	-0.6	0.01
		+ 2 min.	13.559976	-0.000024	-0.00017	-1.7	0.01
		+ 5 min.	13.559976	-0.000024	-0.00018	-1.8	0.01
		+ 10 min.	13.559926	-0.000074	-0.00054	-5.4	0.01
-20	12	Power on	13.559951	-0.000049	-0.00036	-3.6	0.01
		+ 2 min.	13.559927	-0.000073	-0.00054	-5.4	0.01
		+ 5 min.	13.560021	0.000021	0.00015	1.5	0.01
		+ 10 min.	13.560001	0.000001	0.00001	0.1	0.01

Calculation formula: Frequency error = Measured frequency - Tested frequency (13.56 MHz)
Result [%] = Frequency error / Tested frequency * 100

*The test was begun from 50 deg. C and the temperature was lowered each 10 deg. C.

APPENDIX 2: Test instruments

Test Equipment

Test Item	LIMS ID	Description	Manufacturer	Model	Serial	Last Calibration Date	Cal Int
CE	144896	Attenuator	JFW IND. INC.	50HF-003N	-	2023/07/11	12
CE	144969	Coaxial Cable&RF Selector	Suhner/Suhner/TOYO	RG223U/141PE/NS4906	-/0901-270(RF Selector)	2023/04/18	12
CE	145540	LISN	Rohde & Schwarz	ENV216	100513	2024/02/06	12
CE	150463	Test Receiver	Rohde & Schwarz	ESW44	101581	2023/08/25	12
CE	191839	Thermo-Hygrometer	CUSTOM. Inc	CTH-201	-	2023/08/01	12
CE	199781	Attenuator	JFW	50HF-006N	-	2023/06/14	12
CE	213530	Test Receiver	Rohde & Schwarz	ESW44	103068	2024/02/22	12
CE,RE	145793	Digital Hitester	HIOKI E.E. CORPORATION	3805-50	80997819	2023/05/26	12
CE,RE	170932	EMI Software	TSJ (Techno Science Japan)	TEPTO-DV3(RE,CE,ME,PE)	-	-	-
CE,RE	207277	Measuring	ASKUL	-	-	-	-
RE	144975	Coaxial Cable&RF Selector	Fujikura/Fujikura/Suhner/Suhner/Suhner/TOYO	8D2W/12DSFA/141PE/141PE/141PE/141PE/NS4906	-/0901-270(RF Selector)	2023/04/18	12
RE	144976	Coaxial Cable&RF Selector	Fujikura/Fujikura/Suhner/Suhner/Suhner/TOYO	8D2W/12DSFA/141PE/141PE/141PE/141PE/NS4906	-/0901-270(RF Selector)	2023/04/18	12
RE	145004	Pre Amplifier	SONOMA	310N	290212	2024/02/13	12
RE	145022	Biconical Antenna	Schwarzbeck Mess-Elektronik OHG	BBA9106	91032665	2023/04/12	12
RE	145536	Loop Antenna	Rohde & Schwarz	HFH2-Z2	100218	2023/04/10	12
RE	145563	Semi-Anechoic Chamber	TDK	SAEC-02(NSA)	2	2023/03/28	12
RE	145790	Test Receiver	Rohde & Schwarz	ESU40	100093	2023/04/22	12
RE	150921	Attenuator	JFW	50HF-003N	-	2024/02/13	12
RE	167095	Attenuator	JFW	50HF-006N	-	2024/02/13	12
RE	167096	Attenuator	JFW	50HF-006N	-	2024/02/13	12
RE	191838	Thermo-Hygrometer	CUSTOM. Inc	CTH-201	-	2023/08/03	12
RE	194601	Coaxial Cable	Fjikura	5D-2W	-	2023/12/08	12
RE	236418	Logperiodic Antenna	Schwarzbeck Mess-Elektronik OHG	VULP 9118 B	00975	2023/07/11	12
FT,BW	145111	Digital Tester	SANWA	PC500	7019232	2023/09/25	12
FT,BW	146424	Search coil	Langer	RF-R 400-1	02-0628	-	-
FT,BW	191845	Thermo-Hygrometer	CUSTOM. Inc	CTH-201	-	2023/08/07	12
FT,BW	201085	Constant Climate Cabinet	Espec	LHU-124	1013000486	2023/09/30	12
FT,BW	235604	Spectrum Analyzer	Keysight Technologies Inc	E4440A	MY45300743	2023/05/18	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
FT: Frequency Tolerance
BW: 20 dB Bandwidth and 99% Occupied Bandwidth