



Test Report

FCC Rule Parts: 15.249, 22, 24, and 27
ISED Canada Radio Standards Specification: RSS-210/132/133/139

Report Number: AT72146891-5T1

Manufacturer: GE Infrastructure Sensing, LLC
Model: LUMEN-TERRAIN-1-0-0-0-F-0-2

Test Begin Date: June 7, 2019
Test End Date: June 10, 2019

Report Issue Date: August 7, 2019



FOR THE SCOPE OF ACCREDITATION UNDER Certificate Number: 2955.09

This report must not be used by the client to claim product certification, approval, or endorsement by A2LA, NIST, or any agency of the Federal Government.

Prepared By:

A handwritten signature in blue ink, appearing to read 'Jeremy Pickens'.

Jeremy Pickens
Senior Wireless Engineer
TÜV SÜD America Inc.

Reviewed by:

A handwritten signature in blue ink, appearing to read 'Ryan McGann'.

Ryan McGann
Senior Engineer
TÜV SÜD America Inc.

This test report shall not be reproduced except in full. This report may be reproduced in part with prior written consent of TÜV SÜD America Inc. The results contained in this report are representative of the sample(s) submitted for evaluation.

This report contains 12 pages

TABLE OF CONTENTS

1	GENERAL	3
1.1	PURPOSE.....	3
1.2	PRODUCT DESCRIPTION.....	3
1.3	TEST METHODOLOGY AND CONSIDERATIONS	4
2	TEST FACILITIES.....	4
2.1	LOCATION	4
2.2	LABORATORY ACCREDITATIONS/RECOGNITIONS/CERTIFICATIONS	4
2.3	RADIATED EMISSIONS TEST SITE DESCRIPTION	5
2.3.1	<i>Semi-Anechoic Chamber Test Site – Chamber A.....</i>	<i>5</i>
2.3.2	<i>Semi-Anechoic Chamber Test Site – Chamber B.....</i>	<i>6</i>
2.4	CONDUCTED EMISSIONS TEST SITE DESCRIPTION	7
2.4.1	<i>Conducted Emissions Test Site</i>	<i>7</i>
3	APPLICABLE STANDARD REFERENCES.....	8
4	LIST OF TEST EQUIPMENT	9
5	SUPPORT EQUIPMENT	10
6	EQUIPMENT UNDER TEST SETUP BLOCK DIAGRAM	10
7	SUMMARY OF TESTS.....	11
7.1.1	<i>Intermodulation Products due to Simultaneous Transmissions.....</i>	<i>11</i>
7.1.1.1	Measurement Procedure.....	11
7.1.1.2	Measurement Results	11
8	ESTIMATION OF MEASUREMENT UNCERTAINTY	12
9	CONCLUSION.....	12

1 GENERAL

1.1 Purpose

The purpose of this report is to demonstrate continued compliance with Parts 15.249, 22, and 24 of the FCC's Code of Federal Regulations and Innovation, Science and Economic Development Canada's Radio Standards Specification RSS-210/132/133/139 with respect to co-location of a licensed cellular module and a low power 900MHz transceiver.

1.2 Product Description

The LUMEN-TERRAIN system consists of a communications (base) station along with ten sensor monitoring nodes supporting a typical 300 ft. by 300 ft. well site. The base station includes a weather station to measure wind speed and direction. Power is provided to the base station and sensor nodes via solar panels and battery backup. Communications between the sensor nodes and base station is via sub 1 GHz. (ISM) wireless and communications between the base station and cloud server via cellular modem.

This test report documents the compliance of the intermodulation products and spurious emissions resulting from the colocation of a licensed cellular module and a low power 900MHz transceiver.

Technical Information (900MHz Radio):

Detail	Description
Frequency Range (MHz)	902.2 – 927.8 MHz
Number of Channels	129
Channel Spacing	200 kHz
Modulation Format	GFSK
Data Rates	50kbps
Operating Voltage	12Vdc Battery
Antenna Type / Gain	External Dipole / 2dBi (Pulse Larsen, P/N: W5017)Ceramic Chip / 1.7dBi
FCC ID	2ATKJ-LTBS

Technical Information (Cellular Radio):

Detail	Description
Frequency Range	WCDMA / LTE Band 2 1850-1910MHz WCDMA / LTE Band 4 1710-1755MHz WCDMA / LTE Band 5 824-849MHz LTE Band 7 2500-2570MHz LTE Band 12 699-716MHz LTE Band 13 777-787MHz LTE Band 25 1850-1915MHz LTE Band 26 814-849MHz LTE Band 30 2305-2315MHz LTE Band 41 2496-2690MHz
Operating Voltage	8.5Vdc
Antenna Type / Gain	Multi-band LTE/GPS: 2.74 dBi (698-960MHz), 4.39 dBi (1710-2170MHz), 3.49 dBi (2500-2800MHz) Taoglas, P/N: MA140.A.LB.001
Manufacturer	Sierra Wireless
FCC ID	N7NMC7455

Host Manufacturer Information:
GE Infrastructure Sensing, LLC
1100 Technology Park Dr.
Billerica, MA 01821, USA

Test Sample Serial Number(s): Pilot 8

Test Sample Condition: The test samples were provided in good working order with no visible defects.

1.3 Test Methodology and Considerations

For intermodulation product testing, each cellular technology was placed into maximum power transmission mode at the middle of each band under investigation; simultaneously, the Sub 1GHz ISM radio was placed into constant transmission at the center channel.

2 TEST FACILITIES

2.1 Location

The radiated and conducted emissions test sites are located at the following addresses:

TÜV SÜD America, Inc.
5945 Cabot Pkwy, Suite 100
Alpharetta, GA 30005
Phone: (678) 341-5900

2.2 Laboratory Accreditations/Recognitions/Certifications

TÜV SÜD America, Inc. is accredited to ISO/IEC 17025 by the American Association for Laboratory Accreditation/A2LA accreditation program and has been issued certificate number 2955.09 in recognition of this accreditation.

Unless otherwise specified, all tests methods described within this report are covered under the ISO/IEC 17025 scopes of accreditation.

The Semi-Anechoic Chamber Test Sites and Conducted Emissions Sites have been fully described, submitted to, and accepted by the FCC, ISED Canada and the Japanese Voluntary Control Council for Interference by information technology equipment.

FCC Registration Number:	967699
ISED Canada Lab Code:	23932
VCCI Member Number:	1831
• VCCI Registration Number	A-0295

2.3 Radiated Emissions Test Site Description

2.3.1 Semi-Anechoic Chamber Test Site – Chamber A

The Semi-Anechoic Chamber Test Site consists of a 20' x 30' x 18' shielded enclosure. The chamber is lined with Toyo Ferrite Grid Absorber, model number FFG-1000. The ferrite tile grid is 101 x 101 x 19mm thick and weighs approximately 550 grams. These tiles are mounted on steel panels and installed directly on the inner walls of the chamber.

The turntable is 5' in diameter and is located 5'6" from the back wall of the chamber. The chamber is grounded via 1 - 8' copper ground rod, installed at the center of the back wall, it is bound to the ground plane using 3/4" stainless steel braided cable.

The turntable is all steel, flush mounted EMCO Model 1060 installed in an all steel frame. The table is remotely operated from inside the control room located 25' from the range. The turntable is electrically bonded to the surrounding ground plane via steel fingers installed on the edge of the turn table. The steel fingers make constant contact with the ground plane during operation.

Behind the turntable is a 3' x 6' x 4' deep shielded pit used for support equipment if necessary. The pit is equipped with 1 - 4" PVC chase from the turntable to the pit that allows for cabling to the EUT if necessary. The underside of the turntable can be accessed from the pit, so cables can be supplied to the EUT from the pit.

The chamber rear wall is covered with a mixture of Siepel pyramidal absorber. The side walls of the chamber are partially covered with Siepel pyramidal absorber.

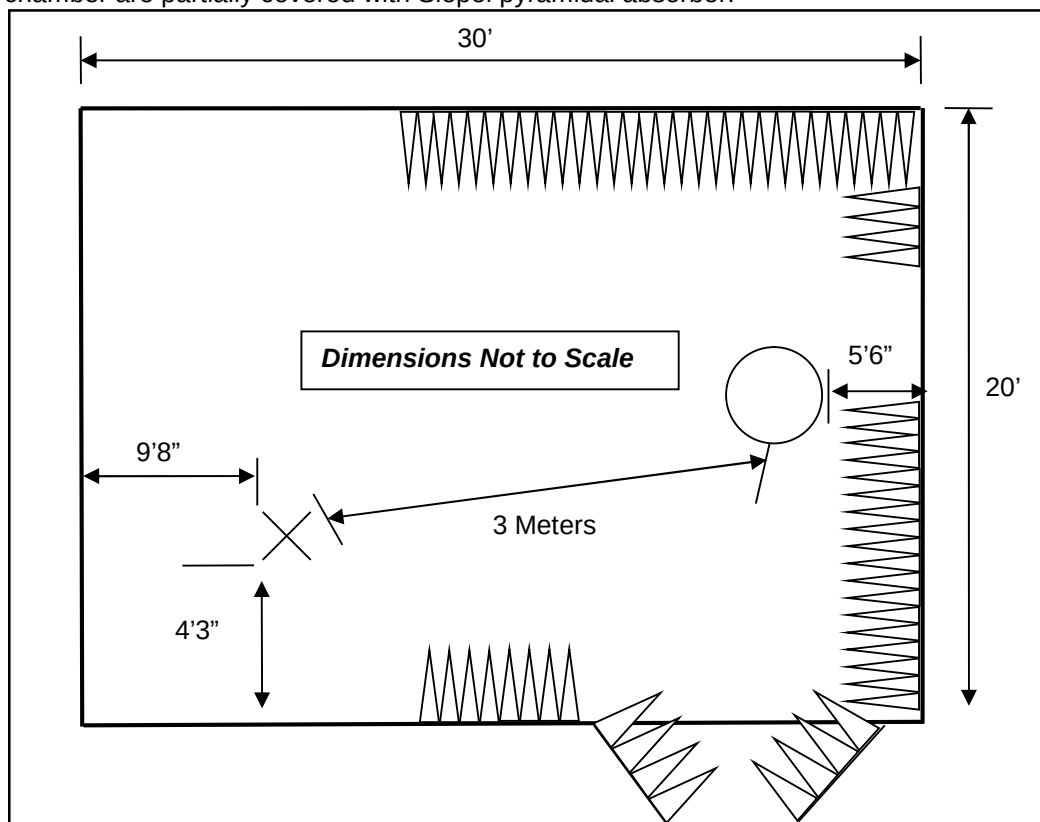


Figure 2.3.1-1: Semi-Anechoic Chamber Test Site – Chamber A

2.3.2 Semi-Anechoic Chamber Test Site – Chamber B

The Semi-Anechoic Chamber Test Site consists of a 20'W x 30'L x 20'H shielded enclosure. The chamber is lined with ETS-Lindgren Ferrite Absorber, model number FT-1500. The ferrite tile 600 mm x 600 mm (2.62 in x 23.62 in) panels and are mounted directly on the inner walls of the chamber shield.

The specular regions of the chamber are lined with additional ETS-Lindgren PS-600 hybrid absorber to extend its frequency range up to 18GHz and beyond.

The turntable is a 2m ETS-Lindgren Model 2170 and installed off the center axis is located 5'6" from the back wall of the chamber. The chamber is grounded via 1 - 8' copper ground rod, installed at the center of the back wall, it is bound to the shield using #8 solid copper wire.

The antenna mast is an EMCO 1060 and is remotely controlled from the control room for both antenna height and polarization.

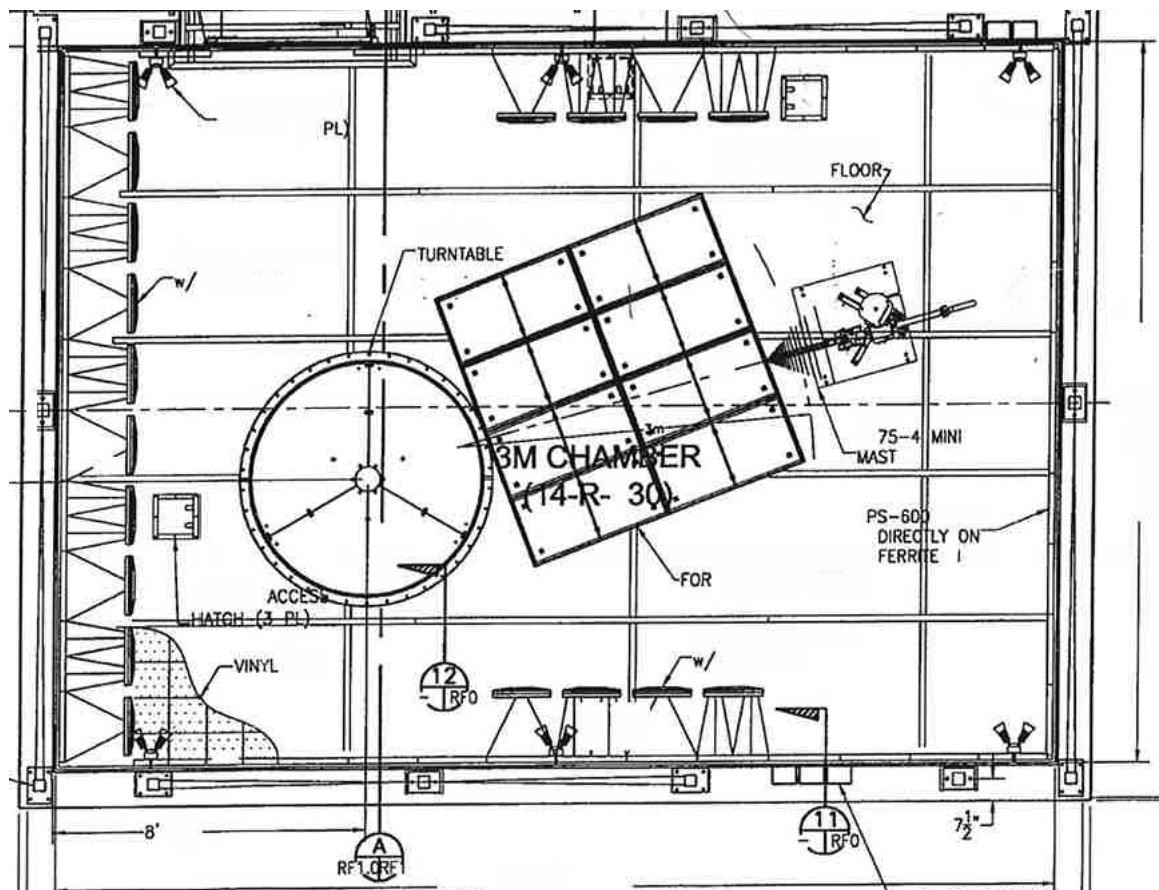


Figure 2.3.2-1: Semi-Anechoic Chamber Test Site – Chamber B

2.4 Conducted Emissions Test Site Description

2.4.1 Conducted Emissions Test Site

The AC mains conducted EMI site is located in the main EMC lab. It consists of a 12' x 10' horizontal coupling plane (HCP) as well as a 12'x8' vertical coupling plane (VCP). The HGP is constructed of 4' x 10' sheets of particle board sandwiched by galvanized steel sheets. These panels are bonded using 11AWG 1/8" x 2" by 10' galvanized sheet steel secured to the panels via by screws. The VCP is constructed of three 4'x8' sheets of 11AWG solid aluminum.

The HCP and VCP are electrically bonded together using 1"x1" angled aluminum secured with screws.

The site is of sufficient size to test table top and floor standing equipment in accordance with ANSI C63.10.

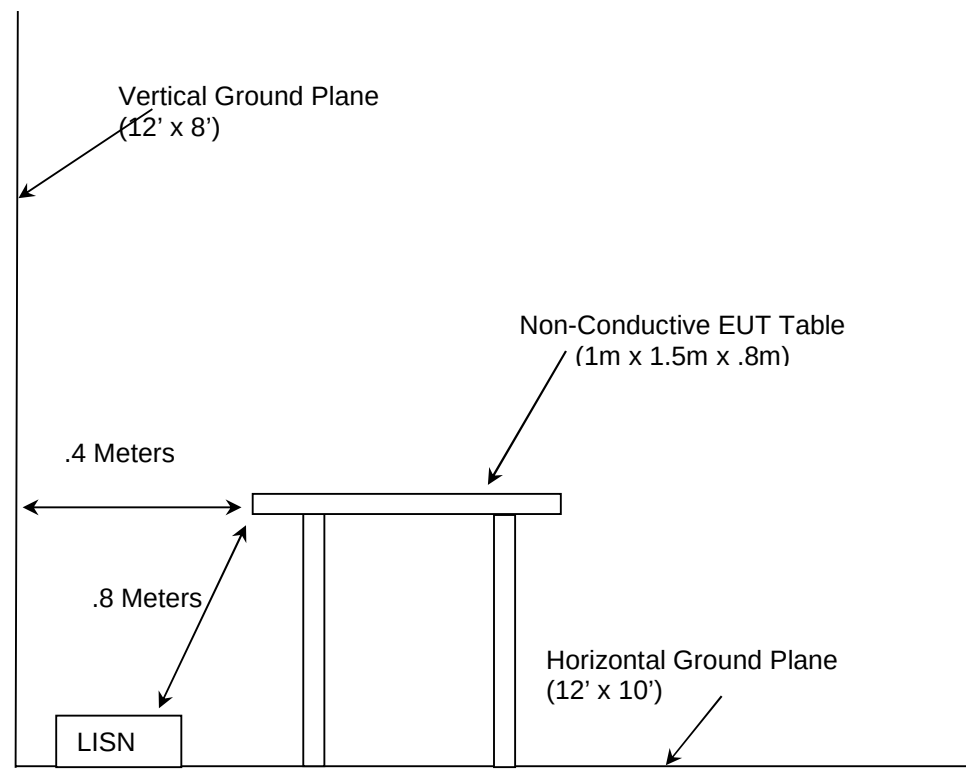


Figure 2.4.1-1: AC Mains Conducted EMI Site

3 APPLICABLE STANDARD REFERENCES

The following standards were used:

- ❖ ANSI C63.10-2013: American National Standard of Procedures for Compliance Testing of Unlicensed Wireless Devices.
- ❖ ANSI C63.26-2015: American National Standard for Compliance Testing of Transmitters Used in Licensed Radio Services
- ❖ US Code of Federal Regulations (CFR): Title 47, Chapter I, Subchapter A, Part 2, Subpart J: Equipment Authorization Procedures, 2019
- ❖ US Code of Federal Regulations (CFR): Title 47, Chapter I, Subchapter A, Part 15, Subpart C: Radio Frequency Devices, Intentional Radiators, 2019
- ❖ US Code of Federal Regulations (CFR): Title 47, Chapter I, Subchapter B, Part 22: Equipment Authorization Procedures, 2019
- ❖ US Code of Federal Regulations (CFR): Title 47, Chapter I, Subchapter B, Part 24: Equipment Authorization Procedures, 2019
- ❖ US Code of Federal Regulations (CFR): Title 47, Chapter I, Subchapter B, Part 27: Equipment Authorization Procedures, 2019
- ❖ US Code of Federal Regulations (CFR): Title 47, Chapter I, Subchapter D, Part 90 - Equipment Authorization Procedures, 2019
- ❖ Innovation, Science and Economic Development Canada Radio Standards Specification: RSS-210 – Low-power License-exempt Radiocommunication Devices (All Frequency Bands): Category I Equipment, Issue 9, August 2016, Amendment November 2017
- ❖ Innovation, Science and Economic Development Canada Radio Standards Specification: RSS-GEN – General Requirements for Compliance of Radio Apparatus, Issue 5, April 2018, Amendment March 2019
- ❖ Innovation, Science and Economic Development Canada Radio Standards Specification: RSS-130 - Equipment Operating in the Frequency Bands 617-652 MHz, 663-698 MHz, 698-756 MHz and 777-787 MHz, Issue 2, February 2019
- ❖ Innovation, Science and Economic Development Canada Radio Standards Specification: RSS-132 - Cellular Telephone Systems Operating in the Bands 824-849 MHz and 869-894 MHz, Issue 3, January 2013
- ❖ Innovation, Science and Economic Development Canada Radio Standards Specification: RSS-133 - 2 GHz Personal Communications Services, Issue 6, Amendment 1, January, 2018
- ❖ Innovation, Science and Economic Development Canada Radio Standards Specification: RSS-139 - Advanced Wireless Services (AWS) Equipment Operating in the Bands 1710-1780 MHz and 2110-2180 MHz, Issue 3, July, 2015
- ❖ Innovation, Science and Economic Development Canada Radio Standards Specification: RSS-199 - Broadband Radio Service (BRS) Equipment Operating in the Band 2500–2690 MHz, Issue 3, December 2016

4 LIST OF TEST EQUIPMENT

The calibration interval of test equipment is annually or the manufacturer's recommendations. Where the calibration interval deviates from the annual cycle based on the instrument manufacturer's recommendations, it shall be stated below.

Table 4-1: Test Equipment

Asset ID	Manufacturer	Model	Equipment Type	Serial Number	Last Calibration Date	Calibration Due Date
30	Spectrum Technologies	DRH-0118	1-18GHz Horn Antenna	970102	05/29/2019	05/29/2021
213	TEC	PA 102	Amplifier	44927	07/19/2018	07/19/2019
331	Microwave Circuits	H1G513G1	Microwave Bandpass Filter	31417	5/31/2019	5/31/2020
338	Hewlett Packard	8449B	High Frequency Pre-Amp	3008A01111	07/11/2017	07/11/2019
622	Rohde & Schwarz	FSV40 (v3.40)	FSV Signal Analyzer 10Hz to 40GHz	101338	07/30/2018	07/30/2020
628	EMCO	6502	Active Loop Antenna 10kHz-30MHz	9407-2877	02/11/2019	11/02/2021
851	TUV ATLANTA	FMC0101951-100CM	ASAC Cable Set Consisting of 566, 619, and 564	N/A	09/26/2018	09/26/2019
852	Teseq	CBL 6112D	Bilog Antenna; Attenuator	51617	10/15/2018	10/15/2019

NCR = No Calibration Required

NOTE: All Equipment only used during active calibration cycles.

5 SUPPORT EQUIPMENT

Table 5-1: Support Equipment

Item #	Type Device	Manufacturer	Model/Part #	Serial #
1	DC Power Supply	TekPower	TP300ST	483280
2	Wideband Communications Analyzer	Rohde & Schwarz	CMW-500	116944

Table 5-2: Cable Description

Cable #	Cable Type	Length	Shield	Termination
A	DC Power	2 m	None	EUT - 1

6 EQUIPMENT UNDER TEST SETUP BLOCK DIAGRAM

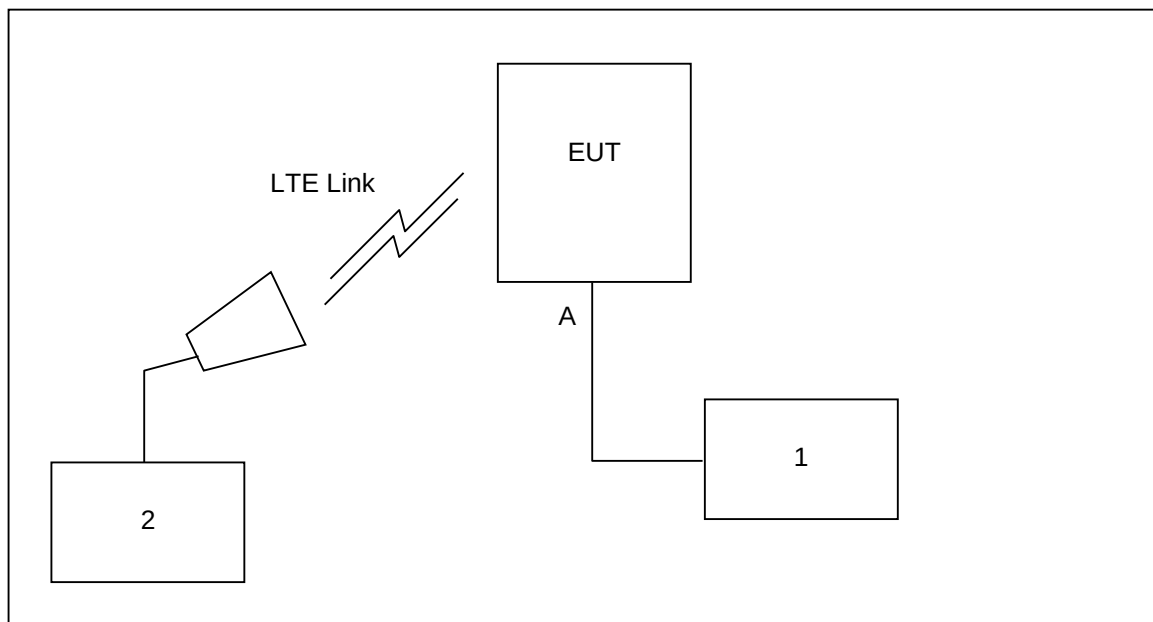


Figure 6-1: EUT Test Setup

7 SUMMARY OF TESTS

7.1.1 Intermodulation Products due to Simultaneous Transmissions

7.1.1.1 Measurement Procedure

The unwanted emissions due to intermodulation products up to the 5th order were investigated over the frequency range of 9 kHz to 18 GHz.

The EUT was rotated through 360° and the receive antenna height was varied from 1 meter to 4 meters so that the maximum radiated emissions level would be detected. For frequencies below 1000 MHz, RMS measurements were made using a resolution bandwidth RBW of 100 kHz and a video bandwidth VBW of 300 kHz. For frequencies above 1000 MHz, RMS measurements were made with RBW and VBW of 1 MHz and 3 MHz respectively.

Each identified emission was measured and compared to the licensed limit of -13dBm which equates to 82.2dBuV/m at 3 meters.

7.1.1.2 Measurement Results

Performed by: Jeremy Pickens

Table 7.1.1.2-1: Substitution Method Results- Simultaneous Transmission

Frequency (MHz)	Level (dBuV)		Antenna Polarity (H/V)	Correction Factors (dB)	Corrected Level (dBuV/m)		Limit (dBuV/m)		Margin (dB)	
	pk	RMS			pk	RMS	pk	RMS	pk	RMS
915MHz + LTE Band 1 - 1950MHz / 5MHz BW										
3900	-----	35.60	V	3.04	-----	38.64	-----	82.2	-----	43.6
915MHz + LTE Band 4 - 1747.5MHz / 1.4MHz BW										
832.5	-----	49.50	V	1.21	-----	50.71	-----	82.2	-----	31.5
1747.5	-----	40.40	V	-5.05	-----	35.35	-----	82.2	-----	46.8
915MHz + LTE Band 12 - 707.5MHz / 1.4MHz BW										
207.55	-----	63.00	V	-10.47	-----	52.53	-----	82.2	-----	29.7
500	-----	52.60	V	-1.99	-----	50.61	-----	82.2	-----	31.6
1415	-----	48.30	V	-6.04	-----	42.26	-----	82.2	-----	39.9
1415	-----	48.10	H	-6.04	-----	42.06	-----	82.2	-----	40.1
915MHz + LTE Band 13 - 782MHz / 5MHz BW										
133	-----	59.90	V	-8.19	-----	51.71	-----	82.2	-----	30.5
649	-----	56.60	V	0.22	-----	56.82	-----	82.2	-----	25.4
915MHz + LTE Band 25 - 1882.5MHz / 1.4MHz BW										
967.5	-----	54.30	V	3.10	-----	57.40	-----	82.2	-----	24.8
3765	-----	36.00	V	2.39	-----	38.39	-----	82.2	-----	43.8
915MHz + LTE Band 26 - 831.5MHz / 1.4MHz BW										
83.5	-----	65.2	V	-12.48	-----	52.72	-----	82.2	-----	29.5
745.6	-----	65.2	V	0.82	-----	66.02	-----	82.2	-----	16.2
1663	-----	40.3	V	-5.04	-----	35.26	-----	82.2	-----	46.9
915MHz + LTE Band 41 - 2567.5MHz / 5MHz BW										
5135	-----	36.4	V	5.61	-----	42.01	-----	82.2	-----	40.2

8 ESTIMATION OF MEASUREMENT UNCERTAINTY

The expanded laboratory measurement uncertainty figures (U_{Lab}) provided below correspond to an expansion factor (coverage factor) $k = 1.96$ which provide confidence levels of 95%.

Table 8-1: Estimation of Measurement Uncertainty

Parameter	U_{lab}
Occupied Channel Bandwidth	$\pm 0.009 \%$
RF Conducted Output Power	$\pm 0.349 \text{ dB}$
Power Spectral Density	$\pm 0.372 \text{ dB}$
Antenna Port Conducted Emissions	$\pm 1.264 \text{ dB}$
Radiated Emissions $\leq 1 \text{ GHz}$	$\pm 5.814 \text{ dB}$
Radiated Emissions $> 1 \text{ GHz}$	$\pm 4.318 \text{ dB}$
Temperature	$\pm 0.860 \text{ }^{\circ}\text{C}$
Radio Frequency	$\pm 2.832 \times 10^{-8}$
AC Power Line Conducted Emissions	$\pm 3.360 \text{ dB}$

9 CONCLUSION

In the opinion of TÜV SÜD America, Inc. the LUMEN-TERRAIN-1-0-0-0-F-0-2 manufactured by GE Measurement & Control meets the requirements of Parts 15.249, 22, and 24 of the FCC's Code of Federal Regulations and Innovation, Science and Economic Development Canada's Radio Standards Specification RSS-210/132/133/139 for the tests documented in this test report.

END REPORT