FCC 47CFR part 15C
Test Report
For
2.4GHz IEEE 802.15.4 wireless controller module
JN5148-001-M06

Reference Standard: FCC 47CFR part 15C
Manufacturer: NXP Labs UK Ltd
For type of equipment and serial number, refer to section 3
Report Number: 01-540/4933/3/12
Report Produced by: -

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1. Contents

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2. Summary of Test Results

The 2.4GHz IEEE 802.15.4 wireless controller module JN5148-001-M06 was tested to the following standards: -

FCC 47CFR Part 15C (effective date October 1st, 2011); Class DTS Intentional Radiator

Any compliance statements are made reliant on the modes of operation as instructed to us by the Manufacturer based on their specific knowledge of the application and functionality of the equipment tested. Whilst every effort is made to assure quality of testing, type tests are not exhaustive and although no non-conformances may be found, this doesn't exclude the possibility of equipment not meeting the intentions of the standard, particularly under different conditions to those during testing.

Title	Reference	Results
1. Conducted Emissions	FCC Part 15C §15.207	NOT APPLICABLE[1]
2. Radiated Emissions	FCC Part 15C §15.205, §15.209 & §15.247(d)	PASSED
3. Modulation Bandwidth	FCC Part 15C §15.215(c), §15.247(a)(2)	PASSED
4. Intentional Radiator Field Strength	FCC Part 15C §15.247(b)(3)	PASSED
5. Power Spectral Density	FCC Part 15C §15.247(e)	PASSED
6. Band Edge Compliance	FCC Part 15C §15.205, §15.209 & §15.247	PASSED

Notes:
[1] The digital device tested is intended to be powered from 3V dc supply (battery) and intended for modular approval. Any third party device it is incorporated into with a connection to the AC power line will require demonstration of compliance with the limits. Refer to §15.207(c) "Measurements to demonstrate compliance with the conducted limits are not required for devices which only employ battery power for operation and which do not operate from the AC power lines or contain provisions for operation while connected to AC power lines".

This report relates to the equipment tested as identified by a unique serial number and at the time it was tested. It does not relate to any other similar equipment and performance of the product before or after the test cannot be guaranteed.

Date of Test: 23rd to 26th January 2012

Test Engineer: Digitally signed by: Daniel Sims DN: CN = Daniel Sims C = GB O = RN Electronics Date: 2012.02.14 11:52:38 Z

Approved By: Roger Ray

Customer Representative:

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3. Equipment Under Test (EUT)

3.1 Equipment Specification

Applicant	NXP Laboratories UK Ltd Furnival Street Sheffield S1 4QT
Manufacturer of EUT	NXP Laboratories UK Ltd
Brand name of EUT	NXP Labs UK Ltd
Model Number of EUT	JN5148-001-M06
Serial Number of EUT	1
Date when equipment was received by RN Electronics	10th January 2012
Date of test:	23rd to 26th January 2012
Customer order number:	GB62820002699
Visual description of EUT:	A small metal canned enclosure mounted onto a PCB. The EUT has a UFL RF port. For the purpose of tests the PCB was mounted onto a battery powered motherboard.
Main function of the EUT:	A 2.4GHz IEEE 802.15.4 wireless microcontroller module
Height	40.5 mm
Width	18 mm
Depth	3 mm
Weight	0.004 kg
Voltage	3V DC battery powered (2of AA batteries)
Current required from above voltage source	Not specified

3.2 EUT Configurations for testing

Frequency range	2.405 - 2.480 GHz
Normal use position	fitted to host equipment
Normal test signals	IEEE 802.15.4 test packet
Declared Power Level	+22dBm at RF port
Declared Channel Bandwidth	1.725 MHz
Highest Frequencies generated/used	2.480 GHz

3.3 EUT Modes

Mode	Description of mode	Used for Testing
Transmit CW 2.405GHz	Unit in constant transmit with no mod @ 2.405GHz	YES
Transmit CW 2.440GHz	Unit in constant transmit with no mod @ 2.440GHz	YES
Transmit CW 2.480GHz	Unit in constant transmit with no mod @ 2.480GHz	YES
Transmit Mod 2.405GHz	Unit in constant transmit with mod @ 2.405GHz	YES
Transmit Mod 2.440GHz	Unit in constant transmit with mod @ 2.440GHz	YES
Transmit Mod 2.480GHz	Unit in constant transmit with mod @ 2.480GHz	YES
Receive 2.405GHz	Unit in receive mode @2.405 GHz	YES
Receive 2.440GHz	Unit in receive mode @2.440 GHz	YES
Receive 2.480GHz	Unit in receive mode @2.480 GHz	YES
Transmit 1% duty cycle	Unit transmitting system modulation 1% duty cycle	YES

Description of ancillary equipment connected to the equipment under test, for the purpose of tests, can be found in Section 10.

Any modifications made to the EUT, whilst under test, can be found in Section 11.

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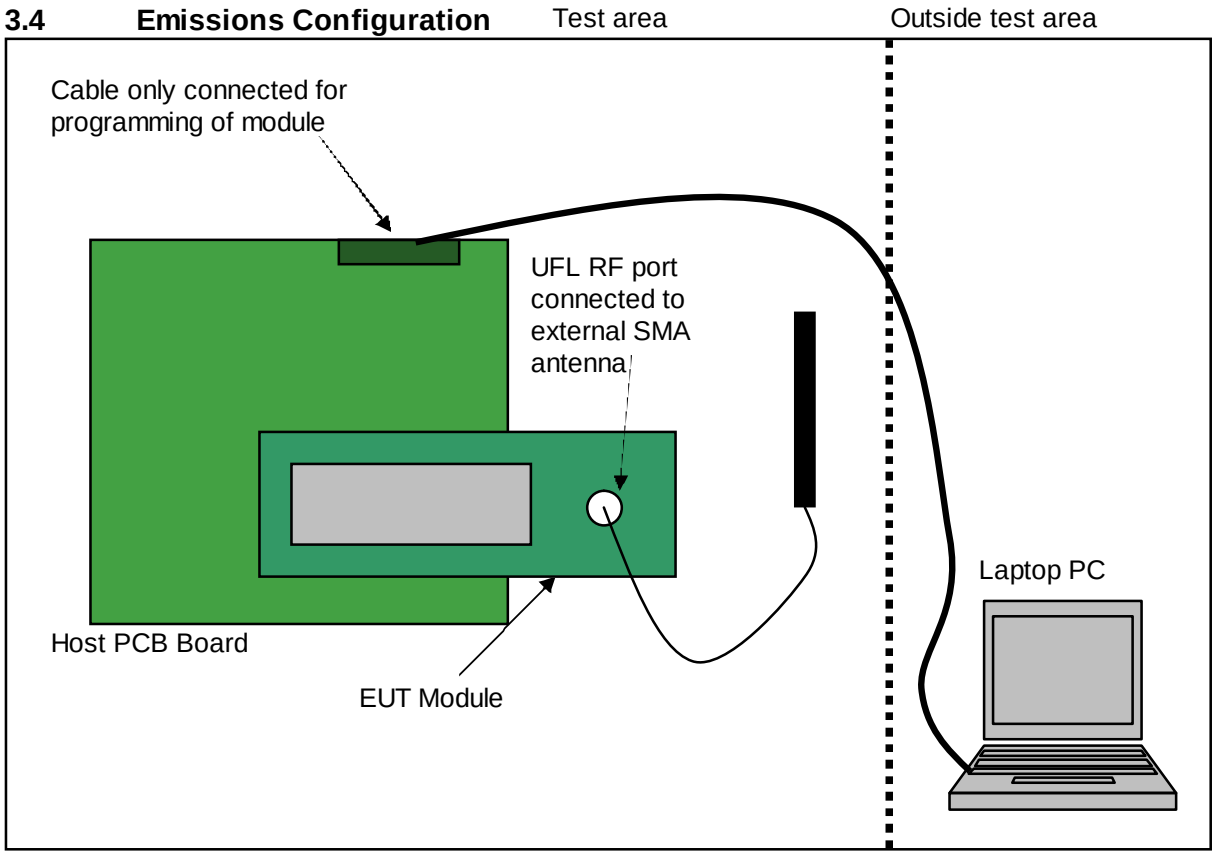
This report was printed on: 14 February 2012

3.4 Emissions Configuration



The equipment under test was supplied by 3V DC from two new batteries situated on the provided host PCB board. The battery levels were monitored throughout tests to ensure the levels did not drop below the +/- 10% required. To change channels and select the correct modes for test a programming lead was connected and the unit programmed. The programming lead was removed for tests. Application programming software was provided by NXP Semiconductors UK Ltd. A laptop provided by RN Electronics was used to program the modules.

For radiated emissions the support equipment was situated outside the chamber and the programming lead removed after each channel/mode change.

Top, middle & bottom channels were tested in both Transmit and Receive modes using the 32MHz clock option. All power levels were left at the Default setting, as set by the selection of the root menu mode named "**High Power module**".

Bottom channel = 2.405GHz
Middle channel = 2.440GHz
Top channel = 2.480GHz

The module had a UFL RF port which was attached to a dedicated antenna supplied by NXP Semiconductors UK Ltd.

Separate antenna details: Manufacturer: Antenova
Model: TITANIS (2.2dBi) 2.4 GHz

4. Specifications

The tests were performed by RN Electronics Engineer Daniel Sims who set up the tests, the test equipment, and operated it in accordance with the ***R.N. Electronics Ltd*** procedures manual, FCC Part 15 and those specifications incorporated by reference into 47CFR15 (e.g. ANSI C63.4-2003).

R.N. Electronics Ltd sites M and OATS are listed with the FCC. Registration Number 293246

4.1 Deviations

ANSI C63-10-2009 deviations:
The reference standard ANSI C63.4-2003 was used, not the latest ANSI C63.4-2009
Power spectral density was measured instead per KDB558074, PSD Option 1

FCC Part 15 deviations:
None.

4.2 Tests at Extremes of Temperature & Voltage

No tests were required at temperature extremes.
Tests were performed with new batteries.

☐ A permanent integral antenna was used for testing.
☐ A test fixture was used for testing.
☐ A temporary RF port was created for testing.
☒ The equipment external RF port was used for testing.

4.3 Measurement Uncertainties

Parameter	Uncertainty
Transmitter Tests	
Conducted RF power	<± 1.0 dB
Spectral power density	<± 1.5 dB
Bandwidth	<± 1.9 %
Radiated RF Power	<± 3.5 dB
Radiated Spurious Emissions	<± 3.4 dB
H-Field Emissions	<± 2.8 dB

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5. Tests, Methods and Results
5.1 Conducted Emissions

NOT APPLICABLE.
The digital device tested is intended to be powered from 3V DC supply (battery) and intended for modular approval. Any third party device it is incorporated into with a connection to the AC power line will require demonstration of compliance with the limits. Refer to §15.207(c) "Measurements to demonstrate compliance with the conducted limits are not required for devices which only employ battery power for operation and which do not operate from the AC power lines or contain provisions for operation while connected to AC power lines"

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5.2 Radiated Emissions

5.2.1 Test Methods

Test Requirements	FCC Part 15C, Reference (15.209)
Test Method:	ANSI C63.10, Reference (6.4 – 6.6.)

5.2.1.1 Configuration of EUT

The EUT was placed on a 0.8 metres high turntable. The front edge of the EUT was initially positioned facing the antenna. The EUT was measured at a distance of 3 metres. The EUT was rotated in all three orthogonal planes. Radiated Emissions testing was performed with a new battery.

5.2.1.2 Test Procedure

Tests were made in accordance with FCC Part 15 using the measuring equipment noted below.

Below 30MHz, measurements were made in a semi-anechoic chamber (pre-scan) with final measurements on an OATS without a ground plane. The antenna was placed 1m above the ground. The equipment and the antenna were rotated 360° to record the worst case emissions.

30MHz - 1GHz, measurements were made on a site listed with the FCC. The equipment was rotated 360° and the antenna scanned 1 – 4 metres in both horizontal and vertical polarisations to record the worst case emissions.

Above 1GHz, measurements were made in a semi-anechoic chamber with appropriate absorbing material for use in this range. The antenna was placed 1m above the ground in line with the EUT, which was rotated through 360° to record the worst case emissions.

At least 6 signals within 20dB and all signals within 10dB of the limit were investigated.

5.2.2 Test results

Tests were performed using Test Site M**.**

Test Environment: M

Temperature: 18-20°C Humidity: 34-36%

Analyser plots for the Quasi-Peak / Average values as applicable and any table of signals within 20dB of the limit line can be found in Section 6.2 of this report. Band Edge Compliance plots can be found in section 6.6 of this report.

These show that the **EUT** has **PASSED** this test.

5.2.2.1 Test Equipment used

E410, E411, E412, TMS933, E268, E342, E429, TMS78, TMS79, TMS82, TMS81

See Section 10 for more details

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5.3 Intentional Radiator Field Strength/Peak Conducted Power

5.3.1 Test Methods

Test Requirements	FCC Part 15C, Reference (15.247)
Test Method:	ANSI C63.10, Reference (6.6) ANSI C63.10, Reference (6.10.2.1 a))

5.3.1.1 Configuration of EUT

The conducted EUT was measured on a bench using a power meter connected to the RF port.
For radiated measurements, the EUT was placed on a 0.8 metres high turntable. The front edge of the EUT was initially positioned facing the antenna. The EUT was measured at a distance of 3 metres. The antenna was scanned 1-4m in height in both Horizontal and Vertical polarisations. The EUT was rotated in all three orthogonal planes.

5.3.1.2 Test Procedure

Tests were made in accordance with FCC Part 15 using the measuring equipment noted below.

Measurements were made in a semi-anechoic chamber and on a test bench.
The equipment was rotated 360° to record the maximised emission.

Radiated measurements in alternative bandwidths and conducted Average measurements are presented for reference only. They are required to observe (a) the 1MHz reference levels for band edge compliance measurements above 1GHz (b) the 100kHz reference levels for spurious emission measurements per 15.247(d) and are useful as a comparison of the antenna performances.

5.3.2 Test results

Test Environment: Temperature: 22°C Humidity: 36 %

Any Analyser plots can be found in Section 6.3 of this report.

Frequency (MHz)	PK Power (dBm) (3MHz RBW)	AV Power (dBm) (RBW N/A)
2405	+20.2	+19.4
2440	+20.1	+19.1
2480	+19.8	+18.8

Limits: 1Watt (+30dBm). (Equivalent to 125.2dBuV/m @ 3m).

These results show that the EUT has **PASSED** this test.

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The maximised field strength measured was:-

Dedicated antenna results M06 unit

Frequency (MHz)	PK Power (1MHz RBW) (dBuV/m @ 3 metres)	PK Power (100kHz RBW) (dBuV/m @ 3 metres)
2405	114.5	112.6
2440	115.6	113.0
2480	113.1	109.8

Limits: Not applicable.

These results are for demonstration of required reference levels only.

5.3.2.1 Test Equipment used

E268, E410, E411, E412, TMS82, E003, E131, E266, E313, E290, E397, E434, TMS10

See Section 10 for more details

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5.4 Duty Cycle

Test not applicable. However, a basic duty cycle measurement was made in order to ascertain any duty cycle corrections required to be applied to the test results.

According to 15.35(b): the limit on peak radio frequency emissions is 20 dB above the maximum permitted average emission limit applicable to the equipment under test.

As peak emissions (upper restricted band edge – see page 51-54) were no more than 19.6dB above the average emissions measured then the condition for peak emissions is met.

The worst case average emission measured at the upper restricted band edge (see page 51-54) is 16.7dB above the permitted average emission limit, However, according to 15.35(c): when the radiated emission limits are expressed in terms of the average value of the emission, and pulsed operation is employed, the measurement field strength shall be determined by averaging over one complete pulse train, including blanking intervals, as long as the pulse train does not exceed 0.1 seconds.

For purposes of test the equipment was operated with the transmitter continuously on. For a 10% duty cycle, the power measured would be reduced by 20 log (0.10) = -20dB. According to the declared duty cycle, therefore, the emissions observed are below the limit after averaging for pulse rate.

Duty Cycle

In normal operation the equipment employs pulsing at a variable rate, depending on the application. The manufacturer has declared a duty cycle of 1% and quotes IEEE 802.15.4: "The specifications of IEEE Std 802.15.4-2003 are tailored for applications with low power and low data rates (a maximum of 250 kb/s and down to 20 kb/s). Typical applications for IEEE 802.15.4 devices are anticipated to run with low duty cycles (under 1%). This will make IEEE 802.15.4 devices less likely to cause interference to other standards".
IEEE 802.15.4 also quotes a nominal packet length of 0.01472ms (40 data bytes) and for <10% duty cycle restrictions up to 6 packets per 100ms. A measurement of the EUT operating at the nominal 1% rate is shown in the plots section **6.4.**

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5.5 Maximum Spectral Power Density

5.5.1 Test Methods

Test Requirements	FCC Part 15C, Reference (15.247)
Test Method:	FCC Part 15C, Reference (15.247) KDB558074, PSD Option 1

5.5.1.1 Configuration of EUT

The EUT was tested on a bench via the RF port.

5.5.1.2 Test Procedure

Tests were made in accordance with FCC Part 15 using the measuring equipment noted below. The peak of the power envelope was found and zoomed in on; the spectrum analyser was then set to measure at a slow sweep, per KDB558074, in 3kHz bandwidth.

5.5.2 Test results

Tests were performed using Test Site **K.**

Temperature of test Environment: 20°C

Channel	Duty cycle adjustment (dB)	Result (dBm/3kHz)
Bottom	100	+7.9
Middle	100	+7.3
Top	100	+6.3

Limits: +8dBm/3kHz.

Any Analyser plots for the Spectral density test can be found in Section 6.7 of this report.

These results show that the **EUT** has **PASSED** to this test.

5.5.2.1 Test Equipment used

P240, E412

See Section 10 for more details.

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5.6 6 Bandwidth

5.6.1 Test Methods

Test Requirements FCC Part 15C, Reference (15.247)

Test Method: ANSI C63.10, Reference (6.9.1)

5.6.1.1 Configuration of EUT

The EUT was tested on a bench via the RF port.

5.6.1.2 Test Procedure

Tests were made in accordance with FCC Part 15 using the measuring equipment noted below.

5.6.2 Test results

Tests were performed using Test Site **A**.

Temperature of test Environment: 22°C

Analyser plots for the 6dB bandwidth can be found in Section 6.5 of this report.

Channel	Result	Plot reference
Bottom	1.525 MHz	J4933-3, bottom channel 6dB BW (OBW)
Middle	1.575 MHz	J4933-3, middle channel 6dB BW (OBW)
Top	1.613 MHz	J4933-3, top channel 6dB BW (OBW)

Limits: > 500kHz BW.

These results show that the **EUT** has PASSED this test.

5.6.2.1 Test Equipment used

E003, E434

See Section 10 for more details.

5.7 Band Edge Compliance

5.7.1 Test Methods

Test Requirements FCC Part 15C, Reference (15.215 and 15.247)

Test Method: ANSI C63.10, Reference (6.9.2)

5.7.1.1 Configuration of EUT

The EUT was placed on a 0.8 metres high turntable. The front edge of the EUT was initially positioned facing the antenna. The EUT was measured at a distance of 3 metres.

5.7.1.2 Test Procedure

Tests were made in accordance with FCC Part 15 using the measuring equipment noted below.

5.7.2 Test results

Tests were performed using Test Site **A**.

Temperature of test Environment: 22°C

Analyser plots for the Band Edge Compliance can be found in Section 6.5 and 6.6 of this report. These show the 30dBc requirement of 15.247(d) are met at the band edges of 2400 and 2483.5 MHz.

The following tables list the field strengths observed in the adjacent restricted bands, which are required to meet the tighter 15.209 limits:

Channel	Band edge PK reading (dBuV/m)	Band edge AV reading (dBuV/m)	Plot reference
Bottom	72.2	*59.9	J4933-3, Band edge bottom channel 1MHz RBW PK J4933-3, Band edge bottom channel 1MHz RBW AV (10Hz VBW)
Top	73.6	*71.7	J4933-3, Band edge top channel 1MHz RBW PK J4933-3, Band edge top channel 1MHz RBW AV (10Hz VBW) J4933-3, Top chan restrict band Delta Mrkr 1M RBW PK J4933-3, Top chan restrict band Delta Mrkr 1M RBW AV J4933-3, Top chan restrict band Delta Mrkr 30k RBW PK J4933-3, Top chan restrict band Delta Mrkr 30k RBW AV

The band edge readings were performed with a peak detector (max held plot) and with the EUT set in a constant 100% transmit state. Extra plots have been shown to show compliance of the EUT (after Duty cycle correction) at the upper restricted band using the Delta marker method as stated in ANSI C63.10 2009 clause 6.9.3.

*The limit is 54dBuV/m for Average emissions. According to 15.35(c): when the radiated emission limits are expressed in terms of the average value of the emission, and pulsed operation is employed, the measurement field strength shall be determined by averaging over one complete pulse train, including blanking intervals, as long as the pulse train does not exceed 0.1 seconds. For a 10% duty cycle, the power measured would be reduced by 20 log (0.10) = 20dB. According to the declared duty cycle, therefore, the emissions observed are below the limit after averaging for pulse rate.

Limits: AV = 54dBuV/m at band edges
PK = 74dBuV/m at band edges

These results show that the **EUT** has **PASSED** this test.

5.7.2.1 Test Equipment used

P240, E003, E268, E411, E412, E434

See Section 10 for more details.

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6. Plots and Results
6.1 Conducted Emissions

Test not applicable.
The digital device tested is intended to be powered from 3V DC supply (battery) and intended for modular approval. Any third party device it is incorporated into with a connection to the AC power line will require demonstration of compliance with the limits. Refer to §15.207(c) "Measurements to demonstrate compliance with the conducted limits are not required for devices which only employ battery power for operation and which do not operate from the AC power lines or contain provisions for operation while connected to AC power lines"

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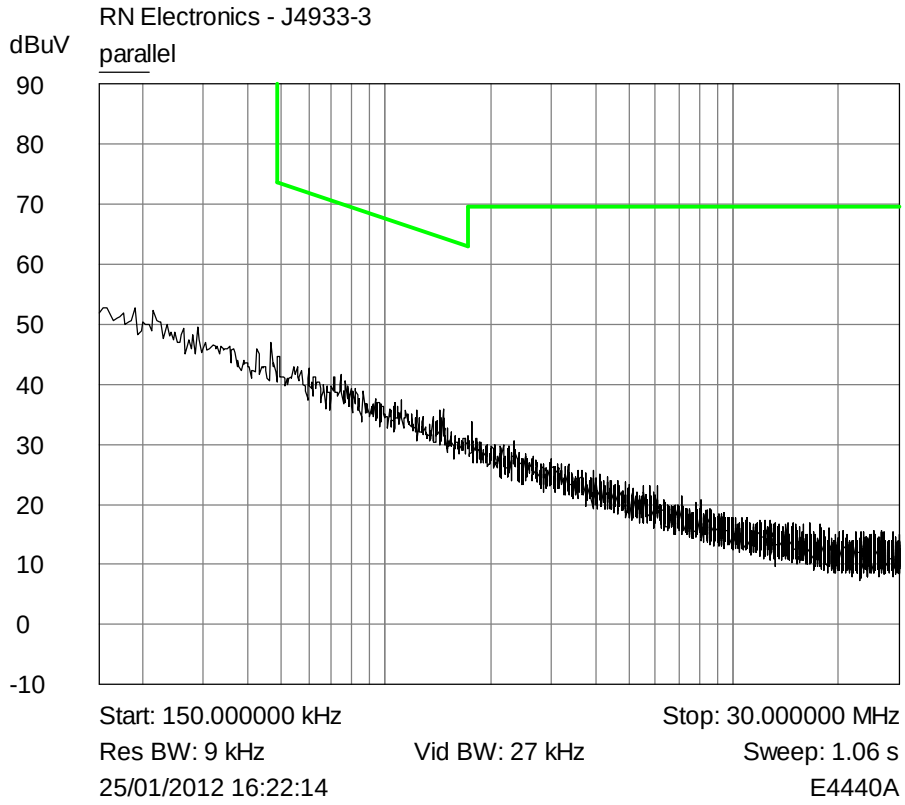
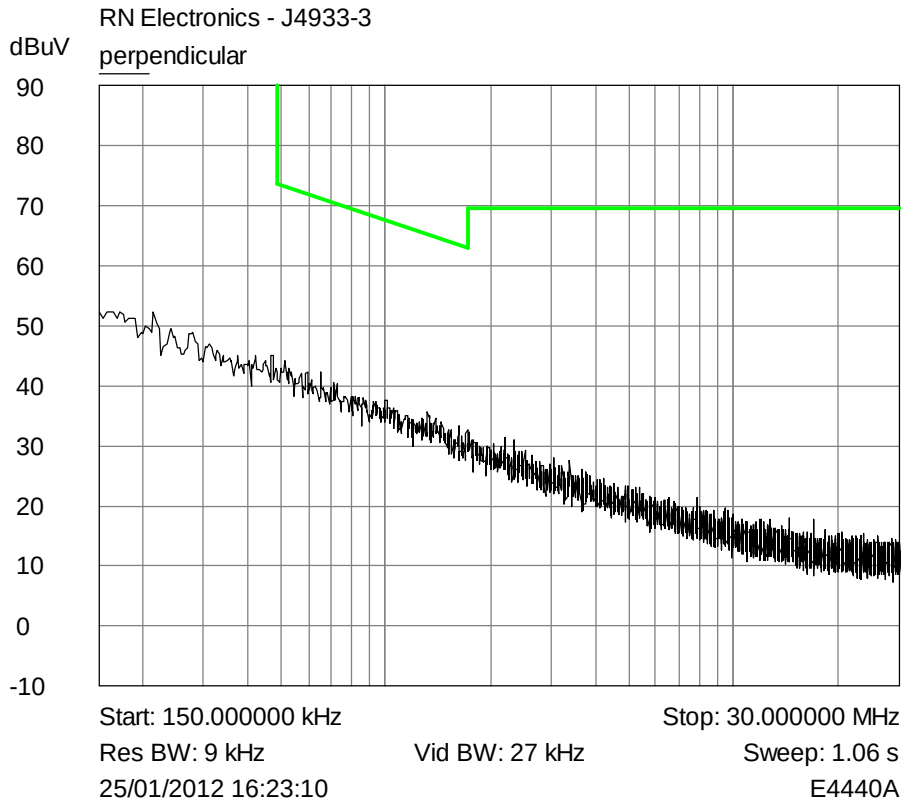
6.2 Radiated Emissions

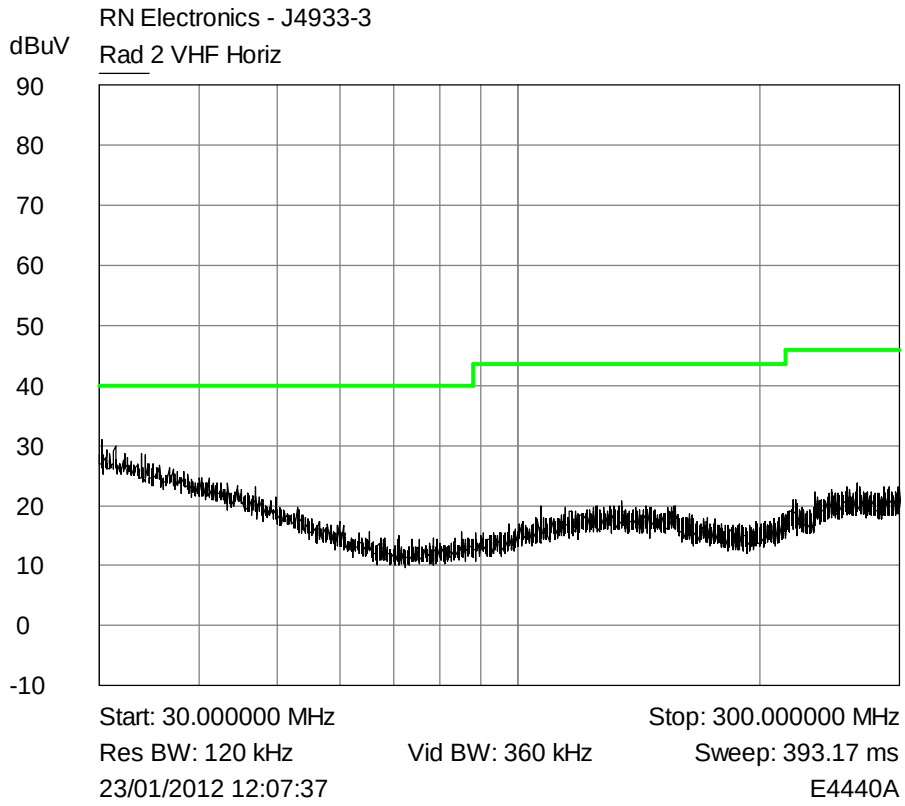
Plots shown are for middle channel only, However, Bottom, Middle and Top channels were all tested.



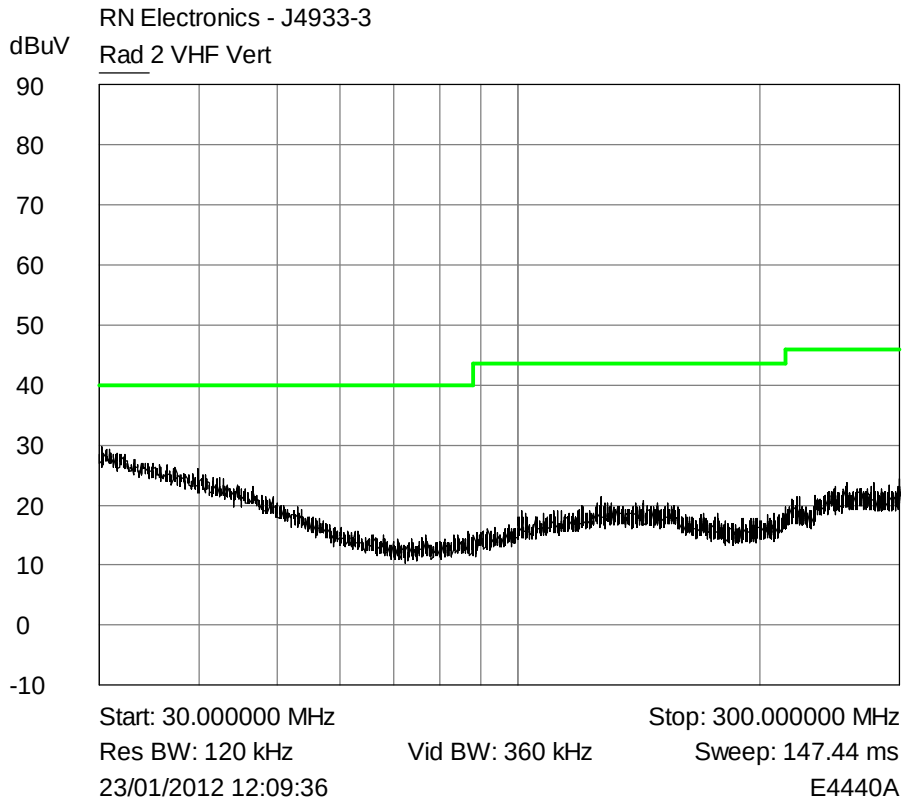
Plot of peak Parallel emissions 150kHz - 30MHz against the quasi-peak limit line.



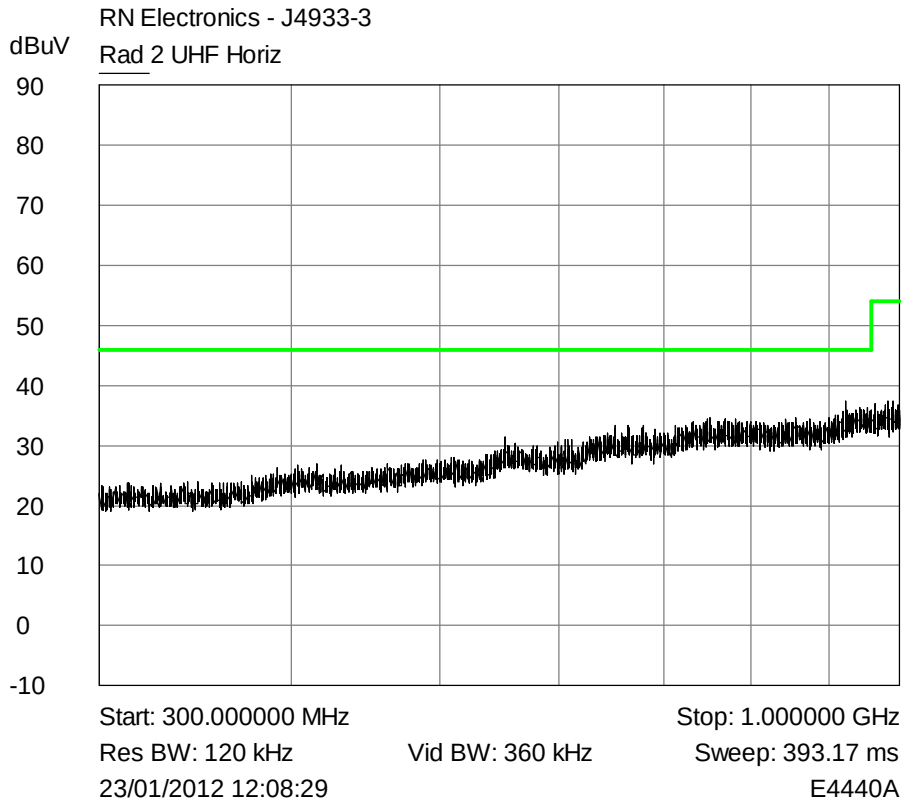
Plot of peak Perpendicular emissions 150kHz - 30MHz against the quasi-peak limit line.



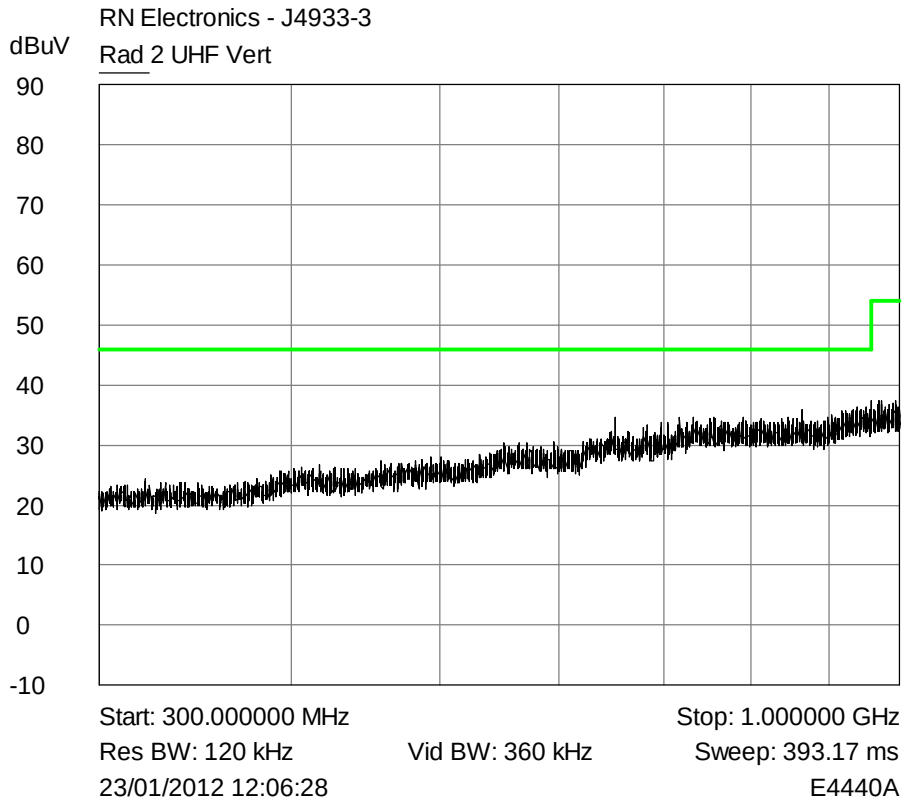
Plot of peak horizontal emissions 30MHz - 300MHz against the quasi-peak limit line.



Plot of peak vertical emissions 30MHz - 300MHz against the quasi-peak limit line.



Plot of peak horizontal emissions 300MHz - 1GHz against the quasi-peak limit line.



Plot of peak vertical emissions 300MHz - 1GHz against the quasi-peak limit line.

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Table of signals measured below 1GHz.

Bottom channel Horizontal
No signals found.

Bottom channel Vertical
No signals found.

Middle channel Horizontal
No signals found.

Middle channel Vertical

Signal No.	Freq (MHz)	Peak Amp (dBuV)	QP Amp (dBuV)	QP - Lim1 (dB)
1	649.493	35.7	30.3	-15.7

Top channel Horizontal
No signals found.

Top channel Vertical
No signals found.

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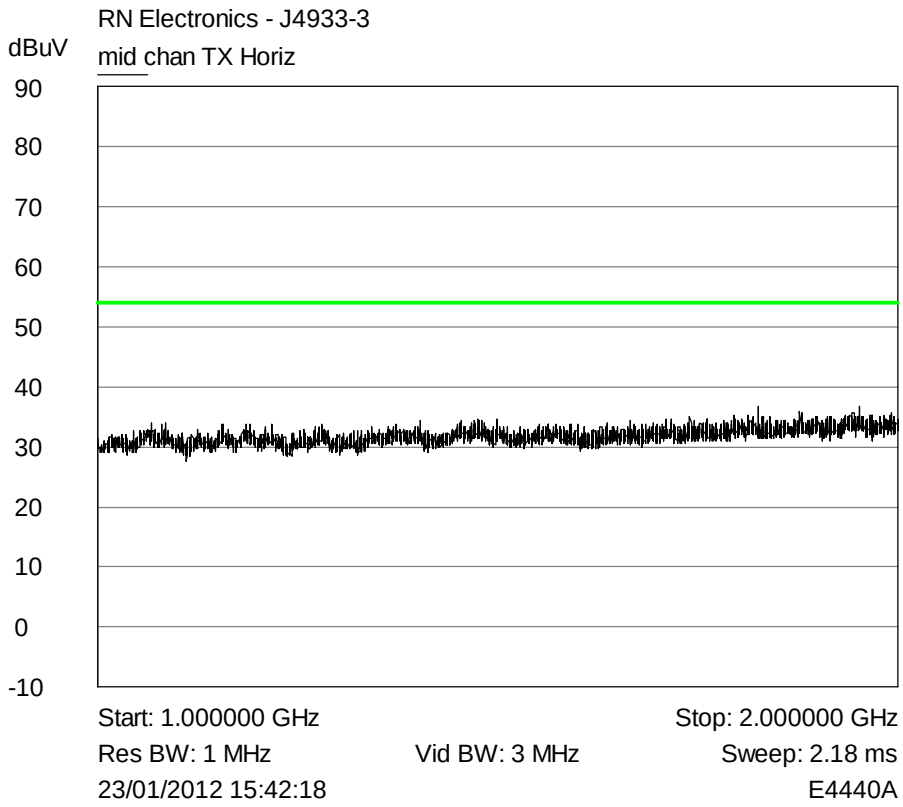
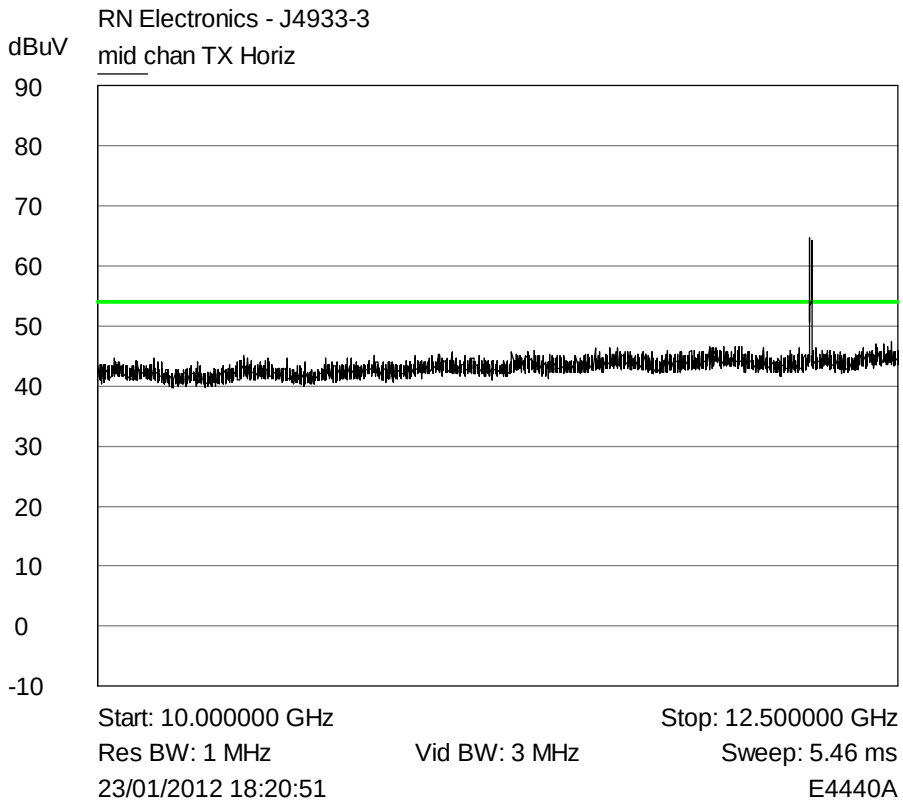
Plots of Average horizontal emissions 1GHz - 25GHz against the Average limit line.





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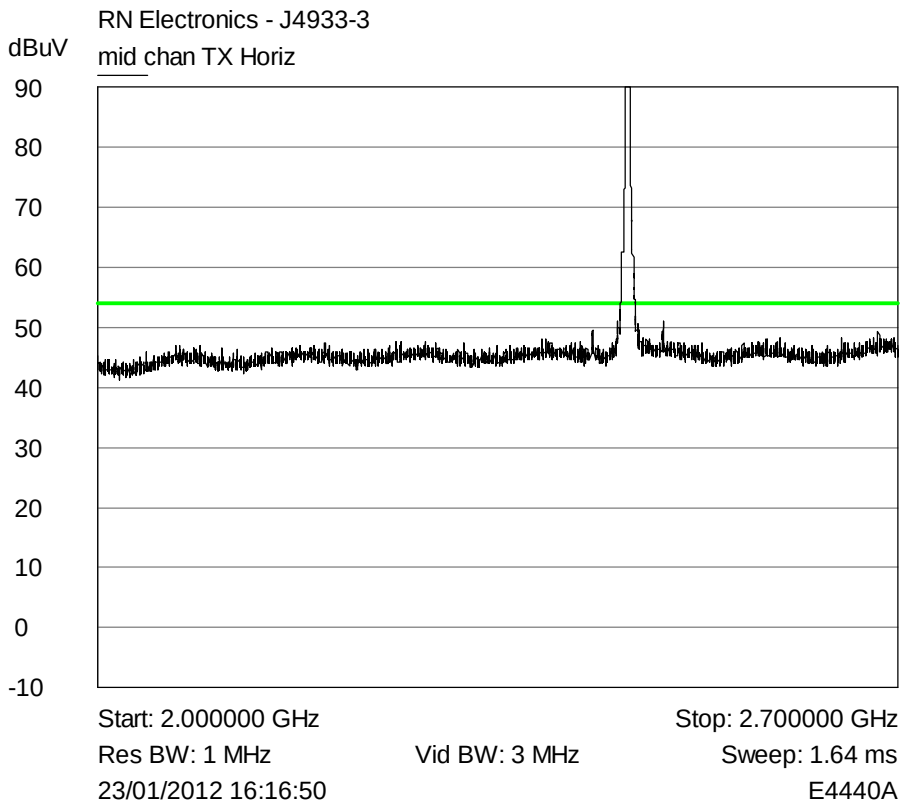

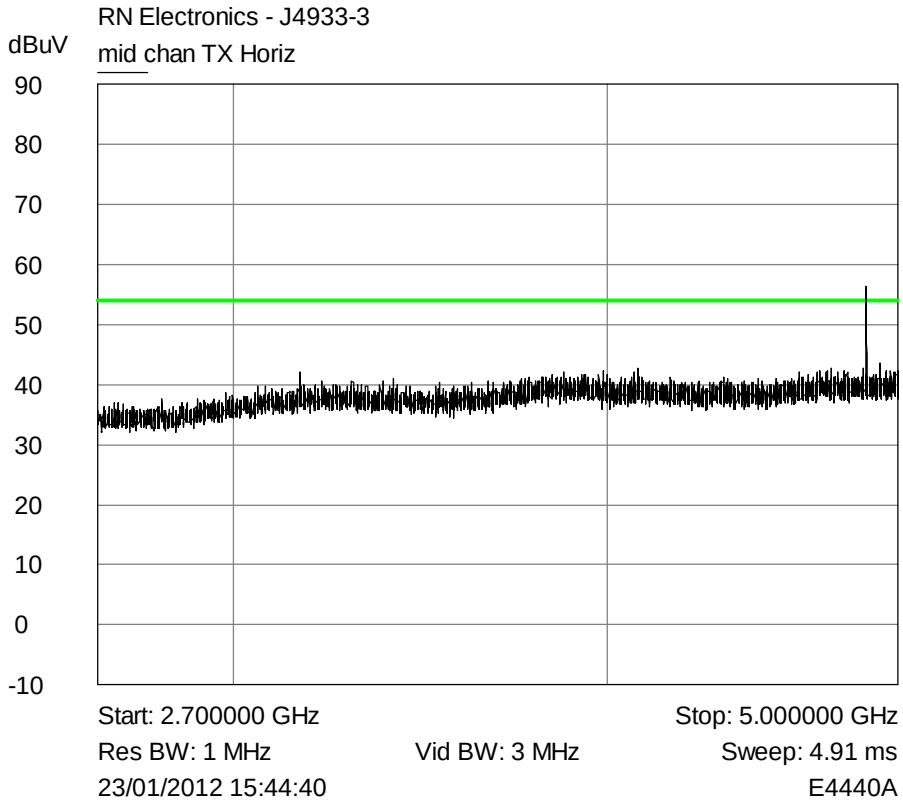

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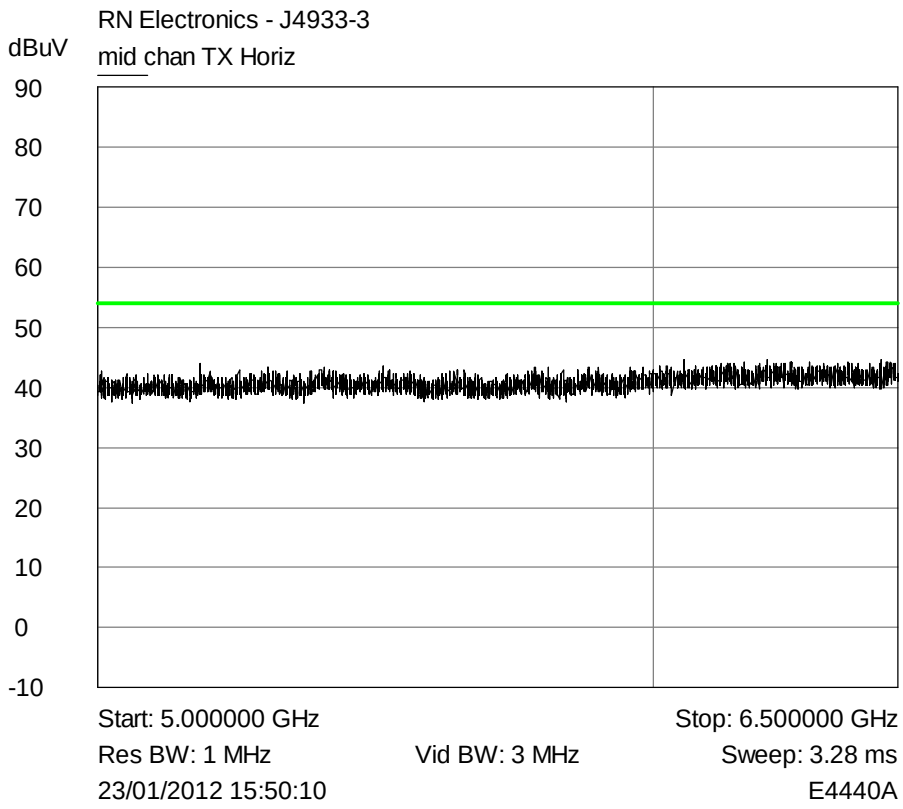

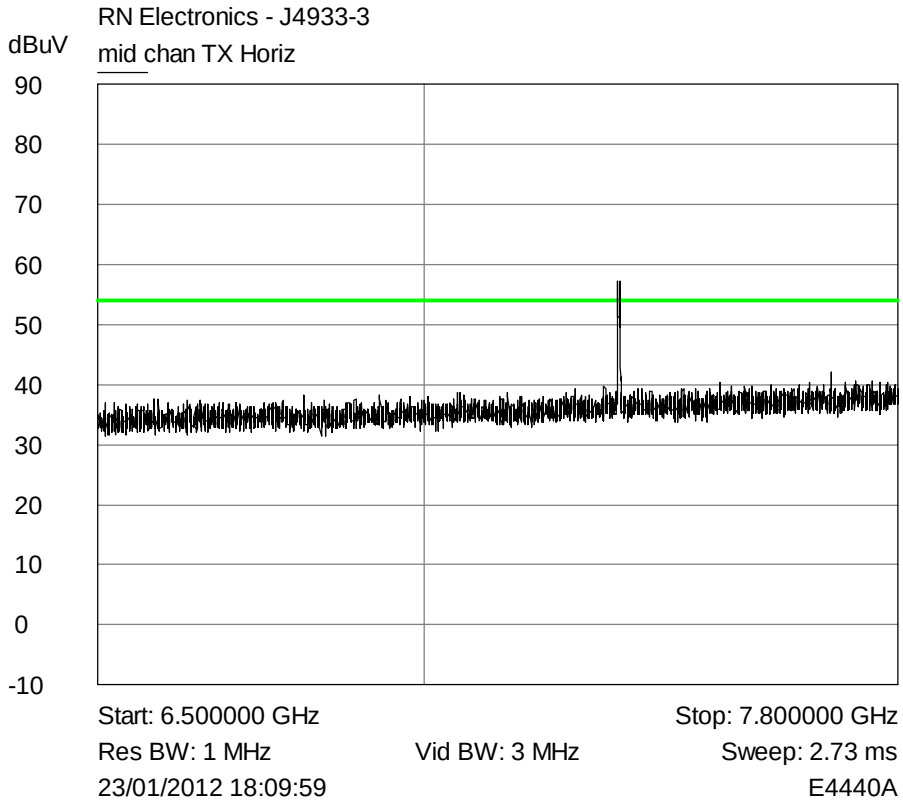

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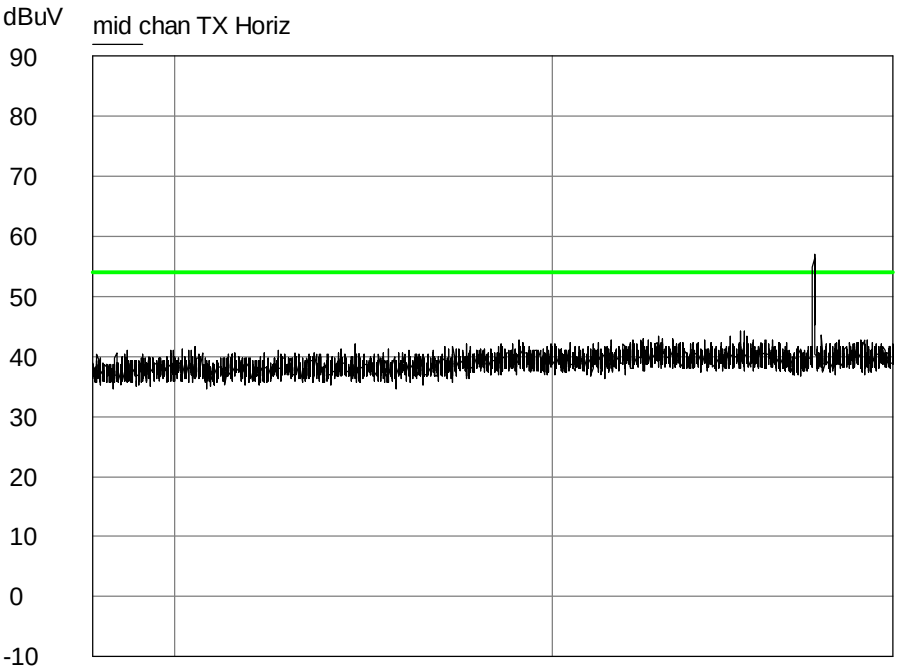
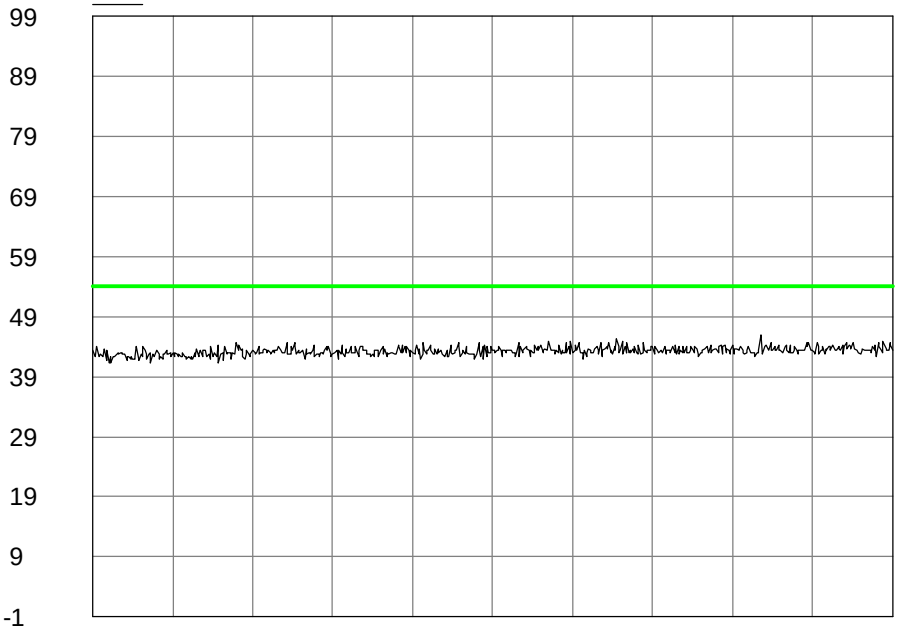
RN Electronics - J4933-3
mid chan TX Horiz



Start: 7.800000 GHz Stop: 10.000000 GHz
Res BW: 1 MHz Vid BW: 3 MHz Sweep: 4.91 ms
23/01/2012 18:14:10 E4440A

J4933-3 mid chan TX Horizontal 12.5-14GHz
Trace A



Start: 12.500000 GHz Atten: 10 dB Stop: 14.000000 GHz
Res BW: 1 MHz Vid BW: 3 MHz Sweep: 50.00 ms
23/01/2012 18:55:11 HP8563E

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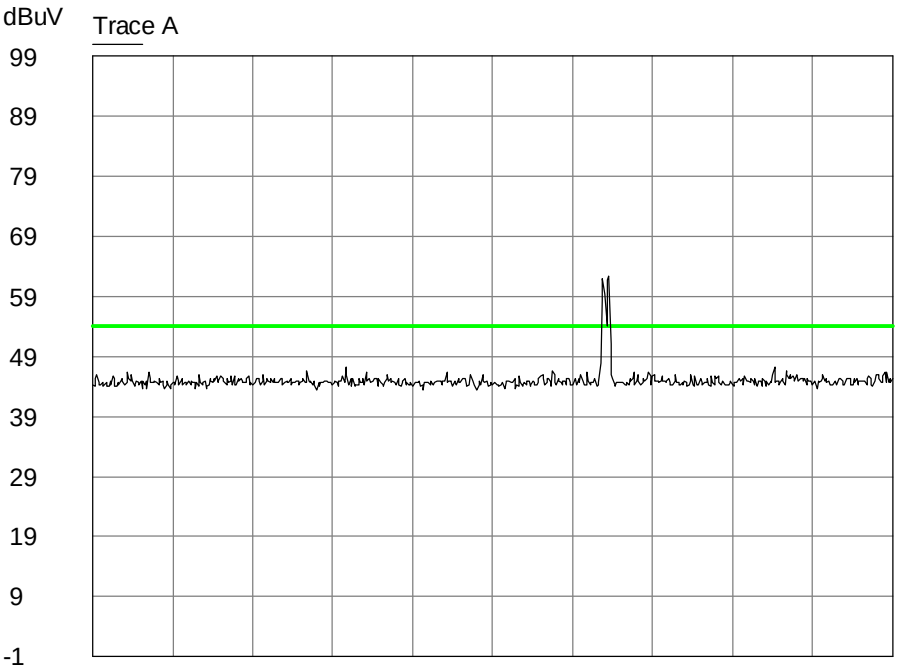
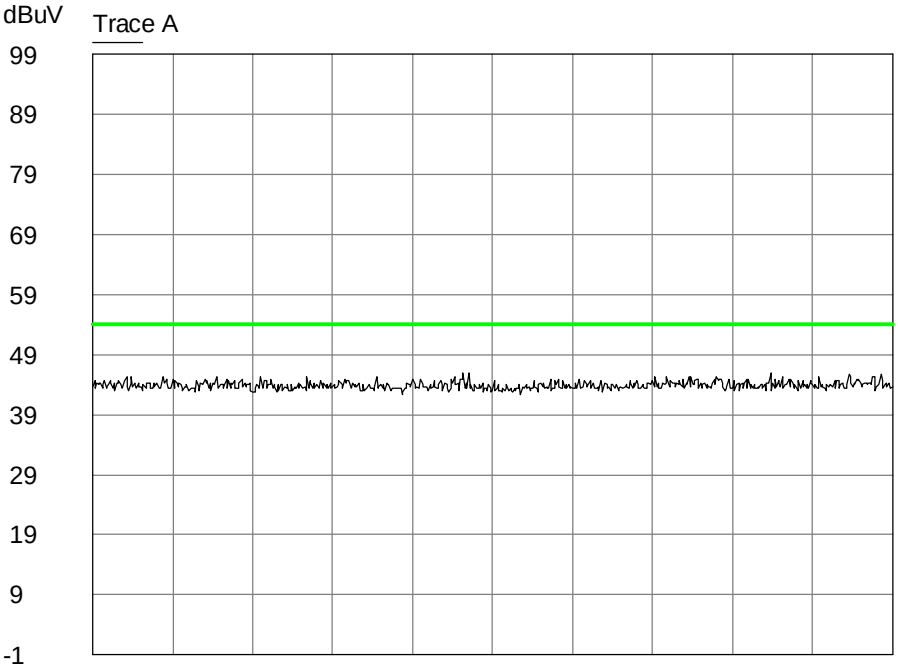
J4933-3 mid chan TX Horizontal 14-15GHz



Start: 14.000000 GHz Atten: 10 dB Stop: 15.000000 GHz
Res BW: 1 MHz Vid BW: 3 MHz Sweep: 50.00 ms
23/01/2012 18:56:17 HP8563E

J4933-3 mid chan TX Horizontal 15-16GHz



Start: 15.000000 GHz Atten: 10 dB Stop: 16.000000 GHz
Res BW: 1 MHz Vid BW: 3 MHz Sweep: 50.00 ms
23/01/2012 18:59:54 HP8563E

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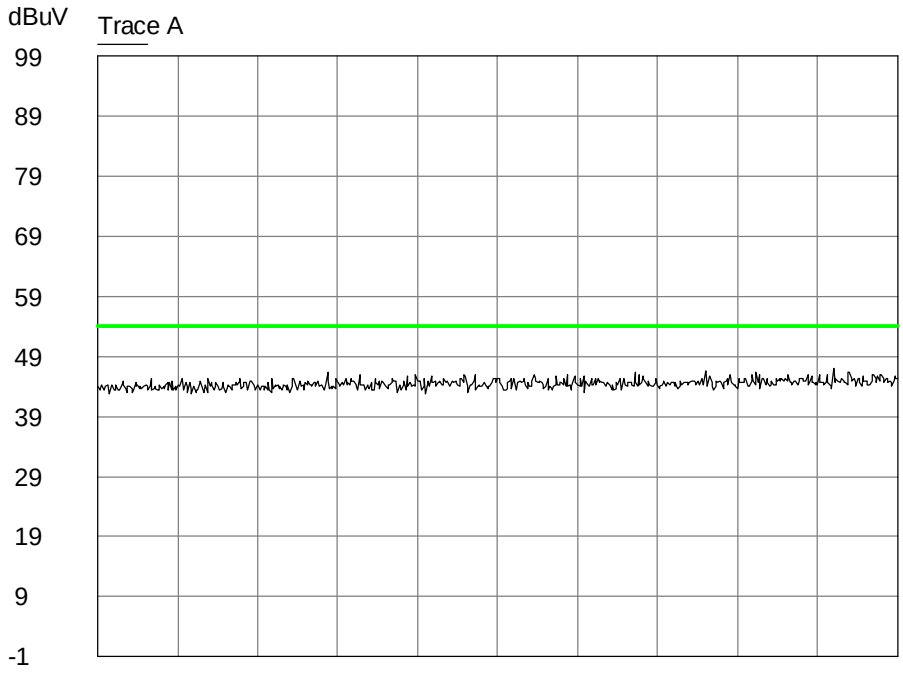
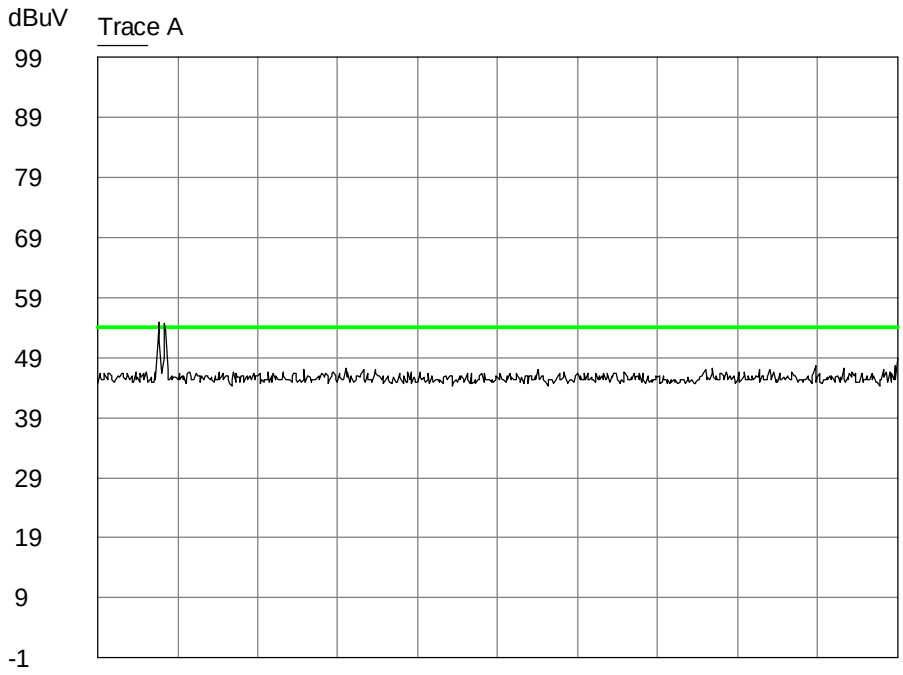
J4933-3 mid chan TX Horizontal 16-17GHz



Start: 16.000000 GHz Atten: 10 dB Stop: 17.000000 GHz
Res BW: 1 MHz Vid BW: 3 MHz Sweep: 50.00 ms
23/01/2012 19:00:13 HP8563E

J4933-3 mid chan TX Horizontal 17-18GHz



Start: 17.000000 GHz Atten: 10 dB Stop: 18.000000 GHz
Res BW: 1 MHz Vid BW: 3 MHz Sweep: 50.00 ms
23/01/2012 19:01:14 HP8563E

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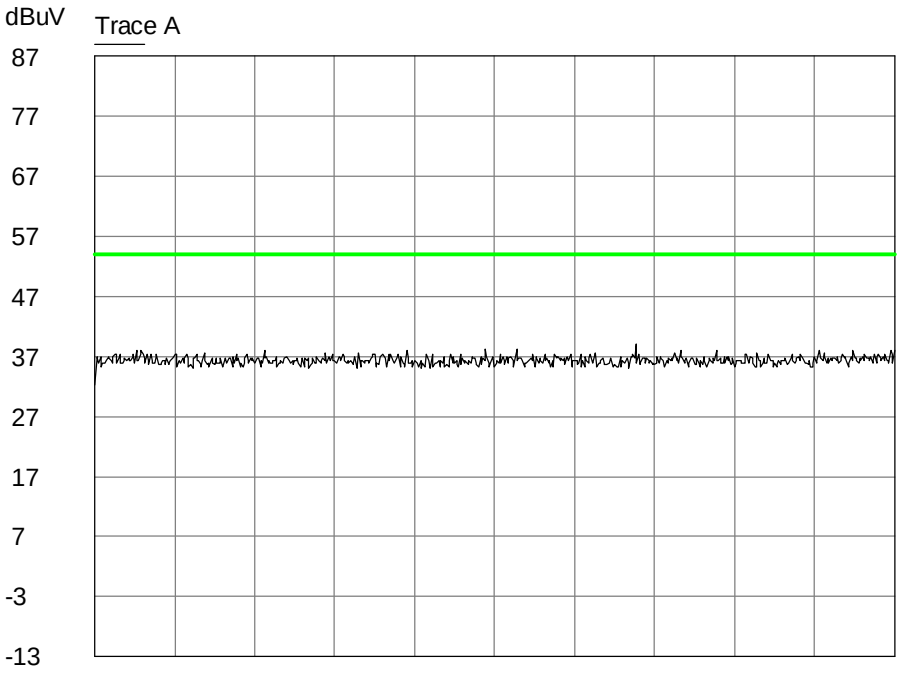
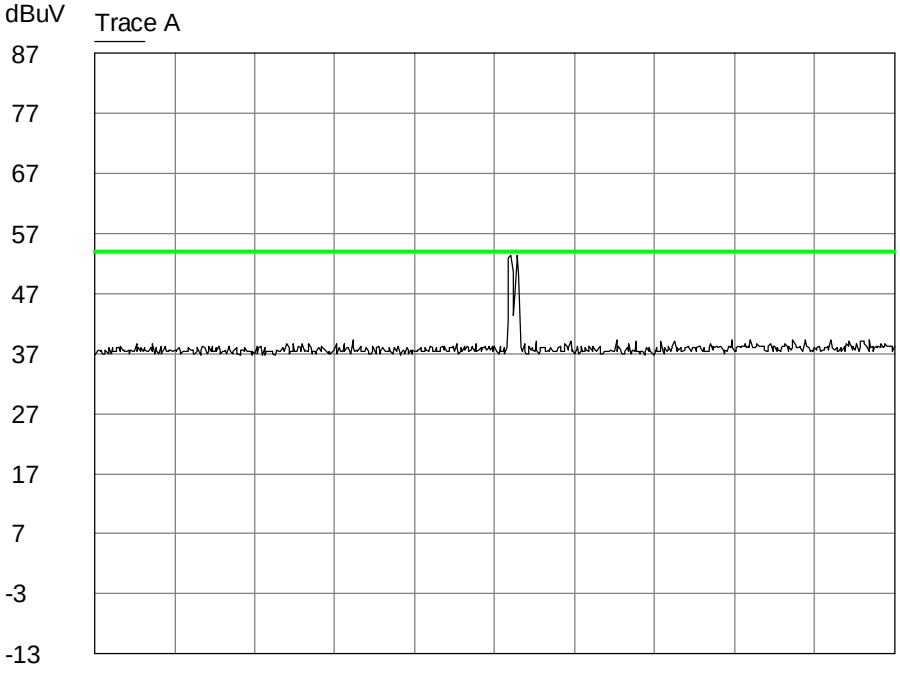
J4933-3 mid chan TX Horizontal 18-19GHz



Start: 18.000000 GHz Atten: 10 dB Stop: 19.000000 GHz
Res BW: 1 MHz Vid BW: 3 MHz Sweep: 50.00 ms
23/01/2012 19:53:58 HP8563E

J4933-3 mid chan TX Horizontal 19-20GHz



Start: 19.000000 GHz Atten: 10 dB Stop: 20.000000 GHz
Res BW: 1 MHz Vid BW: 3 MHz Sweep: 50.00 ms
23/01/2012 19:54:32 HP8563E

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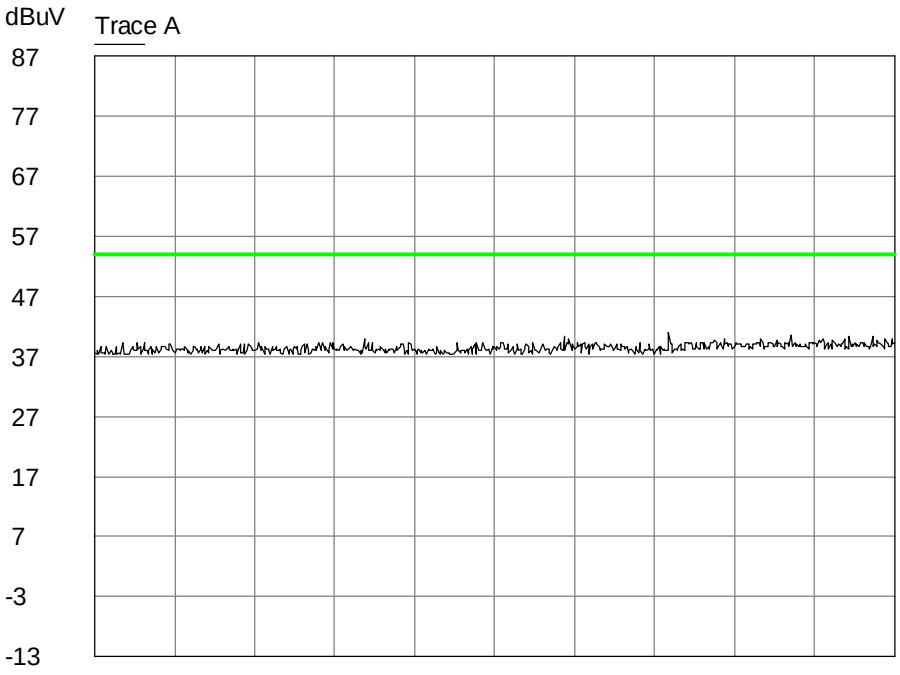
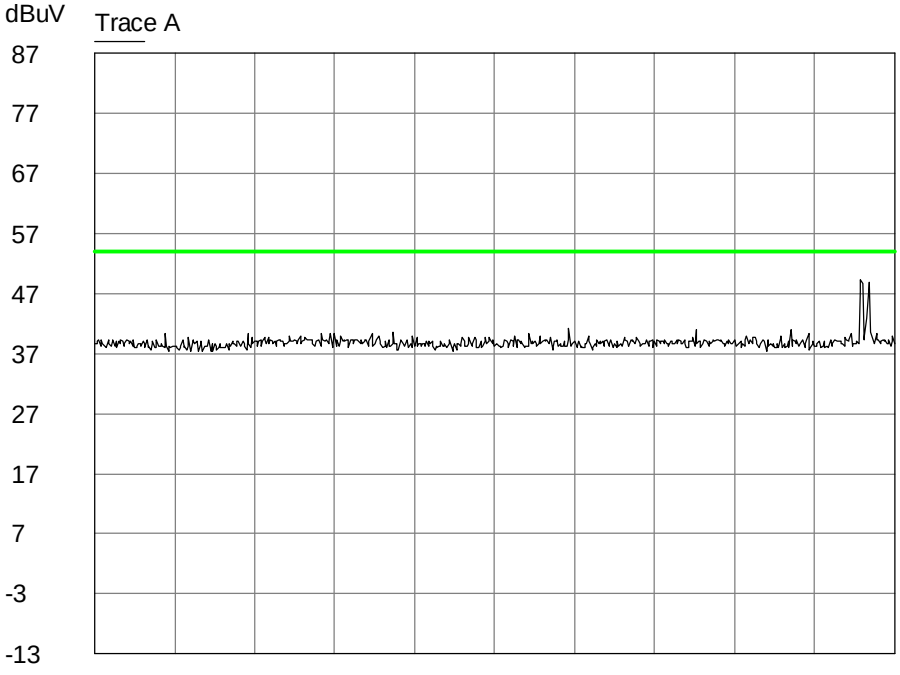
J4933-3 mid chan TX Horizontal 20-21GHz



Start: 20.000000 GHz Atten: 10 dB Stop: 21.000000 GHz
Res BW: 1 MHz Vid BW: 3 MHz Sweep: 50.00 ms
23/01/2012 19:55:00 HP8563E

J4933-3 mid chan TX Horizontal 21-22GHz



Start: 21.000000 GHz Atten: 10 dB Stop: 22.000000 GHz
Res BW: 1 MHz Vid BW: 3 MHz Sweep: 50.00 ms
23/01/2012 19:55:22 HP8563E

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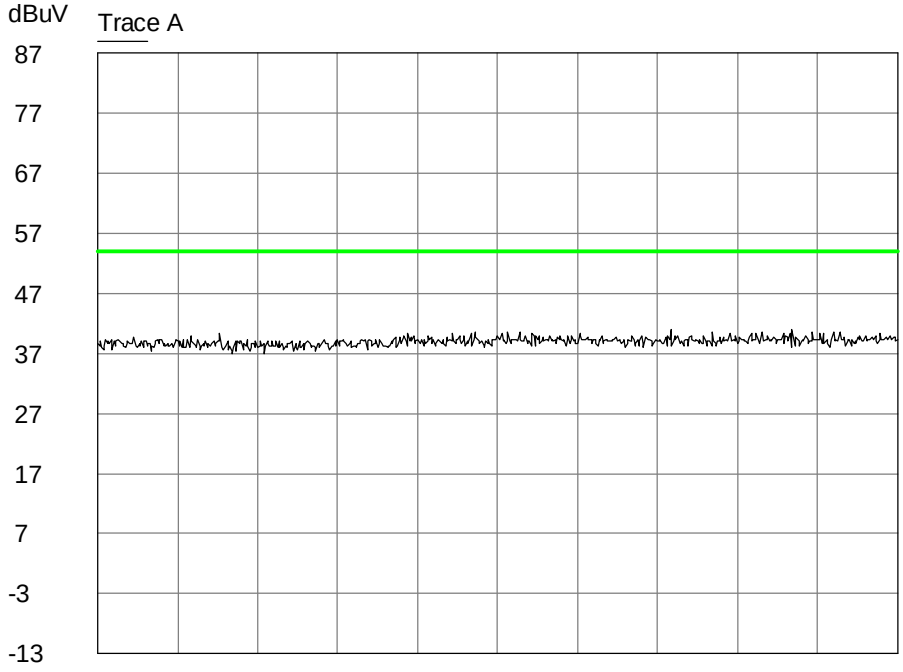
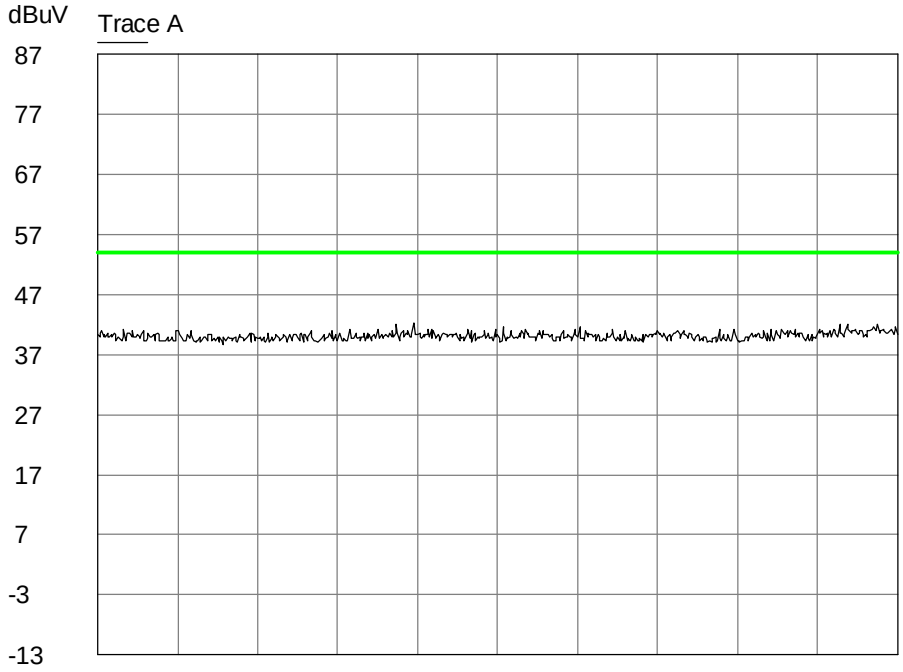
J4933-3 mid chan TX Horizontal 22-23GHz



Start: 22.000000 GHz Atten: 10 dB Stop: 23.000000 GHz
Res BW: 1 MHz Vid BW: 3 MHz Sweep: 50.00 ms
23/01/2012 19:56:20 HP8563E

J4933-3 mid chan TX Horizontal 23-24GHz



Start: 23.000000 GHz Atten: 10 dB Stop: 24.000000 GHz
Res BW: 1 MHz Vid BW: 3 MHz Sweep: 50.00 ms
23/01/2012 19:56:43 HP8563E

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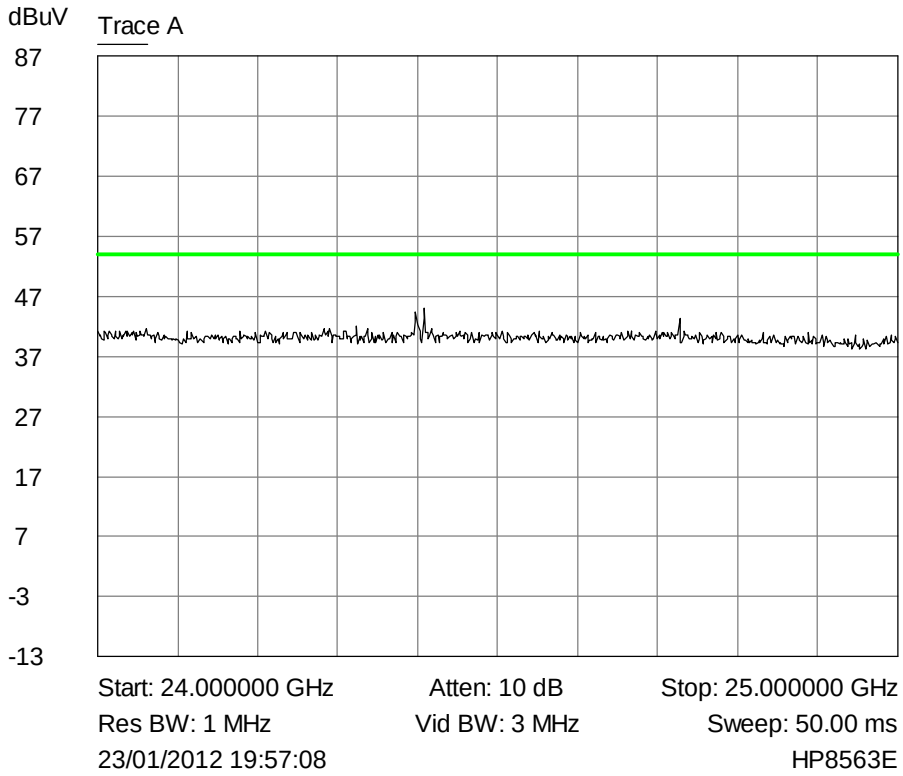
J4933-3 mid chan TX Horizontal 24-25GHz



Start: 24.000000 GHz Atten: 10 dB Stop: 25.000000 GHz
Res BW: 1 MHz Vid BW: 3 MHz Sweep: 50.00 ms
23/01/2012 19:57:08 HP8563E

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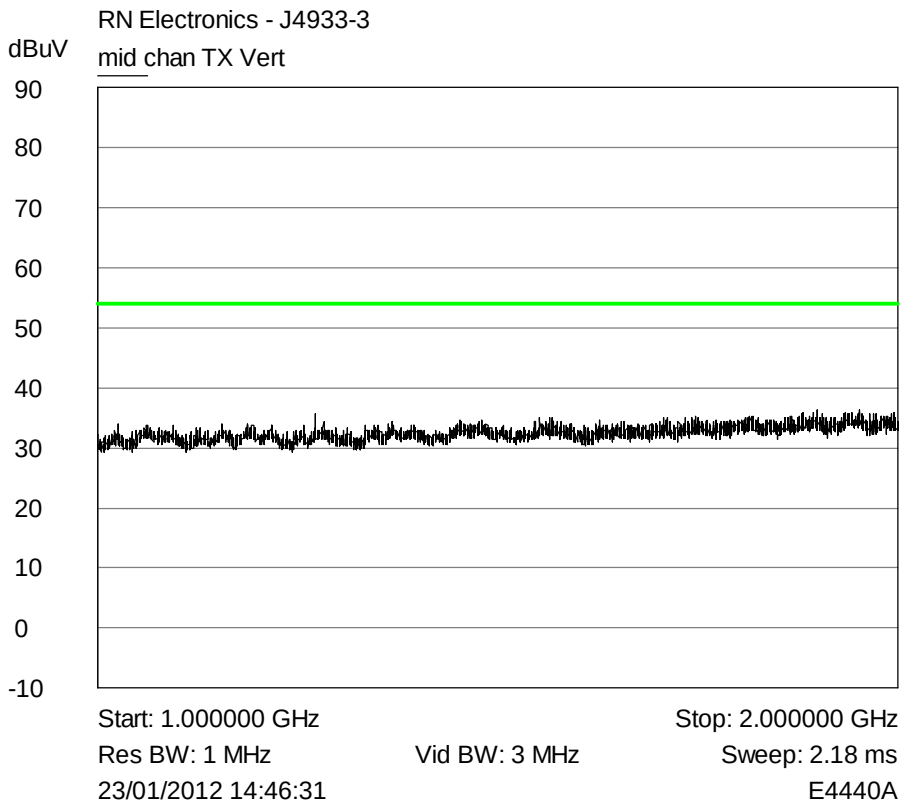
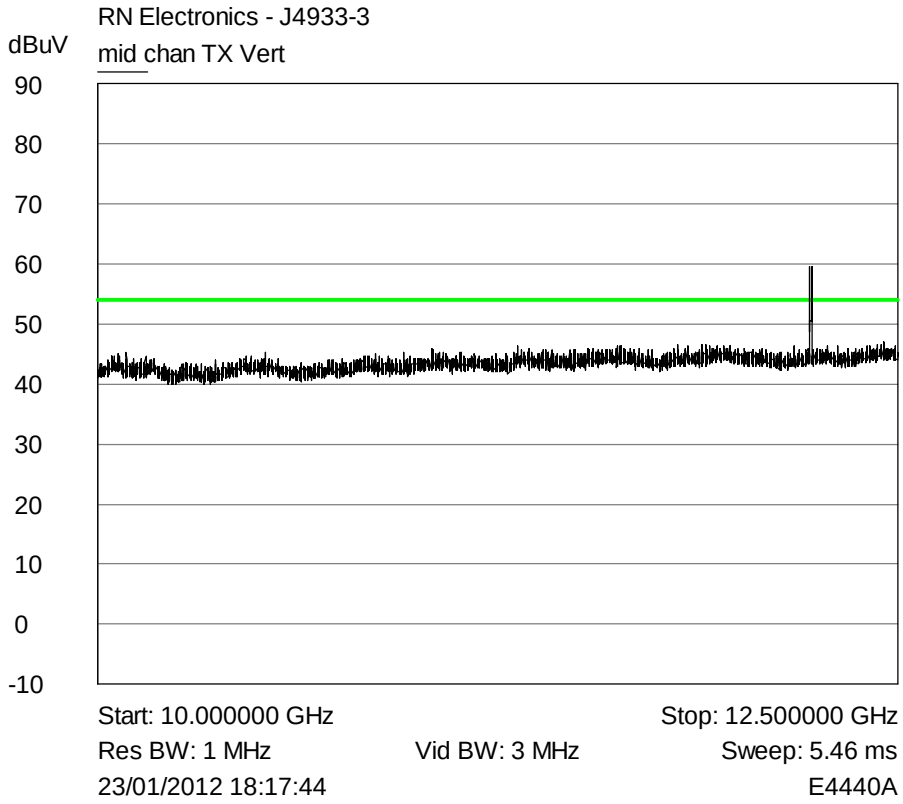
Plot of Average Vertical emissions 1GHz - 25GHz against the Average limit line.





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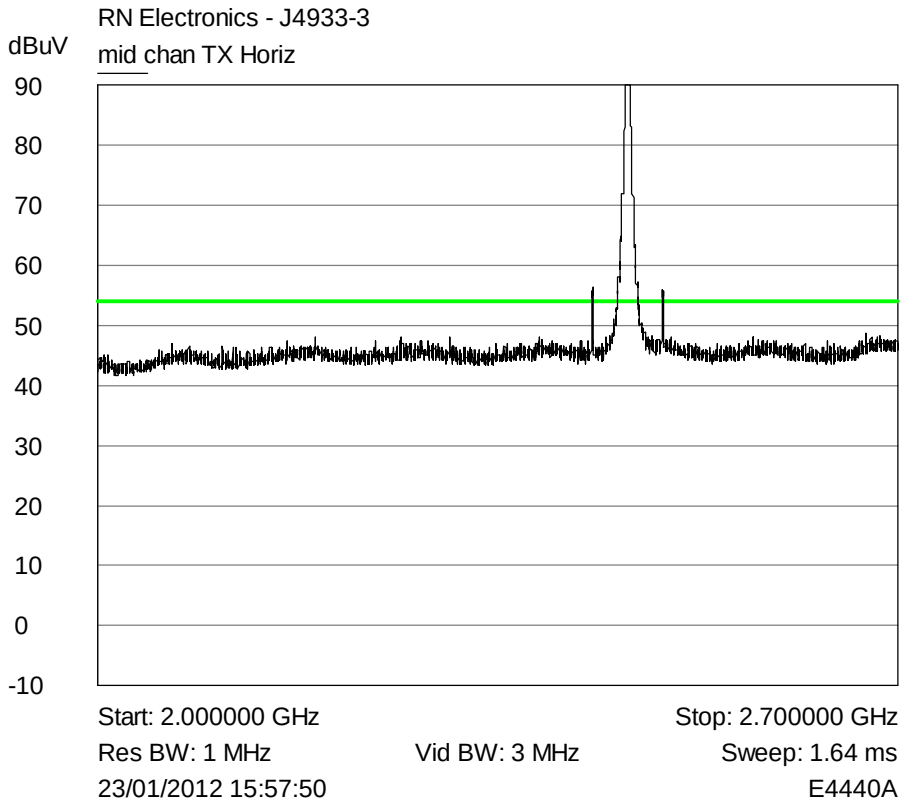

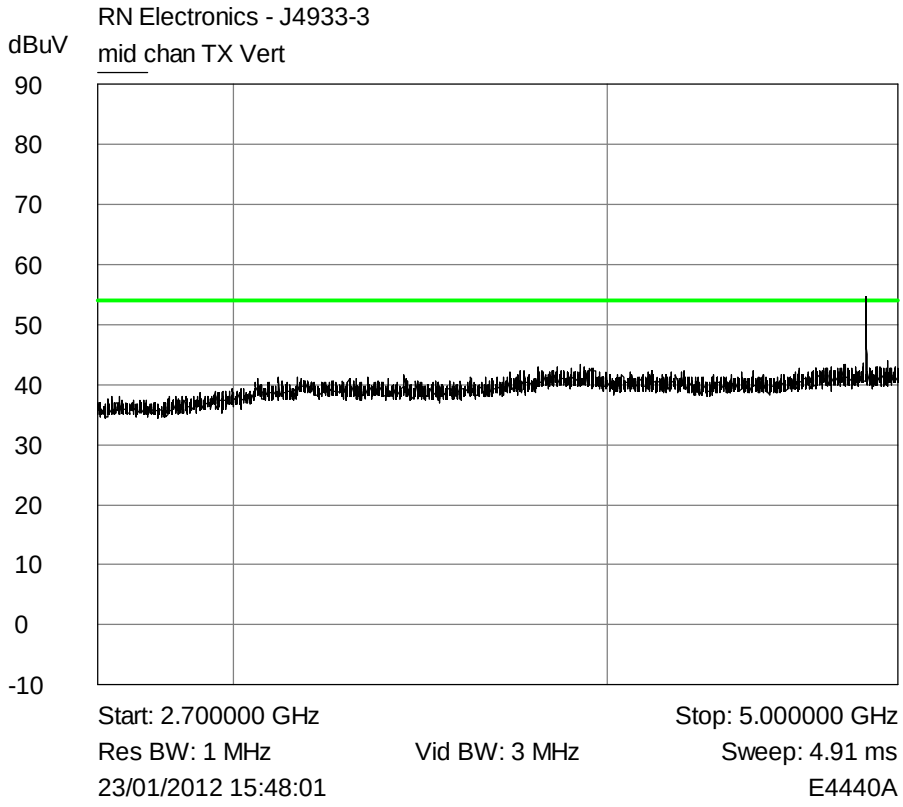

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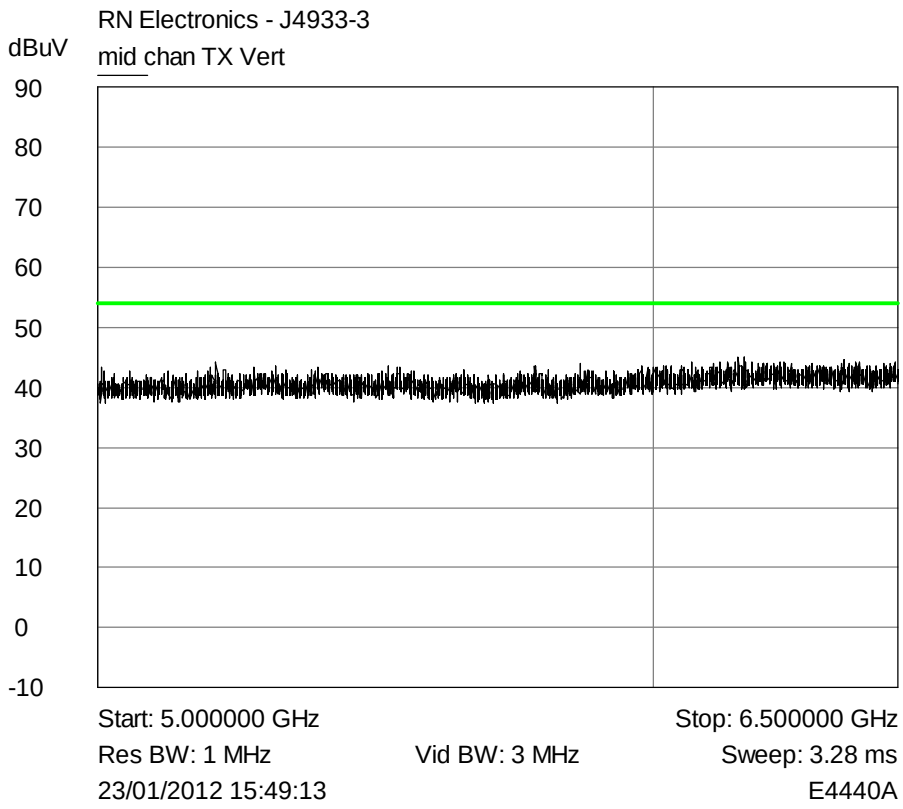

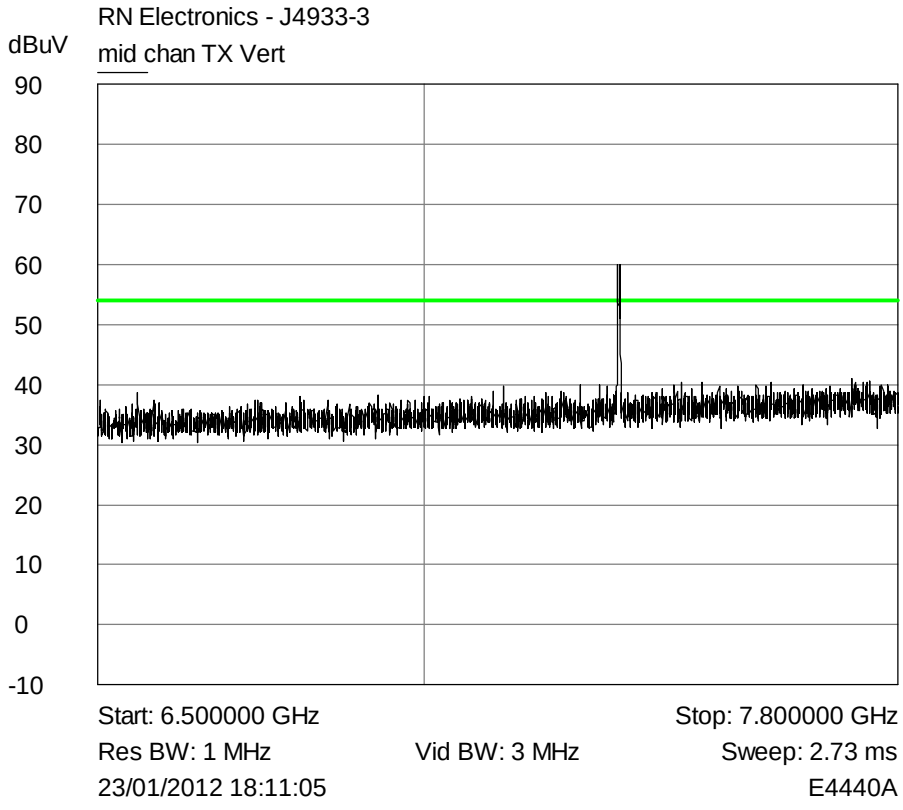

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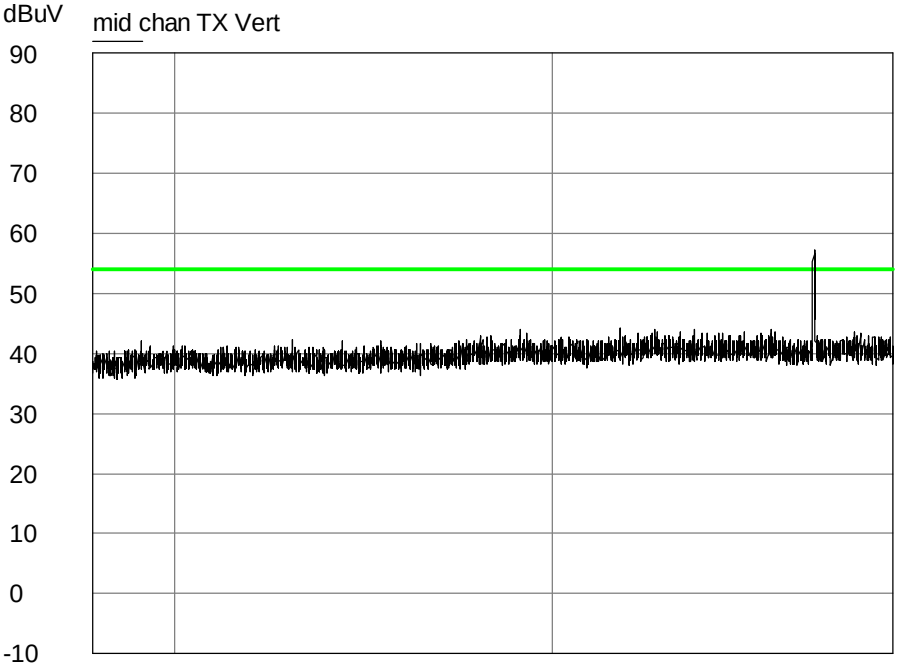
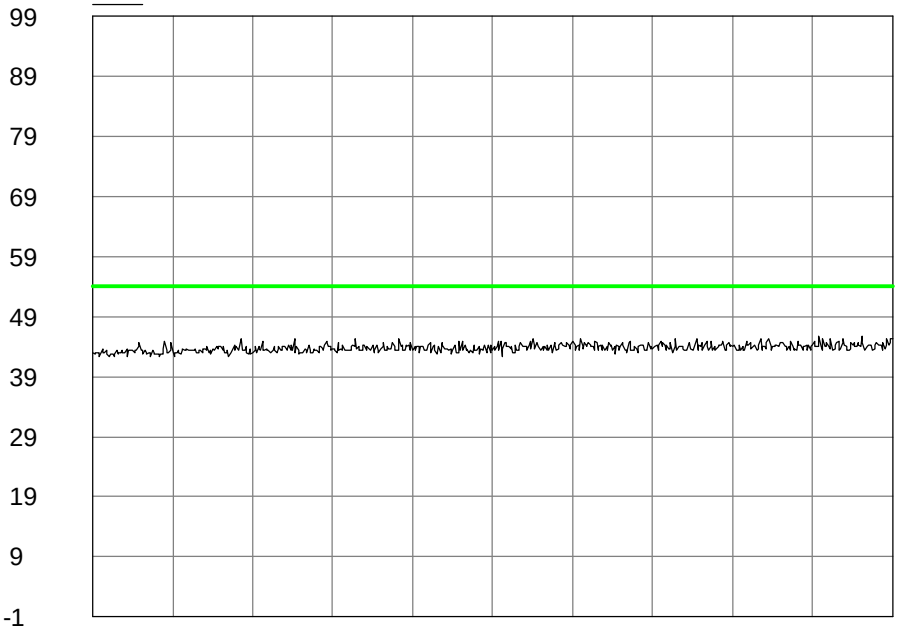
RN Electronics - J4933-3
mid chan TX Vert



Start: 7.800000 GHz Stop: 10.000000 GHz
Res BW: 1 MHz Vid BW: 3 MHz Sweep: 4.91 ms
23/01/2012 18:12:58 E4440A

J4933-3 mid chan TX Vertical 12.5-14GHz
Trace A



Start: 12.500000 GHz Atten: 10 dB Stop: 14.000000 GHz
Res BW: 1 MHz Vid BW: 3 MHz Sweep: 50.00 ms
23/01/2012 18:46:51 HP8563E

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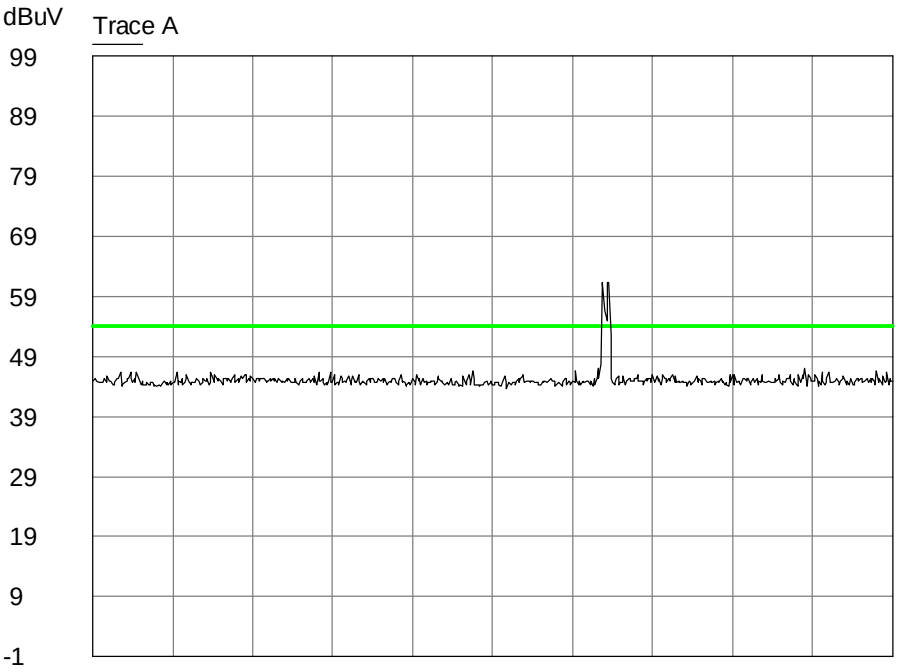
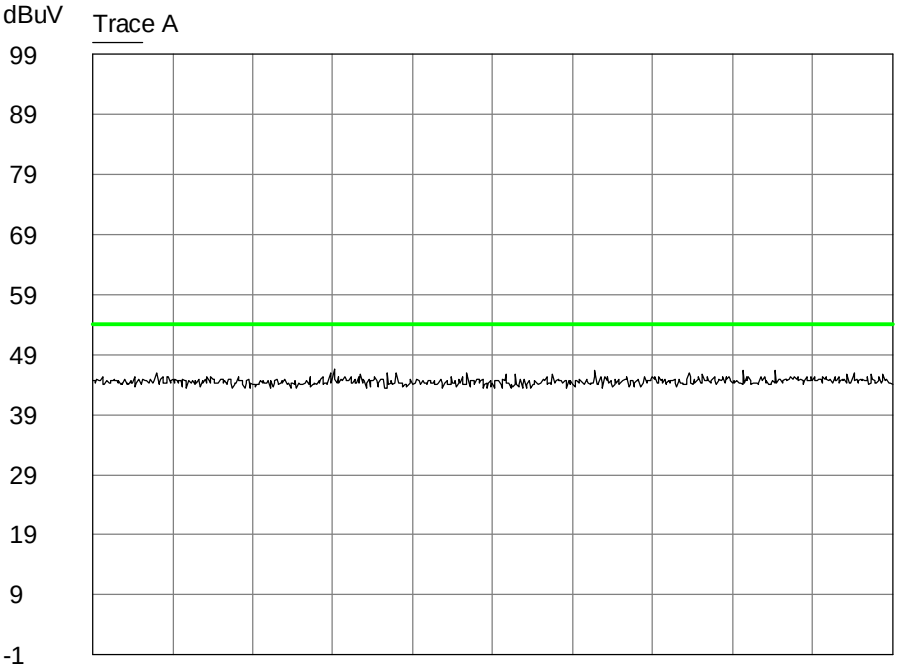
J4933-3 mid chan TX Vertical 14-15GHz



Start: 14.000000 GHz Atten: 10 dB Stop: 15.000000 GHz
Res BW: 1 MHz Vid BW: 3 MHz Sweep: 50.00 ms
23/01/2012 18:44:33 HP8563E

J4933-3 mid chan TX Vertical 15-16GHz



Start: 15.000000 GHz Atten: 10 dB Stop: 16.000000 GHz
Res BW: 1 MHz Vid BW: 3 MHz Sweep: 50.00 ms
23/01/2012 18:47:46 HP8563E

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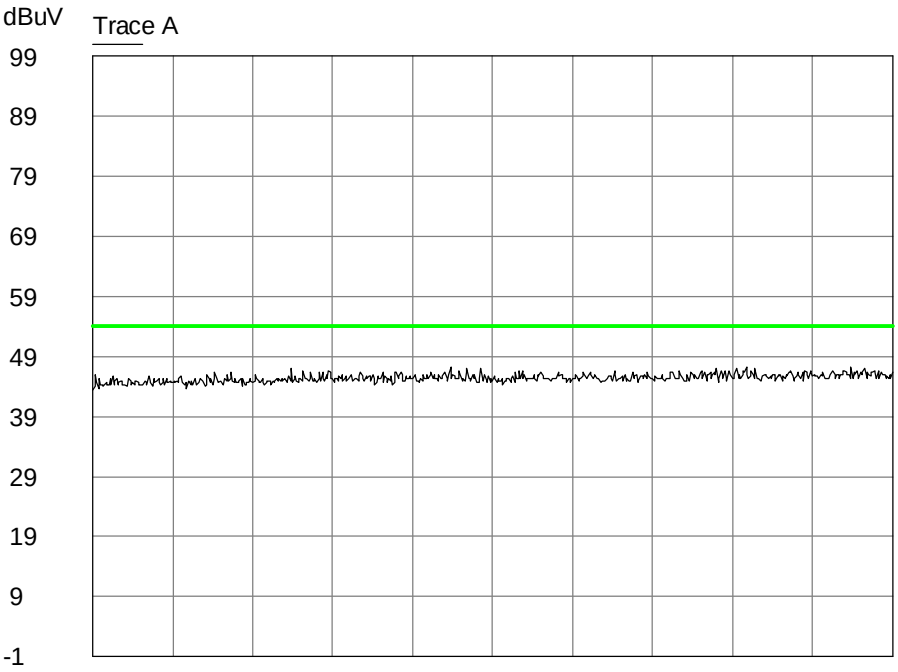
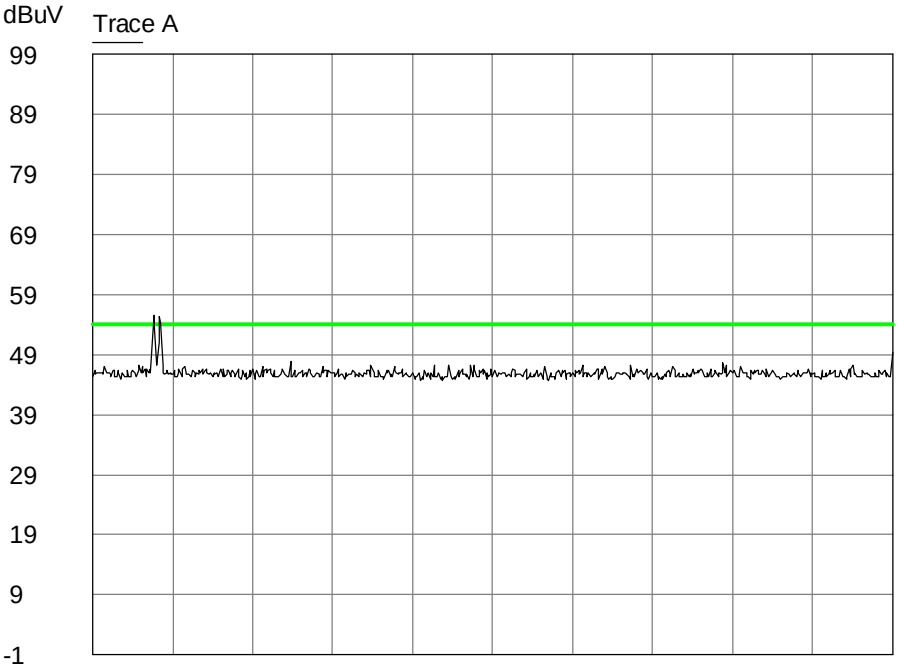
J4933-3 mid chan TX Vertical 16-17GHz



Start: 16.000000 GHz Atten: 10 dB Stop: 17.000000 GHz
Res BW: 1 MHz Vid BW: 3 MHz Sweep: 50.00 ms
23/01/2012 18:48:16 HP8563E

J4933-3 mid chan TX Vertical 17-18GHz



Start: 17.000000 GHz Atten: 10 dB Stop: 18.000000 GHz
Res BW: 1 MHz Vid BW: 3 MHz Sweep: 50.00 ms
23/01/2012 18:49:04 HP8563E

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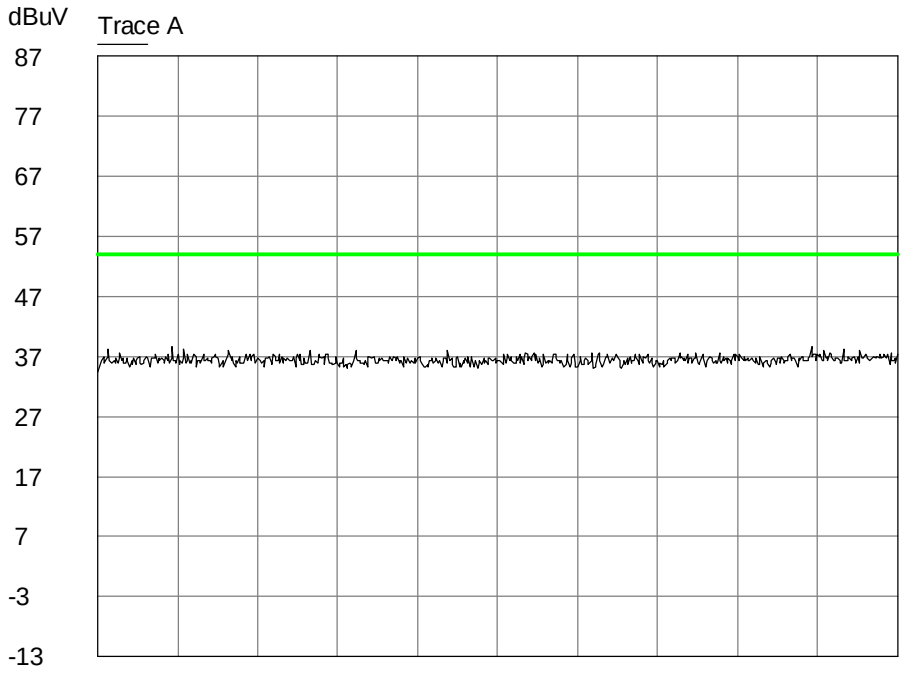
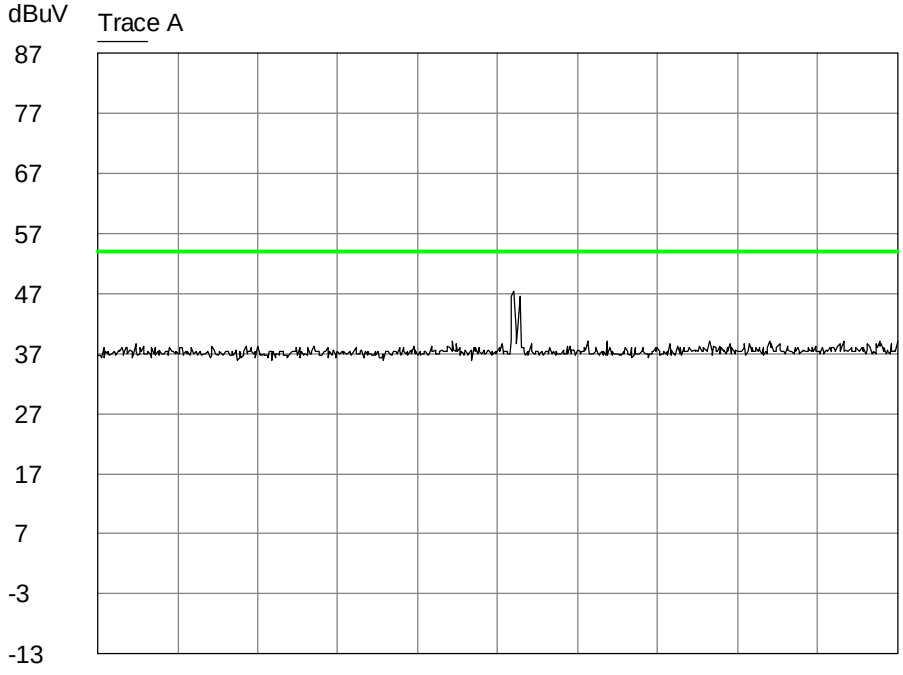
J4933-3 mid chan TX Vertical 18-19GHz



Start: 18.000000 GHz Atten: 10 dB Stop: 19.000000 GHz
Res BW: 1 MHz Vid BW: 3 MHz Sweep: 50.00 ms
23/01/2012 20:01:57 HP8563E

J4933-3 mid chan TX Vertical 19-20GHz



Start: 19.000000 GHz Atten: 10 dB Stop: 20.000000 GHz
Res BW: 1 MHz Vid BW: 3 MHz Sweep: 50.00 ms
23/01/2012 20:01:38 HP8563E

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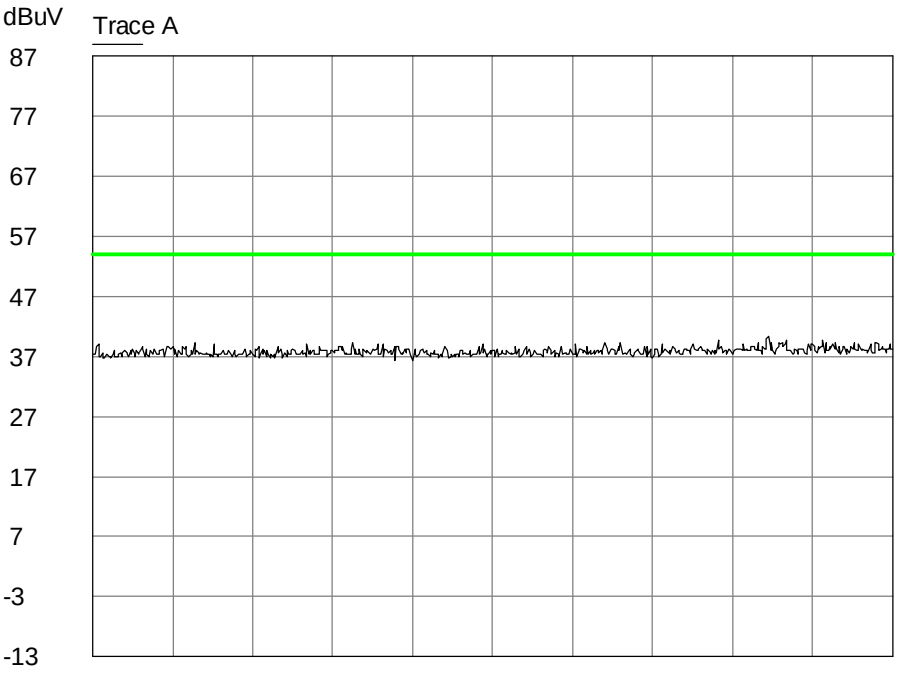
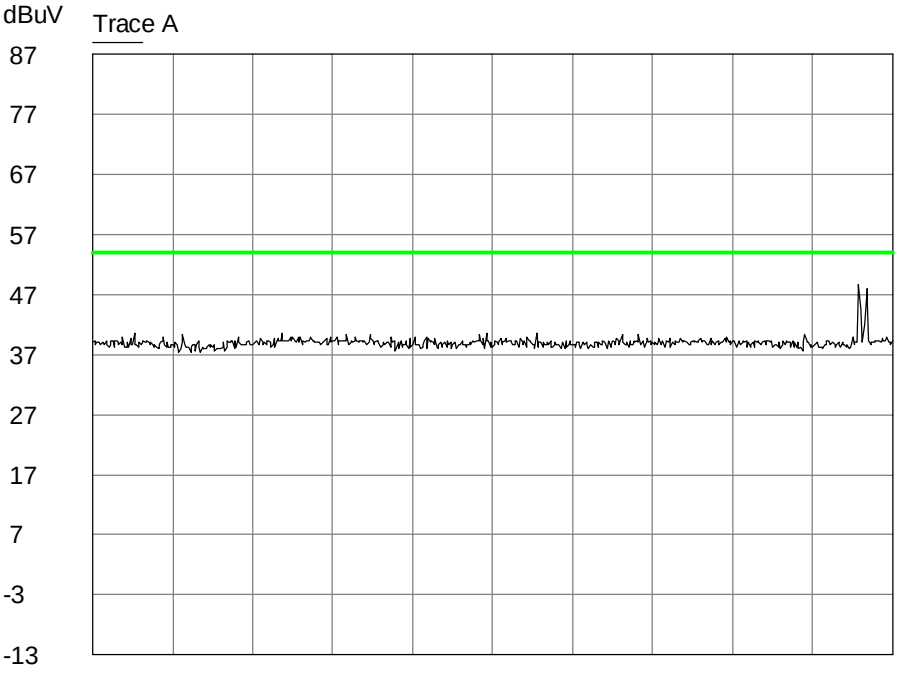
J4933-3 mid chan TX Vertical 20-21GHz



Start: 20.000000 GHz Atten: 10 dB Stop: 21.000000 GHz
Res BW: 1 MHz Vid BW: 3 MHz Sweep: 50.00 ms
23/01/2012 20:01:13 HP8563E

J4933-3 mid chan TX Vertical 21-22GHz



Start: 21.000000 GHz Atten: 10 dB Stop: 22.000000 GHz
Res BW: 1 MHz Vid BW: 3 MHz Sweep: 50.00 ms
23/01/2012 20:00:53 HP8563E

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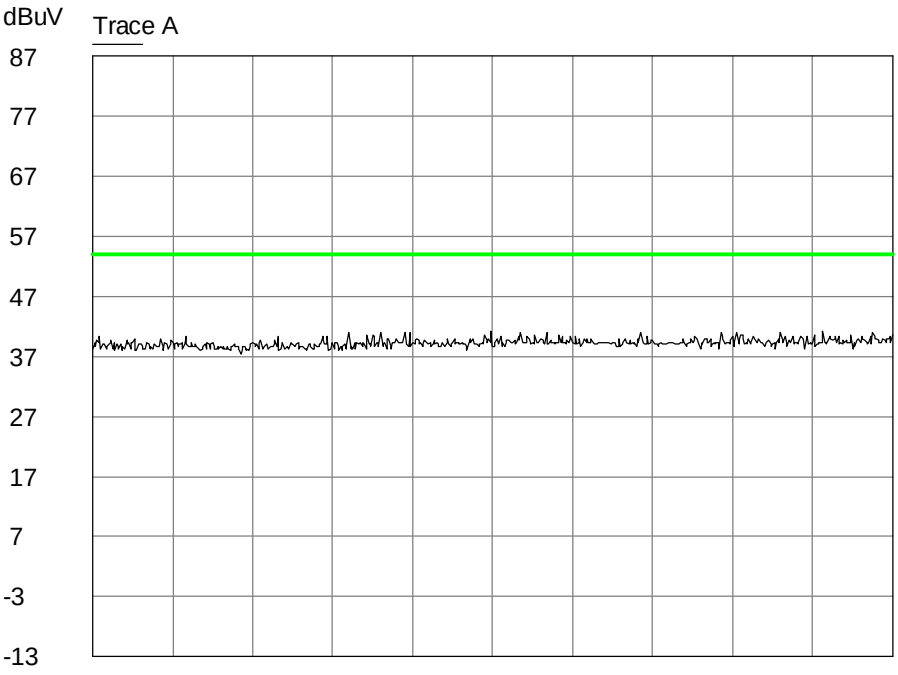
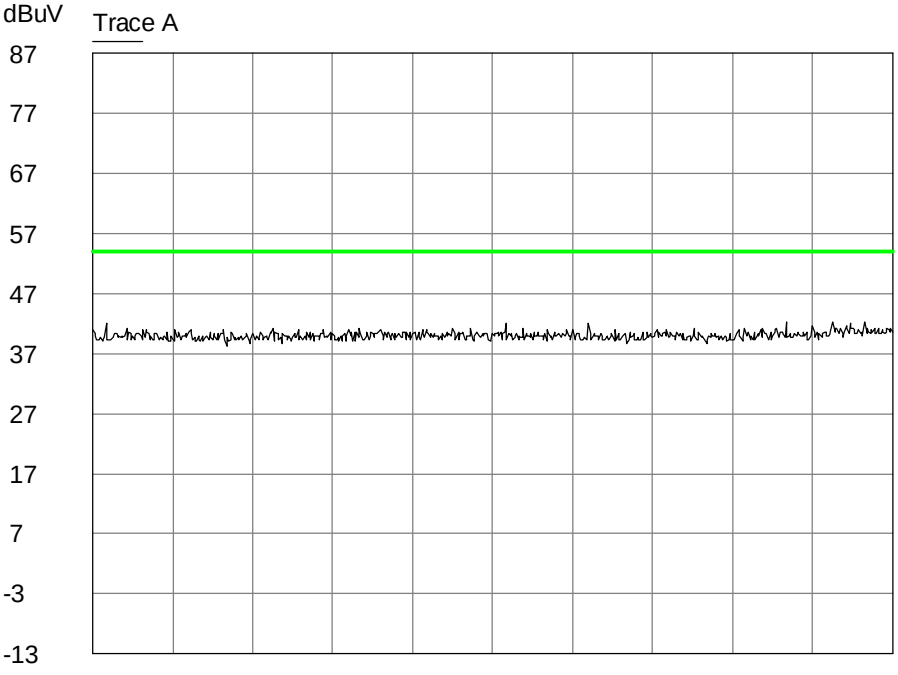
J4933-3 mid chan TX Vertical 22-23GHz



Start: 22.000000 GHz Atten: 10 dB Stop: 23.000000 GHz
Res BW: 1 MHz Vid BW: 3 MHz Sweep: 50.00 ms
23/01/2012 19:59:55 HP8563E

J4933-3 mid chan TX Vertical 23-24GHz



Start: 23.000000 GHz Atten: 10 dB Stop: 24.000000 GHz
Res BW: 1 MHz Vid BW: 3 MHz Sweep: 50.00 ms
23/01/2012 19:58:44 HP8563E

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J4933-3 mid chan TX Vertical 24-25GHz

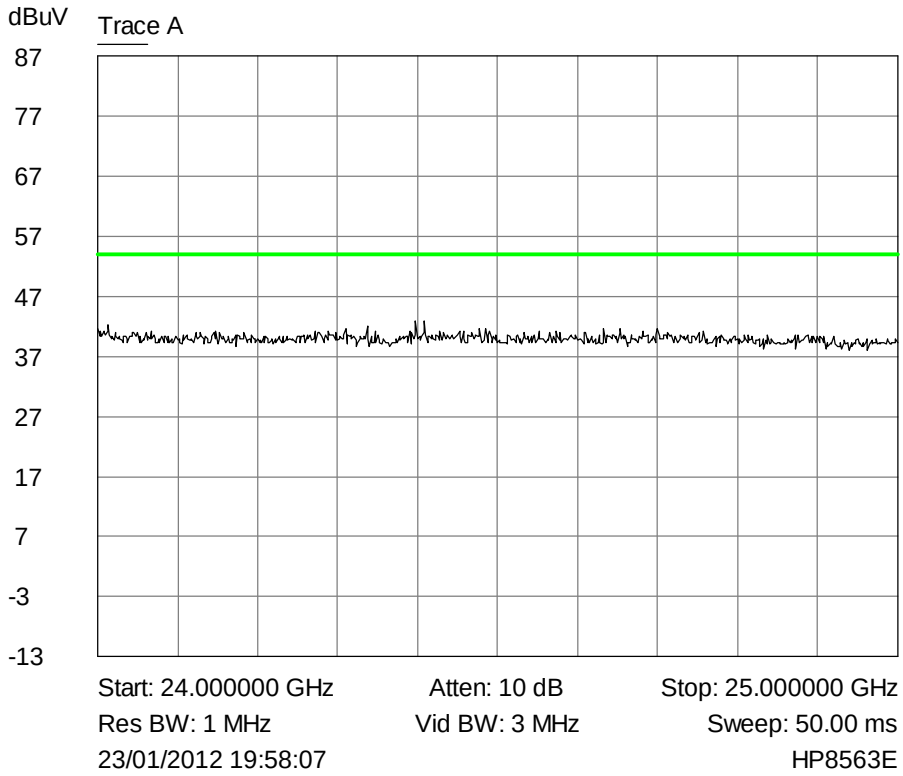

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Table of signals measured above 1GHz.

Note: The values measured and tabulated below are with the EUT operating in continuous transmit and are directly a result of the modulated signal (harmonics). According to 15.35(c) the duty cycle should be taken into consideration when calculating the average value of the emission. Therefore these values will actually be reduced in practice. Refer to the manufacturer's statement regarding actual duty cycle.

Horizontal

Bottom Channel

Signal No.	Freq (MHz)	Peak Amp (dBuV)	AV Amp (dBuV)	AV - Lim1 (dB)
1	4810	59.4	51.7	-2.3
2	7215	65.3	58.2	4.2[1]
3	9620	58.2	49.1	-4.9
4	12025	68.0	60.6	6.6[1]
5	14430	61.8	53.7	-0.3
6	16835	57.8	49.3	-4.7
7	19240	50.2	41.0	-13
8	21645	49.8	40.8	-13.2

Middle Channel

Signal No.	Freq (MHz)	Peak Amp (dBuV)	AV Amp (dBuV)	AV - Lim1 (dB)
1	4880	59.9	52.5	-1.5
2	7320	61.5	54.5	0.5[1]
3	9760	59.9	52.2	-1.8
4	12200	70.6	63.2	9.2[1]
5	14640	62.7	54.0	0.0[1]
6	17080	55.3	44.2	-9.8
7	19520	48.5	39.0	-15.0
8	21960	49.7	40.2	-13.8
9	24400	42.0	30.0	-24.0

Top Channel

Signal No.	Freq (MHz)	Peak Amp (dBuV)	AV Amp (dBuV)	AV - Lim1 (dB)
1	4960	56.8	48.9	-5.1
2	7440	56.8	48.7	-5.3
3	9920	56.8	47.2	-6.8
4	12400	69.6	61.5	7.5[1]
5	14880	61.8	51.5	-2.5
6	17360	51.7	41.8	-12.2
7	19840	46.0	36.3	-17.7
8	22320	50.8	41.3	-12.7
9	24800	47.2	35.6	-18.4

[1] The values in the above table are from an EUT operating at 100% duty. The manufacturer has declared the actual duty per 100ms to be typically 10% and therefore an additional correction factor of up to 20dB can be applied.

Vertical

Bottom Channel

Signal No.	Freq (MHz)	Peak Amp (dBuV)	AV Amp (dBuV)	AV - Lim1 (dB)
1	4810	56.6	48.4	-5.6
2	7215	63.2	56.1	2.1[1]
3	9620	62.4	54.1	0.1[1]
4	12025	66.9	59.2	5.2[1]
5	14430	61.7	54.0	0.0[1]
6	16835	56.8	45.8	-8.2
7	19240	56.0	47.3	-6.7
8	21645	49.0	39.1	-14.9
9	24050	45.0	33.5	-20.5

Middle Channel

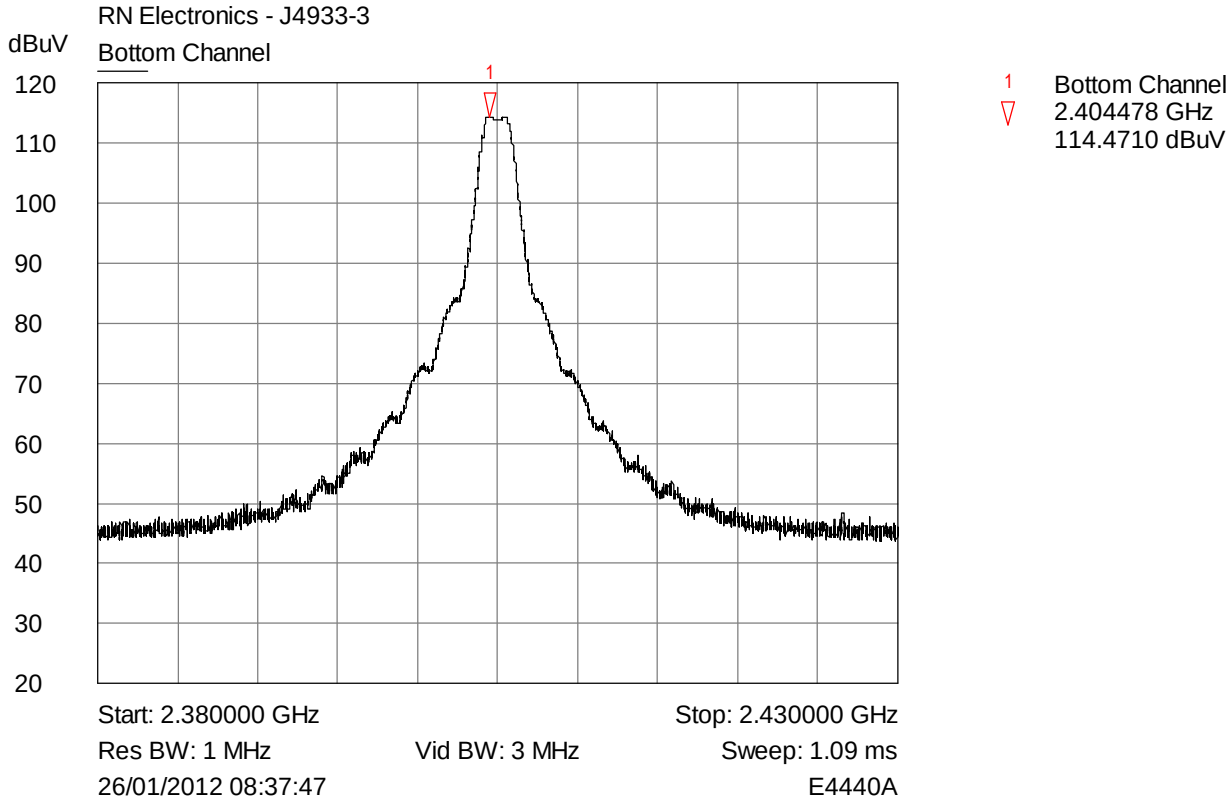
Signal No.	Freq (MHz)	Peak Amp (dBuV)	AV Amp (dBuV)	AV - Lim1 (dB)
1	4880	58.4	50.9	-3.1
2	7320	62.8	55.7	1.7[1]
3	9760	60.5	53.2	-0.8
4	12200	66.0	57.9	3.9[1]
5	14640	63.2	52.0	-2.0
6	17080	56.5	46.5	-7.5
7	19520	53.7	45.0	-9.0
8	21960	49.3	41.0	-13.0
9	24400	45.2	34.0	-20.0

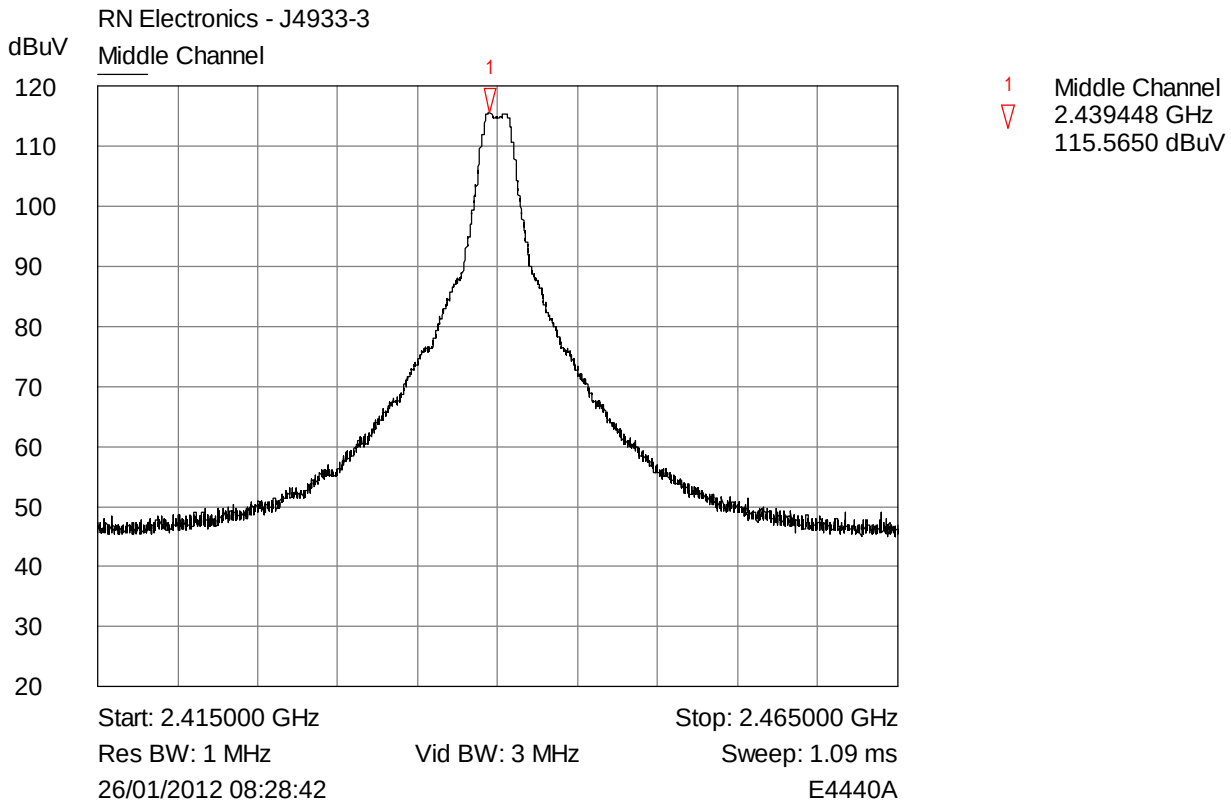
Top Channel

Signal No.	Freq (MHz)	Peak Amp (dBuV)	AV Amp (dBuV)	AV - Lim1 (dB)
1	4960	55.6	47.2	-6.8
2	7440	61.5	54.1	0.1[1]
3	9920	59.0	50.0	-4.0
4	12400	65.3	56.1	2.1[1]
5	14880	59.8	51.5	-2.5
6	17360	54.0	42.8	-11.2
7	19840	42.5	30.0	-24.0
8	22320	52.2	42.0	-12.0
9	24800	45.8	34.5	-19.5

[1] The values in the above table are from an EUT operating at 100% duty. The manufacturer has declared the actual duty per 100ms to be typically 10% and therefore an additional correction factor of up to 20dB can be applied.

6.3 Fundamental Emissions





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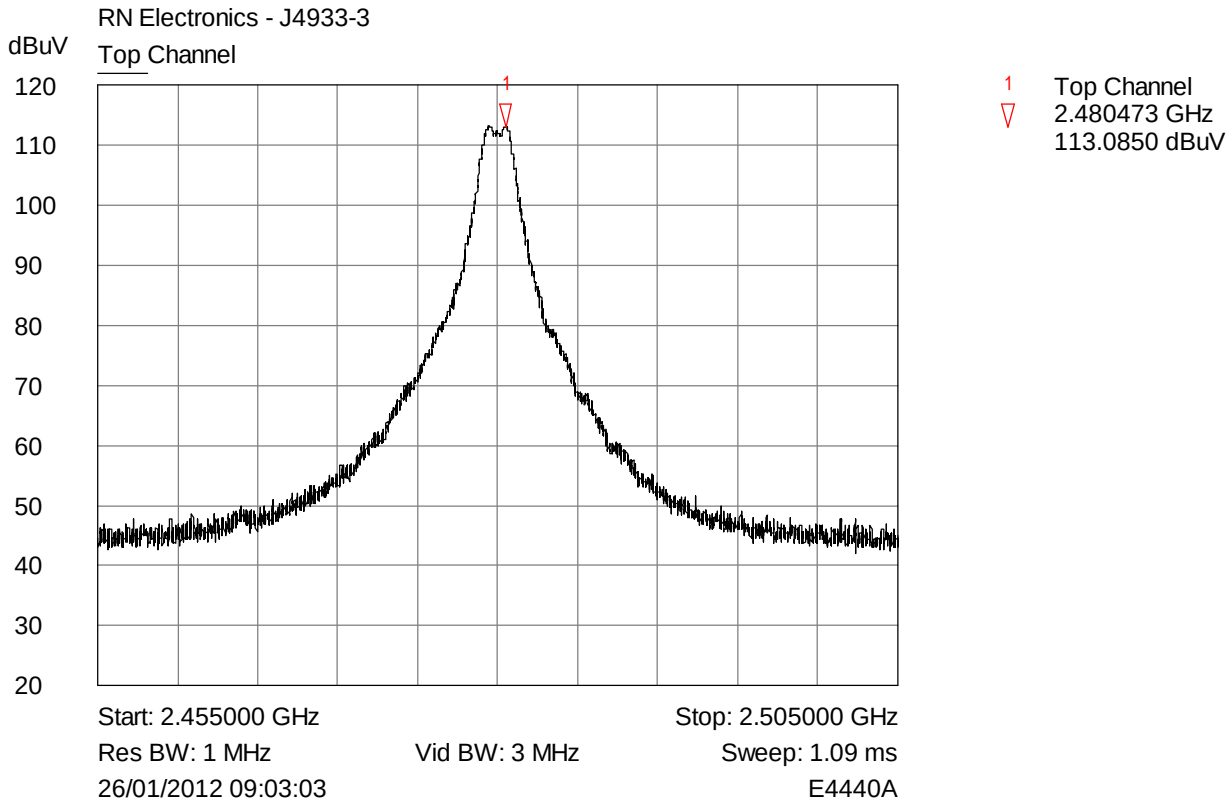

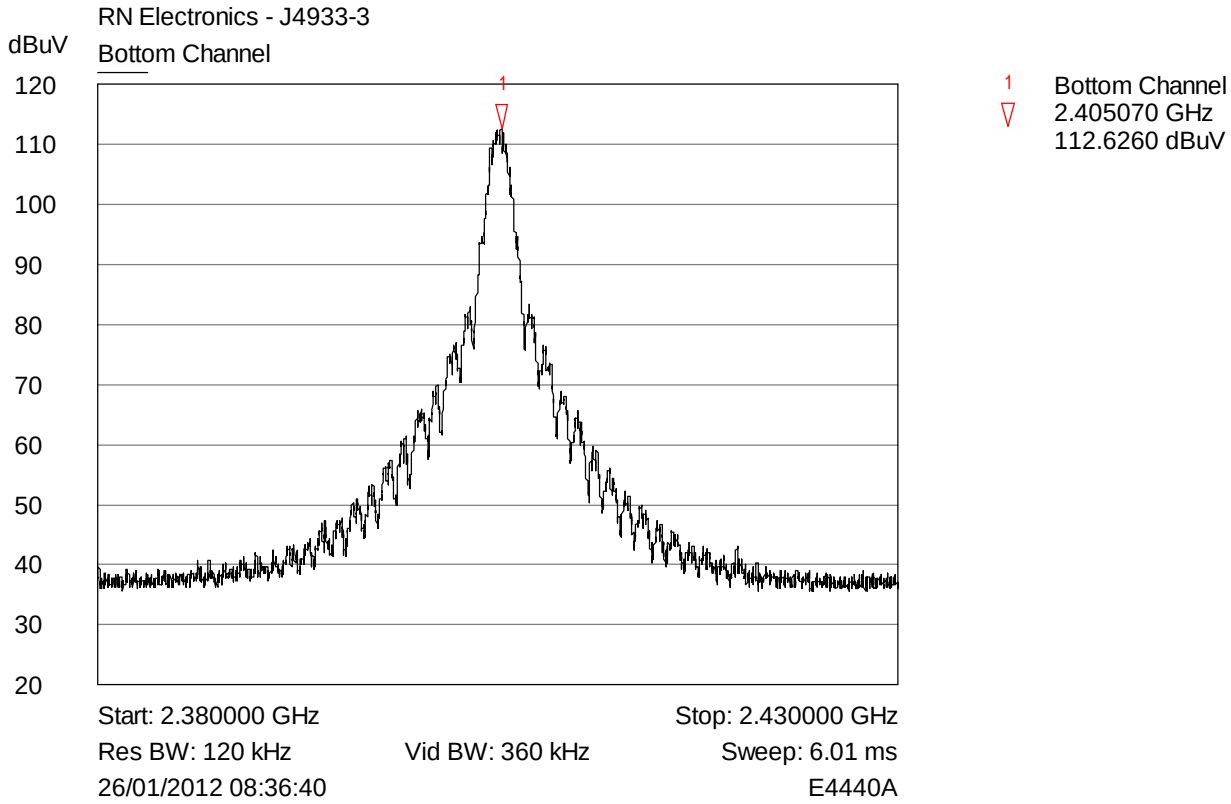

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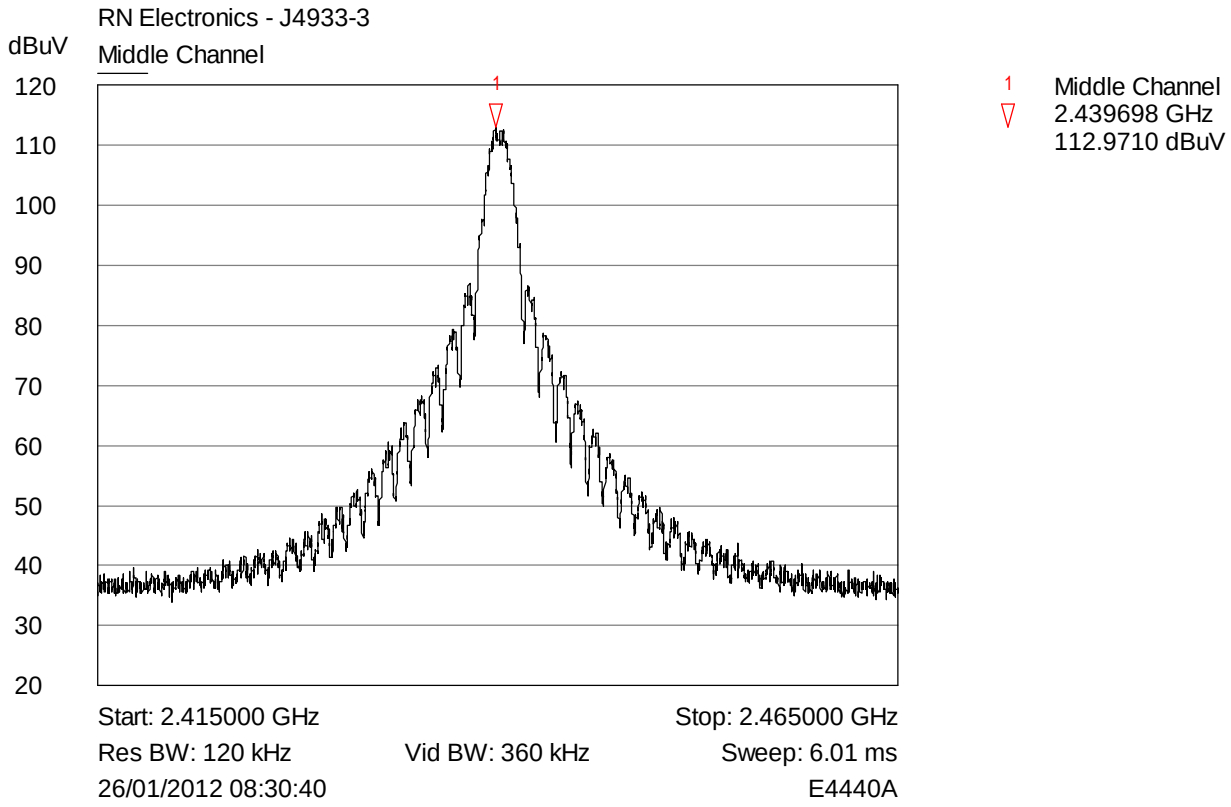

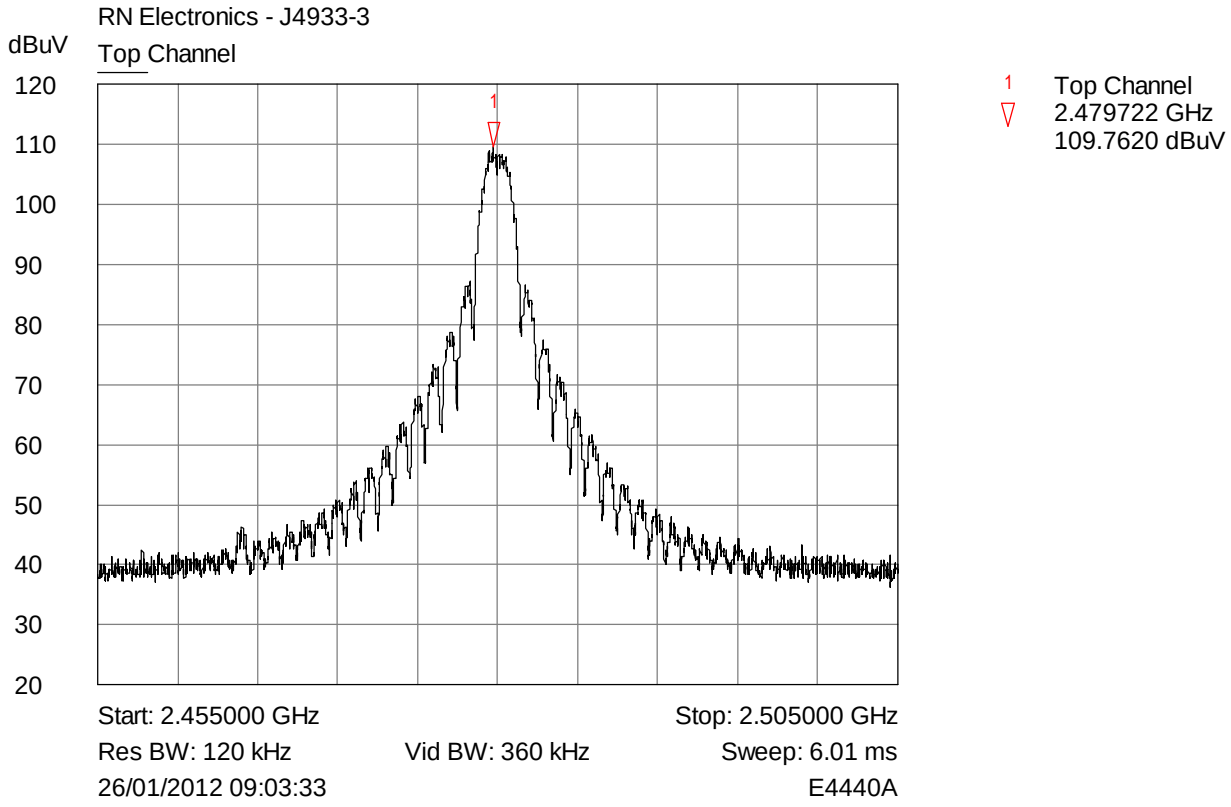

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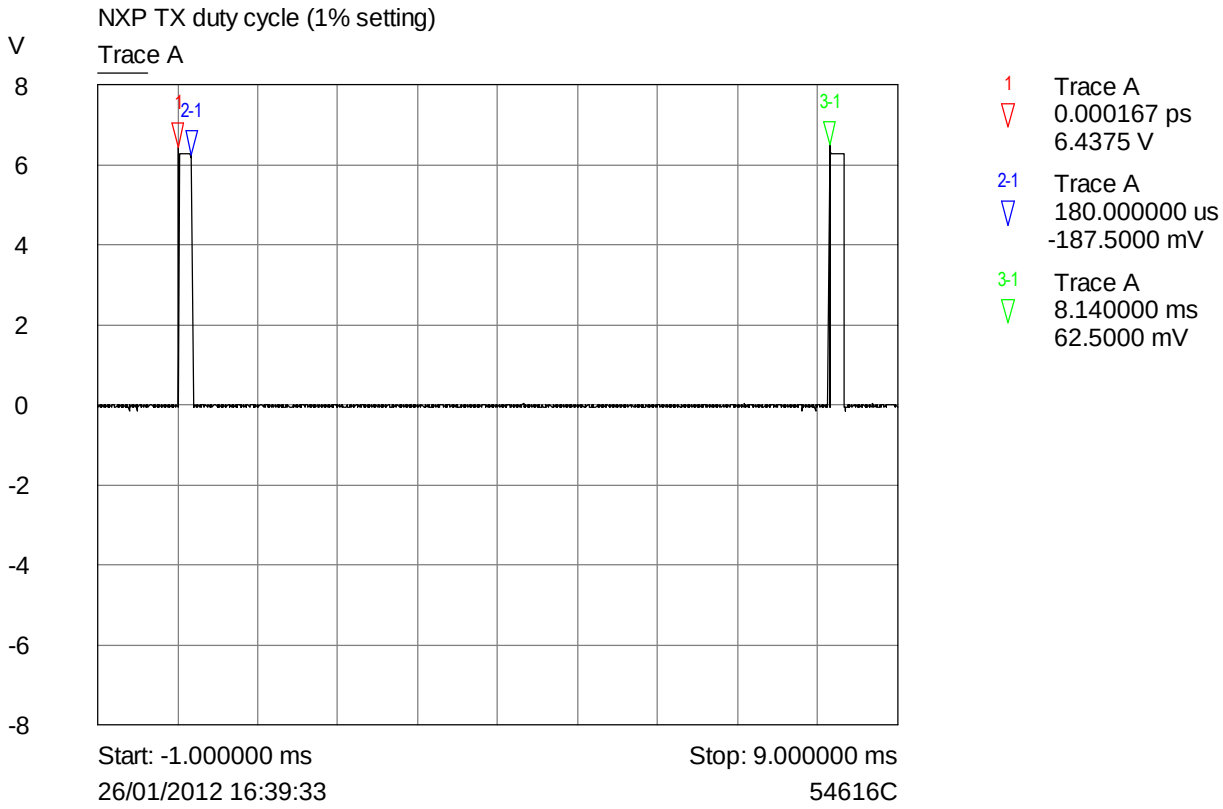
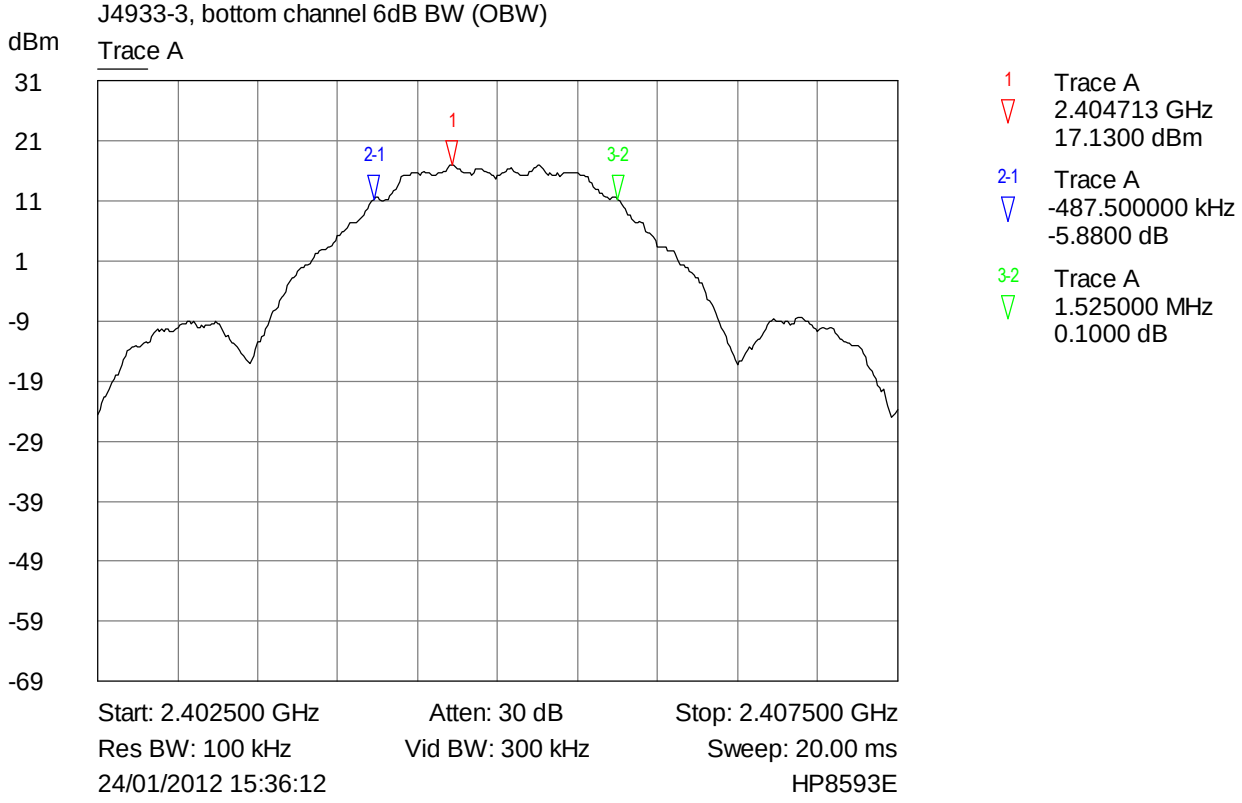
6.4 Duty Cycle

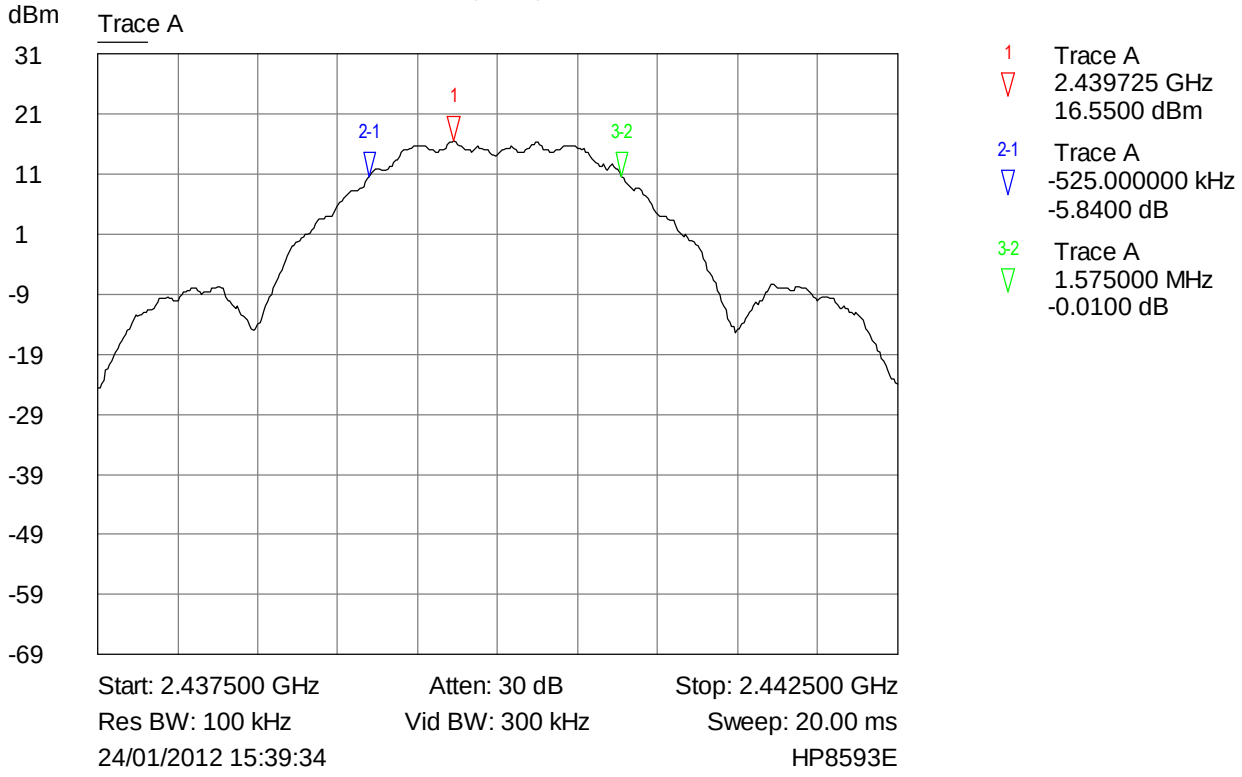


6.5 6dB Bandwidth

J4933-3, bottom channel 6dB BW (OBW)



J4933-3, middle channel 6dB BW (OBW)



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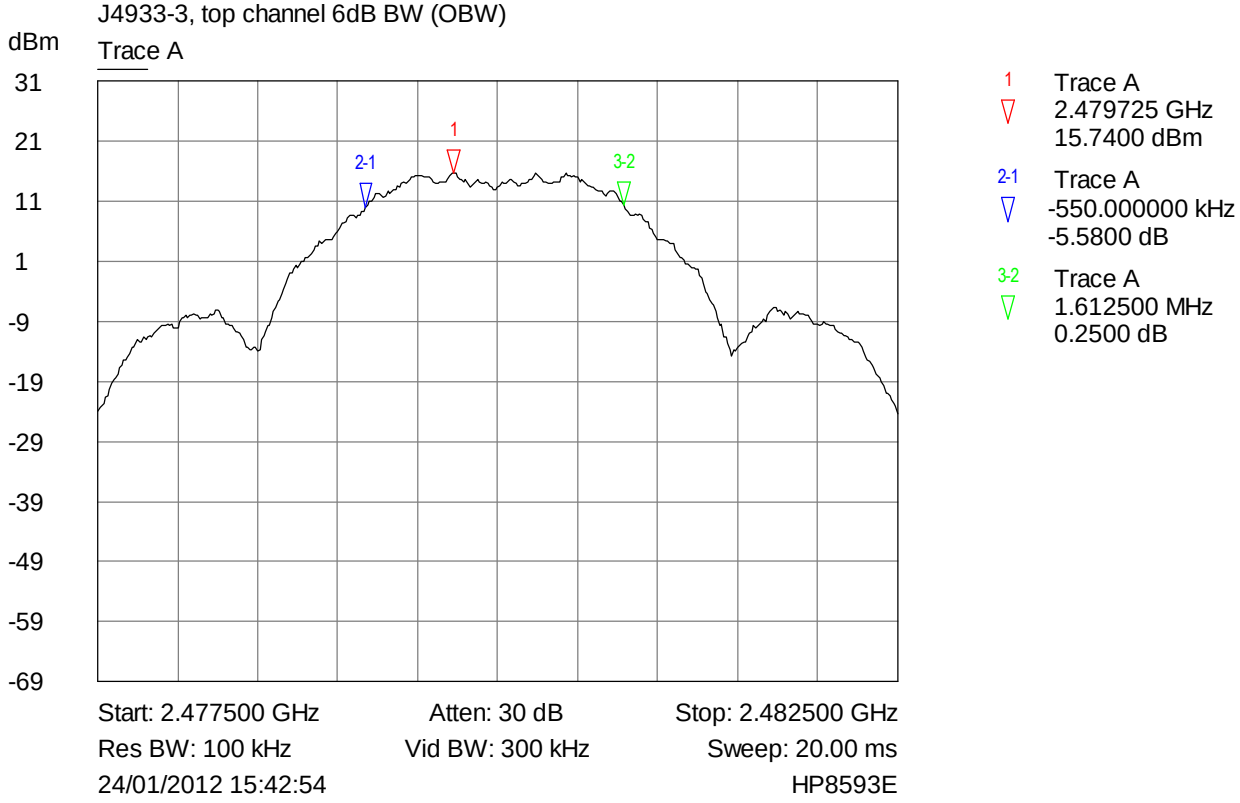
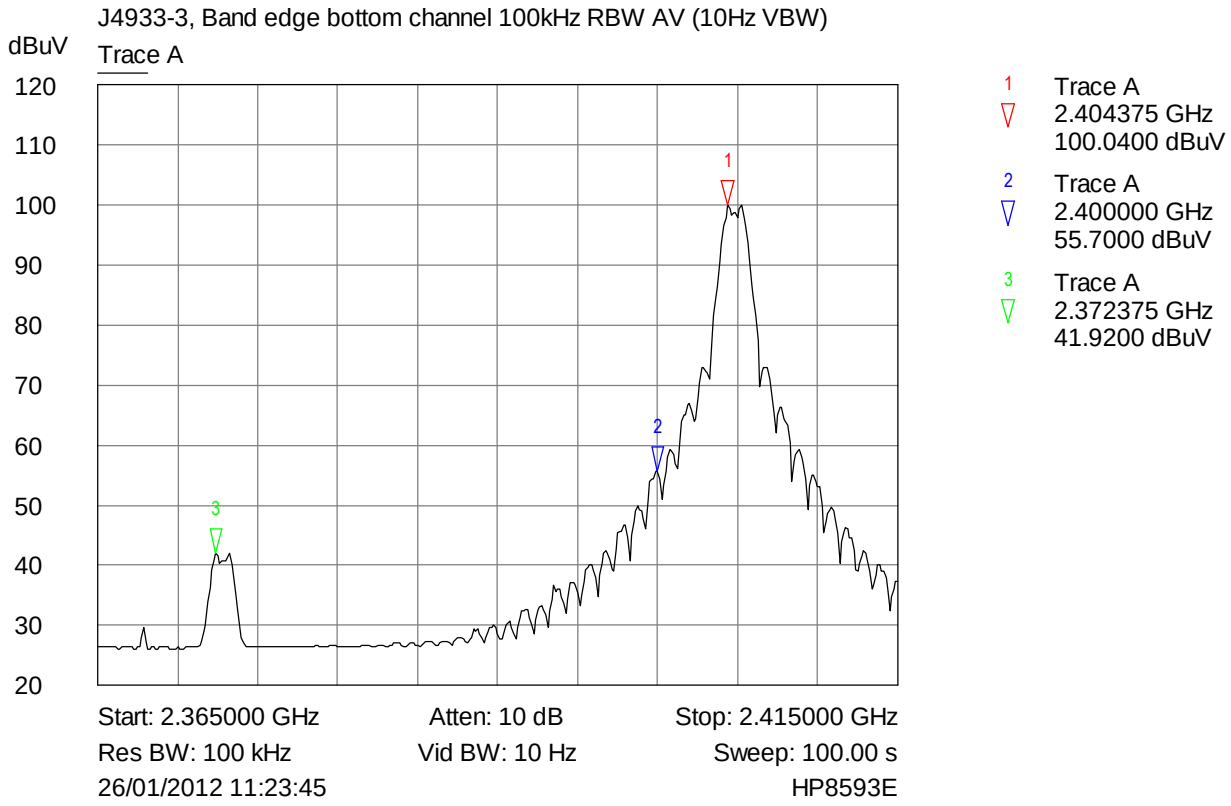
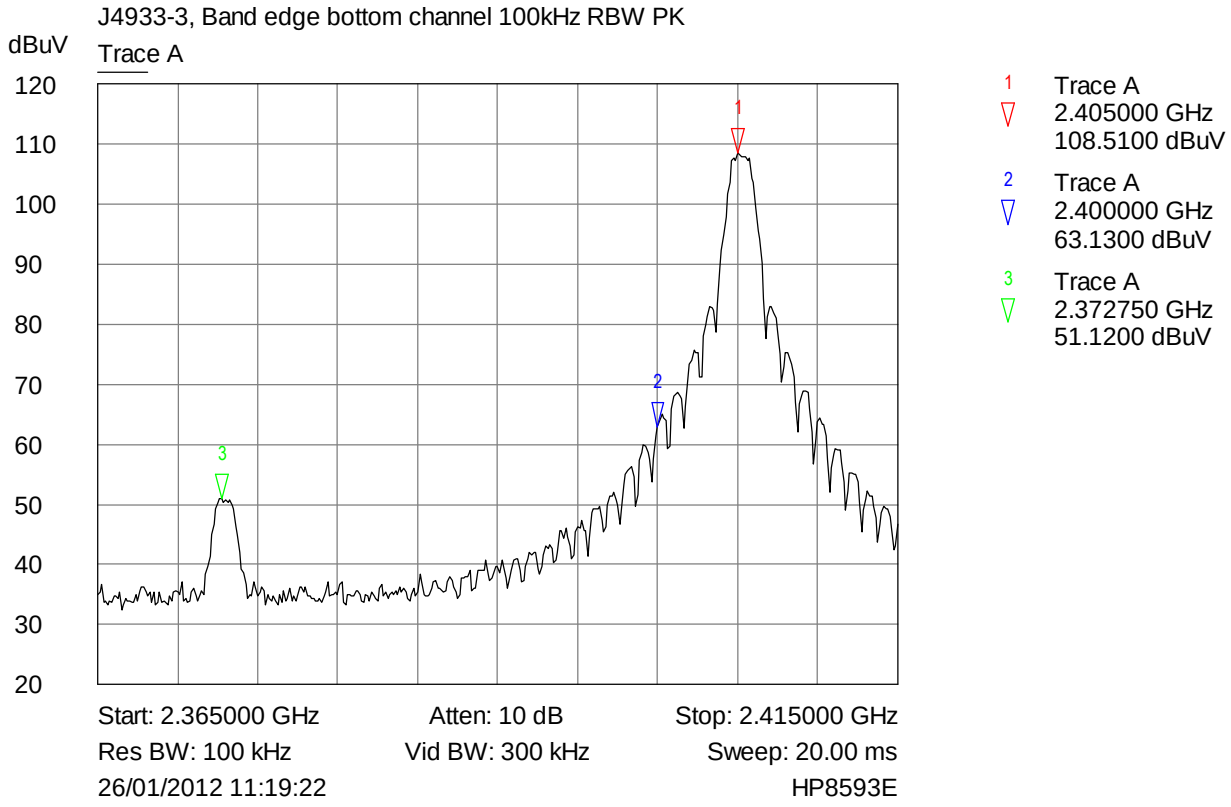
J4933-3, top channel 6dB BW (OBW)

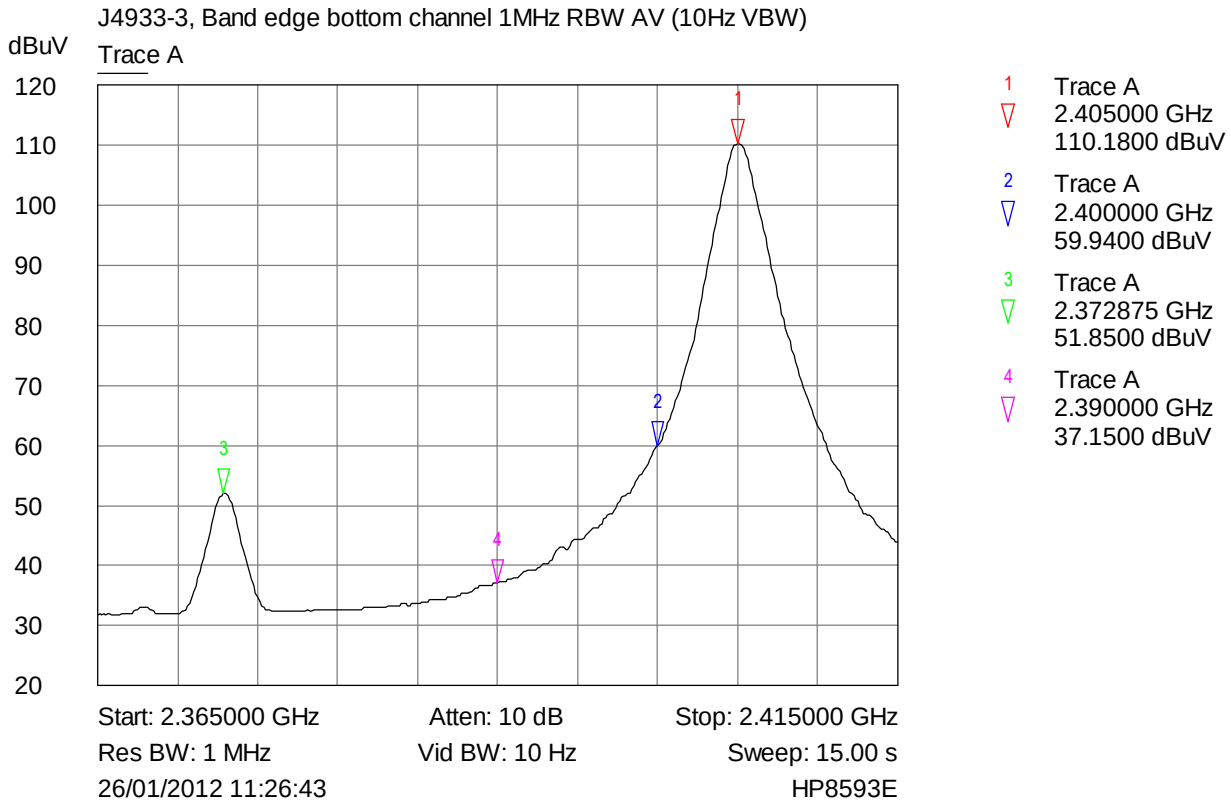


6.6 Band Edge Compliance

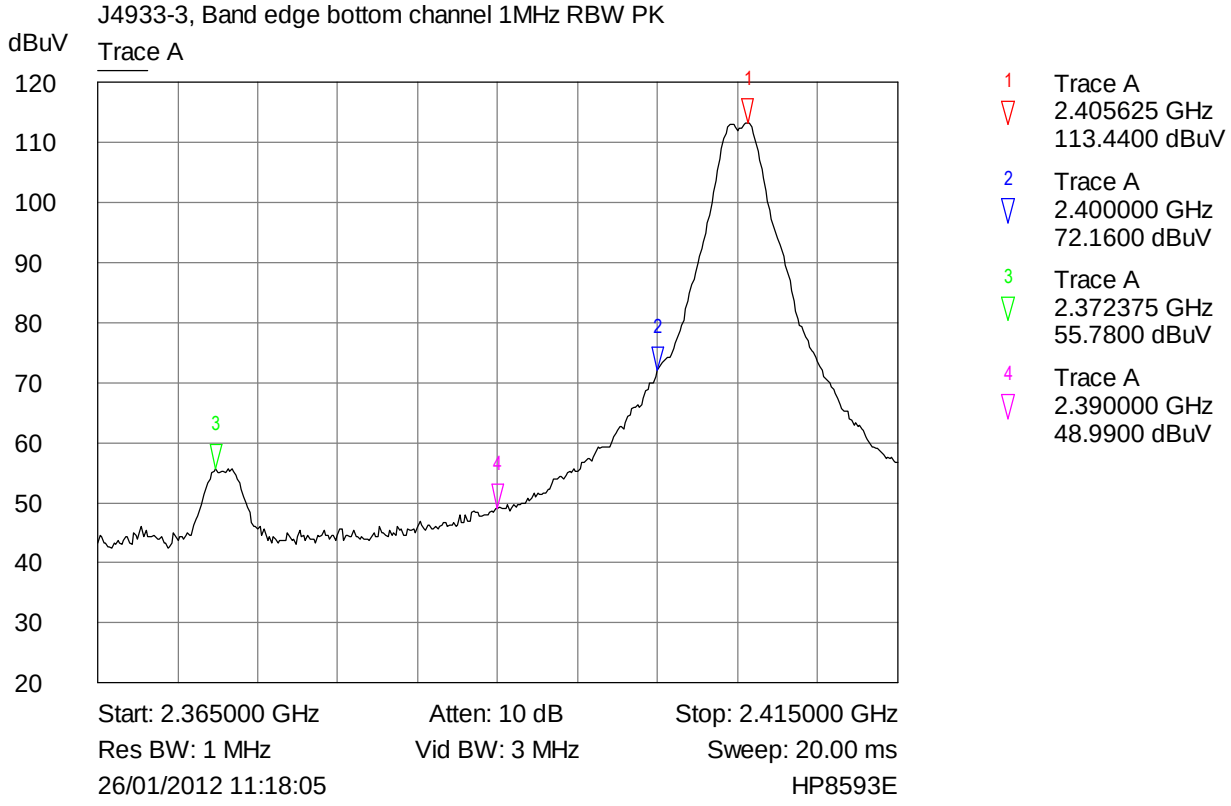
Band Edge & Restricted band edge.



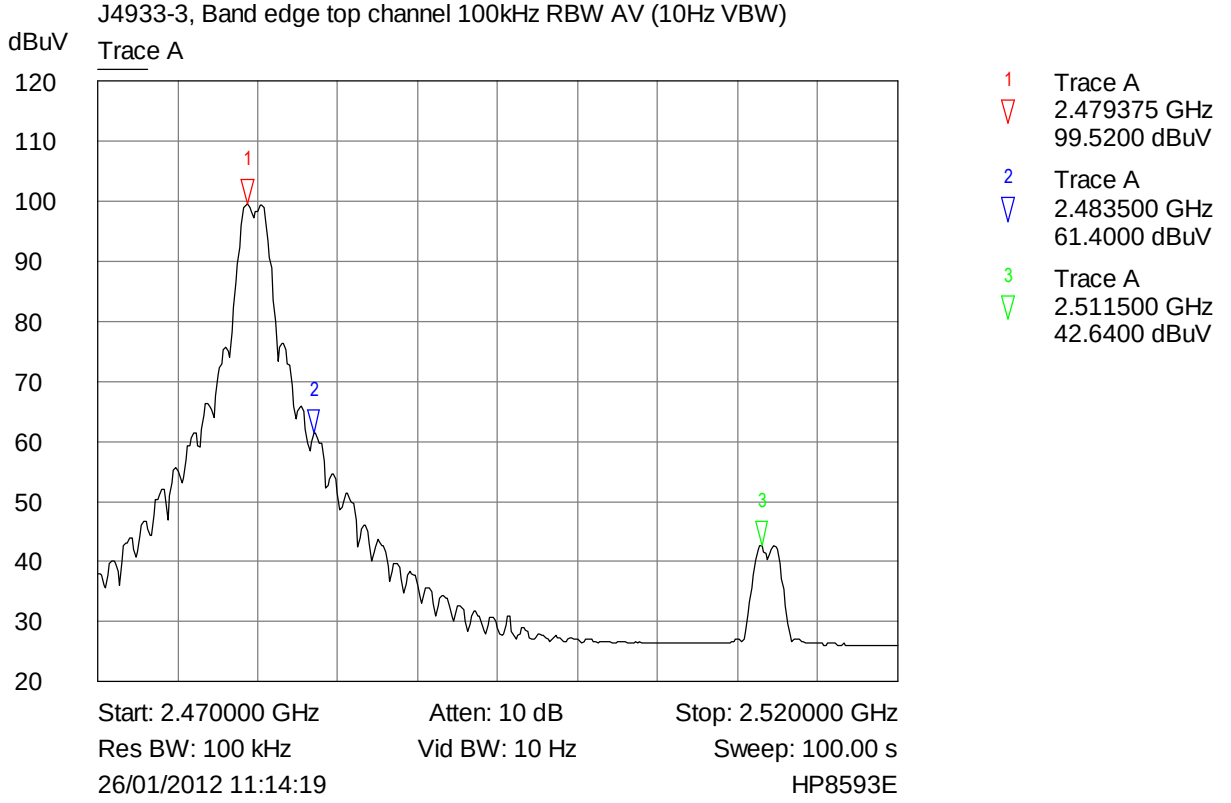




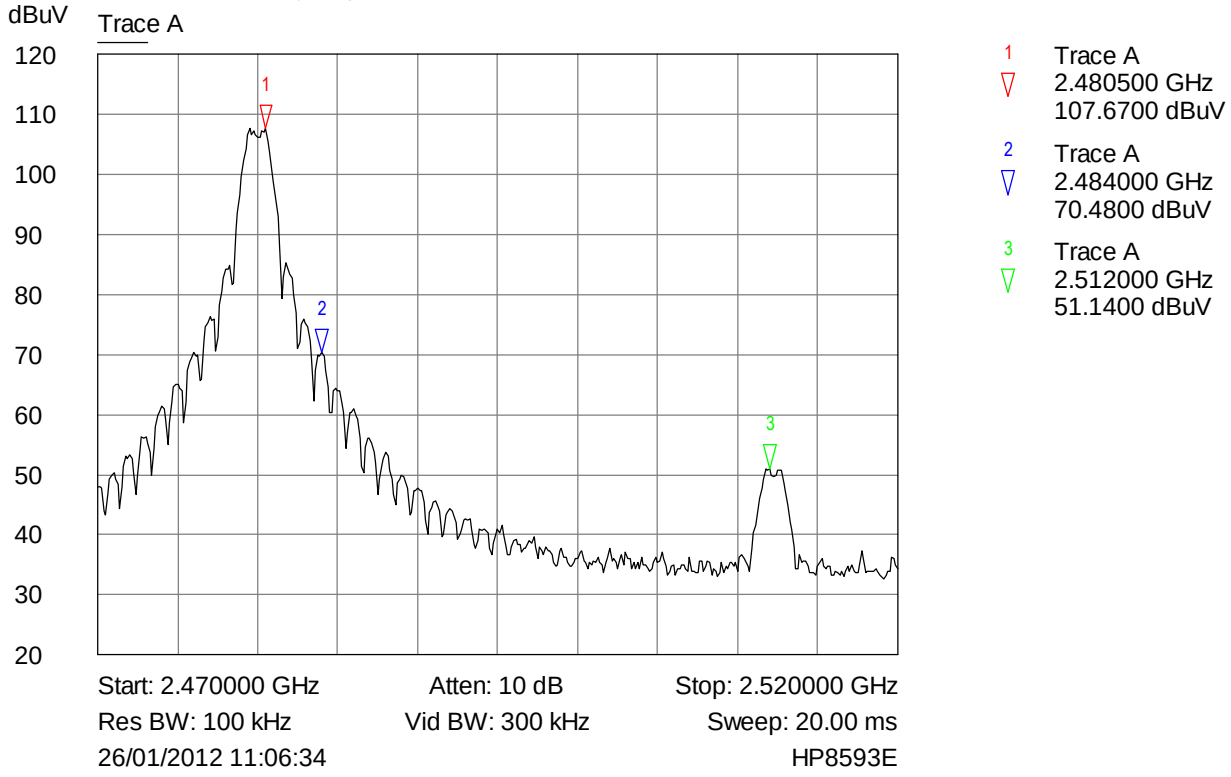
The limit is 54dBuV/m for Average emissions. According to 15.35(c): when the radiated emission limits are expressed in terms of the average value of the emission, and pulsed operation is employed, the measurement field strength shall be determined by averaging over one complete pulse train, including blanking intervals, as long as the pulse train does not exceed 0.1 seconds. For a 10% duty cycle, the power measured would be reduced by 20 log (0.10) = 20dB. According to the declared duty cycle, therefore, the emissions observed are below the limit after averaging for pulse rate.



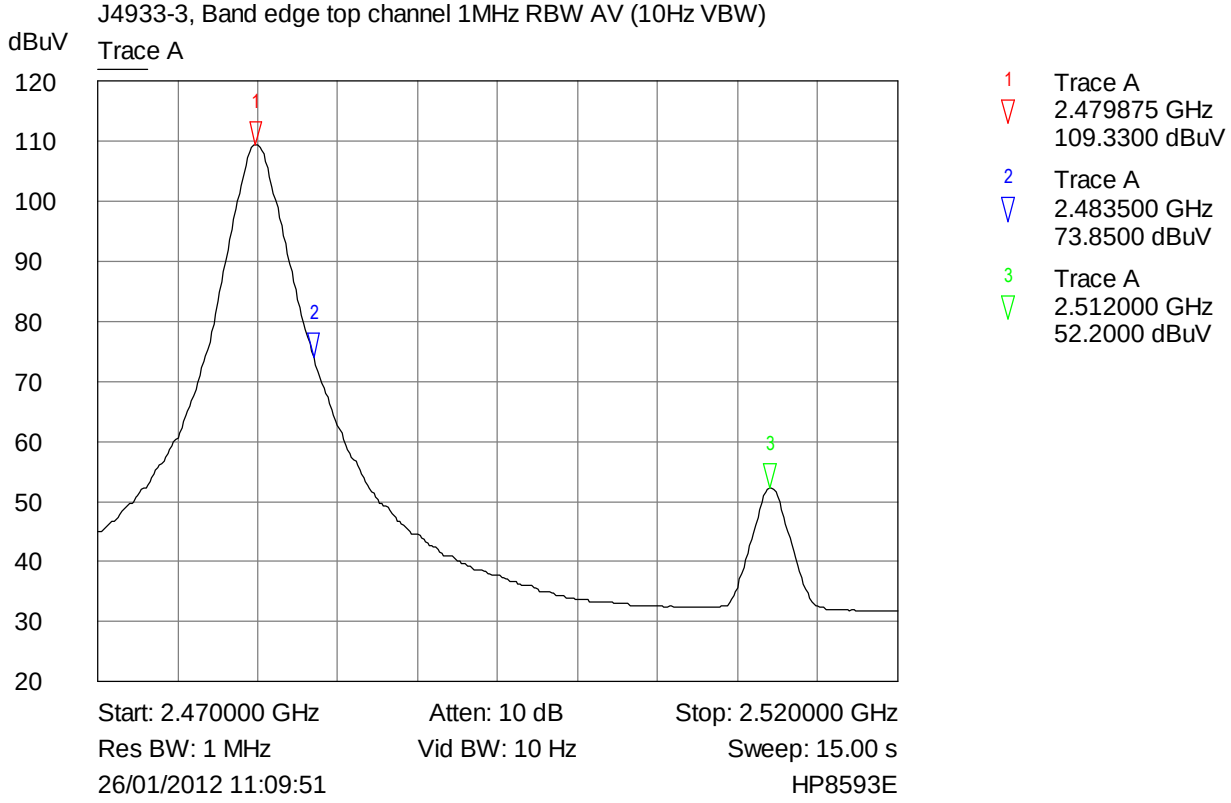
J4933-3, Band edge top channel 100kHz RBW AV (10Hz VBW)



J4933-3, Band edge top channel 100kHz RBW PK

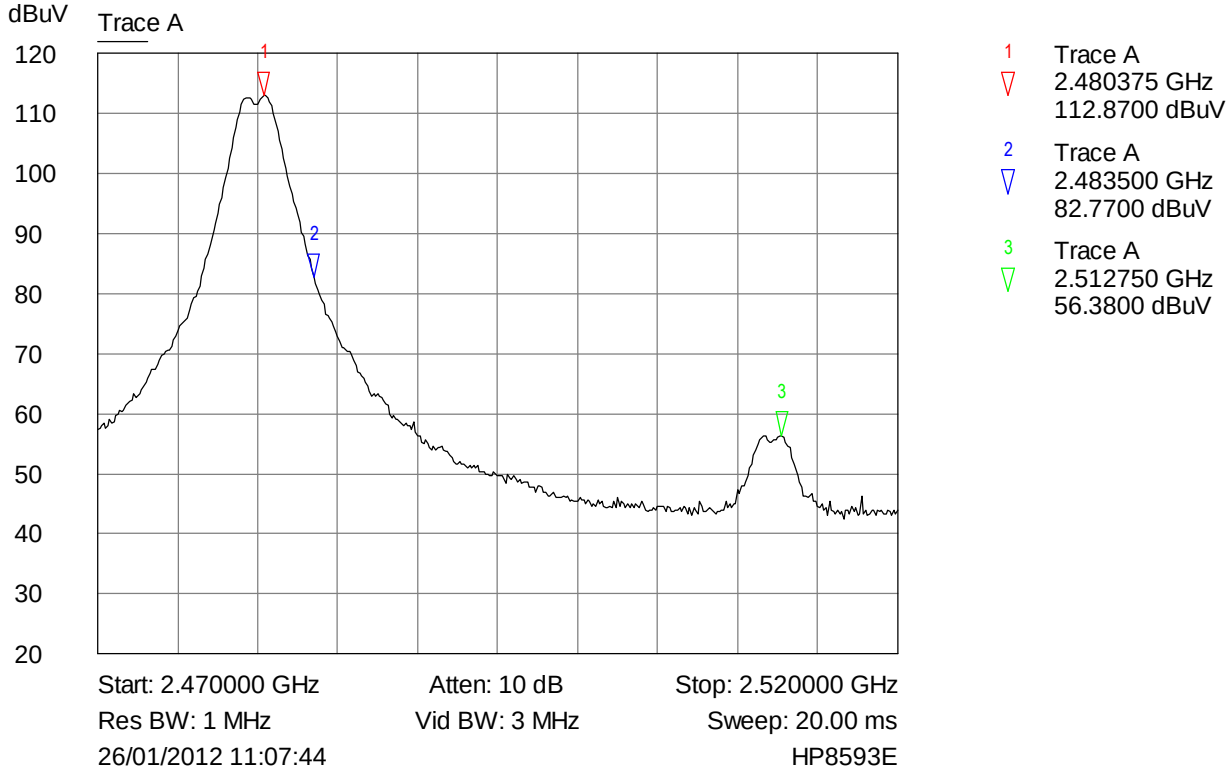


J4933-3, Band edge top channel 1MHz RBW AV (10Hz VBW)

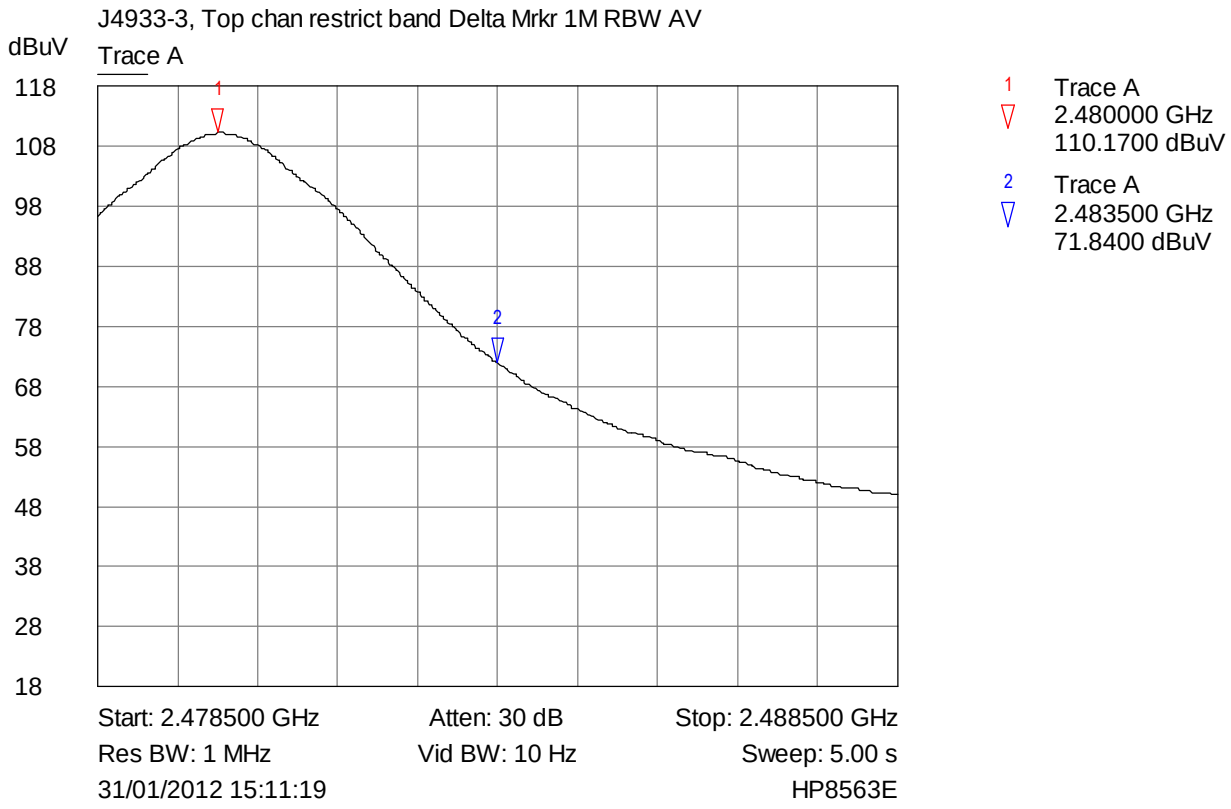


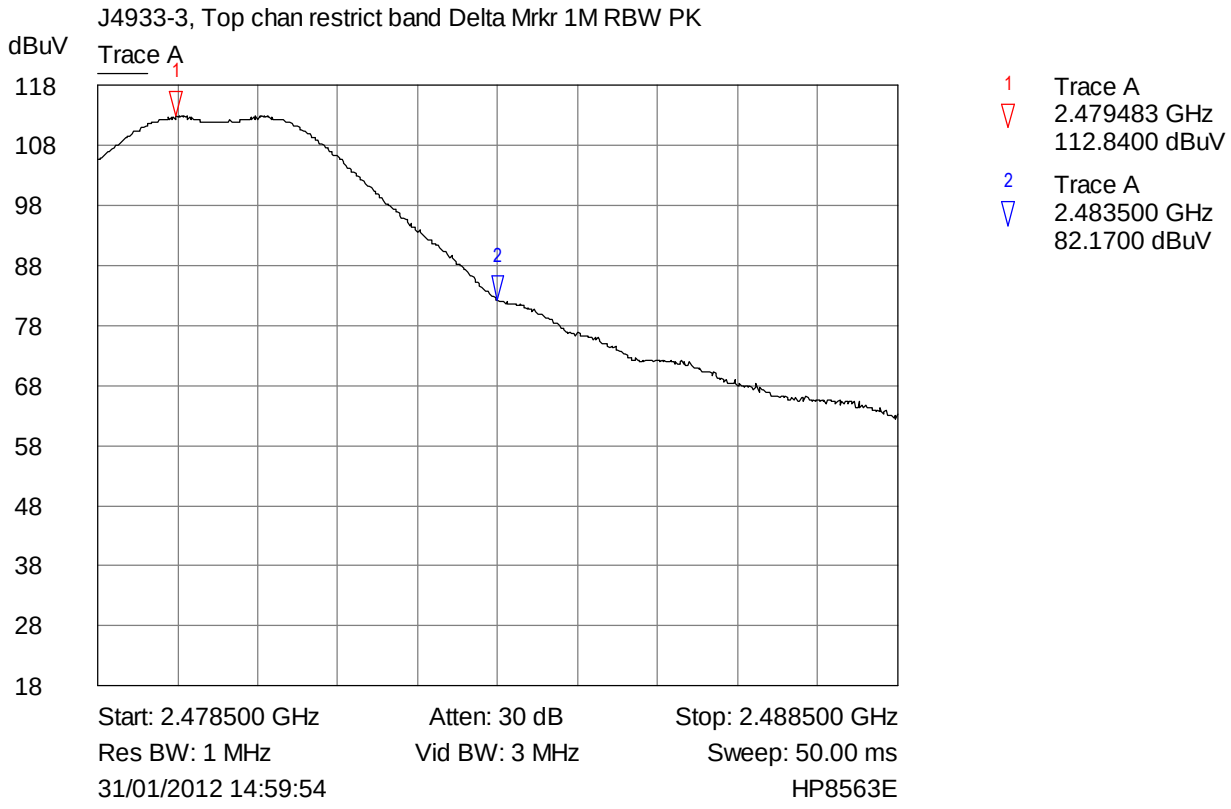
The limit is 54dBuV/m for Average emissions. According to 15.35(c): when the radiated emission limits are expressed in terms of the average value of the emission, and pulsed operation is employed, the measurement field strength shall be determined by averaging over one complete pulse train, including blanking intervals, as long as the pulse train does not exceed 0.1 seconds. For a 10% duty cycle, the power measured would be reduced by 20 log (0.10) = 20dB. According to the declared duty cycle, therefore, the emissions observed are below the limit after averaging for pulse rate.

J4933-3, Band edge top channel 1MHz RBW PK

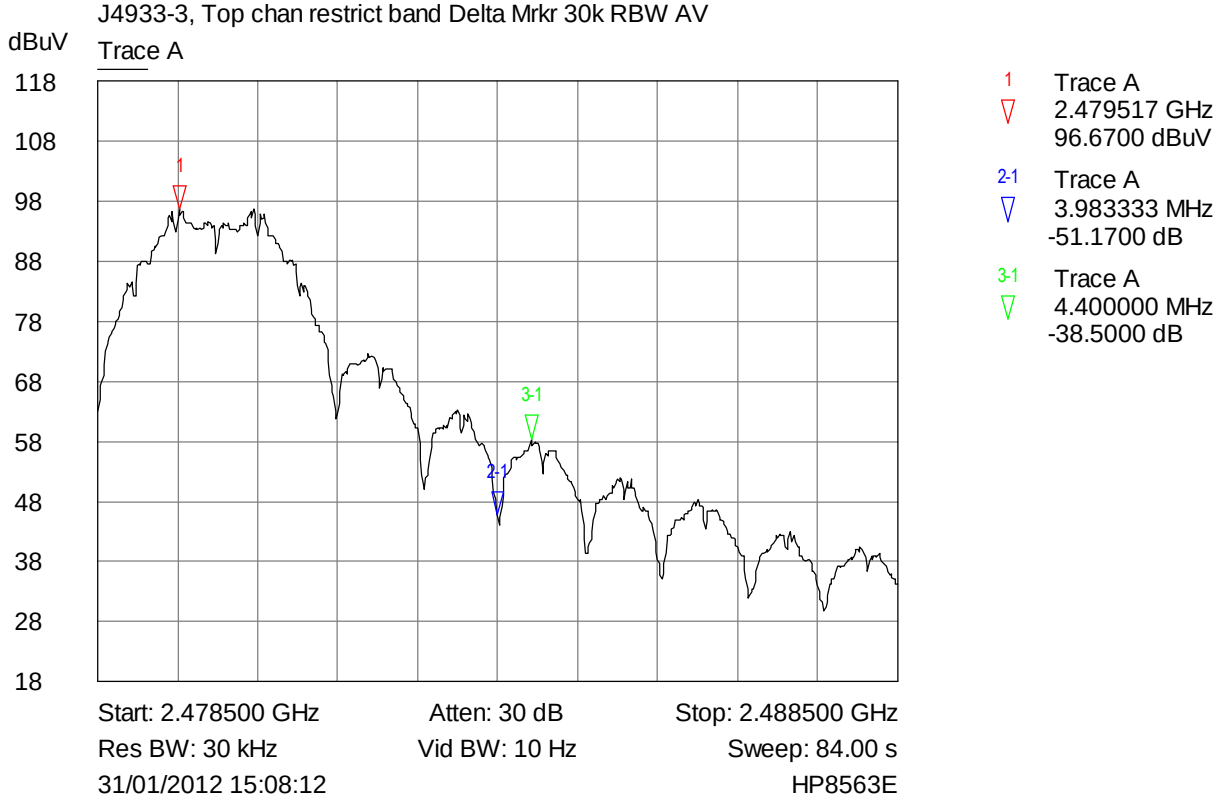


Delta Marker Plots for Upper restricted band.



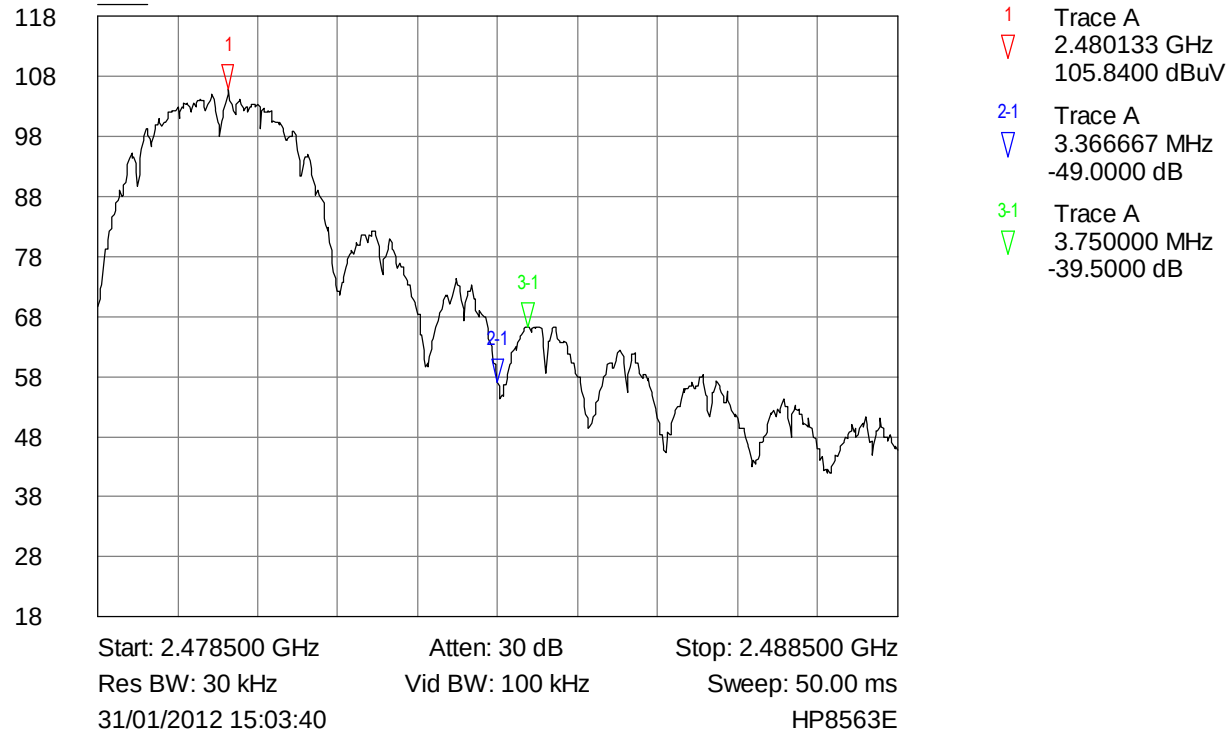


J4933-3, Top chan restrict band Delta Mrkr 30k RBW AV



Start: 2.478500 GHz Atten: 30 dB Stop: 2.488500 GHz
Res BW: 30 kHz Vid BW: 10 Hz Sweep: 84.00 s
31/01/2012 15:08:12 HP8563E

J4933-3, Top chan restrict band Delta Mrkr 30k RBW PK



Start: 2.478500 GHz Atten: 30 dB Stop: 2.488500 GHz
Res BW: 30 kHz Vid BW: 100 kHz Sweep: 50.00 ms
31/01/2012 15:03:40 HP8563E

Top Channel Delta Marker ratio from PK plot = 39.5dB. PK power in 1MHz RBW = 113.1.
113.1-39.5 = 73.6 dBuV/m @3m PK field strength.
Top Channel Delta Marker ratio from AV plot = 38.5dB. AV power in 1MHz RBW = 110.2.
110.2-38.5 = 71.7 dBuV/m @3m AV field strength.

The limit is 54dBuV/m for Average emissions. According to 15.35(c): when the radiated emission limits are expressed in terms of the average value of the emission, and pulsed

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operation is employed, the measurement field strength shall be determined by averaging over one complete pulse train, including blanking intervals, as long as the pulse train does not exceed 0.1 seconds. For a 10% duty cycle, the power measured would be reduced by 20 log (0.10) = 20dB. According to the declared duty cycle, therefore, the emissions observed are below the limit after averaging for pulse rate.

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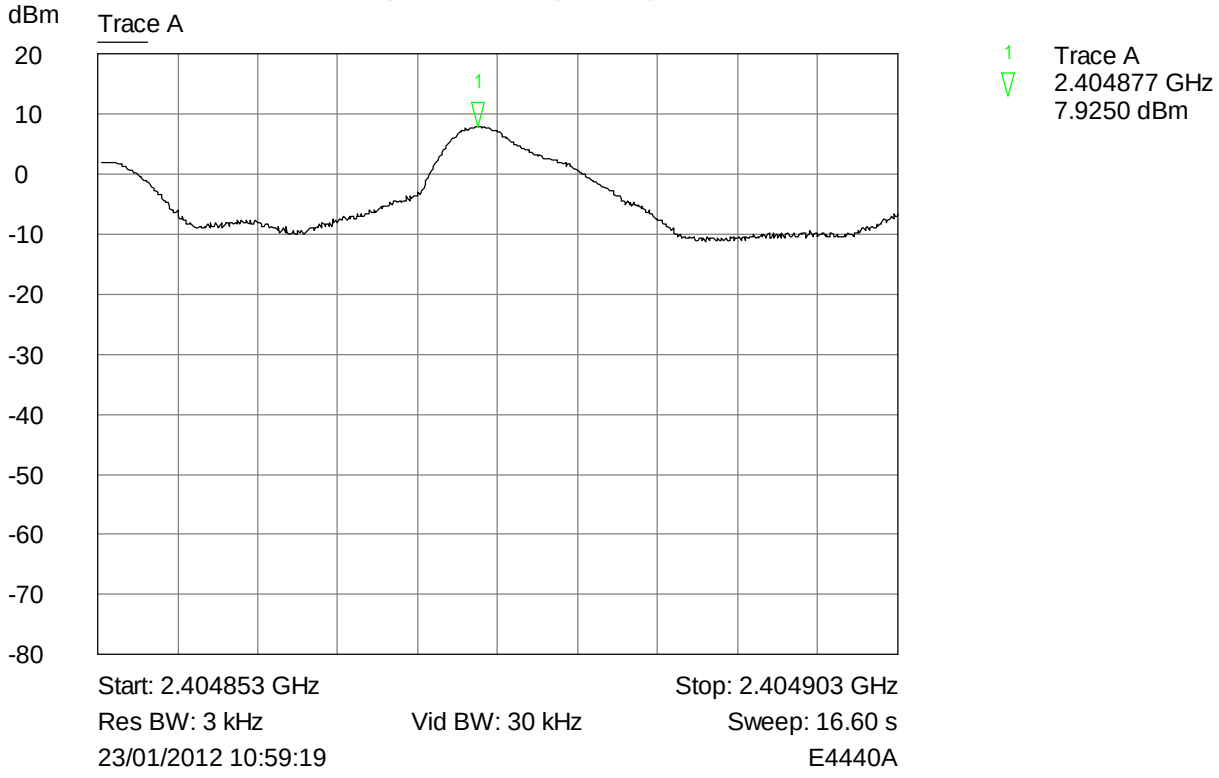
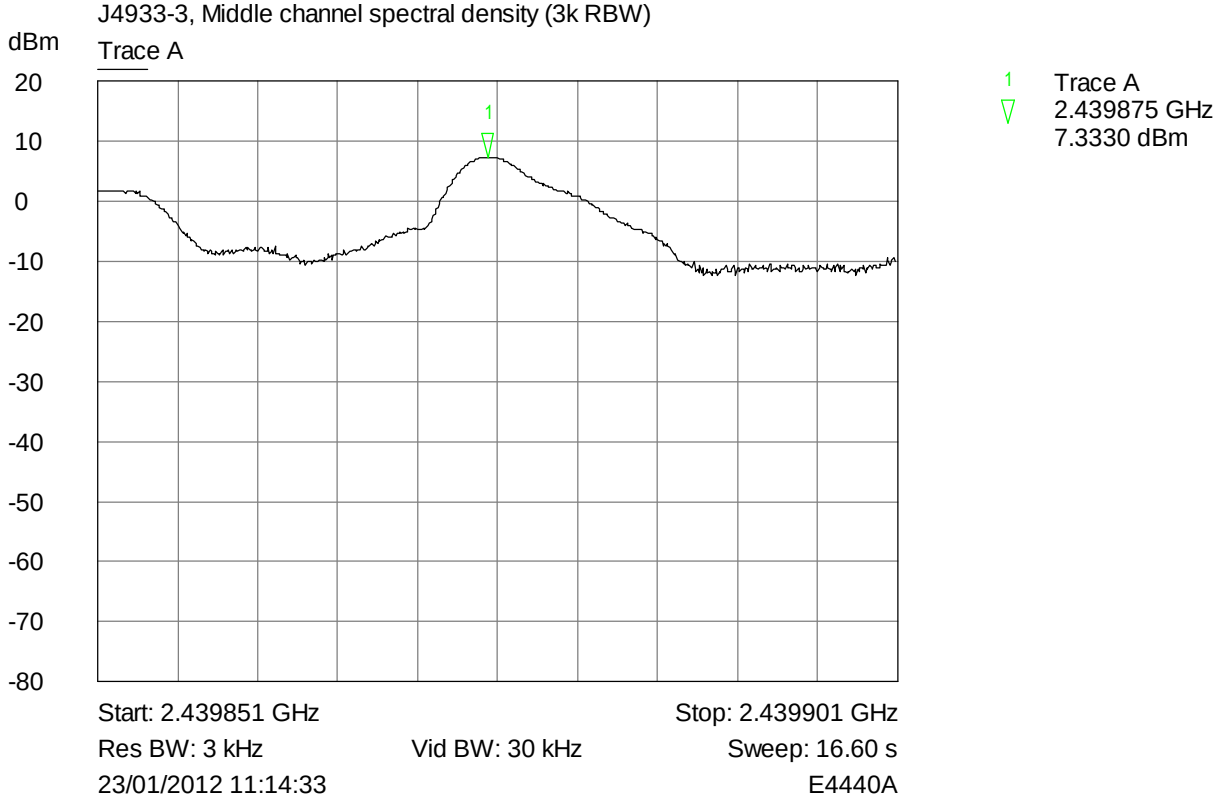
6.7 Spectral Density

J4933-3, Bottom channel spectral density (3k RBW)



J4933-3, Middle channel spectral density (3k RBW)



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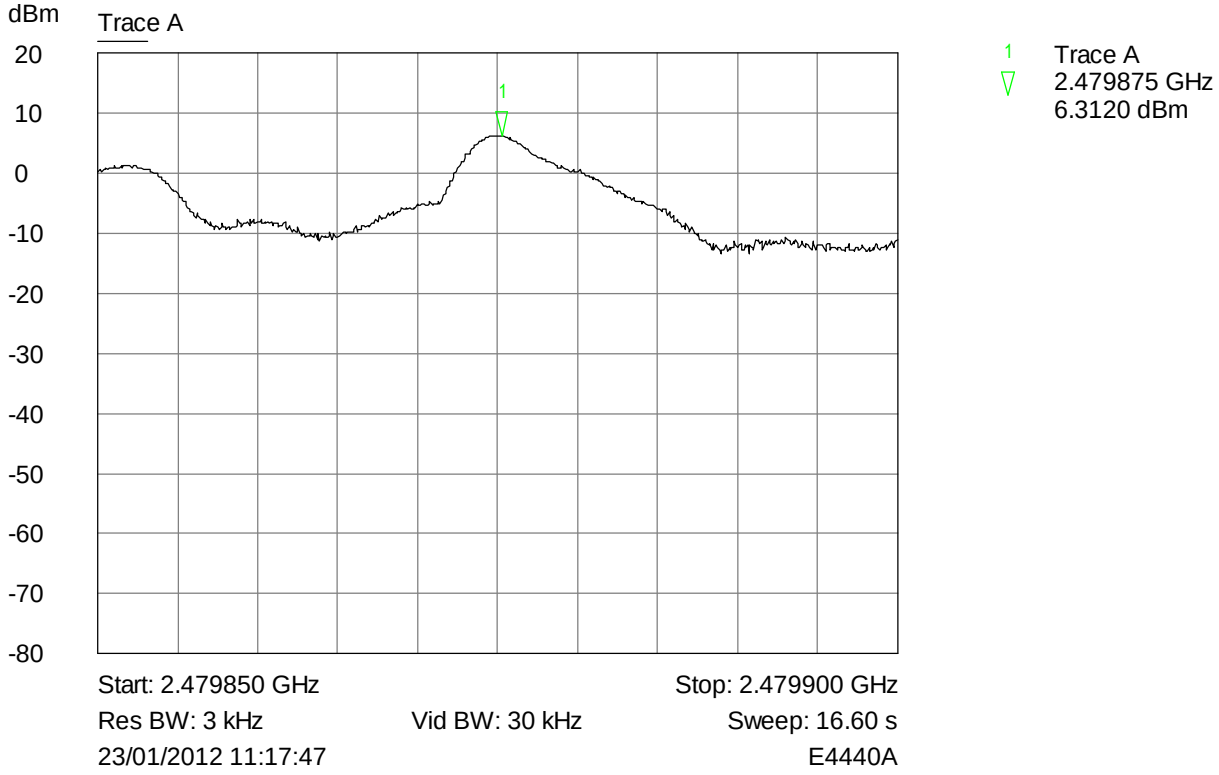
J4933-3, Top channel spectral density (3k RBW)



7 Explanatory Notes

7.1 Explanation of FAIL LIMIT 1 Statement

The **FAIL MARGIN 1** statement(s) may appear on the graphical plots when the receiver used to measure your equipment detects a signal that exceeds the dashed line. This does not mean that the **EUT** has failed the test, only that the 10 dB calculation margin set, has been exceeded on a peak measurement.

Following the indication that the margin has been exceeded, measurements are made at the frequency (ies) of the peaks. These peaks have been calculated to either Quasi Peak or Average Peak dependant on the test. A table of results has been printed on the reverse of the page. This table looks similar to the one illustrated below: -

Signal Number	Frequency (MHz)	Peak (dBμV)	PK Delta L 1 (dB)	Avg (dBμV)	Av Delta L 1 (dB)
1	12345.0000	12.9	-2.5	10.2	-5.2

The First column, labelled Signal Number, is a number that the receiver has given to each signal, which has been calculated.

Column Two, labelled Frequency (MHz), is the frequency of the signal received.

Column Three, labelled Peak (dBμV), (can also be labelled, in the case of Quasi Peak, Peak dBμV/m) is the Level that was received at peak amount in dB above 1μV.

Column Four, labelled PK Delta L1 (dB), is the same level as Column three but is given in a level relative to the limit line required.

Column Five, labelled AVG (dBμV), (can also be labelled, in the case of Quasi Peak, QP dBμV/m) when undertaking a Quasi peak test, This is the Average or Quasi peak calculation results given in dBμV or dBμV/m above 1μV.

Column Six, labelled AV Delta L 1 (dB), (can also be labelled, in the case of Quasi Peak, QP Delta L 1 (dB)) is the Average or Quasi Peak calculation relevant to the limit line. The results entered in this column indicate the signal level relative to the compliance limit required. Negative numbers indicate that the product is compliant.

7.2 Explanation of limit line calculations for radiated measurements

The limits given in the test standard are normally expressed as absolute values (e.g. in μV/m at a specified distance), whereas the measured values are expressed as peak, quasi peak or average values in dBμV/m referenced to the measuring instrument inputs. RN Electronics calibrate the test set-up to account for any path losses, antenna gains, etc. so that the value read at the receiver relates directly to the absolute value required, except that it is expressed in dB relative to one microVolt and may need to take account of any alternative measuring distance used. Examples:

(a) limit of 500 μV/m equates to 20.log (500) = 54 dB μV/m.

(b) limit of 300 μV/m at 10m equates to 20.log (300 . 10/3) = 60 dB μV/m at 3m

(c) limit of 30 μV/m at 30m, but below 30MHz, equates to 20.log(30) + 40.log(30/3) = 69.5 dBμV/m at 3m, as extrapolation factor below 30MHz is 40dB/decade per 15.31(f)(2).

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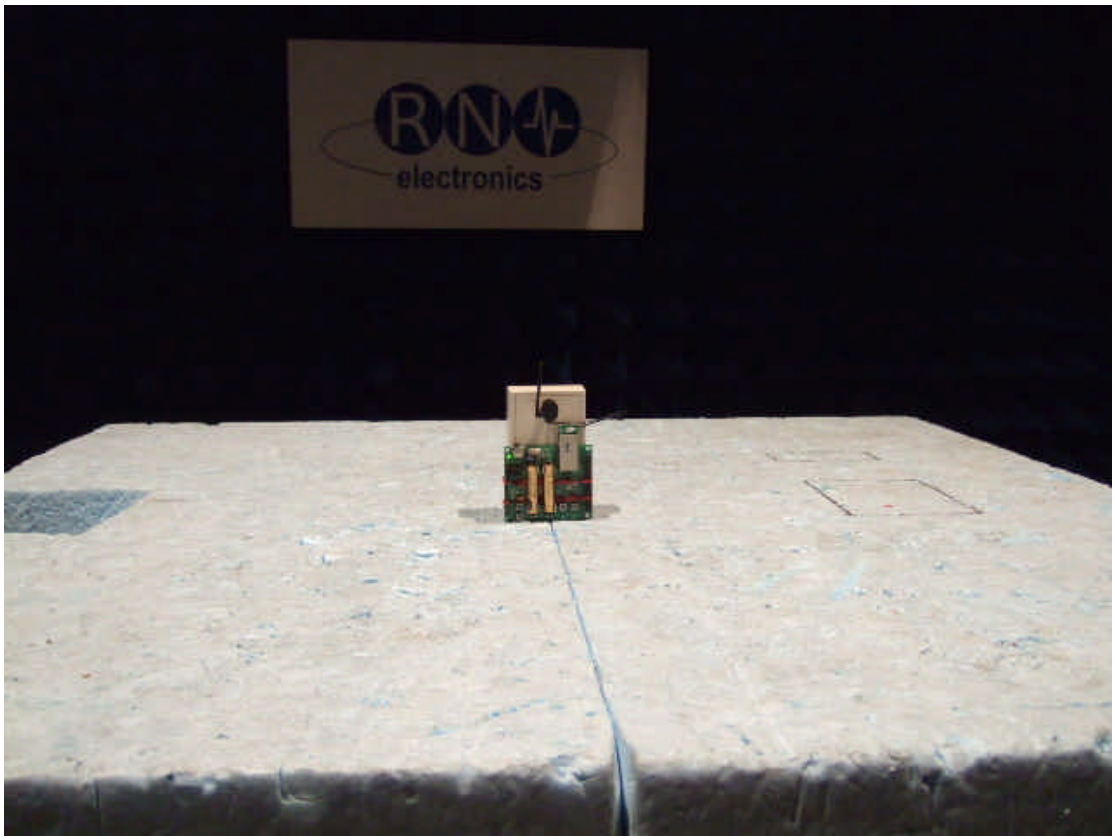
8. Photographs



Photograph of the EUT as viewed from in front of the antenna, site M.

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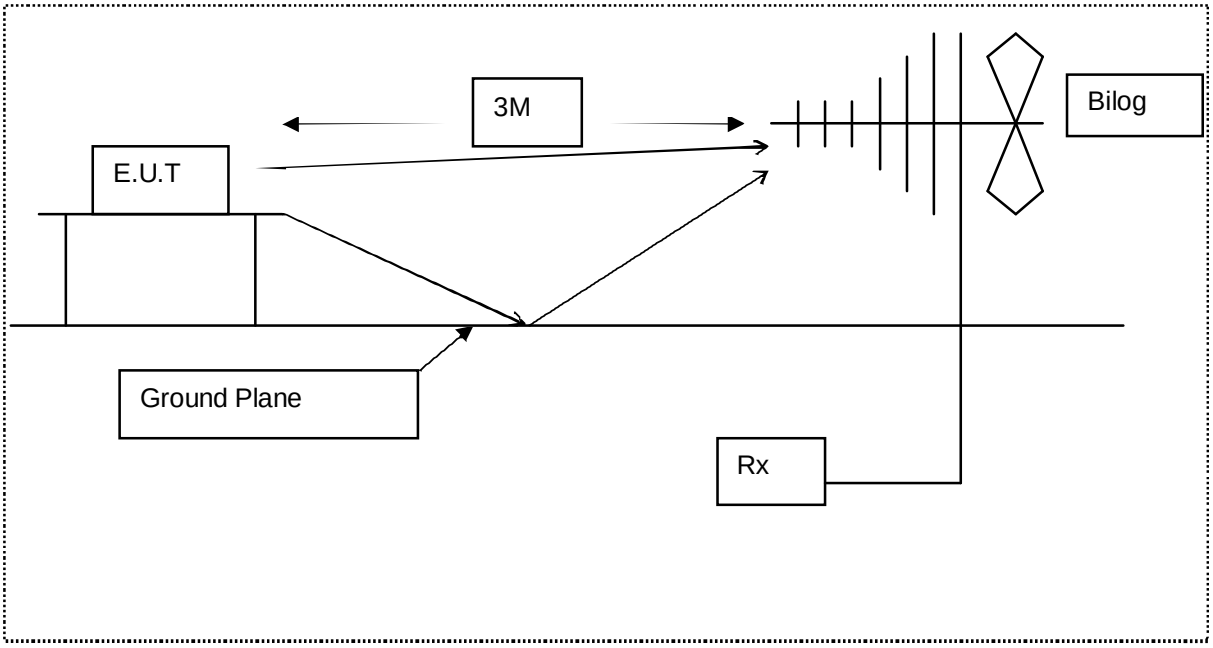
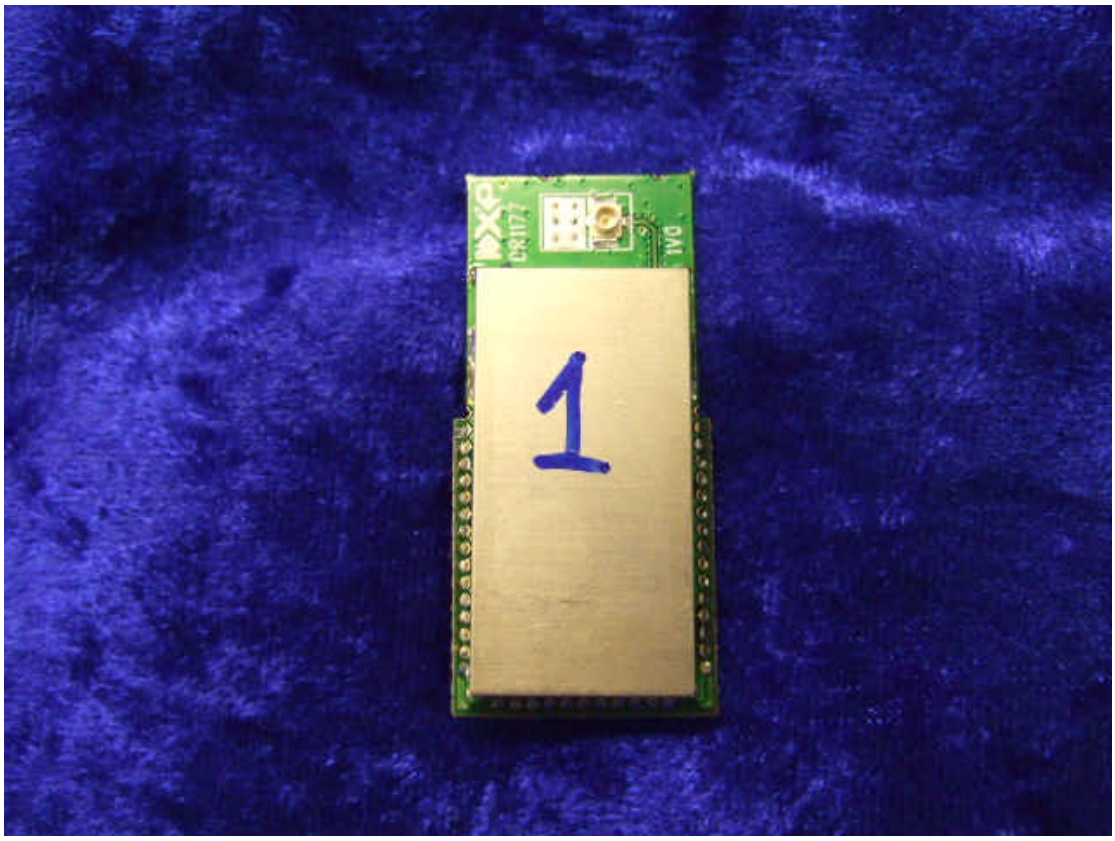
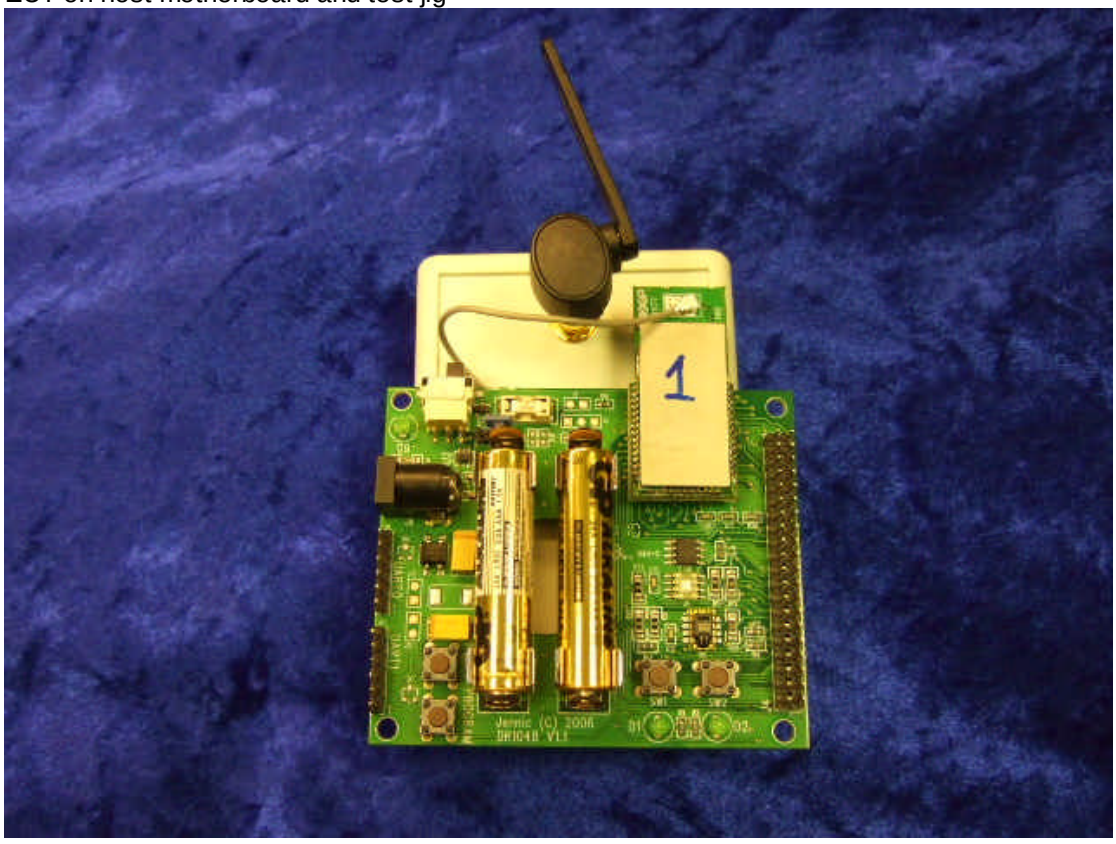


Diagram of the radiated emissions test setup.



EUT on host motherboard and test jig



Identifying Photographs of the EUT

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9. Signal Leads

Port Name	Cable Type
Antenna	UFL connection to test jig SMA adaptor.

The Module plugged directly into the test board.

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10. Test Equipment Calibration list

The following table lists the test equipment used, last calibration date and calibration interval. All test equipment used has been maintained within the calibration requirements of ***R.N. Electronics Ltd.*** test facility quality system. Calibration intervals are regularly reviewed dependent on equipment manufacturer's recommendations and actual usage of the equipment.

RNNo	Model	Description	Manufacturer	Date Calibrated	Period
E003	HP8593E	Spectrum Analyser	Hewlett Packard	21-Oct-10	24
E131	ESG-3000A	Signal Generator	Hewlett Packard	09-Nov-10	24
E249	8471E	Detector	Hewlett Packard	08-Sep-11	12
E266	2032	5.4GHz Signal Generator	Marconi Instruments	09-Apr-10	24
E268	BHA 9118	1-18 GHz Horn Antenna	Schaffner	02-Mar-09	60
E290	6914	Power Sensor	Marconi Instruments	23-Aug-11	24
E342	8563E	Spectrum Analyser 26.5 GHz	HP	29-Mar-11	24
E351	54616C	500 MHz 2GSa/S Oscilloscope	HP (Agilent)	14-Oct-11	12
E397	6960B	RF Power Meter	Marconi Instruments	16-Jul-11	24
E410	N5181A	3 GHz MXG Signal Generator	Agilent Technologies	26-Oct-11	12
E411	N9039A	9 kHz - 1 GHz RF Filter Section	Agilent Technologies	26-Oct-11	12
E412	E4440A	3 Hz - 26.5 GHz PSA	Agilent Technologies	26-Oct-11	12
E429	-	5 Switch Filter Box 0.91 GHz - 16.3 GHz	RN Electronics	10-Nov-11	12
E434	G3RUH	10 MHz GPS Oscillator	James Miller	N/A	N/A
P240	A110-26711-0005	10dB Attn	Avantek/Midwest Microwave	N/A	N/A
TMS10	TH200	Thermo Hygrometer	RS Components	07-Sep-10	24
TMS78	3160-08	Std Gain Horn Antenna 12.4-18 GHz	ETS Systems	03-Nov-10	24
TMS79	3160-09	Std Gain Horn Antenna 18-26.5 GHz	ETS Systems	03-Nov-10	24
TMS81	6502	Active Loop Antenna	EMCO	13-Apr-10	24
TMS82	8449B	Pre Amplifier 1 - 26 GHz	Agilent	14-Nov-11	12
TMS933	CBL6141A	Bilog Antenna 30MHz - 2GHz	York EMC	09-Sep-10	36

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11. Auxiliary equipment

11.1 Auxiliary equipment supplied by NXP Laboratories UK Ltd

Auxiliary equipment used for the purpose of test supplied by the above has been listed below

Manufacturer	Description	Model Number	Serial Number
NXP Labs UK Ltd	UFL to SMA lead/test jig	-	-
NXP Labs UK Ltd	FTDI USB Lead	TTL-232R-3V3	-
NXP Labs UK Ltd	PCB Motherboard	DR1048 V1.1	-

11.2 Auxiliary equipment supplied by RN Electronics Limited

Auxiliary equipment used for the purpose of test supplied by the above has been listed below

RN Number	Manufacturer	Description	Model Number	Serial Number
I005	HP	Laptop	NX9010	CNF3512U85

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12. Modifications

In order for the EUT to produce the results shown within this report the following modifications, if any, were implemented.

12.1 Modifications before test

There were no modifications made by R.N. Electronics Ltd before testing commenced.

12.2 Modifications during test

There were no modifications made by R.N. Electronics Ltd during testing.

n.b. The settings of the device - continuous transmit, power level & frequency were set by test software not normally available to the user.

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13. Compliance information

Products subject to the Declaration of Conformity procedure are required to be supplied with a compliance information statement. A copy of this statement may be included here:

Not Applicable – Device to be certified.

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14 Description of Test Sites

Site A	Radio / Calibration Laboratory and anechoic chamber
Site B	Semi-anechoic chamber
Site B1	Control Room for Site B
Site C	Transient Laboratory
Site D	Screened Room (Conducted Immunity)
Site E	Screened Room (Control Room for Site D)
Site F	Screened Room (Conducted Emissions) VCCI Registration No. C-2823
Site K	Screened Room (Control Room for Site M)
Site M	3m Semi-anechoic chamber (indoor OATS) FCC Registration No. 293246
Site Q	Fully-anechoic chamber
Site OATS	3m and 10m Open Area Test Site FCC Registration No. 293246 IC Registration No. 5612A-1 VCCI Registration No. R-2580

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15 Abbreviations and Units

%	Percent
µA/m	microAmps per metre
µV	microVolts
µW	microWatts
AC	Alternating Current
ALSE	Absorber Lined Screened Enclosure
AM	Amplitude Modulation
Amb	Ambient
ATPC	Automatic Transmit Power Control
BER	Bit Error Rate
ºC	Degrees Celsius
C/I	Carrier / Interferer
CEPT	European Conference of Postal and Telecommunications Administrations
COFDM	Coherent OFDM
CS	Channel Spacing
CW	Continuous Wave
dB	deciBels
dBµA/m	deciBels relative to 1µA/m
dBµV	deciBels relative to 1µV
dBc	deciBels relative to Carrier
dBm	deciBels relative to 1mW
DC	Direct Current
DTA	Digital Transmission Analyser
EIRP	Equivalent Isotropic Radiated Power
ERP	Effective Radiated Power
EU	European Union
EUT	Equipment Under Test
FM	Frequency Modulation
FSK	Frequency Shift Keying
g	Grams
GHz	GigaHertz
Hz	Hertz
IF	Intermediate Frequency
kHz	kiloHertz
LBT	Listen Before Talk
LO	Local Oscillator
mA	milliAmps
max	maximum
mbar	milliBars
Mbit/s	MegaBits per second
MHz	MegaHertz
mic	Microphone
min	minimum
mm	milliMetres
ms	milliSeconds
mW	milliWatts
NA	Not Applicable
nom	Nominal
nW	nanoWatt
OATS	Open Area Test Site
OFDM	Orthogonal Frequency Division Multiplexing
ppm	Parts per million
PRBS	Pseudo Random Bit Sequence
QAM	Quadrature Amplitude Modulation
QPSK	Quadrature Phase Shift Keying
R&TTE	Radio and Telecommunication Terminal Equipment
Ref	Reference
RF	Radio Frequency
RFC	Remote Frequency Control
RSL	Received Signal Level
RTP	Room Temperature and Pressure
RTPC	Remote Transmit Power Control
Rx	Receiver
s	Seconds
SINAD	SIgnal to Noise And Distortion
Tx	Transmitter
V	Volts

RN Electronics
EMC & RADIO TEST SERVICES

Certificate of Test 4933/3

The equipment noted below has been tested by ***R.N. Electronics Limited*** and conforms with the relevant subpart of FCC 47CFR part 15, subject to deviations as detailed in this report.

This certificate relates to the unit, as identified by unique serial number(s) and further detailed in the referenced report, in the condition(s) at the time it was tested. It does not relate to any other similar equipment and performance of the product before or after the test cannot be guaranteed. Furthermore, this is a certificate of test only and should not be confused with an equipment authorisation.

Equipment:	2.4GHz IEEE 802.15.4 wireless controller module
Model Number(s):	JN5148-001-M06
Unique Serial Number(s):	1
Manufacturer:	NXP Laboratories UK Ltd Furnival Street Sheffield S1 4QT
Customer Purchase Order Number:	GB62820002699
R.N. Electronics Limited Report Number:	01-540/4933/3/12
Test Standards:	FCC 47CFR Part 15C: effective date **October 1st 2011,** Class **DTS** Intentional Radiator
Date:	23rd to 26th January 2012
For and on behalf of R.N. Electronics Limited	Roger Ray
Signature:	
Notes:	

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