



Nemko Test Report: 10233152RUS2

Applicant: Weathermatic
3301 Kingsley Road
Garland, TX 75041
USA

**Equipment Under Test:
(E.U.T.)** SLHUBRF-5

FCC ID# OLPSLHUBRF900MZ

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

TESTED BY:



David Light, Senior Wireless Engineer

DATE: 16 November 2012

APPROVED BY:



Michael Cantwell, Reviewer

DATE: 29 April 2013

Total Number of Pages: 38

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Section 1. Summary of Test Results

Manufacturer: Weathermatic

Model No.: SLHUBRF-5

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 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".



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Summary Of Test Data

NAME OF TEST	PARA. NO.	RESULT
Powerline Conducted Emissions	15.207(a)	Complies
Channel Separation	15.247(a)(1)	Complies
Time of Occupancy	15.247(a)(1)	Complies
20 dB Occupied Bandwidth	15.247(a)(1)	Complies
Peak Power Output	15.247(b)	Complies
Spurious Emissions (Antenna Conducted)	15.247(d)	Complies
Spurious Emissions (Radiated)	15.247(d)	Complies

Footnotes:

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:

902.35 to 927.6 MHz

Number of Channels:

50

Channel Spacing:

513 kHz

Channel Bandwidth:

178 kHz

User Frequency Adjustment:

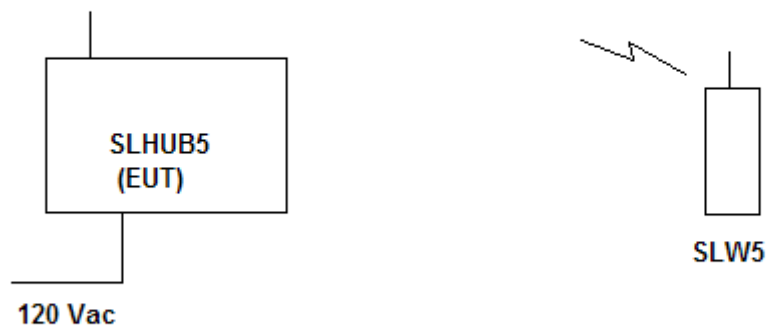
Software controlled

Input Power:

120 Vac

Description of EUT

The SLHUB-RF-5 communicates with the SLW5 weather station and sends data to the control panel for lawn irrigation system.

System Diagram

Section 3. Channel Separation

NAME OF TEST: Channel Separation	PARA. NO.: 15.247(a)(1)
TESTED BY: David Light	DATE: 15 November 2012

Test Results: Complies.

Measurement Data: See 20 dB BW plot

Measured 20 dB bandwidth: 178 kHz
Channel Separation: 513 kHz

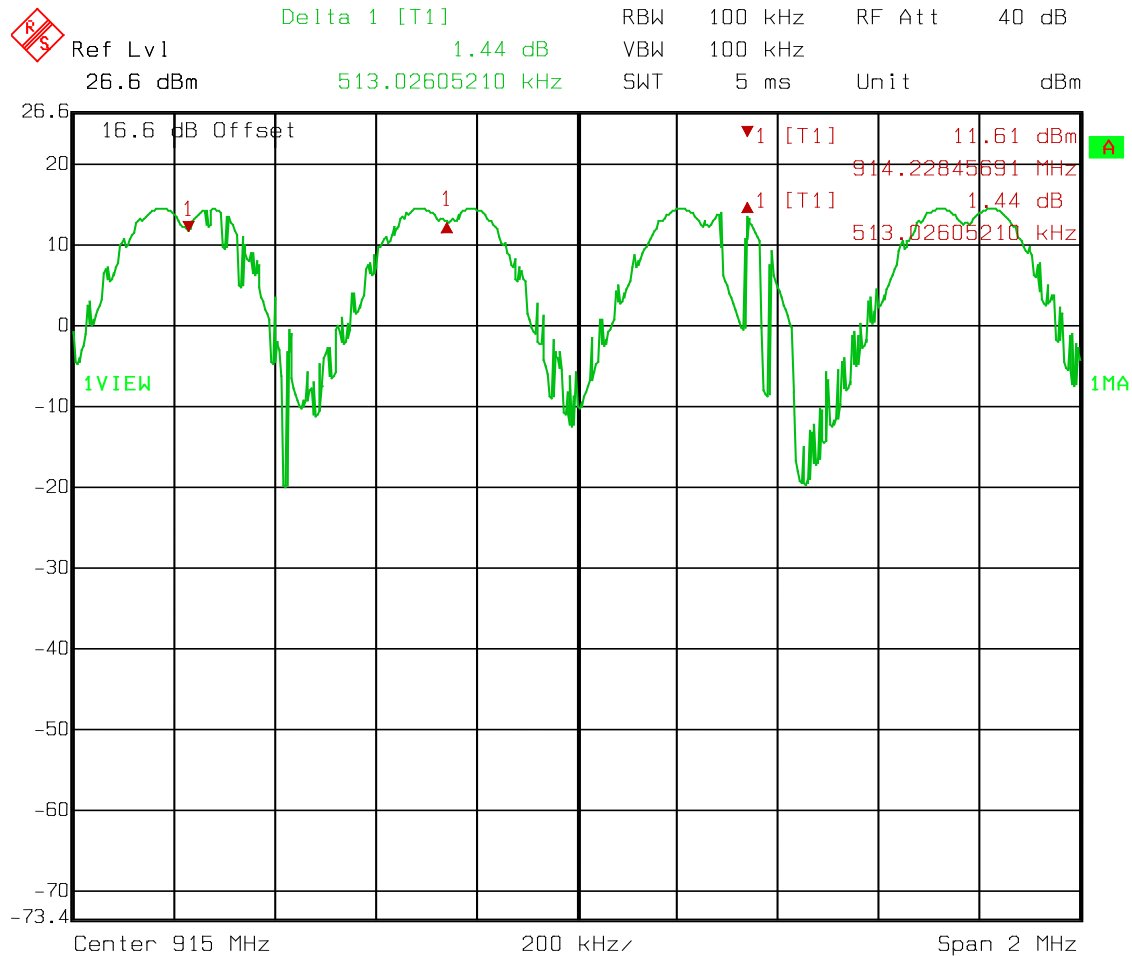
Equipment Used: 1036-1082-1472

Measurement Uncertainty: 1X10⁻⁷ppm

Temperature: 20 °C

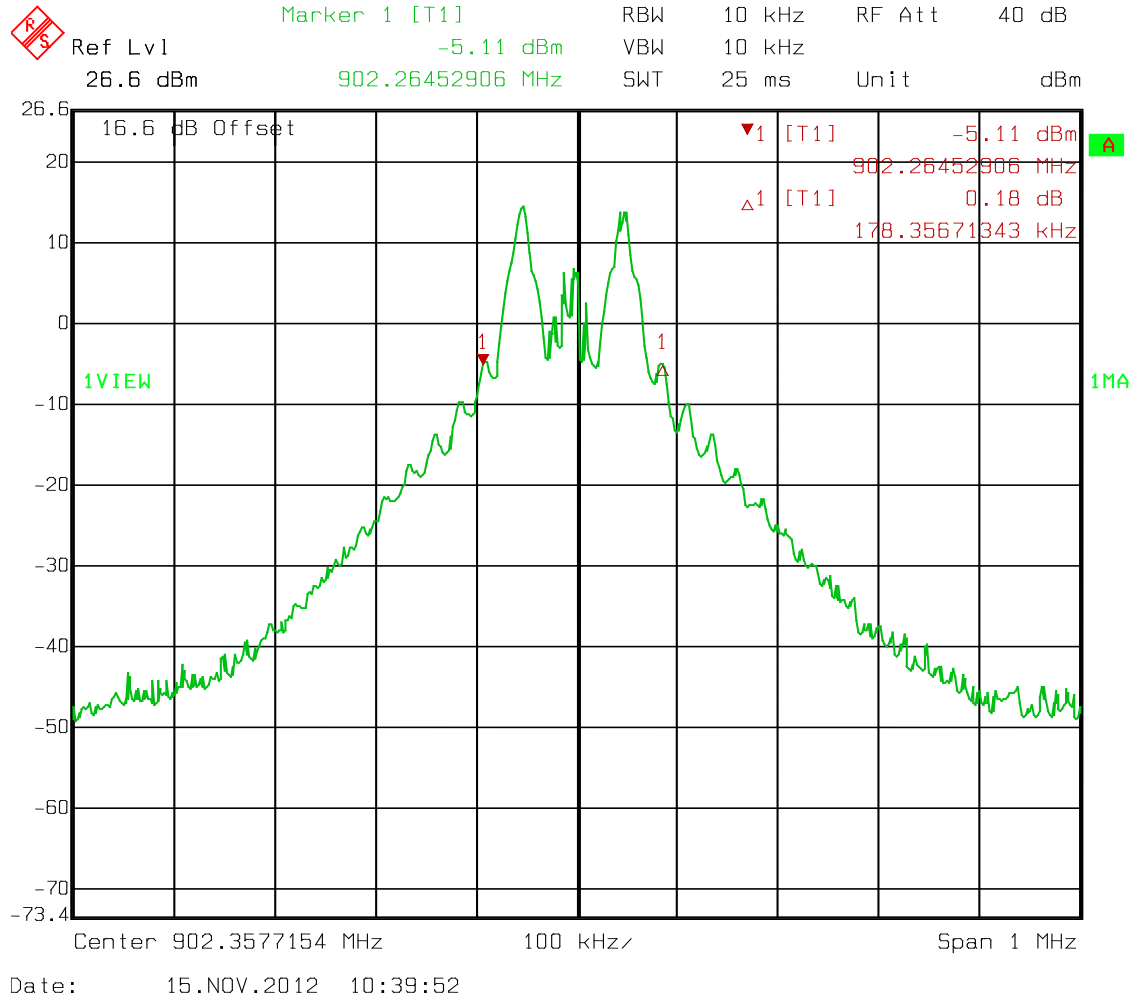
Relative Humidity: 31 %

Test Data – Channel Separation



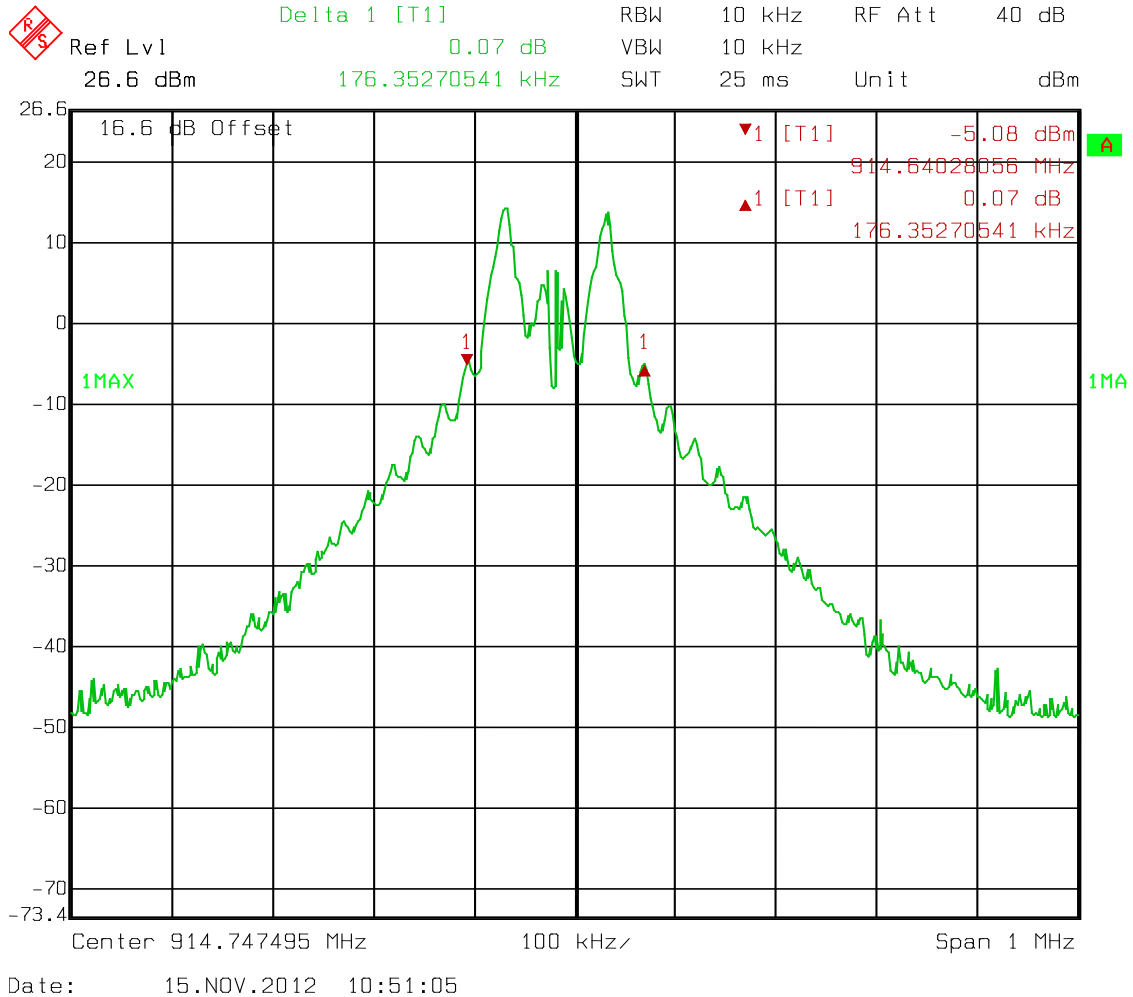
Test Data – 20 dB Bandwidth

Low Channel



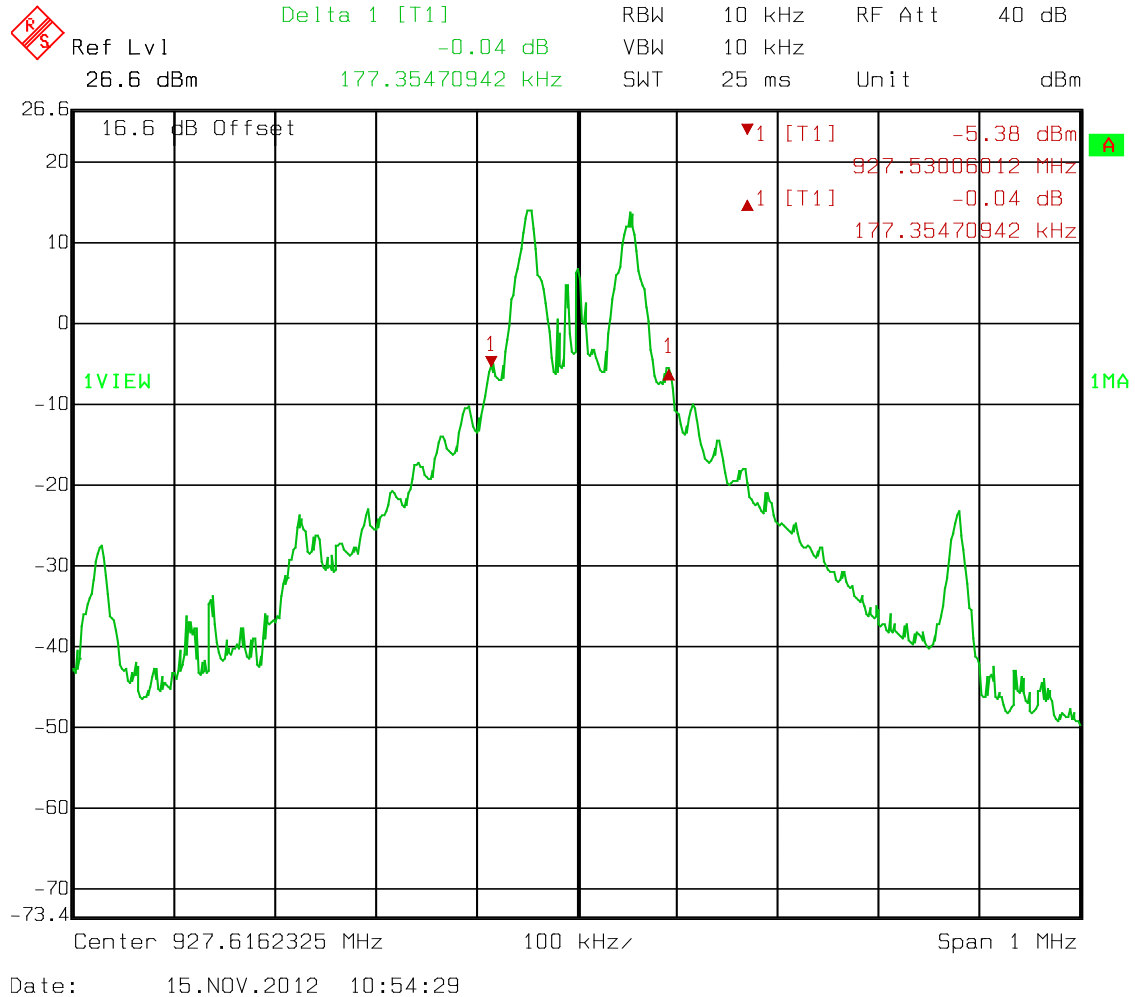
Test Data – 20 dB Bandwidth

Mid Channel



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: 15 November 2012

Test Results: Complies.

Measurement Data: See attached plots

Maximum Dwell Time On Any Channel: 29.7 ms in 20 seconds

Equipment Used: 1036-1082-1472

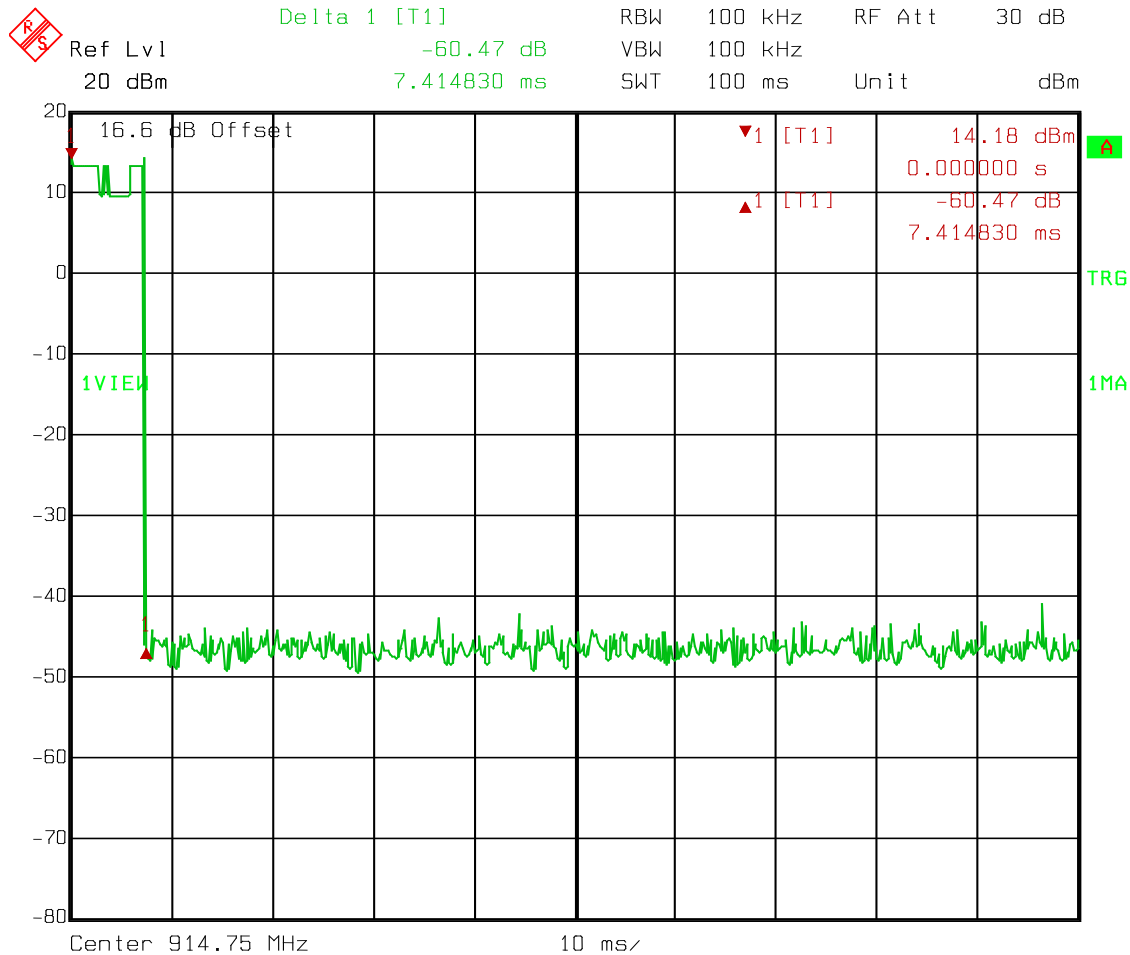
Measurement Uncertainty: 1X10⁻⁷ppm

Temperature: 20 °C

Relative Humidity: 31 %

Test Data – Time of Occupancy

Pulse Width



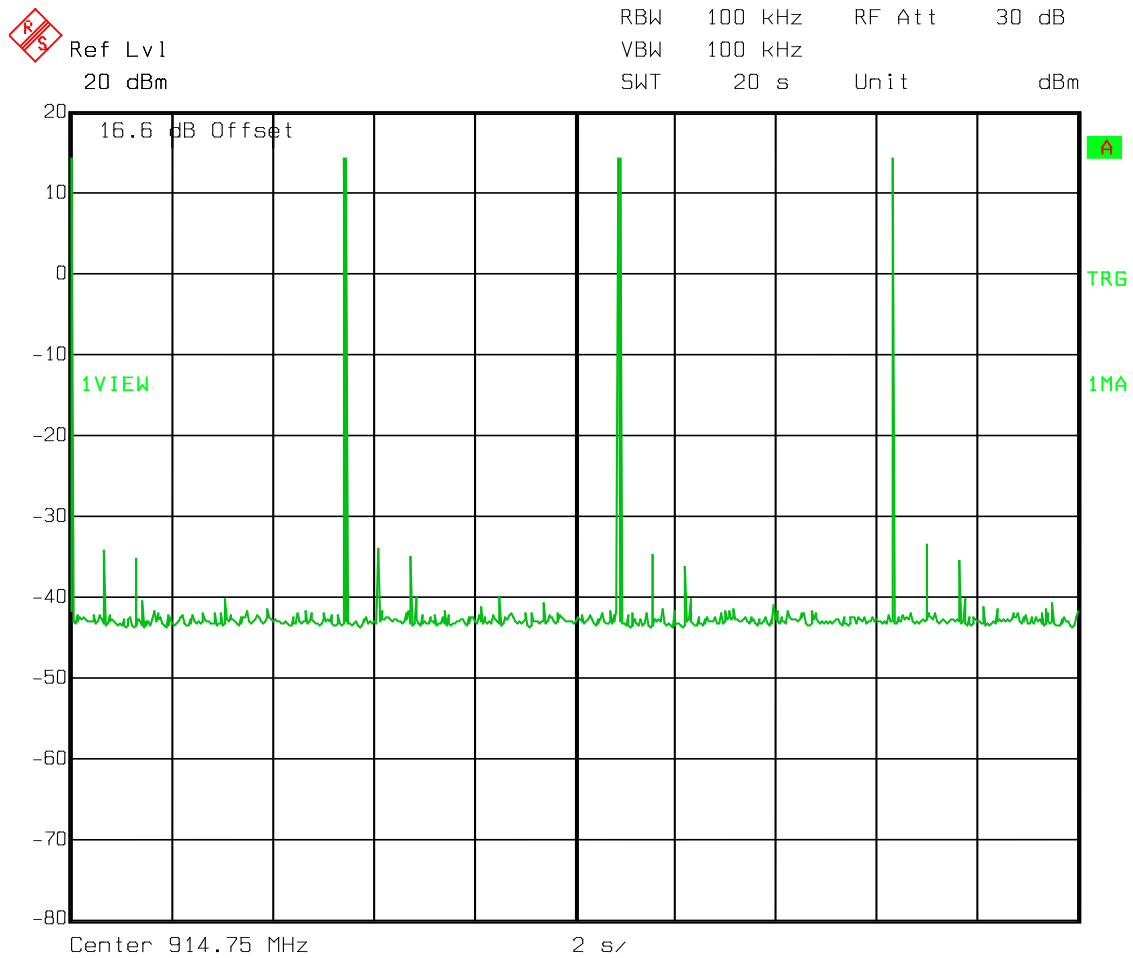
Date: 15.NOV.2012 11:05:39

Test Data – Time of Occupancy

Pulse Width

4 hops at 7.42 ms each = 29.68 ms within 20 seconds

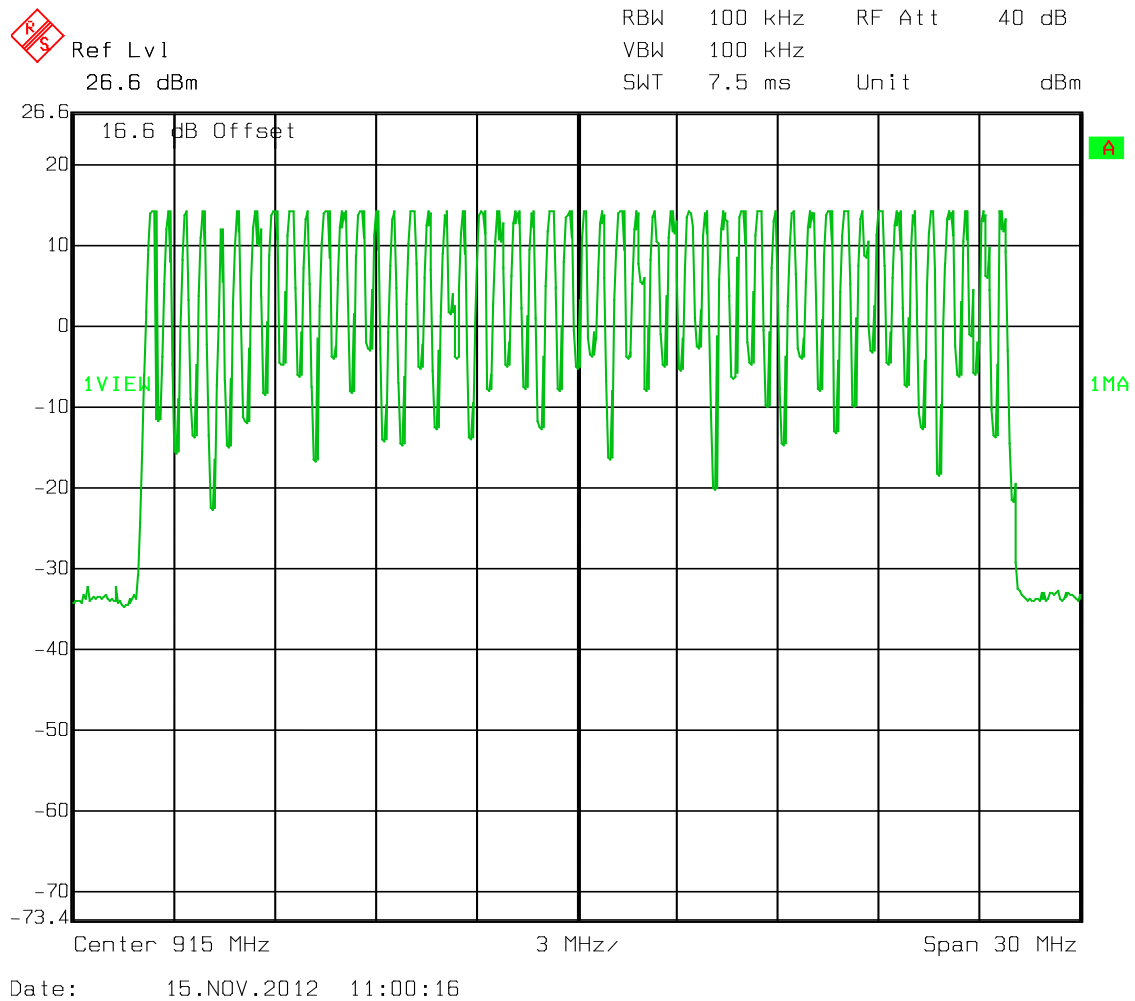
Limit = 400 ms within 20 seconds



Date: 15.NOV.2012 11:09:35

Test Data – Time of Occupancy

Number of hopping channels = 50



Section 5. Peak Power Output

NAME OF TEST: Peak Power Output	PARA. NO.: 15.247 (b)
TESTED BY: David Light	DATE: 15 November 2012

Test Results: Complies.

Measurement Data: See attached plots.

Detachable antenna? ☐ Yes ☒ No
If yes, state the type of non-standard connector used:

Frequency (MHz)	Peak Power (dBm)	Peak Power (W)	Antenna Type	Gain (dBi)	E.I.R.P. (dBm)	E.I.R.P. (W)
902.35	14.6	0.029	Monopole	0	14.6	0.029
914.75	14.4	0.028	Monopole	0	14.4	0.028
927.60	14.3	0.027	Monopole	0	14.3	0.027
Maximum EIRP (W): 0.029						

- ☒ 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.

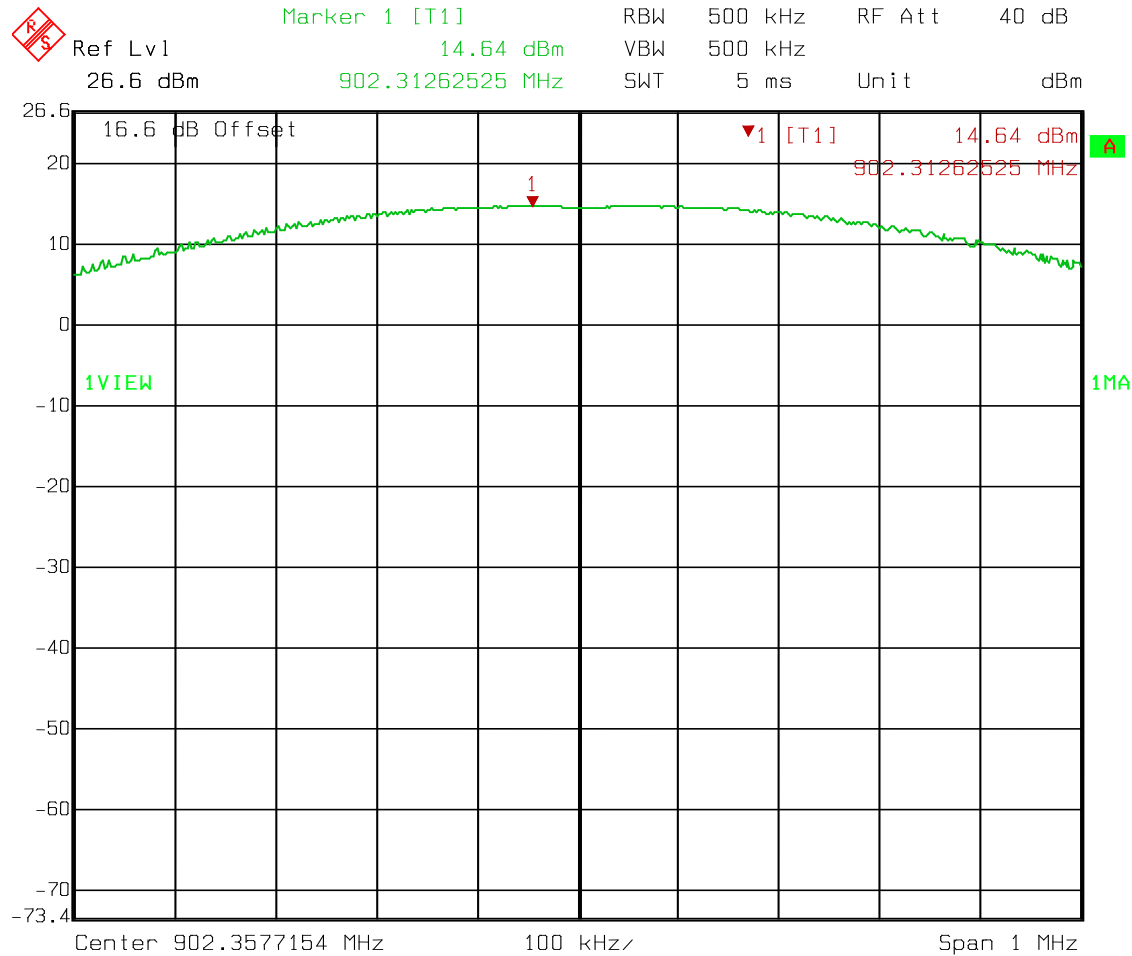
Equipment Used: 1036-1082-1472

Measurement Uncertainty: 1.7 dB

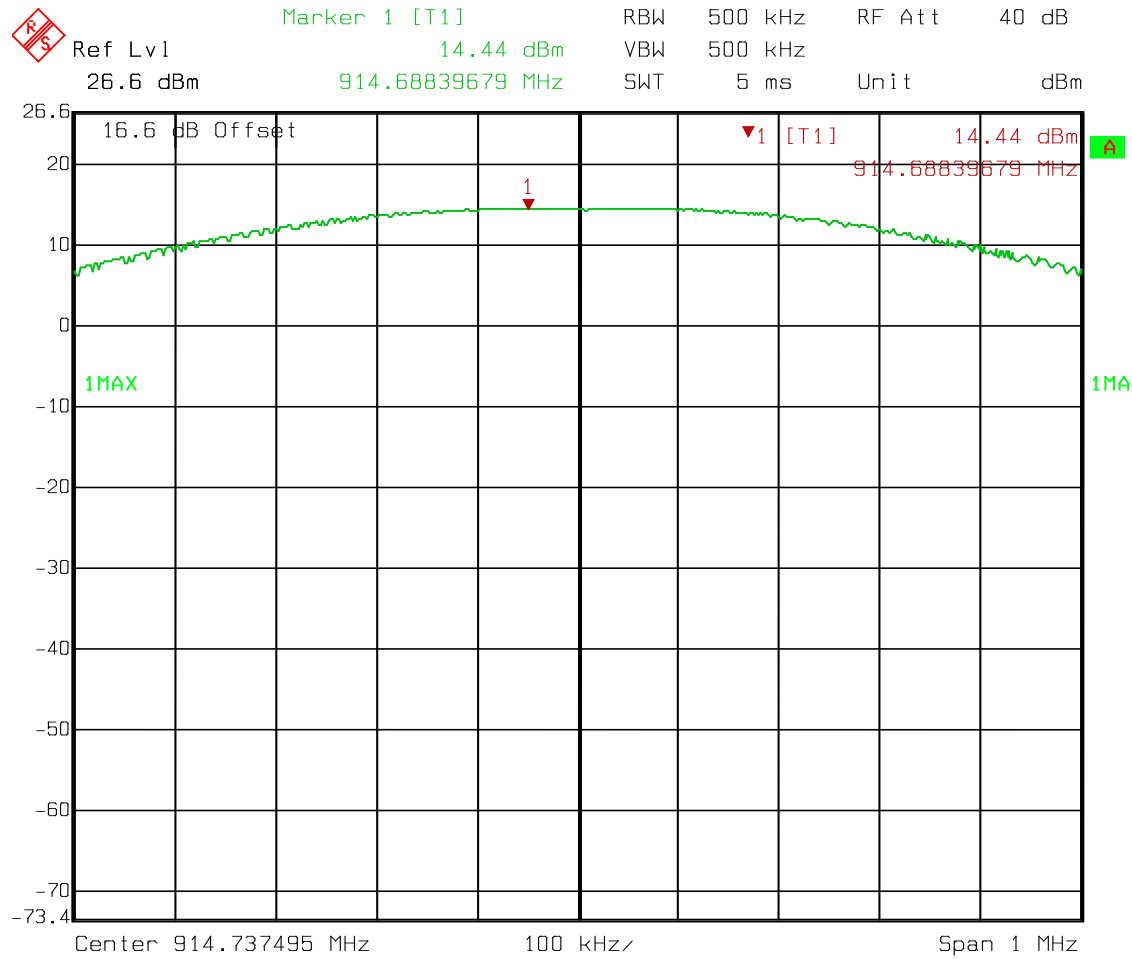
Temperature: 20 °C

Relative Humidity: 31 %

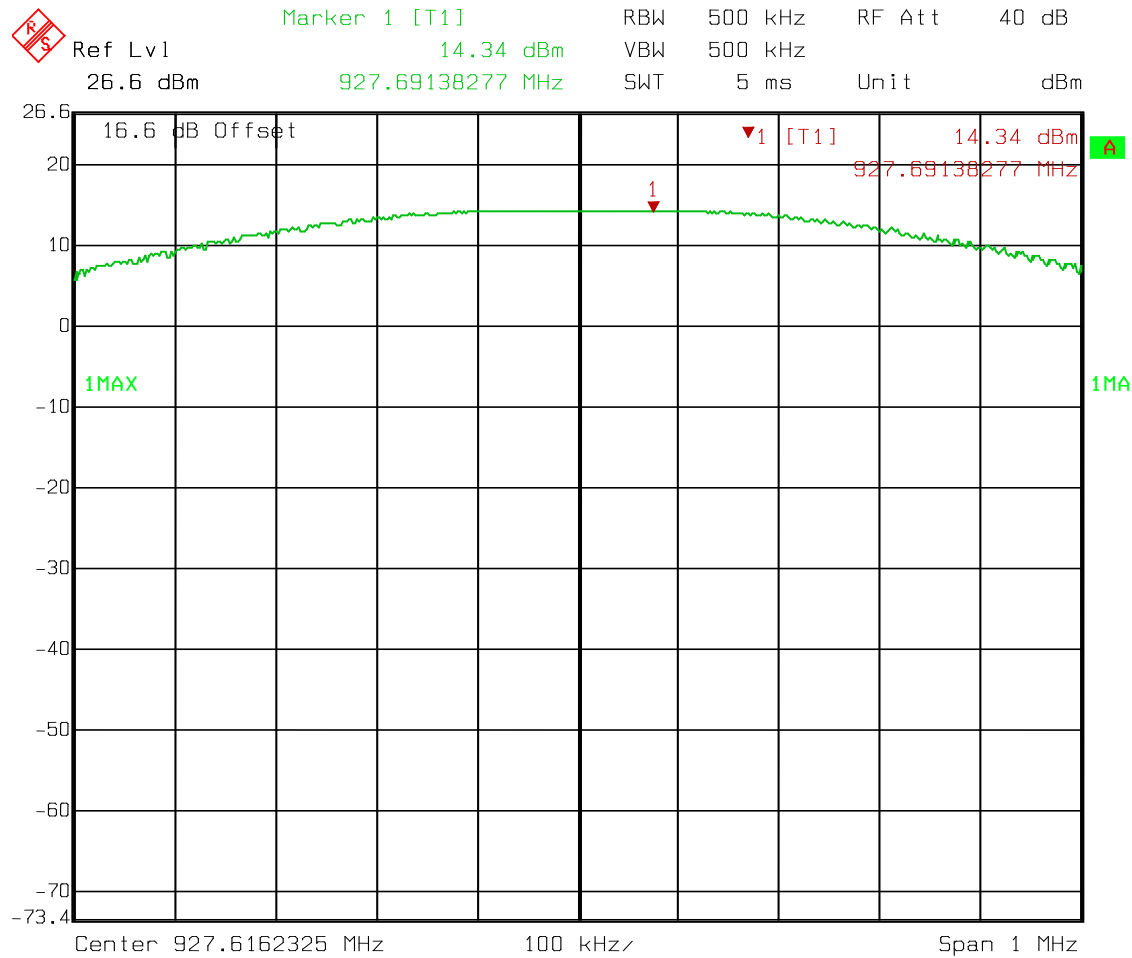
Low channel



Date: 15.NOV.2012 10:40:42



Date: 15.NOV.2012 10:51:46



Date: 15.NOV.2012 10:55:06

Section 6. Spurious Emissions (Antenna Conducted)

NAME OF TEST: Spurious Emissions (Antenna Conducted)	PARA. NO.: 15.247(d)
TESTED BY: David Light	DATE: 15 Nov 2012

Test Results:

Complies.

Measurement Data: See attached plots.

Equipment Used: 1036-1082-1472

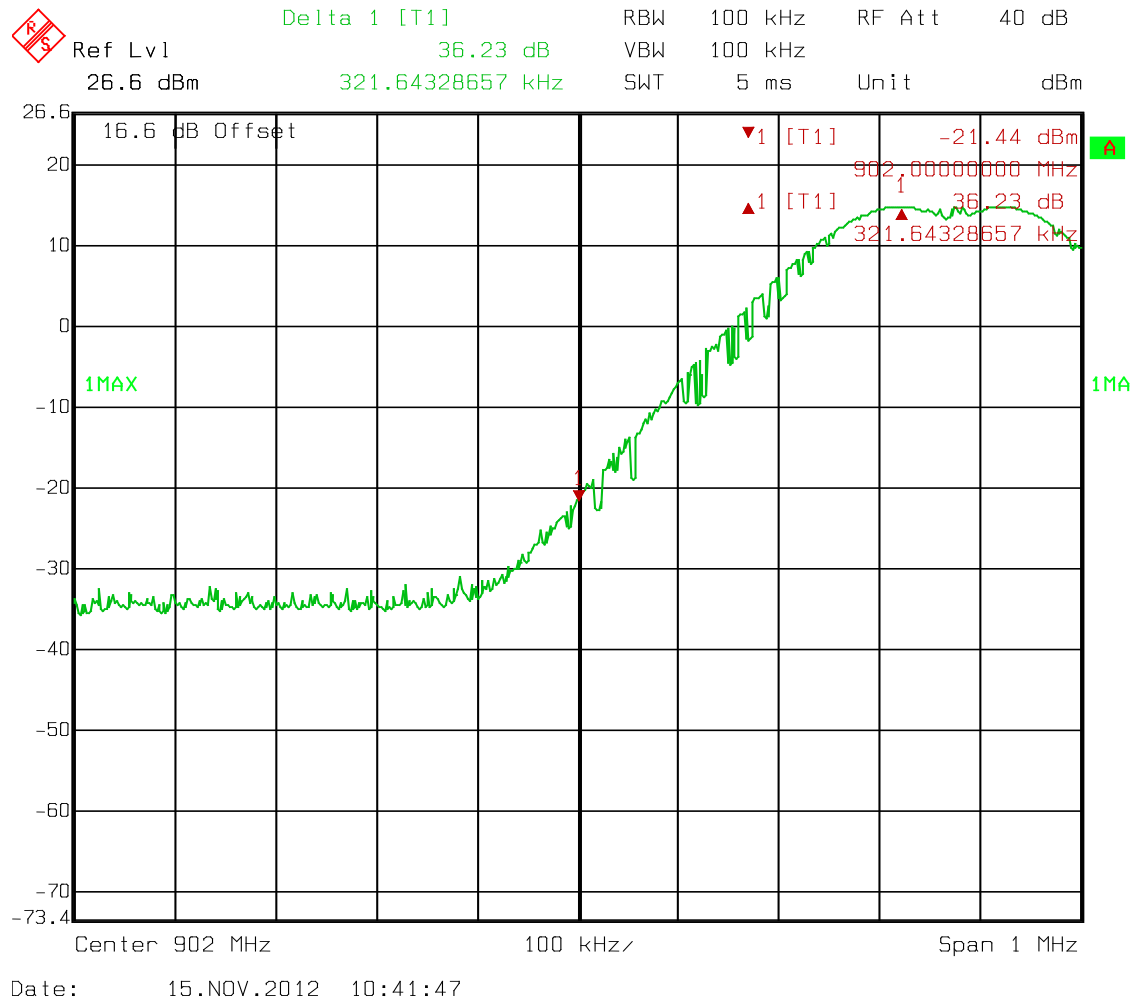
Measurement Uncertainty: 1X10⁻⁷ppm

Temperature: 20 °C

Relative Humidity: 31 %

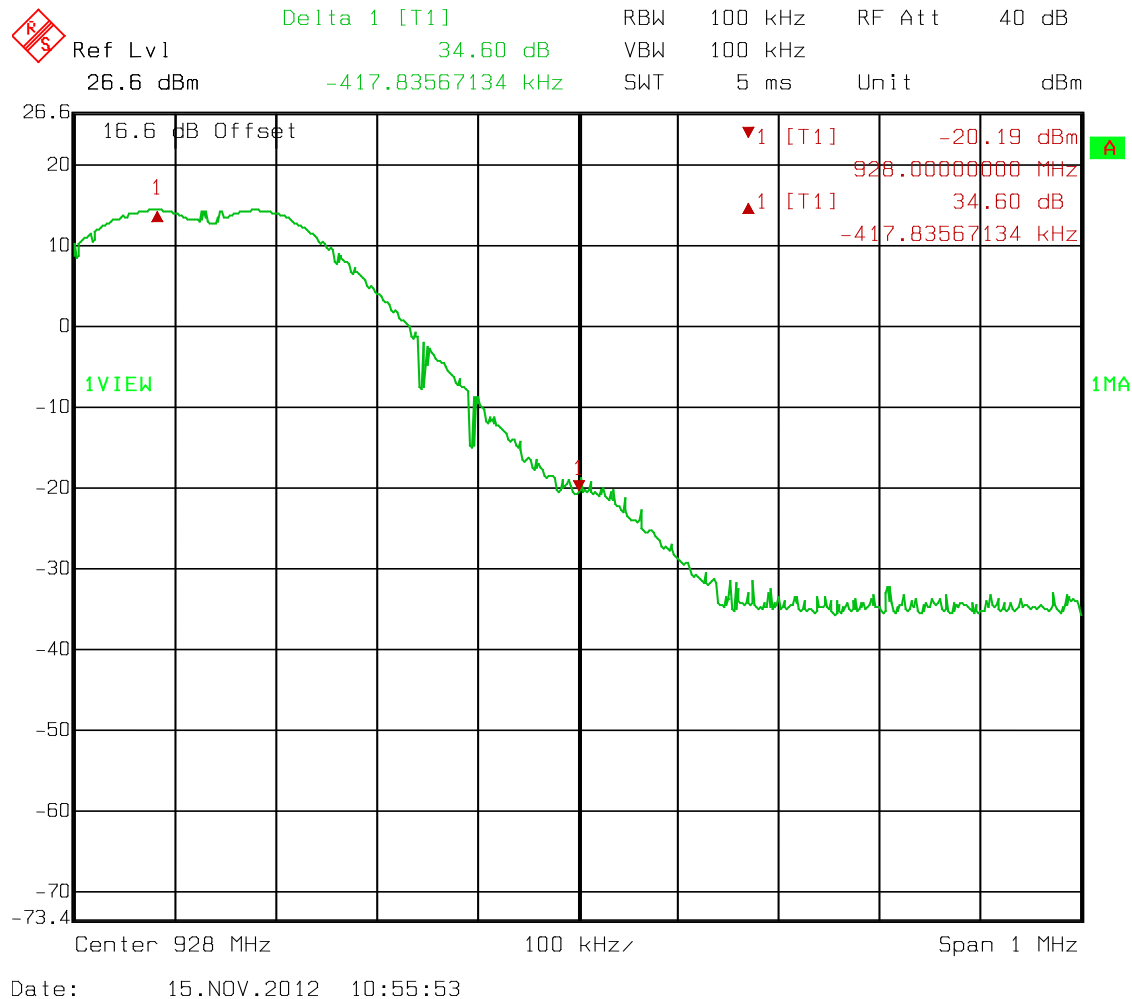
Test Data – Spurious Emissions at Antenna Terminals

Lower Band Edge



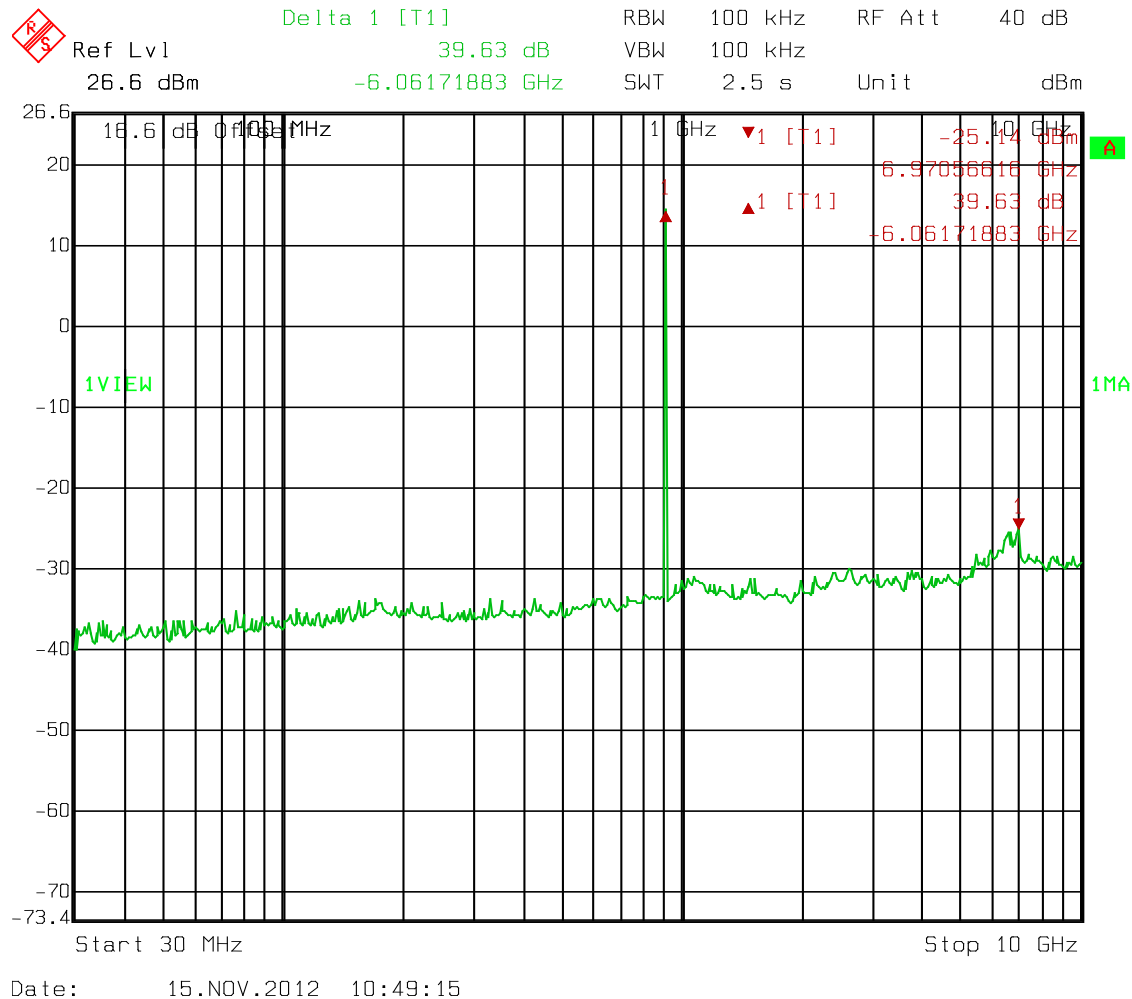
Test Data – Spurious Emissions at Antenna Terminals

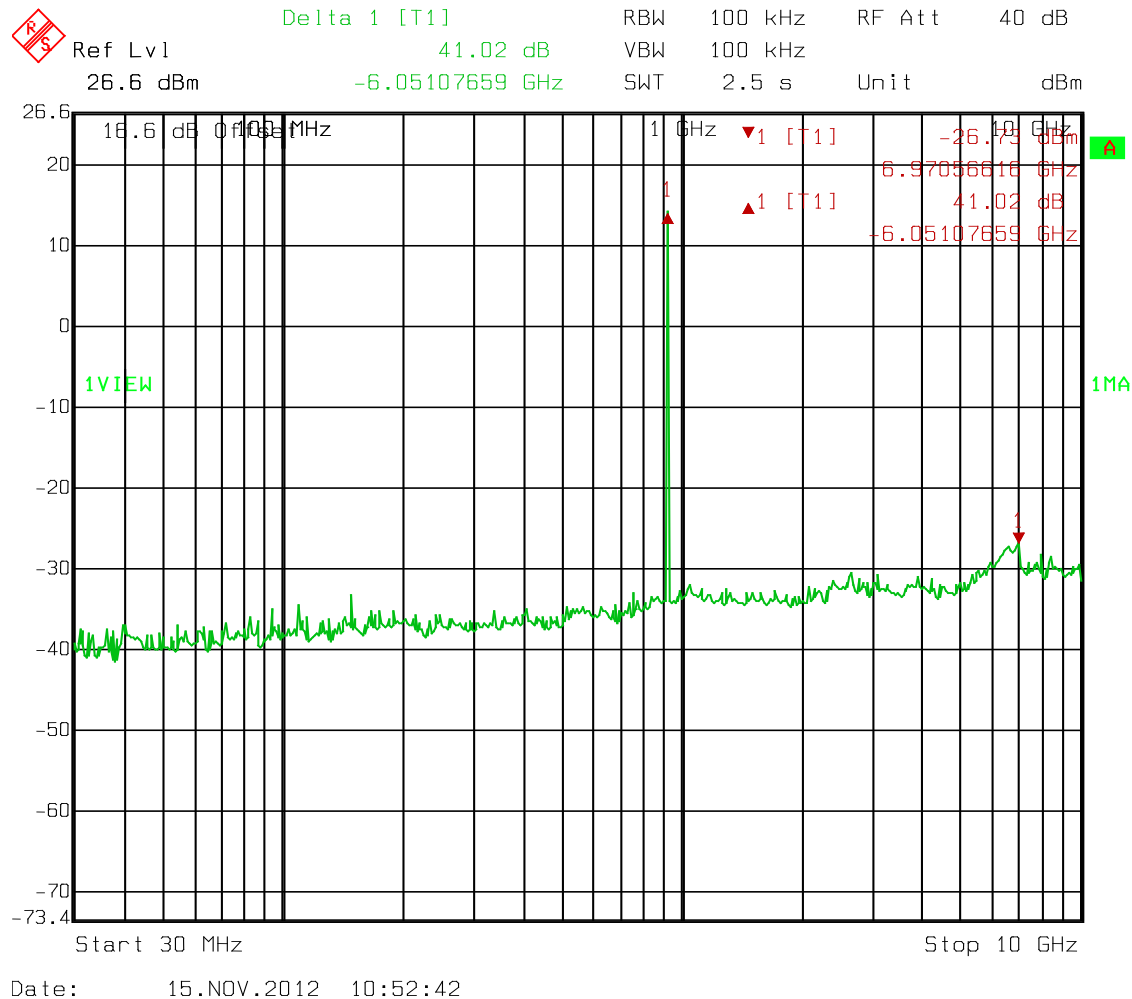
Upper Band Edge



Test Data – Spurious Emissions at Antenna Terminals

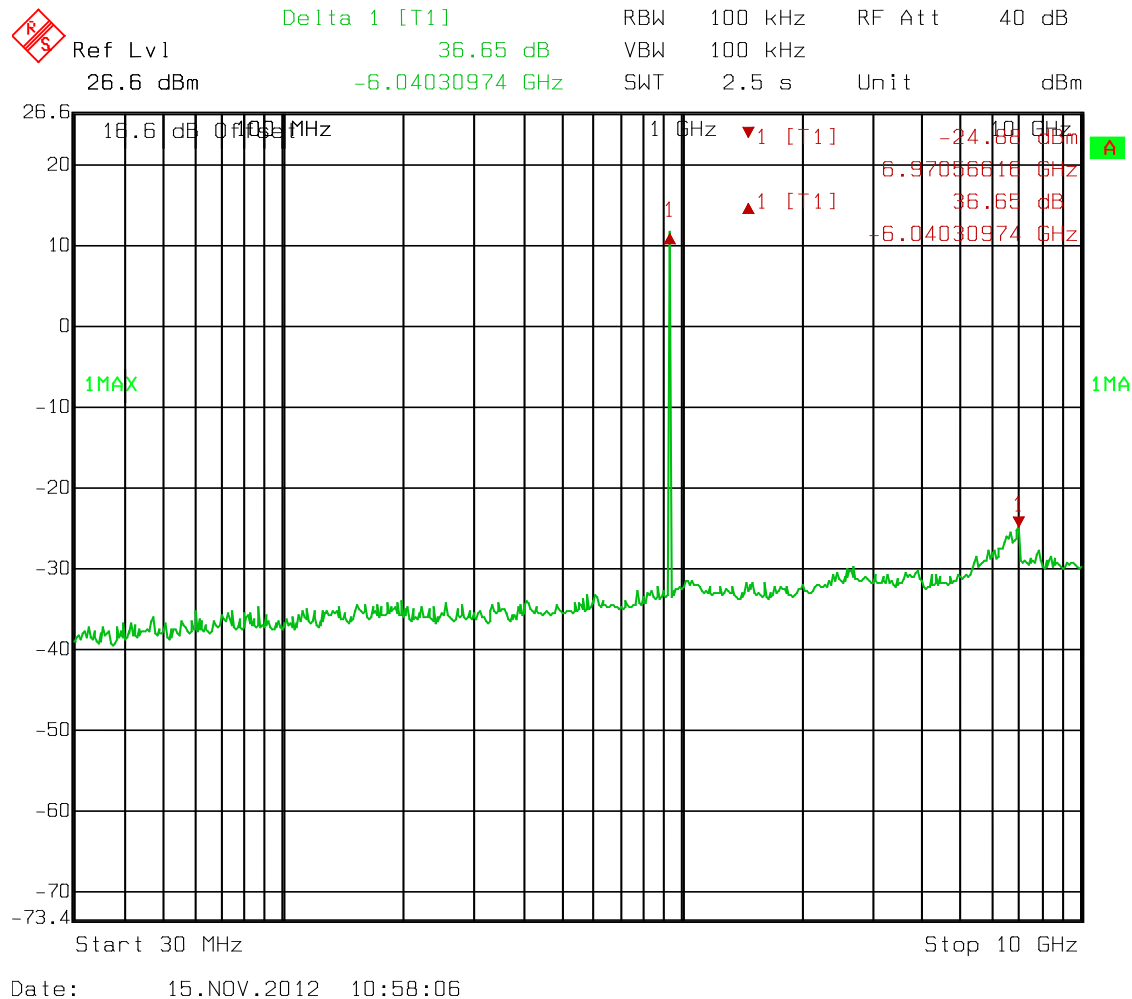
Spurs – Low Channel



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

Test Data – Spurious Emissions at Antenna Terminals

Spurs – High Channel



Section 7. Spurious Emissions (Radiated)

NAME OF TEST: Spurious Emissions (Radiated)	PARA. NO.: 15.247(d)
TESTED BY: David Light	DATE: 15 November 2012

Test Results: Complies. The worst case emission was 36.9 dB μ V/m at 2707.5 MHz. This is 17.7 dB below the specification limit of 54.0 dB μ V/m.

Measurement Data: See attached table.

Duty Cycle Calculation:

Duty Cycle correction factor(dB) = 20 log (rf_{ON} 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).
- ☒ All emissions within 20 dB of the specification limit are reported per 15.31(o).

Equipment Used: 1036-1025-1016-993-1480-1783

Measurement Uncertainty: +/-3.6 dB

Temperature: 20 °C

Relative Humidity: 31 %

Test Data - Radiated Emissions

Meas.	Ant.	Duty	Meter	Antenna	Path	RF	Corrected	Spec.	CR/SL	Pass		
Freq.	Pol.	Cycle	Reading	Factor	Loss	Gain	Reading	limit	Diff.	Fail		
(MHz)	(H/V)	(dB)	(dBuV)	(dB)	(dB)	(dB)	(dBuV/m)	(dBuV/m)	(dB)	Unc.	Comments	
											Low Ch.	SLHUB5
2707.05	H	0	55	29	3.7	30.8	56.9	74	-17.1	Pass	Peak	
2707.05	H	-20	55	29	3.7	30.8	36.9	54	-17.1	Pass	Average	
											Mid Ch.	SLHUB5
2744.75	H	0	54	29	3.7	30.8	55.9	74	-18.1	Pass	Peak	
2744.75	H	-20	54	29	3.7	30.8	35.9	54	-18.1	Pass	Average	
											High Ch.	SLHUB5
2782.8	H	0	55	29	3.7	30.8	56.9	74	-17.1	Pass	Peak	
2782.8	H	-20	55	29	3.7	30.8	36.9	54	-17.1	Pass	Average	

Section 8. Powerline Conducted Emissions

NAME OF TEST: Powerline Conducted Emissions	PARA. NO.: 15.207(a)
TESTED BY: David Light	DATE: 15 November 2012

Test Results: Complies. The worst case emission was 49.5 dB μ V at 0.238 MHz. This is 2.7 dB below the quasi-peak specification limit of 52.2 dB μ V.

Test Data: Refer to attached plots

Equipment Used: 1659-1924-1548-704-1188

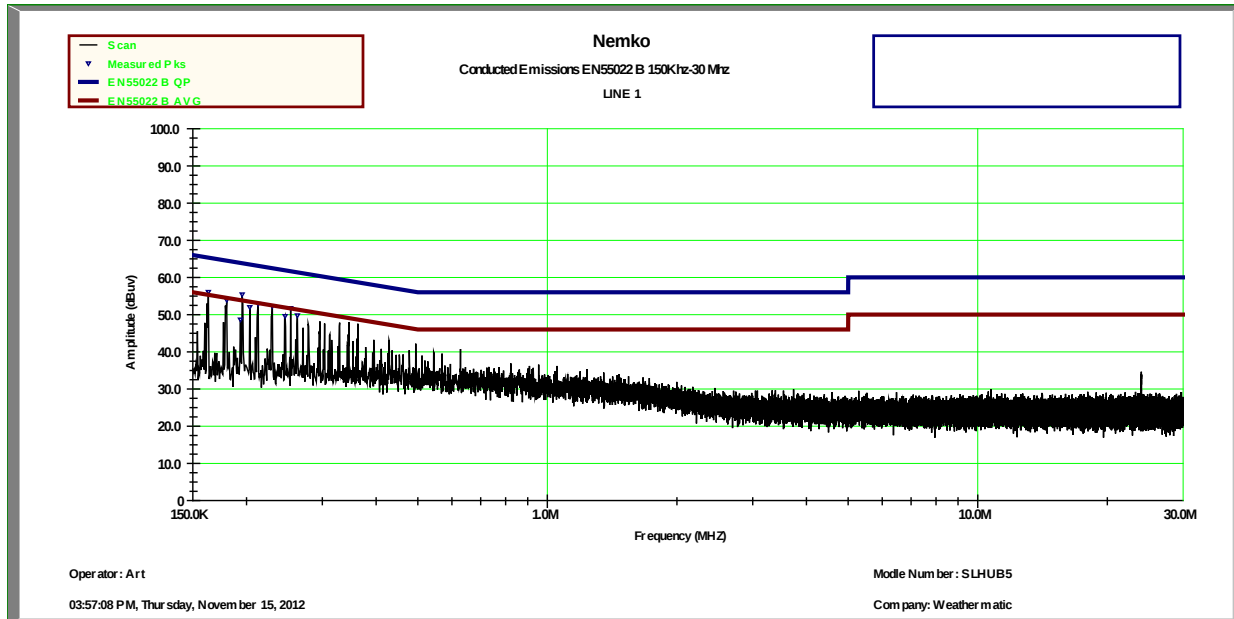
Measurement Uncertainty: +/- 1.7 dB

Temperature: 20 °C

Relative Humidity: 31 %

Test Data – Powerline Conducted Emissions

Line side



Operator: Light

Model Number: SLHUB-RF-5

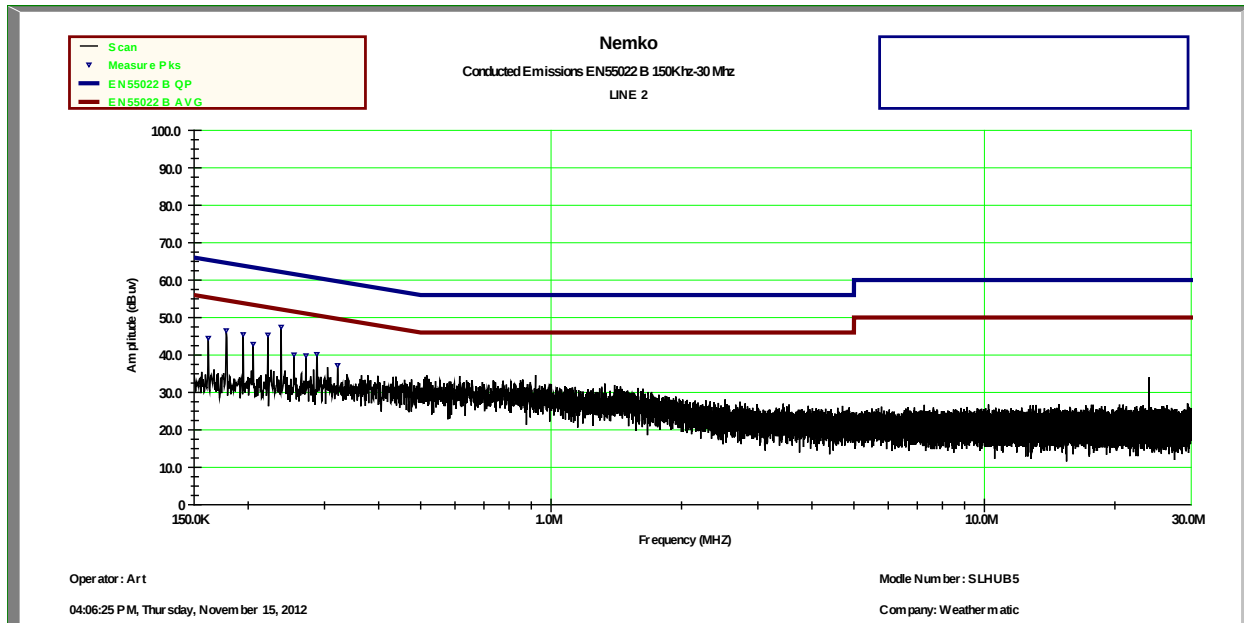
Company: Weathermatic

04:04:58 PM, Thursday, November 15, 2012

Frequency	15.207	15.207	AVG	AVG	QP	QP
(kHz)	QP LIMIT	AVG	Meas	Margin	Meas	Margin
165.14	65.6	55.6	29.8	-25.8	44.7	-20.9
179.09	65.2	55.2	33.2	-22.0	42.9	-22.3
195.74	64.7	54.7	33.2	-21.5	53.3	-11.4
210.89	64.3	54.3	31.4	-22.9	48.9	-15.4
227.75	63.8	53.8	35.0	-18.7	53.4	-10.3
252.45	63.1	53.1	28.8	-24.2	41.3	-21.8

Test Data – Powerline Conducted Emissions

Neutral side



All peak measured emissions are below the Quasi-peak limit therefore the a table of emissions is not available. See above plot.

Section 9. Test Equipment List

Asset Tag	Description	Manufacturer	Model	Serial #	Last Cal	Next Cal
993	Antenna, Horn	A.H. Systems	SAS-200/571	162	22-Sep-2011	22-Sep-2013
1016	Preamplifier	Hewlett Packard	8449A	2749A00159	23-Jul-2012	23-Jul-2013
1025	Preamplifier, 25dB	Nemko USA, Inc.	LNA25	399	27-Feb-2012	27-Feb-2013
1036	Spectrum Analyzer	Rohde & Schwartz	FSEK30	830844/006	23-Dec-2011	23-Dec-2013
1082	Cable, 2m	Astrolab	32027-2- 29094-72TC		N/R	
1472	Attenuator	Omni Spectra	20600-20db		N/R	
1480	Antenna, Bilog	Schaffner- Chase	CBL6111C	2572	07-Feb-2012	07-Feb-2013
1783	Cable Assy,	Nemko	Chamber		26-Sep-2012	26-Sep-2013
704	Filter, High Pass, 5KHz	Solar Electronics	7930-5.0	933126	13-Feb-2012	13-Feb-2013
1188	LISN	EMCO	3825/2	1214	22-Nov-2011	22-Nov-2012
1659	Spectrum Analyzer	Rohde & Schwartz	FSP	973353	17-Oct-2012	17-Oct-2014
1548	0.5m Cable Assy	Nemko USA	RG213		13-Feb-2012	13-Feb-2013
1924	3m Cable	Nemko USA	1924 RG 214	1	14-Feb-2012	14-Feb-2013

ANNEX A - TEST DETAILS

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. 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)

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)

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)

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)
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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(d)

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

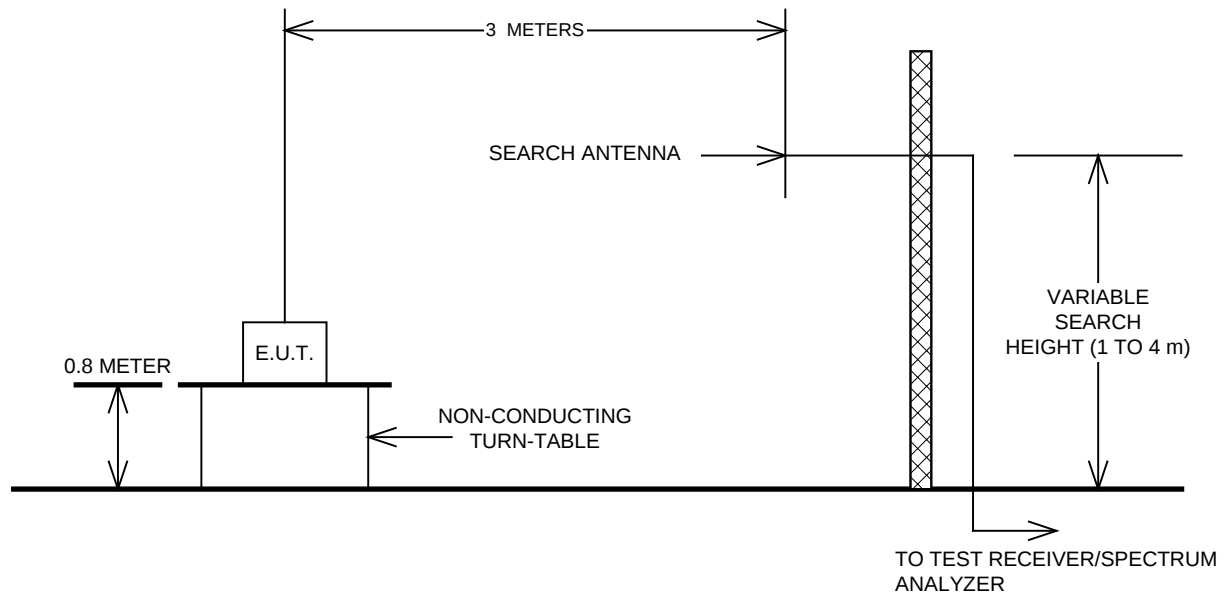
MHz	MHz	MHz	GHz
0.09-0.11	16.42-16.423	399.9-410	4.5-5.25
0.495-0.505	16.69475-16.69525	608-614	5.35-5.46
2.1735-2.1905	16.80425-16.80475	960-1240	7.25-7.75
4.125-4.128	25.5-25.67	1300-1427	8.025-8.5
4.17725-4.17775	37.5-38.25	1435-1626.5	9.0-9.2
4.20725-4.20775	73-74.6	1645.5-1646.5	9.3-9.5
6.125-6.218	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

ANNEX B - TEST DIAGRAMS

Test Site For Radiated Emissions



Conducted at Antenna Terminal

