

Global EMC Labs

EMC / EMI Test Report

As per

FCC Part 15.225, Subpart C: 2013

RSS 210:Issue 8: 2010

on the

IOX-NFC

**GLOBAL
EMC INC**



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

Testing produced for

GEOTAB
management by measurement

See appendix A for full customer & EUT details.



REGISTRATION #6844A-1



Client	Geotab Inc
Product	IOX-NFC
Standard(s)	FCC Part 15 Subpart C 2013 & RSS-210: Issue 8



Table of Contents

Table of Contents	2
Report Scope	3
Summary	4
Test Results Summary	5
Justifications or Deviations	6
Applicable Standards, Specifications and Methods	7
Document Revision Status	8
Definitions and Acronyms	9
Testing Facility	10
Calibrations and Accreditations	10
Testing Environmental Conditions and Dates	11
Detailed Test Result Section	12
Transmitter Radiated Emissions	13
Unintentional Radiated Emissions from Digital Circuitry	20
Emissions Mask	26
20 dB Bandwidth Measurement	37
Carrier Frequency Stability	40
Appendix A – EUT Summary	47
Appendix B – EUT & Test Setup Photos	51

Client	Geotab Inc
Product	IOX-NFC
Standard(s)	FCC Part 15 Subpart C 2013 & RSS-210: Issue 8



Report Scope

This report addresses the EMC verification testing and test results of the **Geotab IOX-NFC**, herein referred to as EUT (Equipment Under Test) performed at Global EMC Labs.

The EUT was tested for compliance against the following standards:

FCC Part 15 Subpart C: 2013
 RSS 210: Issue 8: 2010

Radiated emissions testing were evaluated on the EUT. 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.

Client	Geotab Inc	
Product	IOX-NFC	
Standard(s)	FCC Part 15 Subpart C 2013 & RSS-210: Issue 8	

Summary

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

FCC ID #	2AAFQ-NFC1
IC Registration #	11140A-NFC1
Equipment under test	IOX-NFC
EUT Passed all tests performed.	Yes
Tests conducted by	Min Xie

Note: For testing dates see 'Testing Environmental Conditions'.

Client	Geotab Inc	
Product	IOX-NFC	
Standard(s)	FCC Part 15 Subpart C 2013 & RSS-210: Issue 8	

Test Results Summary

Standard/Method	Description	Result
FCC 15.209 RSS-GEN Tables 5 & 6	Radiated emissions	PASS
FCC 15.203 RSS-Gen 7.1.2	Antenna Requirement	PASS – See Justifications
FCC 15.205 RSS-GEN Table 3	Restricted Bands	PASS – See Justifications
FCC 15.225 (a)(b)(c)(d) RSS-210 A2.6	Emissions Mask	PASS
FCC 15.225 (e) RSS-210 A2.6	Carrier Frequency Stability	PASS
Overall Result		PASS

If the product as tested complies with the specification or requirement, the EUT is deemed to comply and is issued a 'PASS' grade. If not 'FAIL' grade will be issued.

Client	Geotab Inc
Product	IOX-NFC
Standard(s)	FCC Part 15 Subpart C 2013 & RSS-210: Issue 8



Justifications or Deviations

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

For FCC 15.203 requirements, the EUT employs molded plastic as its enclosure and the PCB antenna is fully contained in the molding which the end users cannot replace.

For Restricted Frequency Bands requirements, this product does not intentionally transmit in any of the restricted bands. The EUT is designed to only operate between 13.110 MHz to 14.010 MHz band.

For FCC 15.207 requirements, the EUT is designed to use in a motor vehicle and does not connect to the public AC mains supply; therefore, this require is not applicable.

All radiated emission measurements were performed at a 3 meter distance, with the extrapolation factor applied as per applicable guidance, where applicable.

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

The EUT was powered from a DC power source for all applicable tests.

A later revision of the standard may have been substituted in place of the previous dated referenced revision. The year of the specification used are listed under applicable standards. Using the later revision accomplishes the goal of ensuring compliance to the intent of the previous specification, while allowing the laboratory to incorporate the extensions and clarifications made available by a later revision.

Client	Geotab Inc
Product	IOX-NFC
Standard(s)	FCC Part 15 Subpart C 2013 & RSS-210: Issue 8



Applicable Standards, Specifications and Methods

ANSI C63.4:2009 - Methods of Measurement of Radio-Noise Emissions from Low-Voltage Electrical and Electronic Equipment in the Range of 9 kHz to 40 GHz

ANSI C63.10:2009 - American national standard for testing unlicensed wireless devices

CFR 47 FCC 15 - Code of Federal Regulations – Radio Frequency Devices

RSS 210:2010 - Issue 8: Spectrum Management and Telecommunications Policy. Radio Standards Specification Low Power Licence-Exempt Radio communication Devices

RSS-GEN General Requirements and Information for the Certification of Radio Apparatus

CISPR 22:2008 - Information technology equipment – Radio disturbance characteristics – Limits and methods of measurement

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

Client	Geotab Inc	
Product	IOX-NFC	
Standard(s)	FCC Part 15 Subpart C 2013 & RSS-210: Issue 8	

Document Revision Status

Revision 1 - June 7, 2013
 - First Revision

Client	Geotab Inc
Product	IOX-NFC
Standard(s)	FCC Part 15 Subpart C 2013 & RSS-210: Issue 8



Definitions and Acronyms

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

AE – Auxillary Equipment.

Class A device – A digital device that is marketed for use in a commercial, industrial or business environment. A ‘Class A’ device should not be marketed for use by the general public. A ‘Class A’ device should contain the following or similar warning in its user manual: “**Warning:** This is a Class A product. In a domestic environment this product may cause radio interference, in which case the user may be required to take adequate measures.”

Class B device – A digital device that is marketed for use in a residential environment and may also be used in a commercial, business or industrial environments. A ‘Class B’ device may also be defined as a device to which a broadcast radio or television receivers would be expected to be common within a distance of 10 m of the device concerned.

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

Test Plan – See ‘Appendix A – Client Provided Details’.

Client	Geotab Inc
Product	IOX-NFC
Standard(s)	FCC Part 15 Subpart C 2013 & RSS-210: Issue 8



Testing Facility

Testing for EMC on the EUT was carried out at Global EMC labs in Toronto, Ontario, Canada. The testing lab consists of a 3m semi-anechoic chamber calibrated to be able to allow measurements on an EUT with a maximum width or length of up to 2m and height up to 3m. The chamber is equipped with a turn table that is capable of testing devices up to 3300lb in weight. This facility is capable of testing products that are rated for 120 Vac and 240Vac single phase, or 208 Vac 3 phase input. DC capability is also available. The chamber is equipped with an antenna mast that controls polarization and height 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 and using the Vertical Ground plane.

Calibrations and Accreditations

The 3m semi-anechoic chamber is registered with Federal Communications Commission (FCC, 377448), Industry Canada (IC, 6844A-3) and VCCI (R-2621 and C-2864). This semi-anechoic chamber complies with the requirements of EN55016-2-3:2006, section 7.5 and the site attenuation requirements of EN55016-1-4. This chamber was additionally 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 laboratories 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.

Client	Geotab Inc
Product	IOX-NFC
Standard(s)	FCC Part 15 Subpart C 2013 & RSS-210: Issue 8



Testing Environmental Conditions and Dates

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

Date	Test	Initials	Ambient Temperature (°C)	Relative Humidity (%)	Pressure (kPa)
May-8, 2013	Radiated Emissions	MX	20 – 23 °C	40 – 45 %	100 – 102 kPa
May-8, 2013	Emissions Mask	MX	20 – 23 °C	40 – 45 %	100 – 102 kPa
May-8, 2013	20 dB Bandwidth Measurement	MX	20 – 23 °C	40 – 45 %	100 – 102 kPa
May-8, 2013	Carrier Frequency Stability	MX	20 – 23 °C	40 – 45 %	100 – 102 kPa

Client	Geotab Inc
Product	IOX-NFC
Standard(s)	FCC Part 15 Subpart C 2013 & RSS-210: Issue 8



Detailed Test Result Section

Client	Geotab Inc
Product	IOX-NFC
Standard(s)	FCC Part 15 Subpart C 2013 & RSS-210: Issue 8



Transmitter Radiated Emissions

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 as defined in ANSI C63.4:2003.

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

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 (46.4 dBuV/m¹) at 3 m
 Above 960 MHz, 500 uV/m (54.0 dBuV/m¹) at 3 m
 Above 1000 MHz², 500 uV/m (54 dBuV/m) at 3m

¹Limit is with using a Quasi Peak detector at bandwidths defined in CISPR 16.

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

The highest operating clock of the EUT's digital circuitry is 100 MHz, and therefore, in accordance with FCC Part 15, Subpart A, Section 15.33, was scanned to 1 GHz.

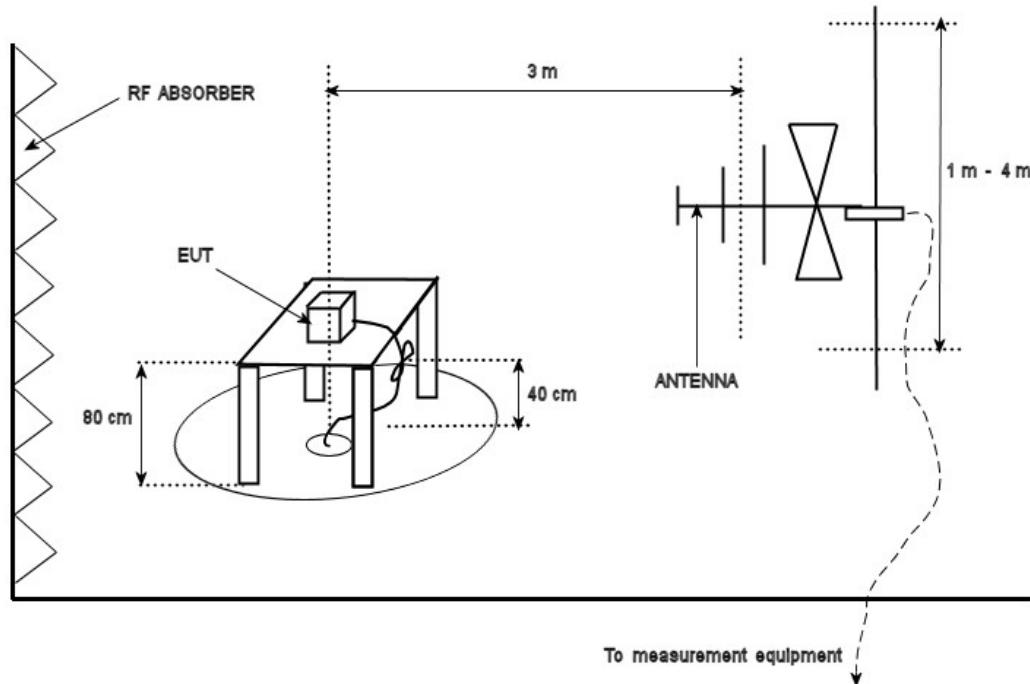
The EUT was tested in three orthogonal axes to maximize emissions. Worst case results are presented.

Devices scanned below 30 MHz are scanned at a 3 meter test distance, and in accordance with FCC Part 15, Subpart A, Section 15.31, an extrapolation factor of 40dB/decade was used. For example for 3 meter measurements, an extrapolation factor 40 dB from 40 Log (30m / 3m) is applied.

Client	Geotab Inc
Product	IOX-NFC
Standard(s)	FCC Part 15 Subpart C 2013 & RSS-210: Issue 8



Typical Radiated Emissions Setup



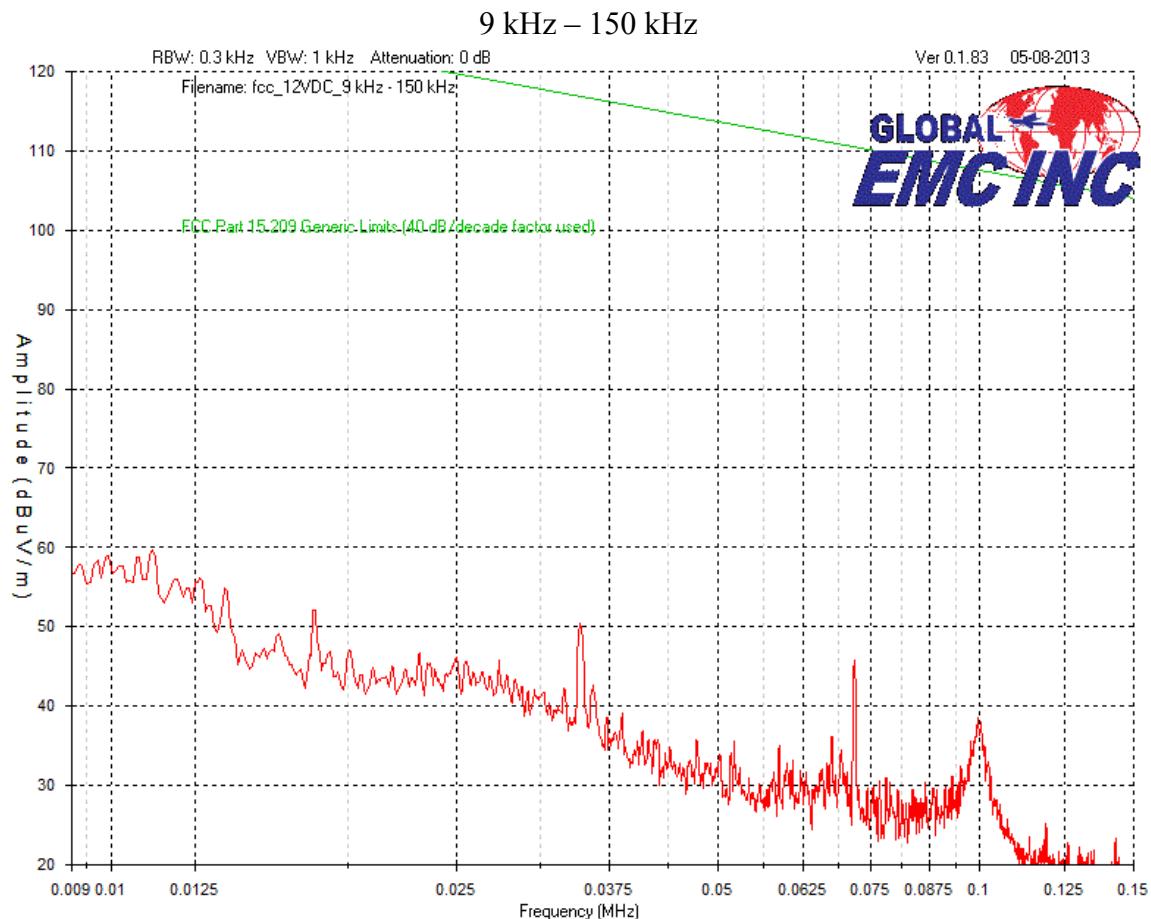
Measurement Uncertainty

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.

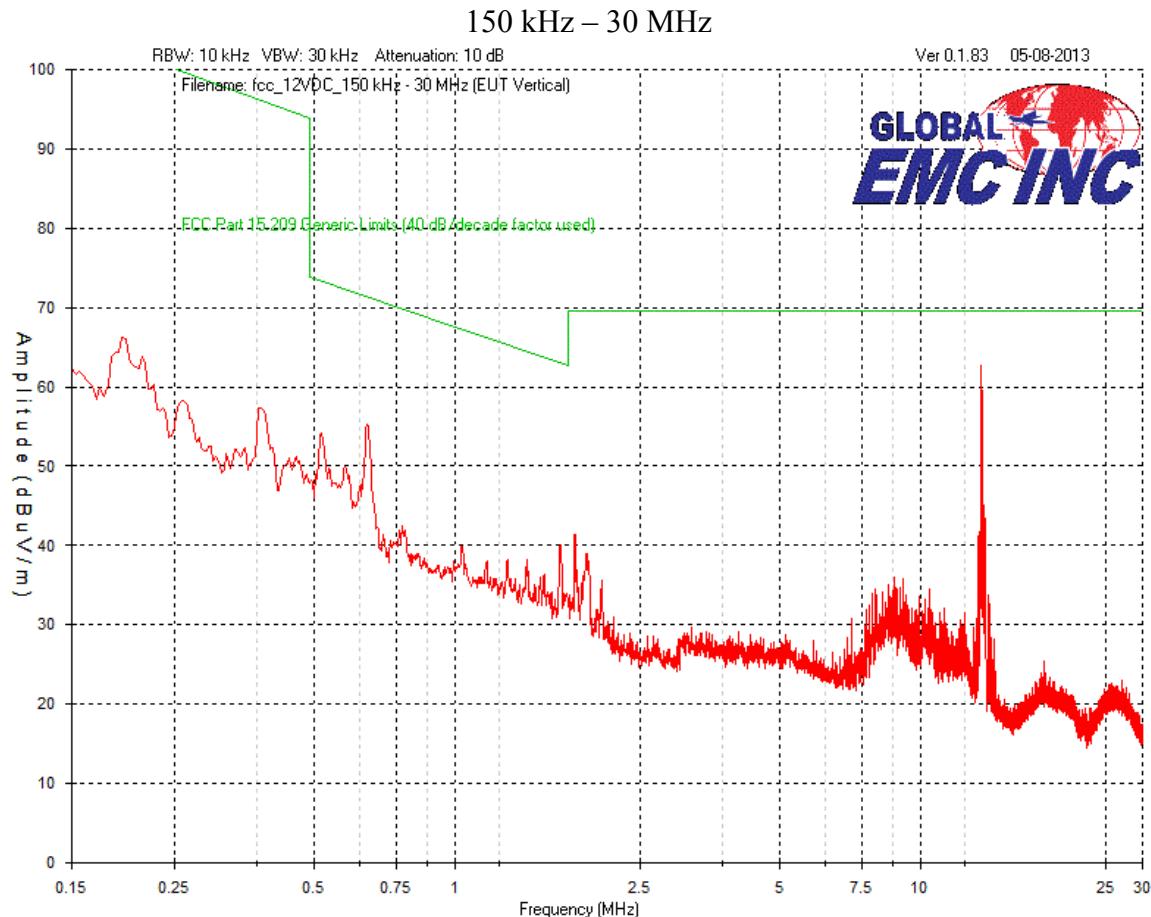
Preliminary Graphs

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.

Client	Geotab Inc
Product	IOX-NFC
Standard(s)	FCC Part 15 Subpart C 2013 & RSS-210: Issue 8



Client	Geotab Inc
Product	IOX-NFC
Standard(s)	FCC Part 15 Subpart C 2013 & RSS-210: Issue 8

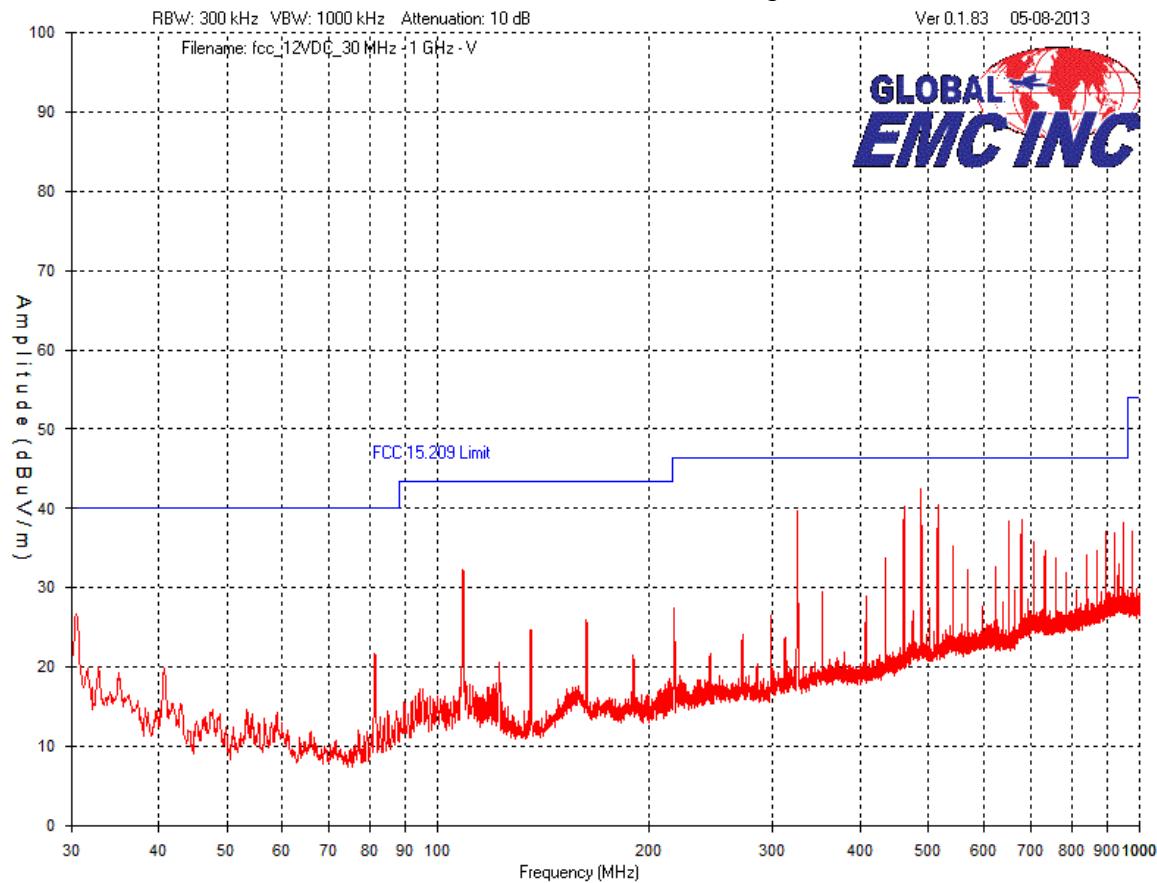


Note: The emission at 13.56 MHz is the fundamental frequency of the intentional radiator.

Client	Geotab Inc
Product	IOX-NFC
Standard(s)	FCC Part 15 Subpart C 2013 & RSS-210: Issue 8



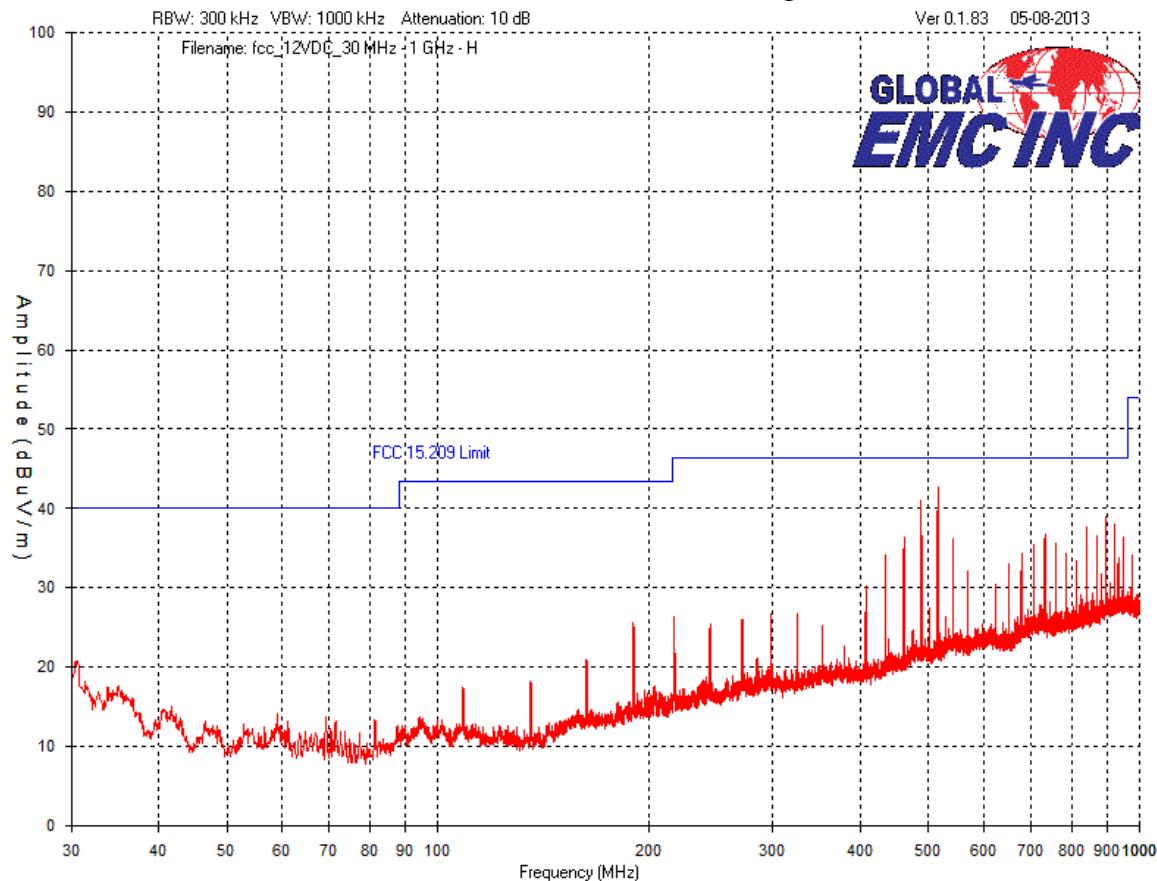
30 MHz – 1 GHz Vertical – Peak Emissions Graph



Client	Geotab Inc
Product	IOX-NFC
Standard(s)	FCC Part 15 Subpart C 2013 & RSS-210: Issue 8



30 MHz – 1 GHz Horizontal – Peak Emissions Graph



Client	Geotab Inc	
Product	IOX-NFC	
Standard(s)	FCC Part 15 Subpart C 2013 & RSS-210: Issue 8	

Final Measurements

Product Category			Class B					
Product Name			IOX-NFC					
Supply			12 VDC					
Quasi-Peak Emissions Table - Vertical								
Frequency (MHz)	Raw (dBuV)	Antenna Factor (dB/m)	Cable RE Factor (dB)	Pre-Amp (dB)	Level (dBuV/m)	Limit (dB)	Margin (dB)	Pass/Fail
488.174	47.7	17.8	1.7	-28.9	38.3	46.4	8.1	Pass
515.194	47.18	17.9	1.8	-28.9	37.98	46.4	8.42	Pass
Quasi Peak Emissions Table - Horizontal								
515.194	50.7	17.9	1.8	-28.9	41.5	46.4	4.9	Pass
488.174	49.24	17.8	1.7	-28.9	39.84	46.4	6.56	Pass

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

Test Equipment List

Equipment	Model No.	Manufacturer	Last calibration date	Next calibration due date	Asset #
Spectrum Analyzer	ESL 6	Rohde & Schwarz	Oct. 06, 2011	Oct. 06, 2013	GEMC 160
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
Preamp 9kHz - 1 GHz	LNA 6901	Teseq	Feb. 25, 2013	Feb. 25, 2015	GEMC 168
RF Cable 7m	LMR-400-7M-50OHM-MN-MN	LexTec	NCR	NCR	GEMC 28
RF Cable 10m	LMR-400-10M-50OHM-MN-MN	LexTec	NCR	NCR	GEMC 29

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

Client	Geotab Inc
Product	IOX-NFC
Standard(s)	FCC Part 15 Subpart C 2013 & RSS-210: Issue 8



Unintentional Radiated Emissions from Digital Circuitry

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 as defined in ANSI C63.4:2003.

The limits are as defined in FCC Part 15, Section 15.109.

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 (46.4 dBuV/m¹) at 3 m

Above 960 MHz, 500 uV/m (54.0 dBuV/m¹) at 3 m

Above 1000 MHz², 500 uV/m (54 dBuV/m) at 3m

¹Limit is with using a Quasi Peak detector at bandwidths defined in CISPR 16.

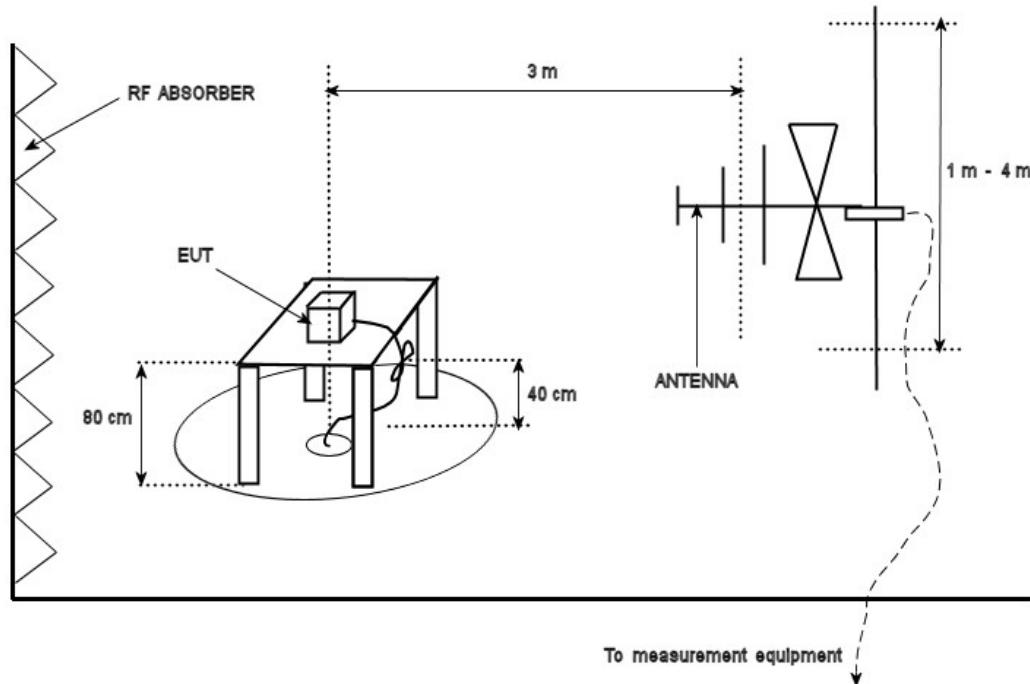
²Limit is with 1 MHz measurement bandwidth and using an Average detector

The highest operating clock of the EUT's digital circuitry is 100 MHz, and therefore, in accordance with FCC Part 15, Subpart A, Section 15.33, was scanned to 1 GHz.

Client	Geotab Inc
Product	IOX-NFC
Standard(s)	FCC Part 15 Subpart C 2013 & RSS-210: Issue 8



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.

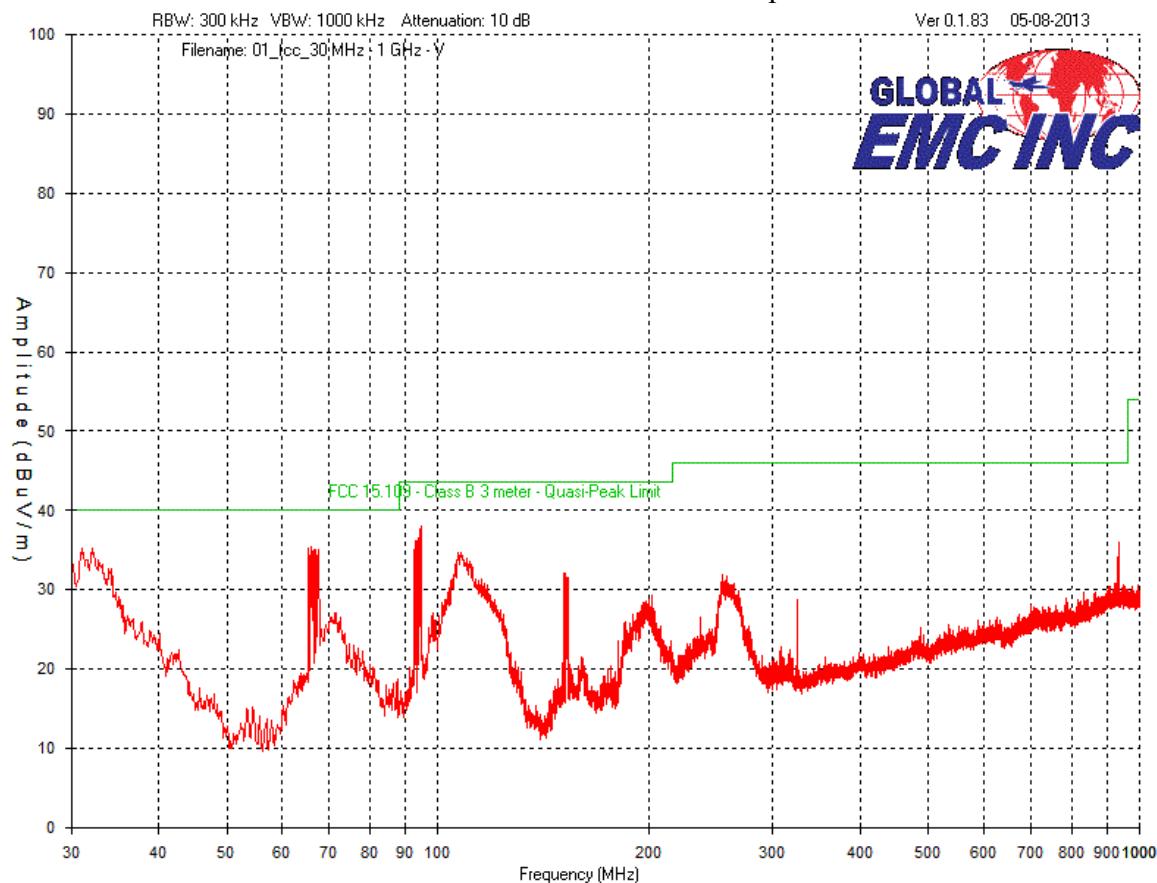
Preliminary Graphs

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.

Client	Geotab Inc
Product	IOX-NFC
Standard(s)	FCC Part 15 Subpart C 2013 & RSS-210: Issue 8



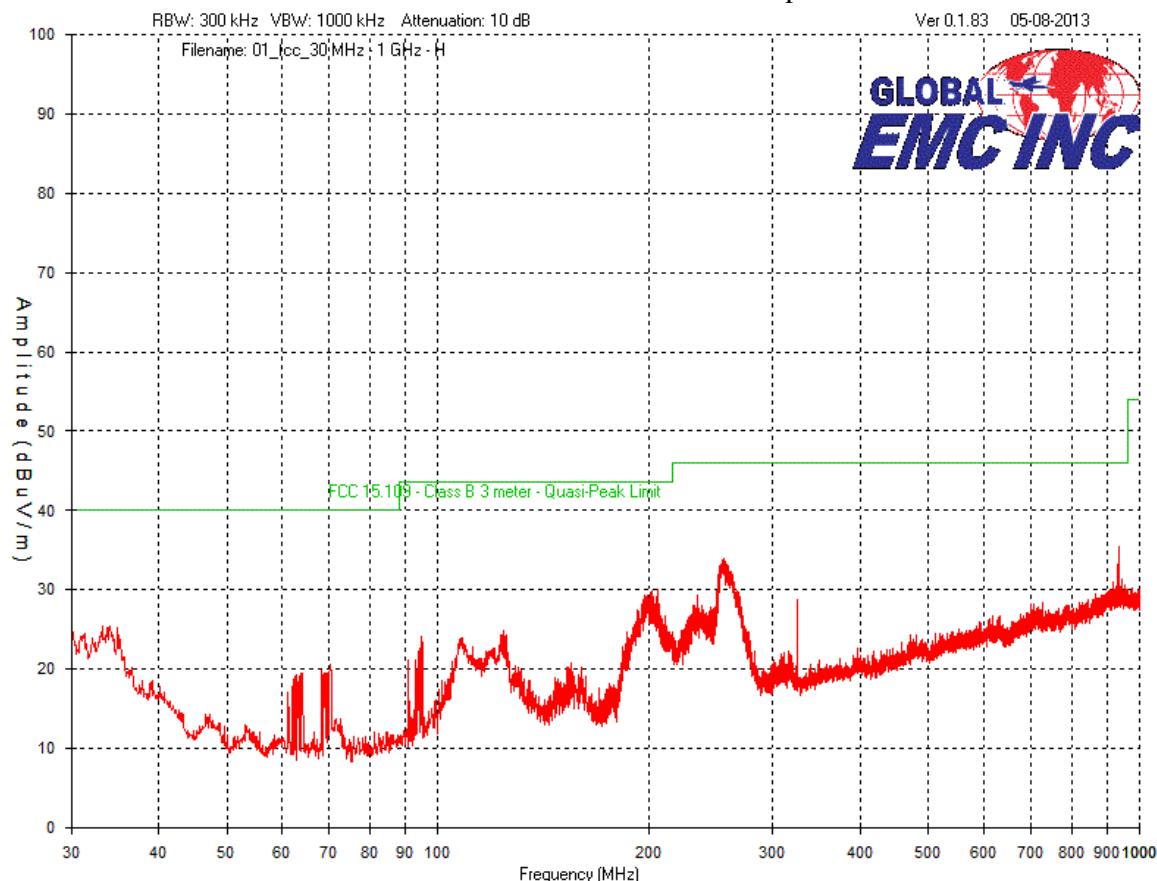
30 MHz – 1 GHz
Vertical – Peak Emissions Graph



Client	Geotab Inc
Product	IOX-NFC
Standard(s)	FCC Part 15 Subpart C 2013 & RSS-210: Issue 8



30 MHz – 1 GHz Horizontal – Peak Emissions Graph



Client	Geotab Inc
Product	IOX-NFC
Standard(s)	FCC Part 15 Subpart C 2013 & RSS-210: Issue 8



Final Measurements

Product Category	Class B							
Product Name	IOX-NFC							
Supply	12 VDC							

Peak Emission with respect to Quasi-Peak Limit Table - Vertical

Frequency (MHz)	Raw (dBuV)	Antenna Factor (dB/m)	Cable RE Factor (dB)	Pre-Amp (dB)	Level (dBuV/m)	Limit (dB)	Margin (dB)	Pass/Fail
65.8647	56.8	6.7	0.7	-28.7	35.5	40	4.5	Pass
31.0691	45.9	17.6	0.5	-28.7	35.3	40	4.7	Pass
65.3788	56.4	6.8	0.7	-28.7	35.2	40	4.8	Pass
66.8367	56.5	6.6	0.7	-28.7	35.1	40	4.9	Pass
66.5451	56.4	6.7	0.7	-28.7	35.1	40	4.9	Pass
67.517	56.4	6.6	0.7	-28.7	35	40	5	Pass

Peak Emission with respect to Quasi-Peak Limit Table - Horizontal

931.867	37.6	24	2.3	-28.5	35.4	46	10.6	Pass
255.005	48.9	12.6	1.2	-28.7	34	46	12	Pass
205.922	46.9	10.8	1.1	-28.7	30.1	43.5	13.4	Pass
30.0972	35.6	18.1	0.5	-28.7	25.5	40	14.5	Pass
234.011	44.8	12	1.2	-28.7	29.3	46	16.7	Pass
325.471	41.7	14.6	1.4	-28.8	28.9	46	17.1	Pass

Note:

1. During this test, the EUT was modified to have its transmitter turned off and it is exercised by having continuous data communication with a Geotab GO⁶.
2. No peak emissions were above radiated emission Quasi-Peak limits, and thus, the EUT was deemed to meet radiated emission requirements base on peak emission.
3. See 'Appendix B – EUT & Test Setup Photographs' for photos showing the test set-up for the highest radiated emission.

Client	Geotab Inc	
Product	IOX-NFC	
Standard(s)	FCC Part 15 Subpart C 2013 & RSS-210: Issue 8	

Test Equipment List

Equipment	Model No.	Manufacturer	Last calibration date	Next calibration due date	Asset #
Spectrum Analyzer	ESL 6	Rohde & Schwarz	Oct. 06, 2011	Oct. 06, 2013	GEMC 160
BiLog Antenna	3142-C	ETS	Feb. 4, 2013	Feb. 4, 2015	GEMC 137
Preamp 9kHz - 1 GHz	LNA 6901	Teseq	Feb. 25, 2013	Feb. 25, 2015	GEMC 168
RF Cable 7m	LMR-400-7M-50OHM-MN-MN	LexTec	NCR	NCR	GEMC 28
RF Cable 10m	LMR-400-10M-50OHM-MN-MN	LexTec	NCR	NCR	GEMC 29

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

Client	Geotab Inc
Product	IOX-NFC
Standard(s)	FCC Part 15 Subpart C 2013 & RSS-210: Issue 8



Emissions Mask

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 other devices which may be using the same spectrum allocations for similar or other purposes. This also ensures the transmit range of the device is within the pre-determined suitable range. This also ensures public safety by not exceeding a level which has been deemed safe for human exposure.

Limit(s) and Method

The limits are as defined in FCC Part 15, Section 15.225

Method is using a loop antenna and converting to voltage based on the impedance of free space.

Frequency range (MHz)	Limit (uV/m @ 30 m)	Limit (dBuV/m @ 3 m)
13.110-13.410	106	80.5
13.410-13.553	334	90.5
13.553-13.567	15,848	124.0
13.567-13.710	334	90.5
13.710-14.010	106	80.5

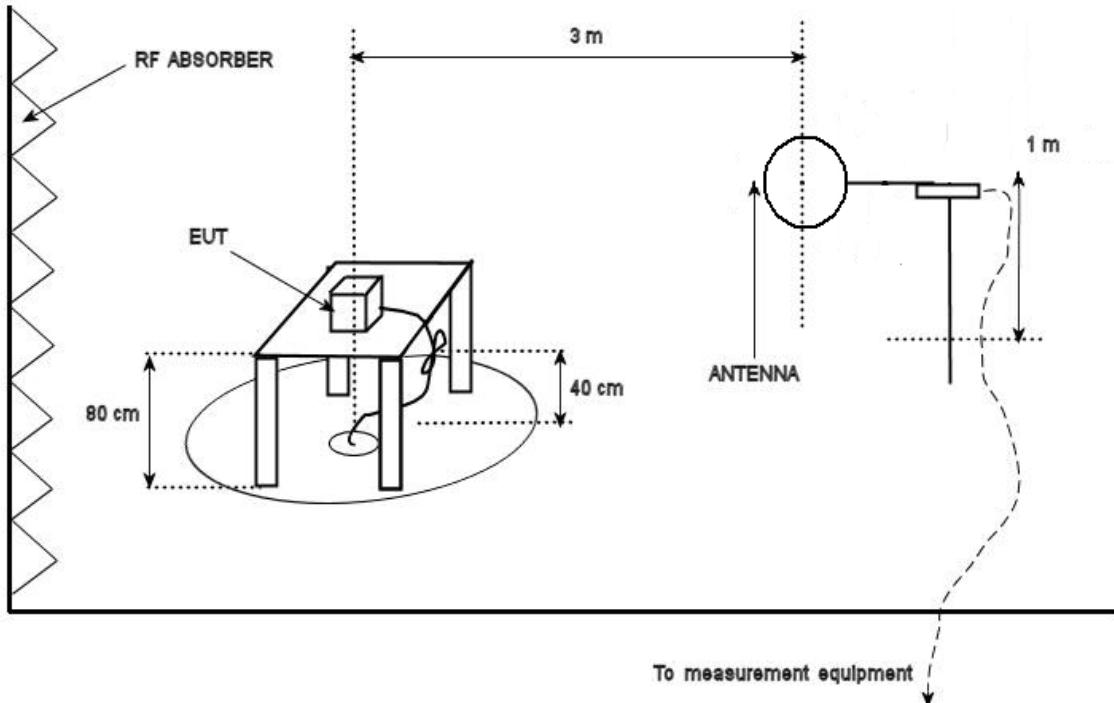
¹Limit is with a Quasi Peak detector using bandwidths defined in CISPR16.

Devices scanned below 30 MHz are scanned at a 3 meter test distance, and in accordance with FCC Part 15, Subpart A, Section 15.31, an extrapolation factor of 40 dB/decade was used. For example for 3 meter measurements, an extrapolation factor of $20 \log(uV/m) + 40 \log(30m / 3m)$ is applied.

Client	Geotab Inc
Product	IOX-NFC
Standard(s)	FCC Part 15 Subpart C 2013 & RSS-210: Issue 8



Typical Emissions Mask Test 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.

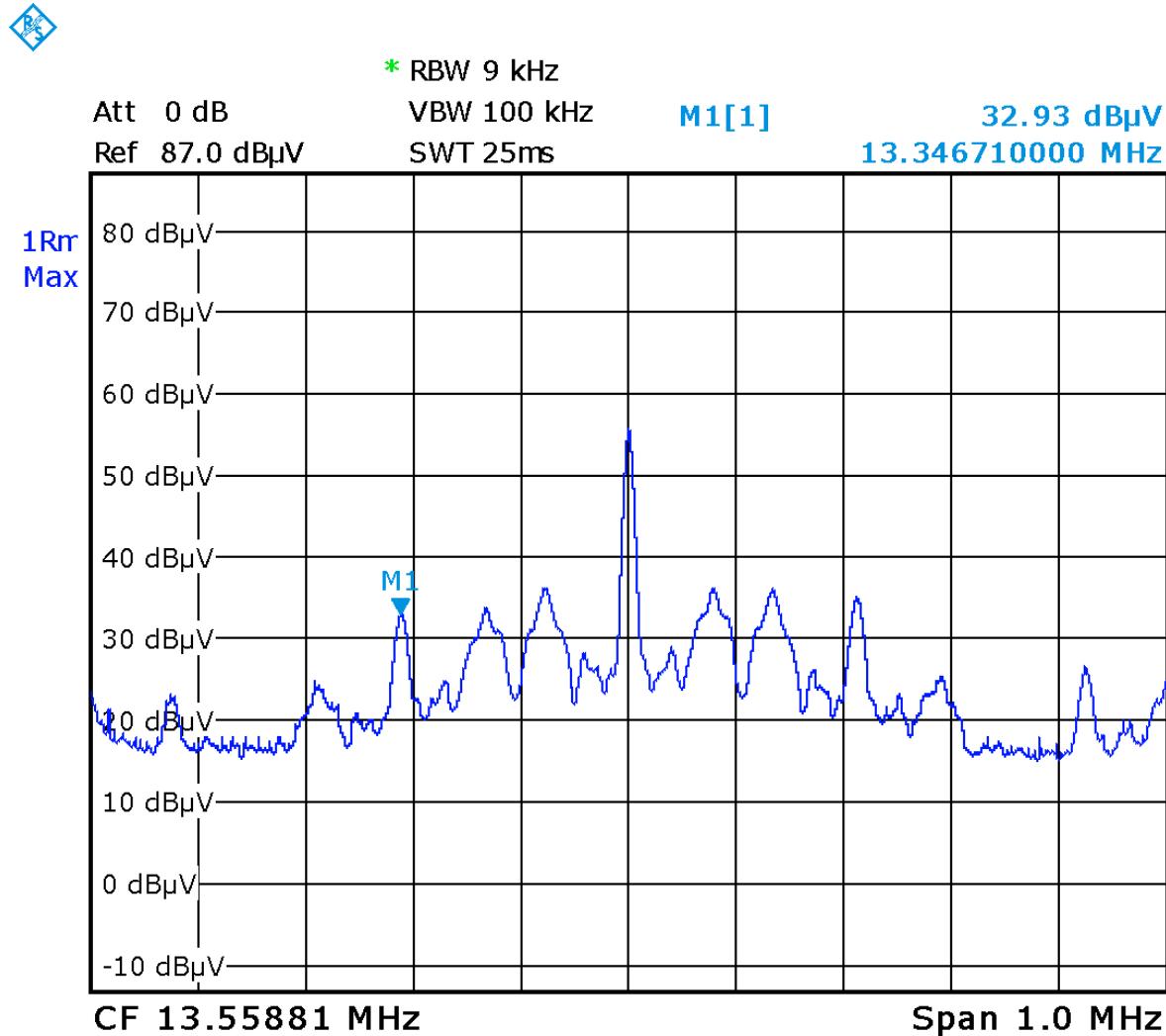
Preliminary Graphs

Note the graphs shown below are for graphical illustration. For final measurements, 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. Also the loop was orientated at 0 degrees and 90 degrees and a maximized reading is shown. 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.

Client	Geotab Inc
Product	IOX-NFC
Standard(s)	FCC Part 15 Subpart C 2013 & RSS-210: Issue 8



Peak emission within band: 13.110-13.410 MHz

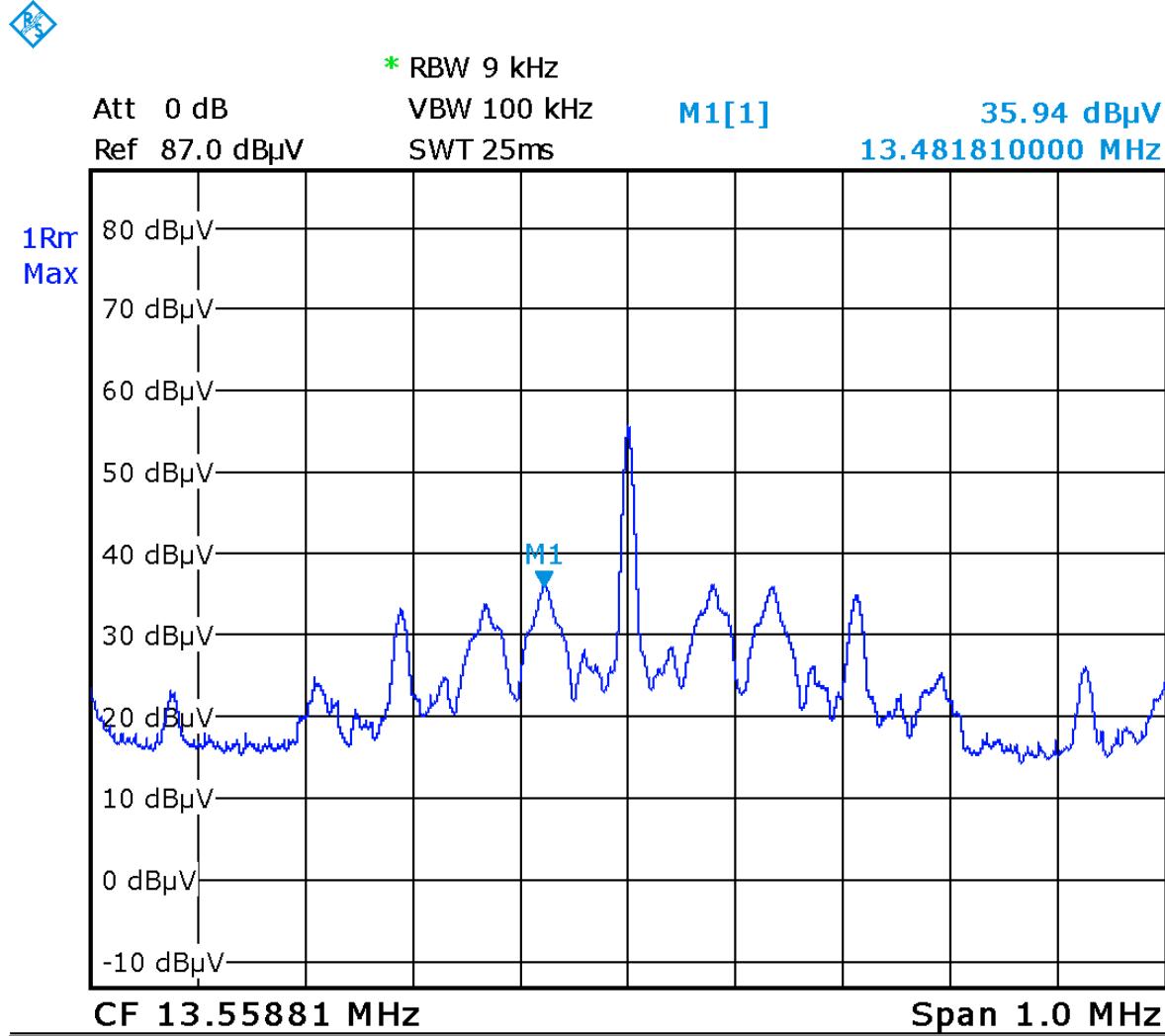


Date: 8.MAY.2013 14:18:22

Client	Geotab Inc
Product	IOX-NFC
Standard(s)	FCC Part 15 Subpart C 2013 & RSS-210: Issue 8



Peak emission within emission band: 13.410-13.553 MHz

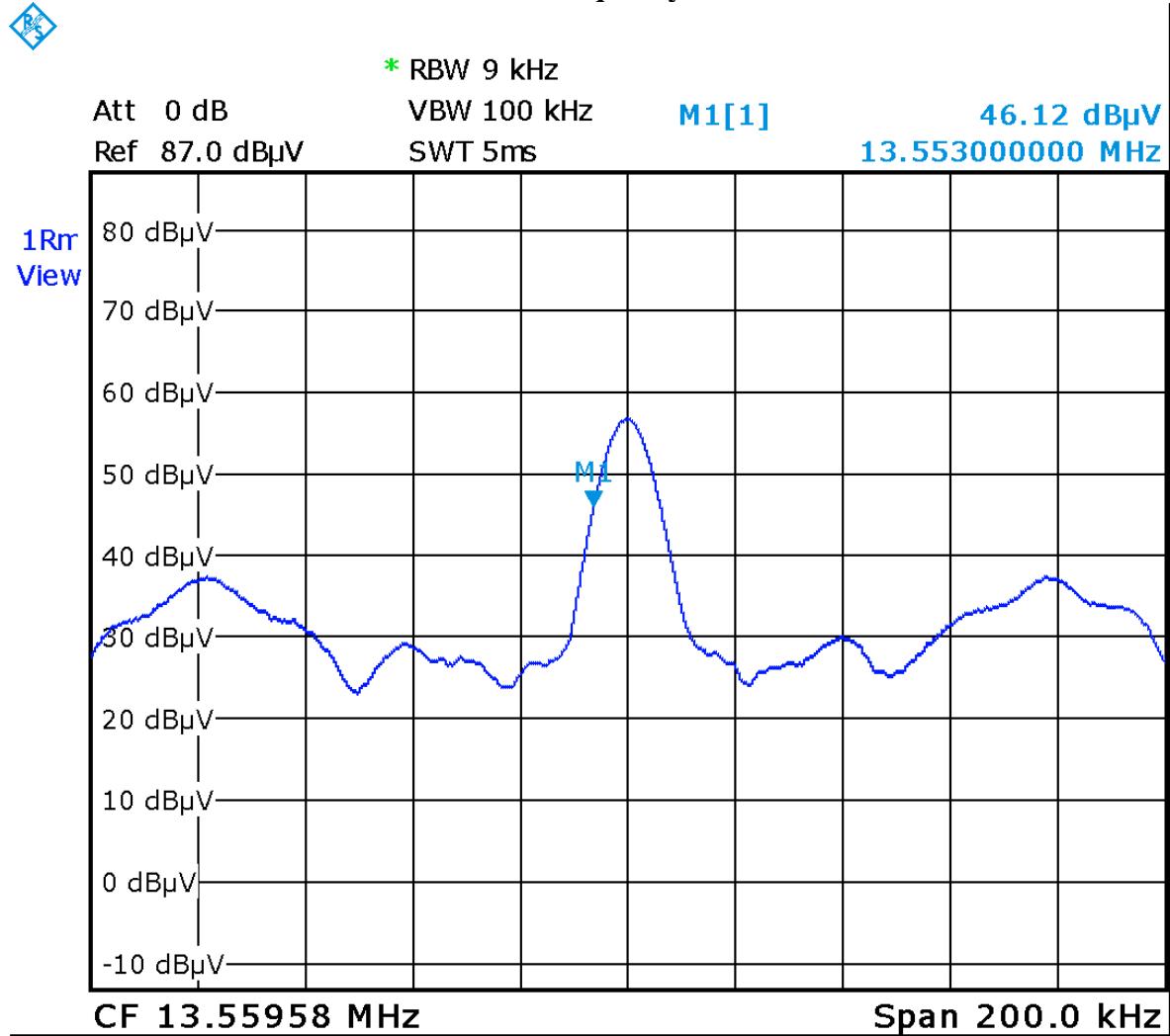


Date: 8.MAY.2013 14:12:48

Client	Geotab Inc
Product	IOX-NFC
Standard(s)	FCC Part 15 Subpart C 2013 & RSS-210: Issue 8



Peak emission at frequency 13.553 MHz

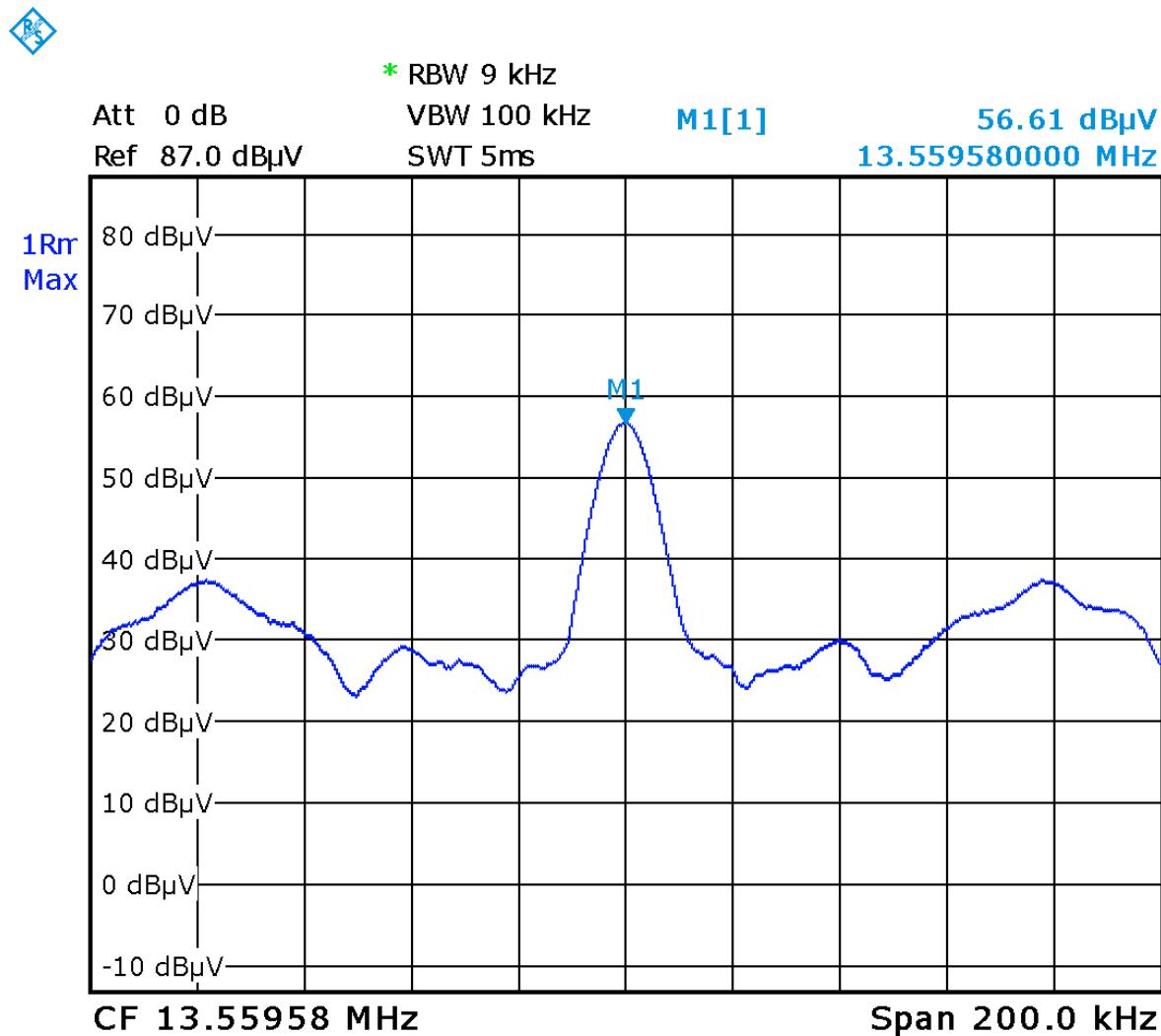


Date: 8.MAY.2013 13:53:24

Client	Geotab Inc
Product	IOX-NFC
Standard(s)	FCC Part 15 Subpart C 2013 & RSS-210: Issue 8



Peak emission at carrier frequency within emission band: 13.553-13.567MHz

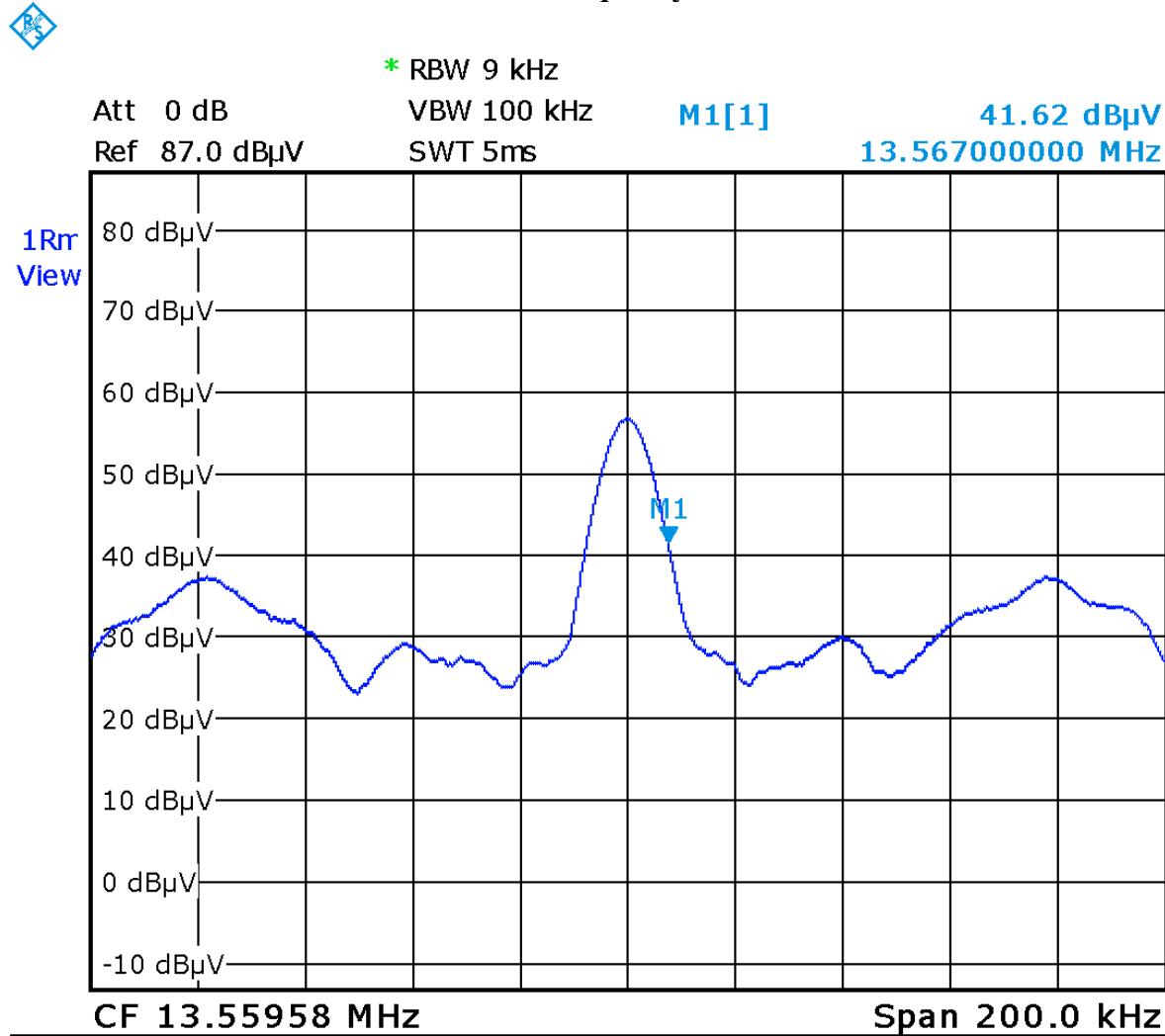


Date: 8.MAY.2013 12:09:40

Client	Geotab Inc
Product	IOX-NFC
Standard(s)	FCC Part 15 Subpart C 2013 & RSS-210: Issue 8



Peak emission at frequency 13.567MHz

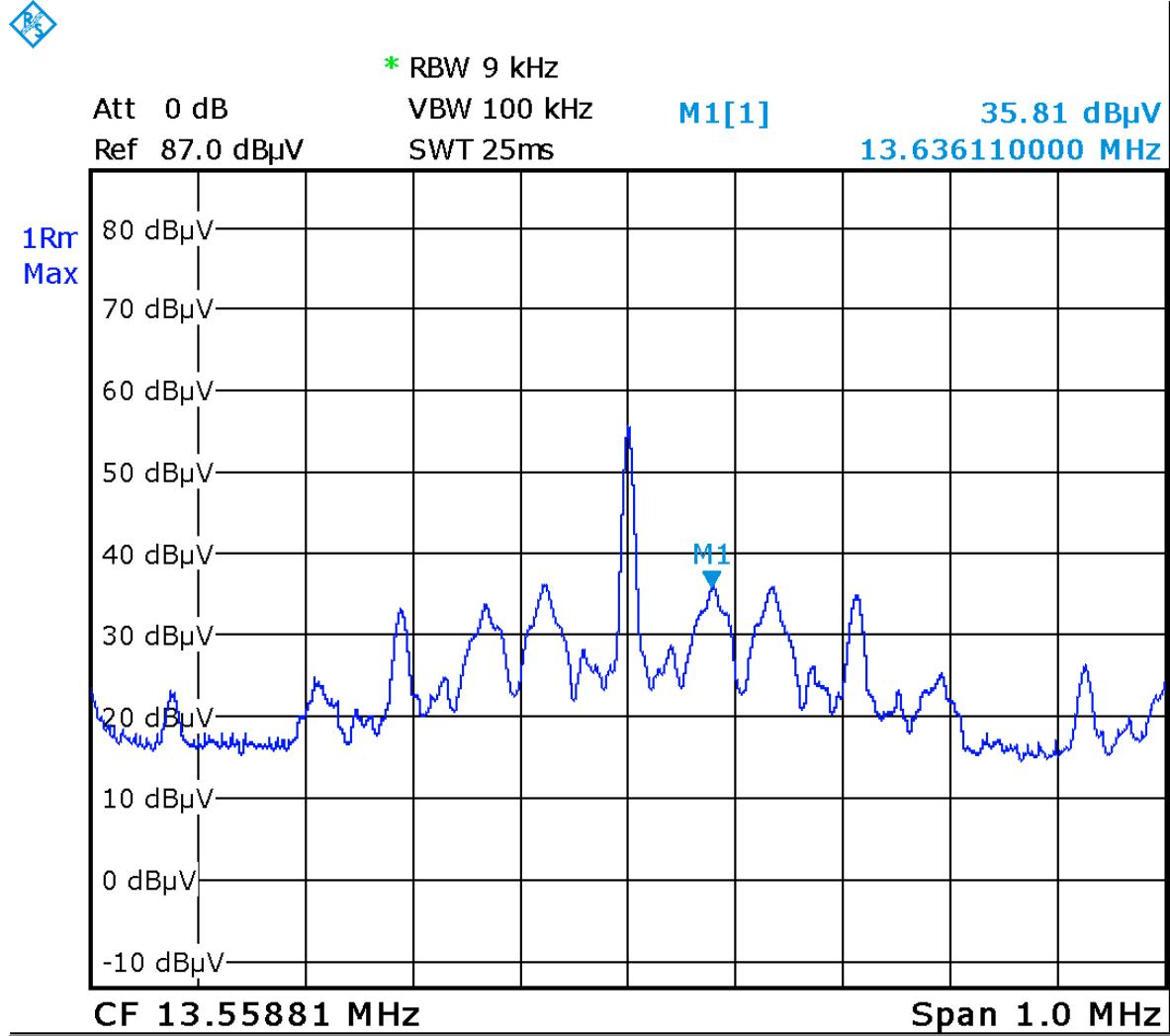


Date: 8.MAY.2013 13:54:44

Client	Geotab Inc
Product	IOX-NFC
Standard(s)	FCC Part 15 Subpart C 2013 & RSS-210: Issue 8



Peak emission within emission band: 13.567-13.710 MHz

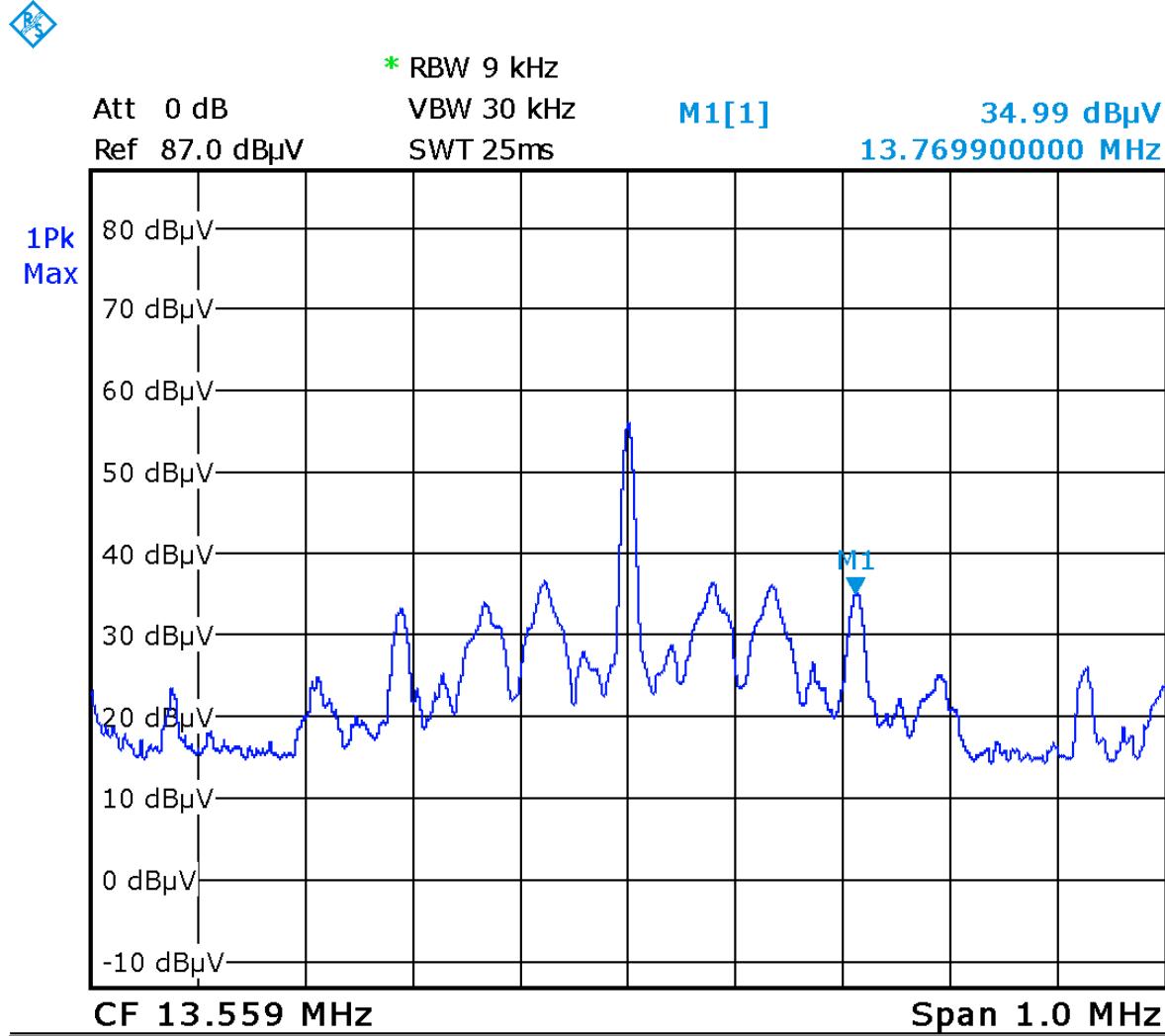


Date: 8.MAY.2013 14:15:15

Client	Geotab Inc
Product	IOX-NFC
Standard(s)	FCC Part 15 Subpart C 2013 & RSS-210: Issue 8



Peak emission within emission band: 13.710-14.010 MHz



Date: 8.MAY.2013 14:21:32

Client	Geotab Inc	
Product	IOX-NFC	
Standard(s)	FCC Part 15 Subpart C 2013 & RSS-210: Issue 8	

Final Measurements

Test Frequency (MHz)	Received signal (dB μ V)	Antenna factor (dB)	Cable loss (dB)	Current to voltage factor	Pre-Amp (dB)	Emission Level dB(μ V/m)	Emission limit dB(μ V/m)	Margin (dB)	Result
13.5596	56.6	0.3	51.5	-17.2	-28.7	62.5	124.0	61.5	Pass
13.553	46.1	0.3	51.5	-17.2	-28.7	52.0	90.5	38.5	Pass
13.567	41.6	0.3	51.5	-17.2	-28.7	47.5	90.5	43.0	Pass
13.4818	35.9	0.3	51.5	-17.2	-28.7	41.8	80.5	38.7	Pass
13.6361	35.8	0.3	51.5	-17.2	-28.7	41.7	80.5	38.8	Pass
13.3467	32.9	0.3	51.5	-17.2	-28.7	38.8	54.0	15.2	Pass
13.7699	35.0	0.3	51.5	-17.2	-28.7	40.9	54.0	13.1	Pass

Note:

- 1) See 'Appendix B – EUT & Test Setup Photographs' for photos showing the test set-up for the highest RFID radiated emission mask.
- 2) No peak emissions were detected that exceeded the 15.225 limits, therefore no Quasi-peak measurements were deemed necessary.

Client	Geotab Inc	
Product	IOX-NFC	
Standard(s)	FCC Part 15 Subpart C 2013 & RSS-210: Issue 8	

Test Equipment List

Equipment	Model No.	Manufacturer	Last calibration date	Next calibration due date	Asset #
Spectrum Analyzer	ESL 6	Rohde & Schwarz	Oct. 06, 2011	Oct. 06, 2013	GEMC 160
Loop Antenna	EM 6872	Electro-Metrics	Feb 5, 2013	Feb 5, 2015	GEMC 71
Preamp 9kHz - 1 GHz	LNA 6901	Teseq	Feb. 25, 2013	Feb. 25, 2015	GEMC 168
RF Cable 7m	LMR-400-7M-50OHM-MN-MN	LexTec	NCR	NCR	GEMC 28
RF Cable 10m	LMR-400-10M-50OHM-MN-MN	LexTec	NCR	NCR	GEMC 29

This report module is based on GEMC template "FCC - 15.225 - RFID Emissions Mask_Rev1.doc"

Client	Geotab Inc
Product	IOX-NFC
Standard(s)	FCC Part 15 Subpart C 2013 & RSS-210: Issue 8



20 dB Bandwidth Measurement

15.215 c) intentional radiators operating under the alternative provisions to the general emission limits, as contained in §§ 15.217 through 15.257 and in Subpart E of this part, must be designed to ensure that the 20 dB bandwidth of the emission, or whatever bandwidth may otherwise be specified in the specific rule section under which the equipment operates, is contained within the frequency band designated in the rule section under which the equipment is operated. The requirement to contain the designated bandwidth of the emission within the specified frequency band includes the effects from frequency sweeping, frequency hopping and other modulation techniques that may be employed as well as the frequency stability of the transmitter over expected variations in temperature and supply voltage. If a frequency stability is not specified in the regulations, it is recommended that the fundamental emission be kept within at least the central 80% of the permitted band in order to minimize the possibility of out-of-band operation.

Test Results

The EUT passed. The 20 dB BW was wholly contained within the 15.225 emission band of 13.110-14.010 MHz.

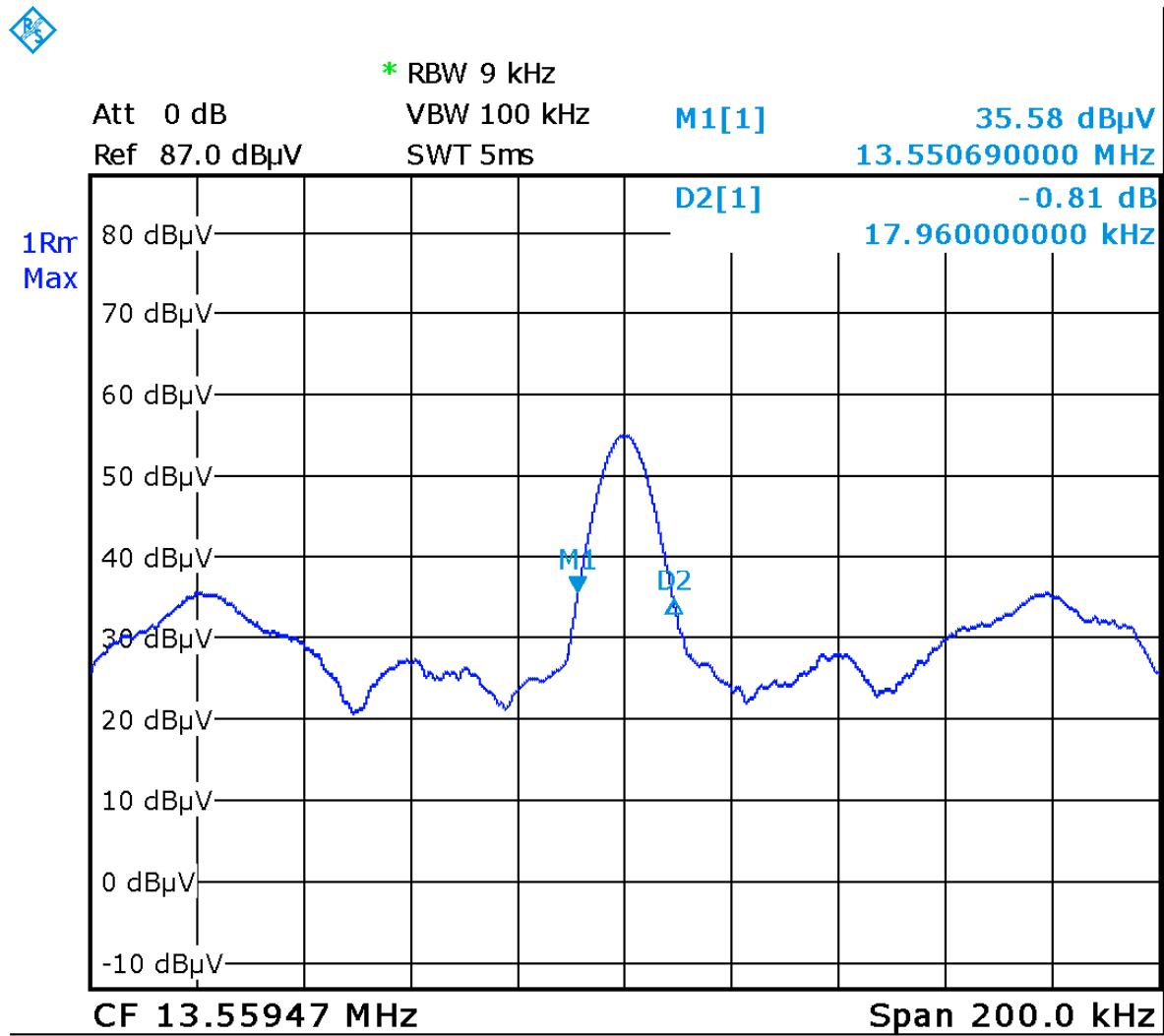
Channel Frequency (MHz)	20dB Measured Bandwidth (kHz)
13.56	17.96

Client	Geotab Inc
Product	IOX-NFC
Standard(s)	FCC Part 15 Subpart C 2013 & RSS-210: Issue 8



20 dB Bandwidth measurement graph

The graph below shows the 20 dB bandwidth 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 20 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.



Date: 8.MAY.2013 17:48:07

Client	Geotab Inc	
Product	IOX-NFC	
Standard(s)	FCC Part 15 Subpart C 2013 & RSS-210: Issue 8	

Test Equipment List

Equipment	Model No.	Manufacturer	Last calibration date	Next calibration due date	Asset #
Spectrum Analyzer	ESL 6	Rohde & Schwarz	Oct. 06, 2011	Oct. 06, 2013	GEMC 160
Loop Antenna	EM 6872	Electro-Metrics	Feb 5, 2013	Feb 5, 2015	GEMC 71
Preamp 9kHz - 1 GHz	LNA 6901	Teseq	Feb. 25, 2013	Feb. 25, 2015	GEMC 168
RF Cable 7m	LMR-400-7M-50OHM-MN-MN	LexTec	NCR	NCR	GEMC 28
RF Cable 10m	LMR-400-10M-50OHM-MN-MN	LexTec	NCR	NCR	GEMC 29

This report module is based on GEMC template "FCC - 15.225 - RFID Emissions Mask_Rev1.doc"

Client	Geotab Inc
Product	IOX-NFC
Standard(s)	FCC Part 15 Subpart C 2013 & RSS-210: Issue 8



Carrier Frequency Stability

Purpose

The purpose of this test is to ensure that the RF energy intentionally emitted from the EUT does not exceed the permitted bandwidth or level during extreme temperature variations. This helps protect radio broadcasts and receivers with spectrum nearby to the equipment under test from unwanted interference. This also helps ensure proper reception of the intended signal by ensuring the transmit frequency is correct over the expected temperature range.

Limit(s) and Method

The limits are as defined in FCC Part 15, Section 15.225(e)

The frequency tolerance of the carrier signal shall be maintained within $\pm 0.01\%$ of the operating frequency over a temperature variation of -20 degrees to $+50$ degrees C at normal supply voltage, and for a variation in the primary supply voltage from 85% to 115% of the rated supply voltage at a temperature of 20 degrees C. For battery operated equipment, the equipment tests shall be performed using a new battery.

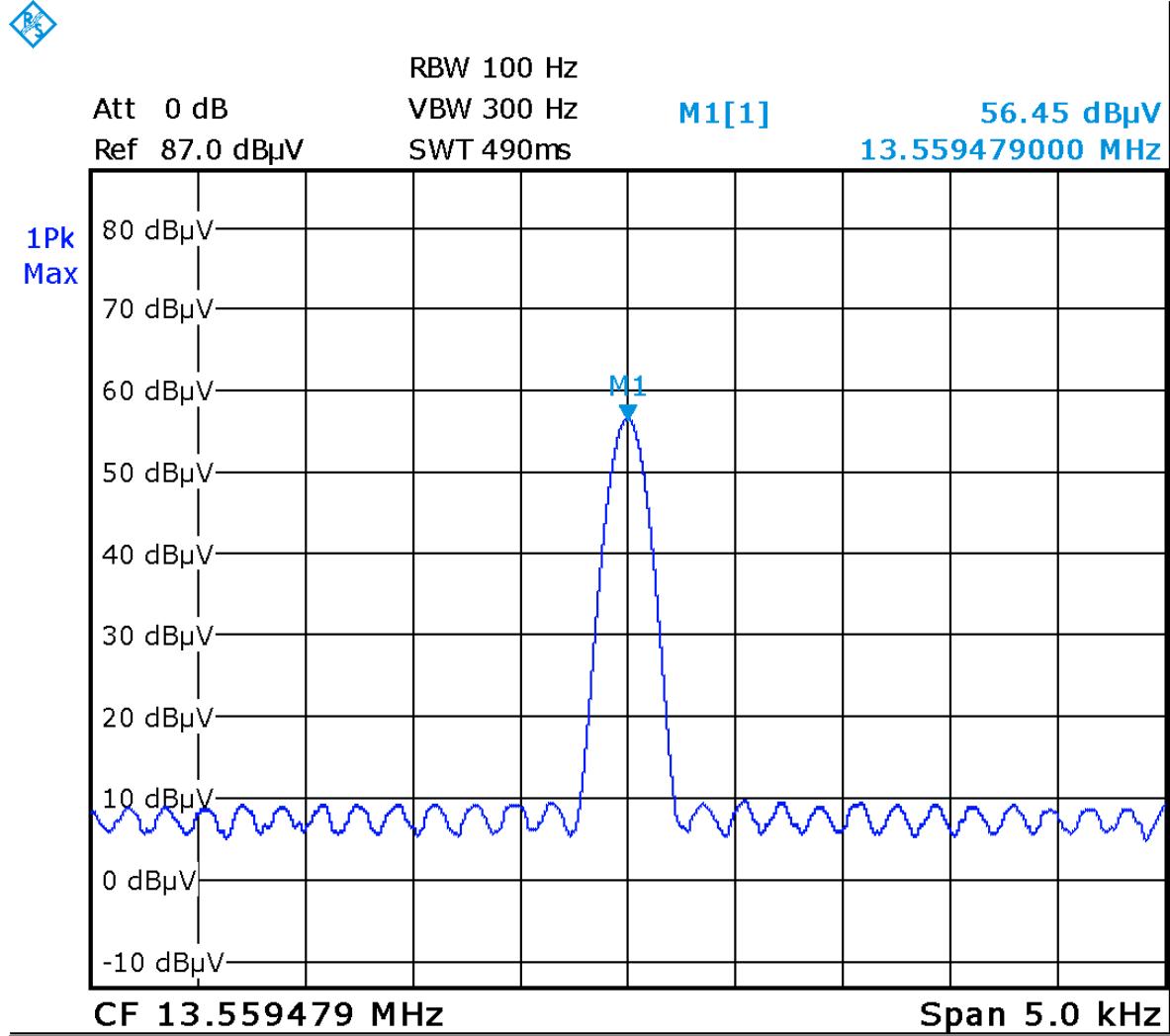
Results / Measurement Graphs

No deviation in amplitude or frequency would cause any EUT to be non compliant with the specification. The worst case results are presented in the graphs below with the frequency shown. The device was checked at each 10 degree increment of temperature, however the worst case results at the extreme temperatures are presented in this test report.

Client	Geotab Inc
Product	IOX-NFC
Standard(s)	FCC Part 15 Subpart C 2013 & RSS-210: Issue 8



Measurement at Ambient temperature and nominal voltage (20°C & 12 VDC)

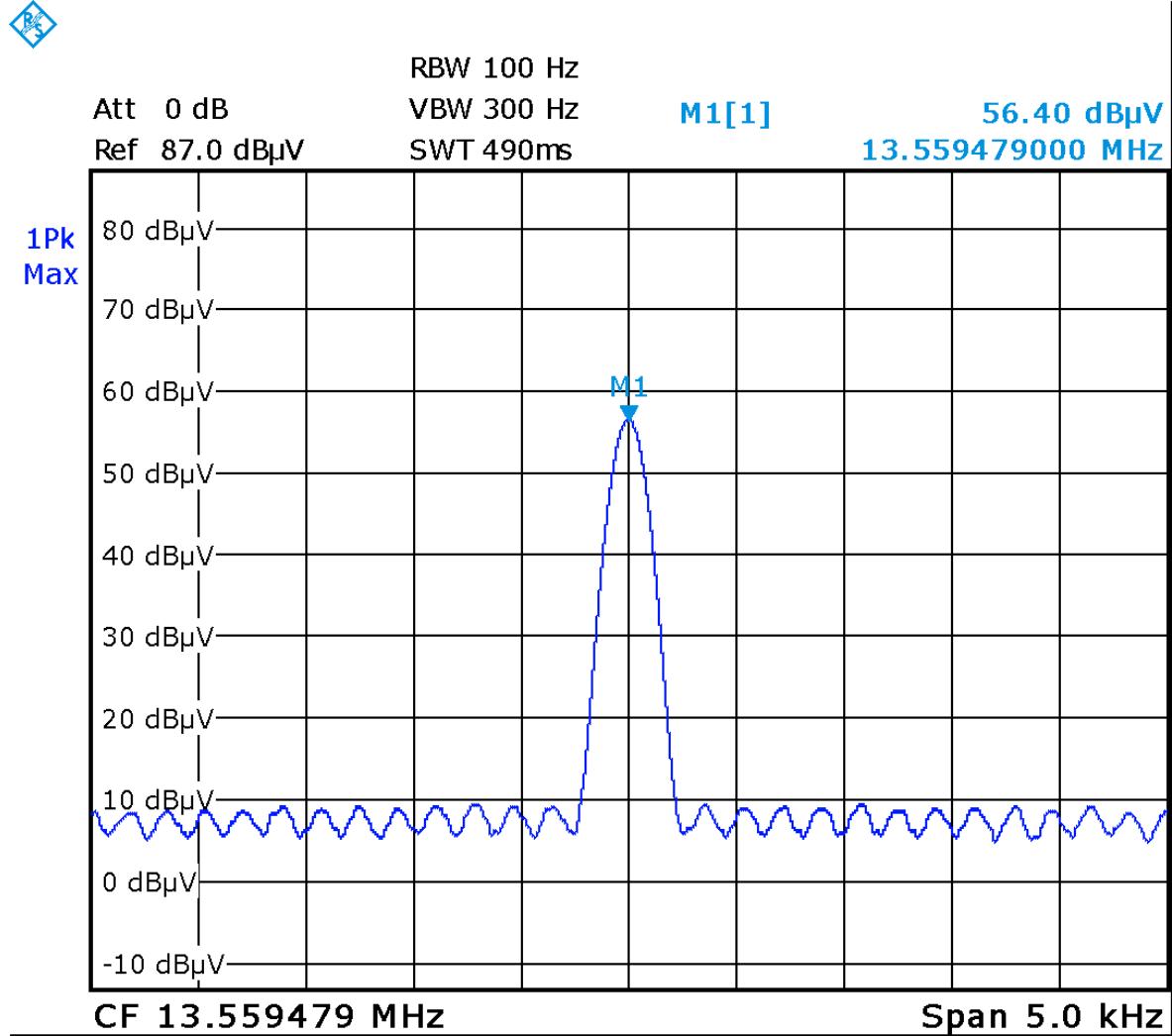


Date: 8.MAY.2013 16:01:38

Client	Geotab Inc
Product	IOX-NFC
Standard(s)	FCC Part 15 Subpart C 2013 & RSS-210: Issue 8



Measurement at 85% of rated voltage (8-32 VDC): 6.8VDC

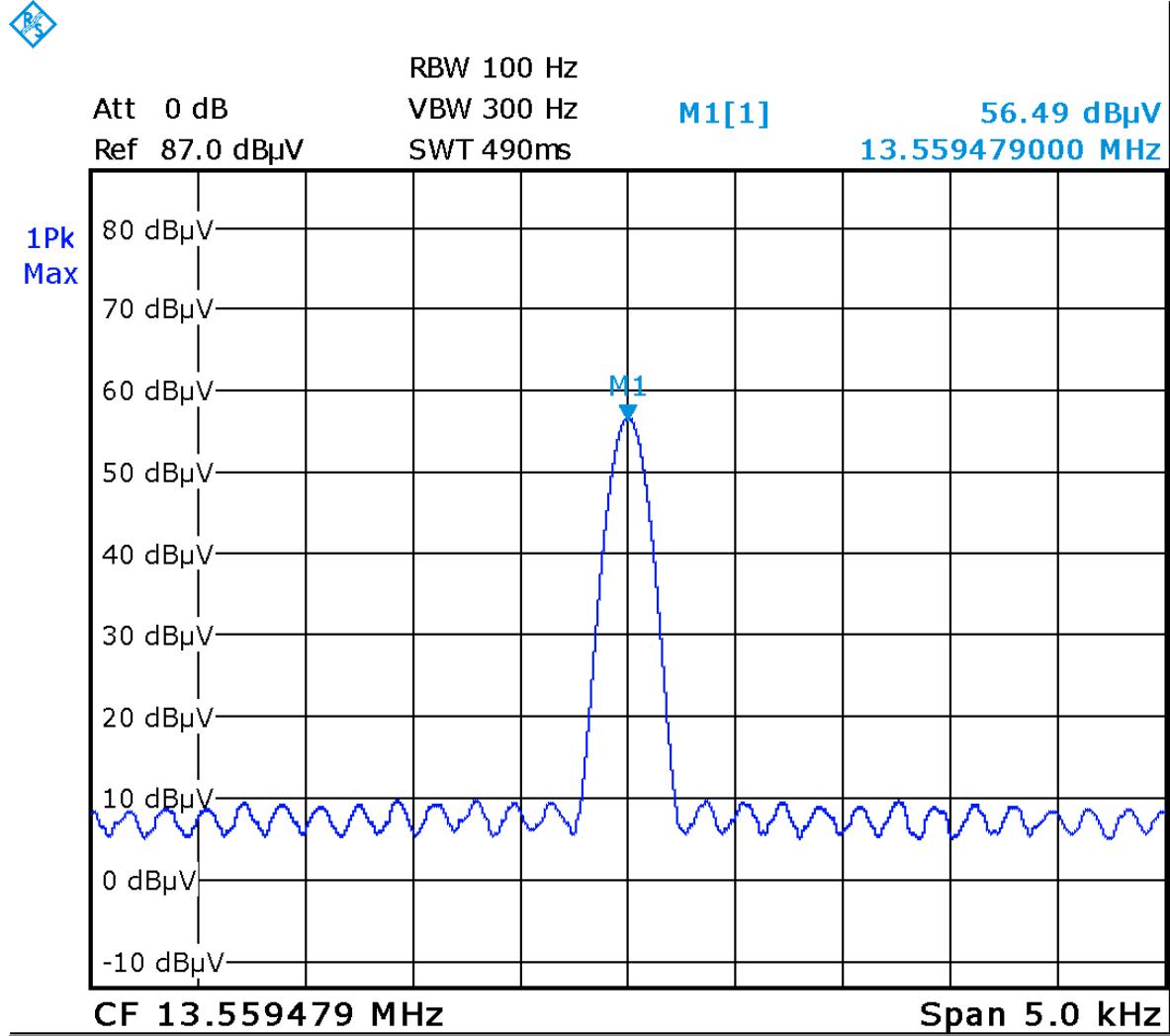


Date: 8.MAY.2013 15:57:18

Client	Geotab Inc
Product	IOX-NFC
Standard(s)	FCC Part 15 Subpart C 2013 & RSS-210: Issue 8



Measurement at 115% of rated voltage (8-32 VDC): 36.8VDC

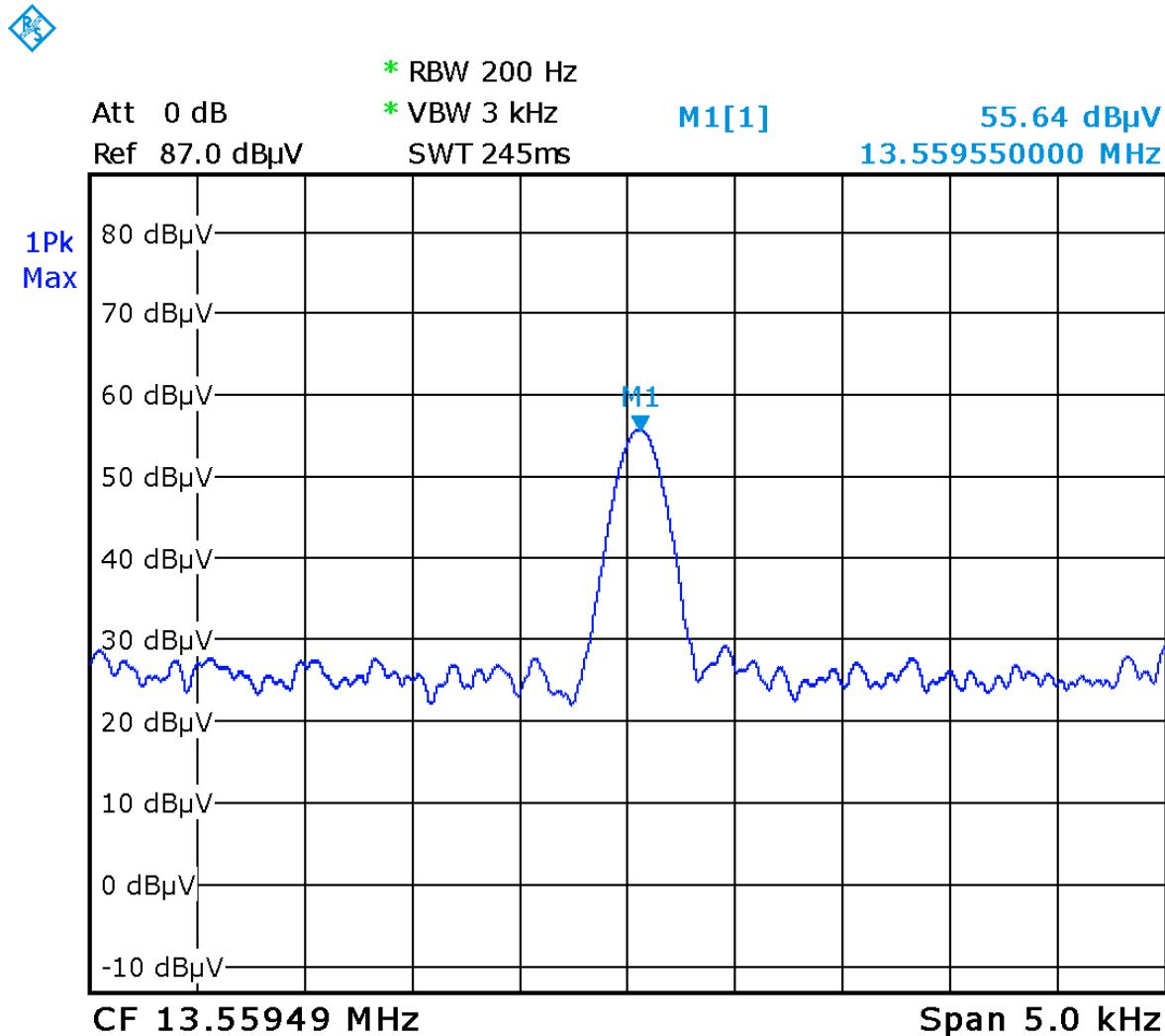


Date: 8.MAY.2013 16:06:35

Client	Geotab Inc
Product	IOX-NFC
Standard(s)	FCC Part 15 Subpart C 2013 & RSS-210: Issue 8



Measurement at lower temperature (-20°C)



Date: 8.MAY.2013 18:46:19

Client	Geotab Inc
Product	IOX-NFC
Standard(s)	FCC Part 15 Subpart C 2013 & RSS-210: Issue 8



Measurement at Higher temperature (+50°C)



* RBW 200 Hz

Att 0 dB

VBW 3 kHz

M1[1]

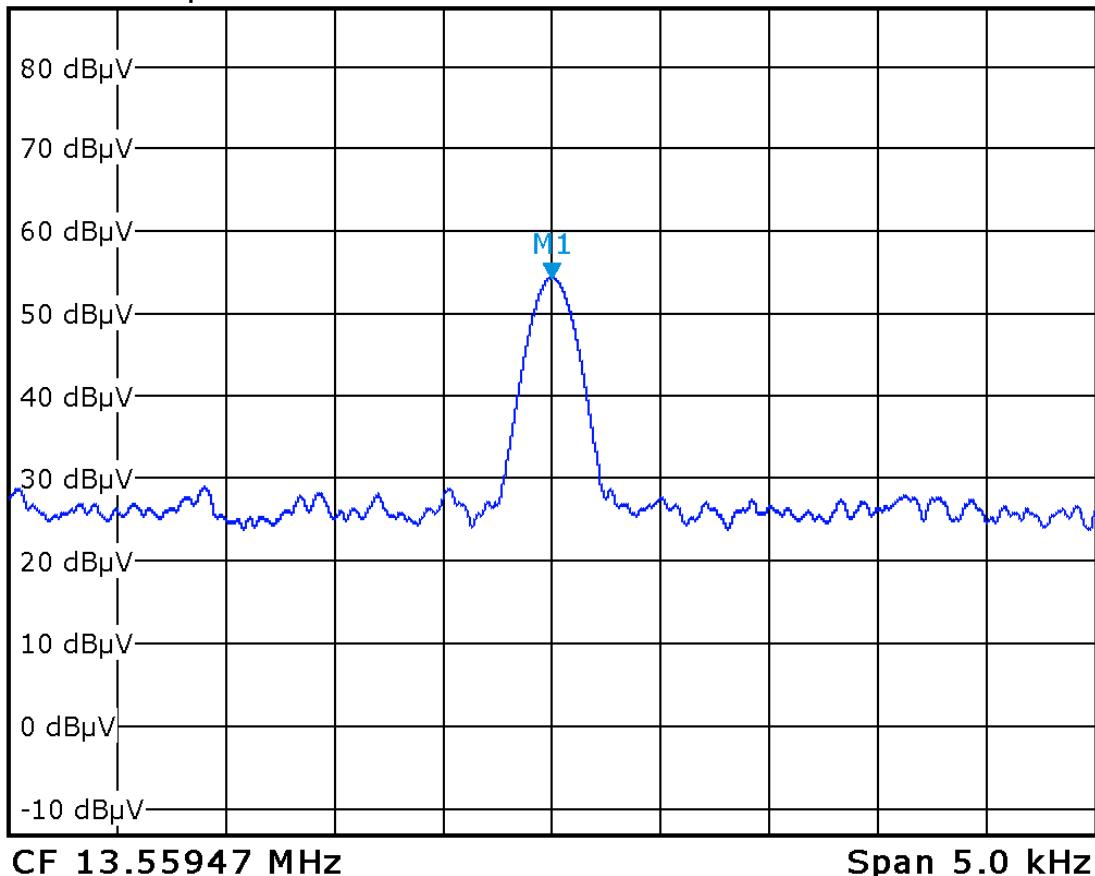
54.27 dB μ V

Ref 87.0 dB μ V

SWT 245ms

13.559470000 MHz

1R_{rr}
Max



Date: 8.MAY.2013 17:25:56

Client	Geotab Inc	
Product	IOX-NFC	
Standard(s)	FCC Part 15 Subpart C 2013 & RSS-210: Issue 8	

Results Table

Carrier frequency stability shall be maintained to +/-0.01% (100ppm)

Temperature (deg Celsius)	Measured Frequency (MHz)	% of operating frequency	Pass / Fail
-20	13.559550	< 0.01 %	PASS
+20	13.559479	0 %	PASS
+50	13.559470	< 0.01%	PASS

Supply Voltage (VDC)	Measured Frequency (MHz)	% of operating frequency	Pass / Fail
6.8	13.559479	0 %	PASS
12	13.559479	0 %	PASS
36.8	13.559479	0%	PASS

Test Equipment List

Equipment	Model No.	Manufacturer	Last calibration date	Next calibration due date	Asset #
Spectrum Analyzer	ESL 6	Rohde & Schwarz	Oct. 06, 2011	Oct. 06, 2013	GEMC 160
Loop Antenna	EM 6872	Electro-Metrics	Feb 5, 2013	Feb 5, 2015	GEMC 71
Preamp 9kHz - 1 GHz	LNA 6901	Teseq	Feb. 25, 2013	Feb. 25, 2015	GEMC 168
Temperature/Humidity meter	HMP233	Vaisala	Oct 25, 2012	Oct 25, 2013	CANE00043
RF Cable 7m	LMR-400-7M-50OHM-MN-MN	LexTec	NCR	NCR	GEMC 28
Environmental Chamber	SM-32-7800	Thermotron	NCR	NCR	GEMC 153
DC Power Supply	DCR150-3B	Sorensen	NCR	NCR	GEMC 187
Digital Multi meter	TX1	Tektronix	5/25/2012	5/25/2013	CANE0004

This report module is based on GEMC template "FCC - 15.225 - RFID Freq Stab_Rev1.doc

Client	Geotab Inc
Product	IOX-NFC
Standard(s)	FCC Part 15 Subpart C 2013 & RSS-210: Issue 8



Appendix A – EUT Summary

Client	Geotab Inc	
Product	IOX-NFC	
Standard(s)	FCC Part 15 Subpart C 2013 & RSS-210: Issue 8	

General EUT Description

Client Details	
Organization / Address	Geotab, Inc. 1081 South Service Rd. W., Oakville, ON, L6L 6K3, Canada.
Contact	Moussa Kfouri
Phone	647 728 4535
Email	moussak@geotab.com
EUT (Equipment Under Test) Details	
EUT Name (for report title)	IOX-NFC
EUT Model / SN (if known)	V3.2
EUT revision	3.0
Software version	1.xx
Equipment category	Driver Identification
EUT is powered using	12V\24V Vehicle Battery
Input voltage range(s) (V)	8-32 V DC
Frequency range(s) (Hz)	RF field: 13.56MHz
Rated input current (A)	100mA
Nominal power consumption (W)	1.2W
Number of power supplies in EUT	1 switch mode 1 linear.
Transmits RF energy? (describe)	Yes, NFC Field
Basic EUT functionality description	Wireless Card Detection
High level block diagram of EUT (attachment)	See Attached
Modes of operation	Only 1. 13.56MHz emitted as described above.
Step by step instructions for setup and operation	Connect device to Powered GO Device. Swipe a card over the antenna portion.
EUT response time (ms)	< 500ms
EUT setup time (min)	1 minute
Frequency of all clocks present in EUT	LPC1756 - XTAL: 16MHz - RTC: 32.768KHz - Main operating clock: 100MHz - Wake up clock: 4MHz

Client	Geotab Inc	
Product	IOX-NFC	
Standard(s)	FCC Part 15 Subpart C 2013 & RSS-210: Issue 8	

	<p>PN532</p> <ul style="list-style-type: none"> - XTAL: 27.12MHz - Main operating clock: 27.12MHz - Waiting state clock: 6.78MHz
I/O cable description Specify length and type	26AWG 5 conductor 300mm long with mini USB plug. 300V 105°C AWM2517
Available connectors on EUT	<ol style="list-style-type: none"> 1. Molex 43650-0200 (2 pin). Provides path to ground through transistor. 2. Mini USB Plug. Power supply to the unit, can bus communication and level line. 3. Mini USB Socket. Power supply to next unit, can bus communication and level line.
Peripherals required to exercise EUT Ex. Signal generator	None
Dimensions of product	45mm x 50mm x 13mm and 30mm x 53mm x 15mm joint by 1m long cable. 300mm cable and plug on latter enclosure.

Client	Geotab Inc
Product	IOX-NFC
Standard(s)	FCC Part 15 Subpart C 2013 & RSS-210: Issue 8



EUT Functional Description

The IOX-NFC is a wireless contactless identification card reader.

EUT Configuration

- The IOX-NFC was configured by the manufacturer to operate in 100% duty cycle RF transmission.
- The IOX-NFC was powered nominally at 12 VDC.

Operational Setup

These devices are required to be attached to the EUT for its normal operation.

- None

Modifications for Compliance

The following modifications were made during testing for the sample to achieve compliance with the testing requirements:

- None

Client	Geotab Inc
Product	IOX-NFC
Standard(s)	FCC Part 15 Subpart C 2013 & RSS-210: Issue 8



Appendix B – EUT & Test Setup Photos

Client	Geotab Inc
Product	IOX-NFC
Standard(s)	FCC Part 15 Subpart C 2013 & RSS-210: Issue 8



Figure 1: EUT

Client	Geotab Inc
Product	IOX-NFC
Standard(s)	FCC Part 15 Subpart C 2013 & RSS-210: Issue 8

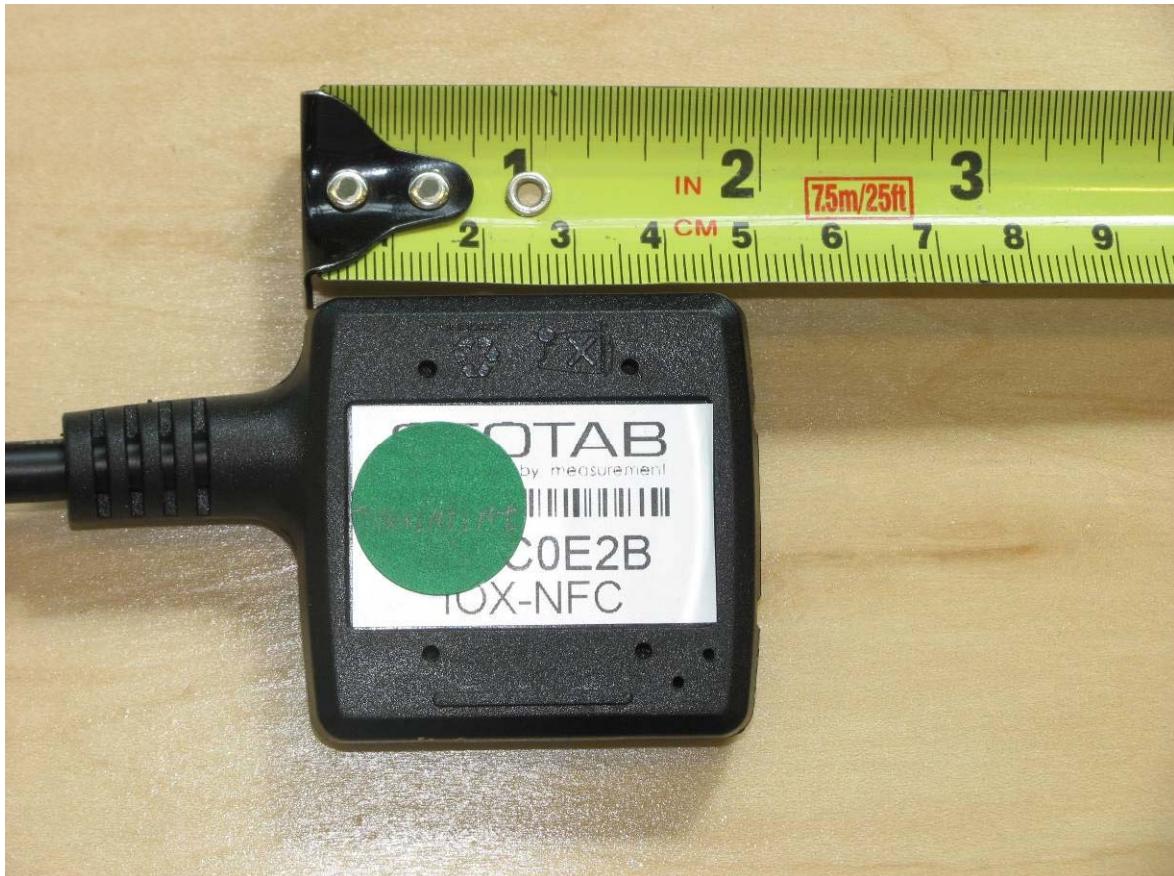


Figure 2: Transmitter/main board – external photo – bottom and label

Client	Geotab Inc
Product	IOX-NFC
Standard(s)	FCC Part 15 Subpart C 2013 & RSS-210: Issue 8

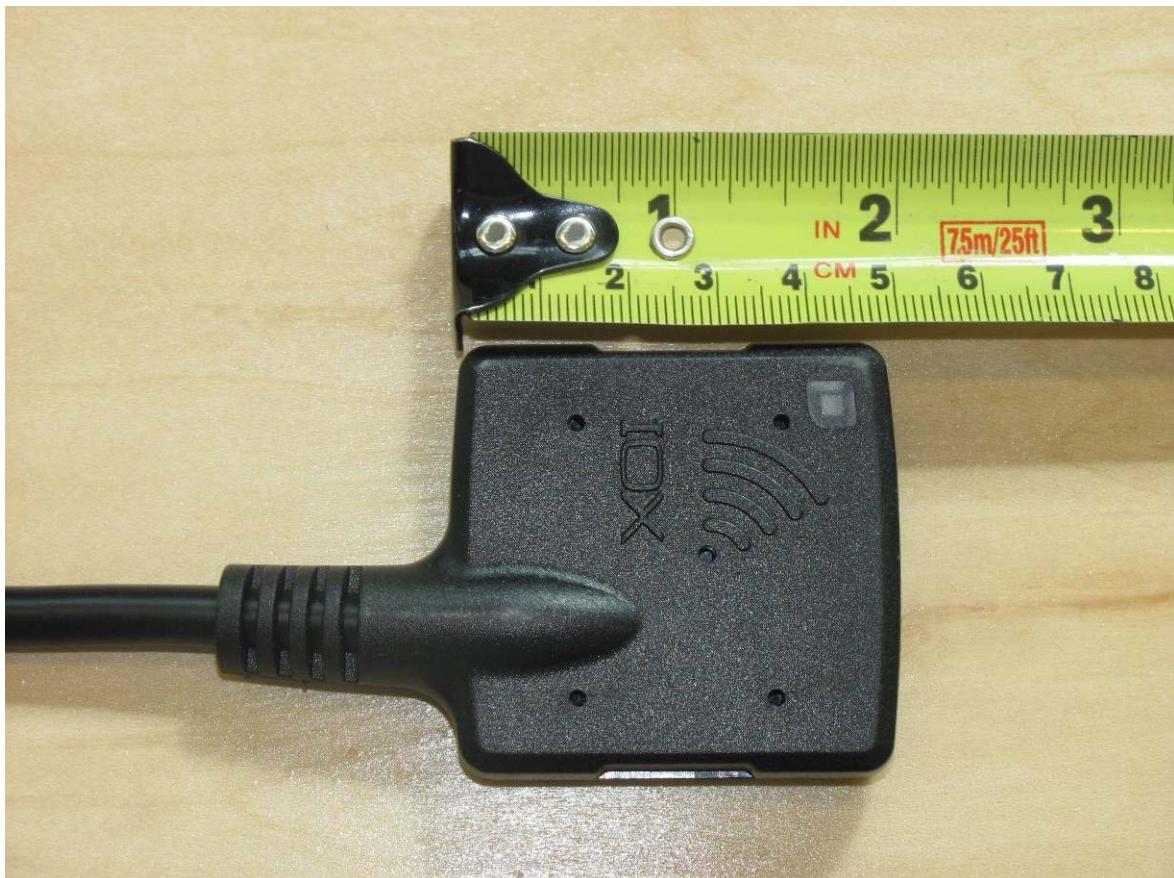


Figure 3: Transmitter/main board – external photo – top

Client	Geotab Inc
Product	IOX-NFC
Standard(s)	FCC Part 15 Subpart C 2013 & RSS-210: Issue 8

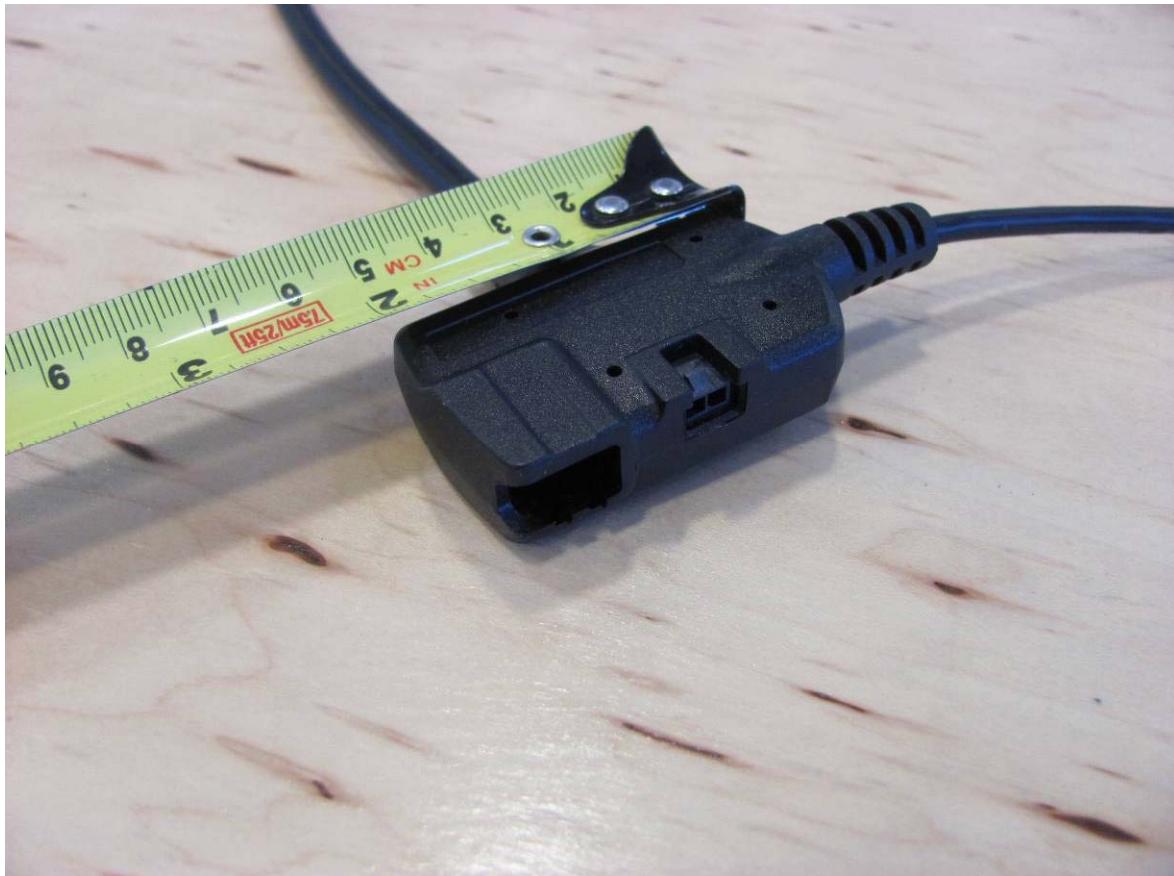


Figure 4: Interface board – external photo

Client	Geotab Inc
Product	IOX-NFC
Standard(s)	FCC Part 15 Subpart C 2013 & RSS-210: Issue 8



Figure 5: Radiated emission setup – photo 1

Client	Geotab Inc
Product	IOX-NFC
Standard(s)	FCC Part 15 Subpart C 2013 & RSS-210: Issue 8



Figure 6: Radiated emission setup – photo 2

Client	Geotab Inc
Product	IOX-NFC
Standard(s)	FCC Part 15 Subpart C 2013 & RSS-210: Issue 8



Figure 7: Radiated emission setup – photo 3

Client	Geotab Inc
Product	IOX-NFC
Standard(s)	FCC Part 15 Subpart C 2013 & RSS-210: Issue 8



Figure 8: Carrier frequency stability setup – photo 1

Client	Geotab Inc
Product	IOX-NFC
Standard(s)	FCC Part 15 Subpart C 2013 & RSS-210: Issue 8



Figure 9: Carrier frequency stability setup – photo 2