

TEST REPORT

For

RFID Reader/Writer Unit

In conformity with

FCC CFR 47 Part15 Subpart C

Model : TR3X-SD01-24-CS141

FCC ID : MK4SD01-24-CS141

Report No. : WE211110BB2-13

Issue Date : April 7, 2022

Prepared for

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Prepared by

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Table of contents

1 General information.....	3
1.1 Product information from applicant.....	3
1.2 Test(s) performed/ Summary of test result.....	3
1.3 Test facility	4
1.4 Measurement uncertainty.....	4
1.5 Summary of test results.....	4
1.6 Setup of equipment under test (EUT)	5
1.6.1 Test configuration of EUT	5
1.6.2 Setup diagram of tested system:.....	6
1.6.3 Operating condition:	6
1.7 Equipment modifications.....	6
1.8 Deviation from the standard.....	6
2 Test procedure and test data	7
2.1 Occupied Bandwidth (99 %).....	7
2.2 Transmitter radiated spurious emissions between 9 kHz to 30 MHz.....	9
2.3 Transmitter radiated spurious emissions between 30MHz to 1000MHz	17
2.4 Frequency stability.....	23
2.5 AC power line conducted emissions.....	25
3 Test setup photographs.....	28
3.1 Radiated spurious emissions	28
3.2 AC power line conducted emissions.....	29
3.3 Frequency Stability	29
4 List of utilized test equipment/ calibration	30

History

Report No.	Date	Revisions	Issued By
WE211110BB2-11	January 28, 2022	Initial Issue	K. Onishi
WE211110BB2-12	March 31, 2022	Added test data (antenna port: 12ch, 24ch)	K. Onishi
WE211110BB2-13	April 7, 2022	Added information of antenna port (Page. 7, 24)	K. Onishi

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1 General information

1.1 Product information from applicant

Test item	: RFID Reader/Writer Unit
Manufacturer	: TAKAYA Corporation
Address	: 661-1, Ibara-cho, Ibara-city, Okayama, 715-8503 Japan
Model	: TR3X-SD01-24-CS141
FCC ID	: MK4SD01-24-CS141
Serial numbers	: 21000010
Hardware version	: FT0300
Software version	: FT0300
Transmitting Frequency	: 13.56 MHz
Type of Modulation	: ASK 10%
Operating temperature range	: +5 to +50 degree C
Receipt date of EUT	: December 29, 2021
Nominal power source voltages	: DC 24.0V
Operating voltage range	: DC 24.0V±10%

1.2 Test(s) performed/ Summary of test result

Test specification(s)	: FCC CFR 47. Part 15 Subpart C (October 1, 2021)
Test method(s)	: ANSI C63.10: 2013
Test(s) started	: January 21, 2022
Test(s) completed	: March 31, 2022

Summary of test result : Complied

Note: The above judgment is only based on the measurement data and it does not include the measurement uncertainty. Accordingly, the statement below is applied to the test result.

The EUT complies with the limit required in the standard in case that the margin is not less than the measurement uncertainty in the Laboratory.

Compliance of the EUT is more probable than non-compliance in case that the margin is less than the measurement uncertainty in the Laboratory.

Test engineer

: 
Kazuyuki Onishi

C&P Connectivity Wireless RF Operation RF/EMC Lab.

Reviewer

: 
Yoshihiko Taki

Manager
C&P Connectivity Wireless RF Operation RF/EMC Lab.

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1.3 Test facility

Address: 3-5-23, Kitayamata, Tsuzuki-ku, Yokohama, 224-0021, Japan
TEL: +81-(0)50-3773-4513
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Registered by Innovation, Science and Economic Development Canada (ISED):
The registered CAB identifier is JP0009.

This report must not be used by the client to claim product certification, approval, or endorsement by NVLAP, NIST, or any agency of the US Government.



1.4 Measurement uncertainty

The treatment of uncertainty is based on the general matters on the definition of uncertainty in "Guide to the expression of uncertainty in measurement (GUM)" published by ISO. The Lab's uncertainty is determined by referring ETSI TR 100 028-1 V1.4.1 (2001-12).

The uncertainty of the measurement result in the level of confidence of approximately 95% (k=2) is as follows;

Conducted emission (150 kHz - 30 MHz):	± 3.3 dB
Radiated emission (9 kHz - 30 MHz):	± 5.6 dB
Radiated emission (30 MHz - 1000 MHz):	± 5.1 dB

1.5 Summary of test results

Requirements	Section in FCC	Section in this report	Results
Occupied bandwidth	2.1049	2.1	-
Radiated Emissions between 9 kHz to 30 MHz	15.225 (a) - (d)	2.2	Complied
Radiated Emissions between 30 to 1000 MHz	15.209	2.3	Complied
Carrier Frequency Stability	15.225 (e)	2.4	Complied
AC Power Line Conducted Emissions	15.207	2.5	Complied

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1.6 Setup of equipment under test (EUT)

1.6.1 Test configuration of EUT

The test configuration of the EUT refers to following Tables.

Table: EUT

No.	Equipment	Model name	S/N	Note
A	RFID Reader/Writer Unit	TR3X-SD01-24-CS141	21000010	-
B	Antenna Unit 1	TR3-CA065 (12)	21000253~264	-
C	Antenna Unit 2	TR3-CA065 (12)	21000265~276	-

Table: Support equipment

No.	Item	Model Name	Manufacturer	S/N
D	PC	PP22L	DELL	JX189 A00
E	AC adapter	LA90PS0-00	DELL	CN-0DF266-71615-78V-B442
F	DC power supply	PMC35-2A	KUKUSUI	EF001839
G	USB dongle	BF07-1033R	pqi	P077023200464

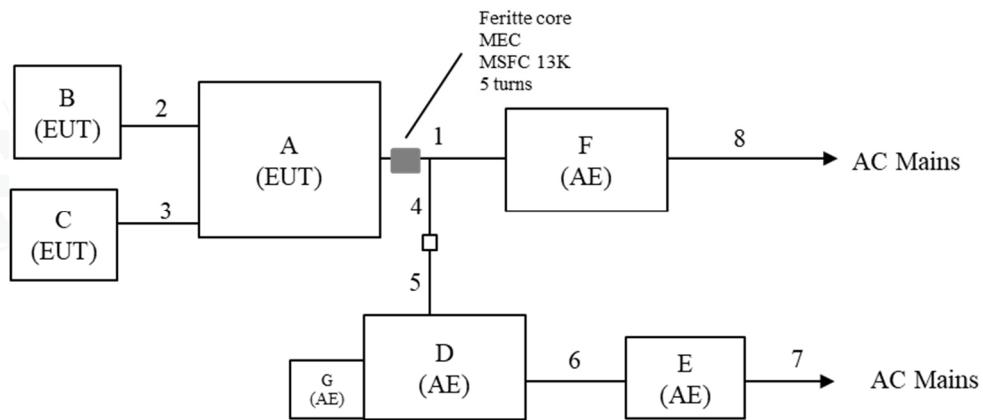
Table: Cable connected to the EUT

No.	Cable Name	From	To	Length [m]	Shielded	Ferrite
1	DC cable 1	A	F	3.0	No	Yes
2	Antenna cable 1 (12 cables)	A	B	0.6	No	No
3	Antenna cable 2 (12 cables)	A	C	0.6	No	No
4	Serial cable	A	D	3.2	No	Yes
5	USB - Serial cable	A	D	0.2	Yes	No
6	DC cable 2	D	E	1.8	No	No
7	AC cable 1	E	AC	0.9	No	No
8	AC cable 2	F	AC	2.0	No	No

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1.6.2 Setup diagram of tested system:



1.6.3 Operating condition:

Software: TR3 R/W Mode Set Program 1.3.1.0
 Operating mode: 1. No modulation
 2. ISO 15693 ASK 10%
 Power setting: High power mode (100mW)
 Power mode: Continuous (TEST)

Note: This EUT has 24 antenna ports (3 switch circuit \times 8 antennas), these antennas do not work with simultaneous transmission.

Test was performed to one antenna port of each switch circuit, which has highest field strength (Antenna port No. 1, 12, 24).

1.7 Equipment modifications

No modifications have been made to the equipment in order to achieve compliance with the applicable standards described in clause 1.2.

1.8 Deviation from the standard

No deviations from the standards described in clause 1.2.

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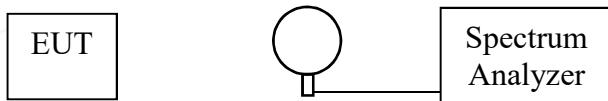
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2 Test procedure and test data

2.1 Occupied Bandwidth (99 %)

Test setup

Test setup is the following drawing. The antenna port of EUT was connected to the spectrum analyzer.



Test procedure

Spectrum analyzer is set as below according to ANSI C63.10 clause 6.9

- RBW: 1 to 5 % of OBW
- VBW > 3 x RBW
- Span: OBW x 1.5 to 5
- Trace: Max hold

Limitation

There are no limitations.

The measurement value is used for the emission designator.

Test equipment used (refer to List of utilized test equipment)

CL71	LP05	TR10	-	-	-	-	-	-	-
------	------	------	---	---	---	---	---	---	---

Test Date

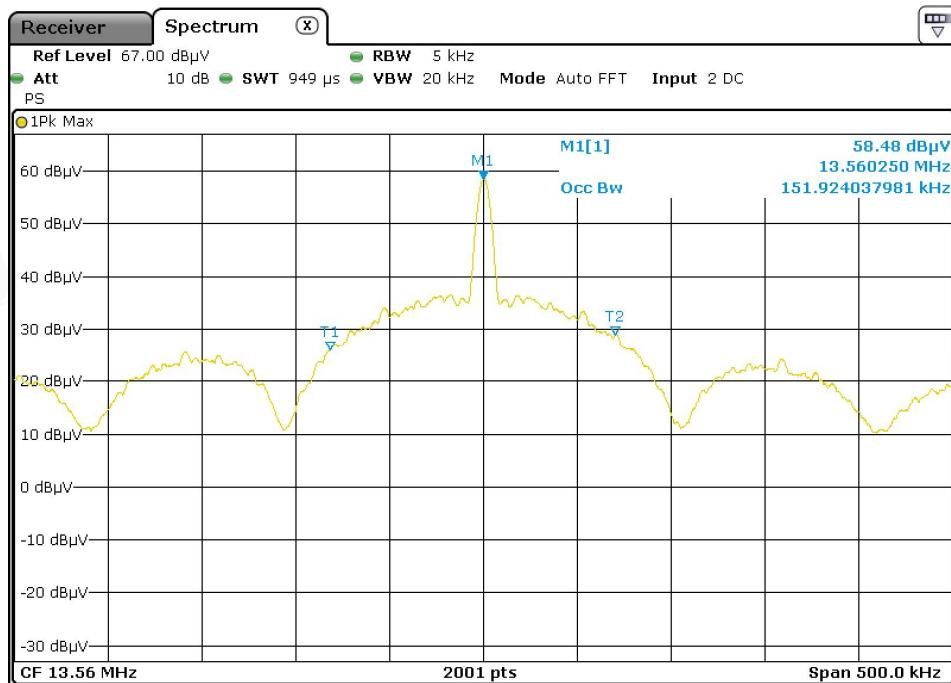
Tested Date: January 21, 2022 Temperature: 15 deg. C
Humidity: 26 % Atmos. Press: 1015 hPa

Test results

Operating mode	Antenna port	99% Bandwidth [kHz]
ISO 15693 ASK10%	1ch	151.924

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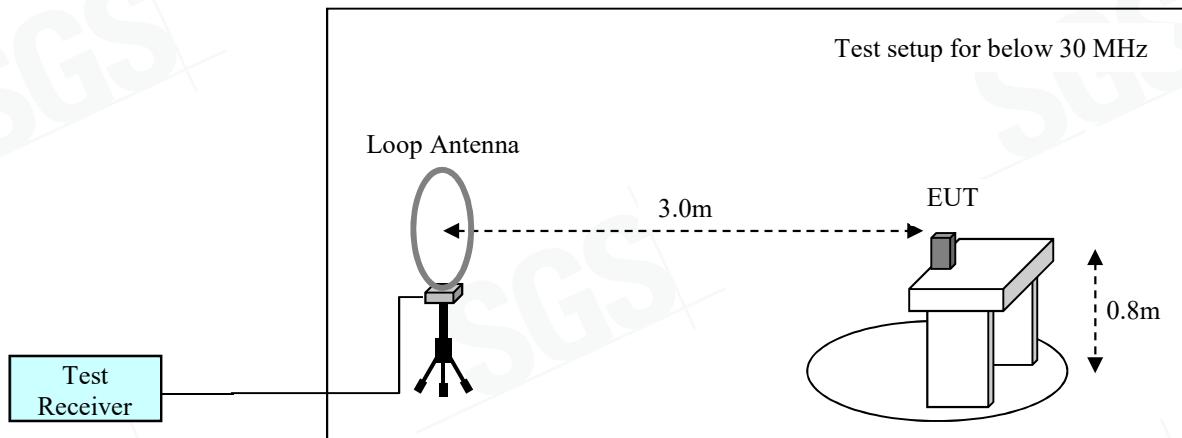
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2.2 Transmitter radiated spurious emissions between 9 kHz to 30 MHz

Test setup

Test setup was implemented according to the method of ANSI C63.10 clause 6.4.



Test procedure

Measurement procedures were implemented according to the method of ANSI C63.10: 2013 clauses 6.4. The EUT is placed on a non-conducted table which is 0.8m height from a ground plane and the measurement antenna to EUT distance is 3 meters. The turn table is rotated for 360 degrees to determine the maximum emission level. In the frequency range of 9 kHz to 30 MHz, a calibrated loop antenna was positioned with its plane vertical at the distance 3m from the EUT with an extrapolation of corrected distance factor and rotated about its vertical axis for maximum response at each azimuth about the EUT. For certain applications, the loop antenna also needs to be positioned horizontally. The lowest height of the loop antenna shall be 1 m above the ground. EUT is placed at three different orientations (X, Y and Z axis) in order to find the worst orientation. The spectrum analyzer and receiver are set to the followings;

Below 30 MHz:

RBW=10 kHz, VBW= 30 kHz, final measurement is carried out with a receiver RBW of 9 kHz (QP)

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Applicable rule and limitation

§15.205: Restricted bands of operation

MHz	MHz	MHz	GHz
0.090 - 0.110	16.42 - 16.423	399.9 - 410	4.5 - 5.15
0.490 - 0.510	16.69475 - 16.69525	608 - 614	5.35 - 5.46
2.1735 - 2.1905	16.80425 - 16.80475	960 - 1240	7.25 - 7.75
4.125 - 4.128	25.5 - 25.67	1300 - 1427	8.025 - 8.5
4.17725 - 4.17775	37.5 - 38.25	1435 - 1626.5	9.0 - 9.2
4.20725 - 4.20775	73 - 74.6	1645.5 - 1646.5	9.3 - 9.5
6.215 - 6.218	74.8 - 75.2	1660 - 1710	10.6 - 12.7
6.26775 - 6.26825	108 - 121.94	1718.8 - 1722.2	13.25 - 13.4
6.31175 - 6.31225	123 - 138	2200 - 2300	14.47 - 14.5
8.291 - 8.294	149.9 - 150.05	2310 - 2390	15.35 - 16.2
8.362 - 8.366	156.52475 -	2483.5 - 2500	17.7 - 21.4
8.37625 - 8.38675	156.52525	2690 - 2900	22.01 - 23.12
8.41425 - 8.41475	156.7 - 156.9	3260 - 3267	23.6 - 24.0
12.29 - 12.293	162.0125 - 167.17	3332 - 3339	31.2 - 31.8
12.51975 - 12.52025	167.72 - 173.2	3345.8 - 3358	36.43 - 36.5
12.57675 - 12.57725	240 - 285 322 - 335.4	3600 - 4400	(1)

§15.209: General requirements

Frequency (MHz)	Field Strength (uV/m)	Measurement Distance (m)
0.009 - 0.490	2400/F (kHz)	300
0.490 - 1.705	24000/F (kHz)	30
1.705 - 30.0	30	30

In the emission table above, the tighter limit applies at the band edges.

The level of any unwanted emissions from an intentional radiator operating under these general provisions shall not exceed the level of the fundamental emission. The emission limits shown in the above table are based on measurements employing a CISPR quasi-peak detector except for the frequency bands 9-90 kHz, 110-490 kHz.

§15.225: Operation within the band 13.110 - 14.010 MHz

Frequency (MHz)	Field strength @30m (uV/m)	Field strength @30m (dBuV/m)	Field strength @3m (dBuV/m)
13.110 - 13.410	106	40.5	61.8
13.410 - 13.553	334	50.5	71.8
13.553 - 13.567	15,848	84.0	105.3
13.567 - 13.710	334	50.5	71.8
13.710 - 14.010	106	40.5	61.8

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Extrapolation factor of 3m test distance (ANSI C63.10-2013 6.4.4)

Frequency [MHz]	D ($\lambda/2\pi$) [m]	D (Limit) [m]	Extrapolation Factor
0.009	5305.16	300	80.00
0.159	300.29	300	80.00
0.160	298.42	300	79.95
0.490	97.44	300	70.23
0.490	97.44	30	40.00
1.591	30.01	30	40.00
1.592	29.99	30	40.00
10.000	4.77	30	24.04
13.560	3.52	30	21.39
15.910	3.00	30	20.00
30.000	1.59	30	20.00

Test equipment used (refer to List of utilized test equipment)

AC01	CL71	LP05	TR10	-	-	-	-	-
------	------	------	------	---	---	---	---	---

Test software used

EMI1 Ver. 6.1

Calculation method

The Correction Factor and Result are calculated as followings.

$$\begin{aligned} \text{Correction Factor [dB/m]} &= \text{Ant. Factor [dB/m]} + \text{Loss [dB]} \\ \text{Result [dB}\mu\text{V/m]} &= \text{Reading [dB}\mu\text{V]} + \text{Correction Factor [dB/m]} \end{aligned}$$

Test results - Complied with requirement.

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Test Data

§15.225 (a), (b), (c): Fundamental emission

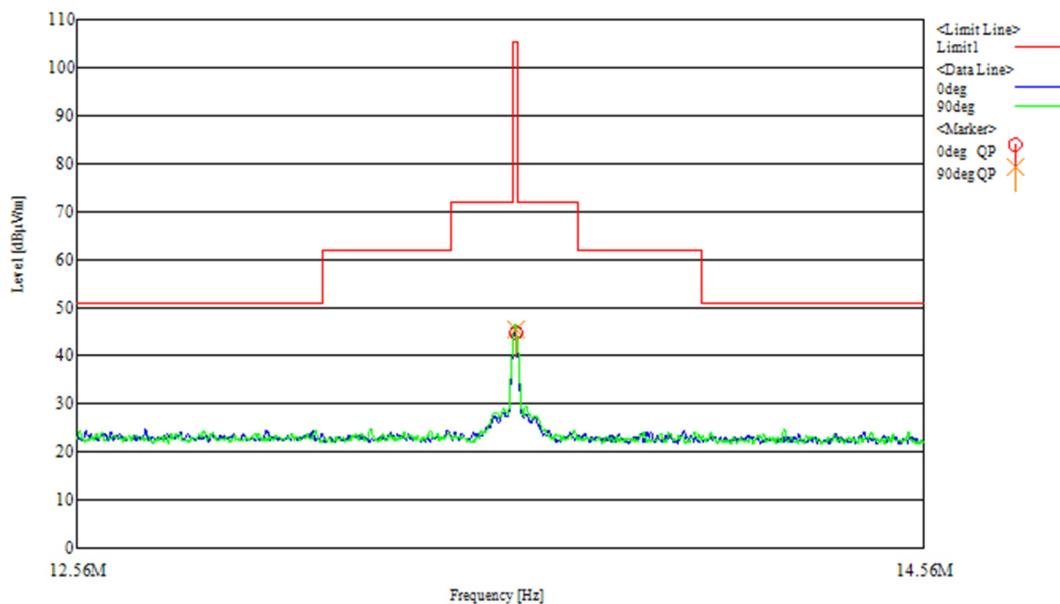
Operating mode: ISO 15693 ASK 10%

EUT condition: Y-plane (Maximum position)

Measurement distance: 3 m

No.	Frequency [MHz]	Reading [dBuV]	Detector	Corr. Factor [dB]	Result [dBuV/m]	Limit [dBuV/m]	Margin [dB]	Ant
1	13.56017	34.9	QP	9.6	44.5	105.3	60.8	0deg
2	13.56014	35.7	QP	9.6	45.3	105.3	60.0	90deg

Graphical express of test result



Tested Date: January 21, 2022 Temperature: 15 deg. C
 Humidity: 26 % Atmos. Press: 1015 hPa

Field strength of each antenna [dBuV/m]

1ch	45.3	9ch	43.3	17ch	42.8
2ch	43.8	10ch	43.4	18ch	42.7
3ch	43.6	11ch	43.5	19ch	42.9
4ch	43.7	12ch	44.5	20ch	43.2
5ch	43.6	13ch	43.3	21ch	43.1
6ch	43.3	14ch	42.9	22ch	43.1
7ch	43.3	15ch	42.5	23ch	43.3
8ch	43.4	16ch	42.5	24ch	43.8

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§15.225 (d): Harmonics and spurious emission between 9 kHz to 30MHz

Operating mode: ISO 15693 ASK 10%

Antenna port: 1ch

Measurement distance: 3 m

[X-plane]

No.	Frequency [MHz]	Reading [dB μ V]	Factor [dB/m]	Loss [dB]	Result [dB μ V/m]	Limit [dB μ V/m]	Margin [dB]	Ant.
1	0.59005	37.7	10.7	0.1	48.5	72.2	23.7	0deg
2	0.88225	25.8	10.7	0.1	36.6	68.7	32.1	0deg
3	1.18035	30.1	10.6	0.1	40.8	66.1	25.3	0deg
4	0.59003	38.4	10.7	0.1	49.2	72.2	23.0	90deg
5	0.88225	35.2	10.7	0.1	46.0	68.7	22.7	90deg
6	1.18018	30.6	10.6	0.1	41.3	66.1	24.8	90deg

[Y-plane]

No.	Frequency [MHz]	Reading [dB μ V]	Factor [dB/m]	Loss [dB]	Result [dB μ V/m]	Limit [dB μ V/m]	Margin [dB]	Ant.
1	0.59011	37.5	10.7	0.1	48.3	72.2	23.9	0deg
2	0.88515	26.0	10.7	0.1	36.8	68.7	31.9	0deg
3	1.18013	29.9	10.6	0.1	40.6	66.1	25.5	0deg
4	0.59018	38.2	10.7	0.1	49.0	72.2	23.2	90deg
5	0.88225	26.1	10.7	0.1	36.9	68.7	31.8	90deg
6	1.18030	30.6	10.6	0.1	41.3	66.1	24.8	90deg

[Z-plane]

No.	Frequency [MHz]	Reading [dB μ V]	Factor [dB/m]	Loss [dB]	Result [dB μ V/m]	Limit [dB μ V/m]	Margin [dB]	Ant.
1	0.59018	37.7	10.7	0.1	48.5	72.2	23.7	0deg
2	0.88225	25.7	10.7	0.1	36.5	68.7	32.2	0deg
3	1.18035	30.0	10.6	0.1	40.7	66.1	25.4	0deg
4	0.59004	38.4	10.7	0.1	49.2	72.2	23.0	90deg
5	0.88565	26.3	10.7	0.1	37.1	68.7	31.6	90deg
6	1.18015	30.6	10.6	0.1	41.3	66.1	24.8	90deg

Tested Date: January 21, 2022
 Humidity: 26 %

Temperature: 15 deg. C
 Atmos. Press: 1015 hPa

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Operating mode: ISO 15693 ASK 10%

Antenna port: 12ch

Measurement distance: 3 m

[X-plane]

No.	Frequency [MHz]	Reading [dB μ V]	Factor [dB/m]	Loss [dB]	Result [dB μ V/m]	Limit [dB μ V/m]	Margin [dB]	Ant.
-	-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-	-

There are no spurious emissions greater than noise floor or 20dB below the limit.

[Y-plane]

No.	Frequency [MHz]	Reading [dB μ V]	Factor [dB/m]	Loss [dB]	Result [dB μ V/m]	Limit [dB μ V/m]	Margin [dB]	Ant.
-	-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-	-

There are no spurious emissions greater than noise floor or 20dB below the limit.

[Z-plane]

No.	Frequency [MHz]	Reading [dB μ V]	Factor [dB/m]	Loss [dB]	Result [dB μ V/m]	Limit [dB μ V/m]	Margin [dB]	Ant.
-	-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-	-

There are no spurious emissions greater than noise floor or 20dB below the limit.

Tested Date: March 31, 2022
 Humidity: 53 %

Temperature: 20 deg. C
 Atmos. Press: 1009 hPa

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Operating mode: ISO 15693 ASK 10%

Antenna port: 24ch

Measurement distance: 3 m

[X-plane]

No.	Frequency [MHz]	Reading [dB μ V]	Factor [dB/m]	Loss [dB]	Result [dB μ V/m]	Limit [dB μ V/m]	Margin [dB]	Ant.
-	-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-	-

There are no spurious emissions greater than noise floor or 20dB below the limit.

[Y-plane]

No.	Frequency [MHz]	Reading [dB μ V]	Factor [dB/m]	Loss [dB]	Result [dB μ V/m]	Limit [dB μ V/m]	Margin [dB]	Ant.
-	-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-	-

There are no spurious emissions greater than noise floor or 20dB below the limit.

[Z-plane]

No.	Frequency [MHz]	Reading [dB μ V]	Factor [dB/m]	Loss [dB]	Result [dB μ V/m]	Limit [dB μ V/m]	Margin [dB]	Ant.
-	-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-	-

There are no spurious emissions greater than noise floor or 20dB below the limit.

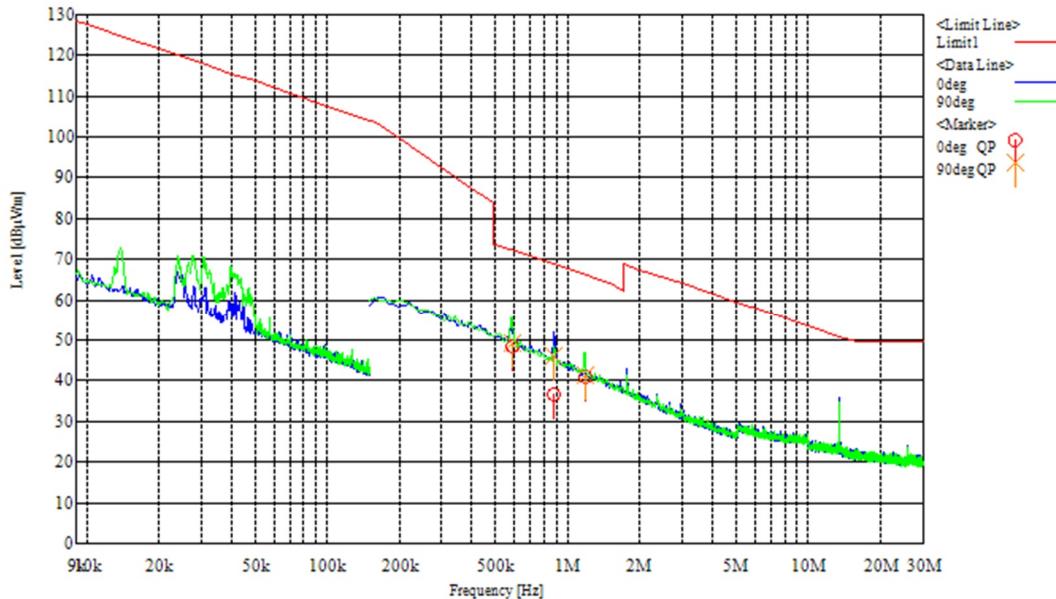
Tested Date: March 31, 2022
 Humidity: 53 %

Temperature: 20 deg. C
 Atmos. Press: 1009 hPa

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Graphical express of test result (Antenna port: 1ch, X-plane)



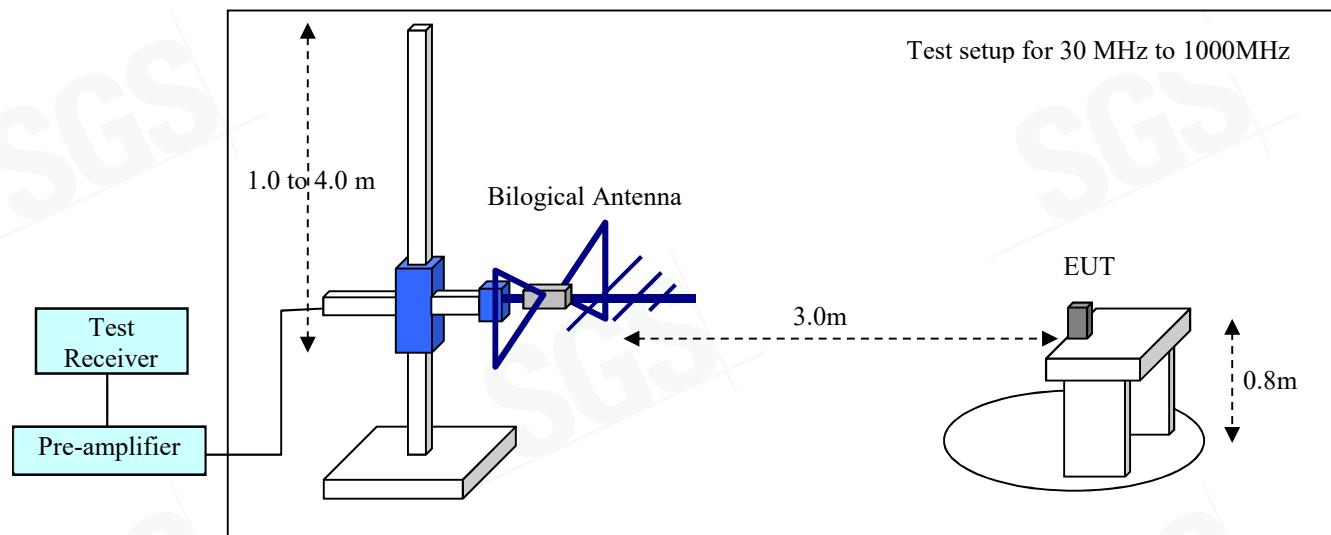
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2.3 Transmitter radiated spurious emissions between 30MHz to 1000MHz

Test setup

Test setup was implemented according to the method of ANSI C63.10 clause 6.



Test procedure

Measurement procedures were implemented according to the method of ANSI C63.10: 2013 clauses 6.5.

Exploratory radiated measurements were performed at the measurement distance of 3 meters using broadband antennas and a spectrum analyzer. The EUT was set up in its typical configuration and arrangement, and operated in its various modes.

For each mode of operation required to be tested, the frequency spectrum were monitored. Variations in antenna height between 1 and 4 m, antenna polarization, EUT azimuth, and cable or wire placement (each variable within bounds specified elsewhere) were explored to produce the emission that has the highest amplitude relative to the limit.

Based on the exploratory measurement results, the one EUT, cable and wire arrangement, and mode of operation that produces the emission that has the highest amplitude relative to the limit is selected for the final measurement.

This investigation was performed with the EUT rotated 360° , the antenna height scanned between 1m and 4m, and the antenna rotated to repeat the measurements for both the horizontal and vertical antenna polarizations. EUT was placed at three different orientations (X, Y and Z axis) in order to find the worst orientation.

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Applicable rule and limitation

§15.209: General requirements

Except as provided elsewhere in this Subpart, the emissions from an intentional radiator shall not exceed the field strength levels specified in the following table:

Frequency [MHz]	Field Strength [μ V/m]	Measurement Distance [m]	Field Strength [dB μ V/m]
30 – 88	100	3	40.0
88 – 216	150	3	43.5
216 – 960	200	3	46.0
Above 960	500	3	53.9

In the emission table above, the tighter limit applies at the band edges.

The level of any unwanted emissions from an intentional radiator operating under these general provisions shall not exceed the level of the fundamental emission.

The emission limits shown in the above table are based on measurements employing a CISPR quasi-peak detector.

Test equipment used (refer to List of utilized test equipment)

AC01	BA10	CL71	PR15	TR10	-	-	-	-
------	------	------	------	------	---	---	---	---

Test software used

EMI1 Ver. 6.1

Calculation method

The Correction Factors and RESULT are calculated as followings.

$$\begin{aligned} \text{Correction Factor [dB/m]} &= \text{Ant. Factor [dB/m]} + \text{Loss [dB]} - \text{Gain [dB]} \\ \text{Result [dB}\mu\text{V/m]} &= \text{Reading [dB}\mu\text{V]} + \text{Correction Factor [dB/m]} \end{aligned}$$

Test results - Complied with requirement.

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Test Data

Operating mode: ISO 15693 ASK 10%

Antenna port: 1ch

Measurement distance: 3 m

[X-plane]

No.	Frequency [MHz]	Reading [dB μ V]	Factor [dB/m]	Loss [dB]	Gain [dB]	Result [dB μ V/m]	Limit [dB μ V/m]	Margin [dB]	Ant.
1	54.094	45.0	6.4	6.5	30.2	27.7	40.0	12.3	Vert.
2	83.487	42.7	8.1	6.7	30.1	27.4	40.0	12.6	Vert.
3	124.652	42.0	11.8	6.9	30.1	30.6	43.5	12.9	Vert.
4	172.929	45.7	9.5	7.1	30.0	32.3	43.5	11.2	Vert.
5	180.075	47.5	9.0	7.1	30.0	33.6	43.5	9.9	Vert.
6	664.905	30.0	20.4	8.7	29.7	29.4	46.0	16.6	Vert.

[Y-plane]

No.	Frequency [MHz]	Reading [dB μ V]	Factor [dB/m]	Loss [dB]	Gain [dB]	Result [dB μ V/m]	Limit [dB μ V/m]	Margin [dB]	Ant.
1	124.226	42.3	11.8	6.9	30.1	30.9	43.5	12.6	Vert.
2	166.987	44.1	9.9	7.1	30.0	31.1	43.5	12.4	Vert.
3	173.032	46.0	9.5	7.1	30.0	32.6	43.5	10.9	Vert.
4	178.899	48.2	9.1	7.1	30.0	34.4	43.5	9.1	Vert.
5	664.783	29.9	20.4	8.7	29.7	29.3	46.0	16.7	Vert.
6	797.654	27.3	22.0	9.0	30.3	28.0	46.0	18.0	Vert.

[Z-plane]

No.	Frequency [MHz]	Reading [dB μ V]	Factor [dB/m]	Loss [dB]	Gain [dB]	Result [dB μ V/m]	Limit [dB μ V/m]	Margin [dB]	Ant.
1	271.203	31.8	12.5	7.5	29.9	21.9	46.0	24.1	Hori.
2	54.094	45.7	6.4	6.5	30.2	28.4	40.0	11.6	Vert.
3	84.733	43.6	8.1	6.7	30.1	28.3	40.0	11.7	Vert.
4	119.998	47.9	11.7	6.9	30.1	36.4	43.5	7.1	Vert.
5	180.190	42.7	9.0	7.1	30.0	28.8	43.5	14.7	Vert.
6	664.779	27.0	20.4	8.7	29.7	26.4	46.0	19.6	Vert.

Tested Date: January 21, 2022
 Humidity: 26 %

Temperature: 15 deg. C
 Atmos. Press: 1015 hPa

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Operating mode: ISO 15693 ASK 10%

Antenna port: 12ch

Measurement distance: 3 m

[X-plane]

No.	Frequency [MHz]	Reading [dB μ V]	Factor [dB/m]	Loss [dB]	Gain [dB]	Result [dB μ V/m]	Limit [dB μ V/m]	Margin [dB]	Ant.
1	132.087	38.2	11.8	6.9	30.0	26.9	43.5	16.6	Hori.
2	81.227	45.8	7.7	6.7	30.1	30.1	40.0	9.9	Vert.
3	148.172	42.3	11.2	7.0	30.0	30.5	43.5	13.0	Vert.
4	152.876	43.4	10.9	7.0	30.0	31.3	43.5	12.2	Vert.
5	169.278	47.1	9.7	7.1	30.0	33.9	43.5	9.6	Vert.
6	338.678	39.3	14.1	7.8	29.9	31.3	46.0	14.7	Vert.

[Y-plane]

No.	Frequency [MHz]	Reading [dB μ V]	Factor [dB/m]	Loss [dB]	Gain [dB]	Result [dB μ V/m]	Limit [dB μ V/m]	Margin [dB]	Ant.
1	131.995	42.6	11.8	6.9	30.0	31.3	43.5	12.2	Hori.
2	81.167	42.6	7.7	6.7	30.1	26.9	40.0	13.1	Vert.
3	152.875	42.8	10.9	7.0	30.0	30.7	43.5	12.8	Vert.
4	167.981	48.4	9.9	7.1	30.0	35.4	43.5	8.1	Vert.
5	338.678	39.6	14.1	7.8	29.9	31.6	46.0	14.4	Vert.
6	431.988	34.7	16.7	8.0	29.7	29.7	46.0	16.3	Vert.

[Z-plane]

No.	Frequency [MHz]	Reading [dB μ V]	Factor [dB/m]	Loss [dB]	Gain [dB]	Result [dB μ V/m]	Limit [dB μ V/m]	Margin [dB]	Ant.
1	131.997	38.6	11.8	6.9	30.0	27.3	43.5	16.2	Hori.
2	79.962	44.2	7.6	6.7	30.2	28.3	40.0	11.7	Vert.
3	148.172	41.7	11.2	7.0	30.0	29.9	43.5	13.6	Vert.
4	152.876	42.2	10.9	7.0	30.0	30.1	43.5	13.4	Vert.
5	166.987	47.7	9.9	7.1	30.0	34.7	43.5	8.8	Vert.
6	664.434	29.8	20.4	8.6	29.7	29.1	46.0	16.9	Vert.

Tested Date: March 30, 2022
 Humidity: 47 %

Temperature: 22 deg. C
 Atmos. Press: 1019 hPa

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Operating mode: ISO 15693 ASK 10%

Antenna port: 24ch

Measurement distance: 3 m

[X-plane]

No.	Frequency [MHz]	Reading [dB μ V]	Factor [dB/m]	Loss [dB]	Gain [dB]	Result [dB μ V/m]	Limit [dB μ V/m]	Margin [dB]	Ant.
1	271.203	46.5	12.5	7.5	29.9	36.6	46.0	9.4	Hori.
2	284.763	42.5	12.7	7.6	29.9	32.9	46.0	13.1	Hori.
3	54.094	47.4	6.4	6.5	30.2	30.1	40.0	9.9	Vert.
4	81.228	45.8	7.7	6.7	30.1	30.1	40.0	9.9	Vert.
5	168.234	39.7	9.8	7.1	30.0	26.6	43.5	16.9	Vert.
6	178.706	44.8	9.1	7.1	30.0	31.0	43.5	12.5	Vert.

[Y-plane]

No.	Frequency [MHz]	Reading [dB μ V]	Factor [dB/m]	Loss [dB]	Gain [dB]	Result [dB μ V/m]	Limit [dB μ V/m]	Margin [dB]	Ant.
1	131.989	42.5	11.8	6.9	30.0	31.2	43.5	12.3	Hori.
2	271.203	44.7	12.5	7.5	29.9	34.8	46.0	11.2	Hori.
3	79.990	44.0	7.6	6.7	30.2	28.1	40.0	11.9	Vert.
4	168.011	48.6	9.9	7.1	30.0	35.6	43.5	7.9	Vert.
5	181.151	44.5	8.9	7.1	30.0	30.5	43.5	13.0	Vert.
6	271.221	39.8	12.5	7.5	29.9	29.9	46.0	16.1	Vert.

[Z-plane]

No.	Frequency [MHz]	Reading [dB μ V]	Factor [dB/m]	Loss [dB]	Gain [dB]	Result [dB μ V/m]	Limit [dB μ V/m]	Margin [dB]	Ant.
1	271.200	43.9	12.5	7.5	29.9	34.0	46.0	12.0	Hori.
2	81.114	42.6	7.7	6.7	30.1	26.9	40.0	13.1	Vert.
3	119.949	38.9	11.7	6.9	30.1	27.4	43.5	16.1	Vert.
4	168.224	47.5	9.8	7.1	30.0	34.4	43.5	9.1	Vert.
5	271.203	40.0	12.5	7.5	29.9	30.1	46.0	15.9	Vert.
6	528.845	33.9	18.9	8.2	29.5	31.5	46.0	14.5	Vert.

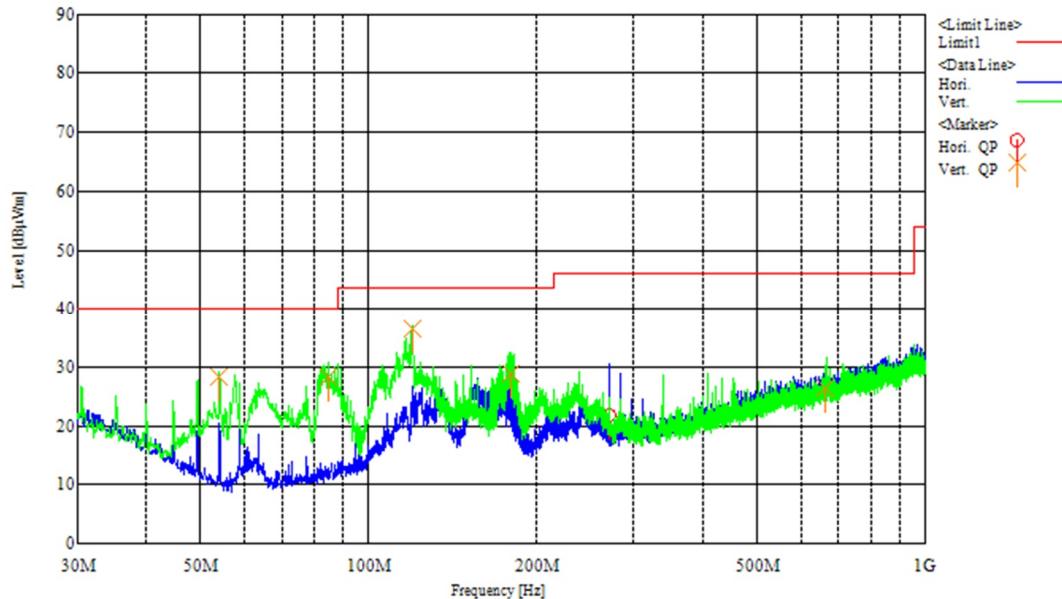
Tested Date: March 30, 2022
 Humidity: 47 %

Temperature: 22 deg. C
 Atmos. Press: 1019 hPa

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Graphical express of test result (Antenna port: 1ch, Z-plane)



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2.4 Frequency stability

Test setup

Test setup was implemented according to the method of ANSI C63.10: 2013 clauses 6.8 “Frequency stability tests”.

Test procedure

Measurement procedures were implemented according to the test method of ANSI C63.10: 2013 clause 6.8.1.

Place the de-energized EUT in the temperature test chamber. Supply the EUT with nominal ac voltage, or install a new or fully charged battery in the EUT. An antenna was connected to the antenna output connector of the EUT if possible. The frequency counter was connected to the measurement antenna with a suitable length of coaxial cable.

The environmental chamber set to the highest temperature specified in applicable regulation.

Allow sufficient time (approximately 30 minutes) for the temperature of the chamber to stabilize.

Turn the EUT on and measure the EUT operating frequency at startup, and two, five, and ten minutes after startup. The measurements were performed that the temperature chamber set to reduce the lowest temperature specified in applicable regulation.

Applicable rule and limitation

§15.225 (e): Frequency tolerance

Test items	Variation ranges		Limit
Temperature variations	+5 to +50 degrees C *	24.0 +/-10% VDC *	+/-0.01%

Note1: The above operating range is declared by manufacturer.

Test equipment used (refer to List of utilized test equipment)

TR09	-	-	-	-	-	-	-	-	-	-	-
------	---	---	---	---	---	---	---	---	---	---	---

Test results - Complied with requirement.

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Test Data

Operating mode: No modulation

Antenna port: 1ch

Temp. (Degrees)	Voltages (V)	Measured Frequency (MHz)				Worst Deviation (%)	Limit (%)
		Start-up	2 min.	5 min.	10 min.		
5	24.0	13.5601774	13.5601755	13.5601741	13.5601735	+0.0013	+/-0.01
10	24.0	13.5601745	13.5601688	13.5601672	13.5601666	+0.0013	+/-0.01
20	26.4	13.5601626	13.5601482	13.5601463	13.5601452	+0.0012	+/-0.01
	24.0	13.5601556	13.5601483	13.5601459	13.5601452	+0.0011	+/-0.01
	21.6	13.5601622	13.5601480	13.5601462	13.5601452	+0.0012	+/-0.01
30	24.0	13.5601396	13.5601246	13.5601217	13.5601209	+0.0010	+/-0.01
40	24.0	13.5601155	13.5601041	13.5601021	13.5601014	+0.0009	+/-0.01
50	24.0	13.5600948	13.5600939	13.5600938	13.5600938	+0.0007	+/-0.01

Tested Date: January 26, 2022
 Humidity: 25 %

Temperature: 18 deg. C
 Atmos. Press: 1010 hPa

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2.5 AC power line conducted emissions

Test setup

Test setup was implemented according to the method of ANSI C63.10: 2013 clause 6.2.

Test procedure

Measurement procedures were implemented according to the method of ANSI C63.10: 2013 clauses 6.2 “Standard test method for ac power line conducted emissions from unlicensed wireless devices”.

Exploratory measurements were used the spectrum analyzer to identify the frequency of the emission that has the highest amplitude relative to the limit by operating the EUT in a range of typical modes of operation, cable positions, and with a typical system equipment configuration and arrangement.

Final ac power line conducted emission measurements were performed based on the exploratory tests.

The EUT cable configuration and arrangement and mode of operation that produced the emission with the highest amplitude relative to the limit are selected for the final measurement.

When the measurement value is greater than average limitation the average detection measurements were performed.

Applicable rule and limitation

§15.207 (a): AC power line conducted limits

Frequency of Emission [MHz]	Conducted emissions Limit [dB μ V]	
	Quasi-peak	Average
0.15 - 0.5	66 to 56 *	56 to 46 *
0.5 - 5	56	46
5 - 30	60	50

* Decreases with the logarithm of the frequency. The lower limit applies at the band edges.

Test equipment used (refer to List of utilized test equipment)

CL72	LN13	TR09	-				-	-	-
------	------	------	---	--	--	--	---	---	---

Test software used

EMI Ver. 6.1

Calculation method

The Correction Factor and Result are calculated as followings.

$$\begin{aligned}\text{Correction Factor [dB]} &= \text{ISN Factor [dB]} + \text{Loss [dB]} \\ \text{Result [dB}\mu\text{V]} &= \text{Reading [dB}\mu\text{V]} + \text{Correction Factor [dB]}\end{aligned}$$

Test results - Complied with requirement.

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Test Data

Operating mode: ISO 15693 ASK 10%

Antenna port: 1ch

No.	Frequency [MHz]	Reading		C.F. [dB]	Result		Limit		Margin		PHASE
		QP [dBuV]	AV [dBuV]		QP [dBuV]	AV [dBuV]	QP [dBuV]	AV [dBuV]	QP [dB]	AV [dB]	
1	7.05578	27.5	26.1	10.2	37.7	36.3	60.0	50.0	22.3	13.7	Va
2	13.56018	35.2	35.2	10.3	45.5	45.5	60.0	50.0	14.5	4.5	Va
3	25.87133	26.4	26.1	10.5	36.9	36.6	60.0	50.0	23.1	13.4	Va
4	7.05586	27.2	25.6	10.2	37.4	35.8	60.0	50.0	22.6	14.2	Vb
5	13.56018	32.5	32.6	10.3	42.8	42.9	60.0	50.0	17.2	7.1	Vb
6	25.87133	27.0	26.7	10.5	37.5	37.2	60.0	50.0	22.5	12.8	Vb

Tested Date: January 18, 2022
 Humidity: 36 %

Temperature: 25 deg. C
 Atmos. Press: 1006 hPa

Antenna port: 12ch

No.	Frequency [MHz]	Reading		C.F. [dB]	Result		Limit		Margin		PHASE
		QP [dBuV]	AV [dBuV]		QP [dBuV]	AV [dBuV]	QP [dBuV]	AV [dBuV]	QP [dB]	AV [dB]	
1	0.15493	24.1	6.4	10.2	34.3	16.6	65.7	55.7	31.4	39.1	Va
2	0.18449	20.8	4.4	10.2	31.0	14.6	64.3	54.3	33.3	39.7	Va
3	7.05578	27.2	25.7	10.2	37.4	35.9	60.0	50.0	22.6	14.1	Va
4	11.75971	26.9	26.5	10.3	37.2	36.8	60.0	50.0	22.8	13.2	Va
5	25.87129	24.9	24.8	10.5	35.4	35.3	60.0	50.0	24.6	14.7	Va
6	25.87123	27.2	27.2	10.5	37.7	37.7	60.0	50.0	22.3	12.3	Vb

Tested Date: March 30, 2022
 Humidity: 47 %

Temperature: 22 deg. C
 Atmos. Press: 1019 hPa

Antenna port: 24ch

No.	Frequency [MHz]	Reading		C.F. [dB]	Result		Limit		Margin		PHASE
		QP [dBuV]	AV [dBuV]		QP [dBuV]	AV [dBuV]	QP [dBuV]	AV [dBuV]	QP [dB]	AV [dB]	
1	0.20913	20.5	3.6	10.2	30.7	13.8	63.2	53.2	32.5	39.4	Va
2	7.05576	26.9	25.4	10.2	37.1	35.6	60.0	50.0	22.9	14.4	Va
3	13.56015	36.1	35.8	10.3	46.4	46.1	60.0	50.0	13.6	3.9	Va
4	0.18449	21.6	7.9	10.2	31.8	18.1	64.3	54.3	32.5	36.2	Vb
5	7.05569	26.6	24.9	10.2	36.8	35.1	60.0	50.0	23.2	14.9	Vb
6	13.56020	32.9	32.7	10.3	43.2	43.0	60.0	50.0	16.8	7.0	Vb

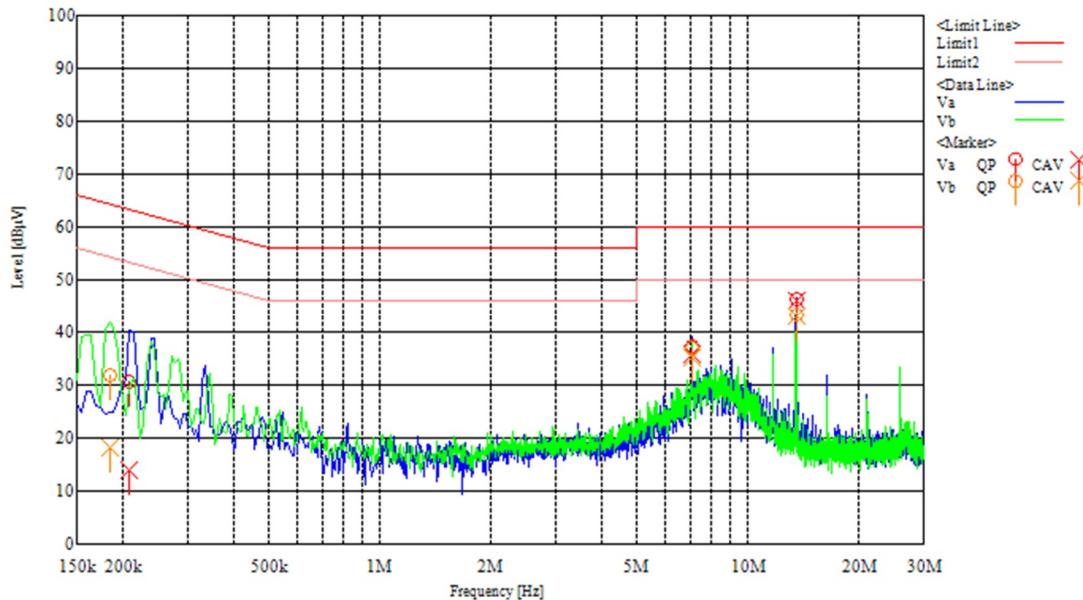
Tested Date: March 30, 2022
 Humidity: 47 %

Temperature: 22 deg. C
 Atmos. Press: 1019 hPa

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Graphical express of test result (Antenna port: 24ch)



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4 List of utilized test equipment/ calibration

RFT ID No.	Kind of Equipment and Precision	Manufacturer	Model No.	Serial Number	Calibration Date	Calibrated until
AC11(EM)	Anechoic Chamber	TDK	-	-	2021/08/10	2022/08/31
BA10	Biological Antenna	TESEQ	CBL6111D	32342	2021/06/15	2022/06/30
CL71	RF Cable for RE	RFT	-	-	2022/01/14	2023/01/31
CL72	RF Cable for CE	RFT	-	-	2022/01/11	2023/01/31
LN13	LISN	Kyoritsu	KNW-407F	8-2003-3	2021/08/02	2022/08/31
LP05	Loop Antenna	ETS-Lindgren	6502	00143302	2021/03/09	2022/03/31
PR15	Pre. Amplifier	Anritsu	MH648A	6201156141	2021/06/15	2022/06/30
TC01	Temperature Chamber	ESPEC	SH-641	92000964	2021/12/10	2022/12/31
TR09	Test Receiver (F/W : 4.43 SP3)	Rohde & Schwarz	ESU8	100386	2021/07/08	2022/07/31
TR10	Test Receiver (F/W : 2.26)	Rohde & Schwarz	ESR26	101313	2021/03/22	2022/03/31

The measuring equipment, which was utilized in performing the tests documented herein, has been calibrated in accordance with the manufacturer's recommendations for utilizing calibration equipment, which is traceable to recognized national standards.

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