



# TEST REPORT



Report No. : RF-230715

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**KES Co., Ltd.**

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## ■ FCC&IC TEST REPORT

### 1. Client

- Name : RFengine Co., Ltd.
- Address : 1-618, Cheongju Techono S-Tower, 530 Jikji-daero, Heungdeok-gu, Cheongju-si  
Chungcheongbuk-do, South Korea

### 2. Sample Description

- Product item : 13.56MHz RFID READER
- Model name : HFR-4AM
- Manufacturer etc. : RFengine Co., Ltd.

3. Date of test : 2024.01.22 ~ 2024.01.30

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

- Address : 473-21, Gayeo-ro, Yeoju-si, Gyeonggi-do, Korea

5. Test method used : Part 15.225 & RSS-210

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 : Bong-Seok Kim (Signature) | Name : Yeong-Jun Cho (Signature) |

2024. 02. 02.

**KES Co., Ltd.**

**Accredited by KOLAS, Republic of KOREA**



## REPORT REVISION HISTORY

| Date       | Test Report No. | Revision History |
|------------|-----------------|------------------|
| 2024.02.02 | RF-230715       | 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 RFEngine Co., Ltd.  
Applicant address 1-618, Cheongju Techono S-Tower, 530 Jikji-daero, Heungdeok-gu,  
Cheongju-si, Chungcheongbuk-do, South Korea  
Test site KES Co., Ltd.  
Test site address ☐ #3002, #3503, #3701, 40, Simin-daero 365beon-gil,  
Dongan-gu, Anyang-si, Gyeonggi-do, 14057, Republic of Korea  
☒ 473-21, Gayeo-ro, Yeoju-si, Gyeonggi-do, Korea  
Test Facility FCC Accreditation Designation No.: KR0100, Registration No.: 444148  
FCC rule part(s): FCC : 15.225  
IC rule part(s): IC : RSS-210 & RSS-Gen  
FCC ID: 2BDL2HFR4AM  
IC ID: 31937-HFR4AM  
Test device serial No. ☒ Production ☐ Pre-production ☐ Engineering

**1.1. EUT description**

Equipment under test 13.56MHz RFID READER  
Frequency range 13.561 4 MHz (NFC)  
Model HFR-4AM  
Variant Model: -  
Modulation technique ASK  
Number of channels 13.561 4 MHz (NFC) : 1 ch  
Antenna specification NFC : Loop Antenna  
Power source AC 120 V (Adapter Output DC 5 V)  
H/W Version HFR-4AM-V02  
S/W Version "4D 44 F3"



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**1.2. Test configuration**

The **RFengine Co., Ltd. // 13.56MHz RFID READER // HFR-4AM // FCC ID: 2BDL2HFR4AM // IC :31937-HFR4AM** 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  
ISED RSS-210 Issue 10 and RSS-Gen Issue 5

**1.3. Information about derivative model**

N/A

**1.4. Accessory information**

| Equipment     | Manufacturer                          | Model           | Serial No. | Power source |
|---------------|---------------------------------------|-----------------|------------|--------------|
| AC/DC Adapter | Shenzhen Perfect Gallant Tec Co.,Ltd. | PG122-0502000UD | -          | AC 100~240 V |

**1.5. Sample calculation**

Where relevant, the following sample calculation is provided  
For all conducted test items :

The offset level is set in the spectrum analyzer to compensate the RF cable loss and attenuator factor between EUT conducted output port and spectrum analyzer. With the offset compensation, the spectrum analyzer reading level is exactly the EUT RF output level.

$$\begin{aligned}\text{Offset(dB)} &= \text{RF cable loss(dB)} + \text{attenuator factor(dB)} \\ &= 0.69 + 10 = 10.69 \text{ (dB)}\end{aligned}$$

For Radiation test :

$$\text{Field strength level (dB}\mu\text{V/m)} = \text{Measured level (dB}\mu\text{V)} + \text{Antenna factor (dB)} + \text{Cable loss (dB)} - \text{Amplifier gain (dB)}$$

**1.6. Measurement Uncertainty**

| Test Item   |            | Uncertainty                |
|---|------------|----------------------------|
| Uncertainty for Conduction emission test  |            | 2.22 dB ( SHIELD ROOM #6 ) |
| Uncertainty for Radiation emission test<br>(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) | Rate(Mbps) |
|-----|-----------------|------------|
| 01  | 13.561 4        | NFC        |



**1.0 Summary of tests**

| Section in<br>FCC Part 15 & 2 | Section in<br>RSS-210 & Gen | Parameter  | Test<br>results |
|-------------------------------|-----------------------------|--|-----------------|
| -                             | RSS-Gen 6.7                 | 99% Occupied Bandwidth                               | Pass            |
| 15.225(a)                     | RSS-210 B.6                 | The field strength of fundamental                    | Pass            |
| 15.225(b)(c)                  | RSS-210 B.6                 | The field strength of spurious<br>emission(In-band)  | Pass            |
| 15.225(d)<br>15.209           | RSS-Gen 8.9                 | The field strength of spurious<br>emission(Out-band) | Pass            |
| 2.1049                        | RSS-Gen 6.7                 | 20 dB bandwidth                                      | Pass            |
| 15.225(e)                     | RSS-210 B.6                 | Frequency stability                                  | Pass            |
| 15.207                        | RSS-Gen 8.8                 | AC conducted emissions                               | Pass            |
| 15.203                        | -                           | Antenna Requirement                                  | Pass            |



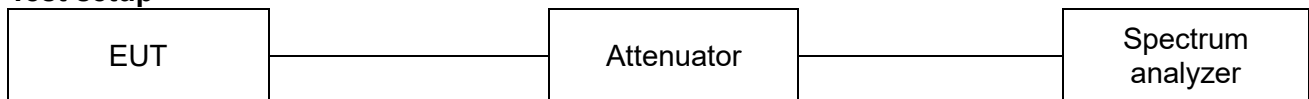
### 3 Test results

#### 3.1. 99% Occupied Bandwidth

##### Test procedure

ANSI C63.10-2013 clause 6.9.2 and 6.9.3

##### Test setup



##### Test setting

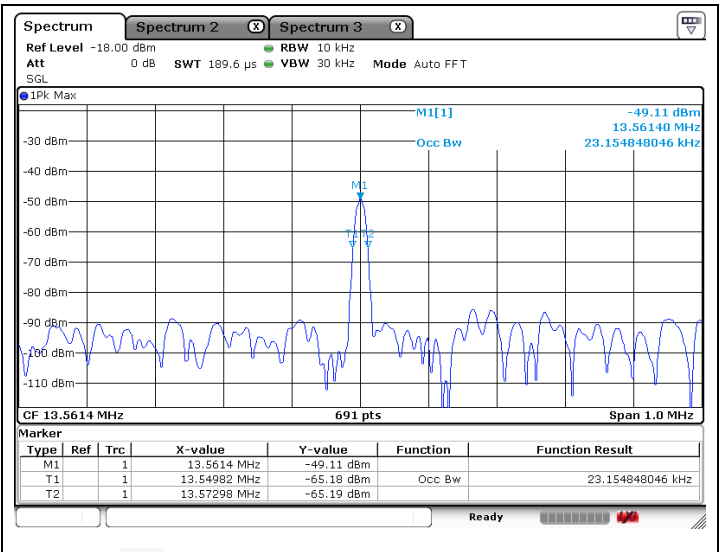
1. Span = The instrument center frequency is set to the nominal EUT channel center frequency.  
The frequency span for the spectrum analyzer shall be between 1.5 times and 5.0 times the OBW.
2. RBW = The nominal IF filter bandwidth (3 dB RBW) shall be in the range of 1% to 5% of the OBW
3. VBW = shall be approximately three times the RBW
4. Sweep = auto
5. Detector function = Peak
6. Trace = Max hold

##### Limit

None; for reporting purpose only.



Test results



Note.

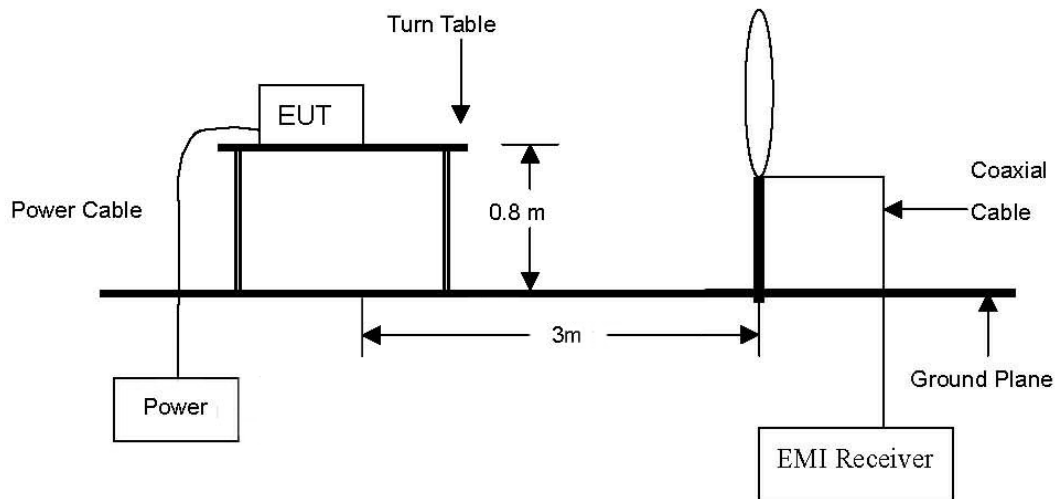
Because the measured signal is CW/CW-like, adjusting the RBW per C63.10 would not be practical since measured bandwidth will always follow the RBW and the result will be approximately twice the RBW.



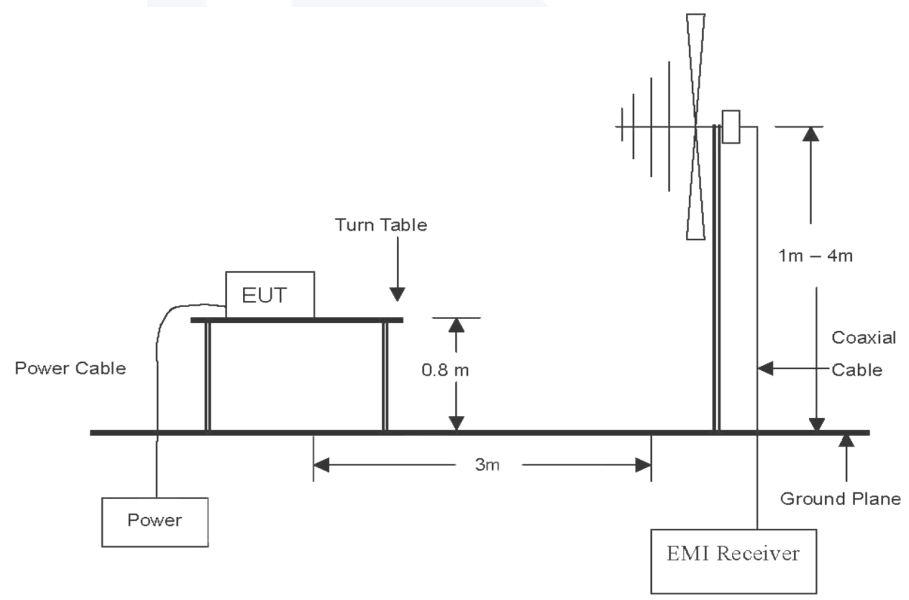
### 3.2. Radiated spurious emissions

#### 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.





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**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 13.56 MHz 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.

**FCC 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               | $2400/F(\text{kHz})$   |
| 0.490 ~ 1.705   | 30                | $24000/F(\text{kHz})$  |
| 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.

**IC Limit**

According to RSS-Gen, except where otherwise indicated in the applicable RSS, radiated emissions shall comply with the field strength limits shown in table 5 and table 6. Additionally, the level of any transmitter unwanted emission shall not exceed the level of the transmitter's fundamental emission.

| Table 5 – General field strength limits at frequencies above 30 MHz |   |                          |
|---|---|--------------------------|
| Frequency (MHz)   | Field strength ( $\mu V/m$ at 3 m)              |                          |
| 30 ~ 88   | 100   |                          |
| 88 ~ 216  | 150   |                          |
| 216 ~ 960   | 200   |                          |
| Above 960*  | 500   |                          |
| Table 6 – General field strength limits at frequencies below 30 MHz |   |                          |
| Frequency   | Magnetic field strength (H-Field) ( $\mu A/m$ ) | Measurement distance (m) |
| 9 - 490 kHz <sup>Note 1</sup>                                       | 6.37/F (F in kHz)                               | 300                      |
| 490 - 1705 kHz  | 63.7/F (F in kHz)                               | 30                       |
| 1.705 - 30 MHz  | 0.08  | 30                       |

**Note:** The emission limits for the ranges 9-90 kHz and 110-490 kHz are based on measurements employing a linear average detector.

In the section RSS-210 B.6 :

The field strength of any emission shall not exceed the following limits:

- i. 15.848 mV/m (84 dB $\mu V/m$ ) at 30 m, within the band 13.553-13.567 MHz
- ii. 334  $\mu V/m$  (50.5 dB $\mu V/m$ ) at 30 m, within the bands 13.410-13.553 MHz and 13.567-13.710 MHz
- iii. 106  $\mu V/m$  (40.5 dB $\mu V/m$ ) at 30 m, within the bands 13.110-13.410 MHz and 13.710-14.010 MHz
- iv. RSS-Gen general field strength limits for frequencies outside the band 13.110-14.010 MHz



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**Test results for fundamental**

Operating frequency: 13.561 4 MHz

Distance of measurement: 3 meter

| Radiated emissions |                      | Ant. | Total factors            |                      | Total                 | Limit                |             |
|--------------------|----------------------|------|--------------------------|----------------------|-----------------------|----------------------|-------------|
| Frequency (MHz)    | Reading (dB $\mu$ V) | Pol. | Correction factor (dB/m) | Distance factor (dB) | Actual (dB $\mu$ V/m) | Limit (dB $\mu$ V/m) | Margin (dB) |
| 13.561             | 45.60                | H    | 19.67                    | 40.00                | 25.27                 | 84.00                | 58.73       |
| 13.561             | 45.70                | V    | 19.67                    | 40.00                | 25.37                 | 84.00                | 58.63       |

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

| Radiated emissions |                      | Ant. | Total factors            |                      | Total                 | Limit                |             |
|--------------------|----------------------|------|--------------------------|----------------------|-----------------------|----------------------|-------------|
| Frequency (MHz)    | Reading (dB $\mu$ V) | Pol. | Correction factor (dB/m) | Distance factor (dB) | Actual (dB $\mu$ V/m) | Limit (dB $\mu$ V/m) | Margin (dB) |
| 12.053             | 16.73                | H    | 19.62                    | 40.00                | -3.65                 | 29.54                | 33.19       |
| 12.247             | 18.34                | V    | 19.63                    | 40.00                | -2.03                 | 29.54                | 31.57       |
| 13.362             | 15.37                | V    | 19.66                    | 40.00                | -4.97                 | 40.50                | 45.47       |
| 13.387             | 14.84                | H    | 19.66                    | 40.00                | -5.50                 | 40.50                | 46.00       |
| 13.553             | 30.27                | H    | 19.67                    | 40.00                | 9.94                  | 50.50                | 40.56       |
| 13.553             | 28.66                | V    | 19.67                    | 40.00                | 8.33                  | 50.50                | 42.17       |
| 13.567             | 34.38                | H    | 19.67                    | 40.00                | 14.05                 | 50.50                | 36.45       |
| 13.567             | 32.73                | V    | 19.67                    | 40.00                | 12.40                 | 50.50                | 38.10       |
| 13.720             | 17.32                | H    | 19.67                    | 40.00                | -3.01                 | 40.50                | 43.51       |
| 13.737             | 17.01                | V    | 19.67                    | 40.00                | -3.32                 | 40.50                | 43.82       |
| 15.098             | 16.33                | H    | 19.71                    | 40.00                | -3.96                 | 29.54                | 33.50       |
| 15.071             | 15.79                | V    | 19.71                    | 40.00                | -4.50                 | 29.54                | 34.04       |

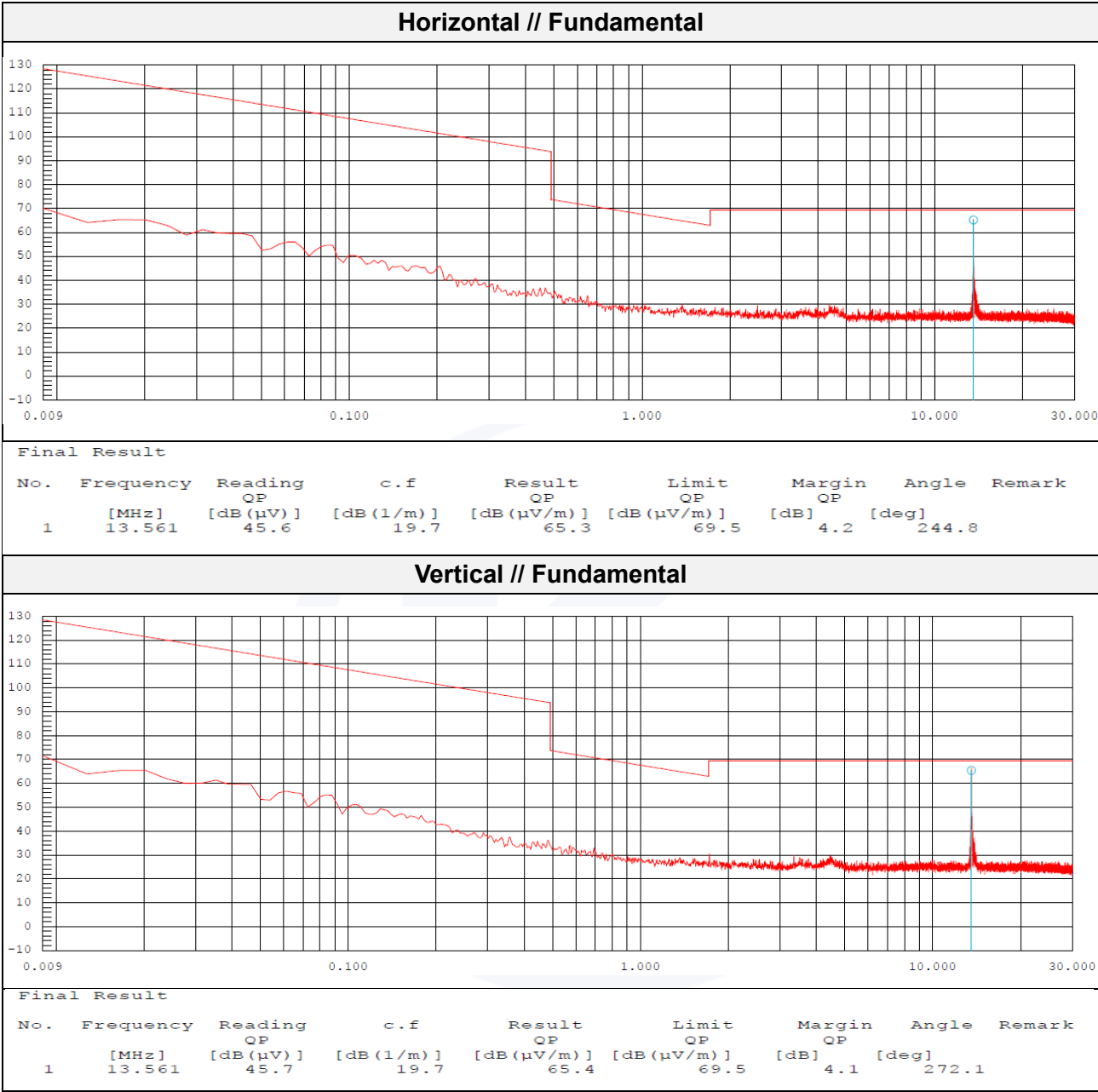


**Note.**

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 $\mu$ V/m] - Field Strength Level [dB $\mu$ 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.

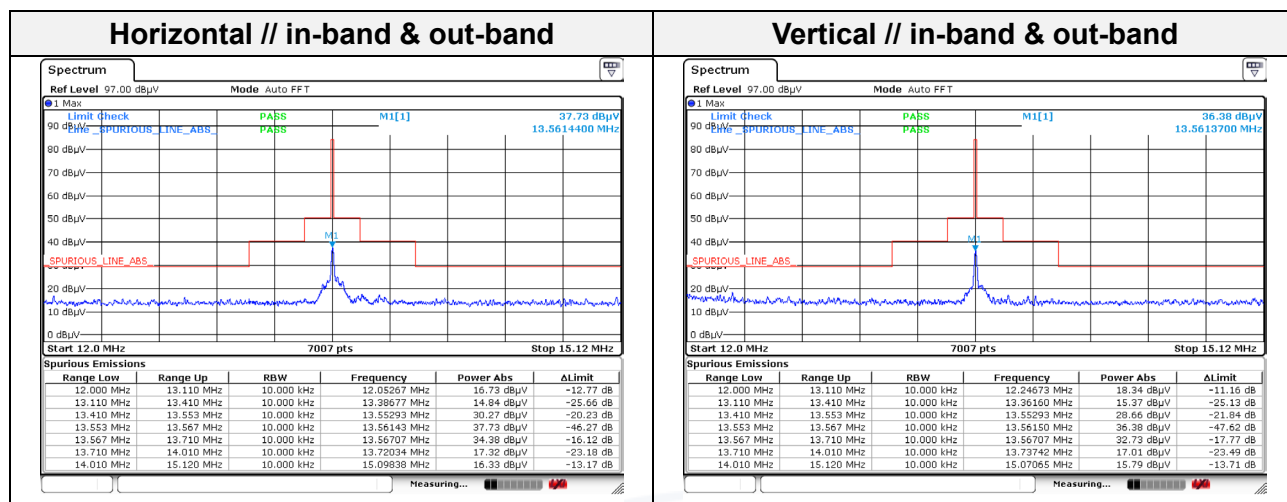


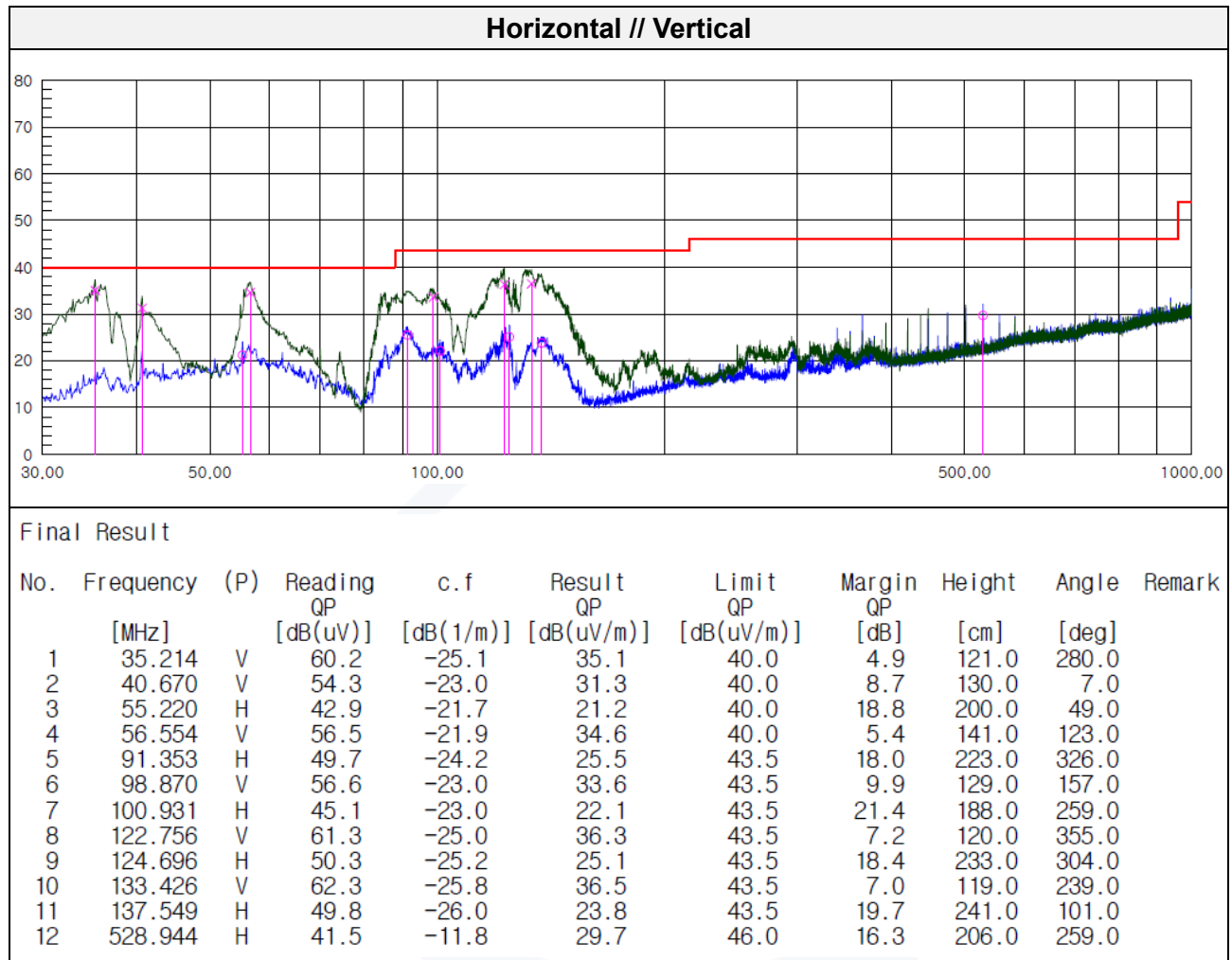
Test results (9 kHz to 30 MHz)





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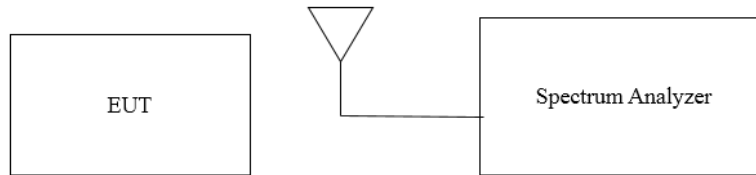
**Test results (Below 1 000 MHz)****Note.**

1. All measurements were recorded using a spectrum analyzer employing a quasi-peak detector for emissions below 960 MHz.
2. Both Vertical and Horizontal polarities of the receive antenna were evaluated with the worst case emissions being reported. Below 30 MHz the loop antenna was positioned in 3 orthogonal planes (X Front, Y side, Z top) to determine the orientation resulting in the worst case emissions.
3. The EUT was positioned in three orthogonal planes to determine the orientation resulting in the worst case emissions.
4. No spurious emissions levels were found to be greater than the level of the fundamental.



### 3.3 20 dB bandwidth

#### Test setup



#### Test procedure

ANSI C63.10-2013 – Section 6.9.2

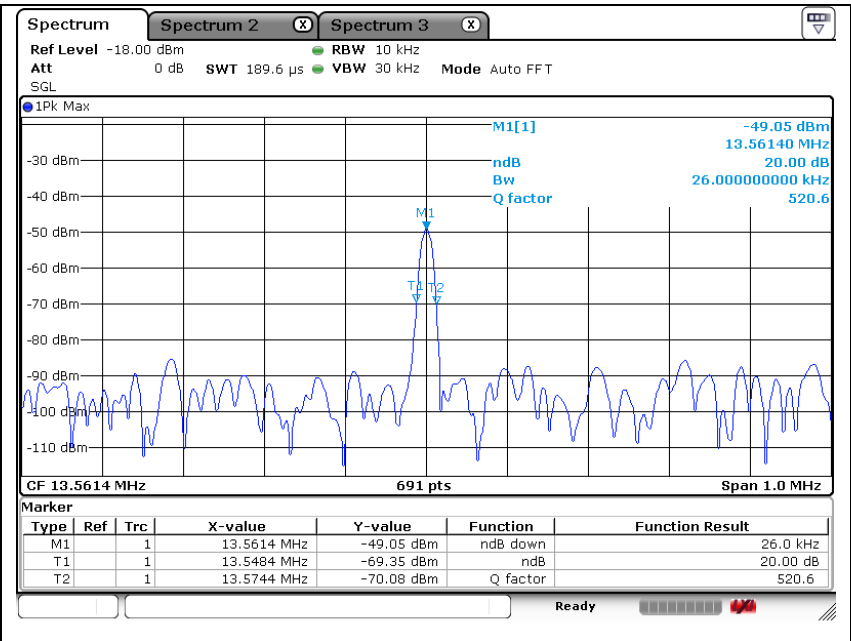
1. Spectrum analyzer frequency is set to the nominal EUT channel center frequency.
2. RBW = 1~5% OBW
3. VBW  $\geq 3 \times$  RBW
4. Reference level set to keep signal from exceeding maximum input mixer for linear operation.
5. Detector = Peak
6. Trace mode = Max hold
7. Sweep = Auto couple
8. The trace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

#### Limit

None; for reporting purpose only.



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.

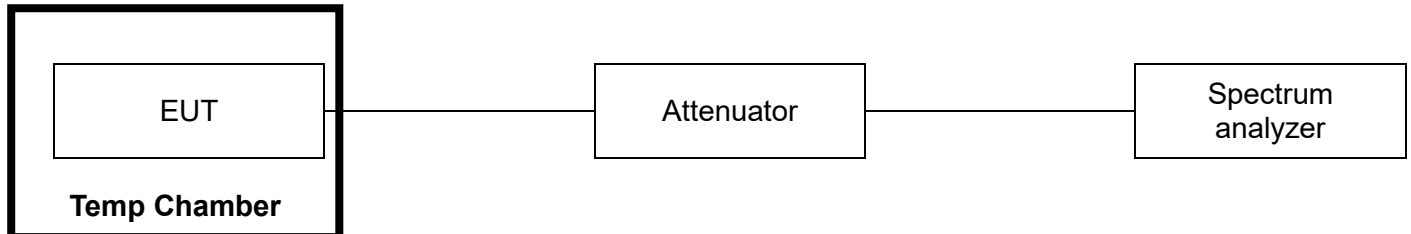


### 3.4. Frequency Stability

#### 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.

#### FCC 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.

#### IC Limit

According to §RSS-210 B.6 the carrier frequency stability shall not exceed  $\pm 0.01\%$  ( $\pm 100$  ppm)

**Test results**

| Test voltage (%) | Test voltage (V) | Temperature (°C) | Maintaining time | Measure frequency (MHz) | Frequency deviation (Hz) | Deviation (%) |
|------------------|------------------|------------------|------------------|-------------------------|--------------------------|---------------|
| 100 %            | AC 120 V         | -20              | Startup          | 13.561 400              | 0                        | 0.000 00      |
|                  |                  |                  | 2 minutes        | 13.561 401              | 1                        | 0.000 01      |
|                  |                  |                  | 5 minutes        | 13.561 408              | -11                      | 0.000 06      |
|                  |                  |                  | 10 minutes       | 13.561 416              | -15                      | 0.000 12      |
|                  |                  | -10              | Startup          | 13.561 405              | 5                        | 0.000 04      |
|                  |                  |                  | 2 minutes        | 13.561 409              | 9                        | 0.000 07      |
|                  |                  |                  | 5 minutes        | 13.561 410              | 10                       | 0.000 07      |
|                  |                  |                  | 10 minutes       | 13.561 402              | 2                        | 0.000 01      |
|                  |                  | 0                | Startup          | 13.561 400              | 0                        | 0.000 00      |
|                  |                  |                  | 2 minutes        | 13.561 405              | -3                       | 0.000 04      |
|                  |                  |                  | 5 minutes        | 13.561 410              | -1                       | 0.000 07      |
|                  |                  |                  | 10 minutes       | 13.561 412              | 6                        | 0.000 09      |
|                  |                  | 10               | Startup          | 13.561 404              | 4                        | 0.000 03      |
|                  |                  |                  | 2 minutes        | 13.561 410              | 10                       | 0.000 07      |
|                  |                  |                  | 5 minutes        | 13.561 411              | 11                       | 0.000 08      |
|                  |                  |                  | 10 minutes       | 13.561 408              | 8                        | 0.000 06      |
|                  |                  | 20               | Startup          | 13.561 410              | 10                       | 0.000 07      |
|                  |                  |                  | 2 minutes        | 13.561 420              | 20                       | 0.000 15      |
|                  |                  |                  | 5 minutes        | 13.561 415              | 15                       | 0.000 11      |
|                  |                  |                  | 10 minutes       | 13.561 418              | 18                       | 0.000 13      |
|                  |                  | 30               | Startup          | 13.561 419              | 19                       | 0.000 14      |
|                  |                  |                  | 2 minutes        | 13.561 420              | 20                       | 0.000 15      |
|                  |                  |                  | 5 minutes        | 13.561 422              | 22                       | 0.000 16      |
|                  |                  |                  | 10 minutes       | 13.561 417              | 17                       | 0.000 13      |
|                  |                  | 40               | Startup          | 13.561 420              | 20                       | 0.000 15      |
|                  |                  |                  | 2 minutes        | 13.561 422              | 22                       | 0.000 16      |
|                  |                  |                  | 5 minutes        | 13.561 418              | 18                       | 0.000 13      |
|                  |                  |                  | 10 minutes       | 13.561 415              | 15                       | 0.000 11      |
|                  |                  | 50               | Startup          | 13.561 420              | 0                        | 0.000 15      |
|                  |                  |                  | 2 minutes        | 13.561 422              | -6                       | 0.000 16      |
|                  |                  |                  | 5 minutes        | 13.561 426              | -8                       | 0.000 19      |
|                  |                  |                  | 10 minutes       | 13.561 430              | -10                      | 0.000 22      |
| 85 %             | AC 102 V         | 24.5             | Startup          | 13.561 405              | 5                        | 0.000 04      |
|                  |                  |                  | 2 minutes        | 13.561 409              | 9                        | 0.000 07      |
|                  |                  |                  | 5 minutes        | 13.561 410              | 10                       | 0.000 07      |
|                  |                  |                  | 10 minutes       | 13.561 402              | 2                        | 0.000 01      |
| 115 %            | AC 138 V         | 24.5             | Startup          | 13.561 402              | 2                        | 0.000 01      |
|                  |                  |                  | 2 minutes        | 13.561 404              | 4                        | 0.000 03      |
|                  |                  |                  | 5 minutes        | 13.561 405              | 5                        | 0.000 04      |
|                  |                  |                  | 10 minutes       | 13.561 407              | 7                        | 0.000 05      |



### 3.5. AC conducted emissions

#### FCC 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) |          |
|-----------------------------|------------------------|----------|
|                             | Quasi-peak             | Average  |
| 0.15 – 0.50                 | 66 - 56*               | 56 - 46* |
| 0.50 – 5.00                 | 56                     | 46       |
| 5.00 – 30.0                 | 60                     | 50       |

\*Decreases with the logarithm of the frequency



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**IC Limit**

Unless stated otherwise in the applicable RSS, for radio apparatus that are designed to be connected to the public utility AC power network, the radio frequency voltage that is conducted back onto the AC power line on any frequency or frequencies within the range 150 kHz to 30 MHz shall not exceed the limits in table 4, as measured using a 50 H / 50 line impedance stabilization network. This requirement applies for the radio frequency voltage measured between each power line and the ground terminal of each AC power-line mains cable of the EUT.

For an EUT that connects to the AC power lines indirectly, through another device, the requirement for compliance with the limits in table 4 shall apply at the terminals of the AC power-line mains cable of a representative support device, while it provides power to the EUT. The lower limit applies at the boundary between the frequency ranges. The device used to power the EUT shall be representative of typical applications.

| Frequency of Emission (MHz) | Conducted limit (dB $\mu$ V) |                           |
|-----------------------------|------------------------------|---------------------------|
|                             | Quasi-peak                   | Average                   |
| 0.15 – 0.5                  | 66 to 56 <sup>note1</sup>    | 56 to 46 <sup>note1</sup> |
| 0.5 – 5.                    | 56                           | 46                        |
| 5 – 30                      | 60                           | 50                        |

Note 1: The level decreases linearly with the logarithm of the frequency.

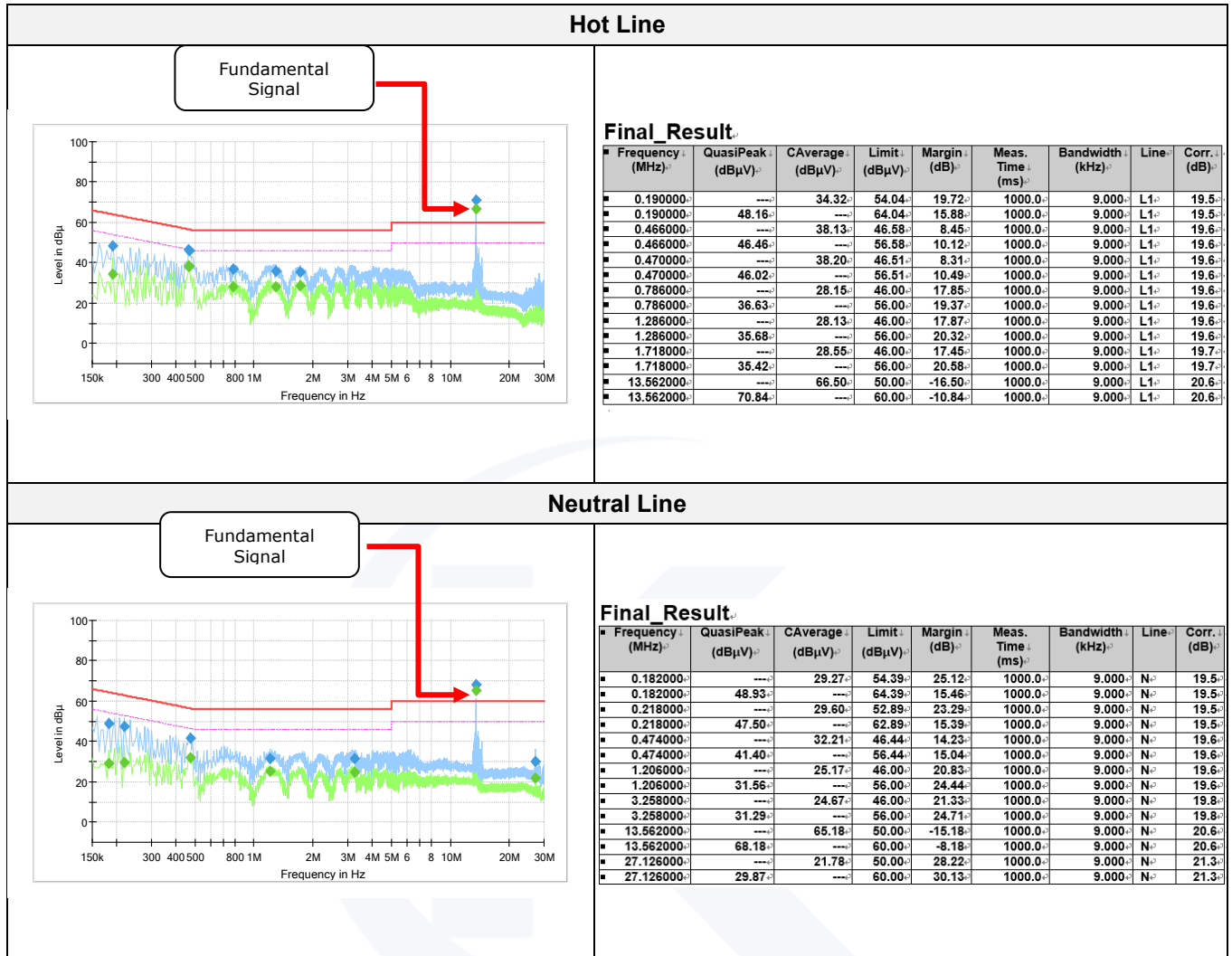
For an EUT with a permanent or detachable antenna operating between 150 kHz and 30 MHz, the AC power-line conducted emissions must be measured using the following configurations:

- Perform the AC power-line conducted emissions test with the antenna connected to determine compliance with the limits of table 4 outside the transmitter's fundamental emission band.
- Retest with a dummy load instead of the antenna to determine compliance with the limits b. of table 4 within the transmitter's fundamental emission band. For a detachable antenna, remove the antenna and connect a suitable dummy load to the antenna connector. For a permanent antenna, remove the antenna and terminate the RF output with a dummy load or network that simulates the antenna in the fundamental frequency band.



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## Test results





### 3.6. Antenna Requirement

According to 15.203, 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.

**Appendix A. Measurement equipment**

| Equipment                      | Manufacturer      | Model         | Serial No. | Calibration interval | Calibration due. |
|--------------------------------|-------------------|---------------|------------|----------------------|------------------|
| SPECTRUM ANALYZER              | R&S               | FSV40         | 101725     | 1 year               | 2024.03.16       |
| ATTENUATOR                     | Mini-Circuits     | BW-S10-2W263+ | 2          | 1 year               | 2025.01.15       |
| SIGNAL GENERATOR               | KEYSIGHT          | N5182B        | MY59100115 | 1 year               | 2024.04.19       |
| Loop Antenna                   | Schwarzbeck       | FMZB1513      | 1513-257   | 2 years              | 2025.03.22       |
| BILOG ANTENNA                  | Schwarzbeck       | VULB 9163     | 714        | 2 years              | 2024.04.19       |
| TRILOG-BROADBAND ANTENNA       | VULB9163          | Schwarzbeck   | 715        | 2 years              | 2024.11.17       |
| ATTENUATOR                     | 8491A             | HP            | 32173      | 1 year               | 2024.03.03       |
| Attenuator                     | HUBER+SHHNER      | 6806.17.A     | NONE       | 1 year               | 2024.03.21       |
| Amplifier                      | SONOMA INSTRUMENT | 310N          | 186549     | 1 year               | 2024.03.21       |
| AMPLIFIER                      | SCU 01            | R & S         | 100603     | 1 year               | 2024.11.08       |
| EMI TEST RECEIVER              | ESU26             | R & S         | 100551     | 1 year               | 2024.03.21       |
| AC POWER SOURCE/ANALYZER       | HP                | 6813A         | 3729A00754 | 1 year               | 2025.01.12       |
| EMI Test Receiver              | R&S               | ESR3          | 101783     | 1 year               | 2024.11.08       |
| PULSE LIMITER                  | R&S               | ESH3-Z2       | 101915     | 1 year               | 2024.11.08       |
| LISN                           | R&S               | ENV216        | 101787     | 1 year               | 2024.11.08       |
| LISN                           | R&S               | ESH2-Z5       | 100450     | 1 year               | 2024.11.08       |
| Temperature & Humidity Chamber | ESPEC             | SH-642        | 93012658   | 1 year               | 2024.06.15       |

\* Statement of Traceability: KES Co., Ltd. attests that all calibrations have been performed, traceable to National Primary Standards and International System of Units (SI).

**Peripheral device**

| Device          | Manufacturer                                | Model No.  | Serial No.        |
|-----------------|---|------------|-------------------|
| Monitor         | Samsung Electronics Co., Ltd.               | S24E370DL  | 0NTWHTPH200179Y   |
| Monitor Adapter | Chicony Power Technology (Suzhou) Co., Ltd. | A16-140P1A | ZL6PS64929301A110 |
| KeyBoard        | CAN TECHNOLOGY CO., LTD                     | ST-600     | -                 |
| Mouse           | Intech Electronics Corp.                    | XM-1600    | -                 |
| Desktop PC      | SuZhou MEAN WELL Technology Co., Ltd.       | DB400T2A   | -                 |

**The end of test report.**