# Tantalus Systems Corp.

# VC-910

## Report of Measurements

**per**

## Industry Canada RSS-210 Issue 8

**and**

## FCC CFR47 Part 15/B; FCC CFR47 Part 15/C – 15.247

Revision 2.0
May 16, 2014

| | | |
|---|---|---|
| **Reviewed By:** | **Parm Singh, EMC Division Manager** | May 16 2014<br>**Date** |

| | | |
|---|---|---|
| **Tested By:** | **Aman Jathaul, EMC Project Manager** | May 16 2014<br>**Date** |

**Quality Auditing Institute**
**19473 Fraser Way, Pitt Meadows, BC, V3Y 2V4, Canada**

# Test Report Summary

FCC 15.247 / IC RSS-210

Frequency Hopping 902.17 – 927.83MHz communication Module

**FCC ID:** OZFVC910 **IC:** 3669A-VC910

| | |
|---|---|
| **Organization Requesting Report:** | Tantalus Systems Corp. |
| **Contact:** | Mark Fairburn, RF Design Engineer |
| **Test Organization:** | Quality Auditing Institute Ltd. |
| **Contact:** | Aman Jathaul, EMC Project Manager |
| **Test Personnel:** | Aman Jathaul |

# Index

# List of Figures

# List of Tables

# Section 1: Information for Test Report of Measurements

## Testing Details

TESTED BY: Aman Jathaul

ENVIRONMENTAL CONDITIONS:

| | |
|---|---|
| Day 1: Dec 18 2013 | Temperature: 22.0ºC, R.H.: 40.3%, Barometric Pressure: 1015.8 mBar. |
| Day 2: Dec 23 2013 | Temperature: 20.5ºC, R.H.: 38.4%, Barometric Pressure: 1016.8 mBar. |
| Day 3: Dec 23 2013 | Temperature: 19.7ºC, R.H.: 39.3%, Barometric Pressure: 1014.8 mBar. |
| Day 4: Jan 07 2014 | Temperature: 21.5ºC, R.H.: 39.7%, Barometric Pressure: 1014.3 mBar. |
| Day 5: Feb 04 2014 | Temperature: 22.3ºC, R.H.: 39.0%, Barometric Pressure: 1015.0 mBar. |
| Day 6: Mar 21 2014 | Temperature: 23.4ºC, R.H.: 41.2%, Barometric Pressure: 1015.3 mBar. |

## Test Facilities

**Main Laboratory Headquarters**: Quality Auditing Institute

Headquarters Location/Address: 16 – 211 Schoolhouse Street, Coquitlam, BC, 3K 4X9, Canada

**Associated Laboratory:** Quality Auditing Institute (Remote Location)

EMC Test Laboratory Location/Address: 19473 Fraser Way, Pitt Meadows, BC, V3Y 2V4, Canada

FCC Test Site Registration Number: 3 m /10 m Open Area Test Site [OATS] and
3 m Semi-Anechoic Chamber [SAC]: 226383

Industry Canada Test Site Registration Number (3m SAC): 9543B-1

Standard Council of Canada: ISO/IEC 17025:2005 Accredited Laboratory No. 743

International Accreditation Service Inc.: ISO/IEC 17025:2005 Accredited Laboratory: No. TL-239

## Test Equipment List

| Device | Model Number | Equipment Description | Serial No. | Last Cal | Next Cal |
|---|---|---|---|---|---|
| Antenna | Sunol Sciences JB3 | Biconilog Antenna (30MHz-3GHz) | A042004 | Mar 12, 2012 | Mar 12, 2015 |
| EMI Receiver | Rohde & Schwarz ESU40 | EMI Receiver (20Hz-40GHz) | 100011 | June 26, 2012 | June 26, 2015 |
| LISN | COM-POWER LI-115 | LISN (150kHz-30MHz) | 241036 | Mar 9, 2011 | Mar 9, 2014 |
| Horn Antenna | COM-POWER AHA-118 | Horn Antenna with LNA (1-18Ghz) | 711040 | Mar 11, 2011 | Mar 11, 2014 |
| Turntable | ETS Lindgren 2165 | 00043677 | N/A | N/A | N/A |
| Mast | ETS Lindgren 2165 | 00077487 | N/A | N/A | N/A |

Note: All the equipments have 3-years calibartion cycle.

## Measurement Uncertainty

| Parameter | Uncertainty |
|---|---|
| Radio Frequency | ±1 x 10-5 MHz |
| Radiated Emissions | ±3 dB |
| Temperature | ±1°C |
| Humidity | ±5 % |

| | |
|---|---|
| DC and low frequency voltages | ±3 % |

## Company Tested

NAME: Tantalus Systems Corp.

ADDRESS: 301–3480 Gilmore Way
Burnaby, BC V5G 4Y1
Canada

CONTACT PERSON: Mr. Mark Fairburn

PHONE NUMBER: 1-604-299-0458 x:229

## Equipment Under Test

THE TEST SYSTEM:

The Tantalus Systems VC-910 is a high capacity LAN collector that allows electrical utilities to create LAN's with an endpoint capacity of upto 2000 devices with a variety of data rates and multi-level FSK modulation formats to achieve data rates of upto 640kbps.

Product ID: VC-910
Manufacturer: Tantalus Systems Corp.

LAN Controller
Part Numbers: 100-0161-B
Serial number: 001865F80A

WAN Controller
Part Numbers: 100-0090-L
Serial number: 0018633D9A

TEST SETUP: This EUT is designed to communicate with other LAN devices in the Tantalus Utility Network (TUNet®) and employs a Frequency Hopping Spread Spectrum (FHSS) system operating on the 902-928 MHz band for LAN communication.

CABLING:

| Cable | Pins | Connector | Load/Termination | Shielded | Ferrites |
|---|---|---|---|---|---|
| Power | 3 | Terminal | No | No | No |

MODIFICATIONS: No modifications were made for this unit to pass.

CONCLUSION: The VC-910 complies with the requirements of FCC CFR47 and the requirements of Industry Canada RSS-210.

# Section II: IC RSS-210 Iss.8 & FCC CFR47 Part 15/B Report of Measurements

## Markings

According to FCC Section 15.19 and ICES 003, a statement similar to the following must be included on an identification label, which also uniquely identifies the Manufactured date, either explicitly or through a Serial number etc.:

> "This equipment complies with FCC Rules, Part 15 and Industry Canada's ICES 003 for a Class B Digital Device. Operation is subject to two conditions:
>
> 1) This device may not cause harmful interference, and
>
> 2) This device must accept any interference that may cause any undesired operation"

Additionally, if the manufacturer markets product to Quebec, the following supplemental information should be added to the label:

> "Cet Apparreil numerique de la Classe B respecte toutes les exigences du Reglement sur le material brouilleur du Canada."

## Labeling

According to FCC Section 15.105, and ICES 003, the following statement must be included in a prominent location in your User's Manual:

NOTE: This equipment has been tested and found to comply with the limits for a Class B digital device, pursuant to part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful intereference when the equipment is operated in a commercial environment. This equipment generates, uses, and can radiate radio frequency energy, and, if not installed and used in accordance with the instruction manual, may cause harmful interference to radio communications. Operation of this equipment in a residential area is likely to cause harmful interference in which case the user will be required to correct the interference at his own expense.

It is also required according to FCC Part B Section 15.21 that a caution is included such as:

> Caution: Changes or modifications to this equipment, not expressly approved by the manufacturer could void the user's authority to operate the equipment.

This product is License Exempt for FCC and IC. There is a requirement for this product to be submitted for certification and requires both an FCC ID and an IC ID number to be added to the labels in accordance with FCC CFR47 Part 2 Subpart J (2.901 to 2.956) as well as IC Self-Marking standards.

# Section III: IC RSS-210 Issue 8 Emissions Testing

**Test Results – Summary**

Testing was performed pursuant to Industry Canada RSS-210 Issue 8.

| Test | Standard | Description | Result |
|---|---|---|---|
| Radiated Emissions Idle Mode<br>Subclause 8.2 | RSS-210 2.2(b) | The radiated emissions are measured in the 0.009 - 9280MHz range | Complies |
| Conducted Emissions Idle Mode<br>Subclause 8.3 | EN55022<br>Class A Limits | The Conducted Emissions are measured on the phase and neutral power lines in the 0.15 – 30.0 MHz range | Complies |
| Radiated Emissions Transmit Mode | RSS-210 A8.5 | The radiated emissions are measured in the 0.009 -9280MHz range | Complies |
| Output Power and EIRP Emissions | RSS-210 A8.4(1) | Output power will not exceed 1 Watt and the E.I.R.P. will not exceed 4 Watts | Complies |

# Part 1 – Radiated Emissions Testing

DATE April 03, 2013

TEST STANDARD: RSS-210 2.2(b)

TEST SETUP: The EUT was operated and tested at 240Vac and 120Vac 60Hz in its normal mode of operation. It was in receive mode for these tests.

MINIMUM STANDARD: Class B Limit:

| Frequency (MHz) | Field Strength (µV/m) | Measurement Distance (m) |
|---|---|---|
| 30 – 88 | 100 | 3 |
| 88 – 216 | 150 | 3 |
| 216 – 960 | 200 | 3 |
| Above 960 | 500 | 3 |

METHOD OF MEASUREMENT: Measurements were made using a spectrum analyzer with a 9kHz RBW, Peak detector. Any emissions that are close to the limit are measured using a test receiver with a 9kHz bandwidth, CISPR Quasi-Peak detector as well as an averaging meter. The EUT was set up in a 3 meter semi-anechoic chamber, using the manufacturer's specified normal cabling configuration, with all cables over 1 meter in length bundled at 1 meter and retained from the floor. A typical application was tested.

Emissions in both horizontal and vertical polarization were measured while rotating the EUT on a turntable to maximize the emissions signal strength and the results recorded on the attached plots.

EMISSIONS DATA: See Appendix A for corresponding frequencies.

PERFORMANCE: Complies.

# Part 2 – Conducted Emissions Testing

DATE: April 01, 2013

TEST STANDARD: EN55022

MINIMUM STANDARD: Class B Limit:

TEST SETUP: The EUT was connected to the conducted emissions LISN appartus. The device was operated and tested at 240Vac and 120Vac 60Hz.

MINIMUM STANDARD: Class A Limit:

| Frequency (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 |

METHOD OF MEASUREMENT: Measurements were made using a spectrum analyzer with a 9kHz RBW, Peak detector. Any emissions that are close to the limit are measured using a test receiver with a 9kHz bandwidth, CISPR Quasi-Peak detector as well as an averaging meter.

MEASUREMENT DATA: See Appendix A for Plots.

EMISSIONS DATA: See Appendix A for corresponding frequencies.

PERFORMANCE: Complies.

# Part 3 – Radiated Emissions – Transmit Mode

DATE: April 03, 2013

TEST STANDARD: RSS-210 Iss.8 Annex 8 Frequency Hopping Systems 902-928MHz Band.

MINIMUM STANDARD: **A8.1 – Frequency Hopping Systems (General Conditions)**

Frequency hopping systems are spread spectrum systems in which the carrier is modulated with coded information in a conventional manner causing a conventional spreading of the RF energy about the carrier frequency. The frequency of the carrier is not fixed but changes at fixed intervals under the direction of a coded sequence. Frequency hopping systems are not required to employ all available hopping frequencies during each transmission. However the system, consisting of both the transmitter and the receiver, must be designed to comply with all of the regulations in this section should the transmitter be presented with a continuous data (or information) stream.

Incorporation of intelligence into a frequency hopping system that enables it to recognize other users of the band and to avoid occupied frequencies is permitted, provided that the frequency hopping system does it individually, and independently chooses or adapts its hopset. The coordination of frequency hopping systems in any other manner for the express purpose of avoiding the simultaneous occupancy of individual hopping frequencies by multiple transmitters is not permitted.

**(a)** The bandwidth of a frequency hopping channel is the 20 dB emission bandwidth, measured with the hopping stopped. The system RF bandwidth is equal to the channel bandwidth multiplied by the number of channels in the hopset. The hopset shall be such that the near-term distribution of frequencies appears random, with sequential hops randomly distributed in both direction and magnitude of change in the hopset while the long-term distribution appears evenly distributed.

**(b)** Frequency hopping systems shall have hopping channel carrier frequencies separated by a minimum of 25 kHz or the 20 dB bandwidth of the hopping channel, whichever is greater. The system receivers shall have input bandwidths that match the hopping channel bandwidths of their corresponding transmitters and shall shift frequencies in synchronization with the transmitted signals.

**(c)** For frequency hopping systems in the band 902-928 MHz: if the 20 dB bandwidth of the hopping channel is less than 250 kHz, the system shall use at least 50 hopping channels and the average time of occupancy on any channel 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 channels and the average time of occupancy on any channel 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.

**A8.4 Transmitter Output Power and e.i.r.p. Requirements**

**(1)** For frequency hopping systems operating in the band 902-928 MHz, the maximum peak conducted output power shall not exceed 1.0 W, and the e.i.r.p. shall not exceed 4 W, if the hopset uses 50 or more hopping channels; the maximum peak conducted output power shall not exceed 0.25 W, and the e.i.r.p. shall not exceed 1 W, if the hopset uses less than 50 hopping channels. As an alternative to a peak power measurement, compliance can be based on a measurement of the maximum conducted output power (see RSS-Gen).

**A8.5 Out-of-band Emissions**

In any 100 kHz bandwidth outside the frequency band in which the spread spectrum or digitally modulated device is operating, the radio frequency 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 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 Section A8.4(4), the attenuation required shall be 30 dB instead of 20 dB.

TEST SETUP: The EUT was operated and tested at 240Vac and 120V 60Hz for the tests and the unit was transmitting at its maximum rate based on the energy that it could sustain in normal operation.

METHOD OF MEASUREMENT: Measurements were made using a spectrum analyzer. The EUT was set up in a 3 meter Semi-Anechoic test site, using the manufacturer's specified normal cabling configuration, with all cables over 1 meter in length bundled at 1 meter and retained from the floor.

Emissions in both horizontal and vertical polarization were measured while rotating the EUT on a turntable to maximize the emissions signal strength and the results recorded on the attached plots.

All frequencies 0.009 -1000MHz were tested at 3m and all frequencies 1GHz and up were tested at 1m in accordance with ANSI c63.4.

EMISSIONS DATA: See Appendix A for results.

| Test | Standard | Results |
|---|---|---|
| Spread Spectrum Method of Modulation | RSS-210 A8.1 | This product meets the requirements of a Frequency Hopping Spread Spectrum (FHSS) system operating in the 902-928MHz band |
| Output Power and EIRP | RSS-210 A8.4(1) | See the Measurement Data section in Part 4 of this Section. The output EIRP is a maximum of 0.759W. The conducted output power is 550mW. |
| Out of Band Emissions | RSS-210 A8.5 | See Tables 6 - 8 in Appendix A. All radiated emissions were within the RSS-210 A8.5 limit. |

## Low Data Rate

| | | |
|---|---|---|
| Channel Bandwidth | RSS-210 A8.1(a) | See Figures 6 - 8 in Appendix A. The 20dB bandwidth was measured to be 112.2 kHz. |
| Channel Separation | RSS-210 A8.1(c) | See Figure 9 in Appendix A. The Channel separation was measured to be 128.1 kHz. |
| Number of Hopping Channels | RSS-210 A8.1(c) | See Figures 10 -13 in Appendix A. The number of frequencies used is 50. |
| Hopping Channels Time of Occupancy | RSS-210 A8.1(c) | See Figures 14 and 15 in Appendix A; the time of occupancy is 4.4 milliseconds at an interval of 1.9 seconds. This is equal to an average time “ON” of 46.3 mSecs within a 20 second period. |

## High Data Rate

| | | |
|---|---|---|
| Channel Bandwidth | RSS-210 A8.1(a) | See Figures 18 - 20 in Appendix A. The 20dB bandwidth was measured to be 300 kHz. |
| Channel Separation | RSS-210 A8.1(c) | See Figure 21 in Appendix A. The Channel separation was measured to be 318.4 kHz. |
| Number of Hopping Channels | RSS-210 A8.1(c) | See Figures 22 - 27 in Appendix A. The number of frequencies used is 54. |
| Hopping Channels Time of Occupancy | RSS-210 A8.1(c) | See Figures 28 and 29 in Appendix A; the time of occupancy is 624 microseconds at an interval of 0.114 seconds. This is equal to an average time “ON” of 109.3 mSecs within a 20 second period. |

# Communication Data Rate to Certifed OEM Part 15 Device

| | | |
|---|---|---|
| Channel Bandwidth | RSS-210 A8.1(a) | See Figures 31 - 33 in Appendix A. The 20dB bandwidth was measured to be 156.6 kHz. |
| Channel Separation | RSS-210 A8.1(c) | See Figure 21 in Appendix A. The Channel separation was measured to be 200.6 kHz. |
| Number of Hopping Channels | RSS-210 A8.1(c) | See Figures 35 - 43 in Appendix A. The number of frequencies used is 120. |
| Hopping Channels Time of Occupancy | RSS-210 A8.1(c) | See Figures 31 and 32 in Appendix A; the time of occupancy is 6.40 milliseconds at an interval of 120 seconds. This is equal to an average time “ON” of 1.067mSecs within a 20 second period. |

PERFORMANCE: Complies.

# Part 4 – Output Power and EIRP Emissions

DATE: April 05, 2013

TEST STANDARD: RSS-210 Iss.8 A8.4 – Frequency Hopping Spread Spectrum Systems 902-928MHz

MINIMUM STANDARD: For frequency hopping systems operating in the band 902-928 MHz, the maximum peak conducted output power shall not exceed 1.0 W, and the e.i.r.p. shall not exceed 4 W, if the hopset uses 50 or more hopping channels; the maximum peak conducted output power shall not exceed 0.25 W, and the e.i.r.p. shall not exceed 1 W, if the hopset uses less than 50 hopping channels.

TEST SETUP: Refer to setup in Part 3 above.

METHOD OF MEASUREMENT: The Antenna is connected directly to the PCB using a coaxial pigtail; the conducted output power was measured at this point. A 30dB attenuator was used to protect the instumentattion. See Figures 13-15.

EIRP was measured at the 3m distance and the measurement was adjusted to account for cable loss and Antenna factor.

**EIRP measurements**

| Freq(MHz) | Corrected Field at 3m (dBµV/m) | 3m EIRP (dBm) |
|---|---|---|
| 902.17 | 124.02 | 28.79 |
| 915 | 123.78 | 28.55 |
| 927.83 | 123.33 | 28.10 |

**Conducted Output Power measurements**

| Freq(MHz) | Meas. Output Power (dBm) | Correction Factor* (dB) | Output Power (dBm) |
|---|---|---|---|
| 902.17 | -2.78 | 30.3 | 27.52 |
| 915 | -3.04 | 30.1 | 27.06 |
| 927.83 | -2.86 | 30.1 | 27.44 |

* Correction Factor accounts for a nominal 30dB attenuator and 0.5dB cable loss.

PERFORMANCE: Complies.

# Part 5: Out of Band Emissions

DATE: April 05, 2013

TEST STANDARD: RSS-210 A8.5

MINIMUM STANDARD: In any 100 kHz bandwidth outside the frequency band in which the spread spectrum or digitally modulated device is operating, the radio frequency 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 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 Section A8.4(4), the attenuation required shall be 30 dB instead of 20 dB.

TEST SETUP: Refer to the setup in Part 3 above.

METHOD OF MEASUREMENT: Measurements were made using a horn antenna connected directly into a spectrum analyzer. The EUT was set up in a 1 meter open field test site, using the manufacturer's specified normal cabling configuration, with all cables over 1 meter in length bundled at 1 meter and retained from the floor. An application which transmitted a constant CW at the highest output power was used.

Emissions in the horizontal and vertical polarization were measured while rotating the EUT on a turntable to maximize the emissions signal strength and the results recorded on the attached plots.

Due to the presence of high ambient noise making it impossible to measure an emission at the required distance, the measurement was performed at 1 meter distance and the limit is adjusted per EN61000-6-3:2001

The following formula was used to convert the maximum field strength (FS) in volts/meter to calculate the EUT output power (TP) in Watts:

$$TP = ((FS \times D) \times 2) / (30 \times G)$$

Where D is the distance in meters between the two antennas and G is the EUT antenna numerical gain referenced to isotropic gain.

MEASUREMENT DATA: See Tables 6 to 8 in Appendix A.

PERFORMANCE: Complies.

# Section IV: FCC CFR47 Part 15/C Report of Measurements

## General

Tests were conducted on a sample of the equipment for the purpose of demonstrating compliance with FCC Part 15 – Subpart C - Intentional Radiators. The Testing was performed pursuant to ANSI 63.4, 2003.

Additionally, the specific section used for compliance is 15.247 – Operation within the bands 902-928MHz – limited to frequency hopping intentional radiator. This includes the use of the FCC Public Notice DA 00-705 (Filing and Measurement Guidelines for Frequency hopping Spread Spectrum Systems) that was used as a guide to the tests that were performed.

## Labeling Requirements

Please refer to labeling requirements as outlined above in Section 1.

## Test Results - Summary

Testing was performed pursuant to ANSI 63.4, 2003.

| Test | Standard | Description | Result |
|---|---|---|---|
| Radiated Emissions Idle Mode | FCC Part 15 Subpart B Class B Limits | The radiated emissions are measured in the 0.009 - 9280MHz range | Complies |
| Conducted Emissions Idle Mode | FCC Part 15 Subpart B Class B Limits | The conducted emissions are measured on the phase and neutral power lines in the 0.15 – 30.0 MHz range. | Complies |
| Antenna Requirement | FCC Part 15 Subpart 15.203 | Proper Antenna is specified and used | Complies |
| Radiated Emissions Transmit Mode – Frequency Hopping Spread Spectrum Operation | FCC Part 15 Subpart C 15.247 | Radiated emission characteristics for Spread Sprectrum devices operating in the range 902-928 MHz that use the Spread Spectrum Modulation technique. Emissions are measured in the 0.009 - 9280MHz range. | Complies |

# Part 1 – Radiated Emission Testing

DATE: April 02, 2013

TEST STANDARD: FCC CFR47, Part 15, Subpart B Class B and Subpart C-Section 15.247

TEST VOLTAGE: 240Vac 60Hz

TEST SETUP: The equipment was set up in a 3-meter semi-anechoic chamber. Emissions in both horizontal and vertical polarization's were measured while rotating the EUT on a turntable to maximize the emissions signal strength and the results recorded on the attached plots. In cases where the presence of high ambient noise makes it impossible to measure an emission at the required distance, the measurement is performed at a closer distance and the limit is adjusted 20dB per Decade using the formula

20*Log (d1/d2)

Where d1 is the required distance and d2 is the new distance.

MINIMUM STANDARD: When the EUT is operating in Receive mode FCC Part 15 Subpart B Unintentional Radiators Limits for a Class B product.:

| Frequency (MHz) | Field Strength (μV/m) | Measurement Distance (m) |
|---|---|---|
| 0.009 – 0.490 | 2400/F(kHz) | 300 |
| 0.490 – 1.705 | 24000/F(kHz) | 30 |
| 1.705 – 30.0 | 30 | 30 |
| 30 – 88 | 100 | 3 |
| 88 – 216 | 150 | 3 |
| 216 – 960 | 200 | 3 |
| Above 960 | 500 | 3 |

DEVICE DESCRIPTIONS: Refer to the Equipment Under Test information in the Section 1 above, for EUT Descriptions.

CABLING DETAILS: The EUT was set up using the manufacturer's specified normal cabling configuration.

CABLING:

| Cable | Pins | Connector | Load/Termination | Shielded | Ferites |
|---|---|---|---|---|---|
| Power | 3 | Terminal | No | No | No |

MODIFICATIONS: No modifications were required for the devices to pass the test.

MEASUREMENT DATA: See Appendix A for Plots.

**EMISSIONS DATA:** **See** This plot is for refenence only. This plot was taken using the peak detector function, some of the emissions seems closer or over the limit line. But Final qausi peak readings meets the standard requirement as shown in the Table 1 below.

Table 1 in Appendix A for corresponding frequencies. Emmisions that were attenuated by more than 20dB from the permissible value are not reported in accordance with 15.31(o). The device was tested to 10MHz since it uses clock circuitry at this frequency.

PERFORMANCE: Complies.

# Part 2 – Antenna Requirement – 15.203

2.1 APPLICABLE REGULATIONS:

An intentional radiator shall be designed to ensure that no antenna other than that furnished by the responsible party shall be used with the device. The use of a permanently attached antenna or of an antenna that uses a unique coupling to the intentional radiator shall be considered sufficient to comply with the provisions of this Section. The manufacturer may design the unit so that a broken antenna can be replaced by the user, but the use of a standard antenna jack or electrical connector is prohibited. This requirement does not apply to carrier current devices or to devices operated under the provisions of Sections 15.211, 15.213, 15.217, 15.219, or 15.221. Further, this requirement does not apply to intentional radiators that must be professionally installed, such as perimeter protection systems and some field disturbance sensors, or to other intentional radiators which, in accordance with Section 15.31(d), must be measured at the installation site. However, the installer shall be responsible for ensuring that the proper antenna is employed so that the limits in this Part are not exceeded.

2.2 RESULTS: The Part 15 device inside the EUT is comprised of a proprietary design antenna that is soldered to the PCB by means of a coaxial cable. The entire module is underneath a clear plastic cover that is sealed at installation by the utility company and cannot be accessed.

PERFORMANCE: Complies.

# Part 3 – Conducted Emissions Tests – 15.207

3.1 Applicable Regulations

**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 µH/50 ohms line impedance stabilization network (LISN). Compliance with the provisions of this paragraph shall be based on the measurement of the radio frequency voltage between each power line and ground at the power terminal. The lower limit applies at the boundary between the frequency ranges.

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

3.2 RESULT

MEASUREMENT DATA: See Appendix A for Plots.

EMISSIONS DATA: See Tables 3 - 4 and Figures 1 – 2 in Appendix A for corresponding data.

PERFORMANCE: Complies.

# Part 4 – Frequency Hopping Spread Spectrum Operation – 15.247

4.1 APPLICABLE REGULATIONS:

**15.247(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)** Frequency hopping systems shall have hopping channel carrier frequencies separated by a minimum of 25 kHz or the 20 dB bandwidth of the hopping channel, whichever is greater. Alternatively, frequency hopping systems operating in the 2400-2483.5 MHz band may have hopping channel carrier frequencies that are separated by 25 kHz or two-thirds of the 20 dB bandwidth of the hopping channel, whichever is greater, provided the systems operate with an output power no greater than 125 mW. The system shall hop to channel frequencies that are selected at the system hopping rate from a pseudorandomly ordered list of hopping frequencies. Each frequency must be used equally on the average by each transmitter. The system receivers shall have input bandwidths that match the hopping channel bandwidths of their corresponding transmitters and shall shift frequencies in synchronization with the transmitted signals.

**(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.

**(b)** The maximum peak conducted output power of the intentional radiator shall not exceed the following:

**(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.

**(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 Section 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(c)).

**(g)** Frequency hopping spread spectrum systems are not required to employ all available hopping channels during each transmission. However, the system, consisting of both the transmitter and the receiver, must be designed to comply with all of the regulations in this section should the transmitter be presented with a continuous data (or information) stream. In addition, a system employing short transmission bursts must comply with the definition of a frequency hopping system and must distribute its transmissions over the minimum number of hopping channels specified in this section.

**(h)** The incorporation of intelligence within a frequency hopping spread spectrum system that permits the system to recognize other users within the spectrum band so that it individually and independently chooses and adapts its hopsets to avoid hopping on occupied channels is permitted. The coordination of frequency hopping systems in any other manner for the express purpose of avoiding the simultaneous occupancy of individual hopping frequencies by multiple transmitters is not permitted.

4.2 TEST PROCEDURES:

TEST STANDARD: FCC CFR47, Part 15, Subpart C 15.247

DEVICE DESCRIPTIONS: Refer to the Equipment Under Test Section, above, for EUT Descriptions.

TEST SETUP:

| | |
|---|---|
| Frequency Range Measured | 30MHz – 10000MHz |
| Test Distance | 1m and 3m |
| Test Instrumentation Resolution | 120kHz (30MHz to 1000MHz)<br>1MHz (1000MHz to 10000MHz) |
| Receive Antenna Scan Height | 1m – 4m |
| Receive Antenna Polarization | Vertical and Horizontal |

CABLING DETAILS:

| Cable | Pins | Connector | Load/Termination | Shielded | Ferrites |
|---|---|---|---|---|---|
| Power | 3 | Terminal | No | No | No |

4.3 RESULTS: In all 3 configurations a minimum of at least 50 frequencies are used. A pseudorandom sequence is used at the transmitter and in order to receive the packet successfully the receiver must hop in synchronization with the transmitter. All frequencies are used equally.

MODIFICATIONS No modifications were required for the devices to pass the test.

MEASUREMENT DATA: See Figures 3-44 in Appendix A.

PERFORMANCE: Complies.

# Part 5: Output Power and EIRP Emissions

DATE: April 08, 2013

TEST STANDARD: FCC 15.247(b)(2) – Hopping Frequency Systems 902-928MHz

MINIMUM STANDARD: **15.247(b)(2)** – For the band 902-928MHz, the transmitter output power shall not exceed 1.0 watt and the E.I.R.P shall not exceed 4W for systems employing at least 50 Hopping Channels.

TEST SETUP: Refer to setup in Part 1 above.

METHOD OF MEASUREMENT: The Antenna is connected directly to the PCB using a coaxial pigtail; the conducted output power was measured at this point. A 30dB attenuator was used to protect the instumentattion. See Figures 13 - 15.

EIRP was measured at the 3m distance and the measurement was adjusted to account for cable loss and Antenna factor.

MEASUREMENT DATA:

**EIRP measurements**

| Freq(MHz) | Corrected Field at 3m (dBµV/m) | 3m EIRP (dBm) |
|---|---|---|
| 902.17 | 124.02 | 28.79 |
| 915 | 123.78 | 28.55 |
| 927.83 | 123.33 | 28.10 |

**Conducted Output Power measurements**

| Freq(MHz) | Meas. Output Power (dBm) | Correction Factor* (dB) | Output Power (dBm) |
|---|---|---|---|
| 902.17 | -2.78 | 30.3 | 27.52 |
| 915 | -3.04 | 30.1 | 27.06 |
| 927.83 | -2.86 | 30.1 | 27.44 |

* Correction Factor accounts for a nominal 30dB attenuator and 0.5dB cable loss.

PERFORMANCE: Complies.

# Part 6: Restricted Bands Review – 15.205(b)

6.1 APPLICABLE REGULATIONS:

**(b)** Except as provided in paragraphs (d) and (e), 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.

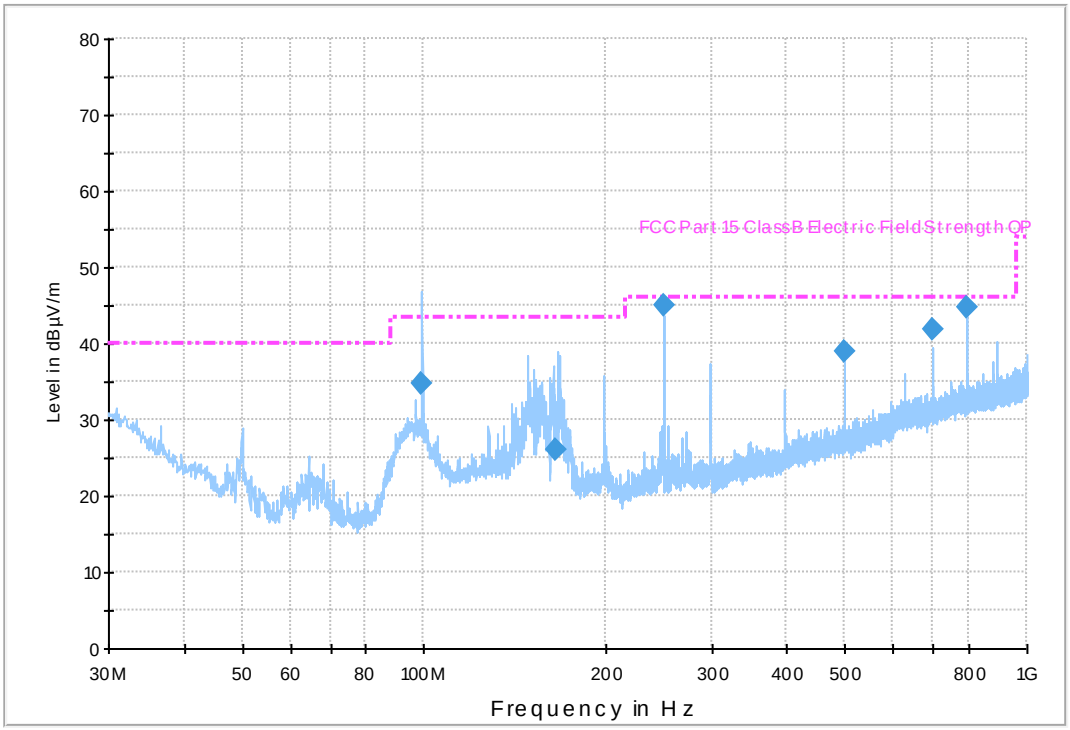
6.2 RESULTS

All of the measurements for the Part 15 device were made when the EUT was set into transmitting mode to allow measurements of spurious emissions. The spurious frequencies that have been identified to fall into restricted bands are the various harmonics generated from 902 to 928 MHz. The restricted bands affected are 2655-2900MHz, 3600-4400MHz, 4500-5150MHz, 5350- 5460MHz, 7250-7750MHz, 8025-8500MHz and 9000-9200MHz.

EMISSIONS DATA: See Tables 6 -8 in Appendix A for corresponding data.

# Appendix A: Test Plots VC-910

## Unintentional Radiated Emissions, Idle Mode



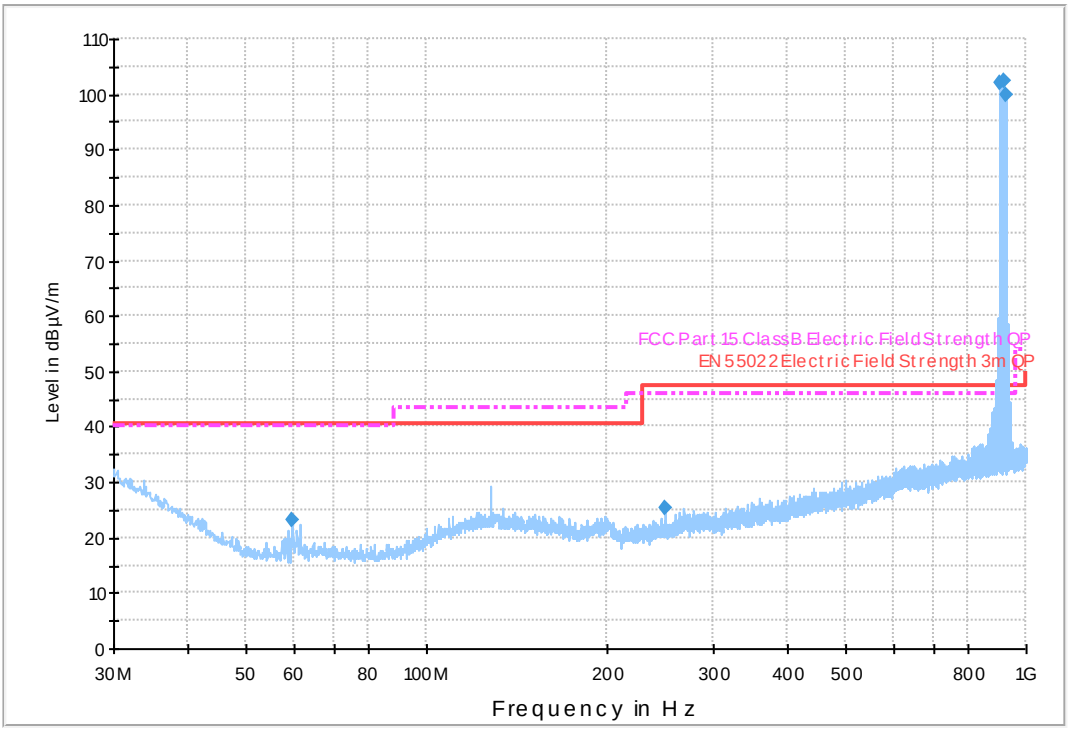

This plot is for refenence only. This plot was taken using the peak detector function, some of the emissions seems closer or over the limit line. But Final qausi peak readings meets the standard requirement as shown in the Table 1 below.

**Table 1: FCC Class B Emissions, Idle Mode - 3m***

| Frequency | QuasiPeak | Meas. Time | Bandwidth | Antenna height | Polarity | Turntable position | Margin | Limit |
|---|---|---|---|---|---|---|---|---|
| (MHz) | (dBµV/m) | (ms) | (kHz) | (cm) | | (deg) | (dB) | (dBµV/m) |
| 99.3852 | 37.8 | 1000 | 120 | 100 | V | 134 | 2.2 | 40 |
| 165.15288 | 26.2 | 1000 | 120 | 211 | H | 238 | 14.3 | 40 |
| 249.9984 | 45.1 | 1000 | 120 | 100 | V | 38 | 2.4 | 46 |
| 496.61972 | 38.9 | 1000 | 120 | 100 | V | 3 | 8.6 | 46 |
| 695.27596 | 41.8 | 1000 | 120 | 125 | H | 301 | 5.7 | 46 |
| 794.65004 | 44.7 | 1000 | 120 | 100 | H | 317 | 2.8 | 46 |

* Unintentional emissions were measured from 0.009Mhz -1000MHz. In accordance with 15.31(o) emissions that are 20dB below the permissible value have not been reported.

## Intentional Radiated Emissions, Tx Mode




Note: A 20dB attenuator was placed in the circuit to prevent the receiver from compressing due to the fundamental power and therefore the noise floor is very high. The plot is misleading when compared to the unintentional emmisisons in idle mode, but it is included for a relative comparison to the unintentional emmissions plot in idle mode. The results shown in Table 2 have all the appropriate correction applied. Frequency signals above the limit lines are fundamental frequencies between 902-928MHz

**Table 2: FCC Class B Emissions, Tx Mode - 3m**

| Frequency | QuasiPeak | Meas. Time | Bandwidth | Antenna height | Polarity | Turntable position | Margin | Limit |
|---|---|---|---|---|---|---|---|---|
| (MHz) | (dBµV/m) | (ms) | (kHz) | (cm) | | (deg) | (dB) | (dBµV/m) |
| 59.7 | 24.1 | 1000 | 120 | 100 | V | 327 | 15.9 | 40 |
| 99.3852 | 37.8 | 1000 | 120 | 100 | V | 137 | 2.2 | 40 |
| 165.15288 | 27 | 1000 | 120 | 150 | H | 230 | 16.5 | 43.5 |
| 249.9984 | 44.9 | 1000 | 120 | 100 | V | 37 | 1.1 | 46 |
| 496.61972 | 39.2 | 1000 | 120 | 100 | V | 10 | 6.8 | 46 |
| 695.27596 | 43.5 | 1000 | 120 | 139 | H | 333 | 2.5 | 46 |
| 794.65004 | 43.6 | 1000 | 120 | 100 | H | 327 | 2.4 | 46 |

## A.C. Mains Conducted Emissions

FCC/CE Class A - Emissions

**Table 3: AC Conducted Emissions, Line 1**

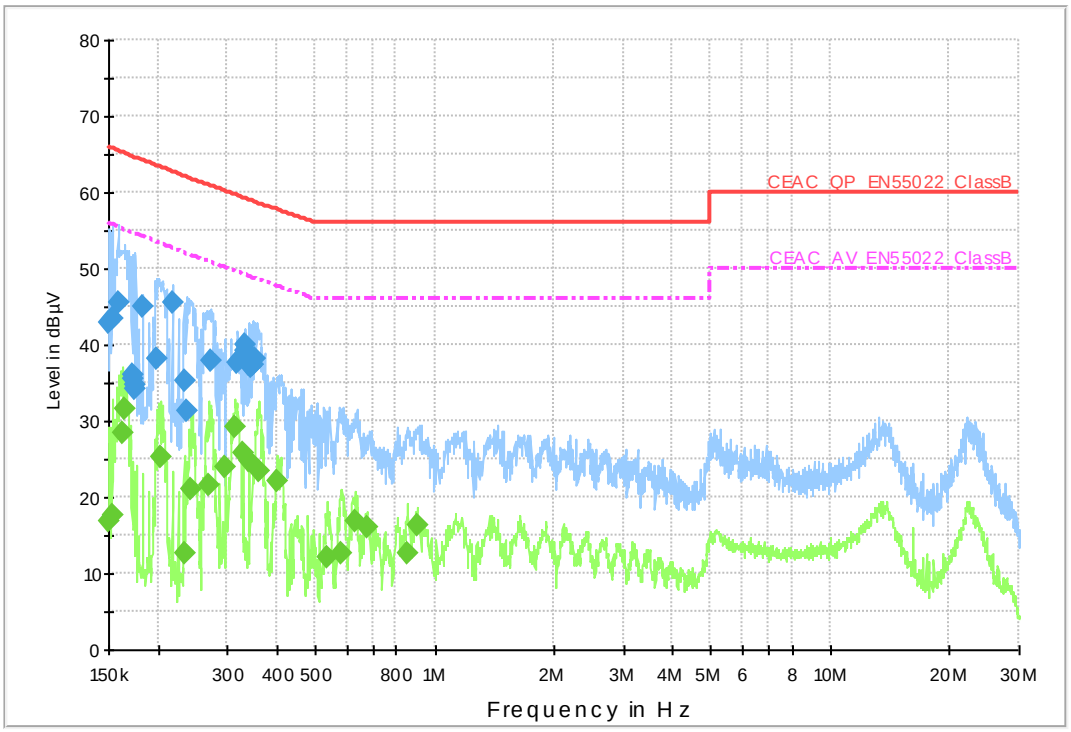
120VAC 60Hz

| Frequency (MHz) | Average (dBµV) | Meas. Time (ms) | Bandwidth (kHz) | Filter | Line | Corr. (dB) | Margin (dB) | Limit (dBµV) |
|---|---|---|---|---|---|---|---|---|
| 0.150300 | 16.9 | 1000.000 | 9.000 | On | L1 | 0.6 | 39.1 | 56.0 |
| 0.153027 | 17.6 | 1000.000 | 9.000 | On | L1 | 0.6 | 38.2 | 55.8 |
| 0.162156 | 28.4 | 1000.000 | 9.000 | On | L1 | 0.5 | 26.9 | 55.3 |
| 0.165428 | 31.7 | 1000.000 | 9.000 | On | L1 | 0.5 | 23.4 | 55.1 |
| 0.203635 | 25.3 | 1000.000 | 9.000 | On | L1 | 0.5 | 28.0 | 53.3 |
| 0.232804 | 12.7 | 1000.000 | 9.000 | On | L1 | 0.5 | 39.4 | 52.1 |
| 0.243265 | 21.2 | 1000.000 | 9.000 | On | L1 | 0.5 | 30.5 | 51.7 |
| 0.269360 | 21.6 | 1000.000 | 9.000 | On | L1 | 0.4 | 29.3 | 50.9 |
| 0.295881 | 24.0 | 1000.000 | 9.000 | On | L1 | 0.4 | 26.1 | 50.1 |
| 0.313531 | 29.1 | 1000.000 | 9.000 | On | L1 | 0.4 | 20.5 | 49.6 |
| 0.328275 | 25.9 | 1000.000 | 9.000 | On | L1 | 0.4 | 23.4 | 49.3 |
| 0.339617 | 24.9 | 1000.000 | 9.000 | On | L1 | 0.4 | 24.1 | 49.0 |
| 0.360596 | 23.5 | 1000.000 | 9.000 | On | L1 | 0.4 | 25.0 | 48.5 |
| 0.400076 | 22.1 | 1000.000 | 9.000 | On | L1 | 0.4 | 25.6 | 47.7 |
| 0.535587 | 12.1 | 1000.000 | 9.000 | On | L1 | 0.4 | 33.9 | 46.0 |
| 0.583636 | 12.6 | 1000.000 | 9.000 | On | L1 | 0.4 | 33.4 | 46.0 |
| 0.629673 | 16.9 | 1000.000 | 9.000 | On | L1 | 0.4 | 29.1 | 46.0 |
| 0.672590 | 16.1 | 1000.000 | 9.000 | On | L1 | 0.5 | 29.9 | 46.0 |
| 0.851415 | 12.7 | 1000.000 | 9.000 | On | L1 | 0.5 | 33.3 | 46.0 |
| 0.902205 | 16.2 | 1000.000 | 9.000 | On | L1 | 0.5 | 29.8 | 46.0 |

## Table 4: AC Conducted Emissions, Line 2

120VAC 60Hz

| Frequency (MHz) | Average (dBµV) | Meas. Time (ms) | Bandwidth (kHz) | Filter | Line | Corr. (dB) | Margin (dB) | Limit (dBµV) |
|---|---|---|---|---|---|---|---|---|
| 0.154564 | 31.5 | 1000.000 | 9.000 | On | L1 | 0.6 | 24.2 | 55.7 |
| 0.159584 | 30.2 | 1000.000 | 9.000 | On | L1 | 0.6 | 25.2 | 55.4 |
| 0.161509 | 27.3 | 1000.000 | 9.000 | On | L1 | 0.6 | 28.0 | 55.3 |
| 0.167758 | 30.9 | 1000.000 | 9.000 | On | L1 | 0.5 | 24.1 | 55.0 |
| 0.172862 | 28.2 | 1000.000 | 9.000 | On | L1 | 0.5 | 26.5 | 54.7 |
| 0.175647 | 27.4 | 1000.000 | 9.000 | On | L1 | 0.5 | 27.2 | 54.6 |
| 0.209412 | 13.4 | 1000.000 | 9.000 | On | L1 | 0.5 | 39.6 | 53.0 |
| 0.221461 | 22.1 | 1000.000 | 9.000 | On | L1 | 0.5 | 30.4 | 52.5 |
| 0.224132 | 21.4 | 1000.000 | 9.000 | On | L1 | 0.5 | 31.0 | 52.4 |
| 0.249168 | 23.6 | 1000.000 | 9.000 | On | L1 | 0.4 | 27.9 | 51.5 |
| 0.266151 | 20.2 | 1000.000 | 9.000 | On | L1 | 0.4 | 30.8 | 51.0 |
| 0.269360 | 18.2 | 1000.000 | 9.000 | On | L1 | 0.4 | 32.7 | 50.9 |
| 0.289449 | 25.9 | 1000.000 | 9.000 | On | L1 | 0.4 | 24.4 | 50.3 |
| 0.319220 | 25.6 | 1000.000 | 9.000 | On | L1 | 0.4 | 23.9 | 49.5 |
| 0.335570 | 21.2 | 1000.000 | 9.000 | On | L1 | 0.4 | 27.9 | 49.1 |
| 0.354170 | 20.9 | 1000.000 | 9.000 | On | L1 | 0.4 | 27.8 | 48.7 |
| 0.371567 | 21.9 | 1000.000 | 9.000 | On | L1 | 0.4 | 26.4 | 48.3 |
| 0.411425 | 19.7 | 1000.000 | 9.000 | On | L1 | 0.4 | 27.8 | 47.5 |
| 0.455559 | 13.2 | 1000.000 | 9.000 | On | L1 | 0.4 | 33.5 | 46.7 |
| 22.825007 | 20.5 | 1000.000 | 9.000 | On | L1 | 0.8 | 29.5 | 50.0 |



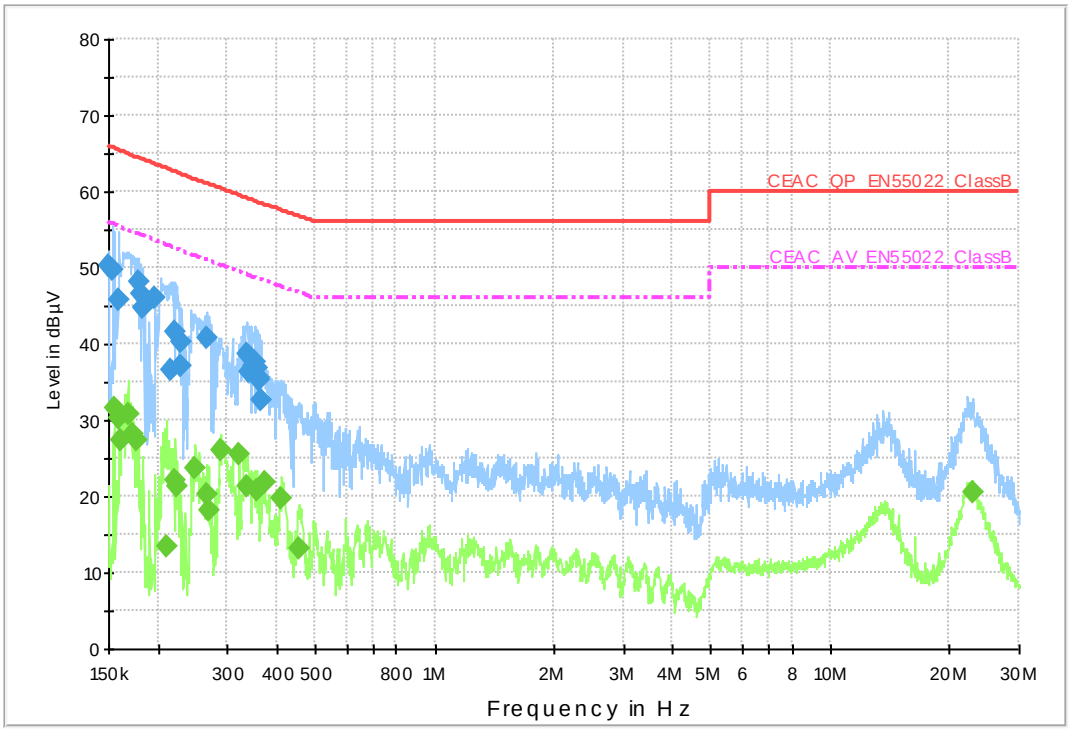
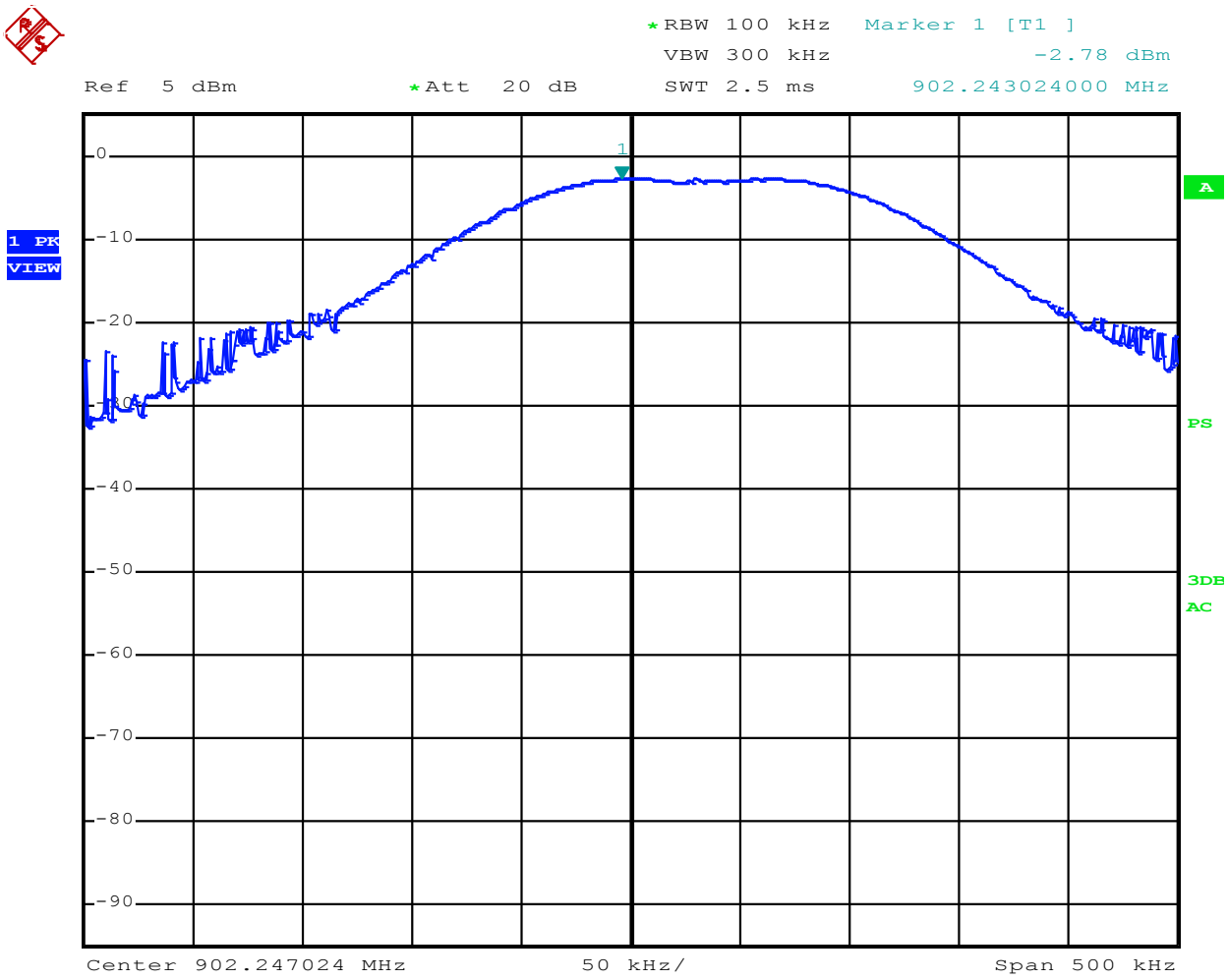




**Figure 1: 120V AC Conducted Emissions - Line 1 and Line 2**

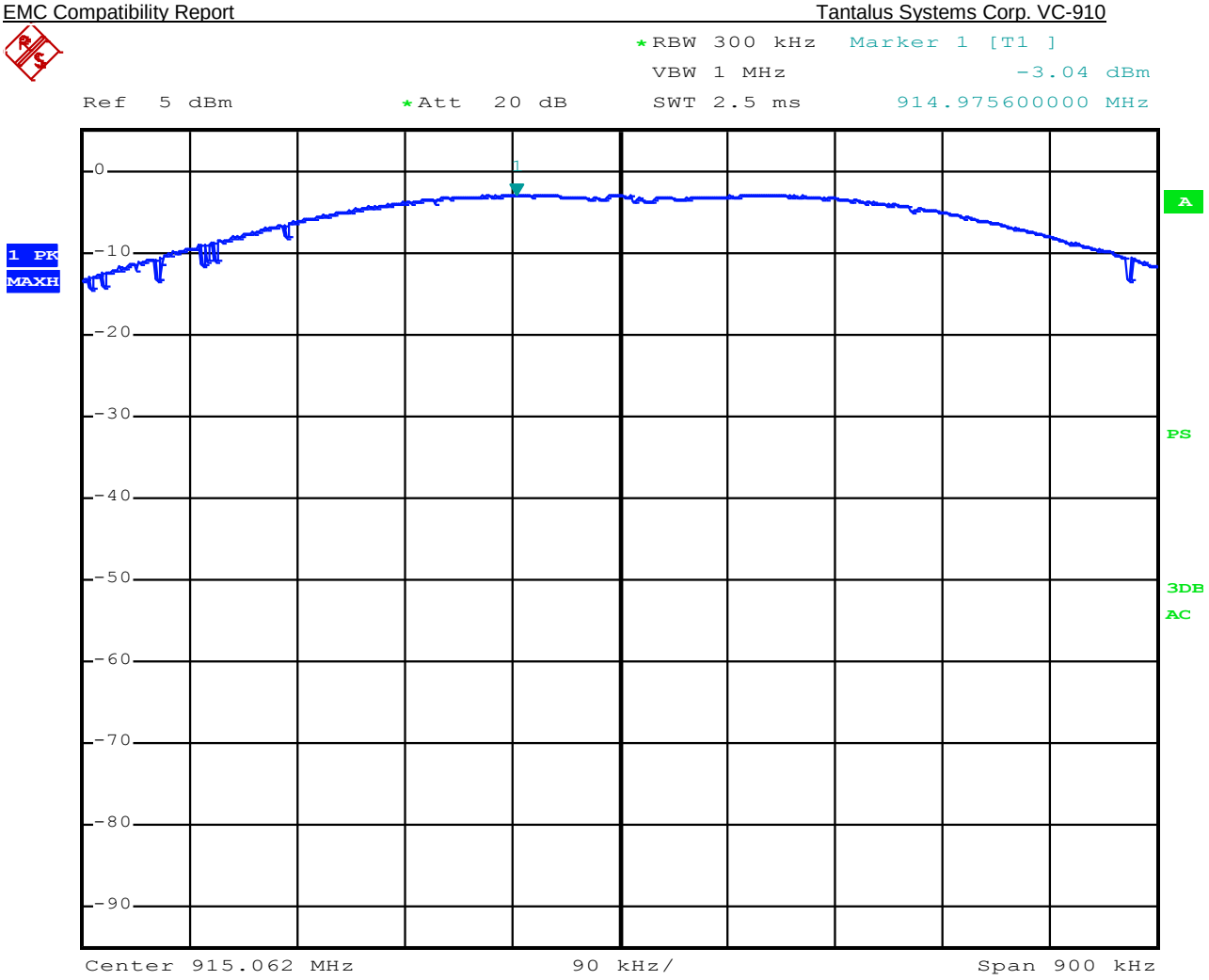
# FHSS Compliance Tests

## Output Power



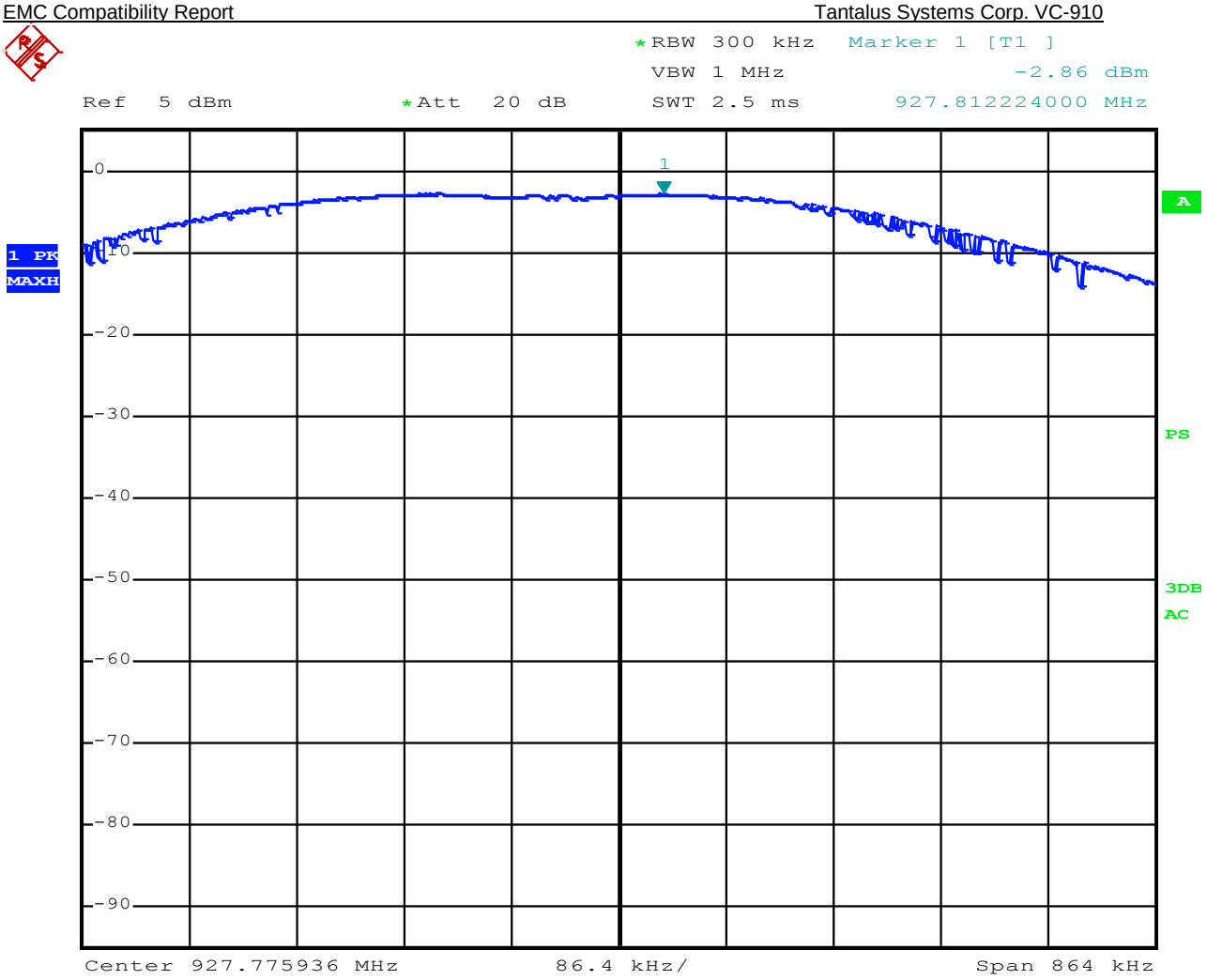

Date: 24.DEC.2013 09:39:31

**Figure 2: Output Power at LOW Frequency**




Date: 24.DEC.2013 11:09:55

**Figure 3: Output Power at MID Frequency**

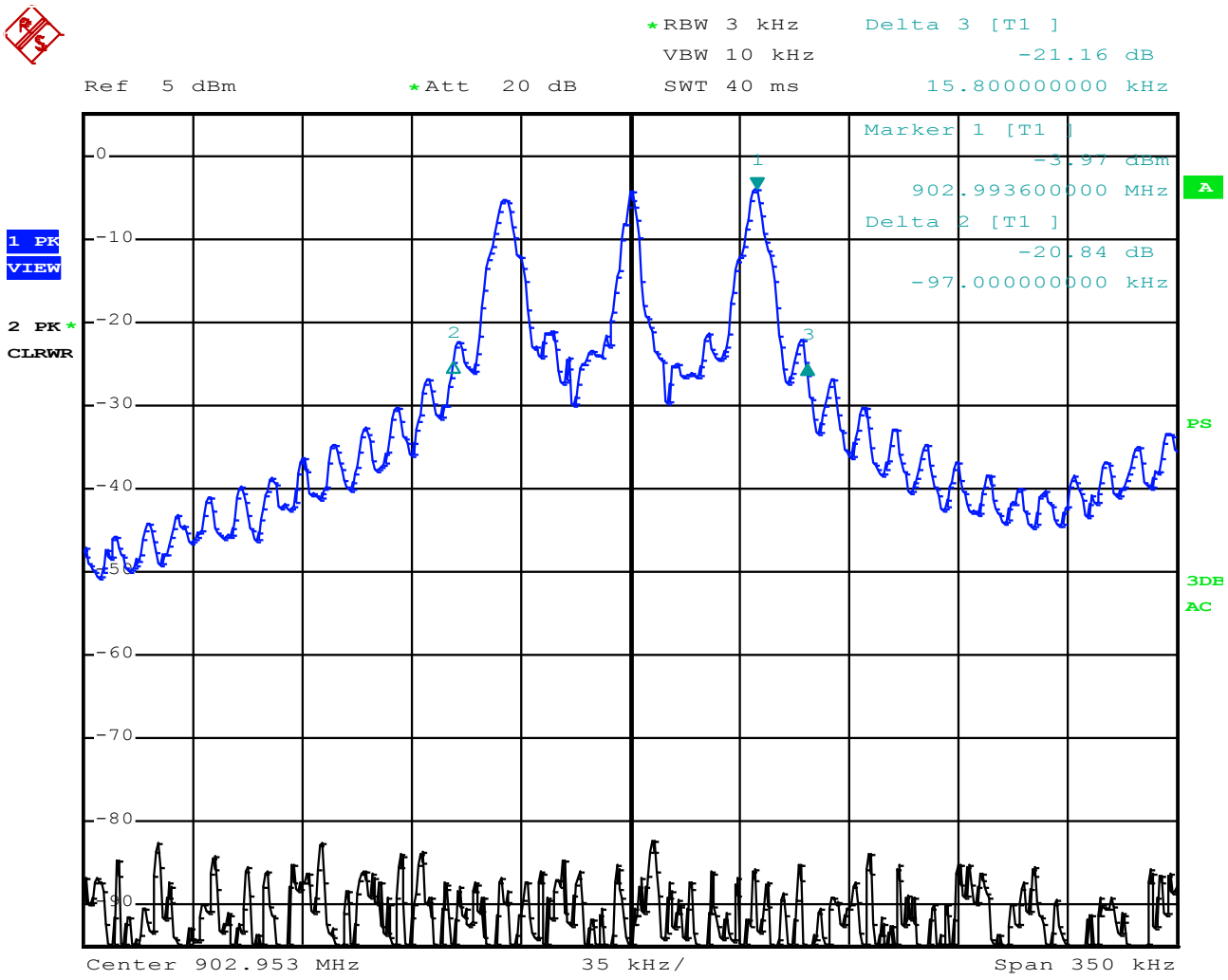



Date: 24.DEC.2013 11:20:32

**Figure 4: Output Power at HIGH Frequency**

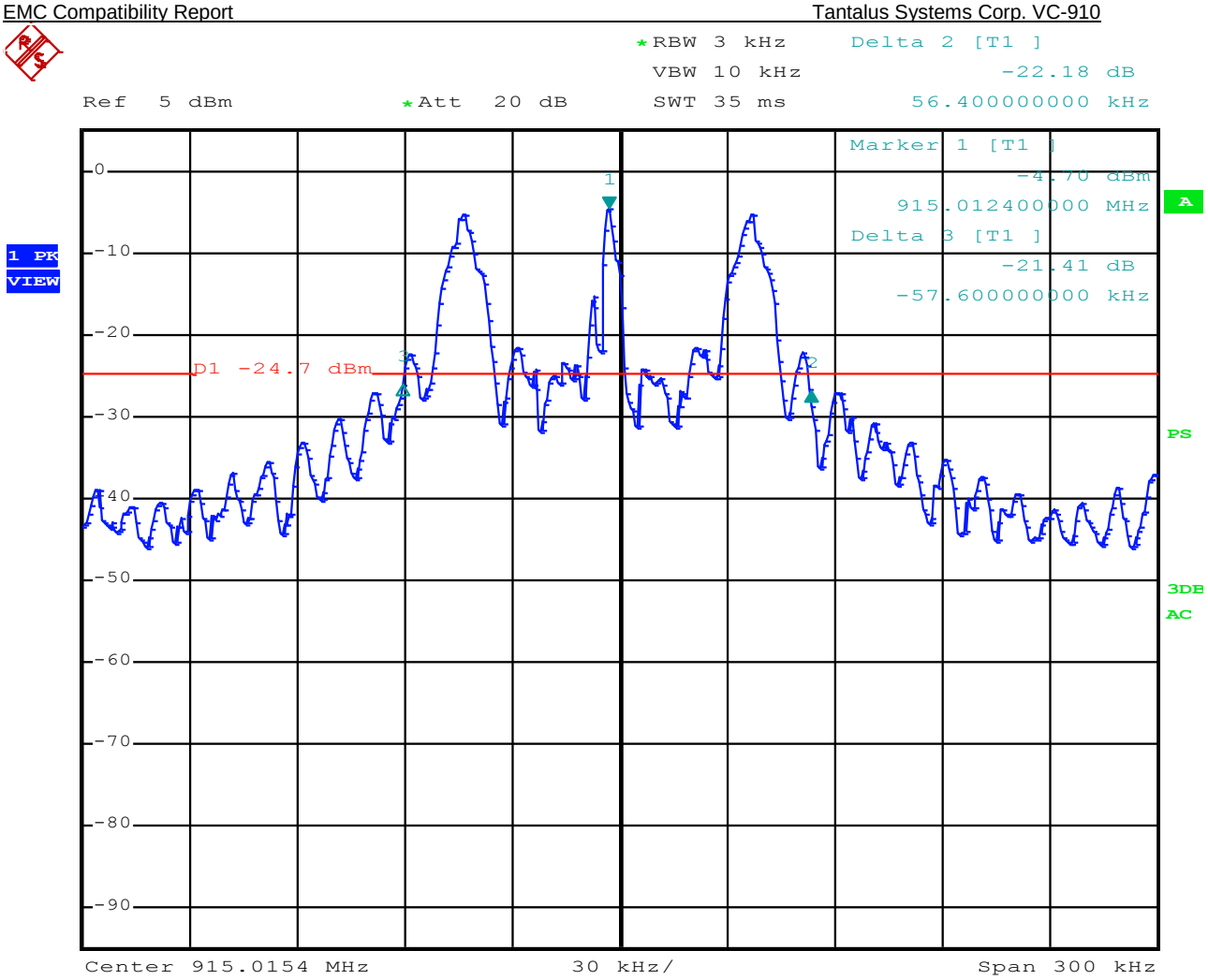
# Low Data Rate Tests

## 20 dB Bandwidth



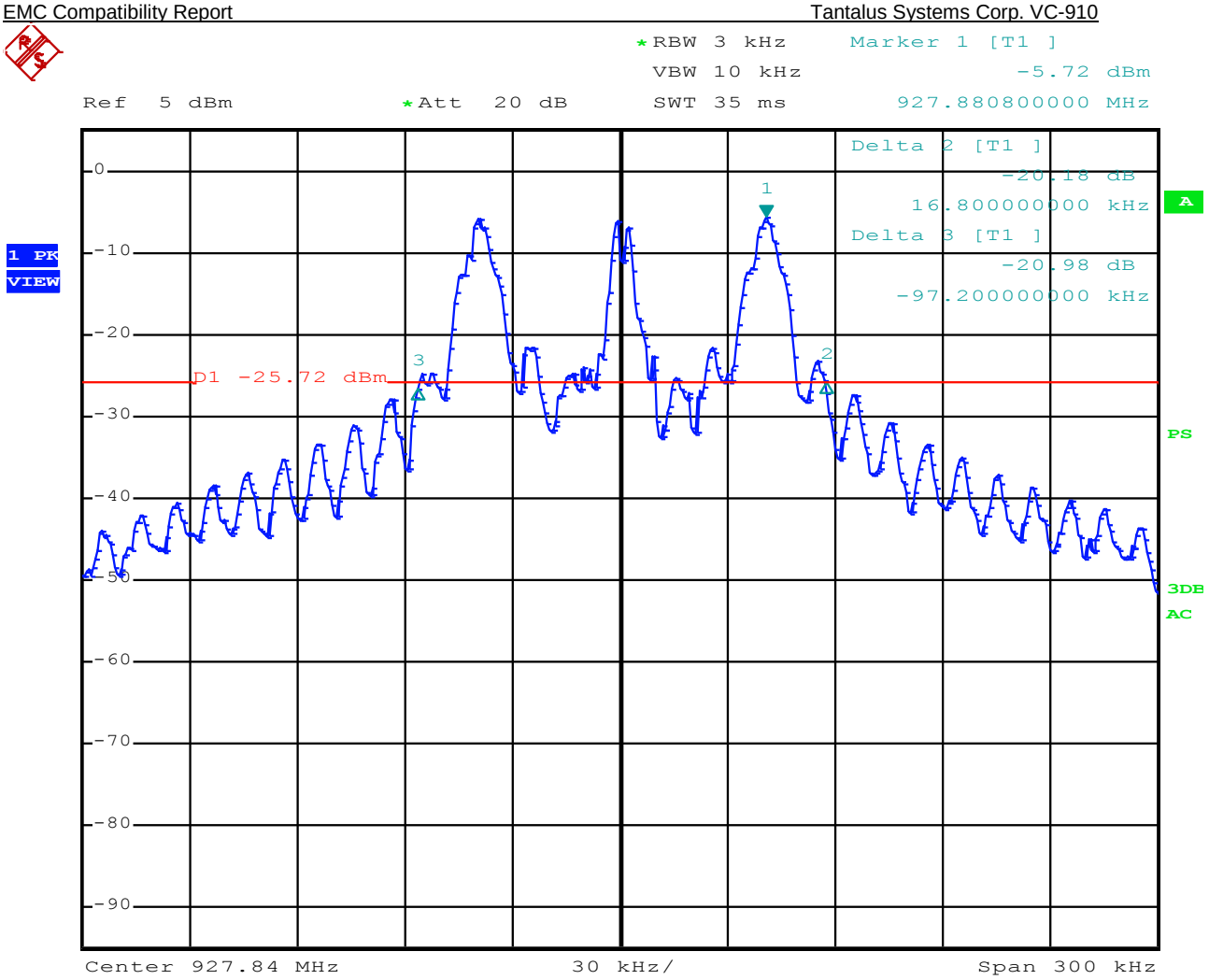

Date: 21.MAR.2014 09:40:42

**Figure 5: 20dB Bandwidth at LOW Frequency – 112.8 kHz**




Date: 21.MAR.2014 11:19:23

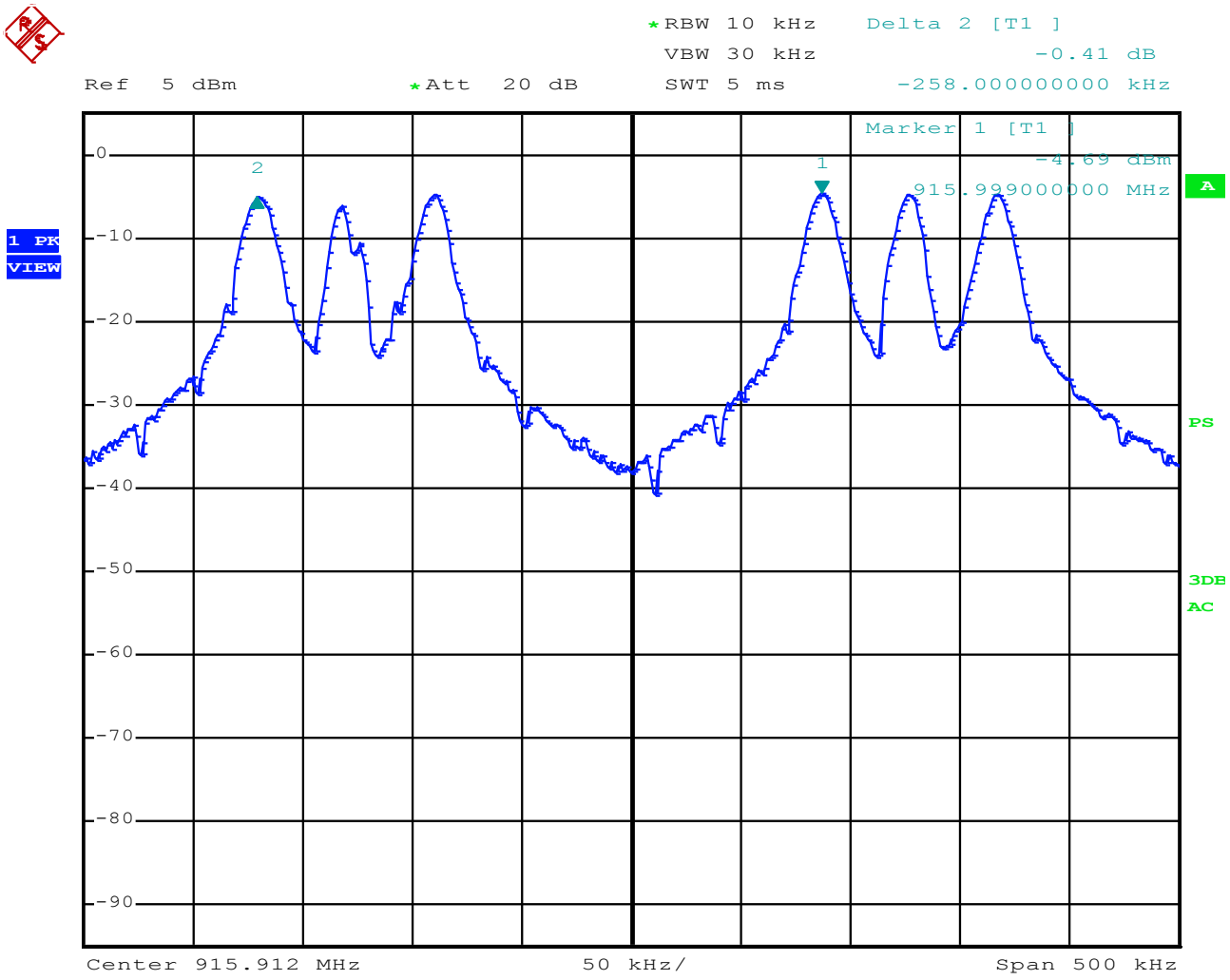
**Figure 6: 20dB Bandwidth at MID Frequency – 114.0 kHz**




Date: 21.MAR.2014 11:25:43

**Figure 7: 20dB Bandwidth at HIGH Frequency – 114.0 kHz**

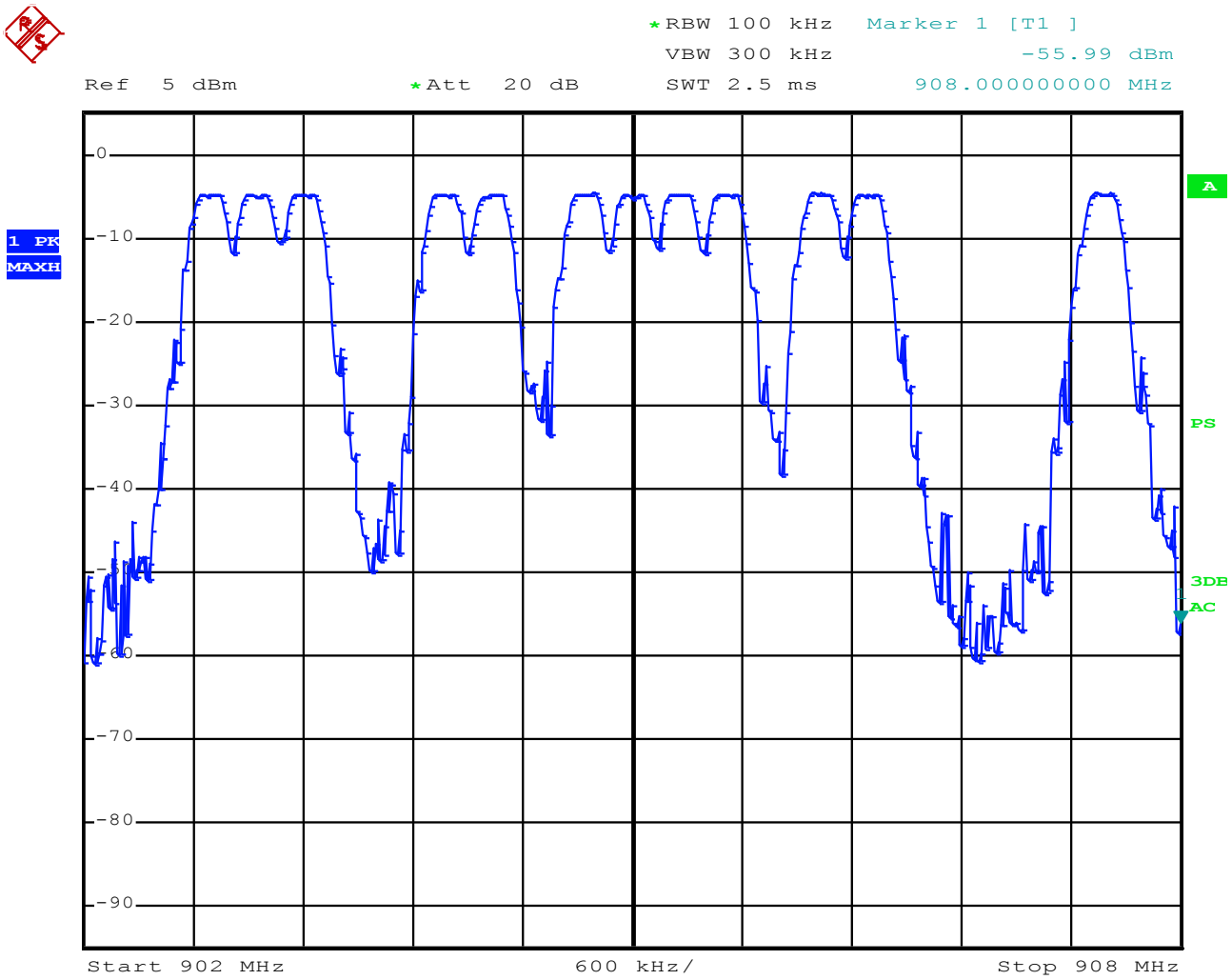
# Channel Separation




Date: 23.DEC.2013 11:42:23

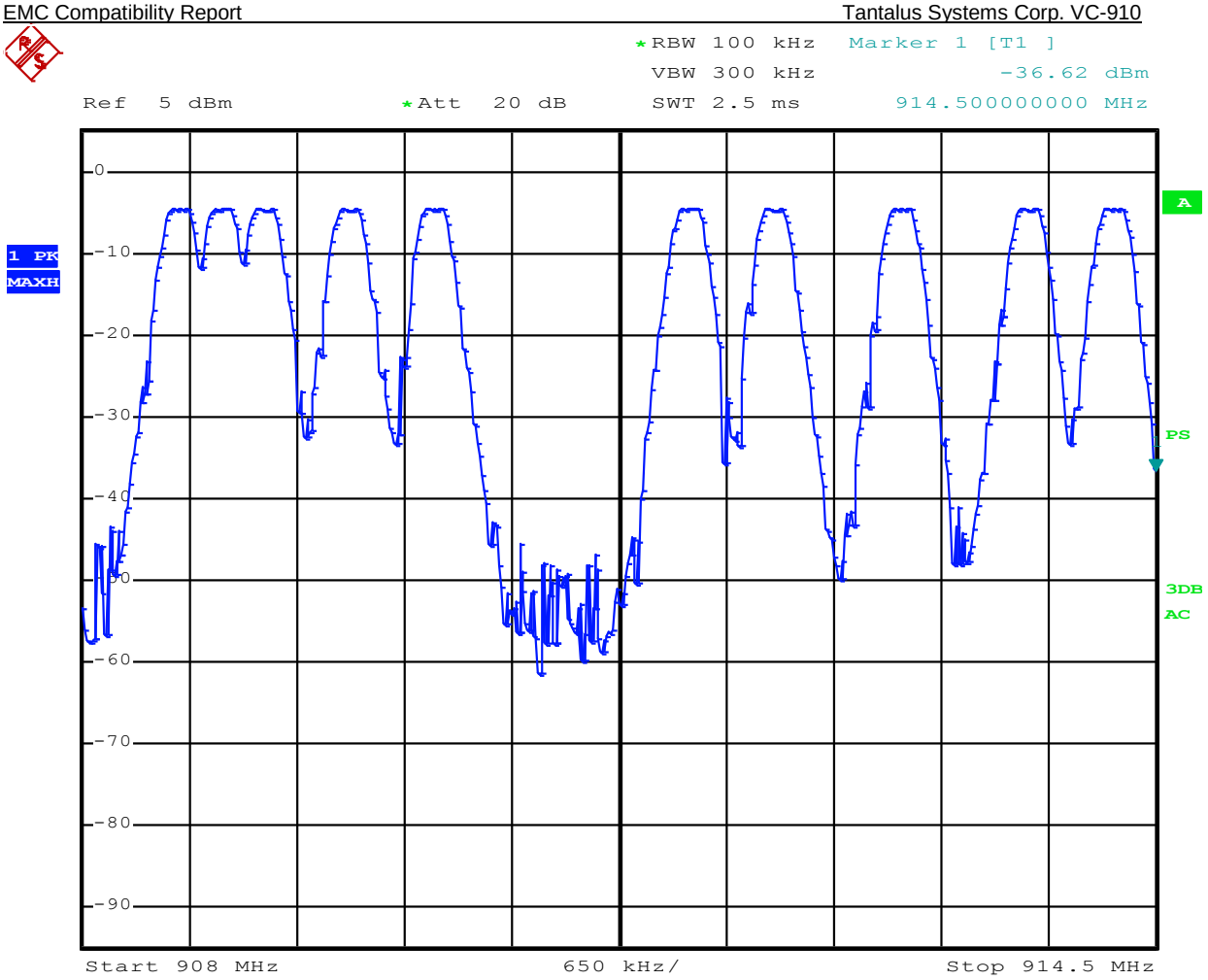
**Figure 8: Channel Separation = 258.0 kHz**

## Number of Hopping Channels



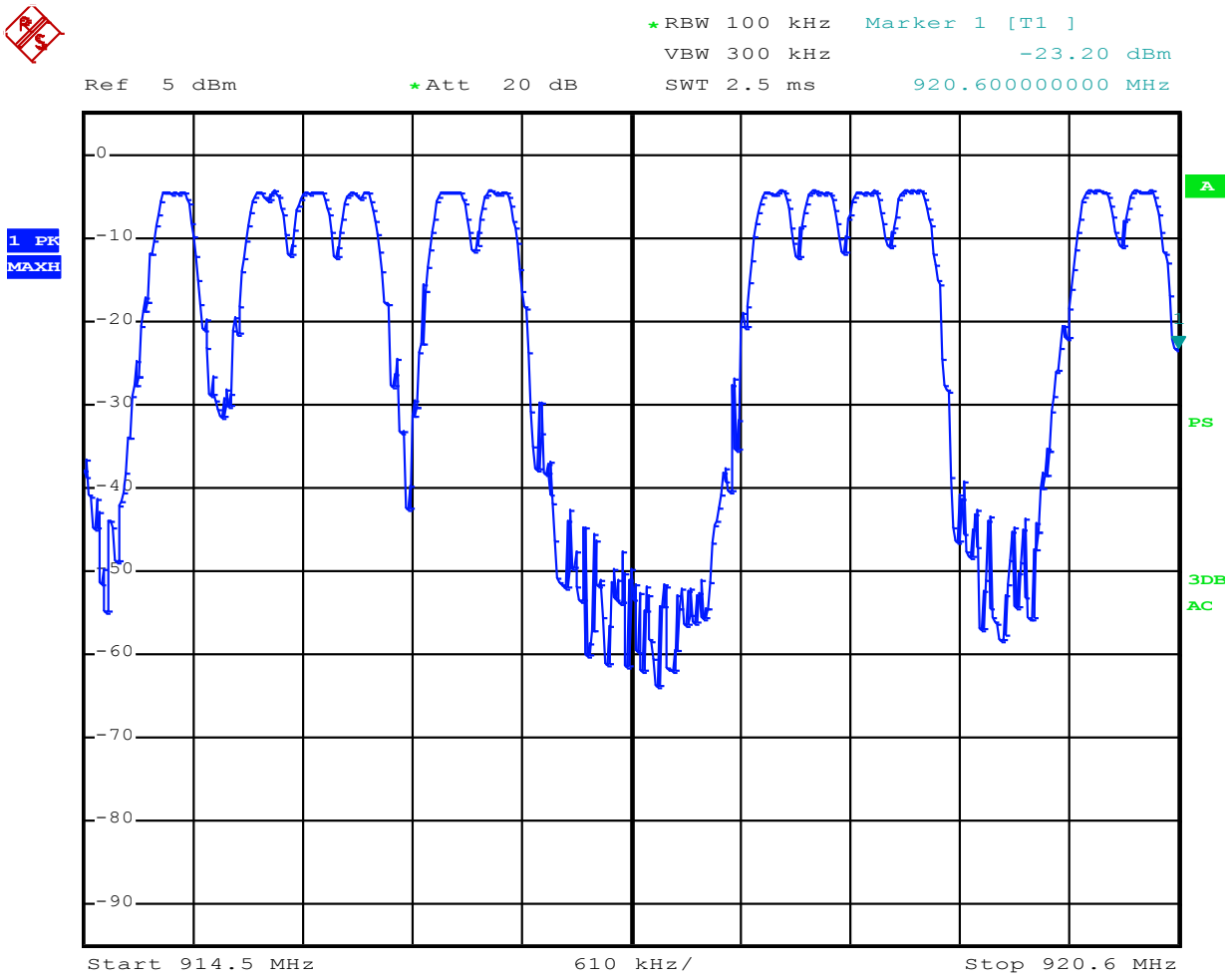

Date: 23.DEC.2013 11:20:01

**Figure 9: Number of Hopping Frequencies 902MHz to 908MHz - 12 Frequencies**



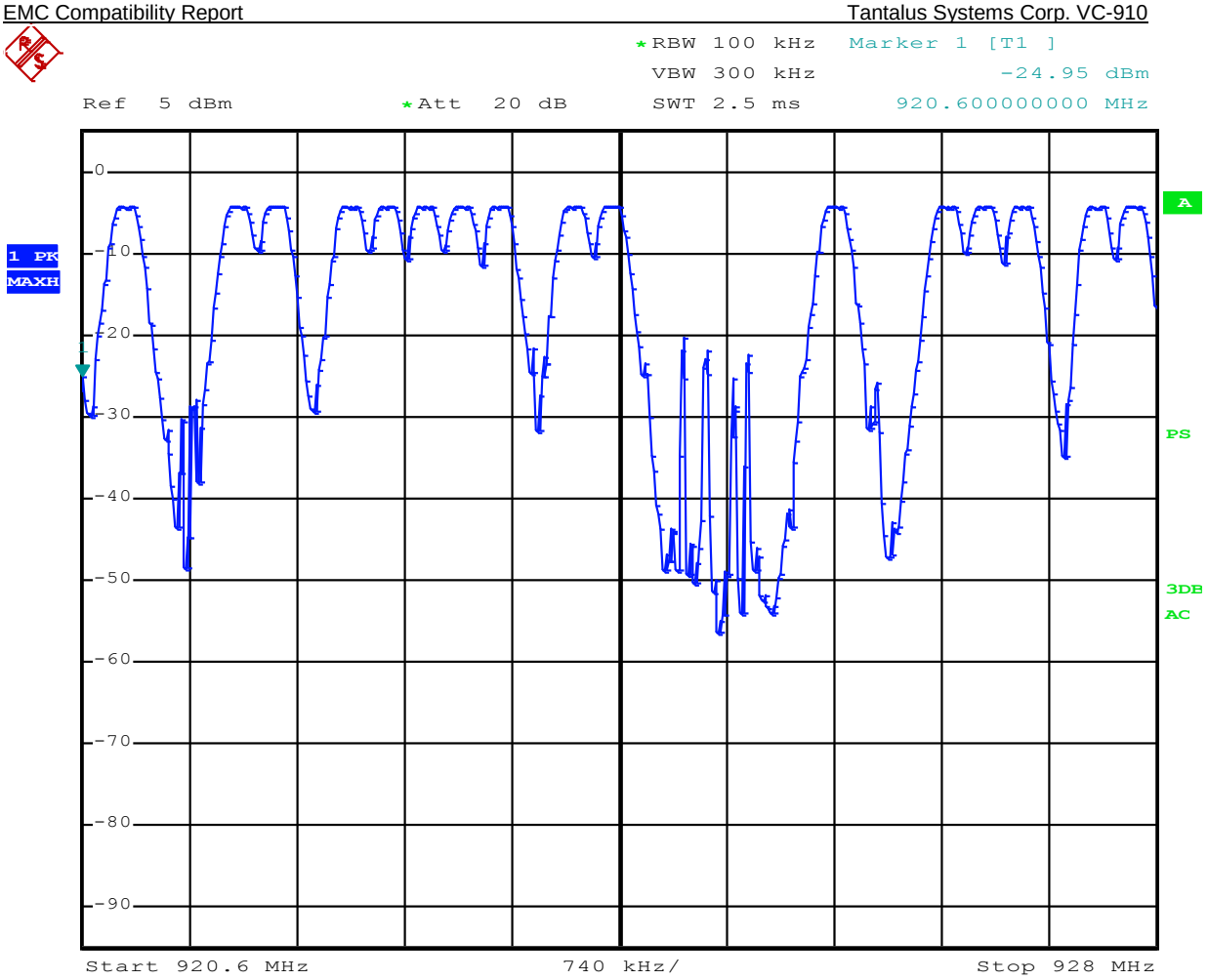

Date: 23.DEC.2013 11:06:54

**Figure 10: Number of Hopping Frequencies 908MHz to 914.5MHz - 10 Frequencies**




Date: 23.DEC.2013 11:09:22

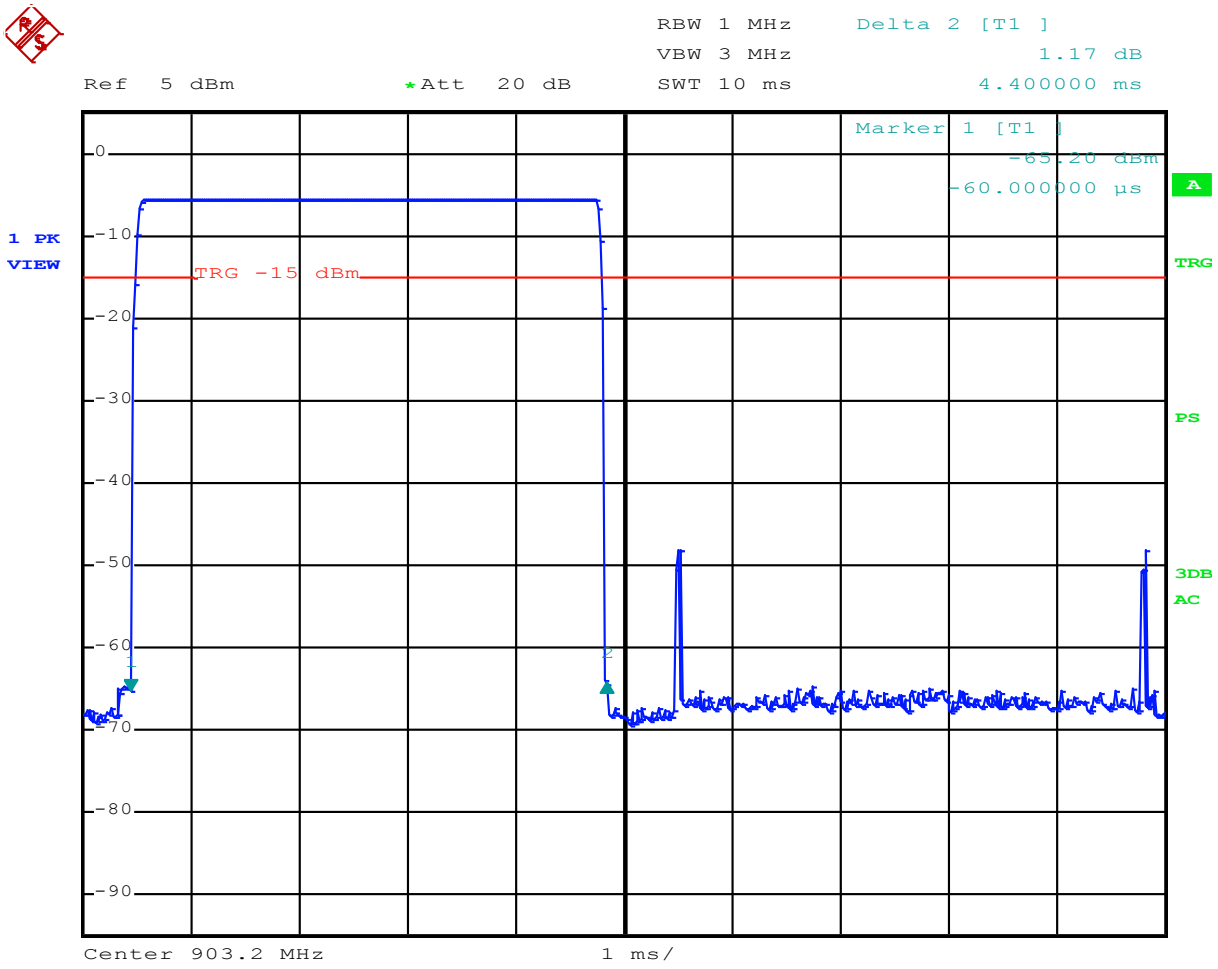
**Figure 11: Number of Hopping Frequencies 914.5MHz to 920.6MHz - 12 Frequencies**




Date: 23.DEC.2013 11:17:30

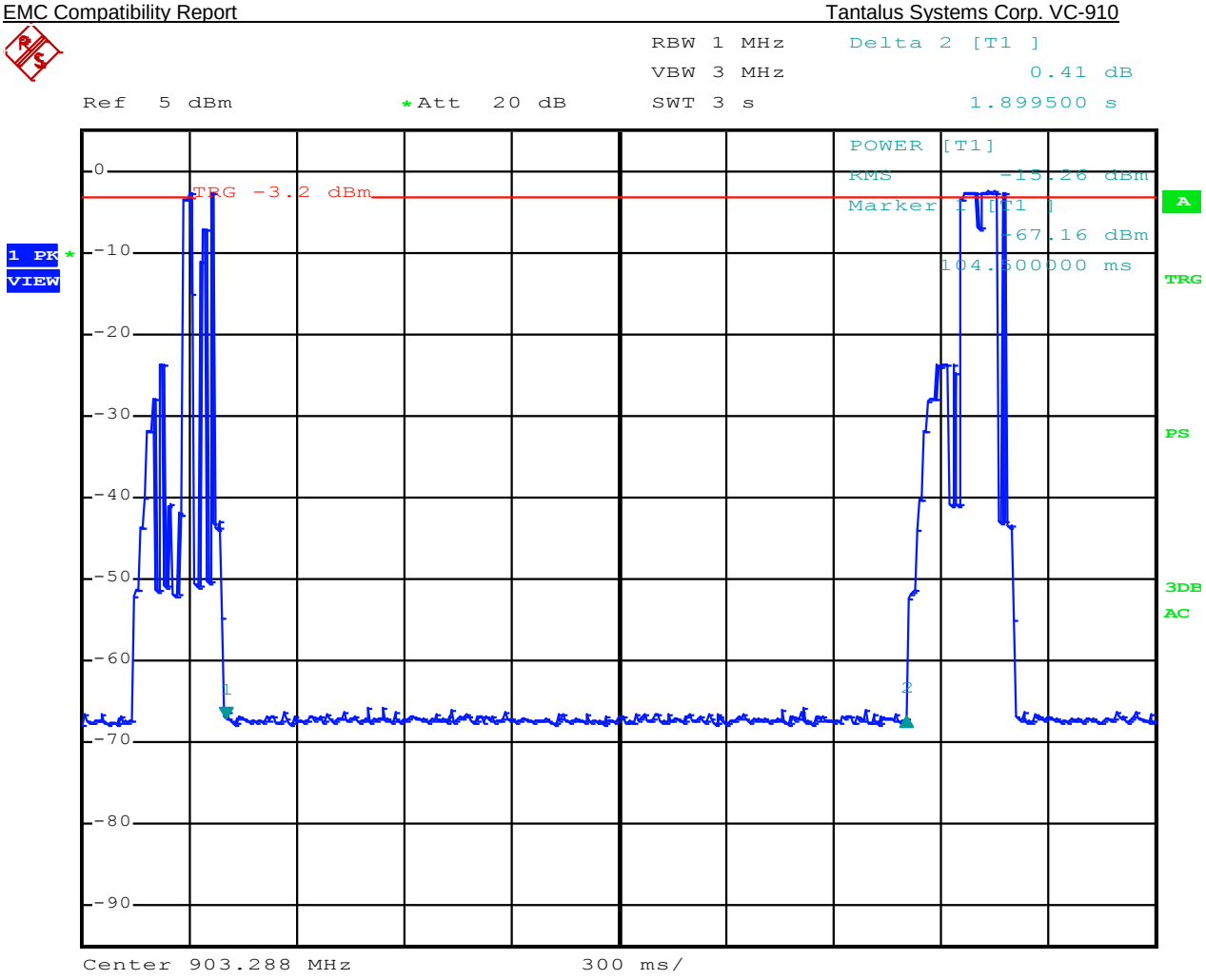
**Figure 12: Number of Hopping Frequencies 920.6MHz to 928MHz - 16 Frequencies**

# Dwell Time and Time of Occupancy




Date: 23.DEC.2013 13:49:53

**Figure 13: Dwell Time – 4.4mS**

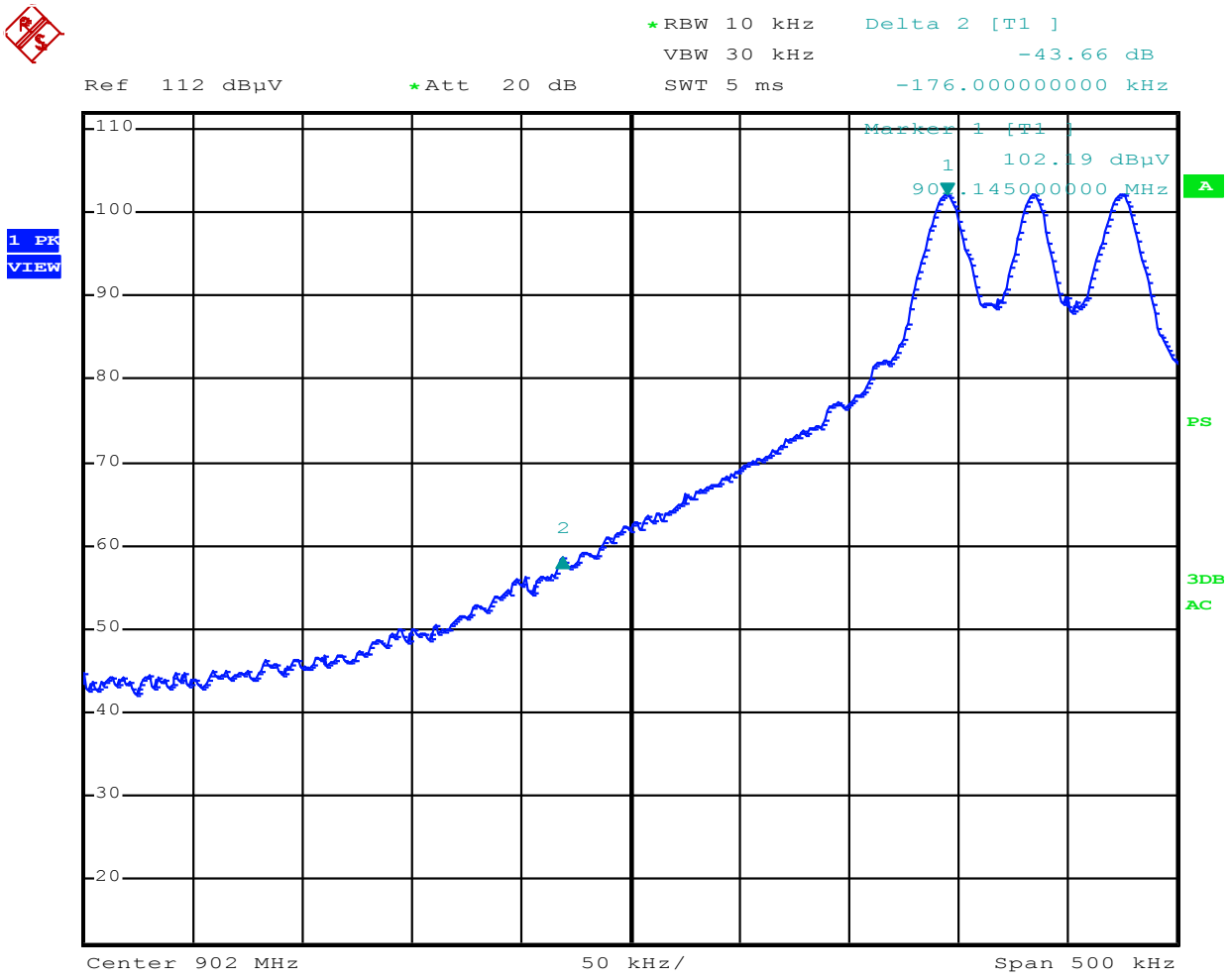



Date: 21.MAR.2014 09:17:52

**Figure 14: Time Occupancy Per Frequency – 46.32mS***

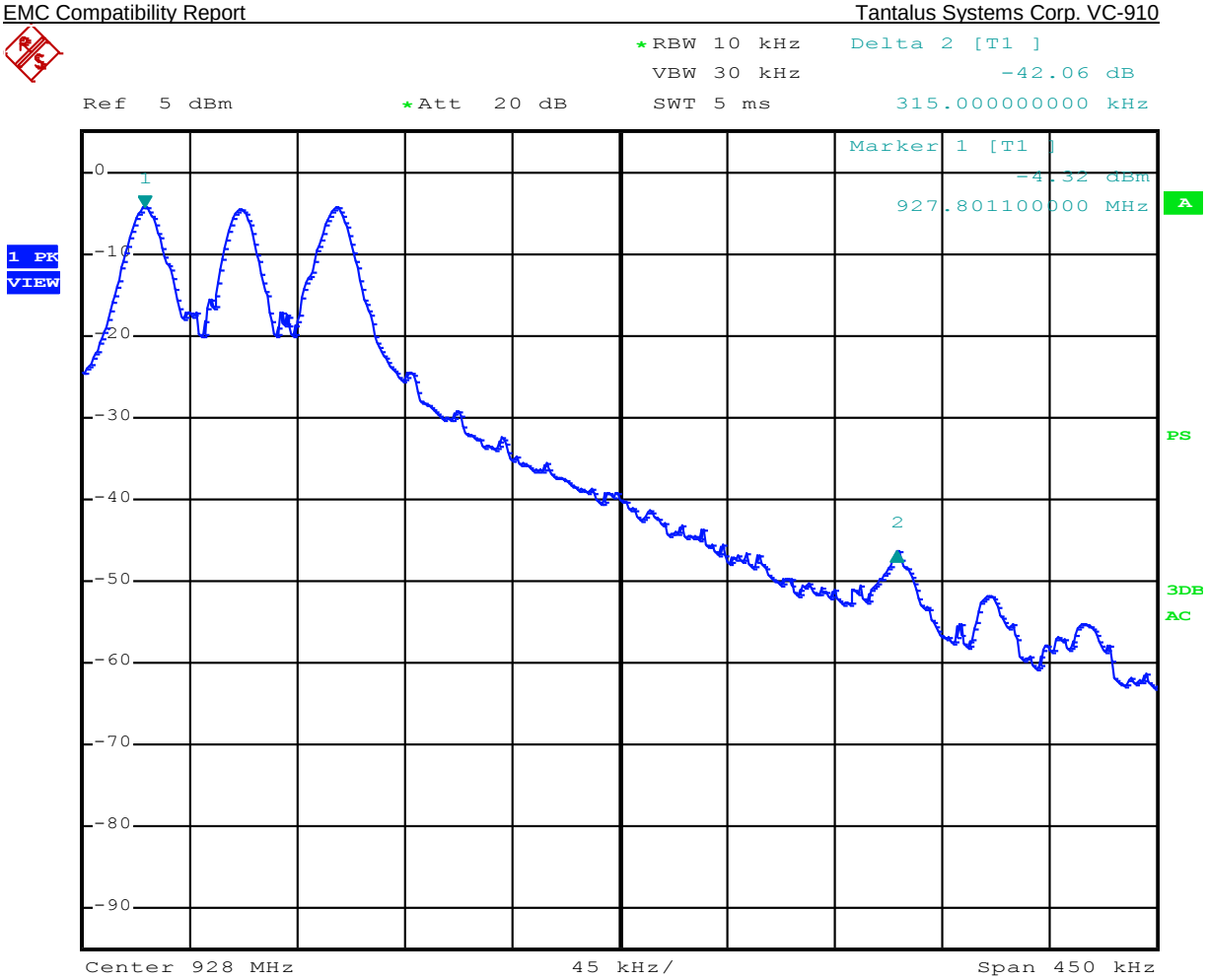
*(* Time betwen 2 consecutive transmissions on the same frequency is 1.9 Seconds, dwell time per frequency is 4.40mS, therefore occupancy time per frequency within a 20 Second period is 46.32mS)*

# Channel Bandedge




Date: 23.DEC.2013 09:46:24

**Figure 15: Low Channel Bandedge**

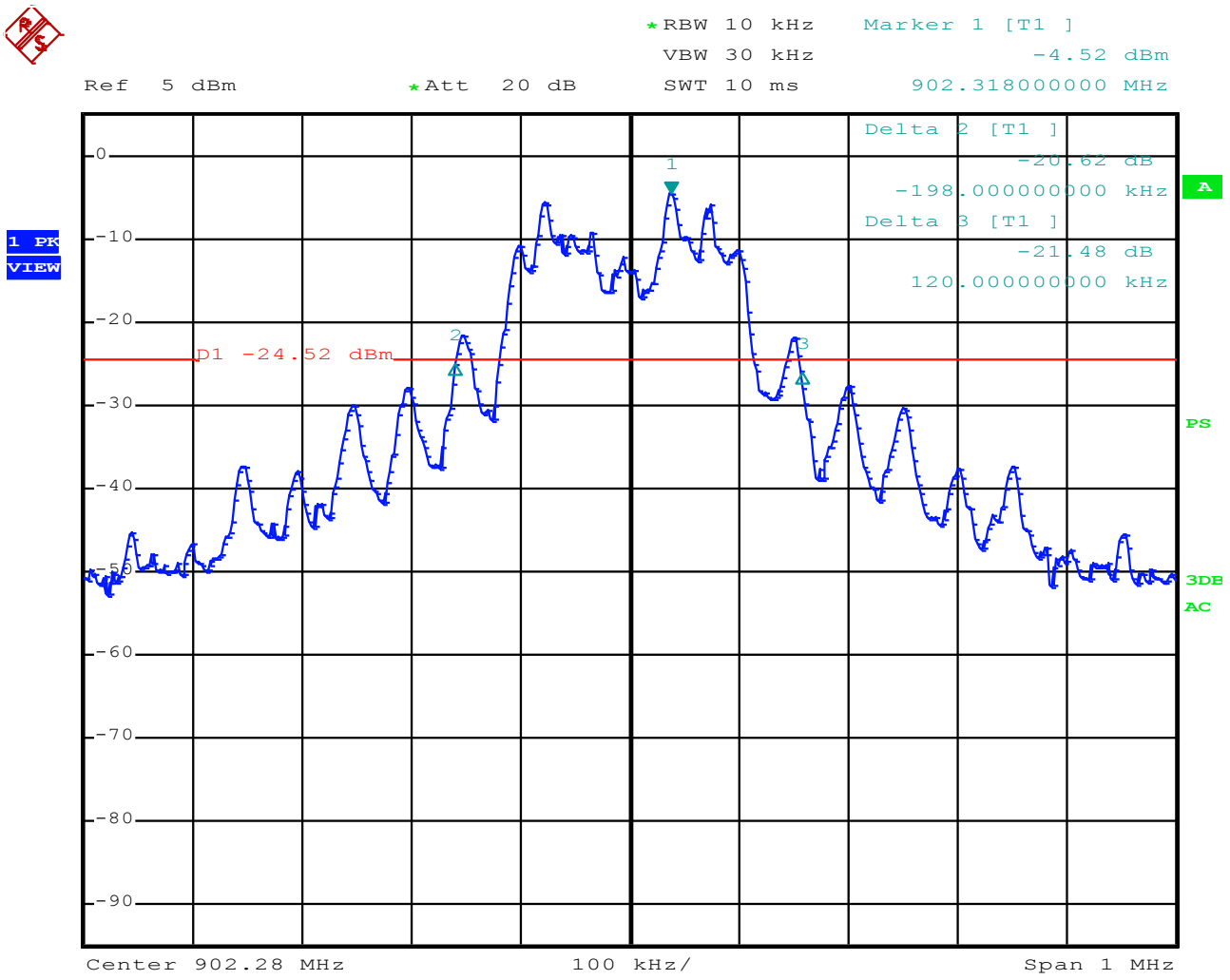



Date: 23.DEC.2013 10:24:44

**Figure 16: High Channel Bandedge**

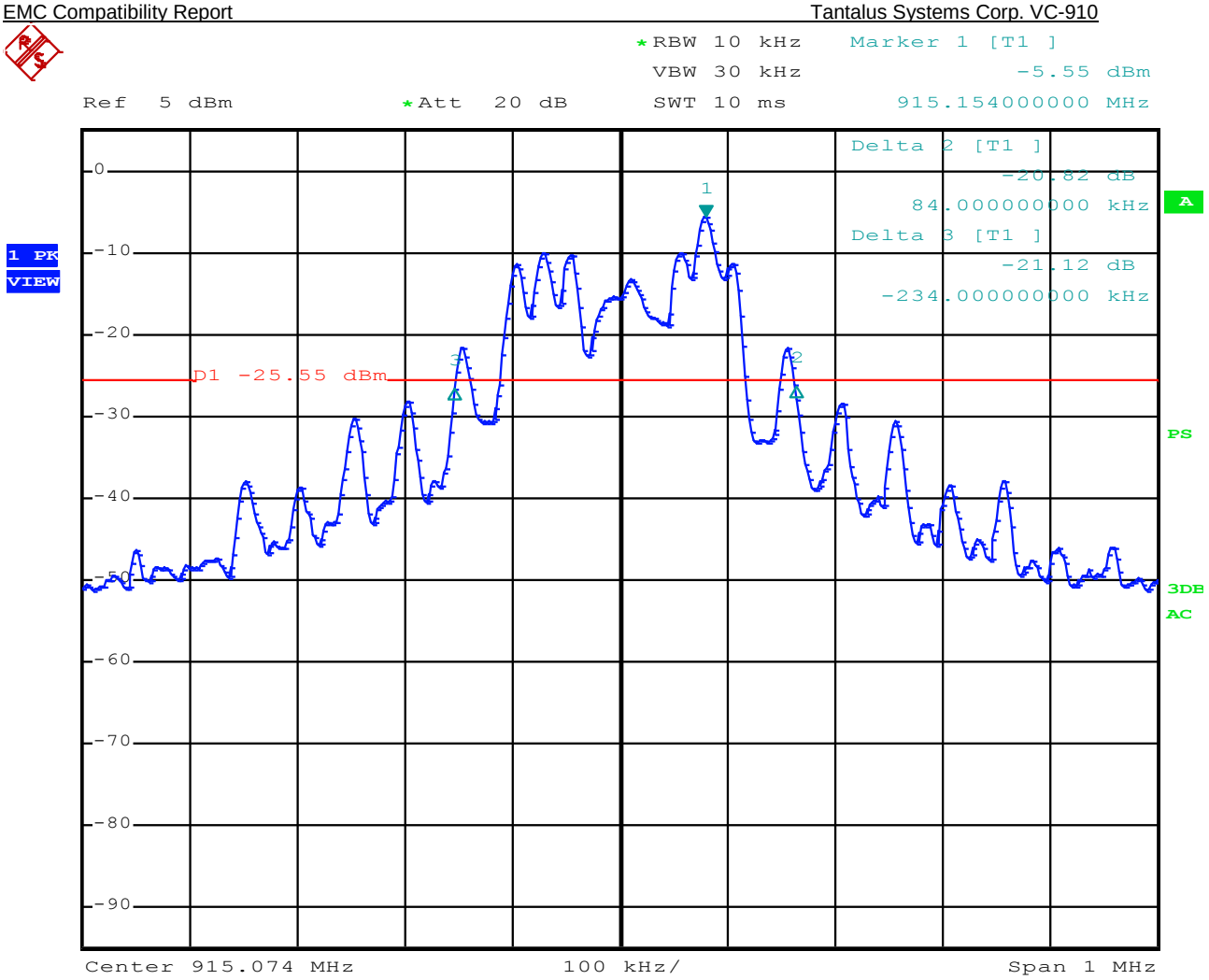
# High Data Rate Tests

## 20 dB Bandwidth



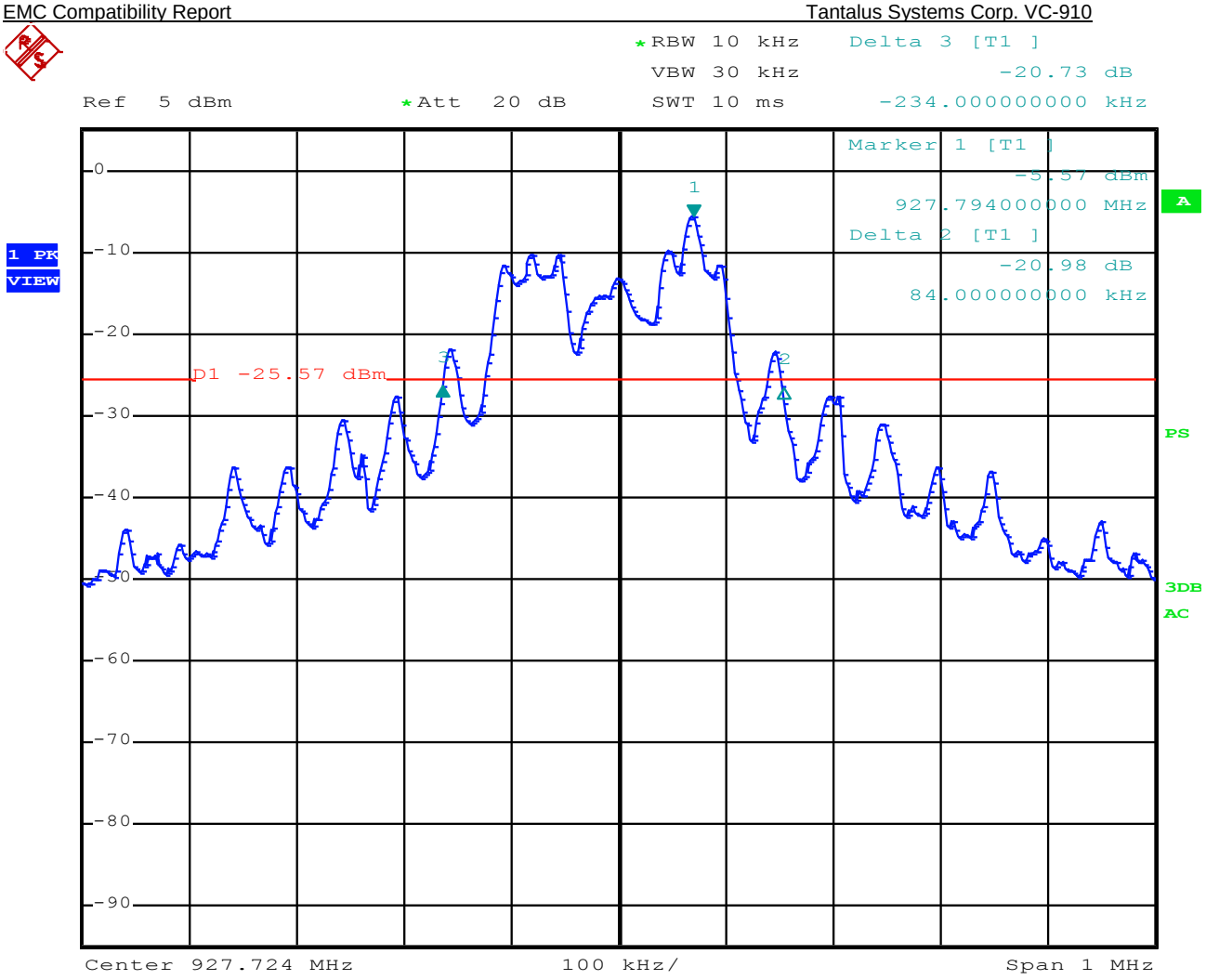

Date: 21.MAR.2014 11:56:31

**Figure 17: 20dB Bandwidth at LOW Frequency – 318 kHz**




Date: 21.MAR.2014 11:47:33

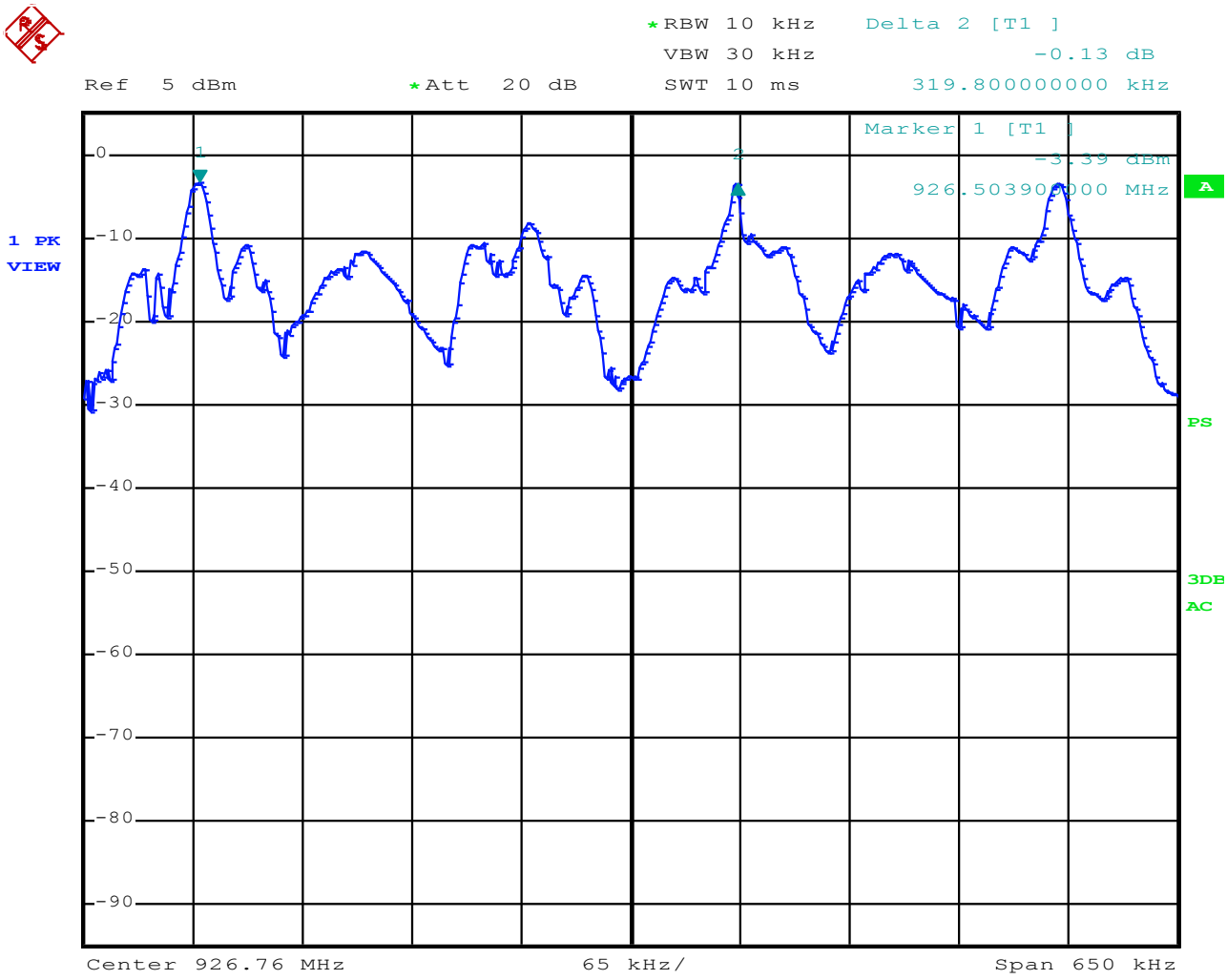
**Figure 18: 20dB Bandwidth at MID Frequency – 318 kHz**




Date: 21.MAR.2014 11:42:31

**Figure 19: 20dB Bandwidth at HIGH Frequency – 318 kHz**

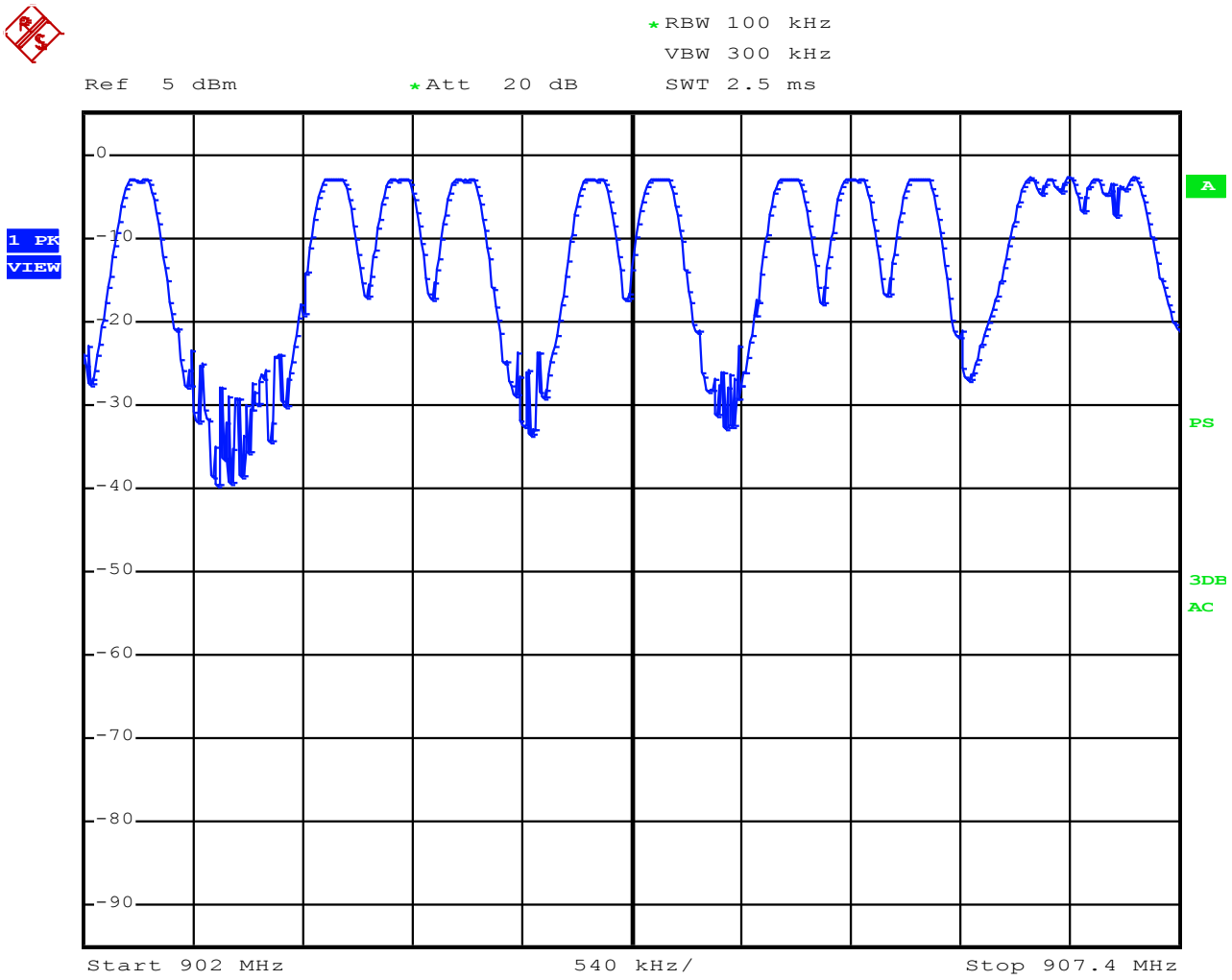
# Channel Separation




Date: 23.DEC.2013 17:15:18

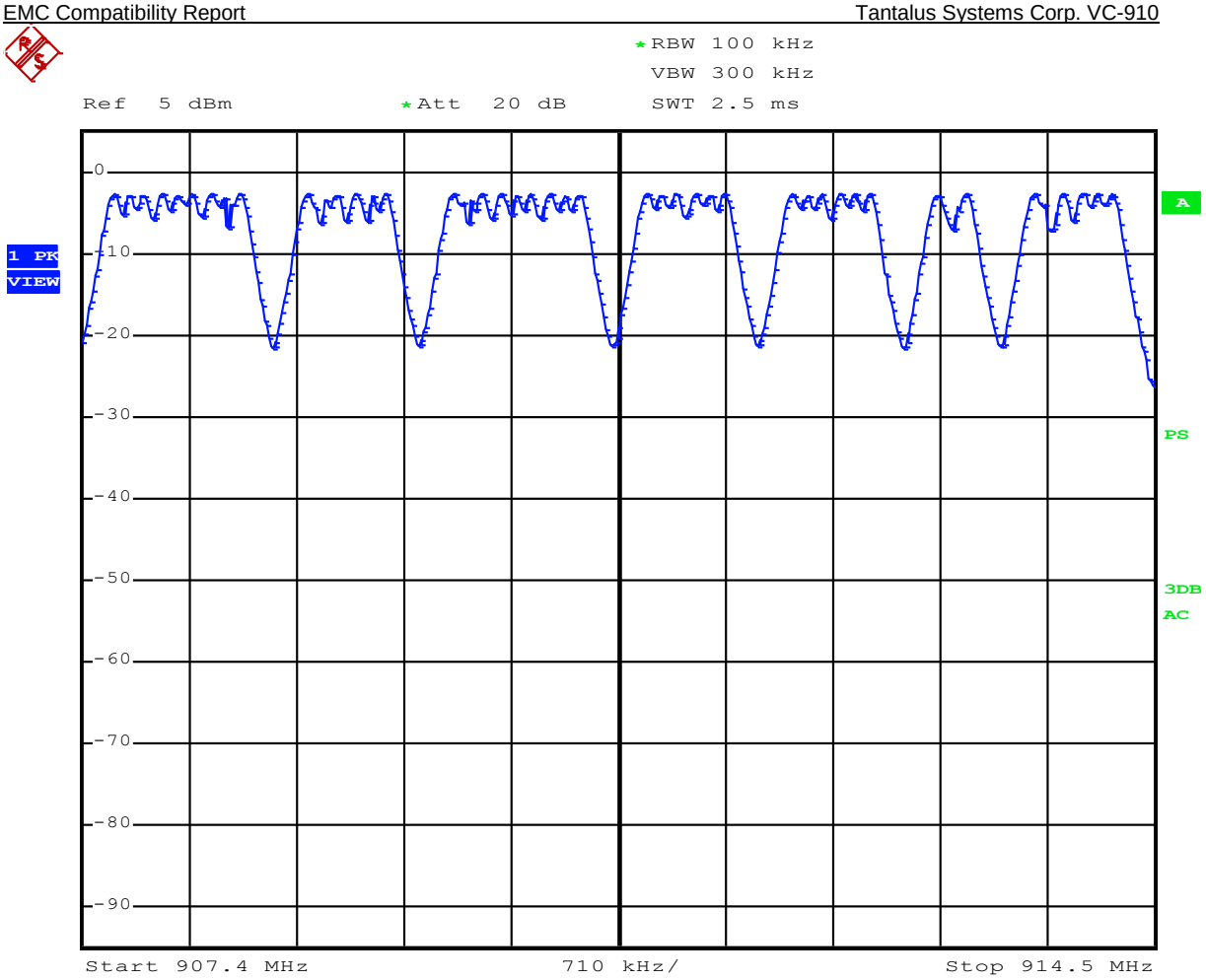
**Figure 20: Channel Separation = 319.8kHz**

## Number of Hopping Channels



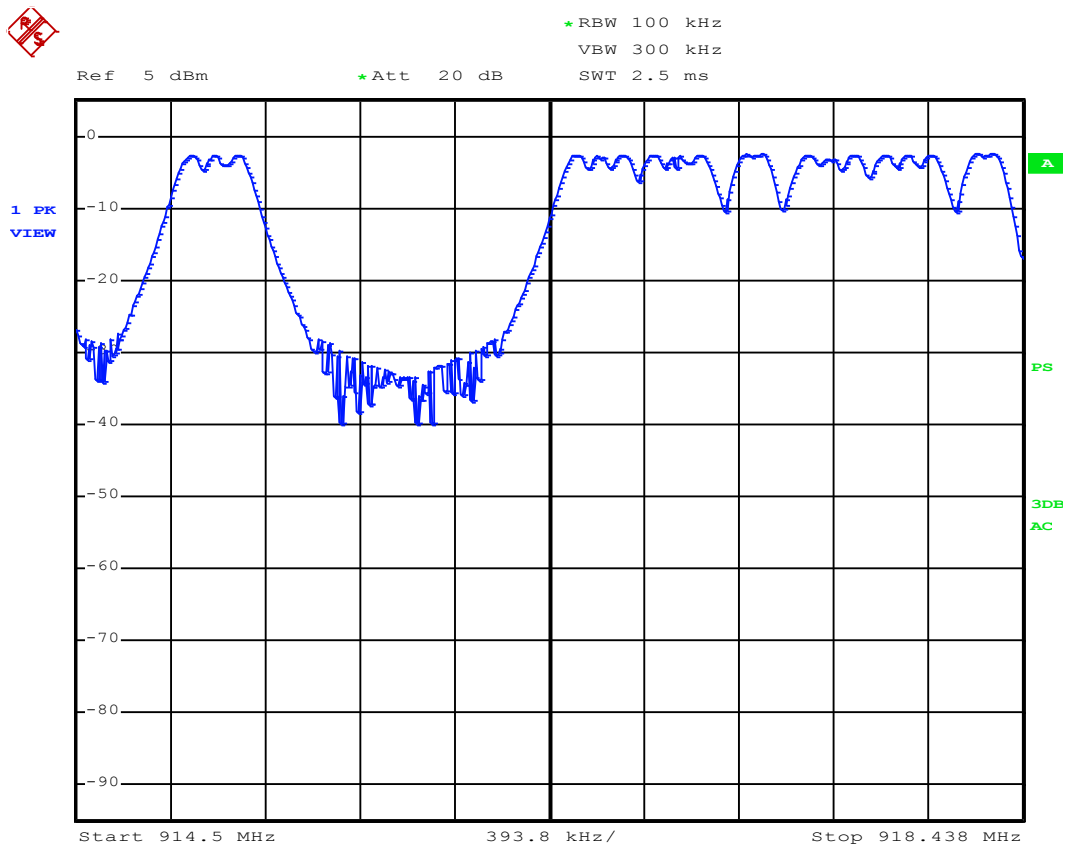

Date: 23.DEC.2013 15:17:19

**Figure 21: Number of Hopping Frequencies 902MHz to 907.4MHz - 11 Frequencies**



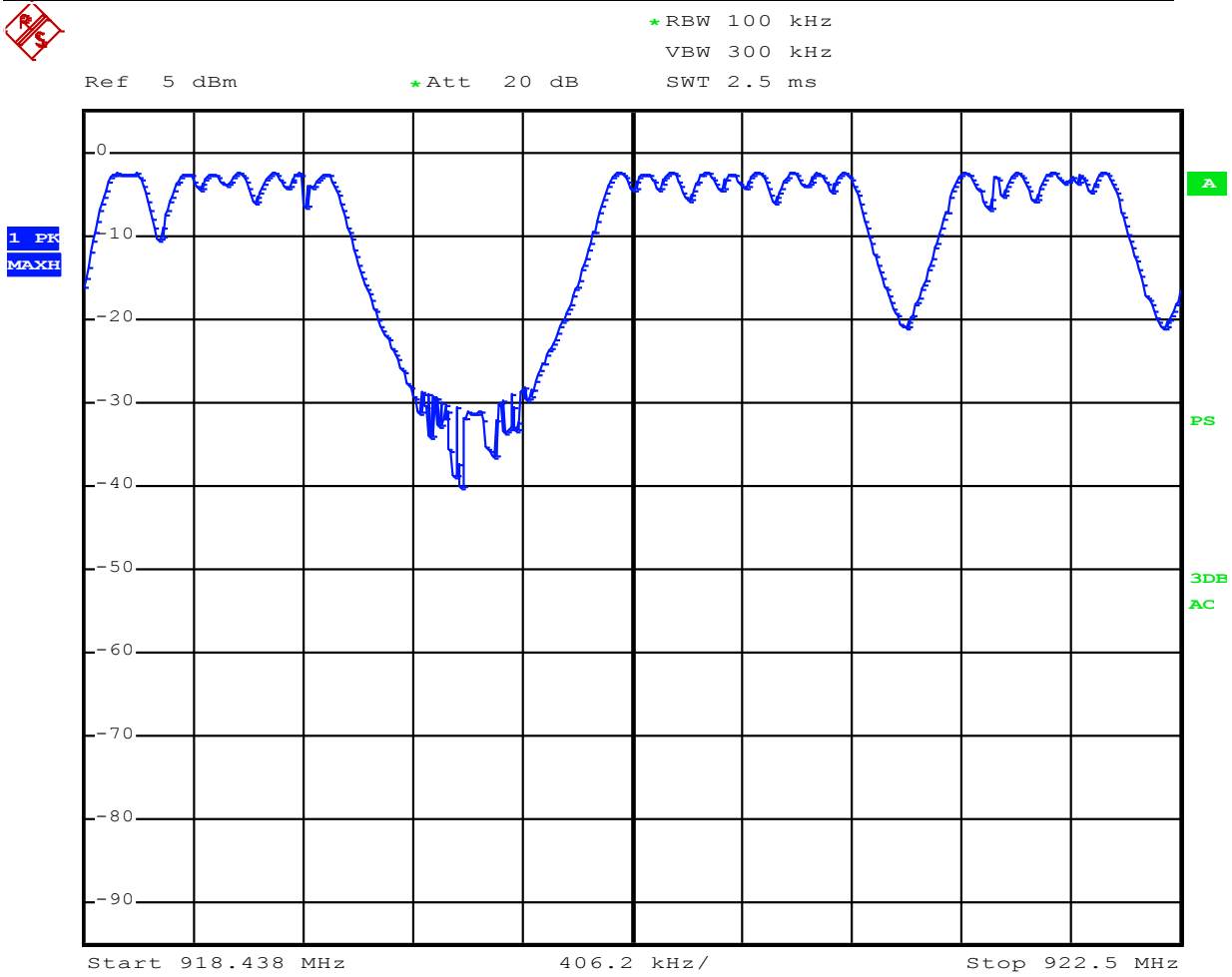

Date: 23.DEC.2013 15:25:36

**Figure 22: Number of Hopping Frequencies 907.4MHz to 9014.5MHz - 15 Frequencies**



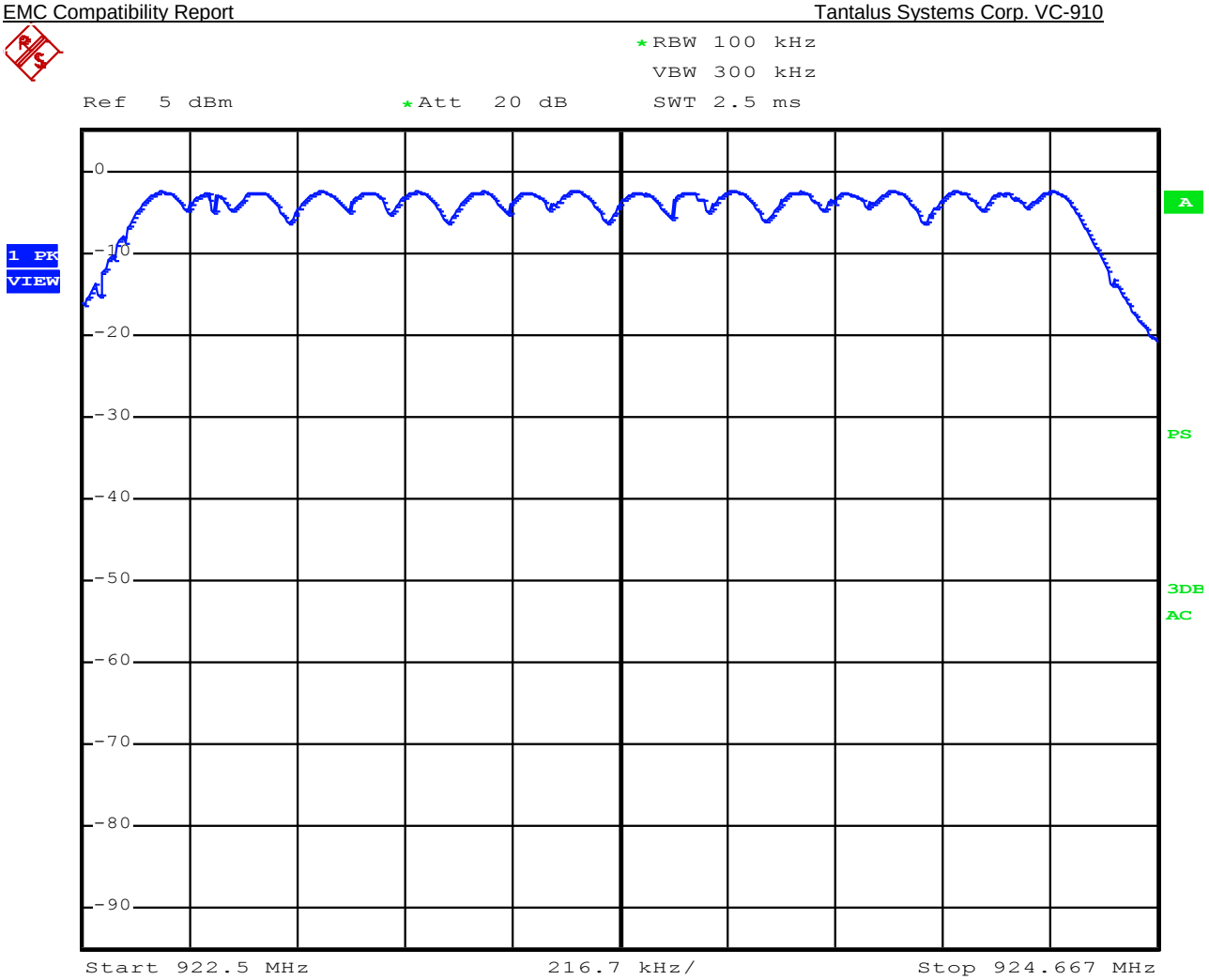

Date: 23.DEC.2013 15:41:17

**Figure 23: Number of Hopping Frequencies 914.5MHz to 918.4MHz - 7 Frequencies**



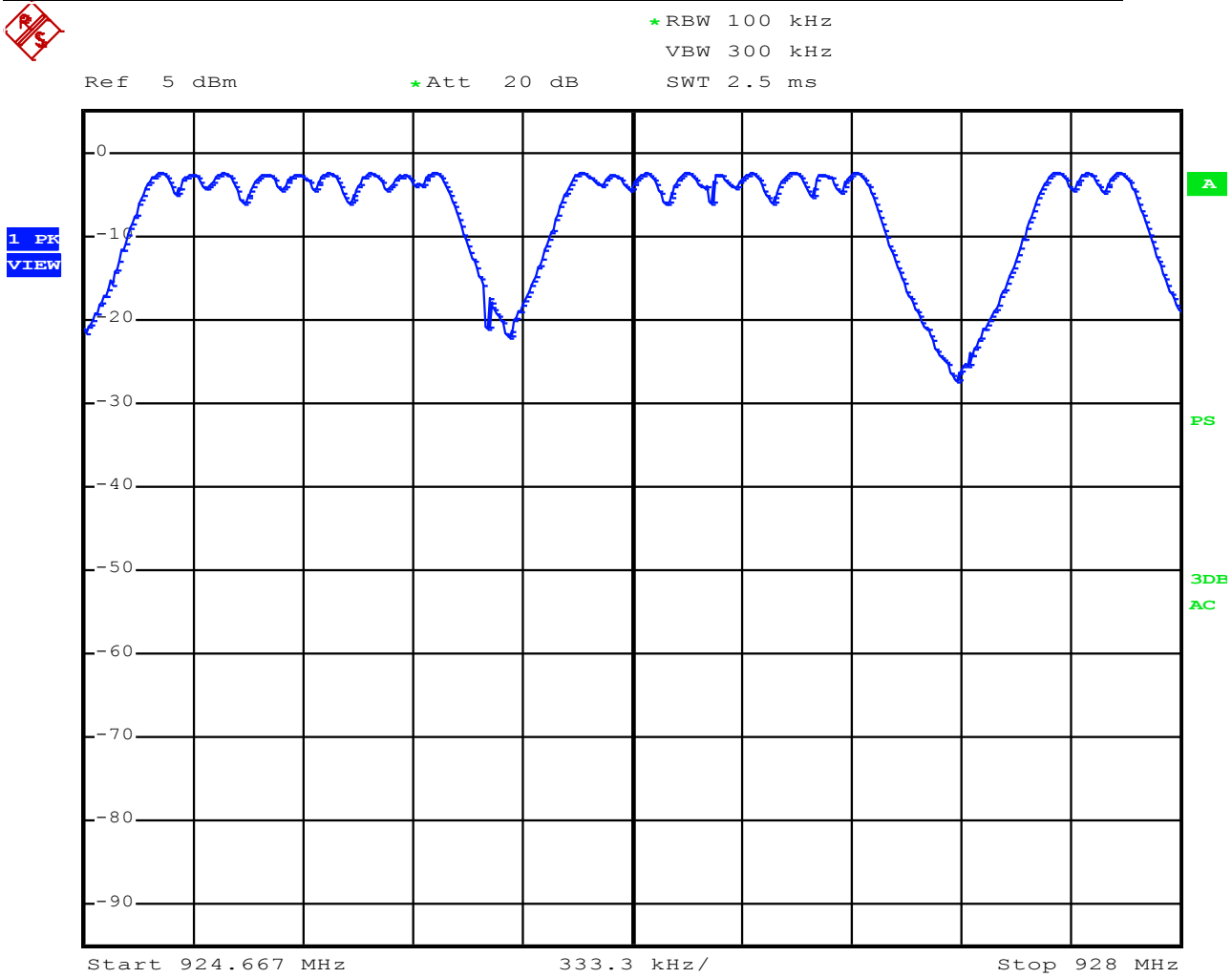

Date: 23.DEC.2013 15:46:37

**Figure 24: Number of Hopping Frequencies 918.4MHz to 922.5MHz - 8 Frequencies**




Date: 23.DEC.2013 15:59:14

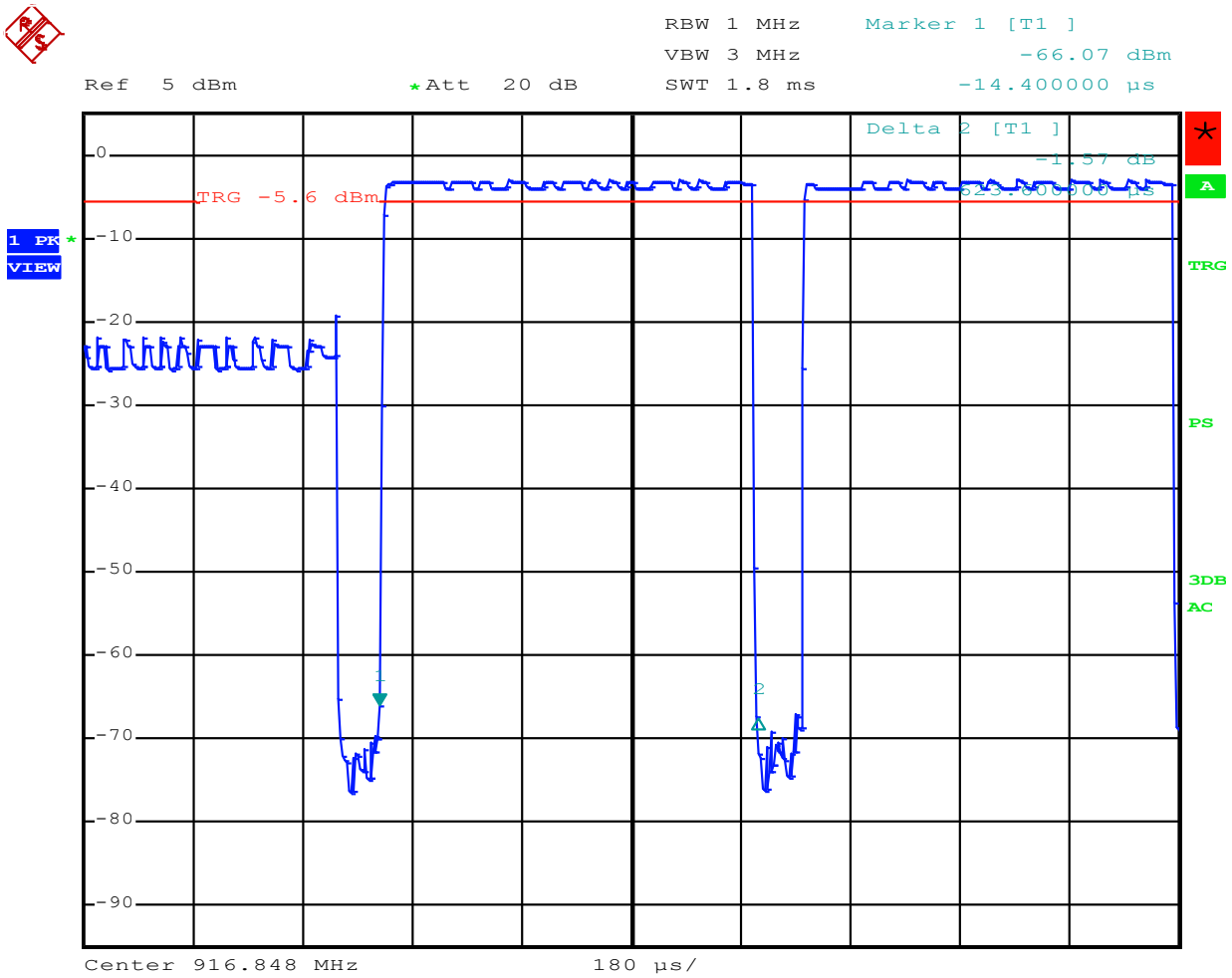
**Figure 25: Number of Hopping Frequencies 922.5MHz to 924.7MHz - 6 Frequencies**




Date: 23.DEC.2013 16:05:44

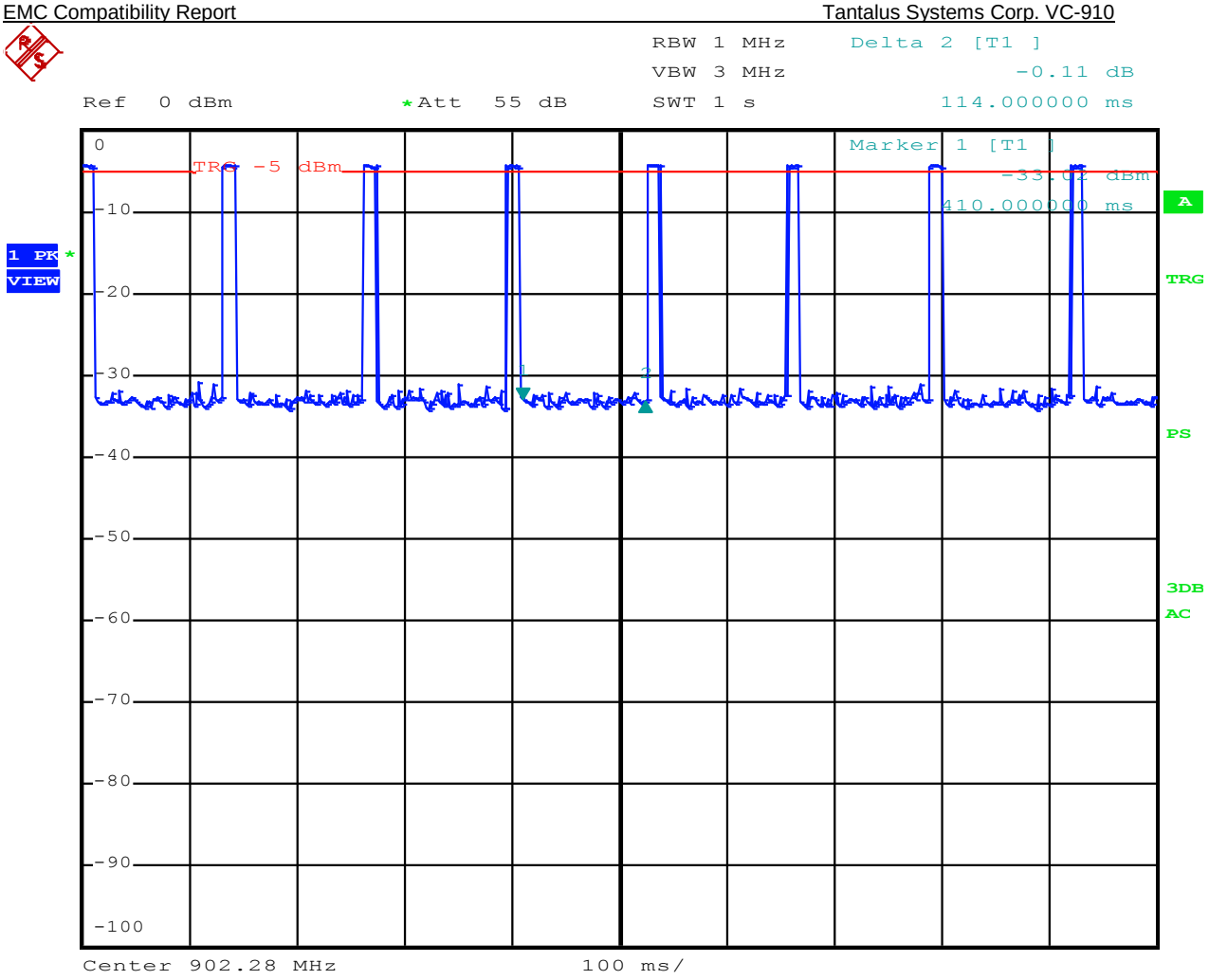
**Figure 26: Number of Hopping Frequencies 924.7MHz to 928MHz - 7 Frequencies**

# Dwell Time and Time of Occupancy




Date: 24.DEC.2013 09:26:18

**Figure 27: Dwell Time – 623.6uS**

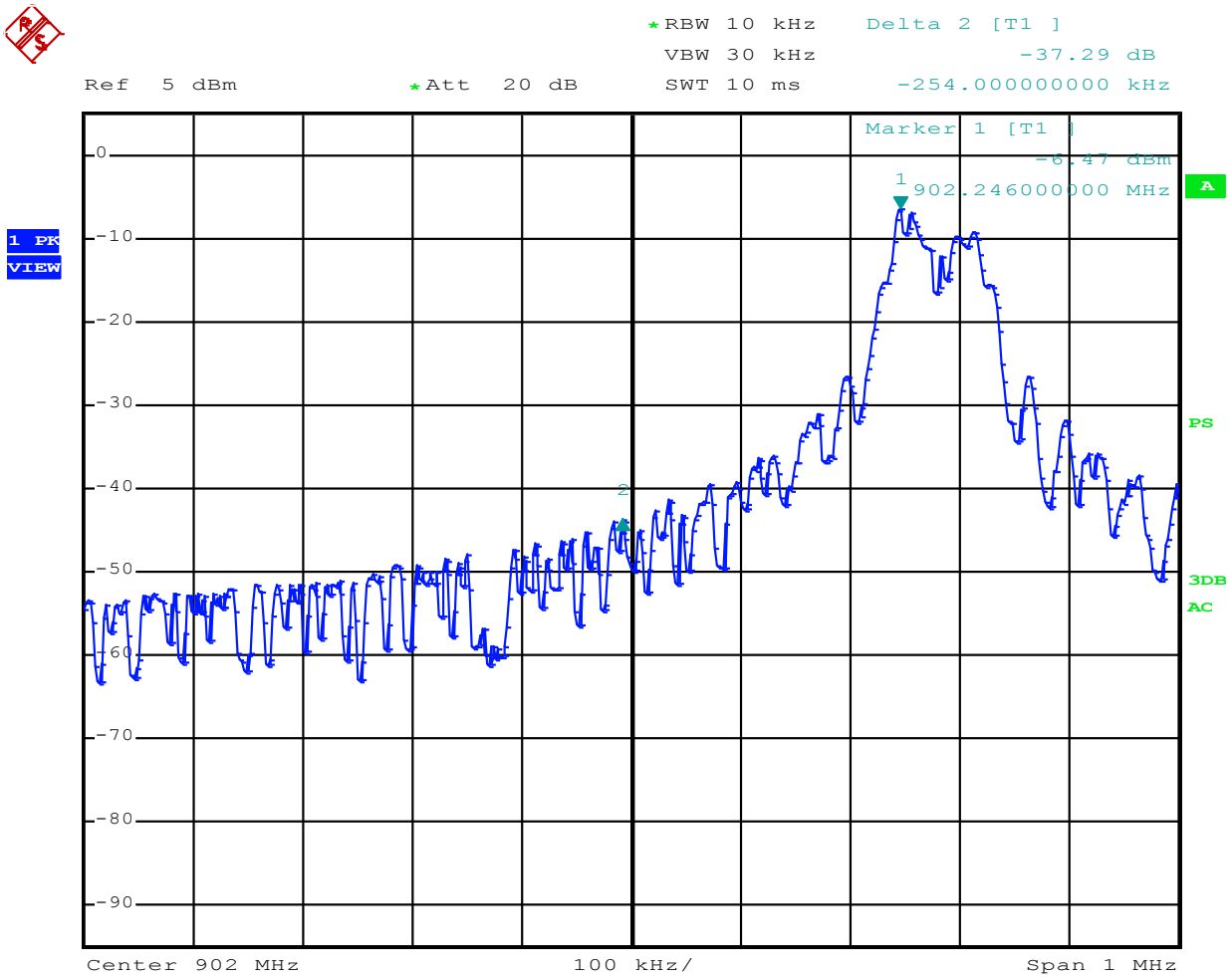



Date: 21.MAR.2014 09:03:38

**Figure 28: Time Occupancy Per Frequency – 109.3mS***

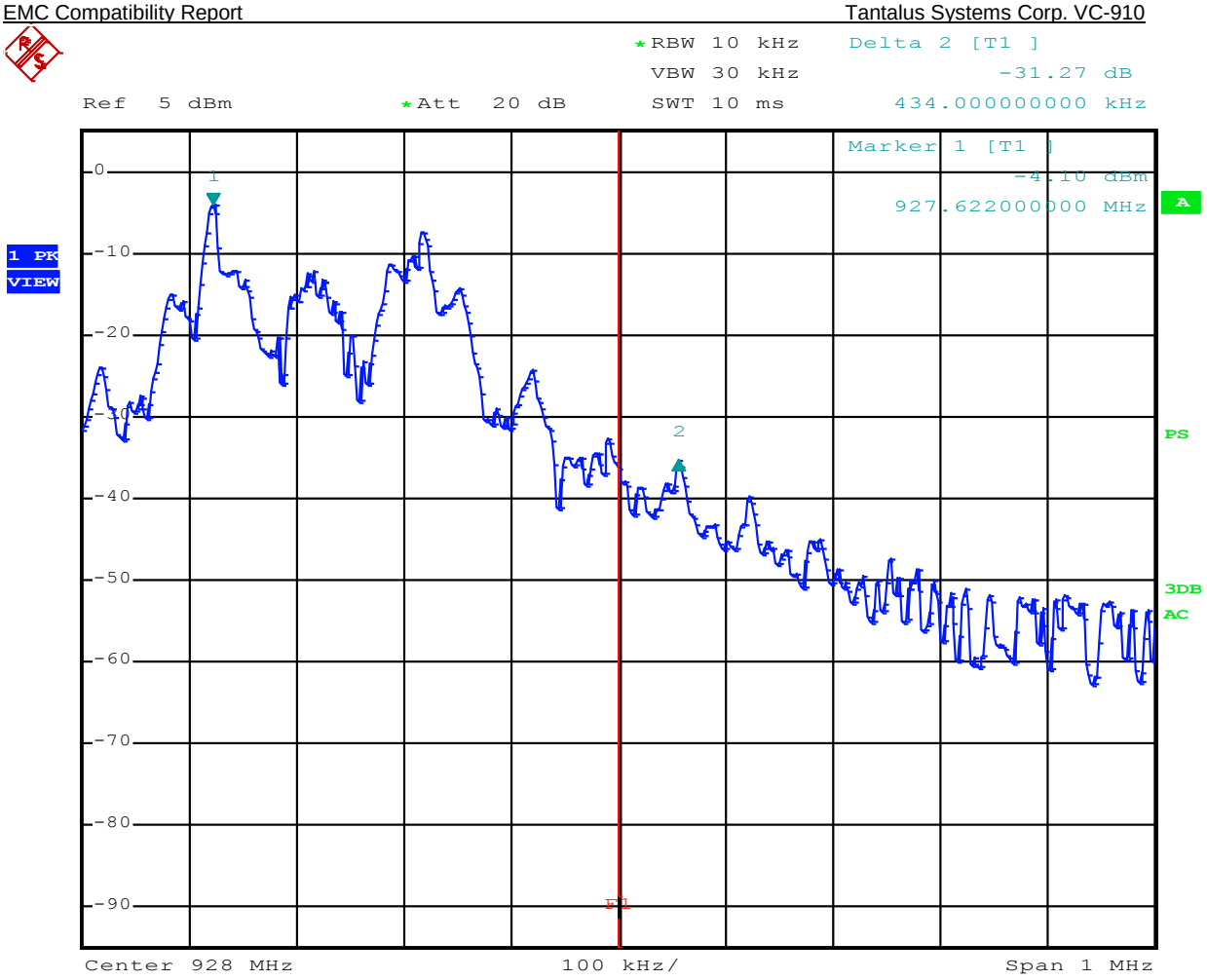
*(***** Time betwen 2 consecutive transmissions on the same frequency is 0.114 Seconds, dwell time per frequency is 0.623mS, therefore occupancy time per frequency within a 20 Second period is 109.3 mS)*

# Channel Bandedge




Date: 23.DEC.2013 16:56:03

**Figure 29: Low Channel Bandedge**

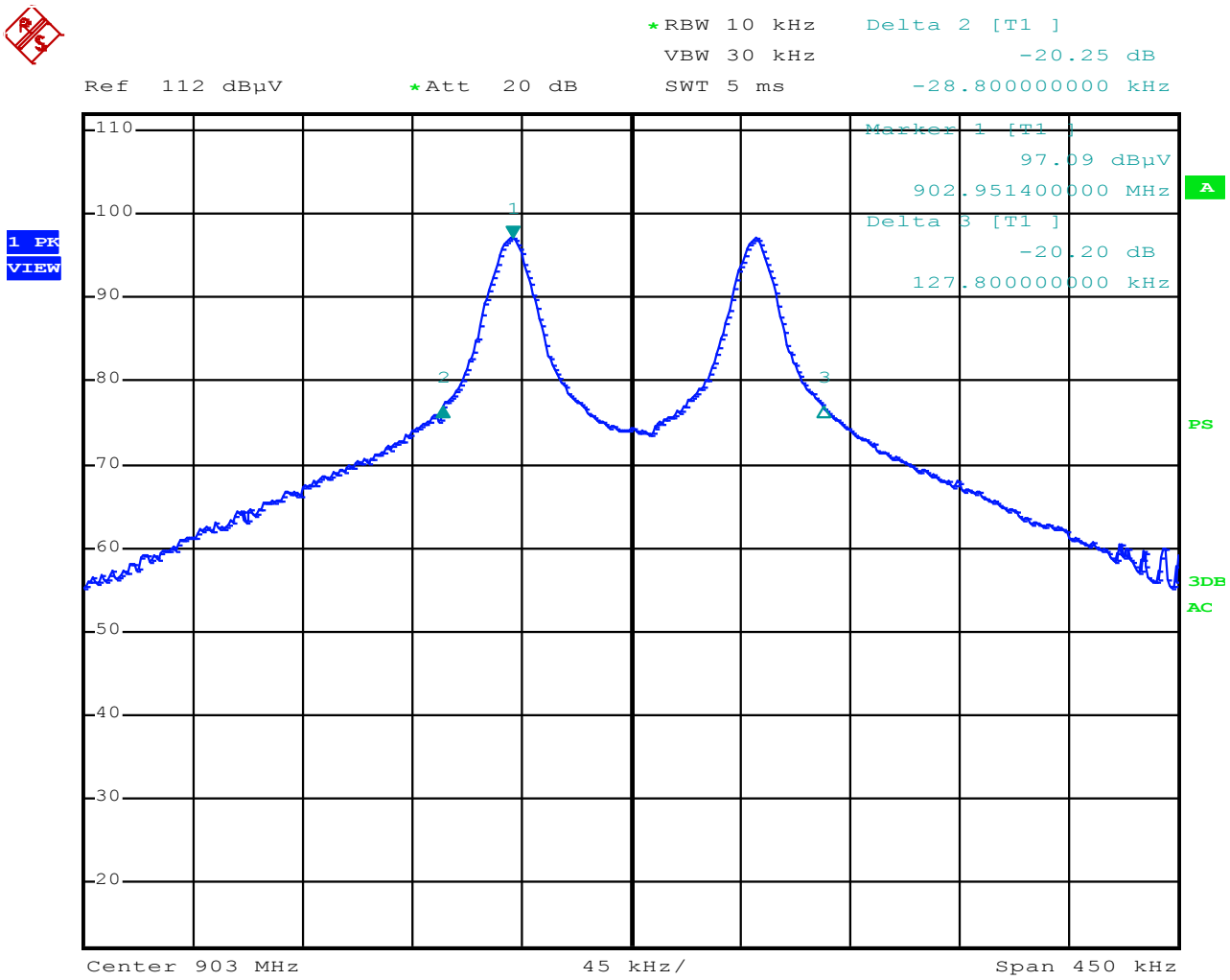



Date: 23.DEC.2013 16:58:48

**Figure 30: High Channel Bandedge**

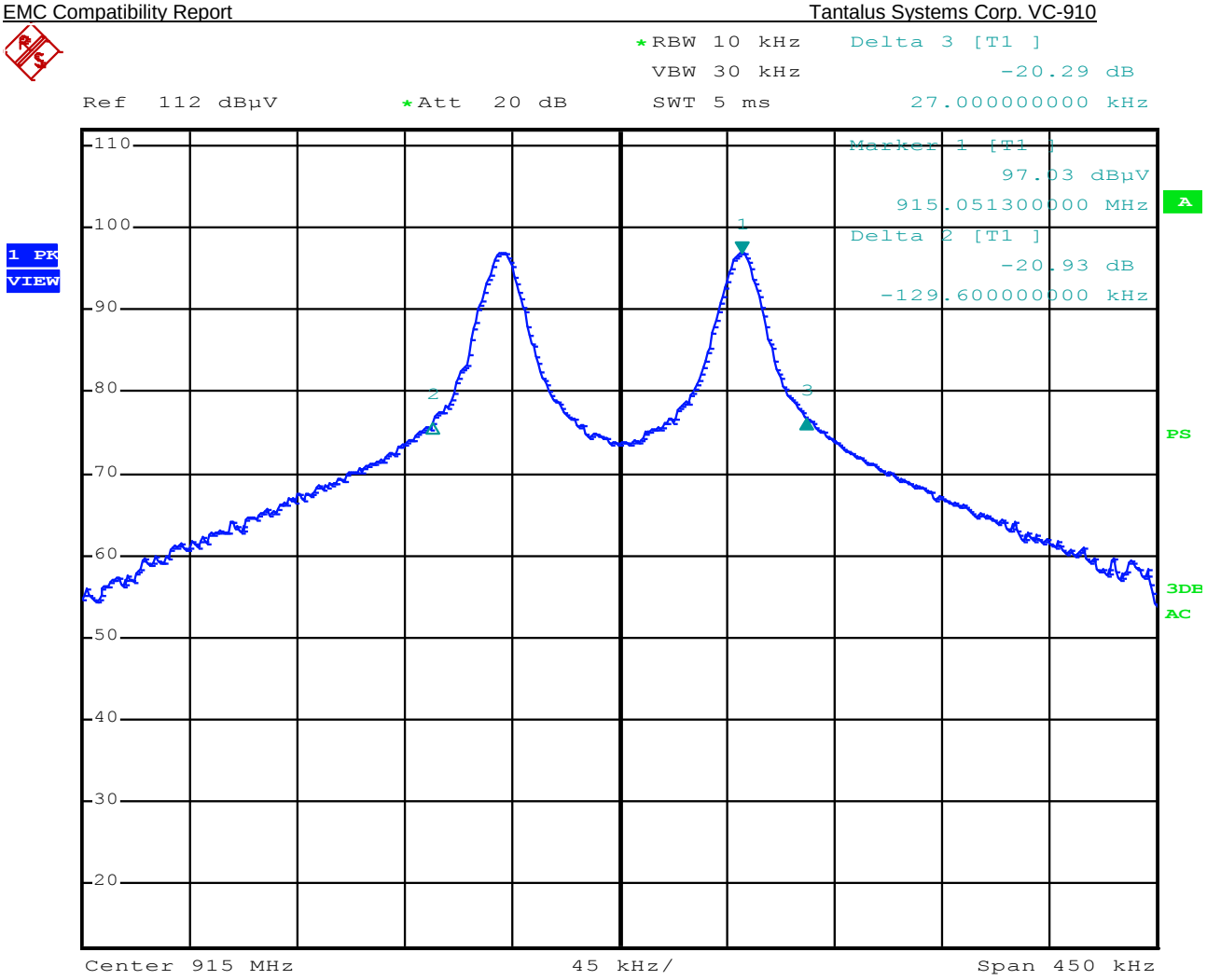
# Tests when unit is communicating to OEM Part 15 approved Device

## 20 dB Bandwidth



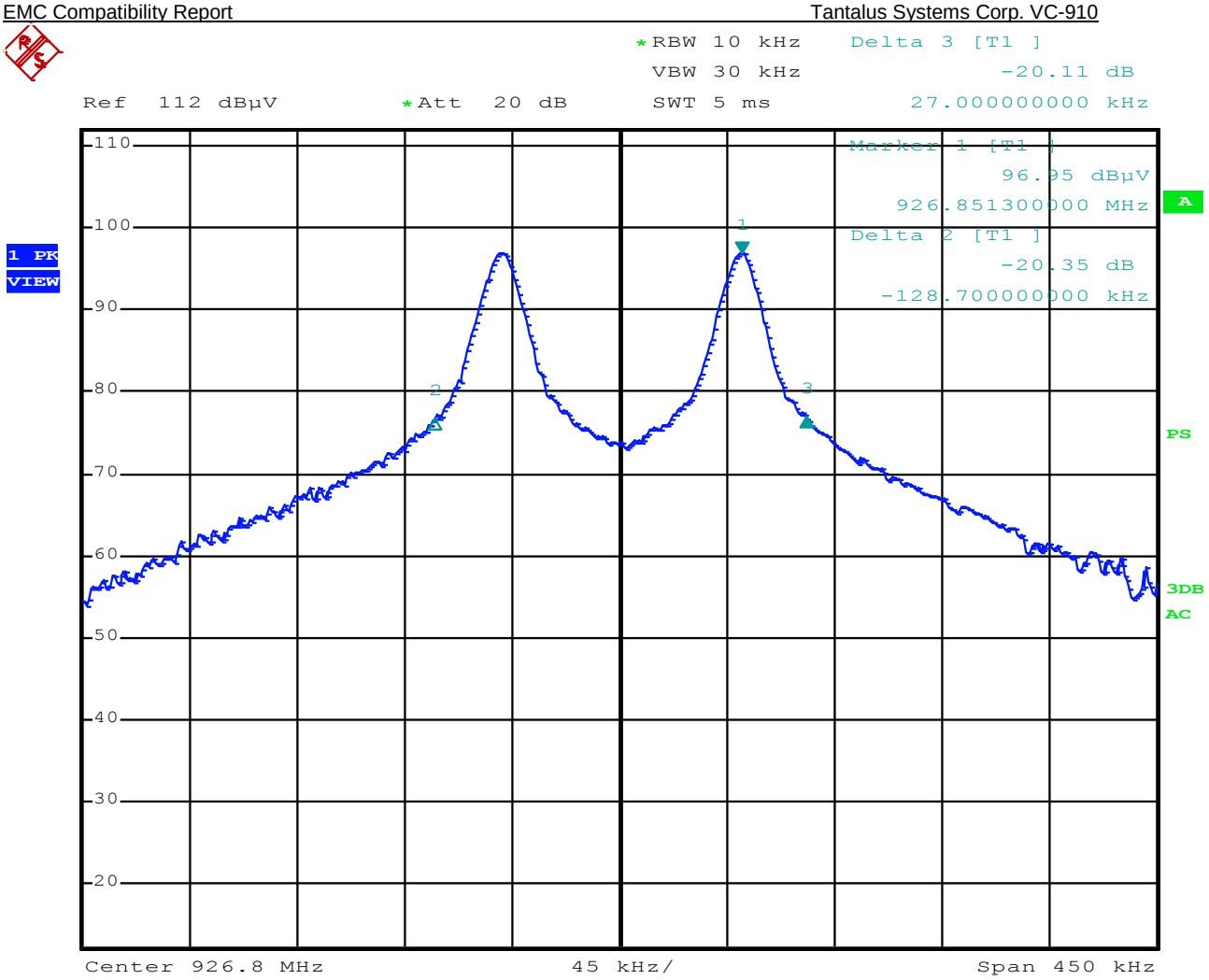

Date: 18.DEC.2013 16:06:09

**Figure 31: 20dB Bandwidth at LOW Frequency – 156.6 kHz**




Date: 18.DEC.2013 16:00:51

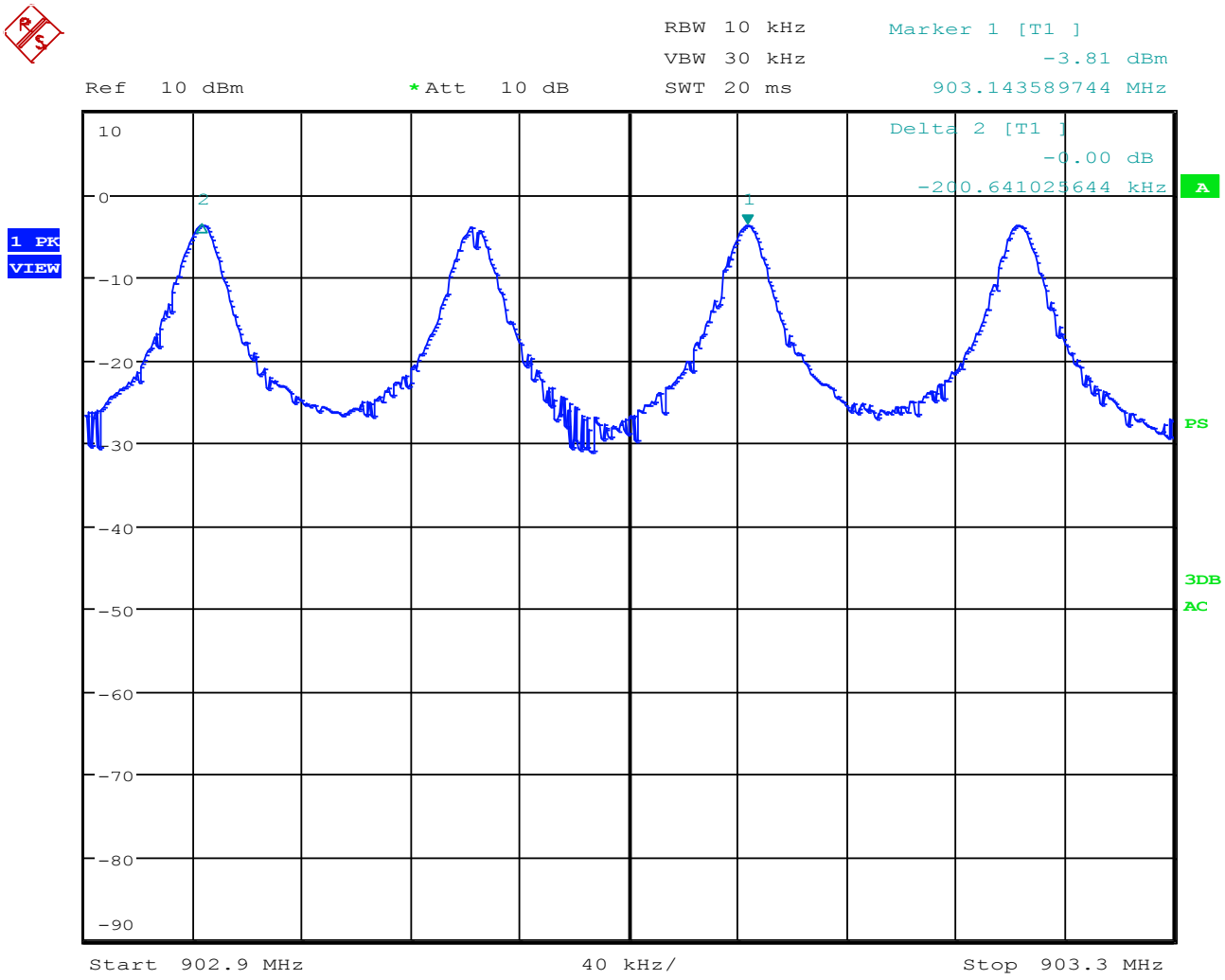
**Figure 32: 20dB Bandwidth at MID Frequency – 156.6 kHz**




Date: 18.DEC.2013 16:12:21

**Figure 33: 20dB Bandwidth at HIGH Frequency – 155.7 kHz**

# Channel Separation

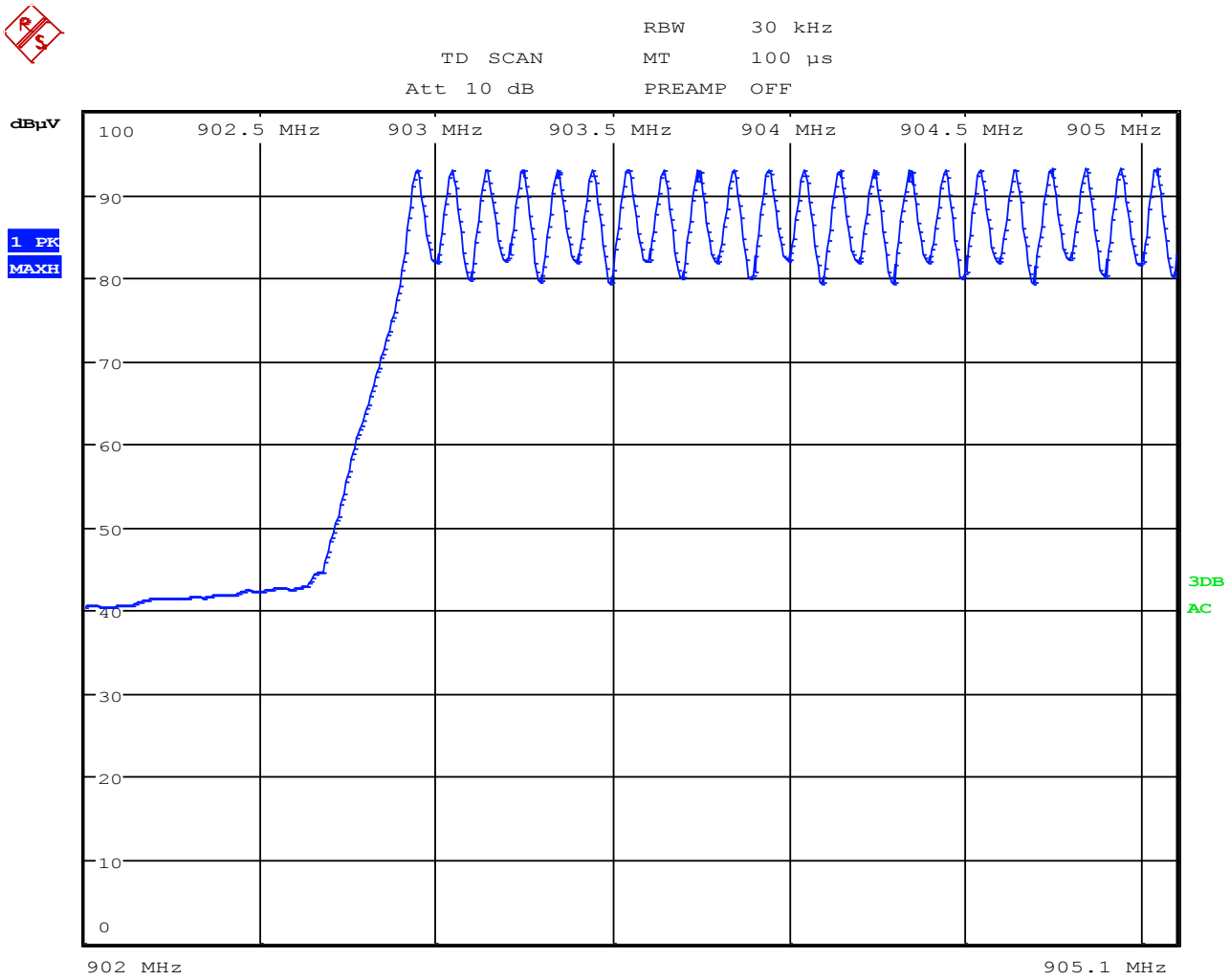



TTTTTT

Date: 7.JAN.2014 13:55:37

**Figure 34: Channel Separation = 200.6kHz**

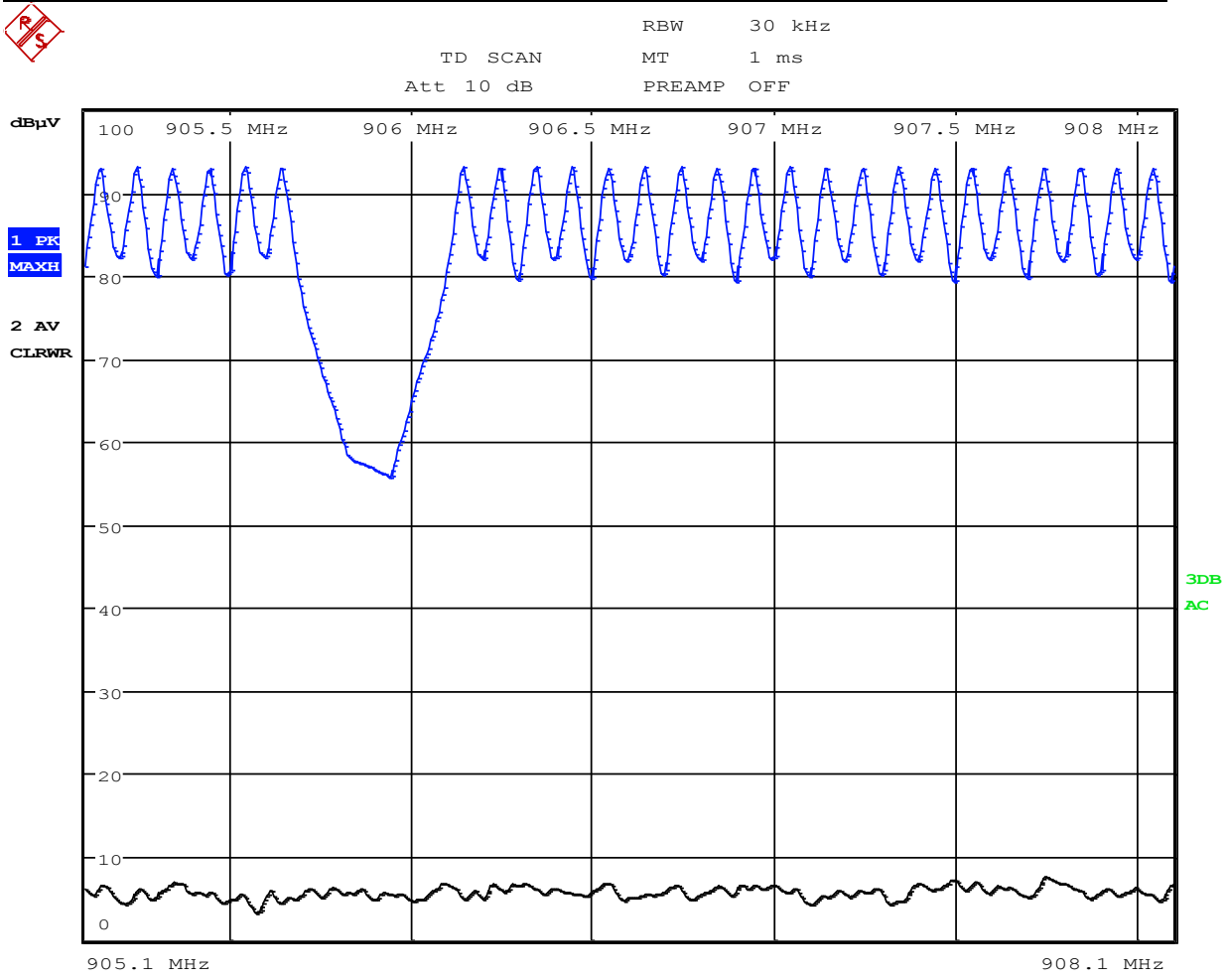
# Number of Hopping Channels




TTTTTT

Date: 7.JAN.2014 15:32:13

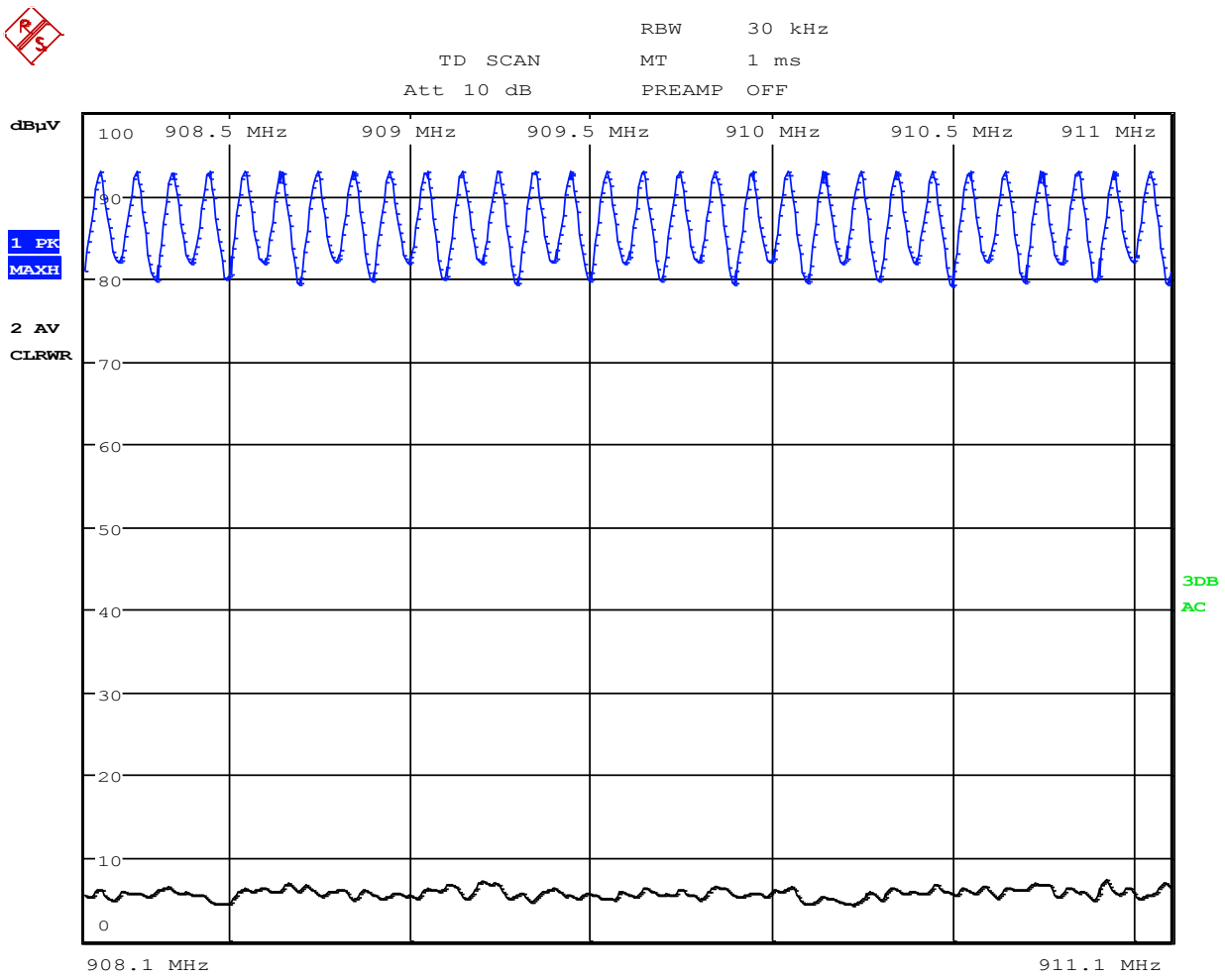
**Figure 35: Number of Hopping Frequencies 902MHz to 905MHz - 11 Frequencies**




TTTTTT

Date: 7.JAN.2014 16:18:05

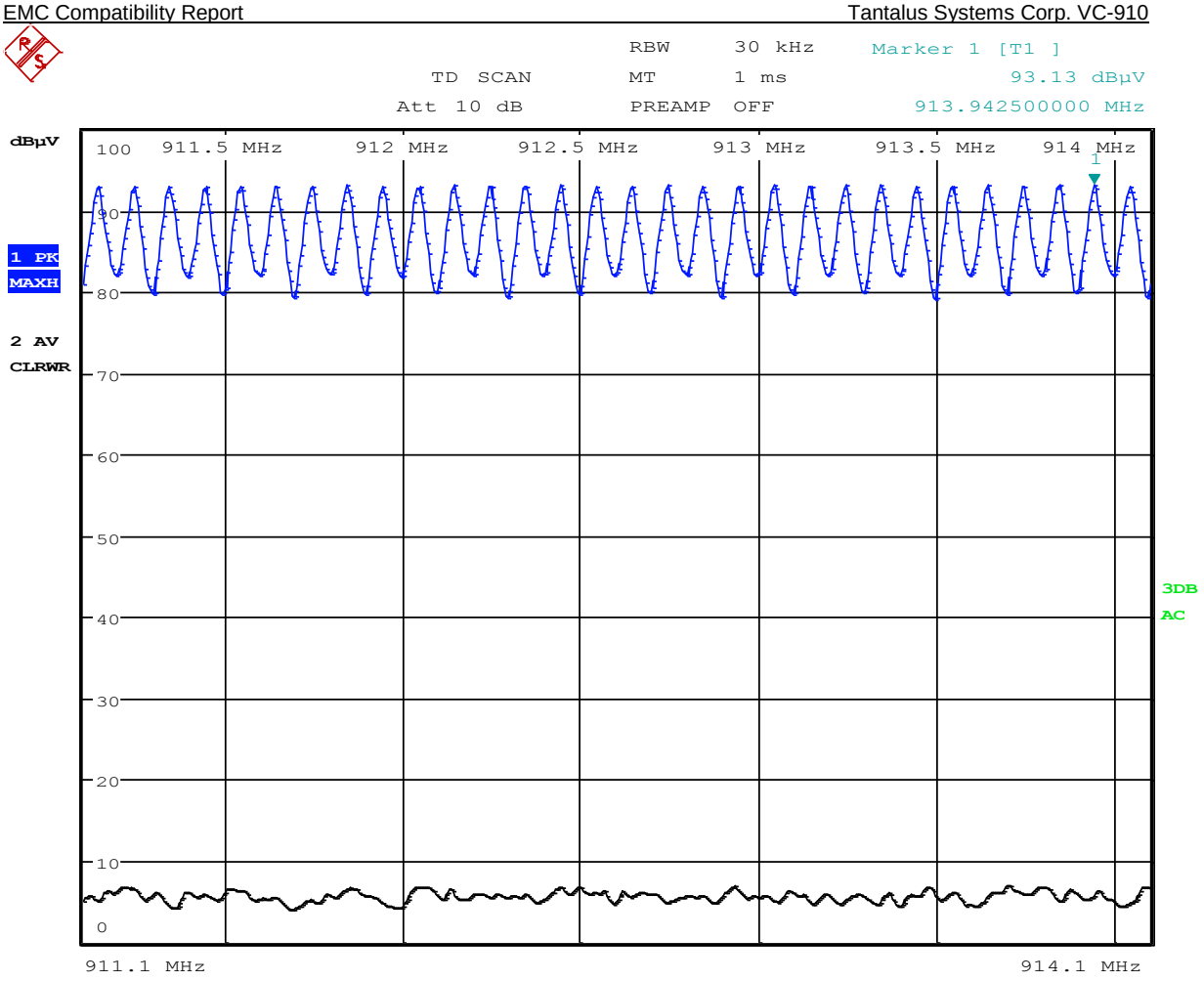
**Figure 36: Number of Hopping Frequencies 905MHz to 908MHz - 13 Frequencies**




TTTTTT

Date: 7.JAN.2014 15:41:12

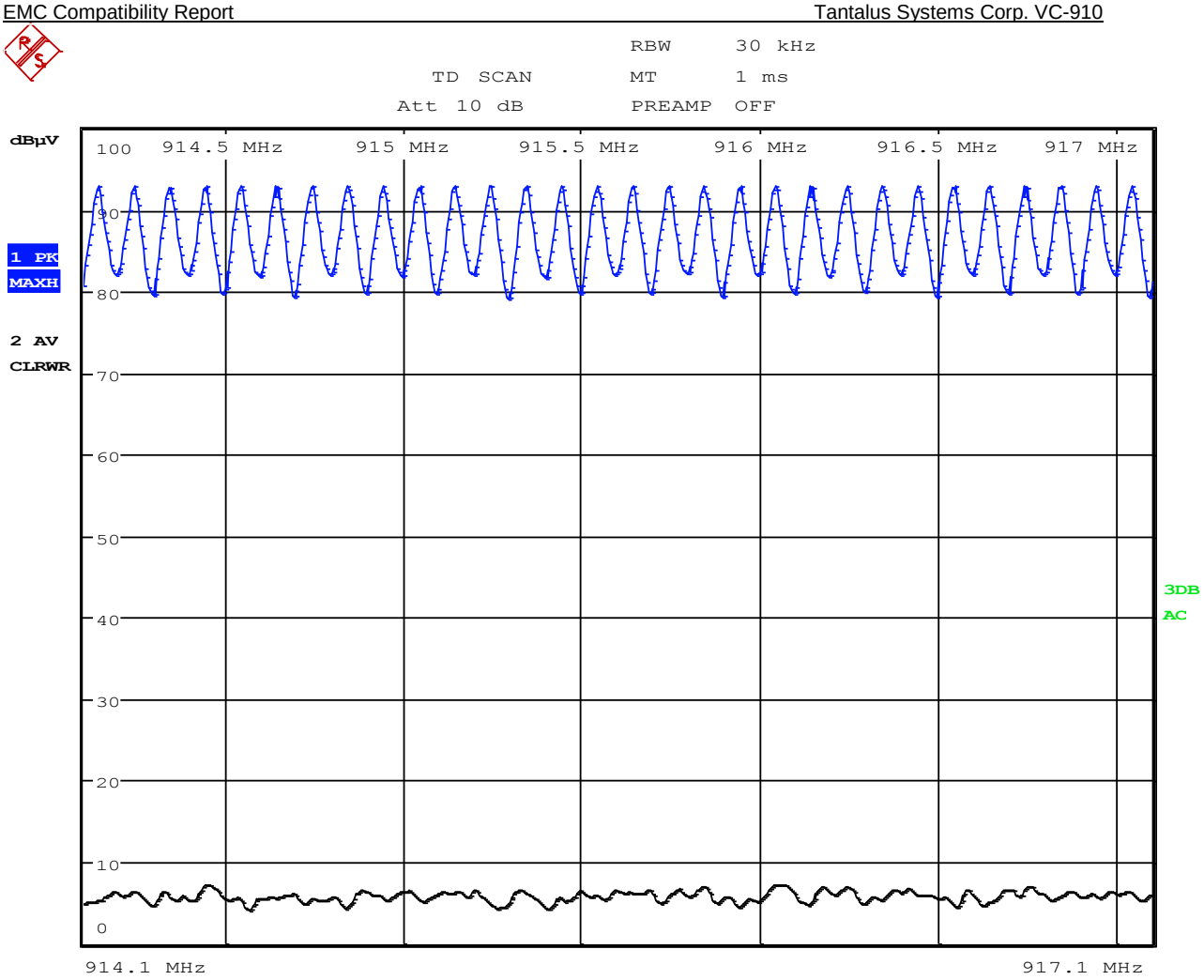
**Figure 37: Number of Hopping Frequencies 908MHz to 911MHz - 15 Frequencies**




TTTTTT

Date: 7.JAN.2014 16:33:12

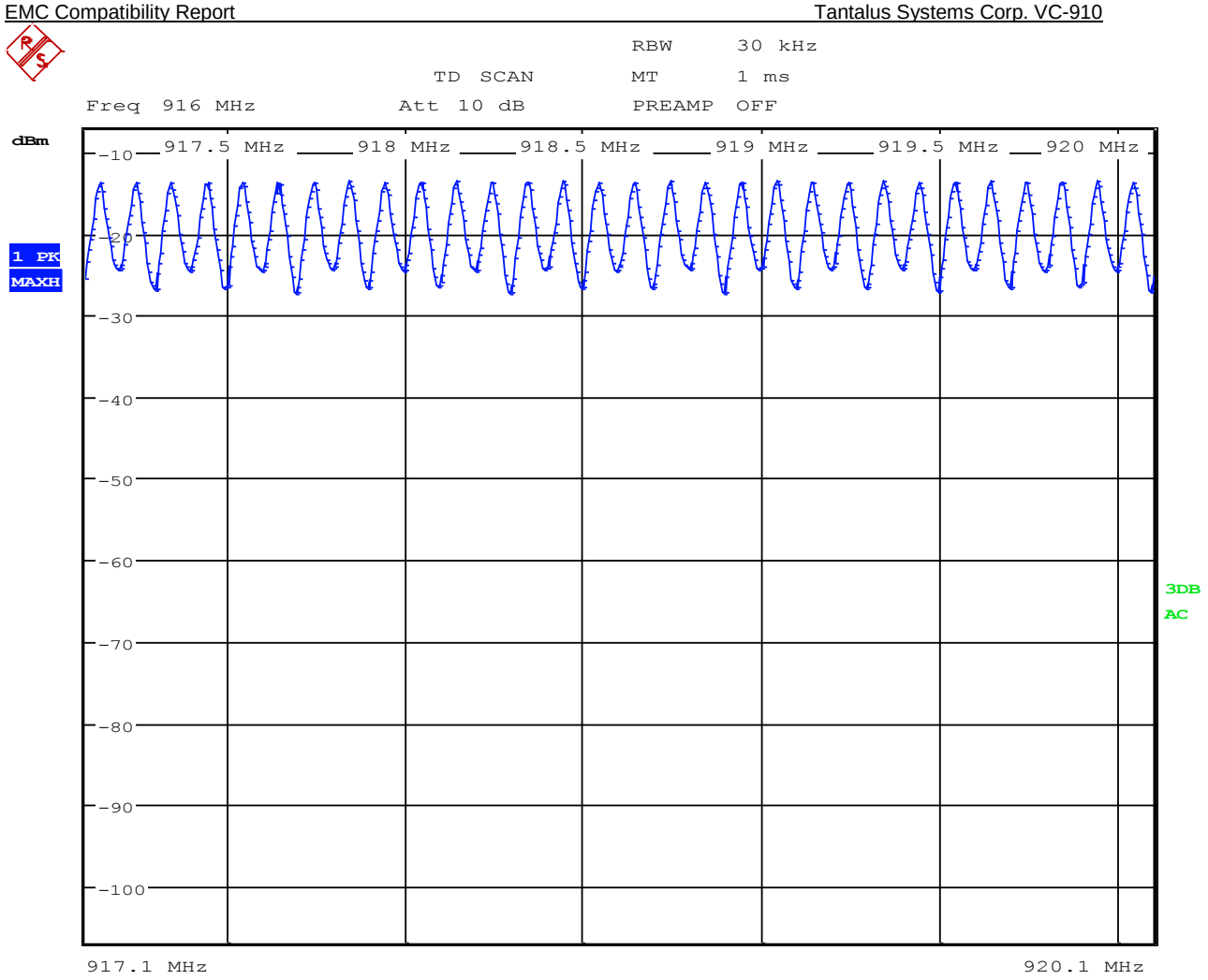
**Figure 38: Number of Hopping Frequencies 911MHz to 914MHz - 15 Frequencies**




TTTTTT

Date: 7.JAN.2014 15:52:41

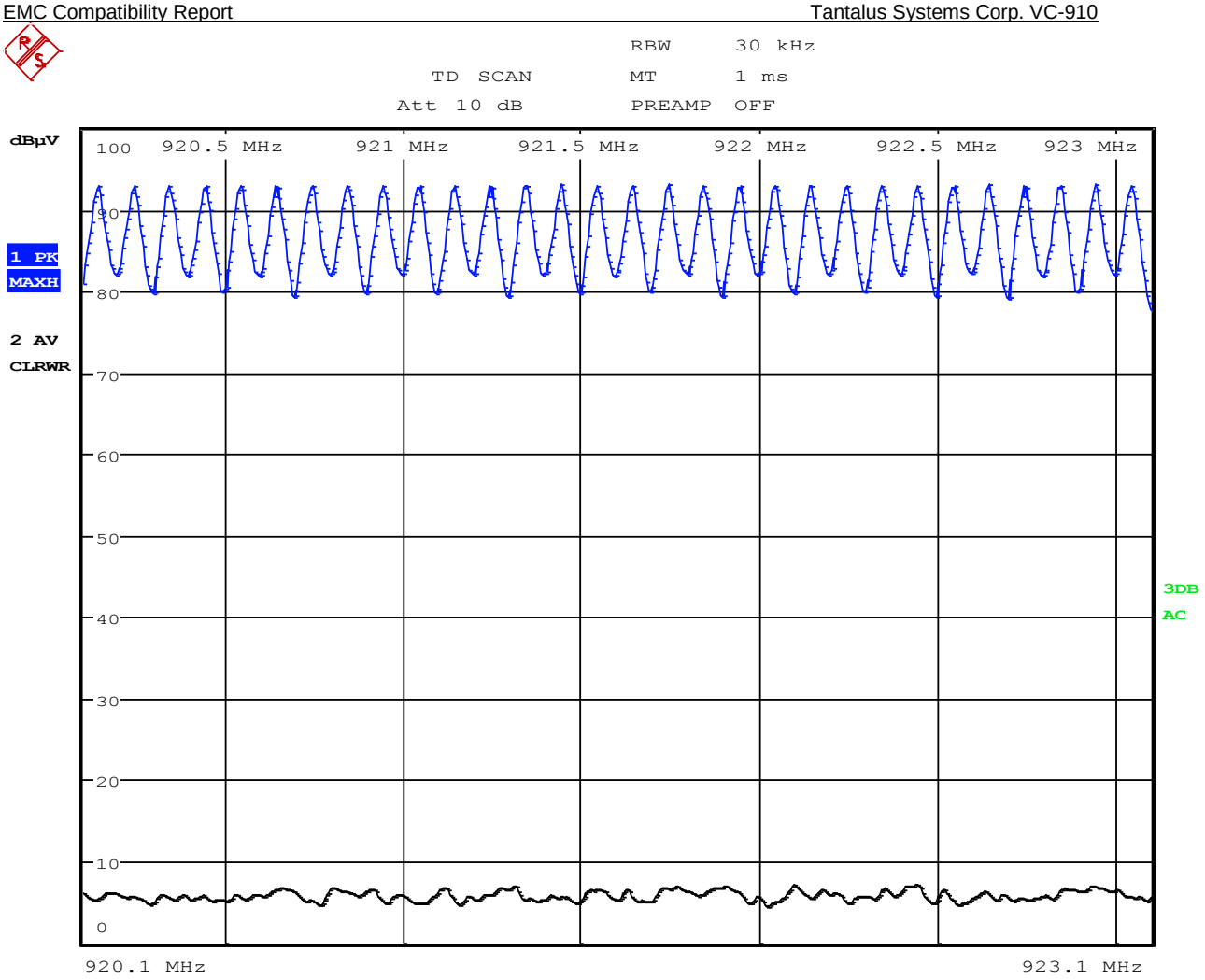
**Figure 39: Number of Hopping Frequencies 914MHz to 917MHz - 15 Frequencies**




TTTTTT

Date: 8.JAN.2014 19:40:08

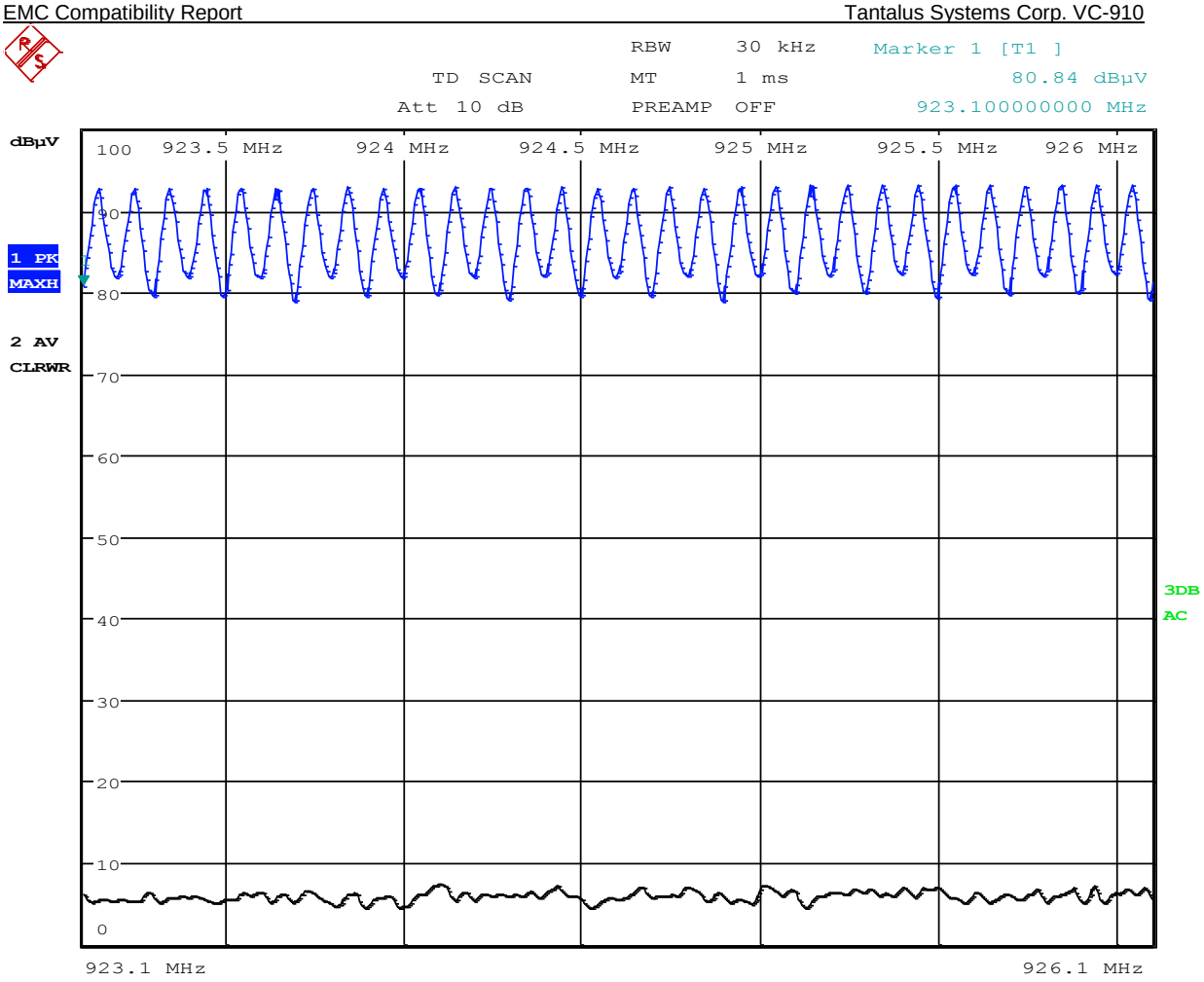
**Figure 40: Number of Hopping Frequencies 917MHz to 920MHz - 15 Frequencies**




TTTTTT

Date: 7.JAN.2014 16:00:54

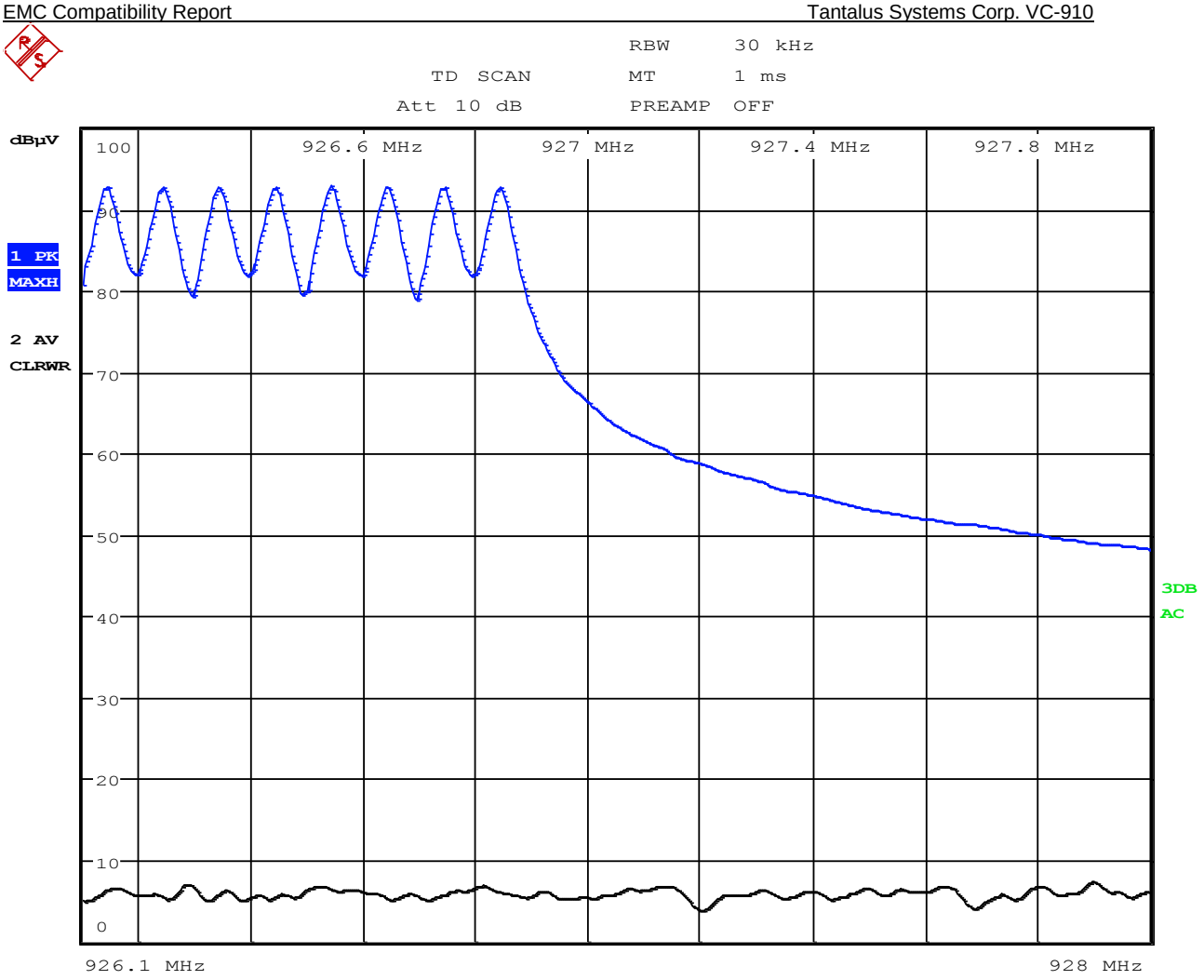
**Figure 41: Number of Hopping Frequencies 920MHz to 922MHz - 15 Frequencies**




TTTTTT

Date: 7.JAN.2014 17:46:50

**Figure 42: Number of Hopping Frequencies 923MHz to 926MHz - 15 Frequencies**

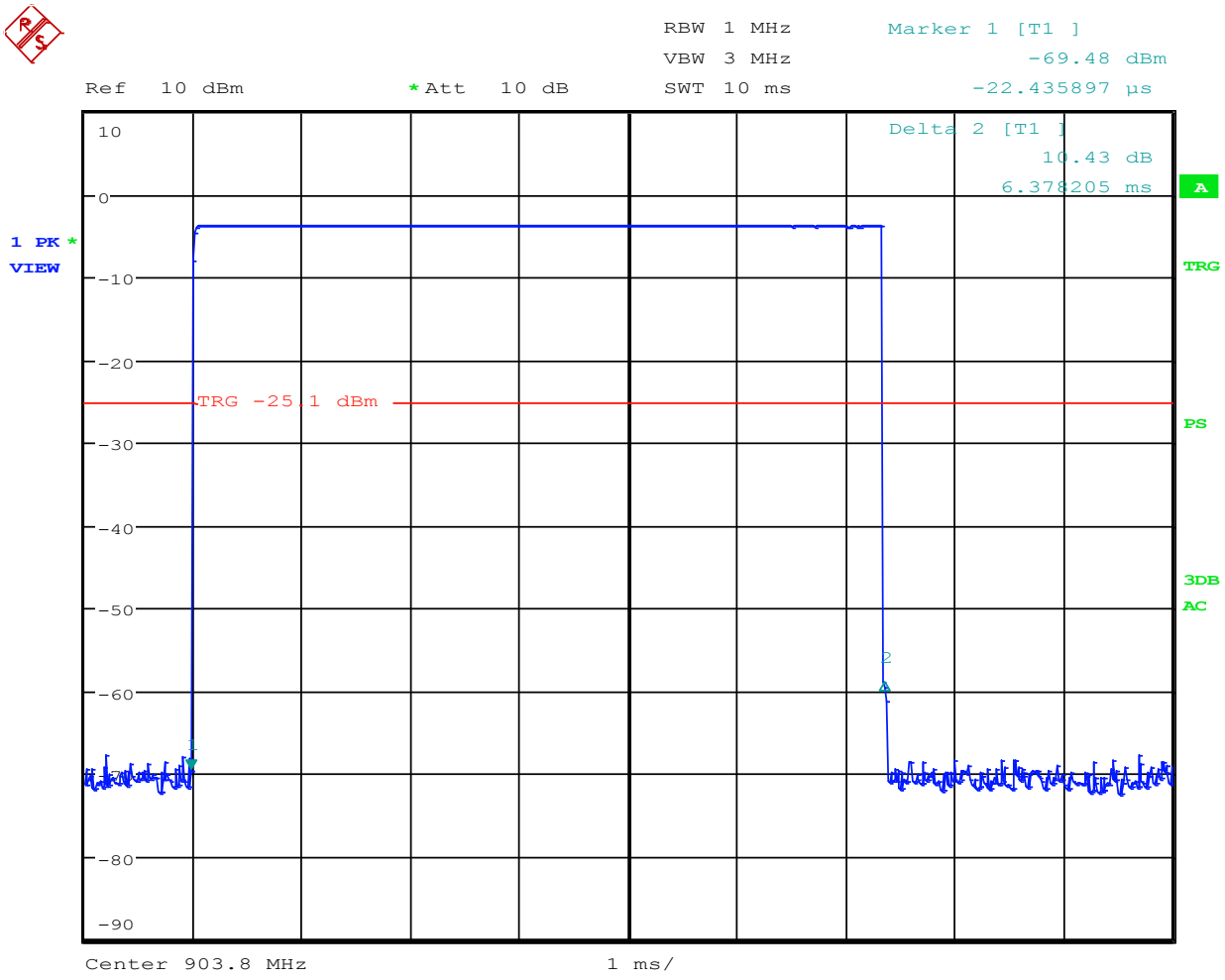



TTTTTT

Date: 7.JAN.2014 16:07:51

**Figure 43: Number of Hopping Frequencies 926MHz to 928MHz - 8 Frequencies**

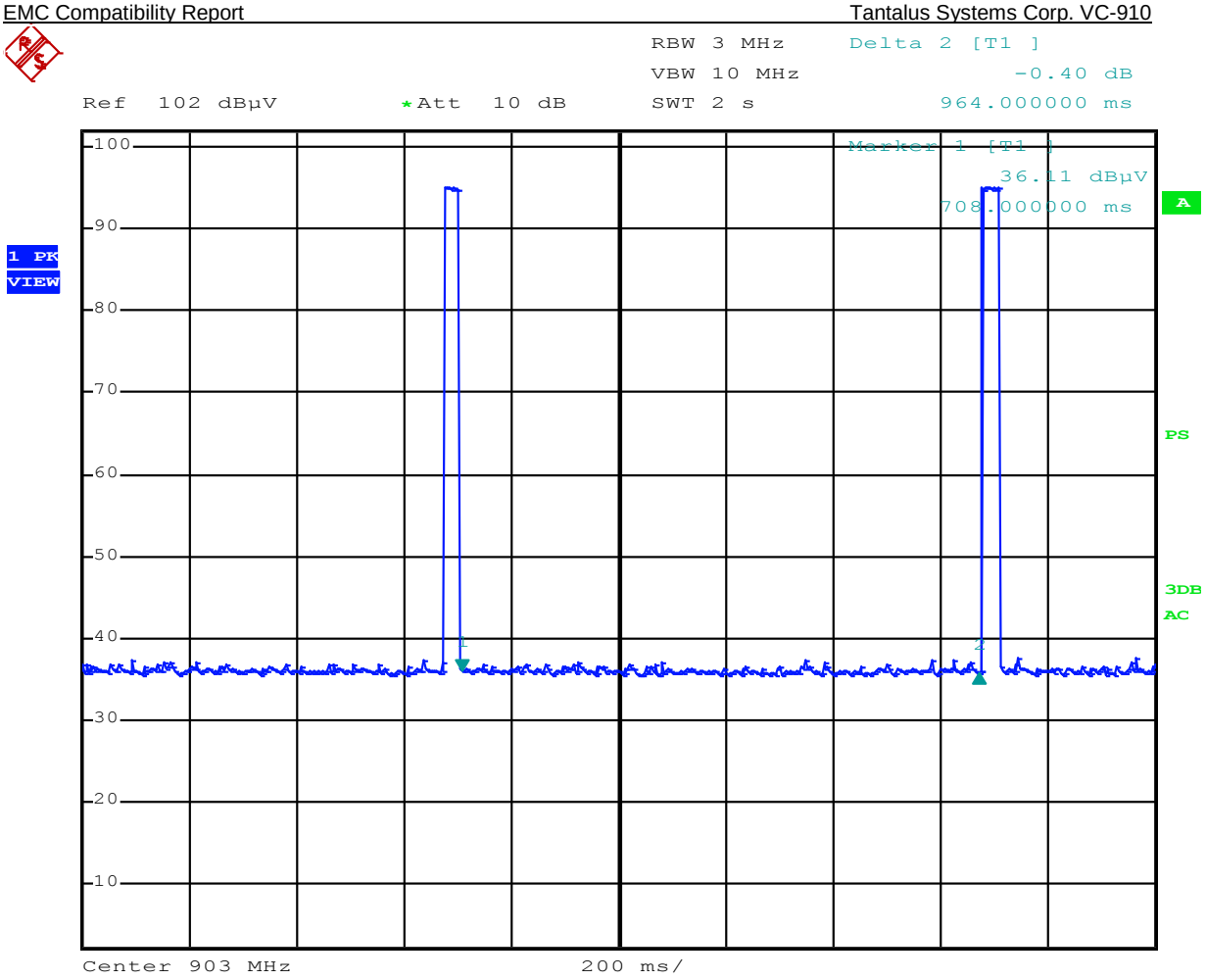
# Dwell Time and Time of Occupancy




TTTTTT

Date: 7.JAN.2014 13:46:45

**Figure 44: Dwell Time – 6.4mS**




Date: 4.FEB.2014 14:21:46

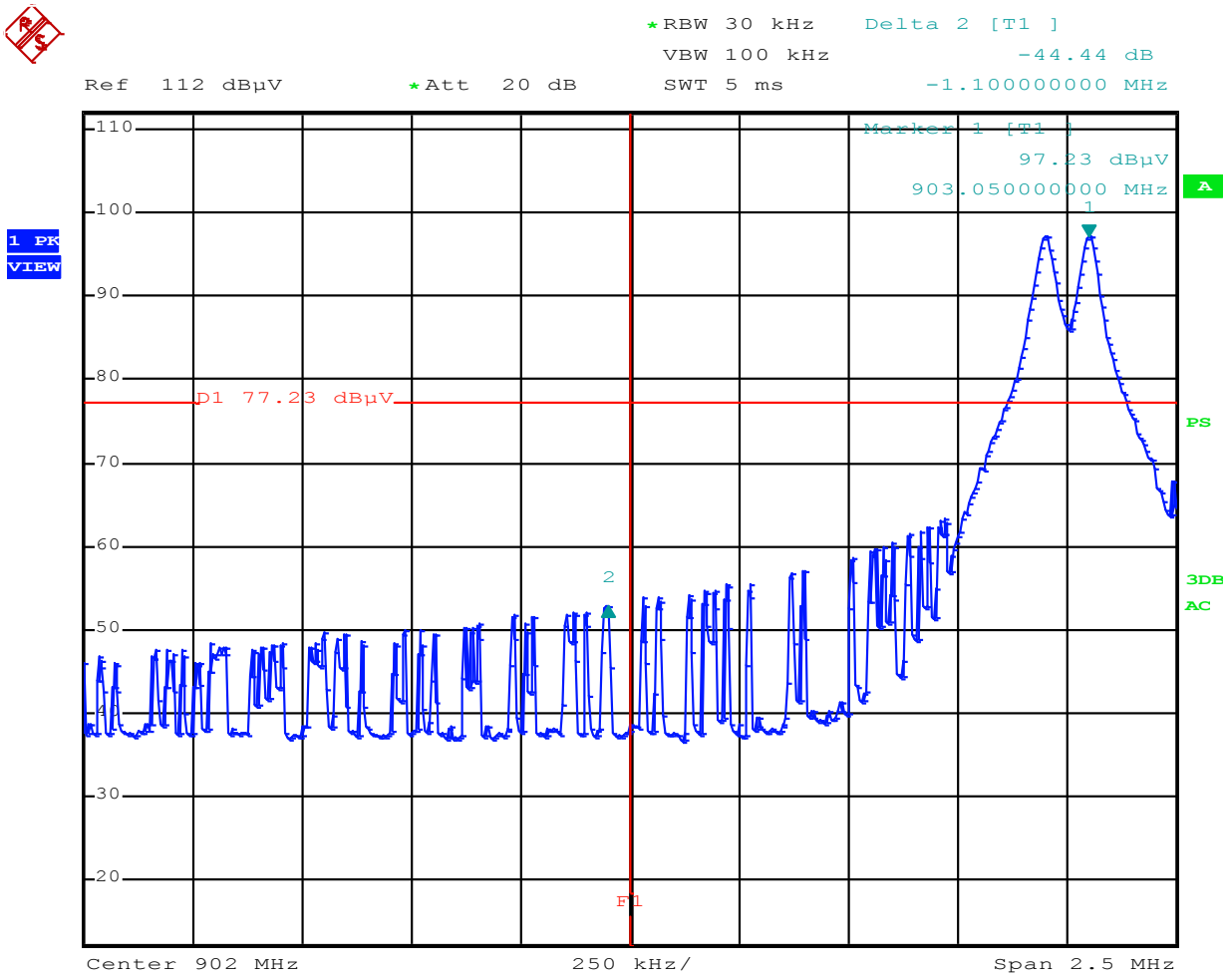
**Figure 45: Time Occupancy Per Frequency – 1.067mS***

*Figure 42 indicates that the interval between the frequency of interest and the nearest adjacent frequency in the pseudo random hopping list is 1 seconds. (A wide RBW was used to capture the nearest adjacent channel).

There are 120 channels in the pseudo random sequence so the next time the same channel will be used will be in 120 seconds.

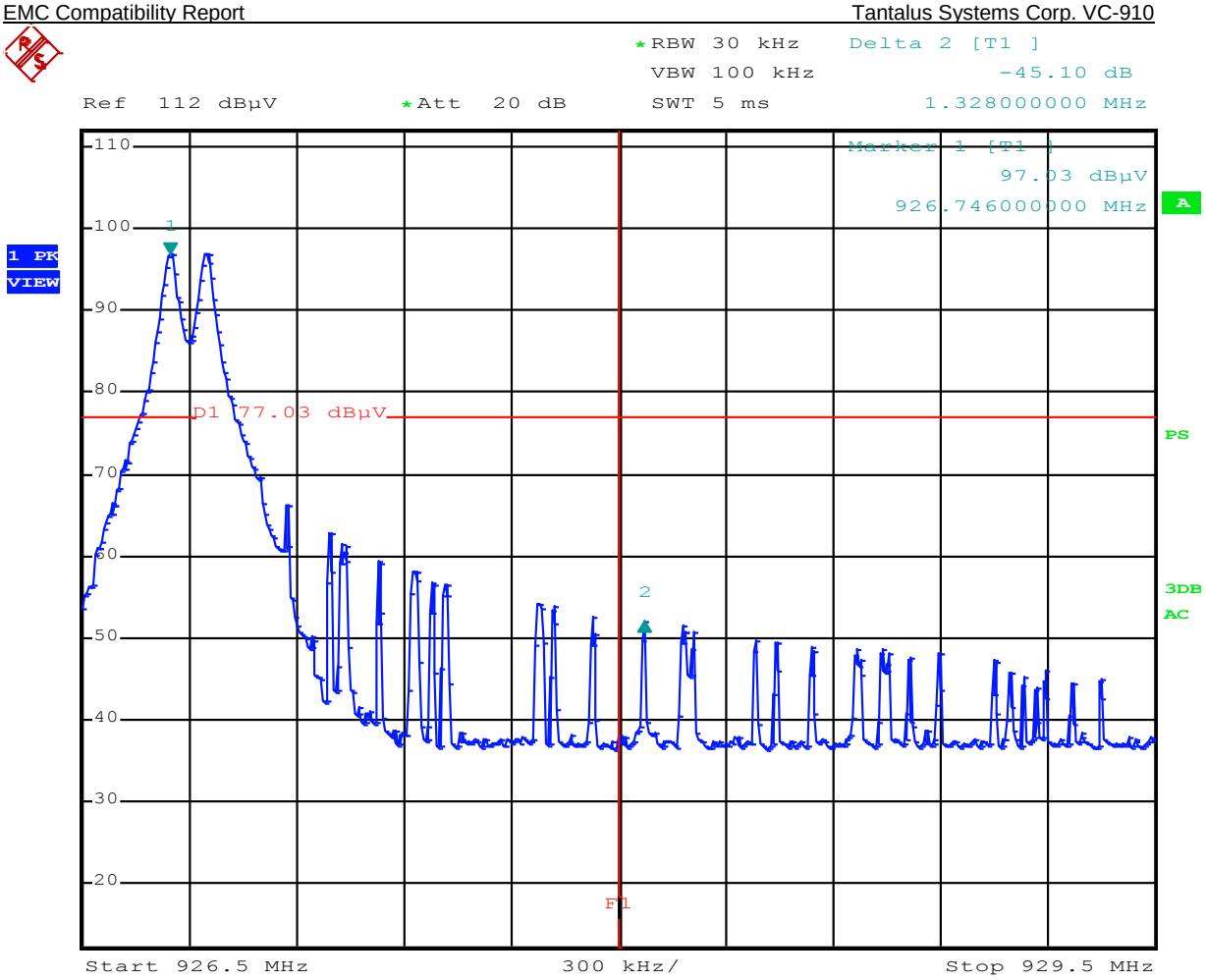
Therefore the time of occupancy per frequency is 0.0064/120 Seconds or 1.067mS in 20 Seconds.

## Channel Bandedge




Date: 18.DEC.2013 17:08:46

**Figure 46: Low Channel Bandedge**




Date: 18.DEC.2013 16:39:00

**Figure 47: High Channel Bandedge**

## Radiated Spurious Harmonics

Measurement Date: July 1, 2013

**Setup:**

Correction factor includes antenna, cables.

NOTE: The EUT worst case "ON" time was measured to be 0.624 ms per 100ms. This equates to a duty cycle correction factor of -44.1 dB that has been applied to the measured average values in accordance with 15.35(c). In accordance with 15.31(o) emissions that are 20dB below the permissible value have not been reported.

All emmissions, when the fundamental frequency is at the low frequency band of operation, were below 20dB of the permissible value and in accordance with 15.31(o) they have not been reported.

**Table 5: Harmonics at Low Frequency**

| Frequency | Pol. | Corrected Value | Average Limit at 3m | Duty Cycle Correction | Delta Limit-Meas. | Peak Limit at 3m | Delta Limit-Meas |
|---|---|---|---|---|---|---|---|
| (MHz) | | (dBuV/m) | (dBuV/m) | (dB) | (dB) | dB(uV/m) | (dB) |
| 8234.8 | H | 56.4 | 54 | 44.1 | **41.7** | 74 | **17.6** |

**Table 6: Harmonics at Mid Frequency**

| Frequency | Pol. | Corrected Value | Average Limit at 3m | Duty Cycle Correction | Delta Limit-Meas. | Peak Limit at 3m | Delta Limit-Meas |
|---|---|---|---|---|---|---|---|
| (MHz) | | (dBuV/m) | (dBuV/m) | (dB) | (dB) | dB(uV/m) | (dB) |
| 7420.9 | H | 54.6 | 54 | 44.1 | **43.5** | 74 | **19.4** |
| 7420.9 | V | 57.1 | 54 | 44.1 | **41.0** | 74 | **16.9** |

**Table 7: Harmonics at High Frequency**

# Appendix B: Test Setup Photos

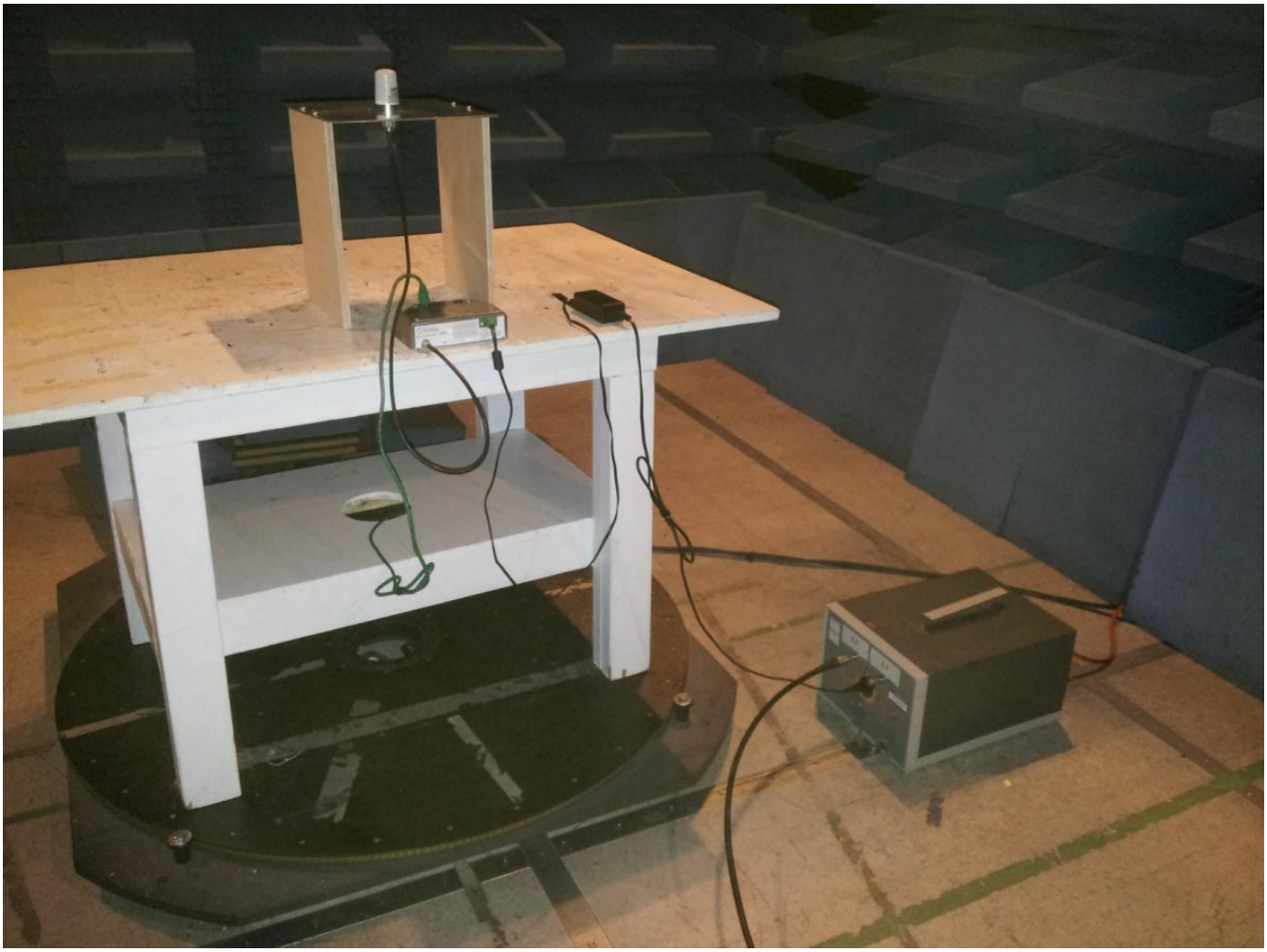
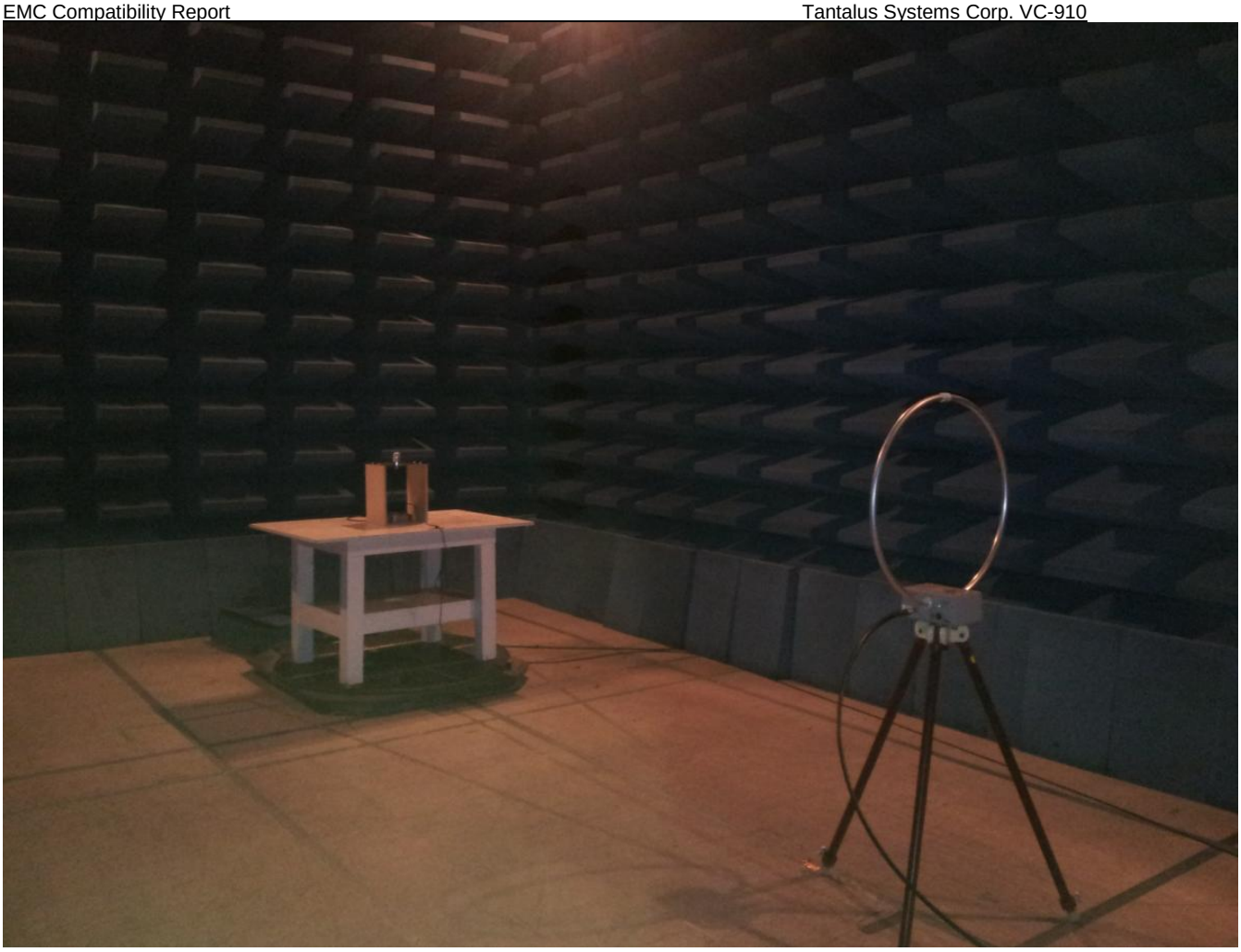
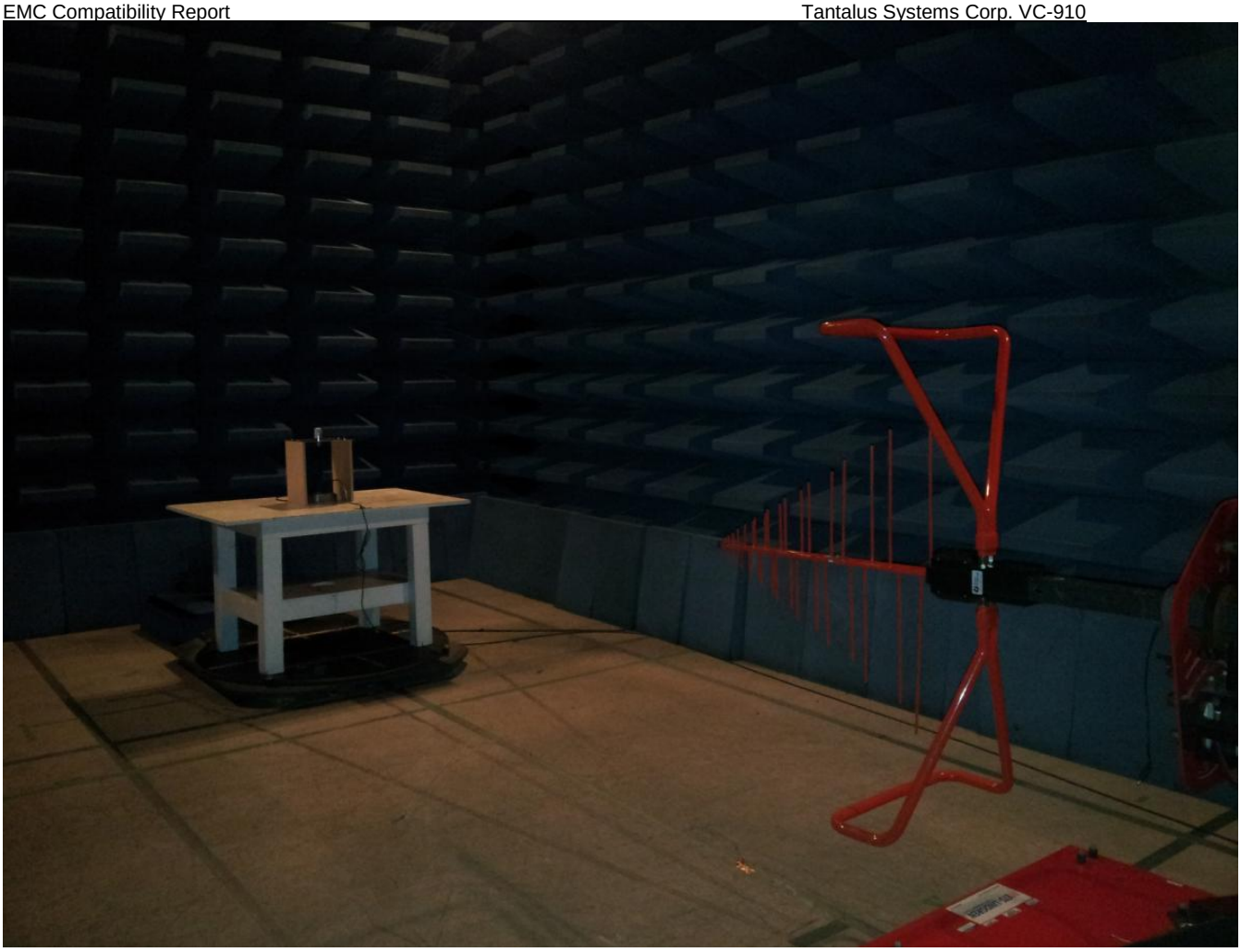


**Figure 48: AC Conducted Test Setup**



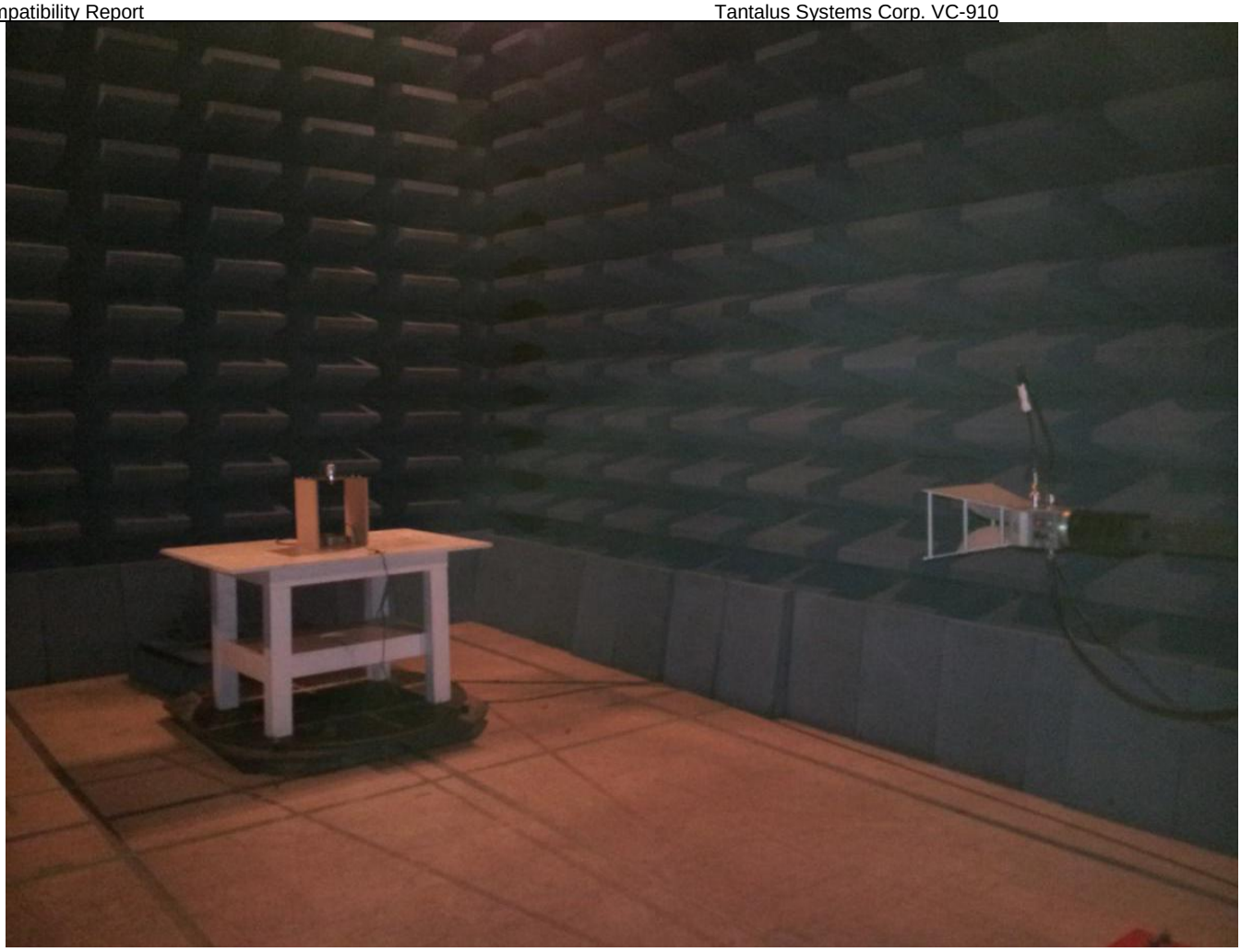
Intentional / Unintentional Radiated Emmission 9kHz – 30 MHz setup.

**Figure 49: Emissions Test Setup – Intentional / Unintentional Radiated Emissions**



Intentional / Unintentional Radiated Emmission 30 – 1000 MHz setup.

**Figure 50: Emissions Test Setup – Intentional / Unintentional Radiated Emissions**



Intentional Radiated Emmissions 1000 – 10000 MHz setup.

**Figure 51: Emissions Test Setup – Intentional Harmonics**