SK TECH CO., LTD.



# Certificate of Compliance

| | | | |
|---|---|---|---|
| **Test Report No.:** | **SKTTRT-051019-027** | | |
| **NVLAP CODE:** | **200220-0** | | |
| **Applicant:** | **NITGen Co., Ltd.** | | |
| **Applicant Address:** | Sanhak Research Foundation B/D, 5th Fl. 1337-31, Seocho-dong, Seocho-ku, Seoul, 137-070 South Korea | | |
| **Manufacturer:** | **NITGen Co., Ltd.** | | |
| **Manufacturer Address:** | Sanhak Research Foundation B/D, 5th Fl. 1337-31, Seocho-dong, Seocho-ku, Seoul, 137-070 South Korea | | |
| **Device Under Test:** | **Multi-Biometrics System** | | |
| **FCC ID:** | **PEBENBIOGATE** | **Model Name:** | **eNBio Gate** |
| **Receipt No.:** | SKTEU05-0570 | **Date of receipt:** | August 29, 2005 |
| **Date of Issue:** | October 19, 2005 | | |
| **Location of Testing:** | **SK TECH CO., LTD.**<br>820-2, Wolmoon-Ri, Wabu-Up, Namyangju-Si, Kyunggi-Do, Korea | | |
| **Test Specification:** | **FCC Part 15 Rules** | | |
| **FCC Equipment Class:** | **DXX - Part 15 Low Power Communication Device Transmitter** | | |
| **Test Result:** | The above-mentioned device has been tested and passed. | | |

**Tested & Reported by**: *Jong-Soo, Yoon*

*2005. 10. 19*

*Signature* *Date*

**Approved by**: *Jae-Kyung, Bae*

*2005. 10. 19*

*Signature* *Date*

| | |
|---|---|
| **Other Aspects:** | - |
| **Abbreviations:** | · OK, Pass = passed · Fail = failed · N/A = not applicable |

☞
- **This test report is not permitted to copy partly without our permission.**
- **This test result is dependent on only equipment to be used.**
- **This test result is based on a single evaluation of one sample of the above mentioned.**
- **This test report must not be used to claim product endorsement by NVLAP or any agency of the U.S Government.**
- **We certify that this test report has been based on the measurement standards that is traceable to the national or International standards.**

NVLAP®

**NVLAP Lab. Code: 200220-0**

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# 1. GENERAL

These tests were performed using the test procedure outlined in ANSI C63.4, 2003 for intentional radiators, and in accordance with the limits set forth in FCC Part 15.225. The EUT (Equipment Under Test) has been shown to be capable of compliance with the applicable technical standards.

We attest to the accuracy of data. All measurements reported herein were performed by SK Tech Co., Ltd. and were made under Chief Engineer's supervision.
We assume full responsibility for the completeness of these measurements and vouch for the qualifications of all persons taking them.

# 2. TEST SITE

SK TECH Co., Ltd.

## 2.1 Location

820-2, Wolmoon Ri, Wabu-Up, Namyangju-Si, Kyunggi-Do, Korea

This test site is in compliance with ISO/IEC 17025 for general requirements for the competence of testing and calibration laboratories.
This laboratory is accredited by NVLAP for NVLAP Lab. Code: 200220-0 and DATech for DAR-Registration No.: TTI-P-G155/97-10

## 2.2 List of Test and Measurement Instruments

| Description | Manufacturer | Model # | Serial # | |
|---|---|---|---|---|
| Spectrum Analyzer | Agilent | E4405B | US40520856 | ☒ |
| EMC Spectrum Analyzer | Agilent | E7405A | US40240203 | ☒ |
| EMI Test Receiver | Rohde&Schwarz | ESVS10 | 825120/013 | ☒ |
| EMI Test Receiver | Rohde&Schwarz | ESVS10 | 834468/008 | ☒ |
| EMI Test Receiver | Rohde&Schwarz | ESHS10 | 825120/013 | ☒ |
| EMI Test Receiver | Rohde&Schwarz | ESHS10 | 834468/008 | ☒ |
| Artificial Mains Network | Rohde&Schwarz | ESH3-Z5 | 836679/018 | ☒ |
| Pre-amplifier | HP | 8447F | 3113A05153 | ☒ |
| Pre-amplifier | HP | 8349B | 2644A03250 | |
| Power Meter | Agilent | E4418B | 3318A13916 | |
| Power Sensor | HP | 8485A | 3318A13916 | |
| Frequency Counter | HP | 5343A | 2022A00167 | ☒ |
| VHF Precision Dipole Antenna (TX & RX) | Schwarzbeck | VHAP | 1014 & 1015 | |
| UHF Precision Dipole Antenna (TX & RX) | Schwarzbeck | UHAP | 989 & 990 | |
| Loop Antenna | Schwarzbeck | HFH2-Z2 | 863048/019 | ☒ |
| TRILOG Broadband Antenna | Schwarzbeck | VULB9160 | 3141 | ☒ |
| Biconical Antenna | Schwarzbeck | VHA9103 | 2265 | ☒ |
| Log-Periodic Antenna | Schwarzbeck | UHALP9107 | 1819 | ☒ |
| Horn Antenna | AH Systems | SAS-200/571 | 304 | |
| Horn Antenna | ETS-LINDGREN | 3115 | 00040723 | |
| Horn Antenna | ETS-LINDGREN | 3115 | 00056768 | |
| Vector Signal Generator | Agilent | E4438C | MY42080359 | |
| Signal Generator | HP | 8349B | 2644A03250 | |
| DC Power Supply | HP | 6634A | 2926A-01078 | |
| DC Power Supply | HP | 6268B | 2542A-07856 | |
| Digital Multimeter | HP | HP3458A | 2328A14389 | |
| PCS Interface | HP | 83236B | 3711J00881 | |
| CDMA Mobile Test Set | HP | 8924C | US35360253 | |
| Hygro/Thermo Graph | SATO | PC-5000TRH-II | - | ☒ |
| Temperature/Humidity Chamber | All Three | ATH-50M | 20030425 | |
| Temperature/Humidity Chamber | Tabai | PR-4STH | 1300515 | ☒ |

## 2.3 Test Date

Date of Application : August 29, 2005

Date of Test : October 15, 2005 ~ October 17, 2005

## 2.4 Test Environment

See each test item's description.

# 3. DESCRIPTION OF THE EQUIPMENT UNDER TEST

The product specification described herein was obtained from the product data sheet or user's manual.

## 3.1 Rating and Physical Characteristics

| Product description | Multi-Biometrics System |
|---|---|
| FCC ID | PEBENBIOGATE |
| Model Name | eNBio Gate |
| Power source | DC 24V (AC/DC Adaptor), DC 5V (USB) |
| Dimensions [mm] | 320 (W) × 380 (D) × 866 (H) |
| Local Oscillator, X-tal | RFID card reader: 12 MHz, 13.56 MHz, 22.1184 MHz<br>Main board: 15 MHz<br>Fingerprint scanner: 12 MHz |
| Operating frequency | 13.56MHz (fixed) |
| Type of Modulation | ASK |
| Antenna | Integral (PCB loop antenna, Diameter: about 51mm, 3-turns) |
| External Interface | USB interface for RFID card reader<br>Parallel & PS2 connector for Fingerprint scanner 1<br>USB interface for Fingerprint scanner 2<br>Video signal output<br>Audio signal connector |

** The test report for compliance with FCC Part 15B as a Class B digital should be issued with other test report number.

## 3.2 Submitted Documents

Block diagram / Schematic diagram / Part List / User's manual

## 3.3 Equipment Modifications

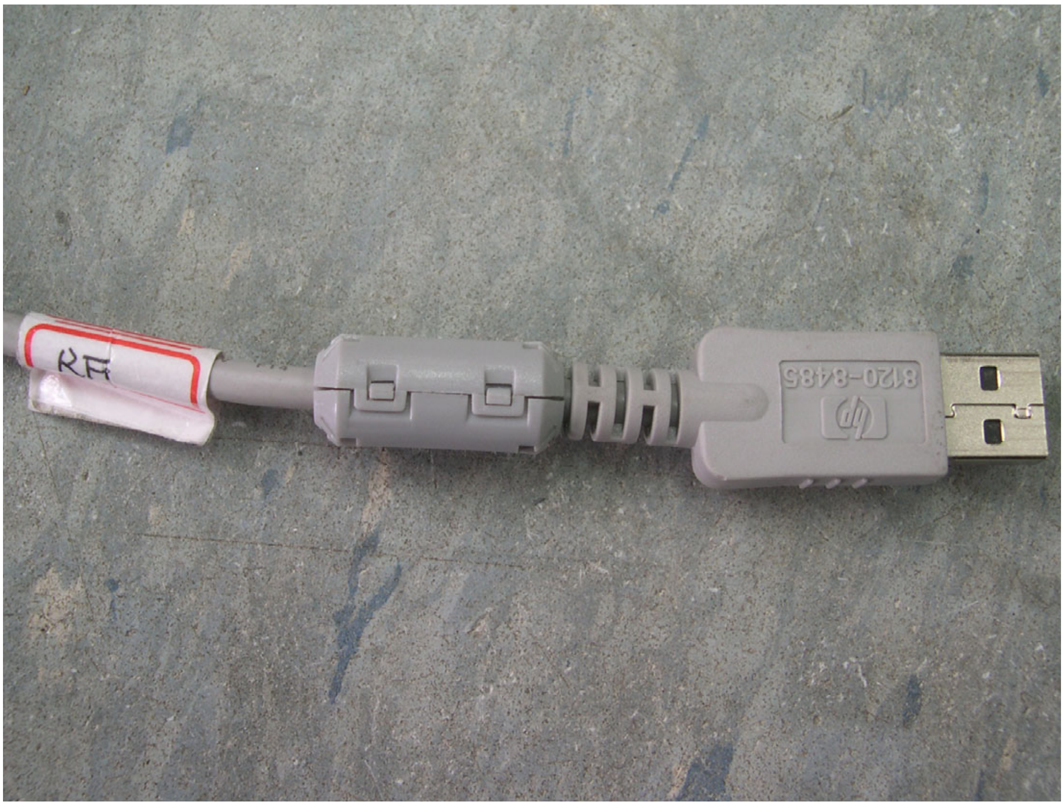
The following modifications were necessary for compliance:

Ferrite cores are inserted additionally as follows:

| # | Ferrite core location | Manufacturer | Model Name | Quantity |
|---|---|---|---|---|
| 1 | USB cable | TDK | ZCAT1325-0530 | 2 |
| 2 | Video signal cable | FEELUX | BNF-18 | 1 |
| 3 | Audio signal cable | TDK | ZCAT1730-0730 | 1 |
| 4 | External cables | FEELUX | BNF-27 | 1 |
| 5 | AC/DC adaptor | TOKIN | ESD-SR-15 | 1 |

1. Ferrite core on USB Cable for RFID card reader


2. Ferrite core on USB Cable for RFID card reader



3. Ferrite core on Video signal cable

4. Ferrite core on Audio signal cable

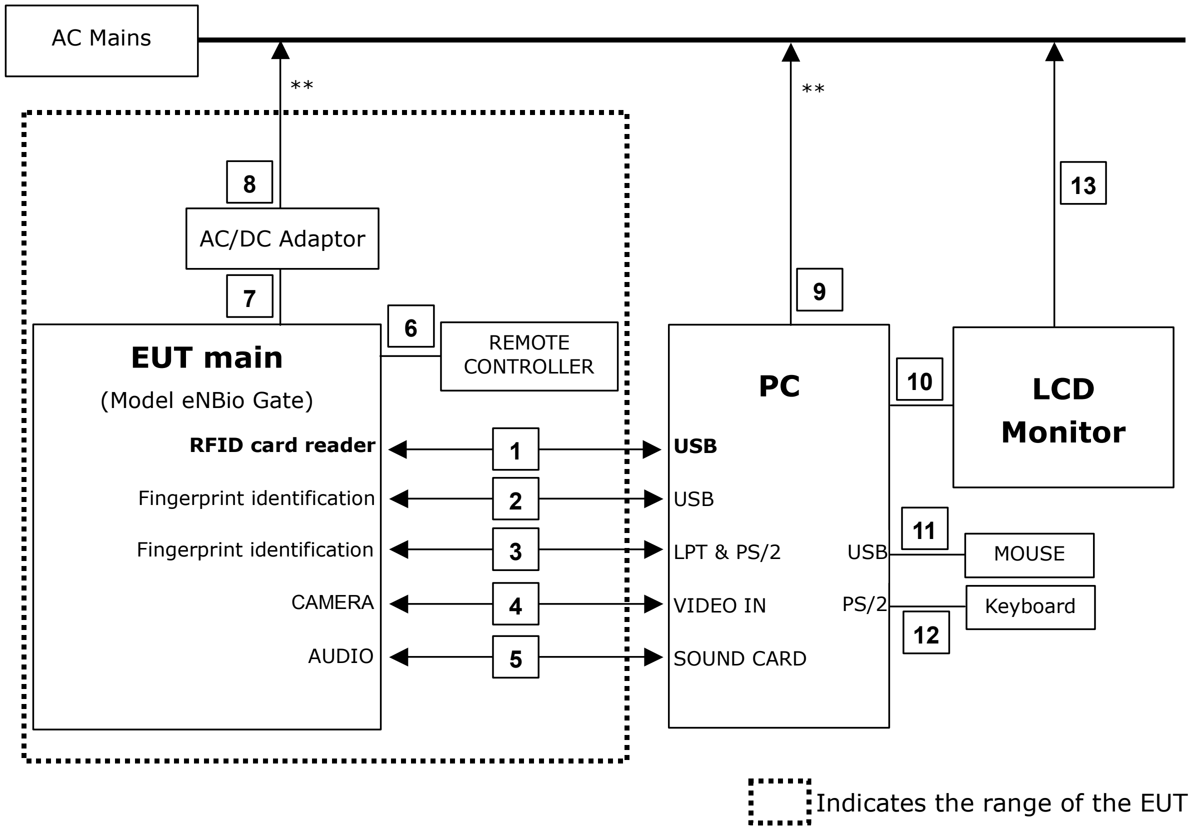
5. Ferrite core on External cables


6. Ferrite core on AC/DC Adaptor

# 4. MEASUREMENT CONDITIONS

## 4.1 Description of test configuration

The EUT was connected to AC mains through AC/DC Adaptor and the measurements were taken in transmitting mode under practical operation, without RFID card (unmodulated carrier signal) and with RFID card (modulated) using RF test program, RF_API_TEST.exe, supplied by the applicant.




** For conducted emission measurements, both tested; The EUT was DIRECTLY powered from the LISN port and the transmitter portion of the EUT, RFID card reader, was INDIRECTLY powered from the LISN port (to which the PC was connected).

## 4.2 List of Peripherals

| Equipment Type | Manufacturer | Model | S/N |
|---|---|---|---|
| PC | SAMSUNG | DM-P40 | Z39699AXC00334V |
| LCD Monitor | LG IBM | 1510TFT Rev B | 304KG04896 |
| Mouse (USB type) | LG | LMULBGS011 | 04CU000247 |
| Keyboard (PS/2 type) | LG | LK3100 | - |

## 4.3 Type of Used Cables

| # | START | | END | | Cable | | |
|---|---|---|---|---|---|---|---|
| | Name | I/O Port | Name | I/O Port | Length | Shielded | Ferrite Core |
| 1 | EUT main | RFID card reader | PC | USB | 1.8 | YES | YES ** |
| 2 | EUT main | Fingerprint ID | PC | USB | 1.8 | YES | YES |
| 3 | EUT main | Fingerprint ID | PC | LPT & PS/2 | 2.5 | NO | YES |
| 4 | EUT main | CAMERA | PC | VIDEO IN | 1.8 | NO | YES ** |
| 5 | EUT main | AUDIO | PC | Sound Card | 2.5 | NO | YES ** |
| 6 | EUT main | Remote Controller | - | - | 1.5 | NO | NO |
| 7 | EUT main | DC input | Adaptor | DC output cable | 1.5 | NO | YES ** |
| 8 | Adaptor | AC power cable | AC Mains | - | 1.8 | NO | NO |
| 9 | PC | AC input | AC Mains | - | 1.8 | NO | NO |
| 10 | PC | VGA output | LCD | Monitor cable | 1.8 | YES | YES |
| 11 | PC | USB | MOUSE | Mouse cable | 1.8 | NO | NO |
| 12 | PC | PS/2 | Keyboard | Keyboard cable | 1.5 | NO | NO |
| 13 | LCD | AC power cable | AC Mains | - | 1.8 | NO | NO |

** Ferrite cores are additionally inserted for compliance

## 4.4 Uncertainty

| Measurement Item | Combined Standard Uncertainty Uc | Expanded Uncertainty U = KUc (K = 2) |
|---|---|---|
| Radiated disturbance | ± 2.37 dB | ±4.74dB |
| Conducted disturbance | ± 1.47 dB | ±2.94dB |

# 5. TEST AND MEASUREMENTS

## Summary of Test Results

| Requirement | FCC, 47CFR15 | Report Section | Test Result |
|---|---|---|---|
| Antenna Requirement | 15.203 | 5.1 | PASS |
| Radiated Emissions<br>Field Strength within the band<br>13.553-13.567 MHz | 15.225(a) | 5.2 | PASS |
| Field Strength within the bands<br>13.410-13.553 MHz and 13.567-13.710 MHz<br>13.110-13.410 MHz and 13.710-14.010 MHz | 15.225(b) & (c) | 5.2 | PASS |
| Radiated Harmonics and Spurious<br>Emissions Outside of the 13.110 – 14.010 MHz | 15.225(d) | 5.2 | PASS |
| Frequency Tolerance of Carrier Signal | 15.225(e) | 5.3 | PASS |
| Power Line Conducted Emissions | 15.207(a) | 5.4 | PASS |

## 5.1 ANTNNA REQUIRMENT

### 5.1.1 Regulation

**FCC 47CFR15 – 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.

### 5.1.2 Result: PASS

The transmitter has an integral PCB loop antenna that is enclosed within the housing of the EUT, and meets the requirements of this section.

# 5.2 RADIATED EMISSIONS

## 5.2.1 Regulation

**FCC 47CFR15 – 15.225**

(a) The field strength of any emissions within the band 13.553-13.567 MHz shall not exceed 15,848 microvolts/meter 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 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 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.

| Frequency (MHz) | Field strength limit (μV/m) @ 30 m | Field strength limit (dBμV/m) @ 30 m | Field strength limit (dBμV/m) @ 3 m |
|---|---|---|---|
| 13.110 – 13.410 | 106 | 40.5 | 80.5 |
| 13.410 – 13.553 | 334 | 50.5 | 90.5 |
| 13.553 – 13.567 | 15,848 | 84.0 | 124.0 |
| 13.567 – 13.710 | 334 | 50.5 | 90.5 |
| 13.710 – 14.010 | 106 | 40.5 | 80.5 |

**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 |

* Use quasi-peak below 1000 MHz and averaging meter above 1000 MHz.

* The lower limit shall apply at the transition frequencies.

### 5.2.2 Measurement Procedure

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

1. 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).
2. The EUT was placed on the top of the 0.8-meter height, 1 × 1.5 meter non-metallic table.
3. 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.
4. 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.

**Radiated Emissions Test, 30 MHz to 18000 MHz**

1. The preliminary radiated measurements were performed to determine the frequency producing the maximum emissions in an anechoic chamber at a distance of 3 meters.
2. The EUT was placed on the top of the 0.8-meter height, 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˚.
3. The antenna polarization was also changed from vertical to horizontal. The spectrum was scanned from 30 to 1000 MHz using the TRILOG broadband antenna, and from 1000 MHz to 18000 MHz using the horn antenna.
4. To obtain the final measurement data, the EUT was arranged on a turntable situated on a 4 × 4 meter at the Open Area Test Site. The EUT was tested at a distance 3 meters.
5. 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.
6. The presence of ambient signals was verified by turning the EUT off. In case an ambient signal was detected, the measurement bandwidth was reduced temporarily and verification was made that an additional adjacent peak did not exist. This ensures that the ambient signal does not hide any emissions from the EUT.

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

1. 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.
2. 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).
3. All following emission measurements were performed using the test receiver's average, peak, and quasi-peak detector function with specified bandwidth.
4. The basic equation is as follows;

FS= RA + DF

Where

FS = Field strength in dBµV/m

RA = Receiver Amplitude in dBµV/m

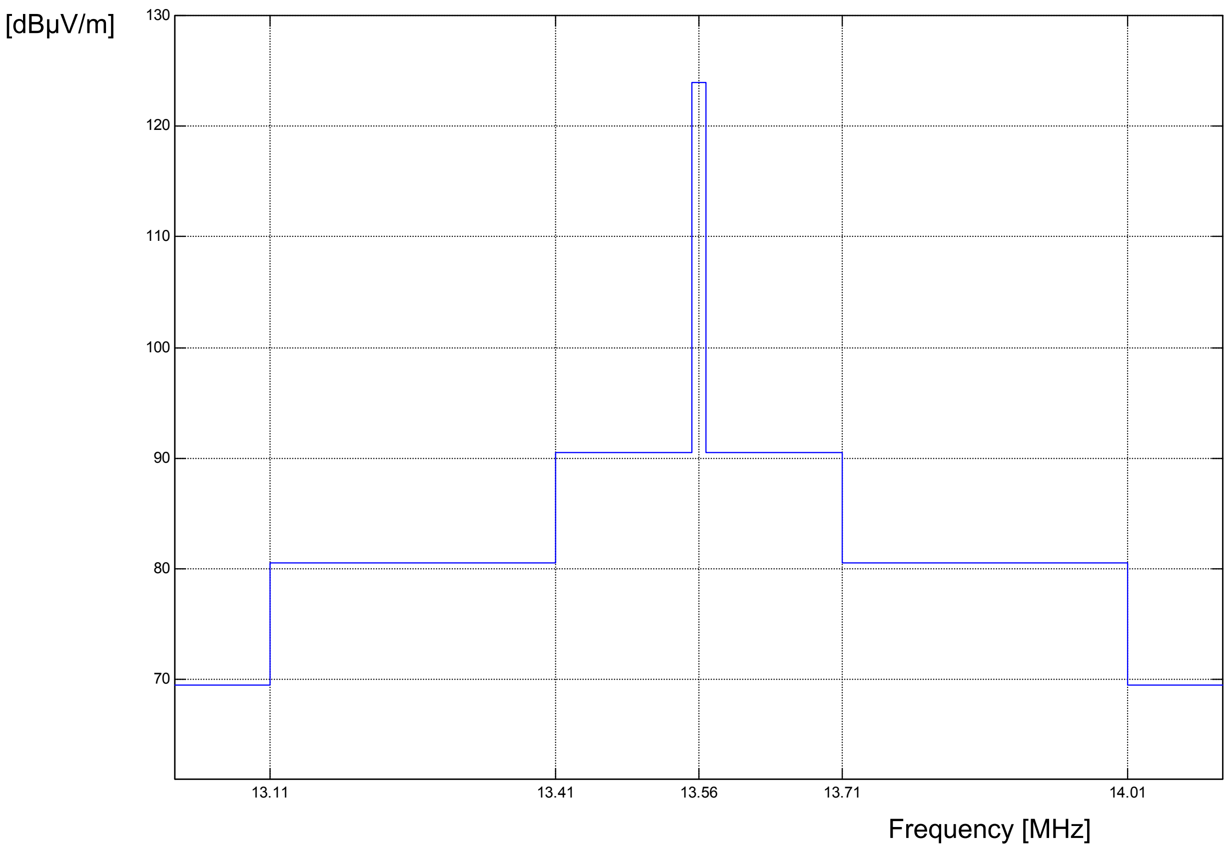
DF = Distance Extrapolation Factor in dB

Where DF = 40log($D_{TEST}$ / $D_{SPEC}$) where $D_{TEST}$ = Test Distance and $D_{SPEC}$ = Specified Distance

DF = 40log(3m/300m) = -80dB, for frequency band: 0.009 to 0.490MHz

DF = 40log(3m/30m) = -40dB, for frequency band: 0.490 to 30MHz

Calculated Field Strength Limit at 3-m distance



### 5.2.4 Test Results: PASS

**TEST MODE: without RFID card (unmodulated)**

**Table 1: Field strength below 30 MHz**

| Frequency [MHz] | Receiver Bandwidth [kHz] | Reading [dB(μV/m)] | Preamp Gain [dB] | Actual [dB(μV/m)] | Limit (at 3m) [dB(μV/m)] | Margin [dB] |
|---|---|---|---|---|---|---|
| **Emissions Quasi-peak DATA under 15.225(a), (b)&(c)** | | | | | | |
| 13.560 | 10 | 79.4 | 28.5 | 50.9 | 124.0 | 73.1 |
| | | | | | | |
| | | | | | | |
| | | | | | | |
| **Emissions Quasi-peak DATA under 15.225(d), 15.209** | | | | | | |
| --- | | | | | | |
| | | | | | | |
| | | | | | | |
| | | | | | | |

**TEST MODE: with RFID card (modulated)**

| Frequency [MHz] | Receiver Bandwidth [kHz] | Reading [dB(μV/m)] | Preamp Gain [dB] | Actual [dB(μV/m)] | Limit (at 3m) [dB(μV/m)] | Margin [dB] |
|---|---|---|---|---|---|---|
| **Emissions Quasi-peak DATA under 15.225(a), (b)&(c)** | | | | | | |
| 13.560 | 10 | 79.6 | 28.5 | 51.1 | 124.0 | 72.9 |
| 13.349 | 10 | 54.3 | 28.5 | 25.8 | 80.5 | 54.7 |
| 13.427 | 10 | 54.8 | 28.5 | 26.3 | 90.5 | 64.2 |
| 13.484 | 10 | 55.2 | 28.5 | 26.7 | 90.5 | 63.8 |
| 13.639 | 10 | 55.6 | 28.5 | 27.1 | 90.5 | 63.4 |
| 13.695 | 10 | 54.8 | 28.5 | 26.3 | 90.5 | 64.2 |
| 13.769 | 10 | 54.6 | 28.5 | 26.1 | 80.5 | 54.4 |
| | | | | | | |
| **Emissions Quasi-peak DATA under 15.225(d), 15.209** | | | | | | |
| --- | | | | | | |
| | | | | | | |
| | | | | | | |
| | | | | | | |

**Actual (dBμV/m) = Reading – Preamp Gain**
**Margin (dB) = Limit – Actual**

**TEST MODE: without RFID card (unmodulated)**

**Table 2: Field strength above 30 MHz**

| Frequency [MHz] | Receiver Bandwidth [kHz] | Pol. (V/H) | Antenna Height [m] | Reading [dB(μV)] | Amp Gain [dB] | AF / CL [dB(1/m)] | Actual [dB(μV/m)] | Limit [dB(μV/m)] | Margin [dB] |
|---|---|---|---|---|---|---|---|---|---|
| **Emissions Quasi-peak DATA 15.225(d), 15.209** | | | | | | | | | |
| 109.58 | 120 | H | 1.4 | 45.7 | 27.9 | 11.6/1.7 | 31.1 | 43.5 | 12.4 |
| 127.96 | 120 | H | 1.5 | 48.1 | 27.8 | 13.7/1.7 | 35.7 | 43.5 | 7.8 |
| 162.72 | 120 | H | 2.8 | 36.8 | 27.5 | 15.3/2.1 | 26.7 | 43.5 | 16.8 |
| 216.96 | 120 | H | 1.8 | 38.0 | 27.2 | 16.9/2.5 | 30.2 | 46.0 | 15.8 |
| 230.52 | 120 | H | 1.3 | 37.3 | 27.1 | 17.2/2.6 | 30.0 | 46.0 | 16.0 |
| 244.08 | 120 | H | 1.4 | 38.3 | 27.0 | 17.4/2.6 | 31.3 | 46.0 | 14.7 |

**TEST MODE: with RFID card (modulated)**

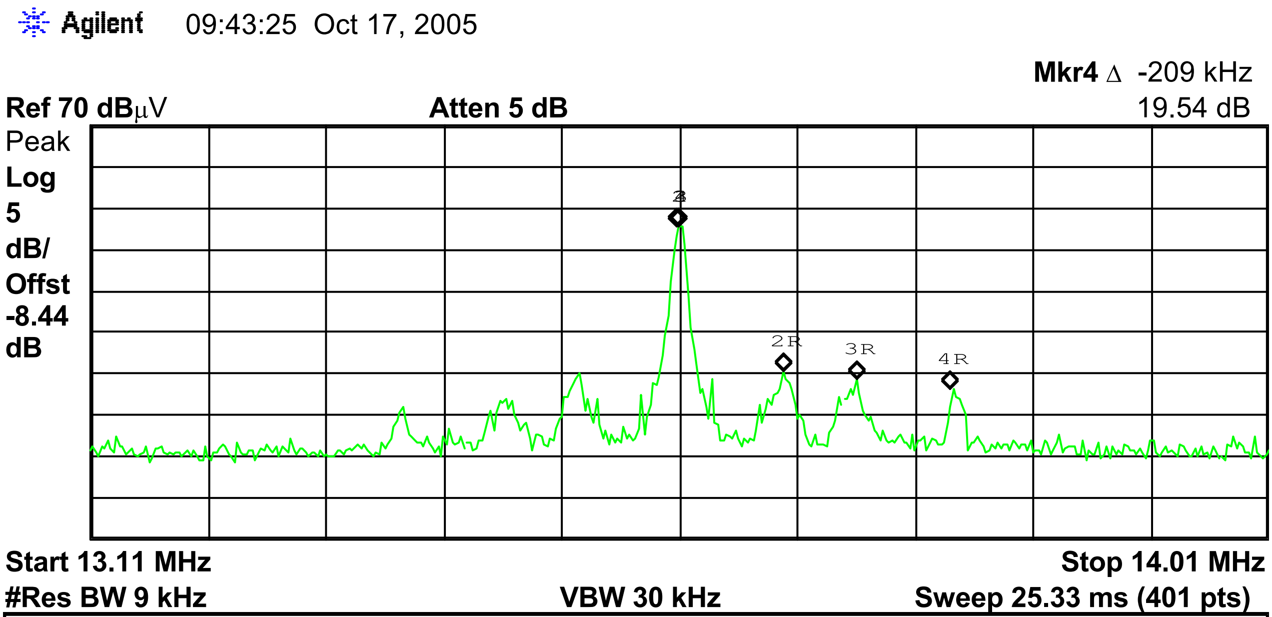
| Frequency [MHz] | Receiver Bandwidth [kHz] | Pol. (V/H) | Antenna Height [m] | Reading [dB(μV)] | Amp Gain [dB] | AF / CL [dB(1/m)] | Actual [dB(μV/m)] | Limit [dB(μV/m)] | Margin [dB] |
|---|---|---|---|---|---|---|---|---|---|
| **Emissions Quasi-peak DATA 15.225(d), 15.209** | | | | | | | | | |
| 109.58 | 120 | H | 1.4 | 46.2 | 27.9 | 11.6/1.7 | 31.6 | 43.5 | 11.9 |
| 127.96 | 120 | H | 1.5 | 48.7 | 27.8 | 13.7/1.7 | 36.3 | 43.5 | 7.2 |
| 162.72 | 120 | H | 2.8 | 38.4 | 27.5 | 15.3/2.1 | 28.3 | 43.5 | 15.2 |
| 216.96 | 120 | H | 1.8 | 39.0 | 27.2 | 16.9/2.5 | 31.2 | 46.0 | 14.8 |
| 230.52 | 120 | H | 1.3 | 38.5 | 27.1 | 17.2/2.6 | 31.2 | 46.0 | 14.8 |
| 244.08 | 120 | H | 1.4 | 41.6 | 27.0 | 17.4/2.6 | 34.6 | 46.0 | 11.4 |

**Margin (dB) = Limit – Actual**
**[Actual = Reading – Amp Gain + AF + CL]**
1. H = Horizontal, V = Vertical Polarization
2. AF/CL = Antenna Factor and Cable Loss

NOTE: The spectrum was scanned from 30 MHz to 1 GHz. All emissions not reported were more than 20 dB below the specified limit or in the noise floor.

## Figure 1: Plot of the Band edge

**TEST MODE: with RFID card (modulated)**




| Marker | Trace | Type | X Axis | Amplitude |
|---|---|---|---|---|
| 1 | (1) | Freq | 13.560 MHz | 57.76 dBμV |
| 2R | (1) | Freq | 13.639 MHz | 40.35 dBμV |
| 2Δ | (1) | Freq | -79 kHz | 17.4 dB |
| 3R | (1) | Freq | 13.695 MHz | 39.38 dBμV |
| 3Δ | (1) | Freq | -135 kHz | 18.38 dB |
| 4R | (1) | Freq | 13.769 MHz | 38.21 dBμV |
| 4Δ | (1) | Freq | -209 kHz | 19.54 dB |

Offset (-8.44 dB) = Antenna Factor (19.56 dB) + Cable Loss (0.5 dB) - Preamp Gain (28.5 dB)

Spectrum Analyzer setting was as follows:

- Frequency range: 13.11 – 14.01 MHz
- Resolution bandwidth: 9 kHz
- Detector: Peak
- Trace: Max Hold mode
- Sweep: Auto

# 5.3 FREQUENCY TOLERANCE OF CARRIER SIGNAL

## 5.3.1 Regulation

**FCC 47CFR15 – 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.

## 5.3.2 Measurement Procedure

**Frequency stability versus environmental temperature**

1. Supply the EUT with nominal AC voltage.
2. Turn the EUT off, and place it inside an environmental temperature chamber. For devices that are normally operated continuously, the EUT may be energized while inside the test chamber. For devices that have oscillator heaters, energize only the heater circuit while the EUT is inside the chamber.
3. RF output was connected to a frequency counter or other frequency-measuring instrument via feed through attenuators.
4. Set the temperature control on the chamber to the highest specified EUT operating temperature, and allow the temperature inside the chamber to stabilize at the set temperature before starting frequency measurements.
5. While maintaining a constant temperature inside the environmental chamber, turn the EUT on and record the operating frequency at startup and two, five, and ten minutes after the EUT is energized.
6. After all measurements have been made at the highest specified temperature turn the EUT off.
7. Repeat the above measurement process for the EUT with the test chamber set at the appropriate temperature.

**Frequency Stability versus Input Voltage**

1. At room temperature (20 ± 5 °C), supply the EUT with nominal AC voltage.
2. Couple RF output to a frequency counter or other frequency-measuring instrument.
3. Turn the EUT on, and measure the EUT operating frequency at startup and two, five, and ten minutes after startup.
4. Supply it with 85% of the nominal AC voltage and repeat the above procedure.
5. Supply it with 115% of the nominal AC voltage and repeat the above procedure.

### 5.3.3 Test Results: PASS

**TEST MODE: without RFID card (unmodulated)**

**Table 3: Frequency Tolerance**

| Reference Frequency: 13.5600MHz, LIMIT: within ± 1356 Hz | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Environment Temperature | Power Supplied | Carrier Frequency Measured with Time Elapsed | | | | | | | |
| | | STARUP | | 2 minutes | | 5 minutes | | 10 minutes | |
| [°C] | [$V_{AC}$] | [MHZ] | Err [Hz] | [MHZ] | Err [Hz] | [MHZ] | Err [Hz] | [MHZ] | Err [Hz] |
| +50 | 120 | 13.559511 | -489 | 13.559508 | -492 | 13.559507 | -493 | 13.559507 | -493 |
| +40 | 120 | 13.559533 | -467 | 13.559528 | -472 | 13.559525 | -475 | 13.559524 | -476 |
| +30 | 120 | 13.559571 | -429 | 13.559561 | -439 | 13.559558 | -442 | 13.559555 | -445 |
| +20 | 120 | 13.559609 | -391 | 13.559599 | -401 | 13.559596 | -404 | 13.559592 | -408 |
| +10 | 120 | 13.559634 | -366 | 13.559632 | -368 | 13.559632 | -368 | 13.559631 | -369 |
| 0 | 120 | 13.559654 | -346 | 13.559652 | -348 | 13.559651 | -349 | 13.559651 | -349 |
| -10 | 120 | 13.559636 | -364 | 13.559644 | -356 | 13.559646 | -354 | 13.559647 | -353 |
| -20 | 120 | 13.559611 | -389 | 13.559621 | -379 | 13.559628 | -372 | 13.559630 | -370 |

| Reference Frequency: 13.5600MHz, LIMIT: 100 PPM (within ± 1356 Hz) | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Power Supplied | Carrier Frequency Measured with Time Elapsed | | | | | | | |
| | STARUP | | 2 minutes | | 5 minutes | | 10 minutes | |
| [$V_{AC}$] | [MHZ] | Err [Hz] | [MHZ] | Err [Hz] | [MHZ] | Err [Hz] | [MHZ] | Err [Hz] |
| 85 % | 13.559601 | -399 | 13.559585 | -415 | 13.559577 | -423 | 13.559573 | -427 |
| 100 % | 13.559601 | -399 | 13.559585 | -415 | 13.559577 | -423 | 13.559573 | -427 |
| 115 % | 13.559601 | -399 | 13.559585 | -415 | 13.559577 | -423 | 13.559573 | -427 |

**Err [Hz] = Measured carrier frequency (MHz) - Reference Frequency (13.56 MHz)**

# 5.4 CONDUCTED EMISSIONS

## 5.4.1 Regulation

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 50μH/50Ω line impedance stabilization network (LISN). Compliance with the provisions of this paragraph shall be based on the measurement of the radio frequency voltage between each power line and ground at the power terminal. The lower limit applies at the boundary between the frequency ranges.

| Frequency of emission (MHz) | Conducted limit (dBμV) | |
|---|---|---|
| | Qausi-peak | Average |
| 0.15 – 0.5 | 66 to 56 * | 56 to 46 * |
| 0.5 – 5 | 56 | 46 |
| 5 – 30 | 60 | 50 |

* Decreases with the logarithm of the frequency.

According to §15.107(a), for unintentional device, except for Class A digital devices, line conducted emission limits are the same as the above table.

## 5.4.2 Test Procedure

1. The EUT was placed on a wooden table of size, 1 m by 1.5 m, raised 80 cm in which is located 40 cm away from the vertical wall and 1.5m away from the side wall of the shielded room.
2. Each current-carrying conductor of the EUT power cord was individually connected through a 50Ω/50μH LISN, which is an input transducer to a Spectrum Analyzer or an EMI/Field Intensity Meter, to the input power source.
3. Exploratory measurements were made to identify the frequency of the emission that had the highest amplitude relative to the limit by operating the EUT in a range of typical modes of operation, cable position, and with a typical system equipment configuration and arrangement. Based on the exploratory tests of the EUT, the one EUT cable configuration and arrangement and mode of operation that had produced the emission with the highest amplitude relative to the limit was selected for the final measurement.
4. The final test on all current-carrying conductors of all of the power cords to the equipment that comprises the EUT (but not the cords associated with other non-EUT equipment is the system) was then performed over the frequency range of 0.15 MHz to 30 MHz.
5. The measurements were made with the detector set to PEAK amplitude within a bandwidth of 10 kHz or to QUASI-PEAK and AVERAGE within a bandwidth of 9 kHz. The EUT was in transmitting mode during the measurements.

### 5.4.3 Test Results: PASS

The EUT was DIRECTLY powered from the LISN port and the transmitter portion of the EUT, RFID card reader, was powered from the PC.

**TEST MODE: without RFID card (unmodulated)**

**Table 4: Conducted Emissions – DIRECT**

| Frequency [MHz] | Reading [dBμV] | | CF/CL [dB] | Actual [dBμV] | | Limit [dBμV] | | Margin [dB] | |
|---|---|---|---|---|---|---|---|---|---|
| | Qp | Ave | | Qp | Ave | Qp | Ave | Qp | Ave |
| **LINE – PE** | | | | | | | | | |
| 0.18 | 46.68 | --- | 0.08/0.1 | 46.86 | --- | 64.49 | 54.49 | 17.63 | --- |
| 0.24 | 40.54 | --- | 0.08/0.1 | 40.72 | --- | 62.10 | 52.10 | 21.38 | --- |
| 0.30 | 36.50 | --- | 0.08/0.1 | 36.68 | --- | 60.24 | 50.24 | 23.56 | --- |
| 13.56 | 42.14 | --- | 0.61/0.6 | 43.35 | --- | 60.00 | 50.00 | 16.65 | --- |
| 15.37 | 36.24 | --- | 0.67/0.6 | 37.51 | --- | 60.00 | 50.00 | 22.49 | --- |
| 15.43 | 36.71 | --- | 0.67/0.6 | 37.98 | --- | 60.00 | 50.00 | 22.02 | --- |
| 15.61 | 35.88 | --- | 0.70/0.6 | 37.18 | --- | 60.00 | 50.00 | 22.82 | --- |
| 16.14 | 35.80 | --- | 0.70/0.6 | 37.10 | --- | 60.00 | 50.00 | 22.90 | --- |
| | | | | | | | | | |
| | | | | | | | | | |
| | | | | | | | | | |
| **NEUTRAL – PE** | | | | | | | | | |
| 0.18 | 48.61 | --- | 0.13/0.1 | 48.84 | --- | 64.49 | 54.49 | 15.65 | --- |
| 0.24 | 41.06 | --- | 0.13/0.1 | 41.29 | --- | 62.10 | 52.10 | 20.81 | --- |
| 0.30 | 36.91 | --- | 0.14/0.1 | 37.15 | --- | 60.24 | 50.24 | 23.09 | --- |
| 13.56 | 41.82 | --- | 0.47/0.6 | 42.89 | --- | 60.00 | 50.00 | 17.11 | --- |
| 15.43 | 38.24 | --- | 0.50/0.6 | 39.34 | --- | 60.00 | 50.00 | 20.66 | --- |
| 16.02 | 36.30 | --- | 0.52/0.6 | 37.42 | --- | 60.00 | 50.00 | 22.58 | --- |
| 16.08 | 36.24 | --- | 0.52/0.6 | 37.36 | --- | 60.00 | 50.00 | 22.64 | --- |
| 16.14 | 37.33 | --- | 0.52/0.6 | 38.45 | --- | 60.00 | 50.00 | 21.55 | --- |
| 16.26 | 37.13 | --- | 0.52/0.6 | 38.25 | --- | 60.00 | 50.00 | 21.75 | --- |
| | | | | | | | | | |
| | | | | | | | | | |

**Margin (dB) = Limit – Actual**
**[Actual = Reading + CF + CL]**
1. Remark "---" means the level is undetectable or the Qausi-peak value is lower than the limit of Average.
2. CF/CL = Correction Factor and Cable Loss
3. Qp = Quasi-peak, Ave = Average value

NOTE: The frequency range was scanned from 150 kHz to 30 MHz. All emissions not reported were more than 20 dB below the specified limit.

The EUT was DIRECTLY powered from the LISN port and the transmitter portion of the EUT, RFID card reader, was powered from the PC.

**TEST MODE: with RFID card (modulated)**

**Table 4: Conducted Emissions – DIRECT (continued)**

| Frequency [MHz] | Reading [dBμV] | | CF/CL [dB] | Actual [dBμV] | | Limit [dBμV] | | Margin [dB] | |
|---|---|---|---|---|---|---|---|---|---|
| | Qp | Ave | | Qp | Ave | Qp | Ave | Qp | Ave |
| **LINE – PE** | | | | | | | | | |
| 0.18 | 43.74 | --- | 0.08/0.1 | 43.92 | --- | 64.49 | 54.49 | 20.57 | --- |
| 0.24 | 37.67 | --- | 0.08/0.1 | 37.85 | --- | 62.10 | 52.10 | 24.25 | --- |
| 0.30 | 33.66 | --- | 0.08/0.1 | 33.84 | --- | 60.24 | 50.24 | 26.40 | --- |
| 13.56 | 42.26 | --- | 0.61/0.6 | 43.47 | --- | 60.00 | 50.00 | 16.53 | --- |
| 14.83 | 34.13 | --- | 0.67/0.6 | 35.40 | --- | 60.00 | 50.00 | 24.60 | --- |
| 16.02 | 35.78 | --- | 0.70/0.6 | 37.08 | --- | 60.00 | 50.00 | 22.92 | --- |
| 16.08 | 35.92 | --- | 0.70/0.6 | 37.22 | --- | 60.00 | 50.00 | 22.78 | --- |
| 16.14 | 35.60 | --- | 0.70/0.6 | 36.90 | --- | 60.00 | 50.00 | 23.10 | --- |
| 16.32 | 35.68 | --- | 0.70/0.6 | 36.98 | --- | 60.00 | 50.00 | 23.02 | --- |
| | | | | | | | | | |
| | | | | | | | | | |
| **NEUTRAL – PE** | | | | | | | | | |
| 0.18 | 50.17 | --- | 0.13/0. | 50.40 | --- | 64.49 | 54.49 | 14.09 | --- |
| 0.24 | 42.59 | --- | 0.13/0.1 | 42.82 | --- | 62.10 | 52.10 | 19.28 | --- |
| 0.30 | 38.52 | --- | 0.14/0.1 | 38.76 | --- | 60.24 | 50.24 | 21.48 | --- |
| 13.56 | 43.07 | --- | 0.47/0.6 | 44.14 | --- | 60.00 | 50.00 | 15.86 | --- |
| 15.37 | 37.43 | --- | 0.50/0.6 | 38.53 | --- | 60.00 | 50.00 | 21.47 | --- |
| 15.43 | 37.63 | --- | 0.50/0.6 | 38.73 | --- | 60.00 | 50.00 | 21.27 | --- |
| 15.61 | 35.46 | --- | 0.52/0.6 | 36.58 | --- | 60.00 | 50.00 | 23.42 | --- |
| 16.14 | 37.49 | --- | 0.52/0.6 | 38.61 | --- | 60.00 | 50.00 | 21.39 | --- |
| | | | | | | | | | |
| | | | | | | | | | |
| | | | | | | | | | |

**Margin (dB) = Limit – Actual**
**[Actual = Reading + CF + CL]**
1. Remark "---" means the level is undetectable or the Qausi-peak value is lower than the limit of Average.
2. CF/CL = Correction Factor and Cable Loss
3. Qp = Quasi-peak, Ave = Average value

NOTE: The frequency range was scanned from 150 kHz to 30 MHz. All emissions not reported were more than 20 dB below the specified limit.

The transmitter portion of the EUT, RFID card reader, was INDIRECTLY powered from the LISN port (to which the PC was connected).

**TEST MODE: without RFID card (unmodulated)**

**Table 5: Conducted Emissions – INDIRECT**

| Frequency [MHz] | Reading [dBμV] | | CF/CL [dB] | Actual [dBμV] | | Limit [dBμV] | | Margin [dB] | |
|---|---|---|---|---|---|---|---|---|---|
| | Qp | Ave | | Qp | Ave | Qp | Ave | Qp | Ave |
| **LINE – PE** | | | | | | | | | |
| 0.15 | 51.06 | --- | 0.09/0.1 | 51.25 | --- | 66.00 | 56.00 | 14.75 | --- |
| 0.22 | 44.62 | --- | 0.08/0.1 | 44.80 | --- | 62.82 | 52.82 | 18.02 | --- |
| 0.44 | 44.76 | --- | 0.09/0.1 | 44.95 | --- | 57.06 | 47.06 | 12.11 | --- |
| 0.65 | 39.85 | --- | 0.12/0.1 | 40.07 | --- | 56.00 | 46.00 | 15.93 | --- |
| 1.16 | 39.53 | --- | 0.11/0.1 | 39.74 | --- | 56.00 | 46.00 | 16.26 | --- |
| 2.57 | 38.55 | --- | 0.15/0.3 | 39.00 | --- | 56.00 | 46.00 | 17.00 | --- |
| 2.64 | 39.59 | --- | 0.15/0.3 | 40.04 | --- | 56.00 | 46.00 | 15.96 | --- |
| 2.71 | 39.18 | --- | 0.15/0.3 | 39.63 | --- | 56.00 | 46.00 | 16.37 | --- |
| 5.43 | 34.20 | --- | 0.24/0.4 | 34.84 | --- | 60.00 | 50.00 | 25.16 | --- |
| 13.56 | 38.36 | --- | 0.61/0.6 | 39.57 | --- | 60.00 | 50.00 | 20.43 | --- |
| | | | | | | | | | |
| **NEUTRAL – PE** | | | | | | | | | |
| 0.15 | 49.19 | --- | 0.13/0.1 | 49.42 | --- | 66.00 | 56.00 | 16.58 | --- |
| 0.22 | 45.90 | --- | 0.13/0.1 | 46.13 | --- | 62.82 | 52.82 | 16.69 | --- |
| 0.44 | 45.40 | --- | 0.15/0.1 | 45.65 | --- | 57.06 | 47.06 | 11.41 | --- |
| 0.66 | 38.93 | --- | 0.15/0.1 | 39.18 | --- | 56.00 | 46.00 | 16.82 | --- |
| 1.16 | 39.53 | --- | 0.15/0.1 | 39.78 | --- | 56.00 | 46.00 | 16.22 | --- |
| 2.57 | 37.93 | --- | 0.18/0.3 | 38.41 | --- | 56.00 | 46.00 | 17.59 | --- |
| 2.64 | 39.19 | --- | 0.18/0.3 | 39.67 | --- | 56.00 | 46.00 | 16.33 | --- |
| 2.71 | 39.11 | --- | 0.19/0.3 | 39.60 | --- | 56.00 | 46.00 | 16.60 | --- |
| 5.43 | 33.36 | --- | 0.25/0.4 | 34.01 | --- | 60.00 | 50.00 | 25.99 | --- |
| 13.56 | 38.22 | --- | 0.47/0.6 | 39.29 | --- | 60.00 | 50.00 | 20.71 | --- |
| | | | | | | | | | |

**Margin (dB) = Limit – Actual**
**[Actual = Reading + CF + CL]**

1. Remark "---" means the level is undetectable or the Qausi-peak value is lower than the limit of Average.
2. CF/CL = Correction Factor and Cable Loss
3. Qp = Quasi-peak, Ave = Average value

NOTE: The frequency range was scanned from 150 kHz to 30 MHz. All emissions not reported were more than 20 dB below the specified limit.

The transmitter portion of the EUT, RFID card reader, was INDIRECTLY powered from the LISN port (to which the PC was connected).

**TEST MODE: with RFID card (modulated)**

**Table 5: Conducted Emissions – INDIRECT (continued)**

| Frequency [MHz] | Reading [dBμV] | | CF/CL [dB] | Actual [dBμV] | | Limit [dBμV] | | Margin [dB] | |
|---|---|---|---|---|---|---|---|---|---|
| | Qp | Ave | | Qp | Ave | Qp | Ave | Qp | Ave |
| **LINE – PE** | | | | | | | | | |
| 0.15 | 43.01 | --- | 0.09/0.1 | 43.20 | --- | 66.00 | 56.00 | 22.80 | --- |
| 0.22 | 36.01 | --- | 0.08/0.1 | 36.19 | --- | 62.82 | 52.82 | 26.63 | --- |
| 0.44 | 38.43 | --- | 0.09/0.1 | 38.62 | --- | 57.06 | 47.06 | 18.44 | --- |
| 0.66 | 35.00 | --- | 0.12/0.1 | 35.22 | --- | 56.00 | 46.00 | 20.78 | --- |
| 1.16 | 32.35 | --- | 0.11/0.1 | 32.56 | --- | 56.00 | 46.00 | 23.44 | --- |
| 2.57 | 29.70 | --- | 0.15/0.3 | 30.15 | --- | 56.00 | 46.00 | 25.85 | --- |
| 2.64 | 31.34 | --- | 0.15/0.3 | 31.79 | --- | 56.00 | 46.00 | 24.21 | --- |
| 2.71 | 31.49 | --- | 0.15/0.4 | 32.04 | --- | 56.00 | 46.00 | 23.96 | --- |
| 13.56 | 38.73 | --- | 0.61/0.6 | 39.94 | --- | 60.00 | 50.00 | 20.06 | --- |
| 16.39 | 35.53 | --- | 0.70/0.6 | 36.83 | --- | 60.00 | 50.00 | 23.17 | --- |
| | | | | | | | | | |
| **NEUTRAL – PE** | | | | | | | | | |
| 0.15 | 44.36 | --- | 0.13/0.1 | 44.59 | --- | 66.00 | 56.00 | 21.41 | --- |
| 0.22 | 41.23 | --- | 0.13/0.1 | 41.46 | --- | 62.82 | 52.82 | 21.36 | --- |
| 0.44 | 41.88 | --- | 0.15/0.1 | 42.13 | --- | 57.06 | 47.06 | 14.93 | --- |
| 0.66 | 37.44 | --- | 0.15/0.1 | 37.69 | --- | 56.00 | 46.00 | 18.31 | --- |
| 1.16 | 35.62 | --- | 0.15/0.1 | 35.87 | --- | 56.00 | 46.00 | 20.13 | --- |
| 2.57 | 32.99 | --- | 0.18/0.3 | 33.47 | --- | 56.00 | 46.00 | 22.53 | --- |
| 2.64 | 34.43 | --- | 0.18/0.3 | 34.91 | --- | 56.00 | 46.00 | 21.09 | --- |
| 2.71 | 34.72 | --- | 0.19/0.3 | 35.21 | --- | 56.00 | 46.00 | 20.79 | --- |
| 13.56 | 37.96 | --- | 0.47/0.6 | 39.03 | --- | 60.00 | 50.00 | 20.97 | --- |
| | | | | | | | | | |
| | | | | | | | | | |

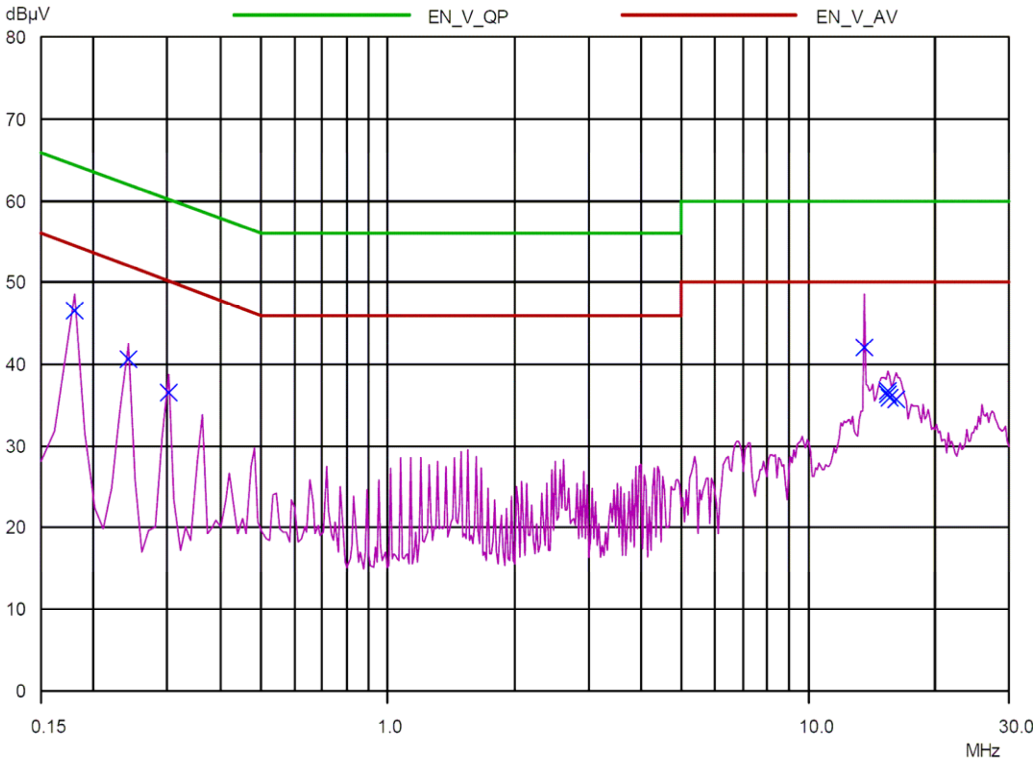
**Margin (dB) = Limit – Actual**
**[Actual = Reading + CF + CL]**

1. Remark "---" means the level is undetectable or the Qausi-peak value is lower than the limit of Average.
2. CF/CL = Correction Factor and Cable Loss
3. Qp = Quasi-peak, Ave = Average value

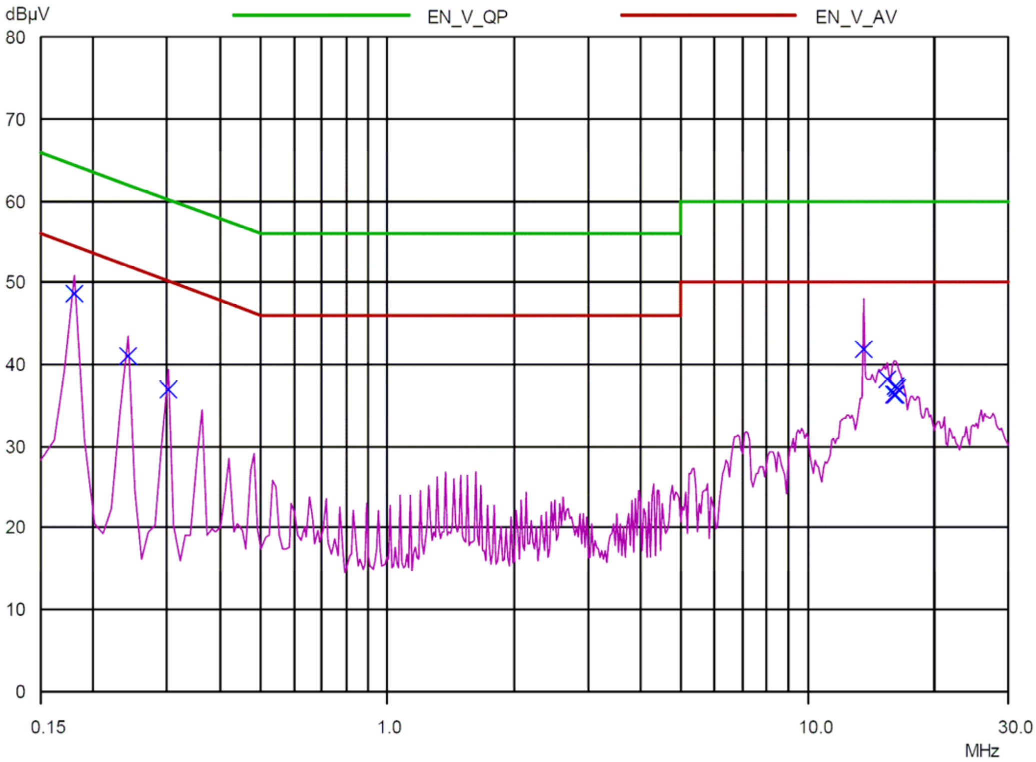
NOTE: The frequency range was scanned from 150 kHz to 30 MHz. All emissions not reported were more than 20 dB below the specified limit.

## Figure 2. Plot of the Conducted Emissions – DIRECT without RFID card (unmodulated)

### Line – PE (Quasi-Peak reading)

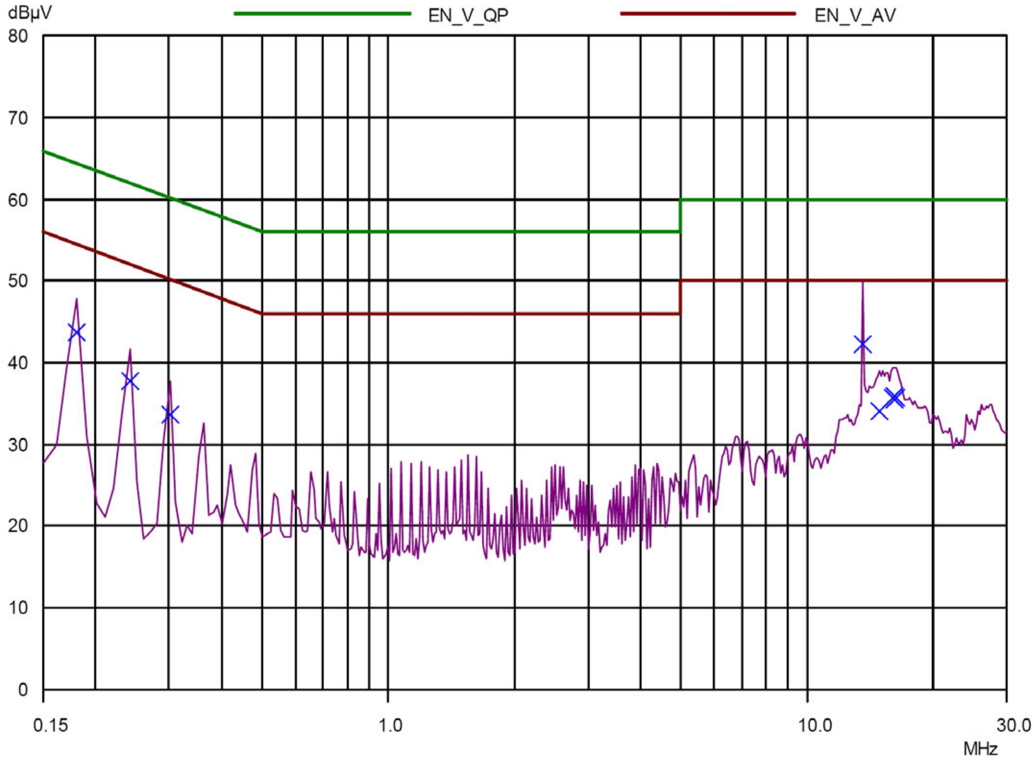



### Neutral – PE (Quasi-Peak reading)

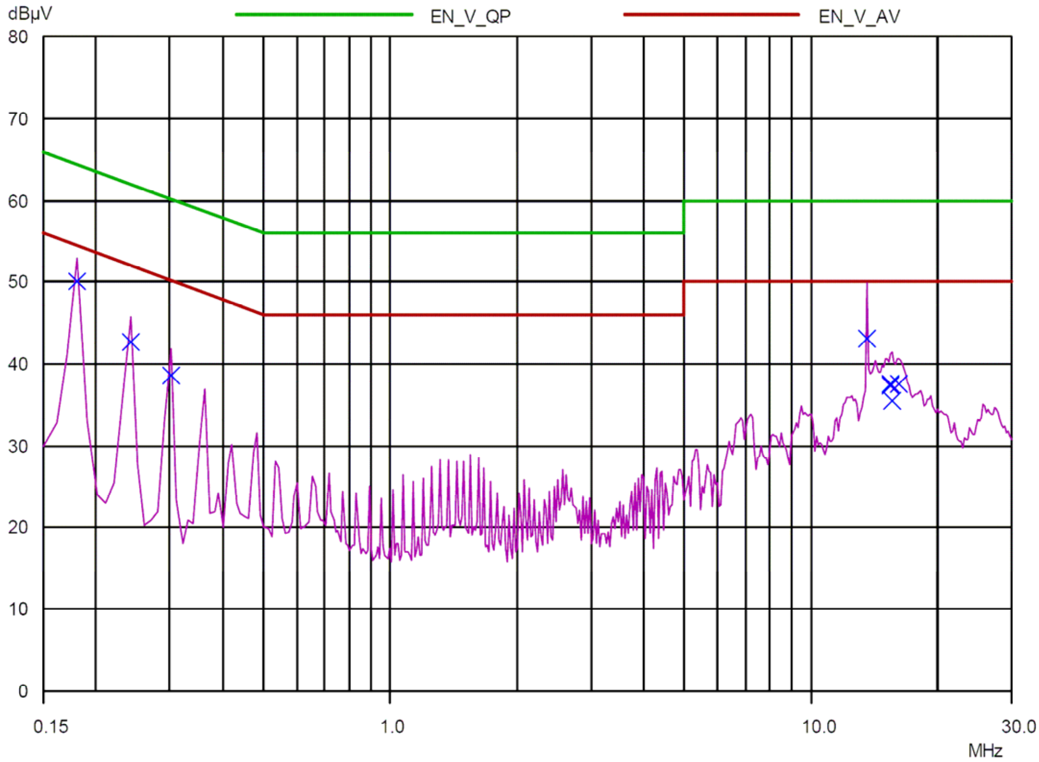


## Figure 2. Plot of the Conducted Emissions – DIRECT (Continued) with RFID card (modulated)

### Line – PE (Quasi-Peak reading)

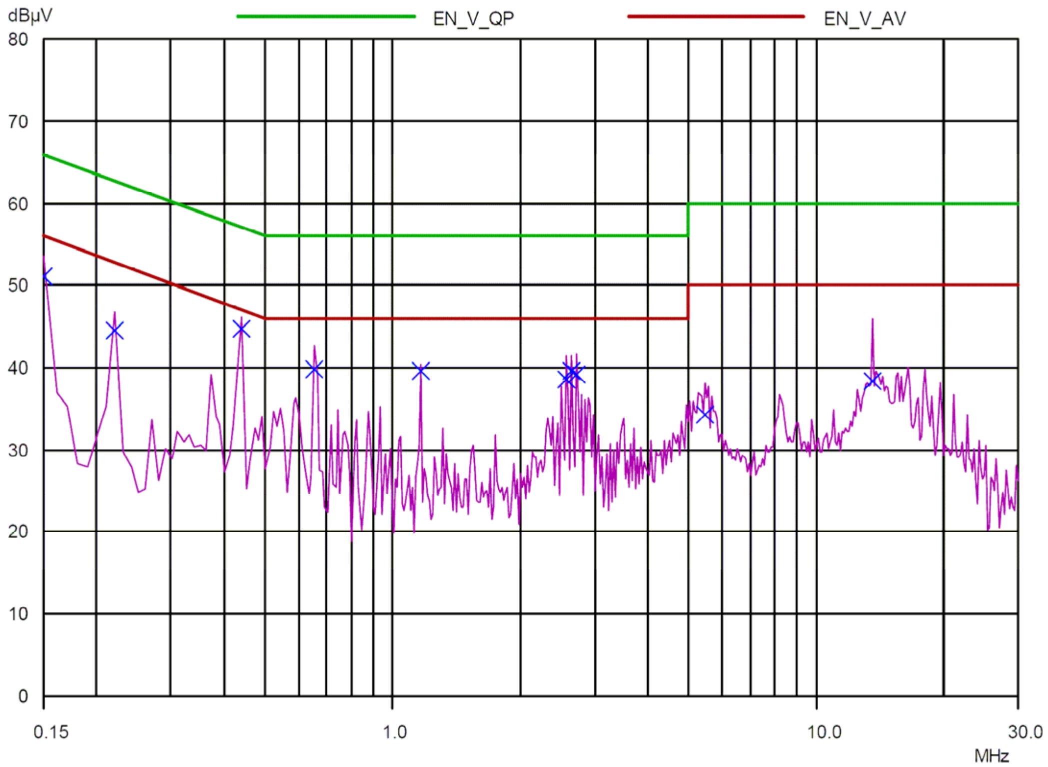



### Neutral – PE (Quasi-Peak reading)

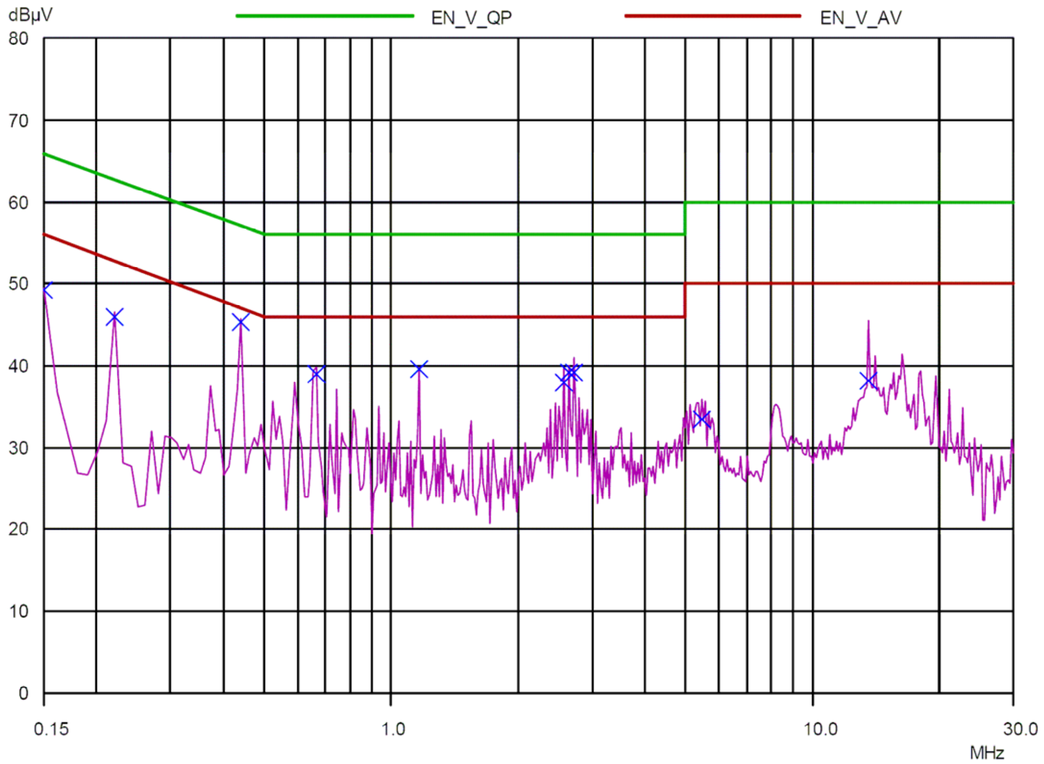


## Figure 3. Plot of the Conducted Emissions - INDIRECT without RFID card (unmodulated)

### Line – PE (Quasi-Peak reading)

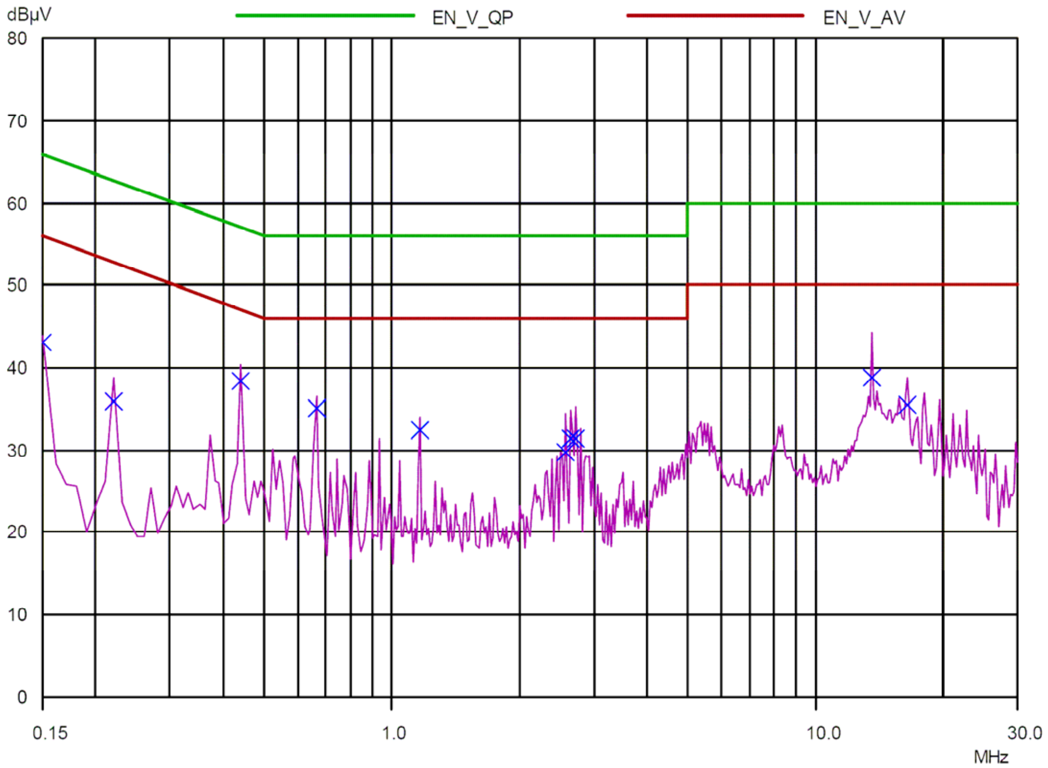



### Neutral – PE (Quasi-Peak reading)



## Figure 3. Plot of the Conducted Emissions – INDIRECT (Continued) with RFID card (modulated)

**Line – PE (Quasi-Peak reading)**




**Neutral – PE (Quasi-Peak reading)**