Exhibit 6: Test Report

TEST REPORT FROM:

COMMUNICATION CERTIFICATION LABORATORY
1940 W. Alexander Street
Salt Lake City, Utah
84119-2039

Type of Report: Certification

TEST OF: 900 SS Direct

FCC ID: NQE-900DS

To FCC PART 15.247, Subpart C

Test Report Serial No: 73-6891

Applicant:

World Wireless Communications, Inc.
2441 South 3850 West
West Valley City, UT 84116

Date(s) of Test: June 17 18, 1999

Issue Date: June 30, 1999

Equipment Receipt Date: June 17, 1999

CERTIFICATION OF ENGINEERING REPORT

This report has been prepared by Communication Certification Laboratory to determine compliance of the device described below with the requirements of FCC PART 15.247, Subpart C. This report may be reproduced in full, partial reproduction may only be made with the written consent of the laboratory. The results in this report apply only to the sample tested.

- Applicant: World Wireless Communications, Inc.
- Manufacturer: World Wireless Communications, Inc.
- Brand Name: WWC
- Model Number: 900 SS Direct
- FCC ID: NQE-900DS

On this 30th day of June 1999, I, individually, and for Communication Certification Laboratory, certify that the statements made in this engineering report are true, complete, and correct to the best of my knowledge, and are made in good faith.

COMMUNICATION CERTIFICATION LABORATORY

Checked by: William S. Hurst, P.E.
Vice President

Tested by: Roger J. Midgley
EMC Engineering Manager

SECTION 1. CLIENT INFORMATION AND RESPONSIBLE PARTY:

1.1 Client Information:

Company Name: World Wireless Communications, Inc.
2441 South 3850 West
West Valley City, UT 84116

Contact Name: Rich Saywer
Title: Project Engineer

SECTION 2. EQUIPMENT UNDER TEST (EUT)

2.1 Identification of EUT:

Trade Name:	WWC
Model Name or Number:	900 SS Direct
Serial Number:	N/A
Options Fitted:	None
Country of Manufacture:	U.S.A.

2.2 Description of EUT:

The 900 SS Direct is a direct sequence spread spectrum radio. It has an RS-232 interface that can be connected to a computer or any other equipment that has RS-232 capability.

The applications of this radio are limited only by the need and imagination, some examples are:

- Short/Long distance telemetry
- Weather Stations
- Wireless security stations
- Remote data collections
- SCADA applications

The 900 SS Direct operates on 9-15 VDC supplied via a 120 VAC to 12 VDC power supply.

This report covers the transmitter only the receiver is covered under a separate verification report.

2.3 Modification Incorporated/Special Accessories on EUT:

The following modifications were made to the 900 SS Direct by the Client during testing to comply with the specification. These modifications will be implemented during manufacturing.

1. C902 was changed from 3.9 pF to 2.2 pF
2. C85 was changed from 3.3 pF to 3.7 pF

Signature: ______________________________

Typed Name: Rich Sawyer

2.4 EUT and Support Equipment:

The FCC ID numbers for all the EUT and support equipment used during the test (including inserted cards) are listed below:

Brand Name Model Number Serial No.	FCC ID Number	Description	Name of Interface Ports/Interface Cables
BN: WWC MN: 900 SS Direct SN: N/A	NQE-900DS	Direct Sequence Spread Spectrum Radio	N/A

SECTION 3. TEST SPECIFICATION, METHODS & PROCEDURES

3.1 Test Specification:

Title: FCC PART 15.247, Subpart C (47 CFR 15).

Limits and methods of measurement of radio interference characteristics of radio frequency devices. Operation within the bands 902-928 MHz, 2400-2483.5 MHz and 5725-5850 MHz.

Purpose of Test: The tests were performed to demonstrate Initial compliance.

3.2 Methods & Procedures:

3.2.1 § 15.247

(a) Operation under the provisions of this section is limited to frequency hopping and direct sequence spread spectrum intentional radiators that comply with the following provisions:

(1) Frequency hoping 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 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 transmitting 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.

(ii) Frequency hopping systems operating in the 2400 – 2483.5 MHz and the 5725 – 5850 MHz bands shall use at least 75 hopping frequencies. The maximum allowed 20 dB bandwidth of the hopping channel is 1 MHz. The average time of occupancy on any frequency shall not be greater than 0.4 seconds within a 30 second period.

(2) For direct sequence systems, the minimum 6 dB bandwidth shall be at least 500 kHz.

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

(1) For frequency hopping systems operating in the 2400 – 2483.5 MHz or 5725 – 5850 MHz band and for all direct sequence systems: 1 watt.

(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.

(3) Except as show in paragraphs (b)(3)(i), (ii) and (iii) of this section, if transmitting antennas of directional gain greater than 6 dBi are used the peak output power from the intentional radiator shall be reduced below the stated values in paragraphs (b)(1) or (b)(2) of this section, as appropriate, by the amount in dB that the directional gain of the antenna exceeds 6 dBi.

(i) Systems operating in the 2400 – 2483.5 MHz band that are used exclusively for fixed, point-to-point operations may employ transmitting antennas with directional gain greater than 6 dBi provided the maximum peak output power of the intentional radiator is reduced by 1 dB for every 3 dB that the directional gain of the antenna exceeds 6 dBi.

(ii) Systems operating in the 5725 – 5850 MHz band that are used exclusively for fixed, point-to-point operations may employ transmitting antennas with directional gain greater than 6 dBi without any corresponding reduction in transmitter peak output power.

(iii) Fixed, point-to-point operation, as used in paragraphs (b)(3)(i) and (b)(3)(ii) of this section, excludes the use of point-to-multipoint systems, omnidirectional applications, and multiple co-located intentional radiators transmitting the same information. The operator of the spread spectrum intentional radiator or, if the equipment is professionally installed, the installer is responsible for ensuring that the system is used exclusively for fixed, point-to-point operations. The instruction manual furnished with the intentional radiator shall contain language in the installation instructions informing the operator and the installer of the responsibility.

(4) Systems operating under the provisions of this section shall be operated in a manner that ensures that the public is not exposed to radio frequency energy levels in excess of the Commission's guidelines. See Sec. 1.1307(b)(1) of this chapter.

(c) In any 100 kHz bandwidth outside the frequency band in which the spread spectrum intentional radiator is operating, the radio frequency power that is produced by the intentional radiator shall be at least 20 dB below that in any 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. Attenuation below the general levels specified in § 15.209(a) is not required. In addition, radiated emissions which fall in the restricted bands, as defined in § 15.205(a), must also comply with the radiated emission limits specified in § 15.209(a) (see § 15.205(c)).

(d) For direct sequence systems, the peak power density conducted from the intentional radiator to the antenna shall not be greater than 8 dBm in any 3 kHz band during any time interval of continuous transmission.

(e) The processing gain of a direct sequence system shall be at least 10 dB. The processing gain represents the improvement to the received signal-to-noise ratio, after filtering to the information bandwidth, from the spreading/despreading function. The processing gain may be determined using one of the following methods:

(1) As measured at the demodulated output of the receiver: the ratio in dB of the signal-to-noise ratio with the system spreading code turned off to the signal-to-noise ratio with the system spreading code turned on.

(2) As measured using the CW jamming margin method: a signal generator is stepped in 50 kHz increments across the passband of the system, recording at each pint the generator level required to produce the recommended Bit Error Rate (BER). This level is the jammer level. The output power of the intentional radiator is measured at the same point. This jammer to signal ratio (J/S) is than calculated, discarding the worst 20% of the J/S data points. The lowest remaining J/S ratio is used to calculate the

processing gain, as follows: Gp = (S/N)o+Mj+Lsys, where Gp = processing gain of the system, (S/N)o = signal to noise ratio required for the chosen BER, Mj = J/S ratio, and Lsys = system losses. Note that total losses in a system, including intentional radiator and receiver, should be assumed to be no more than 2 dB.

(f) Hybrid systems that employ a combination of both direct sequence and frequency hopping modulation techniques shall achieve a processing gain of at least 17 dB from the combined techniques. The frequency hopping operation of the hybrid system, with the direct sequence operation turned off, shall have an average time of occupancy on any frequency not to exceed 0.4 seconds within a time period in seconds equal to the number of hopping frequencies employed multiplied by 0.4. The direct sequence operation of the hybrid system, with the frequency hopping operation turned off, shall comply with the power density requirements of paragraph (d) of this section.

(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 deigned 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 transmission 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 hopset 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 in not permitted.

NOTE: Spread spectrum systems are sharing these bands on a non-interference basis with systems supporting critical Government requirements that have been allocated the usage of these bands, secondary only to ISM equipment operated under the provisions of part 18 of this chapter. Many of these Government systems are airborne radiolocation systems that emit a high EIRP, which can cause interference to other users. Also, investigations of the effect of spread spectrum interference to U.S. Government operations in the 902-928 MHz band may require a future decrease in the power limits allowed for spread spectrum operation.

3.2.2 § 15.207 Conducted Limits

(a) For an intentional radiator which 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 450 kHz to 30 MHz shall not exceed 250 microvolts. Compliance with the provision shall be based on the measurement of the radio frequency voltage between each power line and ground at the power terminals.

(b) The following option may be employed if the conducted emissions exceed the limits in paragraph (a) of this section when measured using instrumentation employing a quasi-peak detector function: If the level of the emission measured using the quasi-peak instrumentation is 6 dB, or more, higher than the level of the same emission measured with instrumentation having an average detector and a 9 kHz minimum bandwidth, that emission is considered broadband and the level obtained with the quasi-peak detector may be reduced by 13 dB for comparison to the limits. When employing this option, the following conditions shall be observed:

(1) The measuring instrumentation with the average detector shall employ a linear IF amplifier.

(2) Care must be taken not to exceed the dynamic range of the measuring instrument when measuring an emission with a low duty cycle.

(3) The test report required for verification of for an application for a grant of equipment authorization shall contain all details supporting the use of this option.

(c) The limit shown in paragraph (a) of this section shall not apply to carrier current systems operation as intentional radiators on frequencies below 30 MHz. In lieu thereof, these carrier current systems shall be subject to the following standards:

(1) For carrier current systems containing their fundamental emission within the frequency band 535-1705 kHz and intended to be received using a standard AM broadcast receiver: no limit on conducted emissions.

(2) For all other carrier current systems: 1000 μV within the frequency band 535-1705 kHz.

(3) Carrier current systems operating below 30 MHz are also subject to the radiated emission limits in §§ 15.205, 15.209, 15.221, 15.223, 15.225 or 15.227, as appropriate.

(d) Measurements to demonstrate compliance with the conducted limits are not required for devices which only employ battery power for operation and which do not operate from the AC power lines or contain provisions for operation while connected to the AC power lines. Devices that include, or make provision for, the use of battery chargers which permit operation while charging, AC adapters or battery eliminators or that connect to the AC power lines indirectly, obtaining their power through another device which is connected to the AC power lines, shall be tested to demonstrate compliance with the conducted limits.

3.2.3 Test Procedure

The testing was performed according to the procedures in ANSI C63.4 (1992). Testing was performed at CCL’s anechoic chamber located in Salt Lake City, Utah. This site has been fully described in a report submitted to the FCC, and was accepted in a letter dated March 1, 1999 (31040/SIT).

CCL participates in the National Voluntary Laboratory Accreditation Program (NVLAP) and has been accepted under NVLAP Lab Code:100272-0, which is effective until September 30,1999.

For radiated emissions testing that is performed at distances closer than the specified distance, an inverse proportionality factor of 20 dB per decade is used to normalize the measured data for determining compliance.

SECTION 4. OPERATION OF EUT DURING TESTING.

4.1 Operating Environment:

Power Supply: 12 VDC
AC Mains Frequency: N/A

4.2 Operating Modes:

Each mode of operation was exercised to produce worst case emissions. The worst case emissions were with the 900 SS Direct running in the following mode. The 900 SS Direct was placed in the transmit mode with the same type of modulation that would normally be used during normal operation.

4.3 Configuration & Peripherals:

The 900 SS Direct was placed on the table in the transmit mode with the same type of modulation that would normally be used during normal operation.

SECTION 5. SUMMARY OF TEST RESULTS:

5.1 FCC PART 15.247, Subpart C

5.1.1 Summary of Tests:

Section	Test Performed	Frequency Range (MHz)	Result
15.247 (a)(2)	Emission Bandwidth	902 to 928	Complied
15.247 (b)(1)	Peak Output Power	902 to 928	Complied
15.247 (C)	Antenna Conducted Spurious Emissions	3 to 10,000	Complied
15.247 (C)	Radiated Spurious Emissions	3 to 10,000	Complied
15.247 (d)	Power Spectral Density	902 to 928	Complied
15.247 (e)	Processing Gain	902 to 928	Complied
15.207	Line Conducted Emissions (Hot Lead to Ground)	0.45 to 30	Complied
15.207	Line Conducted Emissions (Neutral Lead to Ground)	0.45 to 30	Complied

5.2 Result

In the configuration tested, the EUT complied with the requirements of the specification.

SECTION 6. MEASUREMENTS, EXAMINATIONS AND DERIVED RESULTS:

6.1 General Comments:

This section contains the test results only. Details of the test methods used, etc., can be found in Appendix B of this report.

The 900 SS Direct can operate on four channels, 905 MHz, 910 MHz, 915 MHz or 923 MHz. The transmit frequency is set by adjusting the jumpers as shown on page 7 of the users manual. The 900 SS Direct was tested on three different channels (905, 915 and 923 MHz), the results for each channel are shown below.

6.2 Test Results

6.2.1 § 15.247 (a) (2)

Measurement Data Emission Bandwidth:

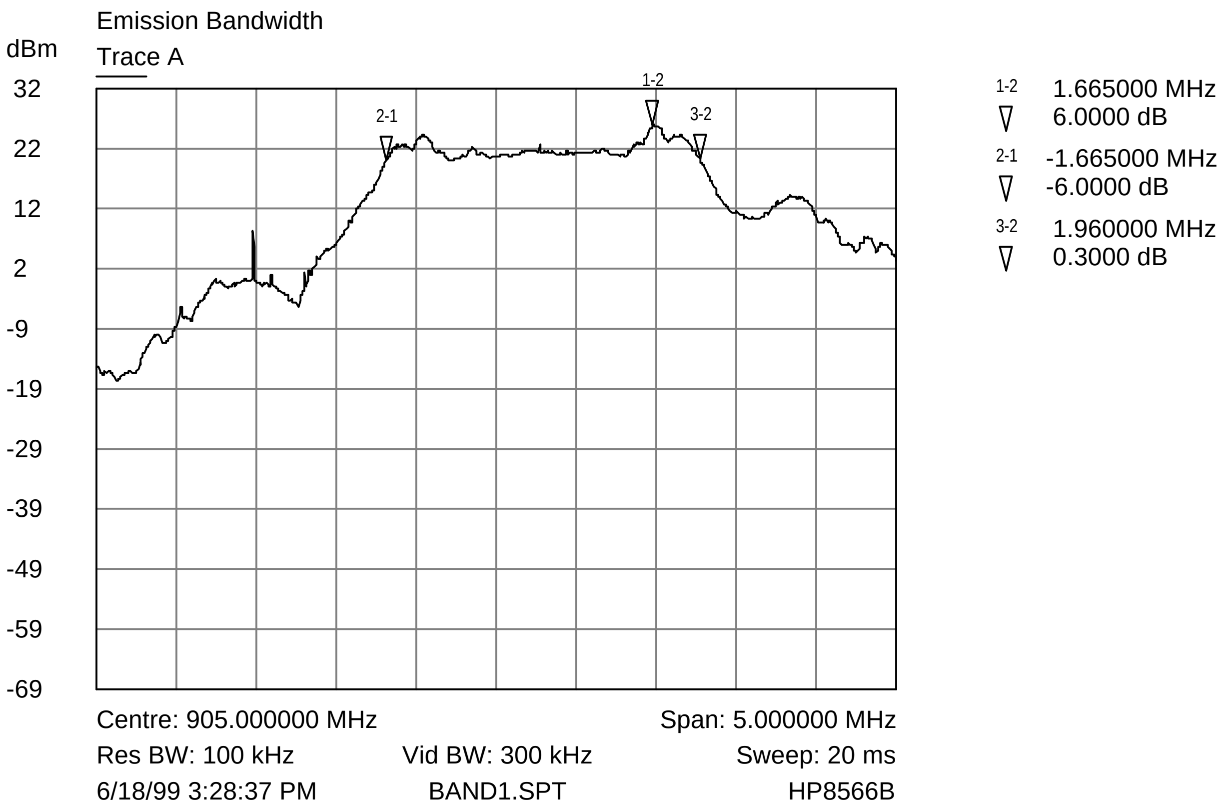
A diagram of the test configuration is enclosed in Appendix A and a list of reference codes for test equipment used is enclosed in Appendix B.

Test equipment used: 1, 3 and 4.

Frequency (MHz)	Emission Bandwidth (MHz)
905.0	1.96
915.0	1.97
923.0	1.97

RESULT

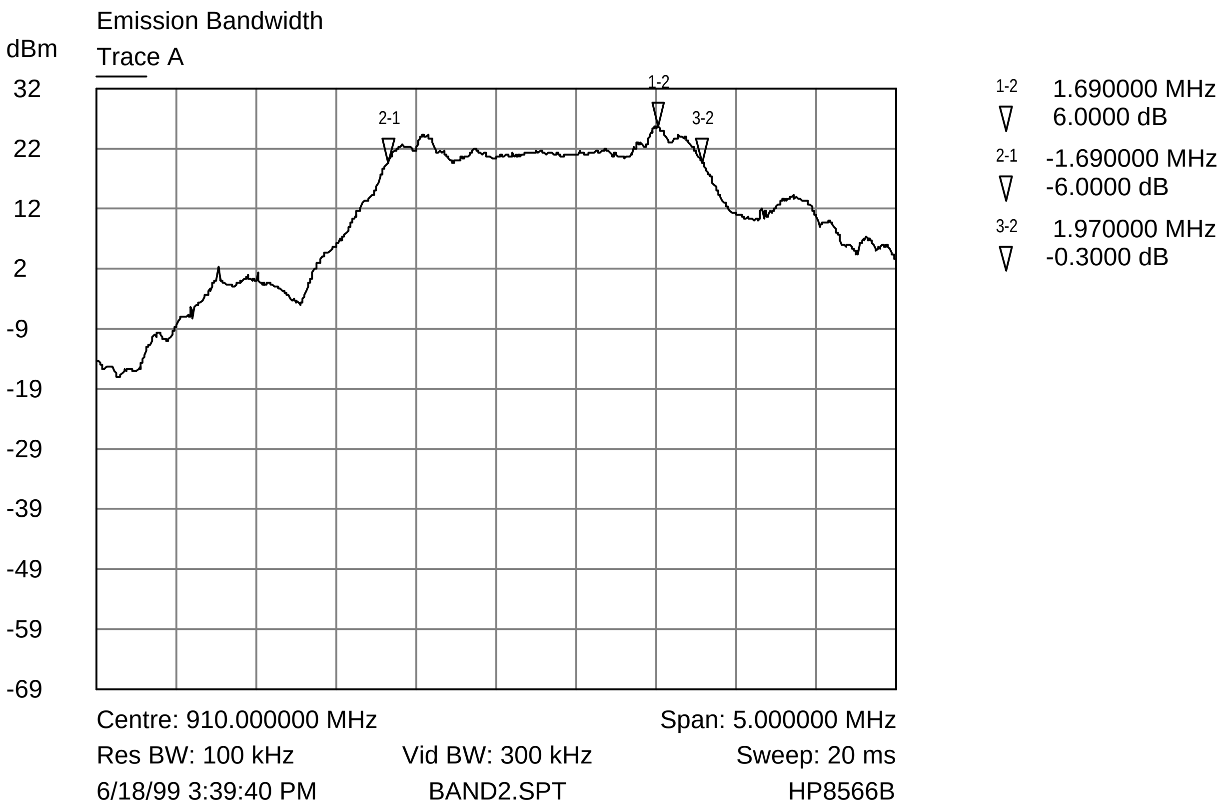
In the configuration tested, the 6 dB bandwidth was greater than 500 kHz; therefore, the EUT complied with the requirements of the specification (see spectrum analyzer plots below).



Emission Bandwidth (Low End of Band)

Trace A 31.5 dB Offset (30 dB Attenuator and Cable)

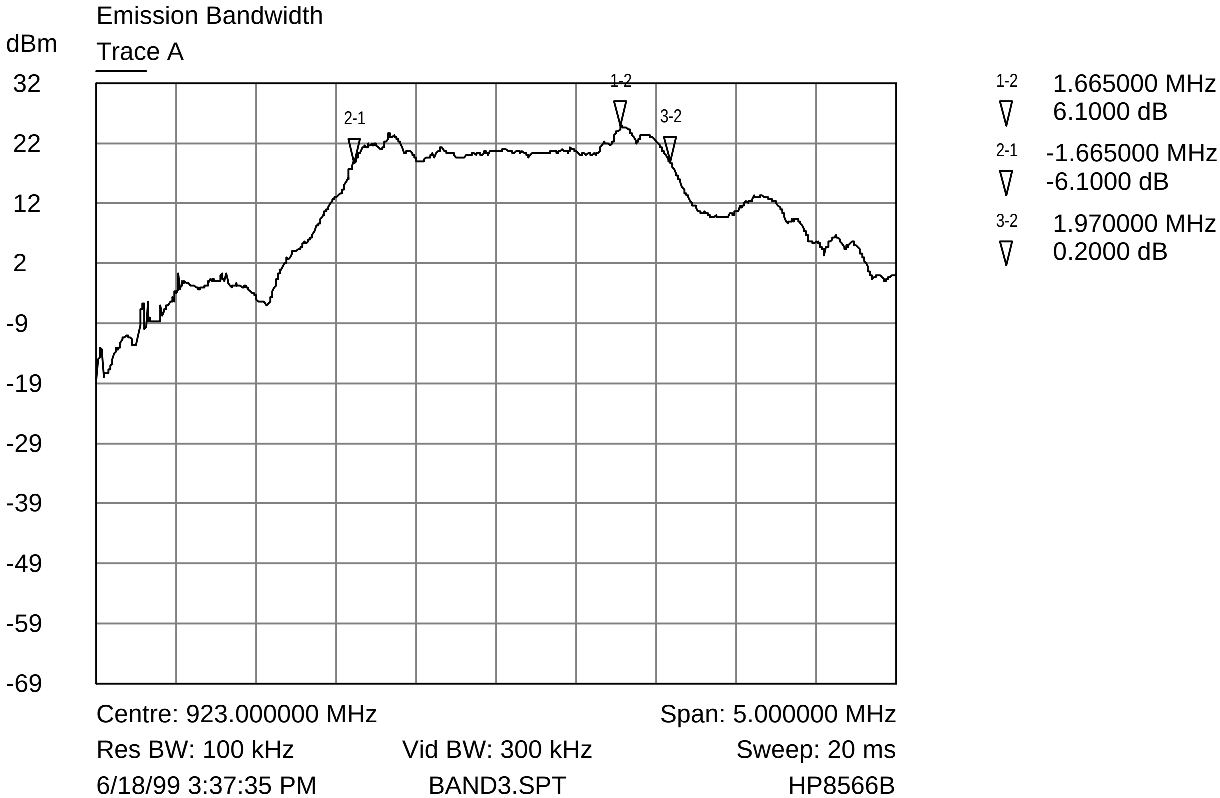
Emission Bandwidth Plot - (Low Channel)



Emission Bandwidth (Middle of Band)

Trace A 31.5 dB Offset (30 dB Attenuator and Cable)

Emission Bandwidth Plot - (Middle Channel)



Emission Bandwidth (High End of Band)

Trace A 31.5 dB Offset (30 dB Attenuator and Cable)

Emission Bandwidth Plot - (High Channel)

6.2.2 § 15.247 (b) Peak Output Power:

Measurement Data:

The maximum peak output power measured for this device was 398.0 mW or 26.0 dBm. Shown below is the measured peak output power. The 900 SS Direct can be installed with the three different types of antennas listed below; therefore, measurements were performed with the 900 SS Direct transmitting on all four antennas. The results for each measurement are shown below.

Antenna Type	Model	Antenna Gain
Centurion Dipole	CAF28715	2.15 dBi
Comtelco Yagi	Y2283A-66	6 dBi
Maxrad Omni	MFB9155	5 dBi

The maximum directional gain of the each antenna is less than 6 dBi; therefore, the maximum output power is not required to be reduced from the value measured.

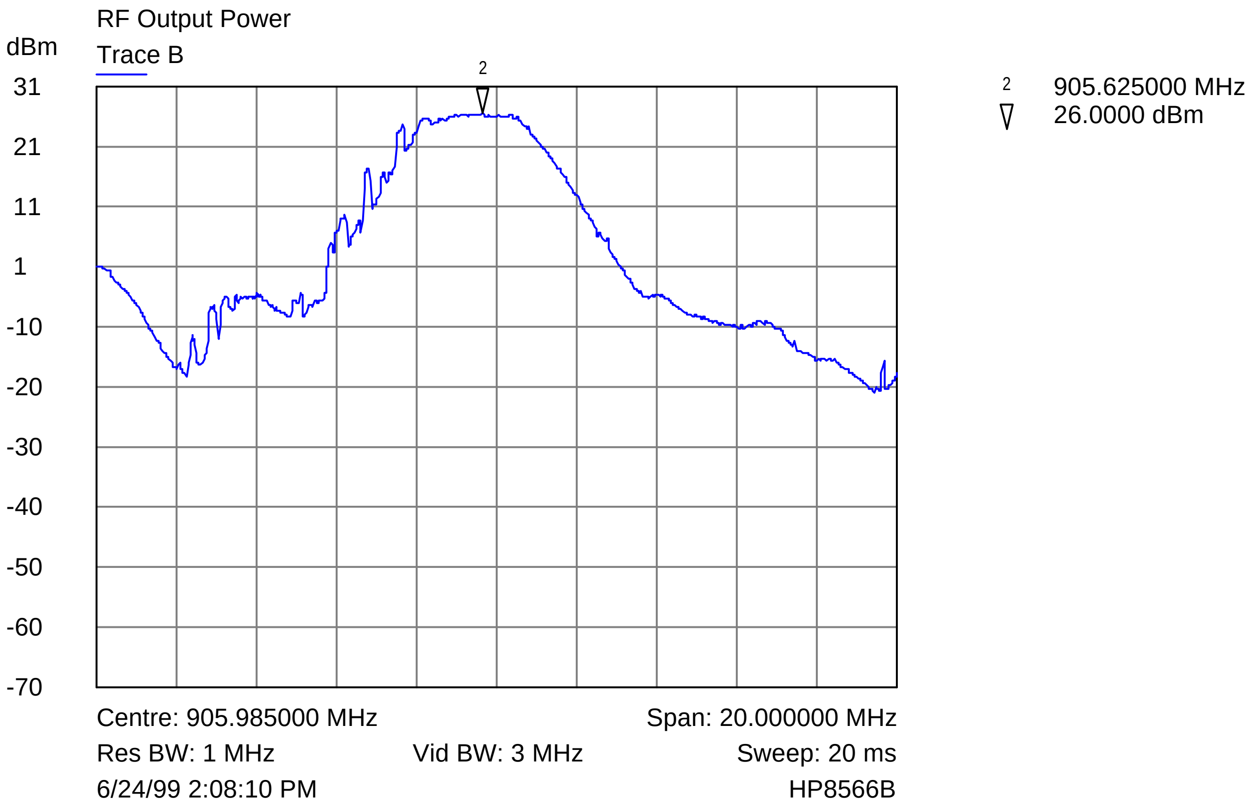
A diagram of the test configuration is enclosed in Appendix A and a list of reference codes for test equipment used is enclosed in Appendix B.

Test equipment used: 1, 3 and 4.

Frequency (MHz)	Measured Output Power (dBm)	Measured Output Power (mW)
905.0	26.0	398.0
915.0	25.7	372.0
923.0	25.6	363.0

RESULT

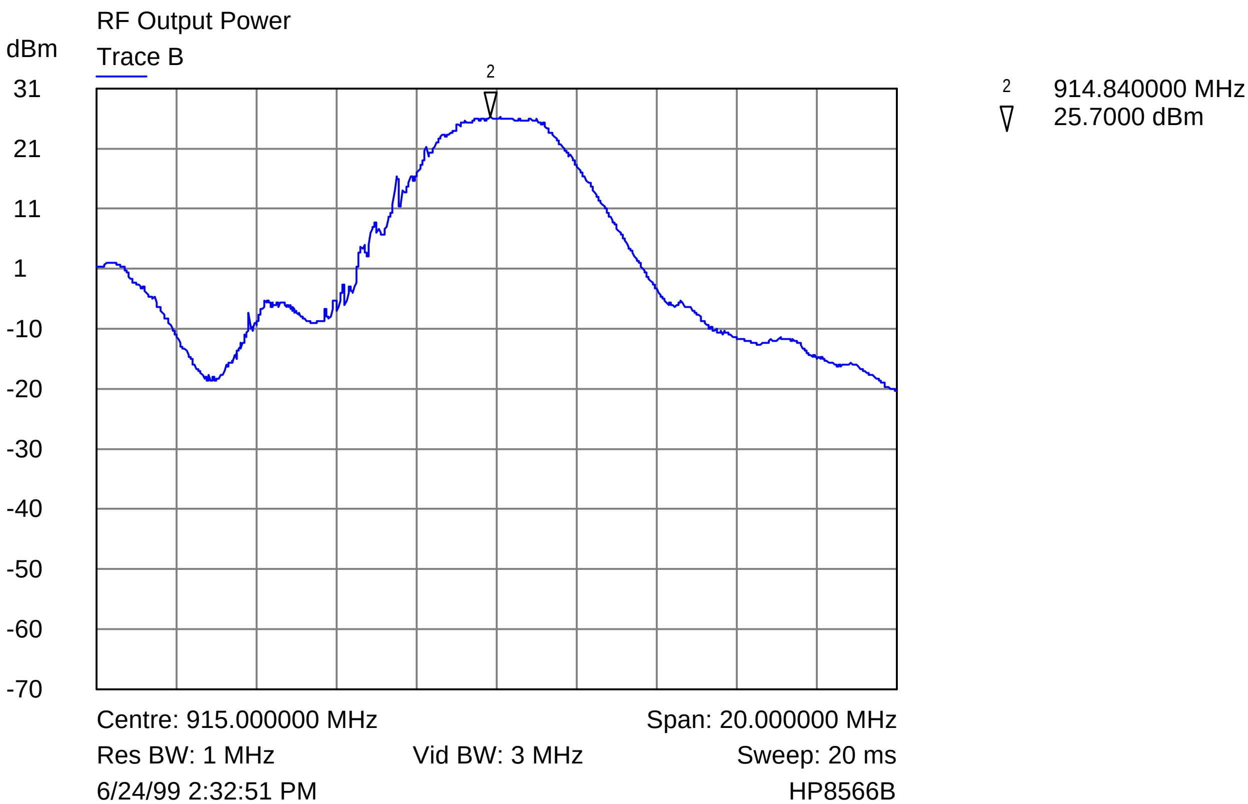
In the configuration tested, the EUT complied with the requirements of the specification (see spectrum analyzer plots below).



RF Output Power (Low End of Band)

Trace B 31.5 dB Offset (30 dB Attenuator and Cable)

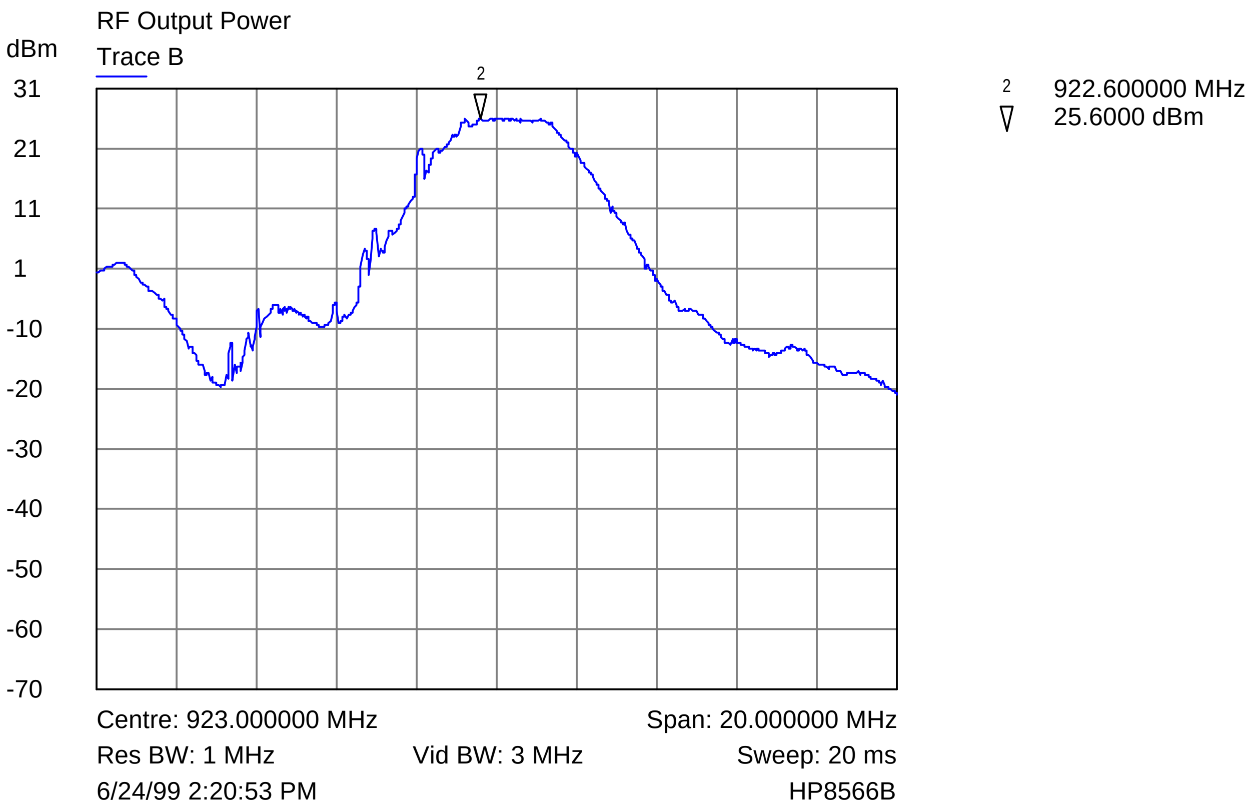
RF Power Output Plot - (Low Channel)



RF Output Power (Middle of Band)

Trace B 31.5 dB Offset (30 dB Attenuator and Cable)

RF Power Output Plot - (Middle Channel)



RF Output Power (High End of Band)

Trace B 31.5 dB Offset (30 dB Attenuator and Cable)

RF Power Output Plot - (High Channel)

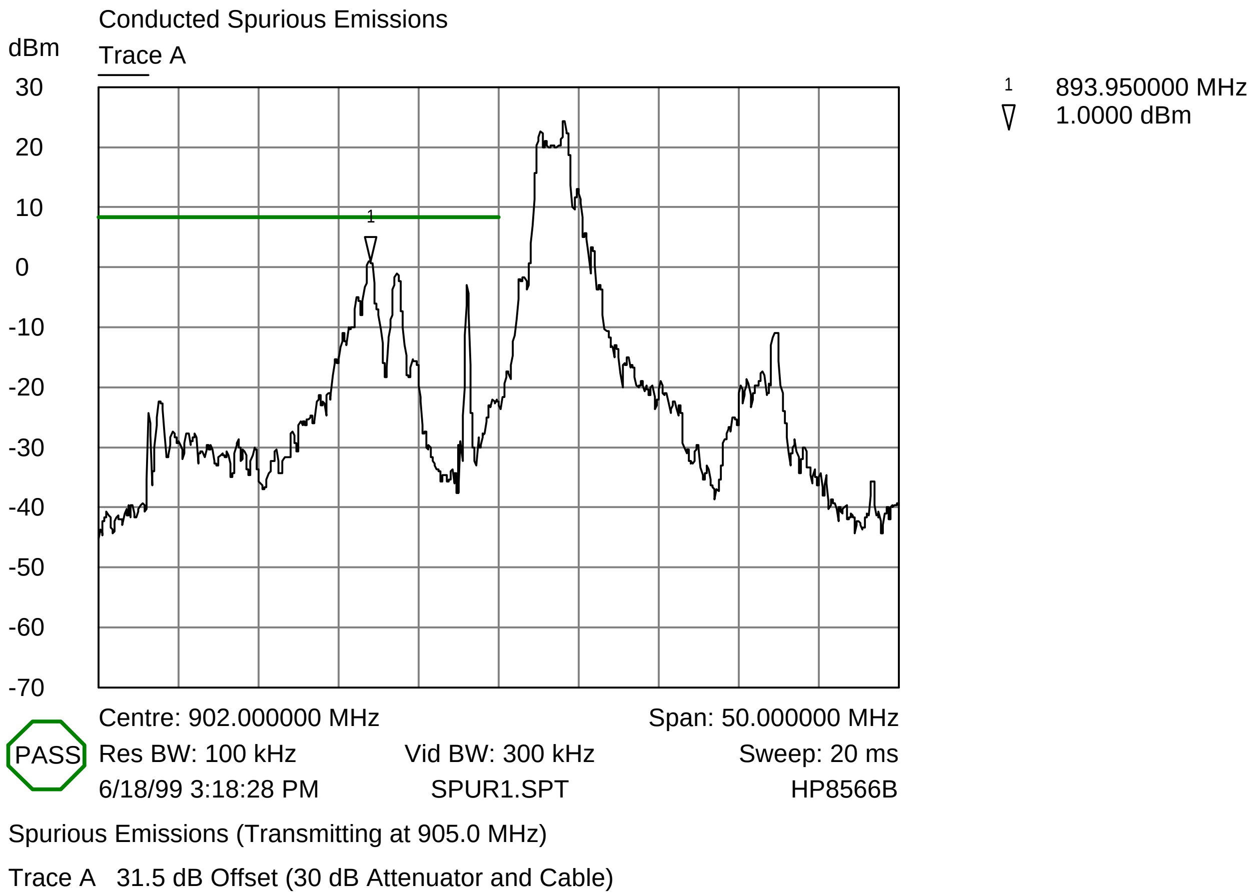
6.2.3 § 15.247 (c) Spurious Emissions:

Measurement Data Antenna Conducted Emissions:

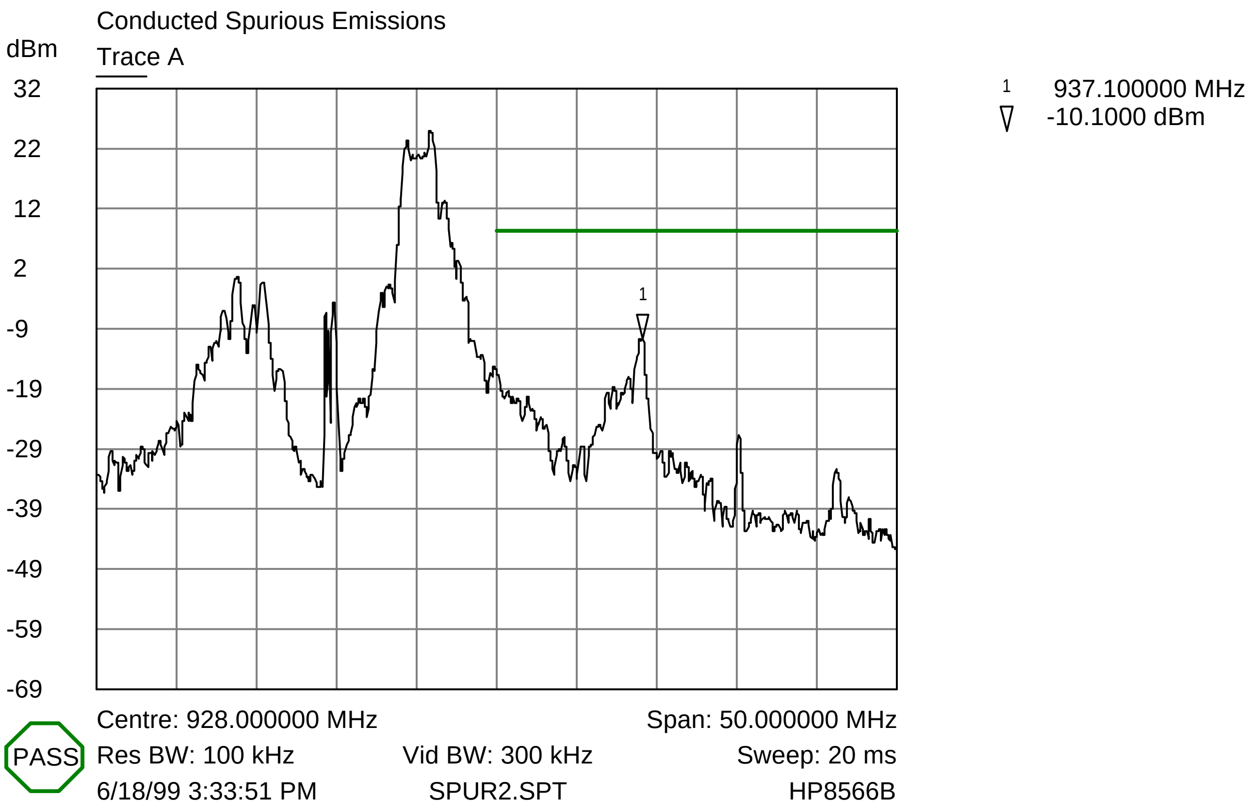
The frequency range from 3 MHz to the tenth harmonic of the highest fundamental frequency was investigated to measure any antenna-conducted emissions. Shown below are plots with the 900 SS Direct tuned to the upper and lower band edges. These demonstrate compliance with the provisions of this section.

A diagram of the test configuration is enclosed in Appendix A and a list of reference codes for test equipment used is enclosed in Appendix B.

Test equipment used: 1, 3 and 4.



Spurious emissions plot (Transmitting at 905 MHz)



Spurious Emissions (Transmitting at 923.0 MHz)

Trace A 31.5 dB Offset (30 dB Attenuator and Cable)

Spurious emissions plot (Transmitting at 923 MHz)

The emissions must be attenuated 20 dB below the highest power level measured; therefore, the criteria is 26.0 – 20.0 = 6.0 dBm.

Transmitting at 905.0 MHz			
Frequency Range MHz	Frequency MHz	Corrected Level dBm	Criteria dBm
3 - 30	7.4	-42.1	6.0
30 - 200	30.7	-60.7	6.0
200 - 500	442.6	-49.5	6.0
500 – 901.9	830.9	-54.0	6.0
928.1 - 1000	931.4	-29.6	6.0
1000 – 2000	1811.0	-49.8	6.0
2000 - 3000	2716.0	-61.9	6.0
3000 - 4000	3621.0	-50.8	6.0
4000 - 5000	4526.0	-64.0	6.0
5000 - 6000	5431.0	-66.5 *	6.0
6000 - 7000	6336.0	-67.0 *	6.0
7000 - 8000	7241.0	-67.4 *	6.0
8000 - 9000	8146.0	-66.8 *	6.0
9000 - 10000	9051.0	-66.9 *	6.0
* Noise Floor			

The emissions must be attenuated 20 dB below the highest power level measured; therefore, the criteria is 25.7 – 20.0 = 5.7 dBm.

Transmitting at 915.0 MHz			
Frequency Range MHz	Frequency MHz	Corrected Level dBm	Criteria dBm
3 - 30	4.5	-40.4	5.7
30 - 200	116.0	-61.6	5.7
200 - 500	461.6	-45.7	5.7
500 – 901.9	824.8	-52.7	5.7
928.1 - 1000	936.2	-31.6	5.7
1000 – 2000	1830.0	-43.9	5.7
2000 - 3000	2745.0	-65.4	5.7
3000 - 4000	3660.0	-64.5	5.7
4000 - 5000	4575.0	-70.0	5.7
5000 - 6000	5490.0	-72.2 *	5.7
6000 - 7000	6405.0	-67.0 *	5.7
7000 - 8000	7320.0	-67.1 *	5.7
8000 - 9000	8235.0	-67.3 *	5.7
9000 - 10000	9150.0	-65.8 *	5.7
* Noise Floor			

The emissions must be attenuated 20 dB below the highest power level measured; therefore, the criteria is 25.6 – 20.0 = 5.6 dBm.

Transmitting at 923.0 MHz			
Frequency Range MHz	Frequency MHz	Corrected Level dBm	Criteria dBm
3 - 30	4.2	-41.5	5.6
30 - 200	114.0	-63.7	5.6
200 - 500	493.5	-49.1	5.6
500 – 901.9	898.6	-28.4	5.6
928.1 - 1000	937.0	-11.2	5.6
1000 – 2000	1846.0	-47.9	5.6
2000 - 3000	2769.0	-71.5	5.6
3000 - 4000	3692.0	-66.6	5.6
4000 - 5000	4615.0	-72.2	5.6
5000 - 6000	5538.0	-72.9 *	5.6
6000 - 7000	6461.0	-67.0 *	5.6
7000 - 8000	7384.0	-67.4 *	5.6
8000 - 9000	8307.0	-66.8 *	5.6
9000 - 10000	9230.0	-66.9 *	5.6
* Noise Floor			

Measurement Data Radiated Emissions Restricted Bands § 15.205:

The frequency range from 3 MHz to 10 GHz was investigated to measure any radiated emissions in the restricted bands.

A diagram of the test configuration is enclosed in Appendix A and a list of reference codes for test equipment used is enclosed in Appendix B.

Test equipment used: 1, 3, 4, 7, 8, 9 and 12.

AVERAGE FACTOR

The 900 SS Direct transmits continuously therefore, there is not an average factor for this device.

The 900 SS Direct can be installed with the three different types of antennas listed below; therefore, measurements were performed with the 900 SS Direct transmitting on all four antennas.

The results for each measurement are shown below.

Antenna Type	**Model**	**Antenna Gain**
Centurion Dipole	CAF28715	2.15 dBi
Comtelco Yagi	Y2283A-66	6 dBi
Maxrad Omni	MFB9155	5 dBi

Vertical Polarity
Centurion w/elbow Model CAS28715 Antenna

Transmitting at 905.0 MHz					
Frequency MHz	Receiver Reading dBμV	Correction Factor dB	Average Factor dB	Corrected Reading dBμV/m	Limit dBμV/m
2715.0 P	17.7	36.8	0.0	54.5	74.0
2715.0 A	6.5	36.8	0.0	43.3	54.0
3620.0 P	23.3	39.9	0.0	63.2	74.0
3620.0 A	10.7	39.9	0.0	50.6	54.0
4525.0 P	20.7	41.4	0.0	62.1	74.0
4525.0 A	7.8	41.4	0.0	49.2	54.0
5430.0 P	11.2 *	45.5	0.0	56.7	74.0
5430.0 A	-0.8 *	45.5	0.0	44.7	54.0
8145.0 P	13.4 *	40.5	0.0	53.9	74.0
8145.0 A	2.3 *	40.5	0.0	42.8	54.0
9050.0 P	12.6 *	42.1	0.0	54.7	74.0
9050.0 A	3.7 *	42.1	0.0	45.8	54.0

P = Peak Detection

A = Average Detection

Note 1: All Emissions from 3 MHz to the first harmonic that were with the restricted bands were more than 20 dB below the limit.

* No emissions were detected with the antenna 1 meter from the EUT, the indicated readings are the noise floor measurements from the spectrum analyzer

Transmitting at 915.0 MHz					
Frequency MHz	Receiver Reading dBμV	Correction Factor dB	Average Factor dB	Corrected Reading dBμV/m	Limit dBμV/m
2745.0 P	20.9	36.8	0.0	57.7	74.0
2745.0 A	8.0	36.8	0.0	44.8	54.0
3660.0 P	25.6	39.9	0.0	65.5	74.0
3660.0 A	8.3	39.9	0.0	48.2	54.0
4575.0 P	18.2	41.4	0.0	59.6	74.0
4575.0 A	5.2	41.4	0.0	46.6	54.0
7320.0 P	11.2 *	38.9	0.0	50.1	74.0
7320.0 A	1.6 *	38.9	0.0	40.5	54.0
8235.0 P	13.4 *	40.8	0.0	54.2	74.0
8235.0 A	1.8 *	40.8	0.0	42.6	54.0
9150.0 P	12.6 *	42.4	0.0	55.0	74.0
9150.0 A	2.9 *	42.4	0.0	45.3	54.0

P = Peak Detection

A = Average Detection

Note 1: All Emissions from 3 MHz to the first harmonic that were with the restricted bands were more than 20 dB below the limit.

* No emissions were detected with the antenna 1 meter from the EUT, the indicated readings are the noise floor measurements from the spectrum analyzer

Transmitting at 923.0 MHz					
Frequency MHz	Receiver Reading dBμV	Correction Factor dB	Average Factor dB	Corrected Reading dBμV/m	Limit dBμV/m
2769.0 P	23.1	36.8	0.0	59.9	74.0
2769.0 A	12.4	36.8	0.0	49.2	54.0
3692.0 P	17.5	39.9	0.0	57.4	74.0
3692.0 A	5.5	39.9	0.0	45.4	54.0
4615.0 P	14.0	41.4	0.0	55.4	74.0
4615.0 A	2.0	41.4	0.0	43.4	54.0
7384.0 P	11.2 *	38.9	0.0	50.1	74.0
7384.0 A	1.6 *	38.9	0.0	40.5	54.0
8307.0 P	13.4 *	40.8	0.0	54.2	74.0
8307.0 A	1.8 *	40.8	0.0	42.0	54.0

P = Peak Detection

A = Average Detection

Note 1: All Emissions from 3 MHz to the first harmonic that were with the restricted bands were more than 20 dB below the limit.

* No emissions were detected with the antenna 1 meter from the EUT, the indicated readings are the noise floor measurements from the spectrum analyzer

Horizontal Polarity
Centurion w/elbow Model CAS28715 Antenna

Transmitting at 905.0 MHz					
Frequency MHz	Receiver Reading dBμV	Correction Factor dB	Average Factor dB	Corrected Reading dBμV/m	Limit dBμV/m
2715.0 P	14.1	36.8	0.0	50.9	74.0
2715.0 A	2.3	36.8	0.0	39.1	54.0
3620.0 P	21.0	39.9	0.0	60.9	74.0
3620.0 A	9.8	39.9	0.0	49.7	54.0
4525.0 P	11.7	41.4	0.0	53.1	74.0
4525.0 A	0.0	41.4	0.0	41.4	54.0
5430.0 P	9.1	45.5	0.0	54.6	74.0
5430.0 A	-1.5	45.5	0.0	44.0	54.0
8145.0 P	13.4 *	40.5	0.0	53.9	74.0
8145.0 A	2.3 *	40.5	0.0	42.8	54.0
9050.0 P	12.6 *	42.1	0.0	54.7	74.0
9050.0 A	3.7 *	42.1	0.0	45.8	54.0

P = Peak Detection

A = Average Detection

Note 1: All Emissions from 3 MHz to the first harmonic that were with the restricted bands were more than 20 dB below the limit.

* No emissions were detected with the antenna 1 meter from the EUT, the indicated readings are the noise floor measurements from the spectrum analyzer

Transmitting at 915.0 MHz					
Frequency MHz	Receiver Reading dBμV	Correction Factor dB	Average Factor dB	Corrected Reading dBμV/m	Limit dBμV/m
2745.0 P	20.0	36.8	0.0	56.8	74.0
2745.0 A	9.0	36.8	0.0	45.8	54.0
3660.0 P	21.3	39.9	0.0	61.2	74.0
3660.0 A	10.1	39.9	0.0	50.0	54.0
4575.0 P	10.6	41.4	0.0	52.0	74.0
4575.0 A	0.0	41.4	0.0	41.4	54.0
7320.0 P	11.2 *	38.9	0.0	50.1	74.0
7320.0 A	1.6 *	38.9	0.0	40.5	54.0
8235.0 P	13.4 *	40.8	0.0	54.2	74.0
8235.0 A	1.8 *	40.8	0.0	42.6	54.0
9150.0 P	12.6 *	42.4	0.0	55.0	74.0
9150.0 A	2.9 *	42.4	0.0	45.3	54.0

P = Peak Detection

A = Average Detection

Note 1: All Emissions from 3 MHz to the first harmonic that were with the restricted bands were more than 20 dB below the limit.

* No emissions were detected with the antenna 1 meter from the EUT, the indicated readings are the noise floor measurements from the spectrum analyzer

Transmitting at 923.0 MHz					
Frequency MHz	Receiver Reading dBμV	Correction Factor dB	Average Factor dB	Corrected Reading dBμV/m	Limit dBμV/m
2769.0 P	20.3	36.8	0.0	57.1	74.0
2769.0 A	9.1	36.8	0.0	45.9	54.0
3692.0 P	15.3	39.9	0.0	55.2	74.0
3692.0 A	3.6	39.9	0.0	43.5	54.0
4615.0 P	10.2	41.4	0.0	51.6	74.0
4615.0 A	-0.9	41.4	0.0	40.5	54.0
7384.0 P	11.2 *	38.9	0.0	50.1	74.0
7384.0 A	1.6 *	38.9	0.0	40.5	54.0
8307.0 P	13.4 *	40.8	0.0	54.2	74.0
8307.0 A	1.8 *	40.8	0.0	42.0	54.0

P = Peak Detection

A = Average Detection

Note 1: All Emissions from 3 MHz to the first harmonic that were with the restricted bands were more than 20 dB below the limit.

* No emissions were detected with the antenna 1 meter from the EUT, the indicated readings are the noise floor measurements from the spectrum analyzer

Vertical Polarity
Comtelco Yagi Model Y2283A-66 Antenna

Transmitting at 905.0 MHz					
Frequency MHz	Receiver Reading dBμV	Correction Factor dB	Average Factor dB	Corrected Reading dBμV/m	Limit dBμV/m
2715.0 P	18.7	36.8	0.0	55.5	74.0
2715.0 A	7.6	36.8	0.0	44.4	54.0
3620.0 P	23.4	39.9	0.0	63.3	74.0
3620.0 A	12.7	39.9	0.0	52.6	54.0
4525.0 P	10.0	41.4	0.0	51.4	74.0
4525.0 A	-1.2	41.4	0.0	40.2	54.0
5430.0 P	11.2 *	45.5	0.0	56.7	74.0
5430.0 A	-0.8 *	45.5	0.0	44.7	54.0
8145.0 P	13.4 *	40.5	0.0	53.9	74.0
8145.0 A	2.3 *	40.5	0.0	42.8	54.0
9050.0 P	12.6 *	42.1	0.0	54.7	74.0
9050.0 A	3.7 *	42.1	0.0	45.8	54.0

P = Peak Detection

A = Average Detection

Note 1: All Emissions from 3 MHz to the first harmonic that were with the restricted bands were more than 20 dB below the limit.

* No emissions were detected with the antenna 1 meter from the EUT, the indicated readings are the noise floor measurements from the spectrum analyzer

Transmitting at 915.0 MHz					
Frequency MHz	Receiver Reading dBμV	Correction Factor dB	Average Factor dB	Corrected Reading dBμV/m	Limit dBμV/m
2745.0 P	23.7	36.8	0.0	60.5	74.0
2745.0 A	13.2	36.8	0.0	50.0	54.0
3660.0 P	18.9	39.9	0.0	58.8	74.0
3660.0 A	7.6	39.9	0.0	47.5	54.0
4575.0 P	12.4	41.4	0.0	53.8	74.0
4575.0 A	0.9	41.4	0.0	42.3	54.0
7320.0 P	11.2 *	38.9	0.0	50.1	74.0
7320.0 A	1.6 *	38.9	0.0	40.5	54.0
8235.0 P	13.4 *	40.8	0.0	54.2	74.0
8235.0 A	1.8 *	40.8	0.0	42.6	54.0
9150.0 P	12.6 *	42.4	0.0	55.0	74.0
9150.0 A	2.9 *	42.4	0.0	45.3	54.0

P = Peak Detection

A = Average Detection

Note 1: All Emissions from 3 MHz to the first harmonic that were with the restricted bands were more than 20 dB below the limit.

* No emissions were detected with the antenna 1 meter from the EUT, the indicated readings are the noise floor measurements from the spectrum analyzer

Transmitting at 923.0 MHz					
Frequency MHz	Receiver Reading dBμV	Correction Factor dB	Average Factor dB	Corrected Reading dBμV/m	Limit dBμV/m
2769.0 P	25.1	36.8	0.0	61.9	74.0
2769.0 A	14.8	36.8	0.0	51.6	54.0
3692.0 P	17.2	39.9	0.0	57.1	74.0
3692.0 A	5.8	39.9	0.0	45.7	54.0
4615.0 P	11.9	41.4	0.0	53.3	74.0
4615.0 A	-0.2	41.4	0.0	41.2	54.0
7384.0 P	11.2 *	38.9	0.0	50.1	74.0
7384.0 A	1.6 *	38.9	0.0	40.5	54.0
8307.0 P	13.4 *	40.8	0.0	54.2	74.0
8307.0 A	1.8 *	40.8	0.0	42.0	54.0

P = Peak Detection

A = Average Detection

Note 1: All Emissions from 3 MHz to the first harmonic that were with the restricted bands were more than 20 dB below the limit.

* No emissions were detected with the antenna 1 meter from the EUT, the indicated readings are the noise floor measurements from the spectrum analyzer

Horizontal Polarity
Comtelco Yagi Model Y2283A-66 Antenna

Transmitting at 905.0 MHz					
Frequency MHz	Receiver Reading dBμV	Correction Factor dB	Average Factor dB	Corrected Reading dBμV/m	Limit dBμV/m
2715.0 P	14.8	36.8	0.0	51.6	74.0
2715.0 A	4.1	36.8	0.0	40.9	54.0
3620.0 P	20.1	39.9	0.0	60.0	74.0
3620.0 A	9.1	39.9	0.0	49.0	54.0
4525.0 P	10.9	41.4	0.0	52.3	74.0
4525.0 A	-0.8	41.4	0.0	40.6	54.0
5430.0 P	11.2 *	45.5	0.0	56.7	74.0
5430.0 A	-0.8 *	45.5	0.0	44.7	54.0
8145.0 P	13.4 *	40.5	0.0	53.9	74.0
8145.0 A	2.3 *	40.5	0.0	42.8	54.0
9050.0 P	12.6 *	42.1	0.0	54.7	74.0
9050.0 A	3.7 *	42.1	0.0	45.8	54.0

P = Peak Detection

A = Average Detection

Note 1: All Emissions from 3 MHz to the first harmonic that were with the restricted bands were more than 20 dB below the limit.

* No emissions were detected with the antenna 1 meter from the EUT, the indicated readings are the noise floor measurements from the spectrum analyzer

Transmitting at 915.0 MHz					
Frequency MHz	Receiver Reading dBμV	Correction Factor dB	Average Factor dB	Corrected Reading dBμV/m	Limit dBμV/m
2745.0 P	19.0	36.8	0.0	55.8	74.0
2745.0 A	7.6	36.8	0.0	44.4	54.0
3660.0 P	13.0	39.9	0.0	52.9	74.0
3660.0 A	7.5	39.9	0.0	47.4	54.0
4575.0 P	10.5	41.4	0.0	51.9	74.0
4575.0 A	-0.5	41.4	0.0	40.9	54.0
7320.0 P	11.2 *	38.9	0.0	50.1	74.0
7320.0 A	1.6 *	38.9	0.0	40.5	54.0
8235.0 P	13.4 *	40.8	0.0	54.2	74.0
8235.0 A	1.8 *	40.8	0.0	42.6	54.0
9150.0 P	12.6 *	42.4	0.0	55.0	74.0
9150.0 A	2.9 *	42.4	0.0	45.3	54.0

P = Peak Detection

A = Average Detection

Note 1: All Emissions from 3 MHz to the first harmonic that were with the restricted bands were more than 20 dB below the limit.

* No emissions were detected with the antenna 1 meter from the EUT, the indicated readings are the noise floor measurements from the spectrum analyzer

Transmitting at 923.0 MHz					
Frequency MHz	Receiver Reading dBμV	Correction Factor dB	Average Factor dB	Corrected Reading dBμV/m	Limit dBμV/m
2769.0 P	22.3	36.8	0.0	59.1	74.0
2769.0 A	11.0	36.8	0.0	47.8	54.0
3692.0 P	16.1	39.9	0.0	56.0	74.0
3692.0 A	5.2	39.9	0.0	45.1	54.0
4615.0 P	10.2	41.4	0.0	51.6	74.0
4615.0 A	-0.5	41.4	0.0	40.9	54.0
7384.0 P	11.2 *	38.9	0.0	50.1	74.0
7384.0 A	1.6 *	38.9	0.0	40.5	54.0
8307.0 P	13.4 *	40.8	0.0	54.2	74.0
8307.0 A	1.8 *	40.8	0.0	42.0	54.0

P = Peak Detection

A = Average Detection

Note 1: All Emissions from 3 MHz to the first harmonic that were with the restricted bands were more than 20 dB below the limit.

* No emissions were detected with the antenna 1 meter from the EUT, the indicated readings are the noise floor measurements from the spectrum analyzer

Vertical Polarity
Maxrad Omni Model MFB9155 Antenna

Transmitting at 905.0 MHz					
Frequency MHz	Receiver Reading dBμV	Correction Factor dB	Average Factor dB	Corrected Reading dBμV/m	Limit dBμV/m
2715.0 P	19.8	36.8	0.0	56.6	74.0
2715.0 A	8.6	36.8	0.0	45.4	54.0
3620.0 P	24.1	39.9	0.0	64.0	74.0
3620.0 A	12.1	39.9	0.0	52.0	54.0
4525.0 P	11.0	41.4	0.0	52.4	74.0
4525.0 A	-0.8	41.4	0.0	40.6	54.0
5430.0 P	11.2 *	45.5	0.0	56.7	74.0
5430.0 A	-0.8 *	45.5	0.0	44.7	54.0
8145.0 P	13.4 *	40.5	0.0	53.9	74.0
8145.0 A	2.3 *	40.5	0.0	42.8	54.0
9050.0 P	12.6 *	42.1	0.0	54.7	74.0
9050.0 A	3.7 *	42.1	0.0	45.8	54.0

P = Peak Detection

A = Average Detection

Note 1: All Emissions from 3 MHz to the first harmonic that were with the restricted bands were more than 20 dB below the limit.

* No emissions were detected with the antenna 1 meter from the EUT, the indicated readings are the noise floor measurements from the spectrum analyzer

Transmitting at 915.0 MHz					
Frequency MHz	Receiver Reading dBμV	Correction Factor dB	Average Factor dB	Corrected Reading dBμV/m	Limit dBμV/m
2745.0 P	23.4	36.8	0.0	60.2	74.0
2745.0 A	12.6	36.8	0.0	49.4	54.0
3660.0 P	22.6	39.9	0.0	62.5	74.0
3660.0 A	11.2	39.9	0.0	51.1	54.0
4575.0 P	12.0	41.4	0.0	53.4	74.0
4575.0 A	-0.2	41.4	0.0	41.2	54.0
7320.0 P	11.2 *	38.9	0.0	50.1	74.0
7320.0 A	1.6 *	38.9	0.0	40.5	54.0
8235.0 P	13.4 *	40.8	0.0	54.2	74.0
8235.0 A	1.8 *	40.8	0.0	42.6	54.0
9150.0 P	12.6 *	42.4	0.0	55.0	74.0
9150.0 A	2.9 *	42.4	0.0	45.3	54.0

P = Peak Detection

A = Average Detection

Note 1: All Emissions from 3 MHz to the first harmonic that were with the restricted bands were more than 20 dB below the limit.

* No emissions were detected with the antenna 1 meter from the EUT, the indicated readings are the noise floor measurements from the spectrum analyzer

Transmitting at 923.0 MHz					
Frequency MHz	Receiver Reading dBμV	Correction Factor dB	Average Factor dB	Corrected Reading dBμV/m	Limit dBμV/m
2769.0 P	23.9	36.8	0.0	60.7	74.0
2769.0 A	13.6	36.8	0.0	50.4	54.0
3692.0 P	14.1	39.9	0.0	54.0	74.0
3692.0 A	5.0	39.9	0.0	44.9	54.0
4615.0 P	11.2	41.4	0.0	52.6	74.0
4615.0 A	-0.4	41.4	0.0	41.0	54.0
7384.0 P	11.2 *	38.9	0.0	50.1	74.0
7384.0 A	1.6 *	38.9	0.0	40.5	54.0
8307.0 P	13.4 *	40.8	0.0	54.2	74.0
8307.0 A	1.8 *	40.8	0.0	42.0	54.0

P = Peak Detection

A = Average Detection

Note 1: All Emissions from 3 MHz to the first harmonic that were with the restricted bands were more than 20 dB below the limit.

* No emissions were detected with the antenna 1 meter from the EUT, the indicated readings are the noise floor measurements from the spectrum analyzer

Horizontal Polarity
Maxrad Omni Model MFB9155 Antenna

Transmitting at 905.0 MHz					
Frequency MHz	Receiver Reading dBμV	Correction Factor dB	Average Factor dB	Corrected Reading dBμV/m	Limit dBμV/m
2715.0 P	13.3	36.8	0.0	50.1	74.0
2715.0 A	2.1	36.8	0.0	38.9	54.0
3620.0 P	21.8	39.9	0.0	61.7	74.0
3620.0 A	9.8	39.9	0.0	49.7	54.0
4525.0 P	9.4	41.4	0.0	50.8	74.0
4525.0 A	-0.6	41.4	0.0	40.8	54.0
5430.0 P	11.2 *	45.5	0.0	56.7	74.0
5430.0 A	-0.8 *	45.5	0.0	44.7	54.0
8145.0 P	13.4 *	40.5	0.0	53.9	74.0
8145.0 A	2.3 *	40.5	0.0	42.8	54.0
9050.0 P	12.6 *	42.1	0.0	54.7	74.0
9050.0 A	3.7 *	42.1	0.0	45.8	54.0

P = Peak Detection

A = Average Detection

Note 1: All Emissions from 3 MHz to the first harmonic that were with the restricted bands were more than 20 dB below the limit.

* No emissions were detected with the antenna 1 meter from the EUT, the indicated readings are the noise floor measurements from the spectrum analyzer

Transmitting at 915.0 MHz					
Frequency MHz	Receiver Reading dBμV	Correction Factor dB	Average Factor dB	Corrected Reading dBμV/m	Limit dBμV/m
2745.0 P	17.2	36.8	0.0	54.0	74.0
2745.0 A	5.9	36.8	0.0	42.7	54.0
3660.0 P	19.4	39.9	0.0	59.3	74.0
3660.0 A	8.2	39.9	0.0	48.1	54.0
4575.0 P	9.1	41.4	0.0	50.5	74.0
4575.0 A	-1.1	41.4	0.0	40.3	54.0
7320.0 P	11.2 *	38.9	0.0	50.1	74.0
7320.0 A	1.6 *	38.9	0.0	40.5	54.0
8235.0 P	13.4 *	40.8	0.0	54.2	74.0
8235.0 A	1.8 *	40.8	0.0	42.6	54.0
9150.0 P	12.6 *	42.4	0.0	55.0	74.0
9150.0 A	2.9 *	42.4	0.0	45.3	54.0

P = Peak Detection

A = Average Detection

Note 1: All Emissions from 3 MHz to the first harmonic that were with the restricted bands were more than 20 dB below the limit.

* No emissions were detected with the antenna 1 meter from the EUT, the indicated readings are the noise floor measurements from the spectrum analyzer

Transmitting at 923.0 MHz					
Frequency MHz	Receiver Reading dBμV	Correction Factor dB	Average Factor dB	Corrected Reading dBμV/m	Limit dBμV/m
2769.0 P	19.5	36.8	0.0	56.3	74.0
2769.0 A	8.3	36.8	0.0	45.5	54.0
3692.0 P	16.8	39.9	0.0	56.7	74.0
3692.0 A	4.6	39.9	0.0	44.5	54.0
4615.0 P	9.6	41.4	0.0	51.0	74.0
4615.0 A	0.0	41.4	0.0	41.4	54.0
7384.0 P	11.2 *	38.9	0.0	50.1	74.0
7384.0 A	1.6 *	38.9	0.0	40.5	54.0
8307.0 P	13.4 *	40.8	0.0	54.2	74.0
8307.0 A	1.8 *	40.8	0.0	42.0	54.0

P = Peak Detection

A = Average Detection

Note 1: All Emissions from 3 MHz to the first harmonic that were with the restricted bands were more than 20 dB below the limit.

* No emissions were detected with the antenna 1 meter from the EUT, the indicated readings are the noise floor measurements from the spectrum analyzer

Sample Field Strength Calculation:

The field strength is calculated by adding the Correction Factor (Antenna Factor + Cable Factor), to the measured level from the receiver. The basic equation with a sample calculation is shown below:

FS = RA + CF - AF Where
FS = Field Strength
RA = Receiver Amplitude (Receiver Reading - Amplifier Gain)
CF = Correction Factor (Antenna Factor + Cable Factor)
AF = Average Factor

RESULT

In the configuration tested, the EUT complied with the requirements of the specification.

6.2.4 § 15.247 (d) Power Spectral Density:

Measurement Data:

The maximum power spectral density measured for this device was 7.8 dBm. Shown below is the measured power spectral density.

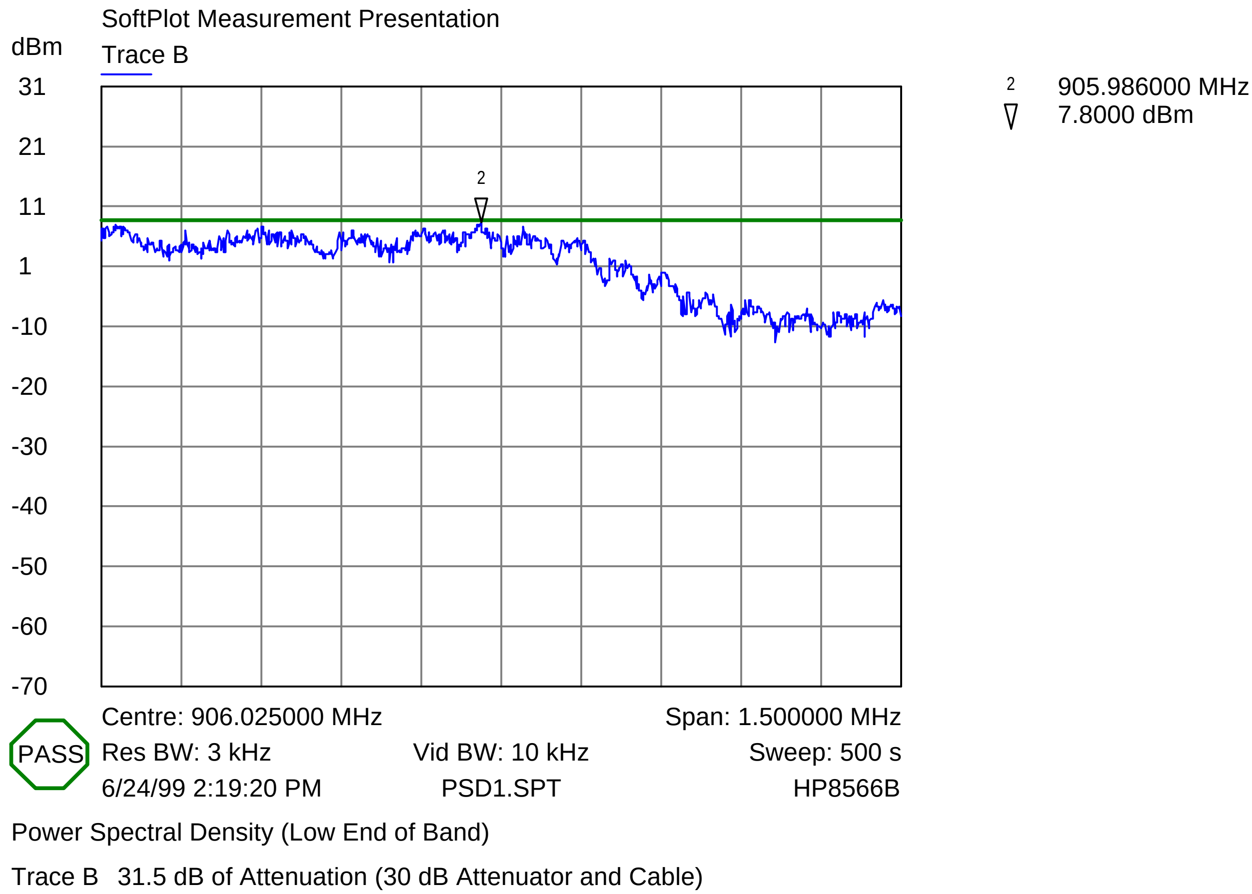
A diagram of the test configuration is enclosed in Appendix A and a list of reference codes for test equipment used is enclosed in Appendix B.

Test equipment used: 1, 3 and 4.

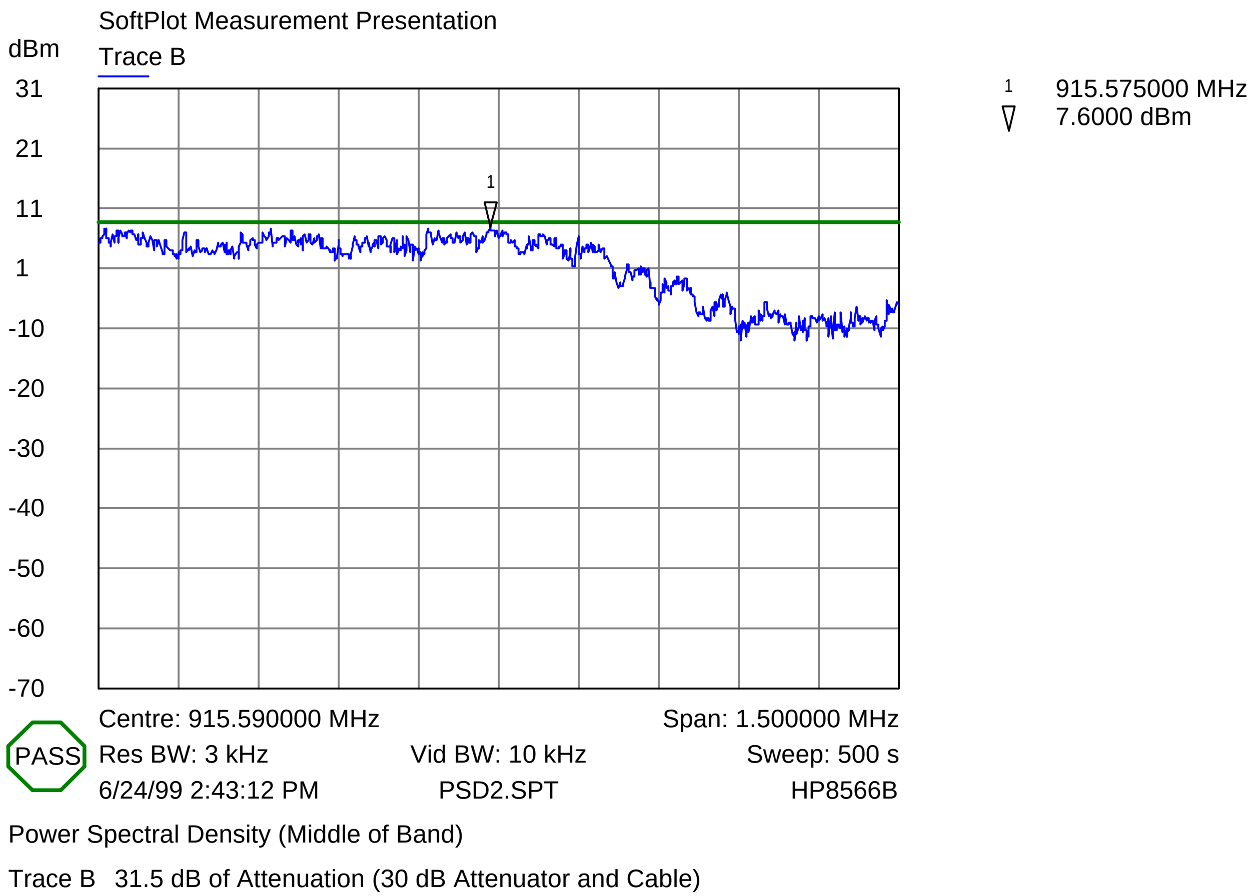
Frequency (MHz)	Measured Power Spectral Density (dBm)
905.0	7.8
915.0	7.6
923.0	7.4

RESULT

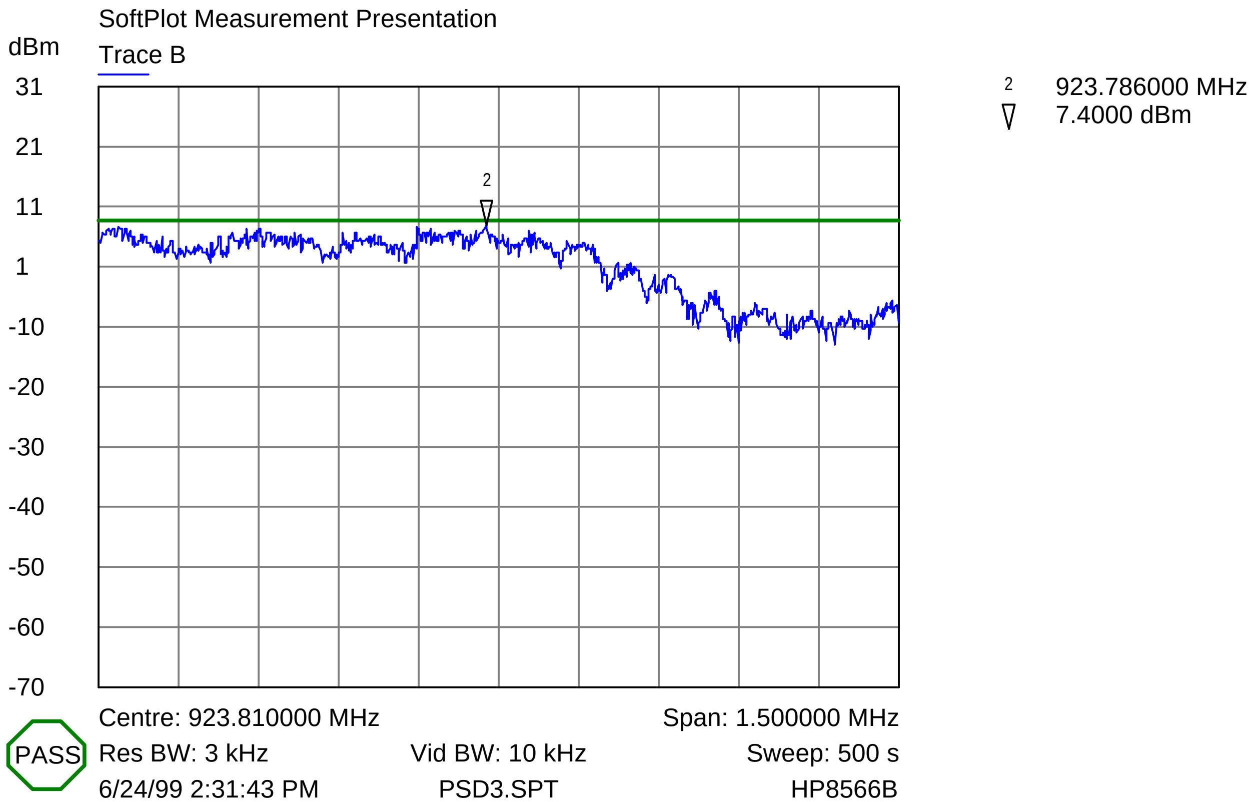
In the configuration tested, the EUT complied with the requirements of the specification (see spectrum analyzer plots below).



Power Spectral Density Plot (Low Channel)



Power Spectral Density Plot (Middle Channel)



Power Spectral Density (High End of Band)

Trace B 31.5 dB of Attenuation (30 dB Attenuator and Cable)

Power Spectral Density Plot (High Channel)

6.2.5 § 15.247 (e) Processing Gain:

The minimum processing gain measured for this device was 10.97 dB.

The 900 SS Direct uses a digital spread spectrum transceiver chip manufactured by Intellon Corporation. The processing gain was measured by Intellon Corporation, enclosed below are the processing gain measurements.

PROCESSING GAIN DATA

The following data shows the processing gain of the SRL-100 spread spectrum transceiver. Please refer to the attached memo from Intellon corporation for the explanation of the measurement method. The SRL-100 uses Intellon's CELINX RF spread spectrum baseband transceiver IC. The data was taken with a 1 dB signal to jammer ratio. The attached block diagram shows the measurement setup. The 1 dB signal to jammer ratio was verified by turning off the jammer and measuring the transmitter power, then turning off the transmitter and turning on the jammer and measuring the power.

The data portion of the packets was 14 bits long. The RF center frequency was 915 MHz. The jammer was stepped across the 2.2 MHz bandwidth of the desired signal in 50 KHz steps. The average packet success ratio was 0.9947.

Calculate bit error rate in terms of packet success rate:

$$BER = 1 - (Pktsr)^{(1/pktlng)}$$

$$BER = 1 - (0.9947)^{(1/14)} = 3.8 * 10^{-4}$$

Calculate EB/No from bit error rate

$$EB/No = -2*\ln(2*BER)$$

$$EB/No = -2*\ln(2*[3.8*10^{-4}]) = 15.753$$

Calculate theoretical signal to noise ratio

$$S/N = 10*\log_{10}(EB/No)$$

$$S/N = 10*\log_{10}(15.753) = 11.97 \text{ dB}$$

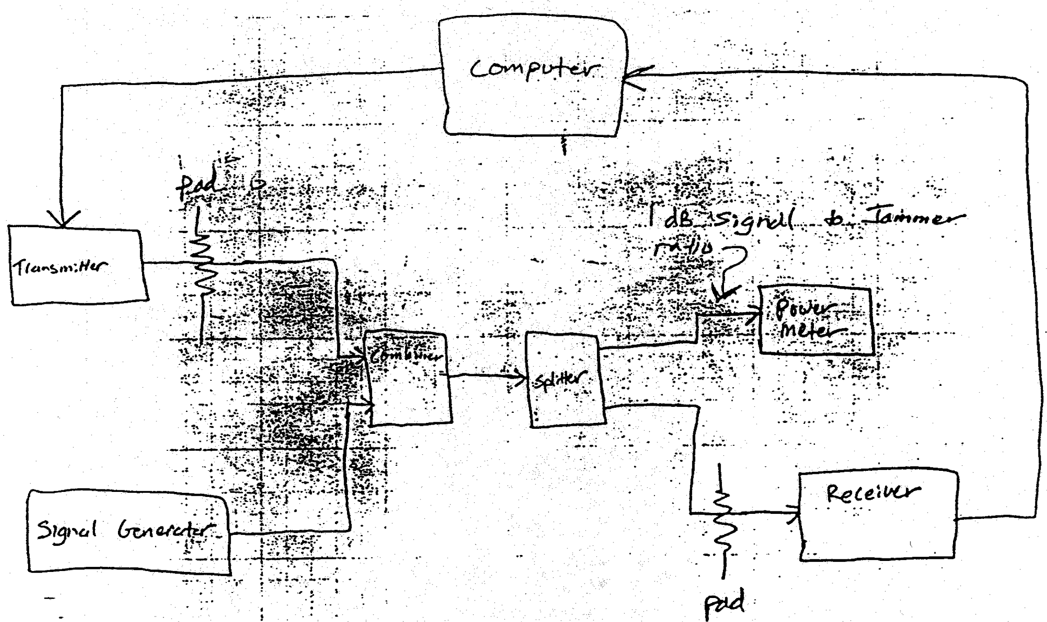
Calculate process gain from difference in signal to noise and signal to jam

Process gain = S/N - S/Jam

Process gain = 11.97dB - 1dB = 10.97 dB

The processing gain is 10.97 dB.

PROCESSING GAIN DATA



PROCESSING GAIN DATA

Freq. (MHz)	Packets transmitted	Packets received	Packet Success Ratio
913.8	10,000	10,000	1
913.85	10,000	10,000	1
913.9	10,000	10,000	1
913.95	10,000	10,000	1
914	10,000	10,000	1
914.05	10,000	9,960	0.996
914.1	10,000	10,000	1
914.15	10,000	9,997	0.9997
914.2	10,000	10,000	1
914.25	10,000	10,000	1
914.3	10,000	10,000	1
914.35	10,000	9,999	0.9999
914.4	10,000	9,992	0.9992
914.45	10,000	9,997	0.9997
914.5	10,000	9,996	0.9996
914.55	10,000	9,988	0.9988
914.6	10,000	9,909	0.9909
914.65	10,000	9,968	0.9968
914.7	10,000	10,000	1
914.75	10,000	9,939	0.9939
914.8	10,000	9,804	0.9804
914.85	10,000	9,640	0.964
914.9	10,000	9,661	0.9661
914.95	10,000	9,870	0.987
915	10,000	9,533	0.9533
915.05	10,000	9,731	0.9731
915.1	10,000	9,599	0.9599
915.15	10,000	9,856	0.9856
915.2	10,000	9,980	0.998
915.25	10,000	9,980	0.998
915.3	10,000	10,000	1
915.35	10,000	10,000	1
915.4	10,000	10,000	1
915.45	10,000	10,000	1
915.5	10,000	10,000	1
915.55	10,000	10,000	1
915.6	10,000	10,000	1
915.65	10,000	10,000	1
915.7	10,000	10,000	1
915.75	10,000	10,000	1
915.8	10,000	10,000	1
915.85	10,000	10,000	1
915.9	10,000	10,000	1
915.95	10,000	10,000	1
916	10,000	10,000	1
916.05	10,000	10,000	1
916.1	10,000	10,000	1
916.15	10,000	10,000	1
916.2	10,000	10,000	1
Average Packet Success Ratio			0.9947

PROCESSING GAIN DATA

INTELLON

Interoffice Correspondence

To: File

From: Jim Vander Mey

Date: November 2, 1992

Re: **Bit Error Rate Testing for CEBus Data**

Summary

Conventional methods and equipment for bit error rate (BER) testing with CEBus packets cannot be used. The reason is that all data sent in CEBus packets is converted to a "symbol" format which typically creates multiple data (symbol) errors for each communication bit error. Since data that is measured by any instrumentation will have been subject to the symbol encoding technique, the results will be highly inflated and invalid. The suggested method of evaluating bit error rate is to observe the packet error rate and infer from it the bit error rate. An explanation of various causes of multiple CEBus data errors per communication bit error is given below, as well as a method of inferring the bit error rate from the packet error (or success) rate.

General Description of CEBus Symbol Encoding

CEBus uses four symbols to encode all information in a CEBus packet. The transmitted communications media data bits (the media 1 and 0 states) are used to encode the four symbols "1", "0", "EOF" and "EOP". The EOF symbol is used to delimit the end of a field within a packet and the EOP symbol to delimit the end of a packet, while the "1" and "0" symbols are used to convey the data information. The symbols are encoded by the length of time the transmission media has the same value or state. Media data bits are called "Unit Symbol Times - USTs". A "1" symbol is define as the duration of 1 UST with the same value (or "state" in CEBus terminology), a "0" as 2 USTs of the same value, a "EOF" as 3 USTs of the same value, and an "EOP" as 4 USTs (or more) of the same value. As an example, the following shows how the symbols could be encoded in a transmitted bit stream with xx representing either a 1 or a 0.

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"1" symbol	xx101xx	or	xx010xx
"0" symbol	xx1001xx	or	xx0110xx
"EOF" symbol	xx10001xx	or	xx01110xx
"EOP" symbol	xx10000xx	or	xx01111xx

The advantage of this symbol encoding approach is that short variable length fields can be efficiently handled. One side effect though is that any single transmitted bit error (UST) can create many symbol errors. And since symbols are the way in which information is transmitted within CEBus, a single transmission error can/will create many packet "data" errors. Even worse the occurrence of a single error can create additional instances of symbols that did not exist, or totally delete symbols that did. This does not represent a problem for CEBus since any single error voids the packet anyway, and the CRC is responsible for protecting against undetected errors at the UST level.

Examples of Multiple Symbol Errors per Transmitted Bit Error

Below are examples of high probability instances in which single errors create multiple symbols or errors.

- String of "1" symbols where any single communications error creates an EOF symbol and deletes three "1" symbols. There are therefore three less data symbols in the information packet as well as a new undefined field. The extra field will generate an unpredictable number of additional errors depending on the interpretation of the new field (e.g. control or data information?)
  - USTs -x1010101x Original Symbols - x11111x
  - Error USTs - x1011101x Resulting Symbols - x1(EOF)1x
- String of "0" symbols, where any single communications error creates an EOF symbol, deletes one data symbol and changes the remaining data symbol. Again as above the actual number of data symbol errors is unpredictably larger than this due to the introduction of another field.
  - USTs -x1001001x Original Symbols - x000x
  - Error USTs -x1011001x Resulting symbols - x1(EOF)0x

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- A string of alternating "1" and "0" symbols where any single communications error on a "1" symbol will create an EOP symbol thereby resulting in packet termination, loosing (deleting) all remaining data symbols. On a probability basis this one error will cause a half a packet full of data symbol errors.

  - USTs - x0110110110x Original Symbols -x01010x
  - Error USTs - x0110110110x Resulting Symbols -x(EOP).....

There are other combinations that cause similar problems, but this should be sufficient to demonstrate that a single communications bit error can and most probably will generate a large number of "data" errors within a single CEBus packet.

A Method for Deriving Bit Error Rate

Since any packet with one (or more) communications bit errors could potentially create many data bit errors, normal bit error rate measurement equipment cannot produce useful results. The data measured by this equipment will have been subject to the symbol encoding process and thus yield highly inflated error results. However, a reliable method of calculating bit error rate can be accomplished by using the packet error rate. In this instance we know that packets that are successful received have no bit errors, while those that are not successfully received experienced one or more communications bit errors.

Let the packet success rate (PSR) be defined as the number of error free packets divided by the total number of transmitted packets. Then assuming bit errors are independent, the PSR probability can be expressed in terms of the bit error rate (BER) probability as:

$$PSR = (1-BER)^{Pktlng}$$

where Pktlng is the packet length in communications data bits. The derivation of this formula is seen where the probability of any single bit error being error-free is (1-BER), and the probability of an entire packet being free of any bit errors is the product of the probabilities of all the bits being error-free. (This formula can also be found in communications theory literature.)

Conclusion

To measure the bit error rate for CEBus packet communication, transmit a statistically significant number of packets, collect statistics on the number correctly received versus the number transmitted, calculate the packet success rate, and then calculate the bit error rate per the following formula.

$$BER = 1-PSR^{1/Pktlng}$$

PROCESSING GAIN DATA

Appendix A Deriving Process Gain from Packet Success Rates

A Packet Success Rate (PSR), defined as those packets received without any bit errors divided by total packets transmitted, can be derived from the Bit Error Rate (BER). Assuming that bit errors are independent, the PSR is given as a function of BER:

$$PSR(Plng, BER) := (1 - BER)^{Plng}$$

where Plng is the length of the packet in bits. The derivation of this formula is seen where the probability of any single bit being error-free is (1-BER), and the probability of an entire packet being free of any bit errors is the product of the probability for all the bits being error-free, leading to the formula above. (This formula is also found in communications theory literature.)

The Packet Error Rate (PER), defined as any packet with one or more errors, is thus defined as:

$$PER(Plng, BER) := 1 - PSR(Plng, BER)$$

In a non-coherent limiter based FSK demodulator, the theoretical Bit Error Rate (BER) can be calculated for any particular Signal to Noise (StoN) level by the formulas below.

$$EbNo(StoN) := 10^{\frac{StoN}{10}} \qquad BER(EbNo) := 0.5 \cdot \exp\left(-\frac{EbNo}{2}\right)$$

The data portion of the packet (that part in which a bit error will cause a packet error) for the packets under test is 41 bits. This provides a more correct (and conservative) measurement than using the entire length of the packet. Therefore we use:

$$Pktlng := 41$$

The calculated theoretical BER and resultant PSR for a non-coherent limiter based FSK demodulator over a Signal to Noise range of 10 to 15 db in .5 db increments is thus:

$StoN := 10, 10.5 .. 15$ $\qquad$ $StoJam := 0, .5 .. 5$

StoN	StoJam	BER(EbNo(StoN))	PSR(Pktlng, BER(EbNo(StoN)))
10	0	0.00336897	0.87078418
10.5	0.5	0.00183037	0.92763795
11	1	0.0009231	0.96284337
11.5	1.5	0.00042824	0.98259185
12	2	0.00018089	0.99261022
12.5	2.5	0.00006878	0.99718375
13	3	0.00002324	0.99904743
13.5	3.5	0.00000688	0.99971792
14	4	0.00000176	0.99992801
14.5	4.5	0.00000038	0.99998445
15	5	0.00000007	0.99999721

A minimum 10db process gain implies that a Signal to Jam ratio 10 db lower than the theoretical Signal to Noise ratio should produce equal or better performance. Therefore, a Signal to Jam (StoJam) ratio 10 db lower than the Signal to Noise (StoN) ratios given above that produces an equivalent or better Packet Success Rate (PSR) demonstrates at least a 10 db process gain.

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The following test results are used to demonstrate process gain:

Specify Signal to Jam for this test

$StoJam := 1$

Read test data file

$TstData := READPRN(pgdata1_{prn})$ $tstpoints := last(TstData^{<0>}) + 1$ $i := 0 .. tstpoints - 1$

Put test data in vectors

$Freq := TstData^{<0>}$ $PktsTxd := TstData^{<1>}$ $PktsRcd := TstData^{<2>}$

Calculate results

$Pktsr_i := \frac{PktsRcd_i}{PktsTxd_i}$ Calculate packet success rate from packets transmitted and correctly received

$Ber_i := 1 - (Pktsr_i)^{\frac{1}{Pktlng}}$ Calculate bit error rate in terms of packet success rate

$EbNo_i := -2 \cdot \ln(2 \cdot Ber_i)$ Calculate EbNo from bit error rate

$StoN_i := 10 \cdot \log(EbNo_i)$ Calculate theoretical signal to noise

$PrcGn_i := StoN_i - StoJam$ Calculate process gain from difference in signal to noise and signal to jam

Results

$$\frac{\sum_i (PrcGn_i > 10)}{tstpoints} \cdot 100 = 100$$ Percent of points greater than 10 db process gain

$$\frac{\sum_i PrcGn_i}{tstpoints} = 12.0722$$ Average Process Gain

Process Gain by Frequency (in Mhz)

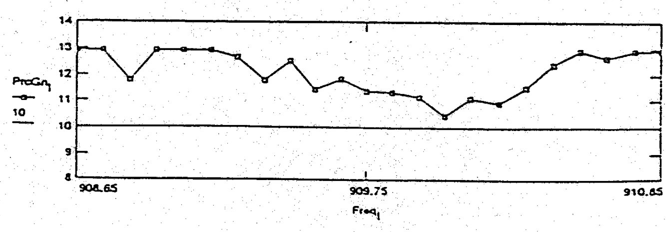


Exhibit 6

PROCESSING GAIN DATA

Tables of input data and results

StoJam = 1

$Freq_i$	$PktsTxd_i$	$PktsRcd_i$	$Pktsr_i$	Ber_i	$PrcGn_i$
908.65	10081	10080	0.999900803	0.00000242	12.887682742
908.75	10074	10073	0.999900735	0.000002421	12.887436238
908.85	10072	10055	0.998312153	0.000041201	11.743380995
908.95	10079	10078	0.999900784	0.00000242	12.887612331
909.05	10085	10084	0.999900843	0.000002419	12.887823519
909.15	10080	10079	0.999900794	0.00000242	12.887647538
909.25	10083	10081	0.999801646	0.000004838	12.63453539
909.35	10089	10072	0.998314997	0.000041131	11.744160398
909.45	10084	10081	0.999702499	0.000007257	12.479297178
909.55	10073	10039	0.99662464	0.000082462	11.410496162
909.65	10075	10060	0.998511166	0.000036339	11.800983036
909.75	10079	10042	0.996329001	0.000089697	11.368355647
909.85	10077	10037	0.996030565	0.000097003	11.328750399
909.95	10082	10026	0.994445547	0.000135843	11.154188745
910.05	10094	9902	0.980978799	0.000468291	10.444666838
910.15	10087	10021	0.993456925	0.000160099	11.066409217
910.25	10078	9990	0.991268109	0.000213885	10.907194883
910.35	10087	10057	0.997025875	0.000072645	11.473239238
910.45	10137	10133	0.999605406	0.000009626	12.367752486
910.55	10078	10077	0.999900774	0.00000242	12.88757712
910.65	10089	10087	0.999801764	0.000004835	12.634759172
910.75	10078	10077	0.999900774	0.00000242	12.88757712
910.85	10103	10102	0.999901019	0.000002414	12.888456266

6.2.6 § 15.207 Line Conducted Emissions:

The frequency range from 450 kHz to 30 MHz was investigated to measure any AC line conducted emissions.

A diagram of the test configuration is enclosed in Appendix A and a list of reference codes for test equipment used is enclosed in Appendix B.

Test equipment used: 1, 3, 4 and 13.

Line Conducted Data - (Hot Lead)

Frequency MHz	Detector	Measured Level dBμV	Limit dBμV
0.49	Quasi-Peak	39.9	48.0
0.68	Quasi-Peak	34.8	48.0
0.80	Quasi-Peak	31.8	48.0
1.03	Quasi-Peak	29.8	48.0
1.21	Quasi-Peak	26.8	48.0

Line Conducted Data - (Neutral Lead)

Frequency MHz	Detector	Measured Level dBμV	Limit dBμV
0.49	Quasi-Peak	52.0	48.0
0.62	Quasi-Peak	49.9	48.0
0.71	Quasi-Peak	48.2	48.0
0.86	Quasi-Peak	44.3	48.0
0.97	Quasi-Peak	42.9	48.0
1.09	Quasi-Peak	41.4	48.0
1.21	Quasi-Peak	39.4	48.0

APPENDIX A. TEST EQUIPMENT USED:

Reference No.	Type	Manufacturer	Model
1	Anechoic Chamber	EMC Test Systems	N/A
2	Wanship Open Area Test Site	CCL	N/A
3	Spectrum Analyzer	Hewlett Packard	8568B or 8566B
4	Quasi-Peak Detector	Hewlett Packard	8565A
5	Biconical Antenna	EMCO	3108 or 3104P
6	Log-Periodic Antenna	EMCO	3146
7	Biconilog Antenna	EMCO	3142
8	Double Ridged Guide Antenna	EMCO	3115
9	Pre-Amplifier	Hewlett Packard	8447D
10	Power Amplifier	Hewlett Packard	8447E
11	Power Amplifier	Hewlett Packard	8449A
12	Power Amplifier	Hewlett Packard	8449B
13	LISN Anechoic Chamber	EMCO	3825/2
14	LISN Wanship	EMCO	3725

An independent calibration laboratory following outlined calibration procedures calibrates all the equipment listed above every 12 months.

APPENDIX B. TEST PROCEDURES:

Line Conducted Emissions:

The line-conducted emission from the digital apparatus was measured using a spectrum analyzer with a quasi-peak adapter for peak, quasi-peak and average readings. The quasi-peak adapter uses a bandwidth of 9 kHz, with the spectrum analyzer's resolution bandwidth set at 100 kHz, for readings in the 450 kHz to 30 MHz frequency ranges.

The line conducted emissions measurements are performed in a screen room using a (50 Ω/50 μH) Line Impedance Stabilization Network (LISN).

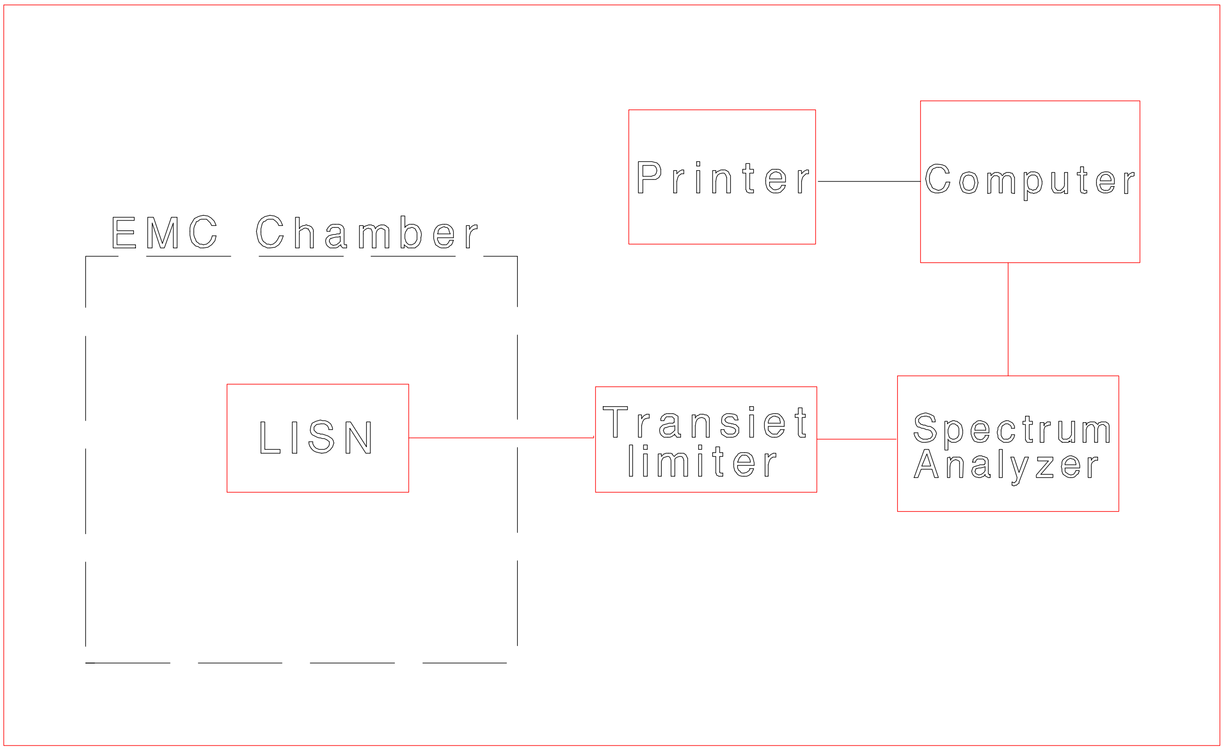
Where mains flexible power cords are longer than 1 m, the excess cable is folded back and forth as far as possible so as to form a bundle not exceeding 0.4 m in length.

Where the EUT is a collection of digital apparatus with each digital apparatus having its own power cord, the point of connection for the LISN is determined from the following rules:

a) Each power cord, which is terminated in a mains supply plug, shall be tested separately.
b) Power cords, which are not specified by the manufacturer to be connected via a host unit, shall be tested separately.
c) Power cords which are specified by the manufacturer to be connected via a host unit or other power supplying equipment shall be connected to that host unit and the power cords of that host unit connected to the LISN and tested.

Desktop digital apparatus are placed on a non-conducting table at least 80 cm from the metallic floor. The equipment is placed a minimum of 40 cm from all walls. Floor standing equipment is placed directly on the earth grounded floor.

Line Conducted Emissions Test



Radiated Spurious Emissions:

The radiated emission from the transmitter was measured using a spectrum analyzer with a quasi-peak adapter for peak and quasi-peak readings. A preamplifier with a fixed gain of 30 dB was used to increase the sensitivity of the measuring instrumentation.

A Biconilog antenna was used to measure the frequency range of 30 to 1000 MHz and a Double Ridge Guide Horn antenna was used to measure the frequency range 1 GHz to 10 GHz, at a distance of 3 meters from the EUT. The readings obtained by these antennas are correlated to the levels obtained with a tuned dipole antenna by adding antenna factors.

The configuration of the transmitter was varied to find the maximum radiated emission. The EUT was connected to the peripherals listed in Section 2.4 via the interconnecting cables listed in Section 2.5. These interconnecting cable were manipulated manually by a technician to obtain worst case radiated emissions. The digital apparatus was rotated 360 degrees, and the antenna height was varied from 1 to 4 meters to find the maximum radiated emission. Where there were multiple interface ports all of the same type, cables are either placed on all of the ports or cables added to these ports until the emissions do not increase by more than 2 dB.

Transmitters are measured on a non-conducting table one-meter above the ground plane. The table is placed on a turntable which is level with the ground plane. The turntable has slip rings, which supply AC power to the digital apparatus. For equipment normally placed on floors, the equipment shall be placed directly on the turntable.

Radiated Emissions Test

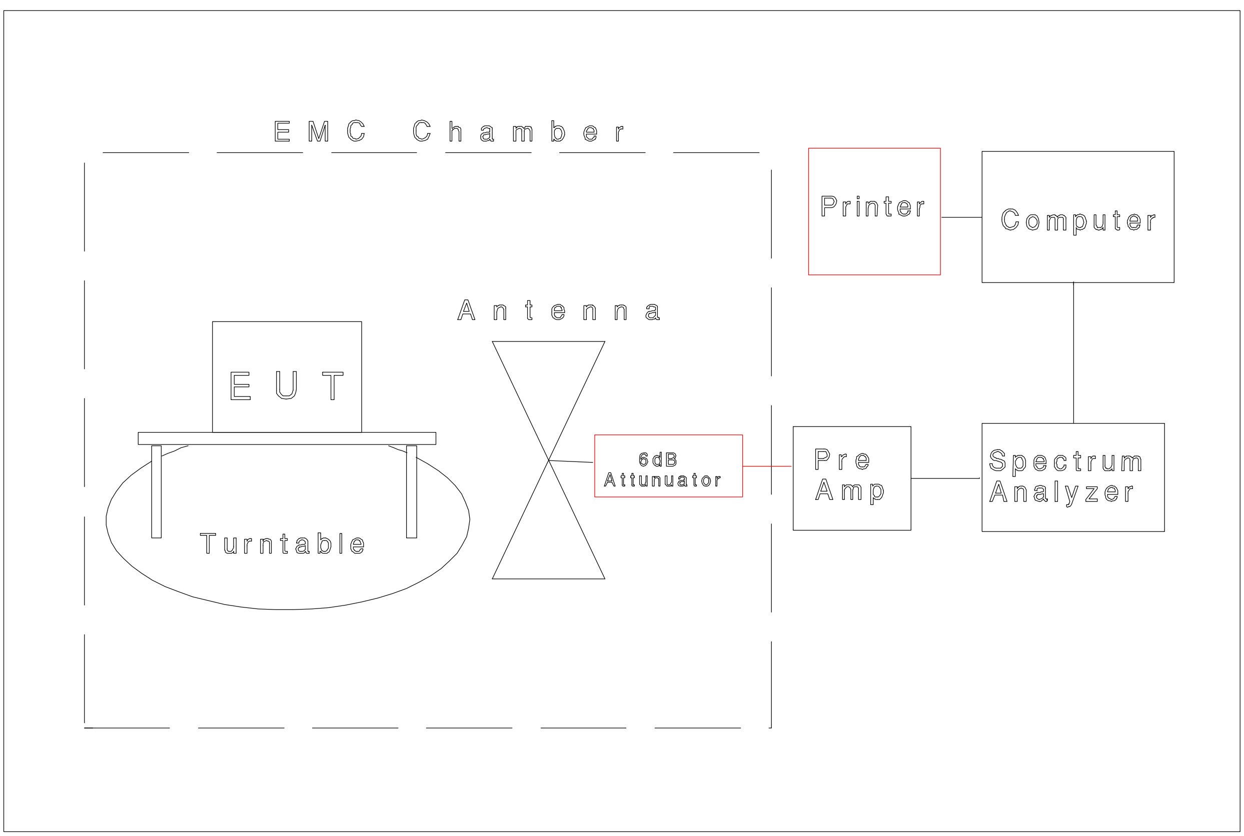


Exhibit 6

FCC Sections 15.247 Peak Transmit Power, Emission Bandwidth and Spurious Emissions (antenna conducted)

The EUT was directly connected to the spectrum analyzer via the antenna output port as shown in the block diagram below.

The measurements were performed on three channels, as per 47 CFR 15.31(m), one near the bottom of the spectrum, one near the middle of the spectrum and one near the top of the spectrum.

The spectrum analyzer's resolution bandwidth and video bandwidth were set as follows:

Peak Transmit Power

RBW = 1 MHz
VBW = 3 MHz

Emission Bandwidth

RBW = 3 kHz
VBW = 10 kHz

Spurious Emissions (Antenna Conducted)

RBW = 100 kHz – 30 MHz to 1000 MHz
VBW = 300 kHz

Peak Detection

RBW = 1 MHz – 1 GHz to 10 GHz
VBW = 3 MHz

Average Detection

RBW = 1 MHz – 1 GHz to 10 GHz
VBW = 10 Hz

Test Configuration Block Diagram