

**COMPLIANCE WORLDWIDE INC.
TEST REPORT 183-17**

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

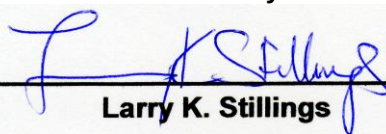
**Ciholas, Inc.
3700 Bell Road
Newbergh, IN 47630**

**For the
DWETH111**

FCC ID: 2ALIR-DWETH111

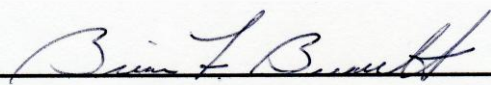
Report Issued on May 8, 2017

Tested By



Larry K. Stillings

Reviewed By



Brian F. Breault

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1. Scope

This test report certifies that the DWETH111 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: DWETH111
- 2.3. Serial Number: Pre production
- 2.4. 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.
- 2.5. Power Source: 56 VDC via PoE Injector
- 2.6. Hardware Revision: 2.2
- 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 DWETH111 to a laptop via a PoE Injector. The laptop is then used to telnet into the DWETH111 containing special firmware to configure packet size, and PRFs for the EUT. The DWETH111 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 configured in two orientations, upright on the table as if the device was wall mounted, and flat on the table as if the device was tripod or ceiling mounted. The axes were defined as follows:

- X-Axis Flat on the Table with the unit pointed towards the ceiling with the Ethernet cable coming out the bottom.
- Y-Axis On Edge on the table with the face of the unit pointed towards the antenna and Ethernet cable exiting the rear of the unit determining the zero degree point.

3.2. Cables

Cable Type	Length	Shield	From	To
Ethernet	10M	No	EUT	POE Injector
Ethernet	1M	No	POE Injector	Laptop

3. Product Configuration (cont.)

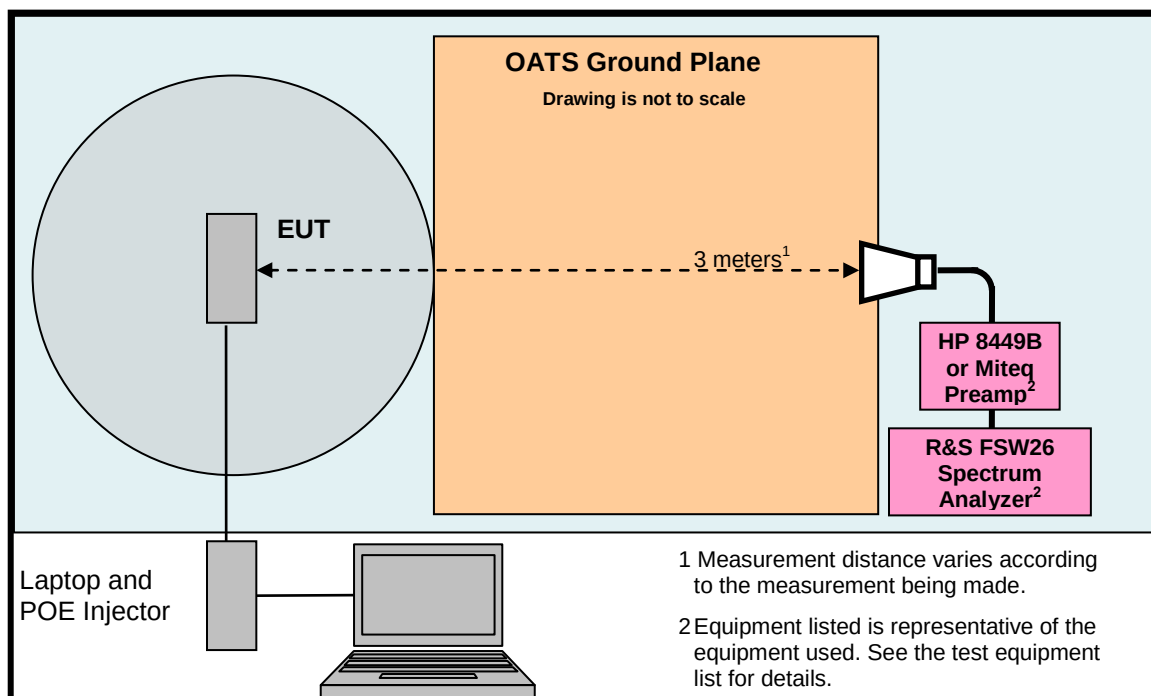
3.3. EUT Hardware

Manufacturer	Model/Part # / Options	Serial Number	Input Volts	Freq (Hz)	Description/Function
Ciholas	DWETH111	Pre Production	56	DC	UWB Anchor

3.4. Support Equipment

Description	Manufacturer	Model/Part #	
Laptop	Dell	Inspiron E1505	
POE Injector	Phihong	POE31U-1AT	

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 960 MHz to 18 GHz	ETS-Lindgren	3117	00143292	2/22/2019	3 Years
Horn Antenna 18 to 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
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:	4/18/2017, 4/19/2017, 5/3/2017, 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	Meas Freq.	-10 dB Band Edges		15.250 Frequency Band		Result
		(MHz)	Lower	Upper	F _{MIN} (MHz)	F _{MAX} (MHz)	
-	OATS	6505	6207.3	6817.7	5925	7250	Compliant
-	Ambient	6505	6234.3	6808.7	5925	7250	Compliant
1	-20	6505	6893.3	6824.7	5925	7250	Compliant
2	-10	6505	6190.3	6811.7	5925	7250	Compliant
3	0	6505	6189.3	6812.7	5925	7250	Compliant
4	+10	6505	6190.3	6810.7	5925	7250	Compliant
5	+20	6505	6189.3	6811.7	5925	7250	Compliant
6	+30	6505	6193.3	6812.7	5925	7250	Compliant
7	+40	6505	6201.3	6811.7	5925	7250	Compliant
8	+50	6505	6194.3	6814.7	5925	7250	Compliant

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6. Measurement Data (continued)

6.3. Wideband Bandwidth (15.250 (b))

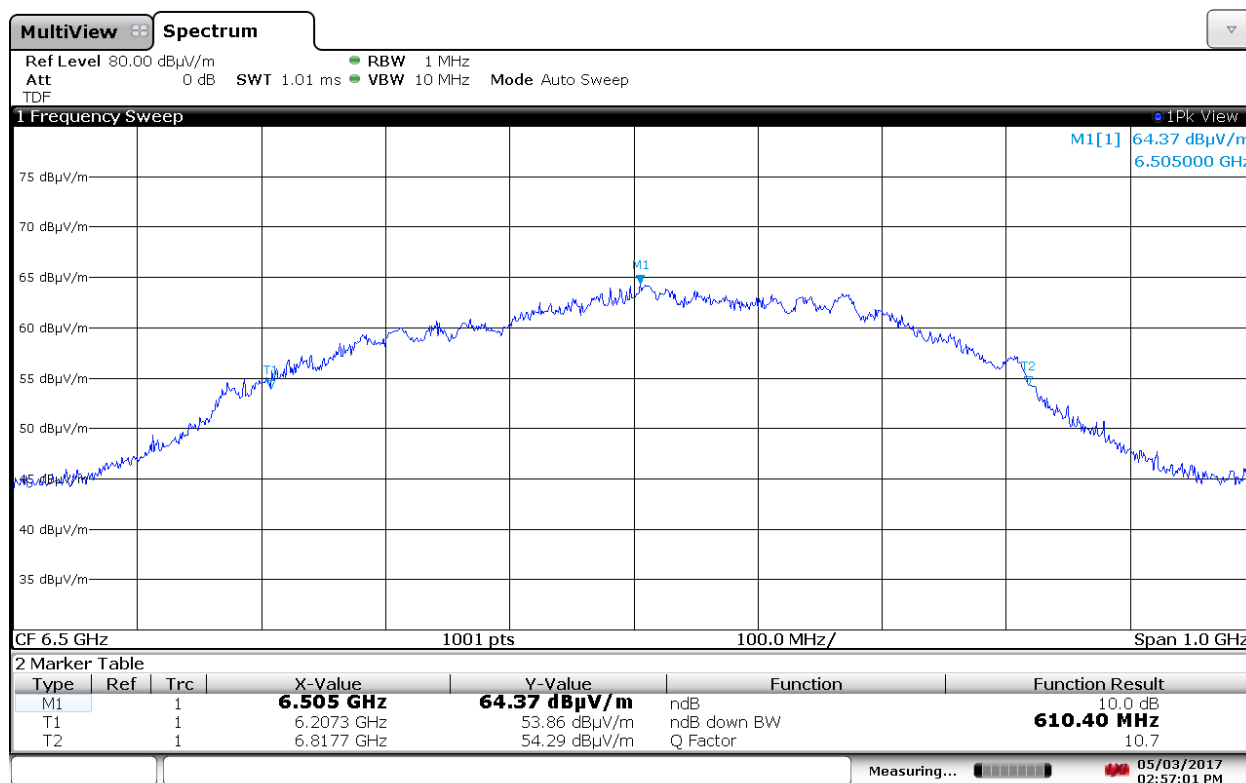
Requirement: The -10 dB bandwidth of the fundamental emission shall be at least 50 MHz.

Result: Compliant

6.3.1. Measurement Data – Values in GHz

f_M	The highest emission peak	6.5050
f_L	10 dB below the highest peak	6.2073
f_H	10 dB above the highest peak	6.8177
Bandwidth	Calculated: ($f_H - f_L$)	0.6104

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



02:57:01 PM 05/03/2017

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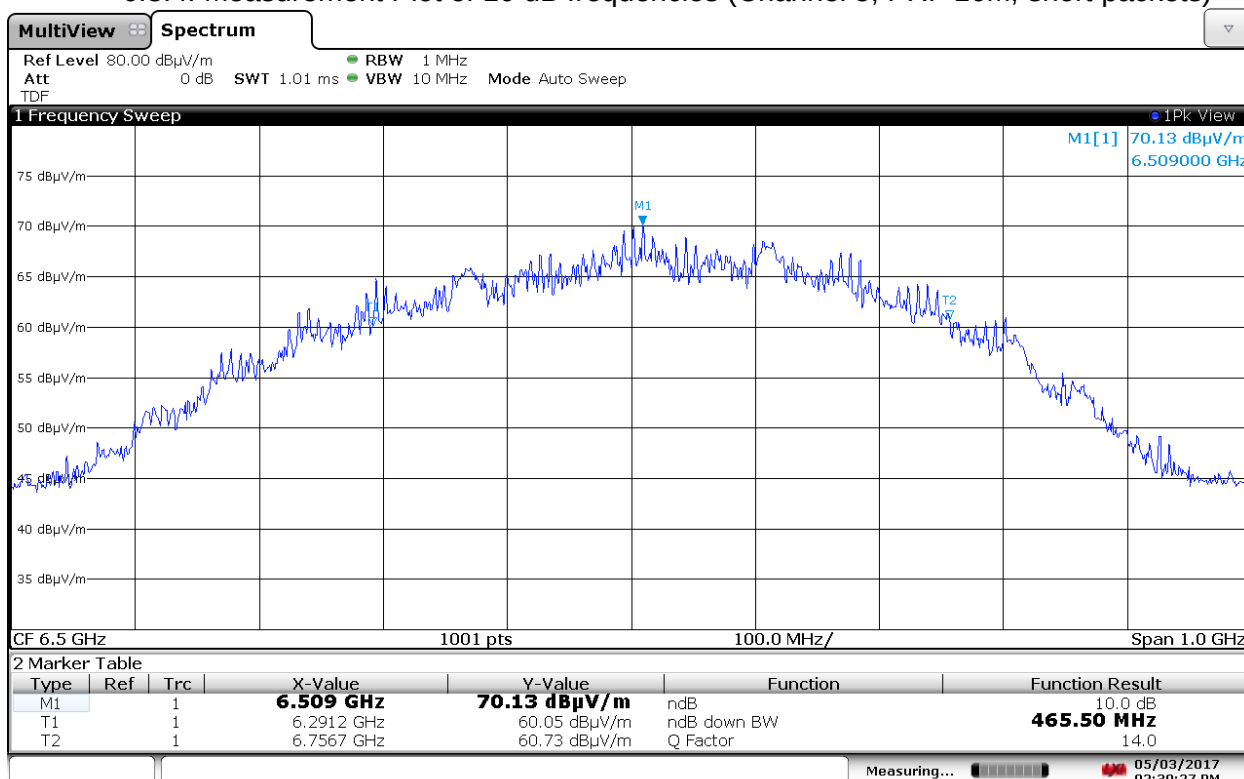
6. Measurement Data (continued)

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

6.3.3. Measurement Data – Values in GHz

f_M	The highest emission peak	6.5090
f_L	10 dB below the highest peak	6.2912
f_H	10 dB above the highest peak	6.7567
Bandwidth	Calculated: ($f_H - f_L$)	0.4655

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



02:39:27 PM 05/03/2017

Test Number: 183-17

Issue Date: 5/8/2017

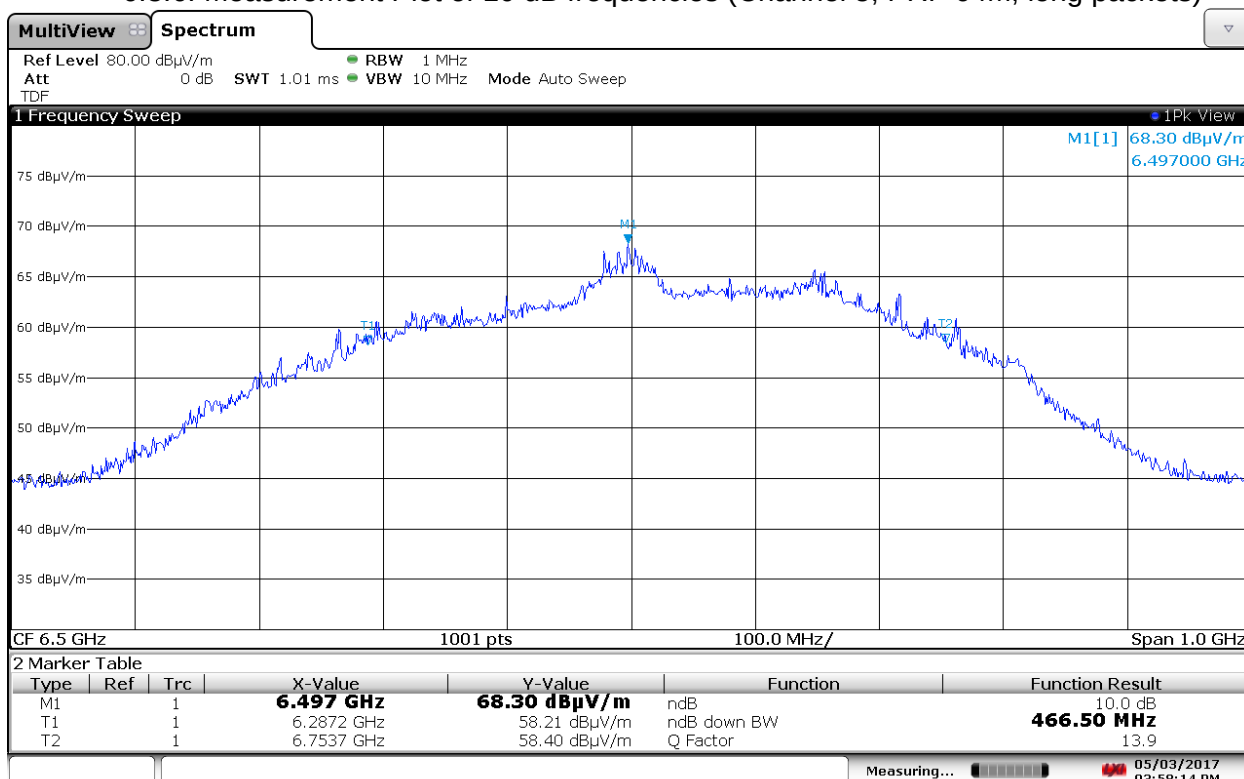
6. Measurement Data (continued)

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

6.3.5. Measurement Data – Values in GHz

f_M	The highest emission peak	6.4970
f_L	10 dB below the highest peak	6.2872
f_H	10 dB above the highest peak	6.7537
Bandwidth	Calculated: ($f_H - f_L$)	0.4665

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



03:58:14 PM 05/03/2017

Test Number: 183-17

Issue Date: 5/8/2017

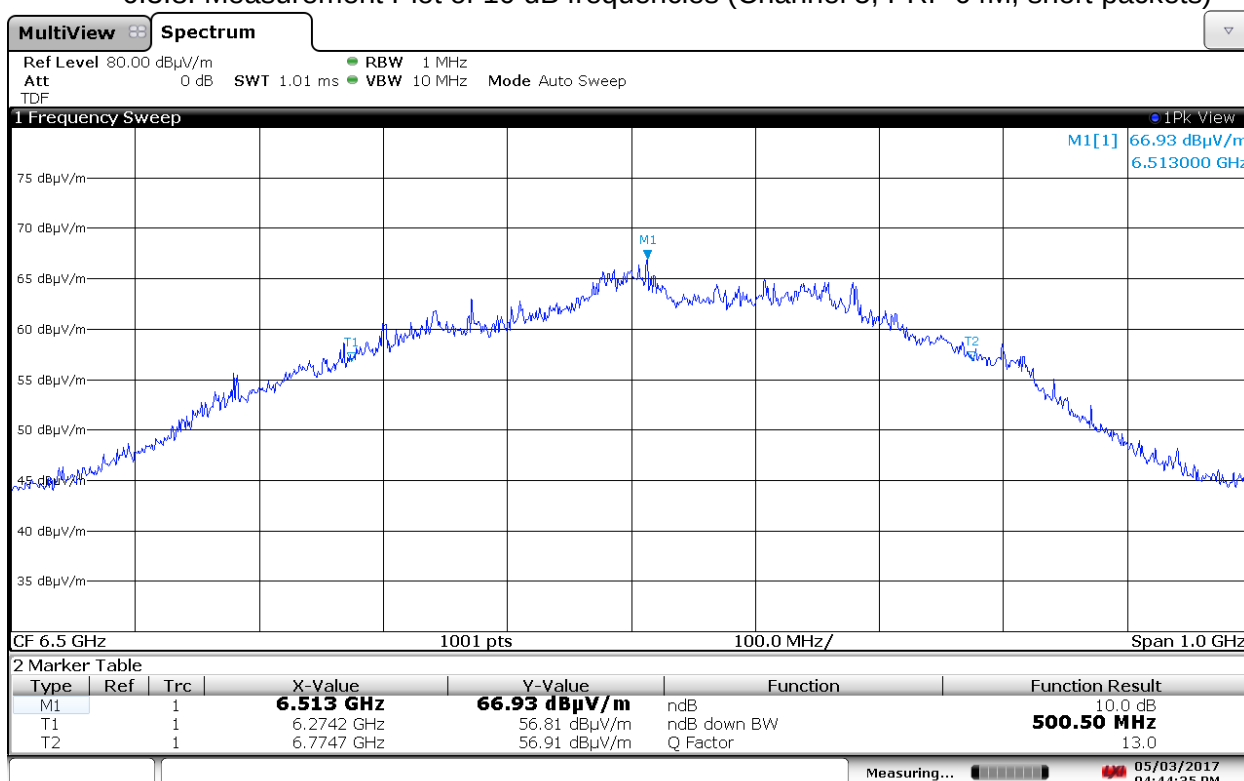
6. Measurement Data (continued)

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

6.3.7. Measurement Data – Values in GHz

f_M	The highest emission peak	6.5130
f_L	10 dB below the highest peak	6.2742
f_H	10 dB above the highest peak	6.7747
Bandwidth	Calculated: ($f_H - f_L$)	0.5005

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



04:44:36 PM 05/03/2017

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 (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

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 ($\mu\text{V/m}$)	Field Strength ($\text{dB}\mu\text{V/m}$)
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

Notes: The signals in the 960 MHz to 3 GHz range on the 960 MHz to 8 GHz plots in sections 6.4.2 to 6.4.17 are due to the Ethernet packet traffic from the processor to the UWB chipset and fall under the requirements of 15.209, where the average limit is 54 $\text{dB}\mu\text{V/m}$.

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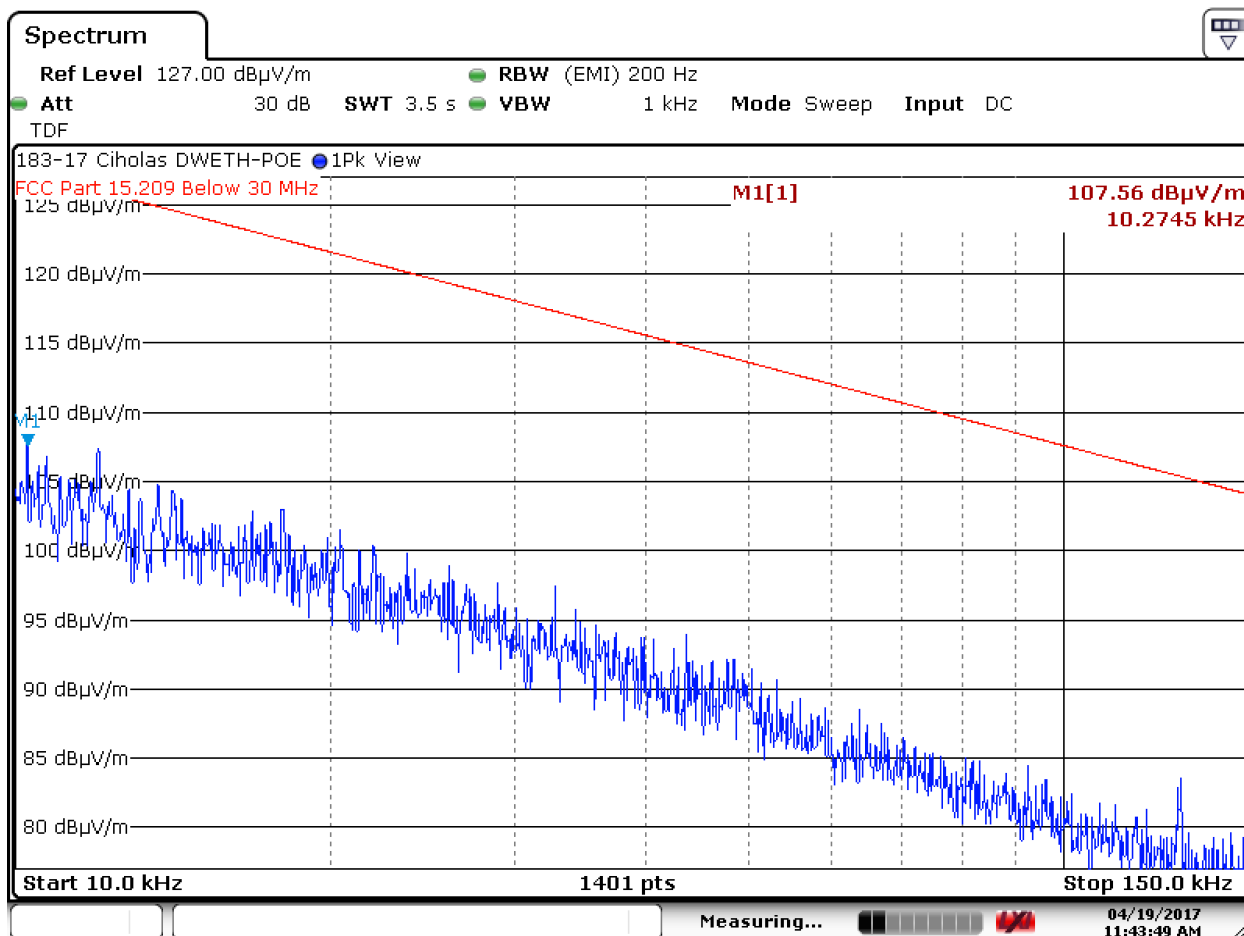
6. Measurement Data (continued)

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

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: 19.APR.2017 11:43:48

Test Number: 183-17

Issue Date: 5/8/2017

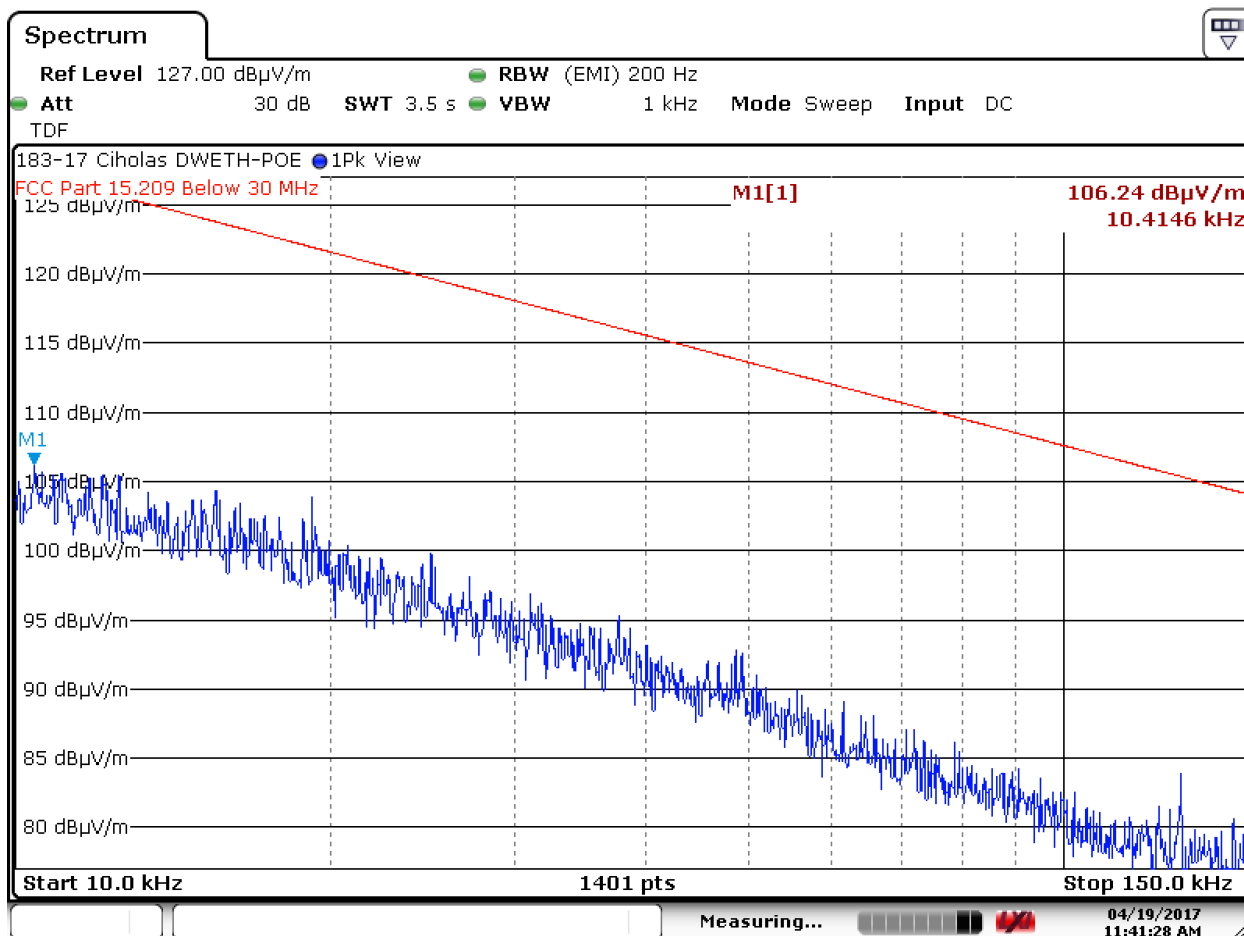
6. Measurement Data (continued)

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

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: 19.APR.2017 11:41:27

Test Number: 183-17

Issue Date: 5/8/2017

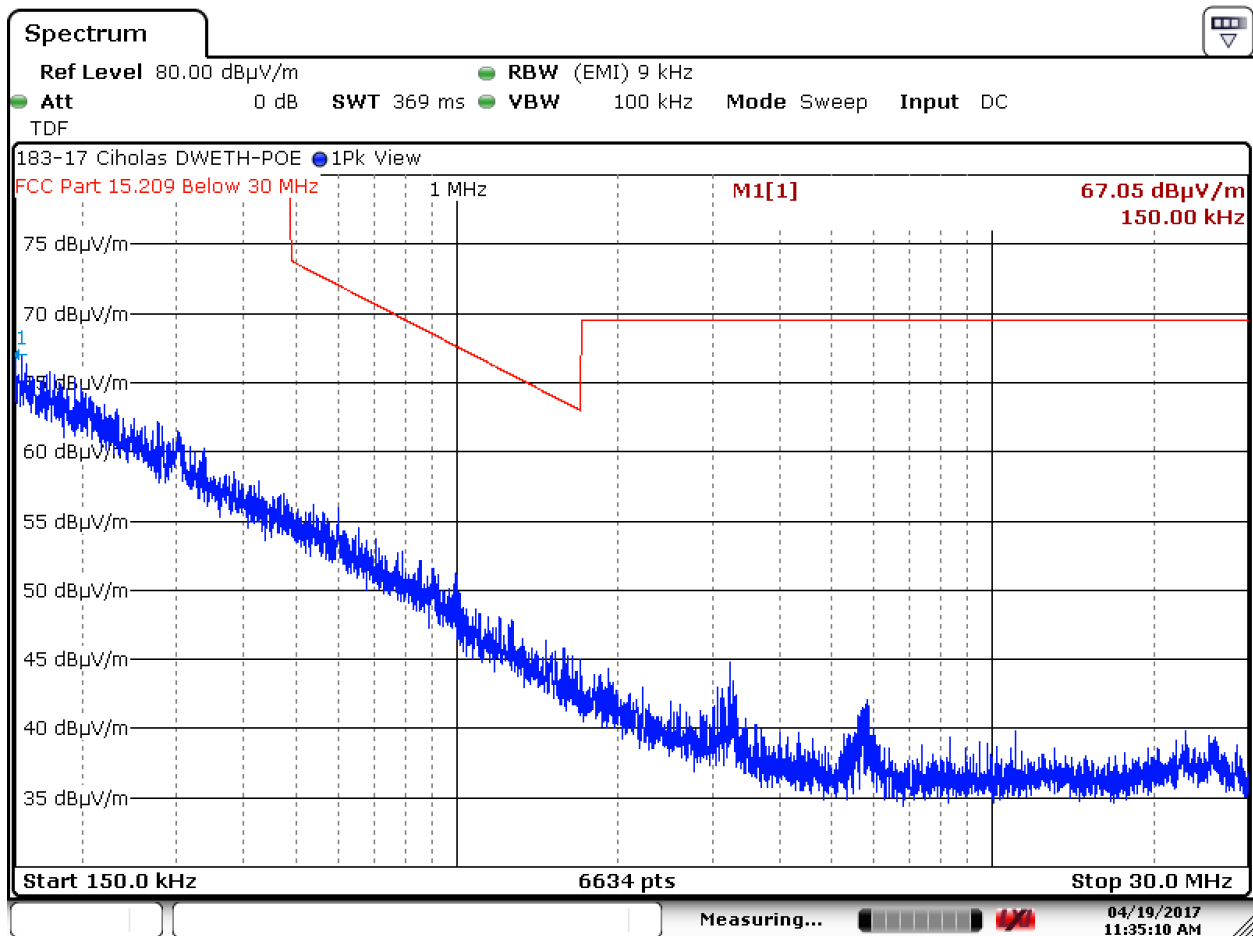
6. Measurement Data (continued)

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

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: 19.APR.2017 11:35:08

Test Number: 183-17

Issue Date: 5/8/2017

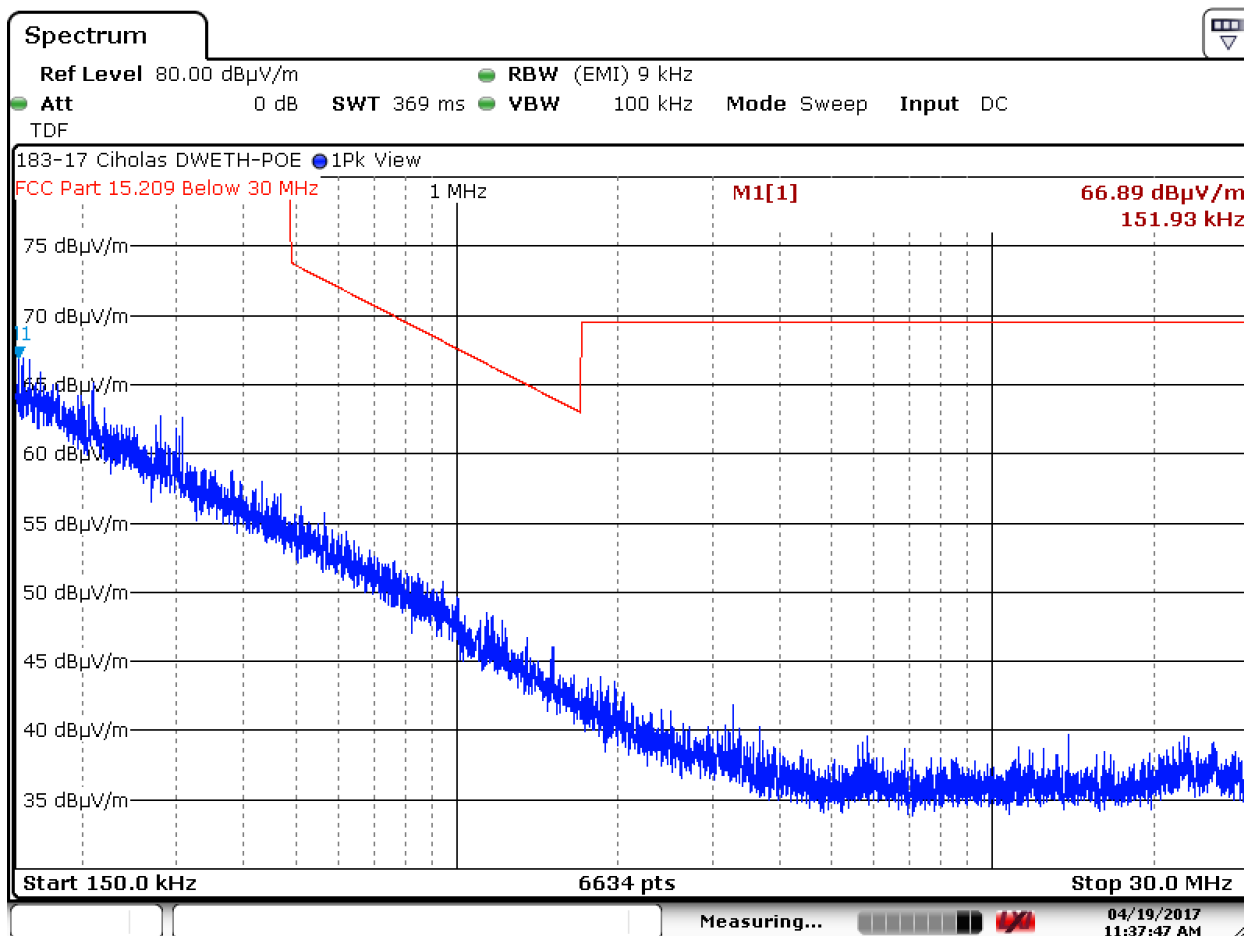
6. Measurement Data (continued)

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

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: 19.APR.2017 11:37:45

Test Number: 183-17

Issue Date: 5/8/2017

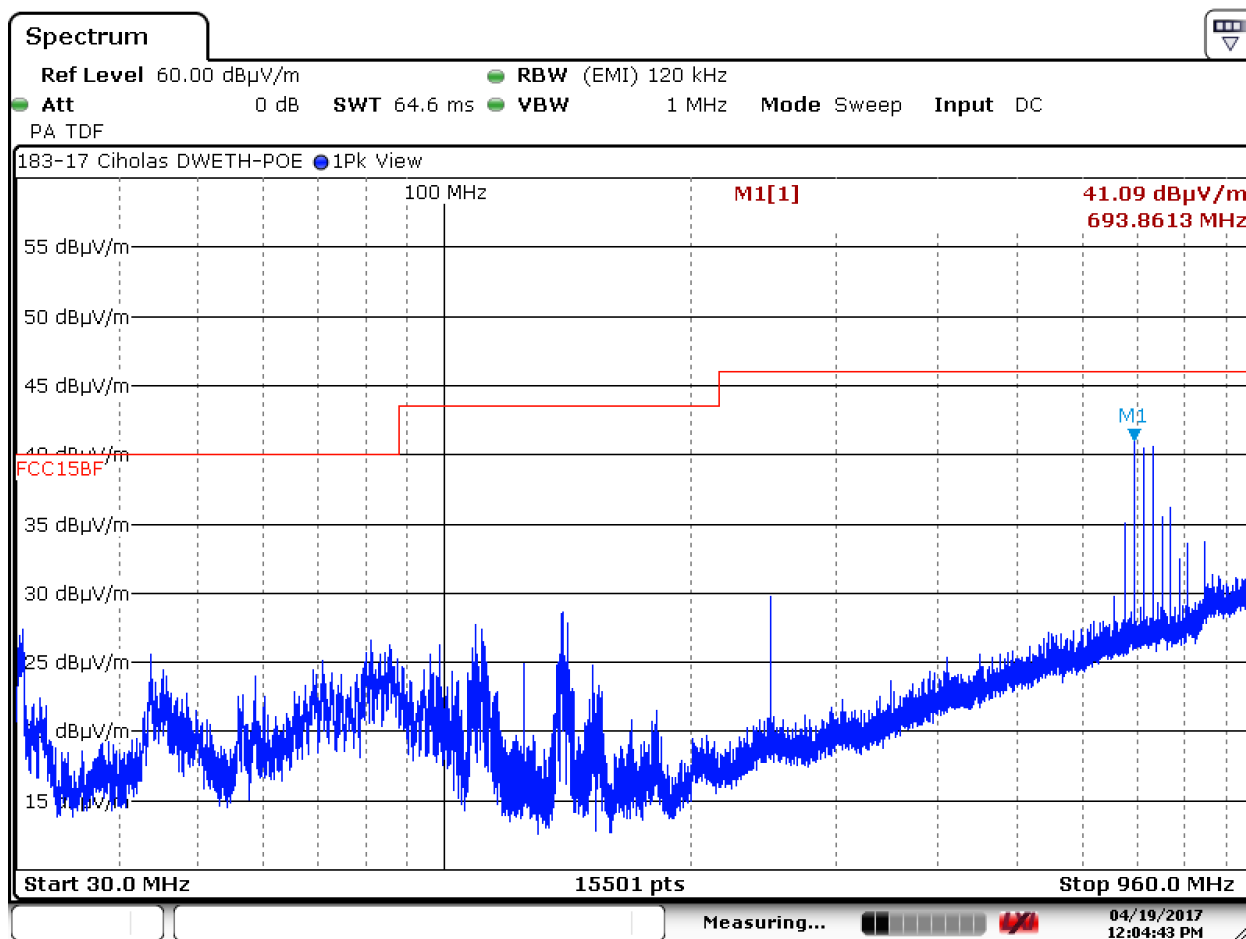
6. Measurement Data (continued)

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

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 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: 19.APR.2017 12:04:41

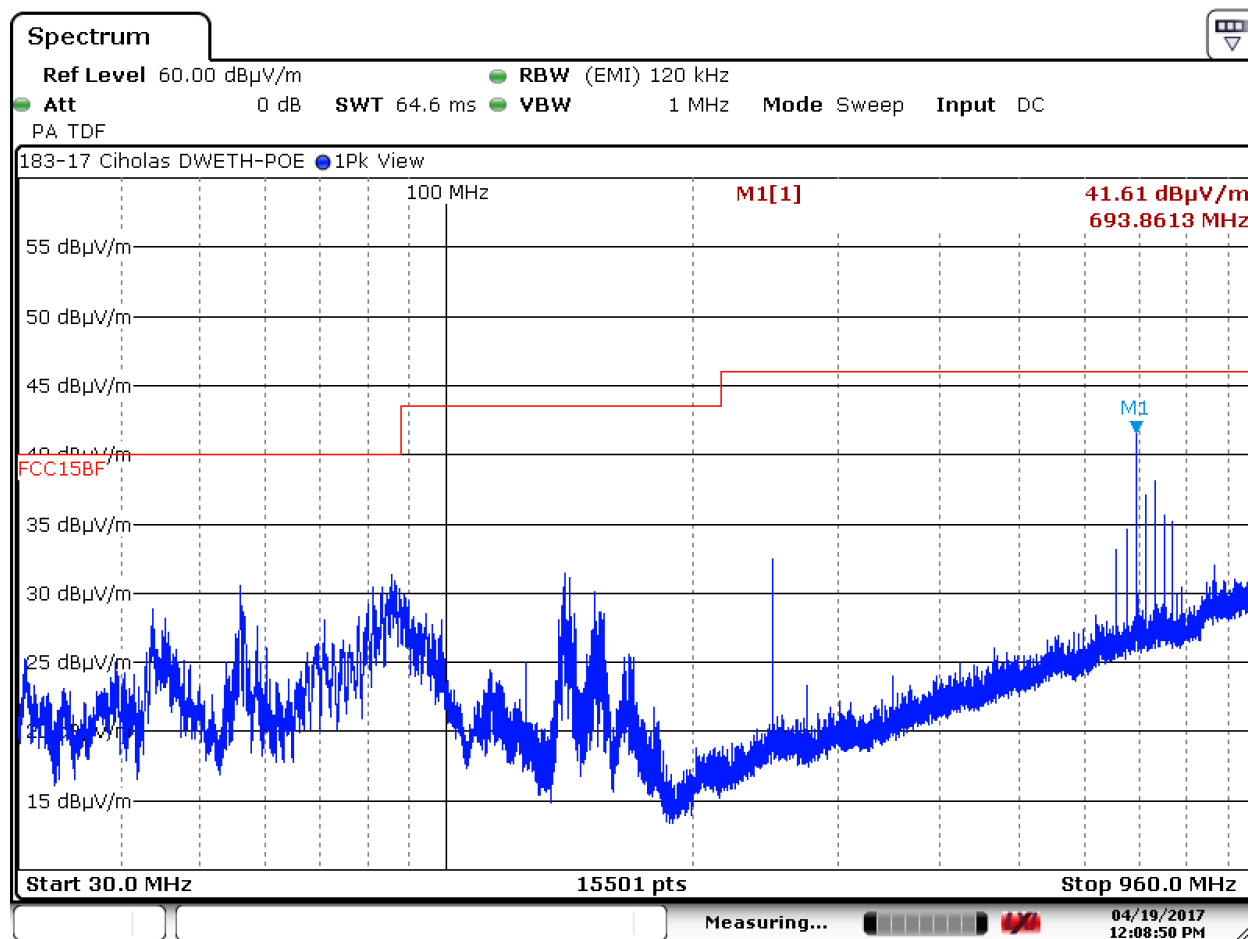
6. Measurement Data (continued)

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

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 within 6 dB of the limits below 960 MHz on our 3 Meter OATS.

6.4.1.6 Vertical Polarity – 30 to 960 MHz

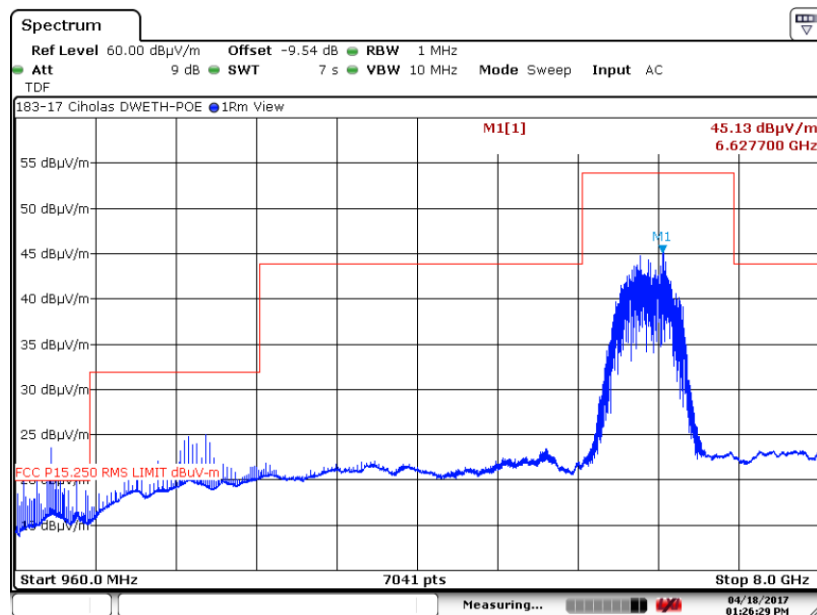


Date: 19.APR.2017 12:08:49

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)



Date: 18.APR.2017 13:26:27

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

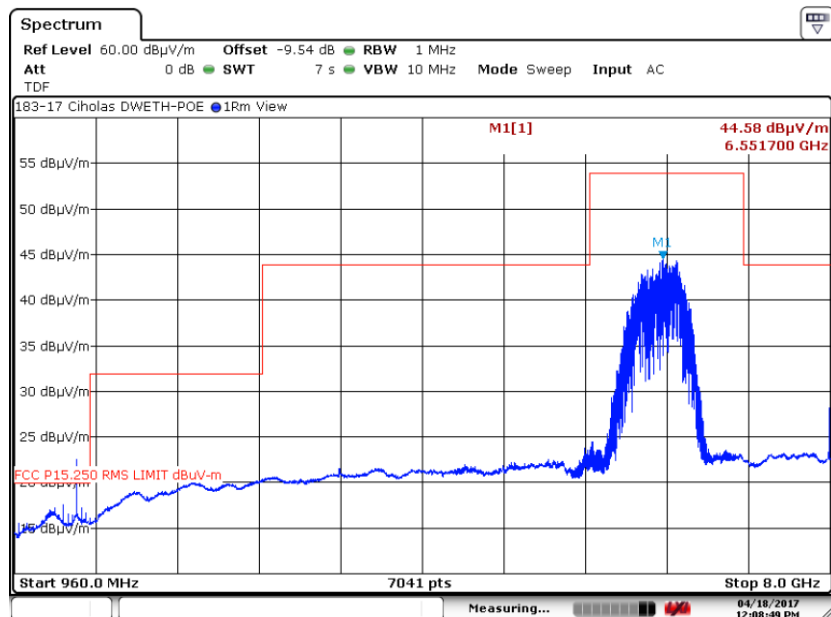


Date: 18.APR.2017 13:19:51

6. Measurement Data (continued)

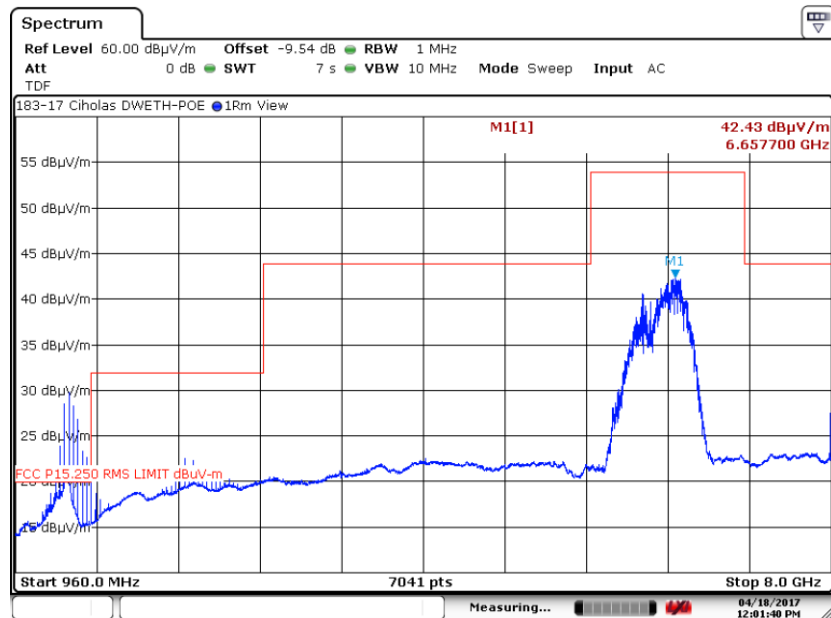
6.4. Spurious Radiated Emissions (15.250 (d) (1) continued)

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



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

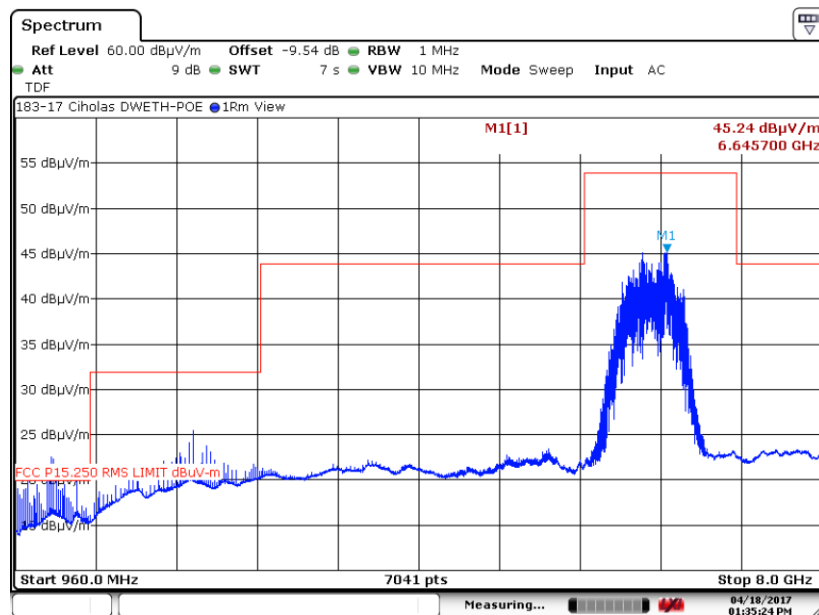


Date: 18.APR.2017 12:01:39

6. Measurement Data (continued)

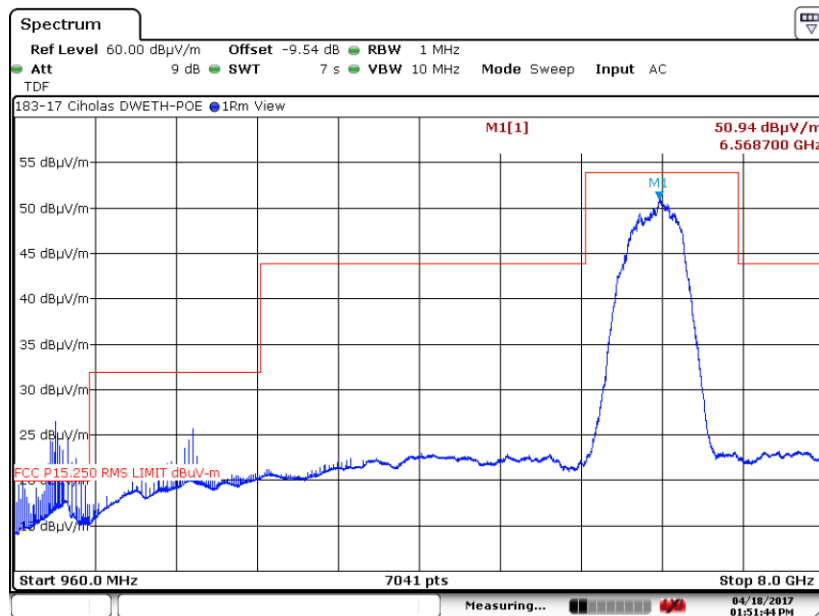
6.4. Spurious Radiated Emissions (15.250 (d) (1) continued)

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



Date: 18.APR.2017 13:35:23

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

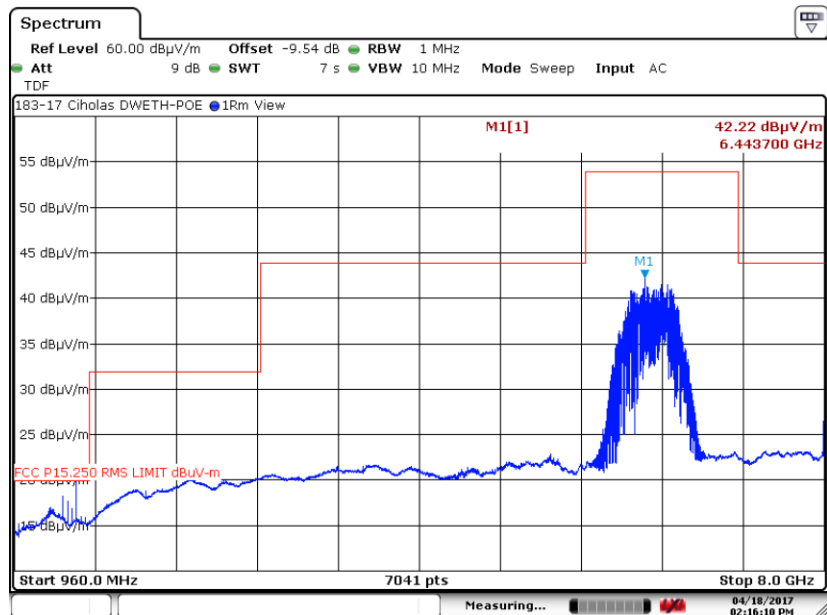


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6. Measurement Data (continued)

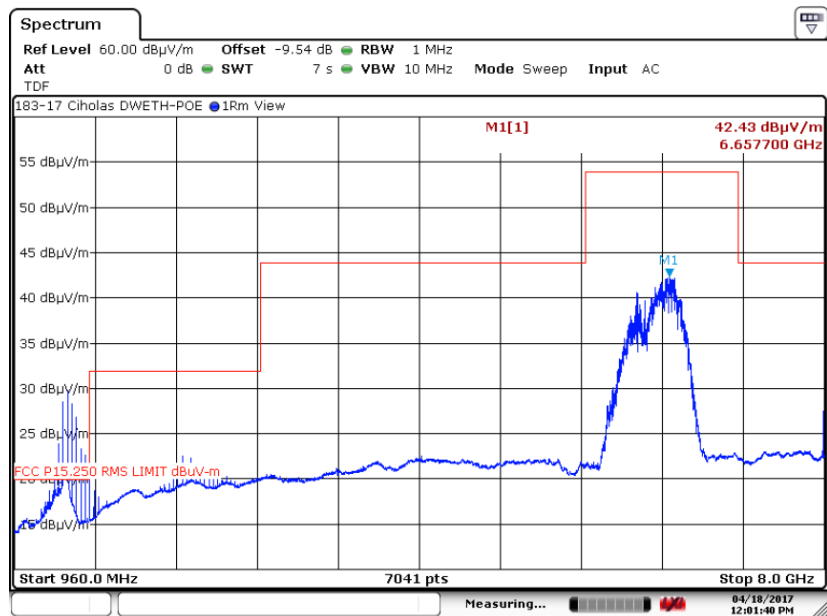
6.4. Spurious Radiated Emissions (15.250 (d) (1) continued)

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



Date: 18.APR.2017 14:16:09

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



Date: 18.APR.2017 12:01:39

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6. Measurement Data (continued)

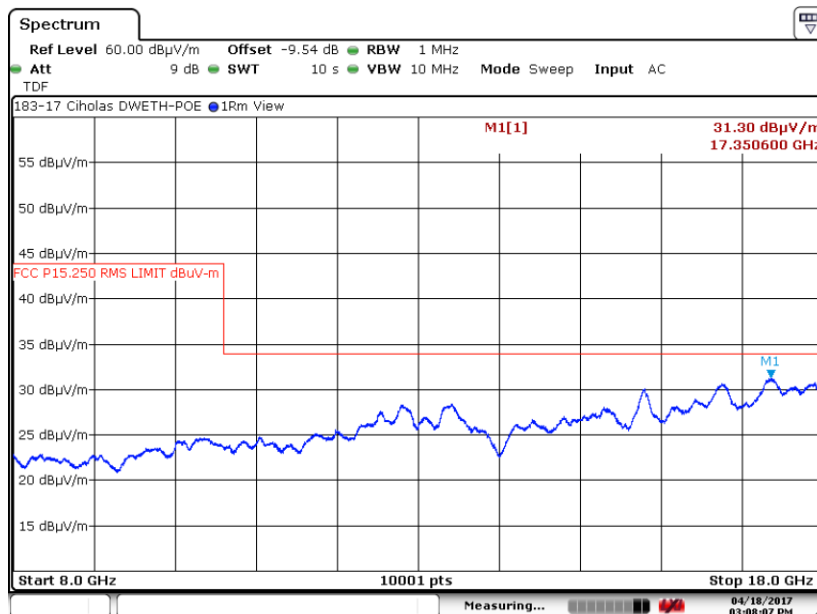
6.4. Spurious Radiated Emissions (15.250 (d) (1) continued)

6.4.10. 8 to 18 GHz Horizontal at 1 Meter



Date: 18.APR.2017 15:12:51

6.4.11. 8 to 18 GHz Vertical at 1 Meter



Date: 18.APR.2017 15:08:06

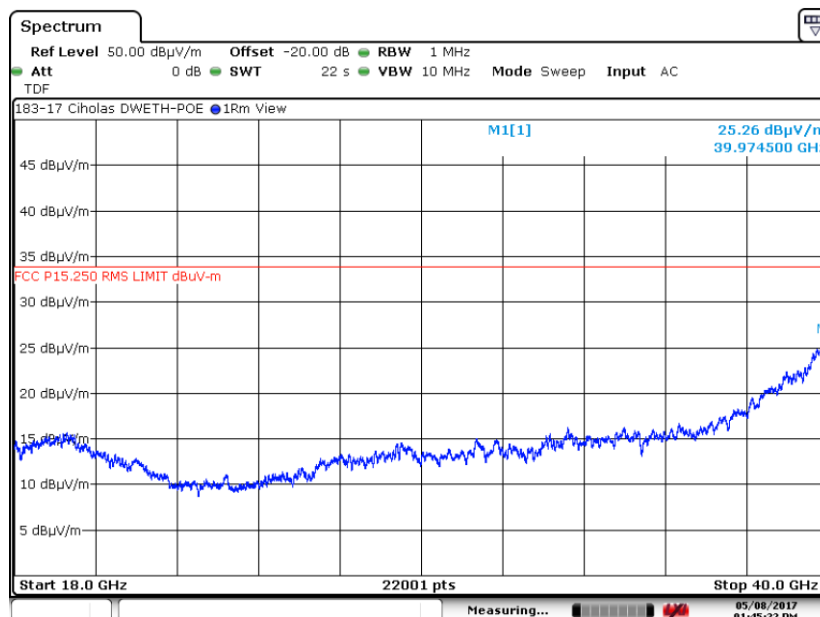
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6. Measurement Data (continued)

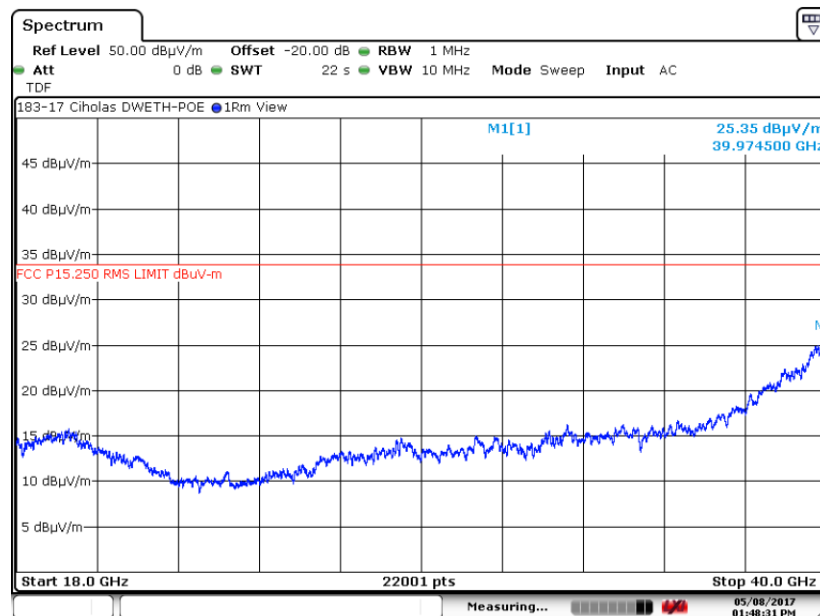
6.4. Spurious Radiated Emissions (15.250 (d) (1) continued)

6.4.12. 18 to 40 GHz Horizontal at 0.3 Meter



Date: 8.MAY.2017 13:45:22

6.4.13. 18 to 40 GHz Vertical at 0.3 Meter



Date: 8.MAY.2017 13:48:31

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

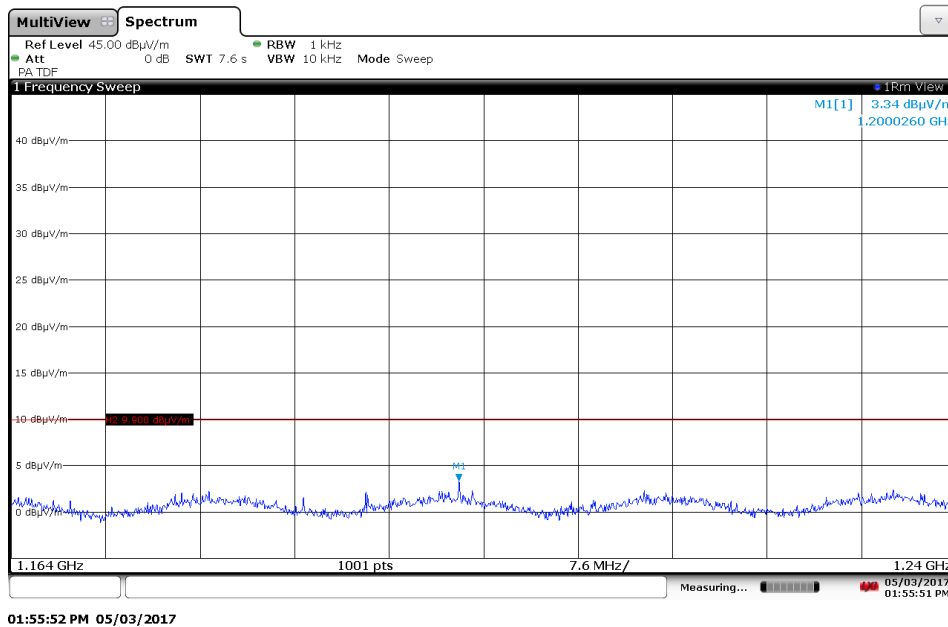
There were no broadband emissions related to the UWB transmitter. Measured signals were narrowband and related to the microprocessor / clocks and do not fall under the requirements of this section. Measurements were made at 3 Meters and the -85.3 dBm limit was converted to a field strength limit of 9.9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

6. Measurement Data (continued)

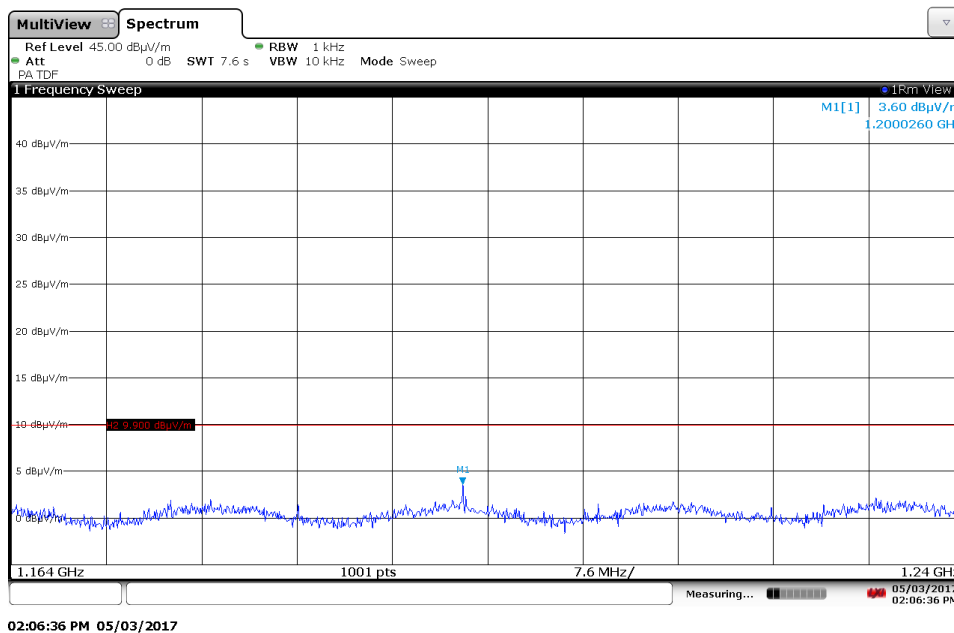
6.5. Spurious Radiated Emissions in GPS Bands (15.250 (d) (2))

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

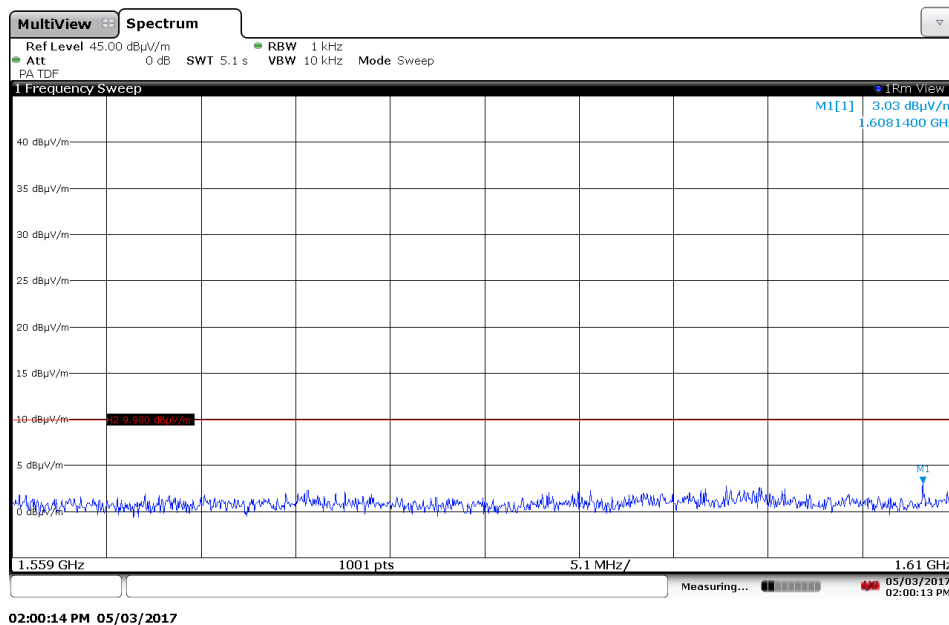


6. Measurement Data (continued)

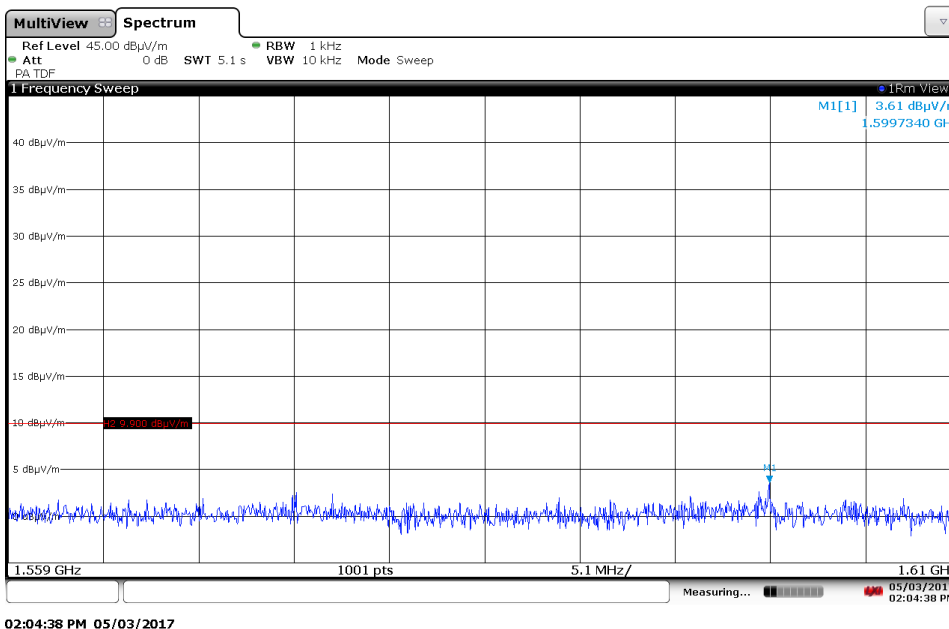
6.5. Spurious Radiated Emissions in GPS Bands (15.250 (d) (2) continued)

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	
6.5050	53.52	53.90	-0.38	V	272	353	Compliant

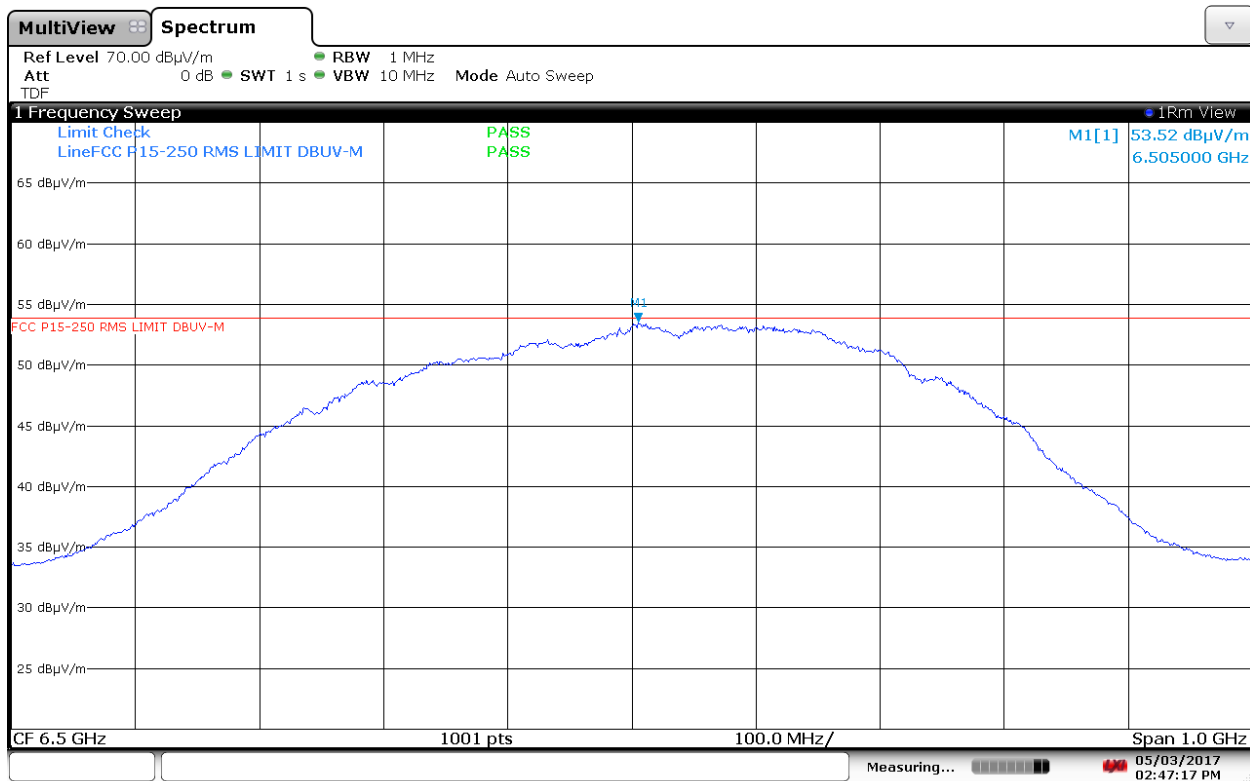
Notes: ¹ Antenna Factor (AF), Cable Factor (CF) and External Preamplifier Gain (PAG) have been entered into the analyzer as transducer factors.

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	
6.5050	-41.68	-41.30	-0.38	V	272	353	Compliant

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



02:47:18 PM 05/03/2017

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	
6.5020	51.02	53.90	-2.88	V	272	353	Compliant

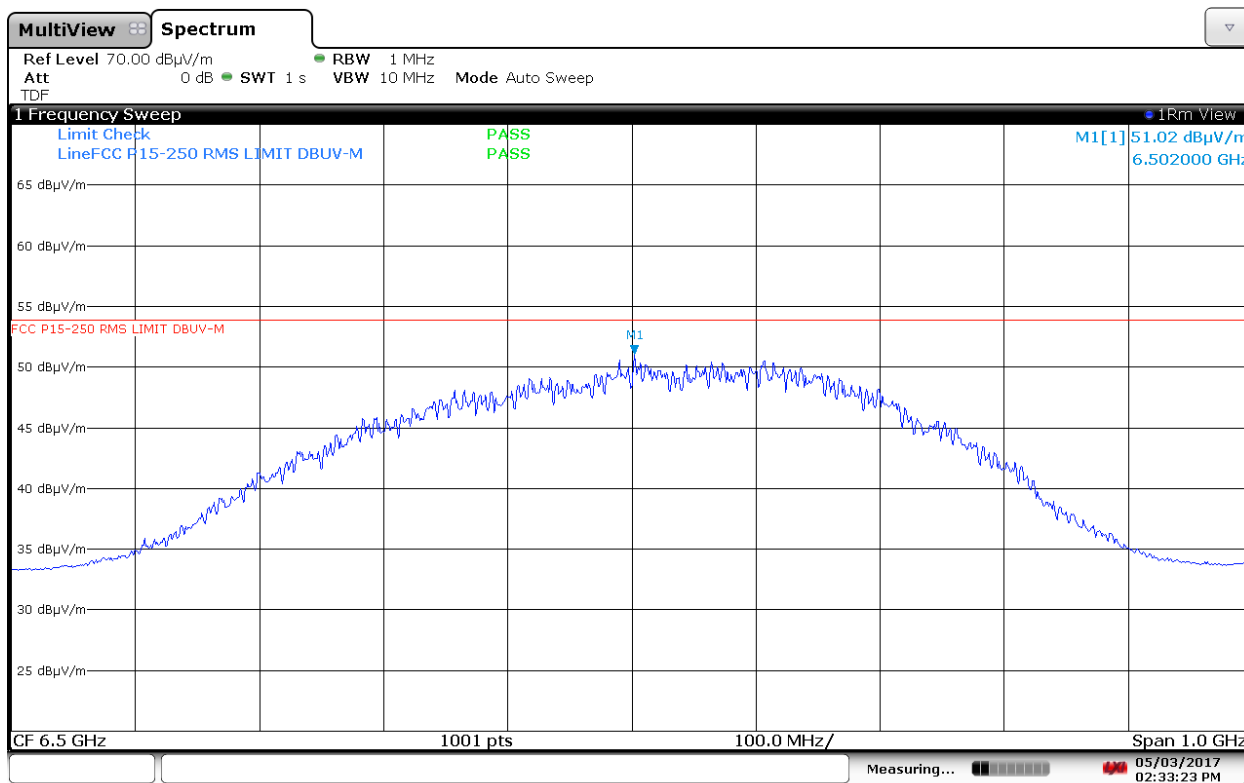
Notes: ¹ Antenna Factor (AF), Cable Factor (CF) and External Preamplifier Gain (PAG) have been entered into the analyzer as transducer factors.

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	-44.18	-41.30	-2.88	V	272	353	Compliant

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



02:33:23 PM 05/03/2017

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	
6.5110	53.88	53.90	-0.02	V	272	353	Compliant

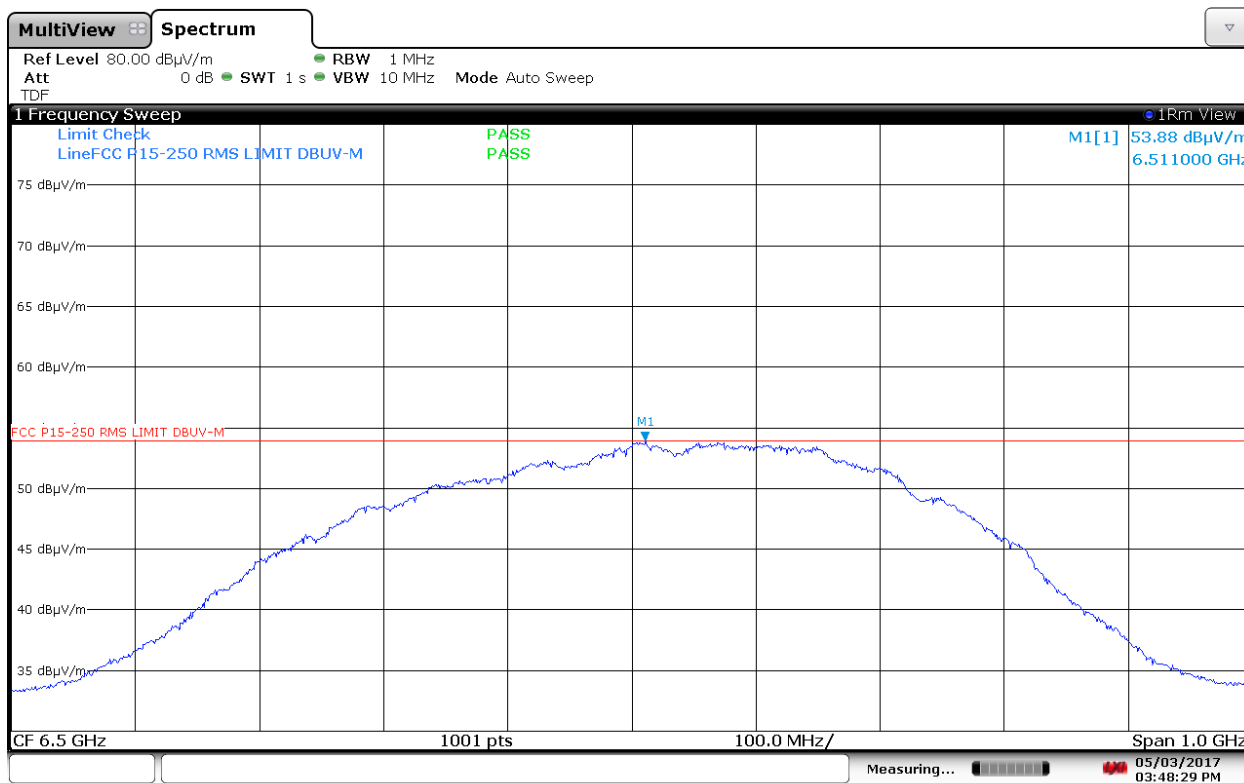
Notes: ¹ Antenna Factor (AF), Cable Factor (CF) and External Preamplifier Gain (PAG) have been entered into the analyzer as transducer factors.

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	
6.5110	-41.32	-41.30	-0.02	V	272	353	Compliant

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



03:48:29 PM 05/03/2017

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	51.91	53.90	-1.99	V	272	353	Compliant

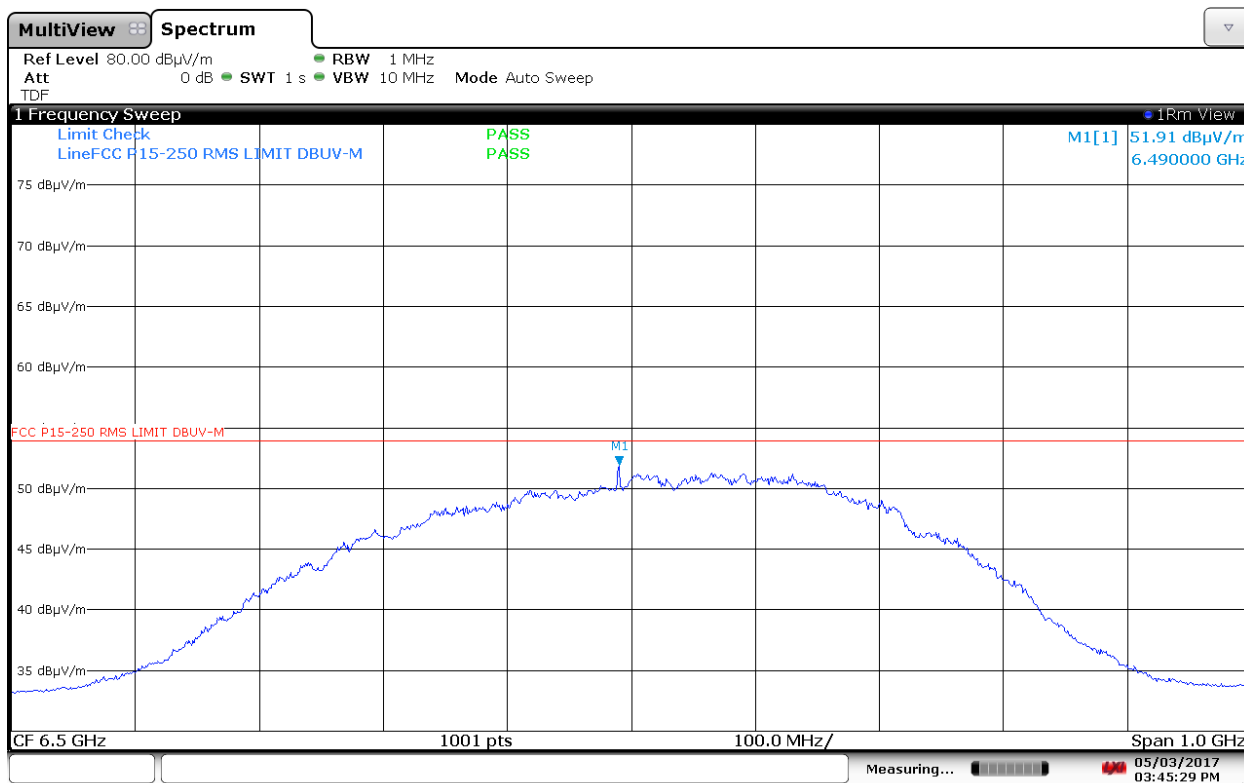
Notes: ¹ Antenna Factor (AF), Cable Factor (CF) and External Preamplifier Gain (PAG) have been entered into the analyzer as transducer factors.

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	-43.29	-41.30	-1.99	V	272	353	Compliant

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



03:45:29 PM 05/03/2017

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	
6.4970	92.14	95.20	-3.06	V	272	353	Compliant

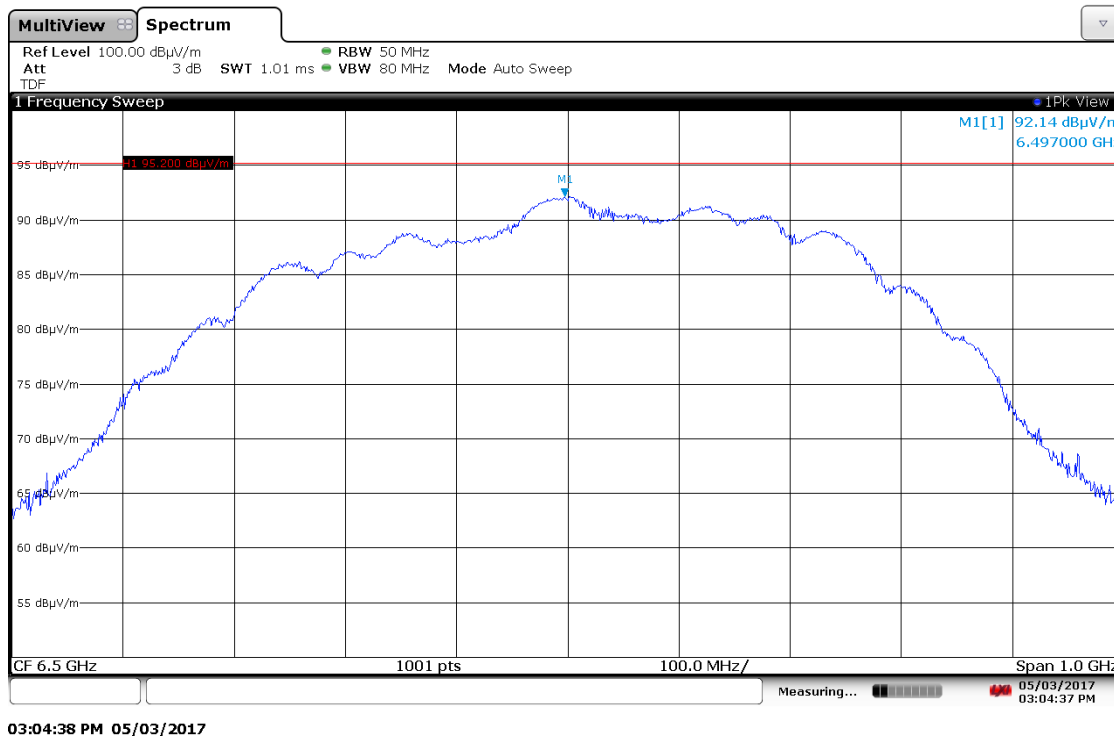
Notes: ¹ Antenna Factor (AF), Cable Factor (CF) and External Preamplifier Gain (PAG) have been entered into the analyzer as transducer factors.

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	
6.4970	-3.06	0.00	-3.06	V	272	353	Compliant

6.7.1 Plot of Peak Power at 3 Meters (16M PRF, long 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	
6.5939	95.11	95.20	-0.09	V	272	353	Compliant

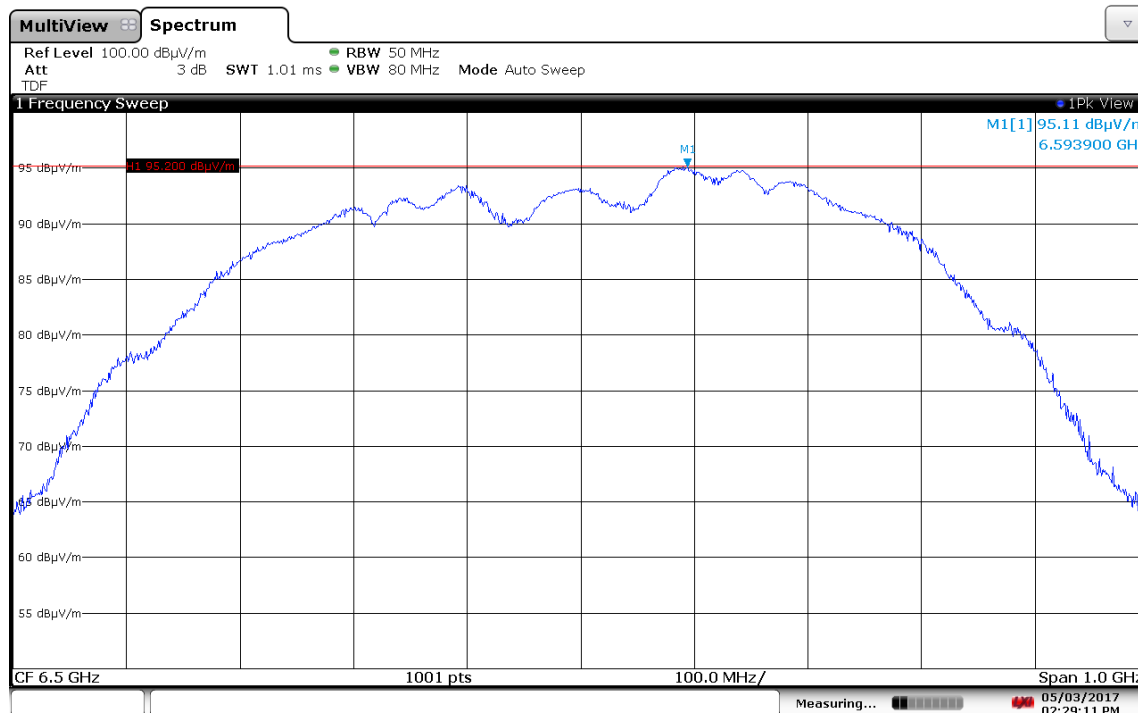
Notes: ¹ Antenna Factor (AF), Cable Factor (CF) and External Preamplifier Gain (PAG) have been entered into the analyzer as transducer factors.

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	
6.5939	-0.09	0.00	-0.09	V	272	353	Compliant

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



02:29:11 PM 05/03/2017

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	
6.5030	88.18	95.20	-7.02	V	272	353	Compliant

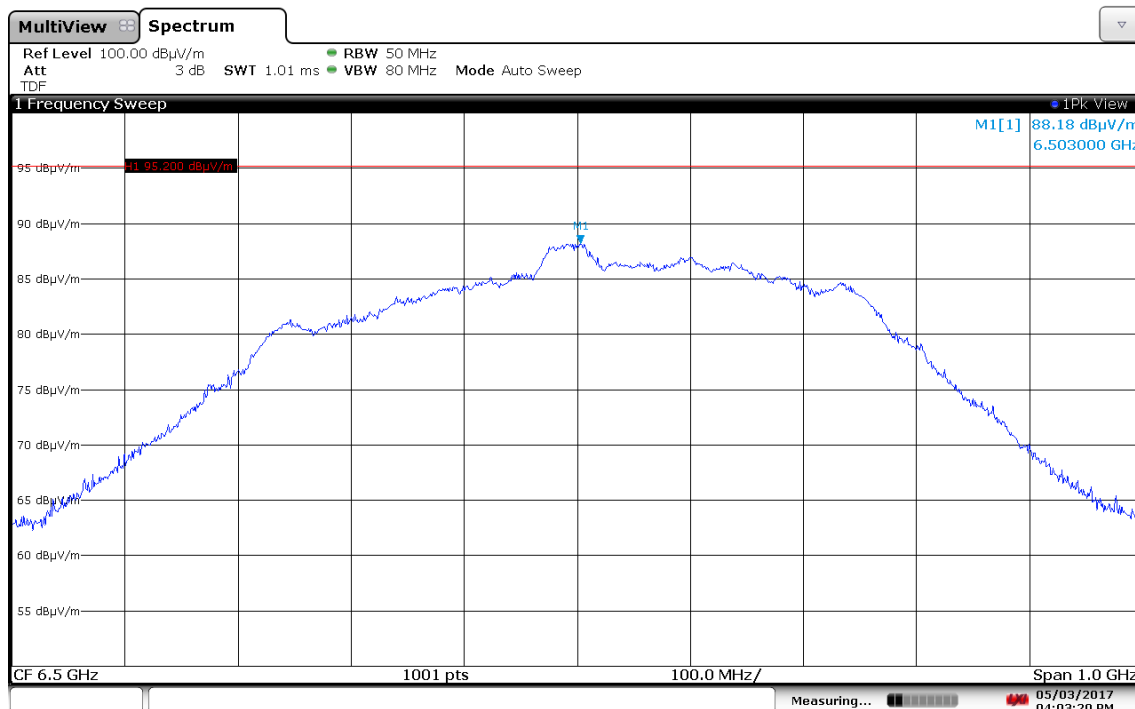
Notes: ¹ Antenna Factor (AF), Cable Factor (CF) and External Preamplifier Gain (PAG) have been entered into the analyzer as transducer factors.

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	
6.5030	-7.02	0.00	-7.02	V	272	353	Compliant

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



04:03:21 PM 05/03/2017

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	
6.5020	95.00	95.20	-0.20	V	272	353	Compliant

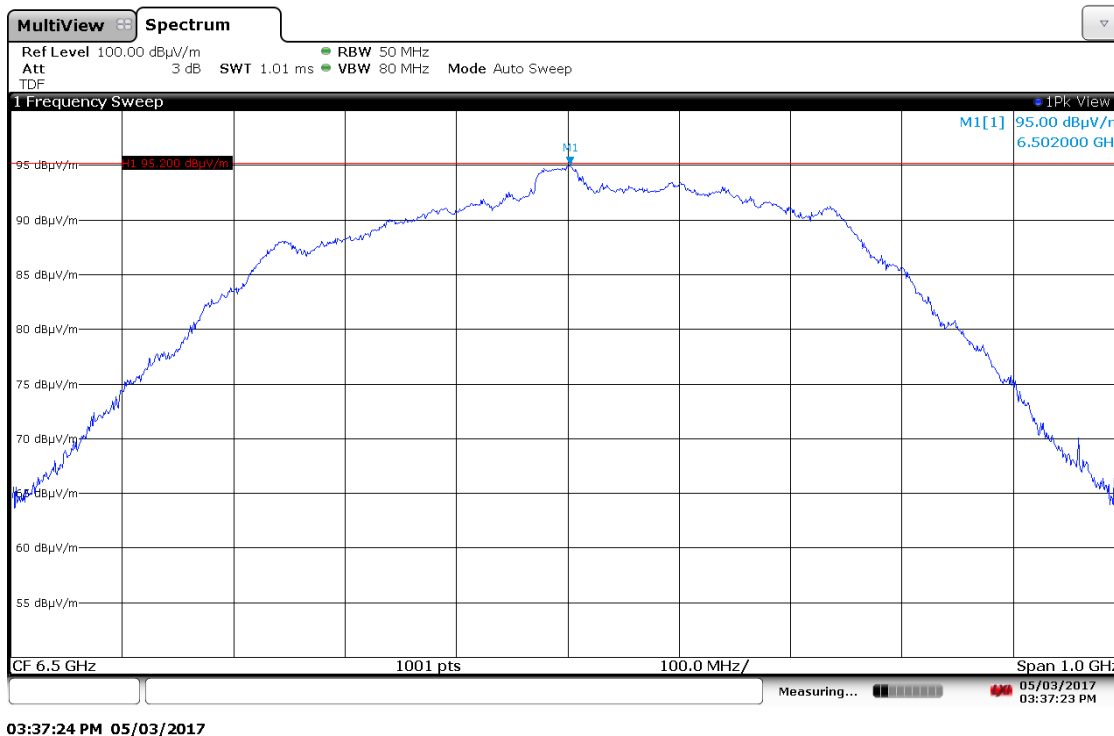
Notes: ¹ Antenna Factor (AF), Cable Factor (CF) and External Preamplifier Gain (PAG) have been entered into the analyzer as transducer factors.

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	-0.20	0.00	-0.20	V	272	353	Compliant

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



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: 4/23/2017
 Test Engineer: Mark McSweeney
 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.

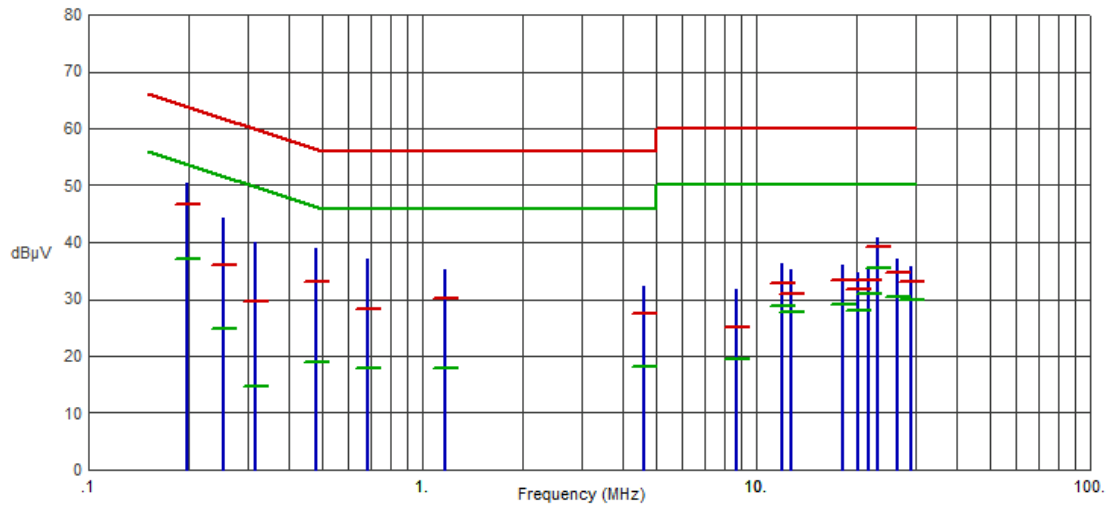
6. Measurement Data (continued)

6.9 Conducted Emissions Test Results

6.9.1 120 Volts, 60 Hz Phase

Test No.: 183-17, 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
.1973	50.46	46.67	63.72	-17.05	37.15	53.72	-16.57	
.2535	44.37	36.06	61.64	-25.58	24.90	51.64	-26.74	
.3165	39.89	29.53	59.80	-30.27	14.67	49.80	-35.13	
.4808	39.04	33.13	56.33	-23.20	18.86	46.33	-27.47	
.6855	37.19	28.16	56.00	-27.84	17.83	46.00	-28.17	
1.1643	35.08	30.11	56.00	-25.89	17.81	46.00	-28.19	
4.6023	32.39	27.40	56.00	-28.60	18.01	46.00	-27.99	
8.7175	31.76	25.20	60.00	-34.80	19.55	50.00	-30.45	
11.8923	36.35	32.92	60.00	-27.08	28.83	50.00	-21.17	
12.7473	35.11	30.84	60.00	-29.16	27.64	50.00	-22.36	
18.2440	35.88	33.27	60.00	-26.73	29.04	50.00	-20.96	
20.2578	34.76	31.81	60.00	-28.19	27.98	50.00	-22.02	
21.6618	35.61	33.40	60.00	-26.60	30.96	50.00	-19.04	
23.1288	40.85	39.12	60.00	-20.88	35.53	50.00	-14.47	
26.4880	37.13	34.69	60.00	-25.31	30.39	50.00	-19.61	
29.2353	35.82	33.07	60.00	-26.93	29.93	50.00	-20.07	

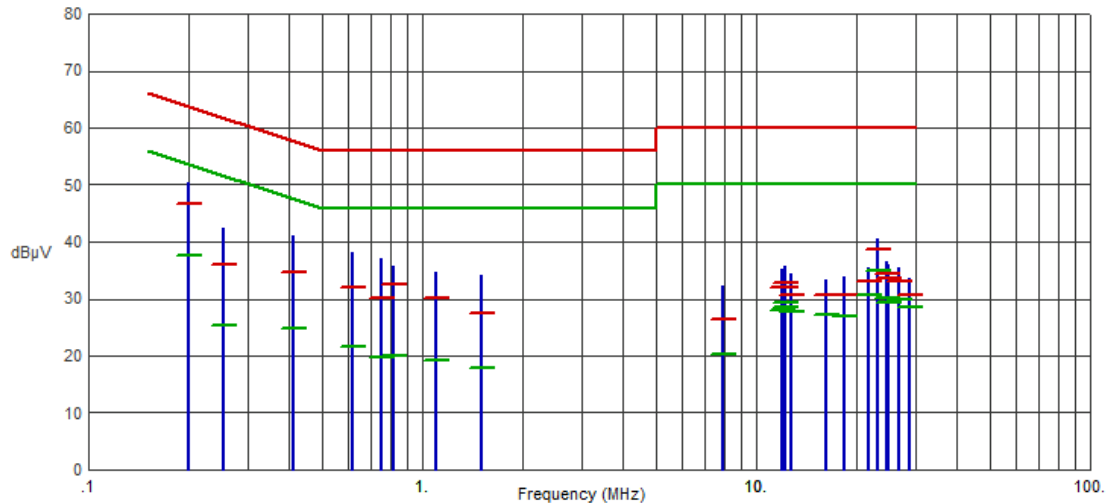
6. Measurement Data (continued)

6.9. Conducted Emissions Test Results (continued)

6.9.2. 120 Volts, 60 Hz Neutral

Test No.: 183-17, 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	50.41	46.57	63.63	-17.06	37.52	53.63	-16.11	
.2535	42.41	36.03	61.64	-25.61	25.21	51.64	-26.43	
.4110	41.18	34.66	57.63	-22.97	24.84	47.63	-22.79	
.6180	38.20	32.13	56.00	-23.87	21.67	46.00	-24.33	
.7553	37.14	30.04	56.00	-25.96	19.67	46.00	-26.33	
.8228	35.66	32.44	56.00	-23.56	19.99	46.00	-26.01	
1.0990	34.76	30.09	56.00	-25.91	19.30	46.00	-26.70	
1.5063	34.22	27.47	56.00	-28.53	17.81	46.00	-28.19	
7.9233	32.25	26.37	60.00	-33.63	20.32	50.00	-29.68	
11.9530	35.11	31.93	60.00	-28.07	27.96	50.00	-22.04	
12.1375	35.46	32.04	60.00	-27.96	28.45	50.00	-21.55	
12.1983	35.83	32.80	60.00	-27.20	29.30	50.00	-20.70	
12.7473	34.34	30.71	60.00	-29.29	27.76	50.00	-22.24	
16.2280	33.42	30.67	60.00	-29.33	27.13	50.00	-22.87	
18.3048	33.89	30.60	60.00	-29.40	26.91	50.00	-23.09	
21.6618	35.56	33.08	60.00	-26.92	30.57	50.00	-19.43	
23.1288	40.40	38.54	60.00	-21.46	34.94	50.00	-15.06	
24.5328	36.60	34.34	60.00	-25.66	30.08	50.00	-19.92	
24.8995	36.13	33.49	60.00	-26.51	29.27	50.00	-20.73	
26.6095	35.48	33.08	60.00	-26.92	29.90	50.00	-20.10	
28.6840	33.65	30.58	60.00	-29.42	28.60	50.00	-21.40	

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)
6.4970	5	-3.06	0.0	0.0015734	0.0157344	1
6.5939	5	-0.09	0.0	0.0031178	0.0311781	1
6.5030	5	-7.09	0.0	0.0006221	0.0062209	1
6.5020	5	-0.20	0.0	0.0030398	0.0303984	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.

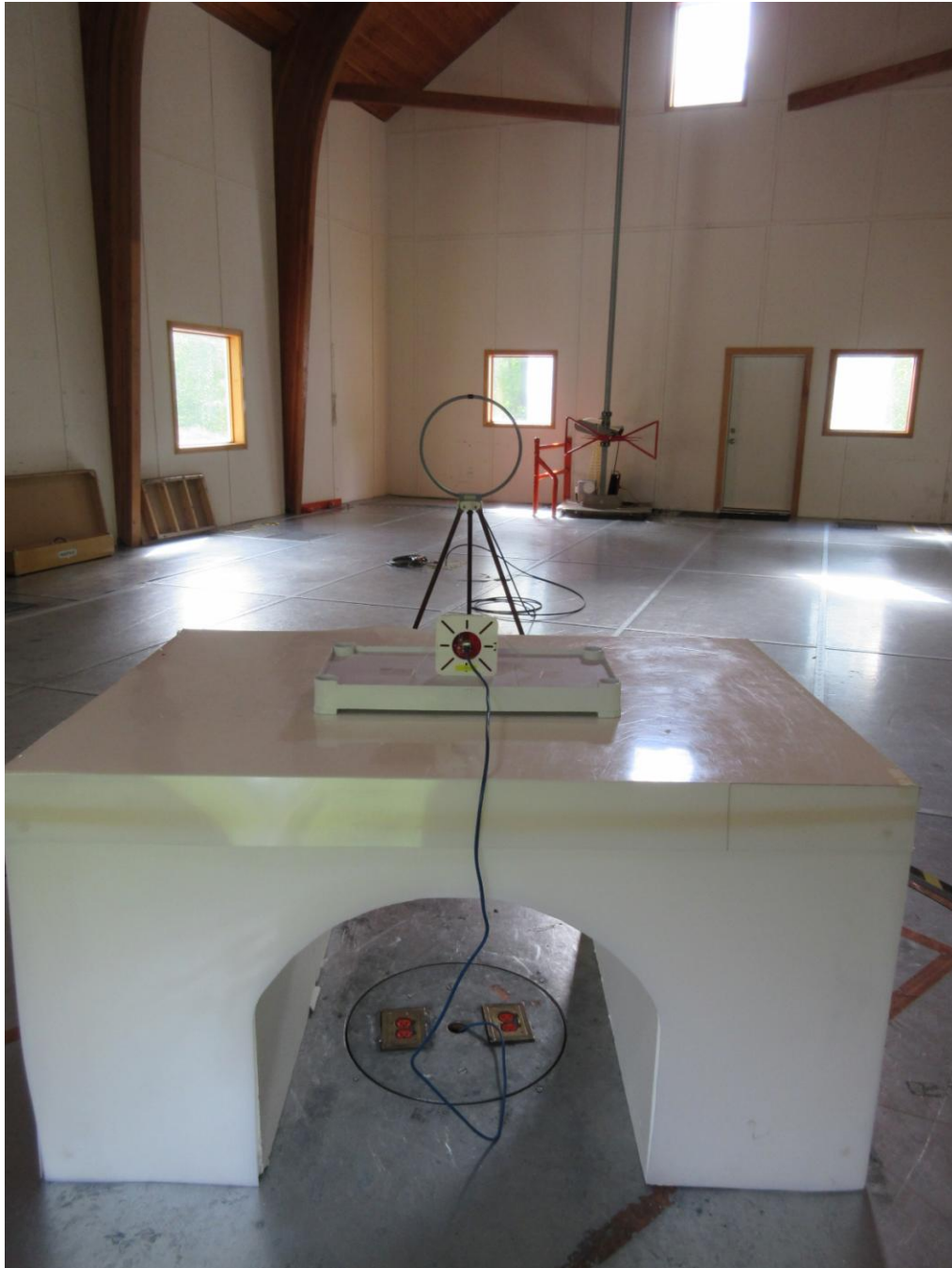
8. Test Images

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



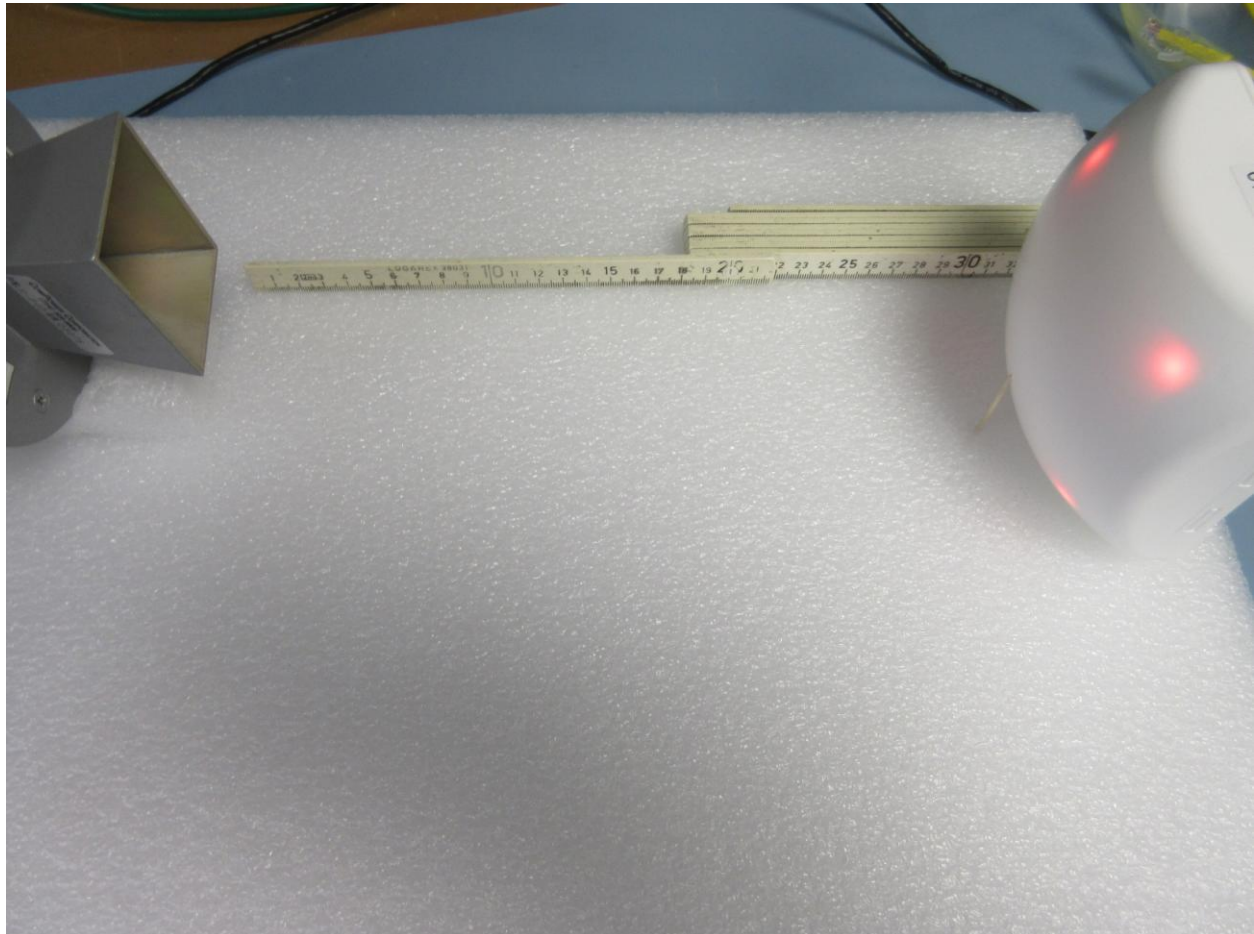
8. Test Images

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



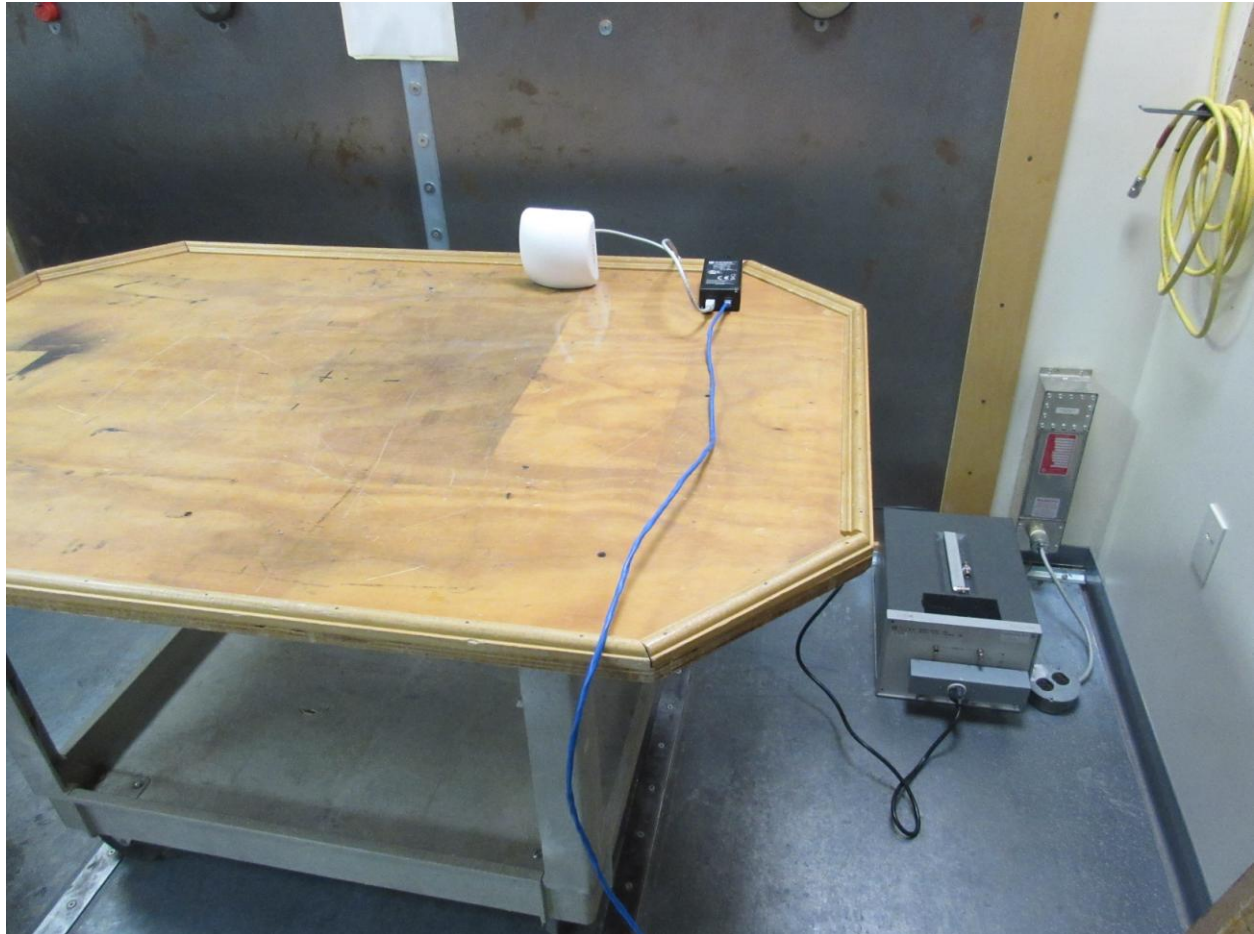
8. Test Images

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)

