

COMPLIANCE WORLDWIDE INC. TEST REPORT 142-17

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

Issued to

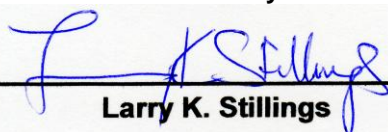
Ciholas, Inc.
3700 Bell Road
Newbergh, IN 47630

For the
DWTAG100


FCC ID: 2ALIR-DWTAG100

Report Issued on May 8, 2017

Tested By


Larry K. Stillings

Reviewed By


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1. Scope

This test report certifies that the Ciholas DWTAG100 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.

2. Product Details

- 2.1. Manufacturer:** Ciholas, Inc.
- 2.2. Model Number:** DWTAG100
- 2.3. Serial Number:** 01:05:01B1
- 2.4. Description:** Battery powered tag that transmits UWB beacons for real time location calculation
- 2.5. Power Source:** 3.7 VDC 300 mAh Rechargeable Battery
- 2.6. Hardware Revision:** 1.1.0
- 2.7. Software Revision:** N/A
- 2.8. Modulation Type:** Pulse Modulation, Frequency Hopping
- 2.9. Operating Frequency:** 6489.6 GHz Center Frequency Nominal (Channel 5 – 500 MHz BW)
- 2.10. EMC Modifications:** None

3. Product Configuration

3.1 Operational Characteristics & Software

Hardware Setup:

Connect the Tag to the laptop via a USB cable. Using a serial port emulator, the tag contains special firmware to configure packet size, and PRFs for the EUT. The DWTAG100 was tested in a total of six modes consisting of long and short packet types, and 16M and 64M PRFs at a 6.8 Mbps data rate

During the measurement testing, the product was mounted on a polystyrene form to facilitate rotating the In-Line Control Module through three orthogonal axes as required by ANSI C63.10-2013, section 5.10.1, for a hand held or body worn device. The three axes were defined as follows:

- X-Axis** Flat on the Table. The surface mount antenna of the EUT was facing the antenna at 0° turntable azimuth.
- Y-Axis** Sideways on the table. The surface mount antenna of the EUT was facing the antenna at 0° turntable azimuth.
- Z-Axis** Upright on the table. The surface mount antenna was pointed upwards with the top side of the circuit board facing the antenna at 0° turntable azimuth.

3.2. Cables

Cable Type	Length	Shield	From	To
USB	10M	Yes	EUT	Laptop

3. Product Configuration (cont.)

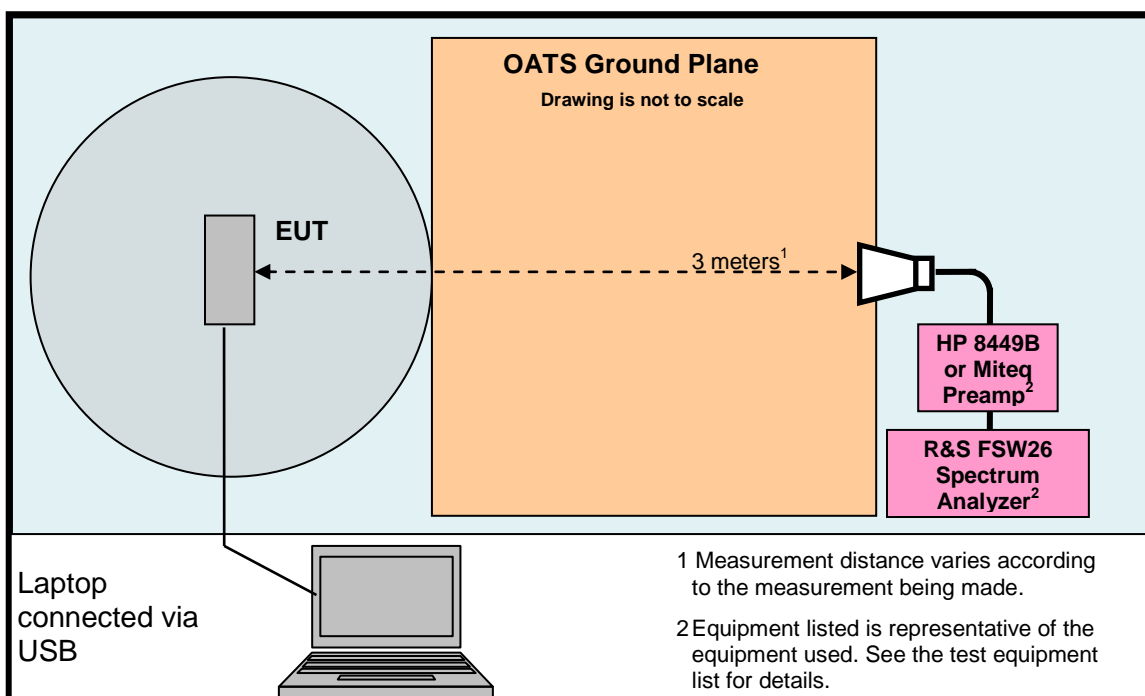
3.3. EUT Hardware

Manufacturer	Model/Part # / Options	Serial Number	Input Volts	Freq (Hz)	Description/Function
Ciholas	DWTAG100	01:05:01B1	3.7	DC	UWB Tag

3.4. Support Equipment

Manufacturer	Model/Part #	Serial Number	Description
Dell	Inspiron E1505		Laptop for configuration

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	7/23/2017	2 Years
Spectrum Analyzer 9 kHz to 40 GHz	Rohde & Schwarz	FSV40	100899	7/23/2017	2 Years
Spectrum Analyzer 10 Hz to 40 GHz	Rohde & Schwarz	FSVR40	100909	7/23/2017	2 Years
Spectrum Analyzer 3 Hz to 26.5 GHz	Rohde & Schwarz	FSW26	102044	12/7/2018	2 Years
Biconilog Antenna 30 MHz to 2 GHz	Sunol Sciences	JB1	A050913	6/3/2019	3 Years
Loop Antenna 9 kHz to 30 MHz	EMCO	6512	9309-1139	10/26/2018	2 Years
Preamplifier 100 MHz to 7 GHz	Miteq	AFS3-00100200-10-15P-4	988773	6/2/2017	1 Year
Preamplifier 100 MHz to 18 GHz	Miteq	AMF-7D-00101800-30-10P	1953081	6/1/2017	1 Year
Preamplifier 2 to 12 GHz	JCA	JCA48-4111B1	7087S	6/2/2017	1 Year
Preamplifier 1 to 26.5 GHz	Hewlett Packard	8449B	3008A01323	7/22/2017	2 Years
Preamplifier 18 to 40 GHz	Avantek	AWT-40039	FM22038832	6/2/2017	1 Year
Horn Antenna 1 to 18 GHz	ETS-Lindgren	3117	00143292	2/22/2019	3 Years
Horn Antenna 18-40 GHz	Com Power	AH-840	101032	2/24/2018	2 Years
High Pass Filter 8 to 18 GHz	Micro-Tronics	HPM50107	G036	6/1/2017	1 Year
2.4 GHz Band Pass Filter	Micro-Tronics	BRM50702	150	6/1/2017	1 Year
Barometer	Control Company	4195	Cal ID# 236	10/8/2017	2 Years

¹ ESR7 Firmware revision: V2.28,SP1 Date installed: 9/2/2016 Previous V2.26, installed 8/15/2014.
² FSV40 Firmware revision: V2.30 SP4, Date installed: 5/4/2016 Previous V2.30 SP1, installed 10/22/2014.
³ FSVR40 Firmware revision: V2.23, Date installed: 10/20/2014 Previous V1.63 SP1, installed 8/28/2013.
⁴ FSW26 Firmware revision: V2.50, Date installed: 9/12/2016 Previous V2.40, installed 5/4/2016.

4. Measurements Parameters (continued)**4.2. Measurement & Equipment Setup**

Test Dates:	2/17/2017, 2/20/2017, 2/22/2017, 3/15/2017, 5/8/2017
Test Engineers:	Brian Breault, Larry Stillings
Normal Site Temperature (15 - 35°C):	21.6
Relative Humidity (20 - 75%RH):	35
Frequency Range:	10 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 & 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	The antenna is a surface mount PCB type antenna.
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	
Radio Frequency Exposure	FCC OET Bulletin 65 1.1307 (b) (1)	6.10	Compliant	

6. Measurement Data

6.1. Antenna Requirement (15.203)

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 device under test is a surface mount PCB Type, non user replaceable unit.

6.2. Operational Requirements of the Device under Test (15.250 (a))

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	6439.1	6194.3	6754.7	5925	7250	Compliant
-	Ambient	6439.1	6210.2	6790.8	5925	7250	Compliant
1	-20	6439.1	6211.2	6791.7	5925	7250	Compliant
2	-10	6439.1	6214.1	6797.8	5925	7250	Compliant
3	0	6439.1	6215.2	6797.8	5925	7250	Compliant
4	+10	6439.1	6212.2	6795.8	5925	7250	Compliant
5	+20	6439.1	6212.2	6794.8	5925	7250	Compliant
6	+30	6439.1	6205.2	6791.8	5925	7250	Compliant
7	+40	6439.1	6213.3	6792.8	5925	7250	Compliant
8	+50	6439.1	6217.3	6790.8	5925	7250	Compliant

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6. Measurement Data (continued)

6.3. Wideband Bandwidth (15.250 (b))

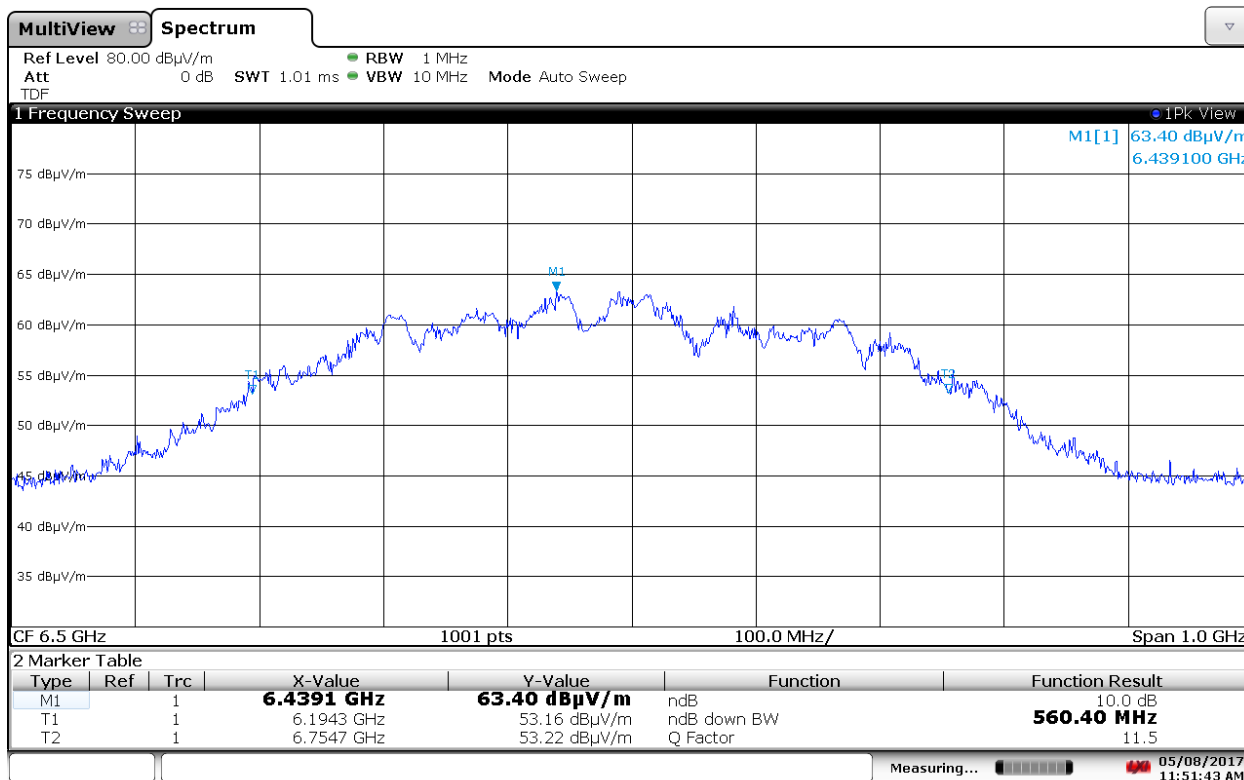
Requirement: The -10 dB bandwidth of the fundamental emission shall be at least 50 MHz.

Result: Compliant

6.3.1. Measurement Data – Values in GHz

f_M	The highest emission peak	6.4391
f_L	10 dB below the highest peak	6.1943
f_H	10 dB above the highest peak	6.7547
Bandwidth	Calculated: ($f_H - f_L$)	0.5604

6.3.2. Measurement Plot of 10 dB frequencies (Channel 5, PRF 16M, long packets)



11:51:44 AM 05/08/2017

Test Number: 142-17

Issue Date: 5/8/2017

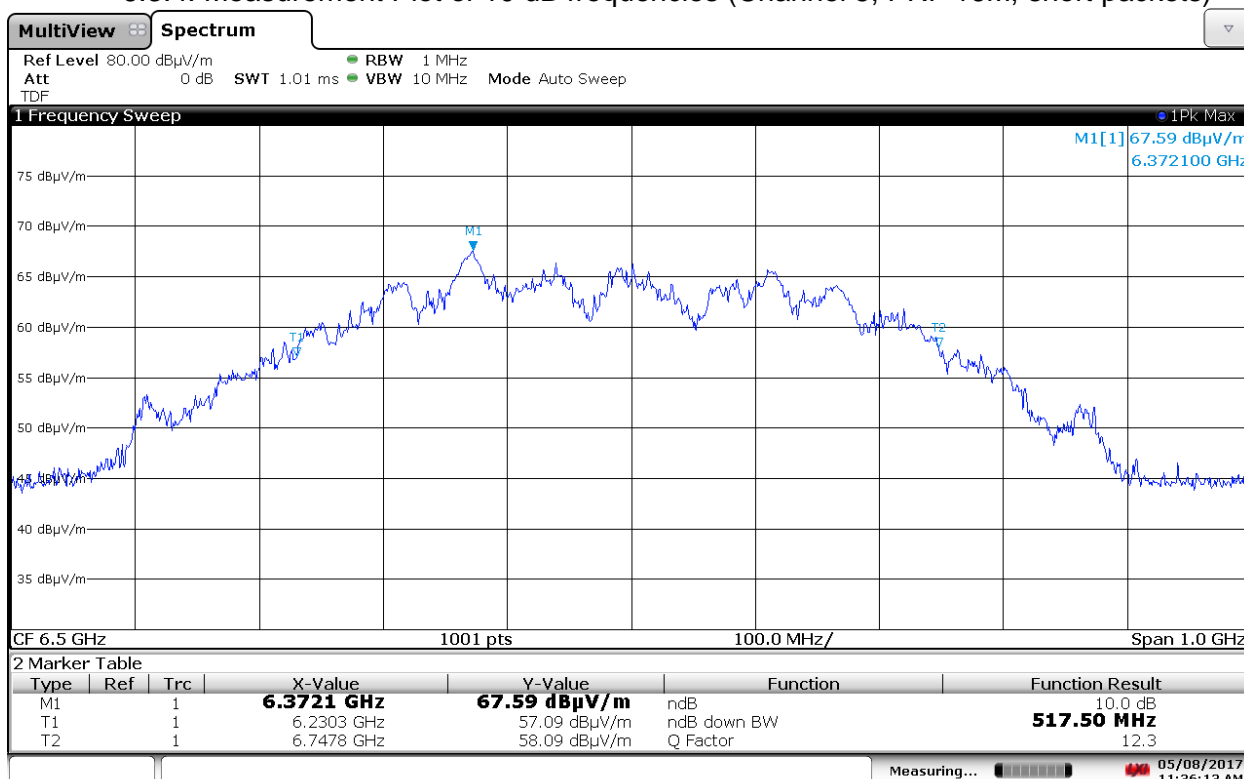
6. Measurement Data (continued)

6.3. Wideband Bandwidth (15.250 (b)) (continued)

6.3.3. Measurement Data – Values in GHz

f_M	The highest emission peak	6.3721
f_L	10 dB below the highest peak	6.2303
f_H	10 dB above the highest peak	6.7478
Bandwidth	Calculated: ($f_H - f_L$)	0.5175

6.3.4. Measurement Plot of 10 dB frequencies (Channel 5, PRF 16M, short packets)



11:36:14 AM 05/08/2017

Test Number: 142-17

Issue Date: 5/8/2017

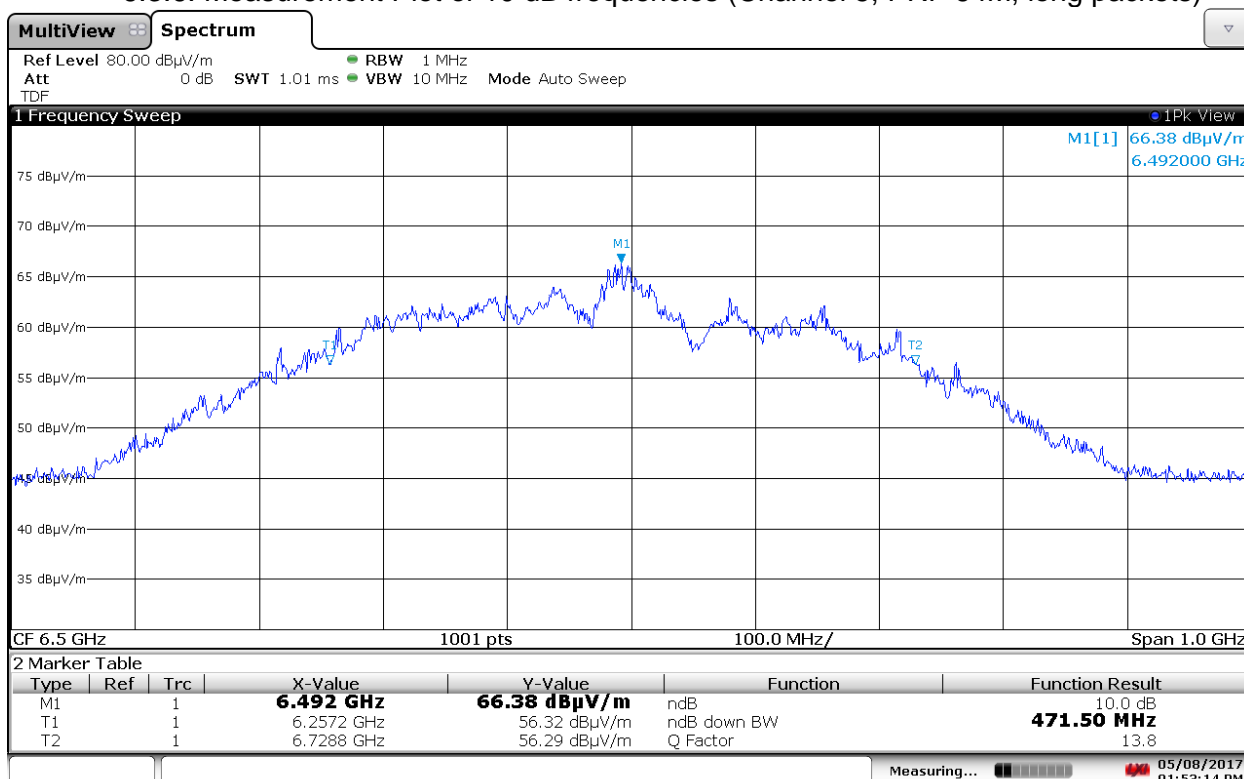
6. Measurement Data (continued)

6.3. Wideband Bandwidth (15.250 (b)) (continued)

6.3.5. Measurement Data – Values in GHz

f_M	The highest emission peak	6.4920
f_L	10 dB below the highest peak	6.2572
f_H	10 dB above the highest peak	6.7288
Bandwidth	Calculated: ($f_H - f_L$)	0.4715

6.3.6. Measurement Plot of 10 dB frequencies (Channel 5, PRF 64M, long packets)



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Test Number: 142-17

Issue Date: 5/8/2017

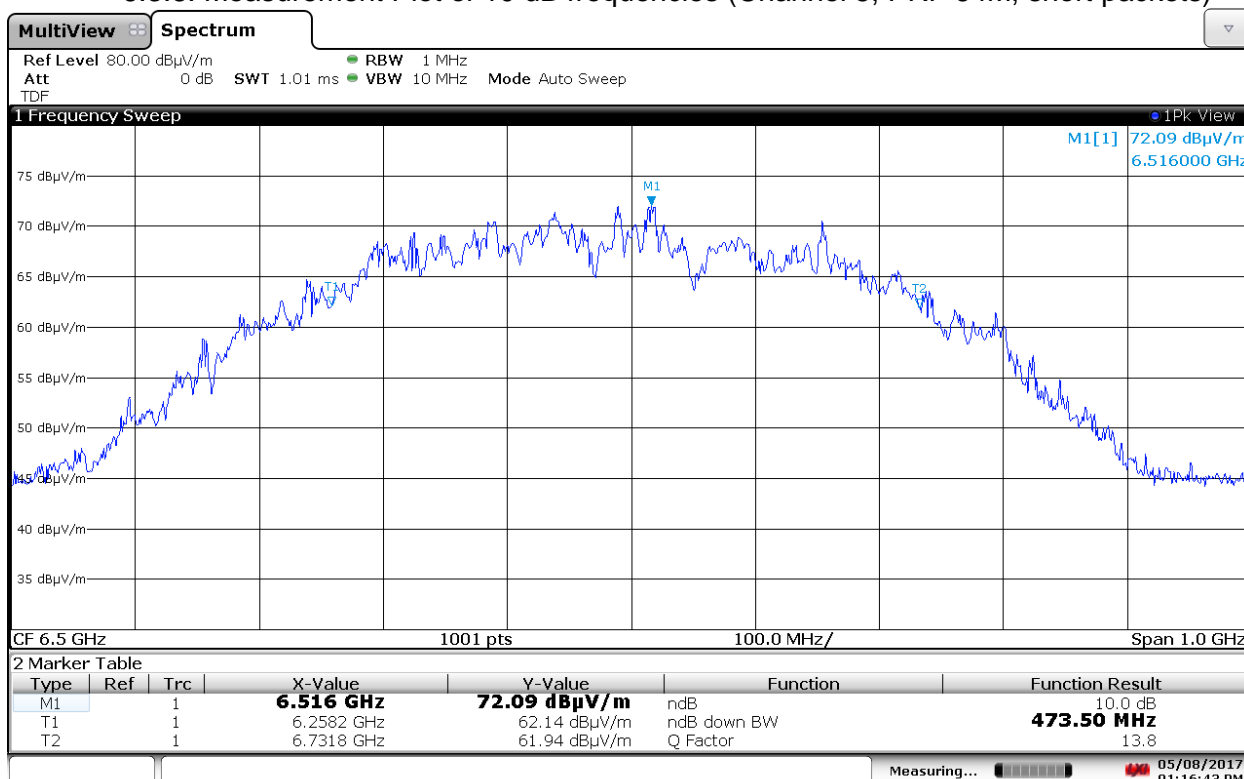
6. Measurement Data (continued)

6.3. Wideband Bandwidth (15.250 (b)) (continued)

6.3.7. Measurement Data – Values in GHz

f_M	The highest emission peak	6.5160
f_L	10 dB below the highest peak	6.2582
f_H	10 dB above the highest peak	6.7318
Bandwidth	Calculated: ($f_H - f_L$)	0.4735

6.3.8. Measurement Plot of 10 dB frequencies (Channel 5, PRF 64M, short packets)



01:16:44 PM 05/08/2017

6. Measurement Data (continued)**6.4. Spurious Radiated Emissions (15.250 (d) (1), 15.209)**

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 (dB μ V/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

6. Measurement Data (continued)

6.4. Spurious Radiated Emissions (15.250 (d) (1), 15.209 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

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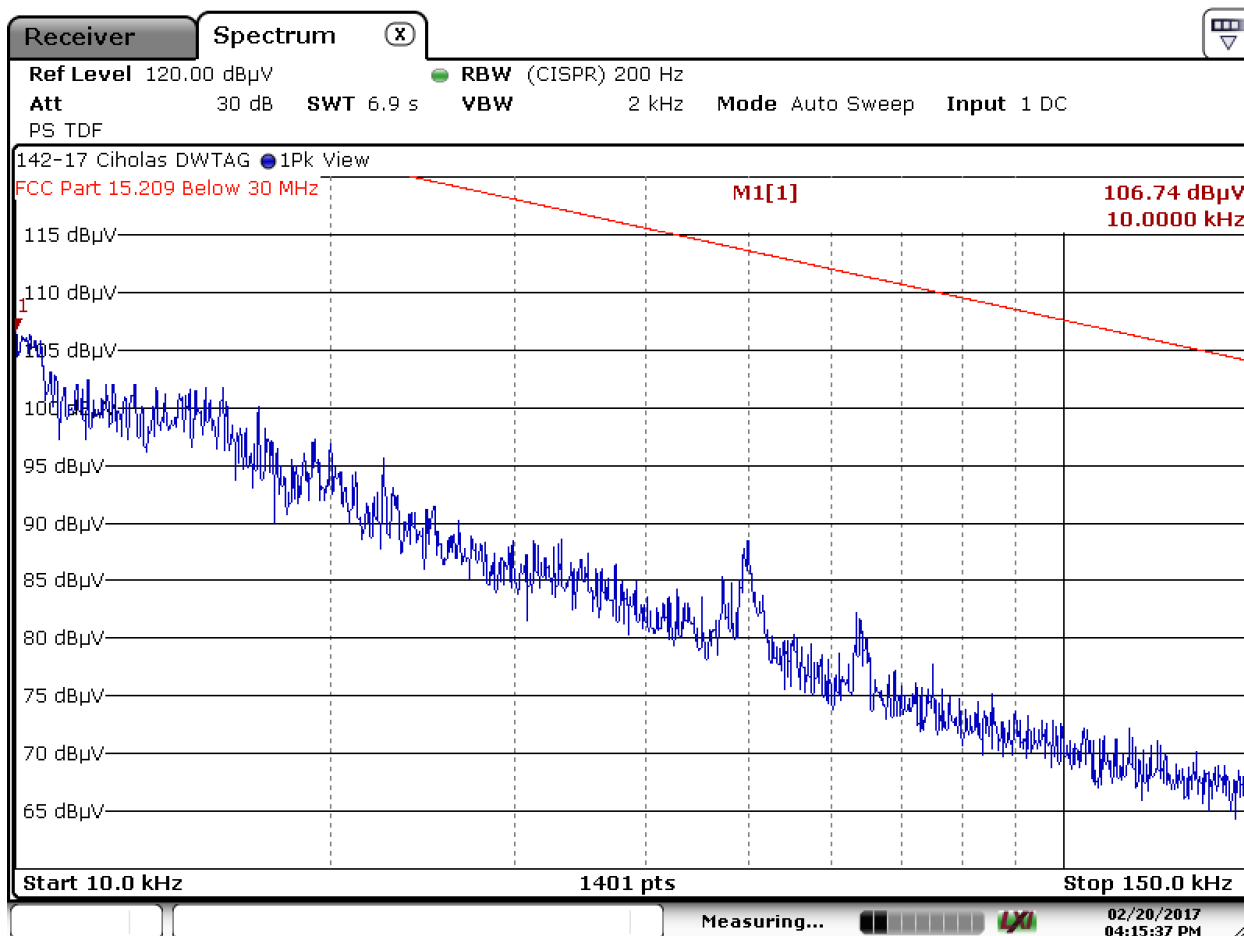
6. Measurement Data (continued)

6.4. Spurious Radiated Emissions (15.250 (d) (5), 15.209 continued)

6.4.1. 10 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 – 10 to 150 kHz



Date: 20.FEB.2017 16:15:36

Test Number: 142-17

Issue Date: 5/8/2017

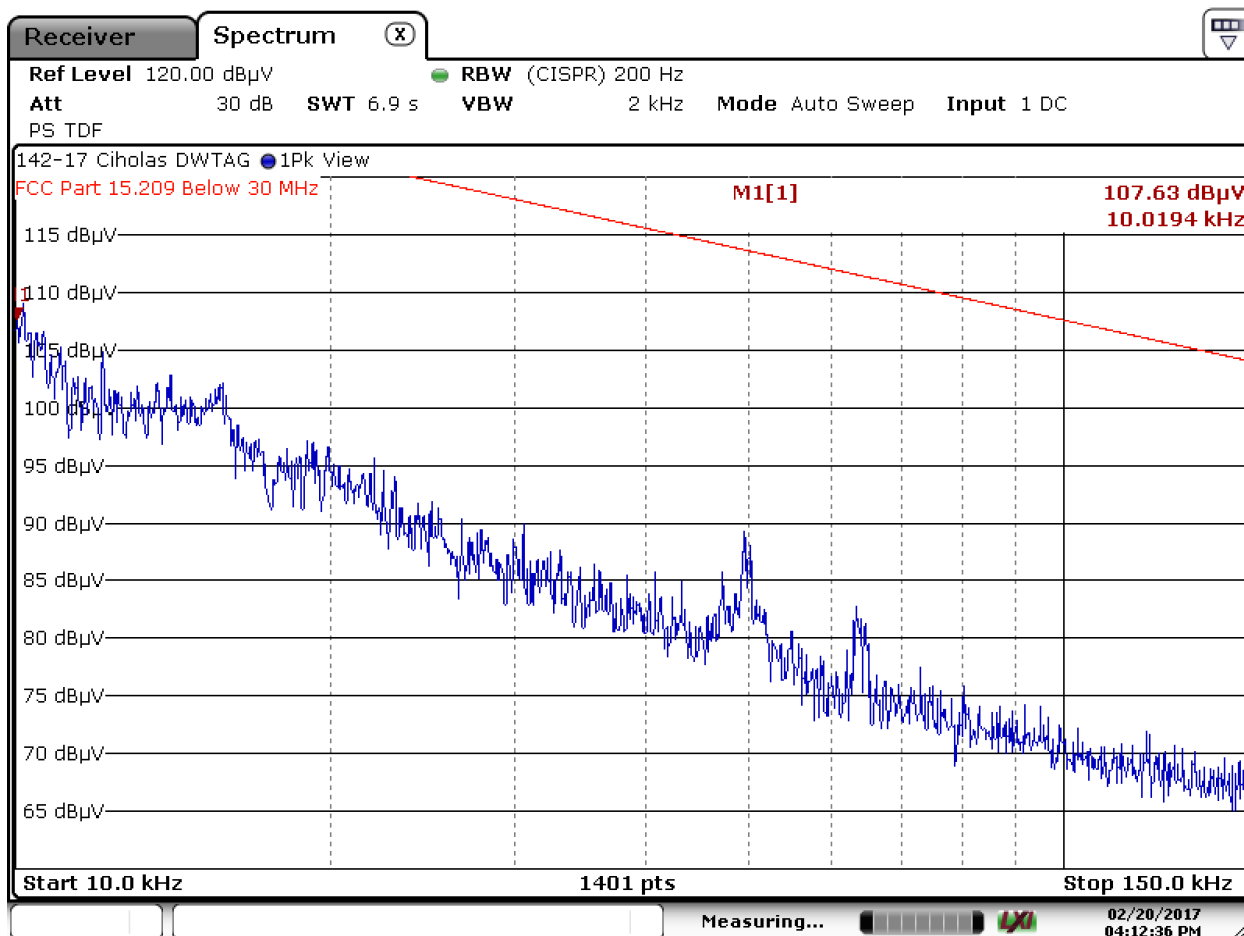
6. Measurement Data (continued)

6.4. Spurious Radiated Emissions (15.250 (d) (5), 15.209 continued)

6.4.1. 10 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 – 10 to 150 kHz



Date: 20.FEB.2017 16:12:35

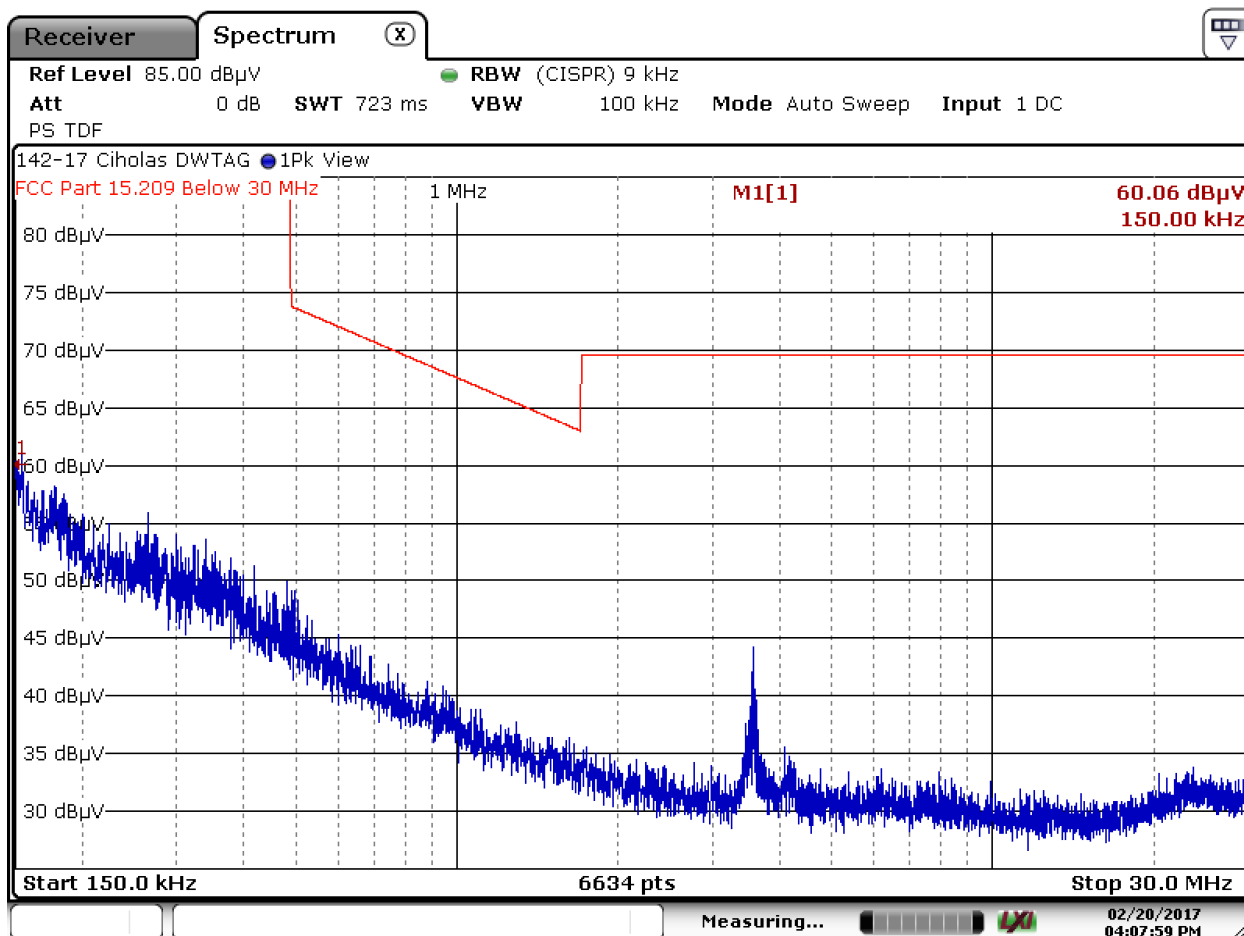
6. Measurement Data (continued)

6.4. Spurious Radiated Emissions (15.250 (d) (5), 15.209 continued)

6.4.1. 10 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 Parallel Measurement Antenna – 150 kHz to 30 MHz



Date: 20.FEB.2017 16:07:59

Test Number: 142-17

Issue Date: 5/8/2017

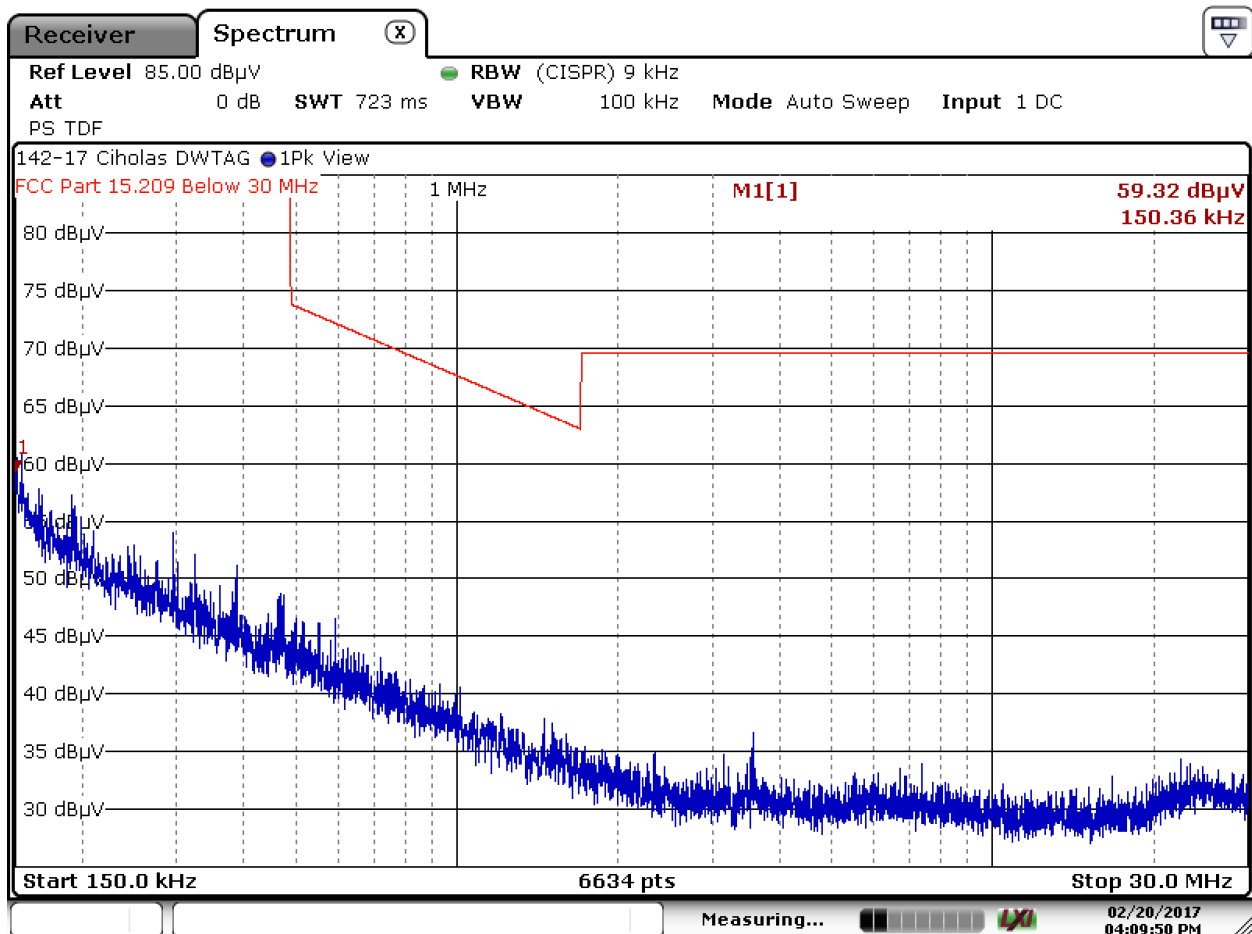
6. Measurement Data (continued)

6.4. Spurious Radiated Emissions (15.250 (d) (5), 15.209 continued)

6.4.1. 10 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 Perpendicular Measurement Antenna – 150 kHz to 30 MHz



Date: 20.FEB.2017 16:09:49

Test Number: 142-17

Issue Date: 5/8/2017

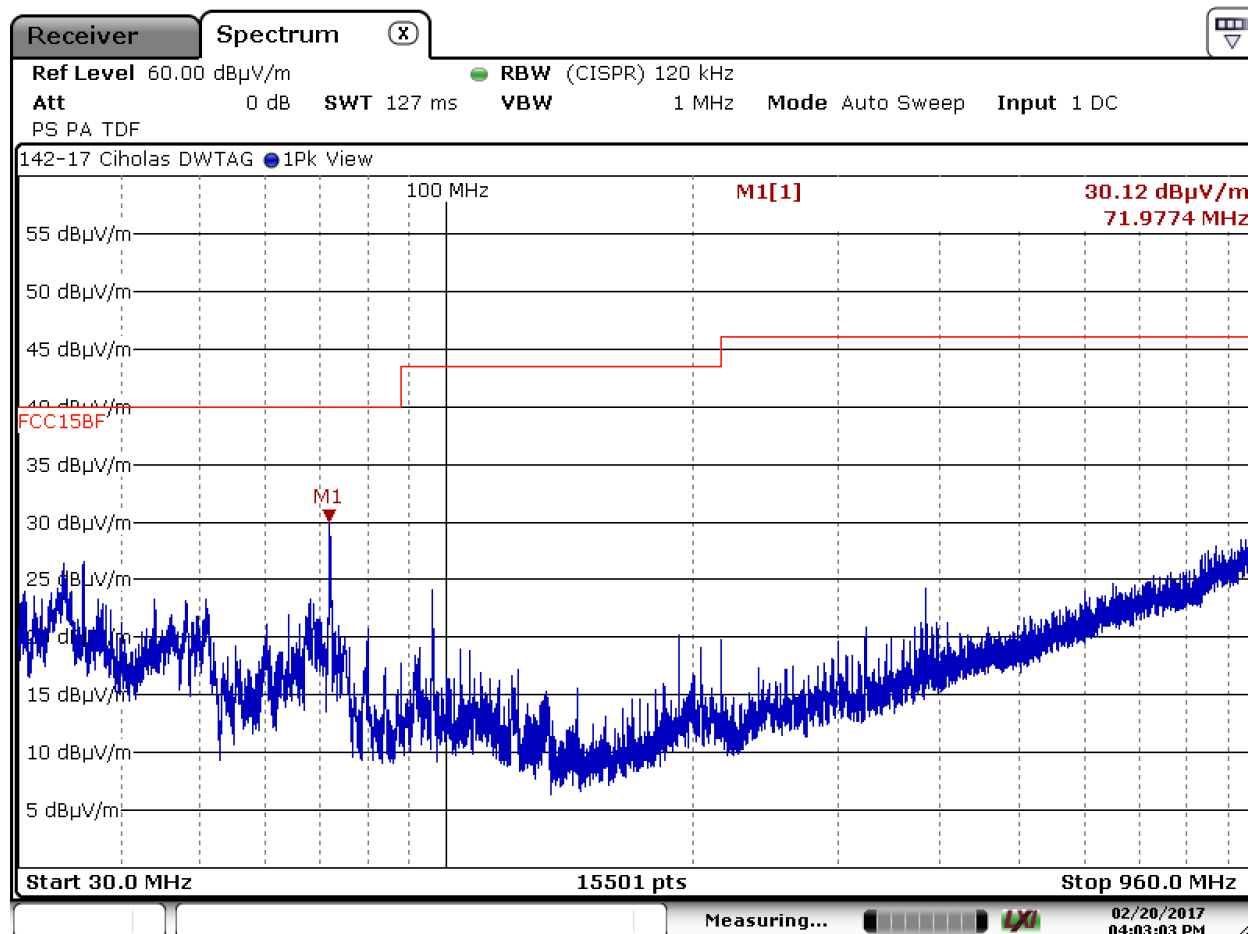
6. Measurement Data (continued)

6.4. Spurious Radiated Emissions (15.250 (d) (5), 15.209 continued)

6.4.1. 10 MHz to 960 MHz, measured at 3 Meters

The device was prescreened in our 3 Meter Semi-Anechoic Chamber. There were no emissions within 6 dB of the limits below 960 MHz on our 3 Meter OATS.

6.4.1.5 Horizontal Polarity – 30 to 960 MHz



Date: 20.FEB.2017 16:03:02

Test Number: 142-17

Issue Date: 5/8/2017

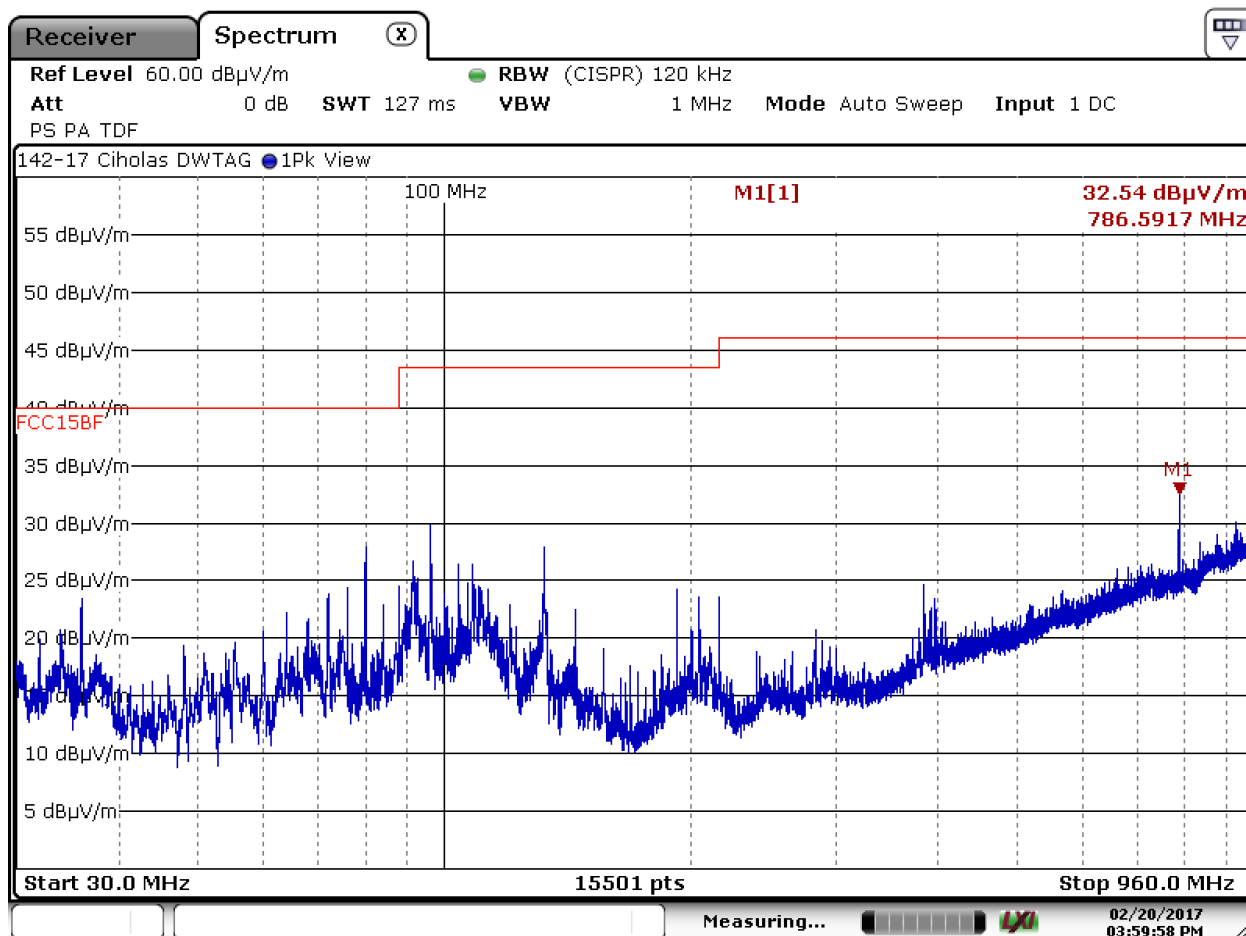
6. Measurement Data (continued)

6.4. Spurious Radiated Emissions (15.250 (d) (5), 15.209 continued)

6.4.1. 10 MHz 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 Vertical Polarity – 30 to 960 MHz



Date: 20.FEB.2017 15:59:57

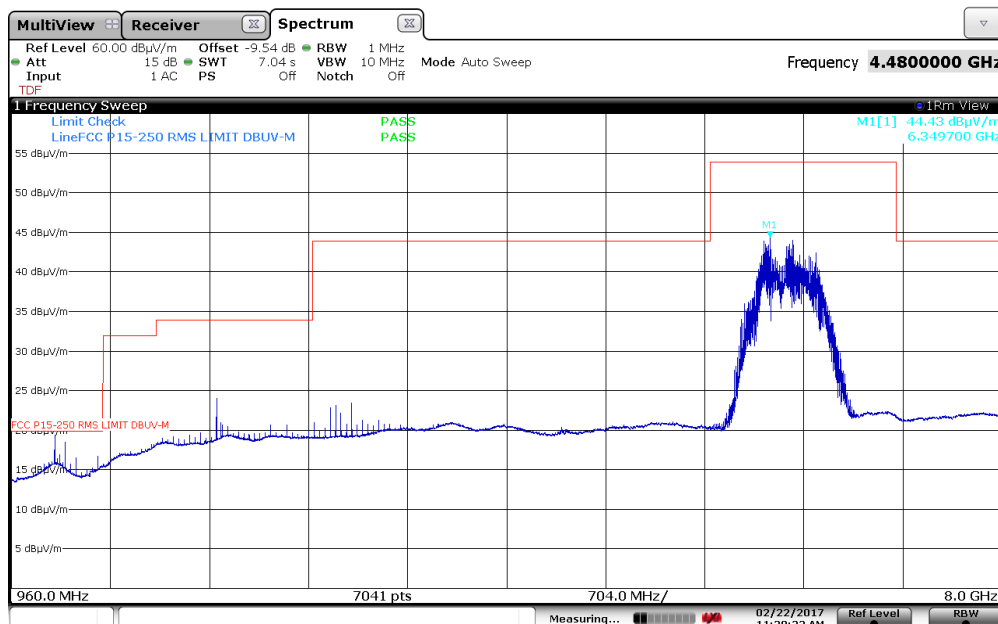
Test Number: 142-17

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6. Measurement Data (continued)

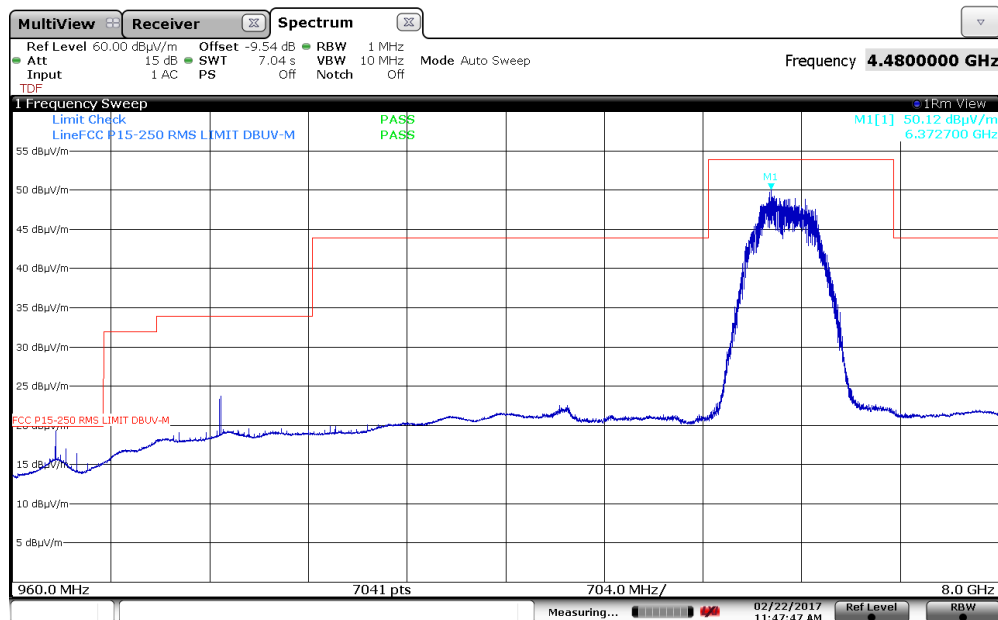
6.4. Spurious Radiated Emissions (15.250 (d) (1))

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



11:38:32 AM 02/22/2017

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

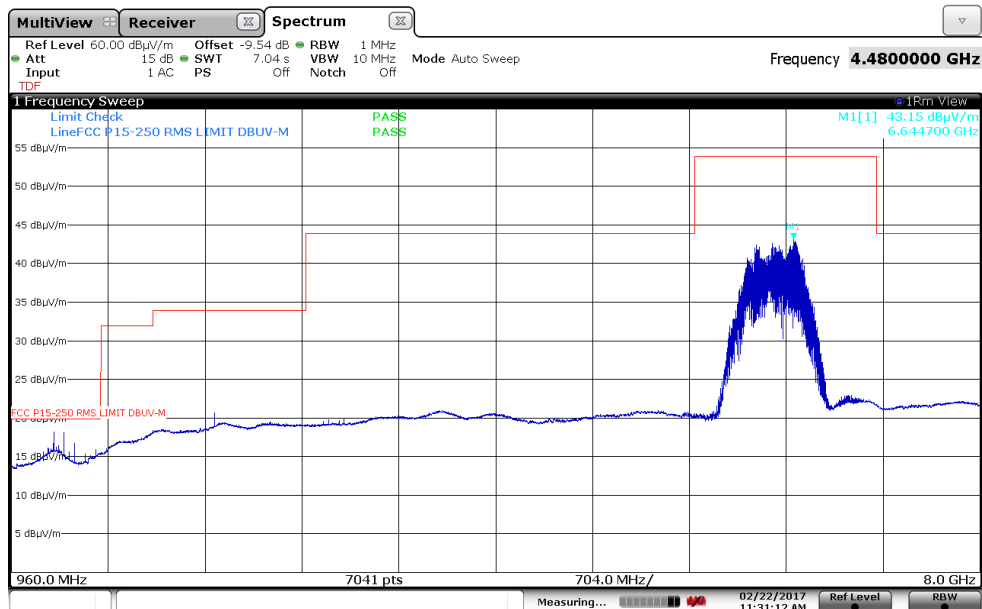


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6. Measurement Data (continued)

6.4. Spurious Radiated Emissions (15.250 (d) (1) continued)

6.4.4. 960 MHz to 8 GHz Horizontal at 1 Meter (16M PRF, short packets)



11:31:12 AM 02/22/2017

6.4.5. 960 MHz to 8 GHz Vertical at 1 Meter (16M PRF, short packets)



11:23:42 AM 02/22/2017

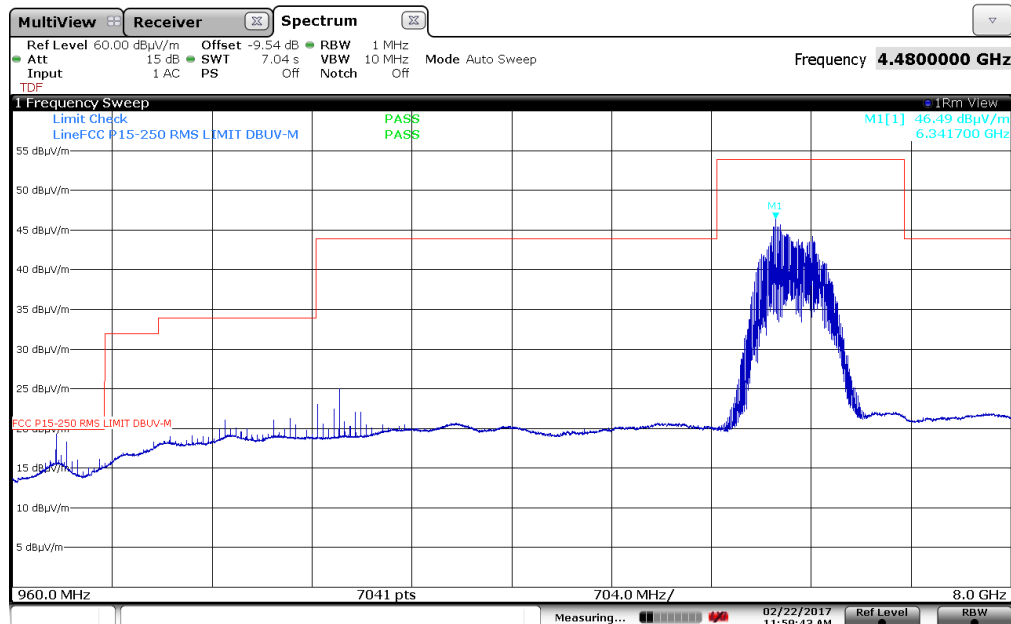
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6. Measurement Data (continued)

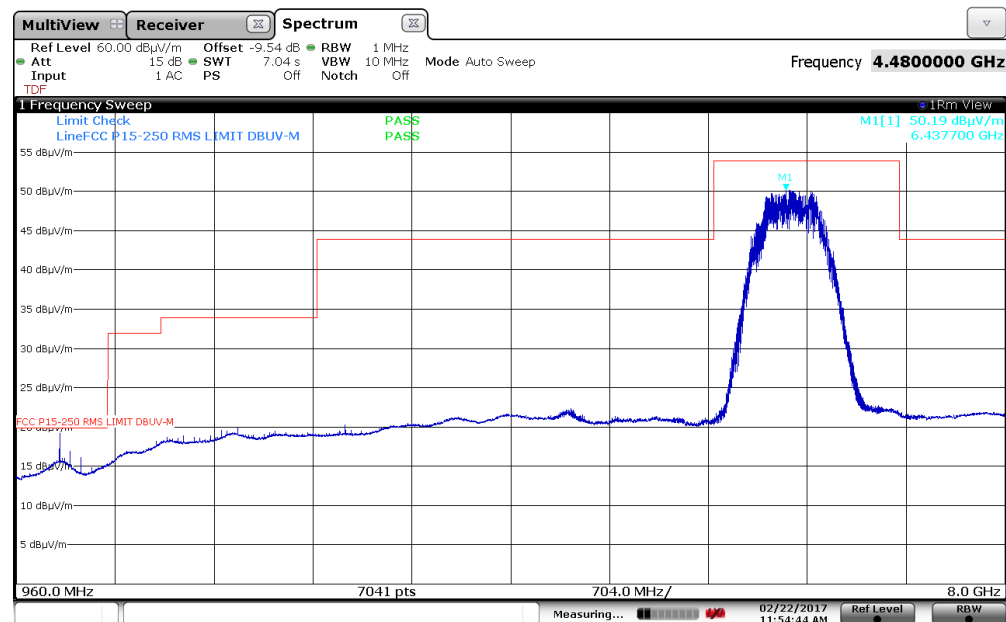
6.4. Spurious Radiated Emissions (15.250 (d) (1) continued)

6.4.6. 960 MHz to 8 GHz Horizontal at 1 Meter (64M PRF, long packets)



11:59:44 AM 02/22/2017

6.4.7. 960 MHz to 8 GHz Vertical at 1 Meter (64M PRF, long packets)



11:54:45 AM 02/22/2017

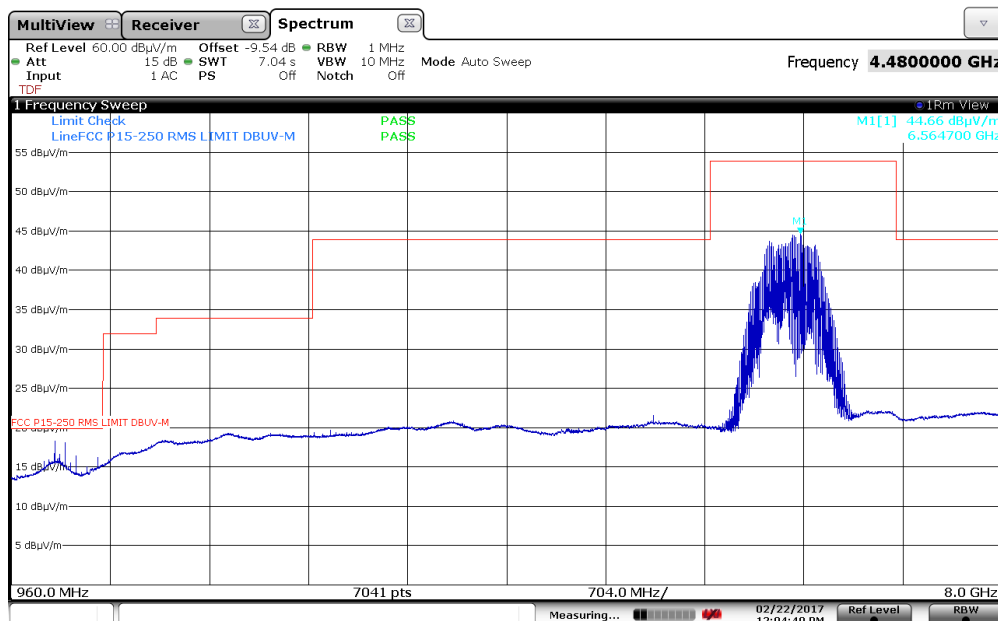
Test Number: 142-17

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6. Measurement Data (continued)

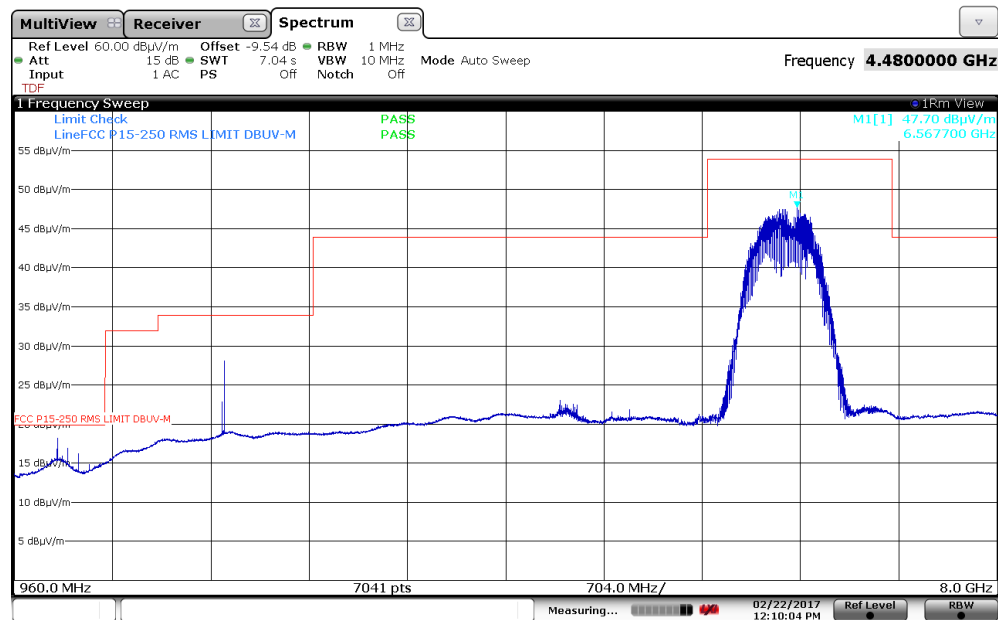
6.4. Spurious Radiated Emissions (15.250 (d) (1) continued)

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



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



12:10:04 PM 02/22/2017

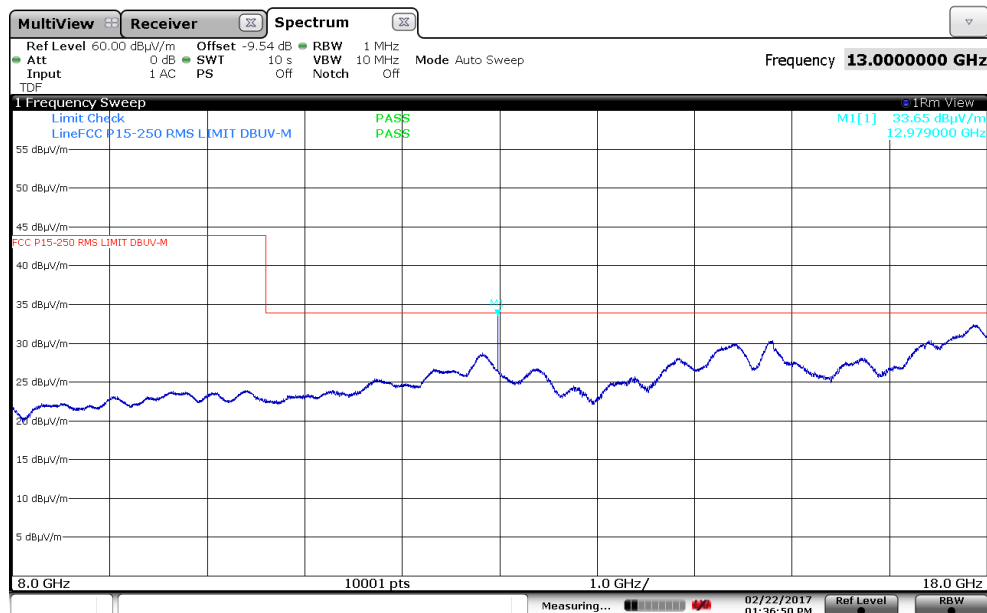
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6. Measurement Data (continued)

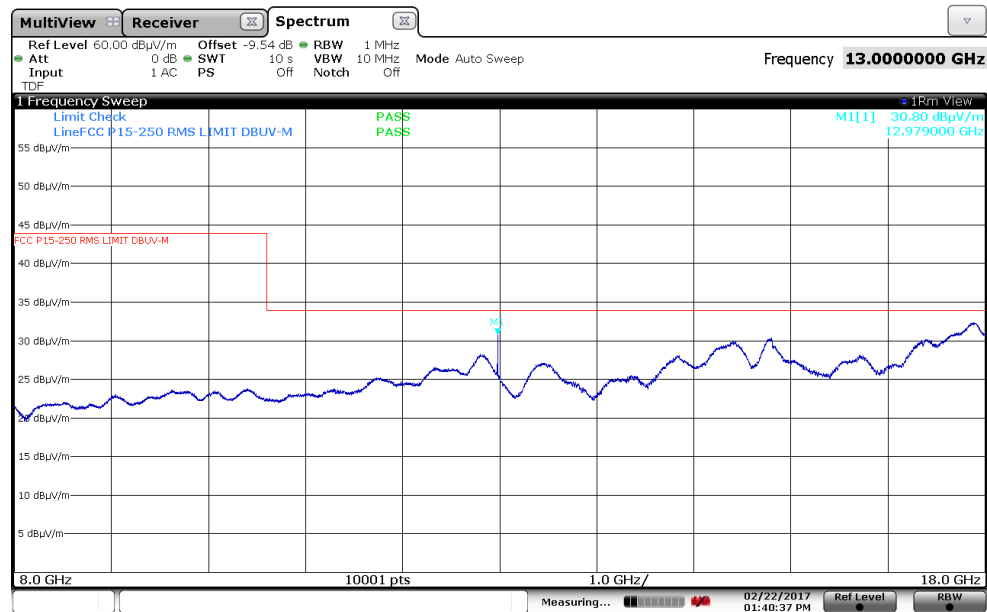
6.4. Spurious Radiated Emissions (15.250 (d) (1) continued)

6.4.10. 8 to 18 GHz Horizontal at 1 Meter (16M PRF, long packets)



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6.4.11. 8 to 18 GHz Vertical at 1 Meter (16M PRF, long packets)



01:40:38 PM 02/22/2017

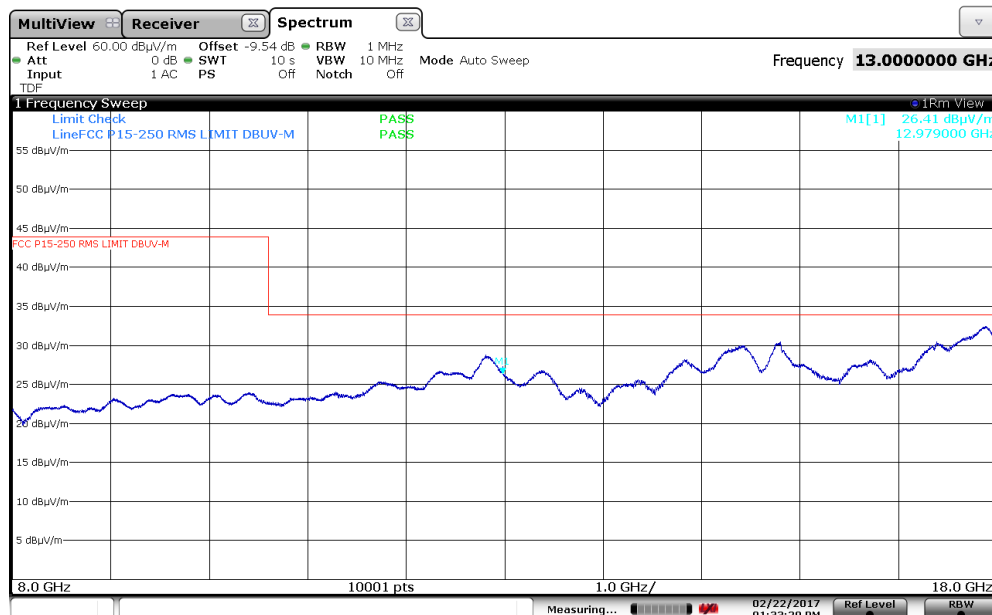
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6. Measurement Data (continued)

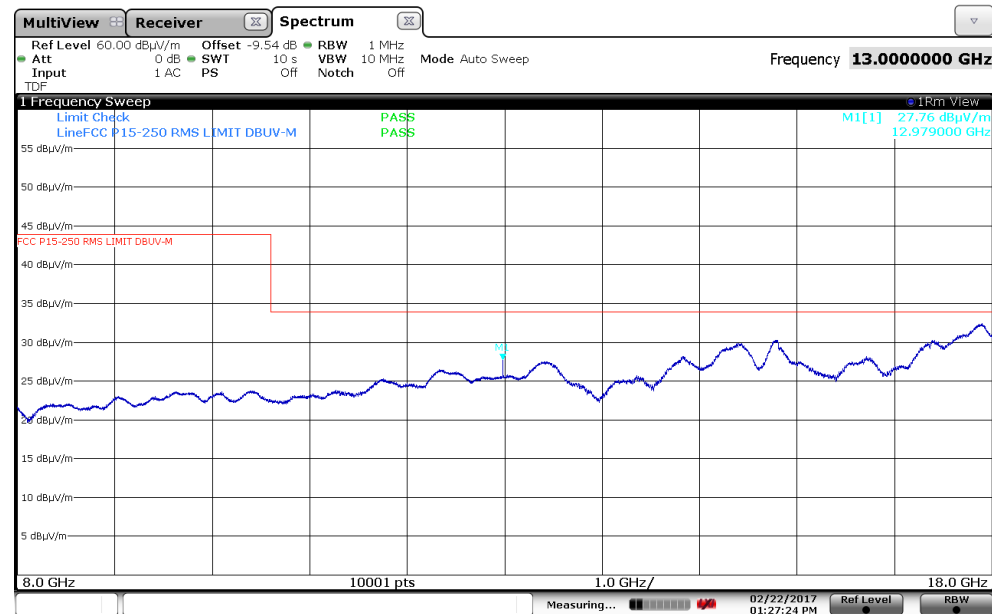
6.4. Spurious Radiated Emissions (15.250 (d) (1) continued)

6.4.12. 8 to 18 GHz Horizontal at 1 Meter (16M PRF, short packets)



01:33:29 PM 02/22/2017

6.4.13. 8 to 18 GHz Vertical at 1 Meter (16M PRF, short packets)



01:27:24 PM 02/22/2017

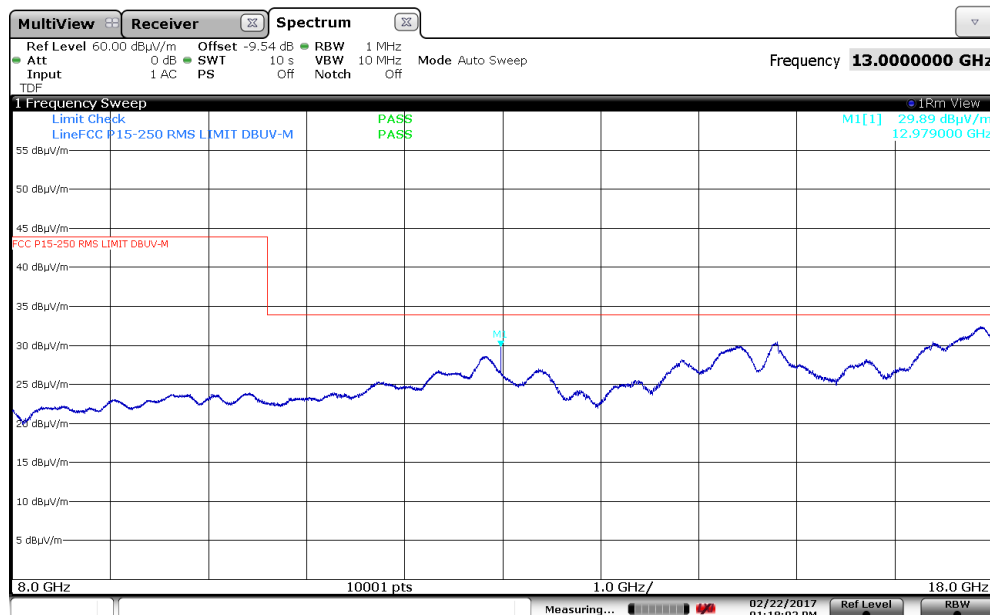
Test Number: 142-17

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6. Measurement Data (continued)

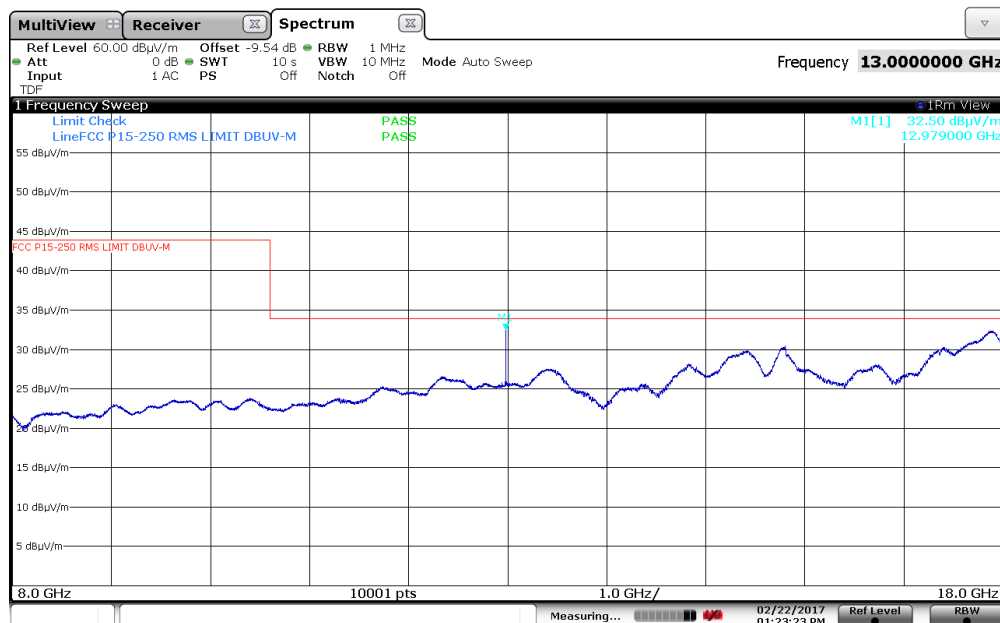
6.4. Spurious Radiated Emissions (15.250 (d) (1) continued)

6.4.14. 8 to 18 GHz Horizontal at 1 Meter (64M PRF, long packets)



01:18:03 PM 02/22/2017

6.4.15. 8 to 18 GHz Vertical at 1 Meter (64M PRF, long packets)



01:23:24 PM 02/22/2017

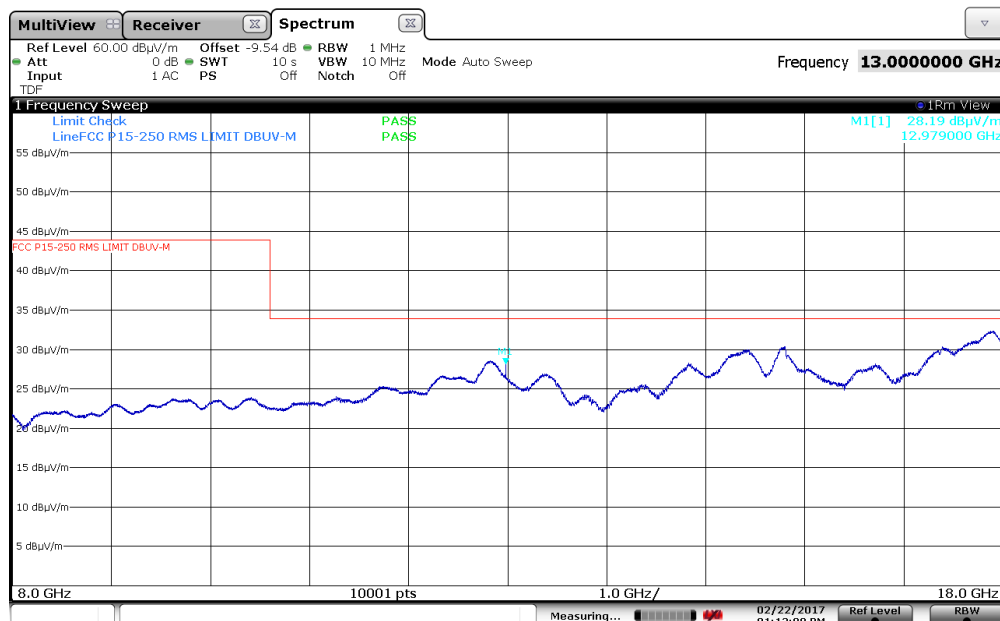
Test Number: 142-17

Issue Date: 5/8/2017

6. Measurement Data (continued)

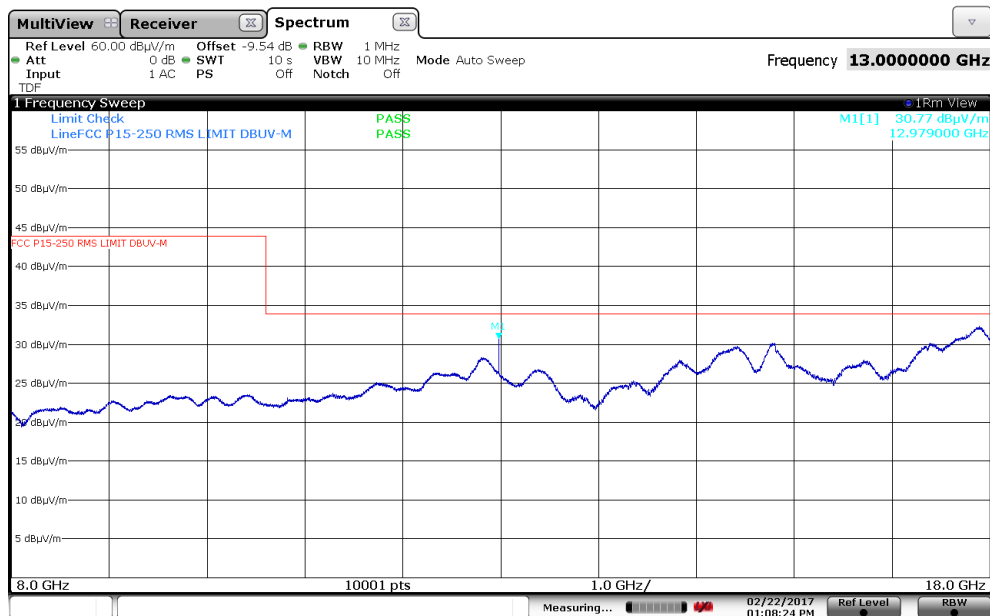
6.4. Spurious Radiated Emissions (15.250 (d) (1) continued)

6.4.16. 8 to 18 GHz Horizontal at 1 Meter (64M PRF, short packets)



01:13:10 PM 02/22/2017

6.4.17. 8 to 18 GHz Vertical at 1 Meter (64M PRF, short packets)



01:08:24 PM 02/22/2017

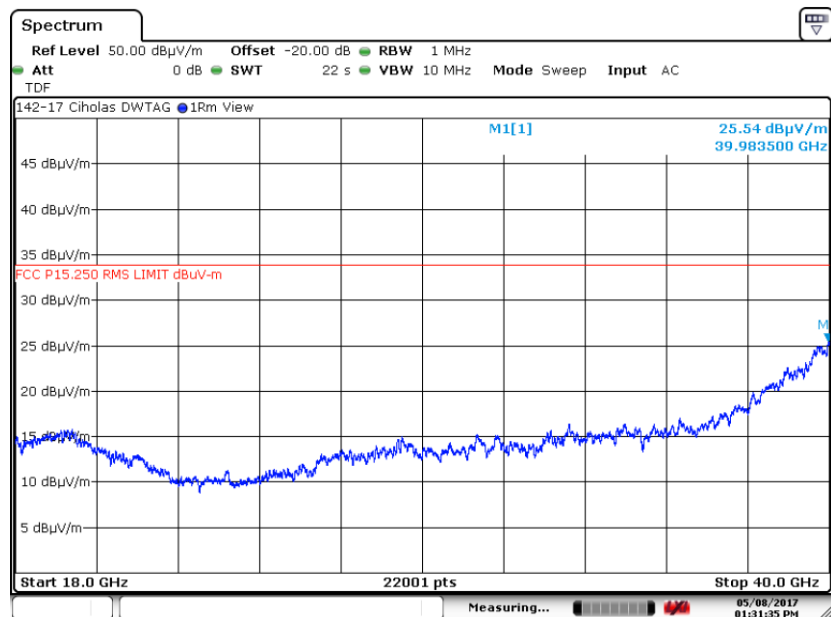
Test Number: 142-17

Issue Date: 5/8/2017

6. Measurement Data (continued)

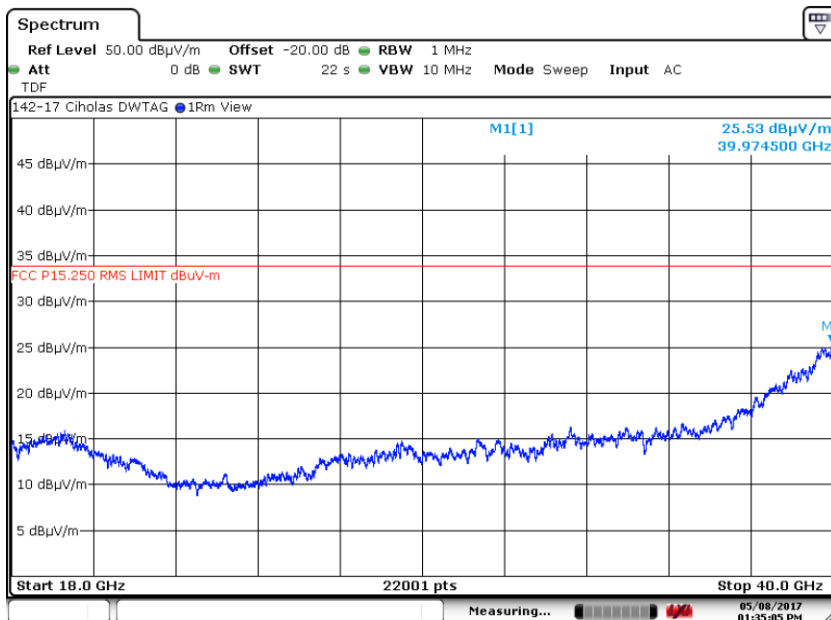
6.4. Spurious Radiated Emissions (15.250 (d) (1) continued)

6.4.18. 18 to 40 GHz Horizontal at 0.3 Meter



Date: 8.MAY.2017 13:31:35

6.4.19. 18 to 40 GHz Vertical at 0.3 Meter



Date: 8.MAY.2017 13:35:05

6. Measurement Data (continued)**6.5. Spurious Radiated Emissions in GPS Bands (15.250 (d) (2))**

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

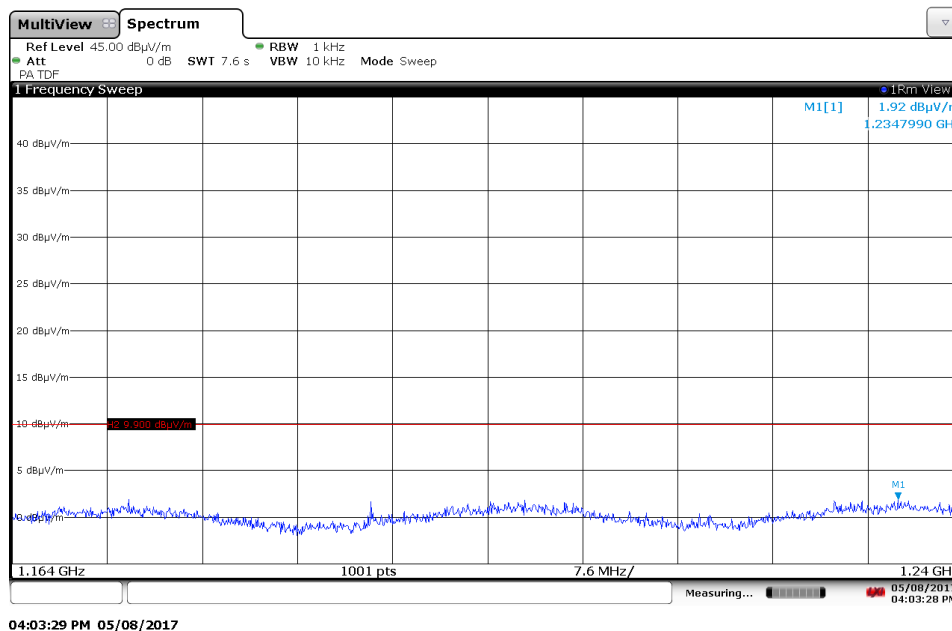
There were no broadband emissions related to the UWB transmitter. Measured signals were narrowband and related to the microprocessor / clocks and do not fall under the requirements of this section. Measurements were made at 3 Meters and the -85.3 dBm limit was converted to a field strength limit of 9.9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

6. Measurement Data (continued)

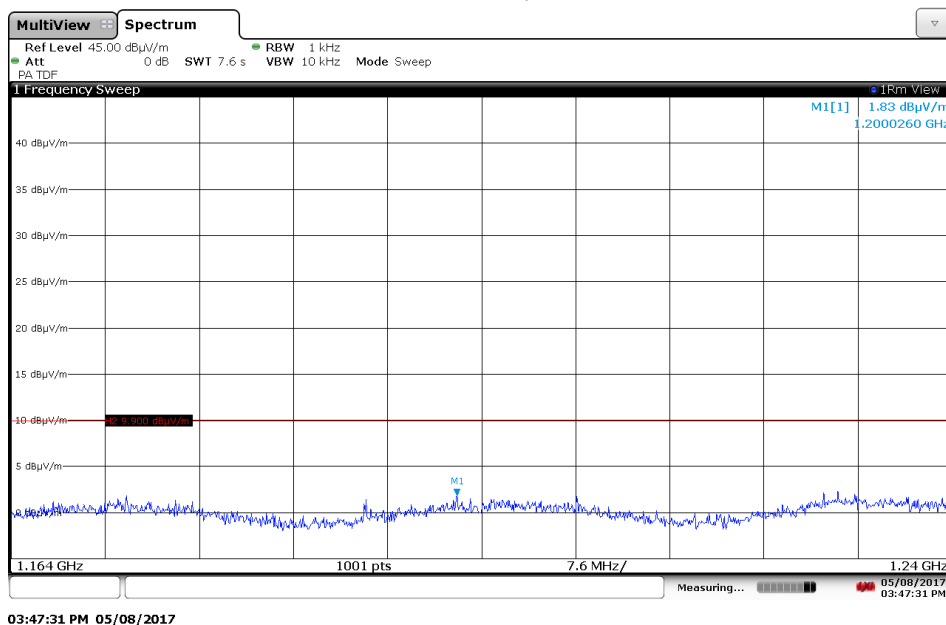
6.5. Spurious Radiated Emissions in GPS Bands (15.250 (d) (2) continued)

6.5.2 1164 to 1240 MHz Band

6.5.2.1 Horizontal Measurement Polarity 1164 to 1240 MHz



6.5.2.2 Vertical Measurement Polarity 1164 to 1240 MHz

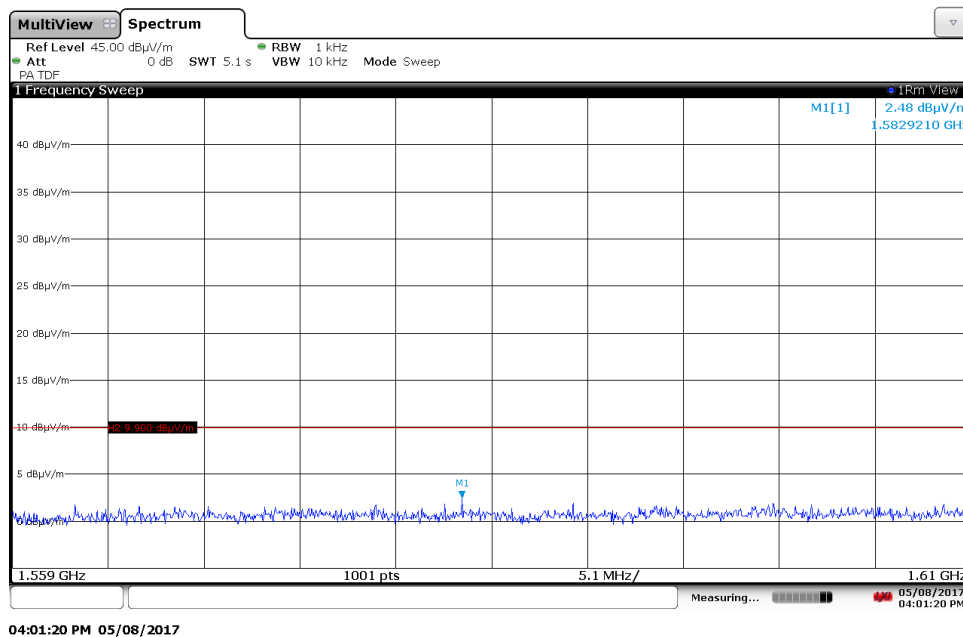


6. Measurement Data (continued)

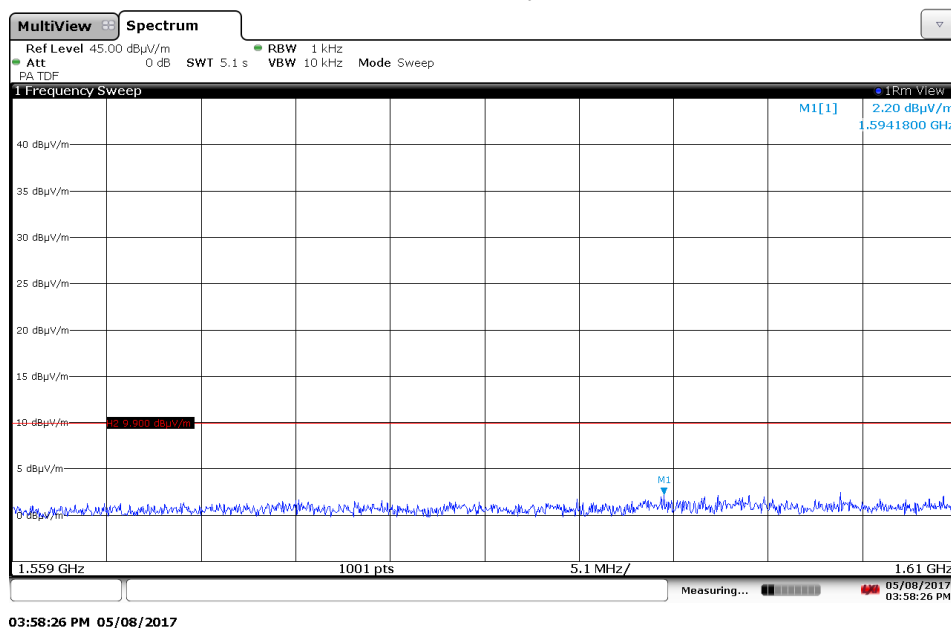
6.5. Spurious Radiated Emissions in GPS Bands (15.250 (d) (2) continued)

6.5.3 1559 to 1610 MHz Band

6.5.3.1 Horizontal Measurement Polarity 1559 to 1610 MHz



6.5.3.2 Vertical Measurement Polarity 1559 to 1610 MHz



6. Measurement Data (continued)

6.6. RMS Power in a 1 MHz Bandwidth (15.250 (d) (1))

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

Frequency (GHz)	Amplitude ¹	Limit	Margin	Ant Polarity	Ant Height	Turntable Azimuth	Result
	(dBμV/m)	(dBμV/m)	(dB)	H/V	cm	Deg	
6.4351	53.84	53.90	-0.06	V	140	316	Compliant

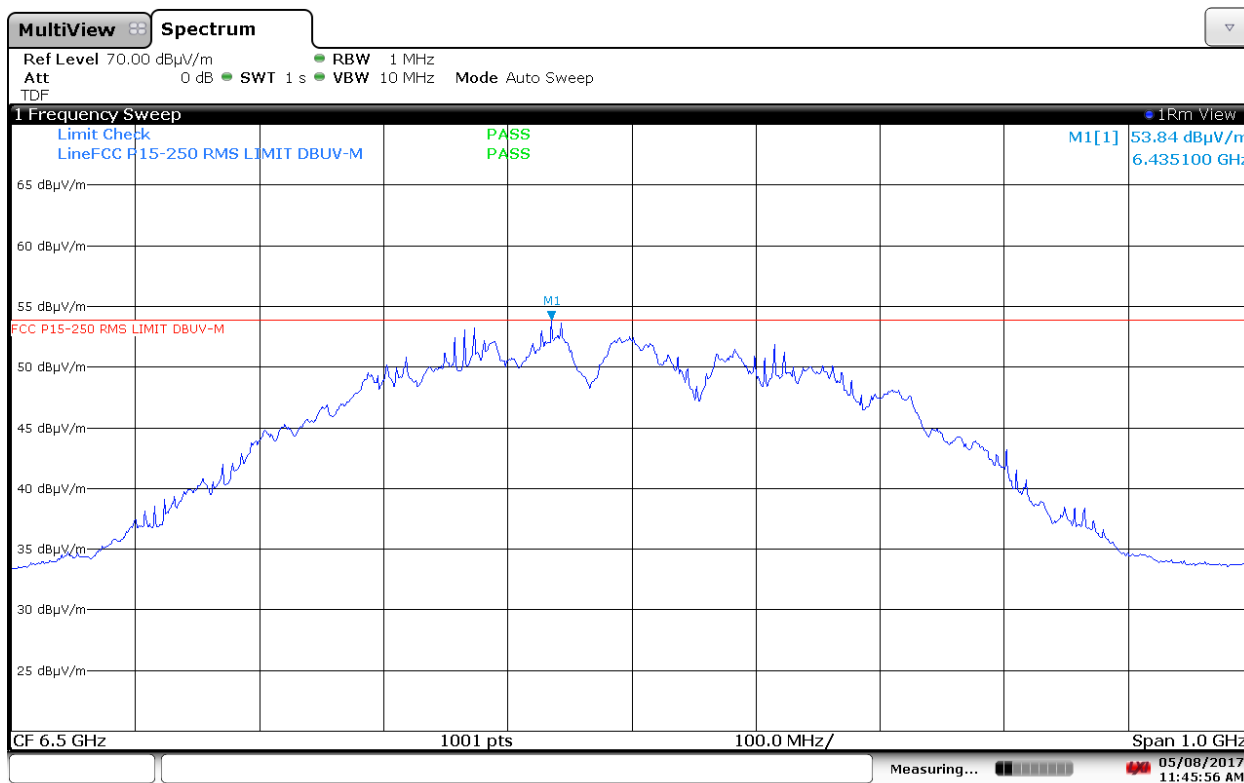
Notes: ¹ Antenna Factor (AF), Cable Factor (CF) and External Preamplifier Gain (PAG) have been entered into the analyzer as transducer factors.

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	Limit	Margin	Ant Polarity	Ant Height	Turntable Azimuth	Result
	(dBm)	(dBm)	(dB)	H/V	cm	Deg	
6.5351	-43.36	-41.30	-0.06	V	140	316	Compliant

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



11:45:57 AM 05/08/2017

6. Measurement Data (continued)

6.6. RMS Power in a 1 MHz Bandwidth (15.250 (d) (1) continued)

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

Frequency (GHz)	Amplitude ¹	Limit	Margin	Ant Polarity	Ant Height	Turntable Azimuth	Result
	(dBμV/m)	(dBμV/m)	(dB)	H/V	cm	Deg	
6.4900	51.00	53.90	-3.90	V	140	316	Compliant

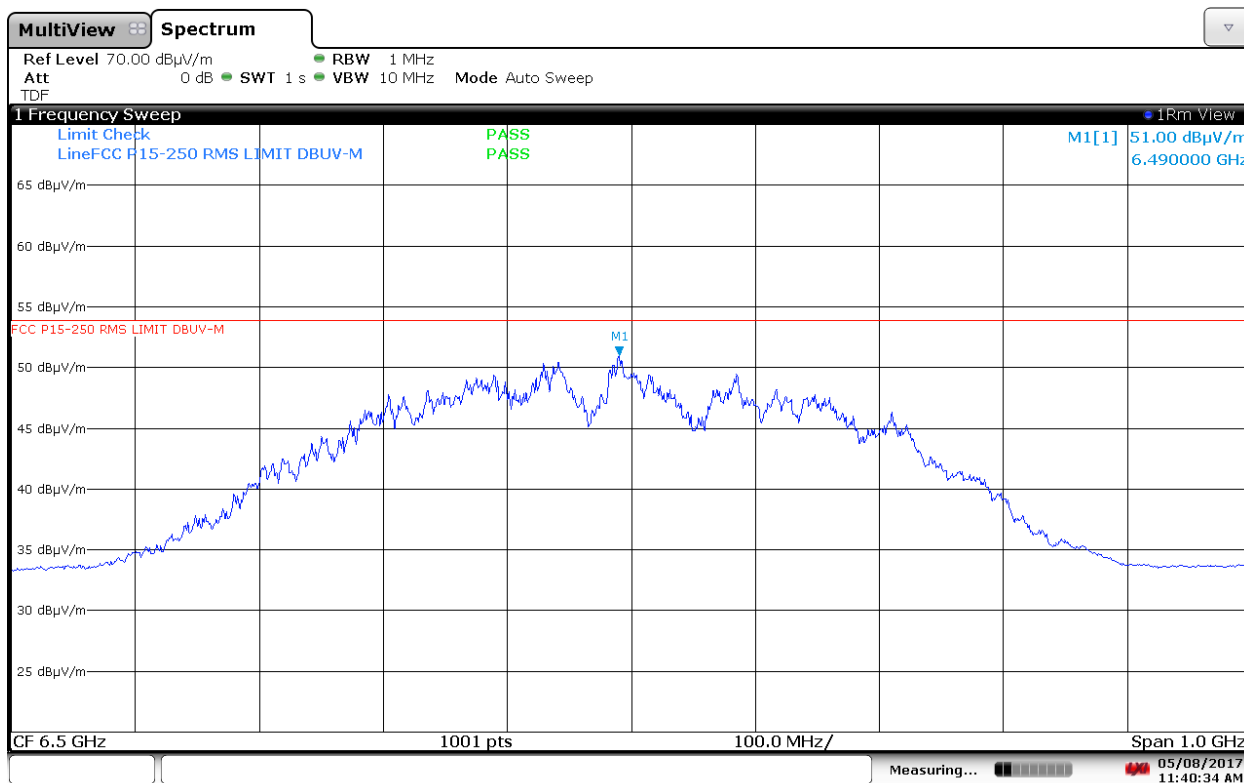
Notes: ¹ Antenna Factor (AF), Cable Factor (CF) and External Preamplifier Gain (PAG) have been entered into the analyzer as transducer factors.

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	Limit	Margin	Ant Polarity	Ant Height	Turntable Azimuth	Result
	(dBm)	(dBm)	(dB)	H/V	cm	Deg	
6.4900	-45.20	-41.30	-3.90	V	140	316	Compliant

6.6.2. Plot of RMS Power at 3 Meters (16M PRF, short packets)



11:40:35 AM 05/08/2017

6. Measurement Data (continued)

6.6. RMS Power in a 1 MHz Bandwidth (15.250 (d) (1) continued)

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

Frequency (GHz)	Amplitude ¹	Limit	Margin	Ant Polarity	Ant Height	Turntable Azimuth	Result
	(dBμV/m)	(dBμV/m)	(dB)	H/V	cm	Deg	
6.4431	53.46	53.90	-0.44	V	140	316	Compliant

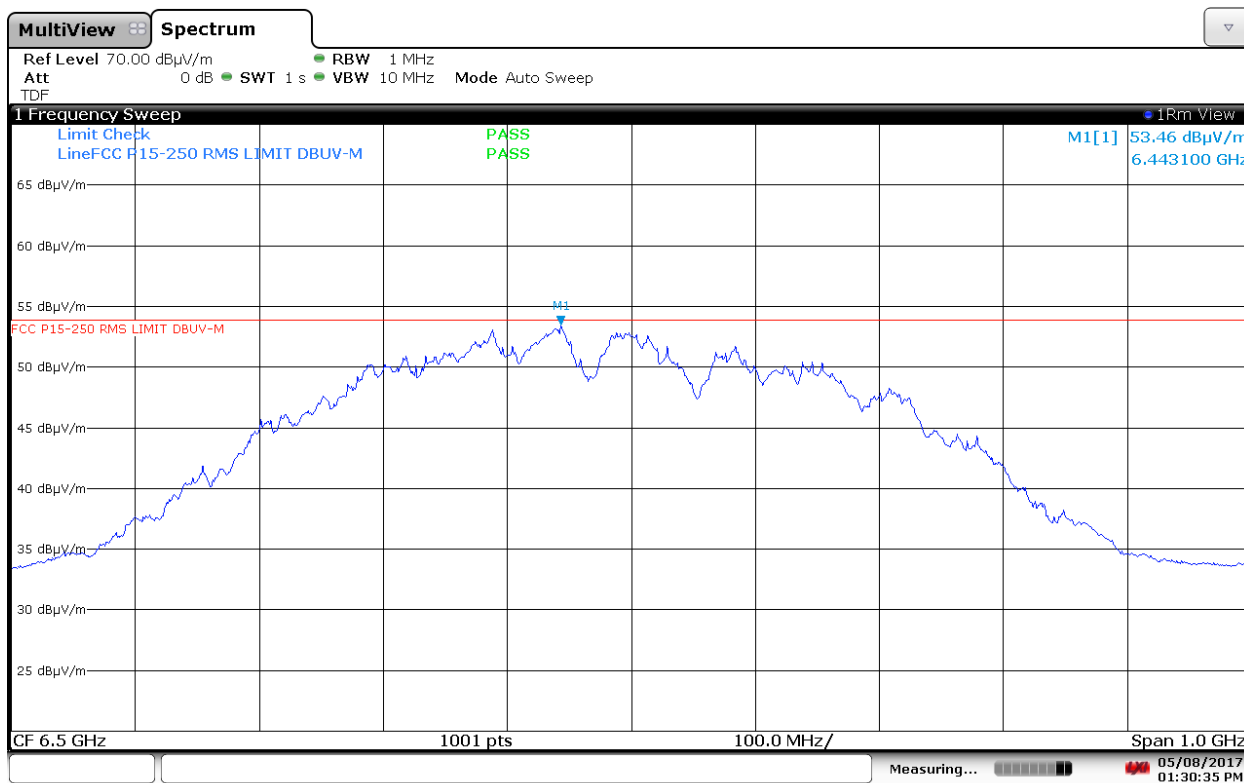
Notes: ¹ Antenna Factor (AF), Cable Factor (CF) and External Preamplifier Gain (PAG) have been entered into the analyzer as transducer factors.

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	Limit	Margin	Ant Polarity	Ant Height	Turntable Azimuth	Result
	(dBm)	(dBm)	(dB)	H/V	cm	Deg	
6.4431	-41.74	-41.30	-0.44	V	140	316	Compliant

6.6.3. Plot of RMS Power at 3 Meters (64M PRF, long packets)



01:30:35 PM 05/08/2017

6. Measurement Data (continued)

6.6. RMS Power in a 1 MHz Bandwidth (15.250 (d) (1) continued)

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

Frequency (GHz)	Amplitude ¹	Limit	Margin	Ant Polarity	Ant Height	Turntable Azimuth	Result
	(dBμV/m)	(dBμV/m)	(dB)	H/V	cm	Deg	
6.4900	52.95	53.90	-0.95	V	140	316	Compliant

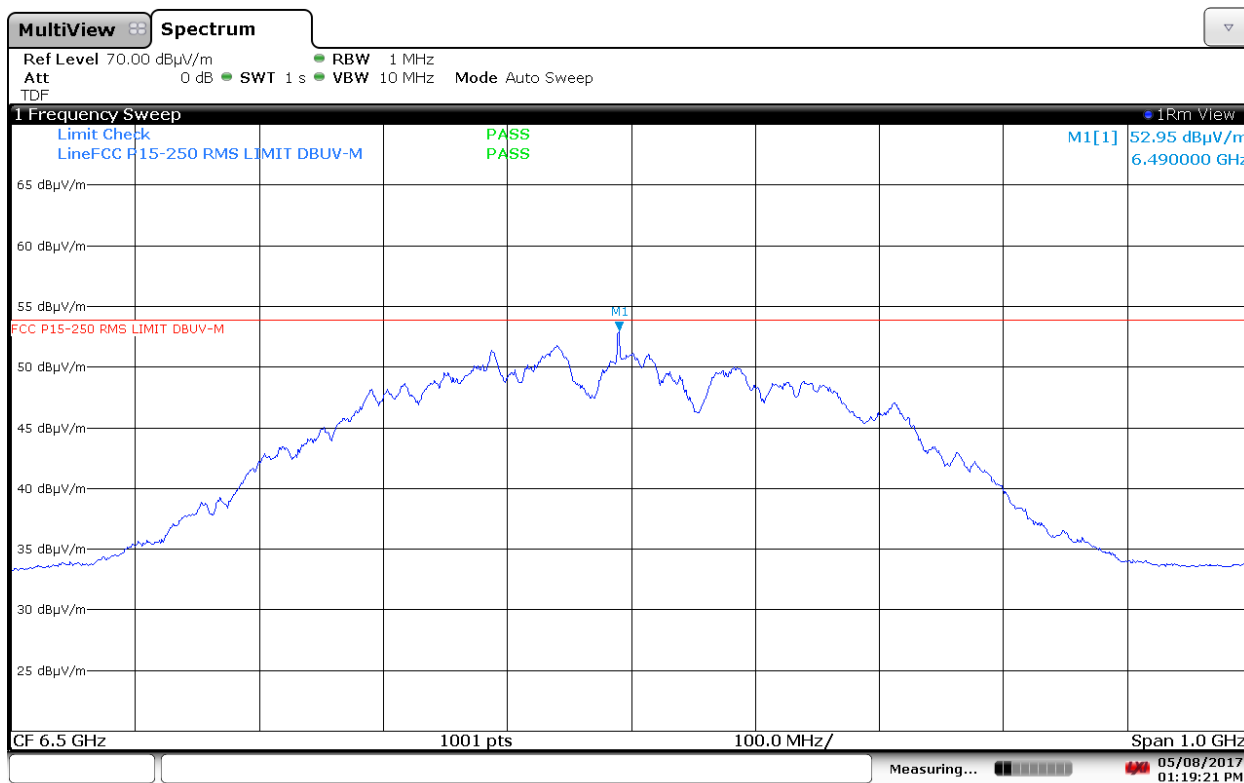
Notes: ¹ Antenna Factor (AF), Cable Factor (CF) and External Preamplifier Gain (PAG) have been entered into the analyzer as transducer factors.

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	Limit	Margin	Ant Polarity	Ant Height	Turntable Azimuth	Result
	(dBm)	(dBm)	(dB)	H/V	cm	Deg	
6.4900	-42.25	-41.30	-0.95	V	140	316	Compliant

6.6.4. Plot of RMS Power at 3 Meters (64M PRF, short packets)



01:19:21 PM 05/08/2017

6. Measurement Data (continued)

6.7. Peak Emissions in a 50 MHz Bandwidth (15.250 (d) (3))

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	
6.4900	91.15	95.20	-4.05	V	140	316	Compliant

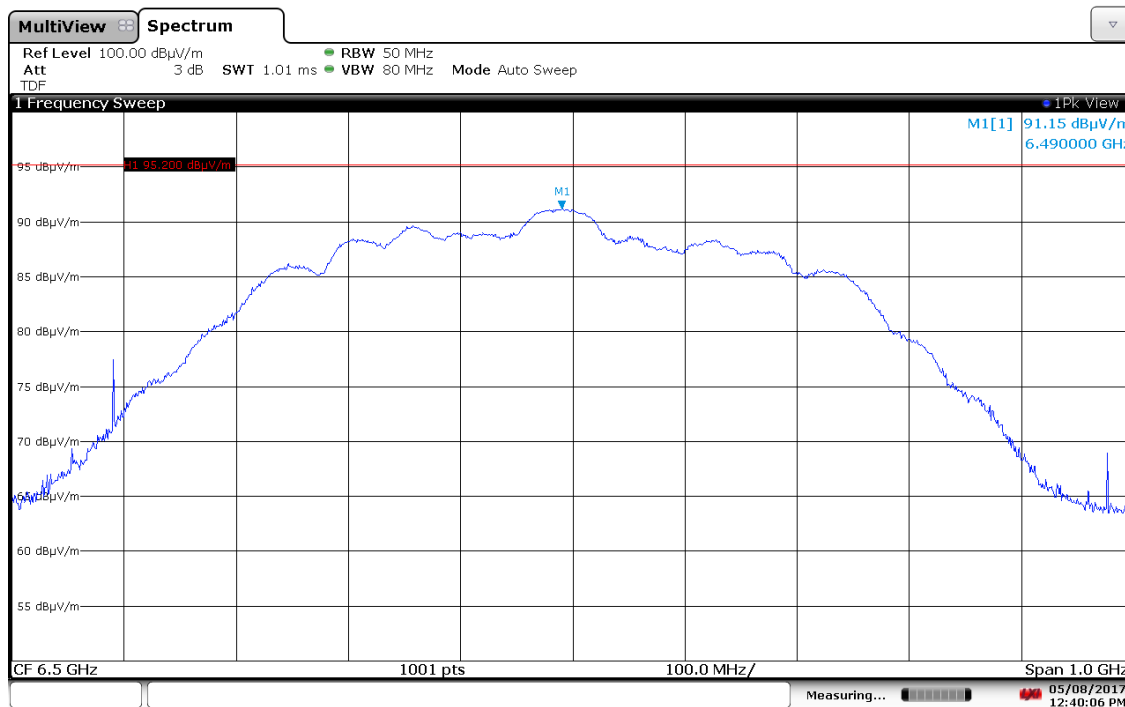
Notes: ¹ Antenna Factor (AF), Cable Factor (CF) and External Preamplifier Gain (PAG) have been entered into the analyzer as transducer factors.

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	
6.4900	-4.05	0.00	-4.05	V	140	316	Compliant

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



12:40:07 PM 05/08/2017

6. Measurement Data (continued)

6.7. Peak Emissions in a 50 MHz Bandwidth (15.250 (d) (3) continued)

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	
6.3901	95.00	95.20	-0.20	V	140	316	Compliant

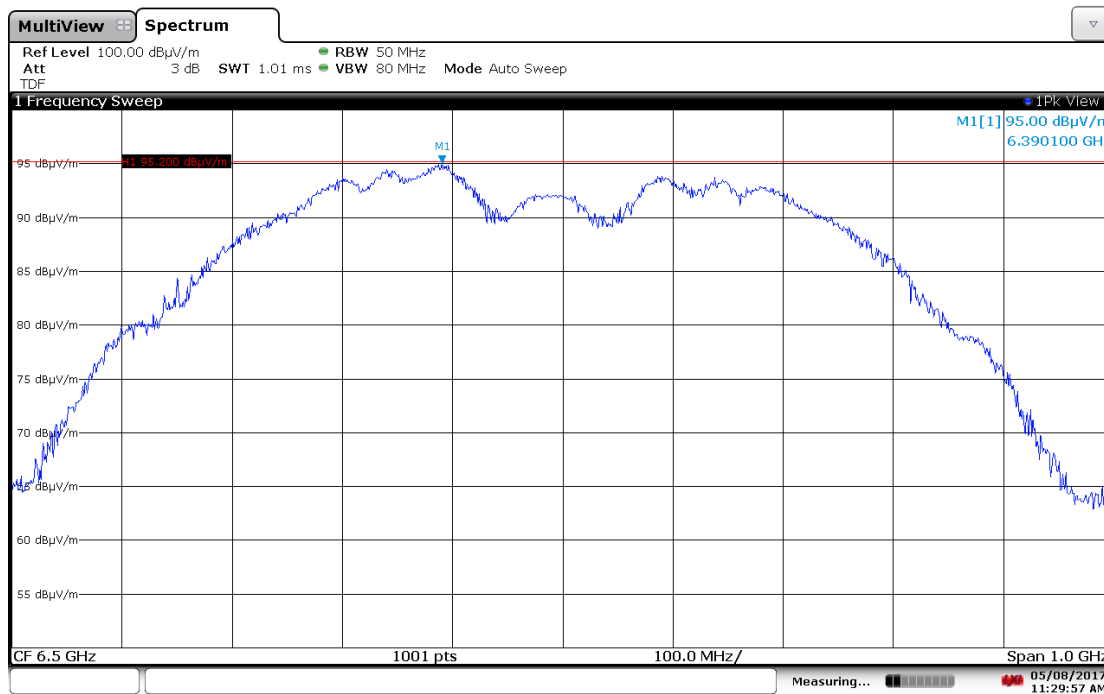
Notes: ¹ Antenna Factor (AF), Cable Factor (CF) and External Preamplifier Gain (PAG) have been entered into the analyzer as transducer factors.

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	
6.3901	-0.20	0.00	-0.20	V	140	316	Compliant

6.7.2 Plot of Peak Power at 3 Meters (16M PRF, short packets)



6. Measurement Data (continued)

6.7. Peak Emissions in a 50 MHz Bandwidth (15.250 (d) (3) continued)

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	
6.5020	87.18	95.20	-8.02	V	140	316	Compliant

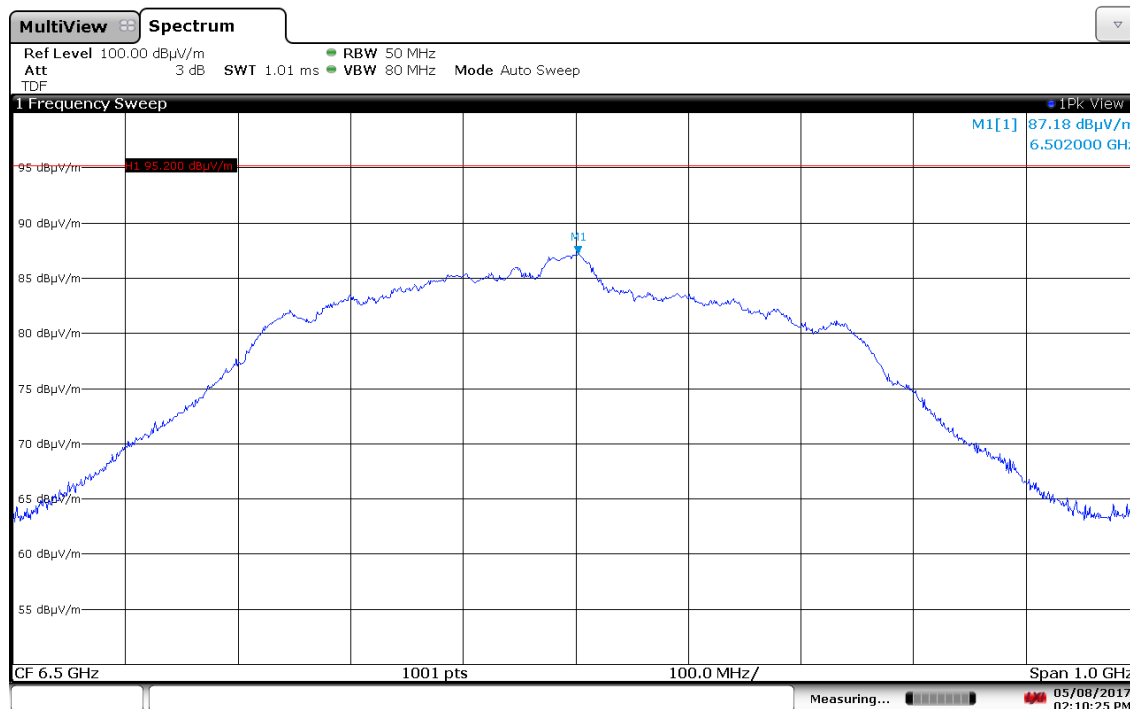
Notes: ¹ Antenna Factor (AF), Cable Factor (CF) and External Preamplifier Gain (PAG) have been entered into the analyzer as transducer factors.

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	
6.5020	-8.02	0.00	-8.02	V	140	316	Compliant

6.7.3 Plot of Peak Power at 3 Meters (64M PRF, long packets)



02:10:25 PM 05/08/2017

6. Measurement Data (continued)

6.7. Peak Emissions in a 50 MHz Bandwidth (15.250 (d) (3) continued)

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 (dBμV/m)	Limit (dBμV/m)	Margin (dB)	Ant Polarity H/V	Ant Height cm	Turntable Azimuth Deg	Result
6.4990	95.02	95.20	-0.18	V	140	316	Compliant

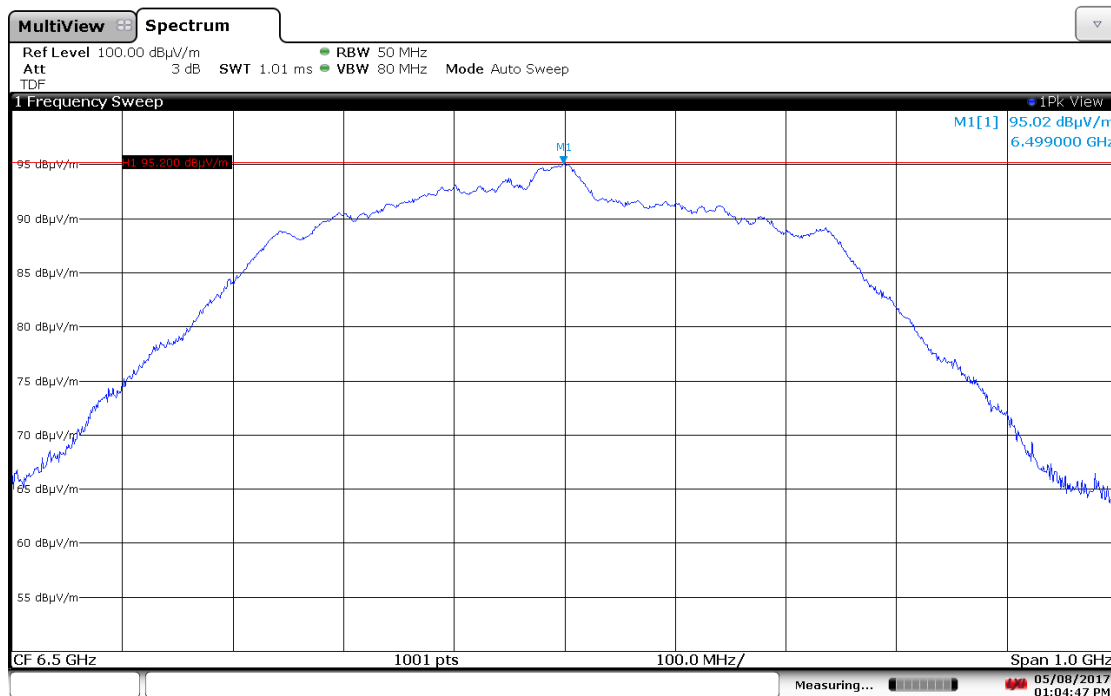
Notes: ¹ Antenna Factor (AF), Cable Factor (CF) and External Preamplifier Gain (PAG) have been entered into the analyzer as transducer factors.

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
6.4990	-0.18	0.00	-0.18	V	140	316	Compliant

6.7.4 Plot of Peak Power at 3 Meters (64M PRF, short packets)



01:04:47 PM 05/08/2017

6. Measurement Data (continued)

6.8 Conducted Emissions Test Setup

6.8.1. Regulatory Limit: FCC Part 15.207

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	Hewlett Packard	8546A	3330A00115	12/4/2018
RF Filter Section	Hewlett Packard	85460A	3325A00121	12/4/2018
LISN	EMCO	3825/2	9109-1860	11/17/2017
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: 3/15/2017
 Test Engineer: Brian Breault
 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.

Test Number: 142-17

Issue Date: 5/8/2017

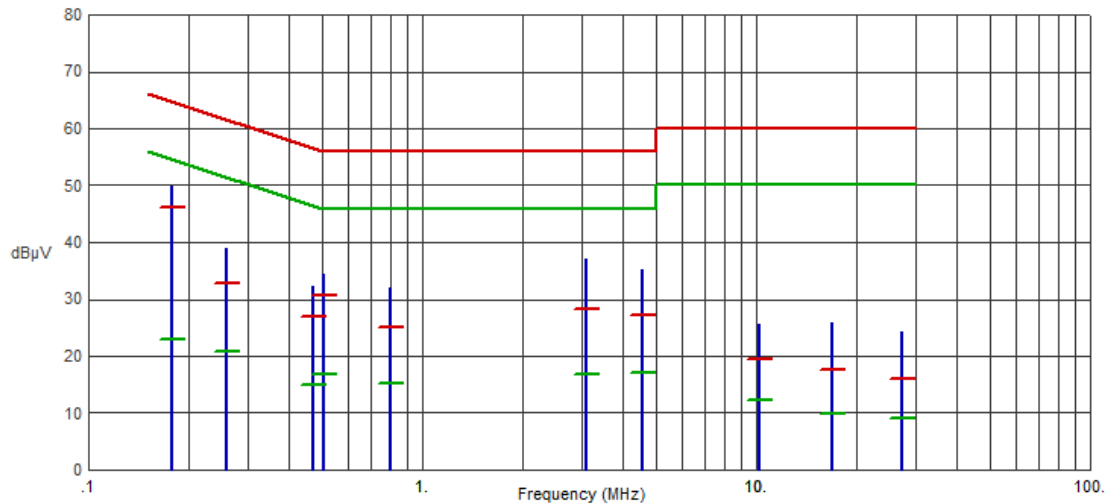
6. Measurement Data (continued)

6.9 Conducted Emissions Test Results

6.9.1 120 Volts, 60 Hz Phase

Test No.: 142-17, 120 Volts, 60 Hz Phase

EN55022, 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
.1770	49.95	46.05	64.63	-18.58	23.02	54.63	-31.61	
.2590	38.91	32.69	61.46	-28.77	20.67	51.46	-30.79	
.4729	32.33	26.88	56.46	-29.58	14.96	46.46	-31.50	
.5090	34.43	30.79	56.00	-25.21	16.78	46.00	-29.22	
.8057	32.09	25.01	56.00	-30.99	15.15	46.00	-30.85	
3.1130	37.19	28.27	56.00	-27.73	16.71	46.00	-29.29	
4.5829	35.09	27.30	56.00	-28.70	17.11	46.00	-28.89	
10.2509	25.50	19.34	60.00	-40.66	12.34	50.00	-37.66	
16.8795	25.79	17.67	60.00	-42.33	9.85	50.00	-40.15	
27.4139	24.35	16.00	60.00	-44.00	9.13	50.00	-40.87	

Test Number: 142-17

Issue Date: 5/8/2017

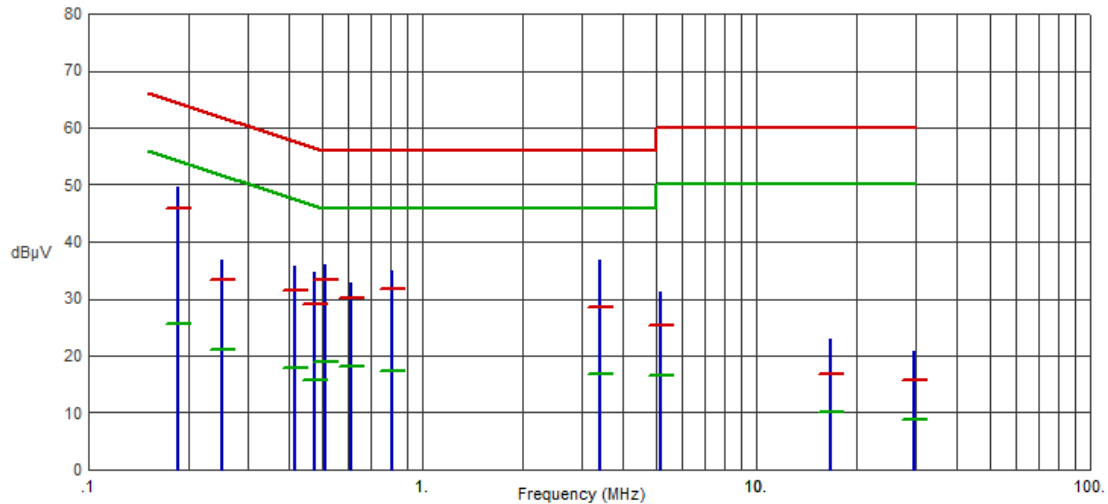
6. Measurement Data (continued)

6.9. Conducted Emissions Test Results (continued)

6.9.2. 120 Volts, 60 Hz Neutral

Test No.: 142-17, 120 Volts, 60 Hz Neutral

EN55022, 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
.1845	49.61	45.88	64.28	-18.40	25.72	54.28	-28.56	
.2508	36.88	33.35	61.73	-28.38	21.09	51.73	-30.64	
.4150	35.67	31.56	57.55	-25.99	17.96	47.55	-29.59	
.4772	34.74	28.97	56.39	-27.42	15.76	46.39	-30.63	
.5096	36.02	33.27	56.00	-22.73	19.00	46.00	-27.00	
.6117	32.74	30.01	56.00	-25.99	18.07	46.00	-27.93	
.8106	35.00	31.64	56.00	-24.36	17.34	46.00	-28.66	
3.4125	36.67	28.44	56.00	-27.56	16.73	46.00	-29.27	
5.1604	31.27	25.34	60.00	-34.66	16.45	50.00	-33.55	
16.7052	22.97	16.77	60.00	-43.23	10.08	50.00	-39.92	
29.6543	20.89	15.73	60.00	-44.27	8.70	50.00	-41.30	

6. Measurement Data (continued)

6.10. Public Exposure to Radio Frequency Energy Levels (1.1307 (b)(1))

6.10.1 RF Exposure for devices that operate above 6 GHz

Center Frequency (GHz)	MPE Distance (cm)	DUT Output Power (dBm)	DUT Antenna Gain (dBi)	Power Density		FCC Limit (mW/cm ²)
				(mW/cm ²)	(W/m ²)	
	(1)	(2)	(3)	(4)		(5)
6.4900	5	-4.05	0.0	0.0012527	0.0125271	1
6.3901	5	-0.20	0.0	0.0030398	0.0303984	1
6.5020	5	-8.02	0.0	0.0005022	0.0050217	1
6.4990	5	-0.18	0.0	0.0030539	0.0305387	1

$$PD = \frac{OP + AG}{(4 \times \pi \times d^2)}$$

1. Reference CFR 2.1093(b): For purposes of this section, a portable device is defined as a transmitting device designed to be used so that the radiating structure(s) of the device is/are within 5 centimeters of the body of the user.
2. Section 6.7 of this test report.
3. Data supplied by the client.
4. Power density is calculated from field strength measurement and antenna gain.
5. Reference CFR 1.1310, Table 1: Limits for Maximum Permissible Exposure (MPE), Section (B): Limits for General Population/Uncontrolled Exposure.
6. Reference IC RSS-102 Section 4 Table 4 RF Field Strength Limits for Devices Used by the General Public (Uncontrolled Environment)

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 17025:2005 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-0208.

Compliance Worldwide is also designated as a Phase 1 CAB under APEC-MRA (US0132) for Australia/New Zealand AS/NZS CISPR 22, 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 required by EN 55022. 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.

Both 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 – 10 kHz to 1 GHz Front



8. Test Images

8.2. Spurious and Harmonic Emissions – 10 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



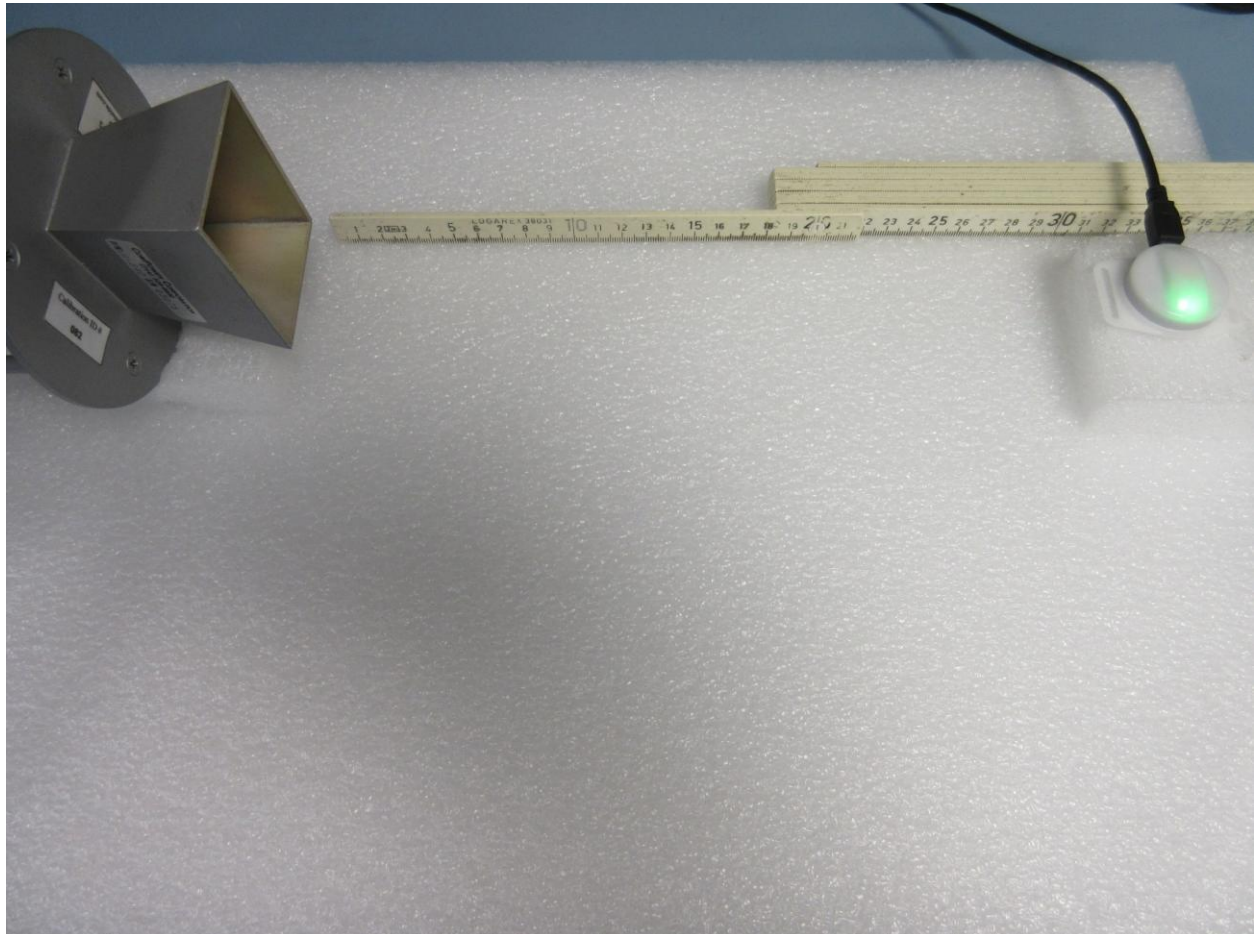
8. Test Images

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



8. Test Images

8.5. 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)

