

**COMPLIANCE WORLDWIDE INC.
TEST REPORT 459-19**

In Accordance with the Requirements of

**Federal Communications Commission 47 CFR Part 15.250, Subpart C
Wideband Systems within the band 5925 to 7250 MHz
Class II Permissive Change**

Issued to

**Ciholas, Inc.
3700 Bell Road
Newburgh, IN 47630**

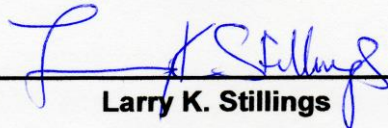
For the

DWETH101

FCC ID: 2ALIR-DWETH101

Report Issued on February 4, 2020

Tested By



Larry K. Stillings

Reviewed By



Brian F. Breault

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1. Scope

This test report certifies that the Ciholas DWETH101 as tested, meets the FCC Part 15.250, Subpart C requirements. The scope of this test report is limited to the test sample provided by the client, only in as much as that sample represents other production units. If any significant changes are made to the unit, the changes shall be evaluated and a retest may be required. The purpose of this testing was to add an alternate antenna design to the certification.

2. Product Details

- 2.1. Manufacturer:** Ciholas, Inc.
2.2. Product Name: DWETH101
2.3. Model Number: E00524
2.4. Serial Number: 0104081B
2.5. Description: The DWETH101 is an Ethernet device that relies on ultra-wideband (UWB) pulses and time-stamp information to capture real-time location and sensor data.
2.6. Power Source: 48 VDC via PoE Injector
2.7. Hardware Revision: 2.2.3
2.8. Software Revision: N/A
2.9. Modulation Type: Pulse Modulation, Frequency Hopping
2.10. Operating Frequency: CH 5 – 6.49 GHz Nominal
2.11. EMC Modifications: None

3. Product Configuration

3.1 Operational Characteristics & Software

Connect the DWETH101 to a laptop via a PoE Injector. A laptop is then used with a UWB dongle to communicate to DWETH101 containing special firmware to configure packet size, and PRFs for the EUT. The DWETH101 was tested in a total of four modes consisting of long and packet types, and 16M and 64M PRFs at a 6.8 Mbps data rate.

3.2. Cables

Cable Type	Length	Shield	From	To
Ethernet	10M	No	EUT	POE Injector
Ethernet	2M	No	EUT	Unterminated

3. Product Configuration (cont.)

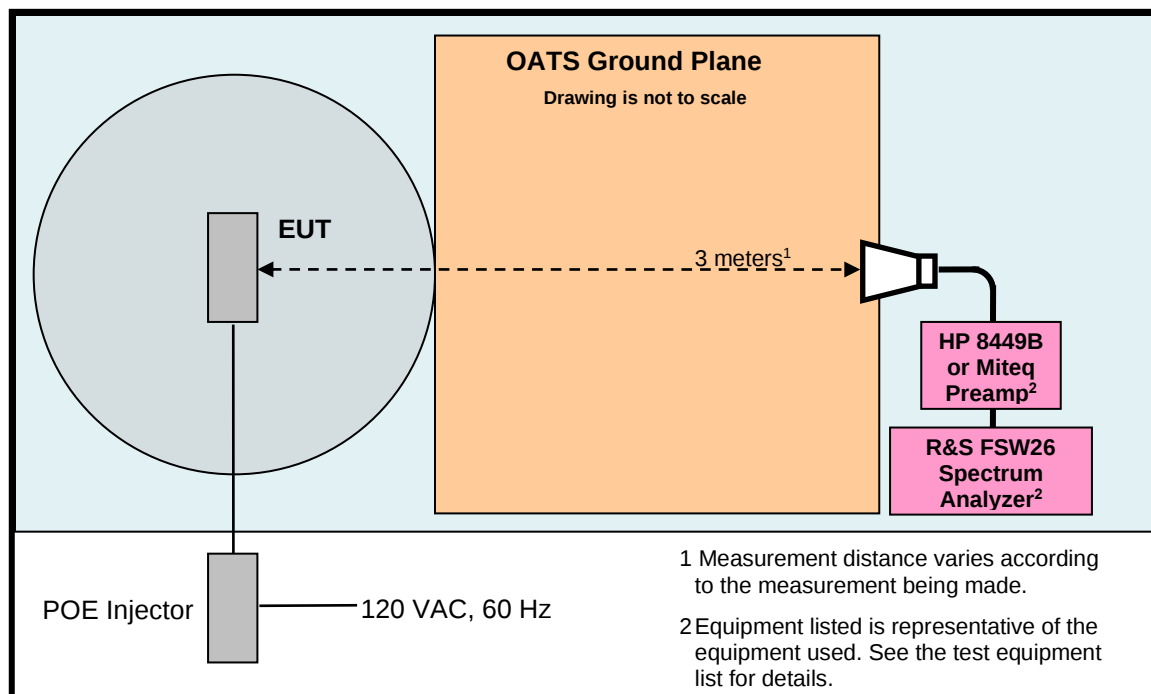
3.3. EUT Hardware

Manufacturer	Model/Part # / Options	Serial Number	Input Volts	Freq (Hz)	Description/Function
Ciholas	DWETH101	0104081B	48	DC	UWB Anchor

3.4. Support Equipment

Description	Manufacturer	Model/Part #	
Lenovo	ThinkPad T440p	PB-031DX9	Laptop for configuration
Ciholas	DWUWB-SMA	01:00:07FC	Wireless dongle for configuration
POE Injector	Ault	PW130	POE Injector for powering DWETH101

3.5. Test Setup Diagram



4. Measurements Parameters

4.1. Measurement Equipment Used to Perform Test

Device	Manufacturer	Model No.	Serial No.	Cal Due	Interval
EMI Receiver 9 kHz to 7 GHz	Rohde & Schwarz	ESR7	101156	9/10/2020	2 Years
Spectrum Analyzer 9 kHz to 40 GHz	Rohde & Schwarz	FSV40	100899	9/10/2020	2 Years
Spectrum Analyzer 10 Hz to 40 GHz	Rohde & Schwarz	FSVR40	100909	5/3/2020	3 Years
Spectrum Analyzer 3 Hz to 26.5 GHz	Rohde & Schwarz	FSW26	102044	9/13/2020	2 Years
Bilog Antenna 30 to 2000 MHz	Sunol Sciences	JB1	A050913	6/5/2022	3 Years
Loop Antenna 9 kHz to 30 MHz	EMCO	6512	9309-1139	1/28/2022	3 Years
Preamplifier 100 MHz to 7 GHz	Miteq	AFS3-00100200-10-15P-4	988773	4/17/2020	2 Years
Preamplifier 100 MHz to 18 GHz	Miteq	AMF-7D-00101800-30-10P	1953081	4/16/2020	2 Years
Preamplifier 2 to 12 GHz	JCA	JCA48-4111B1	7087S	4/17/2020	2 Years
Preamplifier 1 to 26.5 GHz	Hewlett Packard	8449B	3008A01323	9/11/2020	2 Years
Preamplifier 18 to 40 GHz	Miteq	JSD42-21004200-40-5P	649199/649219	1/6/2021	1 Year
Horn Antenna 1 to 18 GHz	ETS-Lindgren	3117	00143292	3/21/2022	3 Years
Horn Antenna 18 to 40 GHz	Com Power	AH-840	101032	10/9/2020	2 Years
High Pass Filter 8 to 18 GHz	Micro-Tronics	HPM50107	G036	1/6/2021	1 Year
Barometer	Control Company	4195	Cal ID# 236	4/3/2020	2 Years

¹ ESR7 Firmware revision: V3.36, SP2 Date installed: 11/02/2017 Previous V3.36, installed 05/16/2017.
² FSV40 Firmware revision: V2.30 SP4, Date installed: 05/04/2016 Previous V2.30 SP1, installed 10/22/2014.
³ FSVR40 Firmware revision: V2.23 SP1, Date installed: 08/19/2016 Previous V2.23, installed 10/20/2014.
⁴ FSW26 Firmware revision: V2.80, Date installed: 10/28/2017 Previous V2.61, installed 04/04/2017.

4. Measurements Parameters (continued)

4.2. Measurement & Equipment Setup

Test Dates:	12/9/2019, 12/18/2019, 12/19/2019, 2/3/2020
Test Engineers:	Sean Defelice, Larry Stillings
Normal Site Temperature (15 - 35°C):	21.6
Relative Humidity (20 -75%RH):	35
Frequency Range:	30 kHz to 40 GHz
Measurement Distance:	3 Meters
EMI Receiver IF Bandwidth:	200 Hz – 10 kHz to 150 kHz 9 kHz – 10 to 30 MHz 120 kHz - 30 MHz to 1 GHz 1 MHz - Above 1 GHz
EMI Receiver Avg Bandwidth:	300 Hz – 10 kHz to 150 kHz 30 kHz – 10 to 30 MHz 300 kHz - 30 MHz to 1 GHz 3 MHz - Above 1 GHz
Detector Function:	Peak, Quasi-Peak, RMS & CISPR Average

4.3. Measurement Procedure

Test measurements were made in accordance FCC Parts 15.209, 15.250 Subpart C.

The test methods used to generate the data in this test report is in accordance with ANSI C63.10:2013, American National Standard for Testing Unlicensed Wireless Devices.

4.4. Measurement Uncertainty

The following uncertainties are expressed for an expansion/coverage factor of K=2.

RF Frequency (out of band)	$\pm 1 \times 10^{-8}$
Radiated Emission of Transmitter to 100 GHz	± 4.55 dB
Radiated Emission of Receiver	± 4.55 dB
Temperature	$\pm 0.91^{\circ}$ C
Humidity	$\pm 5\%$

5. Measurements Summary

Test Requirement	FCC Rule Requirement	Test Report Section	Result	Comment
Antenna Requirement	15.203	6.1	Compliant	
Operational Requirements	15.250 (a)	6.2	Compliant	
Wideband Bandwidth	15.250 (b)	6.3	Compliant	
Spurious Radiated Emissions	15.250 (d) (1) 15.209	6.4	Compliant	
Radiated Emissions in GPS Bands	15.250 (d) (2)	6.5	Compliant	
RMS Power in a 1 MHz Bandwidth	15.250 (d) (1)	6.6	Compliant	
Peak Emissions in a 50 MHz Bandwidth	15.250 (d) (3)	6.7	Compliant	
Conducted Emissions	15.207	6.8 6.9	Compliant	Via PoE Injector
Radio Frequency Exposure	FCC OET Bulletin 65 1.1310	6.10	Compliant	

6. Measurement Data

6.1. Antenna Requirement (15.203, RSS-220 5.1 (b))

Requirement: An intentional radiator shall be designed to ensure that no antenna other than that furnished by the responsible party shall be used with the device. The use of a permanently attached antenna or of an antenna that uses a unique coupling to the intentional radiator shall be considered sufficient to comply

Result: The antenna utilized by the product is a PCB mounted board antenna.

6.2. Operational Requirements of the Device under Test (15.250 (a), RSS-220)

Requirement: The -10 dB bandwidth of a device operating under the provisions of this section must be contained within the 5925 to 7250 MHz band under all conditions of operation including the effects from stepped frequency, frequency hopping or other modulation techniques that may be employed as well as the frequency stability of the transmitter over expected variations in temperature and supply voltage.

Result: Compliant

6.2.1 Frequency Stability over Temperature

Marker	Temp °C	Measured Frequency	-10 dB Band Edges		15.250 Frequency Band		Result
		(MHz)	Lower	Upper	F _{MIN} (MHz)	F _{MAX} (MHz)	
-	OATS	6486.1	6272.2	6683.8	5925	7250	Compliant
-	Ambient	6458.3	6226.9	6755.4	5925	7250	Compliant
1	-20	6452.5	6270.3	6730.4	5925	7250	Compliant
2	-10	6454.5	6269.9	6730.2	5925	7250	Compliant
3	0	6452.5	6270.1	6724.3	5925	7250	Compliant
4	+10	6452.6	6269.9	6755.3	5925	7250	Compliant
5	+20	6459.0	6270.0	6755.1	5925	7250	Compliant
6	+30	6457.9	6270.2	6754.7	5925	7250	Compliant
7	+40	6457.7	6274.1	6754.6	5925	7250	Compliant
8	+50	6454.3	6270.3	6715.1	5925	7250	Compliant

6. Measurement Data (continued)

6.3. Wideband Bandwidth (15.250 (b), RSS-220 2, 5.1)

Requirement: The -10 dB bandwidth of the fundamental emission shall be at least 50 MHz.

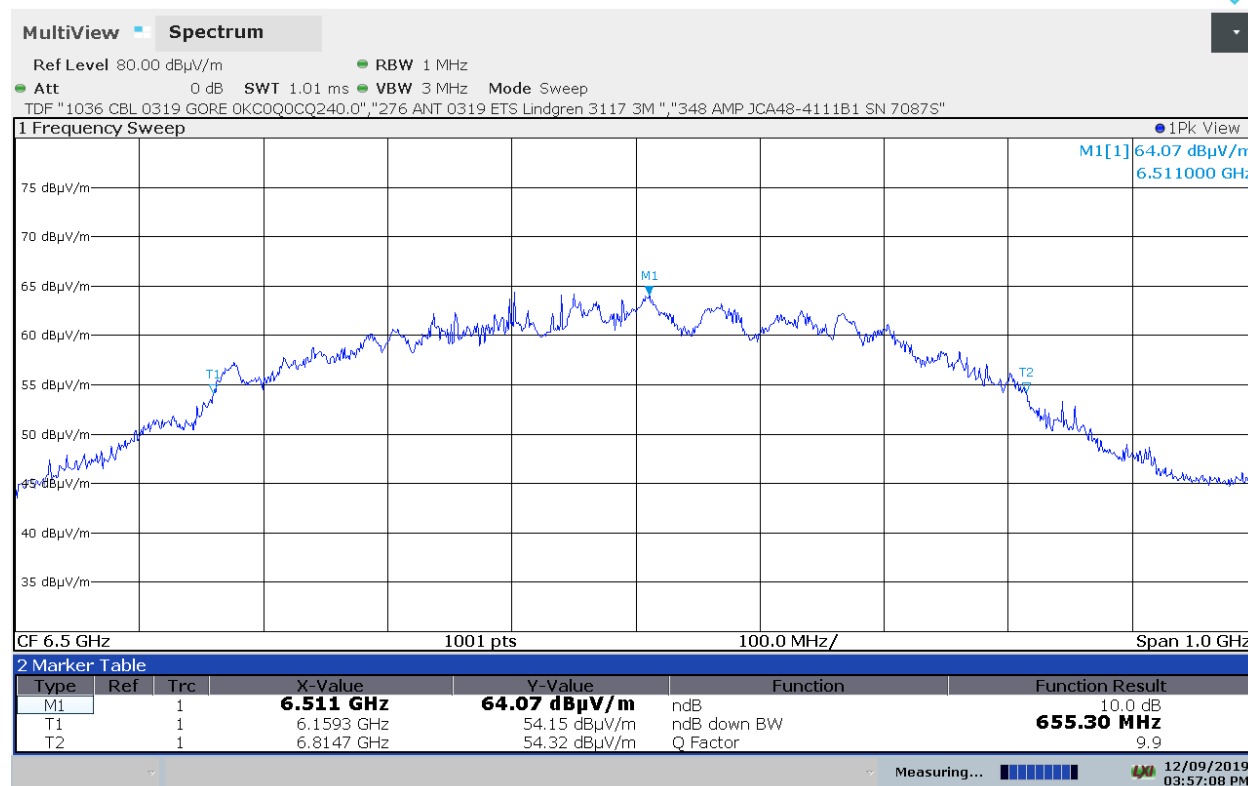
Result: Compliant

6.3.1. Measurement Data – Values in GHz

f_M	The highest emission peak	6.511
f_L	10 dB below the highest peak	6.1593
f_H	10 dB above the highest peak	6.8147
Bandwidth	Calculated: ($f_H - f_L$)	0.6553

6.3.2. Measurement Plot of 10 dB frequencies (16M PRF)

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03:57:08 PM 12/09/2019

6. Measurement Data (continued)

6.3. Wideband Bandwidth (15.250 (b), RSS-220 2, 5.1)

Requirement: The -10 dB bandwidth of the fundamental emission shall be at least 50 MHz.

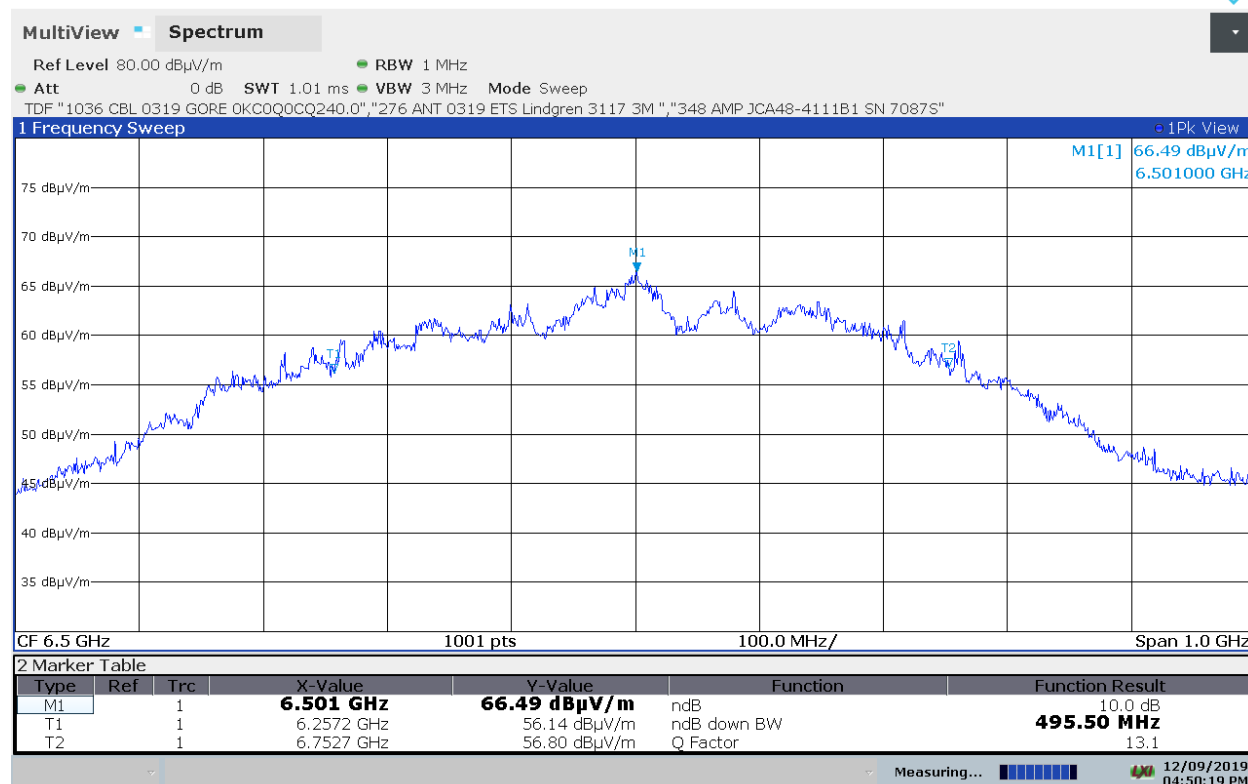
Result: Compliant

6.3.3. Measurement Data – Values in GHz

f_M	The highest emission peak	6.501
f_L	10 dB below the highest peak	6.2572
f_H	10 dB above the highest peak	6.7527
Bandwidth	Calculated: ($f_H - f_L$)	0.4955

6.3.4. Measurement Plot of 10 dB frequencies (64M PRF)

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04:50:20 PM 12/09/2019

6. Measurement Data (continued)

6.4. Spurious Radiated Emissions (15.250 (d) (1), 15.209, RSS-220 3.4)

Requirement: The radiated emissions at or below 960 MHz from a device operating under the provisions of this section shall not exceed the emission levels in Section 15.209. The radiated emissions above 960 MHz from a device operating under the provisions of this section shall not exceed the following average limits when measured using a resolution bandwidth of 1 MHz:

Frequency (MHz)	EIRP (dBm)	EIRP at 3 Meters (dBμV/m)
960 - 1610	-75.3	19.9
1610 - 1990	-63.3	31.9
1990 - 3100	-61.3	33.9
3100 – 5925	-51.3	43.9
5925 – 7250	-41.3	53.9
7250 – 10,600	-51.3	43.9
Above 10,600	-61.3	33.9

Spurious Radiated Emissions (RSS-220 5.3.1 (d))

Requirement: The radiated emissions at or below 960 MHz from a device shall not exceed the limits in Section 3.4. The radiated emissions above 960 MHz from a device shall not exceed the following average limits when measured using a resolution bandwidth of 1 MHz:

Frequency (MHz)	EIRP (dBm)	EIRP at 3 Meters (dBμV/m)
960 - 1610	-75.3	19.9
1610 – 4750	-70.0	25.2
4750 – 10,600	-41.3	53.9
Above 10,600	-61.3	33.9

6. Measurement Data (continued)

6.4. Spurious Radiated Emissions (15.250 (d) (1), 15.209, RSS-220 3.4 continued)

Radiated Emissions Field Strength Limits at 3 Meters (Section 15.250 (d), 15.209)

Frequency (MHz)	Field Strength (μV/m)	Field Strength (dBμV/m)
0.009 to 0.490	2,400/F	128.5 to 93.8
0.490 to 1.705	24,000/F	73.8 to 63
1.705 - 30	30	69.5
30 - 88	100	40
88 - 216	150	43.5
216 - 960	200	46
960 - 40,000	500	54

Test Notes: Refer to Section 4.1 for the test equipment used.

Frequency Range:	10 kHz to 40 GHz
Measurement Distance:	3 Meters
EMI Receiver IF Bandwidth:	200 Hz – 10 kHz to 150 kHz 9 kHz – 150 kHz to 30 MHz 120 kHz - 30 MHz to 1 GHz 1 MHz - Above 1 GHz
EMI Receiver Avg Bandwidth (minimum):	300 Hz – 10 kHz to 150 kHz 30 kHz – 150 kHz to 30 MHz 300 kHz - 30 MHz to 1 GHz 3 MHz - Above 1 GHz
Detector Function:	Peak, Quasi-Peak & Average

Note: Narrow band emissions between 960 and 1610 MHz that are over the limit are created by the digital communications between the processor and the UWB chipset and are subjected to the limits of 15.209.

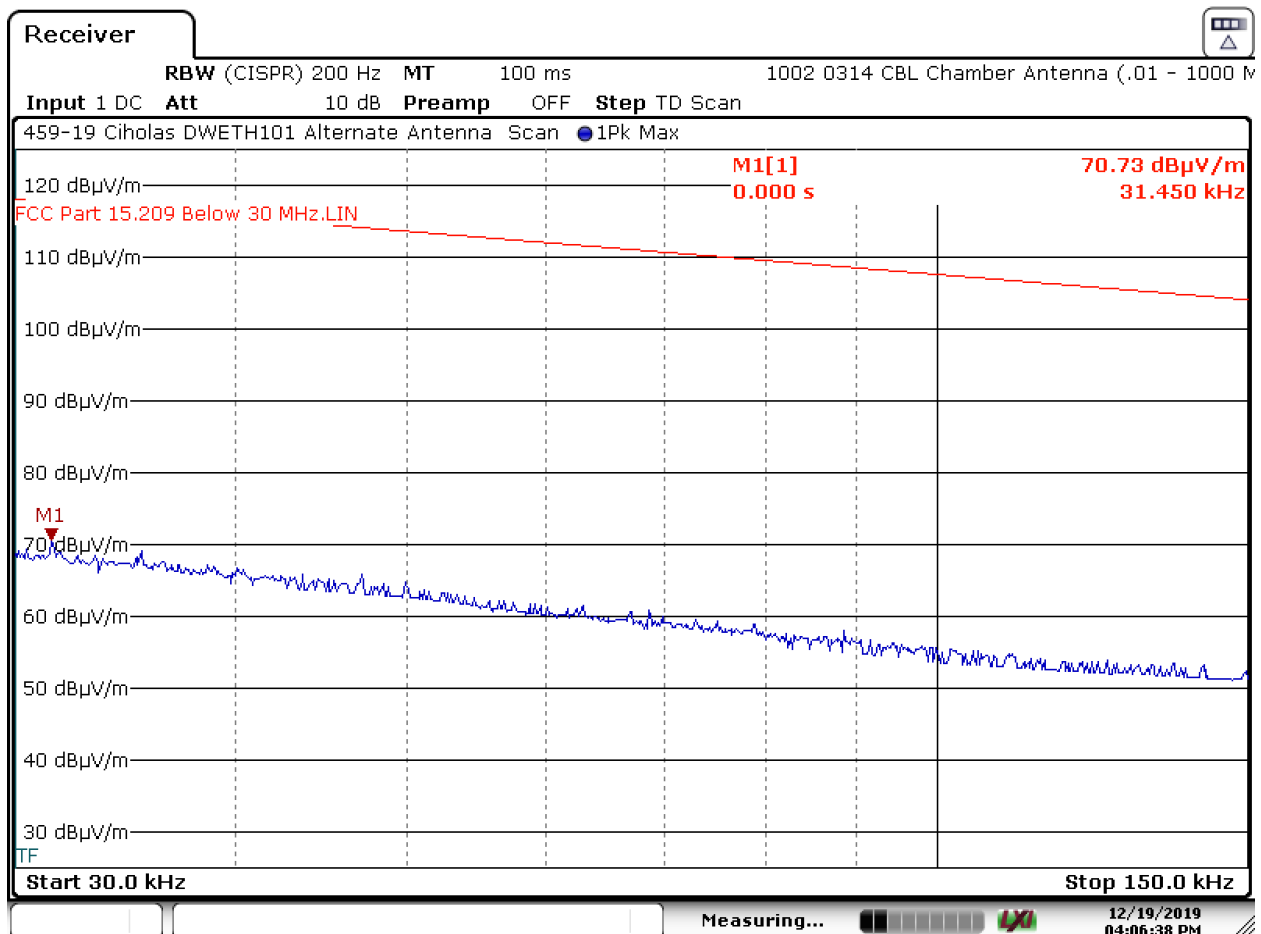
6. Measurement Data (continued)

6.4. Spurious Radiated Emissions (15.250 (d) (5), 15.209, RSS-220 3.4 continued)

6.4.1. 30 kHz to 960 MHz, measured at 3 Meters

The device was prescreened in our 3 Meter Semi-Anechoic Chamber. There were no measurable emissions below 960 MHz on our 3 Meter OATS.

6.4.1.1 Parallel Measurement Antenna – 30 to 150 kHz



Date: 19.DEC.2019 16:06:39

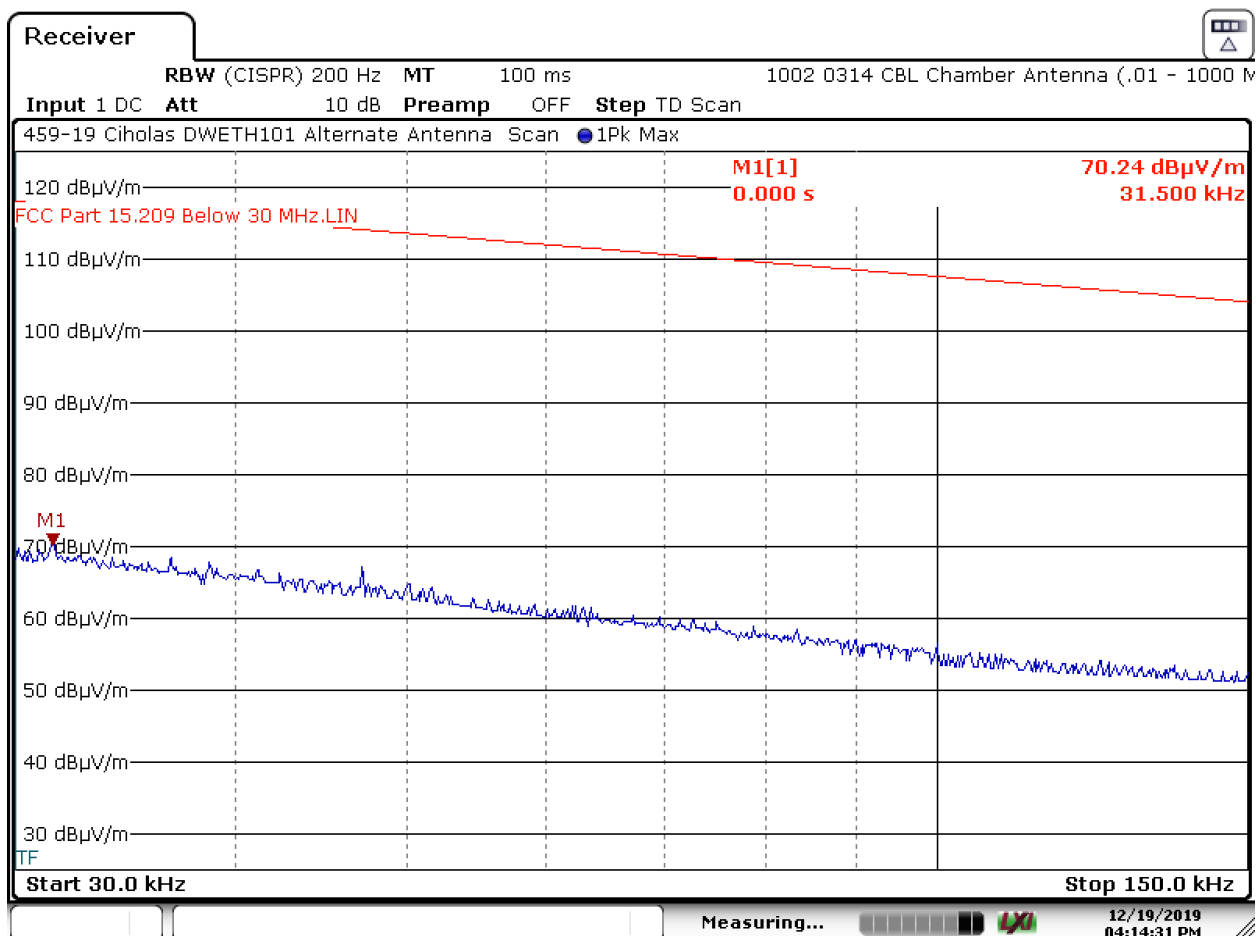
6. Measurement Data (continued)

6.4. Spurious Radiated Emissions (15.250 (d) (5), 15.209, RSS-220 3.4 continued)

6.4.1. 30 kHz to 960 MHz, measured at 3 Meters

The device was prescreened in our 3 Meter Semi-Anechoic Chamber. There were no measurable emissions below 960 MHz on our 3 Meter OATS.

6.4.1.2 Perpendicular Measurement Antenna – 30 to 150 kHz



Date: 19.DEC.2019 16:14:32

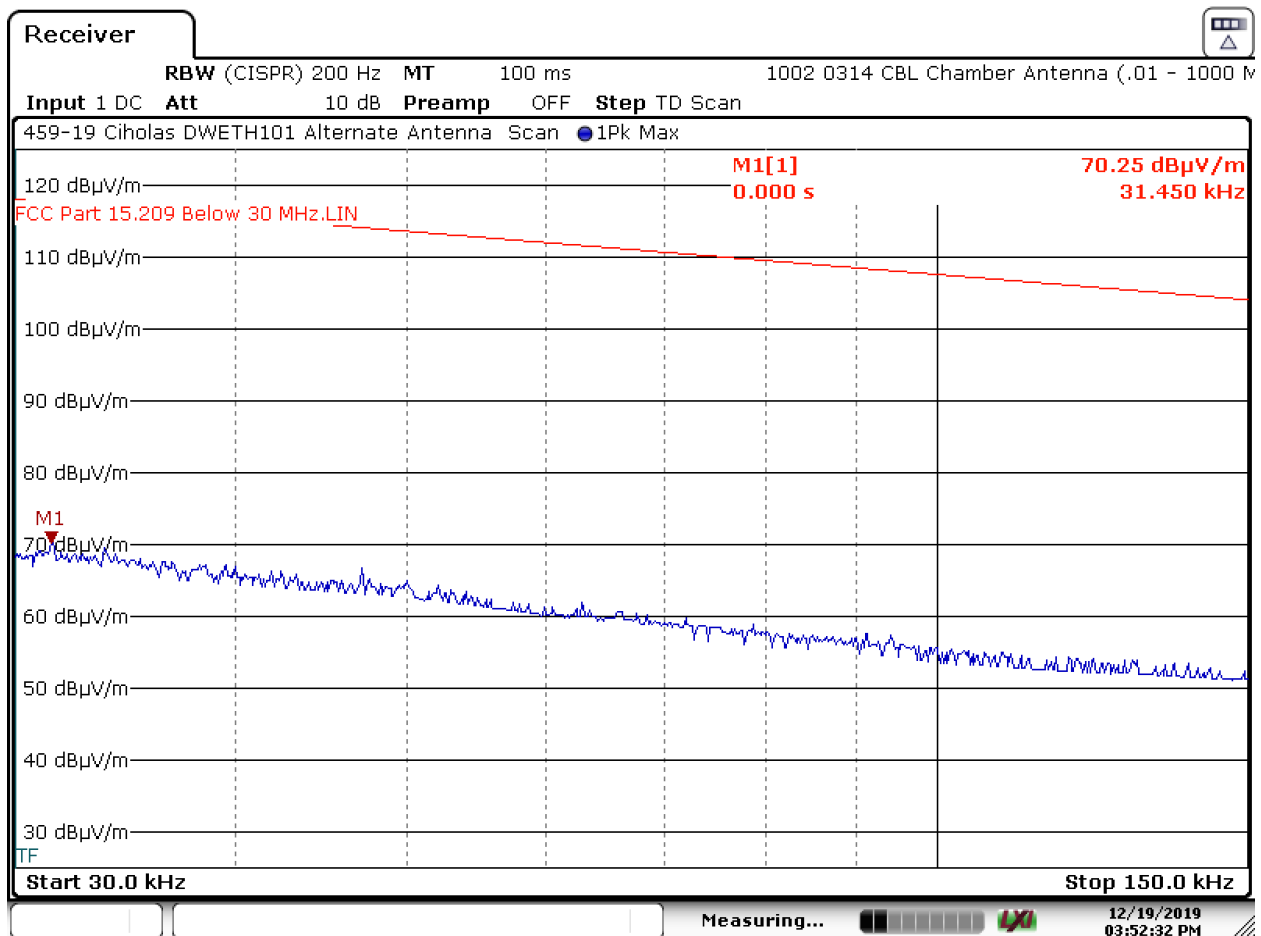
6. Measurement Data (continued)

6.4. Spurious Radiated Emissions (15.250 (d) (5), 15.209, RSS-220 3.4 continued)

6.4.1. 30 kHz to 960 MHz, measured at 3 Meters

The device was prescreened in our 3 Meter Semi-Anechoic Chamber. There were no measurable emissions below 960 MHz on our 3 Meter OATS.

6.4.1.3 Ground Parallel Measurement Antenna – 30 to 150 kHz



Date: 19.DEC.2019 15:52:32

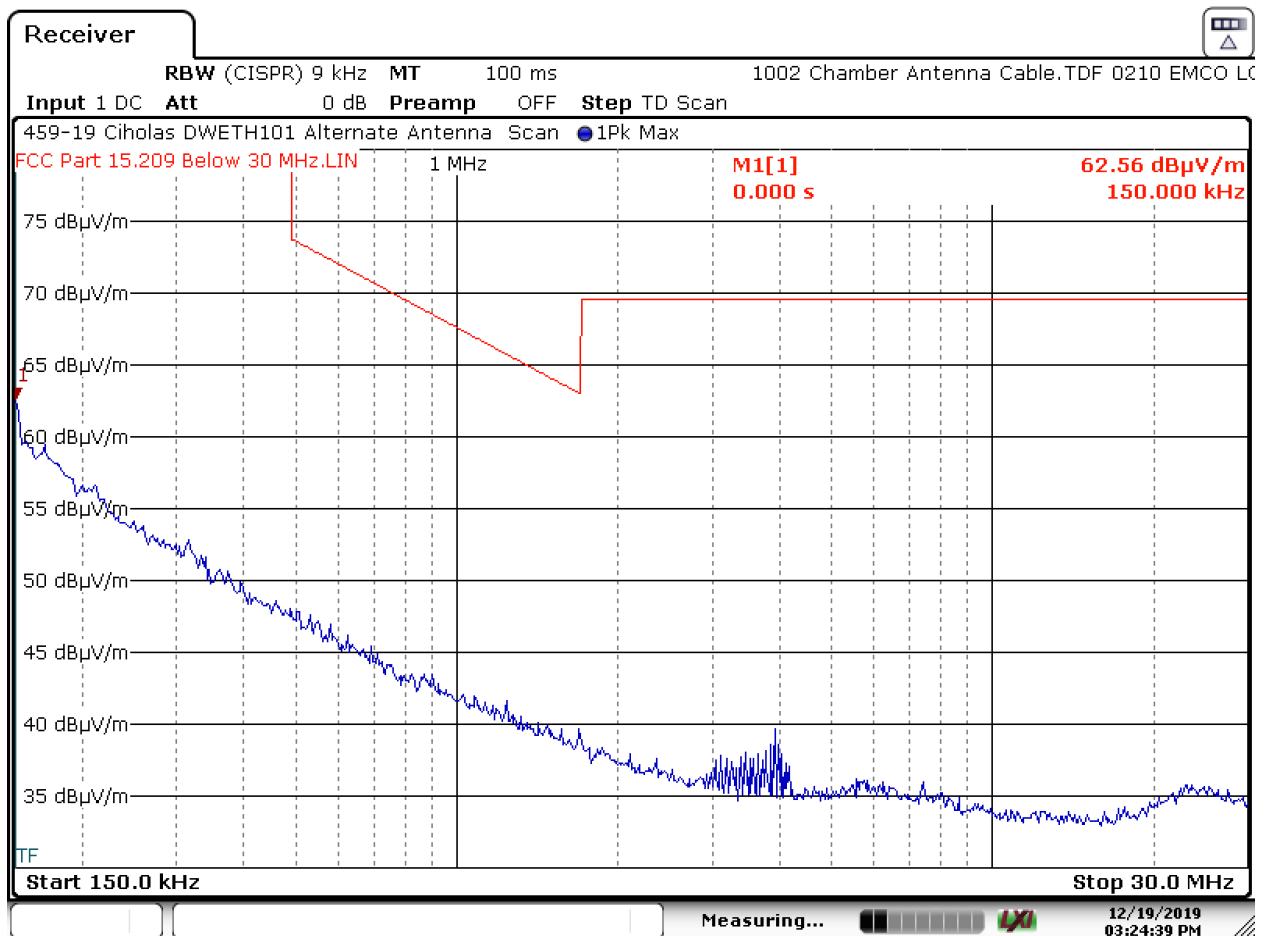
6. Measurement Data (continued)

6.4. Spurious Radiated Emissions (15.250 (d) (5), 15.209, RSS-220 3.4 continued)

6.4.1. 30 kHz to 960 MHz, measured at 3 Meters

The device was prescreened in our 3 Meter Semi-Anechoic Chamber. There were no measurable emissions below 960 MHz on our 3 Meter OATS.

6.4.1.4 Parallel Measurement Antenna – 150 kHz to 30 MHz



Date: 19.DEC.2019 15:24:40

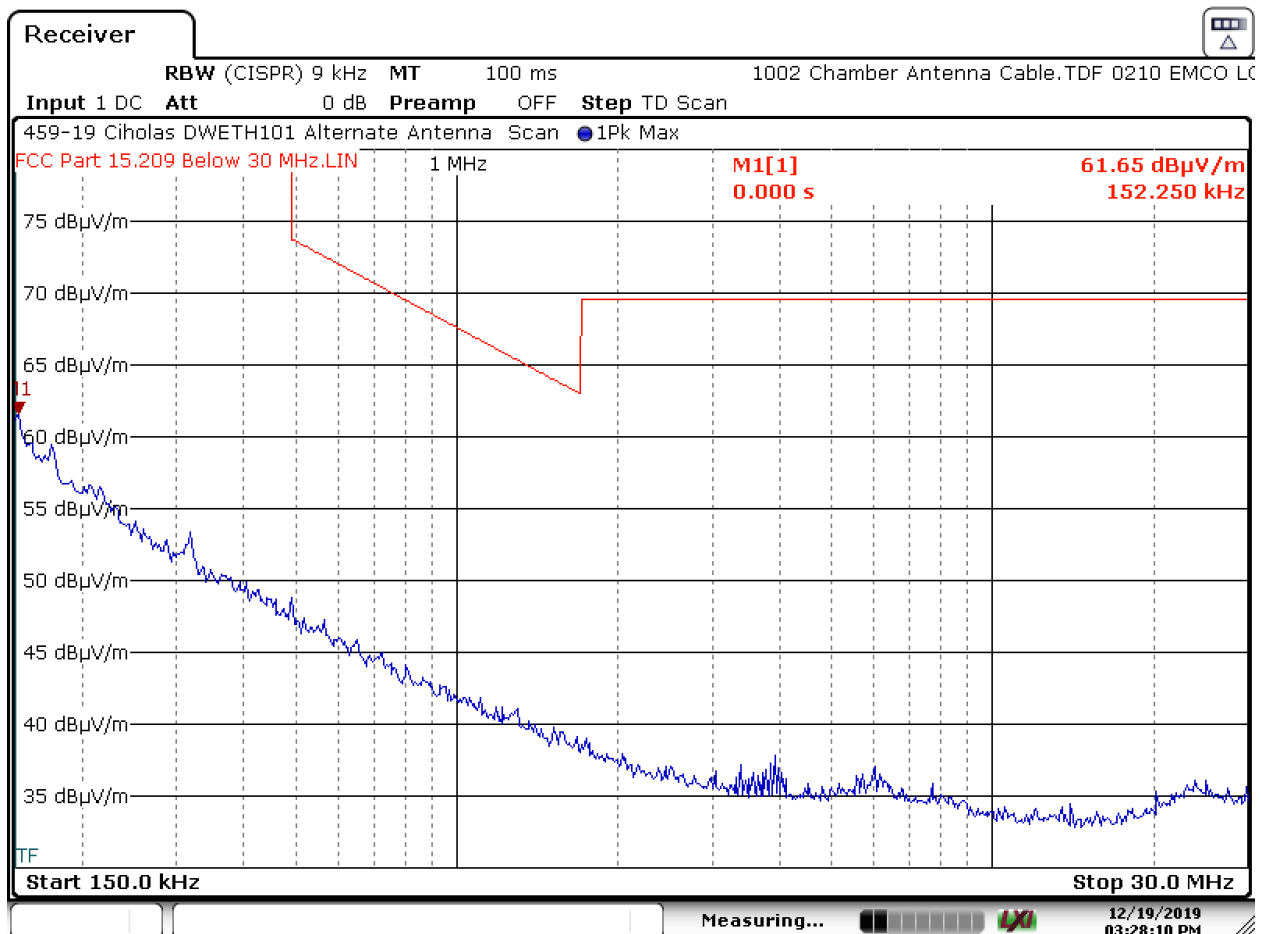
6. Measurement Data (continued)

6.4. Spurious Radiated Emissions (15.250 (d) (5), 15.209, RSS-220 3.4 continued)

6.4.1. 30 kHz to 960 MHz, measured at 3 Meters

The device was prescreened in our 3 Meter Semi-Anechoic Chamber. There were no measurable emissions below 960 MHz on our 3 Meter OATS.

6.4.1.5 Perpendicular Measurement Antenna – 150 kHz to 30 MHz



Date: 19.DEC.2019 15:28:10

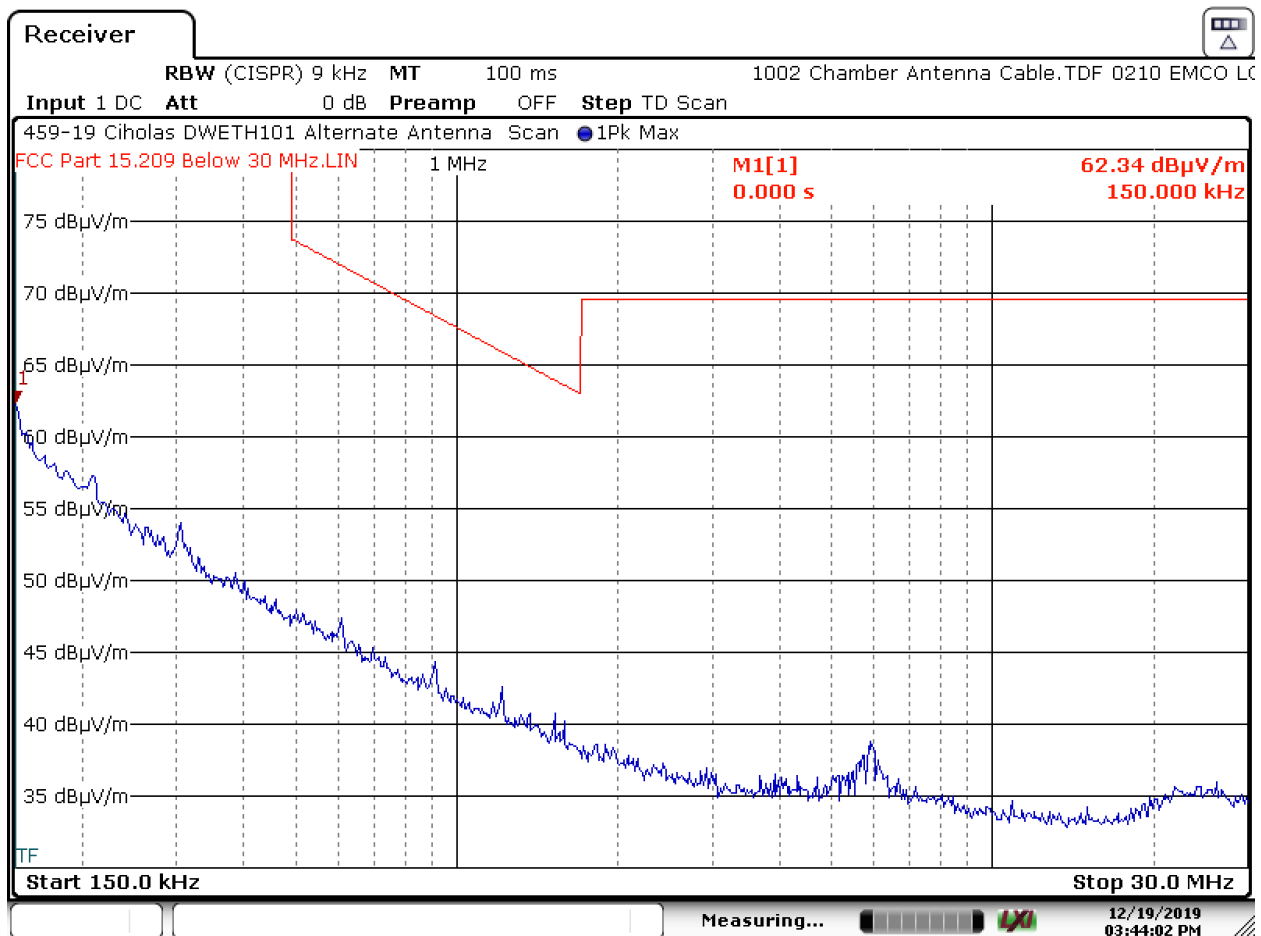
6. Measurement Data (continued)

6.4. Spurious Radiated Emissions (15.250 (d) (5), 15.209, RSS-220 3.4 continued)

6.4.1. 30 kHz to 960 MHz, measured at 3 Meters

The device was prescreened in our 3 Meter Semi-Anechoic Chamber. There were no measurable emissions below 960 MHz on our 3 Meter OATS.

6.4.1.6 Ground Parallel Measurement Antenna – 150 kHz to 30 MHz



Date: 19.DEC.2019 15:44:02

6. Measurement Data (continued)

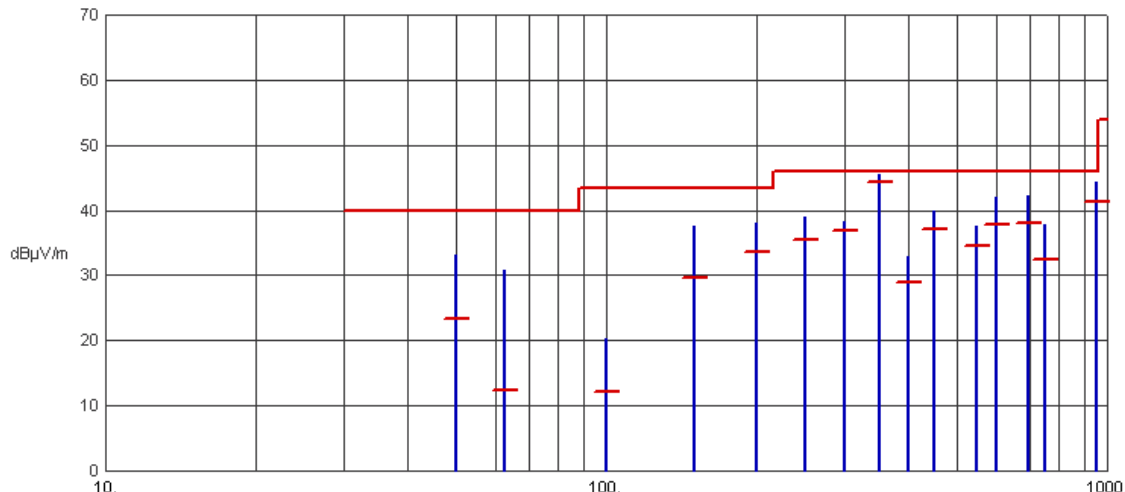
6.4. Spurious Radiated Emissions (15.250 (d) (5), 15.209, RSS-220 3.4 continued)

6.4.1. 30 kHz to 960 MHz, measured at 3 Meters

6.4.1.7 Horizontal Polarity – 30 to 960 MHz

Test No.: 459-19, Radiated Emissions - Horizontal Polarity

FCC, Class B



Frequency (MHz)	Pk Amp (dBμV/m)	QP Amp (dBμV/m)	QP Limit (dBμV/m)	Margin (dB)	Ant Ht (cm)	Table (Deg)	Comments
50.0000	33.22	23.40	40.00	-16.60	N/A	N/A	
62.7000	30.81	12.41	40.00	-27.59	N/A	N/A	
100.0000	20.24	12.06	43.50	-31.44	N/A	N/A	
150.0000	37.53	29.69	43.50	-13.81	N/A	N/A	
200.0000	38.08	33.70	43.50	-9.80	N/A	N/A	
250.0000	39.08	35.35	46.00	-10.65	N/A	N/A	
300.0000	38.35	36.80	46.00	-9.20	N/A	N/A	
350.0000	45.44	44.32	46.00	-1.68	N/A	N/A	
400.0000	33.01	28.96	46.00	-17.04	N/A	N/A	
450.0000	39.85	37.13	46.00	-8.87	N/A	N/A	
550.0000	37.57	34.45	46.00	-11.55	N/A	N/A	
600.0000	42.06	37.70	46.00	-8.30	N/A	N/A	
693.7200	42.20	37.95	46.00	-8.05	N/A	N/A	
750.0010	37.75	32.50	46.00	-13.50	N/A	N/A	
950.0000	44.42	41.32	46.00	-4.68	N/A	N/A	

6. Measurement Data (continued)

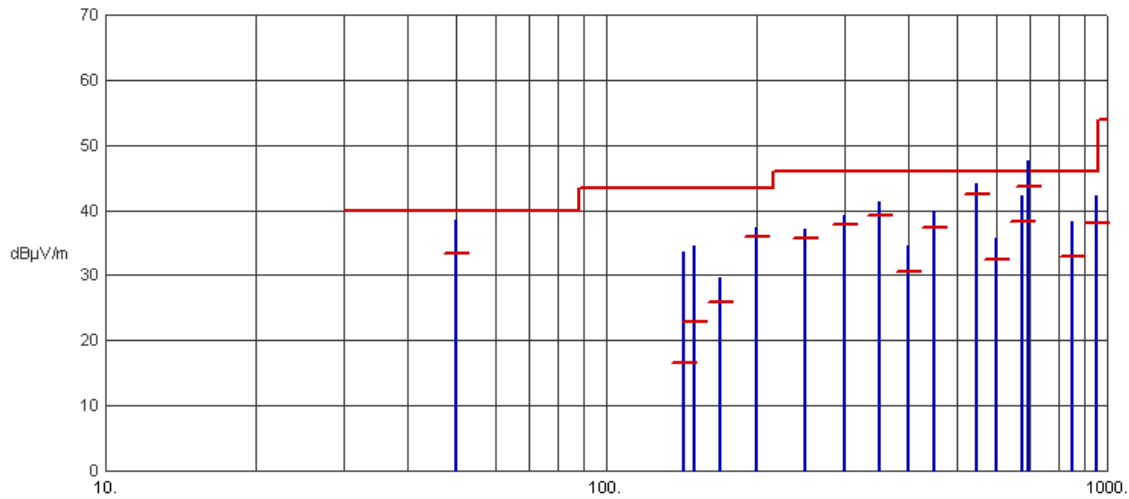
6.4. Spurious Radiated Emissions (15.250 (d) (5), 15.209, RSS-220 3.4 continued)

6.4.1. 30 kHz to 960 MHz, measured at 3 Meters

6.4.1.8 Vertical Polarity – 30 to 960 MHz

Test No.: 459-19, Radiated Emissions - Vertical Polarity

FCC, Class B

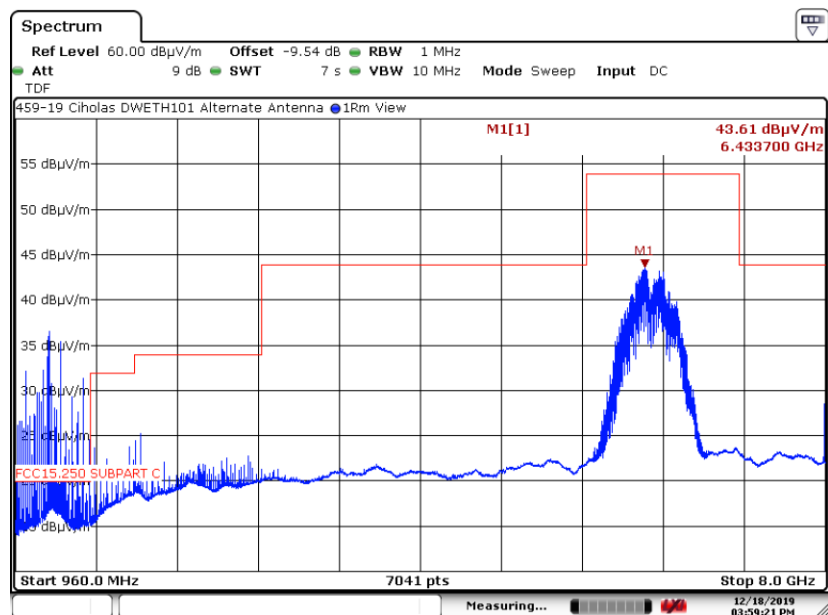


Frequency (MHz)	Pk Amp (dBμV/m)	QP Amp (dBμV/m)	QP Limit (dBμV/m)	Margin (dB)	Ant Ht (cm)	Table (Deg)	Comments
50.0000	38.45	33.40	40.00	-6.60	N/A	N/A	
142.7000	33.55	16.49	43.50	-27.01	N/A	N/A	
150.0000	34.62	22.94	43.50	-20.56	N/A	N/A	
168.7500	29.59	25.87	43.50	-17.63	N/A	N/A	
200.0000	37.44	35.84	43.50	-7.66	N/A	N/A	
250.0000	37.10	35.60	46.00	-10.40	N/A	N/A	
300.0000	39.23	37.83	46.00	-8.17	N/A	N/A	
350.0000	41.26	39.27	46.00	-6.73	N/A	N/A	
400.0000	34.42	30.51	46.00	-15.49	N/A	N/A	
450.0000	39.97	37.34	46.00	-8.66	N/A	N/A	
550.0000	44.06	42.55	46.00	-3.45	N/A	N/A	
600.0000	35.74	32.41	46.00	-13.59	N/A	N/A	
674.9600	42.16	38.27	46.00	-7.73	N/A	N/A	
693.7200	47.68	43.53	46.00	-2.47	N/A	N/A	
850.0000	38.27	32.96	46.00	-13.04	N/A	N/A	
950.0000	42.15	37.94	46.00	-8.06	N/A	N/A	

6. Measurement Data (continued)

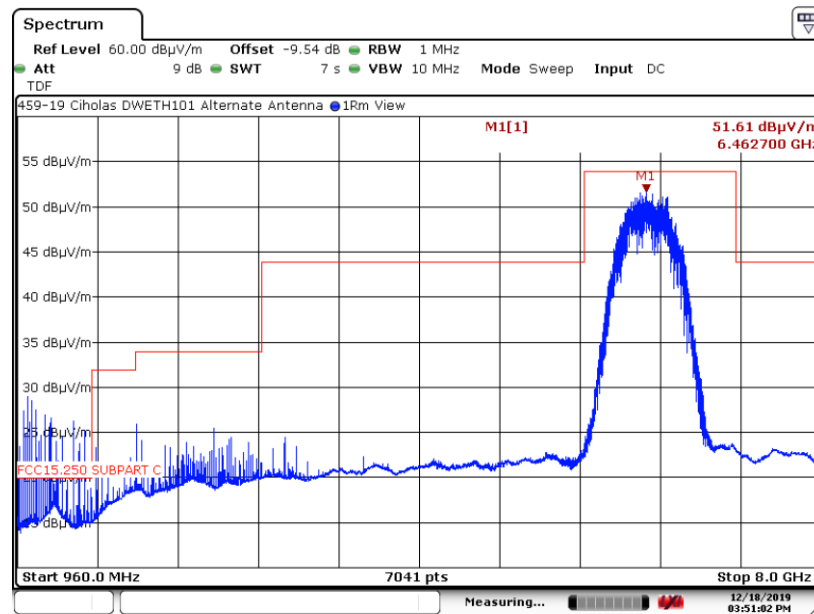
6.4. Spurious Radiated Emissions (15.250 (d) (1), RSS-220 5.3.1(d))

6.4.2. 960 MHz to 8 GHz Horizontal at 1 Meter (16M PRF)



Date: 18.DEC.2019 15:59:21

6.4.3. 960 MHz to 8 GHz Vertical at 1 Meter (16M PRF)

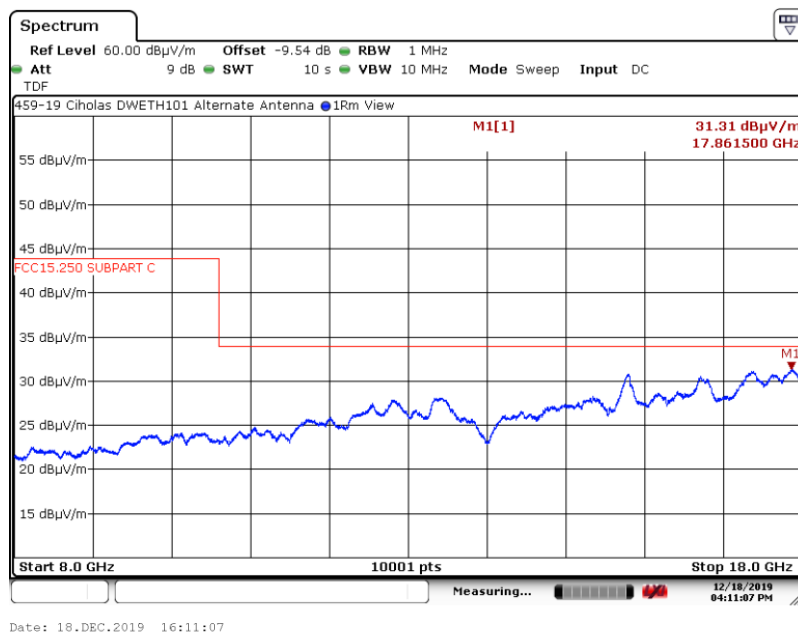


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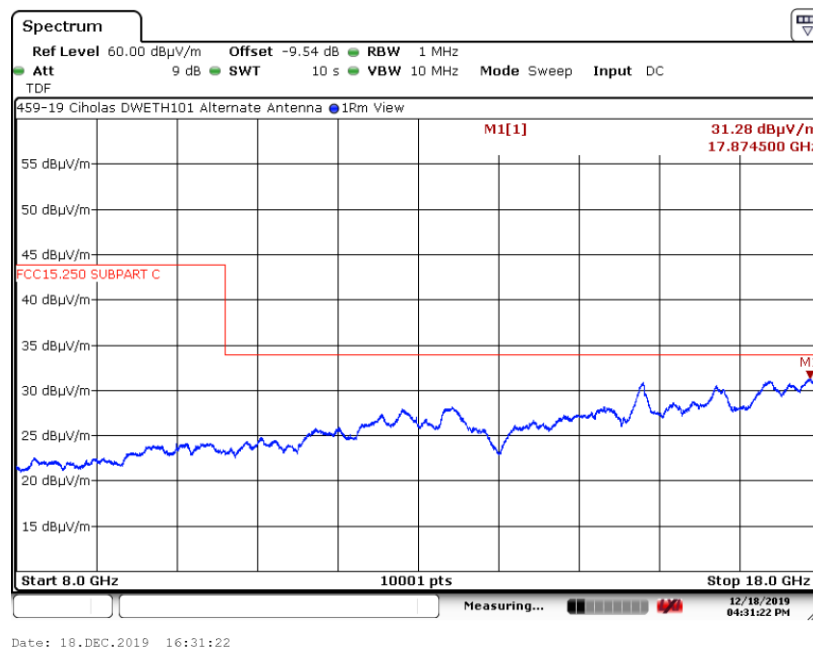
6. Measurement Data (continued)

6.4. Spurious Radiated Emissions (15.250 (d) (1), RSS-220 5.3.1 (d) continued)

6.4.4. 8 to 18 GHz Horizontal at 1 Meter (16M PRF)



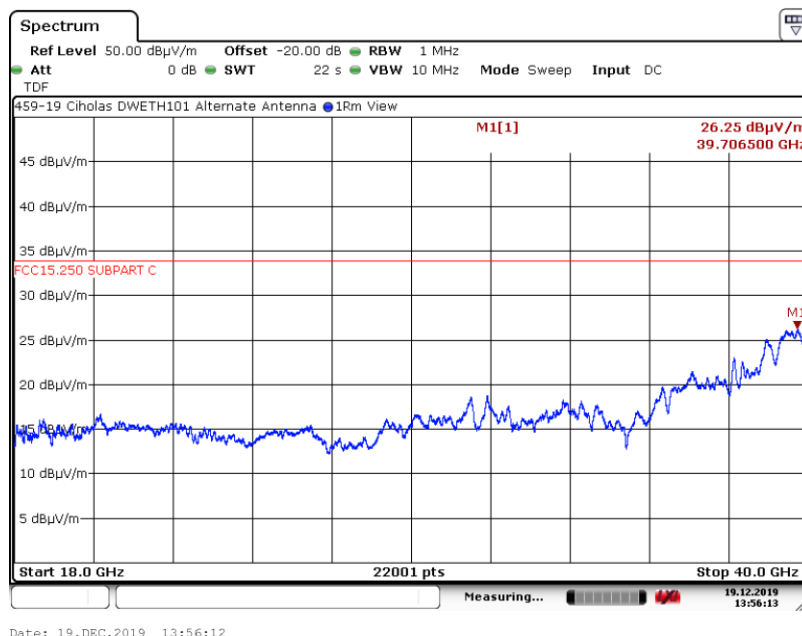
6.4.5. 8 to 18 GHz Vertical at 1 Meter (16M PRF)



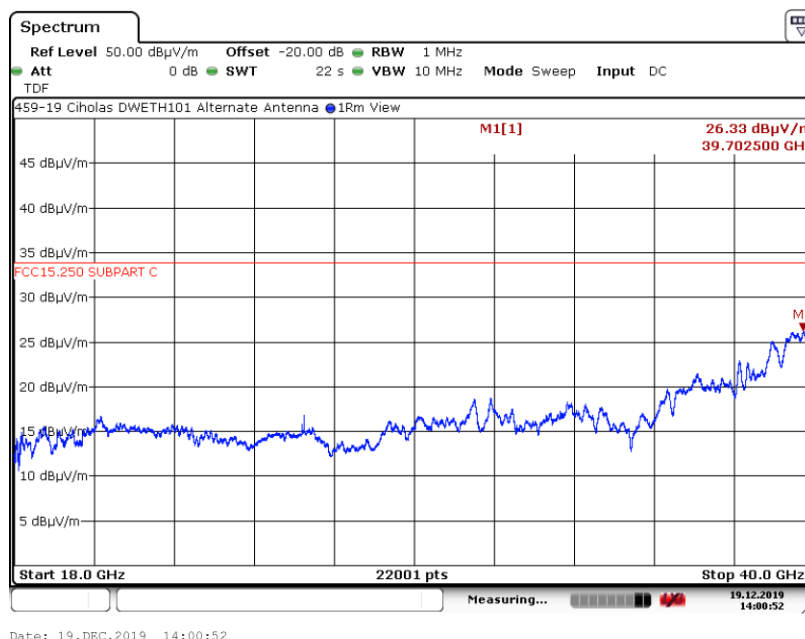
6. Measurement Data (continued)

6.4. Spurious Radiated Emissions (15.250 (d) (1), RSS-220 5.3.1 (d) continued)

6.4.6. 18 to 40 GHz Horizontal at 0.3 Meter (16M PRF)



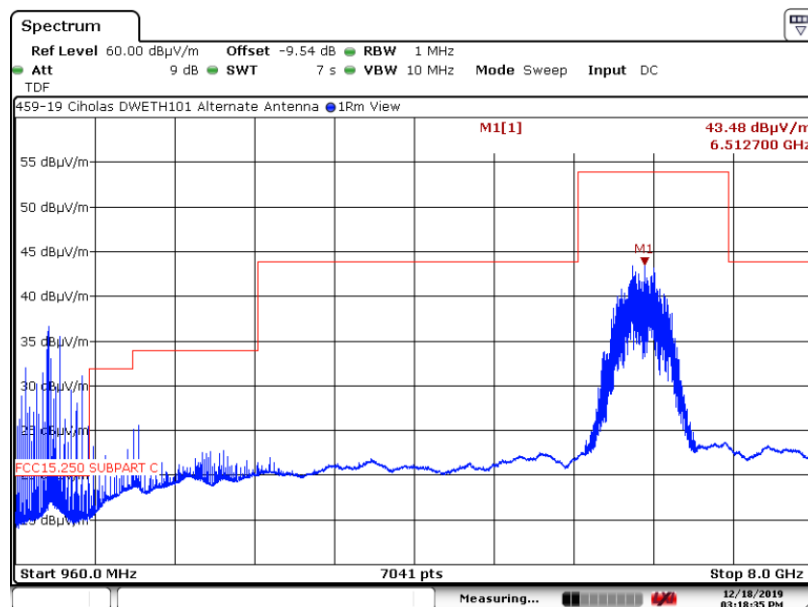
6.4.7. 18 to 40 GHz Vertical at 0.3 Meter (16M PRF)



6. Measurement Data (continued)

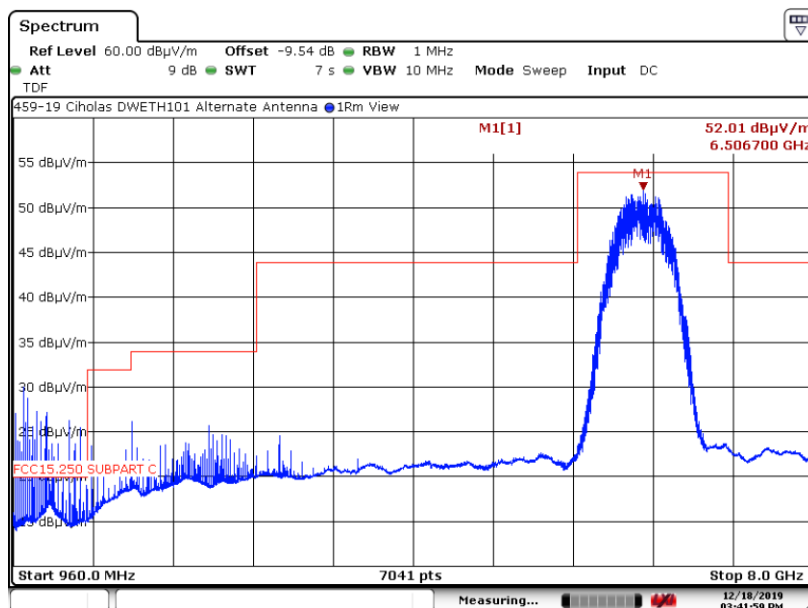
6.4. Spurious Radiated Emissions (15.250 (d) (1), RSS-220 5.3.1(d))

6.4.8. 960 MHz to 8 GHz Horizontal at 1 Meter (64M PRF)



Date: 18.DEC.2019 15:18:34

6.4.9. 960 MHz to 8 GHz Vertical at 1 Meter (64M PRF)

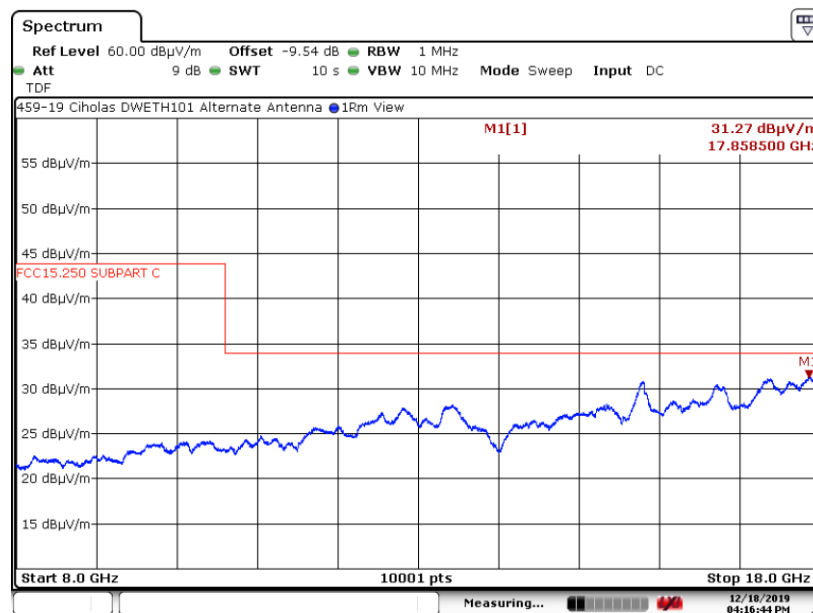


Date: 18.DEC.2019 15:41:59

6. Measurement Data (continued)

6.4. Spurious Radiated Emissions (15.250 (d) (1), RSS-220 5.3.1 (d) continued)

6.4.10. 8 to 18 GHz Horizontal at 1 Meter (64M PRF)



Date: 18.DEC.2019 16:16:44

6.4.11. 8 to 18 GHz Vertical at 1 Meter (64M PRF)

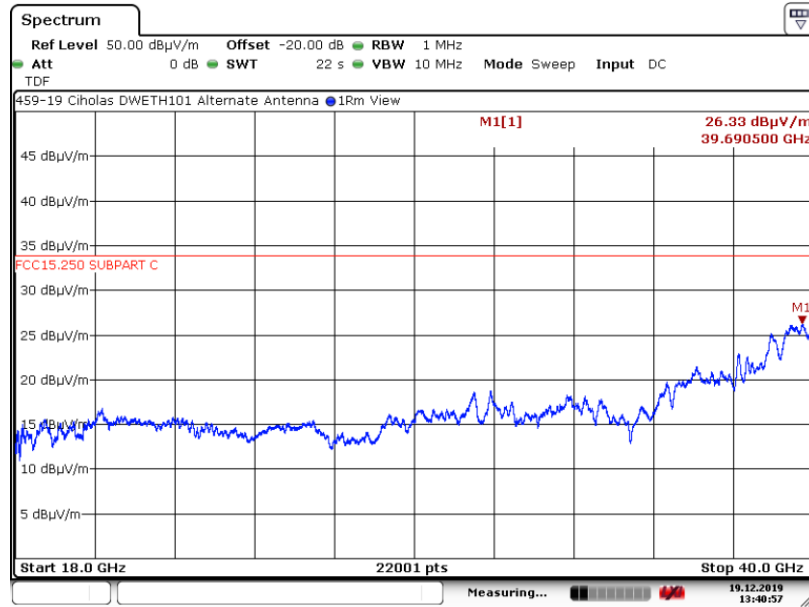


Date: 18.DEC.2019 16:24:00

6. Measurement Data (continued)

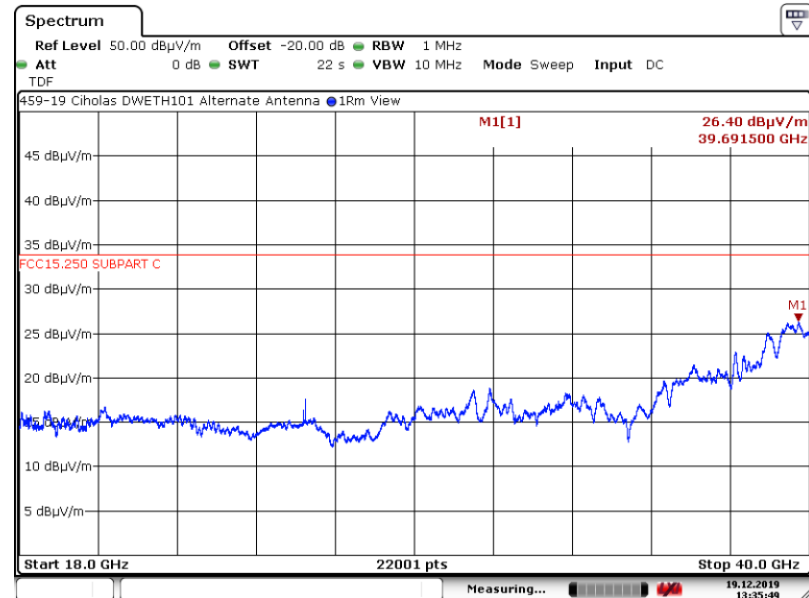
6.4. Spurious Radiated Emissions (15.250 (d) (1), RSS-220 5.3.1 (d) continued)

6.4.12. 18 to 40 GHz Horizontal at 0.3 Meter (64M PRF)



Date: 19.DEC.2019 13:40:57

6.4.13. 18 to 40 GHz Vertical at 0.3 Meter (64M PRF)



Date: 19.DEC.2019 13:35:49

6. Measurement Data (continued)

6.5. Spurious Radiated Emissions in GPS Bands (15.250 (d) (2), RSS-220 5.3.1 (e))

Requirement: In addition to the radiated emission limits specified in the table in paragraph (d) of this section, UWB transmitters operating under the provisions of this section shall not exceed the following average limits when measured using a resolution bandwidth of no less than 1 kHz:

Frequency (MHz)	EIRP (dBm)	EIRP at 3 Meters (dBμV/m)
1164 - 1240	-85.3	9.9
1559 - 1610	-85.3	9.9

6.5.1. Measurement & Equipment Setup

EMI Receiver IF Bandwidth: 1 kHz
EMI Receiver Avg Bandwidth: 10 kHz
Detector Function: RMS

6.5.2. Test Procedure

Test measurements were made in accordance with ANSI C63.10:2013, American National Standard for Testing Unlicensed Wireless Devices.

6.5.3. 1164 to 1240 MHz & 1559 to 1610 MHz

There were no broadband emissions related to the UWB transmitter. Measured signals were narrowband and related to the microprocessor / clocks and do not fall under the requirements of this section. At 3 Meters the -85.3 dBm limit is converted to a field strength limit of 9.9 dBuV/m using a distance correction factor of 95.2.

A distance correction factor of -9.54 dB was entered into the analyzer as an offset since the measurements were made at 1 meter.

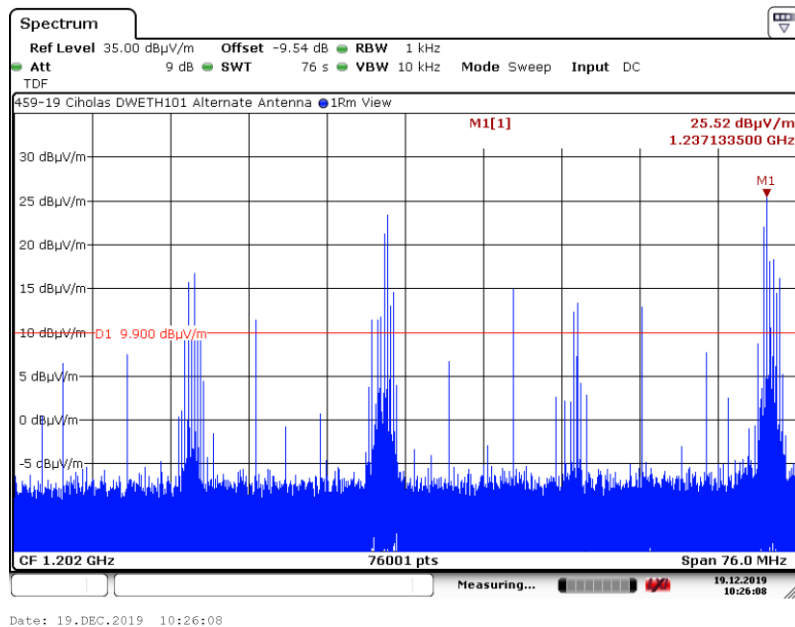
Note: Narrow band emissions that are over the limit are created by the digital communications between the processor and the UWB chipset and are subjected to the limits of 15.209.

6. Measurement Data (continued)

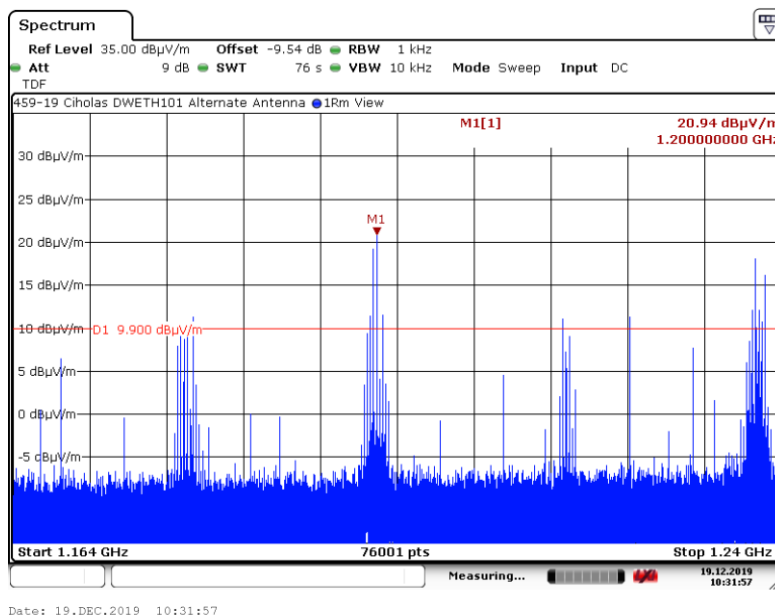
6.5. Spurious Radiated Emissions in GPS Bands (15.250 (d) (2), RSS-220 5.3.1 (e))

6.5.2 1164 to 1240 MHz Band

6.5.2.1 Horizontal Measurement Polarity 1164 to 1240 MHz (16M PRF)



6.5.2.2 Vertical Measurement Polarity 1164 to 1240 MHz (16M PRF)

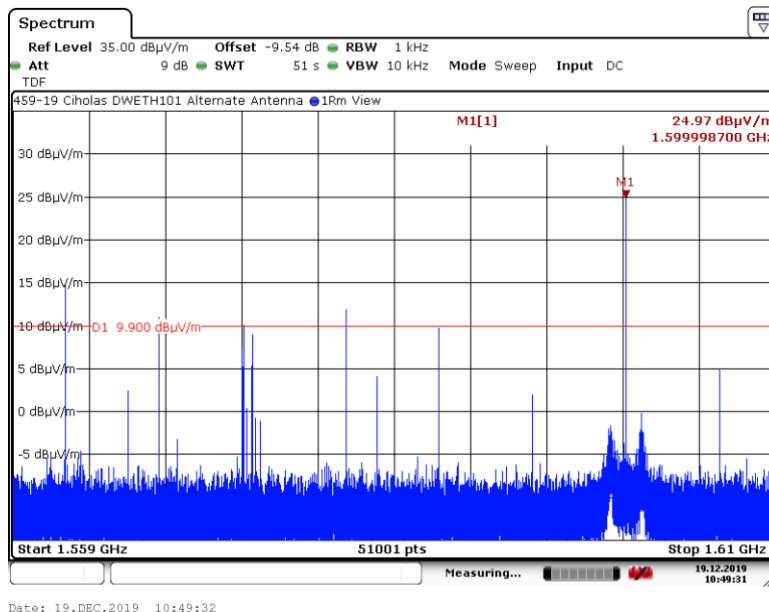


6. Measurement Data (continued)

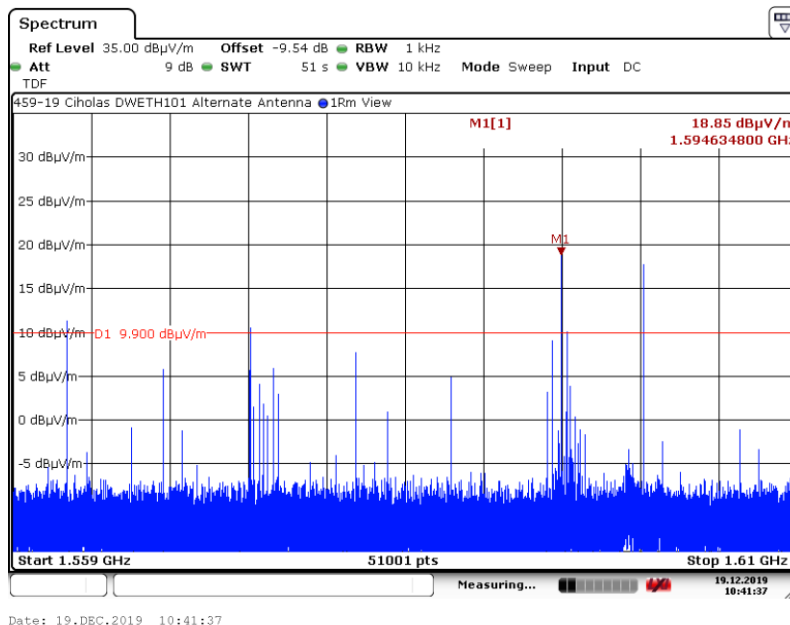
6.5. Spurious Radiated Emissions in GPS Bands (15.250 (d) (2), RSS-220 5.3.1 (e))

6.5.3 1559 to 1610 MHz Band

6.5.3.1 Horizontal Measurement Polarity 1559 to 1610 MHz (16M PRF)



6.5.3.2 Vertical Measurement Polarity 1559 to 1610 MHz (16M PRF)

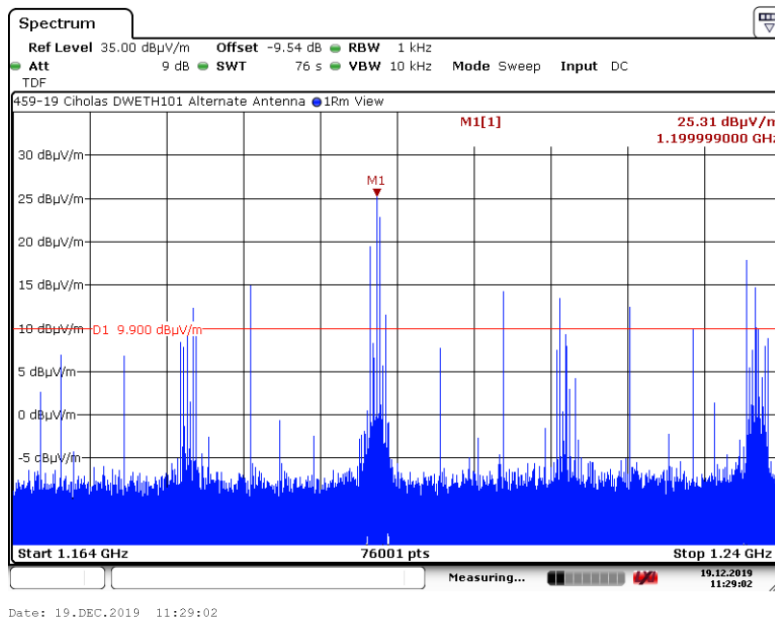


6. Measurement Data (continued)

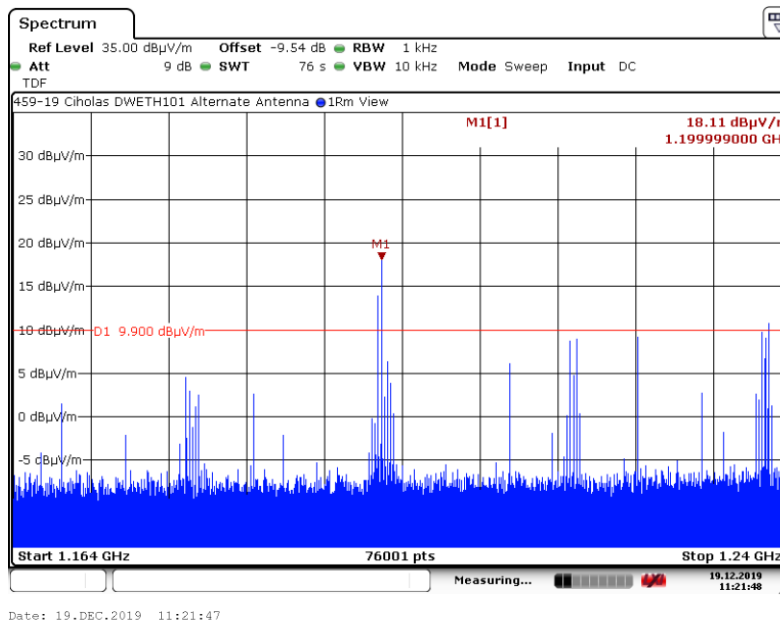
6.5. Spurious Radiated Emissions in GPS Bands (15.250 (d) (2), RSS-220 5.3.1 (e))

6.5.4 1164 to 1240 MHz Band

6.5.4.1 Horizontal Measurement Polarity 1164 to 1240 MHz (64M PRF)



6.5.4.2 Vertical Measurement Polarity 1164 to 1240 MHz (64M PRF)

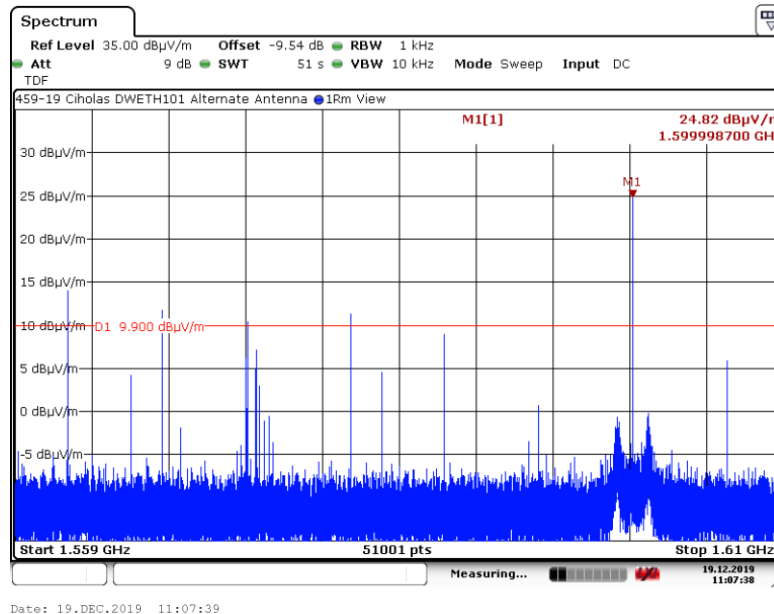


6. Measurement Data (continued)

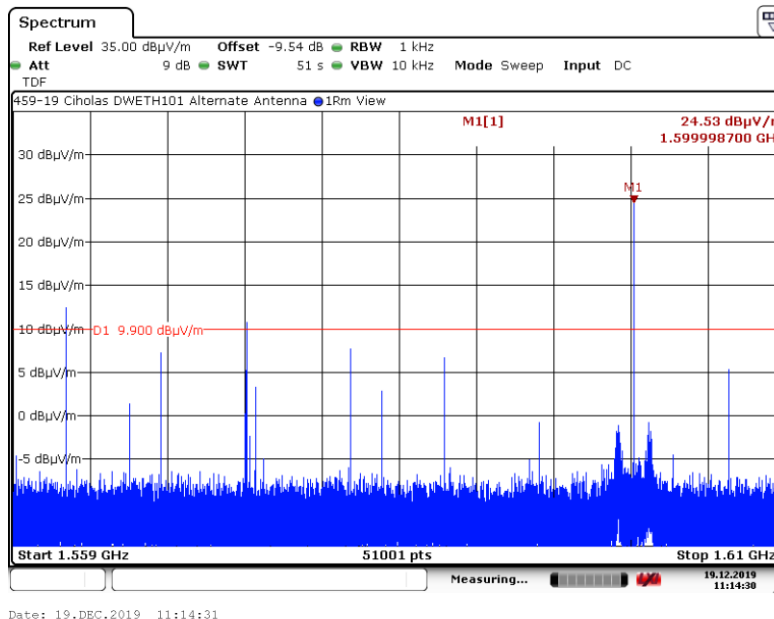
6.5. Spurious Radiated Emissions in GPS Bands (15.250 (d) (2), RSS-220 5.3.1 (e))

6.5.5 1559 to 1610 MHz Band

6.5.5.1 Horizontal Measurement Polarity 1559 to 1610 MHz (64M PRF)



6.5.5.2 Vertical Measurement Polarity 1559 to 1610 MHz (64M PRF)



6. Measurement Data (continued)**6.6. RMS Power in a 1 MHz Bandwidth (15.250 (d) (1), RSS-220 5.3.1 (d))**

Requirement: The radiated emissions above 960 MHz from a device operating under the provisions of this section shall not exceed the following average limits when measured using a resolution bandwidth of 1 MHz:

The RMS average measurement is based on the use of a spectrum analyzer with a resolution bandwidth of 1 MHz, an RMS detector, and a 1 millisecond or less averaging time.

The EIRP in terms of dBm, can be converted to a field strength, in dB μ V/m at 3 Meters by adding 95.2.

Frequency (MHz)	EIRP (dBm)	EIRP at 3 Meters (dB μ V/m)
5925 - 7250	-41.3	53.9

Frequency Range:	6 to 7 GHz
Measurement Distance:	3 Meters
EMI Receiver IF Bandwidth:	1 MHz
EMI Receiver Avg Bandwidth	10 MHz
Detector Function:	RMS 1 mS Average

6. Measurement Data (continued)

6.6. RMS Power in a 1 MHz Bandwidth (15.250 (d) (1), RSS-220 5.3.1 (d))

Requirement: The limit for operation in the 5925 to 7250 MHz band is -41.3 dBm EIRP.

Frequency (GHz)	Amplitude ¹ (dBμV/m)	Limit (dBμV/m)	Margin (dB)	Ant Polarity H/V	Ant Height cm	Turntable Azimuth Deg	Result
6.5649	53.48	53.90	-0.42	V	181	250	Compliant

Notes: ¹ Antenna Factor (AF), Cable Factor (CF) and External Preamplifier Gain (PAG) have been entered into the analyzer as transducer factors.

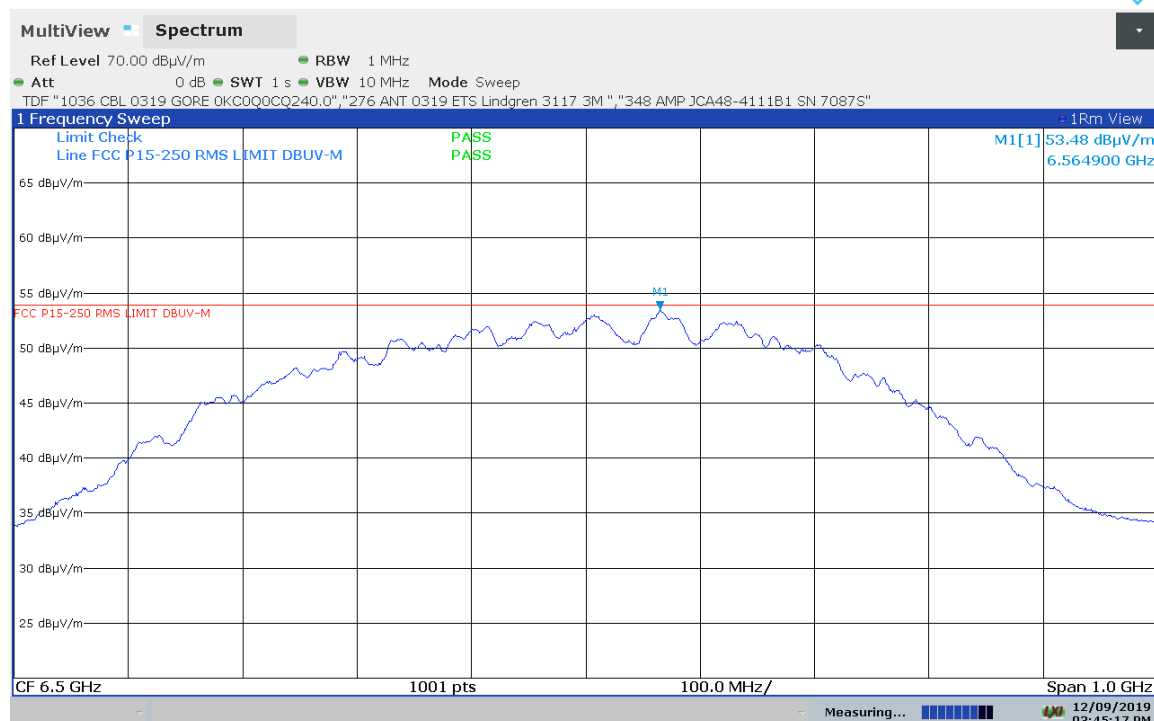
Equation (22) from ANSI C63.10-2013, $EIRP = E_{meas} + 20 \log(d_{meas}) - 104.7$; $d_{meas} = 3$

$EIRP (dBm) = E_{meas} (dBμV/m) - 95.2$

Frequency (GHz)	Amplitude ¹ (dBm)	Limit (dBm)	Margin (dB)	Ant Polarity H/V	Ant Height cm	Turntable Azimuth Deg	Result
6.5649	-41.72	-41.30	-0.42	V	181	250	Compliant

6.6.1. Plot of RMS Power at 3 Meters (16M PRF)

459-19 Ciholas DWETH101



03:45:18 PM 12/09/2019

6. Measurement Data (continued)

6.6. RMS Power in a 1 MHz Bandwidth (15.250 (d) (1), RSS-220 5.3.1 (d))

Requirement: The limit for operation in the 5925 to 7250 MHz band is -41.3 dBm EIRP.

Frequency (GHz)	Amplitude ¹ (dBμV/m)	Limit (dBμV/m)	Margin (dB)	Ant Polarity H/V	Ant Height cm	Turntable Azimuth Deg	Result
6.5649	53.40	53.90	-0.50	V	181	250	Compliant

Notes: ¹ Antenna Factor (AF), Cable Factor (CF) and External Preamplifier Gain (PAG) have been entered into the analyzer as transducer factors.

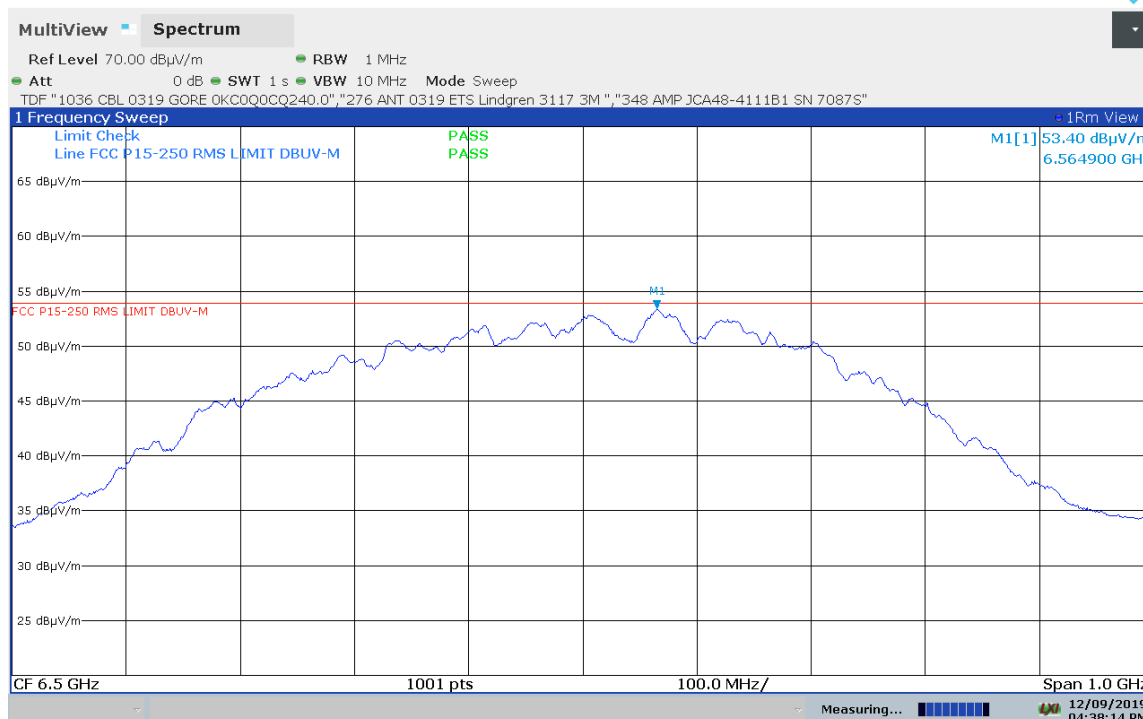
Equation (22) from ANSI C63.10-2013, $EIRP = E_{meas} + 20 \log(d_{meas}) - 104.7$; $d_{meas} = 3$

$EIRP (dBm) = E_{meas} (dBμV/m) - 95.2$

Frequency (GHz)	Amplitude ¹ (dBm)	Limit (dBm)	Margin (dB)	Ant Polarity H/V	Ant Height cm	Turntable Azimuth Deg	Result
6.5649	-41.80	-41.30	-0.50	V	181	250	Compliant

6.6.2. Plot of RMS Power at 3 Meters (64M PRF)

459-19 Ciholas DWETH101



04:38:15 PM 12/09/2019

6. Measurement Data (continued)**6.7. Peak Emissions in a 50 MHz Bandwidth (15.250 (d) (3), RSS-220 5.3.1 (g))**

Requirement: There is a limit on the peak level of the emissions contained within a 50 MHz bandwidth centered on the frequency at which the highest radiated emission occurs, f_m . That limit is 0 dBm EIRP.

The EIRP in terms of dBm, can be converted to a field strength, in dB μ V/m at 3 Meters by adding 95.2.

Frequency (MHz)	EIRP (dBm)	EIRP at 3 Meters (dB μ V/m)
5925 - 7250	0	95.2

Frequency Range:	6 to 7 GHz
Measurement Distance:	3 Meters
EMI Receiver IF Bandwidth:	50 MHz
EMI Receiver Avg Bandwidth	80 MHz
Detector Function:	Peak, Max Held

6. Measurement Data (continued)

6.7. Peak Emissions in a 50 MHz Bandwidth (15.250 (d) (3), RSS-220 5.3.1 (g))

Requirement: There is a limit on the peak level of the emissions contained within a 50 MHz bandwidth centered on the frequency at which the highest radiated emission occurs, f_M . That limit is 0 dBm EIRP.

Frequency (GHz)	Amplitude ¹	Limit	Margin	Ant Polarity	Ant Height	Turntable	Result
	(dBμV/m)	(dBμV/m)	(dB)	H/V	cm	Deg	
6.489	91.18	95.20	-4.02	V	181	250	Compliant

Notes: ¹ Antenna Factor (AF), Cable Factor (CF) and External Preamplifier Gain (PAG) have been entered into the analyzer as transducer factors.

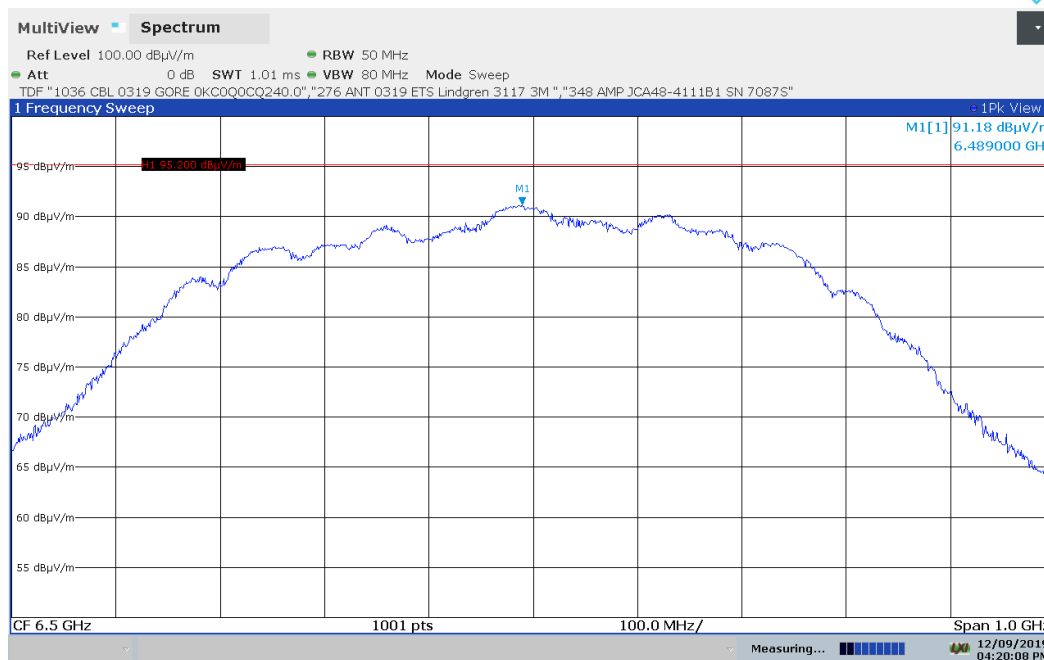
Equation (22) from ANSI C63.10-2013, $EIRP = E_{meas} + 20 \log(d_{meas}) - 104.7$; $d_{meas} = 3$

$EIRP (dBm) = E_{meas} (dBμV/m) - 95.2$

Frequency (GHz)	Amplitude ¹ (dBm)	Limit (dBm)	Margin	Ant Polarity	Ant Height	Turntable Azimuth	Result
	EIRP	EIRP	(dB)	H/V	cm	Deg	
6.489	-4.02	0.00	-4.02	V	181	250	Compliant

6.7.1 Plot of Peak Power at 3 Meters (16M PRF)

459-19 Ciholas DWETH101



04:20:09 PM 12/09/2019

6. Measurement Data (continued)

6.7. Peak Emissions in a 50 MHz Bandwidth (15.250 (d) (3), RSS-220 5.3.1 (g))

Requirement: There is a limit on the peak level of the emissions contained within a 50 MHz bandwidth centered on the frequency at which the highest radiated emission occurs, f_M . That limit is 0 dBm EIRP.

Frequency (GHz)	Amplitude ¹	Limit	Margin	Ant Polarity	Ant Height	Turntable Azimuth	Result
	(dBμV/m)	(dBμV/m)	(dB)	H/V	cm	Deg	
6.501	86.95	95.20	-8.25	V	181	250	Compliant

Notes: ¹ Antenna Factor (AF), Cable Factor (CF) and External Preamplifier Gain (PAG) have been entered into the analyzer as transducer factors.

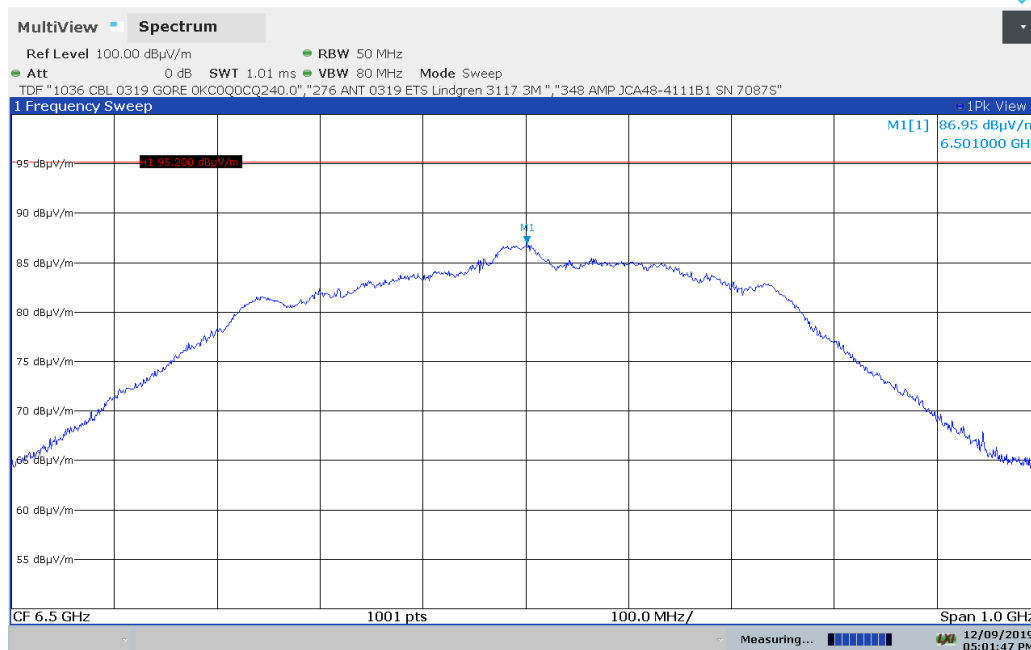
Equation (22) from ANSI C63.10-2013, $EIRP = E_{meas} + 20 \log(d_{meas}) - 104.7$; $d_{meas} = 3$

$EIRP (dBm) = E_{meas} (dBμV/m) - 95.2$

Frequency (GHz)	Amplitude ¹ (dBm)	Limit (dBm)	Margin	Ant Polarity	Ant Height	Turntable Azimuth	Result
	EIRP	EIRP	(dB)	H/V	cm	Deg	
6.501	-8.25	0.00	-8.25	V	181	250	Compliant

6.7.2 Plot of Peak Power at 3 Meters (64M PRF)

459-19 Ciholas DWETH101



05:01:47 PM 12/09/2019

6. Measurement Data (continued)

6.8 Conducted Emissions Test Setup

6.8.1. Regulatory Limit: FCC Part 15.207, RSS-Gen

Frequency Range (MHz)	Limits (dBμV)	
	Quasi-Peak	Average
0.15 to 0.50	66 to 56*	56 to 46*
0.50 to 5.0	56	46
5.0 to 30.0	60	50

* Decreases with the logarithm of the frequency.

6.8.2 Measurement Equipment and Software Used to Perform Test

Device	Manufacturer	Model No.	Serial No.	Cal Due
EMI Receiver	Rohde & Schwarz	ESR7	101156	9/10/2020
LISN	EMCO	3825/2	9109-1860	9/10/2020
Manufacturer	Software Description		Title/Model #	Rev.
Compliance Worldwide	Test Report Generation Software		Test Report Generator	1.0

6.8.3. Measurement & Equipment Setup

Test Date:	12/19/2019
Test Engineer:	Sean Defelice
Site Temperature (°C):	22.2
Relative Humidity (%RH):	45.3
Frequency Range:	0.15 MHz to 30 MHz
EMI Receiver IF Bandwidth:	9 kHz
EMI Receiver Avg Bandwidth:	30 kHz
Detector Functions:	Peak, Quasi-Peak. & Average

6.8.4. Test Procedure

Test measurements were made in accordance with ANSI C63.4-2014, Standard Methods of Measurement of Radio Noise Emissions from Low-Voltage Electrical and Electronics Equipment in the Range of 9 kHz to 40 GHz.

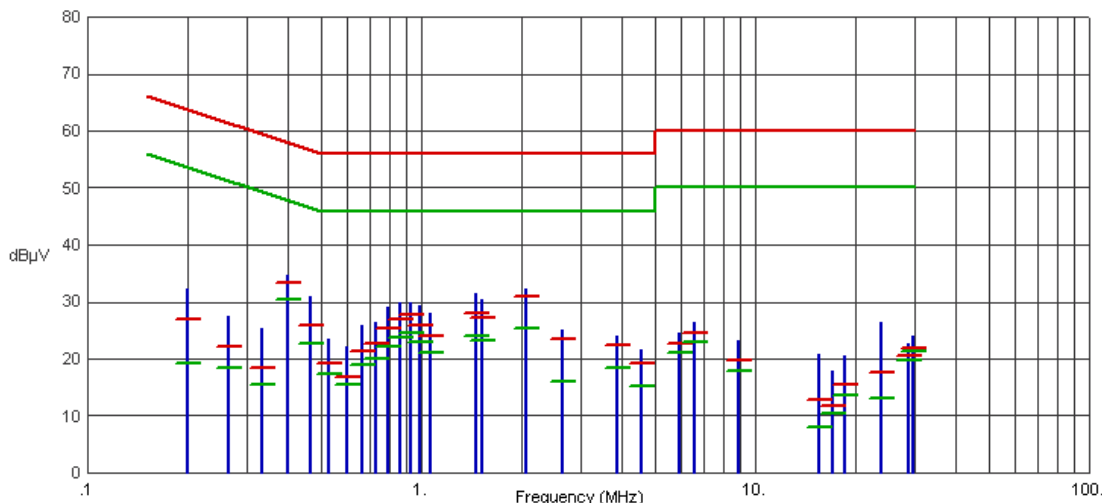
6. Measurement Data (continued)

6.9 Conducted Emissions Test Results

6.9.1 120 Volts, 60 Hz Phase

Test No.: 459-19, 120 Volts, 60 Hz Phase

FCC, Class B



Frequency (MHz)	Pk Amp (dBμV)	QP Amp (dBμV)	QP Limit (dBμV)	QP Margin (dB)	Avg Amp (dBμV)	Avg Limit (dBμV)	Avg Margin (dB)	Comments
.1995	32.31	26.90	63.63	-36.73	19.32	53.63	-34.31	
.2648	27.48	22.25	61.28	-39.03	18.44	51.28	-32.84	
.3323	25.22	18.51	59.39	-40.88	15.39	49.39	-34.00	
.3975	34.55	33.28	57.91	-24.63	30.48	47.91	-17.43	
.4650	31.01	25.79	56.60	-30.81	22.55	46.60	-24.05	
.5303	23.38	19.12	56.00	-36.88	17.43	46.00	-28.57	
.5978	22.24	16.70	56.00	-39.30	15.36	46.00	-30.64	
.6630	25.96	21.46	56.00	-34.54	18.84	46.00	-27.16	
.7283	26.28	22.74	56.00	-33.26	19.92	46.00	-26.08	
.7958	29.00	25.33	56.00	-30.67	22.21	46.00	-23.79	
.8633	29.93	27.06	56.00	-28.94	23.86	46.00	-22.14	
.9285	29.81	27.60	56.00	-28.40	24.59	46.00	-21.41	
.9938	29.20	25.78	56.00	-30.22	22.80	46.00	-23.20	
1.0613	28.03	23.87	56.00	-32.13	20.97	46.00	-25.03	
1.4595	31.43	27.89	56.00	-28.11	23.93	46.00	-22.07	
1.5248	30.44	27.18	56.00	-28.82	23.17	46.00	-22.83	
2.0558	32.32	30.85	56.00	-25.15	25.37	46.00	-20.63	
2.6543	25.08	23.39	56.00	-32.61	16.13	46.00	-29.87	
3.8490	24.08	22.37	56.00	-33.63	18.43	46.00	-27.57	
4.5780	21.68	19.16	56.00	-36.84	15.24	46.00	-30.76	
5.9055	24.62	22.72	60.00	-37.28	21.15	50.00	-28.85	
6.5693	26.37	24.57	60.00	-35.43	23.02	50.00	-26.98	
8.9565	23.23	19.80	60.00	-40.20	17.92	50.00	-32.08	
15.5243	20.87	12.78	60.00	-47.22	7.89	50.00	-42.11	
17.0498	17.77	11.70	60.00	-48.30	10.37	50.00	-39.63	
18.5753	20.49	15.54	60.00	-44.46	13.59	50.00	-36.41	
23.7435	26.35	17.60	60.00	-42.40	13.07	50.00	-36.93	
28.9275	22.69	20.55	60.00	-39.45	19.72	50.00	-30.28	
29.8365	24.13	21.85	60.00	-38.15	21.32	50.00	-28.68	

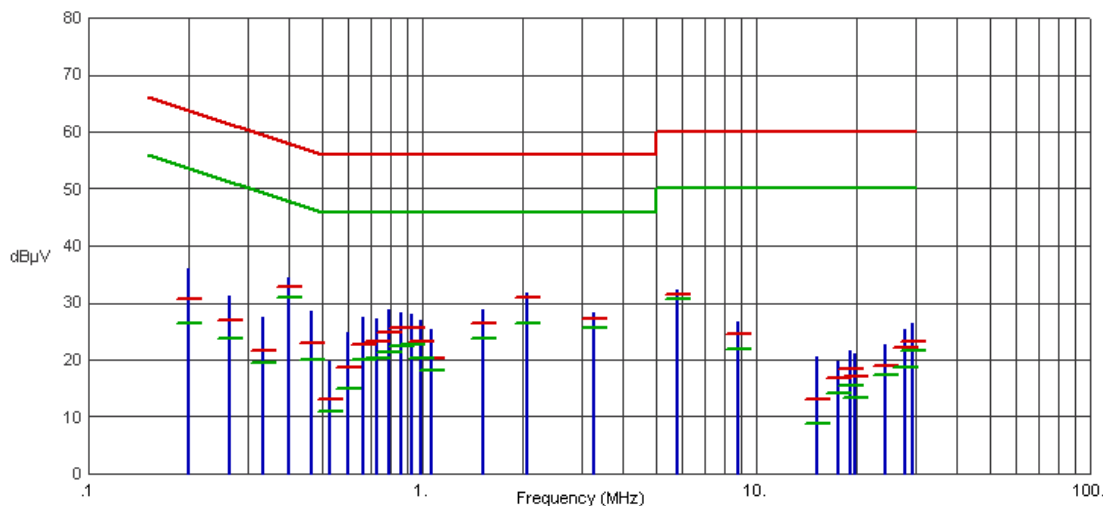
6. Measurement Data (continued)

6.9. Conducted Emissions Test Results (continued)

6.9.2. 120 Volts, 60 Hz Neutral

Test No.: 459-19, 120 Volts, 60 Hz Neutral

FCC, Class B



Frequency (MHz)	Pk Amp (dBμV)	QP Amp (dBμV)	QP Limit (dBμV)	QP Margin (dB)	Avg Amp (dBμV)	Avg Limit (dBμV)	Avg Margin (dB)	Comments
.1995	35.95	30.54	63.63	-33.09	26.51	53.63	-27.12	
.2648	31.16	26.91	61.28	-34.37	23.77	51.28	-27.51	
.3323	27.50	21.57	59.39	-37.82	19.34	49.39	-30.05	
.3975	34.27	32.84	57.91	-25.07	30.88	47.91	-17.03	
.4650	28.41	22.91	56.60	-33.69	20.07	46.60	-26.53	
.5303	19.73	13.16	56.00	-42.84	10.85	46.00	-35.15	
.5978	24.69	18.63	56.00	-37.37	14.98	46.00	-31.02	
.6630	27.51	22.63	56.00	-33.37	19.89	46.00	-26.11	
.7283	27.27	23.14	56.00	-32.86	20.23	46.00	-25.77	
.7958	28.72	24.69	56.00	-31.31	21.37	46.00	-24.63	
.8633	28.38	25.69	56.00	-30.31	22.49	46.00	-23.51	
.9285	28.01	25.72	56.00	-30.28	22.66	46.00	-23.34	
.9938	26.93	23.08	56.00	-32.92	20.29	46.00	-25.71	
1.0613	25.35	20.27	56.00	-35.73	18.00	46.00	-28.00	
1.5248	28.85	26.36	56.00	-29.64	23.63	46.00	-22.37	
2.0580	31.77	30.81	56.00	-25.19	26.48	46.00	-19.52	
3.2528	28.17	27.11	56.00	-28.89	25.49	46.00	-20.51	
5.7750	32.33	31.35	60.00	-28.65	30.68	50.00	-19.32	
8.8283	26.70	24.56	60.00	-35.44	21.97	50.00	-28.03	
15.2633	20.62	13.02	60.00	-46.98	8.88	50.00	-41.12	
17.6573	19.63	16.71	60.00	-43.29	14.11	50.00	-35.89	
19.1805	21.62	18.27	60.00	-41.73	15.47	50.00	-34.53	
19.7858	21.00	17.00	60.00	-43.00	13.29	50.00	-36.71	
24.3533	22.57	18.85	60.00	-41.15	17.32	50.00	-32.68	
28.0095	25.29	22.23	60.00	-37.77	18.59	50.00	-31.41	
29.5328	26.36	23.22	60.00	-36.78	21.48	50.00	-28.52	

6. Measurement Data (continued)

6.10. Public Exposure to Radio Frequency Energy Levels (1.1310)

6.10.1 RF Exposure for devices that operate above 6 GHz (continued)

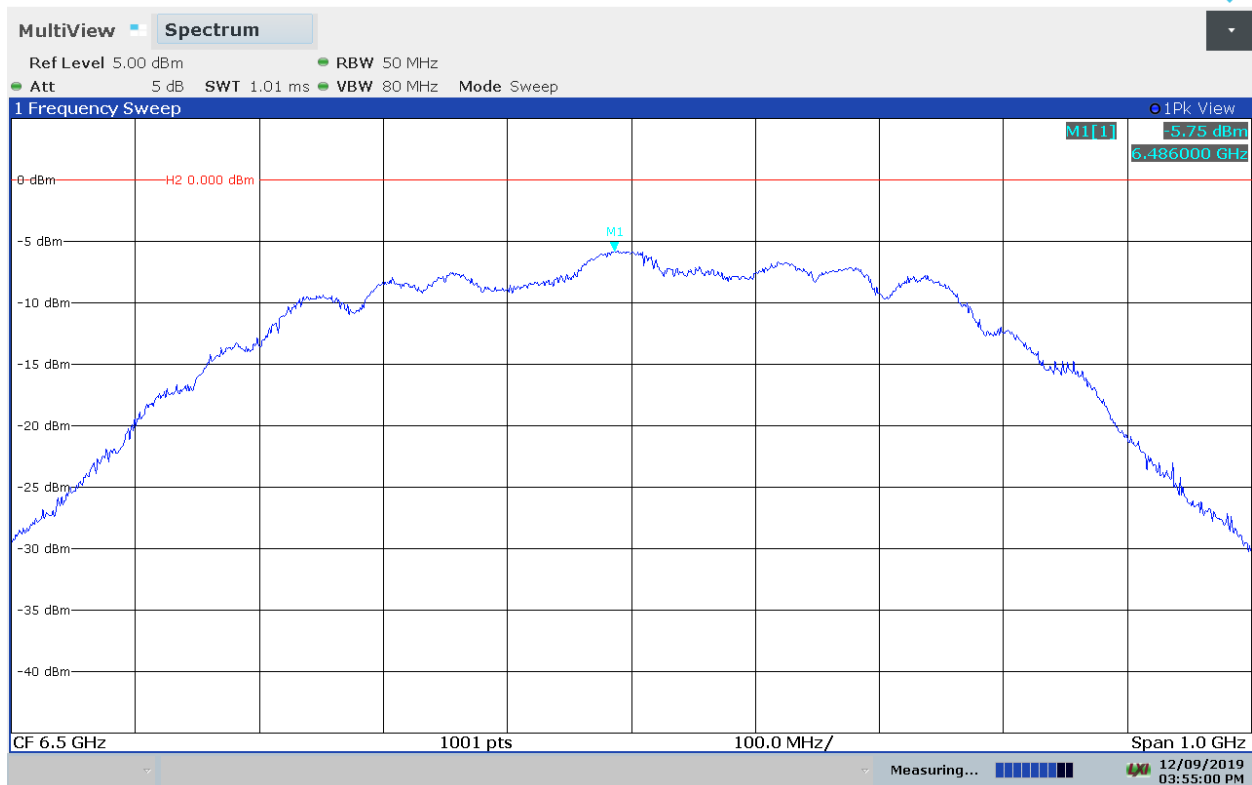
Requirement: TCB Workshop November 2019 RF Exposure Policy Updates dated November 13, 2019, specifically slide 11.

Test exclusion based on 1 mW may be used now with the portable device $f > 6$ GHz FCC MPE power density limits. Maximum time-averaged conducted power irrespective of distance from the body.

Worst Case conducted peak power = **-5.75 dBm or 0.266 mW**

Result: Device is compliant with the Test Exclusion requirement of 1 mW.

459-19 Ciholas DWETH101



03:55:00 PM 12/09/2019

7. Test Site Description

Compliance Worldwide is located at 357 Main Street in Sandown, New Hampshire. The test sites at Compliance Worldwide are used for conducted and radiated emissions testing in accordance with the Federal Communications Commission (FCC) and Industry Canada standards. Through our American Association for Laboratory Accreditation (A2LA) ISO Guide 17025 Accreditation our test sites are designated with the FCC (designation number **US1091**), Industry Canada (file number **IC 3023A-1**) and VCCI (Member number 3168) under registration number A-0274.

Compliance Worldwide is also designated as a Phase 1 CAB under APEC-MRA (US0132) for Australia/New Zealand AS/NZS CISPR 32, Chinese-Taipei (Taiwan) BSMI CNS 13438 and Korea (RRA) KN 11, KN 13, KN 14-1, KN 22, KN 32, KN 61000-6-3, KN 61000-6-4.

The radiated emissions test site is a 3 and 10 meter enclosed open area test site (OATS). Personnel, support equipment and test equipment are located in the basement beneath the OATS ground plane.

The conducted emissions site is part of a 16' x 20' x 12' ferrite tile chamber and uses one of the walls for the vertical ground plane. A second conducted emissions site is also located in the basement of the OATS site with a 2.3 x 2.5 meter ground plane and a 2.4 x 2.4 meter vertical wall.

The radiated emissions test site for measurements above 1GHz is a 3 Meter open area test site (OATS) with a 3.6 by 3.6 meter anechoic absorber floor patch to achieve a quasi-free space measurement environment per ANSI C63.4/C63.10 and CISPR 16-1-4 standards.

The sites are designed to test products or systems 1.5 meters W x 1.5 meters L x 2.0 meters H, floor standing or table top.

8. Test Images

8.1. Spurious and Harmonic Emissions – 30 kHz to 1 GHz Front



8. Test Images

8.2. Spurious and Harmonic Emissions – 30 kHz to 30 MHz Rear



8. Test Images

8.3. Spurious and Harmonic Emissions – 30 MHz to 1 GHz Rear



8. Test Images

8.4. Spurious and Harmonic Emissions – 1 to 18 GHz Front



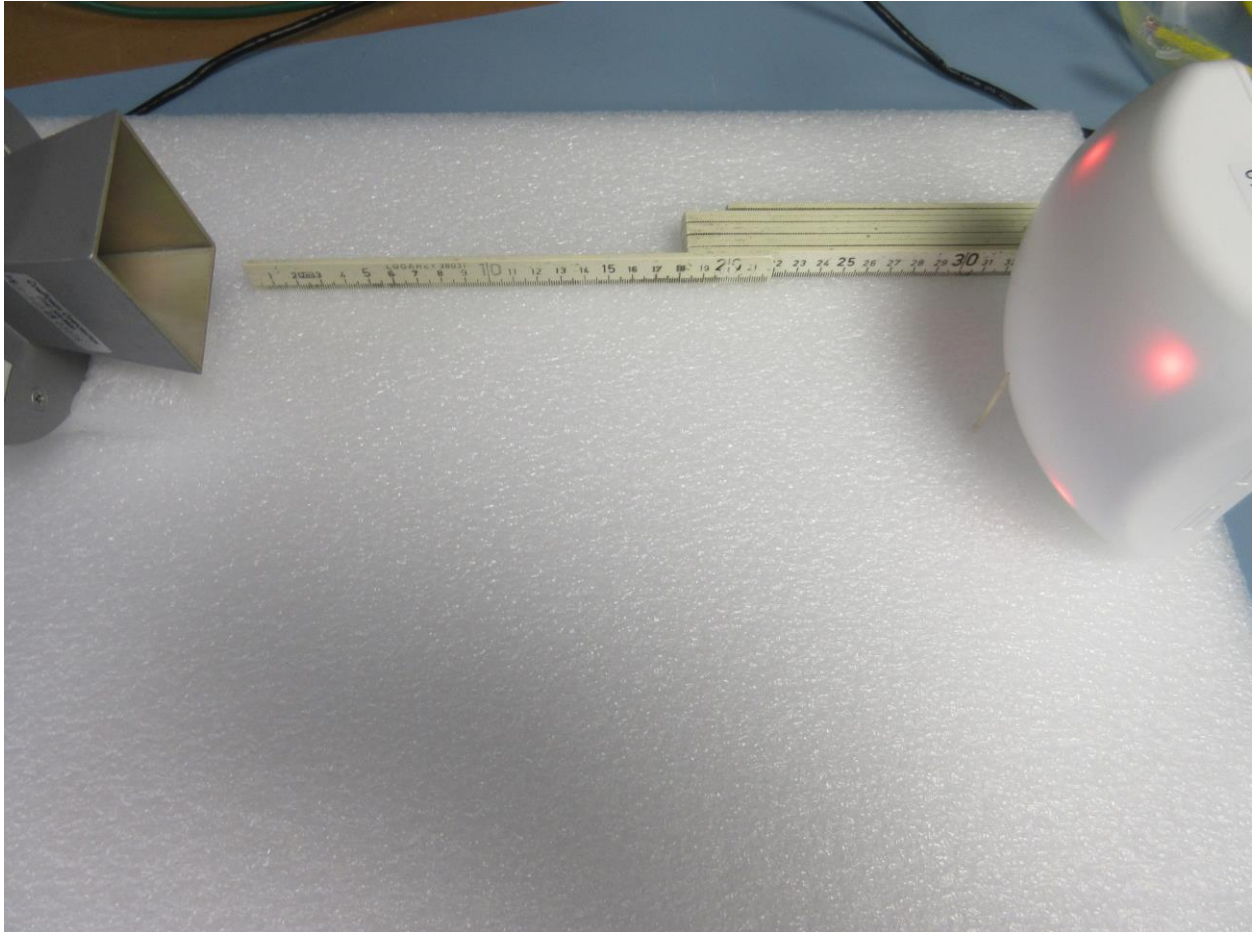
8. Test Images

8.5. Spurious and Harmonic Emissions – 1 to 18 GHz Rear



8. Test Images

8.6. Spurious and Harmonic Emissions – 18 to 40 GHz Side



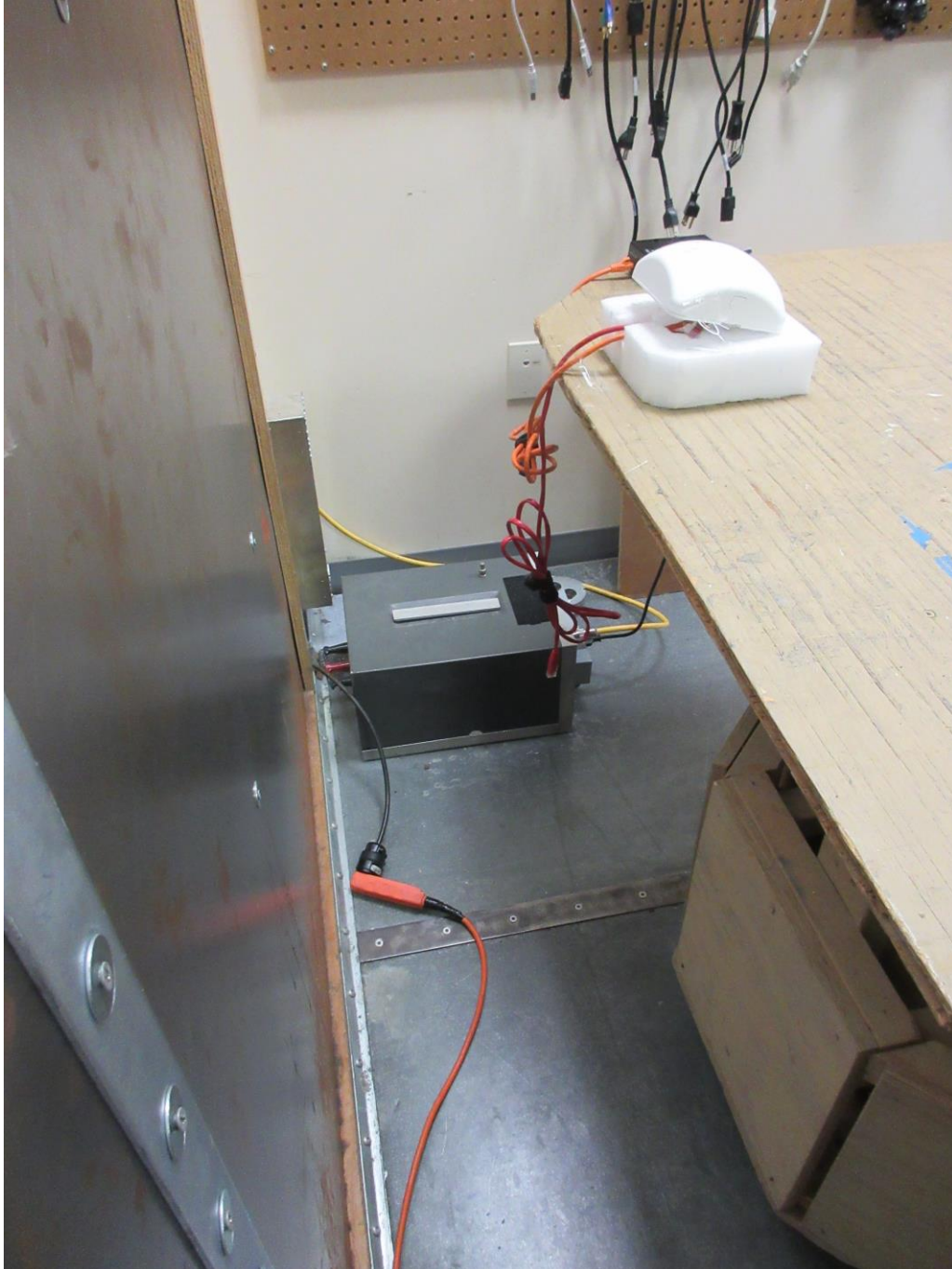
8. Test Images

8.7. Conducted Emissions (Front)



8. Test Images

8.8. Conducted Emissions (Rear)



8. Test Images

8.9. Frequency Stability (Setup)

