



TEST REPORT



Report No. : KES-RF-23T0131
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■ FCC TEST REPORT

1. Client

- Name : AMOSENSE
- Address : 19-1BL, 90, 4sandan 5-gil, Jiksan-eup, Seobuk-gu, Cheonan-si,
Chungcheongnam-do, Republic of Korea

2. Sample Description

- Product item : AMOBAND
- Model name : AMB-100
- Manufacturer etc. : AMOSENSE

3. Date of test : 2023.08.01 ~ 2023.10.11

4. Location of Test : Permanent Testing Lab On Site Testing

- Address : 473-21, Gayeo-ro, Yeosu-si, Gyeonggi-do, Korea
3701, 40, Simin-daero 365beon-gil, Dongan-gu, Anyang-si,
Gyeonggi-do, 14057, Korea

5. Test method used : Part 15 Subpart C 15.225

6. Test result : PASS

The results shown in this test report refer only to the sample(s) tested unless otherwise stated.
This laboratory is not accredited for the test results marked *.
This test report is not related to KOLAS accreditation.

Affirmation	Tested by	Technical Manager
	Name : Do-won, Ahn (Signature)	Name : Young-Jin Lee (Signature)

2023 . 10. 30.

KES Co., Ltd.

Accredited by KOLAS, Republic of KOREA



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REPORT REVISION HISTORY

Date	Test Report No.	Revision History
2023.10.30	KES-RF-23T0131	Initial

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Use of uncertainty of measurement for decisions on conformity (decision rule):

No decision rule is specified by the standard, when comparing the measurement result with the applicable limit according to the specification in that standard. The decisions on conformity are made without applying the measurement uncertainty("simple acceptance" decision rule, previously known as "accuracy method").

Other (to be specified, for example when required by the standard or client)



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1. General information

Applicant: AMOSENSE
 Applicant address: 19-1BL, 90, 4sandan 5-gil, Jiksan-eup, Seobuk-gu, Cheonan-si, Chungcheongnam-do, Republic of Korea
 Test site: KES Co., Ltd.
 Test site address: 3701, 40, Simin-daero 365beon-gil, Dongan-gu, Anyang-si, Gyeonggi-do, 14057, Korea
 473-21, Gayeo-ro, Yeoju-si, Gyeonggi-do, Korea
 Test Facility: FCC Accreditation Designation No.: KR0100, Registration No.: 444148
 FCC rule part(s): 15.225
 FCC ID: 2AS9T-AMB100
 Test device serial No.: Production Pre-production Engineering

1.1. EUT description

Equipment under test: AMOBAND
 Frequency range: 2 402 MHz ~ 2 480 MHz (BLE 1 Mbps)
13.561 MHz (NFC)
 Model: AMB-100
 Modulation technique: GFSK, ASK
 Number of channels: 2 402 MHz ~ 2 480 MHz (BLE 1 Mbps) : 40 ch
13.561 MHz (NFC) : 1ch
 Antenna specification: Chip Antenna // Peak gain: -3.87 dBi
Antenna type(NFC) : Loop Antenna
 Power source: DC 3.70 V (Battery)
 H/W version: MAIN BOARD 4.0 / PPG SENSOR BOARD 5.0
 S/W version: Ver 4.1

1.2. Test configuration

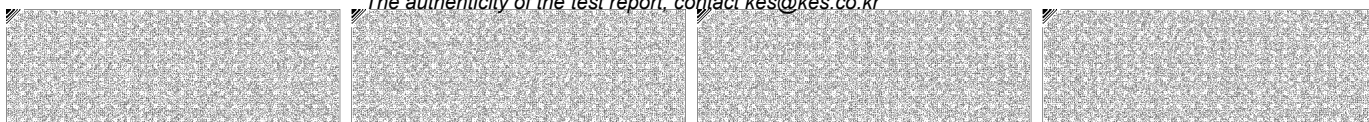
The **AMOSENSE // AMOBAND // AMB-100 // FCC ID: 2AS9T-AMB100** was tested according to the specification of EUT, the EUT must comply with following standards and KDB documents.

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

KES-QP16-F01(00-23-01-01)

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1.3. Derivative Model Information

AMB-100-1

(A derivative model was added at the buyer's request, and there is no other difference.)

1.4. Information about derivative model

N/A

1.5. Accessory information

Equipment	Manufacturer	Model	Serial No.	Power source
NFC Reader	N/A	N/A	N/A	AC 120 V (Output : DC 5.0V/1.0A)

For Radiation test :

Field strength level (dB μ V/m) = Measured level (dB μ V) + Antenna factor (dB) + Cable loss (dB) – Amplifier gain (dB)

1.6. Measurement Uncertainty

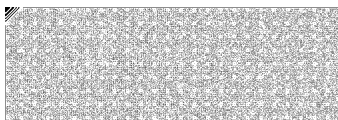
Test Item	Uncertainty	
Uncertainty for Conduction emission test	2.22 dB (SHIELD ROOM #6)	
Uncertainty for Radiation emission test (include Fundamental emission)	Below 1GHz	4.04 dB (SAC #6)
	Above 1GHz	5.32 dB (SAC #5)
Note. This uncertainty represents an expanded uncertainty expressed at approximately the 95% confidence level using a coverage factor of k=2.		



1.7. Frequency/channel operations

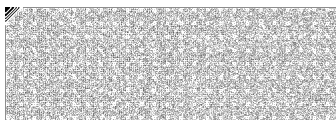
Ch.	Frequency (MHz)
01	13.561

Ch.	Frequency (MHz)	Rate(Mbps)
00	2 402	BLE_1 Mbps
.	.	.
20	2 442	BLE_1 Mbps
.	.	.
39	2 480	BLE_1 Mbps



2. Summary of tests

Section in FCC Part 15	Test description	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
15.203	Antenna Requirement	Pass

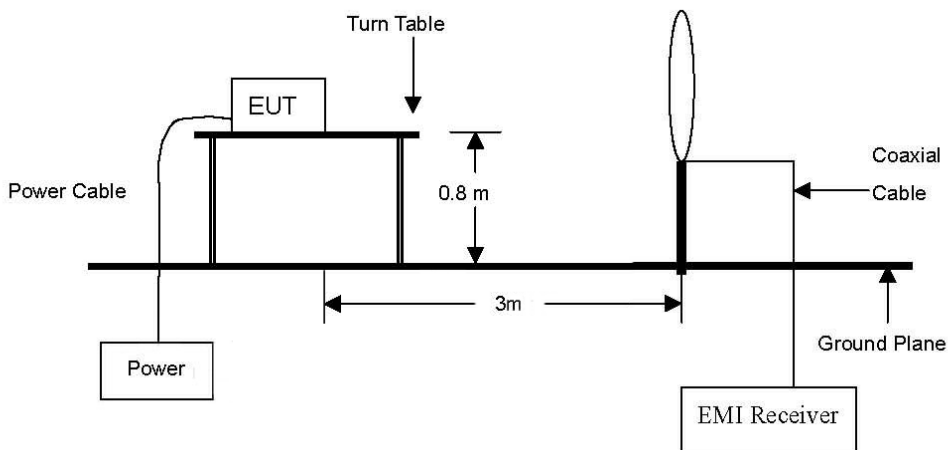


3 Test results

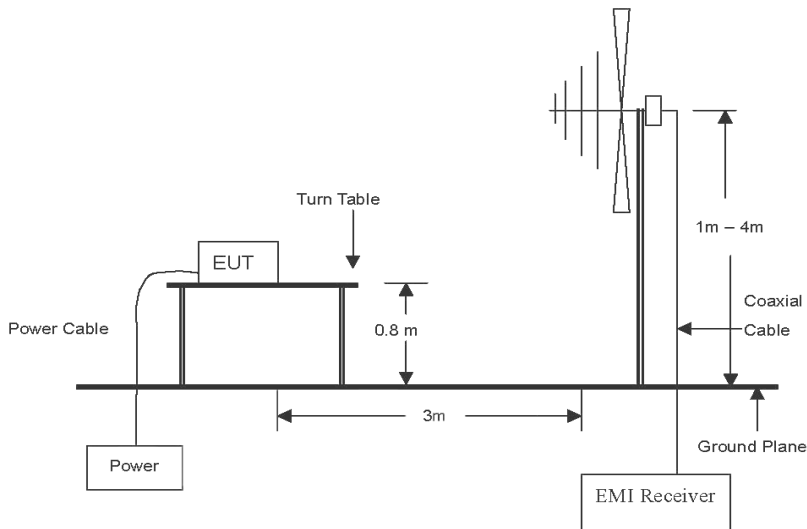
3.1. Radiated spurious emissions

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.

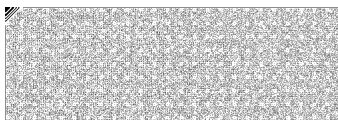
The measurement was made in both the vertical and horizontal polarization, and the maximum value is presented in the report.

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 ($\mu\text{V}/\text{m}$)
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 $\mu\text{V}/\text{m}$) 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 $\mu\text{V}/\text{m}$) 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 $\mu\text{V}/\text{m}$) 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: 13.561 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	16.50	H	19.80	40.00	3.70	84.00	87.70
13.561	27.90	V	19.80	40.00	7.70	84.00	76.30

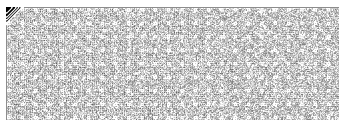
Test results for in-band & out-band(9 kHz to 30 MHz)

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)
12.082	11.18	H	19.78	40.00	-9.04	29.54	38.58
12.566	10.90	V	19.79	40.00	-9.31	29.54	38.85
13.162	10.98	H	19.79	40.00	-9.23	40.50	49.73
13.311	10.45	V	19.79	40.00	-9.76	40.50	50.26
13.501	10.58	H	19.79	40.00	-9.63	50.50	60.13
13.552	14.53	V	19.80	40.00	-5.67	50.50	56.17
13.561	20.25	V	19.80	40.00	0.05	84.00	83.95
13.562	12.55	H	19.80	40.00	-7.65	84.00	91.65
13.647	10.11	H	19.80	40.00	-10.09	50.50	60.59
13.568	16.09	V	19.80	40.00	-4.11	50.50	54.61
13.765	10.06	V	19.79	40.00	-10.15	40.50	50.65
13.976	10.70	H	19.80	40.00	-9.50	40.50	50.00
14.125	11.39	H	19.81	40.00	-8.80	29.54	38.34
14.631	10.54	V	19.81	40.00	-9.65	29.54	39.19

KES-QP16-F01(00-23-01-01)

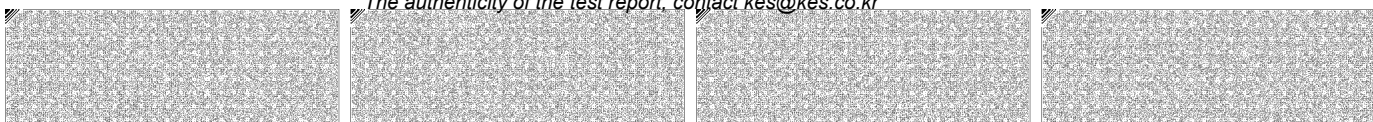
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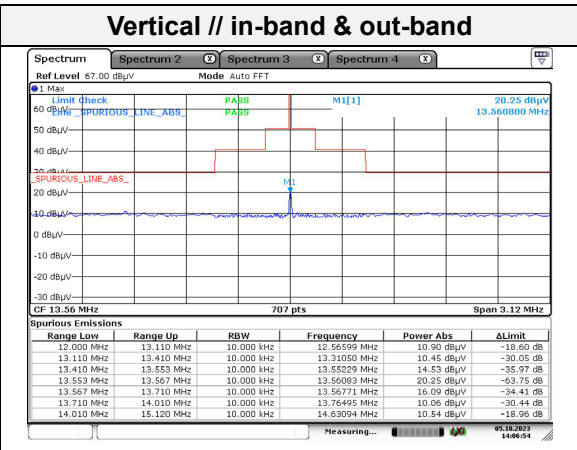
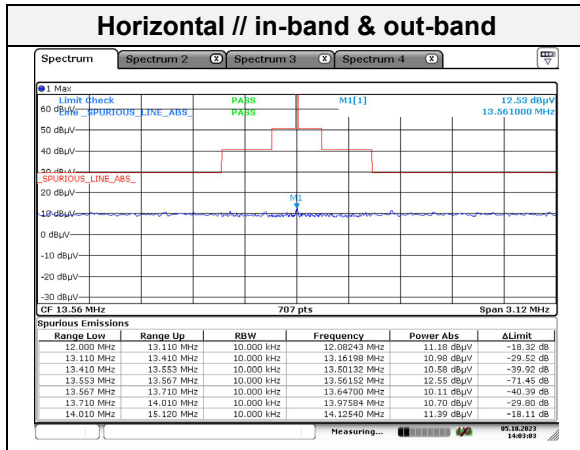
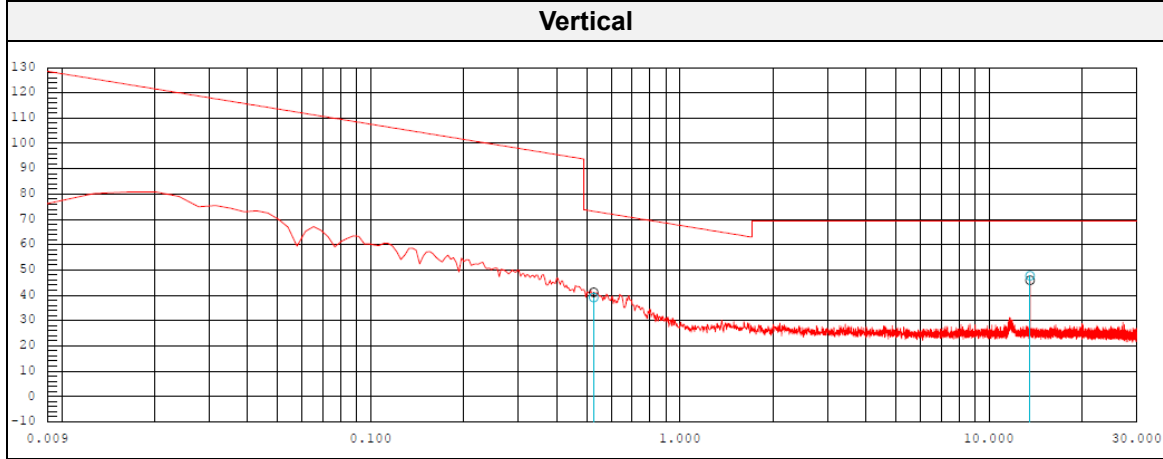
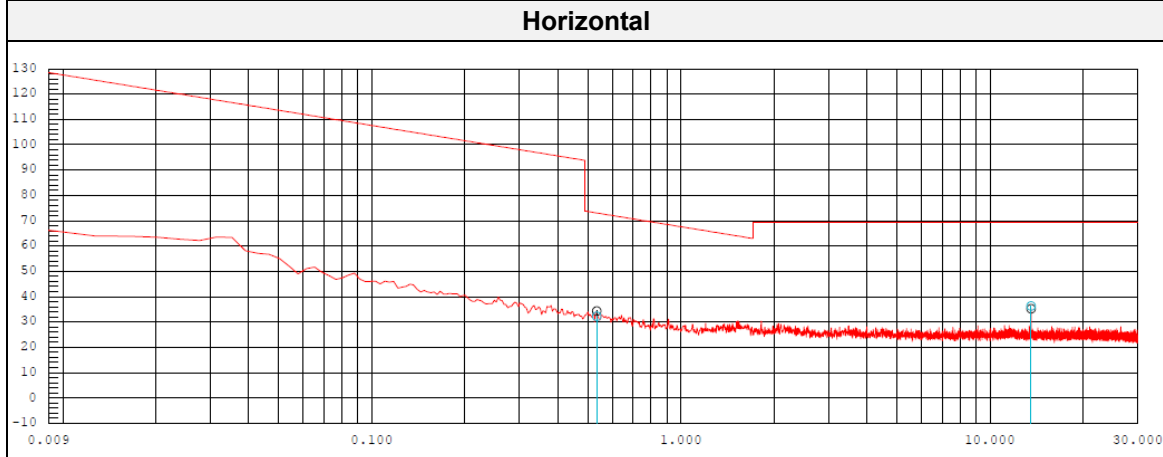


Note.

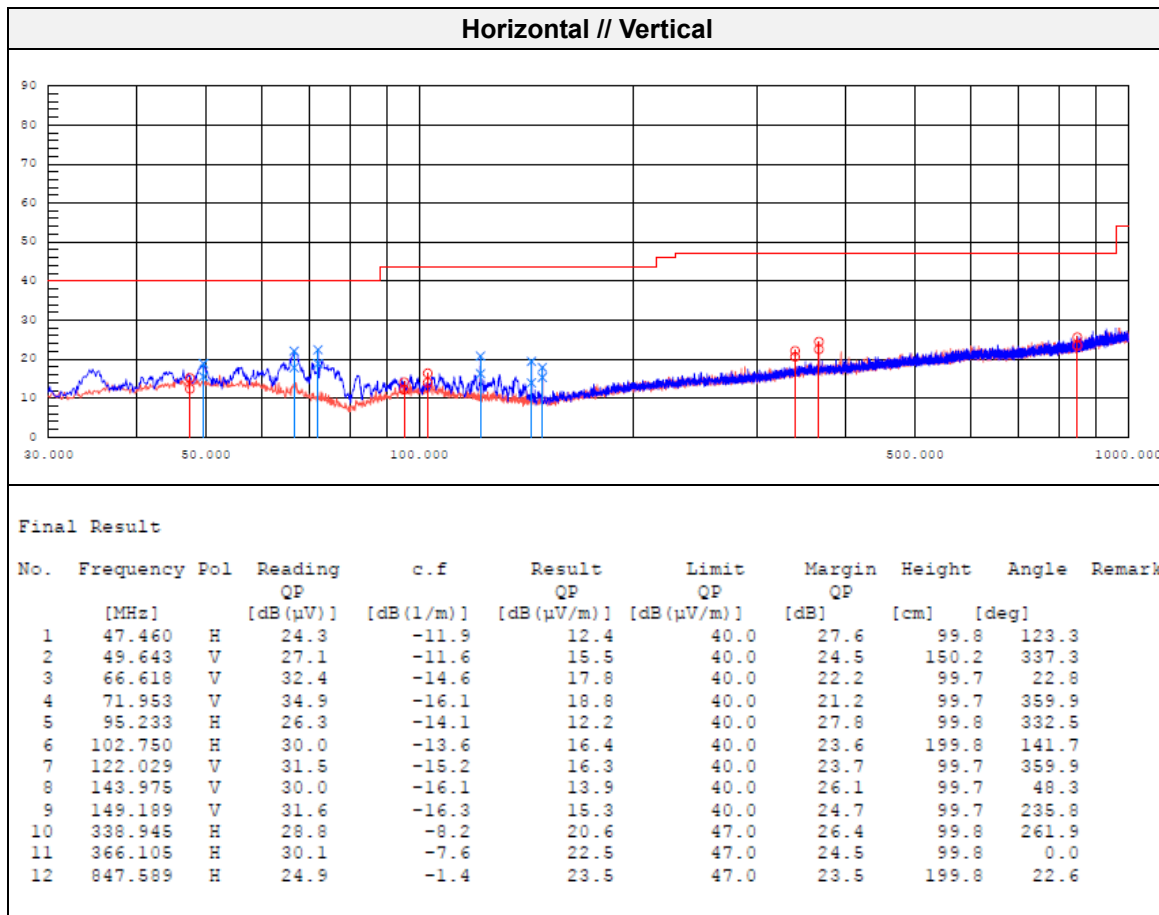
1. All measurements were performed using a loop antenna. The antenna was investigated with three polarizations, and horizontal and vertical polarizations were reported as the worst case.
2. The EUT was positioned in three orthogonal planes to determine the orientation resulting in the worst case emissions.
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.



Test results (9 kHz to 30 MHz)



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.

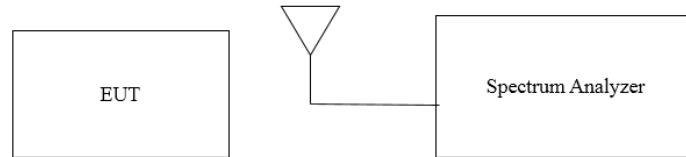


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3.2 20 dB bandwidth

Test setup



Test procedure

ANSI C63.10-2013 – Section 6.9.2

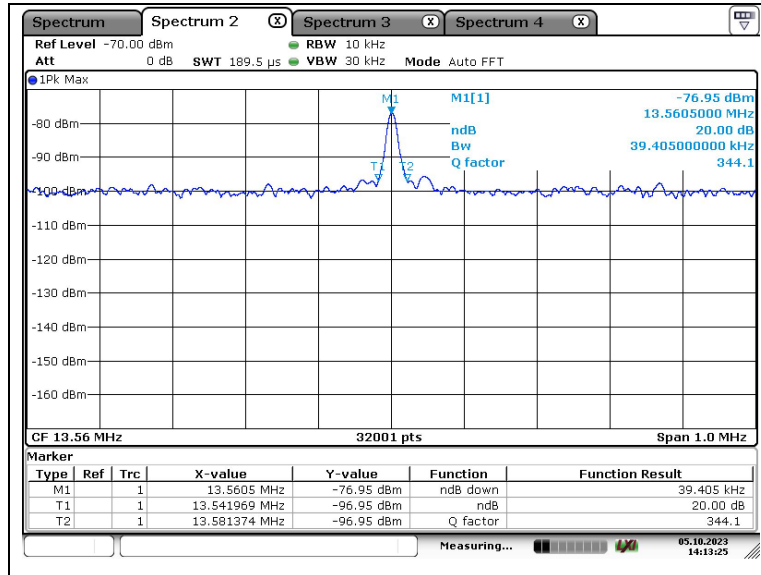
1. Spectrum analyzer frequency is set to the nominal EUT channel center frequency.
2. RBW = 1~5% OBW
3. VBW $\geq 3 \times$ RBW
4. Reference level set to keep signal from exceeding maximum input mixer for linear operation.
5. Detector = Peak
6. Trace mode = Max hold
7. Sweep = Auto couple
8. The trace 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.



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Test results



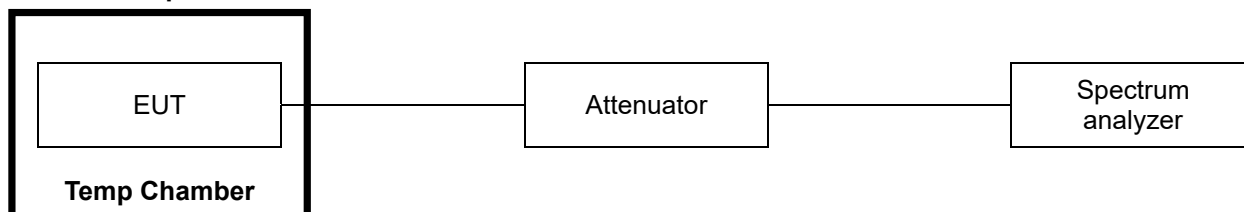
Note.

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.



3.3. Frequency Stability**Test procedure**

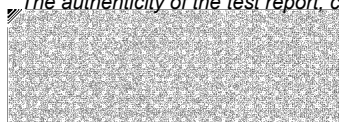
ANSI C63.10-2013, clause 6.8.1

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 +/-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 %	DC 3.70 V	-20	Startup	13.560 532	-468	0.003 451		
			2 minutes	13.560 385	-615	0.004 535		
			5 minutes	13.560 533	-467	0.003 444		
			10 minutes	13.560 536	-464	0.003 422		
		-10	Startup	13.560 595	-405	0.002 987		
			2 minutes	13.560 595	-405	0.002 987		
			5 minutes	13.560 594	-406	0.002 994		
			10 minutes	13.560 532	-468	0.003 451		
		0	Startup	13.560 617	-383	0.002 824		
			2 minutes	13.560 527	-473	0.003 488		
			5 minutes	13.560 604	-396	0.002 920		
			10 minutes	13.560 520	-480	0.003 540		
		10	Startup	13.560 521	-479	0.003 532		
			2 minutes	13.560 624	-376	0.002 773		
			5 minutes	13.560 522	-478	0.003 525		
			10 minutes	13.560 524	-476	0.003 510		
		20	Startup	13.560 624	-376	0.002 773		
			2 minutes	13.560 521	-479	0.003 532		
			5 minutes	13.560 618	-382	0.002 817		
			10 minutes	13.560 619	-381	0.002 810		
		30	Startup	13.560 513	-487	0.003 591		
			2 minutes	13.560 539	-461	0.003 399		
			5 minutes	13.560 520	-480	0.003 540		
			10 minutes	13.560 610	-390	0.002 876		
		40	Startup	13.560 716	-284	0.002 094		
			2 minutes	13.560 591	-409	0.003 016		
			5 minutes	13.560 591	-409	0.003 016		
			10 minutes	13.560 437	-563	0.004 152		
		50	Startup	13.560 581	-419	0.003 090		
			2 minutes	13.560 522	-478	0.003 525		
			5 minutes	13.560 581	-419	0.003 090		
			10 minutes	13.560 631	-369	0.002 721		
		85 %	DC 3.15 V	23	Startup	13.560 717	-283	0.002 087
					2 minutes	13.560 611	-389	0.002 869
					5 minutes	13.560 503	-497	0.003 665
					10 minutes	13.560 542	-458	0.003 377
115 %	DC 4.26 V	23	Startup	13.560 590	-410	0.003 023		
			2 minutes	13.560 303	-697	0.005 140		
			5 minutes	13.560 615	-385	0.002 839		
			10 minutes	13.560 472	-528	0.003 894		

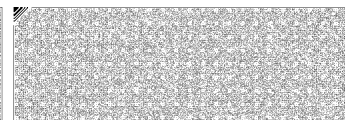
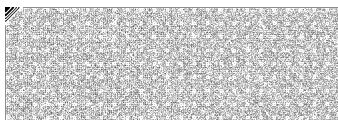


3.4. AC conducted emissions

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



Test results



3.5. Antenna Requirement

According to 15.207(a), An intentional radiator shall be designed to ensure that no antenna other than that furnished by the responsible party shall be used with the device. The use of a permanently attached antenna or of an antenna that uses a unique coupling to the intentional radiator shall be considered sufficient to comply with the provisions of this Section. The manufacturer may design the unit so that a broken antenna can be replaced by the user, but the use of a standard antenna jack or electrical connector is prohibited. This requirement does not apply to carrier current devices or to devices operated under the provisions of Sections 15.211, 15.213, 15.217, 15.219, or 15.221. Further, this requirement does not apply to intentional radiators that must be professionally installed, such as perimeter protection systems and some field disturbance sensors, or to other intentional radiators which, in accordance with Section 15.31(d), must be measured at the installation site. However, the installer shall be responsible for ensuring that the proper antenna is employed so that the limits in this Part are not exceeded.

The EUT has an internal Loop antenna and meets the requirements of this section.



A appendix A. Measurement equipment

Equipment	Manufacturer	Model	Serial No.	Calibration interval	Calibration due.
EMI Test Receiver	R&S	ESU26	100552	1 year	2024.03.21
Spectrum Analyzer	R&S	FSV40	101002	1 year	2024.06.14
EMI Test Receiver	R&S	ESR3	101783	1 year	2023.11.11
ATTENUATOR	KEYSIGHT	8493C	82506	1 year	2024.01.17
SIGNAL GENERATOR	KEYSIGHT	N5182B	MY59100115	1 year	2024.05.26
SIGNAL GENERATOR	Anritsu	68369B	002118	1 year	2024.05.12
Loop Antenna	Schwarzbeck	FMZB1513	1513-257	2 years	2025.03.22
TRILOG-BROADBAND ANTENNA	VULB9163	Schwarzbeck	714	2 years	2024.04.19
Amplifier	SONOMA INSTRUMENT	310N	186549	1 year	2024.03.21
LISN	R&S	ENV216	101787	1 year	2023.11.10
PULSE LIMITER	R&S	ESH3-Z2	101915	1 year	2023.11.10
Attenuator	KEYSIGHT	-	-	1 year	2024.03.21
Temperature Chamber	TABAI	MC711P	112000492	1 year	2024.01.13
DIGITAL MULTI METER	TEKTRONIX	DMM916	138401	1 year	2024.01.13
DC POWER SUPPLY	AGILENT	6632B	US36351824	1 year	2024.01.13
Programmable AC Source	Chroma ATE Inc	61501	615010000000	1 year	2024.06.14

Peripheral device

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

The end of test report.

