

Nemko Test Report: 5L0469RUS1

Applicant: Kemp-Meek Manufacturing
101 Park Central
Mineola, TX 75773

Equipment Under Test: COLLECTOR-M

In Accordance With: **FCC Part 15, Subpart C, 15.247**
Frequency Hopping Transmitters

Tested By: Nemko USA Inc.
802 N. Kealy
Lewisville, Texas 75057-3136

Authorized By: 
David Light, Senior Wireless Engineer

Date: 21 December 2005

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Section 1. Summary of Test Results

Manufacturer: Kemp-Meek Manufacturing

Model No.: COLLECTOR-M

Serial No.: NA

General: **All measurements are traceable to national standards.**

These tests were conducted on a sample of the equipment for the purpose of demonstrating compliance with Part 15, Subpart C, Paragraph 15.247 for Frequency Hopping Spread Spectrum devices. Radiated tests were conducted in accordance with ANSI C63.4-2003. Radiated emissions are made on an open area test site. A description of the test facility is on file with the FCC.



New Submission



Production Unit



Class II Permissive Change



Pre-Production Unit

THIS TEST REPORT RELATES ONLY TO THE ITEM(S) TESTED.

THE FOLLOWING DEVIATIONS FROM, ADDITIONS TO, OR EXCLUSIONS FROM THE TEST SPECIFICATIONS HAVE BEEN MADE.

See " Summary of Test Data".



NVLAP LAB CODE: 100426-0

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Summary Of Test Data

NAME OF TEST	PARA. NO.	SPEC.	RESULT
Powerline Conducted Emissions	15.207(a)	48 dB μ V	NA
Channel Separation	15.247(a)(1)	Greater of 25 kHz or 20 dB Bandwidth	COMPLIES
Pseudorandom Hopping Algorithm	15.247(a)(1)		COMPLIES NOTE1
Time of Occupancy	15.247(a)(1)(ii)	≤ 0.4 sec in 20 sec	COMPLIES
20 dB Occupied Bandwidth	15.247(a)(1)	≤ 1 MHz	COMPLIES
Peak Power Output	15.247(b)	1 Watt	COMPLIES
Spurious Emissions (Antenna Conducted)	15.247(c)	-20 dBc	COMPLIES
Spurious Emissions (Radiated)	15.247(c)	Table 15.209(a)	COMPLIES

Footnotes:**NOTE 1 CUSTOMER WILL PROVIDE IN DOCUMENTATION****NA THE EUT IS BATTERY POWERED DEVICE**

Section 2. Equipment Under Test (E.U.T.)

General Equipment Information

Frequency Band:

☒ 902 – 928 MHz

☐ 2400 – 2483.5 MHz

Operating Frequencies:

922.7 to 927.9 MHz

Number of Channels:

50

Channel Spacing:

100 kHz

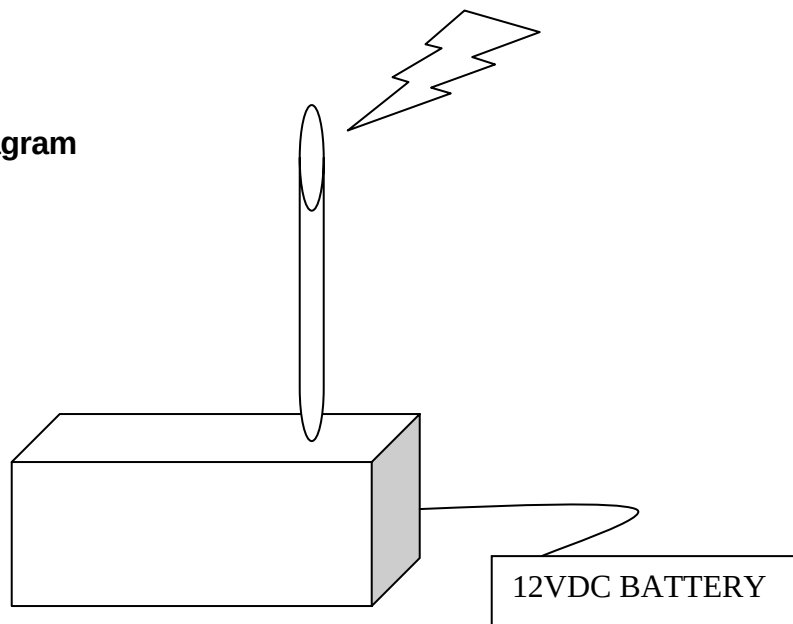
User Frequency Adjustment:

Software controlled

Theory of Operation

FREQUENCY HOPPER TX TO COMMUNICATE WITH METERS

System Diagram



Section 3. Channel Separation

NAME OF TEST: Channel Separation	PARA. NO.: 15.247(a)(1)
TESTED BY: Kevin Rose	DATE: October 8, 2005

Test Results: Complies.

Measurement Data: See attached plot

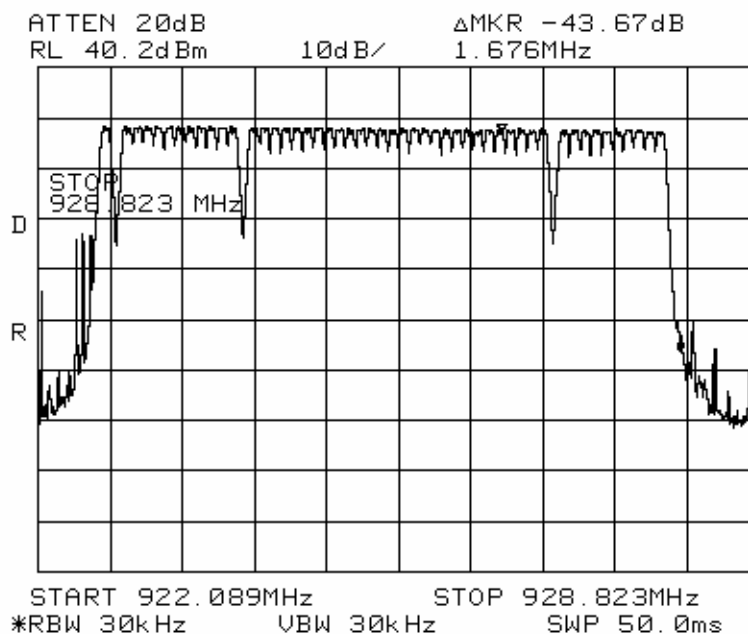
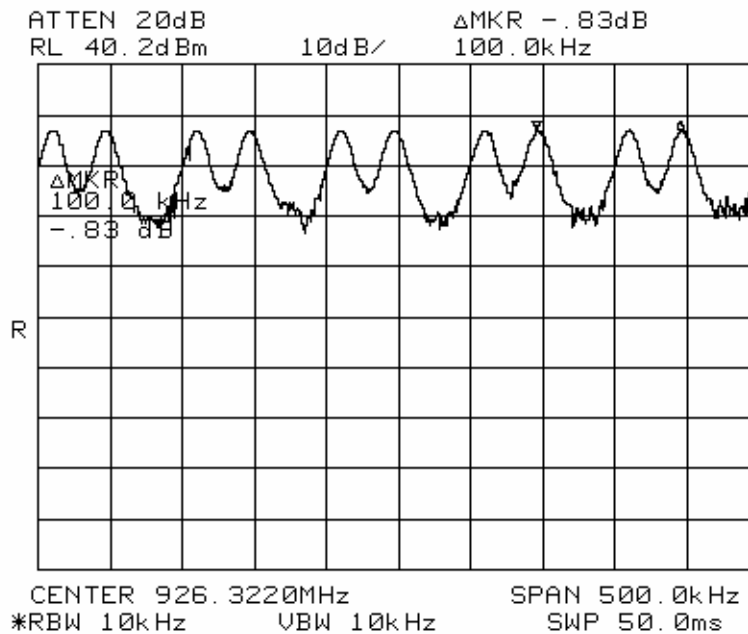
Equipment Used: 1472, 1464, 1081, 1471

Measurement Uncertainty: +/- 1.7 dB

Temperature: °21C

Relative Humidity: 46%

Channel Separation



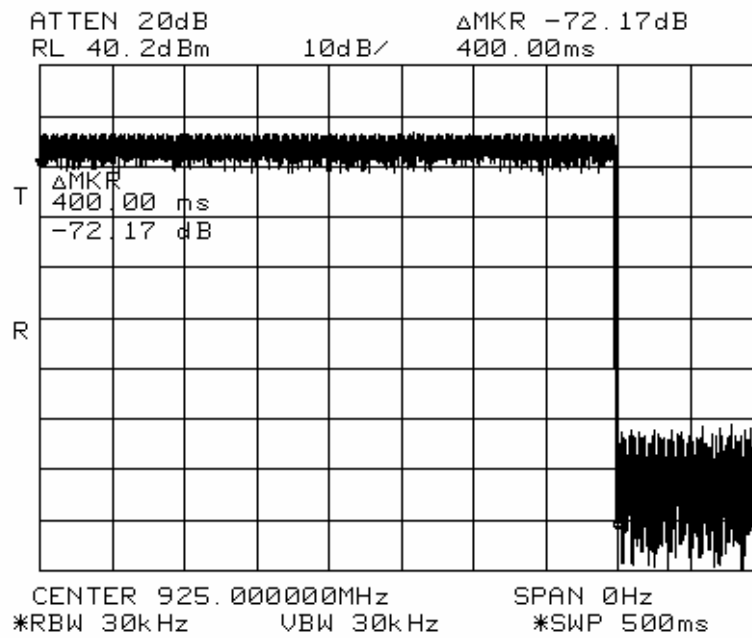
Section 4. Time of Occupancy

NAME OF TEST: Time of Occupancy	PARA. NO.: 15.247(a)(1)
TESTED BY: Kevin Rose	DATE: October 9, 2005

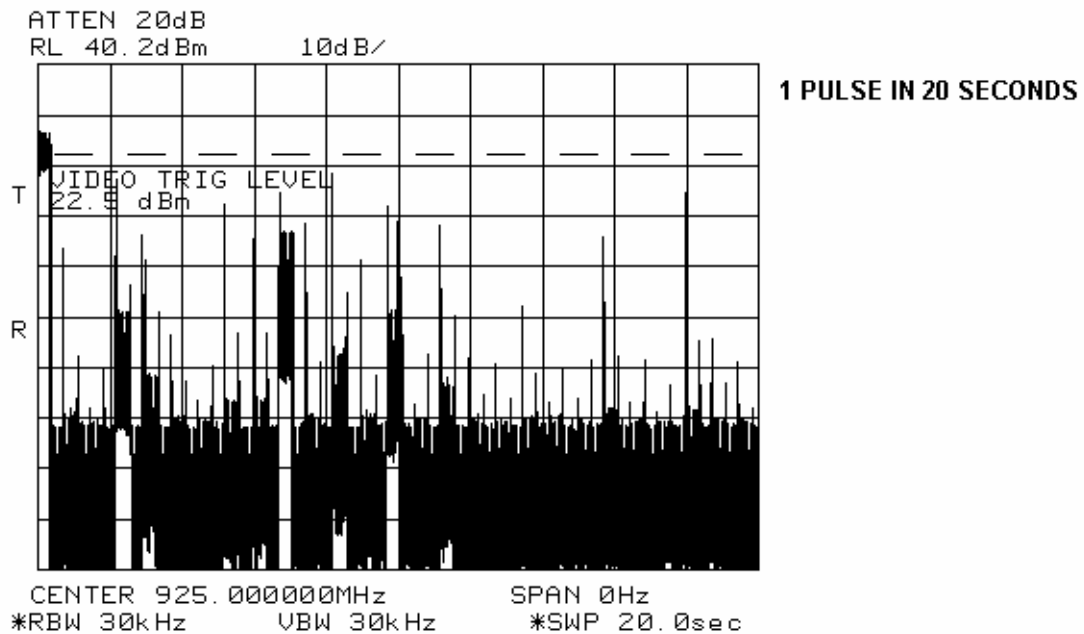
Test Results: Complies.

Equipment Used: 1472, 1464, 1081, 1471

Measurement Data: See attached plot



400 mS per pulse



Section 5. Occupied Bandwidth and Bandedges

NAME OF TEST: Occupied Bandwidth	PARA. NO.: 15.247(a)(1)(i)
TESTED BY: Kevin Rose	DATE: October 9, 2005

Test Results: Complies.

Measurement Data: See attached plots.

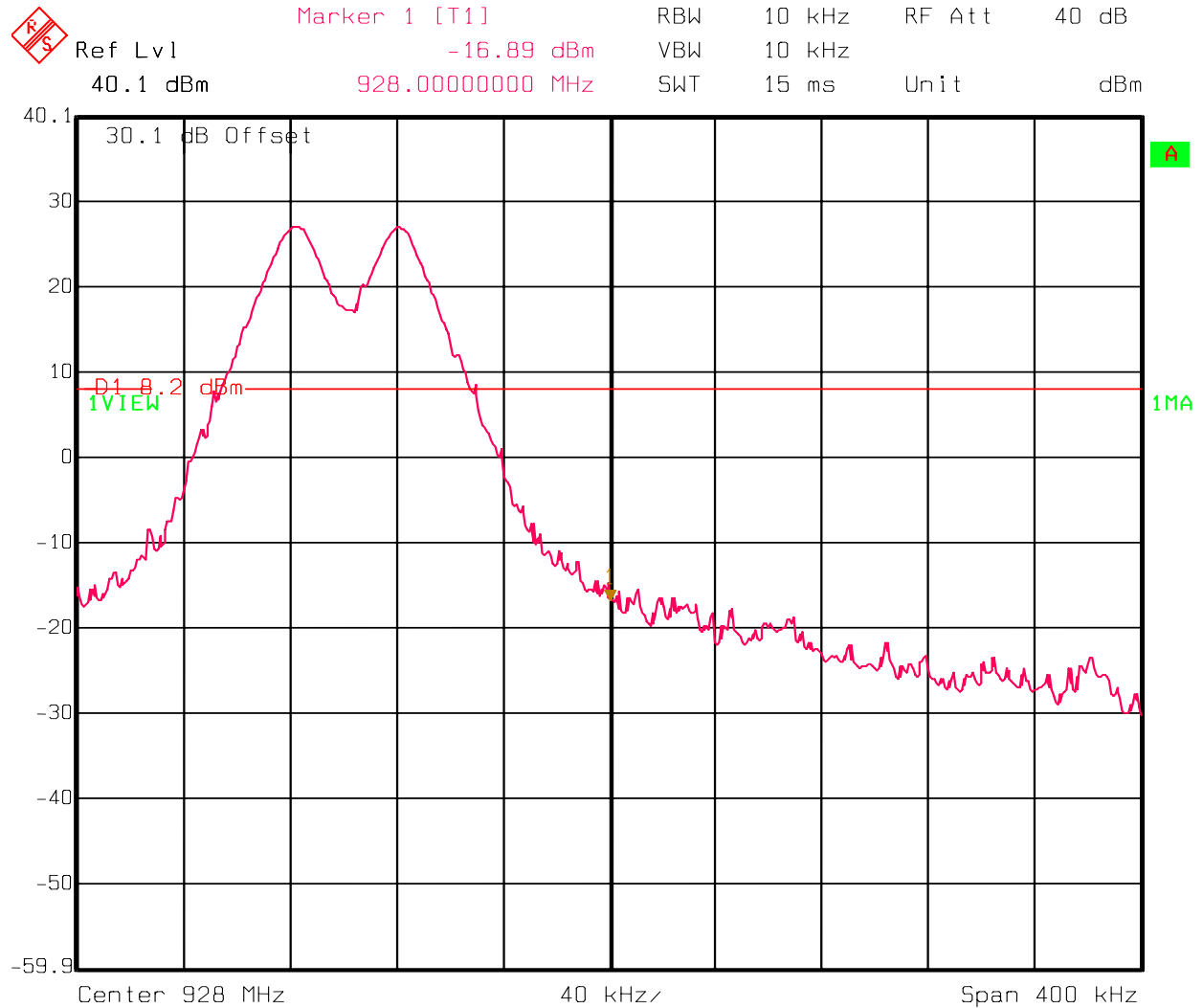
Equipment Used: 1472, 1464, 1081, 1471, 1659.

Measurement Uncertainty: +/- 1.7 dB

Temperature: 22°C

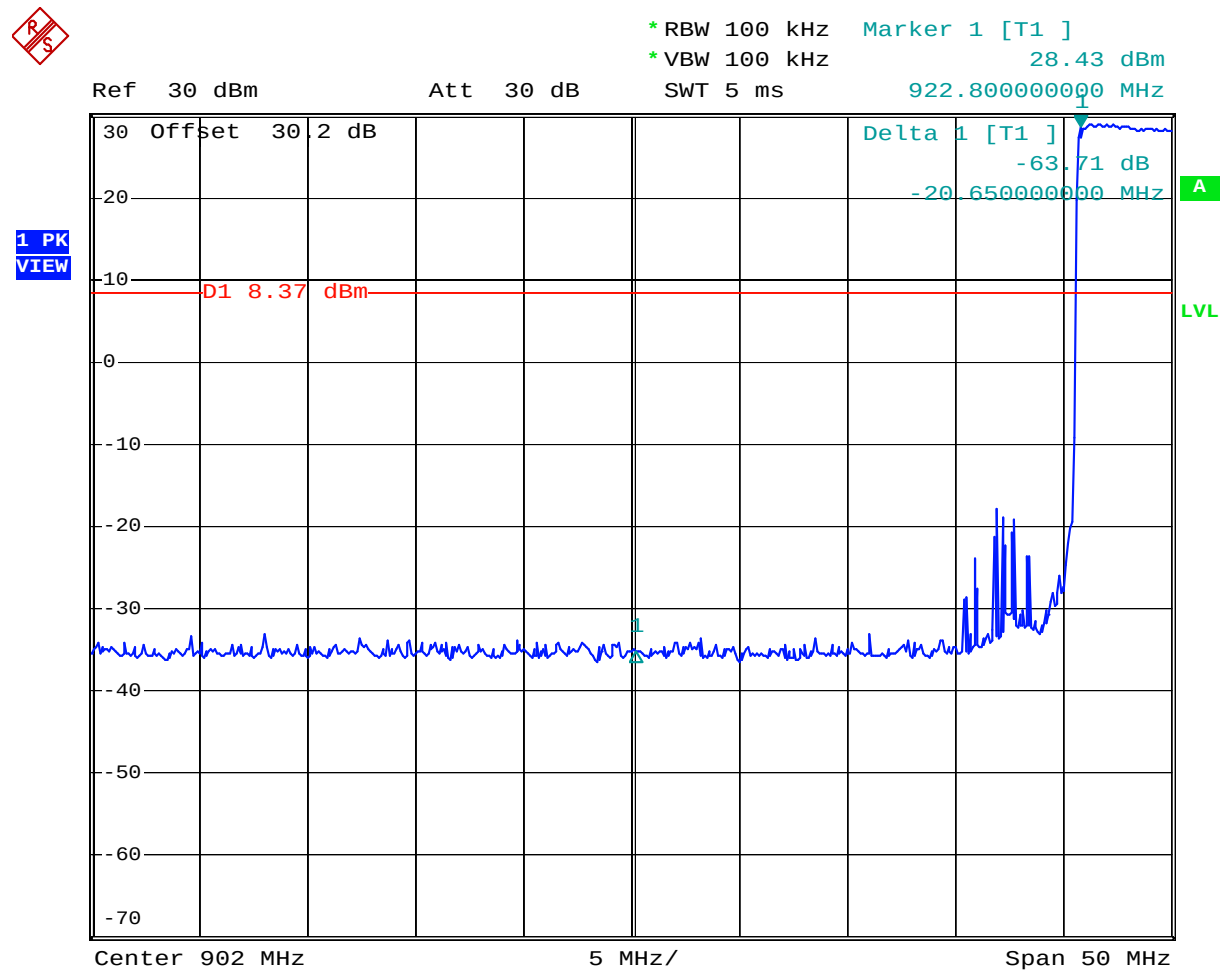
Relative Humidity: 46%

UPPER BAND EDGE



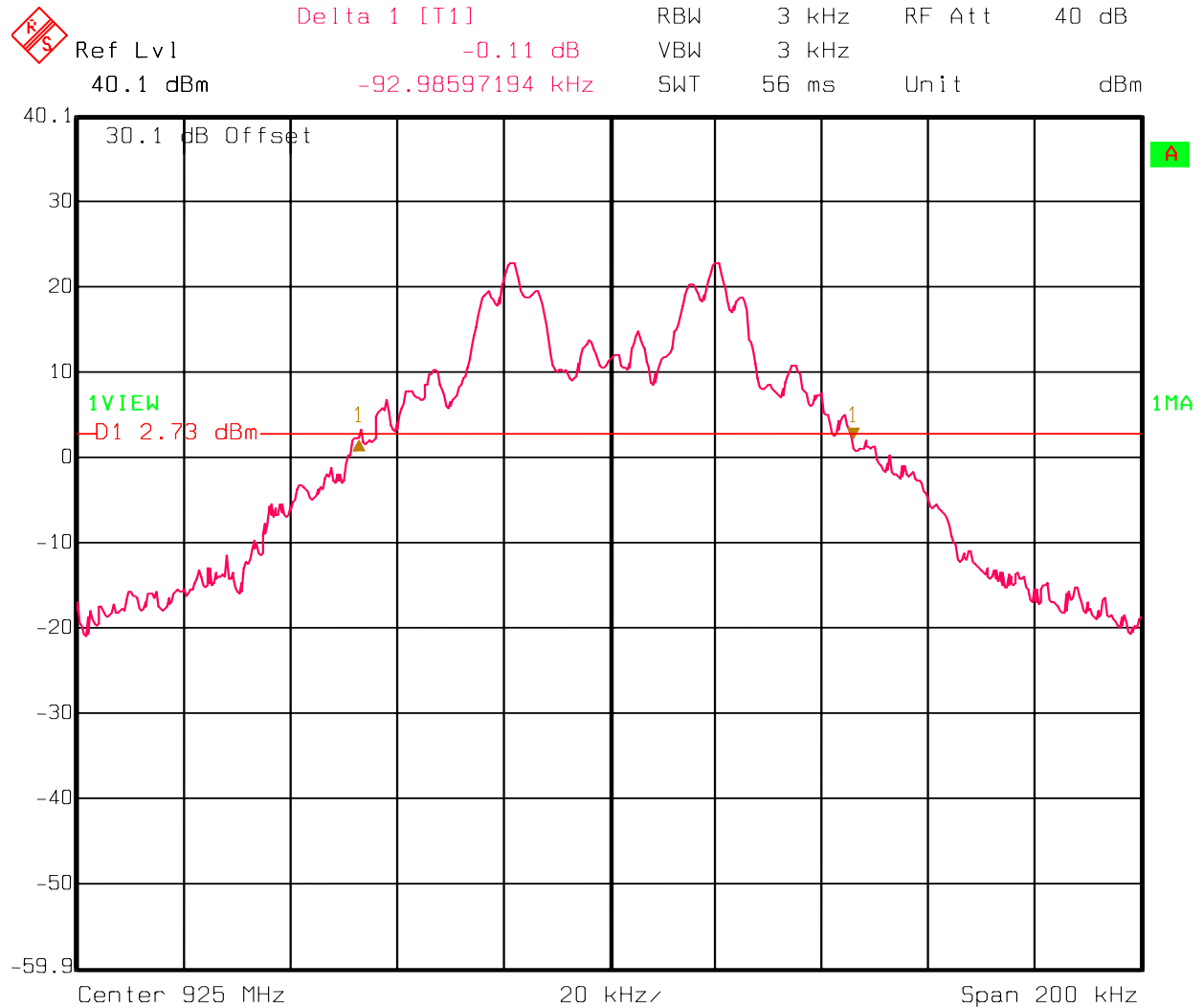
Date: 22.DEC.2005 09:14:04

LOWER BANDEDGE



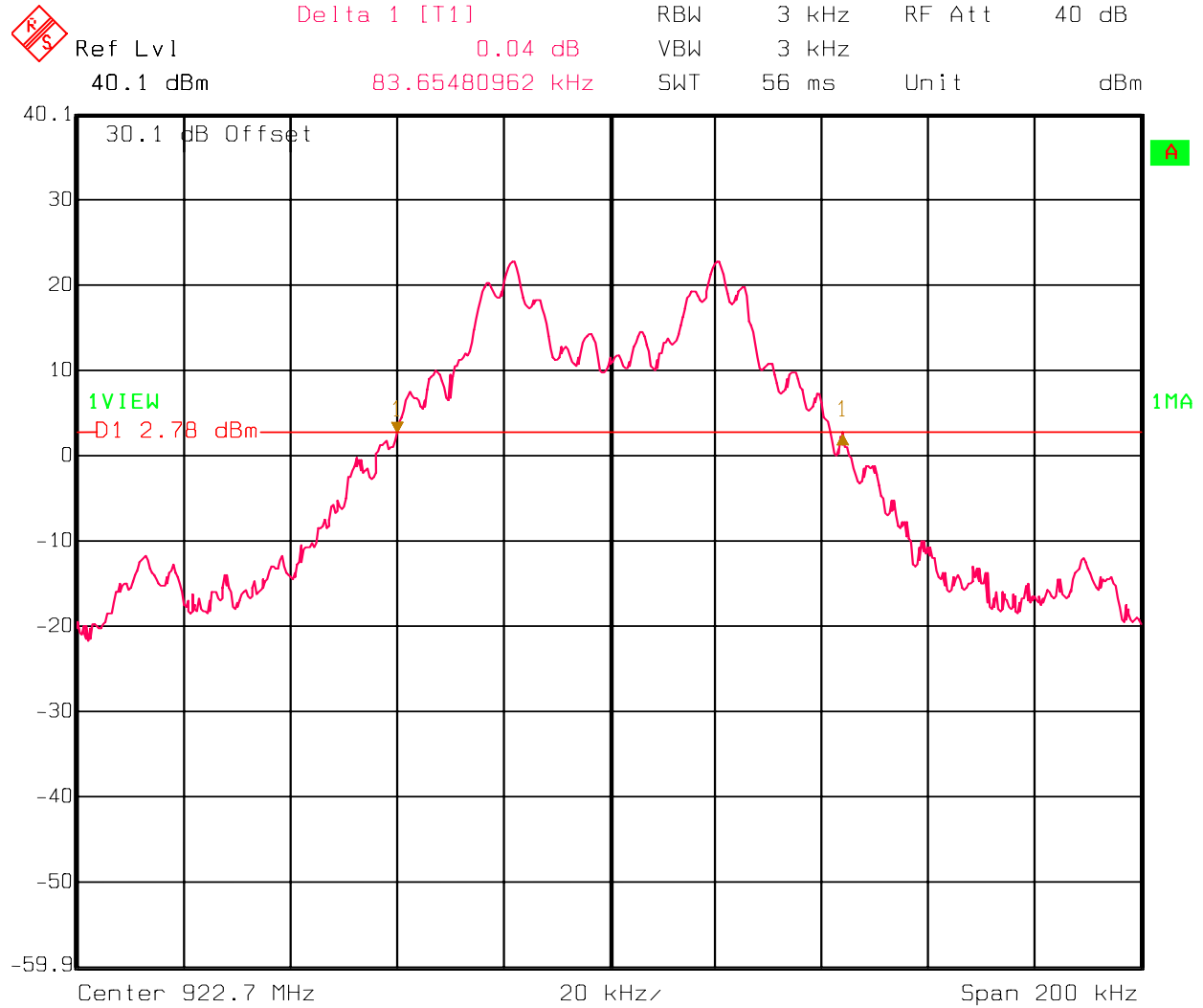
Date: 19.AUG.2005 13:10:22

Mid channel OBW



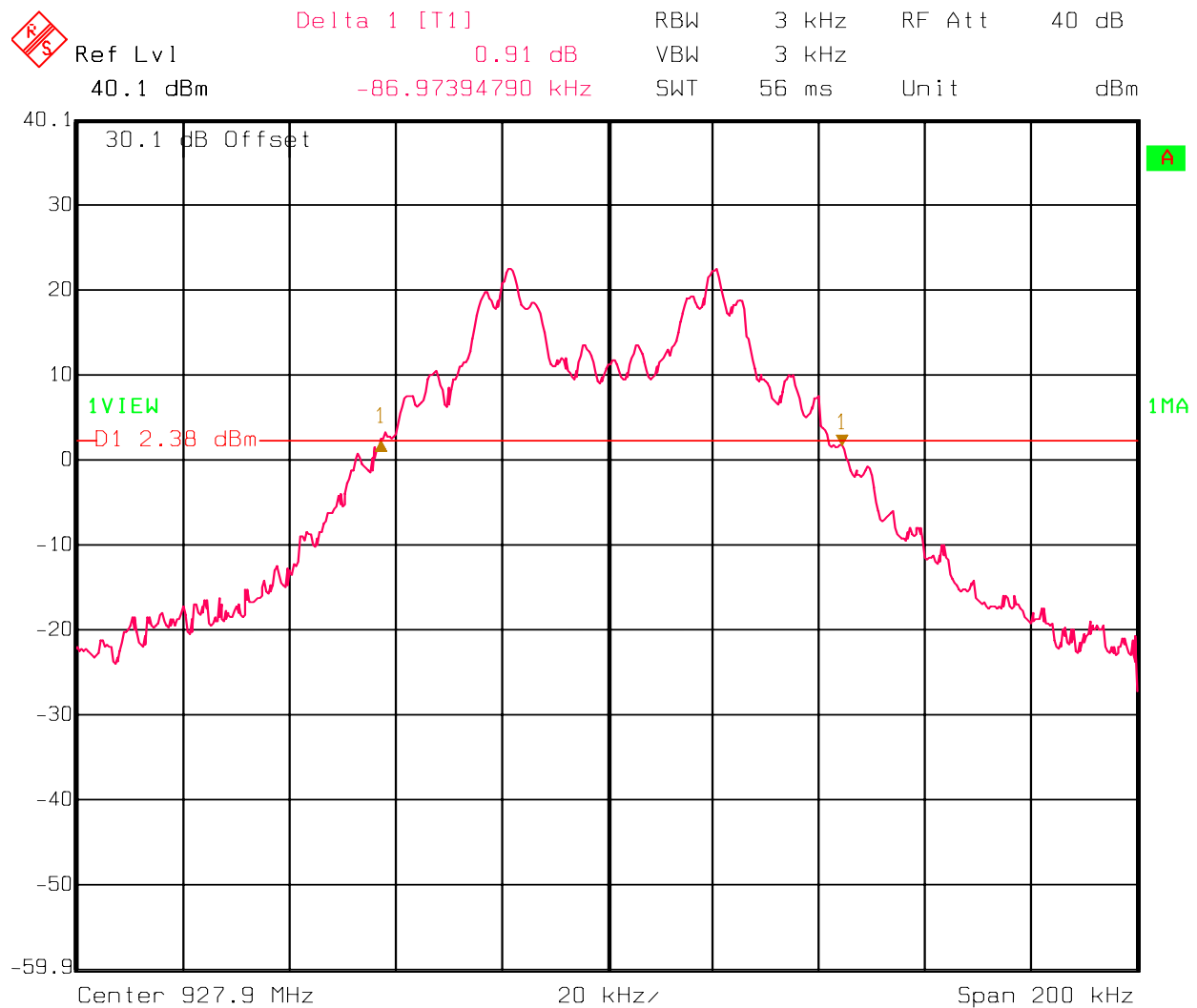
Date: 22.DEC.2005 09:06:04

Low channel OBW



Date: 22.DEC.2005 08:59:53

High channel OBW



Date: 22.DEC.2005 09:04:04

Section 6. Peak Power Output

NAME OF TEST: Peak Power Output

PARA. NO.: 15.247 (b)

TESTED BY: Kevin Rose

DATE: October 9, 2005

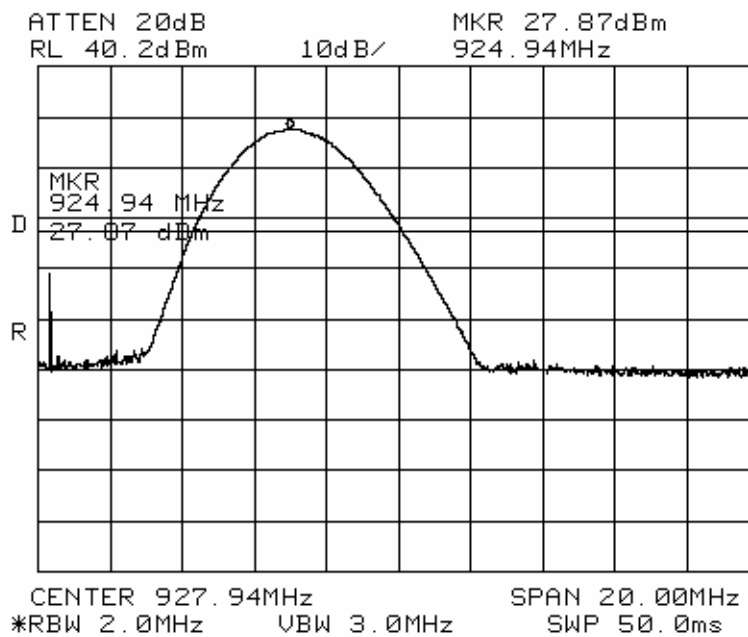
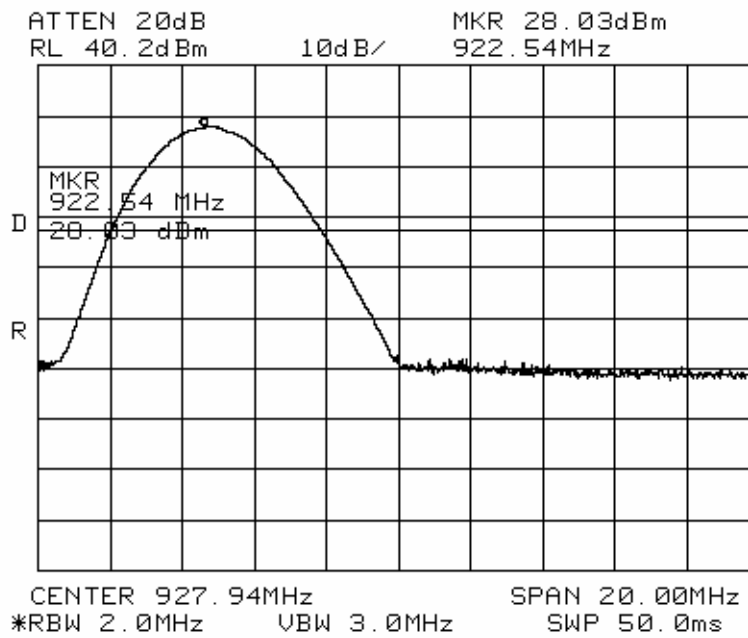
Test Results: Complies.**Measurement Data:** See attached plots.Detachable antenna? ☒ Yes ☐ No

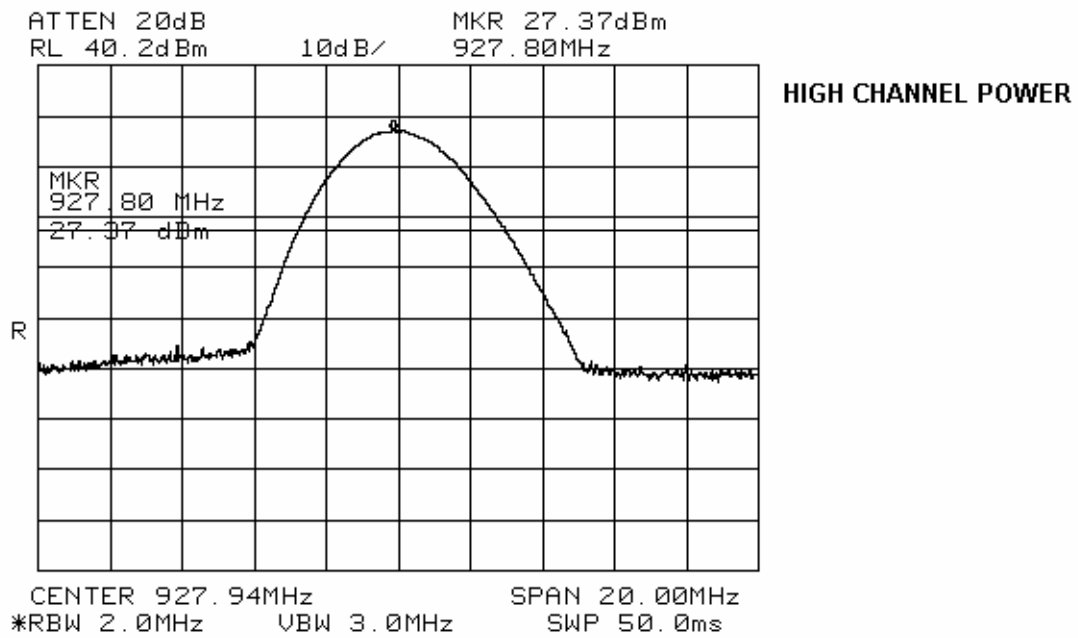
If yes, state the type of non-standard connector used:

Antennas: Mono pole

Model	Type	Gain (dBi)	E.I.R.P. (dBm)
MUF9035NGPS	Low channel	7.15	35.18
MUF9035NGPS	Mid channel	7.15	34.52
MUF9035NGPS	High channel	7.15	35.18
Peak power output at antenna port(dBm):			

Equipment Used: 1472, 1464, 1081, 1471**Measurement Uncertainty:** +/- 1.7 dB**Temperature:** 22°C**Relative Humidity:** 46%





Section 7. Spurious Emissions (Antenna Conducted)

NAME OF TEST: Spurious Emissions (Antenna Conducted)	PARA. NO.: 15.247(c)
TESTED BY: Kevin Rose	DATE: October 9, 2005

Test Results: Complies.

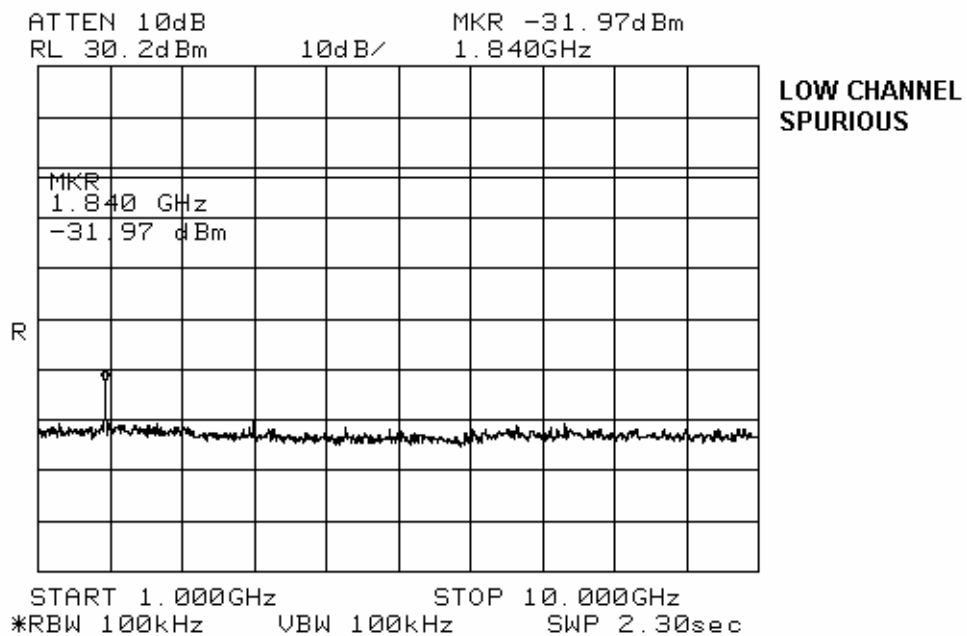
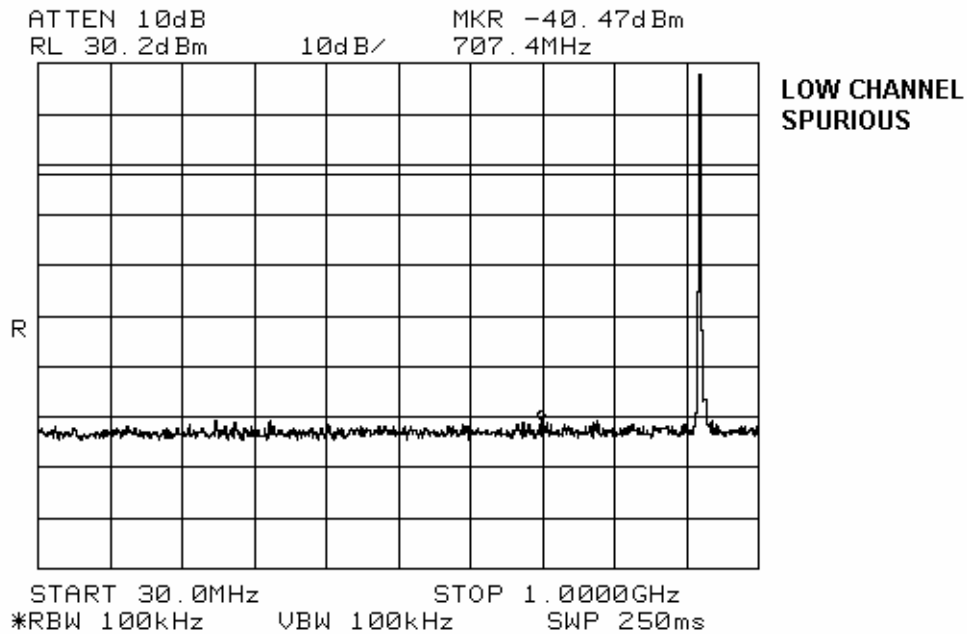
Measurement Data: See attached plots.

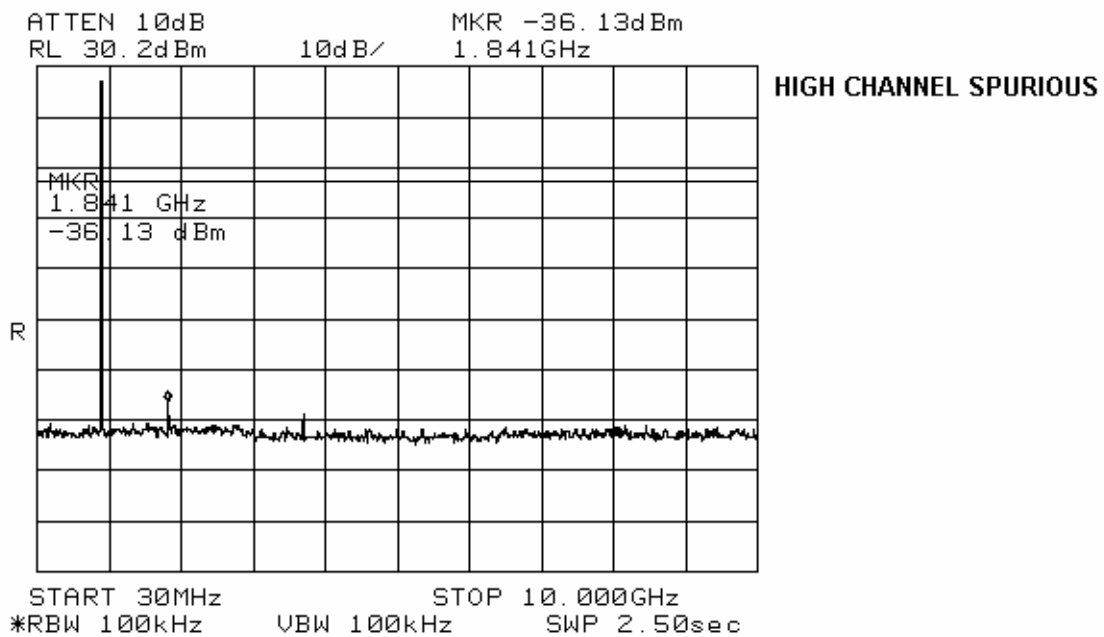
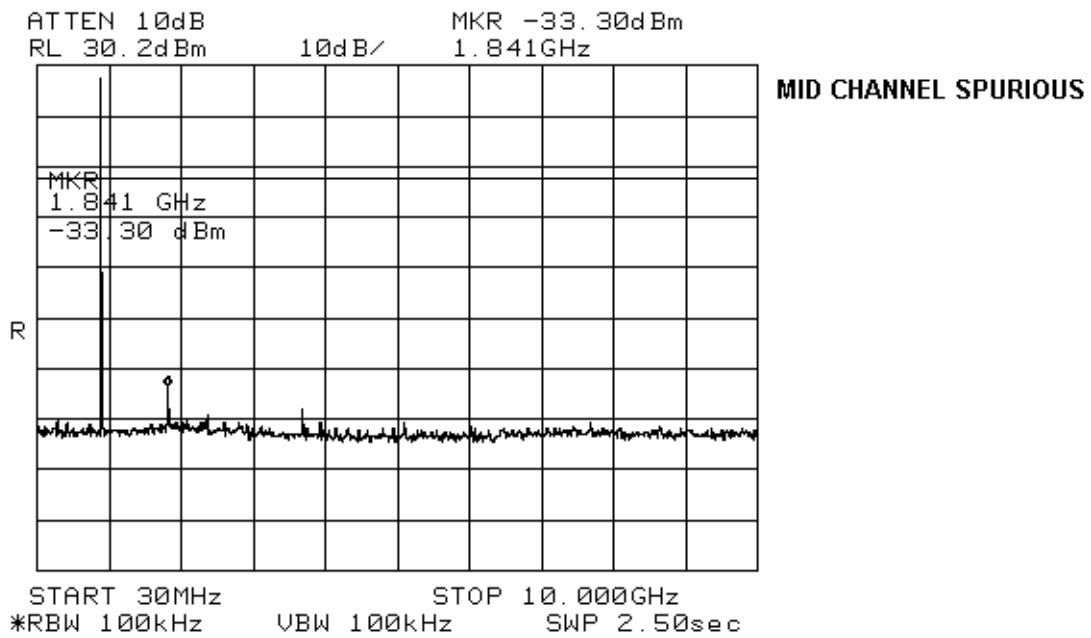
Equipment Used: 1472, 1464, 1081, 1471

Measurement Uncertainty: +/- 1.7 dB

Temperature: 22°C

Relative Humidity: 46%





Section 8. Spurious Emissions (Radiated)

NAME OF TEST: Spurious Emissions (Radiated)	PARA. NO.: 15.247(c)
TESTED BY: Kevin Rose	DATE: October 9, 2005

Test Results: Complies.

Measurement Data: See attached table.

Duty Cycle Calculation:

Duty Cycle correction factor(dB) = $20 \log (rf_{ON} \text{ in ms}/100\text{ms})$

Equipment Used: 993, 1484, 1485, 1464, 1016, 791,760,759, 1481

Measurement Uncertainty: +/- 1.7 dB

Temperature: 22°C

Relative Humidity: 46%

The spectrum was searched from 30 MHz to 9500 MHz. No emissions were detected below 1 GHz with the noise floor being at least 20 dB below the specification limit.

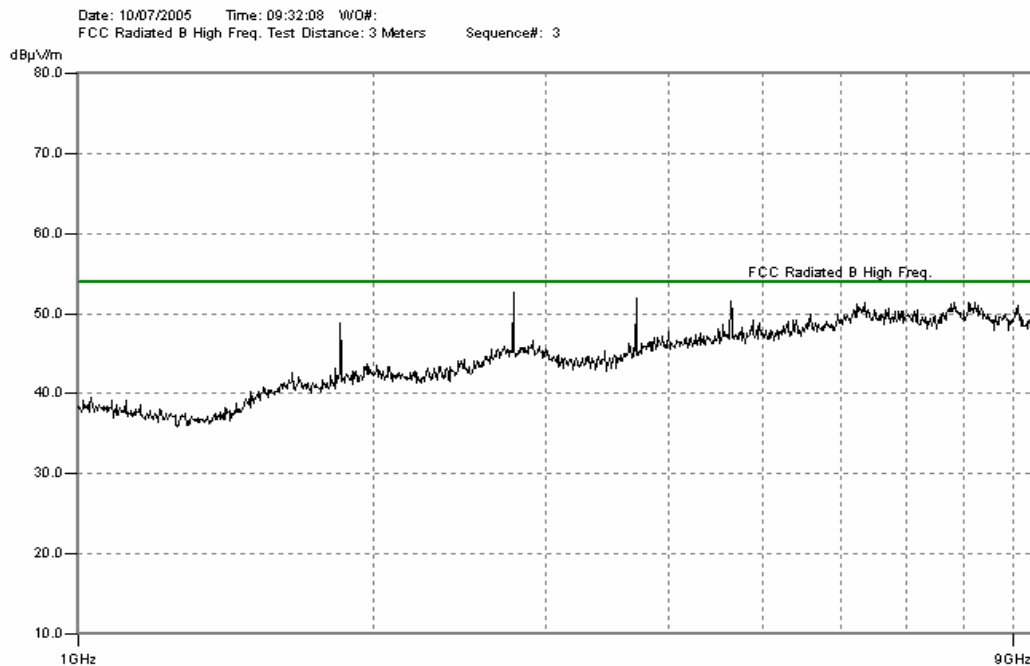
RBW=VBW=1 MHz > 1 GHz Peak Detector was used.

Average measurements are made with RBW=1MHz and VBW=10Hz

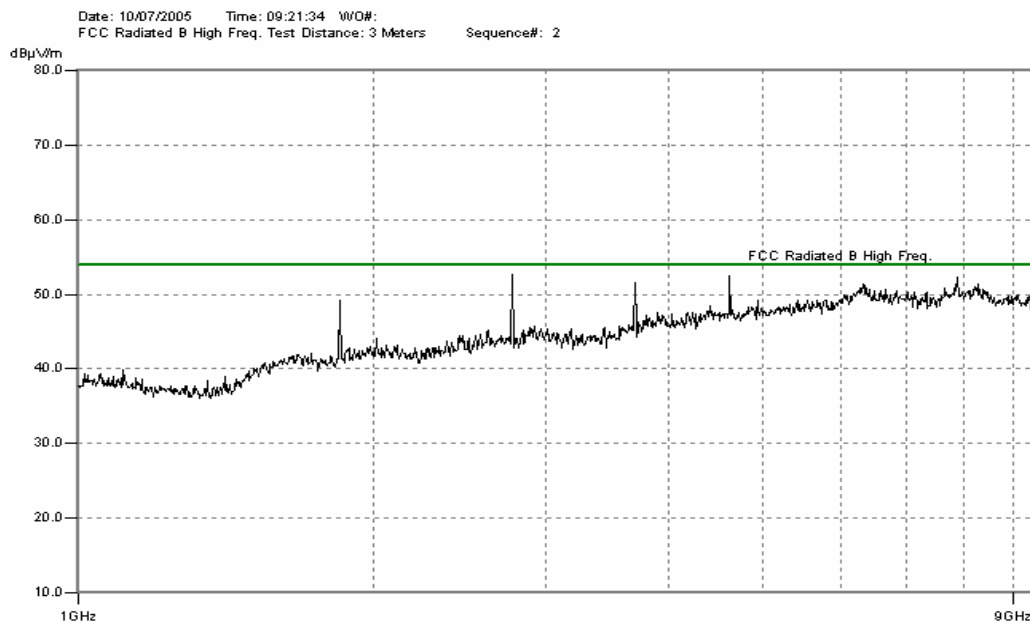
RBW=VBW=100 kHz <1 GHz Peak Detector was used.

Peak reading is lower then the average limit.

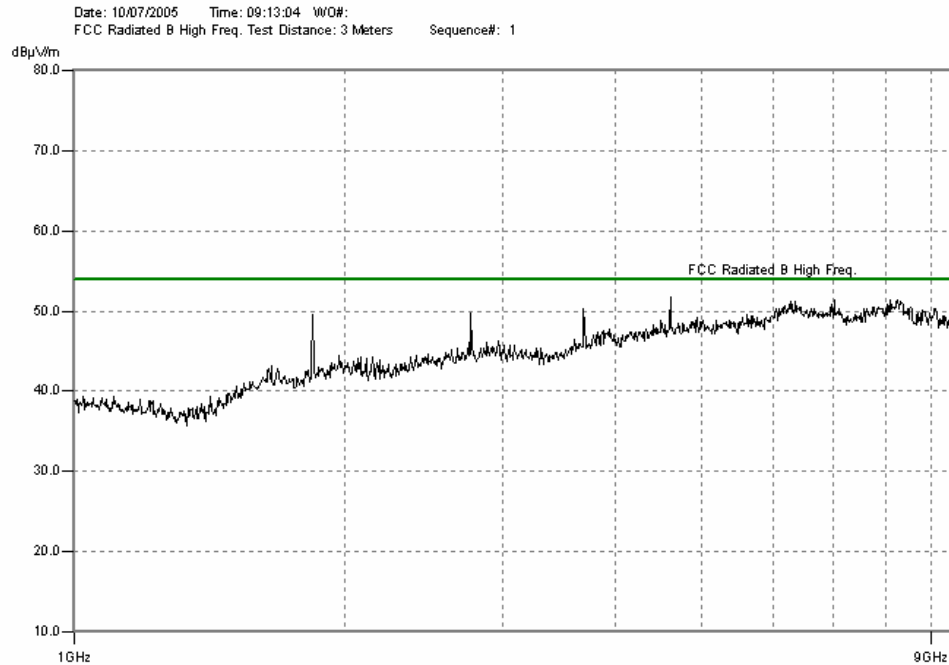
VERTICAL HIGH CHANNEL



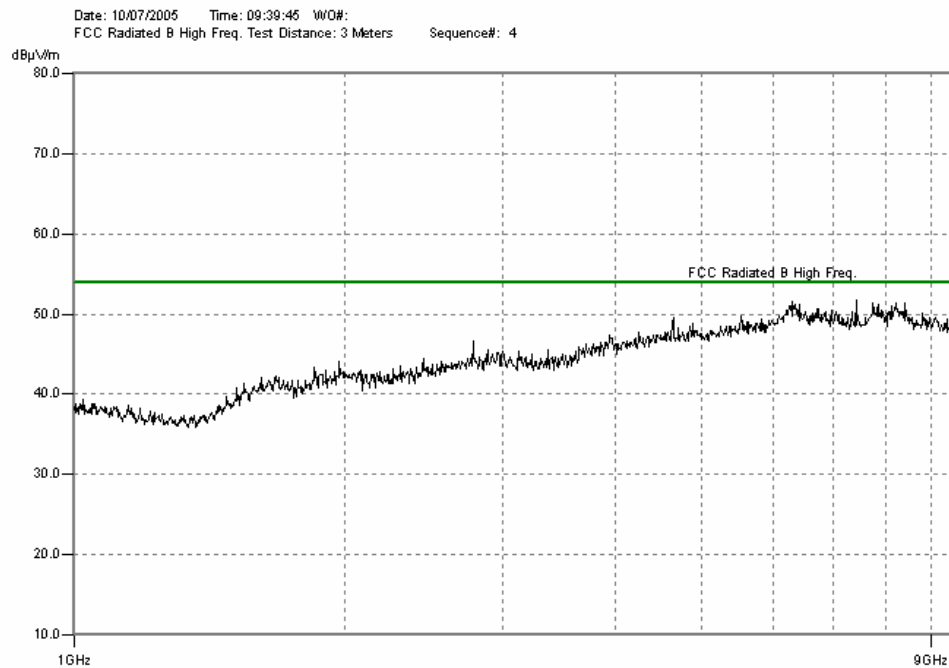
VERTICAL MID CHANNEL



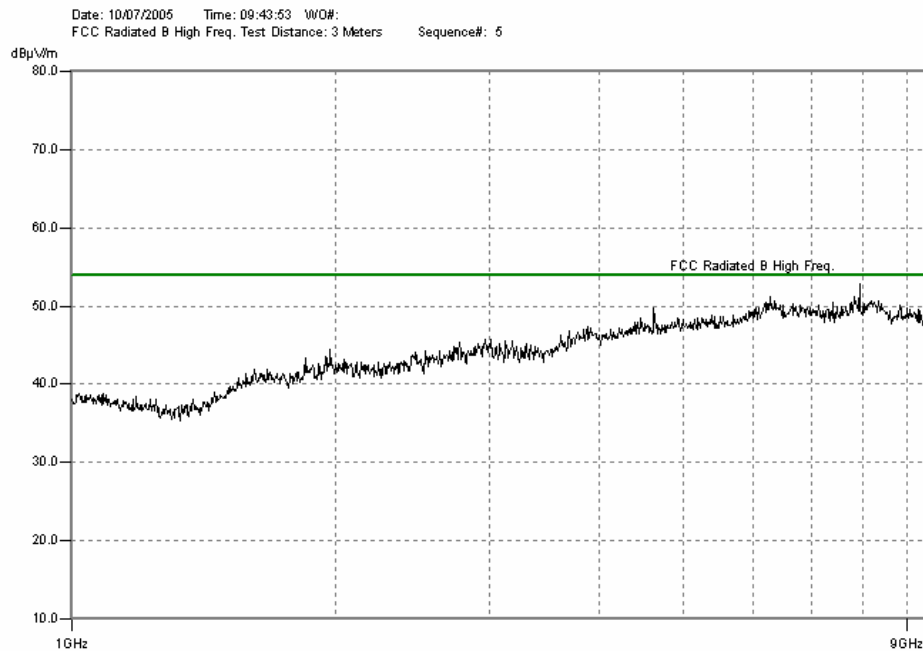
VERTICAL LOW CHANNEL



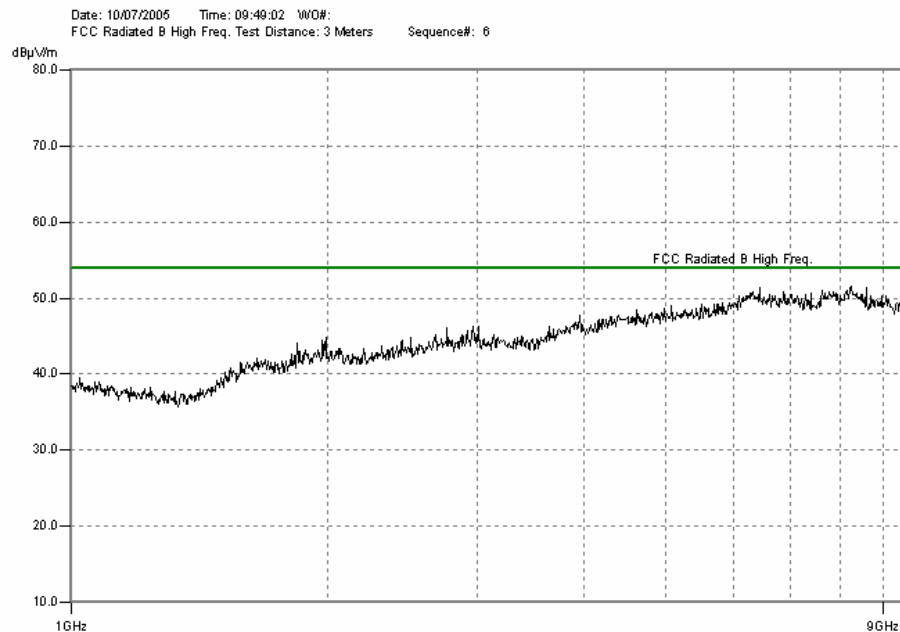
HORIZONTAL HIGH CHANNEL



HORIZONTAL MID CHANNEL

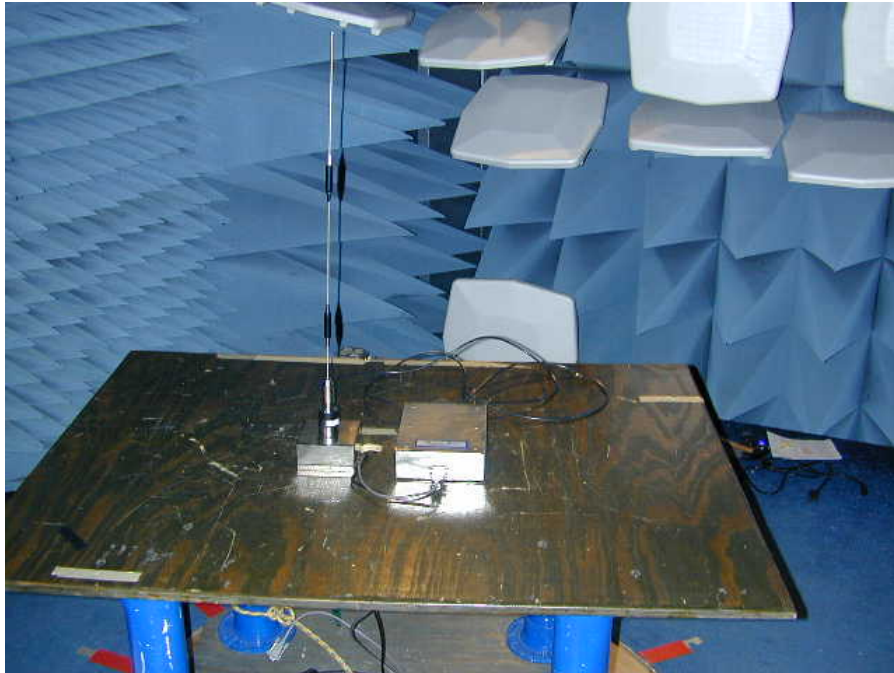


HORIZONTAL LOW CHANNEL

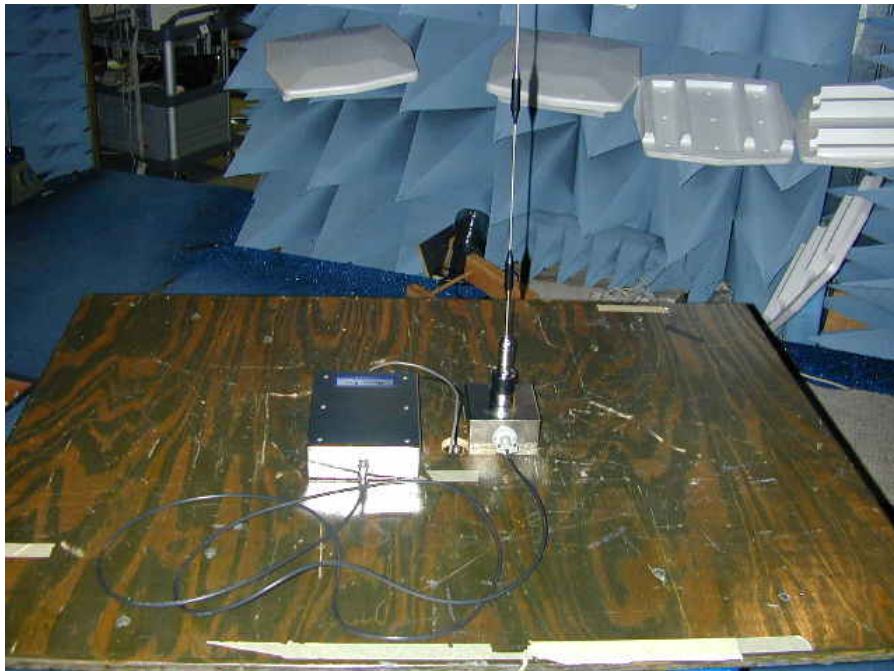


Radiated Photographs

FRONT VIEW



REAR VIEW



Section 9. Test Equipment List

Nemko ID	Description	Manufacturer	Serial Number	Calibration Date	Calibration Due
		Model Number			
1472	20db Attenuator DC 18 Ghz	Omni Spectra 20600-20db	NONE	CBU	N/A
1464	Spectrum analyzer	Hewlett Packard 8563E	3551A04428	01/15/07	01/15/07
1081	CABLE 2m	Astrolab 32027-2-29094-72TC	N/A	CBU	N/A
1471	10 db Attenuator DC 18 Ghz	MCL Inc. BW-S10W2 10db-2WDC	NONE	CBU	N/A
1659	Spectrum Analyzer	Rhode & Schwarz FSP	973353	10/02/03	10/02/05
993	Horn antenna	A.H. Systems SAS-200/571	XXX	08/01/05	08/01/07
1484	Cable 2.0-18.0 Ghz	Storm PR90-010-072	N/A	09/18/05	09/18/06
1485	Cable 2.0-18.0 Ghz	Storm PR90-010-216	N/A	09/18/05	09/18/06
1016	Pre-Amp	HEWLETT PACKARD 8449A	2749A00159	11/12/04	11/12/05
791	PREAMP, 25dB	ICC LNA25	398	11/12/04	11/12/05
760	Antenna biconical	Electro Metrics MFC-25	477	01/23/05	01/23/06
759	ANTENNA, LOG PERIODIC	A.H. SYSTEMS SAS-200/510	556	01/23/05	01/23/06
1481	Microwave Highpass Filter	K & L 3DH1-2000/T8000-0/0	4	Cal B4 Use	N/A

Nemko USA

FCC PART 15, SUBPART C

FREQUENCY HOPPING SPREAD SPECTRUM TRANSMITTER

EQUIPMENT: COLLECTOR-M

PROJECT NO.: 5L0469RUS1

ANNEX A - TEST DETAILS

Nemko USA

FCC PART 15, SUBPART C

FREQUENCY HOPPING SPREAD SPECTRUM TRANSMITTER

EQUIPMENT: COLLECTOR-M

PROJECT NO.: 5L0469RUS1

NAME OF TEST: Channel Separation	PARA. NO.: 15.247(a)(1)
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Minimum Standard:

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.

NAME OF TEST: Time of Occupancy

PARA. NO.: 15.247(a)(1)(ii)

Minimum Standard:

Frequency Band (MHz)	20 dB Bandwidth	No. of Hopping Channels	Average Time of Occupancy
902 - 928	<250 kHz	50	=<0.4 sec. in 20 sec.
902 - 928	=>250 kHz	25	=<0.4 sec. in 10 sec.
2400 - 2483.5	-----	75	=<0.4 sec. in 30 sec.
5725 - 5850	-----	75	=<0.4 sec. in 30 sec.

Method Of Measurement:

The spectrum analyzer is set as follows:

RBW: 1 MHz

VBW: = RBW

Span: 0 Hz

LOG dB/div.: 10 dB

Sweep: Sufficient to see one hop time sequence.

Trigger: Video

The occupancy time of one hop is measured as above. The average time of occupancy is calculated over the appropriate period of time from above table (10, 20, or 30 seconds).

Avg. time of occupancy = (period from table/duration of one hop)/no. of channels multiplied by the duration of one hop.

For instance:

If a 2.4 GHz system has a measured hop duration time of 1 msec. and uses 75 channels, then the average time of occupancy would be:

$(30 \text{ sec.} / .001 \text{ sec.}) / 75 \text{ chan.} = 400 \times 1 \text{ msec.} = 400 \text{ msec. or } 0.4 \text{ sec. in } 30 \text{ sec.}$

NAME OF TEST: Occupied Bandwidth

PARA. NO.: 15.247(a)(2)

Minimum Standard:

Frequency Band (MHz)	Maximum 20 dB Bandwidth
902 - 928	500 kHz
2400 – 2483.5	1 MHz
5725 – 5850	1 MHz

Method Of Measurement:

The spectrum analyzer is set as follows:

RBW: At least 1% of span/div.

VBW: >RBW

Span: Sufficient to display 20 dB bandwidth

LOG dB/div.: 10 dB

Sweep: Auto

Number of channels tested:

Tuning range	Number of channels tested	Channel location in band
1 MHz or less	1	middle
1 to 10 MHz	2	top and bottom
more than 10 MHz	3	top, middle, bottom

NAME OF TEST: Peak Power Output

PARA. NO.: 15.247(b)

Minimum Standard:

Frequency Band (MHz)	No. of Hopping Channels	Maximum Peak Power Output at Antenna Port
902 - 928	at least 50	1 watt
902 – 928	25 - 49	0.25 watts
2400 – 2483.5	75	1 watt
5725 – 5850	75	1 watt

If transmitting antennas of directional gain greater than 6 dBi are used, the power shall be reduced by the amount in dB that the directional gain of the antenna exceeds 6 dBi.

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

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

Direct Measurement Method For Detachable Antennas:

If the antenna is detachable, a peak power meter is used to measure the power output with the transmitter operating into a 50 ohm load. The dBi gain of the antenna(s) employed shall be reported.

Calculation Of EIRP For Integral Antenna:

If the antenna is not detachable from the circuit then the Peak Power Output is derived from the peak radiated field strength of the fundamental emission by using the plane wave relation $GP/4\pi R^2 = E^2/120\pi$ and proceeding as follows:

$$P = \frac{E^2 R^2}{30G} = \frac{E^2 3^2}{30G}$$

where,

P = the equivalent isotropic radiated power in watts

E = the maximum measured field strength in V/m

R = the measurement range (3 meters)

G = the numeric gain of the transmit antenna in relation to an isotropic radiator

The RBW of the spectrum analyzer shall be set to a value greater than the measured 20 dB occupied bandwidth of the E.U.T.

Number of channels tested:

Tuning range	Number of channels tested	Channel location in band
1 MHz or less	1	middle
1 to 10 MHz	2	top and bottom
more than 10 MHz	3	top, middle, bottom

NAME OF TEST: Spurious Emissions at Antenna Terminals	PARA. NO.: 15.247(c)
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Minimum Standard:

In any 100kHz bandwidth outside the frequency band in which the transmitter is operating, emissions shall be at least 20 dB below the fundamental emission or shall not exceed the following field strength limits. Emissions falling in the restricted bands of 15.205 shall not exceed the following field strength limits:

Frequency (MHz)	Field Strength ($\mu\text{V/m}$ @ 3m)	Field Strength (dB @ 3m)
30 - 88	100	40.0
88 - 216	150	43.5
216 - 960	200	46.0
Above 960	500	54.0

THE SPECTRUM WAS SEARCHED TO THE 10th HARMONIC**Method Of Measurement:**30 MHz - 10th harmonic plot

RBW: 100 kHz

VBW: 300 kHz

Sweep: Auto

Display line: -20 dBc

Lower Band Edge

RBW: At least 1% of span/div.

VBW: >RBW

Span: As necessary to display any spurious at band edge.

Sweep: Auto

Center Frequency: 902 MHz, 2400 MHz, or 5725 MHz

Marker: Peak of fundamental emission

Marker Δ : Peak of highest spurious level below center frequency.Upper Band Edge

RBW: At least 1% of span/div.

VBW: >RBW

Span: As necessary to display any spurious at band edge.

Sweep: Auto

Center Frequency: 928 MHz, 2483.5 MHz, or 5850 MHz

Marker: Peak of fundamental emission

Marker Δ : Peak of highest spurious level above center frequency.

Number of channels tested:

Tuning range	Number of channels tested	Channel location in band
1 MHz or less	1	middle
1 to 10 MHz	2	top and bottom
more than 10 MHz	3	top, middle, bottom

NAME OF TEST: Radiated Spurious Emissions

PARA. NO.: 15.247(c)

Minimum Standard: In any 100kHz bandwidth outside the frequency band in which the transmitter is operating, emissions shall be at least 20 dB below the fundamental emission or shall not exceed the following field strength limits:

Emissions falling in the restricted bands of 15.205 shall not exceed the following field strength limits:

Frequency (MHz)	Field Strength ($\mu\text{V/m}$ @ 3m)	Field Strength (dB @ 3m)
30 - 88	100	40.0
88 - 216	150	43.5
216 - 960	200	46.0
Above 960	500	54.0

THE SPECTRUM WAS SEARCHED TO THE 10th HARMONIC

15.205 Restricted Bands

MHz	MHz	MHz	GHz
0.09-0.11	16.42-16.423	399.9-410	4.5-5.25
0.495-0.505	16.69475-16.69525	608-614	5.35-5.46
2.1735-2.1905	16.80425-16.80475	960-1240	7.25-7.75
4.125-4.128	25.5-25.67	1300-1427	8.025-8.5
4.17725-4.17775	37.5-38.25	1435-1626.5	9.0-9.2
4.20725-4.20775	73-74.6	1645.5-1646.5	9.3-9.5
6.125-6.218	74.8-75.2	1660-1710	10.6-12.7
6.26775-6.26825	108-121.94	1718.8-1722.2	13.25-13.4
6.31175-6.31225	123-138	2200-2300	14.47-14.5
8.291-8.294	149.9-150.05	2310-2390	15.35-16.2
8.362-8.366	156.52475-156.52525	2483.5-2500	17.7-21.4
8.37625-8.38675	156.7-156.9	2655-2900	22.01-23.12
8.41425-8.41475	162.0125-167.17	3260-3267	23.6-24.0
12.29-12.293	167.72-173.2	3332-3339	31.2-31.8
12.51975-12.52025	240-285	3345.8-3358	36.43-36.5
12.57675-12.57725	322-335.4	3600-4400	Above 38.6
13.36-13.41	1718		

Number of channels tested:

Tuning range	Number of channels tested	Channel location in band
1 MHz or less	1	middle
1 to 10 MHz	2	top and bottom
more than 10 MHz	3	top, middle, bottom

Nemko USA

FCC PART 15, SUBPART C

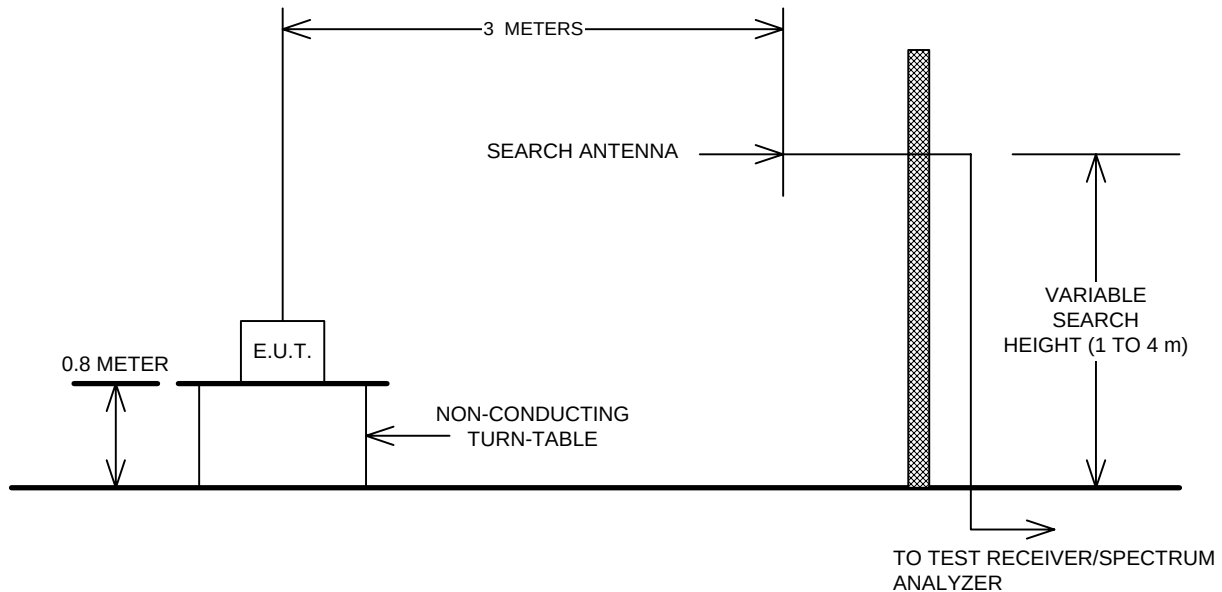
FREQUENCY HOPPING SPREAD SPECTRUM TRANSMITTER

EQUIPMENT: COLLECTOR-M

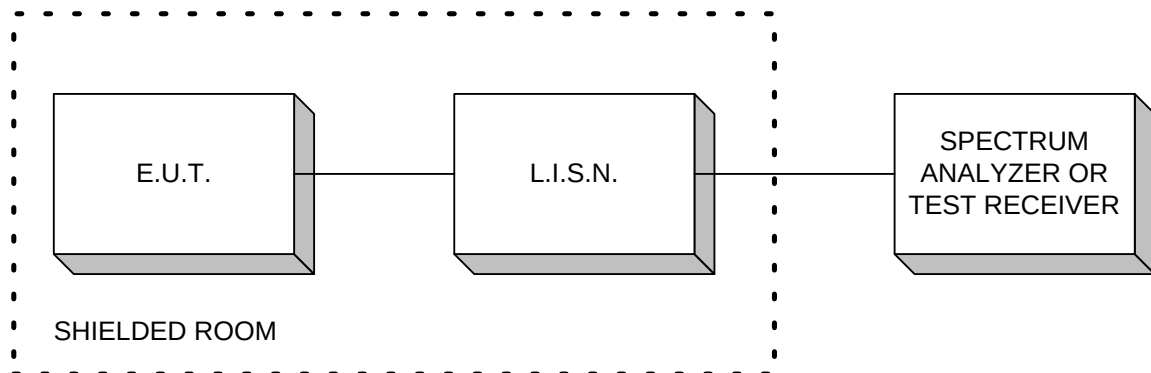
PROJECT NO.: 5L0469RUS1

ANNEX B - TEST DIAGRAMS

Test Site For Radiated Emissions



Conducted Emissions



Peak Power At Antenna Terminals

