Electromagnetic Compatibility Test Report

Tests Performed on an Omnex Control Systems, Inc.

Spread Spectrum Tx Module, Model LPT-900

Radiometrics Document RP-4736

ACCREDITED
Certification # 1495.01

Product Detail:
FCC ID: **IAPLPT900**
Equipment type: Frequency Hopping Spread Spectrum 900 MHz transmitters

Test Standards:
US CFR Title 47, Chapter I, FCC Part 15 Subpart C
FCC Part 15 CFR Title 47: 2001
Industry Canada RSS-210, Section 6.2.2(o) as required for Category I Equipment

This report concerns: Original Grant for **Certification for Limited Modular Approval**.
FCC Part 15.247

Tests Performed For:	*Test Facility:*
Omnex Control Systems, Inc. Bldg. 74-1833 Coast Meridian Road Port Coquitlam, BC Canada V3C 6G5 Phone: (604) 944-9247	**Radiometrics Midwest Corporation** 12 East Devonwood Romeoville, IL 60446 Phone: (815) 293-0772 e-mail: info@radiomet.com

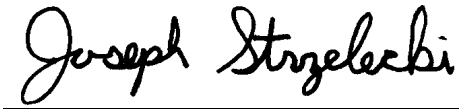
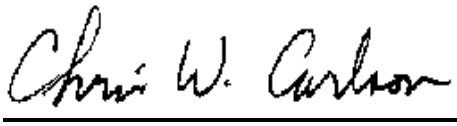
Test Date(s): (Month-Day-Year)
3-11 to 3-20-02

Document RP-4736 Revisions:

Rev.	Issue Date	Affected Pages	Revised By	Authorized Signature for Revision
0	April 24, 2002			

Table of Contents

1 ADMINISTRATIVE DATA

Equipment Under Test: A Omnex Control Systems, Inc., Spread Spectrum Tx Module Model: LPT-900 Serial Number: 12PLT This will be referred to as the EUT in this Report	
Date EUT Received at Radiometrics: (Month-Day-Year) 2-15-02	*Test Date(s): (Month-Day-Year)* 3-11 to 3-26-02
Test Report Written By: Joseph Strzelecki Senior EMC Engineer	*Test Witnessed By:* The tests were not witnessed by Omnex Control Systems, Inc.
Radiometrics' Personnel Responsible for Test:  Joseph Strzelecki Senior EMC Engineer NARTE EMC-000877-NE	*Test Report Approved By*  Chris W. Carlson Director of Engineering NARTE EMC-000921-NE

2 TEST SUMMARY AND RESULTS

The EUT (Equipment Under Test) is a Spread Spectrum Tx Module, Model LPT-900, manufactured by Omnex Control Systems, Inc.. The detailed test results are presented in a separate section. The following is a summary of the test results.

Emissions Tests Results

Environmental Phenomena	Frequency Range	FCC Section	RSS-210 Section	Test Result
Carrier Frequency Separation	902-928 MHz	15.247 a	6.2.2 (a)	Pass
Number of Hopping Frequencies	902-928 MHz	15.247 a	6.2.2 (a)	Pass
Time of Occupancy (Dwell Time)	902-928 MHz	15.247 a	6.2.2 (a)	Pass
20 dB Bandwidth Test	902-928 MHz	15.247 a	6.2.2 (a)	Pass
Peak Output Power	902-928 MHz	15.247 b	6.2.2 (a)	Pass
Band-edge Compliance of RF Conducted Emissions	902-928 MHz	15.247 c	6.2.2 (e)	Pass
Spurious RF Conducted Emissions	30-9300 MHz	15.247 c	6.2.2 (e)	Pass
Spurious Radiated Emissions	30-9300 MHz	15.247 c	6.2.2 (e)	Pass

2.1 RF Exposure Compliance Requirements

Since the power output is 10 mW, The EUT meets the FCC requirement for RF exposure. Since the EUT is less than 200 mW, it is exempt from RSS-102. There are no power level adjustments and the only antenna that will ever be used is the trace antenna internal to the remote control product.

3 EQUIPMENT UNDER TEST (EUT) DETAILS

3.1 EUT Description

The EUT is a Frequency Hopping Spread Spectrum Transmitter, Model LPT-900, manufactured by Omnex Control Systems, Inc. The EUT was in good working condition during the tests, with no known defects.

3.1.1 System Receiver Input Bandwidth

The LPT900 Transmitter Module transmits frequency modulated data at 4800 baud at a nominal deviation of ±4 kHz. This would suggest an occupied bandwidth of approximately ±8.8 kHz. The receiver module used in all of the associated receivers is a dual conversion type with a first I.F. of 45 MHz and second I.F. of 455 kHz. Most of the band shaping is provided by the second I.F. filter that is a MuRata ceramic filter, model CFGCG455DX. This filter has a bandwidth of ±10 kHz, which is wide enough to pass the data signal with a little extra to allow for drift over temperature.

3.1.2 System Receiver Hopping Capability

Both the transmitter and receiver generate Reed-Solomon pseudo random frequency hop sequences of length 64. A preset seed is programmed into the transmitter at the time the microprocessor is programmed. When the transmitter is paired with its matching receiver, a set up routine is invoked which allows the transmitter to transfer its seed and identity code to the receiver over an R.F. link.

In operation the receiver will go to a “home” channel when first powered up and wait to receive a signal from its mating transmitter. When a signal with the correct ID code is received, the receiver will begin hopping in synchronization with the transmitter. The receiver hop timing is then corrected on each successful hop.

3.1.3 Section 15.247(g) Hopping Requirements

Each transmitter/receiver pair uses 64 hopping channels that are used equally on average.

3.1.4 Section 15.247(h)

The receiver hops in synchronization with signals having the correct data format, ID code, and CRC word for its mating transmitter. All other signals are ignored. The hop sequence is generated in a pseudorandom manner and is not affected by transmissions from other radiators.

3.2 Related Submittals

Omnex Control Systems, Inc. is not submitting any other products simultaneously for equipment authorization related to the EUT.

4 TESTED SYSTEM DETAILS

4.1 Tested System Configuration

The system was configured for testing in a typical fashion. The EUT was placed on an 80-cm high, nonconductive test stand. The testing was performed in conditions as close as possible to installed conditions. Wiring was consistent with manufacturer's recommendations. A 14 cm power cord was used from the batteries to the EUT during the tests.

Tested System Configuration List

Item	Description	Type*	Manufacturer	Model Number	Serial Number
1	Spread Spectrum Tx Module	E	Omnex Control Systems, Inc.	LPT-900	12PLT

* Type: E = EUT, P = Peripheral, S = Support Equipment

The EUT was tested as a stand-alone device. The wiring was consistent with manufacturer's recommendations. The system was configured for testing in a typical fashion (as it would be normally installed in a product).

Power was supplied with a new battery.

4.2 Special Accessories

No special accessories were used during the tests in order to achieve compliance.

4.3 Equipment Modifications

No modifications were made to the EUT at Radiometrics' test facility in order to comply with the standards listed in this report.

5 TEST SPECIFICATIONS AND RELATED DOCUMENTS

Test Specifications

Document	Date	Title
FCC CFR Title 47	1999	Code of Federal Regulations Title 47, Chapter 1, Federal Communications Commission, Part 15 - Radio Frequency Devices
ANSI C63.4-1992	1992	Methods of Measurement of Radio Noise Emissions from Low-Voltage Electrical and Electronic Equipment in the Range of 9 kHz to 40 GHz
IC RSS-210 Issue 5	2001	Low Power Licence-Exempt Radiocommunication Devices (All Frequency Bands)
IC RSS-212 Issue 1	1998	Test Methods For Radio Equipment
FCC DA 00-705	2000	Filing and Measurement Guidelines for Frequency Hopping Spread Spectrum Systems

The test procedures used are in accordance with the FCC DA 00-75, Industry Canada RSS-212 and ANSI document C63.4-1992, (July 17, 1992) "Methods of Measurement of Radio Noise Emissions from Low-Voltage Electrical and Electronic Equipment in the Range of 9 kHz to 40 GHz". The specific procedures are described herein. Radiated testing was performed at an antenna to EUT distance of 3 meters. The antenna was raised and lowered from 1 to 4 meters.

6 RADIOMETRICS' TEST FACILITIES

The results of these tests were obtained at Radiometrics Midwest Corp. in Romeoville, Illinois, USA. Radiometrics has been accredited by A2LA (American Association for Laboratory Accreditation) to conform to ISO/IEC 17025: 1999 "General Requirements for the Competence of Calibration and Testing Laboratories". Radiometrics' Lab Code is 121191 and Certification Number is 1495.01. Radiometrics' scope of accreditation includes all of the "basic standards" listed herein. A copy of the accreditation can be accessed on our web site (www.radiomet.com). Radiometrics accreditation status can be verified at A2LA's web site (www.a2la.org).

The following is a list of shielded enclosures located in Romeoville, Illinois:

Chamber A: Is an anechoic chamber that measures 24' L X 12' W X 12' H. The walls and ceiling are fully lined with ferrite absorber tiles. The floor has a 10' x 10' section of ferrite absorber tiles in the located in the center. Panashield of Rowayton, Connecticut manufactured the chamber. The enclosure is NAMAS certified.

Chamber B: Is a shielded enclosure that measures 24' L X 12' W X 8' H. Erik A. Lindgren & Associates of Chicago, Illinois manufactured the enclosure.

Chamber C: Is a shielded enclosure that measures 20' L X 10' W X 8' H. Lindgren RF Enclosures Inc. of Addison, Illinois manufactured the enclosure.

Chamber D: Is a fully anechoic chamber that measures 22' L X 10' W X 10' H. The walls, ceiling and floor are fully lined with ferrite absorber tiles. Braden Shielding Systems of Tulsa, Oklahoma manufactured the chamber.

A separate ten-foot long, brass plated, steel ground rod attached via a 6 inch copper braid grounds each of the above chambers. Each enclosure is also equipped with low-pass power line filters.

Open Area Test Site (OATS): Is located on 8625 Helmar Road in Newark, Illinois, USA and measures 56' L X 24' W X 17' H. The entire open field test site has a metal ground screen. The FCC has accepted these sites as test site number 31040/SIT 1300F2. The FCC test site Registration Number is 90897. Details of the site characteristics are on file with the Industry Canada as file number IC3124.

A complete list of the test equipment is provided herein. The calibration due dates are indicated on the equipment list. The equipment is calibrated in accordance to ANSI/NCSL Z540-1 with traceability to the National Institute of Standards and Technology (NIST).

7 DEVIATIONS AND EXCLUSIONS FROM THE TEST SPECIFICATIONS

There were no deviations or exclusions from the test specifications.

8 CERTIFICATION

Radiometrics Midwest Corporation certifies that the data contained herein was taken under conditions that meet or exceed the requirements of the test specification. The results relate only to the EUT listed herein. Any modifications made to the EUT subsequent to the indicated test date will invalidate the data and void this certification.

9 TEST EQUIPMENT TABLE

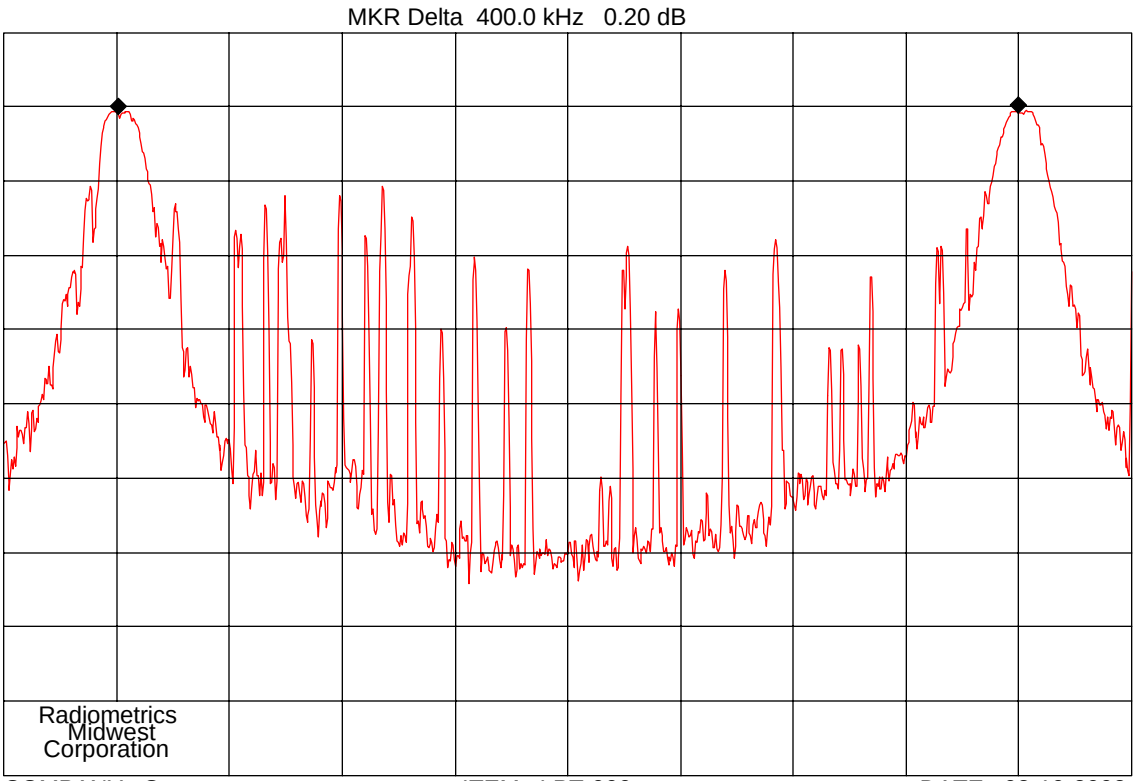
RMC ID	Manufacturer	Description	Model No.	Serial No.	Frequency Range	Cal Period	Cal Date
AMP-05	RMC/Celeritek	Pre-amplifier	MW110G	1001	1.0-12GHz	12 Mo.	11/28/01
AMP-12	MITEQ	Pre-amplifier	AM-1431	530935	0.01-1000MHz	12 Mo.	12/28/01
ANT-03	Tensor	Biconical Antenna	4104	2231	20-200MHz	24 Mo.	08/07/01
ANT-06	EMCO	Log-Periodic Ant.	3146	1248	200-1000MHz	24 mo	08/07/01
ANT-13	EMCO	Horn Antenna	3115	2502	1.0-18GHz	24 Mo.	09/28/00
HPF-01	Solar	High Pass Filter	7930-100	HPF-1	0.15-30MHz	24 Mo.	12/28/00
HPF-02	Microwave Cir.	High Pass Filter	H2G09G02	HPF-2	1.5-11 GHz	24 Mo.	05/29/01
REC-01	Hewlett Packard	Spectrum Analyzer	8566A	2106A02115, 2209A01349	30Hz-22GHz	12 Mo.	06/08/01
REC-03	Anritsu	Spectrum Analyzer	MS2601B	MT94589	0.01-2200MHz	12 Mo.	10/12/01
SCP-01	Tektronix	Oscilloscope	TDS724A	B010117	DC-500MHz	12 Mo.	10/19/01
THM-01	Extech Inst.	Temp/Humid Meter	4465CF	001106557	N/A	12 Mo.	12/26/01

Note: All calibrated equipment is subject to periodic checks.
NCR – No Calibration Required. Device monitored by calibrated equipment. N/A: Not Applicable.

10 TEST SECTIONS

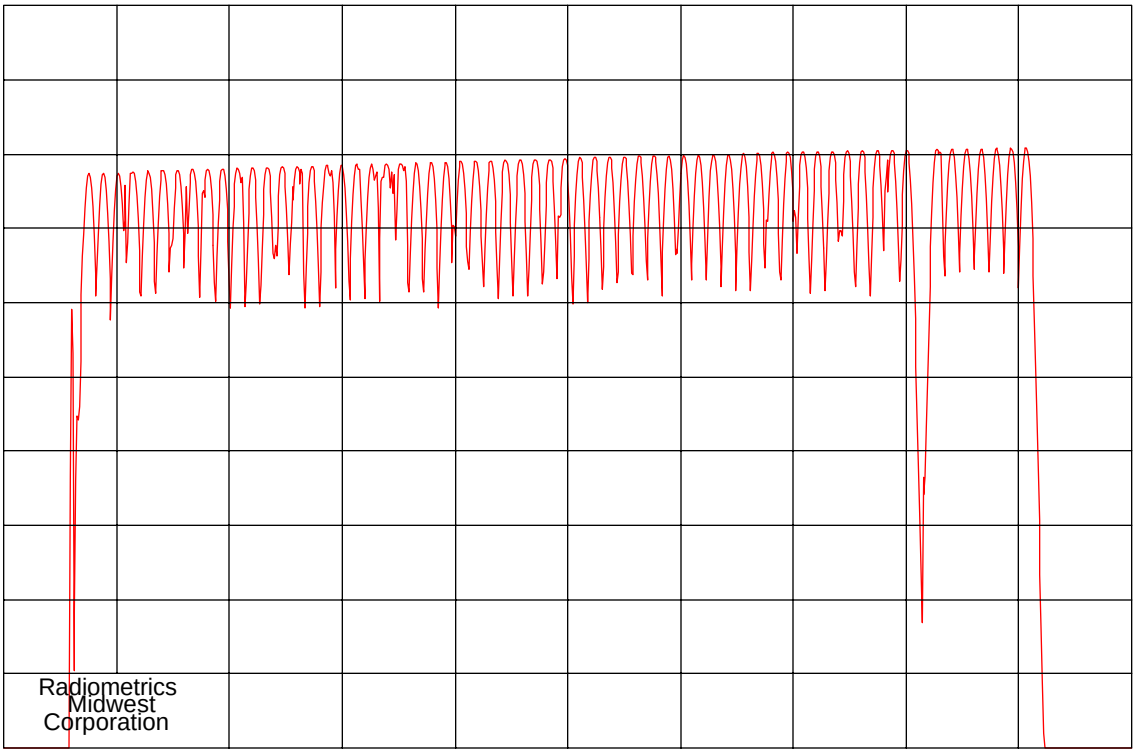
10.1 Carrier Frequency Separation

The EUT has its hopping function enabled. The spectrum analyzer was set to the "MAX HOLD" mode to read peak emissions. The sweep was set to “auto.” The trace was allowed to stabilize. The marker-delta function was used to determine the separation between the peaks of the adjacent channels.



10.2 Number of Hopping Frequencies

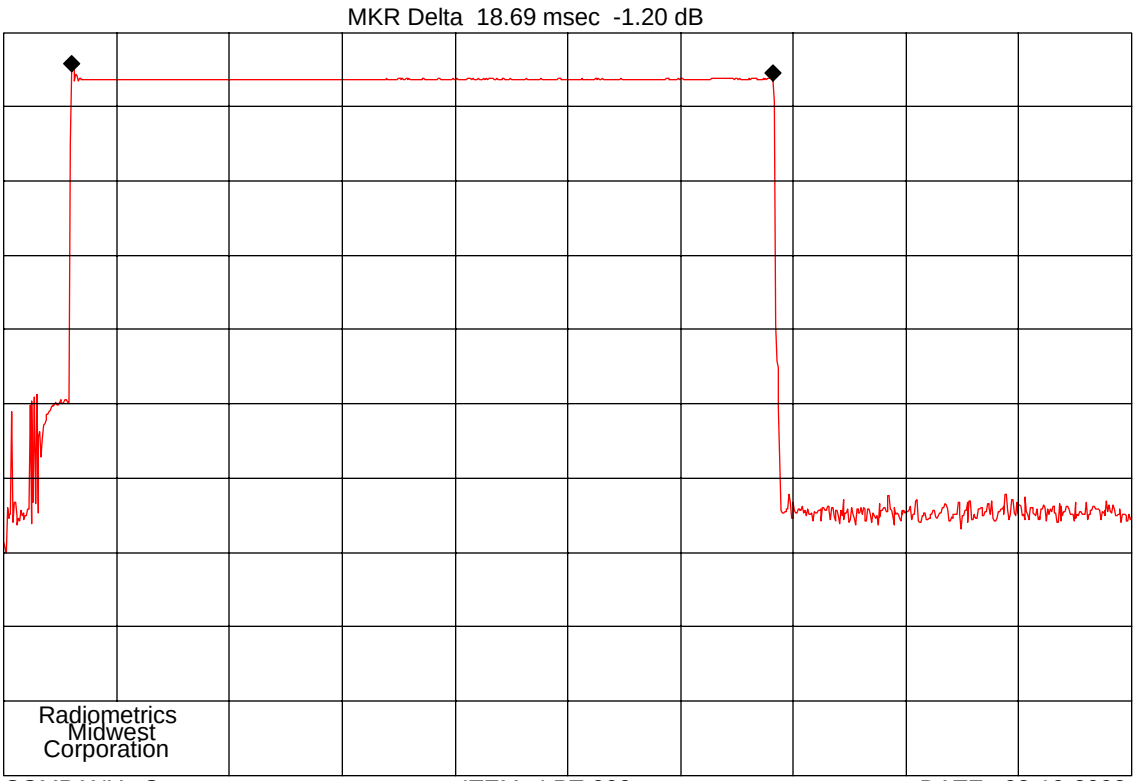
The EUT has its hopping function enabled. The spectrum analyzer was set to the "MAX HOLD" mode to read peak emissions. The sweep was set to “auto.” The trace was allowed to stabilize.



COMPANY : Omnex
START 900.0 MHz
RES BW 300 kHz
2 dB/
ITEM : LPT-900
REF 14.0 dBm
VBW 30 kHz
TIME : 16:18
DATE : 03-19-2002
STOP 930.0 MHz
ATTEN 30 dB
SWP 20.0 msec
NOTES : Number of Hopping Frequencies, Section 15.247(a)

10.3 Time of Occupancy (Dwell Time)

The EUT has its hopping function enabled. The spectrum analyzer was set to the "MAX HOLD" mode to read peak emissions. The span was set to zero. The marker-delta function to determine the dwell time.

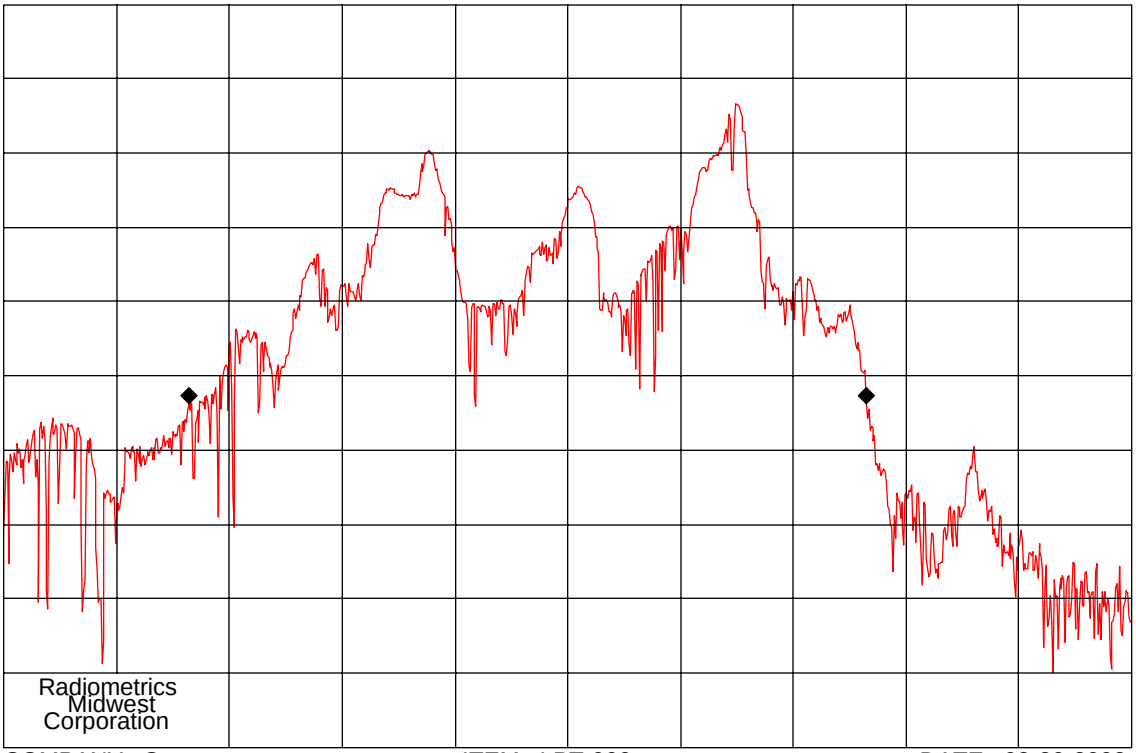


10.4 Occupied Bandwidth (20 dB)

The spectrum analyzer was set to the "MAX HOLD" mode to record the worst case of the modulation. The EUT was transmitting at its maximum data rate. The trace was allowed to stabilize.

The marker-to-peak function was set to the peak of the emission. Then the marker-delta function was used to measure 20 dB down one side of the emission. The marker-delta function was reset and then moved to the other side of the emission, until it is (as close as possible to) even with the reference marker level. The marker-delta reading at this point is the 20 dB bandwidth of the emission.

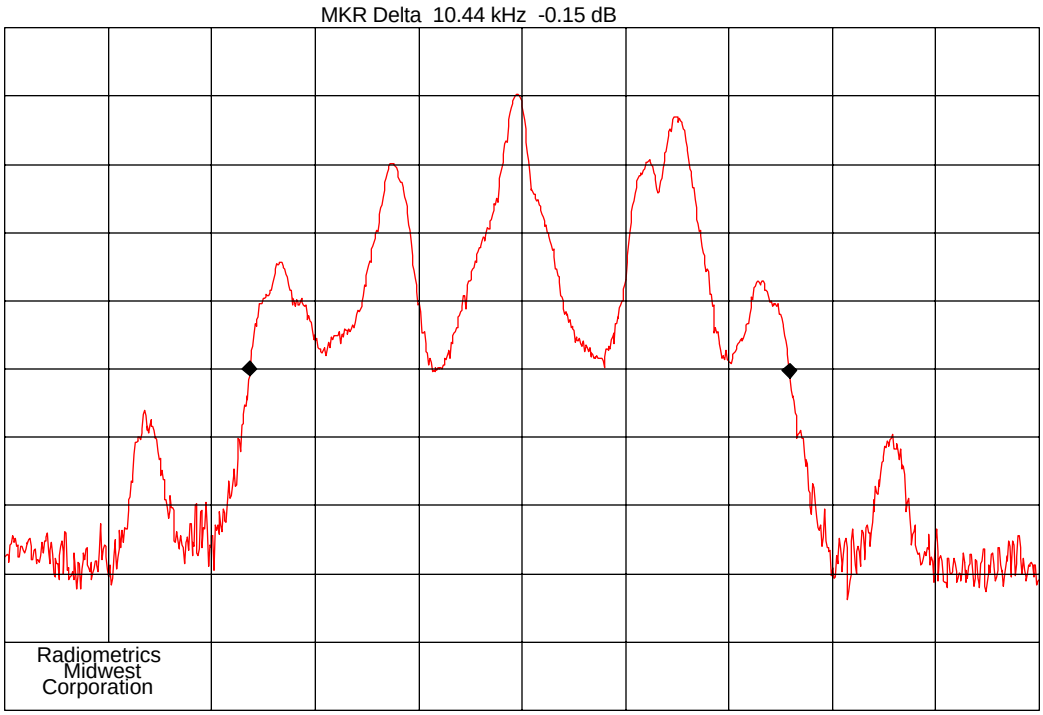
MKR Delta 12.03 kHz 0.00 dB



COMPANY : Omnex
CENTER 915.100 0 MHz
RES BW 300 Hz
5 dB/
NOTES : 20 dB Bandwidth; Section 15.247(a), Actively Hopping

ITEM : LPT-900
REF 15.0 dBm
VBW 1 kHz
TIME : 12:40

DATE : 03-20-2002
SPAN 20.0 kHz
ATTEN 30 dB
SWP 1.00 sec



10.5 Peak Output Power

The spectrum analyzer was set to the following settings:

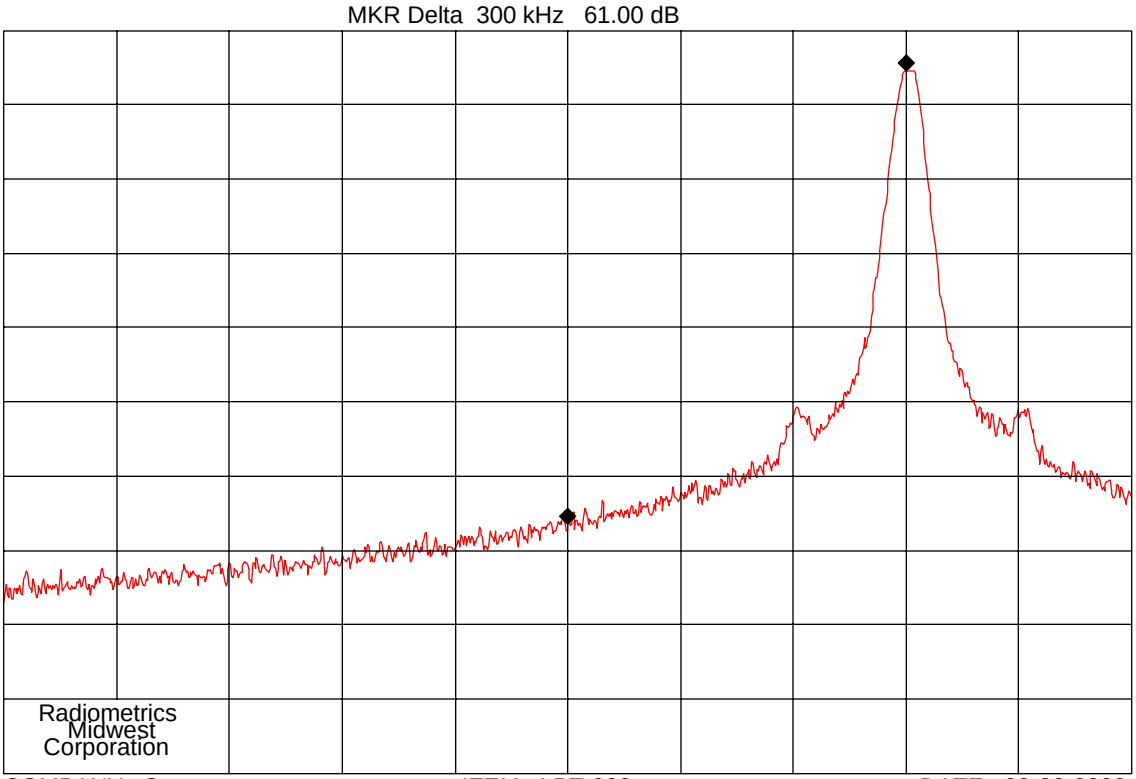
Span = 50 kHz (approximately 5 times the 20 dB bandwidth, centered on a hopping channel)
RBW = 100 kHz (> the 20 dB bandwidth of the emission being measured)
VBW = 300 kHz
Sweep = auto
Detector function = peak
Trace = max hold

The trace was allowed to stabilize. The marker-to-peak function was used to measure the peak of the emission. The indicated level is the peak output power. Note 30 dBm = 1 watt. Since the gain of the antenna is always less than 6dB, the limit is not reduced.

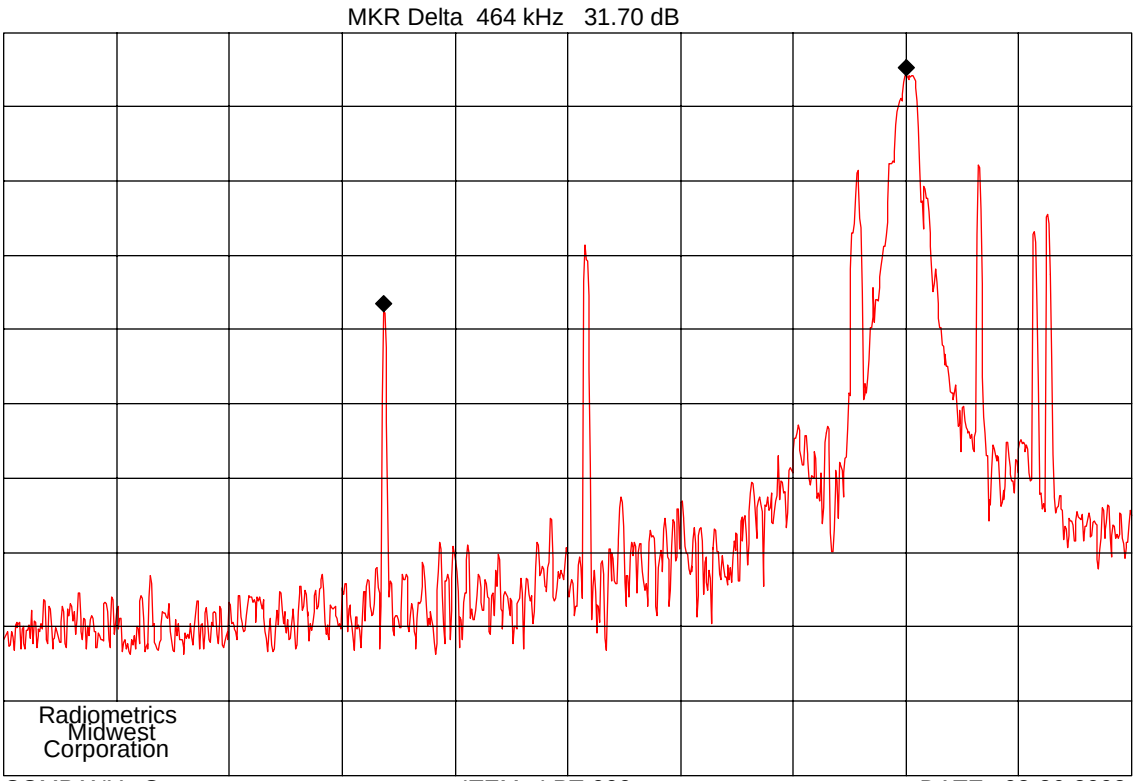
Frequency (MHz)	Reading (dBm)	Cable Loss (dB)	Total Power (dBm)		Limit (dBm)
			dBm	Watts	
902.2	10.2	0.1	10.3	0.01	30
915	10.3	0.1	10.4	0.01	30
927.7	10.3	0.1	10.4	0.01	30

10.6 Band-edge Compliance of RF Conducted Emissions

The spectrum analyzer was set to the "MAX HOLD" mode to record the worst case of the modulation at the band-edge, with the EUT set to the lowest frequency. The trace was allowed to stabilize.

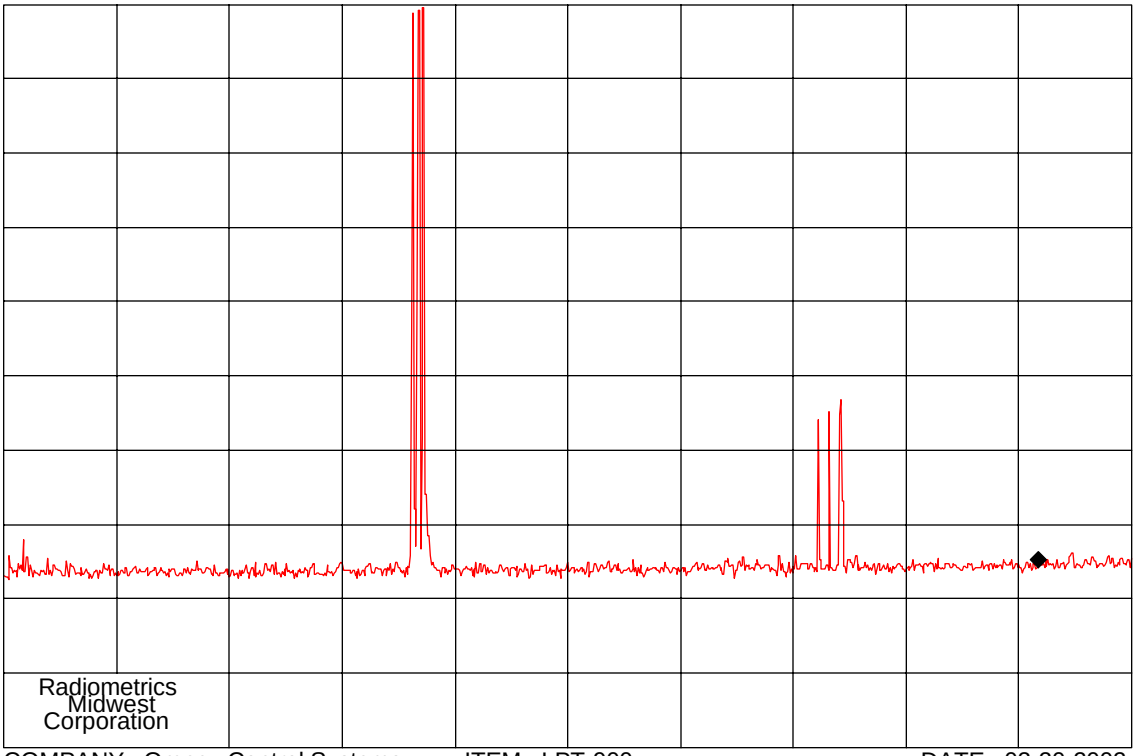


The spectrum analyzer was set to the "MAX HOLD" mode to record the worst case of the modulation at the band-edge, with the hopping function of the EUT enabled. The trace was allowed to stabilize.



10.7 Spurious RF Conducted Emissions

The spectrum analyzer was set to the "MAX HOLD" mode to record all spurious emissions from the lowest frequency generated in the EUT up through the 10th harmonic. The trace was allowed to stabilize. The first two plots were made while stepping through three frequencies (Low middle and high). Each frequency was on for 30 seconds. The last two plots were made with hopping enabled.



COMPANY : Omnex Control Systems
START 1 MHz
RES BW 100 kHz
10 dB/
NOTES : Spurious Conducted Emissions,

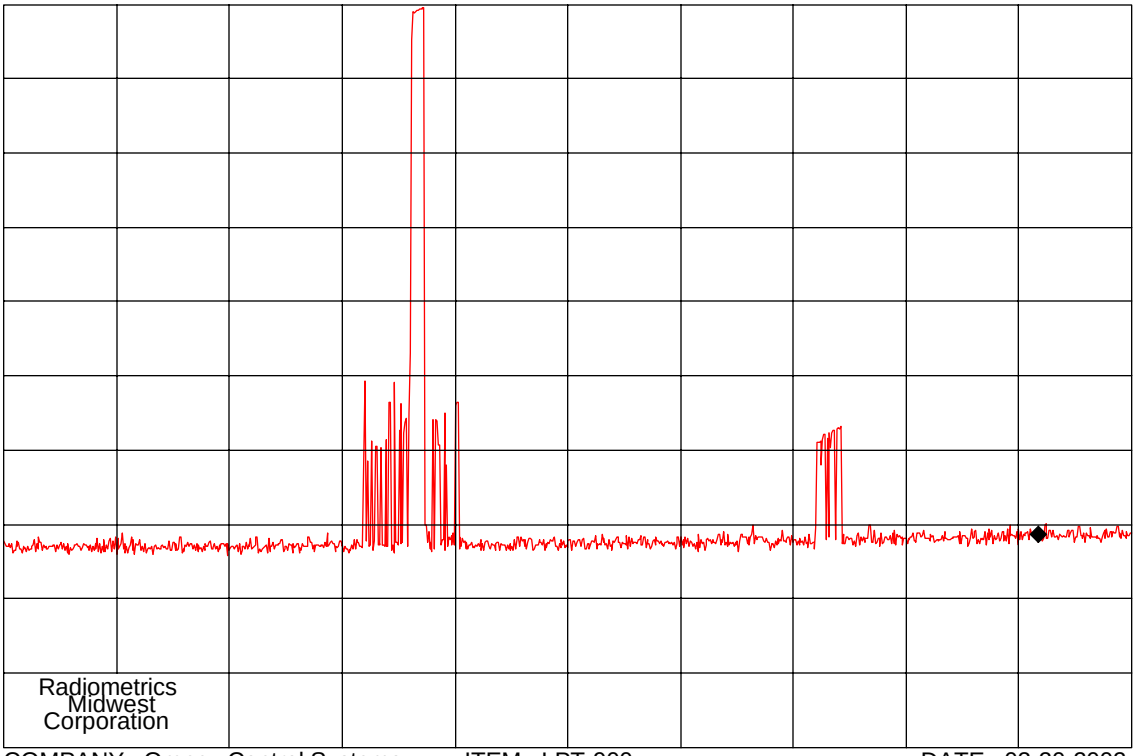
ITEM : LPT-900
REF 10.0 dBm
VBW 300 kHz
TIME : 17:39

DATE : 03-20-2002
STOP 2.50 GHz
ATTEN 20 dB
SWP 750 msec

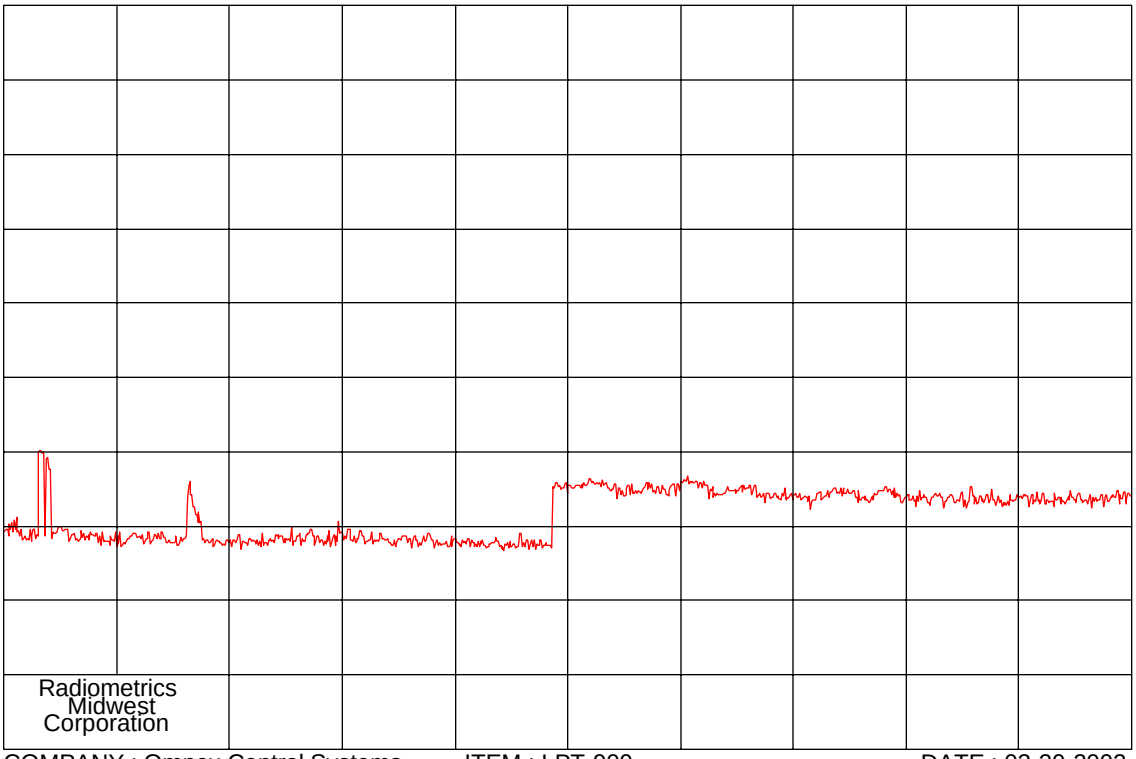
COMPANY : Omnex Control Systems
START 2.50 GHz
RES BW 100 kHz
10 dB/
NOTES : Spurious Conducted Emissions,

ITEM : LPT-900
REF 10.0 dBm
VBW 300 kHz
TIME : 17:41

DATE : 03-20-2002
STOP 9.30 GHz
ATTEN 20 dB
SWP 2.04 sec



COMPANY : Omnex Control Systems ITEM : LPT-900 DATE : 03-20-2002
START 3 MHz REF 10.0 dBm STOP 2.50 GHz
RES BW 300 kHz VBW 1 MHz ATTEN 20 dB
10 dB/ TIME : 17:52 SWP 75.0 msec
NOTES : Spurious Conducted Emissions, Hopping



COMPANY : Omnex Control Systems
START 2.50 GHz
RES BW 300 kHz
10 dB/
NOTES : Spurious Conducted Emissions, Hopping

ITEM : LPT-900
REF 10.0 dBm
VBW 1 MHz
TIME : 17:49

DATE : 03-20-2002
STOP 9.30 GHz
ATTEN 20 dB
SWP 204 msec

10.8 Spurious Radiated Emissions

Radiated emission measurements in the Restricted bands were performed with linearly polarized broadband antennas. The results obtained with these antennas can be correlated with results obtained with a tuned dipole antenna. Below 1 GHz, when a radiated emission is detected approaching the specification limit, the measurement of the emission is repeated using a tuned dipole antenna with a Roberts Balun. A 10 dB linearity check is performed prior to start of testing in order to determine if an overload condition exists.

From 30 to 1000 MHz, an Anritsu Spectrum analyzer and a MITEQ AM-1431 amplifier with a 10 dB attenuator connected to the input were used. The out of band emissions and the ambient emissions were below the level of input overload (80 dBuV).

For tests from 1 to 9.3 GHz, an HP8566A spectrum analyzer was used with a Celeritek uWave amplifier. The out of band emissions and the ambient emissions were below the level of input overload (72 dBuV). In addition, a high pass filter was used to reduce the fundamental emission.

Radiated emission measurements are performed with linearly polarized broadband antennas. Measurements were performed using two antenna polarizations, (vertical and horizontal). The worst case emissions were recorded.

Final radiated emissions measurements were performed in the open area test site at a test distance of 3 meters. The entire frequency range from 30 to 9300 MHz was slowly scanned and the emissions in the restricted frequency bands were recorded. Measurements were performed using the peak detector function. The detected emission levels were maximized by rotating the EUT, adjusting the positions of all cables, and by scanning the measurement antenna from 1 to 4 meters above the ground. The open area test site used to collect the radiated data is located on 8625 Helmar Road in Newark, Illinois. The open field test site has a metal ground screen. All other tests are performed at 12 East Devonwood Ave. Romeoville, Illinois EMI test lab.

The was device was rotated through three orthogonal axis as per 13.1.4.1 of ANSI C63.4 during the prescans and during final radiated tests.

10.8.1 Radiated Emissions Field Strength Sample Calculation

The field strength is calculated by adding the Antenna Factor and Cable Loss, and by subtracting the Amplifier Gain from the measured reading. The basic equation with a sample calculation is as follows:

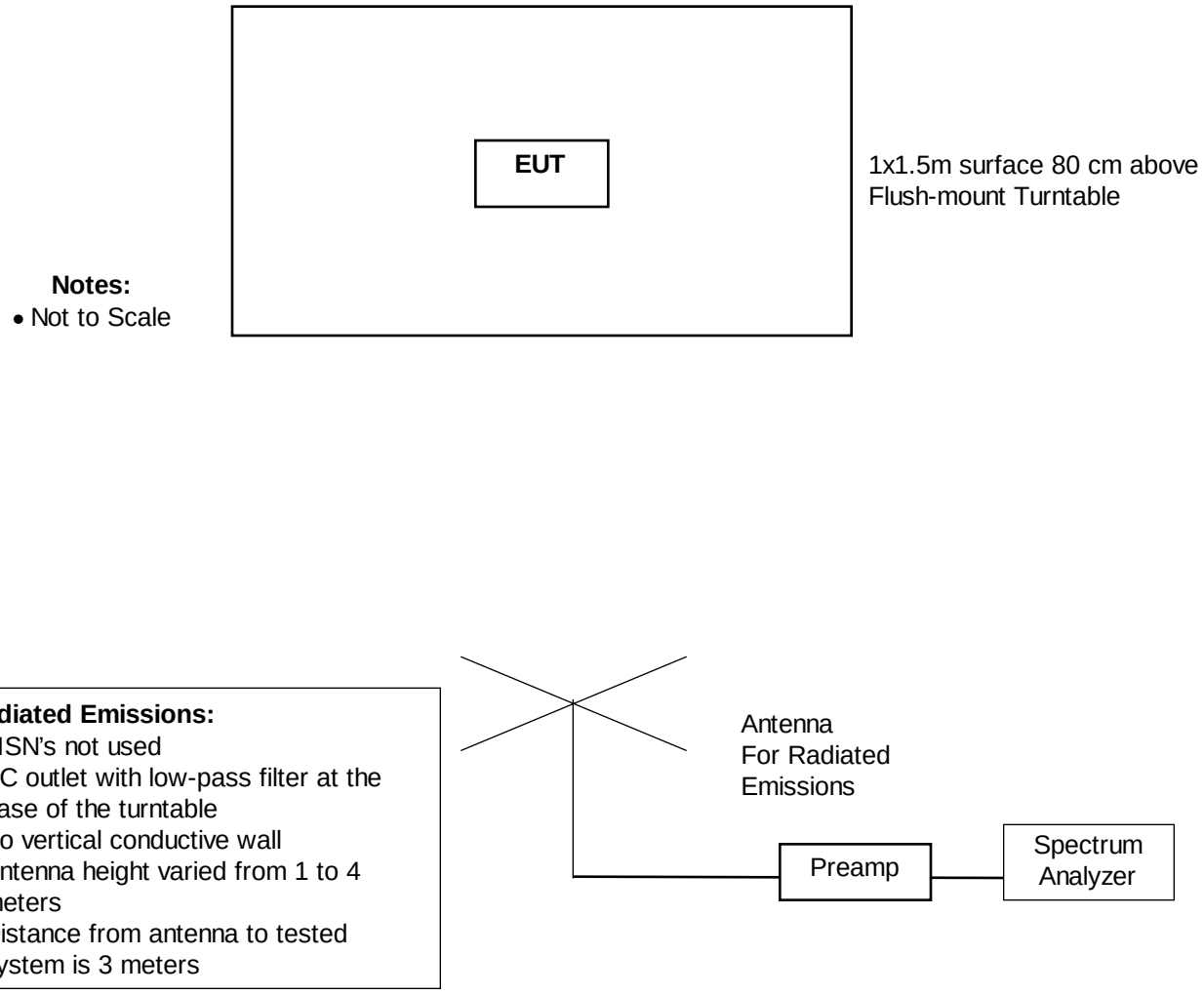
FS = RA + AF + CF - AG

Where: FS = Field Strength
RA = Receiver Amplitude
AF = Antenna Factor
CF = Cable Attenuation Factor
AG = Amplifier Gain

Assume a receiver reading of 49.5 dBuV is obtained. The Antenna Factor of 8.1 and a Cable Factor of 1.7 is added. The Amplifier Gain of 23.3 dB is subtracted, giving a field strength of 36 dBuV/m. The 36 dBuV/m can be mathematically converted to its corresponding level in uV/m.

FS = 49.5 + 8.1 + 1.7 - 23.3 = 36.0 dBuV/m
Level in uV/m = Common Antilogarithm [(36 dBuV/m)/20] = 63.1 uV/m

Figure 1. Drawing of Radiated Emissions Setup



10.8.2 Spurious Radiated Emissions Test Results (Restricted Band)

The following spectrum analyzer settings were used.

Span = wide enough to fully capture the emission being measured
RBW = 1 MHz for f ≥ 1 GHz, 100 kHz for f < 1 GHz
VBW ≥ RBW
Sweep = auto
Detector function = peak
Trace = max hold

The duty cycle factor is 20 * Log(18.7/100) = -14.5 dB; The plot for this is in section 10.3. The peak emissions did not exceed the average by more than 20 dB.

Manufacturer	Omnex Control Systems	Specification	FCC Part 15 Subpart C & RSS-210
Model	LPT-900	Test Date	3/19/02
Serial Number	12PLT	Test Distance	3 Meters
Abbreviations	Pol = Antenna Polarization; V = Vertical; H = Horizontal; BC = Biconical (ANT-3); LP = Log-Periodic (ANT-6); HN = Horn (ANT-13) P = peak; Q = QP		
Notes	Corr. Factors = Cable Loss – Preamp Gain – Duty Cycle Factor + HP Filter Loss		

Freq. MHz	Meter Reading dBuV	Antenna Factor dB	Antenna Pol/ Type	Corr. Factors dB	Field Strength dBuV/m EUT	Field Strength dBuV/m Limit	Margin Under Limit dB
2706.6	53.1	31.0	H	-40.4	43.7	54.0	10.3
2745.0	52.0	31.0	H	-40.4	42.6	54.0	11.4
2783.1	52.5	31.1	H	-40.3	43.3	54.0	10.7
3608.8	44.7	33.4	H	-39.5	38.6	54.0	15.4
3660.0	45.2	33.5	H	-39.4	39.3	54.0	14.7
3710.8	45.0	33.7	H	-39.4	39.3	54.0	14.7
4511.0	46.8	34.9	H	-38.7	43.0	54.0	11.0
4575.0	38.8	35.0	H	-38.6	35.2	54.0	18.8
4638.5	39.4	35.0	H	-38.6	35.8	54.0	18.2
5413.2	35.7	36.1	H	-38.4	33.4	54.0	20.6
5490.0	35.8	36.2	H	-38.4	33.6	54.0	20.4
7320.0	40.9	37.8	H	-37.2	41.5	54.0	12.5
7421.5	41.1	38.0	H	-37.2	41.9	54.0	12.1
8119.6	34.5	38.1	H	-36.9	35.7	54.0	18.3
8234.6	34.0	38.2	H	-36.7	35.5	54.0	18.5
8349.3	33.4	38.4	H	-36.2	35.6	54.0	18.4
9021.8	34.4	40.3	H	-34.5	40.2	54.0	13.8
9149.8	33.7	40.0	H	-34.0	39.7	54.0	14.3
9276.9	31.7	39.7	H	-33.5	37.9	54.0	16.1
2706.6	51.0	31.0	V	-40.4	41.6	54.0	12.4
2745.0	51.2	31.0	V	-40.4	41.8	54.0	12.2
3608.8	44.0	33.4	V	-39.5	37.9	54.0	16.1
3660.0	44.0	33.5	V	-39.4	38.1	54.0	15.9
4511.0	39.6	34.9	V	-38.7	35.8	54.0	18.2
4575.0	39.7	35.0	V	-38.6	36.1	54.0	17.9
5413.2	34.7	36.1	V	-38.4	32.4	54.0	21.6
5490.0	36.1	36.2	V	-38.4	33.9	54.0	20.1
7320.0	38.6	37.8	V	-37.2	39.2	54.0	14.8
8119.8	34.5	38.1	V	-36.9	35.7	54.0	18.3
8235.0	32.9	38.2	V	-36.7	34.4	54.0	19.6
9022.1	33.7	40.3	V	-34.5	39.5	54.0	14.5
9150.0	33.0	40.0	V	-34.0	39.0	54.0	15.0

Judgment: Passed by 10.3 dB

No other emissions were detected in the restricted bands.