Nemko Test Report:	10241616_TRF_15.247_RSS-210
Applicant:	Research Electronics International, LLC 455 Security Drive Algood, TN 38506 USA
Equipment Under Test: (E.U.T.)	ORION 2.4
FCC Identifier:	EIH-ORION24
Industry Canada Identifier:	11220A-ORION24
In Accordance With:	**FCC Part 15, Subpart C, 15.247 and Industry Canada RSS-210, Issue 8** Digital Transmission Systems
Tested By:	Nemko USA, Inc. 802 N. Kealy Lewisville, Texas 75057-3136

TESTED BY: _____ **DATE:** **27-June-2013**

David Light, Senior Wireless Engineer

APPROVED BY: _____ **DATE:** **28-June-2013**

Michael Cantwell, Reviewer

Number of Pages: 38

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Section 1. Summary of Test Results

Manufacturer: Research Electronics International, LLC

Model No.: ORION 2.4

Serial No.: O24P8

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 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 and Industry Canada.

☒	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) / RSS-Gen 7.2.4	Complies
Minimum 6 dB Bandwidth	15.247(a)(2) / RSS-210 A8.2(a)	Complies
Maximum Peak Power Output	15.247(b)(3) / Rss-210 A8.4(4)	Complies
Spurious Emissions (Antenna Conducted)	15.247(d) / RSS-210 A8.5	Complies
Spurious Emissions (Restricted Bands)	15.247(d)/15.209(a) / RSS-Gen 7.2.2	Complies
Peak Power Spectral Density	15.247(e) / RSS-210 A8.2(b)	Complies

Footnotes:

The EUT is battery powered.

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: 2404 to 2473 MHz

Channel Spacing: 1 MHz

User Frequency Adjustment: Software controlled

Supply Voltage: 10.8 Vdc lithium ion battery

Integral Antenna: Yes

Antenna Gain: 8.2 dBi

Description of EUT

Portable device designed for commercial applications used to detect and locate hidden electronics

Section 3. Occupied Bandwidth

NAME OF TEST: Occupied Bandwidth	PARA. NO.: 15.247(a)(2) A8.2(a)
TESTED BY: David Light	DATE: 21 June 2013

Test Results: Complies.

Measurement Data: See 6 dB BW plot

Measured 6 dB bandwidth:	1.23 MHz
Channel Separation:	1 MHz

Test Conditions:

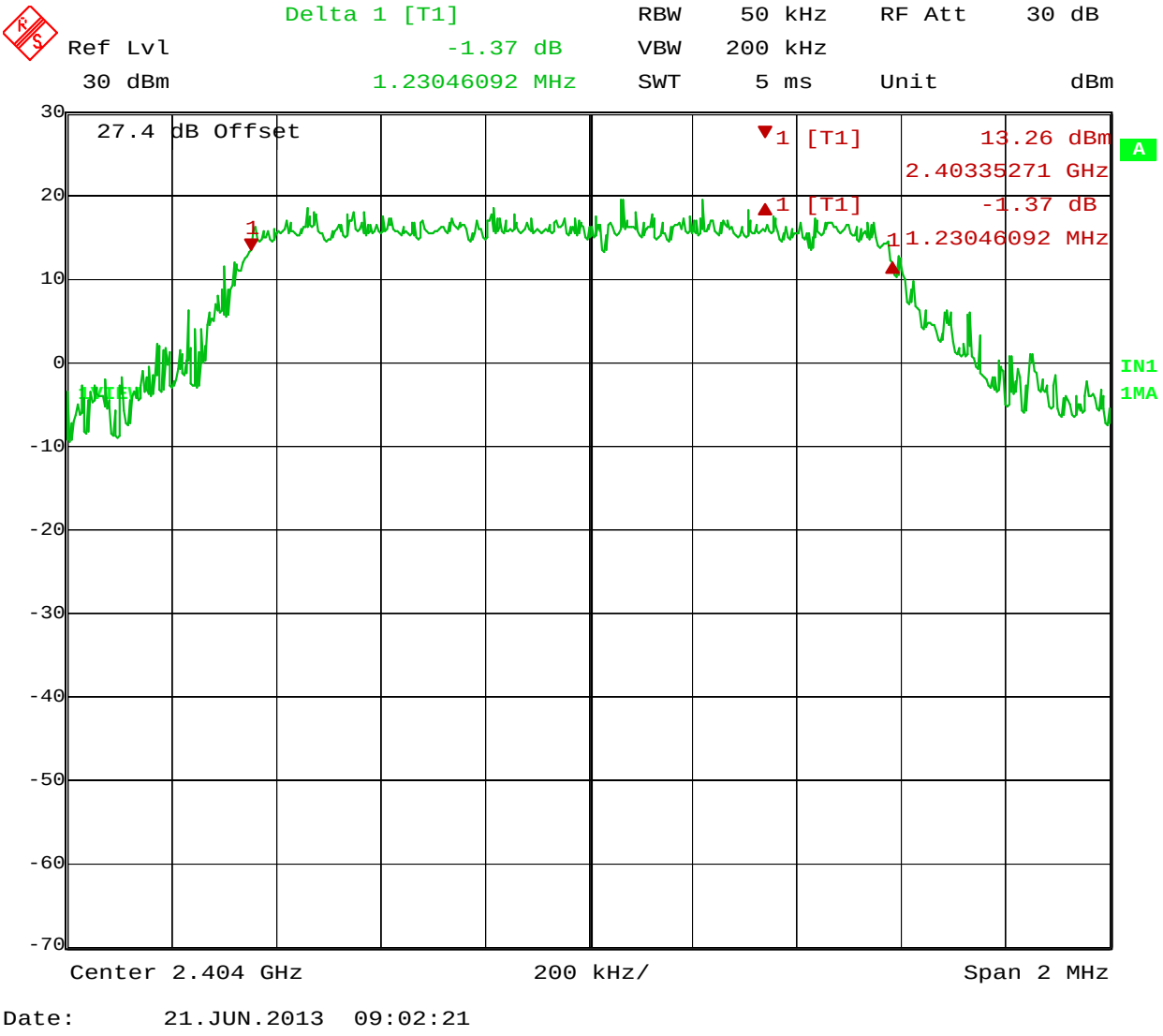
49	%RH
23	°C

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

Test Equipment Used: 1767-1082-1472

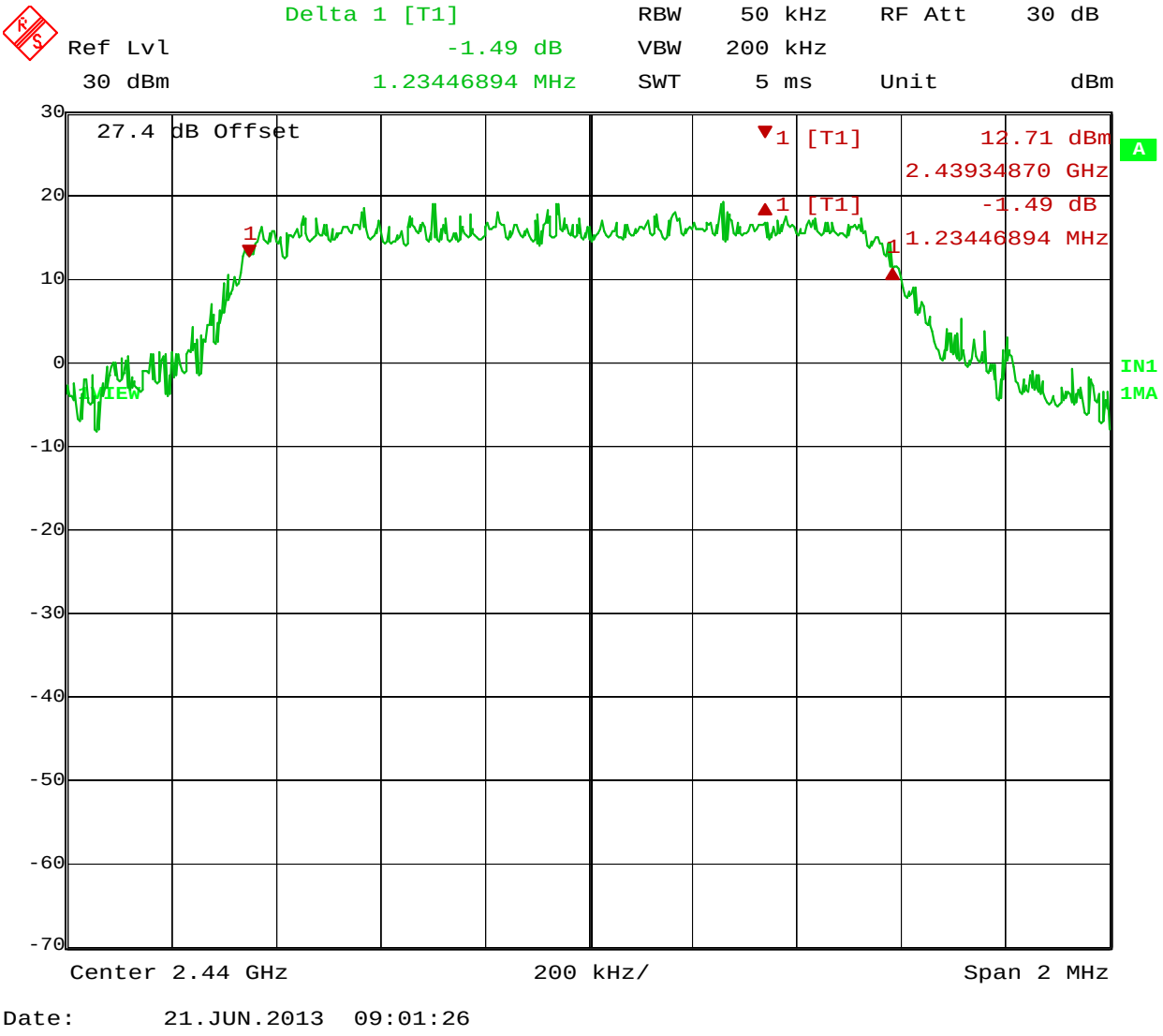
Test Data – Occupied Bandwidth

Low Channel



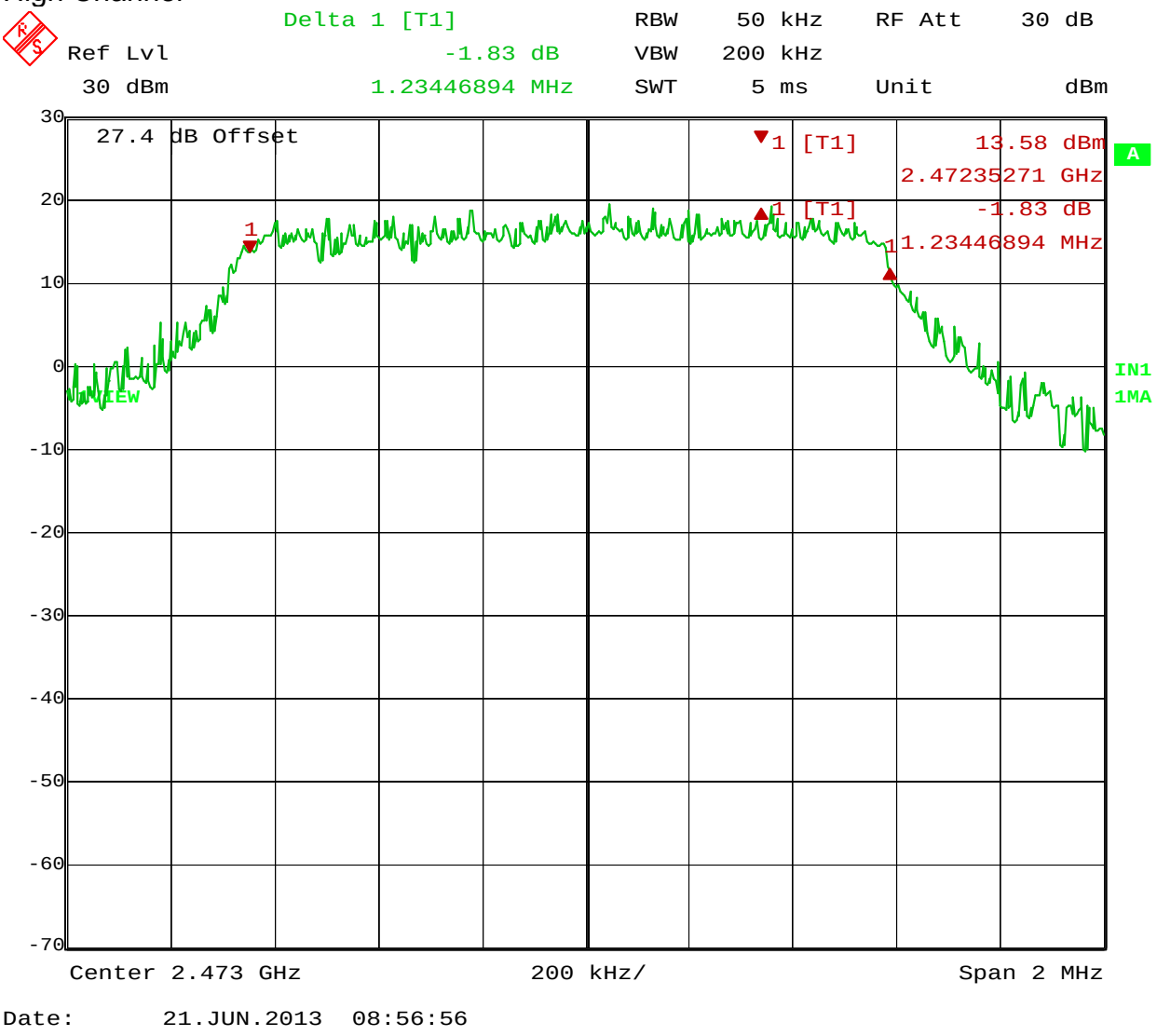
Test Data – Occupied Bandwidth

Mid Channel



Test Data – Occupied Bandwidth

High Channel



Section 4. Maximum Output Power

NAME OF TEST: Maximum Output power	PARA. NO.: 15.247(b)(3) A8.4(4)
TESTED BY: David Light	DATE: 27 June 2013

Test Results: Complies.

Measurement Data: Refer to attached data

Test Conditions: 51 %RH
24 °C

Measurement Uncertainty: +/-1.7 dB

Test Equipment Used: 1767-1082-1472

☒ This device was tested at +/- 15% input power per 15.31(e), with no variation in output power.

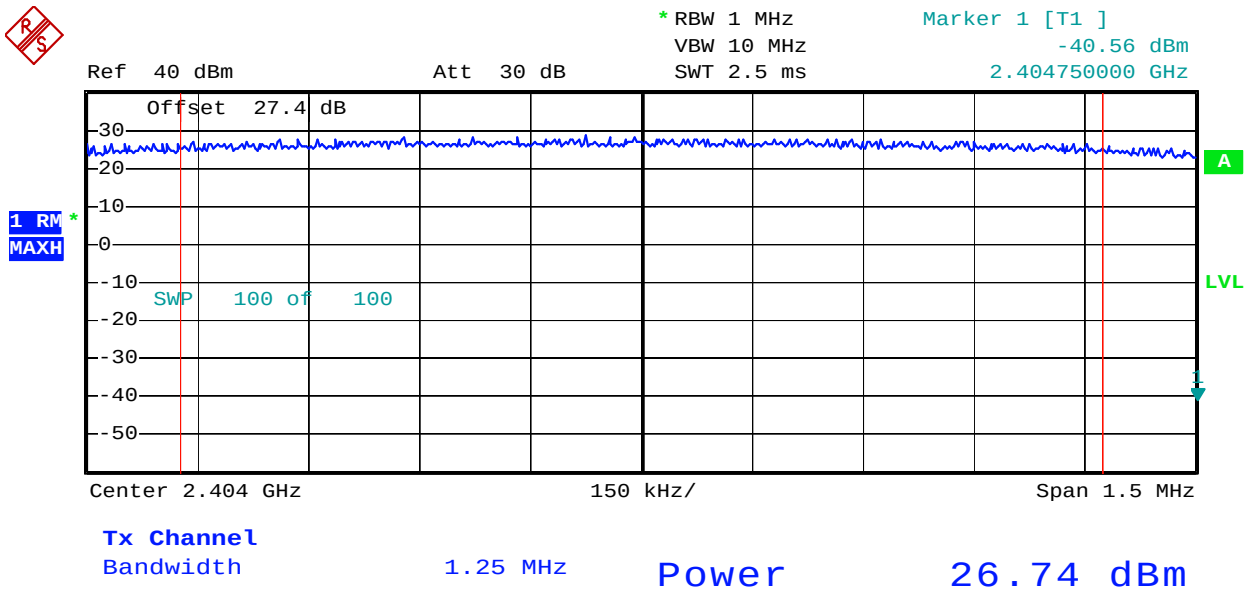
☒ For battery powered equipment, the device was tested with a fresh battery per 15.31(e).

☒ The device was tested on three channels per 15.31(l).

☐ This test was performed radiated.

Test Data – Maximum Output Power

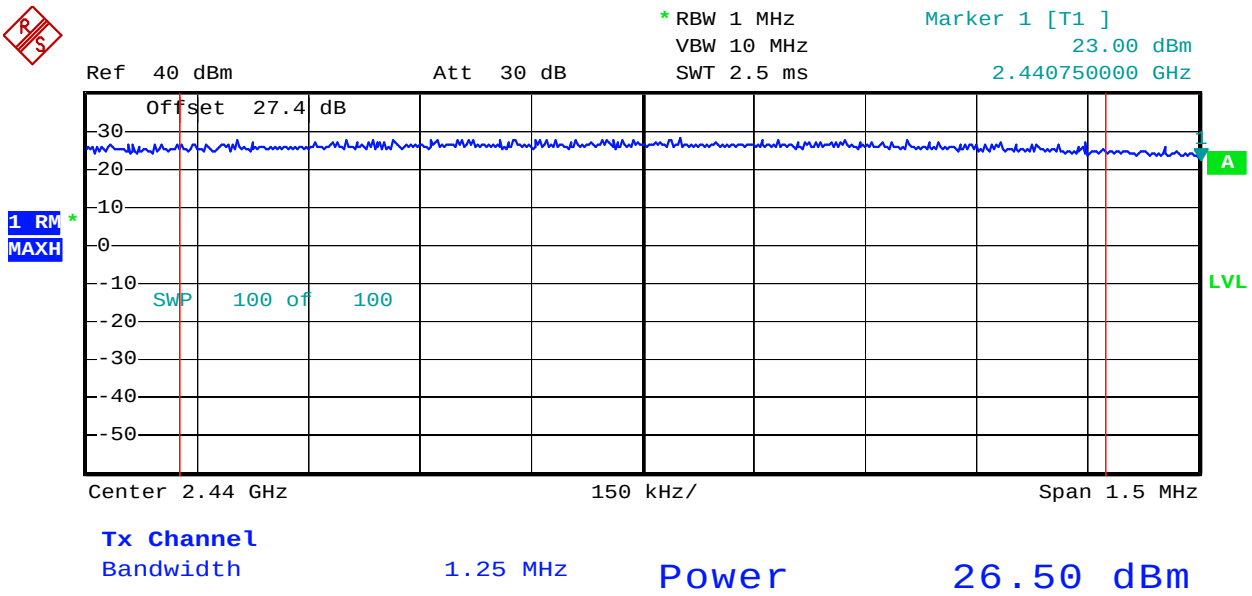
Measurement Procedure AVG1



Date: 27.JUN.2013 02:13:00

Test Data – Maximum Output Power

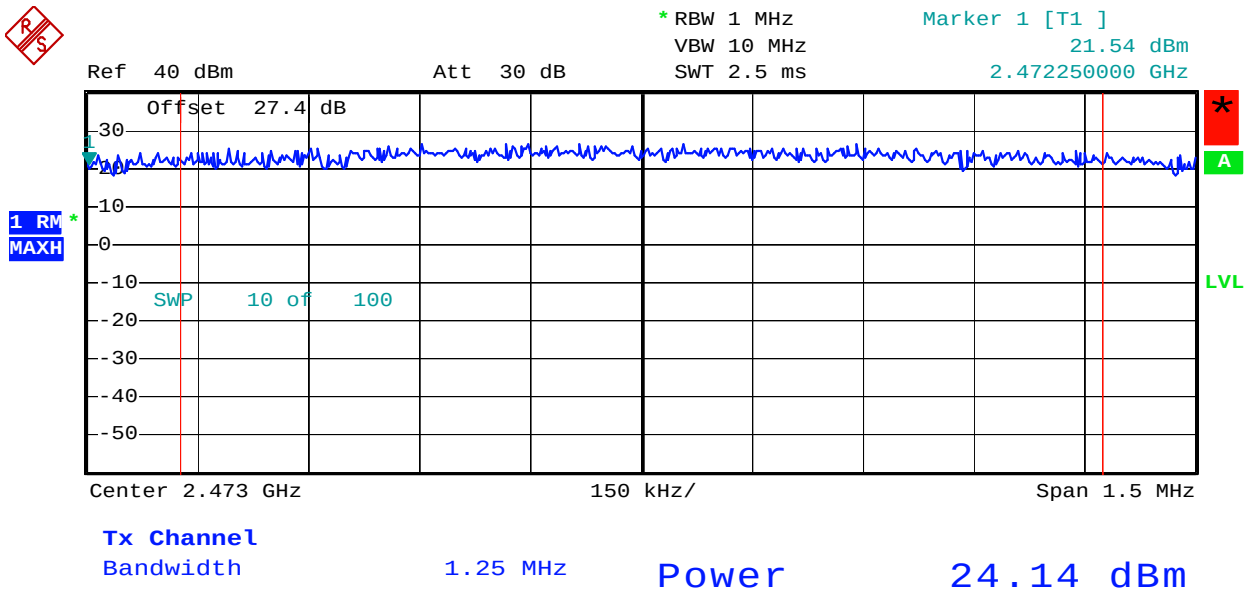
Measurement Procedure AVG1



Date: 27.JUN.2013 02:12:21

Test Data – Maximum Output Power

Measurement Procedure AVG1



Date: 27.JUN.2013 02:11:38

Section 5 Spurious Emissions at Antenna Terminals

NAME OF TEST: Spurious Emissions at Antenna Terminals	PARA. NO.: 15.247 (d) A8.5
TESTED BY: David Light	DATE: 24 June 2013

Test Results: Complies.

Measurement Data: See attached plots.

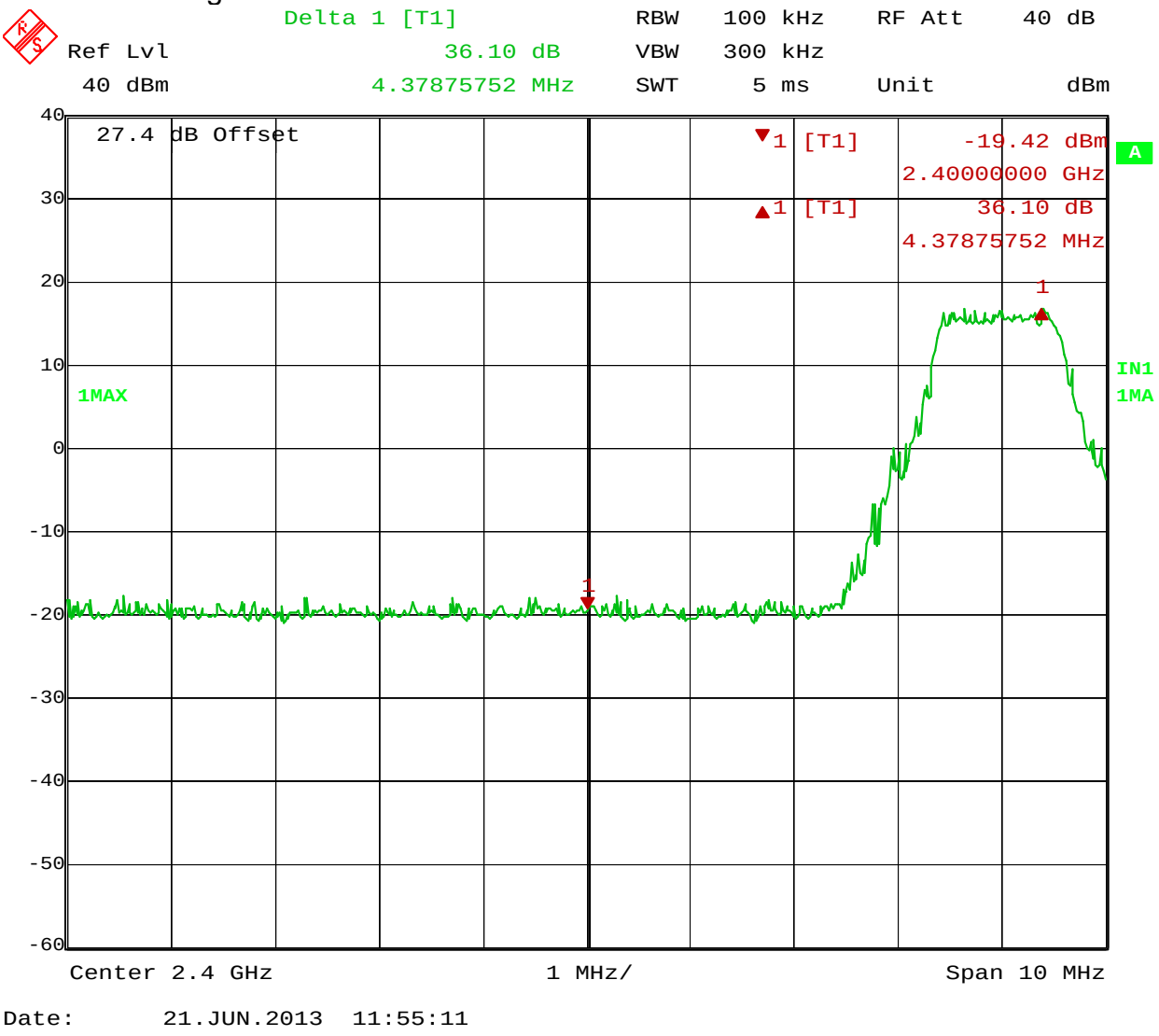
Test Conditions: 51 %RH
24 °C

Measurement Uncertainty: +/-1.7 dB

Test Equipment Used: 1767-1082-1472

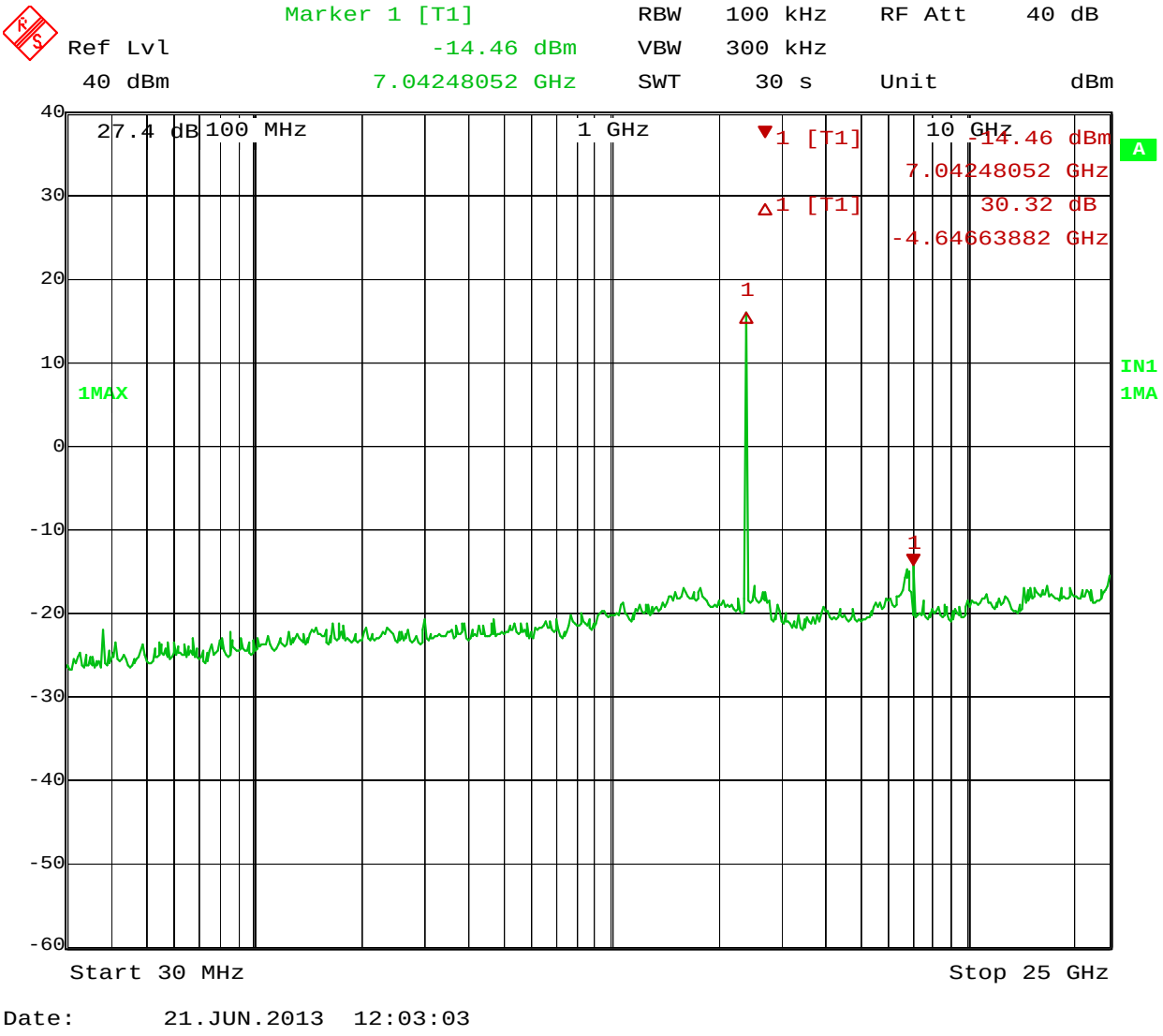
Test Data – Spurious Emissions at Antenna Terminals

Lower Band Edge



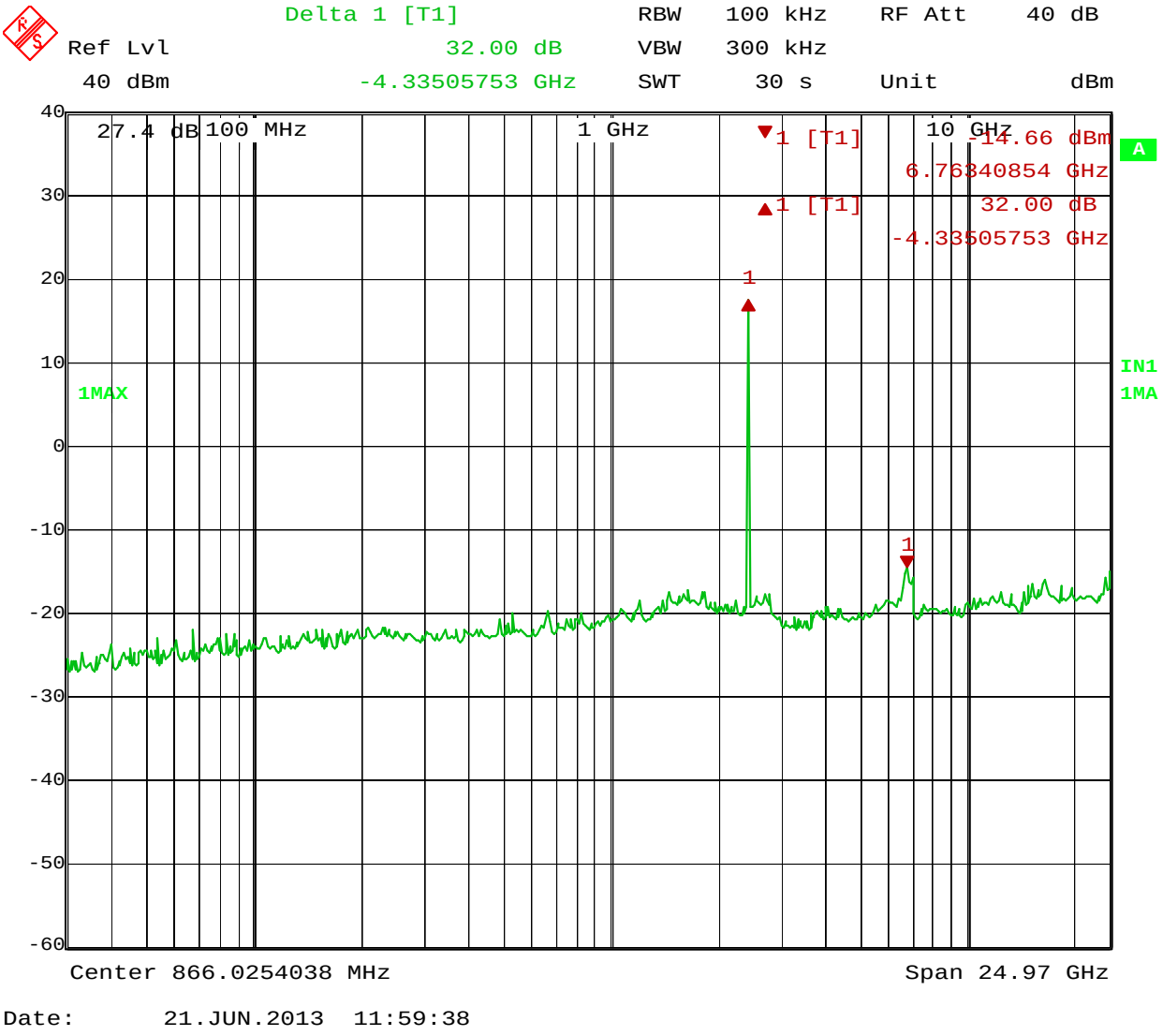
Test Data – Spurious Emissions at Antenna Terminals

Low Channel



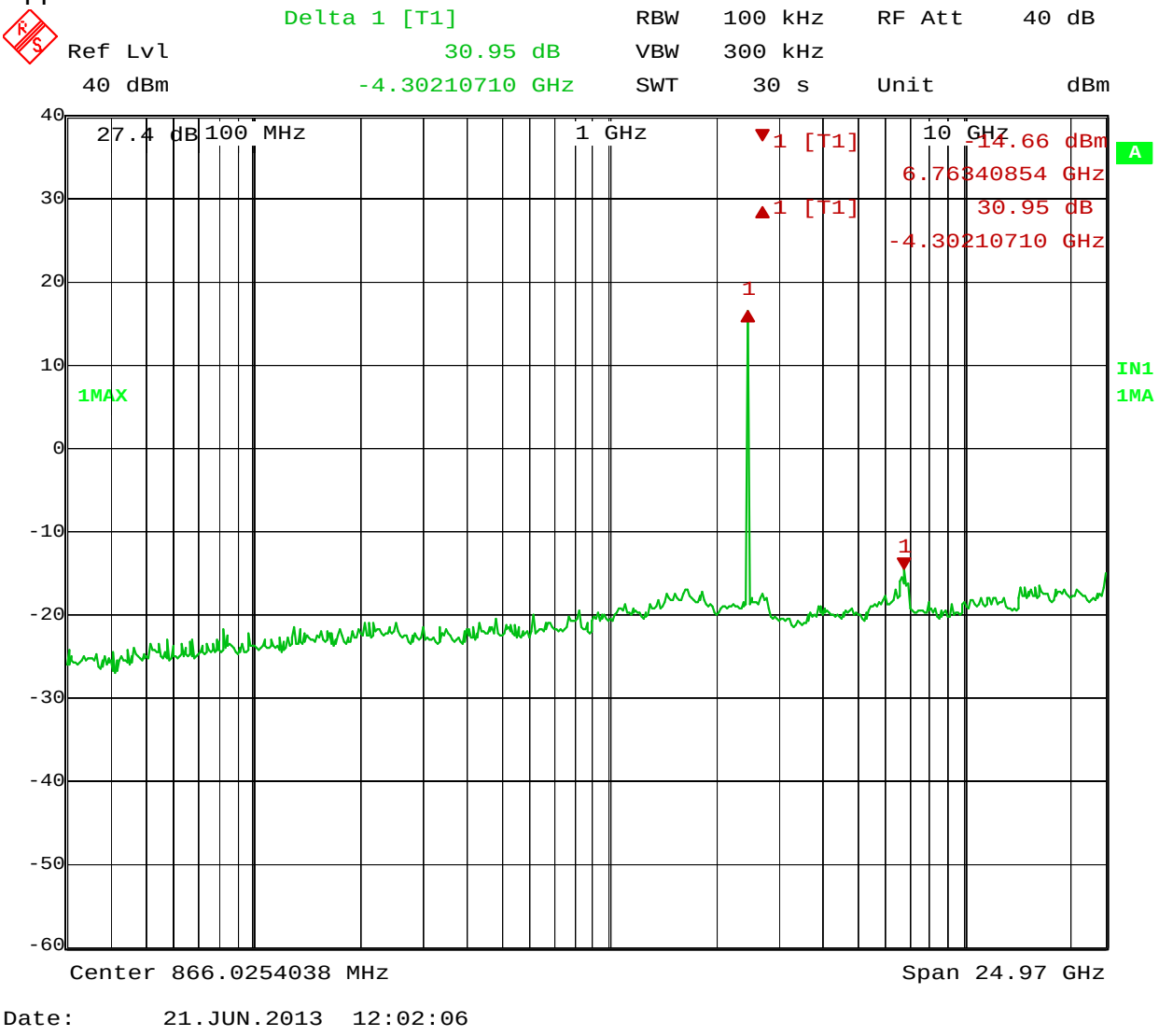
Test Data – Spurious Emissions at Antenna Terminals

Mid Channel



Test Data – Spurious Emissions at Antenna Terminals

Upper Channel



Section 6. Radiated Emissions

NAME OF TEST: Radiated Emissions	PARA. NO.: 15.247 (d) RSS-Gen 7.2.2
TESTED BY: David Light	DATE: 21 June 2013

Test Results: Complies.

Measurement Data: See attached table.

Test Conditions: 49 %RH
23 °C

Measurement Uncertainty: +/-1.7 dB

Test Equipment Used: 1767-1763-1783-1025-1785-1304

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.

Frequency Range	Limit Type	RBW (MHz)	VBW (MHz)	Detector Type
30-1000	Peak	0.1	0.3	Peak
>1000	Peak	1	3	Peak
>1000	Average	1	10	RMS

Radiated Emissions

Meas. Freq. (MHz)	Ant. Pol. (H/V)	Atten. (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	Detector	Comment:
											High Channel	
2483.5	H	0	28.7	29	5.8	0.0	63.5	74.0	-10.5	Pass	Peak	NF
2483.5	H	0	18.3	29	5.8	0.0	53.1	54.0	-0.9	Pass	Average	NF
2483.5	V	0	28.7	29	5.8	0.0	63.5	74.0	-10.5	Pass	Peak	NF
2483.5	V	0	18.3	29	5.8	0.0	53.1	54.0	-0.9	Pass	Average	NF

Section 7. Peak Power Spectral Density

NAME OF TEST: Peak Power Spectral Density	PARA. NO.: 15.247(e) A8.2(b)
TESTED BY: David Light	DATE: 21 June 2013

Test Results: Complies.

Measurement Data: See attached data..

Test Conditions: 49 %RH
23 °C

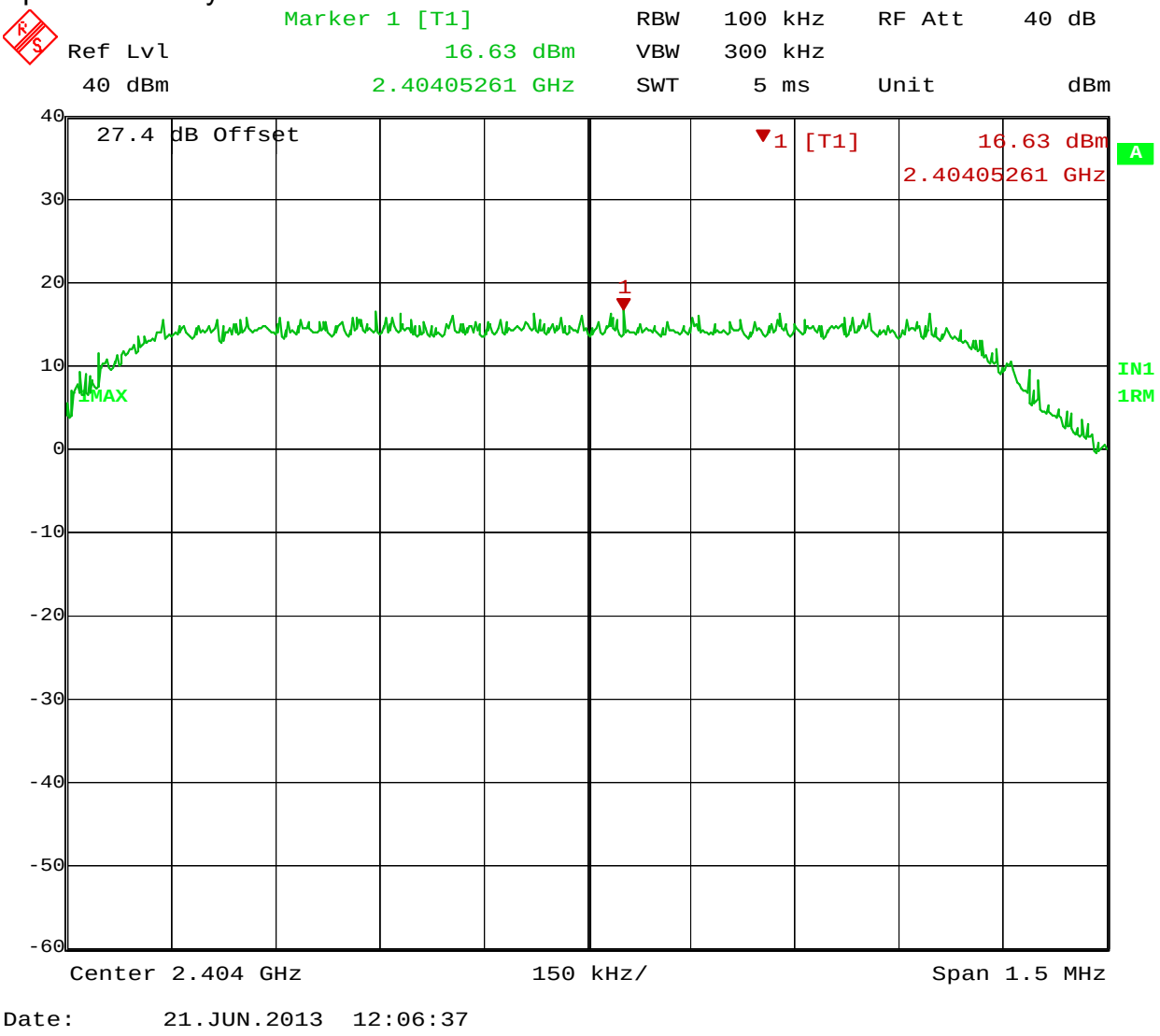
Measurement Uncertainty: +/-1.7 dB

Test Equipment Used: 1767-1082-1472

Peak Power Spectral Density

Low Channel

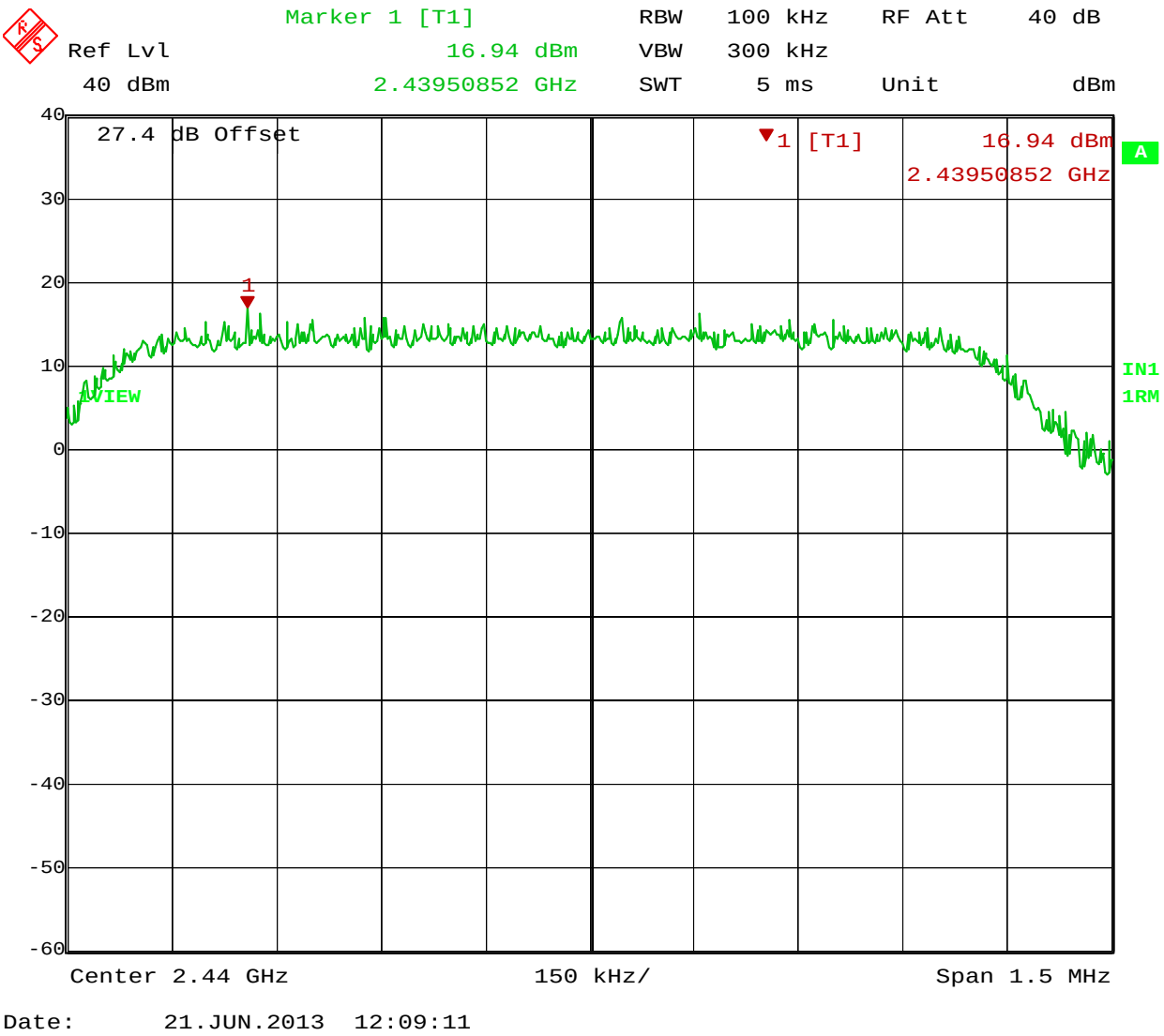
Spectral Density = 16.63 dBm – 15.2 dB = +1.43 dBm



Peak Power Spectral Density

Mid Channel

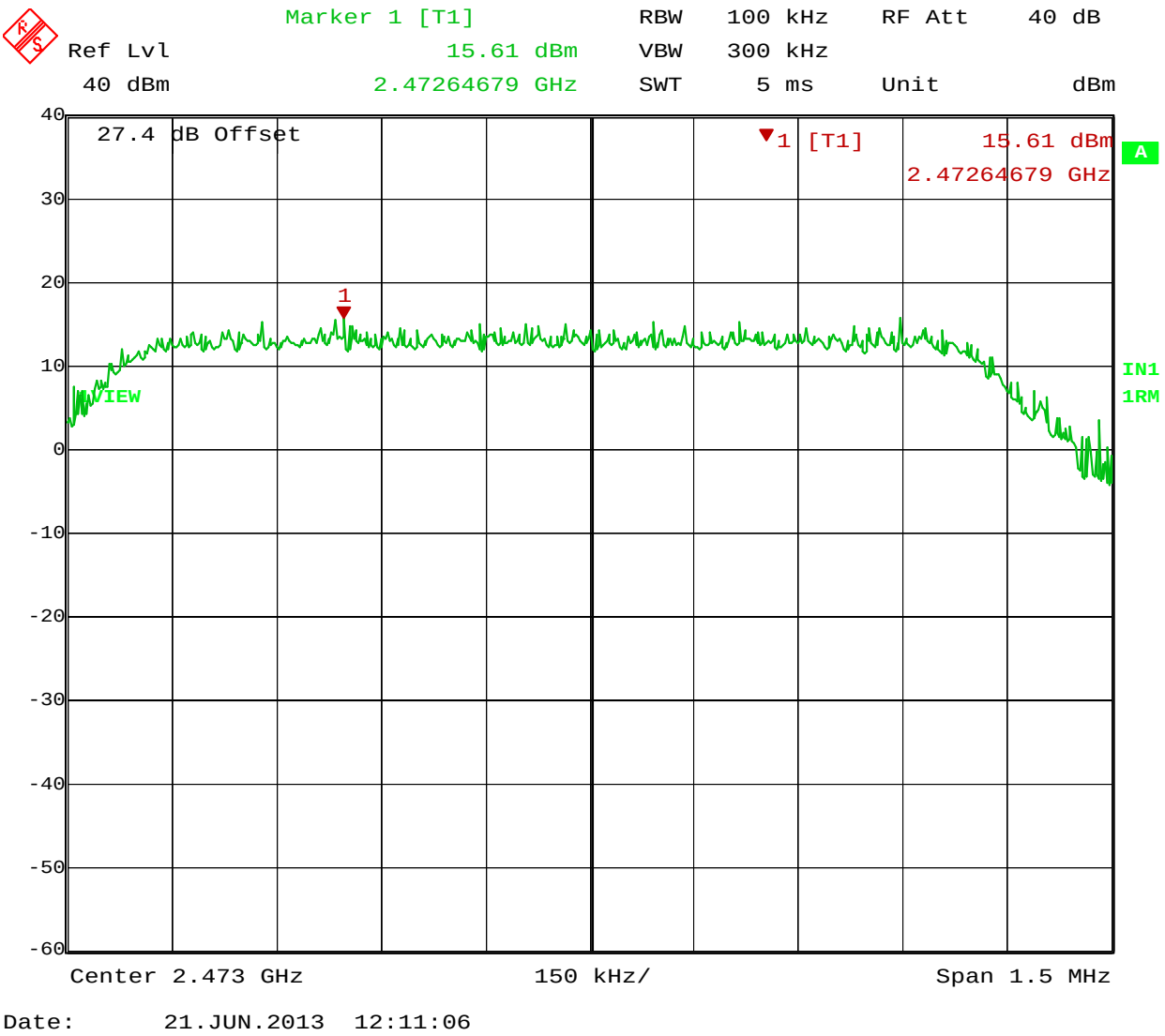
Spectral Density = 16.94 dBm – 15.2 dB = 1.74 dBm



Peak Power Spectral Density

Upper Channel

Spectral Density = 15.61 dBm – 15.2 dB = 0.41 dBm



Section 8. Powerline Conducted Emissions

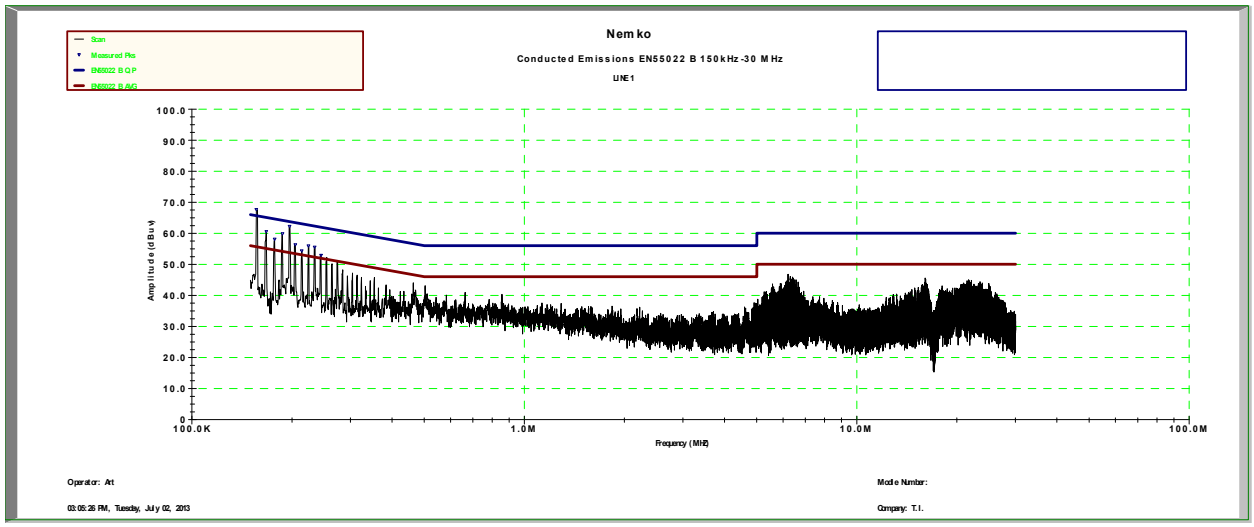
NAME OF TEST: Powerline Conducted Emissions	PARA. NO.: 15.207(a)
TESTED BY: Brian Boyea	DATE: 03 July 2013

Test Results: Complies.

Measurement Data: See attached plots.

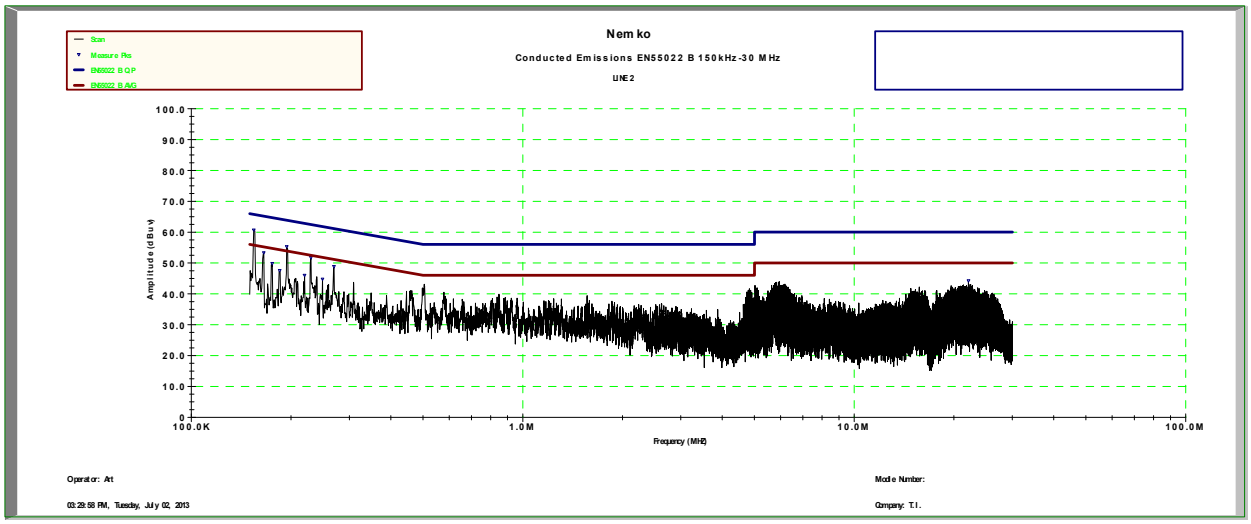
Measurement Uncertainty: +/- 1.7 dB

Test Data – Powerline Conducted Emissions (Neutral Side)



(1)	(2)	(4)	(5)	(6)	(7)	(8)	(9)
			Quasi-Peak		Average		
Frequency (MHz)	QP Level (dBµV)	AVE Level (dBµV)	Limit (dBµV)	Margin (dB)	Limit (dBµV)	Margin (dB)	Pass/ Fail
0.1557	64.6	49.7	65.8	1.2	55.8	6.1	Pass
0.1648	54.5	39.6	65.6	11.1	55.6	15.9	Pass
0.1795	52.0	35.6	65.2	13.2	55.2	19.5	Pass
0.1871	55.7	42.2	64.9	9.2	54.9	12.7	Pass
0.1938	57.5	43.7	64.7	7.2	54.7	11.0	Pass
0.2022	50.2	37.6	64.5	14.3	54.5	16.9	Pass
0.2117	51.7	30.4	64.2	12.5	54.2	23.9	Pass
0.2242	47.7	34.7	63.9	16.2	53.9	19.2	Pass
0.2321	51.9	38.8	63.7	11.8	53.7	14.8	Pass
0.2424	43.2	31.3	63.4	20.1	53.4	22.0	Pass

Test Data – Powerline Conducted Emissions (Line Side)



(1)	(2)	(4)	(5)	(6)	(7)	(8)	(9)
			Quasi-Peak		Average		
Frequency (MHz)	QP Level (dBµV)	AVE Level (dBµV)	Limit (dBµV)	Margin (dB)	Limit (dBµV)	Margin (dB)	Pass/ Fail
0.1523	56.7	44.6	65.9	9.2	55.9	11.3	Pass
0.1942	52.5	41.9	64.7	12.2	54.7	12.8	Pass
0.2299	47.5	36.9	63.7	16.2	53.7	16.8	Pass

Section 9. Test Equipment List

Asset Tag	Description	Manufacturer	Model	Serial #	Last Cal	Next Cal
1025	Preamplifier, 25dB	Nemko USA, Inc.	LNA25	399	05-Mar-2013	05-Mar-2014
1082	Cable, 2m	Astrolab	32027-2-29094-72TC		N/R	
1304	Antenna, Horn	Electro Metrics	RGA-60	6151	11-Dec-2012	11-Dec-2014
1472	Attenuator,	Omni Spectra	20600-20db		N/R	
1763	Antenna, Bilog	Schaffner	CBL 6111D	22926	07-Mar-2013	07-Mar-2014
1767	Receiver	Rohde & Schwartz	ESIB26	837491/0002	19-Dec-2012	19-Dec-2013
1783	Cable Assy, 3m Chamber	Nemko	Chamber		26-Sep-2012	26-Sep-2013
1785	Preamplifier	A.H. Systems	PAM-0126	143	09-Jan-2013	09-Jan-2014
1258	LISN .15mhz-30mhz	EMCO	3825/2	1305	04-Mar-2013	04-Mar-2014
1922	.5m Cable	Nemko USA	1922 RG 214	1	18-Jan-2013	18-Jan-2014
1924	3m Cable	Nemko USA	1924 RG 214	1	21-Jan-2013	21-Jan-2014
1949	Transient Limiter	Com-Power	LIT-153	531129	07-Jan-2013	07-Jan-2014
1950	Spectrum Analyzer	Rohde & Schwartz	FSP	100037	17-Jan-2013	17-Jan-2014

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.

Measurement Method

5.2.1 Maximum Peak Conducted Output Power Level

§15.247(b)(3) specifies that the maximum peak conducted output power for DTS transmitters in any of the three authorized frequency bands is 1 watt (30 dBm). The following procedures can be used to determine the maximum peak conducted output power from a DTS EUT using a spectrum analyzer.

5.2.1.1 Measurement Procedure PK1:
1. This procedure requires availability of a spectrum analyzer resolution bandwidth that is ≥ EBW.
2. Set the RBW ≥ EBW.
3. Set VBW ≥ 3 x RBW.
4. Set span = zero.
5. Sweep time = auto couple.
6. Detector = peak.
7. Trace mode = max hold.
8. Allow trace to fully stabilize.
9. Use peak marker function to determine the peak amplitude level within the fundamental emission.

5.2.1.2 Measurement Procedure PK2:

1. This procedure provides an integrated measurement alternative when the maximum available RBW < EBW.
2. Set the RBW = 1 MHz.
3. Set the VBW = 3 MHz.
4. Set the span to a value that is 5-30 % greater than the EBW.
5. Detector = peak.
6. Sweep time = auto couple.
7. Trace mode = max hold.
8. Allow trace to fully stabilize.
9. Use the spectrum analyzer's integrated band power measurement function with band limits set equal to the EBW band edges (for some analyzers, this may require a manual override to ensure use of peak detector). If the spectrum analyzer does not have a band power function, sum the spectrum levels (in linear power units) at 1 MHz intervals extending across the EBW of the spectrum.

5.2.2 Maximum Conducted (Average) Output Power Level

§15.247(b)(3) permits the maximum conducted output power to be measured as an alternative to a peak power measurement to demonstrate compliance to the one watt (30 dBm) output power limit. The maximum conducted output power is the highest total transmit power occurring in any mode when averaged over the EUT EBW. This measurement requires that the EUT be configured to transmit continuously (at a minimum duty cycle of 98%) at full power over the measurement duration. Time intervals during which the transmitter is off or transmitting at reduced power levels shall not be included.

The spectrum analyzer must be capable of utilizing a number of measurement points in each sweep that is greater than or equal to twice the span/RBW in order to ensure bin-to-bin spacing of ≤ RBW/2 so that narrowband signals are not lost between frequency bins (the use of a greater number of measurement points than the minimum requirement is recommended).
The following procedures are acceptable for determining the maximum conducted output power with a spectrum analyzer.

5.2.2.1 Measurement Procedure AVG1 (power averaging over the EBW with slow sweep speed):
1. Set the analyzer span to 5-30% greater than the EBW.
2. Set the RBW = 1 MHz.
3. Set the VBW ≥ 3 MHz.
4. Detector = power average (RMS).
5. Ensure that the number of measurement points in the sweep ≥ 2 x (span/RBW).
6. Manually set the sweep time to: ≥10 x (number of measurement points in sweep) x (transmission symbol period).
7. Perform the measurement over a single sweep.
8. Use the spectrum analyzer's integrated band power measurement function with band limits set equal to the EBW band edges to determine the maximum conducted output power of the EUT over the EBW.

Note: If the analyzer does not have a band power function, sum the spectral levels (in linear power units) at 1 MHz intervals extending across the entire EBW.

5.2.2.2 Measurement Procedure AVG2 (trace averaging over the EBW):
1. Set the analyzer span to 5-30% greater than the EBW.
2. Set the RBW = 1 MHz.
3. Set the VBW ≥ 3 MHz.
4. Ensure that the number of measurement points in the sweep ≥ 2 x (span/RBW).
5. Sweep time = auto couple.
6. Detector = power averaging (RMS) or sample.
7. Employ trace averaging in power averaging (RMS) mode over a minimum of 100 traces.
8. Use the spectrum analyzer's integrated band power measurement function with band limits set equal to the EBW band edges to determine the maximum conducted output power of the EUT over the EBW. If the analyzer does not have a band power function, sum the spectral levels (in linear power units) at 1 MHz intervals extending across the entire EBW.

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:

5.1.1 EBW Measurement Procedure:
1. Set resolution bandwidth (RBW) = 1-5 % of the emission bandwidth (EBW).
2. Set the video bandwidth (VBW) ≥ 3 x RBW.
3. Detector = Peak.
4. Trace mode = max hold.
5. Sweep = auto couple.
6. Allow the trace to stabilize.
7. Measure the maximum width of the emission that is constrained by the frequencies associated with the two outermost amplitude points (upper and lower) that are attenuated by 6 dB relative to the maximum level measured in the fundamental emission. Compare the resultant bandwidth with the RBW setting of the analyzer. Readjust RBW and repeat measurement as needed until the RBW/EBW ratio is 1-5 %.

5.1.2 Alternate EBW Measurement Procedure:
The automatic bandwidth measurement capability of a spectrum analyzer may be employed if it implements the functionality described above (*e.g.*, RBW = 1-5% of EBW, VBW ≥ 3 x RBW, peak detector with maximum hold). When using this capability, care should be taken to ensure that the bandwidth measurement is not influenced by any nulls in the fundamental emission.

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(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:

5.4.1.1 Measurement Procedure – Reference Level

1. Set the RBW = 100 kHz.
2. Set the VBW ≥ 300 kHz.
3. Set the span to 5-30 % greater than the EBW.
4. Detector = peak.
5. Sweep time = auto couple.
6. Trace mode = max hold.
7. Allow trace to fully stabilize.
8. Use the peak marker function to determine the maximum power level in any 100 kHz band segment within the fundamental EBW. Next, determine the power in 100 kHz band segments outside of the authorized frequency band using the following measurement:

5.4.1.2 Measurement Procedure - Unwanted Emissions

1. Set RBW = 100 kHz.
2. Set VBW ≥ 300 kHz.
3. Set span to encompass the spectrum to be examined.
4. Detector = peak.
5. Trace Mode = max hold.
6. Sweep = auto couple.
7. Allow the trace to stabilize (this may take some time, depending on the extent of the span).

Ensure that the amplitude of all unwanted emissions outside of the authorized frequency band (excluding restricted frequency bands) is attenuated by at least the minimum requirements specified above.

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.

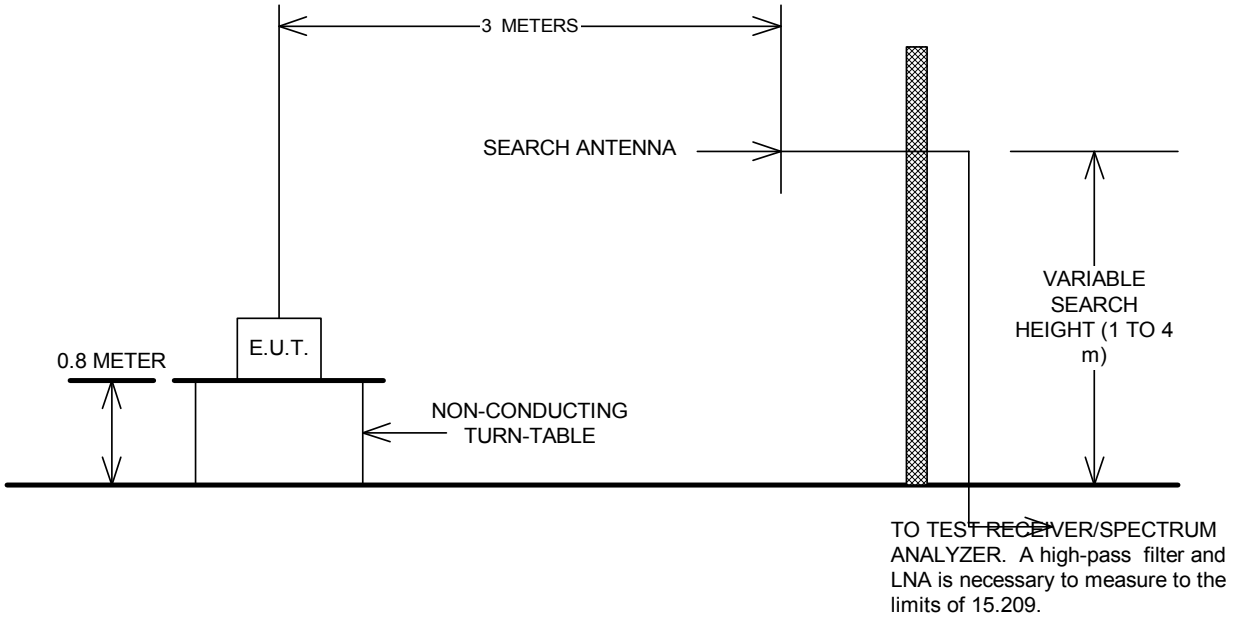
Method Of Measurement:

5.3.1 Measurement Procedure PKPSD:
1. Use this procedure when the maximum peak conducted output power in the fundamental emission is used to demonstrate compliance.
2. Set the RBW = 100 kHz.
3. Set the VBW ≥ 300 kHz.
4. Set the span to 5-30 % greater than the EBW.
5. Detector = peak.
6. Sweep time = auto couple.
7. Trace mode = max hold.
8. Allow trace to fully stabilize.
9. Use the peak marker function to determine the maximum power level in any 100 kHz band segment within the fundamental EBW.
10. Scale the observed power level to an equivalent value in 3 kHz by adjusting (reducing) the measured power by a bandwidth correction factor (BWCF) where
BWCF = 10log (3 kHz/100 kHz = -15.2 dB).
11. The resulting peak PSD level must be ≤ 8 dBm.

5.3.2 Measurement Procedure AVGPSD:
1. Use this procedure when the maximum conducted output power in the fundamental emission is used to demonstrate compliance. The EUT must be configured to transmit continuously at full power over the measurement duration.
2. Set the analyzer span to 5-30% greater than the EBW.
3. Set the RBW = 100 kHz.
4. Set the VBW ≥ 300 kHz.
5. Detector = power average (RMS).
6. Ensure that the number of measurement points in the sweep ≥ 2 x span/RBW (use of a greater
number of measurement points than this minimum requirement is recommended).
7. Manually set the sweep time to: ≥ 10 x (number of measurement points in sweep) x (transmission symbol period).
8. Perform the measurement over a single sweep.
9. Use the peak marker function to determine the maximum level in any 100 kHz band segment within the fundamental EBW.
10. Scale the observed power level to an equivalent level in 3 kHz by adjusting (reducing) the measured power by a bandwidth correction factor (BWCF) where
BWCF = 10log (3 kHz/100 kHz = -15.2 dB).
11. The resulting PSD level must be ≤ 8 dBm.

ANNEX B - TEST DIAGRAMS

Test Site For Radiated Emissions



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