

# WRAU-2120

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## F.6 WRAU-2120 Occupied Bandwidth (2.1049)

### Requirement:

Section 2.1049 "The occupied bandwidth, that is the frequency bandwidth such that, below its lower and above its upper frequency limits, the mean powers radiated are each equal to 0.5 percent of the total mean power radiated by a given emission shall be measured under the following conditions as applicable."

Section 2.1049(i) "Transmitters designed for other types of modulation – when modulated by an appropriate signal of sufficient amplitude to be representative of the type of service in which used. A description of the input signal should be supplied."

### Section 87.135

(a) Occupied bandwidth is the width of a frequency band such that, below the lower and above the upper frequency limits, the mean powers emitted are each equal to 0.5 percent of the total mean power of a given emission.

(b) The authorized bandwidth is the maximum occupied bandwidth authorized to be used by a station.

(c) The necessary bandwidth for a given class of emission is the width of the frequency band which is just sufficient to ensure the transmission of information at the rate and with the quality required under specified conditions.

Section 87.137 Authorized Bandwidth for Emission Type P0N – Note 9 "To be specified on license."

### Test Procedure:

The Occupied Bandwidth of the WRAU-2120 was measured using test equipment connected to the WRAU-2120 antenna terminal. The equipment used for the Occupied Bandwidth Test is shown in Table F-9.

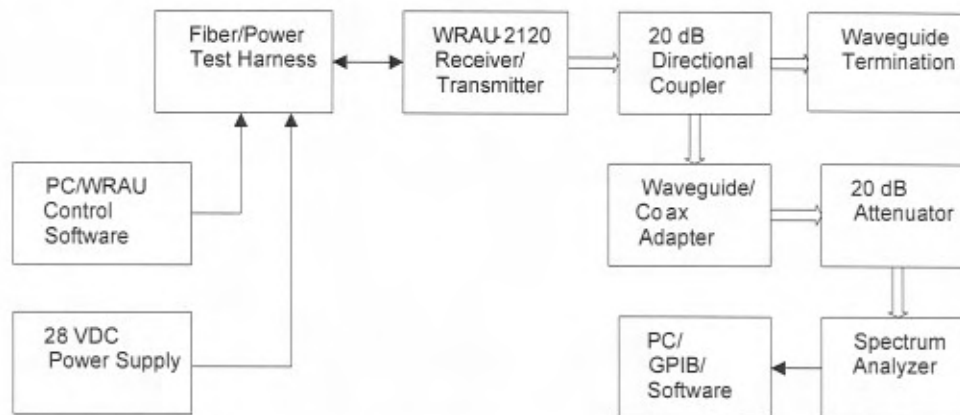
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**Table F-9. Equipment Used for Occupied Bandwidth Tests**

Equipment	Manufacturer/Model Number	Specific Identification
Receiver/Transmitter Module	Rockwell Collins RTM-2100 (822-2127-001)	S/N 2GJ4L
Antenna Pedestal	Rockwell Collins DRV-2120 (822-2131-001)	S/N 04
Test Harness	Rockwell Collins Fiber/Power Test Harness	827-3389-121
Variable DC Power Source	Sorensen DCR40-13B DC Power Supply	SN 00001257 460-0059-555
Directional Coupler (20dB)	HP X752D	SN 622 460-0132-809 Component of 460-0132-809
Waveguide Termination	CMT LPT90-1B	SN 970005-001 460-0133-413 Component of 460-0132-809
Waveguide to Coax Adapter	HP X281C	SN 3032A-06660 460-0210-312 Component of 460-0132-809
Attenuator (20 dB)	Weinschel WA1-20	460-0203-439 Component of 460-0132-809
Spectrum Analyzer	Agilent 8564EC	SN 4123A00551 460-0132-916
Personal Computer	IBM Compatible with National Instruments GPIB Interface and Agilent E4444A Benchlink Software	Gateway 2000 P5-120 SN 4250149
Personal Computer.	IBM Compatible with WRAU Controller Software	Dell OptiPlex GX260 CRP09003

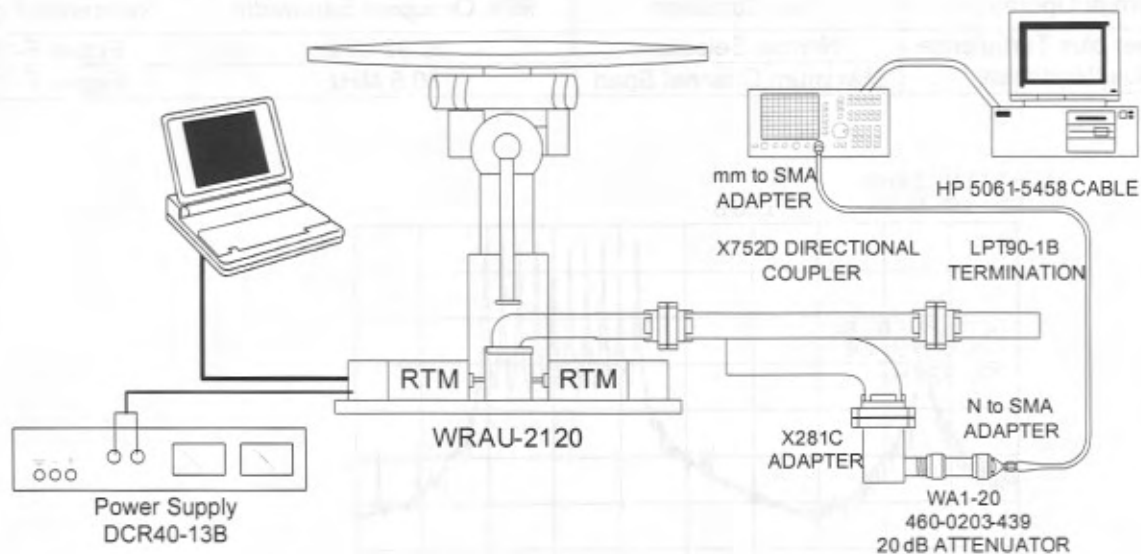
## Test Setup:

A functional block diagram of the equipment setup for the Occupied Bandwidth Test is shown in Figure F-8. The actual test equipment setup is shown in Figure F-9.



**Figure F-8. Occupied Bandwidth Test Setup**

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**Figure F-9. Equipment Setup for Occupied Bandwidth Tests**

## Measurement Objectives:

The WRAU-2120 radar system is designed to operate on 64 separate frequencies in the band from 9.320412798 GHz to 9.400412796 GHz. During normal operation, each selected mode utilizes multiple transmitter frequencies. Utilization of multiple frequencies enables the radar system to obtain significantly greater accuracy in estimation of echo signal strength from both ground targets and weather targets. Each selected mode utilizes a different subset of the available 64 channels and varying pulse widths. The choice of frequencies utilized for each mode can vary depending on such parameters as radio altitude on approach or takeoff. Although each mode may only use a subset of the available 64 channels, it is desired to have FCC certification for use of all 64 channels within the specified range. A complete description of the frequency selection, pulse repetition frequencies, and pulse width selection is provided in Section F.2 WRAU-2120 Modulation Characteristics.

To provide test data representing the extremes of possible operation, the occupied bandwidth measurements are grouped into two sets. The first set represents currently available normal operating modes with the unit operating on the subset of frequencies chosen for that mode. This normal channeling case is shown in Figure F-10. The second measurement was made with the unit operating in Maximum Channel Frequency mode. This special configuration utilizes channels at the extremes of the channel frequencies described in Section F.3 Special FCC Test Conditions. The Occupied Bandwidth plot for this Maximum Channel Frequency configuration is shown in Figure F-11. In both cases, the unit is operating in Weather + Turbulence + Windshear mode which represents the extremes of transmitter PRF and pulse widths.

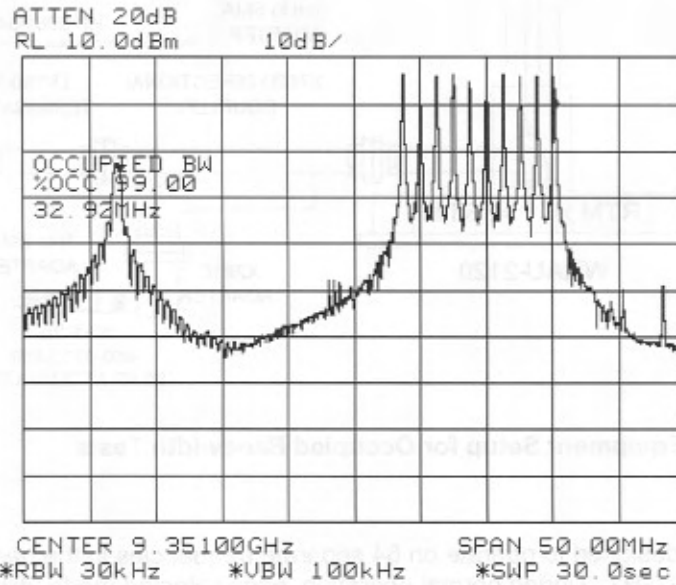
## Measurements:

The Agilent 8564EC spectrum analyzer was set up to automatically measure 99% occupied bandwidth. The measurements were made under each specified condition with the desired occupied bandwidth set to 99%. Table F-10 contains the test result for the Weather plus Turbulence plus Windshear operating mode.

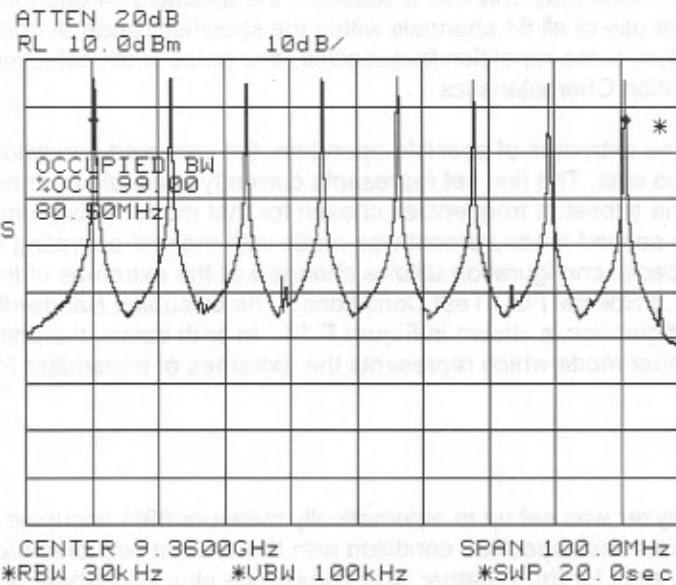
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**Table F-10. WRAU-2120 Occupied Bandwidth Measurement Results**

Normal Operation	Test Condition	99% Occupied Bandwidth	Reference Figure
Weather plus Turbulence plus Windshear	Normal Selection	32.92 MHz	Figure F-10
	Maximum Channel Span	80.5 MHz	Figure F-11



**Figure F-10. Occupied Bandwidth – Normal Channel Selections**



**Figure F-11. Occupied Bandwidth – Maximum Channel Span**

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## Additional Occupied Bandwidth Plots:

Fourteen additional scans were completed for reference purposes to show the Occupied Bandwidth for individual fixed channels 0, 10, 27-36, 50 and 63.

Table F-11 below summarizes the additional Occupied Bandwidth plots for each channel.

**Table F-11. WRAU-2120 Occupied Bandwidth Measurement Results – Fixed Channels**

Bench Test	99% Occupied Bandwidth	Reference Figure
Channel 0 9320.412798000 MHz	1.183 MHz	Figure F-12
	816.7 kHz	Figure F-13
Channel 10 9333.111210381 MHz	1.017 MHz	Figure F-14
	816.7 kHz	Figure F-15
Channel 27 9354.698511429 MHz	1.067 MHz	Figure F-16
	826.7 kHz	Figure F-17
Channel 28 9355.968352667 MHz	1.117 MHz	Figure F-18
	823.3 kHz	Figure F-19
Channel 29 9357.238193905 MHz	766.7 kHz	Figure F-20
	813.3 kHz	Figure F-21
Channel 30 9358.508035143 MHz	783.3 kHz	Figure F-22
	1.037 MHz	Figure F-23
Channel 31 9359.777876381 MHz	1.083 MHz	Figure F-24
	813.3 kHz	Figure F-25
Channel 32 9361.047717619 MHz	883.3 kHz	Figure F-26
	806.7 kHz	Figure F-27
Channel 33 9361.047717619 MHz	1.117 MHz	Figure F-28
	823.3 kHz	Figure F-29
Channel 34 9361.047717619 MHz	1.033 MHz	Figure F-30
	810 kHz	Figure F-31
Channel 35 9361.047717619 MHz	1.100 MHz	Figure F-32
	813.3 kHz	Figure F-33
Channel 36 9361.047717619 MHz	1.050 MHz	Figure F-34
	820.0 kHz	Figure F-35
Channel 50 9361.047717619 MHz	1.083 MHz	Figure F-36
	826.7 kHz	Figure F-37
Channel 63 9361.047717619 MHz	1.050 MHz	Figure F-38
	813.3 kHz	Figure F-39

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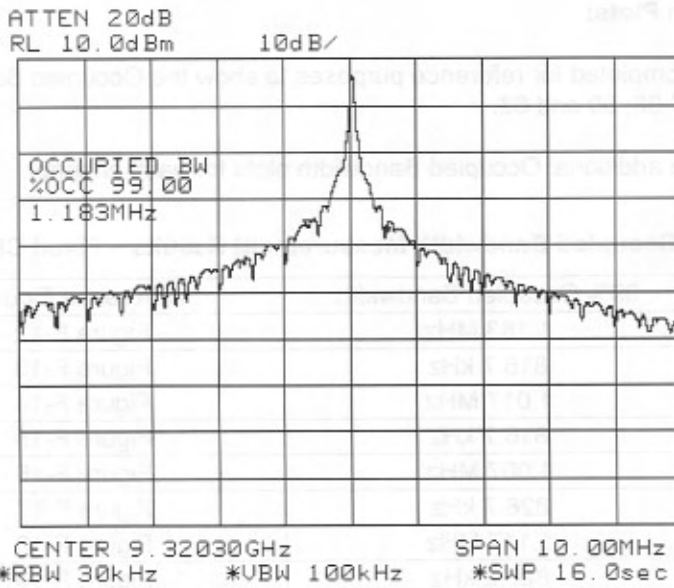


Figure F-12. Occupied bandwidth – Channel 0

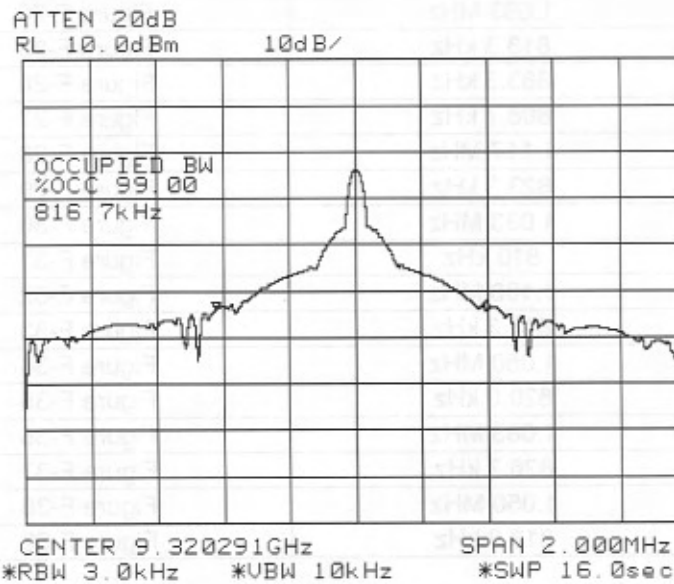


Figure F-13. Occupied bandwidth – Channel 0

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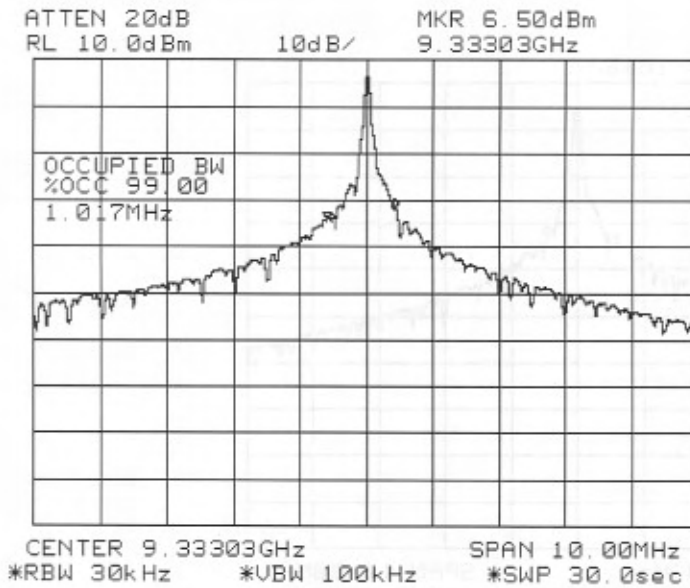


Figure F-14. Occupied Bandwidth – Channel 10

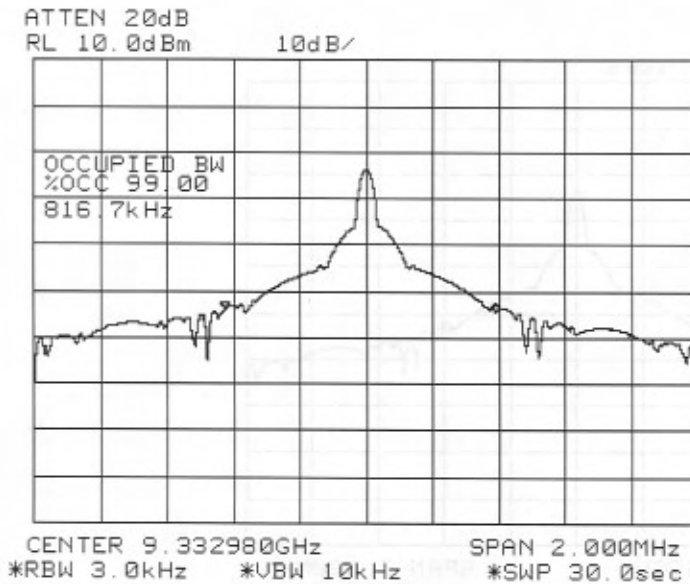


Figure F-15. Occupied bandwidth – Channel 10



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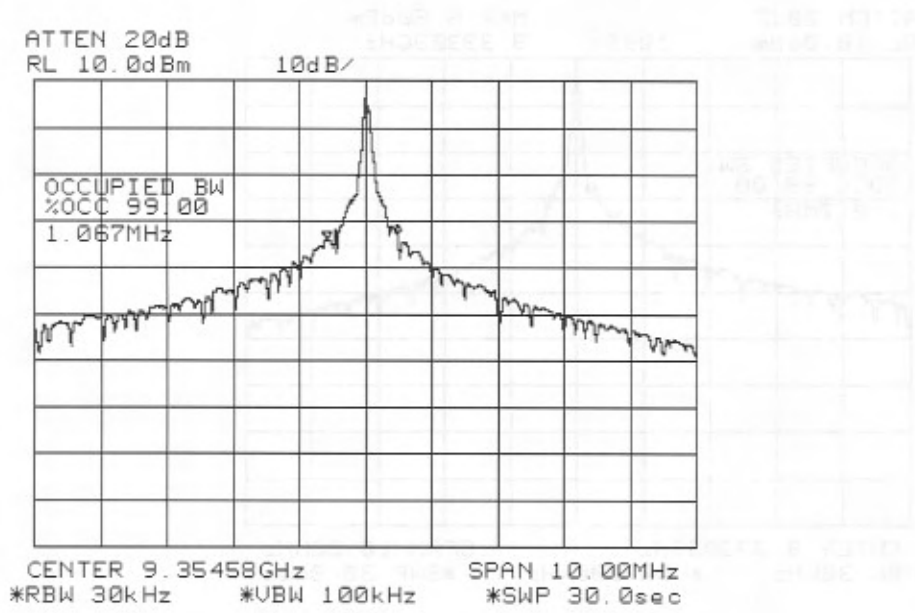


Figure F-16. Occupied Bandwidth – Channel 27

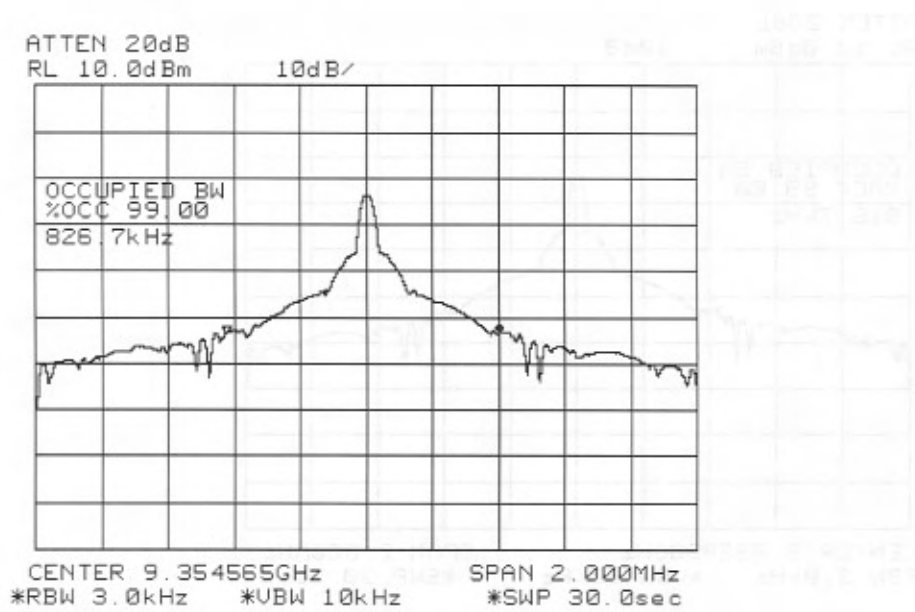


Figure F-17. Occupied Bandwidth – Channel 27



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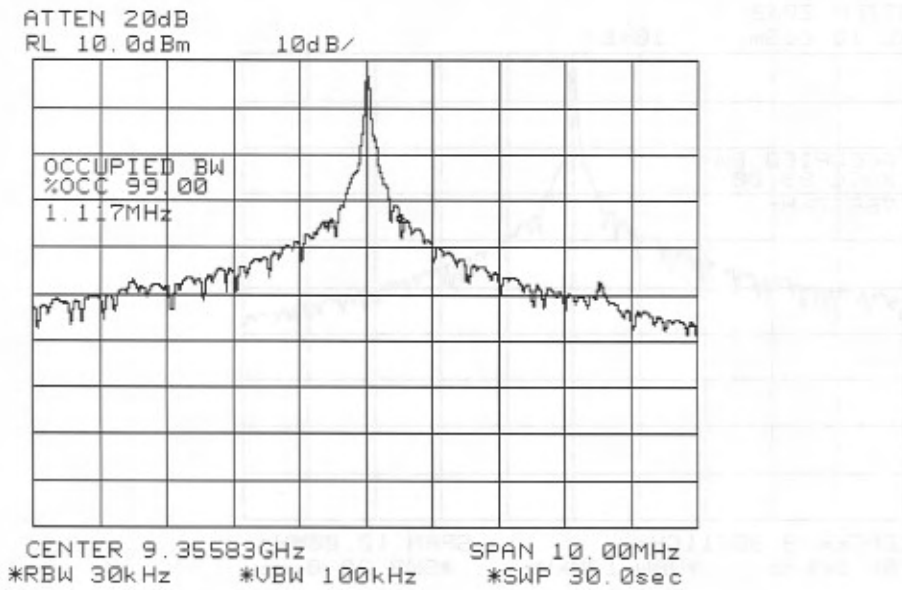


Figure F-18. Occupied Bandwidth – Channel 28

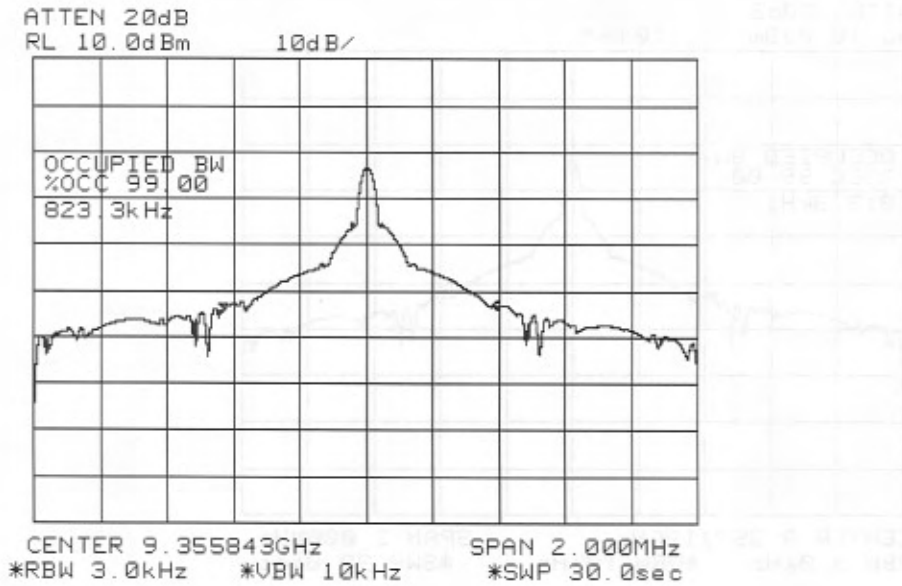


Figure F-19. Occupied Bandwidth – Channel 28

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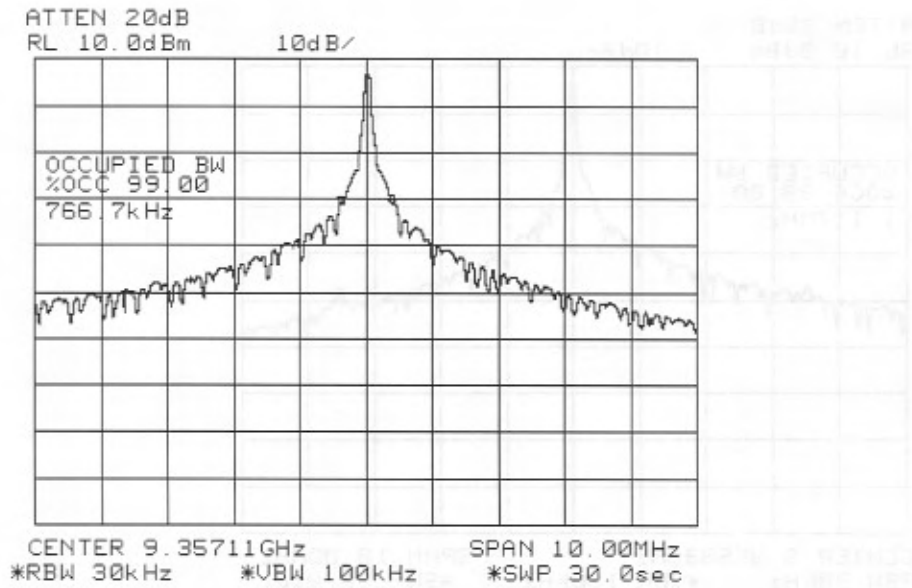


Figure F-20. Occupied Bandwidth – Channel 29

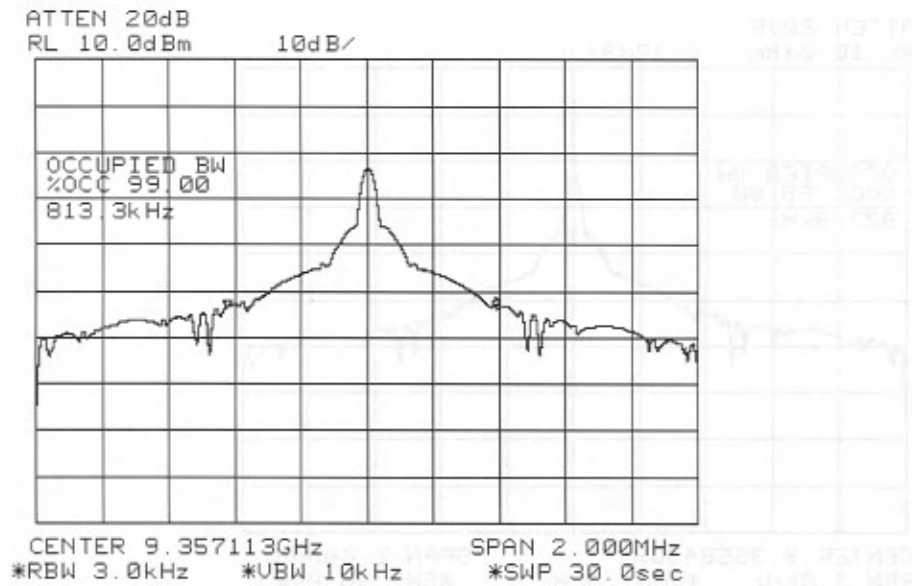


Figure F-21. Occupied Bandwidth – Channel 29

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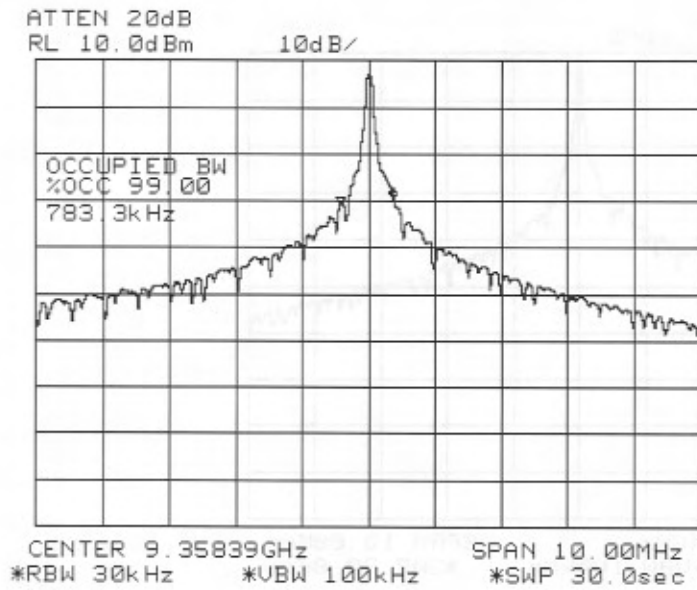


Figure F-22. Occupied Bandwidth – Channel 30

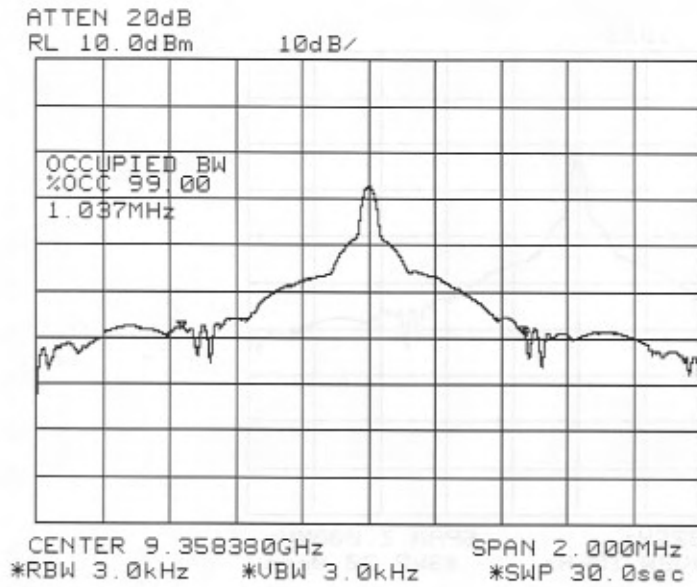


Figure F-23. Occupied Bandwidth – Channel 30

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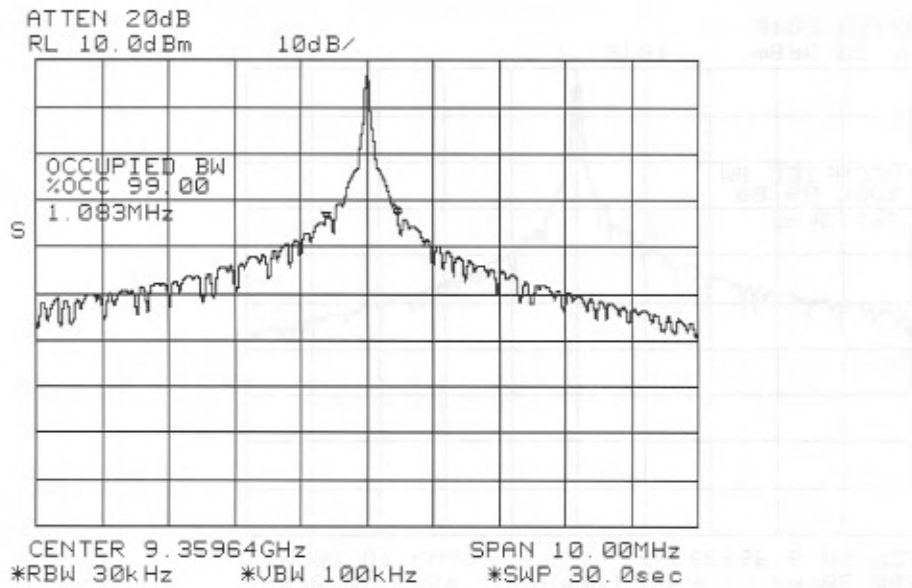


Figure F-24. Occupied Bandwidth – Channel 31

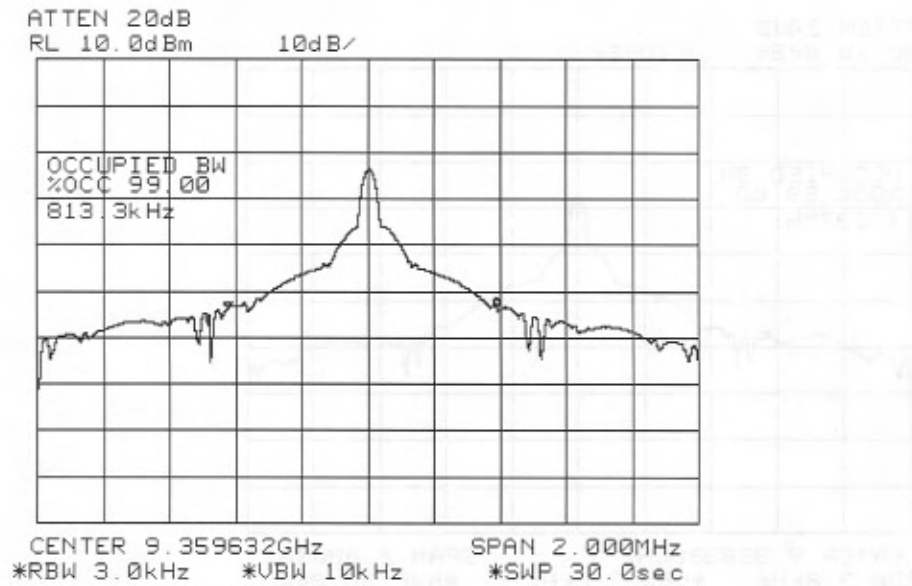


Figure F-25. Occupied Bandwidth – Channel 31

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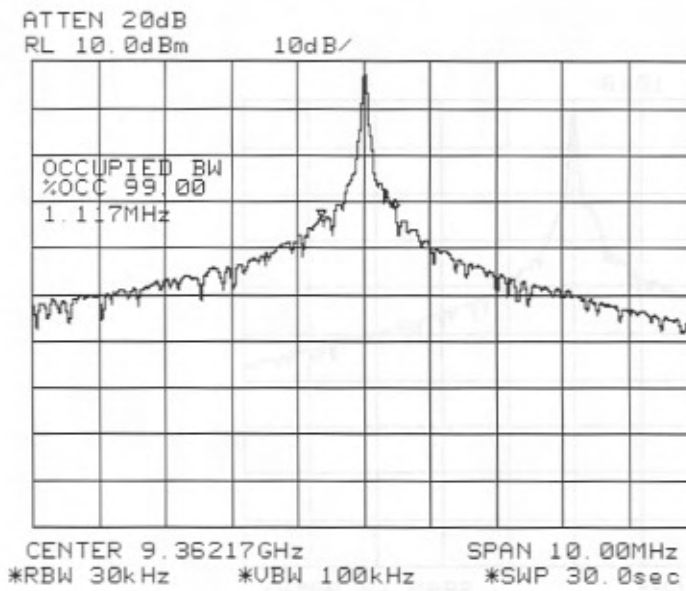


Figure F-28. Occupied Bandwidth – Channel 33

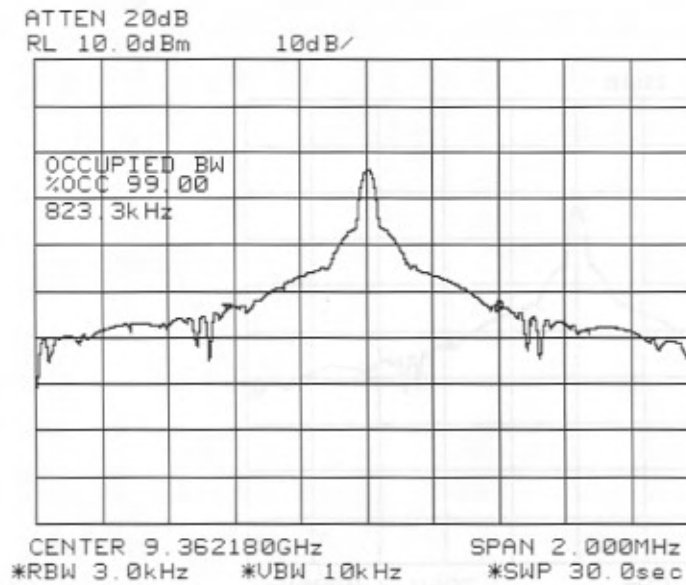


Figure F-29. Occupied Bandwidth – Channel 33

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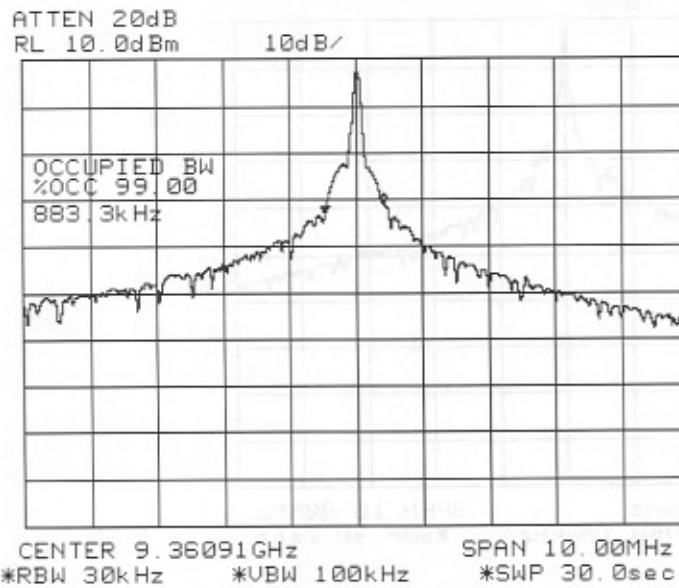


Figure F-26. Occupied Bandwidth – Channel 32

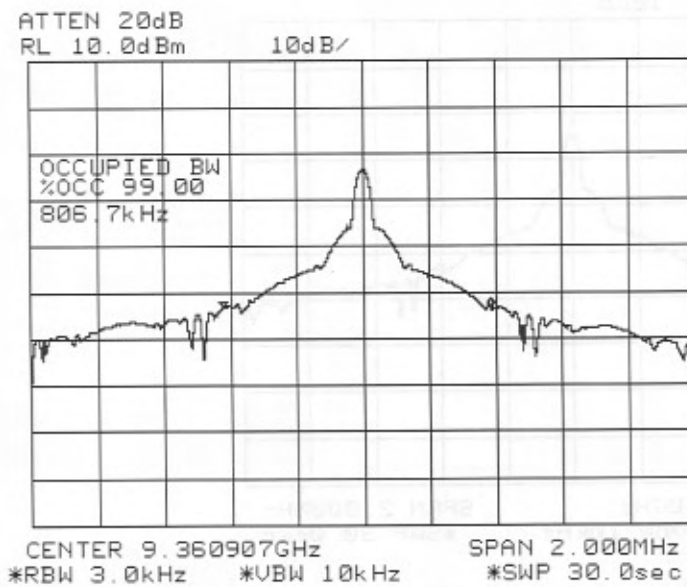


Figure F-27. Occupied Bandwidth – Channel 32

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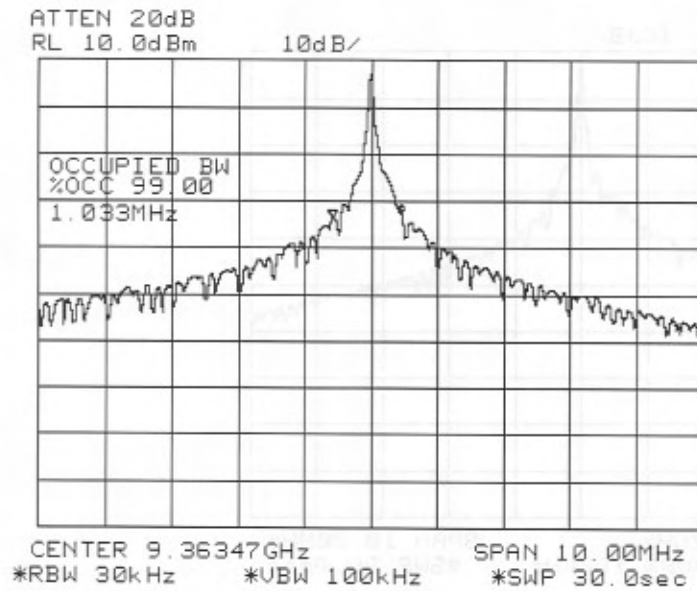


Figure F-30. Occupied Bandwidth – Channel 34

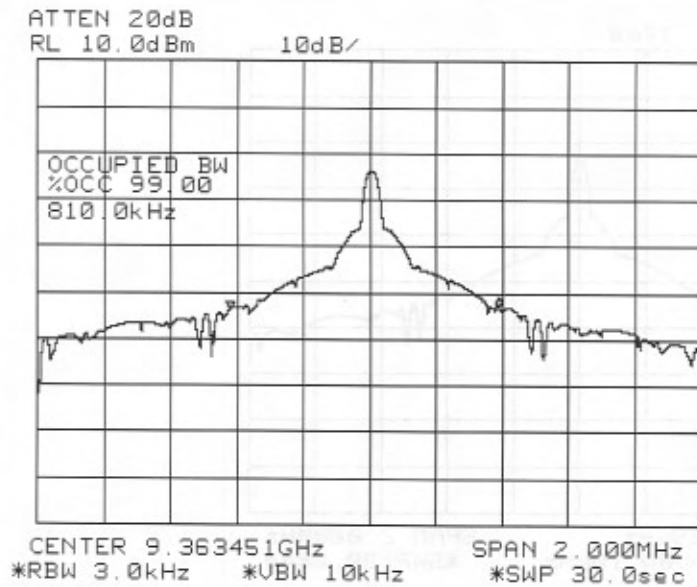


Figure F-31. Occupied Bandwidth – Channel 34



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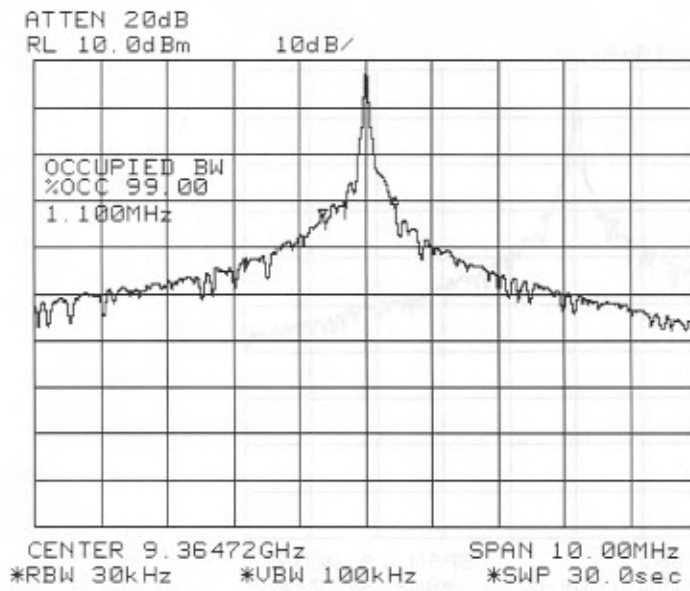


Figure F-32. Occupied Bandwidth – Channel 35

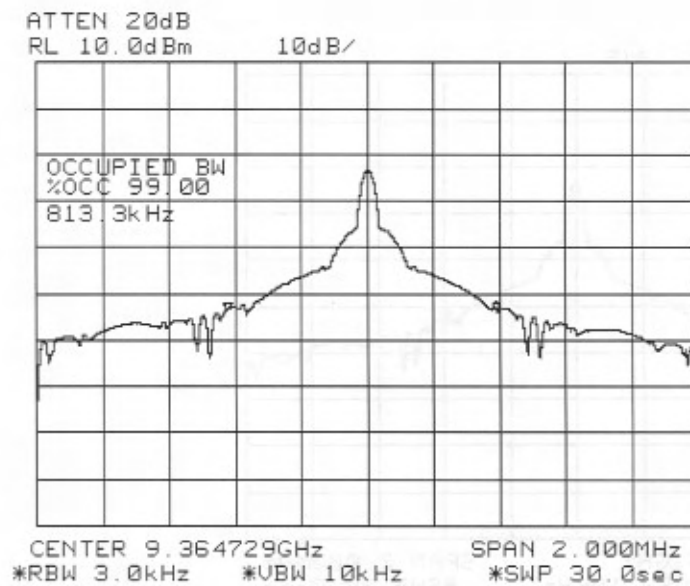


Figure F-33. Occupied Bandwidth – Channel 35

# WRAU-2120

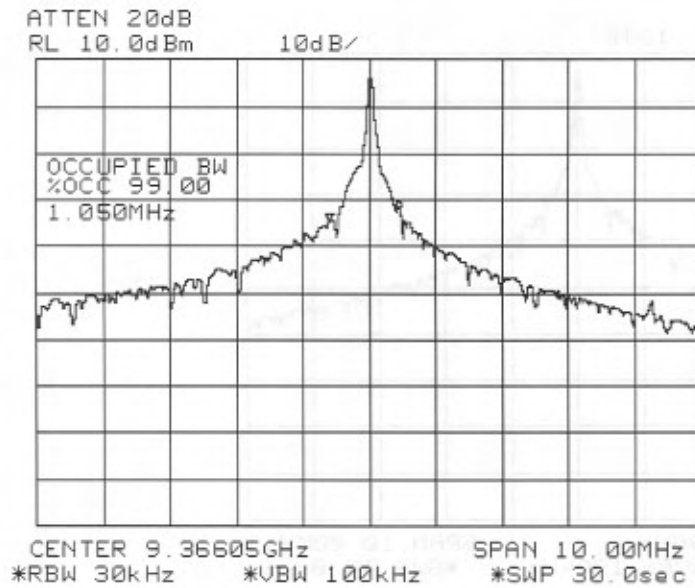


Figure F-34. Occupied Bandwidth – Channel 36

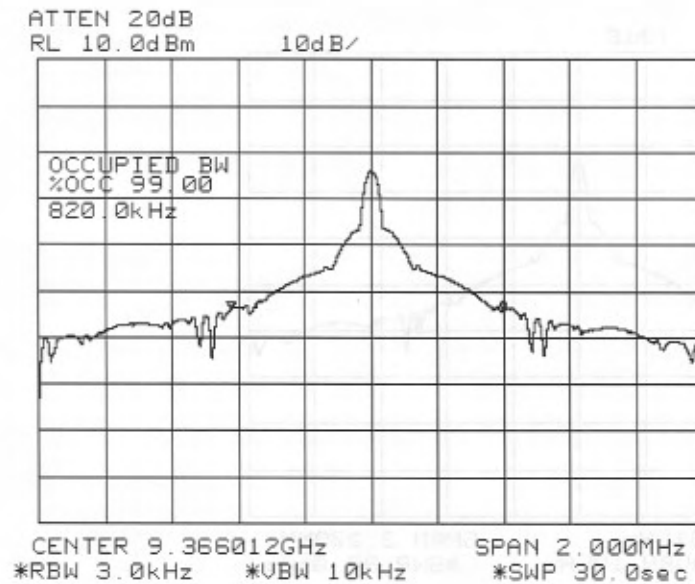


Figure F-35. Occupied Bandwidth – Channel 36

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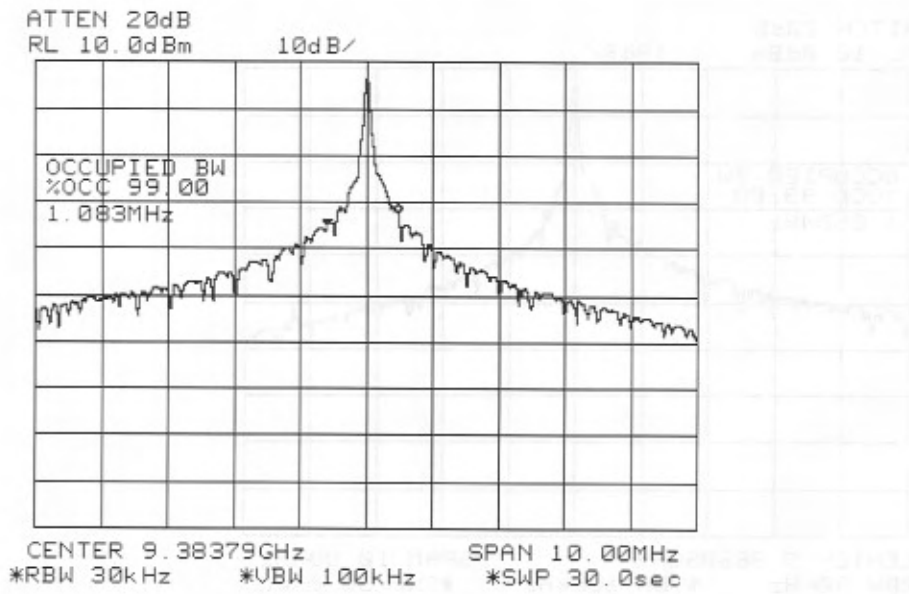


Figure F-36. Occupied Bandwidth – Channel 50

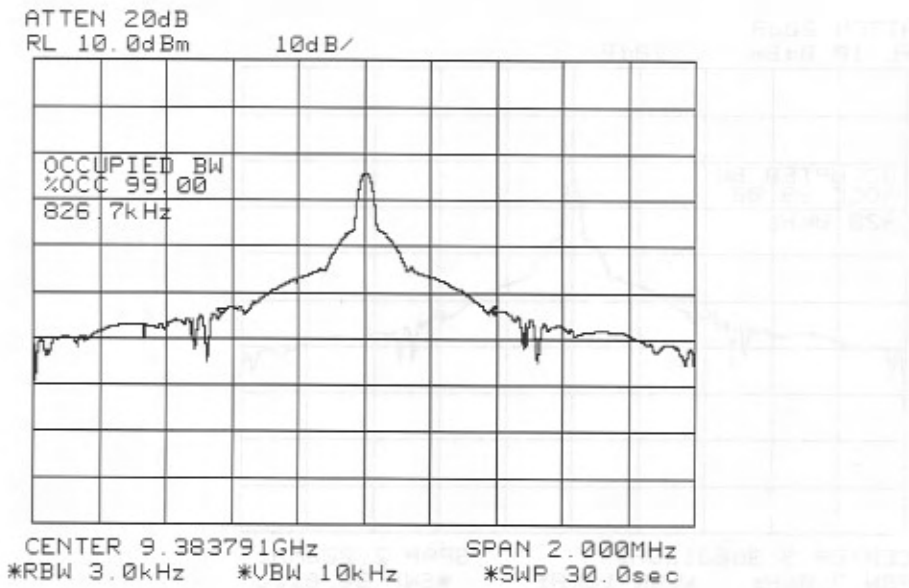


Figure F-37. Occupied Bandwidth – Channel 50

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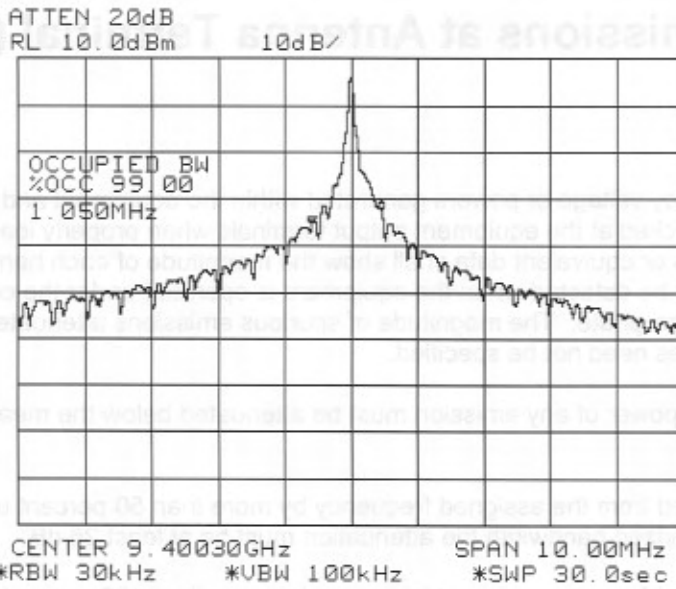


Figure F-38. Occupied Bandwidth – Channel 63

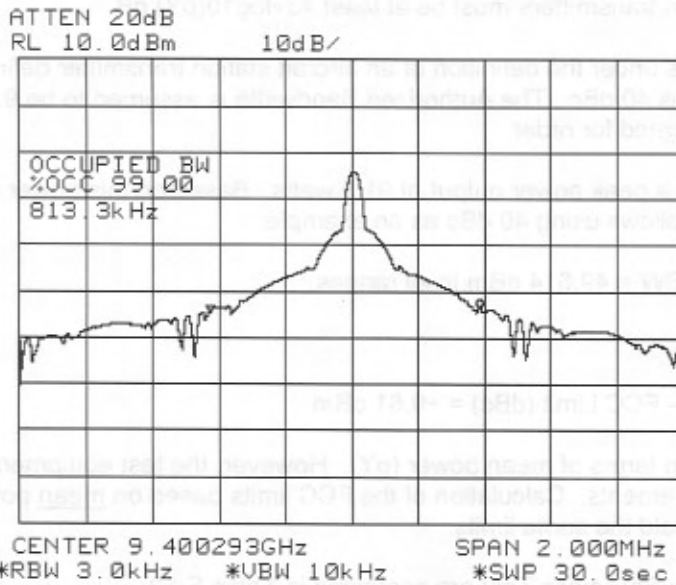


Figure F-39. Occupied Bandwidth – Channel 63

Frequency Band	Emission Level	Absolute FCC Limit (Peak)
From 900 MHz to 960 MHz	-35 dBc (dB relative to carrier)	-24 dBm
From 960 MHz to 1000 MHz	-35 dBc	-14 dBm
Over 1000 MHz	-40 dBc	-14 dBm

## F.7 Spurious Emissions at Antenna Terminal (2.1051)

### Requirements:

Section 2.1051 The radio frequency voltage or powers generated within the equipment and appearing on a spurious frequency shall be checked at the equipment output terminals when properly loaded with a suitable artificial antenna. Curves or equivalent data shall show the magnitude of each harmonic and other spurious emissions that can be detected when the equipment is operated under the conditions specified in Section 2.1049 as appropriate. The magnitude of spurious emissions attenuated more than 20 dB below the permissible values need not be specified.

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.

Since the WRAU-2120 clearly falls under the definition of an aircraft station transmitter defined in Section 87.139(a)(3), the worst case limit is 40 dBc. The Authorized Bandwidth is assumed to be 9.3 – 9.5 GHz which is the frequency range allocated for radar.

The WRAU-2120 Test Article had a peak power output of 91.5 watts. Based on this power level, the absolute limits are calculated as follows using 40 dBc as an example.

$P_{tx-peak} = 91.5 \text{ Watts or } 19.61 \text{ dBW} = 49.614 \text{ dBm in all ranges.}$

FCC Limit = 40 dBc

Absolute Limit =  $P_{tx-peak} \text{ (dBm)} - \text{FCC Limit (dBc)} = +9.61 \text{ dBm}$

Note: The FCC limit is specified in terms of mean power (pY). However, the test equipment utilized for these tests provides peak measurements. Calculation of the FCC limits based on mean power, then converting to peak readings will yield the same limits.

The requirements for the Spurious Emissions Test are contained in Table F-12.

**Table F-12. Spuious Emission Test Requirements (87.139(a)(3))**

Frequency Band	Emission Level	Absolute FCC Limit (Peak)
From 9500.412796 MHz to 9600.412796 MHz	-25 dBc (dB relative to carrier level)	+24.61 dBm
From 9600.412796 MHz to 9900.412796 MHz	-35 dBc	+14.61 dBm
Over 9900.412796 MHz	-40 dBc	+9.61 dBm