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CERTIFICATION TEST REPORT

Manufacturer: SEAL Innovation, Inc.
3801 Computer Drive, Suite 201
Raleigh, North Carolina 27609 USA

Applicant: Same As Above

Product Name: SEAL SwimSafe 2.0 Hub

Product Description: Base station for a swim safety monitoring system.

Model: SH200

FCC ID: 2AFCI-SH200

Testing Commenced: July 30, 2019

Testing Ended: Oct. 1, 2019

Summary of Test Results: **In Compliance**

The EUT complies with the EMC requirements when manufactured identically as the unit tested in this report, including any required modifications and/or manufacturer's statement. Any changes to the design or build of this unit subsequent to this testing may deem it non-compliant.

Standards:

- **FCC Part 15 Subpart C, Section 15.247**
- **FCC15.207 - Conducted Limits**
- **FCC Part 15.31(e)**
- **ANSI C63.10:2013**



Order Number: F2P21802

Applicant: SEAL Innovation, Inc.
Model: SH200

Evaluation Conducted by:

Julius Chiller, EMC/Wireless Engineer

Report Reviewed by:

Ken Littell, Director of EMC & Wireless Operations

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1 ADMINISTRATIVE INFORMATION

1.1 Measurement Location:

F2 Labs in Middlefield, Ohio. Site description and attenuation data are on file with the FCC's Sampling and Measurement Branch at the FCC Laboratory in Columbia, MD.

1.2 Measurement Procedure:

All measurements were performed according to the 2013 version of ANSI C63.10 and recommended FCC procedure of measurement of DTS operating under Section 15.247 and in KDB558074. A list of the measurement equipment can be found in Section 6.

1.3 Uncertainty Budget:

The uncertainty in EMC measurements arises from several factors which affect the results, some associated with environmental conditions in the measurement room, the test equipment being used and the measurement techniques adopted.

The measurement uncertainty budgets detailed below are calculated from the test and calibration data, and are expressed with a 95% confidence factor. Note: Only measurements listed below which relate to tests included in this Test Report are applicable to it.

Measurement Range	Expanded Uncertainty	Combined Uncertainty
Radiated Emissions <1 GHz @ 3m	$\pm 5.07\text{dB}$	± 2.54
Radiated Emissions <1 GHz @10m	$\pm 5.09\text{dB}$	± 2.55
Radiated Emissions 1 GHz to 2.7 GHz	$\pm 3.62\text{dB}$	± 1.81
Radiated Emissions 2.7 GHz to 18 GHz	$\pm 3.10\text{dB}$	± 1.55
AC Power Line Conducted Emissions, 150kHz to 30 MHz	$\pm 2.76\text{dB}$	± 1.38

This Uncertainty represents an expanded uncertainty expressed at approximately the 95% confidence level using a coverage factor of $k=2$.

1.4 Document History

Document Number	Description	Issue Date	Approved By
F2P21802-01E	First Issue	Oct. 11, 2019	K. Littell

**2 SUMMARY OF TEST RESULTS**

Test Name	Standard(s)	Results
Occupied Bandwidth	CFR 47 Part 15.247(a)(2) / KDB558074	Complies
Conducted Output Power	CFR 47 Part 15.247(b)(3) / KDB558074	Complies
Voltage Variations	CFR 47 Part 15.31(e)	Complies
Conducted Spurious Emissions	CFR 47 Part 15.247(d) / Part 15.207 / KDB558074	Complies
Radiated Spurious Emission with Integral Antenna	CFR 47 Part 15.247(d) / Part 15.209 / KDB558074	Complies
Peak Power Spectral Density	CFR 47 Part 15.247(e) / KDB558074	Complies
Conducted Emissions	CFR 47 Part 15.207(a)	Complies

Modifications Made to the Equipment
None

**3 TABLE OF MEASURED RESULTS**

Test	High Channel 906 MHz	Mid Channel 916 MHz	Low Channel 924 MHz
Conducted Output Power	17.4dBm	17.31dBm	17.35dBm
	54.95mW (17.4dBm)	53.83mW (17.31dBm)	54.32mW (17.35dBm)
Conducted Output Power Limit	1 Watt, (30dBm)	1 Watt, (30dBm)	1 Watt, (30dBm)
E.I.R.P. with -1.05dBi Antenna	43.15mW (16.35dBm)	42.27mW (16.26dBm)	42.66mW (16.30dBm)
E.I.R.P. Limit	4 Watts, (36.02dBm)	4 Watts, (36.02dBm)	4 Watts, (36.02dBm)
Peak Power Spectral Density	6.96dBm	6.59dBm	6.99dBm
Peak Power Spectral Density Limit	8 dBm	8 dBm	8 dBm
-6dB Occupied Bandwidth	0.611 MHz	0.611 MHz	0.610 MHz
-6dB Occupied Bandwidth Limit	≥ 500KHz	≥ 500KHz	≥ 500KHz
Voltage Variations -15%	17.89	17.98	17.56
Voltage Variations +15%	17.89	17.97	17.55

**To meet the requirements of 15.31, voltage was varied by ±15% of the nominal voltage of 110VAC. All tests were then performed at the highest output power voltage setting.*



4 ENGINEERING STATEMENT

This report has been prepared on behalf of SEAL Innovation, Inc. to provide documentation for the testing described herein. This equipment has been tested and found to comply with Part 15.247 of the FCC Rules using ANSI C63.10:2013 and KDB558074 standards. The test results found in this test report relate only to the items tested.



5 EUT INFORMATION AND DATA

5.1 Equipment Under Test:

Product: **SEAL SwimSafe 2.0 Hub**

Model: SH200

Serial No.: None Specified

FCC ID: **2AFCI-SH200**

5.2 Trade Name:

SEAL Innovation, Inc.

5.3 Power Supply:

AC Adapter – Globtek GT86120-1005-W2

5.4 Applicable Rules:

CFR 47, Part 15.247, subpart C

5.5 Equipment Category:

Radio Transmitter-DTS

5.6 Antenna:

Dipole – Pulse W3538B0150

5.7 Accessories:

N/A

5.8 Test Item Condition:

The equipment to be tested was received in good condition.

5.9 Testing Algorithm:

The EUT is set to transmit a continuous modulated carrier in the 915 MHz band on a low, mid and high channel (906/916/924 MHz). EUT functions on ten channels, from 906 to 924 MHz. USB and internal battery.

**6 LIST OF MEASUREMENT INSTRUMENTATION**

Equipment Type	Asset Number	Manufacturer	Model	Serial Number	Calibration Due Date
Shielded Chamber	CL166-E	AlbatrossProjects	B83117-DF435-T261	US140023	Oct. 31, 2019
Shield Room	0175-3V	Ray Proof	N/A	11645	Apr. 23, 2020
Temp/Hum. Recorder	CL262	Extech	445814	05	Mar. 6, 2020
Spectrum Analyzer	CL147	Agilent	E7402A	MY45101241	Jan. 25, 2020
Receiver	CL204	Rohde & Schwarz	ESR7	101714	Oct. 29, 2019
Antenna 1-Chamber	0142	ETS/EMCO	3142B	9811-1330	Verified
Software:	Tile Version 3.4.B.3		Software Verified: July 30-31, 2019		
Software:	EMC 32, Version 8.53.		Software Verified: July 30-31, 2019		
Antenna, JB3 Combination	CL175	Sunol Sciences	JB3	A030315	Oct. 11, 2019
Antenna, Horn	CL098	Emco	3115	9809-5580	Jan. 31, 2021
Pre-Amplifier	0197	Hewlett Packard	8447D	1726A01006	Oct. 25, 2019
Amplifier w/Monopole & 18"	CL194-Loop	AH Systems, Inc.	EHA-52B	281	May 23, 2020
Transient Limiter	CL102	Hewlett Packard	11947A	3107A03325	Feb. 7, 2020
LISN	CL181	Com-Power	LI-125A	191226	Sept. 6, 2020
LISN	CL182	Com-Power	LI-125A	191225	Sept. 6, 2020



7 FCC PART 15.247(a)(2) – OCCUPIED BANDWIDTH

7.1 Requirements:

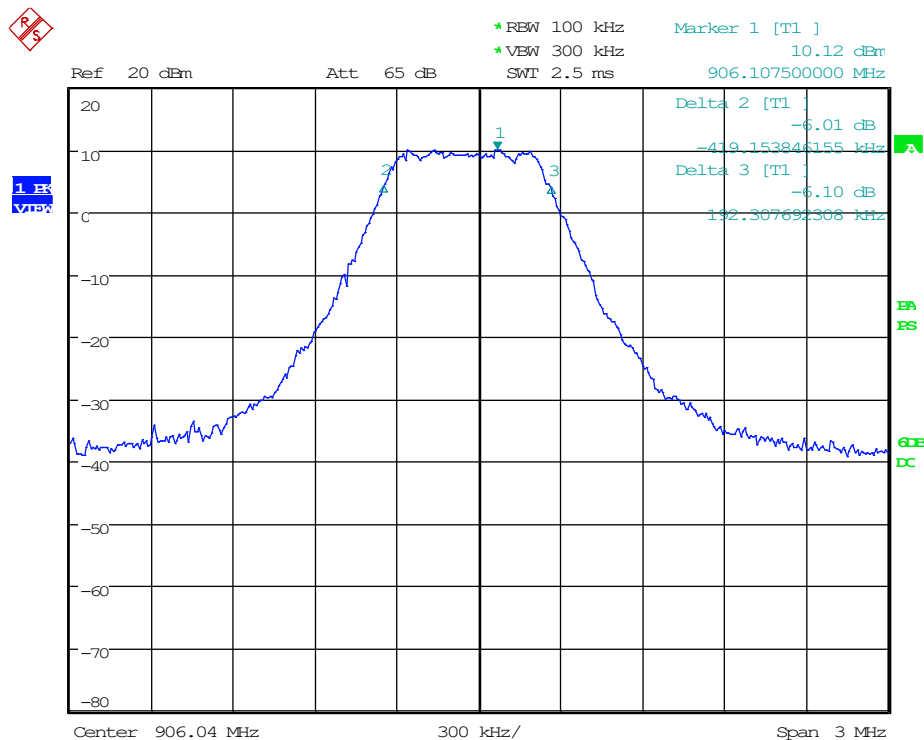
The 6dB bandwidth shall be greater than 500 kHz.

Bandwidth measurements were made at the low, mid and upper frequencies with the resolution Bandwidth set at 100 kHz (video bandwidth set at 300 kHz). The bandwidth was measured using the analyzer's marker function.



7.2 Occupied Bandwidth Test Data

Test Date:	July 30, 2019	Test Engineer:	J. Chiller
Standards:	CFR 47 Part 15.247(a)(2); KDB558074	Air Temperature:	22.3°C
		Relative Humidity:	42%

-6dB, Low Channel

Date: 30.JUL.2019 18:33:16



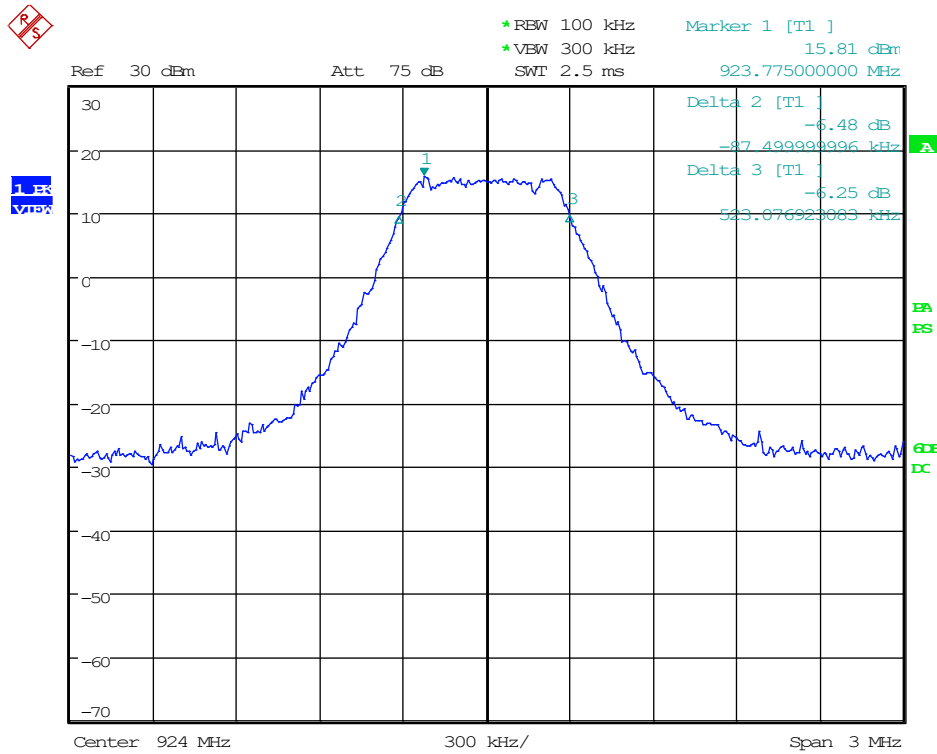
Model: SH200

-6dB, Mid Channel





-6dB, High Channel



Date: 30.JUL.2019 18:38:38



8 FCC PART 15.247(b)(3) – CONDUCTED OUTPUT POWER

The EUT antenna port was fitted with an SMA connector and directly connected to the input of the receiver. The peak power output was measured.

8.1 Requirements:

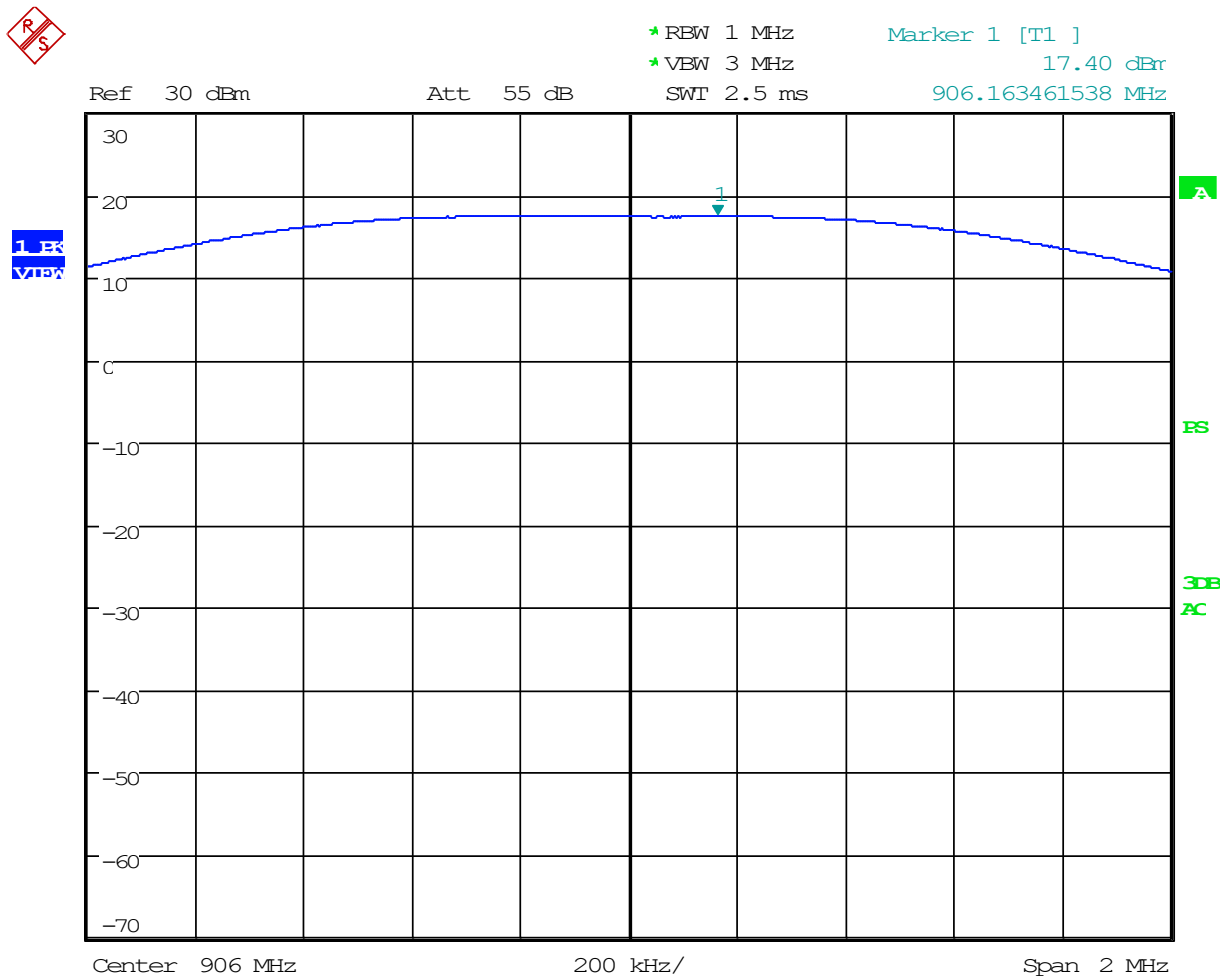
The peak power output shall be 1 watt (30 dBm) or less when using an antenna with a gain of less than 6dBi. For antennas having a gain of more than 6dBi, the limit is reduced by 1dB for every dB the antenna gain is over 6dBi.



8.2 Conducted Output Power Test Data

Test Date:	Oct. 1, 2019	Test Engineer:	J. Chiller
Standards:	CFR 47 Part 15.247(b)(3); KDB558074	Air Temperature:	19.9°C
		Relative Humidity:	50%

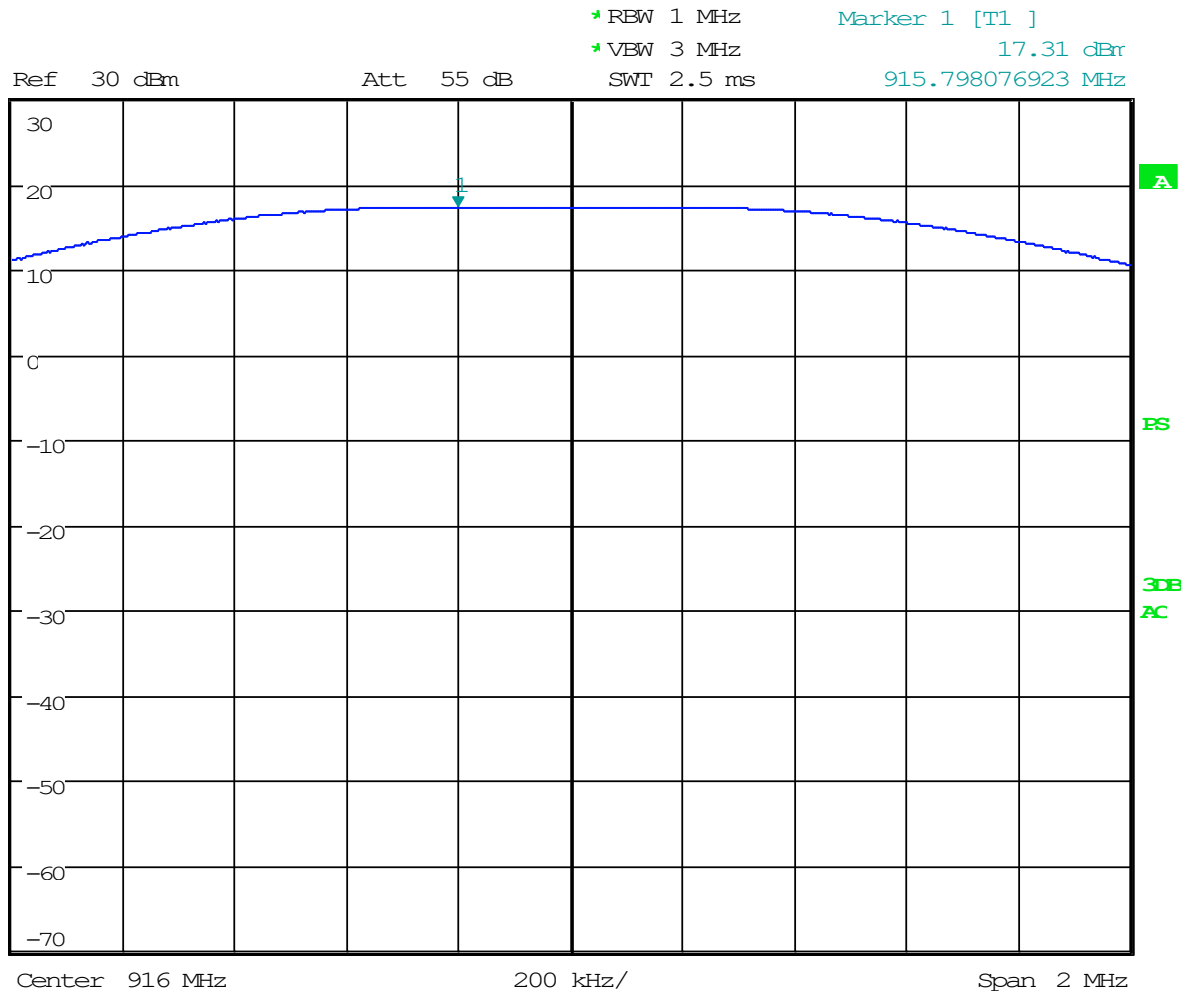
GFSK, Low Channel



Date: 1.OCT.2019 11:45:13



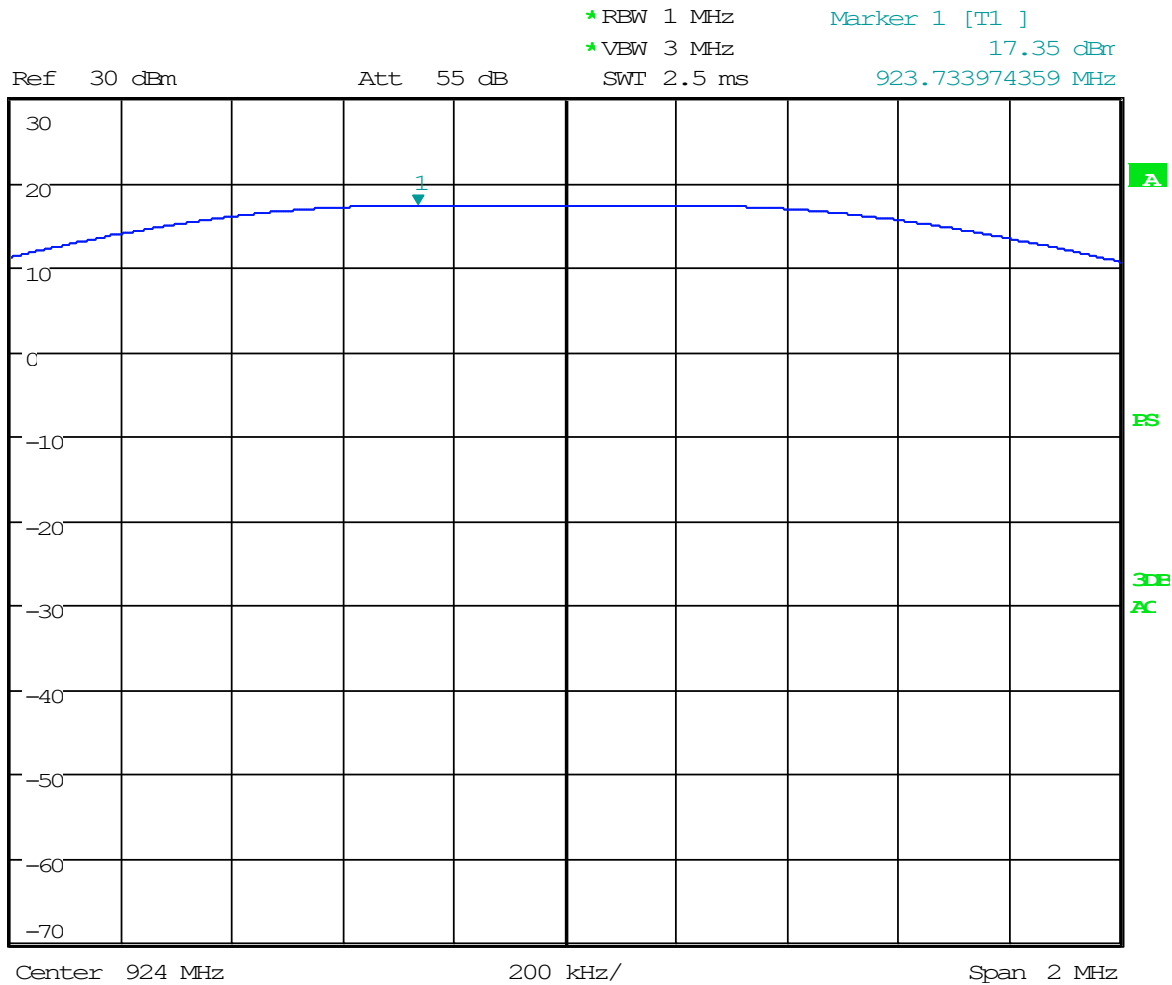
GFSK, Mid Channel



Date: 1.OCT.2019 11:50:52



GFSK, High Channel



Date: 1.OCT.2019 12:02:08



9 VOLTAGE VARIATIONS

9.1 Requirements

For intentional radiators, measurements of the variation of the input power or the radiated signal level of the fundamental frequency component of the emission, as appropriate, shall be performed with the supply voltage varied between 85% and 115% of the nominal rated supply voltage. For battery-operated equipment, the equipment tests shall be performed using a new battery.

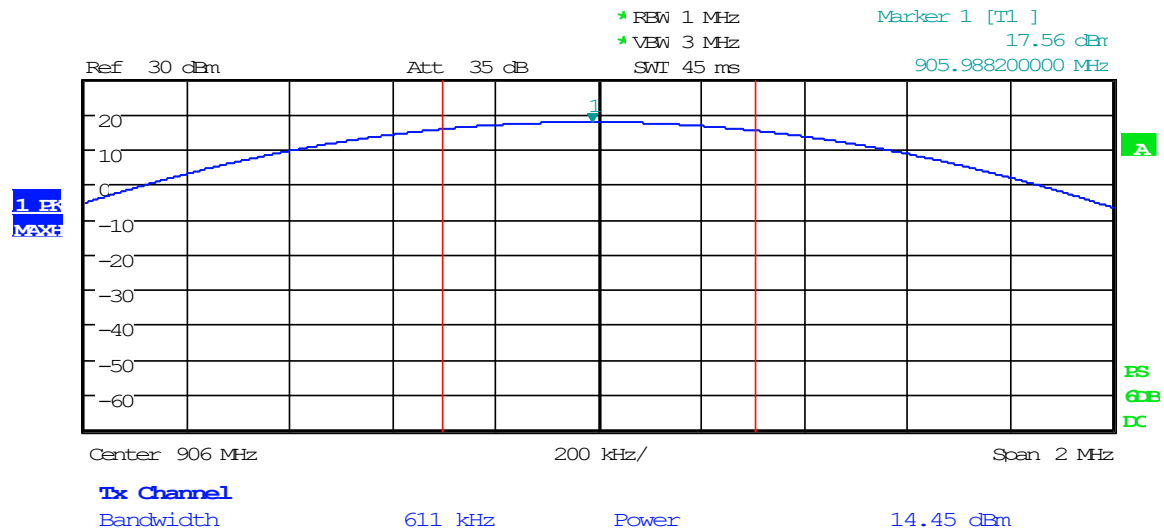
In the following graphs, the Peak power was used and not the Channel Power.



9.2 Voltage Variations Test Data

Test Date(s):	July 31, 2019	Test Engineer:	J. Chiller
Rule:	15.31(e)	Air Temperature:	20.7° C
Test Results:	Complies	Relative Humidity:	53%

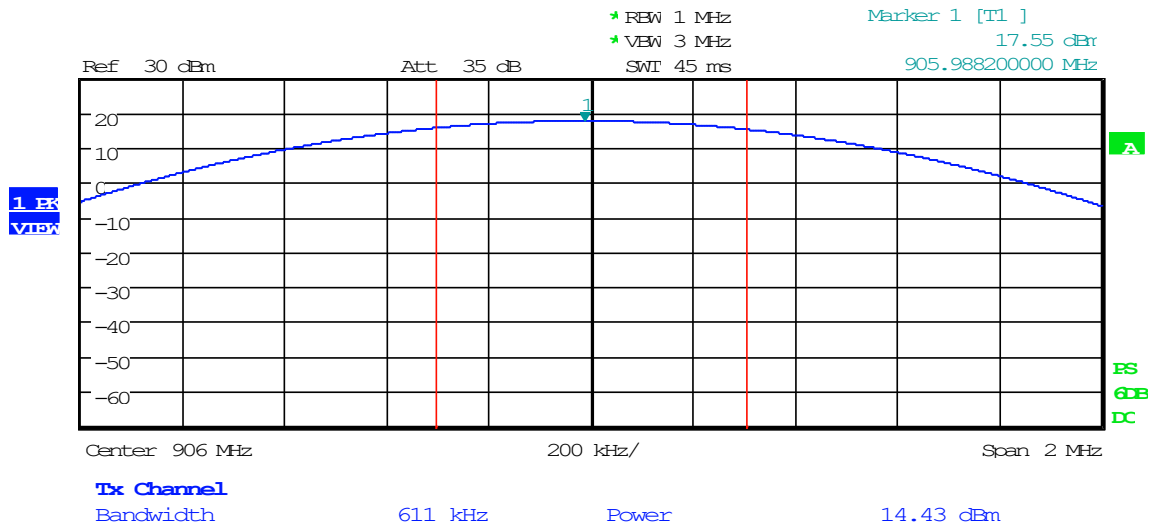
Low Channel, -15%



Date: 31.JUL.2019 13:48:06



Low Channel, +15%



Date: 31.JUL.2019 13:48:56



Model: SH200

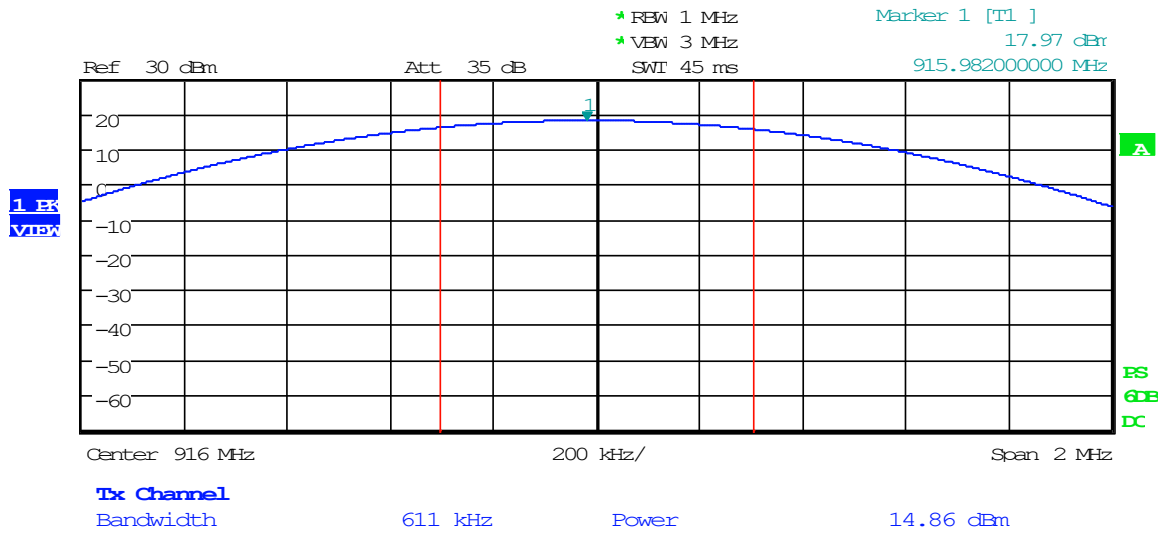
Mid Channel, -15%



Date: 31.JUL.2019 13:53:39



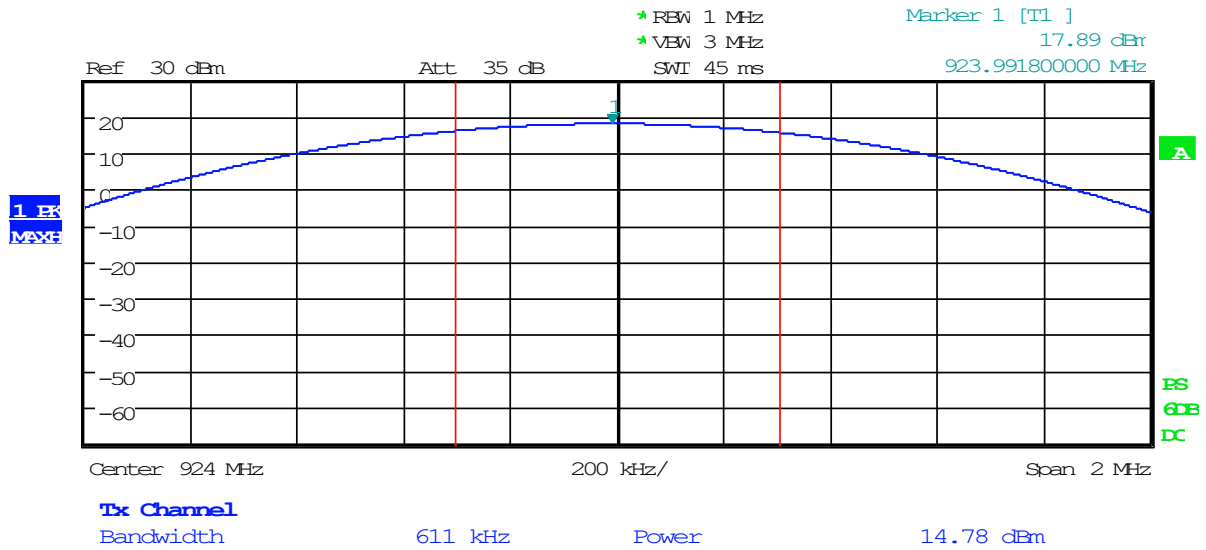
Mid Channel, +15%



Date: 31.JUL.2019 13:54:25



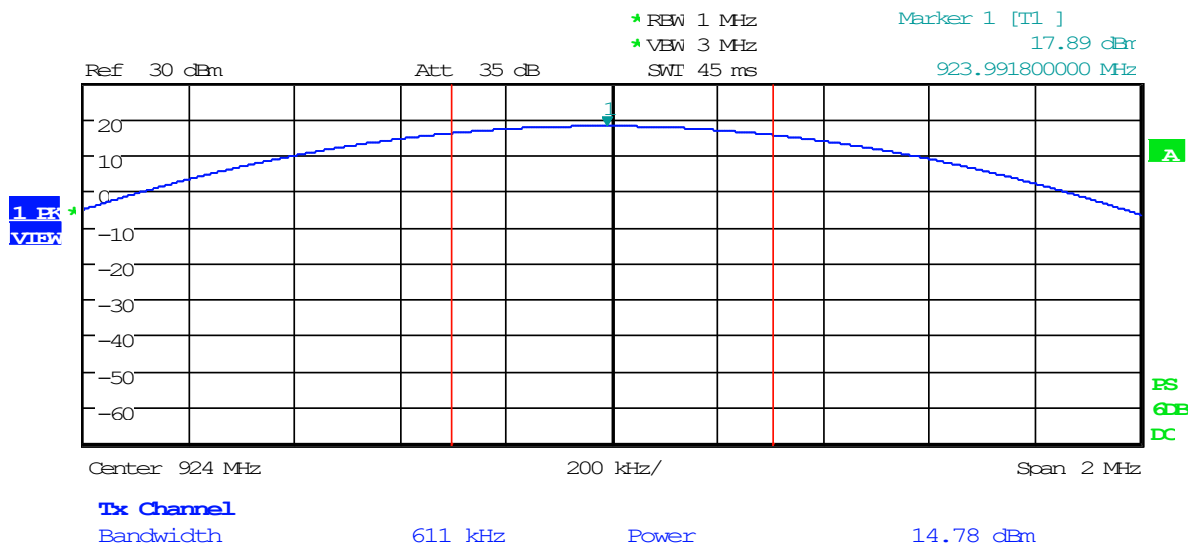
High Channel, -15%



Date: 31.JUL.2019 13:58:41



High Channel, +15%



Date: 31.JUL.2019 13:57:42



10 FCC Part 15.247(d) – CONDUCTED SPURIOUS EMISSIONS

The following tests were performed to demonstrate compliance.

RF Antenna Conducted Test

The EUT antenna port was fitted with an SMA connector and directly connected to the input of the spectrum analyzer.

10.1 Requirements:

All Spurious Emissions must be at least 20dB down from the highest emission level measured within the authorized band up through the tenth harmonic.

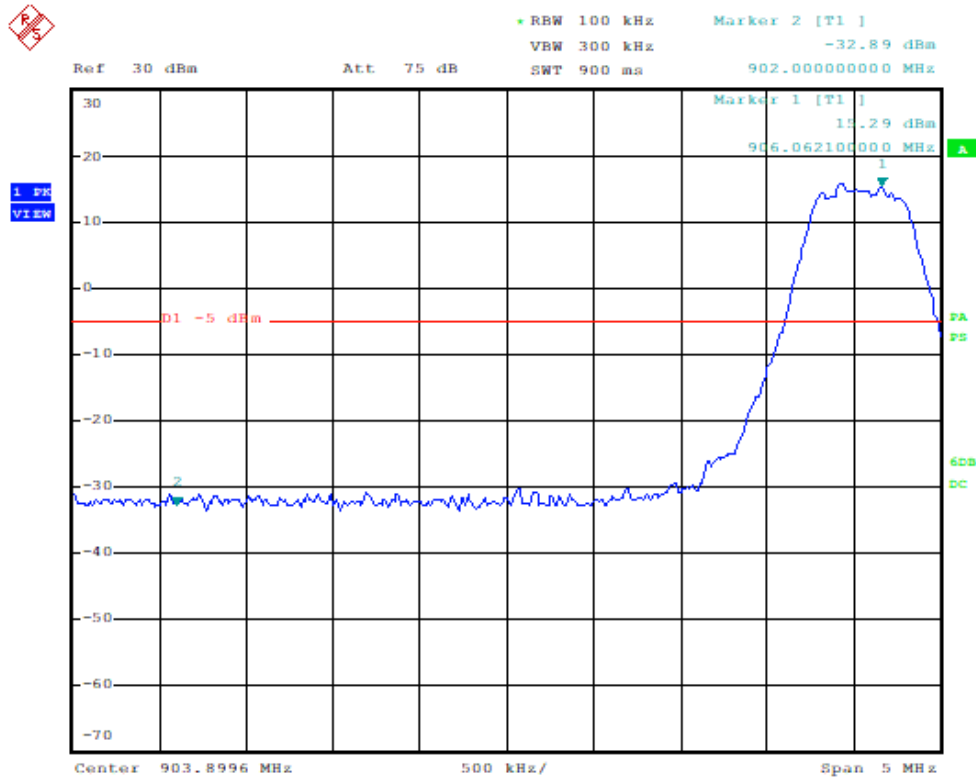
Spurious emissions measurements were made at the low, mid, and upper channels with the appropriate spectrum analyzer impulse bandwidth. Additionally, 20dB down points were measured for the low and high channels to verify band edge compliance.



10.2 Conducted Spurious Emissions Test Data

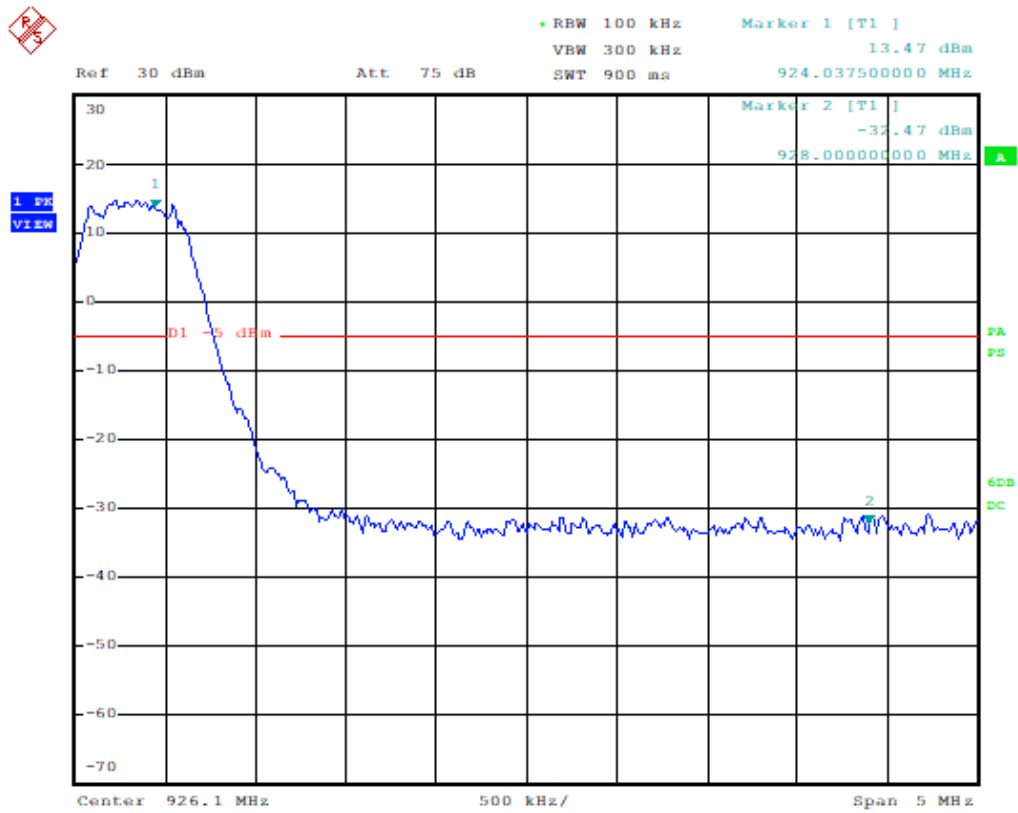
Test Date:	July 31, 2019; Oct. 1, 2019	Test Engineer:	J. Chiller
Standards:	CFR 47 Part 15.247(d) / Part 15.207; KDB558074	Air Temperature:	20.5°C
		Relative Humidity:	50%

Low Band Edge



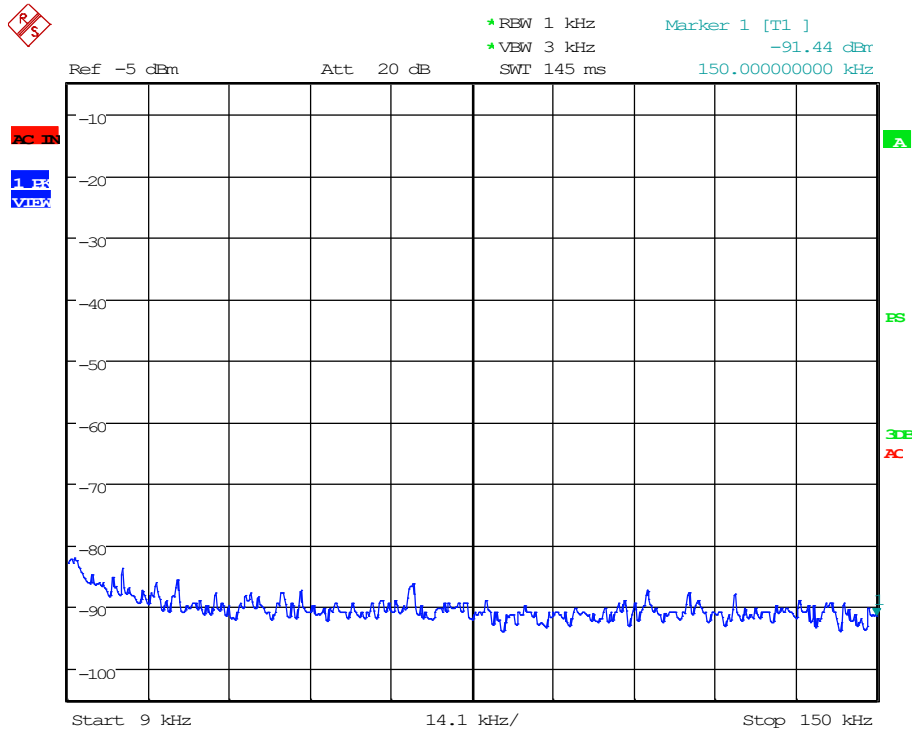


High Band Edge





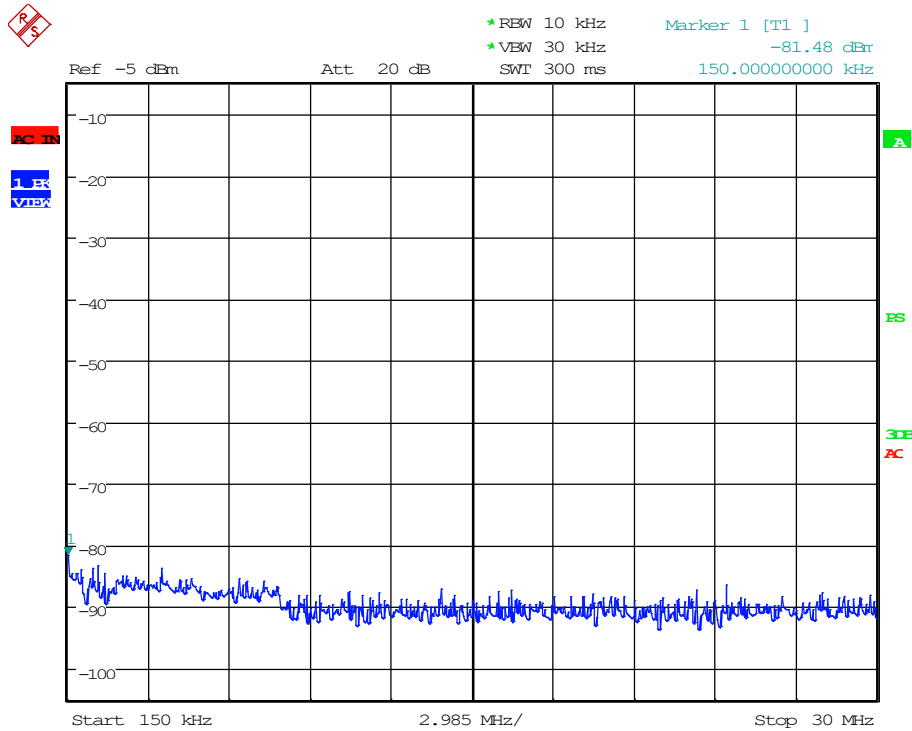
Low Channel: 0.009 MHz to 0.15 MHz



Date: 1.OCT.2019 11:35:57



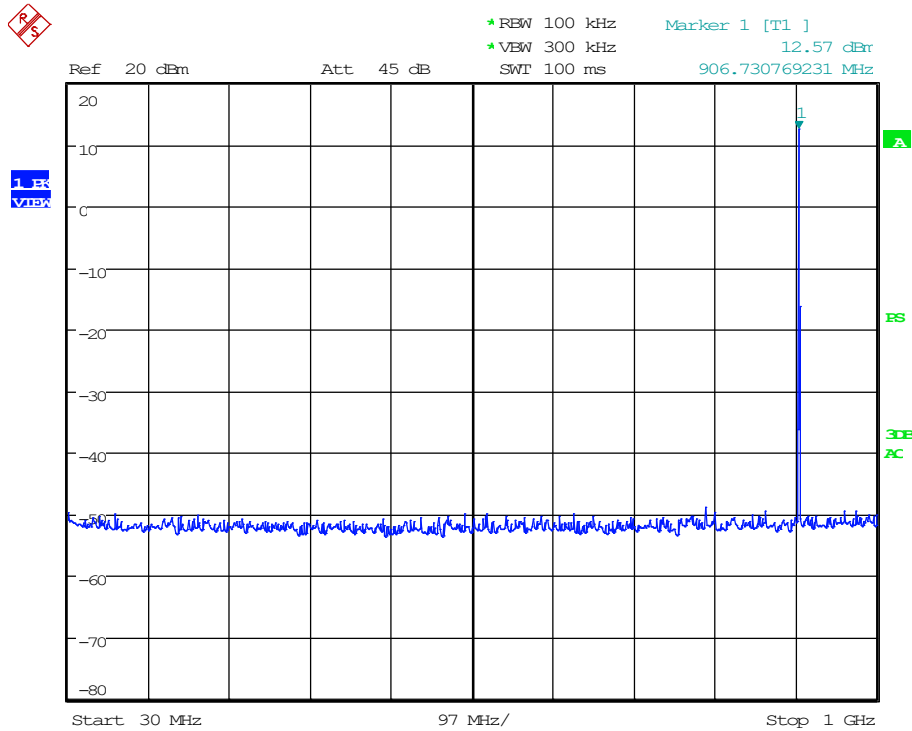
Low Channel: 0.15 MHz to 30 MHz



Date: 1.OCT.2019 11:36:34



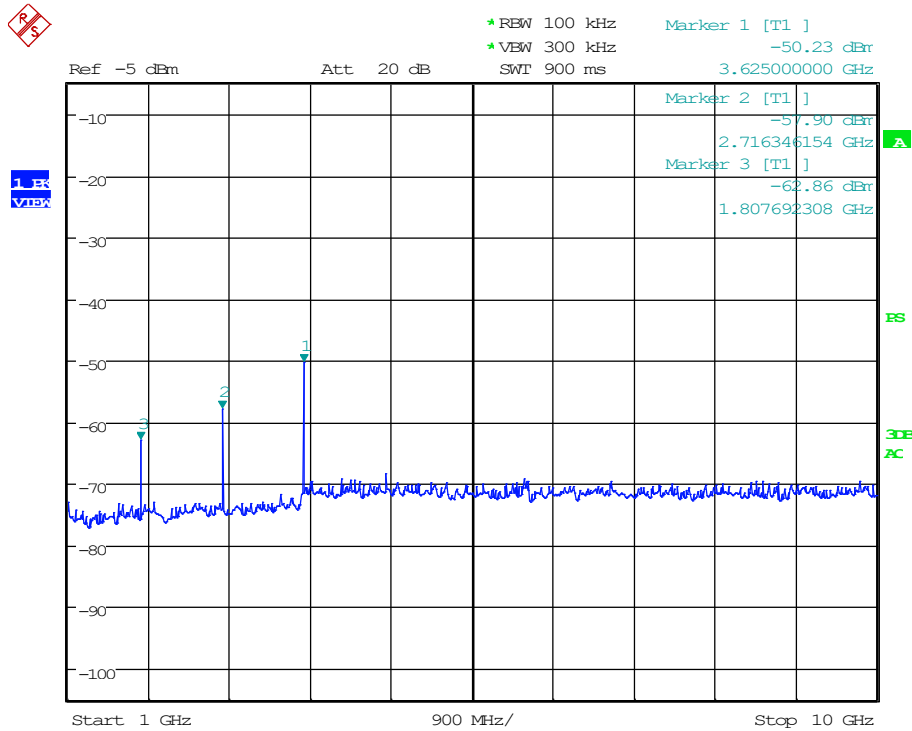
Low Channel: 30 MHz to 1000 MHz



Date: 1.OCT.2019 11:37:30



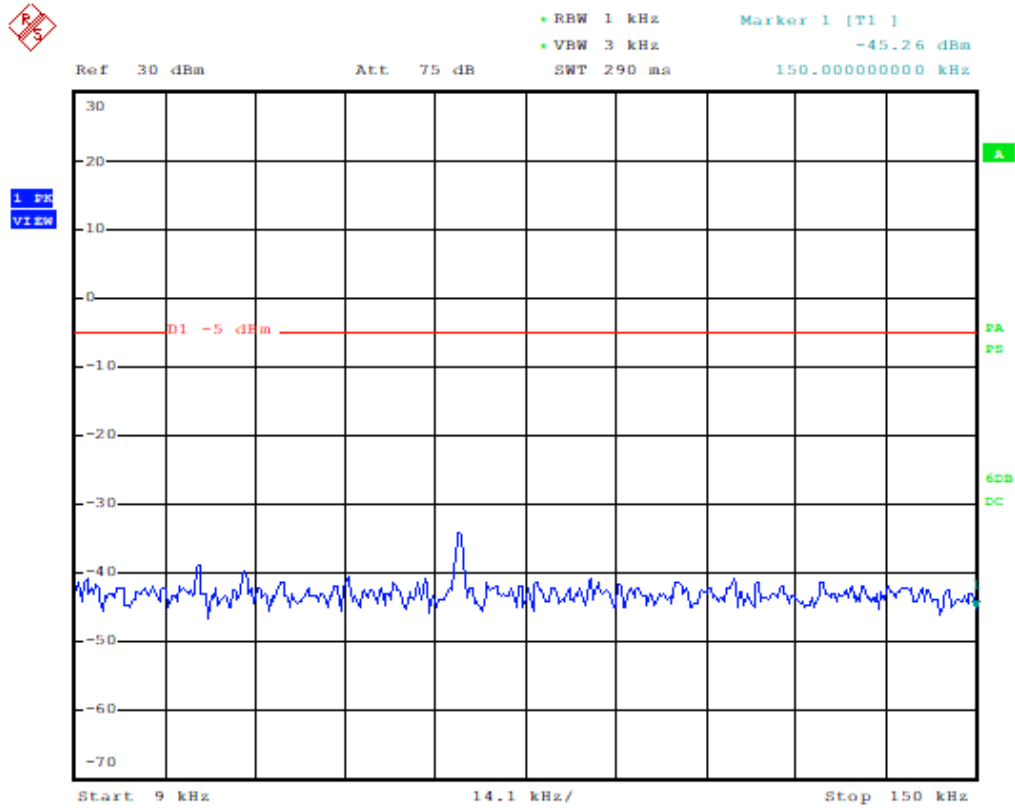
Low Channel: 1 GHz to 10 GHz



Date: 1.OCT.2019 11:38:24

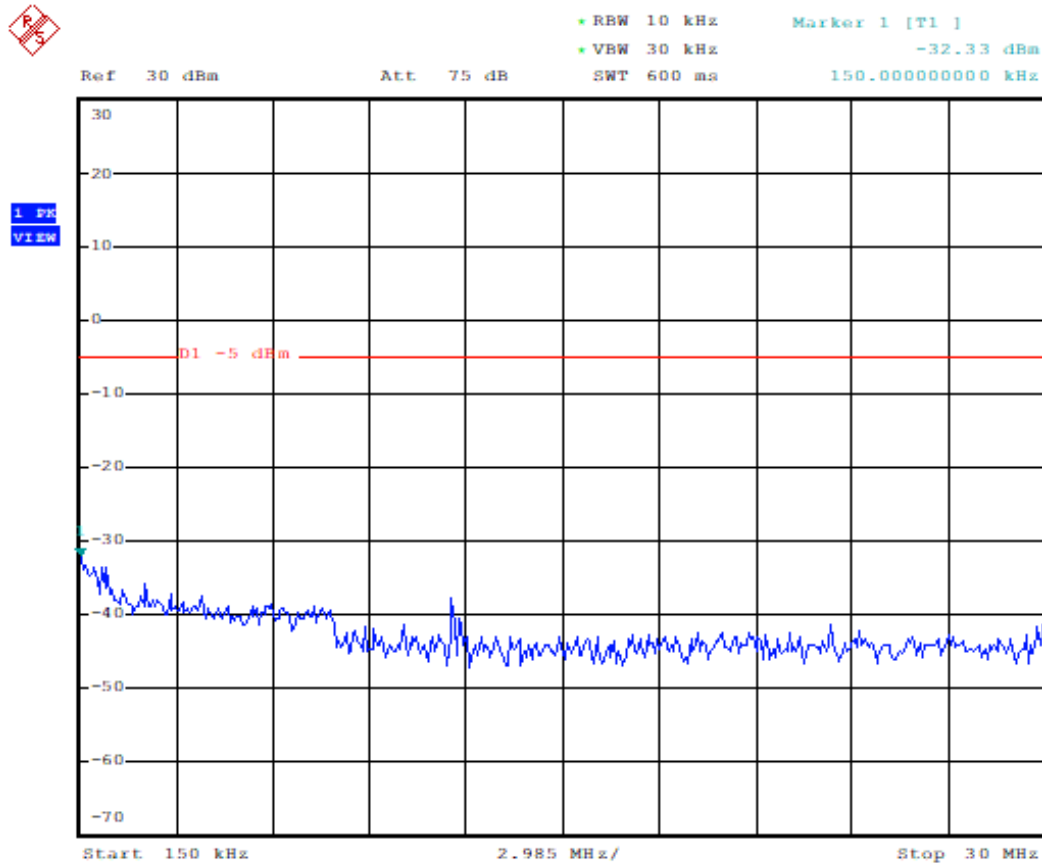


Mid Channel: 0.009 MHz to 0.15 MHz



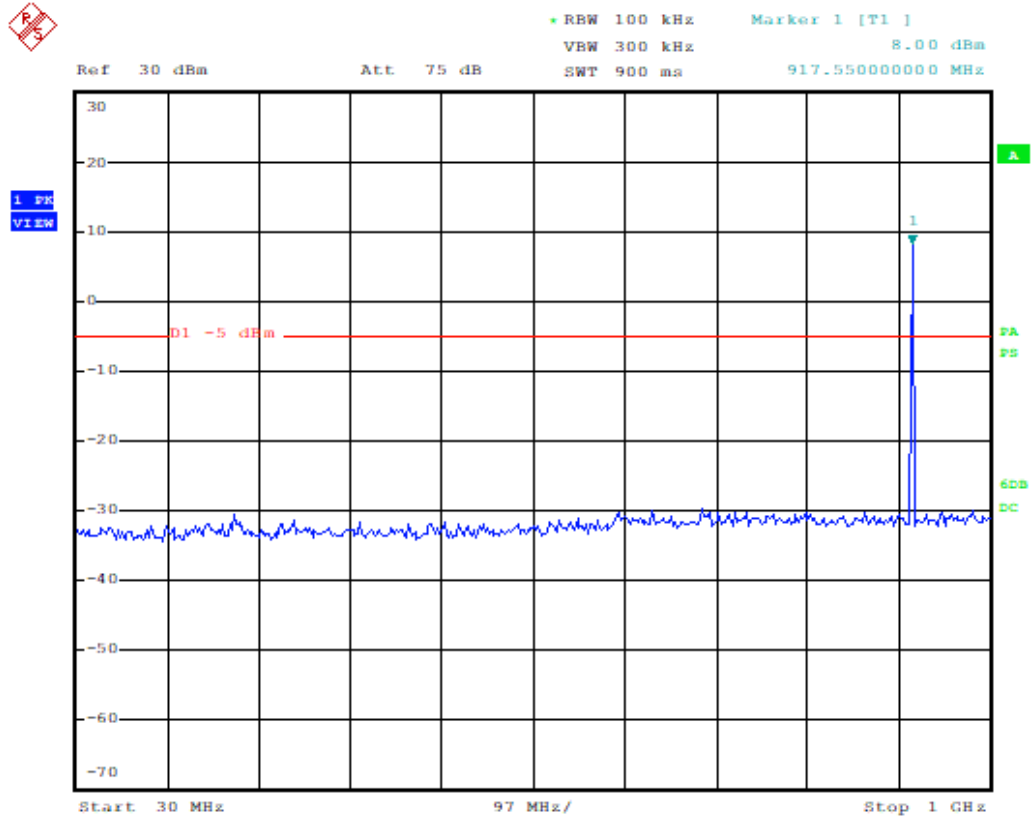


Mid Channel: 0.15 MHz to 30 MHz



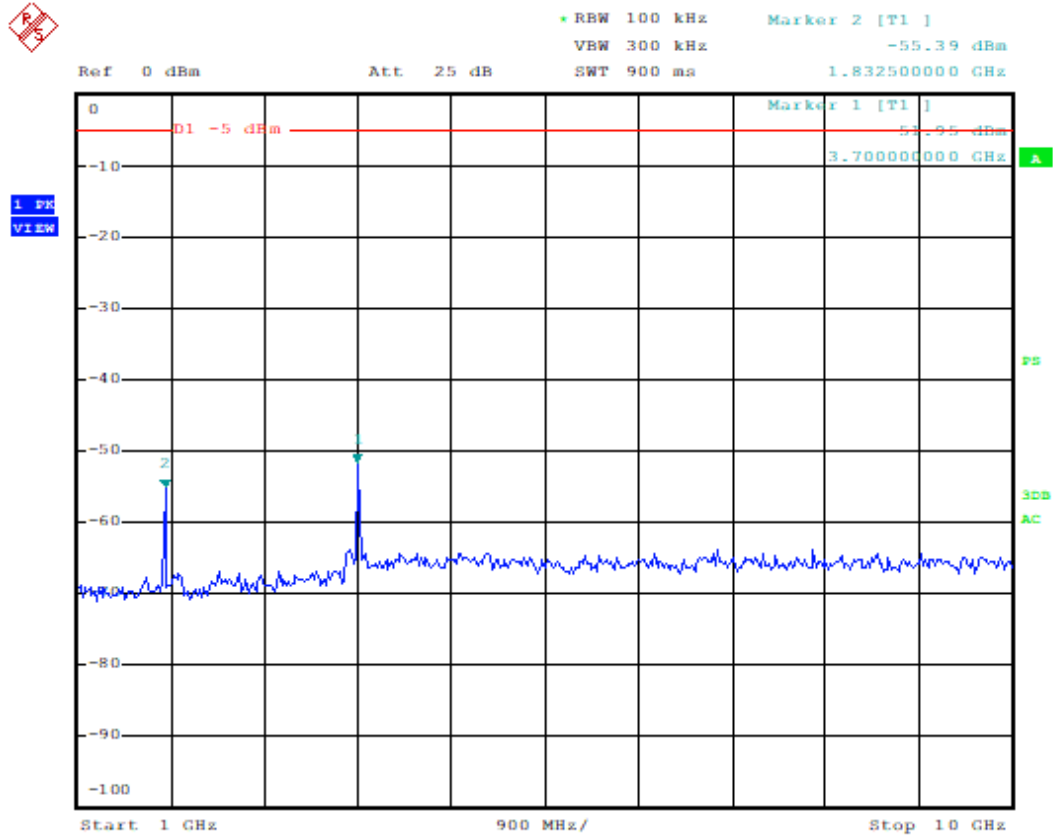


Mid Channel: 30 MHz to 1000 MHz





Mid Channel: 1 GHz to 10 GHz





High Channel: 0.009 MHz to 0.15 MHz



*RBW 1 kHz
*VBW 3 kHz
Marker 1 [T1]
-66.23 dBm
150.00000000 kHz

Ref 20 dBm

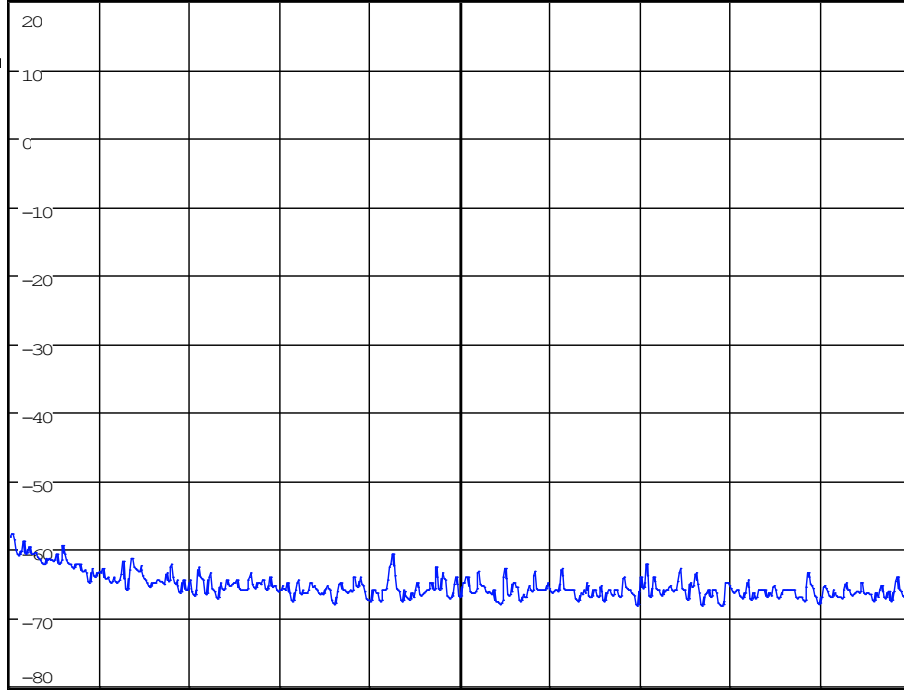
Att 45 dB

SWT 145 ms

150.00000000 kHz

AC IN

1 B
VdB



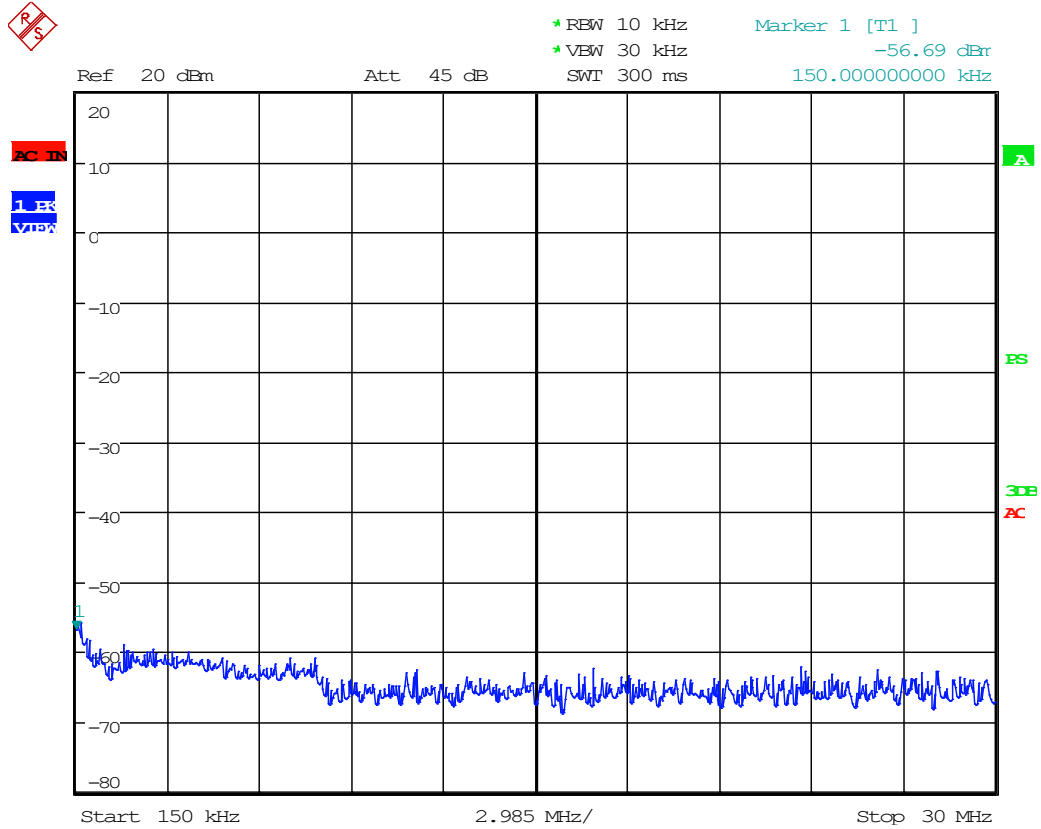
Start 9 kHz

14.1 kHz/

Stop 150 kHz



High Channel: 0.15 MHz to 30 MHz

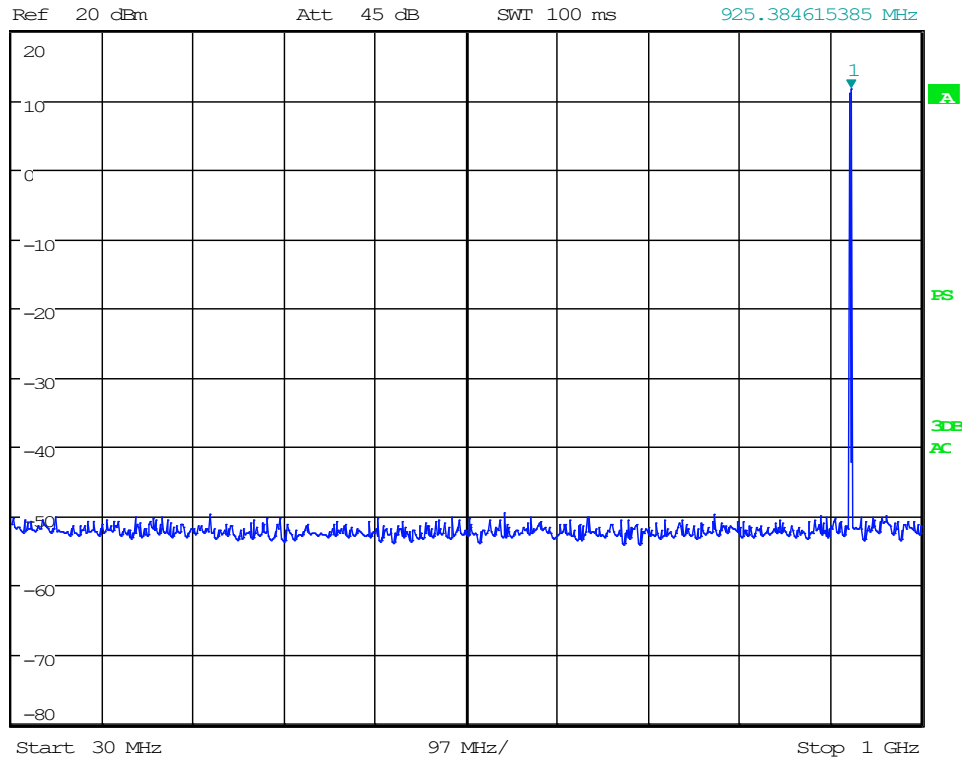




High Channel: 30 MHz to 1000 MHz



REW 100 kHz Marker 1 [T1]
VBW 300 kHz 11.70 dBm
SWT 100 ms 925.384615385 MHz

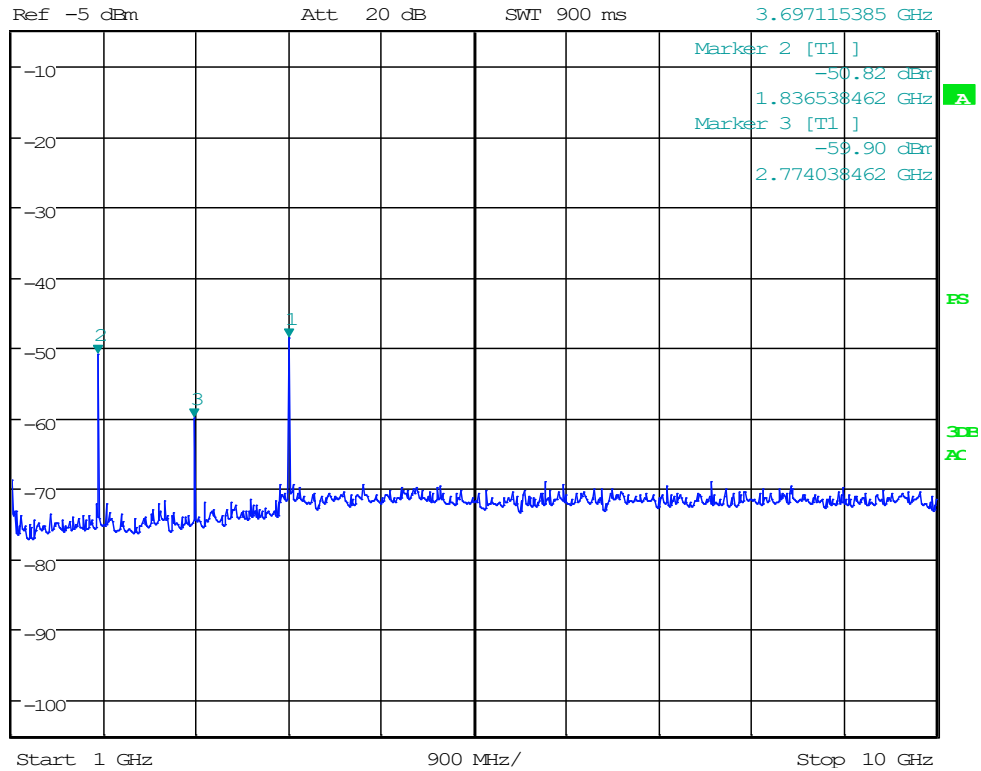




High Channel: 1 GHz to 10 GHz



RBW 100 kHz Marker 1 [T1]
VBW 300 kHz -48.52 dBm
SWT 900 ms 3.697115385 GHz





11 RADIATED SPURIOUS EMISSION

The EUT antenna port was fitted with its integral/internal chip antenna. Radiated emissions were measured in a Semi-Anechoic Chamber. All emissions generated that fall in the restricted bands per FCC Part 15.205 were examined.

11.1 Requirements:

All emissions that fall in the restricted bands defined in FCC Part 15.205 shall not exceed the maximum field strength listed in FCC Part 15.209(a).



11.2 Radiated Spurious Emission Test Data

Test Date(s):	July 30, 2019	Test Engineer:	J. Chiller
Standards:	CFR 47 Part 15.247(d); Part 15.209 / KDB558074	Air Temperature:	20.7°C
		Relative Humidity:	52%

Notes: Plots are peak, max hold prescan data included only to determine what frequencies to investigate and measure. The EUT was initially placed in a semi-anechoic chamber, and rotated in all three orthogonal positions to maximize the emissions. Characterization measurements were then performed to determine at which frequencies significant emissions occurred. These graphs are shown below.

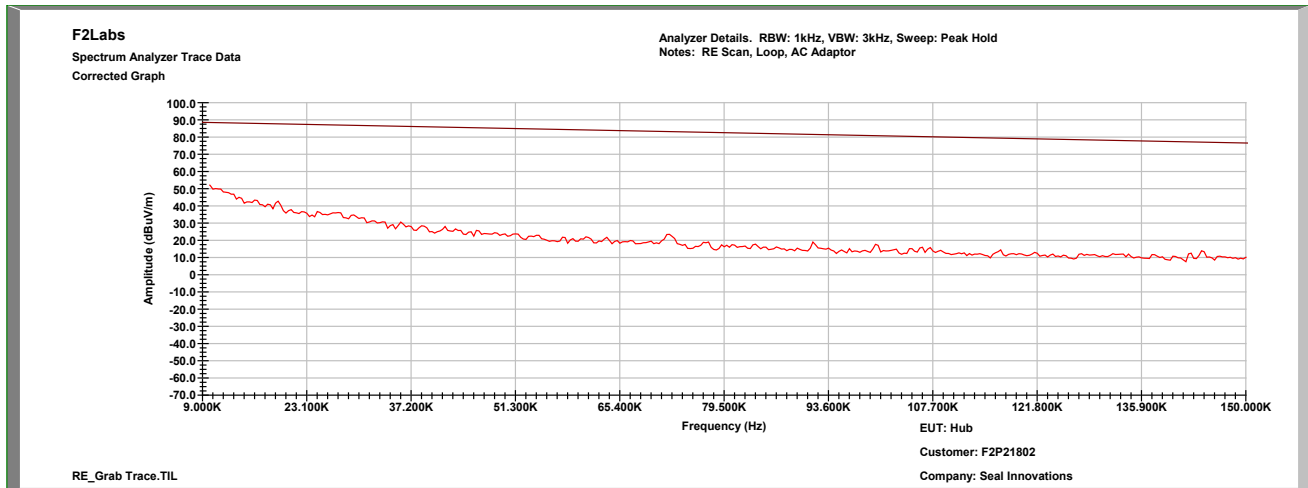
The equipment was fully exercised with all cabling attached to the EUT and was positioned on the OATS for maximum emissions. While the equipment was energized, the receiving antenna was scanned from 1.0 meter to 4.0 meters in both vertical and horizontal polarities while the turntable was adjusted 360 degrees to determine the maximum field strength. The tables of measured results can be found below.

Some of the frequencies did not change with the EUT on or off. At those frequencies, the test distance was shortened to 1 meter and still no emissions from the EUT were visible or over the ambient or limit.

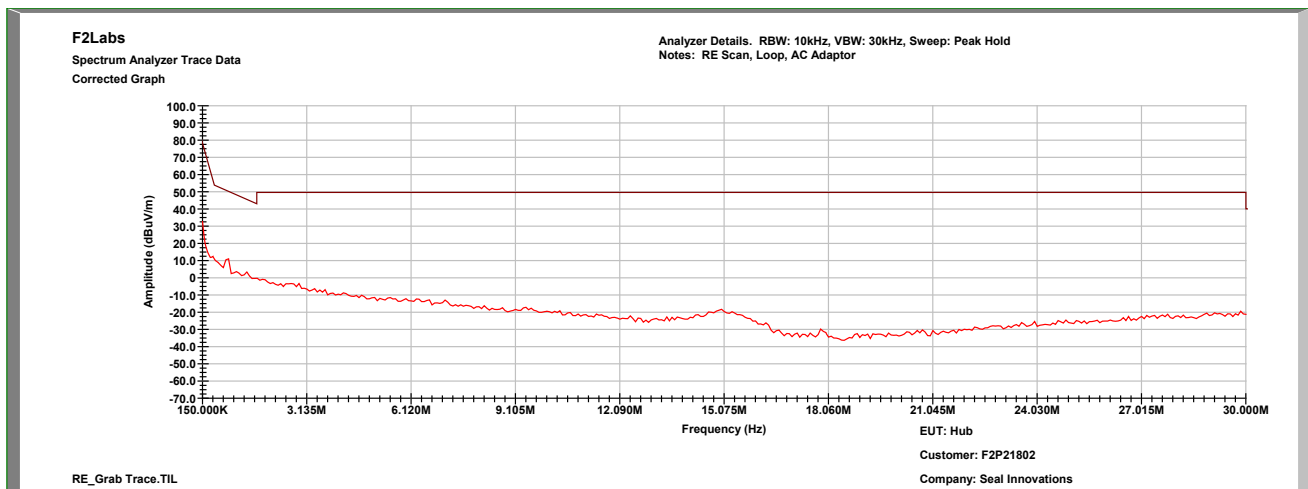
In the following plots, the black line indicates the active scan and the green line indicates the MaxPk measurement with the EUT on during rotation. Emissions to be found by the EUT were measured and listed in tables. The plots are for reference only and the limit lines are not actual limit lines but merely a guide. Graphs presented reflect the Mid Channel, found to be worst-case.



AC Mode, Characterization Scan, 0.009 MHz to 0.15 MHz Channel 0

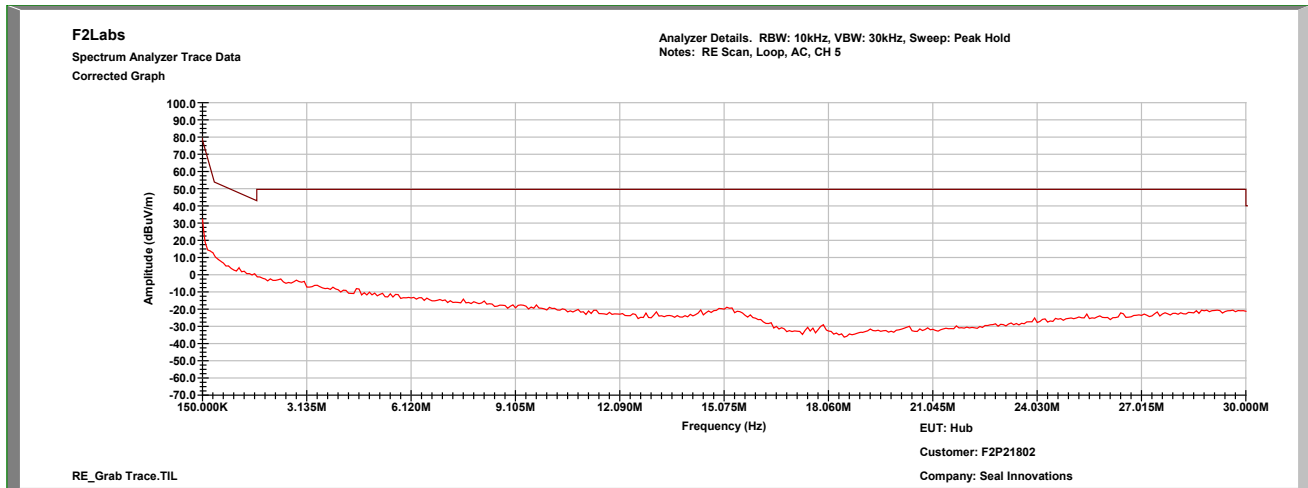


AC Mode, Characterization Scan, 0.15 MHz to 30.0 MHz Channel 0

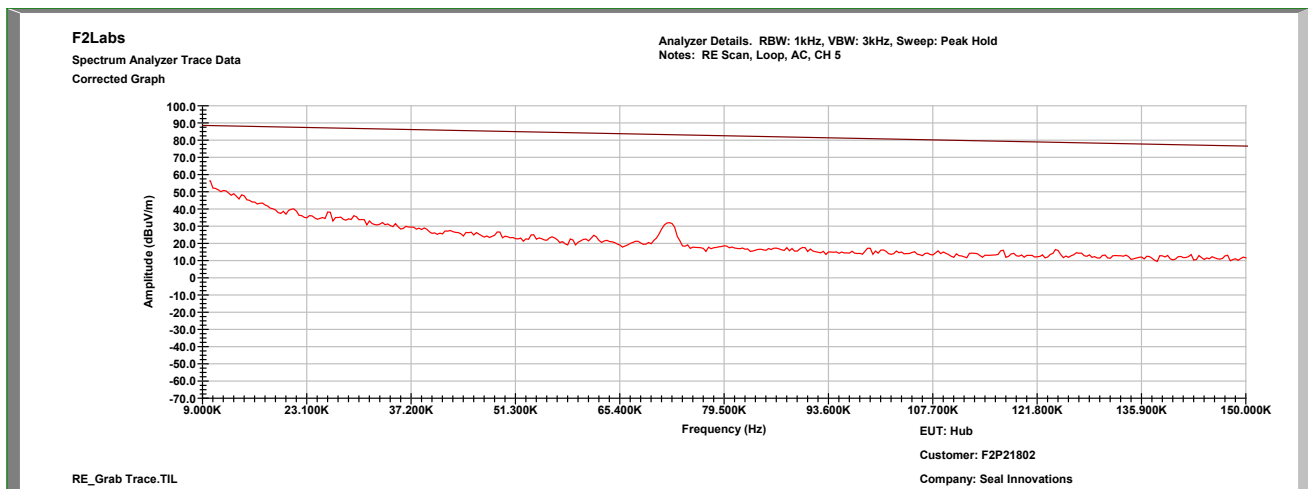




AC Mode, Characterization Scan, 0.009 MHz to 0.15 MHz Channel 5

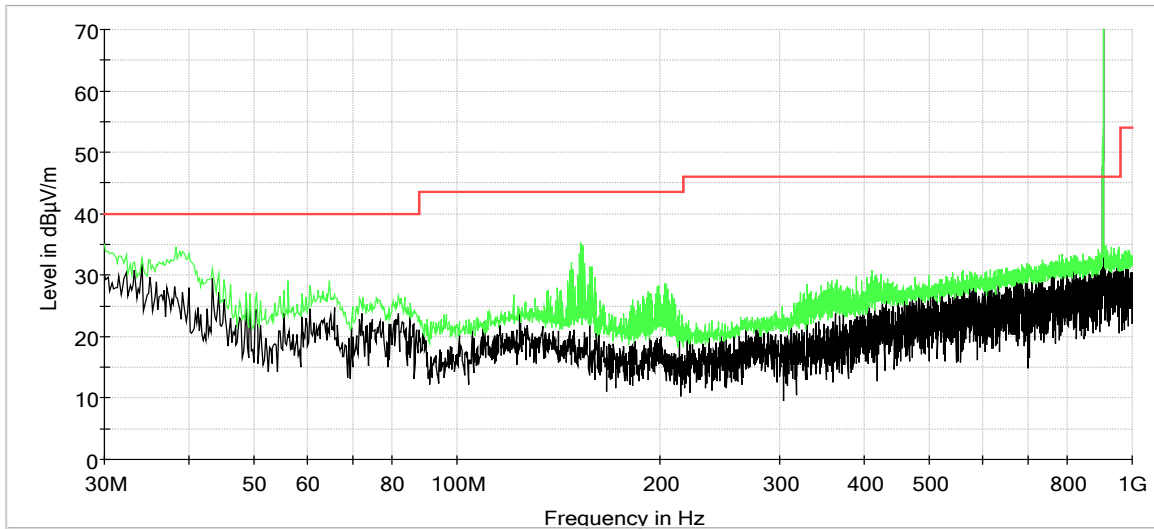


AC Mode, Characterization Scan, 0.15 MHz to 30.0 MHz Channel 5

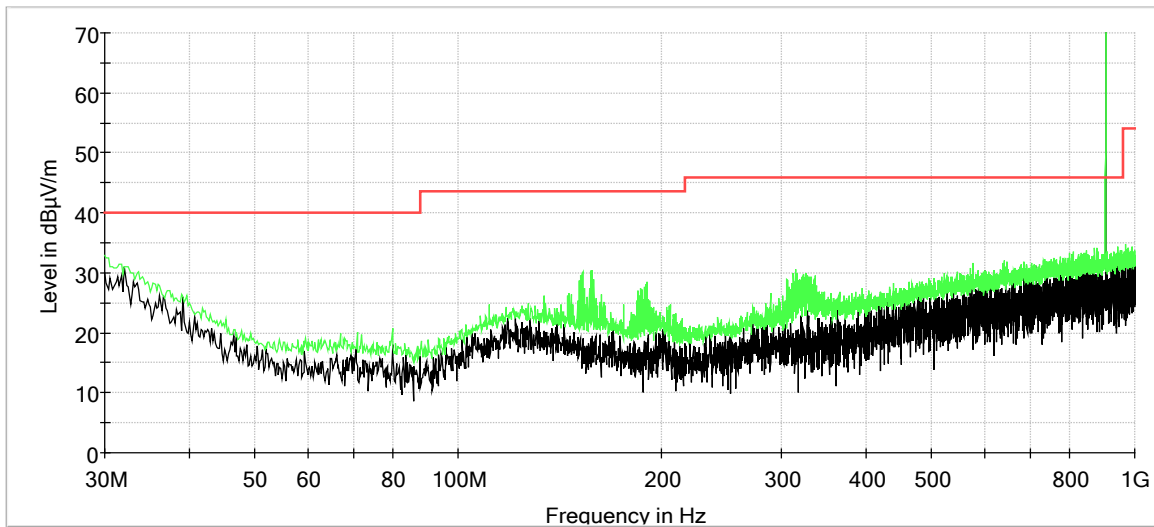




Characterization Scan, 30 MHz to 1000 MHz, Vertical

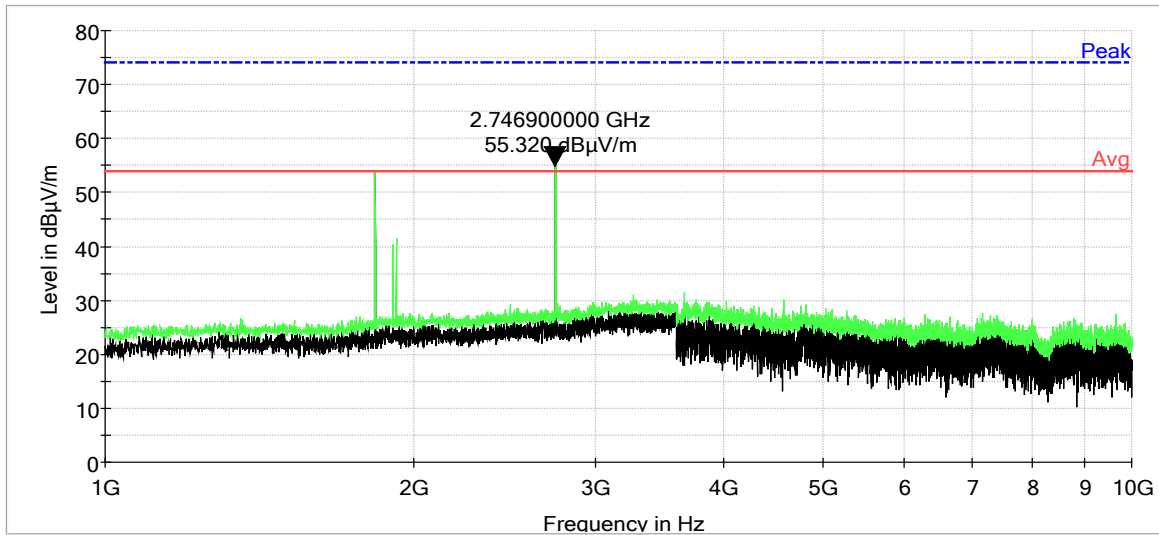


Characterization Scan, 30 MHz to 1000 MHz, Horizontal

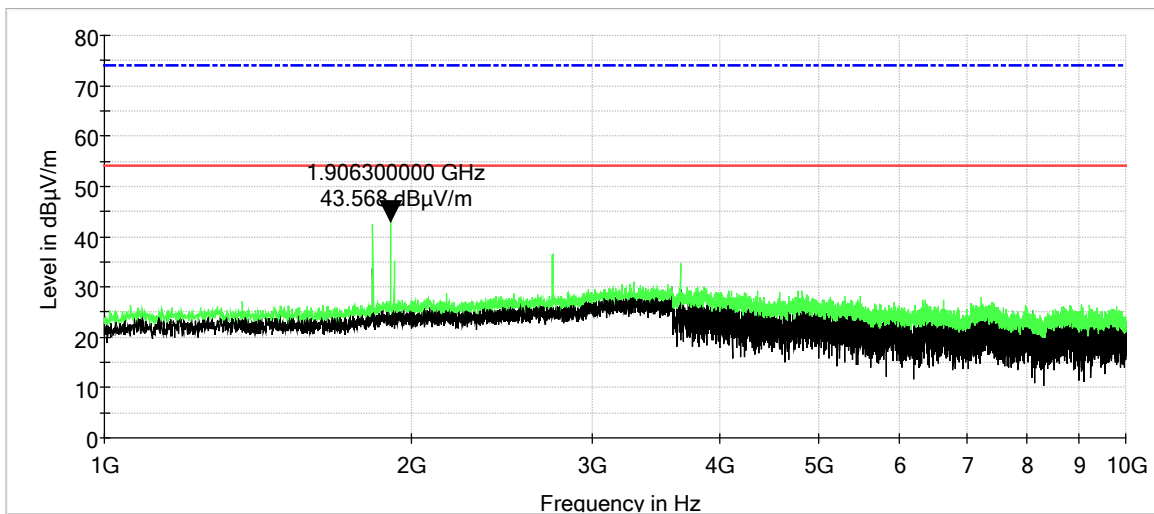




AC Mode, Characterization Scan, 1 GHz to 10 GHz, Vertical

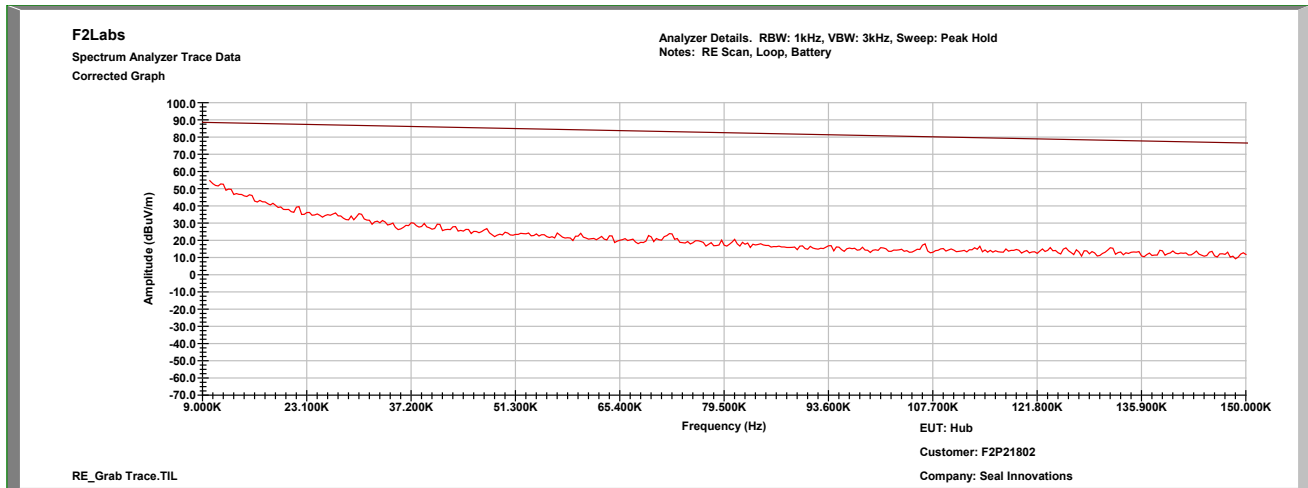


AC Mode, Characterization Scan, 1 GHz to 10 GHz, Horizontal

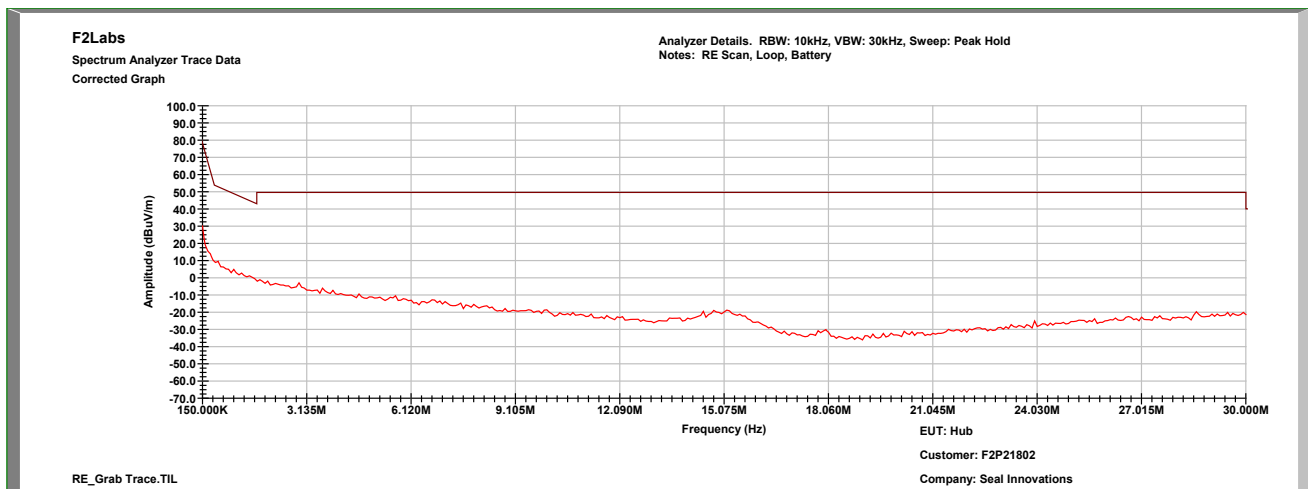




Battery Mode, Characterization Scan, 0.009 MHz to 0.15 MHz Channel 0



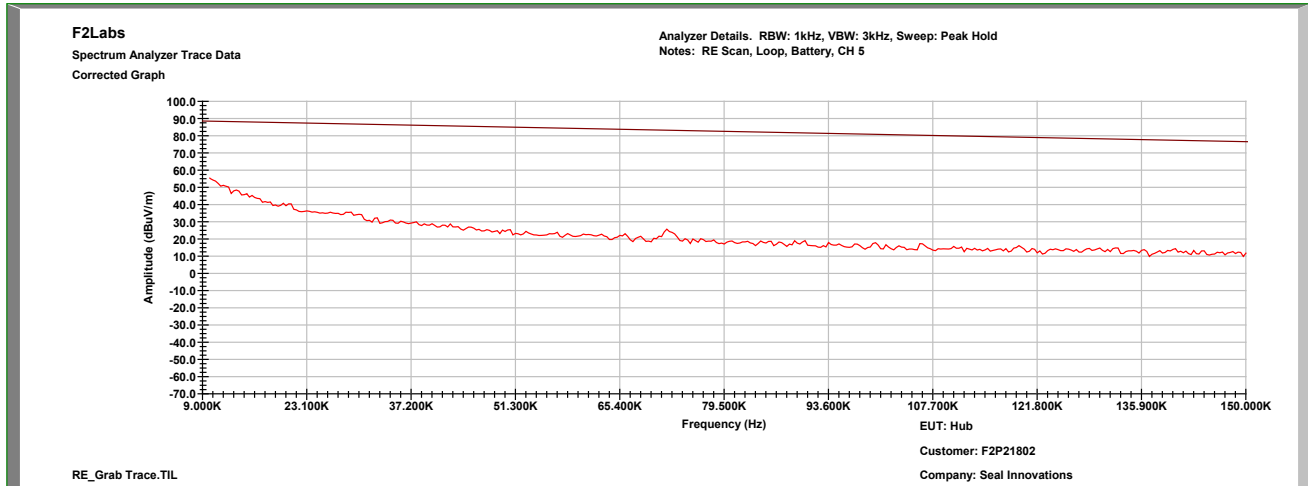
Battery Mode, Characterization Scan, 0.15 MHz to 30.0 MHz Channel 0





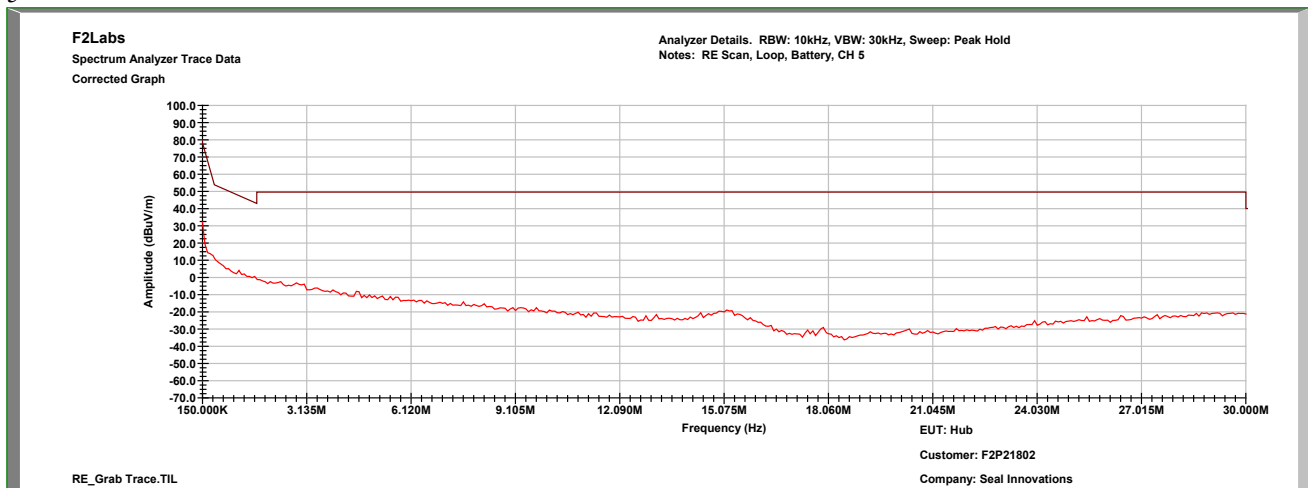
Battery Mode, Characterization Scan, 0.009 MHz to 0.15 MHz Channel 5

5



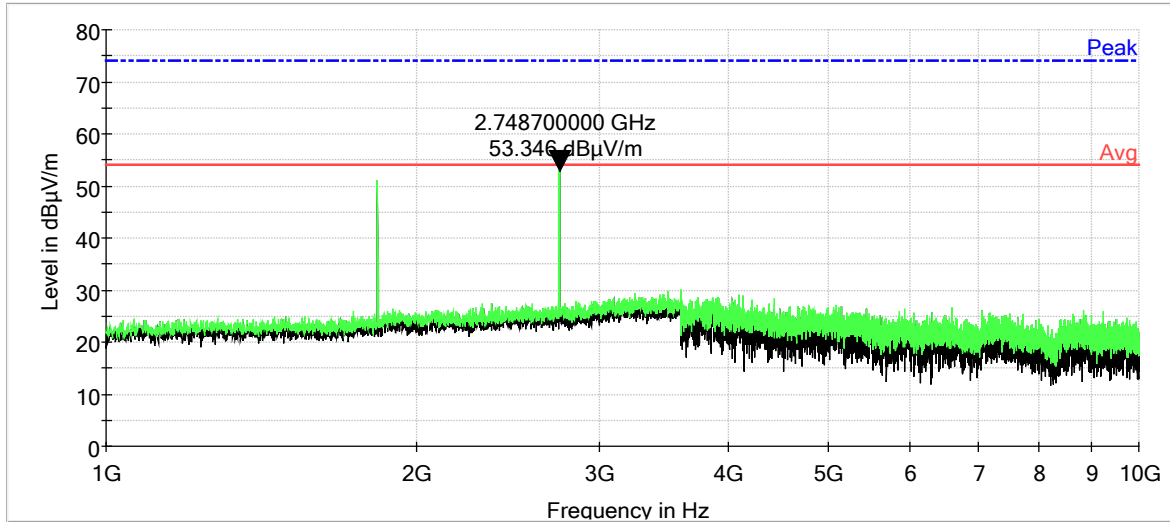
Battery Mode, Characterization Scan, 0.15 MHz to 30.0 MHz Channel 5

5

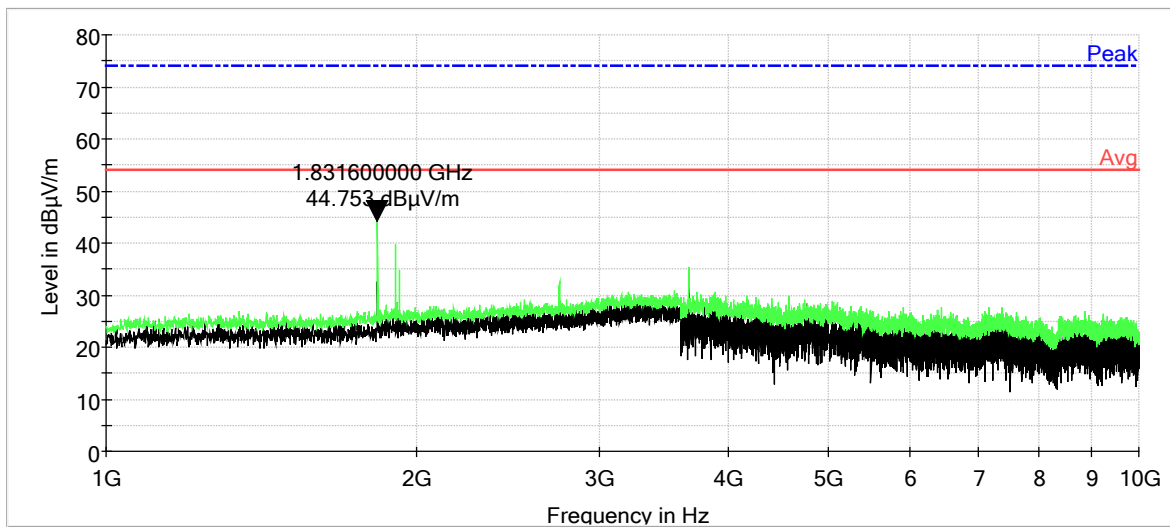




Battery Mode, Characterization Scan, 1 GHz to 10 GHz, Vertical



Battery Mode, Characterization Scan, 1 GHz to 10 GHz, Horizontal

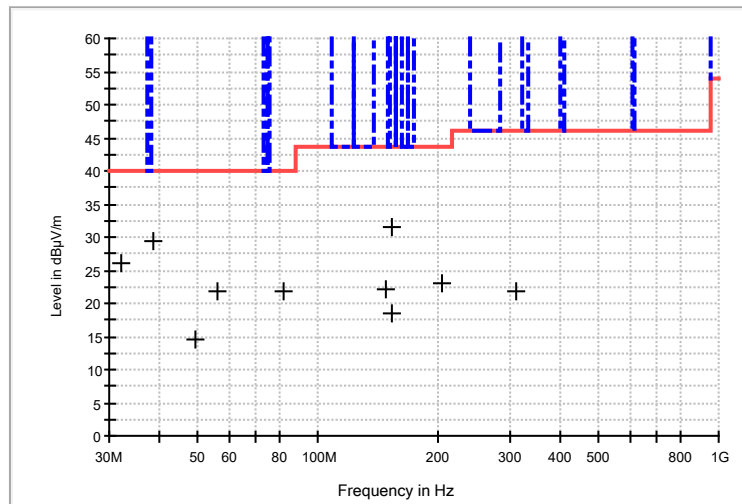




Measurements

The following data reflects results from high, mid, and low channels.

Frequency (MHz)	Antenna Polarization	Antenna Height (cm)	Azimuth (degrees)	Reading (dBμV)	Cable Loss & Antenna Factor (dB)	Emission (dBμV/m)	Limit (dBμV/m)	Margin (dB)
32.120000	H	100.00	0.00	20.9	5.2	26.10	40.0	-13.9
38.720000	V	100.00	0.00	29.3	0.2	29.50	40.0	-10.5
49.400000	H	100.00	0.00	20.7	-6.3	14.40	40.0	-25.6
56.200000	V	100.00	0.00	28.3	-7.6	20.70	40.0	-19.3
82.000000	V	100.00	0.00	29.6	-7.8	21.80	40.0	-18.2
147.560000	V	100.00	133.00	25.0	-2.9	22.10	43.5	-21.4
152.600000	V	100.00	202.00	21.6	-3.0	18.60	43.5	-24.9
152.800000	H	131.00	215.00	34.5	-3.0	31.50	43.5	-12.0
204.000000	V	100.00	17.00	26.8	-3.7	23.10	43.5	-20.4
313.240000	H	100.00	0.00	23.1	-1.3	21.80	46.0	-24.2



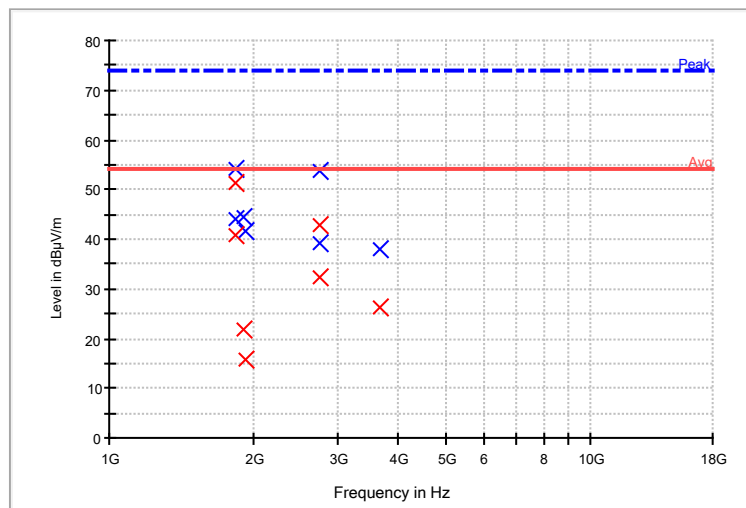


Mid Channel - MaxPeak

Frequency (MHz)	Antenna Polarization	Antenna Height (cm)	Azimuth (deg)	Reading (dB μ V)	Cable Loss & Antenna Factor (dB)	Emission (dB μ V/m)	Limit (dB μ V/m)	Margin (dB)
1832.000000	H	150.0	148.0	63.2	-19.0	44.20	74.0	-29.8
1832.000000	V	150.0	0.0	73.2	-19.0	54.20	74.0	-19.8
1906.000000	H	150.0	216.0	62.8	-18.5	44.30	74.0	-29.7
1922.000000	V	150.0	355.0	60.1	-18.5	41.60	74.0	-32.4
2747.000000	V	150.0	0.0	72.1	-18.3	53.80	74.0	-20.2
2748.000000	H	150.0	200.0	57.4	-18.3	39.10	74.0	-34.9
3663.000000	H	150.0	193.0	54.4	-16.4	38.00	74.0	-36.0

Mid Channel - Average

Frequency (MHz)	Antenna Polarization	Antenna Height (cm)	Azimuth (deg)	Reading (dB μ V)	Cable Loss & Antenna Factor (dB)	Emission (dB μ V/m)	Limit (dB μ V/m)	Margin (dB)
1832.000000	H	150.0	148.0	59.6	-19.0	40.60	54.0	-13.4
1832.000000	V	150.0	0.0	70.4	-19.0	51.40	54.0	-2.6
1906.000000	H	150.0	216.0	40.4	-18.5	21.90	54.0	-32.1
1922.000000	V	150.0	355.0	34.2	-18.5	15.70	54.0	-38.3
2747.000000	V	150.0	0.0	61.0	-18.3	42.70	54.0	-11.3
2748.000000	H	150.0	200.0	50.5	-18.3	32.20	54.0	-21.8
3663.000000	H	150.0	193.0	42.8	-16.4	26.40	54.0	-27.6





12 FCC PART 15.247(e) – PEAK POWER SPECTRAL DENSITY (PSD)

Peak power spectral density measurements were performed.

12.1 Requirements:

The peak power spectral density shall not exceed +8dBm in any 3 kHz band during any time interval of continuous transmission.

Power spectral density measurements were performed at a resolution bandwidth of 3 kHz (video bandwidth set at 10 KHz). The peak spectral densities were measured at the low, mid, and upper channels.



12.2 Peak Power Spectral Density Test Data

Test Date(s):	Oct. 1, 2019	Test Engineer:	J. Chiller
Standards:	CFR 47 Part 15.247(e); KDB558074	Air Temperature:	19.9°C
		Relative Humidity:	50%

Low Channel



*RBW 3 kHz Marker 1 [T1]
*VBW 10 kHz 6.36 dBm
SWT 225 ms 906.16666667 MHz



Date: 1.OCT.2019 11:47:54



Mid Channel



RBW 3 kHz

Marker 1 [T1]

VBW 10 kHz

6.59 dBm

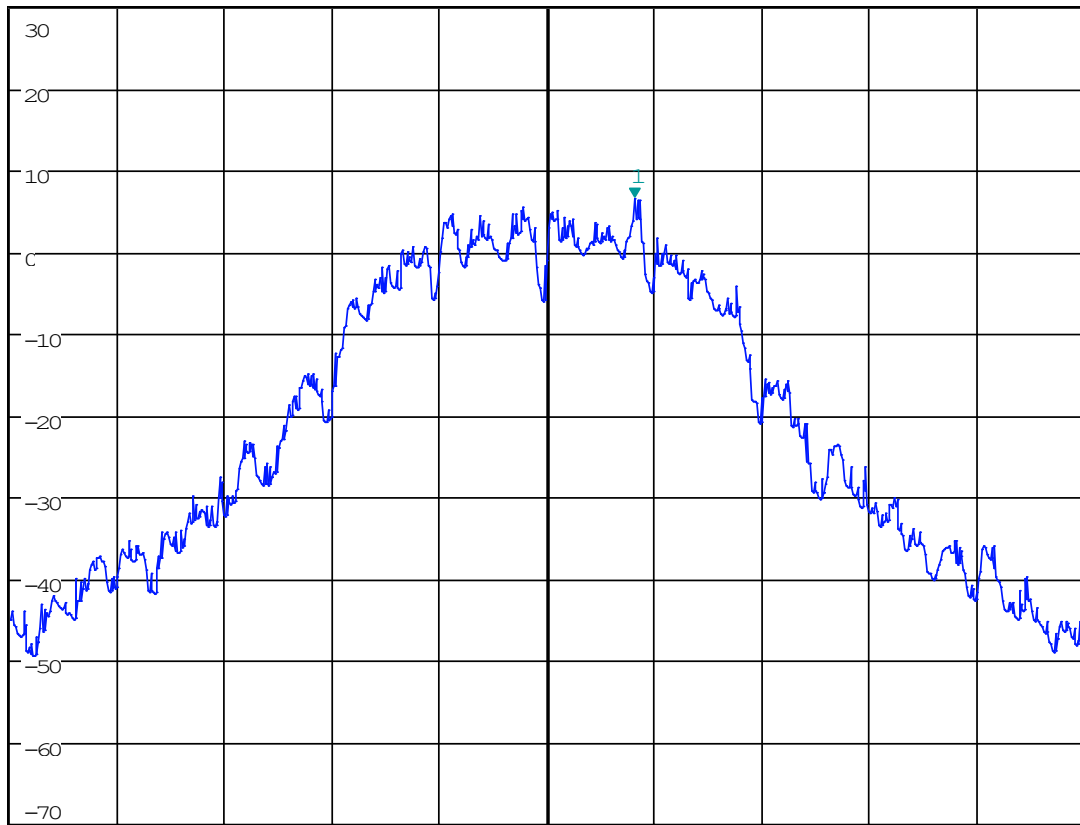
SWT 225 ms

916.163461538 MHz

Ref 30 dBm

Att 55 dB

1.00
VdBm



Center 916 MHz

200 kHz/

Span 2 MHz

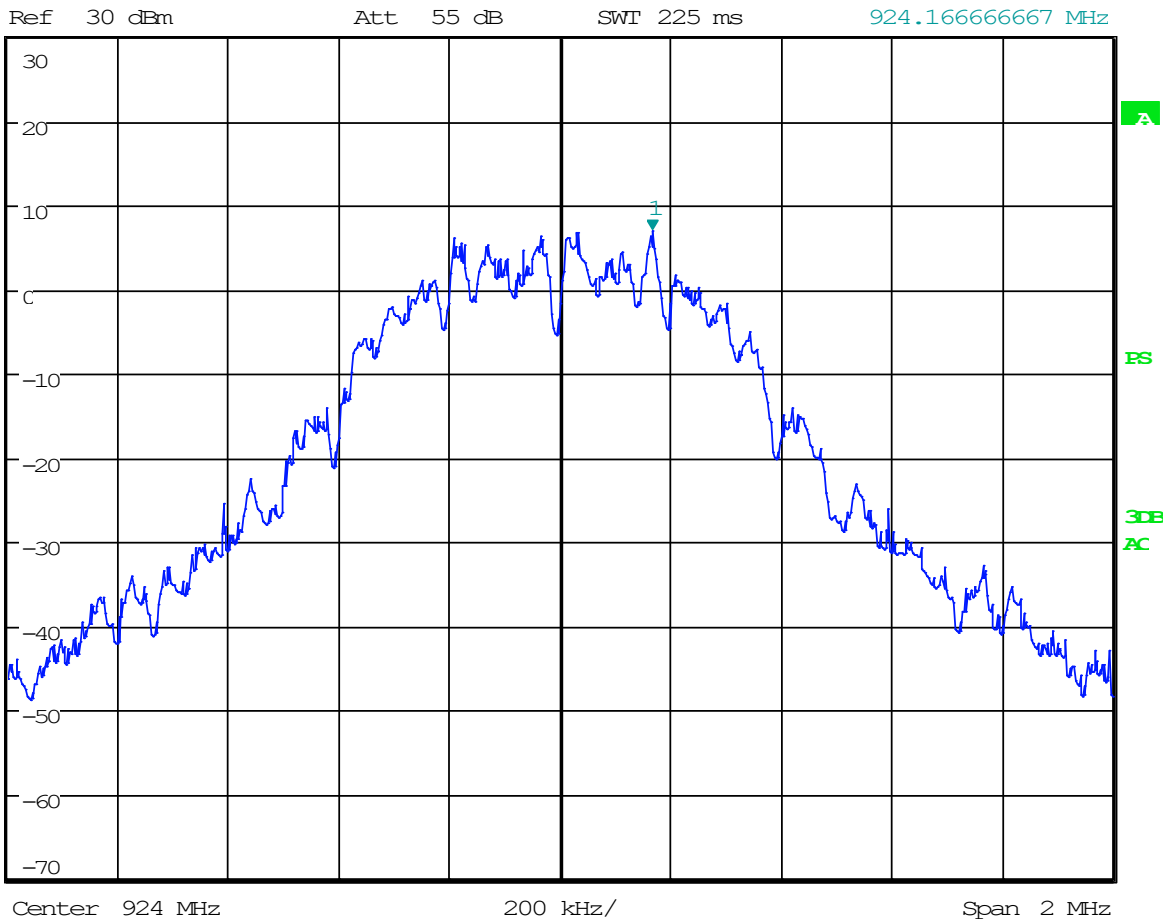
Date: 1.OCT.2019 11:50:04



High Channel



RBW 3 kHz
VBW 10 kHz
SWT 225 ms
Marker 1 [T1]
6.99 dBm
924.166666667 MHz



Date: 1.OCT.2019 12:02:44



13 CONDUCTED EMISSIONS

13.1 Requirements

In accordance with FCC CFR 47 Part 15.207(a), "Except as shown in paragraphs (b) and (c) of this section, for an intentional radiator that is designed to be connected to the public utility (AC) power line, the radio frequency voltage that is conducted back onto the AC power line on any frequency or frequencies, within the band 150 kHz to 30 MHz, shall not exceed the limits in the following table, as measured using a 50 μ H/50 ohms line impedance stabilization network (LISN). Compliance with the provisions of this paragraph shall be based on the measurement of the radio frequency voltage between each power line and ground at the power terminal. The lower limit applies at the boundary between the frequency ranges.

Frequency of Emission (MHz)	Conducted Limit (dB μ V)	
	Quasi-peak	Average
0.15-0.5	66 to 56*	56 to 46*
0.5-5	56	46
5-30	60	50

*Decreases with the logarithm of the frequency.

13.2 Procedure

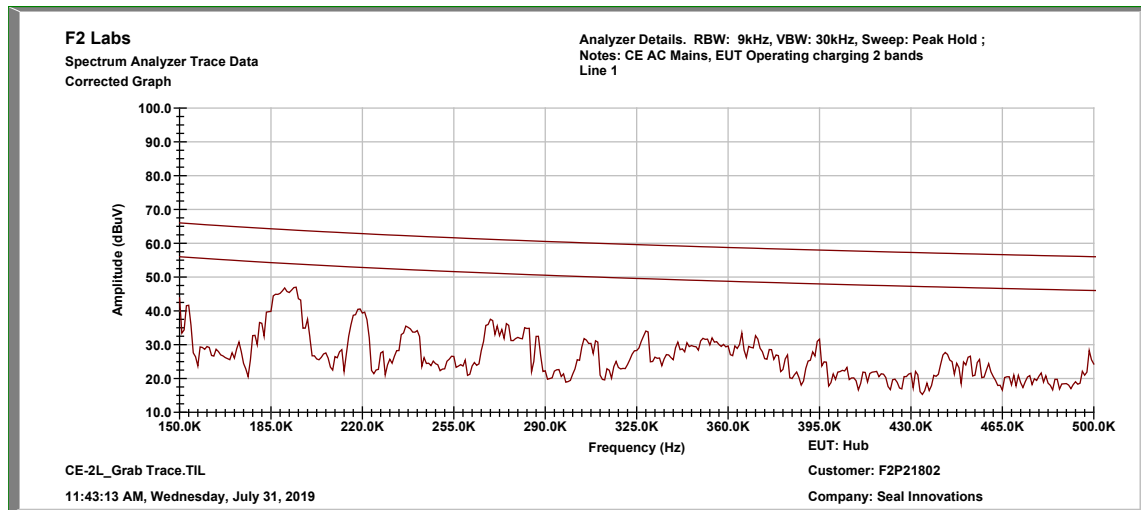
The EUT was placed on a 1.0 x 1.5 meter non-conductive table, 0.8 meter above a horizontal ground plane and 0.4 meter from a vertical ground plane. Power was provided to the EUT through a LISN bonded to a 3 x 2 meter ground plane. The LISN and peripherals were supplied power through a filtered AC power source. The output of the LISN was connected to the input of the receiver via a transient limiter, and emissions in the range 150 kHz to 30 MHz were measured. The measurements were recorded using the quasi-peak and average detectors as directed by the standard, and the resolution bandwidth during testing was 9 kHz. The raw measurements were corrected to allow for attenuation from the LISN, transient limiter and cables.



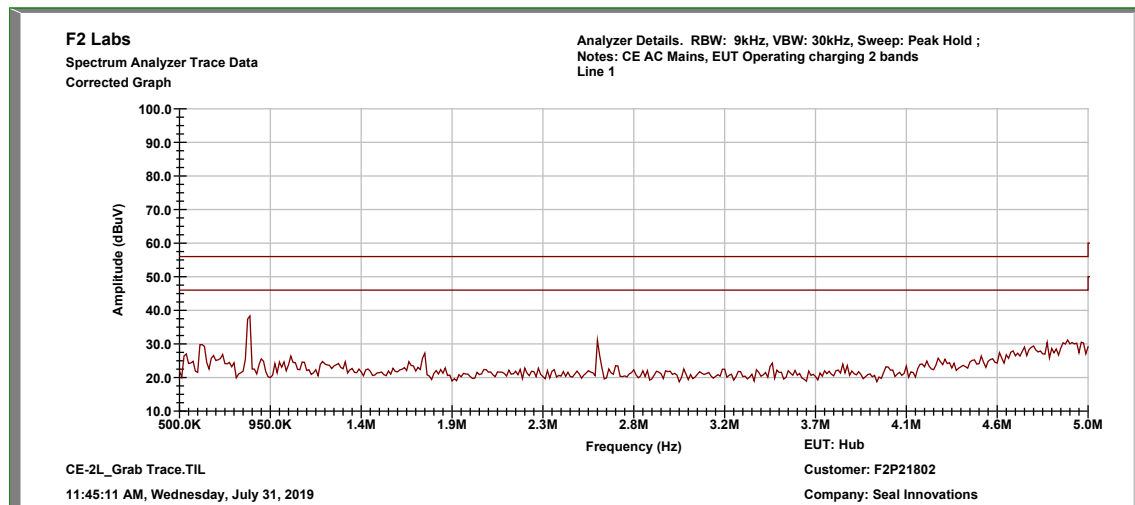
13.3 Conducted Emissions Test Data

Test Date:	July 31, 2018	Test Engineer:	J. Chiller
Rule:	15.207	Air Temperature:	20.9° C
Test Results:	Complies	Relative Humidity:	38%

Conducted Test – Line 1: 0.15 MHz to 0.5 MHz

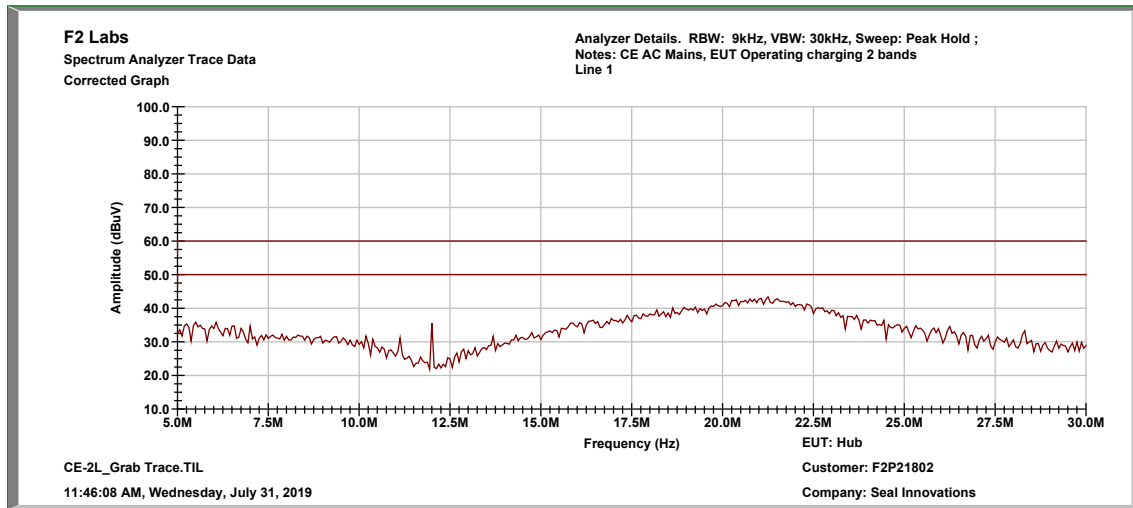


Conducted Test – Line 1: 0.5 MHz to 5.0 MHz





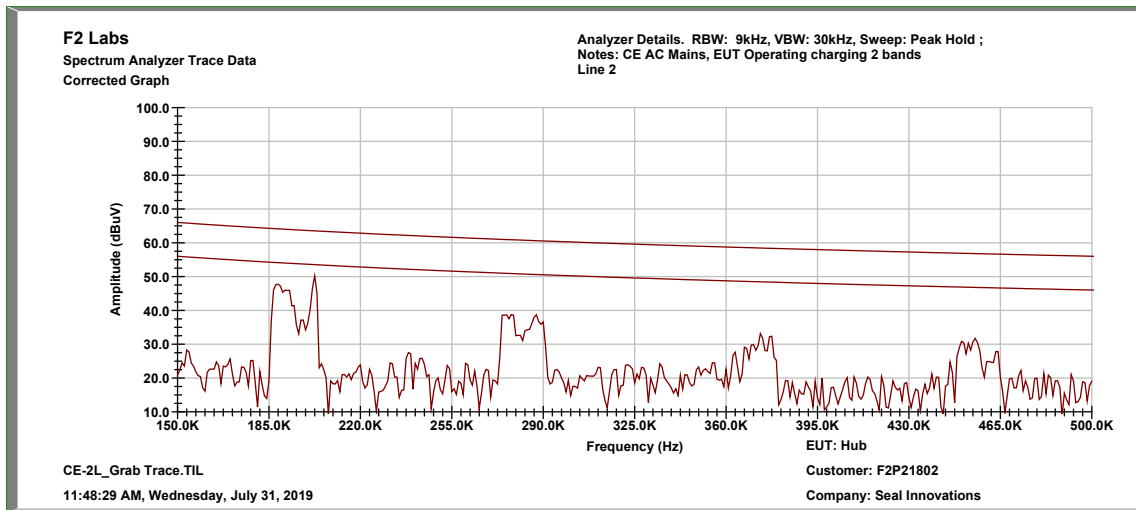
Conducted Test – Line 1: 5.0 MHz to 30.0 MHz



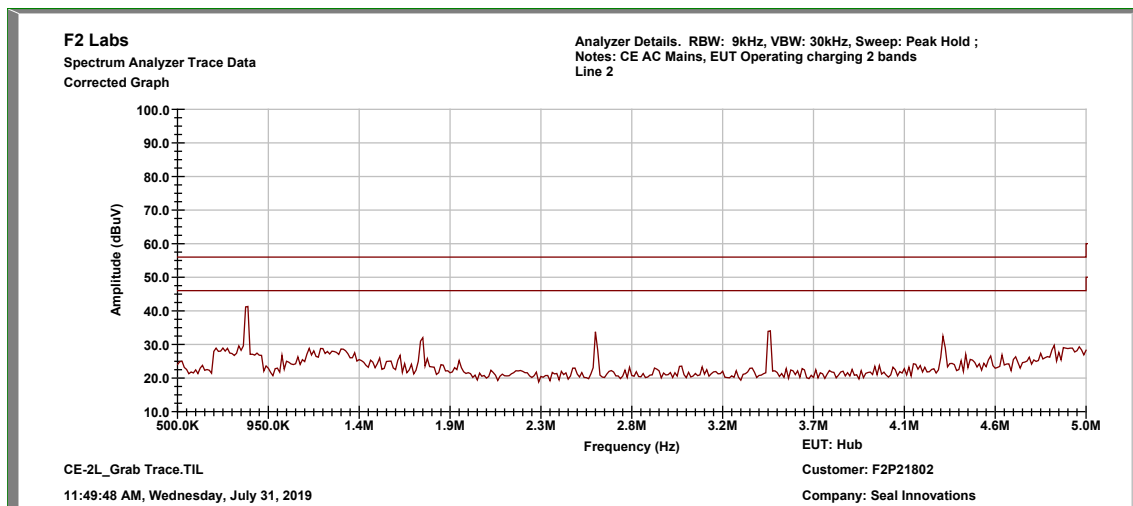
Note: Peak Data is below the Average Limit Line.



Conducted Test – Line 2: 0.15 MHz to 0.5 MHz

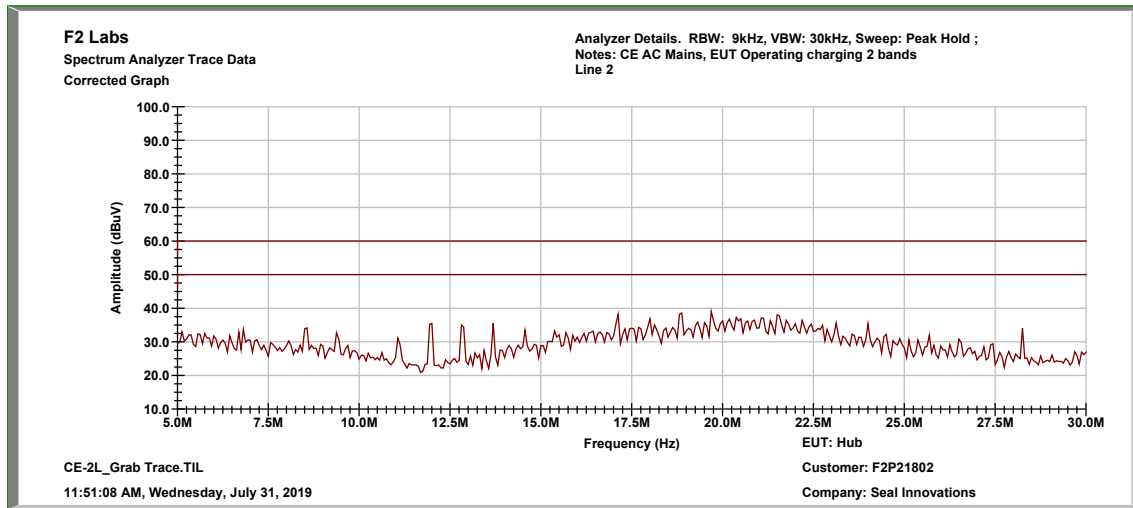


Conducted Test – Line 2: 0.5 MHz to 5.0 MHz





Conducted Test – Line 2: 5.0 MHz to 30.0 MHz



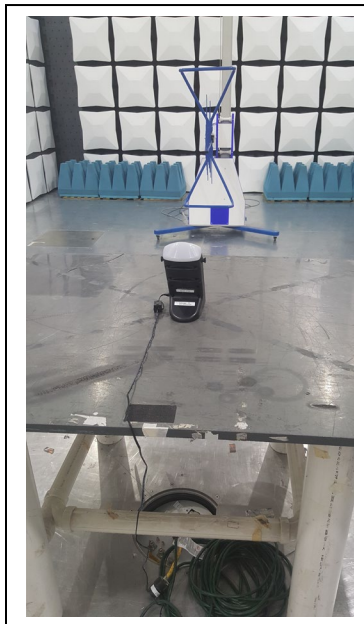
Note: Peak Data is below the Average Limit Line.

14 PHOTOGRAPHS

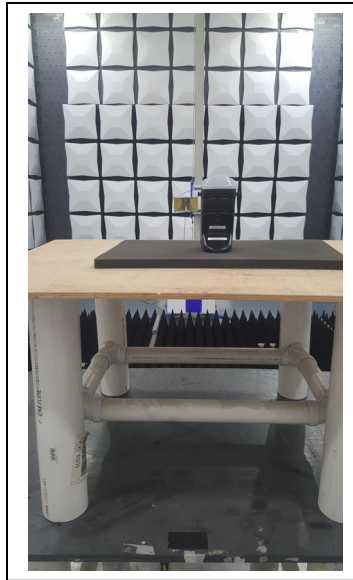
Radiated Spurious Emission: 0.15 MHz to 30 MHz



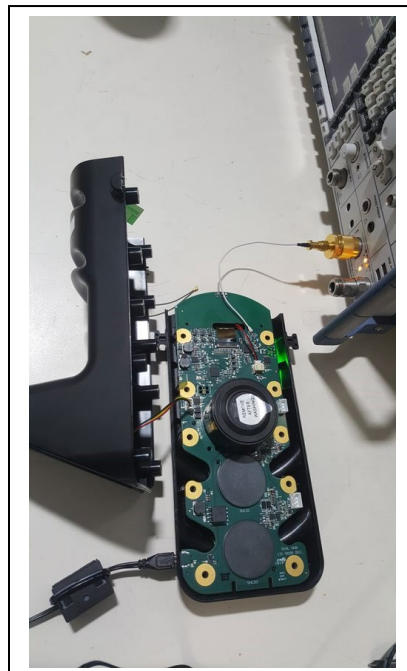
Radiated Spurious Emission: 30 MHz to 1000 MHz



Radiated Spurious Emission: 1 GHz to 10 GHz



**Occupied Bandwidth, Power Spectral Density,
Output Power, Conducted Spurious Emissions**



Voltage Variations



Conducted Emissions

