

COMPLIANCE WORLDWIDE INC. TEST REPORT 514-16R1

In Accordance with the Requirements of
FCC PART 90:2015 Subpart S
Operation in the 806 to 824 MHz and 851 to 869 MHz bands
and PART 20:2015

Issued to

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

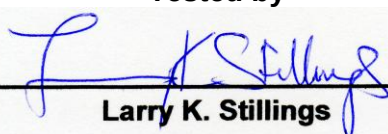
for

2 Watt Public Safety Signal Booster
Model: PS71090-PS78

FCC ID: NVRPS71090-PS78

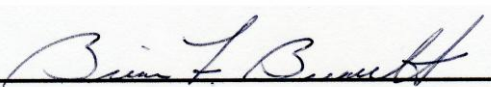
Original Report Issued on February 7, 2017

Tested by



Larry K. Stillings

Reviewed By



Brian F. Breault

This test report shall not be reproduced, except in full, without written permission from Compliance Worldwide, Inc.

Table of Contents

1. Scope	3
2. Product Details	3
2.1. Manufacturer	3
2.2. Model Number	3
2.3. Serial Number	3
2.4. Description	3
2.5. Power Source	3
2.6. Software Version	3
2.7. EMC Modifications	3
2.8. DC Voltages and Currents at Final Transmitter Stage	3
3. Product Configuration	4
3.1. Support Equipment	4
3.2. Cables	4
3.3. Operational Characteristics & Software	5
3.4. Block Diagram	5
4. Measurement Parameters	6
4.1. Measurement Equipment Used to Perform Test	6
4.2. Measurement & Equipment Setup	6
4.3. Test Procedure	6
5. Measurement Summary	7
6. Measurement Data	8
6.1. Broadband Transmitting Power Limits 90.635	8
6.2. Bandwidth Limitations (FCC Part 2.1049) and Emission Mask 90.210	18
6.3. Spurious Emissions at the Antenna Terminals 90.669	32
6.4. Field Strength of Spurious Emissions 90.669	41
6.5. Frequency Stability 90.539	45
6.6. Out of Band Rejection	46
6.7. Noise Figure	48
6.8. Public Exposure to Radio Frequency Energy Levels 1.1307 (b)(1)	50
7. Test Site Description	51
8. Test Setup Photographs	52
Appendix A	57

1. Scope

This test report certifies that the Westell 2 Watt Public Safety Signal Booster Model PS71090-PS78, as tested, meets the FCC Part 90 Subpart S 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. Revision R1 updates the company address on the cover page, and adds the DC power input information to Section 2.8 on this page.

2. Product Details

2.1. Manufacturer: Westell, Inc.

2.2. Model Numbers: PS71090-PS78

2.3. Serial Number: 1610002S

2.4. Description: The PS71090-PS78 2 Watt Public Safety Signal Booster is an in-building signal booster with NFPA72-compliant features such as antenna monitoring and alarming and 24-hour battery back-up capabilities. The unit, which also meets future FirstNet requirements, is provided in a NEMA Type 4 red enclosure. The PS71090-PS78 supports uplink bands of 788-805 or 806-816/806-824 MHz and downlink bands of 758-775 or 851-861/851-869 MHz.

2.5. Power Source: 120 VAC, 60 Hz

2.6. Software Version: 0.1

2.7. EMC Modifications: None

2.8. DC voltages and currents of final transmitter stage @ 25°C

Frequency Range	758 -775 MHz / 851~869 MHz & 788 – 824 MHz
DC Input Voltage Range	+27VDC , 5.3VDC
DC Current	1.1(Typ.), 1.5A (Max.) @CW 36.5dBm / 27V 120mA (Typ.), 0.15A (Max.) @CW 36.5dBm / 5.3V

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

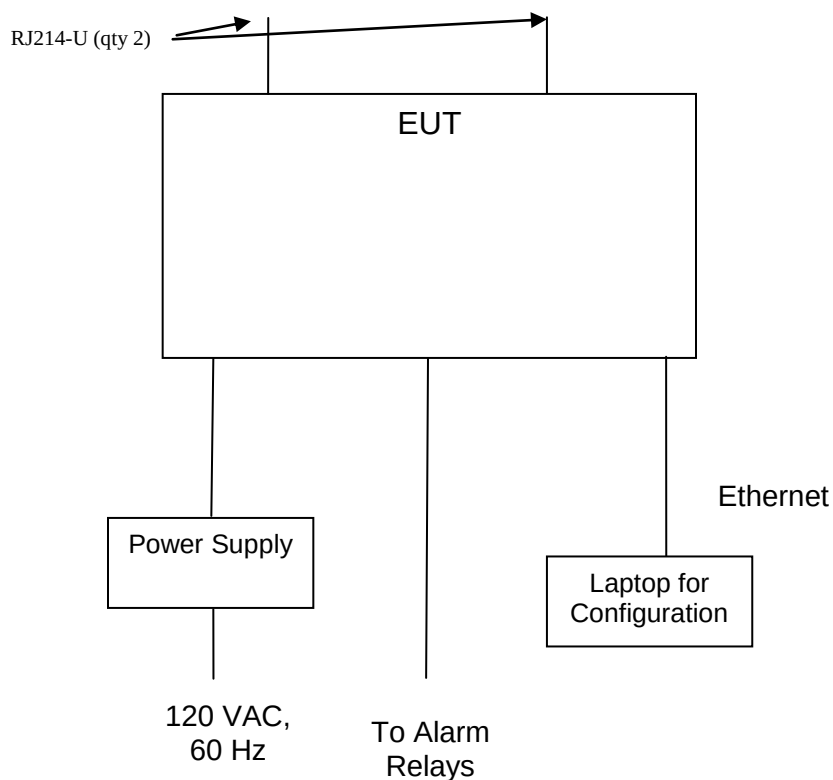
- (1) The unit was allowed to power up normally and go through its configuration cycle.
- (2) Using an RF Signal Generator on the Input and a Spectrum Analyzer on the output Downlink or Uplink frequencies a signal was generated over the intended bandwidth of operation.
- (3) The signal generator was configured to provide CW, 6.25, 12.5 and 25 kHz FM modulated, CPAO P25 Phase 1 and Phase 2 signals to the input of the amplifier across the public safety bands 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	Audio Frequency
16K0F3E	FM	16.0 kHz	25 kHz	1 kHz
11K3F3E	FM	11.3 kHz	12.5 kHz	1 kHz
4K03F1E	FM	4.03 kHz	6.25 kHz	1 kHz
N/A	CW	N/A	N/A	N/A
8K08F1D	C4FM	8.08 kHz	12.5 kHz	N/A
9K82G1D	$\pi/4$ -DQPSK	9.82 kHz	12.5 kHz	N/A

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	6/3/2019	3 Years
Horn Antenna, 960 MHz – 18 GHz	Electro-Metrics	RGA-50 / 60	2813	10/13/2017	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	10/15/2017	1 Year
Digital Barometer	Control Company	4195	ID236	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.

4.2. Measurement & Equipment Setup

Test Dates: 11/28/2016, 11/29/2016, 11/30/2016,
1/20/2017, 2/6/2017

Test Engineers: Larry Stillings, Cody Merry, Mark McSweeney

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 and Subpart S.

The test methods used to generate the data in this test report are in accordance with ANSI C63.26:2015, American National Standard for Compliance Testing of Transmitters Used in Licensed Radio Services, FCC OET KDB 935210 D05 Indus Booster Basic Meas v01r01 dated 2-12-2016, Measurements Guidance for Industrial and Non-Consumer Signal Booster, Repeater and Amplifier Devices, FCC OET KDB 971168 D01 Power Meas License Digital Systems v02r02 dated 10-17-2014 and ANSI/TIA-102.CAAA-D-2013, Digital C4FM/CQPSK Transceiver Measurement Methods.

Measurements were also made in accordance with ANSI/TIA-603-D 2010 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
Limitations on power and antenna height	90.219(e)(1) 90.635	6.1	Compliant	
Occupied Bandwidth and Emission Mask	90.219(e)(4)(ii) Part 2.1049 90.210	6.2	Compliant	
Spurious Emissions at Antenna Terminals	90.219(e)(3) 90.543	6.3	Compliant	
Field Strength of Spurious Emissions	90.219(e)(3) 90.543	6.4	Compliant	
Frequency Stability	90.213	6.5	N/A	The EUT does not translate the frequency of the input signal
Out of Band Rejection	N/A	6.6	Compliant	
Noise Figure	90.219(e)(2)	6.7	Compliant	
Public Exposure to Radio Frequency Energy Levels	Section 1.1307 (b)(1)	6.8	Compliant	

6. Measurement Data

6.1. Limitations on power and antenna height 90.219(e)(1), 90.635

Requirement: The transmitter output power of mobile and control transmitters operating in the 806 to 824 MHz, 851 to 869 MHz, 896 to 901 MHz and 935 to 940 MHz bands must not exceed 1 kilowatt (30 dBw) and 304 meters (1,000 ft) above average terrain.

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

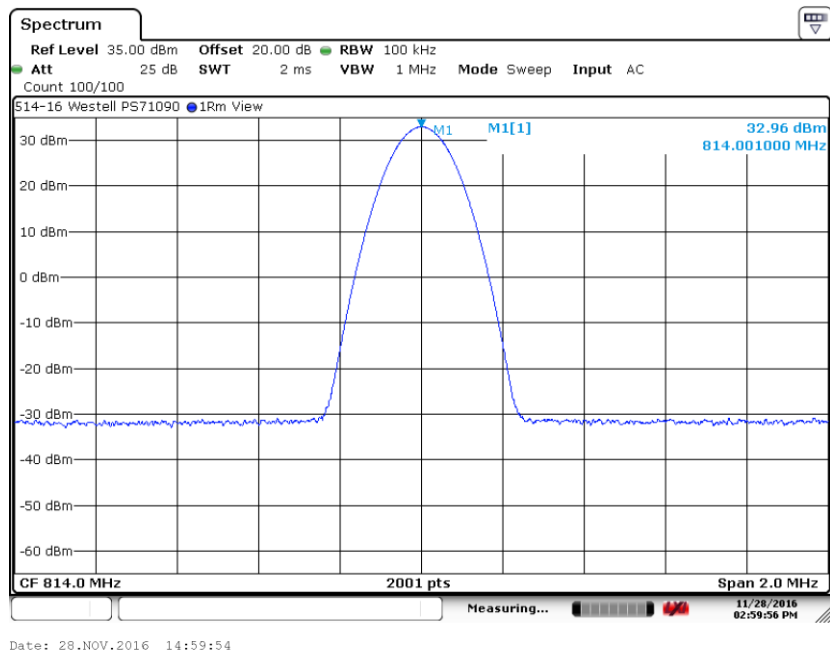
Modulation Type	Center Frequency	Output Power		Input Power (dBm)	Result
	(MHz)	(dBm)	(Watts)		
FM Modulation	814	32.96	1.977	-57.04	Compliant
CW	814	33.01	2.000	-57.03	Compliant
C4FM Modulation	814	32.98	1.986	-57.02	Compliant
$\pi/4$ -DQPSK Modulation	814	32.94	1.968	-56.88	Compliant
FM Modulation	860.5	32.48	1.770	-57.85	Compliant
CW	860.5	32.49	1.774	-57.84	Compliant
C4FM Modulation	860.5	32.50	1.778	-57.82	Compliant
$\pi/4$ -DQPSK Modulation	860.5	32.69	1.858	-57.91	Compliant

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

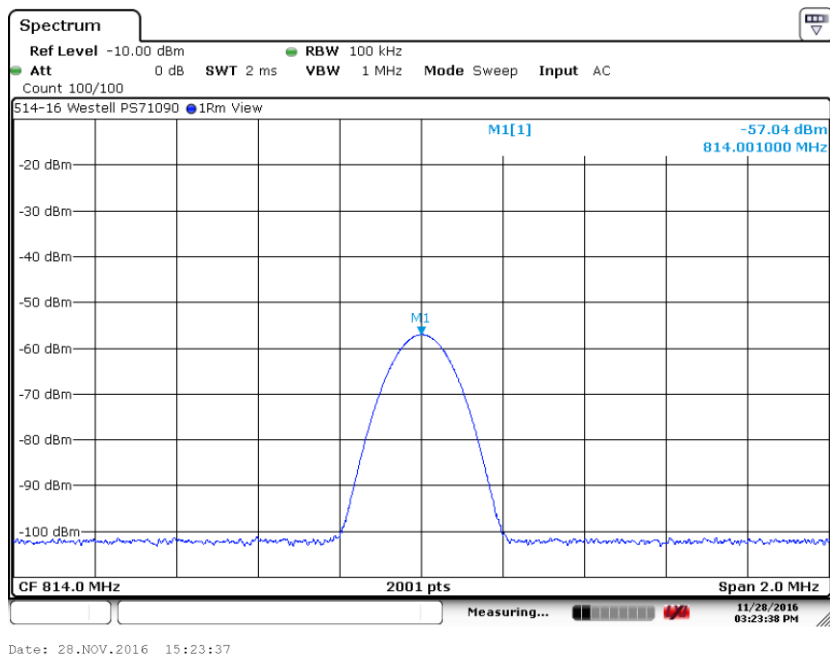
6. Measurement Data

6.1. Limitations on power and antenna height 90.219(e)(1), 90.635 (cont)

6.1.2. Mean Transmitter Output Power, 814 MHz, FM Modulation



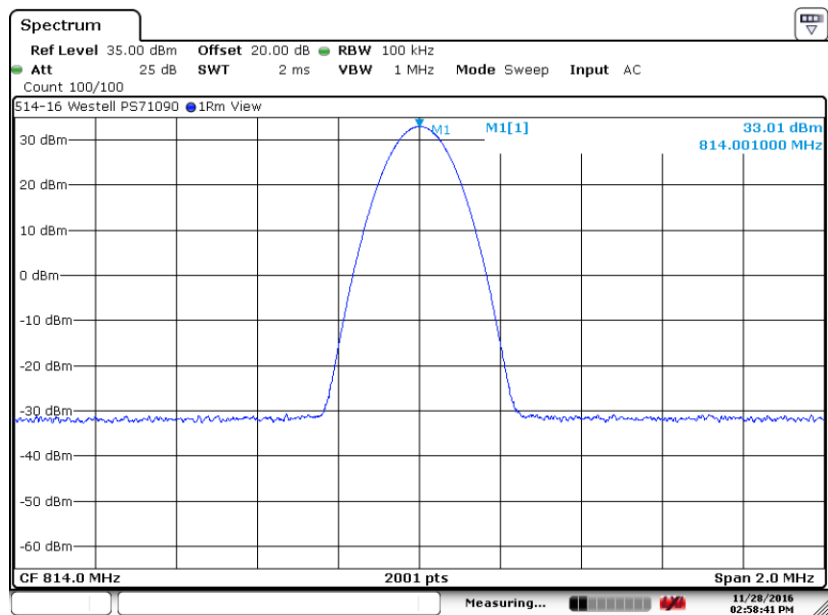
6.1.3. Mean Transmitter Input Power, 814 MHz, FM Modulation



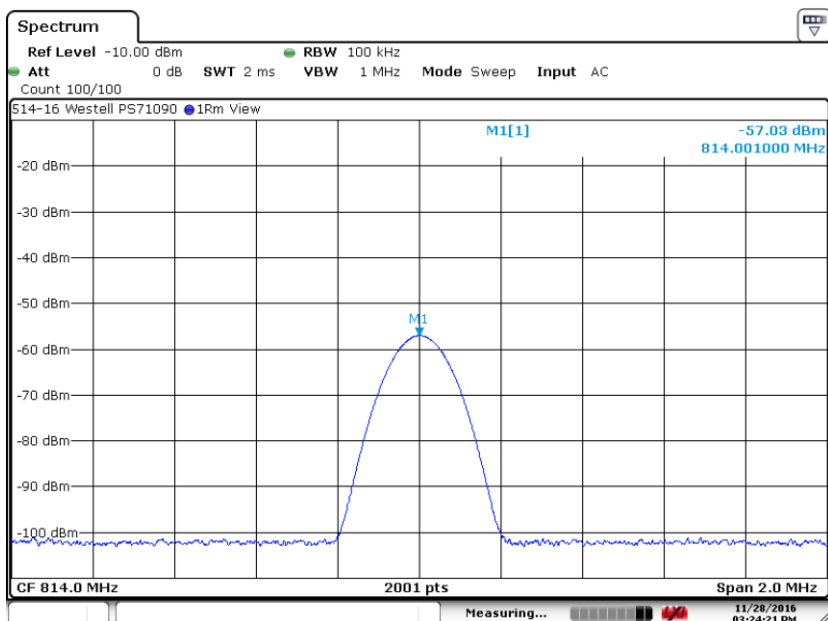
6. Measurement Data

6.1. Limitations on power and antenna height 90.219(e)(1), 90.635 (cont)

6.1.4. Mean Transmitter Output Power, 814 MHz, CW Signal



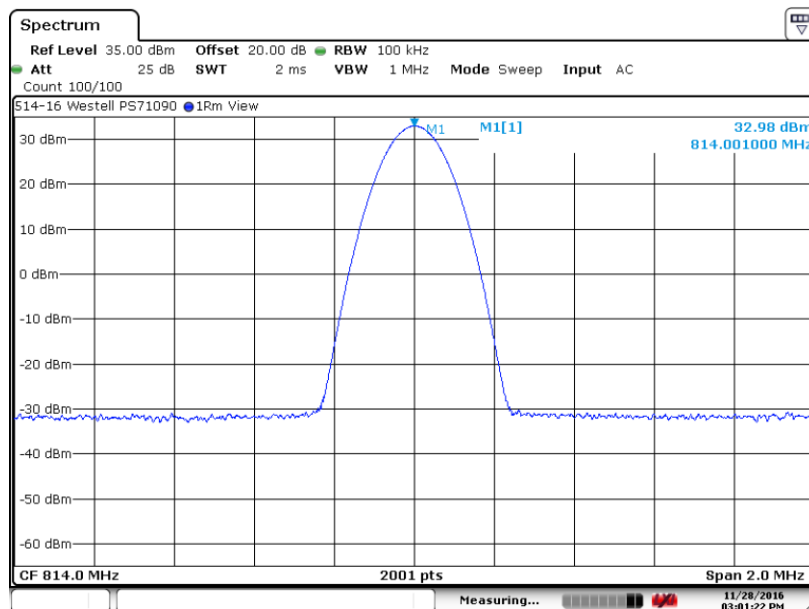
6.1.5. Mean Transmitter Input Power, 814 MHz, CW Signal



6. Measurement Data

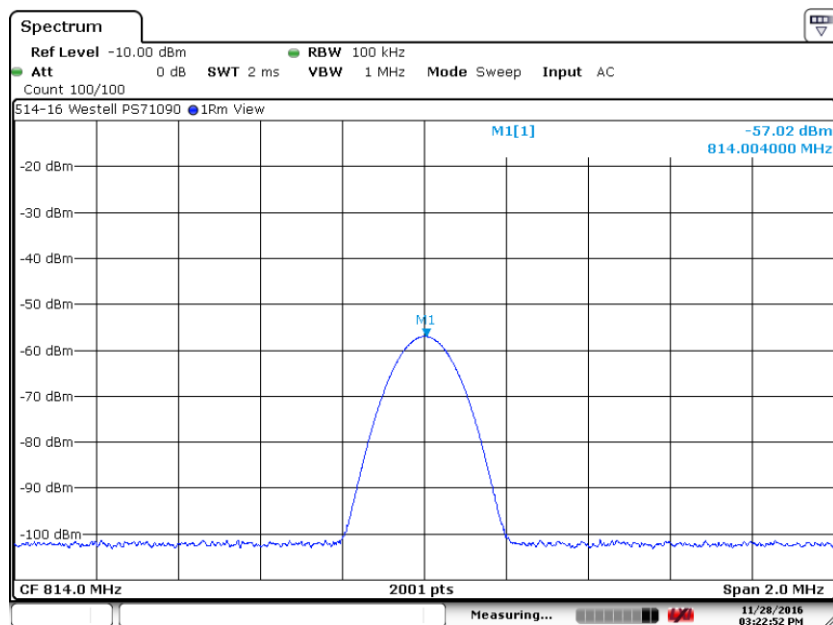
6.1. Limitations on power and antenna height 90.219(e)(1), 90.635 (cont)

6.1.6. Mean Transmitter Output Power, 814 MHz, C4FM Modulation



Date: 28.NOV.2016 15:01:21

6.1.7. Mean Transmitter Input Power, 814 MHz, C4FM Modulation

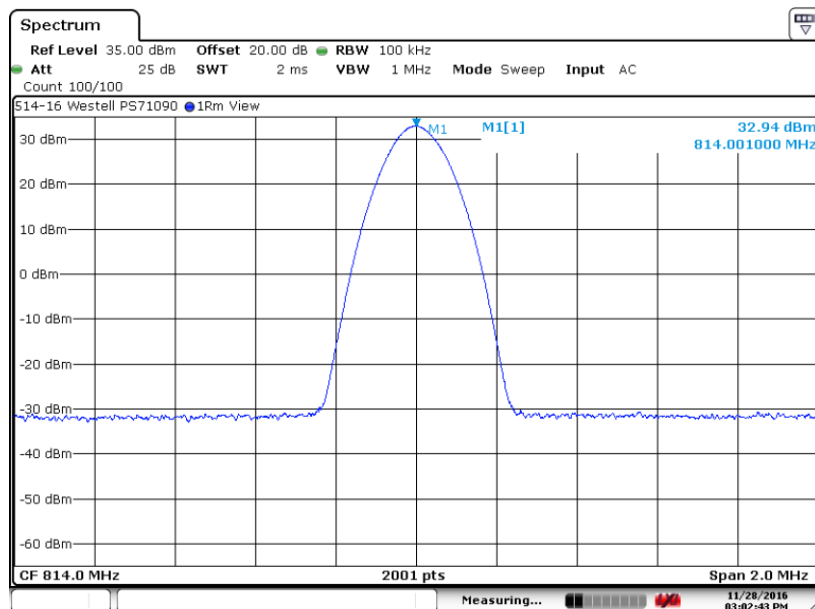


Date: 28.NOV.2016 15:22:51

6. Measurement Data

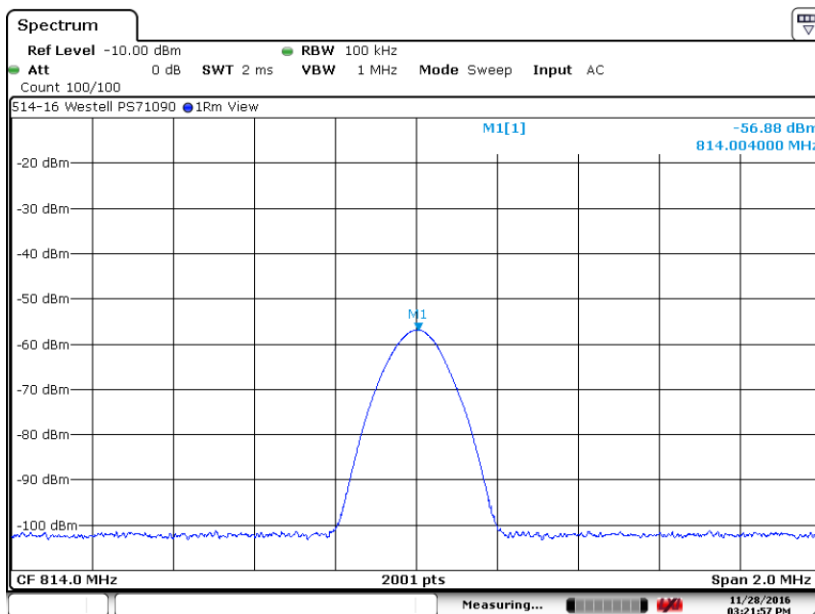
6.1. Limitations on power and antenna height 90.219(e)(1), 90.635 (cont)

6.1.8. Mean Transmitter Output Power, 814 MHz, $\pi/4$ -DQPSK Modulation



Date: 28.NOV.2016 15:02:42

6.1.9. Mean Transmitter Input Power, 814 MHz, $\pi/4$ -DQPSK Modulation

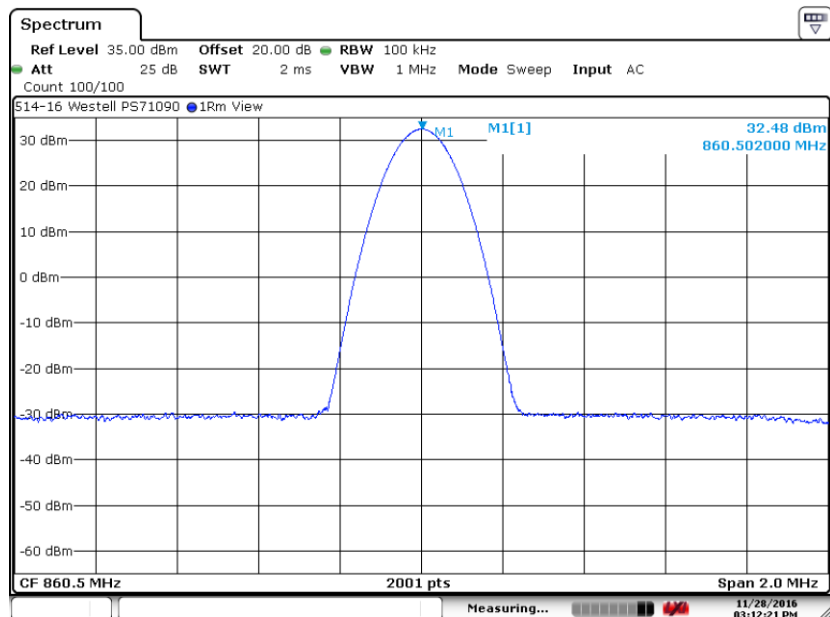


Date: 28.NOV.2016 15:21:56

6. Measurement Data

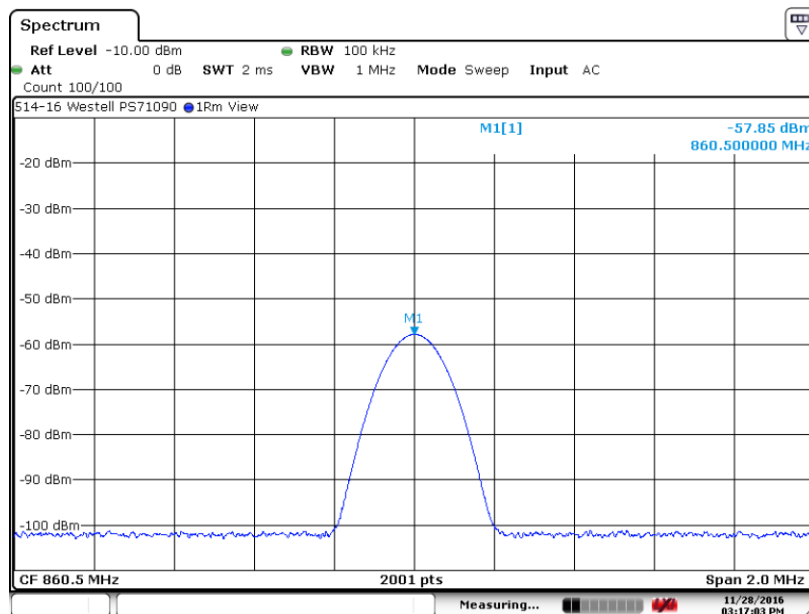
6.1. Limitations on power and antenna height 90.219(e)(1), 90.635 (cont)

6.1.10. Mean Transmitter Output Power, 860.5 MHz, FM Modulation



Date: 28.NOV.2016 15:12:20

6.1.11. Mean Transmitter Input Power, 860.5 MHz, FM Modulation

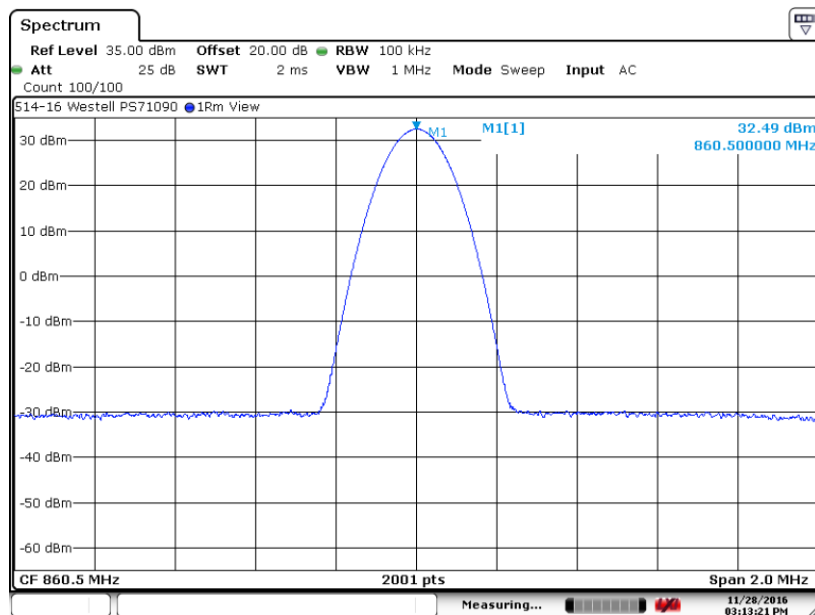


Date: 28.NOV.2016 15:17:02

6. Measurement Data

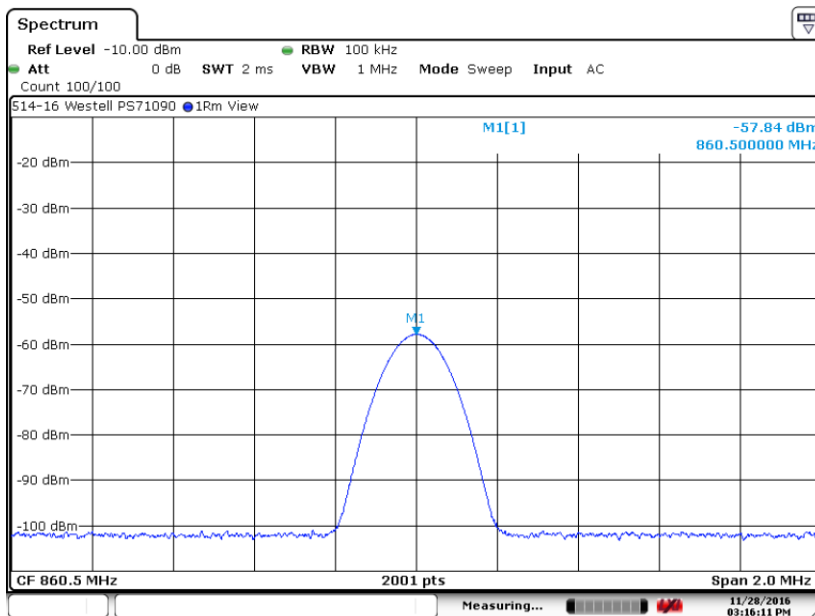
6.1. Limitations on power and antenna height 90.219(e)(1), 90.635 (cont)

6.1.12. Mean Transmitter Output Power, 860.5 MHz, CW Signal



Date: 28.NOV.2016 15:13:20

6.1.13. Mean Transmitter Input Power, 860.5 MHz, CW Signal

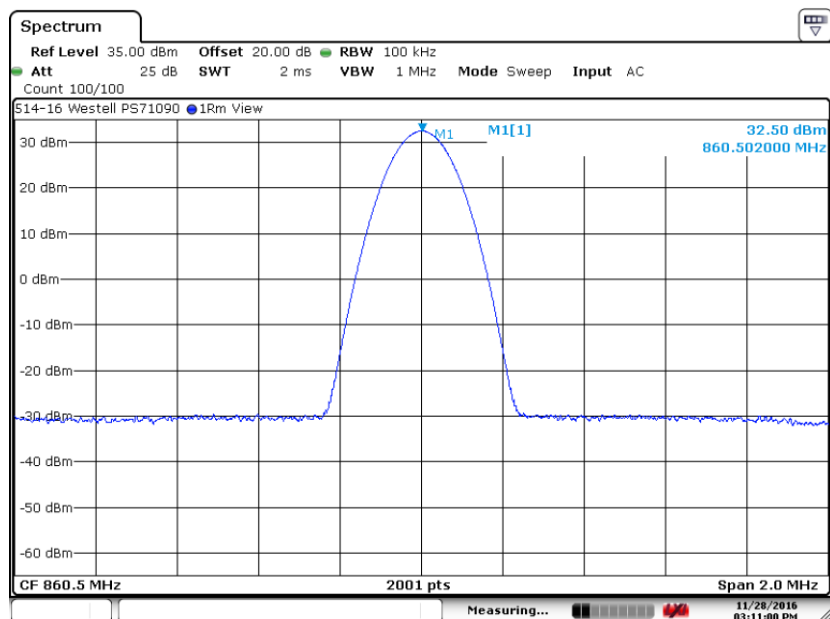


Date: 28.NOV.2016 15:16:10

6. Measurement Data

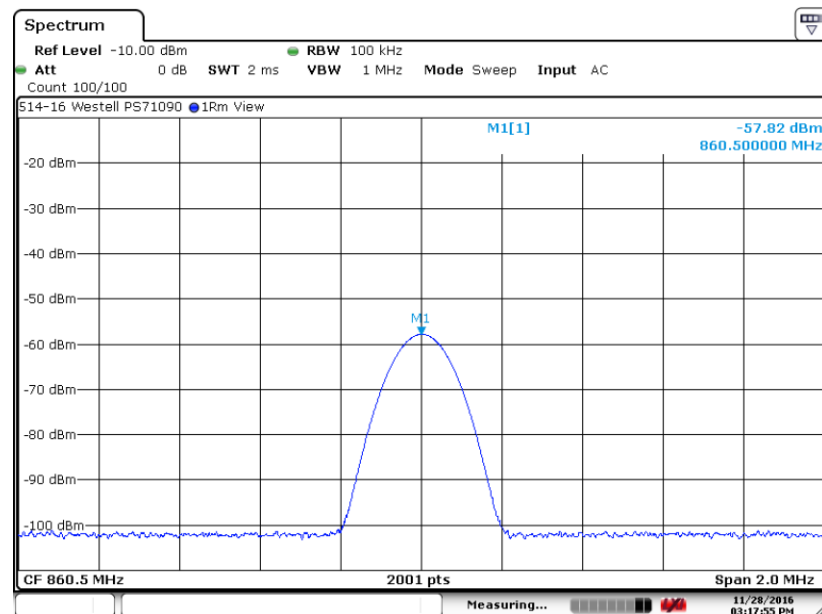
6.1. Limitations on power and antenna height 90.219(e)(1), 90.635 (cont)

6.1.14. Mean Transmitter Output Power, 860.5 MHz, C4FM Modulation



Date: 28.NOV.2016 15:10:59

6.1.15. Mean Transmitter Input Power, 860.5 MHz, C4FM Modulation

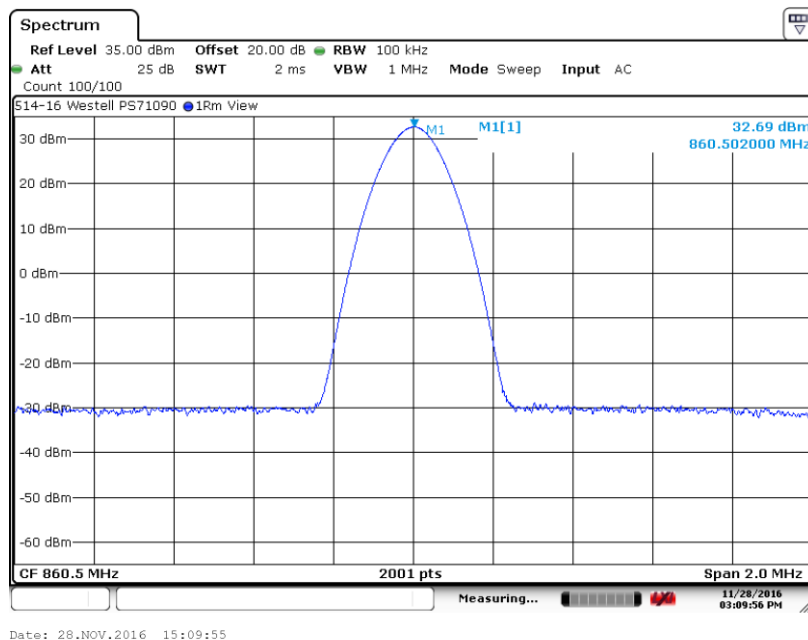


Date: 28.NOV.2016 15:17:53

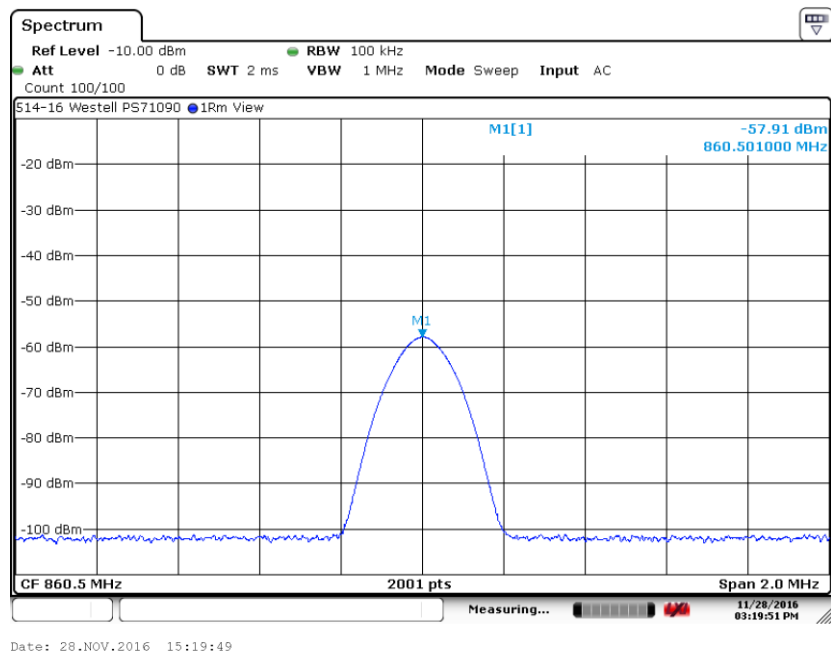
6. Measurement Data

6.1. Limitations on power and antenna height 90.219(e)(1), 90.635 (cont)

6.1.16. Mean Transmitter Output Power, 860.5 MHz, $\pi/4$ -DQPSK Modulation



6.1.17. Mean Transmitter Input Power, 860.5 MHz, $\pi/4$ -DQPSK Modulation



6. Measurement Data

6.1. Limitations on power and antenna height 90.219(e)(1), 90.635 (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."

ERP = Transmitter Power (dBm) - Cable Loss (dB) + 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
FM Modulation	814	32.96	0.00	3.00	35.96	3.94
CW	814	33.01	0.00	3.00	36.01	3.99
C4FM Modulation	814	32.98	0.00	3.00	35.98	3.96
$\pi/4$ -DQPSK Modulation	814	32.94	0.00	3.00	35.94	3.93
FM Modulation	860.5	32.48	0.00	3.00	35.48	3.53
CW	860.5	32.49	0.00	3.00	35.49	3.54
C4FM Modulation	860.5	32.50	0.00	3.00	35.50	3.55
$\pi/4$ -DQPSK Modulation	860.5	32.69	0.00	3.00	35.69	3.71

¹ Measured. See section 6.1.1.

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

6.1.3. Booster gain – 90 dB Nominal

Modulation Type	Frequency	Output Power	Input Power	Gain (dB)
	(MHz)	(dBm)	(dBm)	
FM Modulation	814	32.96	-57.04	90.00
CW	814	33.01	-57.03	90.04
C4FM Modulation	814	32.98	-57.02	90.00
$\pi/4$ -DQPSK Modulation	814	32.94	-56.88	89.82
FM Modulation	860.5	32.48	-57.85	90.33
CW	860.5	32.49	-57.84	90.33
C4FM Modulation	860.5	32.50	-57.82	90.32
$\pi/4$ -DQPSK Modulation	860.5	32.69	-57.91	90.60

6. Measurement Data (continued)**6.2. Bandwidth Limitations 90.219(e)(4)(ii), FCC Part 2.1049 and Emission Mask 90.210**

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.

Emission Mask shall also be met for each modulation type. Emission Mask H is used for the 806 to 809 MHz and 851 to 854 MHz bands and Emission Mask G is used for the 809 to 824 MHz and 854 to 869 MHz Bands per the table in section 90.210.

FM modulation at 16 kHz was used as worst case against emission Mask G at AGC threshold and 3 dB above AGC threshold as the other modulations are narrower.

Test Method: KDB 935210 Section 4.4

6. Measurement Data (continued)

6.2. Bandwidth Limitations 90.219(e)(4)(ii), FCC Part 2.1049 and Emission Mask 90.210

6.2.1. Occupied (99% Power) Bandwidth

Modulation Type	Frequency	Output Occupied Bandwidth	Input Occupied Bandwidth	Difference	Result
	MHz	kHz	kHz	kHz	
FM 16K0F3E	814	16.017	16.017	0.000	Compliant
FM 11K3F3E	814	11.334	11.334	0.000	Compliant
FM 4K03F1E	814	4.033	4.033	0.000	Compliant
C4FM	814	8.081	8.111	-0.030	Compliant
$\pi/4$ -DQPSK	814	9.820	9.820	0.000	Compliant
FM 16K0F3E	860.5	16.017	16.017	0.000	Compliant
FM 11K3F3E	860.5	11.334	11.334	0.000	Compliant
FM 4K03F1E	860.5	4.033	4.033	0.000	Compliant
C4FM	860.5	8.021	8.126	-0.105	Compliant
$\pi/4$ -DQPSK	860.5	9.820	9.820	0.000	Compliant

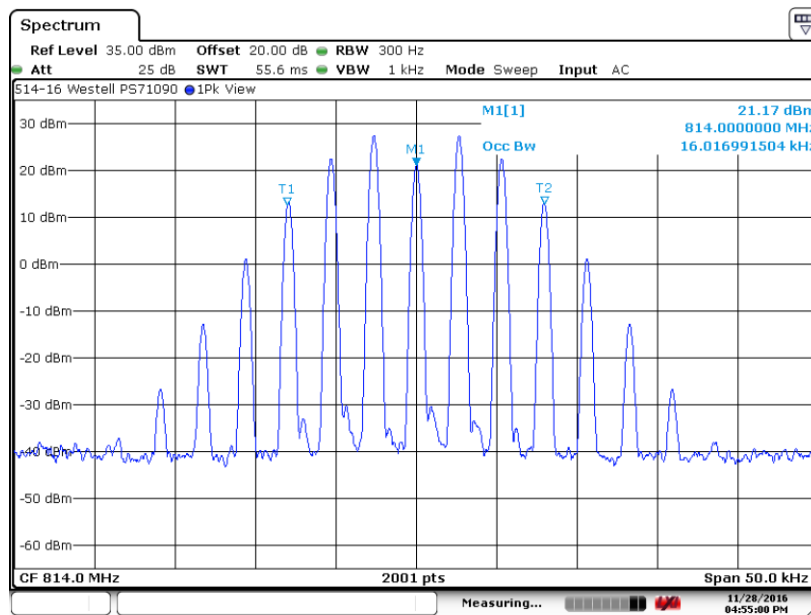
Test Number: 514-16R1

Issue Date: 2/7/2017

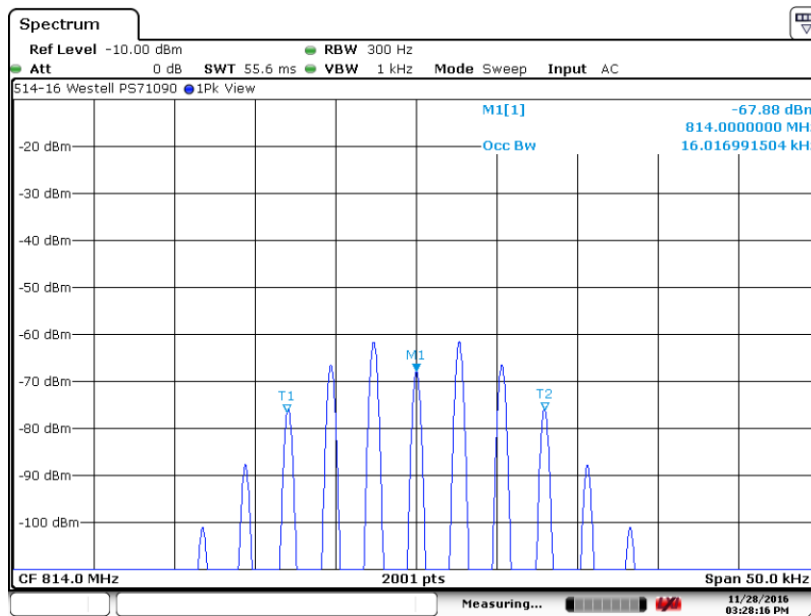
6. Measurement Data (continued)

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

6.2.1.1. Occupied (99% Power) Bandwidth Measurement, 814 MHz, 16k FM



6.2.1.2. Occupied (99% Power) Bandwidth Input, 814 MHz, 16k FM



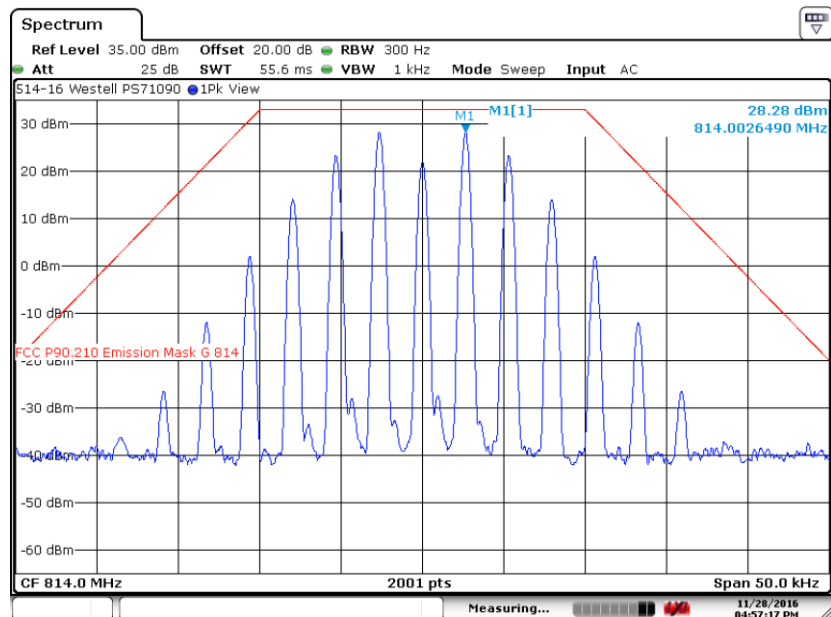
Test Number: 514-16R1

Issue Date: 2/7/2017

6. Measurement Data (continued)

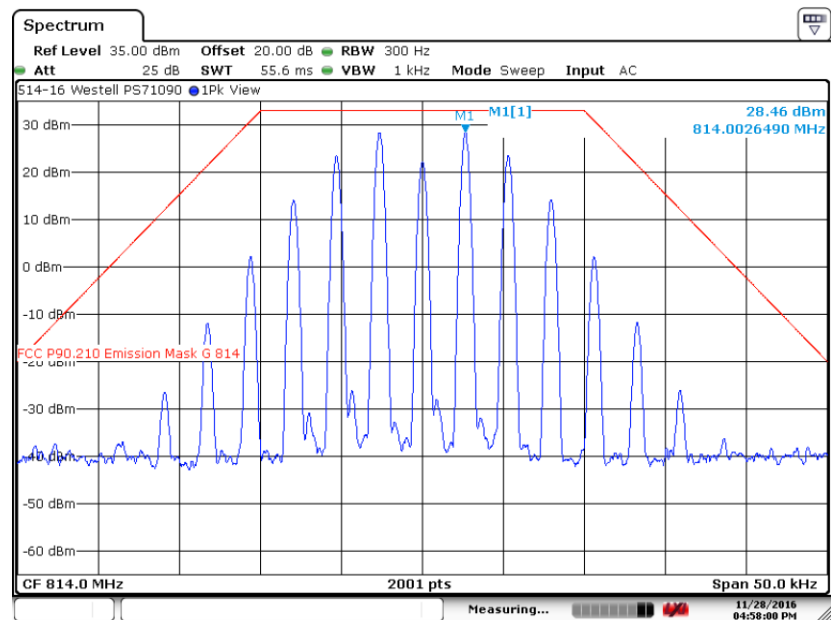
6.2. Bandwidth Limitations 90.219(e)(4)(ii), FCC Part 2.1049 (continued)

6.2.1.3. Occupied (99% Power) Emissions Mask G, 814 MHz, 16k FM



Date: 28.NOV.2016 16:57:16

6.2.1.4. Occupied (99% Power) Emissions Mask G plus 3 dB, 814 MHz, 16k FM

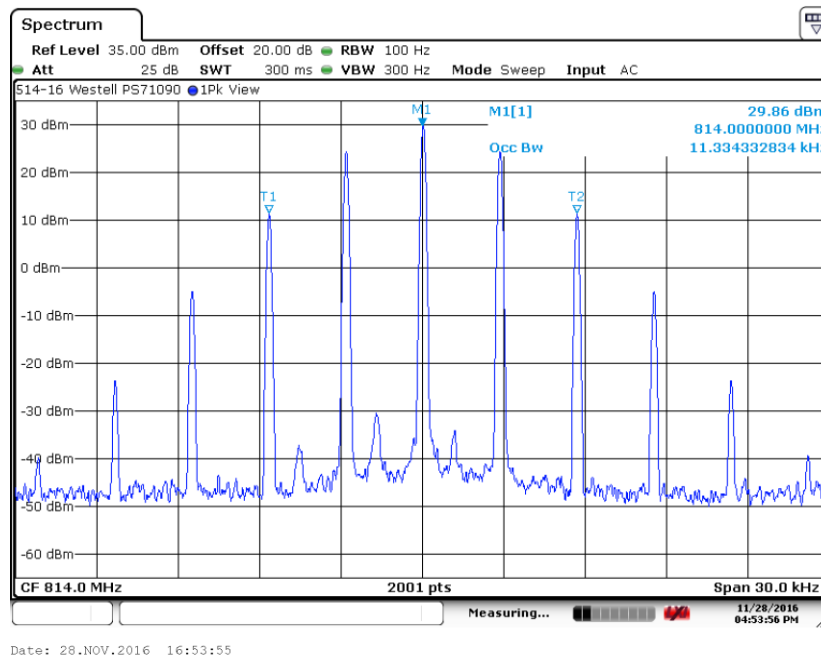


Date: 28.NOV.2016 16:57:58

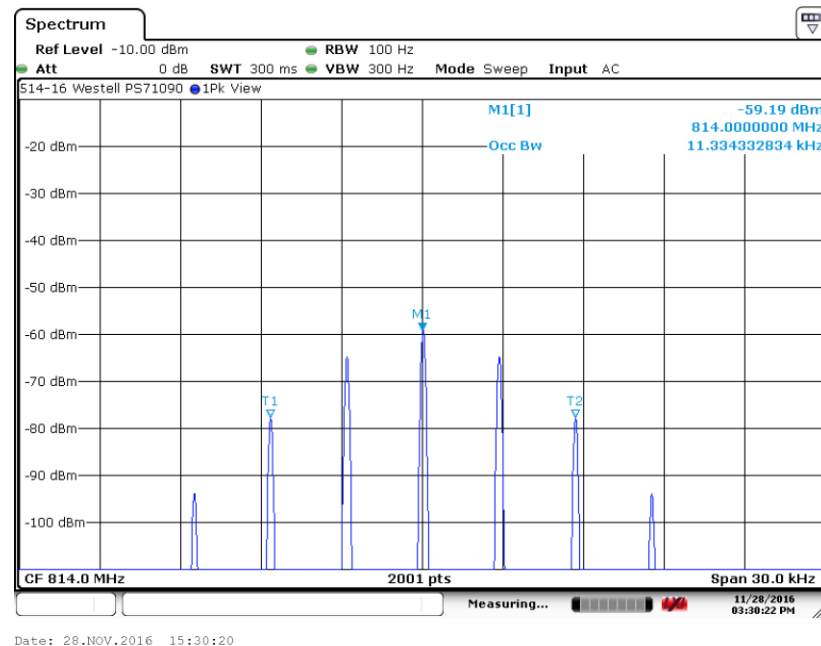
6. Measurement Data (continued)

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

6.2.1.5. Occupied (99% Power) Bandwidth Measurement, 814 MHz, 11k FM



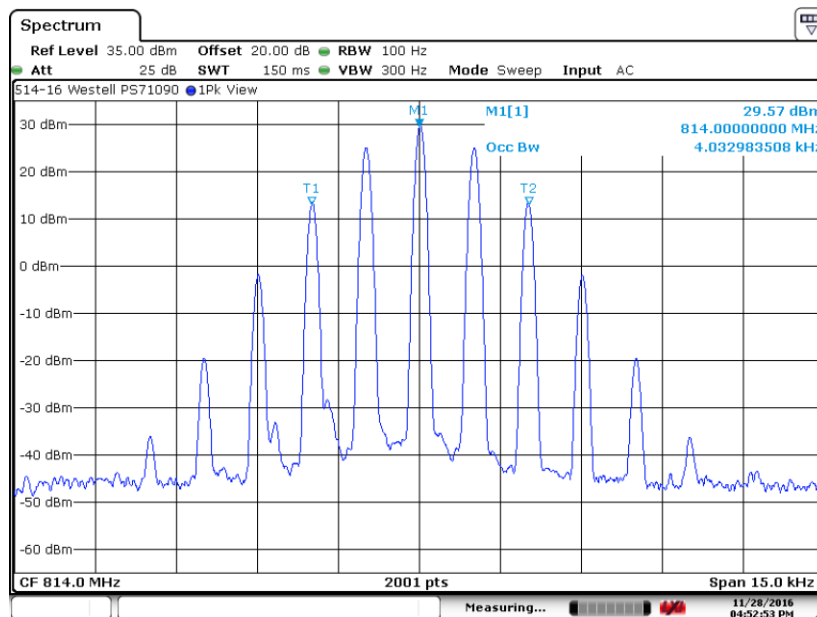
6.2.1.6. Occupied (99% Power) Bandwidth Input, 814 MHz, 11k FM



6. Measurement Data (continued)

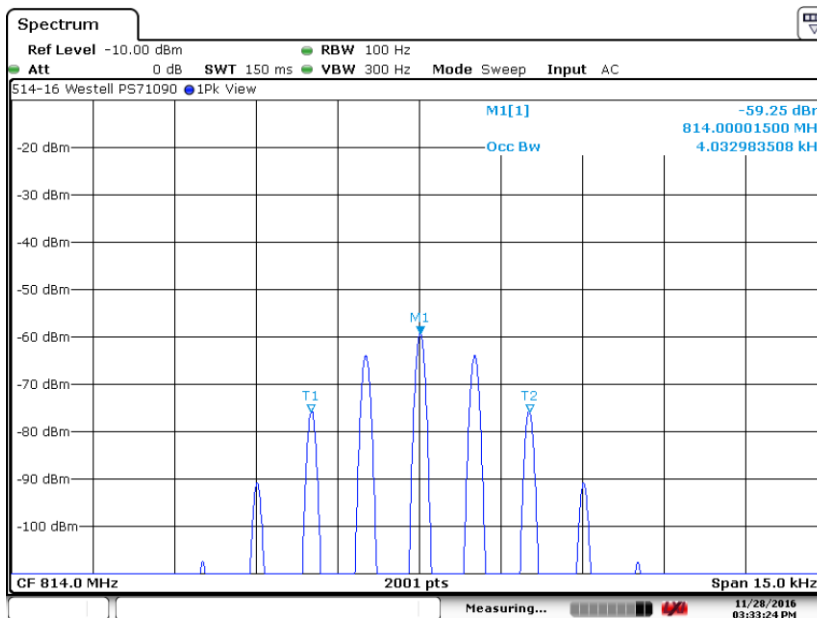
6.2. Bandwidth Limitations 90.219(e)(4)(ii), FCC Part 2.1049 (continued)

6.2.1.7. Occupied (99% Power) Bandwidth Measurement, 814 MHz, 4k FM



Date: 28.NOV.2016 16:52:51

6.2.1.8. Occupied (99% Power) Bandwidth Input, 814 MHz, 4k FM



Date: 28.NOV.2016 15:33:23

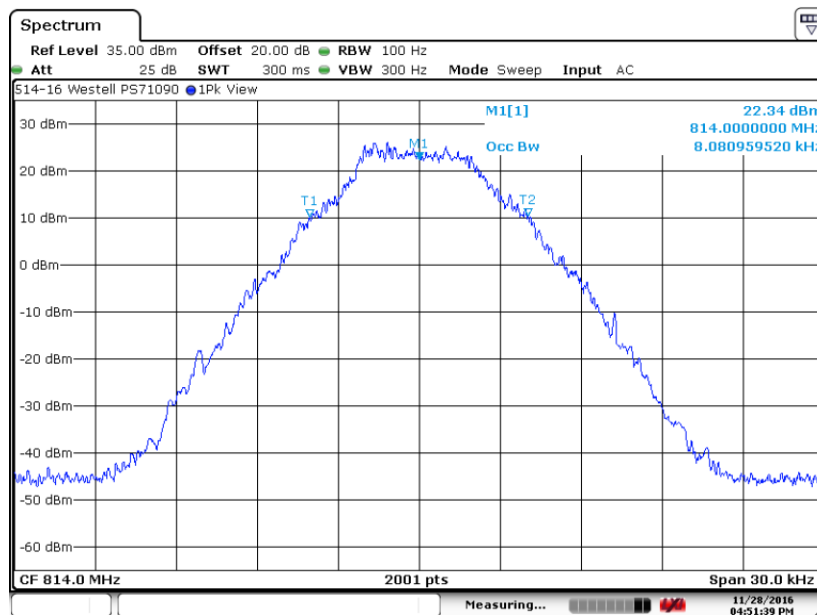
Test Number: 514-16R1

Issue Date: 2/7/2017

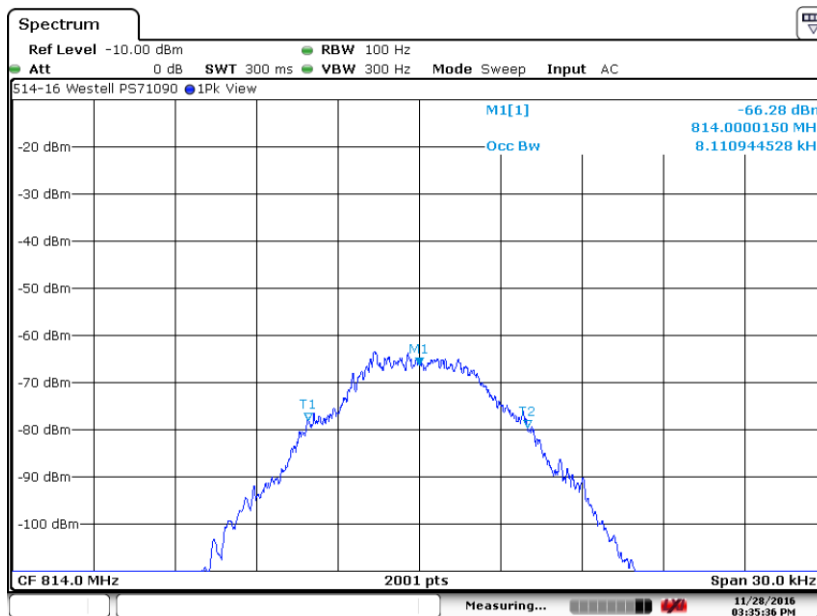
6. Measurement Data (continued)

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

6.2.1.9. Occupied (99% Power) Bandwidth Measurement, 814 MHz, C4FM



6.2.1.10. Occupied (99% Power) Bandwidth Input, 814 MHz, C4FM



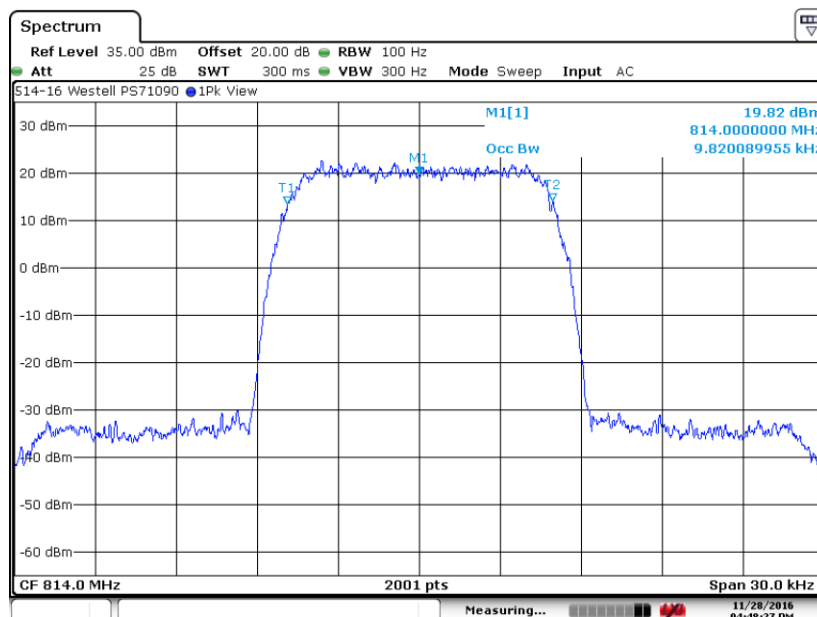
Test Number: 514-16R1

Issue Date: 2/7/2017

6. Measurement Data (continued)

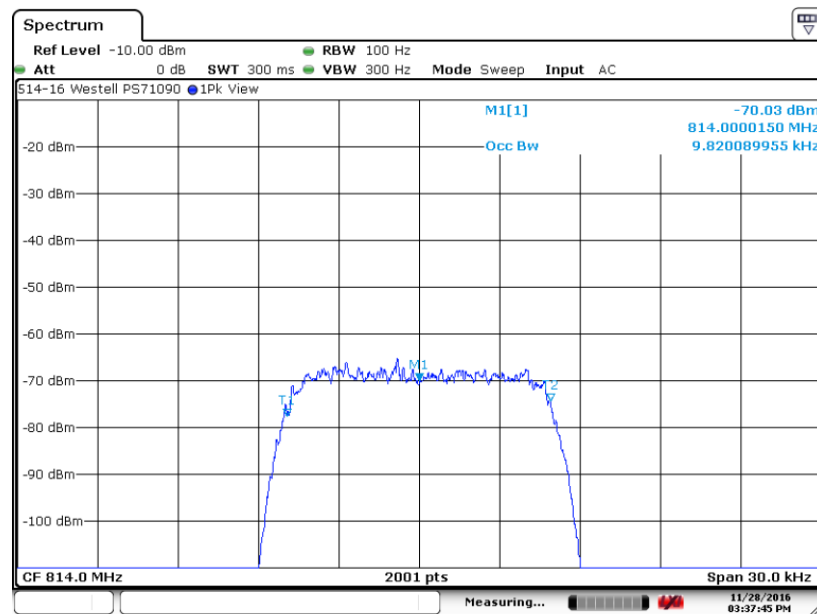
6.2. Bandwidth Limitations 90.219(e)(4)(ii), FCC Part 2.1049 (continued)

6.2.1.11. Occupied (99% Power) Bandwidth Measurement, 814 MHz, $\pi/4$ -DQPSK



Date: 28.NOV.2016 16:48:26

6.2.1.12. Occupied (99% Power) Bandwidth Input, 814 MHz, $\pi/4$ -DQPSK



Date: 28.NOV.2016 15:37:43

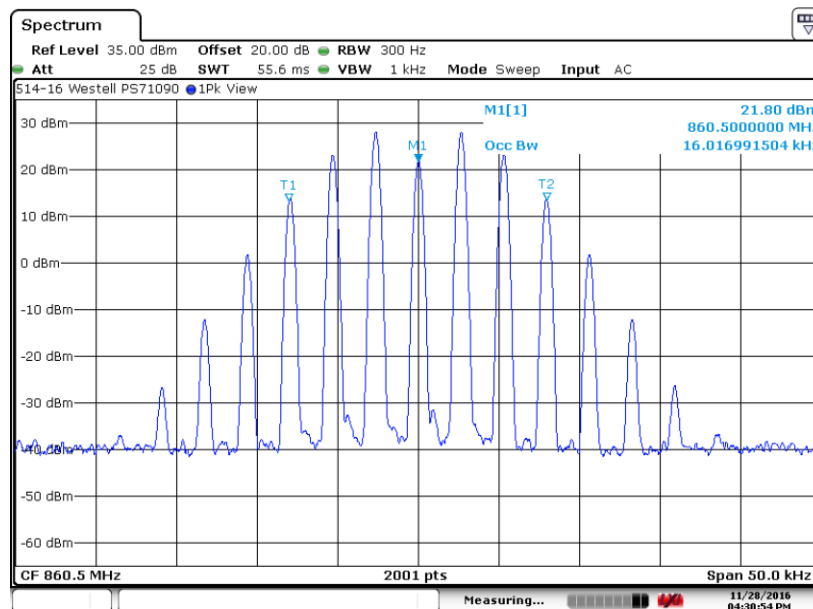
Test Number: 514-16R1

Issue Date: 2/7/2017

6. Measurement Data (continued)

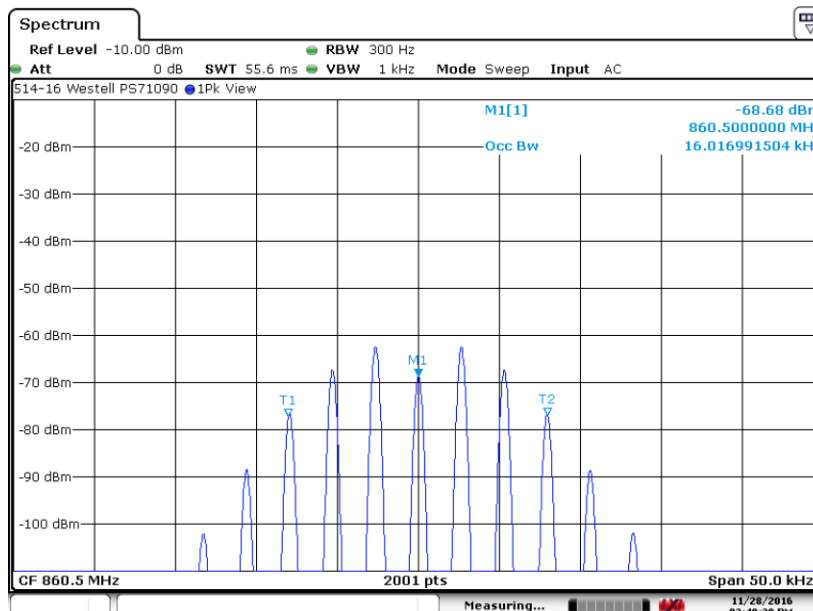
6.2. Bandwidth Limitations 90.219(e)(4)(ii), FCC Part 2.1049 (continued)

6.2.1.13. Occupied (99% Power) Bandwidth Measurement, 860.5 MHz, 16k FM



Date: 28.NOV.2016 16:30:52

6.2.1.14. Occupied (99% Power) Bandwidth Input, 860.5 MHz, 16k FM



Date: 28.NOV.2016 15:49:37

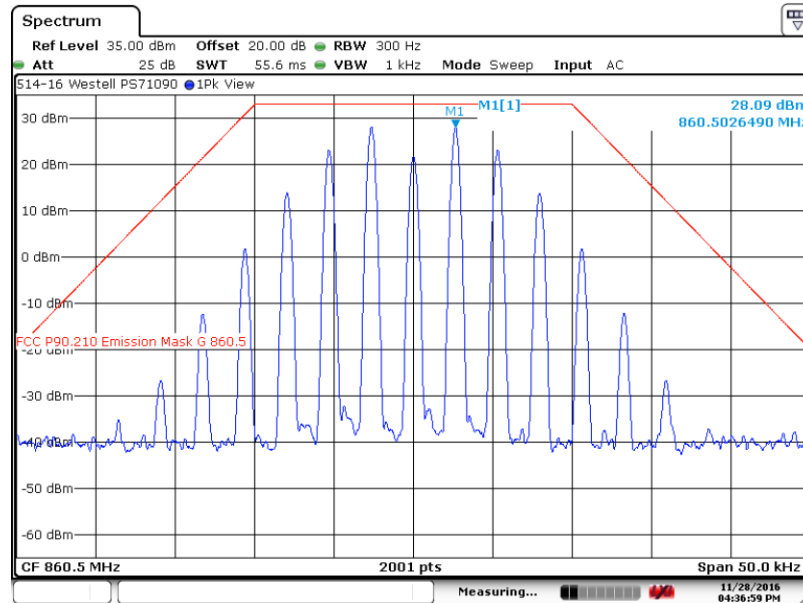
Test Number: 514-16R1

Issue Date: 2/7/2017

6. Measurement Data (continued)

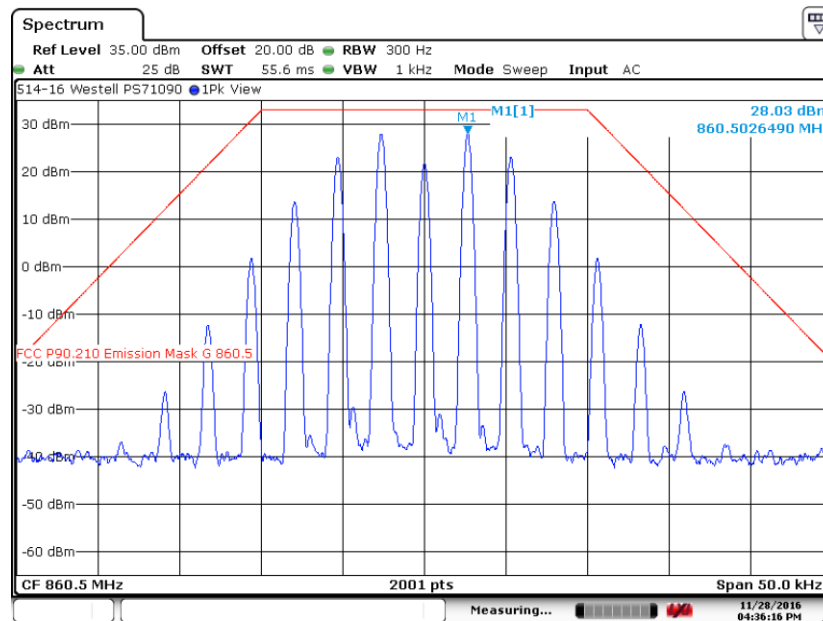
6.2. Bandwidth Limitations 90.219(e)(4)(ii), FCC Part 2.1049 (continued)

6.2.1.15. Occupied (99% Power) Emissions Mask G, 860.5 MHz, 16k FM



Date: 28.NOV.2016 16:36:58

6.2.1.16. Occupied (99% Power) Emissions Mask G plus 3 dB, 860.5 MHz, 16k FM



Date: 28.NOV.2016 16:36:15

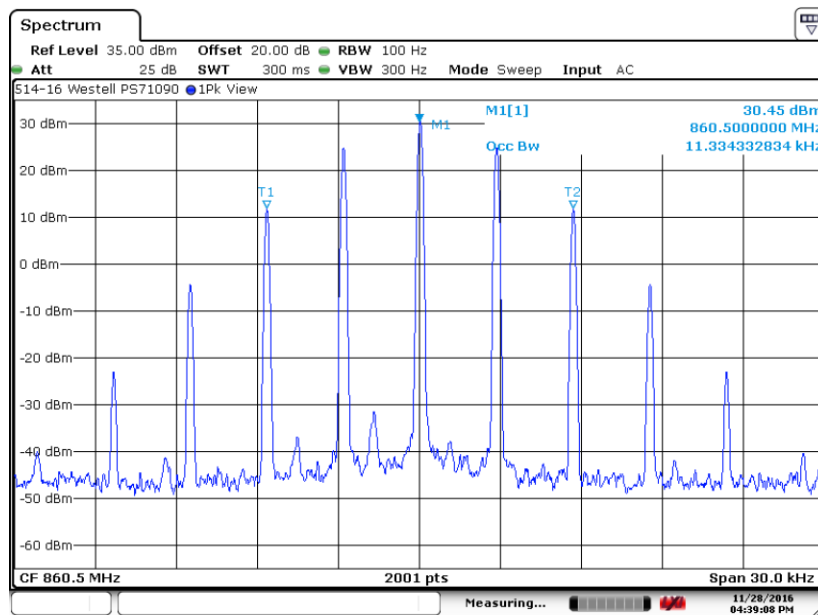
Test Number: 514-16R1

Issue Date: 2/7/2017

6. Measurement Data (continued)

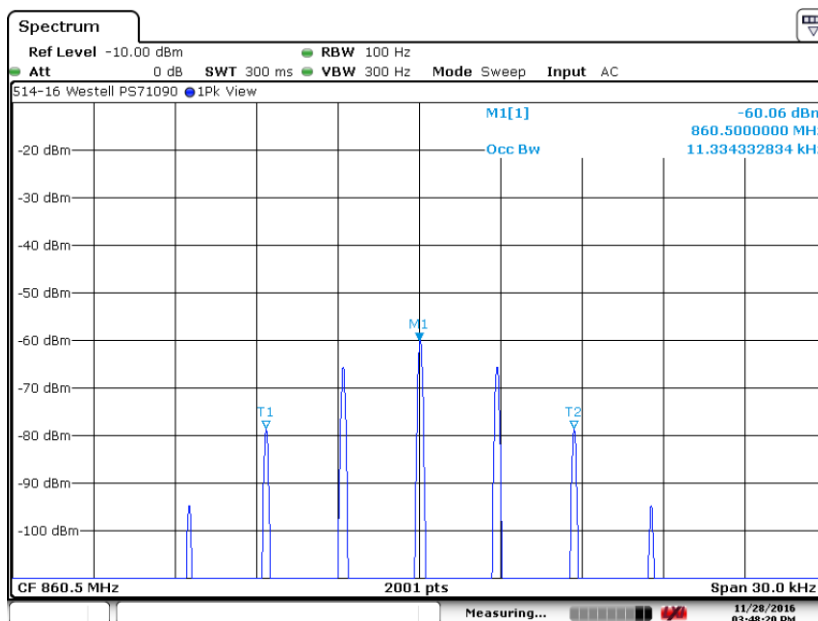
6.2. Bandwidth Limitations 90.219(e)(4)(ii), FCC Part 2.1049 (continued)

6.2.1.17. Occupied (99% Power) Bandwidth Measurement, 860.5 MHz, 11k FM



Date: 28.NOV.2016 16:39:06

6.2.1.18. Occupied (99% Power) Bandwidth Input, 860.5 MHz, 11k FM



Date: 28.NOV.2016 15:48:19

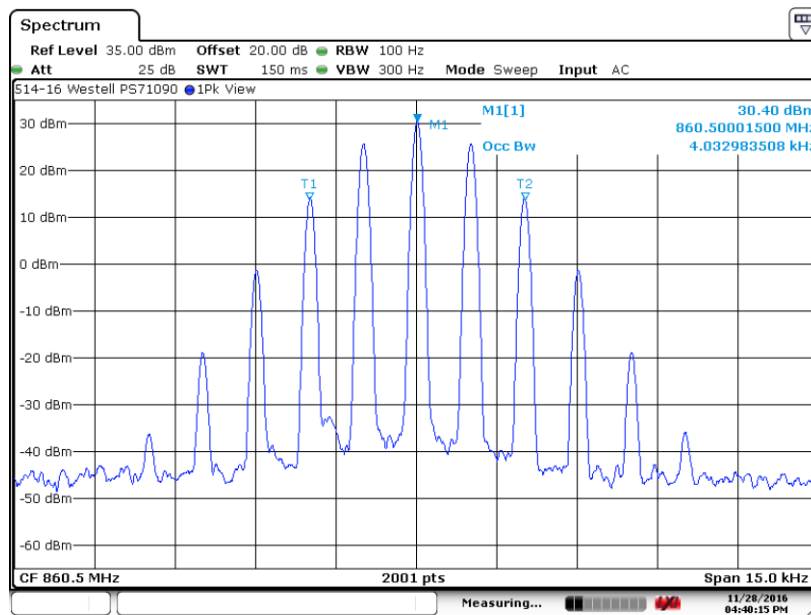
Test Number: 514-16R1

Issue Date: 2/7/2017

6. Measurement Data (continued)

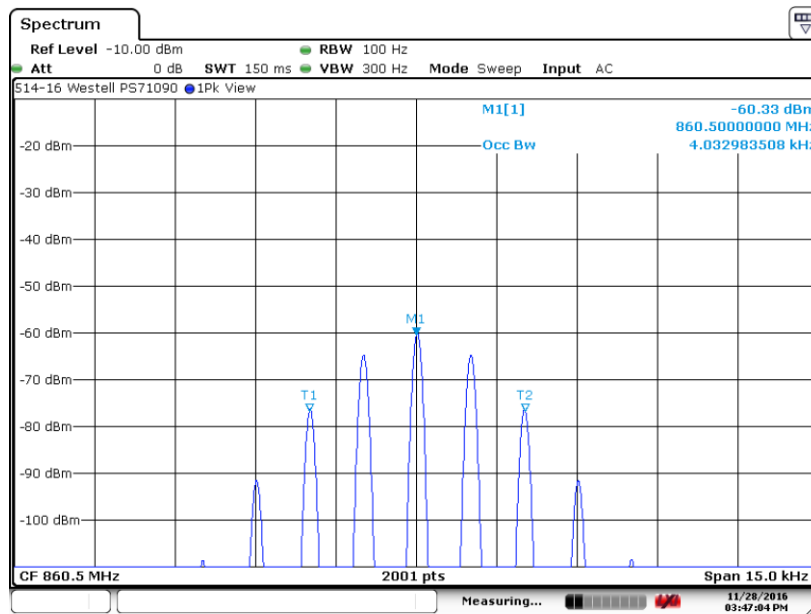
6.2. Bandwidth Limitations 90.219(e)(4)(ii), FCC Part 2.1049 (continued)

6.2.1.19. Occupied (99% Power) Bandwidth Measurement, 860.5 MHz, 4k FM



Date: 28.NOV.2016 16:40:14

6.2.1.20. Occupied (99% Power) Bandwidth Input, 860.5 MHz, 4k FM

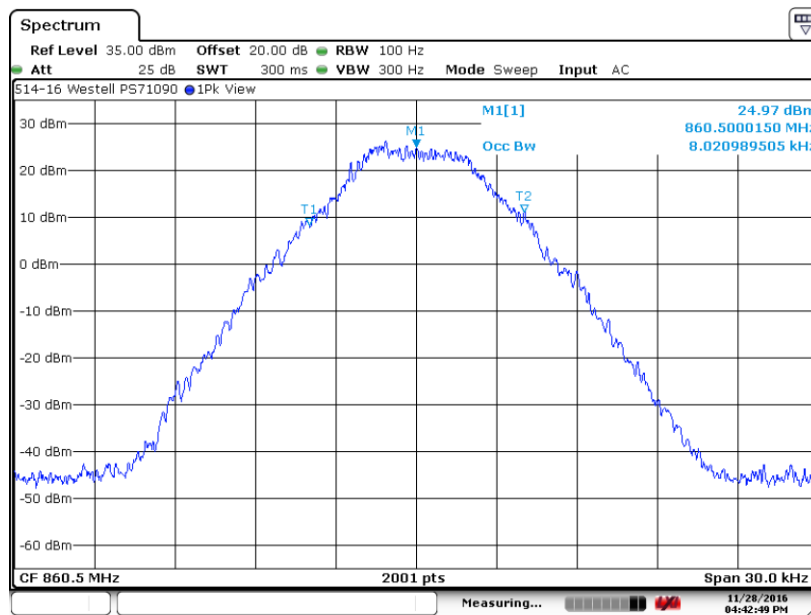


Date: 28.NOV.2016 15:47:03

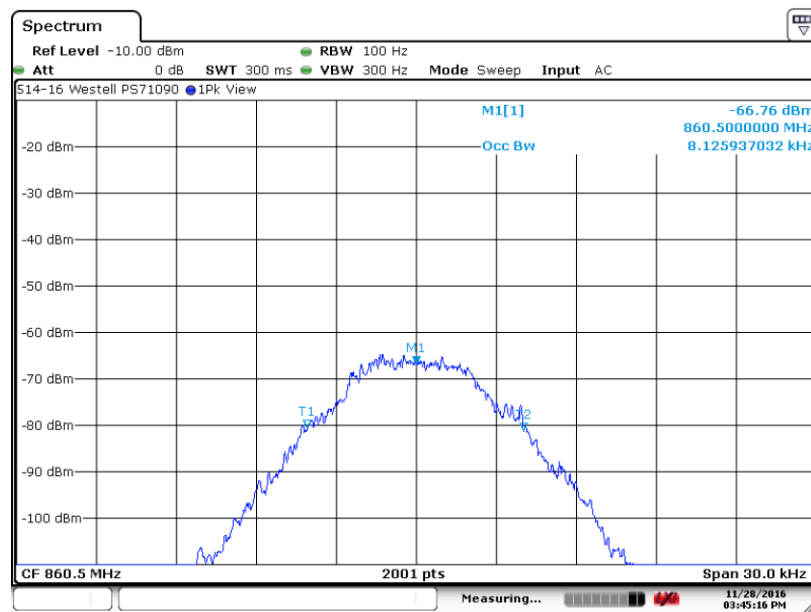
6. Measurement Data (continued)

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

6.2.1.21. Occupied (99% Power) Bandwidth Measurement, 860.5 MHz, C4FM



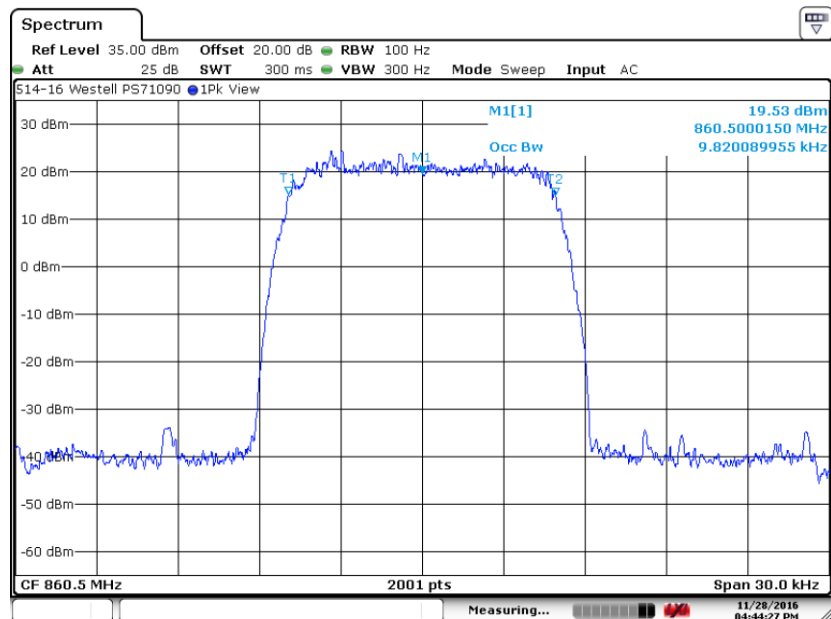
6.2.1.22. Occupied (99% Power) Bandwidth Input, 860.5 MHz, C4FM



6. Measurement Data (continued)

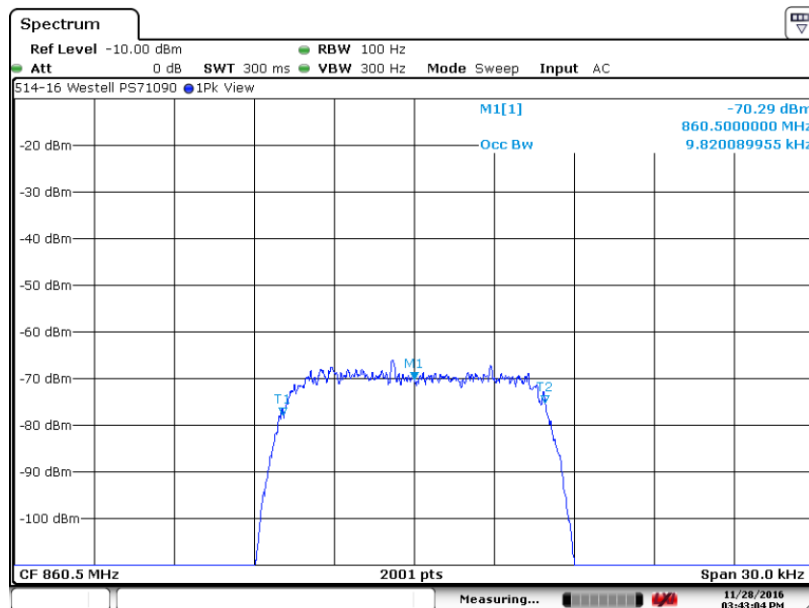
6.2. Bandwidth Limitations 90.219(e)(4)(ii), FCC Part 2.1049 (continued)

6.2.1.23. Occupied (99% Power) Bandwidth Measurement, 860.5 MHz, $\pi/4$ -DQPSK



Date: 28.NOV.2016 16:44:25

6.2.1.24. Occupied (99% Power) Bandwidth Input, 860.5 MHz, $\pi/4$ -DQPSK



Date: 28.NOV.2016 15:43:02

6. Measurement Data (continued)

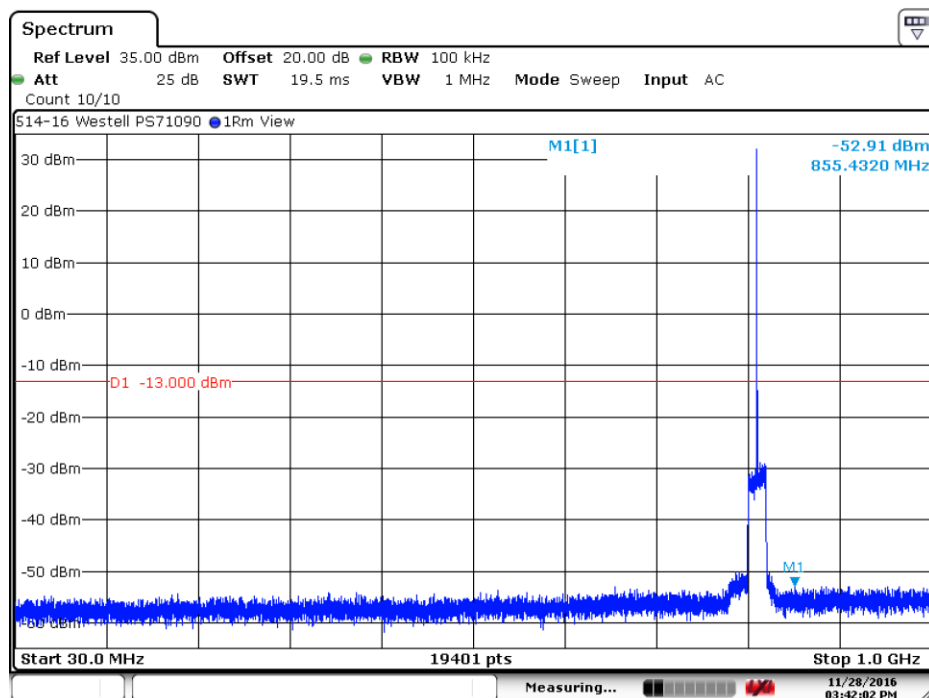
6.3. Spurious Emissions at the Antenna Terminals 90.219(e)(3), 90.669

Requirement: Transmitters designed to operate in the 806 to 824 MHz, 851 to 869 MHz, 896 to 901 MHz and 935 to 940 MHz bands, any emission outside of the MTA licensee's spectrum shall be attenuated below the transmitter power (P) by at least $43 + 10 \log (P)$ dB or 80 decibels, whichever is the lesser attenuation.

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 4.73

6.3.1. 815 MHz, 30 MHz to 1 GHz



Date: 28.NOV.2016 15:42:00

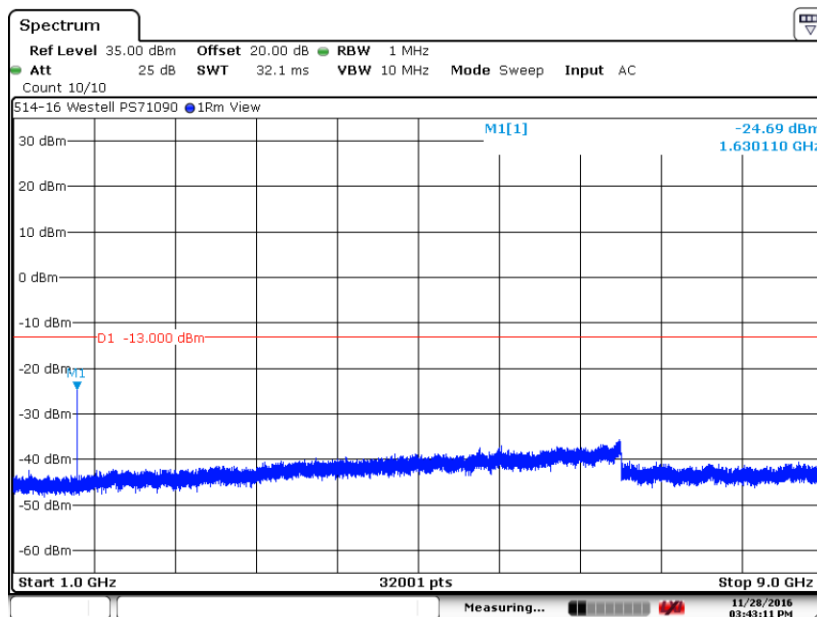
Test Number: 514-16R1

Issue Date: 2/7/2017

6. Measurement Data (continued)

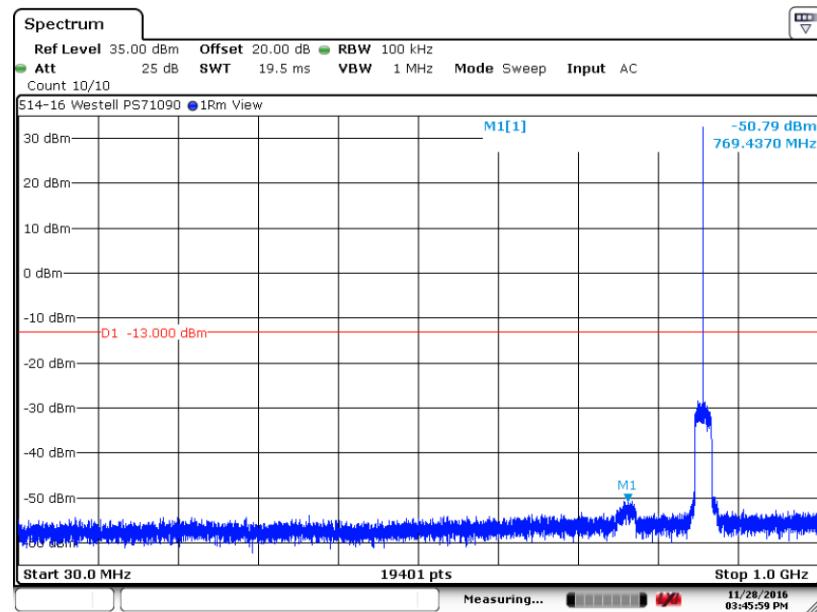
6.3. Spurious Emissions at the Antenna Terminals 90.219(e)(3), 90.669 (continued)

6.3.2. 815 MHz, 1 to 9 GHz



Date: 28.NOV.2016 15:43:10

6.3.3. 860 MHz, 30 MHz to 1 GHz

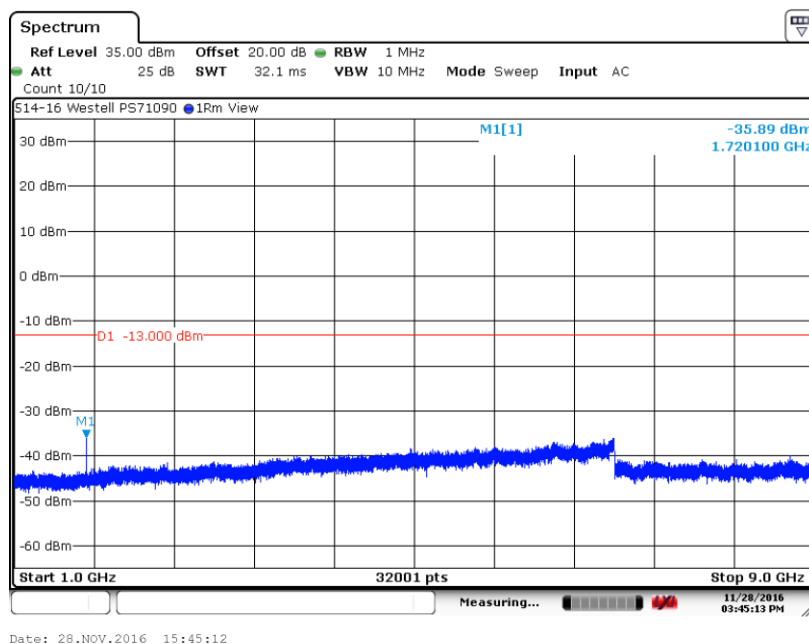


Date: 28.NOV.2016 15:45:58

6. Measurement Data (continued)

6.3. Spurious Emissions at the Antenna Terminals 90.219(e)(3), 90.669 (continued)

6.3.4. 860 MHz, 1 to 9 GHz



Out of Band / Out of Block Inter-modulation

Requirement: The mean power Inter-modulation products shall be measured using two CW signals with each of the available channel spacings of 6.25 kHz, 12.5 kHz and 25 kHz on a center frequency of each applicable band over a 100 kHz span when measured in a 300 Hz RBW. This shall be verified at AGC threshold and 3 dB above AGC threshold. See next pages for plots.

Test Method: KDB 935210 Section 4.7.1, 4.7.2

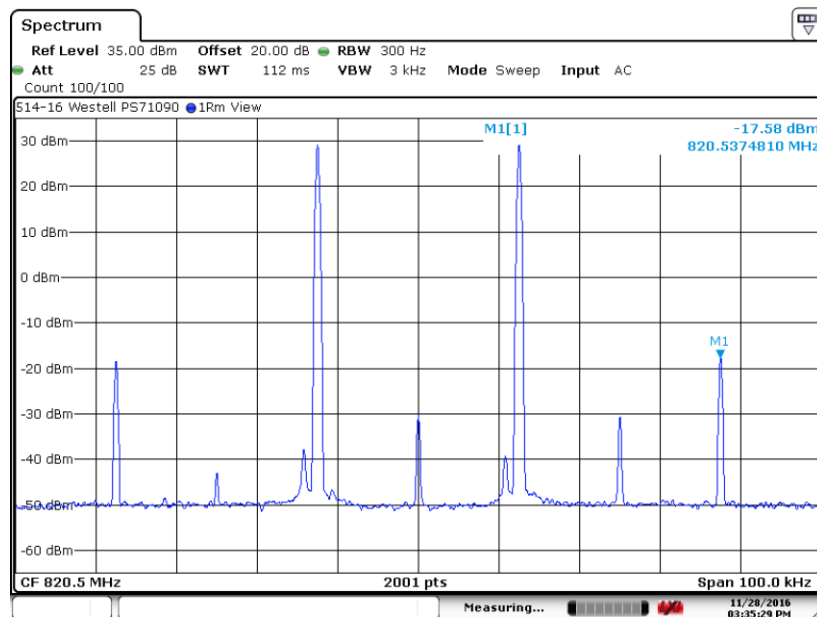
Test Number: 514-16R1

Issue Date: 2/7/2017

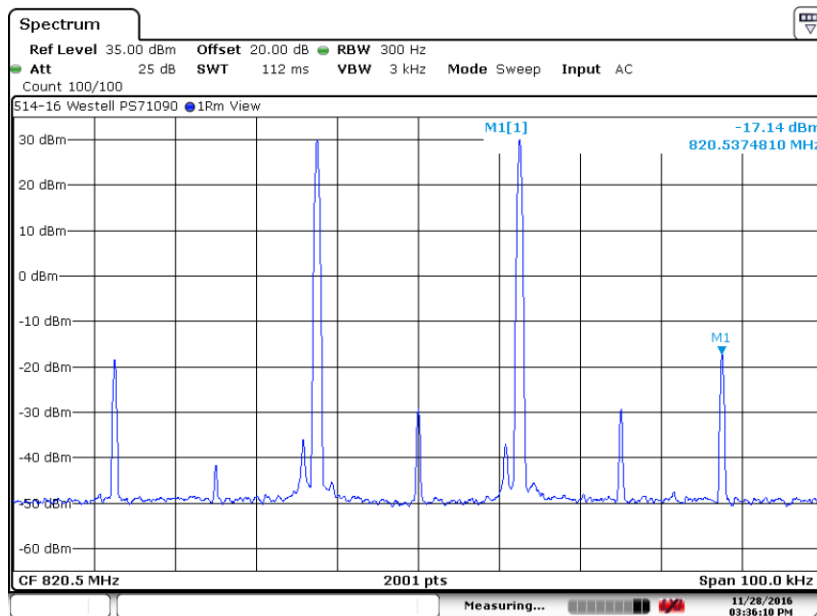
6. Measurement Data (continued)

6.3. Spurious Emissions at the Antenna Terminals 90.219(e)(3), 90.669 (continued)

6.3.5. 820.5 MHz Two Tone Modulation, 25 kHz Spacing



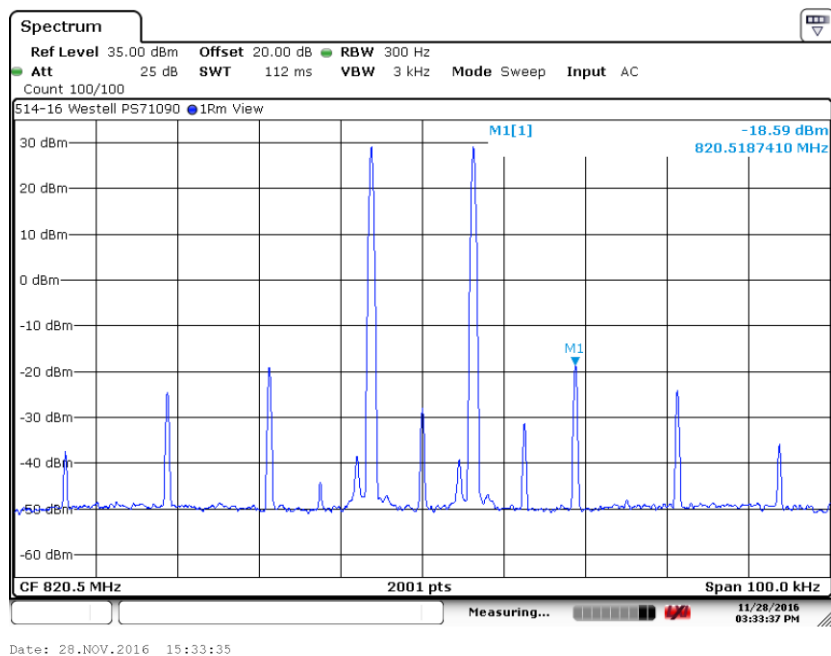
6.3.6. 820.5 MHz Two Tone Modulation plus 3 dB, 25 kHz Spacing



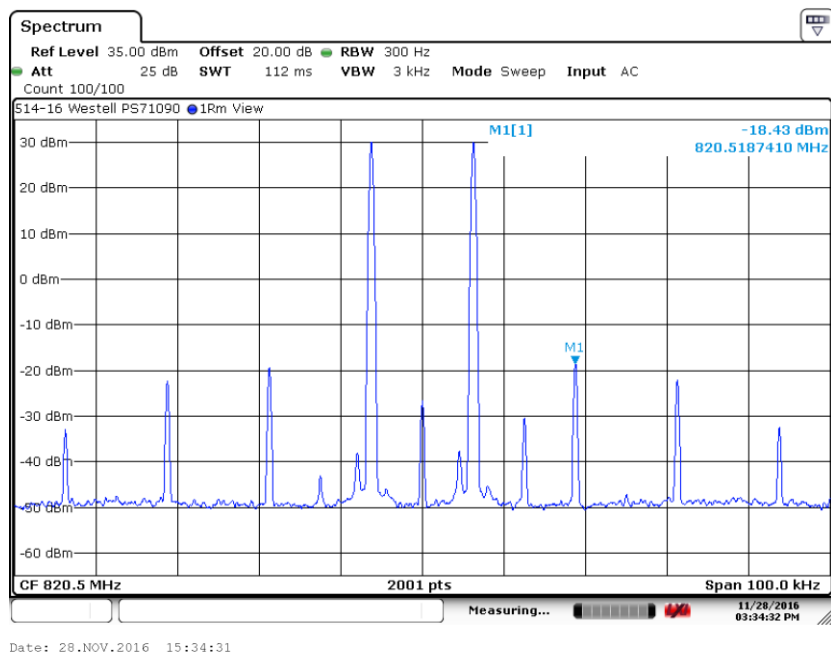
6. Measurement Data (continued)

6.3. Spurious Emissions at the Antenna Terminals 90.219(e)(3), 90.669 (continued)

6.3.7. 820.5 MHz Two Tone Modulation, 12.5 kHz Spacing



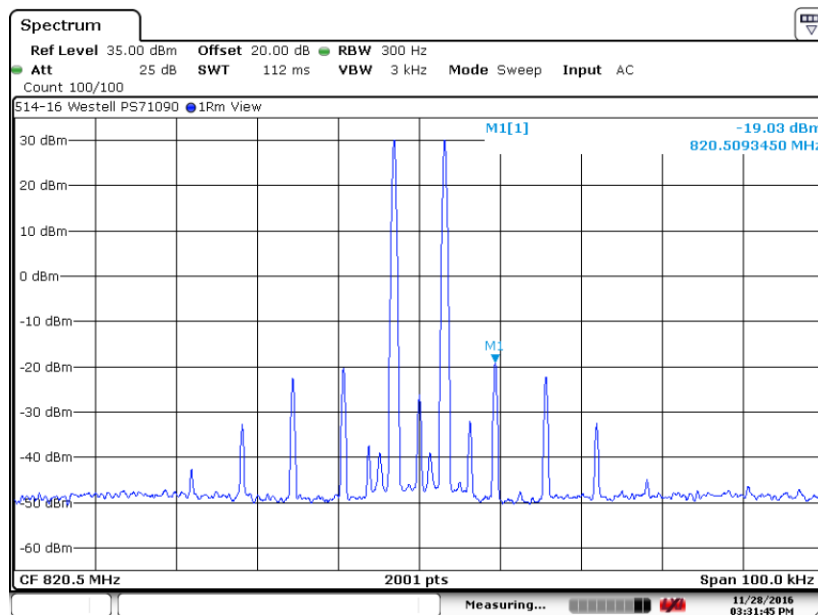
6.3.8. 820.5 MHz Two Tone Modulation plus 3 dB, 12.5 kHz Spacing



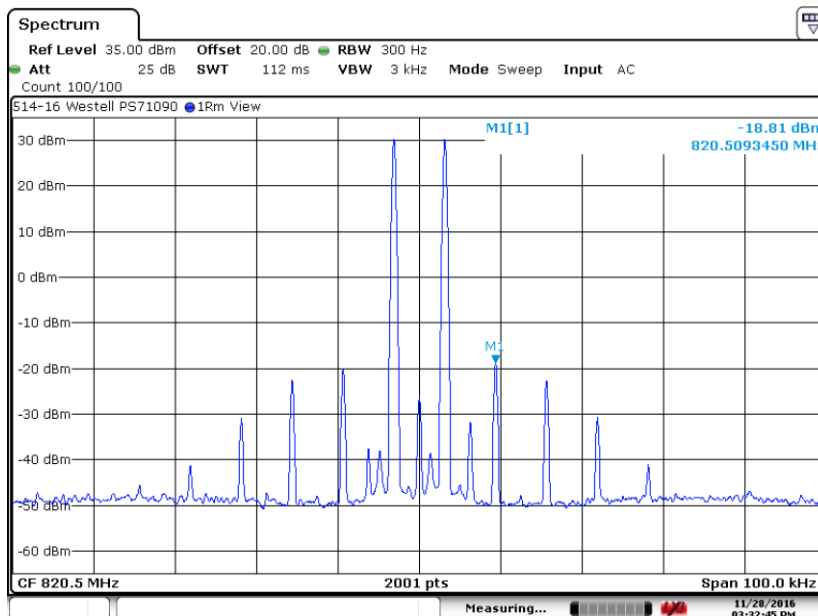
6. Measurement Data (continued)

6.3. Spurious Emissions at the Antenna Terminals 90.219(e)(3), 90.669 (continued)

6.3.9. 820.5 MHz Two Tone Modulation, 6.25 kHz Spacing



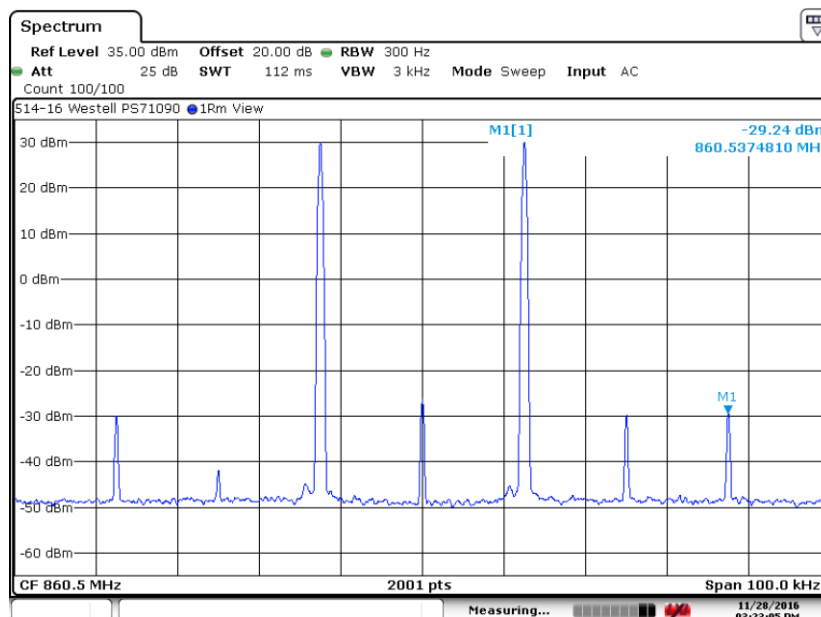
6.3.10. 820.5 MHz Two Tone Modulation plus 3 dB, 6.25 kHz Spacing



6. Measurement Data (continued)

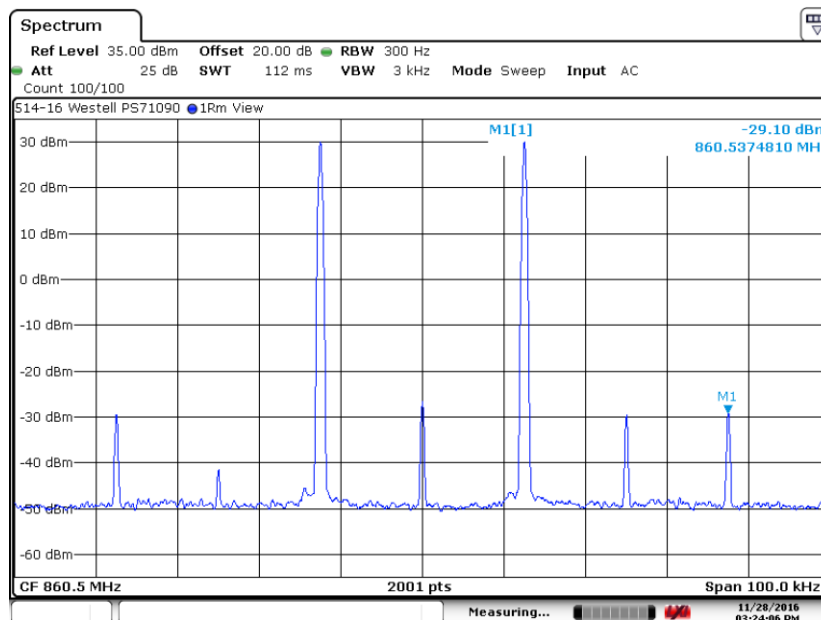
6.3. Spurious Emissions at the Antenna Terminals 90.219(e)(3), 90.669 (continued)

6.3.11. 860.5 MHz 2 Tone Modulation, 25 kHz Spacing



Date: 28.NOV.2016 15:23:03

6.3.12. 860.5 MHz 2 Tone Modulation plus 3 dB, 25 kHz Spacing



Date: 28.NOV.2016 15:24:05

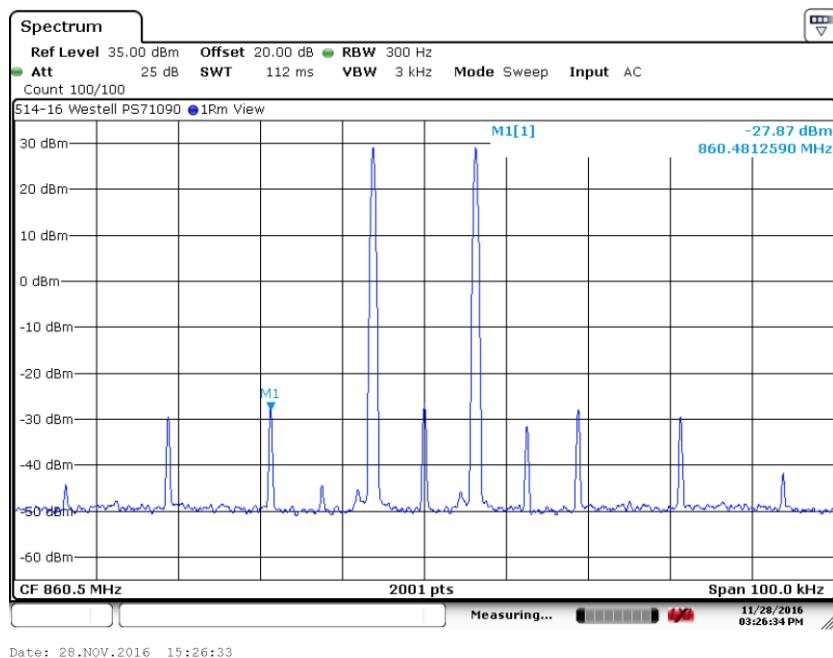
Test Number: 514-16R1

Issue Date: 2/7/2017

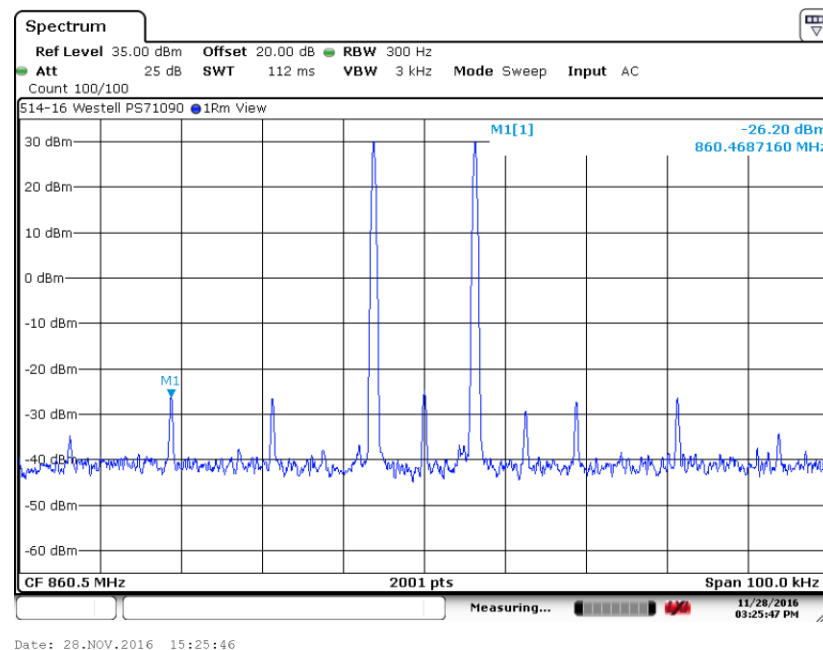
6. Measurement Data (continued)

6.3. Spurious Emissions at the Antenna Terminals 90.219(e)(3), 90.669 (continued)

6.3.13. 860.5 MHz 2 Tone Modulation, 12.5 kHz Spacing



6.3.14. 860.5 MHz 2 Tone Modulation plus 3 dB, 12.5 kHz Spacing



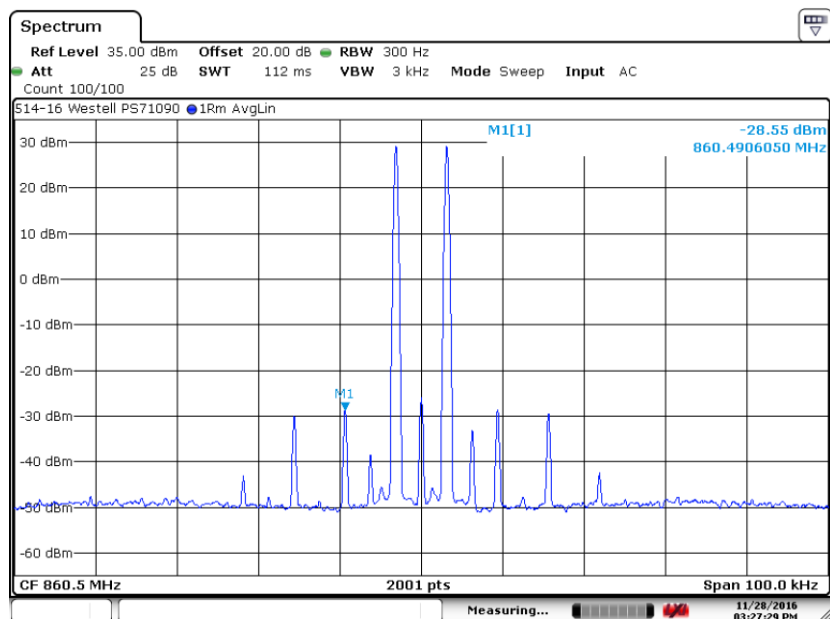
Test Number: 514-16R1

Issue Date: 2/7/2017

6. Measurement Data (continued)

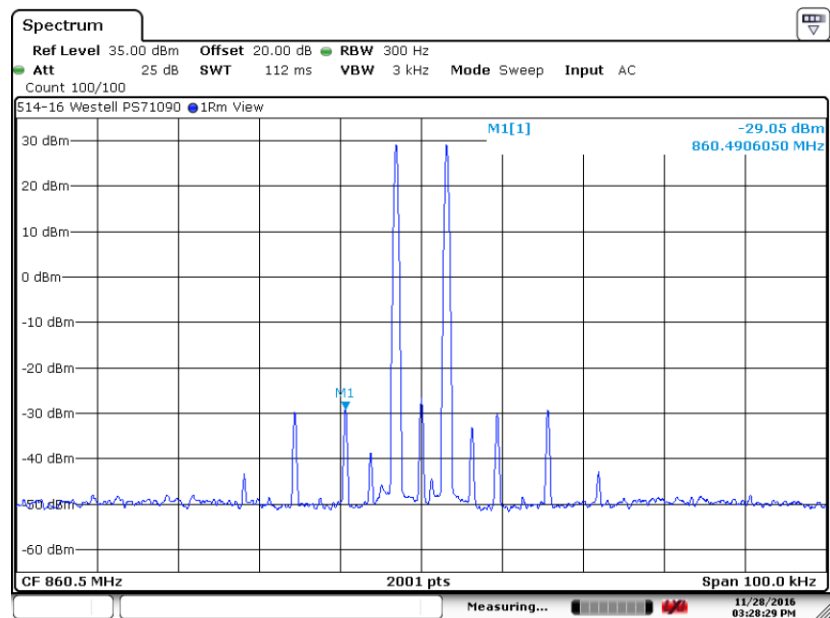
6.3. Spurious Emissions at the Antenna Terminals 90.219(e)(3), 90.669 (continued)

6.3.15. 860.5 MHz 2 Tone Modulation, 6.25 kHz Spacing



Date: 28.NOV.2016 15:27:28

6.3.16. 860.5 MHz 2 Tone Modulation plus 3 dB, 6.25 kHz Spacing



Date: 28.NOV.2016 15:28:28

6. Measurement Data (continued)**6.4. Field Strength of Spurious Emissions 90.219(e)(3), 90.669**

Requirement: Transmitters designed to operate in the 806 to 824 MHz, 851 to 869 MHz, 896 to 901 MHz and 935 to 940 MHz bands, any emission outside of the MTA licensee's spectrum 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 4.9

6.4.1. Measurement and Equipment Setup

Test Date:	11/30/2016, 1/20/2017
Test Engineer:	Cody Merry, Mark McSweeney
Site Temperature (°C):	22
Relative Humidity (%RH):	32
Frequency Range:	30 MHz to 1 GHz
Measurement Distance:	3 Meters
EMI Receiver IF Bandwidth:	120 kHz
EMI Receiver Avg Bandwidth:	300 kHz
Detector Functions:	Peak and Quasi-Peak.
Antenna Height:	1 to 4 meters

6.4.2 Test Procedure

Test measurements were made in accordance with ANSI/TIA-603-D 2010 Land Mobile FM or PM Communications Equipment Measurement and Performance Standards and ANSI C63.26 2015 American National Standard for Compliance Testing of Transmitters Used in Licensed Radio Services, Substitution Methodology.

6. Measurement Data (continued)
6.4. Field Strength of Spurious Emissions 90.219(e)(3), 90.669 (continued)
6.4.3. Horizontal Polarity

Frequency (MHz)	Antenna Height (cm)	Signal Gen Amp (dBm)	At Antenna Level (dBm)	Antenna Gain (dBi)	EIRP (dBm)	Limit (dBm)	Margin (dB)
43.3800	400	-79.80	-80.00	-7.6	-87.60	-13.00	-74.60
70.4655	290	-67.50	-68.06	-7.7	-75.76	-13.00	-62.76
113.4313	253	-64.21	-65.36	-8.4	-73.76	-13.00	-60.76
126.0933	236	-69.30	-70.35	-8.4	-78.75	-13.00	-65.75
140.1336	213	-63.50	-64.90	-7.7	-72.60	-13.00	-59.60
149.9884	200	-60.82	-62.33	-7.7	-70.03	-13.00	-57.03
170.3058	166	-66.97	-68.23	-7.2	-75.43	-13.00	-62.43
224.9936	108	-71.50	-72.60	-7.9	-80.50	-13.00	-67.50
249.9800	100	-58.90	-61.00	-8.4	-69.40	-13.00	-56.40
444.0456	157	-81.00	-81.62	-7.7	-89.32	-13.00	-76.32
996.5413	106	-64.50	-68.54	-8.2	-76.74	-13.00	-63.74

6. Measurement Data (continued)

6.4. Field Strength of Spurious Emissions 90.219(e)(3), 90.669 (continued)

6.4.4. Vertical Polarity

Frequency (MHz)	Antenna Height (cm)	Signal Gen Amp (dBm)	At Antenna Level (dBm)	Antenna Gain (dBi)	EIRP (dBm)	Limit (dBm)	Margin (dB)
36.8845	100	-59.90	-60.84	-7.6	-68.44	-13.00	-55.44
70.1944	100	-59.00	-60.21	-7.7	-67.91	-13.00	-54.91
114.6105	100	-59.20	-60.65	-8.4	-69.05	-13.00	-56.05
128.2111	100	-56.00	-57.56	-8.4	-65.96	-13.00	-52.96
136.8173	100	-62.00	-63.42	-7.7	-71.12	-13.00	-58.12
150.0207	100	-63.30	-64.76	-7.5	-72.26	-13.00	-59.26
174.9861	100	-61.00	-62.53	-7.2	-69.73	-13.00	-56.73
224.9713	230	-51.00	-52.99	-7.9	-60.89	-13.00	-47.89
249.9838	197	-49.10	-51.20	-8.4	-59.60	-13.00	-46.60
996.5315	100	-70.00	-73.56	-8.2	-81.76	-13.00	-68.76

6. Measurement Data (continued)**6.4. Field Strength of Spurious Emissions 90.219(e)(3), 90.669 (continued)****6.4.5. Measurement and Equipment Setup**

Test Date:	11/30/2016
Test Engineer:	Cody Merry
Site Temperature (°C):	24
Relative Humidity (%RH):	33
Frequency Range:	Above 1 GHz
Measurement Distance:	3 Meters
EMI Receiver IF Bandwidth:	1 MHz
EMI Receiver Avg Bandwidth:	3 MHz
Detector Functions:	Peak and Average
Antenna Height:	1 to 4 meters

6.4.6. Radiated Emissions above 1 GHz

There were no measureable emissions above 1 GHz

6. Measurement Data (continued)

6.5. Frequency Stability 90.213

Requirement: Fixed and base stations designed to operating in the 806 to 809 MHz, 809 to 824 MHz, 851 to 854 MHz and 854 to 869 MHz frequency bands must meet the frequency stability requirements of this section which is either 1.0 or 1.5 ppm respectively.

Test Method: KDB 935210 Section 4.8

Note: The EUT does not translate the input frequency and therefore this testing was not performed.

Test Number: 514-16R1

Issue Date: 2/7/2017

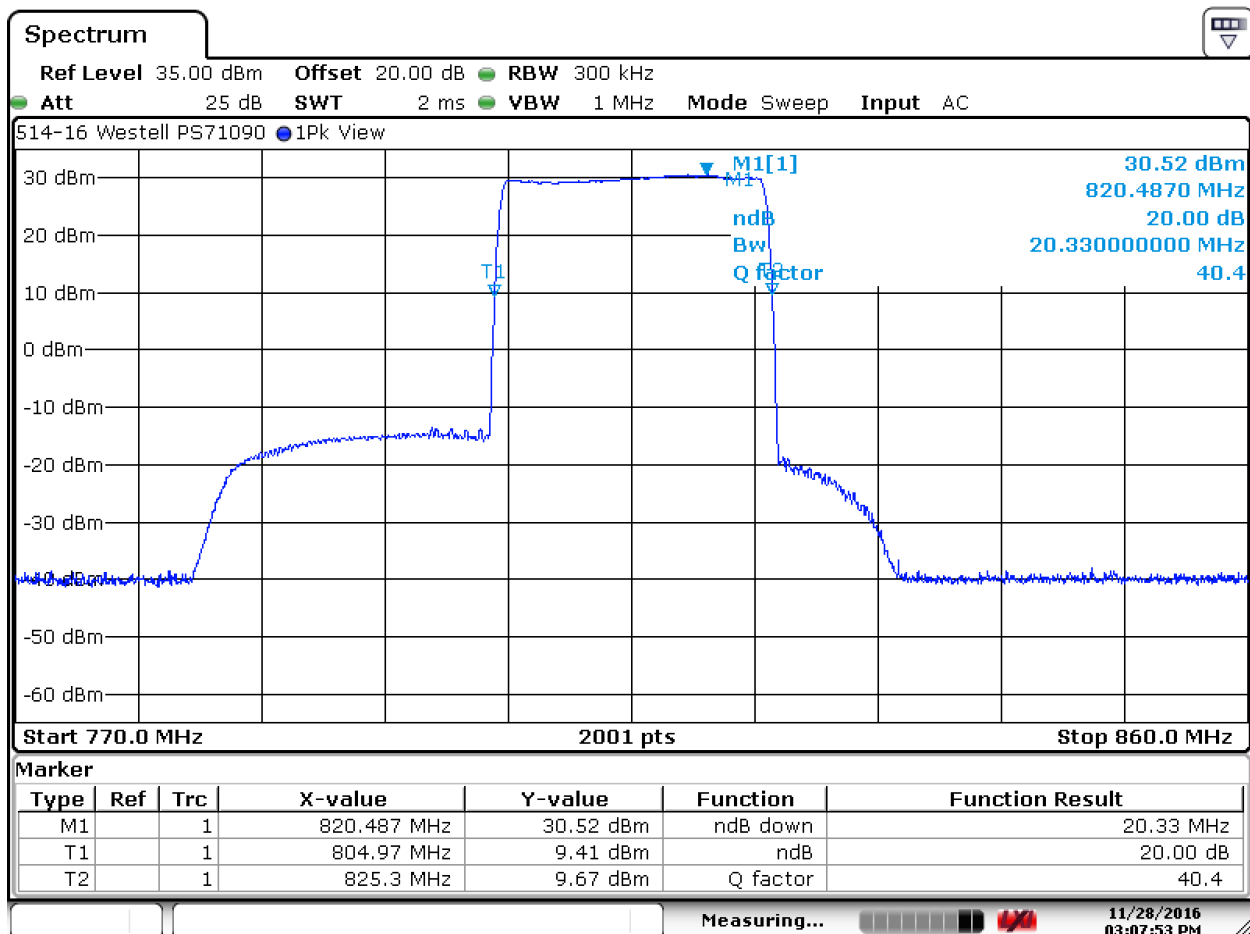
6. Measurement Data (continued)

6.6. Out of Band Rejection

Requirement: Over a +/- 250 % span of the passband of the EUT measure the 20 dB bandwidth of the pass band of the EUT.

Test Method: KDB 935210 Section 4.3

6.6.1. 815 MHz Center Frequency, $f_o = 820.487$ MHz



Date: 28.NOV.2016 15:07:52

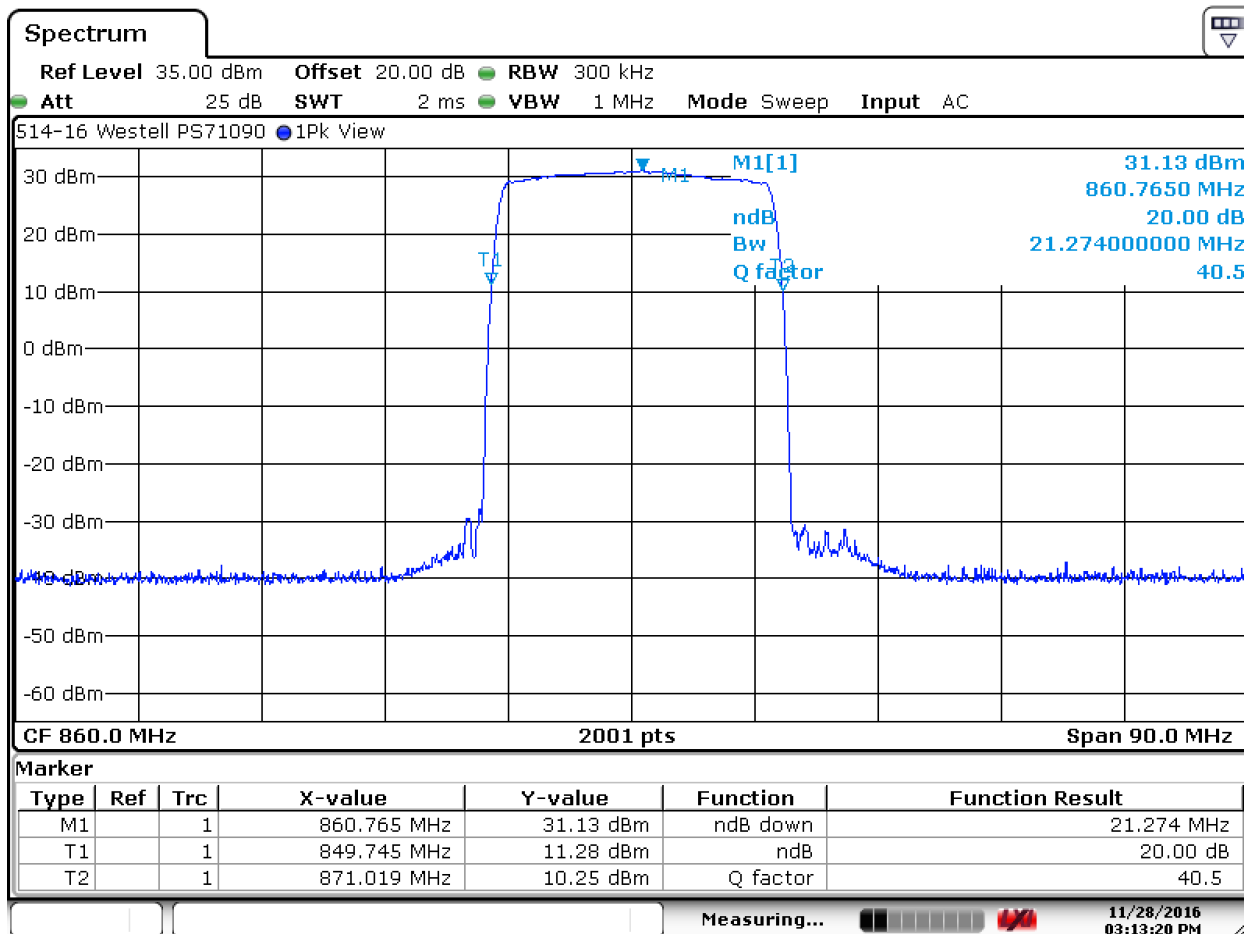
Test Number: 514-16R1

Issue Date: 2/7/2017

6. Measurement Data (continued)

6.6. Out of Band Rejection (continued)

6.6.2. 860 MHz, Center Frequency, $f_o = 860.765$ MHz



Date: 28.NOV.2016 15:13:18

Test Number: 514-16R1

Issue Date: 2/7/2017

6. Measurement Data (continued)

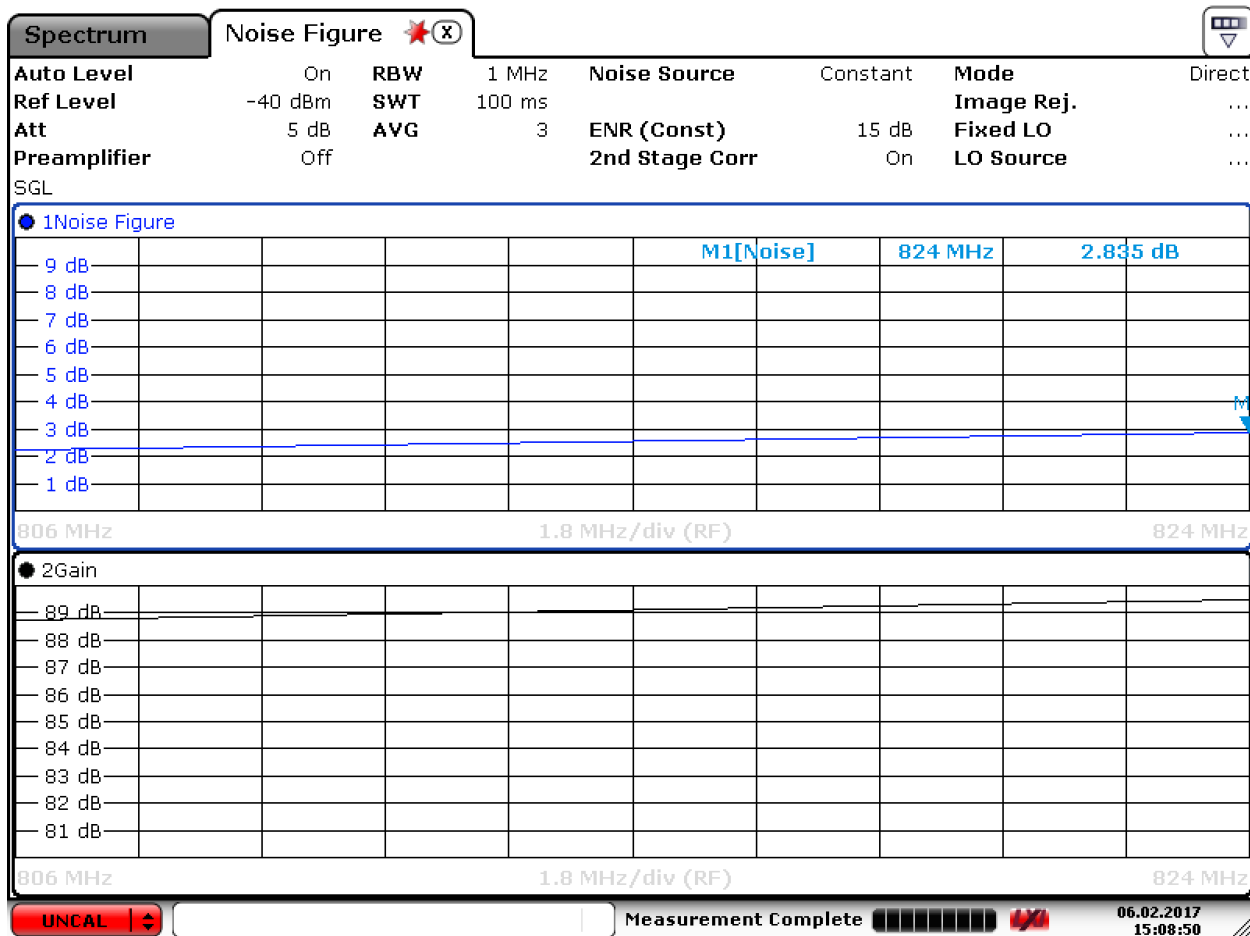
6.7. Noise Figure

Requirement: The noise figure of a signal booster must not exceed 9 dB in either direction.

Test Method: KDB 935210 Section 4.6

Result: Compliant, 2.835 dB

6.7.1. 806 to 824 MHz band



Date: 6.FEB.2017 15:08:49

Test Number: 514-16R1

Issue Date: 2/7/2017

6. Measurement Data (continued)

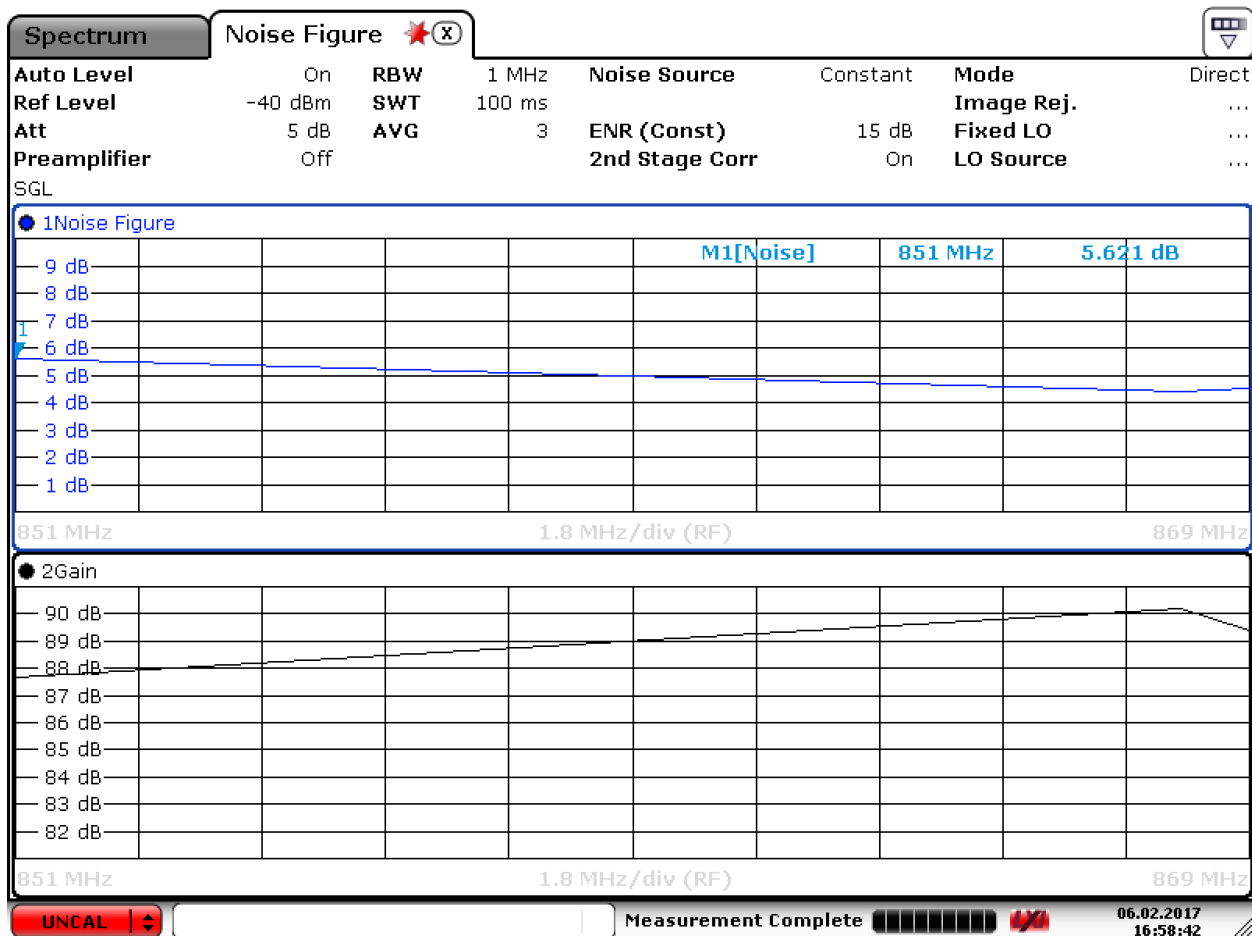
6.7. Noise Figure (continued)

Requirement: The noise figure of a signal booster must not exceed 9 dB in either direction.

Test Method: KDB 935210 Section 4.6

Result: Compliant, 5.621 dB

6.7.2. 851 to 869 MHz band



Date: 6.FEB.2017 16:58:41

6. Measurement Data (continued)

6.8. 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/cm2)	Result
				(mW/cm2)	(W/m2)		
	(1)	(2)	(3)	(4)		(5)	
814.0	20.0	32.96	3.00	0.7847479	7.8474787	2.71	Compliant
814.0	20.0	33.01	3.00	0.7938348	7.9383482	2.71	Compliant
814.0	20.0	32.98	3.00	0.7883701	7.8837010	2.71	Compliant
814.0	20.0	32.94	3.00	0.7811423	7.8114228	2.71	Compliant
860.5	20.0	32.48	3.00	0.7026356	7.0263559	2.87	Compliant
860.5	20.0	32.49	3.00	0.7042553	7.0425533	2.87	Compliant
860.5	20.0	32.50	3.00	0.7058788	7.0587881	2.87	Compliant
860.5	20.0	32.69	3.00	0.7374459	7.3744586	2.87	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 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.

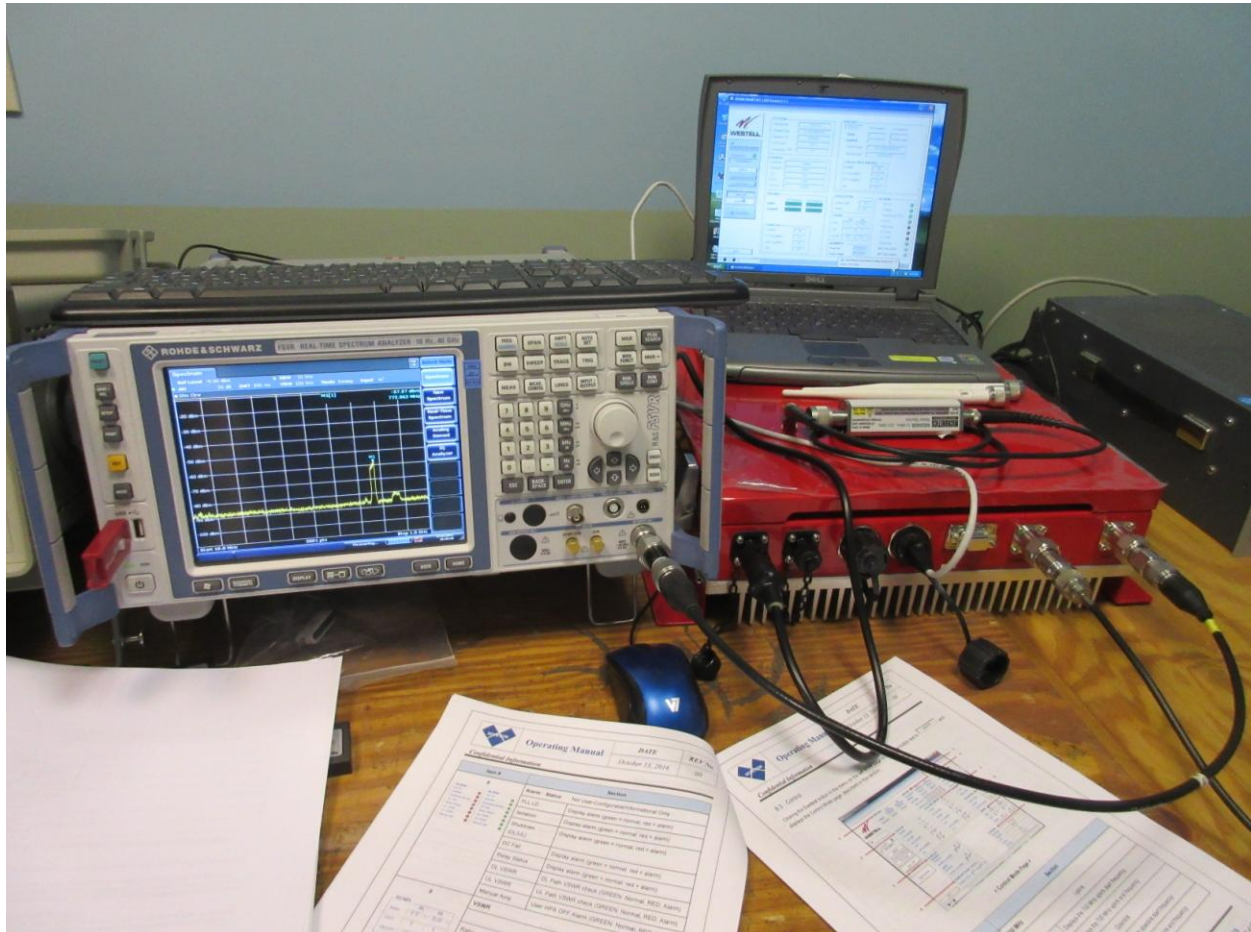
The radiated emissions test site is a 3 and 10 meter enclosed open area test site (OATS). Personnel, support equipment and test equipment are located in the basement beneath the OATS ground plane.

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 Setup Photographs

8.1 Antenna Port Conducted Emissions



8. Test Setup Photographs (cont)

8.2 Radiated Emissions (Front)



8. Test Setup Photographs (cont)

8.3 Radiated Emissions (Rear)



8. Test Setup Photographs (cont)

8.4 Radiated Emissions Above 1 GHz (Front)



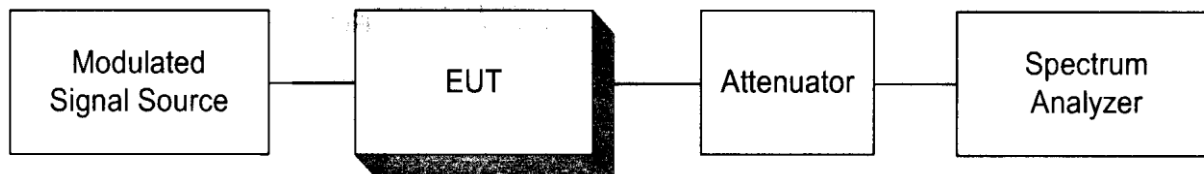
8. Test Setup Photographs (cont)

8.5 Radiated Emissions Above 1 GHz (Rear)

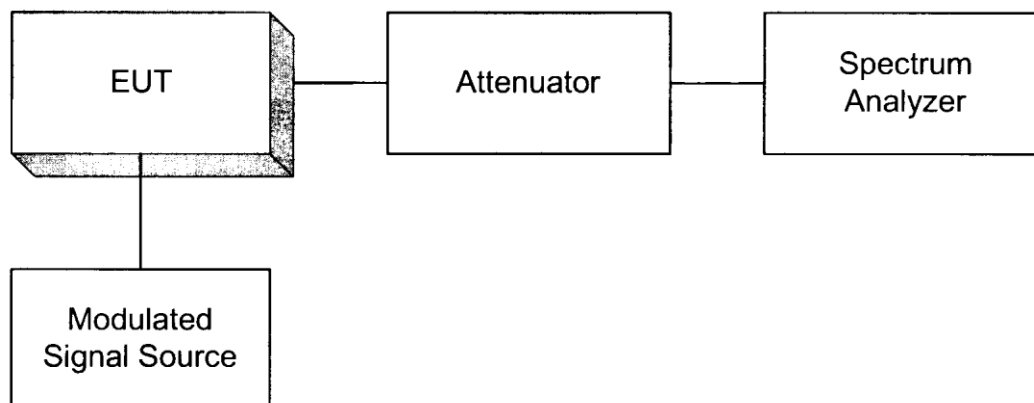


Appendix A

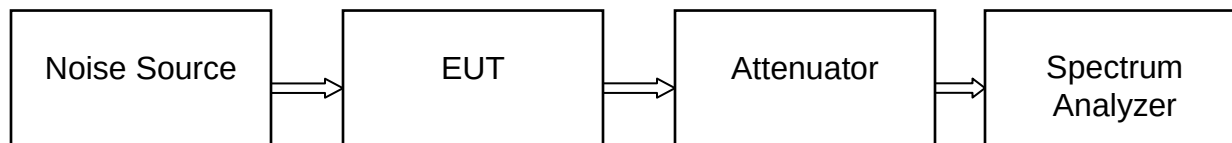
RF Output Power



Occupied Bandwidth

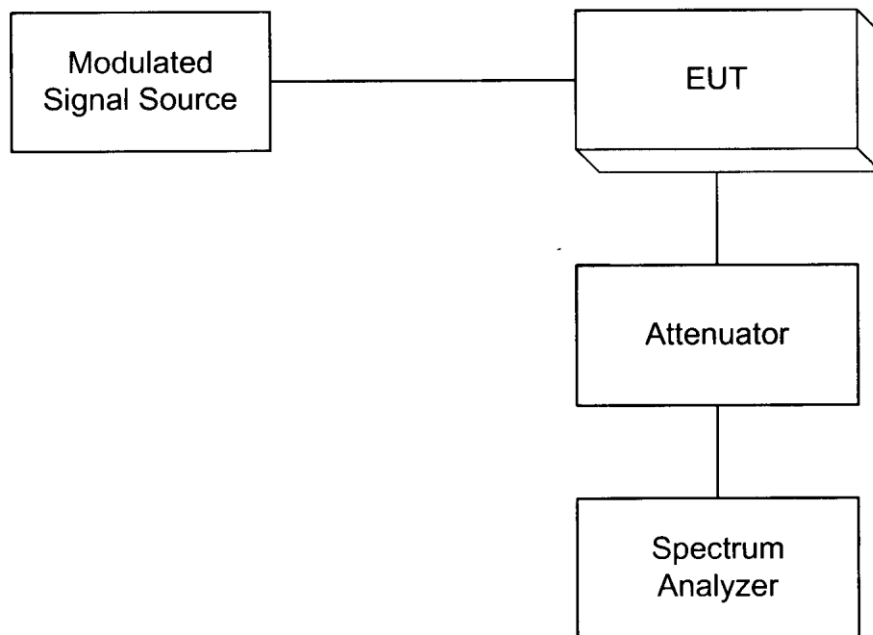


Noise Figure



Appendix A

Spurious Emissions at the Antenna Terminals



Field Strength of Spurious Radiation

