

Global EMC Inc. Labs

EMC & RF Test Report

As per
RSS 210 Issue 8:2010
&
FCC Part 15 Subpart C:2014
Unlicensed Intentional Radiators
on the
WBT1012



Min Xie
Project Engineer
11 Gordon Collins Dr,
Gormley, ON, L0H 1G0 Canada
Ph: (905) 883-8189

Testing produced for



See Appendix A for full customer & EUT details.



Industry
Canada

LAB REGISTRATION
#6844A-3



Testing Laboratory
Certificate
#2555.01



R-4023, G-506
T-1246, C-4498



Client	Sonavox Inc	
Product	WBT1012	
Standard(s)	RSS 210 Issue 8:2010 / FCC Part 15 Subpart C 15:2014	

Table of Contents

Table of Contents	2
Report Scope	3
Summary	4
Test Results Summary	5
Justifications, Descriptions, or Deviations.....	6
Applicable Standards, Specifications and Methods.....	7
Sample calculation(s).....	8
Document Revision Status.....	8
Definitions and Acronyms	9
Testing Facility	10
Calibrations and Accreditations.....	10
Testing Environmental Conditions and Dates	11
Detailed Test Results Section	12
6dB Bandwidth of Digitally Modulated Systems	13
Maximum Peak Envelope Conducted Power	17
Antenna Spurious Conducted Emissions (-20 dBc Requirement) – 15.247.....	20
Radiated Emissions – 15.247.....	24
Power Spectral Density – 15.247 DM	52
Maximum Permissible Exposure – 15.247	55
Power Line Conducted Emissions	56
Appendix A – EUT Summary.....	62
Appendix B – EUT and Test Setup Photographs.....	65

Client	Sonavox Inc	
Product	WBT1012	
Standard(s)	RSS 210 Issue 8:2010 / FCC Part 15 Subpart C 15:2014	

Report Scope

This report addresses the EMC verification testing and test results of Sonavox Inc's WBT1012 herein referred to as EUT (Equipment Under Test) performed at Global EMC Labs.

The EUT was tested for compliance against the following standards:


RSS 210 Issue 8:2010
FCC Part 15 Subpart C 15:2014

Test procedures, results, justifications, and engineering considerations, if any, follow later in this report.

The results contained in this report relate only to the item(s) tested.

This report does not imply product endorsement by A2LA or any other accreditation agency, any government, or Global EMC Inc.


Opinions/interpretations expressed in this report, if any, are outside the scope of Global EMC Inc accreditation. Any opinions expressed do not necessarily reflect the opinions of Global EMC Inc, unless otherwise stated.

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Standard(s)	RSS 210 Issue 8:2010 / FCC Part 15 Subpart C 15:2014	

Summary

The results contained in this report relate only to the item(s) tested.

EUT FCC Certification #, FCC ID:	WUO-WBT1012
EUT Industry Canada Certification #, IC:	7985A-WBT1012
EUT Passed all tests performed.	Yes (see test results summary)
Tests conducted by	Min Xie


Client	Sonavox Inc	
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Test Results Summary

Standard/Method	Description	Class/Limit	Result
FCC 15.203	Antenna Requirement	Unique	Pass See Justification
FCC 15.205 RSS 210 (Table 1)	Restricted Bands for intentional operation	QuasiPeak Average	Pass
FCC 15.207	Power line conducted emissions	QuasiPeak Average	N/A, (See Justifications)
FCC 15.209 RSS-210 (Table 2)	Spurious Radiated emissions	QuasiPeak Average	Pass
FCC 15.247(a)2 RSS-210 A8.2(a)	6 dB Bandwidth	> 500 kHz	Pass
FCC 15.247(b)2 RSS-210 A8.4(4)	Max output power	< 1 Watt	Pass
FCC 15.247(b)(4) RSS-210 A8.4(5)	Antenna Gain	< 6 dBi	Pass See Justifications
FCC 15.247(d) RSS-210 A8.5	Antenna conducted spurious	< 20 dBc	Pass
FCC 15.247(e) RSS-210 A8.2(b)	Spectral Density	< 8 dBm (3 kHz BW)	Pass
FCC 15.247(i) IC Safety code 6	Maximum Permissible Exposure	> 20 cm separation.	Pass See justification and calculations
Overall Result			PASS

All tests were performed by Min Xie.

If the product as tested or otherwise complies with the specification, the EUT is deemed to comply with the requirement and is deemed a 'PASS' grade. If not 'FAIL' grade will be issued. Note that 'PASS' / 'FAIL' grade is independent of any measurement uncertainties.

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Justifications, Descriptions, or Deviations

The following justifications for tests not performed or deviations from the above listed specifications apply:

For the Antenna requirement specified in FCC 15.203 (RSS 210 section 5.5), the unit uses a permanently connected SMD ceramic chip antenna (0.5 dBi peak gain – Johanson Technology 2.4 GHz Antenna, Model: 2450AT18A100).

For the Restricted Bands of operation, the EUT is designed to only operate between 2400 – 2483.5 MHz.


For maximum permissible exposure, this device operates at less than 1 Watt at 2400 – 2483.5 MHz and is designed to operate greater than 20 cm from any personnel during normal operation. No testing is required, however worst case calculated exposure compliance follows later in this report.

The EUT is not a hybrid system and FCC 15.247 (f) does not apply to it. However the 15.247 (d) requirement of power density were met and are detailed later in this test report.

For the scope of this test report the EUT was mounted in three orthogonal axes to maximize emissions. Worst case results are presented.


For FCC 15.107 power line conducted emission, the device is battery operated, this requirement does not apply. The batteries are rechargeable batteries and the device turns the transmitter off when charging. The devices charges through a micro USB port and it does not sell with a power supply. Power line conducted emissions test is include for information purpose only and is performed on an Lenovo T410 laptop with AC Adapter (Model: 45N0201) with the EUT in charging mode.

For antenna port conducted emissions, a SMA connection was soldered at the antenna input and the chip antenna was removed.

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Applicable Standards, Specifications and Methods

CFR 47 FCC 15	- Code of Federal Regulations – Radio Frequency Devices
CISPR 22:2008	- Information technology equipment – Radio disturbance characteristics – Limits and methods of measurement
ANSI C63.10:2009	- American national standard for testing unlicensed wireless devices
FCC KDB 558074	- FCC KDB 558074 Digital Transmission Systems, measurements and procedures
ICES-003:2012	- Digital Apparatus - Spectrum Management and Telecommunications Policy Interference-Causing Equipment Standard
ISO 17025:2005	- General Requirements for the competence of testing and calibration laboratories
RSS-GEN	General Requirements and Information for the Certification of Radio Apparatus
RSS 210:2010	- Issue 8: Spectrum Management and Telecommunications Policy. Radio Standards Specification Low Power License-Exempt Radiocommunication Devices

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Sample calculation(s)

Margin = limit – (received signal + antenna factor + cable loss – pre-amp gain)


Margin = 50.5dBuV/m – (50dBuV + 10dB + 2.5dB – 20dB)

Margin = 8.5 dB

Document Revision Status

Revision 1 - December 8, 2014

Initial release

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Standard(s)	RSS 210 Issue 8:2010 / FCC Part 15 Subpart C 15:2014	

Definitions and Acronyms

The following definitions and acronyms are applicable in this report.
See also ANSI C63.14.

AE – Auxillary Equipment.

BW – Bandwidth. Unless otherwise stated, this refers to the 6 dB bandwidth.

EMC – Electro-Magnetic Compatibility

EMI – Electro-Magnetic Immunity


EUT – Equipment Under Test

ITE – Information Technology Equipment with a primary function(s) of entry, storage, display, retrieval, transmission, processing, switching, or control, of data.

LISN – Line impedance stabilization network

NCR – No Calibration Required

RF – Radio Frequency

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Testing Facility

Testing for EMC on the EUT was carried out at Global EMC labs in Gormley, Ontario, Canada. The testing lab consists of a 3m semi-anechoic chamber that is calibrated to be able to allow measurements on an EUT that has a maximum width or length of up to 2m and a height of up to 3m. The chamber is equipped with a turntable that is capable of testing devices that are up to 3300lb in weight. This facility is capable of testing products that are rated for 120 Vac and 240Vac single phase, or devices that are rated for a 208 Vac 3 phase input. DC capability is also available for testing. The chamber is equipped with an antenna mast, which controls the polarization and height of the measuring antenna from the control room adjoining the shielded chamber. Radiated emissions measurements are performed using a Bilog and Horn antenna where applicable. Conducted emissions, unless otherwise stated, are performed using a LISN.

For ESD testing, the HCP is 1.6m x 0.8m and the VCP is 0.5m x 0.5m. The reference ground plane, when applicable, is 1.6m x 1.6m.

Calibrations and Accreditations


The 3m semi-anechoic chamber is registered with Federal Communications Commission (FCC, 377448), Industry Canada (IC, 6844A-3) and VCCI (R-4023, G-506, C-4498, and T-1246). This chamber was calibrated for Normalized Site Attenuation (NSA) using test procedures outlined in ANSI C63.4 "Methods of Measurement of Radio-Noise Emissions from Low-Voltage Electrical and Electronic Equipment in the Range of 9 kHz to 40 GHz". The chamber is lined with ferrite tiles and absorption cones to minimize any undesired reflections. The NSA data is kept on file at Global EMC. For radiated susceptibility testing, a 16 point field calibration has been performed on the chamber. The field uniformity data is kept on file at Global EMC. Global EMC Inc is accredited to ISO 17025 by A2LA with Testing Certificate #2555.01. The laboratory's current scope of accreditation listing can be found as listed on the A2LA website. All measuring equipment is calibrated on an annual or bi-annual basis as listed for each respective test.

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Standard(s)	RSS 210 Issue 8:2010 / FCC Part 15 Subpart C 15:2014	


Testing Environmental Conditions and Dates

Following were the environmental conditions in the facility during time of testing –

Date	Test	Init.	Temperature (°C)	Humidity (%)	Pressure (kPa)
	Radiated Emissions	MX	20-25°C	20 - 35%	98 -103kPa
	Antenna Conducted Emissions	MX	20-25°C	20 - 35%	98 -103kPa
	Power Line Conducted Emissions	MX	20-25°C	20 - 35%	98 -103kPa

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Standard(s)	RSS 210 Issue 8:2010 / FCC Part 15 Subpart C 15:2014	

Detailed Test Results Section

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Standard(s)	RSS 210 Issue 8:2010 / FCC Part 15 Subpart C 15:2014	

6dB Bandwidth of Digitally Modulated Systems

Purpose

The purpose of this test is to ensure that the bandwidth occupied exceeds a stated minimum. This helps ensure the utilization of the frequency allocation is sufficiently wide. This also helps prevent corruption of data by ensuring adequate data separation to distinguish the reception of the intended information.

Limits and Methods

The Limit is as specified in FCC Part 15.247 (a) and RSS 210.

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. This should be measured with a 100 kHz RBW and a 300 kHz VBW.


The method is given in Section 8.1 of FCC KDB 558074: June 9, 2014.

Results

The EUT meet the 6 dB bandwidth requirement. Low, mid and high channels are measured. The minimum 6 dB BW measured was 694.0 kHz.

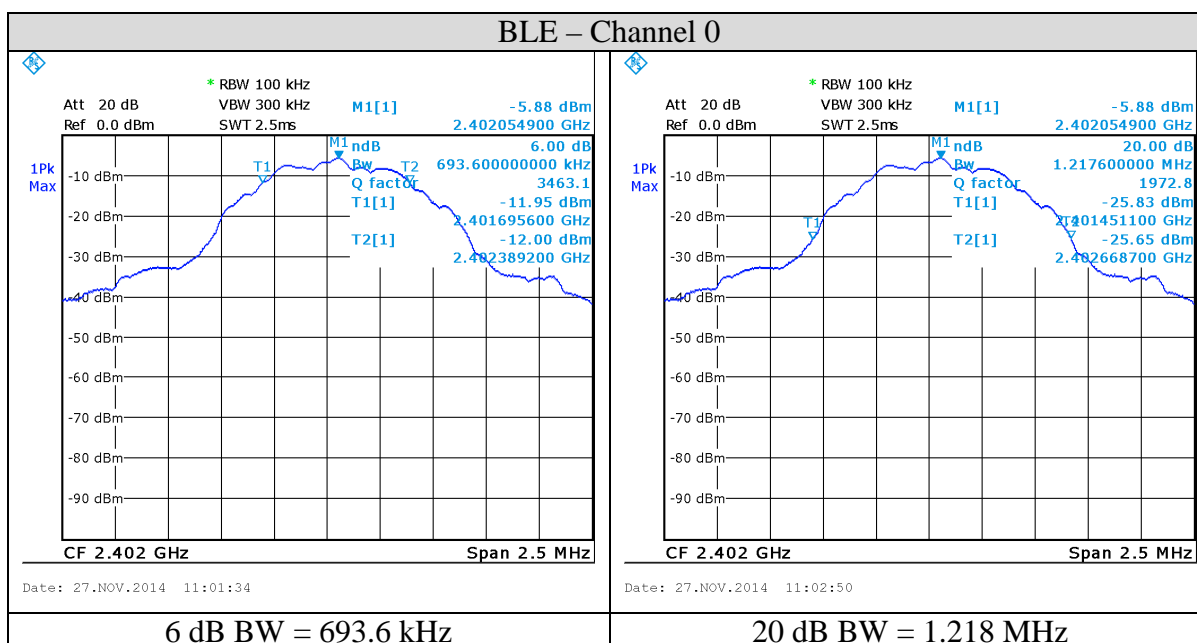
Table 1: 6 dB and 20 dB Bandwidth


Mode	Channel	Frequency (MHz)	6 dB Bandwidth (MHz)	20 dB Bandwidth (MHz)	6 dB Bandwidth Min. Limit (MHz)	Results
BLE	0	2402	0.694	1.218	0.5	Pass
BLE	19	2440	0.694	1.223	0.5	Pass
BLE	39	2480	0.704	1.238	0.5	Pass

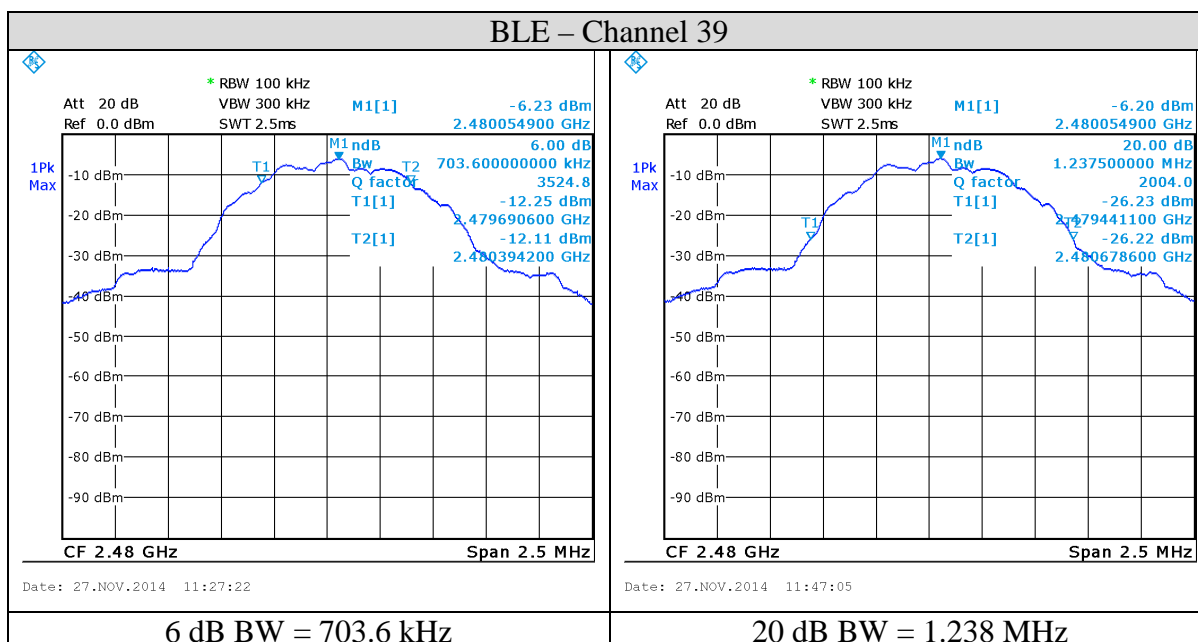
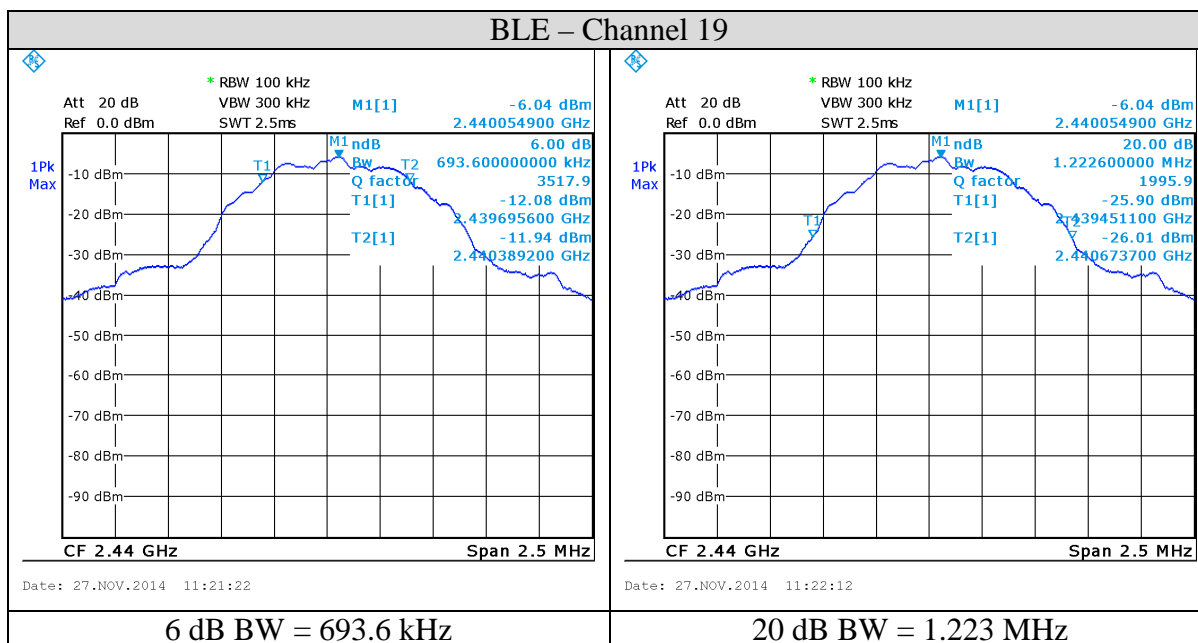
Client	Sonavox Inc	
Product	WBT1012	
Standard(s)	RSS 210 Issue 8:2010 / FCC Part 15 Subpart C 15:2014	

Graph(s)


The graphs showed below shows the DTS Bandwidth during the operation of the device. This is measured by a max hold on the spectrum analyzer and the highest resolution bandwidth that is sufficiently low to exhibit the 6 dB bandwidth of a channel during operation of the EUT. This measurement is a peak measurement. Max hold is performed for a duration of not less than 1 minute.



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Product	WBT1012	
Standard(s)	RSS 210 Issue 8:2010 / FCC Part 15 Subpart C 15:2014	




Note: See 'Appendix B – EUT & Test Setup Photographs' for photos showing the test set-up.

Client	Sonavox Inc	
Product	WBT1012	
Standard(s)	RSS 210 Issue 8:2010 / FCC Part 15 Subpart C 15:2014	

Test Equipment List

Equipment	Model No.	Manufacturer	Last calibration date	Next calibration due date	Asset #
Spectrum Analyzer	ESL6	Rohde & Schwarz	Nov 15, 2013	Nov 15, 2015	GMEC 160
RF Cable 1m	LMR-400-1M-50OHM-MN-MN	LexTec	NCR	NCR	GEMC 29

This report module is based on GEMC template "FCC – Power Line Conducted Emissions Class B_Rev1"

Client	Sonavox Inc	
Product	WBT1012	
Standard(s)	RSS 210 Issue 8:2010 / FCC Part 15 Subpart C 15:2014	

Maximum Peak Envelope Conducted Power

Purpose

The purpose of this test is to ensure that the maximum power conducted to the radiating element does not exceed the limits specified. This ensures that if the end-user replaces the antenna, that the maximum power does not exceed an amount which may create an excessive power level.

Limits and Methods

The limits are defined in FCC Part 15.247(b) and RSS 210.

For systems using digital modulation in the 902-928 MHz, 2400-2483.5 MHz, and 5725-5850 MHz bands, the peak limit is 1 watt.


The method is given in Section 9.1.1 of FCC KDB 558074: April 9, 2013.

Results

The EUT passed. The power of the EUT was set to transmit at maximum power. Three channels were measured. The following table shows the peak power of each channel:

Table 2: Peak conducted output power

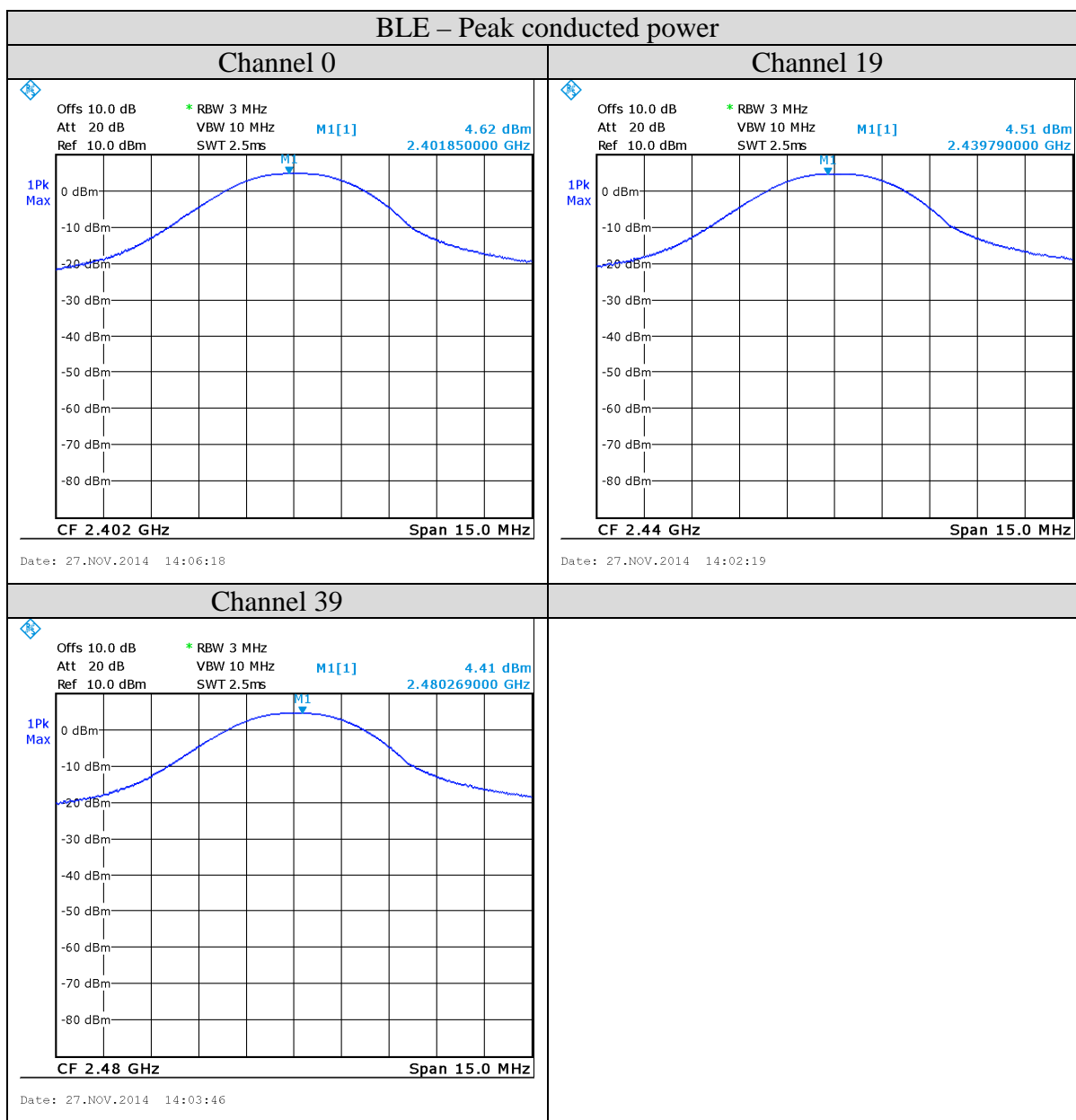
Mode	Channel	Frequency (MHz)	Peak Conducted Power (dBm)	Limit (dBm)	Results
BLE	0	2402	4.62	30	Pass
BLE	19	2440	4.51	30	Pass
BLE	39	2480	4.41	30	Pass


Client	Sonavox Inc	
Product	WBT1012	
Standard(s)	RSS 210 Issue 8:2010 / FCC Part 15 Subpart C 15:2014	

Readings

The photos shown below shows the peak power output of the device during the antenna conducted measurement during transmit operation of the EUT.

Tests were conducted using a spectrum analyzer.




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Standard(s)	RSS 210 Issue 8:2010 / FCC Part 15 Subpart C 15:2014	

Note: See 'Appendix B – EUT & Test Setup Photographs' for photos showing the test set-up.

Test Equipment List

Equipment	Model No.	Manufacturer	Last calibration date	Next calibration due date	Asset #
Spectrum Analyzer	ESL6	Rohde & Schwarz	Nov 15, 2013	Nov 15, 2015	GMEC 160
RF Cable 1m	LMR-400-1M-50OHM-MN-MN	LexTec	NCR	NCR	GEMC 29

This report module is based on GEMC template "FCC – Power Line Conducted Emissions Class B_Rev1"

Client	Sonavox Inc	
Product	WBT1012	
Standard(s)	RSS 210 Issue 8:2010 / FCC Part 15 Subpart C 15:2014	

Antenna Spurious Conducted Emissions (-20 dBc Requirement) – 15.247

Purpose

The purpose of this test is to ensure that the maximum power conducted to the radiating element at frequencies outside of the authorized spectrum does not exceed the limits specified. This ensures that the only the intended signal is delivered to the radiating element.


Limits and Methods

The limits are defined in 15.247(d). In any 100 kHz band, the peak spurious harmonics emissions must be at least 20 dB below the fundamental. Spurious Conducted emissions are to be evaluated up to the 10th harmonic. This -20 dBc requirement also applies at the 'band edge' or 2.4 GHz and 2.4835 GHz.

The method is given in Section 11 of FCC KDB 558074: June 9, 2014.

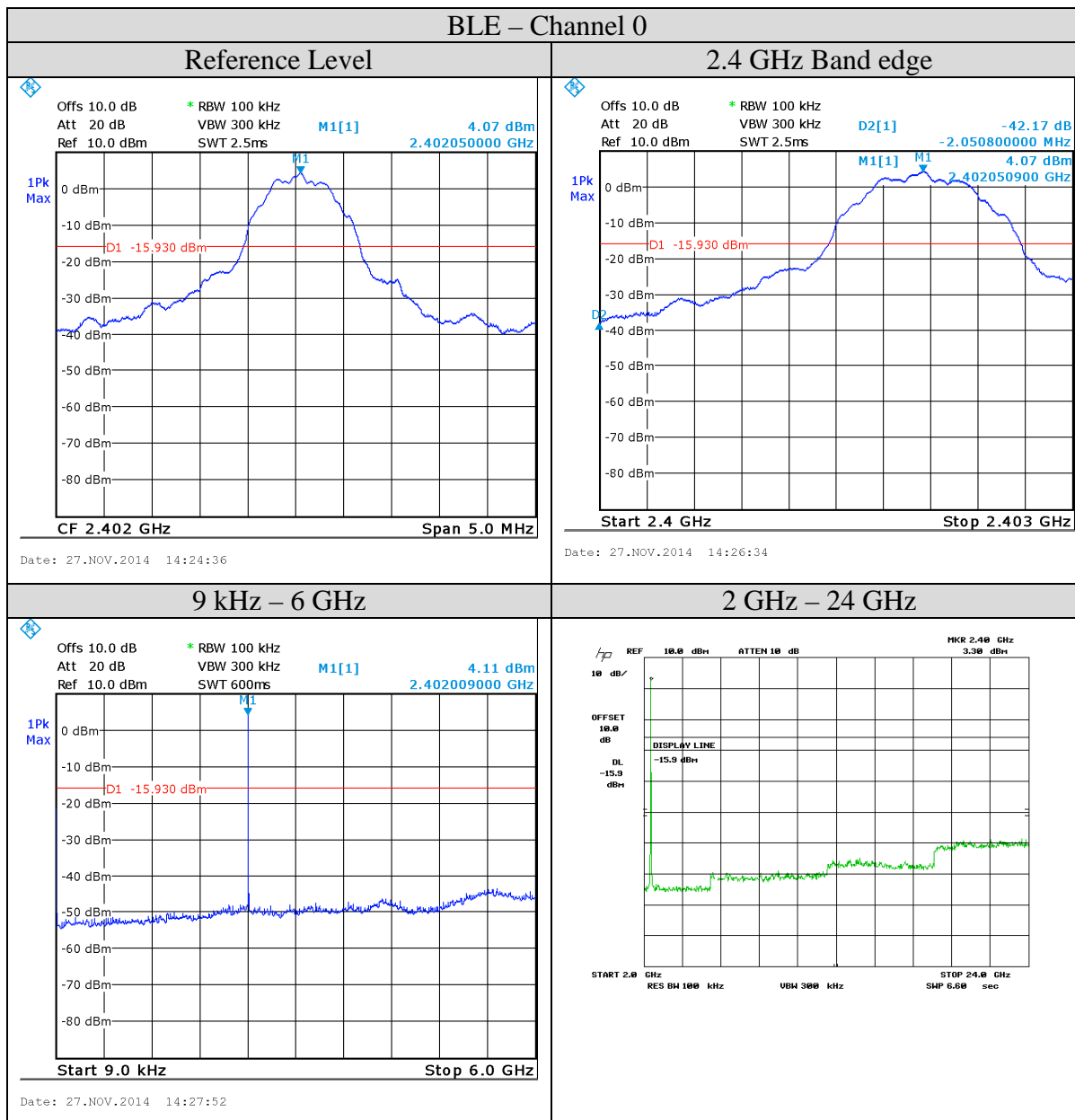
Results


The EUT passed the limits. Low, middle and high channels were measured. The worst case was presented as a graph for the spectrum. The -20 dBc requirement is shown for the lower band edge at 2.4 GHz in the low channel. The -20 dBc requirement is also shown for the higher band edge at 2.4835 GHz in the high channel.

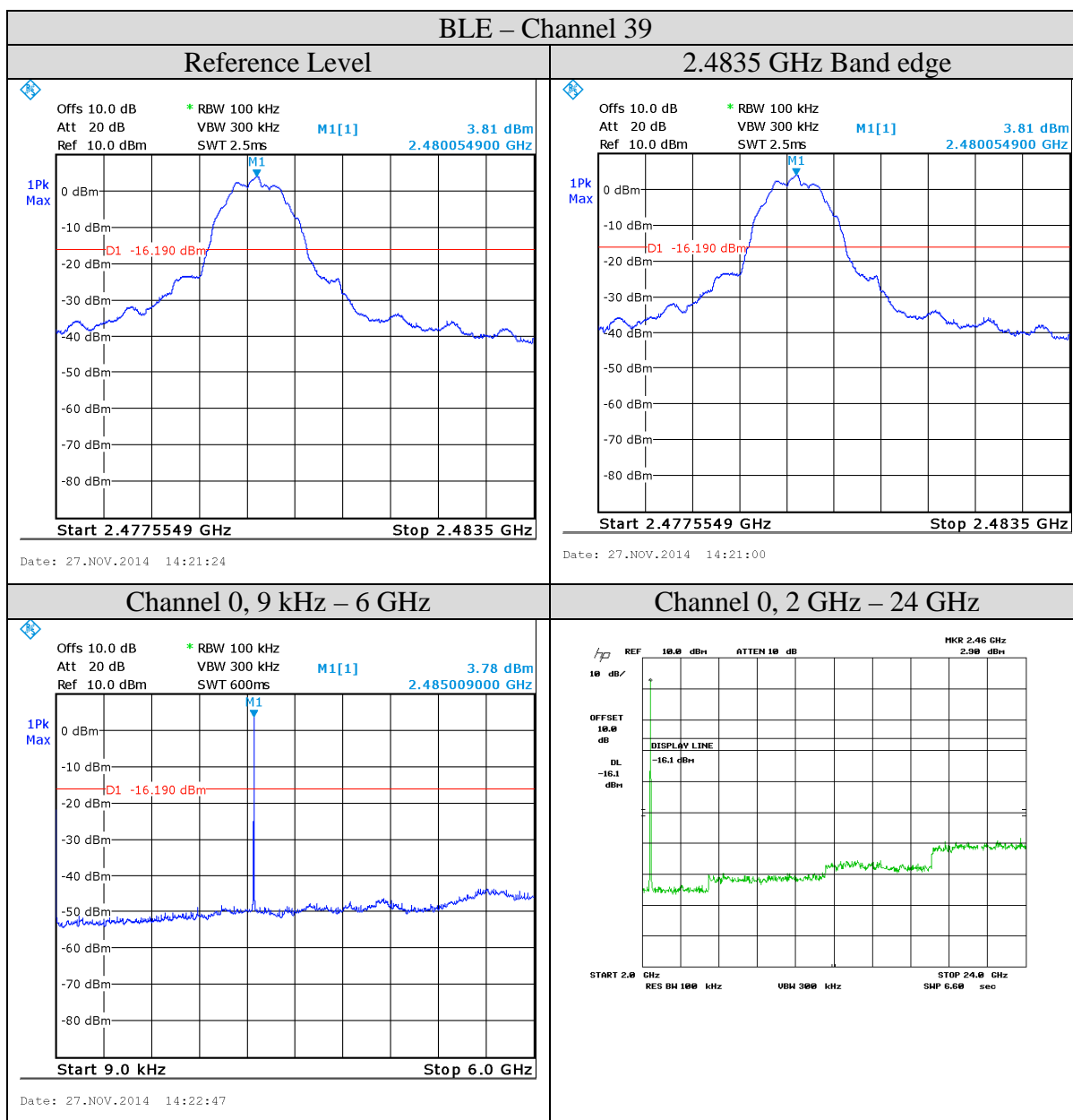
Client	Sonavox Inc	
Product	WBT1012	
Standard(s)	RSS 210 Issue 8:2010 / FCC Part 15 Subpart C 15:2014	

Graph(s)


The graphs shown below shows the peak power output of the device during the antenna conducted measurement during transmit operation of the EUT.



Client	Sonavox Inc	
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Note: See ‘Appendix B – EUT & Test Setup Photographs’ for photos showing the test set-up.

Client	Sonavox Inc	
Product	WBT1012	
Standard(s)	RSS 210 Issue 8:2010 / FCC Part 15 Subpart C 15:2014	

Test Equipment List

Equipment	Model No.	Manufacturer	Last calibration date	Next calibration due date	Asset #
Spectrum Analyzer	8566B	HP	May 21, 2014	May 21, 2016	GEMC 193
Quasi Peak Adapter	85650A	HP	May 21, 2014	May 21, 2016	GEMC 194
Spectrum Analyzer	ESL6	Rohde & Schwarz	Nov 15, 2013	Nov 15, 2015	GEMC 160
RF Cable 1m	LMR-400-1M-50OHM-MN-MN	LexTec	NCR	NCR	GEMC 29

This report module is based on GEMC template "FCC – Power Line Conducted Emissions Class B_Rev1"

Client	Sonavox Inc	
Product	WBT1012	
Standard(s)	RSS 210 Issue 8:2010 / FCC Part 15 Subpart C 15:2014	

Radiated Emissions – 15.247

Purpose

The purpose of this test is to ensure that the RF energy unintentionally emitted from the EUT does not exceed the limits listed below as defined in the applicable test standard, as measured from a receiving antenna. This helps protect broadcast radio services such as television, FM radio, pagers, cellular telephones, emergency services, and so on, from unwanted interference.

Limit(s) and Method

The method is given in Section 12.1 of FCC KDB 558074: April 9, 2013.

The limits are as defined in FCC Part 15, Section 15.209:

The limits, as defined in 15.247(d) for unintentional radiated emissions apply for those emissions that fall in the restricted bands, as defined in Section 15.205(a). These emissions must comply with the radiated emission limits specified in Section 15.209(a).


All unintentional emissions must also meet the ‘Spurious Conducted Emissions’ requirements of -20 dBc or greater. See also ‘Spurious Conducted Emissions’ for further details.

0.009 MHz – 0.490 MHz, 2400/F(kHz) uV/m at 300 m¹
0.490 MHz – 1.705 MHz, 24000/F(kHz) uV/m at 30 m¹
1.705 MHz – 30 MHz, 30 uV/m at 30 m¹
30 MHz – 88 MHz, 100 uV/m (40.0 dBuV/m¹) at 3 m
88 MHz – 216 MHz, 150 uV/m (43.5 dBuV/m¹) at 3 m
216 MHz – 960 MHz, 200 uV/m (46.0 dBuV/m¹) at 3 m
Above 960 MHz, 500 uV/m (54.0 dBuV/m¹) at 3 m
Above 1000 MHz, 500 uV/m (54 dBuV/m²) at 3m
Above 1000 MHz, 500 uV/m (74 dBuV/m³) at 3m

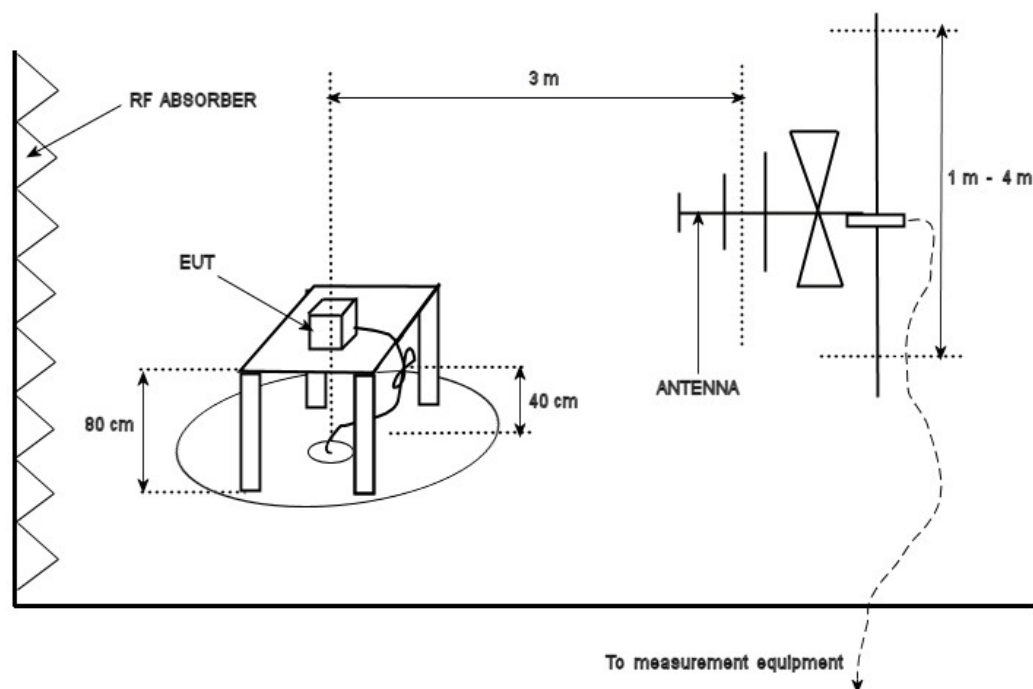
¹Limit is with Quasi Peak detector with bandwidths as defined in CISPR-16-1-1

²Limit is with 1 MHz measurement bandwidth and using an Average detector

³Limit is with 1 MHz measurement bandwidth and using a Peak detector

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Typical Radiated Emissions Setup



Measurement Uncertainty


The expanded measurement uncertainty is calculated in accordance with CISPR 16-4-2 and is ± 4.4 dB with a 'k=2' coverage factor and a 95% confidence level.

Preliminary Graphs

Note the graphs shown below are for graphical illustration only. For final measurements with the appropriate detector, please refer to the final measurement table where applicable. The graph shown below is a maximized peak measurement graph, measured with a resolution bandwidth greater than the final required detector and over a full 0-360 rotation. This peaking process is done as a worst case measurement. This process enables the detection of frequencies of concern for final measurement, and provides considerable time savings.

In accordance with FCC Part 15, Subpart A, Section 15.33, the device was scanned to the 10th harmonic (a minimum of a 24.835 GHz).

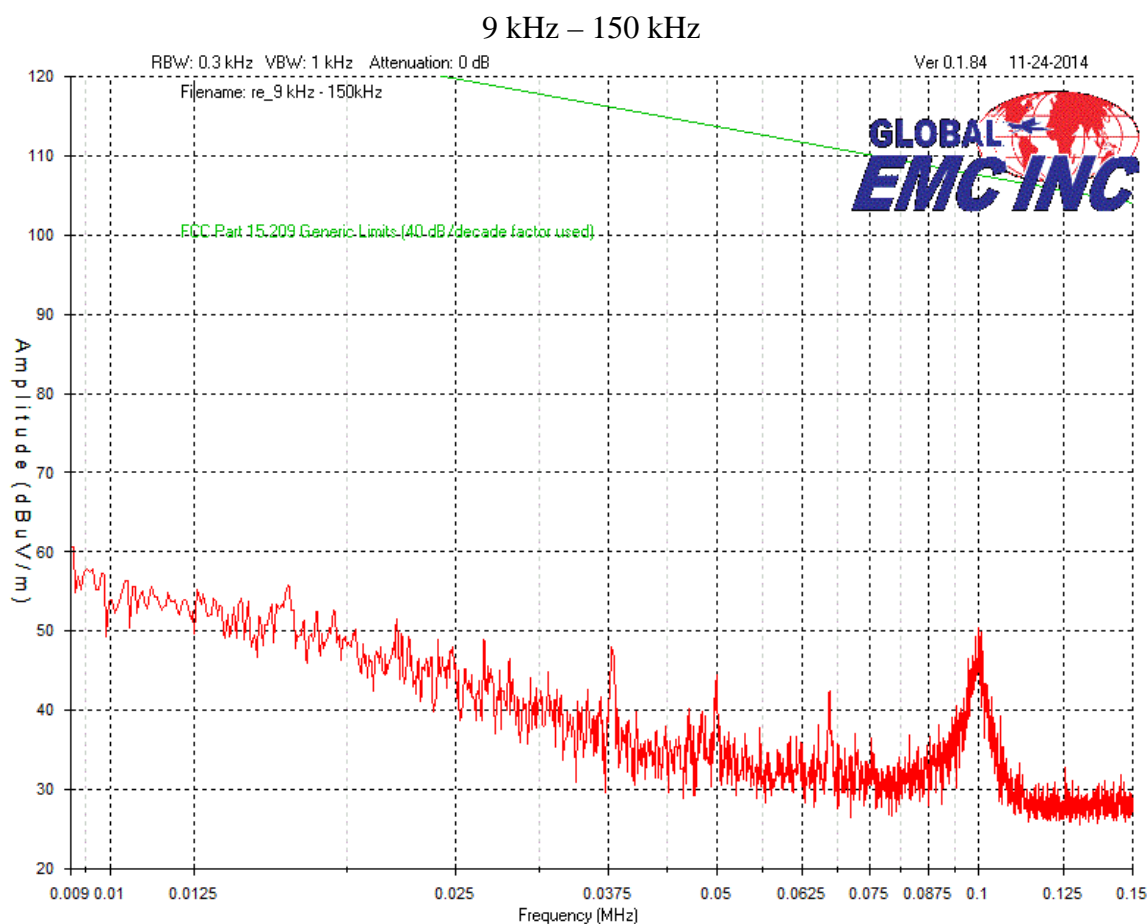
Devices scanned may be scanned at alternate test distances, and in accordance with FCC Part 15, Subpart A, Section 15.31, an extrapolation factor of 20 dB/decade was used above


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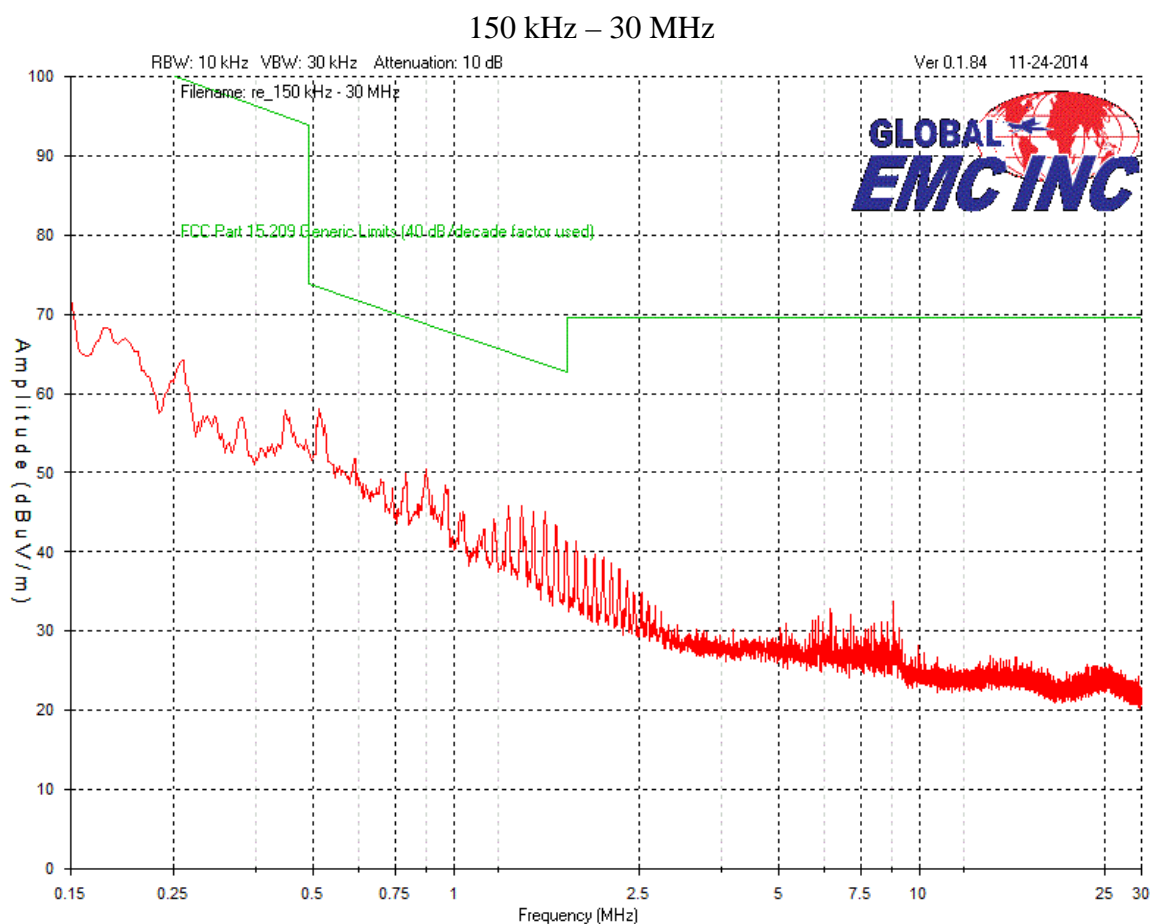
30 MHz and 40 dB/decade below 30 MHz. For example for 1 meter measurements, an extrapolation factor 9.5 dB from 20 Log (1m / 3m) is applied.


Low, middle and high channels were measured, each in three orthogonal axes were checked; however the worst case graphs are presented.

Band edge measure graphs were shown for illustrations purpose. See final measurement section for all measurements.

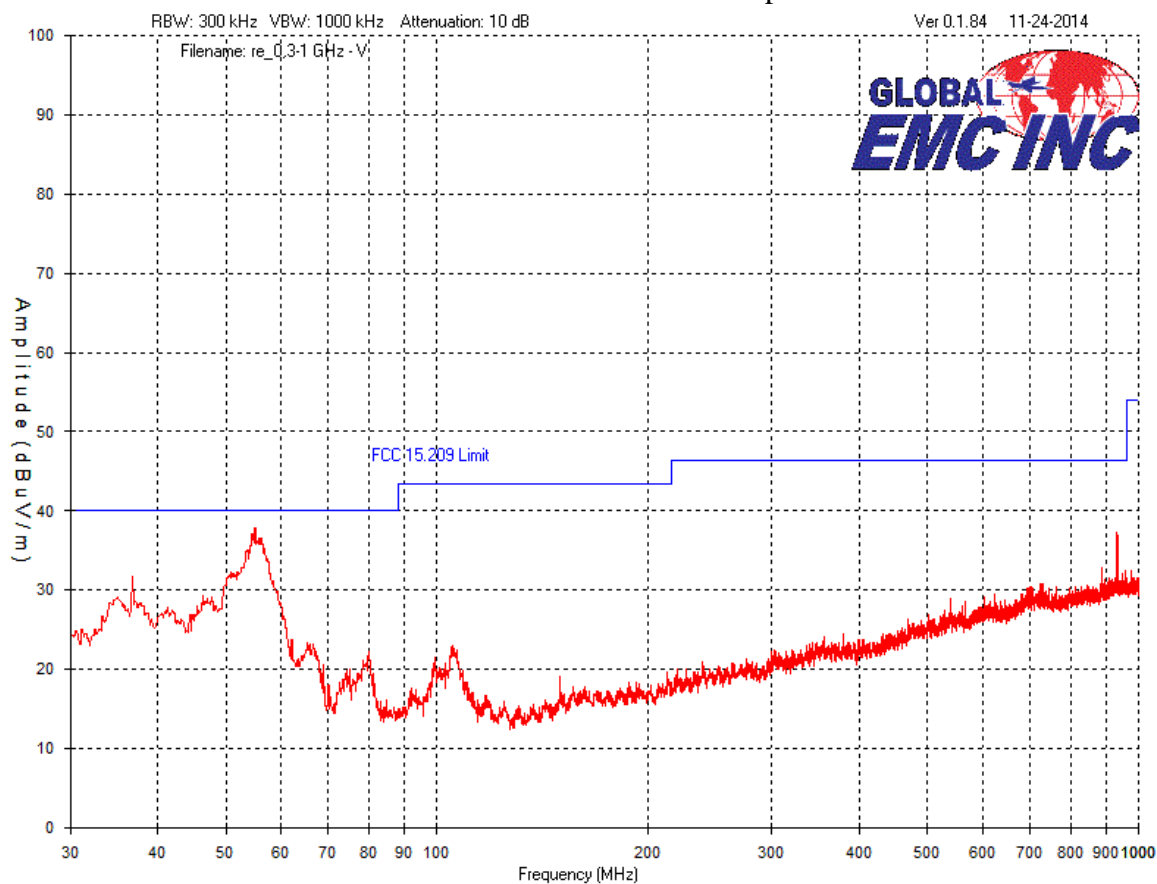



Client	Sonavox Inc	
Product	WBT1012	
Standard(s)	RSS 210 Issue 8:2010 / FCC Part 15 Subpart C 15:2014	



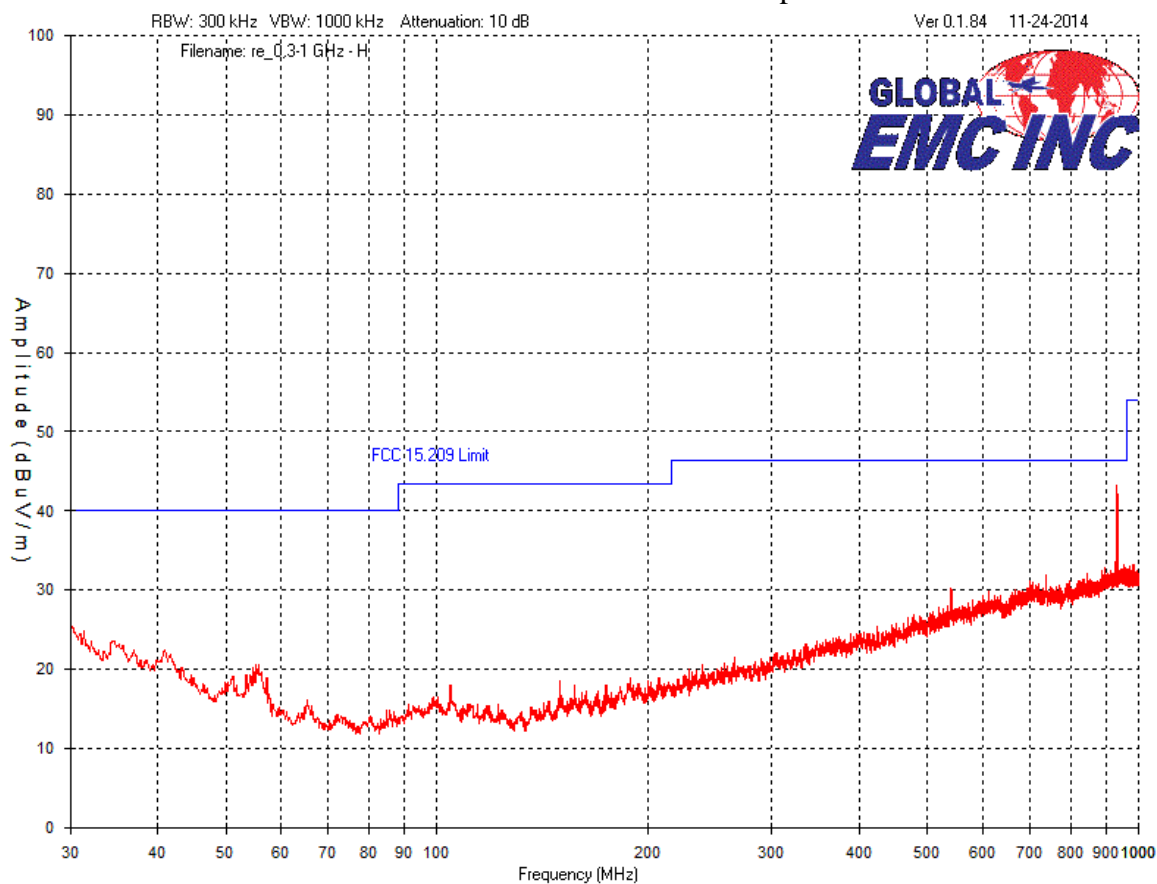
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Standard(s)	RSS 210 Issue 8:2010 / FCC Part 15 Subpart C 15:2014	


Low Channel - 30 MHz – 1 GHz
Vertical – Peak Emission Graph



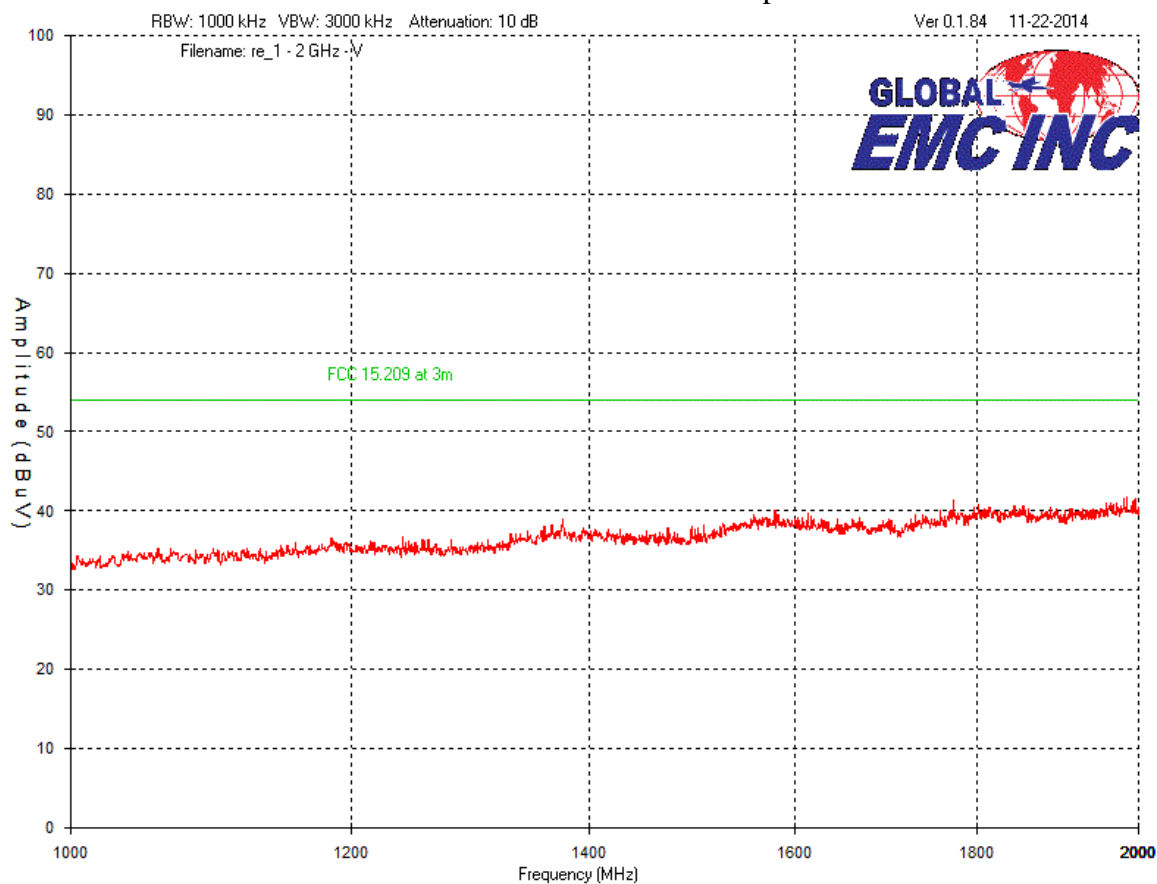
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Product	WBT1012	
Standard(s)	RSS 210 Issue 8:2010 / FCC Part 15 Subpart C 15:2014	


Low Channel – 30 MHz – 1 GHz
Horizontal - Peak Emission Graph



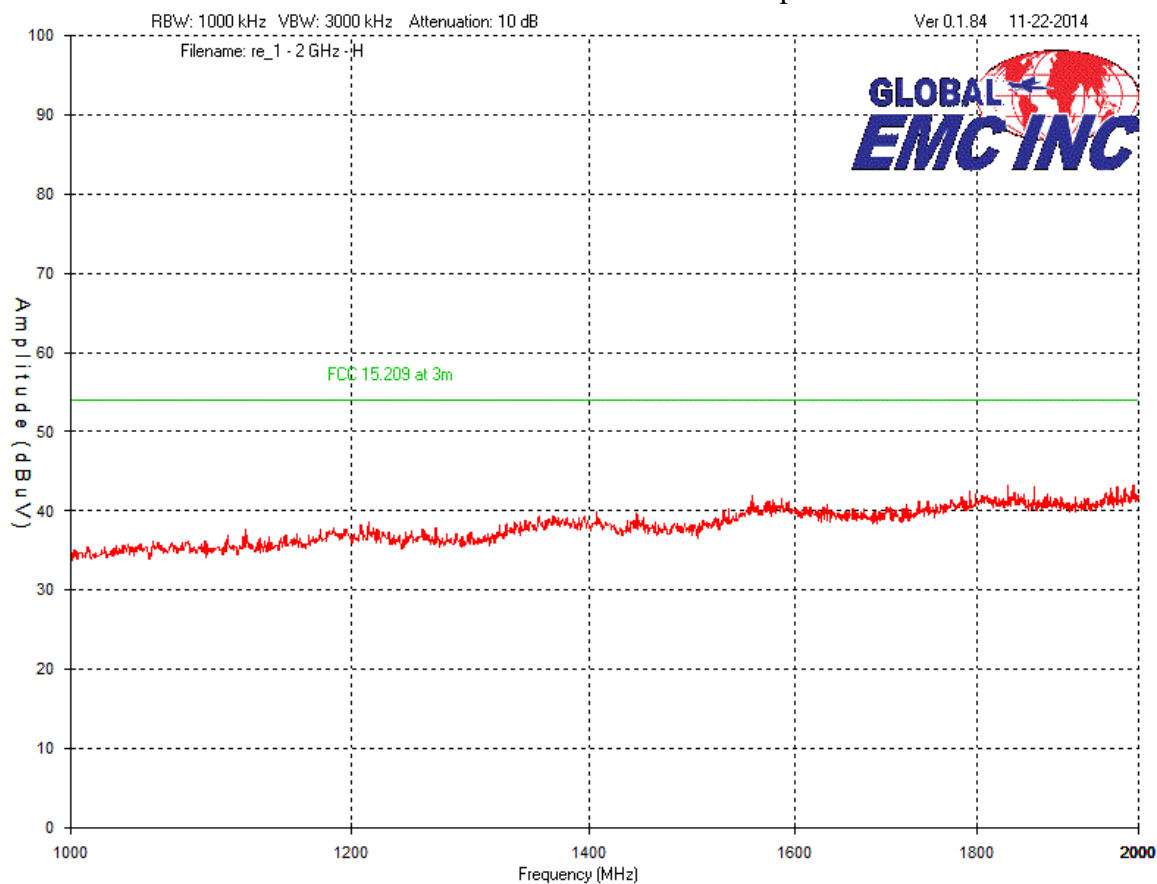
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Product	WBT1012	
Standard(s)	RSS 210 Issue 8:2010 / FCC Part 15 Subpart C 15:2014	


Low Channel – 1 GHz – 2 GHz
Vertical - Peak Emission Graph



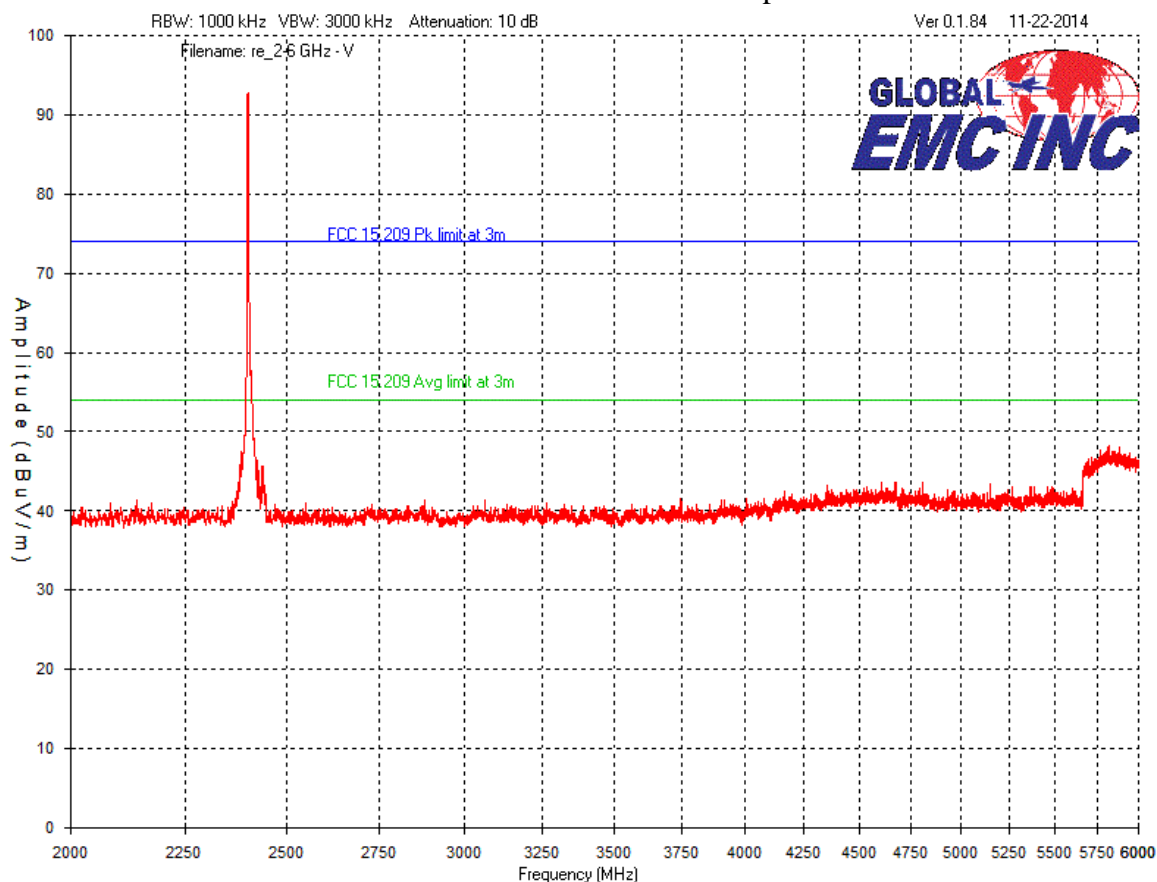
Client	Sonavox Inc	
Product	WBT1012	
Standard(s)	RSS 210 Issue 8:2010 / FCC Part 15 Subpart C 15:2014	

Low Channel – 1 GHz – 2 GHz
Horizontal - Peak Emission Graph




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Standard(s)	RSS 210 Issue 8:2010 / FCC Part 15 Subpart C 15:2014	

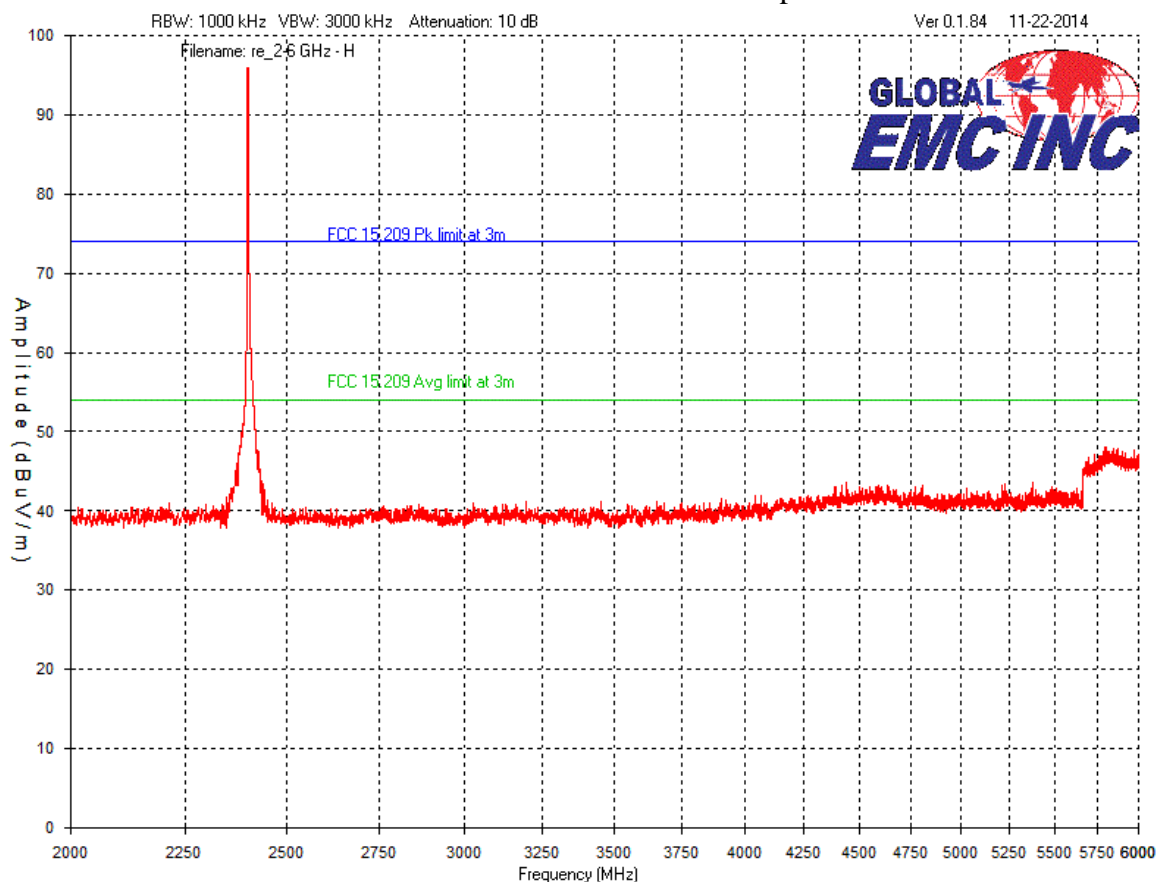
Low Channel – 2 GHz – 6 GHz
Vertical - Peak Emission Graph




Note: See Final Measurements and Results section for measurements.

Client	Sonavox Inc	
Product	WBT1012	
Standard(s)	RSS 210 Issue 8:2010 / FCC Part 15 Subpart C 15:2014	

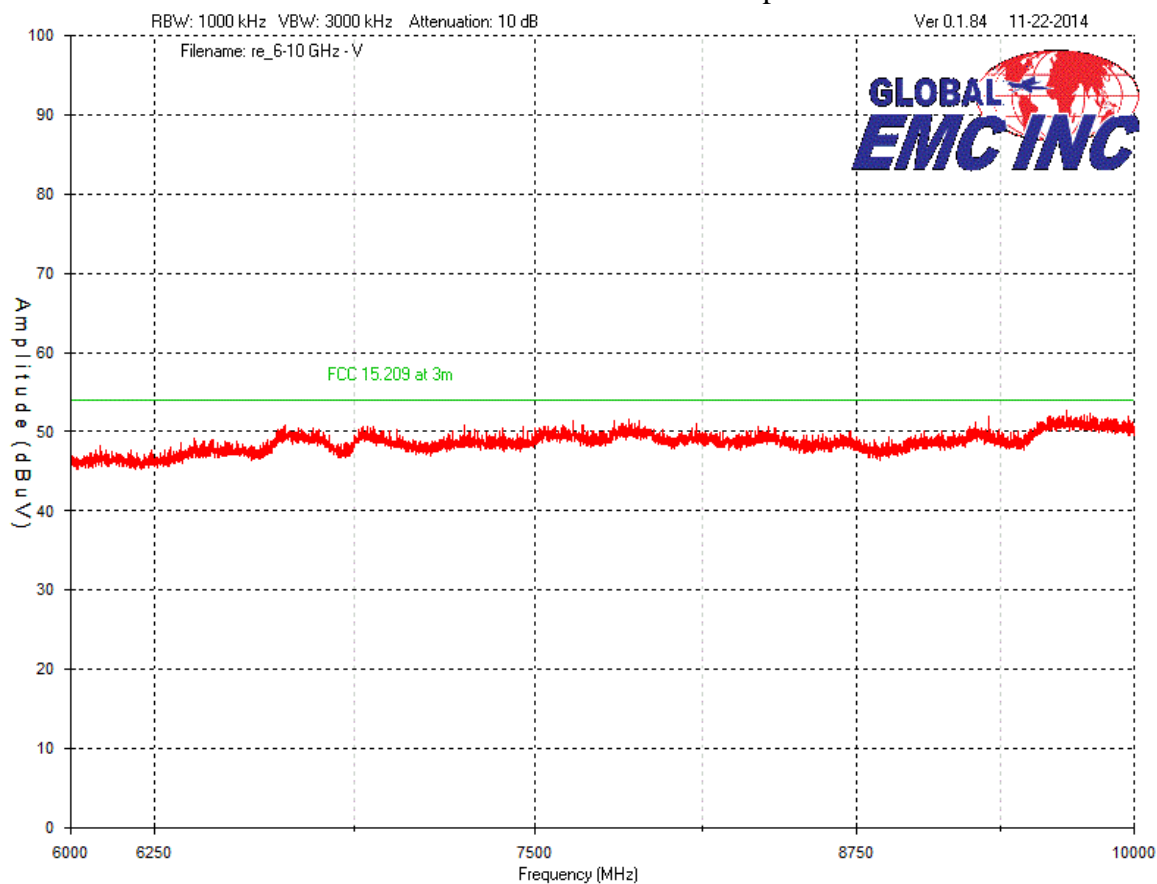
Low Channel – 2 GHz –6 GHz
Horizontal - Peak Emission Graph




Note: See Final Measurements and Results section for measurements.

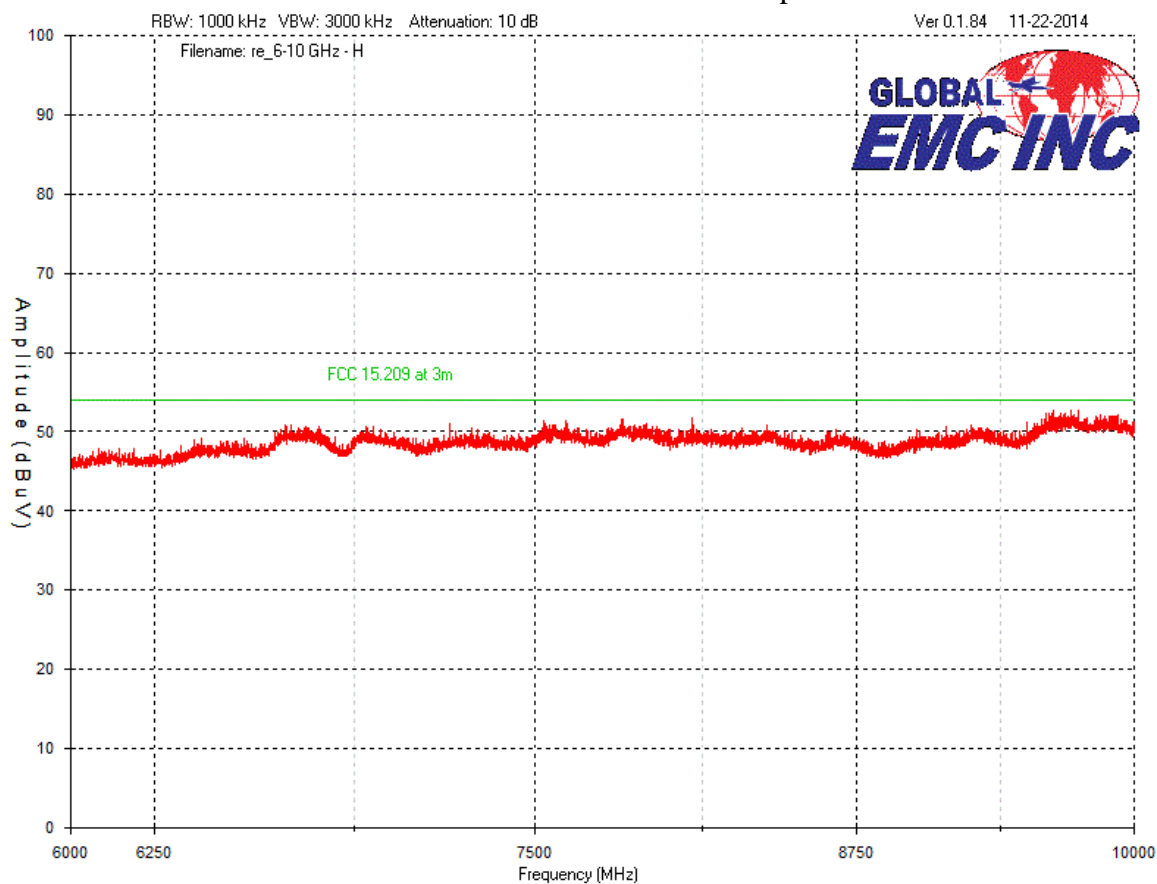
Client	Sonavox Inc	
Product	WBT1012	
Standard(s)	RSS 210 Issue 8:2010 / FCC Part 15 Subpart C 15:2014	


Low Channel –6 GHz – 10 GHz
Vertical - Peak Emission Graph



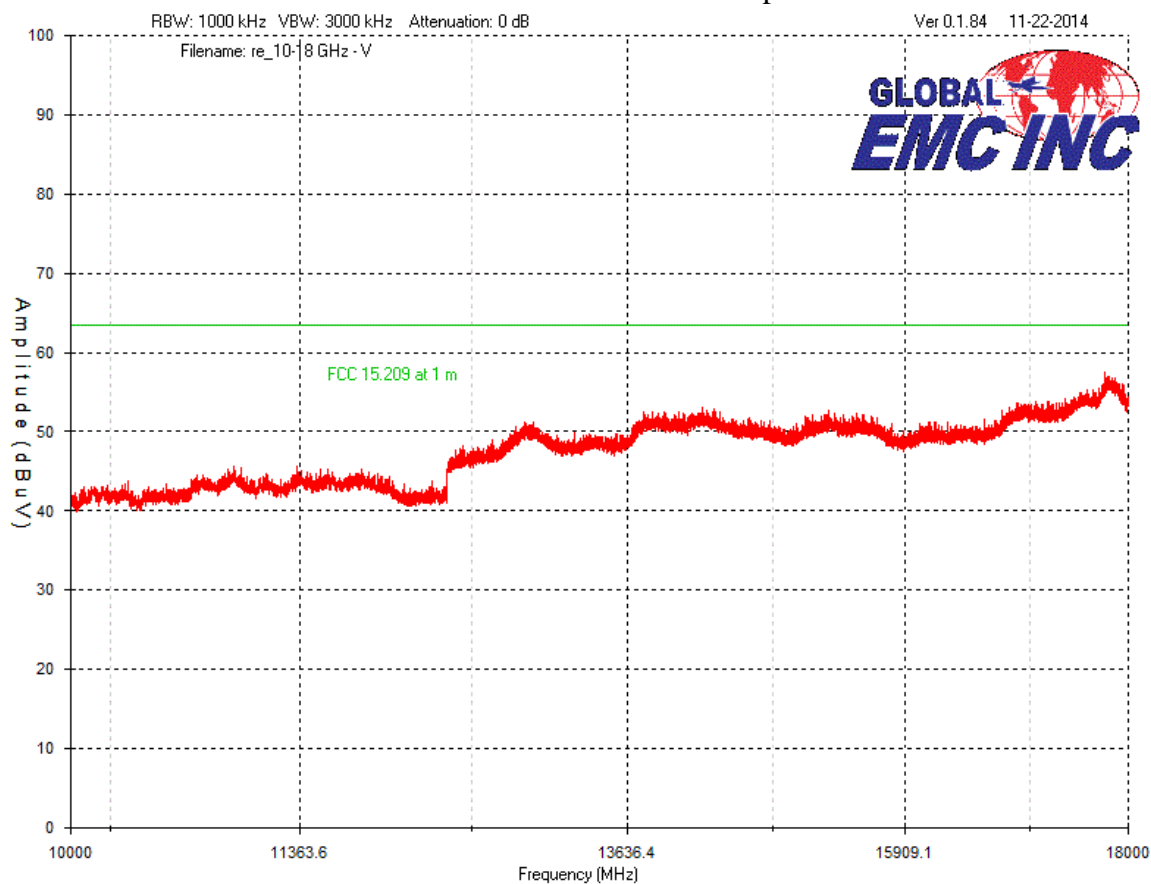
Client	Sonavox Inc	
Product	WBT1012	
Standard(s)	RSS 210 Issue 8:2010 / FCC Part 15 Subpart C 15:2014	

Low Channel –6 GHz – 10 GHz
Horizontal - Peak Emission Graph




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Product	WBT1012	
Standard(s)	RSS 210 Issue 8:2010 / FCC Part 15 Subpart C 15:2014	

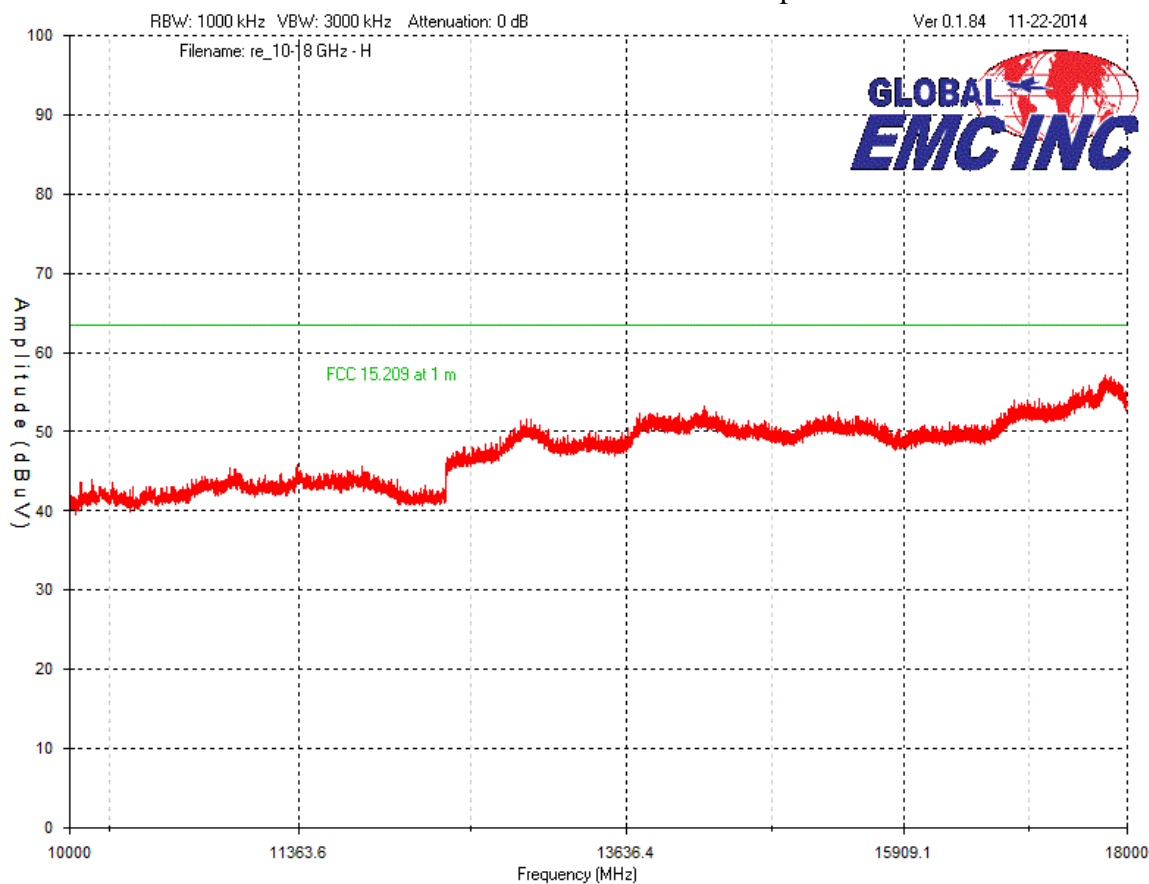
Low Channel – 10 GHz – 18 GHz
Vertical - Peak Emission Graph




Plot was taken at 1 meter distances. All emission shown were instrument noise floor of measurement instrument. No emissions were found in this frequency range.

Client	Sonavox Inc	
Product	WBT1012	
Standard(s)	RSS 210 Issue 8:2010 / FCC Part 15 Subpart C 15:2014	

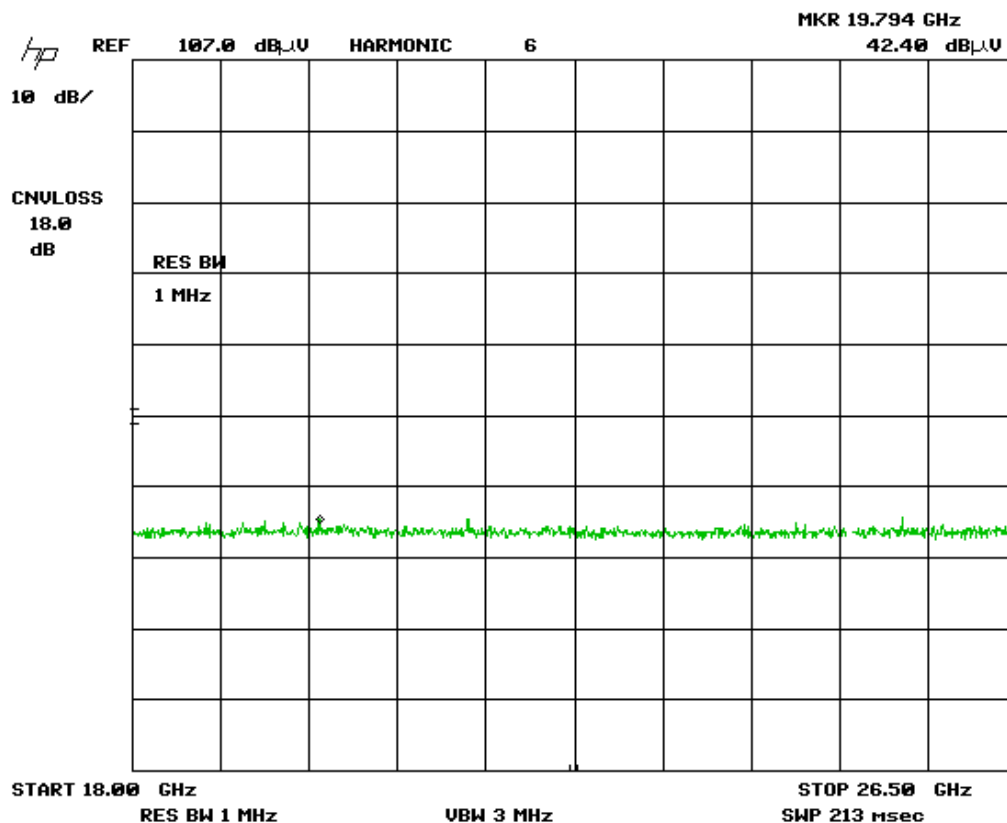
High Channel – 10 GHz – 18 GHz Horizontal - Peak Emission Graph




Plot was taken at 1 meter distances. All emission shown were instrument noise floor of measurement instrument. No emissions were found in this frequency range.

Client	Sonavox Inc	
Product	WBT1012	
Standard(s)	RSS 210 Issue 8:2010 / FCC Part 15 Subpart C 15:2014	

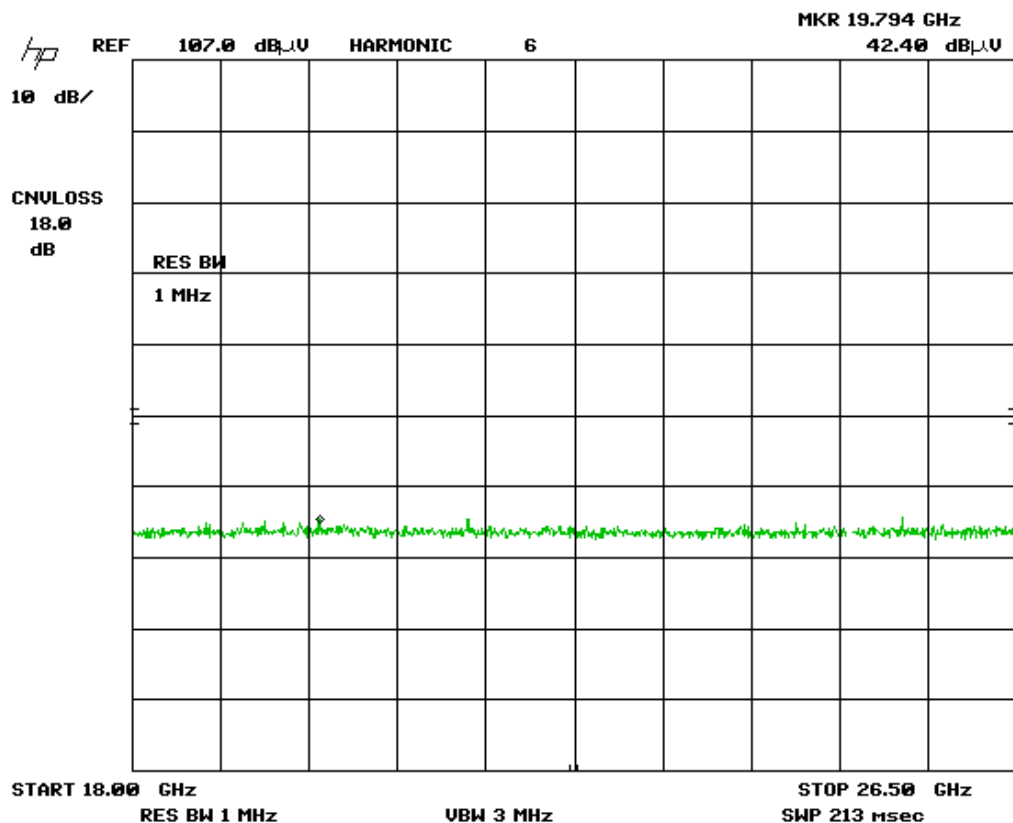
High Channel – 18 GHz – 26 GHz
Vertical - Peak Emission Graph




Plot was taken at 1 meter distances. All emission shown were instrument noise floor of measurement instrument. No emissions were found in this frequency range.

Client	Sonavox Inc	
Product	WBT1012	
Standard(s)	RSS 210 Issue 8:2010 / FCC Part 15 Subpart C 15:2014	

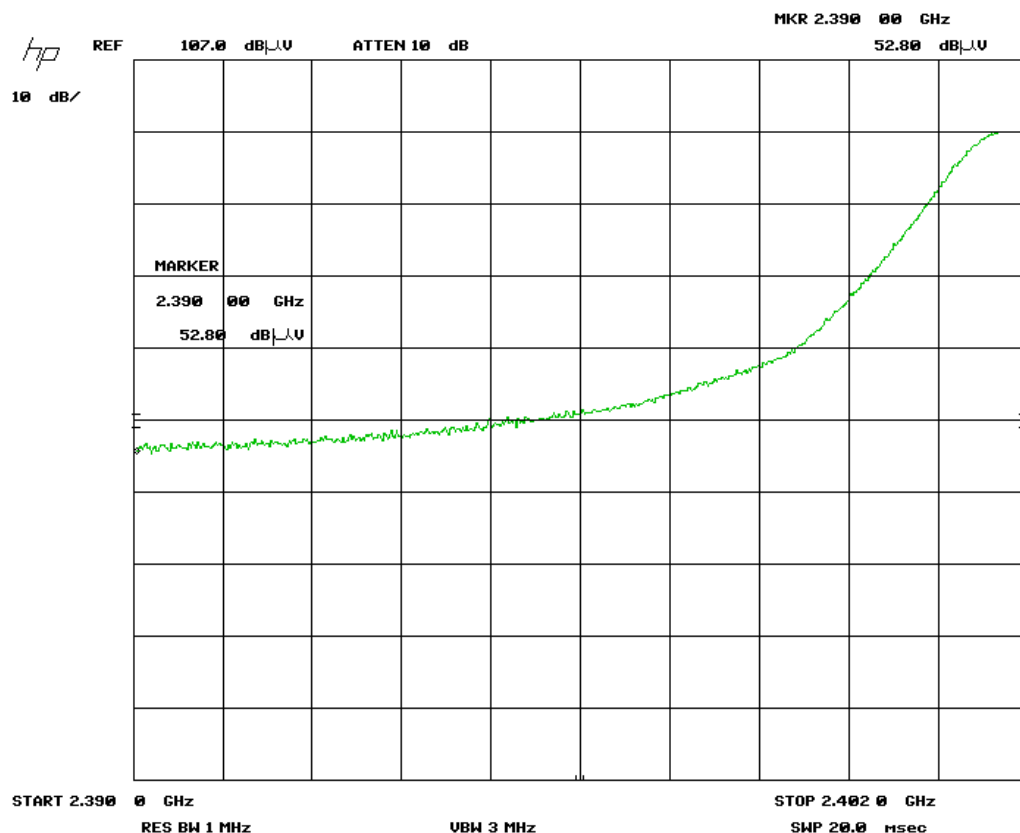
High Channel – 18 GHz – 26 GHz
Horizontal - Peak Emission Graph




Plot was taken at 1 meter distances. All emission shown were instrument noise floor of measurement instrument. No emissions were found in this frequency range.

Client	Sonavox Inc	
Product	WBT1012	
Standard(s)	RSS 210 Issue 8:2010 / FCC Part 15 Subpart C 15:2014	

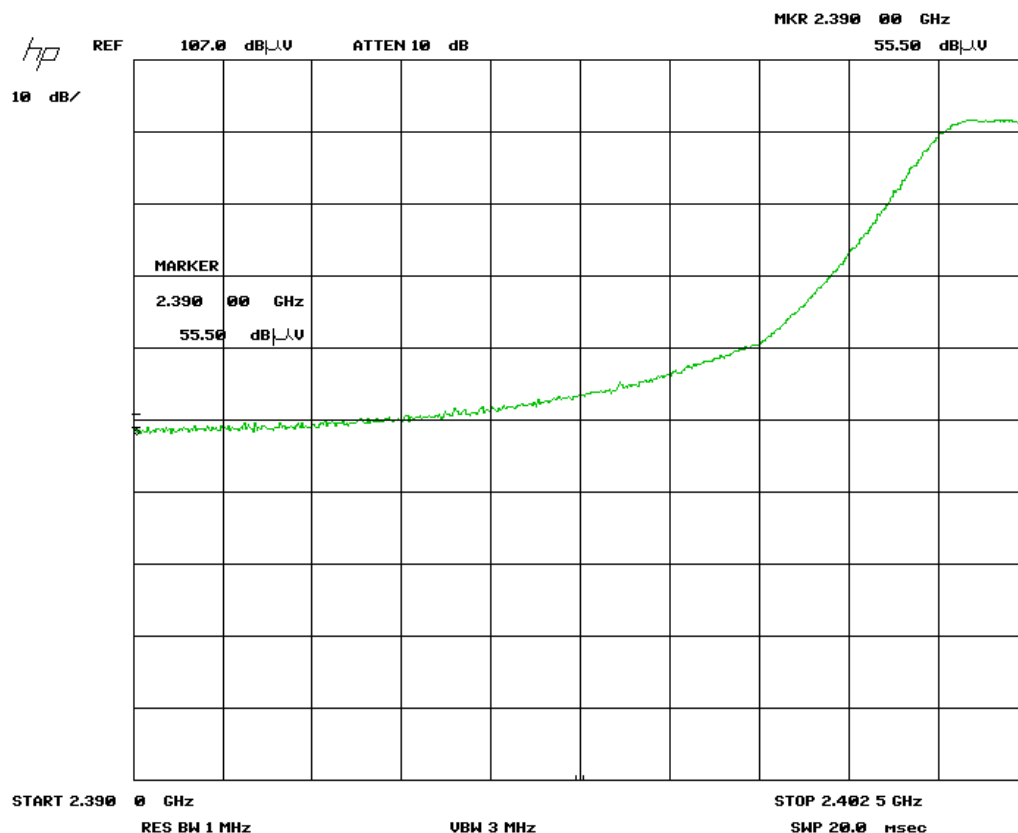
Band Edge – Low Channel
Vertical - Peak Emission




Note: Bandedge plots were taken with 3 m measurements distance. The marker shows the raw value; see Final Measurements and Results section for corrected values.

Client	Sonavox Inc	
Product	WBT1012	
Standard(s)	RSS 210 Issue 8:2010 / FCC Part 15 Subpart C 15:2014	

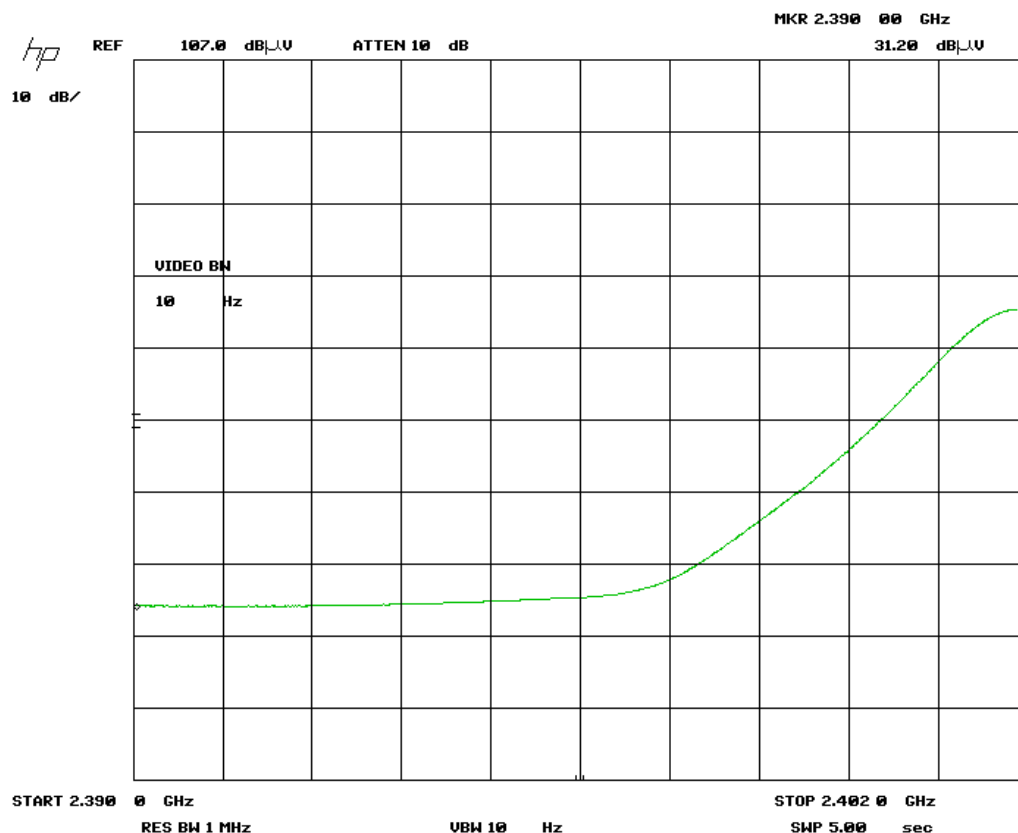
Band Edge – Low Channel
Horizontal - Peak Emission




Note: Bandedge plots were taken with 3 m measurements distance. The marker shows the raw value; see Final Measurements and Results section for corrected values.

Client	Sonavox Inc	
Product	WBT1012	
Standard(s)	RSS 210 Issue 8:2010 / FCC Part 15 Subpart C 15:2014	

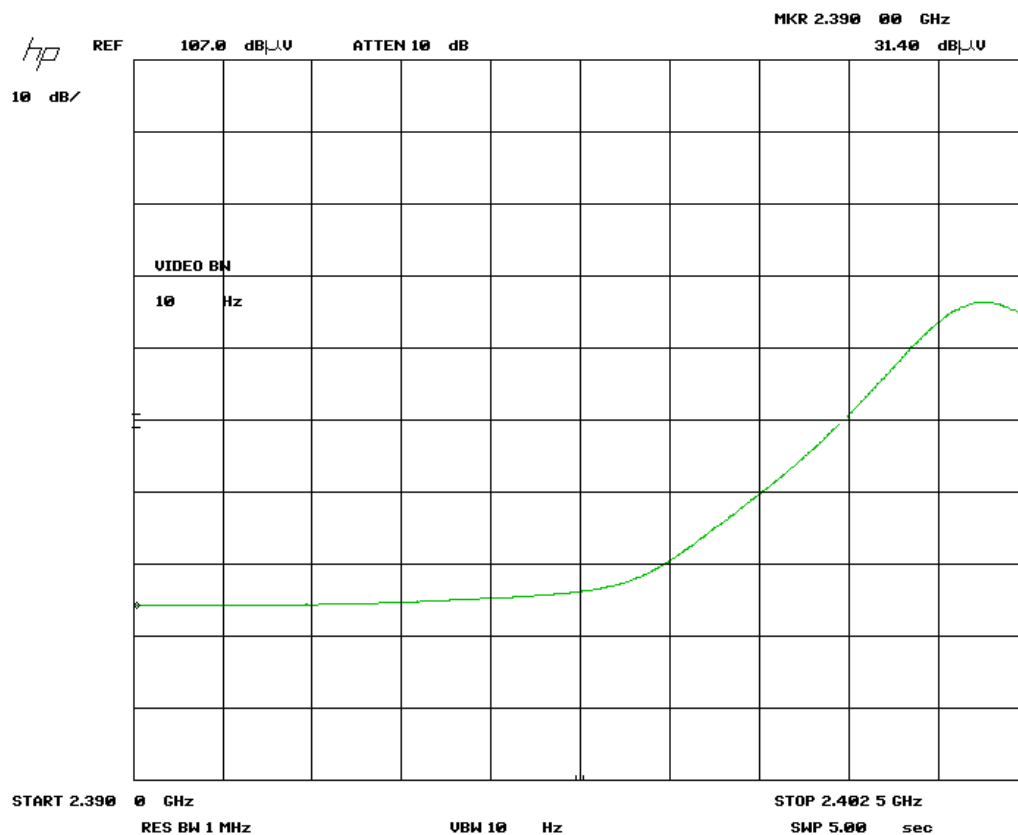
Band Edge – Low Channel
Vertical – Average Emission




Note: Bandedge plots were taken with 3 m measurements distance. The marker shows the raw value; see Final Measurements and Results section for corrected values.

Client	Sonavox Inc	
Product	WBT1012	
Standard(s)	RSS 210 Issue 8:2010 / FCC Part 15 Subpart C 15:2014	

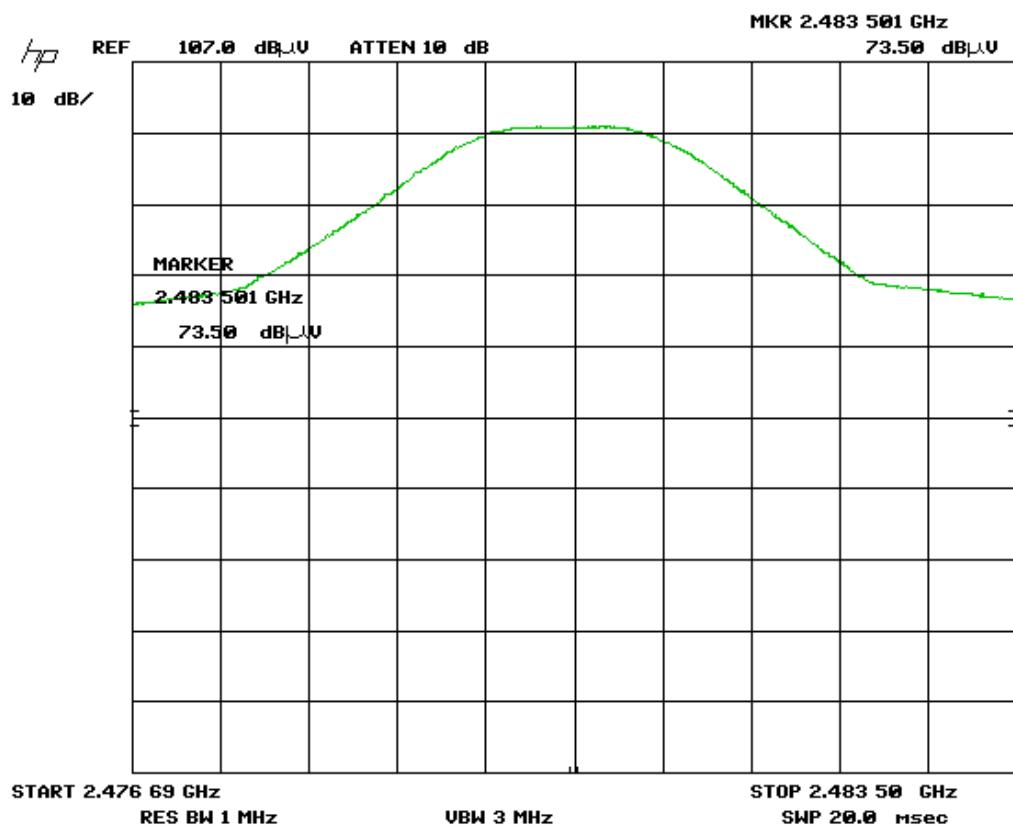
Band Edge – Low Channel
Horizontal - Average Emission




Note: Bandedge plots were taken with 3 m measurements distance. The marker shows the raw value; see Final Measurements and Results section for corrected values.

Client	Sonavox Inc	
Product	WBT1012	
Standard(s)	RSS 210 Issue 8:2010 / FCC Part 15 Subpart C 15:2014	

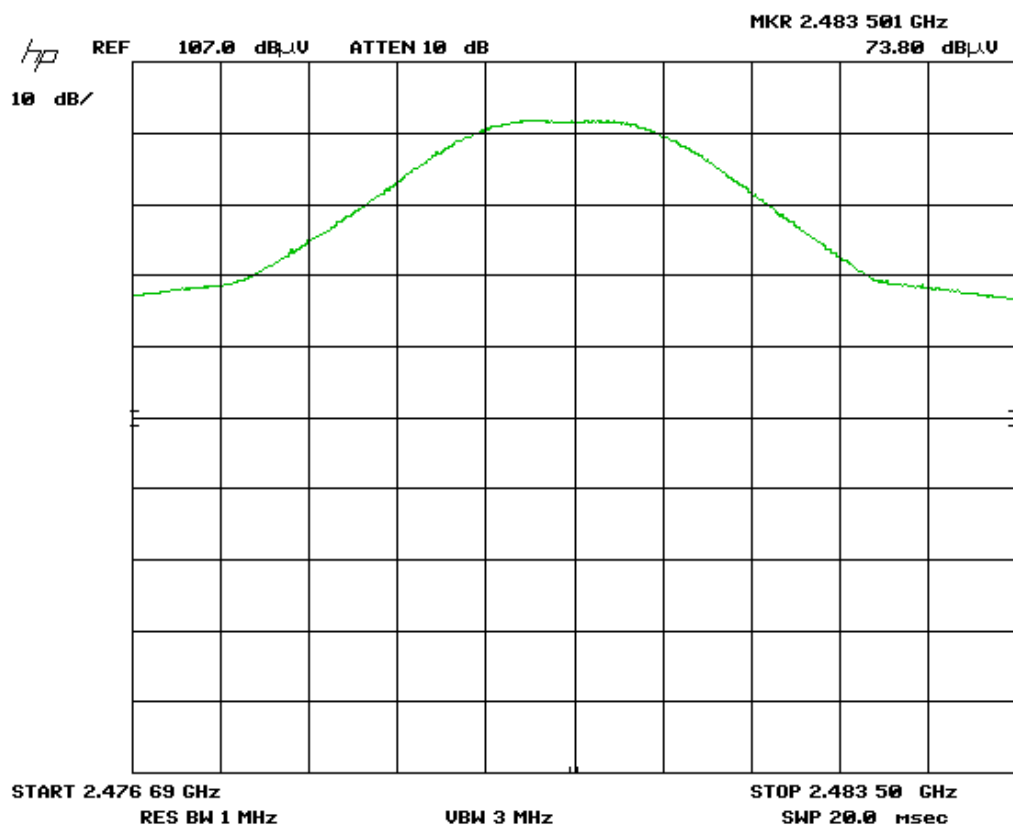
Band Edge – High Channel
Vertical - Peak Emission




Note: Bandedge plots were taken with 3 m measurements distance. The marker shows the raw value; see Final Measurements and Results section for corrected values.

Client	Sonavox Inc	
Product	WBT1012	
Standard(s)	RSS 210 Issue 8:2010 / FCC Part 15 Subpart C 15:2014	

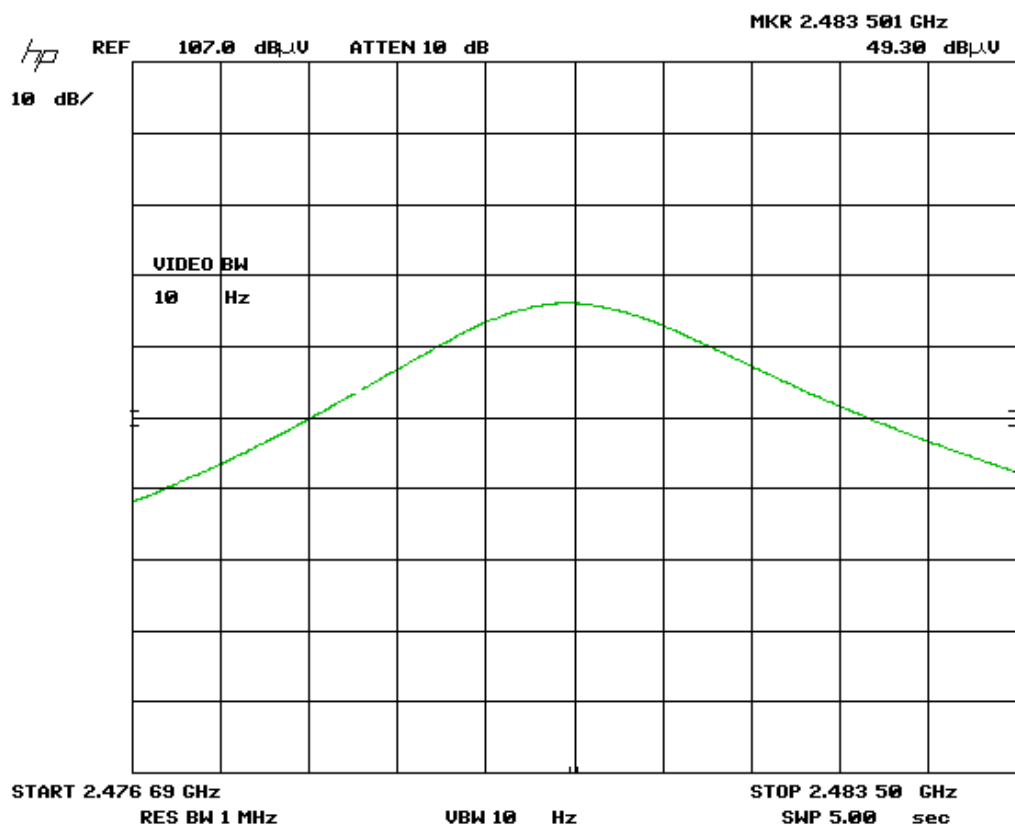
Band Edge – High Channel
Horizontal - Peak Emission




Note: Bandedge plots were taken with 3 m measurements distance. The marker shows the raw value; see Final Measurements and Results section for corrected values.

Client	Sonavox Inc	
Product	WBT1012	
Standard(s)	RSS 210 Issue 8:2010 / FCC Part 15 Subpart C 15:2014	

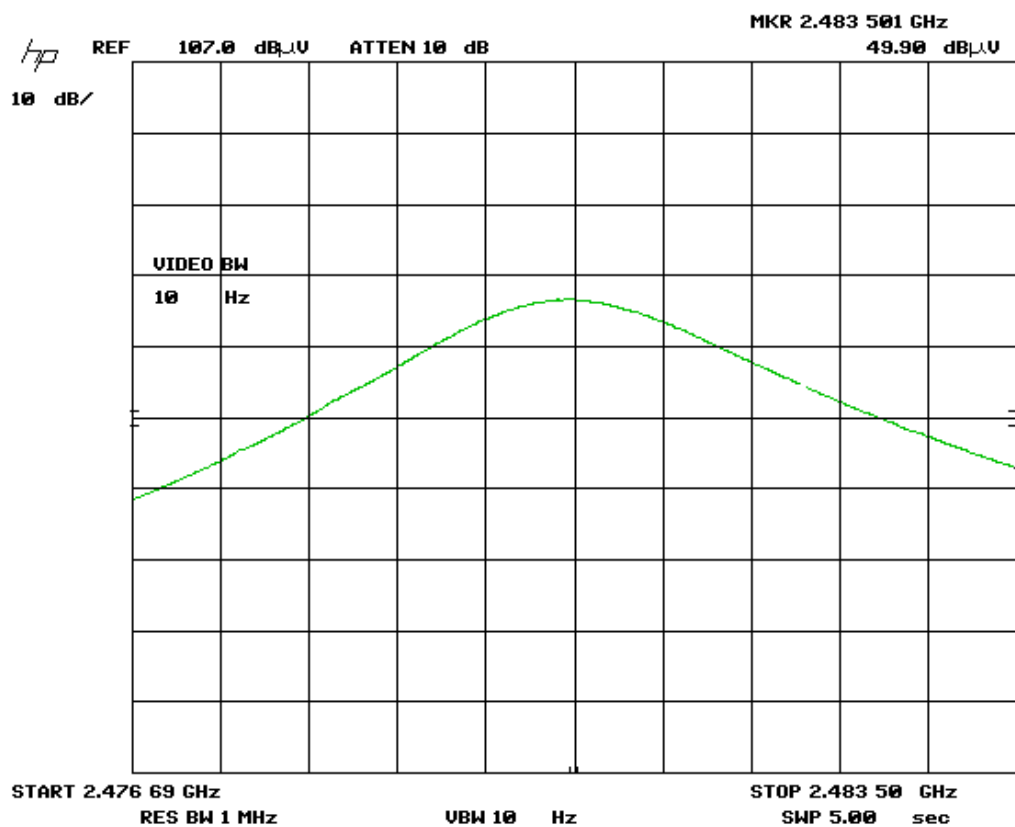
Band Edge – High Channel
Vertical - Average Emission




Note: Bandedge plots were taken with 3 m measurements distance. The marker shows the raw value; see Final Measurements and Results section for corrected values.

Client	Sonavox Inc	
Product	WBT1012	
Standard(s)	RSS 210 Issue 8:2010 / FCC Part 15 Subpart C 15:2014	

Band Edge – High Channel
Horizontal - Average Emission



Note: Bandedge plots were taken with 3 m measurements distance. The marker shows the raw value; see Final Measurements and Results section for corrected values.

Client	Sonavox Inc	
Product	WBT1012	
Standard(s)	RSS 210 Issue 8:2010 / FCC Part 15 Subpart C 15:2014	

Final Measurements and Results


The EUT passed the limits. Low, middle and high bands were measured.

In accordance with 15.247(d), only frequencies exceeding the 15.209 limit that occur within the bands listed in 15.205, need to be verified with a final detector.


For frequency shown on the peak graphs and not listed in 15.205, measurements were taken for reference.

The measurements were maximized by rotating the turn table over a full 0-360 rotation and the antenna height was varied from 1 m to 4 m.


Test Frequency (MHz)	Detection mode	Antenna polarity (Horz/Vert)	Raw signal dB(μV)	Antenna factor dB	Cable loss dB + Preselector	Attenuator dB	Pre-Amp Gain dB	Received signal dB(μV/m)	Emission limit dB(μV/m)	Margin dB(μV)	Result
Low Channel - X axis											
2402	Peak	Horz	99.0	30.8	4.1	0.0	35.8	98.1			PASS
2402	Avg	Horz	73.5	30.8	4.1	0.0	35.8	72.6			PASS
2402	Peak	Vert	97.1	30.8	4.1	0.0	35.8	96.2			PASS
2402	Avg	Vert	72.5	30.8	4.1	0.0	35.8	71.6			PASS
2390	Peak	Horz	55.5	30.8	4.1	0.0	35.8	54.6	74.0	19.4	PASS
2390	Avg	Horz	31.4	30.8	4.1	0.0	35.8	30.5	54.0	23.5	PASS
2390	Peak	Vert	52.4	30.8	4.1	0.0	35.8	51.5	74.0	22.5	PASS
2390	Avg	Vert	31.9	30.8	4.1	0.0	35.8	31.0	54.0	23.0	PASS
4804	Peak	Horz	45.0	33.5	5.9	0.0	35.2	49.2	74.0	24.8	PASS
4804	Avg	Horz	33.5	33.5	5.9	0.0	35.2	37.7	54.0	16.3	PASS
4804	Peak	Vert	44.3	33.5	5.9	0.0	35.2	48.5	74.0	25.5	PASS
4804	Avg	Vert	33.7	33.5	5.9	0.0	35.2	37.9	54.0	16.1	PASS
7206	Peak	Vert	45.9	37.9	9.6	0.0	35.9	57.5	74.0	16.5	PASS
7206	Avg	Vert	32.8	37.9	9.6	0.0	35.9	44.4	54.0	9.6	PASS
7206	Peak	Horz	45.7	37.9	9.6	0.0	35.9	57.3	74.0	16.7	PASS
7206	Avg	Horz	32.4	37.9	9.6	0.0	35.9	44.0	54.0	10.0	PASS
Low Channel Y - Axis											
2402	Peak	Horz	97.8	30.8	4.1	0.0	35.8	96.9			PASS
2402	Avg	Horz	72.9	30.8	4.1	0.0	35.8	72.0			PASS
2402	Peak	Vert	100.5	30.8	4.1	0.0	35.8	99.6			PASS
2402	Avg	Vert	74.6	30.8	4.1	0.0	35.8	73.7			PASS
2390	Peak	Horz	53.7	30.8	4.1	0.0	35.8	52.8	74.0	21.2	PASS
2390	Avg	Horz	31.3	30.8	4.1	0.0	35.8	30.4	54.0	23.6	PASS
2390	Peak	Vert	56.5	30.8	4.1	0.0	35.8	55.6	74.0	18.4	PASS
2390	Avg	Vert	31.5	30.8	4.1	0.0	35.8	30.6	54.0	23.4	PASS
Low Channel Z - Axis											
2402	Peak	Horz	95.0	30.8	4.1	0.0	35.8	94.1			PASS
2402	Avg	Horz	71.2	30.8	4.1	0.0	35.8	70.3			PASS
2402	Peak	Vert	96.8	30.8	4.1	0.0	35.8	95.9			PASS
2402	Avg	Vert	72.3	30.8	4.1	0.0	35.8	71.4			PASS
2390	Peak	Horz	52.3	30.8	4.1	0.0	35.8	51.4	74.0	22.6	PASS
2390	Avg	Horz	31.3	30.8	4.1	0.0	35.8	30.4	54.0	23.6	PASS
2390	Peak	Vert	54.0	30.8	4.1	0.0	35.8	53.1	74.0	20.9	PASS
2390	Avg	Vert	31.3	30.8	4.1	0.0	35.8	30.4	54.0	23.6	PASS

Client	Sonavox Inc	
Product	WBT1012	
Standard(s)	RSS 210 Issue 8:2010 / FCC Part 15 Subpart C 15:2014	

Test Frequency (MHz)	Detection mode	Antenna polarity (Horz/Vert)	Raw signal dB(μV)	Antenna factor dB	Cable loss dB + Preselector	Attenuator dB	Pre-Amp Gain dB	Received signal dB(μV/m)	Emission limit dB(μV/m)	Margin dB(μV)	Result
Mid channel X-Axis											
2440	Peak	Horz	98.9	30.8	4.1	0.0	35.8	98.0			PASS
2440	Avg	Horz	73.4	30.8	4.1	0.0	35.8	72.5			PASS
2440	Peak	Vert	98.8	30.8	4.1	0.0	35.8	97.9			PASS
2440	Avg	Vert	73.5	30.8	4.1	0.0	35.8	72.6			PASS
4880	Peak	Horz	45.9	33.5	5.9	0.0	35.2	50.1	74.0	23.9	PASS
4880	Avg	Horz	35.6	33.5	5.9	0.0	35.2	39.8	54.0	14.2	PASS
4880	Peak	Vert	48.1	33.5	5.9	0.0	35.2	52.3	74.0	21.7	PASS
4880	Avg	Vert	40.7	33.5	5.9	0.0	35.2	44.9	54.0	9.1	PASS
7320	Peak	Vert	45.7	37.9	9.6	0.0	35.2	58.0	74.0	16.0	PASS
7320	Avg	Vert	32.3	37.9	9.6	0.0	35.2	44.6	54.0	9.4	PASS
7320	Peak	Horz	45.8	37.9	9.6	0.0	35.2	58.1	74.0	15.9	PASS
7320	Avg	Horz	32.3	37.9	9.6	0.0	35.2	44.6	54.0	9.4	PASS
Mid channel Y-Axis											
2440	Peak	Horz	98.7	30.8	4.1	0.0	35.8	97.8			PASS
2440	Avg	Horz	73.2	30.8	4.1	0.0	35.8	72.3			PASS
2440	Peak	Vert	98.9	30.8	4.1	0.0	35.8	98.0			PASS
2440	Avg	Vert	73.5	30.8	4.1	0.0	35.8	72.6			PASS
Mid channel Z-Axis											
2440	Peak	Horz	95.6	30.8	4.1	0.0	35.9	94.6			PASS
2440	Avg	Horz	71.3	30.8	4.1	0.0	35.9	70.3			PASS
2440	Peak	Vert	96.5	30.8	4.1	0.0	35.9	95.5			PASS
2440	Avg	Vert	71.9	30.8	4.1	0.0	35.9	70.9			PASS

Client	Sonavox Inc	
Product	WBT1012	
Standard(s)	RSS 210 Issue 8:2010 / FCC Part 15 Subpart C 15:2014	


Test Frequency (MHz)	Detection mode	Antenna polarity (Horz/Vert)	Raw signal dB(μV)	Antenna factor dB	Cable loss dB + Preselector	Attenuator dB	Pre-Amp Gain dB	Received signal dB(μV/m)	Emission limit dB(μV/m)	Margin dB(μV)	Result
High channel - Horizontal (X)											
2480	Peak	Horz	98.8	30.8	4.1	0.0	35.8	97.9			PASS
2480	Avg	Horz	73.6	30.8	4.1	0.0	35.8	72.7			PASS
2480	Peak	Vert	98.2	30.8	4.1	0.0	35.8	97.3			PASS
2480	Avg	Vert	73.1	30.8	4.1	0.0	35.8	72.2			PASS
2483.5	Peak	Horz	73.0	30.8	4.1	0.0	35.8	72.1	74.0	1.9	PASS
2483.5	Avg	Horz	49.9	30.8	4.1	0.0	35.8	49.0	54.0	5.0	PASS
2483.5	Peak	Vert	73.5	30.8	4.1	0.0	35.8	72.6	74.0	1.4	PASS
2483.5	Avg	Vert	49.2	30.8	4.1	0.0	35.8	48.3	54.0	5.7	PASS
4960	Peak	Horz	46.0	33.5	5.9	0.0	35.2	50.2	74.0	23.8	PASS
4960	Avg	Horz	35.9	33.5	5.9	0.0	35.2	40.1	54.0	13.9	PASS
4960	Peak	Vert	47.0	33.5	5.9	0.0	35.2	51.2	74.0	22.8	PASS
4960	Avg	Vert	37.3	33.5	5.9	0.0	35.2	41.5	54.0	12.5	PASS
7440	Peak	Vert	46.2	38.6	7.4	0.0	35.6	56.6	74.0	17.4	PASS
7440	Avg	Vert	31.8	38.6	7.4	0.0	35.6	42.2	54.0	11.8	PASS
7440	Peak	Horz	45.7	38.6	7.4	0.0	35.6	56.1	74.0	17.9	PASS
7440	Avg	Horz	31.7	38.6	7.4	0.0	35.6	42.1	54.0	11.9	PASS
High channel - Vertical (Y)											
2480	Peak	Horz	99.0	30.8	4.1	0.0	35.8	98.1			PASS
2480	Avg	Horz	73.6	30.8	4.1	0.0	35.8	72.7			PASS
2480	Peak	Vert	96.6	30.8	4.1	0.0	35.8	95.7			PASS
2480	Avg	Vert	71.9	30.8	4.1	0.0	35.8	71.0			PASS
2483.5	Peak	Horz	73.4	30.8	4.1	0.0	35.8	72.5	74.0	1.5	PASS
2483.5	Avg	Horz	50.0	30.8	4.1	0.0	35.8	49.1	54.0	4.9	PASS
2483.5	Peak	Vert	71.1	30.8	4.1	0.0	35.8	70.2	74.0	3.8	PASS
2483.5	Avg	Vert	48.1	30.8	4.1	0.0	35.8	47.2	54.0	6.8	PASS
High channel - Vertical (Z)											
2480	Peak	Horz	97.3	30.8	4.1	0.0	35.8	96.4			PASS
2480	Avg	Horz	72.4	30.8	4.1	0.0	35.8	71.5			PASS
2480	Peak	Vert	98.2	30.8	4.1	0.0	35.8	97.3			PASS
2480	Avg	Vert	73.2	30.8	4.1	0.0	35.8	72.3			PASS
2483.5	Peak	Horz	72.2	30.8	4.1	0.0	35.8	71.3	74.0	2.7	PASS
2483.5	Avg	Horz	48.4	30.8	4.1	0.0	35.8	47.5	54.0	6.5	PASS
2483.5	Peak	Vert	73.3	30.8	4.1	0.0	35.8	72.4	74.0	1.6	PASS
2483.5	Avg	Vert	49.2	30.8	4.1	0.0	35.8	48.3	54.0	5.7	PASS

Client	Sonavox Inc	
Product	WBT1012	
Standard(s)	RSS 210 Issue 8:2010 / FCC Part 15 Subpart C 15:2014	

Test Equipment List

Equipment	Model No.	Manufacturer	Last calibration date	Next calibration due date	Asset #
Spectrum Analyzer	8566B	HP	Oct 2, 2013	Oct 2, 2015	GEMC 190
Quasi Peak Adapter	85650A	HP	Oct 1, 2013	Oct 1, 2015	GEMC 191
Loop Antenna	EM 6871	Electro-Metrics	Feb 5, 2013	Feb 5, 2015	GEMC 70
Loop Antenna	EM 6872	Electro-Metrics	Feb 5, 2013	Feb 5, 2015	GEMC 71
BiLog Antenna	3142-C	ETS	Feb 4, 2013	Feb 4, 2015	GEMC 137
4GHZ-12GHZ High Pass filter	11SH10-4000/T12000-0/0	K & L Microwave	NCR	NCR	GEMC 119
Chase Preamp 9kHz - 2 GHz	CPA9231A	Chase	Sept 9, 2014	Sept 9, 2016	GEMC 6403
Q-Par 1.5-18 GHz Horn	6878/24	Q-par	Sept 10, 2014	Sept 10, 2016	GEMC 6365
Horn Antenna 18 GHz - 26.5 GHz	SAS-572	A.H. Systems	Sept 9, 2014	Sept 9, 2016	GEMC 6371
18.0-26.5 GHz Harmonic Mixer	11970K	HP	Jan 28, 2014	Jan 28, 2016	GEMC 158
1-26G pre-amp	HP 8449B	HP	Sept 9, 2014	Sept 9, 2016	GEMC 6351
RF Cable 7m	LMR-400-7M-50OHM-MN-MN	LexTec	NCR	NCR	GEMC 28
RF Cable 1m	LMR-400-1M-50OHM-MN-MN	LexTec	NCR	NCR	GEMC 29
RF Cable 0.5M	LMR-400-0.5M-50OHM-MN-MN	LexTec	NCR	NCR	GEMC 31

This report module is based on GEMC template "FCC - 15.209 - Radiated Emissions_Rev1.doc"

Client	Sonavox Inc	
Product	WBT1012	
Standard(s)	RSS 210 Issue 8:2010 / FCC Part 15 Subpart C 15:2014	

Power Spectral Density – 15.247 DM

Purpose

The purpose of this test is to ensure that the maximum power spectral density to the radiating element does not exceed the limits specified. This ensures that the modulation is significantly wide enough, or low enough in power that it will allow for co-operation of other wireless devices operating within this frequency allocation.

Limits and Methods

The limits are defined in 15.247(e).

For digitally modulated systems, the power spectral density conducted from the intentional radiator to the antenna shall not be greater than 8 dBm in any 3 kHz band during any time interval of continuous transmission.

The method is given in Section 10.2 of FCC KDB 558074: June 9, 2014.

Results


The EUT passed. Low, medium, and high band was tested. The peak power spectral density of the EUT was measured with the EUT set to transmit at maximum power. The maximum power spectral density is 3.12 dBm/3 kHz

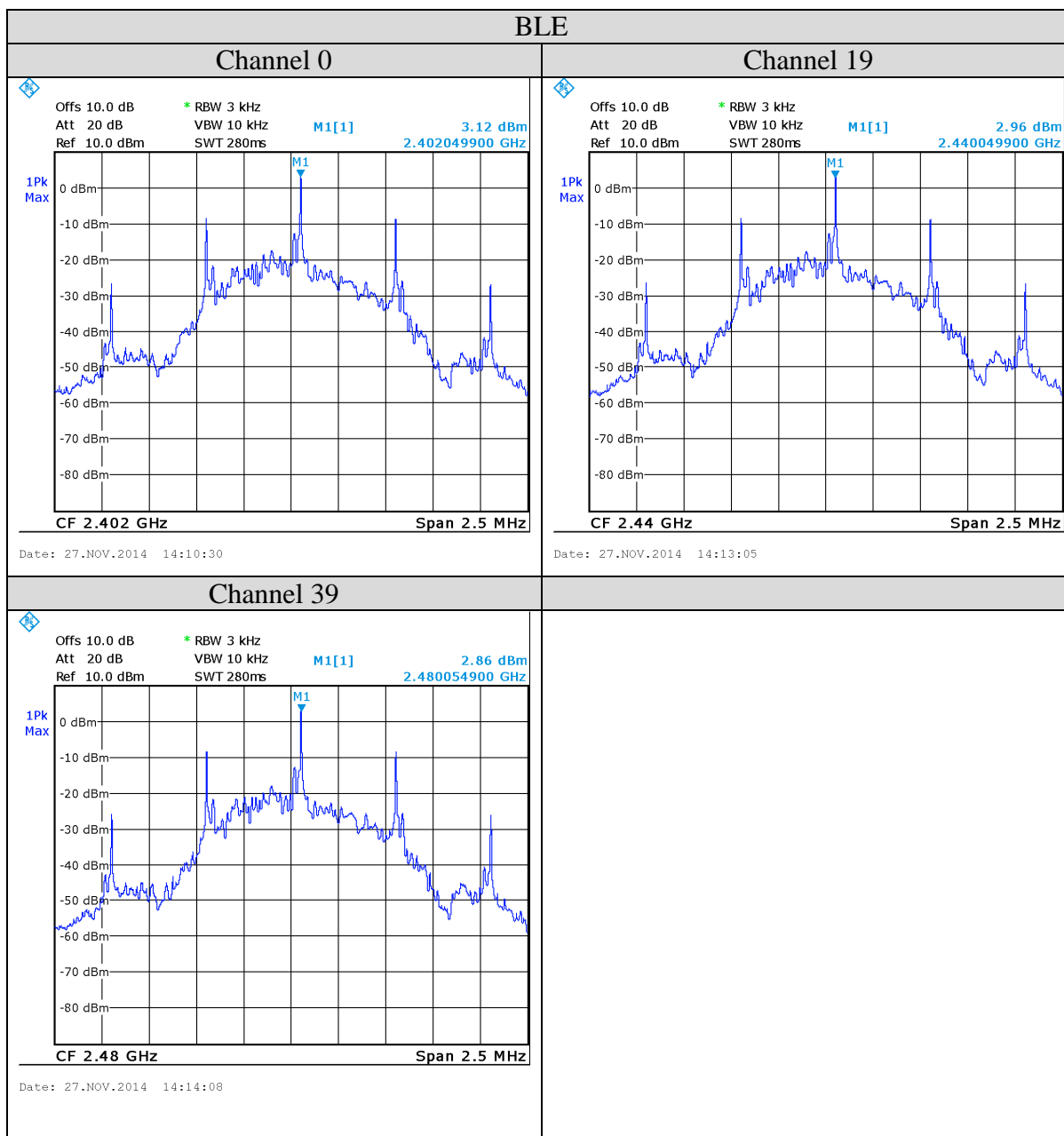
Table 3: Peak power spectral density

Mode	Channel	Frequency (MHz)	PKPSD (dBm/3 kHz)	PSD Limit (dBm)	Results
BLE	0	2402	3.12	8	Pass
BLE	19	2440	2.96	8	Pass
BLE	39	2480	2.86	8	Pass


Graph(s)

The graphs shown below show the power spectral density of the device during the conducted measurement operation of the EUT. Low, middle, and high channel was investigated.

Client	Sonavox Inc	
Product	WBT1012	
Standard(s)	RSS 210 Issue 8:2010 / FCC Part 15 Subpart C 15:2014	




Note: See 'Appendix B – EUT & Test Setup Photographs' for photos showing the test set-up.

Client	Sonavox Inc	
Product	WBT1012	
Standard(s)	RSS 210 Issue 8:2010 / FCC Part 15 Subpart C 15:2014	

Test Equipment List

Equipment	Model No.	Manufacturer	Last calibration date	Next calibration due date	Asset #
Spectrum Analyzer	ESL6	Rohde & Schwarz	Nov 15, 2013	Nov 15,2015	GMEC 160
RF Cable 1m	LMR-400-1M-50OHM-MN-MN	LexTec	NCR	NCR	GEMC 29

This report module is based on GEMC template "FCC – Power Line Conducted Emissions Class B_Rev1"

Client	Sonavox Inc	
Product	WBT1012	
Standard(s)	RSS 210 Issue 8:2010 / FCC Part 15 Subpart C 15:2014	

Maximum Permissible Exposure – 15.247

Purpose

The purpose of this test is to ensure that the RF energy intentionally transmitted, in terms of power density emitted from the EUT at a stated operating distance does not exceed the limits listed below as defined in the applicable test standard, as calculated based upon readings obtained during testing. This helps protect human exposure to excessive RF fields.

Limit(s) and Method

The limits, as defined in FCC 15.247(i) and FCC 1.1310 Table 1 (B) limits for general public exposure was applied. The limit for the frequency range of 1.5 GHz to 100 GHz was applied to the 15.247 device. This is a limit of 1.0 mW/cm². The distance used for calculations was 0.5 cm, as this is the minimum distance an operator will be from the EUT during normal operation, as stated by the manufacturer.

Results

The EUT passed the requirements. The worst case calculated power density was 0.26 mW/cm², this is under the 1.0 mW/cm² requirement.

Calculations

Method 1 (conducted power)

Internal antenna

$$P_d = (P_t * G) / (4 * \pi * R^2)$$

Where P_t = 4.62 dBm or 2.90 mW as per Peak power conducted output


Where G = 0.5 dBi, or numerically 1.12

Where R = 1 cm

$$P_d = (2.90 \text{ mW} * 1.12) / (4 * \pi * 1 \text{ cm}^2)$$

$$P_d = 3.25 \text{ mW} / 12.57 \text{ cm}^2$$

$$P_d = 0.26 \text{ mW/cm}^2$$

Client	Sonavox Inc	
Product	WBT1012	
Standard(s)	RSS 210 Issue 8:2010 / FCC Part 15 Subpart C 15:2014	

Power Line Conducted Emissions

Purpose

The purpose of this test is to ensure that the RF energy unintentionally emitted from the EUT's power line does not exceed the limits listed below as defined in the applicable test standard, as measured from a LISN. This helps protect lower frequency radio services such as AM radio, shortwave radio, amateur radio operators, maritime radio, CB radio, and so on, from unwanted interference.

Limits & Method

The limits are as defined in 47 CFR FCC Part 15 Section 15.207


Method is as defined in ANSI C64.10:2009

Average Limits		QuasiPeak Limits	
150 kHz – 500 kHz	56 to 46 dBuV	150 kHz – 500 kHz	66 to 56 dBuV
500 kHz – 5 MHz	46 dBuV	500 kHz – 5 MHz	56 dBuV
5 MHz – 30 MHz	50 dBuV	500 kHz – 30 MHz	60 dBuV

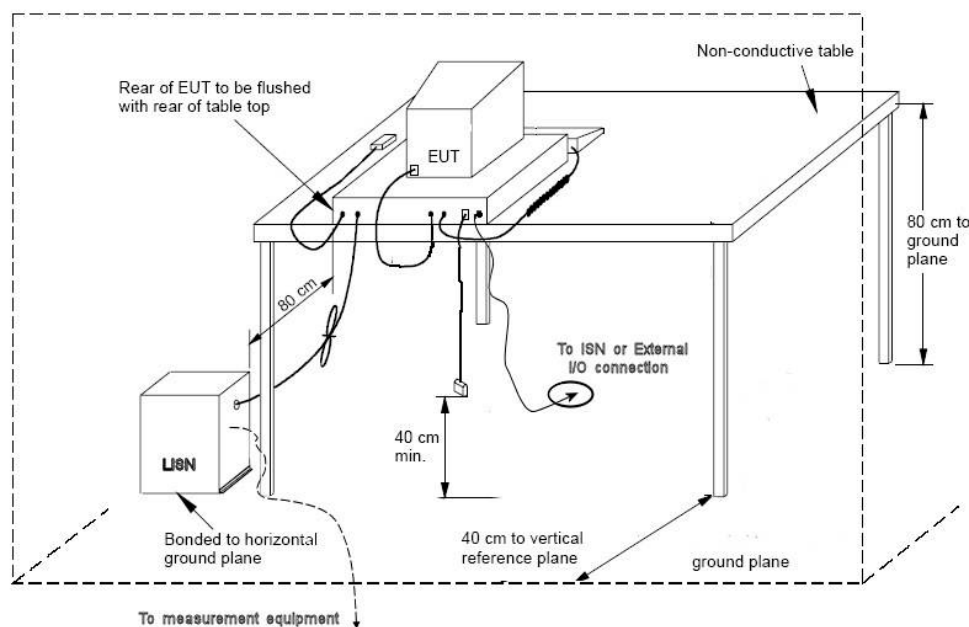
The limit decreases linearly with the logarithm of the frequency in the range 0.15 MHz to 0.50 MHz.

Note: If the Peak or Quasi Peak detector measurements do not exceed the Average limits, then the EUT is deemed to have passed the requirements.

Both limits are applicable, and each is specified as being measured with a 9 kHz measurement bandwidth.

Client	Sonavox Inc	
Product	WBT1012	
Standard(s)	RSS 210 Issue 8:2010 / FCC Part 15 Subpart C 15:2014	

Typical Setup Diagram




Measurement Uncertainty

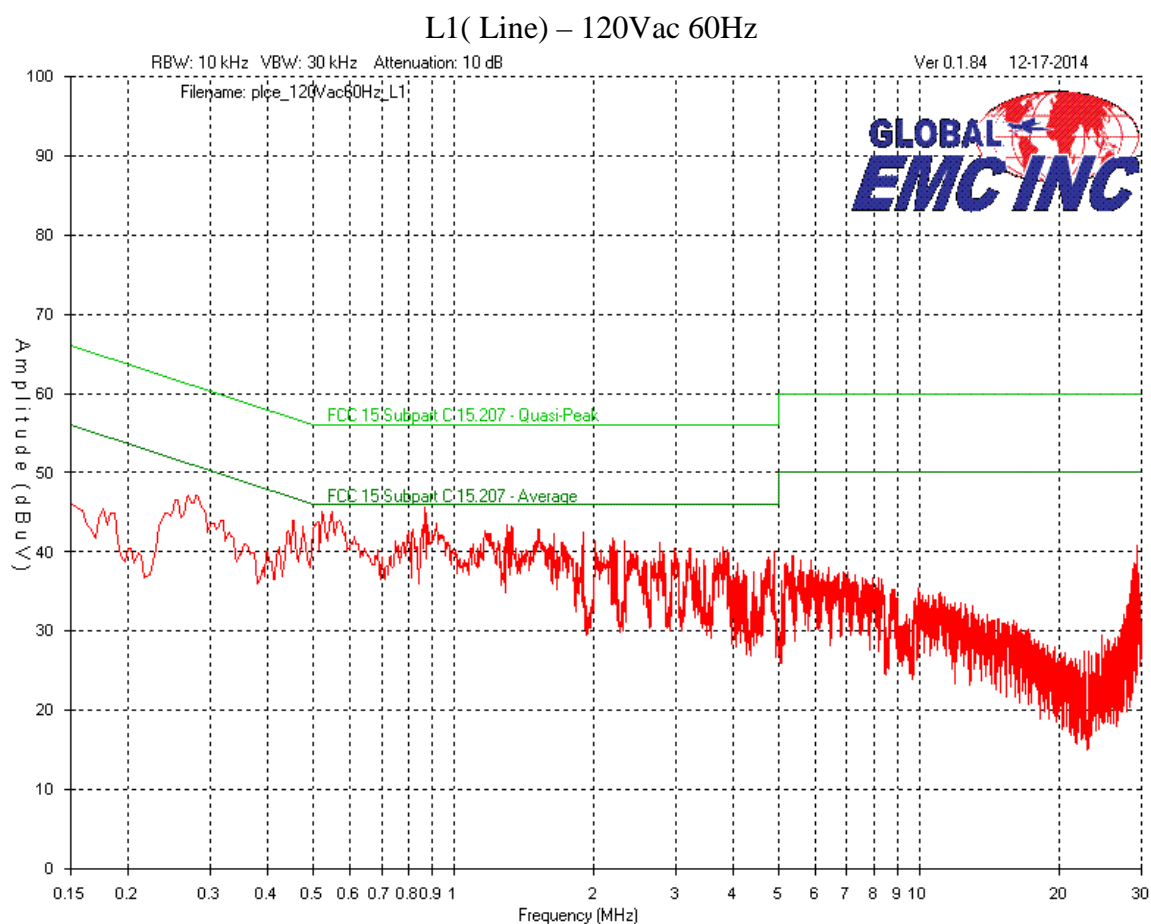
The expanded measurement uncertainty is calculated in accordance with CISPR 16-4-2 and is ± 3.6 dB with a 'k=2' coverage factor and a 95% confidence level.


Preliminary Graphs

Note the graphs shown below are for graphical illustration only. For final measurements with the appropriate detector where applicable, please refer to the table. The graph shown below is a peak measurement graph, measured with a resolution bandwidth greater than or equal to the final required detector. These graphs are performed as a worst case measurement to enable the detection of frequencies of concern and for considerable time savings.

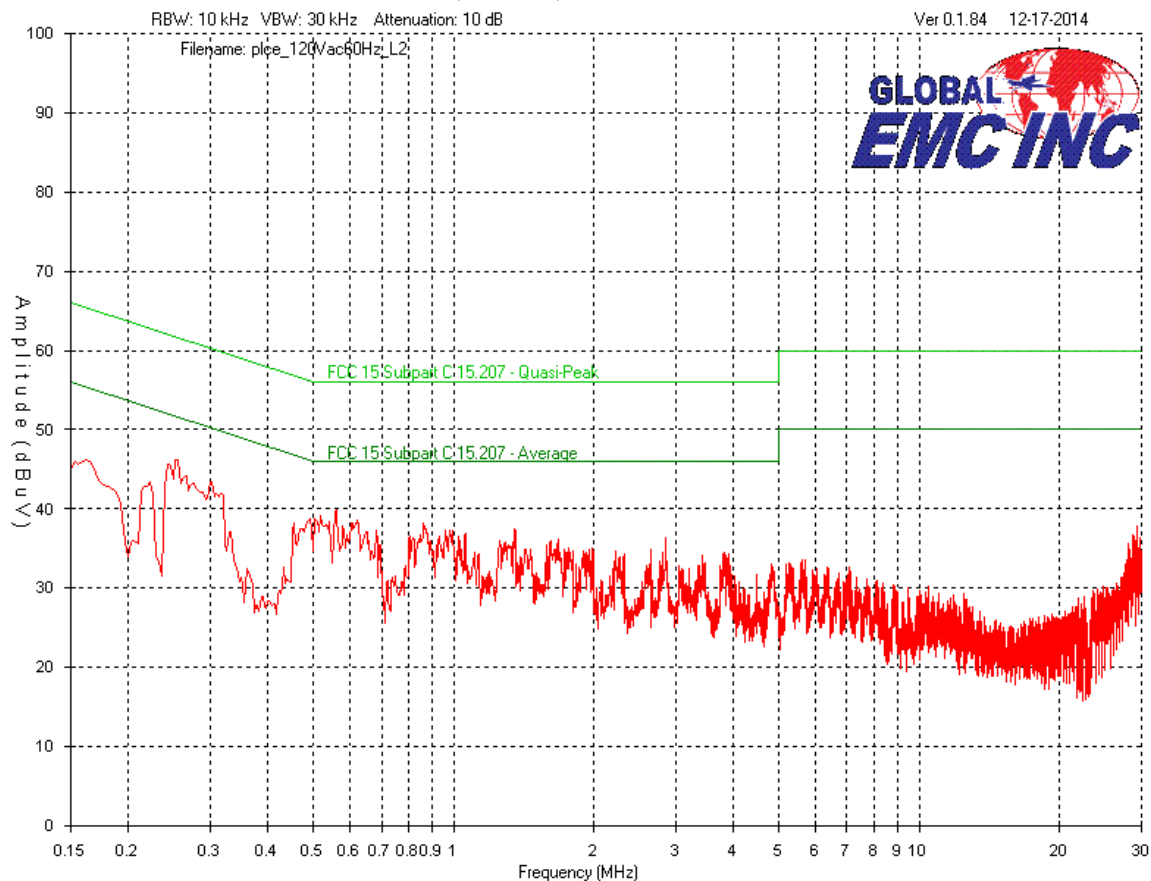
Power line conducted emissions were performed with the device in charging mode.


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Standard(s)	RSS 210 Issue 8:2010 / FCC Part 15 Subpart C 15:2014	



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L2 (Neutral) – 120Vac 60Hz




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Final Measurements

Product Category		Class B					
Product		WBT1012					
Supply		120 VAC 60 Hz					
L1(Line) Emission Table							
Frequency (MHz)	Detector	Raw (dBuV)	Factors	Level (dBuV)	Limit (dB)	Margin (dB)	Pass/Fail
0.8678	AVG	16.8	10.2	27.0	46	19	Pass
0.5488	AVG	17.8	10.2	28.0	46	18	Pass
0.8678	Peak	35.5	10.2	45.7	46	0.3	Pass
0.5488	Peak	34.9	10.2	45.1	46	0.9	Pass
1.2999	Peak	33.2	10.2	43.4	46	2.6	Pass
1.3331	Peak	33.1	10.2	43.3	46	2.7	Pass
L2 (Neutral) Emission Table							
0.253	Peak	36.1	10.2	46.3	51.7	5.4	Pass
0.5588	Peak	29.7	10.2	39.9	46	6.1	Pass
0.8612	Peak	28.2	10.2	38.4	46	7.6	Pass
1.353	Peak	27.3	10.2	37.5	46	8.5	Pass
0.9941	Peak	27.2	10.2	37.4	46	8.6	Pass
0.1633	Peak	35.9	10.2	46.1	55.3	9.2	Pass

Notes:


1. For L2, no peak emissions exceeded power line conducted emission average limits; therefore, the unit was deemed to meet power line conducted emission requirements base on peak emissions.
2. See 'Appendix B – EUT & Test Setup Photographs' for photos showing the test set-up for the highest line conducted emission

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Test Equipment List

Equipment	Model No.	Manufacturer	Last calibration date	Next calibration due date	Asset #
Spectrum Analyzer	ESL 6	Rohde & Schwarz	Nov 15, 2013	Nov 15,2015	GMEC 160
LISN	FCC-LISN-50/250-16-2-01	FCC	2013-02-06	2015-02-06	GEMC 65
RF Cable 7m	LMR-400-7M-50OHM-MN-MN	LexTec	NCR	NCR	GEMC 28

This report module is based on GEMC template "FCC – Power Line Conducted Emissions Class B_Rev1"

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Standard(s)	RSS 210 Issue 8:2010 / FCC Part 15 Subpart C 15:2014	


Appendix A – EUT Summary

Client	Sonavox Inc	
Product	WBT1012	
Standard(s)	RSS 210 Issue 8:2010 / FCC Part 15 Subpart C 15:2014	

For further details for filing purposes, refer to filing package.

General EUT Description

Client Details	
Organization / Address	Sonavox Canada Inc. 81 Zenway Blvd. #25 Woodbridge, Ontario L4H 0S5, Canada
Contact	Stephanie Tedesco-Rizzo
Phone	1-905-265-2060
Email	STedesco-Rizzo@sonavox.com
EUT (Equipment Under Test) Details	
EUT Name (for report title)	WBT1012
EUT Model / SN (if known)	WBT1012
EUT revision	New product, Rev 1
Equipment category	RF module
EUT is powered using	Click here... Battery or DC supply, 3.3V
Input voltage range(s) (V)	2V .. 3.6V
Frequency range(s) (Hz)	N/A
Rated input current (A)	N/A
Nominal power consumption (W)	0.1
Number of power supplies in EUT	0
Transmits RF energy? (describe)	8dBm +/-2dB
Basic EUT functionality description	Bluetooth Low Energy module for control applications
Modes of operation	ON, OFF
Step by step instructions for setup and operation	1. power up. 2. press button until desired mode of operation is set.
Customer to setup EUT on site?	Yes
EUT response time (ms)	500
EUT setup time (min)	5
Frequency of all clocks present in EUT	16MHz
Available connectors on EUT	power jack
Peripherals required to exercise	none

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Standard(s)	RSS 210 Issue 8:2010 / FCC Part 15 Subpart C 15:2014	

EUT Ex. Signal generator	
Dimensions of product	L 27mm W 20mm H 3mm
Method of monitoring EUT and description of failure for immunity.	unit stops responding to button press

Note the EUT is considered to have been received the date of the commencement of the first test, unless otherwise stated. For a close-up picture of the EUT, see ‘Appendix B – EUT & Test Setup Photographs’.


EUT Configuration

Please see Appendix B for a picture of the unit running in normal conditions.


- The EUT was configured with continuous transmission at 100% duty cycle which was the maximum possible duty cycle the EUT can operate even with low level software supplied by the BLE chip’s manufacturer.

Operational Setup

The EUT was connected to a development board.

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Standard(s)	RSS 210 Issue 8:2010 / FCC Part 15 Subpart C 15:2014	

Appendix B – EUT and Test Setup Photographs

Client	Sonavox Inc	
Product	WBT1012	
Standard(s)	RSS 210 Issue 8:2010 / FCC Part 15 Subpart C 15:2014	

Note: These photos are for information purposes only. Also refer to PDF files that are separate from this test report.



Illustration 1: Radiated emission setup – photo 1



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Standard(s)	RSS 210 Issue 8:2010 / FCC Part 15 Subpart C 15:2014	



Illustration 2: Radiated emission setup - photo 2

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Client	Sonavox Inc	
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Standard(s)	RSS 210 Issue 8:2010 / FCC Part 15 Subpart C 15:2014	

Illustration 3: Radiated setup - photo 3

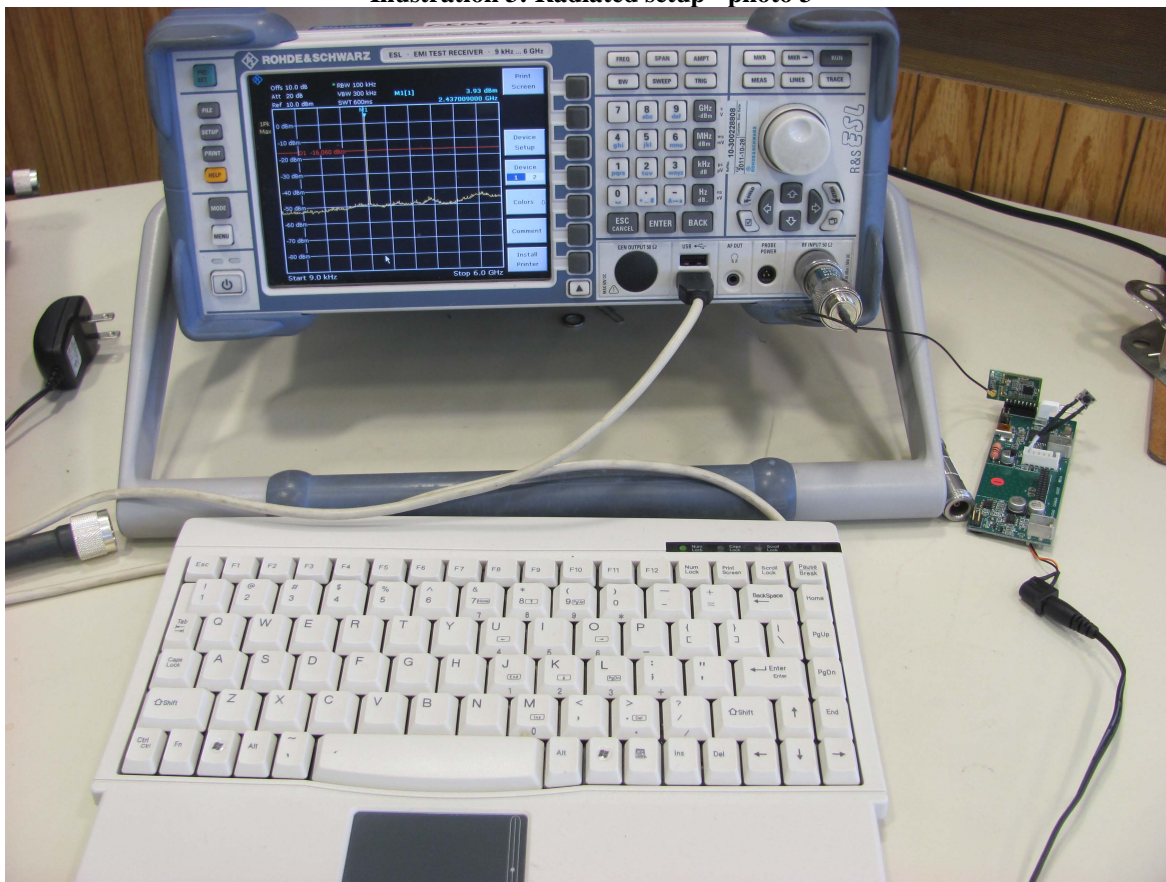



Illustration 4: Antenna conducted emission setup

Client	Sonavox Inc	
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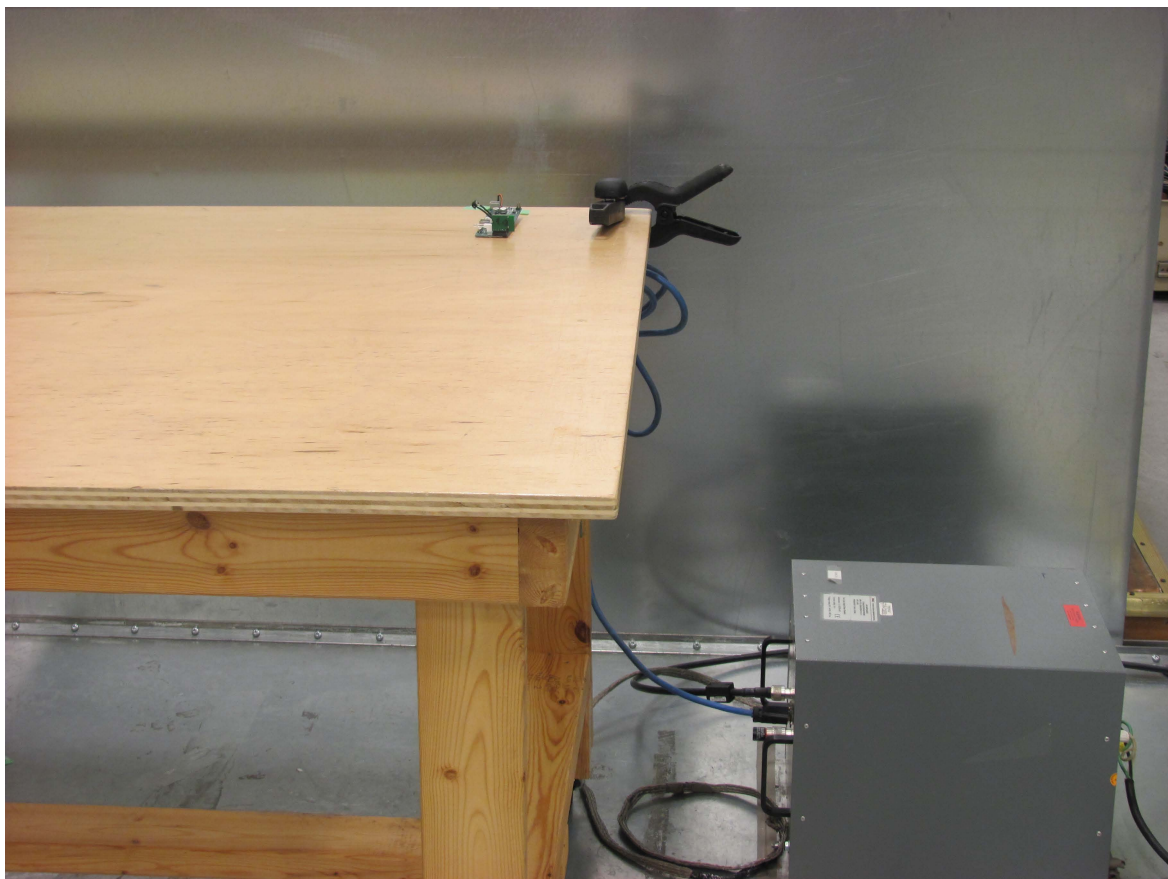



Illustration 5: Power line conducted emission setup – photo 1

Client	Sonavox Inc	
Product	WBT1012	
Standard(s)	RSS 210 Issue 8:2010 / FCC Part 15 Subpart C 15:2014	

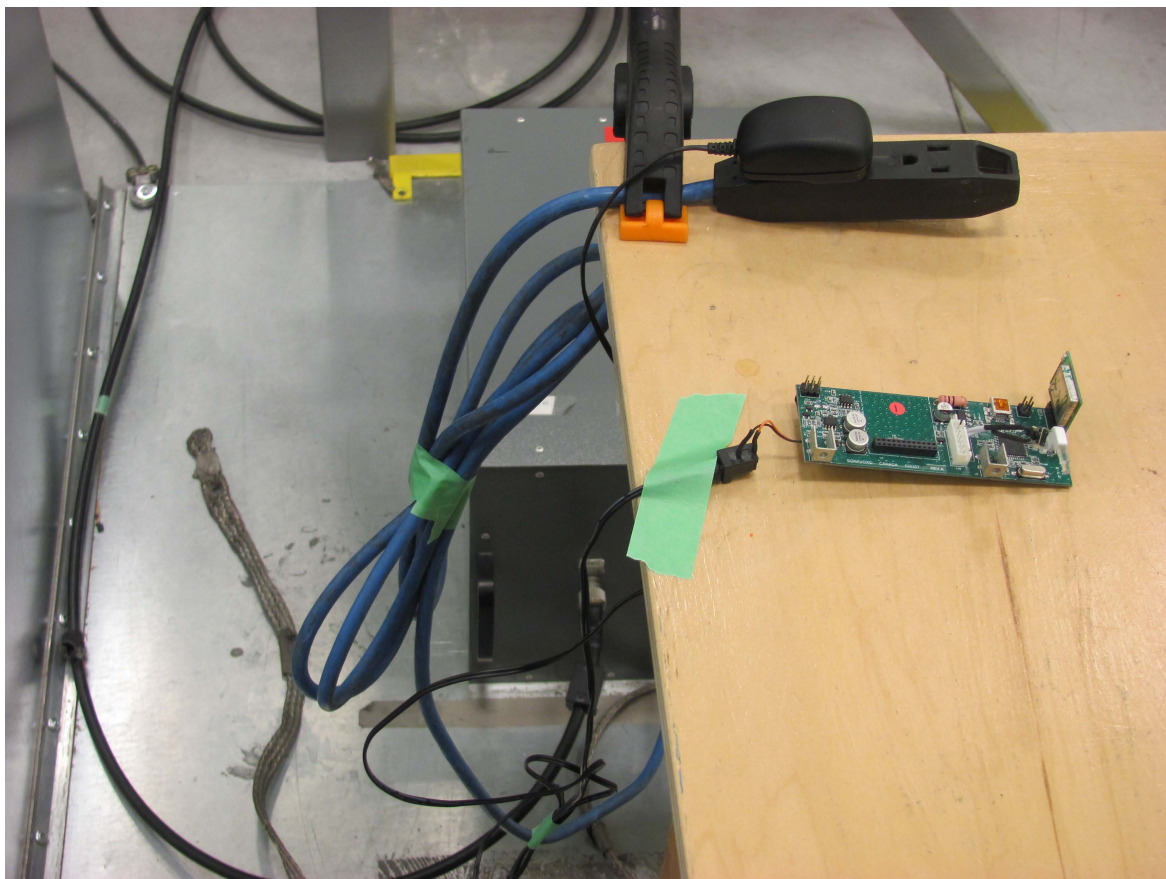


Illustration 6: Power line conducted emission setup – photo 2