



**Nemko Test Report:** 2014\_272453\_FCC\_15247 rev2

**Applicant:** HM Electronics, Inc.  
14110 Stowe Drive  
Poway, CA 92064  
USA


**Equipment Under Test:  
(E.U.T.)** 1404

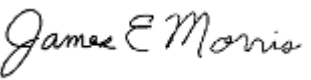
**FCC Identifier:** BYM1404

**IC Identifier:** 1860A-1404

**In Accordance With:** **FCC Part 15, Subpart C, 15.247 and  
Industry Canada RSS-210, Issue 8**  
Frequency Hopping Transmitters

**Tested By:** Nemko USA, Inc.  
2210 Faraday Ave. Ste 150  
Carlsbad, CA 92008  
USA

**TESTED BY:**   
David Light, Wireless Engineer **DATE:** 14 November 2014

**APPROVED BY:**   
Jim Morris, EMC Manager **DATE:** December 10, 2014

**Total Number of Pages: 38**

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**Section 1. Summary of Test Results**

Manufacturer: HM Electronics, Inc.

Model No.: 1404

Serial No.: None

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 and Industry Canada RSS-210, Issue 8 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 and Industry Canada.

- |                                     |                            |                                     |                     |
|-------------------------------------|----------------------------|-------------------------------------|---------------------|
| <input checked="" type="checkbox"/> | New Submission             | <input checked="" type="checkbox"/> | Production Unit     |
| <input type="checkbox"/>            | Class II Permissive Change | <input type="checkbox"/>            | 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 200116-0

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**Summary Of Test Data**

<b>NAME OF TEST</b>	<b>PARA. NO.</b>	<b>RESULT</b>
Powerline Conducted Emissions	15.207(a) / RSS-Gen 7.2.4	NA
Channel Separation	15.247(a)(1) / RSS-210 A8.1(b)	Complies
Time of Occupancy	15.247(a)(1) / RSS-210 A8.1(d)	Complies
20 dB Occupied Bandwidth	15.247(a)(1) / RSS-210 A8.1(a)	Complies
Peak Power Output	15.247(b) / RSS-210 A8.4(2)	Complies
Spurious Emissions (Conducted)	15.247(d) / RSS-210 A8.5	Complies
Spurious Emissions (Radiated)	15.247(d) / RSS-Gen 7.2.2	Complies

**Footnotes:**

The EUT is powered by a 3.7 V lithium battery.

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

### **General Equipment Information**

**Frequency Band:**  902 – 928 MHz  
 2400 – 2483.5 MHz  
 5725 – 5850 MHz

**Operating Frequency Range:** 2401.92 to 2481.408 MHz

**Number of Channels:** 47

**Channel Spacing:** 1.72 MHz

**User Frequency Adjustment:** Software controlled

**Software Version:** Ver. 2.10

### **Description of EUT**

The 1404 is a 2.4 GHz FHSS wireless belt worn transceiver designed to operate with a base station transceiver.

**Section 3. Channel Separation**

NAME OF TEST: Channel Separation	PARA. NO.: 15.247(a)(1)
TESTED BY: David Light	DATE: 05 Nov. 2014

**Test Results:** Complies.

**Measurement Data:** See 20 dB BW plot

Measured 20 dB bandwidth: 1.28 MHz

Channel Separation: 1.72 MHz

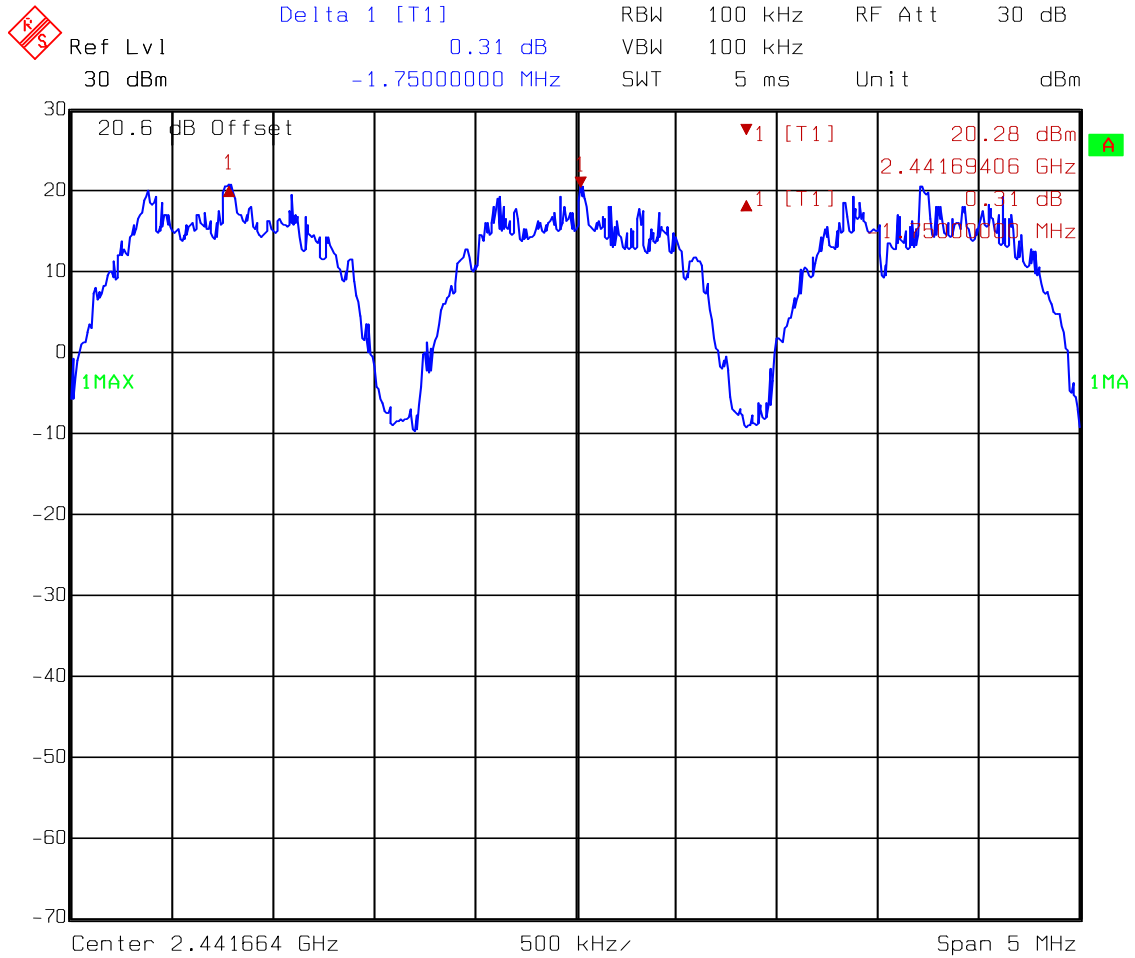
**Equipment Used:** 1036

**Measurement Uncertainty:**  $1 \times 10^{-7}$  ppm

**Temperature:** 20 °C

**Relative Humidity:** 30 %

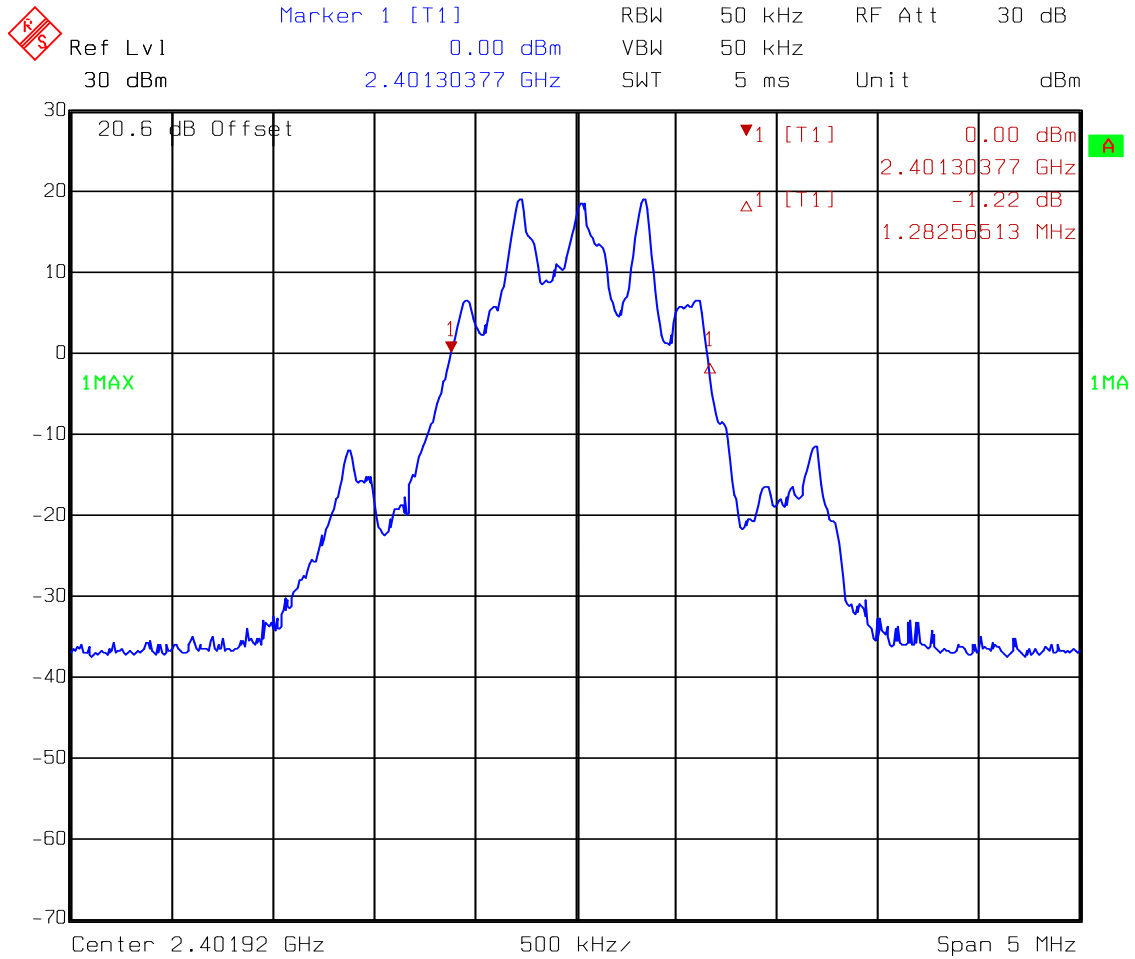
Test Data – Channel Separation



Date: 05.NOV.2014 09:46:59

Test Data – 20 dB Bandwidth

Low Channel

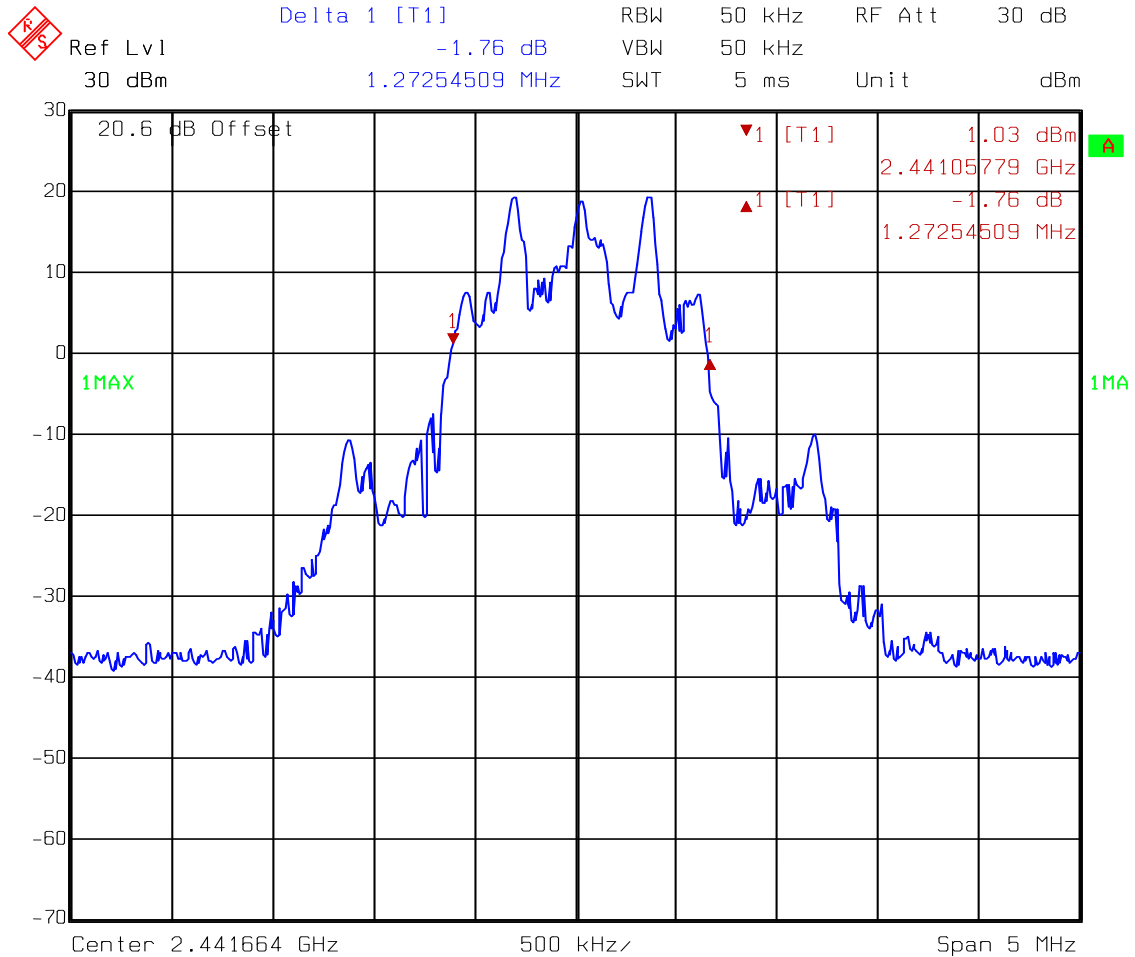


Date: 05.NOV.2014 08:40:59



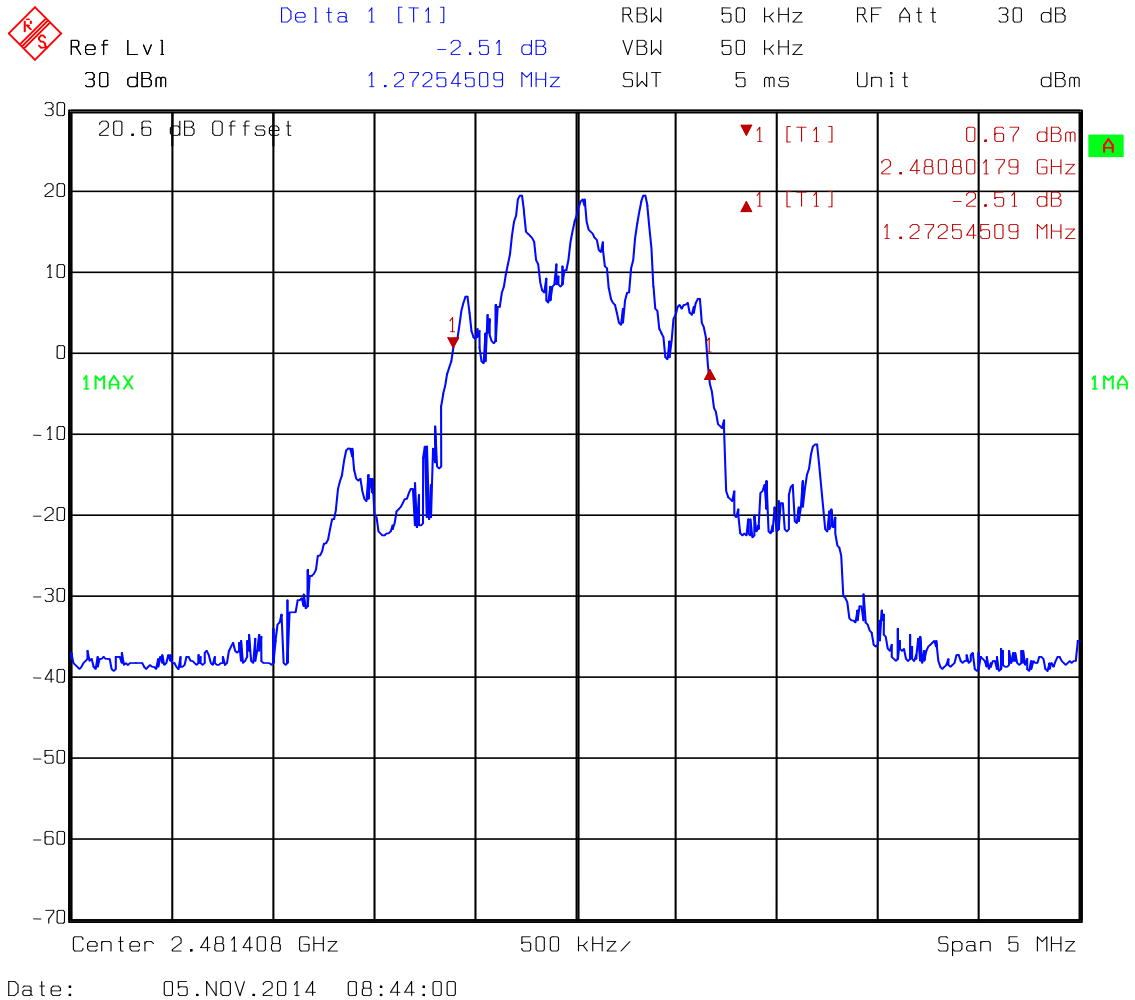
**Test Data – 20 dB Bandwidth**

Mid Channel



Date: 05.NOV.2014 08:42:36

**Test Data – 20 dB Bandwidth**  
High Channel



**Section 4. Time of Occupancy**

NAME OF TEST: Time of Occupancy	PARA. NO.: 15.247(a)(1)
TESTED BY: David Light	DATE: 05 Nov. 2014

**Test Results:** Complies.

**Measurement Data:**

Maximum Dwell Time On Any Channel: 16.64 ms in 19 seconds

**Equipment Used:** 1036

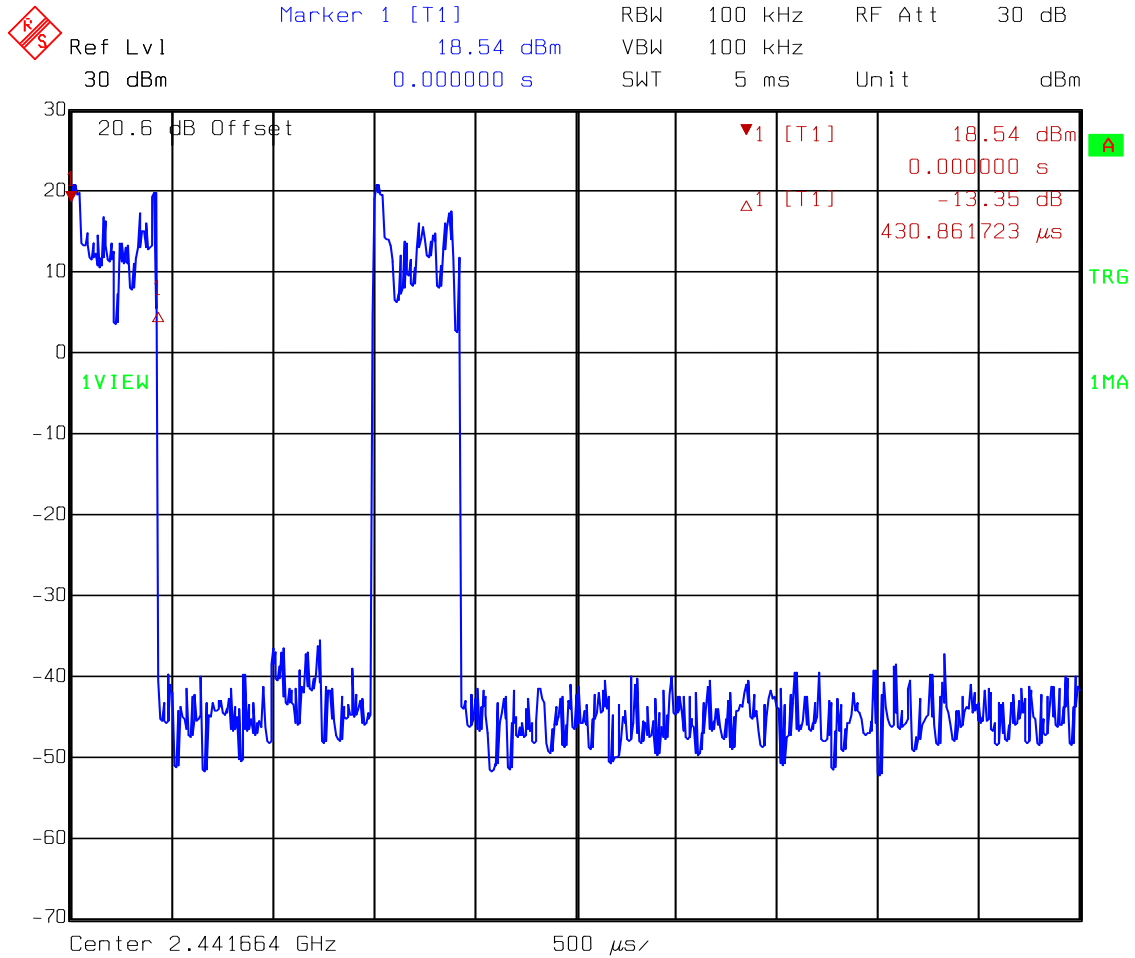
**Measurement Uncertainty:** 1X10<sup>-7</sup>ppm

**Temperature:** 20 °C

**Relative Humidity:** 30 %

**Test Data – Time of Occupancy**

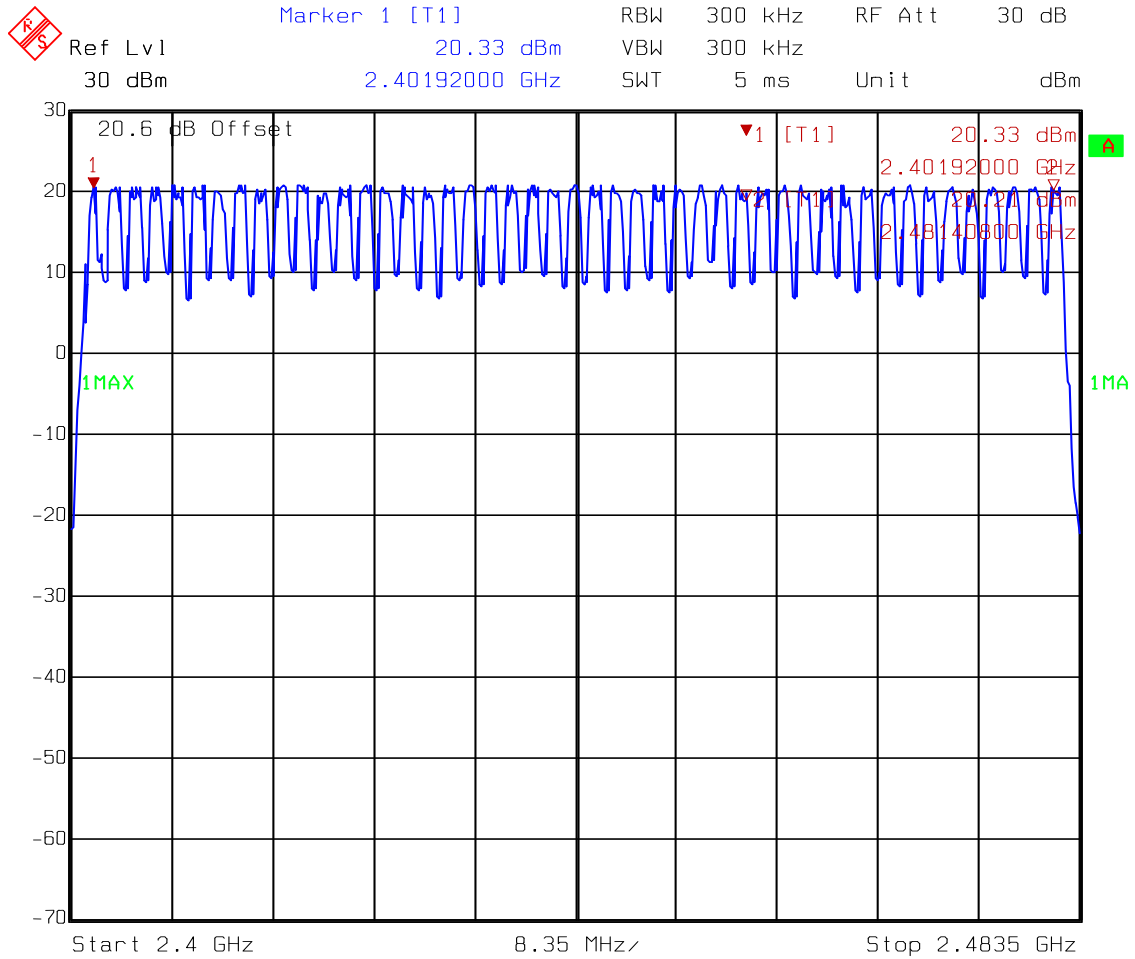
Hop time =  $431 \mu\text{s} \times 2 = 862 \mu\text{s}$



Date: 05.NOV.2014 09:25:49

Test Data – Time of Occupancy

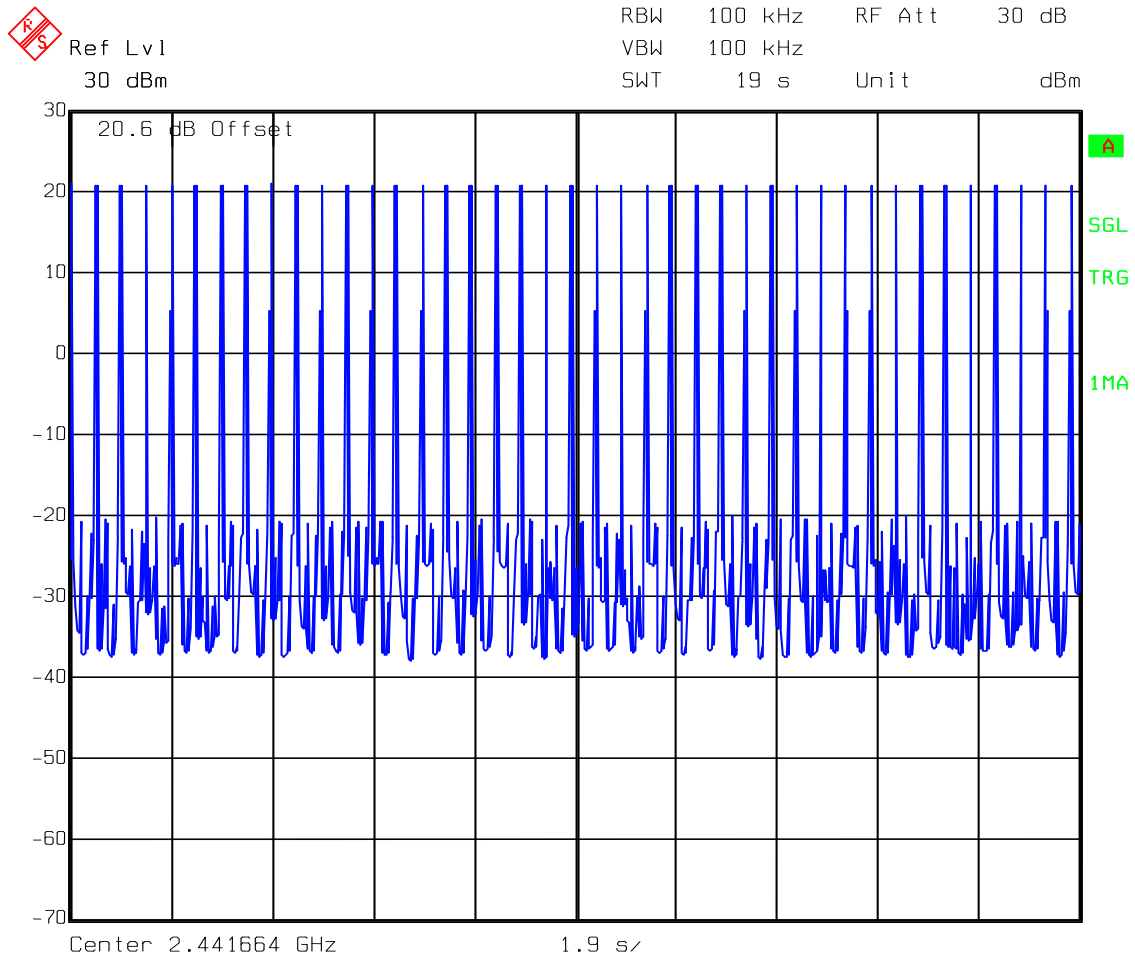
47 Hopping channels



Date: 05.NOV.2014 09:22:18

Test Data – Time of Occupancy

41 x 862  $\mu$ s = 35.3 ms



Date: 05.NOV.2014 09:29:39

**Section 5. Peak Power Output**

NAME OF TEST: Peak Power Output	PARA. NO.: 15.247 (b)
TESTED BY: David Light	DATE: 5 Nov. 2014

**Test Results:** Complies.

**Measurement Data:** See attached plots.  
Detachable antenna?  Yes  No

Frequency (MHz)	Peak Power (dBm)	Peak Power (mW)	Antenna Type	Gain (dBi)	E.I.R.P. (dBm)	E.I.R.P. (mW)
2401.9	19.0	79.4	Inverted F	2.0	21.0	125.9
2441.6	19.4	87.1	Inverted F	2.0	21.4	138.0
2481.4	19.4	87.1	Inverted F	2.0	21.4	138.0
Maximum EIRP (W): 0.138						

- This device was tested at +/- 15% input power per 15.31(e), with no variation in output power.
- For battery powered equipment, the device was tested with a fresh battery per 15.31(e).
- The device was tested on three channels per 15.31(l).
- This test was performed radiated.

**Equipment Used:** 1036

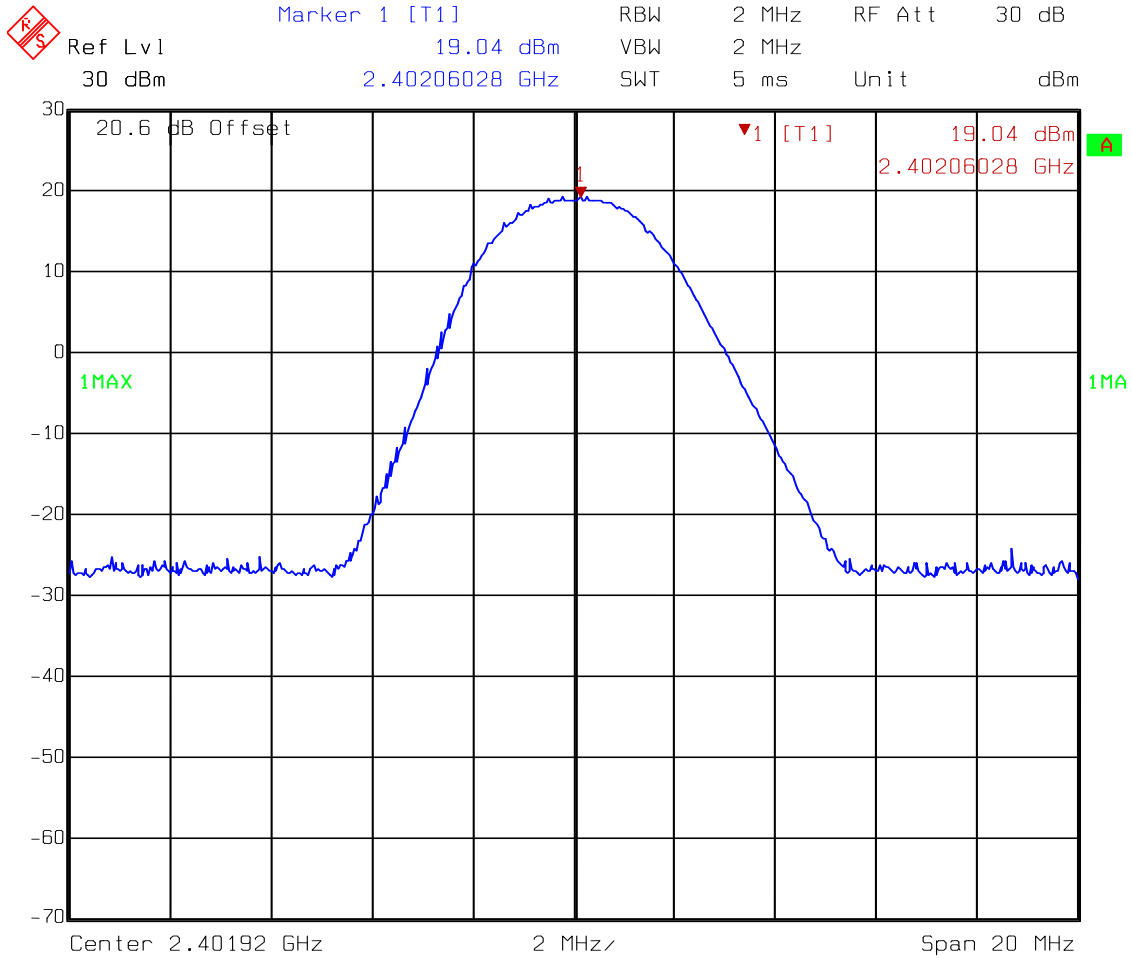
**Measurement Uncertainty:** 1.7 dB

**Temperature:** 20 °C

**Relative Humidity:** 30 %

**Detector Function = PEAK**

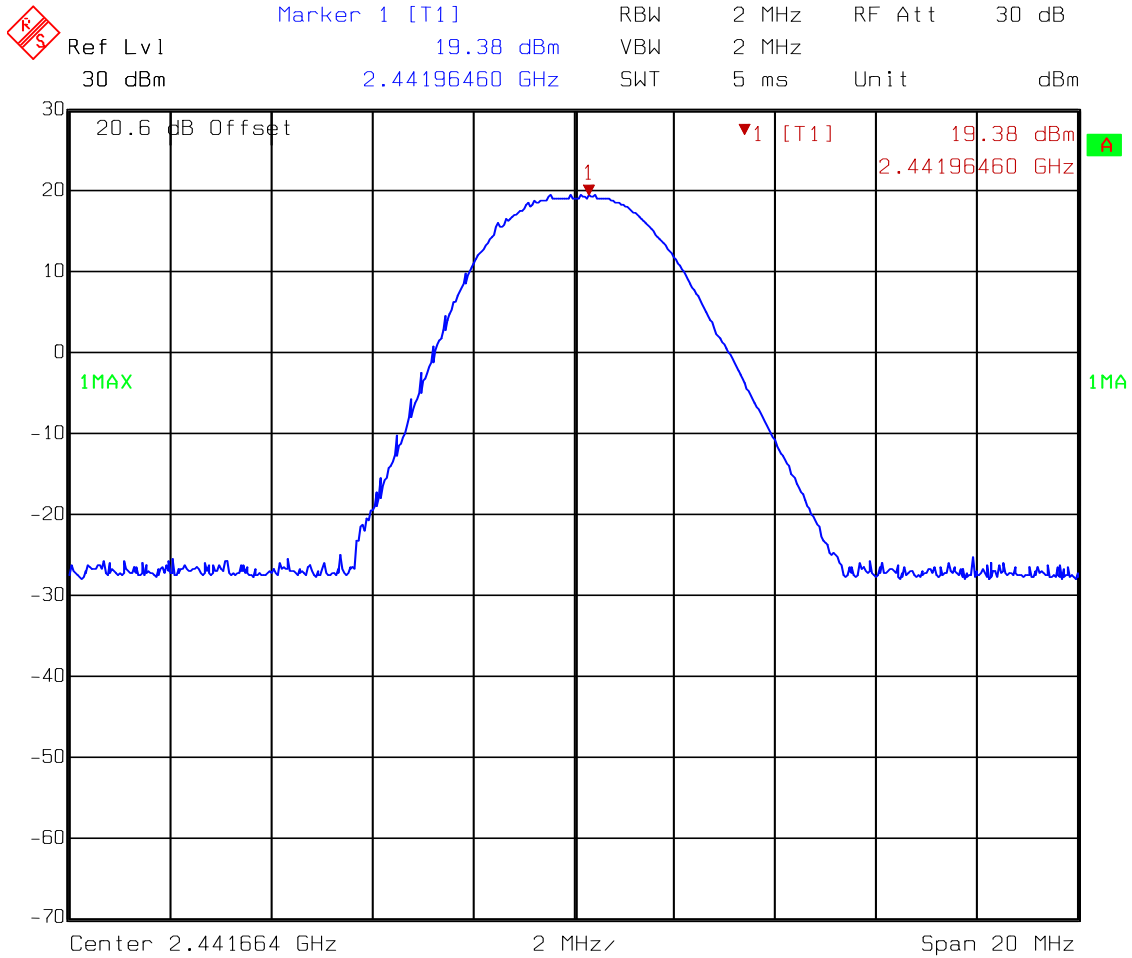
Test Data – Peak Power Output



Date: 05.NOV.2014 08:49:00

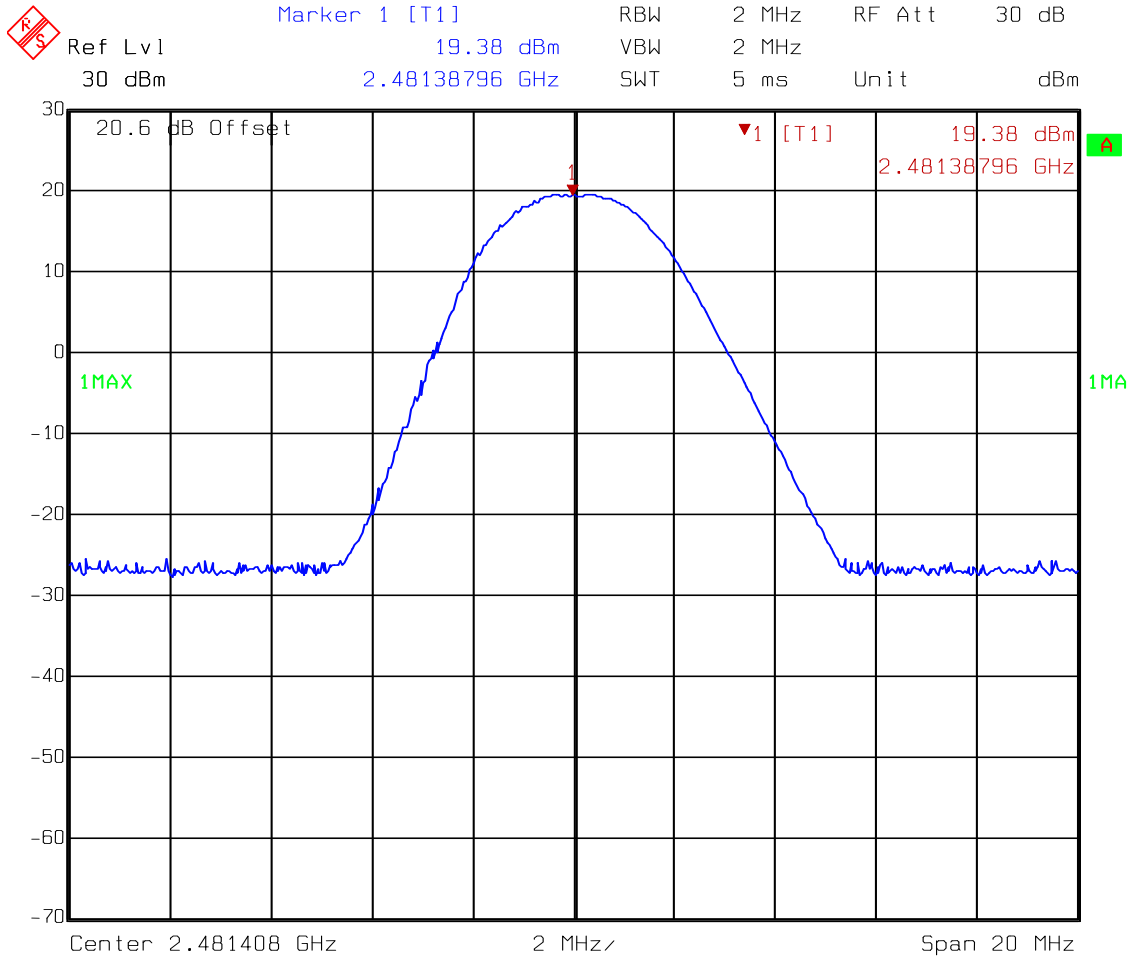


Test Data – Peak Power Output



Date: 05.NOV.2014 08:46:00

Test Data – Peak Power Output



Date: 05.NOV.2014 08:45:16

**Section 6. Spurious Emissions (Conducted)**

NAME OF TEST: Spurious Emissions (Conducted)	PARA. NO.: 15.247(d)
TESTED BY: David Light	DATE: 05 Nov. 2014

**Test Results:** Complies.

**Measurement Data:** See attached plots.

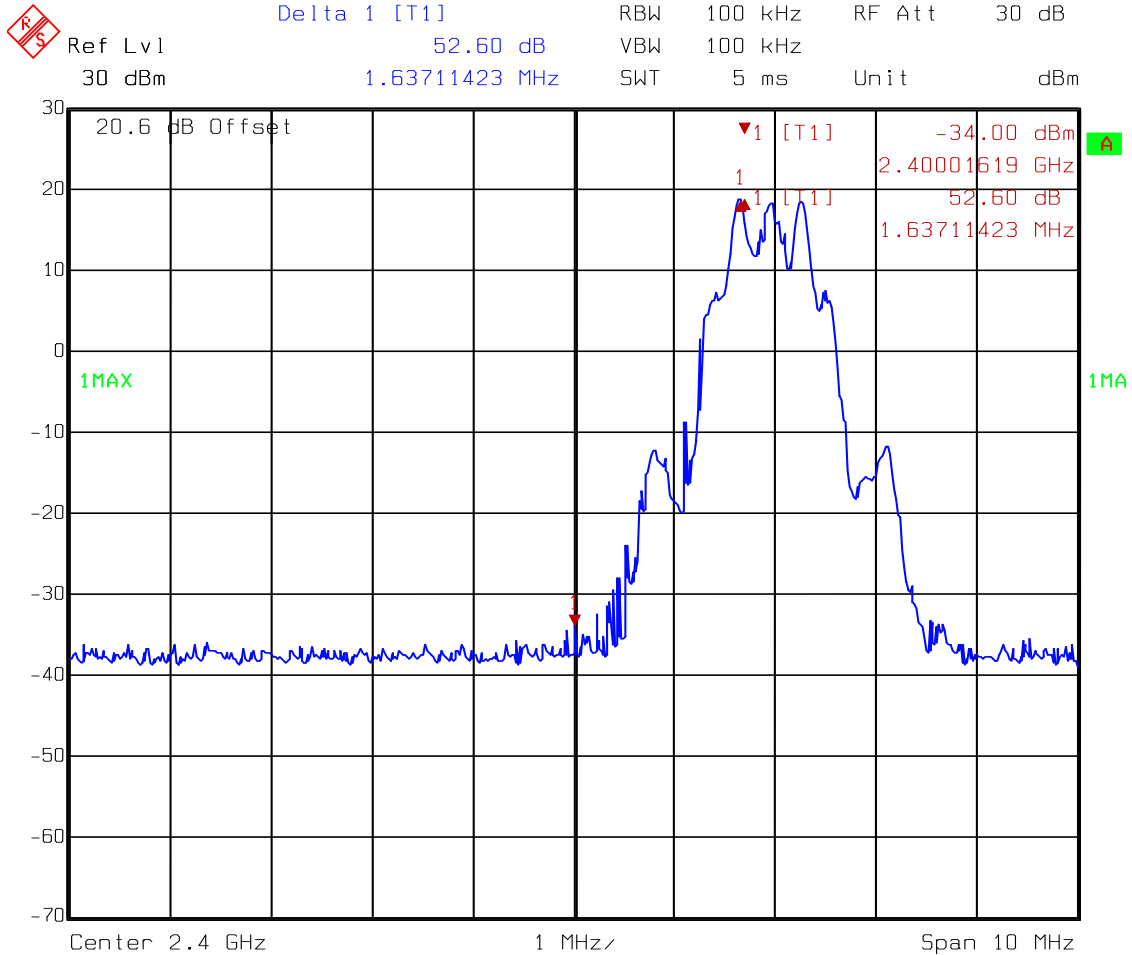
**Equipment Used:** 1036

**Measurement Uncertainty:** 1X10<sup>-7</sup>ppm

**Temperature:** 20 °C

**Relative Humidity:** 30 %

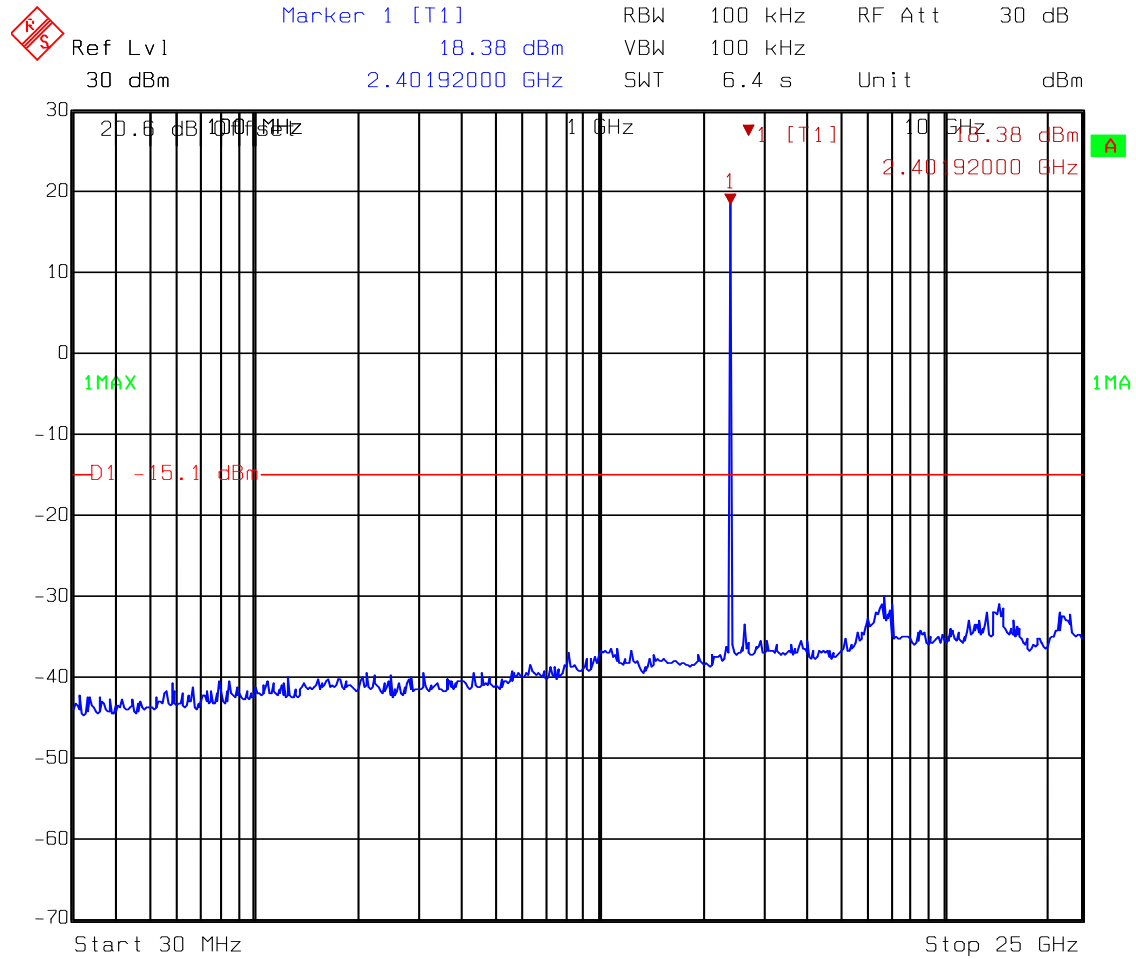
**Test Data – Spurious Emissions at Antenna Terminals**  
Lower Band Edge



Date: 05.NOV.2014 08:51:19

Test Data – Spurious Emissions at Antenna Terminals

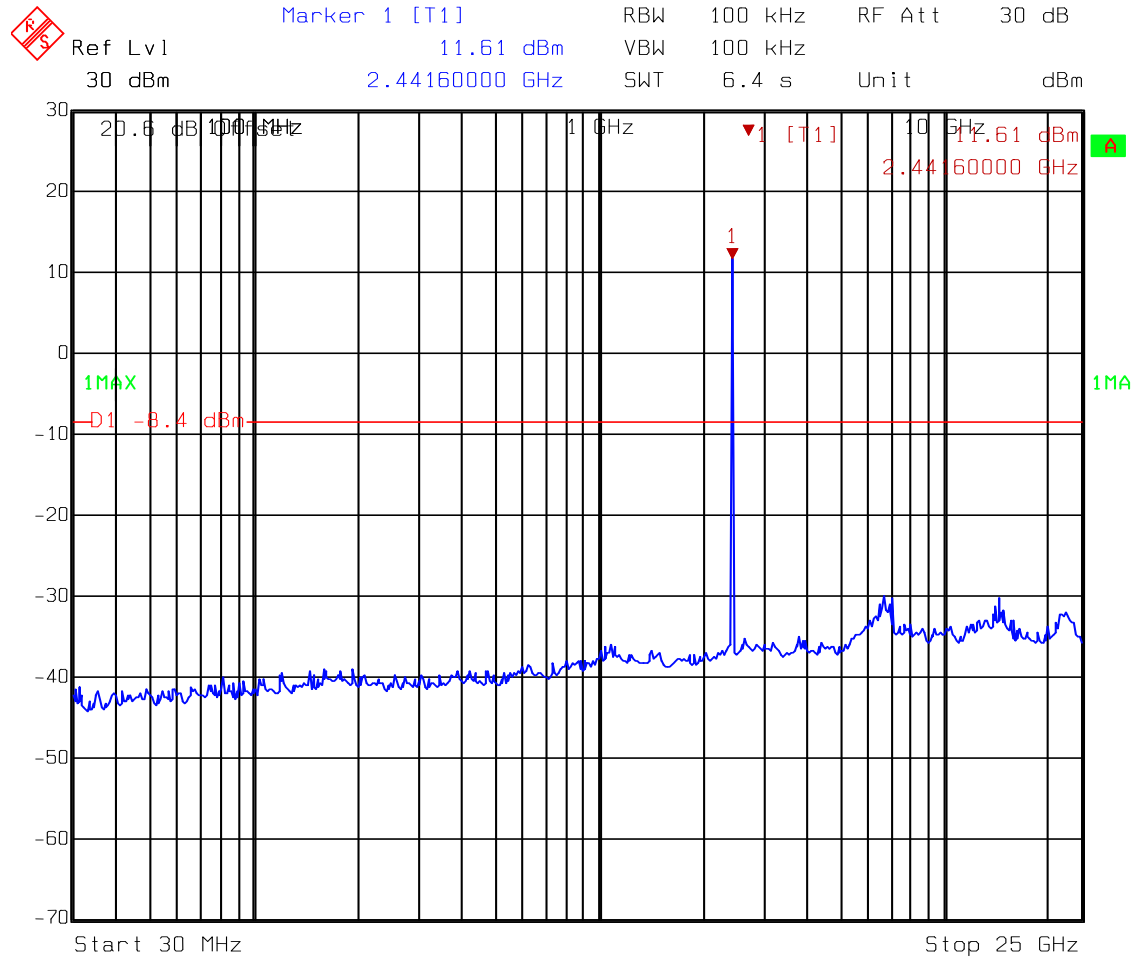
Spurs – Low Channel



Date: 05.NOV.2014 08:53:43

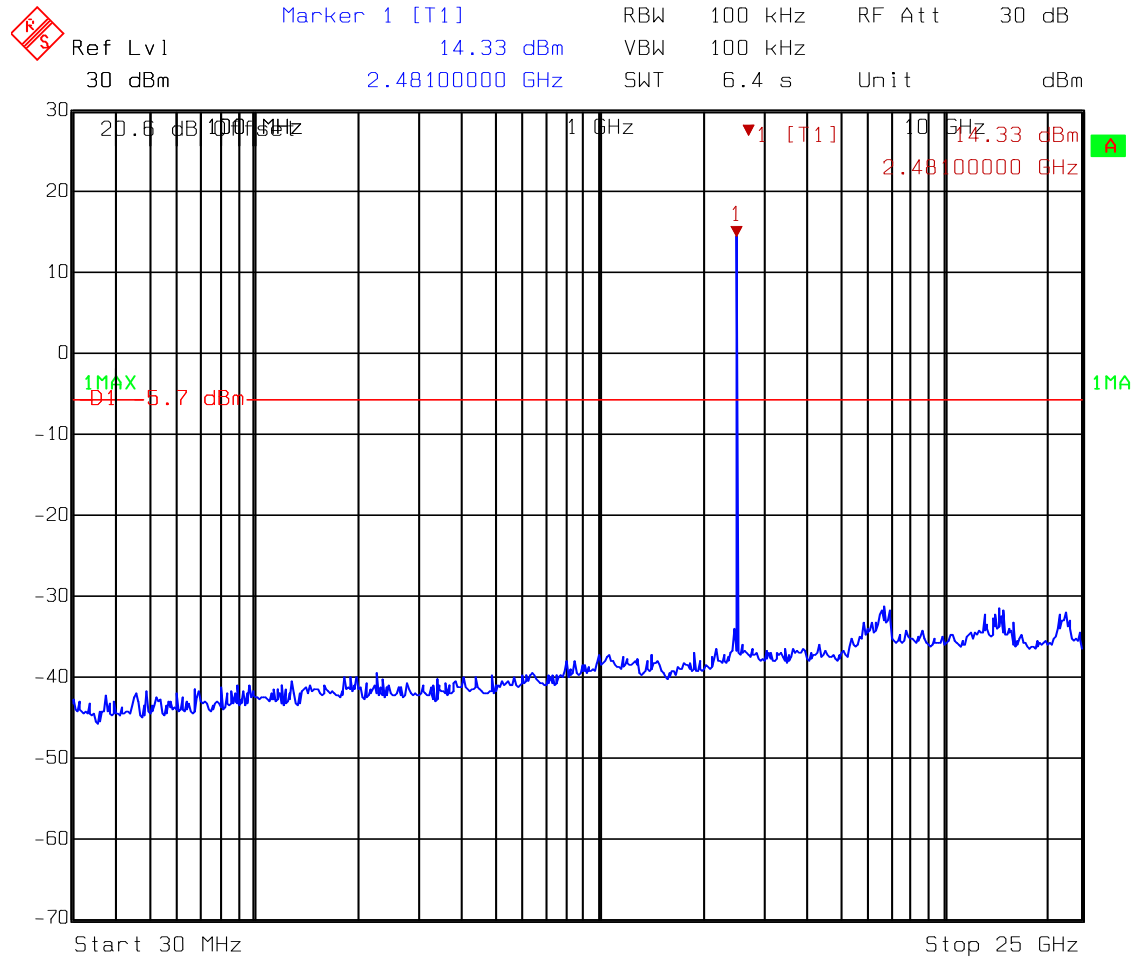
Test Data – Spurious Emissions at Antenna Terminals

Spurs – Mid Channel



Date: 05.NOV.2014 08:59:40

**Test Data – Spurious Emissions at Antenna Terminals**  
Spurs – High Channel



Date: 05.NOV.2014 09:00:54

### Section 7. Spurious Emissions (Radiated)

NAME OF TEST: Spurious Emissions (Radiated)	PARA. NO.: 15.247(d)
TESTED BY: David Light	DATE: 05 Nov. 2014

**Test Results:** Complies. The worst case emission was 51.5 dBµV/m at 2483.5 MHz. This is 2.5 dB below the specification limit of 54 dBµV/m.

**Measurement Data:** See attached table.

**Duty Cycle Calculation:**

Duty Cycle correction factor(dB) = 20 log (rf<sub>ON</sub> in ms/100ms)

Notes:

- For handheld devices, the EUT was tested on three orthogonal axis'
- The device was tested from 30 MHz to the tenth harmonic of the highest fundamental frequency per 15.33
- The device was tested on three channels per 15.31(l).
- No emissions were detected within 20 dB of the specification limit therefore none are reported per 15.31(o). Band edge data is presented below.

**Equipment Used:** E1029-529-1480-1036

**Measurement Uncertainty:** +/-3.6 dB

**Temperature:** 21 °C

**Relative Humidity:** 28 %

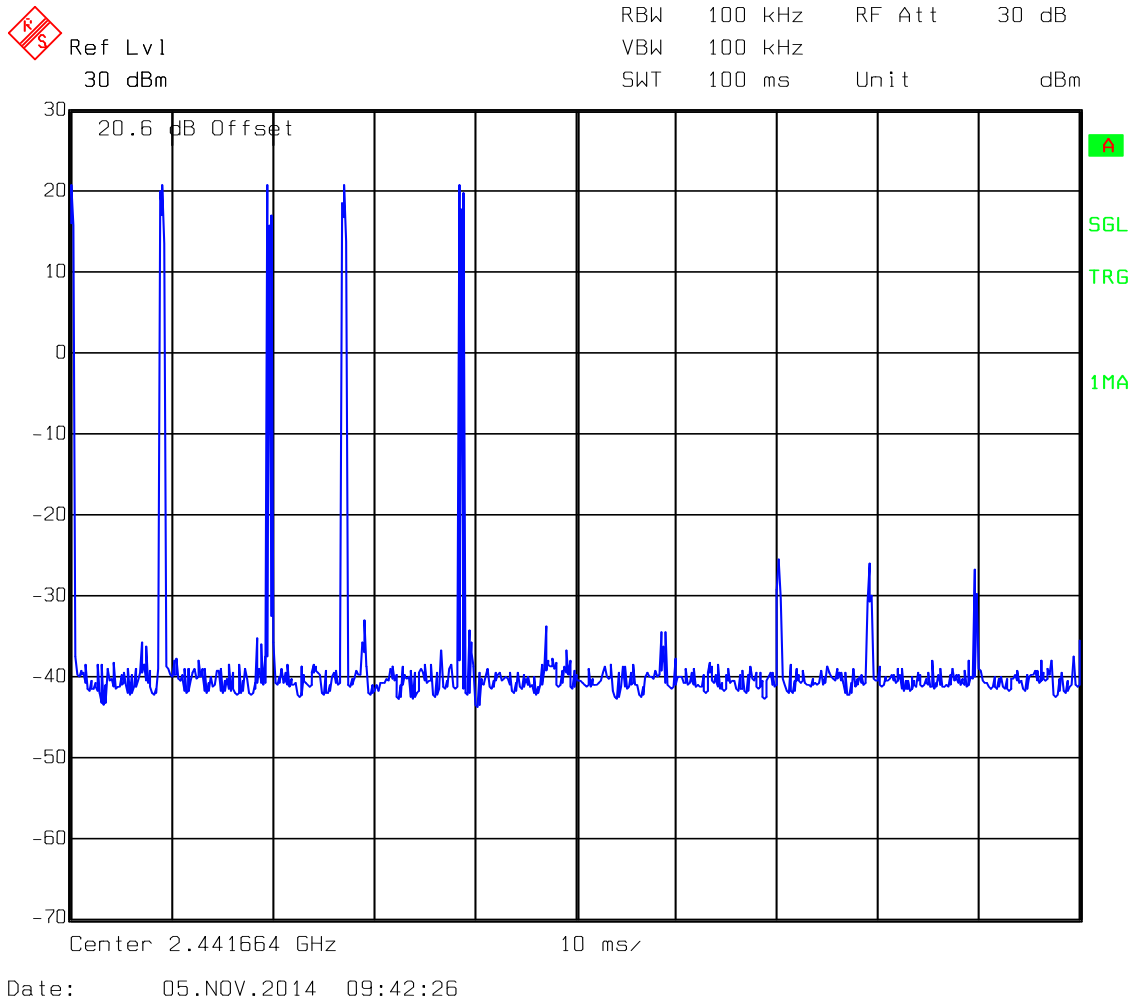


**Test Data - Radiated Emissions**

Meas. Freq. (MHz)	Ant. Pol. (H/V)	Duty Cycle (dB)	Meter Reading (dBuV)	Antenna Factor (dB)	Path Loss (dB)	RF Gain (dB)	Corrected Reading (dBuV/m)	Spec. limit (dBuV/m)	CR/SL Diff. (dB)	Pass Fail Unc.	Comment
											Highest channel
2483.500	H	0.0	30.1	28.7	9.4	0.0	68.2	74.0	-5.8	Pass	
2483.500	H	-20.0	30.1	28.7	9.4	0.0	48.2	54.0	-5.8	Pass	
2483.500	V	0.0	33.4	28.7	9.4	0.0	71.5	74.0	-2.5	Pass	
2483.500	V	-20.0	33.4	28.7	9.4	0.0	51.5	54.0	-2.5	Pass	

Test Data - Radiated Emissions

Transmit time in 100 mS (For duty cycle calculation)



$862 \mu\text{s} \times 5 = 4.31 \text{ ms}$

$\text{Duty Cycle} = 20 \log (4.31/100) = -27.3 \text{ dB}$

**Section 8. Test Equipment List**

<b>Asset</b>	<b>Description</b>	<b>Manufacturer</b>	<b>Model</b>	<b>Cal Date</b>	<b>Due Date</b>
1036	Spectrum Analyzer	Rohde & Schwartz	FSEK30	14-Jul-2014	15-Jul-2016
1082	Cable	Astrolab	NA	Verify before use	NA
1472	Attenuator	Mini-Circuits	DB20	Verify before use	NA
1763	Antenna, Bilog	Schaffner	CBL 6111D	13-May-2014	13-May-2015
752	Antenna, DRWG	EMCO	3115	19-Feb-2014	19-Feb-2015
E1029	Preamplifier	A.H. Systems, Inc.	PAM-0118	12-Aug-2014	12-Aug-2015
902	pre amp	Sonoma	310 N	08-Aug-2014	08-Aug-2015

**Nemko USA, Inc.**

FCC PART 15, SUBPART C and  
Industry Canada RSS-210 Issue 8

FREQUENCY HOPPING SPREAD SPECTRUM TRANSMITTER

*EQUIPMENT:* 1404

PROJECT NO.: 2014\_272453\_FCC\_15247\_Rev2

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## **ANNEX A - TEST DETAILS**

NAME OF TEST: Channel Separation

PARA. NO.: 15.247(a)(1)  
RSS-210 A8.1(b)

**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. Alternatively, frequency hopping systems operating in the 2400-2483.5 MHz band may have hopping channel carrier frequencies that are separated by 25 kHz or two-thirds of the 20 dB bandwidth of the hopping channel, whichever is greater, provided the systems operate with an output power no greater than 125 mW.

NAME OF TEST: Time of Occupancy	PARA. NO.: 15.247(a)(1) RSS-210 A8.1(d)
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**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 0.4 seconds multiplied by the number of hopping channels employed.
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

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)(1) RSS-210 A8.1(a)
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**Minimum Standard:**

Frequency Band (MHz)	Maximum 20 dB Bandwidth
902 - 928	500 kHz
2400 – 2483.5	Not defined
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)  
RSS-210 A8.4(2)

**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(d) RSS-210 A8.5
---	--------------------------------------

**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  $\Delta$ : 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  $\Delta$ : 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(d)  
RSS-Gen 7.2.2

**Minimum Standard:**

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

Frequency (MHz)	Field Strength (µV/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, Inc.**

FCC PART 15, SUBPART C and  
Industry Canada RSS-210 Issue 8

FREQUENCY HOPPING SPREAD SPECTRUM TRANSMITTER

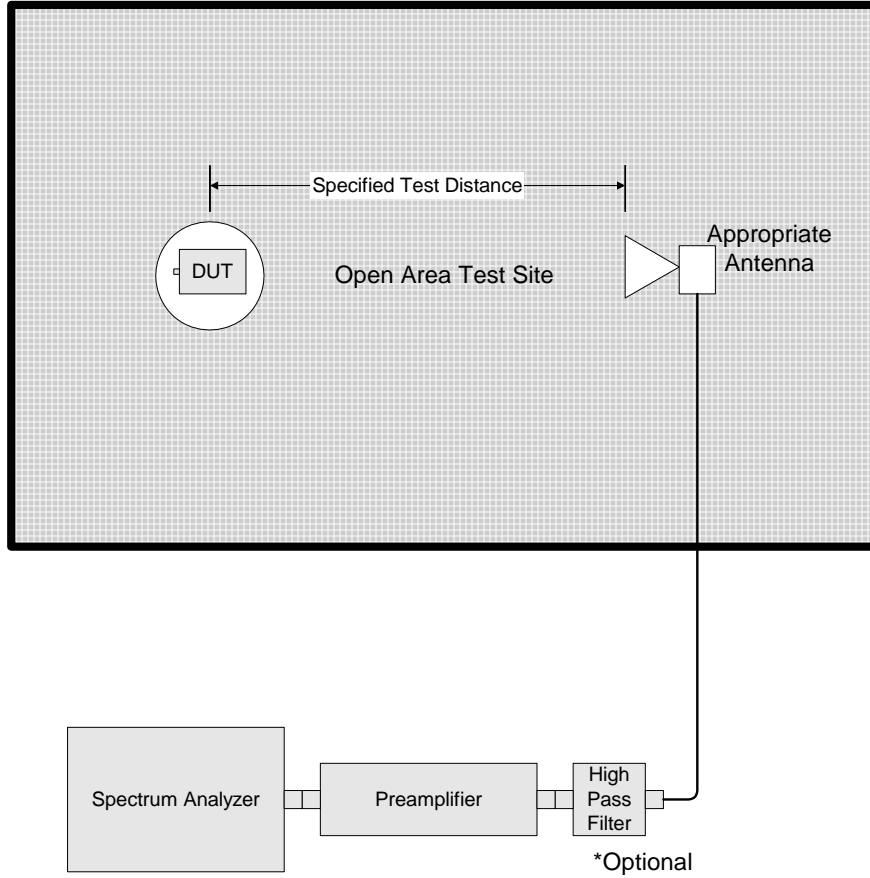
*EQUIPMENT:* 1404

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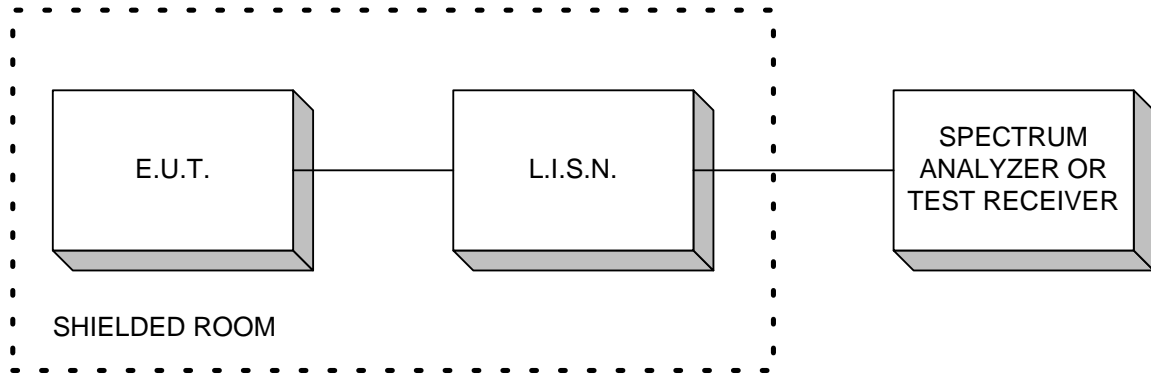
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## **ANNEX B - TEST DIAGRAMS**

### Test Site For Radiated Emissions



### Conducted Emissions



### Measurements at Antenna Terminals

