

TEST REPORT

Part 15 Subpart C 15.225

Equipment under test RF Card Reader

Model name T-40

FCC ID 2AVVCT40

Applicant ARVRATECH Co., Ltd

Manufacturer ARVRATECH Co., Ltd

Date of test(s) 2021.09.17 ~ 2021.09.28

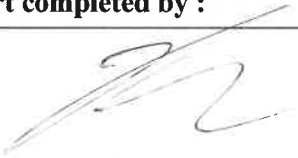
Date of issue 2021.10.18

Issued to
ARVRATECH Co., Ltd

807, housD The SkyValley 2-Cha, Beoman-ro 1142, Geumcheon-gu,
Seoul, South Korea
Tel: +82-2-2027-2027

Issued by
KES Co., Ltd.

C-3701, 40, Simin-daero 365beon-gil, Dongan-gu, Anyang-si,
Gyeonggi-do, 14057, Korea
473-21, Gayeo-ro, Yeosu-si, Gyeonggi-do, Korea
Tel: +82-31-425-6200 / Fax: +82-31-424-0450

Test and report completed by :	Report approval by :
	
Gu-Bong, Kang Test engineer	Young-Jin, Lee Technical manager

This report shall not be reproduced except in full, without the written approval of KES Co., Ltd.
The results shown in this test report refer only to the sample(s) tested unless otherwise stated.
The authenticity of the test report, contact shchoi@kes.co.kr



Revision history

Revision	Date of issue	Test report No.	Description
-	2021.10.18	KES-RF1-21T0188	Initial

This report shall not be reproduced except in full, without the written approval of KES Co., Ltd.
The results shown in this test report refer only to the sample(s) tested unless otherwise stated.
The authenticity of the test report, contact shchoi@kes.co.kr



TABLE OF CONTENTS

1.	General information	4
1.1.	EUT description	4
1.2.	Test configuration.....	4
1.3.	Accessory information.....	5
1.4.	Measurement uncertainty	5
1.5.	Test frequency/Channel operation	5
2.	Summary of tests	6
3	Test results	7
3.1.	Radiated spurious emissions.....	7
3.2	20 dB bandwidth	14
3.3.	Frequency Stability.....	16
3.4.	AC conducted emissions	18
Appendix A.	Measurement equipment.....	20
Appendix B.	Test setup photos	21



KES Co., Ltd.

C-3701, 40, Simin-daero 365beon-gil,
Dongan-gu, Anyang-si, Gyeonggi-do, Korea
Tel: +82-31-425-6200 / Fax: +82-31-424-0450
www.kes.co.kr

Test report No.:
KES-RF1-21T0188
Page (4) of (21)

1. General information

Applicant ARVRATECH Co., Ltd
Applicant address 807, housD The SkyValley 2-Cha, Beoman-ro 1142, Geumcheon-gu,
Seoul, South Korea
Test site KES Co., Ltd.
Test site address ☐ 3701, 40, Simin-daero 365beon-gil, Dongan-gu, Anyang-si,
Gyeonggi-do, 14057, Korea
☒ 473-29, Gayeo-ro, Yeosu-si, Gyeonggi-do, Korea
Standard(s) Part 15.225
Test device serial No. ☒ Production ☐ Pre-production ☐ Engineering

1.1. EUT description

Equipment under test RF Card Reader
Frequency range 13.561 MHz
Model: T-40
Modulation technique ASK
Number of channels 13.561 MHz (NFC) : 1ch
Antenna specification Antenna type(NFC) : Loop Antenna
Power source AC 120 V (AC/DC Adapter Output 5 V)
H/W version T40 REV3.5
F/W version Ver1.2.5

1.2. Test configuration

The **ARVRATECH Co., Ltd // T-40 // RF Card Reader // FCC ID: 2AVVCT40** was tested according to the specification of EUT, the EUT must comply with following standards

FCC Part 15
FCC Part 2
ANSI C63.10-2013

This report shall not be reproduced except in full, without the written approval of KES Co., Ltd.
The results shown in this test report refer only to the sample(s) tested unless otherwise stated.
The authenticity of the test report, contact shchoi@kes.co.kr



1.3. Accessory information

Equipment	Manufacturer	Model	Serial No.	Power source
AC adaptor	ShenZhen Smart Power Technology Co., Ltd.	SW40-05004000-W	SW40-05004000WA1	AC 120 V (Output : DC 5.0V/4.0A)

1.4 Measurement uncertainty

Test Item		Uncertainty
Uncertainty for Conduction emission test		2.46 dB
Uncertainty for Radiation emission test (include Fundamental emission)	Below 1GHz	4.40 dB
	Above 1GHz	5.94 dB
Note. This uncertainty represents an expanded uncertainty expressed at approximately the 95% confidence level using a coverage factor of k=2.		

1.5. Test frequency/Channel operation

Ch.	Frequency (MHz)
01	13.561



2. Summary of tests

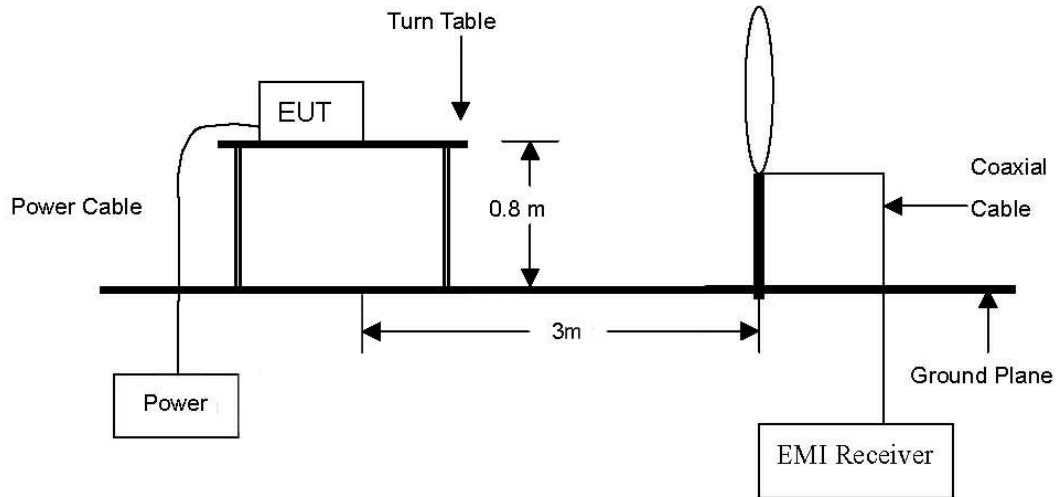
Section in FCC Part 15 & 2	Parameter	Test results
15.225(a)	The field strength of fundamental	Pass
15.225(b)(c)	The field strength of spurious emission(In-band)	Pass
15.225(d) 15.209	The field strength of spurious emission(Out-band)	Pass
2.1049	20 dB bandwidth	Pass
15.225(e)	Frequency stability	Pass
15.207	AC conducted emissions	Pass

3 Test results

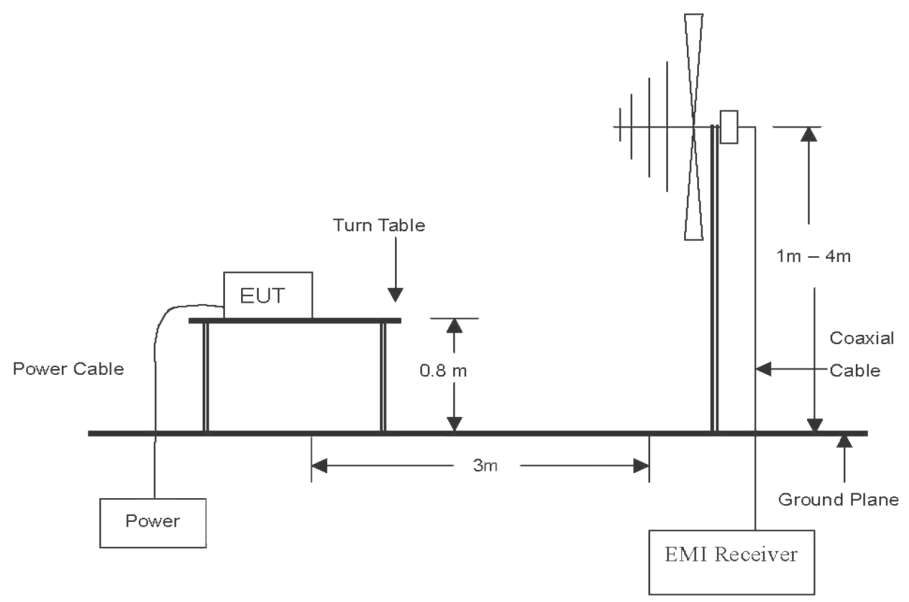
3.1. Radiated spurious emissions

Test setup

The diagram below shows the test setup that is utilized to make the measurements for emission from 9 kHz to 30 MHz Emissions.



The diagram below shows the test setup that is utilized to make the measurements for emission from 30 MHz to 1 GHz emissions.



Test procedure

[9 kHz to 30 MHz]

The EUT was placed on the top of a rotating table 0.8 meter above the ground at a 3 meter anechoic chamber. The table was rotated 360 degrees to determine the position of the highest radiation. Then antenna is a loop antenna is fixed at one meter above the ground to determine the maximum value of the field strength. Both parallel and perpendicular of the antenna are set to make the measurement. For each suspected emission, the EUT was arranged to its worst case and then the table was turned from 0 degrees to 360 degrees to find the maximum reading. The test-receiver system was set to Quasi-peak function and specified bandwidth with maximum hold mode.

The spectrum analyzer is set to:

1. The resolution bandwidth and video bandwidth of test receiver/spectrum analyzer 200 Hz for Quasi-peak detection (QP) at frequency below 9 kHz~ 150 kHz.
2. The resolution bandwidth and video bandwidth of test receiver/spectrum analyzer 9 kHz for Quasi-peak detection (QP) at frequency below 150 kHz~ 30 MHz.

[30 MHz to 1 GHz]

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

The measurement was made in both the vertical and horizontal polarization, and the maximum value is presented in the report.

The spectrum analyzer is set to:

1. The resolution bandwidth and video bandwidth of test receiver/spectrum analyzer is 120 kHz for Peak detection (PK) or Quasi-peak detection (QP) at frequency below 1 GHz.

Note.

According to exploratory test no any obvious emission except for fundamental 13.56MHz were detected from 9 kHz to 30 MHz. Although these test were performed other than open field test site, adequate comparison measurements were confirmed against 30 m open field 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.

Limit

According to 15.209(a), for an intentional radiator devices, the general required of field strength of radiated emissions from unintentional radiators at a distance of 3 meters shall not exceed the following values :

Frequency (MHz)	Distance (Meters)	Radiated ($\mu\text{V/m}$)
0.009 ~ 0.490	300	2400/F(kHz)
0.490 ~ 1.705	30	24000/F(kHz)
1.705 ~ 30.0	30	30
30 ~ 88	3	100**
88 ~ 216	3	150**
216 ~ 960	3	200**
Above 960	3	500

**Except as provided in paragraph (g), fundamental emissions from intentional radiators operating under this Section shall not be located in the frequency bands 54 ~ 72 MHz, 76 ~ 88 MHz, 174 ~ 216 MHz or 470 ~ 806 MHz. However, operation within these frequency bands is permitted under other sections of this Part, e.g., Sections 15.231 and 15.241.

In the section 15.225:

- (a) The field strength of any emissions within the band 13.553 ~ 13.567 MHz shall not exceed 15,848 microvolts/meter (= 84 dB $\mu\text{V/m}$) at 30 meters.
- (b) Within the bands 13.410 ~ 13.553 MHz and 13.567 ~ 13.710 MHz, the field strength of any emissions shall not exceed 334 microvolts/meter (=50.5 dB $\mu\text{V/m}$) at 30 meters.
- (c) Within the bands 13.110 ~ 13.410 MHz and 13.710 ~ 14.010 MHz the field strength of any emissions shall not exceed 106 microvolts/meter (=40.5 dB $\mu\text{V/m}$) at 30 meters.
- (d) The field strength of any emissions appearing outside of the 13.110 ~ 14.010 MHz band shall not exceed the general radiated emission limits in § 15.209.



Test results for fundamental

Operating frequency: 13.561 MHz

Distance of measurement: 3 meter

Radiated emissions		Ant.	Total factors		Total	Limit	
Frequency (MHz)	Reading (dB μ V)	Pol.	Correction factor (dB/m)	Distance factor (dB)	Actual (dB μ V/m)	Limit (dB μ V/m)	Margin (dB)
13.561	35.58	H	20.62	40.00	16.20	84.00	67.80
13.561	16.82	V	20.62	40.00	-2.56	84.00	86.56

Test results for in-band & out-band(9 kHz to 30 MHz)

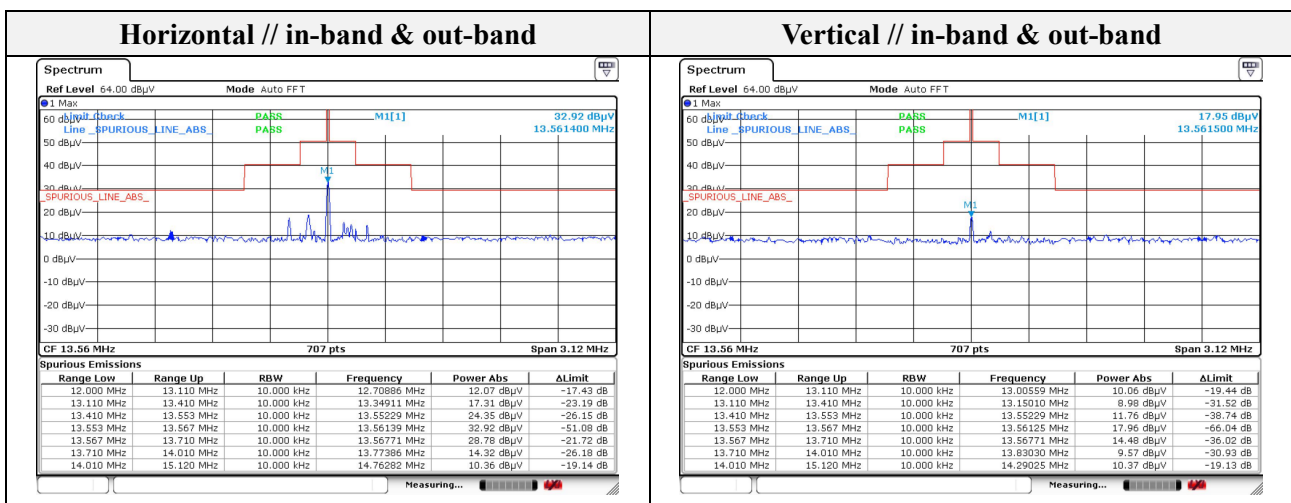
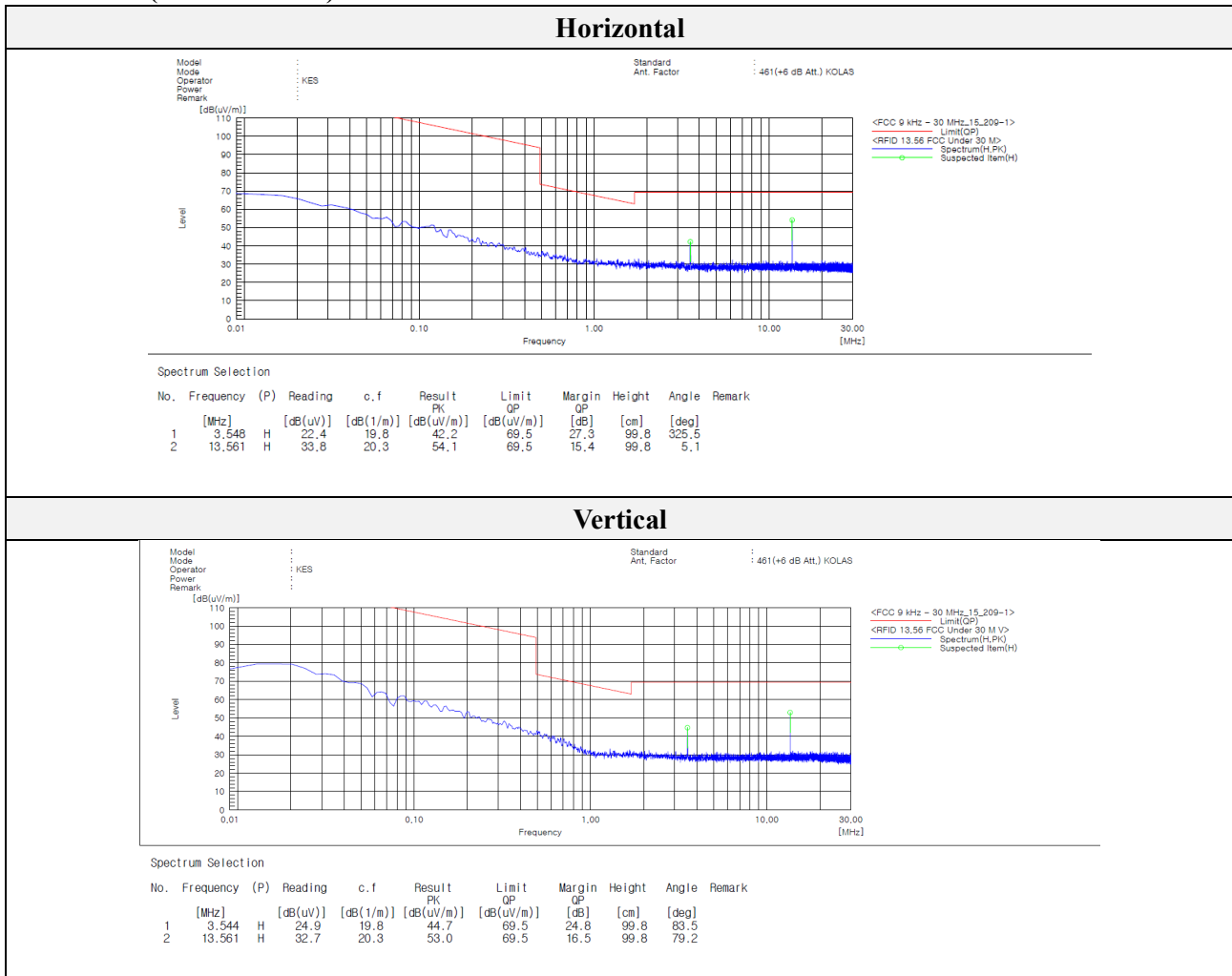
Radiated emissions		Ant.	Total factors		Total	Limit	
Frequency (MHz)	Reading (dB μ V)	Pol.	Correction factor (dB/m)	Distance factor (dB)	Actual (dB μ V/m)	Limit (dB μ V/m)	Margin (dB)
12.709	12.07	H	20.61	40.00	-7.32	29.54	36.86
13.006	10.06	V	20.65	40.00	-9.29	29.54	38.83
13.150	8.98	V	20.64	40.00	-10.38	40.50	50.88
13.349	17.31	H	20.63	40.00	-2.06	40.50	42.56
13.552	24.35	H	20.62	40.00	4.97	50.50	45.53
13.552	11.76	V	20.62	40.00	-7.62	50.50	58.12
13.561	32.92	H	20.62	40.00	13.54	84.00	70.46
13.561	17.96	V	20.62	40.00	-1.42	84.00	85.42
13.568	28.78	H	20.62	40.00	9.40	50.50	41.10
13.568	14.48	V	20.62	40.00	-4.90	50.50	55.40
13.774	14.32	H	20.61	40.00	-5.07	40.50	45.57
13.830	9.57	V	20.60	40.00	-9.83	40.50	50.33
14.290	10.37	V	20.60	40.00	-9.03	29.54	38.57
14.763	10.36	H	20.62	40.00	-9.02	29.54	38.56

Note.

1. All measurements were performed using a loop antenna. The antenna was investigated with three polarizations, and horizontal and vertical polarizations were reported as the worst case.
2. The EUT was positioned in three orthogonal planes to determine the orientation resulting in the worst case emissions.
3. Measurements were performed at 3m and the data was extrapolated to the specified measurement distance of 30m using the square of an inverse linear distance extrapolation factor (40 dB/decade) as specified in §15.31(f)(2). Extrapolation Factor = $20 \log_{10}(30/3)^2 = 40$ dB.
4. The spectrum was investigated from 9 kHz up to 30 MHz using the loop antenna. Only the emissions shown in the table above were found to be significant.
5. All measurements were recorded using a spectrum analyzer employing a quasi-peak detector.
6. Actual = Reading + Correction factors(Ant. factor + Cable loss) - Distance factor
7. Margin [dB] = Limit [dB μ V/m] - Field Strength Level [dB μ V/m]
8. All modes (e.g. with and without a tag) were investigated. Only the radiated emissions of the configuration (with a tag) that produced the worst case emissions are reported in this section.



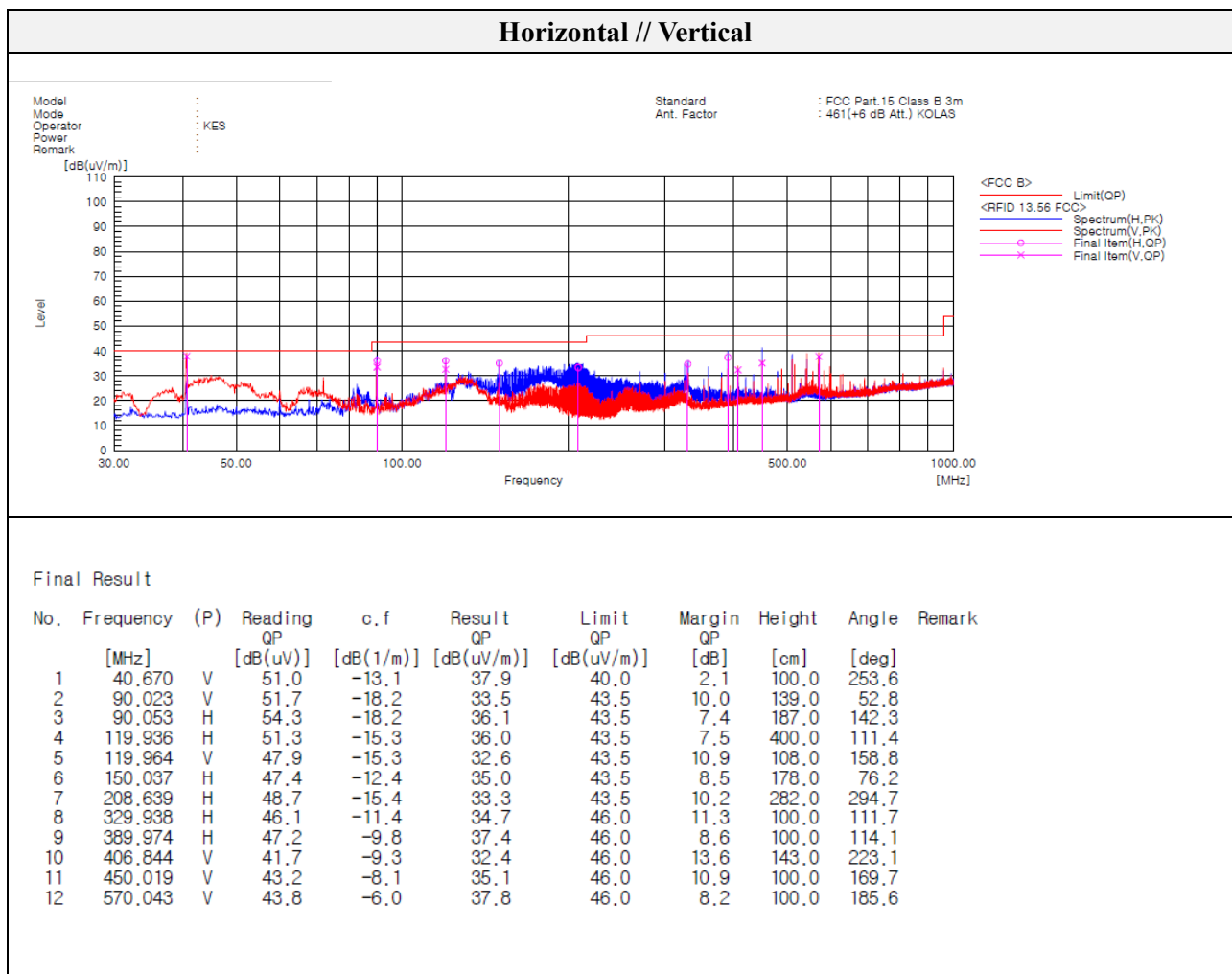
Test results (9 kHz to 30 MHz)



This report shall not be reproduced except in full, without the written approval of KES Co., Ltd.
The results shown in this test report refer only to the sample(s) tested unless otherwise stated.
The authenticity of the test report, contact shchoi@kes.co.kr



Test results (Below 1 000 MHz)

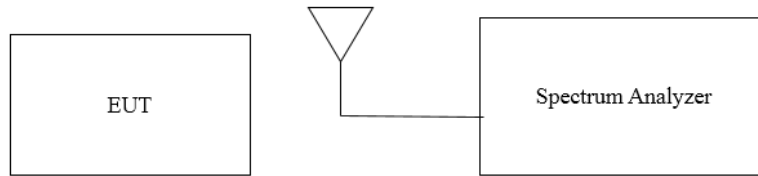


Note.

1. All measurements were recorded using a spectrum analyzer employing a quasi-peak detector for emissions below 960 MHz.
2. Below 30 MHz, loop Antenna was investigated with three polarizations, horizontal and vertical polarizations were reported as the worst case.
3. The EUT was positioned in three orthogonal planes to determine the orientation resulting in the worst case emissions.
4. The spectrum is measured from 9 kHz to the 10th harmonic and the worst-case emissions are reported.
5. No spurious emissions levels were found to be greater than the level of the fundamental.

3.2 20 dB bandwidth

Test setup

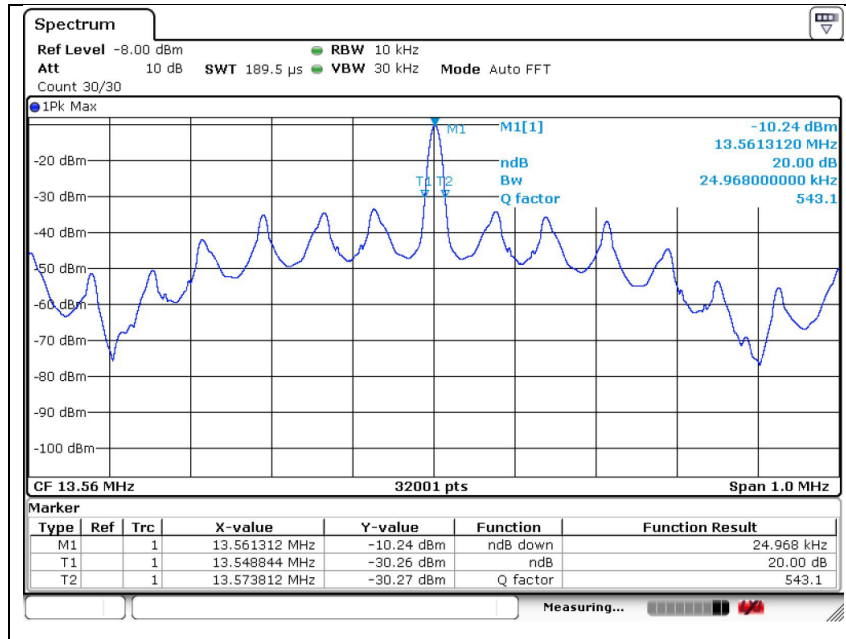


Test procedure

ANSI C63.10-2013 – Section 6.9.2

1. Spectrum analyzer frequency is set to the nominal EUT channel center frequency.
2. RBW = 1~5% OBW
3. VBW $\geq 3 \times$ RBW
4. Reference level set to keep signal from exceeding maximum input mixer for linear operation.
5. Detector = Peak
6. Trace mode = Max hold
7. Sweep = Auto couple
8. The trace was allowed to stabilize
9. Using the marker-delta function, determine the “-20 dB down amplitude” using [(highest in band spectral density) – 20 dB]
10. Set a marker at the lowest frequency of the envelope of the spectral density, such that the marker is at or slightly below the “-20 dB down amplitude” determined in Step 9.
11. Reset Marker-delta function and move the marker to other side of the emission until the delta marker amplitude is the same level as reference amplitude. The marker delta frequency reading at this point is the specified emission bandwidth.

Test results



Note.

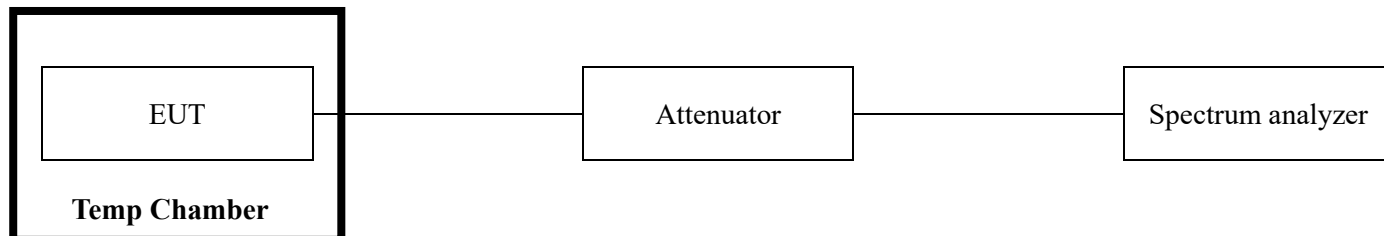
Because the measured signal is CW/CW-like, adjusting the RBW per C63.10 would not be practical since measured bandwidth will always follow the RBW and the result will be approximately twice the RBW.

3.3. Frequency Stability

Test procedure

ANSI C63.10-2013, clause 6.8.1

Test setup



1. The EUT was placed inside the environmental test chamber and powered by nominal DC voltage.
2. Turn the EUT on and couple its output to a spectrum analyzer.
3. Turn the EUT off and set the chamber to the highest temperature specified.
4. Allow sufficient time (approximately 30 min) for the temperature of the chamber to stabilize, turn the EUT on and measure the operating frequency.
5. Repeat step 2 and 3 with the temperature chamber set to the lowest temperature.
6. The test chamber was allowed to stabilize at +20 degree C for a minimum of 30 minutes. The supply voltage was then adjusted on the EUT from 85% to 115% and the frequency record.
7. While maintaining a constant temperature inside the environmental chamber, turn the EUT on and record the operating frequency at startup, and at 2 minutes, 5 minutes, and 10 minutes after the EUT is energized. Four measurements in total are made.

Limit

According to §15.225 (e), the frequency tolerance of the carrier signal shall be maintained within $\pm 0.01\%$ of the operating frequency over a temperature variation of -20 degrees to +50 degrees C at normal supply voltage, and for a variation in the primary supply voltage from 85 % to 115 % of the rated supply voltage at a temperature of 20 degrees C. For battery operated equipment, the equipment tests shall be performed using a new battery.



Test results

Test voltage (%)	Test voltage (V)	Temperature (°C)	Maintaining time	Measure frequency (MHz)	Frequency deviation (Hz)	Deviation (%)
100 %	AC 120 V	-20	Startup	13.561 344	344	0.002 537
			2 minutes	13.561 344	344	0.002 537
			5 minutes	13.561 344	344	0.002 537
			10 minutes	13.561 344	344	0.002 537
		-10	Startup	13.561 062	62	0.000 457
			2 minutes	13.561 125	125	0.000 922
			5 minutes	13.561 094	94	0.000 693
			10 minutes	13.561 125	125	0.000 922
		0	Startup	13.561 156	156	0.001 150
			2 minutes	13.560 969	-31	0.000 229
			5 minutes	13.560 812	-188	0.001 386
			10 minutes	13.560 937	-63	0.000 465
		10	Startup	13.560 937	-63	0.000 465
			2 minutes	13.560 531	-469	0.003 458
			5 minutes	13.560 969	-31	0.000 229
			10 minutes	13.560 844	-156	0.001 150
		20	Startup	13.561 312	312	0.002 301
			2 minutes	13.561 250	250	0.001 844
			5 minutes	13.561 250	250	0.001 844
			10 minutes	13.561 219	219	0.001 615
		30	Startup	13.561 344	344	0.002 537
			2 minutes	13.561 187	187	0.001 379
			5 minutes	13.561 156	156	0.001 150
			10 minutes	13.561 250	250	0.001 844
		40	Startup	13.561 281	281	0.002 072
			2 minutes	13.561 312	312	0.002 301
			5 minutes	13.561 281	281	0.002 072
			10 minutes	13.561 281	281	0.002 072
		50	Startup	13.561 250	250	0.001 844
			2 minutes	13.561 281	281	0.002 072
			5 minutes	13.561 281	281	0.002 072
			10 minutes	13.561 219	219	0.001 615
85 %	AC 102 V	23	Startup	13.561 250	250	0.001 844
			2 minutes	13.561 250	250	0.001 844
			5 minutes	13.561 312	312	0.002 301
			10 minutes	13.561 287	287	0.002 116
115 %	AC 138 V	23	Startup	13.561 263	263	0.001 939
			2 minutes	13.561 263	263	0.001 939
			5 minutes	13.561 250	250	0.001 844
			10 minutes	13.561 250	250	0.001 844

This report shall not be reproduced except in full, without the written approval of KES Co., Ltd.
The results shown in this test report refer only to the sample(s) tested unless otherwise stated.
The authenticity of the test report, contact shchoi@kes.co.kr

3.4. AC conducted emissions

Limit

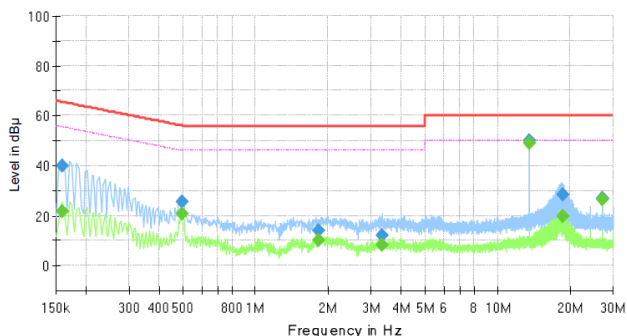
According to 15.207(a), for an intentional radiator that is designed to be connected to the public utility (AC) power line, the radio frequency voltage that is conducted back onto the AC power line on any frequency or frequencies, within the band 150 kHz to 30 MHz, shall not exceed the limits in the following table, as measured using a 50uH/50 ohm line impedance stabilization network (LISN). Compliance with the provision of this paragraph shall on the measurement of the radio frequency voltage between each power line and ground at the power terminal. The lower applies at the boundary between the frequencies ranges.

Frequency of Emission (MHz)	Conducted limit (dBμV/m)	
	Quasi-peak	Average
0.15 – 0.50	66 - 56*	56 - 46*
0.50 – 5.00	56	46
5.00 – 30.0	60	50



Test results

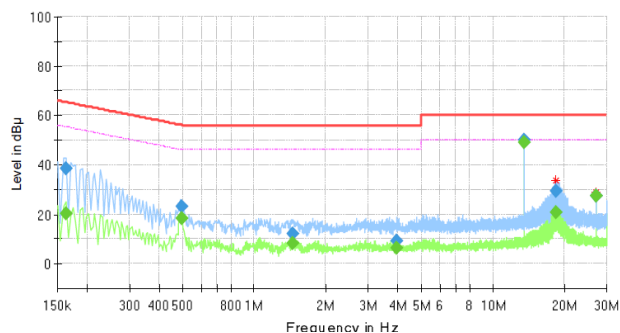
Hot Line



Final Result

Frequency (MHz)	QuasiPeak (dBμV)	Average (dBμV)	Limit (dBμV)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Line	Corr. (dB)
0.158000	39.73	---	65.57	25.84	1000.0	9.000	L1	19.8
0.158000	---	21.77	55.57	33.80	1000.0	9.000	L1	19.8
0.494000	25.75	---	56.10	30.35	1000.0	9.000	L1	20.1
0.494000	---	20.94	46.10	25.16	1000.0	9.000	L1	20.1
1.822000	13.78	---	56.00	42.22	1000.0	9.000	L1	20.7
1.822000	---	10.06	46.00	35.94	1000.0	9.000	L1	20.7
3.334000	12.02	---	56.00	43.98	1000.0	9.000	L1	20.5
3.334000	---	8.40	46.00	37.60	1000.0	9.000	L1	20.5
13.562000	50.13	---	60.00	9.87	1000.0	9.000	L1	20.6
13.562000	---	49.03	50.00	0.97	1000.0	9.000	L1	20.6
18.650000	---	19.90	50.00	30.10	1000.0	9.000	L1	20.9
18.650000	28.52	---	60.00	31.48	1000.0	9.000	L1	20.9
27.122000	---	26.74	50.00	23.26	1000.0	9.000	L1	21.3
27.122000	26.98	---	60.00	33.02	1000.0	9.000	L1	21.3

Neutral Line



Final Result

Frequency (MHz)	QuasiPeak (dBμV)	Average (dBμV)	Limit (dBμV)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Line	Corr. (dB)
0.162000	38.59	---	65.36	26.77	1000.0	9.000	N	19.7
0.162000	---	20.41	55.36	34.95	1000.0	9.000	N	19.7
0.498000	23.37	---	56.03	32.66	1000.0	9.000	N	20.1
0.498000	---	18.27	46.03	27.76	1000.0	9.000	N	20.1
1.442000	12.24	---	56.00	43.76	1000.0	9.000	N	20.5
1.442000	---	8.43	46.00	37.57	1000.0	9.000	N	20.5
3.930000	9.45	---	56.00	46.55	1000.0	9.000	N	20.3
3.930000	---	6.53	46.00	39.47	1000.0	9.000	N	20.3
13.562000	50.02	---	60.00	9.98	1000.0	9.000	N	20.6
13.562000	---	48.90	50.00	1.10	1000.0	9.000	N	20.6
18.442000	---	20.87	50.00	29.13	1000.0	9.000	N	20.9
18.442000	29.23	---	60.00	30.77	1000.0	9.000	N	20.9
27.122000	---	27.31	50.00	22.69	1000.0	9.000	N	21.3
27.122000	27.53	---	60.00	32.47	1000.0	9.000	N	21.3

This report shall not be reproduced except in full, without the written approval of KES Co., Ltd.
The results shown in this test report refer only to the sample(s) tested unless otherwise stated.
The authenticity of the test report, contact shchoi@kes.co.kr



Appendix A. Measurement equipment

Equipment	Manufacturer	Model	Serial No.	Calibration interval	Calibration due.
Spectrum Analyzer	R&S	FSV40-N	102194	1 year	2022.06.18
8360B Series Swept Signal Generator	HP	83630B	3844A00786	1 year	2022.01.15
Loop Antenna	Schwarzbeck	FMZB1513	225	2 years	2023.01.18
TRILOG-BROADBAND ANTENNA	VULB9163	Schwarzbeck	714	2 years	2022.11.11
Amplifier	SONOMA INSTRUMENT	310N	401123	1 year	2022.06.07
Attenuator	HUBER+SUHNER	6806.17.A	-	1 year	2021.11.03
EMI TEST RECEIVER	Rohde & Schwarz	ESU26	100552	1 year	2022.04.01
Temperature & Humidity Chamber	ESPEC	SH-642	93012658	1 year	2022.06.18
AC POWER SOURCE/ANALYZER	HP	6813A	3729A00754	1 year	2022.01.15
LISN	ENV216	R & S	101787	1 year	2021.12.29
EMI TEST RECEIVER	ESR3	R & S	101783	1 year	2022.01.15
PULSE LIMITER	ESH3-Z2	R & S	101915	1 year	2021.12.29

Peripheral device

Device	Manufacturer	Model No.	Serial No.
-	-	-	-