# FCC RF TEST REPORT

**Test Laboratory:**
**SK Tech Co., Ltd.**
820-2, Wolmoon-ri, Wabu-up,
Namyangju-si, Kyunggi-do
472-905 South Korea
TEL: +82-31-576-2204
FAX: +82-31-576-2205

**Test Report Number: SKTRFC-130612-008**

**Date of issue: June 12, 2013**

| | |
|---|---|
| **Applicant:** | **DUALi Inc.**<br>1-309 Innoplex, 552 Woncheon-dong, Youngtong-gu, Suwon, Gyeonggi-do<br>South Korea |
| **Manufacturer:** | **DUALi Inc.**<br>1-309 Innoplex, 552 Woncheon-dong, Youngtong-gu, Suwon, Gyeonggi-do<br>South Korea |
| **Product:** | SMART CARD READER |
| **Model:** | **DE-950**<br>(please see P5 for all the model numbers) |
| **FCC ID:** | **SWUDE-950** |
| **File number:** | SKTEU13-0007 |
| **EUT received:** | January 3, 2013 |
| **Applied standards:** | ANSI C63.10-2009 and ANSI C63.4-2009 |
| **Rule parts:** | FCC Part 15 Subpart C - Intentional radiators |
| **Equipment Class:** | DXT - Part 15 Low Power Transceiver, Rx Verified |
| **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.

Jungtae Kim / **Testing Engineer**

Jongsoo Yoon / **Technical Manager**

# Revision History of Report

| Rev. | Revisions | Effect page | Reviewed by | Date |
|---|---|---|---|---|
| - | Initial issue | All | Jongsoo Yoon | June 12, 2013 |

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# 1 Summary of test results

| Requirement | CFR 47 Section | Result |
|---|---|---|
| Antenna Requirement | 15.203 | Meets the requirements |
| Radiated Emissions<br>Field Strength within the band<br>13.553-13.567 MHz | 15.225(a) | Meets the requirements |
| 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) | Meets the requirements |
| Radiated Harmonics and Spurious<br>Emissions Outside of the 13.110 – 14.010 MHz | 15.225(d)<br>15.209(a) | Meets the requirements |
| Frequency Tolerance of Carrier Signal | 15.225(e) | Meets the requirements |
| AC power line Conducted emissions | 15.207(a) | Meets the requirements |

Note: -

## 2 Description of equipment under test (EUT)

| | |
|---|---|
| Product: | SMART CARD READER |
| Model: | DE-950 |
| Serial number: | None (prototype) |

**Model differences:**

| Model name | Difference | Tested (checked) |
|---|---|---|
| DE-950 | Original | ☒ |
| | | |

Note: *All the differences were compared with the test sample.*

**Technical data:**

| | |
|---|---|
| Power source | DC 12 V (from AC/DC Adapter) |
| Local Oscillator or X-Tal | 27.12 MHz |
| Transmit Frequency | 13.56 MHz |
| Antenna Type | Internal PCB antenna (80 × 36 mm, 1-turns) |
| Type of Modulation | ASK |
| External Ports | RS-232 interface for DATA communication with a host device |

| I/O port | Type | Q'ty | Remark |
|---|---|---|---|
| RS-232 interface | For DATA communication with a PC | 1 | - |
| | | | |
| | | | |

Note: The equipment authorization for FCC Part 15B a separate test report number.

**Equipment Modifications**

none

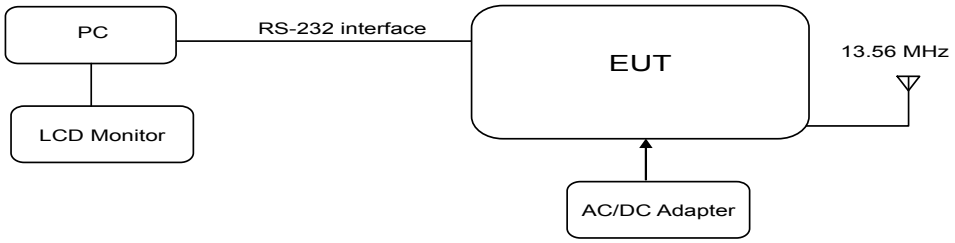
**Submitted Documents**

Block diagram
Schematic diagram
Antenna Specification
Part List
User manual

# 3 Test and measurement conditions

## 3.1. Test configuration (arrangement of EUT)

The EUT was transmitting RF signals continuously while the RS-232 cable was connected to PC.
Test software used: DualCard.exe, Ver2.8 (Card Reader Test Program)




## 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 | PC | Samsung Electronics Co., Ltd. | DM-V50 | 371F97BA100188D |
| 2 | LCD Monitor | LC Electronics Nanjing Display Co., Ltd | L1954TQS | 903NDYG4J122 |
| 3 | AC/DC Adapter | Ningbo ISO Electronics Co., Ltd. | PAA040F | D09-D0711 |
| 4 | RFID Cards | N/A | N/A | N/A |

## 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 | RS-232 | PC | RS-232 | 0.5 | N |
| 2 | EUT | DC IN | AC/DC Adapter | DC OUT | 0.5 | N (w/ ferrite core) |
| 3 | AC/DC Adapter | AC IN | AC mains | AC mains | 1.7 | N |
| 4 | PC | AC IN | AC mains | AC mains | 1.7 | N |
| 5 | LCD Monitor | AC IN | AC mains | AC mains | 1.7 | N |

Note: *1) All the equipment/cables were placed in the worst-case configuration to maximize the emission during the test.*
*2) Grounding was established in accordance with the manufacturer's requirements and conditions for the intended use.*

## 3.4. Measurement Uncertainty (*U*)

| Measurement Item | Combined Standard Uncertainty *Uc* | Expanded Uncertainty $U = k \times Uc$ ($k = 2$) |
|---|---|---|
| Conducted RF power | ±1.49 dB | ±2.98 dB |
| Radiated disturbance | ±2.30 dB | ±4.60 dB |
| Conducted disturbance | ±1.96 dB | ±3.92 dB |

## 3.5. Test date

| | |
|---|---|
| Date Tested | April 25, 2013 – May 7, 2013 |

# 4 Facilities and accreditations

## 4.1. Facilities

All of the measurements described in this report were performed at SK Tech Co., Ltd
Site I: 820-2, Wolmoon-ri, Wabu-up, Namyangju-si, Kyunggi-do, Korea
Site II: 688-8, Wolmoon-ri, Wabu-up, Namyangju-si, Kyunggi-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 Declaration of Conformity (DOC) 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 | Spectrum Analyzer | Agilent | E4405B | US40520856 | 2014.03.07 | ☒ |
| 2 | Spectrum Analyzer | Agilent | E4440A | MY46186322 | 2014.03.18 | ☒ |
| 3 | EMC Spectrum Analyzer | Agilent | E7405A | US40240203 | 2013.07.09 | |
| 4 | EMI Test Receiver | Rohde&Schwarz | ESPI7 | 101206 | 2013.07.10 | ☒ |
| 5 | EMI Test Receiver | Rohde&Schwarz | ESHS10 | 835871/002 | 2013.09.18 | ☒ |
| 6 | Artificial Mains Network | Rohde&Schwarz | ESH3-Z5 | 834549/011 | 2013.07.09 | ☒ |
| 7 | Pre-amplifier | HP | 8447F | 3113A05153 | 2013.07.10 | ☒ |
| 8 | Pre-amplifier | MITEQ | AFS44 | 1116321 | 2013.12.15 | |
| 9 | Pre-amplifier | MITEQ | AFS44 | 1116322 | 2014.03.08 | |
| 10 | Power Meter | Agilent | E4417A | MY45100426 | 2013.07.10 | |
| 11 | Power Meter | Agilent | E4418B | US39402176 | 2013.07.10 | |
| 12 | Power Sensor | Agilent | E9327A | MY44420696 | 2013.07.10 | |
| 13 | Power Sensor | Agilent | 8485A | 3318A13916 | 2013.07.10 | |
| 14 | Attenuator (10dB) | HP | 8491B | 38072 | 2013.07.09 | |
| 15 | High Pass Filter | Wainwright | WHKX3.0/18G | 8 | 2013.07.09 | |
| 16 | VHF Precision Dipole Antenna (TX/RX) | Schwarzbeck | VHAP | 1014 / 1015 | 2013.10.04 | |
| 17 | UHF Precision Dipole Antenna (TX/RX) | Schwarzbeck | UHAP | 989 / 990 | 2013.10.04 | |
| 18 | Loop Antenna | Schwarzbeck | HFH2-Z2 | 863048/019 | 2013.12.22 | ☒ |
| 19 | TRILOG Broadband Antenna | Schwarzbeck | VULB9168 | 189 | 2014.05.21 | ☒ |
| 20 | Horn Antenna | AH Systems | SAS-200/571 | 304 | N/A | |
| 21 | Horn Antenna | EMCO | 3115 | 00040723 | 2014.03.26 | |
| 22 | Horn Antenna | EMCO | 3115 | 00056768 | 2013.08.13 | |
| 23 | Horn Antenna | Schwarzbeck | BBHA9170 | BBHA9170318 | 2013.09.28 | |
| 24 | Vector Signal Generator | Agilent | E4438C | MY42080359 | 2013.07.10 | |
| 25 | PSG analog signal generator | Agilent | E8257D-520 | MY45141255 | 2013.07.10 | |
| 26 | DC Power Supply | HP | 6622A | 3348A03223 | 2013.07.10 | |
| 27 | Hygro/Thermo Graph | SATO | PC-5000TRH-II | - | 2013.07.18 | ☒ |
| 28 | Temperature/Humidity Chamber | All Three | ATM-50M | 20030425 | 2014.03.08 | ☒ |

# 5 Test and measurements

## 5.1. Antenna requirement

### 5.1.1 Regulation

FCC section 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 Part 15C. The manufacturer may design the unit so that the user can replace a broken antenna, 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 EUT has an integral PCB loop antenna, 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 |

* 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

**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 1 meter or 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, above 30 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.
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 EUT is situated in three orthogonal planes (if appropriate)
7. 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) = -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: Field strength below 30 MHz**

| Frequency [MHz] | RBW [kHz] | Reading [dB(μV/m)] | Cable Loss [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 0 | 9 | 61.76 | 0.3 | 62.06 | 124.0 | 61.94 |
| 13.348 0 | 9 | --- | 0.3 | --- | 80.5 | --- |
| 13.484 0 | 9 | --- | 0.3 | --- | 90.5 | --- |
| 13.635 7 | 9 | --- | 0.3 | --- | 90.5 | --- |
| 13.772 8 | 9 | --- | 0.3 | --- | 80.5 | --- |
| **Emissions Quasi-peak DATA under 15.225(d), 15.209** | | | | | | |
| 27.12 | 9 | --- | 0.3 | --- | 69.5 | --- |
| | | | | | | |
| | | | | | | |

**Actual (dBμV/m) = Reading + Cable Loss**
**Margin (dB) = Limit – Actual**
NOTE: These test results were measured at the 3 m distance.
Remark:"---" means the emission level was too low to be measured or in the noise floor.

**Table 2: Measured values of the Field strength (above 30 MHz)**

| Frequency [MHz] | RBW [kHz] | POL [V/H] | ANT [m] | Reading [dBμV] | AMP [dB] | AF [dB/m] | CL [dB] | Actual [dBμV/m] | Limit [dBμV/m] | Margin [dB] |
|---|---|---|---|---|---|---|---|---|---|---|
| 40.68 | 120 | H | 2.57 | 47.88 | 27.64 | 12.66 | 0.77 | 33.67 | 40.00 | 6.33 |
| 40.68 | 120 | V | 1.00 | 52.14 | 27.64 | 12.66 | 0.77 | 37.93 | 40.00 | 2.07** |
| 311.05 | 120 | H | 1.24 | 45.76 | 26.79 | 14.03 | 2.03 | 35.03 | 46.00 | 10.97 |
| 311.05 | 120 | V | 1.00 | 41.05 | 26.79 | 14.03 | 2.03 | 30.32 | 46.00 | 15.68 |
| 338.95 | 120 | H | 1.00 | 46.73 | 26.93 | 14.52 | 2.14 | 36.46 | 46.00 | 9.54 |
| 338.95 | 120 | V | 1.10 | 40.87 | 26.93 | 14.52 | 2.14 | 30.60 | 46.00 | 15.40 |
| 447.00 | 120 | H | 1.30 | 41.20 | 27.83 | 16.58 | 2.48 | 32.43 | 46.00 | 13.57 |
| 447.00 | 120 | V | 1.00 | 38.51 | 27.83 | 16.58 | 2.48 | 29.74 | 46.00 | 16.26 |
| 474.57 | 120 | H | 1.20 | 40.48 | 28.04 | 17.16 | 2.56 | 32.16 | 46.00 | 13.84 |
| 474.57 | 120 | V | 1.00 | 39.29 | 28.04 | 17.16 | 2.56 | 30.97 | 46.00 | 15.03 |

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

** The measured result is within the test standard limit by a margin less than the measurement uncertainty; it is therefore not possible to state compliance based on the 95 % level of confidence. However, the result indicates that compliance is more probable than non-compliance.

NOTE: 1. All emissions not reported were more than 20 dB below the specified limit or in the noise floor.
2. These test results measured at the 3 m distance.

**Figure 1.** **Plot of the Band edge** (Preliminary measurement in the anechoic chamber at 3 m distance to find out the frequencies, at which the spurious emissions occur, with the peak detector function)

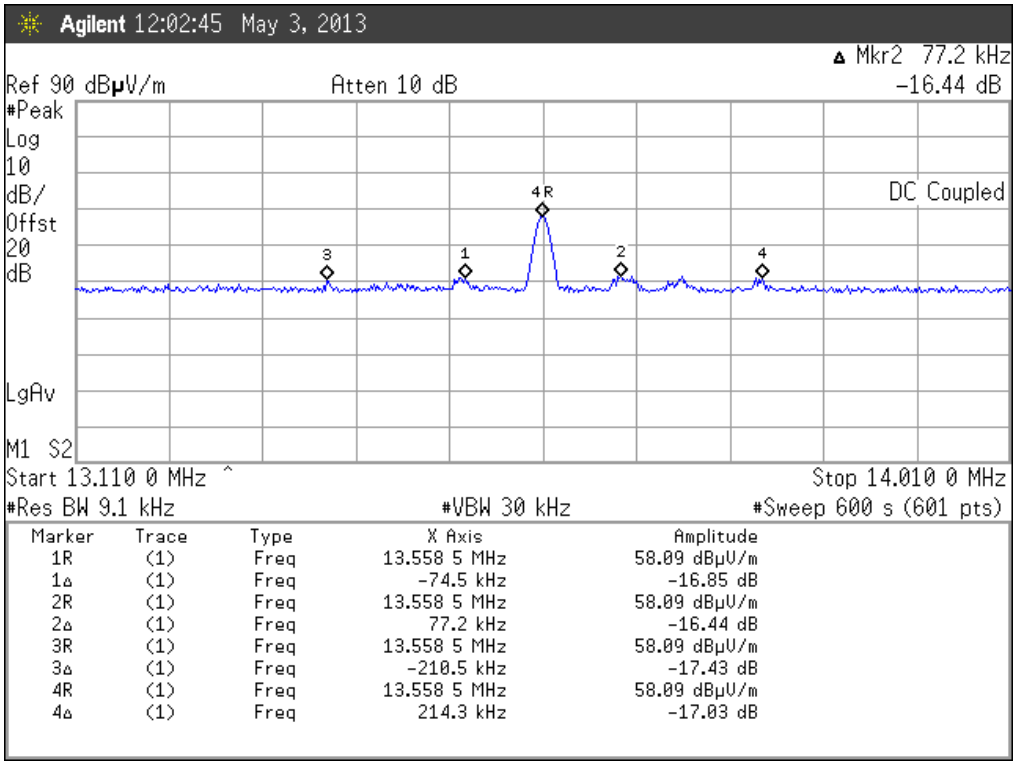
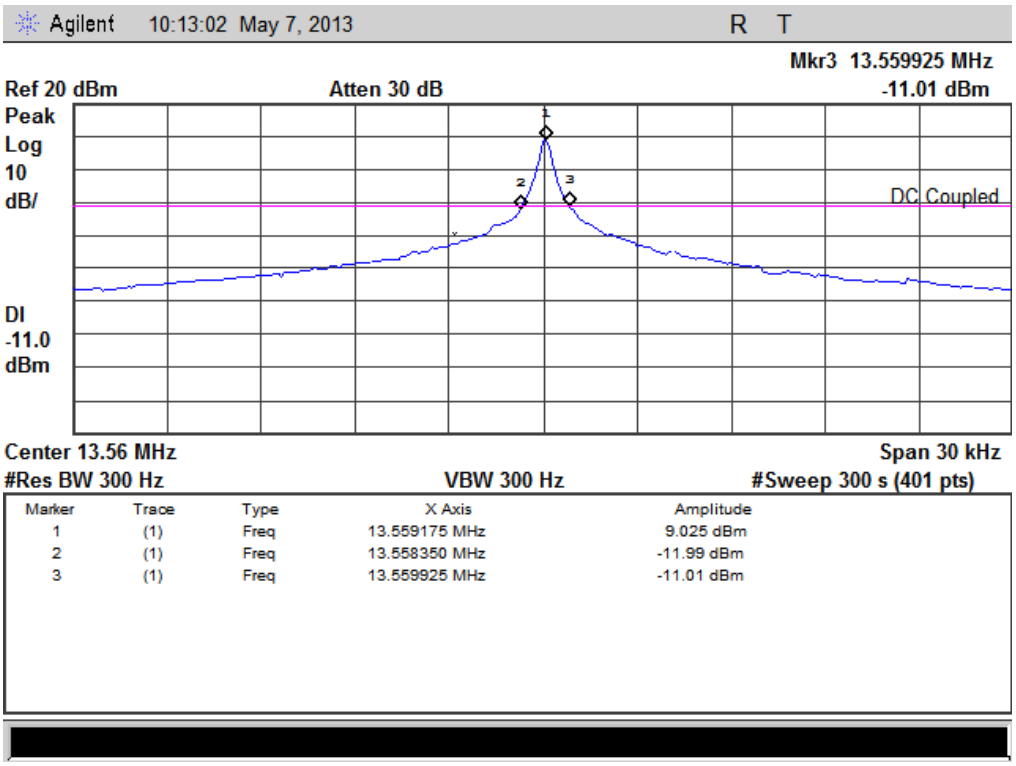



**Figure 2.** **Plot of the 20 dB bandwidth**



## 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 Regulation

**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**

**Table 3: Frequency Tolerance**

| Reference Frequency: 13.5600MHz, LIMIT: within ± 1 356 Hz | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Environment Temperature [°C] | Power Supplied [$V_{AC}$] | Carrier Frequency Measured with Time Elapsed | | | | | | | |
| | | STARUP | | 2 minutes | | 5 minutes | | 10 minutes | |
| | | [MHZ] | Err [Hz] | [MHZ] | Err [Hz] | [MHZ] | Err [Hz] | [MHZ] | Err [Hz] |
| +50 | 120 | 13.559115 | -885 | 13.559121 | -879 | 13.559131 | -869 | 13.559143 | -857 |
| +40 | 120 | 13.559107 | -893 | 13.559106 | -894 | 13.559107 | -893 | 13.559111 | -889 |
| +30 | 120 | 13.559119 | -881 | 13.559113 | -887 | 13.559110 | -890 | 13.559108 | -892 |
| +20 | 120 | 13.559147 | -853 | 13.559143 | -857 | 13.559127 | -873 | 13.559123 | -877 |
| +10 | 120 | 13.559178 | -822 | 13.559171 | -829 | 13.559158 | -842 | 13.559151 | -849 |
| 0 | 120 | 13.559229 | -771 | 13.559213 | -787 | 13.559196 | -804 | 13.559188 | -812 |
| -10 | 120 | 13.559216 | -784 | 13.559213 | -787 | 13.559208 | -792 | 13.559204 | -796 |
| -20 | 120 | 13.559192 | -808 | 13.559201 | -799 | 13.559210 | -790 | 13.559216 | -784 |

| Reference Frequency: 13.5600MHz, LIMIT: within ± 1 356 Hz | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Power Supplied [$V_{AC}$] | Carrier Frequency Measured with Time Elapsed | | | | | | | |
| | STARUP | | 2 minutes | | 5 minutes | | 10 minutes | |
| | [MHZ] | Err [Hz] | [MHZ] | Err [Hz] | [MHZ] | Err [Hz] | [MHZ] | Err [Hz] |
| 85 % | 13.559147 | -853 | 13.559144 | -856 | 13.559126 | -874 | 13.559122 | -878 |
| 100 % | 13.559147 | -853 | 13.559143 | -857 | 13.559127 | -873 | 13.559123 | -877 |
| 115 % | 13.559146 | -854 | 13.559143 | -857 | 13.559125 | -875 | 13.559124 | -876 |

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

## 5.4. AC power line Conducted emissions

### 5.4.1 Regulation

FCC 47CFR15 – 15.207(a)

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.

### 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**

**Table 4: Measured values of the Conducted Emissions**

| Frequency [MHz] | Reading [dBμV] | L / N | CF [dB] | CL [dB] | Actual [dBμV] | Limit [dBμV] | Margin [dB] |
|---|---|---|---|---|---|---|---|
| **QUASI-PEAK DATA** | | | | | | | |
| 0.180 | 43.67 | L | 0.10 | 0.01 | 43.78 | 64.49 | 20.71 |
| 0.240 | 36.77 | L | 0.10 | 0.01 | 36.88 | 62.10 | 25.22 |
| 0.300 | 30.81 | L | 0.12 | 0.01 | 30.94 | 60.24 | 29.30 |
| 0.415 | 31.07 | L | 0.12 | 0.01 | 31.20 | 57.55 | 26.35 |
| 1.135 | 30.37 | N | 0.15 | 0.05 | 30.57 | 56.00 | 25.43 |
| 12.245 | 26.02 | N | 0.31 | 0.19 | 26.52 | 60.00 | 33.48 |
| 13.560 | 43.15 | L | 0.39 | 0.20 | 43.74 | 60.00 | 16.26 |
| 26.870 | 26.17 | N | 0.72 | 0.30 | 27.19 | 60.00 | 32.81 |
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| **AVERAGE DATA** | | | | | | | |
| 0.180 | 35.57 | L | 0.10 | 0.01 | 35.68 | 54.49 | 18.81 |
| 0.240 | 29.75 | L | 0.10 | 0.01 | 29.86 | 52.10 | 22.24 |
| 0.300 | 22.66 | L | 0.12 | 0.01 | 22.79 | 50.24 | 27.45 |
| 0.415 | 26.34 | L | 0.12 | 0.01 | 26.47 | 47.55 | 21.08 |
| 1.135 | 25.61 | N | 0.15 | 0.05 | 25.81 | 46.00 | 20.19 |
| 12.245 | 21.39 | N | 0.31 | 0.19 | 21.89 | 50.00 | 28.11 |
| 13.560 | 42.91 | L | 0.39 | 0.20 | 43.50 | 50.00 | 6.50 |
| 26.870 | 25.36 | N | 0.72 | 0.30 | 26.38 | 50.00 | 23.62 |
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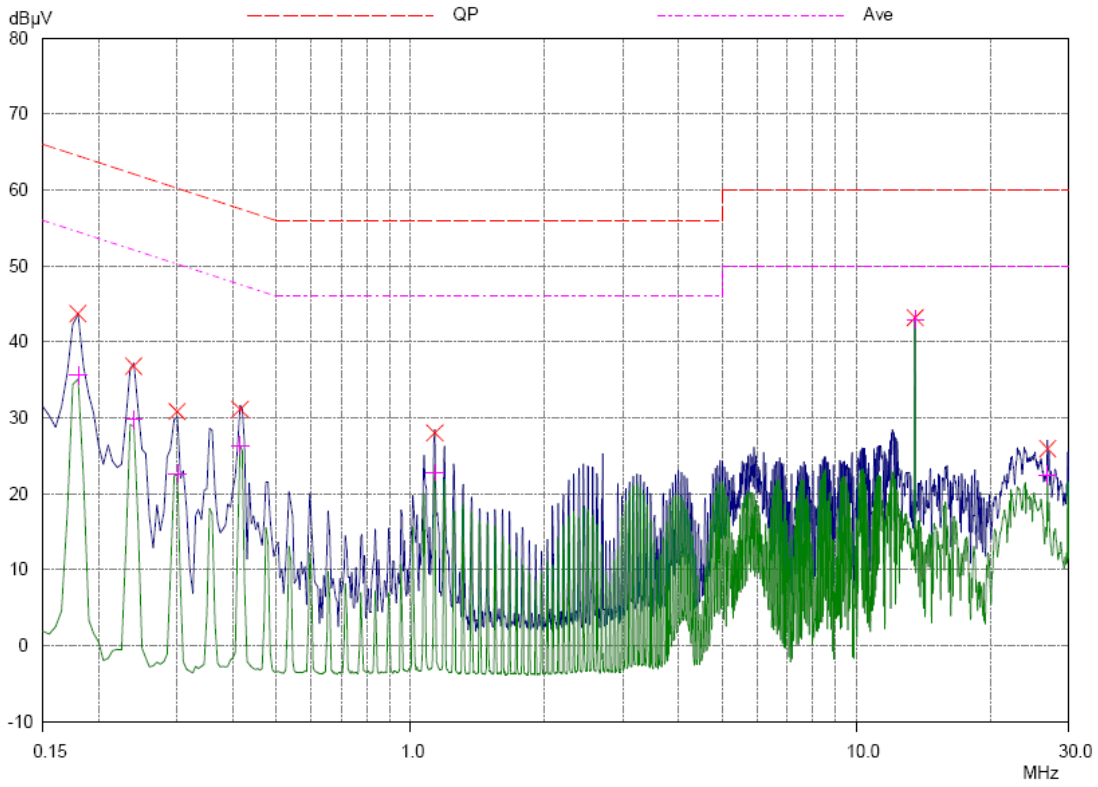
**Margin (dB) = Limit – Actual**
**[Actual = Reading + CF + CL]**
L/N = LINE / NEUTRAL
CF/CL = Correction Factor and Cable Loss

NOTE: All emissions not reported were more than 20 dB below the specified limit.

**Figure 3. Plot of the Conducted Emissions**
**Line – PE (Peak and Average detector used)**




**Neutral – PE (Peak and Average detector used)**