RADIO TEST REPORT

Test Report No.: 14862956H-C

Customer	**Keyence Corporation**
Description of EUT	**Level sensor**
Model Number of EUT	**FR-LM20L**
FCC ID	**RF41754C**
Test Regulation	**FCC Part 15 Subpart C**
Test Result	**Complied**
Issue Date	**September 25, 2023**
Remarks	**Conducted Emission and Radiated Spurious Emission tests only**

Representative test engineer	Approved by
Sayaka Hara 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.
- For test report(s) referred in this report, the latest version (including any revisions) is always referred.

REVISION HISTORY

Original Test Report No.: 14862956H-C

Revision	Test Report No.	Date	Page Revised Contents
- (Original)	14862956H-C	September 25, 2023	-

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	Keyence Corporation
Address	1-3-14, Higashinakajima Higashiyodogwa-ku, Osaka, 533-8555 Japan
Telephone Number	+81-6-6379-1111
Contact Person	Takashi Suzuki

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	Level sensor
Model Number	FR-LM20L
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	July 10, 2023
Test Date	July 10 to August 4, 2023

2.2 Product Description

General Specification

Rating	DC 24 V
Operating temperature	-20 deg. C to 50 deg. C

Radio Specification

Equipment Type	Transceiver
Frequency of Operation	60.5 GHz (Center) (58 GHz to 63GHz)
Bandwidth	5 GHz
Type of Modulation	Frequency modulation (FMCW)
Antenna Gain	26.8 dBi
Steerable Antenna	Electrically
Usage location	Fixed Field disturbance sensor

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 15.255 Operation within the band 57-71 GHz.

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	32.47 dB, 0.56124 MHz, AV Phase L	Complied	-
Spurious Emissions	**FCC:** ANSI C63.10 2013, 6. Standard test methods 9. Procedures for testing millimeter-wave systems	**FCC:** Section 15.255(d) Section 15.209	5.1 dB 328.9 MHz, QP, Horizontal	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 Module regardless of input voltage.
Therefore, this EUT complies with the requirement.

FCC Part 15.203 Antenna requirement
The antenna is not removable from the EUT.
Therefore, the equipment complies with the antenna requirement of Section 15.203.

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.

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
>= 3.8 cm	110 GHz to 170 GHz		5.8 dB
>= 2.5 cm	170 GHz to 260 GHz		5.0 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 m × 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, RF Exposure, Test instruments, and Test set up

Refer to APPENDIX.

SECTION 4: Operation of EUT during testing

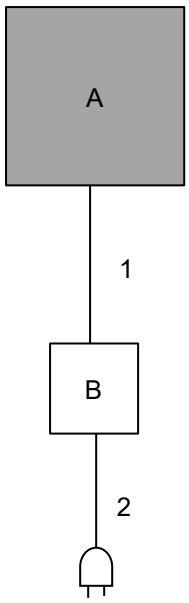
4.1 Operating Mode(s)

Mode	Test Item
Test mode (Tx) - Symbol Pattern A*1)	Conducted Emission Spurious Emissions
*Power of the EUT was set by the software as follows; Power Setting: 5 Software: Ver226 (Date: 2023.07.10, 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.	

*1) The test was performed with reference to the report (14862956H-A) for model name: FR-LMH20L, with symbol pattern A as a representative.

4.2 Configuration and peripherals

Conducted Emission test



AC 120 V / 60 Hz

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

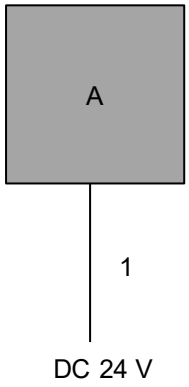
Description of EUT and Support equipment

No.	Item	Model number	Serial number	Manufacturer	Remarks
A	Level sensor	FR-LM20L	LHM39	Keyence Corporation	EUT
B	DC power supply	RPE-4323	824B168G2	RS COMPONENTS LTD	-

List of cables used

No.	Name	Length (m)	Shield		Remarks
			Cable	Connector	
1	DC & Signal Cable	8.4	Unshielded	Unshielded	-
2	AC Cable	1.9	Unshielded	Unshielded	-

Radiated Emission test



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

Description of EUT

No.	Item	Model number	Serial number	Manufacturer	Remarks
A	Level sensor	FR-LM20L	LHM39	Keyence Corporation	EUT

List of cables used

No.	Name	Length (m)	Shield		Remarks
			Cable	Connector	
1	DC & Signal Cable	30.0	Unshielded	Unshielded	-

SECTION 5: Conducted Emission

Test Procedure and Conditions

EUT was placed on a urethane platform of nominal size, 1.0 m by 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.

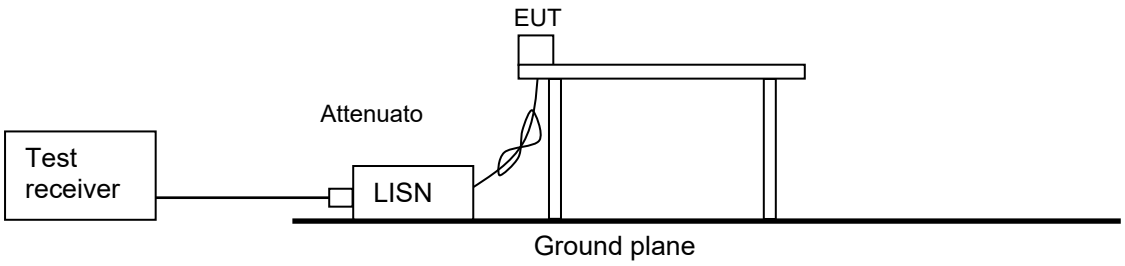
For the tests on EUT with other peripherals (as a whole system)
I/O cables that were connected to the peripherals were bundled in center. They were folded back and forth forming a bundle 30 cm to 40 cm long and were hanged at a 40 cm height to the ground plane. All unused 50 ohm connectors of the LISN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

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

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

Detector : QP and CISPR AV
Measurement Range : 0.15 MHz to 30 MHz
Test Data : APPENDIX
Test Result : Pass

Figure 1: Test Setup



SECTION 6: Radiated Emissions

Test Procedure

[For below 30 MHz]

The 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 Radiated Electric Field Strength has been measured in a Semi Anechoic Chamber with absorbent materials lined on a ground plane.
The loop antenna was fixed height at 1.0 m.
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 1 about Direction of the Loop Antenna.

[For above 30 MHz, up to 1 GHz]

The 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 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 and EUT was rotated a full revolution in order to obtain the maximum value of the electric field strength.

[For above 1 GHz, up to 40 GHz]

The EUT was placed on a urethane platform of nominal size, 0.5 m by 0.5 m, raised 1.5 m above the conducting ground plane.
The Radiated Electric Field Strength has been measured in a Semi Anechoic Chamber with absorbent materials lined on a ground plane.
The height of the measuring antenna varied between 1 m and 4 m and EUT was rotated a full revolution in order to obtain the maximum value of the electric field strength.
Test antenna was aimed at the EUT for receiving the maximum signal and always kept within the illumination area of the 3 dB beamwidth of the antenna.

The measurements were performed for both vertical and horizontal antenna polarization with the Test Receiver, or the Spectrum Analyzer.
The measurements were made with the following detector function of the test receiver and the Spectrum analyzer.
The test was made with the detector (RBW/VBW) in the following table.

Test Antennas are used as below;

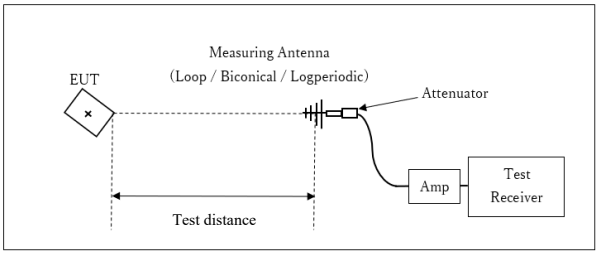
Frequency	Below 30 MHz	30 MHz to 200 MHz	200 MHz to 1 GHz	Above 1 GHz
Antenna Type	Loop	Biconical	Logperiodic	Horn

Frequency	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	From 1 GHz to 40 GHz	
Instrument used	Test Receiver					Spectrum Analyzer	
Detector	PK / AV	QP	PK / AV	QP	QP	PK *a)	AV
IF Bandwidth	200 Hz	200 Hz	9 kHz	9 kHz	120 kHz	RBW: 1 MHz VBW: 3 MHz	RBW: 1 MHz VBW: 1 / T

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

[Test setup]

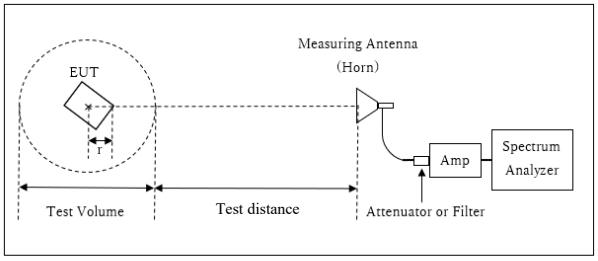
Below 1 GHz



× : Center of turn table

Test Distance: 3 m

1 GHz to 10 GHz



r : Radius of an outer periphery of EUT

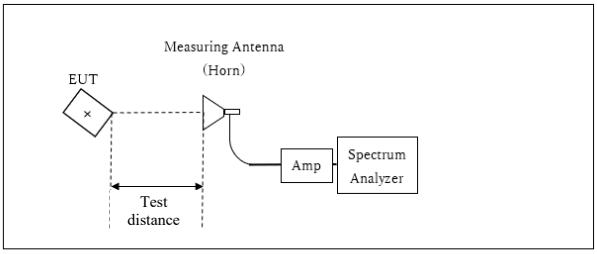
× : Center of turn table

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

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

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

10 GHz to 40 GHz

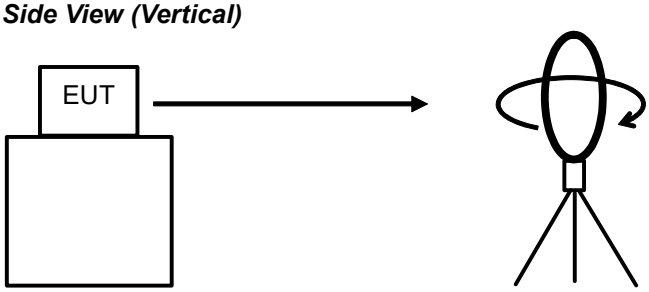


× : Center of turn table

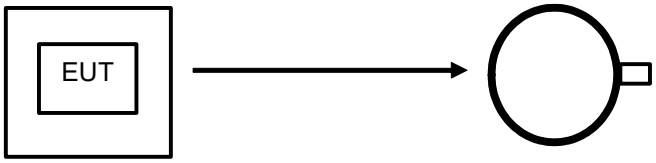
Distance Factor: 20 x log (1.0 m* / 3.0 m) = -9.5 dB
*Test Distance: 1 m

Figure 1: Direction of the Loop Antenna

Side View (Vertical)

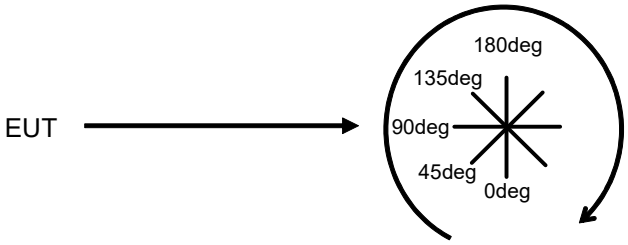


Top View (Horizontal)



Antenna was not rotated.

Top View (Vertical)



Front side: 0 deg.
Forward direction: clockwise

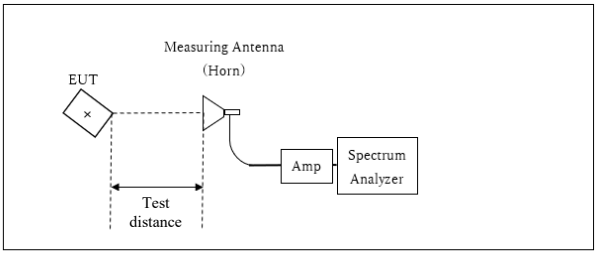
[Above 40 GHz]
The test was performed based on “Procedures for testing millimeter-wave systems” of ANSI C63.10-2013.
The EUT was placed on a urethane platform, raised 1.5 m above the conducting ground plane. The measurements were performed on handheld method.

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.

Note the maximum level indicated on the spectrum analyzer. Adjust this level, if necessary, by the antenna gain, filter loss, conversion loss of the external mixer and gain of LNA used, at the frequency under investigation. Calculate the field strength of the emission at the measurement distance from the Friis’ transmission equation.

Frequency	40 GHz to 50 GHz	50 GHz to 75 GHz	75 GHz to 110 GHz	110 GHz to 200 GHz
Final measurement distance with 1 MHz Peak detector	1.0 m	0.75 m	0.5 m	0.01 m

[Test setup]
40 GHz to 200 GHz



× : Center of turn table

*Test Distance: Refer to the above table.

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

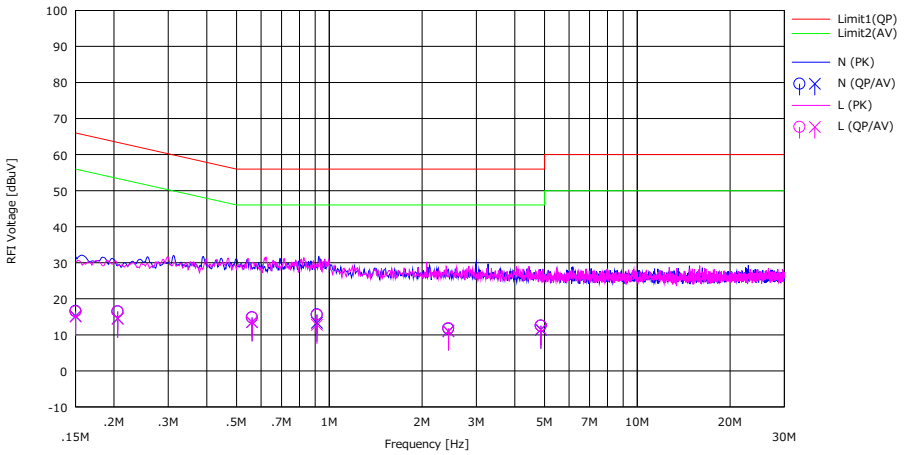
Measurement range : 9 kHz to 200 GHz
Test data : APPENDIX
Test result : Pass

APPENDIX 1: Test data

Conducted Emission

Test place	Ise EMC Lab.
Semi Anechoic Chamber	No. 4
Date	August 4, 2023
Temperature / Humidity	23 deg. C / 50 % RH
Engineer	Sayaka Hara
Mode	Tx Symbol Pattern A

Limit : FCC_Part 15 Subpart C(15.207)



No.	Freq.	Reading ⟨QP⟩	Reading ⟨AV⟩	LISN	LOSS	Results ⟨QP⟩	Results ⟨AV⟩	Limit ⟨QP⟩	Limit ⟨AV⟩	Margin ⟨QP⟩	Margin ⟨AV⟩	Phase	Comment
	[MHz]	[dBuV]	[dBuV]	[dB]	[dB]	[dBuV]	[dBuV]	[dBuV]	[dBuV]	[dB]	[dB]		
1	0.15000	3.40	2.00	0.05	13.13	16.58	15.18	66.00	56.00	49.42	40.82	N	
2	0.20554	3.30	1.40	0.04	13.13	16.47	14.57	63.38	53.38	46.91	38.81	N	
3	0.56124	1.60	0.30	0.05	13.17	14.82	13.52	56.00	46.00	41.18	32.48	N	
4	0.91174	2.40	0.10	0.06	13.20	15.66	13.36	56.00	46.00	40.34	32.64	N	
5	2.43710	-1.70	-2.40	0.07	13.31	11.68	10.98	56.00	46.00	44.32	35.02	N	
6	4.86310	-1.00	-2.10	0.11	13.42	12.53	11.43	56.00	46.00	43.47	34.57	N	
7	0.15000	3.30	1.90	0.05	13.13	16.48	15.08	66.00	56.00	49.52	40.92	L	
8	0.20554	3.30	1.30	0.04	13.13	16.47	14.47	63.38	53.38	46.91	38.91	L	
9	0.56124	1.60	0.30	0.06	13.17	14.83	13.53	56.00	46.00	41.17	32.47	L	
10	0.91174	2.30	-0.50	0.06	13.20	15.56	12.76	56.00	46.00	40.44	33.24	L	
11	2.43710	-1.60	-2.40	0.08	13.31	11.79	10.99	56.00	46.00	44.21	35.01	L	
12	4.86310	-1.00	-2.00	0.13	13.42	12.55	11.55	56.00	46.00	43.45	34.45	L	

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

*The test result is rounded off to one or two decimal places, so some differences might be observed.

Spurious Emissions
(Below 40 GHz)

Test place	Ise EMC Lab.				
Semi Anechoic Chamber	No. 3	No. 3	No. 4	No. 4	No. 4
Date	July 10, 2023	July 11, 2023	July 18, 2023	July 18, 2023	August 3, 2023
Temperature / Humidity	24 deg. C / 49 % RH	23 deg. C / 44 % RH	23 deg. C / 42 % RH	23 deg. C / 42 % RH	23 deg. C / 59 % RH
Engineer	Sayaka Hara	Sayaka Hara	Junki Nagatomi	Sayaka Hara	Sayaka Hara
	(9 kHz to 30 MHz)	(30 MHz to 1000 MHz)	(18 GHz to 26.5 GHz)	(10 GHz to 18 GHz)	(1 GHz to 10 GHz, 26.5 GHz to 40 GHz)
Mode	Tx Symbol Pattern A				

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.	162.0	26.1	-	15.5	8.8	32.1	18.3	-	43.5	-	25.2	-	
Hori.	311.1	42.0	-	13.9	10.1	32.0	34.1	-	46.0	-	12.0	-	
Hori.	328.9	48.0	-	14.7	10.2	32.0	40.9	-	46.0	-	5.1	-	
Hori.	417.9	40.3	-	16.2	10.9	32.0	35.4	-	46.0	-	10.6	-	
Hori.	533.4	41.9	-	17.8	11.6	32.0	39.3	-	46.0	-	6.7	-	
Hori.	791.2	33.4	-	20.8	13.1	31.4	35.9	-	46.0	-	10.2	-	
Vert.	162.0	26.7	-	15.5	8.8	32.1	18.9	-	43.5	-	24.6	-	
Vert.	311.1	34.5	-	13.9	10.1	32.0	26.6	-	46.0	-	19.5	-	
Vert.	328.9	44.4	-	14.7	10.2	32.0	37.3	-	46.0	-	8.7	-	
Vert.	417.9	36.4	-	16.2	10.9	32.0	31.5	-	46.0	-	14.5	-	
Vert.	533.3	33.6	-	17.8	11.6	32.0	31.0	-	46.0	-	15.0	-	
Vert.	791.2	26.7	-	20.8	13.1	31.4	29.2	-	46.0	-	16.9	-	

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

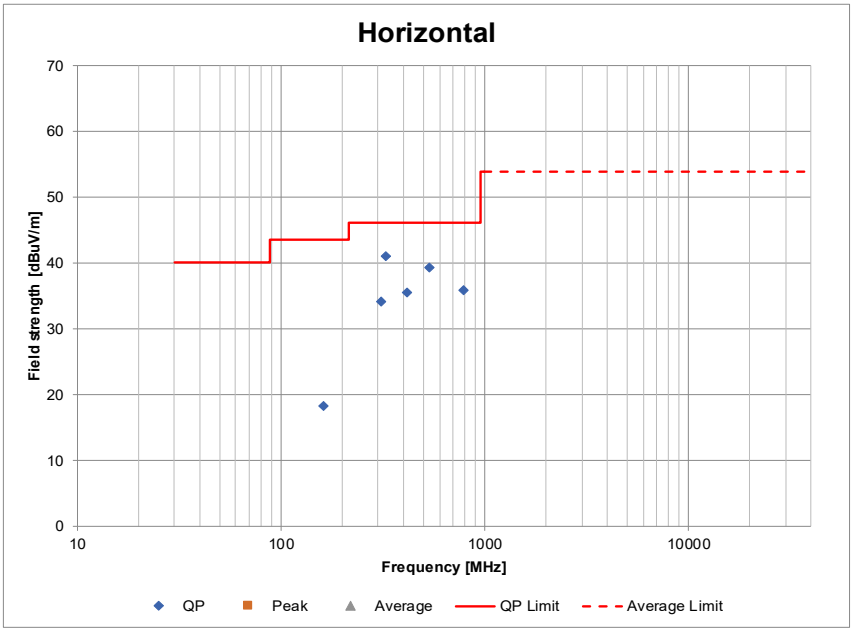
*Other frequency noises omitted in this report were not seen or had enough margin (more than 20 dB).

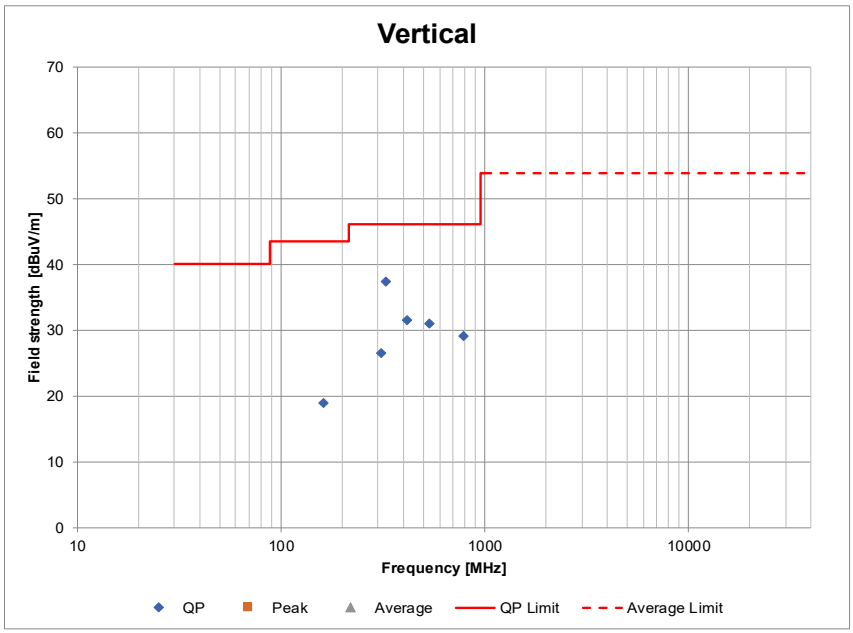
*QP detector was used up to 1GHz.

Distance factor: 1 GHz - 10 GHz 20log (4.0 m / 3.0 m) = 2.5 dB
10 GHz - 40 GHz 20log (1.0 m / 3.0 m) = -9.5 dB

Spurious Emissions
(Below 40 GHz)
(Plot data, Worst case)

Test place	Ise EMC Lab.				
Semi Anechoic Chamber	No. 3	No. 3	No. 4	No. 4	No. 4
Date	July 10, 2023	July 11, 2023	July 18, 2023	July 18, 2023	August 3, 2023
Temperature / Humidity	24 deg. C / 49 % RH	23 deg. C / 44 % RH	23 deg. C / 42 % RH	23 deg. C / 42 % RH	23 deg. C / 59 % RH
Engineer	Sayaka Hara	Sayaka Hara	Junki Nagatomi	Sayaka Hara	Sayaka Hara
	(9 kHz to 30 MHz)	(30 MHz to 1000 MHz)	(18 GHz to 26.5 GHz)	(10 GHz to 18 GHz)	(1 GHz to 10 GHz, 26.5 GHz to 40 GHz)
Mode	Tx Symbol Pattern A				





Spurious Emissions
(Above 40 GHz)

Test place	Ise EMC Lab.			
Semi Anechoic Chamber	No. 4	No. 4	No. 4	No. 4
Date	July 14, 2023	July 18, 2023	July 18, 2023	July 19, 2023
Temperature / Humidity	20 deg. C / 50 % RH	23 deg. C / 42 % RH	23 deg. C / 42 % RH	23 deg. C / 64 % RH
Engineer	Sayaka Hara	Junki Nagatomi	Sayaka Hara	Sayaka Hara
	(110 GHz to 170 GHz)	(40 GHz to 50 GHz)	(50 GHz to 110 GHz)	(170 GHz to 200 GHz)
Mode	Tx Symbol Pattern A			

Freq. [GHz]	Reading (Peak) [dBm]	Rx Ant. Gain [dBi]	Filter Loss [dB]	LNA Gain [dB]	Mixer Conv. Loss [dB]	IF Amp. Gain [dB]	IF Cable Loss [dB]	Test Distance *D* [m]	FSL [dB]	EIRP [dBm]	EIRP [mW]	Power density Result at 3 m (Peak) [pW/cm^2]	Limit Average [pW/cm^2]	Margin Average [dB]	Remarks
44.955	-54.83	21.73	0.00	32.22	0.00	0.00	8.00	1.00	65.50	-35.28	0.000296	0.26	90	25.36	NS
49.935	-53.74	22.62	0.00	31.84	0.00	0.00	8.63	1.00	66.41	-33.16	0.000483	0.43	90	23.24	NS
55.094	-63.69	23.29	0.00	26.59	46.65	32.04	0.11	0.75	64.77	-34.09	0.000390	0.34	90	24.16	NS
72.602	-68.45	24.40	0.00	21.33	50.40	32.04	0.11	0.75	67.16	-28.55	0.001397	1.24	90	18.62	NS
81.973	-57.53	23.50	0.37	34.55	41.11	32.04	0.11	0.50	64.69	-41.33	0.000074	0.07	90	31.41	NS
88.386	-56.83	23.88	0.43	33.01	42.14	32.04	0.11	0.50	65.35	-37.73	0.000169	0.15	90	27.81	NS
95.651	-56.41	24.23	0.38	34.22	43.12	32.04	0.11	0.50	66.03	-37.25	0.000188	0.17	90	27.33	NS
96.296	-55.96	24.25	0.39	34.74	43.24	32.04	0.11	0.50	66.09	-37.16	0.000192	0.17	90	27.23	NS
108.508	-56.47	24.80	1.01	22.03	44.16	32.04	0.11	0.50	67.13	-22.93	0.005097	4.51	90	13.00	NS
116.685	-82.22	22.52	0.00	17.52	55.58	0.00	0.00	0.01	33.78	-32.90	0.000513	0.45	90	22.98	NS
120.827	-84.51	22.67	0.00	19.20	51.60	0.00	0.00	0.01	34.09	-40.70	0.000085	0.08	90	30.78	NS
121.013	-82.92	22.68	0.00	19.29	51.49	0.00	0.00	0.01	34.10	-39.30	0.000117	0.10	90	29.38	NS
130.939	-82.85	22.97	0.00	20.29	53.59	0.00	0.00	0.01	34.78	-37.73	0.000169	0.15	90	27.81	NS
131.177	-83.61	22.98	0.00	20.14	53.42	0.00	0.00	0.01	34.80	-38.51	0.000141	0.12	90	28.59	NS
141.718	-84.27	23.22	0.00	18.73	54.04	0.00	0.00	0.01	35.47	-36.71	0.000213	0.19	90	26.78	NS
147.474	-85.76	23.30	0.00	18.80	56.63	0.00	0.00	0.01	35.82	-35.41	0.000288	0.25	90	25.49	NS
159.837	-86.26	23.39	0.00	16.54	58.52	0.00	0.00	0.01	36.52	-31.15	0.000767	0.68	90	21.23	NS
165.857	-87.26	23.41	0.00	14.01	59.93	0.00	0.00	0.01	36.84	-27.91	0.001616	1.43	90	17.99	NS
173.989	-85.58	22.49	0.00	0.00	57.51	0.00	0.00	0.01	37.25	-13.30	0.046743	41.33	90	3.38	NS
178.347	-86.29	22.59	0.00	0.00	56.83	0.00	0.00	0.01	37.47	-14.58	0.034834	30.80	90	4.66	NS
187.165	-86.41	22.78	0.00	0.00	56.11	0.00	0.00	0.01	37.89	-15.19	0.030250	26.75	90	5.27	NS
198.491	-86.97	22.99	0.00	0.00	55.10	0.00	0.00	0.01	38.40	-16.46	0.022571	19.96	90	6.54	NS

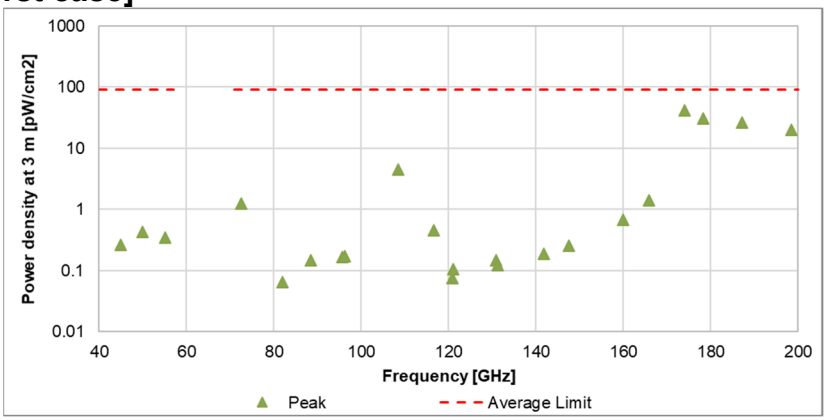
Calculation:
FSL (Free Space path Loss) = 10 * log ((4 * Pi * D / λ)^2)
EIRP = Reading - Rx Ant. gain + Filter loss - LNA gain + Mixer conversion loss - IF Amp. gain + IF Cable loss + FSL
Power density Result at 3 m = EIRP / (4 * Pi * 300^2)

These calculation results are same as results which were calculated with formulas described in the Section 9 of ANSI C63.10-2013.

The equipment were not used for factor 0 dB of the data sheets.
The IF Cable loss is included in Mixer loss, so the factor of data sheet were 0 dB.

NS: No signal detected.

[Plot data, Worst case]



*The peak result is less than the average limit.

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-04	142011	AC4_Semi Anechoic Chamber(NSA)	TDK	Semi Anechoic Chamber 3m	DA-10005	05/22/2022	24
CE	MAT-64	141290	Attenuator(13dB)	JFW Industries, Inc.	50FP-013H2 N	-	12/22/2022	12
CE	MCC-113	141217	Coaxial cable	Fujikura/Suhner/TSJ	5D-2W/SFM141/ 421-010/ sucoform141-PE/ RFM-E121(SW)	-/04178	06/27/2023	12
CE	MJM-29	142230	Measure, Tape, Steel	KOMELON	KMC-36	-	-	-
CE	MLS-23	141357	LISN(AMN)	Schwarzbeck Mess-Elektronik OHG	NSLK8127	8127-729	07/05/2023	12
CE	MMM-10	141545	DIGITAL HiTESTER	HIOKI E.E. CORPORATION	3805	51201148	01/18/2023	12
CE	MOS-15	141562	Thermo-Hygrometer	CUSTOM. Inc	CTH-201	0010	01/13/2023	12
CE	MTR-10	141951	EMI Test Receiver	Rohde & Schwarz	ESR26	101408	04/10/2023	12
RE	COTS-MEMI-02	178648	EMI measurement program	TSJ (Techno Science Japan)	TEPTO-DV	-	-	-
RE	KBA-05	141198	Biconical Antenna	Schwarzbeck Mess-Elektronik OHG	VHA9103+ BBA9106	2513	06/06/2023	12
RE	MAEC-03	142008	AC3_Semi Anechoic Chamber(NSA)	TDK	Semi Anechoic Chamber 3m	DA-10005	05/23/2022	24
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-95	142314	Attenuator	Pasternack Enterprises	PE7390-6	D/C 1504	06/23/2023	12
RE	MCC-112	141216	Coaxial cable	Fujikura/Suhner/TSJ	5D-2W/SFM14/ sucoform141-PE/ 421-010/ RFM-E321(SW)	-/00640	07/25/2023	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-217	141393	Microwave Cable	Junkosha	MWX221	1604S254(1 m) / 1608S088(5 m)	08/01/2023	12
RE	MCC-219	159670	Coaxial Cable	UL Japan	-	-	11/18/2022	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-265	234602	Microwave Cable	Huber+Suhner	SF126E/11PC35/ 11PC35/ 1000M,5000M	537063/126E / 537074/126E	03/16/2023	-
RE	MCC-51	141323	Coaxial cable	UL Japan	-	-	09/27/2022	12
RE	MDPLX-01	142026	Diplexer	OML INC.	DPL26	-	11/25/2022	12
RE	MHA-02	141503	Horn Antenna 18-26.5GHz	EMCO	3160-09	1265	06/23/2023	12
RE	MHA-06	141512	Horn Antenna 1-18GHz	Schwarzbeck Mess-Elektronik OHG	BBHA9120D	254	10/20/2022	12
RE	MHA-21	141508	Horn Antenna 1-18GHz	Schwarzbeck Mess-Elektronik OHG	BBHA9120D	557	05/17/2023	12
RE	MHA-24	142036	Horn Antenna	Custom Microwave Inc.	HO6R	-	09/01/2022	12
RE	MHA-27	142039	Horn Antenna	Custom Microwave Inc.	HO4R	-	09/01/2022	12
RE	MHA-29	141517	Horn Antenna 26.5-40GHz	ETS-Lindgren	3160-10	152399	11/14/2022	12

Test equipment (2/2)

Test Item	Local ID	LIMS ID	Description	Manufacturer	Model	Serial	Last Calibration Date	Cal Int
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	06/20/2023	12
RE	MHA-35	180544	Horn Antenna	SAGE Millimeter, Inc.	SAZ-2410-10-S1	17343-01	06/21/2023	12
RE	MHF-31	199856	WR-10 HighPass Filter	Oshima Prototype Engineering Co.	A20-110-A01	001	04/13/2023	12
RE	MJM-16	142183	Measure	KOMELON	KMC-36	-	10/03/2022	12
RE	MJM-29	142230	Measure, Tape, Steel	KOMELON	KMC-36	-	-	-
RE	MLA-22	141266	Logperiodic Antenna(200-1000MHz)	Schwarzbeck Mess-Elektronik OHG	VUSLP9111B	9111B-191	08/26/2022	12
RE	MLPA-02	142152	Loop Antenna	Rohde & Schwarz	HFH2-Z2	836553/009	10/11/2022	12
RE	MMM-08	141532	DIGITAL HiTESTER	HIOKI E.E. CORPORATION	3805	51201197	01/17/2023	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
RE	MMX-02	142048	Harmonic Mixer	Keysight Technologies Inc	11970W	2521 A01909	10/06/2022	12
RE	MMX-03	142049	Harmonic Mixer	OML INC.	M06HWD	D100709-1	11/25/2022	12
RE	MMX-04	142053	Harmonic Mixer	OML INC.	M04HWD	Y100709-1	05/16/2023	12
RE	MOS-13	141554	Thermo-Hygrometer	CUSTOM. Inc	CTH-201	1301	01/13/2023	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-13	141582	Pre Amplifier	SONOMA INSTRUMENT	310	260834	02/07/2023	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	06/19/2023	12
RE	MPA-29	176027	D-Band Low Noise Amplifier	SAGE Millimeter, Inc.	SBL-1141741860-0606-EI	15235-01	07/11/2023	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	MSA-22	141978	Spectrum Analyzer	Keysight Technologies Inc	E4448A	MY46180899	03/06/2023	12
RE	MTR-10	141951	EMI Test Receiver	Rohde & Schwarz	ESR26	101408	04/10/2023	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