Report on the Testing of the Pavement Density Profile (PDP) system

In accordance with: RSS 220 Issue 1:2009+A1:2018 & FCC Part 15:2020 Subpart F

Prepared for: COMMERCIAL-IN-CONFIDENCE

Document Number: TR-7169008429-004

Add value.
Inspire trust.

RESPONSIBLE FOR	NAME	DATE	SIGNATURE
Authorised Signatory	Scott Drysdale	May 11, 2021	Scott Drysdale
Document Reviewer	Glen Westwell	May 11, 2021	Glen Westwell

Signatures in this approval box have checked this document in line with the requirements of TÜV SÜD Product Service document control rules.

EXECUTIVE SUMMARY

A sample of this product was tested and found to be compliant with the standards listed above. (See Justifications and deviations section)

A2LA Cert. No. 2955.19

ACCREDITATION
Our A2LA Accreditation does not cover opinions and interpretations and any expressed are outside the scope of our A2LA Accreditation.

Table of Contents

Report Scope

This report addresses the EMC verification testing and test results of the Pavement Density Profile (PDP) system, herein referred to as EUT (Equipment Under Test) performed at TUV SUD Canada.

The EUT was tested for compliance against the following standards:

RSS 220 Issue 1:2009+Ammendment 1:2018 and FCC Part 15 Subpart F 15:2020

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 government agency, or TUV SUD Canada..

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

Client	**Sensors & Software**	
Product	Pavement Density Profile (PDP) system	
Standard(s)	RSS 220 Issue 1:2009+A1:2018 & FCC Part 15:2020 Subpart F	

Summary

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

EUT FCC Certification #, FCC ID:	QJQ-PDP1000
EUT Industry Canada Certification #, IC:	8393A-PDP1000
EUT Passed all tests performed.	Yes (see test results summary)
Tests conducted by	Scott Drysdale

Client	**Sensors & Software**
Product	Pavement Density Profile (PDP) system
Standard(s)	RSS 220 Issue 1:2009+A1:2018 & FCC Part 15:2020 Subpart F

Test Results Summary

Standard/Method	Description	Class/Limit	Result
FCC 15.203 RSS-GEN	Antenna Requirement	Unique	Pass See Justification
FCC 15.207 RSS-GEN	Power line conducted emissions	QuasiPeak Average	Pass. See justification
FCC 15.503(d) RSS-220 2	Fractional BW	> 0.20 or > 500 MHz	Pass
RSS-220 3.2	Data Port	N/A	See Justification
RSS-220 3.2	Subclass	N/A	See Justification
FCC 15.509(a) RSS-220 6.2.1(a)	UWB Bandwidth	< 10.6 GHz	Pass
FCC 15.509(b)(1)	Operating Parties	Eligible for licensing	Pass See Justification
FCC 15.509(b)(2)	Coordination	Required	Pass See Justification
FCC 15.509(c) RSS-220 6.2.1 (b)	Handheld / Wall	Tx < 10 Seconds	Pass See Justification
FCC 15.509(d) RSS-220 3.5 RSS-220 6.2.1(c) & (d)	Radiated emissions	Under limit	Pass
FCC 15.509(e)	Narrowband Radiated emissions	Under limit	Pass
FCC 15.509(f) RSS-220 6.2.1 (g)	Peak power EIRP (50 MHz)	< 0 dBm	Pass See Justification
FCC 15.521(a)	Operation requirements	Not toys, aircraft, ship or satellite	Pass See justification
Overall Result			**PASS**

All tests were performed by Scott Drysdale.

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 '*'.

Justifications, Descriptions, or Deviations

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

The EUT has the following data ports:
Wheel motion sensor, RS-485.

The EUT is categorized in subclass of Ground penetrating radar (GPR).

For the 'Antenna requirement' specified in FCC 15.203 (RSS 220), the device has an internal antenna which is not accessible.

For the 'power line conducted emissions' requirements as specified in FCC 15.207 (RSS-GEN 8.8), the EUT is DC powered (battery operated), and this test does not apply during operation. However, power line conducted emissions was performed in charging mode, where the device does not transmit.

For the 'eligible parties' requirement as per FCC 15.509 (b)(1), refer to the user's manual which includes the applicable guidance.

For the 'coordination' requirement as per FCC 15.509(b)(2), refer to the user's manual which includes the applicable guidance.

For the 'handheld' requirement as per FCC 15.509(c) of 10 seconds of maximum Tx after release, this does not apply as this device is not handheld or wall imaging. A 10 second requirement does apply as per RSS-220 6.2.1b, refer to the user's manual. The sensor on the wheels is the remote-control switch, with release being determined as stopping of motion.

For the 'peak power' requirement as per FCC 15.509(f), this does not apply at the center frequency or frequency of highest peak as the frequency at which the highest radiated emission occurs is below 960 MHz. However, for information purposes, this requirement is evaluated at the highest peak occurring at or above 960 MHz.

For the ‘operation’ requirements as per FCC 15.521(a), this device is not marketed as a toy or for general use. Operation is not intended, or designed for, use on an aircraft, ship or satellite.

As per guidance in ANSI C63.10 section.10.2.2, the device evaluated above a raised 50 cm bed of dry sand, placed above the ground plane. Due to the use of a semi-anechoic chamber, the 50 cm of dry sand could not feasibly be placed below the ground plane. Sand placed over top of the ground plane will likely result in discontinuities within the medium, reflections from which may adversely impact the compliance measurement. Anechoic material was evaluated as an alternative to a bed of sand, and was evaluated to have similar attenuation with respect to the directly radiated UWB emissions. However, since the EUT met the requirements this was deemed a worst case measurement and suitable for the purposes of compliance.

For final measurements, the EUT was placed at a height of 80 cm on a non-conducting support with the emitter directed downwards. As the EUT emissions was expected to have components below 500 MHz, a layer of ferrite tile was placed directly on the floor below the EUT. Pyramidal or wedge-shaped RF absorbers not less than 60 cm in height was placed directly below the EUT. Some sections of absorber were inverted and placed over other absorbers to form a solid block. Care was taken not to place any RF absorber between the device and the EMI receive antenna. The placement of the absorber was positioned such that it was not disturbed when the device was rotated. This arrangement prevents energy directed downwards from consideration during the measurement. A search in azimuth and elevation for indirect emissions was performed.

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
ICES-003:2020	- Digital Apparatus - Spectrum Management and Telecommunications Policy Interference-Causing Equipment Standard
ISO/IEC 17025:2017	- General Requirements for the competence of testing and calibration laboratories
RSS-GEN :2019	- Issue 5: General Requirements for Compliance of Radio Apparatus
RSS 210:2019	- Issue 10: Spectrum Management and Telecommunications Policy. Radio Standards Specification Low Power Licence-Exempt Radiocommunication Devices
RSS 220:2009+A1:2018	- Issue 1: Spectrum Management and Telecommunications Policy. Radio Standards Specification Devices Using Ultra-Wideband (UWB) Technology +Amendment 1

Sample calculation(s)

Margin = limit – (received signal + antenna factor + cable loss – pre-amp gain)
Margin = 50.5dBuV/m – (50dBuV + 10dB + 2.5dB – 20dB)
Margin = 8.5 dB

Document Revision Status

Revision 000 – Feb 8, 2021. Initial release.

Revision 001 – April 5, 2021. Corrections as per client and TCB request. Kept on file.

Revision 002 – April 6, 2021. Corrections as per TCB request to correct center frequency of 1184.1 MHz.

Revision 003 – April 19, 2021. Added GPR as subclass as per RSS-220 requirements.

Revision 004 – May 11, 2021. Definitions added for intentional, unintentional, spurious, and out-of-band emissions. Clarifications to previous descriptive text.

Definitions and Acronyms

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

AE – Auxiallary Equipment.

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

EMC – Electro-Magnetic Compatibility

EMI – Electro-Magnetic Immunity

EUT – Equipment Under Test

GPR – Ground Penetrating Radar

Intentional Emissions – RF Emissions that are intended to be transmitted from the EUT within the

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

Out-of-band Emission. - Emission on a frequency or frequencies immediately outside the necessary bandwidth which results from the intentional emission modulation process but excluding spurious emissions.

RBW – Resolution Bandwidth

RF – Radio Frequency

Spurious Emission – Emission on a frequency or frequencies which are outside the necessary bandwidth and the level of which may be reduced without affecting the corresponding transmission of information and are related to the intentional RF. Spurious emissions include harmonic emissions, parasitic emissions, intermodulation products and frequency conversion products, but exclude out-of-band emissions.

Unintentional Digital Emissions – Emissions which are not intended to be transmitted from the EUT, and are also not related to the intentional emissions. These emissions are caused by the use of digital techniques, timing signals, pulses at a rate in excess of 9000 pulses (cycles) per second, inclusive uses for the purpose of performing data processing functions, such as electronic computations, operations, transformations, recording, filing, sorting, storage, retrieval, or transfer.

UWB – Ultra Wide Band

VBW – Video Bandwidth

Testing Facility

Testing for EMC on the EUT was carried out at TUV SUD Canada, Ottawa, Ontario, Canada, as described in Appendix A. The testing lab consists of an absorber lined semianechoic chamber. . Radiated emissions measurements are performed using a Bilog, and Horn antenna where applicable. Conducted emissions, unless otherwise stated, are performed using a LISN.

Calibrations and Accreditations

All measuring equipment is calibrated on an annual or bi-annual basis as listed for each respective test. TUV SUD Canada is accredited under ISO/IEC 17025 for testing performed at TUV SUD Canada. TUV SUD Canada's scope of accreditation can be found at the A2LA website www.a2la.org under certificate number 2955.19. The policies of the quality manual and ISO/IEC 17025 procedures were followed for all testing.

Testing Environmental Conditions and Dates

All testing was performed December 7^{h} 2020 through December 18th, 2020.

Each graph shows the respective date under which the test was performed. The testing was performed in a room with environmental controls for temperature and humidity, in a range of 25 to 65 % RH and 18 to 25 degrees celcius. Precise temperate readings are kept on file.

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

Date	Test	Init.	Temperature (ºC)	Humidity (%)	Pressure (kPa)
Dec 11 – 18th	All	SD	20-25ºC	30-45%	100 -103kPa

Detailed Test Results Section

Bandwidth of Ultra Wide Band Transmitters

Purpose

The purpose of this test is to ensure that the device is capable of being classified as an Ultra Wide Band (UWB) transmitter.

Limits

The Limit is as specified in FCC Part 15 and RSS 220.

In accordance with 15.503(a), “the UWB bandwidth is the frequency band bounded by the points that are 10 dB below the highest radiated emission, as based on the complete transmission system including the antenna. The upper boundary is designated f_H and the lower boundary is designated f_L. The frequency at which the highest radiated emission occurs is designated f_M.

In accordance with 15.503(c), Fractional bandwidth. The fractional bandwidth equals $2(f_H - f_L)/ (f_H + f_L)$.

For the product to be defined as a UWB is that, at any point in time, has a fractional bandwidth equal to or greater than 0.20 or has a UWB bandwidth equal to or greater than 500 MHz, regardless of the fractional bandwidth.

In accordance with FCC 15.509(a), the UWB Bandwidth must be below 10.6 GHz.

Results

The EUT passed, as the bandwidth was greater than 500 MHz.

f_L was 615.1 MHz and f_H was 1753.1 MHz. The 10 dB BW was measured to be 1.138 GHz.

For information, the fractional bandwidth is
2 (1753.1 – 615.1) / (1753.1 + 615.1)
= 2 x 1138 / 2368.2
= 2276 / 2368
= 0.96

The fractional bandwidth meets the fractional bandwidth requirement as well as the minimum bandwidth requirement.

Center Frequency (f_C) = 1753.1 MHz + 615.1 MHz / 2 = 1184.1 MHz

Peak Frequency (f_M) = 765.1 MHz.

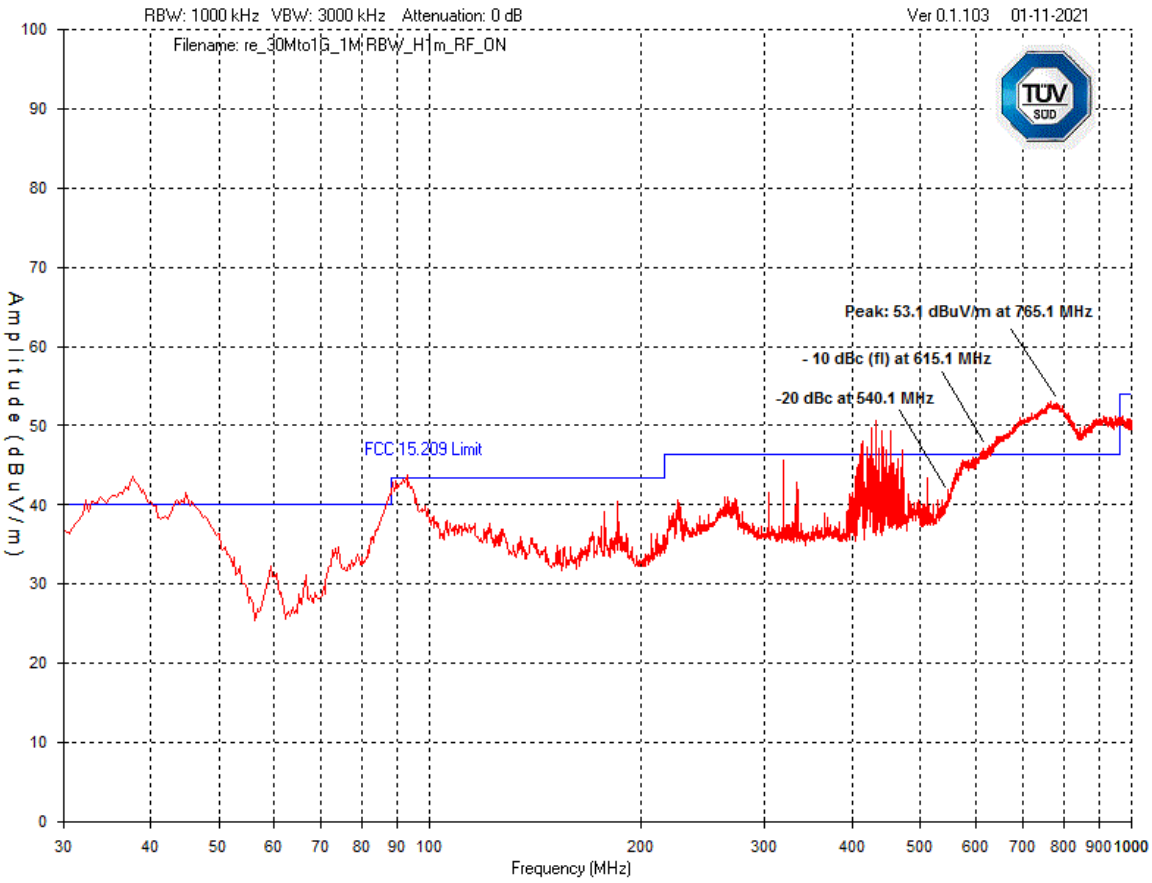
Occupied Bandwidth

For information purposes, the Occupied Bandwidth was from 540.1 MHz to 3751 MHz, which is an occupied bandwidth of 3210.9 MHz. As there was no 99% power function on the analyzer, that could work with the factored radiated measurement over the EUTs bandwidth of operation, this was achieved via the method as described in ANSI C63.10 section 6.9.3(g).

Graph(s)

Graph showing fl (615.1 MHz)

The below graph is a peak graph obtained with a 1 MHz RBW.

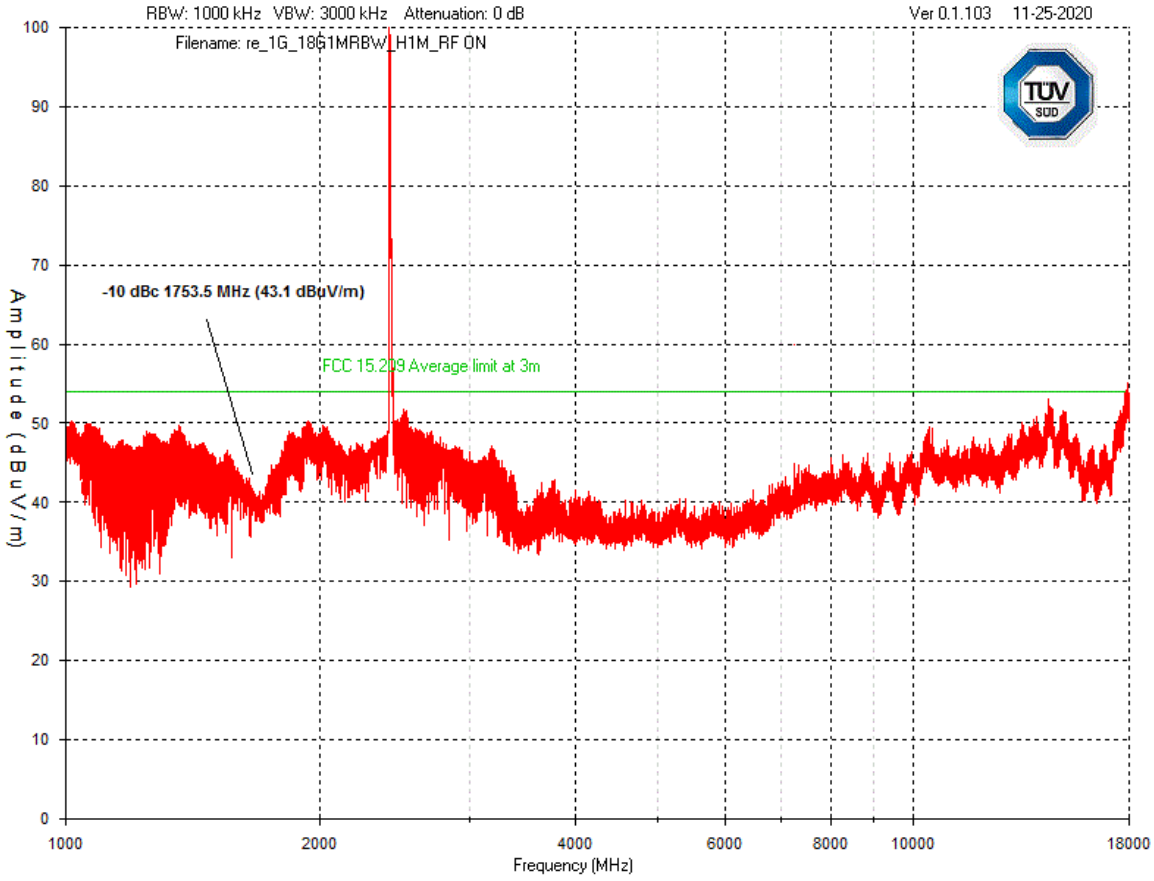


Note: Emissions shown as exceeding the 15.209 Quasi-peak limit as shown above, occurring below 500 MHz, were determined to be not part of the intentional UWB signal[1]. Those emissions are measured as part of the radiated unintentional digital emissions[1], subject to the limits in 15.109 and/or 15.209 as documented later in this report.

Note 1: This was confirmed by turning off and on the intentional UWB signal and noting no change to these emissions. Additionally, to verify this was the EUT and not present in ambient, the EUT digital device portion was additionally completely turned off and these emissions ceased. This portion of the EUT operates under the provisions in FCC Part 15B.

Graph showing fh (1753.5 MHz)

The below graph is a peak graph obtained with a 1 MHz RBW.



Note: The field strength drops below the 20 dB point from the peak (to 33.1 dBuV/m) at 3.751 GHz. The 20 dB point was measured using a 100 kHz resolution bandwidth.
Emissions

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

Test Equipment List

Equipment	Model No.	Manufacturer	Last calibration date	Next calibration due date	Asset #
Spectrum Analyzer	FSV40	Rohde & Schwarz	4-1-19	4-1-21	SSG013948
EMI Receiver	ESCI	Rohde & Schwarz	12-9-19	12-9-21	SSG013727
Bilog Antenna	6111D	Teseq	12-03-10	12-3-21	SSG013955
1 – 18 GHz horn Antenna	3115	EMCO (ETS Lindgren)	5-11-20	5-11-21	SSG012508
LNA preamp	LNA1450	RF Bay	11-11-19	11-11-21	4089
1-18G Preamp	A7	BNR	5-11-20	5-11-21	SSG012085
RF Cable 7m	LMR-400-7M-50OHM-MN-MN	LexTec	7-1-20	7-1-21	4026
RF Cable 1m	LMR-400-1M-50OHM-MN-MN	LexTec	7-1-20	7-1-21	4039

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

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, GPS, and so on, from unwanted interference.

Limit(s) and Method

The method is as defined in ANSI C63.4 and ANSI C63.10.

For devices operating under provisions of 15.509(d), the limits are as defined in FCC Part 15, Section 15.209 and 15.509(d).

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 (46.4 dBuV/m[1]) at 3 m
[1]Limit is specified as with 120 kHz measurement bandwidth and a using a Quasi Peak detector.

Above 960 MHz [2]

Frequency (MHz)	EIRP (dBm)	dBuV/m @ 3m
960-1610	-65.3	29.9
1610-1990	-53.3	41.9
1990-3100	-51.3	43.9
3100-10600	-41.3	53.9
Above 10600	-51.3	43.9

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

Above 960 MHz [3]

Frequency (MHz)	EIRP (dBm)	dBuV/m @ 3m
1164-1240	-75.3	19.9
1559-1610	-75.3	19.9

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

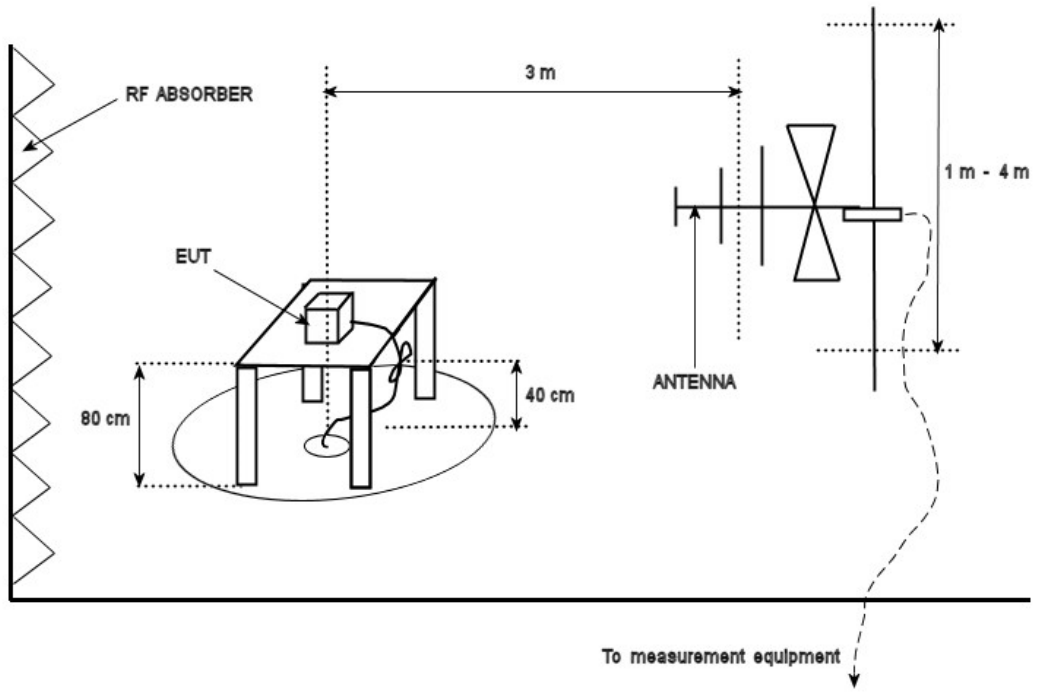
For unintentional digital emissions, for the portions of the device applicable as operating under provisions of FCC part 15B, the limits are as defined in FCC Part 15, Section 15.109

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 (46.4 dBuV/m[1]) at 3 m
Above 960 MHz, 500 uV/m (54 dBuV/m[2]) at 3 m

[1]Limit is specified as with 120 kHz measurement bandwidth and a using a Quasi Peak detector.
[2]Limit is specified with 1 MHz measurement bandwidth and using an Average detector

In accordance with FCC Part 15, Subpart A, Section 15.33, the device was scanned to over 10 GHz, which exceeds the 10th harmonic of f_h (1.753 GHz).

Typical Radiated Emissions Setup



Measurement Uncertainty

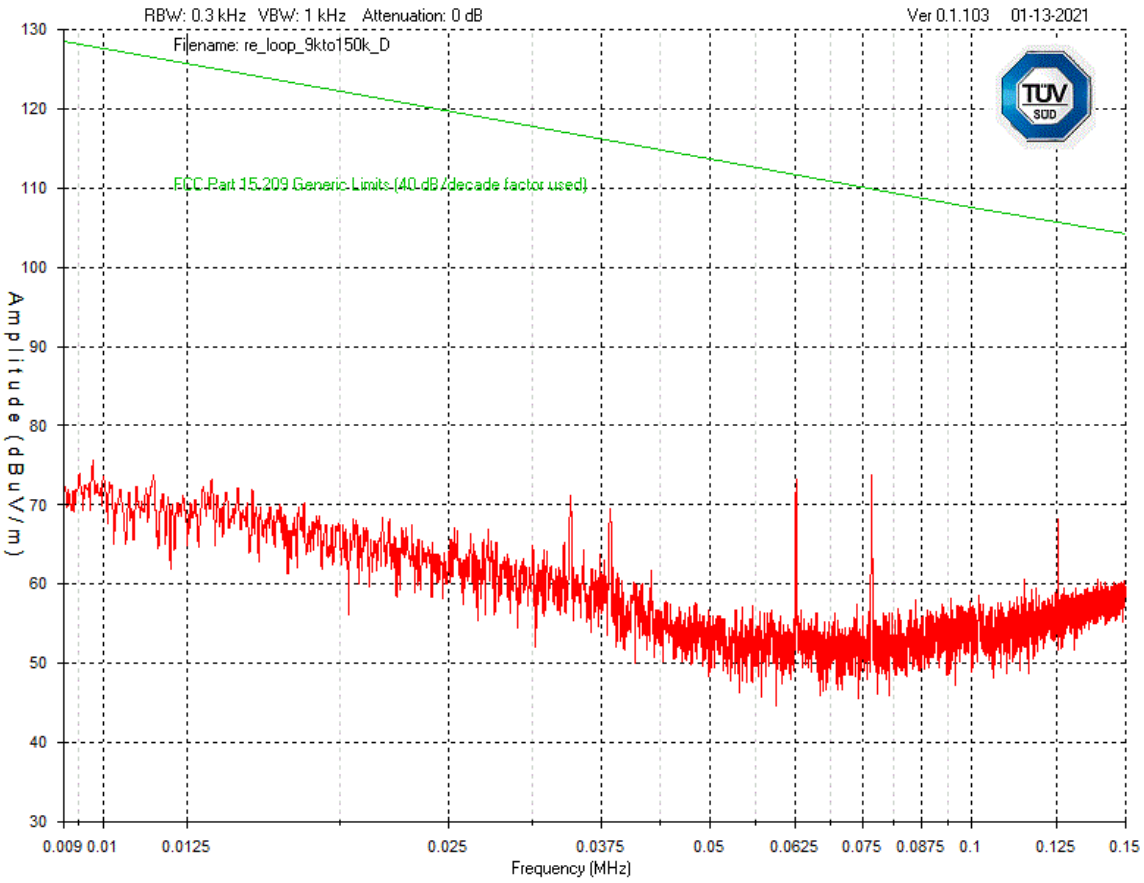
The expanded measurement uncertainty is calculated in accordance with CISPR 16-4-2 and is +/-4.4 dB with a 'k=2' coverage factor and a 95% confidence level.

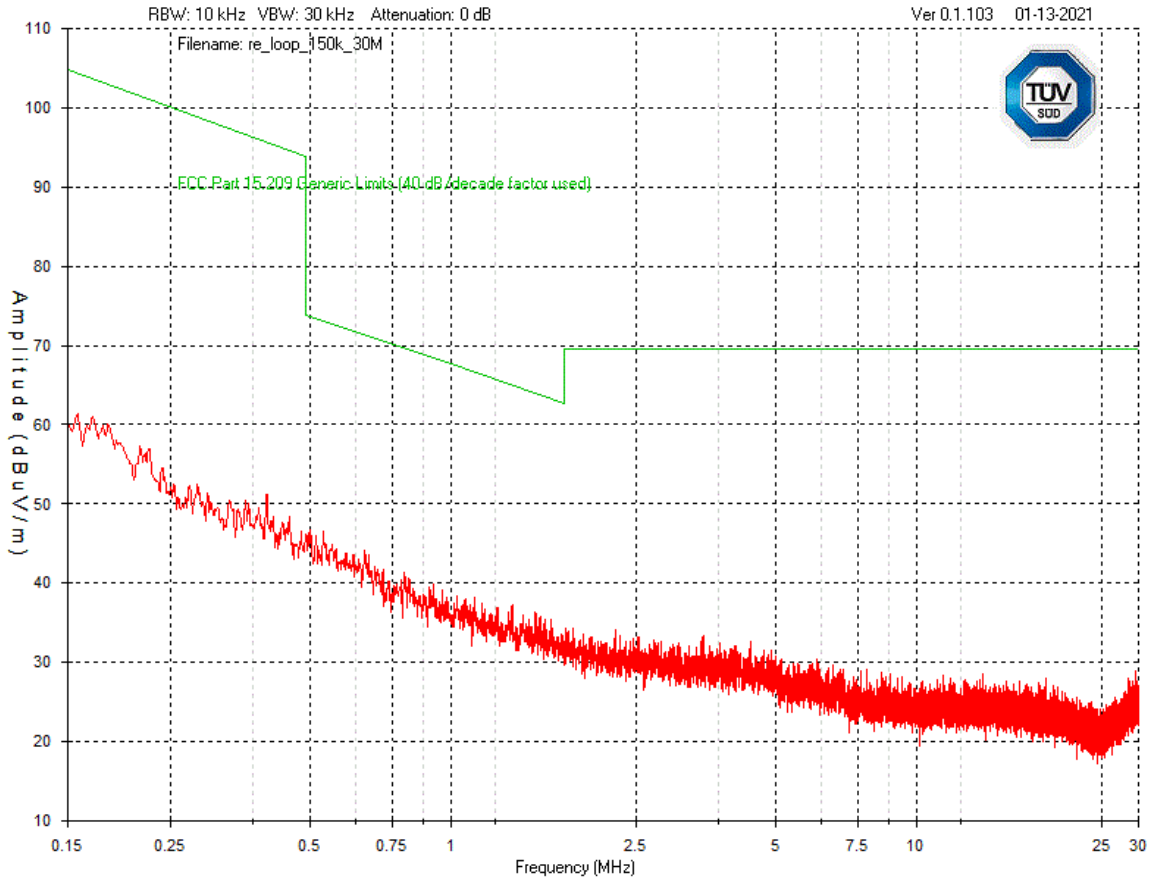
Preliminary Graphs

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 graphs shown below are a maximized peak measurement graph, measured with a resolution bandwidth approximately the same as the final required detector and over a full 0-360 rotation. This peaking process is done as a worst case measurement. This process enables the detection of frequencies of concern for final measurement, and provides considerable time savings.

In accordance with FCC Part 15, Subpart A, Section 15.33, the device was scanned to a minimum of the 10^{th} harmonic.

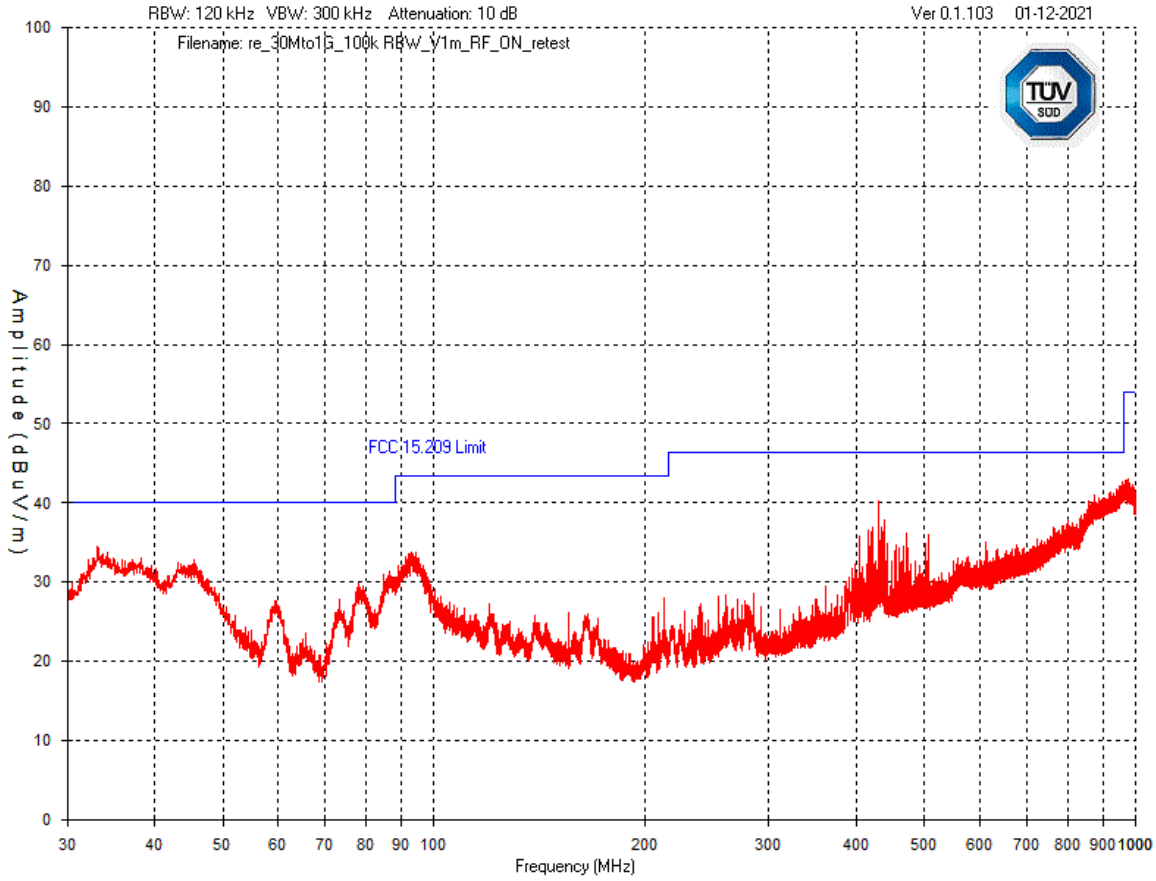
Emissions below 30 MHz



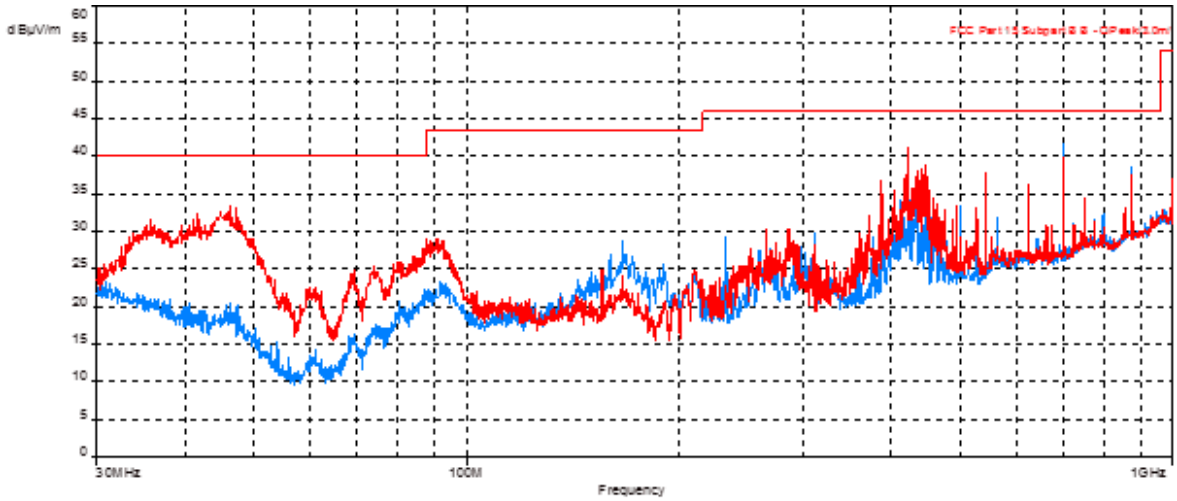


Vertical – Peak Emissions Graph (30 MHz to 960 MHz)

Operating



Vertical/Horizontal – Peak Emissions Graph (30 MHz to 1 GHz)

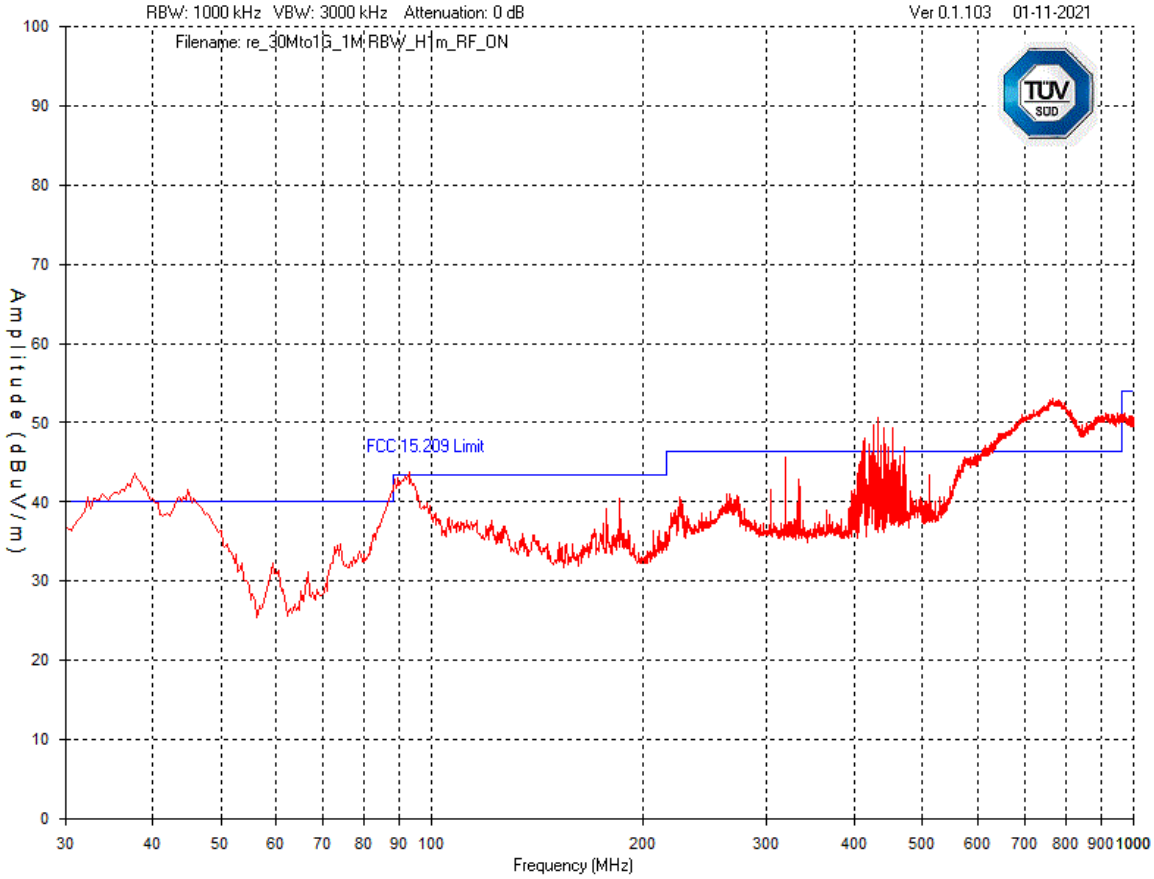


Standby (digital emissions[1] – peak at 120 kHz RBW)

RED = Vertical
BLUE – Horizontal

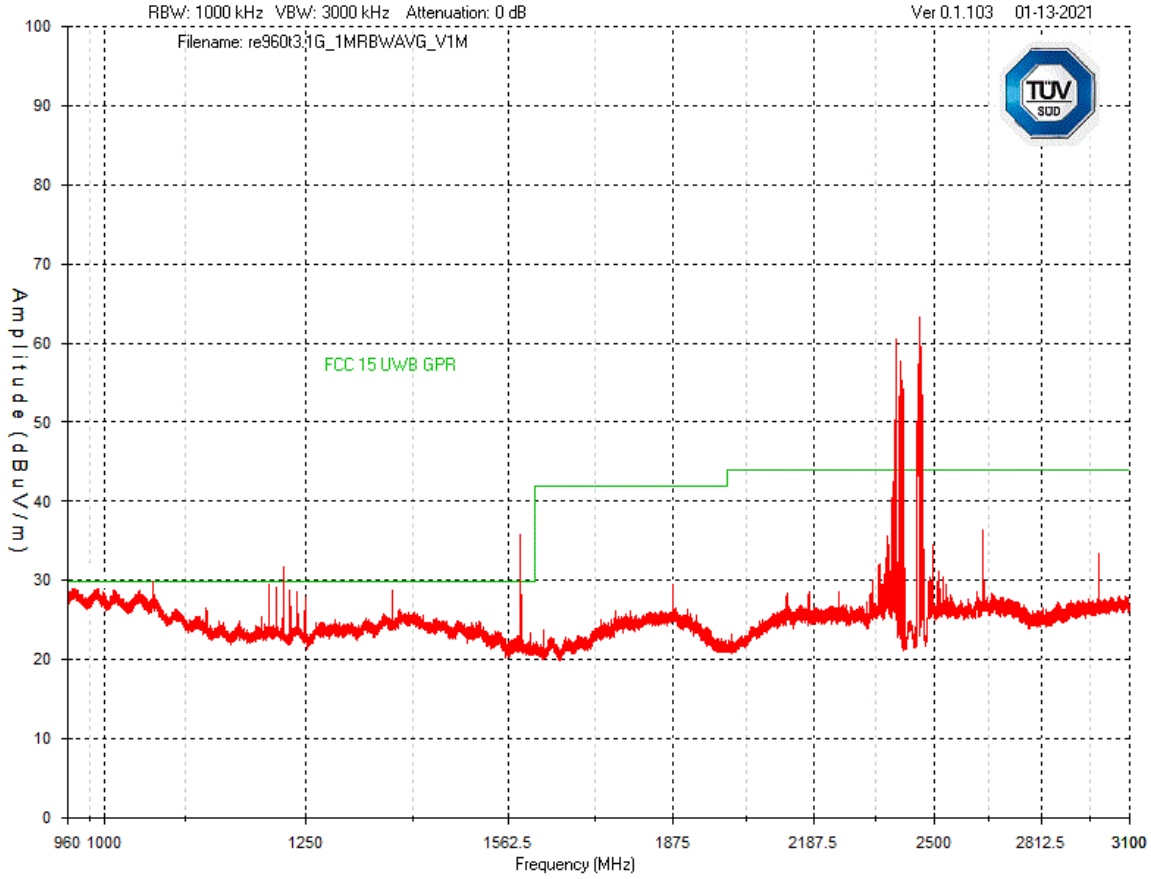
Note 1: Unintentional Digital Emissions during standby are from the EUT is operating under the provisions in FCC Part 15B.

Horizontal – Peak Emissions Graph (30 MHz to 960 MHz)



Operating

Vertical –Emissions Graph (960 MHz to 3100 MHz)

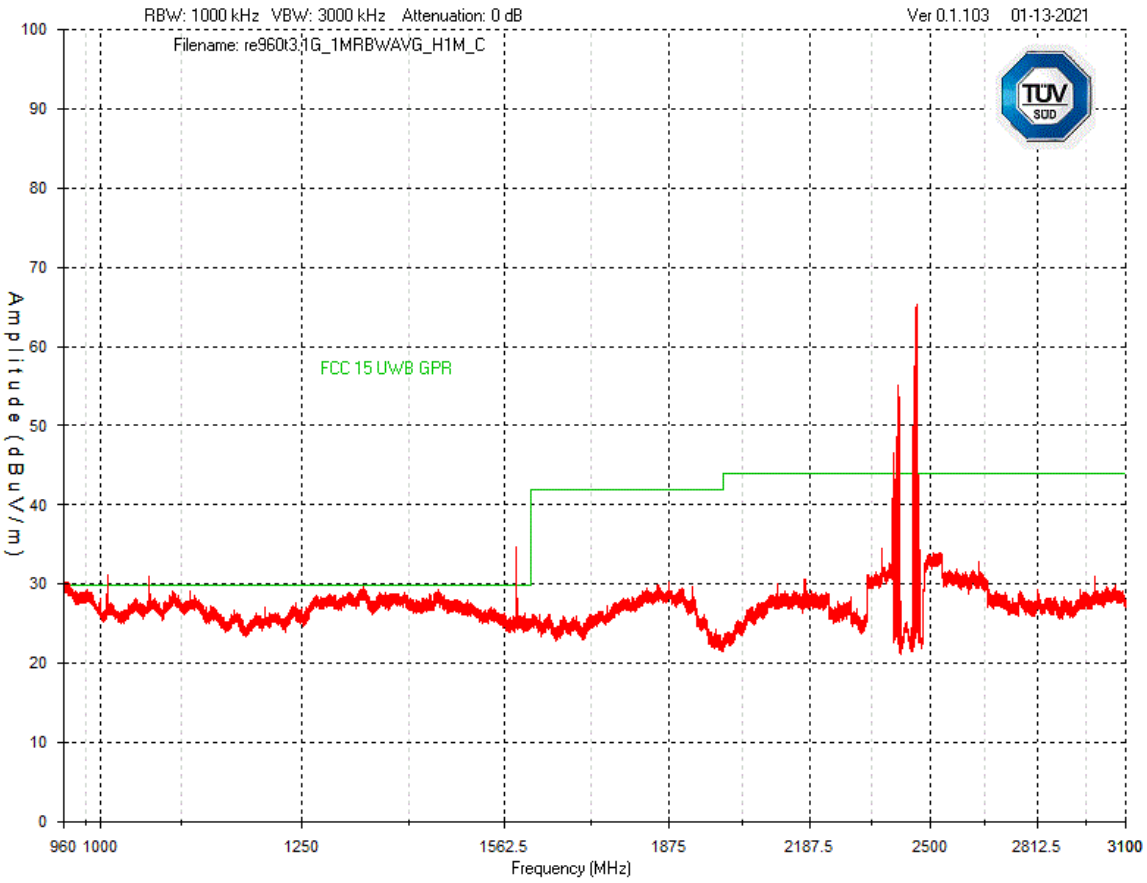


Operating

Note: For final average measurements, refer to table. All emissions shown in the above graph below 2 GHz that are above the average limit were determined to be unintentional digital emissions[1] for the portion of the device operating under the provisions as defined in FCC Part 15, Subpart B, and subject to the 15.109 and/or 15.209 limits, an average limit of 54 dBuV/m applies. The emissions shown between 2.3 GHz and 2.5 GHz were from the previously certified Wi-Fi module, and a notch filter was applied.

Note 1: This was confirmed by turning off and on the intentional UWB signal and noting no change to these emissions. Additionally, to verify this was the EUT and not present in ambient, the EUT digital device portion was additionally completely turned off and these emissions ceased. This portion of the EUT operates under the provisions in FCC Part 15B.

Horizontal –Emissions Graph (960 MHz to 3100 MHz)

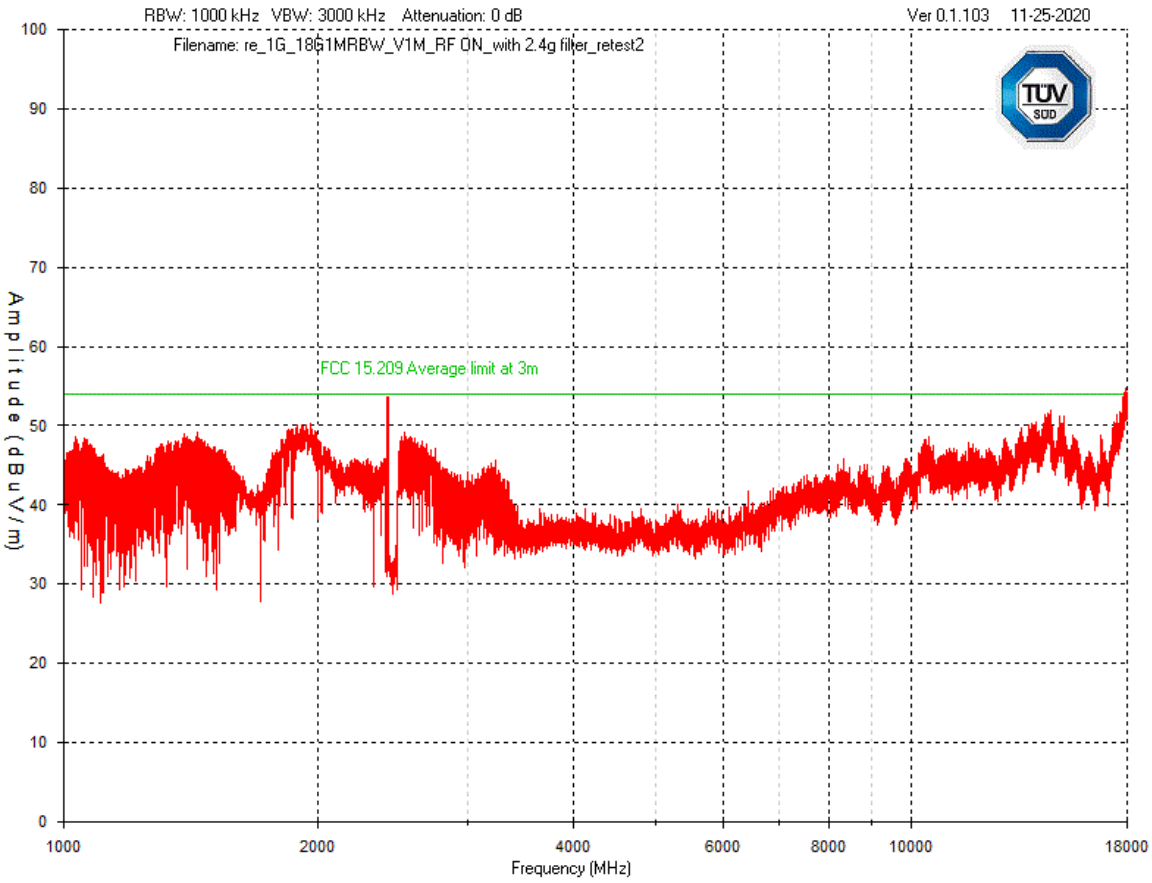


Operating

Note: For final average measurements, refer to table. All emissions shown in the above graph below 2 GHz that are above the average limit were determined to be unintentional digital emissions[1] for the portion of the device operating under the provisions as defined in FCC Part 15, Subpart B, and subject to the 15.109 and/or 15.209 limits, where an average limit of 54 dBuV/m applies. The emissions shown between 2.3 GHz and 2.5 GHz were from the previously certified Wi-Fi module, and a notch filter was applied.

Note 1: This was confirmed by turning off and on the intentional UWB signal and noting no change to these emissions. Additionally, to verify this was the EUT and not present in ambient, the EUT digital device portion was additionally completely turned off and these emissions ceased. This portion of the EUT operates under the provisions in FCC Part 15B.

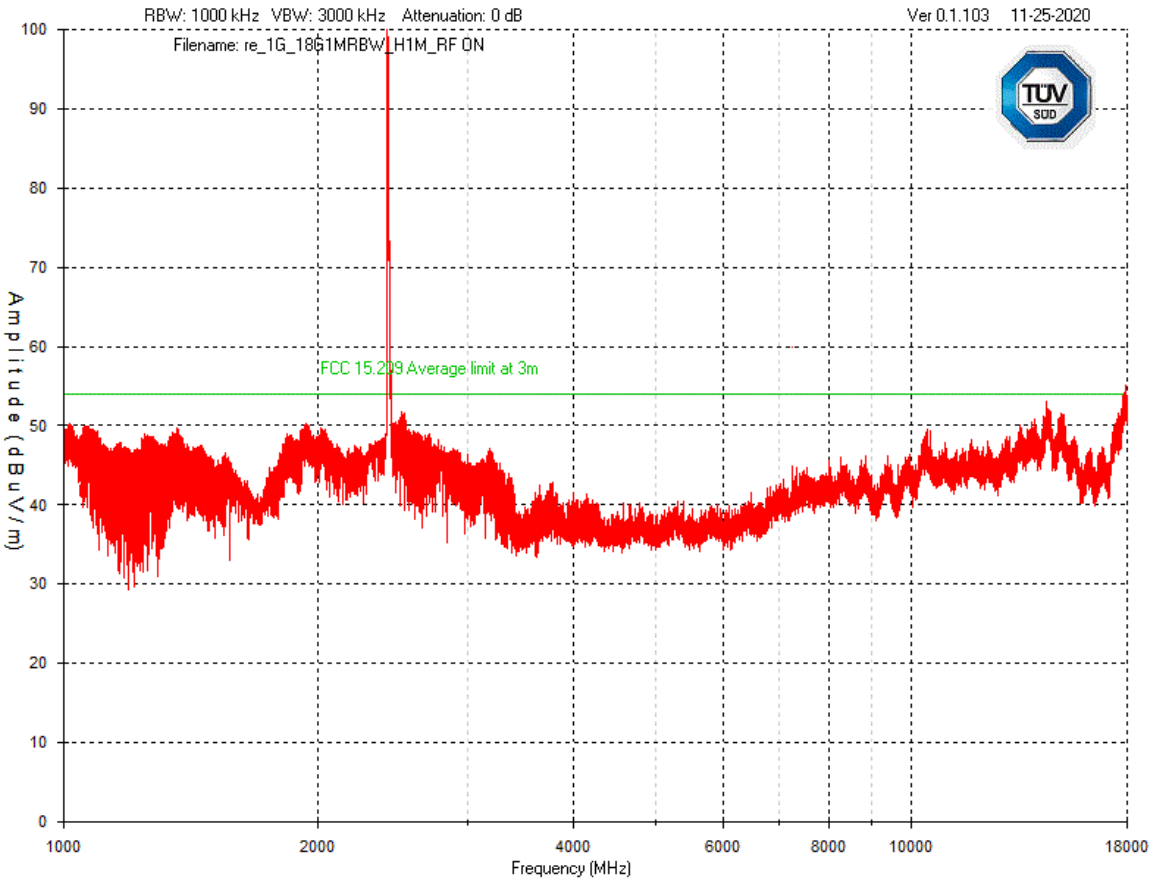
Vertical – Peak Emissions Graph (1 GHz to 18 GHz)



Operating

Note: A 2.4 GHz notch filter was used in the graph above. The device was scanned to 40 GHz. No emissions were determined to be from the EUT above 6 GHz and the noise floor was below the applicable limit.

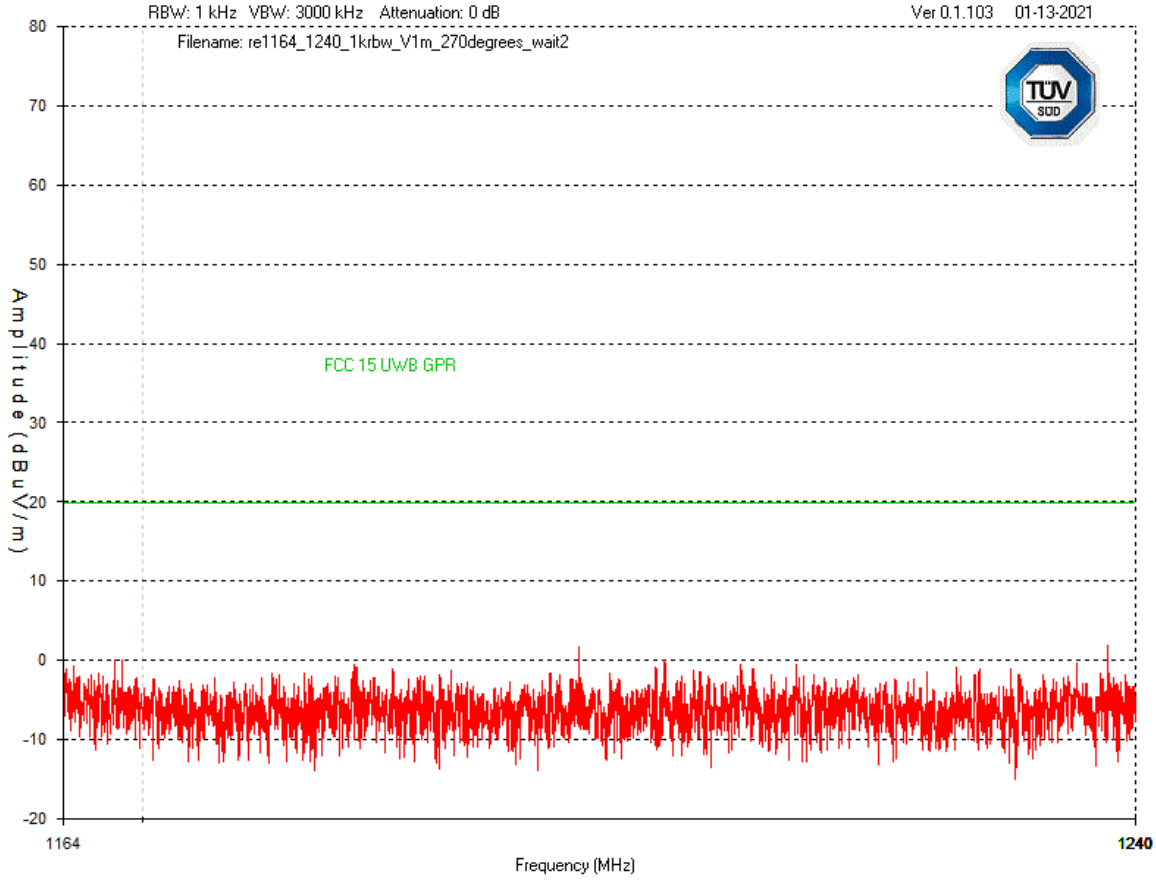
Horizontal – Peak Emissions Graph (1 GHz to 18 GHz)



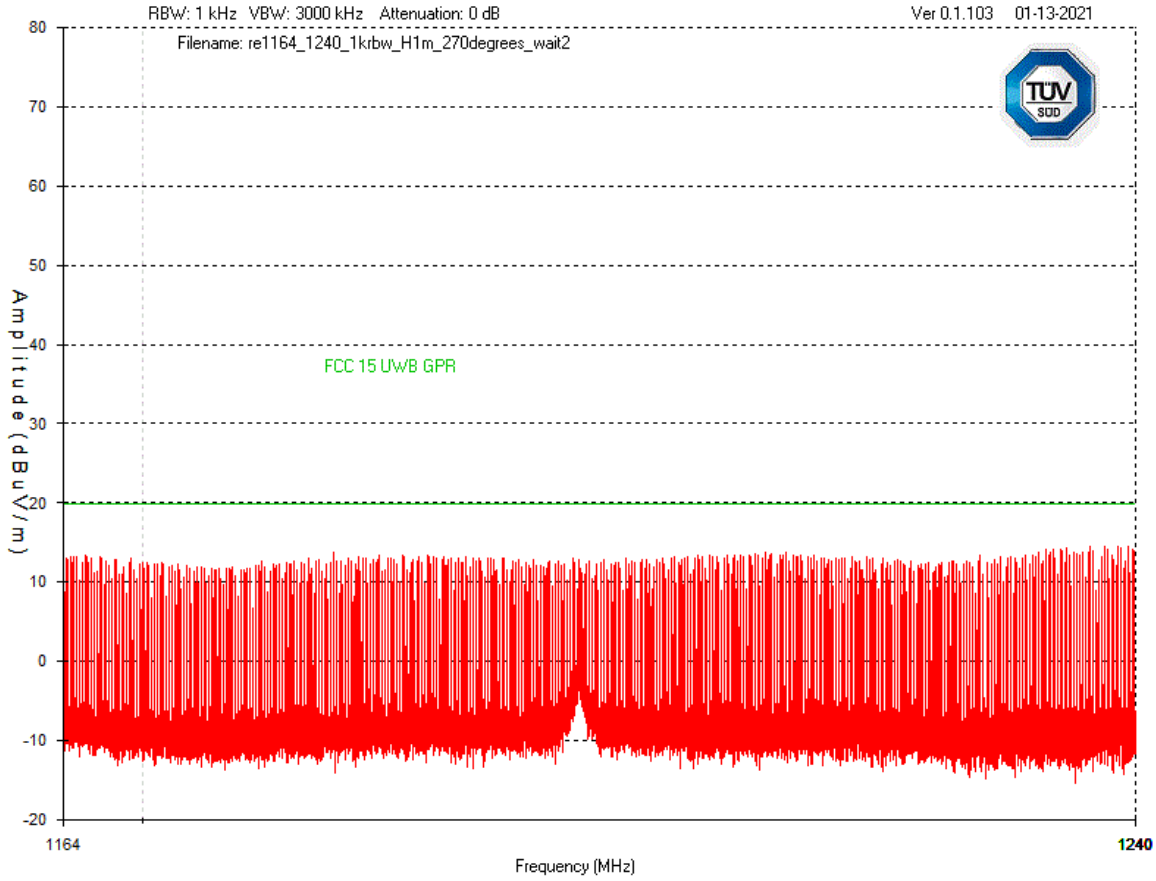
Operating

Note: The device was scanned to 40 GHz. No emissions were determined to be from the EUT above 6 GHz and the noise floor was below the applicable limit.

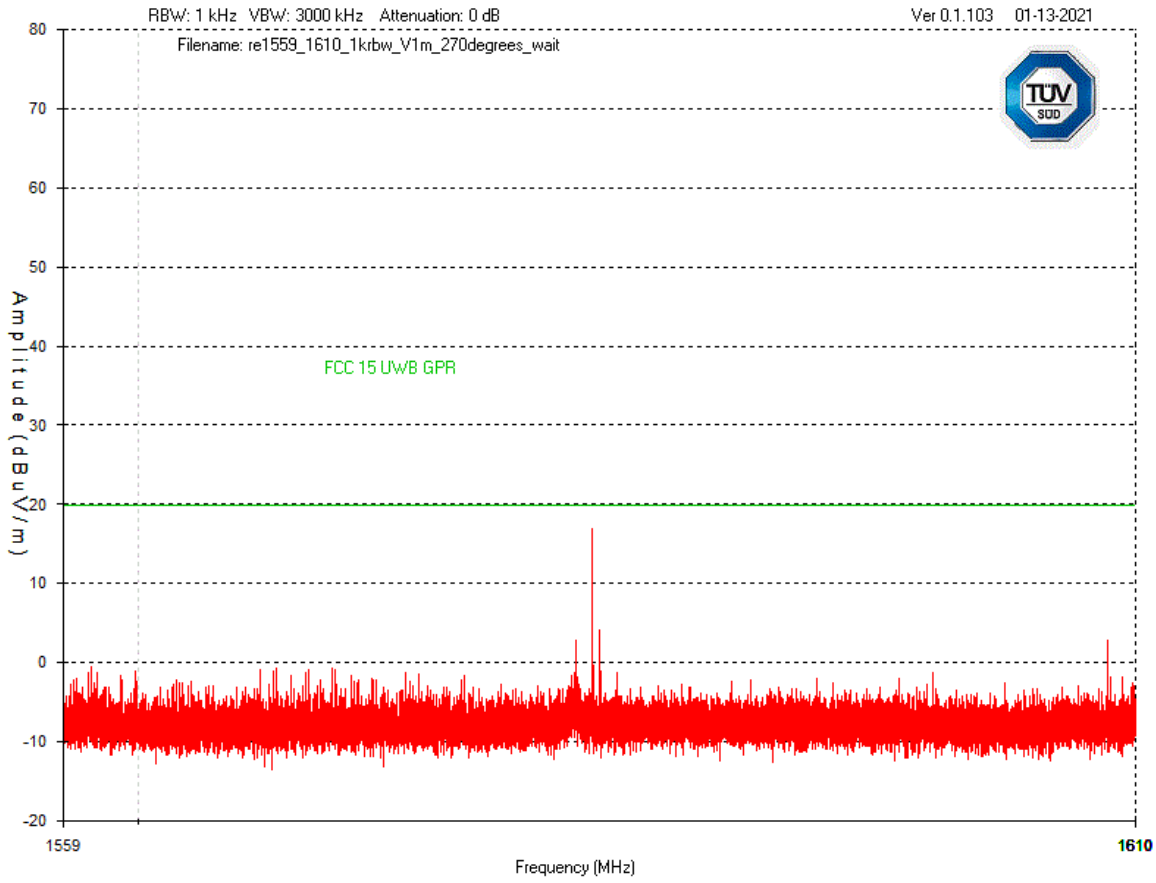
Narrowband Peak Emissions Vertical (1164 to 1240 MHz) - Operating



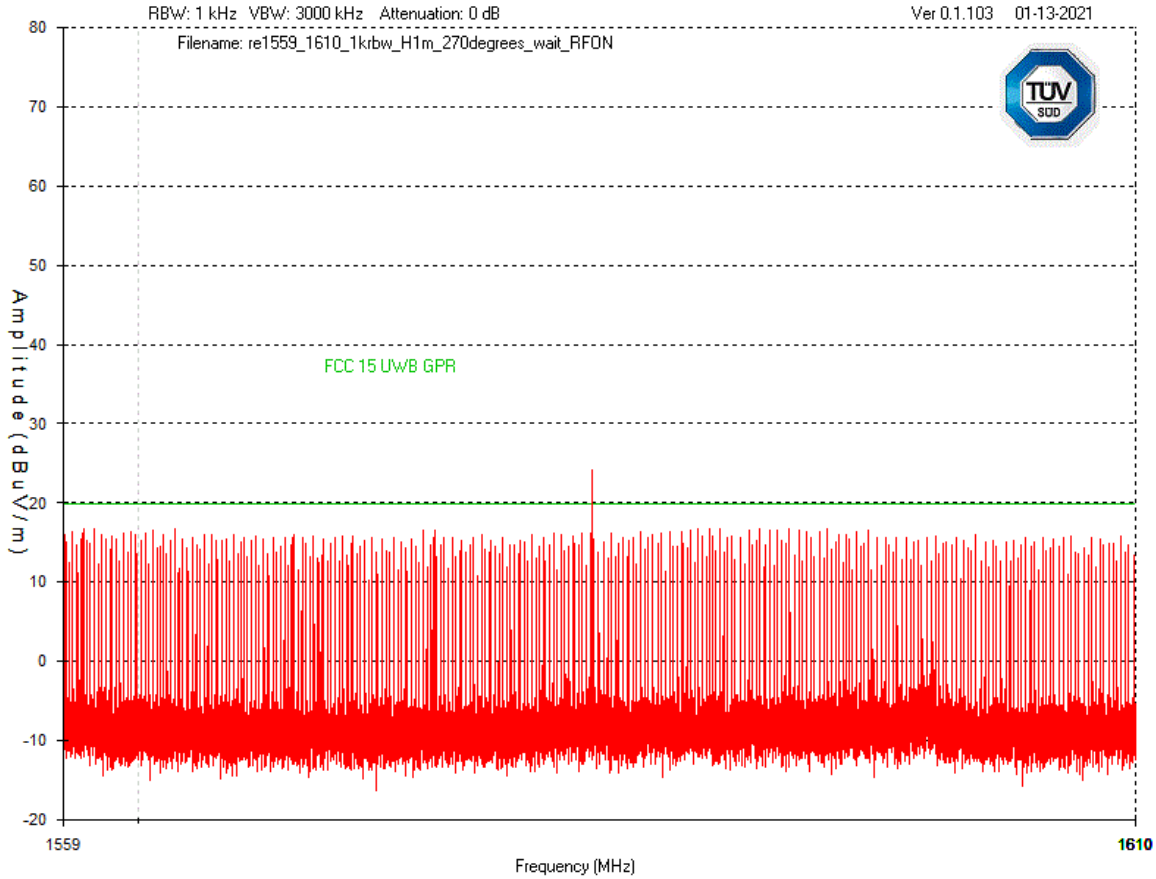
Narrowband Peak Emissions Horizontal (1164 to 1240 MHz) - Operating



Narrowband Peak Emissions Vertical (1559 to 1610 MHz) - Operating



Narrowband Peak Emissions Horizontal (1559 to 1610 MHz) - Operating



Note: The emission shown at 1584 MHz was determined to be an unintentional digital emission not related to the intentional UWB transmission.

Note 1: This was confirmed by turning off and on the intentional UWB signal and noting no change to this emission. Additionally, to verify this was the EUT and not present in ambient, the EUT digital device portion was additionally completely turned off and this emission ceased. This portion of the EUT operates under the provisions in FCC Part 15B.

Final Measurements

Unintentional Digital Emissions - Quasi Peak Emissions Table

Frequency (MHz)	Level (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Height (m) (dB)	Azimuth (°) (dB)	Polarization (dB)	Correction (dB)
35.726	27.40	40.00	-12.60	1.00	255.00	Vertical	-5.19
46.409	27.69	40.00	-12.31	1.00	321.50	Vertical	-10.92
47.286	26.40	40.00	-13.60	1.00	297.75	Vertical	-11.41
87.794	26.51	40.00	-13.49	1.30	254.50	Vertical	-12.16
420.791	22.16	46.02	-23.86	1.52	291.50	Vertical	-2.41
432.782	20.16	46.02	-25.86	2.21	297.75	Horizontal	-2.32
445.347	21.71	46.02	-24.31	1.43	284.25	Vertical	-2.36
544.316	37.11	46.02	-8.91	1.73	103.25	Horizontal	-0.73
544.316	37.55	46.02	-8.47	1.00	220.75	Vertical	-0.73
699.837	41.67	46.02	-4.35	1.08	133.25	Horizontal	2.04
699.837	39.47	46.02	-6.55	1.00	277.00	Vertical	2.04
874.979	39.12	46.02	-6.90	1.00	212.25	Horizontal	5.73

Intentional Emissions - Quasi Peak Emissions Table

Frequency (MHz)	Level (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Height (m) (dB)	Azimuth (°) (dB)	Polarization (dB)	Correction (dB)
765.1	33.1	46.02		1.00	255.00	Horizontal	3.30
765.1	N/A	46.02	N/A	1.00	321.50	Vertical	3.30

Note: Quasi-peak for 765.1 MHz in vertical was not observed, and the noise floor did not exceed the applicable limit.

Average Emissions Table - Vertical

Frequency (MHz)	Raw (dBuV)	Ant. (dB/m)	Amp / Cable (dB)	Level (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Pass/Fail
960.07	40.6	23.1	-35.8	27.9	30	2.1	Pass
1100.6	41.5	24.6	-37.2	28.9	30	1.1	Pass
1350	36.4	27.2	-36.9	26.7	30	3.3	Pass

The worst case emission appeared at 960 MHz at a horizontal antenna height of 1 m and at turn table azimuth of 185 degrees as depicted in Appendix B of this test report.

Average Emissions Table - Horizontal

Frequency (MHz)	Raw (dBuV)	Ant. (dB/m)	Amp / Cable (dB)	Level (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Pass/Fail
960.07	42.2	23.1	-35.8	29.5	30	0.5	Pass
1100.6	39.5	24.6	-37.2	26.9	30	3.1	Pass
1350	38.6	27.2	-36.9	28.9	30	1.1	Pass

Test Equipment List

Description	Make	Model number	Asset ID	Calibr. date	Calibr. due
Bilog Antenna	Teseq	6111D	SSG013955	2019-12-03	2021-12-03
Double Ridged Horn Antenna	Emco	3115	SSG012508	2020-05-11	2021-05-11
Horn Antenna (18 - 26.5 GHz)	Emco	3160-09	SSG012292	2019-08-26	2021-08-26
Horn Antenna (26.5 - 40 GHz)	Emco	3160-10	SSG012294	2019-08-26	2021-08-26
EMI Receiver	Rohde & Schwarz	ESU26	SSG013729	2020-03-19	2021-03-19
EMI Receiver	Rohde & Schwarz	ESU40	SSG013672	2019-10-08	2021-01-08
Coaxial Cable	Huber & Suhner	106A	SSG013841	2020-01-06	2021-01-06
Coaxial Cable	Huber & Suhner	106A	SSG012711	2020-01-06	2021-01-06
Coaxial Cable	Huber & Suhner	104PEA	SSG012041	2020-01-06	2021-01-06
Coaxial Cable	Huber & Suhner	ST18/Nm/ Nm/36	SSG012785	2020-01-06	2021-01-06
Coaxial Cable	Micro-Coax	UFA 210B-1-1500-504504	SSG012376	2020-01-02	2021-01-02
RF Amplifier	Hewlett Packard	8447D	SSG013045	2020-01-08	2021-01-08
Pre-Amplifier	BNR	LNA	SSG012360	2019-09-26	2021-12-26
Power Supply	Hewlett Packard	6216A	SSG013063	not required	not required
Power Supply	Lambda	LPD-421A-FM	SSG013085	not required	not required
Loop Antenna	EM 6871	Electro-Metrics	GEMC 70	2019-02-15	2021-02-15
Loop Antenna	EM 6872	Electro-Metrics	GEMC 71	2019-02-15	2021-02-15

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

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 15.107, FCC Part 15 Section 15.207 and RSS-GEN:

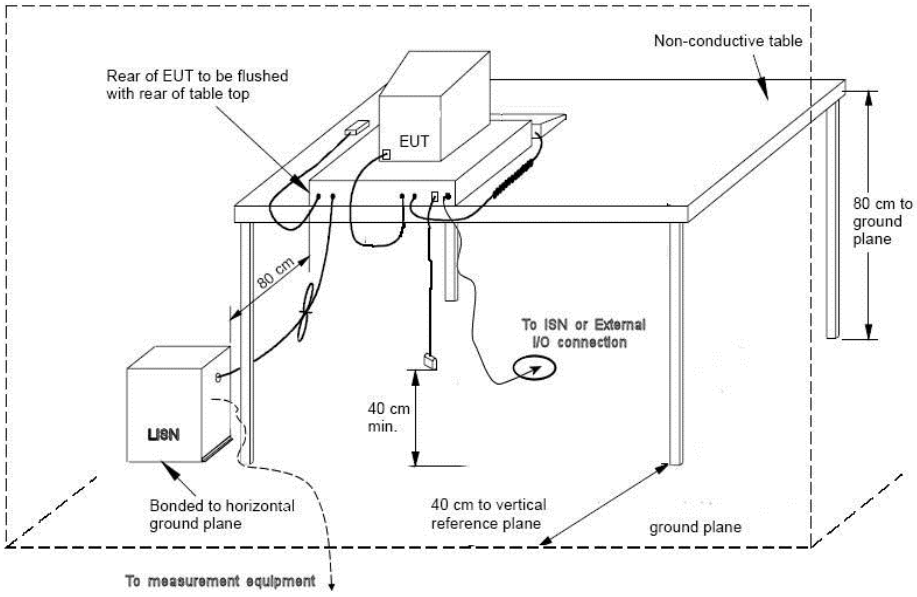
Average Limits		Quasi-Peak Limits	
150 kHz – 500 kHz	56 to 46* dBµV	150 kHz – 500 kHz	66 to 56* dBµV
500 kHz – 5 MHz	46 dBµV	500 kHz – 5 MHz	56 dBµV
5 MHz – 30 MHz	50 dBµV	5 MHz – 30 MHz	60 dBµV

* 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.

Typical Setup Diagram



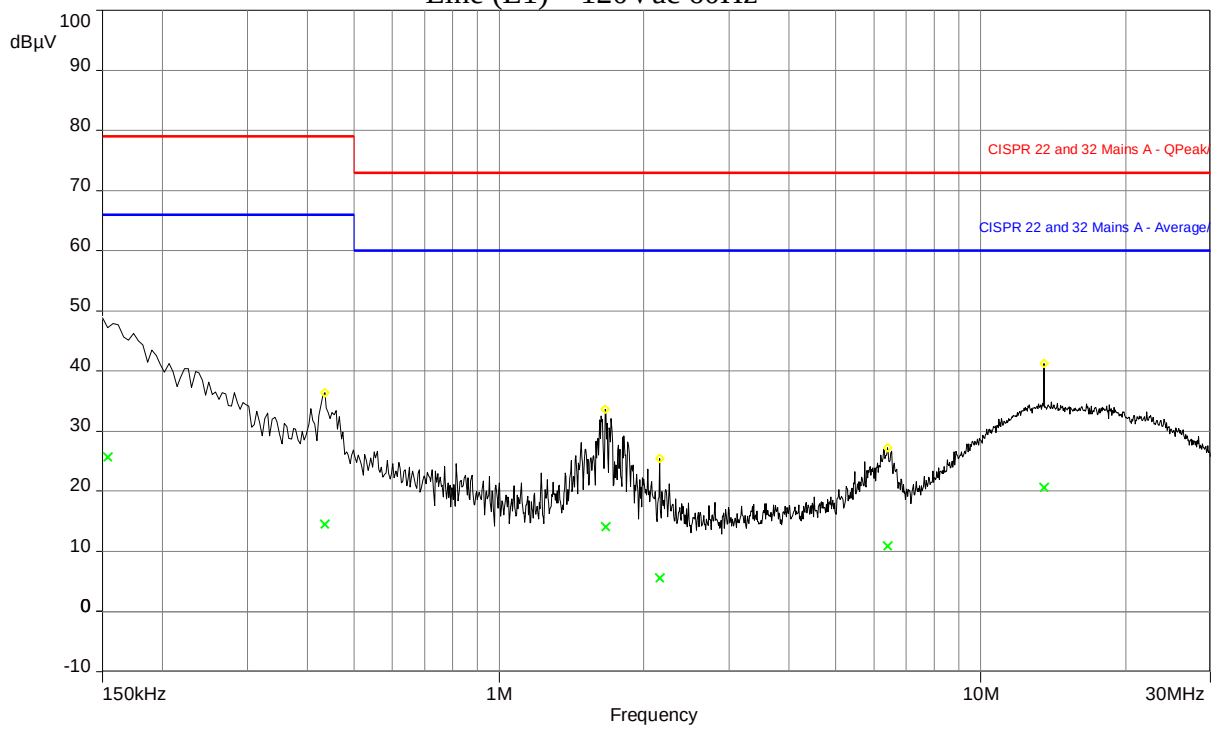
Measurement Uncertainty

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.

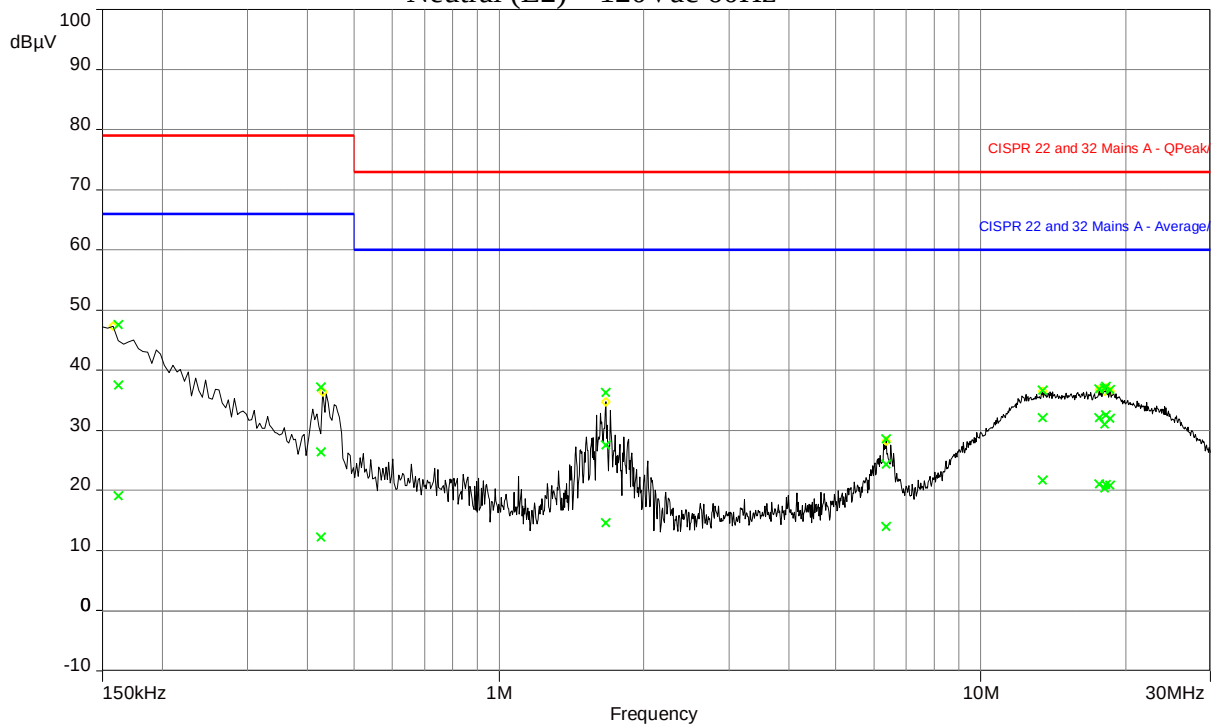
Preliminary Graphs

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.

Line (L1) – 120Vac 60Hz



Neutral (L2) – 120Vac 60Hz



Final Measurements

Line 1

Frequency (MHz)	Level Average (dBµV)	Level QP (dBµV)	Level Peak (dBµV)	Margin AVG (dB) (dBµV)	Margin QP (dB) (dBµV)	Margin - Peak to AVG (dB) (dBµV)	Limit AVG (dBuV) (dBµV)	Limit QP (dBuV) (dBµV)	Correction (dB)
0.153132	25.65	41.33	50.60	-40.35	-37.67	-15.40	66.00	79.00	19.43
0.432704	14.52	30.86	37.81	-51.48	-48.14	-28.19	66.00	79.00	19.51
1.664538	14.08	27.29	37.18	-45.92	-45.71	-22.82	60.00	73.00	19.55
2.159782	5.61	11.03	19.11	-54.39	-61.97	-40.89	60.00	73.00	19.56
6.415278	10.92	19.67	26.55	-49.08	-53.33	-33.45	60.00	73.00	19.66
13.54203	20.61	31.56	42.48	-39.39	-41.44	-17.52	60.00	73.00	19.85

Line 2

Frequency (MHz)	Level Average (dBµV)	Level QP (dBµV)	Level Peak (dBµV)	Margin AVG (dB) (dBµV)	Margin QP (dB) (dBµV)	Margin - Peak to AVG (dB) (dBµV)	Limit AVG (dBuV) (dBµV)	Limit QP (dBuV) (dBµV)	Correction (dB)
0.16043	19.04	37.55	47.59	-46.96	-41.45	-18.41	66.00	79.00	19.51
0.42766	12.26	26.40	37.17	-53.74	-52.60	-28.83	66.00	79.00	19.52
1.6666	14.60	27.60	36.25	-45.40	-45.40	-23.75	60.00	73.00	19.55
6.36613	13.96	24.34	28.52	-46.04	-48.66	-31.48	60.00	73.00	19.66
13.461	21.74	32.11	36.66	-38.26	-40.89	-23.34	60.00	73.00	19.84
17.626	20.99	32.03	36.81	-39.01	-40.97	-23.19	60.00	73.00	19.99
18.059	20.33	30.99	36.92	-39.67	-42.01	-23.08	60.00	73.00	20.01

Test Equipment List

Equipment	Model No.	Manufacturer	Last Calibration Date	Next Calibration Date	Asset #
Spectrum Analyzer	ESU26	Rohde & Schwarz	Mar 19, 2020	Mar 19, 2021	SSG013729
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	NCR	NCR	GEMC 276
Attenuator 10 dB	10-A-MFN-10	Bird/Hutton	NCR	NCR	GEMC 323
Emissions Software	0.1.99	TUV SUD Canada, Inc.	NCR	NCR	GEMC 58

This report module is based on report template 'FCC_ICES003_CE_Rev1'

Appendix A – EUT Summary

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

General EUT Description

Manufacturer	**Sensors & Software Inc.** 1040 Stacey Court, Mississauga ON. L4W 2X8 Toll Free: 1-800-267-6013 T: 905-624-8909
EUT Name	Pavement Density Profile (PDP) system
FCCID	QJQ-PDP1000
IC #	8393A-PDP1000
Approximate Size (LxWxH)	40 cm x 60 cm x 30 cm
Equipment Category (Commercial / Residential / Medical)	Commercial
Input Voltage and Frequency	N/A – Battery operated
Rated Input Current	N/A
Table Top / Wall mount / Floor standing (choose table top if unsure)	Floor standing (ground)
Minimum Separation distance from operator	> 20 cm from transmit antenna

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

Appendix B – EUT and Test Setup Photographs

(See separate photo exhibit)