Test of: Thinkify LLC UHF RFID 915 MHz Module

To: FCC 47 CFR Part 15.247 & IC RSS-210

Test Report Serial No.: THNK10-U2 Rev A

# TEST REPORT

FROM

Test of: Thinkify LLC UHF RFID 915 MHz Module

to

To: FCC 47 CFR Part 15.247 & IC RSS-210

Test Report Serial No.: THNK10-U2 Rev A

This report supersedes: NONE

Applicant: Thinkify LLC
18450 Technology Drive, Suite E1
Morgan Hill, California 95037
USA

Product Function: UHF RFID 915 MHz Module

Copy No: pdf Issue Date: 10th September 2014

**This Test Report is Issued Under the Authority of;**

**MiCOM Labs, Inc.**
575 Boulder Court,
Pleasanton, CA 94566 USA
Phone: +1 (925) 462-0304
Fax: +1 (925) 462-0306
www.micomlabs.com

ACCREDITED
TESTING CERT #2381.01

**MiCOM Labs is an ISO 17025 Accredited Testing Laboratory**

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# ACCREDITATION, LISTINGS & RECOGNITION

## TESTING ACCREDITATION

MiCOM Labs, Inc. is an accredited Electrical testing laboratory per the international standard EN ISO/IEC 17025. The company is accredited by the American Association for Laboratory Accreditation (A2LA) www.a2la.org test laboratory number 2381.01. MiCOM Labs test schedule is available at the following URL; http://www.a2la.org/scopepdf/2381-01.pdf

ilac-MRA

A2LA American Association for Laboratory Accreditation

*Accredited Laboratory*

A2LA has accredited

**MICOM LABS**

*Pleasanton, CA*

for technical competence in the field of

Electrical Testing

This laboratory is accredited in accordance with the recognized International Standard ISO/IEC 17025:2005 *General Requirements for the Competence of Testing and Calibration Laboratories*. This accreditation demonstrates technical competence for a defined scope and the operation of a laboratory quality management system (*refer to joint ISO-ILAC-IAF Communiqué dated 8 January 2009*).

Presented this 28th day of February 2014.

President & CEO
For the Accreditation Council
Certificate Number 2381.01
Valid to November 30, 2015

*For the tests or types of tests to which this accreditation applies, please refer to the laboratory's Electrical Scope of Accreditation.*

## RECOGNITION

MiCOM Labs, Inc has widely recognized Electrical testing capabilities. Our international recognition includes Conformity Assessment Body designation by APEC MRA** countries. Our test reports are widely accepted for global type approvals.

| Country | Recognition Body | Status | Phase | Identification No. |
|---|---|---|---|---|
| USA | Federal Communications Commission (FCC) | TCB | - | US0159<br>Listing #: 102167 |
| Canada | Industry Canada (IC) | FCB | APEC MRA 2 | US0159<br>Listing #: 4143A-2<br>4143A-3 |
| Japan | MIC (Ministry of Internal Affairs and Communication) | CAB | APEC MRA 2 | RCB 210 |
| | VCCI | -- | -- | A-0012 |
| Europe | European Commission | NB | EU MRA | NB 2280 |
| Australia | Australian Communications and Media Authority (ACMA) | CAB | APEC MRA 1 | US0159 |
| Hong Kong | Office of the Telecommunication Authority (OFTA) | CAB | APEC MRA 1 | |
| Korea | Ministry of Information and Communication Radio Research Laboratory (RRL) | CAB | APEC MRA 1 | |
| Singapore | Infocomm Development Authority (IDA) | CAB | APEC MRA 1 | |
| Taiwan | National Communications Commission (NCC)<br>Bureau of Standards, Metrology and Inspection (BSMI) | CAB | APEC MRA 1 | |
| Vietnam | Ministry of Communication (MIC) | CAB | APEC MRA 1 | |

**APEC MRA – Asia Pacific Economic Community Mutual Recognition Agreement.
Is a recognition agreement under which test lab is accredited to regulatory standards of the APEC member countries.
Phase I - recognition for product testing
Phase II – recognition for both product testing and certification
N/A – Not Applicable

**EU MRA – European Union Mutual Recognition Agreement.
Is a recognition agreement under which test lab is accredited to regulatory standards of the EU member countries.

**NB – Notified Body

## PRODUCT CERTIFICATION

MiCOM Labs, Inc. is an accredited Product Certification Body per the international standard EN ISO/IEC 17065. The company is accredited by the American Association for Laboratory Accreditation (A2LA) www.a2la.org test laboratory number 2381.02. MiCOM Labs test schedule is available at the following URL; http://www.a2la.org/scopepdf/2381-02.pdf


**United States of America – Telecommunication Certification Body (TCB)**
TCB Identifier – US0159

**Industry Canada – Certification Body**
CAB Identifier – US0159

**Europe – Notified Body**
Notified Body Identifier - 2280

**Japan – Recognized Certification Body (RCB)**
RCB Identifier - 210

# DOCUMENT HISTORY

| Document History | | |
|---|---|---|
| Revision | Date | Comments |
| Draft | | |
| Rev A | 10th September 2014 | Initial Release |
| | | |
| | | |
| | | |
| | | |
| | | |

# 1. TEST RESULT CERTIFICATE

| | | | |
|---|---|---|---|
| Manufacturer: | Thinkify LLC<br>18450 Technology Drive, Suite E1<br>Morgan Hill, California 95037<br>USA | Tested By: | MiCOM Labs, Inc.<br>575 Boulder Court<br>Pleasanton<br>California, 94566, USA |
| EUT: | UHF RFID 915 MHz Module | Telephone: | +1 925 462 0304 |
| Model: | TR-65 | Fax: | +1 925 462 0306 |
| S/N's: | #1 | | |
| Test Date(s): | 11th - 20th August 2014 | Website: | www.micomlabs.com |

| STANDARD(S) | TEST RESULTS |
|---|---|
| FCC 47 CFR Part 15.247 & IC RSS-210<br>(Bluetooth Functionality Only) | EQUIPMENT COMPLIES |

MiCOM Labs, Inc. tested the equipment mentioned in accordance with the requirements set forth in the above standards. Test results indicate that the equipment tested is capable of demonstrating compliance with the requirements as documented within this report.

**Notes:**

1. This document reports conditions under which testing was conducted and the results of testing performed.
2. Details of test methods used have been recorded and kept on file by the laboratory.
3. Test results apply only to the item(s) tested.

**Approved & Released for MiCOM Labs, Inc. by:**

A2LA ACCREDITED
TESTING CERT #2381.01

Graeme Grieve
Quality Manager MiCOM Labs,

Gordon Hurst
President & CEO MiCOM Labs, Inc.

# 2. REFERENCES AND MEASUREMENT UNCERTAINTY

## 2.1. Normative References

| REF. | PUBLICATION | YEAR | TITLE |
|---|---|---|---|
| **i.** | FCC 47 CFR Part 15, Subpart C | 2012 | Title 47: Telecommunication PART 15 — Radio Frequency Devices Subpart C—Intentional Radiators |
| **ii.** | RSS-210 Annex 8 | 2010 | Radio Standards Specification 210, Issue 8, Low-power Licence-exempt Radiocommunication Devices (All Frequency Bands): Category I Equipment |
| **iii.** | FCC OET KDB 662911 | 4th April 2011 | Emissions Testing of Transmitters with Multiple Outputs in the Same Band |
| **iv.** | DA 00-705 | 2000 | FCC DA 00-705 "Filing and Measurement Guidelines for Frequency Hopping Spread Spectrum Systems" released March 30, 2000 |
| **v.** | RSS-GEN | 2010 | Radio Standards Specification-Gen, Issue 3, General Requirements and Information for the Certification of Radiocommunication Equipment |
| **vi.** | FCC 47 CFR Part 15, Subpart B | 2010 | 47 CFR Part 15, SubPart B; Unintentional Radiators |
| **vii.** | ICES-003 | 2004 | Spectrum Management and Telecommunications Policy Interference-Causing Equipment Standard Digital Apparatus; Issue 4 |
| **viii.** | ANSI C63.4 | 2009 | American National Standards for Methods of Measurement of Radio-Noise Emissions from Low-Voltage Electrical and Electronic Equipment in the Range of 9 kHz to 40 GHz |
| **ix.** | CISPR 22/ EN 55022 | 2008 2006 +A1:2007 | Limits and Methods of Measurements of Radio Disturbance Characteristics of Information Technology Equipment |
| **x.** | M 3003 | Edition 2 Jan. 2007 | Expression of Uncertainty and Confidence in Measurements |
| **xi.** | LAB34 | Edition 1 Aug 2002 | The expression of uncertainty in EMC Testing |
| **xii.** | ETSI TR 100 028 | 2001 | Parts 1 and 2 Electromagnetic compatibility and Radio Spectrum Matters (ERM); Uncertainties in the measurement of mobile radio equipment characteristics |
| **xiii.** | A2LA | April 2014 | Reference to A2LA Accreditation Status – A2LA Advertising Policy |

## 2.2. Test and Uncertainty Procedures

Conducted and radiated emission measurements were conducted in accordance with American National Standards Institute ANSI C63.4, listed in the Normative References section of this report.

Measurement uncertainty figures are calculated in accordance with ETSI TR 100 028 Parts 1 and 2.

Measurement uncertainties stated are based on a standard uncertainty multiplied by a coverage factor k = 2, providing a level of confidence of approximately 95 % in accordance with UKAS document M 3003 listed in the Normative References section of this report.

# 3. PRODUCT DETAILS AND TEST CONFIGURATIONS

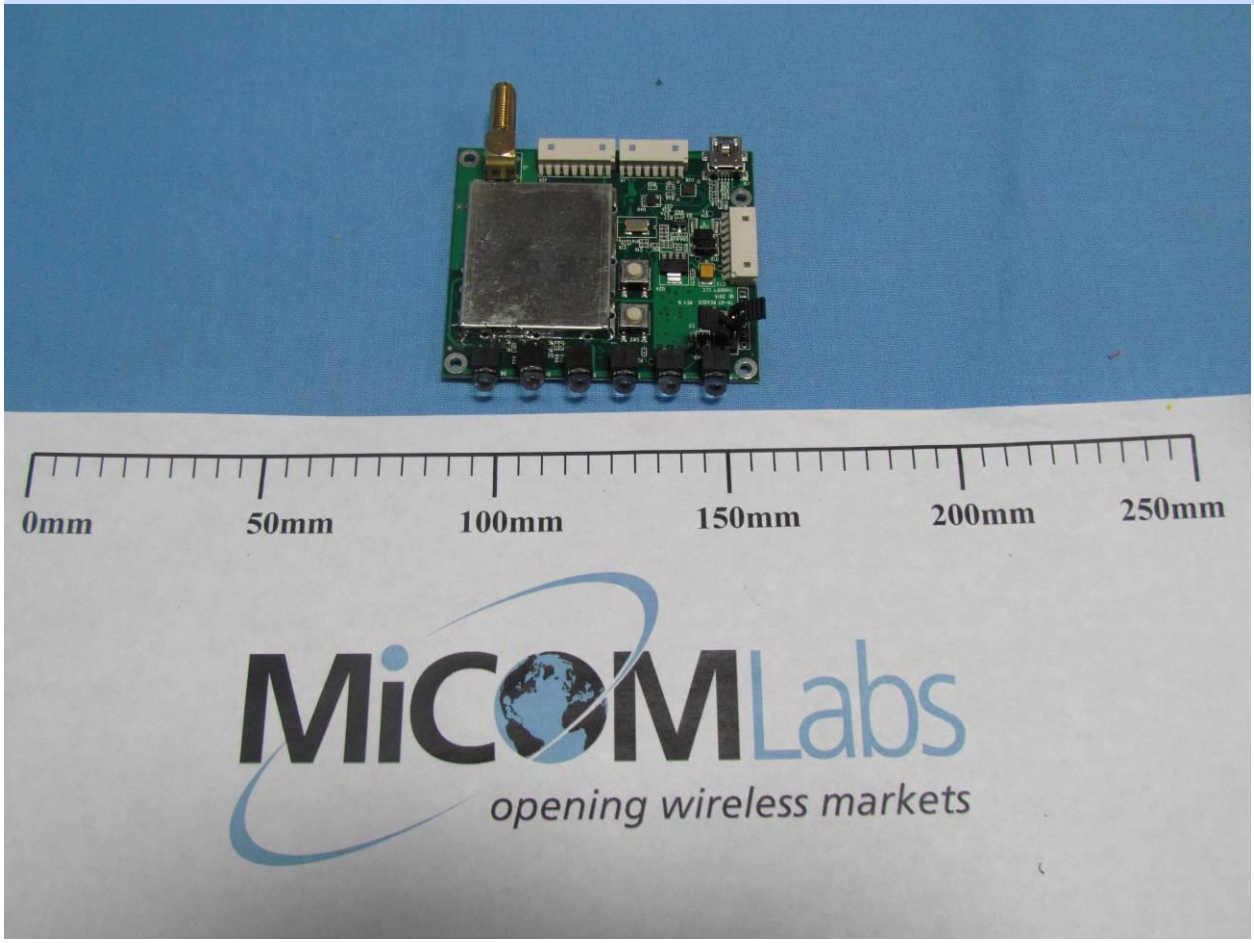
## 3.1. Technical Details

| Details | Description |
|---|---|
| Purpose: | Test of Thinkify LLC UHF 915 MHz RFID Module to FCC Part 15.247 and Industry Canada RSS-210 regulations. |
| Applicant: | Thinkify LLC<br>18450 Technology Drive, Suite E1<br>Morgan Hill, California 95037<br>USA |
| Manufacturer: | As applicant. |
| Laboratory performing the tests: | MiCOM Labs, Inc.<br>575 Boulder Court<br>Pleasanton, California 94566 USA |
| Test report reference number: | THNK10-U2 Rev A |
| Date EUT received: | 11th August 2014 |
| Standard(s) applied: | FCC 47 CFR Part 15.247 & IC RSS-210 |
| Dates of test (from - to): | 11th - 20th August 2014 |
| No of Units Tested: | One |
| Type of Equipment: | 915 MHz RFID Module |
| Manufacturers Trade Name: | Thinkify LLC |
| Model(s): | TR-65 |
| Location for use: | Outdoor |
| Declared Frequency Range(s): | 900 - 928 MHz |
| Software Release | 3.2.1 |
| Type of Modulation: | ASK |
| EUT Modes of Operation: | Single Mode Frequency Hopping |
| Transmit/Receive Operation: | Simplex |
| Output Power Type: | Variable |
| Rated Input Voltage and Current: | 5 Vdc  800 mA |
| Operating Temperature Range: | Declared range -40º to +70ºC |
| Equipment Dimensions: | 60 x 70 x 10 mm |
| Weight: | 1.5 oz |
| Primary function of equipment: | Radio Frequency Identification |
| Equipment Secondary Function(s): | None |

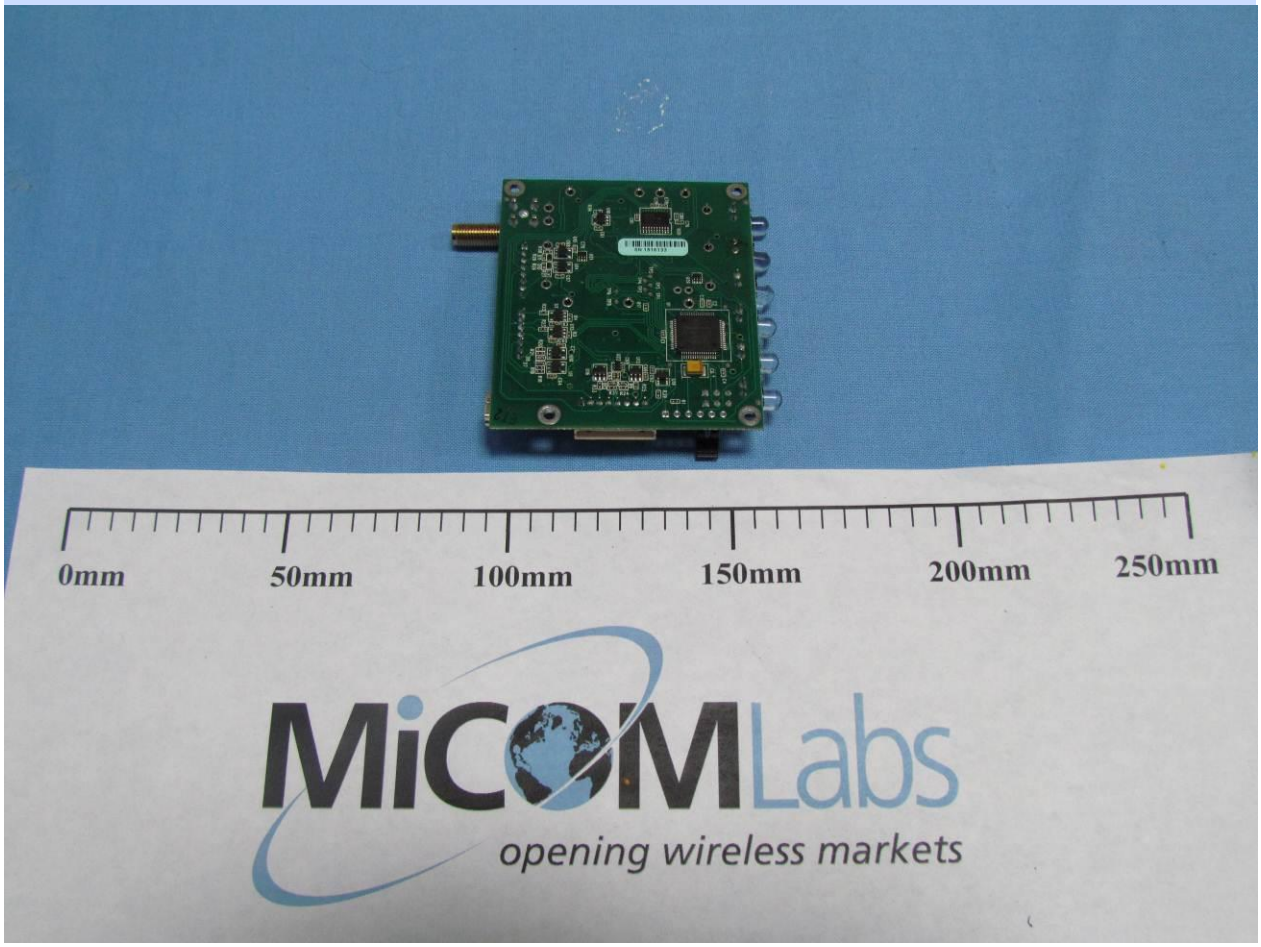
## 3.2. Scope of Test Program

The scope of the test program was to test the Thinkify LLC UHF 915 MHz RFID Module configuration in the frequency range 900 - 928 MHz for compliance against FCC 47 CFR Part 15.247 and Industry Canada RSS-210 specifications.

**TR-65 915 MHz RFID**



## TR-65 915 MHz RFID



## 3.3. Equipment Model(s) and Serial Number(s)

| Equipment Type | Equipment Description (Including Brand Name) | Mfr | Model No. | Serial No. |
|---|---|---|---|---|
| EUT | 915 MHz RFID Module | Thinkify LLC | TR-65 | #1 |
| Support | Laptop PC | IBM | Thinkpad | None |

## 3.4. Antenna Details

| Antenna Type | Manufacturer | Model Number | Antenna Gain (dBi) |
|---|---|---|---|
| Dipole | Linx | ANT-916-CW-HWR-RPS | 2.0 |
| Patch (Circular) | Thinkify LLC | TAC-060 | 6.0 |
| Patch (Linear) | Thinkify LLC | TAL-060 | 6.0 |

## 3.5. Cabling and I/O Ports

The following is a description of the cable and input, output ports available on the EUT.

| Type of I/O Ports | Description | Screened (y/n) | Description | Qty |
|---|---|---|---|---|
| TTL RS 232 | Digital Data | Yes | 2 meters | 2 |
| GPIO | I/O | Yes | 2 meters | 1 |
| USB | I/O | Yes | 2 meters | 1 |

## 3.6. EUT Configurations

| Band (MHz) | Mode | Freq Band (MHz) | Freq Range (MHz) | Low ch | Mid ch | High ch |
|---|---|---|---|---|---|---|
| 900 | RFID | 900 - 928 | 902.75 – 927.25 | 902.75 | 915.25 | 927.25 |

## 3.7. Test Configurations

| Operational Mode(s) | Variant | Data Rate with Highest Power | Frequencies (MHz) |
|---|---|---|---|
| TR65, P232 | N/A | N/A | 902.75<br>915.25<br>927.25 |

Results for the above configurations are provided in this report.

## 3.8. Equipment Modifications

The following modifications were required to bring the equipment into compliance

1).. NONE

## 3.9. Deviations from the Test Standard

The following deviations from the test standard were required in order to complete the test program:

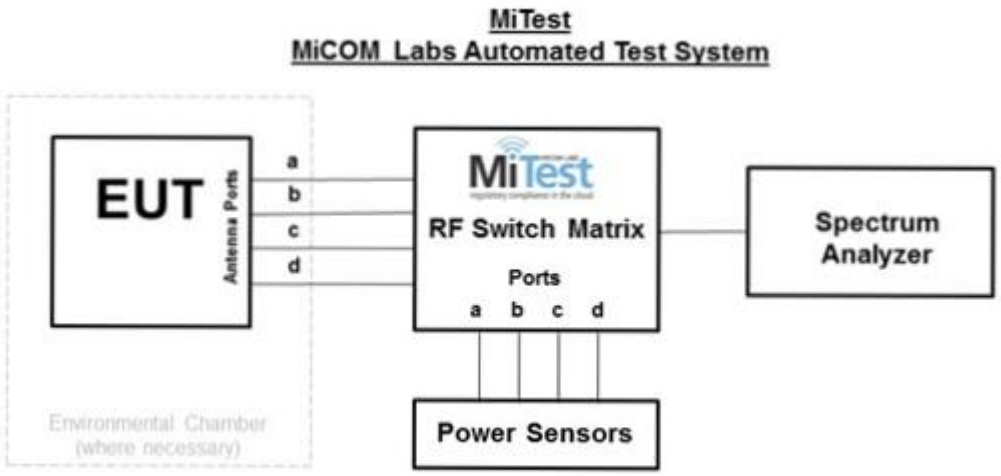
1. NONE

# 4. TESTING CONFIGURATION(S)

## 4.1. Conducted RF Emission Test Set-up

The following tests were performed using the conducted test set-up shown in the diagram below.

1. Section 6.1.1.1. 20 dB and 99% Bandwidth
2. Section 6.1.1.2. Peak Output Power
3. Section 6.1.1.3. Transmitter Channel Spacing, Occupancy etc.
4. Section 6.1.1.4. Conducted Spurious Emissions including band-edge




Conducted Test Measurement Setup

**Traceability**

| Test Equipment Utilized for Conducted Testing |
|---|
| 075, 117, 158, 223, 376, 378, 380, 390, 398, 405, RF#1 SMA#SA, RF#1 SMA#1, RF#1 SMA#2, RF#1 SMA#3, RF#1 SMA#4 |

**Measurement and Presentation of Test Data**

The measurement and graphical data presented in this test report was generated automatically using state-of-the-art technology creating an easy to read report structure. Numerical measurement data is separated from supporting graphical data (plots) through hyperlinks. Numerical measurement data can be reviewed without scrolling through numerous graphical pages to arrive at the next data matrix.

Plots have been relegated into the Appendix 'Graphical Data'.

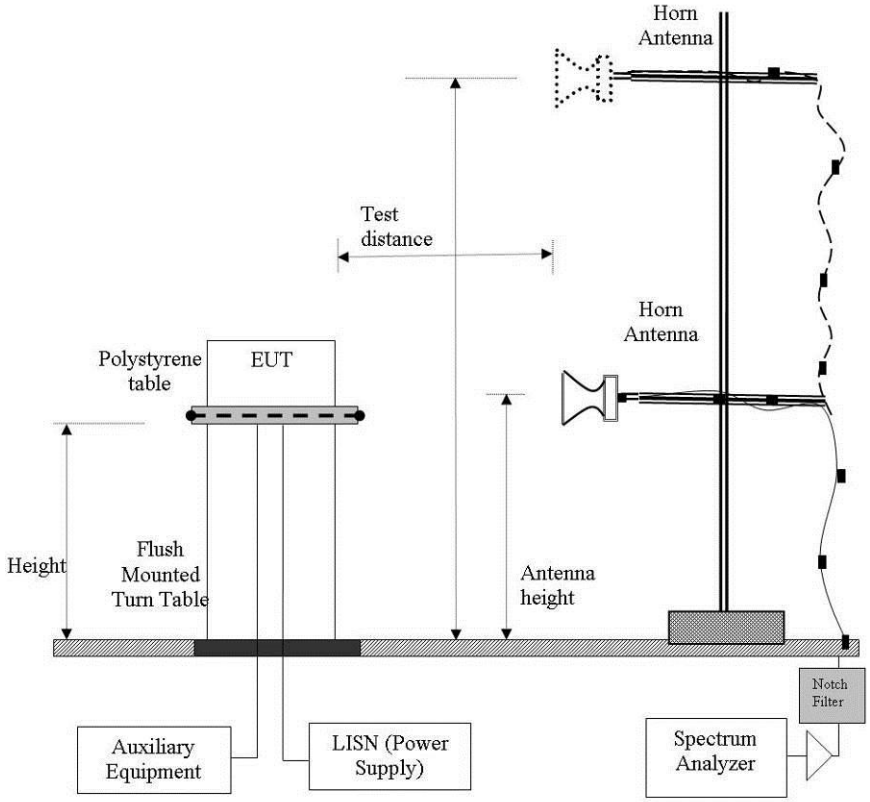
Test and report automation was performed by MiTest. MiTest is an automated test system developed by MiCOM Labs. MiTest is the first cloud based modular test system enabling end-to-end automation of regulatory compliance testing for conducted RF testing.


The MiCOM Labs "***MiTest***" Automated Test System" (Patent Pending)

## 4.2. Radiated Spurious Emission Test Set-up > 1 GHz

The following tests were performed using the radiated test set-up shown in the diagram below.

**Radiated Emission Measurement Setup – Above 1 GHz**



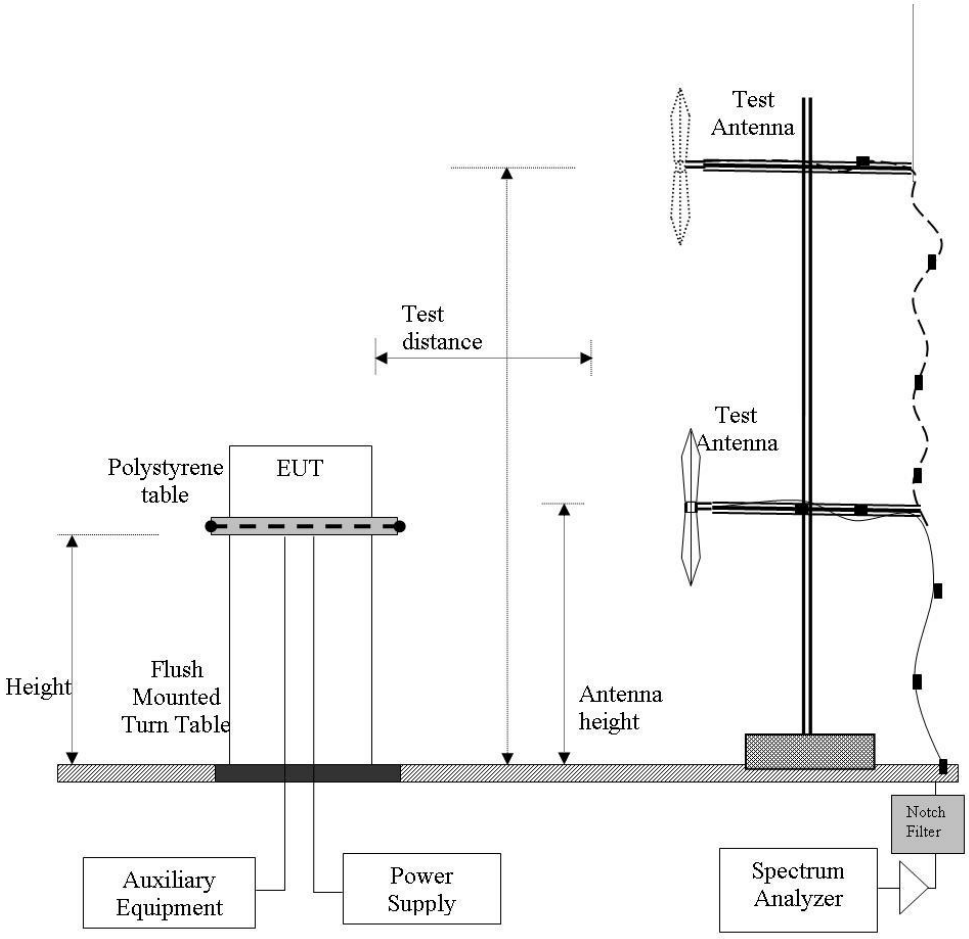

**Traceability**

| Test Equipment Utilized for Radiated Emission Testing > 1GHz |
|---|
| 158, 252, 310, 312, 377, 393, 396, 399, 406, 411, 413, 4165, 416, 502, 503 |

## 4.3. Digital Emissions Test Set-up (0.03 – 1 GHz)

The following tests were performed using the radiated test set-up shown in the diagram below.

**Digital Emission Measurement Setup ≤ 1 GHz**




EUT Table Top Height = Fixed Test Antenna Height = 1.5 m

**Traceability**

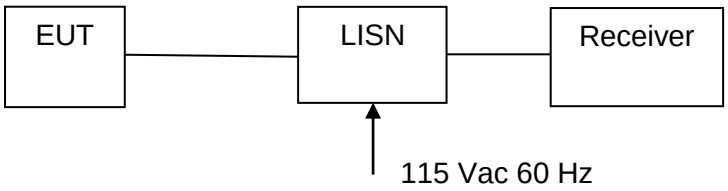
| Test Equipment Utilized for Radiated Emission Testing 0.03 - 1GHz |
|---|
| 158, 252, 310, 312, 338, 377, 393, 396, 397, 411, 413, 4165, 416, 502, 503 |

## 4.4. ac Wireline Emission Test Set-up

The following tests were performed using the conducted test set-up shown in the diagram below.

1. Section 5.1.3 ac Wireline Conducted Emissions

**Test Measurement Set up**




Measurement set up for AC Wireline Conducted Emissions Test

| Test Equipment Utilized for ac Wireline Emissions |
|---|
| 158, 193, 190, 307 |

# 5. TEST SUMMARY

## List of Measurements

The following table represents the list of measurements required under the **FCC CFR47 Part 15.247** and **Industry Canada RSS-210** and **Industry Canada RSS-Gen.**

| Section(s) | Test Items | Description | Condition | Result | Test Report Section |
|---|---|---|---|---|---|
| **15.247(a)(1)** **A8.1** | 20 dB BW | 20 dB Bandwidth | Conducted | Complies | 6.1.1.1 |
| **15.247(b)(2)** **A8.4** | Output Power | Transmit Power | Conducted | Complies | 6.1.1.2 |
| **15.247(a)(1)** **A8.1** | Transmitter Channels | Channel Spacing | Conducted | Complies | 6.1.1.3 |
| **15.247(a)(1)** **A8.1** | Transmitter Channels | Number of Hopping Frequencies | Conducted | Complies | 6.1.1.4 6.1.1.5 |
| | | Channel Occupancy | Conducted | Complies | 6.1.1.6 |
| **15.247(d)** **A8.5** | Conducted Spurious Emissions | Band Edge | Conducted | Complies | 6.1.1.7 6.1.1.8 |
| | | Spurious Emissions Transmitter | Conducted | Complies | |

## List of Measurements

The following table represents the list of measurements required under the **FCC CFR47 Part 15.247**, **Industry Canada RSS-210** and **Industry Canada RSS-Gen.**

| Section(s) | Test Items | Description | Condition | Result | Test Report Section |
|---|---|---|---|---|---|
| **15.247(d)**<br>**15.205**<br>**15.209**<br>**A8.5**<br>**2.2**<br>**2.6**<br>**4.9** | Radiated Emissions above 1 GHz | Transmitter | Radiated | Complies | *6.1.2.1* |
| **4.10** | | Receiver | Radiated | Complies | |
| **15.247(d)**<br>**15.205**<br>**15.209**<br>**A8.5**<br>**2.2**<br>**2.6** | Radiated Emissions below 1 GHz | | Radiated | Complies | *6.1.2.2* |
| **15.207**<br>**7.2.2** | Conducted | AC Wireline Conducted Emissions | Conducted | Not Applicable<br>EUT dc Powered | *N/A* |

***Note 1:*** *Test results reported in this document relate only to the items tested*
***Note 2:*** *The required tests demonstrated compliance as per client declaration of test configuration, monitoring methodology and associated pass/fail criteria*
***Note 3:*** *Section 3.7 - Equipment Modifications highlights the equipment modifications that were required to bring the product into compliance with the above test matrix*

# 6. TEST RESULTS

## 6.1. Device Characteristics

### 6.1.1. Conducted Testing

#### 6.1.1.1. 20 dB Bandwidth

**Test Procedure**

The 20 dB bandwidth is measured with a spectrum analyzer connected to the antenna terminal, while the EUT is operating in transmission mode at the appropriate center frequency and modulation.

**Test Results for 20 dB & 99% Bandwidth**

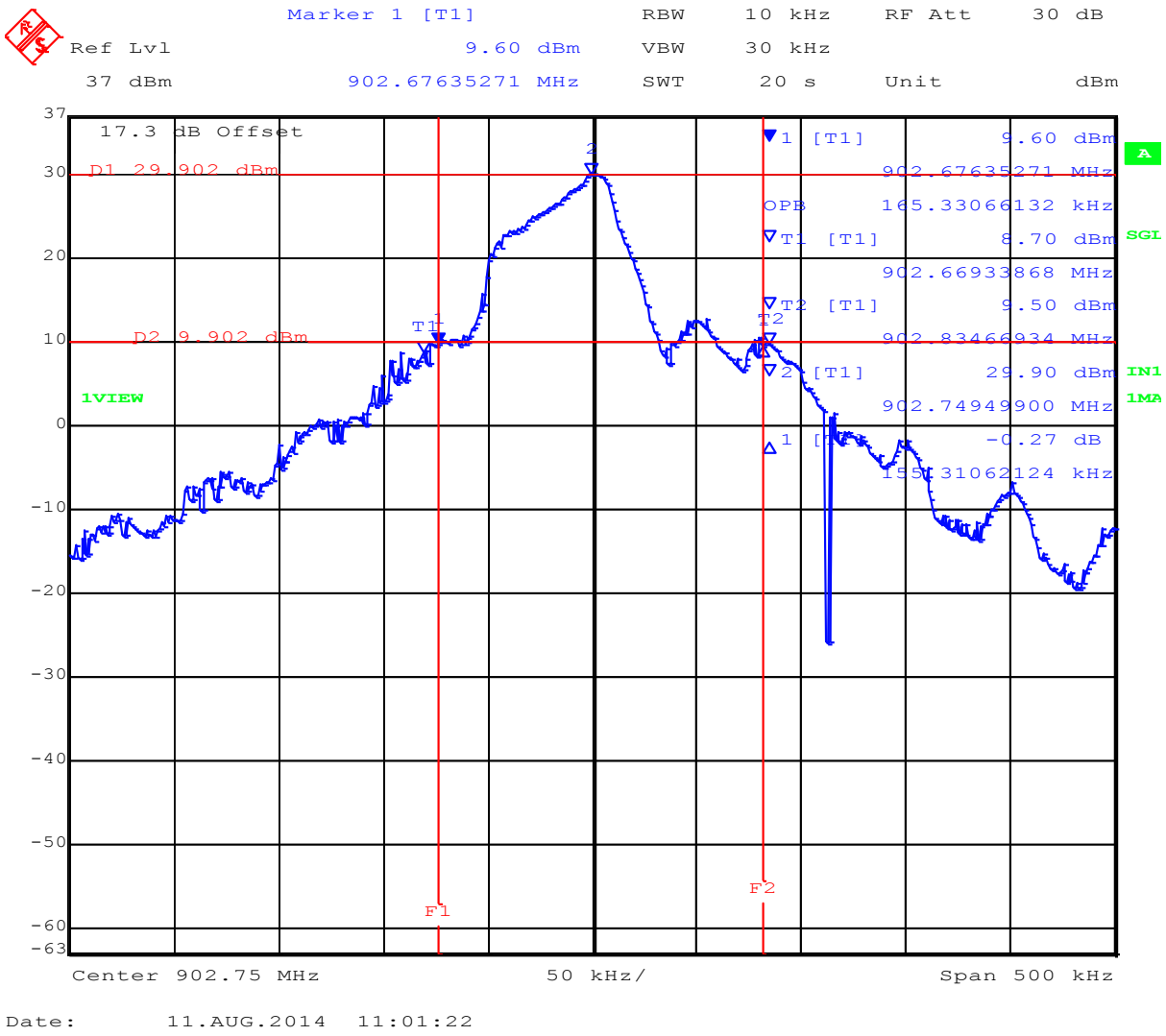
| Equipment Configuration for 20 dB Bandwidth | | | |
|---|---|---|---|
| **Variant:** | | **Duty Cycle (%):** | 95 |
| **Data Rate:** | 250 KHz | **Antenna Gain (dBi):** | Not Applicable |
| **Modulation:** | | **Beam Forming Gain (Y):** | Not Applicable |
| **TPC:** | Not Applicable | **Tested By:** | CC |
| **Engineering Test Notes:** | | | |

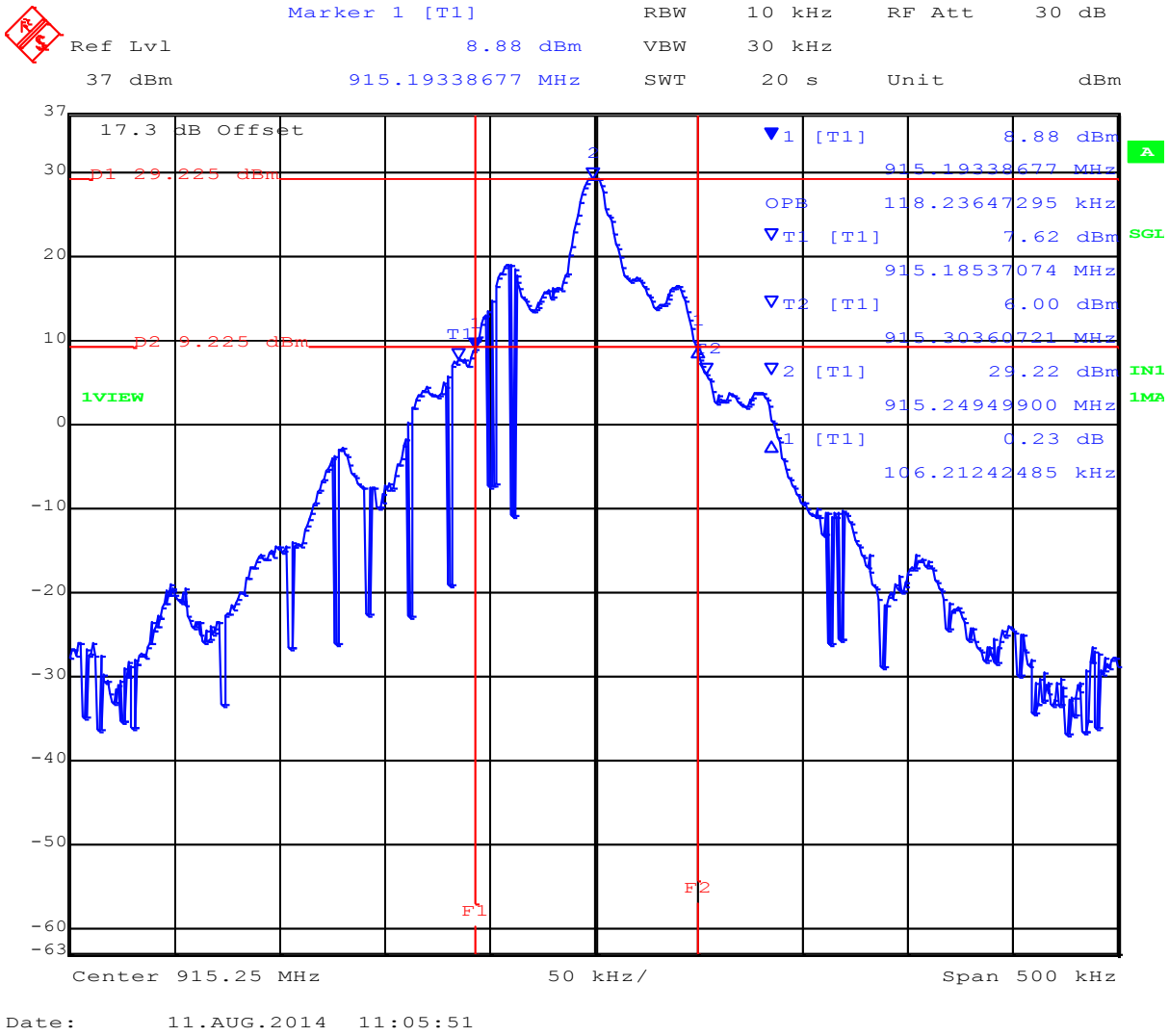
**Test Measurement Results**

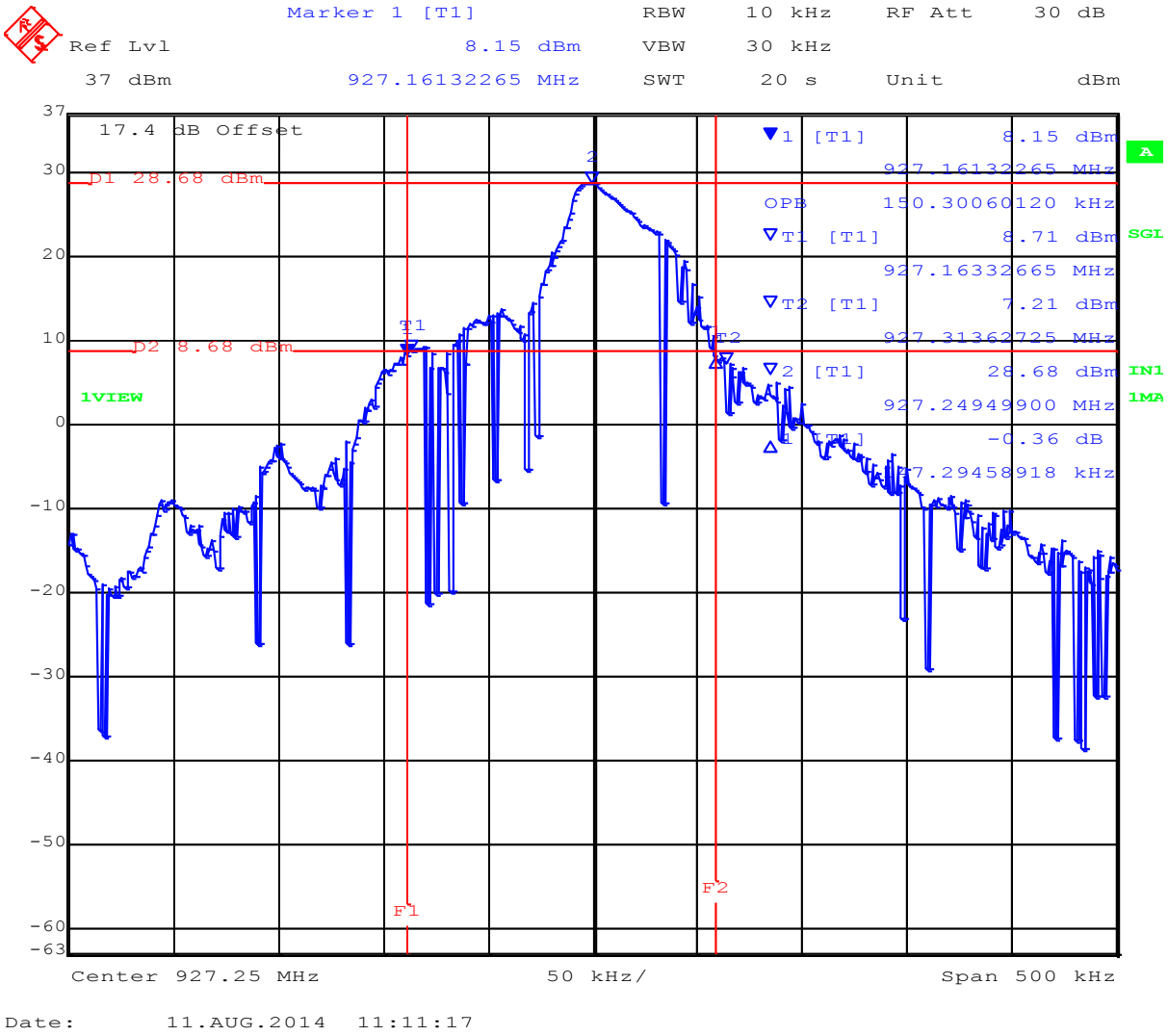
| Test Frequency | Measured 20 dB & 99% Bandwidth (kHz) Port(s) | | | | 20 dB Bandwidth (MHz) | | Limit | Lowest Margin |
|---|---|---|---|---|---|---|---|---|
| MHz | a | b | c | d | Highest | Lowest | KHz | kHz |
| 902.8 | 155.131 | -- | -- | -- | 155.131 | 155.131 | ≤250.0 | -98.869 |
| 915.3 | 106.212 | -- | -- | -- | 106.212 | 106.212 | ≤250.0 | -143.788 |
| 927.3 | 147.295 | -- | -- | -- | 147.295 | 147.295 | ≤250.0 | -102.705 |

| Test Frequency | Measured 99% Bandwidth (kHz) Port(s) | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| MHz | a | b | c | d | | | | |
| 902.8 | 165.331 | -- | -- | -- | | | | |
| 915.3 | 118.236 | -- | -- | -- | | | | |
| 927.3 | 150.301 | -- | -- | -- | | | | |

| Traceability to Industry Recognized Test Methodologies | |
|---|---|
| Work Instruction: | WI-03 MEASURING RF SPECTRUM MASK |
| Measurement Uncertainty: | ±2.81 dB |







## Specification

### Limits

**FCC §15.247 (a)(1)**
**Industry Canada RSS-210** §**8.1**

(a) Operation under the provisions of this Section is limited to frequency hopping and digitally modulated intentional radiators that comply with the following provisions:

(1) (i) For frequency hopping systems operating in the 902–928 MHz band: if the 20 dB bandwidth of the hopping channel is less than 250 kHz, the system shall use at least 50 hopping frequencies

### 6.1.1.2. Peak Output Power

**FCC, Part 15 Subpart C §15.247(b)(2)**
**Industry Canada RSS-210 §A8.4**

**Test Procedure**
The transmitter terminal of EUT was set for the channel of interest and connected to the input of the power meter which was calibrated to measure power. The value of measured power including antenna cable loss was reported.

| Equipment Configuration for Average Output Power | | | |
|---|---|---|---|
| **Variant:** | 802.11b | **Duty Cycle (%):** | 95.0 |
| **Data Rate:** | 250 KHz | **Antenna Gain (dBi):** | 2.0 |
| **Modulation:** | CCK | **Beam Forming Gain (Y):** | Not Applicable |
| **TPC:** | Not Applicable | **Tested By:** | CC |
| **Engineering Test Notes:** | | | |

**Test Measurement Results**

| Test Frequency | Measured Output Power (dBm) Port(s) | | | | Calculated Total Power Σ Port(s) + DCCF Duty Cycle Correction Factor : +0.22 dB | Limit | Margin | EUT Power Setting |
|---|---|---|---|---|---|---|---|---|
| MHz | a | b | c | d | dBm | dBm | dB | |
| **902.8** | 26.22 | -- | -- | -- | 26.44 | 30.00 | -3.56 | RA7 |
| **915.3** | 25.34 | -- | -- | -- | 25.56 | 30.00 | -4.44 | RA7 |
| **927.3** | 24.57 | -- | -- | -- | 24.79 | 30.00 | -5.21 | RA7 |

| Traceability to Industry Recognized Test Methodologies | |
|---|---|
| Work Instruction: | WI-01 MEASURING RF OUTPUT POWER |
| Measurement Uncertainty: | ±1.33 dB |

## Specification

## Limits

**FCC Part 15 Subpart C §15.247 (b)(1)**

(b) (2) For frequency hopping systems operating in the 902–928 MHz band: 1 watt for systems employing at least 50 hopping channels; and, 0.25 watts for systems employing less than 50 hopping channels, but at least 25 hopping channels, as permitted under paragraph (a)(1)(i) of this section

### 6.1.1.3. Carrier Frequency Separation

**Test Procedure**

The EUT must have its hopping function enabled.

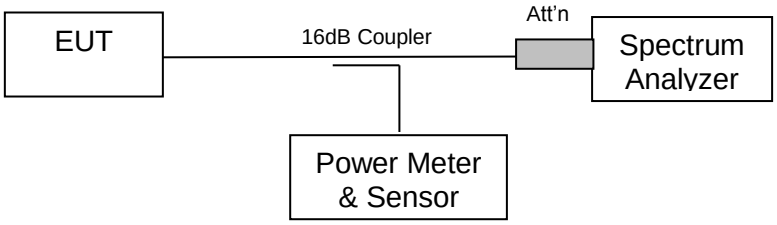
The following spectrum analyzer settings were used:

Span = wide enough to capture the peaks of two adjacent channels
Resolution (or IF) Bandwidth (RBW) ≥ 1 % of the span
Video (or Average) Bandwidth (VBW) ≥ RBW
Sweep = auto
Detector function = peak
Trace = max hold

Allow the trace to stabilize. Use the marker-delta function to determine the separation between the peaks of the adjacent channels. The limit is specified in one of the subparagraphs of this Section. Submit this plot.

*Reference: FCC DA 00-705 "Filing and Measurement Guidelines for Frequency Hopping Spread Spectrum Systems"*

**Test Setup**



## Specification for Carrier Frequency Separation Limits

**FCC §15.247**

(a) (1) (i) For frequency hopping systems operating in the 902–928 MHz band: if the 20 dB bandwidth of the hopping channel is less than 250 kHz, the system shall use at least 50 hopping frequencies

## Laboratory Measurement Uncertainty

| | |
|---|---|
| **Measurement Uncertainty (Spectrum/Amplitude)** | ±2.81 dB |

## Traceability

| **Method** |
|---|
| FCC DA 00-705 |

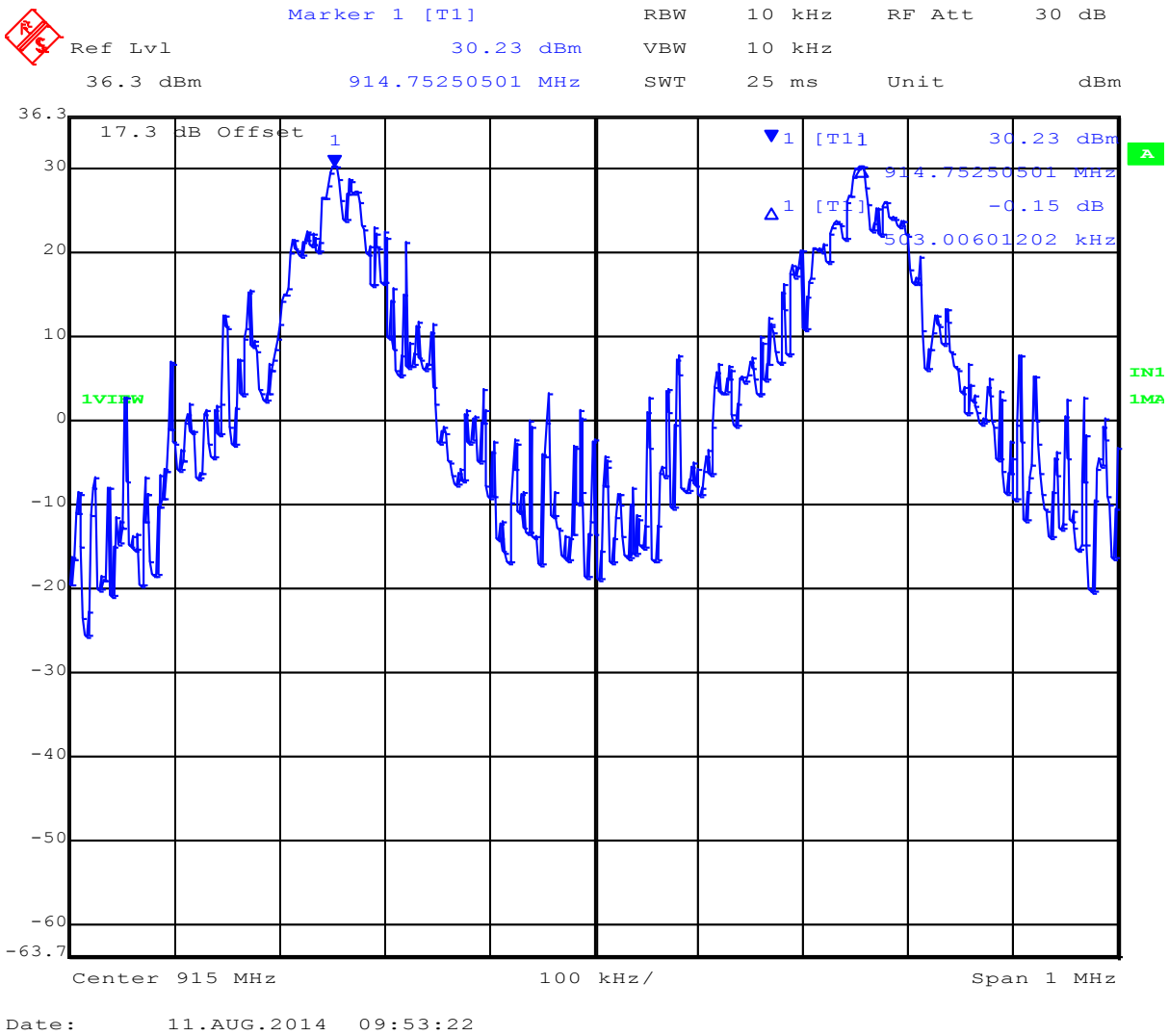
## Test Results for Carrier Frequency Separation

Ambient conditions.

Temperature: 17 to 23 °C  Relative humidity: 31 to 57 %  Pressure: 999 to 1012 mbar

| Channel Spacing (kHz) | Maximum 20 dB Bandwidth (kHz) |
|---|---|
| 503.01 | 155.131 |

### Carrier Frequency Separation; Hopping On = 1.004 MHz



### 6.1.1.4. Number of Hopping Frequencies

**Test Procedure**

The EUT must have its hopping function enabled.

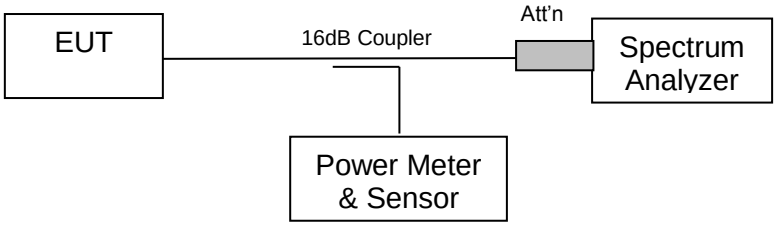
The following spectrum analyzer settings were used:

Span = the frequency band of operation
RBW ≥ 1% of the span
VBW ≥ RBW
Sweep = auto
Detector function = peak
Trace = max hold

Allow the trace to stabilize. It may prove necessary to break the span up to sections, in order to clearly show all of the hopping frequencies. The limit is specified in one of the sub-paragraphs of this Section.

*Reference: FCC DA 00-705 "Filing and Measurement Guidelines for Frequency Hopping Spread Spectrum Systems"*

**Test Setup**



## Specification for Number of Hopping Frequencies Limits

**FCC §15.247**

(a) (1) (i) For frequency hopping systems operating in the 902–928 MHz band: if the 20 dB bandwidth of the hopping channel is less than 250 kHz, the system shall use at least 50 hopping frequencies

## Laboratory Measurement Uncertainty

| | |
|---|---|
| **Measurement Uncertainty Spectrum/Amplitude)** | ±2.81 dB |
| **Measurement Uncertainty (Frequency)** | ±0.86 ppm |

## Traceability

| **Method** |
|---|
| FCC DA 00-705 |

## Test Results for Number of Hopping Frequencies

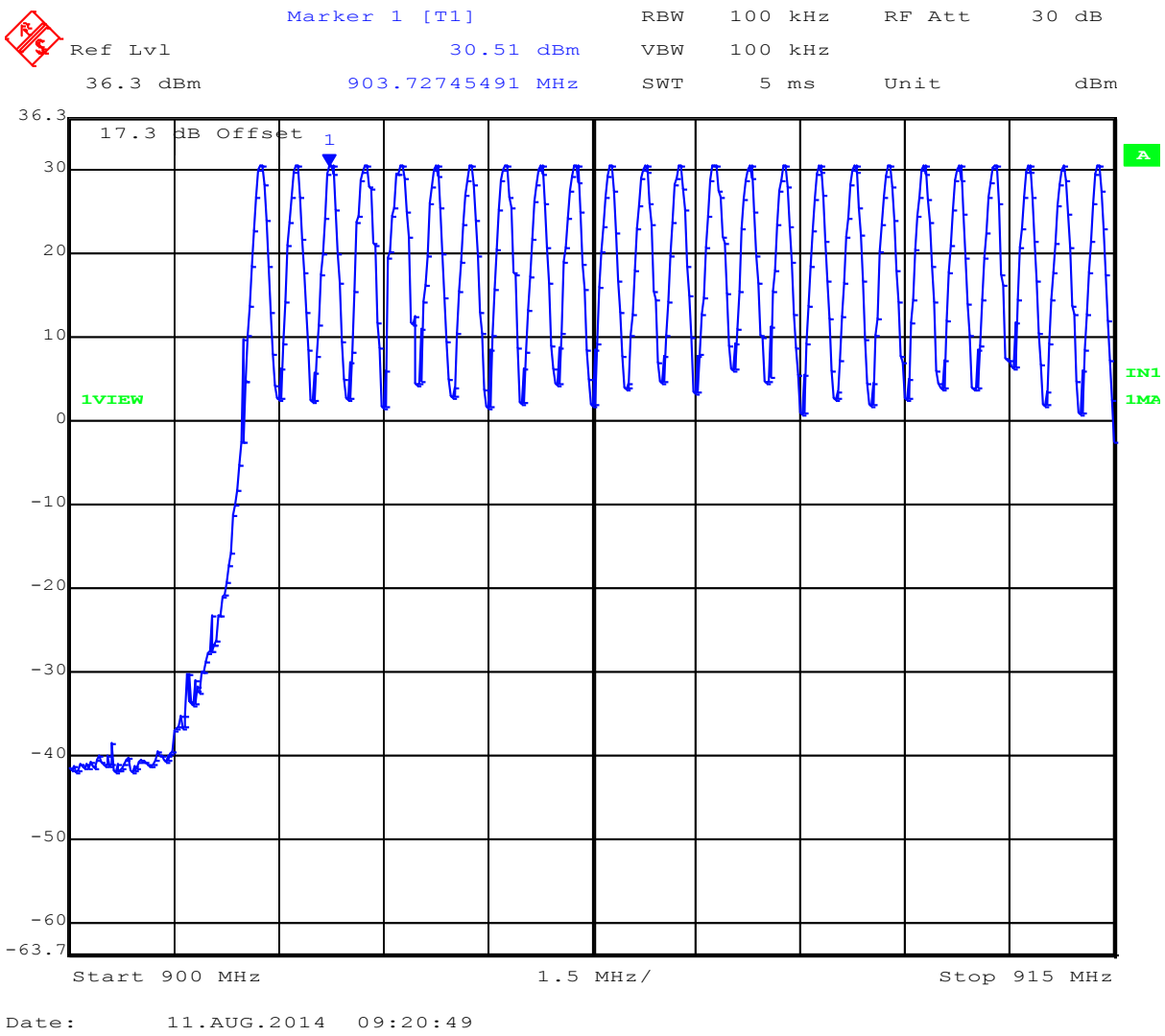
Ambient conditions.

Temperature: 17 to 23 °C  Relative humidity: 31 to 57 %  Pressure: 999 to 1012 mbar

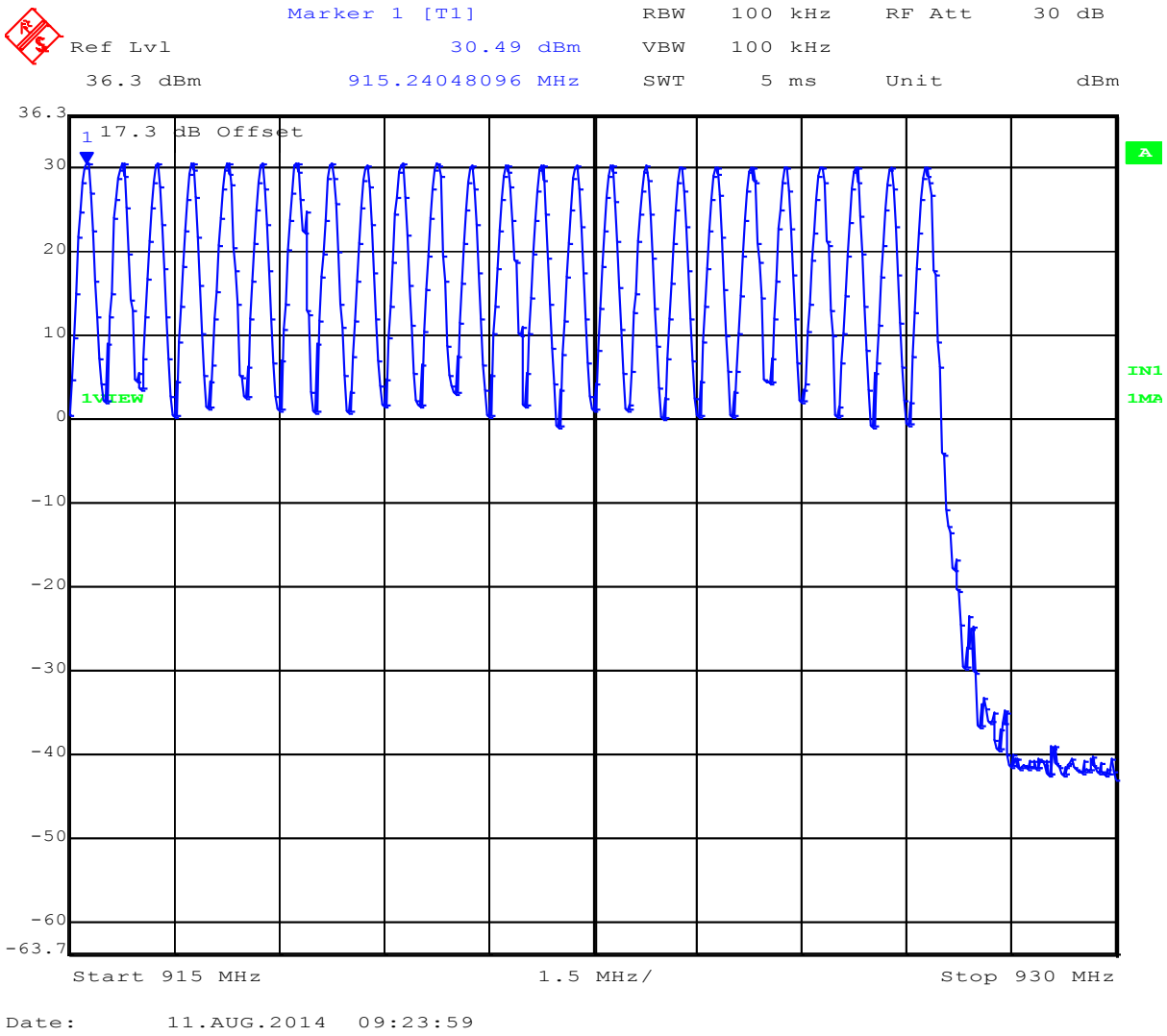
| Number of Channels | Specification |
|---|---|
| 50 | 1 Watt Output Power - Minimum 50 hopping channels |

EUT operates at a peak output power less than 1 Watt

## Number of Hopping Frequencies; Hopping On; 902 - 915 MHz



## Number of Hopping Frequencies; Hopping On; 915 – 928 MHz



### 6.1.1.5. Time of Occupancy (Dwell Time)

**Test Procedure**

The EUT must have its hopping function enabled.

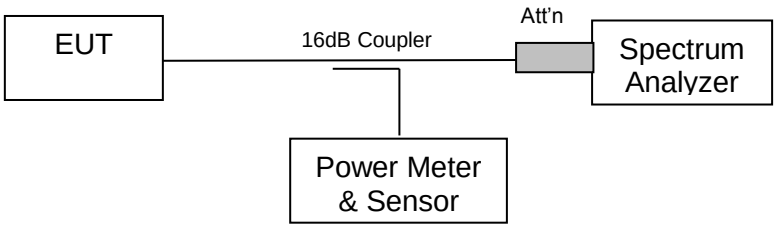
The following spectrum analyzer settings were used:

Span = zero span, centered on a hopping channel
RBW = 1MHz
VBW ≥ RBW
Sweep = as necessary to capture the entire dwell time per hopping channel
Detector function = peak
Trace = max hold

If possible, use the marker-delta function to determine the dwell time. If this value varies with different modes of operation (e.g., data rate, modulation format, etc.), repeat this test for each variation. The limit is specified in one of the subparagraphs of this Section. An oscilloscope may be used instead of a spectrum analyzer.

*Reference: FCC DA 00-705 "Filing and Measurement Guidelines for Frequency Hopping Spread Spectrum Systems"*

**Test Setup**



## Specification for Time of Occupancy (Dwell Time) Limits

**FCC §15.247**

(a)(1)(i) For frequency hopping systems operating in the 902–928 MHz band: if the 20 dB bandwidth of the hopping channel is less than 250 kHz, the system shall use at least 50 hopping frequencies and the average time of occupancy on any frequency shall not be greater than 0.4 seconds within a 20 second period; if the 20 dB bandwidth of the hopping channel is 250 kHz or greater, the system shall use at least 25 hopping frequencies and the average time of occupancy on any frequency shall not be greater than 0.4 seconds within a 10 second period. The maximum allowed 20 dB bandwidth of the hopping channel is 500 kHz

## Laboratory Measurement Uncertainty

| | |
|---|---|
| **Measurement Uncertainty (Spectrum/Amplitude)** | ±2.81 dB |
| **Measurement Uncertainty (Frequency)** | ±0.86 ppm |

## Traceability

| **Method** |
|---|
| FCC DA 00-705 |

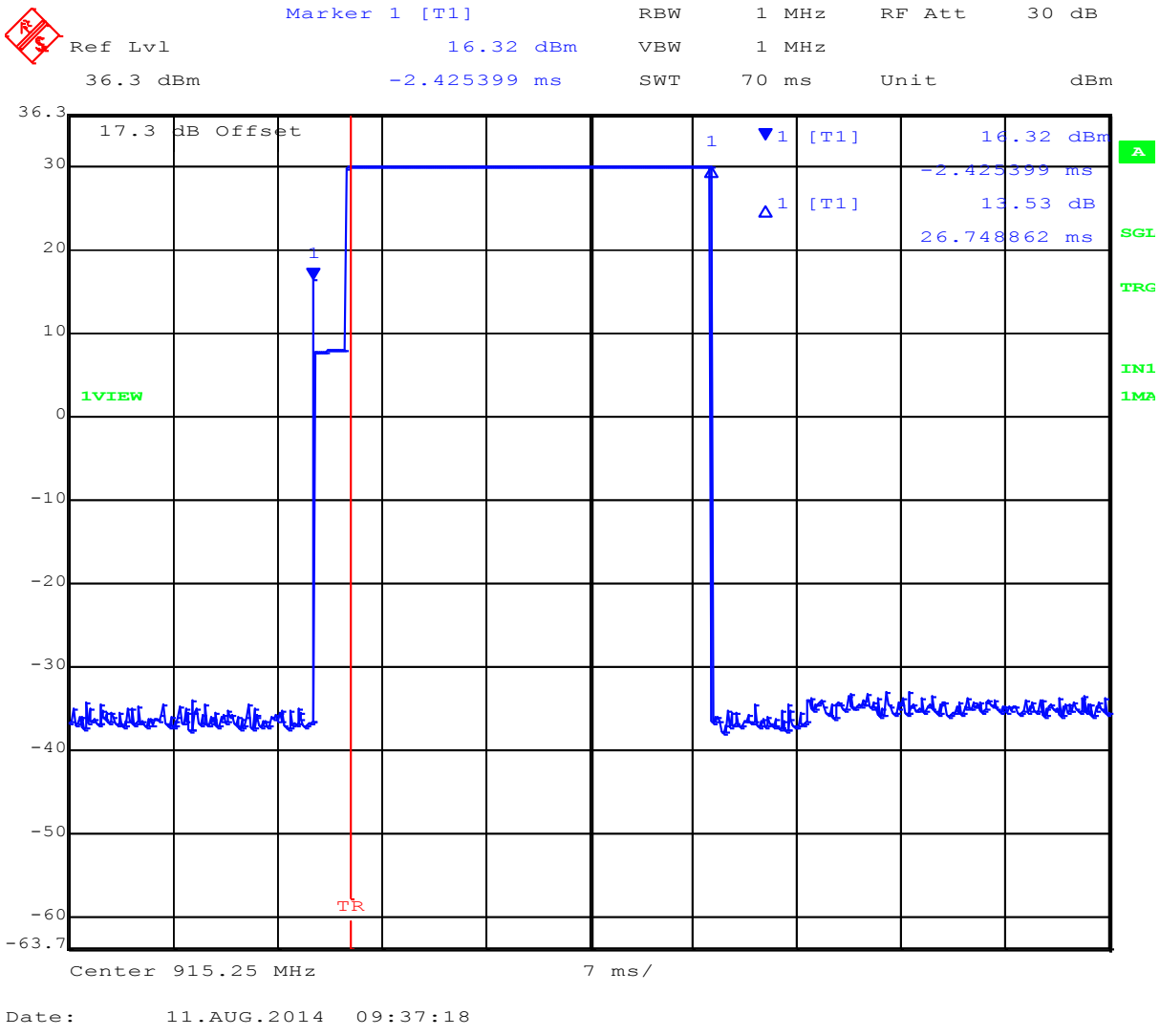
## Test Results for Time of Occupancy (Dwell Time)

Ambient conditions.

Temperature: 17 to 23 °C  Relative humidity: 31 to 57 %  Pressure: 999 to 1012 mbar

| Centered on Channel | Center Frequency (MHz) | Channel Dwell Time (single channel) (ms) |
|---|---|---|
| -- | 915.25 | 26.749 |

## Time of Occupancy; Hopping On; 915.25 MHz; 26.749 ms



### 6.1.1.6. Channel Occupancy

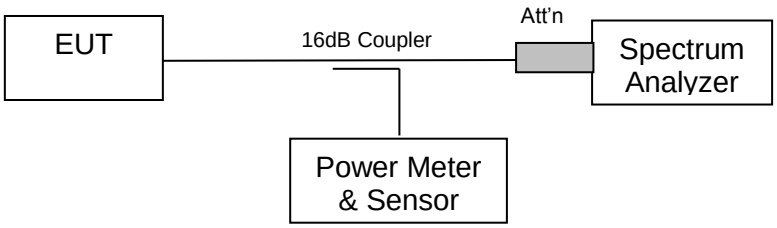
**Test Procedure**

The EUT must have its hopping function enabled.

The following spectrum analyzer settings were used:

Span = zero span, centered on a hopping channel
RBW = 1MHz (or appropriate RBW to distinguish center channel from adjacent channels)
VBW ≥ RBW
Sweep = Dwell time x Number of Hopping Frequencies
Detector function = peak
Trace = max hold

**Test Setup**



## Specification for Number of Channels and Channel Occupancy Limits

**FCC §15.247 (a)(1)(iii)**

(a)(1)(i) For frequency hopping systems operating in the 902–928 MHz band: if the 20 dB bandwidth of the hopping channel is less than 250 kHz, the system shall use at least 50 hopping frequencies and the average time of occupancy on any frequency shall not be greater than 0.4 seconds within a 20 second period; if the 20 dB bandwidth of the hopping channel is 250 kHz or greater, the system shall use at least 25 hopping frequencies and the average time of occupancy on any frequency shall not be greater than 0.4 seconds within a 10 second period. The maximum allowed 20 dB bandwidth of the hopping channel is 500 kHz

## Laboratory Measurement Uncertainty

| | |
|---|---|
| **Measurement Uncertainty (Spectrum/Amplitude)** | ±2.81 dB |
| **Measurement Uncertainty (Frequency)** | ±0.86 ppm |

## Traceability

| **Method** |
|---|
| FCC DA 00-705 |

## Test Results for Channel Occupancy

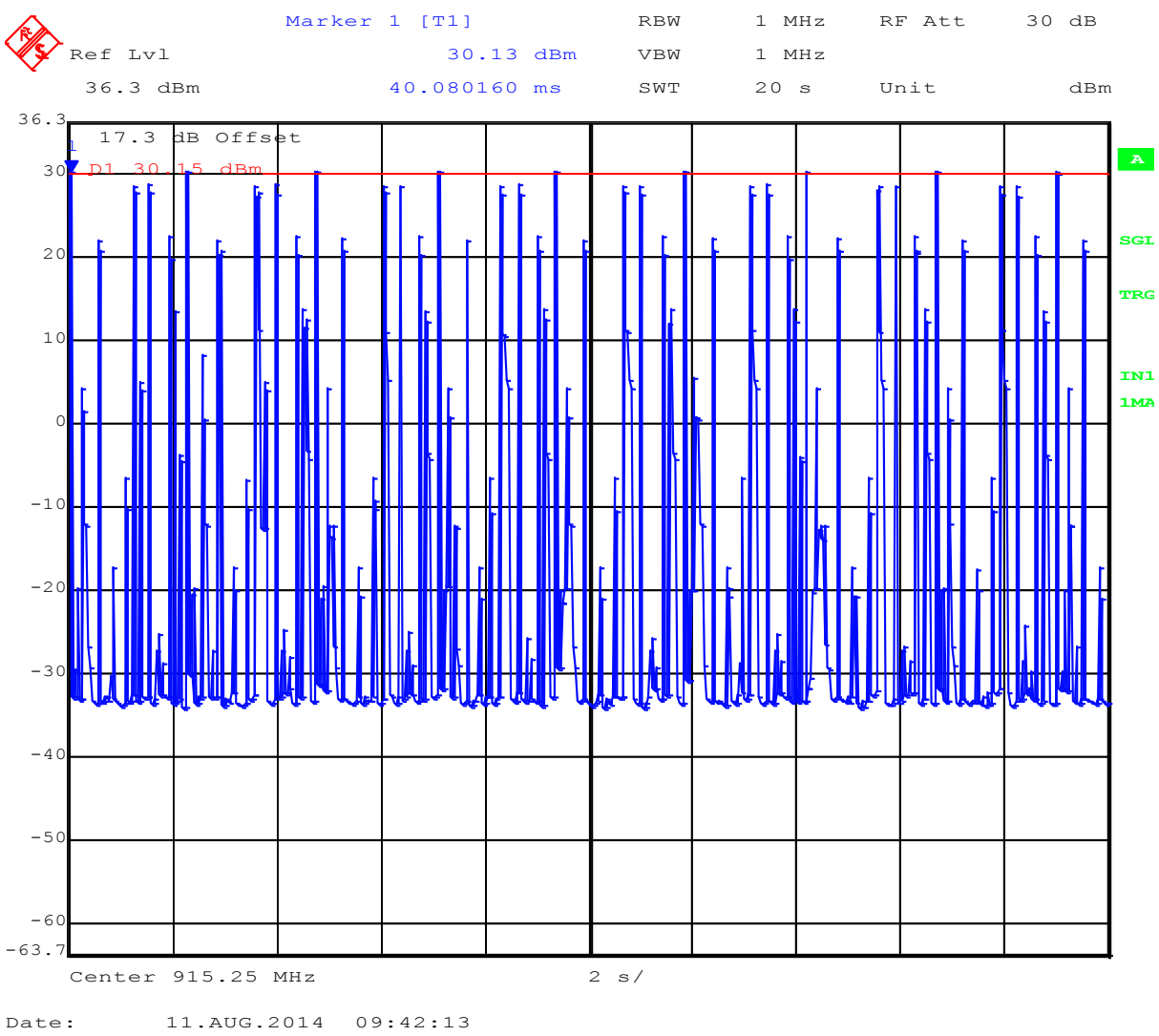
Ambient conditions.

Temperature: 17 to 23 °C  Relative humidity: 31 to 57 %  Pressure: 999 to 1012 mbar

| Channel # | Center Frequency (MHz) | Channel Dwell Time (single channel) (ms) | Number of Hops | Channel Occupancy (ms) | Limit (ms) | Result |
|---|---|---|---|---|---|---|
| -- | 915.25 | 26.749 | 9 | 240.741 | 400 | PASS |

Channel occupancy was performed using a sweep time of 20 seconds

## Channel Occupancy; 915.25 MHz; Sweep Time 20 s



### 6.1.1.7. Band-Edge Compliance of RF Conducted Emissions

**Test Procedure**

The following spectrum analyzer settings were used:

Span = wide enough to capture the peak level of the emission operating on the channel closest to the band-edge, as well as any modulation products which fall outside of the authorized band of operation
RBW ≥ 1% of the span
VBW ≥ RBW
Sweep = auto
Detector function = peak
Trace = max hold

Allow the trace to stabilize. Set the marker on the emission at the band-edge, or on the highest modulation product outside of the band, if this level is greater than that at the band-edge. Enable the marker-delta function, then use the marker-to-peak function to move the marker to the peak of the in-band emission. The marker-delta value now displayed must comply with the limit specified in this Section.

**Specification for Band-edge Limits**

### FCC Part 15 Subpart C §15.247(d)

(d) In any 100 kHz bandwidth outside the frequency band in which the spread spectrum or digitally modulated intentional radiator is operating, the radio frequency power that is produced by the intentional radiator shall be at least 20 dB below that in the 100 kHz bandwidth within the band that contains the highest level of the desired power, based on either an RF conducted or a radiated measurement, provided the transmitter demonstrates compliance with the peak conducted power limits. If the transmitter complies with the conducted power limits based on the use of RMS averaging over a time interval, as permitted under paragraph (b)(3) of this section, the attenuation required under this paragraph shall be 30 dB instead of 20 dB. Attenuation below the general limits specified in §15.209(a) is not required. In addition, radiated emissions which fall in the restricted bands, as defined in §15.205(a), must also comply with the radiated emission limits specified in §15.209(a) (see §15.205(c)).

### Industry Canada RSS-210 §A8.5

In any 100 kHz bandwidth outside the frequency band in which the spread spectrum or digitally modulated device is operating, the RF power that is produced shall be at least 20 dB below that in the 100 kHz bandwidth within the band that contains the highest level of the desired power, based on either an RF conducted or a radiated measurement, provided that the transmitter demonstrates compliance with the peak conducted power limits. If the transmitter complies with the conducted power limits based on the use of root-mean-square averaging over a time interval, as permitted under Section A8.4 (4), the attenuation required shall be 30 dB instead of 20 dB. Attenuation below the general field strength limits specified in RSS-Gen is not required.

### RSS-GEN 6.2

If the receiver has a detachable antenna of known impedance, antenna conducted spurious emissions measurement is permitted as an alternative to radiated measurement. However, the radiated method of Section 6.1 is recommended:

The antenna conducted test shall be performed with the antenna disconnected and the receiver antenna terminals connected to a measuring instrument having equal impedance to that specified for the antenna

The receiver spurious emissions measured at the antenna terminals by the antenna conducted method shall then comply with the following limits:

Receiver spurious emissions at any discrete frequency shall not exceed 2 nanowatts in the band 30-1000 MHz, and 5 nanowatts above 1000 MHz.

| Equipment Configuration for Conducted Low Band-Edge Emissions - Average | | | |
|---|---|---|---|
| **Variant:** | -- | **Duty Cycle (%):** | 100 |
| **Data Rate:** | 250 kHz | **Antenna Gain (dBi):** | Not Applicable |
| **Modulation:** | -- | **Beam Forming Gain (Y):** | Not Applicable |
| **TPC:** | Not Applicable | **Tested By:** | CC |
| **Engineering Test Notes:** | | | |

**Test Measurement Results**

| **Channel Frequency:** | 902.75 MHz | | | | | |
|---|---|---|---|---|---|---|
| **Band-Edge Frequency:** | 902.0 MHz | | | | | |
| **Test Frequency Range:** | 886 – 903.5 MHz | | | | | |
| **Port(s)** | **Band-Edge Markers and Limit** | | | **Amended Limit** | | **Margin** |
| | **M1 Amplitude (dBm)** | **Plot Limit (dBm)** | **M2 Frequency (MHz)** | **Amplitude (dBm)** | **M2A Frequency (MHz)** | **(MHz)** |
| **a** | -46.96 | -0.336 | 902.518 | -- | -- | -0.518 |

| Traceability to Industry Recognized Test Methodologies | |
|---|---|
| Work Instruction: | WI-05 MEASUREMENT OF SPURIOUS EMISSIONS |
| Measurement Uncertainty: | <=40 GHz ±2.37 dB, > 40 GHz ±4.6 dB |

Note: click the links in the above matrix to view the graphical image (plot).

| Equipment Configuration for Conducted High Band-Edge Emissions - Average | | | |
|---|---|---|---|
| **Variant:** | -- | **Duty Cycle (%):** | 100 |
| **Data Rate:** | 250 kHz | **Antenna Gain (dBi):** | Not Applicable |
| **Modulation:** | -- | **Beam Forming Gain (Y):** | Not Applicable |
| **TPC:** | Not Applicable | **Tested By:** | CC |
| **Engineering Test Notes:** | | | |

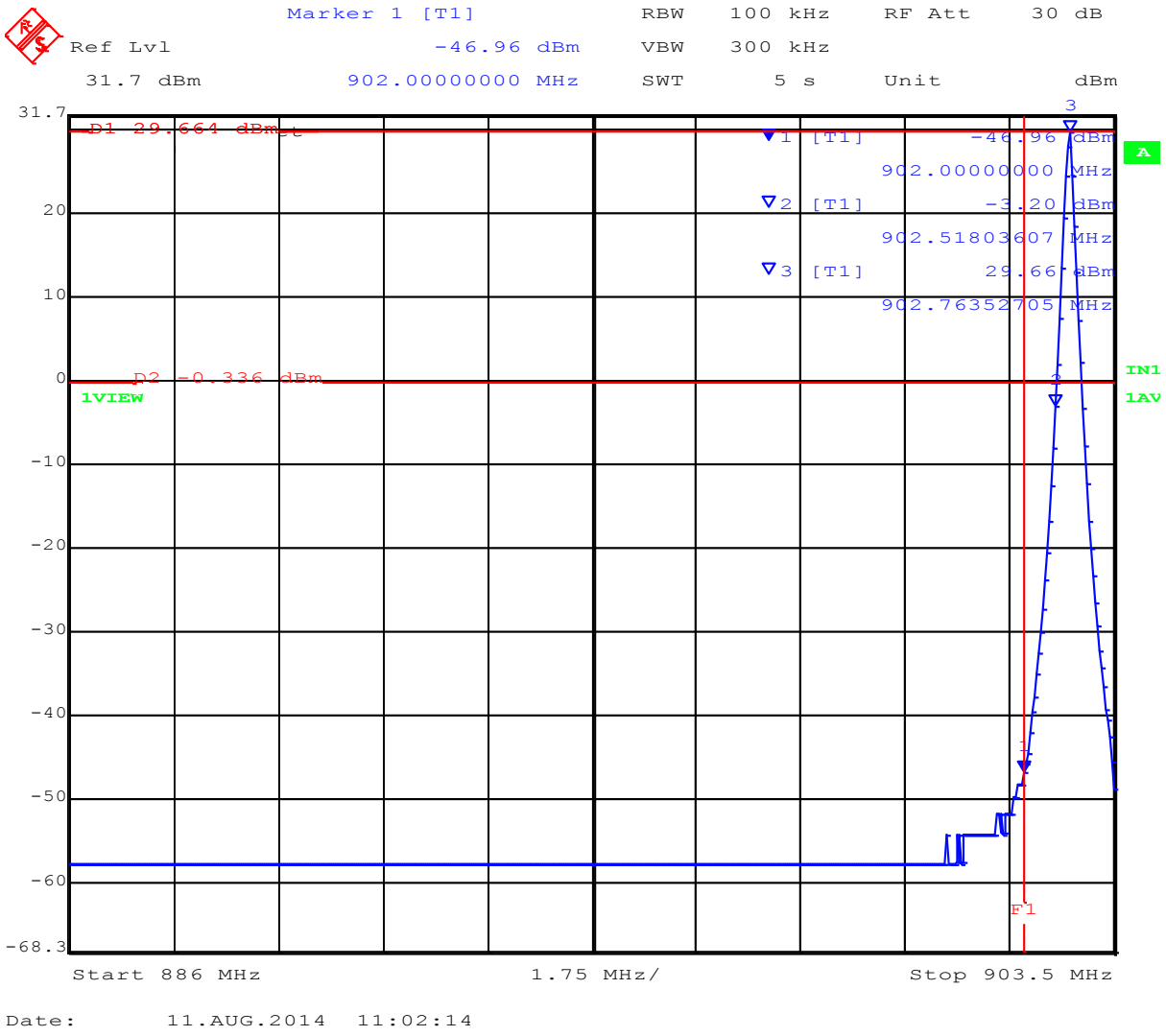
**Test Measurement Results**

| **Channel Frequency:** | 927.25 MHz | | | | | |
|---|---|---|---|---|---|---|
| **Band-Edge Frequency:** | 928.0 MHz | | | | | |
| **Test Frequency Range:** | 926.5 – 935 MHz | | | | | |
| **Port(s)** | **Band-Edge Markers and Limit** | | | **Amended Limit** | | **Margin** |
| | **M3 Amplitude (dBm)** | **Plot Limit (dBm)** | **M2 Frequency (MHz)** | **Amplitude (dBm)** | **M2A Frequency (MHz)** | **(MHz)** |
| **a** | -46.86 | -1.901 | 927.471 | -- | -- | -0.518 |

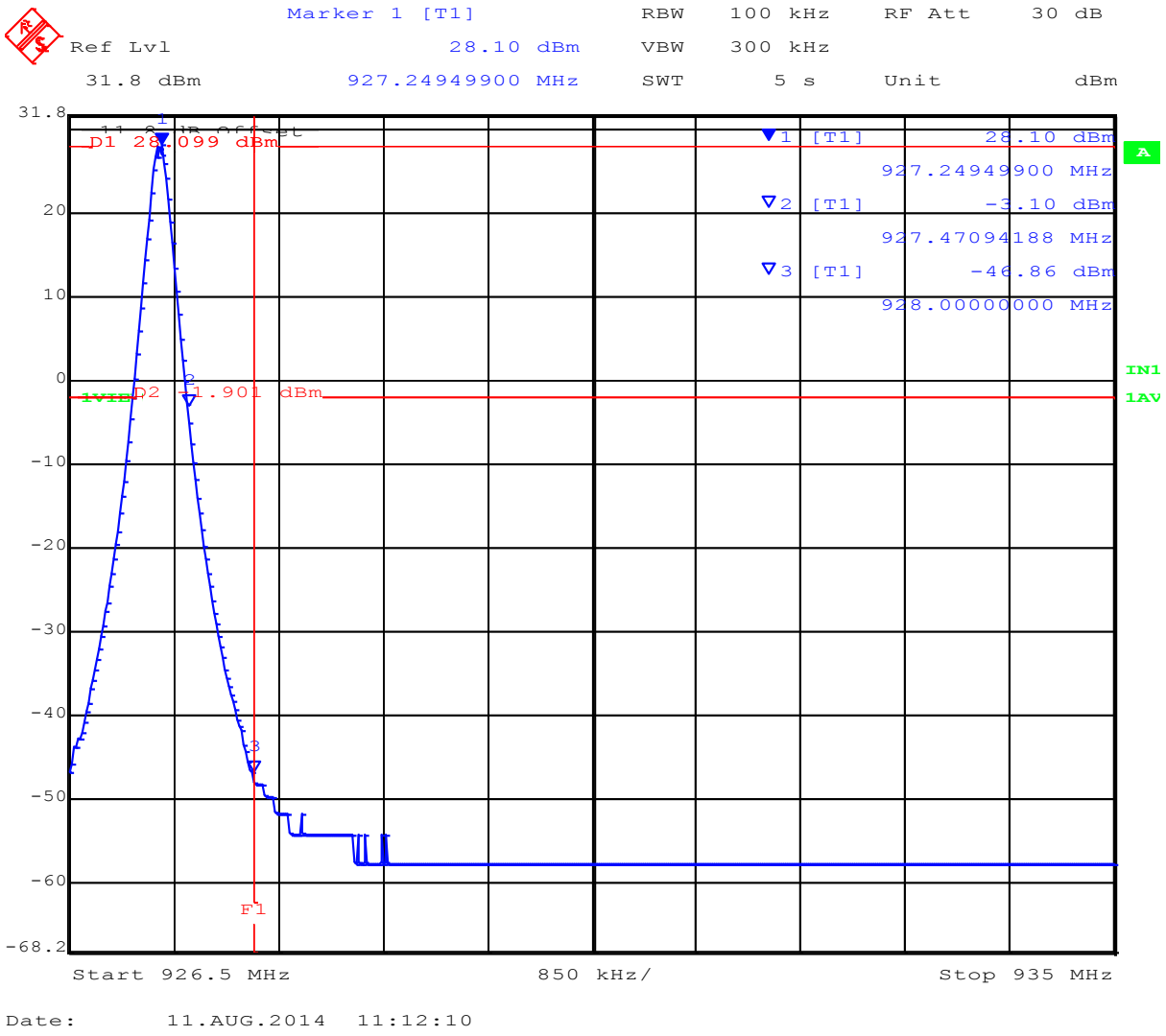
| Traceability to Industry Recognized Test Methodologies | |
|---|---|
| Work Instruction: | WI-05 MEASUREMENT OF SPURIOUS EMISSIONS |
| Measurement Uncertainty: | <=40 GHz ±2.37 dB, > 40 GHz ±4.6 dB |

Note: click the links in the above matrix to view the graphical image (plot).

## Low Conducted Band-Edge (902 MHz)



## High Conducted Band-Edge (928 MHz)



### 6.1.1.8. Spurious RF Conducted Emissions - Transmitter

**Test Procedure**

The following spectrum analyzer settings were used:

Span = wide enough to capture the peak level of the in-band emission and all spurious emissions (e.g., harmonics) from the lowest frequency generated in the EUT up through the 10th harmonic.
RBW = 100 kHz
VBW ≥ RBW
Sweep = auto
Detector function = peak
Trace = max hold

Allow the trace to stabilize. Set the marker on the peak of any spurious emission recorded. The level displayed must comply with the limit specified in this Section.

*Reference: FCC DA 00-705 "Filing and Measurement Guidelines for Frequency Hopping Spread Spectrum Systems"*

**Specification for Spurious RF Conducted Emissions**

**FCC Part 15 Subpart C §15.247(d)**

(d) In any 100 kHz bandwidth outside the frequency band in which the spread spectrum or digitally modulated intentional radiator is operating, the radio frequency power that is produced by the intentional radiator shall be at least 20 dB below that in the 100 kHz bandwidth within the band that contains the highest level of the desired power, based on either an RF conducted or a radiated measurement, provided the transmitter demonstrates compliance with the peak conducted power limits. If the transmitter complies with the conducted power limits based on the use of RMS averaging over a time interval, as permitted under paragraph (b)(3) of this section, the attenuation required under this paragraph shall be 30 dB instead of 20 dB. Attenuation below the general limits specified in §15.209(a) is not required. In addition, radiated emissions which fall in the restricted bands, as defined in §15.205(a), must also comply with the radiated emission limits specified in §15.209(a) (see §15.205(c)).

**Industry Canada RSS-210 §A8.5**

In any 100 kHz bandwidth outside the frequency band in which the spread spectrum or digitally modulated device is operating, the RF power that is produced shall be at least 20 dB below that in the 100 kHz bandwidth within the band that contains the highest level of the desired power, based on either an RF conducted or a radiated measurement, provided that the transmitter demonstrates compliance with the peak conducted power limits. If the transmitter complies with the conducted power limits based on the use of root-mean-square averaging over a time interval, as permitted under Section A8.4 (4), the attenuation required shall be 30 dB instead of 20 dB. Attenuation below the general field strength limits specified in RSS-Gen is not required.

| Equipment Configuration for Transmitter Conducted Spurious Emissions | | | |
|---|---|---|---|
| **Variant:** | -- | **Duty Cycle (%):** | 100 |
| **Data Rate:** | 250 kHz | **Antenna Gain (dBi):** | Not Applicable |
| **Modulation:** | -- | **Beam Forming Gain (Y):** | Not Applicable |
| **TPC:** | Not Applicable | **Tested By:** | CC |
| **Engineering Test Notes:** | | | |

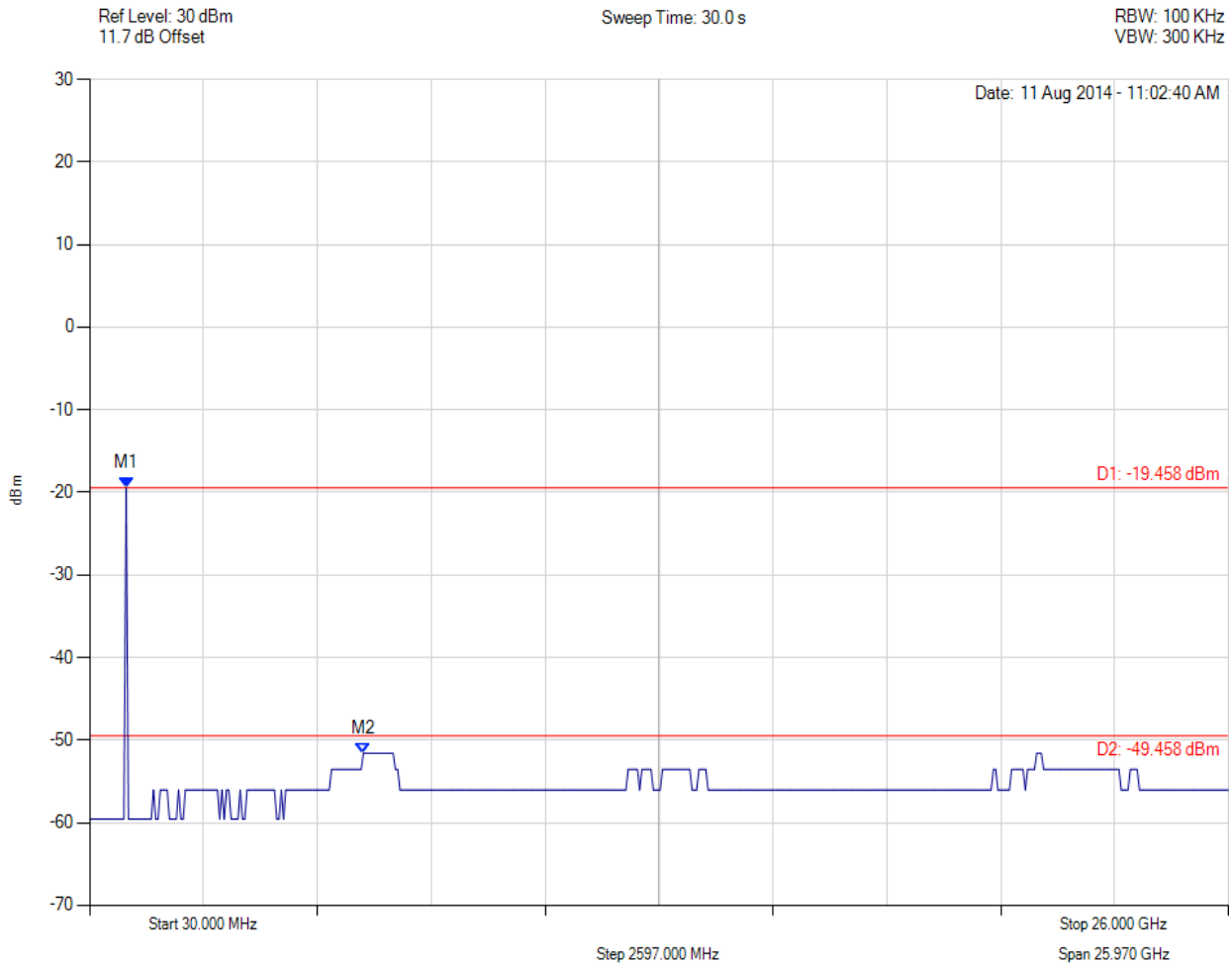
**Test Measurement Results**

| Test Frequency | Frequency Range | Transmitter Conducted Spurious Emissions (dBm) | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | Port a | | Port b | | Port c | | Port d | |
| MHz | MHz | SE | Limit | SE | Limit | SE | Limit | SE | Limit |
| **902.75** | 30 – 10000 | -51.586 | -49.46 | -- | -- | -- | -- | -- | -- |
| **915.25** | 30 – 10000 | -50.002 | -49.04 | -- | -- | -- | -- | -- | -- |
| **927.25** | 30 – 10000 | -51.586 | -50.86 | -- | -- | -- | -- | -- | -- |

| Traceability to Industry Recognized Test Methodologies | |
|---|---|
| Work Instruction: | WI-05 MEASUREMENT OF SPURIOUS EMISSIONS |
| Measurement Uncertainty: | <=40 GHz ±2.37 dB, > 40 GHz ±4.6 dB |

CONDUCTED SPURIOUS EMISSIONS - AVERAGE

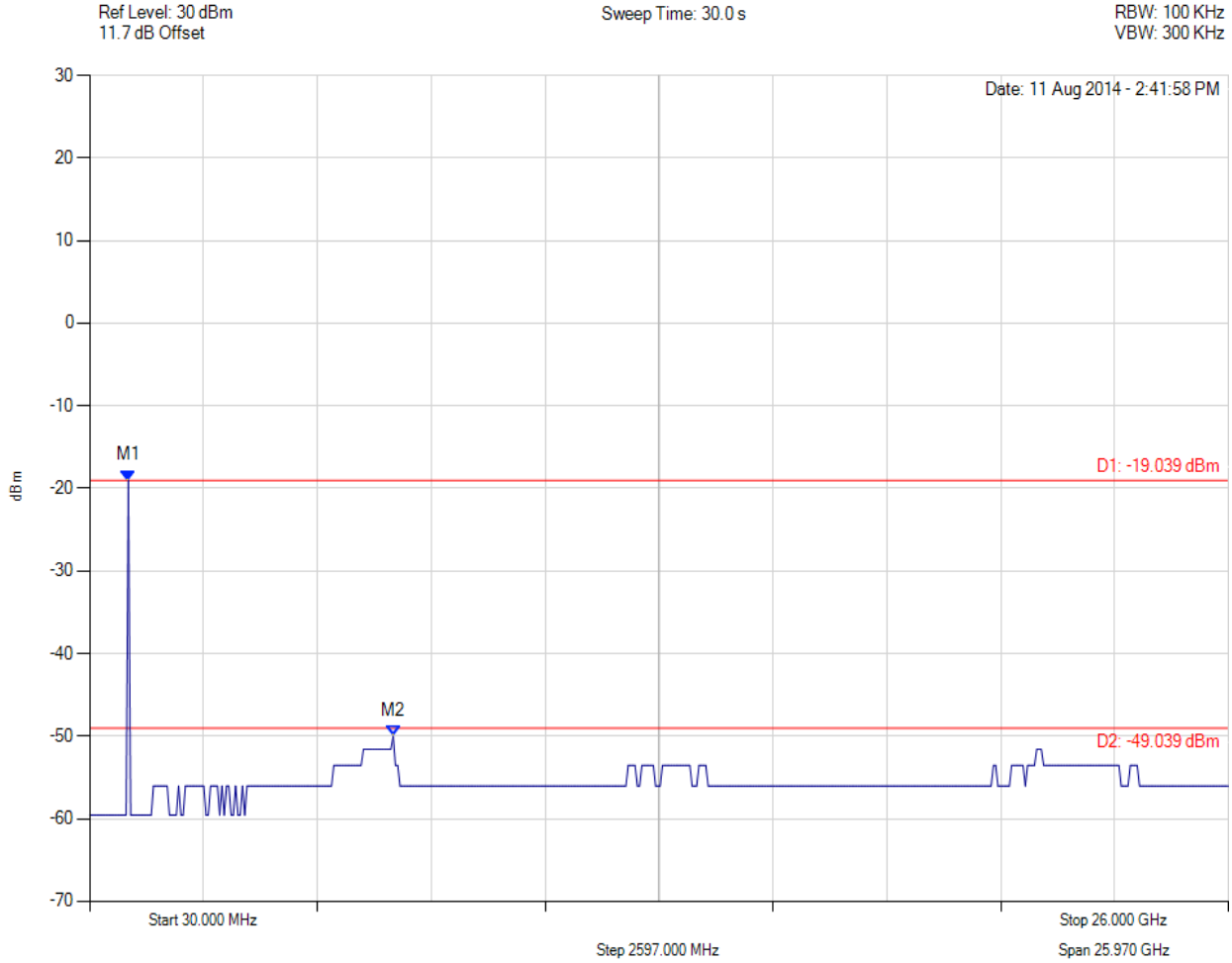
Variant: 802.11b, Channel: 902.75 MHz, Chain a, Temp: Ambient, Voltage: 5 Vdc




| Analyser Setup | Marker:Frequency:Amplitude | Test Results |
|---|---|---|
| Detector = AVERAGE<br>Sweep Count = 0<br>RF Atten (dB) = 30<br>Trace Mode = VIEW | M1 : 862.705 MHz : -19.458 dBm<br>M2 : 6275.291 MHz : -51.586 dBm | Limit: -49.46 dBm<br>Margin: -2.13 dB |

CONDUCTED SPURIOUS EMISSIONS - AVERAGE

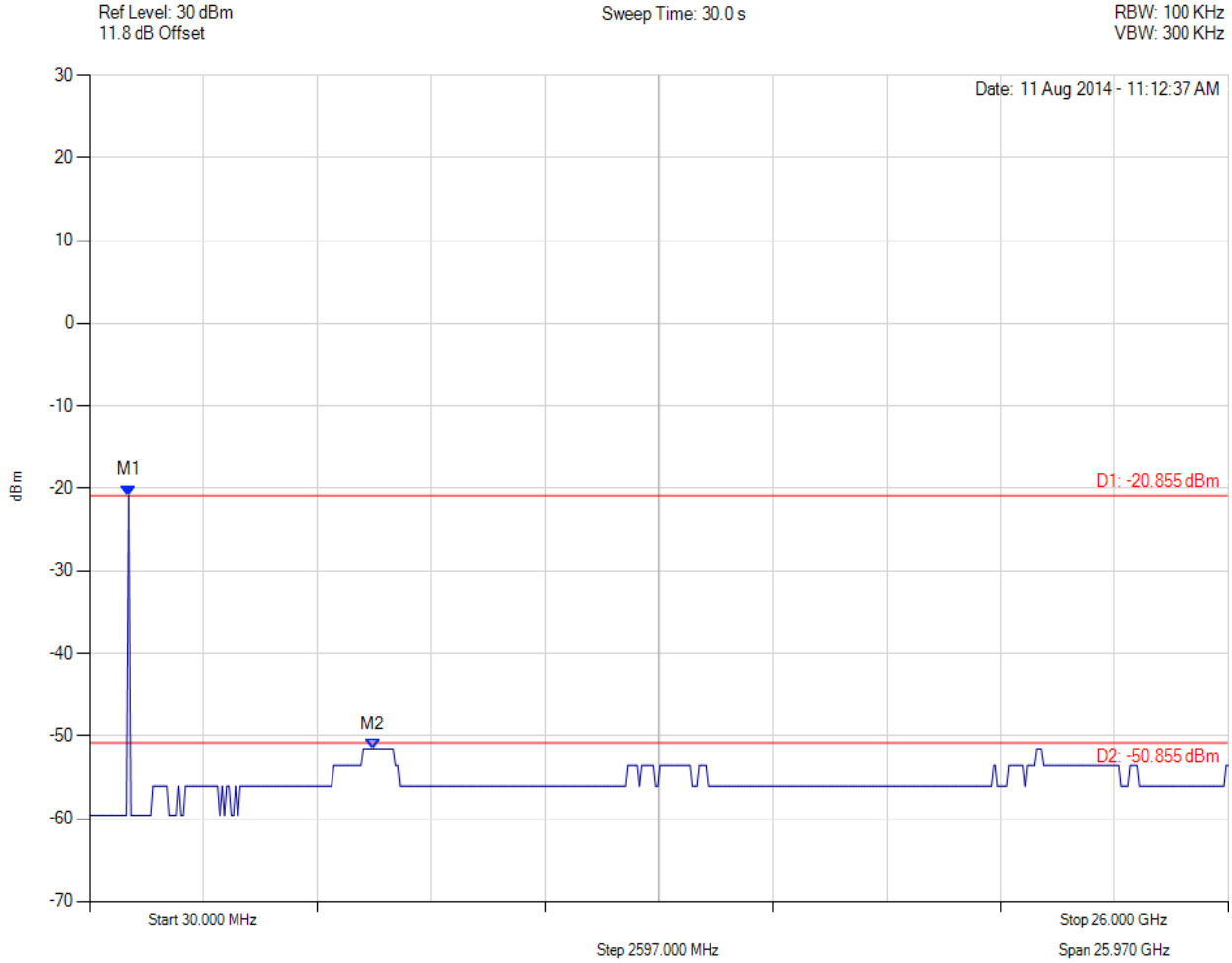
Variant: 802.11b, Channel: 915.25 MHz, Chain a, Temp: Ambient, Voltage: 5 Vdc




| Analyser Setup | Marker:Frequency:Amplitude | Test Results |
|---|---|---|
| Detector = AVERAGE<br>Sweep Count = 0<br>RF Atten (dB) = 30<br>Trace Mode = VIEW | M1 : 914.749 MHz : -19.039 dBm<br>M2 : 6951.864 MHz : -50.002 dBm | Limit: -49.04 dBm<br>Margin: -0.96 dB |

CONDUCTED SPURIOUS EMISSIONS - AVERAGE

Variant: 802.11b, Channel: 927.25 MHz, Chain a, Temp: Ambient, Voltage: 5 Vdc




| Analyser Setup | Marker:Frequency:Amplitude | Test Results |
|---|---|---|
| Detector = AVERAGE<br>Sweep Count = 0<br>RF Atten (dB) = 30<br>Trace Mode = VIEW | M1 : 914.749 MHz : -20.855 dBm<br>M2 : 6483.467 MHz : -51.586 dBm | Limit: -50.86 dBm<br>Margin: -0.73 dB |

### 6.1.1.9. Pseudorandom Frequency Hopping Sequence

**Description**

Describe how the hopping sequence is generated. Provide an example of the hopping sequence channels, in order to demonstrate that the sequence meets the requirement specified in the definition of a frequency hopping spread spectrum system, found in Section 2.1.

*Reference: FCC DA 00-705 "Filing and Measurement Guidelines for Frequency Hopping Spread Spectrum Systems"*

**Declaration from the Manufacturer**

The hopping sequence for channels 1 through 50 are as follows (ordered 1 to 50, start top to bottom left hand column progressing to column 2 etc.):

| Frequency (MHz) | Frequency (MHz) | Frequency (MHz) | Frequency (MHz) | Frequency (MHz) |
|---|---|---|---|---|
| 923.25 | 915.75 | 907.75 | 921.75 | 903.25 |
| 922.75 | 924.75 | 913.75 | 917.25 | 904.25 |
| 921.25 | 927.25 | 925.75 | 907.25 | 906.25 |
| 914.75 | 911.25 | 912.75 | 912.25 | 910.25 |
| 916.75 | 920.25 | 923.75 | 922.25 | 918.25 |
| 920.75 | 910.75 | 925.25 | 918.75 | 902.75 |
| 913.25 | 919.75 | 915.25 | 905.25 | 903.75 |
| 924.25 | 909.25 | 919.25 | 908.25 | 905.75 |
| 926.75 | 916.25 | 906.75 | 914.25 | 909.75 |
| 908.75 | 904.75 | 911.75 | 926.25 | 917.75 |

### 6.1.1.10. Equal Hopping Frequency Use

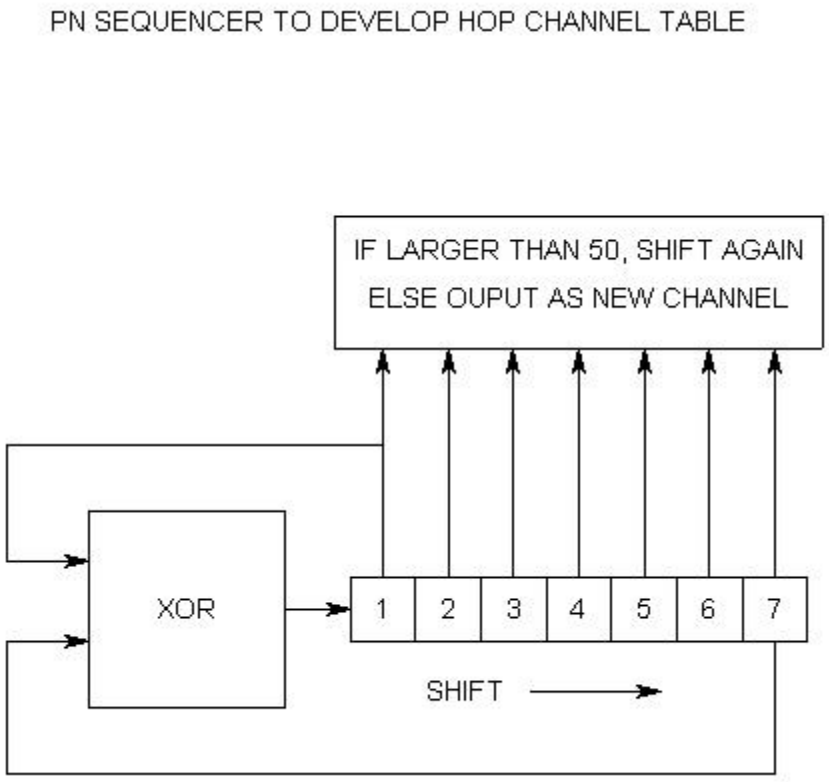
**Description**

Describe how each individual EUT meets the requirement that each of its hopping channels is used equally on average (e.g., that each new transmission event begins on the next channel in the hopping sequence after the final channel used in the previous transmission event).

*Reference: FCC DA 00-705 "Filing and Measurement Guidelines for Frequency Hopping Spread Spectrum Systems"*

**Declaration from the Manufacturer**

The 915 MHz UHF RFID device uses a **psuedo random sequence**, so all **50** frequencies in the hopping sequence get used equally.




The EUT hops from each channel to the next based on the table, above, devised from this sequencer. A system clock insures that we dwell a maximum of 380 mS maximum on each frequency before commencing to the next hop frequency.

### 6.1.1.11.System Receiver Input Bandwidth

### Description

Describe how the associated receiver(s) complies with the requirement that its input bandwidth (either RF or IF) matches the bandwidth of the transmitted signal.

*Reference: FCC DA 00-705 "Filing and Measurement Guidelines for Frequency Hopping Spread Spectrum Systems"*

### Declaration from the Manufacturer

The 20dB bandwidth of the received signal is less than 250 KHz in all operational modes and matches the bandwidth of the transmitted signal

### 6.1.1.12.System Receiver Hopping Capability

### Description

Describe how the associated receiver(s) has the ability to shift frequencies in synchronization with the transmitted signals.

*Reference: FCC DA 00-705 "Filing and Measurement Guidelines for Frequency Hopping Spread Spectrum Systems"*

### Declaration from the Manufacturer

A tag device follows the reader device's hopping sequence by **"obtaining power from the transmitter."** It then uses information in that packet and the same algorithmic process described in the standard to determine what the hopping sequence is that the master is using.

### 6.1.2. Radiated Emission Testing

**Transmitter Radiated Spurious Emissions (above 1 GHz); Peak Field Strength Measurements; and Radiated Band Edge Measurements – Restricted Bands**

**FCC, Part 15 Subpart C §15.247(d) 15.205; 15.209**
**Industry Canada RSS-210 §A8.5, §2.2, §2.6**
**Industry Canada RSS-Gen §4.7**

**Test Procedure**

Radiated emissions above 1 GHz are measured in the anechoic chamber at a 3-meter distance on every azimuth in both horizontal and vertical polarities. The emissions are recorded and maximized as a function of azimuth by rotation through 360° with a spectrum analyzer in peak hold mode. Depending on the frequency band spanned a notch filter and waveguide filter was used to remove the fundamental frequency. The highest emissions relative to the limit are listed for each frequency spanned.

All measurements on any frequency or frequencies over 1 MHz are based on the use of measurement instrumentation employing an average detector function. All measurements above 1 GHz were performed using a minimum resolution bandwidth of 1 MHz.

**Field Strength Calculation**

The field strength is calculated by adding the Antenna Factor and Cable Loss, and subtracting Amplifier Gain from the measured reading. All factors are included in the reported data.

FS = R + AF + CORR - FO

where: FS = Field Strength
R = Measured Spectrum analyzer Input Amplitude
AF = Antenna Factor
CORR = Correction Factor = CL – AG + NFL
CL = Cable Loss
AG = Amplifier Gain
FO = Distance Falloff Factor
NFL = Notch Filter Loss or Waveguide Loss

For example:
Given receiver input reading of 51.5 dBμV; Antenna Factor of 8.5 dB; Cable Loss of 1.3 dB; Falloff Factor of 0 dB, an Amplifier Gain of 26 dB and Notch Filter Loss of 1 dB. The Field Strength of the measured emission is:

FS = 51.5 + 8.5 + 1.3 - 26.0 +1 = 36.3 dBμV/m

Conversion between dBμV/m (or dBμV) and μV/m (or μV) are done as:

Level (dBμV/m) = 20 * Log (level (μV/m))

40 dBμV/m = 100 μV/m
48 dBμV/m = 250 μV/m

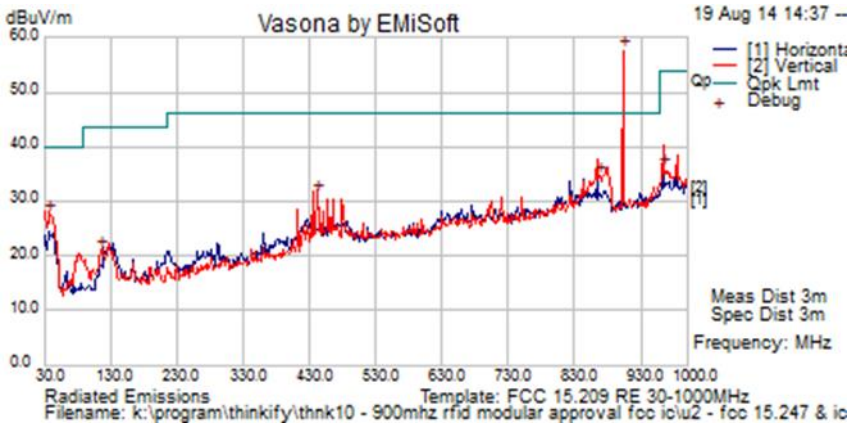
### 6.1.2.1. Transmitter Radiated Spurious Emissions (>1 GHz)

The EUT was evaluated to determine orientation where maximum emissions were observed (i.e. horizontal or vertical). The EUT + antenna was positioned on the test table during radiated emissions testing. Emission scans are generated using a peak detector.

## Antenna ANT-916-CW-HWR-RPS Test Results

Operational Mode - Continuous Transmit

| | | | |
|---|---|---|---|
| **Test Freq.** | 902.75 MHz | **Engineer** | SB |
| **Variant** | Cont TX | **Temp (ºC)** | 21 |
| **Freq. Range** | 30 MHz - 1000 MHz | **Rel. Hum.(%)** | 38 |
| **Power Setting** | RA7 | **Press. (mBars)** | 998 |
| **Antenna** | ANT-916 | **Duty Cycle (%)** | 100 |
| **Test Notes 1** | Unit:#2;5VDC external PSU; No LEDs; | | |
| **Test Notes 2** | IP=0; | | |



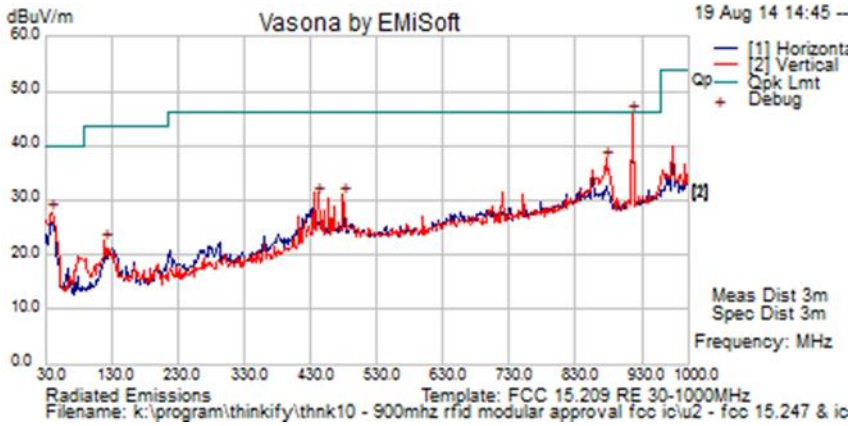

### Formally measured emission peaks

| Frequency MHz | Raw dBuV | Cable Loss | AF dB | Level dBuV/m | Measurement Type | Pol | Hgt cm | Azt Deg | Limit dBuV/m | Margin dB | Pass /Fail | Comments |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 902.806 | 58.3 | 7.1 | -7.8 | 57.6 | Peak [Scan] | V | 100 | 0 | | | | FUND |
| 441.919 | 39.8 | 5.6 | -14.1 | 31.3 | Peak [Scan] | V | 98 | -1 | 46.0 | -14.7 | Pass | |
| 37.275 | 39.5 | 3.6 | -15.4 | 27.7 | Peak [Scan] | V | 98 | -1 | 40.0 | -12.3 | Pass | |
| 868.080 | 35.7 | 7.1 | -8.2 | 34.6 | Peak [Scan] | V | 98 | -1 | 46.0 | -11.4 | Pass | |
| 964.595 | 36.0 | 7.3 | -7.1 | 36.3 | Peak [Scan] | V | 98 | -1 | 54.0 | -17.7 | Pass | |
| 115.360 | 34.6 | 4.2 | -18.0 | 20.8 | Peak [Scan] | V | 98 | -1 | 43.5 | -22.7 | Pass | |

| | |
|---|---|
| Legend: | TX = Transmitter Emissions; DIG = Digital Emissions; FUND = Fundamental; WB = Wideband Emission |
| | RB = Restricted Band (15.209 Limits); NRB = Non Restricted Band, Limit is 20dB below fundamental peak |

## Operational Mode - Continuous Transmit

| | | | |
|---|---|---|---|
| **Test Freq.** | 915.25 MHz | **Engineer** | SB |
| **Variant** | Cont TX | **Temp (ºC)** | 21 |
| **Freq. Range** | 1000 MHz - 10000 MHz | **Rel. Hum.(%)** | 38 |
| **Power Setting** | RA7 | **Press. (mBars)** | 998 |
| **Antenna** | ANT-916 | **Duty Cycle (%)** | 100 |
| **Test Notes 1** | Unit:#2;5VDC external PSU; No LEDs; | | |
| **Test Notes 2** | IP=0; | | |



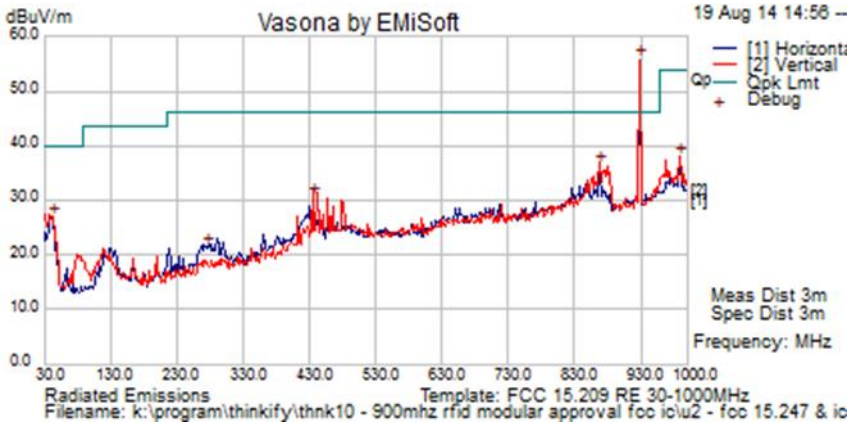

### Formally measured emission peaks

| Frequency MHz | Raw dBuV | Cable Loss | AF dB | Level dBuV/m | Measurement Type | Pol | Hgt cm | Azt Deg | Limit dBuV/m | Margin dB | Pass /Fail | Comments |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 916.413 | 46.3 | 7.2 | -7.7 | 45.7 | Peak [Scan] | V | 100 | 0 | | | | FUND |
| 119.157 | 35.5 | 4.2 | -17.5 | 22.2 | Peak [Scan] | V | 98 | -1 | 43.5 | -21.3 | Pass | |
| 876.132 | 38.1 | 7.1 | -8.1 | 37.1 | Peak [Scan] | V | 98 | -1 | 46.0 | -8.9 | Pass | |
| 40.185 | 41.6 | 3.6 | -17.7 | 27.5 | Peak [Scan] | V | 98 | -1 | 40.0 | -12.5 | Pass | |
| 479.688 | 37.4 | 5.8 | -12.8 | 30.4 | Peak [Scan] | V | 98 | -1 | 46.0 | -15.6 | Pass | |
| 441.802 | 39.1 | 5.6 | -14.1 | 30.5 | Peak [Scan] | V | 98 | -1 | 46.0 | -15.5 | Pass | |

| | |
|---|---|
| Legend: | TX = Transmitter Emissions; DIG = Digital Emissions; FUND = Fundamental; WB = Wideband Emission |
| | RB = Restricted Band (15.209 Limits); NRB = Non Restricted Band, Limit is 20dB below fundamental peak |

## Operational Mode - Continuous Transmit

| | | | |
|---|---|---|---|
| **Test Freq.** | 927.25 MHz | **Engineer** | SB |
| **Variant** | Cont TX | **Temp (ºC)** | 21 |
| **Freq. Range** | 1000 MHz - 10000 MHz | **Rel. Hum.(%)** | 38 |
| **Power Setting** | RA7 | **Press. (mBars)** | 998 |
| **Antenna** | ANT-916 | **Duty Cycle (%)** | 100 |
| **Test Notes 1** | Unit:#2;5VDC external PSU; No LEDs; | | |
| **Test Notes 2** | IP=0; | | |



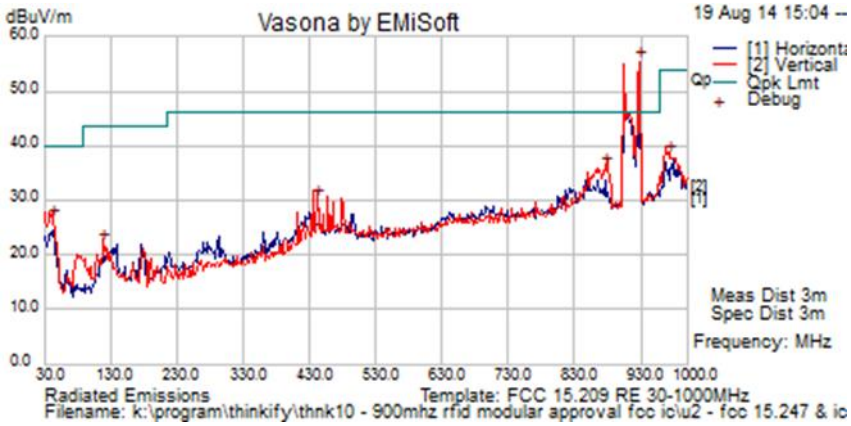

### Formally measured emission peaks

| Frequency MHz | Raw dBuV | Cable Loss | AF dB | Level dBuV/m | Measurement Type | Pol | Hgt cm | Azt Deg | Limit dBuV/m | Margin dB | Pass /Fail | Comments |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 928.076 | 56.0 | 7.2 | -7.5 | 55.8 | Peak [Scan] | V | 100 | 0 | | | | FUND |
| 434.738 | 39.0 | 5.6 | -14.2 | 30.5 | Peak [Scan] | V | 98 | -1 | 46.0 | -15.5 | Pass | |
| 868.060 | 37.7 | 7.1 | -8.2 | 36.6 | Peak [Scan] | V | 98 | -1 | 46.0 | -9.4 | Pass | |
| 43.095 | 42.8 | 3.6 | -19.6 | 26.8 | Peak [Scan] | V | 98 | -1 | 40.0 | -13.2 | Pass | |
| 988.382 | 37.4 | 7.3 | -6.7 | 38.0 | Peak [Scan] | V | 98 | -1 | 54.0 | -16.0 | Pass | |
| 275.895 | 33.8 | 5.0 | -17.4 | 21.4 | Peak [Scan] | H | 98 | -1 | 46.0 | -24.6 | Pass | |

| | |
|---|---|
| Legend: | TX = Transmitter Emissions; DIG = Digital Emissions; FUND = Fundamental; WB = Wideband Emission |
| | RB = Restricted Band (15.209 Limits); NRB = Non Restricted Band, Limit is 20dB below fundamental peak |

## Operational Mode - Frequency Hopping

| | | | |
|---|---|---|---|
| **Test Freq.** | 902.75-927.25 MHz | **Engineer** | SB |
| **Variant** | FHSS | **Temp (ºC)** | 21 |
| **Freq. Range** | 1000 MHz - 10000 MHz | **Rel. Hum.(%)** | 38 |
| **Power Setting** | RA7 | **Press. (mBars)** | 998 |
| **Antenna** | ANT-916 | **Duty Cycle (%)** | 100 |
| **Test Notes 1** | Unit:#2;5VDC external PSU; No LEDs; | | |
| **Test Notes 2** | IP=0; | | |




### Formally measured emission peaks

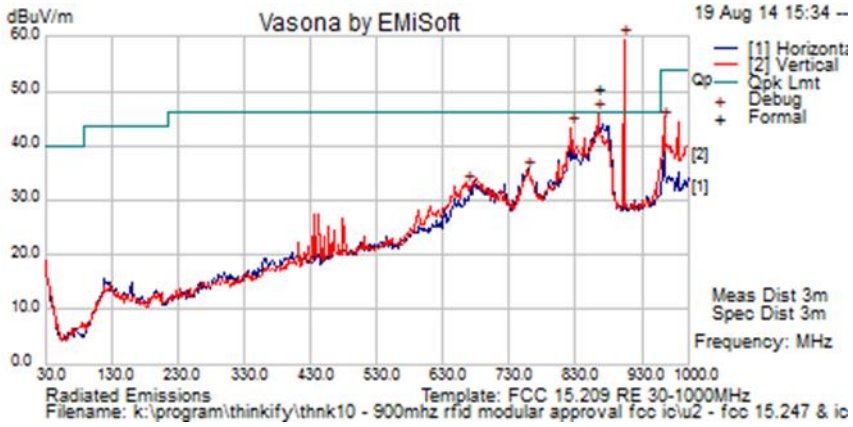
| Frequency MHz | Raw dBuV | Cable Loss | AF dB | Level dBuV/m | Measurement Type | Pol | Hgt cm | Azt Deg | Limit dBuV/m | Margin dB | Pass /Fail | Comments |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 928.076 | 55.7 | 7.2 | -7.5 | 55.5 | Peak [Scan] | V | 100 | 0 | 46.0 | 9.5 | Fail | |
| 876.810 | 36.9 | 7.1 | -8.1 | 35.9 | Peak [Scan] | V | 99 | -1 | 46.0 | -10.1 | Pass | |
| 973.810 | 37.9 | 7.3 | -7.0 | 38.2 | Peak [Scan] | V | 99 | -1 | 54.0 | -15.8 | Pass | |
| 441.765 | 38.9 | 5.6 | -14.1 | 30.4 | Peak [Scan] | V | 99 | -1 | 46.0 | -15.6 | Pass | |
| 118.755 | 35.6 | 4.2 | -17.5 | 22.3 | Peak [Scan] | V | 99 | -1 | 43.5 | -21.2 | Pass | |
| 43.095 | 42.7 | 3.6 | -19.6 | 26.7 | Peak [Scan] | V | 99 | -1 | 40.0 | -13.4 | Pass | |

| | |
|---|---|
| Legend: | TX = Transmitter Emissions; DIG = Digital Emissions; FUND = Fundamental; WB = Wideband Emission |
| | RB = Restricted Band (15.209 Limits); NRB = Non Restricted Band, Limit is 20dB below fundamental peak |

## Antenna TAC-060 Test Results

Operational Mode - Continuous Transmit

| | | | |
|---|---|---|---|
| **Test Freq.** | 902.75 MHz | **Engineer** | SB |
| **Variant** | Cont TX | **Temp (ºC)** | 21 |
| **Freq. Range** | 30 MHz - 1000 MHz | **Rel. Hum.(%)** | 38 |
| **Power Setting** | RA7 | **Press. (mBars)** | 998 |
| **Antenna** | TAC-060 | **Duty Cycle (%)** | 100 |
| **Test Notes 1** | Unit:#2;5VDC external PSU; LEDs; | | |
| **Test Notes 2** | IP=0; | | |




### Formally measured emission peaks

| Frequency MHz | Raw dBuV | Cable Loss | AF dB | Level dBuV/m | Measurement Type | Pol | Hgt cm | Azt Deg | Limit dBuV/m | Margin dB | Pass /Fail | Comments |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 902.806 | 60.2 | 7.1 | -7.8 | 59.5 | Peak [Scan] | V | 100 | 0 | | | | FUND |
| 862.771 | 47.1 | 7.0 | -8.2 | 45.9 | Peak [Scan] | V | 100 | 0 | | | | NRB |
| 666.428 | 37.0 | 6.4 | -10.7 | 32.8 | Peak [Scan] | V | 99 | 328 | | | | NRB |
| 756.579 | 37.9 | 6.7 | -9.3 | 35.3 | Peak [Scan] | V | 99 | 328 | | | | NRB |
| 823.125 | 44.7 | 6.9 | -8.4 | 43.3 | Peak [Scan] | V | 99 | 328 | | | | NRB |
| 962.760 | 44.2 | 7.3 | -7.1 | 44.4 | Peak [Scan] | V | 99 | 328 | 54.0 | -9.6 | Pass | RB |

| | |
|---|---|
| Legend: | TX = Transmitter Emissions; DIG = Digital Emissions; FUND = Fundamental; WB = Wideband Emission |
| | RB = Restricted Band (15.209 Limits); NRB = Non Restricted Band, Limit is 20dB below fundamental peak |

## Operational Mode - Continuous Transmit

| | | | |
|---|---|---|---|
| **Test Freq.** | 915.25 MHz | **Engineer** | SB |
| **Variant** | Cont TX | **Temp (ºC)** | 21 |
| **Freq. Range** | 1000 MHz - 10000 MHz | **Rel. Hum.(%)** | 38 |
| **Power Setting** | RA7 | **Press. (mBars)** | 998 |
| **Antenna** | TAC-060 | **Duty Cycle (%)** | 100 |
| **Test Notes 1** | Unit:#2;5VDC external PSU; LEDs; | | |
| **Test Notes 2** | IP=0; | | |

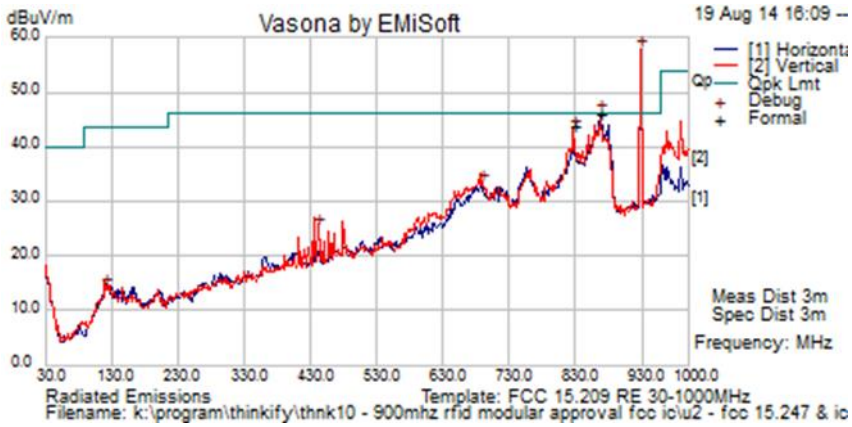

### Formally measured emission peaks

| Frequency MHz | Raw dBuV | Cable Loss | AF dB | Level dBuV/m | Measurement Type | Pol | Hgt cm | Azt Deg | Limit dBuV/m | Margin dB | Pass /Fail | Comments |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 916.413 | 48.2 | 7.2 | -7.7 | 47.6 | Peak [Scan] | H | 100 | 0 | | | | FUND |
| 856.152 | 47.4 | 7.0 | -8.3 | 46.1 | Peak [Scan] | H | 100 | 0 | | | | NRB |
| 434.254 | 35.1 | 5.6 | -14.2 | 26.5 | Peak [Scan] | V | 98 | 361 | | | | NRB |
| 656.620 | 36.3 | 6.4 | -10.6 | 32.1 | Peak [Scan] | V | 98 | 361 | | | | NRB |
| 976.720 | 45.8 | 7.3 | -6.9 | 46.2 | Peak [Scan] | V | 98 | 361 | 54.0 | -7.9 | Pass | RB |
| 30.000 | 24.1 | 3.5 | -9.7 | 17.9 | Peak [Scan] | V | 98 | 361 | 40.0 | -22.1 | Pass | RB |

| | |
|---|---|
| Legend: | TX = Transmitter Emissions; DIG = Digital Emissions; FUND = Fundamental; WB = Wideband Emission |
| | RB = Restricted Band (15.209 Limits); NRB = Non Restricted Band, Limit is 20dB below fundamental peak |

## Operational Mode - Continuous Transmit

| | | | |
|---|---|---|---|
| **Test Freq.** | 927.25 MHz | **Engineer** | SB |
| **Variant** | Cont TX | **Temp (ºC)** | 21 |
| **Freq. Range** | 1000 MHz - 10000 MHz | **Rel. Hum.(%)** | 38 |
| **Power Setting** | RA7 | **Press. (mBars)** | 998 |
| **Antenna** | TAC-060 | **Duty Cycle (%)** | 100 |
| **Test Notes 1** | Unit:#2;5VDC external PSU; LEDs; | | |
| **Test Notes 2** | IP=0; | | |



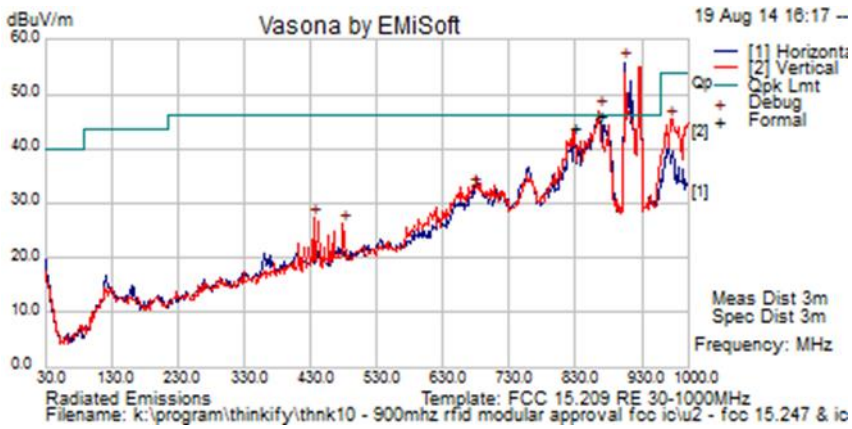

## Formally measured emission peaks

| Frequency MHz | Raw dBuV | Cable Loss | AF dB | Level dBuV/m | Measurement Type | Pol | Hgt cm | Azt Deg | Limit dBuV/m | Margin dB | Pass /Fail | Comments |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 928.076 | 58.2 | 7.2 | -7.5 | 57.9 | Peak [Scan] | V | 100 | 0 | | | | FUND |
| 867.249 | 47.0 | 7.1 | -8.2 | 45.9 | Peak [Scan] | H | 100 | 0 | | | | NRB |
| 827.219 | 44.6 | 6.9 | -8.3 | 43.2 | Peak [Scan] | V | 200 | 0 | | | | NRB |
| 441.765 | 33.5 | 5.6 | -14.1 | 24.9 | Peak [Scan] | V | 129 | 345 | | | | NRB |
| 689.600 | 37.1 | 6.5 | -10.4 | 33.2 | Peak [Scan] | V | 129 | 345 | | | | NRB |
| 121.665 | 27.0 | 4.2 | -17.4 | 13.9 | Peak [Scan] | V | 129 | 345 | 43.5 | -29.6 | Pass | RB |
| | | | | | | | | | | | | |

| | |
|---|---|
| Legend: | TX = Transmitter Emissions; DIG = Digital Emissions; FUND = Fundamental; WB = Wideband Emission |
| | RB = Restricted Band (15.209 Limits); NRB = Non Restricted Band, Limit is 20dB below fundamental peak |

## Operational Mode - Frequency Hopping

| | | | |
|---|---|---|---|
| **Test Freq.** | 902.75-927.25 MHz | **Engineer** | SB |
| **Variant** | FHSS | **Temp (ºC)** | 21 |
| **Freq. Range** | 1000 MHz - 10000 MHz | **Rel. Hum.(%)** | 38 |
| **Power Setting** | RA7 | **Press. (mBars)** | 998 |
| **Antenna** | TAC-060 | **Duty Cycle (%)** | 100 |
| **Test Notes 1** | Unit:#2;5VDC external PSU; LEDs; | | |
| **Test Notes 2** | IP=0; | | |




### Formally measured emission peaks

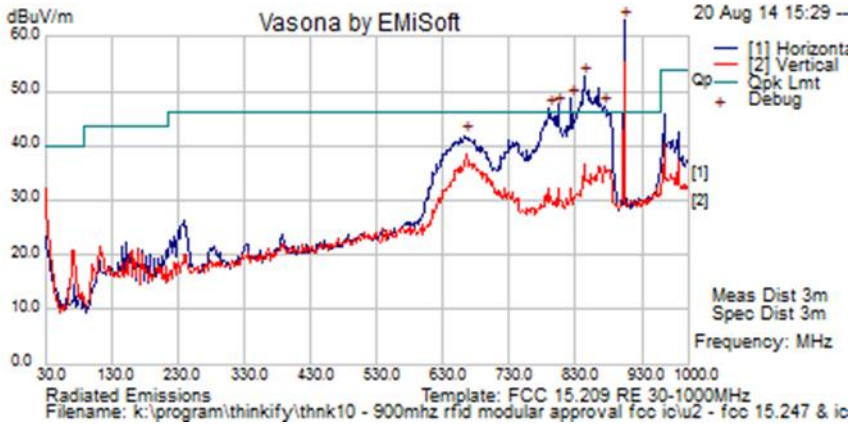
| Frequency MHz | Raw dBuV | Cable Loss | AF dB | Level dBuV/m | Measurement Type | Pol | Hgt cm | Azt Deg | Limit dBuV/m | Margin dB | Pass /Fail | Comments |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 902.806 | 56.4 | 7.1 | -7.8 | 55.8 | Peak [Scan] | H | 200 | 0 | | | | FUND |
| 865.872 | 48.2 | 7.0 | -8.2 | 47.0 | Peak [Scan] | V | 200 | 0 | | | | NRB |
| 434.325 | 36.0 | 5.6 | -14.2 | 27.4 | Peak [Scan] | V | 98 | 361 | | | | NRB |
| 479.159 | 33.2 | 5.8 | -12.9 | 26.1 | Peak [Scan] | V | 98 | 361 | | | | NRB |
| 677.475 | 36.7 | 6.5 | -10.5 | 32.7 | Peak [Scan] | V | 98 | 361 | | | | NRB |
| 973.810 | 45.0 | 7.3 | -7.0 | 45.4 | Peak [Scan] | V | 98 | 361 | 54.0 | -8.6 | Pass | RB |

| | |
|---|---|
| Legend: | TX = Transmitter Emissions; DIG = Digital Emissions; FUND = Fundamental; WB = Wideband Emission |
| | RB = Restricted Band (15.209 Limits); NRB = Non Restricted Band, Limit is 20dB below fundamental peak |

## Antenna TAL-060 Test Results

Operational Mode - Continuous Transmit

| | | | |
|---|---|---|---|
| **Test Freq.** | 902.75 MHz | **Engineer** | SB |
| **Variant** | Cont TX | **Temp (ºC)** | 21 |
| **Freq. Range** | 30 MHz - 1000 MHz | **Rel. Hum.(%)** | 38 |
| **Power Setting** | RA7 | **Press. (mBars)** | 998 |
| **Antenna** | TAL-060 | **Duty Cycle (%)** | 100 |
| **Test Notes 1** | Unit:#2;5VDC external PSU; LEDs; | | |
| **Test Notes 2** | IP=0; | | |



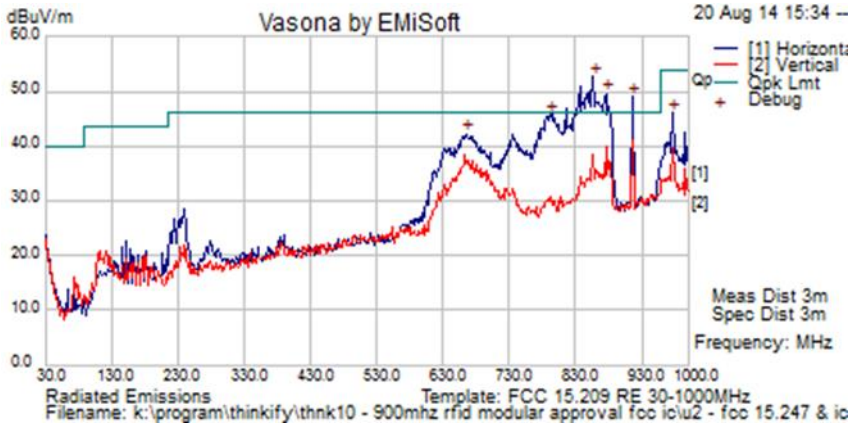

### Formally measured emission peaks

| Frequency MHz | Raw dBuV | Cable Loss | AF dB | Level dBuV/m | Measurement Type | Pol | Hgt cm | Azt Deg | Limit dBuV/m | Margin dB | Pass /Fail | Comments |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 902.806 | 63.7 | 7.1 | -7.8 | 63.1 | Peak [Scan] | H | 100 | 0 | | | | FUND |
| 842.545 | 54.0 | 7.0 | -8.4 | 52.6 | Peak [Scan] | H | 100 | 0 | | | | NRB |
| 873.647 | 48.1 | 7.1 | -8.1 | 47.1 | Peak [Scan] | H | 100 | 0 | | | | NRB |
| 663.707 | 46.1 | 6.4 | -10.7 | 41.9 | Peak [Scan] | H | 200 | 0 | | | | NRB |
| 823.227 | 49.9 | 6.9 | -8.4 | 48.4 | Peak [Scan] | H | 99 | 360 | | | | NRB |
| 803.475 | 49.0 | 7.0 | -8.9 | 47.1 | Peak [Scan] | H | 99 | 360 | | | | NRB |

| | |
|---|---|
| Legend: | TX = Transmitter Emissions; DIG = Digital Emissions; FUND = Fundamental; WB = Wideband Emission |
| | RB = Restricted Band (15.209 Limits); NRB = Non Restricted Band, Limit is 20dB below fundamental peak |

## Operational Mode - Continuous Transmit

| | | | |
|---|---|---|---|
| **Test Freq.** | 915.25 MHz | **Engineer** | SB |
| **Variant** | Cont TX | **Temp (ºC)** | 21 |
| **Freq. Range** | 30 MHz - 1000 MHz | **Rel. Hum.(%)** | 38 |
| **Power Setting** | RA7 | **Press. (mBars)** | 998 |
| **Antenna** | TAL-060 | **Duty Cycle (%)** | 100 |
| **Test Notes 1** | Unit:#2;5VDC external PSU; LEDs; | | |
| **Test Notes 2** | IP=0; | | |



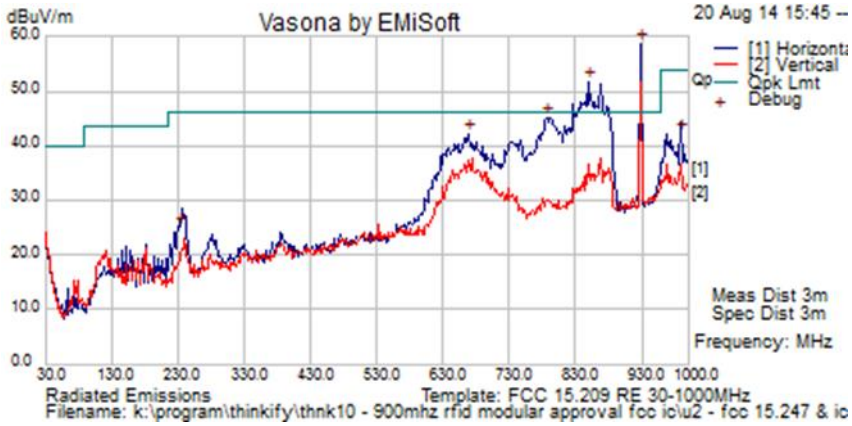

### Formally measured emission peaks

| Frequency MHz | Raw dBuV | Cable Loss | AF dB | Level dBuV/m | Measurement Type | Pol | Hgt cm | Azt Deg | Limit dBuV/m | Margin dB | Pass /Fail | Comments |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 856.152 | 54.0 | 7.0 | -8.3 | 52.7 | Peak [Scan] | H | 100 | 0 | | | | NRB |
| 875.591 | 50.6 | 7.1 | -8.1 | 49.6 | Peak [Scan] | H | 100 | 0 | | | | NRB |
| 916.413 | 49.5 | 7.2 | -7.7 | 48.9 | Peak [Scan] | H | 100 | 0 | | | | FUND |
| 792.420 | 47.9 | 6.8 | -9.0 | 45.8 | Peak [Scan] | H | 98 | 361 | | | | NRB |
| 665.651 | 46.4 | 6.4 | -10.7 | 42.2 | Peak [Scan] | H | 200 | 0 | | | | NRB |
| 976.720 | 45.6 | 7.3 | -6.9 | 45.9 | Peak [Scan] | H | 98 | 361 | | | | NRB |

| | |
|---|---|
| Legend: | TX = Transmitter Emissions; DIG = Digital Emissions; FUND = Fundamental; WB = Wideband Emission |
| | RB = Restricted Band (15.209 Limits); NRB = Non Restricted Band, Limit is 20dB below fundamental peak |

## Operational Mode - Continuous Transmit

| | | | |
|---|---|---|---|
| **Test Freq.** | 927.25 MHz | **Engineer** | SB |
| **Variant** | Cont TX | **Temp (ºC)** | 21 |
| **Freq. Range** | 30 MHz - 1000 MHz | **Rel. Hum.(%)** | 38 |
| **Power Setting** | RA7 | **Press. (mBars)** | 998 |
| **Antenna** | TAL-060 | **Duty Cycle (%)** | 100 |
| **Test Notes 1** | Unit:#2;5VDC external PSU; LEDs; | | |
| **Test Notes 2** | IP=0; | | |



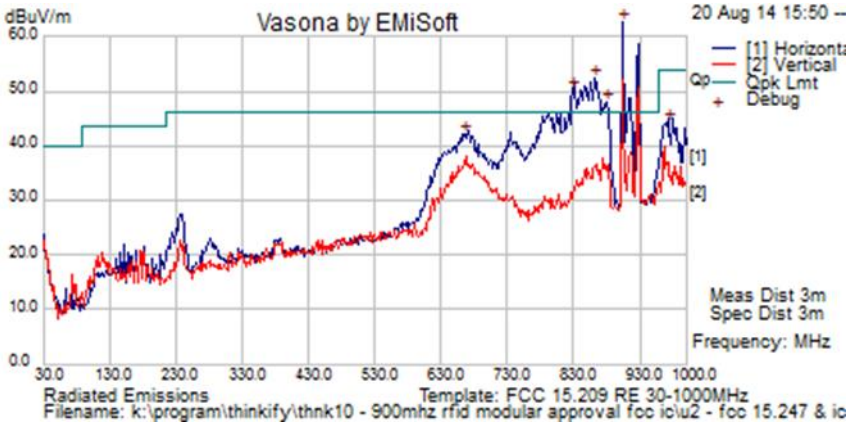

### Formally measured emission peaks

| Frequency MHz | Raw dBuV | Cable Loss | AF dB | Level dBuV/m | Measurement Type | Pol | Hgt cm | Azt Deg | Limit dBuV/m | Margin dB | Pass /Fail | Comments |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 928.076 | 58.9 | 7.2 | -7.5 | 58.7 | Peak [Scan] | H | 100 | 0 | | | | FUND |
| 848.377 | 53.2 | 6.9 | -8.3 | 51.8 | Peak [Scan] | H | 100 | 0 | | | | NRB |
| 667.595 | 46.5 | 6.4 | -10.7 | 42.2 | Peak [Scan] | H | 200 | 0 | | | | NRB |
| 786.115 | 47.4 | 6.8 | -9.1 | 45.1 | Peak [Scan] | H | 98 | 361 | | | | NRB |
| 988.845 | 41.7 | 7.3 | -6.7 | 42.3 | Peak [Scan] | H | 98 | 361 | | | | NRB |
| 233.215 | 39.6 | 4.8 | -19.2 | 25.2 | Peak [Scan] | H | 98 | 361 | 46.0 | -20.8 | Pass | |

| | |
|---|---|
| Legend: | TX = Transmitter Emissions; DIG = Digital Emissions; FUND = Fundamental; WB = Wideband Emission |
| | RB = Restricted Band (15.209 Limits); NRB = Non Restricted Band, Limit is 20dB below fundamental peak |

## Operational Mode - Frequency Hopping

| | | | |
|---|---|---|---|
| **Test Freq.** | 902.75-927.25 MHz | **Engineer** | SB |
| **Variant** | FHSS | **Temp (ºC)** | 21 |
| **Freq. Range** | 30 MHz - 1000 MHz | **Rel. Hum.(%)** | 38 |
| **Power Setting** | RA7 | **Press. (mBars)** | 998 |
| **Antenna** | ANT-916 | **Duty Cycle (%)** | 100 |
| **Test Notes 1** | Unit:#2;5VDC external PSU; LEDs; | | |
| **Test Notes 2** | IP=0; | | |




### Formally measured emission peaks

| Frequency MHz | Raw dBuV | Cable Loss | AF dB | Level dBuV/m | Measurement Type | Pol | Hgt cm | Azt Deg | Limit dBuV/m | Margin dB | Pass /Fail | Comments |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 902.806 | 63.2 | 7.1 | -7.8 | 62.5 | Peak [Scan] | H | 100 | 0 | | | | FUND |
| 861.984 | 53.6 | 7.0 | -8.2 | 52.4 | Peak [Scan] | H | 100 | 0 | | | | NRB |
| 828.795 | 51.4 | 6.9 | -8.3 | 50.0 | Peak [Scan] | H | 98 | 361 | | | | NRB |
| 879.479 | 49.0 | 7.1 | -8.2 | 47.9 | Peak [Scan] | H | 100 | 0 | | | | NRB |
| 665.350 | 46.3 | 6.4 | -10.7 | 42.1 | Peak [Scan] | H | 98 | 361 | | | | NRB |
| 973.810 | 43.7 | 7.3 | -7.0 | 44.1 | Peak [Scan] | H | 98 | 361 | | | | NRB |

| | |
|---|---|
| Legend: | TX = Transmitter Emissions; DIG = Digital Emissions; FUND = Fundamental; WB = Wideband Emission |
| | RB = Restricted Band (15.209 Limits); NRB = Non Restricted Band, Limit is 20dB below fundamental peak |

**Specification Limits**

**FCC §15.247(d) and RSS-210 §A8.5** In any 100 kHz bandwidth outside the frequency band in which the spread spectrum or digitally modulated intentional radiator is operating, the radio frequency power that is produced by the intentional radiator shall be at least 20 dB below that in the 100 kHz bandwidth within the band that contains the highest level of the desired power, based on either an RF conducted or radiated measurement, provided the transmitter demonstrates compliance with the peak conducted power limits.

**FCC §15.247(d)**
If the transmitter complies with the conducted power limits based on the use of RMS averaging over a time interval, as permitted under paragraph (b)(3) of this section, the attenuation required under this paragraph shall be 30 dB instead of 20 dB. Attenuation below the general limits specified §15.209(a) is not required. In addition, radiated emissions which fall in the restricted bands, as defined in Section §15.205(a), must also comply with the radiated emission limits specified in Section 15.209(a) (see Section 15.205(a)).

**IC RSS-210 §A8.5** If the transmitter complies with the conducted power limits based on the use of RMS averaging over a time interval, as permitted under section A8.4(4), the attenuation required shall be 30 dB instead of 20 dB. Attenuation below the general limits specified in Tables 2 and 3 is not required. In addition, radiated emissions which fall in the restricted bands of Table 1 must also comply with the radiated emission limits specified in Tables 2 and 3.

**IC RSS-Gen §4.7**
The search for unwanted emissions shall be from the lowest frequency internally generated or used in the device (local oscillator, intermediate of carrier frequency), or from 30 MHz , whichever is the lowest frequency, to the 5$^{th}$ harmonic of the highest frequency generated without exceeding 40 GHz.

**FCC §15.205 (a)** Except as shown in paragraph (d) of 15.205 (a), only spurious emissions are permitted in any of the frequency bands listed.

**FCC §15.205 (a)** Except as shown in paragraphs (d) and (e) of this section, the field strength of emissions appearing within these frequency bands shall not exceed the limits shown in Section §15.209. At frequencies equal to or less than 1000 MHz, compliance with the limits in Section 15.209 shall be demonstrated using measurement instrumentation employing a CISPR quasi-peak detector. Above 1000 MHz, compliance with the emission limits in Section 15.209 shall be demonstrated based on the average value of the measured emissions. The provisions in Section 15.35 apply to these measurements.

**FCC §15.209 (a)** Except as provided elsewhere in this subpart, the emissions from an intentional radiator shall not exceed the field strength levels specified in the following table.

**§15.209 (a)** Limit Matrix

| Frequency(MHz) | Field Strength (μV/m) | Field Strength (dBμV/m) | Measurement Distance (meters) |
|---|---|---|---|
| 30-88 | 100 | 40.0 | 3 |
| 88-216 | 150 | 43.5 | 3 |
| 216-960 | 200 | 46.0 | 3 |
| Above 960 | 500 | 54.0 | 3 |

**Laboratory Measurement Uncertainty for Radiated Emissions**

| | |
|---|---|
| Measurement uncertainty | +5.6/ -4.5 dB |

**Traceability**

| Method |
|---|
| Measurements were made per work instruction WI-03 'Measurement of Radiated Emissions' |

### 6.1.2.2. Digital Emissions (0.03-1 GHz)

**FCC, Part 15 Subpart C §15.205/ §15.209**
**Industry Canada RSS-210 §2.2**

**Test Procedure**

Testing 30M-1 GHz was performed in a 3-meter anechoic chamber using a CISPR compliant receiver. Preliminary radiated emissions were measured on every azimuth and with the receiving antenna in both horizontal and vertical polarizations. To further maximize emissions the receive antenna was varied between 1 and 4 meters. The emissions are recorded with receiver in peak hold mode. Emissions closest to the limits are measured in the quasi-peak mode with the tuned receiver using a bandwidth of 120 kHz. Only the highest emissions relative to the limit are listed. The anechoic chamber test set-up is identified in Section 6 Test Set-Up Photographs.

The EUT had two methods of powering on ac/dc converter and Power over Ethernet (POE). Both modes were tested for emissions below 1GHz.

**Field Strength Calculation**

The field strength is calculated by adding the Antenna Factor and Cable Loss, and subtracting Amplifier Gain from the measured reading. In this test facility, the Antenna Factor, Cable Loss, and Amplifier Gains are loaded into the Rohde & Schwarz Receiver and the corrected field strength can be read directly on the receiver.

$$FS = R + AF + CORR$$

where:

FS = Field Strength
R = Measured Receiver Input Amplitude
AF = Antenna Factor
CORR = Correction Factor = CL – AG + NFL
CL = Cable Loss
AG = Amplifier Gain

For example:
Given a Receiver input reading of 51.5dBμV; Antenna Factor of 8.5dB; Cable Loss of 1.3dB; Falloff Factor of 0dB, an Amplifier Gain of 26dB and Notch Filter Loss of 1dB. The Field Strength of the measured emission is:

FS = 51.5 + 8.5 + 1.3 - 26.0 +1 = 36.3dBμV/m

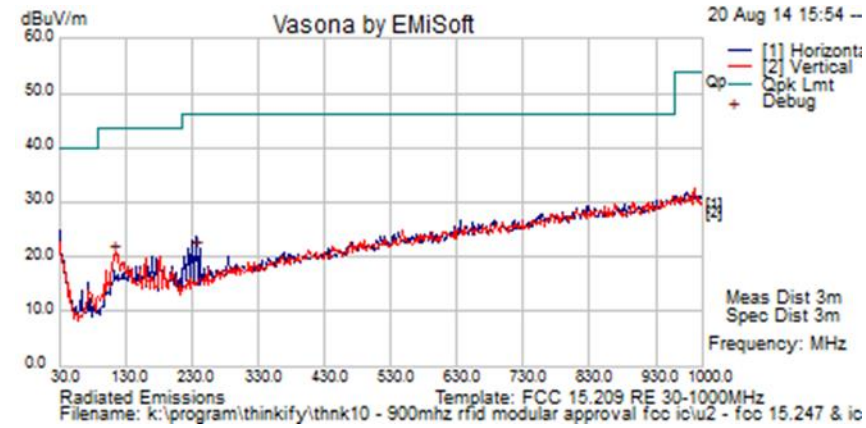
Conversion between dBμV/m (or dBμV) and μV/m (or μV) are done as:

Level (dBμV/m) = 20 * Log (level (μV/m))

40 dBμV/m = 100μV/m
48 dBμV/m = 250μV/m

The EUT was evaluated to determine orientation where maximum emissions were observed (i.e. horizontal or vertical). The EUT + antenna was positioned on the test table during radiated emissions testing. Emission scans are generated using a peak detector.

| | | | |
|---|---|---|---|
| **Test Freq.** | 902.75-927.25 MHz | **Engineer** | SB |
| **Variant** | FHSS | **Temp (ºC)** | 21 |
| **Freq. Range** | 30 MHz - 1000 MHz | **Rel. Hum.(%)** | 38 |
| **Power Setting** | RA7 | **Press. (mBars)** | 998 |
| **Antenna** | ANT-916 | **Duty Cycle (%)** | 100 |
| **Test Notes 1** | Unit:#2;5VDC external PSU; LEDs; TX Off EUT Off; | | |
| **Test Notes 2** | IP=0; | | |




## Formally measured emission peaks

| Frequency MHz | Raw dBuV | Cable Loss | AF dB | Level dBuV/m | Measurement Type | Pol | Hgt cm | Azt Deg | Limit dBuV/m | Margin dB | Pass /Fail | Comments |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 236.610 | 35.4 | 4.8 | -19.1 | 21.1 | Peak [Scan] | H | 98 | 361 | 46 | -24.9 | Pass | |
| 112.450 | 34.3 | 4.2 | -18.4 | 20.2 | Peak [Scan] | H | 98 | 361 | 44 | -23.8 | Pass | |

| | |
|---|---|
| Legend: | TX = Transmitter Emissions; DIG = Digital Emissions; FUND = Fundamental; WB = Wideband Emission |
| | RB = Restricted Band (15.209 Limits); NRB = Non Restricted Band, Limit is 20dB below fundamental peak |

## Specification

### Limits

**§15.205 (a)** Except as shown in paragraph (d) of 15.205 (a), only spurious emissions are permitted in any of the frequency bands listed.

**§15.205 (a)** Except as shown in paragraphs (d) and (e) of this section, the field strength of emissions appearing within these frequency bands shall not exceed the limits shown in Section §15.209. At frequencies equal to or less than 1000 MHz, compliance with the limits in Section 15.209 shall be demonstrated using measurement instrumentation employing a CISPR quasi-peak detector. Above 1000 MHz, compliance with the emission limits in Section 15.209 shall be demonstrated based on the average value of the measured emissions. The provisions in Section 15.35 apply to these measurements.

**§15.209 (a)** Except as provided elsewhere in this subpart, the emissions from an intentional radiator shall not exceed the field strength levels specified in the following table.

**§15.209 (a)** and **RSS-Gen §2.2** Limit Matrix

| Frequency(MHz) | Field Strength (μV/m) | Field Strength (dBμV/m) | Measurement Distance (meters) |
|---|---|---|---|
| 30-88 | 100 | 40.0 | 3 |
| 88-216 | 150 | 43.5 | 3 |
| 216-960 | 200 | 46.0 | 3 |
| Above 960 | 500 | 54.0 | 3 |

### Laboratory Measurement Uncertainty for Radiated Emissions

| | |
|---|---|
| Measurement uncertainty | +5.6/ -4.5 dB |

### Traceability

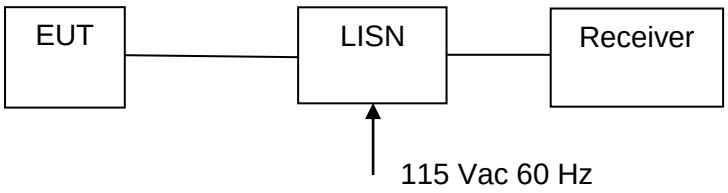
| Method |
|---|
| Measurements were made per work instruction WI-03 'Measurement of Radiated Emissions' |

### 6.1.3. AC Wireline Conducted Emissions (150 kHz – 30 MHz)

**FCC, Part 15 Subpart C §15.207**
**Industry Canada RSS-Gen §7.2.2**

**Test Procedure**
The EUT is configured in accordance with ANSI C63.4. The conducted emissions are measured in a shielded room with a spectrum analyzer in peak hold in the first instance. Emissions closest to the limit are measured in the quasi-peak mode (QP) with the tuned receiver using a bandwidth of 9 kHz. The emissions are maximized further by cable manipulation. The highest emissions relative to the limit are listed.

**Test Measurement Set up**




Measurement set up for AC Wireline Conducted Emissions Test

**Measurement Results for AC Wireline Conducted Emissions (150 kHz – 30 MHz)**

Ambient conditions.
Temperature: 17 to 23 °C Relative humidity: 31 to 57 % Pressure: 999 to 1012 mbar

## Not required - EUT is power by DC only

## Specification

### Limit

**§15.207 (a)** Except as shown in paragraphs (b) and (c) of this section, for an intentional radiator that is designed to be connected to the public utility (AC) power line, the radio frequency voltage that is conducted back onto the AC power line on any frequency or frequencies within the band 150 kHz to 30 MHz shall not exceed the limits in the following table, as measured using a 50 μΩ line impedance stabilization network (LISN), see §15.207 (a) matrix below. Compliance with the provisions of this paragraph shall be based on the measurement of the radio frequency voltage between each power line and ground at the power terminal.

**RSS-Gen §7.2.2**
The radio frequency voltage that is conducted back into the AC power lines in the frequency range of 0.15 MHz to 30 MHz shall not exceed the limits shown in the table below. The tighter limit applies at the frequency range boundaries.

**§15.207 (a)** and **RSS-Gen §7.2.2** Limit Matrix
The lower limit applies at the boundary between frequency ranges

| Frequency of Emission (MHz) | Conducted Limit (dBμV) | |
|---|---|---|
| | Quasi-peak | Average |
| 0.15-0.5 | 66 to 56* | 56 to 46* |
| 0.5-5 | 56 | 46 |
| 5-30 | 60 | 50 |

* Decreases with the logarithm of the frequency

### Laboratory Measurement Uncertainty for Conducted Emissions

| | |
|---|---|
| Measurement uncertainty | ±2.64 dB |

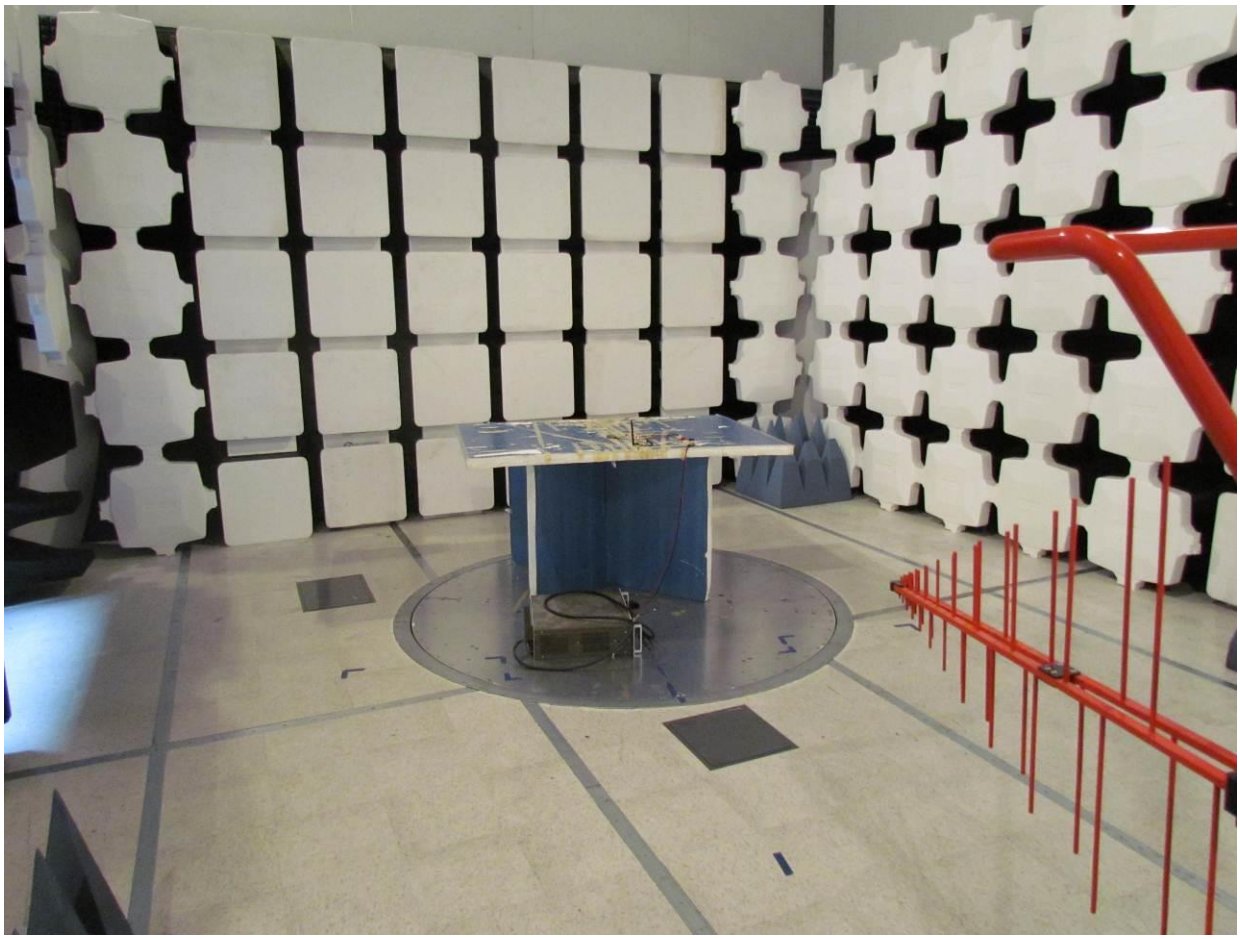
### Traceability

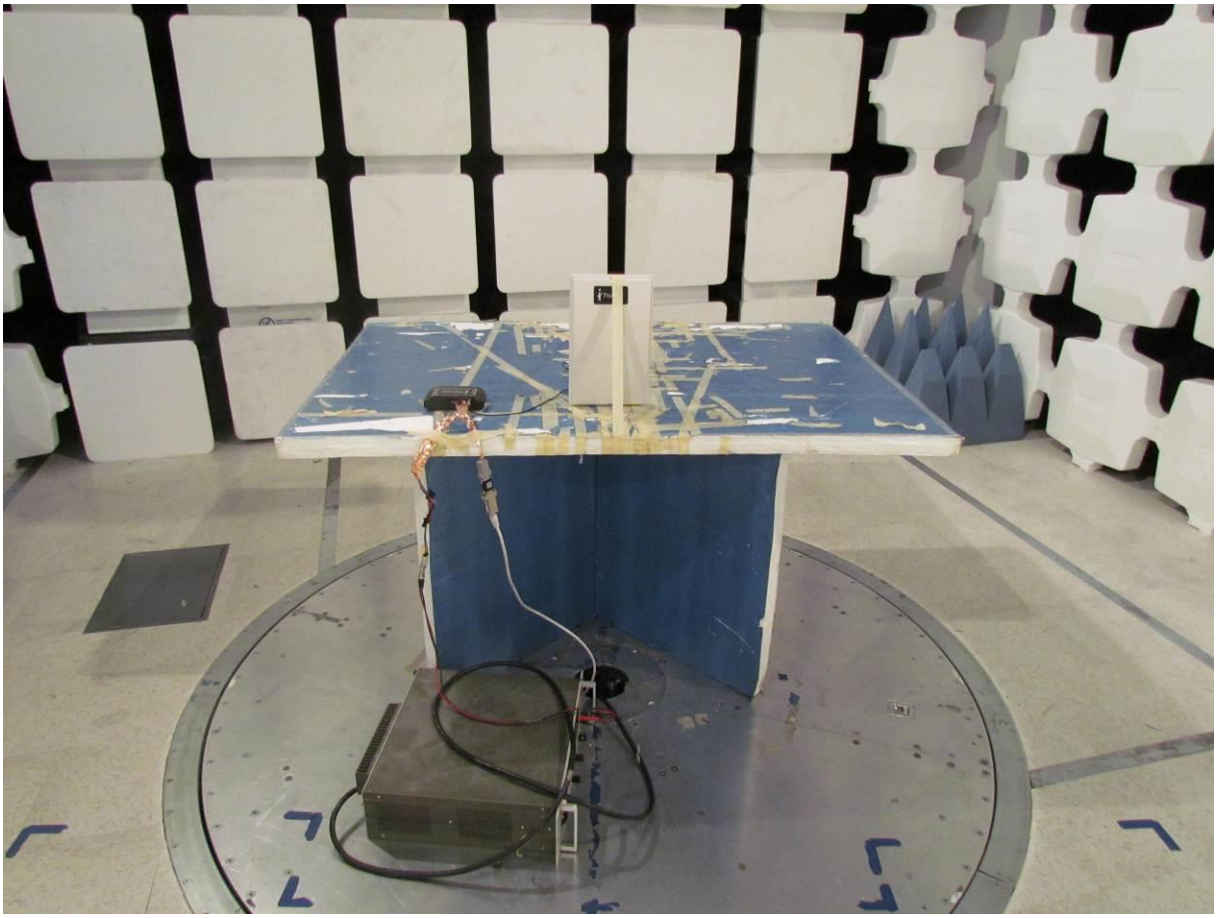
| Method |
|---|
| Measurements were made per work instruction WI-EMC-01 'Measurement of Conducted Emissions' |

# 7. PHOTOGRAPHS

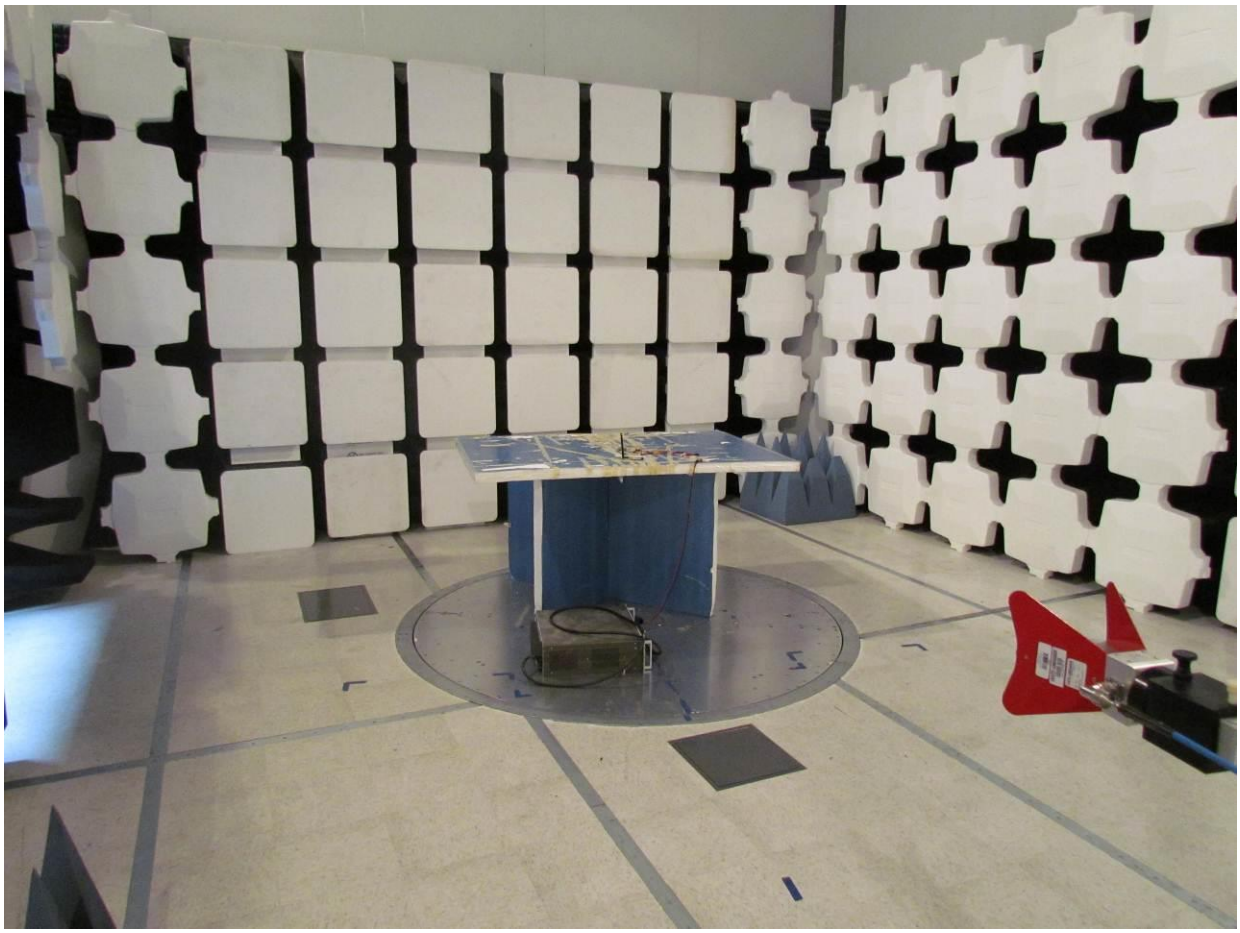
## 7.1. Test Setup - Conducted

## 7.2. Test Setup - Digital Emissions below 1 GHz





## 7.3. Test Setup - Spurious Emissions Above 1 GHz



# 8. TEST EQUIPMENT

| Asset # | Instrument | Manufacturer | Part # | Serial # | Calibration Due Date |
|---|---|---|---|---|---|
| 075 | Environmental Chamber | Thermatron | SE-300-2-2 | 27946 | N/A |
| 091 | Synthesized Sweeper | Hewlett Packard | HP 83640L | 3722A00249 | N/A |
| 117 | Power Sensor | Hewlett Packard | 8487D | 3318A00371 | 18th Oct 14 |
| 158 | Barometer /Thermometer | Control Co. | 4196 | E2846 | 6th Dec 14 |
| 223 | Power Meter | Hewlett Packard | EPM-442A | US37480256 | 18th Oct 14 |
| 252 | SMA Cable | Megaphase | Sucoflex 104 | None | N/A |
| 310 | 2m SMA Cable | Micro-Coax | UFA210A-0-0787-3G03G0 | 209089-001 | N/A |
| 312 | 3m SMA Cable | Micro-Coax | UFA210A-1-1181-3G0300 | 209092-001 | N/A |
| 338 | 30 - 3000 MHz Antenna | Sunol | JB3 | A052907 | 14th Aug 15 |
| 376 | Power Sensor | Agilent | U2000A | MY51440005 | 28th Oct 14 |
| 377 | Notch Filter 5G | Microtronics | BRM50716 | 034 | N/A |
| 378 | EMI Receiver | Rhode & Schwartz | ESIB40 | 100107/040 | 17th Jul 15 |
| 380 | RF Switch | MiCOM Labs | MIC001 | MIC001 | 20th Dec 14 |
| 390 | Power Sensor | Agilent | U2002A | MY50000103 | 17th Oct 14 |
| 393 | Low Pass Filter 1050MHz | Minicircuits | WLFX-1050 | | N/A |
| 396 | Notch Filter 2.4G | Microtronics | BRM50701 | | N/A |
| 397 | Preamp 10-2500 MHz | MiCOM Labs | | 0397 | 23 Oct '14 |
| 398 | RF Conducted Test Software | MiCOM Labs ATS | -- | Version 1.8 | N/A |

| Asset # | Instrument | Manufacturer | Part # | Serial # | Calibration Due Date |
|---|---|---|---|---|---|
| 399 | Horn Antenna 1-18G | ETS | 3117 | 00154575 | 10 Oct '14 |
| 405 | Power Supply 0 -60 Vdc | Agilent | 6654A | MY4001826 | N/A |
| 406 | Preamp 1-18 GHz | MiCOM Labs | | 0406 | 30 May '15 |
| 411 | Mast/Turntable Control | Sunol Sciences | SC98V | 060199-1D | N/A |
| 413 | Mast Controller | Sunol Sciences | TWR95-4 | 030801-3 | N/A |
| 415 | Turntable Controller | Sunol Sciences | | 0415 | N/A |
| 416 | Gigabit Ethernet Filter | ETS | 260366 | 0416 | N/A |
| 502 | EMC Test Software | EMISoft | Vasona | 5.0051 | N/A |
| 503 | RF Conducted Test Software | National Instruments | Labview | Version 8.2 | N/A |
| RF#1SMA #SA | SMA Cable | Flexco | -- | -- | 20th Dec 14 |
| RF#1SMA #1 | SMA Cable | Flexco | -- | -- | 20th Dec 14 |
| RF#1SMA #2 | SMA Cable | Flexco | -- | -- | 20th Dec 14 |
| RF#1SMA #3 | SMA Cable | Flexco | -- | -- | 20th Dec 14 |
| RF#1SMA #4 | SMA Cable | Flexco | -- | -- | 20th Dec 14 |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