

**COMPLIANCE WORLDWIDE INC.
TEST REPORT 136-16A**

In Accordance with the Requirements of
FCC PART 90:2015 Subpart R
Operation in the 758 to 768 MHz and 788 to 798 MHz
Public Safety Broadband (PS-BB)
and PART 20:2015

Issued to

Westell, Inc.
750 North Commons Drive
Aurora, IL 60504

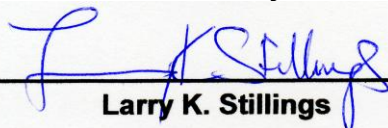
for

NFPA 72 Public Safety Signal Booster
Model: PS51080

FCC ID: NVRCSIPS51080PS78


Original Report Issued on August 26, 2016

Tested by



Larry K. Stillings

Reviewed By



Brian F. Breault

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1. Scope

This test report certifies that the Westell Public Safety Signal Booster Model PS51080, as tested, meets the FCC Part 90 Subpart R Public Safety Broad Band (PS-BB) 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:** Westell, Inc.
- 2.2. Model Numbers:** PS51080
- 2.3. Serial Number:** 15100001 (Radiated Emissions), 16030031
- 2.4. Description:** The PS51080 repeater was developed for use in enclosed structures where signals from local public safety towers to operate mobile units is poor or unavailable. Adequate signal strength must be available outside the structure as a prerequisite to achieving in-building coverage. The device is connected to an external antenna, normally located on a roof, and to one or more internal antennas placed strategically throughout the area where wireless service is desired. The PS51080 supports uplink bands of 788-805/806-809 or 806-816 MHz and downlink bands of 758-775/851-854 or 851-861 MHz.
- 2.5. Power Source:** 120 VAC, 60 Hz
- 2.6. Software Version:** 1.9
- 2.7. EMC Modifications:** None

3. Product Configuration

3.1. Support Equipment

Device	Manufacturer	Model	Serial No.	Comment
Power Supply	APX Technologies	SP130P966ER	n/a	
Notebook PC	Dell	Latitude C400	9760689253	Configuring Unit

3.2. Cables

Cable Type	Length	Shield	From	To
RF, 50 Ω, N male – N male	1M	Yes	EUT	Signal Generator
RF, 50 Ω, N male – N male	1M	Yes	EUT	50 Ω Load
Power Supply	2M + 2M	Yes	EUT	120 VAC, 60 Hz
Ethernet	2M	No	EUT	Notebook PC
DB-9 Alarm Relays	2M	Yes	EUT	Un-terminated

Notebook PC is connected only during setup and configuration

3.3. Operational Characteristics & Software

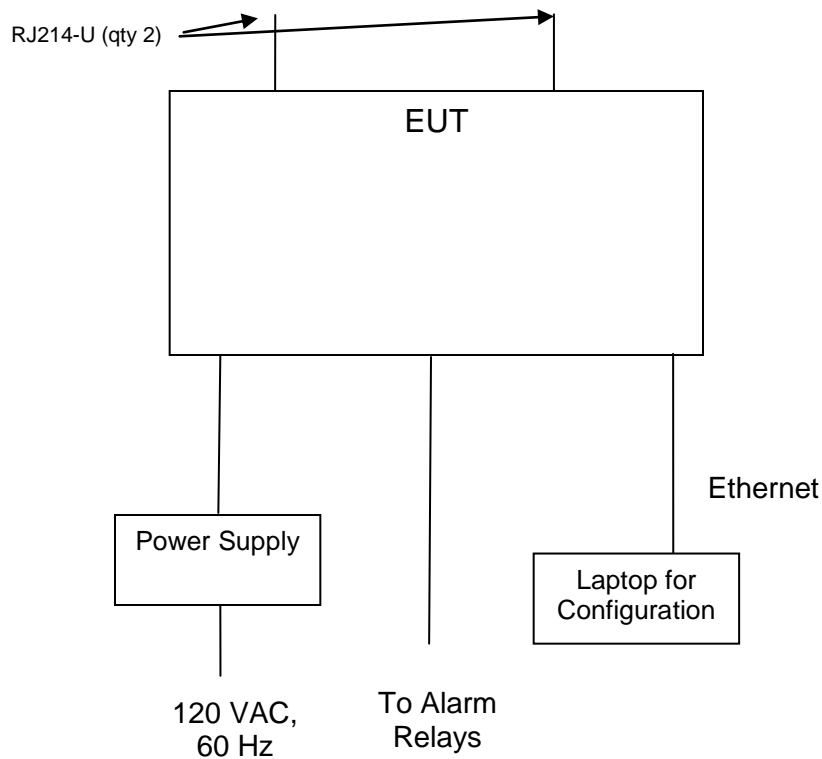
- (1) The unit was allowed to power up normally and go through its configuration cycle.
- (2) Using an RF Signal Generator on the Input and a Spectrum Analyzer on the output Downlink or Uplink frequencies a signal was generated over the intended bandwidth of operation.
- (3) The signal generator was configured to provide a 4.1 MHz AWGN signal to the input of the amplifier across the public safety broadband to be used by the product.
- (4) The units internal AGC threshold was determined by applying an input signal until a 1 dB increase in input signal did not cause a 1 dB in output signal for each of the Uplink and Downlink frequencies.

3. Product Configuration (continued)

3.3. Operational Characteristics & Software

Emission Designator	Modulation	Occupied Bandwidth	Channel Bandwidth
4M10F9W	AWGN	4.1 MHz	5 MHz

3.4. Block Diagram



4. Measurements Parameters

4.1. Measurement Equipment Used to Perform Test

Device	Manufacturer	Model No.	Serial No.	Cal Due	Interval
EMI Test Receiver, 9kHz – 7GHz ¹	Rohde & Schwarz	ESR7	101156	7/23/2017	2 Years
Spectrum Analyzer 20 Hz – 40 GHz ²	Rohde & Schwarz	FSV40	100899	7/23/2017	2 Years
Spectrum Analyzer, 9 kHz to 40 GHz ³	Rohde & Schwarz	FSVR40	100909	7/23/2017	2 Years
EMI Receiver, 9 kHz to 6.5 GHz	Hewlett Packard	8546A	3650A00360	6/4/2017	3 Years
Biconilog Antenna, 30 MHz to 2 GHz	Sunol Sciences Corp	JB1	A050913	5/15/2016	3 Years
Horn Antenna, 1 GHz – 18 GHz	ETS-Lindgren	3117	00143292	2/21/2018	2 Years
Preamplifier, 1 GHz to 26.5 GHz	Hewlett Packard	8449B	3008A01323	7/21/2017	2 Years
RF Signal Generator 5kHz to 6 GHz	Rohde & Schwarz	SMIQ06B	10090	7/23/2017	2 Years
Noise Source 10 MHz to 6 GHz	Micronetics	NS346B	17883	10/15/2016	1 Year
Digital Barometer	Control Company	4195	ID236	10/8/2017	2 Years

¹ ESR7 Firmware revision: V2.26, Date installed: 8/15/2014 Previous V2.17, installed 6/11/2014.
² FSV40 Firmware revision: V2.30 SP1 Date installed: 10/22/2014 Previous V2.30, installed 7/23/2014.
³ FSVR40 Firmware revision: V2.23, Date installed: 10/20/2014 Previous V1.63 SP1, installed 8/28/2013.

4.2. Measurement & Equipment Setup

Test Dates: 8/23/2016, 8/24/2016
 Test Engineer: Larry Stillings
 Normal Site Temperature (15 – 35°C): 24
 Relative Humidity (20 -75%RH): 33

4.3. Test Procedure

The test measurements contained in this report are based on the requirements detailed in FCC Part 90 Subpart R.

The test methods used to generate the data in this test report are in accordance with ANSI C63.4:2014, American National Standard for Methods of Measurement of Radio-Noise Emissions from Low-Voltage Electrical and Electronic Equipment in the Range of 9 kHz to 40 GHz, FCC OET KDB 935210 D05 Indus Booster Basic Meas v01 dated 2-12-2016, Measurements Guidance for Industrial and Non-Consumer Signal Booster, Repeater and Amplifier Devices and FCC OET KDB 971168 D01 Power Meas License Digital Systems v02r02 dated 10-17-2014.

Measurements were also made in accordance with TIA-603-C:2004 Land Mobile FM or PM Communications Equipment Measurement and Performance Standard.

5. Measurement Summary

Section Description or Test Requirement	FCC Part 90 Reference	Test Report Section	Result	Comment
Broadband Transmitting Power Limits	90.219(e)(1) 90.541 90.542	6.1	Compliant	
Occupied Bandwidth	90.219(e)(4)(ii) Part 2.1049	6.2	Compliant	
Spurious Emissions at Antenna Terminals	90.219(e)(3) 90.543(c)	6.3	Compliant	
Field Strength of Spurious Emissions	90.543(f)	6.4	Compliant	
Public Exposure to Radio Frequency Energy Levels	Section 1.1307 (b)(1)	6.5	Compliant	

6. Measurement Data

6.1. Broadband Transmitting Power Limits 90.219(e)(1), 90.541, 90.542

Requirement: The transmitter output power of mobile and control transmitters operating in the 758 to 768 MHz, 769 to 775 MHz, 788 to 798 MHz and 799 to 805 MHz bands must not exceed 30 Watts.

The output power capability of a signal booster must be designed for deployments providing a radiated power not exceeding 5 Watts ERP for each retransmitted channel.

Measurement of AGC Threshold

Test Method: KDB 935210 Section 4.2 & KDB 971168 Section 5.2

6.1.1. Mean Transmitter Output Power, Transmitter Only

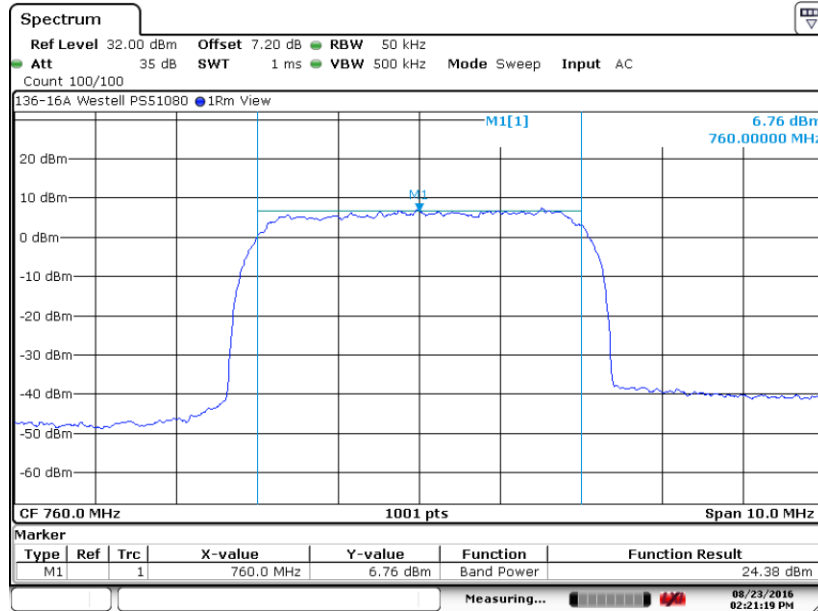
Modulation Type	Center Frequency	Output Power		Input Power (dBm)	Result
	(MHz)	(dBm)	(Watts)		
AWGN Modulation	760	24.38	0.274	-52.06	Compliant
AWGN Modulation	763	25.21	0.332	-52.11	Compliant
AWGN Modulation	765	26.12	0.409	-52.16	Compliant
AWGN Modulation	790	27.21	0.526	-52.19	Compliant
AWGN Modulation	793	27.63	0.579	-52.25	Compliant
AWGN Modulation	796	27.74	0.594	-52.32	Compliant

Note: Input Power is at the 1 dB AGC threshold Level

6. Measurement Data

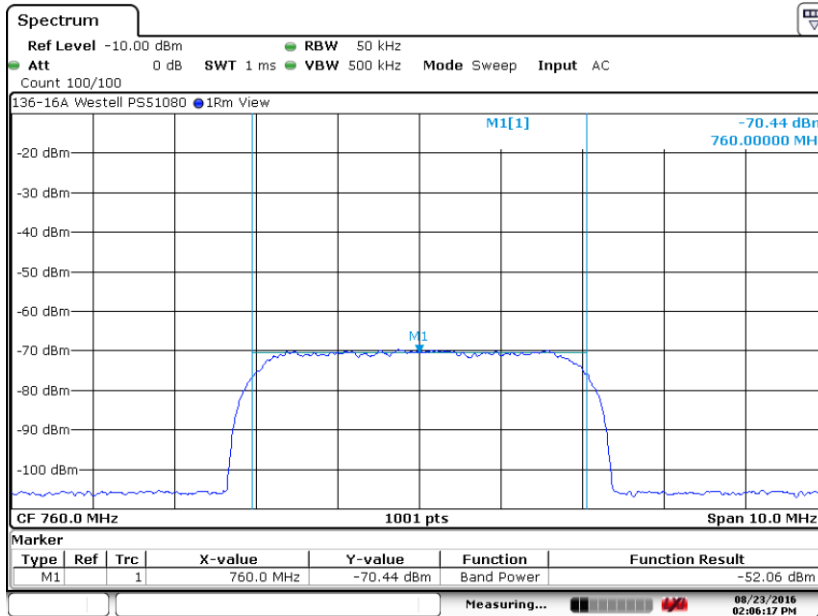
6.1. Broadband Transmitting Power Limits 90.219(e)(1), 90.541, 90.542 (cont)

6.1.2. Mean Transmitter Output Power, 760 MHz, AWGN Modulation



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6.1.3. Mean Transmitter Input Power, 760 MHz, AWGN Modulation

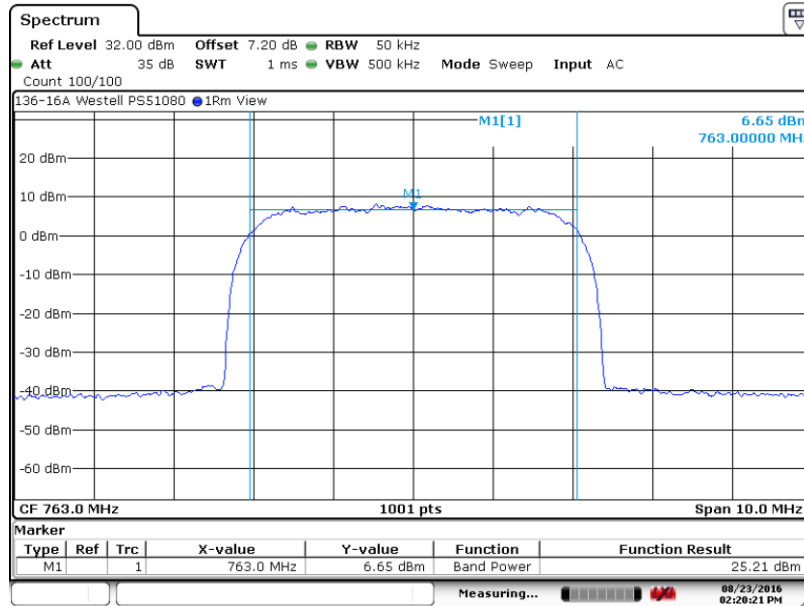


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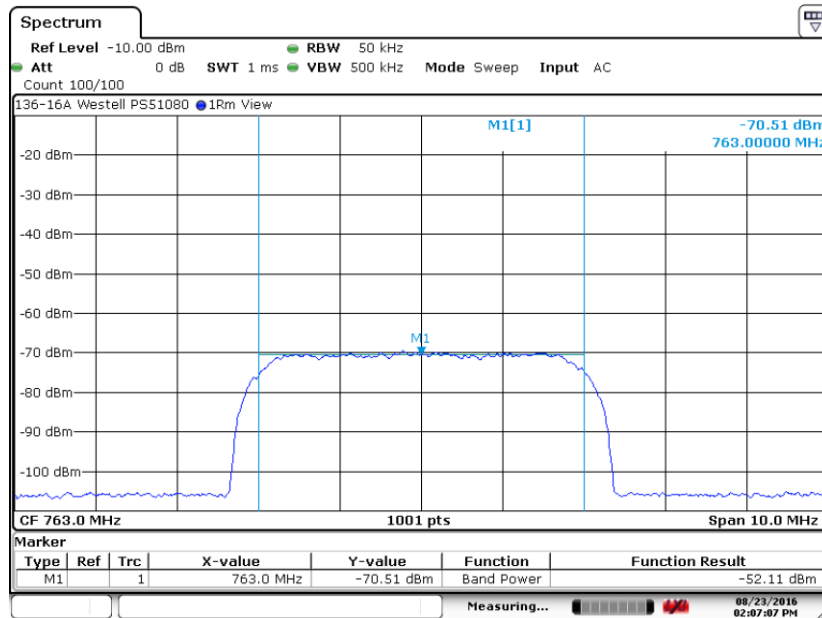
6. Measurement Data

6.1. Broadband Transmitting Power Limits 90.219(e)(1), 90.541, 90.542 (cont)

6.1.4. Mean Transmitter Output Power, 763 MHz, AWGN Modulation



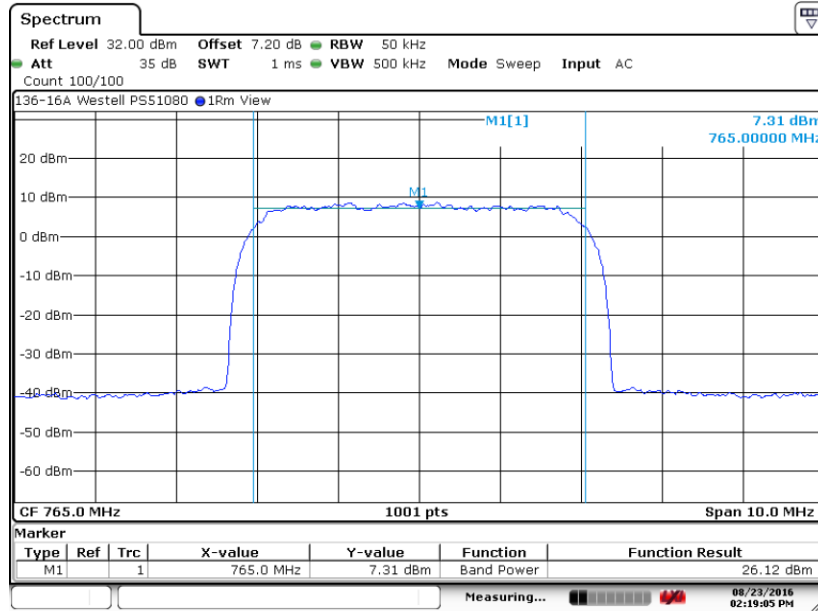
6.1.5. Mean Transmitter Input Power, 763 MHz, AWGN Modulation



6. Measurement Data

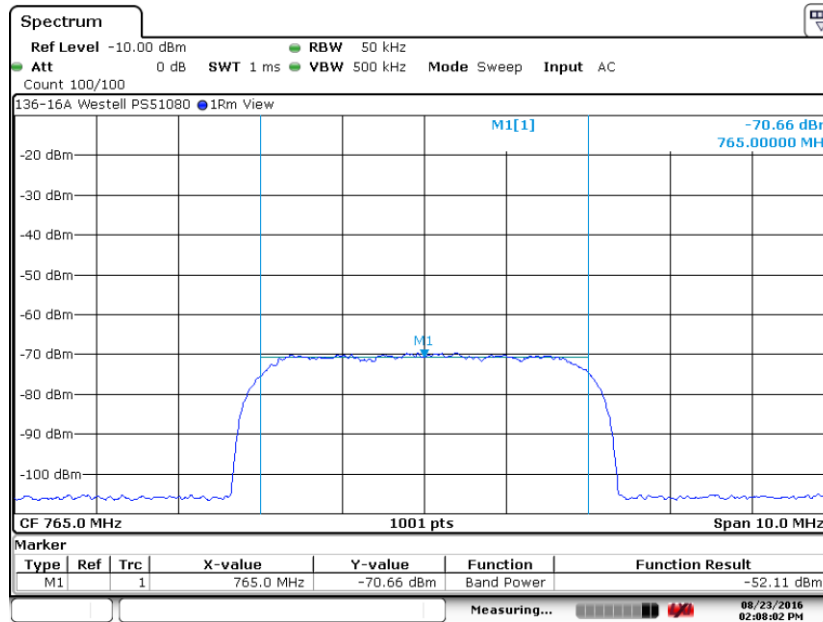
6.1. Broadband Transmitting Power Limits 90.219(e)(1), 90.541, 90.542 (cont)

6.1.6. Mean Transmitter Output Power, 765 MHz, AWGN Modulation



Date: 23.AUG.2016 14:19:04

6.1.7. Mean Transmitter Input Power, 765 MHz, AWGN Modulation

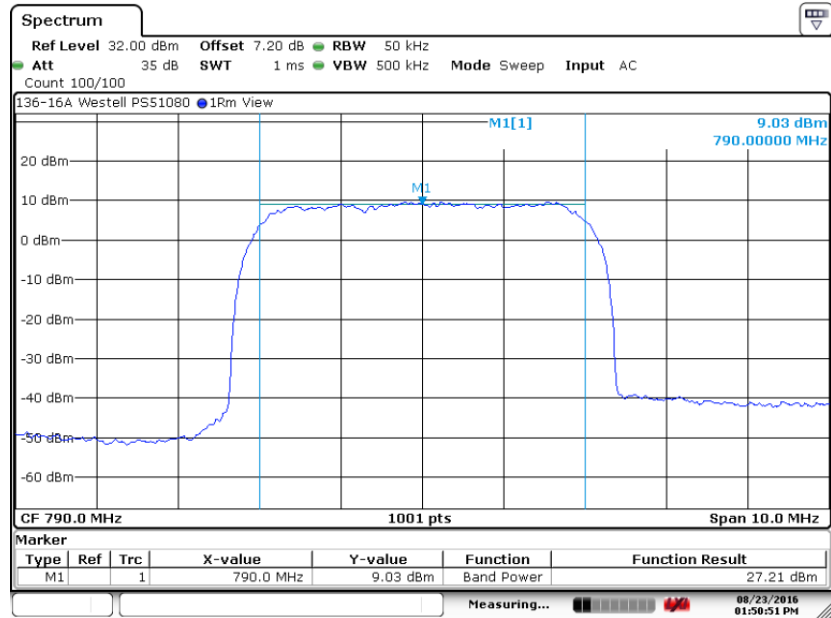


Date: 23.AUG.2016 14:08:01

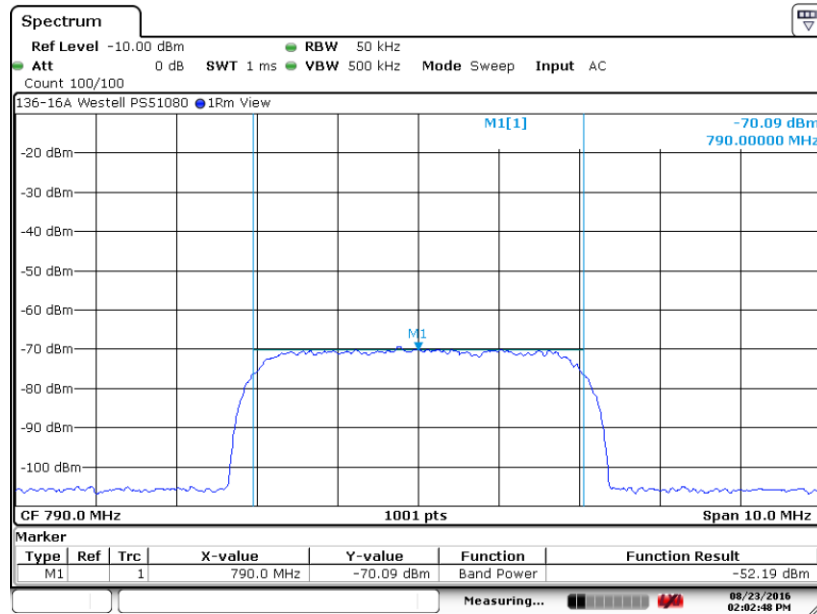
6. Measurement Data

6.1. Broadband Transmitting Power Limits 90.219(e)(1), 90.541, 90.542 (cont)

6.1.8. Mean Transmitter Output Power, 790 MHz, AWGN Signal



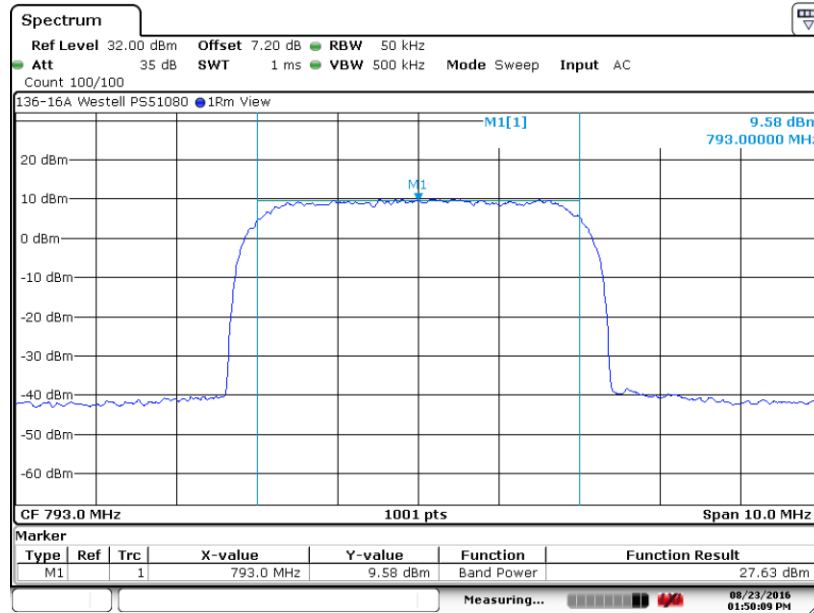
6.1.9. Mean Transmitter Input Power, 790 MHz, AWGN Signal



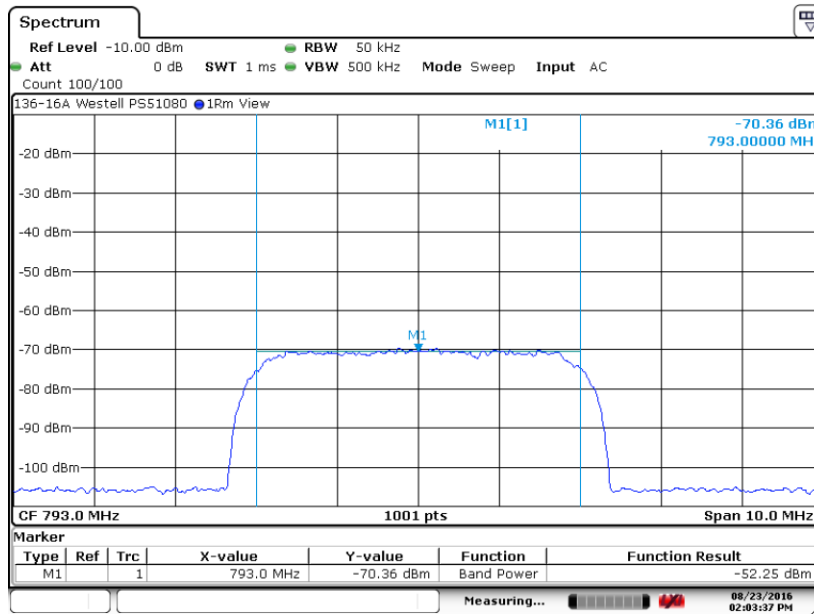
6. Measurement Data

6.1. Broadband Transmitting Power Limits 90.219(e)(1), 90.541, 90.542 (cont)

6.1.10. Mean Transmitter Output Power, 793 MHz, AWGN Signal



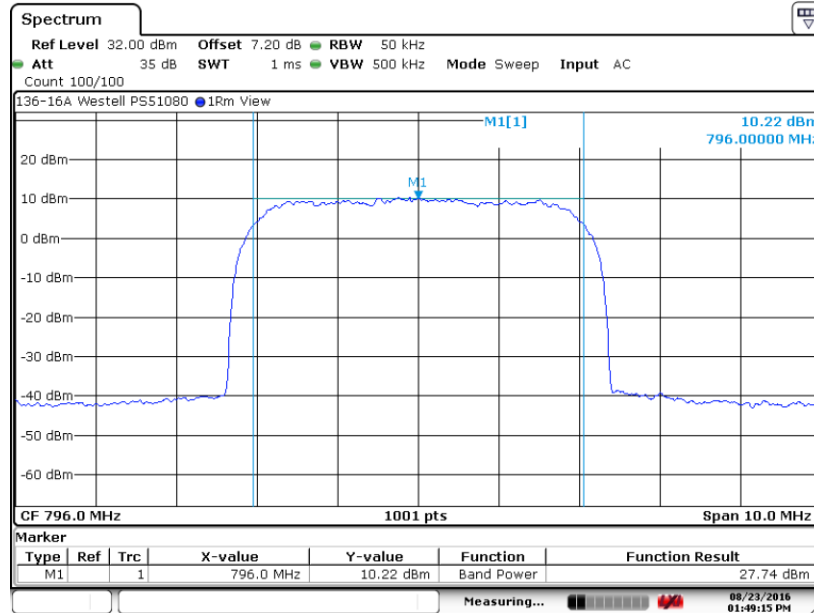
6.1.11. Mean Transmitter Input Power, 793 MHz, AWGN Signal



6. Measurement Data

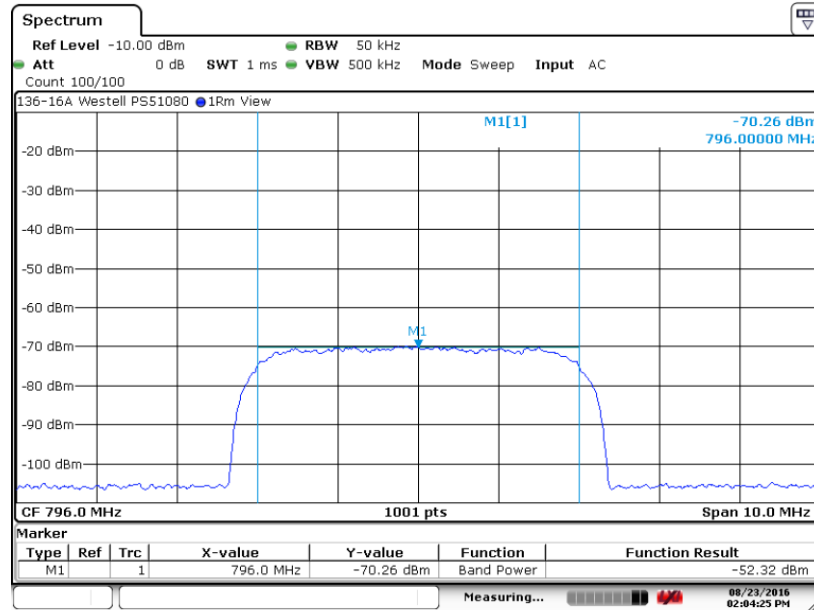
6.1. Broadband Transmitting Power Limits 90.219(e)(1), 90.541, 90.542 (cont)

6.1.12. Mean Transmitter Output Power, 796 MHz, AWGN Signal



Date: 23.AUG.2016 13:49:14

6.1.13. Mean Transmitter Input Power, 796 MHz, AWGN Signal



Date: 23.AUG.2016 14:04:24

6. Measurement Data

6.1. Broadband Transmitting Power Limits 90.219(e)(1), 90.541, 90.542 (continued)

6.1.2. Maximum ERP

ERP is defined in FCC Title 47, Chapter I, Part 2, Subpart A, Section 2.1 as "Effective Radiated Power. The product of the power supplied to the antenna and its gain relative to a half-wave dipole in a given direction."

$$\text{ERP} = \text{Transmitter Power (dBm)} - \text{Cable Loss (dB)} + \text{Antenna Gain (dBi)}$$

The manufacturer of the device under test recommends one antenna and cable combination for use with their product. The following table provides the worst case effective radiated power based on the measured transmitter output power and the antenna gain:

Modulation Type	Center Frequency	Transmitter Power	Cable Insertion Loss	Antenna Gain	Total Output Power	
	MHz	dBm	dB	dBi	dBm	Watts
AWGN Modulation	760	24.38	0.00	3.00	27.38	0.55
AWGN Modulation	763	25.21	0.00	3.00	28.21	0.66
AWGN Modulation	765	26.12	0.00	3.00	29.12	0.82
AWGN Modulation	790	27.21	0.00	3.00	30.21	1.05
AWGN Modulation	793	27.63	0.00	3.00	30.63	1.16
AWGN Modulation	796	27.74	0.00	3.00	30.74	1.19

¹ Measured. See section 6.1.1.

² Customer supplied 3 dBi. Factor is a combination of both antenna gain and cable loss.

6. Measurement Data (continued)

6.2. Bandwidth Limitations 90.219(e)(4)(ii), FCC Part 2.1049

Requirement: Each authorization issued to a station licensed under this part will show an emission designator representing the class of emission authorized. The designator will be prefixed by a specified necessary bandwidth. This number does not necessarily indicate the bandwidth occupied by the emission at any instant.

There is no significant change in the occupied bandwidth of the retransmitted signal.

Test Method: KDB 935210 Section 4.4

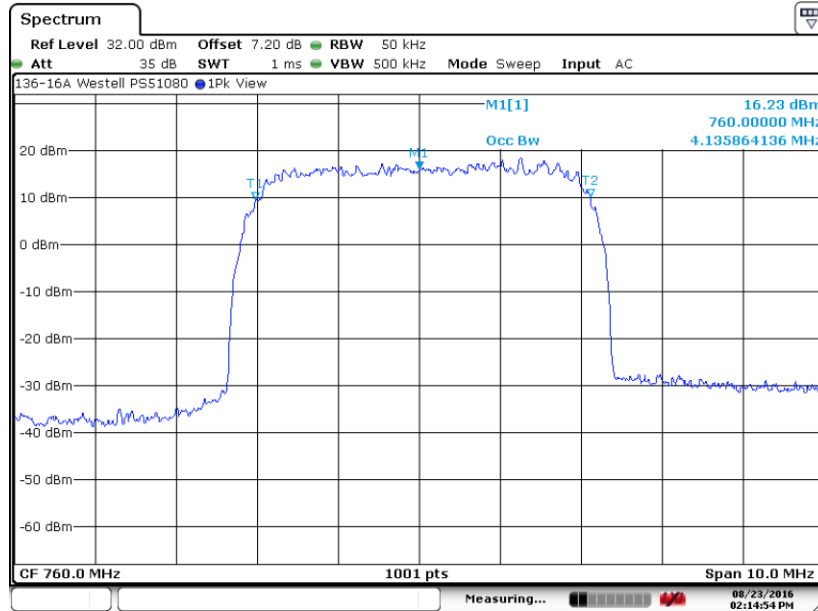
6.2.1. Occupied (99% Power) Bandwidth

Modulation Type	Frequency	Output Occupied Bandwidth	Input Occupied Bandwidth	Difference	Result
	MHz	kHz	kHz	kHz	
AWGN	760	4136	4186	-50	Compliant
AWGN	763	4166	4186	-20	Compliant
AWGN	765	4186	4186	0	Compliant
AWGN	790	4146	4186	-40	Compliant
AWGN	793	4176	4196	-20	Compliant
AWGN	796	4176	4176	0	Compliant

6. Measurement Data (continued)

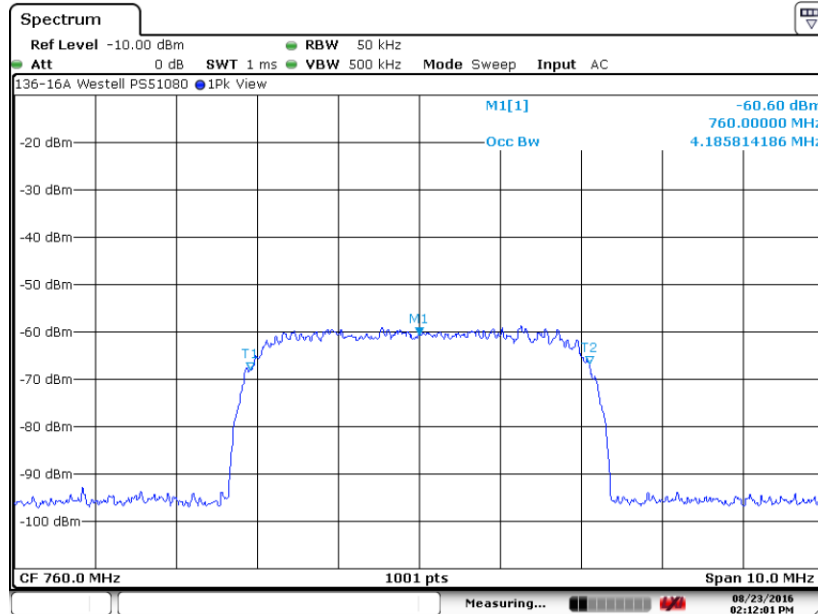
6.2. Bandwidth Limitations 90.219(e)(4)(ii), FCC Part 2.1049 (continued)

6.2.1.1. Occupied (99% Power) Bandwidth Measurement, 760 MHz, AWGN



Date: 23.AUG.2016 14:14:53

6.2.1.2. Occupied (99% Power) Bandwidth Input, 760 MHz, AWGN

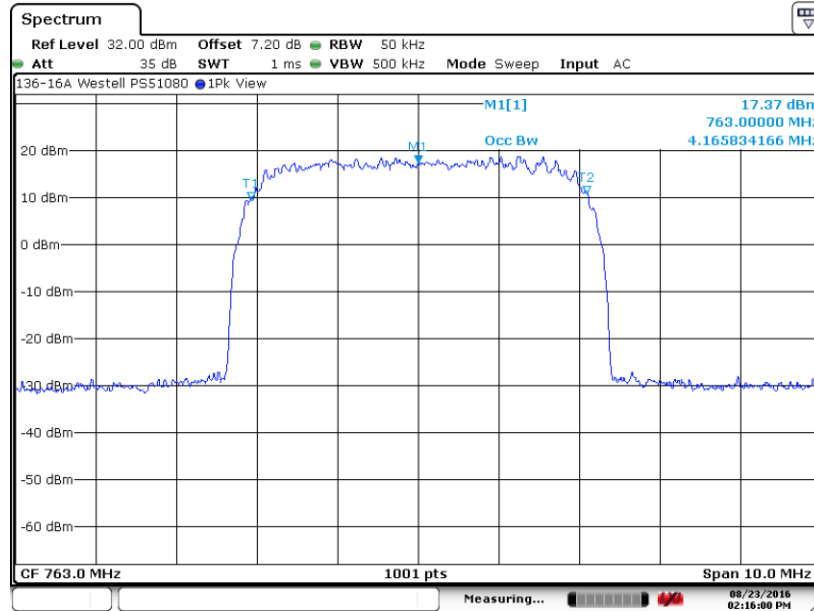


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6. Measurement Data (continued)

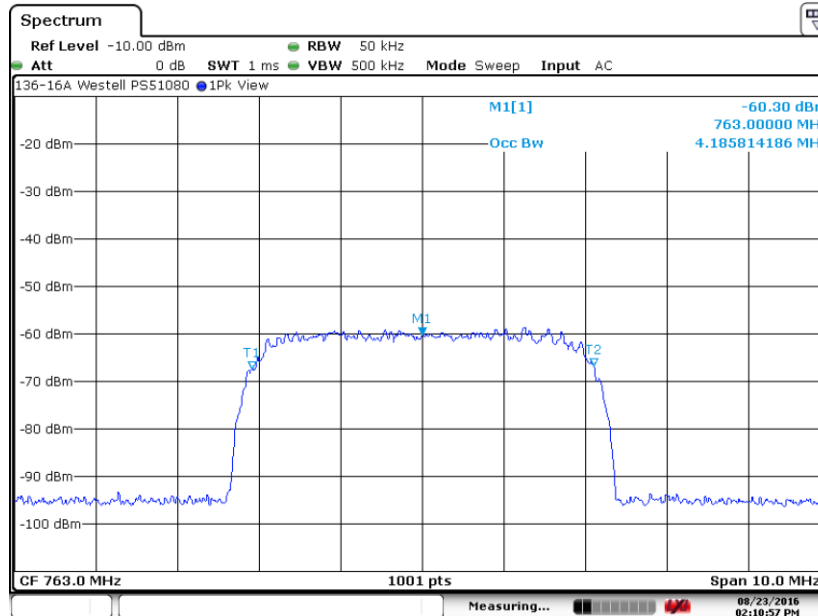
6.2. Bandwidth Limitations 90.219(e)(4)(ii), FCC Part 2.1049 (continued)

6.2.1.3. Occupied (99% Power) Bandwidth Measurement, 763 MHz, AWGN



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6.2.1.4. Occupied (99% Power) Bandwidth Input, 763 MHz, AWGN

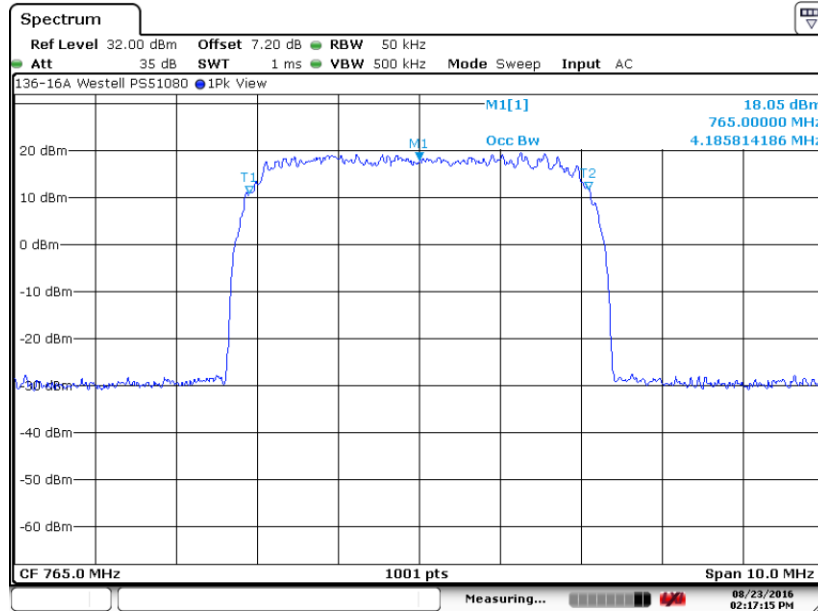


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6. Measurement Data (continued)

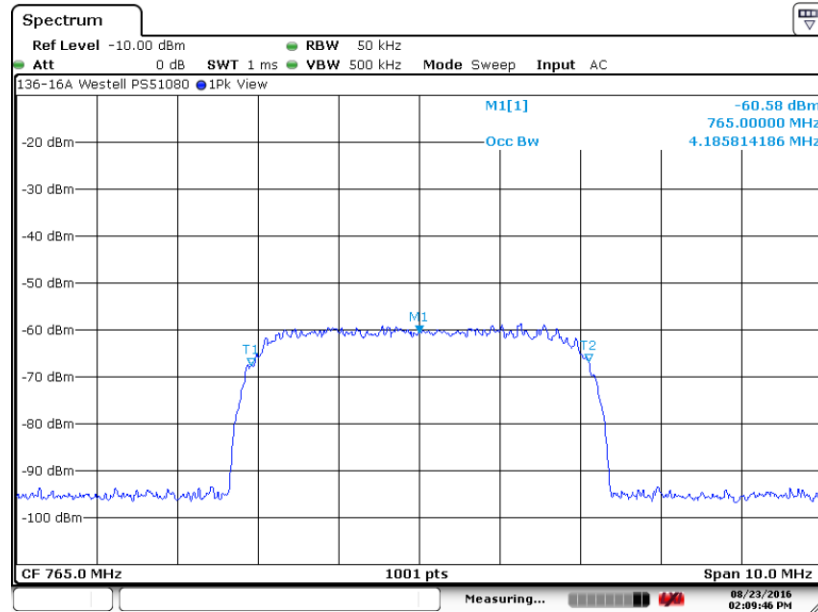
6.2. Bandwidth Limitations 90.219(e)(4)(ii), FCC Part 2.1049 (continued)

6.2.1.5. Occupied (99% Power) Bandwidth Measurement, 765 MHz, AWGN



Date: 23.AUG.2016 14:17:14

6.2.1.6. Occupied (99% Power) Bandwidth Input, 765 MHz, AWGN

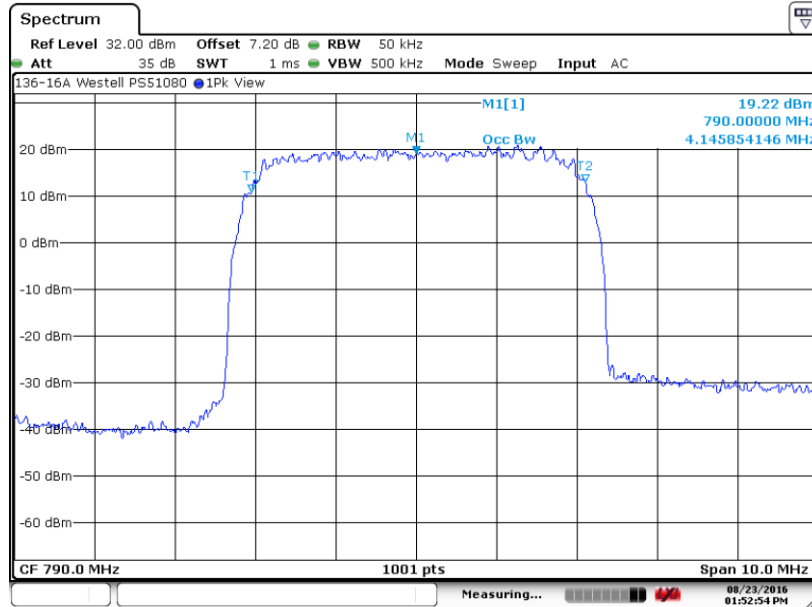


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6. Measurement Data (continued)

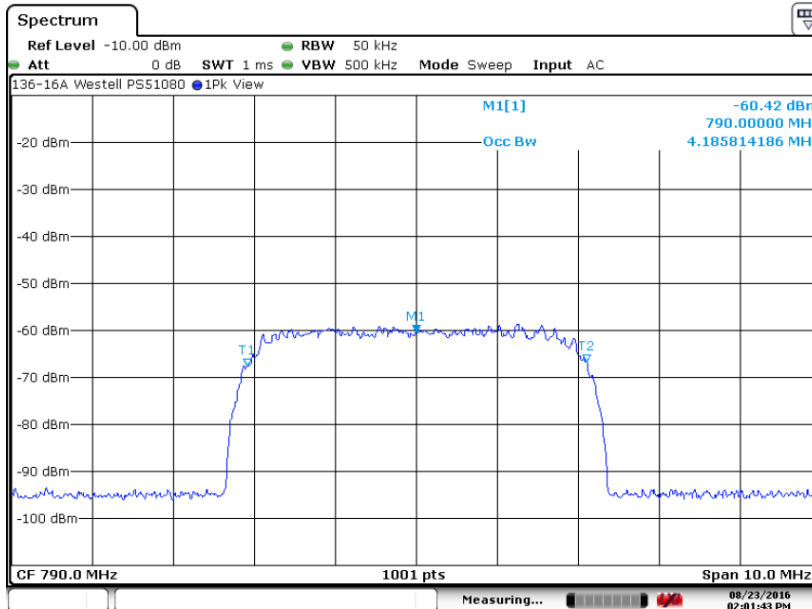
6.2. Bandwidth Limitations 90.219(e)(4)(ii), FCC Part 2.1049 (continued)

6.2.1.7. Occupied (99% Power) Bandwidth Measurement, 790 MHz, AWGN



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6.2.1.8. Occupied (99% Power) Bandwidth Input, 790 MHz, AWGN

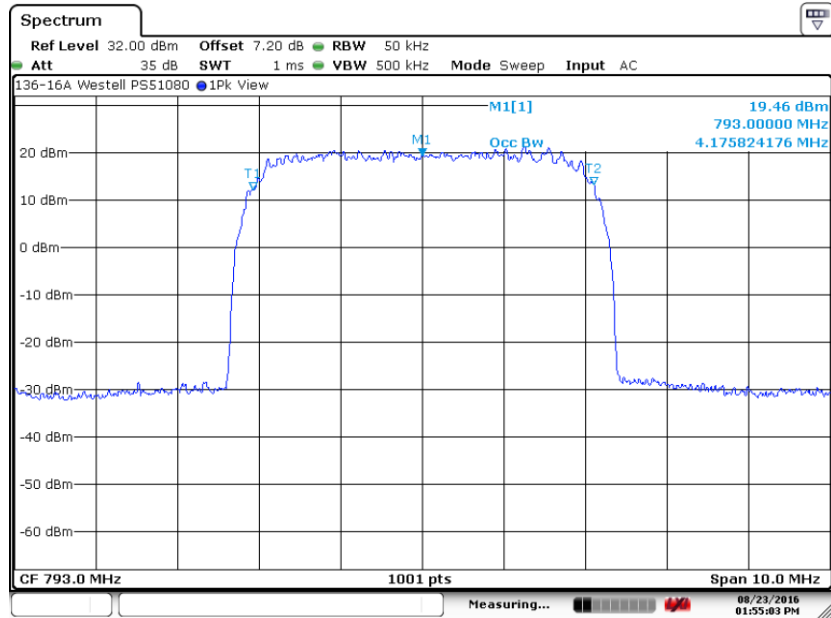


Date: 23.AUG.2016 14:01:42

6. Measurement Data (continued)

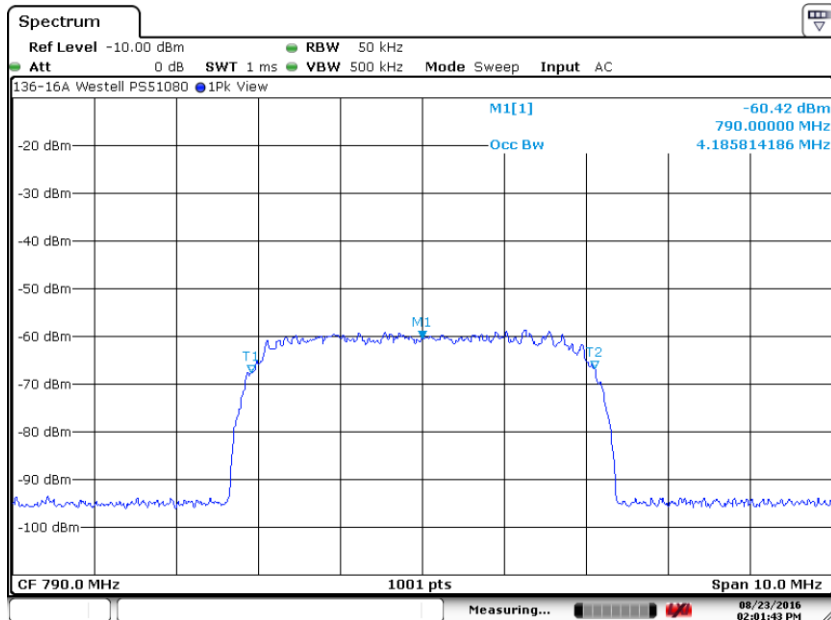
6.2. Bandwidth Limitations 90.219(e)(4)(ii), FCC Part 2.1049 (continued)

6.2.1.9. Occupied (99% Power) Bandwidth Measurement, 793 MHz, AWGN



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6.2.1.10. Occupied (99% Power) Bandwidth Input, 793 MHz, AWGN

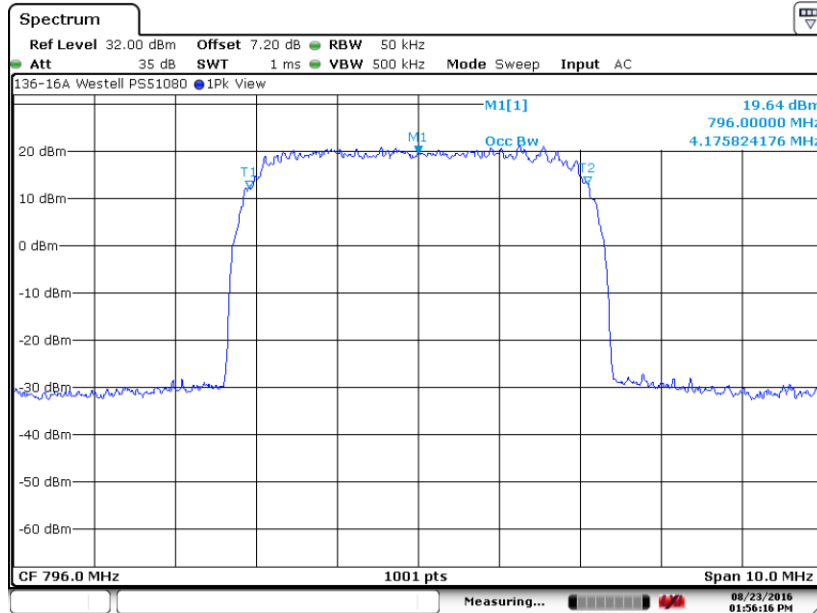


Date: 23.AUG.2016 14:01:42

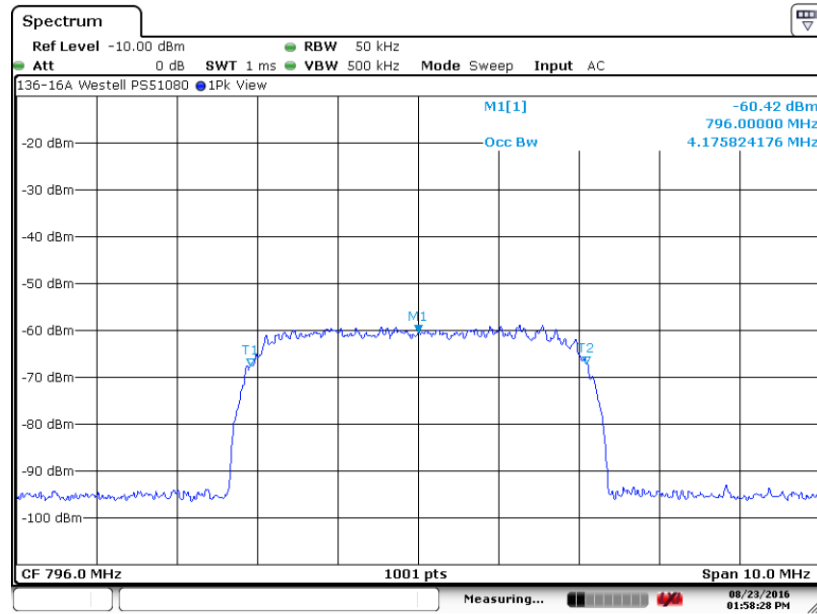
6. Measurement Data (continued)

6.2. Bandwidth Limitations 90.219(e)(4)(ii), FCC Part 2.1049 (continued)

6.2.1.11. Occupied (99% Power) Bandwidth Measurement, 796 MHz, AWGN



6.2.1.12. Occupied (99% Power) Bandwidth Input, 766 MHz, 16k FM



6. Measurement Data (continued)

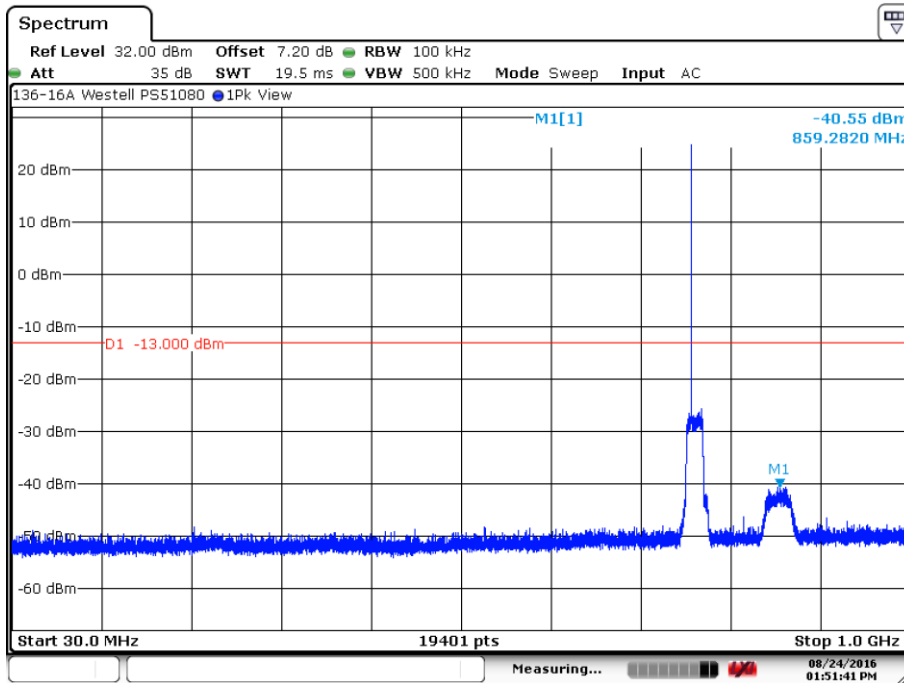
6.3. Spurious Emissions at the Antenna Terminals 90.219(e)(3), 90.543 (c)

Requirement: Transmitters designed to operate in the 758 to 768 MHz and 788 to 798 MHz bands, any emission outside of the ACP tables in this section shall be attenuated below the transmitter power (P) by at least 43 + 10 log (P) dB.

Compliance with this provision is based upon the use of measurement instrumentation employing a resolution bandwidth of 100 kHz bandwidth for frequencies less than 1 GHz, and in a 1 MHz bandwidth for frequencies greater than 1 GHz.

Test Method: KDB 935210 Section 4.7.3

6.3.1. 763 MHz, 30 MHz to 1 GHz

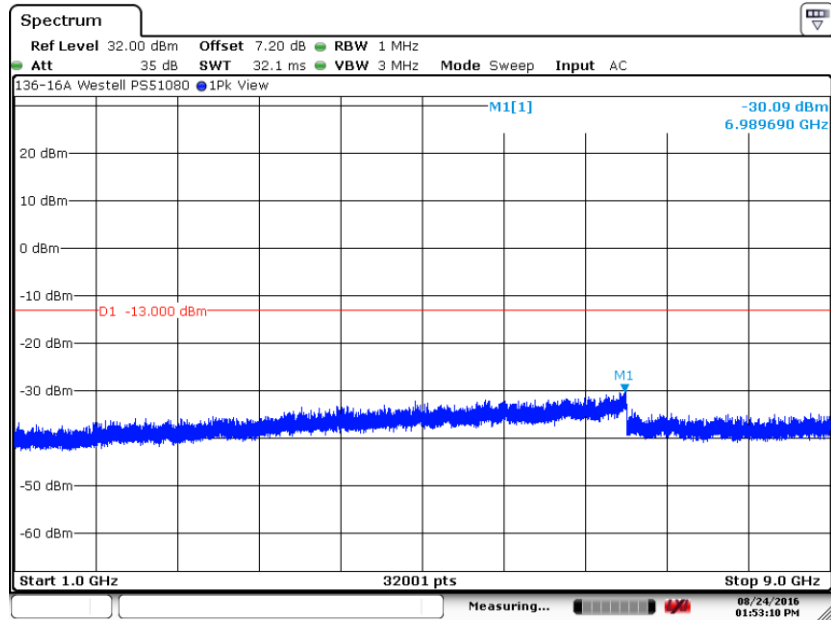


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6. Measurement Data (continued)

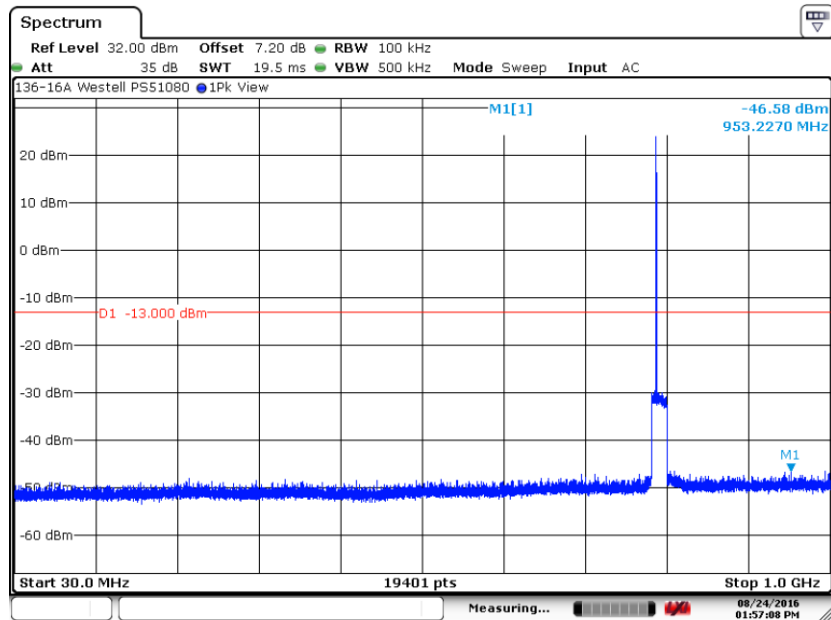
6.3. Spurious Emissions at the Antenna Terminals 90.219(e)(3), 90.543 (c) (continued)

6.3.2. 763 MHz, 1 to 9 GHz



Date: 24.AUG.2016 13:53:09

6.3.3. 793 MHz, 30 MHz to 1 GHz

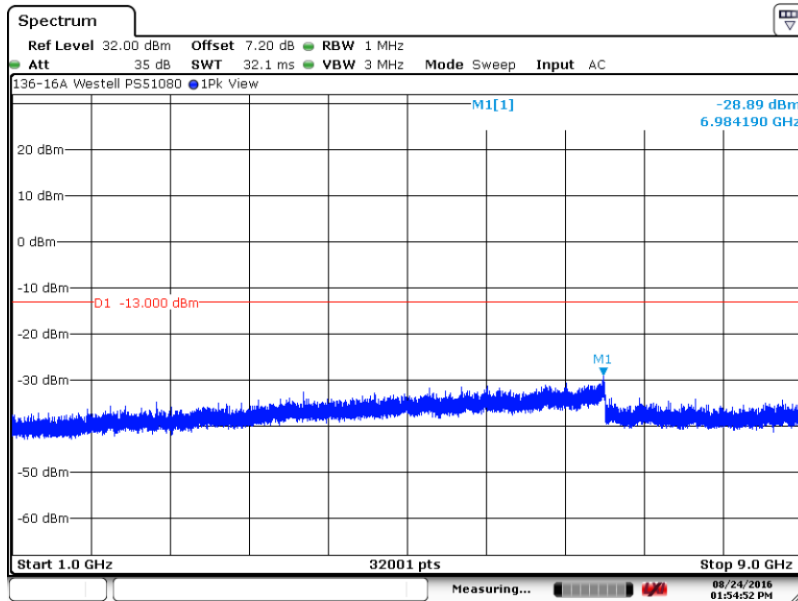


Date: 24.AUG.2016 13:57:07

6. Measurement Data (continued)

6.3. Spurious Emissions at the Antenna Terminals 90.219(e)(3), 90.543 (c) (continued)

6.3.4. 793 MHz, 1 to 9 GHz



Date: 24.AUG.2016 13:54:51

6. Measurement Data (continued)

6.4. Field Strength of Spurious Emissions 90.543 (f)

Requirement: For operations in the 758-775 MHz and 788-805 MHz bands, all emissions including harmonics in the band 1559-1610 MHz shall be limited to -70 dBW/MHz (-40 dBm/MHz) equivalent isotropically radiated power (EIRP) for wideband signals, and -80 dBW (-50 dBm) EIRP for discrete emissions of less than 700 Hz bandwidth.

For the purpose of equipment authorization, a transmitter shall be tested with an antenna that is representative of the type that will be used with the equipment in normal operation. 3 dBi 700 MHz antennas were used with the unit. Narrowband and wideband measurements were made horizontal & vertical polarities.

A 1 kHz RBW was used for the narrowband emissions measurements. A BW Correction factor of $10 \log B1/B2 = 10 \log 700 / 1000 = -1.55 \text{ dB}$ may be applied to the narrowband measurements.

Test Method: KDB 935210 Section 4.9

6.4.1. Measurement and Equipment Setup

Test Date:	8/24/2016
Test Engineer:	Larry Stillings
Site Temperature (°C):	24
Relative Humidity (%RH):	33
Frequency Range:	1559 – 1610 MHz
Measurement Distance:	3 Meters
EMI Receiver IF Bandwidth:	1 MHz, 1 kHz
EMI Receiver Avg Bandwidth:	3 MHz, 10 kHz
Detector Functions:	Peak and Average
Antenna Height:	1 to 4 meters

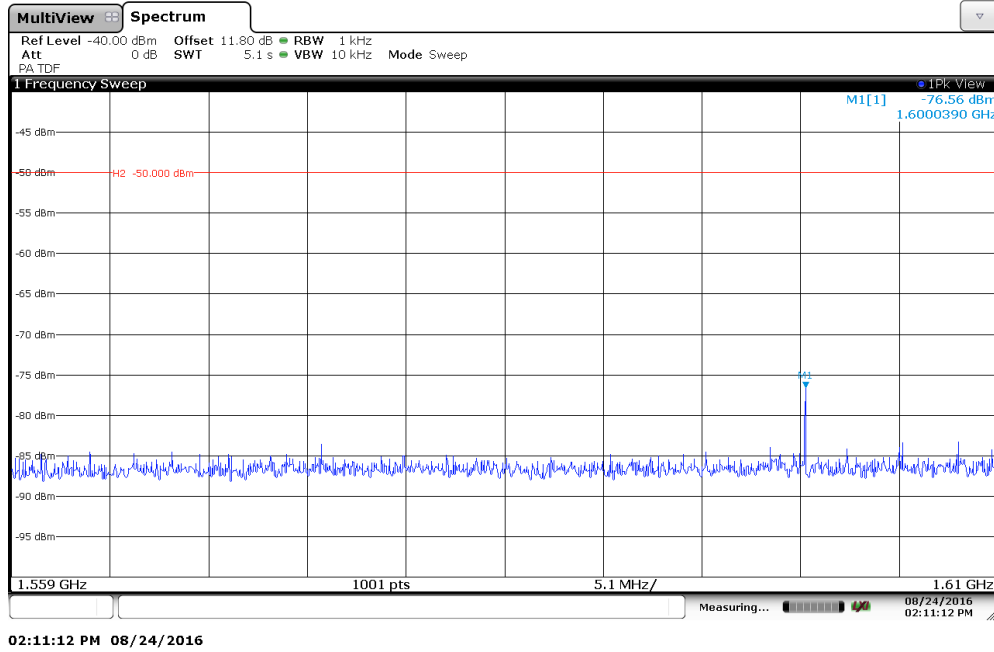
6.4.2 Test Procedure

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.

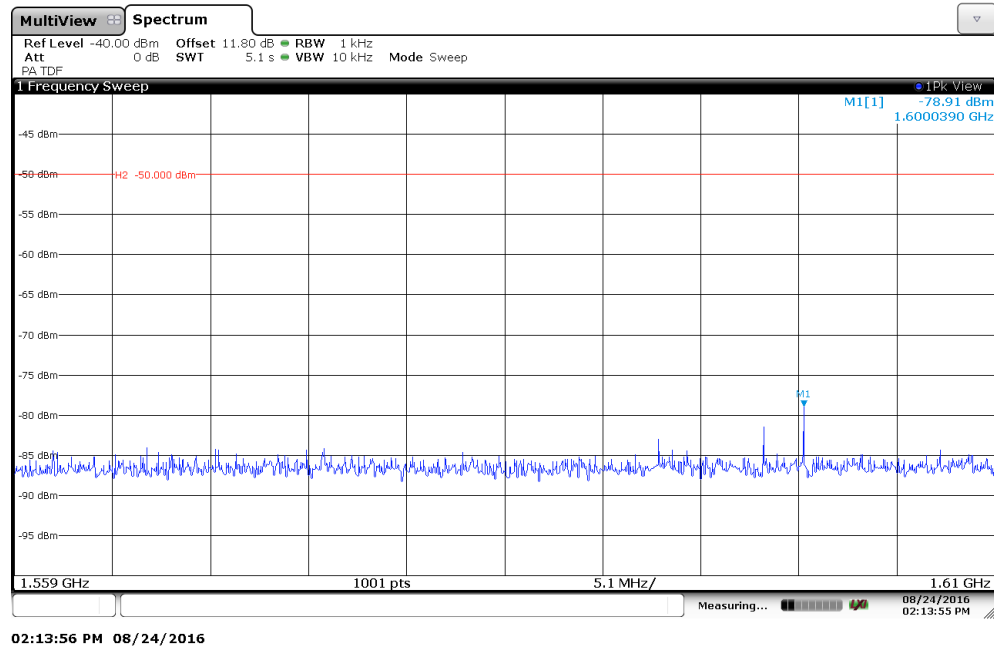
6. Measurement Data (continued)

6.4. Field Strength of Spurious Emissions 90.543 (f) (continued)

6.4.3. Narrowband Emissions 1559 to 1610 MHz Horizontal



6.4.4. Narrowband Emissions 1559 to 1610 MHz Vertical



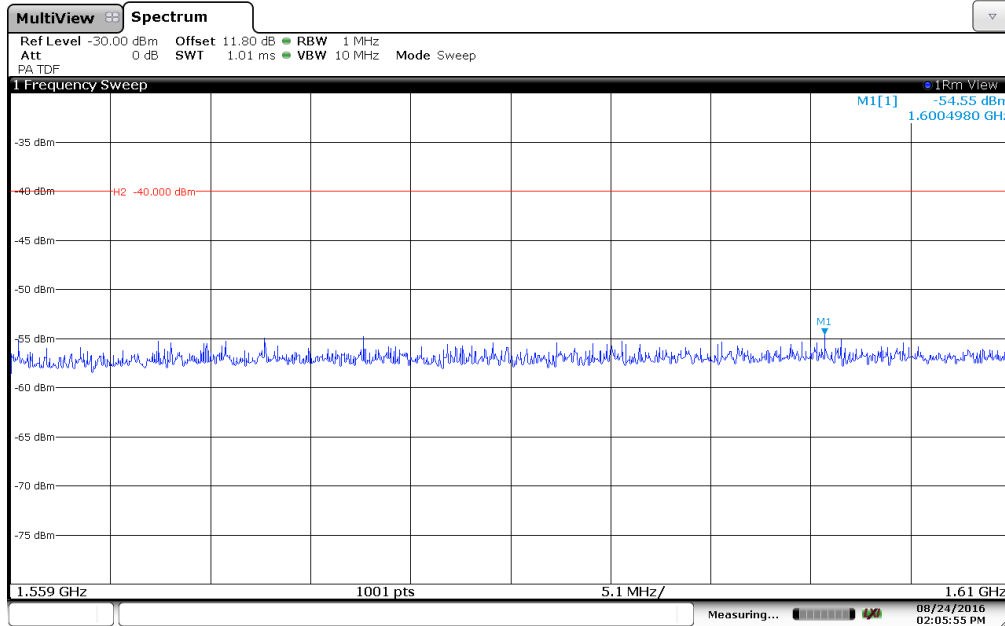
Test Number: 136-16A

Issue Date: 8/26/2016

6. Measurement Data (continued)

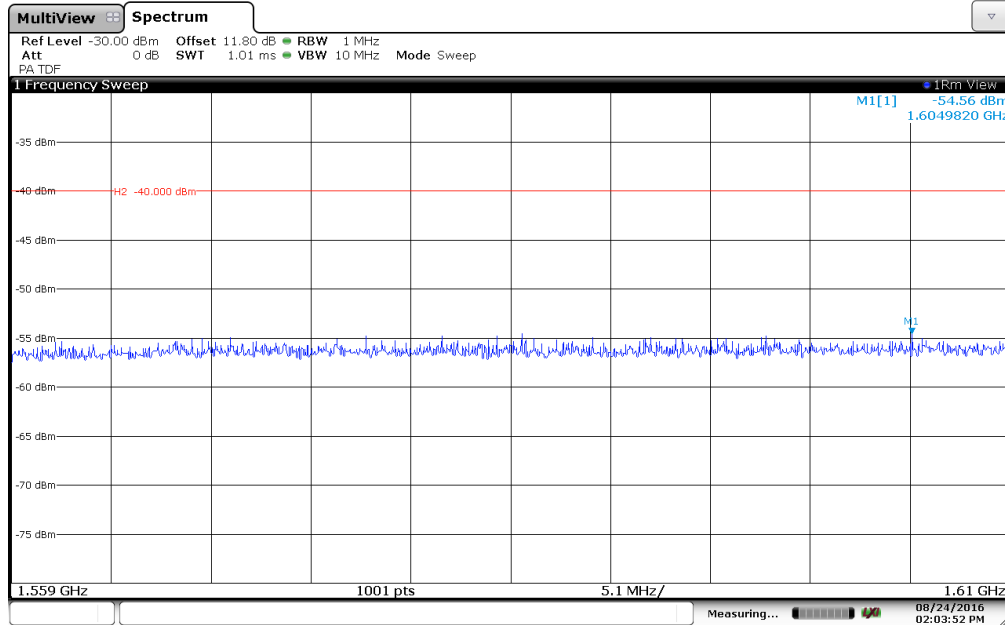
6.4. Field Strength of Spurious Emissions 90.543 (f) (continued)

6.4.5. Wideband Emissions 1559 to 1610 MHz Horizontal



02:05:55 PM 08/24/2016

6.4.6. Wideband Emissions 1559 to 1610 MHz Vertical



02:03:52 PM 08/24/2016

6. Measurement Data (continued)

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

Center Frequency (MHz)	MPE Distance (cm)	DUT Output Power (dBm)	DUT Antenna Gain (dBi)	Power Density		Limit (mW/cm ²)	Result
				(mW/cm ²)	(W/m ²)		
	(1)	(2)	(3)	(4)		(5)	
760	20.0	24.38	3.00	0.1088254	1.0882537	2.53	Compliant
763	20.0	25.21	3.00	0.1317438	1.3174379	2.54	Compliant
765	20.0	26.12	3.00	0.1624539	1.6245390	2.55	Compliant
790	20.0	27.21	3.00	0.2087998	2.0879983	2.63	Compliant
793	20.0	27.63	3.00	0.2300012	2.3000122	2.64	Compliant
796	20.0	27.74	3.00	0.2359012	2.3590120	2.65	Compliant

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

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 20 centimeters of the body of the user.
2. Section 6.1.2 of this test report. Note that the value has been adjusted to include the cable insertion loss.
3. Data supplied by the client for combination of cable loss and antenna gain.
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 (A): Limits for Occupational/Controlled Exposure. $f/300$ where f is in MHz

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 with 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 Setup Photographs

Antenna Port Conducted Emissions



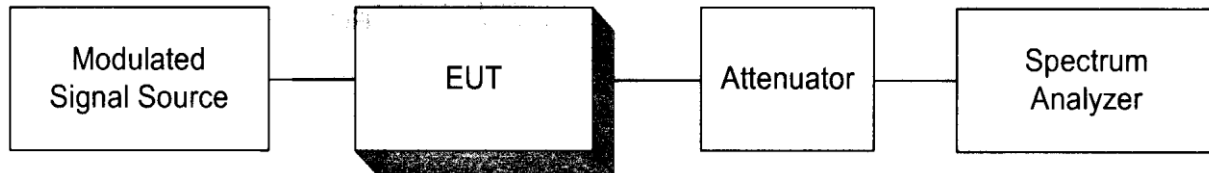
8. Test Setup Photographs (cont)

Narrowband & Wideband Emissions

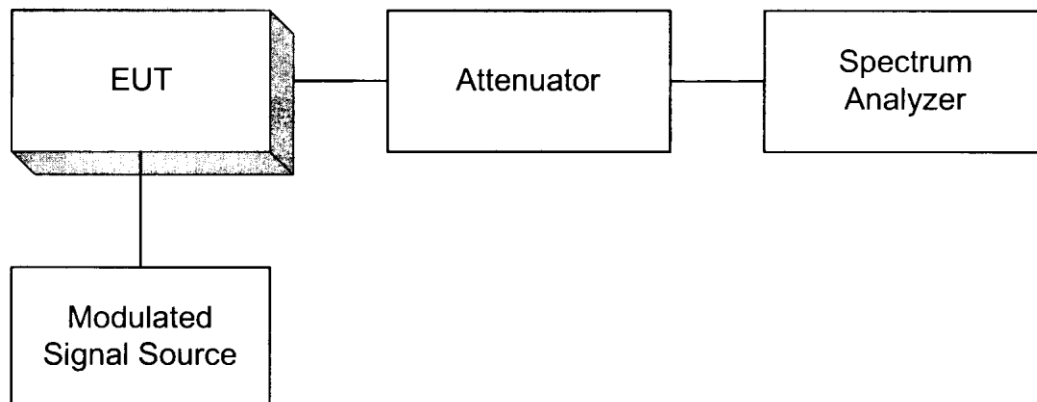


Appendix A

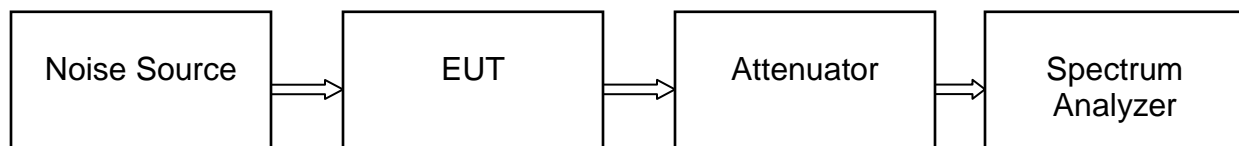
RF Output Power



Occupied Bandwidth

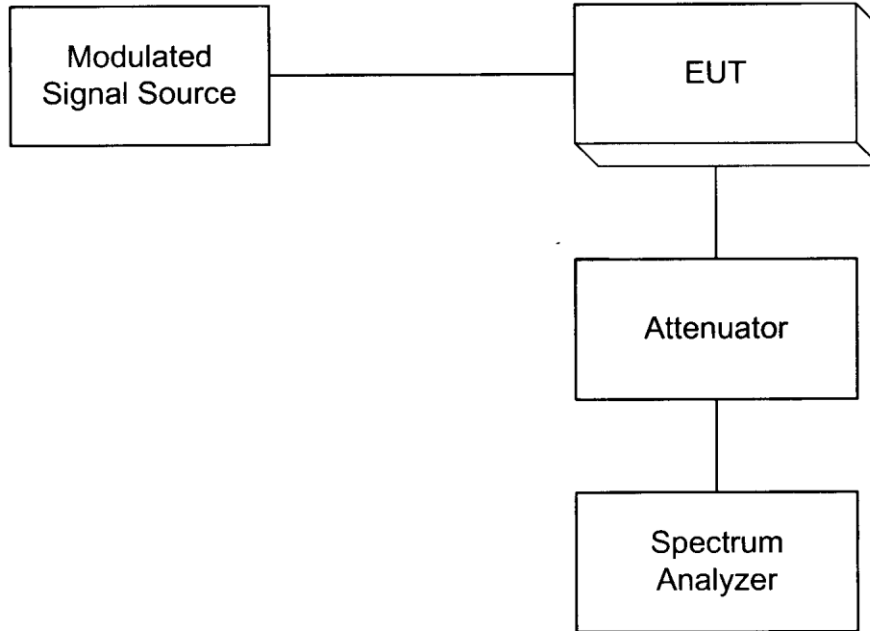


Noise Figure



Appendix A

Spurious Emissions at the Antenna Terminals



Field Strength of Spurious Radiation

