

# Tantalus Systems Corp.

## TC-1120/TC-1220 Series

### Report of Measurements

per

Industry Canada RSS-210 Issue 8

and

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

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Approval		
Checked By:	 Robert Stirling, P.Eng	 Date
Testd By:	 Ed Stirling	 Date

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

## **Test Report Summary**

FCC 15.247 / IC RSS-210

Frequency Hopping 902.17 – 927.83MHz communication Module

**FCC ID:** OZFACXX20 **IC:** 3669A-ACXX20

**Organization Requesting Report:** Tantalus Systems Corp.

**Contact:** Mark Fairburn, RF Design Engineer

**Test Organization:** Protocol Datasystems Labs.

**Contact:** Rob Stirling, P. Eng

**Test Personnel:** Ed Stirling.

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## **Section 1: Information for Test Report of Measurements**

### **Testing Details**

TESTED BY: Rob Stirling and Ed Stirling

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

TEST VOLTAGE: 240V A.C. – TC1220/1220-RD  
120V A.C. – TC1120/1120-RD

### **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	Quasi-Peak Adapter	2811A01080	12/8/2012
HP	85662A	Spectrum Analyzer Display	2152A03569	11/8/2012
HP	8566B	Spectrum Analyzer RF Section	2241A02102	11/8/2012
HP	85685A	RF-Preselector	3107A01222	11/8/2012
EMCO	3146	Ant. Log Periodic 200-1000MHz	9611-4699	8/8/2012
EMCO	3110B	Ant. Biconical 30-200MHz	9401-1850	8/8/2012
EMCO	3115	Horn Antenna 1-18GHz	9403-4251	20/8/2012
HP	362	Controller	6452A40248	N/A
EMCO	6502	Loop Antenna	9002-2489	18/6/2012

### **Measurement Uncertainty**

Parameter	Uncertainty
Radio Frequency	$\pm 1 \times 10^{-5}$ MHz
Radiated Emissions	$\pm 3$ dB
Temperature	$\pm 1^\circ\text{C}$
Humidity	$\pm 5$ %
DC and low frequency voltages	$\pm 3$ %

**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 Smart Meter module attaches to various Itron CENTRON C2s family of Electrical Power Meters. These modules provide real-time two-way communication capability for utilities to manage their network. The communication module can support a variety of data rates and multi-level FSK modulation formats to achieve data rates upto 640kbps.

Product ID: TC-1220  
Communication Module:  
Manufacturer: Tantalus Systems Corp.  
Part Numbers: 100-0133-C  
Serial number: 011-00040  
Metrology Housing:  
Manufacturer: Itron  
Serial Number: 64 727 271

Product ID: TC-1120  
Manufacturer: Tantalus Systems Corp.  
Part Numbers: 100-0134-D  
Serial number: 011-00103  
Metrology Housing:  
Manufacturer: Itron  
Serial Number: 64 727 273

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. 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 TC-1120 and TC-1220 series of communication modules 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 Appareil numerique de la Classe B respecte toutes les exigences du Reglement sur le material brouilleur 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 interference 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.

<b>Test</b>	<b>Standard</b>	<b>Description</b>	<b>Result</b>
Radiated Emissions Idle Mode Subclause 8.2	RSS-210 2.2(b)	The radiated emissions are measured in the 0.009 - 9280MHz range	Complies
Conducted Emissions Idle Mode Subclause 8.3	EN55022 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 0.009 -9280MHz 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 May 28, 2012

TEST STANDARD: RSS-210 2.2(b)

TEST SETUP: The EUTs were operated and tested at 240Vac and 120Vac 60Hz in their normal mode of operation. They were in receive mode for these tests.

MINIMUM STANDARD: Class B Limit:

Frequency (MHz)	Field Strength ( $\mu\text{V}/\text{m}$ )	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.

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

PERFORMANCE: Complies.

## **Part 2 – Conducted Emissions Testing**

DATE: May 31, 2012

TEST STANDARD: EN55022

MINIMUM STANDARD: Class B Limit:

TEST SETUP: The EUTs were connected to the conducted emissions LISN apparatus. The devices were operated and tested at 240Vac and 120Vac 60Hz.

MINIMUM STANDARD: Class B Limit:

Frequency (MHz)	Conducted Limit (dB $\mu$ V)	
	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 to Table 6 in Appendix A for corresponding frequencies.

PERFORMANCE: Complies.

## **Part 3 – Radiated Emissions – Transmit Mode**

DATE: May 29, 2012

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's were operated and tested at 240Vac and 120V 60Hz for the tests and the units were transmitting at their maximum rate based on the energy that it could couple from the supply.

**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 Figures 7-18 and Tables 7-14 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 Appendix A. The widest 20dB bandwidth was measured to be 98.6 kHz.
Channel Separation	RSS-210 A8.1(c)	See Figure 7: Channel Separation – 240V9-10 in Appendix A. The smallest Channel separation was measured to be 253.8 kHz.
Number of Hopping Channels	RSS-210 A8.1(c)	See Appendix A. The number of channels is 50 channels.
Hopping Channels Time of Occupancy	RSS-210 A8.1(c)	Appendix A; the time of occupancy is 4.8 milliseconds at an interval of 2.336 seconds. This is equal to an average time "ON" of 41.1 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 1W (or 30dBm)
Out of Band Emissions	RSS-210 A8.5	See Appendix A. All radiated emissions were within the RSS-210 A8.5 limit.

**PERFORMANCE:**

Complies.

## **Part 4 – Output Power and EIRP Emissions**

DATE: May 29, 2012

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: A coaxial pigtail was soldered onto the antenna coupling point and a conducted measurement was performed across the frequency band with an attenuator protecting the spectrum analyzer.

The output power of the 240V DUT was 29.2dBm and the output power of the 120V DUT was 28dBm,; from the radiated measurements this corresponds to an antenna gain of 0.8dBi and 0.5dBi respectively.

### **EIRP measurements for 240V**

<b>Freq(MHz)</b>	<b>Peak (dBμV)</b>	<b>Corrected Field at 3m (dBμV/m)</b>	<b>3m EIRP (dBm)</b>
902.17	95.2	125.3	30
915	94.4	124.5	29.2
927.83	93.4	123.5	28.2

PERFORMANCE: Complies.

### **EIRP measurements for 120V**

<b>Freq(MHz)</b>	<b>Peak (dBμV)</b>	<b>Corrected Field at 3m (dBμV/m)</b>	<b>3m EIRP (dBm)</b>
902.17	93.7	123.8	28.5
915	93.7	123.8	28.5
927.83	94.0	124.1	28.8

PERFORMANCE: Complies.

## **Part 5: Out of Band Emissions**

DATE: May 30, 2012

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 13 and Table 14 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.

<b>Test</b>	<b>Standard</b>	<b>Description</b>	<b>Result</b>
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 Spectrum 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: May 28, 2012

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 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

$$20 \cdot \log(d_1/d_2)$$

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. Emissions 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 12MHz 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 EUT PCB has an integrated 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  $\mu$ H/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 (db $\mu$ V)	
	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 9 and Table 10 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) 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:

$$\text{Correction Factor (dB)} = 20 \cdot \log(\text{worst case ON time} / 100\text{ms})$$

For this product, the EUT worst case “ON” time was measured on **Error! Reference source not found.** **Error! Reference source not found.** **Error! Reference source not found.** to be 4.8ms per 100ms interval. This equates to a possible correction factor of -26.375dB, which is applied to the emissions data in Table 13 and Table 14.

##### 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 Figures 7-18 and Tables 7-14 in Appendix A.

##### PERFORMANCE:

Complies.

## **Part 5: Output Power and EIRP Emissions**

DATE: May 29, 2012

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: A coaxial pigtail was soldered onto an RF output access point on the PCB and a conducted measurement was performed across the frequency band with an attenuator protecting the spectrum analyzer. The maximum output power observed was 29.2dBm for 240V and 28dBm for 120V; from the radiated measurements this corresponds to an antenna gain of 0.8dBi.

### MEASUREMENT DATA:

240V

Freq(MHz)	Peak (dBμV)	Corrected Field at 3m (dBμV/m)	3m EIRP (dBm)
902.17	95.2	125.3	30
915	94.4	124.5	29.2
927.83	93.4	123.5	28.2

PERFORMANCE: Complies.

120V

Freq(MHz)	Peak (dBμV)	Corrected Field at 3m (dBμV/m)	3m EIRP (dBm)
902.17	93.7	123.8	28.5
915	93.7	123.8	28.5
927.83	94.0	124.1	28.8

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 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 Table 13 and Table 14 in Appendix A for corresponding data.



## Appendix A: Test Plots TC1220

### Unintentional Radiated Emissions – TC1220 (240V)

**Table 1: FCC Class B Emissions - 3m**

Frequency	Pol	Hgt	Angle	Uncor-Pk	Tot Corr	Peak	DelLim-Pk
(MHz)		(cm)	(deg)	(dBuV)	(dB)	(dBuV/m)	(dB)
35.094631	Vert	120	0	13.00	15.59	28.59	-11.41
246.920468	Horz	120	270	25.10	14.55	39.65	-6.35
251.138618	Vert	130	020	15.20	14.68	29.88	-16.12
251.141304	Horz	120	270	25.60	14.68	40.28	-5.72
251.743509	Horz	120	270	25.40	14.71	40.11	-5.89
251.757613	Vert	130	020	14.70	14.71	29.41	-16.59
255.877065	Horz	140	270	27.90	14.91	42.81	-3.19
259.084347	Horz	130	280	23.20	15.07	38.27	-7.73
381.704451	Horz	170	235	15.10	18.68	33.78	-12.22
398.474552	Vert	130	0	14.50	19.16	33.66	-12.34
398.478688	Horz	180	245	14.80	19.16	33.96	-12.04
400.401209	Vert	130	0	12.70	19.21	31.91	-14.09

**Table 2: CISPR Class B Emissions – 3m**

Frequency	Pol	Hgt	Angle	Uncor-Pk	Tot Corr	Peak	DelLim-Pk
(MHz)		(cm)	(deg)	(dBuV)	(dB)	(dBuV/m)	(dB)
35.094631	Vert	120	0	13.00	15.59	28.59	-10.91
246.920468	Horz	120	270	25.10	14.55	39.65	-6.85
251.138618	Vert	130	020	15.20	14.68	29.88	-16.62
251.141304	Horz	120	270	25.60	14.68	40.28	-6.22
251.743509	Horz	120	270	25.40	14.71	40.11	-6.39
251.757613	Vert	130	020	14.70	14.71	29.41	-17.09
255.877065	Horz	140	270	27.90	14.91	42.81	-3.69
259.084347	Horz	130	280	23.20	15.07	38.27	-8.23
381.704451	Horz	170	235	15.10	18.68	33.78	-12.72
398.474552	Vert	130	0	14.50	19.16	33.66	-12.84

398.478688	Horz	180	245	14.80	19.16	33.96	-12.54
400.401209	Vert	130	0	12.70	19.21	31.91	-14.59

### **A.C. Mains Conducted Emissions (Low Power Mode)**

FCC/CE Class B - Emissions

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

240VAC 60Hz – Line 1 peaks

Frequency (MHz)	Peak (dB $\mu$ V)	DelLim-Pk (dB $\mu$ V)
1.030	41.7	-4.3
.1624	44.4	-10.9
22.66	38.4	-11.6
23.77	38.2	-11.8
10.30	38.1	-11.9

**Table 4: AC Conducted Emission Line 2**

240VAC 60Hz – Line 2 – peaks

Frequency (MHz)	Peak (dB $\mu$ V)	DelLim-Pk (dB $\mu$ V)
1.030	41.7	-4.3
.1633	45.5	-9.7
.1749	44.3	-10.4
.2039	42.4	-11.0
11.33	38.7	-11.3

**A.C. Mains Conducted Emissions (High Power Mode)**

FCC/CE Class B - Emissions

**Table 5: AC Conducted Emissions Line 1**

240VAC 60Hz – Line 1 peaks

Frequency (MHz)	Peak (dB $\mu$ V)	DelLim-Pk (dB $\mu$ V)
29.06	46.2	-3.8
28.01	46.0	-4.0
.1548	51.0	-4.7
.2196	47.7	-5.1
.1668	49.9	-5.2

**Table 6: AC Conducted Emission Line 2**

240VAC 60Hz – Line 2 – peaks

Frequency (MHz)	Peak (dB $\mu$ V)	DelLim-Pk (dB $\mu$ V)
1.046	42.6	-3.4
.2105	47.6	-5.5
.1694	49.2	-5.7
.1524	49.4	-5.9
.2403	45.6	-6.4

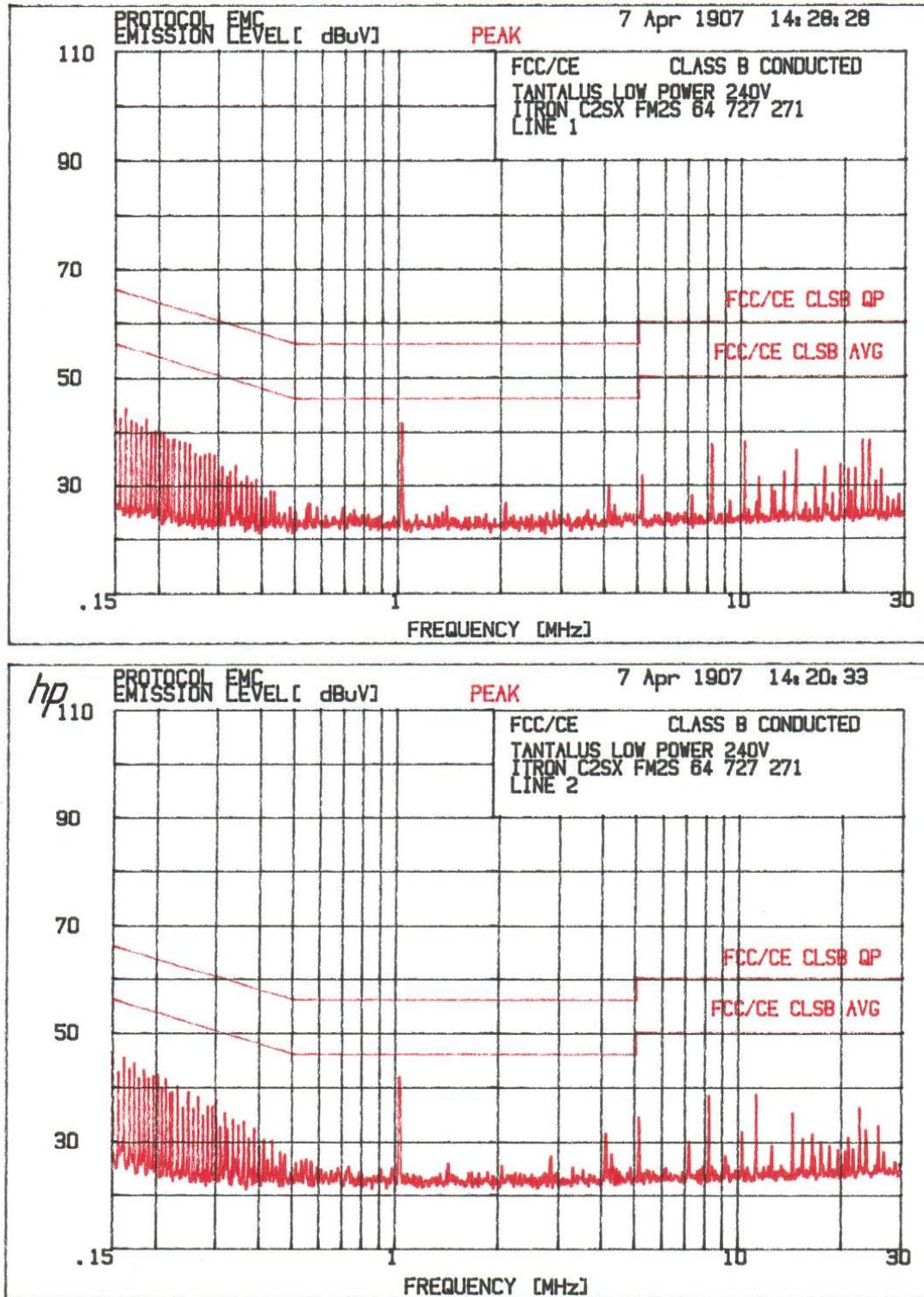


Figure 1: AC Conducted Emissions - Line 1 and Line 2 (Low Power)

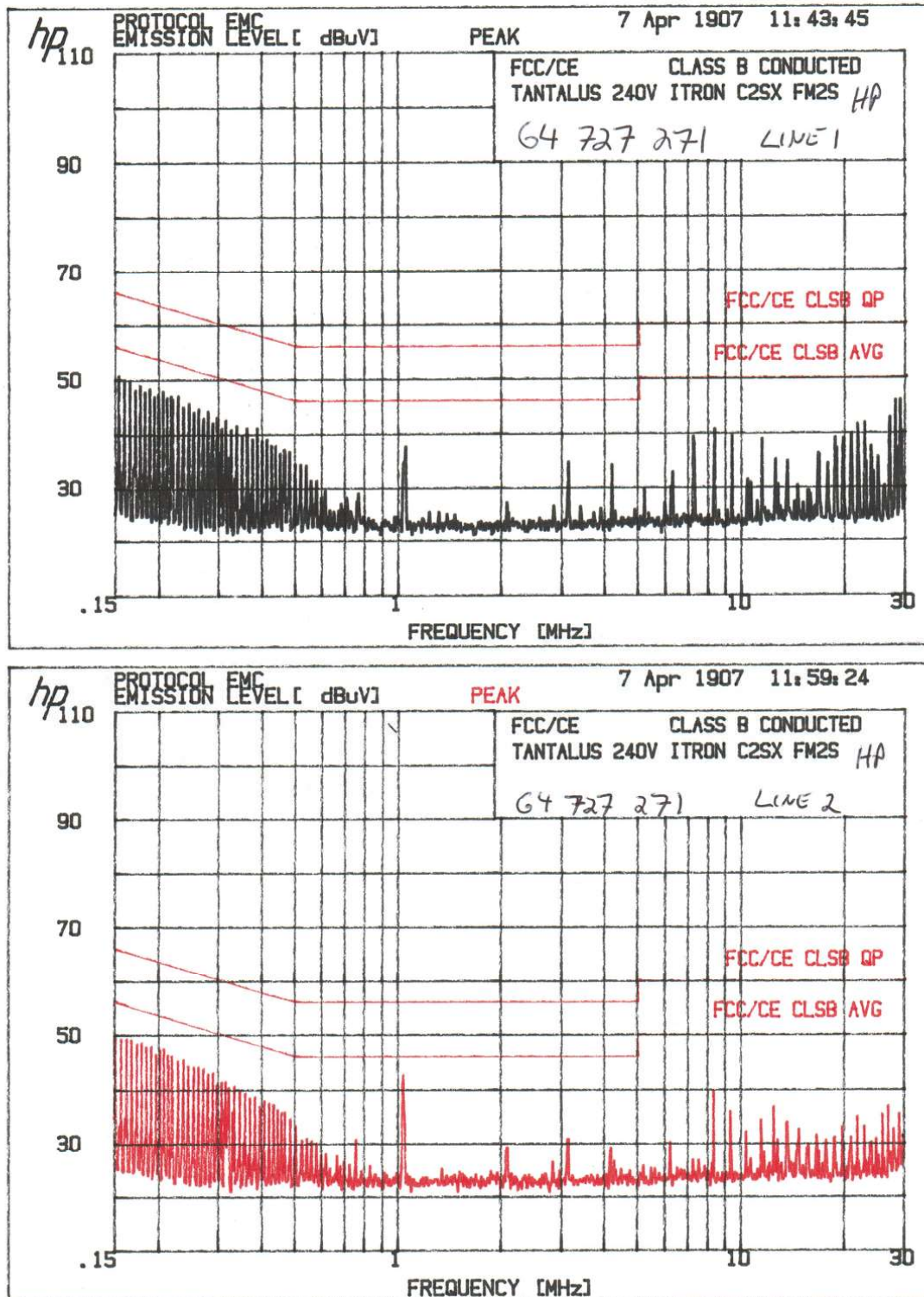


Figure 2: AC Conducted Emissions - Line 1 and Line 2 (High Power)

## **Test Plots TC1120**

### **Unintentional Radiated Emissions – TC1120 (120V)**

**Table 7: FCC Class B Emissions - 3m**

Frequency	Pol	Hgt	Angle	Uncor-Pk	Tot Corr	Peak	QP Lmt	DelLim-Pk	QP	DelLim-QP
(MHz)		(cm)	(deg)	(dBuV)	(dB)	(dBuV/m)	(dBuV/m)	(dB)	(dBuV/m)	(dB)
407.186851	Horz	210	280	22.00	19.34	41.34	46.00	-4.66	38.64	-7.36
409.294138	Horz	200	290	21.10	19.38	40.48	46.00	-5.52	38.88	-7.12
412.225266	Horz	180	300	23.10	19.43	42.53	46.00	-3.47	37.91	-8.09
391.240927	Vert	110	0	20.50	18.95	39.46	46.00	-6.54	34.90	-11.10
402.447582	Vert	100	075	24.50	19.25	43.75	46.00	-2.25	40.09	-5.91
404.154904	Vert	110	075	26.30	19.28	45.58	46.00	-0.42	43.26	-2.74
407.363297	Vert	100	045	22.40	19.34	41.74	46.00	-4.26	40.27	-5.73

**Table 8: CISPR Class B Emissions – 3m**

Frequency	Pol	Hgt	Angle	Uncor-Pk	Tot Corr	Peak	QP Lmt	DelLim-Pk	QP	DelLim-QP
(MHz)		(cm)	(deg)	(dBuV)	(dB)	(dBuV/m)	(dBuV/m)	(dB)	(dBuV/m)	(dB)
407.186851	Horz	210	280	22.00	19.34	41.34	46.50	-5.16	38.64	-7.86
409.294138	Horz	200	290	21.10	19.38	40.48	46.50	-6.02	38.88	-7.62
412.225266	Horz	180	300	23.10	19.43	42.53	46.50	-3.97	37.91	-8.59
391.240927	Vert	110	0	20.50	18.95	39.46	46.50	-7.04	34.90	-11.60
402.447582	Vert	100	075	24.50	19.25	43.75	46.50	-2.75	40.09	-6.41
404.154904	Vert	110	075	26.30	19.28	45.58	46.50	-0.92	43.26	-3.24
407.363297	Vert	100	045	22.40	19.34	41.74	46.50	-4.76	40.27	-6.23

**A.C. Mains Conducted Emissions (Low Power Mode)**

FCC/CE Class B - Emissions

**Table 9: AC Conducted Emissions Line 1**

120VAC 60Hz – Line 1 peaks

Frequency (MHz)	Peak (dB $\mu$ V)	DelLim-Pk (dB $\mu$ V)
.6852	37.8	-8.2
1.046	36.3	-9.7
2.861	29.0	-17.0
11.45	32.6	-17.4

**Table 10: AC Conducted Emission Line 2**

120VAC 60Hz – Line 2 – peaks

Frequency (MHz)	Peak (dB $\mu$ V)	DelLim-Pk (dB $\mu$ V)
22.78	41.2	-8.8
1.041	36.1	-9.9
21.84	40.1	-9.9
19.75	37.1	-12.9
13.49	33.7	-16.3

**A.C. Mains Conducted Emissions (High Power Mode)**

FCC/CE Class B - Emissions

**Table 11: AC Conducted Emissions Line 1**

120VAC 60Hz – Line 1 peaks

Frequency (MHz)	Peak (dB $\mu$ V)	DelLim-Pk (dB $\mu$ V)
.1598	44.0	-11.4
.2007	41.6	-11.9
.1834	42.1	-12.2
.1540	43.4	-12.3
12.46	34.5	-15.5

**Table 12: AC Conducted Emission Line 2**

120VAC 60Hz – Line 2 – peaks

Frequency (MHz)	Peak (dB $\mu$ V)	DelLim-Pk (dB $\mu$ V)
22.90	43.9	-6.1
23.89	39.8	-10.2
21.95	39.5	-10.5
20.82	39.4	-10.6
.1615	43.8	-11.5



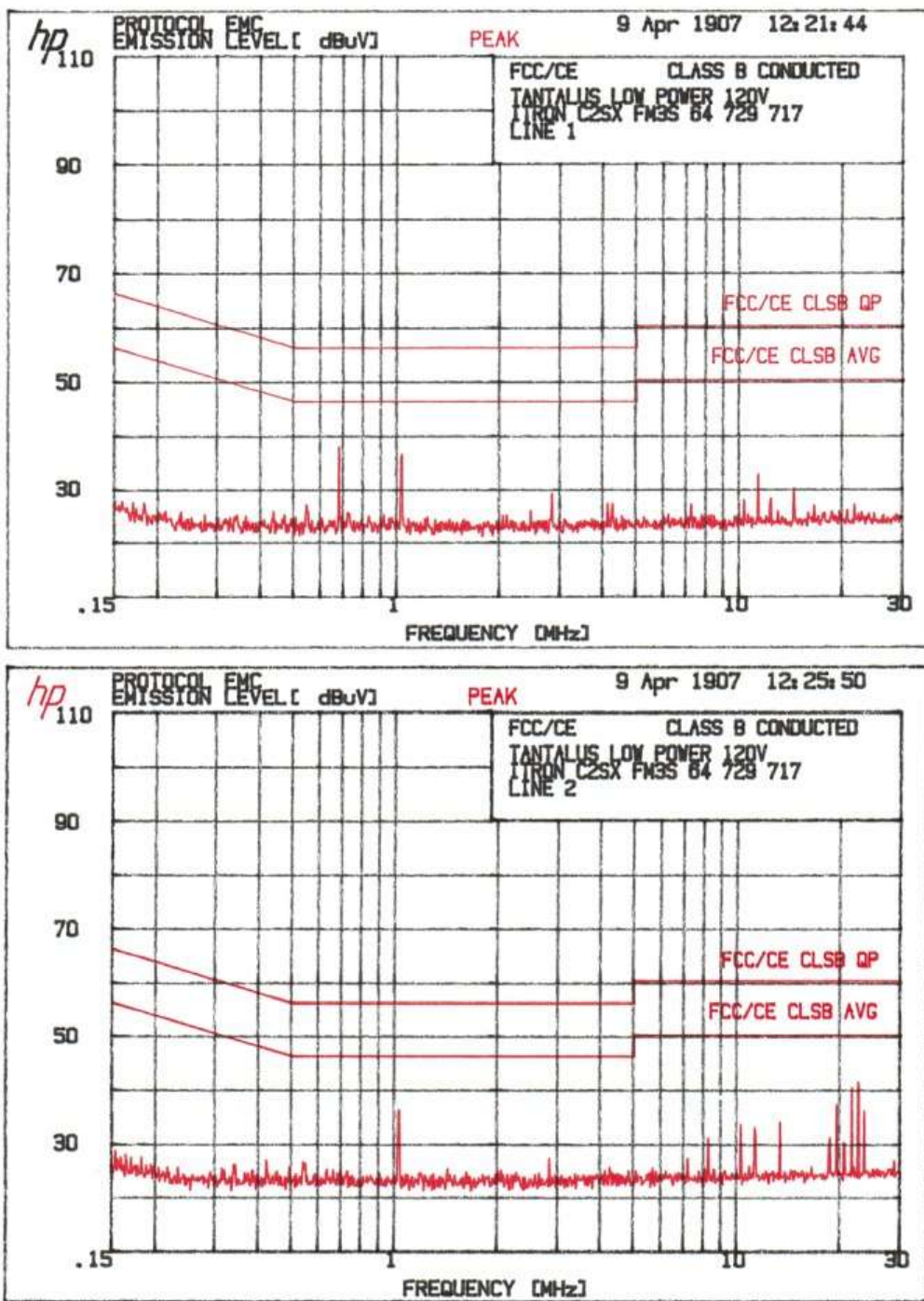


Figure 3: AC Conducted Emissions - Line 1 and Line 2 (Low Power)

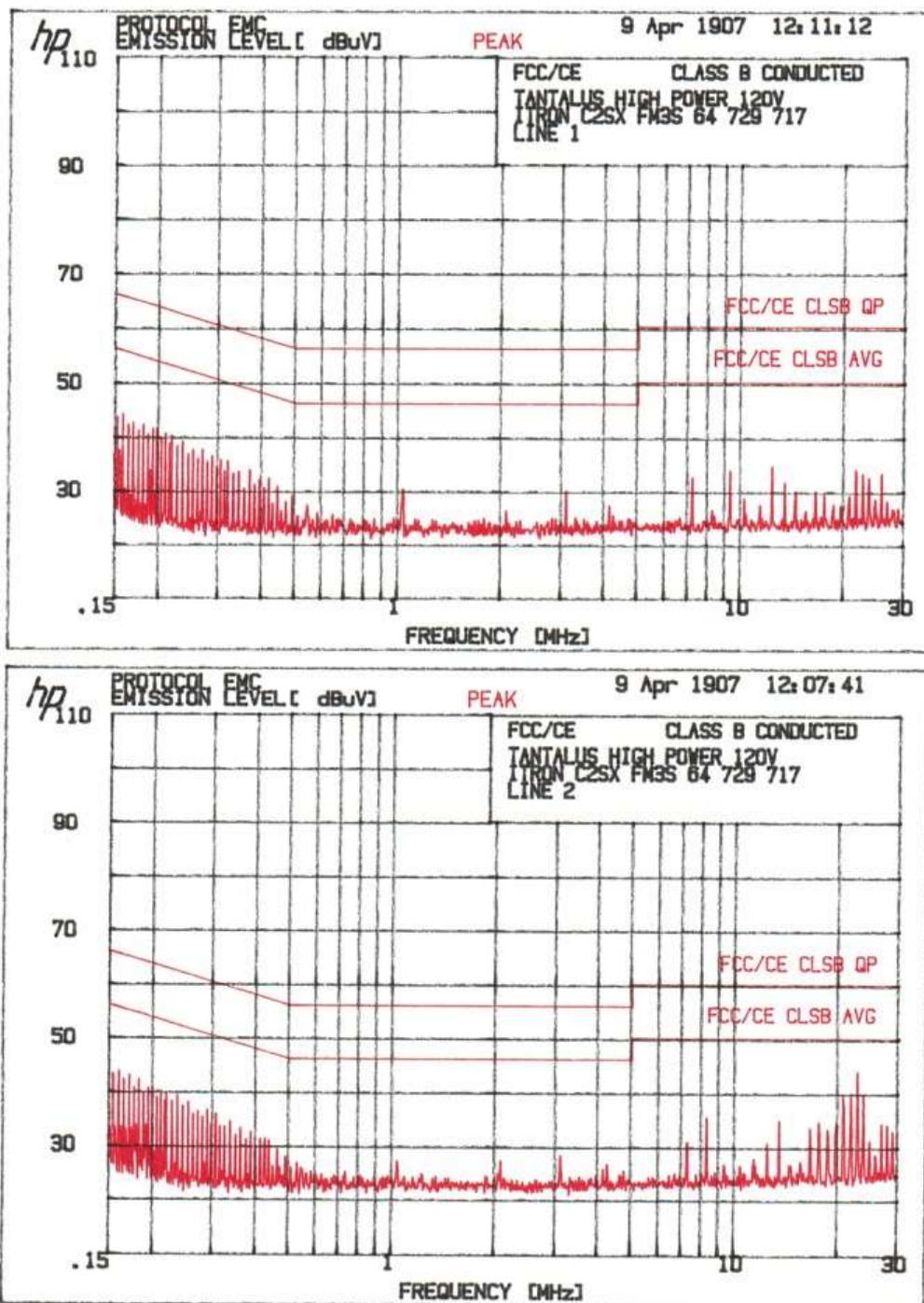


Figure 4: AC Conducted Emissions - Line 1 and Line 2 (High Power)

## FHSS Compliance Tests

### 20 dB Bandwidth

240 V - 64 727 271

20dB Bandwidth - Lower Frequency Band

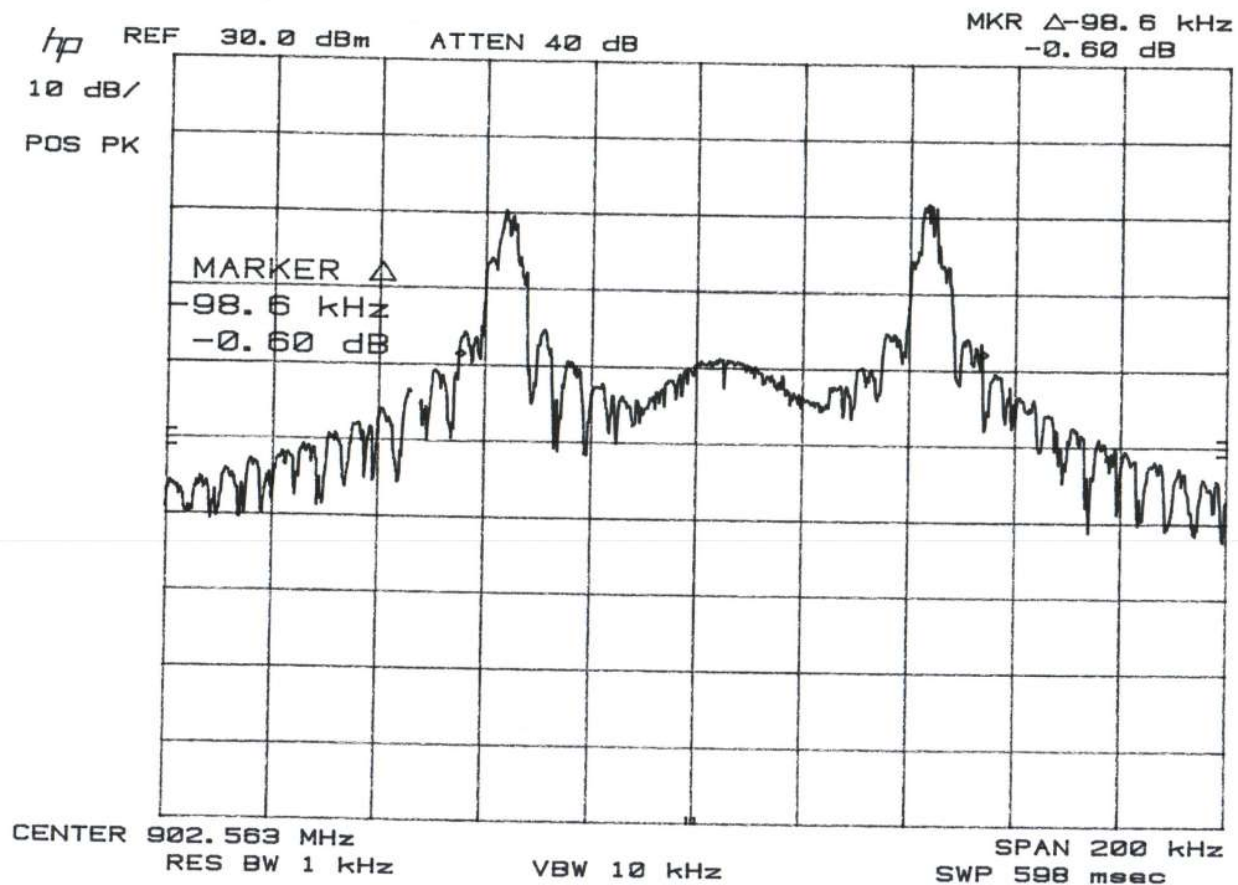


Figure 5: 20dB Bandwidth – 120V

\* 64727.271 240V microwave 20dB BW 10dB/Hz

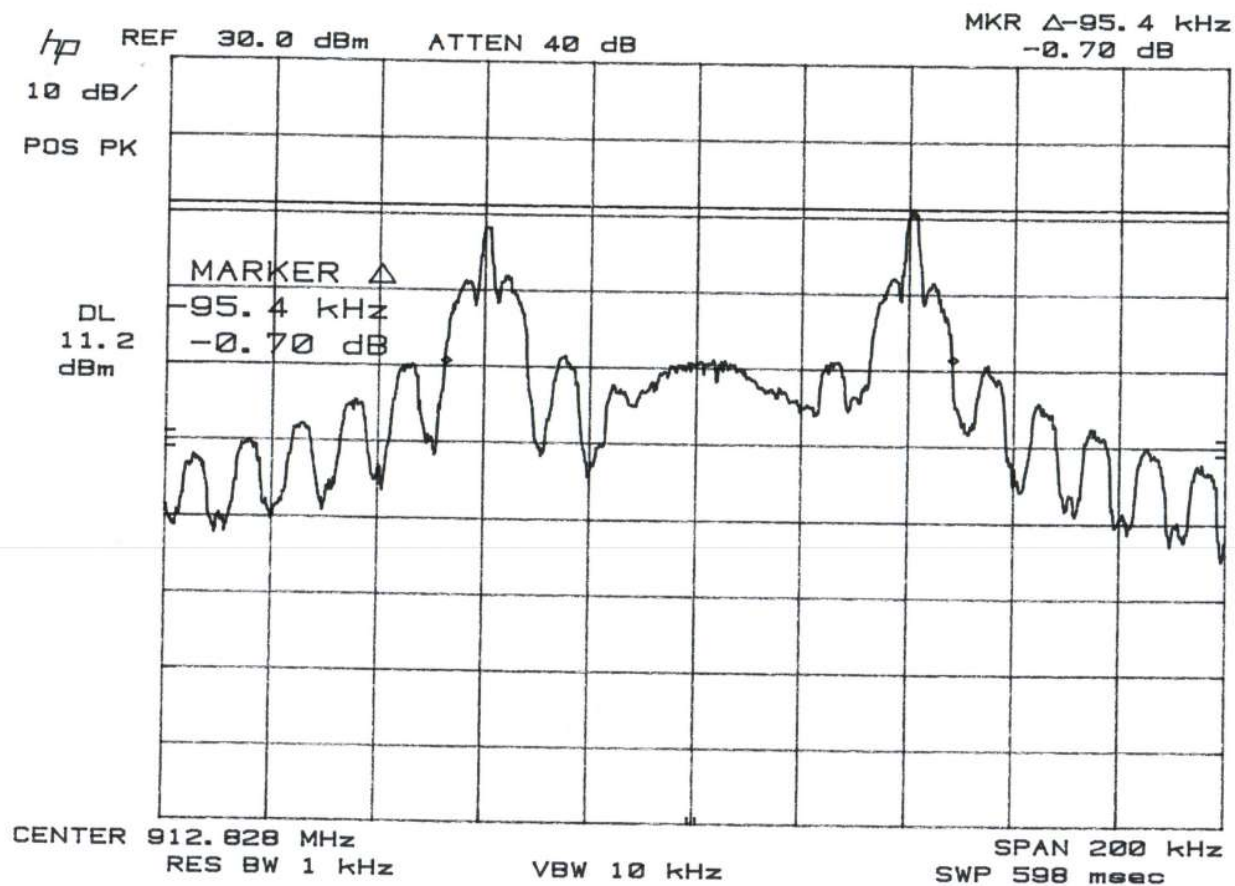


Figure 6: 20dB Bandwidth – 240V



**Channel Separation**

240V - 64 727 271  
Channel Separation

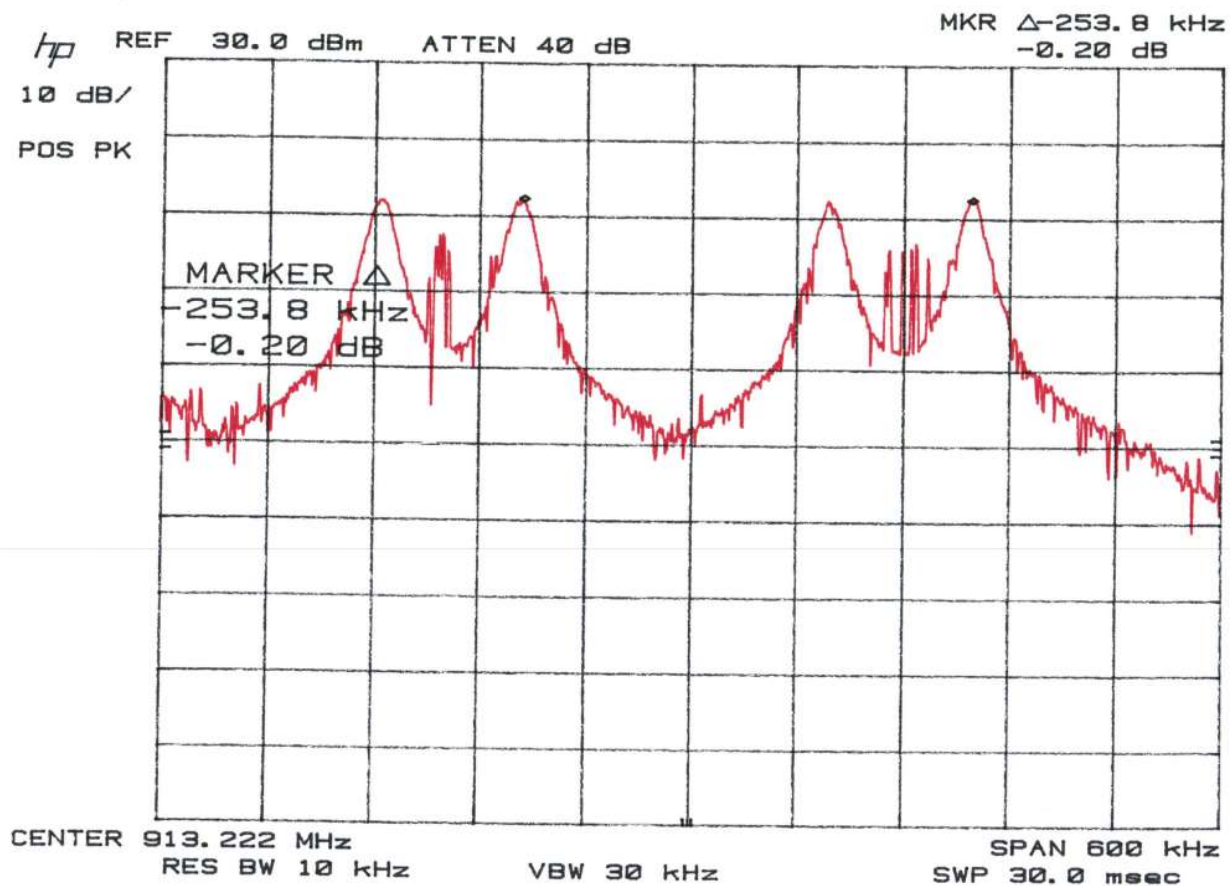


Figure 7: Channel Separation – 240V

120V - 64 727 223

Channel Separation

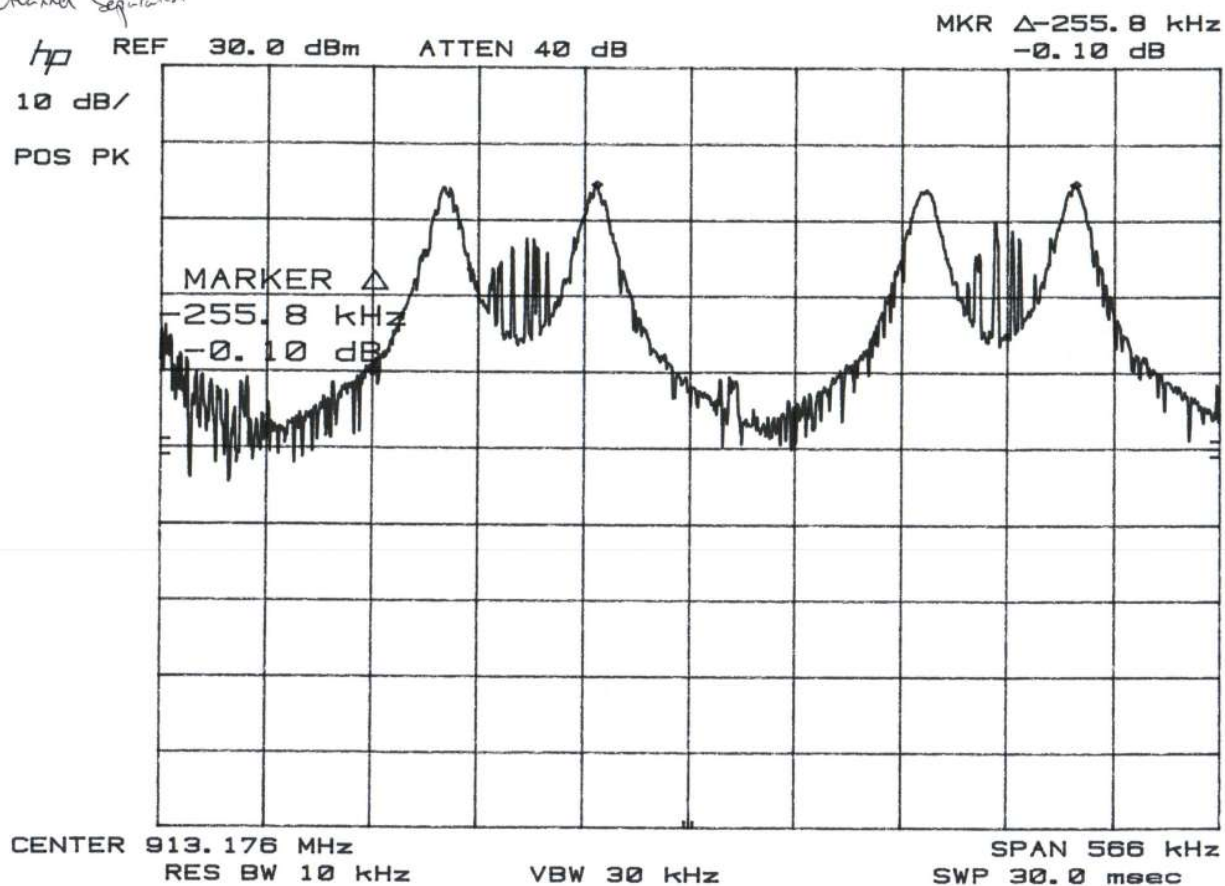
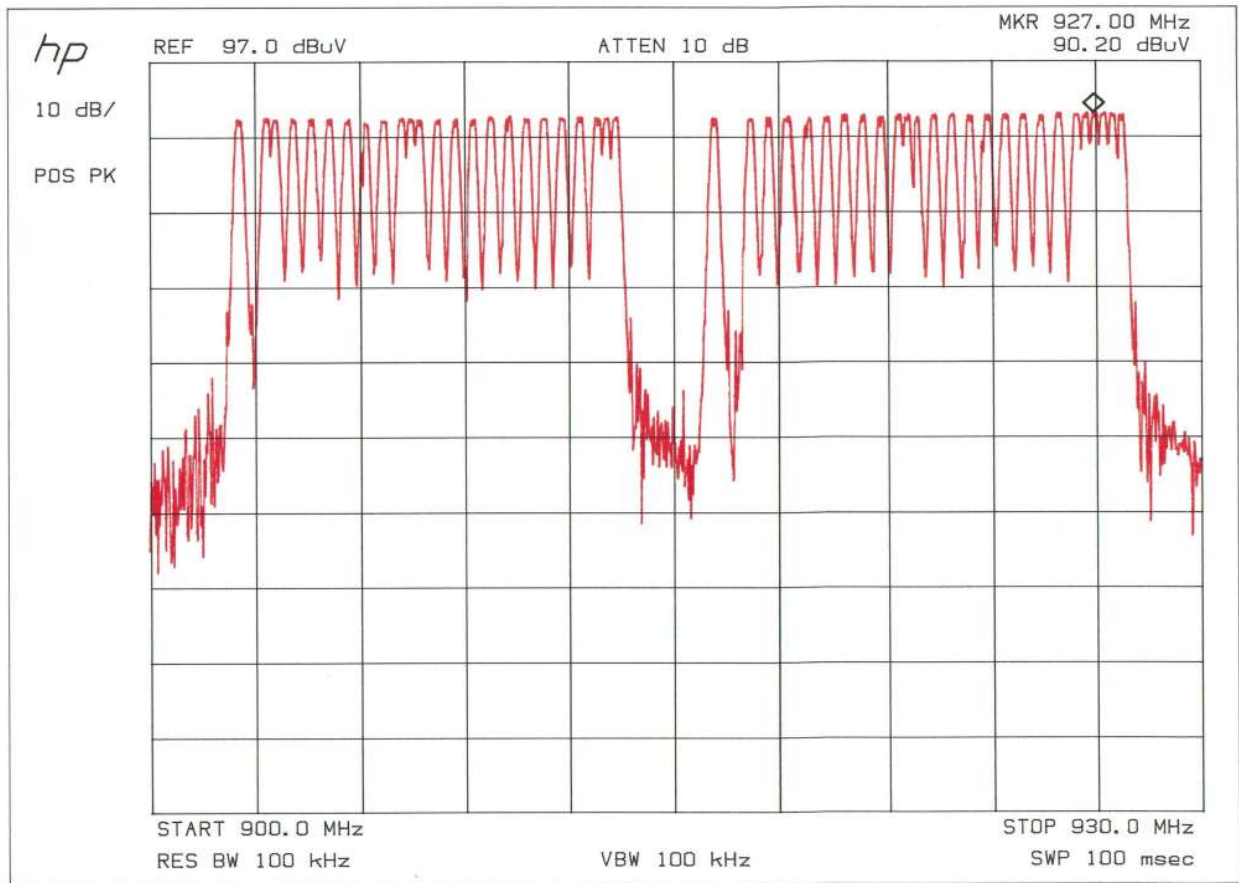
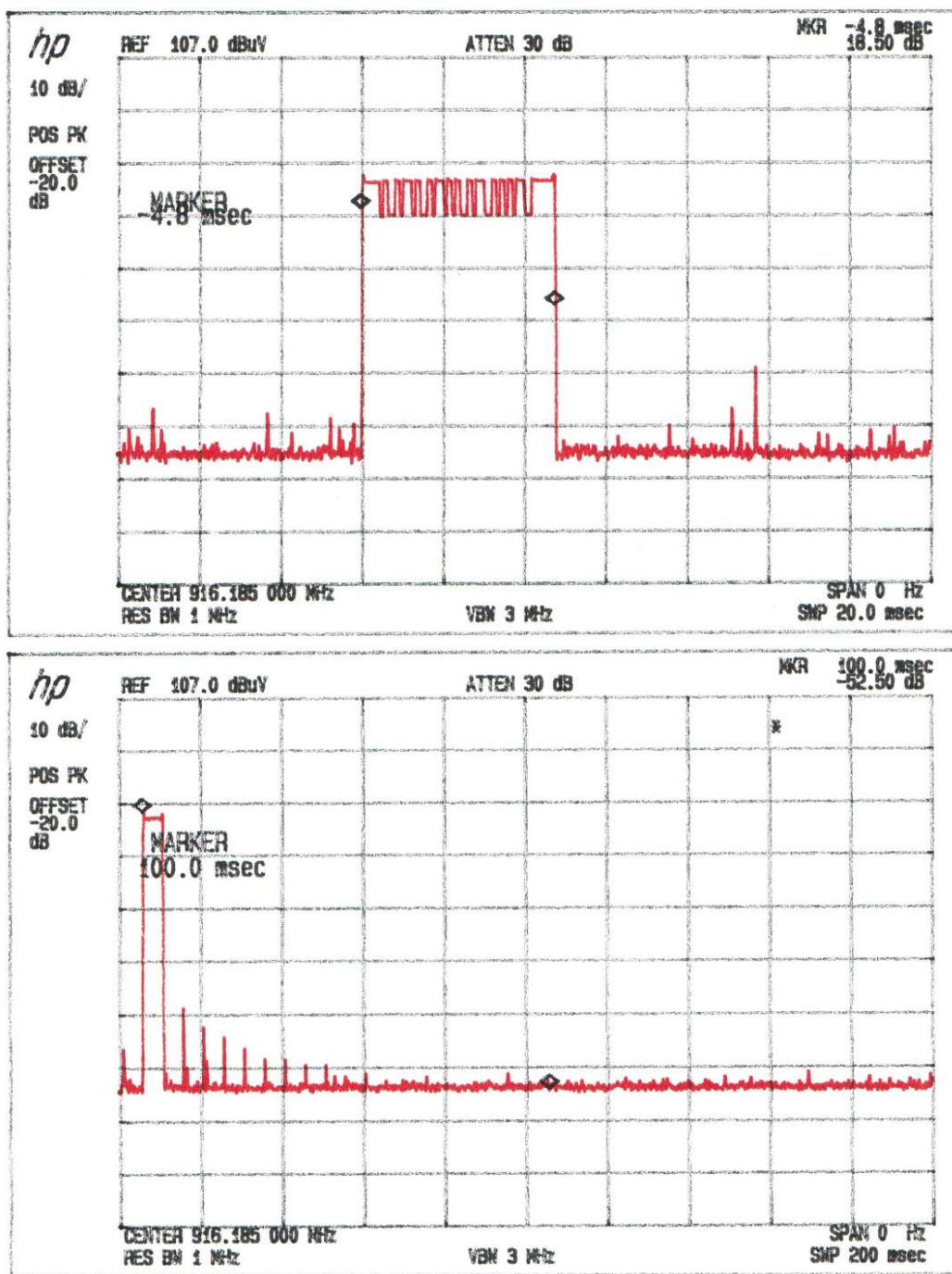


Figure 8: Channel Separation - 120V

**Number of Hopping Channels****Figure 9: Number of Hopping Channels - 50**

**Dwell Time and Time of Occupancy****Figure 10: Dwell Time and Time of Occupancy per Pulse**

Dwell Time per frequency = 4.8mS

Occupancy of each frequency is once every 2.336S (Maximum Tx Duty Cycle is 10.7% as stated in RF exposure document, each Tx packet is 250mS in duration).

Total Occupancy per frequency in a 20 second period is 41.1mS



## Channel Bandedge

120V - 64 727 278

Low Channel Bandedge - Mapping Plot

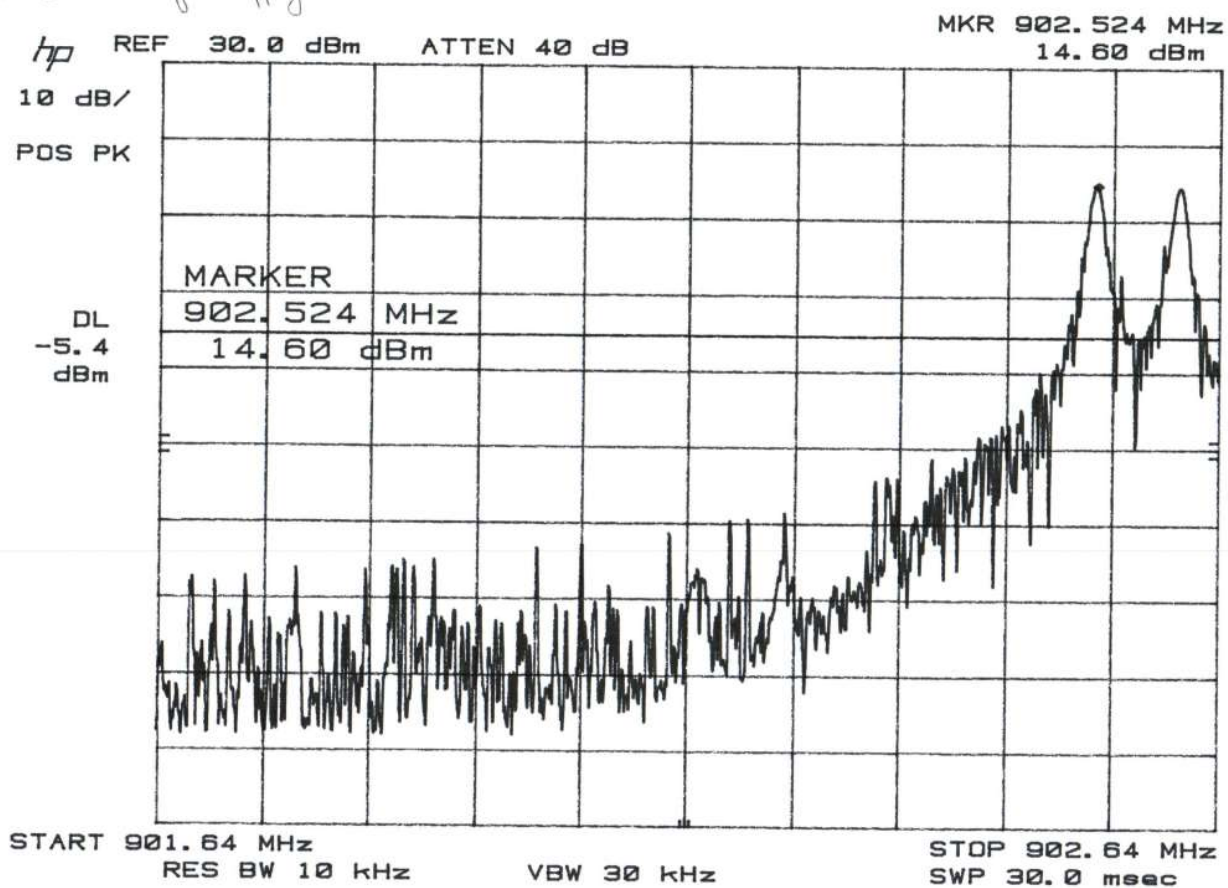


Figure 11: Low Channel Bandedge – 120V

240V - 64 727 271

Low Channel Bandedge - Kipping Plot

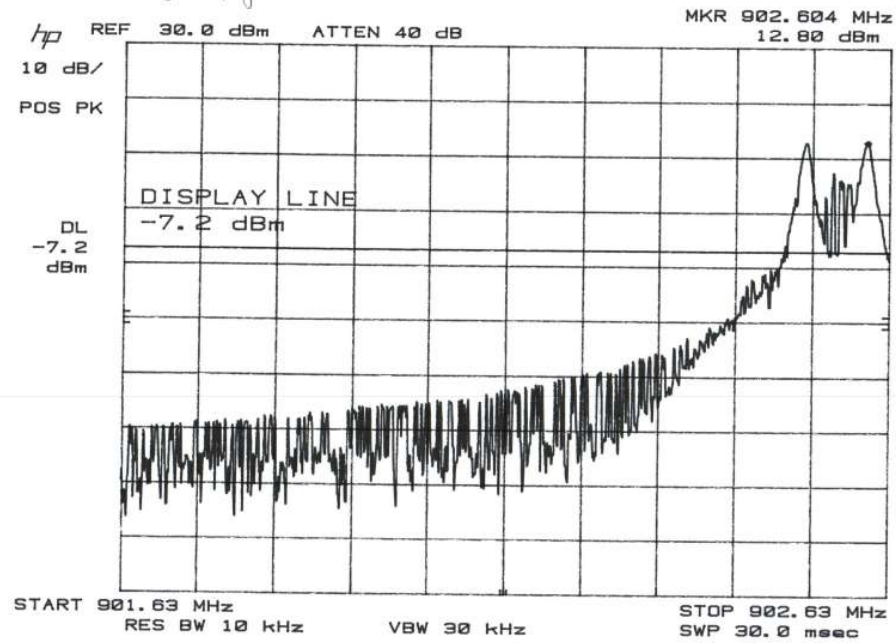


Figure 12: Low Channel Bandedge – 240V

120V - 64 727 273

High Channel Bandedge - Kipping Plot

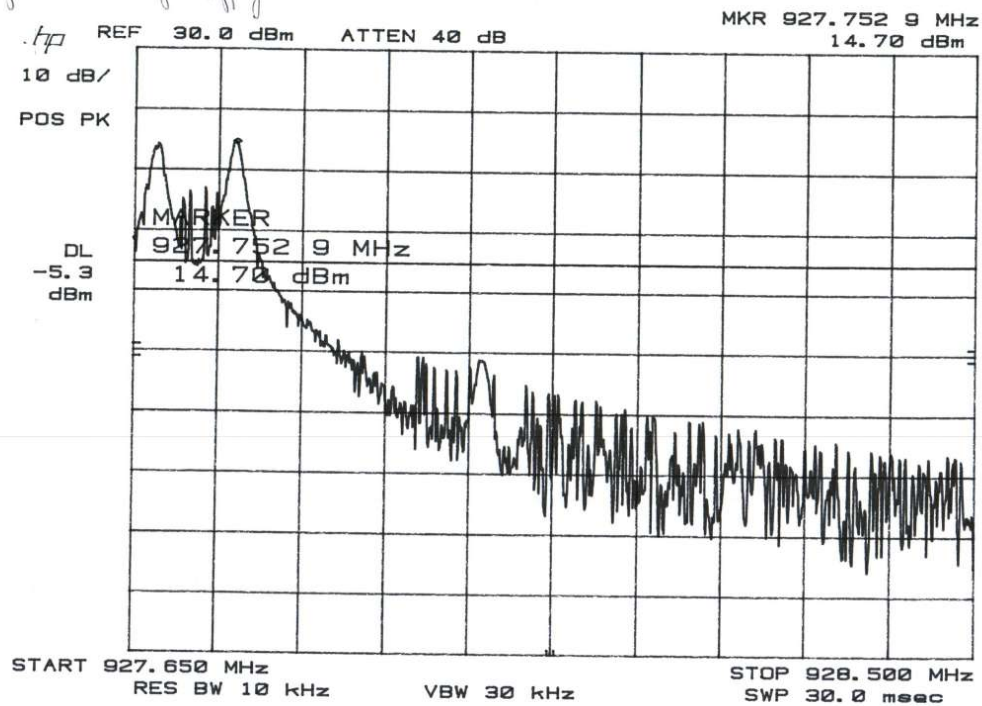


Figure 13: High Channel Bandedge – 120V

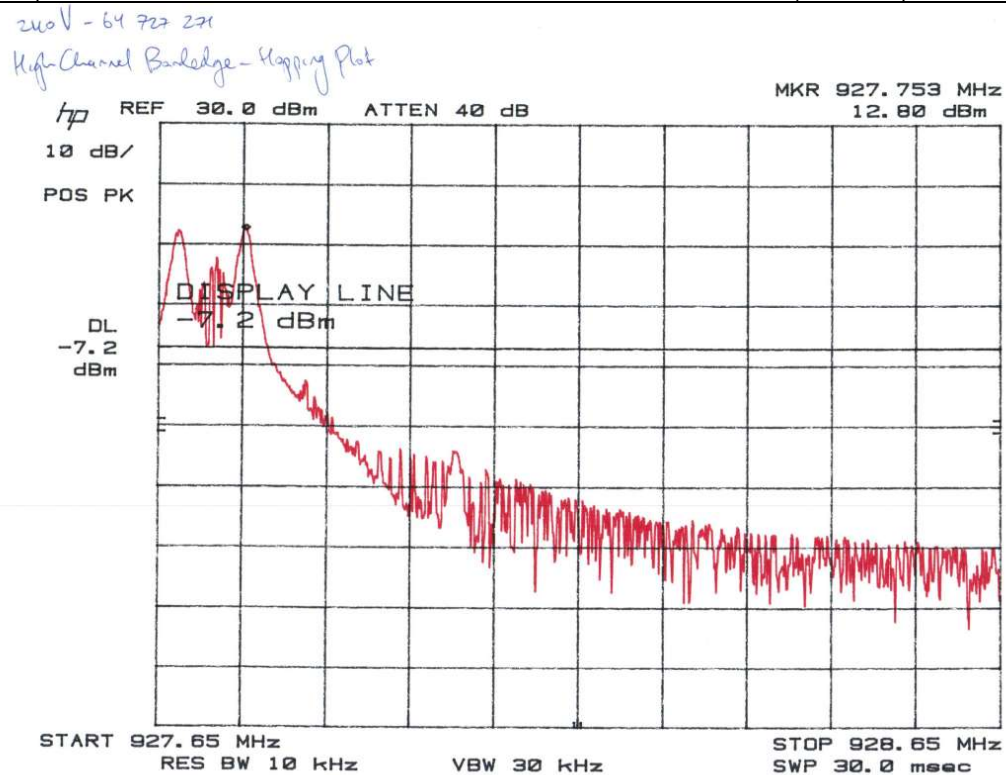
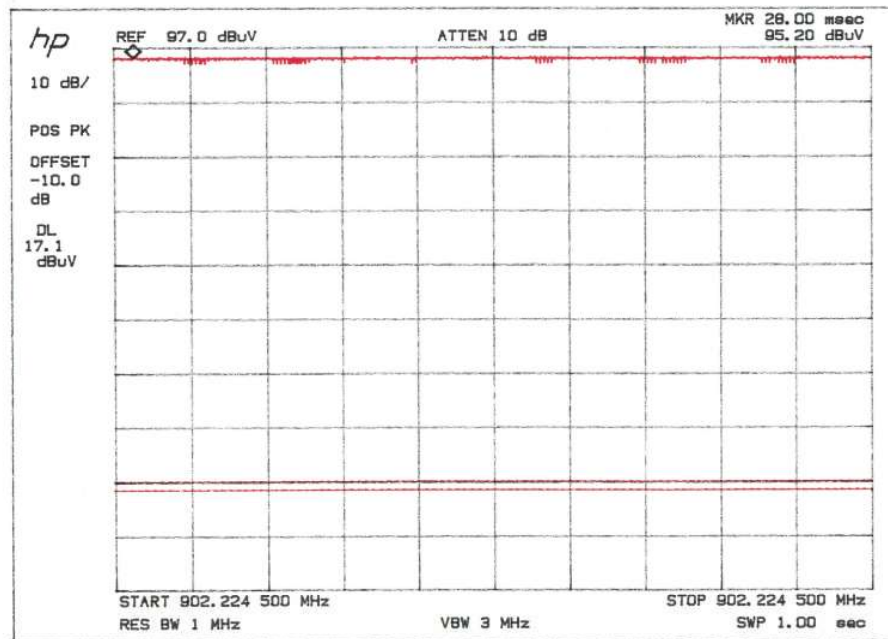
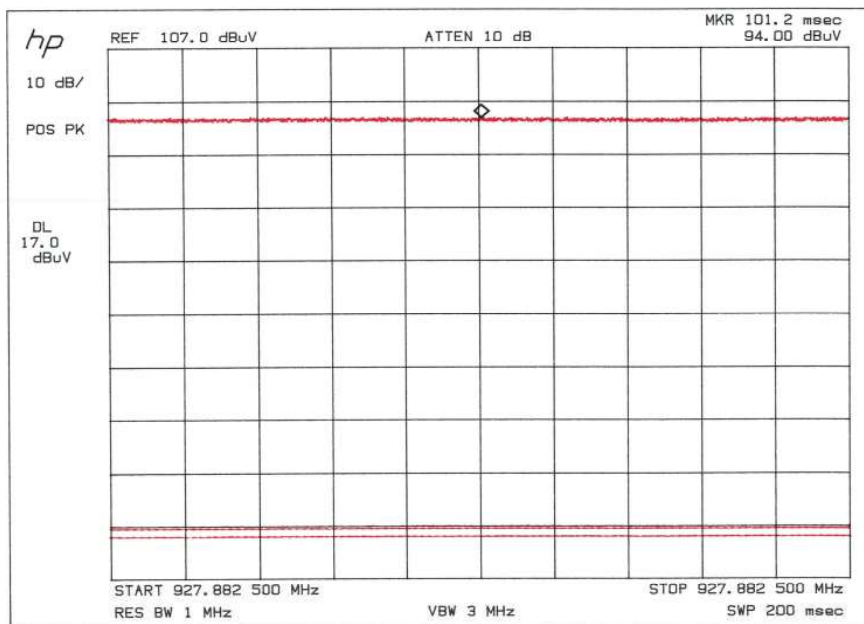


Figure 14: High Channel Bandedge – 240V

**EIRP Max****Figure 15: Maximum EIRP – 240V****Figure 16: Maximum EIRP – 120V**

**Radiated Spurious Harmonics**

Measurement Date: May 22 to June 10, 2012

**Setup:**

Measured at 1m distance. Correction factor includes antenna, cables, amplifier if used, and distance correction to 3 M of 9.54 dB.

NOTE: For this product, the EUT worst case "ON" time was measured be 4.8ms per 100ms. This equates to a possible duty cycle correction factor of -26.375dB, but there is a cap of 20dB per Section 15.35(b), which is applied to the emissions data . The peak emissions data is adjusted by 20dB as permitted by Section 15.35(b).

**Table 13: Test Data for 120V (All measurements with average values within 20 db of the limit.)**

Frequency	Pol.	Un-Corrected Peak	Total Correction	Peak Value	Average Limit at 3m	Duty Cycle Correction Factor	Average Value at 1m	Delta Lim-Peak
(MHz)		(dBuV)	(dB)	(dBuV/m)	dB(uV/m)	(dB)	dB(uV/m)	(dB)
2706.51	H	39.4	22.6	62	54	20	42	-12
2706.51	V	38.9	22.6	61.5	54	20	41.5	-12.5
2745	V	46.3	22.7	69	54	20	49	-5
2745	H	44.8	22.7	67.4	54	20	47.4	-6.6
2783.19	H	47.8	22.7	70.5	54	20	50.5	-3.5
2783.19	V	47.5	22.7	70.2	54	20	50.2	-3.8
3608.68	V	35.7	24.7	60.4	54	20	40.4	-13.6
3608.68	H	35	24.7	59.7	54	20	39.7	-14.3
3660	V	37.7	24.8	62.5	54	20	42.5	-11.5
3660	H	37.7	24.8	62.4	54	20	42.4	-11.6
3710.92	H	36.9	25.1	62	54	20	42	-12
3710.92	V	35.6	25.1	60.7	54	20	40.7	-13.3
4510.85	H	38.4	26.9	65.3	54	20	45.3	-8.7
4510.85	V	37.6	26.9	64.5	54	20	44.5	-9.5
4575	H	45.7	27	72.6	54	20	52.6	-1.4
4575	V	44.8	27	71.8	54	20	51.8	-2.2
4638.65	H	45.6	27.1	72.7	54	20	52.7	-1.3
4638.65	V	41.6	27.1	68.7	54	20	48.7	-5.3
5413.02	H	33.3	28	61.3	54	20	41.3	-12.7
5413.02	V	32.8	28	60.8	54	20	40.8	-13.2
8119.53	H	37.5	31.9	69.4	54	20	49.4	-4.6
8119.53	V	35.9	31.9	67.8	54	20	47.8	-6.2

8349.57	V	48.8	15.1	63.9	54	20	43.9	-10.1
8349.57	H	41.6	15.1	56.7	54	20	36.7	-17.3
9021.7	H	38.8	35.1	73.9	54	20	53.9	-0.1
9021.7	V	38	35.1	73.1	54	20	53.1	-0.9
9150	V	55.1	9.1	64.2	54	20	44.2	-9.8
9150	H	52.7	9.1	62.4	54	20	42.4	-11.6

**Table 14: Test Data for 240V (All measurements with average values within 20 db of the limit.)**

Frequency	Pol.	Un-Corrected Peak	Total Correction	Peak Value	Average Limit at 3m	Duty Cycle Correction Factor	Average Value at 1m	Delta Lim-Avg
(MHz)		(dBuV)	(dB)	(dBuV/m)	dB(uV/m)	(dB)	dB(uV/m)	(dB)
2706.51	H	47.7	22.6	70.3	54	20	50.3	-3.7
2706.51	V	43.9	22.6	66.5	54	20	46.5	-7.5
2745	H	47.5	22.7	70.2	54	20	50.2	-3.8
2745	V	44.5	22.7	67.2	54	20	47.2	-6.8
2783.19	H	47.5	22.7	70.2	54	20	50.2	-3.8
2783.19	V	47.2	22.7	69.9	54	20	49.9	-4.1
3608.68	V	39.3	24.7	64	54	20	44	-10
3608.68	H	37.3	24.7	62	54	20	42	-12
3660	V	37.9	24.8	62.7	54	20	42.7	-11.3
3660	H	36.5	24.8	61.3	54	20	41.3	-12.7
3710.92	H	36.9	25.1	62	54	20	42	-12
3710.92	V	35.6	25.1	60.7	54	20	40.7	-13.3
4510.85	H	39.1	25.1	64.2	54	20	44.2	-9.8
4510.85	V	37.6	25.1	62.7	54	20	42.7	-11.3
4575	V	36.5	26.9	63.4	54	20	43.4	-10.6
4575	H	34.3	26.9	61.2	54	20	41.2	-12.8
4638.65	H	33.9	27	60.9	54	20	40.9	-13.1
4638.65	V	33.3	27	60.3	54	20	40.3	-13.7
4510.85	V	37.1	27.1	64.2	54	20	44.2	-9.8
4510.85	H	35.3	27.1	62.4	54	20	42.4	-11.6
5413.02	H	47.8	7.6	55.4	54	20	35.4	-18.6

8119.53	H	53.0	13.5	66.5	54	20	46.5	-7.5
8119.53	V	52.9	13.5	66.4	54	20	46.4	-7.6
8349.57	H	57.1	15.4	72.5	54	20	52.5	-1.5
8349.57	V	54.1	17.4	71.5	54	20	51.5	-2.5
9021.7	H	56.5	9.1	65.6	54	20	45.6	-8.4
9021.7	V	55.9	9.1	65	54	20	45	-9



## Appendix B: Test Setup Photos



**Figure 17: OATS AC Conducted Test Setup**





OATS Radiated Unintentional 200 – 1000 MHz setup.

**Figure 18: Emissions Test Setup – Unintentional Radiated Emissions, 240V**



OATS Radiated 200 – 1000 MHz setup.

**Figure 19: Emissions Test Setup – Unintentional Radiated Emissions, 120V**