# Certification Report for the Invo 315 Keyfob
# FCC Part 15 & RSS-210

**Document Number:** **KP000938-CR-RAD-112-01**
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**Prepared for:** **Invotronics / Solectron**
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# Release Control Record

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# Approvals

| Function | Name | Job title | Signature and Date |
|---|---|---|---|
| Document Release Approval | Steve Tippet | Manager, Product Engineering and Verification | 7th June 2007 |
| Author | Denis Lalonde | Radio Compliance Discipline Leader | June 7, 2007 |
| Technical Reviewer | Jacques Rollin | EMC Advisor | June 7 2007 |

# Accreditations

Solectron EMS Canada Inc.'s (SDE) test facilities are accredited by the Standards Council of Canada (SCC) to ISO/IEC 17025:2005 [15] in accordance with the scope of accreditation outlined at the following web site http://palcan.scc.ca/specs/pdf/95_e.pdf [2]. The SCC is a signatory of the APLAC [12] and ILAC [13] accreditation organizations.

Solectron EMS Canada Inc.'s (SDE) quality management system is registered to ISO 9001: 2000 [16] and its processes are documented in the SDE Quality Manual [3] and Lab Operations Manual [4].

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# 1. Executive Summary

This test report documents the measurements performed on the Invo 315 Keyfob as part of a Original Equipment Certification for FCC Part 15 and Industry Canada RSS-210.

On the basis of measurements performed in May 2007, the Invo 315 Keyfob is verified to be compliant with FCC Part 15 and Industry Canada RSS-210 requirements. The test data included in this report apply to the product titled above manufactured by Invotronics / Solectron.

This transmitter is a manual operated device and its frequency of operation is 315 MHz.

The FCCID and Industry Canada certification numbers for this equipment are the following:

FCCID: VC5-INVO-315-003

CANADA: 4180I-INVO315

A detailed summary of compliance results is found in Table 2-1: Compliance Results Summary on page 7.

# 2. Compliance Summary

This section summarizes all the measurements performed on the Invo 315 Keyfob and its compliance to FCC Part 15, and Industry Canada RSS-210.

**Table 2-1: Compliance Results Summary**

| **Product Summary** | | | |
|---|---|---|---|
| Product Name: | Invo 315 Keyfob | Project Leader: | Denis Lalonde |
| Product Code: | 519632 | Measurements by : | K. Sivaratnam, D. Lalonde |
| Product Status: | | Date: | May 16, 2007 |

| **Test Cases** | | | | | |
|---|---|---|---|---|---|
| **Performed** | **Description** | **Specification** | **Test Results** | | **Notes** |
| | | | Pass | Fail | |
| ■ | Transmission Holdover Time | FCC Part 15.231 & IC RSS 210 section A1.1 | ■ | ☐ | |
| ■ | Field Strength of Emissions | FCC Part 15.231 & IC RSS 210 section A1.1 | ■ | ☐ | |
| ■ | Occupied Bandwidth | FCC Part 15.231 & IC RSS 210 section A1.1 | ■ | ☐ | |

# 3. Equipment Under Test (EUT)

## 3.1 Product Functional Description

The product trade name of the unit tested is “Invo 315 Keyfob”.

Figure 3-1 shows a picture of the tested product.

**Figure 3-1 Invo 315 Keyfob Picture**

## 3.2 Manufacturer Information

| | |
|---|---|
| Company Name | Invotronics / Solectron |
| Mailing Address | 365 Passmore Ave, Scarborough, Ontario, Canada, M1V 4B3 |
| Product Name | Invo 315 Keyfob |

## 3.3 Transmitter Specifications

Table 3-1 lists the specifications of the transmitter under test

**Table 3-1: Transmitter Specifications**

| Transmitter Characteristic | |
|---|---|
| Operation control | Manual |
| Tx Field Strength | < 67.7 dBuV/m (average detector) at 3 m |
| Tx frequency | 315 MHz |
| Antenna | Integral to the unit |

## 3.4 System Components

The system tested consists of the following units, as shown in Table 3-2.

**Table 3-2: Components**

| Component | Part Number |
|---|---|
| Invo 315 Keyfob | 347036 |

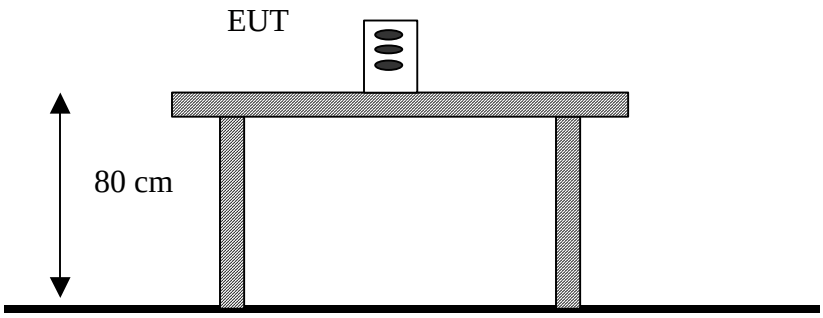
## 3.5 Support Equipment

No support equipment was required

## 3.6 System Set-up and Test Configurations

The system configuration used for all test cases is presented in Figure 3-2.

**Figure 3-2: Test Configuration**




A photograph of the test setup used in this test report is presented in Appendix B: Test Set-up Photographs, on page 24.

## 3.7 EUT Interfaces and Cables

The EUT has no cables.

## 3.8 System Modifications

No modifications were required to pass the requirements.

# 4. General Test Conditions

## 4.1 Test Facility

Radiated emissions testing was performed in a 10-meter Ambient Free Chamber (AFC) located at 21 Richardson Side road, Kanata, Ontario, Canada. The AFC consists of a shielded room lined with ferrite tiles and anechoic material.

These test facilities are accredited by the Standards Council of Canada (SCC) [2]. Through a Mutual Recognition Agreement (MRA) between the National Voluntary Laboratory Accreditation Program (NVLAP) and SCC, the accreditation status of the AFC facility is valid for the U.S.

## 4.2 Measurement Instrumentation

The measurement instrumentation conforms to ANSI C63.2 [6] and CISPR 16 [7]. Calibration of the measurement instrumentation is maintained in accordance with the supplier's recommendations, or as necessary to ensure its accuracy.

# 5. Detailed Test Results

## 5.1 Transmitter Holdover Time

### 5.1.1 Test Specification

The transmitter holdover time was evaluated according to the specifications listed in Table 5-1:

**Table 5-1: Transmitter Holdover Time Requirement**

| Requirement | Part / Section |
|---|---|
| FCC Part 15 | 15.231 a) 1) |
| RSS-210 | A1.1.1 (1) |

#### 5.1.1.1 Limits

The specified limit is shown in Table 5-2.

**Table 5-2: Transmitter Holdover Time Limit**

| Maximum Holdover (sec.) |
|---|
| 5 |

### 5.1.2 Test Facility Information

**Location:** Solectron Design and Engineering Lab 1

**Date tested:** May 31, 2007

**Tested by:** Denis Lalonde

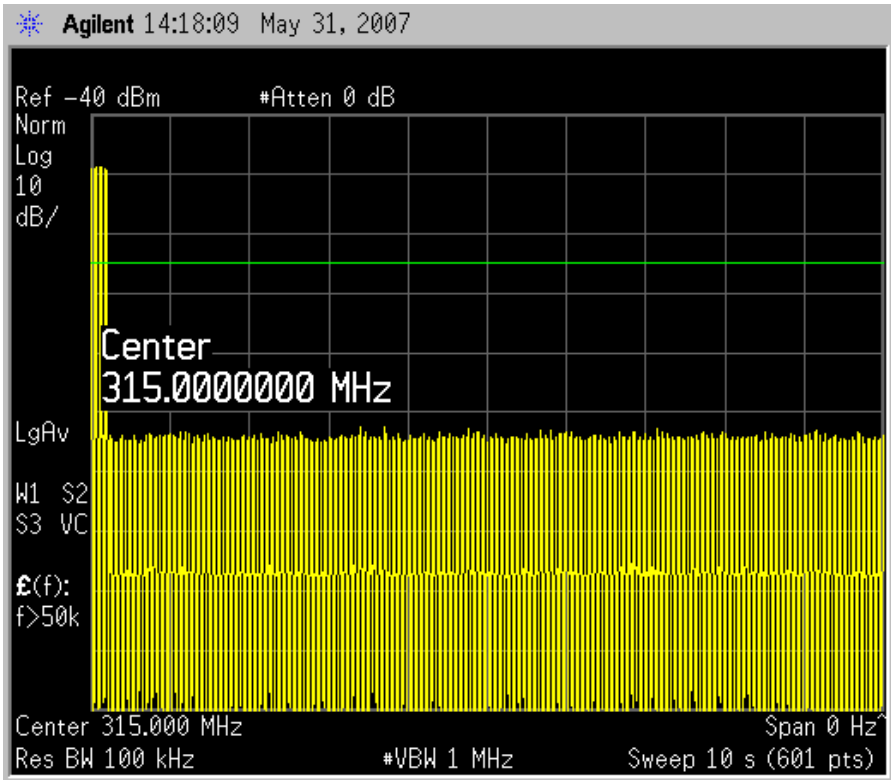
### 5.1.3 Test Procedure

The transmitter was momentarily keyed and the transmitted signal was observed on a spectrum analyzer over a period of 10 seconds. The spectrum analyzer was triggered by the on-ramp of the transmitted pulses.

### 5.1.4 Test Results

The figure below shows the recorded holdover time.

**Figure 5-1: Measured Transmitter Holdover Time**




The transmitter holdover time is less than 5 seconds.

### 5.1.5 Test Conclusion

The test results meet the requirements defined Table 5-1.

### 5.1.6 Test Equipment List

**Table 5-3: Test Equipment used for Occupied bandwidth**

| Category | Manufacture | Model | Description | Serial Number | Cal. Due |
|---|---|---|---|---|---|
| Spectrum analyzer | Agilent | E4440A | 26.5 GHz | MY46185680 | 3-May-2008 |

The measurement instrumentation conforms to ANSI C63.2[6]. Calibration of the measurement instrumentation is maintained in accordance with the supplier's recommendations, or as necessary to ensure its accuracy.

## 5.2 Field Strength of Spurious Emissions

### 5.2.1 Test Specification

The system was tested to the limits of the following requirements:

**Table 5-4: Field Strength of Spurious Emissions Requirement**

| Requirement | Part / Section |
|---|---|
| FCC Part 15 | 15.231 |
| RSS-210 | A1.1.2 (1) |

### 5.2.1.1 Limits

The following specification levels are worst-case limits taken from all test specifications. Their values are calculated at the end off this section.

**Table 5-5: Field Strength of Fundamental Limit**

| Frequency Range (MHz) | Average detector<br>Field Strength Limit at 10 m (dBuV/m) | Peak Detector<br>Field Strength Limit at 10 m (dBuV/m) |
|---|---|---|
| 315 | 57.2 | 74.7 |

**Table 5-6: Field Strength of Spurious Emissions Limit**

| Frequency Range (MHz) | Average detector<br>Field Strength Limit at 10 m (dBuV/m) | Peak Detector<br>Field Strength Limit at 10 m (dBuV/m) |
|---|---|---|
| 37.5-38.25 | 29.5 | 44.9 |
| 73-74.6 | 29.5 | 44.9 |
| 74.8-75.2 | 29.5 | 44.9 |
| 108-138 | 33.1 | 48.5 |
| 156.52475-156.52525 | 33.1 | 48.5 |
| 156.7-156.9 | 33.1 | 48.5 |
| 240-285 | 35.6 | 51.0 |
| 322-335.4 | 35.6 | 51.0 |
| 399.9-410 | 35.6 | 51.0 |
| 608-614 | 35.6 | 51.0 |
| 960-1427 | 43.5 | 58.9 |
| 1435-1626.5 | 43.5 | 58.9 |
| 1645.5-1646.5 | 43.5 | 58.9 |
| 1660-1710 | 43.5 | 58.9 |
| 1718.8-1722.2 | 43.5 | 58.9 |
| 2200-2300 | 43.5 | 58.9 |

| Frequency Range (MHz) | Average detector<br>Field Strength Limit at 10 m (dBuV/m) | Peak Detector<br>Field Strength Limit at 10 m (dBuV/m) |
|---|---|---|
| 2310-2390 | 43.5 | 58.9 |
| 2655-2900 | 43.5 | 58.9 |
| All other frequencies between 30 and 3150 MHz | 37.2 | 54.7 |

The Fundamental Emission limit was calculated using the requirement of FCC 15.231 b).

Field Strength at 3 m = 16.6667 (F) – 2833.3333 uV/m at 3 m

= 2416.8 uV/m or 67.7 dBuV/m

Where F is the transmitting frequency in MHz.

Field Strength at 10 m = Field Strength at 3 m – 20 log (10m/3m)

= 57.2 dBuV/m

The Spurious Emissions limit is 20 dB lower than the limit for the Fundamental Emission.

The calculated fundamental and spurious emissions test limits above apply to measurements performed with an average detector.

The duty cycle of the transmitter is 13.2 %. This is demonstrated by Figure 5-2, Figure 5-3, Figure 5-4, and Figure 5-5.

The first plot shows that the transmit burst is transmitted over a period of 103.3 ms. The second plot shows that the transmit burst lasts 26.7 ms and is halfway composed of ON transmit pulses. (Manchester coding is used). The 2 next plots show that the transmission burst is composed of ON/OFF transitions which have a 210 usec/412 usec duty cycle.

Duty Cycle = (210/412) x (26.7/103.3)

= 0.1317 or 13.17 %

Therefore, field strength measurements performed with an average detector will be 17.6 dB lower (20 log(0.132)) than measurements done with a peak detector.

**Figure 5-2 Transmit Burst Period**

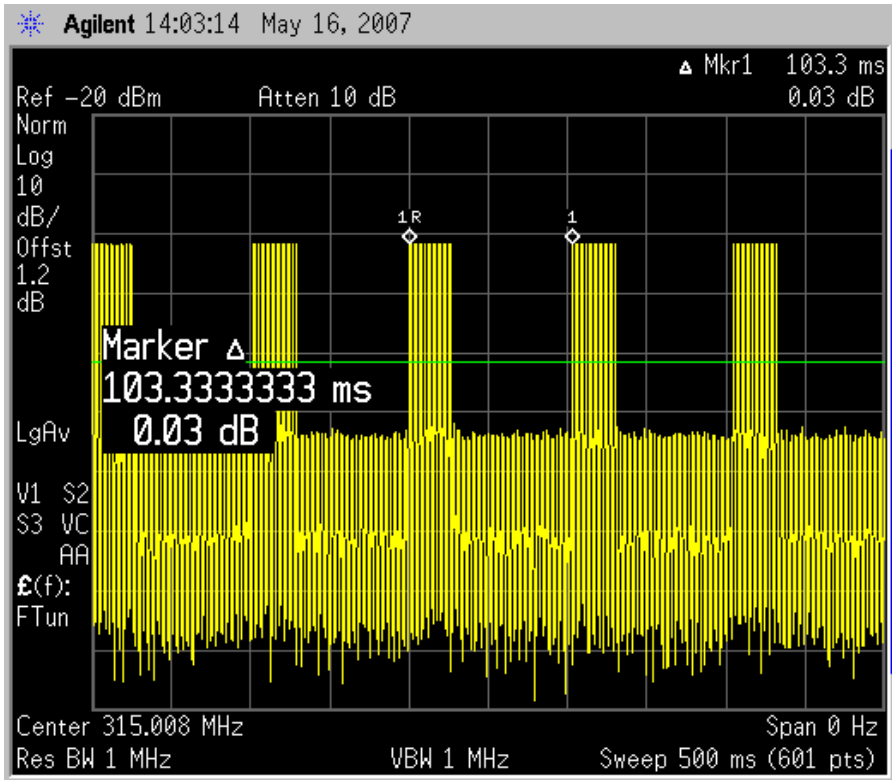



**Figure 5-3 Transmit Burst Width**

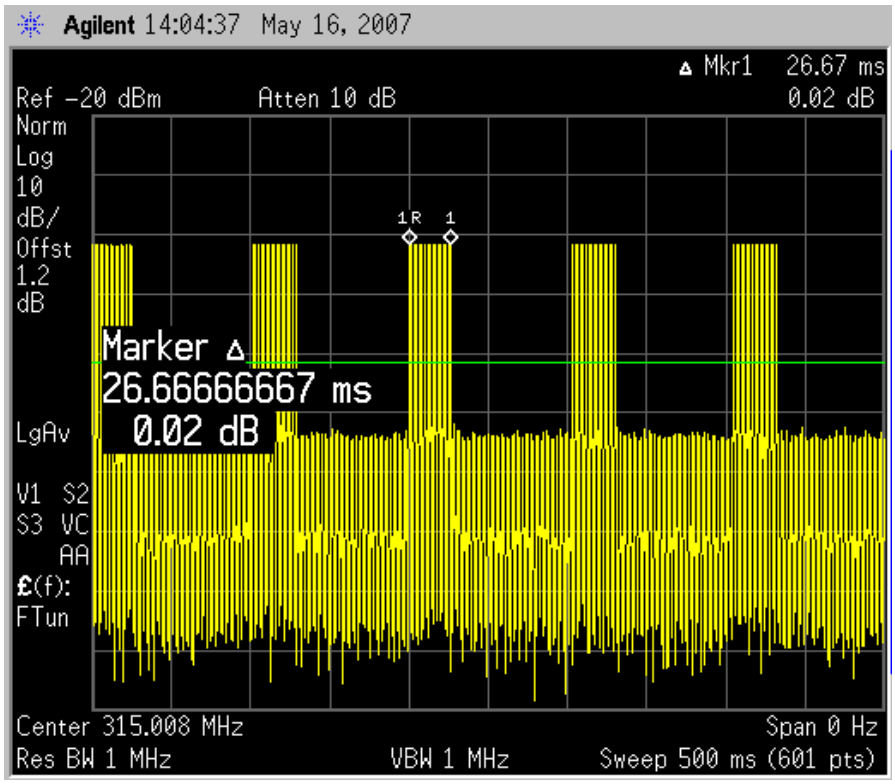


**Figure 5-4 On/Off Transition Period**

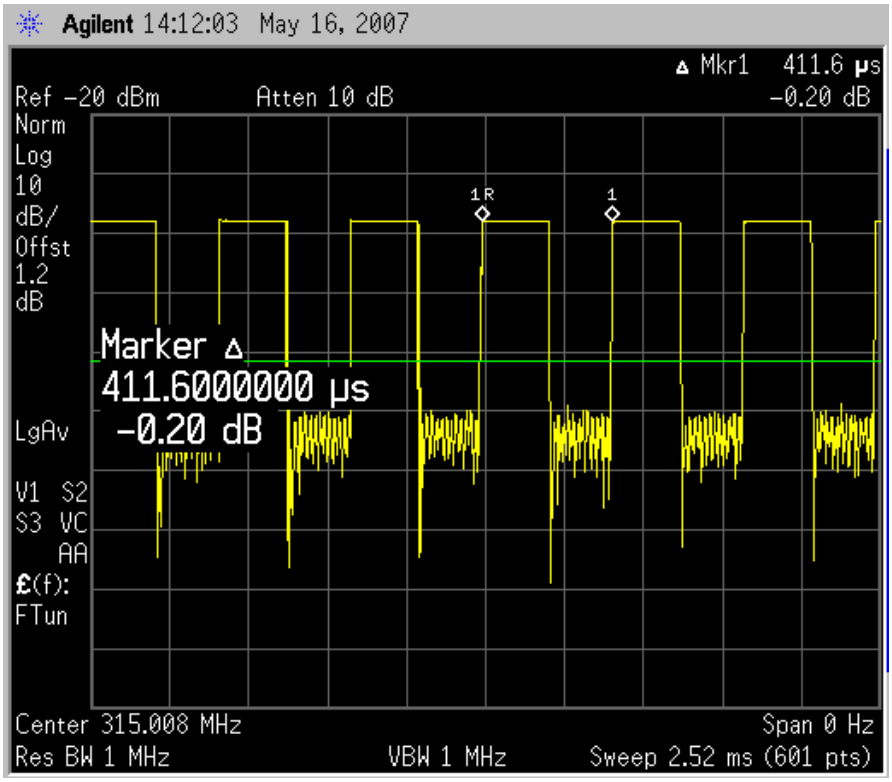
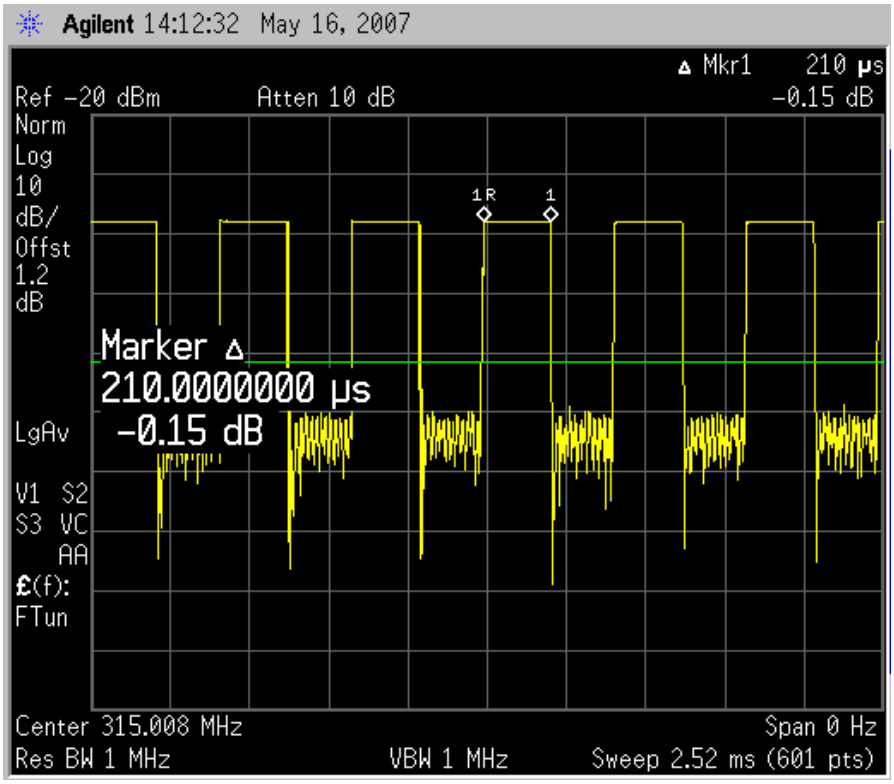



**Figure 5-5 On/Off Transition Width**



### 5.2.2 Test Facility Information

**Location:** Solectron Design and Engineering 10m Ambient Free Chamber

**Date tested:** May 16, 2007

**Tested by:** K. Sivaratnam and D. Lalonde

### 5.2.3 Test Procedure

Verifications of the test equipment and AFC was performed prior to the installation of the EUT in accordance with the quality assurance procedures in KP000270-LP-EMC-01-08 [8]. The test was performed as per the relevant test procedures in ANSI C63.4 [5]:

The system was tested in the following manner:

- The EUT was placed on a turntable inside the AFC and it was configured to transmit continuously. The EUT was mounted on a wooden table with 0.8 m height.
- For tests between 30 MHz and 1 GHz a broadband bilog antenna was placed at a 10 m distance; a horn antenna, placed also at 10 m distance from the EUT, was used for measurements between 1 GHz and 3.15 GHz.
- A pre-scan was performed to find emissions (frequencies) requiring detail measurement. The pre-scan (using a peak detector) was performed by rotating the system 360 degrees while recording all emissions (frequency and amplitude). This procedure was repeated for antenna heights of 1 to 4 meters, in steps of 1 meter, and for horizontal and vertical polarizations of the receiving antenna (for measurements above 30 MHz).
- Prescan optimization was performed based on the pre-scan data. All frequencies, having emission levels within 10 dB of the specification(s) limits, were optimized. For each such frequency, the EUT was rotated in azimuth over 360 degrees and the direction of maximum emission was noted. Antenna height was then varied from 1 to 4 meters at this azimuth to obtain maximum emissions. The procedure was repeated for both horizontal and vertical polarizations of the search antenna. Then the maximum level measured was recorded.
- The frequency range investigated was 30 MHz to 3.15 GHz.
- Between 30 MHz and 1 GHz, a resolution bandwidth of 120 kHz was used.
- Above 1 GHz, a 1 MHz resolution bandwidth was used.
- For tests between 600 MHz and 3.15 GHz a 600 MHz high pass filter was used to prevent saturation of the spectrum analyzer. Its insertion loss was evaluated with a network analyzer before the test.
- All measurements were done using a peak detector.
- The orientation of the EUT for the radiated emissions measurements was chosen by initially rotating the EUT through three orthogonal axes to determine the orientation that maximizes the emissions.

### 5.2.4 Test Results

Table 5-7 lists the highest emissions measured while the transmitter was on continuously, all other emissions had more than 10 dB margin. Plots of the prescan data can be found in Appendix C: Field Strength of Spurious Emissions Plots.

**Table 5-7: Fundamental Emission Field Strength Test Results @ 10m**

| Parameter | Unit | Fundamental Emission |
|---|---|---|
| Frequency | MHz | 315 |
| Azimuth | deg | 286 |
| Height | cm | 222 |
| Polarization | | Horizontal |
| Meter Reading | dB(μV) | 83.9 |
| Detector | PK, QP, AV | PK |
| Gain / Loss Factor | dB | -25.1 |
| Transducer Factor | dB | 13.4 |
| Level | dB(μV/m) | 72.2 |
| Limit | dB(μV/m) | 74.7 (peak) |
| Margin to FCC Part 15 | dB | 2.5 |

**Table 5-8: Spurious Emission Field Strength Test Results @ 10m**

| Parameter | Unit | Spurious Emission 1 | Spurious Emission 2 | Spurious Emission 3 | Spurious Emission 4 | Spurious Emission 5 |
|---|---|---|---|---|---|---|
| Frequency | MHz | 630 | 945 | 1890 | 2520 | 3150 |
| Azimuth | deg | 295 | 325 | 291 | 278 | 278 |
| Height | cm | 105 | 99 | 129 | 374 | 350 |
| Polarization | | Horz | Horz | Horz | Horz | Horz |
| Meter Reading | dB(μV) | 43.5 | 41.5 | 47.5 | 51.8 | 47.8 |
| Detector | PK, QP, AV | pk | pk | pk | pk | pk |
| Gain / Loss Factor | dB | -25.2 | -23.7 | -35.5 | -34.9 | -34.4 |
| Transducer Factor | dB | 18.9 | 22.4 | 27.2 | 28.5 | 30.3 |
| Level (pk) | dB(μV/m) | 37.2 | 40.2 | 39.2 | 45.4 | 43.7 |
| Limit | dB(μV/m) | 54.7 pk | 54.7 pk | 54.7 pk | 54.7 pk | 54.7 pk |
| Margin to FCC Part 15 | dB | 17.5 | 14.5 | 15.5 | 9.3 | 11.0 |

### 5.2.5 Test Conclusion

The test results meet the requirements defined in Table 5-4: Field Strength of Spurious Emissions Requirement.

### 5.2.6 Test Equipment List

**Table 5-9: Test Equipment used for Field Strength of Spurious Emissions**

| Description | Make | Model number | Asset number | Calibr. due |
|---|---|---|---|---|
| Bilog Antenna | Antenna Research Associates | LPB 2520A | SSG012299 | 12/21/2007 |
| Spectrum Analyzer HP8566B (AFC #1) | HP | 8566B | SSG012521 | 4/13/2008 |
| Spec. A, RF PreSelector, HP85685A | HP | 85685A | SSG012010 | 4/13/2008 |
| Power Supply | HP | 6216A | SSG013063 | 2/8/2008 |
| Pre-Amplifier | BNR | LNA | SSG012360 | 2/8/2008 |
| Quasi-Peak Adapter, HP85650A, (EMI # 2) | HP | 85650A | SSG013046 | 10/4/2007 |
| RF Amplifier, HP8447 # 1 | Agilent | 8447D | SSG013045 | 10/6/2007 |
| Sucoflex Cable | Huber & Suhner | 101 PEA | SSG012290 | 12/21/2007 |
| EMC Cable # 14, Sucoflex Cable | Huber & Suhner | 104PEA | SSG012041 | 10/2/2007 |
| EMC Cable # 5, Sucoflex Cable | Huber & Suhner | 104PEA | SSG012359 | 2/8/2008 |
| EMC Cable # 2, Sucoflex Cable | Huber & Suhner | 106A | SSG012453 | 2/5/2008 |
| EMC Cable # 1, Sucoflex Cable | Huber & Suhner | 106A | SSG012454 | 2/5/2008 |
| Spectrum Analyzer Display, HP 85662A | HP | 85662A | SSG012433 | 4/13/2008 |
| Double Ridged Horn | Emco | 3115 | SSG012298 | 17/01/2008 |
| Pre-Amplifier | BNR | LNA | SSG012360 | 08/02/2008 |
| High Pass Filter | Mini-Circuits | NFP | 15542 | CBT |
| Network Analyzer | Hewlett Packard | 8753C | SSG012382 | 07/02/2008 |
| EMC Cable # 25, Sucotest Cable | Huber + Suhner | ST18/Nm/Nm/36 | SSG012788 | 2/8/2008 |

CBT: Calibrated Before Test

The measurement instrumentation conforms to ANSI C63.2 [6] and CISPR 16 [7]. Calibration of the measurement instrumentation is maintained in accordance with the supplier's recommendations, or as necessary to ensure its accuracy.

## 5.3 Occupied Bandwidth

### 5.3.1 Test Specification

The system occupied bandwidth was evaluated according to the specifications listed in Table 5-10:

**Table 5-10: Occupied Bandwidth**

| Requirement | Part / Section |
|---|---|
| FCC Part 15 | 15.231 c) |
| RSP-210 | A1.1.3 |

#### 5.3.1.1 Limits

The specified limit is shown in Table 5-11.

**Table 5-11: Transmitter Maximum Bandwidth**

| Frequency (MHz) | Maximum Bandwidth 0.25% x Tx Frequency (kHz) |
|---|---|
| 315 | 787.5 |

### 5.3.2 Test Facility Information

**Location:** Solectron Design and Engineering Lab 1

**Date tested:** May 16, 2007

**Tested by:** Denis Lalonde

### 5.3.3 Test Procedure

The 26 dB and 99 % bandwidth measurements were performed at 315 MHz. The modulated signal was evaluated by setting the transmitter in continuous transmission mode.

The 26 dB bandwidth was determined by finding the peak of the transmitted signal and the –26 dB points on each side of the peak. The 26 dB bandwidth is the difference in frequency between the –26 dB points.

The occupied bandwidth was also measured using the 99% bandwidth-measuring feature of the spectrum analyzer.

### 5.3.4 Test Results

The table below lists the measured occupied bandwidth.

**Table 5-12: Occupied bandwidth values**

| 26 dB Bandwidth Measurement (kHz) | 99% Bandwidth Measurement (kHz) |
|---|---|
| 39.5 kHz<br>Figure 7-5 | 43.7 kHz<br>Figure 7-5 |

The measured transmitter bandwidth is less than 0.25% of the transmitter frequency.

### 5.3.5 Test Conclusion

The test results meet the requirements defined Table 5-10.

### 5.3.6 Test Equipment List

**Table 5-13: Test Equipment used for Occupied bandwidth**

| Category | Manufacture | Model | Description | Serial Number | Cal. Due |
|---|---|---|---|---|---|
| Spectrum analyzer | Agilent | E4440A | 26.5 GHz | MY46185680 | 3-May-2008 |

The measurement instrumentation conforms to ANSI C63.2 [6]. Calibration of the measurement instrumentation is maintained in accordance with the supplier's recommendations, or as necessary to ensure its accuracy.

# 6. References

## 6.1 Applicable documents

1. [KP000938-TP-EMC-112-01]Test Plan

## 6.2 References Documents

2. Standards Council of Canada, Scope of Accreditation for Solectron EMS Canada Inc. outlined at the following web site http://palcan.scc.ca/specs/pdf/95_e.pdf
3. Solectron EMS Canada Inc. Quality Manual, K0000608-QD-QM-01-09, July 4 2006.
4. Solectron EMS Canada Inc. Lab Operations Manual KG000347-QD-LAB-01-08, July 4 2006.
5. ANSI C63.4-2003 for FCC CFR 47 and ANSI C63.4-2001 for Telcordia, Methods of Measurement of Radio-Noise Emission from Low-Voltage Electrical and Electronic Equipment in the Range of 9 kHz to 40 GHz, 06 June 2001.
6. ANSI C63.2-1996, American National Standard for Electromagnetic Noise and Field Strength Instrumentation, 10 Hz to 40 GHz – Specifications.
7. CISPR 16 Publications (2003), Specification for Radio Disturbance and Immunity Measuring Apparatus and Methods - Part 1: Radio Disturbance and Immunity Measuring Apparatus.
8. Solectron EMS Canada Inc., EMC General Lab Test Procedure, KP000270-LP-EMC-01-08, July 6, 2006.
9. FCC Rules for Radio Frequency Devices, Title 47 of the Code of Federal Regulations), Part 2, U.S. Federal Communications Commission.
10. FCC Rules for Radio Frequency Devices, Title 47 of the Code of Federal Regulations), Part 15, U.S. Federal Communications Commission, 2005.
11. RSS-210, Issue 6, “Low-power Licence-exempt Radiocommunication Devices (All Frequency Bands): Category I Equipment” September 25, 2005.
12. APLAC, Asia Pacific Laboratory Accreditation Cooperation, Website (February 10th, 2004): http://www.aplac.org.
13. ILAC, International Laboratory Accreditation Cooperation, Website (February 10th, 2004): http://www.ilac.org/
14. Industry Canada, RSS 212, Test Facilities and Test Methods for Radio Equipment, Issue 1 (Provisional), February 27, 1999.
15. ISO/IEC 17025:2005, General Requirements for the competence of testing and calibration laboratories, second edition 2005/05/15.
16. ISO 9001:2000, Quality Management Systems – Requirements, third edition, 2000/12/15.

# 7. Appendices

## 7.1 Appendix A: Glossary

Included below are definitions and abbreviations of terms used in this document.

| Term | Definition |
|---|---|
| AC | Alternating Current |
| AFC | Ambient Free Chamber |
| AM | Amplitude modulation |
| ANSI | American National Standards Institute |
| AVG | Average detector |
| CISPR | Comité International Spécial Perturbation Radioélectrique (International Special Committee on Radio Interference) |
| Class A | Class A Limits for typical commercial establishments |
| Class B | Class B Limits for typical domestic and residential establishments |
| dB | Decibel |
| EMC | Electromagnetic Compatibility |
| EMI | Electromagnetic Interference |
| EN | European Normative |
| EUT | Equipment Under Test |
| FCC | Federal Communications Commission, USA |
| GND | Ground |
| IC | Industry Canada |
| PA | Broadband Power Amplifier |
| RBW | Resolution Bandwidth |
| RF | Radio-Frequency |
| RFI | Radio-Frequency Interference |
| SCC | Standards Council of Canada |

## 7.2 Appendix B: Test Set-up Photographs

**Figure 7-1: Invo 315 Keyfob Radiated Emissions Set-up**

## 7.3 Appendix C: Field Strength of Spurious Emissions Plots

This appendix presents all field strength plots for the test cases measured.

**Figure 7-2: Field Strength, 30 MHz to 600 MHz**

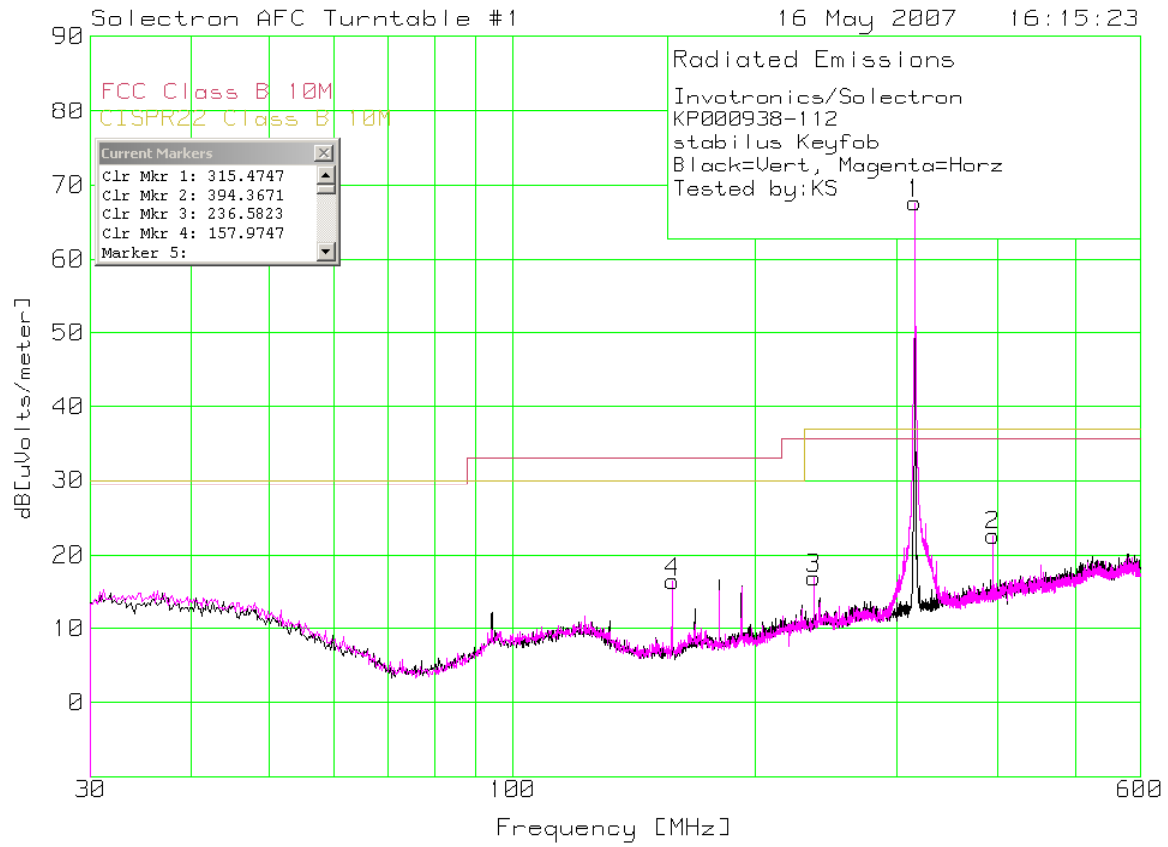


**Figure 7-3: Field Strength, 600 MHz to 1 GHz**

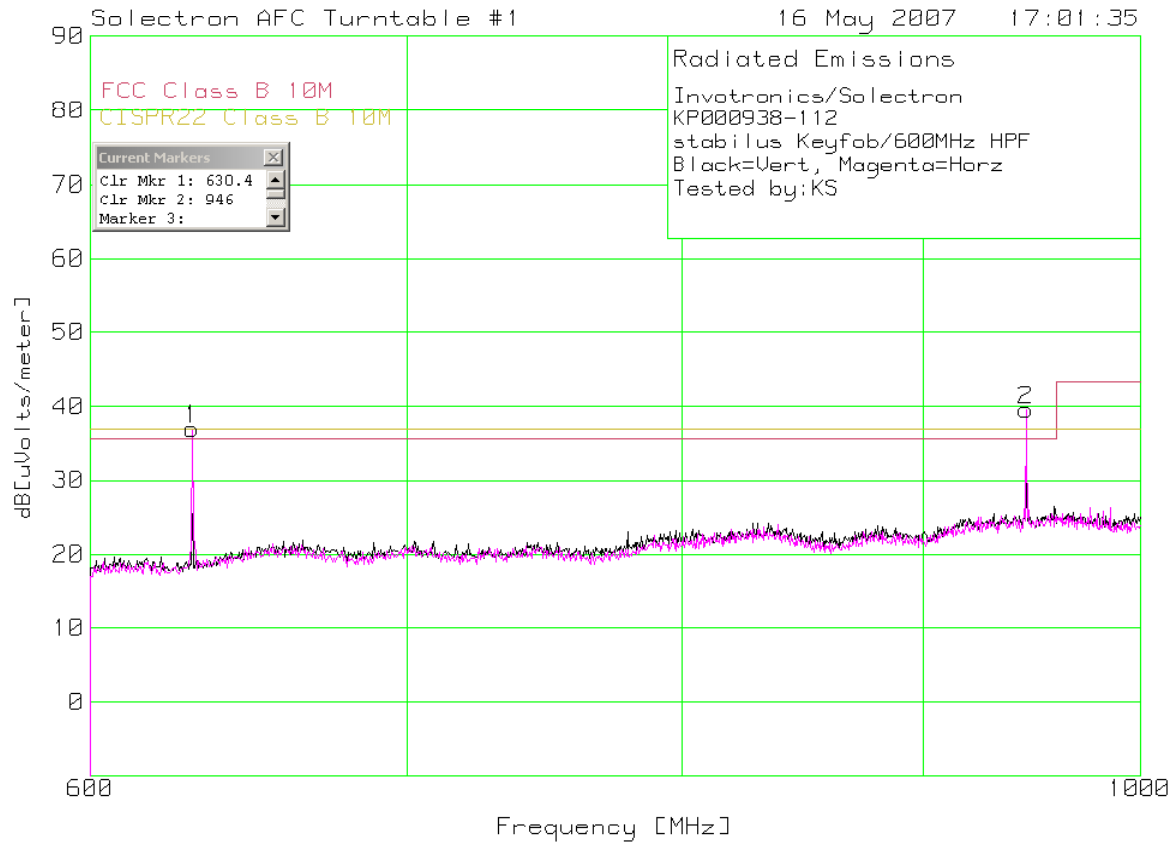
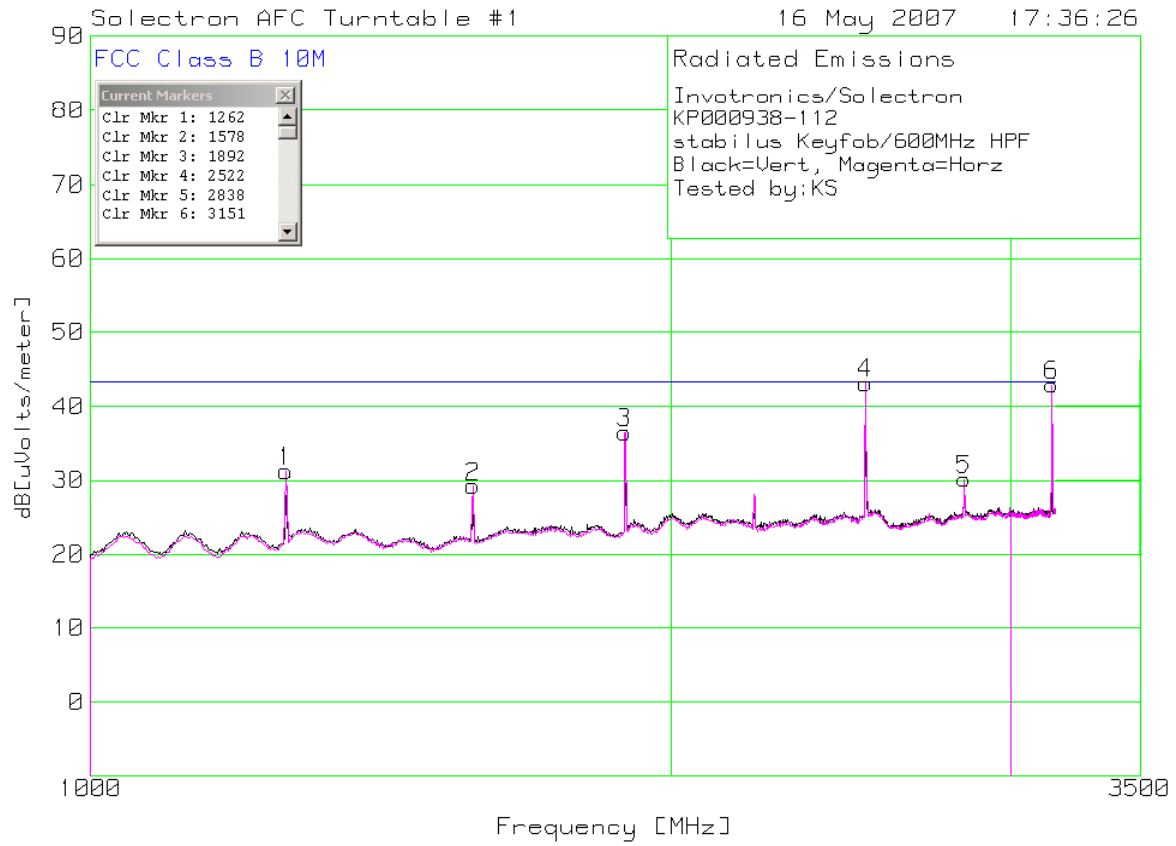


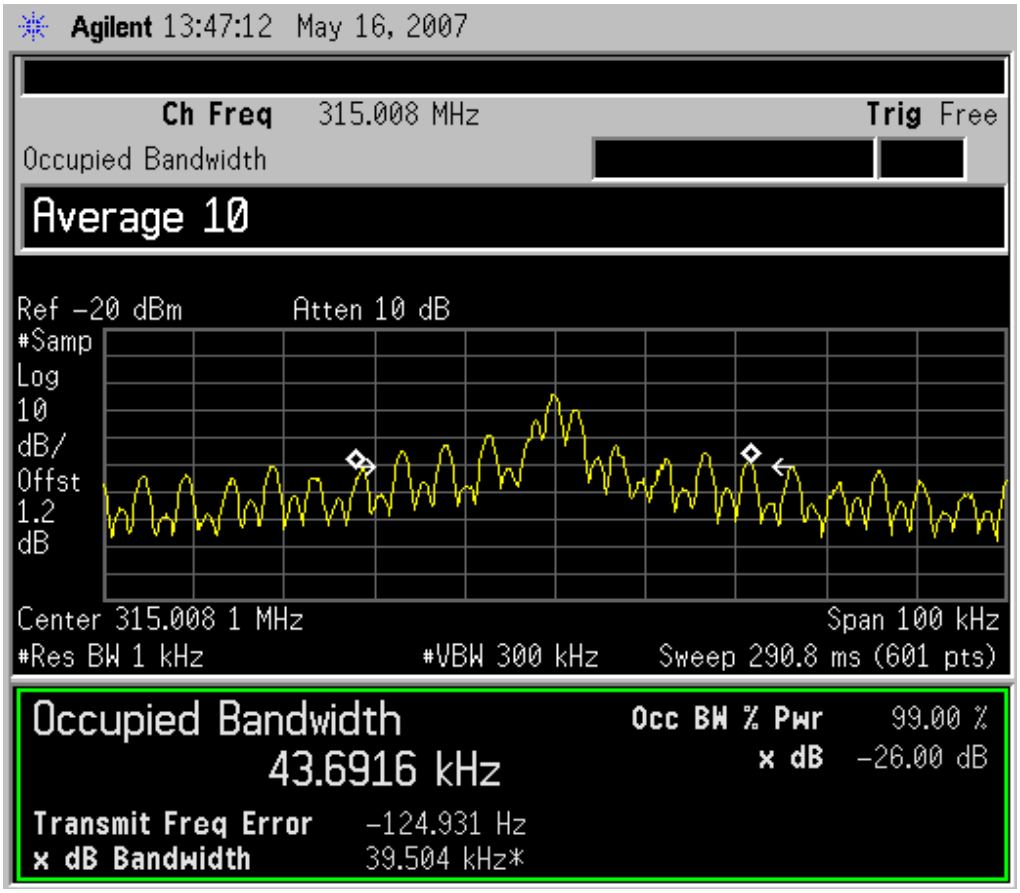
**Figure 7-4: Field Strength, 1 GHz to 3.15 GHz**



## 7.4 Appendix D: Occupied Bandwidth Plots

This appendix presents all the occupied bandwidth plots for the test cases measured.

**Figure 7-5: 20 Bandwidth**



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# Solectron EMS Canada Inc.
# Design and Engineering

# Certification Report for the Invo 315 Keyfob
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# End of Document