RHEIN TECH LABORATORIES, INC.

Engineering Solutions & Electromagnetic Compatibility Services

FCC Part 15.256 & Industry Canada RSS-Gen
Class II Permissive Change Report

Test Laboratory:		Applicant:	
Rhein Tech Laboratories, Inc. Tel: 703-689-0368 360 Herndon Parkway Fax: 703-689-2056 Suite 1400 www.rheintech.com Herndon, VA 20170 E-Mail: atcbinfo@rheintech.com		VEGA Grieshaber KG Tel: 49-7836-50113 Am Hohenstein 113 D-77761 Schiltach Germany Contact: Juergen Motzer	
FCC ID **IC**	O6QPS60XW1 3892A-PS60XW1	**Test Report Date**	February 22, 2017
Platform	N/A	**RTL Work Order #**	2016249
Model	VEGAPULS 69	**RTL Quote #**	QRTL16-249B
FCC Classification	DXX – Part 15 Low Power Communication Device Transmitter		
FCC Rule Part(s)/Guidance	Part 15C, 15.256: Radio Frequency Devices FCC 14-2: ET Docket No. 10-23: Amendment of Part 15 of the Commission's Rules To Establish Regulations for Level Probing Radars and Tank Level Probing Radars in the Frequency Bands 5.925-7.250 GHz, 24.05-29.00 GHz and 75-85 GHz KDB 890966-D01 Meas Level Probing Radars V01 (April 4, 2014)		
Test Procedures	ANSI C63.10-2013: American National Standard of Procedures for Compliance Testing of Unlicensed Wireless Devices ANSI C63.4-2014: American National Standard for Methods of Measurement of Radio-Noise Emissions from Low-Voltage Electrical and Electronic Equipment in the Range of 9 kHz to 40 GHz		
Industry Canada	RSS-Gen Issue 5: General Requirements and Information for the Certification of Radio Apparatus RSS-211 Level Probing Radar Equipment EN 302 729 Short Range Devices (SRD); Level Probing Radar (LPR) equipment		
Digital Interface Information	Digital Interface was found to be compliant		

Frequency Range (GHz)	Output Power (W) Conducted	Frequency Tolerance	Emission Designator
77	0.0015	N/A	N/A

I, the undersigned, hereby declare that the equipment tested and referenced in this report conforms to the identified standard(s) as described in this test report. No modifications were made to the equipment during testing in order to achieve compliance with these standards. Furthermore, there was no deviation from, additions to, or exclusions from, the applicable parts of FCC Part 2, FCC Part 15, Industry Canada RSS-Gen, RSS-211, ANSI C63.10, and ANSI C63.4.

Signature: ____________________ Date: February 22, 2017

Typed/Printed Name: Desmond A. Fraser Position: President

These tests are accredited and meet the requirements of ISO/IEC 17025 as verified by ANAB. Refer to certificate and scope of accreditation AT-1445.

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1 General Information

1.1 Scope

This Class II measurement report is prepared on behalf of VEGA Grieshaber KG in accordance with the applicable Federal Communications Commission and Industry Canada rules and regulations.

The Equipment Under Test (EUT) was the Model VEGAPULS 69 Level Probing Radar, FCC ID: O6QPS60XW1, IC: 3892A-PS60XW1, tested with one antenna. The EUT is available with two different electronics units:

1) HART (PS60HW)
2) PA and FF (PS60PAW and PS60FFW

The worst case emissions are found with the HART (PS60HW) electronic unit implemented in the EUT.

1.2 Test Facility

The open area test site and conducted measurement facility used to collect the radiated data is located on the parking lot of Rhein Tech Laboratories, Inc., 360 Herndon Parkway, Suite 1400, Herndon, Virginia 20170. This site has been fully described in a report submitted to and approved by the Federal Communications Commission to perform AC line conducted and radiated emissions testing.

1.3 Related Submittal(s) and Grant(s)

This FCC §15.256/IC RSS-211 report is intended to support a Class II application for a composite device. The original FCC grant was issued June 15, 2015 and the original IC certificate was issued November 20, 2015. The changes are:

- Via a firmware change, applicant added a second channel carrier frequency at 77 GHz to the original channel carrier frequency at 79 GHz.

- Additional antenna (36mm threaded integrated horn antenna) added at 77 GHz to the two antennas in the original 79 GHz certification.

1.3.1 Additional Pertinent Facts

- The user manual includes references to software updates; software updates do not change any TX parameters (i.e. power, gain, frequency, BW, etc.).

- The lab power supply was EMI unfiltered. The EUT is typically used in industrial applications where an AC-to-DC unfiltered power supply supplies DC power. As such, this represents typical use.

1.4 Modifications

None

2 Tested System Details

The test sample was received on November 28, 2016. Listed below are the identifiers and descriptions of all equipment, cables, and internal devices used with the EUT for this testing, as applicable.

Table 2-1: Equipment under Test (EUT)

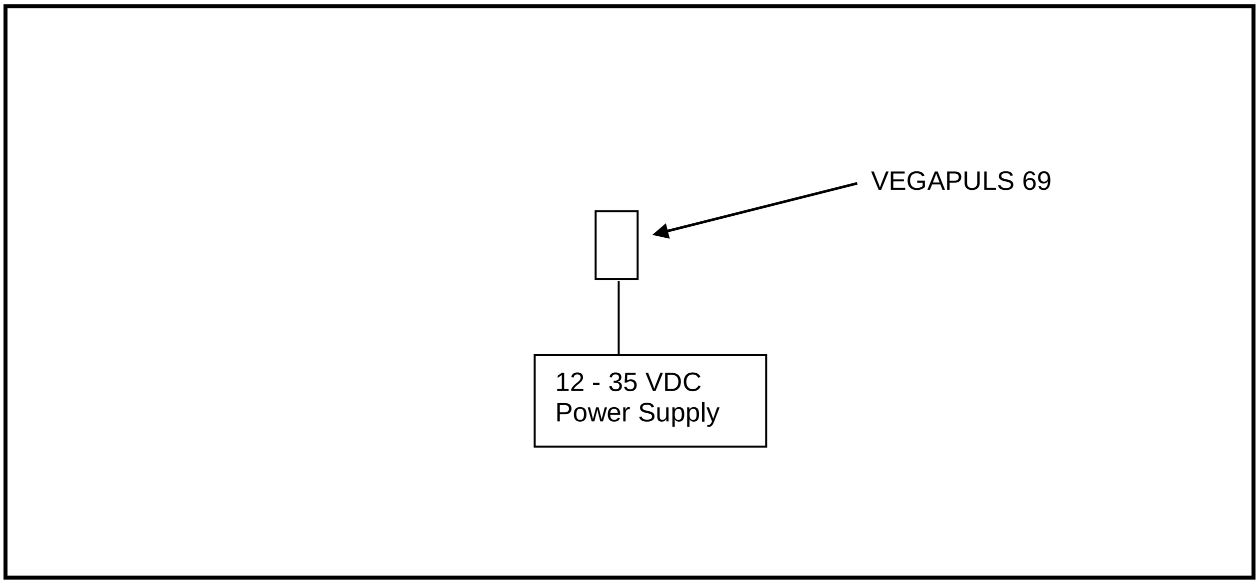
Part	Manufacturer	Model	Serial Number	FCC ID	Cable Type	RTL Bar Code
VEGAPULS 69	VEGA Grieshaber KG	PS69 IXTTCAHXAKJXXX	35036990	06QPS60XW1	N/A	22286
Electronics	VEGA Grieshaber KG	PS60HW	34997194	N/A	N/A	N/A
36mm Threaded Integrated Horn Antenna (24.3 dBi)	VEGA Grieshaber KG	N/A	N/A	N/A	N/A	N/A

Table 2-2: Additional Test Equipment Used

Part	Manufacturer	Model	Serial Number	FCC ID	Cable Type	RTL Bar Code
DC Power Supply	Hewlett Packard	6024A	1912A00331	N/A	1 m un-shielded	901635
AC Adapter (24VDC)	ELPAC Power Systems	FW5024	024851	N/A	2.3m unshielded AC/30 feet unshielded DC	N/A
AC Adapter (12VDC)	CINCON Electronics Co., Ltd.	TR45A12 11A02	45120-0016390	N/A	1m unshielded DC/1.9 feet unshielded DC	15932

Photograph 1: EUT

Figure 2-1: Configuration of Tested System



2.1 Test Distance

The final radiated emissions tests were performed at a 3 meter horizontal distance from the edge of the radar to the test antenna. The EUT was also investigated at closer test distances in order to discern any emissions.

3 Modulated Bandwidth – ANSI C63.10 6.9, FCC 14-2 (§15.256(f)(1)), IC RSS-Gen 4.6

3.1 Modulated Bandwidth Test Procedure - FCC 14-2 (§15.256(f)(1)), IC RSS-Gen 4.6.1

The minimum 10 dB bandwidth was measured using a 50-ohm spectrum analyzer with the resolution bandwidth set at 1 MHz and the video bandwidth set at 3 MHz. The spectrum analyzer's mixer mode resulted in an overlapping bandwidth image with the actual image and a ghost image. The analyzer "Signal ID" and "Auto ID" were used to aid in discerning between the ghost images displayed by the mixer, the left and right markers can be calculated from twice the intermediate frequency of 404.4 MHz (808.8 MHz) from the ghost edge images to the actual bandwidth edges (distance between ghost images). The display markers could not be set to -10 dB from the peak since the spectral lines were completely vertical resulting in a noise floor placement. Max hold was used until the spectrum was adequately filled to portray the bandwidth and a plot was taken.

3.2 Limits

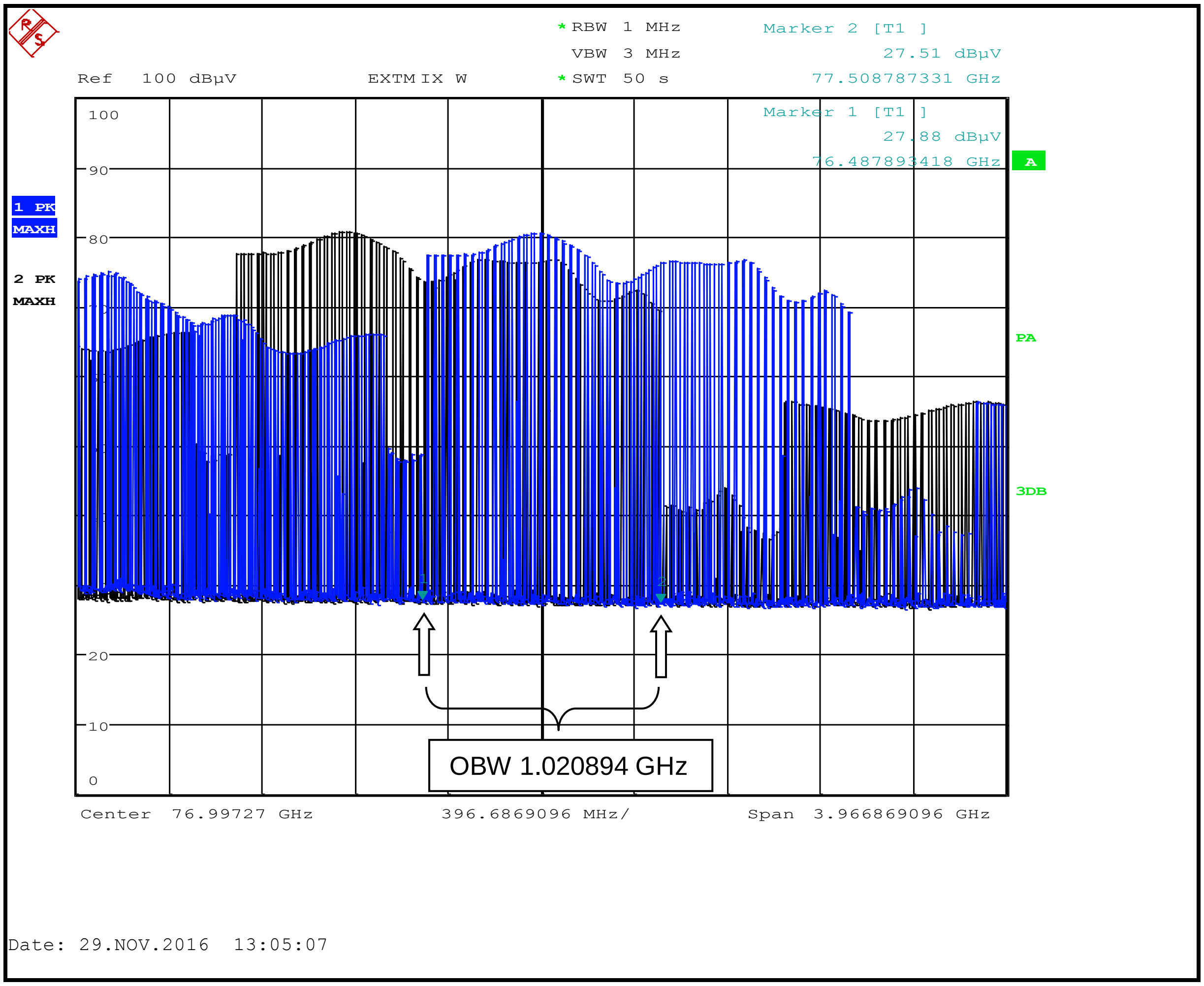
(f) The fundamental bandwidth of an LPR emission is defined as the width of the signal between two points, one below and one above the center frequency, outside of which all emissions are attenuated by at least 10 dB relative to the maximum transmitter output power when measured in an equivalent resolution bandwidth.
(1) The minimum fundamental emission bandwidth shall be 50 MHz for LPR operation under the provisions of this section.

3.3 Modulated Bandwidth Test Data

Table 3-1: 10 dB Modulated Bandwidth - §15.256(f)(1)

Model	10 dB Bandwidth (MHz)	Minimum Limit (MHz)	Margin (MHz)
Electronics PS60HW	1020.9	50	-972

Plot 3-1: 10 dB Modulated Bandwidth



Marker 1: 76.487893418 GHz; Marker 2: 77.508787331 GHz; OBW = 1.020894 GHz

Table 3-2: Modulated Bandwidth Test Equipment

RTL Asset #	Manufacturer	Model	Part Type	Serial Number	Calibration Due Date
901581	Rohde & Schwarz	FSU	Spectrum Analyzer	1166.1660.50	3/22/18

Test Personnel:

Dan Baltzell	[signature]	November 29, 2016
Test Engineer	Signature	Date of Test

4 Radiated Emissions – ANSI C63.10 6.3, FCC §15.256(g)(3), IC RSS-Gen 4.8

4.1 Radiated Fundamental Emissions Test Procedure – FCC §15.256(g)(3); IC RSS-Gen 4.8

Radiated emissions of the fundamental was tested by "bore sighting" the main-beam emissions to produce the maximum realizable antenna coupling. The EUT was also checked in all three orthogonal planes. Measurement was based on an average detector for -3 dBm/1 MHz power density limit and peak detector for 34 dBm/50 MHz limit. Limits are -3 dBm/MHz and 34 dBm/50 MHz bandwidth (20 MHz was used). Since these limits are power density, no pulse desensitization correction factor is required. Both were also measured finding the maximum amplitude at 1 meter and switching from 1 MHz to 20 MHz resolution bandwidths. One meter measuring distance was used since the antenna gain calibration was accomplished at one meter, a correction was used in the correction to dBm as 20 Log (1) = 0 dB.

Limits: The EIRP limits for LPR operations in the bands authorized by this rule section are provided in the following table. These emission limits are based on bore sight measurements (i.e., measurements performed within the main beam of the LPR antenna).

Frequency Band of Operation (GHz)	Average Emission Limit (EIRP in dBm measured in 1 MHz)	Peak Emission Limit (EIRP in dBm measured in 50 MHz)
5.925-7.250	-33	7
24.05-29.00	-14	26
75-85	-3	34

4.2 Radiated Fundamental Emissions Test Data

Radiated measurements are converted from dBuV/m to dBm using the following equation from KDB 890966 6 b:

For radiated emission measurements

EIRP (dBm) = field strength (dBµV/m) – 104.8 + 20 Log D

where:

D is the measurement distance

All power averaging (RMS) emission levels are to be measured utilizing a 1 MHz resolution bandwidth with a one millisecond dwell time over each 1 MHz segment. The frequency span of the analyzer should equal the number of sampling bins times 1 MHz and the sweep rate of the analyzer should equal the number of sampling bins times one millisecond. The video bandwidth of the measurement instrument shall not be less than the resolution bandwidth and trace averaging shall not be employed. The RMS average emission measurement is to be repeated over multiple sweeps with the analyzer set for maximum hold until the amplitude stabilizes. The peak emission measurement is to be repeated over multiple sweeps with the analyzer set for maximum hold until the amplitude stabilizes.

NOTE: The number of sampling BINS used is 2101 corresponding to a span of 2100 MHz, and there are two pulses/second from the DUT; therefore, two pulses will occur per MHz in each second for proper RMS averaging. If one millisecond dwell/MHz is used it will cause artificially high RMS averaging levels per FCC TR 14-1007.

For ISED, the standard ETSI EN 302 729 was used to test the EUT.

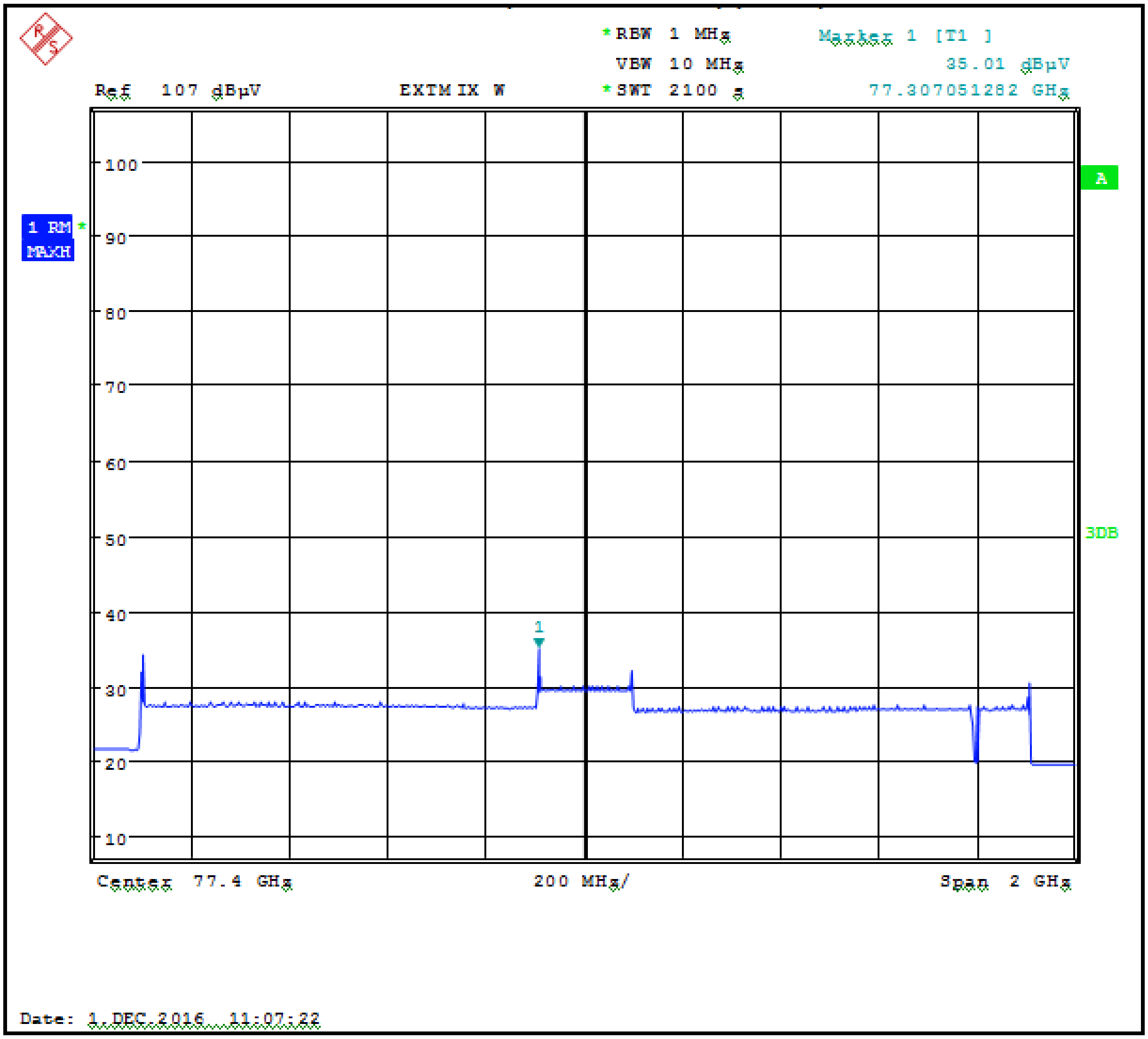
Table 4-1: Radiated Fundamental Emissions (EIRP in 1 MHz, Average Detector)

Frequency (GHz)	Average Spectrum Analyzer Level (dBuV)	Antenna Correction Factor (dB/m)	Corrected Average Measurement (dBuV/m)	Converted to dBm	Limit (dBm)	Margin (dB)
77	35.0	45.3	80.3	-15.0	-3.0	-12.0

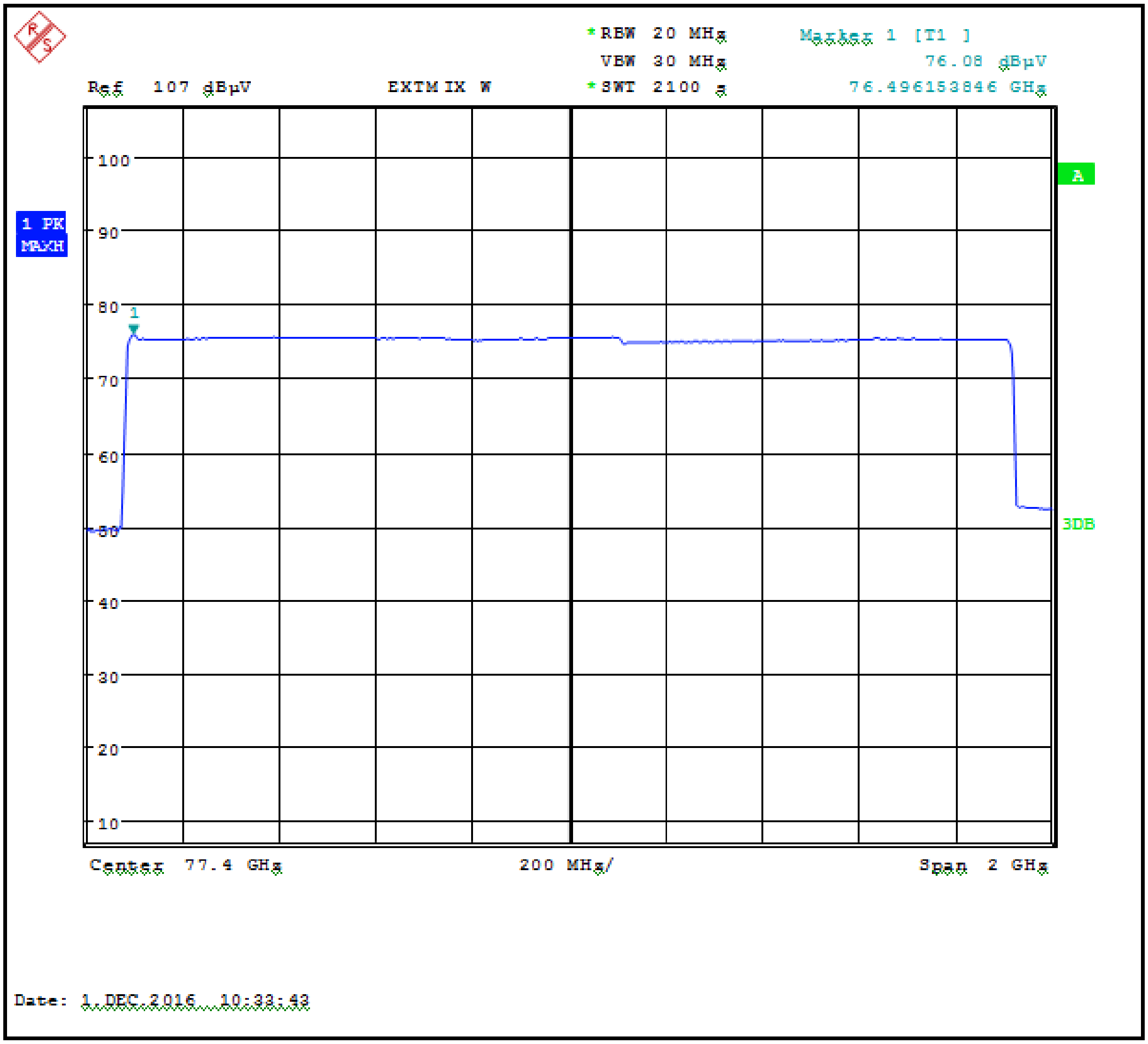
Table 4-2: Radiated Fundamental Emissions (EIRP in 50 MHz, Peak Detector)

Frequency (GHz)	Peak EIRP Measured (dBuV)	Site Correction Factor (dB/m)	Corrected Peak Measurement (dBuV/m)	Converted to dBm	Limit (dBm)	Margin (dB)
77	76.1	45.3	121.4	26.1	34.0	-7.9

Plot 4-1: Radiated Fundamental (EIRP in 1 MHz)



Plot 4-2: Radiated Fundamental (EIRP in 50 MHz)



Note:
Per FCC 15.256(g)(2)(ii): The Rhode & Schwarz FSU 50 spectrum analyzer used a maximum video bandwidth resolution of 20 MHz, which is less than the required 50 MHz RBW. However, no bandwidth correction factor should be used for peak measurements, when the resolution is above 1 MHz since the amplitude is a carrier wave and no amplitude change occurs when the resolution bandwidth is higher than 1 MHz.

In the original FCC application report, two peak plots using 20 MHz and 1 MHz RBW bandwidths respectively were presented, which demonstrated that there are little or no differences between 20 MHz RBW measurement data and 1 MHz RBW measurement data when the EUT is a wave carrier device.

As such in this report, only peak and average plots data are present as worst-case results. Furthermore, a peak-to-average EIRP data calculation is included in this report to show that the worst-case average EIRP test result is the measured average EIRP test result.

4.3 Calculation of Average EIRP Value from Peak EIRP Value

Calculation of average dwell time, TD = $T_S/\Delta F$, where T_S is the signal sweep frequency time in seconds and ΔF is the signal sweep frequency span in MHz. The Average factor = the Average dwell time TD/ Cycle time for an Average factor, where Cycle time is the total time for a complete cycle of the signal including retrace and any other latency times.

4.3.1 Calculated Average EIRP Value

T_S = 0.00516s; Cycle time = 0.0085s; ΔF = 1020.9 MHz

T_D = 0.00516/1020.9 = 0.00001, Average factor = 0.00001/0.0085 = 0.0006

Average EIRP value from Peak EIRP value of 121.4 dBuV/m

Avg Factor x Peak = .0006 x 10^(121.4 dBuV/m / 20) = 704.9 uV = 20Log(704.9) = 57 dBuV/m =

57.0 dBuV/m – 104.8 + 20Log(d) = -38.3 dBm at 3 meters.

The measured EIRP value = -15 dBm

The measured Average EIRP value is presented as worst case data.

Table 4-3: Radiated Fundamental Emissions Test Equipment

RTL Asset #	Manufacturer	Model	Part Type	Serial Number	Calibration Due Date
901581	Rohde & Schwarz	FSU	Spectrum Analyzer	1166.1660.50	3/22/18
901640	Rohde & Schwarz	FS-Z110	Mixer (75–110 GHz)	100010	4/2/17
900711	ATM	10-443-6R	Horn Antenna (75-110 GHz)	8051905-1	12/5/17

Test Personnel:

Dan Baltzell		December 1, 2016
Test Engineer	Signature	Date of Test

4.4 Radiated Emissions – ANSI C63.10 6.3, FCC §15.256(h)(k); IC RSS-Gen 4.9

4.5 Radiated Emissions Harmonics/Spurious Test Procedure - FCC §15.256(h)(k); IC RSS-Gen 4.9

Data was taken at, and corrected to, three meters. The EUT was checked in the three orthogonal planes with the receive antenna in both polarities. A resolution bandwidth of 100 kHz was used for frequencies less than 1000 MHz, and a resolution bandwidth of 1 MHz was used for frequencies greater than or equal to 1000 MHz.

Limit: Unwanted Emissions from LPR devices shall not exceed the general emission limit in §15.209 of this chapter.

4.6 Radiated Emissions Harmonics/Spurious Test Data

The plots were taken with the measuring antenna at a distance to provide sufficient signal to noise ratio for measurement, a distance of 10 mm corrected to 3 m is 20 log (0.01/3) = -49.5 dB. The emissions from the EUT were generally investigated at 0.01 m, 0.1 m, and 3 m to ensure no indication of detectable emissions. A 1 cm distance was used to ensure a worst-case scenario and is equivalent to -49.5 dB.

To reduce errors given the significant mixer ghost images and their amplitudes on measurement plots, the analyzer has a built-in automated signal identification function, as well as an auto identification function, that could be used to identify real and ghost signals. However, the nature of the swept FMCW frequencies warrants that the automated identification function not be used. As a result, real signals were manually identified by calculating the LO. A real signal is dependent upon the LO frequency and selected harmonic of the first LO as:

$f_{in} = n*f_{LO} + f_{IF}$
where f_{in} is the frequency of the signal,
n is the order of the harmonic used for conversion,
f_{LO} is the frequency of the first LO,
and f_{IF} is the intermediate frequency 404.4 MHz

and was used to verify false images. Sweep time can be adjusted for various pulse duration to determine if false images might be overlaying real signals, and the above calculation applied to determine if they are real. Signal strength is increased by moving the receive antenna to the transmitted signal, thus overcoming analyzer dynamic range decrease due to mixer loss. As the image began its sweep, the individual CW pulse image was noted, as well as any CW which might be mixed in the bandwidth, using max hold, thus overcoming the problem of signal bandwidth>2xIF. This was then compared to the IF, order of harmonic, and first LO frequency, and a manual determination made whether the requirements for validation were met.

Plot 4-3: Radiated Spurious Emissions (140 – 200 GHz) - Average

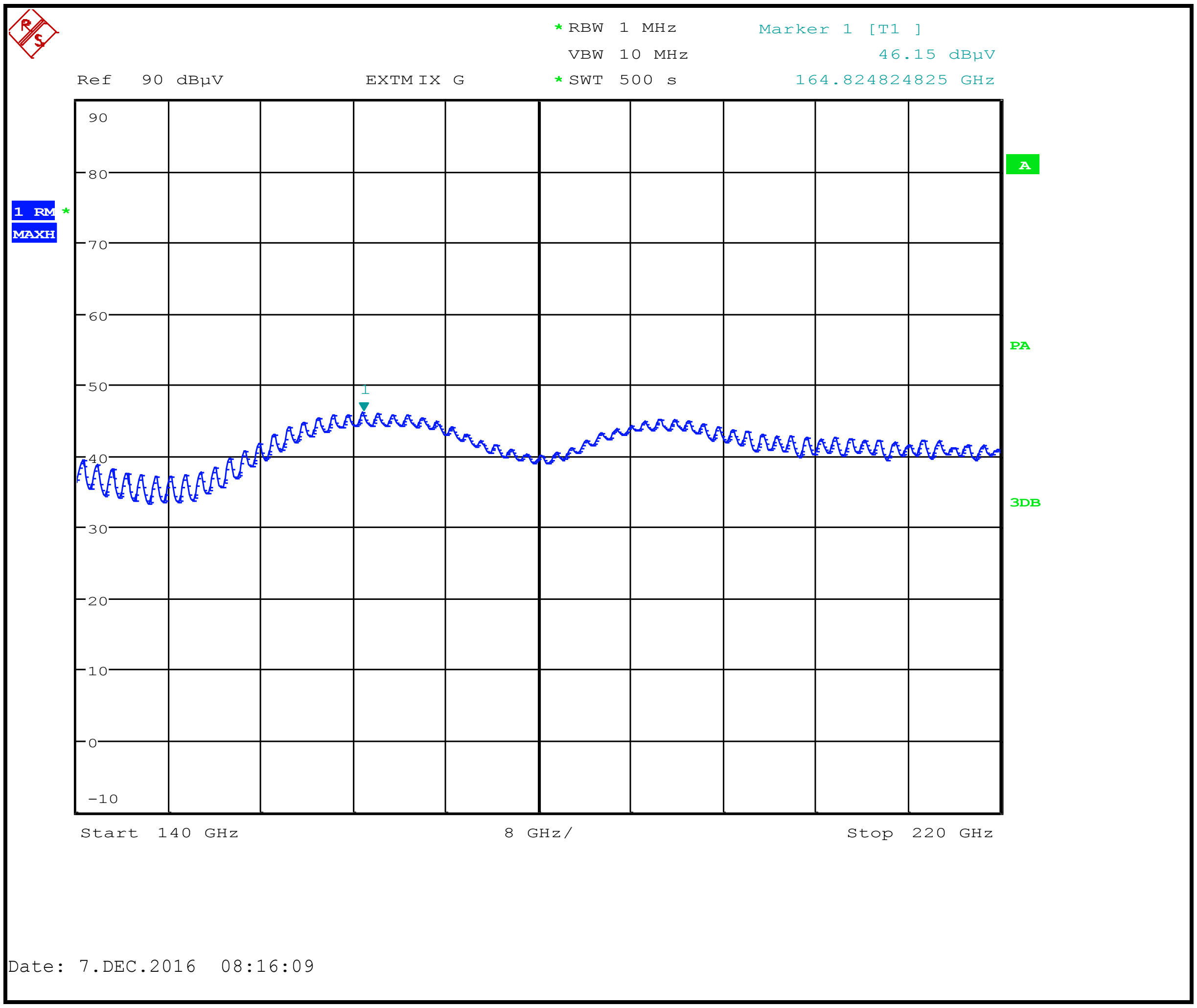


Table 4-4: Radiated Spurious (140 – 200 GHz) – Average

Frequency (MHz)	Average EIRP Measured (dBuV)	Test Antenna Correction Factor (dB/m)	Correction from .01m to 3m (dB)	Corrected Measurement (dBuV/m)	Limit (dBuV/m)	Margin (dB)
164824.824	46.2	51.5	-49.5	48.2	54.0	-5.8

Plot 4-4: Radiated Spurious Emissions (140 – 200 GHz) - Peak

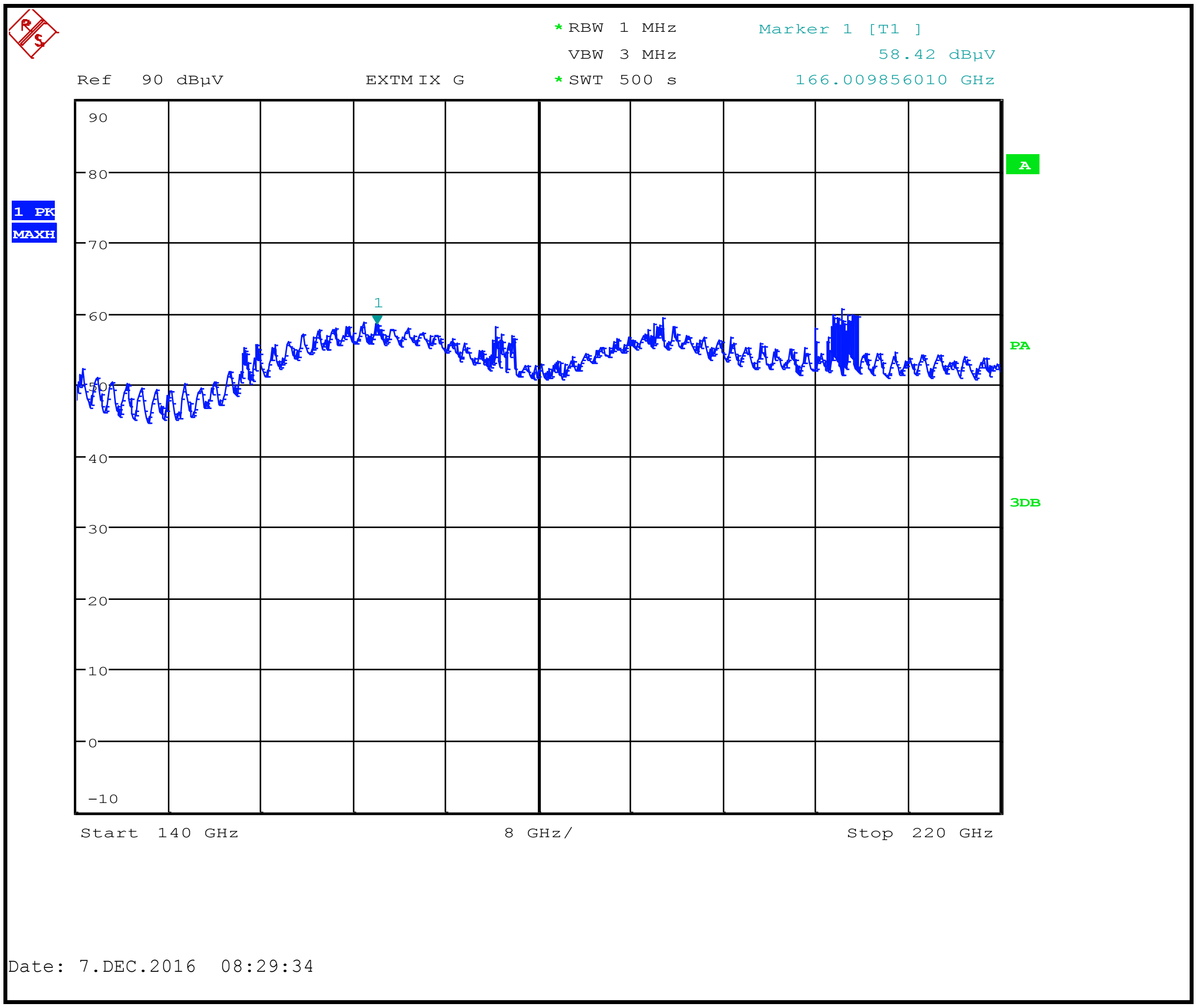


Table 4-5: Radiated Spurious (140 – 200 GHz) – Peak

Frequency (MHz)	Peak EIRP Measured (dBuV)	Test Antenna Correction Factor (dB/m)	Correction from .01m to 3m (dB)	Corrected Measurement (dBuV/m)	Limit (dBuV/m)	Margin (dB)
166009.856	58.4	51.6	-49.5	60.5	74.0	-13.5

Plot 4-5: Radiated Spurious Emissions (Second Harmonic) – Average

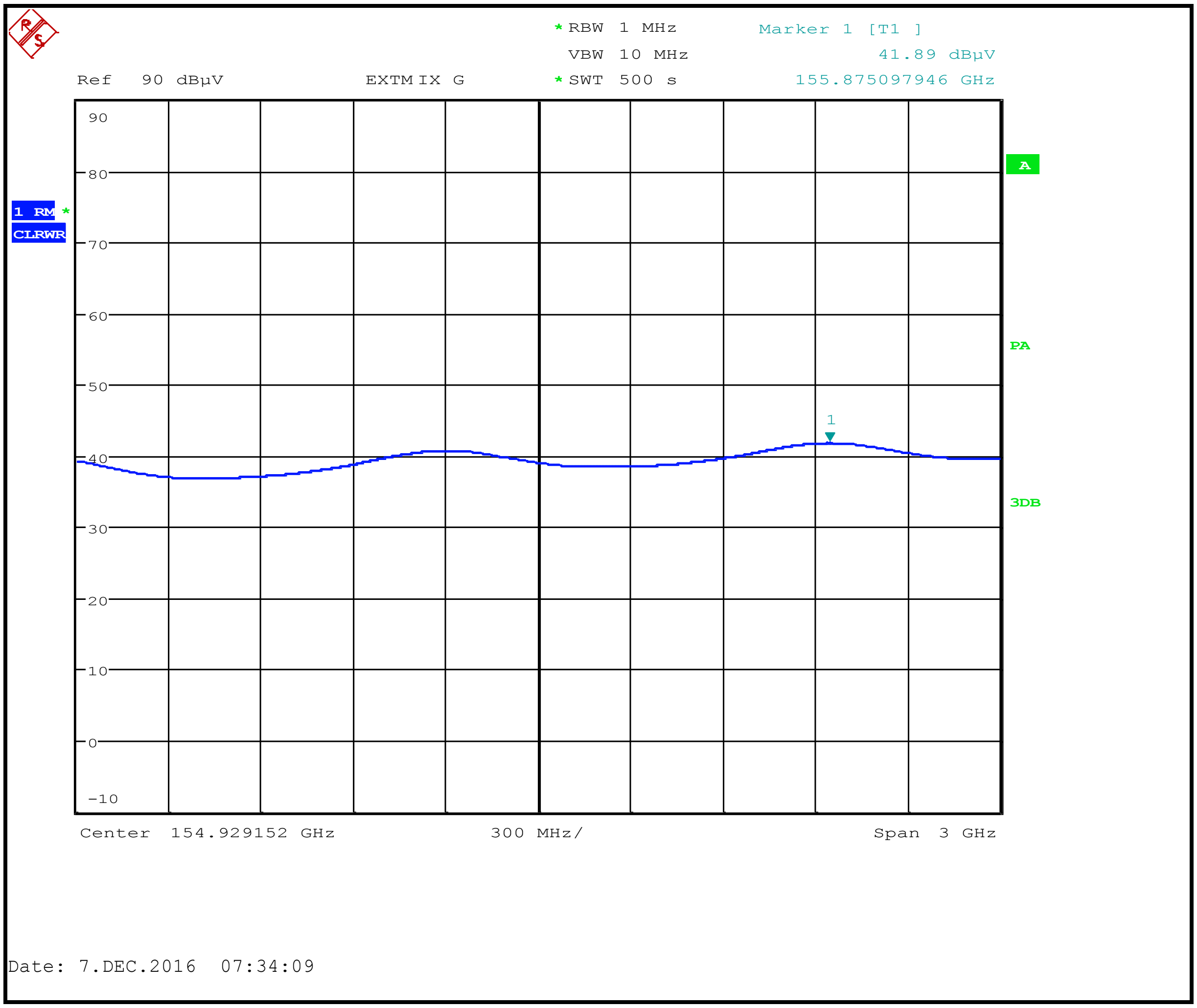


Table 4-6: Radiated Spurious Second Harmonic – Average

Frequency (MHz)	Average EIRP Measured (dBuV)	Test Antenna Correction Factor (dB/m)	Correction from .01m to 3m (dB)	Corrected Measurement (dBuV/m)	Limit (dBuV/m)	Margin (dB)
155875.098	41.9	51.1	-49.5	43.5	54.0	-10.5

Plot 4-6: Radiated Spurious Emissions (Second Harmonic) - Peak

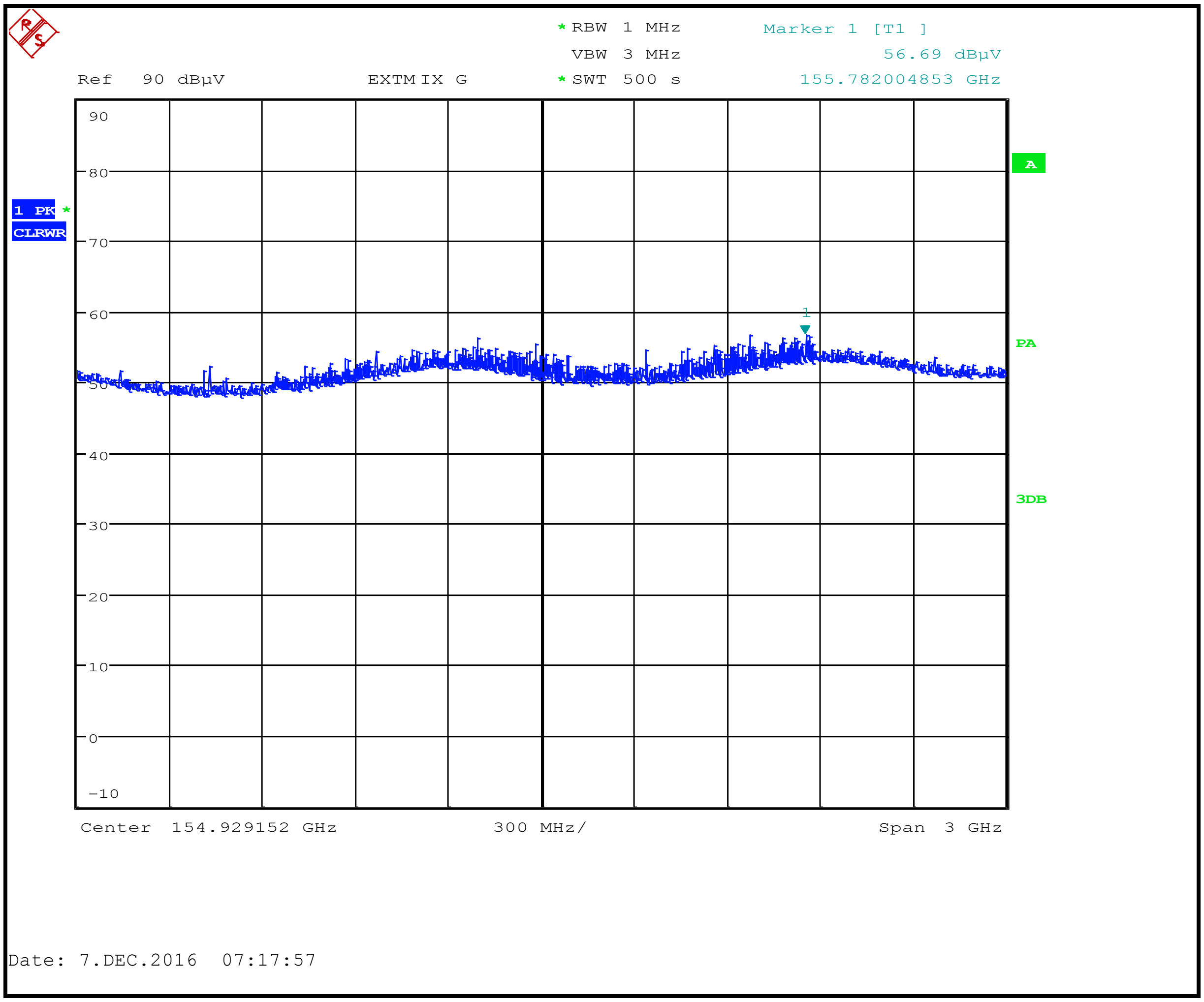


Table 4-7: Radiated Second Harmonic – Peak

Frequency (MHz)	Average EIRP Measured (dBuV)	Test Antenna Correction Factor (dB/m)	Correction from .01m to 3m (dB)	Corrected Measurement (dBuV/m)	Limit (dBuV/m)	Margin (dB)
155782.005	56.7	51.1	-49.5	58.3	74.0	-15.7

Plot 4-7: Radiated Spurious Emissions (90 GHz – 140 GHz) - Average

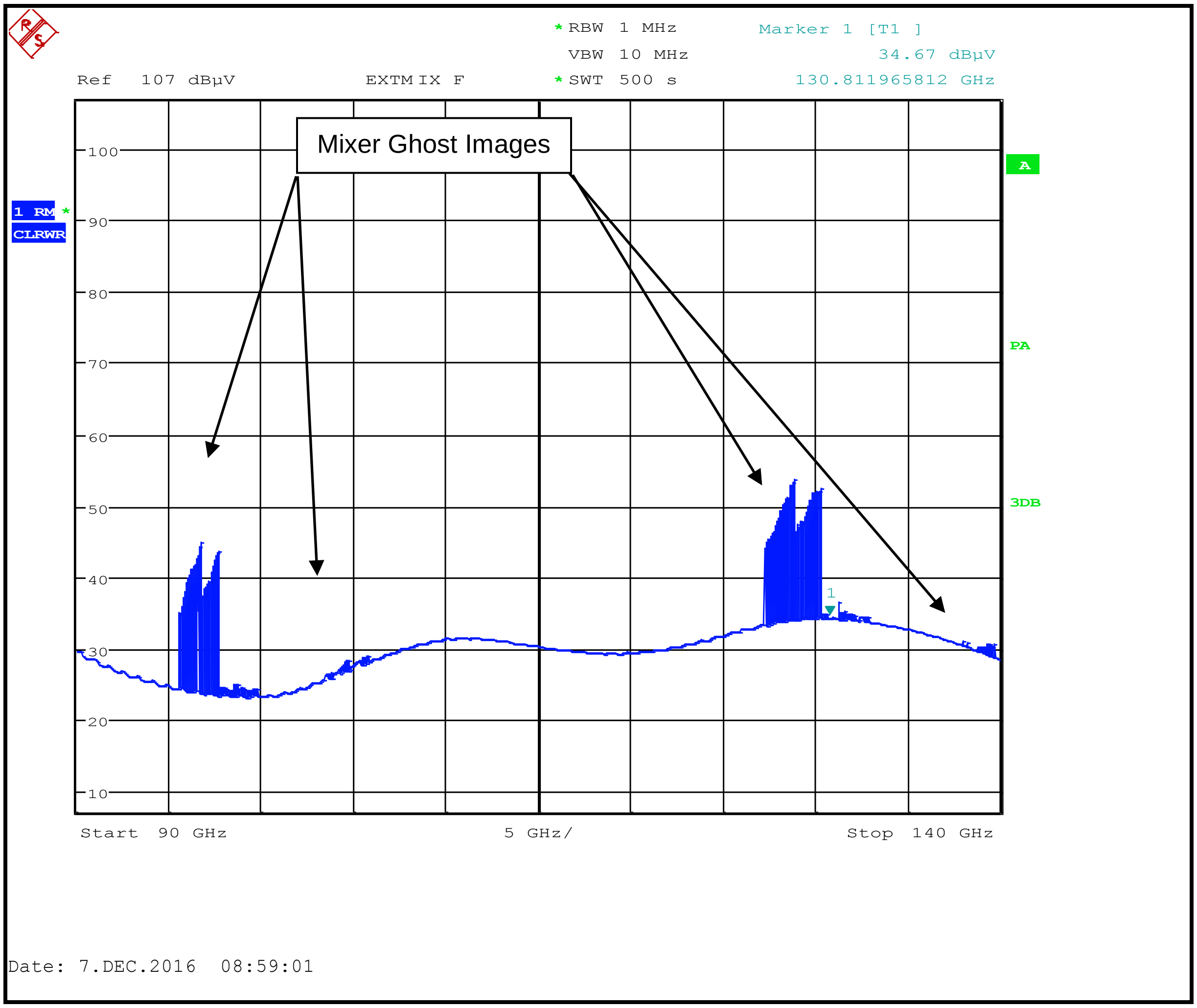


Table 4-8: Radiated Noise Floor Calculation (90 GHz – 140 GHz) – Average

Frequency (MHz)	EIRP Measured (dBuV)	Test Antenna Correction Factor (dB/m)	Correction from .01m to 3m (dB)	Corrected Measurement (dBuV/m)	Limit (dBuV/m)	Margin (dB)
130811.966	34.7	48.5	-49.5	33.7	54.0	-20.3

Plot 4-8: Radiated Spurious Emissions (90 GHz - 140 GHz) - Peak

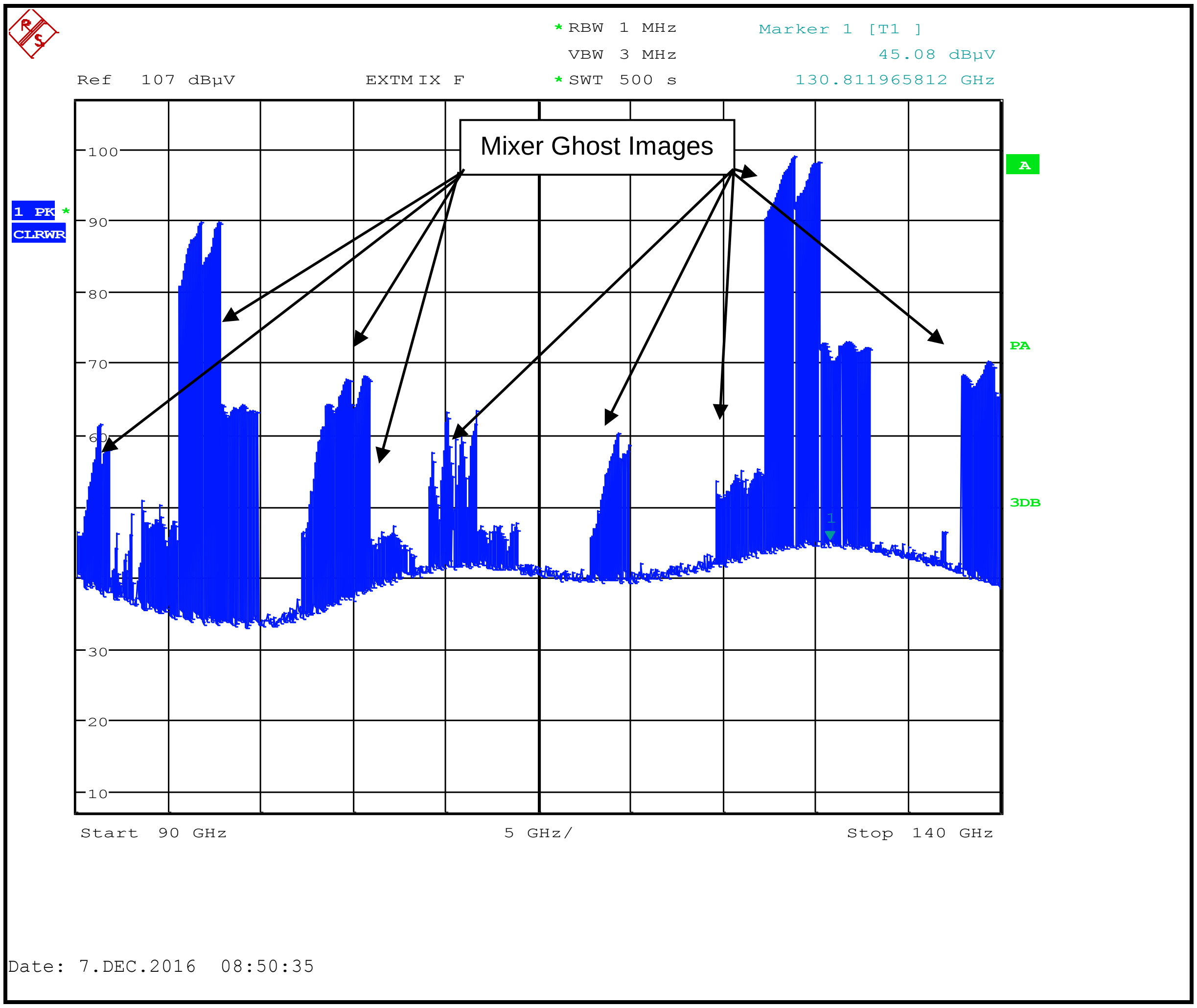


Table 4-9: Radiated Noise Floor Calculation (90 GHz – 140 GHz) – Peak

Frequency (MHz)	EIRP Measured (dBuV)	Test Antenna Correction Factor (dB/m)	Correction from .01m to 3m (dB)	Corrected Measurement (dBuV/m)	Limit (dBuV/m)	Margin (dB)
130811.966	45.1	48.5	-49.5	44.1	74.0	-29.9

Plot 4-9: Radiated Spurious Emissions (75 GHz - 90 GHz) - Average

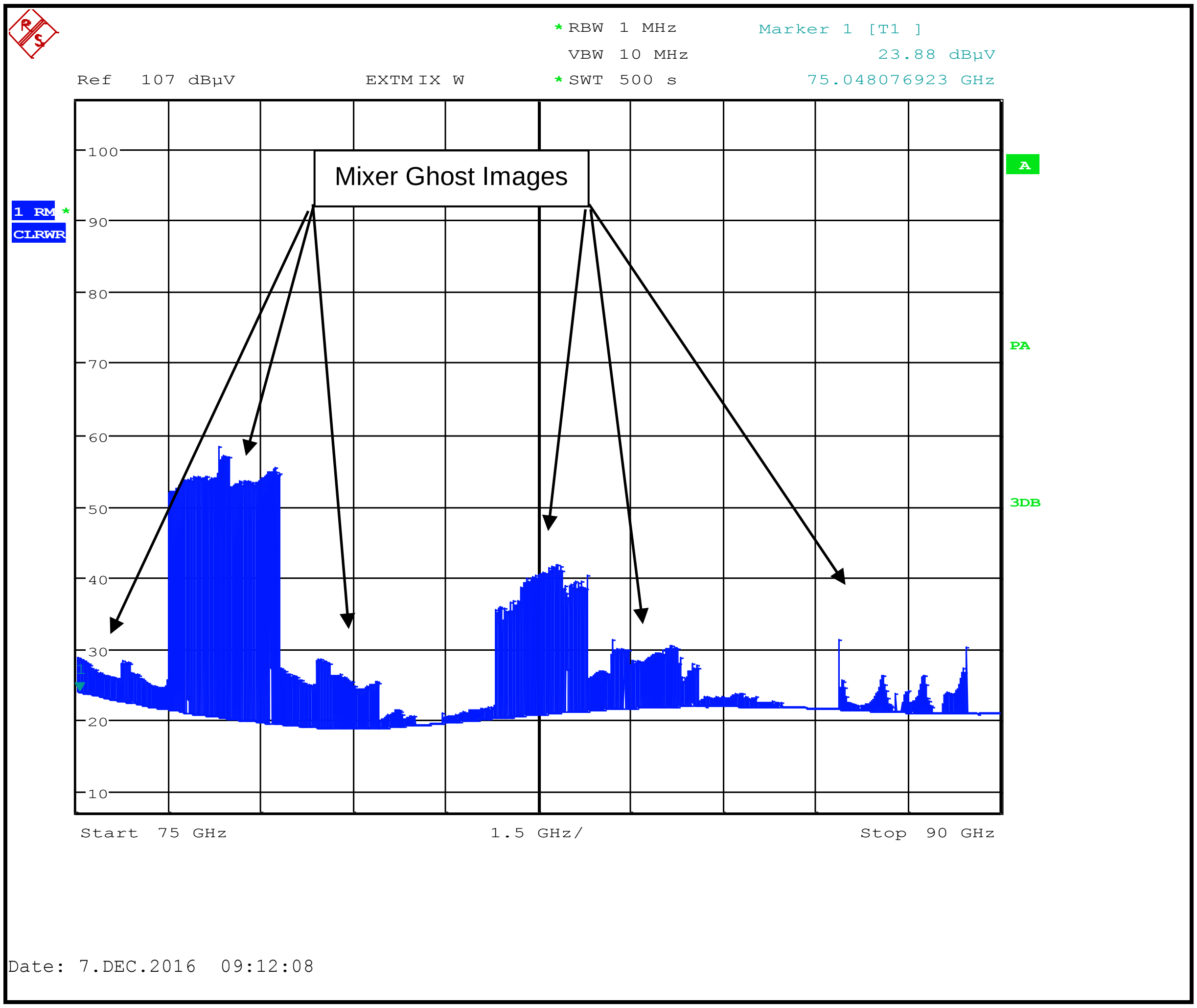


Table 4-10: Radiated Noise Floor Calculation (75 GHz - 90 GHz) – Average

Frequency (MHz)	EIRP Measured (dBuV)	Test Antenna Correction Factor (dB/m)	Correction from .01m to 3m (dB)	Corrected Measurement (dBuV/m)	Limit (dBuV/m)	Margin (dB)
75048.077	23.9	45.2	-49.5	19.6	54.0	-34.4

Plot 4-10: Radiated Spurious Emissions (75 GHz - 90 GHz) - Peak

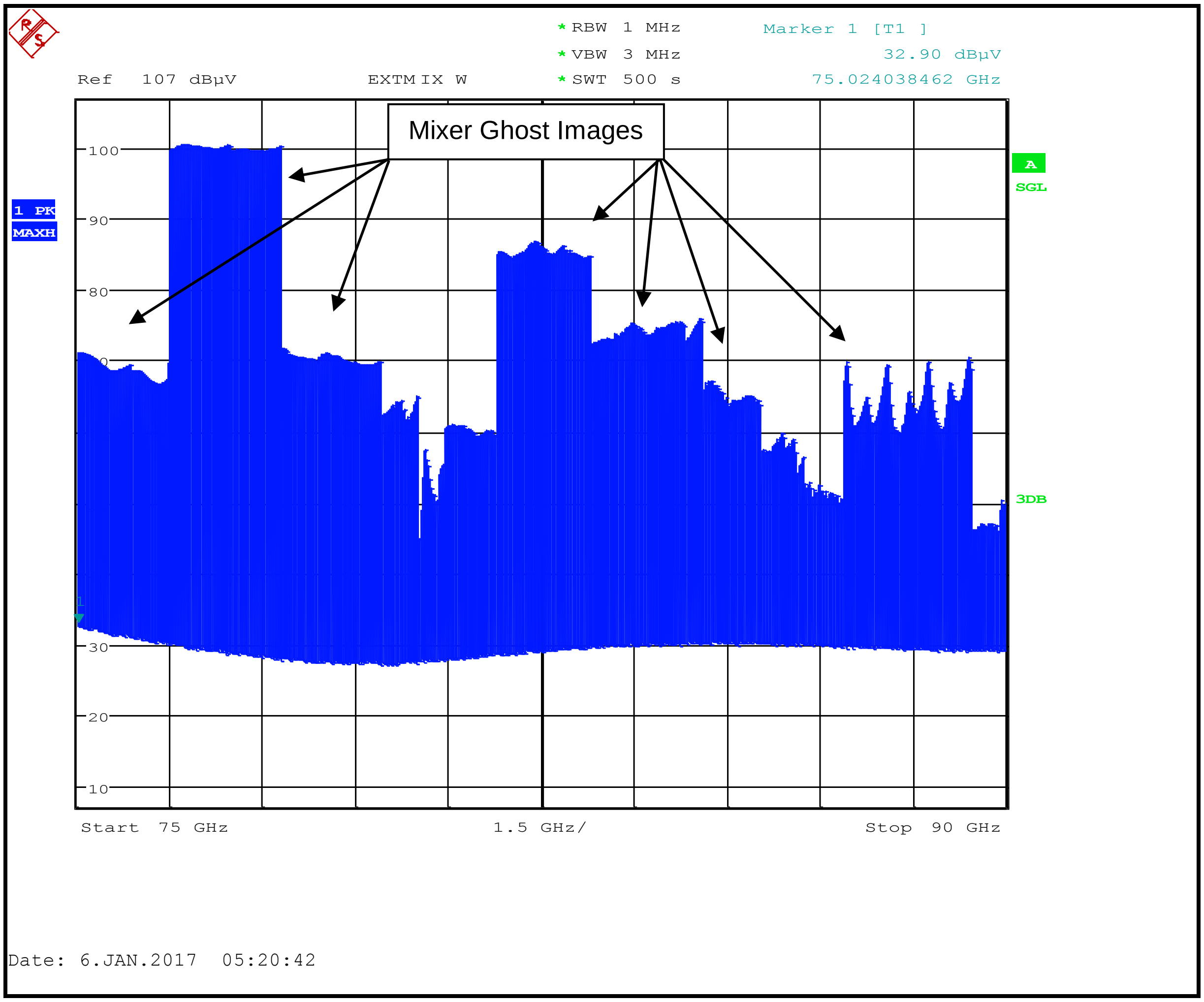


Table 4-11: Radiated Noise Floor Calculation (75 GHz - 90 GHz) – Peak

Frequency (MHz)	EIRP Measured (dBuV)	Test Antenna Correction Factor (dB/m)	Correction from .01m to 3m (dB)	Corrected Measurement (dBuV/m)	Limit (dBuV/m)	Margin (dB)
75048.077	32.9	45.2	-49.5	28.6	74.0	-45.4

Plot 4-11: Radiated Spurious Emissions (50 GHz - 75 GHz) - Average

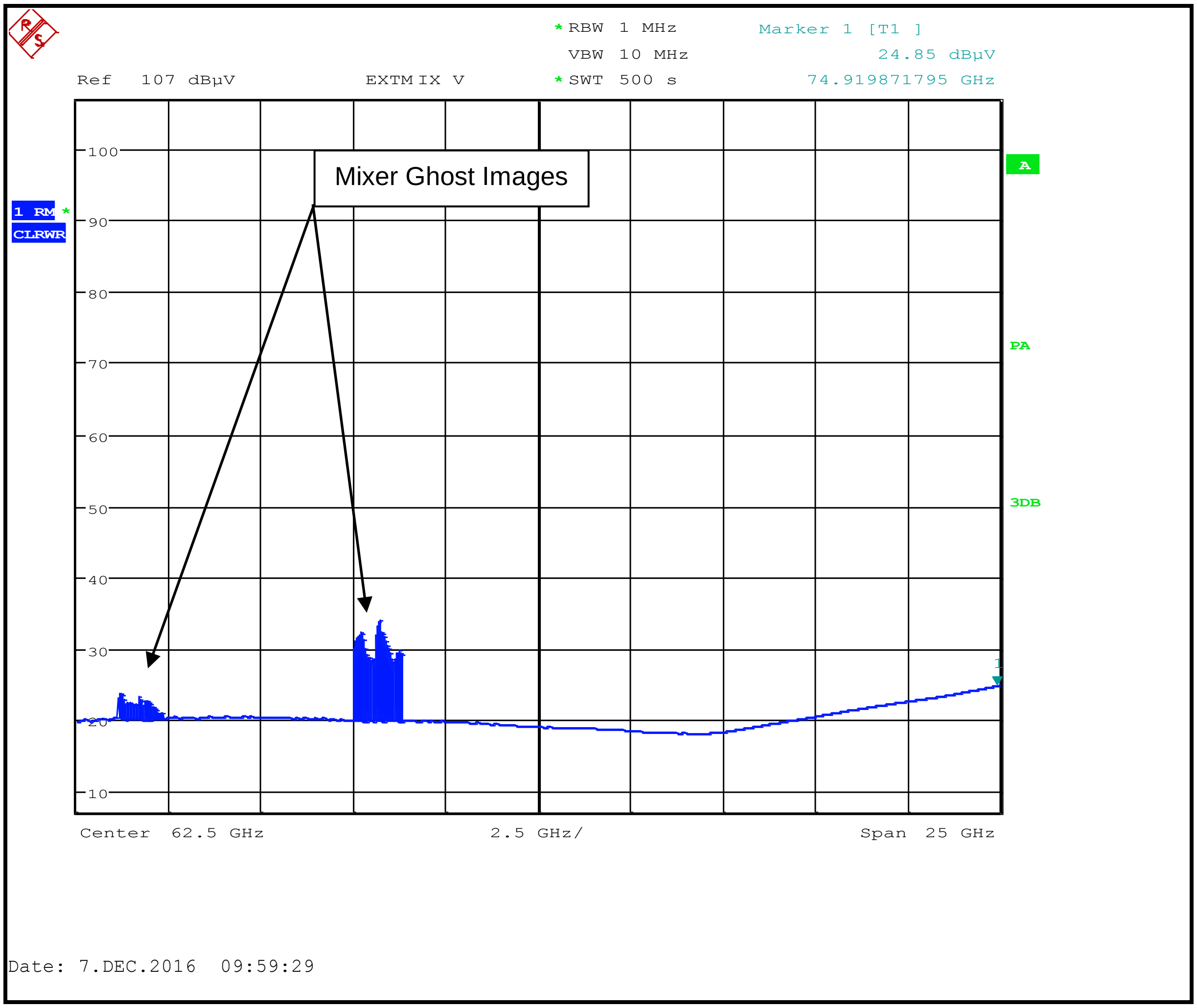


Table 4-12: Radiated Noise Floor Calculation (50 GHz - 75 GHz) – Average

Frequency (MHz)	EIRP Measured (dBuV)	Test Antenna Correction Factor (dB/m)	Correction from .01m to 3m (dB)	Corrected Measurement (dBuV/m)	Limit (dBuV/m)	Margin (dB)
74919.872	24.9	44.3	-49.5	19.7	54.0	-34.3

Plot 4-12: Radiated Spurious Emissions (50 GHz - 75 GHz) - Peak

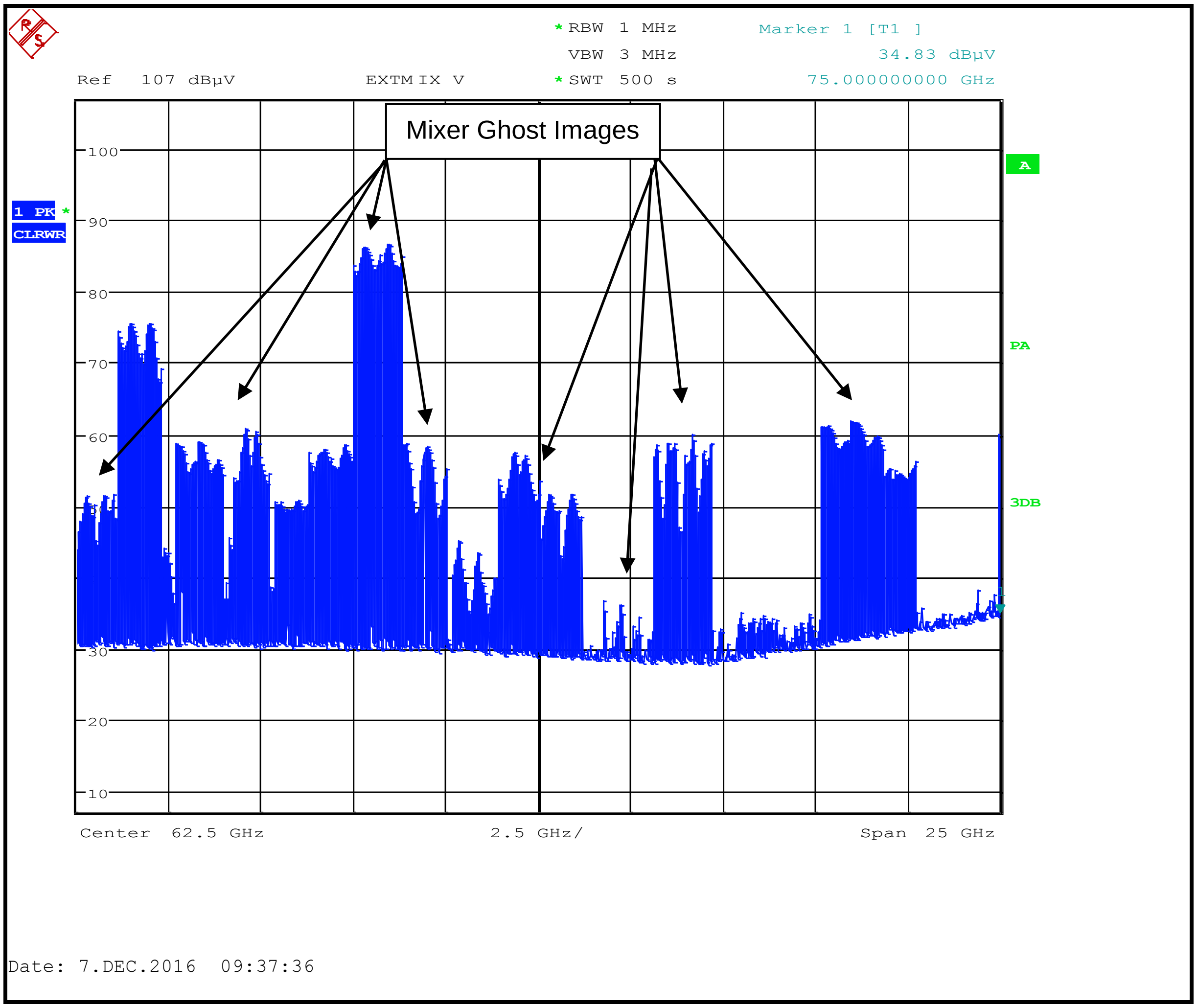


Table 4-13: Radiated Noise Floor Calculation (50 GHz - 75 GHz) – Peak

Frequency (MHz)	EIRP Measured (dBuV)	Test Antenna Correction Factor (dB/m)	Correction from .01m to 3m (dB)	Corrected Measurement (dBuV/m)	Limit (dBuV/m)	Margin (dB)
75000.000	34.8	44.3	-49.5	29.6	75.0	-45.4

Plot 4-13: Radiated Spurious Emissions (40 GHz – 50 GHz) – Average

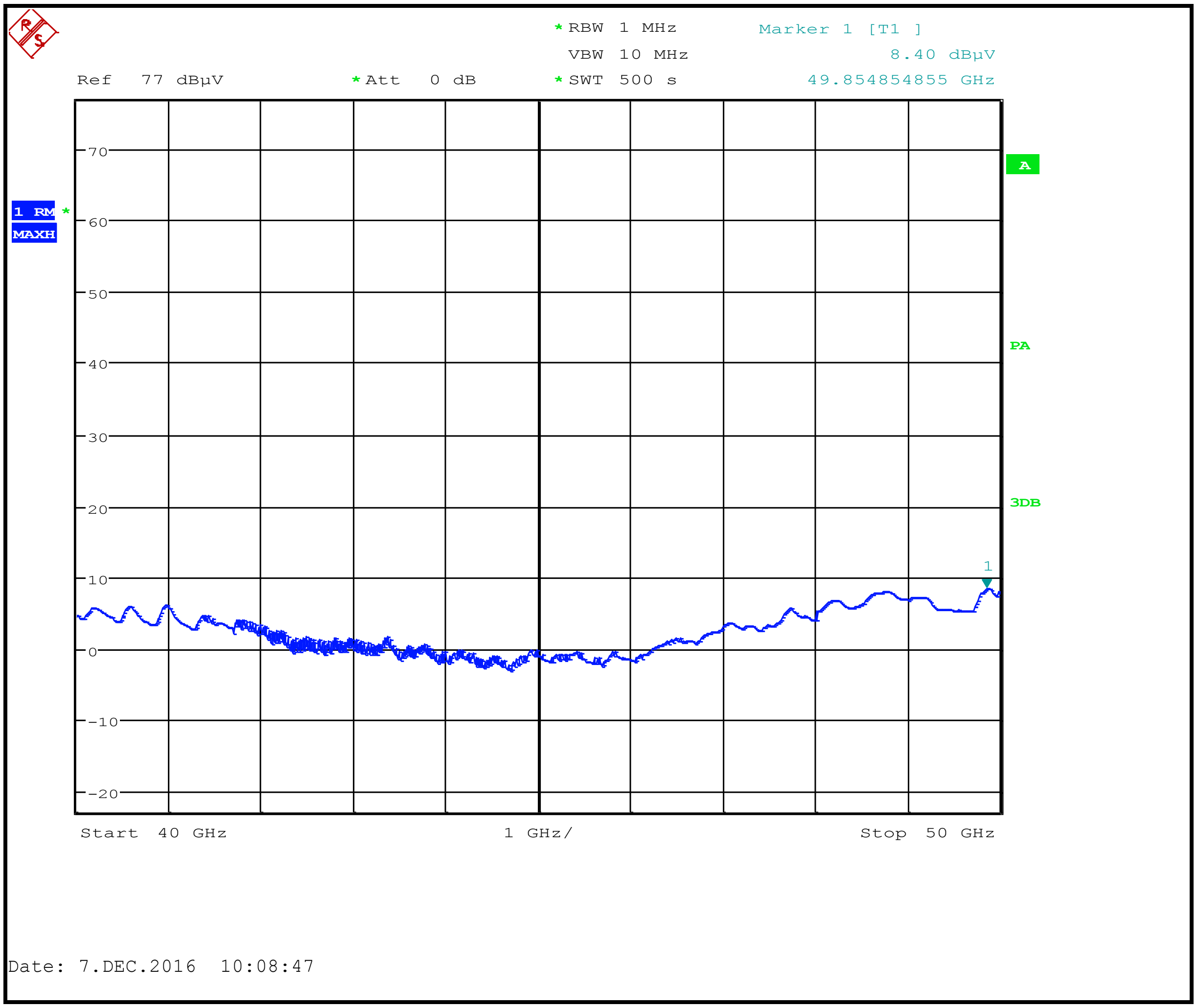


Table 4-14: Radiated Noise Floor Calculation (40 GHz – 50 GHz) – Average

Frequency (MHz)	EIRP Measured (dBuV)	Test Antenna Correction Factor (dB/m)	Correction from .01m to 3m (dB)	Corrected Measurement (dBuV/m)	Limit (dBuV/m)	Margin (dB)
49854.855	8.4	53.1	-49.5	12.0	54.0	-42.0

Plot 4-14: Radiated Spurious Emissions (40 GHz – 50 GHz) – Peak

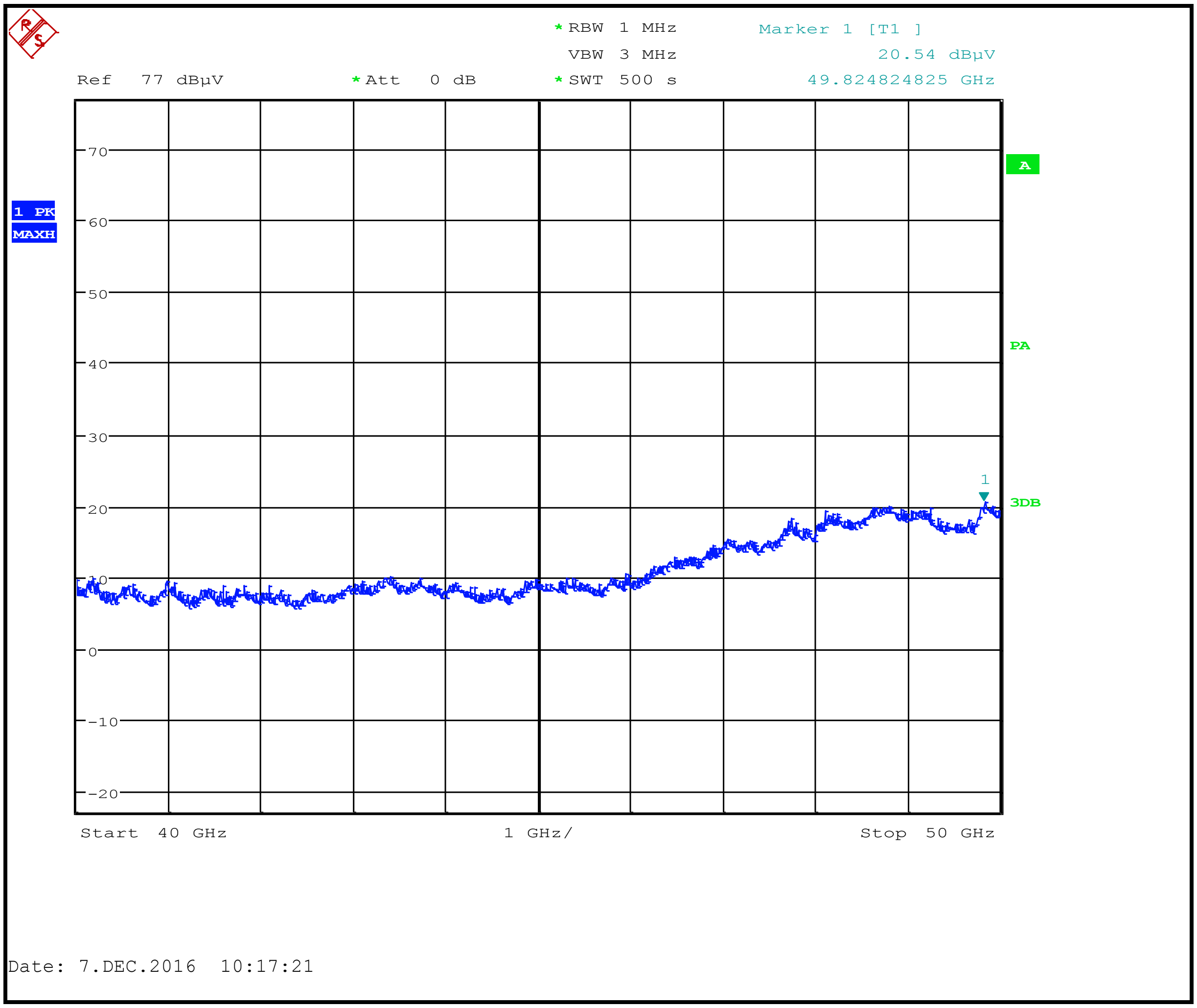


Table 4-15: Radiated Noise Floor Calculation (40 GHz – 50 GHz) – Peak

Frequency (MHz)	EIRP Measured (dBuV)	Test Antenna Correction Factor (dB/m)	Correction from .01m to 3m (dB)	Corrected Measurement (dBuV/m)	Limit (dBuV/m)	Margin (dB)
49824.825	20.5	53.1	-49.5	24.1	74.0	-49.9

Plot 4-15: Radiated Spurious Emissions (26.5 GHz – 40 GHz) – Average

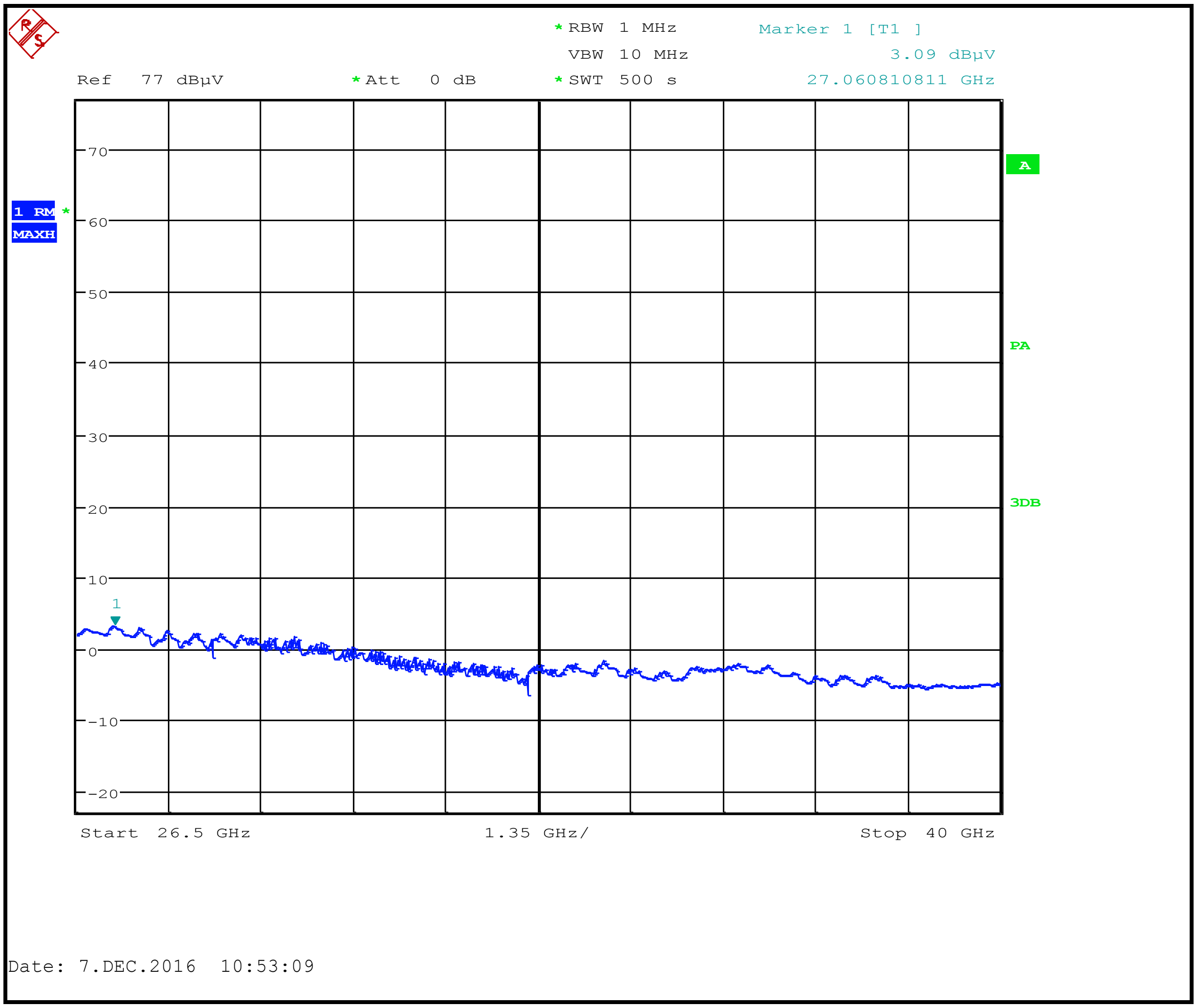


Table 4-16: Radiated Noise Floor Calculation (26.5 GHz – 40 GHz) – Average

Frequency (MHz)	EIRP Measured (dBuV)	Test Antenna Correction Factor (dB/m)	Correction from .01m to 3m (dB)	Corrected Measurement (dBuV/m)	Limit (dBuV/m)	Margin (dB)
27060.810	3.1	51.7	-49.5	5.3	54.0	-48.7

Plot 4-16: Radiated Spurious Emissions (26.5 GHz – 40 GHz) – Peak

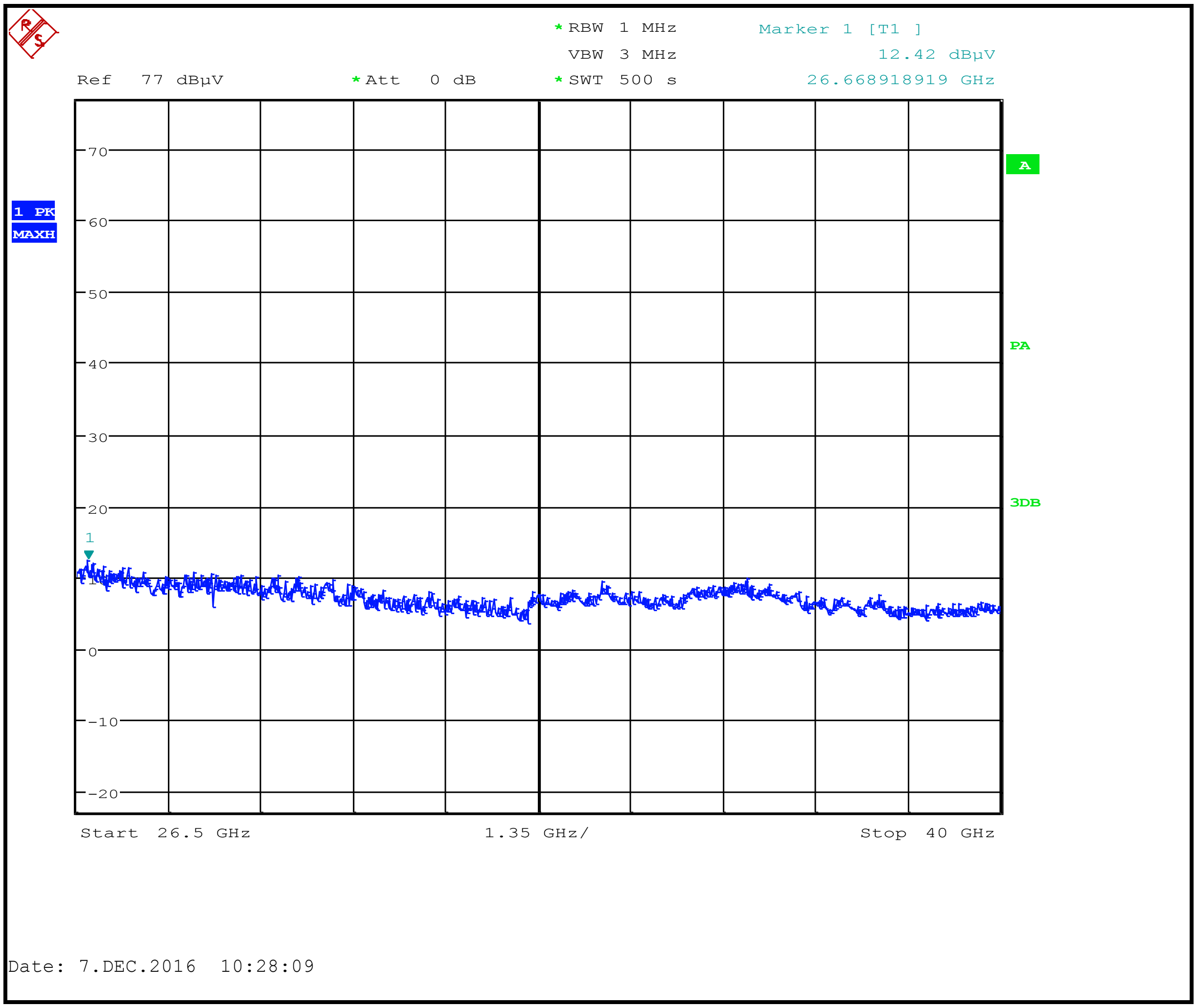


Table 4-17: Radiated Noise Floor Calculation (26.5 GHz – 40 GHz) – Peak

Frequency (MHz)	EIRP Measured (dBuV)	Test Antenna Correction Factor (dB/m)	Correction from .01m to 3m (dB)	Corrected Measurement (dBuV/m)	Limit (dBuV/m)	Margin (dB)
26668.919	12.4	51.7	-49.5	14.6	74.0	-59.4

Plot 4-17: Radiated Spurious Emissions (18 GHz – 26.5 GHz)

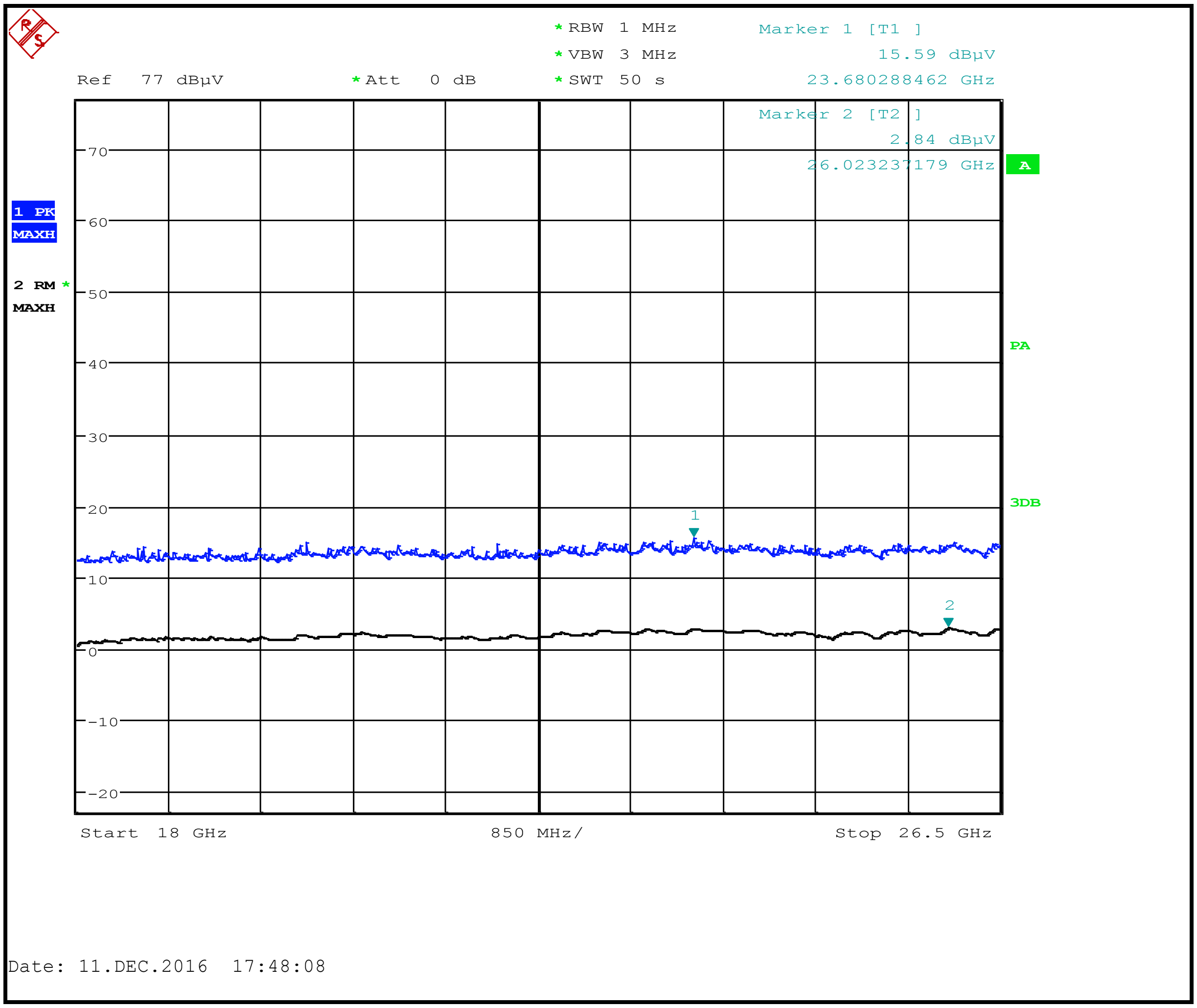


Table 4-18: Radiated Noise Floor Calculation (18 GHz – 26.5 GHz)

Frequency (MHz)	EIRP Measured (dBuV)	Test Antenna Correction Factor (dB/m)	Corrected Measurement (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Peak/ Average
23680.289	15.6	46.4	62.0	74.0	-12.0	Peak
26023.237	2.8	47.4	50.2	54.0	-3.8	Average

Plot 4-18: Radiated Spurious Emissions (12.4 GHz - 18 GHz)

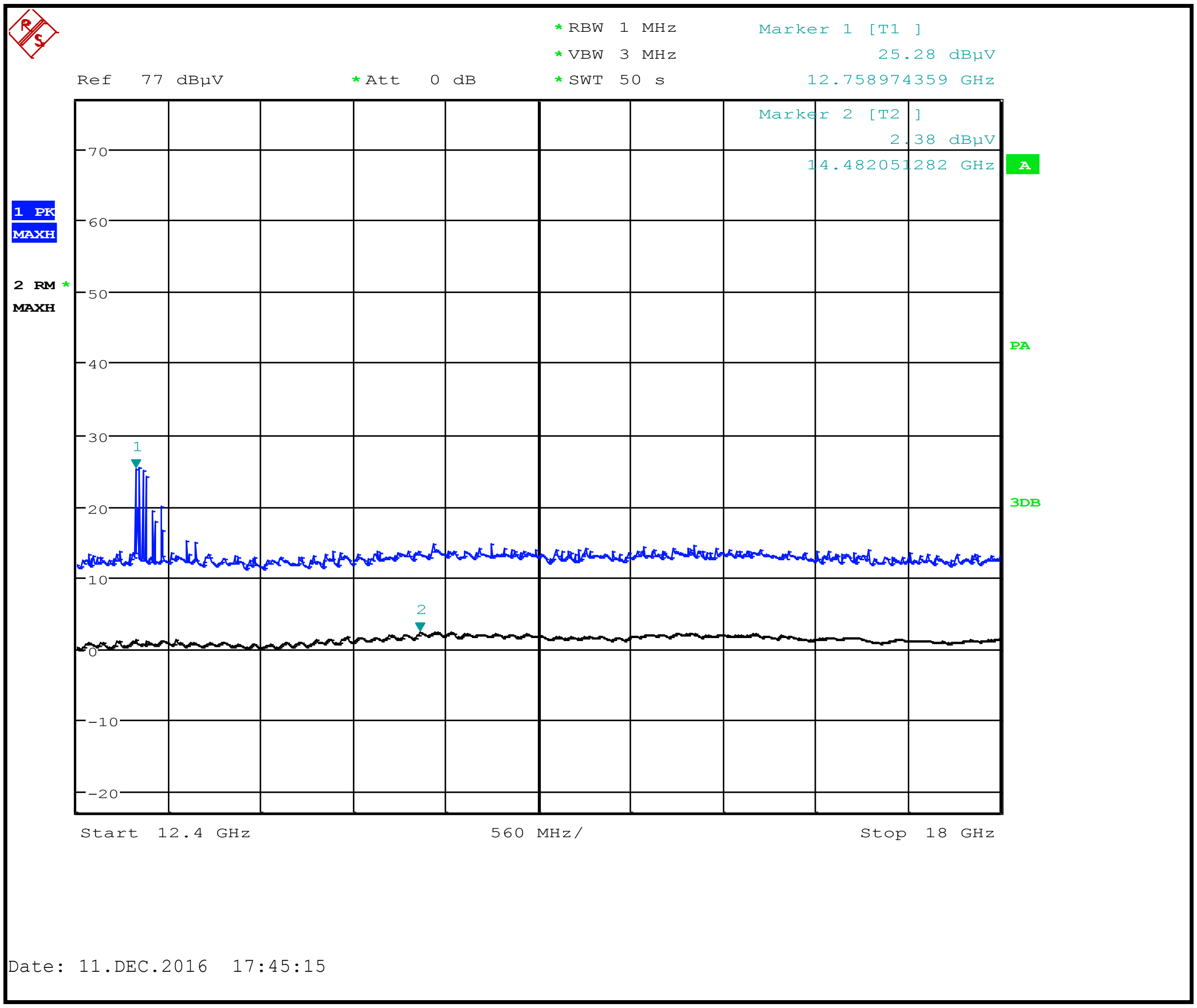


Table 4-19: Radiated Noise Floor Calculation (12.4 GHz - 18 GHz)

Frequency (MHz)	EIRP Measured (dBuV)	Test Antenna Correction Factor (dB/m)	Corrected Measurement (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Peak/ Average
12758.974	25.3	40.1	65.4	74.0	-8.6	Peak
14482.051	2.4	40.5	42.9	54.0	-11.1	Average

Plot 4-19: Radiated Spurious Emissions (8.2 GHz – 12.4 GHz)

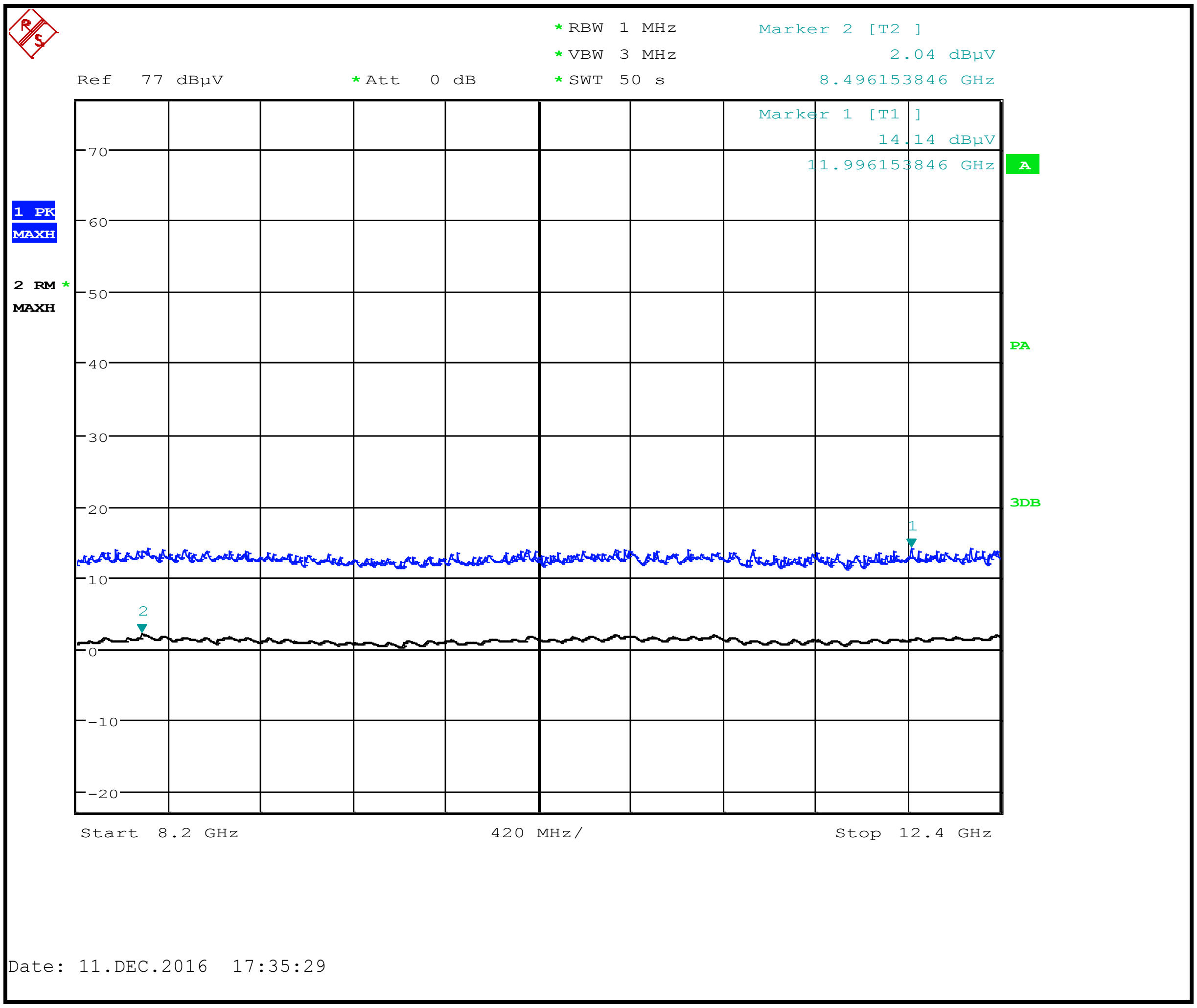


Table 4-20: Radiated Noise Floor Calculation (8.2 GHz – 12.4 GHz)

Frequency (MHz)	EIRP Measured (dBuV)	Test Antenna Correction Factor (dB/m)	Corrected Measurement (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Peak/ Average
11996.2	14.1	36.9	51.0	74.0	-23.0	Peak
8496.2	2.0	35.4	37.4	54.0	-16.6	Average

Plot 4-20: Radiated Spurious Emissions (4 GHz – 8.2 GHz)

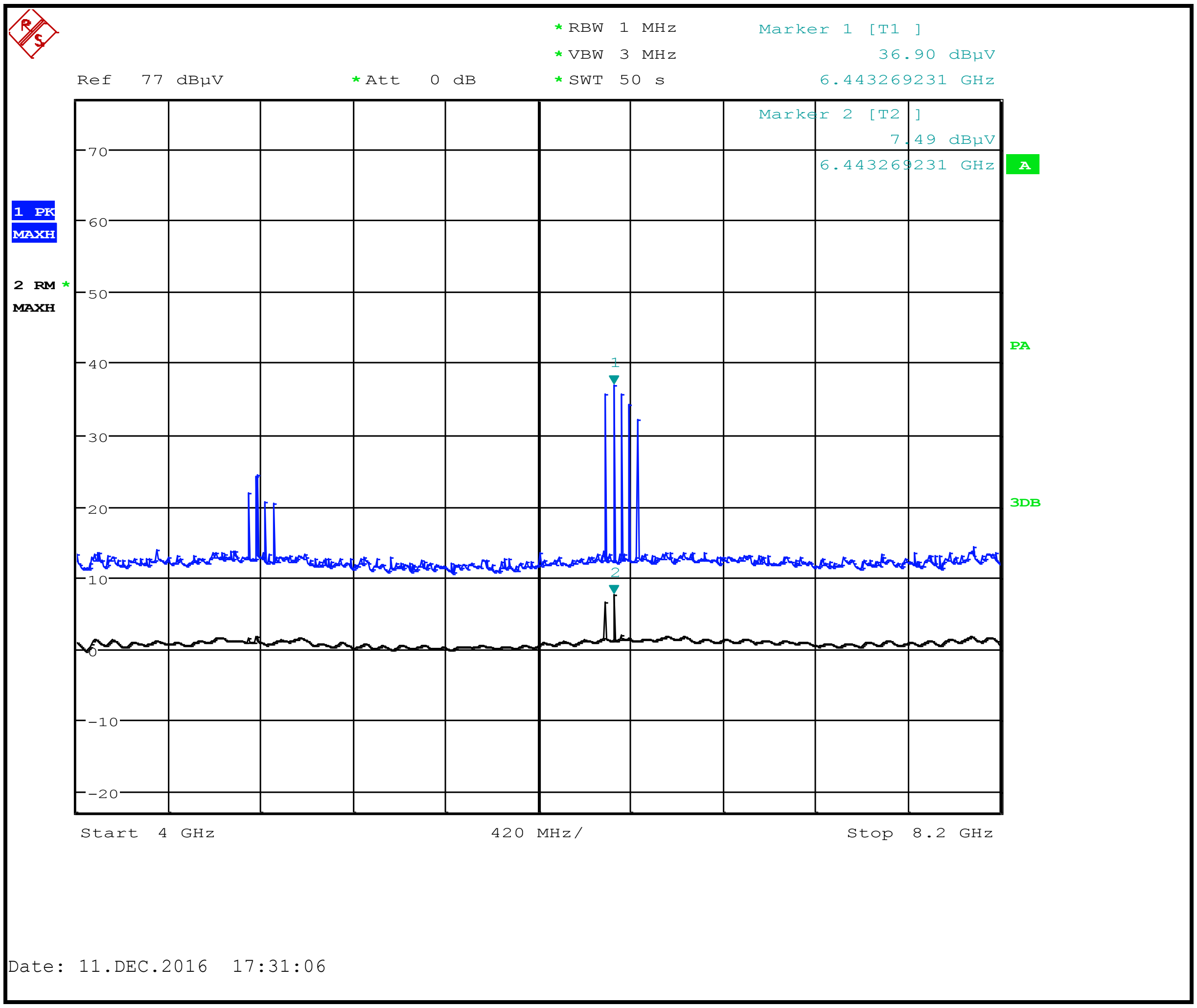


Table 4-21: Radiated Noise Floor Calculation (4 GHz – 8.2 GHz)

Frequency (MHz)	EIRP Measured (dBuV)	Test Antenna Correction Factor (dB/m)	Corrected Measurement (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Peak/ Average
6443.269	36.9	29.4	66.3	74.0	-7.7	Peak
6443.269	7.5	29.4	36.9	54.0	-17.1	Average

Plot 4-21: Radiated Spurious Emissions (2 GHz - 4 GHz)

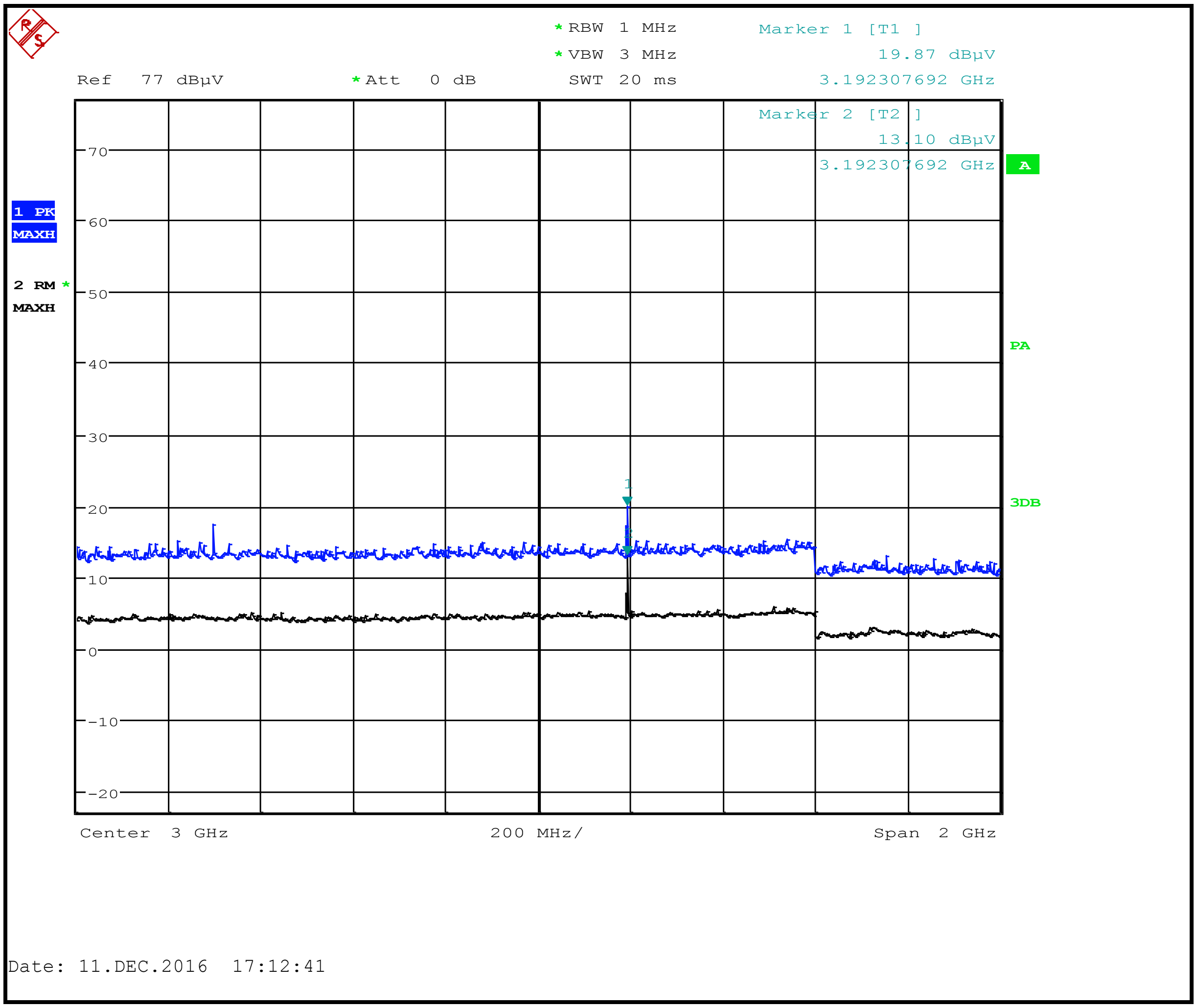


Table 4-22: Radiated Noise Floor Calculation (2 GHz - 4 GHz)

Frequency (MHz)	EIRP Measured (dBuV)	Test Antenna Correction Factor (dB/m)	Corrected Measurement (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Peak/ Average
3192.308	19.9	23.2	43.1	74.0	-30.9	Peak
3192.308	13.1	23.2	36.3	54.0	-17.7	Average

Plot 4-22: Radiated Spurious Emissions (1 GHz - 2 GHz)

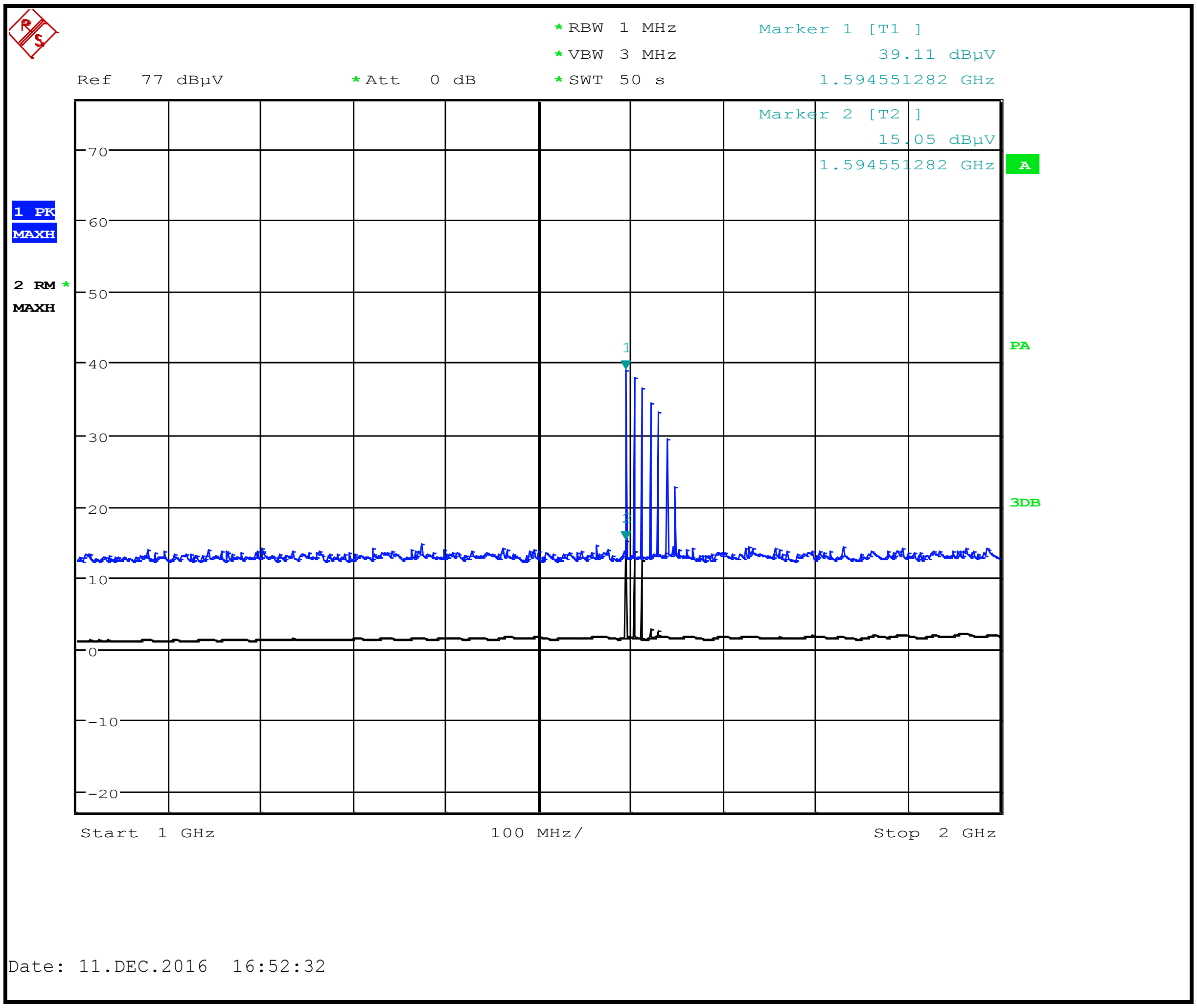


Table 4-23: Radiated Noise Floor Calculation (1 GHz - 2 GHz)

Frequency (MHz)	EIRP Measured (dBuV)	Test Antenna Correction Factor (dB/m)	Corrected Measurement (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Peak/ Average
1594.551	39.1	26.5	65.6	74.0	-8.4	Peak
1594.551	15.1	26.5	41.6	54.0	-12.4	Average

Plot 4-23: Radiated Spurious Emissions (0.03 GHz - 1 GHz)

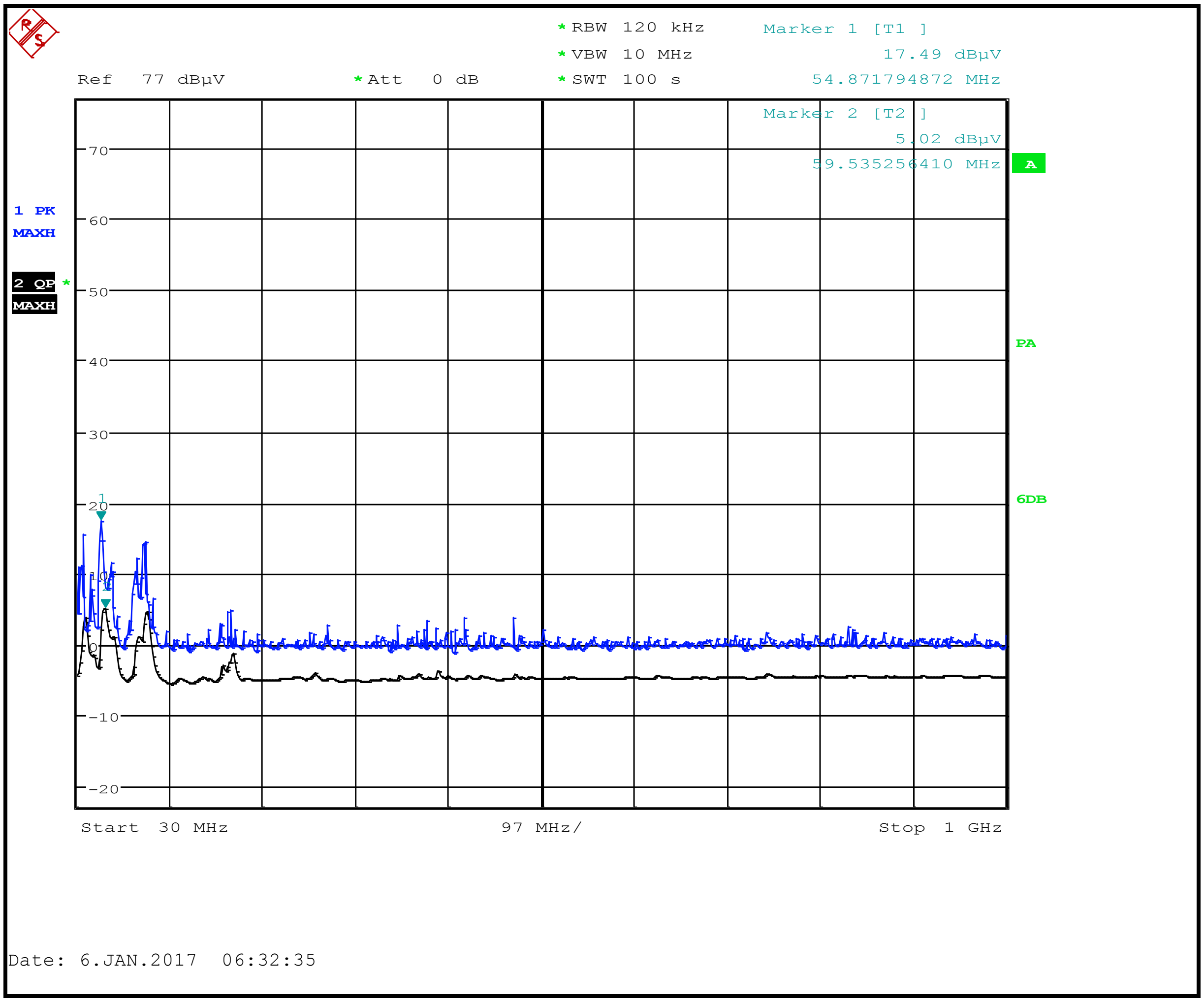


Table 4-24: Radiated Noise Floor Calculation (0.03 GHz - 1 GHz)

Frequency (MHz)	EIRP Measured (dBuV)	Test Antenna Correction Factor (dB/m)	Corrected Measurement (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Peak/ Quasi-Peak
87.542	17.5	10.1	27.6	60.0	-32.4	Peak
59.535	5.0	6.9	11.9	40.0	-28.1	Quasi-Peak

4.7 Radiated Emissions Unintentional/Digital Test Data

Table 4-25: Digital Radiated Emissions Test Data

Temperature: 43°F Humidity: 90%										
Emission Frequency (MHz)	Test Detector	Antenna Polarity (H/V)	Turntable Azimuth (deg)	Antenna Height (m)	Analyzer Reading (dBuV)	Site Correction Factor (dB/m)	Emission Level (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Pass/ Fail
65.300	Qp	V	180	1.2	46.8	-22.2	24.6	40.0	-15.4	Pass
150.400	Qp	V	180	1.5	39.2	-16.7	22.5	43.5	-21.0	Pass
281.240	Qp	V	90	1.3	35.9	-12.3	23.6	46.0	-22.4	Pass
305.000	Qp	H	345	2.5	37.4	-12.0	25.4	46.0	-20.6	Pass
374.900	Qp	V	270	1.6	35.8	-9.4	26.4	46.0	-19.6	Pass
484.854	Qp	H	25	2.0	36.7	-6.0	30.7	46.0	-15.3	Pass

Unwanted emissions were investigated (other than harmonics) as required by 15.33(a)(3).

"If the intentional radiator operates at or above 30 GHz: to the fifth harmonic of the highest fundamental frequency or to 200 GHz, whichever is lower, unless specified otherwise elsewhere in the rules."

Table 4-26: Radiated Emissions Test Equipment

RTL Asset #	Manufacturer	Model	Part Type	Serial Number	Calibration Due Date
901592	Insulated Wire Inc.	KPS-1503-3600-KPR	SMK RF Cables 20'	NA	8/3/17
901593	Insulated Wire Inc.	KPS-1503-360-KPR	SMK RF Cables 36"	NA	8/1/17
900151	Rohde and Schwarz	HFH2-Z2	Loop Antenna, (9 kHz - 30 MHz)	827525/019	3/4/17
900717	Hewlett Packard	11970U	Harmonic Mixer (40 – 60 GHz)	2332A01110	5/20/17
901639	Wiltron	35WR19F	Waveguide (40 – 50 GHz)	N/A	6/18/17
901640	Rohde & Schwarz	FS-Z110	Mixer (75 – 110 GHz)	100010	4/02/17
901581	Rohde & Schwarz	FSU	Spectrum Analyzer	1166.1660.50	3/22/18
901586	Rohde & Schwarz	FS-Z75	Harmonic Mixer (50 – 75 GHz)	100098	1/23/17
901256	ATM	19-443-6R	Horn Antenna (40-60 GHz, WR-19)	8041704-01	1/23/18
901303	EMCO	3160-10	Horn Antenna (26.5-40.0 GHz) WR-28	960452-007	6/19/17
901161	ATM	28-25K-6	Waveguide (26.5 – 40 GHz)	B082304	Not required
900711	ATM	10-443-6R	Horn Antenna (75 - 110 GHz)	8051905-1	12/5/17
900712	ATM	15-443-6R	Horn Antenna (50 GHz - 75 GHz)	8051805-1	3/16/17
900724	Antenna Research Associates, Inc.	LPB-2520	BiLog Antenna (25 - 2000 MHz)	1037	4/30/17
900772	EMCO	3161-02	Horn Antenna (2 - 4 GHz)	9804-1044	4/9/18
900321	EMCO	3161-03	Horn Antenna (4.0 - 8.2 GHz)	9508-1020	4/9/18
901587	Radiometer Physics Gmbh	SAM-220	140-220 GHz Mixer	20005	2/13/17
900713	ATM	05-443-6R	Horn Antenna, 140-220	S0685	5/20/17
900323	EMCO	3160-07	Horn Antenna (8.2 - 12.4 GHz)	9605-1054	4/19/18
900356	EMCO	3160-08	Horn Antenna (12.4 - 18 GHz)	9607-1044	4/9/18
901218	EMCO	3160-09	Horn Antenna (18 - 26.5 GHz)	960281-003	4/14/18

Test Personnel:

Daniel W. Baltzell	Daniel W. Baltzell	November 29, 2016, January 16, 2017
Test Engineer	Signature	Dates of Test

5 Antenna Beam-width & Antenna Side Lobe - FCC 14-2 (§15.256(i) & (j)), IC RSS-211 5.2(a) & 5.2(c)

5.1 Antenna Beam-width & Antenna Side Lobe Data - FCC 14-2 (§15.256(i) & (j)), RSS-211 5.2(a) & 5.2(c)

Antenna beam-width at -3dB no greater than 12 degrees and side lobe antenna gain relative to the main beam gain for off-axis angles from main beam of greater than 60 degrees not greater than -27dB. See Appendix H Technical Operational Description for the Antenna Beam-width and Antenna Side Lobe data.

6 Frequency Stability ANSI C63.10 6.8, FCC 14-2 (§15.256(f)(2)), IC RSS-Gen 4.7

6.1 Frequency Stability Test Procedure - FCC 14-2 (§15.256(f)(2)), IC RSS-Gen 4.7

The carrier frequency stability is the ability of the transmitter to maintain an assigned carrier frequency.

The EUT was evaluated over the temperature range -30°C to +55°C.

The temperature was initially set to -30°C and a 1-hour period was observed for stabilization of the EUT. The frequency stability was measured within one minute after application of primary power to the transmitter. The temperature was raised at intervals of 10 degrees centigrade through the range. A ½-hour period was observed to stabilize the EUT at each measurement step and the frequency stability was measured within one minute after application of primary power to the transmitter. Additionally, the power supply voltage of the EUT was varied +/-15% nominal input voltage, +15% of minimum voltage and -15% of maximum voltage.

6.2 FCC §15.256(f)(2) Limit

LPR devices operating under this section must confine their fundamental emission bandwidth within the 5.925-7.250 GHz, 24.05-29.00 GHz, and 75-85 GHz bands under all conditions of operation.

6.3 Temperature-Voltage Frequency Stability Test Data

Table 6-1: Temperature Frequency Stability

Temp. (°C)	Lower Edge of Measured Frequency (GHz)	Upper Edge of Measured Frequency (GHz)	Margin (GHz)
-30	76.496215716	78.309236672	+1.496/-6.690
-20	76.496341366	78.309410847	+1.496/-6.690
-10	76.496569094	78.309352789	+1.496/-6.690
0	76.496008534	78.309585021	+1.496/-6.690
10	76.495745602	78.30952696	+1.495/-6.690
20	76.496569094	78.309468905	+1.496/-6.690
30	76.496481507	78.309526963	+1.496/-6.690
40	76.496674199	78.309526963	+1.496/-6.690
50	76.496621647	78.309585021	+1.496/-6.690
55	76.496463989	78.309526963	+1.496/-6.690

Table 6-2: Voltage Frequency Stability

Limit (GHz)	+/-15% VDC						
	12 (Min.)	**13.8 (Min. + 15%**	**19.975 (-15%)**	**23.5 (Mid.)**	**27.025 (+ 15%)**	**29.75 (Max. -15%**	**35 (Max.)**
75	76.493693231	76.494032764	76.493688564	76.493969364	76.493831364	76.494020831	76.494228231
85	77. 502796154	77. 543246154	77. 501212821	77. 499579487	77. 500196154	77. 500496154	77. 499779487

Results: The EUT is within band and compliant.

Table 6-3: Frequency Stability Test Equipment

RTL Asset #	Manufacturer	Model	Part Type	Serial Number	Calibration Due Date
900946	Tenney Engineering, Inc.	TH65	Temperature Chamber with Humidity	11380	1/13/17
901581	Rohde & Schwarz	FSU	Spectrum Analyzer	1166.1660.50	3/22/18
901350	Meterman	33XR	Multimeter	040402802	3/20/17

Test Personnel:

Daniel Baltzell		November 29, 2016, January 6, 2017
Test Engineer	Signature	Dates of Tests

7 AC Conducted Emissions - ANSI C63.10 6.2, Part §15.207, IC RSS-Gen 7.2.4

7.1 Test Methodology for Conducted Line Emissions Measurements – Part §15.207, IC RSS-Gen 7.2.4

The power line conducted emission measurements were performed in a Series 81 type shielded enclosure manufactured by Rayproof. The EUT was placed on a wooden table. Power was fed to the EUT through a 50-ohm/50 μHenry Line Impedance Stabilization Network (LISN). The EUT LISN was fed power through an AC filter box on the outside of the shielded enclosure. The filter box and EUT LISN housing are bonded to the ground plane of the shielded enclosure. A second LISN, the peripheral LISN, provides isolation for the EUT's auxiliary equipment. This peripheral LISN was also fed AC power.

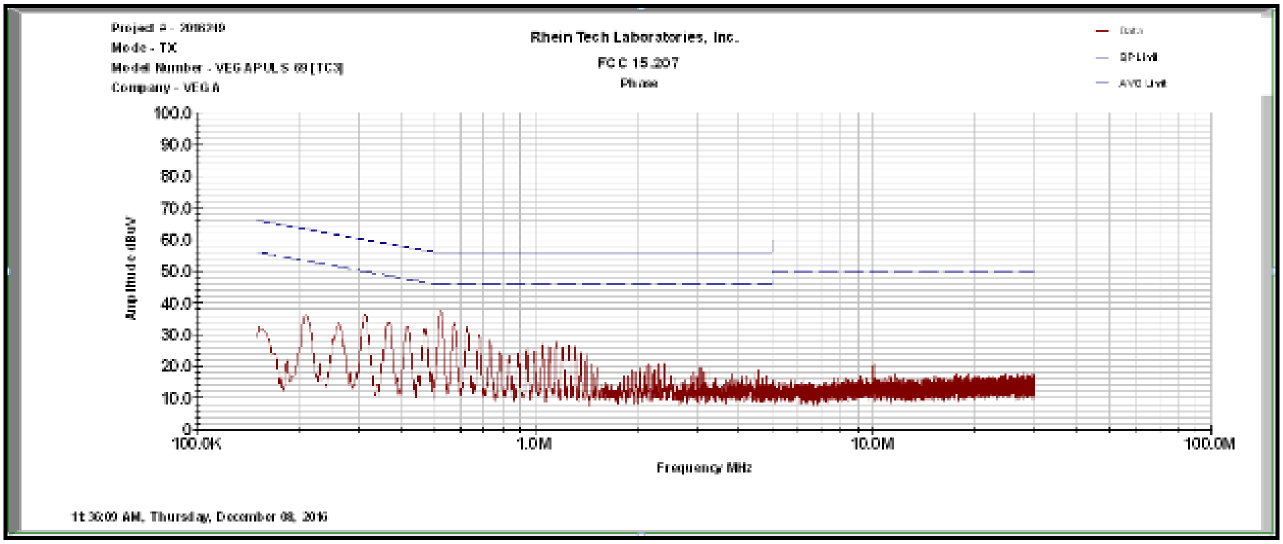
The spectrum analyzer was connected to the AC line through an isolation transformer. The 50-ohm output of the EUT LISN was connected to the spectrum analyzer input through a Solar 100 kHz high-pass filter. The filter is used to prevent overload of the spectrum analyzer from noise below 100 kHz. Conducted emission levels were measured on each current-carrying line with the spectrum analyzer operating in the CISPR quasi-peak mode (or peak mode if applicable). The analyzer's 6 dB bandwidth was set to 9 kHz. Video filter less than 10 times the resolution bandwidth is not used. Average measurements are performed in linear mode using a 10 kHz resolution bandwidth, a 1 Hz video bandwidth, by increasing the sweep time in order to obtain a calibrated measurement. The emission spectrum was scanned from 150 kHz to 30 MHz. The highest emission amplitudes relative to the appropriate limits were measured and have been recorded.

7.2 Conducted Line Emissions Test Procedure

Conducted emissions were performed on the EUT using an off-the-shelf power supply. The general conducted limit under Part 15.207 was applied. The emissions were scanned between 150 kHz to 30 MHz on the neutral and phase conductors.

7.3 Conducted Line Emissions Test Data

Plot 7-1: Conducted Emissions Transmit - Phase



Plot 7-2: Conducted Emissions Transmit – Neutral

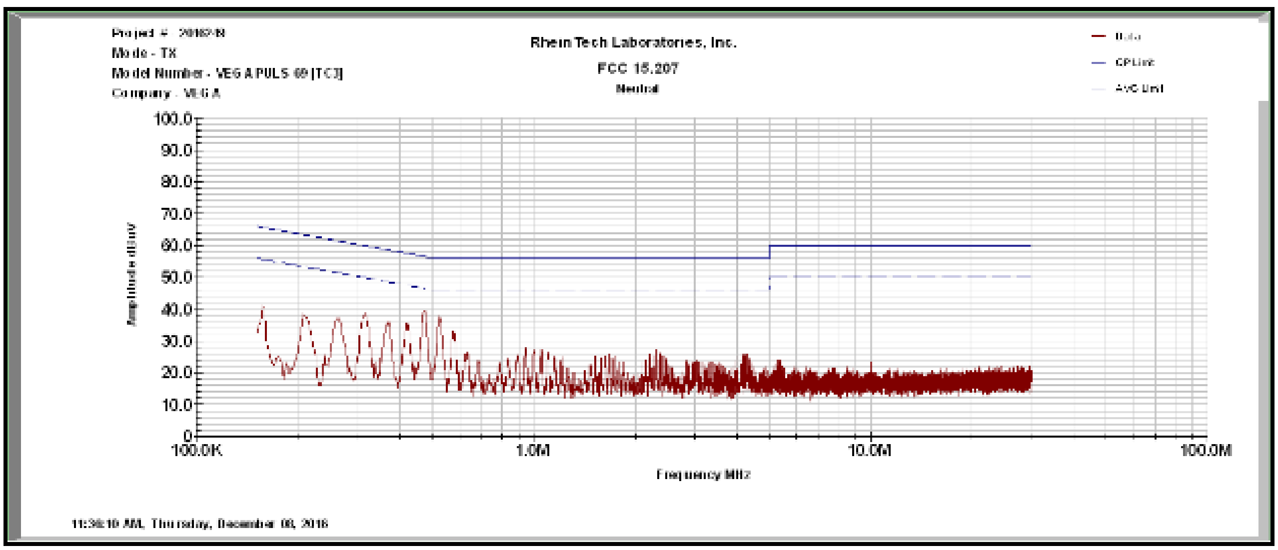
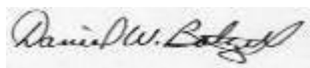


Table 7-1: Conducted Line Emissions Test Equipment

RTL Asset #	Manufacturer	Model	Part Type	Serial Number	Calibration Due Date
901581	Rohde & Schwarz	FSU	Spectrum Analyzer	1166.1660.50	3/22/18
901084	AFJ International	LS16	16A LISN	16010020082	3/24/17
N/A	Rhein Tech Laboratories, Inc.	Automated Emissions Tester	Emissions Testing Software Rev. 14.0.2	N/A	N/A

Test Personnel:

Daniel W. Baltzell  December 8, 2016

Test Engineer — Signature — Date of Test

8 Conclusion

The data in this measurement report shows that the Vega Grieshaber KG Model VEGAPULS 69, FCC ID: O6QPS60XW1, IC: 3892A-PS60XW1, complies with the applicable requirements of Parts 2 and 15 of the FCC Rules and Regulations and Industry Canada RSS-Gen and RSS-211.