HERMON LABORATORIES

ELECTRICAL TESTING
0839.01

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# TEST REPORT

**ACCORDING TO: FCC CFR 47 Part 15 subpart C, section 15.231 (e) and subpart B; RSS-210 issue 8 Annex 1, ICES-003 Issue 5:2012**

**FOR:**

## CartaSense Ltd.

## Temperature & Relative Humidity Wireless Sensor

## Models: U-Sensor, R-Sensor

## FCC ID:2AAEP-URSENSOR01

## IC:11128A-URSENSOR01

# Table of contents

# 1 Applicant information

| | |
|---|---|
| **Client name:** | CartaSense Ltd. |
| **Address:** | 6 Ravnitzki St., Industrial Zone Segula, Petah-Tikva 49277, Israel |
| **Telephone:** | +972 3934 1543 |
| **Fax:** | +972 3930 0877 |
| **E-mail:** | aviv.peled@cartasense.com |
| **Contact name:** | Mr. Aviv Peled |

# 2 Equipment under test attributes

| | |
|---|---|
| **Product name:** | Temperature & Relative Humidity Wireless Sensor |
| **Product type:** | Transceiver |
| **Model:** | U-Sensor |
| **Serial numbers:** | 0000016943, 0000012451 |
| **Hardware version:** | 16 |
| **Software release:** | 7.03 |
| **Model:** | R-Sensor |
| **Serial numbers:** | 0000015084, 0000015114 |
| **Hardware version:** | 15 |
| **Software release:** | 7.03 |
| **Receipt date** | 3/13/2013 |

# 3 Manufacturer information

| | |
|---|---|
| **Manufacturer name:** | CartaSense Ltd. |
| **Address:** | 6 Ravnitzki St., Industrial Zone Segula, Petah-Tikva 49277, Israel |
| **Telephone:** | +972 3934 1543 |
| **Fax:** | +972 (151) 548-046-947 |
| **E-Mail:** | aviv.peled@cartasense.com |
| **Contact name:** | Mr. Aviv Peled |

# 4 Test details

| | |
|---|---|
| **Project ID:** | 24193 |
| **Location:** | Hermon Laboratories Ltd. Harakevet Industrial Zone, Binyamina 30500, Israel |
| **Test started:** | 3/13/2013 |
| **Test completed:** | 3/18/2013 |
| **Test specification(s):** | FCC 47CFR part 15, subpart C, §15.231(e); subpart B;<br>RSS-210 issue 8 Annex 1, RSS-Gen issue 3; ICES-003 Issue 5:2012 |

# 5 Tests summary

| Test | Status |
|---|---|
| **Transmitter characteristics** | |
| FCC Part 15, Section 231(e) / RSS-210, Section A1.1.5, Periodic operation requirements | Pass |
| FCC Part 15, Section 231(e) / RSS-210, Section A1.1.5, Field strength of emissions | Pass |
| FCC Part 15, Section 231(c) / RSS-210, Section A1.1.3, Occupied bandwidth | Pass |
| FCC Part 15, Section 207 / RSS-Gen, Section 7.2.4, Conducted emission | Not required |
| FCC Part 15, Section 203 / RSS-Gen, Section 7.1.2, Antenna requirements | Pass |
| **Unintentional emissions** | |
| FCC section 15.107 / ICES-003, Section 6.1 class B Conducted emission at AC power port | Not required |
| FCC section 15.109 / ICES-003, Section 6.2 class B, Radiated emission | Pass |

Both R-Sensor and U-Sensor have the same PCB and RF module. That is why the fundamental emission was measured for both R-Sensor and U-Sensor to define the worst case. The rest of tests were performed for R-Sensor as the worst case of fundamental emission.

Testing was completed against all relevant requirements of the test standard. The results obtained indicate that the product under test complies in full with the requirements tested.
The test results relate only to the items tested. Pass/ fail decision was based on nominal values.

| | Name and Title | Date | Signature |
|---|---|---|---|
| **Tested by:** | Mr. S.Samokha , test engineer | March 18, 2013 |  |
| **Reviewed by:** | Mrs. M. Cherniavsky, certification engineer | May 27, 2013 |  |
| **Approved by:** | Mr. M. Nikishin, EMC and Radio group manager | June 5, 2014 |  |

# 6 EUT description

## 6.1 General information

The EUT, models U-Sensor and R-Sensor, is a wireless sensor powered by internal battery. The both sensor models have the same PCB and RF module. The R-Sensor differs from the U-Sensor with the following:

1)_Different plastic enclosure;

2)_Batteries are 2 x AAA instead of CR2450;

3)_Different battery holder.

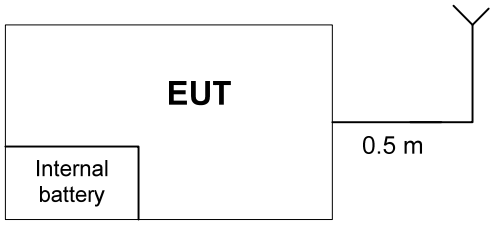
## 6.2 Ports and lines

| Port type | Port description | Connected from | Connected to | Qty. | Cable type | Cable length | Indoor / outdoor |
|---|---|---|---|---|---|---|---|
| RF | RF | EUT | Antenna | 1 | Coax | 0.5 m | Indoor |

## 6.3 Changes made in EUT

No changes were performed in the EUT.

## 6.4 Test configuration



## 6.5 Transceiver characteristics

| **Type of equipment** | | | | | | | |
|---|---|---|---|---|---|---|---|
| X | Stand-alone (Equipment with or without its own control provisions) | | | | | | |
| | Combined equipment (Equipment where the radio part is fully integrated within another type of equipment) | | | | | | |
| | Plug-in card (Equipment intended for a variety of host systems) | | | | | | |
| **Operating frequencies** | 433.75 MHz, 433.90 MHz, 434.05 MHz, 434.20 MHz | | | | | | |
| **Maximum rated output power** | Field strength at 3 m distance | | | | | 91.3 dB(µV/m) | |
| **Is transmitter output power variable?** | X | No | | | | | |
| | | Yes | | continuous variable | | | |
| | | | | stepped variable with stepsize | | dB | |
| | | | | minimum RF power | | dBm | |
| | | | | maximum RF power | | dBm | |
| **Antenna connection** | | | | | | | |
| X unique coupling | standard connector | integral | X with temporary RF connector | | | | |
| | | | without temporary RF connector | | | | |

| **Antenna/s technical characteristics** | | | |
|---|---|---|---|
| Type | Manufacturer | Model number | Antenna gain |
| Omni-directional | NA | TEFZEL #26AWG wire [80cm] | NA |

| | |
|---|---|
| **Transmitter aggregate data rate/s** | 19.2 kbps |
| **Type of modulation** | GFSK |
| **Modulating test signal (baseband)** | PRBS |
| **Maximum transmitter duty cycle** | 0.85 % |

| **Transmitter power source** | | | | | |
|---|---|---|---|---|---|
| X | Battery | **Nominal rated voltage** | 3.0 VDC | Battery type | AAA / CR2450 |
| | DC | **Nominal rated voltage** | | | |
| | AC mains | **Nominal rated voltage** | | Frequency | |

| | | | |
|---|---|---|---|
| **Common power source for transmitter and receiver** | X yes | no |

| Test specification: | FCC Part 15, Section 231(e) / RSS-210, Section A1.1.5, Periodic operation requirements | | |
|---|---|---|---|
| **Test procedure:** | Supplier declaration | | |
| **Test mode:** | Compliance | **Verdict:** | PASS |
| **Date(s):** | 3/14/2013 | | |
| **Temperature:** 23.08 ºC | **Air Pressure:** 1009 hPa | **Relative Humidity:** 45 % | **Power Supply:** Battery |
| **Remarks:** | | | |

# 7 Transmitter tests according to 47CFR part 15 subpart C and RSS-210 requirements

## 7.1 Periodic operation requirements

### 7.1.1 General

The EUT was verified for compliance with periodic operation requirements listed below:

- Continuous transmissions such as voice, video and the radio control of toys are not permitted;
- Duration of each transmission shall not be greater than 1 second;
- Silent period between transmissions shall be at least 30 times the duration of the transmission;
- Silent period between transmissions shall be in no case less than 10 seconds.

The rationale for compliance with the above requirements was either test results or supplier declaration. The summary of results is provided in Table 7.1.1.

### 7.1.2 Test procedure for transmitter shut down test

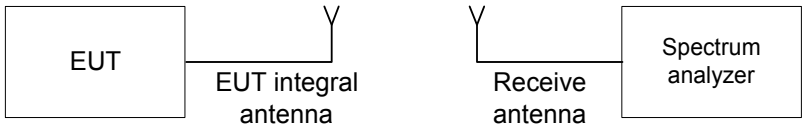
**7.1.2.1** The EUT was set up as shown in Figure 7.1.1.

**7.1.2.2** The spectrum analyzer center frequency was adjusted to the EUT carrier, span set to zero and video triggered for transmission.

**7.1.2.3** The transmitter was activated either manually or automatically. Once manually operated transmitter was activated, the switch was immediately released.

**7.1.2.4** The transmission time was captured and shown in the associated plots. The test results were recorded in Table 7.1.2.

**Figure 7.1.1 Setup for transmitter shut down test**

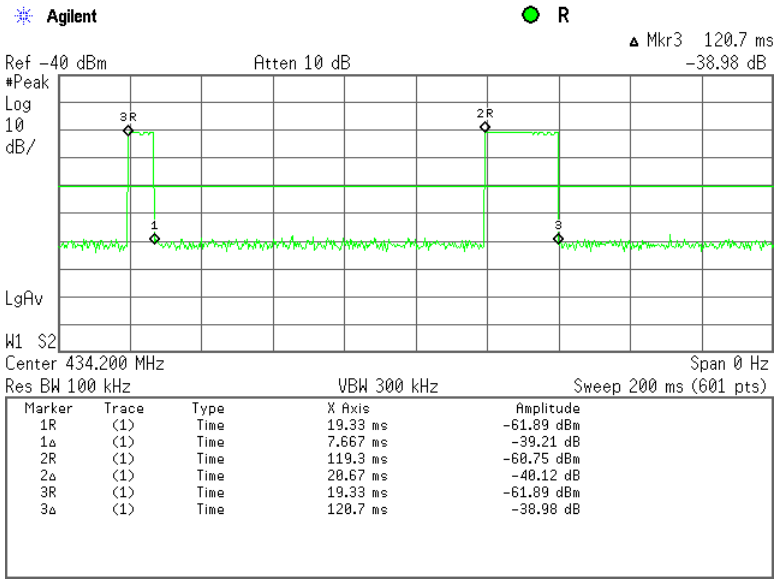


| **Test specification:** | **FCC Part 15, Section 231(e) / RSS-210, Section A1.1.5, Periodic operation requirements** | | |
|---|---|---|---|
| **Test procedure:** | Supplier declaration | | |
| **Test mode:** | Compliance | **Verdict:** | PASS |
| **Date(s):** | 3/14/2013 | | |
| **Temperature:** 23.08 ºC | **Air Pressure:** 1009 hPa | **Relative Humidity:** 45 % | **Power Supply:** Battery |
| **Remarks:** | | | |

**Table 7.1.1 Periodic operation requirements**

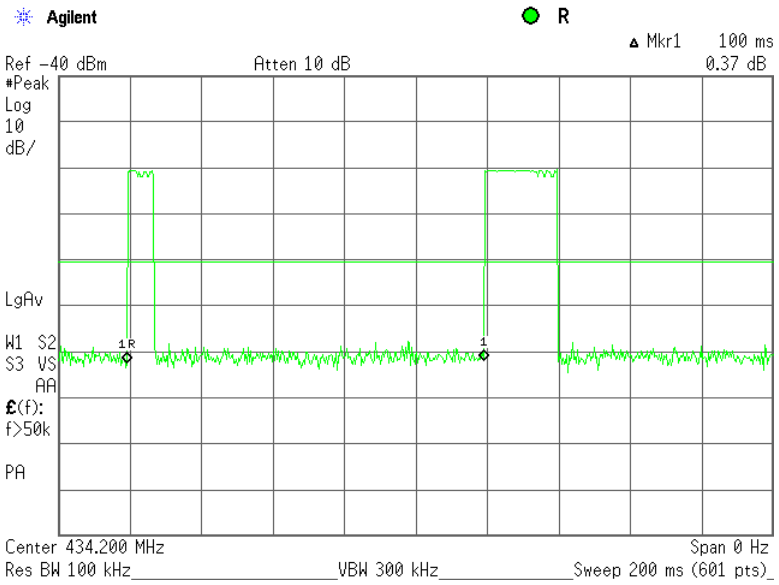
| Requirement | Rationale | Verdict |
|---|---|---|
| Continuous transmissions are not permitted | Supplier declaration | Comply |
| Duration of each transmission shall not be greater than 1 second | Plot 7.1.1 | Comply |
| Silent period between transmissions shall be at least 30 times the duration of the transmission | Plot 7.1.3, Plot 7.1.4 | Comply |
| Silent period between transmissions shall be in no case less than 10 seconds | Plot 7.1.4 | Comply |

**Plot 7.1.1 Transmitter pulse duration**



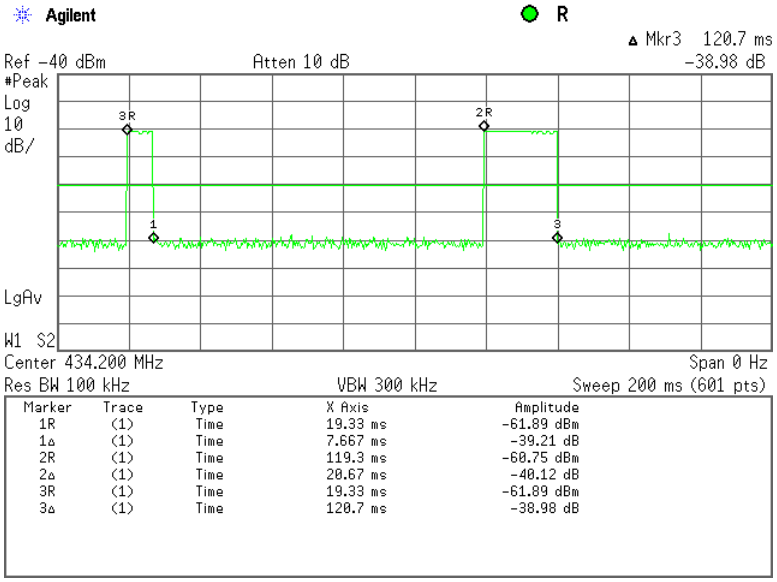
| Test specification: | FCC Part 15, Section 231(e) / RSS-210, Section A1.1.5, Periodic operation requirements | | |
|---|---|---|---|
| Test procedure: | Supplier declaration | | |
| Test mode: | Compliance | Verdict: | PASS |
| Date(s): | 3/14/2013 | | |
| Temperature: 23.08 ºC | Air Pressure: 1009 hPa | Relative Humidity: 45 % | Power Supply: Battery |
| Remarks: | | | |

**Plot 7.1.2 Transmission pulse period**

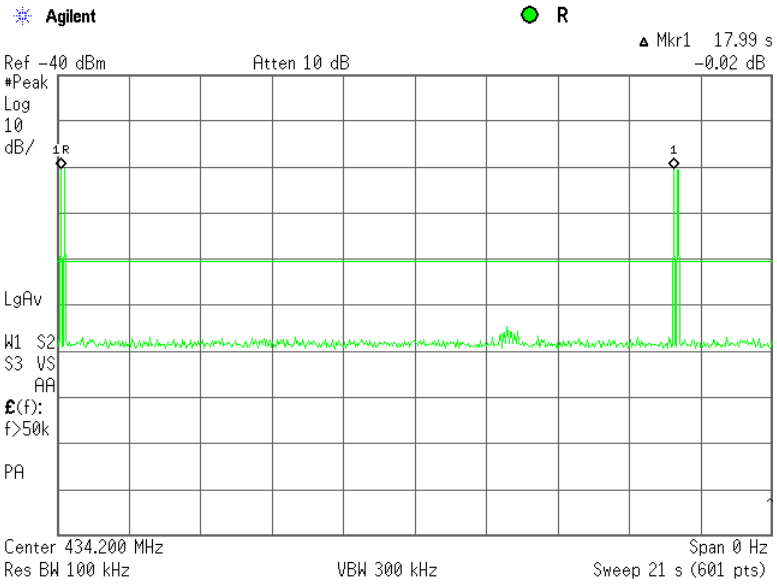


| Test specification: | FCC Part 15, Section 231(e) / RSS-210, Section A1.1.5, Periodic operation requirements | | |
|---|---|---|---|
| Test procedure: | Supplier declaration | | |
| Test mode: | Compliance | Verdict: | PASS |
| Date(s): | 3/14/2013 | | |
| Temperature: 23.08 ºC | Air Pressure: 1009 hPa | Relative Humidity: 45 % | Power Supply: Battery |
| Remarks: | | | |

**Plot 7.1.3 Transmission burst duration**




**Plot 7.1.4 Transmission burst period**



| Test specification: | FCC Part 15, Section 231(e) / RSS-210, Section A1.1.5, Periodic operation requirements | | |
|---|---|---|---|
| Test procedure: | Supplier declaration | | |
| Test mode: | Compliance | Verdict: | PASS |
| Date(s): | 3/14/2013 | | |
| Temperature: 23.08 ºC | Air Pressure: 1009 hPa | Relative Humidity: 45 % | Power Supply: Battery |
| Remarks: | | | |

**Table 7.1.2 Total duration of transmissions**

| Pulse duration, ms | Pulse period, ms | Total transmission duration, ms | Silent period between transmissions, s | Silent period between transmissions limit, s | Margin, s | Verdict |
|---|---|---|---|---|---|---|
| 7.67 + 20.67 | 100.0 | 28.34 | 17.99 | 10.0 | -7.99 | Pass |

**Reference numbers of test equipment used**

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| HL 0337 | HL 3818 | | | | | | |

Full description is given in Appendix A.

| Test specification: | FCC Part 15, Section 231(e) / RSS-210, Section A1.1.5, Field strength of emissions | | |
|---|---|---|---|
| Test procedure: | ANSI C63.4, Section 13.1.4 | | |
| Test mode: | Compliance | Verdict: | PASS |
| Date(s): | 3/14/2013 | | |
| Temperature: 22.3 ºC | Air Pressure: 1012 hPa | Relative Humidity: 44 % | Power Supply: Battery |
| Remarks: | | | |

## 7.2 Field strength of emissions

### 7.2.1 General

This test was performed to measure field strength of fundamental and spurious emissions from the EUT. Specification test limits are given in Table 7.2.1 and Table 7.2.2.

**Table 7.2.1 Radiated fundamental emission limits**

| Fundamental frequency, MHz | Field strength at 3 m, dB(μV/m) | |
|---|---|---|
| | Peak | Average |
| 433.05 – 434.79 | 92.9 | 72.9 |

**Table 7.2.2 Radiated spurious emissions limits**

| Frequency, MHz | Field strength at 3 m, dB(μV/m) | | | | |
|---|---|---|---|---|---|
| | Within restricted bands | | | Outside restricted bands | |
| | Peak | Quasi Peak | Average | Peak | Average |
| 0.009 – 0.090 | 148.5 – 128.5 | NA | 128.5 – 108.5** | 72.9 | 52.9 |
| 0.090 – 0.110 | NA | 108.5 – 106.8** | NA | | |
| 0.110 – 0.490 | 126.8 – 113.8 | NA | 106.8 – 93.8** | | |
| 0.490 – 1.705 | NA | 73.8 – 63.0** | NA | | |
| 1.705 – 30.0* | | 69.5 | | | |
| 30 – 88 | | 40.0 | | | |
| 88 – 216 | | 43.5 | | | |
| 216 – 960 | | 46.0 | | | |
| 960 - 1000 | | 54.0 | | | |
| Above 1000 | 74.0 | NA | 54.0 | | |

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

$$Lim_{S2} = Lim_{S1} + 40 \log (S_1/S_2),$$

where $S_1$ and $S_2$ – standard defined and test distance respectively in meters.
**- The limit decreases linearly with the logarithm of frequency.
The limit for spurious emissions was 20 dB lower than fundamental emission limit.
The above limits provided in terms of average values, peak limit was 20 dB above the average limit.
*Note 2:* The above field strength limits applied from the lowest radio frequency generated in the device, without going below 9 kHz up to the tenth harmonic of the highest fundamental frequency.

| Test specification: | FCC Part 15, Section 231(e) / RSS-210, Section A1.1.5, Field strength of emissions | | |
|---|---|---|---|
| Test procedure: | ANSI C63.4, Section 13.1.4 | | |
| Test mode: | Compliance | Verdict: | PASS |
| Date(s): | 3/14/2013 | | |
| Temperature: 22.3 ºC | Air Pressure: 1012 hPa | Relative Humidity: 44 % | Power Supply: Battery |
| Remarks: | | | |

**7.2.2 Test procedure for spurious emission field strength measurements in 9 kHz to 30 MHz band**

**7.2.2.1** The EUT was set up as shown in Figure 7.2.1, energized and the performance check was conducted.

**7.2.2.2** The specified frequency range was investigated with antenna connected to spectrum analyzer/ EMI receiver. To find maximum radiation the turntable was rotated $360^0$ and the measuring antenna was rotated around its vertical axis.

**7.2.2.3** The worst test results (the lowest margins) were recorded in Table 7.2.3, Table 7.2.5 and shown in the associated plots.

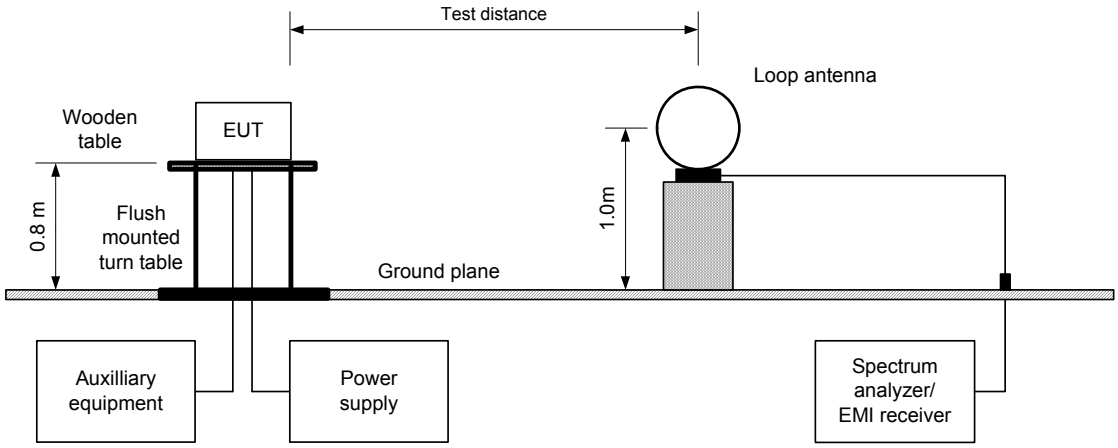
**7.2.3 Test procedure for spurious emission field strength measurements above 30 MHz**

**7.2.3.1** The EUT was set up as shown in Figure 7.2.2, energized and the performance check was conducted.

**7.2.3.2** The specified frequency range was investigated with antenna connected to spectrum analyzer/ EMI receiver. To find maximum radiation the turntable was rotated $360^0$, the measuring antenna height was changed from 1 to 4 m, its polarization was switched from vertical to horizontal.

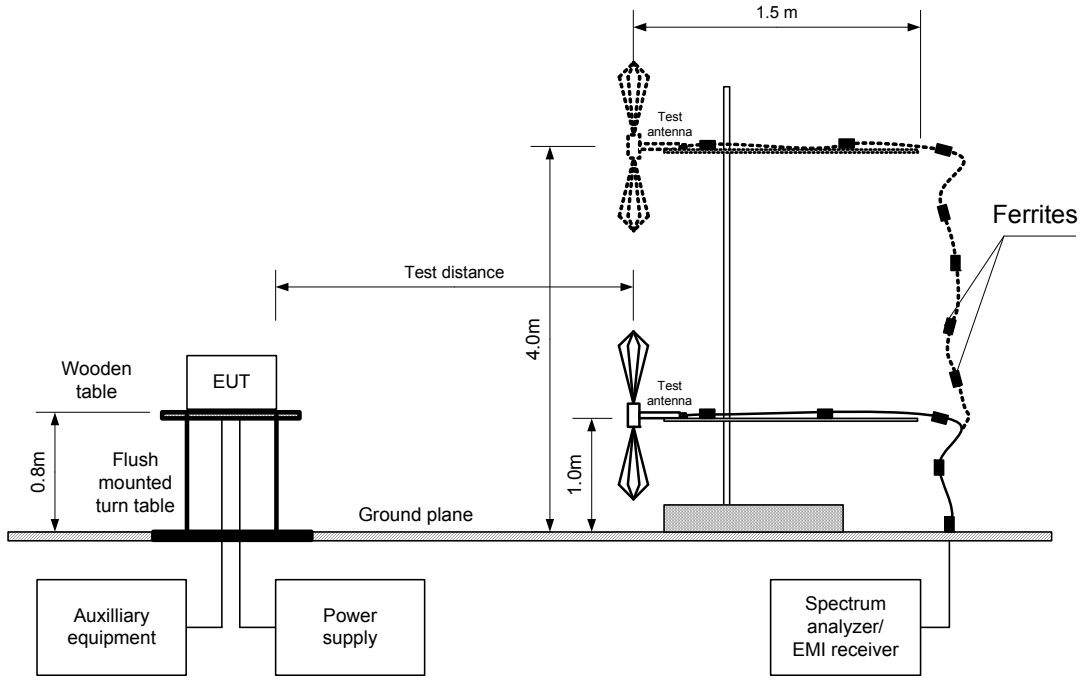
**7.2.3.3** The worst test results (the lowest margins) were recorded in Table 7.2.3, Table 7.2.5 and shown in the associated plots.

**Figure 7.2.1 Setup for spurious emission field strength measurements below 30 MHz**



| Test specification: | FCC Part 15, Section 231(e) / RSS-210, Section A1.1.5, Field strength of emissions | | |
|---|---|---|---|
| Test procedure: | ANSI C63.4, Section 13.1.4 | | |
| Test mode: | Compliance | Verdict: | PASS |
| Date(s): | 3/14/2013 | | |
| Temperature: 22.3 ºC | Air Pressure: 1012 hPa | Relative Humidity: 44 % | Power Supply: Battery |
| Remarks: | | | |

**Figure 7.2.2 Setup for spurious emission field strength measurements above 30 MHz**



| **Test specification:** | **FCC Part 15, Section 231(e) / RSS-210, Section A1.1.5, Field strength of emissions** | | |
|---|---|---|---|
| **Test procedure:** | ANSI C63.4, Section 13.1.4 | | |
| **Test mode:** | Compliance | **Verdict:** | PASS |
| **Date(s):** | 3/14/2013 | | |
| **Temperature:** 22.3 ºC | **Air Pressure:** 1012 hPa | **Relative Humidity:** 44 % | **Power Supply:** Battery |
| **Remarks:** | | | |

**Table 7.2.3 Field strength of fundamental emission, spurious emissions outside restricted bands and within restricted bands at frequencies above 1 GHz**

| | |
|---|---|
| TEST DISTANCE: | 3 m |
| EUT POSITION: | Typical (Vertical) |
| MODULATION: | GFSK |
| BIT RATE: | 19.2 kbps |
| TRANSMITTER OUTPUT POWER SETTINGS: | Maximum |
| INVESTIGATED FREQUENCY RANGE: | 0.009 - 4500 MHz |
| DETECTOR USED: | Peak |
| RESOLUTION BANDWIDTH: | 1.0 kHz (9 kHz – 150 kHz)<br>9.0 kHz (150 kHz – 30 MHz)<br>120 kHz (30 MHz – 1000 MHz)<br>1.0 MHz (above 1000 MHz) |
| VIDEO BANDWIDTH: | ≥ Resolution bandwidth |
| TEST ANTENNA TYPE: | Active loop (9 kHz – 30 MHz)<br>Biconilog (30 MHz – 1000 MHz)<br>Double ridged guide (above 1000 MHz) |

| F, MHz | Antenna | | Azimuth, degrees* | Peak field strength | | | Average field strength | | | | Verdict |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | Pol. | Height, m | | Measured, dB(µV/m) | Limit, dB(µV/m) | Margin, dB** | Measured, dB(µV/m) | Calculated, dB(µV/m) | Limit, dB(µV/m) | Margin, dB** | |
| **Fundamental emission** | | | | | | | | | | | |
| **U-Sensor** | | | | | | | | | | | |
| 433.7975 | Vert | 1.0 | 196 | 88.94 | 92.9 | -3.96 | 84.37 | 70.68 | 72.9 | -2.22 | Pass |
| 434.2425 | Vert | 1.0 | 197 | 89.50 | 92.9 | -3.40 | 84.31 | 70.62 | 72.9 | -2.28 | Pass |
| **R-Sensor** | | | | | | | | | | | |
| 433.7950 | Vert | 1.0 | 314 | 90.81 | 92.9 | -2.09 | 86.24 | 72.55 | 72.9 | -0.35 | Pass |
| 434.2450 | Vert | 1.0 | 196 | 91.33 | 92.9 | -1.57 | 86.14 | 72.45 | 72.9 | -0.45 | Pass |
| **Spurious emissions*** ** | | | | | | | | | | | |
| **Low carrier frequency** | | | | | | | | | | | |
| 867.5900 | Vert | 1.1 | 10 | 57.83 | 72.9 | -15.07 | 57.83 | 44.14 | 52.9 | -8.76 | Pass |
| 1301.400 | Vert | 1.1 | 92 | 50.74 | 74.0 | -23.26 | 50.74 | 37.05 | 54.0 | -16.95 | |
| 1735.225 | Vert | 1.1 | 169 | 46.13 | 72.9 | -26.77 | 46.13 | 32.44 | 52.9 | -20.46 | |
| **High carrier frequency** | | | | | | | | | | | |
| 868.3100 | Vert | 1.1 | 10 | 57.82 | 72.9 | -15.08 | 57.82 | 44.13 | 52.9 | -8.77 | Pass |
| 1302.712 | Vert | 1.1 | 84 | 51.11 | 74.0 | -22.89 | 51.11 | 37.42 | 54.0 | -16.58 | |
| 1737.100 | Vert | 1.1 | 160 | 45.55 | 72.9 | -27.35 | 45.55 | 31.86 | 52.9 | -21.04 | |

*****- EUT front panel refers to 0 degrees position of turntable.
******- Margin = dB below (negative if above) specification limit.
*** The spurious were measured for R-Sensor as the worst case of fundamental emission.

| **Test specification:** | **FCC Part 15, Section 231(e) / RSS-210, Section A1.1.5, Field strength of emissions** | | |
|---|---|---|---|
| **Test procedure:** | ANSI C63.4, Section 13.1.4 | | |
| **Test mode:** | Compliance | **Verdict:** | PASS |
| **Date(s):** | 3/14/2013 | | |
| **Temperature:** 22.3 ºC | **Air Pressure:** 1012 hPa | **Relative Humidity:** 44 % | **Power Supply:** Battery |
| **Remarks:** | | | |

**Table 7.2.4 Average factor calculation**

| Transmission pulse | | Transmission burst | | Transmission train duration, ms | Average factor, dB |
|---|---|---|---|---|---|
| Duration, ms | Period, ms | Duration, ms | Period, ms | | |
| 20.67 | 100.0 | 120.7 | 17.99 | NA | -13.69 |

*- Average factor was calculated as follows

for pulse train shorter than 100 ms: $$Average\ factor = 20 \times \log_{10}\left(\frac{Pulse\ duration}{Pulse\ period} \times \frac{Burst\ duration}{Train\ duration} \times Number\ of\ bursts\ within\ pulse\ train\right)$$

for pulse train longer than 100 ms: $$Average\ factor = 20 \times \log_{10}\left(\frac{Pulse\ duration}{Pulse\ period} \times \frac{Burst\ duration}{100\,ms} \times Number\ of\ bursts\ within\ 100\,ms\right)$$

**Reference numbers of test equipment used**

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| HL 0446 | HL 0604 | HL 2909 | HL 4114 | HL 4351 | HL 4353 | | |

Full description is given in Appendix A.

| **Test specification:** | **FCC Part 15, Section 231(e) / RSS-210, Section A1.1.5, Field strength of emissions** | | |
|---|---|---|---|
| **Test procedure:** | ANSI C63.4, Section 13.1.4 | | |
| **Test mode:** | Compliance | **Verdict:** | PASS |
| **Date(s):** | 3/14/2013 | | |
| **Temperature:** 22.3 ºC | **Air Pressure:** 1012 hPa | **Relative Humidity:** 44 % | **Power Supply:** Battery |
| **Remarks:** | | | |

**Table 7.2.5 Field strength of emissions below 1 GHz within restricted bands**

| | |
|---|---|
| TEST DISTANCE: | 3 m |
| EUT POSITION: | Typical (Vertical) |
| MODULATION: | GFSK |
| MODULATING SIGNAL: | ID code |
| BIT RATE: | 19.2 kbps |
| TRANSMITTER OUTPUT POWER SETTINGS: | Maximum |
| INVESTIGATED FREQUENCY RANGE: | 0.009 – 1000 MHz |
| DETECTOR USED: | Peak |
| RESOLUTION BANDWIDTH: | 1.0 kHz (9 kHz – 150 kHz)<br>9.0 kHz (150 kHz – 30 MHz)<br>120 kHz (30 MHz – 1000 MHz) |
| VIDEO BANDWIDTH: | ≥ Resolution bandwidth |
| TEST ANTENNA TYPE: | Active loop (9 kHz – 30 MHz)<br>Biconilog (30 MHz – 1000 MHz) |

| **Frequency, MHz** | **Peak emission, dB(μV/m)** | **Quasi-peak** | | | **Antenna polarization** | **Antenna height, m** | **Turn-table position**, degrees** | **Verdict** |
|---|---|---|---|---|---|---|---|---|
| | | **Measured emission, dB(μV/m)** | **Limit, dB(μV/m)** | **Margin, dB*** | | | | |
| **Low carrier frequency** | | | | | | | | |
| 120.000 | 31.22 | 30.65 | 43.5 | -12.85 | Vert | 1.0 | 0 | Pass |
| **High carrier frequency** | | | | | | | | |
| 120.000 | 30.91 | 30.33 | 43.5 | -13.17 | Vert | 1.0 | 0 | Pass |

*****- Margin = Measured emission - specification limit.
******- EUT front panel refer to 0 degrees position of turntable.

**Reference numbers of test equipment used**

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| HL 0446 | HL 0604 | HL 2909 | HL 4351 | HL 4353 | | | |

Full description is given in Appendix A.

| Test specification: | FCC Part 15, Section 231(e) / RSS-210, Section A1.1.5, Field strength of emissions | | |
|---|---|---|---|
| Test procedure: | ANSI C63.4, Section 13.1.4 | | |
| Test mode: | Compliance | Verdict: | PASS |
| Date(s): | 3/14/2013 | | |
| Temperature: 22.3 ºC | Air Pressure: 1012 hPa | Relative Humidity: 44 % | Power Supply: Battery |
| Remarks: | | | |

**Table 7.2.6 Restricted bands according to FCC 15, Section 205**

| MHz | MHz | MHz | MHz | MHz | GHz |
|---|---|---|---|---|---|
| 0.09 - 0.11 | 8.37625 - 8.38675 | 73 - 74.6 | 399.9 - 410 | 2690 - 2900 | 10.6 - 12.7 |
| 0.495 - 0.505 | 8.41425 - 8.41475 | 74.8 - 75.2 | 608 - 614 | 3260 - 3267 | 13.25 - 13.4 |
| 2.1735 - 2.1905 | 12.290 - 12.293 | 108 - 121.94 | 960 - 1240 | 3332 - 3339 | 14.47 - 14.5 |
| 4.125 - 4.128 | 12.51975 - 12.52025 | 123 - 138 | 1300 - 1427 | 3345.8 - 3358 | 15.35 - 16.2 |
| 4.17725 - 4.17775 | 12.57675 - 12.57725 | 149.9 - 150.05 | 1435 - 1626.5 | 3600 - 4400 | 17.7 - 21.4 |
| 4.20725 - 4.20775 | 13.36 - 13.41 | 156.52475 - 156.52525 | 1645.5 - 1646.5 | 4500 - 5150 | 22.01 - 23.12 |
| 6.215 - 6.218 | 16.420 - 16.423 | 156.7 - 156.9 | 1660 - 1710 | 5350 – 5460 | 23.6 - 24 |
| 6.26775 - 6.26825 | 16.69475 - 16.69525 | 162.0125 - 167.17 | 1718.8 - 1722.2 | 7250 - 7750 | 31.2 - 31.8 |
| 6.31175 - 6.31225 | 16.80425 - 16.80475 | 167.72 - 173.2 | 2200 - 2300 | 8025 - 8500 | 36.43 - 36.5 |
| 8.291 - 8.294 | 25.5 - 25.67 | 240 - 285 | 2310 - 2390 | 9000 - 9200 | Above 38.6 |
| 8.362 - 8.366 | 37.5 - 38.25 | 322 - 335.4 | 2483.5 - 2500 | 9300 - 9500 | |

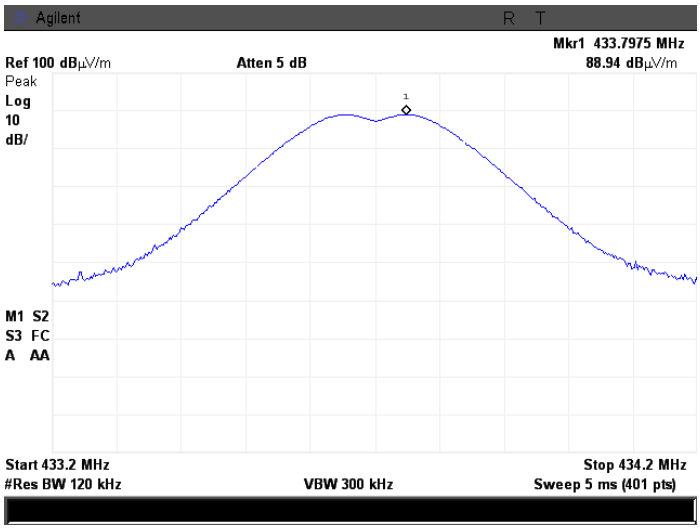
**Table 7.2.7 Restricted bands according to RSS-210, Section 2.7**

| MHz | MHz | MHz | MHz | MHz | GHz |
|---|---|---|---|---|---|
| 0.09 - 0.11 | 8.291 - 8.294 | 16.80425 - 16.80475 | 399.9 - 410 | 3260 - 3267 | 10.6 - 12.7 |
| 2.1735 - 2.190 | 8.362 - 8.366 | 25.5 - 25.67 | 608 - 614 | 3332 - 3339 | 13.25 - 13.4 |
| 3.020 - 3.026 | 8.37625 - 8.38675 | 37.5 - 38.25 | 960 - 1427 | 3345.8 - 3358 | 14.47 - 14.5 |
| 4.125 - 4.128 | 8.41425 - 8.41475 | 73 - 74.6 | 1435 - 1626.5 | 3500 - 4400 | 15.35 - 16.2 |
| 4.17725 - 4.17775 | 12.290 - 12.293 | 74.8 - 75.2 | 1645.5 - 1646.5 | 4500 - 5150 | 17.7 - 21.4 |
| 4.20725 - 4.20775 | 12.51975 - 12.52025 | 108 - 138 | 1660 - 1710 | 5350 – 5460 | 22.01 - 23.12 |
| 5.677 - 5.683 | 12.57675 - 12.57725 | 156.52475 - 156.52525 | 1718.8 - 1722.2 | 7250 - 7750 | 23.6 – 24.0 |
| 6.215 - 6.218 | 13.36 - 13.41 | 156.7 - 156.9 | 2200 - 2300 | 8025 - 8500 | 31.2 - 31.8 |
| 6.26775 - 6.26825 | 16.42 - 16.423 | 240 - 285 | 2310 - 2390 | 9000 - 9200 | 36.43 - 36.5 |
| 6.31175 - 6.31225 | 16.69475 - 16.69525 | 322 - 335.4 | 2655 - 2900 | 9300 - 9500 | Above 38.6 |

| Test specification: | FCC Part 15, Section 231(e) / RSS-210, Section A1.1.5, Field strength of emissions | | |
|---|---|---|---|
| Test procedure: | ANSI C63.4, Section 13.1.4 | | |
| Test mode: | Compliance | Verdict: | PASS |
| Date(s): | 3/14/2013 | | |
| Temperature: 22.3 ºC | Air Pressure: 1012 hPa | Relative Humidity: 44 % | Power Supply: Battery |
| Remarks: | | | |

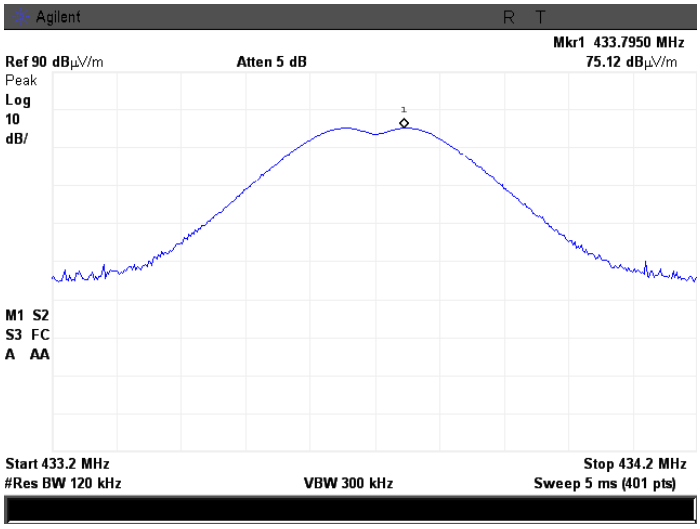
**Plot 7.2.1 Radiated emission measurements at the low carrier frequency, U-Sensor**

TEST SITE: Semi anechoic chamber
TEST DISTANCE: 3 m
ANTENNA POLARIZATION: Vertical
EUT POSITION: Typical (Vertical)
INPUT VOLTAGE: Unom




**Plot 7.2.2 Radiated emission measurements at the low carrier frequency, U-Sensor**

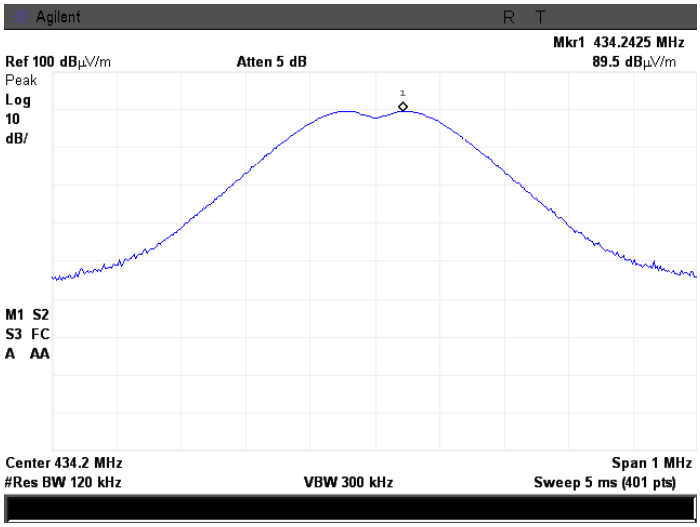
TEST SITE: Semi anechoic chamber
TEST DISTANCE: 3 m
ANTENNA POLARIZATION: Horizontal
EUT POSITION: Typical (Vertical)
INPUT VOLTAGE: Unom



| Test specification: | FCC Part 15, Section 231(e) / RSS-210, Section A1.1.5, Field strength of emissions | | |
|---|---|---|---|
| Test procedure: | ANSI C63.4, Section 13.1.4 | | |
| Test mode: | Compliance | Verdict: | PASS |
| Date(s): | 3/14/2013 | | |
| Temperature: 22.3 ºC | Air Pressure: 1012 hPa | Relative Humidity: 44 % | Power Supply: Battery |
| Remarks: | | | |

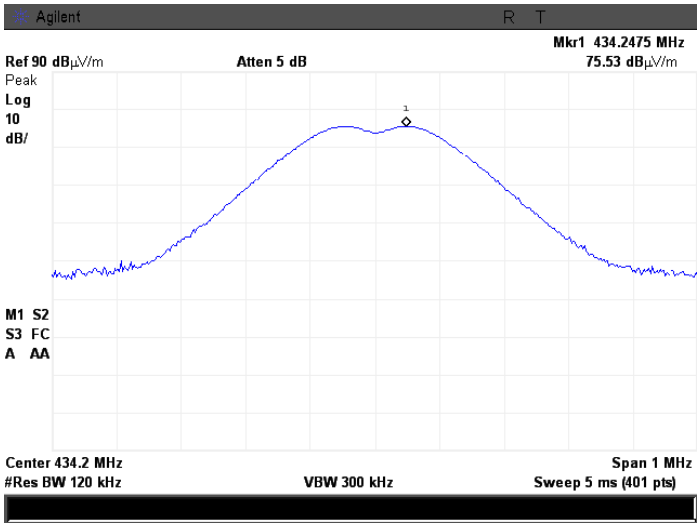
**Plot 7.2.3 Radiated emission measurements at the high carrier frequency, U-Sensor**

TEST SITE: Semi anechoic chamber
TEST DISTANCE: 3 m
ANTENNA POLARIZATION: Vertical
EUT POSITION: Typical (Vertical)
INPUT VOLTAGE: Unom




**Plot 7.2.4 Radiated emission measurements at the high carrier frequency, U-Sensor**

TEST SITE: Semi anechoic chamber
TEST DISTANCE: 3 m
ANTENNA POLARIZATION: Horizontal
EUT POSITION: Typical (Vertical)
INPUT VOLTAGE: Unom

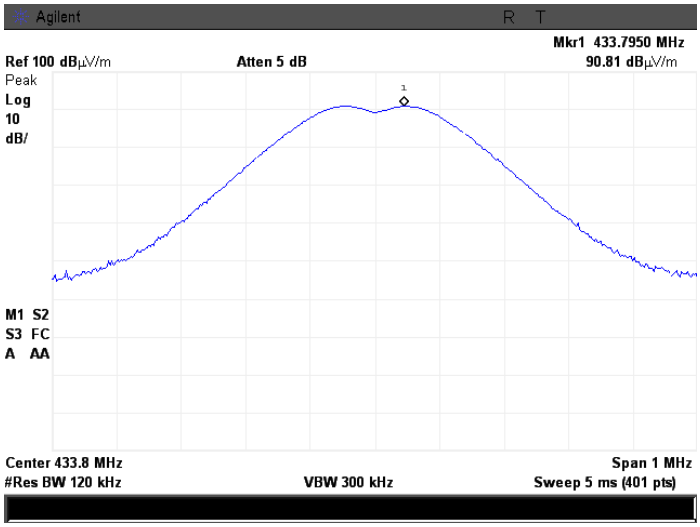


| Test specification: | FCC Part 15, Section 231(e) / RSS-210, Section A1.1.5, Field strength of emissions | | |
|---|---|---|---|
| Test procedure: | ANSI C63.4, Section 13.1.4 | | |
| Test mode: | Compliance | Verdict: | PASS |
| Date(s): | 3/14/2013 | | |
| Temperature: 22.3 ºC | Air Pressure: 1012 hPa | Relative Humidity: 44 % | Power Supply: Battery |
| Remarks: | | | |

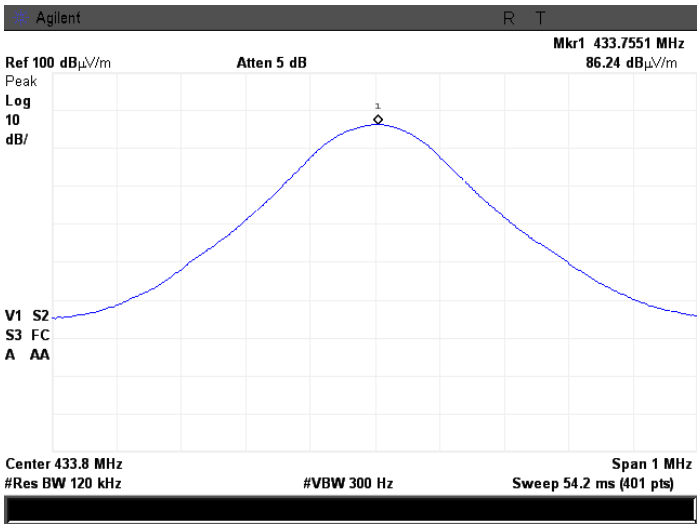
**Plot 7.2.5 Radiated emission measurements at the low carrier frequency, R-Sensor**

TEST SITE: Semi anechoic chamber
TEST DISTANCE: 3 m
ANTENNA POLARIZATION: Vertical
EUT POSITION: Typical (Vertical)
INPUT VOLTAGE: Unom

DETECTOR: Peak



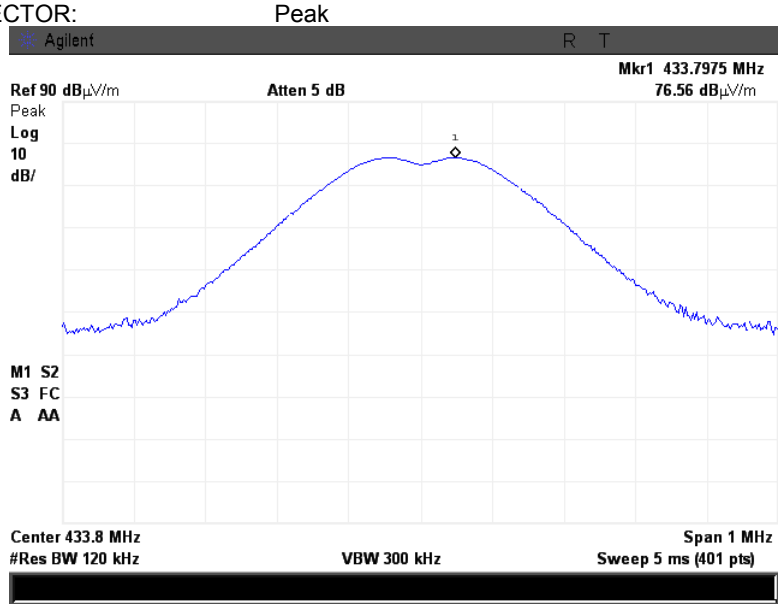

DETECTOR: Average



| **Test specification:** | **FCC Part 15, Section 231(e) / RSS-210, Section A1.1.5, Field strength of emissions** | | |
|---|---|---|---|
| **Test procedure:** | ANSI C63.4, Section 13.1.4 | | |
| **Test mode:** | Compliance | **Verdict:** | PASS |
| **Date(s):** | 3/14/2013 | | |
| **Temperature:** 22.3 ºC | **Air Pressure:** 1012 hPa | **Relative Humidity:** 44 % | **Power Supply:** Battery |
| **Remarks:** | | | |

**Plot 7.2.6 Radiated emission measurements at the low carrier frequency, R-Sensor**

| | |
|---|---|
| TEST SITE: | Semi anechoic chamber |
| TEST DISTANCE: | 3 m |
| ANTENNA POLARIZATION: | Horizontal |
| EUT POSITION: | Typical (Vertical) |
| INPUT VOLTAGE: | Unom |
| DETECTOR: | Peak |

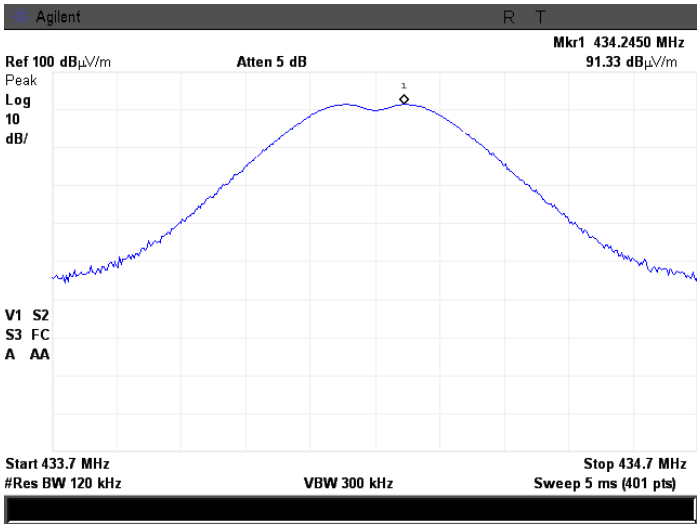


| Test specification: | FCC Part 15, Section 231(e) / RSS-210, Section A1.1.5, Field strength of emissions | | |
|---|---|---|---|
| Test procedure: | ANSI C63.4, Section 13.1.4 | | |
| Test mode: | Compliance | Verdict: | PASS |
| Date(s): | 3/14/2013 | | |
| Temperature: 22.3 ºC | Air Pressure: 1012 hPa | Relative Humidity: 44 % | Power Supply: Battery |
| Remarks: | | | |

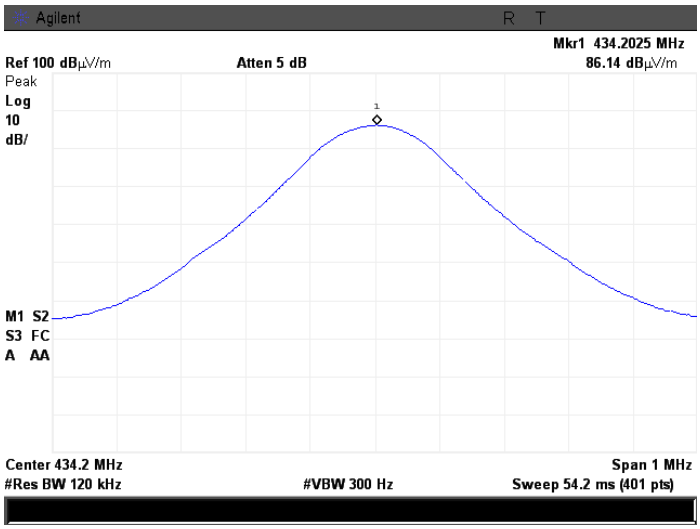
**Plot 7.2.7 Radiated emission measurements at the high carrier frequency, R-Sensor**

TEST SITE: Semi anechoic chamber
TEST DISTANCE: 3 m
ANTENNA POLARIZATION: Vertical
EUT POSITION: Typical (Vertical)
INPUT VOLTAGE: Unom

DETECTOR: Peak



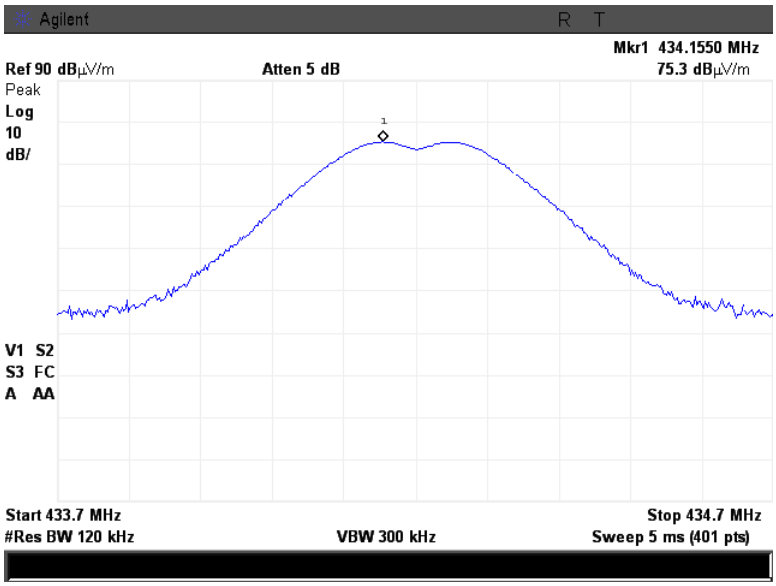

DETECTOR: Average



| **Test specification:** | **FCC Part 15, Section 231(e) / RSS-210, Section A1.1.5, Field strength of emissions** | | |
|---|---|---|---|
| **Test procedure:** | ANSI C63.4, Section 13.1.4 | | |
| **Test mode:** | Compliance | **Verdict:** | PASS |
| **Date(s):** | 3/14/2013 | | |
| **Temperature:** 22.3 ºC | **Air Pressure:** 1012 hPa | **Relative Humidity:** 44 % | **Power Supply:** Battery |
| **Remarks:** | | | |

**Plot 7.2.8 Radiated emission measurements at the high carrier frequency, R-Sensor**

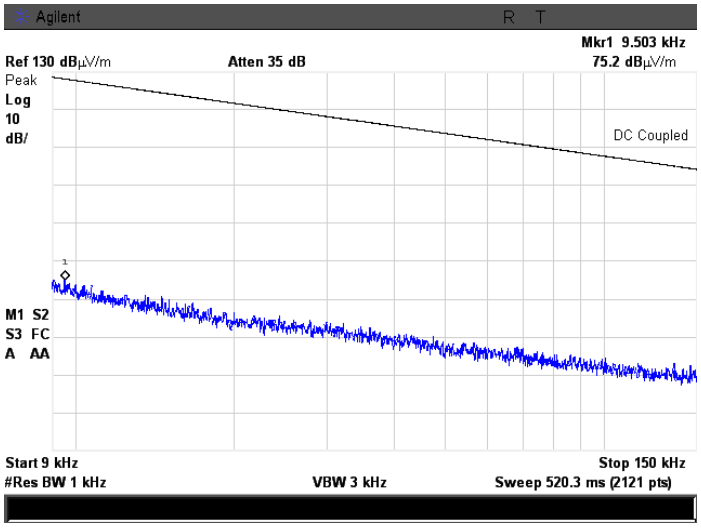
| | |
|---|---|
| TEST SITE: | Semi anechoic chamber |
| TEST DISTANCE: | 3 m |
| ANTENNA POLARIZATION: | Horizontal |
| EUT POSITION: | Typical (Vertical) |
| INPUT VOLTAGE: | Unom |
| DETECTOR: | Peak |



| Test specification: | FCC Part 15, Section 231(e) / RSS-210, Section A1.1.5, Field strength of emissions | | |
|---|---|---|---|
| Test procedure: | ANSI C63.4, Section 13.1.4 | | |
| Test mode: | Compliance | Verdict: | PASS |
| Date(s): | 3/14/2013 | | |
| Temperature: 22.3 ºC | Air Pressure: 1012 hPa | Relative Humidity: 44 % | Power Supply: Battery |
| Remarks: | | | |

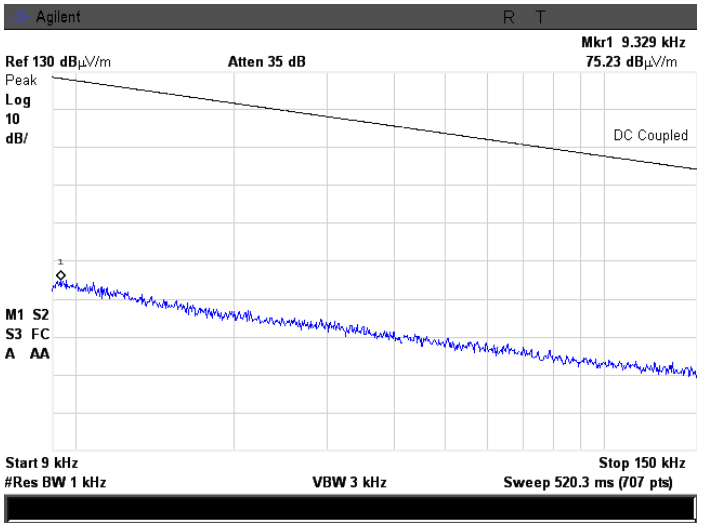
**Plot 7.2.9 Radiated emission measurements from 9 to 150 kHz at the low carrier frequency**

TEST SITE: Semi anechoic chamber
TEST DISTANCE: 3 m
ANTENNA POLARIZATION: Vertical
EUT POSITION: Typical (Vertical)




**Plot 7.2.10 Radiated emission measurements from 9 to 150 kHz at the high carrier frequency**

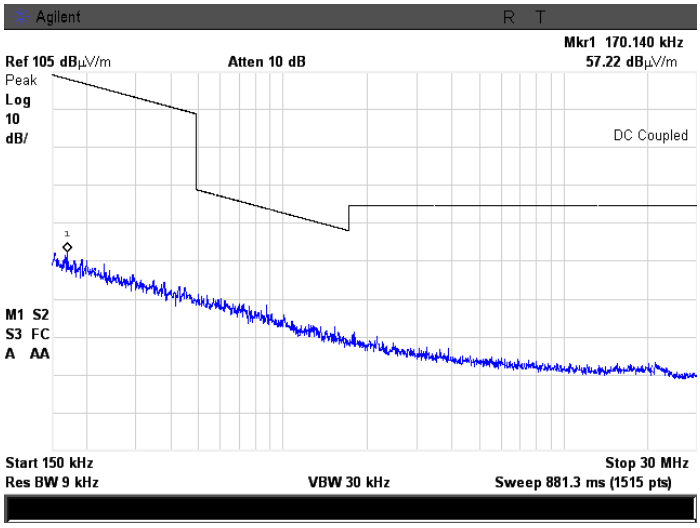
TEST SITE: Semi anechoic chamber
TEST DISTANCE: 3 m
ANTENNA POLARIZATION: Vertical
EUT POSITION: Typical (Vertical)



| **Test specification:** | **FCC Part 15, Section 231(e) / RSS-210, Section A1.1.5, Field strength of emissions** | | |
|---|---|---|---|
| **Test procedure:** | ANSI C63.4, Section 13.1.4 | | |
| **Test mode:** | Compliance | **Verdict:** | PASS |
| **Date(s):** | 3/14/2013 | | |
| **Temperature:** 22.3 ºC | **Air Pressure:** 1012 hPa | **Relative Humidity:** 44 % | **Power Supply:** Battery |
| **Remarks:** | | | |

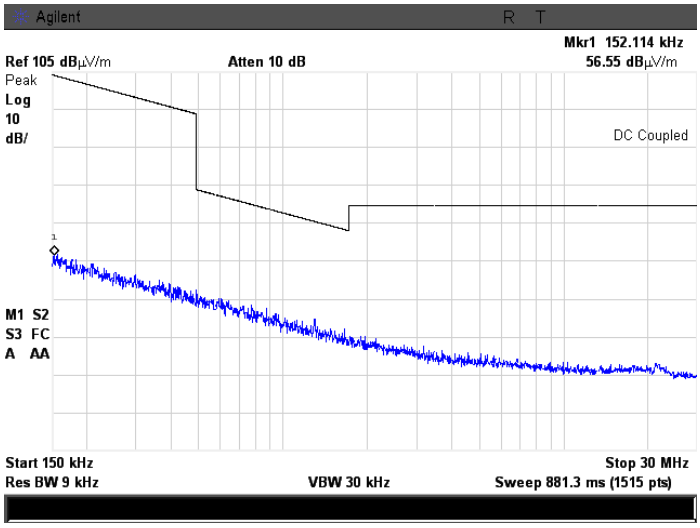
**Plot 7.2.11 Radiated emission measurements from 0.15 to 30 MHz at the low carrier frequency**

TEST SITE: Semi anechoic chamber
TEST DISTANCE: 3 m
ANTENNA POLARIZATION: Vertical
EUT POSITION: Typical (Vertical)




**Plot 7.2.12 Radiated emission measurements from 0.15 to 30 MHz at the high carrier frequency**

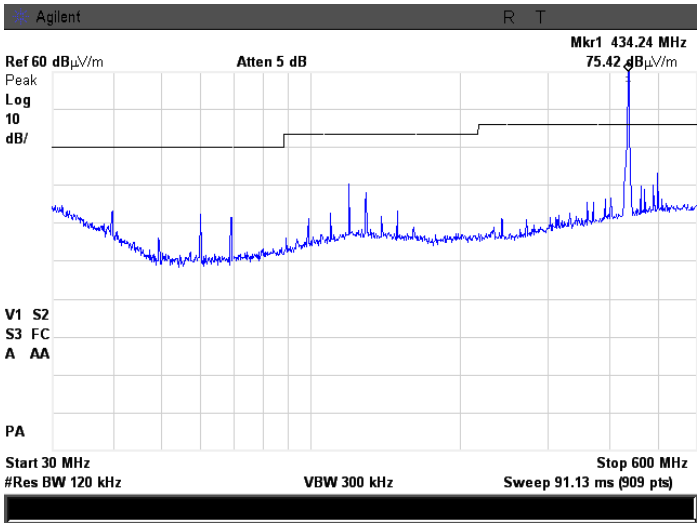
TEST SITE: Semi anechoic chamber
TEST DISTANCE: 3 m
ANTENNA POLARIZATION: Vertical
EUT POSITION: Typical (Vertical)



| Test specification: | FCC Part 15, Section 231(e) / RSS-210, Section A1.1.5, Field strength of emissions | | |
|---|---|---|---|
| Test procedure: | ANSI C63.4, Section 13.1.4 | | |
| Test mode: | Compliance | Verdict: | PASS |
| Date(s): | 3/14/2013 | | |
| Temperature: 22.3 ºC | Air Pressure: 1012 hPa | Relative Humidity: 44 % | Power Supply: Battery |
| Remarks: | | | |

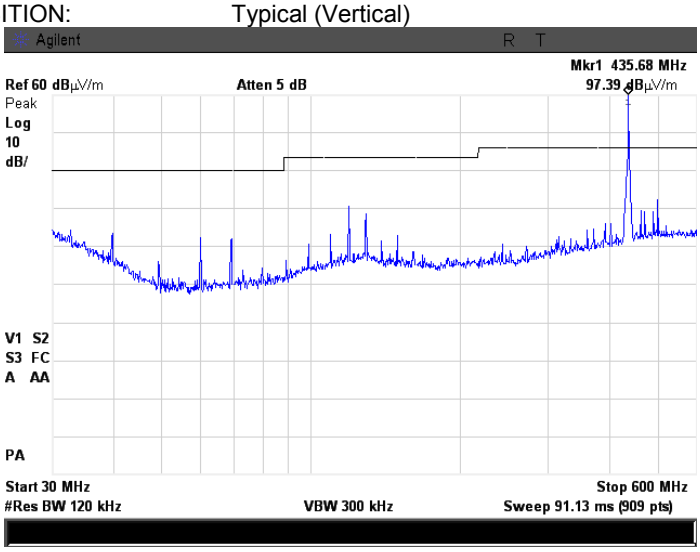
**Plot 7.2.13 Radiated emission measurements from 30 to 600 MHz at the low carrier frequency**

TEST SITE: Semi anechoic chamber
TEST DISTANCE: 3 m
ANTENNA POLARIZATION: Vertical and Horizontal
EUT POSITION: Typical (Vertical)




**Plot 7.2.14 Radiated emission measurements from 30 to 600 MHz at the high carrier frequency**

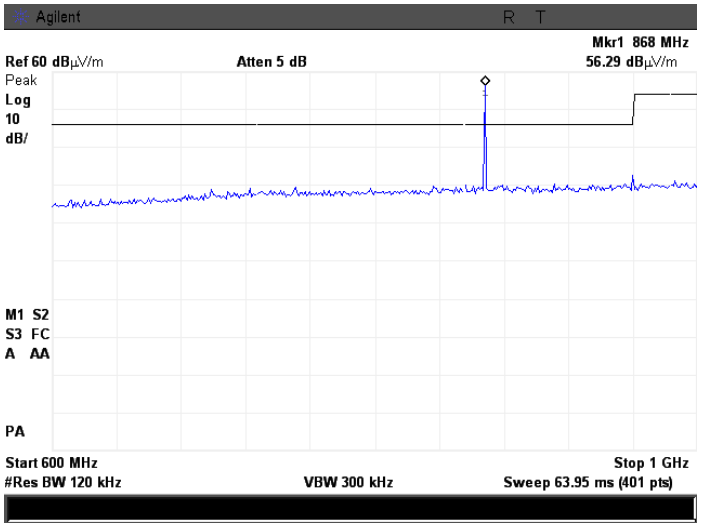
TEST SITE: Semi anechoic chamber
TEST DISTANCE: 3 m
ANTENNA POLARIZATION: Vertical and Horizontal
EUT POSITION: Typical (Vertical)



| **Test specification:** | **FCC Part 15, Section 231(e) / RSS-210, Section A1.1.5, Field strength of emissions** | | |
|---|---|---|---|
| **Test procedure:** | ANSI C63.4, Section 13.1.4 | | |
| **Test mode:** | Compliance | **Verdict:** | PASS |
| **Date(s):** | 3/14/2013 | | |
| **Temperature:** 22.3 ºC | **Air Pressure:** 1012 hPa | **Relative Humidity:** 44 % | **Power Supply:** Battery |
| **Remarks:** | | | |

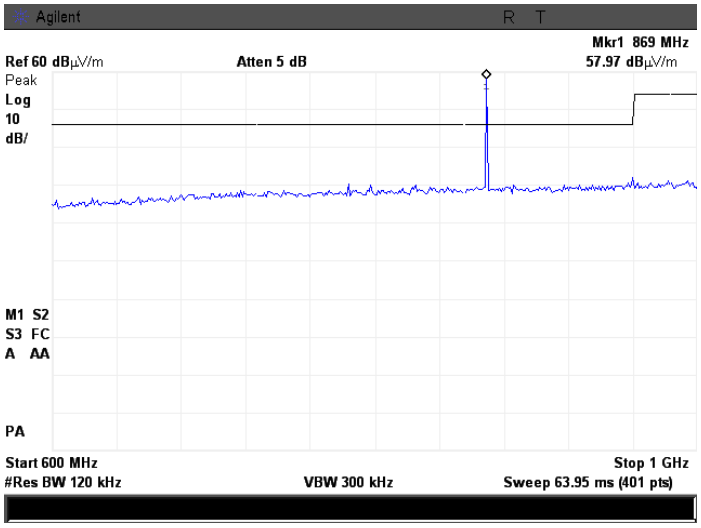
**Plot 7.2.15 Radiated emission measurements from 600 to 1000 MHz at the low carrier frequency**

TEST SITE: Semi anechoic chamber
TEST DISTANCE: 3 m
ANTENNA POLARIZATION: Vertical and Horizontal
EUT POSITION: Typical (Vertical)




**Plot 7.2.16 Radiated emission measurements from 600 to 1000 MHz at the high carrier frequency**

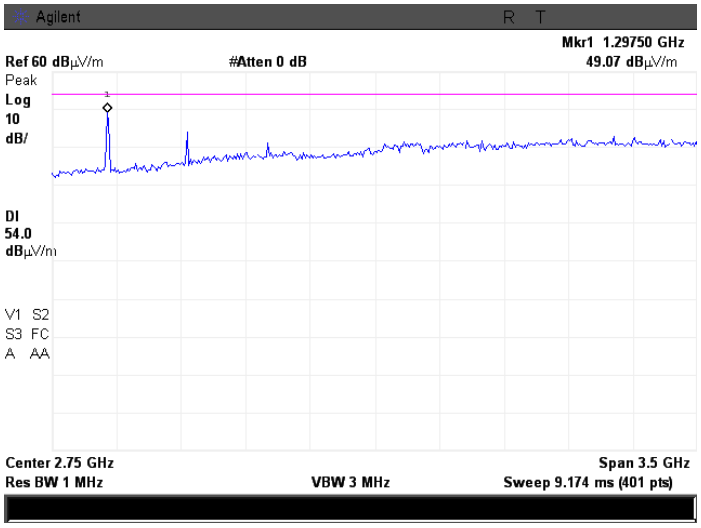
TEST SITE: Semi anechoic chamber
TEST DISTANCE: 3 m
ANTENNA POLARIZATION: Vertical and Horizontal
EUT POSITION: Typical (Vertical)



| **Test specification:** | **FCC Part 15, Section 231(e) / RSS-210, Section A1.1.5, Field strength of emissions** | | |
|---|---|---|---|
| **Test procedure:** | ANSI C63.4, Section 13.1.4 | | |
| **Test mode:** | Compliance | **Verdict:** | PASS |
| **Date(s):** | 3/14/2013 | | |
| **Temperature:** 22.3 ºC | **Air Pressure:** 1012 hPa | **Relative Humidity:** 44 % | **Power Supply:** Battery |
| **Remarks:** | | | |

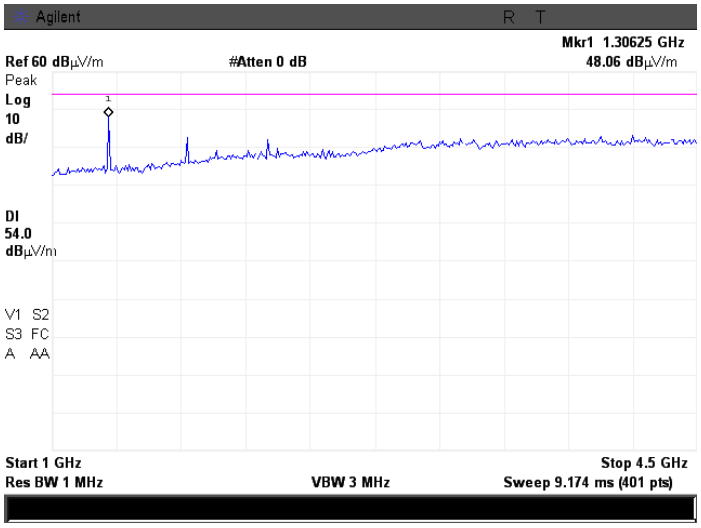
**Plot 7.2.17 Radiated emission measurements from 1000 to 4500 MHz at the low carrier frequency**

TEST SITE: Semi anechoic chamber
TEST DISTANCE: 3 m
ANTENNA POLARIZATION: Vertical and Horizontal
EUT POSITION: Typical (Vertical)




**Plot 7.2.18 Radiated emission measurements from 1000 to 4500 MHz at the high carrier frequency**

TEST SITE: Semi anechoic chamber
TEST DISTANCE: 3 m
ANTENNA POLARIZATION: Vertical and Horizontal
EUT POSITION: Typical (Vertical)

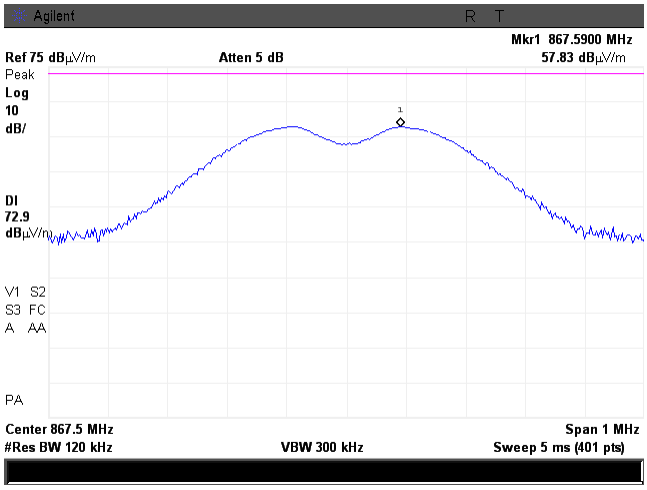


| Test specification: | FCC Part 15, Section 231(e) / RSS-210, Section A1.1.5, Field strength of emissions | | |
|---|---|---|---|
| Test procedure: | ANSI C63.4, Section 13.1.4 | | |
| Test mode: | Compliance | Verdict: | PASS |
| Date(s): | 3/14/2013 | | |
| Temperature: 22.3 ºC | Air Pressure: 1012 hPa | Relative Humidity: 44 % | Power Supply: Battery |
| Remarks: | | | |

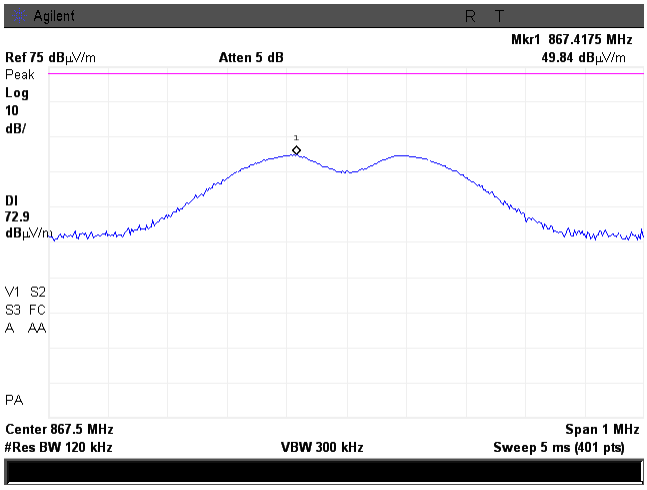
**Plot 7.2.19 Radiated emission measurements at the second harmonic frequency at the low carrier frequency**

TEST SITE: Semi anechoic chamber
TEST DISTANCE: 3 m

EUT POSITION: Typical (Vertical)
ANTENNA POLARIZATION: Vertical

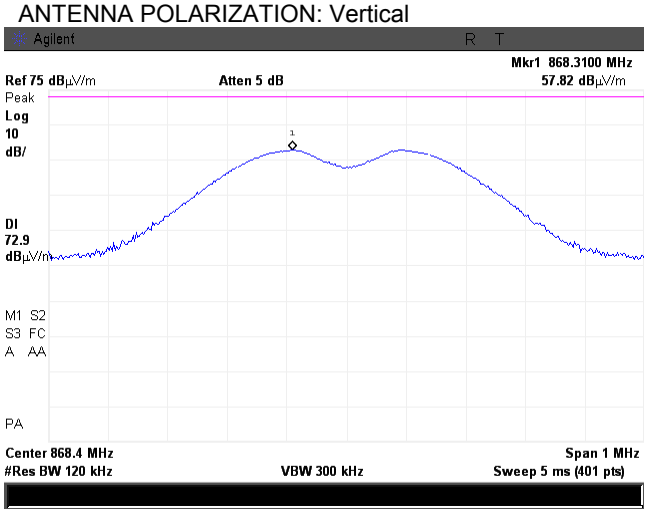



ANTENNA POLARIZATION: Horizontal

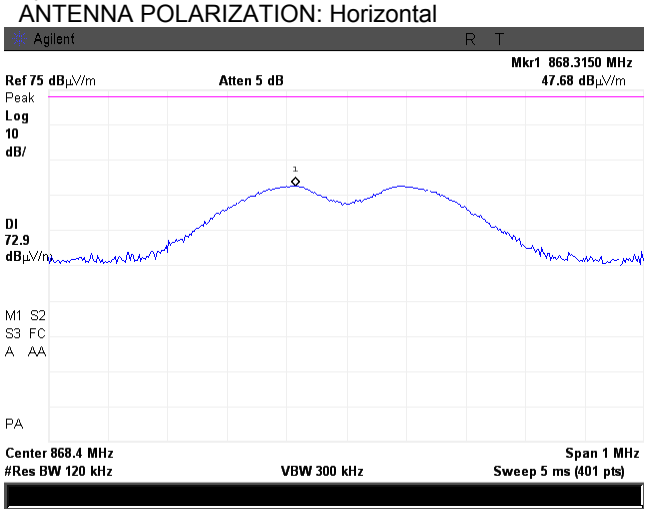



**Plot 7.2.20 Radiated emission measurements at the second harmonic frequency at the high carrier frequency**

TEST SITE: Semi anechoic chamber
TEST DISTANCE: 3 m
EUT POSITION: Typical (Vertical)
ANTENNA POLARIZATION: Vertical



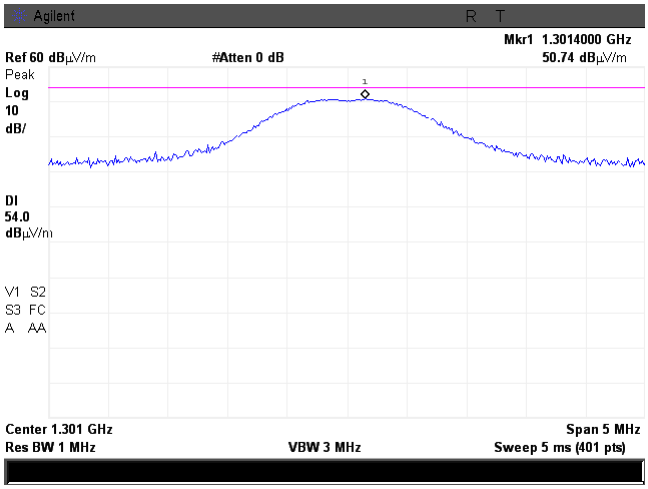

ANTENNA POLARIZATION: Horizontal



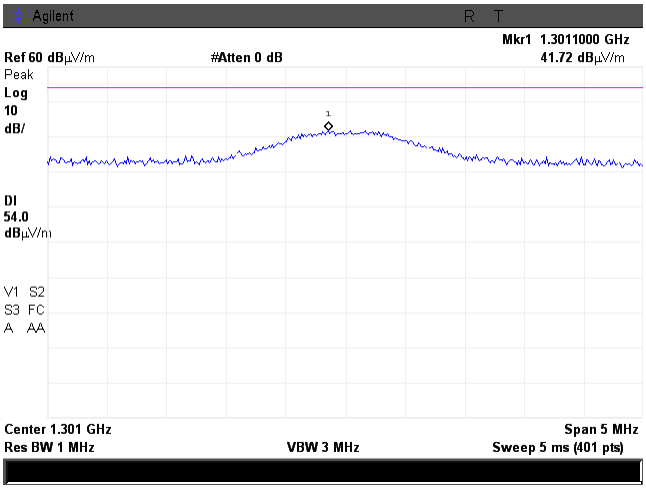
| Test specification: | FCC Part 15, Section 231(e) / RSS-210, Section A1.1.5, Field strength of emissions | | |
|---|---|---|---|
| Test procedure: | ANSI C63.4, Section 13.1.4 | | |
| Test mode: | Compliance | Verdict: | PASS |
| Date(s): | 3/14/2013 | | |
| Temperature: 22.3 ºC | Air Pressure: 1012 hPa | Relative Humidity: 44 % | Power Supply: Battery |
| Remarks: | | | |

**Plot 7.2.21 Radiated emission measurements at the third harmonic frequency at the low carrier frequency**

TEST SITE: Semi anechoic chamber
TEST DISTANCE: 3 m
EUT POSITION: Typical (Vertical)
ANTENNA POLARIZATION: Vertical

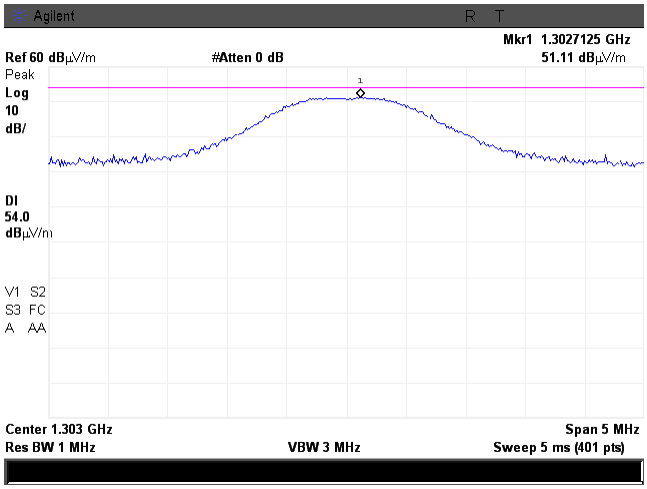



ANTENNA POLARIZATION: Horizontal

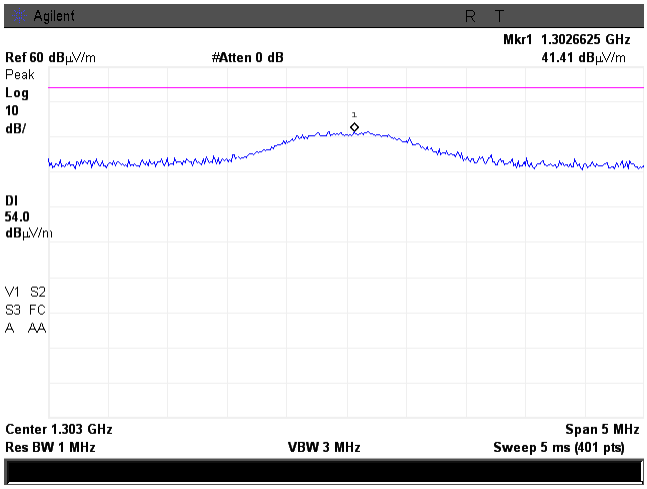



**Plot 7.2.22 Radiated emission measurements at the third harmonic frequency at the high carrier frequency**

TEST SITE: Semi anechoic chamber
TEST DISTANCE: 3 m
EUT POSITION: Typical (Vertical)
ANTENNA POLARIZATION: Vertical



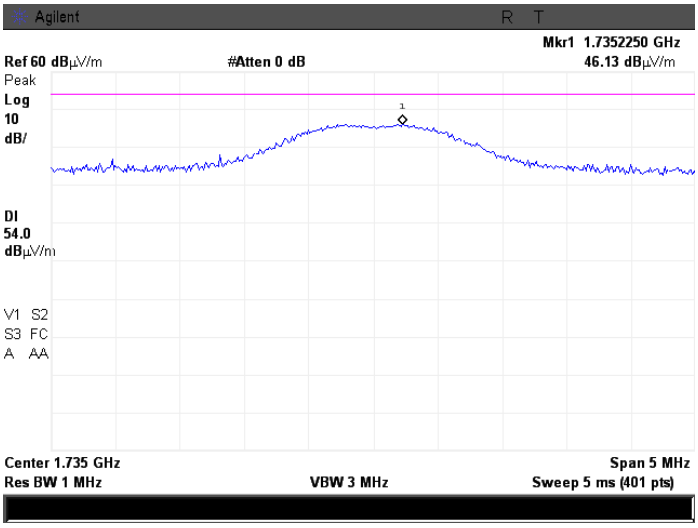

ANTENNA POLARIZATION: Horizontal



| **Test specification:** | **FCC Part 15, Section 231(e) / RSS-210, Section A1.1.5, Field strength of emissions** | | |
|---|---|---|---|
| **Test procedure:** | ANSI C63.4, Section 13.1.4 | | |
| **Test mode:** | Compliance | **Verdict:** | PASS |
| **Date(s):** | 3/14/2013 | | |
| **Temperature:** 22.3 ºC | **Air Pressure:** 1012 hPa | **Relative Humidity:** 44 % | **Power Supply:** Battery |
| **Remarks:** | | | |

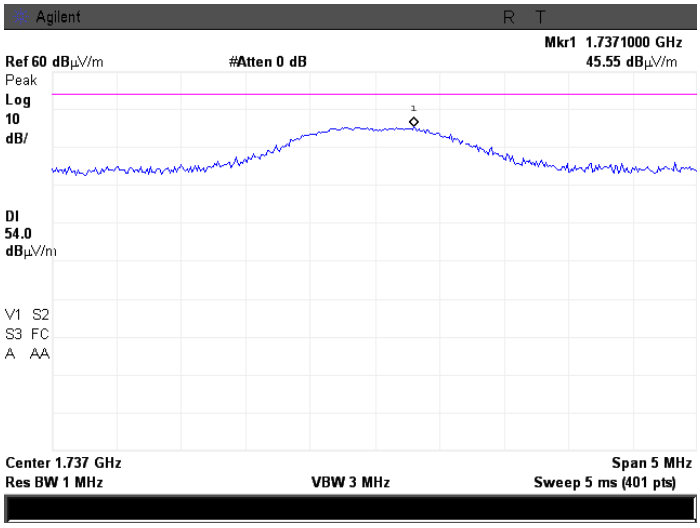
**Plot 7.2.23 Radiated emission measurements at the fourth harmonic frequency at the low carrier frequency**

TEST SITE: Semi anechoic chamber
TEST DISTANCE: 3 m
EUT POSITION: Typical (Vertical)
ANTENNA POLARIZATION: Vertical and Horizontal:




**Plot 7.2.24 Radiated emission measurements at the fourth harmonic frequency at the high carrier frequency**

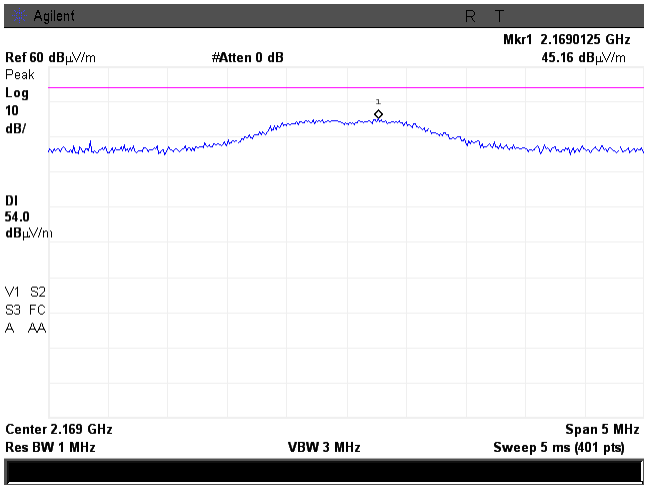
TEST SITE: Semi anechoic chamber
TEST DISTANCE: 3 m
EUT POSITION: Typical (Vertical)
ANTENNA POLARIZATION: Vertical and Horizontal:



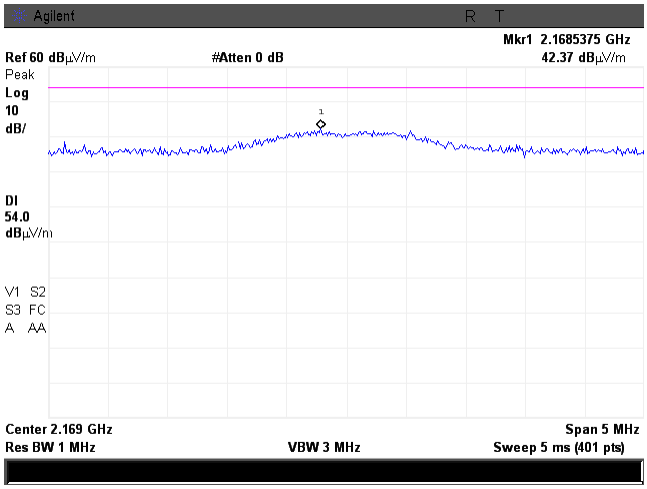
| Test specification: | FCC Part 15, Section 231(e) / RSS-210, Section A1.1.5, Field strength of emissions | | |
|---|---|---|---|
| Test procedure: | ANSI C63.4, Section 13.1.4 | | |
| Test mode: | Compliance | Verdict: | PASS |
| Date(s): | 3/14/2013 | | |
| Temperature: 22.3 ºC | Air Pressure: 1012 hPa | Relative Humidity: 44 % | Power Supply: Battery |
| Remarks: | | | |

**Plot 7.2.25 Radiated emission measurements at the fifth harmonic frequency at the low carrier frequency**

TEST SITE: Semi anechoic chamber
TEST DISTANCE: 3 m
EUT POSITION: Typical (Vertical)
ANTENNA POLARIZATION: Vertical

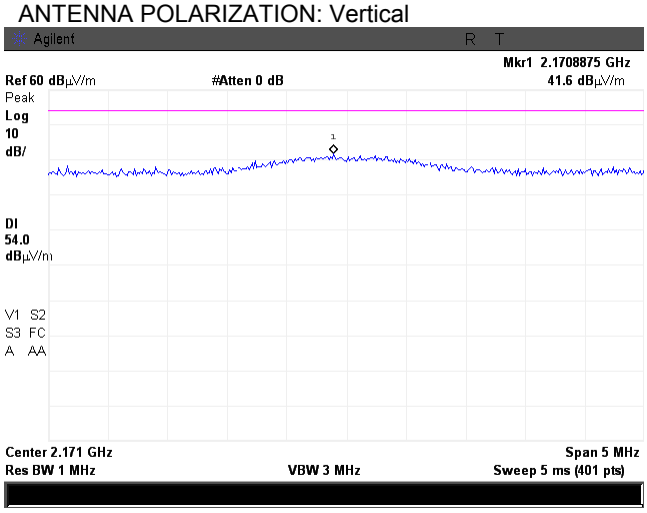



ANTENNA POLARIZATION:Horizontal

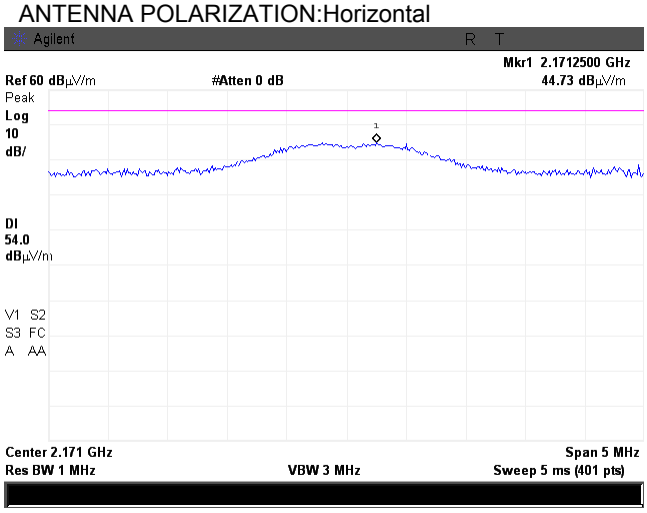



**Plot 7.2.26 Radiated emission measurements at the fifth harmonic frequency at the high carrier frequency**

TEST SITE: Semi anechoic chamber
TEST DISTANCE: 3 m
EUT POSITION: Typical (Vertical)
ANTENNA POLARIZATION: Vertical

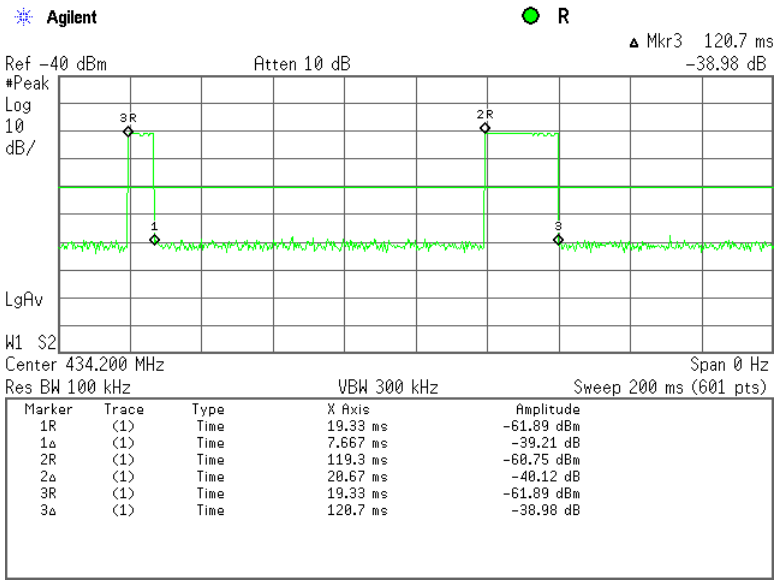



ANTENNA POLARIZATION:Horizontal

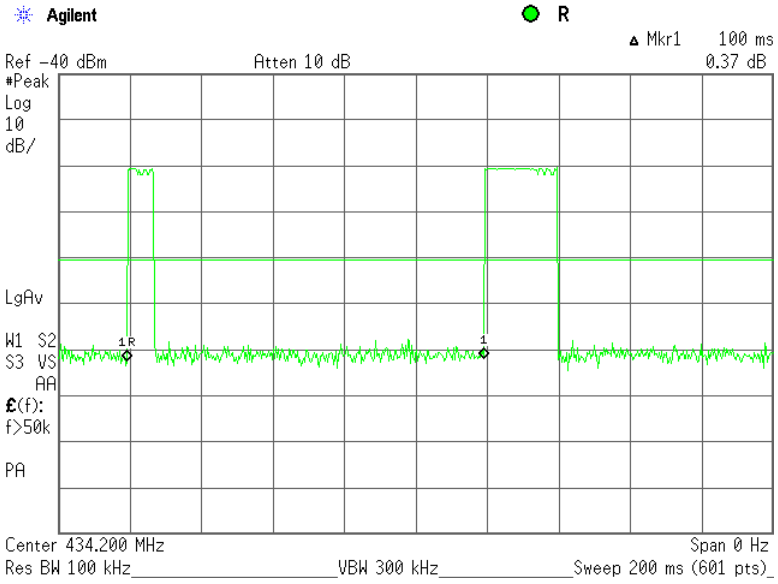


| Test specification: | FCC Part 15, Section 231(e) / RSS-210, Section A1.1.5, Field strength of emissions | | |
|---|---|---|---|
| Test procedure: | ANSI C63.4, Section 13.1.4 | | |
| Test mode: | Compliance | Verdict: | PASS |
| Date(s): | 3/14/2013 | | |
| Temperature: 22.3 ºC | Air Pressure: 1012 hPa | Relative Humidity: 44 % | Power Supply: Battery |
| Remarks: | | | |

**Plot 7.2.27 Transmission pulse duration**

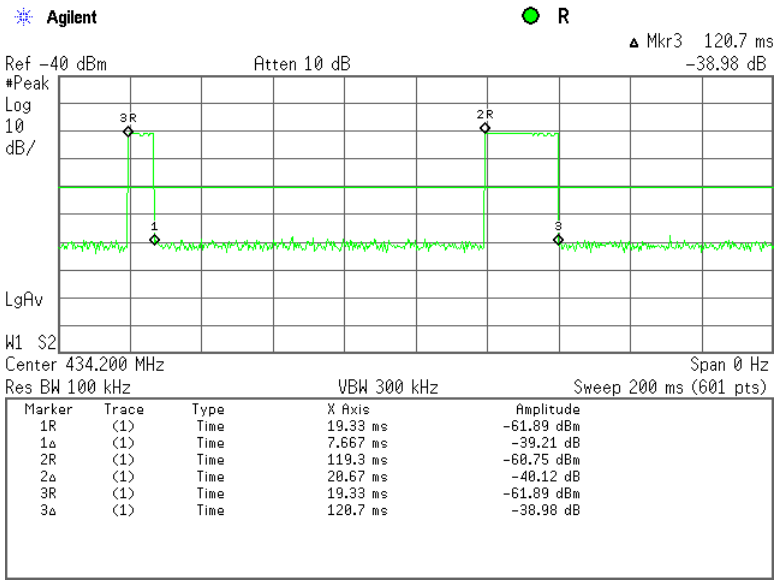



**Plot 7.2.28 Transmission pulse period**

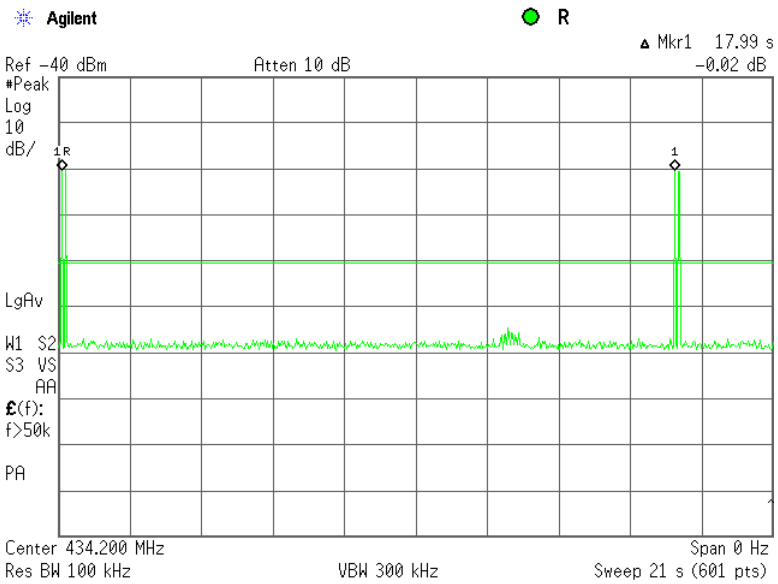


| Test specification: | FCC Part 15, Section 231(e) / RSS-210, Section A1.1.5, Field strength of emissions | | |
|---|---|---|---|
| Test procedure: | ANSI C63.4, Section 13.1.4 | | |
| Test mode: | Compliance | Verdict: | PASS |
| Date(s): | 3/14/2013 | | |
| Temperature: 22.3 ºC | Air Pressure: 1012 hPa | Relative Humidity: 44 % | Power Supply: Battery |
| Remarks: | | | |

**Plot 7.2.29 Transmission burst duration**




**Plot 7.2.30 Transmission burst period**



| Test specification: | FCC Part 15, Section 231(c) / RSS-210, Section A1.1.3, Occupied bandwidth | | |
|---|---|---|---|
| Test procedure: | ANSI C63.4, Section 13.1.7 | | |
| Test mode: | Compliance | Verdict: | PASS |
| Date(s): | 3/14/2013 | | |
| Temperature: 23.8 ºC | Air Pressure: 1009 hPa | Relative Humidity: 45 % | Power Supply: Battery |
| Remarks: | | | |

## 7.3 Occupied bandwidth test

### 7.3.1 General

This test was performed to measure transmitter occupied bandwidth. Specification test limits are given in Table 7.3.1.

**Table 7.3.1 Occupied bandwidth limits**

| Assigned frequency, MHz | Modulation envelope reference points*, dBc | Maximum allowed bandwidth, % of the carrier frequency |
|---|---|---|
| **70 - 900** | **20.0** | **0.25** |
| Above 900 | | 0.50 |

*- Modulation envelope reference points provided in terms of attenuation below modulated carrier.

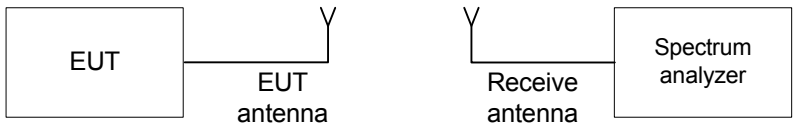
### 7.3.2 Test procedure

**7.3.2.1** The EUT was set up as shown in Figure 7.3.1, energized and its proper operation was checked.

**7.3.2.2** The EUT was set to transmit modulated carrier.

**7.3.2.3** The transmitter occupied bandwidth was measured with spectrum analyzer as frequency delta between reference points on modulation envelope and provided in Table 7.3.2 and the associated plots.

**Figure 7.3.1 Occupied bandwidth test setup**



| Test specification: | FCC Part 15, Section 231(c) / RSS-210, Section A1.1.3, Occupied bandwidth | | |
|---|---|---|---|
| Test procedure: | ANSI C63.4, Section 13.1.7 | | |
| Test mode: | Compliance | Verdict: | PASS |
| Date(s): | 3/14/2013 | | |
| Temperature: 23.8 ºC | Air Pressure: 1009 hPa | Relative Humidity: 45 % | Power Supply: Battery |
| Remarks: | | | |

**Table 7.3.2 Occupied bandwidth test results**

DETECTOR USED: Peak hold
RESOLUTION BANDWIDTH: 10 kHz
VIDEO BANDWIDTH: 30 kHz
MODULATION: FSK
MODULATING SIGNAL: PRBS
BIT RATE: 19.2 kbps

MODULATION ENVELOPE REFERENCE POINTS: 20 dBc

| Carrier frequency, MHz | Occupied bandwidth, kHz | Limit | | Margin, kHz | Verdict |
|---|---|---|---|---|---|
| | | % of the carrier frequency | kHz | | |
| 433.75 | 198.75 | 0.25 | 1084 | -885.25 | Pass |
| 434.20 | 198.70 | 0.25 | 1085 | -886.30 | Pass |

MODULATION ENVELOPE REFERENCE POINTS: 99%

| Carrier frequency, MHz | Occupied bandwidth, kHz | Limit | | Margin, kHz | Verdict |
|---|---|---|---|---|---|
| | | % of the carrier frequency | kHz | | |
| 433.75 | 234.75 | 0.25 | 1084 | -849.25 | Pass |
| 434.20 | 234.70 | 0.25 | 1085 | -850.30 | Pass |

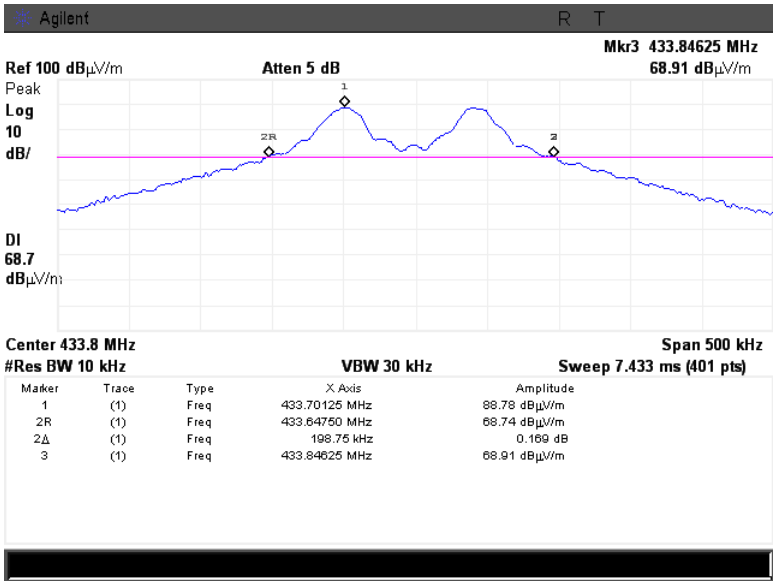
**Reference numbers of test equipment used**

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| HL 0337 | HL 3818 | | | | | | | |

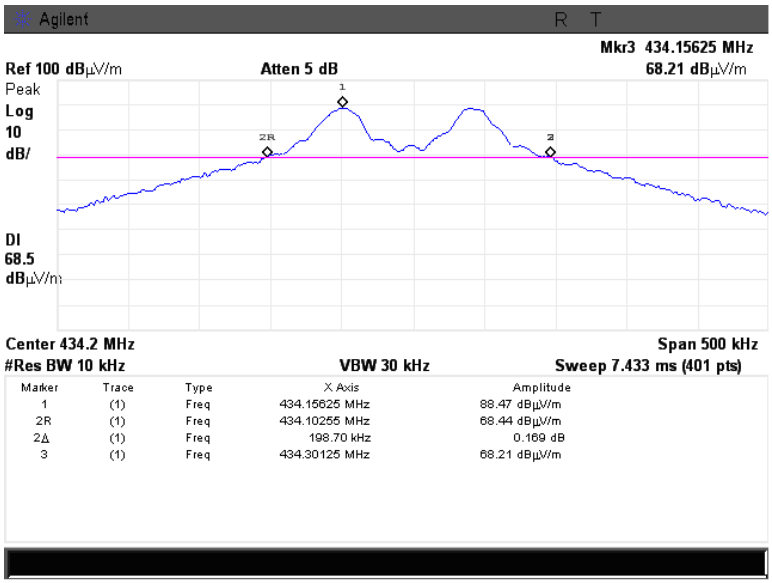
Full description is given in Appendix A.

| Test specification: | FCC Part 15, Section 231(c) / RSS-210, Section A1.1.3, Occupied bandwidth | | |
|---|---|---|---|
| Test procedure: | ANSI C63.4, Section 13.1.7 | | |
| Test mode: | Compliance | Verdict: | PASS |
| Date(s): | 3/14/2013 | | |
| Temperature: 23.8 ºC | Air Pressure: 1009 hPa | Relative Humidity: 45 % | Power Supply: Battery |
| Remarks: | | | |

**Plot 7.3.1 Occupied bandwidth test result at the low frequency, 20 dBc**

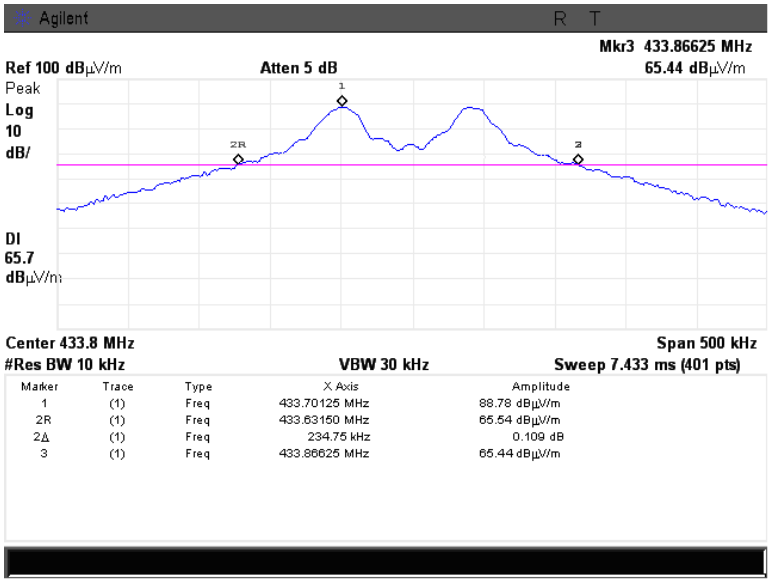



**Plot 7.3.2 Occupied bandwidth test result at the high frequency, 20 dBc**

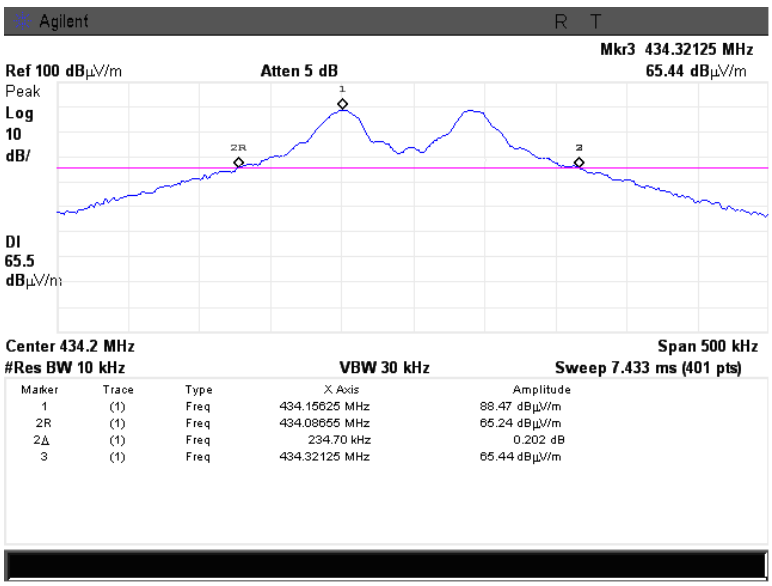


| Test specification: | FCC Part 15, Section 231(c) / RSS-210, Section A1.1.3, Occupied bandwidth | | |
|---|---|---|---|
| Test procedure: | ANSI C63.4, Section 13.1.7 | | |
| Test mode: | Compliance | Verdict: | PASS |
| Date(s): | 3/14/2013 | | |
| Temperature: 23.8 ºC | Air Pressure: 1009 hPa | Relative Humidity: 45 % | Power Supply: Battery |
| Remarks: | | | |

**Plot 7.3.3 Occupied bandwidth test result at the low frequency, 99% power**




**Plot 7.3.4 Occupied bandwidth test result at the high frequency, 99% power**



| Test specification: | FCC Part 15, Section 203 / RSS-Gen, Section 7.1.4, Antenna requirements | | |
|---|---|---|---|
| Test procedure: | Visual inspection / supplier declaration | | |
| Test mode: | Compliance | Verdict: | PASS |
| Date(s): | 3/13/2013 | | |
| Temperature: 22.3 ºC | Air Pressure: 1009 hPa | Relative Humidity: 41 % | Power Supply: Battery |
| Remarks: | | | |

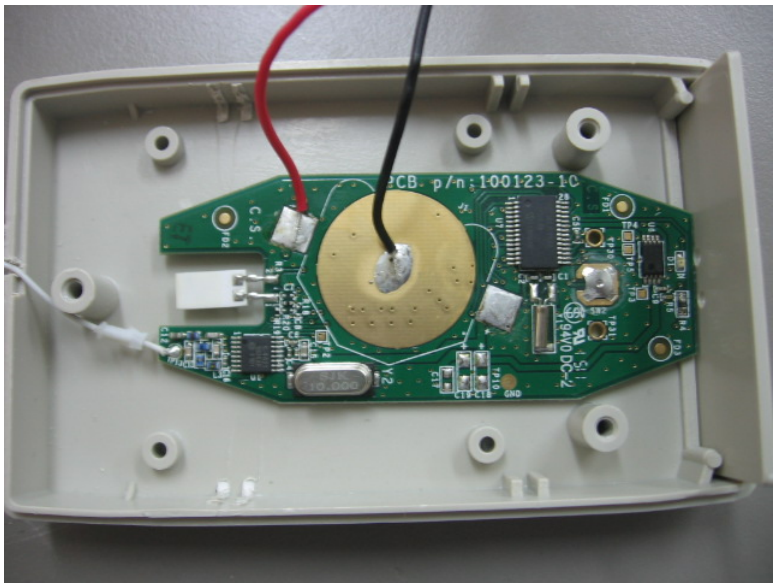
## 7.4 Antenna requirements

The EUT was verified for compliance with antenna requirements. A transmitter shall be designed to ensure that no antenna other than that furnished by the responsible party will be used with the device. It may be either permanently attached or employs a unique antenna connector for every antenna proposed for use with the EUT. This requirement does not apply to professionally installed transmitters.
The rationale for compliance with the above requirements was either visual inspection results or supplier declaration. The summary of results is provided in Table 7.4.1.

**Table 7.4.1 Antenna requirements**

| Requirement | Rationale | Verdict |
|---|---|---|
| The transmitter antenna is permanently attached | Visual inspection | Comply |
| The transmitter employs a unique antenna connector | NA | |
| The transmitter requires professional installation | NA | |

**Photograph 7.4.1 Antenna assembly**



| Test specification: | FCC Section 15.109/ ICES-003 Section 6.2 Class B, Radiated emission | | |
|---|---|---|---|
| Test procedure: | ANSI C63.4, Section 11.6 | | |
| Test mode: | Compliance | Verdict: | PASS |
| Date(s): | 3/18/2013 | | |
| Temperature: 23 ºC | Air Pressure: 1015 hPa | Relative Humidity: 43 % | Power Supply: Battery |
| Remarks: | | | |

# 8 Emissions tests according to 47CFR part 15 subpart B and ICES-003 requirements

## 8.1 Radiated emission measurements

### 8.1.1 General

This test was performed to measure radiated emissions from the EUT enclosure. The specification test limits are given in Table 8.1.1.

**Table 8.1.1 Radiated emission test limits**

| Frequency, MHz | Class B limit, dB(μV/m) | | Class A limit, dB(μV/m) | |
|---|---|---|---|---|
| | 10 m distance | 3 m distance | 10 m distance | 3 m distance |
| 30 - 88 | 29.5* | 40.0 | 39.0 | 49.5* |
| 88 - 216 | 33.0* | 43.5 | 43.5 | 54.0* |
| 216 - 960 | 35.5* | 46.0 | 46.4 | 56.9* |
| Above 960 | 43.5* | 54.0 | 49.5 | 60.0* |

* The limit for test distance other than specified was calculated using the inverse linear distance extrapolation factor as follows: $Lim_{S2} = Lim_{S1} + 20 \log (S_1/S_2)$,
where $S_1$ and $S_2$ – standard defined and test distance respectively in meters.

### 8.1.2 Test procedure

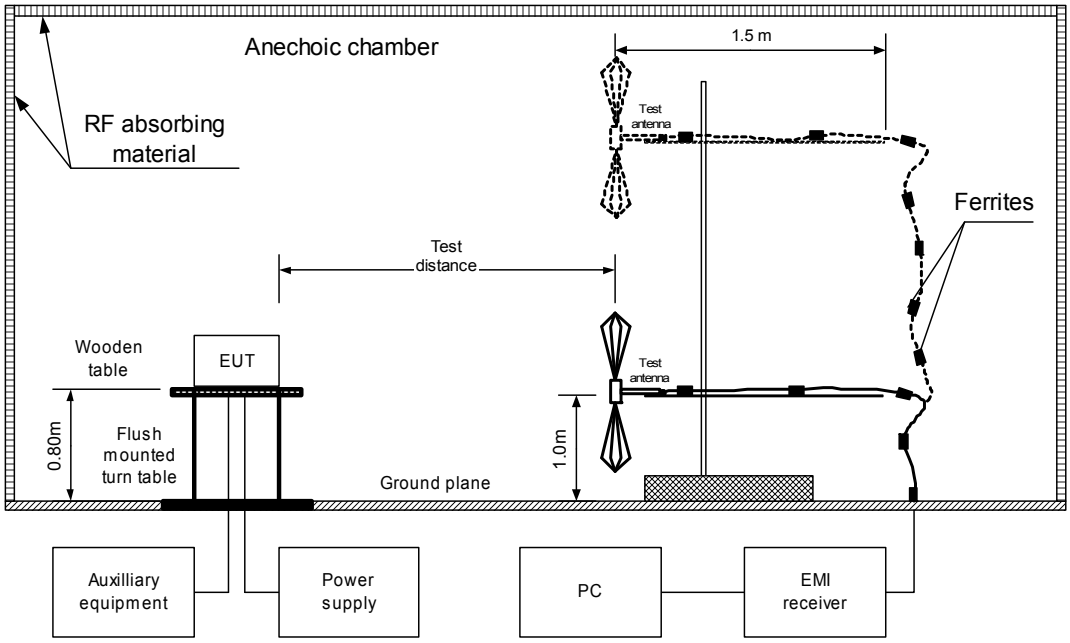
**8.1.2.1** The EUT was set up as shown in Figure 8.1.1 and the associated photographs, energized and the EUT performance was checked.

**8.1.2.2** The measurements were performed in the anechoic chamber at 3 m test distance. The specified frequency range was investigated with the antenna connected to the EMI receiver. To find the highest emission the turntable was rotated $360^0$ and the measuring antenna height was swept from 1 to 4 m in both, vertical and horizontal polarizations. The EUT cables position was varied to maximize emission.

**8.1.2.3** The worst test results with respect to the limits were recorded in Table 8.1.2, Table 8.1.3 and shown in the associated plots.

| Test specification: | FCC Section 15.109/ ICES-003 Section 6.2 Class B, Radiated emission | | |
|---|---|---|---|
| Test procedure: | ANSI C63.4, Section 11.6 | | |
| Test mode: | Compliance | Verdict: | PASS |
| Date(s): | 3/18/2013 | | |
| Temperature: 23 ºC | Air Pressure: 1015 hPa | Relative Humidity: 43 % | Power Supply: Battery |
| Remarks: | | | |

**Figure 8.1.1 Setup for radiated emission measurements in anechoic chamber, table-top EUT**



| Test specification: | FCC Section 15.109/ ICES-003 Section 6.2 Class B, Radiated emission | | |
|---|---|---|---|
| Test procedure: | ANSI C63.4, Section 11.6 | | |
| Test mode: | Compliance | Verdict: | PASS |
| Date(s): | 3/18/2013 | | |
| Temperature: 23 ºC | Air Pressure: 1015 hPa | Relative Humidity: 43 % | Power Supply: Battery |
| Remarks: | | | |

**Photograph 8.1.1 Setup for radiated emission measurements of R-Sensor**

**Photograph 8.1.2 Setup for radiated emission measurements of R-Sensor**

| Test specification: | FCC Section 15.109/ ICES-003 Section 6.2 Class B, Radiated emission | | |
|---|---|---|---|
| Test procedure: | ANSI C63.4, Section 11.6 | | |
| Test mode: | Compliance | Verdict: | PASS |
| Date(s): | 3/18/2013 | | |
| Temperature: 23 ºC | Air Pressure: 1015 hPa | Relative Humidity: 43 % | Power Supply: Battery |
| Remarks: | | | |

**Photograph 8.1.3 Setup for final radiated emission measurements, R-Sensor close view**

| **Test specification:** | **FCC Section 15.109/ ICES-003 Section 6.2 Class B, Radiated emission** | | |
|---|---|---|---|
| **Test procedure:** | ANSI C63.4, Section 11.6 | | |
| **Test mode:** | Compliance | **Verdict:** | PASS |
| **Date(s):** | 3/18/2013 | | |
| **Temperature:** 23 ºC | **Air Pressure:** 1015 hPa | **Relative Humidity:** 43 % | **Power Supply:** Battery |
| **Remarks:** | | | |

**Table 8.1.2 Radiated emission test results**

EUT: R-Sensor
EUT SET UP: TABLE-TOP
TEST SITE: SEMI ANECHOIC CHAMBER
TEST DISTANCE: 3 m
DETECTORS USED: PEAK / QUASI-PEAK
FREQUENCY RANGE: 30 MHz – 1000 MHz
RESOLUTION BANDWIDTH: 120 kHz

| Frequency, MHz | Peak emission, dB(μV/m) | Quasi-peak | | | Antenna polarization | Antenna height, m | Turn-table position**, degrees | Verdict |
|---|---|---|---|---|---|---|---|---|
| | | Measured emission, dB(μV/m) | Limit, dB(μV/m) | Margin, dB* | | | | |
| No emissions were found | | | | | | | | Pass |

DETECTORS USED: PEAK / AVERAGE
FREQUENCY RANGE: 1000 MHz – 2000 MHz
RESOLUTION BANDWIDTH: 1000 kHz

| Frequency, MHz | Peak | | | Average | | | Antenna polarization | Antenna height, m | Turn-table position**, degrees | Verdict |
|---|---|---|---|---|---|---|---|---|---|---|
| | Measured emission, dB(μV/m) | Limit, dB(μV/m) | Margin, dB* | Measured emission, dB(μV/m) | Limit, dB(μV/m) | Margin, dB* | | | | |
| No emissions were found | | | | | | | | | | Pass |

*****- Margin = Measured emission - specification limit.
******- EUT front panel refers to 0 degrees position of turntable.

**Reference numbers of test equipment used**

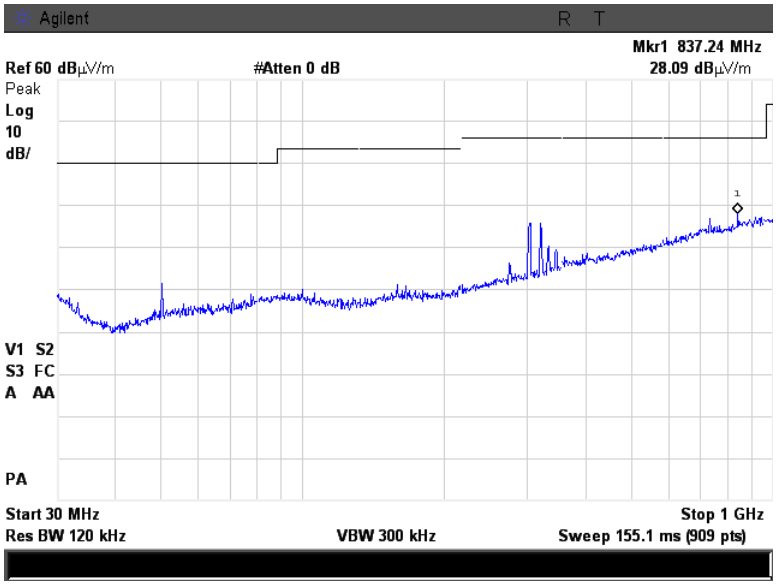
| | | | | | | | |
|---|---|---|---|---|---|---|---|
| HL 0604 | HL 1984 | HL 2780 | HL 2871 | HL 4353 | | | |

Full description is given in Appendix A.

| Test specification: | FCC Section 15.109/ ICES-003 Section 6.2 Class B, Radiated emission | | |
|---|---|---|---|
| Test procedure: | ANSI C63.4, Section 11.6 | | |
| Test mode: | Compliance | Verdict: | PASS |
| Date(s): | 3/18/2013 | | |
| Temperature: 23 ºC | Air Pressure: 1015 hPa | Relative Humidity: 43 % | Power Supply: Battery |
| Remarks: | | | |

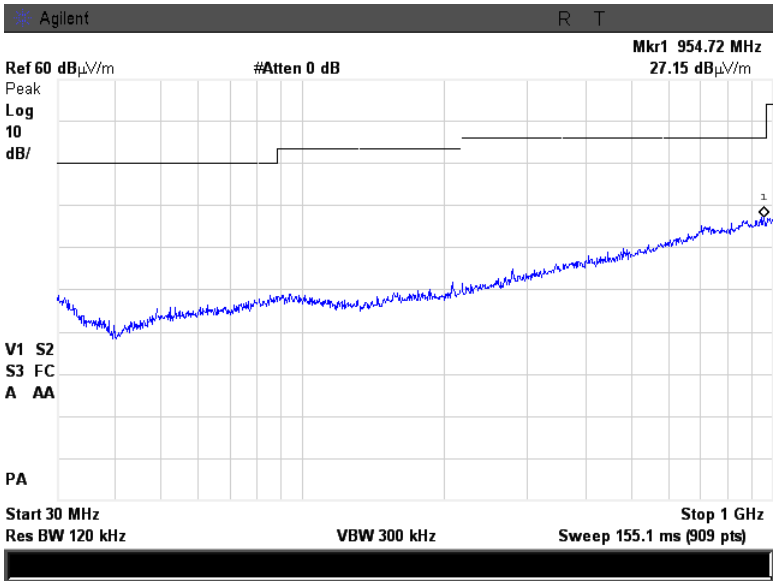
**Plot 8.1.1 Radiated emission measurements in 30 - 1000 MHz range, vertical antenna polarization**

EUT: R-Sensor
TEST SITE: Semi anechoic chamber
TEST DISTANCE: 3 m




**Plot 8.1.2 Radiated emission measurements in 30 - 1000 MHz range, horizontal antenna polarization**

EUT: R-Sensor
TEST SITE: Semi anechoic chamber
TEST DISTANCE: 3 m

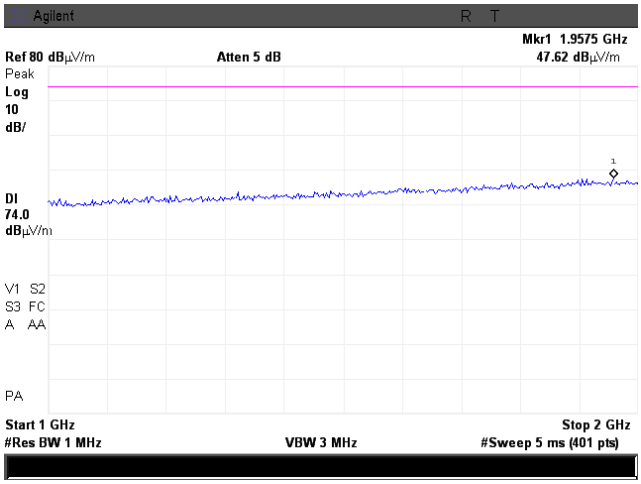


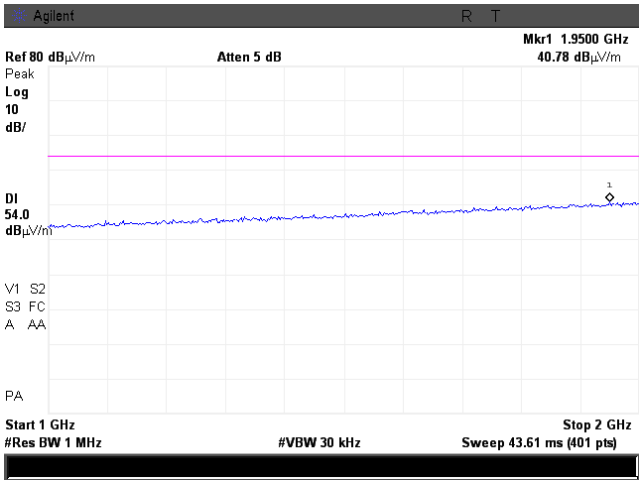
| Test specification: | FCC Section 15.109/ ICES-003 Section 6.2 Class B, Radiated emission | | |
|---|---|---|---|
| Test procedure: | ANSI C63.4, Section 11.6 | | |
| Test mode: | Compliance | Verdict: | PASS |
| Date(s): | 3/18/2013 | | |
| Temperature: 23 ºC | Air Pressure: 1015 hPa | Relative Humidity: 43 % | Power Supply: Battery |
| Remarks: | | | |

**Plot 8.1.3 Radiated emission measurements above 1000 MHz, vertical antenna polarization**

EUT:
TEST SITE:
TEST DISTANCE:

R-Sensor
Semi anechoic chamber
3 m

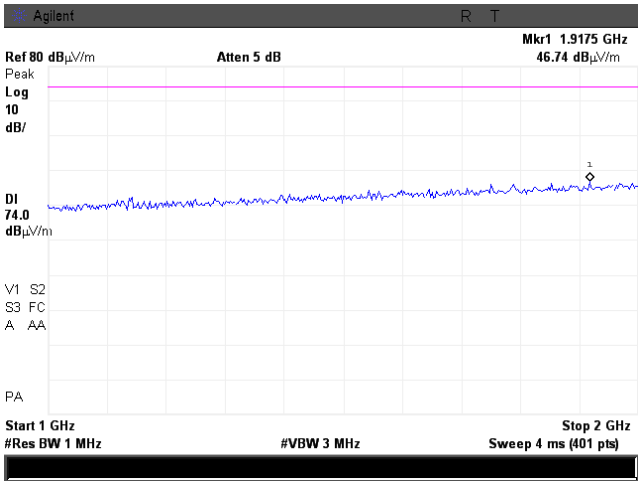


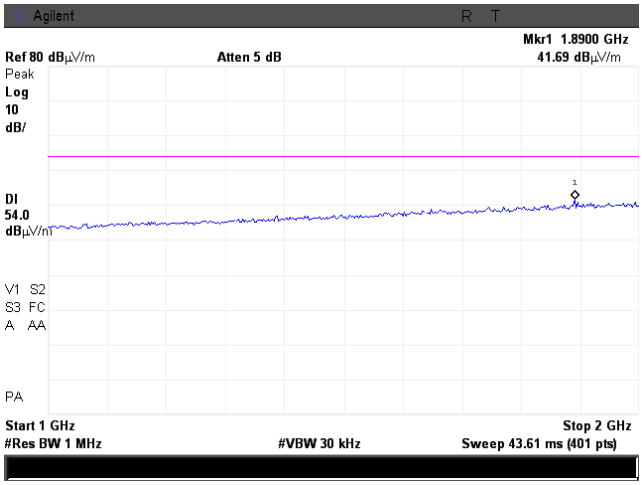




**Plot 8.1.4 Radiated emission measurements above 1000 MHz, horizontal antenna polarization**

EUT:
TEST SITE:
TEST DISTANCE:

R-Sensor
Semi anechoic chamber
3 m



| Test specification: | FCC Section 15.109/ ICES-003 Section 6.2 Class B, Radiated emission | | |
|---|---|---|---|
| Test procedure: | ANSI C63.4, Section 11.6 | | |
| Test mode: | Compliance | Verdict: | PASS |
| Date(s): | 3/18/2013 | | |
| Temperature: 23 ºC | Air Pressure: 1015 hPa | Relative Humidity: 43 % | Power Supply: Battery |
| Remarks: | | | |

**Photograph 8.1.4 Setup for radiated emission measurements of U-Sensor**

**Photograph 8.1.5 Setup for radiated emission measurements of U-Sensor**

| Test specification: | FCC Section 15.109/ ICES-003 Section 6.2 Class B, Radiated emission | | |
|---|---|---|---|
| Test procedure: | ANSI C63.4, Section 11.6 | | |
| Test mode: | Compliance | Verdict: | PASS |
| Date(s): | 3/18/2013 | | |
| Temperature: 23 ºC | Air Pressure: 1015 hPa | Relative Humidity: 43 % | Power Supply: Battery |
| Remarks: | | | |

**Photograph 8.1.6 Setup for final radiated emission measurements, U-Sensor close view**

| **Test specification:** | **FCC Section 15.109/ ICES-003 Section 6.2 Class B, Radiated emission** | | |
|---|---|---|---|
| **Test procedure:** | ANSI C63.4, Section 11.6 | | |
| **Test mode:** | Compliance | **Verdict:** | PASS |
| **Date(s):** | 3/18/2013 | | |
| **Temperature:** 23 ºC | **Air Pressure:** 1015 hPa | **Relative Humidity:** 43 % | **Power Supply:** Battery |
| **Remarks:** | | | |

**Table 8.1.3 Radiated emission test results**

EUT: U-Sensor
EUT SET UP: TABLE-TOP
TEST SITE: SEMI ANECHOIC CHAMBER
TEST DISTANCE: 3 m
DETECTORS USED: PEAK / QUASI-PEAK
FREQUENCY RANGE: 30 MHz – 1000 MHz
RESOLUTION BANDWIDTH: 120 kHz

| **Frequency, MHz** | **Peak emission, dB(μV/m)** | **Quasi-peak** | | | **Antenna polarization** | **Antenna height, m** | **Turn-table position**, degrees** | **Verdict** |
|---|---|---|---|---|---|---|---|---|
| | | **Measured emission, dB(μV/m)** | **Limit, dB(μV/m)** | **Margin, dB*** | | | | |
| No emissions were found | | | | | | | | Pass |

DETECTORS USED: PEAK / AVERAGE
FREQUENCY RANGE: 1000 MHz – 2000 MHz
RESOLUTION BANDWIDTH: 1000 kHz

| **Frequency, MHz** | **Peak** | | | **Average** | | | **Antenna polarization** | **Antenna height, m** | **Turn-table position**, degrees** | **Verdict** |
|---|---|---|---|---|---|---|---|---|---|---|
| | **Measured emission, dB(μV/m)** | **Limit, dB(μV/m)** | **Margin, dB*** | **Measured emission, dB(μV/m)** | **Limit, dB(μV/m)** | **Margin, dB*** | | | | |
| No emissions were found | | | | | | | | | | Pass |

***- Margin = Measured emission - specification limit.
****- EUT front panel refers to 0 degrees position of turntable.

**Reference numbers of test equipment used**

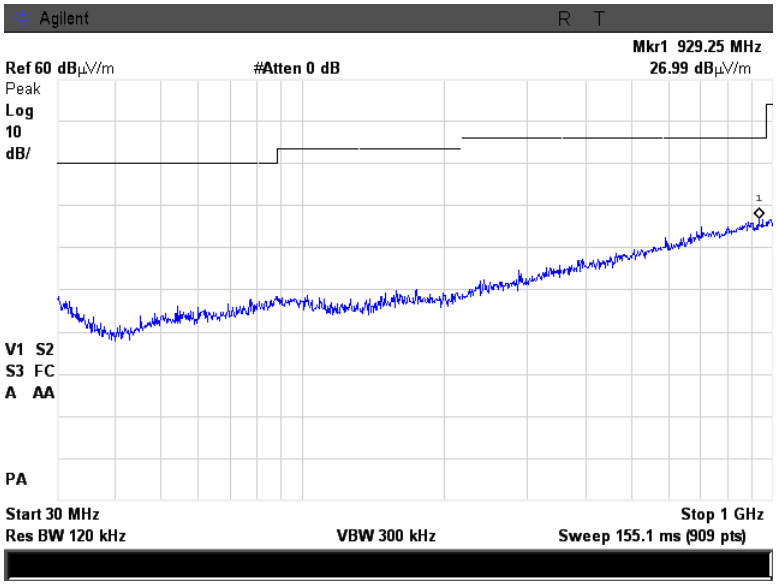
| | | | | | | | |
|---|---|---|---|---|---|---|---|
| HL 0604 | HL 1984 | HL 2780 | HL 2871 | HL 4353 | | | |

Full description is given in Appendix A.

| Test specification: | FCC Section 15.109/ ICES-003 Section 6.2 Class B, Radiated emission | | |
|---|---|---|---|
| Test procedure: | ANSI C63.4, Section 11.6 | | |
| Test mode: | Compliance | Verdict: | PASS |
| Date(s): | 3/18/2013 | | |
| Temperature: 23 ºC | Air Pressure: 1015 hPa | Relative Humidity: 43 % | Power Supply: Battery |
| Remarks: | | | |

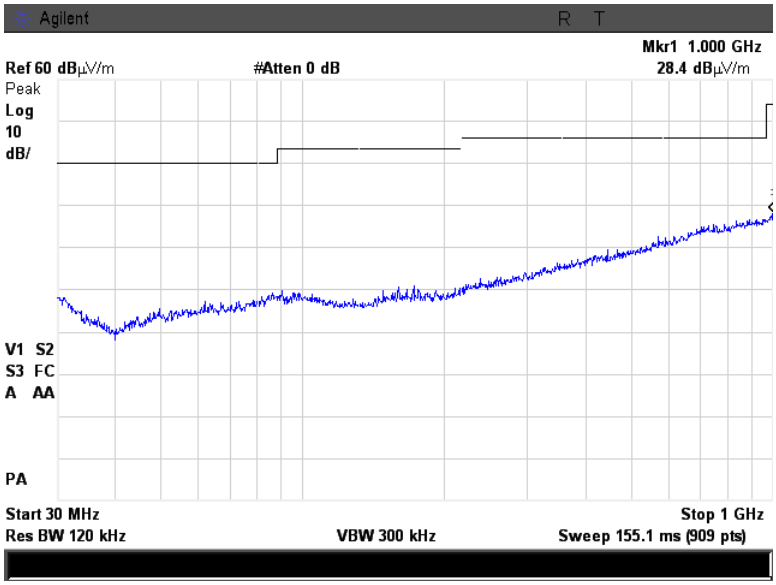
**Plot 8.1.5 Radiated emission measurements in 30 - 1000 MHz range, vertical antenna polarization**

EUT: U-Sensor
TEST SITE: Semi anechoic chamber
TEST DISTANCE: 3 m




**Plot 8.1.6 Radiated emission measurements in 30 - 1000 MHz range, horizontal antenna polarization**

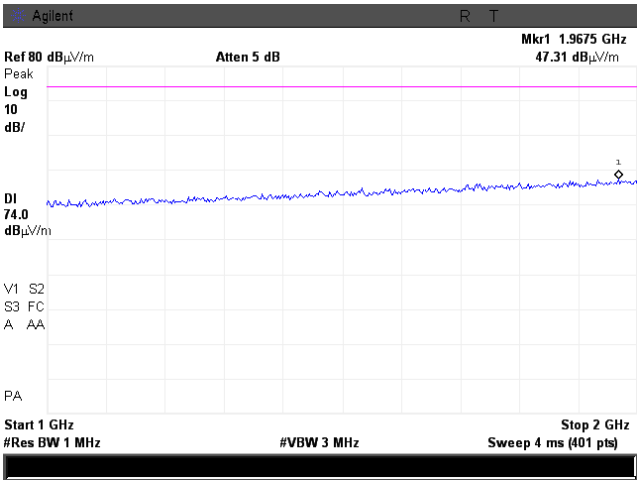
EUT: U-Sensor
TEST SITE: Semi anechoic chamber
TEST DISTANCE: 3 m

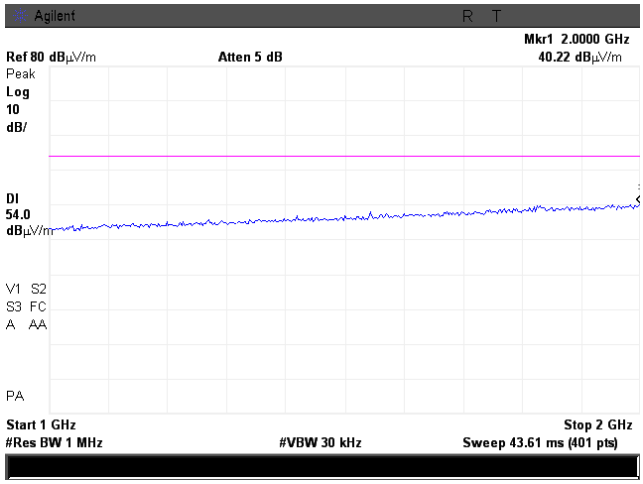


| Test specification: | FCC Section 15.109/ ICES-003 Section 6.2 Class B, Radiated emission | | |
|---|---|---|---|
| Test procedure: | ANSI C63.4, Section 11.6 | | |
| Test mode: | Compliance | Verdict: | PASS |
| Date(s): | 3/18/2013 | | |
| Temperature: 23 ºC | Air Pressure: 1015 hPa | Relative Humidity: 43 % | Power Supply: Battery |
| Remarks: | | | |

**Plot 8.1.7 Radiated emission measurements above 1000 MHz, vertical antenna polarization**

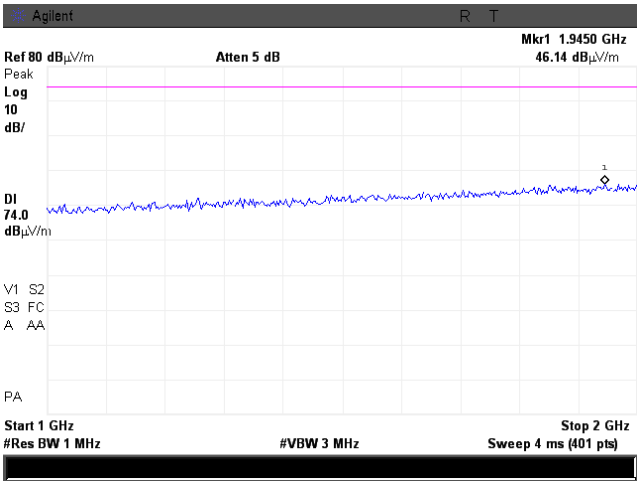
EUT: U-Sensor
TEST SITE: Semi anechoic chamber
TEST DISTANCE: 3 m

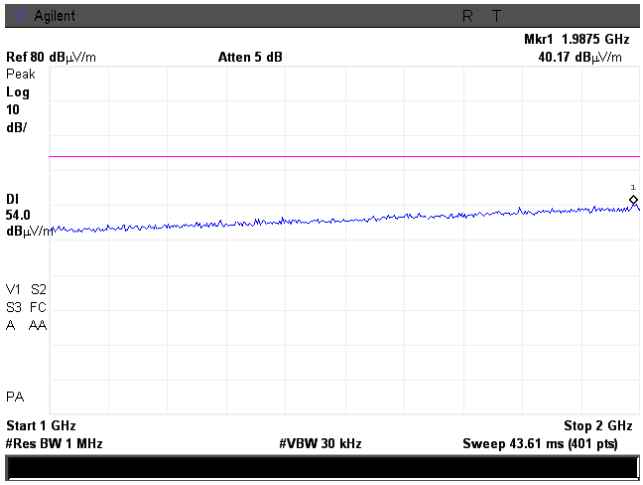



**Plot 8.1.8 Radiated emission measurements above 1000 MHz, horizontal antenna polarization**

EUT: U-Sensor
TEST SITE: Semi anechoic chamber
TEST DISTANCE: 3 m



# 9 APPENDIX A Test equipment and ancillaries used for tests

| HL No | Description | Manufacturer | Model | Ser. No. | Last Cal./ Check | Due Cal./ Check |
|---|---|---|---|---|---|---|
| 0337 | Probe Set, Hand held, 5 probes | Electro-Metrics | EHFP-30 | 238 | 06-Jun-12 | 06-Jun-13 |
| 0446 | Antenna, Loop, Active, 10 kHz - 30 MHz | EMCO | 6502 | 2857 | 03-Jul-12 | 03-Jul-13 |
| 0604 | Antenna BiconiLog Log-Periodic/T Bow-TIE, 26 - 2000 MHz | EMCO | 3141 | 9611-1011 | 20-May-12 | 20-May-14 |
| 1984 | Antenna, Double-Ridged Waveguide Horn, 1-18 GHz, 300 W | EMC Test Systems | 3115 | 9911-5964 | 07-Dec-12 | 07-Dec-13 |
| 2780 | EMC analyzer, 100 Hz to 26.5 GHz | Agilent Technologies | E7405A | MY45102462 | 09-Jul-12 | 09-Jul-13 |
| 2871 | Microwave Cable Assembly, 18 GHz, 6.4 m, SMA - SMA | Huber-Suhner | 198-8155-00 | 2871 | 04-Dec-12 | 04-Dec-13 |
| 2909 | Spectrum analyzer, ESA-E, 100 Hz to 26.5 GHz | Agilent Technologies | E4407B | MY41444762 | 20-Dec-12 | 20-Dec-13 |
| 3818 | PSA Series Spectrum Analyzer, 3 Hz- 44 GHz | Agilent Technologies | E4446A | MY48250288 | 24-Apr-13 | 24-Apr-14 |
| 4114 | Antenna, Double-Ridged Waveguide Horn, 1-18 GHz | ETS Lindgren | 3117 | 00123515 | 07-Dec-12 | 07-Dec-13 |
| 4351 | Low Loss Armored Test Cable, DC - 18 GHz, 6.2 m, N type-M/N type-M | MegaPhase | NC29-N1N1-244 | 12025101001 | 06-Mar-13 | 06-Mar-14 |
| 4353 | Low Loss Armored Test Cable, DC - 18 GHz, 6.2 m, N type-M/N type-M | MegaPhase | NC29-N1N1-244 | 12025101003 | 06-Mar-13 | 06-Mar-14 |

# 10 APPENDIX B Measurement uncertainties

**Expanded uncertainty at 95% confidence in Hermon Labs EMC measurements**

| Test description | Expanded uncertainty |
|---|---|
| Radiated emissions at 10 m measuring distance<br>Horizontal polarization<br><br><br><br>Vertical polarization | <br>Biconilog antenna: ± 5.0 dB<br>Biconical antenna: ± 5.0 dB<br>Log periodic antenna: ± 5.1 dB<br>Double ridged horn antenna: ± 5.3 dB<br>Biconilog antenna: ± 5.5 dB<br>Biconical antenna: ± 5.5 dB<br>Log periodic antenna: ± 5.6 dB<br>Double ridged horn antenna: ± 5.8 dB |
| Radiated emissions at 3 m measuring distance<br>Horizontal polarization<br><br><br><br>Vertical polarization | <br>Biconilog antenna: ± 5.3 dB<br>Biconical antenna: ± 5.0 dB<br>Log periodic antenna: ± 5.3 dB<br>Double ridged horn antenna: ± 5.3 dB<br>Biconilog antenna: ± 6.0 dB<br>Biconical antenna: ± 5.7 dB<br>Log periodic antenna: ± 6.0 dB<br>Double ridged horn antenna: ± 6.0 dB |
| Conducted emissions at RF antenna connector | 9 kHz to 2.9 GHz: ± 2.6 dB<br>2.9 GHz to 6.46 GHz: ± 3.5 dB<br>6.46 GHz to 13.2 GHz: ± 4.3 dB<br>13.2 GHz to 22.0 GHz: ± 5.0 dB<br>22.0 GHz to 26.8 GHz: ± 5.5 dB<br>26.8 GHz to 40.0 GHz: ± 4.8 dB |
| Duty cycle, timing (Tx ON / OFF) and average factor measurements | ± 1.0 % |
| Occupied bandwidth | ± 8.0 % |

Hermon Laboratories is accredited by A2LA for calibration according to present requirements of ISO/IEC 17025 and NCSL Z540-1. The accreditation is granted to perform calibration of parameters that are listed in the Scope of Hermon Laboratories Accreditation.
Hermon Laboratories calibrates its reference and transfer standards by calibration laboratories accredited to ISO/IEC 17025 by a mutually recognized Accreditation Body or by a recognized national metrology institute. All reference and transfer standards used in the calibration system are traceable to national or international standards.
In-house calibration of all test and measurement equipment is performed on a regular basis according to Hermon Laboratories calibration procedures, manufacturer calibration/verification procedures or procedures defined in the relevant standards. The Hermon Laboratories test and measurement equipment is calibrated within the tolerances specified by the manufacturers and/or by the relevant standards.

# 11 APPENDIX C Test laboratory description

Tests were performed at Hermon Laboratories Ltd., which is a fully independent, private, EMC, safety, environmental 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), Registration Numbers 90624 for OATS and 90623 for the anechoic chamber; by Industry Canada for electromagnetic emissions (file numbers IC 2186A-1 for OATS, IC 2186A-2 for anechoic chamber, IC 2186A-3 for full-anechoic chamber for RE measurements above 1 GHz), certified by VCCI, Japan (the registration numbers are R-808 for OATS, R-1082 for anechoic chamber, G-27 for full-anechoic chamber for RE measurements above 1 GHz, C-845 for conducted emissions site, T-1606 for conducted emissions at telecommunication ports), has a status of a Telefication - Listed Testing Laboratory, Certificate No. L138/00. 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). The FCC Designation Number is US1003.

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website: www.hermonlabs.com

Person for contact: Mr. Alex Usoskin, CEO.

# 12 APPENDIX D Specification references

| | |
|---|---|
| FCC 47CFR part 15: 2012 | Radio Frequency Devices |
| ANSI C63.2: 1996 | American National Standard for Instrumentation-Electromagnetic Noise and Field Strength, 10 kHz to 40 GHz-Specifications |
| ANSI C63.4: 2003 | 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 |
| RSS-210 Issue 8: 2010 | Low Power Licence- Exempt Radiocommunication Devices |
| RSS-Gen Issue 3: 2010 | General Requirements and Information for the Certification of Radiocommunication Equipment |
| ICES-003: 2012, Issue 5 | Spectrum Management and Telecommunications Policy. Interference-Causing Equipment Standard. Information Technology Equipment (ITE) – Limits and methods of measurement |

# 13 APPENDIX E Test equipment correction factors

**Antenna factor**
**Active loop antenna**
**Model 6502, S/N 2857, HL 0446**

| 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).

**Antenna factor**
**Biconilog antenna EMCO Model 3141**
**Ser.No.1011, HL 0604**

| 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).

**Antenna factor**
**Double-ridged wave guide horn antenna**
**Model 3115, S/N 9911-5964, HL1984**

| Frequency, MHz | Antenna factor, dB(1/m) |
|---|---|
| 1000.0 | 24.7 |
| 1500.0 | 25.7 |
| 2000.0 | 27.6 |
| 2500.0 | 28.9 |
| 3000.0 | 31.2 |
| 3500.0 | 32.0 |
| 4000.0 | 32.5 |
| 4500.0 | 32.7 |
| 5000.0 | 33.6 |
| 5500.0 | 35.1 |
| 6000.0 | 35.4 |
| 6500.0 | 34.9 |
| 7000.0 | 36.1 |
| 7500.0 | 37.8 |
| 8000.0 | 38.0 |
| 8500.0 | 38.1 |
| 9000.0 | 39.1 |
| 9500.0 | 38.3 |
| 10000.0 | 38.6 |
| 10500.0 | 38.2 |
| 11000.0 | 38.7 |
| 11500.0 | 39.5 |
| 12000.0 | 40.0 |
| 12500.0 | 40.4 |
| 13000.0 | 40.5 |
| 13500.0 | 41.1 |
| 14000.0 | 41.6 |
| 14500.0 | 41.7 |
| 15000.0 | 38.7 |
| 15500.0 | 38.2 |
| 16000.0 | 38.8 |
| 16500.0 | 40.5 |
| 17000.0 | 42.5 |
| 17500.0 | 45.9 |
| 18000.0 | 49.4 |

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

**Antenna factor**
**Double-ridged waveguide horn antenna**
**ETS Lindgren, Model 3117, serial number: 00123515, HL 4114**

| Frequency, MHz | Antenna factor, dB/m | | |
|---|---|---|---|
| | Measured | Manufacturer | Deviation |
| 1000 | 28.0 | 28.4 | -0.4 |
| 1500 | 28.0 | 27.4 | 0.6 |
| 2000 | 31.2 | 30.9 | 0.3 |
| 2500 | 32.5 | 33.4 | -0.9 |
| 3000 | 32.9 | 32.6 | 0.3 |
| 3500 | 32.7 | 32.8 | -0.1 |
| 4000 | 33.1 | 33.4 | -0.3 |
| 4500 | 33.8 | 33.9 | -0.1 |
| 5000 | 33.8 | 34.1 | -0.3 |
| 5500 | 34.4 | 34.5 | -0.1 |
| 6000 | 35.0 | 35.2 | -0.2 |
| 6500 | 35.4 | 35.5 | -0.1 |
| 7000 | 35.7 | 35.7 | 0.0 |
| 7500 | 35.9 | 35.7 | 0.2 |
| 8000 | 35.8 | 35.8 | 0.0 |
| 8500 | 35.9 | 35.8 | 0.1 |
| 9000 | 36.3 | 36.2 | 0.1 |
| 9500 | 36.6 | 36.6 | 0.0 |
| 10000 | 37.1 | 37.1 | 0.0 |
| 10500 | 37.6 | 37.5 | 0.1 |
| 11000 | 37.9 | 37.7 | 0.2 |
| 11500 | 38.5 | 38.1 | 0.4 |
| 12000 | 39.2 | 38.7 | 0.5 |
| 12500 | 39.0 | 38.9 | 0.1 |
| 13000 | 39.1 | 39.1 | 0.0 |
| 13500 | 38.9 | 38.8 | 0.1 |
| 14000 | 39.0 | 38.8 | 0.2 |
| 14500 | 39.6 | 39.9 | -0.3 |
| 15000 | 39.9 | 39.7 | 0.2 |
| 15500 | 39.9 | 40.1 | -0.2 |
| 16000 | 40.7 | 40.8 | -0.1 |
| 16500 | 41.3 | 41.8 | -0.5 |
| 17000 | 42.5 | 42.1 | 0.4 |
| 17500 | 41.3 | 41.2 | 0.1 |
| 18000 | 41.4 | 40.9 | 0.5 |

Antenna factor is to be added to receiver meter reading in dB(μV) to convert to field strength in dB(μV/meter)

**Cable loss**
**Cable coaxial, Huber-Suhner, 18 GHz, 6.4 m, SMA - SMA, model 198-8155-00, HL 2871**

| Frequency, MHz | Cable loss, dB | Frequency, MHz | Cable loss, dB | Frequency, MHz | Cable loss, dB |
|---|---|---|---|---|---|
| 10 | 0.12 | 5750 | 2.34 | 12000 | 3.55 |
| 30 | 0.14 | 6000 | 2.39 | 12250 | 3.61 |
| 100 | 0.27 | 6250 | 2.46 | 12500 | 3.67 |
| 250 | 0.45 | 6500 | 2.52 | 12750 | 3.74 |
| 500 | 0.63 | 6750 | 2.58 | 13000 | 3.79 |
| 750 | 0.76 | 7000 | 2.64 | 13250 | 3.82 |
| 1000 | 0.89 | 7250 | 2.68 | 13500 | 3.83 |
| 1250 | 1.01 | 7500 | 2.73 | 13750 | 3.83 |
| 1500 | 1.12 | 7750 | 2.78 | 14000 | 3.88 |
| 1750 | 1.23 | 8000 | 2.83 | 14250 | 3.93 |
| 2000 | 1.32 | 8250 | 2.88 | 14500 | 3.96 |
| 2250 | 1.41 | 8500 | 2.94 | 14750 | 4.01 |
| 2500 | 1.49 | 8750 | 2.97 | 15000 | 4.00 |
| 2750 | 1.58 | 9000 | 3.02 | 15250 | 4.01 |
| 3000 | 1.66 | 9250 | 3.07 | 15500 | 4.00 |
| 3250 | 1.73 | 9500 | 3.13 | 15750 | 4.13 |
| 3500 | 1.80 | 9750 | 3.18 | 16000 | 4.22 |
| 3750 | 1.87 | 10000 | 3.21 | 16250 | 4.29 |
| 4000 | 1.93 | 10250 | 3.26 | 16500 | 4.29 |
| 4250 | 2.01 | 10500 | 3.30 | 16750 | 4.32 |
| 4500 | 2.06 | 10750 | 3.36 | 17000 | 4.37 |
| 4750 | 2.12 | 11000 | 3.39 | 17250 | 4.45 |
| 5000 | 2.17 | 11250 | 3.44 | 17500 | 4.49 |
| 5250 | 2.24 | 11500 | 3.48 | 17750 | 4.53 |
| 5500 | 2.29 | 11750 | 3.52 | 18000 | 4.55 |

**Cable loss**
**Low Loss Armored Test Cable, MegaPhase, 18 GHz, 6.2 m, N type-M/N type-M,**
**NC29-N1N1-244S/N 12025101 001,**
**HL 4351**

| Frequency, MHz | Cable loss, dB | Frequency, MHz | Cable loss, dB |
|---|---|---|---|
| 50 | 0.21 | 9000 | 2.86 |
| 100 | 0.28 | 9500 | 2.96 |
| 300 | 0.49 | 10000 | 3.05 |
| 500 | 0.63 | 10500 | 3.12 |
| 1000 | 0.90 | 11000 | 3.18 |
| 1500 | 1.10 | 11500 | 3.24 |
| 2000 | 1.29 | 12000 | 3.30 |
| 2500 | 1.44 | 12500 | 3.37 |
| 3000 | 1.58 | 13000 | 3.45 |
| 3500 | 1.71 | 13500 | 3.53 |
| 4000 | 1.84 | 14000 | 3.58 |
| 4500 | 1.95 | 14500 | 3.66 |
| 5000 | 2.05 | 15000 | 3.73 |
| 5500 | 2.17 | 15500 | 3.79 |
| 6000 | 2.29 | 16000 | 3.87 |
| 6500 | 2.39 | 16500 | 3.94 |
| 7000 | 2.47 | 17000 | 3.98 |
| 7500 | 2.56 | 17500 | 4.07 |
| 8000 | 2.70 | 18000 | 4.14 |
| 8500 | 2.77 | | |

**Cable loss**
**Low Loss Armored Test Cable, MegaPhase, 18 GHz, 6.2 m, N type-M/N type-M,**
**NC29-N1N1-244S/N 12025101 003,**
**HL 4353**

| Frequency, MHz | Cable loss, dB | Frequency, MHz | Cable loss, dB |
|---|---|---|---|
| 50 | 0.20 | 9000 | 2.71 |
| 100 | 0.27 | 9500 | 2.81 |
| 300 | 0.47 | 10000 | 2.90 |
| 500 | 0.61 | 10500 | 2.97 |
| 1000 | 0.87 | 11000 | 3.06 |
| 1500 | 1.07 | 11500 | 3.13 |
| 2000 | 1.24 | 12000 | 3.20 |
| 2500 | 1.39 | 12500 | 3.26 |
| 3000 | 1.53 | 13000 | 3.34 |
| 3500 | 1.65 | 13500 | 3.39 |
| 4000 | 1.77 | 14000 | 3.47 |
| 4500 | 1.89 | 14500 | 3.54 |
| 5000 | 1.99 | 15000 | 3.62 |
| 5500 | 2.07 | 15500 | 3.69 |
| 6000 | 2.20 | 16000 | 3.76 |
| 6500 | 2.30 | 16500 | 3.83 |
| 7000 | 2.39 | 17000 | 3.86 |
| 7500 | 2.51 | 17500 | 3.94 |
| 8000 | 2.58 | 18000 | 4.02 |
| 8500 | 2.65 | | |

# 14 APPENDIX F Abbreviations and acronyms

| | |
|---|---|
| A | ampere |
| AC | alternating current |
| A/m | ampere per meter |
| AVRG | average (detector) |
| 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 |
| dB(μA) | decibel referred to one microampere |
| DC | direct current |
| EIRP | equivalent isotropically radiated power |
| ERP | effective radiated power |
| EUT | equipment under test |
| F | frequency |
| GHz | gigahertz |
| GND | ground |
| H | height |
| HL | Hermon laboratories |
| Hz | hertz |
| k | kilo |
| kHz | kilohertz |
| LO | local oscillator |
| m | meter |
| MHz | megahertz |
| min | minute |
| mm | millimeter |
| ms | millisecond |
| μs | microsecond |
| NA | not applicable |
| OATS | open area test site |
| Ω | Ohm |
| PS | power supply |
| ppm | part per million ($10^{-6}$) |
| QP | quasi-peak |
| RE | radiated emission |
| RF | radio frequency |
| rms | root mean square |
| Rx | receive |
| s | second |
| T | temperature |
| Tx | transmit |
| V | volt |

END OF DOCUMENT