EMC Test Report

As per

FCC Part 15 Subpart C & RSS-210

for

Low power unlicensed devices

on the

Terrain Defender ™ TD-100

Issued by: **TÜV SÜD Canada Inc.**
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Testing produced for

Fiber SenSys
AN OPTEX GROUP COMPANY

See Appendix A for full client & EUT details.

Testing Laboratory
Certificate #2955.19

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FCC_ICES003_Emissions_Rev5

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Report Scope

This report addresses the EMC verification testing and test results of the **Terrain Defender ™ TD-100**, herein referred to as EUT (Equipment Under Test). The EUT was tested for emissions compliance against the following standards:

FCC Part 15 Subpart C

RSS-210

For a more detailed list of the standards and the revision used, see the "Applicable Standards, Specifications and Methods" section of this report.

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.

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Summary

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

Equipment Under Test (EUT)	**Terrain Defender ™ TD-100**
EUT passed all tests performed	Yes
Testing conducted by	Scott Drysdale Glen WestWell

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

Test Results Summary

Standard/ Method	Description	Class / Level	Result
FCC 15.207 RSS-210	Power Line Conducted Emissions	N/A	Pass
FCC 15.209 RSS-210	Radiated Emissions	As per 15.209	Pass
RSS-GEN	Frequency Stability	N/A	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 is issued.

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Notes, Justifications, or Deviations

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

In accordance with guidance in ANSI C 63.10, section 6.11.1, radiated emissions testing of the EUT has been accomplished at three or more representative locations, the results may be considered representative of all sites with similar EUT configurations, for the purposes of determining compliance with emission requirements.

For power line conducted emissions, as the EUT is a direct current (dc) powered devices where the ac power adapter is not supplied with the device, an “off-the-shelf” unmodified DC power supply for 48Vdc was used. For representative purposes for power line conducted emissions requirements, the device was tested as a table top configuration with a representative load in place of the typical buried coaxial cable.

During frequency stability the EUT was placed in a test firmware mode with an unmodulated carrier (CW). For frequency stability, the device was placed in a chamber at -30°C, -20°C, +20°C, and +50°C at the manufacturer’s rated supply voltage, no measurable change in frequency or amplitude was observed. At the temperature of +20° and at ±15% of the manufacturer's rated supply voltage (48Vdc), no measurable change in frequency or amplitude was observed..

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Sample Calculation(s)

Radiated Emission Test

E-Field Level = Received Signal + Antenna Factor + Cable Loss – Pre-Amp Gain
E-Field Level = 50dBµV + 10dB/m + 2dB – 20dB
E-Field Level = 42dBµV/m

Margin = Limit – E-Field Level
Margin = 50dBµV/m – 42dBµV/m
Margin = 8.0 dB (pass)

Power Line Conducted Emission Test

Level = Received Signal + Attenuation Factor + Cable Loss + LISN Factor
Level = 50dBµV + 10dB + 2.5dB + 0.5dB
Level = 63dBµV

Margin = Limit - Level
Margin = 73dBµV – 63dBµV
Margin = 10.0 dB (pass)

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Applicable Standards, Specifications and Methods

ANSI C63.10	Licence-Exempt Radio Apparatus: Category I Equipment
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
CFR47 FCC Part 15 Subpart C	Code of Federal Regulations – Radio Frequency Devices
RSS-210 Issue 10	Licence-Exempt Radio Apparatus: Category I Equipment
ISO/IEC 17025:2017	General requirements for the competence of testing and calibration laboratories

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Document Revision Status

Revision	Date	Description
000	August 7, 2020	Initial Release

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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.

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.

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 of telecommunication messages and which may be equipped with one or more terminal ports typically operated for information transfer.

EMC Test Plan – An EMC test plan established prior to testing. See 'Appendix A – EUT & Client Provided Details'

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Testing Facility

Testing for EMC on the EUT was carried out at TÜV SÜD Canada testing lab in Otytawa, Ontario and locations as documented in Appendix C. The testing lab has calibrated 3m and 10- m semi-anechoic chamber which allow measurements on a EUT that has a maximum width or length of up to 4m and a height of up to 4m. The chamber is equipped with a turntable that is capable of testing devices up to 8000lb 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 Loop, Biconical, Log periodic, 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 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. The field uniformity data is kept on file at TÜV SÜD Canada. TÜV SÜD Canada Inc. is accredited to ISO/IEC 17025 by A2LA with Testing Certificate #2955.19. 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 during time of testing:

Date	Test	Initials	Temperature (ºC)	Humidity (%)	Pressure (kPa)
January 9, 2020	Power Line Conducted Emissions	SD	18	25	103.0 – 104.0
Site #1 – November 26, 2019	Radiated Emissions	SD	7 to 10	65	101.2 – 101.8
Site #2 – June 11 (AM), 2020	Radiated Emissions	GW	16-18	50-65	100.0-102.0
Site #3 – June 11 (PM), 2020	Radiated Emissions	GW	16-20	50-60	100.0-102.0

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Detailed Test Result Section

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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 and measured from a LISN. This helps protect lower frequency radio services such as AM radio, shortwave radio, amateur radio, maritime radio, CB radio, and so on, from unwanted interference.

Limits & Method

The method is as defined in ANSI C63.10. The limits are as defined in FCC Part 15 Section 15.207 and RSS-GEN:

Average Limits		Quasi-Peak Limits	
150 kHz – 500 kHz	56 to 46* dBµV	150 kHz – 500 kHz	66 to 56* dBµV
500 kHz – 5 MHz	46 dBµV	500 kHz – 5 MHz	56 dBµV
5 MHz – 30 MHz	50 dBµV	5 MHz – 30 MHz	60 dBµV

* Decreases linearly with the logarithm of the frequency

Both Quasi-Peak and Average limits are applicable, and each is specified as being measured with a resolution bandwidth of 9 kHz. For Quasi-Peak, a video bandwidth at least three times greater than the resolution bandwidth is used.

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

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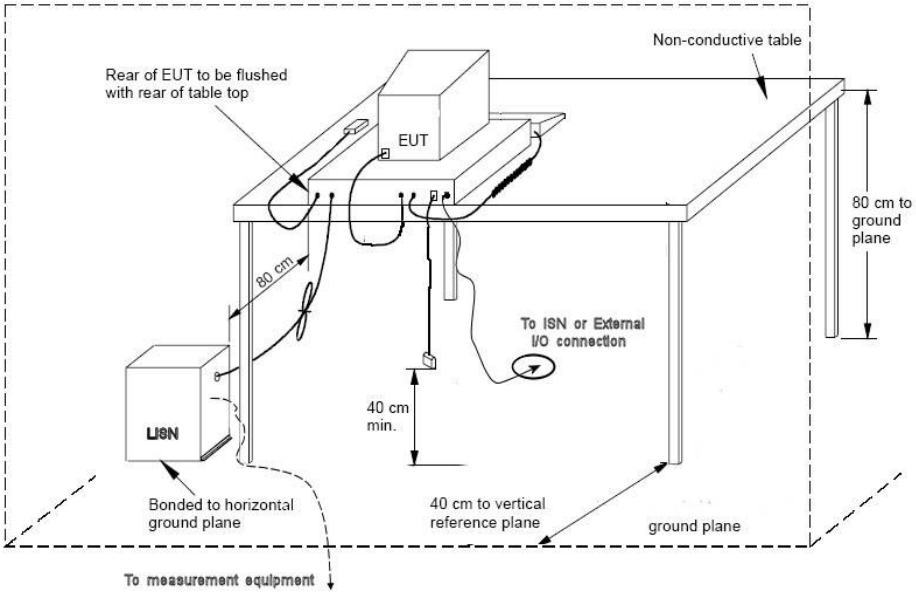
Typical Setup Diagram



Measurement Uncertainty

The expanded measurement uncertainty is calculated in accordance with CISPR 16-4-2 and is ±2.27dB 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. 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.

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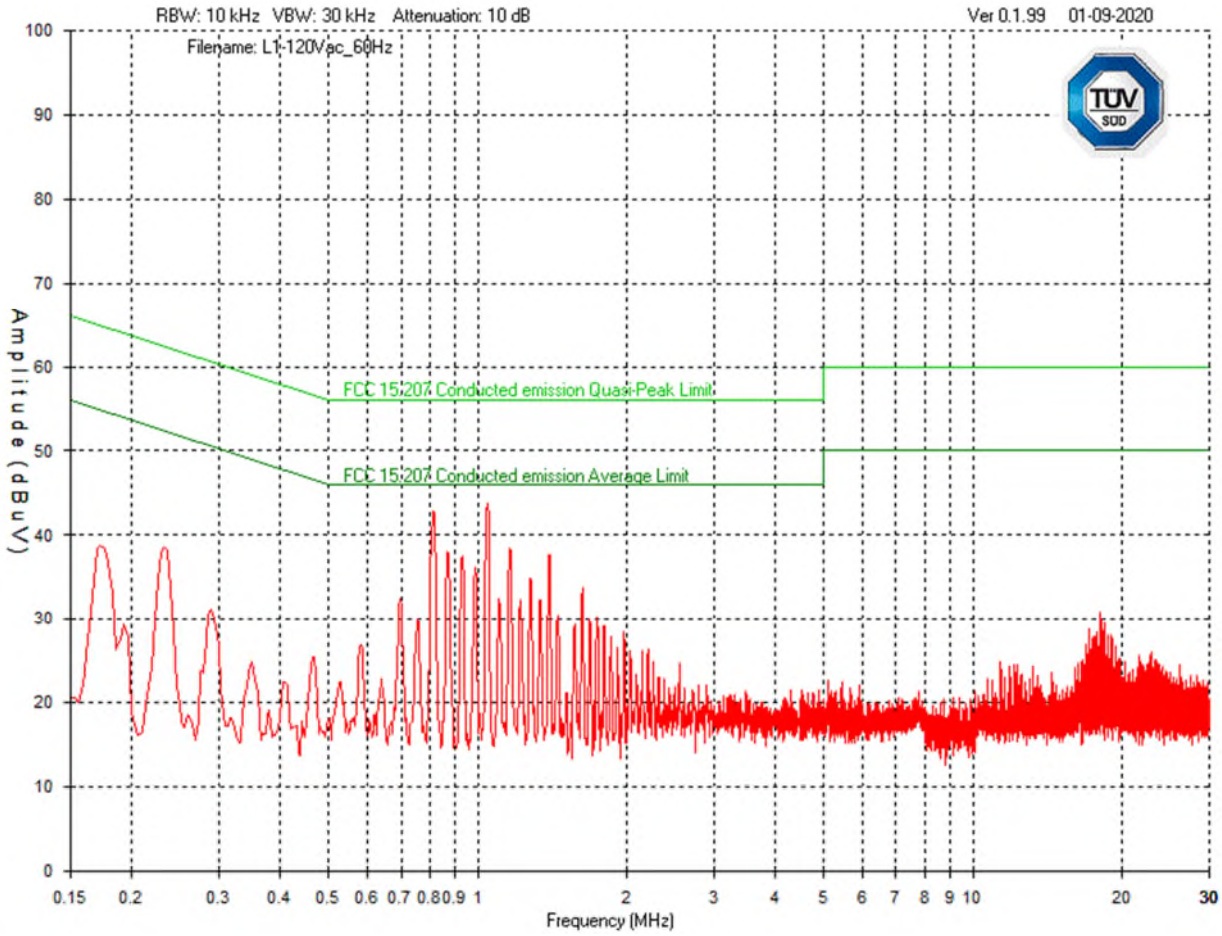
Line (L1) – 120Vac 60Hz



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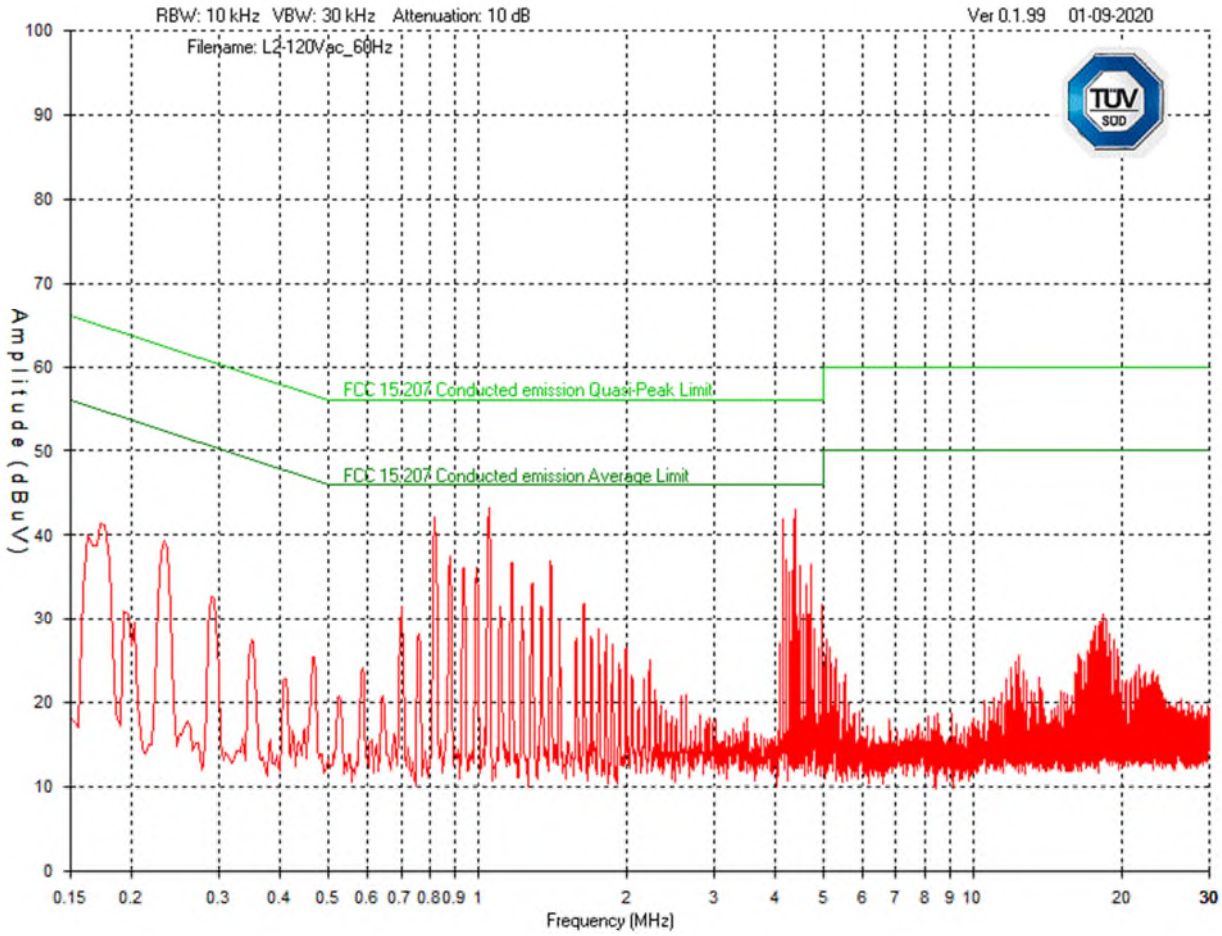
Neutral (L2) – 120Vac 60Hz



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Final Measurements

Peak Emissions Table Vs. Average Limits

Line 1

Frequency (MHz)	Raw Reading dBuV	Atten (dB)	Cable (dB)	LISN (dB)	Level (dBuV)	Limit (dBuV)	Margin
1.0488	33.6	10	0.1	0.2	43.9	46	2.1
0.8133	32.7	10	0	0.2	42.9	46	3.1
1.1616	28.1	10	0.1	0.2	38.4	46	7.6
0.8697	27.8	10	0	0.2	38	46	8
1.3971	27.3	10	0.1	0.2	37.6	46	8.4
0.9294	27.2	10	0	0.2	37.4	46	8.6

Line 2

Frequency (MHz)	Raw Reading dBuV	Atten (dB)	Cable (dB)	LISN (dB)	Level (dBuV)	Limit (dBuV)	Margin
1.053	33	10	0.1	0.2	43.3	46	2.7
4.3697	32.7	10	0.1	0.2	43	46	3
0.8173	31.8	10	0	0.2	42	46	4
4.1373	31.6	10	0.1	0.2	41.9	46	4.1
0.8771	27.3	10	0	0.2	37.5	46	8.5
4.1937	26.9	10	0.1	0.2	37.2	46	8.8

All peak emission were below the average limit thus the EUT was deemed to meet power line conducted emission limits based on peak emission.

See 'Appendix B – EUT, Peripherals and Test Setup Photos' 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 Date	Asset #
Spectrum Analyzer	ESL 6	Rohde & Schwarz	Feb. 25, 2019	Feb. 25, 2021	GEMC 160
LISN	FCC-LISN-50/250-16-2-01	FCC	Feb. 27, 2019	Feb. 27, 2021	GEMC 303
RF Cable 3m	LMR-400-3M-50Ω-MN-MN	LexTec	N/A	N/A	GEMC 276
Attenuator 10 dB	10-A-MFN-10	Bird/Hutton	N/A	N/A	GEMC 323
Emissions Software	0.1.99	TUV SUD Canada, Inc.	N/A	N/A	GEMC 58

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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 and ANSI C63.10
The limits are as defined in FCC Part 15, Section 15.209 / RSS-210

0.009 MHz – 0.490 MHz, 2400/F(kHz) uV/m at 300 m[4]
0.490 MHz – 1.705 MHz, 24000/F(kHz) uV/m at 30 m[4]
1.705 MHz – 30 MHz, 30 uV/m at 30 m[4]
30 MHz – 88 MHz, 100 uV/m (40.0 dBuV/m[1]) at 3 m
88 MHz – 216 MHz, 150 uV/m (43.5 dBuV/m[1]) at 3 m
216 MHz – 960 MHz, 200 uV/m (46.0 dBuV/m[1]) at 3 m
Above 960 MHz, 500 uV/m (54.0 dBuV/m[1]) at 3 m
Above 1000 MHz, 500 uV/m (54 dBuV/m[2]) at 3m
Above 1000 MHz, 5000 uV/m (74 dBuV/m[3]) at 3m

[1]Limit is with 120 kHz measurement bandwidth and a using a Quasi Peak detector.
[2]Limit is with 1 MHz measurement bandwidth and using an Average detector
[3]Limit is with 1 MHz measurement bandwidth and using an Peak detector
[4]Limit is with using a Quasi-peak detector with a bandwidth as defined in CISPR 16-1-1

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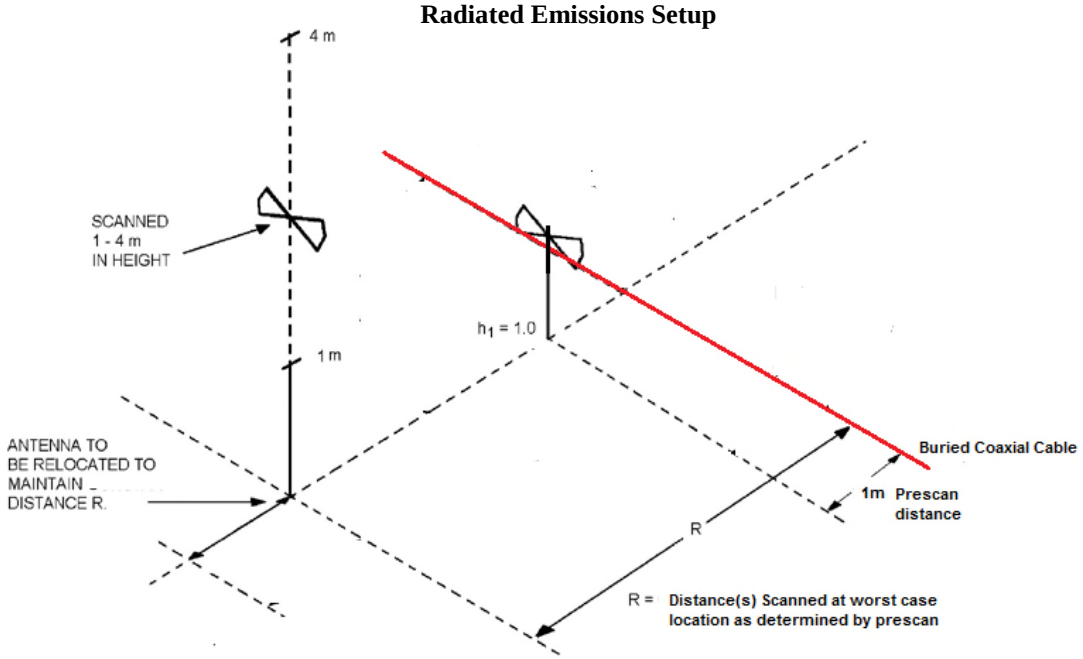
Radiated Emissions Setup



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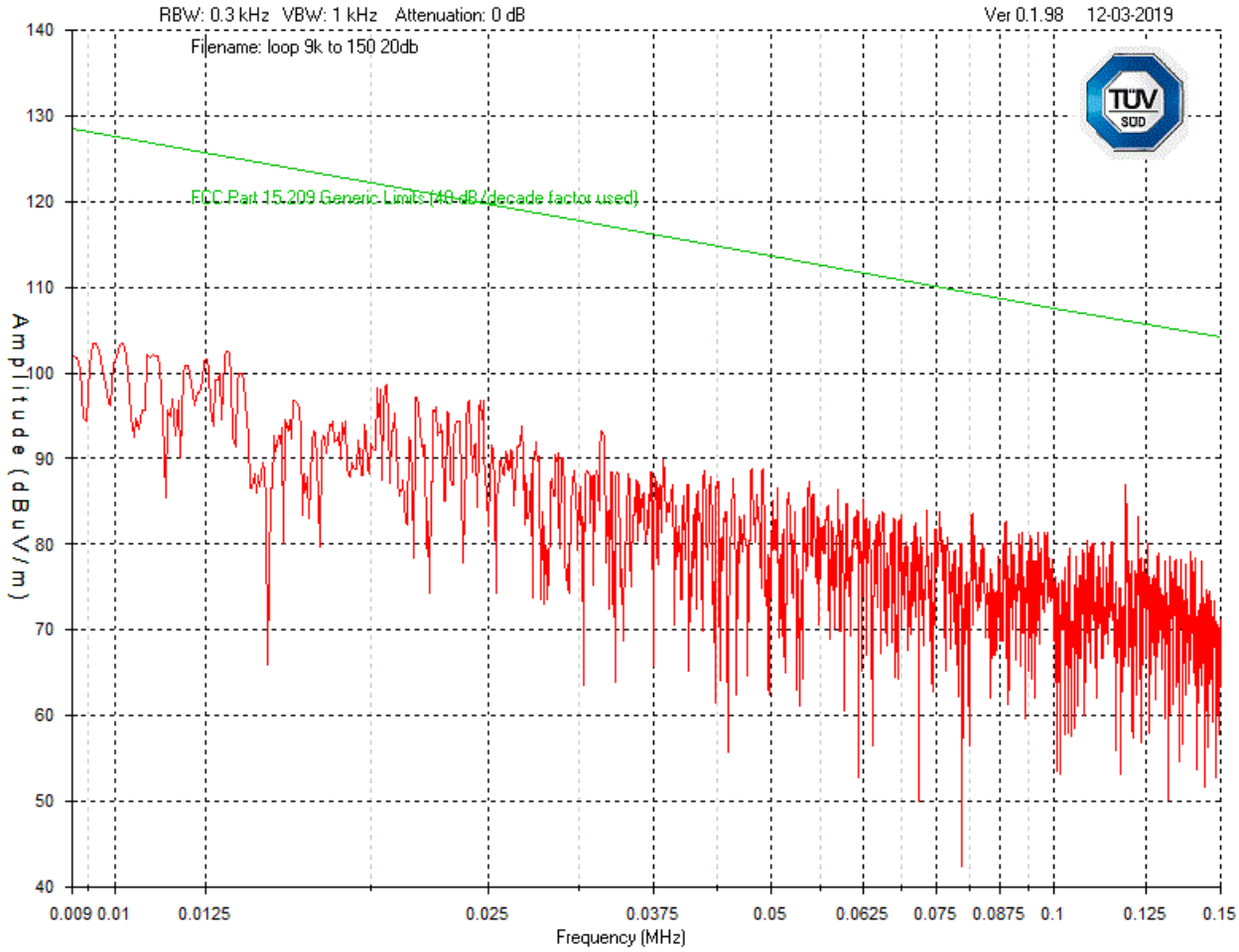
Preliminary Graphs

Note the graphs shown below are for graphical illustration only, obtained at site #1 at 3 meter distance. 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 then or equal to the final required detector. 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 a minimum of a 1 GHz.

Loop– Peak Emissions Graph



Note: No emissions from the EUT were detected in this frequency range.

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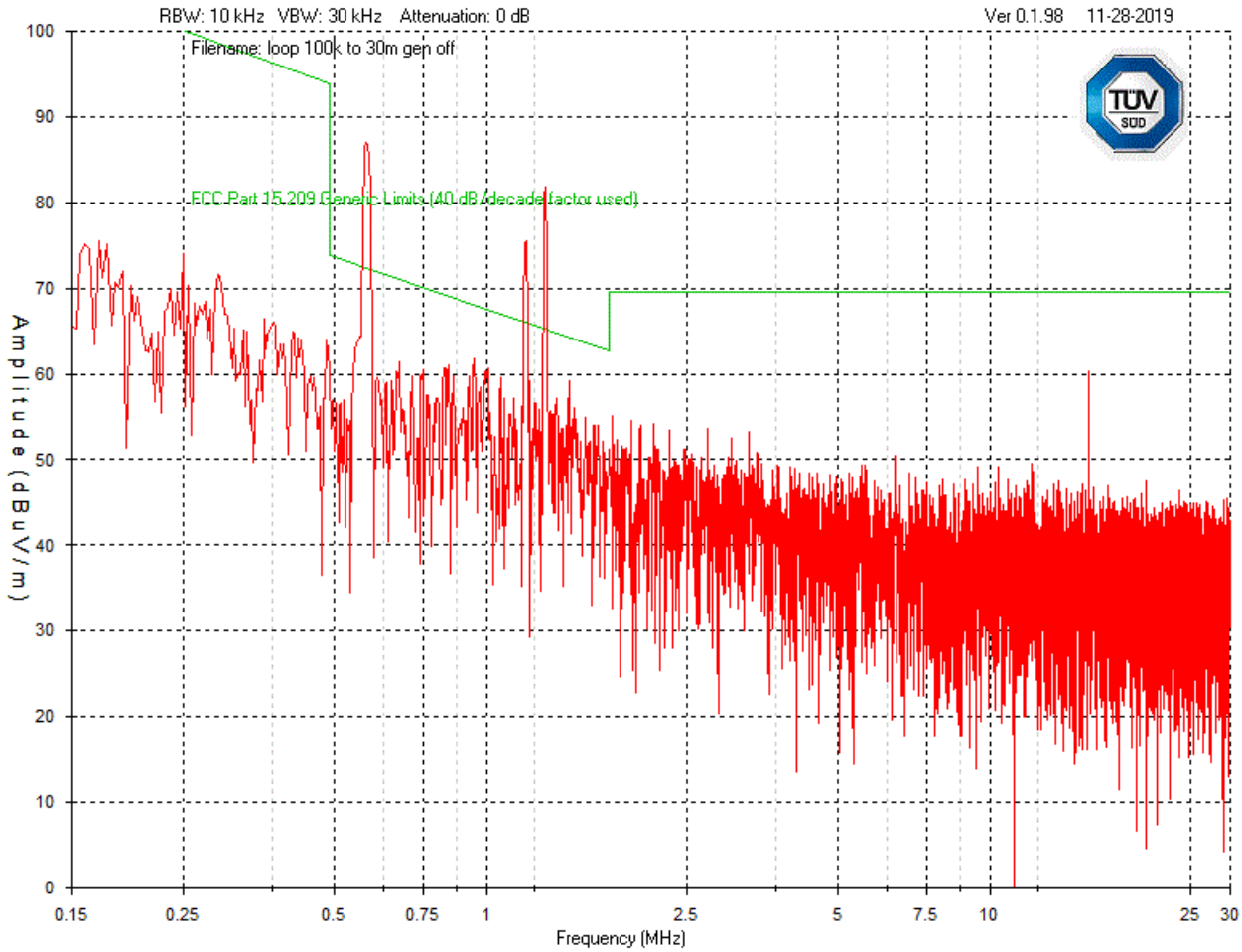
Loop– Peak Emissions Graph



Note: Peaks shown exceeding the limit as shown above were determined to be ambient emissions (AM Radio broadcast)

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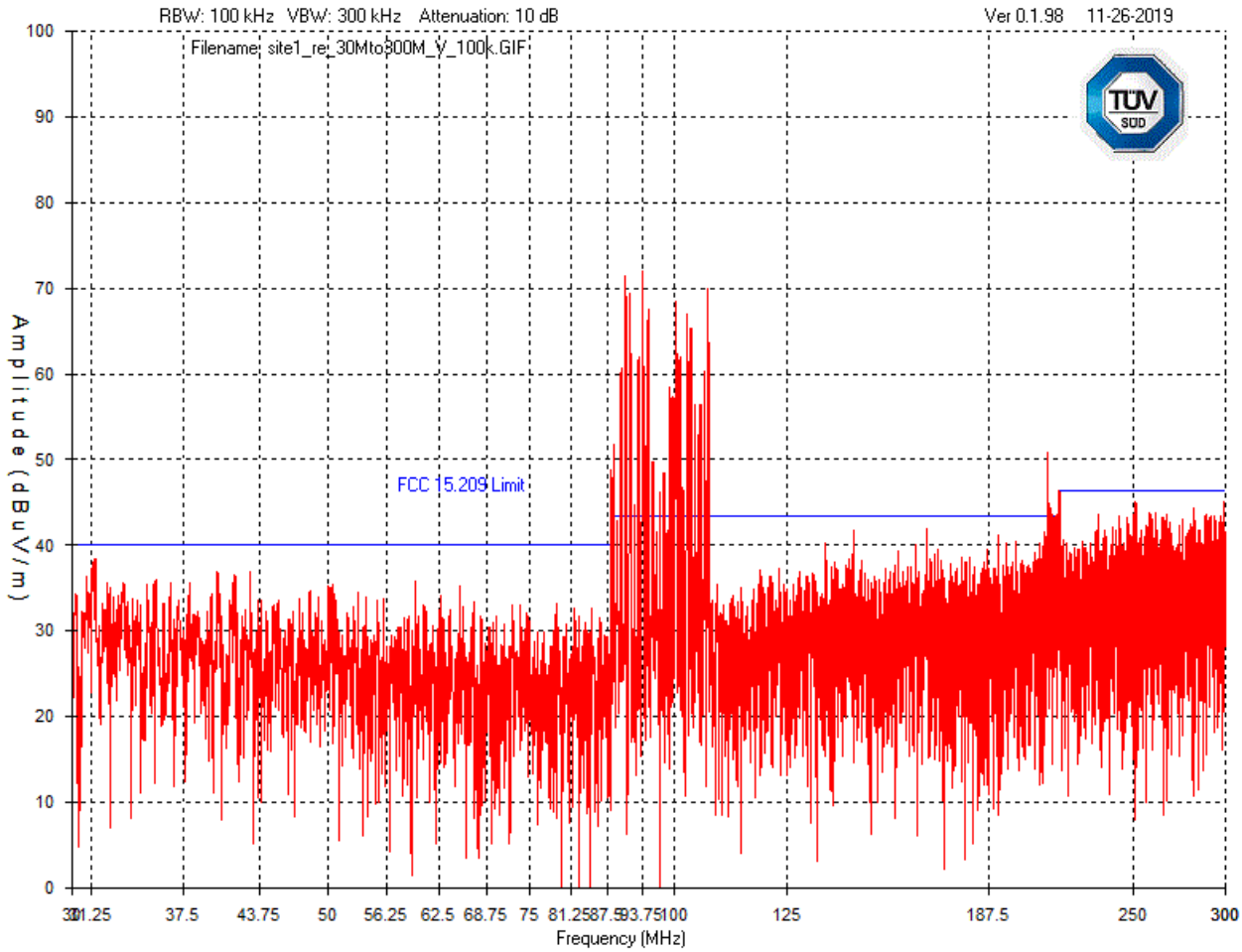
Vertical – Peak Emissions Graph



Note: All emissions other than the emission at 31.2 MHz were determined to be ambient.
No emissions above 300 MHz were detected from the EUT.

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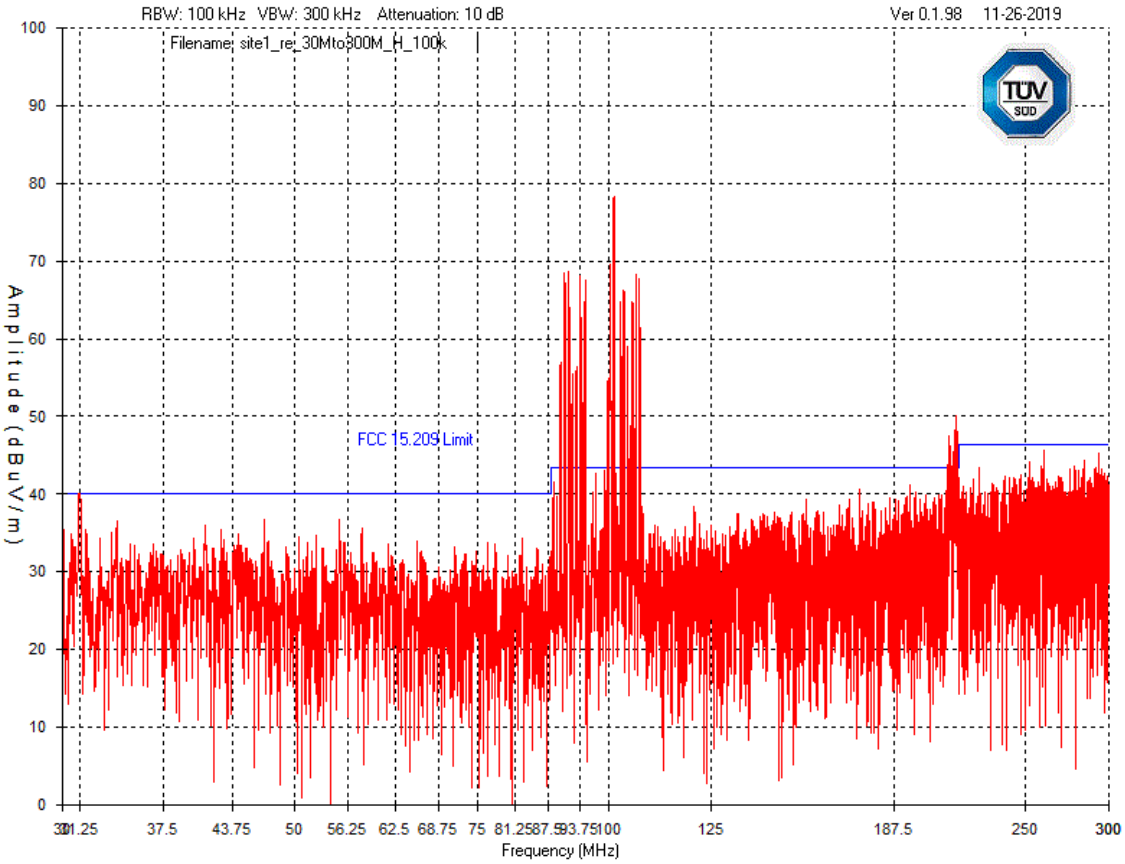
Horizontal – Peak Emissions Graph



Note: All emissions other than the emission at 31.2 MHz were determined to be ambient. No emissions above 300 MHz were detected from the EUT.

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Site #1.

25 Discrete locations were pre-scanned, roughly every 15 meters. The worst case location was then scanned at 30 meters as noted below

Location	1m raw dBuV reading
1	31.6
2	27.2
3	27.5
4	27.9
5	30
6	28.4
7	29.7
8	27.6
9	28.3
10	28.4
11	26.6
12	29.3
13	28.9
14	28.9
15	24.7
16	27.6
17	32
18	30.7
19	34.9
20	33.9
21	26.4
22	35.1
23	21.9
24	22.5
25	26.5

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Final Measurements

Site #1

Frequency (MHz)	Raw Reading QP (dBuV)	Pol	Bicon Factor	Cable 1 Factor	Cable 2 Factor	Level (dBuV/m)	30 meter Limit (dBuV/m)	Margin (dB)	Pass/Fail
31.25	0.4 (note 1)	V	17.6	0.3	0.6	18.9	20	1.1	Pass
31.25	-6.6 (note 1)	H	17.6	0.3	0.6	11.5	20	8.5	Pass

Site #2

Frequency (MHz)	Raw Reading QP (dBuV)	Pol	Bicon Factor	Cable 1 Factor	Cable 2 Factor	Level (dBuV/m)	30 meter Limit (dBuV/m)	Margin (dB)	Pass/Fail
31.25	-2.6 (note 1)	V	17.6	0.3	0.6	15.9	20	4.1	Pass
31.25	-12.7 (note 1)	H	17.6	0.3	0.6	5.8	20	14.2	Pass

Site #3

Frequency (MHz)	Raw Reading QP (dBuV)	Pol	Bicon Factor	Cable 1 Factor	Cable 2 Factor	Level (dBuV/m)	30 meter Limit (dBuV/m)	Margin (dB)	Pass/Fail
31.25	0.0 (note 1)	V	17.6	0.3	0.6	18.5	20	1.5	Pass
31.25	-10.1 (note 1)	H	17.6	0.3	0.6	8.4	20	11.6	Pass

Note 1. This reading was obtained at 30 meters via setting the EUT via test firmware into CW mode, and measured using a lower resolution bandwidth and lower video bandwidth. At a closer distance a delta was obtained at the required resolution bandwidth and detector type when in modulated mode and this was compared to the measurement CW mode to obtain the delta. This delta was applied to the 30 meter CW reading to provide for the equivalent QP reading, as the EUT signal was not detectable at this distance with the QP detector.

The worst case fundamental, with modulation applied, was measured to be 18.9 dBuV/m at 30 meters. All other emissions then what was shown were either determined to be ambient or had more margin than 20 dB to the limit.

Above 300 MHz, no emissions were detected from the EUT.

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Test Equipment List

Equipment	Model No.	Manufacturer	Last calibration date	Next calibration due date	Asset #
Spectrum Analyzer	FSV40	Rhode & Schwarz	4/1/19	4/1/21	SSG013948
Loop Antenna	EM 6871	Electro-Metrics	2/15/19	2/15/2021	70
Loop Antenna	EM 6872	Electro-Metrics	2/15/19	2/15/2021	71
Bicon Antenna	PBA2030	TDK	06/03/19	06/03/21	256
Log Periodic Antenna	PLP3003	TDK	5/30/19	5/30/21	259
Attenuator 6 dB	8491A	HP	06/03/19	06/03/21	289
RF Cable 7m	LMR-400-7M-50OHM-MN-MN	LexTec	N/A	N/A	4026
RF Cable 1M	LMR-400-1M-50OHM-MN-MN	LexTec	N/A	N/A	4039
RF Cable 10m	LMR-400-10M-50OHM-MN-MN	LexTec	N/A	N/A	4025

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20 dB Bandwidth

Purpose

The purpose of this test is to ensure that the bandwidth occupied does not exceed a stated minimum. This helps ensure the utilization of the frequency allocation is sufficiently narrow, and not occupying excessive spectrum or extending into restricted bands of e. This also helps prevent accidently interference of data by ensuring adequate data separation to distinguish the reception of the intended information by enabling the receiver to have a relatively narrow band response tuned to the transmitter's frequency.

Limits

The Limit is as specified in FCC Part 15 and RSS 210 and RSS-GEN to not occupy restricted bands. Method is as per ANSI C63.10.

Results

The EUT passed. The 20 dB BW measured was 8.6 MHz and did not encroach on any restricted bands, nearest being 25.67 MHz and 37.5 MHz

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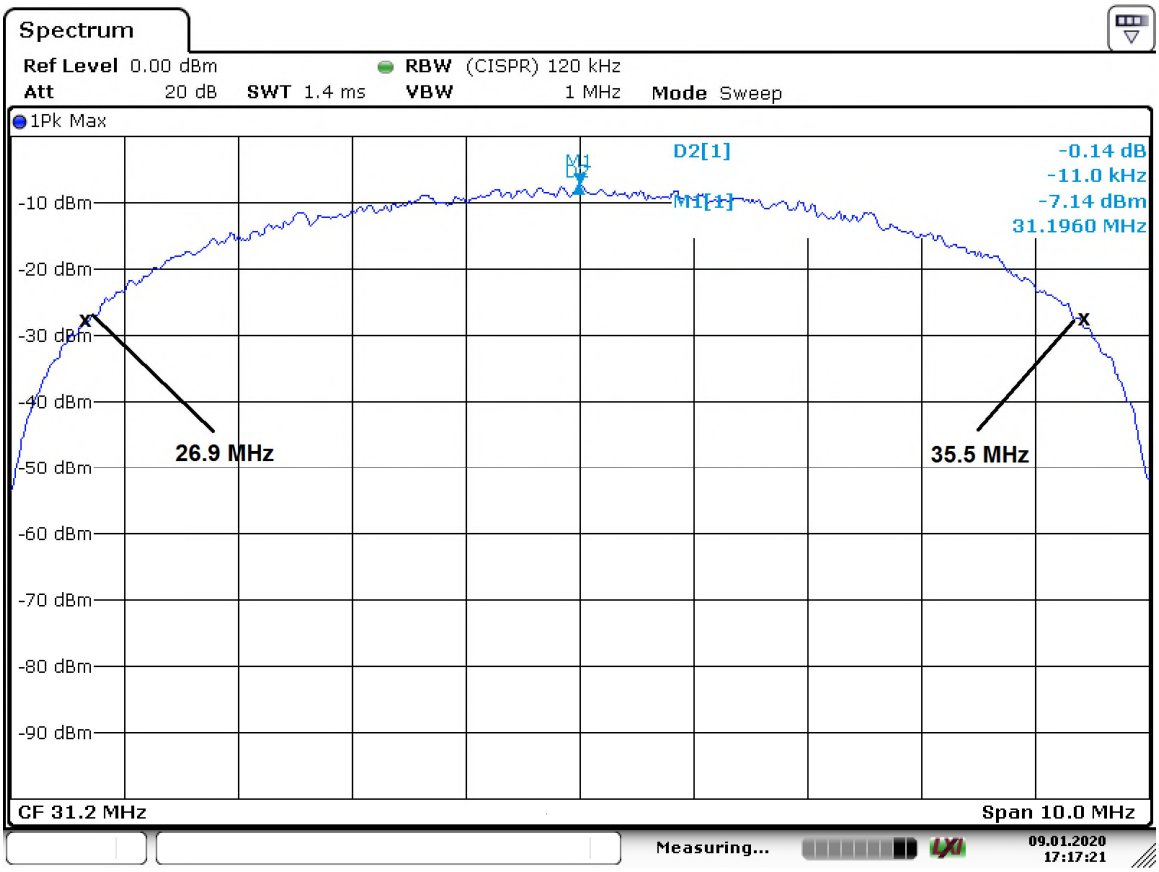
Graph(s)

The graphs shown below shows the channel spacing during the operation of the device. This is measured by a max hold on the spectrum analyzer at a bandwidth that is 1% to 5% of the 20 dB BW during operation of the EUT. This measurement is a peak measurement. Max hold is performed for a duration of not less than 1 minute. Markers are set at 20 dB below peak.



Date: 9.JAN.2020 17:17:21

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

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Test Equipment List

Equipment	Model No.	Manufacturer	Last calibration date	Next calibration due date	Asset #
Spectrum Analyzer	FSV40	Rhode & Schwarz	4/1/19	4/1/21	SSG013948
Attenuator 6 dB	8491A	HP	06/03/19	06/03/21	289
RF Cable 7m	LMR-400-7M-50OHM-MN-MN	LexTec	N/A	N/A	4026

This report module is based on GEMC template "FCC - 15.231 - 20dB Bandwidth_Rev1.doc"

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Appendix A – EUT & Client Provided Details

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General EUT Description

TD-100 is a covert buried line intrusion detection sensor. It utilizes two parallel leaky coaxial cables to create an invisible electromagnetic field that follow the cables around corners and up and down hills. The transmit (TX) cable creates a field that couples into the parallel RX cable. An intruder moving in proximity to the cables disturbs the coupled signal. Measuring the time delay between the onset of the coded pulse transmission and the receipt of the change due to the intruder allows the system to detect and pinpoint the location of the intruder.

TD-100 is unique in its use of Multiple Input and Multiple Output (MIMO) DSP to detect and locate intruders using End to End (E2E) Correlation. To generate an Alarm the intruder must be detected at the same time and same location. The product provides high Probability of Detection (PD) and low Nuisance Alarm Rate and False Alarm Rate (NAR/FAR) detection with unprecedented Fail-Safe features.

Client name and address.

Fiber Sensys
Fiber SenSys, Inc.
6175 NE Century Blvd
Hillsboro, OR 97124

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EUT Functional Description

EUT Configuration

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

- Cables and earthing were connected as per manufacturer's specification.

Operational Setup

Peripheral devices were attached to the EUT for its test operation. However, this report does not represent compliance of these peripheral device(s) in any way.

- None

Modifications for Compliance

No modifications were made during testing for the sample to achieve compliance with the testing requirements.

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

- None

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Appendix B – EUT and Test Setup Photos

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Figure 1 – EUT above ground portion – As typically installed

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Figure 2 – Conducted Emissions Setup – Photo 1

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Figure 3 – Conducted Emissions Setup – Photo 2

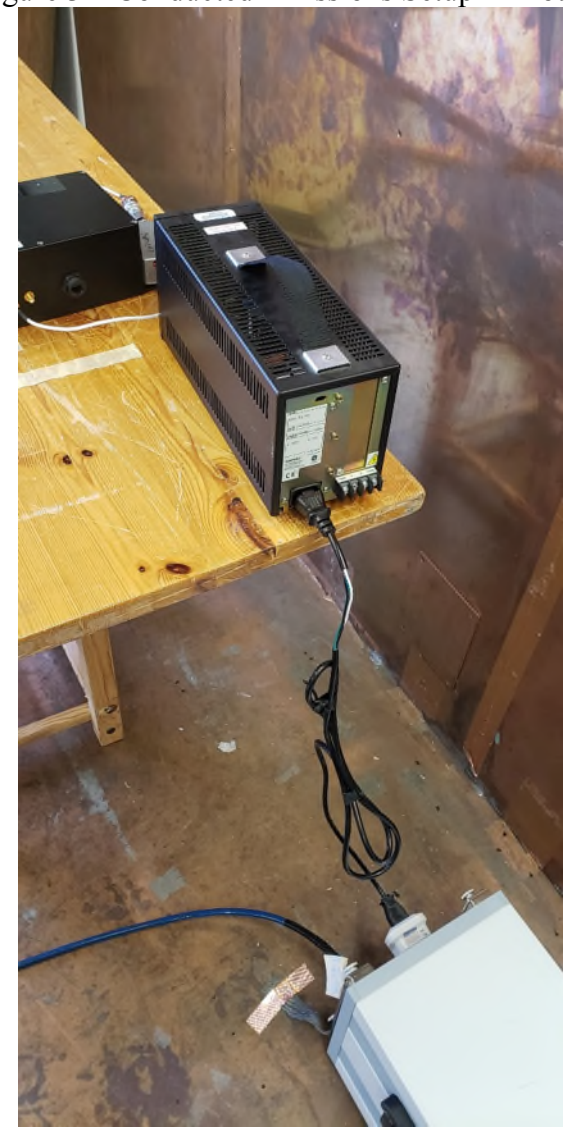

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Figure 4 – Radiated Emissions Setup (1 meter height prescan) – Site 1
30MHz – 300 MHz

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Figure 5 – Radiated Emissions Setup (full height scan) – Site 1
30MHz – 300 MHz

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Figure 6 – Radiated Emissions Setup – Site 2
30MHz – 300 MHz

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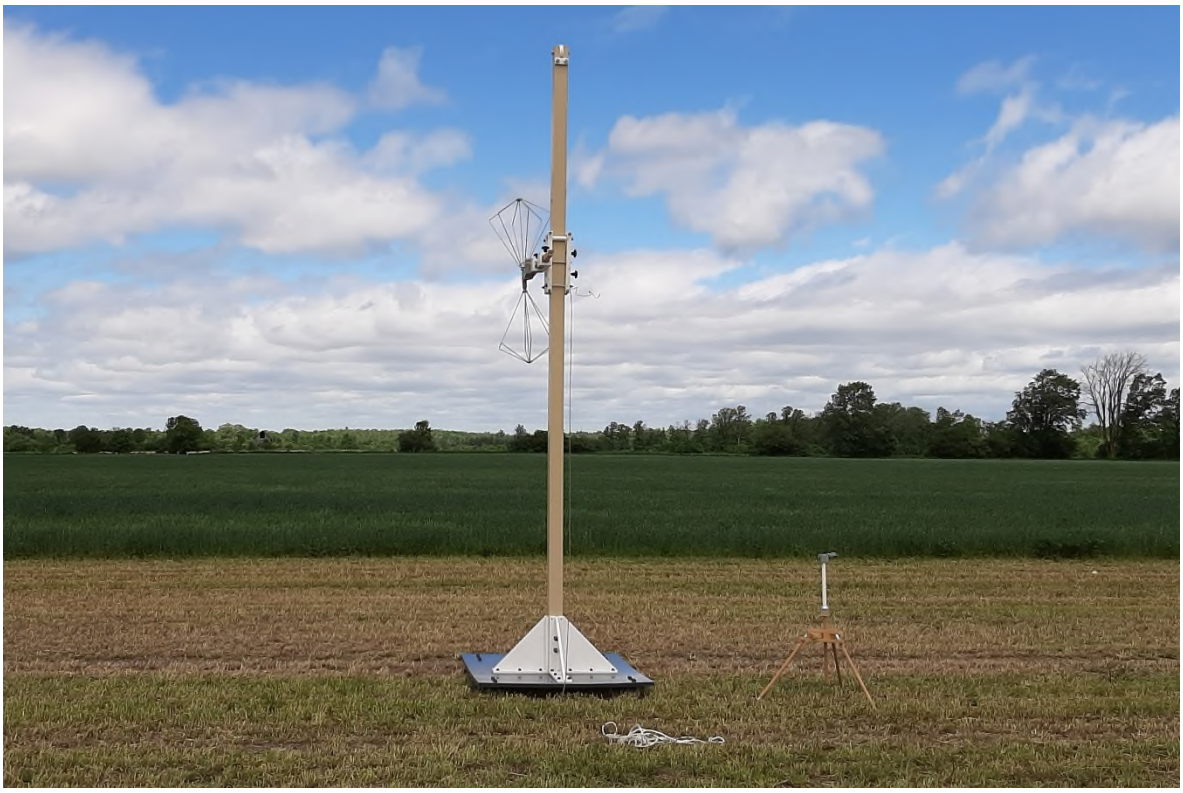
Figure 7 – Radiated Emissions Setup – Site 3
30MHz – 300 MHz



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Appendix C – Testing Locations

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The following locations were used for testing.

45.216169, -76.089044 (Cedar Meadow), length ~ 400 meters.

Note: Red line shows location of leaky coax cable that was buried as per normal installation.

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45.216169, -76.089044 (Sly Farm), length ~ 125 meters.

Note: Red line shows location of leaky coax cable that was buried as per normal installation.

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45.361158, -76.263653 (Wilson Farm), length ~192 meters

Note: Red line shows location of leaky coax cable that was buried as per normal installation.

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