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Electrical

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# ELECTROMAGNETIC EMISSION TEST REPORT

**ACCORDING TO 47CFR part 15, subpart C §15.225 and subpart B**
**for**

## On Track Innovations Ltd.

**EQUIPMENT UNDER TEST:**

## Contactless card reader
## Model: SCIBA-2





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# Contents

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# 1 Project information

## EUT attributes

| | |
|---|---|
| Test items | Contactless card reader |
| Manufacturer | On Track Innovations Ltd. |
| Types (Models) | SCIBA-2 |
| Equipment FCC code | DXX |

## Applicant information

| | |
|---|---|
| Applicant's responsible person | Mr. Hemy Itay, VP of Hardware Engineering |
| Company | On Track Innovations Ltd. |
| Address | Z.H.R. industrial zone, P.O.B. 32 |
| City | Rosh Pina |
| Postal code | 12000 |
| Country | Israel |
| Telephone number | +972 4686 8000 |
| Telefax number | +972 4693 8887 |

## Test details

| | |
|---|---|
| Project Number: | 15845 |
| Location | Hermon Laboratories |
| Receipt date | March 7, 2004 |
| Test performed | March 7, 8, 2004 |
| Purpose of test | Apparatus compliance verification in accordance with emission requirements |
| Test specification(s) | 47CFR Part 15, §15.225 and subpart B |

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# 2 Summary of tests and signatures

The tests listed in the table below were performed.
The EUT was found complying with the limits of 47CFR Part 15, §15.225 and subpart B.

| Test description | Specification reference | Tested by | Date tested | Test report paragraph | Verdict |
|---|---|---|---|---|---|
| **Transmitter parameters** | | | | | |
| Field strength of emission within the assigned band | 15.225 (a) | Mr. Y. Neuman, test engineer | March 7, 2004 | 4.1 | Pass |
| Out of band spurious emissions (radiated) | 15.225 (b), (c), (d) | Mr. Y. Neuman, test engineer | March 7, 2004 | 4.2 | Pass |
| Frequency tolerance of carrier signal | 15.225 (e) | Mr. Y. Neuman, test engineer | March 7, 2004 | 4.3 | Pass |
| **Unintentional radiation** | | | | | |
| Radiated emissions | 15.109 | Mr. Y. Neuman, test engineer | March 7, 2004 | 4.4 | Pass |
| Conducted emissions | 15.207, 15.107 | Mr. B. Efros, test engineer | March 8, 2004 | 4.5 | Pass |

**Test report prepared by:**

Mrs. M. Cherniavsky, MScEE, certification engineer

**Test report approved by:**

Mr. Michael Nikishin, MScEE, group leader

Mr. Edward Usoskin, PhD, C.E.O.

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# 3 EUT description

## 3.1 General description

The EUT is a contactless card reader, operating according to ISO14443 standard. It comprises a microprocessor controlled transceiver with two antenna RF channels, driving a small loop antenna at 13.56 MHz via a 50 Ohm coaxial cable. The magnetic field loop supplies power to a card, which establishes connection by load amplitude modulation at card reader antenna.
The EUT is connected to a computer via USB port and is powered from mains via AC / DC adaptor.

## 3.2 EUT test configuration

The EUT ports and lines description is given in Table 3.2.1, support/test equipment list is provided in Table 3.2.2, operating frequencies – in Table 3.2.3, the test configuration is provided in Figure 3.2.1.

**Table 3.2.1**

**EUT ports and lines**

| Port type | Port description | Connected | | Connector type | Qty. | Cable type | Cable Length, m | Indoor / outdoor |
|---|---|---|---|---|---|---|---|---|
| | | From | To | | | | | |
| Signal | RS232 | Not in use | | RJ-45 | 1 | NA | NA | NA |
| Signal | USB | EUT | PC | USB | 1 | Shielded | 1.5 | Indoor |
| Signal | External buzzer | Not in use | | Molex microfit 2-pin | 1 | NA | NA | NA |
| Signal | External LEDs | EUT | LEDs at antennas | Molex microfit 6-pin | 2 | Shielded | 1.0 | Indoor |
| Power | 12 VDC | EUT | AC/DC adaptor | Molex microfit 4-pin | 1 | Unshielded | 2.0 | Indoor |
| Signal | Ext I/O TTL P7 | Not in use | | Soket 2x5 | 1 | NA | NA | NA |
| Signal | Antenna | EUT | Loop antenna | MCX | 2 | Coaxial | 1.0 | Indoor |
| Signal | RS232 | Not in use | | Molex 3-pin | 1 | NA | NA | NA |
| Signal | RS485 | Not in use | | Terminal block 3-pin | 1 | NA | NA | NA |
| Signal | Console | Not in use | | RJ 45 | 1 | NA | NA | NA |
| Power | 19 VDC | Laptop | AC/DC adaptor | DC jack | 1 | Unshielded | 2.0 | Indoor |
| Power | AC mains | AC/DC adaptor | AC mains | IEC 320 | 1 | Unshielded | 1.5 | Indoor |
| Signal | Parallel (LPT) | Laptop | Data transfer switch / printer | D type 25-pin | 1 | Shielded | 5.0 | Indoor |
| Signal | Ethernet | Laptop | Termination | RJ 45 | 1 | UTP | 2.0 | Indoor |
| Signal | RS-232 | EUT | Mouse (termination) | D type 9-pin | 1 | Unshielded | 2.0 | Indoor |
| Signal | Mouse | EUT | Mouse | PS2 | 1 | Unshielded | 2.0 | Indoor |

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**Table 3.2.2**

**EUT ports and lines**

| Description | Manufacturer | Model number | Serial number |
|---|---|---|---|
| Laptop | Compaq | 2105EA | CN30828506 |
| Mouse (termination) | Microsoft | 2.1A | 00307296 |
| Mouse | IBM | 13H6690 | 23A527616 |
| Printer LX-810 | Seiko Epson Corp. | P80SA | 44B1127035 |
| Data transfer switch | NA | NA | NA |
| AC/DC adaptor of laptop | HP | hp f4600a, f481a | 2102281701 |

**Table 3.2.3**

**EUT operating frequencies**

| Source | Frequency, MHz |
|---|---|
| Crystal Y4, Y5 | 13.56 |
| Crystal Y1 | 24.00 |
| Crystal Y2 | 6.00 |
| Crystal Y3 | 20.00 |

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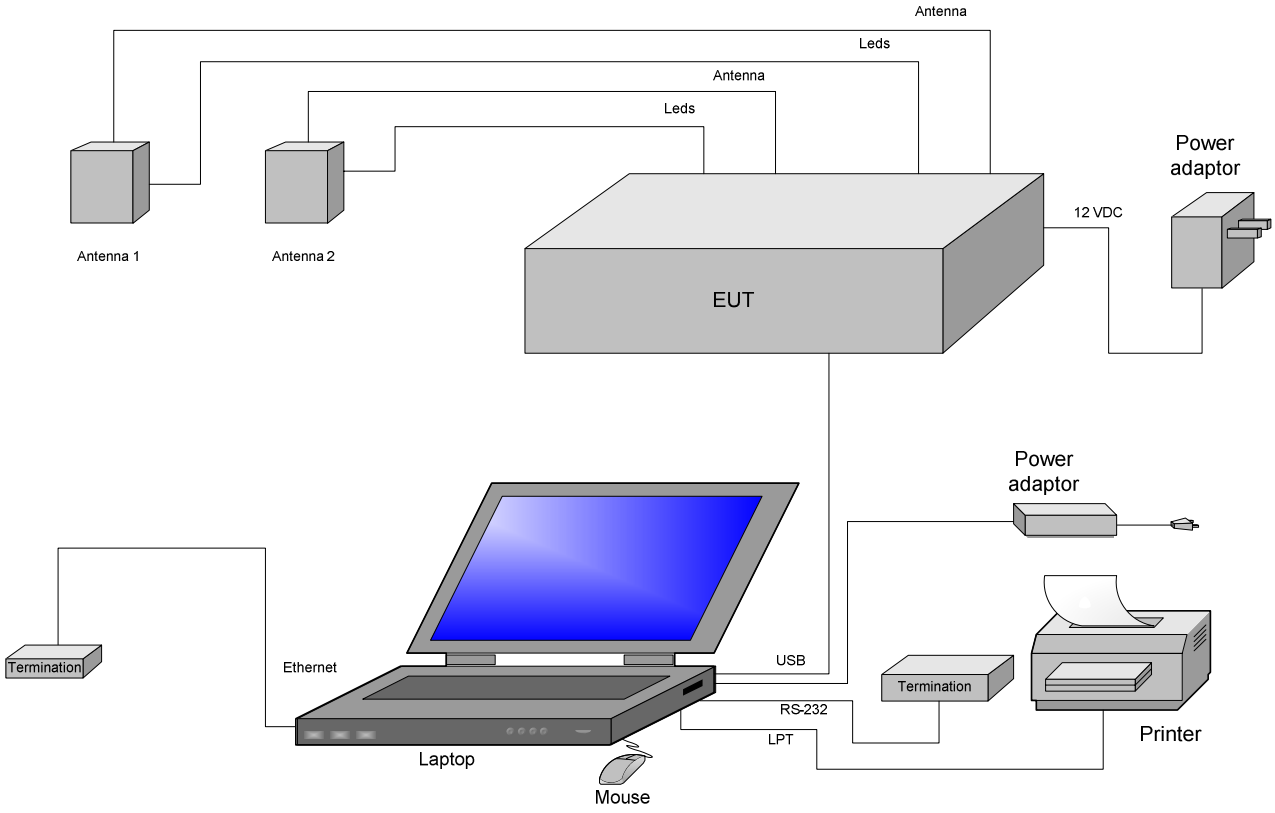
**Figure 3.2.1**

**EUT test configuration**



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# 4 Tests results

## 4.1 Field strength of emission within the assigned band according to §15.225(a)

| | |
|---|---|
| METHOD OF MEASUREMENTS | ANSI 63.4 §13.1.4 |
| DATE of TEST: | March 7, 2004 |
| TEST PERFROMED AT: | Anechoic chamber |
| AMBIENT TEMPERATURE: | 22°C |
| RELATIVE HUMIDITY: | 44% |
| AIR PRESSURE: | 1020 hPa |
| OPERATING FREQUENCY RANGE | 13.553-13.567 MHz |
| TEST DISTANCE | 3 m |
| MEASUREMENT UNCERTAINTY: | ± 5.3 dB |

**Peak detector**

| Frequency, MHz | Channel number | Field strength, dB(μV/m) | Calculated limit*, dB(μV/m) | Margin, dB | Reference to plots in Appendix A |
|---|---|---|---|---|---|
| 13.55983 | 1 | 77.3 | 124 | 46.7 | A1 |
| | 2 | 77.6 | | 46.4 | A2 |

*The limit for 3 m distance was calculated using the square of the inverse linear distance extrapolation factor as follows:

$Lim_{3m} = Lim_{30m} + 40 \log (S_1/S_2)$, where $S_1 = 30$ m, $S_2 = 3$ m.

**LIMIT, §15.225(a)**

The field strength of any emissions within 13.553 - 13.567 MHz band shall not exceed 15,848 μV/m [84 dB(μV/m)] at 30 m.

**TEST PROCEDURE**

The EUT was tested, being placed on a wooden 80 cm height table in typical installation position. The test was performed for two EUT channels.

The loop antenna was positioned with its plane horizontal. The loop center was 1 meter above the ground plane. To find maximum radiation the turntable was rotated 360°. Then the loop position was changed to vertical. To find maximum radiation the turntable was rotated 360° and the measuring antenna was rotated about its vertical axis. Plots A1, A2 in Appendix A refer to vertical antenna polarization as the worst case.

**TEST EQUIPMENT USED:**

| | | | | | | |
|---|---|---|---|---|---|---|
| HL 0446 | HL 0465 | HL 0521 | HL 0589 | HL 0592 | HL 0593 | HL 0594 |
| HL 1004 | HL 2009 | | | | | |

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## 4.2 Out of band radiated spurious emissions according to §15.225(b), (c), (d), §15.209

| | |
|---|---|
| METHOD OF MEASUREMENTS | ANSI 63.4 §13.1.4/ §13.1.5 |
| DATE of TEST: | March 7, 2004 |
| TEST PERFROMED AT: | Anechoic chamber |
| AMBIENT TEMPERATURE: | 22°C |
| RELATIVE HUMIDITY: | 44% |
| AIR PRESSURE: | 1020 hPa |
| RATED CARRIER FIELD STRENGTH: | 77.6 dB(μV/m) |
| TEST DISTANCE | 3 m |
| FREQUENCY RANGE | 9 kHz to 1000 MHz |
| MEASUREMENT UNCERTAINTY: | ± 6 dB |

**Quasi-peak detector, loop antenna**

| Frequency, MHz | Resolution bandwidth, kHz | Radiated emission, dB(μV/m) | Limit*, dB(μV/m) | Margin, dB | Reference to Plots in Appendix A |
|---|---|---|---|---|---|
| 0.009 – 0.15 | 0.2 | No spurious emissions found | | | A6 |
| 0.15 – 10 | 9 | No spurious emissions found | | | A7 |
| 10 – 13.110 | 9 | At least 25 dB below the limit | | | A8 |
| 13.110 – 14.010 | 1 | At least 25 dB below the limit | | | A5 |
| 14.010 - 30 | 9 | At least 25 dB below the limit | | | A10 |

*The limit for 3 m distance was calculated using the square of the inverse linear distance extrapolation factor as follows:

$Lim_{3m} = Lim_{30m} + 40 \log (S_1/S_2)$, where $S_1 = 30$ m, $S_2 = 3$ m.

**Quasi-peak detector, biconilog antenna**

| Frequency, MHz | Turntable position, degrees | Radiated emission, dB(μV/m) | Limit, dB(μV/m) | Margin, dB | Verdict |
|---|---|---|---|---|---|
| 188.035 | 313 | 35.91 | 43.5 | 7.59 | Pass |
| 192.027 | 320 | 36.28 | 43.5 | 7.22 | |
| 200.045 | 0 | 37.53 | 43.5 | 5.97 | |
| 204.040 | 0 | 36.06 | 43.5 | 7.44 | |
| 397.390 | 175 | 38.37 | 46.0 | 7.63 | |
| 799.979 | 0 | 41.86 | 46.0 | 4.14 | |

The listed test results were obtained throughout the measurements with antenna in vertical polarization at 1 m height, quasi-peak detector, resolution bandwidth 120 kHz. For full test results refer to plot A11 in Appendix A.

**Table abbreviations:**
Margin = dB below (negative if above) specification limit.
EUT front panel refer to 0 degrees position of turntable.

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**LIMIT, §15.225(b), (c), (d)**

Within the bands 13.410 – 13.553 MHz and 13.567 – 13.710 MHz, the field strength of any emissions shall not exceed 334 μV/m [50.5 dB(μV/m)] at 30 m.
Within the bands 13.110 – 13.410 MHz and 13.710 – 14.010 MHz, the field strength of any emissions shall not exceed 106 μV/m [40.5 dB(μV/m)] at 30 m.
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.

**TEST PROCEDURE**

Radiated emissions were measured at 3-m test distance in the anechoic chamber with the loop antenna in the 9 kHz to 30 MHz range, with the the biconilog - in the 30 MHz to 1000 MHz range.
The EUT was set up on the 80 cm height wooden table in typical installation position as shown in Figures 4.2.1 and 4.2.2.

**9 kHz – 30 MHz range:** the loop antenna was positioned with its plane vertical. The loop center was 1 meter above the ground plane. To find maximum radiation the turntable was rotated 360 and the measuring antenna was rotated about its vertical axis.

**30 MHz – 1000 MHz range:** to find maximum radiation the turntable was rotated 360$^{o}$, measuring antenna height was changed from 1 to 4 m, and the antennas polarization was changed from vertical to horizontal.

**TEST EQUIPMENT USED:**

| | | | | | | |
|---|---|---|---|---|---|---|
| HL 0446 | HL 0465 | HL 0521 | HL 0589 | HL 0592 | HL 0593 | HL 0594 |
| HL 0604 | HL 1004 | HL 2009 | | | | |

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**Figure 4.2.1**

**Set up for radiated emissions measurement with loop antenna**

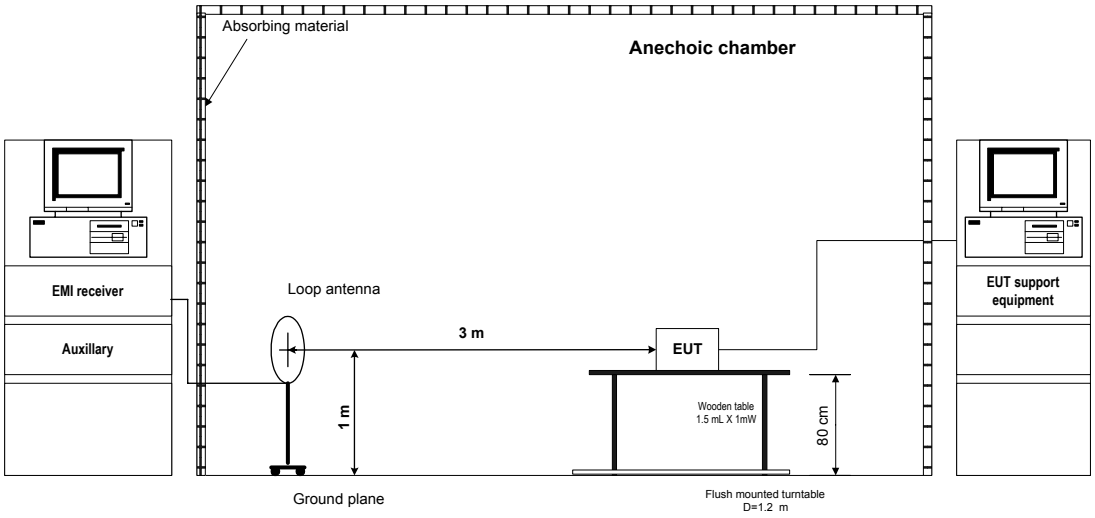
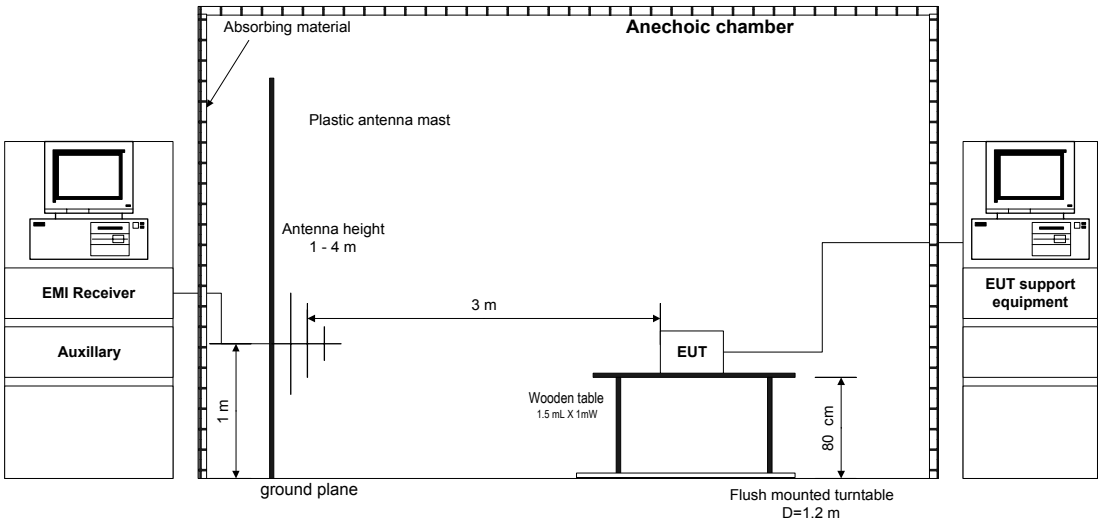



**Figure 4.2.2**

**Set up for radiated emissions measurement with biconilog antenna**



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## 4.3 Frequency tolerance of the carrier signal according to § 15.225 (e)

| | |
|---|---|
| METHOD OF MEASUREMENTS | ANSI 63.4 §13.1.6 |
| DATE of TEST: | March 7, 2004 |
| AMBIENT TEMPERATURE: | 22°C |
| RELATIVE HUMIDITY: | 44% |
| AIR PRESSURE: | 1020 hPa |
| OPERATING FREQUENCY | 13.56 MHz |

**LIMIT**

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.

**TEST PROCEDURE**

The EUT frequency stability was measured with variation of supply voltage at 20°C or ambient temperature in the range from –20°C to +50°C at Ucc=12 V.

**Frequency stability test results vs supply voltage at 20°C**

| Voltage, V | Frequency, kHz | Displacement, Hz | Time, min |
|---|---|---|---|
| Ucc=12 V | 13559.978 | 26 | startup |
| | 13559.958 | 6 | +2 |
| | 13559.953 | 1 | +5 |
| | **13559.952** | 0 | +10 |
| Ucc=7.2 V | 13559.980 | 28 | startup |
| | 13559.958 | 6 | +2 |
| | 13559.953 | 1 | +5 |
| | 13559.952 | 0 | +10 |
| Ucc=15 V | 13559.979 | 27 | startup |
| | 13559.957 | 5 | +2 |
| | 13559.954 | 2 | +5 |
| | 13559.954 | 2 | +10 |

**Reference frequency: 13 559 952 Hz**

Limit = ± 1355.9952 Hz

**Verdict: Pass**

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**Frequency stability test results vs ambient temperature at Ucc=12 V**

| Temperature, °C | Frequency, Hz | Displacement, Hz | Time, min |
|---|---|---|---|
| t°=30°C | 13559.924 | -28 | startup |
| | 13559.915 | -37 | +2 |
| | 13559.915 | -37 | +5 |
| | 13559.915 | -37 | +10 |
| t°=40°C | 13559.934 | -18 | startup |
| | 13559.889 | -63 | +2 |
| | 13559.886 | -66 | +5 |
| | 13559.886 | -66 | +10 |
| t°=50°C | 13559.988 | 36 | startup |
| | 13559.864 | -88 | +2 |
| | 13559.864 | -88 | +5 |
| | 13559.864 | -88 | +10 |
| t°=10°C | 13560.013 | 61 | startup |
| | 13559.998 | 46 | +2 |
| | 13559.997 | 45 | +5 |
| | 13559.997 | 45 | +10 |
| t°=0°C | 13560.028 | 76 | startup |
| | 13560.016 | 64 | +2 |
| | 13560.016 | 64 | +5 |
| | 13560.016 | 64 | +10 |
| t°=-10°C | 13560.038 | 86 | startup |
| | 13560.026 | 74 | +2 |
| | 13560.025 | 73 | +5 |
| | 13560.024 | 72 | +10 |
| t°=-20°C | 13560.047 | 95 | startup |
| | 13560.018 | 66 | +2 |
| | 13560.015 | 63 | +5 |
| | 13560.015 | 63 | +10 |

**Verdict: Pass**

**TEST EQUIPMENT USED:**

| | | | | | | |
|---|---|---|---|---|---|---|
| HL 0057 | HL 0493 | HL 0559 | HL 1082 | HL 1653 | HL 2468 | |

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## 4.4 Unintentional radiated emissions test according to §15.109

| | |
|---|---|
| METHOD OF MEASUREMENT: | ANSI 63.4 §11.6 / ANSI 63.4 §12.1.4 |
| DATE of TEST: | March 7, 2004 |
| TEST PERFROMED AT: | Anechoic chamber |
| AMBIENT TEMPERATURE: | 22°C |
| RELATIVE HUMIDITY: | 44% |
| AIR PRESSURE: | 1020 hPa |
| DISTANCE BETWEEN ANTENNA AND EUT: | 3 m |
| THE EUT WAS TESTED AS: | TABLE-TOP |
| FREQUECNY RANGE: | 30 MHz – 1 GHz |
| DETECTOR TYPE: | QUASI-PEAK |
| RESOLUTION BANDWIDTH: | 120 kHz |

| The EUT highest used frequency (not including operating frequency), MHz | Upper frequency of measurement range, MHz |
|---|---|
| Below 1.705 | 30 |
| 1.705 – 108 | 1000 |
| 108 – 500 | 2000 |
| 500 – 1000 | 5000 |
| Above 1000 | 5th harmonic of the highest frequency or 40 GHz, whichever is lower |

The limits for class B unintentional radiated emissions were used while testing the equipment in Tx mode, for test procedure and results refer to paragraph 4.2 and Plot A11.

**LIMIT (§ 15.109)**

| Frequency, MHz | Class B equipment @ 3 m dB(µV/m) |
|---|---|
| 30 - 88 | 40 |
| 88 - 216 | 43.5 |
| 216 - 960 | 46 |
| 960 - 5000 | 54 |

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## 4.5 Conducted emissions test according to §15.207, §15.107

| | |
|---|---|
| METHOD OF MEASUREMENTS | ANSI 63.4 §13.1.3 |
| DATE of TEST: | March 8, 2004 |
| RELATIVE HUMIDITY: | 43% |
| AMBIENT TEMPERATURE: | 23°C |
| AIR PRESSURE: | 1020 hPa |
| THE EUT WAS TESTED AS: | TABLE-TOP |
| FREQUENCY RANGE: | 150 kHz – 30 MHz |
| RESOLUTION BANDWIDTH: | 9 kHz |
| MEASUREMENT UNCERTAINTY, dB | ± 3.9 dB in 9 – 150 kHz<br>± 3.8 dB in 150 kHz – 30 MHz |

**EUT power lines**

| Frequency, MHz | Quasi-peak | | | Average | | | Line ID | Verdict |
|---|---|---|---|---|---|---|---|---|
| | Measured emission, dB(µV) | Limit, dB(µV) | Margin, dB* | Measured emission, dB(µV) | Limit, dB(µV) | Margin, dB* | | |
| 0.151449 | 47.96 | 65.93 | 17.97 | 17.01 | 55.93 | 38.92 | L1 | Pass |
| 0.401906 | 41.60 | 57.83 | 16.23 | 11.28 | 47.83 | 36.55 | | |
| 0.462015 | 41.04 | 56.71 | 15.67 | 10.83 | 46.71 | 35.88 | | |
| 0.497607 | 40.47 | 56.04 | 15.57 | 10.06 | 46.04 | 35.98 | | |
| 0.306940 | 44.93 | 60.06 | 15.13 | 14.30 | 50.06 | 35.76 | L2 | Pass |
| 0.361595 | 43.93 | 58.75 | 14.82 | 13.18 | 48.75 | 35.57 | | |
| 0.427809 | 43.74 | 57.35 | 13.61 | 12.75 | 47.35 | 34.60 | | |
| 0.454535 | 43.62 | 56.85 | 13.23 | 12.34 | 46.85 | 34.51 | | |
| 0.508921 | 43.11 | 56.00 | 12.89 | 11.39 | 46.00 | 34.61 | | |

**Laptop power lines**

| Frequency, MHz | Quasi-peak | | | Average | | | Line ID | Verdict |
|---|---|---|---|---|---|---|---|---|
| | Measured emission, dB(µV) | Limit, dB(µV) | Margin, dB* | Measured emission, dB(µV) | Limit, dB(µV) | Margin, dB* | | |
| 0.155000 | 51.46 | 65.76 | 14.30 | 38.08 | 55.76 | 17.68 | L1 | Pass |
| 13.559290 | 46.60 | 60.00 | 3.40 | 46.06 | 50.00 | 3.94 | | |
| 0.153863 | 52.58 | 65.81 | 13.23 | 40.46 | 55.81 | 15.35 | L2 | Pass |
| 0.212597 | 45.89 | 63.17 | 17.28 | 39.34 | 53.17 | 13.83 | | |
| 0.525677 | 38.61 | 56.00 | 17.39 | 34.28 | 46.00 | 11.72 | | |

For full test results refer to Plots A12 – A15 in Appendix A.

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**LIMIT**

| Frequency, MHz | Class B equipment, dB(µV) | |
|---|---|---|
| | QP | AVRG |
| 0.15 - 0.5 | 66 - 56* | 56 - 46* |
| 0.5 - 5 | 56 | 46 |
| 5 - 30 | 60 | 50 |

*The limit decreases linearly with the logarithm of frequency.

**TEST PROCEDURE**

The measurements were performed at mains terminals by means of LISN, connected to spectrum analyzer in the frequency range as referred to in the table above. The unused coaxial connector of the LISN was terminated with 50 Ω. The measurements were made with quasi-peak and average detectors as referred to in the tables.
The position of the EUT cables was varied to determine maximum emission level.

**TEST EQUIPMENT USED:**

| | | | | | | |
|---|---|---|---|---|---|---|
| HL 0163 | HL 0447 | HL 0672 | HL 0787 | HL 1430 | HL 1502 | HL 1510 |

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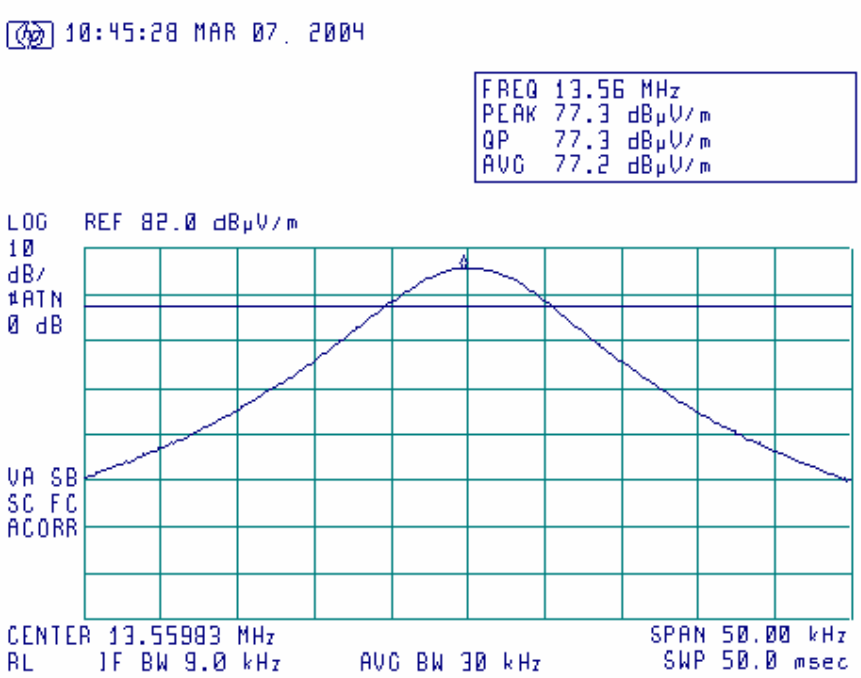
# Appendix A Plots

**Plot A 1**

**Field strength of fundamental measurement in the anechoic chamber, channel 1, unmodulated signal**



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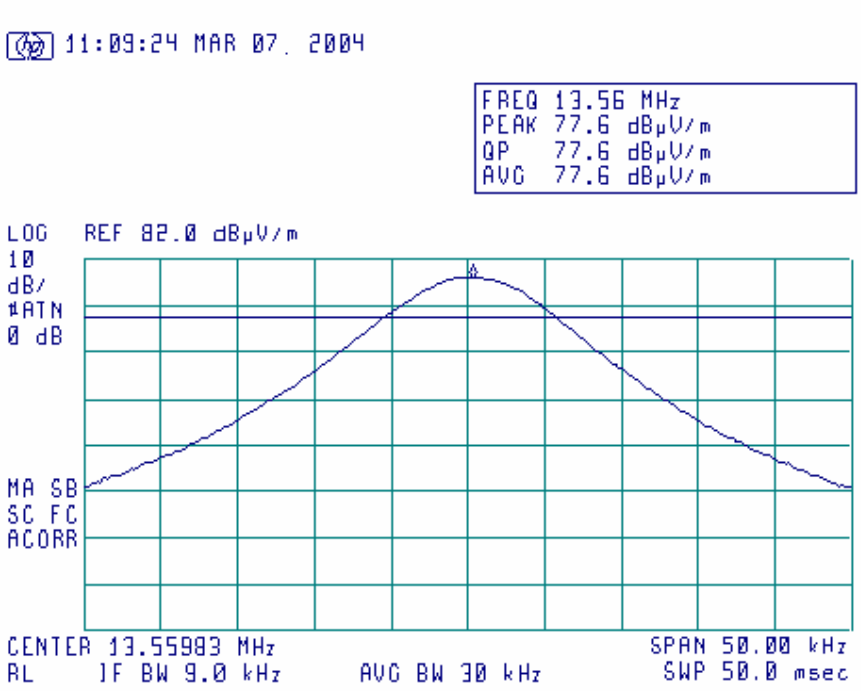
**Plot A 2**

**Field strength of fundamental measurement in the anechoic chamber, channel 2, unmodulated signal**



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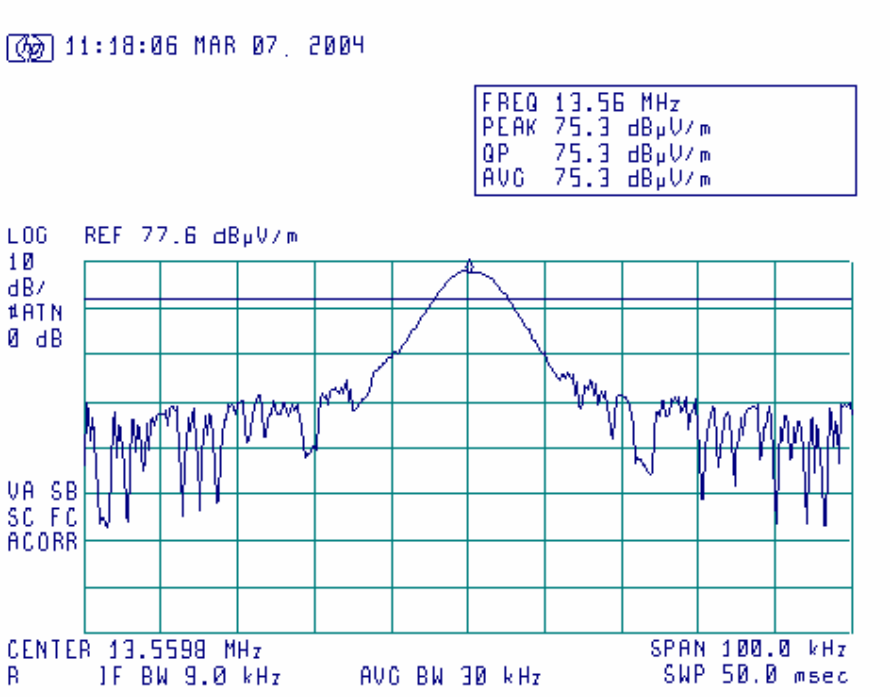
**Plot A 3**

**Field strength of fundamental measurement in the anechoic chamber, channel 2, REQB, repetitive, amplitude modulated signal (with type B contactless card)**



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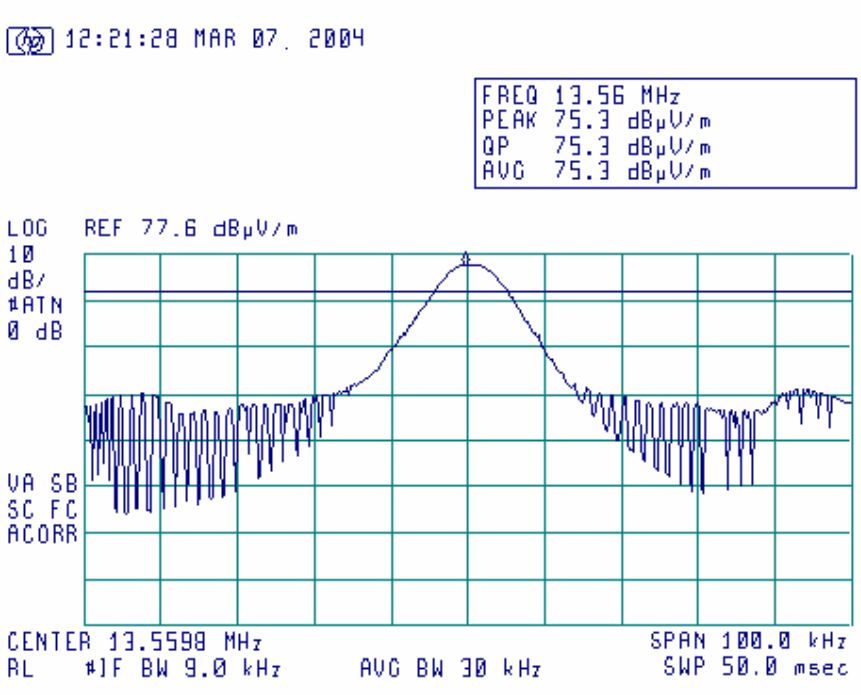
**Plot A 4**

**Field strength of fundamental measurement in the anechoic chamber, channel 2, REQB, repetitive, amplitude modulated signal (with type A contactless card)**



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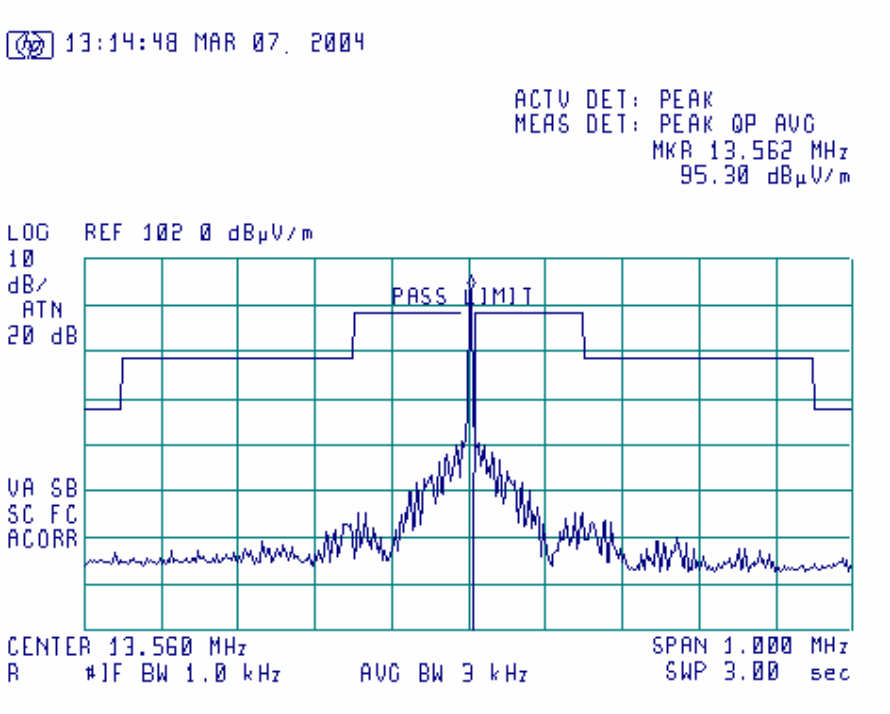
**Plot A 5**

**Radiated emissions within 13.110 MHz to 14.010 MHz measurement in the anechoic chamber, channel 2, REQB, repetitive, amplitude modulated signal (with type B contactless card)**




Correction factor 20 dB was added to the measured result.
All emissions were found more than 25 dB below the limit.

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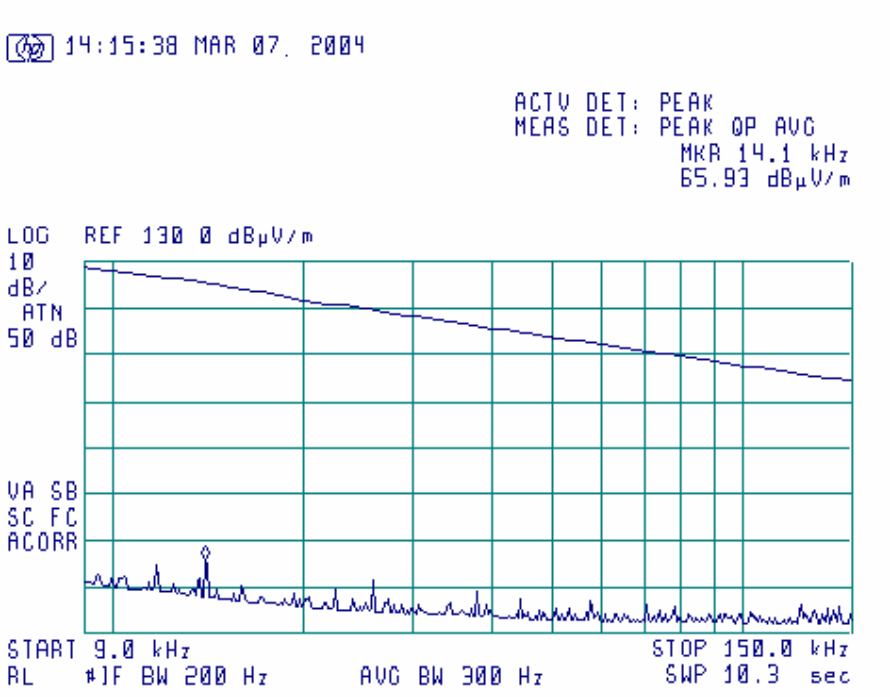
**Plot A 6**

**Radiated emissions measurement from 9 kHz to 150 kHz in the anechoic chamber, channel 2**



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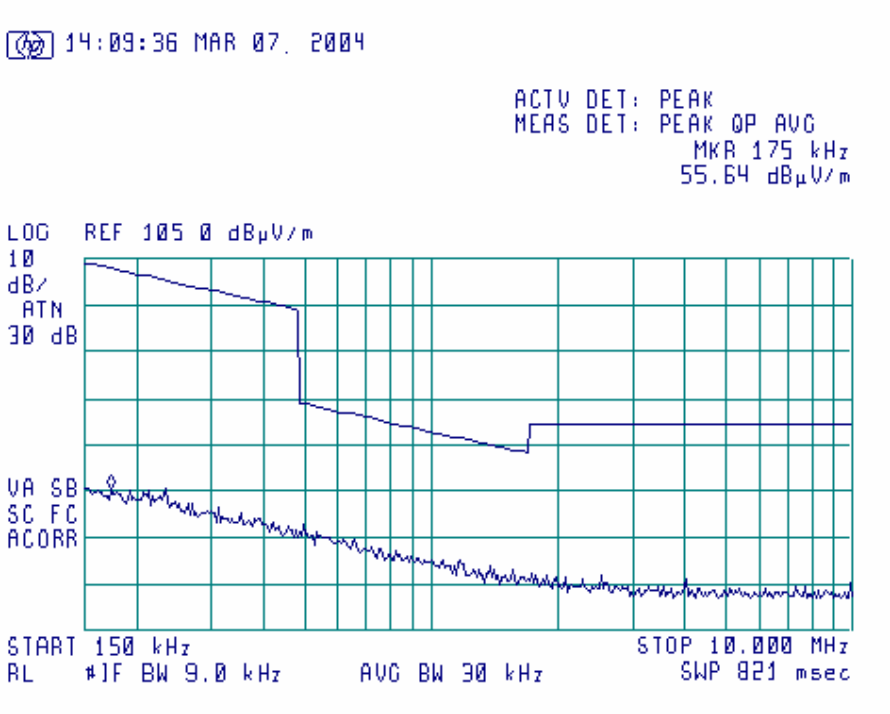
**Plot A 7**

**Radiated emissions measurement from 150 kHz to 10 MHz in the anechoic chamber, channel 2**



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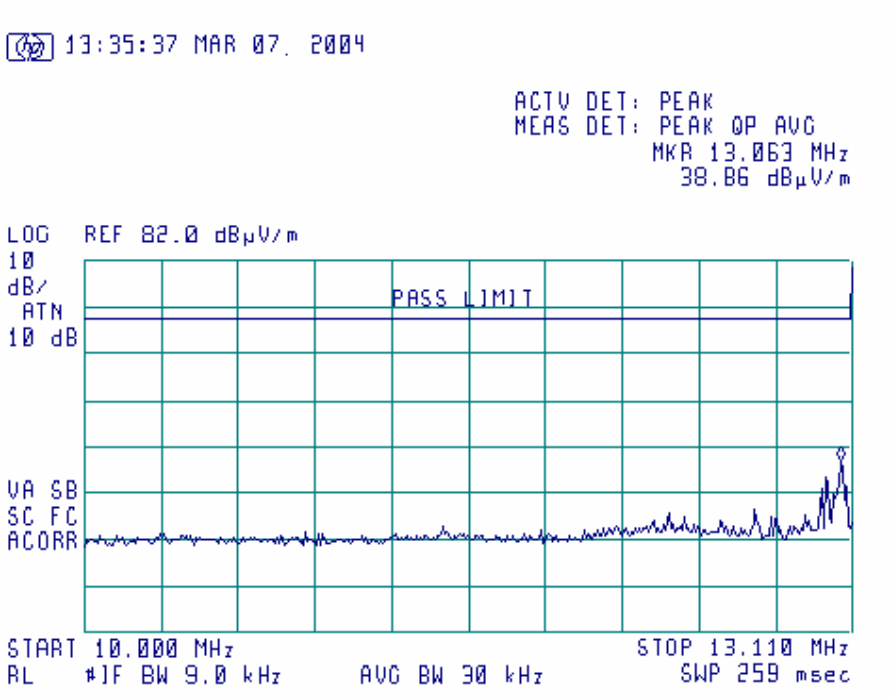
**Plot A 8**

**Radiated emissions measurement from 10 MHz to 13.110 MHz in the anechoic chamber, channel 2**



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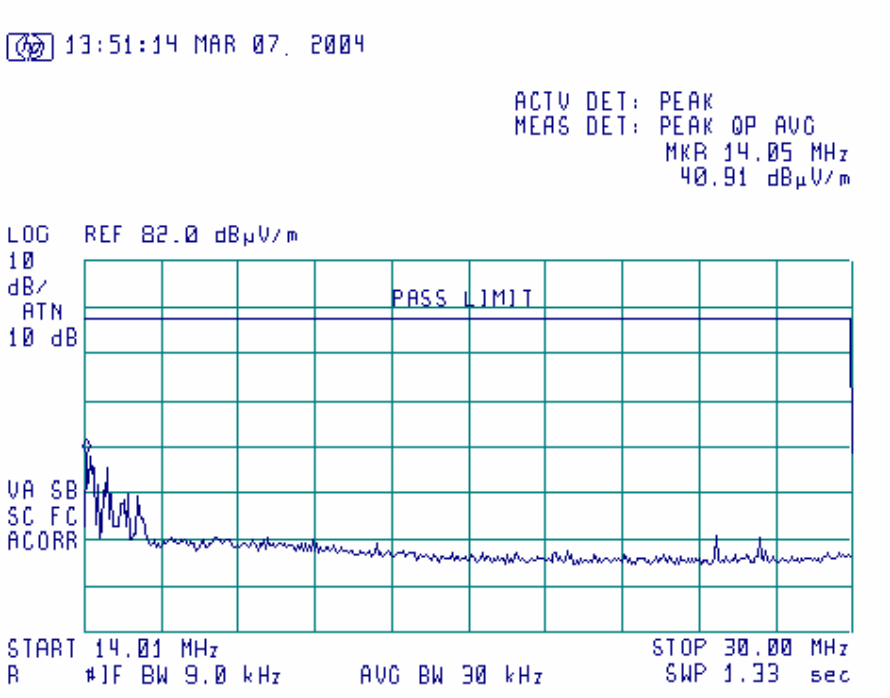
**Plot A 9**

**Radiated emissions measurement from 14.010 MHz to 30 MHz in the anechoic chamber, channel 2**



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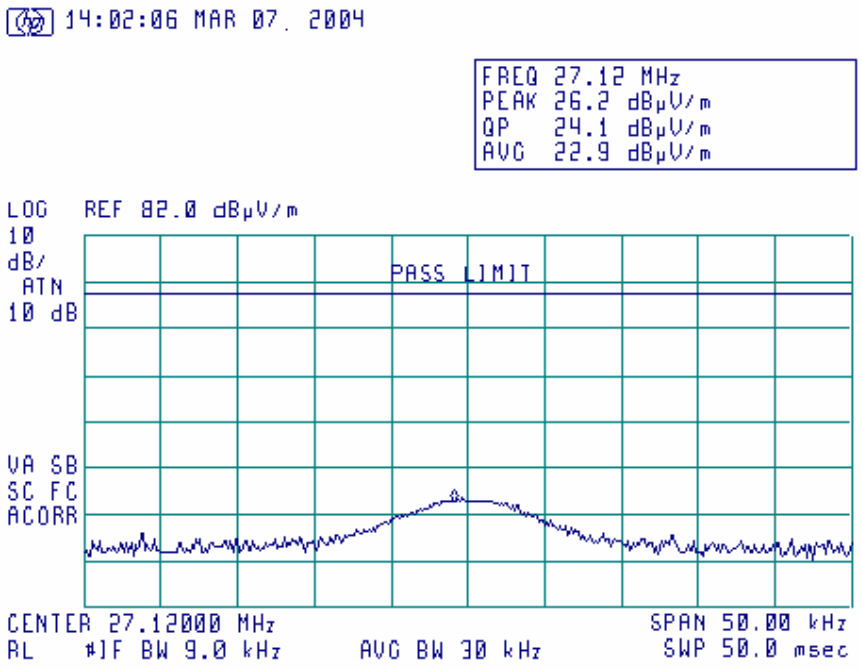
**Plot A 10**

**Field strength of second harmonic measurement in the anechoic chamber, channel 2**




Emission level is more than 40 dB below the limit.

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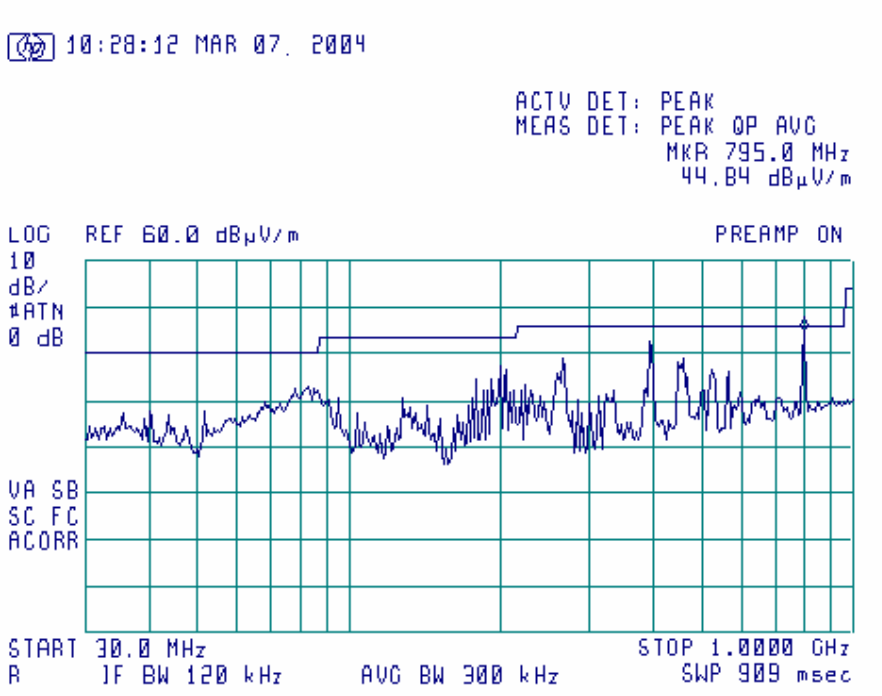
**Plot A 11**

**Radiated emissions measurement in the anechoic chamber from 30 MHz to 1000 MHz**



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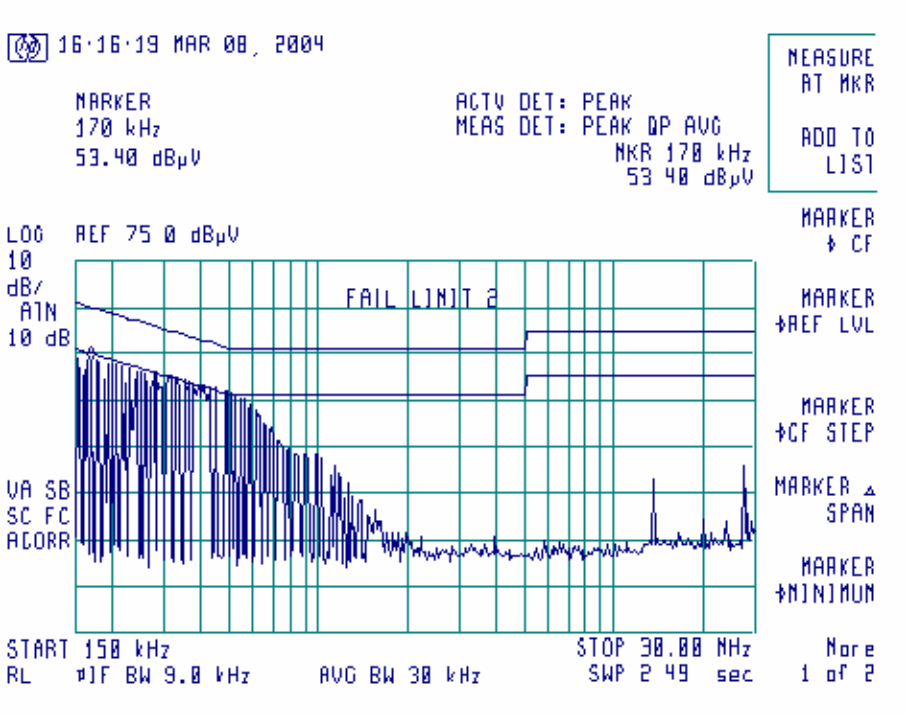
**Plot A 12**

**Conducted emission measurements at 120 VAC power line of EUT**

| | |
|---|---|
| LINE: | L1 |
| LIMIT: | QUASI-PEAK, AVERAGE |
| DETECTOR: | PEAK |



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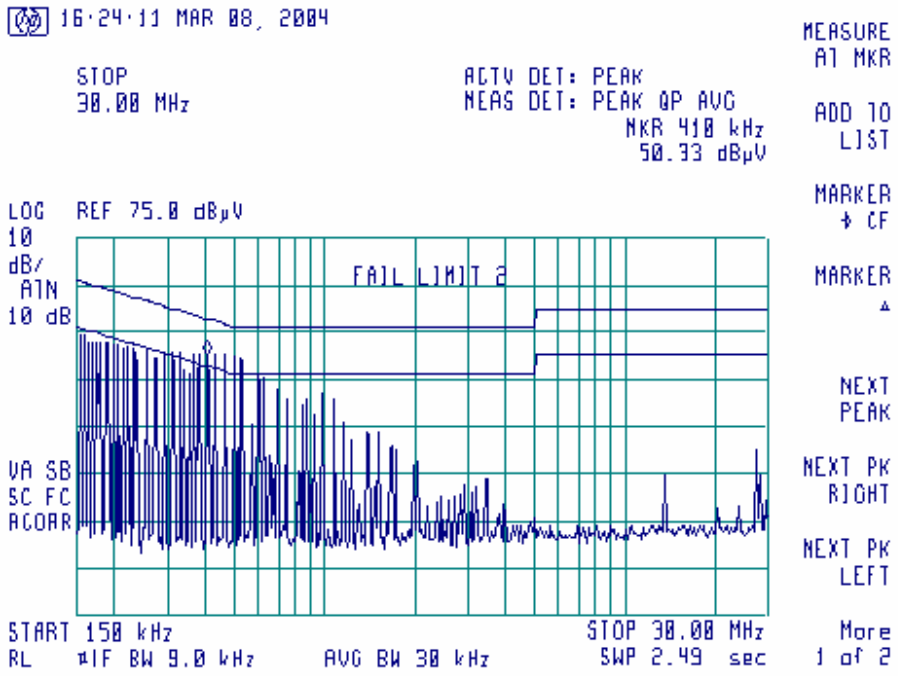
**Plot A 13**

**Conducted emission measurements at 120 VAC power line of EUT**

| | |
|---|---|
| LINE: | L2 |
| LIMIT: | QUASI-PEAK, AVERAGE |
| DETECTOR: | PEAK |



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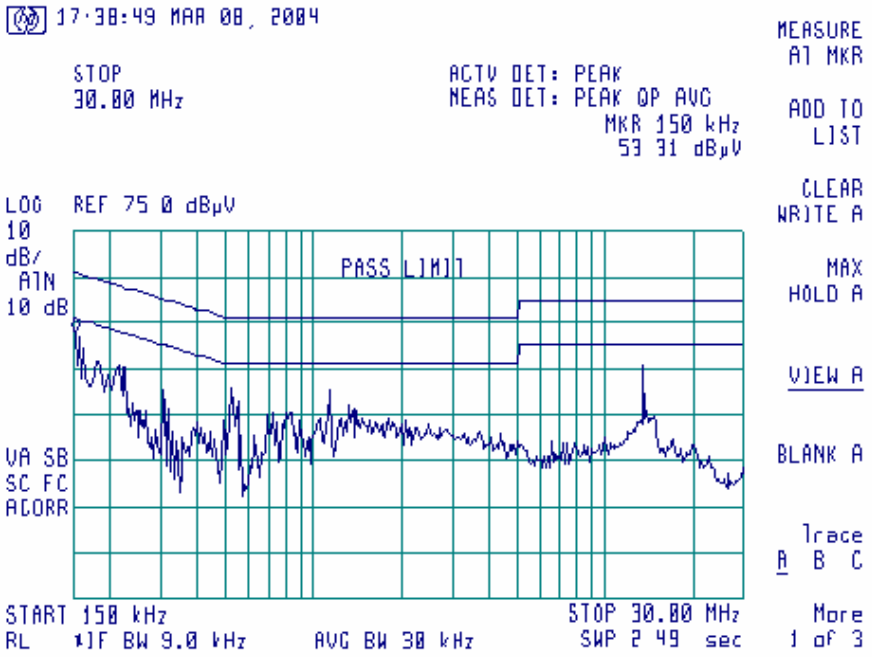
**Plot A 14**

**Conducted emission measurements at 120 VAC power line of PC**

| | |
|---|---|
| LINE: | L1 |
| LIMIT: | QUASI-PEAK, AVERAGE |
| DETECTOR: | PEAK |



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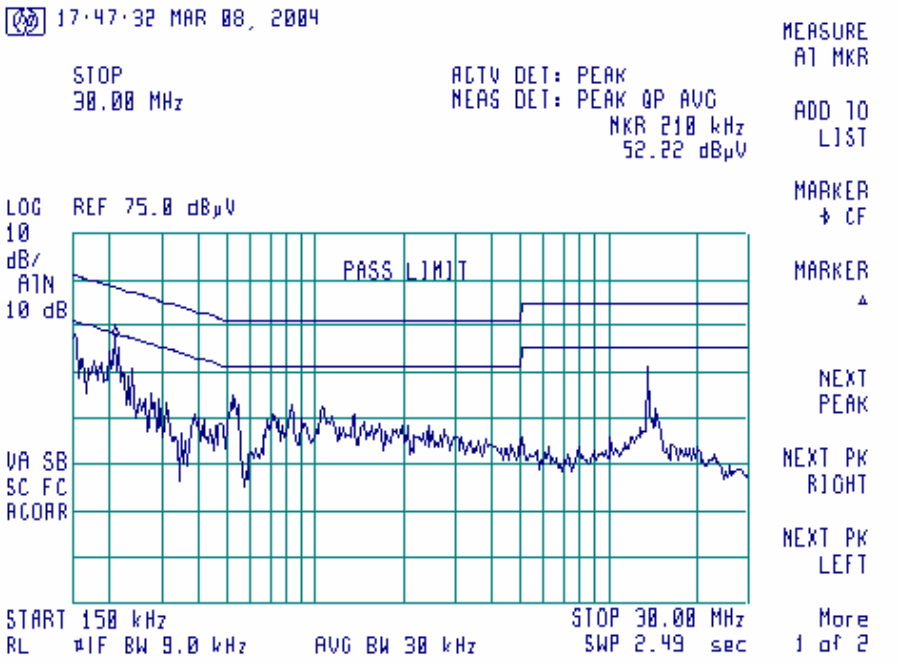
**Plot A 15**

**Conducted emission measurements at 120 VAC power line of PC**

| | |
|---|---|
| LINE: | L2 |
| LIMIT: | QUASI-PEAK, AVERAGE |
| DETECTOR: | PEAK |



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# Appendix B Test equipment used for tests

| HL Serial No. | Description | Manufacturer information | | | Due Calibr. Month/ year |
|---|---|---|---|---|---|
| | | Name | Model No. | Serial No. | |
| 0057 | Attenuator, 50 Ohm, 2W, 0-18 GHz, 30 dB | Hewlett Packard | 8492A | 129 | 3/05 |
| 0163 | LISN FCC/VDE/MIL -STD | Electro-Metrics | ANS-25/2 | 1314 | 10/04 |
| 0446 | Active loop antenna 10 kHz-30 MHz | Electro-Mechanics | 6502 | 2857 | 11/04 |
| 0447 | LISN, 16/2, 300 V RMS | Hermon Labs | LISN 16-1 | 447 | 12/04 |
| 0465 | Anechoic chamber 9 (L) x 6.5 (W) x 5.5 (H) m | Hermon Labs | AC-1 | 023 | 10/05 check |
| 0493 | Oven temperature | Thermotron | S-1.2 Mini-Max | 4016 | 3/05 |
| 0521 | Spectrum analyzer with RF filter section (EMI Receiver 9 kHz - 6.5 GHz) | Hewlett Packard | 8546A | 0319 | 7/04 |
| 0559 | Multimeter digital | Fluke | 76 | 0903 | 10/04 |
| 0589 | Cable coaxial, GORE A2POL118.2, 3 m | Hermon Labs | GORE-3 | 589 | 11/04 |
| 0592 | Position controller | Hermon Labs | L2-SR3000 | 100 | 5/04 check |
| 0593 | Antenna mast, 1-4 m/ 1-6 m Pneumatic | Hermon Labs | AM-F1 | 101 | 2/05 check |
| 0594 | Turntable for Anechoic Chamber, flush mounted, d=1.2 m, pneumatic | Hermon Labs | WDC1 | 102 | 1/05 check |
| 0604 | Antenna Biconilog Log-Periodic/T Bow-Tie, 26 - 2000 MHz | EMCO | 3141 | 9611-1011 | 12/04 |
| 0672 | Shielded room 4.6(L) x 4.2(W) x2.4(H) m | Hermon Labs | SR-3 | 027 | 11/04 check |
| 0787 | Transient limiter | Hewlett Packard | 11947A-8ZE | 3107A01877 | 11/04 |
| 1004 | Cable coaxial, ANDREW PSWJ4, 6 m | Hermon Labs | ANDREW-6 | 163 | 12/04 |
| 1082 | Power supply, DC, 18 V, 2 A | Horizon Electronics | DHR 18-2 | 4220 | 8/04 check |
| 1430 | EMI Receiver System, 9 kHz - 2.9 GHz | Agilent Technologies | 8542E | 3807A00262 | 9/04 |
| 1502 | Cable RF, 6 m | Belden | M17/167 MIL-C-17 | 1502 | 12/04 check |
| 1510 | Cable RF, 8 m | Belden | M17/167 MIL-C-17 | 1510 | 12/04 |
| 1653 | Analyzer EMC, 9 KHz – 1.5 GHz | Aglient Technologies | E7401 | US39440281 | 2/05 |
| 2009 | Cable RF, 8 m | Alpha Wire | RG-214 | C-56 | 12/04 |
| 2468 | Cable RF, 3.4 m | Coleman | M17/84-RG223 | 2468 | 12/04 |

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# Appendix C – Antenna factors and cable loss

**Antenna factor**
**Active loop antenna**
**Model 6502**
**S/N 2857**

| Frequency, MHz | Magnetic antenna factor, dB | Electric antenna factor, dB |
|---|---|---|
| 0.009 | -32.8 | 18.7 |
| 0.010 | -33.8 | 17.7 |
| 0.020 | -38.3 | 13.2 |
| 0.050 | -41.1 | 10.4 |
| 0.075 | -41.3 | 10.2 |
| 0.100 | -41.6 | 9.9 |
| 0.150 | -41.7 | 9.8 |
| 0.250 | -41.6 | 9.9 |
| 0.500 | -41.8 | 9.8 |
| 0.750 | -41.9 | 9.7 |
| 1.000 | -41.4 | 10.1 |
| 2.000 | -41.5 | 10.0 |
| 3.000 | -41.4 | 10.2 |
| 4.000 | -41.4 | 10.1 |
| 5.000 | -41.5 | 10.1 |
| 10.000 | -41.9 | 9.6 |
| 15.000 | -41.9 | 9.6 |
| 20.000 | -42.2 | 9.3 |
| 25.000 | -42.8 | 8.7 |
| 30.000 | -44.0 | 7.5 |

Antenna factor in dB(1/m) is to be added to receiver meter reading in dB(μV) to convert it into field intensity in dB(μV/m).

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**Antenna factor**
**Biconilog antenna EMCO Model 3141**
**Ser.No.1011**

| Frequency, MHz | Antenna Factor, dB(1/m) | Frequency, MHz | Antenna Factor, dB(1/m) |
|---|---|---|---|
| 26 | 7.8 | 940 | 24.0 |
| 28 | 7.8 | 960 | 24.1 |
| 30 | 7.8 | 980 | 24.5 |
| 40 | 7.2 | 1000 | 24.9 |
| 60 | 7.1 | 1020 | 25.0 |
| 70 | 8.5 | 1040 | 25.2 |
| 80 | 9.4 | 1060 | 25.4 |
| 90 | 9.8 | 1080 | 25.6 |
| 100 | 9.7 | 1100 | 25.7 |
| 110 | 9.3 | 1120 | 26.0 |
| 120 | 8.8 | 1140 | 26.4 |
| 130 | 8.7 | 1160 | 27.0 |
| 140 | 9.2 | 1180 | 27.0 |
| 150 | 9.8 | 1200 | 26.7 |
| 160 | 10.2 | 1220 | 26.5 |
| 170 | 10.4 | 1240 | 26.5 |
| 180 | 10.4 | 1260 | 26.5 |
| 190 | 10.3 | 1280 | 26.6 |
| 200 | 10.6 | 1300 | 27.0 |
| 220 | 11.6 | 1320 | 27.8 |
| 240 | 12.4 | 1340 | 28.3 |
| 260 | 12.8 | 1360 | 28.2 |
| 280 | 13.7 | 1380 | 27.9 |
| 300 | 14.7 | 1400 | 27.9 |
| 320 | 15.2 | 1420 | 27.9 |
| 340 | 15.4 | 1440 | 27.8 |
| 360 | 16.1 | 1460 | 27.8 |
| 380 | 16.4 | 1480 | 28.0 |
| 400 | 16.6 | 1500 | 28.5 |
| 420 | 16.7 | 1520 | 28.9 |
| 440 | 17.0 | 1540 | 29.6 |
| 460 | 17.7 | 1560 | 29.8 |
| 480 | 18.1 | 1580 | 29.6 |
| 500 | 18.5 | 1600 | 29.5 |
| 520 | 19.1 | 1620 | 29.3 |
| 540 | 19.5 | 1640 | 29.2 |
| 560 | 19.8 | 1660 | 29.4 |
| 580 | 20.6 | 1680 | 29.6 |
| 600 | 21.3 | 1700 | 29.8 |
| 620 | 21.5 | 1720 | 30.3 |
| 640 | 21.2 | 1740 | 30.8 |
| 660 | 21.4 | 1760 | 31.1 |
| 680 | 21.9 | 1780 | 31.0 |
| 700 | 22.2 | 1800 | 30.9 |
| 720 | 22.2 | 1820 | 30.7 |
| 740 | 22.1 | 1840 | 30.6 |
| 760 | 22.3 | 1860 | 30.6 |
| 780 | 22.6 | 1880 | 30.6 |
| 800 | 22.7 | 1900 | 30.6 |
| 820 | 22.9 | 1920 | 30.7 |
| 840 | 23.1 | 1940 | 30.9 |
| 860 | 23.4 | 1960 | 31.2 |
| 880 | 23.8 | 1980 | 31.6 |
| 900 | 24.1 | 2000 | 32.0 |
| 920 | 24.1 | | |

Antenna factor in dB(1/m) is to be added to receiver meter reading in dB(μV) to convert it into field intensity in dB(μV/m).

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**Cable loss**
**Cable Coaxial, GORE A2P01POL118, 2.3 m, model:GORE-3, HL 0589**
**+ Cable Coaxial, ANDREW PSWJ4, 6m, model: ANDREW-6, HL 1004**

| No. | Frequency, MHz | Cable loss, dB | Tolerance (Specification), dB | Measurement uncertainty, dB |
|---|---|---|---|---|
| 1 | 30 | 0.33 | ≤ 6.5 | ±0.12 |
| 2 | 50 | 0.40 | | |
| 3 | 100 | 0.57 | | |
| 4 | 300 | 0.97 | | |
| 5 | 500 | 1.25 | | |
| 6 | 800 | 1.59 | | |
| 7 | 1000 | 1.81 | | |
| 8 | 1200 | 1.97 | | |
| 9 | 1400 | 2.15 | | |
| 10 | 1600 | 2.28 | | |
| 11 | 1800 | 2.43 | | |
| 12 | 2000 | 2.61 | | |
| 13 | 2200 | 2.75 | | |
| 14 | 2400 | 2.89 | | |
| 15 | 2600 | 2.97 | | |
| 16 | 2800 | 3.21 | ≤ 6.5 | ±0.12 |
| 17 | 3000 | 3.32 | | |
| 18 | 3300 | 3.47 | | |
| 19 | 3600 | 3.62 | | |
| 20 | 3900 | 3.84 | | |
| 21 | 4200 | 3.92 | | ±0.17 |
| 22 | 4500 | 4.07 | | |
| 23 | 4800 | 4.36 | | |
| 24 | 5100 | 4.62 | | |
| 25 | 5400 | 4.78 | | |
| 26 | 5700 | 5.16 | | |
| 27 | 6000 | 5.67 | | |
| 28 | 6500 | 5.99 | | |

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**Cable loss**
**Cable coaxial, 6 m, model: M17/167 MIL-C-17, HL 1502**

| Frequency, MHz | Cable loss, dB |
|---|---|
| 0.1 | 0.02 |
| 1 | 0.07 |
| 3 | 0.15 |
| 5 | 0.17 |
| 10 | 0.26 |
| 30 | 0.43 |
| 50 | 0.57 |
| 80 | 0.72 |
| 100 | 0.81 |
| 300 | 1.48 |
| 500 | 2.00 |
| 800 | 2.70 |
| 1000 | 3.09 |

**Cable loss**
**Cable M17/167 MIL-C-17, HL 1510**

| No. | Frequency, MHz | Cable loss, dB |
|---|---|---|
| 1 | 0.1 | 0.05 |
| 2 | 1 | 0.09 |
| 3 | 3 | 0.16 |
| 4 | 5 | 0.18 |
| 5 | 10 | 0.27 |
| 6 | 30 | 0.44 |
| 7 | 50 | 0.58 |
| 8 | 80 | 0.69 |
| 9 | 100 | 0.82 |
| 10 | 300 | 1.48 |
| 11 | 500 | 2.01 |
| 12 | 800 | 2.65 |
| 13 | 1000 | 3.12 |

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**Cable loss**
**RF cable 8 m, model RG-214, HL 2009**

| No. | Frequency, MHz | Cable loss, dB | Tolerance (Specification), dB | Measurement uncertainty, dB |
|---|---|---|---|---|
| 1 | 1 | 0.10 | NA | ±0.12 |
| 2 | 10 | 0.14 | | |
| 3 | 30 | 0.25 | | |
| 4 | 50 | 0.34 | | |
| 5 | 100 | 0.53 | | |
| 6 | 300 | 0.99 | | |
| 7 | 500 | 1.31 | | |
| 8 | 800 | 1.73 | | |
| 9 | 1000 | 1.98 | | |
| 10 | 1100 | 2.11 | | |
| 11 | 1200 | 2.21 | | |
| 12 | 1300 | 2.35 | | |
| 13 | 1400 | 2.46 | | |
| 14 | 1500 | 2.55 | | |
| 15 | 1600 | 2.68 | | |
| 16 | 1700 | 2.78 | | |
| 17 | 1800 | 2.88 | | |
| 18 | 1900 | 2.98 | | |
| 19 | 2000 | 3.09 | | |

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**Correction factor**
**Line impedance stabilization network**
**Model ANS-25/2**
**Electro-Metrics**

| Frequency, kHz | Correction factor, dB |
|---|---|
| 10 | 4.9 |
| 15 | 2.86 |
| 20 | 1.83 |
| 25 | 1.25 |
| 30 | 0.91 |
| 35 | 0.69 |
| 40 | 0.53 |
| 50 | 0.35 |
| 60 | 0.25 |
| 70 | 0.18 |
| 80 | 0.14 |
| 90 | 0.11 |
| 100 | 0.09 |
| 125 | 0.06 |
| 150 | 0.04 |

**Correction factor**
**Line impedance stabilization network**
**Model LISN 16 - 1**
**Hermon Laboratories**

| Frequency, kHz | Correction factor, dB |
|---|---|
| 10 | 4.9 |
| 15 | 2.86 |
| 20 | 1.83 |
| 25 | 1.25 |
| 30 | 0.91 |
| 35 | 0.69 |
| 40 | 0.53 |
| 50 | 0.35 |
| 60 | 0.25 |
| 70 | 0.18 |
| 80 | 0.14 |
| 90 | 0.11 |
| 100 | 0.09 |
| 125 | 0.06 |
| 150 | 0.04 |

The correction factor in dB is to be added to meter readings of an interference analyzer or a spectrum analyzer.

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# Appendix D General information

## Test facility description

Tests were performed at Hermon Laboratories Ltd., which is a fully independent, private EMC, Safety and Telecommunication testing facility. Hermon Laboratories is listed by the Federal Communications Commission (USA) for all parts of Code of Federal Regulations 47 (CFR 47) and by Industry Canada for electromagnetic emissions (file numbers IC 2186-1 for OATS and IC 2186-2 for anechoic chamber), certified by VCCI, Japan (the registration numbers are R-808 for OATS, R-1082 for anechoic chamber, C-845 for conducted emissions site), assessed by TNO Certification EP&S (Netherlands) for a number of EMC, Telecommunications, Safety standards, and by AMTAC (UK) for safety of Medical Devices. The laboratory is accredited by American Association for Laboratory Accreditation (USA) according to ISO/IEC 17025 for Electromagnetic Compatibility, Product Safety, Telecommunications Testing and Environmental Simulation (for exact scope please refer to Certificate No. 839.01).

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Person for contact: Mr. Alex Usoskin, QA manager.

## Abbreviations and acronyms

The following abbreviations and acronyms are applicable to this test report:

| | |
|---|---|
| AC | alternating current |
| cm | centimeter |
| dB | decibel |
| dBm | decibel referred to one milliwatt |
| dB(μV) | decibel referred to one microvolt |
| dB(μV/m) | decibel referred to one microvolt per meter |
| EMC | electromagnetic compatibility |
| EUT | equipment under test |
| GHz | gigahertz |
| H | height |
| Hz | hertz |
| kHz | kilohertz |
| kV | kilovolt |
| L | length |
| LISN | line impedance stabilization network |
| m | meter |
| MHz | megahertz |
| μV/m | microvolt per meter |
| NA | not applicable |
| QP | quasi-peak |
| RF | radio frequency |
| RE | radiated emission |
| rms | root mean square |
| s | second |
| V | volt |
| W | width |

## Specification references

| | |
|---|---|
| 47CFR part 15: 2003 | Radio Frequency Devices |
| ANSI C63.2:96 | American National Standard for Instrumentation-Electromagnetic Noise and Field Strength, 10 kHz to 40 GHz-Specifications. |
| ANSI C63.4:2001 | American National Standard for Methods of Measurement of Radio-Noise Emissions from Low-Voltage Electrical and Electronic Equipment in the Range of 9 kHz to 40 GHz. |