# TEST REPORT

**Testing Laboratory:**
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**Test Report Number: SKT-RFC-200002**
**Date of issue: Aug 28, 2020**

| | |
|---|---|
| **Applicant:** | **KYUNGWOO SYSTECH INC.**<br>#401, Daeryung Post Tower 5, 68, Digital-ro 9, Geumcheon-gu, Seoul, South Korea |
| **Manufacturer:** | **KYUNGWOO SYSTECH INC.**<br>#401, Daeryung Post Tower 5, 68, Digital-ro 9, Geumcheon-gu, Seoul, South Korea |
| **Product:** | SMK READER |
| **Model:** | **SMK-HXV-10** |
| **FCC ID:** | ZE8- SMK-HXV-10 |
| **Project number:** | SKTEU20-0470 |
| **EUT received:** | April 28, 2020 |
| **Applied standards:** | ANSI C63.10-2013 and ANSI C63.4-2014 |
| **Rule parts:** | FCC Part 15 Subpart C - Intentional radiators |
| **Equipment Class:** | **DCD - Part 15 Low Power Transmitter Below 1705kHz** |
| **Remarks to the standards:** | None |

The above equipment has been tested by SK Tech Co., Ltd., and found compliance with the requirements set forth in the technical standards mentioned above. The results of testing in this report apply only to the product or system, which was tested.

Ahn dowon / **Testing Engineer**

Changmin Kim / **Technical Manager**

# Revision History of Test Report

| Rev. | Revisions | Effect page | Approved by | Date |
|---|---|---|---|---|
| - | Initial issue | All | Changmin Kim | Aug 28, 2020 |

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# 1 Summary of test results

| Requirement | CFR 47 Section | Result |
|---|---|---|
| Antenna Requirement | 15.203 | Meets the requirements |
| Radiated Emissions | 15.209(a) | Meets the requirements |
| AC power line Conducted emissions | 15.207(a) | N/A |

***Note:*** *The EUT is operated from the battery (DC 12 V or DC 24 V) in a vehicle, and therefore the test suites related to AC Mains port were not applicable.*

## 2 Description of equipment under test (EUT)

| | |
|---|---|
| Product: | SMK READER |
| Model: | SMK-HXV-10 |
| Serial number: | None (prototype) |

**Model differences:**

| Model name | Difference | Tested (checked) |
|---|---|---|
| SMK-HXV-10 | fully tested model that was provided by the applicant | ☒ |

**Technical data:**

| | | |
|---|---|---|
| Power source | DC 12 V / DC 24 V (powered from the battery in a vehicle) | |
| Local Oscillator or X-Tal | 8 MHz, 26 MHz | |
| Transmit Frequency | 433.92 MHz | 125 kHz |
| Antenna Type | Integral chip antenna | Integral loop coil antenna |
| Type of Modulation | GFSK | ASK |
| RF Output power | 86.4 dBμV/m (PEAK)<br>(measured @ 3m) | 89.3 dBμV/m(PEAK)<br>(measured @ 3m) |

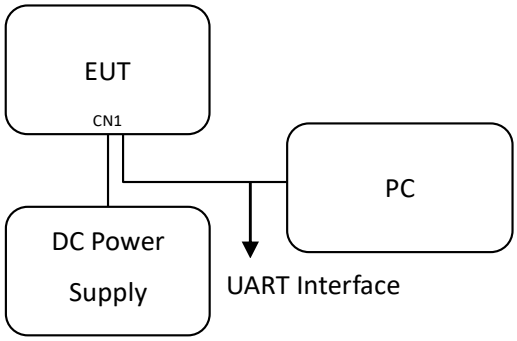
***Note:*** ** The test report for Equipment Class DSC was issued with other test report number.*
*** The test report for the compliance with FCC Part 15B as a digital device was issued with other test report number.*

| I/O port | Type | Q'ty | Remark |
|---|---|---|---|
| CN1 | 12-pin connector (DC IN, ACC, Actuator, LF ANT, etc.) | 1 | |

# 3 Test and measurement conditions

## 3.1. Test configuration (arrangement of EUT)

The EUT was operated from DC Power Supply (12 V or 24 V).




## 3.2. Description of support units (accessory equipment)

The following support units or accessories were used to form a representative test configuration during the tests.

| # | Equipment | Manufacturer | Model No. | Serial No. |
|---|---|---|---|---|
| 1 | DC Power Supply | HP | 6633A | 2838A-01000 |

## 3.3. Interconnection and I/O cables

The following support units or accessories were used to form a representative test configuration during the tests.

| # | Start | | End | | Cable | |
|---|---|---|---|---|---|---|
| | Name | I/O port | Name | I/O port | length (m) | shielded (Y/N) |
| 1 | EUT | DC IN | DC Power Supply | DC OUT | 2.0 | N |

## 3.4. Measurement Uncertainty (*U*)

| Measurement Item | Combined Standard Uncertainty *Uc* | Expanded Uncertainty $U = k \times Uc$ ($k$ = 2) |
|---|---|---|
| Conducted emissions | 1.4 ± dB | 2.8 ± dB |
| Radiated emissions (9 kHz to 30 MHz) | 1.45 ± dB | 2.9 ± dB |
| Radiated emissions (30 MHz to 1000 MHz) | 2.5 ± dB | 5.0 ± dB |

## 3.5. Test date

| | |
|---|---|
| Date Tested | July 15, 2020 – August 3, 2020 |

# 4 Facilities and accreditations

## 4.1. Facilities

All of the measurements described in this report were performed at SK Tech Co., Ltd
Site I: 88, Geulgaeul-ro 81beon-gil, Wabu-eup, Namyangju-si, Gyeonggi-do, Korea
Site II: 124-8, Geulgaeul-ro, Wabu-eup, Namyangju-si, Gyeonggi-do, Korea

The sites are constructed in conformance with the requirements of ANSI C63.4 and CISPR 16-1-4. The sites comply with the Normalized Site Attenuation requirements given in ANSI C63.4, and site VSWR requirements specified in CISPR 16-1-4. The measuring apparatus and ancillary equipment conform to CISPR 16-1 series.

## 4.2. Accreditations

The laboratory has been also notified to FCC by RRA as a Conformity Assessment Body, and designated to perform compliance testing on equipment subject to Supplier's Declaration of Conformity (SDoC) and Certification under Parts 15 and 18 of the FCC Rules.

| Designation No. | KR0007 |
|---|---|

## 4.3. List of test and measurement instruments

| No | Description | Model | Manufacturer | Serial No. | Cal. due | Use |
|---|---|---|---|---|---|---|
| 1 | EMI Test Receiver | ESR26 | Rohde&Schwarz | 101441 | 2021.07.24 | ☒ |
| 2 | EMI Test Receiver | ESIB40 | Rohde&Schwarz | 100277 | 2021.02.25 | ☒ |
| 3 | Pre-amplifier (30 MHz - 1 GHz) | MLA-10K01-B01-27 | TSJ | 2005350 | 2021.06.08 | ☒ |
| 4 | Pre-amplifier (1 GHz - 18 GHz) | MLA-100M18-B02-38 | TSJ | 1539546 | 2021.02.03 | ☒ |
| 5 | Attenuator (6dB) | 18N5W | API Technology | - | 2021.07.06 | ☒ |
| 6 | Loop Antenna | HFH2-Z2 | Schwarzbeck | 863048/019 | 2021.12.20 | ☒ |
| 7 | BILOG Broadband Antenna | VULB9168 | Schwarzbeck | 9168-230 | 2021.07.06 | ☒ |
| 9 | DC Power Supply | 6633A | HP | 2838A-01000 | 2021.06.09 | ☒ |
| 10 | Signal Generator | SMB100A | R & S | 180704 | 2021-02-25 | ☒ |
| 11 | Digital Thermo-Hygrometer | 608-H1 | Testo | - | 2021.06.11 | ☒ |

# 5 Test and measurements

## 5.1. Antenna requirement

### 5.1.1 Regulation

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 §15.211, 15.213, 15.217, 15.219, 15.221, or §15.236. 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 §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.

### 5.1.2 Result: PASS

The EUT has an Internal loop antenna and meets the requirements of this section.

## 5.2. Radiated emissions

### 5.2.1 Regulation

**FCC 47CFR15 - 15.209**

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

| Frequency (MHz) | Field strength limit (μV/m) | Field strength limit (dBμV/m) | Measurement Distance (m) |
|---|---|---|---|
| 0.009 - 0.490 | 2400/F (kHz) = 266.7 - 4.9 | 48.5 - 13.8 | 300 |
| 0.490 - 1.705 | 24000/F (kHz) = 49.0 - 14.1 | 33.8 - 23.0 | 30 |
| 1.705 - 30.0 | 30 | 29.5 | 30 |
| 30 - 88 | 100 | 40.0 | 3 |
| 88 - 216 | 150 | 43.5 | 3 |
| 216 - 960 | 200 | 46.0 | 3 |
| Above 960 | 500 | 54.0 | 3 |

* The emission limits shown in the above table are based on measurement instrumentation employing a CISPR quasi-peak detector. For the frequency bands 9 - 90 kHz, 110 - 490 kHz and above 1000 MHz, the radiated emission limits are based on measurements employing an average detector.

* The lower limit shall apply at the transition frequencies.

### 5.2.2 Measurement Procedure

The EUT repeatedly transmitted RF signals and the following measurement procedure specified in ANSI C63.10-2013 was used

**Radiated Emissions Test, 9 kHz to 30 MHz (Magnetic Field Test)**

(a) The preliminary radiated measurements were performed to determine the frequency producing the maximum emissions at a distance of 3 meters according to Section 15.31(f)(2).

(b) The EUT was placed on the top of the 0.8-meter height, 1 × 1.5 meter non-metallic table.

(c) Emissions from the EUT are maximized by adjusting the orientation of the Loop antenna and rotating the EUT on the turntable. Manipulating the system cables also maximizes EUT emissions if applicable.

(d) To obtain the final measurement data, each frequency found during preliminary measurements was re-examined and investigated. The test-receiver system was set up to average, peak, and quasi-peak detector function with specified bandwidth.

(e) The EUT was situated in three orthogonal planes (if appropriate).

**Radiated Emissions Test, above 30 MHz**

(a) The preliminary radiated measurements were performed to determine the frequency producing the maximum emissions in an anechoic chamber at a distance of 3 meters.

(b) The EUT was placed on the top of the 0.8-meter height (or 1.5 meter height for above 1 GHz), 1 × 1.5 meter non-metallic table. To find the maximum emission levels, the height of a measuring antenna was changed and the turntable was rotated 360˚.

(c) The antenna polarization was also changed from vertical to horizontal. The spectrum was scanned from 30 to 1000 MHz using the Bilog broadband antenna, and from 1 GHz to tenth harmonic of the highest fundamental frequency using the horn antenna.

(d) Each frequency found during preliminary measurements was re-examined and investigated. The test-receiver system was set up to average, peak, and quasi-peak detector function with specified bandwidth.
(e) The EUT was situated in three orthogonal planes (if appropriate).

### 5.2.3 Calculation of the field strength limits below 30 MHz

(a) No special calculation for obtaining the field strength in dBμV/m is necessary, because the EMI receiver and the active loop antenna operate as a system, where the reading gives directly the field strength result (dBμV/m). The antenna factors and cable losses are already taken into consideration.
(b) For test distance other than what is specified, but fulfilling the requirements of section 15.31 (f) (2) the field strength is calculated by adding additionally an extrapolation factor of 40dB/decade (inverse linear distance for field strength measurements).
(c) All following emission measurements were performed using the test receiver's average, peak, and quasi-peak detector function with specified bandwidth.
(d) The basic equation is as follows;

FS= RA + DF
Where
FS = Field strength in dBμV/m
RA = Receiver Amplitude in dBμV/m
DF = Distance Extrapolation Factor in dB
Where DF = $40\log(D_{TEST} / D_{SPEC})$ where $D_{TEST}$ = Test Distance and $D_{SPEC}$ = Specified Distance
DF = 40log(3m/300m) = -80 dB, for frequency band: 0.009 to 0.490 MHz
DF = 40log(3m/30m) = -40 dB, for frequency band: 0.490 to 30 MHz

### 5.2.4 Test Results: PASS

**Table 1: Measured values of the Field strength - Internal Loop antenna**

X-axis is worst-case configuration among 3 axis.

For the measurements under below 30 MHz (DC 12 V)

| Freq. (kHz) | RBW (kHz) | Reading (dBμV) | | AF (dB/m) | Cable Loss (dB) | Actual (dBμV/m) | | Limit (at 3m) (dBμV/m) | | Margin (dB) | | Remark |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | PK | AV | | | PK | AV | PK | AV | PK | AV | |
| 125.0 | 0.2 | 69.0 | 41.1 | 20.2 | 0.1 | 89.3 | 61.4 | 125.7 | 105.7 | 36.4 | 44.3 | X-axis |
| 280.0 | 0.2 | 21.0 | 8.0 | 20.1 | 0.1 | 41.2 | 28.2 | 118.7 | 98.7 | 77.5 | 70.5 | |

For the measurements under below 30 MHz (DC 24 V)

| Freq. (kHz) | RBW (kHz) | Reading (dBμV) | | AF (dB/m) | Cable Loss (dB) | Actual (dBμV/m) | | Limit (at 3m) (dBμV/m) | | Margin (dB) | | Remark |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | PK | AV | | | PK | AV | PK | AV | PK | AV | |
| 125.0 | 0.2 | 69 | 41.1 | 20.2 | 0.1 | 89.3 | 61.4 | 125.7 | 105.7 | 36.4 | 44.3 | X-axis |
| 280.0 | 0.2 | 21.4 | 8.3 | 20.1 | 0.1 | 41.6 | 28.5 | 118.7 | 98.7 | 77.1 | 70.2 | |

Actual (dBμV/m) = Reading + AF + Cable Loss

Margin (dB) = Limit – Actual

Note: These test results were measured at the 3 m distance.

**Table 4: Measured values of the Field strength - Internal Loop antenna**

For the measurements from 30 MHz to 1 GHz (Internal Loop antenna, DC 12 V)

| Frequency (MHz) | Pol. (V/H) | Height (m) | Reading (dBµV) | AMP (dB) | AF (dB/m) | CL (dB) | Actual (dBµV/m) | Limit (dBµV/m) | Margin (dB) | Remark |
|---|---|---|---|---|---|---|---|---|---|---|
| 87.536 | V | 1.12 | 39.5 | 30.3 | 14.0 | 1.3 | 24.5 | 40.0 | 15.5 | X-axis |
| 152.204 | H | 1.94 | 43.8 | 30.0 | 18.9 | 1.7 | 34.4 | 43.5 | 9.1 | |
| 287.992 | H | 1.19 | 50.5 | 30.0 | 19.0 | 2.3 | 41.8 | 46.0 | 4.2 | |
| 360.000 | H | 1.01 | 42.1 | 30.1 | 20.7 | 2.6 | 35.3 | 46.0 | 10.7 | |
| 904.008 | H | 1.00 | 30.7 | 30.3 | 29.3 | 4.1 | 33.8 | 46.0 | 12.2 | |

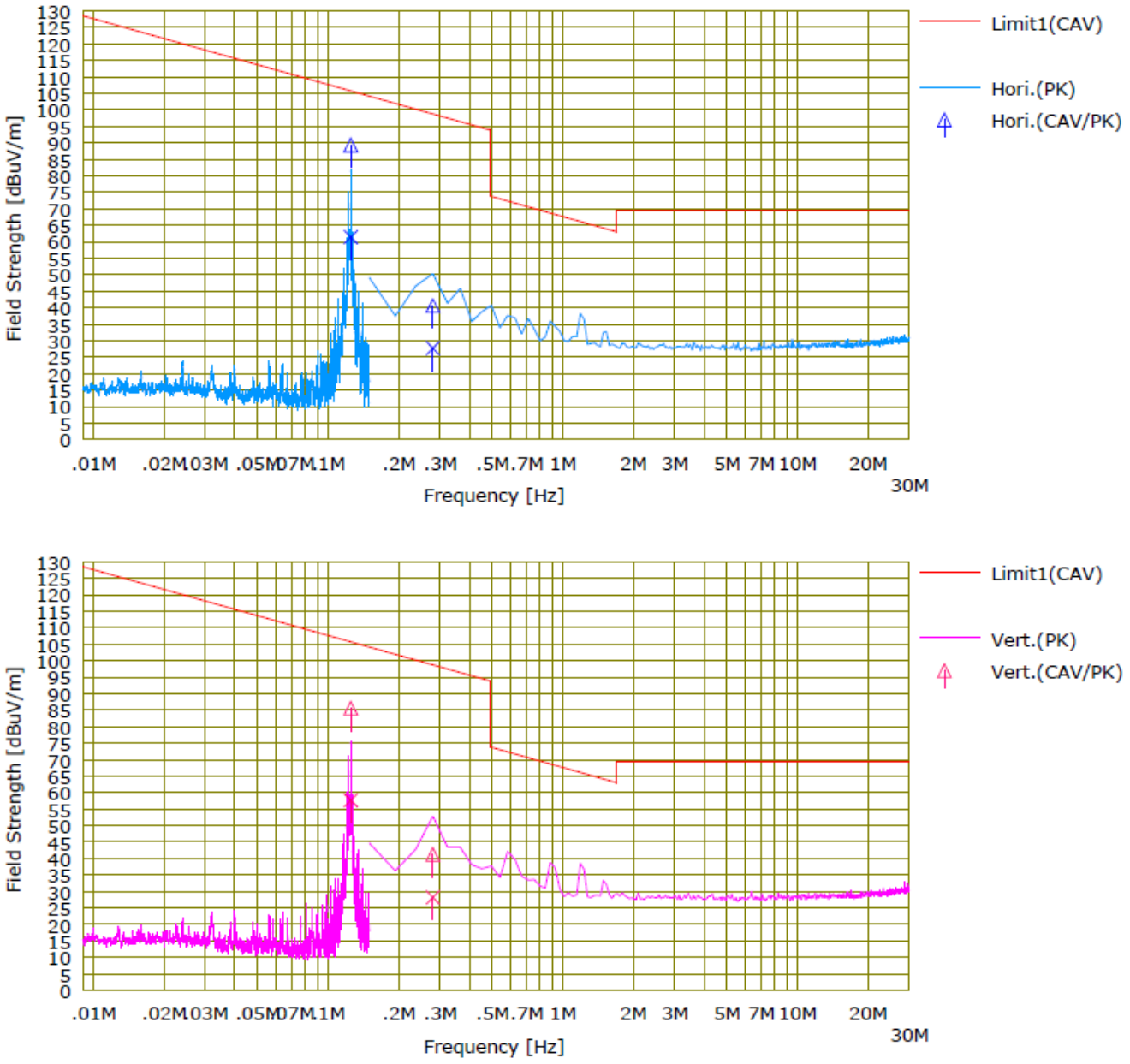
For the measurements from 30 MHz to 1 GHz (Internal Loop antenna, DC 24 V)

| Frequency (MHz) | Pol. (V/H) | Height (m) | Reading (dBµV) | AMP (dB) | AF (dB/m) | CL (dB) | Actual (dBµV/m) | Limit (dBµV/m) | Margin (dB) | Remark |
|---|---|---|---|---|---|---|---|---|---|---|
| 89.474 | H | 3.90 | 41.4 | 30.3 | 13.8 | 1.3 | 26.2 | 43.5 | 17.3 | X-axis |
| 152.786 | H | 2.08 | 43.7 | 30.0 | 18.9 | 1.7 | 34.3 | 43.5 | 9.2 | |
| 287.990 | H | 1.06 | 50.6 | 30.0 | 19.0 | 2.3 | 41.9 | 46.0 | 4.1 | |
| 359.987 | H | 1.01 | 41.8 | 30.1 | 20.7 | 2.6 | 35.0 | 46.0 | 11.0 | |
| 919.975 | H | 1.01 | 31.9 | 30.4 | 29.5 | 4.1 | 35.1 | 46.0 | 10.9 | |

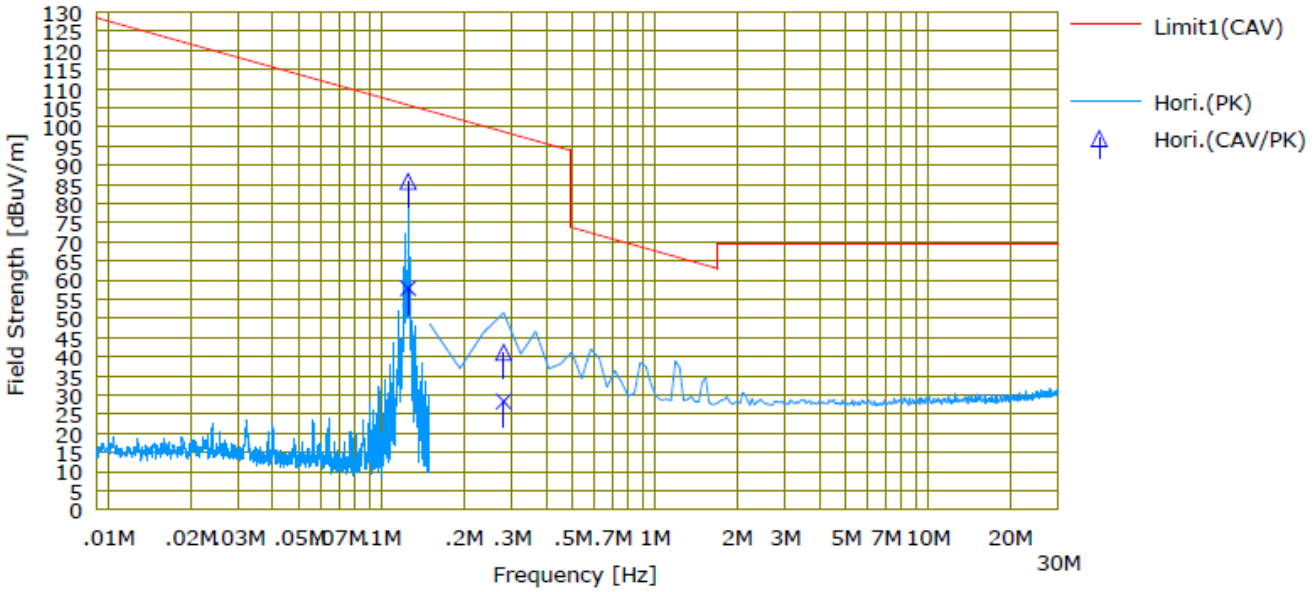
V/H: Vertical / Horizontal polarization
AMP, AF and CL: pre-amplifier gain, antenna factor and cable loss including an attenuator/filter if used
Actual = Reading - AMP + AF + CL
Margin = Limit - Actual

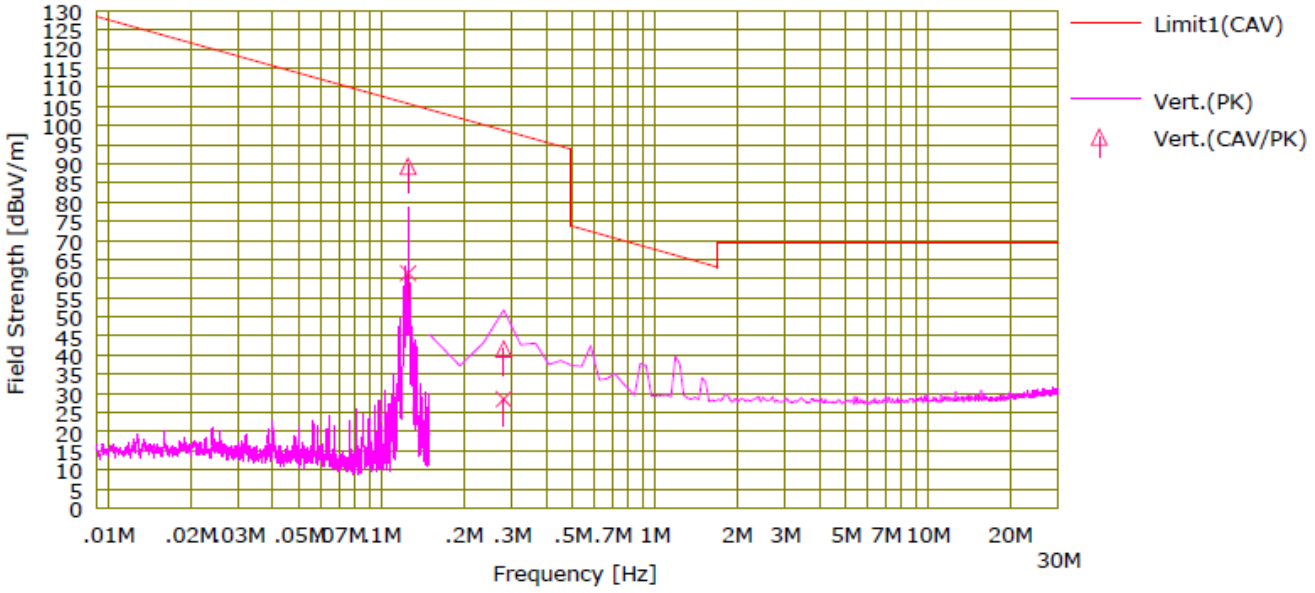
**Figure 1. Emission plot for the preliminary radiated measurements**
The worst-case plots were attached.

Internal Loop antenna (DC 12 V)



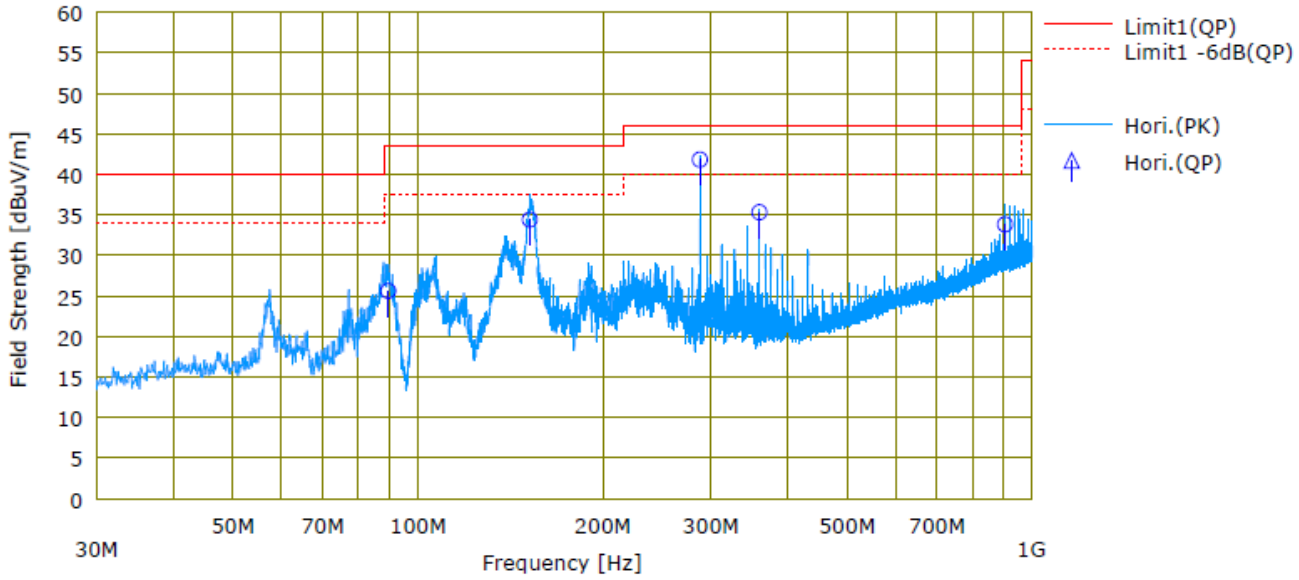
Internal Loop antenna (DC 24 V)

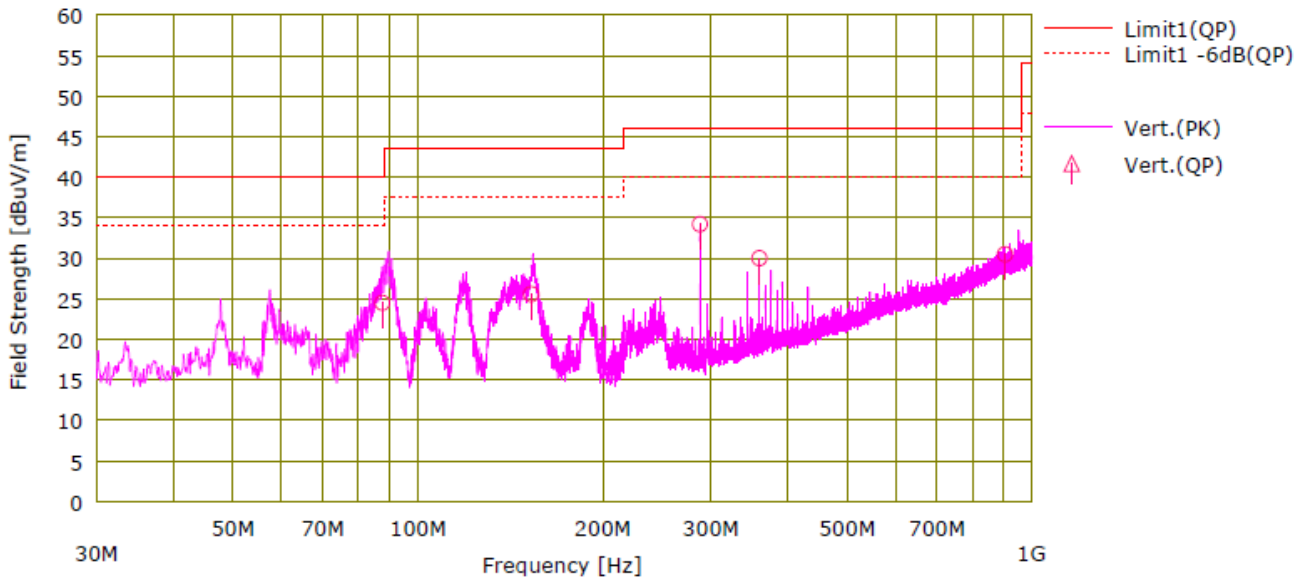


Frequency Range: 30 MHz ~ 1 GHz

Internal Loop antenna (DC 12 V)



Frequency Range: 30 MHz ~ 1 GHz

Internal Loop antenna (DC 24 V)