

# WRAU-2120

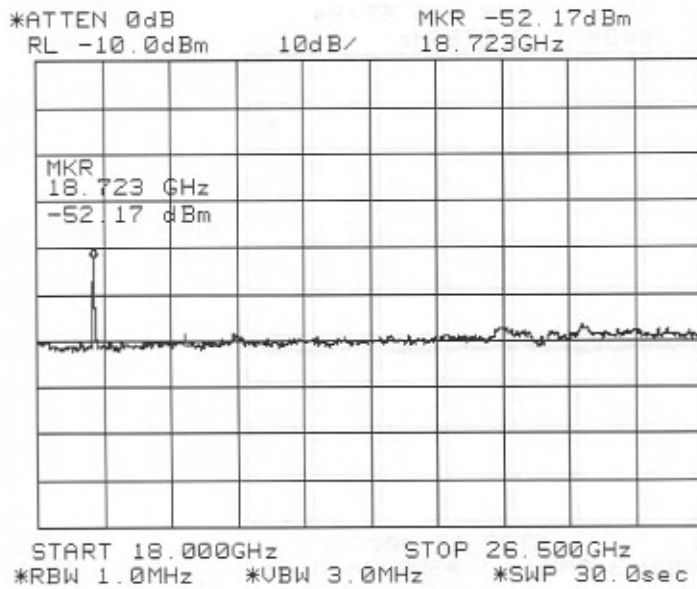


Figure F-74. Conducted Spurious Emissions, Channel 31, 18.0 – 26.5 GHz

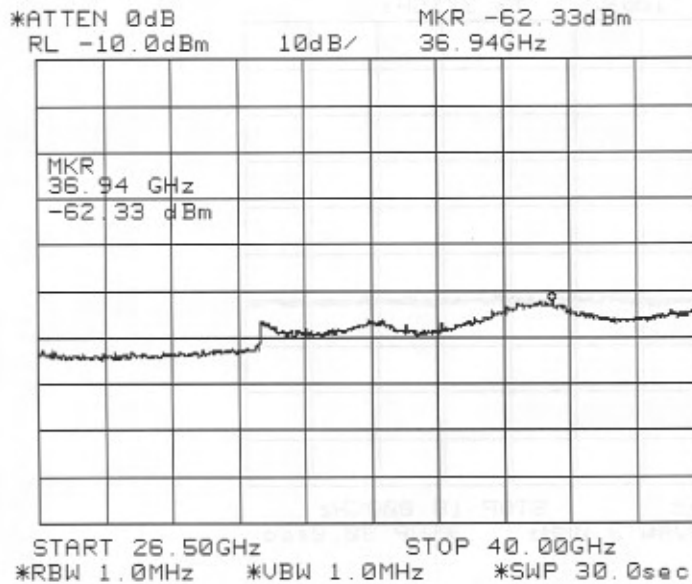


Figure F-75. Conducted Spurious Emissions, Channel 31, 26.5 – 40 GHz

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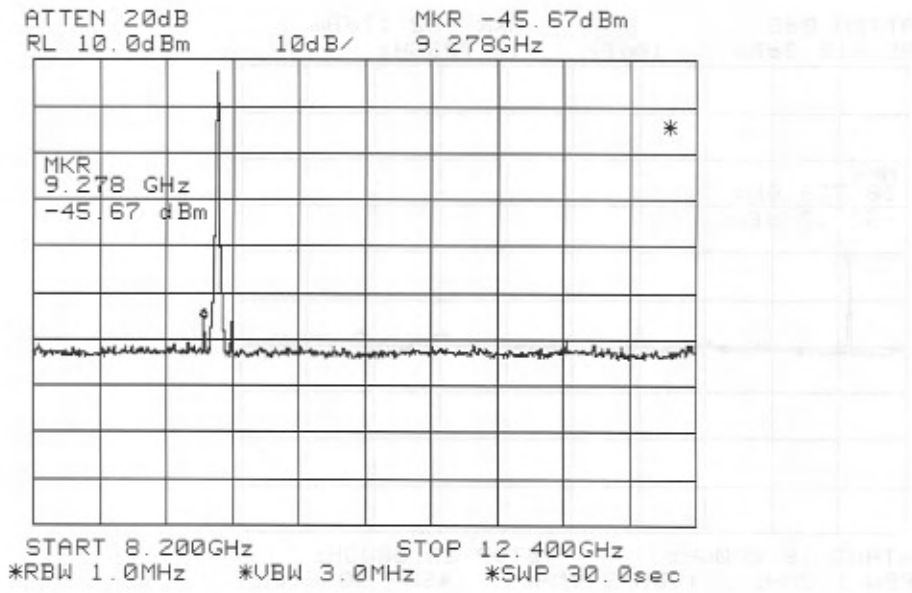


Figure F-76. Conducted Spurious Emissions, Channel 32, 8.2 – 12.4 GHz

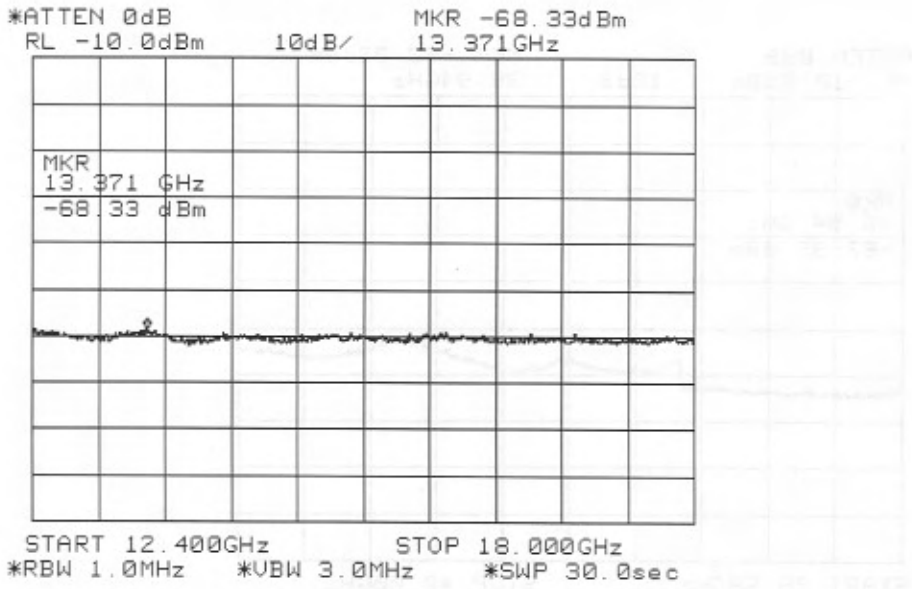


Figure F-77. Conducted Spurious Emissions, Channel 32, 12.4 – 18.0 GHz

# WRAU-2120

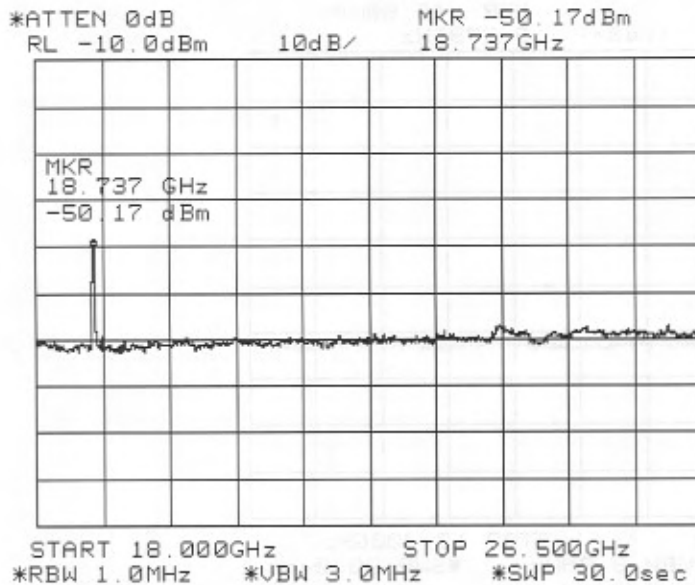


Figure F-78. Conducted Spurious Emissions, Channel 32, 18.0 – 26.5 GHz

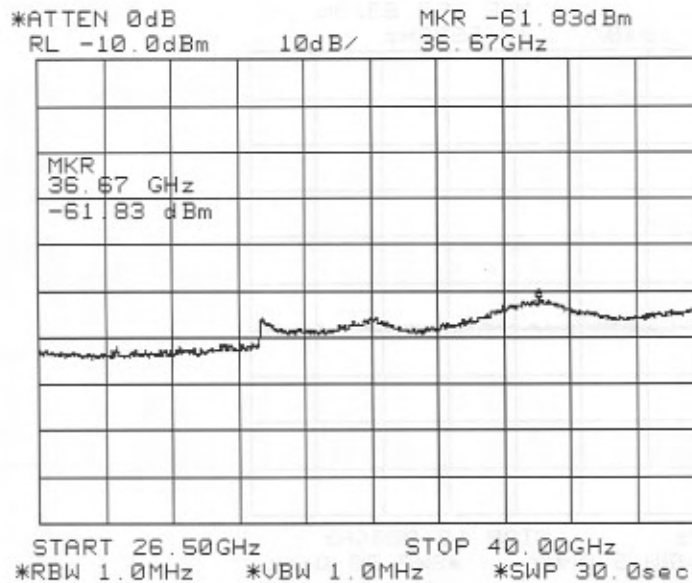


Figure F-79. Conducted Spurious Emissions, Channel 32, 26.5 – 40 GHz

# WRAU-2120

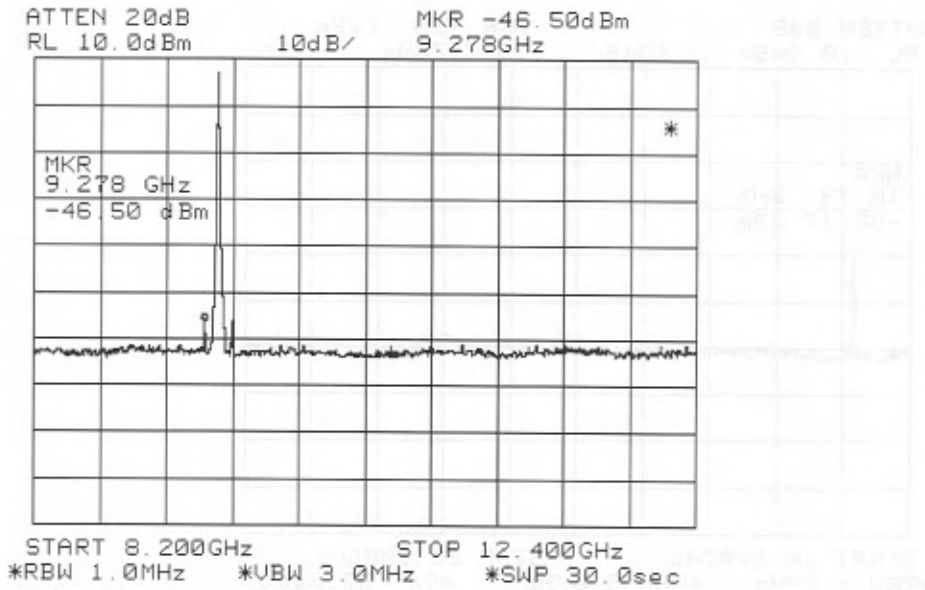


Figure F-80. Conducted Spurious Emissions, Channel 33, 8.2 – 12.4 GHz

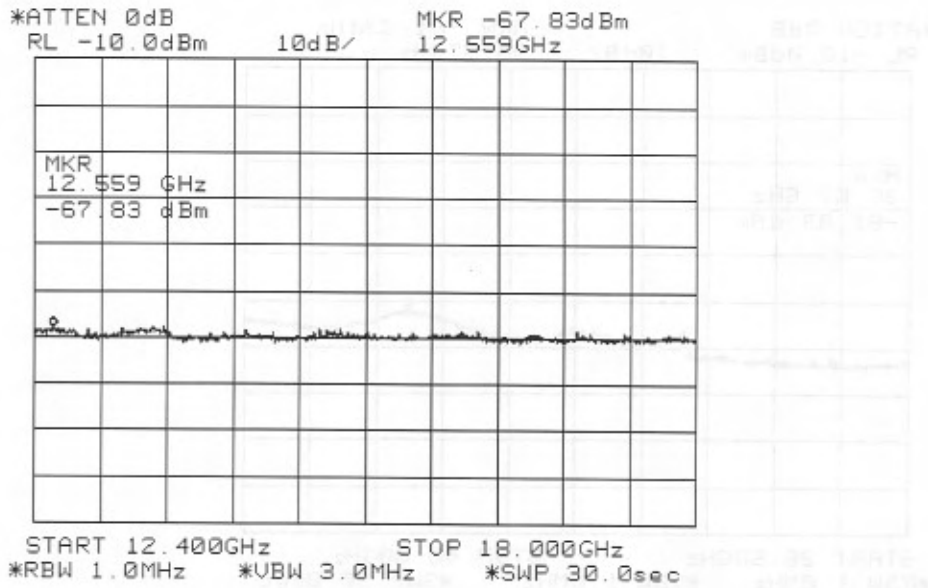


Figure F-81. Conducted Spurious Emissions, Channel 33, 12.4 – 18.0 GHz

# WRAU-2120

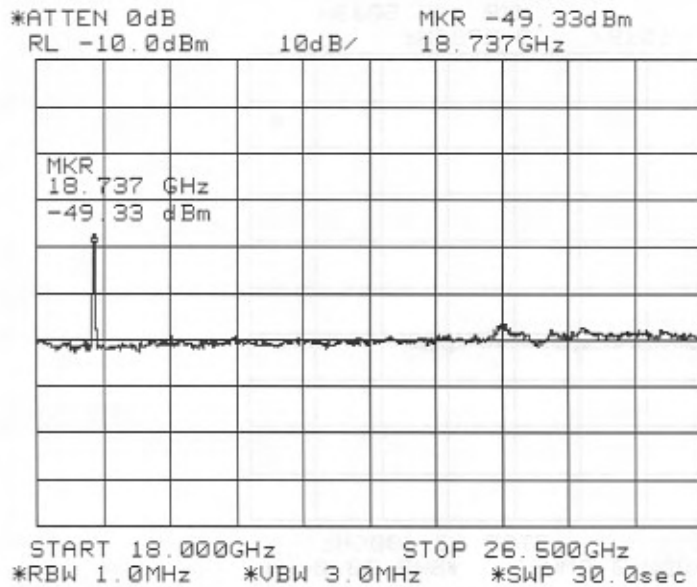


Figure F-82. Conducted Spurious Emissions, Channel 33, 18.0 – 26.5 GHz

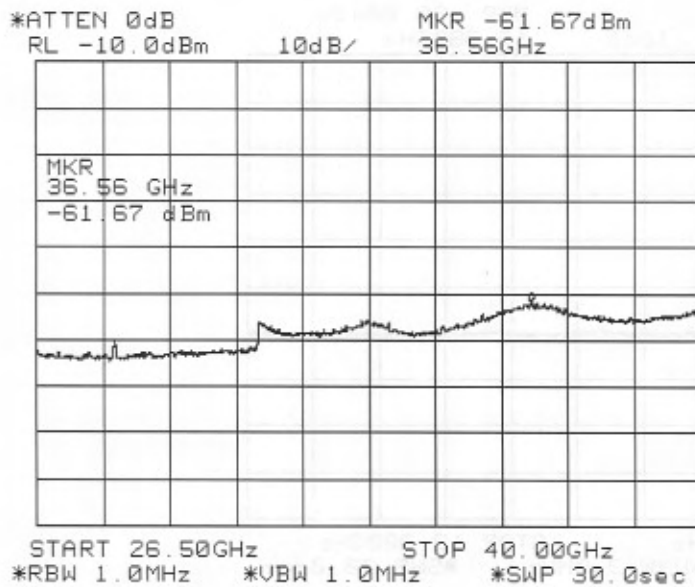


Figure F-83. Conducted Spurious Emissions, Channel 33, 26.5 – 40 GHz

# WRAU-2120

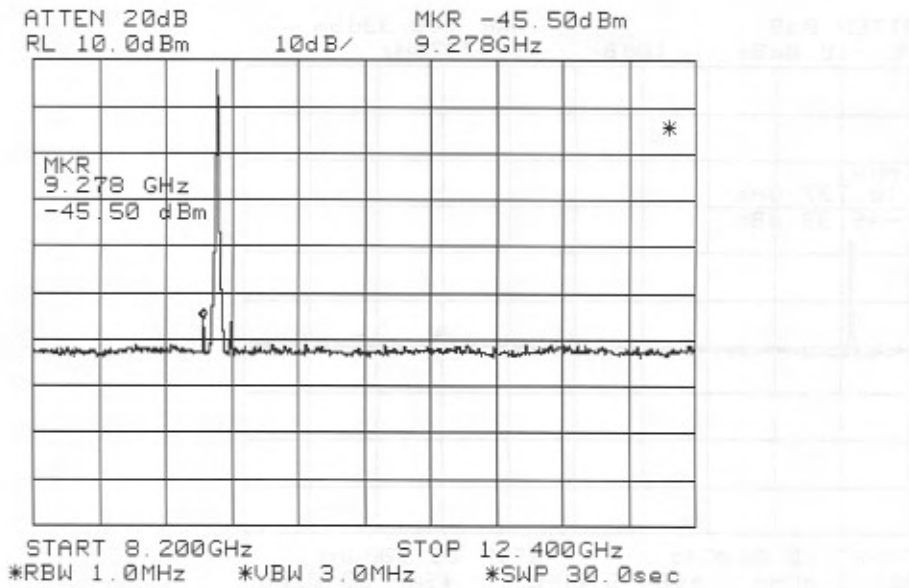


Figure F-84. Conducted Spurious Emissions, Channel 34, 8.2 – 12.4 GHz

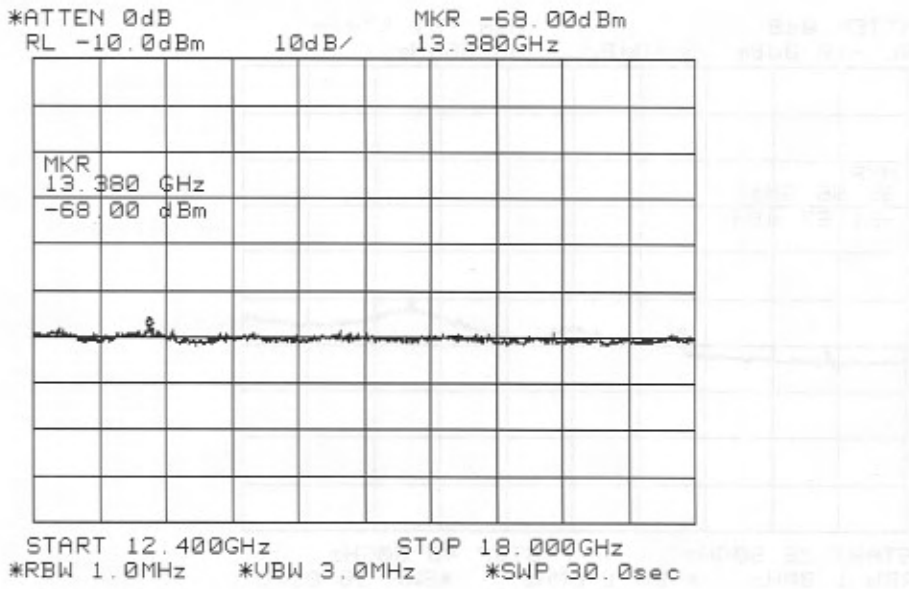


Figure F-85. Conducted Spurious Emissions, Channel 34, 12.4 – 18.0 GHz

# WRAU-2120

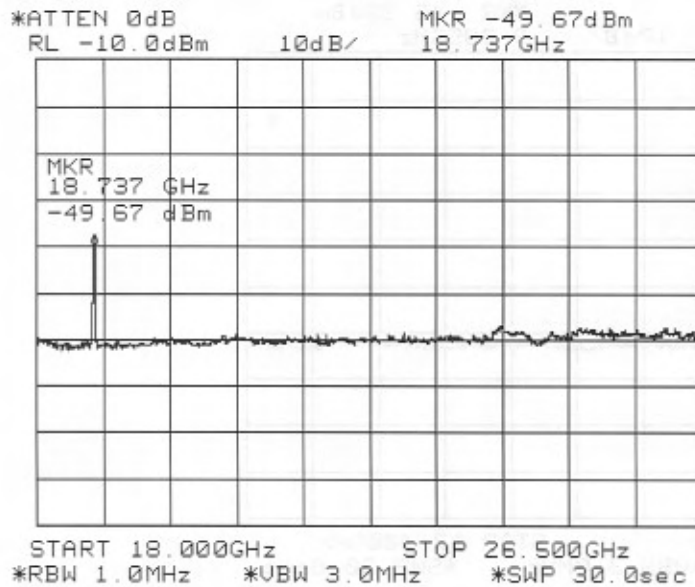


Figure F-86. Conducted Spurious Emissions, Channel 34, 18.0 – 26.5 GHz

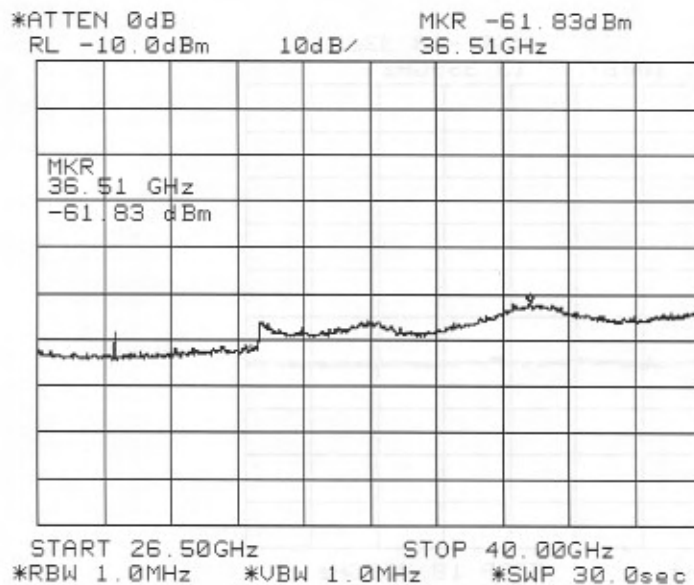


Figure F-87. Conducted Spurious Emissions, Channel 34, 26.5 – 40 GHz

# WRAU-2120

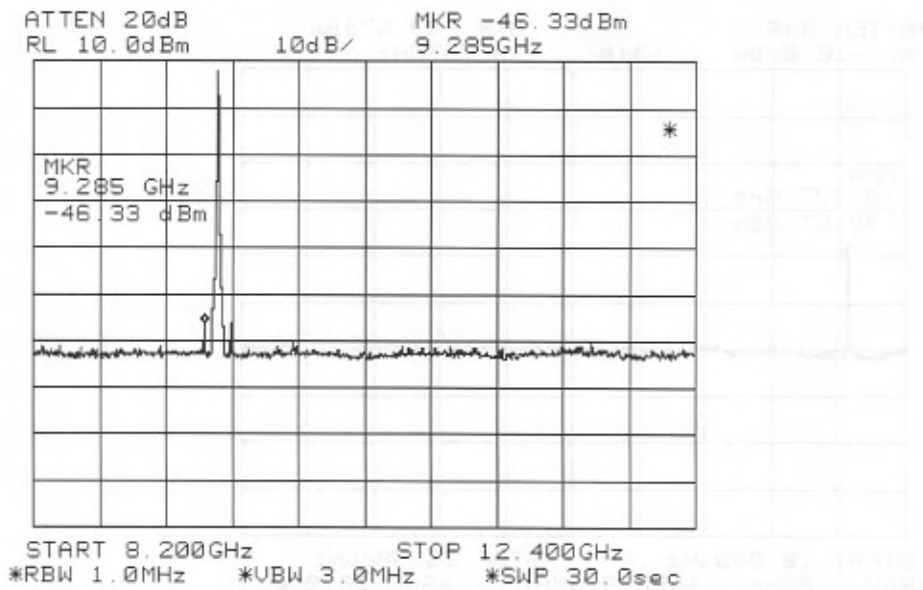


Figure F-88. Conducted Spurious Emissions, Channel 35, 8.2 – 12.4 GHz

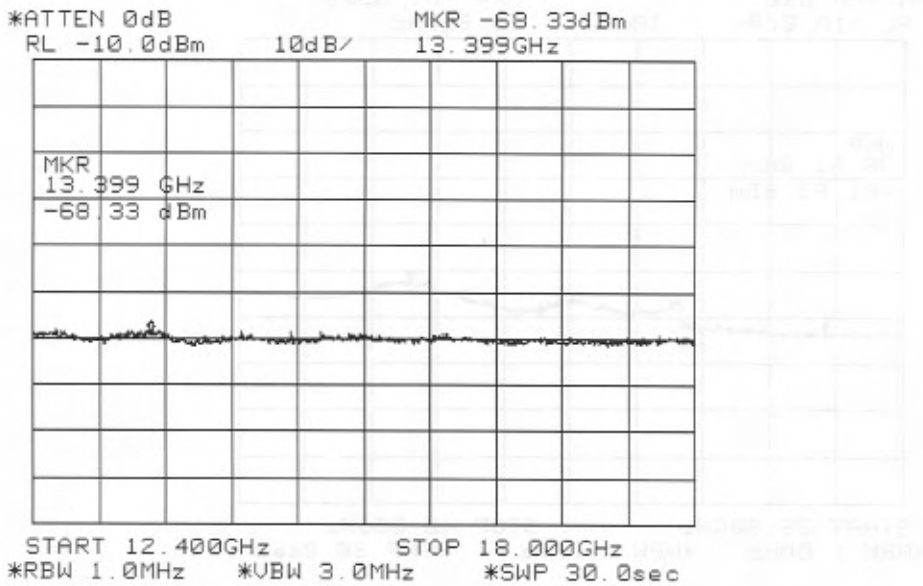


Figure F-89. Conducted Spurious Emissions, Channel 35, 12.4 – 18.0 GHz



# WRAU-2120

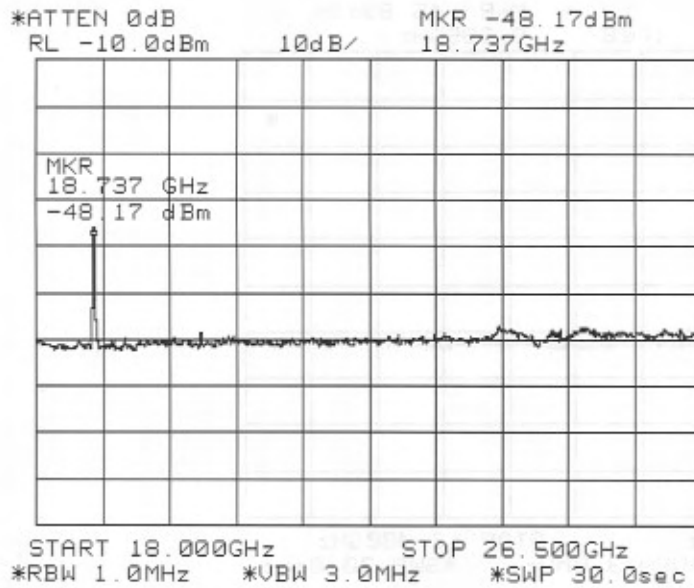


Figure F-90. Conducted Spurious Emissions, Channel 35, 18.0 – 26.5 GHz

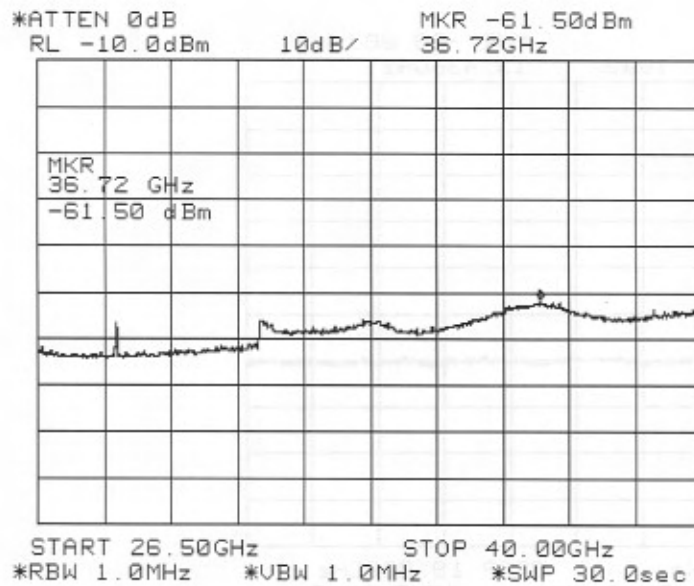


Figure F-91. Conducted Spurious Emissions, Channel 35, 26.5 – 40 GHz

# WRAU-2120

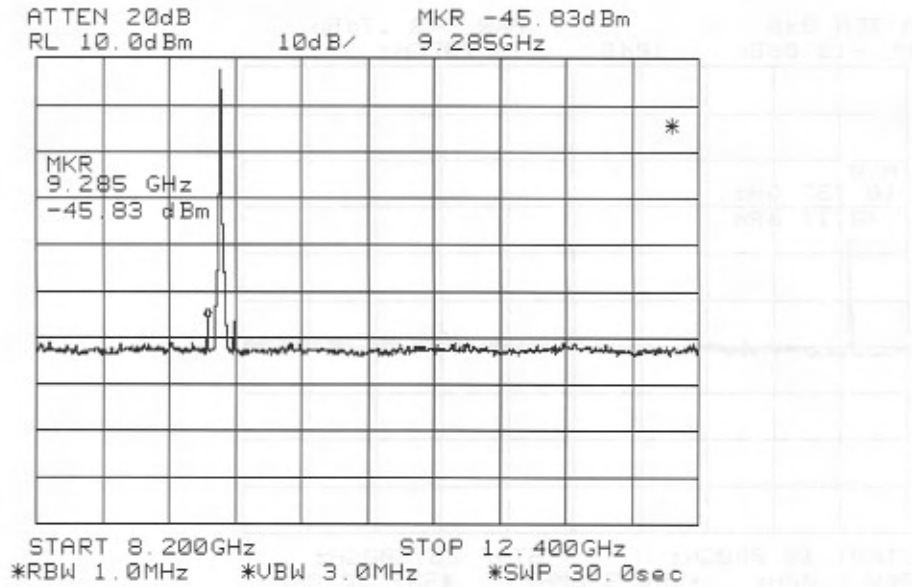


Figure F-92. Conducted Spurious Emissions, Channel 36, 8.2 – 12.4 GHz

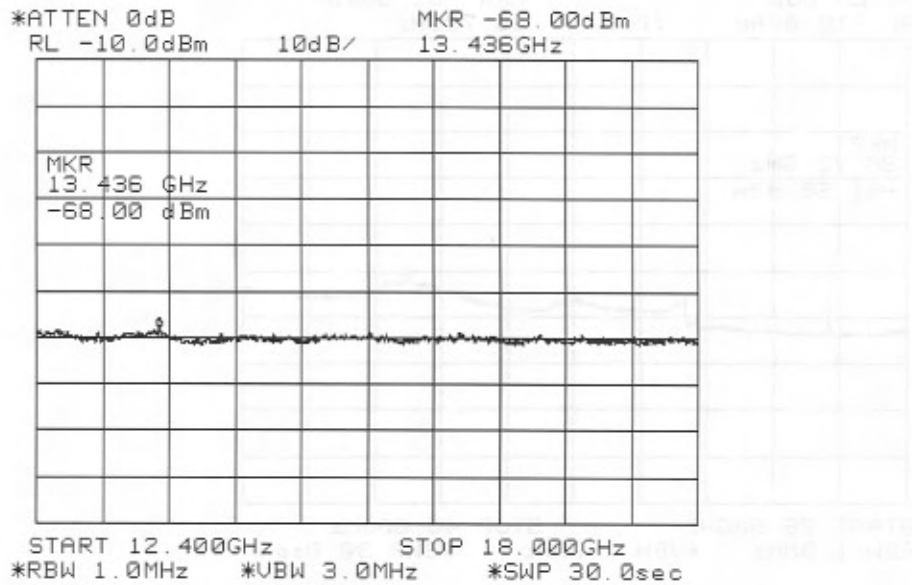


Figure F-93. Conducted Spurious Emissions, Channel 36, 12.4 – 18.0 GHz

# WRAU-2120

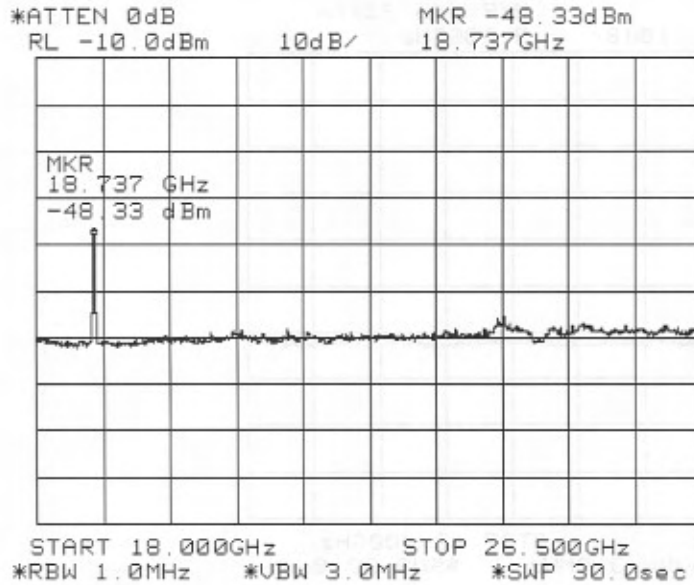


Figure F-94. Conducted Spurious Emissions, Channel 36, 18.0 – 26.5 GHz

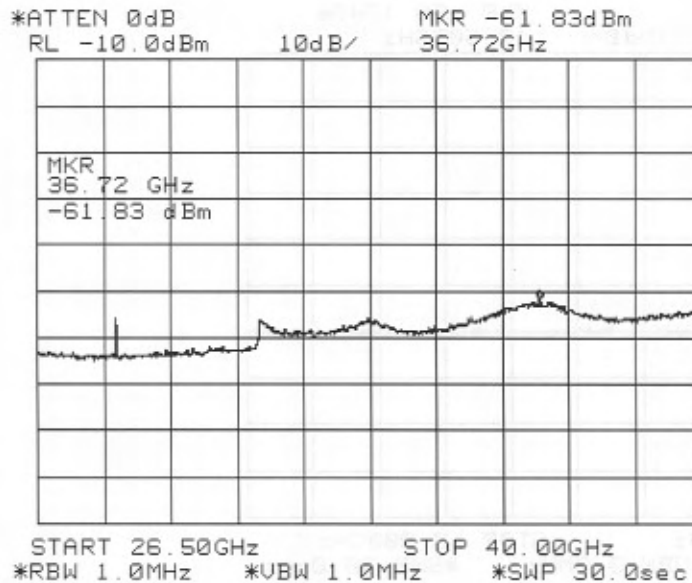


Figure F-95. Conducted Spurious Emissions, Channel 36, 26.5 – 40 GHz



# WRAU-2120

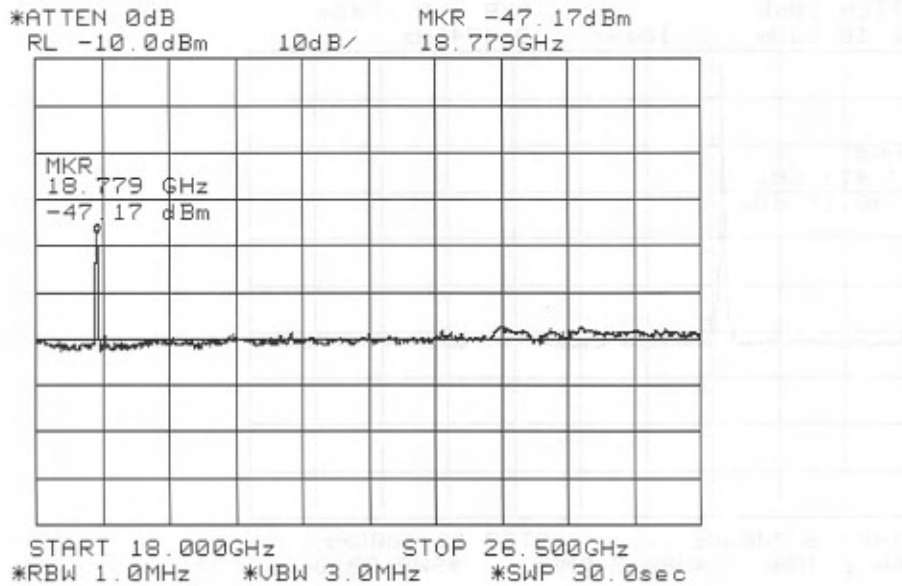


Figure F-98. Conducted Spurious Emissions, Channel 50, 18.0 – 26.5 GHz

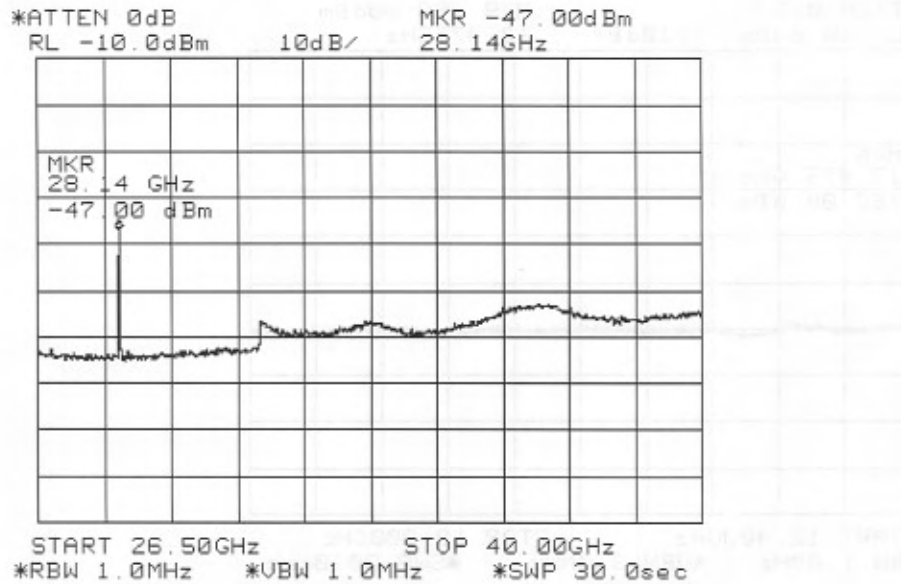


Figure F-99. Conducted Spurious Emissions, Channel 50, 26.5 – 40 GHz

# WRAU-2120

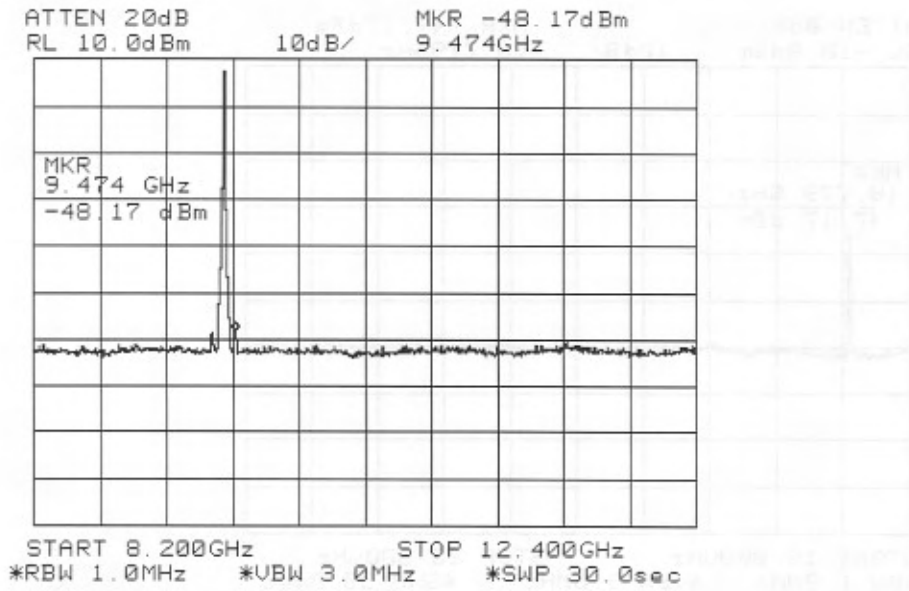


Figure F-100. Conducted Spurious Emissions, Channel 63, 8.2 – 12.4 GHz

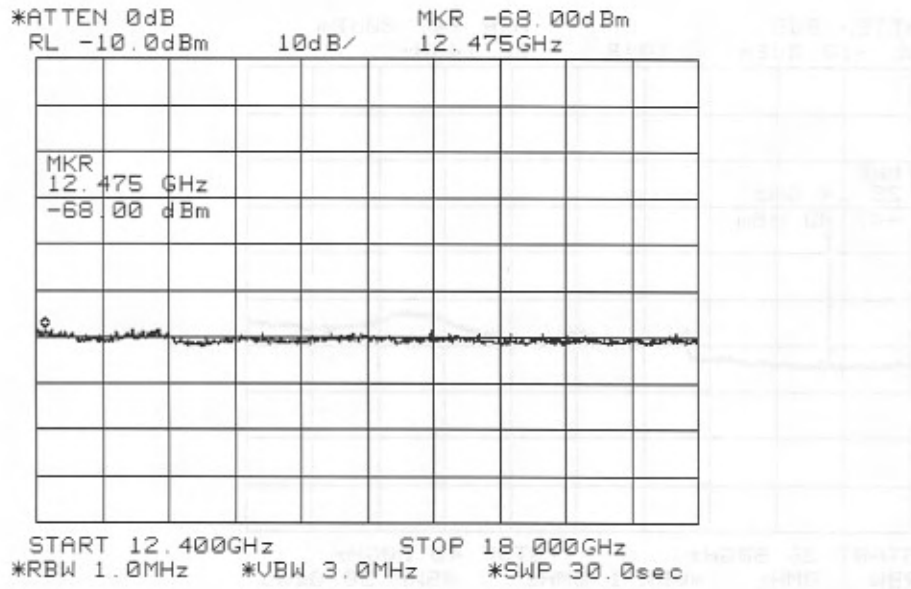


Figure F-101. Conducted Spurious Emissions, Channel 63, 12.4 – 18.0 GHz

# WRAU-2120

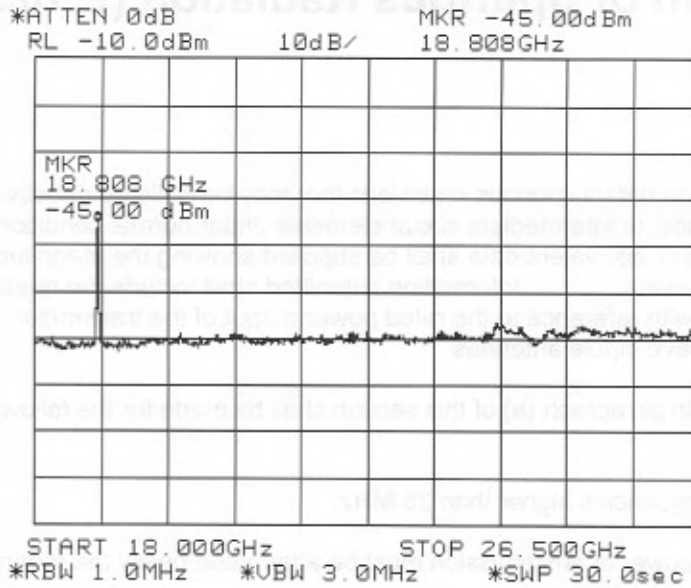


Figure F-102. Conducted Spurious Emissions, Channel 63, 18.0 – 26.5 GHz

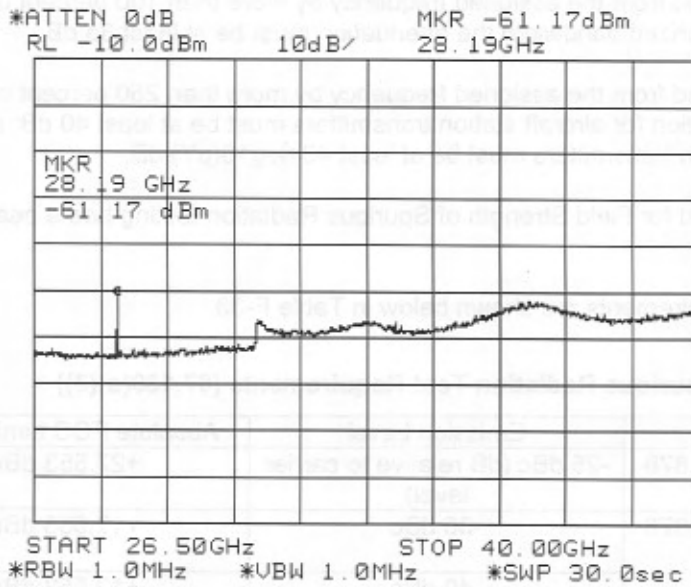


Figure F-103. Conducted Spurious Emissions, Channel 63, 26.5 – 40 GHz

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## F.8 Field Strength of Spurious Radiation (2.1053)

### Requirements:

Section 2.1053 (a), (b)(2)

(a) Measurements shall be made to detect spurious emissions that may be radiated directly from the cabinet, control circuits, power leads, or intermediate circuit elements under normal conditions of installation and operation. Curves or equivalent data shall be supplied showing the magnitude of each harmonic and other spurious emissions. ... Information submitted shall include the relative radiated power of each spurious emission with reference to the rated power output of the transmitter, assuming all emissions are radiated from halfwave dipole antennas.

(b) The measurements specified in paragraph (a) of this section shall be made for the following equipment:

(2) All equipment operating on frequencies higher than 25 MHz.

Section 87.139(a) "... the mean power of any emission must be attenuated below the mean power of the transmitter (pY) as follows:

(1) When the frequency is removed from the assigned frequency by more than 50 percent up to and including 100 percent of the authorized bandwidth the attenuation must be at least 25 dB.

(2) When the frequency is removed from the assigned frequency by more than 100 percent up to and including 250 percent of the authorized bandwidth the attenuation must be at least 35 dB.

(3) When the frequency is removed from the assigned frequency by more than 250 percent of the authorized bandwidth the attenuation for aircraft station transmitters must be at least 40 dB; and the attenuation for aeronautical station transmitters must be at least  $43 + \log_{10}(pY)$  dB.

The WRAU-2120 Test Article used for Field Strength of Spurious Radiation testing had a peak power of 91 Watts.

The Spurious Radiation test Requirements are shown below in Table F-33.

**Table F-33. Spurious Radiation Test Requirements (87.139(a)(3))**

Frequency Band	Emission Level	Absolute FCC Limit (Peak)
From 9438.876 MHz to 9538.876 MHz	-25 dBc (dB relative to carrier level)	+27.553 dBm
From 9538.877 MHz to 9838.876 MHz	-35 dBc	+17.553 dBm
Over 9838.877 MHz	-40 dBc	+12.553 dBm



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Assuming the worst case requirement of 40dBc, the maximum field strength is computed by the following procedure:

FCC Limit = 40 dBc

$$\text{Limit (Watts)} = \text{Ptx(average)} \times 10^{\frac{-\text{FCC Limit (dBc)}}{10}}$$

This level is converted to a field strength value "E" based on a dipole radiator:

$$E^2 = (30 * G * L) / R \quad \text{Where:}$$

- G = 1.64 (dipole gain)
- L = Limit (Watts)
- R = 1 meter (Test distance)
- E = Field strength (volts/meter).

The WRAU-2120 Test Article used for Field Strength of Spurious Radiation testing had a peak power of 91 Watts. The current system has a maximum duty cycle of 0.5% however, this calculation will assume a maximum duty cycle of 5% for computation of average power. (Note: This assumption will not have a bearing on the specified limit.)

$$\text{Peak Power} = 10 * \text{Log}(91/0.001) = 49.59 \text{ dBm, Assumed Duty Cycle} = 0.05$$

$$\text{Ptx(average)} = 91 * 0.05 = 4.55 \text{ Watts average}$$

$$\text{FCC Limit (dBc)} = 40$$

$$\text{Limit (Watts)} = 4.55 * 10^{(-40/10)} = 4.55 * 10^{-4} \text{ W average}$$

$$E^2 = 30 * 1.64 * 4.55 * 10^{-4} = 2.239 * 10^{-2}$$

$$E \text{ (V/m)} = \text{sqrt}(2.239 * 10^{-2}) = 149,619.517 \mu\text{V/m average}$$

$$E \text{ (dB}\mu\text{V/m)} = 20 * \text{log}(149,619.517 \mu\text{V/m}) = 103.500 \text{ dB}\mu\text{V/m}$$

Since the FCC Limit is average power, and the receiver used to detect the radiated power is a peak power reading instrument, the FCC Limit must be converted to peak power, which can be accomplished in two ways. The first method is to simply convert the average limit to peak by taking it out of dB, squaring it, divide by the duty cycle, and convert it back to dB. The second method is to take the difference (in dB) between peak power and average power at a given duty cycle (Assumed maximum 5%) and add it to the average limit in dB $\mu$ V/m.

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## Method 1:

$$\text{Limit (average)} = 103.500 \text{ dB}\mu\text{V/m}$$

$$\text{Limit (average)} = 10(103.5/20) = 149,623.566 \mu\text{V/m}$$

$$\text{Limit (peak)} = ((149623.566)^2)/0.05 = 4.477*10^{11} \mu\text{V/m}$$

$$\text{Limit (peak)} = 10*\log(4.477*10^{11} \mu\text{V/m}) = 116.510 \text{ dB}\mu\text{V/m}$$

## Method 2:

$$\text{Limit (average)} = 103.500 \text{ dB}\mu\text{V/m}$$

$$\text{Peak Power (mW)} = 10(49.59/10) = 90,911.327 \text{ mW}$$

$$\text{Average Power (mW)} = 90,991.327 \text{ mW} \times 0.05 = 4,549.566 \text{ mW}$$

$$\text{Average Power (dBm)} = 10 \log (4,549.566 \text{ mW}) = 36.580 \text{ dBm}$$

$$\text{Difference (dB)} = 49.59 \text{ dBm(peak)} - 36.580 \text{ dBm(average)} = 13.01 \text{ dB}$$

$$\text{Limit (peak)} = 103.500 \text{ dB}\mu\text{V/m} + 13.01 \text{ dB} = 116.510 \text{ dB}\mu\text{V/m}$$

Therefore, the absolute limit of **116.510 dB $\mu$ V/m** was used for these tests.

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## Test Procedure:

FCC Part 2.1057(a) states that the spectrum shall be investigated from the lowest radio frequency generated in the equipment without going below 9 kHz up to the tenth harmonic of the carrier or 40GHz whichever is lower. This test procedure follows the methodology of DO-160D Section 21. DO-160D Section 21 only specifies testing to 6GHz. However, the same test setup and methodology was used to measure radiated emissions up to 40GHz.

The lowest RF oscillator frequency generated in the equipment is 12 MHz.

The frequency range investigated for radiated emissions was: 150 kHz to 40 GHz

The WRAU-2120 was operated in Weather + Turb + Windshear + Auto modes. These modes represent the maximum operating condition for the unit.

Range 320 NM/80 NM  
Mode WX+TURB/Windshear  
Altitude 1000 FT  
W/S Enabled  
Auto Selected

The WRAU-2120 Radiated Emissions Data was taken with the unit operating on each of the four operating conditions specified in Table F-34. The "Mode 1" condition represents the normal operating mode of the WRAU-2120 with the unit automatically controlling the transmitter frequencies. Two additional fixed frequency selections were specified to demonstrate compliance over the complete range of channel capabilities.

**Table F-34. WRAU-2120 Radiated Emissions Test Operating Conditions**

Test Condition	Channel	Tx Freq (MHz)	Remarks
Mode 1	Auto	Multiple	
Fixed 0	0	9320.412798	Lowest Freq
Fixed 63	63	9400.412796	Highest Freq

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The equipment used for the Field Strength of Spurious Radiation test is listed in Table F-35.

**Table F-35. Test Equipment Used for Field Strength of Spurious Radiations Test**

Equipment	Manufacturer/Model Number	Specific Identification	Calibration Due Date
Receiver/Transmitter	Rockwell Collins RTM-2100 (822-2127-001)	2GJ4L	N/A
Radar Drive Assembly	822-2137-001	2GJ2Y	N/A
Test Harness	Rockwell Collins Test Harness	827-3389-121	N/A
Power Supply	CISS 2100 Power Supply	653-4554-001	N/A
RF Dummy Load	ARRA, Inc. 90-660	0508444	N/A
Active Monopole Antenna (150KHz - 25MHz)	Electro-Metrics RVA30	460-0118-548	10/31/2007
Antenna (1GHz - 18GHz)	Emco 3115	460-0078-853	3/31/2009
Biconical Antenna (25 MHz – 200 MHz)	ETS 3104C	460-0133-792	03/31/2009
Antenna (200MHz - 1GHz)	Emco 3106	460-0113-396	06/30/2009
Gain Horn (18 GHz – 26.5 GHz)	Emco 3160-9	RA42-K-F-4B-C	N/A
Gain Horn (26 GHz – 40 GHz)	Emco 3160-10	RA28-K-T-4B-C	N/A
Amplifier (18 - 26.5 GHz)	R & S	TS-PR26	N/A
Amplifier (26.5 - 40 GHz)	R & S	TS-PR40	12/31/2007
EMI Test Receiver	Rohde & Schwarz ESI	460-0212-537	1/31/2008

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## Equipment Setup:

The test setup for the Field Strength of Spurious Radiation test is shown in Figure F-104.

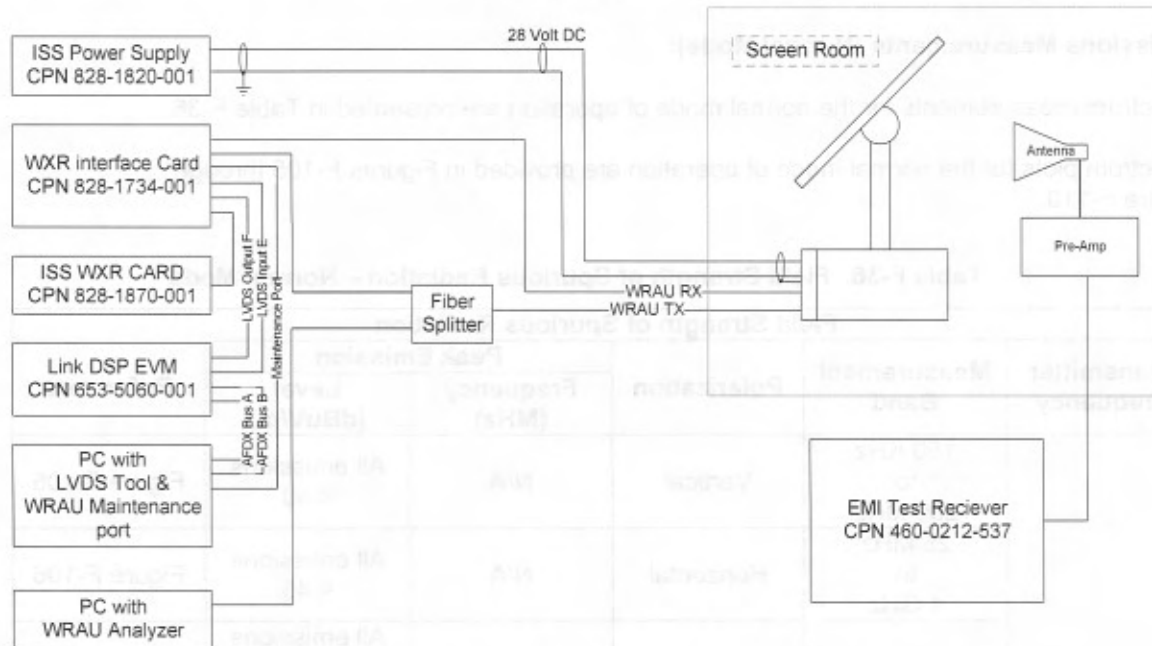


Figure F-104. Field Strength of Spurious Radiation Test Setup

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## Results:

Results are provided in table and spectral plot forms and are provided for **vertical** and **horizontal** polarizations from **150 KHz to 40 GHz** for **each mode of operation**. No emissions (with the exception of the fundamental) exceeded the FCC limit of 116.51 dB $\mu$ V/m.

## Emissions Measurements (Normal Mode):

Spectrum measurements for the normal mode of operation are presented in Table F-36.

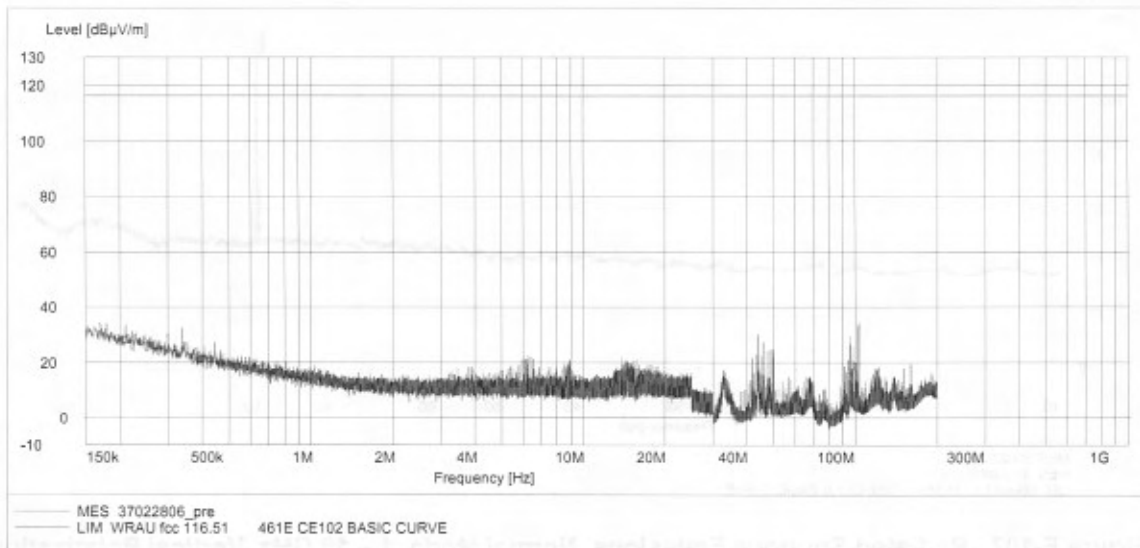
Spectrum plots for the normal mode of operation are provided in Figures F-105 through Figure F-110.

**Table F-36. Field Strength of Spurious Radiation – Normal Mode**

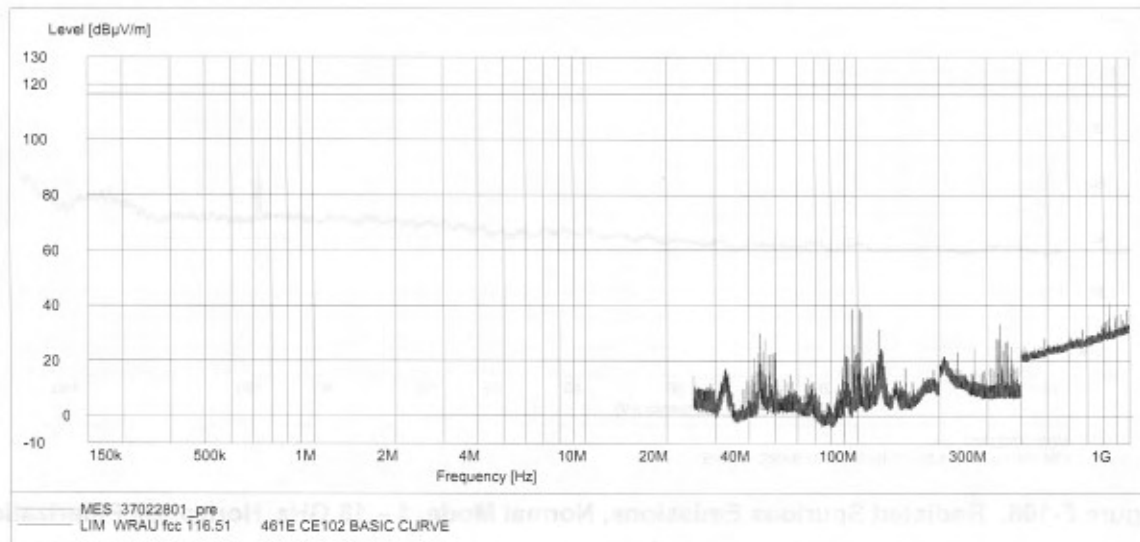
Field Strength of Spurious Radiation					
Transmitter Frequency	Measurement Band	Polarization	Peak Emission		Reference
			Frequency (MHz)	Level (dB $\mu$ V/m)	
Normal Mode	150 KHz to 200 MHz	Vertical	N/A	All emissions < 40	Figure F-105
	25 MHz to 1 GHz	Horizontal	N/A	All emissions < 45	Figure F-106
	1 GHz to 18 GHz	Vertical	N/A	All emissions < 70 (except fundamental)	Figure F-107
		Horizontal	N/A	All emissions < 100	Figure F-108
	18 GHz to 40 GHz	Horizontal	N/A	All emissions < 90	Figure F-109
		Vertical	N/A	All emissions < 90	Figure F-110

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## Spectrum Plots (Normal Mode):



**Figure F-105. Radiated Spurious Emissions, Normal Mode, 150 kHz – 200 MHz, Vertical Polarization**



**Figure F-106. Radiated Spurious Emissions, Normal Mode, 25 MHz – 1 GHz, Horizontal Polarization**

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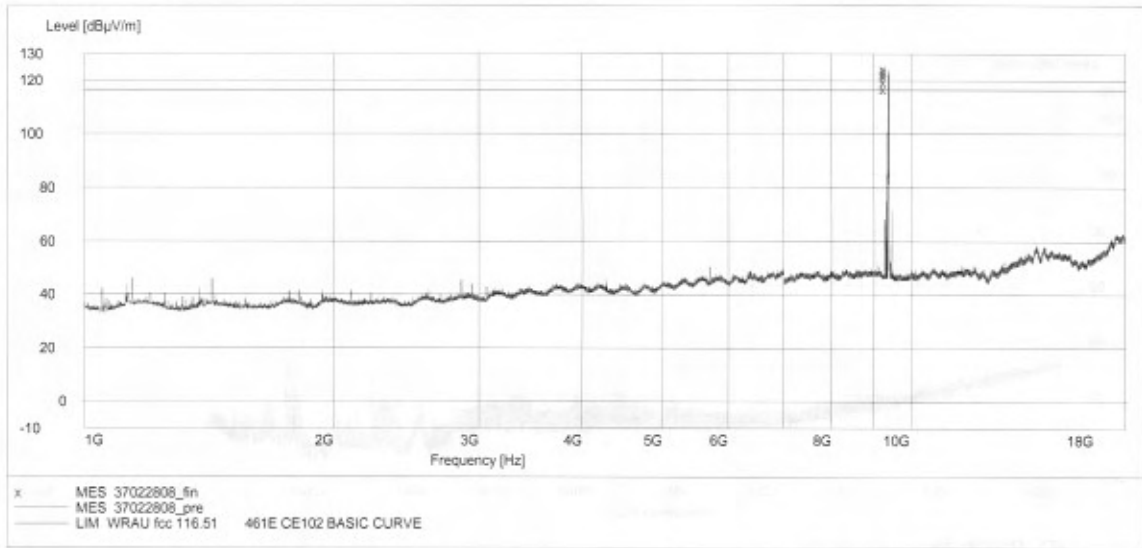


Figure F-107. Radiated Spurious Emissions, Normal Mode, 1 – 18 GHz, Vertical Polarization

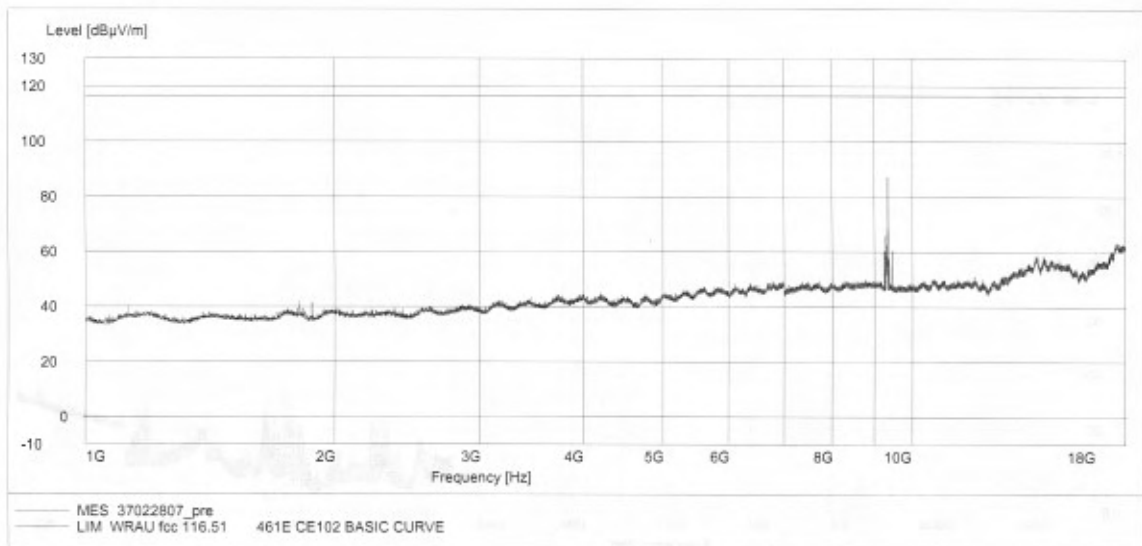


Figure F-108. Radiated Spurious Emissions, Normal Mode, 1 – 18 GHz, Horizontal Polarization



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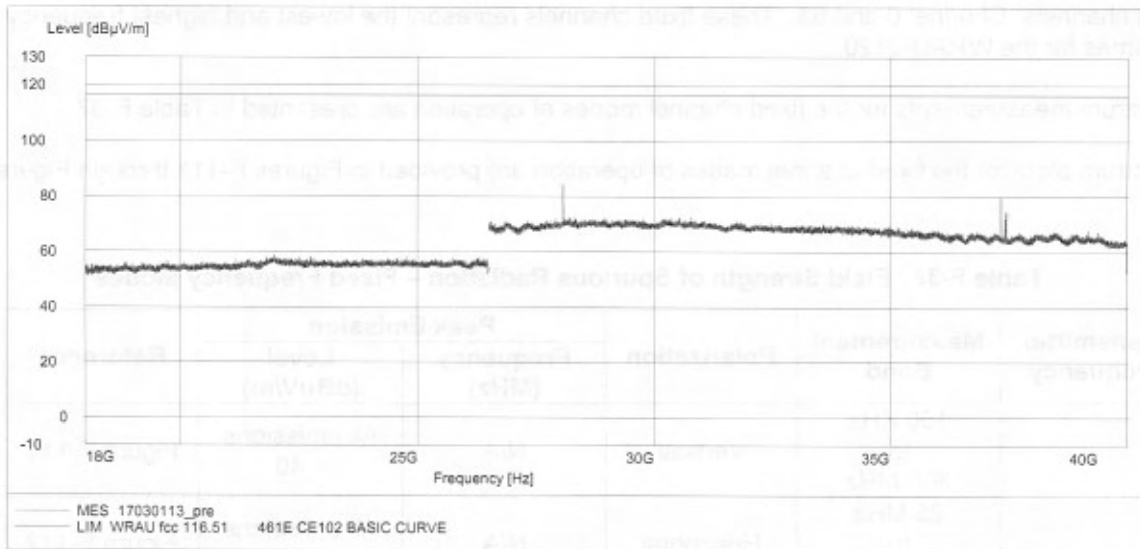


Figure F-109. Radiated Spurious Emissions, Normal Mode, 18 - 40 GHz, Horizontal Polarization

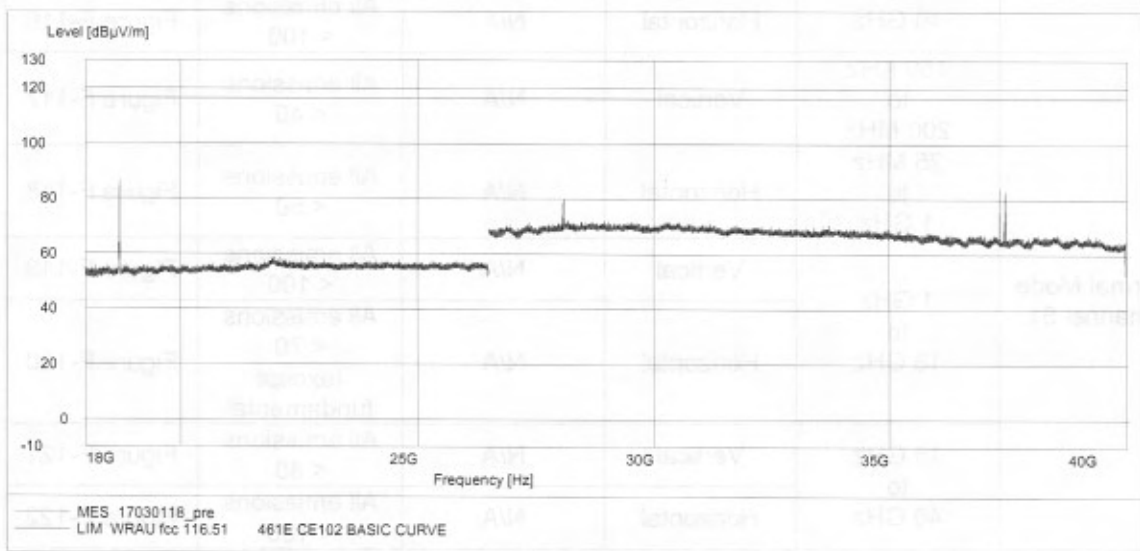


Figure F-110. Radiated Spurious Emissions, Normal Mode, 18 - 40 GHz, Vertical Polarization

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## Emissions Measurements (Fixed Channels):

The following data are additional measurements with the Receiver/Transmitter operating on each of 2 fixed channels: Channel 0 and 63. These fixed channels represent the lowest and highest frequency extremes for the WRAU-2120.

Spectrum measurements for the fixed channel modes of operation are presented in Table F-37.

Spectrum plots for the fixed channel modes of operation are provided in Figures F-111 through Figure F-122.

**Table F-37. Field Strength of Spurious Radiation – Fixed Frequency Modes**

Transmitter Frequency	Measurement Band	Polarization	Peak Emission		Reference
			Frequency (MHz)	Level (dBuV/m)	
Normal Mode Channel 0	150 KHz to 200 MHz	Vertical	N/A	All emissions < 40	Figure F-111
	25 MHz to 1 GHz	Horizontal	N/A	All emissions < 45	Figure F-112
	1 GHz to 18 GHz	Vertical	N/A	All emissions < 100	Figure F-113
		Horizontal	N/A	All emissions < 100	Figure F-114
	18 GHz to 40 GHz	Vertical	N/A	All emissions < 80	Figure F-115
		Horizontal	N/A	All emissions < 100	Figure F-116
Normal Mode Channel 61	150 KHz to 200 MHz	Vertical	N/A	All emissions < 40	Figure F-117
	25 MHz to 1 GHz	Horizontal	N/A	All emissions < 50	Figure F-118
	1 GHz to 18 GHz	Vertical	N/A	All emissions < 100	Figure F-119
		Horizontal	N/A	All emissions < 70 (except fundamental)	Figure F-120
	18 GHz to 40 GHz	Vertical	N/A	All emissions < 80	Figure F-121
		Horizontal	N/A	All emissions < 100	Figure F-122

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## Spectrum Plots (Channel 0):

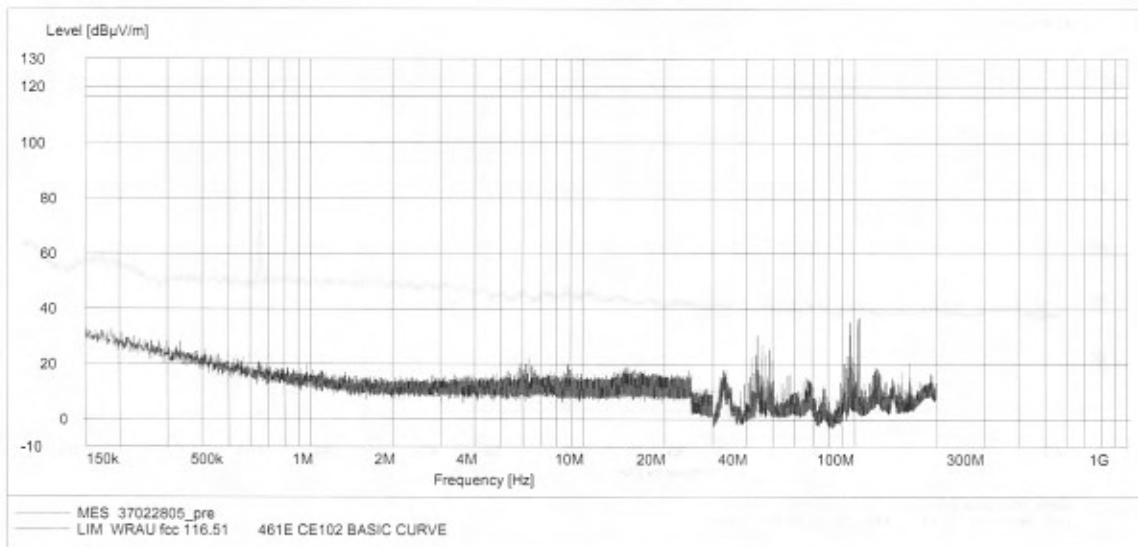


Figure F-111. Radiated Spurious Emissions, Channel 0, 150 kHz – 200 MHz, Vertical Polarization

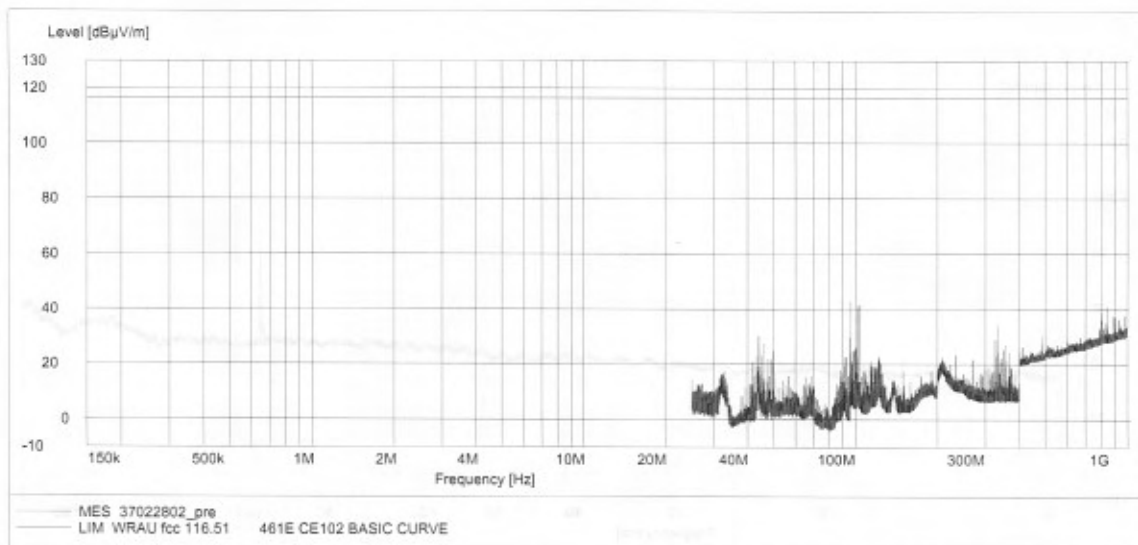


Figure F-112. Radiated Spurious Emissions, Channel 0, 25 MHz – 1 GHz, Horizontal Polarization

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Spectrum Plot (Channel 0)

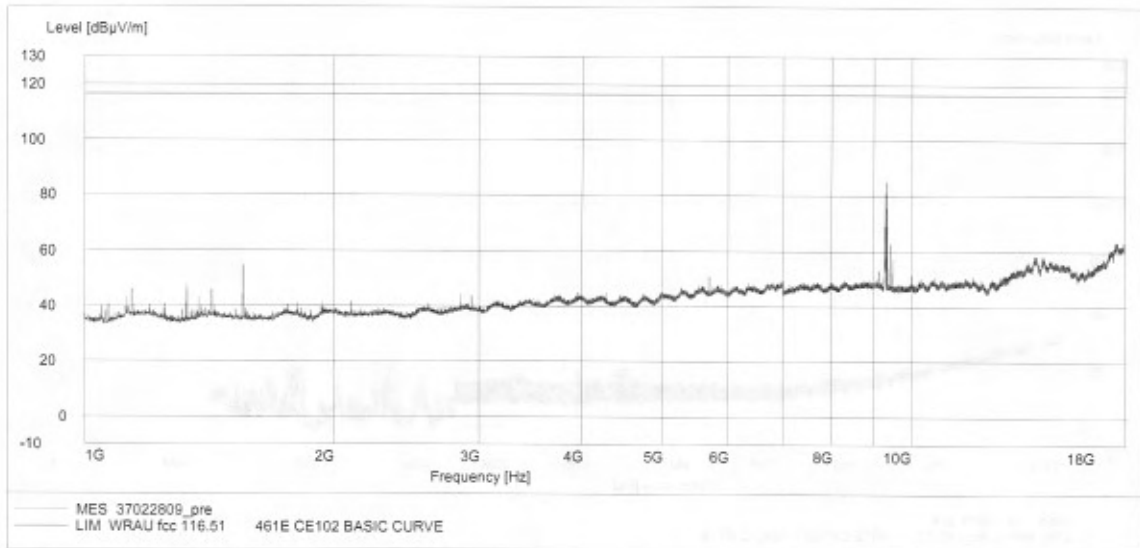


Figure F-113. Radiated Spurious Emissions, Channel 0, 1 GHz – 18 GHz, Vertical Polarization

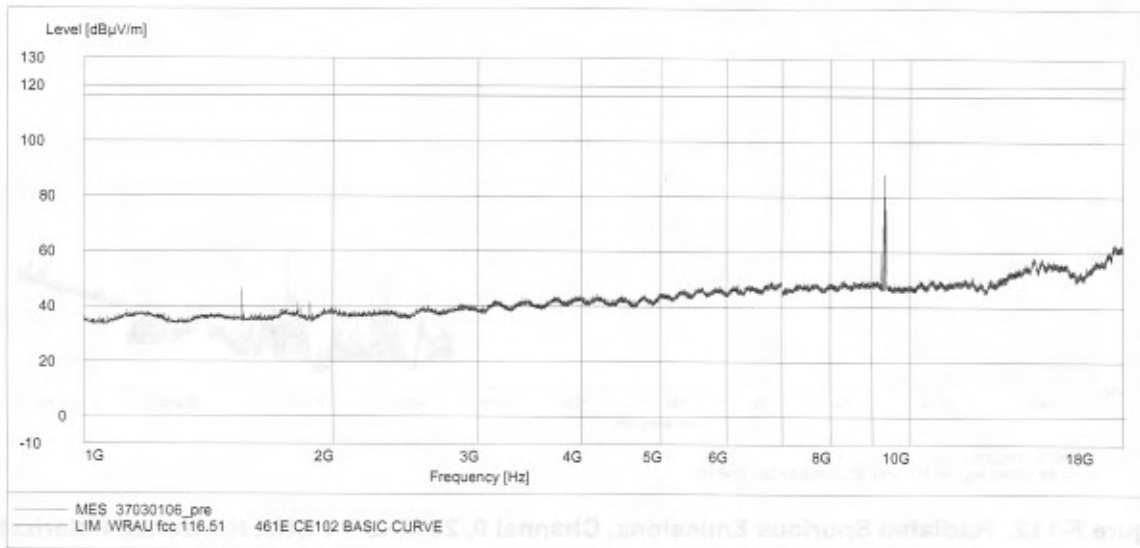


Figure F-114. Radiated Spurious Emissions, Channel 0, 1 GHz – 18 GHz, Horizontal Polarization

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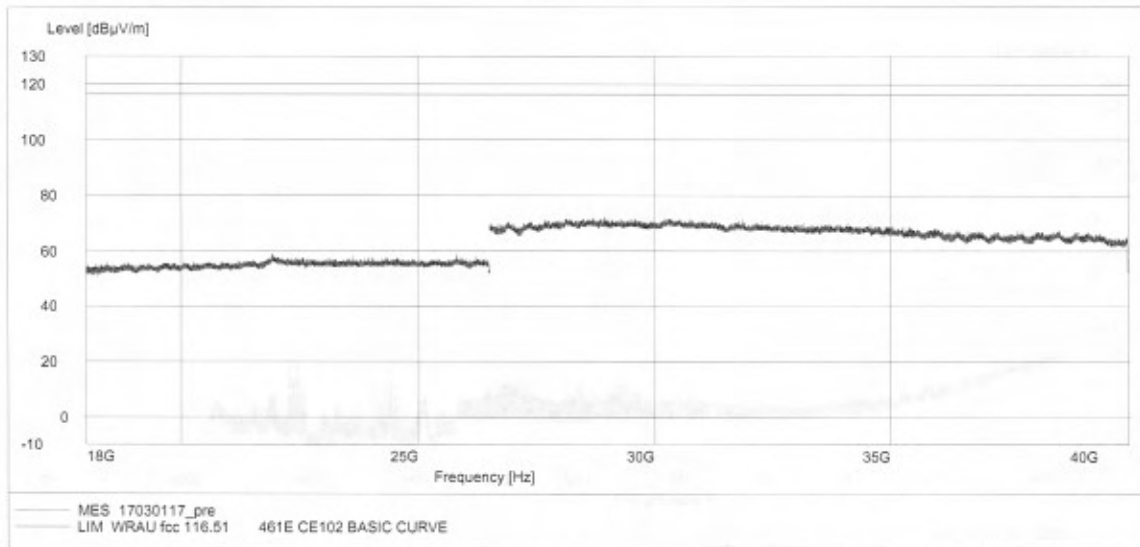


Figure F-115. Radiated Spurious Emissions, Channel 0, 18 GHz – 40 GHz, Vertical Polarization

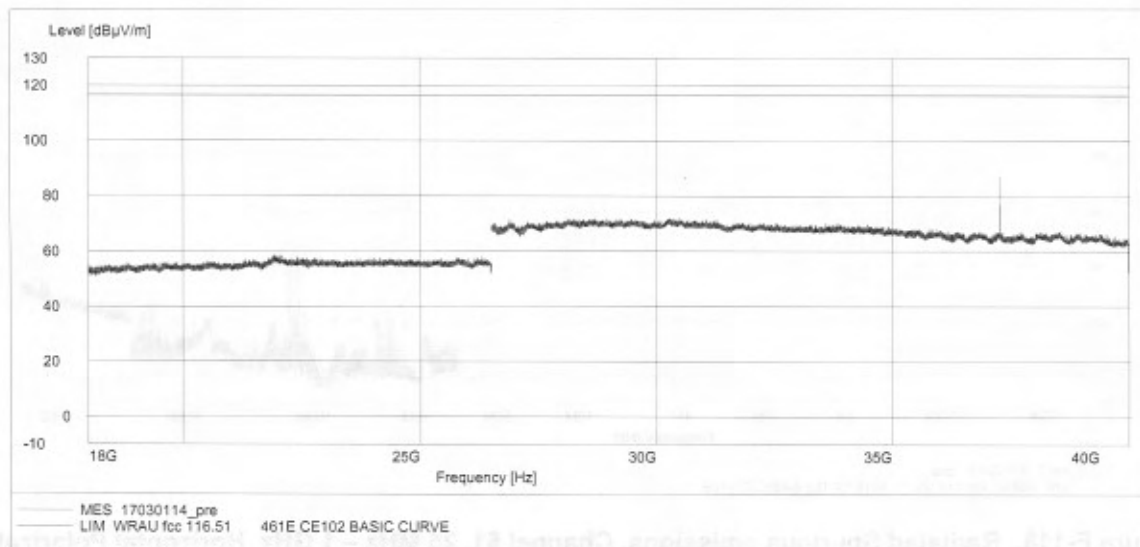


Figure F-116. Radiated Spurious Emissions, Channel 0, 18 GHz – 40 GHz, Horizontal Polarization

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## Spectrum Plots (Channel 61):

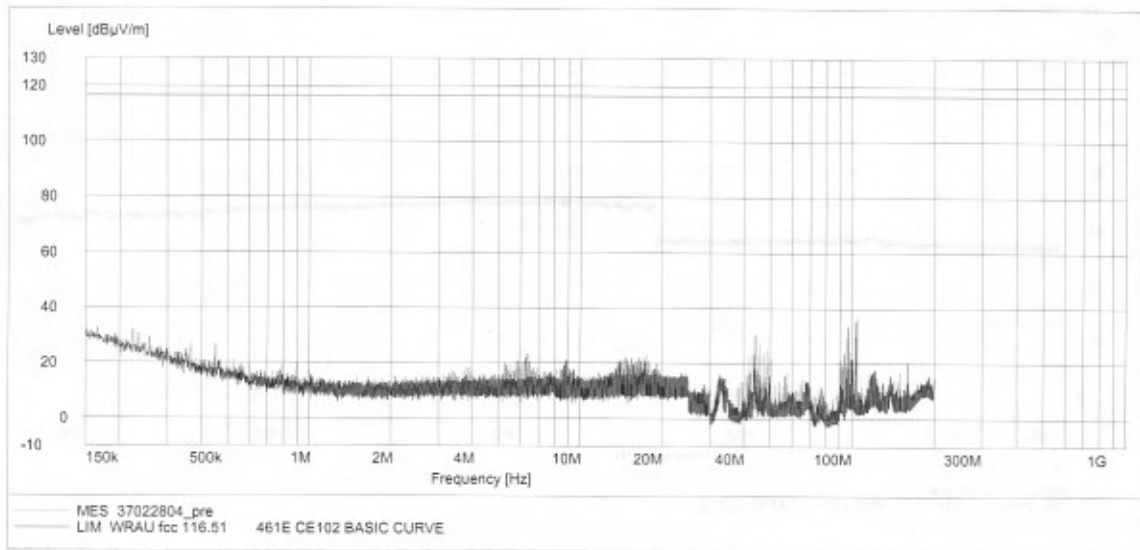


Figure F-117. Radiated Spurious emissions, Channel 61, 150 kHz – 200 MHz, Vertical Polarization

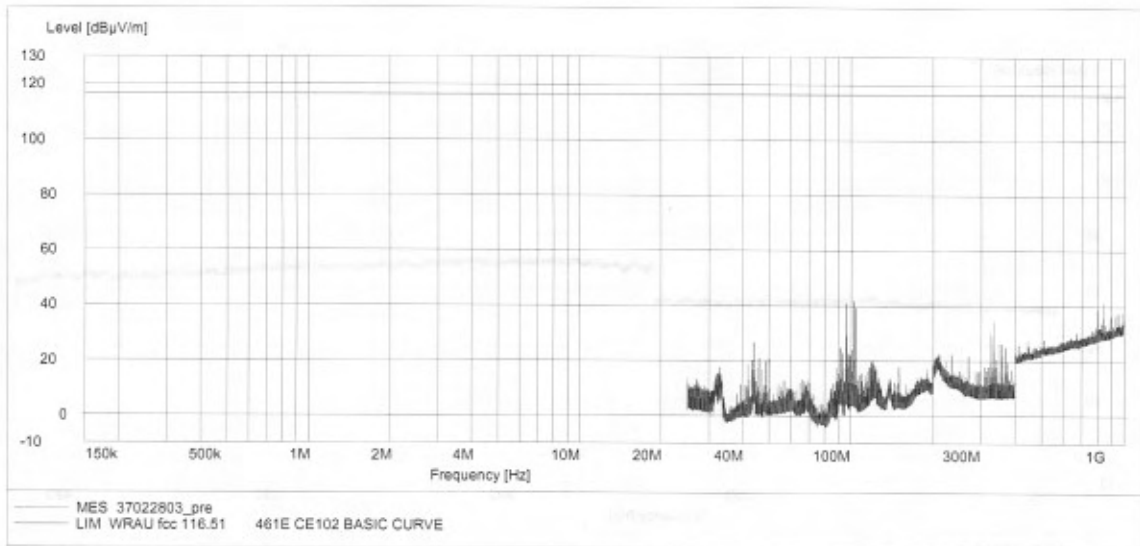


Figure F-118. Radiated Spurious emissions, Channel 61, 25 MHz – 1 GHz, Horizontal Polarization

# WRAU-2120

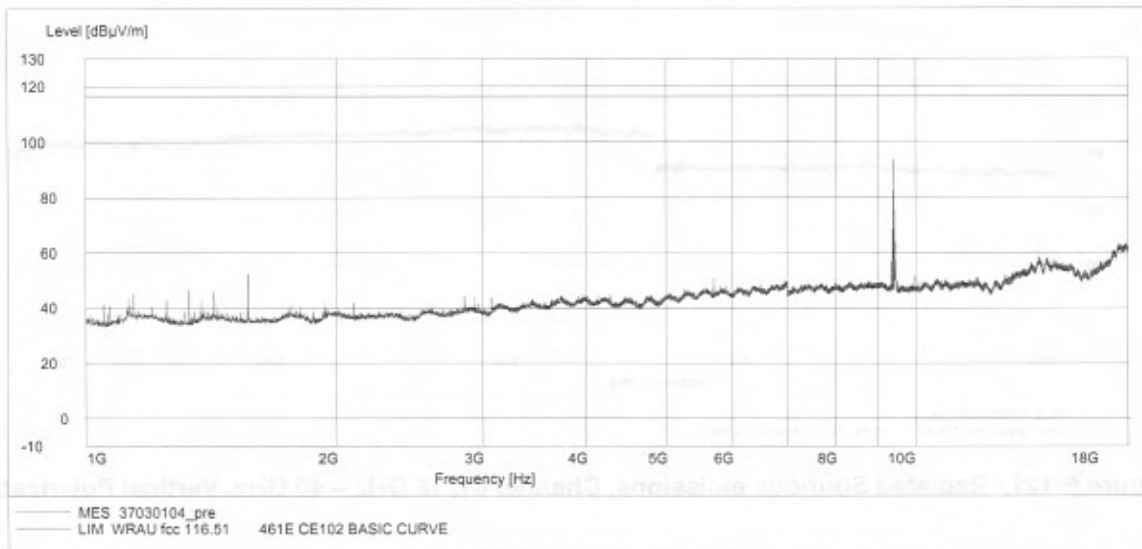


Figure F-119. Radiated Spurious emissions, Channel 61, 1 GHz – 18 GHz, Vertical Polarization

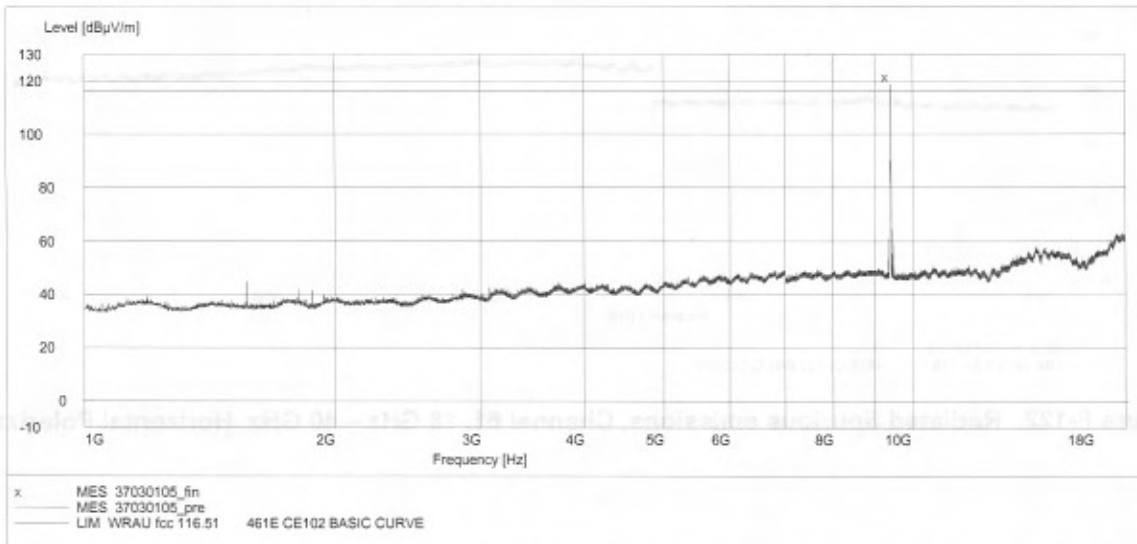


Figure F-120. Radiated Spurious emissions, Channel 61, 1 GHz – 18 GHz, Horizontal Polarization

# WRAU-2120

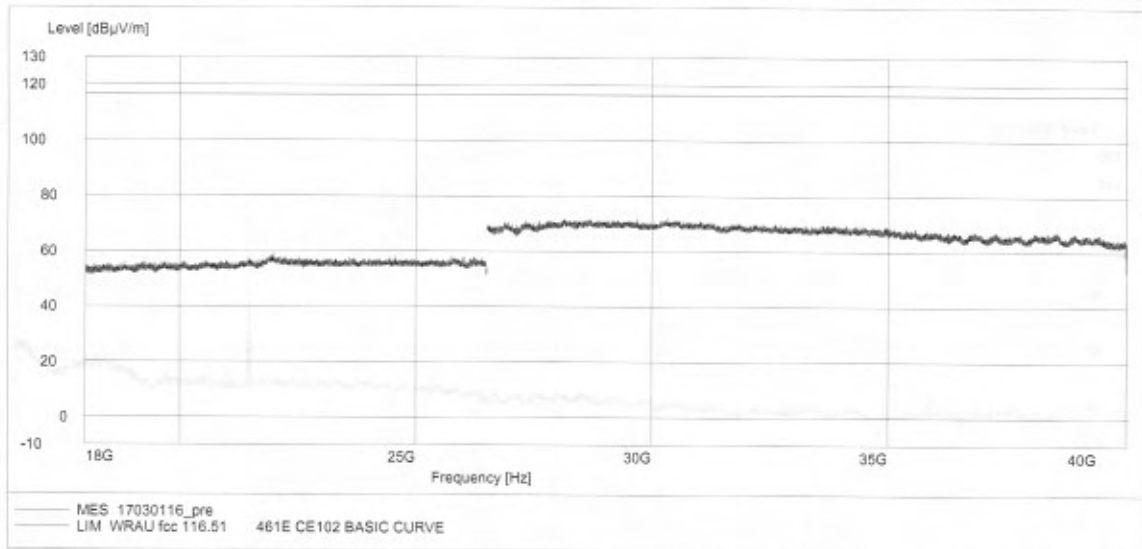


Figure F-121. Radiated Spurious emissions, Channel 61, 18 GHz – 40 GHz, Vertical Polarization

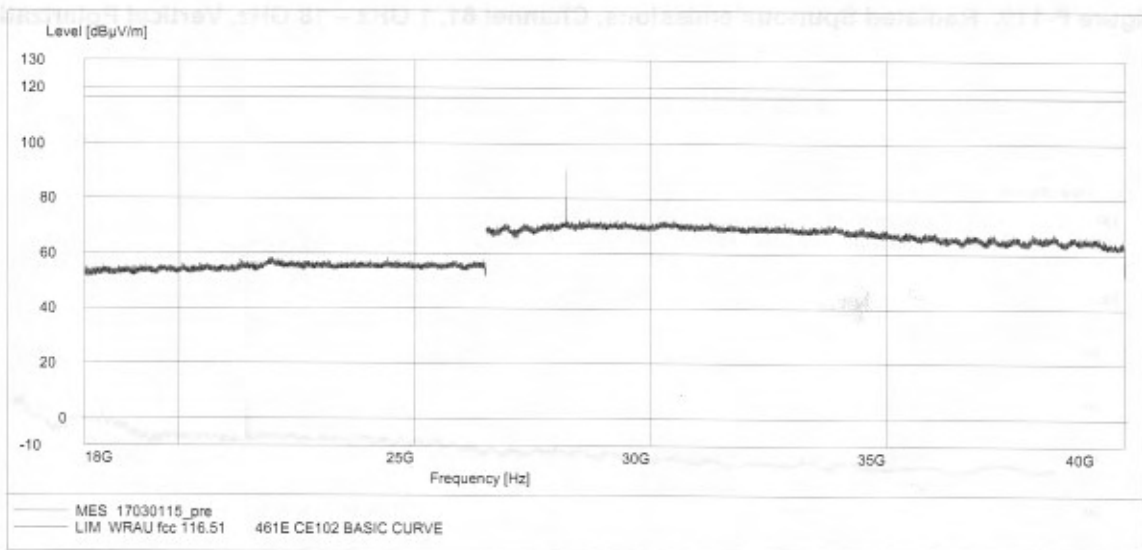


Figure F-122. Radiated Spurious emissions, Channel 61, 18 GHz – 40 GHz, Horizontal Polarization