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Report No.:
KES-RF-23T0055
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TEST REPORT

Part 15 Subpart C 15.225

Equipment under test FACEPASS

Model name FE-500

Derivative Model FE-500L, FE-500S, FE-600, FE-600LE

FCC ID PVRFE-500

Applicant KJ TECH

Manufacturer KJ TECH

Date of test(s) 2023.02.01 ~ 2023.02.15

Date of issue 2023.04.12

Issued to

KJ TECH

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Test and report completed by :	Report approval by :
	
Gu-Bong, Kang Test engineer	Yeong-Jun Cho Technical manager

This test report is not related to KS Q ISO/IEC 17025 and KOLAS

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Revision history

Revision	Date of issue	Test report No.	Description
-	2023.04.12	KES-RF-23T0055	Initial

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1. General information

Applicant KJ TECH
Applicant address 703ho, 3rd Dongyung Venturestel, 45 Deokchon-ro Manangu
Anyang-si Gyeonggi-do South Korea
Test site KES Co., Ltd.
Test site address ☐ 3701, 40, Simin-daero 365beon-gil, Dongan-gu, Anyang-si,
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☒ 473-29, Gayeo-ro, Yeoju-si, Gyeonggi-do, Korea
Test Facility FCC Accreditation Designation No.: KR0100, Registration No.: 444148
Standard(s) Part 15.225
FCC ID PVRFE-500
Test device serial No. ☒ Production ☐ Pre-production ☐ Engineering

1.1. EUT description

Equipment under test FACEPASS
Frequency range 13.560 MHz
Model: FE-500
Derivative Model: FE-500L, FE-500S, FE-600, FE-600LE
Modulation technique ASK
Number of channels 13.560 MHz (NFC) : 1ch
Antenna specification Antenna type(NFC) : Loop antenna
Power source AC 120 V (AC/DC Adapter output 12 V)
H/W version REV1_3
F/W version GD-V30.7808

1.2. Test configuration

The **KJTECH CO.,LTD // FACEPASS // FE-500 // FCC ID: PVRFE-500** 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

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1.3. Information about derivative model

Model	Remark
FE-500L	Derivative models are simply customer requests for marketing purposes and do not represent any hardware or circuitry differences in the product.
FE-500S	
FE-600	
FE-600LE	

1.4. Accessory information

Equipment	Manufacturer	Model	Serial No.	Power source
AC ADAPTER	Channel Well Technology(Guangzhou) Co.,Ltd.	KPL-050F-VI	-	AC Input 120 V 1.7A, DC Output 12 V, 4.17A

1.5 Measurement uncertainty

Test Item		Uncertainty
Uncertainty for Conduction emission test		2.38 dB (SHIELD ROOM #6)
Uncertainty for Radiation emission test (include Fundamental emission)	Below 1GHz	4.50 dB (SAC #6)
	Above 1GHz	4.90 dB (SAC #5)
Note. This uncertainty represents an expanded uncertainty expressed at approximately the 95% confidence level using a coverage factor of k=2.		

1.6. Test frequency/Channel operation

Ch.	Frequency (MHz)
01	13.560

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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

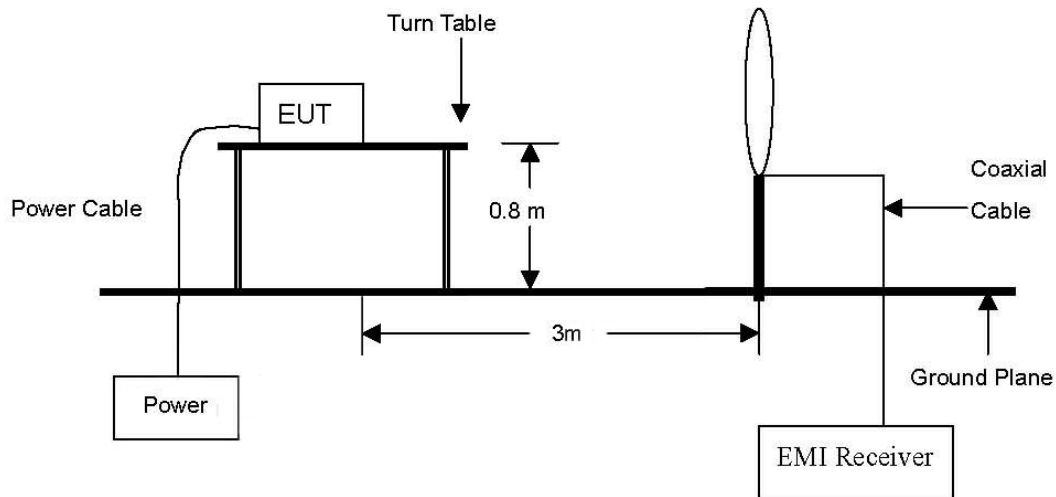
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3 Test results

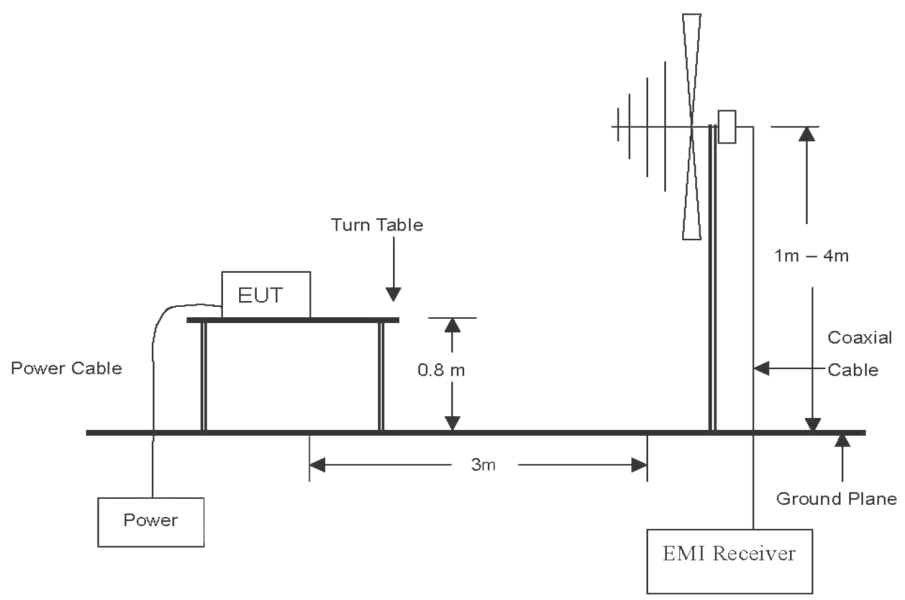
3.1. Radiated spurious emissions

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.

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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 ($\mu V/m$)
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 $\mu V/m$) 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 $\mu V/m$) 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 $\mu V/m$) 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.

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Test results for fundamental

Operating frequency: 13.560 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)
13.560	44.33	H	20.44	40.00	24.77	84.00	59.23
13.560	49.07	V	20.44	40.00	29.51	84.00	54.49

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)
12.598	16.88	H	20.50	40.00	-2.62	29.54	32.16
12.588	16.50	V	20.50	40.00	-3.00	29.54	32.54
13.349	17.89	H	20.46	40.00	-1.65	40.50	42.15
13.349	16.73	V	20.46	40.00	-2.81	40.50	43.31
13.552	37.58	H	20.44	40.00	18.02	50.50	32.48
13.552	41.98	V	20.44	40.00	22.42	50.50	28.08
13.560	44.33	H	20.44	40.00	24.77	84.00	59.23
13.560	49.07	V	20.44	40.00	29.51	84.00	54.49
13.568	38.43	H	20.44	40.00	18.87	50.50	31.63
13.568	42.98	V	20.44	40.00	23.42	50.50	27.08
13.771	22.06	H	20.42	40.00	2.48	40.50	38.02
13.771	29.44	V	20.42	40.00	9.86	40.50	30.64
14.059	16.65	V	20.40	40.00	-2.95	29.54	32.49
14.928	16.33	H	20.40	40.00	-3.27	29.54	32.81

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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.



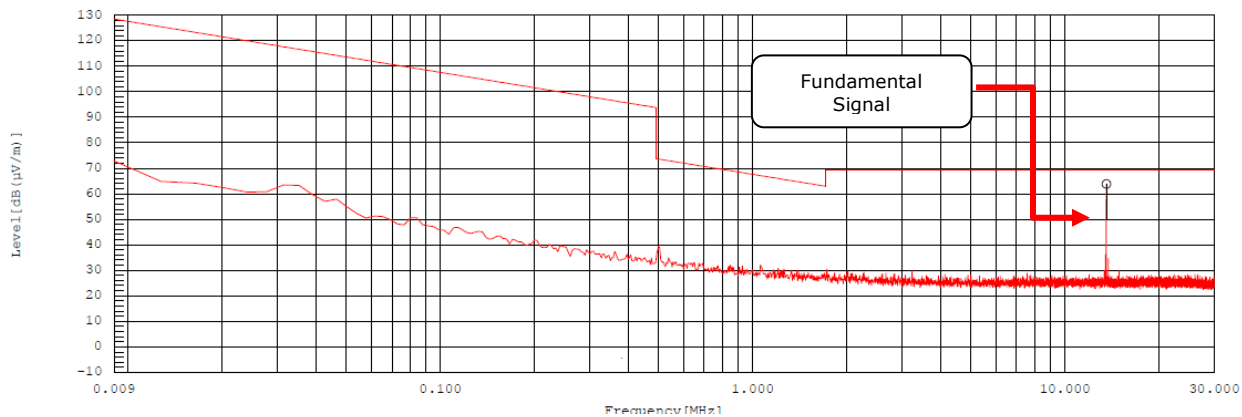
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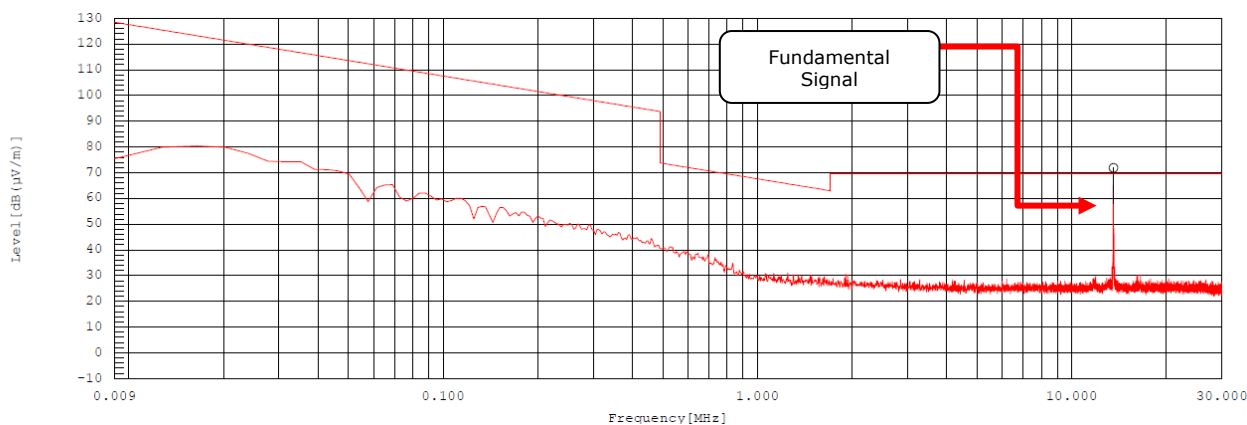
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Test results (9 kHz to 30 MHz)

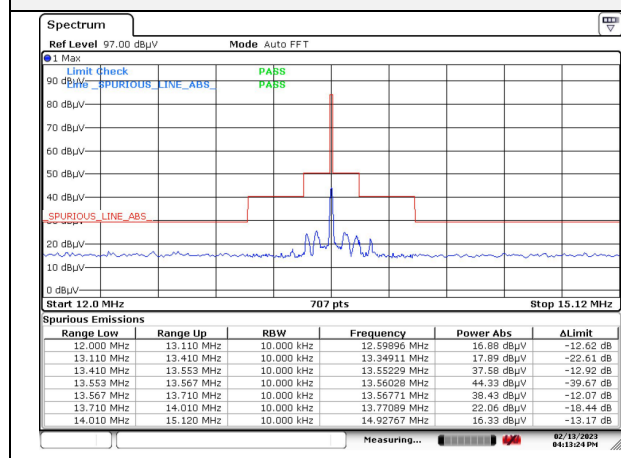
Horizontal



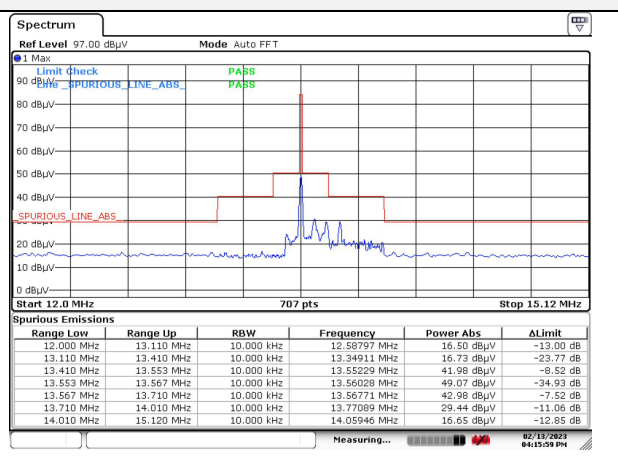
Vertical



Horizontal // in-band & out-band



Vertical // in-band & out-band



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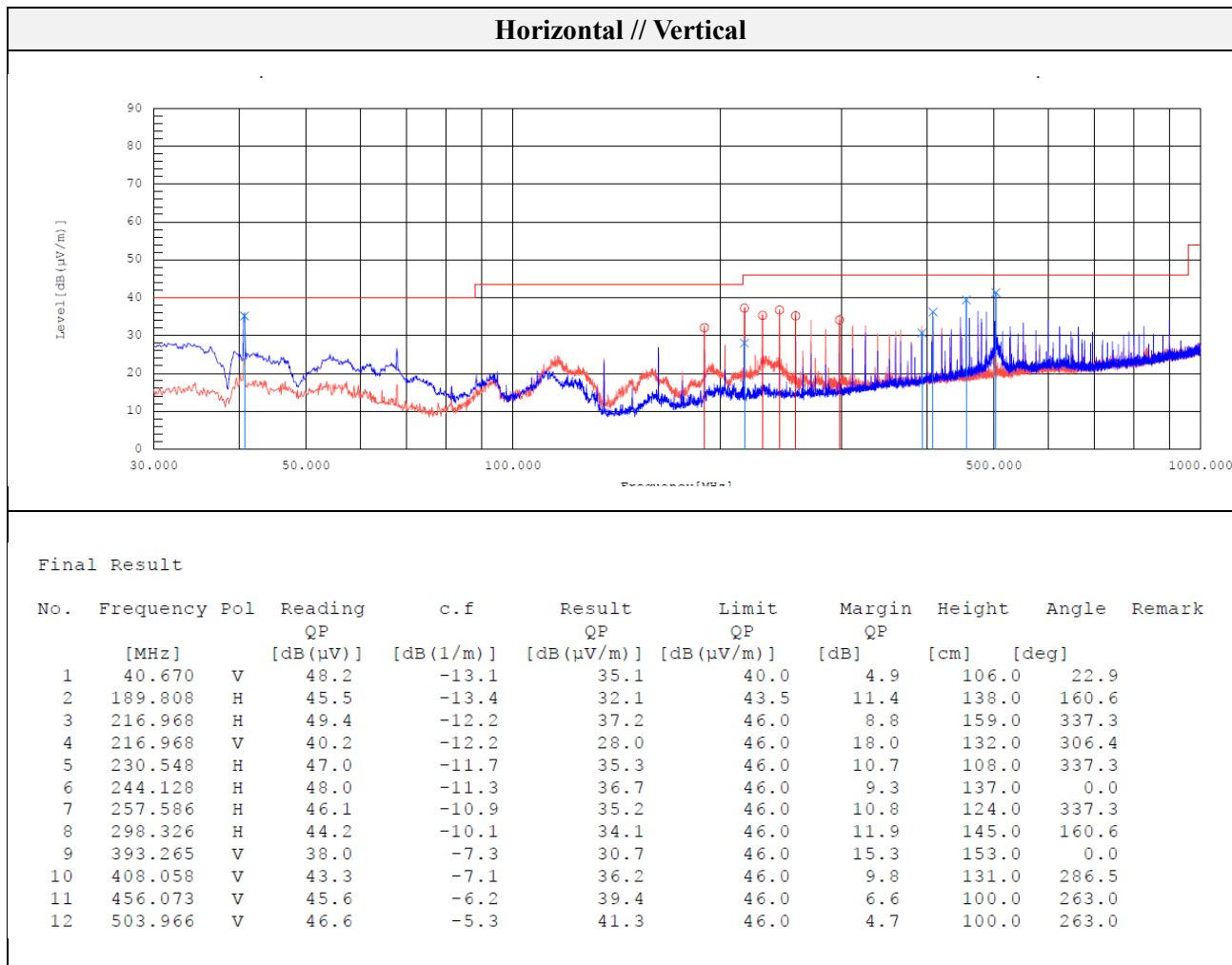


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Test results (Below 1 000 MHz)



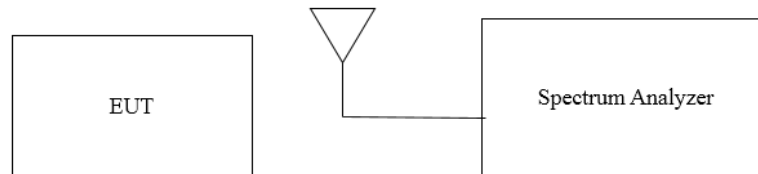
Note.

1. All measurements were recorded using a spectrum analyzer employing a quasi-peak detector for emissions below 960 MHz.
2. The spectrum is measured from 9 kHz to the 10th harmonic and the worst-case emissions are reported.
3. No spurious emissions levels were found to be greater than the level of the fundamental.

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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. $RBW = 1 \sim 5\% \text{ OBW}$
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.

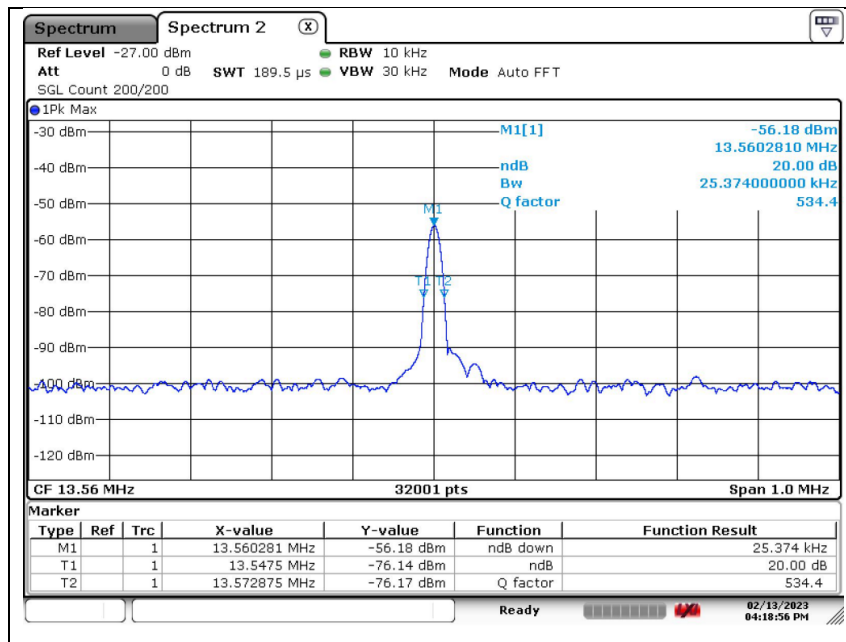


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Test results



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.

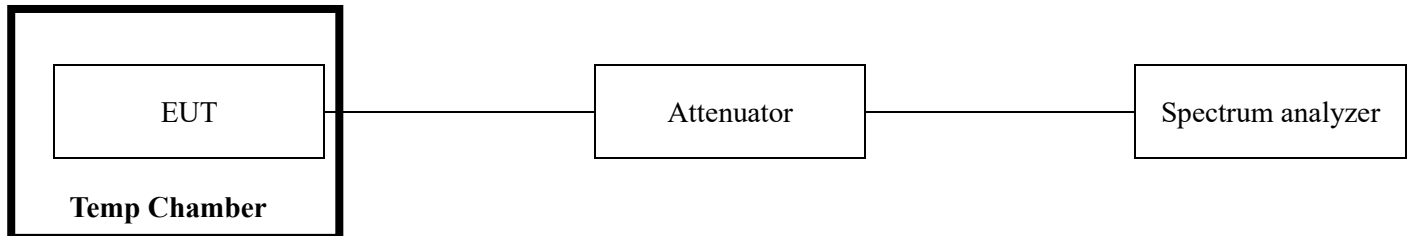
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3.3. Frequency Stability

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.

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Test results

Test voltage (%)	Test voltage (V)	Temperature (°C)	Maintaining time	Measure frequency (MHz)	Frequency deviation (Hz)	Deviation (%)
100 %	AC 120 V	-20	Startup	13.560 138	138	0.001 02
			2 minutes	13.560 146	146	0.001 08
			5 minutes	13.560 142	142	0.001 05
			10 minutes	13.560 158	158	0.001 17
		-10	Startup	13.560 159	159	0.001 17
			2 minutes	13.560 154	154	0.001 14
			5 minutes	13.560 176	176	0.001 30
			10 minutes	13.560 185	185	0.001 36
		0	Startup	13.560 185	185	0.001 36
			2 minutes	13.560 204	204	0.001 50
			5 minutes	13.560 212	212	0.001 56
			10 minutes	13.560 225	225	0.001 66
		10	Startup	13.560 215	215	0.001 59
			2 minutes	13.560 238	238	0.001 76
			5 minutes	13.560 221	221	0.001 63
			10 minutes	13.560 240	240	0.001 77
		20	Startup	13.560 208	208	0.001 53
			2 minutes	13.560 196	196	0.001 45
			5 minutes	13.560 225	225	0.001 66
			10 minutes	13.560 232	232	0.001 71
		30	Startup	13.560 228	228	0.001 68
			2 minutes	13.560 246	246	0.001 81
			5 minutes	13.560 237	237	0.001 75
			10 minutes	13.560 245	245	0.001 81
		40	Startup	13.560 248	248	0.001 83
			2 minutes	13.560 242	242	0.001 78
			5 minutes	13.560 260	260	0.001 92
			10 minutes	13.560 266	266	0.001 96
		50	Startup	13.560 258	258	0.001 90
			2 minutes	13.560 274	274	0.002 02
			5 minutes	13.560 275	275	0.002 03
			10 minutes	13.560 283	283	0.002 09
85 %	AC 102 V	24.5	Startup	13.560 211	188	0.001 39
			2 minutes	13.560 196	196	0.001 45
			5 minutes	13.560 225	225	0.001 66
			10 minutes	13.560 244	244	0.001 80
115 %	AC 138 V	24.5	Startup	13.560 187	187	0.001 38
			2 minutes	13.560 192	192	0.001 42
			5 minutes	13.560 206	206	0.001 52
			10 minutes	13.560 246	246	0.001 81

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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 (dB μ V/m)	
	Quasi-peak	Average
0.15 – 0.50	66 - 56*	56 - 46*
0.50 – 5.00	56	46
5.00 – 30.0	60	50

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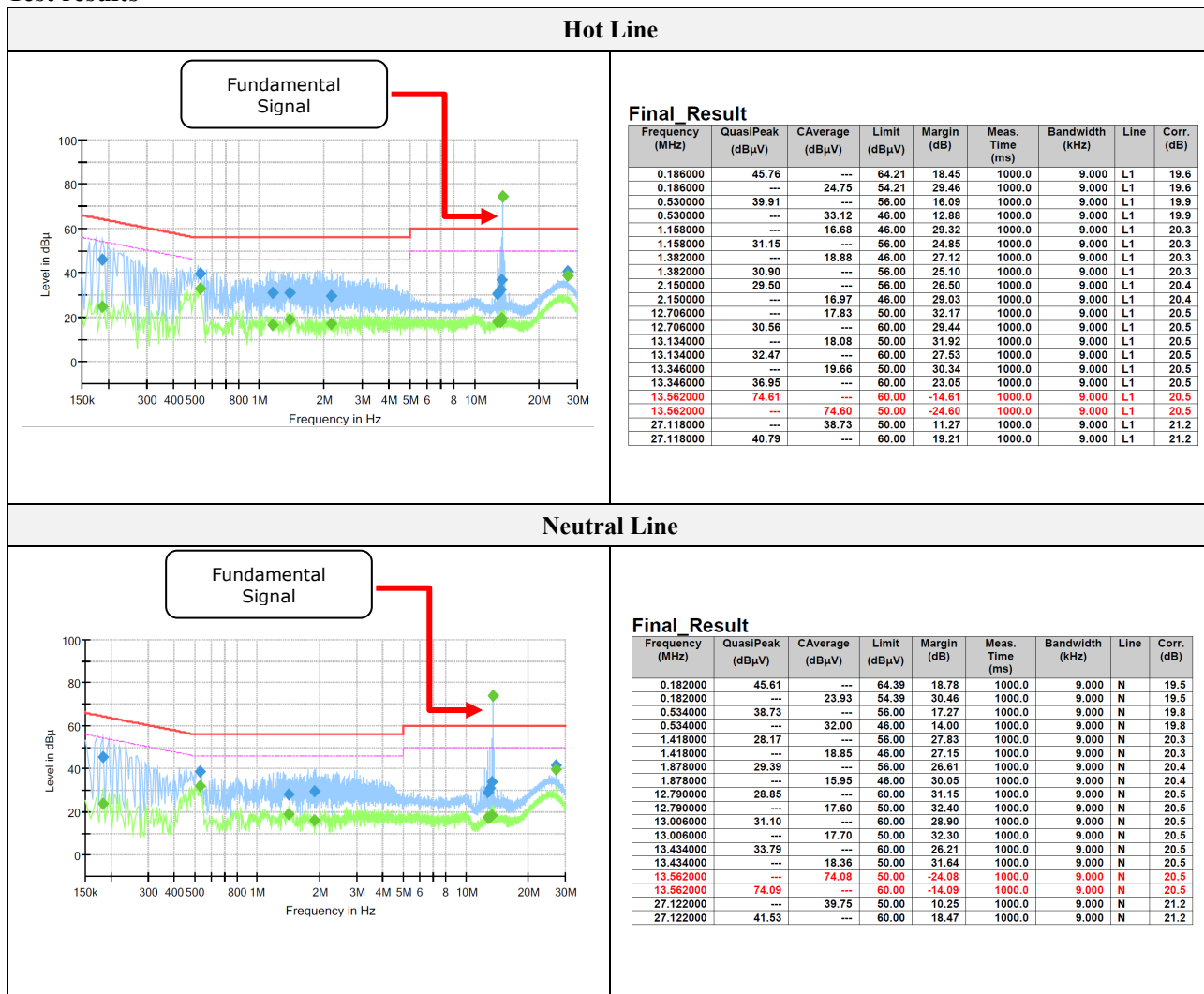


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Test results



Note.

Values which is marked in red in the graph above are fundamental signal values.

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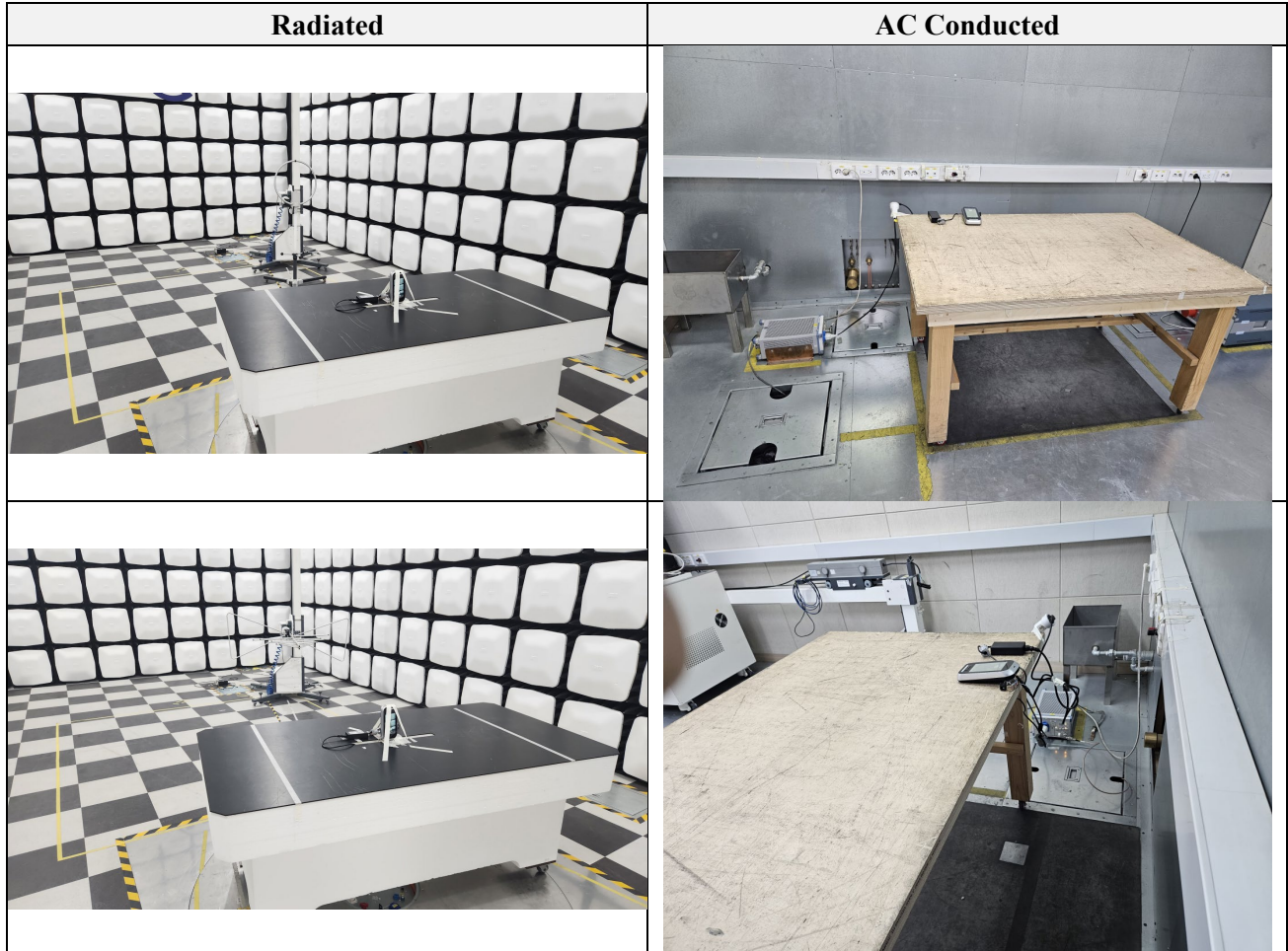
Appendix A. Measurement equipment

Equipment	Manufacturer	Model	Serial No.	Calibration interval	Calibration due.
Spectrum analyzer	R&S	FSV40	101725	1 year	2023.06.16
Spectrum analyzer	R&S	FSV3044	101272	1 year	2023.03.14 2024.03.16
SIGNAL GENERATOR	KEYSIGHT	N5182B	MY59100115	1 year	2023.04.27 2024.04.19
Loop Antenna	Schwarzbeck	FMZB1513	225	2 years	2023.03.18 2024.03.21
TRILOG-BROADBAND ANTENNA	Schwarzbeck	VULB 9163	714	2 years	2024.04.19
Amplifier	SONOMA INSTRUMENT	310N	401123	1 year	2023.06.02
Attenuator	HUBER+SUHNER	6806.17.A	-	1 year	2023.04.01 2024.03.21
EMI Test Receiver	R&S	ESU26	100517	1 year	2023.08.01
Temperature & Humidity Chamber	ESPEC	SH-642	93012658	1 year	2023.06.16
AC POWER SOURCE/ ANALYZER	HP	6813A	3729A00754	1 year	2024.01.12

Peripheral device

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

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Appendix B. Test setup photos

The end of test report.