



Canada

RF Test Report

As per

RSS-210 Issue 10:2019 & FCC Part 15 Subpart 15.209

Low Power Licence Exempt Radio
Communication Devices
Intentional Radiators
on the

R-Series Ground Conductivity Meter

Issued by:

TÜV SÜD Canada Inc.
11 Gordon Collins Dr,
Gormley, ON, L0H 1G0
Canada
Ph: (905) 883-7255

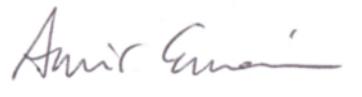
Testing produced for

Geosensors Inc.

See Appendix A for full client &
EUT details.

Prepared by:

Amir Emami,
Project Engineer



Reviewed by:

Min Xie,
Sr. Project Engineer



 Innovation, Science and
Economic Development Canada

Registration #
6844A-3



Testing Laboratory
Certificate #2955.02



R-14023, G-20072
C-14498, T-20060



Registration #
CA6844

Client	Geosensors, Inc.
Product	R-Series Ground Conductivity Meter
Standard(s)	RSS 210 Issue 10:2019 FCC Part 15 Subpart 15.209



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Client	Geosensors, Inc.	 Canada
Product	R-Series Ground Conductivity Meter	
Standard(s)	RSS 210 Issue 10:2019 FCC Part 15 Subpart 15.209	

Report Scope

This report addresses the EMC verification testing and test results of the **Ground Conductivity Meter** Model: **R-Series**, herein referred to as EUT (Equipment Under Test). The EUT was tested for compliance against the following standards:

RSS-210 Issue 10:2019

FCC Part 15 Subpart C 15.209

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

This report does not imply product endorsement by any government, accreditation agency, or TÜV SÜD Canada Inc.

Opinions or interpretations expressed in this report, if any, are outside the scope of TÜV SÜD Canada Inc. accreditations. Any opinions expressed do not necessarily reflect the opinions of TÜV SÜD Canada Inc., unless otherwise stated.

Client	Geosensors, Inc.	 Canada
Product	R-Series Ground Conductivity Meter	
Standard(s)	RSS 210 Issue 10:2019 FCC Part 15 Subpart 15.209	

Summary

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

EUT:	Ground Conductivity Meter, Model: R6
FCC Certification #, FCC ID:	2AZ6A-GSIGCM
ISED Certification #, IC:	27333-GSIGCM
EUT passed all tests performed	Yes
Tests conducted by	Amir Emami
Report reviewed by	Min Xie

For testing dates, see "Testing Environmental Conditions and Dates".

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 and Test Setup Photos'.

Client	Geosensors, Inc.	 Canada
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Test Results Summary

Standard/Method	Description	Class/Limit	Result
FCC 15.203	Antenna Requirement	Unique	Pass See Justification
RSS-GEN Section 6.7	Occupied Bandwidth	99% OBW	Pass
FCC 15.205 RSS-GEN (Table 7)	Restricted Bands for Intentional Operation	QuasiPeak Average	Pass
FCC 15.207 RSS-GEN (Table 4)	Power Line Conducted Emissions	QuasiPeak Average	N/A See Justification
FCC 15.209 RSS-GEN – Clause 8.9	Transmitter Spurious Radiated Emissions	QuasiPeak Average	Pass
Overall Result			Pass

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. A 'PASS' / 'FAIL' grade within measurement uncertainty is marked with a '*'.

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Notes, Justifications, or Deviations

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

For the antenna requirement specified in FCC 15.203, the unit uses custom loop antenna which are integrated and sealed inside the enclosure and not user accessible.

The EUT only transmits at the following frequencies: 8400Hz, 8700Hz, 9000Hz, 9300Hz, or 9600Hz.

The EUT is available in four models. The R2, R4, RF, and R6 and the transmitter between all four models are electrically identical. The only difference between them is the number of receivers and the separation distance between Transmitter-Receiver (Tx-Rx). Longer Tx-Rx separations allow the sensor to probe more deeply into the soil. While having a larger number of separations increases the resolving power of the sensor for layer depth and ECa and MSa.

Model	Number of Receivers
R2	2
R4	4
RF	4
R6	6

For RF exposure, this device is designed to operate more than 20 cm from personnel during normal operation. No testing is required, however worst case calculation is given in the RF Exposure Exhibit.

Power line conducted emissions was not applicable since the EUT is a battery-operated device. All tests were performed with the battery fully charged.

Sample Calculation(s)

Radiated Emission Test

E-Field Level = Received Signal + Antenna Factor + Cable Loss – Pre-Amp Gain

E-Field Level = 50dB μ V + 10dB/m + 2dB – 20dB

E-Field Level = 42dB μ V/m

Margin = Limit – E-Field Level

Margin = 50dB μ V/m – 42dB μ V/m

Margin = 8.0 dB (pass)

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Applicable Standards, Specifications and Methods

ANSI C63.4:2014 Methods of Measurement of Radio-Noise Emissions from Low-Voltage Electrical and Electronic Equipment in the Range of 9 kHz to 40 GHz

ANSI C63.10:2013 American National Standard For Testing Unlicensed Wireless Devices

CFR 47 FCC 15 Code of Federal Regulations – Radio Frequency Devices, Subpart C Intentional Radiators

FCC KDB 558074: FCC KDB 558074 Digital Transmission Systems, measurements 2019 and procedures

FCC KDB 447498: RF exposure procedures and equipment authorization policies for 2015 mobile and portable devices

ICES-003 Issue 7 Digital Apparatus - Spectrum Management and 2020 Telecommunications Policy Interference-Causing Equipment Standard

RSS-GEN Issue 5 General Requirements and Information for the Certification of 2021 Radio Apparatus

RSS-210 Issue 10 Licence-Exempt Radio Apparatus: Category I Equipment 2019

ISO 17025:2017 General Requirements for the Competence of Testing and Calibration Laboratories

Client	Geosensors, Inc.	 Canada
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Standard(s)	RSS 210 Issue 10:2019 FCC Part 15 Subpart 15.209	

Document Revision Status

Revision	Date	Description	Initials
000	July 5, 2021	Initial Release	AE
-	-	-	-

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Definitions and Acronyms

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

LISN – Line Impedance Stabilization Network

NCR – No Calibration Required

NSA – Normalized Site Attenuation

N/A – Not Applicable

RF – Radio Frequency

AE – Auxiliary Equipment. A digital accessory that feeds data into or receives data from another device (host) that in turn, controls its operation.

Antenna Port – Port, other than a broadcast receiver tuner port, for connection of an antenna used for intentional transmission and/or reception of radiated RF energy.

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

EMC – Electro-Magnetic Compatibility. The ability of an equipment or system to function satisfactorily in its electromagnetic environment without introducing intolerable electromagnetic disturbances to anything in that environment.

EMI – Electro-Magnetic Immunity. The ability to maintain a specified performance when the equipment is subjected to disturbance (unwanted) signals of specified levels.

EUT – Equipment Under Test. A device or system being evaluated for compliance that is representative of a product to be marketed.

ITE – Information Technology Equipment. Has a primary function of entry, storage, display, retrieval, transmission, processing, switching, or control of data and/or telecommunication messages and which may be equipped with one or more ports typically for information transfer.

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Testing Facility

Testing for EMC on the EUT was carried out at TÜV SÜD Canada testing lab near Toronto, Ontario. The testing lab has calibrated 3m semi-anechoic chambers which allow measurements on a EUT that has a maximum width or length of up to 2m and a height of up to 3m. The testing lab also has a calibrated 10m Open Area Test Site (OATS). The chambers are equipped with a turntable that is capable of testing devices up to 5000lb in weight and are equipped with a mast that controls the polarization and height of the antenna. Control of the mast occurs in the control room adjoining the shielded chamber. This facility is capable of testing products that are rated for single phase or 3-phase AC input and DC capability is also available. Radiated emission measurements are performed using a BiLog antenna and a Horn antenna where applicable. Conducted emissions, unless otherwise stated, are performed using a LISN and using the vertical ground plane if applicable.

Calibrations and Accreditations

The 3m semi-anechoic chamber is registered with Federal Communications Commission (FCC, CA6844), Innovation, Science and Economic Development Canada (ISED, 6844A-3) and Voluntary Control Council for Interference (VCCI, R-14023, G-20072, C-14498, and T-20060). 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 TÜV SÜD Canada. For radiated susceptibility testing, a 16 point field calibration has been performed on the chamber. The field uniformity data is kept on file at TÜV SÜD Canada. TÜV SÜD Canada Inc. is accredited to ISO 17025 by A2LA with Testing Certificate #2955.02. 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 biennial basis as listed for each respective test.

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Testing Environmental Conditions and Dates

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

Date	Test	Initials	Temperature (°C)	Humidity (%)	Pressure (kPa)
April 28 - 29, 2021	Transmitter Emissions	AE	22 – 24	39 – 45	100 – 101

Client	Geosensors, Inc.
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Canada

Detailed Test Results Section

Client	Geosensors, Inc.	 Canada
Product	R-Series Ground Conductivity Meter	
Standard(s)	RSS 210 Issue 10:2019 FCC Part 15 Subpart 15.209	

Transmitter Spurious 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.

Limits and Method

The method is as defined in ANSI C63.10 Section 6.3.

The limits, as defined in FCC Part 15.209 and RSS-210 B for unintentional radiated emissions, apply for those emissions that fall in the restricted bands defined in FCC Part 15.205(a) and RSS-GEN 8.10 Table 7. These emissions must comply with the radiated emission limits specified in FCC Part 15.209(a) and RSS-GEN 8.9 Tables 5 & 6.

Frequency	Field Strength Limit (μ V/m)	Field Strength at 3m (dB μ V/m)
0.009 MHz – 0.490 MHz	2400/F(kHz) ^a (at 300m)	128.5 to 93.8 ^a
0.490 MHz – 1.705 MHz	24000/F(kHz) ^a (at 30m)	73.8 to 63.0 ^a
1.705 MHz – 30 MHz	30 ^a (at 30m)	69.5 ^a
30 MHz – 88 MHz	100 ^a (at 3m)	40.0 ^a
88 MHz – 216 MHz	150 ^a (at 3m)	43.5 ^a
216 MHz – 960 MHz	200 ^a (at 3m)	46.0 ^a
Above 960 MHz	500 ^a (at 3m)	54.0 ^a
Above 1000 MHz	500 ^b (at 3m)	54.0 ^b
Above 1000 MHz	5 mV/m ^c (at 3m)	74.0 ^c

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

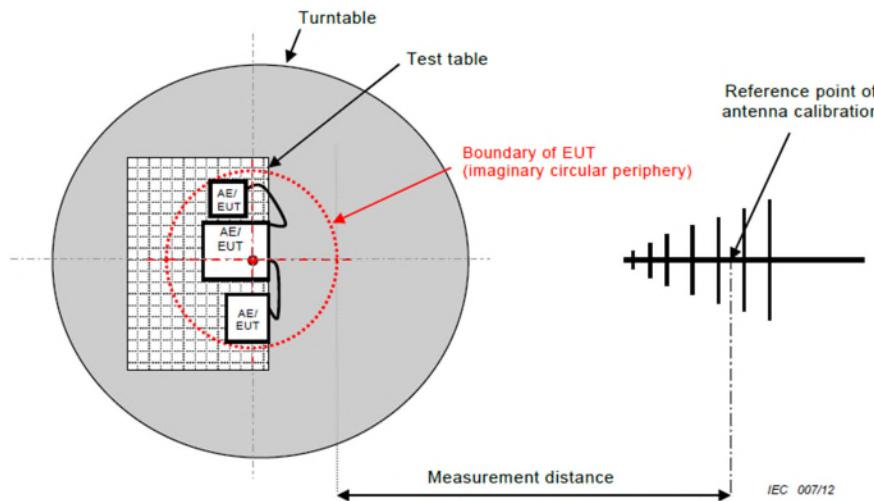
^bLimit is with 1 MHz measurement bandwidth and using an Average detector

^cLimit is with 1 MHz measurement bandwidth and using a Peak detector

Based on ANSI C63.4 Section 4.2, if the Peak detector measurements do not exceed the Quasi-Peak limits, where defined, then the EUT is deemed to have passed the requirements.

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Typical Radiated Emissions Setup



IEC 007/12

Measurement Uncertainty

The expanded measurement uncertainty is calculated in accordance with CISPR 16-4-2 and is $\pm 5.67\text{dB}$ for 30MHz – 1GHz and $\pm 4.58\text{dB}$ for 1GHz – 18GHz with a 'k=2' coverage factor and a 95% confidence level.

Preliminary Graphs

The graphs shown below are maximized peak measurement graphs measured with a resolution bandwidth greater than or equal to the final required detector over a full 0-360°. This peaking process is done as a worst case measurement and enables the detection of frequencies of concern for final measurement. For final measurements with the appropriate detector, where applicable, please refer to the tables under Final Measurements.

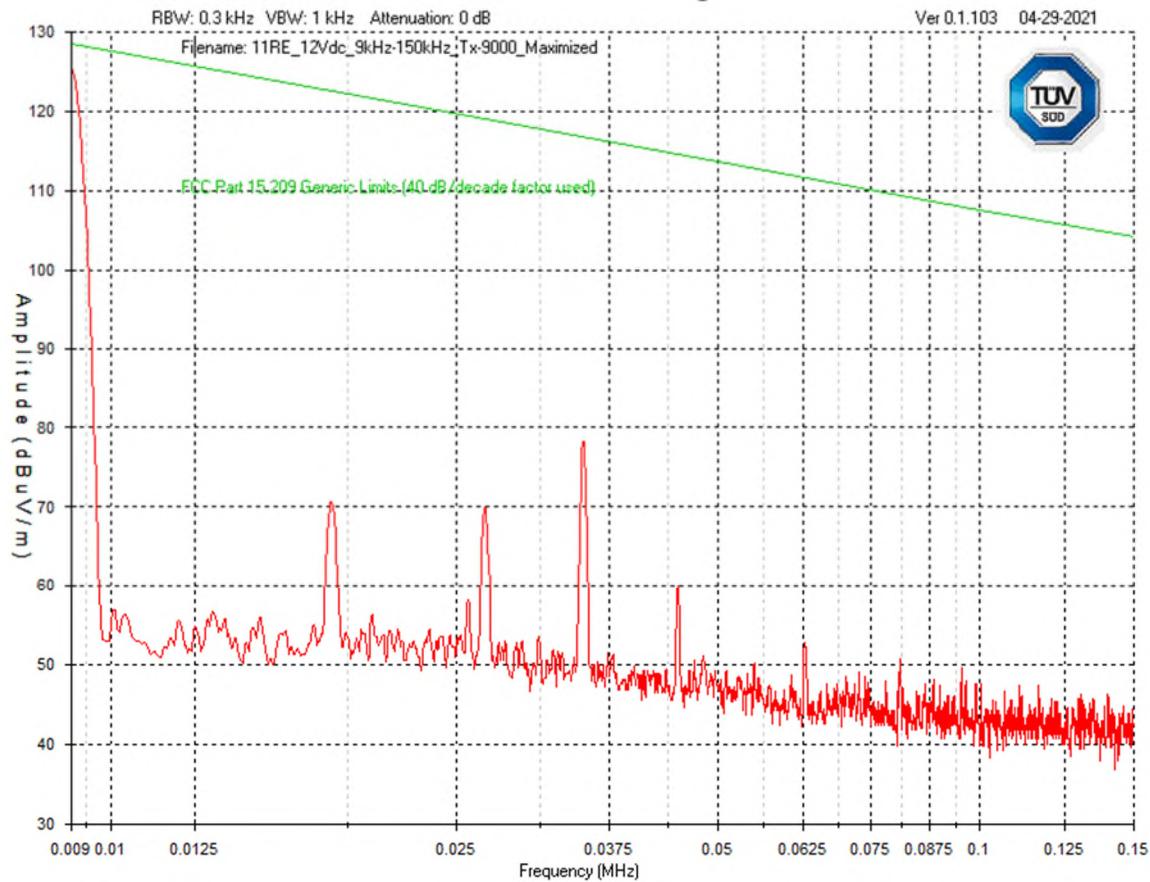
In accordance with FCC Part 15, Subpart A, Section 15.33, the device was scanned to the 10th harmonic (a minimum of 96 kHz).

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 30 MHz and 40 dB/decade below 30 MHz. For example, for 3 meter measurements at 9kHz, an extrapolation factor of 80dB from 40 Log (3m / 300m) is applied.

The EUT was also checked along the roll angle to find the worst-case emission. The worst-case graphs are presented.

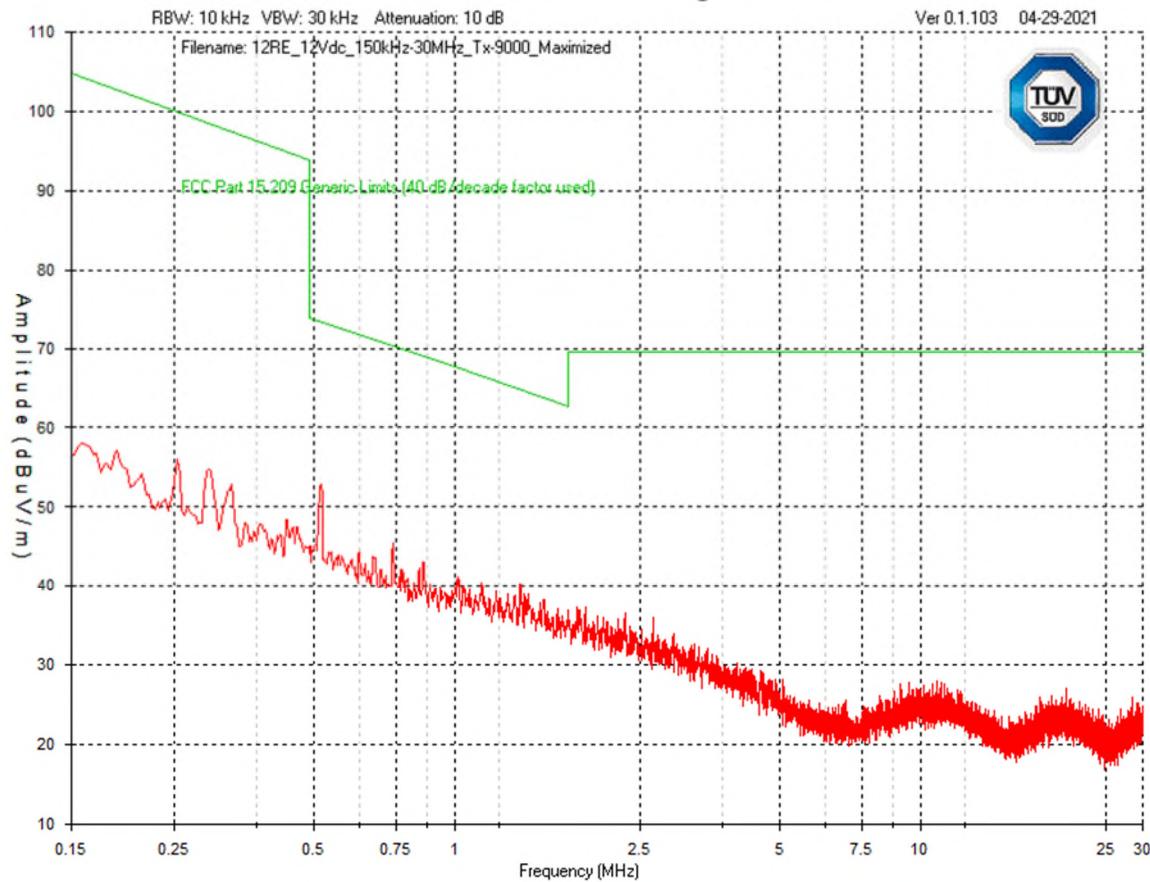
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9.0 kHz Transmitter
 9 kHz – 150 kHz
 Peak Emission Graph



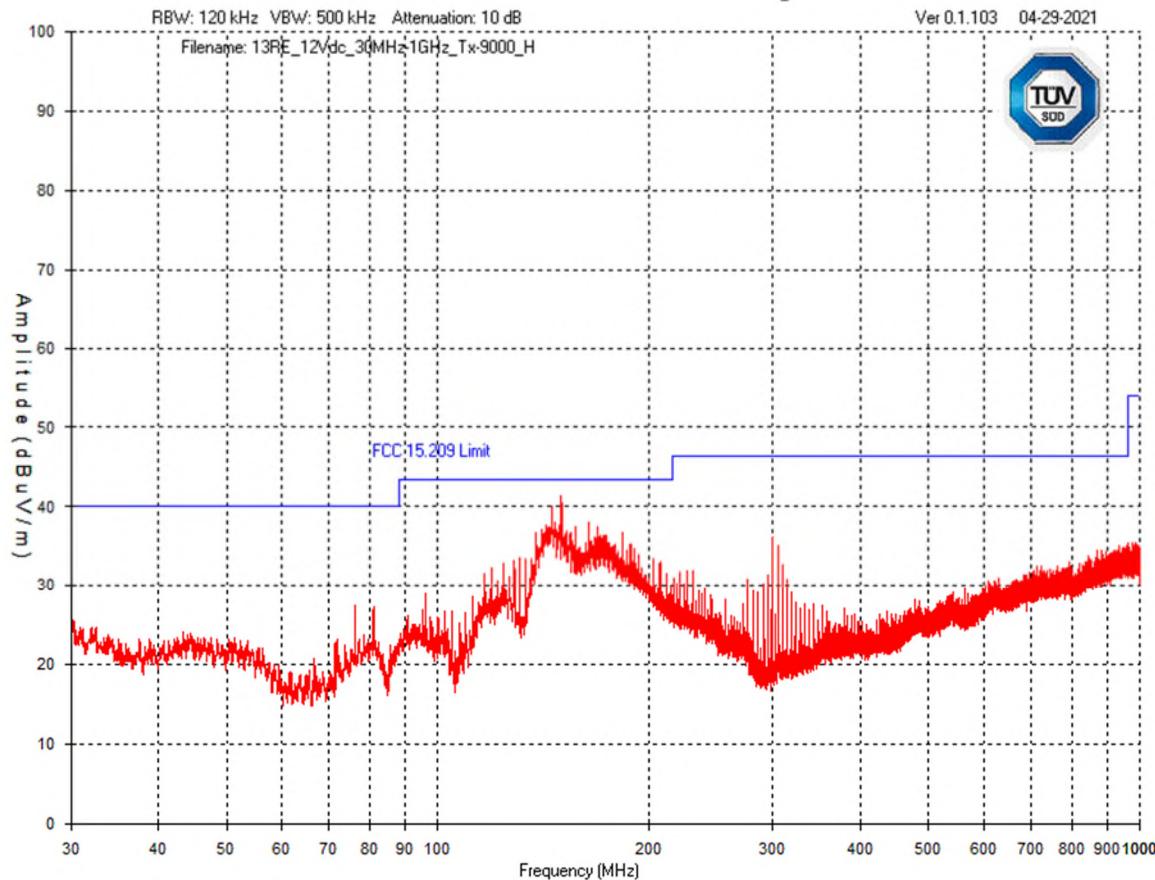
Client	Geosensors, Inc.	 Canada
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9.0 kHz Transmitter
150 kHz – 30 MHz
Peak Emission Graph



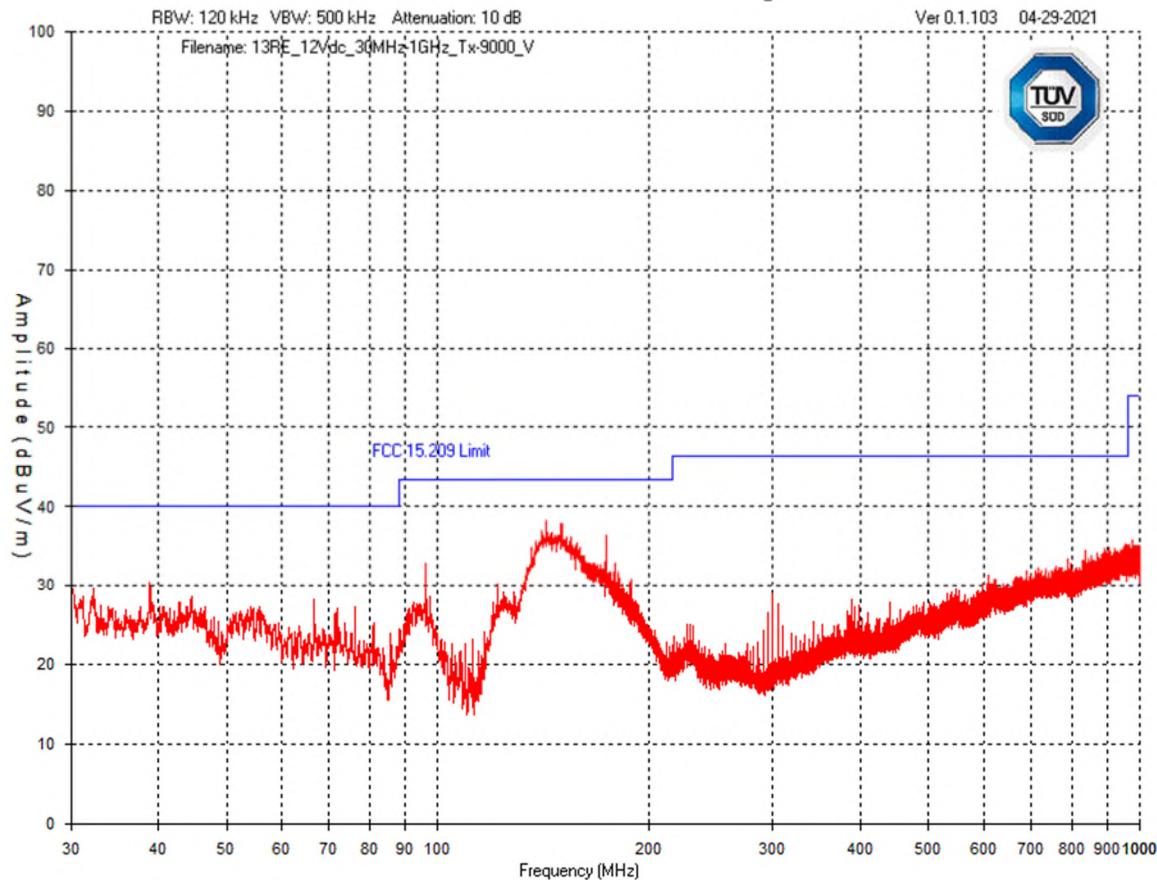
Client	Geosensors, Inc.	 Canada
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9.0 kHz Transmitter – 30 MHz – 1 GHz
Horizontal - Peak Emission Graph



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9.0 kHz Transmitter – 30 MHz – 1 GHz
Vertical - Peak Emission Graph



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Final Measurements and Results

The EUT passed.

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.

Supply			12Vdc Battery							
Frequency (MHz)	Detector	Received Signal (dB μ V)	Cable Factor (dB)	Current to Voltage Factor	Antenna Factor (dB/m)	Pre-Amp (dB)	Level (dB μ V/m)	Limit (dB μ V/m)	Margin (dB)	Test Result
0.009	AVG	92.8	0	51.5	9.6	-28.8	125.1	128.3	3.2	Pass

Intentional Transmitter

Supply			12Vdc Battery							
Frequency (MHz)	Detector	Received Signal (dB μ V)	Antenna Factor (dB/m)	Cable Factor (dB)	Pre-Amp (dB)	Level (dB μ V/m)	Limit (dB μ V/m)	Margin (dB)	Test Result	
Horizontal Antenna Polarization										
149.99	QP	51.4	14.7	1.3	-28.4	39.0	43.5	4.5	Pass	
145.23	QP	52.5	14.1	1.3	-28.4	39.5	43.5	4.0	Pass	
164.27	QP	48.7	15.4	1.4	-28.4	37.1	43.5	6.4	Pass	
183.36	PEAK	48.0	15.8	1.4	-28.5	36.7	43.5	6.8	Pass	
130.92	PEAK	48.2	12.7	1.2	-28.4	33.7	43.5	9.8	Pass	
133.29	PEAK	47.9	12.8	1.2	-28.4	33.5	43.5	10.0	Pass	
Vertical Antenna Polarization										
142.85	QP	46.0	13.9	1.2	-28.4	32.7	43.5	10.8	Pass	
145.22	QP	47.5	14.1	1.2	-28.4	34.4	43.5	9.1	Pass	
173.80	QP	43.4	15.7	1.4	-28.4	32.1	43.5	11.4	Pass	
38.89	PEAK	39.8	18.6	0.6	-28.4	30.6	40.0	9.4	Pass	
32.29	PEAK	35.4	22.2	0.5	-28.4	29.7	40.0	10.3	Pass	
95.95	PEAK	46.3	14.0	1.0	-28.4	32.9	43.5	10.6	Pass	

Spurious Emission Table

Client	Geosensors, Inc.	 Canada
Product	R-Series Ground Conductivity Meter	
Standard(s)	RSS 210 Issue 10:2019 FCC Part 15 Subpart 15.209	

Test Equipment List

Equipment	Model No.	Manufacturer	Last Calibration Date	Next Calibration Date	Asset #
Spectrum Analyzer	ESU 40	Rohde & Schwarz	Jan. 15, 2020	Jan. 15, 2022	GEMC 233
Loop Antenna	EM 6871	Electro-Metrics	Feb 26, 2021	Feb 26, 2023	GEMC 70
Loop Antenna	EM 6872	Electro-Metrics	Feb 26, 2021	Feb 26, 2023	GEMC 71
BiLog Antenna	3142-C	ETS-Lindgren	Nov. 25, 2020	Nov. 25, 2022	GEMC 8
Attenuator 6 dB	6N5W-06	Inmet	NCR	NCR	GEMC 345
Pre-Amp 9 kHz – 1 GHz	LNA 6901	Teseq	Feb. 12, 2021	Feb. 12, 2023	GEMC 168
RF Cable 10m	LMR-400-10M-50Ω-MN-MN	LexTec	NCR	NCR	GEMC 274
RF Cable 2m	Sucoflex 104A	Huber+Suhner	NCR	NCR	GEMC 271
Emissions Software	0.1.103	TUV SUD Canada, Inc.	NCR	NCR	GEMC 58

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Emission Bandwidth

Purpose

The purpose of this test is to verify that intentional radiators operating under the alternative provisions to the general emission limits are designed to ensure 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. This helps ensure the utilization of the frequency allocation and prevent corruption of data by ensuring adequate data separation to distinguish the reception of the intended information.

Limits and Method

The limit is as specified in RSS-GEN Section 6.7 and the method is given in ANSI C63.10.

Results

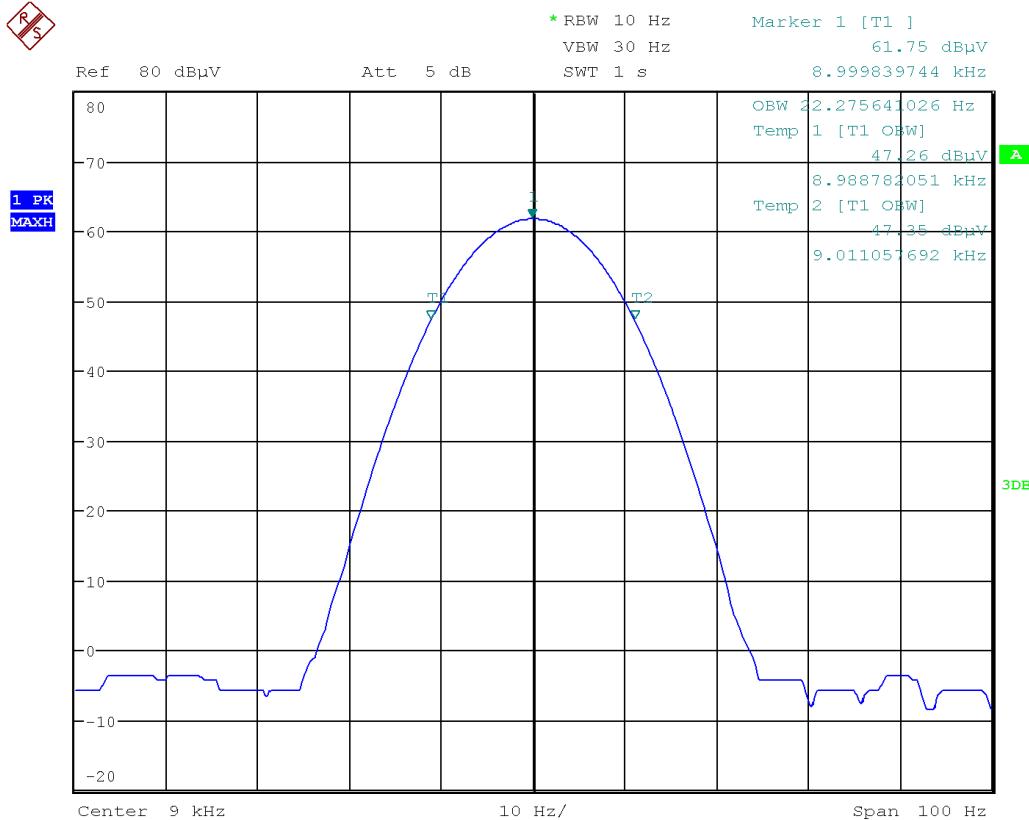
The EUT passed. The 99% bandwidth was measured using the 99% bandwidth function of the spectrum analyzer.

Frequency (kHz)	99% Bandwidth
9	22.3Hz

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Graphs

99% Bandwidth



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

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Equipment	Model No.	Manufacturer	Last Calibration Date	Next Calibration Date	Asset #
Spectrum Analyzer	ESU 40	Rohde & Schwarz	Jan. 15, 2020	Jan. 15, 2022	GEMC 233
Loop Antenna	EM 6871	Electro-Metrics	Feb 26, 2021	Feb 26, 2023	GEMC 70
RF Cable 10m	LMR-400-10M-50Ω-MN-MN	LexTec	NCR	NCR	GEMC 274
RF Cable 2m	Sucoflex 104A	Huber+Suhner	NCR	NCR	GEMC 271

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Appendix A – EUT Summary

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Product	R-Series Ground Conductivity Meter	
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For further details for filing purposes, refer to filing package.

General EUT Description

Client Details	
Organization / Address	Geosensors Inc. 66 Mann Ave Toronto, Ontario, M4S 2Y3 Canada
Contact	Scott Holladay
Phone	416-892-0382
Email	scott.holladay@geosensors.com
EUT (Equipment Under Test) Details	
EUT Name	Ground Conductivity Meter
EUT Model	R-Series – RF, R2, R4, R6 (R6 tested)
EUT revision	New Product
Software version	V1.0.0
Equipment category	Ground Conductivity Meter
Input voltage range(s) (V)	10 – 26Vdc (EUT tested with a 12V battery)
Frequency range(s) (Hz)	N/A
Rated input current (A)	0.5
Nominal power consumption (W)	5
Intentional Radiator Frequency	8.4kHz, 8.7kHz, 9kHz, 9.3kHz, 9.6kHz Optional 2.4GHz WiFi/BT Module
Modes of operation	1
Customer to setup EUT on site?	Yes
EUT setup time (min)	5
I/O cable description	4-wire M12+ Microfast-4 adapter cable,
Specify length and type	approx 6m length overall. DB9s connector for serial I/O, flying leads for power
Available connectors on EUT	M12 4-pin receptacle
Peripherals required to exercise EUT	Laptop with Putty software
EUT Configuration	EUT configured to continuously transmit at 100% duty cycle
Dimensions of product	R6: L 2410mm x D 90mm R2: L 1410mm x D 90mm

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Appendix B – EUT and Test Setup Photos

Refer to the files separate from this test report