# Tantalus Systems Corp.

# ST-1480

## Report of Measurements for FCC and IC Compliance

per

## Industry Canada RSS-210 Issue 7

and

## FCC CFR47 Part 15/C – 15.247

Revision 1.0

Apr 10, 2010

| Approval | | |
|---|---|---|
| Written By: | Ivan Chan | Apr 10, 2010<br>Date |

| Approval | | |
|---|---|---|
| Approved By: | Robert Stirling, P.Eng | May 3, 2010<br>Date |

Protocol Datasystems Labs, Abbotsford BC, Canada
FCC Registration Number 96437
Industry Canada Registration Number IC3384

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# Section 1: Information for Test Report of Measurements

## Testing Details

TESTED BY: Parmvinder

TEST CONDITIONS: Temperature and Humidity: 22°, 47%

TEST VOLTAGE: 24V A.C.

## Test Facilities

Protocol Datasystems Labs
4741 Olund Rd.
Abbotsford BC, Canada, V4X 2A1

FCC Registration Number 96437
Industry Canada Registration Number IC3384

## Test Equipment List

| Device | Model Number | Equipment Description | Serial No. | Next Cal |
|---|---|---|---|---|
| HP | 85650A | CDN Quasi-Peak Adapter | 2811A01080 | 12/08/10 |
| HP | 85662A | Spectrum Analyzer Display | 2152A03569 | 11/08/10 |
| HP | 8566B | Spectrum Analyzer RF Section | 2241A02102 | 11/08/10 |
| HP | 85685A | RF-Preselector | 3107A01222 | 11/08/10 |
| EMCO | CPA-30 | Ant Log Periodic 200-1000MHZ | 9611-4699 | 08/08/10 |
| EMCO | 3110B | Ant Biconical 20-300MHz | 9401-1850 | 08/08/10 |
| EMCO | 3115 | Horn Antenna 1-18GHz | 9403-4251 | 20/08/10 |
| EMCO | 3825/2 | LISN | 2470 | 20/07/10 |
| Rhientech | Custom | Antenna Mast | N/A | N/A |
| Protocol EMC | Custom | Turntable | N/A | N/A |

## Company Tested

NAME: Tantalus Systems Corp.

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

CONTACT PERSON: Mr. Ivan Chan

PHONE NUMBER: 1-604-299-0458 x:203

## Equipment Under Test

THE TEST SYSTEM: EUT: Tantalus Systems have repackaged a previously FCC-compliant transceiver in a different form factor with a Zigbee radio on the board. No hardware, or software changes were made to the transceiver to accomplish this change, and the EUT had certain parametrics re-tested to ensure that the device continues to comply with FCC and IC requirements.

Manufacturer: Tantalus Systems Corp.
Part Numbers: 100-0062-C
Serial number: 0005192318

AUX equipment: COM_POWER board

Manufacturer: Tantalus Systems Corp.
Part Numbers: 200-0014-C
Serial number: ENG01

TEST SETUP: This EUT is designed to communicate with a base unit using a Frequency Hopping Spread Spectrum (FHSS) system operating on the 902-928 MHz band. It has one integrated chip antenna to perform this function. To test the relevant parametrics, a coaxial pigtail was used for any conducted tests.

CABLING:

| Cable | Pins | Connector | Load/Termination | Shielded | Ferrites |
|---|---|---|---|---|---|
| Power | 2 | Terminal | No | No | No |

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

CONCLUSION: The ST-1480 complies with the requirements of FCC CFR47 and the requirements of Industry Canada RSS-210.

# Section II: IC RSS-210 Iss.7 & 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 A respecte toutes les exigences du Reglement sur le material broilleur due 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 7 Emissions Testing

**Test Results – Summary**

Testing was performed pursuant to Industry Canada RSS-210 Issue 7.

| Test | Standard | Description | Result |
|---|---|---|---|
| Radiated Emissions Idle Mode<br>Subclause 8.2 | RSS-210 2.2(b) | The radiated emissions are measured in the 30-1000MHz range | Complies |
| Conducted Emissions Idle Mode<br>Subclause 8.3 | EN55022<br>Class B 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 30-9000MHz range | Complies |
| Output Power and EIRP Emissions | RSS-210 A8.4(1) | Output power shall not exceed 1.0 Watt | Complies |

# Part 1 – Radiated Emissions Testing

DATE Dec 01, 2009

TEST STANDARD: RSS-210 2.2(b)

TEST SETUP: The EUT was operated and tested at 24Vac 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 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. 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.

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

$$L2 = L1(d1/d2)$$

Where L1 is the specified limit in µV/m at the distance d1. L2 is the new limit at the new distance d2.

EMISSIONS DATA: See Table 2 in Appendix A for corresponding frequencies.

PERFORMANCE: Complies.

# Part 2 – Conducted Emission Testing

DATE: Dec 1, 2009

TEST STANDARD: EN55022

MINIMUM STANDARD: Class B Limit:

TEST SETUP: The EUT was connected to the conducted emissions LISN appartus. The equipment was operated and tested at 24Vac 60Hz.

MINIMUM STANDARD: Class B Limit:

| Frequency (MHz) | Conducted Limit (dBµV) | |
|---|---|---|
| | Quasi-Peak | Average |
| 0.15 – 0.50 | 66 to 56 | 56 to 46 |
| 0.50 – 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 Table 3 and Table 4 in Appendix A for corresponding frequencies.

PERFORMANCE: Complies.

# Part 3 – Radiated Emissions – Transmit Mode

DATE: Dec 2, 2009

TEST STANDARD: RSS-210 Iss.7 A8.5 – 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 24Vac 60Hz for the tests where the unit is in continuous transmit mode, the COM_POWER board was added to the EUT.

METHOD OF MEASUREMENT: Measurements were made using 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.

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 30-1000MHz were tested at 3m and all frequencies 1GHz and up were tested at 1m in accordance with ANSI c63.4.

EMISSIONS DATA: See Plots and Tables in Appendix A for corresponding data. A summary of the results as per the above requirements.

| 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 |
| Channel Bandwidth | RSS-210 A8.1(a) | See Figure 4 to Figure 6 in Appendix A. The widest 20dB bandwidth was measured to be 115.1 kHz. |
| Channel Separation | RSS-210 A8.1(c) | See Figure 7 to Figure 9 in Appendix A. The widest Channel separation was measured to be 129.4 kHz. |
| Number of Hopping Channels | RSS-210 A8.1(c) | See Figure 10 in Appendix A. The number of channels has been set to 50 channels. |
| Hopping Channels time of Occupancy | RSS-210 A8.1(c) | See Figure 11 in Appendix A; the time of occupancy is 4.266 milliseconds at an interval of 711 milliseconds per Figure 12. This is equal to an average time "ON" of : 120 milliseconds within a 20 second period. |
| 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 0.252W (or 24dBm) |
| Out of Band Emissions | RSS-210 A8.5 | See Plots Figure 13 to Figure 16 in Appendix A. All radiated emissions |

| | | |
|---|---|---|
| | | were within the RSS-210 A8.5 limit. |

PERFORMANCE: Complies.

# Part 4 – Output Power and EIRP Emissions

DATE: Dec 3, 2009

TEST STANDARD: RSS-210 Iss.7 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 integrated chip antenna and associated matching circuitry was removed from the device under test. A coaxial pigtail was soldered onto the a RF probe point and a conducted measurement was performed across the frequency band with an attenuator protecting the spectrum analyzer.

The peak gain of the integrated chip antenna is -1dBi, hence a conducted test is representative of the worse case power output.

MEASUREMENT DATA:

| Freq(MHz) | Reading (dBµV) | External Attenuation (dB) | Total Value (dBµV) | Total Value (W)) |
|---|---|---|---|---|
| 915 | 120.9 | 10.1 | 131 | 0.252 |
| 927.83 | 119.8 | 10 | 129.8 | 0.191 |
| 902.16 | 120.5 | 10.35 | 130.85 | 0.243 |

PERFORMANCE: Complies.

# Part 5: Out of Band Emissions

DATE: Dec 3, 2009

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 **Table 5** to **Table 10** in Appendix A. All limit lines are referenced against the amplitude of the fundamental frequency.

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. 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) was used as a guide to the tests to be performed.

## Labeling Requirements

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

## Test Results - Summary

Testing was performed pursuant to Industry Canada RSS-210 Issue 7 Section A8.

| Test | Standard | Description | Result |
|---|---|---|---|
| Radiated Emissions Idle Mode | FCC Part 15 Subpart B Class B Limits | The radiated emissions are measured in the 30-1000MHz 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 30-9000MHz range. | Complies |

# Part 1 – Radiated Emission Testing

DATE: Dec 1, 2009

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

TEST VOLTAGE: 24Vac 60Hz

TEST SETUP: The equipment was set up in a 3-meter open field test site. 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 | 2 | 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 Table 1 in Appendix A for corresponding frequencies.

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 EUT PCB has a integrated ceramic chip antenna placed and soldered during manufacturing, as such it is considered to be a permanently attached antenna.

# 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 |

*Decreases with the log of frequency

3.2 RESULT

MEASUREMENT DATA: See Appendix A for Plots.

EMISSIONS DATA: See Table 3 and Table 4 in Appendix A for corresponding frequencies.

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 |

The EUT was set up in a 3-meter open field test site for tests up to 1GHz and tests were performed on a test bench at 1m for emissions 1GHz to 10GHz. Emissions in both horizontal and vertical polarizations were measured while rotating the EUT on a turntable to maximize the emissions signal strength and the results recorded on the attached plots. The EUT was programmable to broadcast on standalone frequencies at the low (902), middle (915) and high (928) channels; 2 channel hopping at the end frequencies (902.5 and 927.5); standalone hopping at the middle frequency (915) and full 50 channel hopping frequencies 902.5 to 927.5MHz.

An average detector was not used in the taking of these measurements. Hence, Section 15.35(b) and (c) permit the allowance of peak radio frequency emissions of 20dB above the maximum permitted average emission level radiated by the device. As the transmitter operates longer than 100ms per transmission of 50 hops, the averaged interval was taken to be 100ms. The calculation of the Average Correction Factor is computed by analyzing the worst case “ON” time in any 100ms time period using the formula:

Correction Factor (dB) = 20*log(worst case ON time / 100ms)

For this product, the EUT worst case “ON” time was measured on Figure 11 to be 4.266ms per 100ms interval. This equates to a possible correction factor of -27.399dB, but there is a cap of 20dB per Section 15.35(b), which is applied to the emissions data in Table 5 to **Error! Reference source not found.**.

CABLING DETAILS:

| Cable | Pins | Connector | Load/Termination | Shielded | Ferrites |
|---|---|---|---|---|---|
| Power | 2 | Terminal | No | No | No |

4.3 RESULTS:

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

MEASUREMENT DATA: See Plots Figure 4 to Figure 16 in Appendix A.

PERFORMANCE: Complies.

# Part 5: Output Power and EIRP Emissions

DATE: Dec 2, 2009

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 for systems employing at least 50 Hopping Channels.

TEST SETUP: Refer to setup in Part 1 above.

METHOD OF MEASUREMENT: The integrated chip antenna and associated matching circuitry was removed from the device under test. A coaxial pigtail was soldered onto the a RF probe point and a conducted measurement was performed across the frequency band with an attenuator protecting the spectrum analyzer.

The peak gain of the integrated chip antenna is -1dBi, hence a conducted test is representative of the worse case power output.

MEASUREMENT DATA:

| Freq(MHz) | Reading (dBµV) | External Attenuation (dB) | Total Value (dBµV) | Total Value (W)) |
|---|---|---|---|---|
| 915 | 120.9 | 10.1 | 131 | 0.252 |
| 927.83 | 119.8 | 10 | 129.8 | 0.191 |
| 902 | 120.5 | 10.35 | 130.85 | 0.243 |

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 RESULT

All of the measurements shown below were made when the EUT was set into a mode that only transmits a CW tone in order to facilitate measurements of the spurious emissions. The 20dB bandwidth of the CW signal is 97Hz, hence it is permissive to use a lower RBW of 1kHz to detect 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.

Due to the prescense of two intentional radiators, one of which being a FCC-certified Zigbee module operating in the 2.4GHz ISM band, intermodulation products mixed from both transmitters operating simultaneously were measured as well. All intermodulation spurious signals which mixed into restricted bands were measured and were all within the emission limits.

EMISSIONS DATA:

See **Table 5** to **Table 10** in Appendix A for corresponding data.

# Appendix A: Test Plots

## Unintentional Radiated Emissions

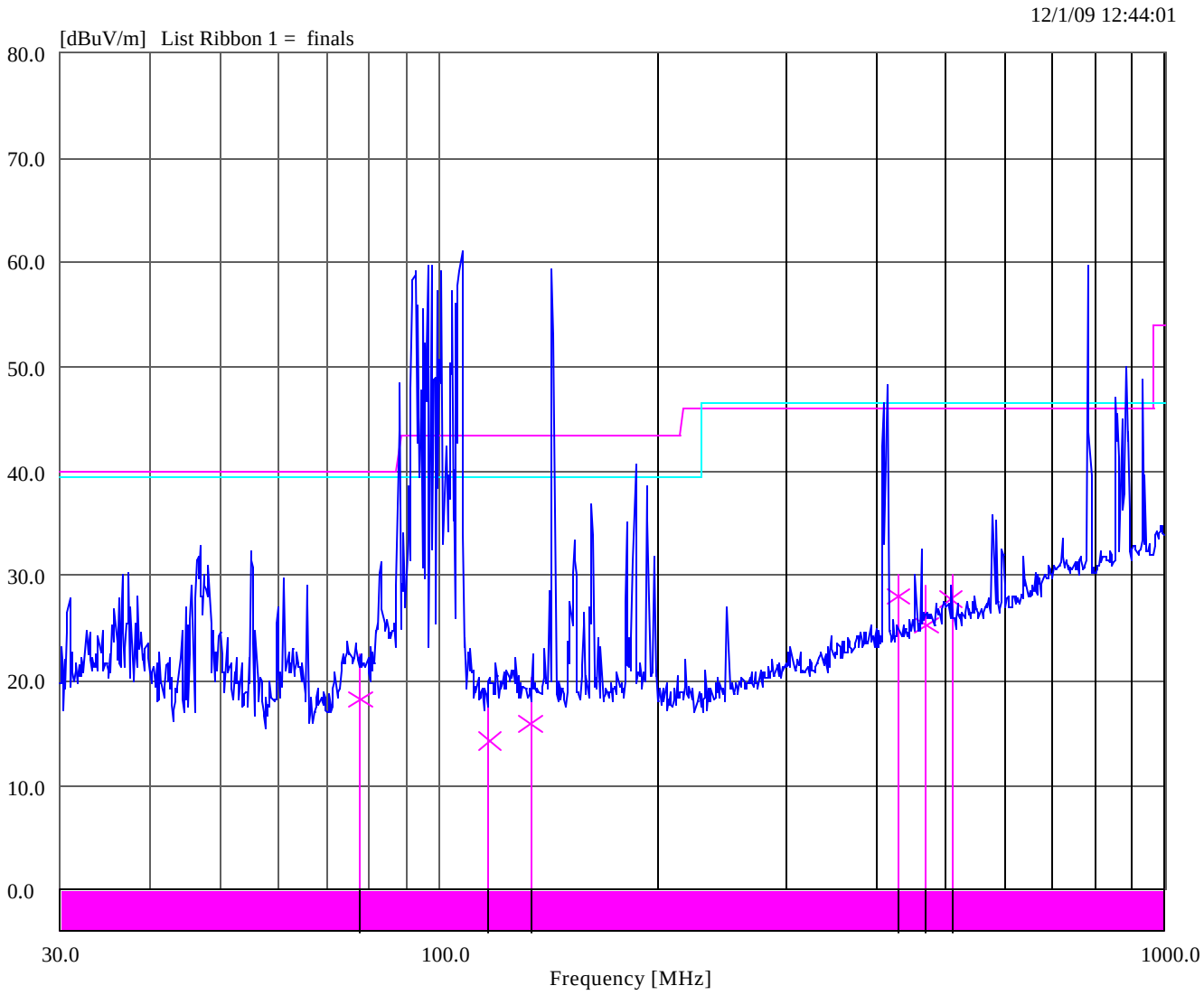


Figure 1: Unintentional Radiated Emissions

Table 1: FCC 15/B Class B Emissions - 3m

| Frequency (MHz) | Pol | Hgt (m) | Angle (deg) | Uncor-Pk (dBuV) | Tot Corr (dB) | Peak (dBuV/m) | QP Lmt (dBuV/m) | DelLim-Pk (dB) | QP (dBuV/m) | DelLim-QP (dB) |
|---|---|---|---|---|---|---|---|---|---|---|
| 77.89523 | V | 1 | 270 | 11.7 | 10.76 | 22.46 | 40 | -17.54 | 18.31 | -21.69 |
| 116.9965 | V | 1 | 90 | 5.2 | 13.04 | 18.24 | 43.5 | -25.26 | 14.37 | -29.13 |
| 133.703 | Horz | 1 | 120 | 6.4 | 13.78 | 20.18 | 43.5 | -23.32 | 15.97 | -27.53 |
| 429 | Horz | 1 | 90 | 10.7 | 19.38 | 30.08 | 46 | -15.92 | 28.05 | -17.95 |
| 467.995 | Horz | 1 | 90 | 8.7 | 20.36 | 29.06 | 46 | -16.94 | 25.27 | -20.73 |
| 506.9915 | Horz | 1 | 360 | 8.9 | 21.22 | 30.12 | 46 | -15.88 | 27.86 | -18.14 |

Table 2: IC/CE Class B

| Frequency (MHz) | Pol | Hgt (m) | Angle (deg) | Uncor-Pk (dBuV) | Tot Corr (dB) | Peak (dBuV/m) | QP Lmt (dBuV/m) | DelLim-Pk (dB) | QP (dBuV/m) | DelLim-QP (dB) |
|---|---|---|---|---|---|---|---|---|---|---|
| 77.89523 | V | 1 | 270 | 11.7 | 10.76 | 22.46 | 39.5 | -17.04 | 18.31 | -21.19 |
| 116.9965 | V | 1 | 90 | 5.2 | 13.04 | 18.24 | 39.5 | -21.26 | 14.37 | -25.13 |
| 133.703 | Horz | 1 | 120 | 6.4 | 13.78 | 20.18 | 39.5 | -19.32 | 15.97 | -23.53 |
| 429 | Horz | 1 | 90 | 10.7 | 19.38 | 30.08 | 46.5 | -16.42 | 28.05 | -18.45 |
| 467.995 | Horz | 1 | 90 | 8.7 | 20.36 | 29.06 | 46.5 | -17.44 | 25.27 | -21.23 |
| 506.9915 | Horz | 1 | 360 | 8.9 | 21.22 | 30.12 | 46.5 | -16.38 | 27.86 | -18.64 |

# A.C. Mains Conducted Emissions

FCC/CE Class B - Emissions

Table 3: AC Conducted Emissions Line 1
120VAC 60Hz – Line 1 peaks

| Freq | Peak | Delta from Avg limit |
|---|---|---|
| (MHz) | (dBuV) | (dB) |
| 0.7263 | 39.1 | -6.9 |
| 0.8741 | 36.8 | -9.2 |
| 0.734 | 36.3 | -9.7 |
| 0.8291 | 35.8 | -10.2 |
| 1.121 | 35.5 | -10.5 |
| 0.7739 | 35.4 | -10.6 |

Table 4: AC Conducted Emission Line 2
120VAC 60Hz – Line 2 - peaks

| Freq | Peak | Delta from Avg limit |
|---|---|---|
| (MHz) | (dBuV) | (dB) |
| 0.6889 | 37.6 | -8.4 |
| 0.7419 | 37.4 | -8.6 |
| 0.8335 | 35.5 | -10.5 |
| 0.9265 | 35 | -11.0 |
| 0.9769 | 34.8 | -11.2 |
| 0.734 | 34.1 | -11.9 |

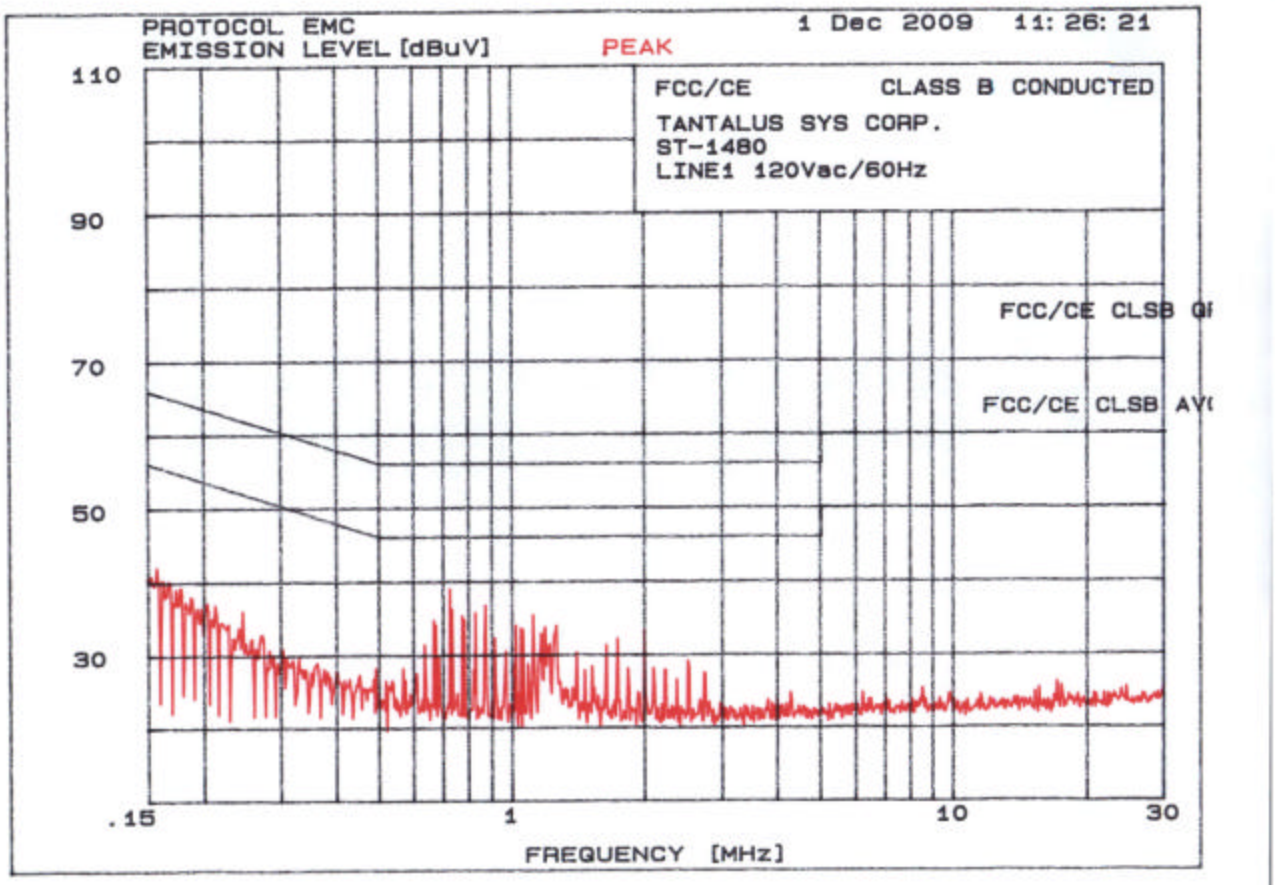


Figure 2: AC Conducted Emissions - Line 1

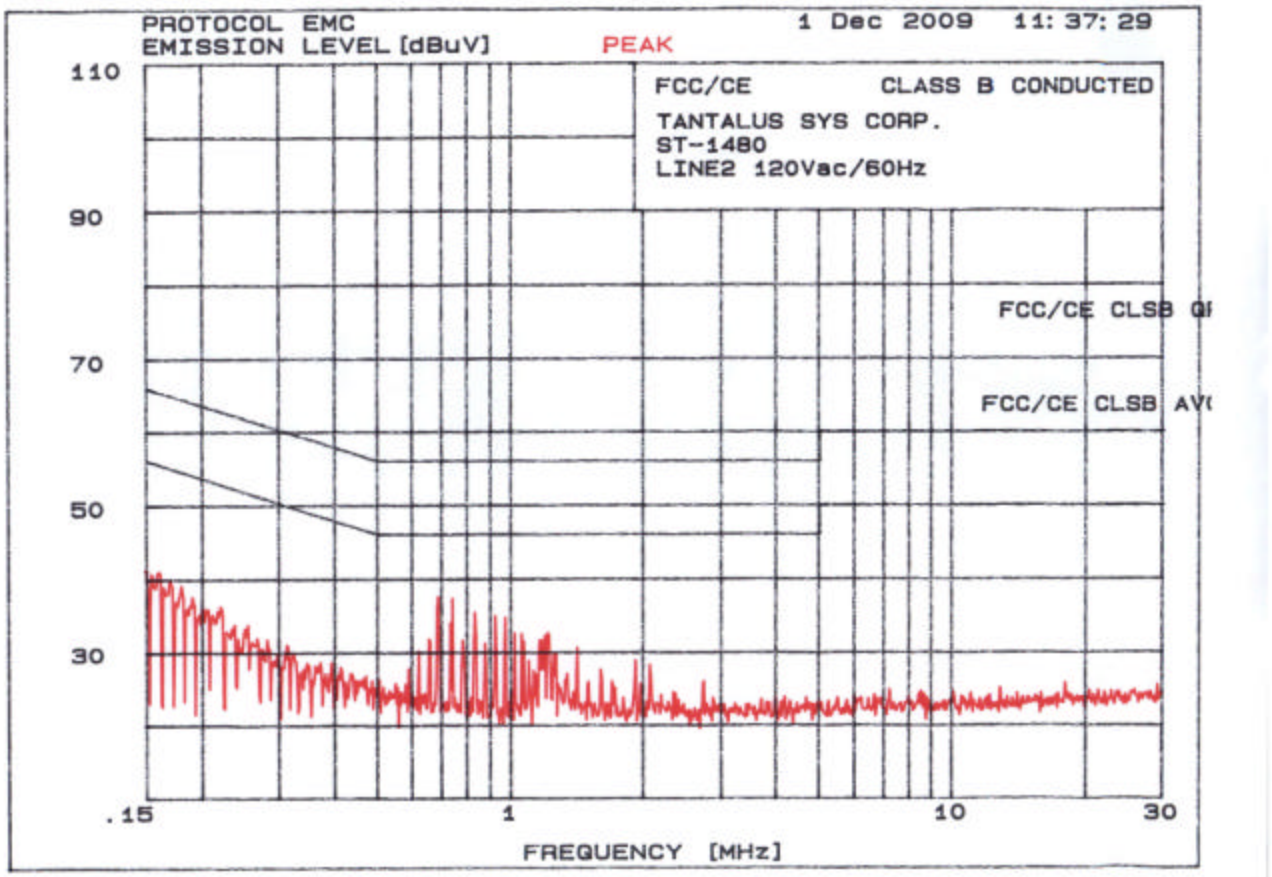


Figure 3: AC Conducted Emissions - Line 2

## 20 dB Bandwidth

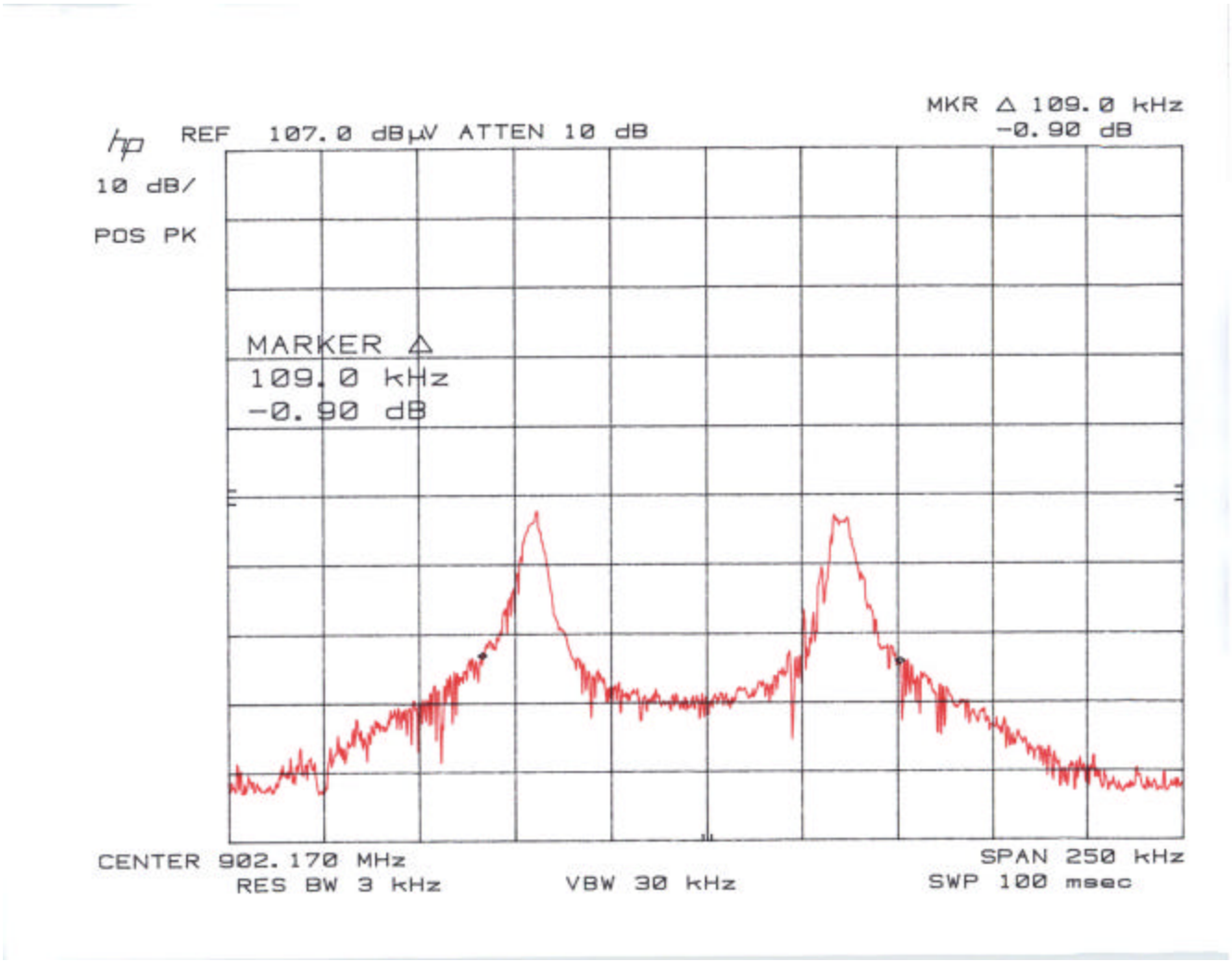


Figure 4: 20dB Bandwidth - Lower Frequency Band

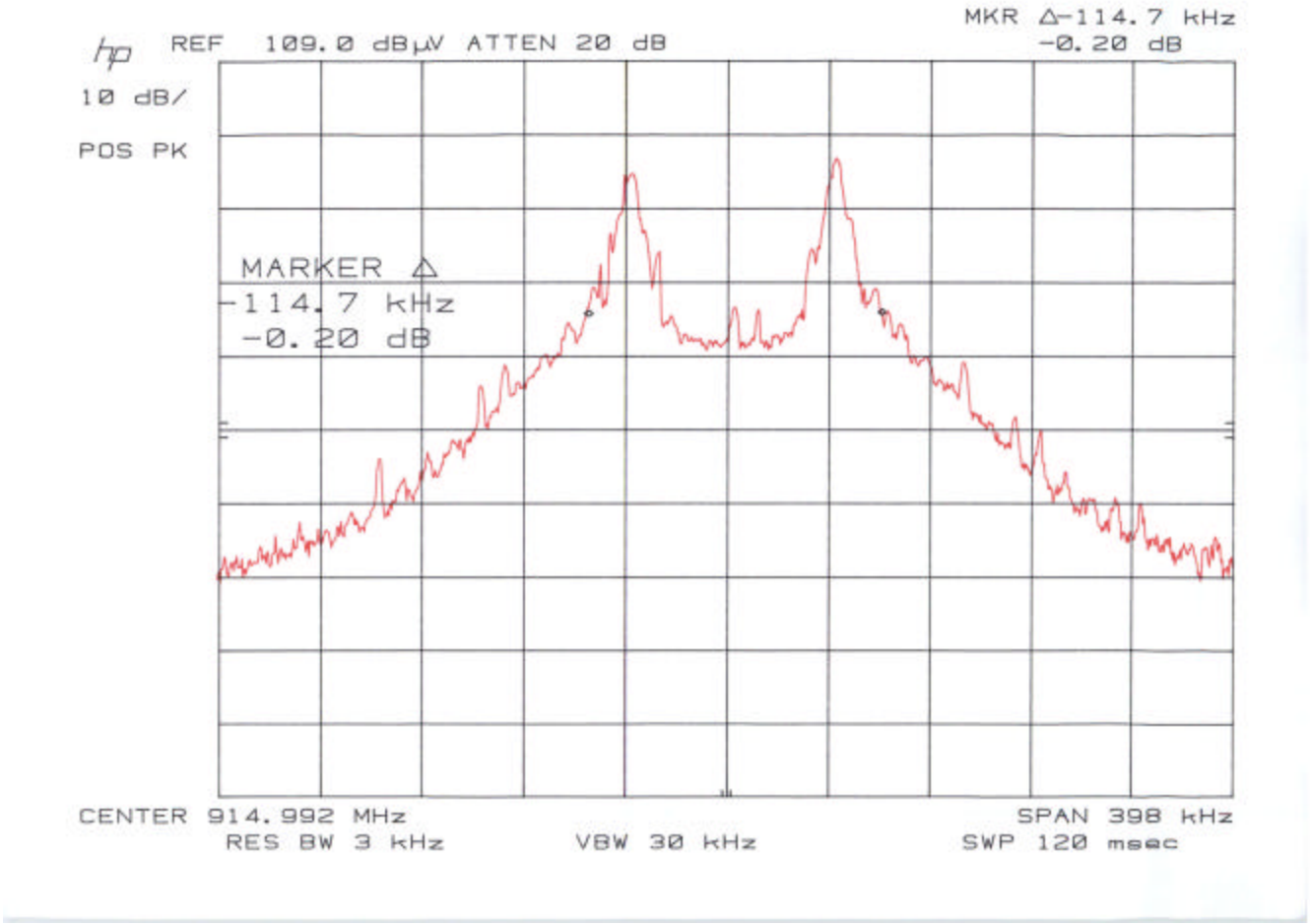


Figure 5: 20dB Bandwidth - Middle Frequency Band

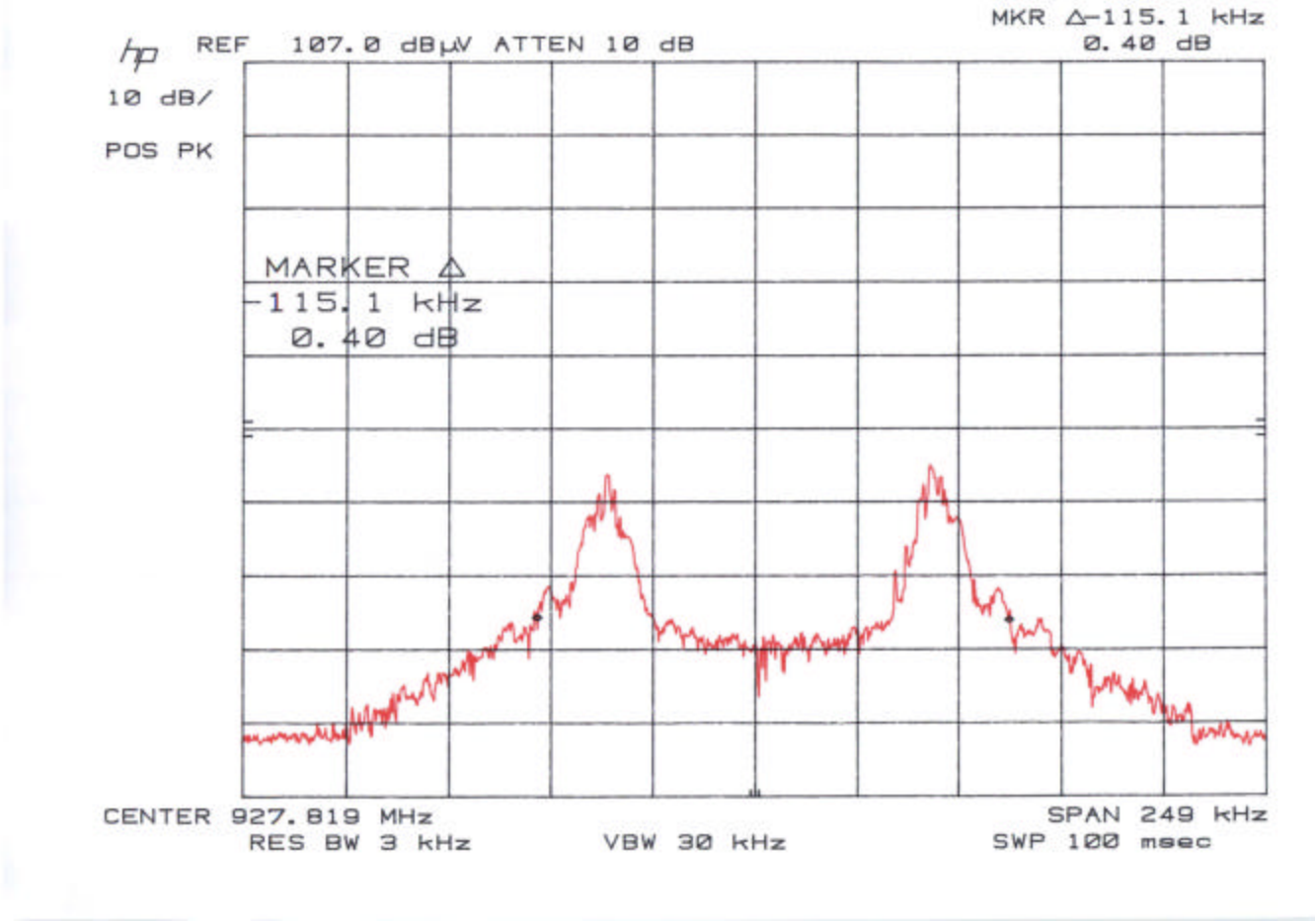


Figure 6: 20dB Bandwidth - Upper Frequency Band

## Channel Separation

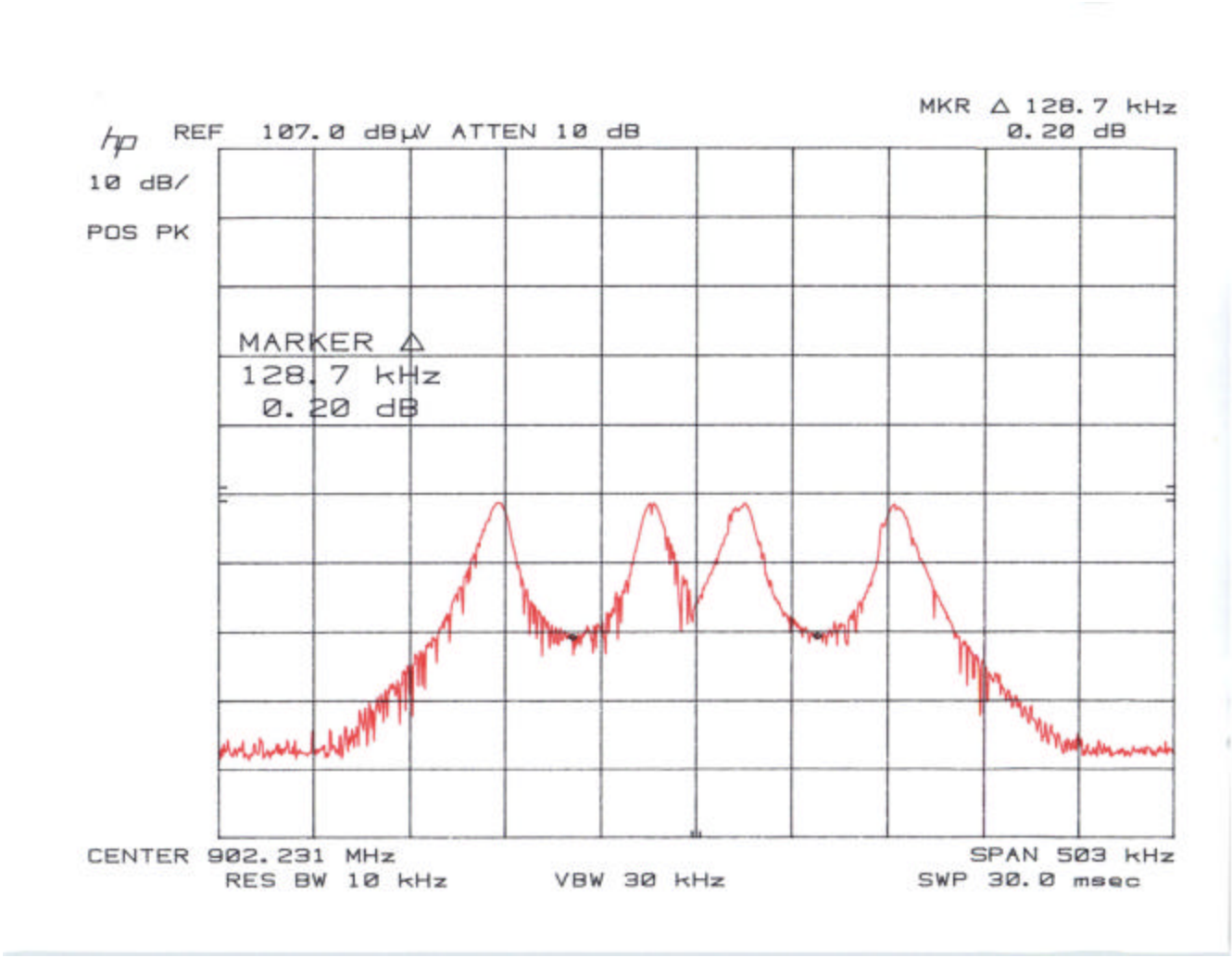


Figure 7: Channel Separation - Lower Frequency Band

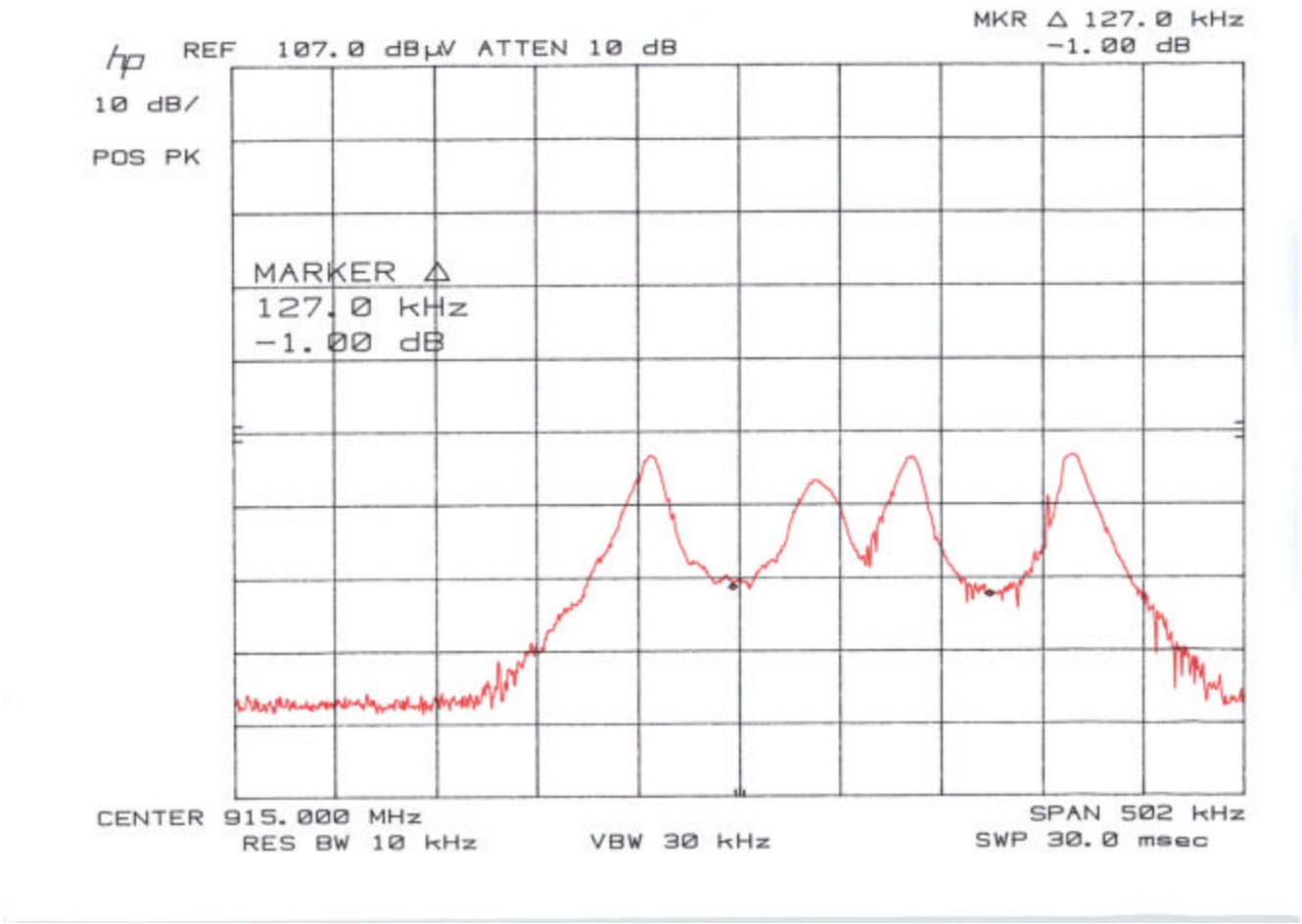


Figure 8: Channel Separation - Middle Frequency Band

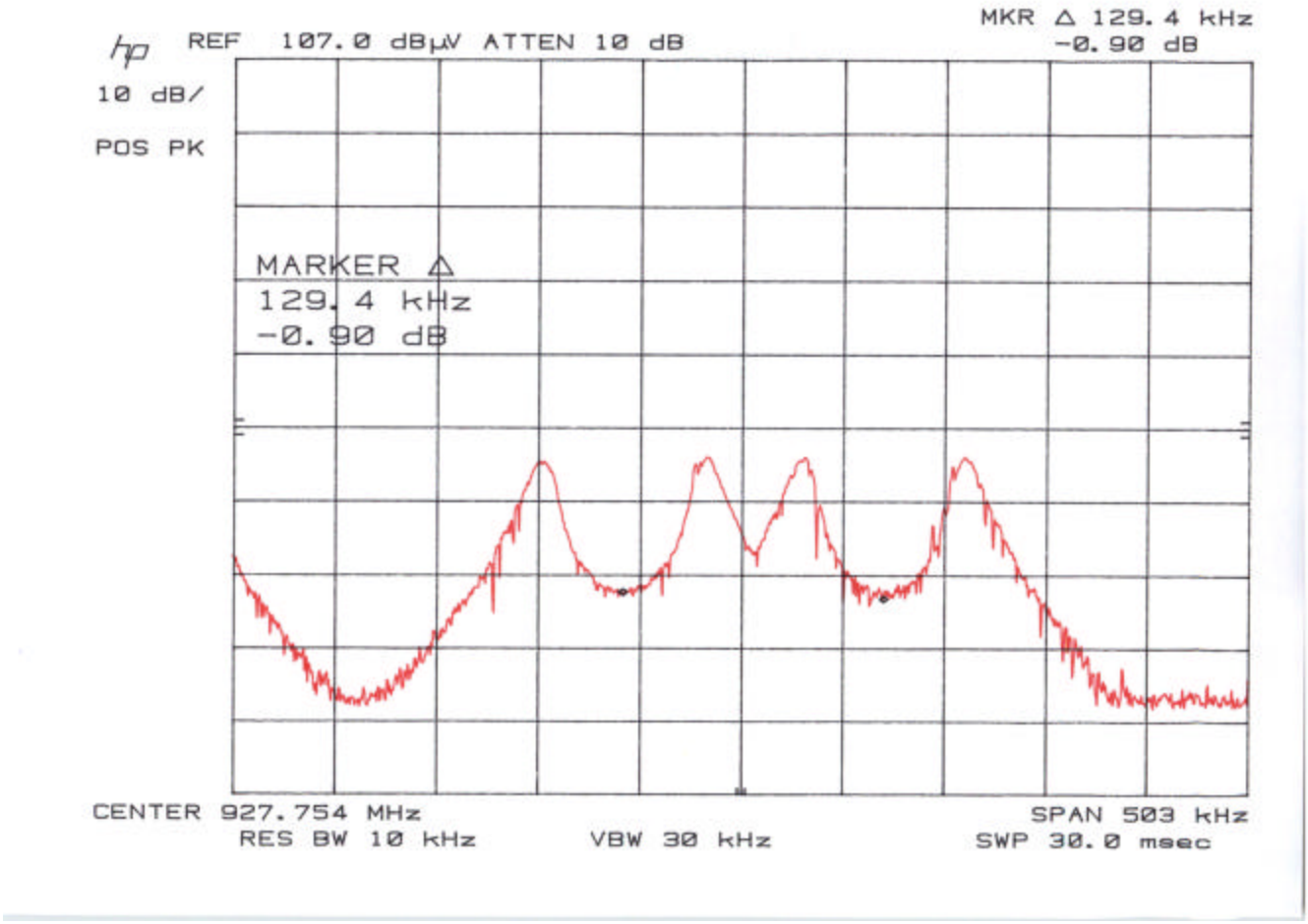


Figure 9: Channel Separation - Upper Frequency Band

## Number of Hopping Channels

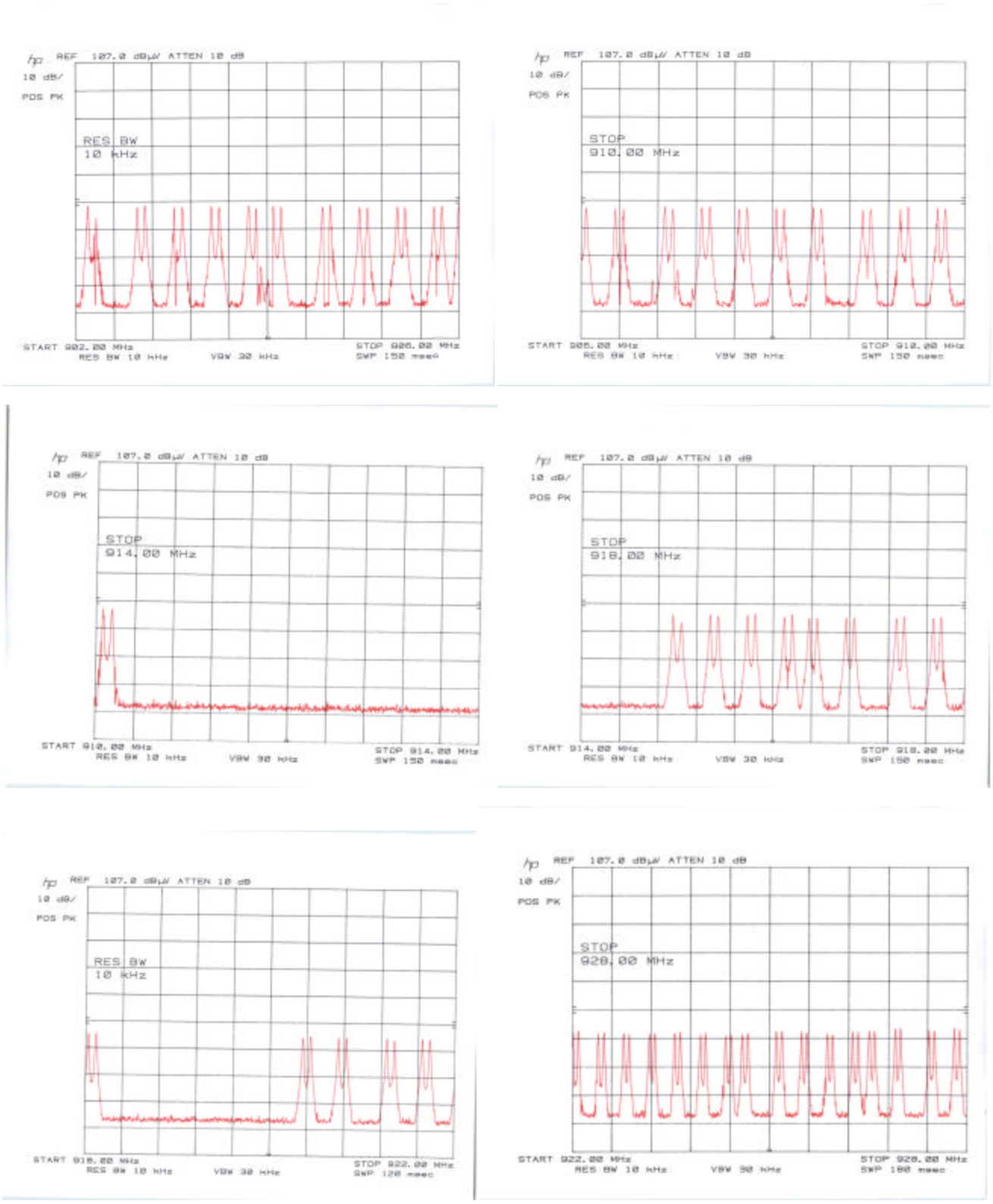


Figure 10: Number of Hopping Channels - 50

## Hopping Channels Time of Occupancy

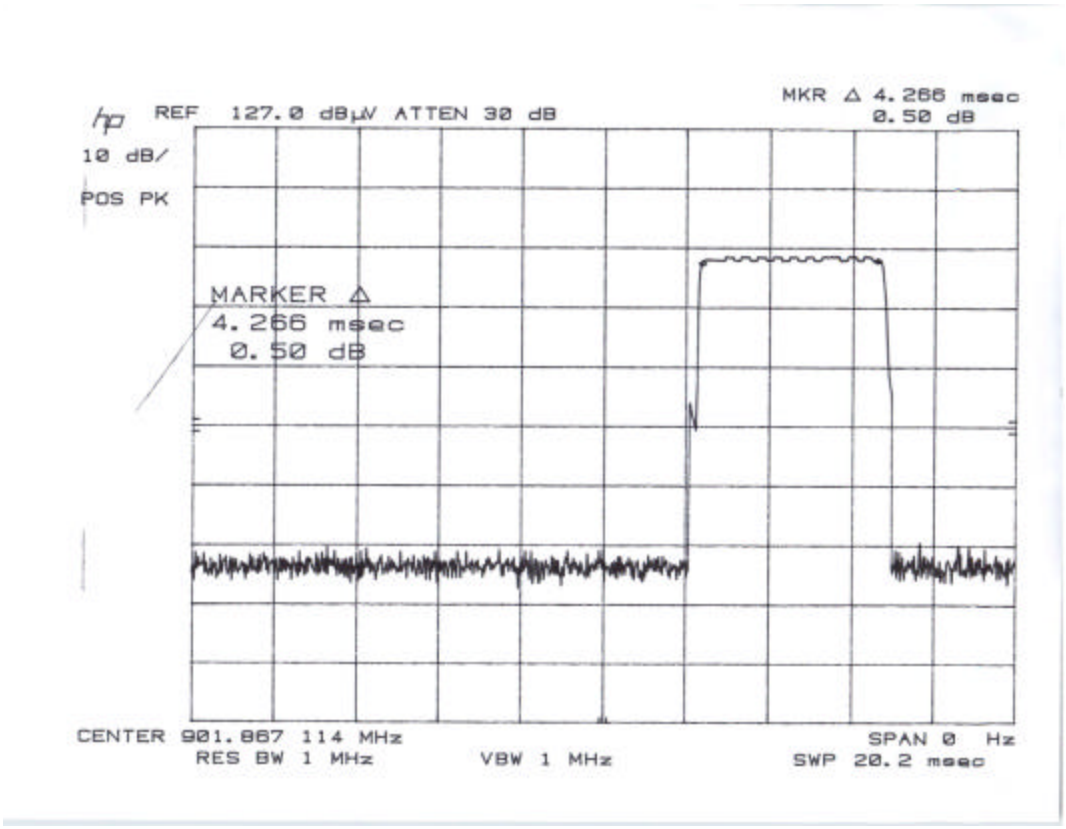


Figure 11: Time of Occupancy per Pulse

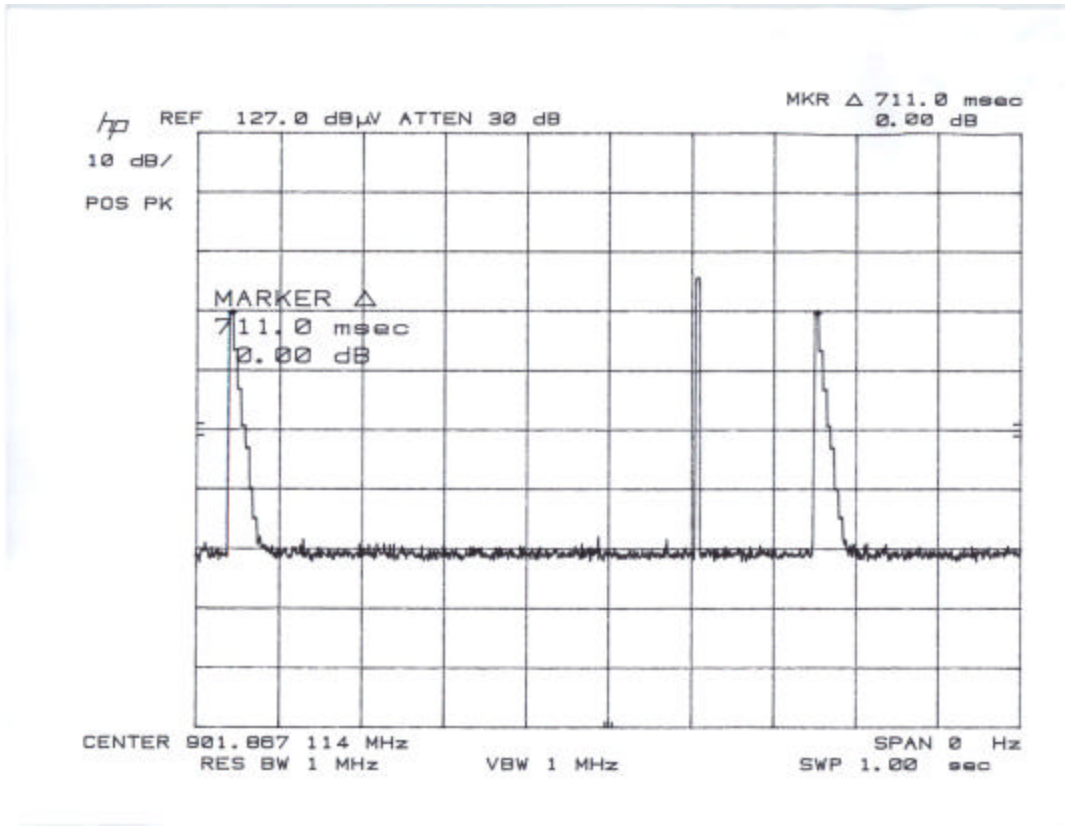

Figure 12: Measured Interval Between 2 Pulses

## Channel Bandedge

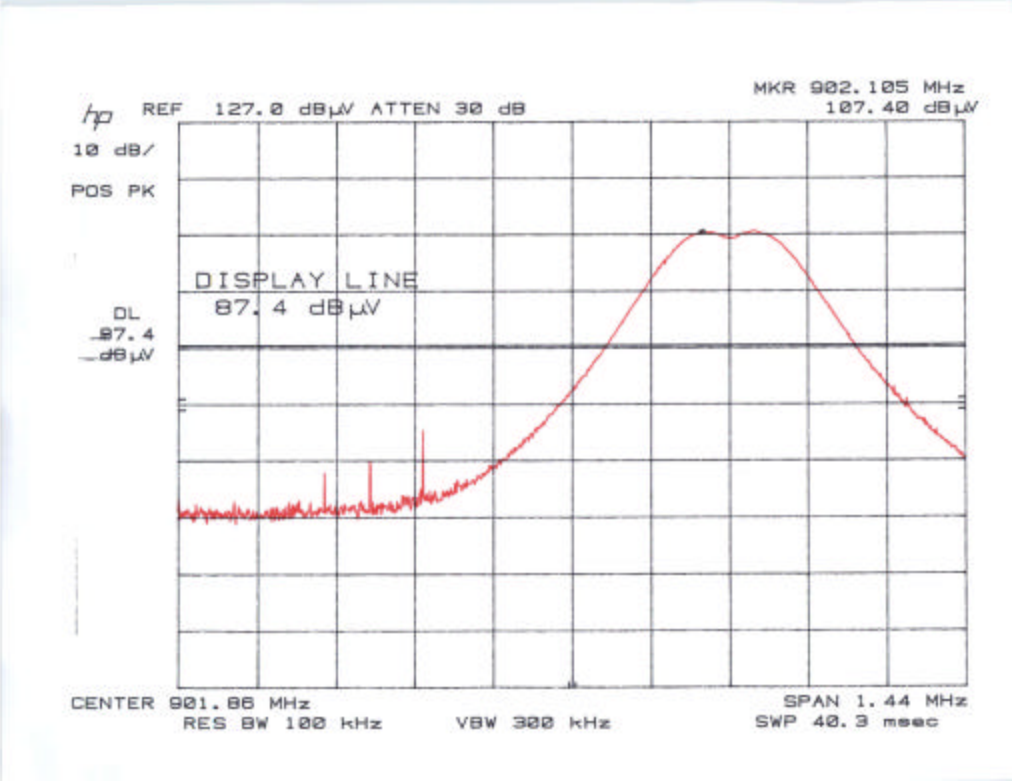


Figure 13: Low Channel Bandedge - Nonhopping Plot

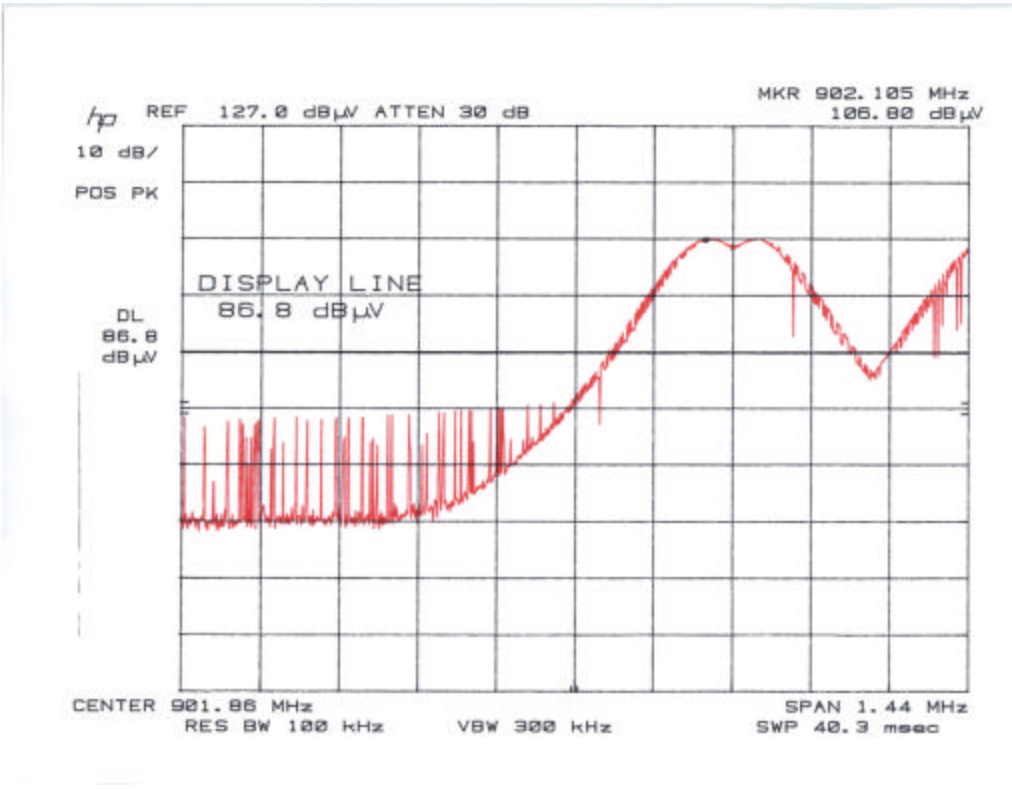

Figure 14: Low Channel Bandedge - Hopping Plot

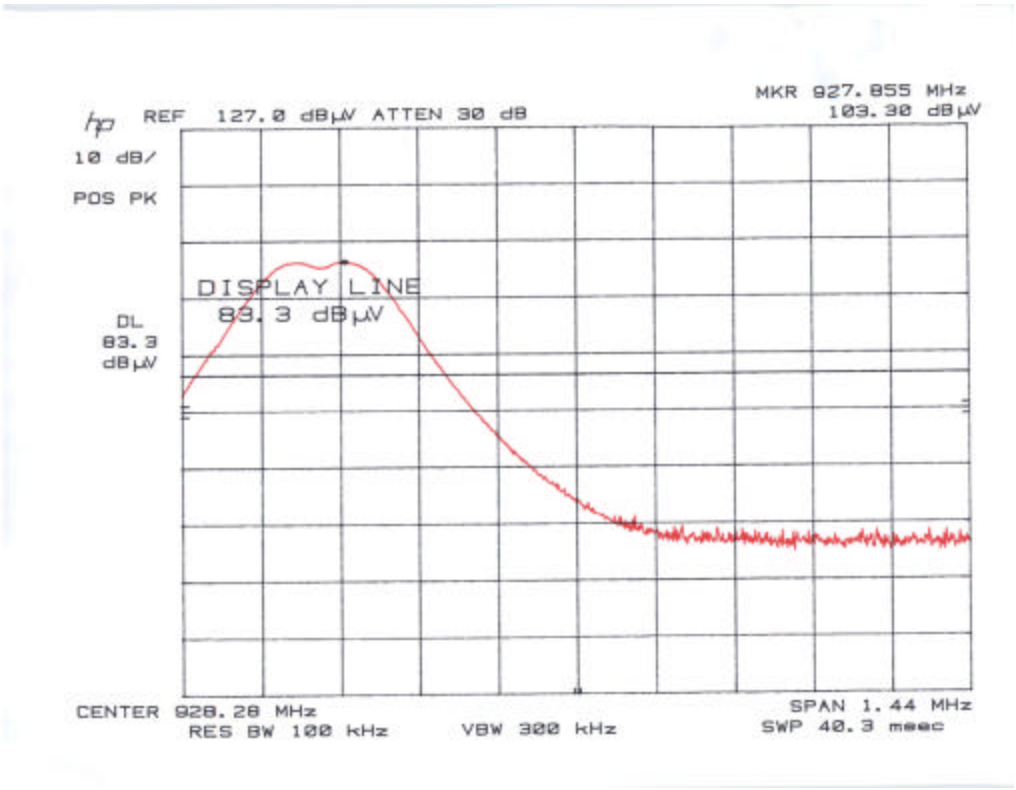


Figure 15: High Channel Bandedge - Nonhopping Plot

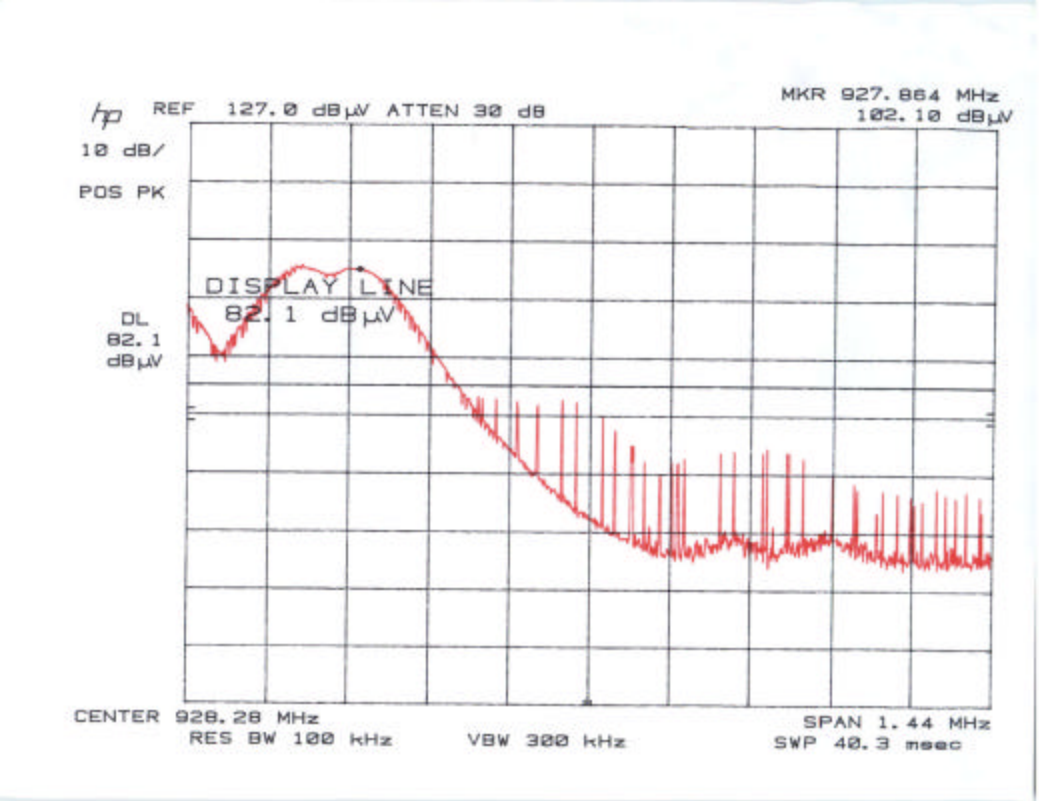


Figure 16: High Channel Bandedge - Hopping Plot

**Measurement Settings for Harmonics:**

RBW: 1kHz
VBW: 10Hz
Span: 5kHz
NOTE: The RBW was adjusted to 1kHz because the 20dB bandwidth of the system was measured to be 97Hz as noted in Section 6.2. The lowered RBW allows us to sufficiently lower the noise floor of spectrum analyzer such that a pre-amplifier may be bypassed.
NOTE: Hopping was disabled for all spurious and harmonic emissions testing.

NOTE: For this product, the EUT worst case "ON" time was measured on Figure 11 to be 4.266ms per 100ms. This equates to a possible duty cycle correction factor of -27.399dB, but there is a cap of 20dB per Section 15.35(b), which is applied to the emissions data in Table 5 to Table 10.

Table 5: 902.164MHz Vertical Polarization Data

| Frequency | DB | Antenna Factor | Total Correction Value | Measured Average (dBuV/m) | Corrected Average Value (dBuV/m) | Average Limit dB(uV/m) at 3m | Average Limit dB(uV/m) at 1m | Average Margin | Includes 20dB Duty Cycle Factor | Final Average Margin |
|---|---|---|---|---|---|---|---|---|---|---|
| 1804.33 | 0.7 | **26.9** | 27.6 | 52.3 | 79.9 | 54.0 | 63.5 | 16.4 | 20.0 | -3.6 |
| ***2706.5*** | ***1.6*** | ***29.0*** | 30.6 | ***35.1*** | 65.7 | 54.0 | 63.5 | 2.2 | 20.0 | -17.8 |
| 3608.59 | 2.0 | **32.3** | 34.3 | ***36.5*** | 70.8 | 54.0 | 63.5 | 7.3 | 20.0 | -12.7 |
| 4510.74 | 3.6 | **33.0** | 36.6 | ***33.1*** | 69.7 | 54.0 | 63.5 | 6.2 | 20.0 | -13.8 |
| 5413.04 | 1.5 | **35.0** | 36.5 | ***23.1*** | 59.6 | 54.0 | 63.5 | -3.9 | 20.0 | -23.9 |
| 6315.2 | 2.4 | **35.5** | 37.9 | 25.2 | 63.1 | 54.0 | 63.5 | -0.4 | 20.0 | -20.4 |
| 7217.34 | 4.9 | **37.2** | 42.1 | 20.4 | 62.5 | 54.0 | 63.5 | -1.0 | 20.0 | -21.0 |
| 8119.43 | 3.6 | **38.0** | 41.6 | 24.5 | 66.1 | 54.0 | 63.5 | 2.6 | 20.0 | -17.4 |
| 9020.74 | 3.1 | **38.3** | 41.4 | 28.1 | 69.5 | 54.0 | 63.5 | 6.0 | 20.0 | -14.0 |
| | | | | | | | | | | |

Table 6: 902.164MHz Horizontal Polarization Data

| Frequency | DB | Antenna Factor | Total Correction Value | Measured Average (dBuV/m) | Corrected Average Value (dBuV/m) | Average Limit dB(uV/m) at 3m | Average Limit dB(uV/m) at 1m | Average Margin | Includes 20dB Duty Cycle Factor | Final Average Margin |
|---|---|---|---|---|---|---|---|---|---|---|
| 1804.286 | 0.7 | **26.9** | 27.6 | 50.3 | 77.9 | 54.0 | 63.5 | 14.4 | 20.0 | -5.6 |
| ***2706.417*** | ***1.6*** | ***29.0*** | 30.6 | ***48.8*** | 79.4 | 54.0 | 63.5 | 15.9 | 20.0 | -4.1 |
| 3608.617 | 2.0 | **32.3** | 34.3 | ***40.7*** | 75.0 | 54.0 | 63.5 | 11.5 | 20.0 | -8.5 |
| 4510.779 | 3.6 | **33.0** | 36.6 | ***43.9*** | 80.5 | 54.0 | 63.5 | 17.0 | 20.0 | -3.0 |
| 5412.954 | 1.5 | **35.0** | 36.5 | ***30.1*** | 66.6 | 54.0 | 63.5 | 3.1 | 20.0 | -16.9 |
| 6315.161 | 2.4 | **35.5** | 37.9 | 29.2 | 67.1 | 54.0 | 63.5 | 3.6 | 20.0 | -16.4 |
| 7217.355 | 4.9 | **37.2** | 42.1 | 24.3 | 66.4 | 54.0 | 63.5 | 2.9 | 20.0 | -17.1 |
| 8119.529 | 3.6 | **38.0** | 41.6 | 29.8 | 71.4 | 54.0 | 63.5 | 7.9 | 20.0 | -12.1 |
| 9020.71 | 3.1 | **38.3** | 41.4 | 21.2 | 62.6 | 54.0 | 63.5 | -0.9 | 20.0 | -20.9 |
| | | | | | | | | | | |

Measurement Settings for Harmonics:

RBW: 1kHz
VBW: 10Hz
Span: 5kHz
NOTE: The RBW was adjusted to 1kHz because the 20dB bandwidth of the system was measured to be 97Hz as noted in Section 6.2. The lowered RBW allows us to sufficiently lower the noise floor of spectrum analyzer such that a pre-amplifier may be bypassed.
NOTE: Hopping was disabled for all spurious and harmonic emissions testing.

NOTE: For this product, the EUT worst case "ON" time was measured on Figure 11 to be 4.266ms per 100ms. This equates to a possible duty cycle correction factor of -27.399dB, but there is a cap of 20dB per Section 15.35(b), which is applied to the emissions data in Table 5 to Table 10.

Table 7: 915MHz Horizontal Polarization Data

| Frequency | DB | Antenna Factor | Total Correction Value | Measured Average (dBuV/m) | Corrected Average Value (dBuV/m) | Average Limit dB(uV/m) at 3m | Average Limit dB(uV/m) at 1m | Average Margin | Includes 20dB Duty Cycle Factor | Final Average Margin |
|---|---|---|---|---|---|---|---|---|---|---|
| 1829.989 | 1.1 | **26.9** | 28.0 | 49.1 | 77.1 | 54.0 | 63.5 | 13.6 | 20.0 | -6.4 |
| ***2744.91*** | ***1.6*** | ***29.0*** | 30.6 | ***48.2*** | 78.8 | 54.0 | 63.5 | 15.3 | 20.0 | -4.7 |
| 3659.95 | 2.0 | **32.3** | 34.3 | ***47.7*** | 82.0 | 54.0 | 63.5 | 18.5 | 20.0 | -1.5 |
| 4574.97 | 3.6 | **33.0** | 36.6 | ***40.7*** | 77.3 | 54.0 | 63.5 | 13.8 | 20.0 | -6.2 |
| 5489.967 | 3.5 | **35.0** | 38.5 | ***21.8*** | 60.3 | 54.0 | 63.5 | -3.2 | 20.0 | -23.2 |
| 6404.99 | 2.5 | **35.5** | 38.0 | 27.5 | 65.5 | 54.0 | 63.5 | 2.0 | 20.0 | -18.0 |
| 7320 | 3.1 | **37.2** | 40.3 | 20 | 60.3 | 54.0 | 63.5 | -3.2 | 20.0 | -23.2 |
| 8235 | 4.4 | **38.0** | 42.4 | 20.6 | 63.0 | 54.0 | 63.5 | -0.5 | 20.0 | -20.5 |
| 9150.03 | 4.2 | **38.3** | 42.5 | 15.7 | 58.2 | 54.0 | 63.5 | -5.3 | 20.0 | -25.3 |
| | | | | | | | | | | |

Table 8: 915MHz Vertical Polarization Data

| Frequency | DB | Antenna Factor | Total Correction Value | Measured Average (dBuV/m) | Corrected Average Value (dBuV/m) | Average Limit dB(uV/m) at 3m | Average Limit dB(uV/m) at 1m | Average Margin | Includes 20dB Duty Cycle Factor | Final Average Margin |
|---|---|---|---|---|---|---|---|---|---|---|
| 1829.93 | 1.1 | **26.9** | 28.0 | 49.8 | 77.8 | 54.0 | 63.5 | 14.3 | 20.0 | -5.7 |
| ***2744.9*** | ***1.6*** | ***29.0*** | 30.6 | ***32.2*** | 62.8 | 54.0 | 63.5 | -0.7 | 20.0 | -20.7 |
| 3659.94 | 2.0 | **32.3** | 34.3 | ***29.7*** | 64.0 | 54.0 | 63.5 | 0.5 | 20.0 | -19.5 |
| 4574.98 | 3.6 | **33.0** | 36.6 | ***13.9*** | 50.5 | 54.0 | 63.5 | -13.0 | 20.0 | -33.0 |
| 5489.93 | 3.5 | **35.0** | 38.5 | ***13.2*** | 51.7 | 54.0 | 63.5 | -11.8 | 20.0 | -31.8 |
| 6405.08 | 2.5 | **35.5** | 38.0 | 20.5 | 58.5 | 54.0 | 63.5 | -5.0 | 20.0 | -25.0 |
| 7320 | 3.1 | **37.2** | 40.3 | 16.6 | 56.9 | 54.0 | 63.5 | -6.6 | 20.0 | -26.6 |
| 8235.17 | 4.4 | **38.0** | 42.4 | 20 | 62.4 | 54.0 | 63.5 | -1.1 | 20.0 | -21.1 |
| 9149.97 | 4.2 | **38.3** | 42.5 | 28.3 | 70.8 | 54.0 | 63.5 | 7.3 | 20.0 | -12.7 |
| | | | | | | | | | | |

**Measurement Settings for Harmonics:**
RBW: 1kHz
VBW: 10Hz
Span: 5kHz
NOTE: The RBW was adjusted to 1kHz because the 20dB bandwidth of the system was measured to be 97Hz as noted in Section 6.2. The lowered RBW allows us to sufficiently lower the noise floor of spectrum analyzer such that a pre-amplifier may be bypassed.
NOTE: Hopping was disabled for all spurious and harmonic emissions testing.

NOTE: For this product, the EUT worst case "ON" time was measured on Figure 11 to be 4.266ms per 100ms. This equates to a possible duty cycle correction factor of -27.399dB, but there is a cap of 20dB per Section 15.35(b), which is applied to the emissions data in Table 5 to Table 10.

Table 9: 927.84MHz Vertical Polarization Data

| Frequency | DB | Antenna Factor | Total Correction Value | Measured Average (dBuV/m) | Corrected Average Value (dBuV/m) | Average Limit dB(uV/m) at 3m | Average Limit dB(uV/m) at 1m | Average Margin | Includes 20dB Duty Cycle Factor | Final Average Margin |
|---|---|---|---|---|---|---|---|---|---|---|
| 1855.64 | 1.3 | **26.9** | 28.2 | 46.4 | 74.6 | 54.0 | 63.5 | 11.1 | 20.0 | -8.9 |
| ***2783.46*** | ***1.6*** | ***29.0*** | 30.6 | ***37.1*** | 67.7 | 54.0 | 63.5 | 4.2 | 20.0 | -15.8 |
| 3711.23 | 2.4 | **32.3** | 34.7 | ***34.8*** | 69.5 | 54.0 | 63.5 | 6.0 | 20.0 | -14.0 |
| 4639.16 | 2.0 | **33.0** | 35.0 | ***28.9*** | 63.9 | 54.0 | 63.5 | 0.4 | 20.0 | -19.6 |
| 5366.93 | 3.4 | **35.0** | 38.4 | ***14.7*** | 53.1 | 54.0 | 63.5 | -10.4 | 20.0 | -30.4 |
| 6494.8 | 2.5 | **35.5** | 38.0 | 20.3 | 58.3 | 54.0 | 63.5 | -5.2 | 20.0 | -25.2 |
| 7422.53 | 3.1 | **37.2** | 40.3 | 18.5 | 58.8 | 54.0 | 63.5 | -4.7 | 20.0 | -24.7 |
| 8350.47 | 4.1 | **38.0** | 42.1 | 14.5 | 56.6 | 54.0 | 63.5 | -6.9 | 20.0 | -26.9 |
| 9278.42 | 3.8 | **38.3** | 42.1 | 28.6 | 70.7 | 54.0 | 63.5 | 7.2 | 20.0 | -12.8 |
| | | | | | | | | | | |

Table 10: 927.84 MHz Horizontal Polarization Data

| Frequency | DB | Antenna Factor | Total Correction Value | Measured Average (dBuV/m) | Corrected Average Value (dBuV/m) | Average Limit dB(uV/m) at 3m | Average Limit dB(uV/m) at 1m | Average Margin | Includes 20dB Duty Cycle Factor | Final Average Margin |
|---|---|---|---|---|---|---|---|---|---|---|
| 1855.68 | 1.3 | **26.9** | 28.2 | 46.2 | 74.4 | 54.0 | 63.5 | 10.9 | 20.0 | -9.1 |
| ***2783.46*** | ***1.6*** | ***29.0*** | 30.6 | ***50.5*** | 81.1 | 54.0 | 63.5 | 17.6 | 20.0 | -2.4 |
| 3711.33 | 2.4 | **32.3** | 34.7 | ***47.3*** | 82.0 | 54.0 | 63.5 | 18.5 | 20.0 | -1.5 |
| 4639.2 | 2.0 | **33.0** | 35.0 | ***39.3*** | 74.3 | 54.0 | 63.5 | 10.8 | 20.0 | -9.2 |
| 5566.9 | 3.4 | **35.0** | 38.4 | ***17.2*** | 55.6 | 54.0 | 63.5 | -7.9 | 20.0 | -27.9 |
| 6494.98 | 2.5 | **35.5** | 38.0 | 28.1 | 66.1 | 54.0 | 63.5 | 2.6 | 20.0 | -17.4 |
| 7422.731 | 3.1 | **37.2** | 40.3 | 21 | 61.3 | 54.0 | 63.5 | -2.2 | 20.0 | -22.2 |
| 8350.52 | 4.1 | **38.0** | 42.1 | 15.7 | 57.8 | 54.0 | 63.5 | -5.7 | 20.0 | -25.7 |
| 9278.224 | 3.8 | **38.3** | 42.1 | 3 | 45.1 | 54.0 | 63.5 | -18.4 | 20.0 | -38.4 |

# Appendix B: Test Setup Photos


Figure 17 - AC Conducted Test Setup - Front View

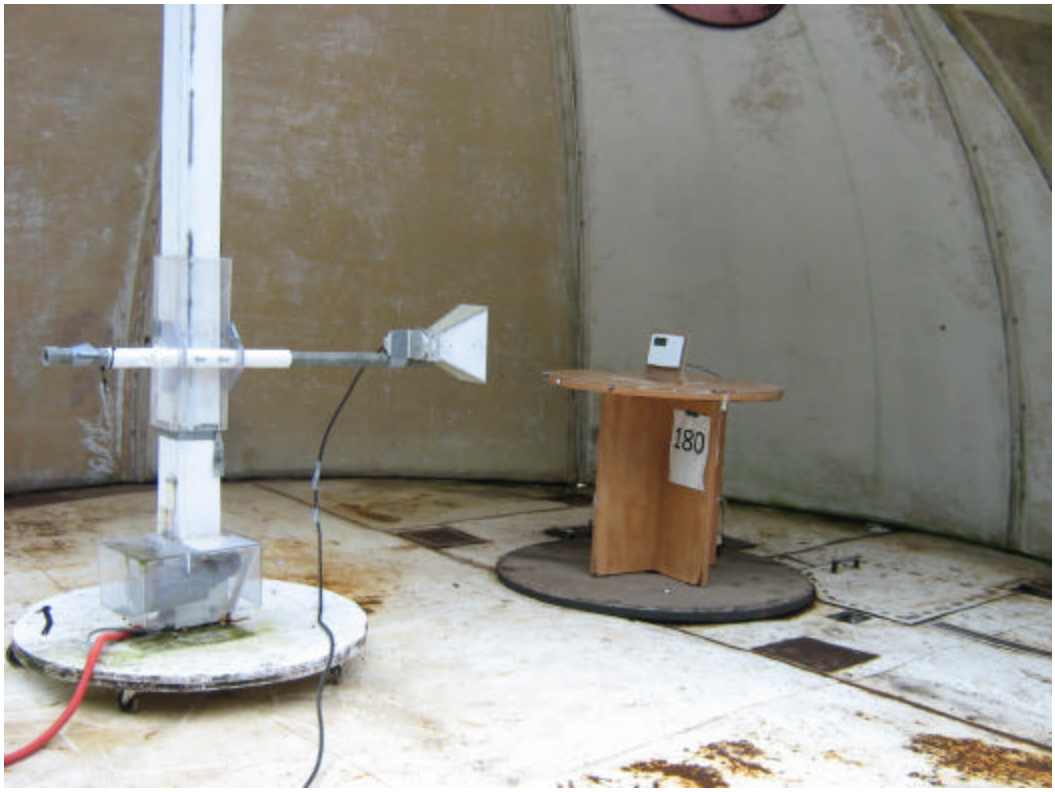


Figure 18 - Emissions Test Setup – Radiated Emissions


Figure 19 - Emissions Test Setup – Unintentional Radiated Emissions