Nemko Test Report: 14703RUS1

Applicant: Crane WMS (Signal Technology Corp.)
1820 Preston Park Blvd #2800
Plano, TX 75093
USA

Equipment Under Test: (E.U.T.) RTCB2400

In Accordance With: **FCC Part 15, Subpart C, 15.247**
Digital Transmission System Transmitter

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

TESTED BY: _____ **DATE:** **10 July 2008**
David Light, Senior Wireless Engineer

APPROVED BY: _____ **DATE:** **15 July, 2008**
Mike Cantwell, Frontline Manager

Number of Pages: 31

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Section 1. Summary of Test Results

Manufacturer: Crane WMS

Model No.: RTCB2400

Serial No.: 12

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 Digital Transmission Systems. Radiated tests were conducted is 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

Summary Of Test Data

NAME OF TEST	PARA. NO.	RESULT
Powerline Conducted Emissions	15.207(a)	NA
Minimum 6 dB Bandwidth	15.247(a)(2)	Complies
Maximum Peak Power Output	15.247(b)(3)	Complies
Spurious Emissions (Antenna Conducted)	15.247(d)	Complies
Spurious Emissions (Restricted Bands)	15.247(d)/15.209(a)	Complies
Peak Power Spectral Density	15.247(e)	Complies

Footnotes:

The device is powered by a 3 Vdc battery.

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

General Equipment Information

Frequency Band (MHz):	902-928	2400-2483.5	5725-5850
	☐	☒	☐

Operating Frequency of Test Sample: 2405 to 2475 MHz

6 dB Bandwidth: 1.73 MHz max

Peak Output Power: 2.73 dBm (1.9 mW)

Spectral Density: -11.4 dBm

User Frequency Adjustment: Software controlled

Description of EUT

2.4 GHz wireless sensor.

Section 3. Occupied Bandwidth

NAME OF TEST: Occupied Bandwidth	PARA. NO.: 15.247(a)(2)
TESTED BY: David Light	DATE: 10 July 2008

Test Results: Complies.

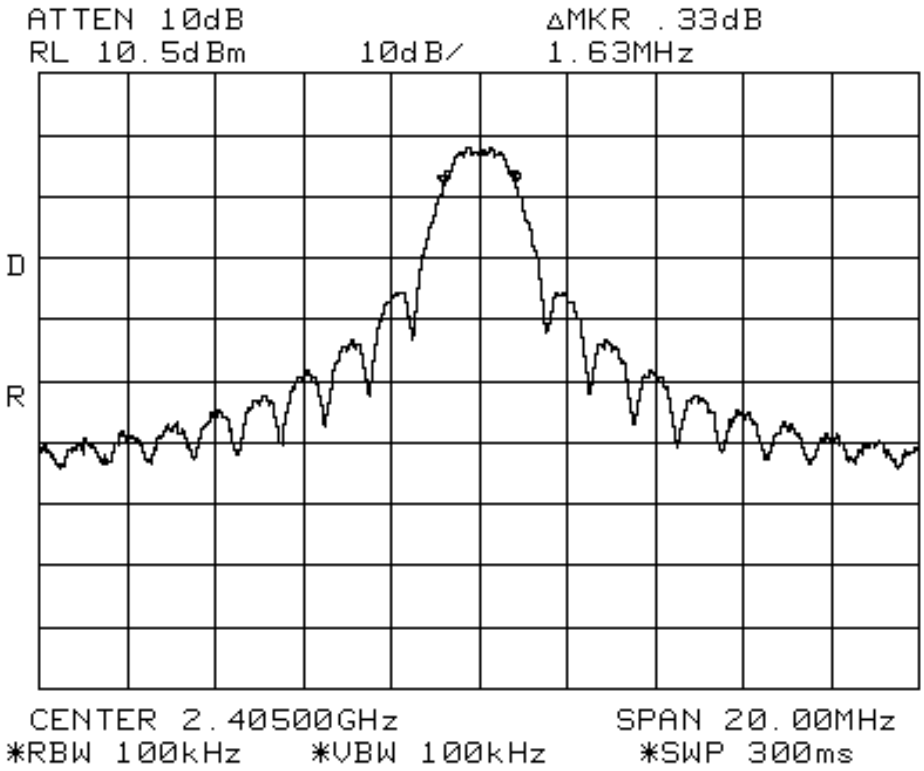
Measurement Data: See 6 dB BW plot
Measured 6 dB bandwidth: 1.73 MHz

Test Conditions: 22 %RH
35 °C

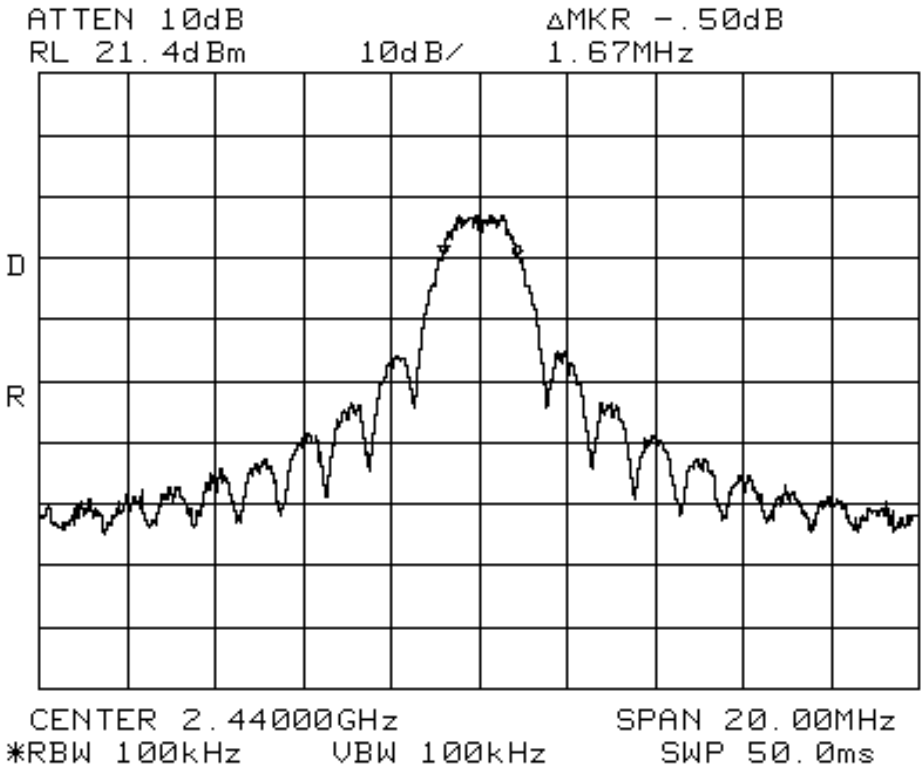
Measurement Uncertainty: +/-1x10^{-7} ppm

Test Equipment Used: 1464-1083-1472

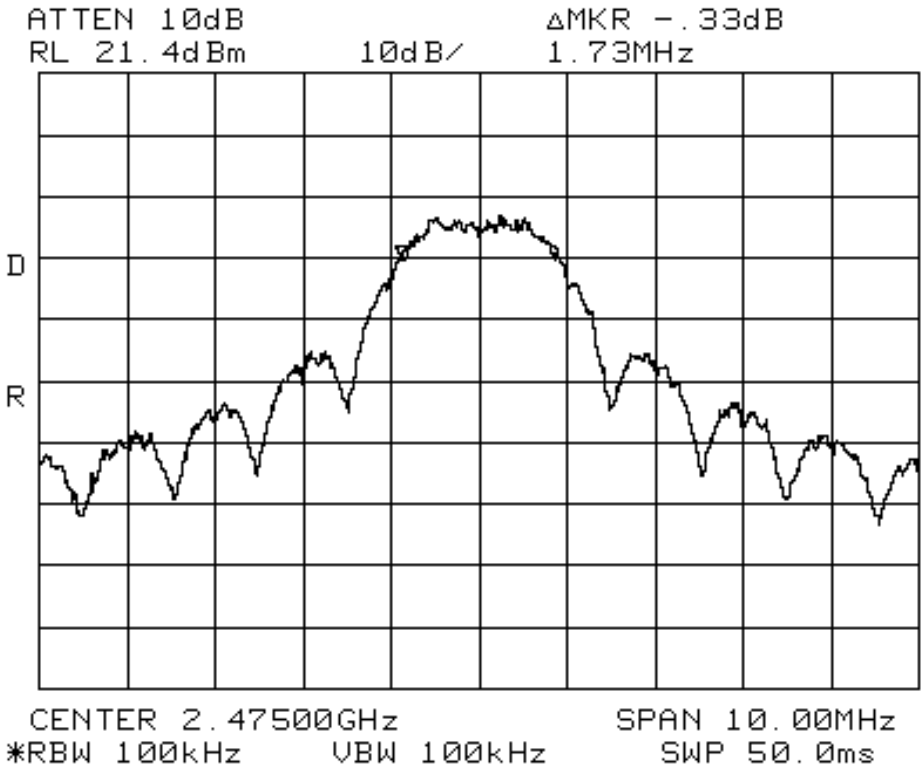
Test Data – Occupied Bandwidth



Test Data – Occupied Bandwidth



Test Data – Occupied Bandwidth



Section 4. Maximum Peak Output Power

NAME OF TEST: Maximum Peak Output power	PARA. NO.: 15.247(b)(3)
TESTED BY: David Light	DATE: 10 July 2008

Test Results: Complies.

Measurement Data:

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

Frequency (MHz)	Peak Power (dBm)	Peak Power (mW)	Antenna Type	Gain (dBi)	E.I.R.P. (dBm)	E.I.R.P. (mW)
2405	2.5	1.8	Chip	2	4.5	2.8
2440	2.7	1.9	Chip	2	4.7	3.0
2475	2.4	1.7	Chip	2	4.4	2.8
Maximum EIRP (mW): 3.0 mW						

A 50 ohm port was provided for testing.

Spectrum analyzer settings: RBW/VBW = 3 MHz, Detector = Max. Peak

Test Conditions: 22 %RH
35 °C

Measurement Uncertainty: +/-1.7 dB

Test Equipment Used: 1464-1082-1472

☒ 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).

Section 5 Spurious Emissions at Antenna Terminals

NAME OF TEST: Spurious Emissions at Antenna Terminals	PARA. NO.: 15.247 (d)
TESTED BY: David Light	DATE: 10 July 2008

Test Results: Complies.

Measurement Data: See attached plots.

Test Conditions: 22 %RH
35 °C

Measurement Uncertainty: +/-1.7 dB

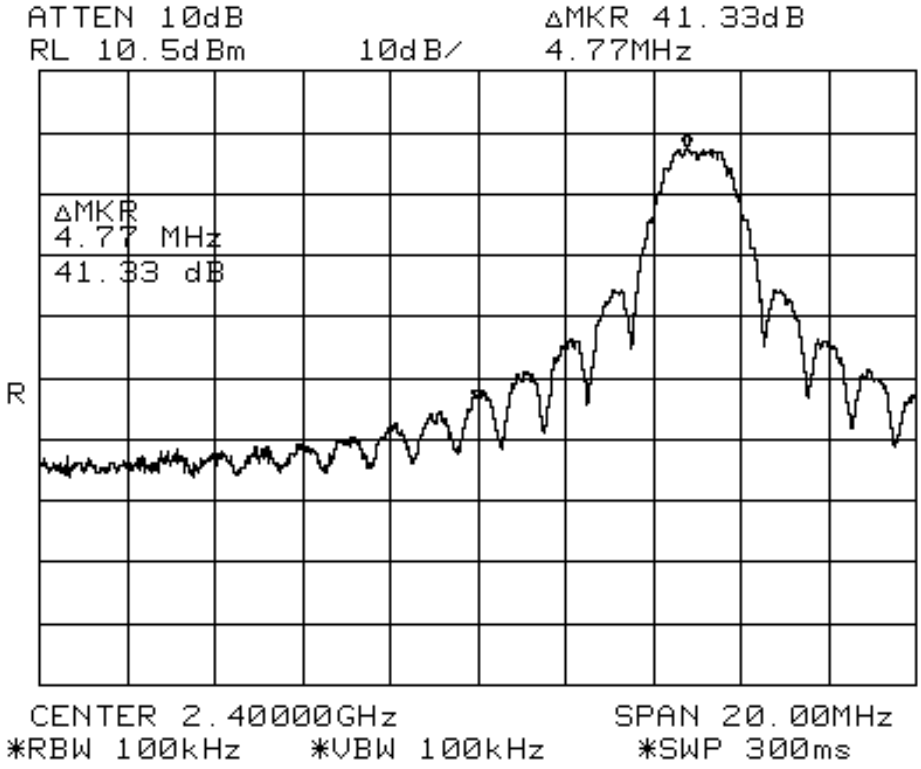
Test Equipment Used: 1464-1082-1472

A 50 ohm port was provided for testing.

Detector: Max. Peak

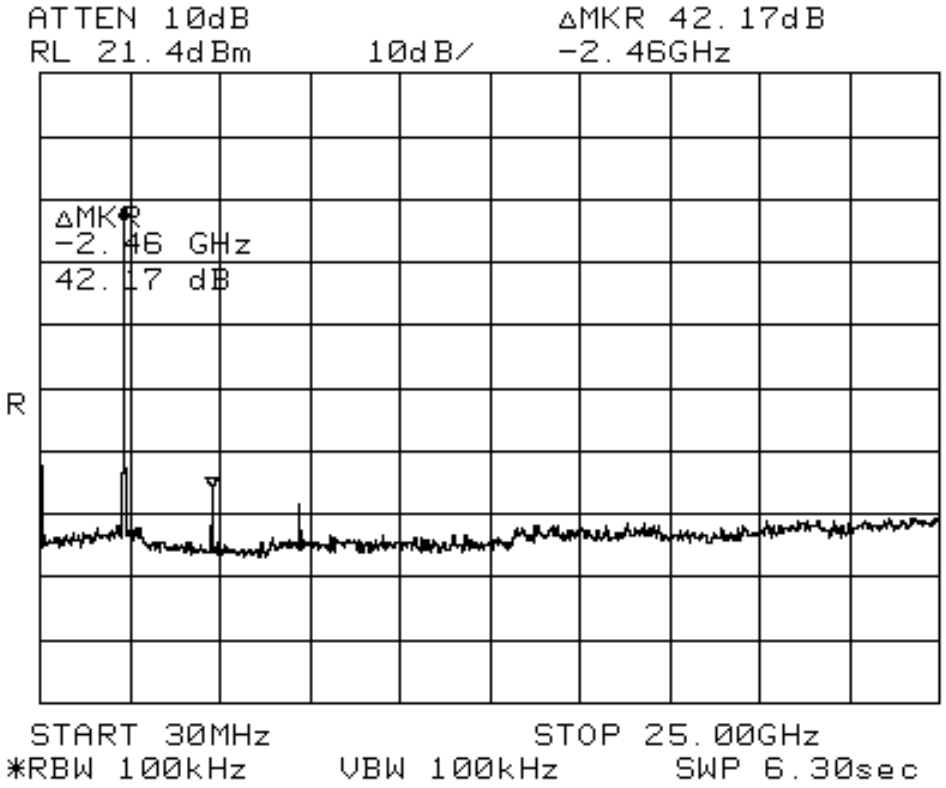
Test Data – Spurious Emissions at Antenna Terminals

Lower Band Edge



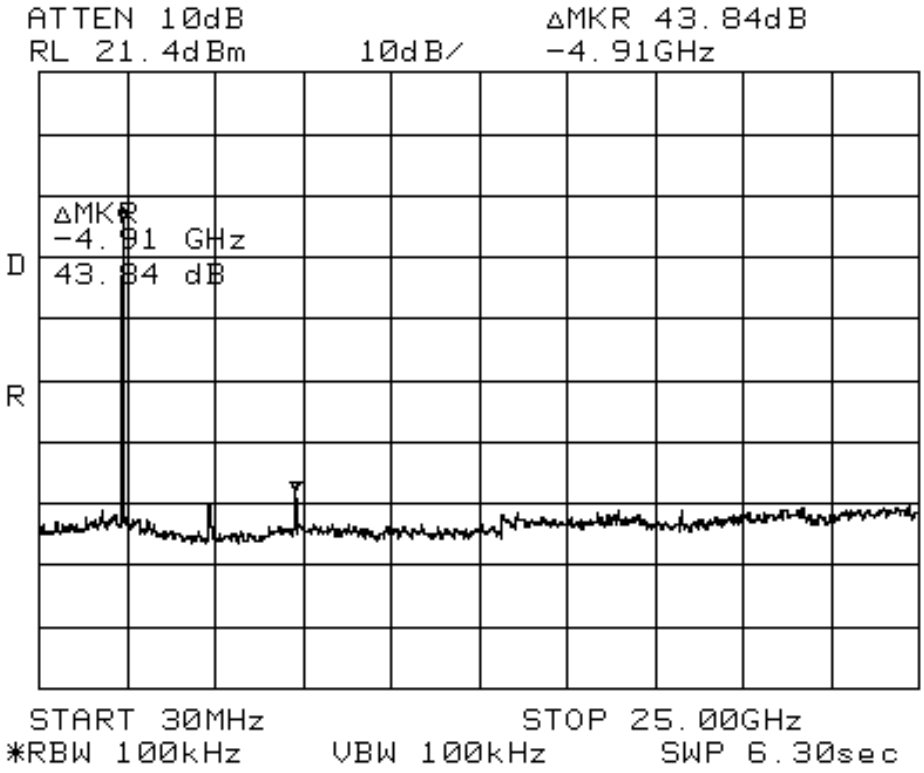
Test Data – Spurious Emissions at Antenna Terminals

Low Channel



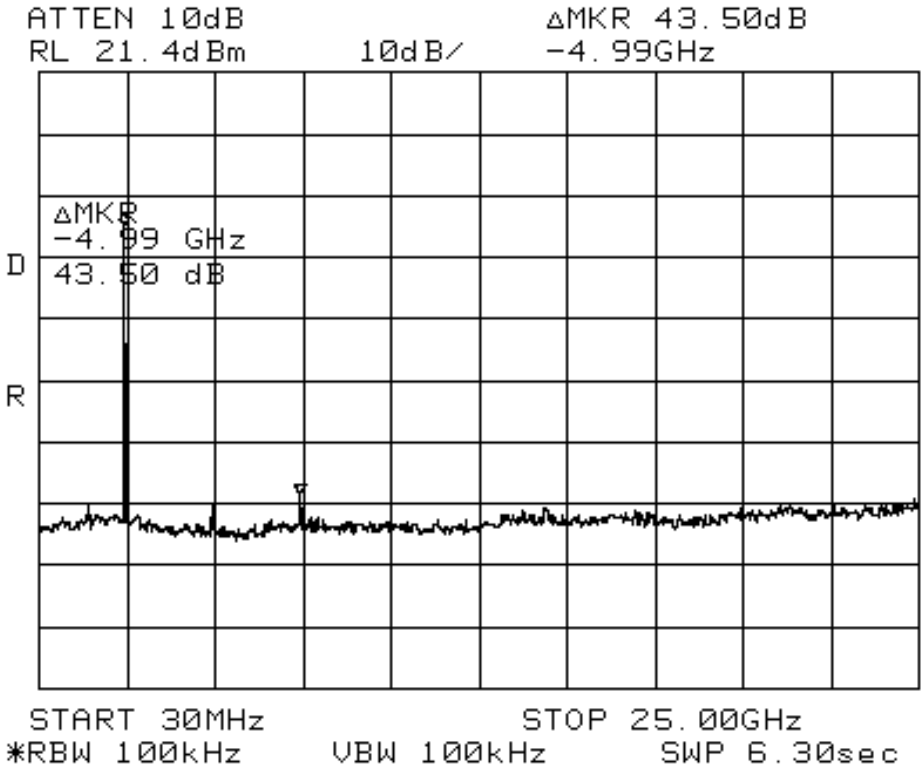
Test Data – Spurious Emissions at Antenna Terminals

Mid Channel



Test Data – Spurious Emissions at Antenna Terminals

High Channel



Section 6. Radiated Emissions

NAME OF TEST: Radiated Emissions	PARA. NO.: 15.247 (d)
TESTED BY: David Light	DATE: 10 July 2008

Test Results: Complies.

Measurement Data: See attached table.

Test Conditions: 22 %RH
35 °C

Measurement Uncertainty: +/-1.7 dB

Test Equipment Used: 1464-1484-1485-993-1016

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).

RBW=VBW=100 kHz below 1000 MHz
RBW=VBW=1 MHz above 1000 MHz (Peak)
RBW= 1 MHz, VBW=10 Hz (Average)

The device transmits at greater than 99% duty cycle.

Radiated Emissions

Meas. Freq. (MHz)	Ant. Pol. (H/V)	Meter Reading (dBuV)	Antenna Factor (dB)	Cable 1 Loss (dB)	Cable 2 Loss (dB)	RF Gain (dB)	Corrected Reading (dBuV/m)	Spec. limit (dBuV/m)	CR/SL Diff. (dB)	Pass Fail Unc.	Comment
											Tx 2440 MHz
4880	V	48.3	33.8	1.0	3.3	31.5	54.9	74.0	-19.1	Pass	Peak
4880	V	39.2	33.8	1.0	3.3	31.5	45.8	54.0	-8.2	Pass	Average
7320	V	46.5	35.9	1.2	4.1	32.6	55.1	74.0	-18.9	Pass	Peak
7321	V	35.5	35.9	1.2	4.1	32.6	44.1	54.0	-9.9	Pass	Average
4880	H	50.2	33.8	1.0	3.3	31.5	56.8	74.0	-17.2	Pass	Peak
4880	H	40.3	33.8	1.0	3.3	31.5	46.9	54.0	-7.1	Pass	Average
7320	H	48.8	35.9	1.2	4.1	32.6	57.4	74.0	-16.6	Pass	Peak
7320	H	39.3	35.9	1.2	4.1	32.6	47.9	54.0	-6.1	Pass	Average
											Tx 2405 MHz
4810	V	45.8	33.8	1.0	3.3	31.5	52.4	54.0	-1.6	Pass	Peak
7215	V	49.7	35.9	1.2	4.1	32.6	58.3	74.0	-15.7	Pass	Peak
7215	V	40.2	35.9	1.2	4.1	32.6	48.8	54.0	-5.2	Pass	Average
4810	H	47.0	33.8	1.0	3.3	31.5	53.6	54.0	-0.4	Pass	Peak
7215	H	54.3	35.9	1.2	4.1	32.6	62.9	74.0	-11.1	Pass	Peak
7215	H	44.5	35.9	1.2	4.1	32.6	53.1	54.0	-0.9	Pass	Average
											Tx 2475 MHz
2483.5	V	45.8	29.0	0.8	2.3	32.8	45.1	54.0	-8.9	Pass	Peak
4950	V	46.0	33.8	1.0	3.3	31.5	52.6	54.0	-1.4	Pass	Peak
7425	V	49.2	35.9	1.2	4.1	32.6	57.8	74.0	-16.2	Pass	Peak
7425	V	38.8	35.9	1.2	4.1	32.6	47.4	54.0	-6.6	Pass	Average
2483.5	H	48.3	29.0	0.8	2.3	32.8	47.6	54.0	-6.4	Pass	Peak
4950	H	49.3	33.8	1.0	3.3	31.5	55.9	74.0	-18.1	Pass	Peak
4950	H	40.2	33.8	1.0	3.3	31.5	46.8	54.0	-7.2	Pass	Average
7425	H	44.0	35.9	1.2	4.1	32.6	52.6	54.0	-1.4	Pass	Peak

Section 7. Peak Power Spectral Density

NAME OF TEST: Peak Power Spectral Density	PARA. NO.: 15.247(e)
TESTED BY: David Light	DATE: 10 July 2008

Test Results: Complies.

Measurement Data: See attached data..

Test Conditions: 22 %RH
35 °C

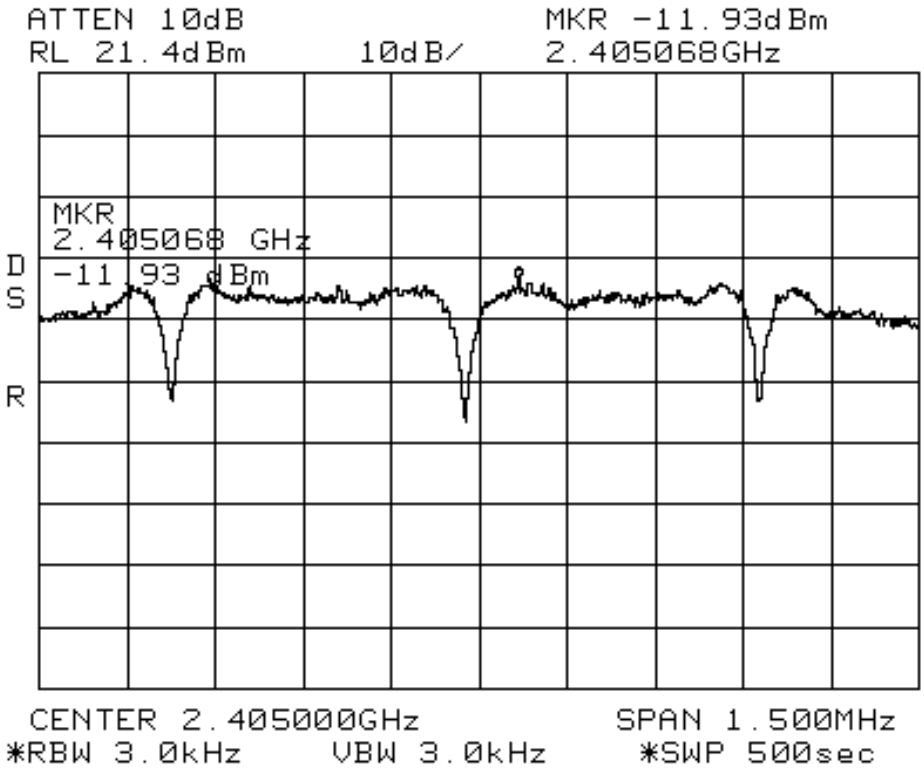
Measurement Uncertainty: +/-1.7 dB

Test Equipment Used: 1464-1082-1472

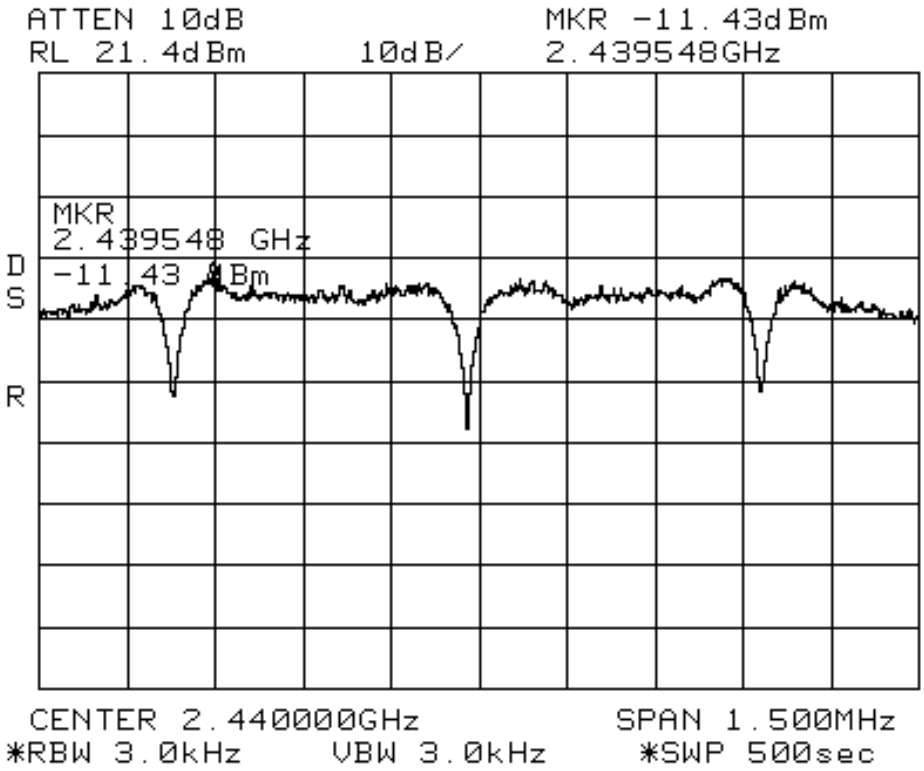
A 50 ohm port was provided for testing.

Detector: Max. Peak

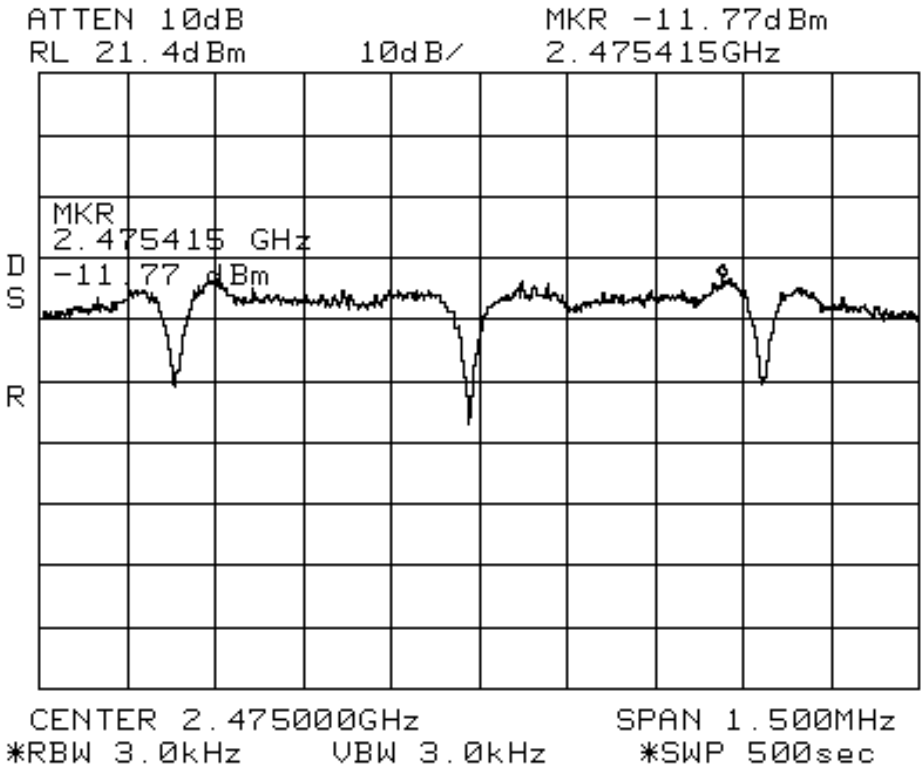
Peak Power Spectral Density



Peak Power Spectral Density



Peak Power Spectral Density



Section 8. Test Equipment List

Nemko ID	Description	Manufacturer Model Number	Serial Number	Calibration Date	Calibration Due
1464	Spectrum analyzer	Hewlett Packard 8563E	3551A04428	01/24/07	01/24/09
1082	CABLE 2m	Astrolab 32027-2-29094-72TC	N/A	CBU	N/A
1472	20db Attenuator DC 18 Ghz	Omni Spectra 20600-20db	NONE	CBU	N/A
1484	Cable	Storm PR90-010-072	N/A	05/07/08	05/07/09
1485	Cable	Storm PR90-010-216	N/A	05/07/08	05/07/09
993	Horn antenna	A.H. Systems SAS-200/571	XXX	08/31/07	08/30/08
1016	Pre-Amp	HEWLETT PACKARD 8449A	2749A00159	05/07/08	05/07/09
1763	Bilog Antenna	Schaffner CBL 6111D	22926	9/21/07	9/21/08

ANNEX A - TEST DETAILS

NAME OF TEST: Maximum Peak Output Power	PARA. NO.: 15.247(b)(3)

Minimum Standard: The maximum peak output power shall not exceed 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.

Substitution Antenna Method for Integral Antennas:
The peak field strength of the carrier is measured in a worst-case configuration with a RBW > 5 times the occupied bandwidth of the transmitted waveform. For cases where the RBW of the test instrument is not sufficient, the power is measured using a peak power meter instead of the spectrum analyzer.

The RBW of the spectrum analyzer shall be set to a value greater than the measured 6 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: Occupied Bandwidth	PARA. NO.: 15.247(a)(2)

Minimum Standard: Systems using digital modulation techniques may operate in the 902-928 MHz, 2400-2483.5 MHz, and 5725-5850 MHz bands. The minimum 6 dB bandwidth shall be at least 500 kHz.

Method Of Measurement:

The spectrum analyzer is set as follows:

RBW = VBW = 100 kHz.
Span: Sufficient to display 6 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: Occupied Bandwidth	PARA. NO.: 15.247(a)(2)

Minimum Standard: The minimum 6 dB bandwidth shall be at least 500 kHz

NAME OF TEST: Spurious Emissions(conducted) 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 (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 IS SEARCHED TO THE 10th HARMONIC OF THE HIGHEST FREQUENCY GENERATED IN THE EUT.

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 (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

NAME OF TEST: Transmitter Power Density	PARA. NO.: 15.247(d)

Minimum Standard: The transmitted power density averaged over any 1 second interval shall not be greater than +8 dBm in any 3 kHz bandwidth.

Method Of Measurement: The spectrum analyzer is set as follows:

RBW: 3 kHz
VBW: >3 kHz
Span: => measured 6 dB bandwidth
Sweep: Span(kHz)/3 (i.e. for a span of 1.5 MHz the sweep rate is 1500/3 = 500 sec.
LOG dB/div.: 2 dB

Note: For devices with spectrum line spacing =< 3 kHz, the RBW of the analyzer is reduced until the spectral lines are resolved. The measurement data is normalized to 3 kHz by summing the power of all the individual spectral lines within a 3 kHz band in linear power units.

For Devices With Integral Antenna:

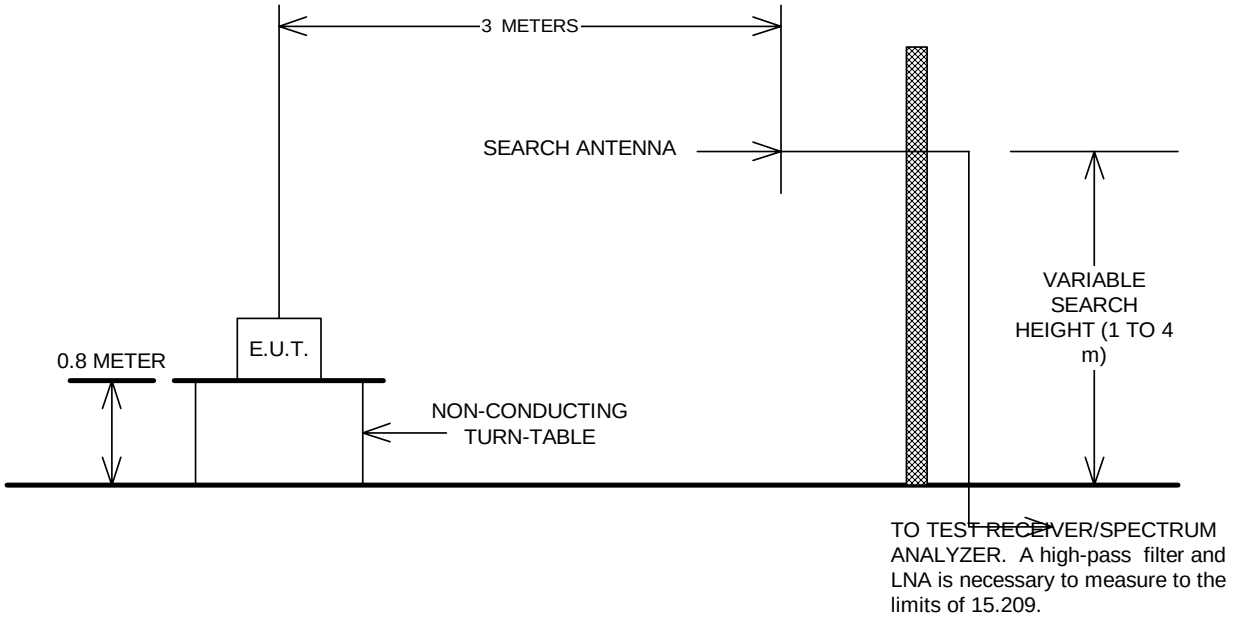
For devices with non-detachable antennas, the received field strength is peaked and the spectrum analyzer is set as above. The peak emission level is then measured and converted to a field strength by adding the appropriate antenna factor and cable loss. This field strength is then converted to an equivalent isotropic radiated power using the same method as described for Peak Power output.

Number of channels tested:

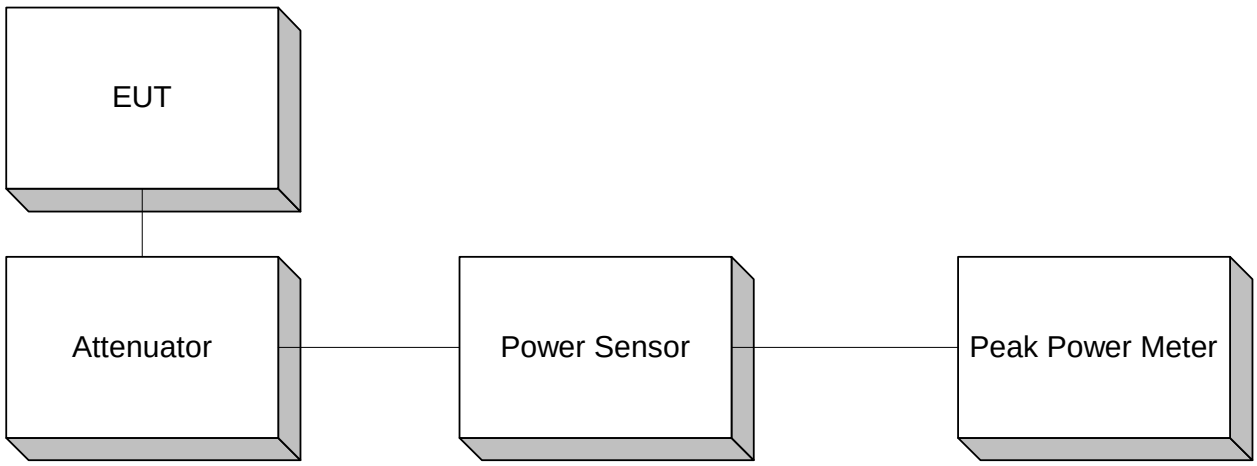
Tuning Range	Number Of Channels Tested	Channel Location In Band
1 MHz or Less	1	Middle
1 to 10 MHz	2	Top And Bottom
More Than 10 MHz	3	Top, Middle, Bottom

ANNEX B - TEST DIAGRAMS

Test Site For Radiated Emissions



Peak Power At Antenna Terminals



Note: A spectrum analyzer may be substituted for Peak Power Meter given that the measurement bandwidth is sufficient to capture the 60 dB bandwidth of the transmitter.

Minimum 6 dB Bandwidth
Peak Power Spectral Density
Spurious Emissions (conducted)