WRT-2100

Exhibit F – Test Report

EXHIBIT F – TEST REPORT

The data required by Sections 2.1046 through 2.1057 inclusive, measured in accordance with the procedures set out in Section 2.1041. (2.1033 (c) (14))

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F.1 Test Procedure and Compliance Matrix

This section documents the test procedures used, and records the results of tests to demonstrate compliance with the applicable requirements of parts 2 and 87 of the FCC Rules and Regulations.

The Table F-1 below identifies the applicable sections of this document and its relationship between the Parts 2 and 87 requirements. The test results are included within each individual test section.

Table F-1. Test Requirements Matrix

FCC Part 2 Section	FCC Part 87 Section	Test Description Summary	Section
2.1047	87.141	Modulation Characteristics	9.2
2.1046	87.131	RF Power Output	9.4
2.1055	87.133	Frequency Stability	9.5
2.1049	87.135	Occupied Bandwidth	9.6
2.1051	87.139	Spurious Emissions at Antenna Terminals	9.7
2.1053	87.139	Field Strength of Spurious Radiation	9.8

F1.1 Description of the WRT-2100 Used for Testing

The WRT-2100 used for testing is part number 822-1710-950. This is a Red Label Part Number, The unit was built by production personnel to meet all production requirements. When the unit goes into full production the part number will change to 822-1710-002 for Boeing units, and for Airbus units the part number will be 822-1710-203.

F.2 WXR-2100 Modulation Characteristics (2.1047)

Requirement:

Section 2.1047(d) states: "A curve or equivalent data which shows that the equipment will meet the modulation requirements of the rules under which the equipment is to be licensed."

The WRT-2100 utilizes un-modulated rectangular pulses.

The following paragraphs describe the transmitted output waveform and frequency utilization.

The WXR-2100 Weather Radar System utilizes two different sets of transmitter pulse patterns, pulse widths and operating frequencies depending on operating mode.

Weather/Turbulence/Map Operation

A single fixed pulse pattern is utilized for all Weather, Turbulence and Map modes of operation. This same pattern is utilized regardless of whether the system is in Manual operation or Automatic MultiScan operation.

The transmitter pulse pattern consists of a sequence of five pulses, a single 25 microsecond transmitter pulse for long-range weather detection and a series of 4, 6 microsecond pulses for measuring weather and turbulence out to 40 nm. Figure F-1 below shows this pattern. The time period for this group of 5 pulses is called an Epoch. A small variable delay is inserted between epochs to reduce mutual interference between radar systems by dithering the pulse timing.

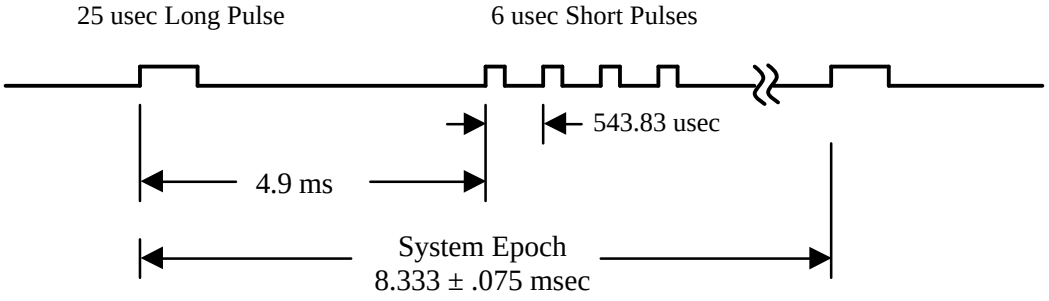


Figure F-1. Transmit Pulse Pattern - Weather/Turbulence

Windshear Operation

Windshear mode is activated during the landing and takeoff phases of flight. In Windshear Mode, the transmitter operates at a 3000 Hz pulse repetition rate with a 2 microsecond pulse width. The pulse pattern for windshear mode is shown in Figure F-2. A small variable delay is inserted between epochs to reduce mutual interference between radar systems by dithering the pulse timing. When Windshear Mode is active, the Windshear sweeps of the antenna are alternated with the normal Weather/Turbulence/Map Sweeps. The left to right sweep is Weather/Turbulence/Map mode with the transmit pulse pattern in Figure F-1. The right to left sweep is Windshear mode with the transmit pulse pattern in Figure F-2. Each sweep direction requires approximately 3 seconds for completion.

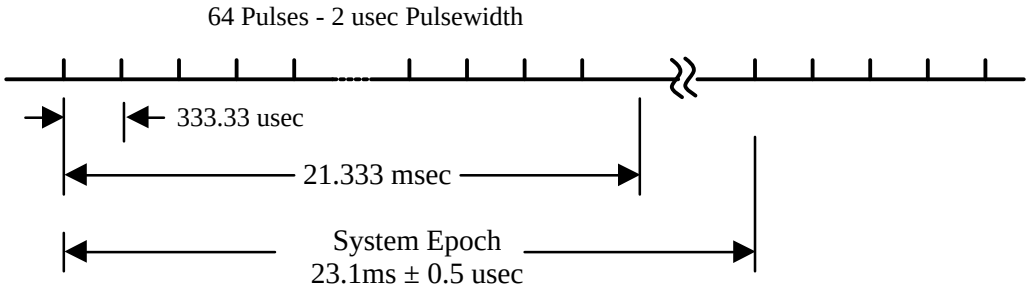


Figure F-2. Transmit Pulse Pattern - Windshear Mode

Frequency Selection:

The WRT-2100X is capable of tuning to 64 different frequencies which are listed in Table F-2 below. Use of multiple frequencies significantly improves the accuracy of weather and ground target amplitude estimations. Each operating mode uses a subset of the available frequencies.

Table F-2. WRT-2100 Channel Frequencies

DDS CH	X Band TX	DDS CH	X Band TX
0	9327424486	32	9333424486
1	9327611986	33	9333611986
2	9327799486	34	9333799486
3	9327986986	35	9333986986
4	9328174486	36	9334174486
5	9328361986	37	9334361986
6	9328549486	38	9334549486
7	9328736986	39	9334736986
8	9328924486	40	9334924486
9	9329111986	41	9335111986
10	9329299486	42	9335299486
11	9329486986	43	9335486986
12	9329674486	44	9335674486
13	9329861986	45	9335861986
14	9330049486	46	9336049486
15	9330236986	47	9336236983
16	9330424486	48	9336424486
17	9330611986	49	9336611986
18	9330799486	50	9336799486
19	9330986986	51	9336986986
20	9331174486	52	9337174486
21	9331361986	53	9337361986
22	9331549486	54	9337549486
23	9331736986	55	9337736983
24	9331924486	56	9337924486
25	9332111986	57	9338111986
26	9332290255	58	9338299486
27	9332486986	59	9338486986
28	9332674486	60	9338674486
29	9332861986	61	9338861986
30	9333049486	62	9348662720
31	9333236986	63	9348568734

Weather Operation

Seven frequencies from Table F-2 are allocated for Weather, Turbulence and Mapping. These are:

F1 – 9328.174486 MHz (Channel 4)
F2 – 9328.736986 MHz (Channel 7)
F3 – 9329.299486 MHz (Channel 10)
F4 – 9329.861986 MHz (Channel 13)
F5 – 9330.424486 MHz (Channel 16)
F6 – 9330.986986 MHz (Channel 19)
F7 – 9331.549486 MHz (Channel 22)

The radar randomly selects one of the seven frequencies for each Epoch and transmits a set of one 25 μsec pulse followed by four 6 μsec pulses on the same frequency. The next Epoch transmitted pulse set (one 25 μsec pulse and four 6 μsec pulses) occurs on one of the six remaining frequencies. This pattern is repeated until all four frequencies are used. The software ensures that the same frequency is not repeated between adjacent pulse sets.

Windshear Operation

One frequency from Table F-3 is allocated to Windshear operation. This frequency is fixed for all pulse sets. Each Windshear Epoch transmits 64 2 microsecond pulses on the same frequency. The next epoch is transmitted on the same frequency. The Windshear frequency is:

F8 – 9332.290255 MHz (Channel 26)

During normal Weather/Turbulence/Map operation without windshear mode activated, both the left to right and right to left sweeps of the antenna utilize the four weather frequencies and pulse patterns from Figure F-1 above. In this condition, each antenna sweep is 180 degrees wide and requires 4 seconds each direction.

When Windshear mode is activated along with Weather/Turbulence/Map mode, the right to left sweep of the antenna employs the windshear pulse pattern in Figure F-2 and the windshear frequency. The left to right sweep of the antenna is per the weather pulse pattern and frequencies described above. In Windshear mode, the total width of the antenna scan is reduced to 120 degrees which requires 3 seconds each direction.

Internal Test Operation

At the end of each antenna sweep two test functions are performed.

1. The PIC controller for the Source Module DDS control is re-initialized which results in a transmitted output pulse on Channel 4 (9328.174486 MHz). This is the lowest of the seven weather channels.
2. The Sampler performs a series of RF tests including a transmit test. This results in transmitter output pulses on Channel 26 (9332.290255 MHz) which is the Windshear frequency.

F.3 Special FCC Test Conditions

To demonstrate compliance of the WRT-2100 over the full range of frequencies listed in Table F-3, it is necessary to configure the R/T unit in a special test condition. Two types of special configurations were used.

1. Fixed Frequency Operation

The WRT-2100 can be locked onto a single fixed frequency by commands through the front panel RS-232 input. The radar operates identically in all respects to normal operation including transmitter pulse patterns with the exception that the transmit frequency is locked to a single channel. Nine conditions were defined; eight fixed frequency channels and one normal operating condition with the normal channel selections. The eight fixed frequencies were selected to represent the lowest and highest channel extremes plus six channels spread through the range. These special test conditions were used during subsequent testing described in this exhibit.

2. Maximum Channel Frequency

To measure Occupied Bandwidth over the maximum channel extremes, the WRT-2100 was locked to each of the eight fixed channels (lowest, highest, and six intermediate) while the spectrum analyzer captured an entire plot of each channel in the peak hold mode of operation. The peak hold mode of operation allowed a composite spectrum analyzer plot to be generated representing the maximum possible occupied bandwidth. The frequencies and assignments utilized for the Maximum Channel Frequency test configuration are listed below.

F1 – 9327.424486 MHz (Channel 0) Weather/Turb/Windshear
F2 – 9329.111986MHz (Channel 9) Weather/Turb/Windshear
F3 – 9330.611986 MHz (Channel 17) Weather/Turb/Windshear
F4 – 9332.290255 MHz (Channel 26) Weather/Turb/Windshear
F5 – 9333.986986 MHz (Channel 35) Weather/Turb/Windshear
F6 – 9335.674486 MHz (Channel 44) Weather/Turb/Windshear
F7 – 9337.174486 MHz (Channel 52) Weather/Turb/Windshear
F8 – 9338.861986 MHz (Channel 61) Weather/Turb/Windshear

Table F-3 lists the Special FCC Test Conditions described above and lists which FCC test paragraphs utilized these conditions.

Table F-3. Special FCC Test Conditions - Test Matrix

Test Condition	Frequency	Comments	2.1046 RF Pwr Out	2.1049 Occ BW	2.1051 Spur Emiss	2.1053 Spur Radiat	2.1055 Freq Stab
Normal	Switching	Normal Operation		X	X	X	
Fixed Channel 0	9327.424486	Lowest Extreme	X	X	X	X	X
Fixed Channel 9	9329.111986	Lower	X	X	X		X
Fixed Channel 17	9330.611986	Low	X	X	X		X
Fixed Channel 26	9332.290255	Low-Mid	X	X	X		X
Fixed Channel 35	9333.986986	Upper-Mid	X	X	X		X
Fixed Channel 44	9335.674486	High	X	X	X		X
Fixed Channel 52	9337.174486	Higher	X	X	X		X
Fixed Channel 61	9338.861986	Highest Extreme	X	X	X	X	X
Maximum Channel	Composite	Widest Freq Range		X			

F.4 WXR-2100 RF Power Output (2.1046)

Requirement:

Section 2.1046(a) "For transmitters other than single sideband, independent sideband and controlled carrier radiotelephone, power output shall be measured at the RF output terminals when the transmitter is adjusted in accordance with the tune-up procedure to give the value of current and voltage on circuit elements specified in 2.1033 (c)(8). The electrical characteristics of the radio frequency load attached to the output terminals when this test is made shall be stated."

Section 2.1033(c)(8) "The dc voltages applied to and dc currents into the several elements of the final radio frequency amplifying device for normal operation over the power range."

Section 87.131, Note 7 "Frequency, emission, and maximum power will be determined by appropriate standards during the certification process".

Test Procedure:

The peak power output of the WXR-2100 was measured using test equipment connected to the WRT-2100 antenna terminal. The equipment used for the RF Power Output Test is shown in Table F-4.

Table F-4. Test Equipment Used for RF Power Output Test

Equipment	Manufacturer/Model Number	Specific Identification
Receiver/Transmitter	Rockwell Collins WRT-2100X (822-1710-950)	S/N 1JLTL
Indicator/Control	Rockwell Collins WXI-711 (622-6514-301)	S/N 133
Control Panel	Rockwell Collins WCP-702 (622-5130-208)	S/N 1529
Antenna Pedestal	Rockwell Collins WMA-701X (622-5136-803)	S/N L4TF
Test Harness	Rockwell Collins J-Box System Test Harness	N/A
Variable Power Source	Agilent 6812A AC Power Source/Analyzer	SN US37290132 469-0068-857
Directional Coupler (20 dB)	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
Peak Power Meter	HP 8900D	SN 3607U004466 460-0205-518
Laptop P.C.	IBM Compatable with EM320 Terminal Emulation Software	HP OmniBook 4150 SN 94281113 4500000897

Test Setup:

A functional block diagram of the equipment setup for the RF Power Output Test is shown in Figure F-3. The actual test equipment setup is shown in Figure F-4.

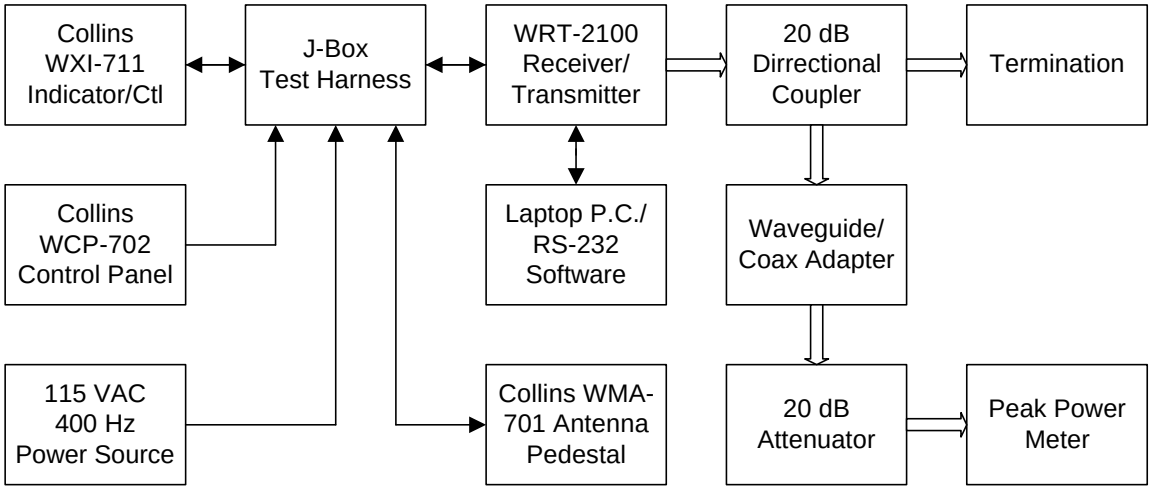


Figure F-3. RF Power Output Test Setup

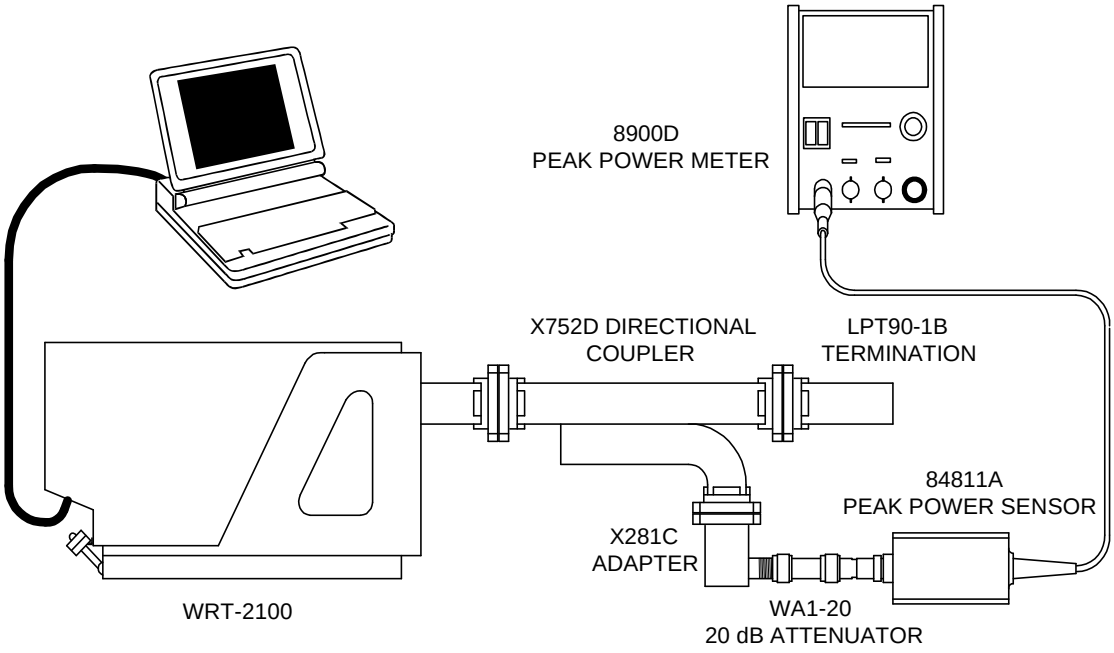


Figure F-4. Setting Up for RF Power Output Test

Measurements:

Peak RF power output of the WRT-2100 transmitter was measured through 40 dB of attenuation. The power output was measured during the Weather plus Windshear plus Turbulence operating mode with the transmitter locked to one of five possible channels. The RF power output was measured with primary power input variations up to +/- 15%. The measured transmitter power output for each of the operating conditions is contained in Table F-5.

Table F-5. RF Power Output

Line Voltage (Vac)	Peak Transmitter Power Output (Watts) Line Voltage							
	Channel 0	Channel 9	Channel 17	Channel 26	Channel 35	Channel 44	Channel 52	Channel 61
97.750 (115-15%)	180	180	180	180	180	180	180	180
103.50 (115-10%)	180	180	180	180	180	180	180	179
109.25 (115-5%)	180	180	180	180	180	179	179	179
115.00	180	180	180	180	180	179	179	179
120.75 (115+5%)	180	180	180	180	179	179	179	179
126.50 (115+10%)	180	180	179	179	179	179	179	179
132.25 (115+15%)	180	180	179	179	179	179	179	179

F.5 Frequency Stability (2.1055)

Requirement:

(a) (2) The frequency shall be measured with variation of ambient temperature from -20° to +50° centigrade for equipment licensed for use aboard aircraft in the Aviation Services under part 87 of FCC Code of Federal Regulations Title 47.

(b) The frequency measurement shall be made at the extremes and at intervals of not more than 10° centigrade through the range. A period of time sufficient to stabilize all of the components of the oscillator circuit at each temperature level shall be allowed prior to frequency measurement.

(d) (1) (3) The frequency stability shall be measured with variation of primary supply voltage from 85 to 115 percent of the nominal value. The supply voltage shall be measured at the input to the cable normally provided with the equipment, or at the power supply terminals if cables are not normally provided.

Per 87.133 (a) Frequency tolerance for Frequency band (8) 2450 to 10500 MHz - Note 9,

“Where specific frequencies are not assigned to radar stations, the bandwidth occupied by the emissions of such stations must be maintained within the band allocated to the service and the indicated tolerance (1250 ppm) does not apply.”

Procedure:

The transmitted frequency of the WXR-2100 was measured using a temperature chamber and test equipment. The equipment used for the Frequency Stability test is shown in Table F-6.

Table F-6. Equipment Used for Frequency Stability Test

Equipment	Manufacturer/Model Number	Specific Identification
Receiver/Transmitter	Rockwell Collins WRT-2100X (822-1710-950)	S/N 1JLTL
Control/Indicator	Rockwell Collins WXI-711 (622-6514-301)	S/N 133
Control Panel	Rockwell Collins WCP-702 (622-5130-208)	S/N 1529
Antenna Pedestal	Rockwell Collins WMA-701 (622-5136-803)	S/N L4TF
Test Harness	Rockwell Collins J-Box System Test Harness	N/A
Variable Power Source	HP6812A AC/Power Source/Analyzer	SN US37290132 469-0068-857
Waveguide to Coax Adapter	HP X281C	SN 3032A-06660 460-0210-312 Component of 460-0132-809
Attenuator (10 dB)	Weinschel 33-10-34	SN 9582 460-0070-249
Attenuator (20 dB)	Weinschel WA1-20	460-0203-439 Component of 460-0132-809
Spectrum Analyzer	Agilent 8563EC	SN 4111A01362 460-0132-667
Temperature Chamber	Thermotron M-8C	SN 21046 460-0203-302
Laptop P.C.	IBM Compatable with EM320 Terminal Emulation Software	HP OmniBook 4150 SN 94281113 4500000897

Equipment Setup:

The test setup for the Frequency Stability test is shown in Figure F-5.

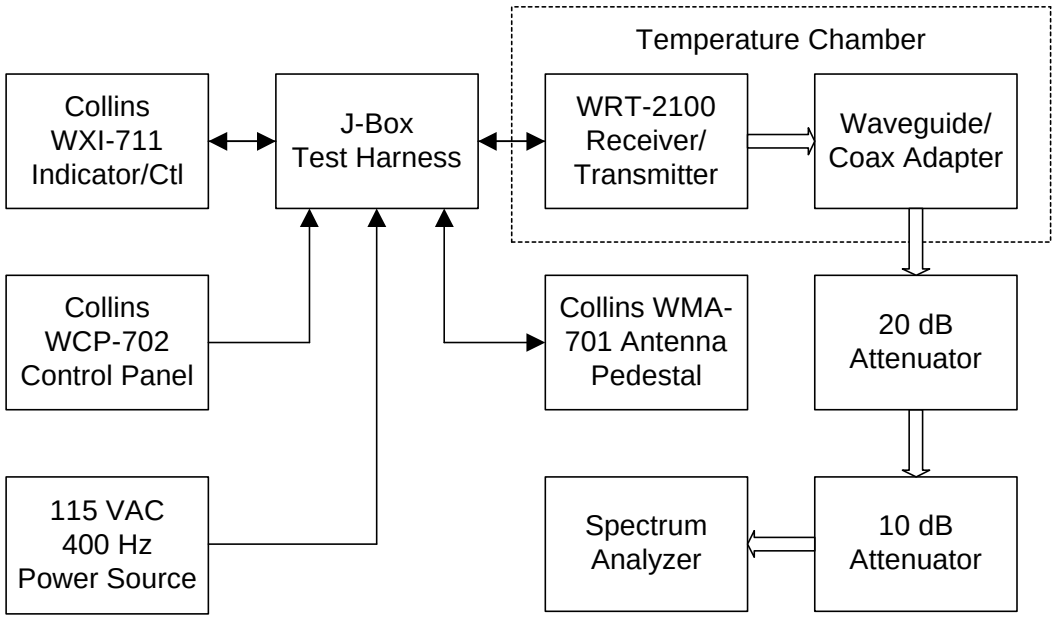


Figure F-5. Frequency Stability Test Setup

Line Voltage Test:

The unit was operated on the bench at ambient temperature. The line voltage was varied from 85% to 115% of 115VAC (97.75VAC to 132.25VAC). All frequency stability tests were conducted with the Receiver/Transmitter operating in the Weather plus Turbulence plus Windshear mode with the frequency locked to a fixed specified in Table F-7 below.

Line Voltage Test Measurements:

Frequency Stability vs Line Voltage Test results are shown in Table F-7.

Table F-7. Transmitted Frequency Vs. Input Voltage

Line Voltage (Vac)	Frequency (Spectrum Analyzer) (MHz)							
	Chan 0	Chan 9	Chan 17	Chan 26	Chan 35	Chan 44	Chan 52	Chan 61
97.750 (115-15%)	9,327.438	9,329.125	9,330.628	9,332.305	9,334.000	9,335.687	9,337.189	9,338.874
103.50 (115-10%)	9,327.437	9,329.123	9,330.626	9,332.302	9,334.002	9,335.689	9,337.189	9,338.876
109.25 (115-5%)	9,327.437	9,329.127	9,330.626	9,332.303	9,334.002	9,335.687	9,337.187	9,338.876
115.00	9,327.438	9,329.128	9,330.626	9,332.305	9,334.002	9,335.687	9,337.187	9,338.876
120.75 (115+5%)	9,327.438	9,329.128	9,330.628	9,332.305	9,334.002	9,335.689	9,337.189	9,338.876
126.50 (115+10%)	9,327.440	9,329.128	9,330.628	9,332.303	9,334.002	9,335.689	9,337.189	9,338.874
132.25 (115+15%)	9,327.440	9,329.128	9,330.628	9,332.305	9,334.002	9,335.689	9,337.189	9,338.874

Results: There were no out of tolerance frequency variations as a result of line voltage variations from 97.75VAC to 132.25 VAC.

Temperature Test:

The WRT-2100X was placed in a temperature chamber with all other equipment outside at room ambient. The test unit was operated using nominal115VAC 400Hz primary power and the temperature varied from –55 ºC to +70 ºC. The WRT-2100X frequency was measured on the Spectrum Analyzer. Sufficient time was allowed to stabilize the unit after the chamber reached the desired temperature. Data was taken in 10 degree (or less) steps.

Temperature Test Measurements:

Temperature Test results are shown in Table F-8 and Figure F-6.

Table F-8. Transmitted Frequency Vs. Temperature

Temp. (ºC)	Frequency (Spectrum Analyzer) (MHz)							
	Chan 0	Chan 9	Chan 17	Chan 26	Chan 35	Chan 44	Chan 52	Chan 61
-55	9327.075	9328.757	9330.258	9331.935	9333.625	9335.318	9336.817	9338.508
-50	9327.143	9328.83	9330.33	9332.01	9333.707	9335.393	9336.894	9338.58
-40	9327.271	9328.96	9330.458	9332.138	9333.835	9335.526	9337.022	9338.713
-30	9327.376	9329.065	9330.563	9332.247	9333.94	9335.626	9337.127	9338.813
-20	9327.449	9329.137	9330.638	9332.316	9334.012	9335.7	9337.199	9338.886
-10	9327.489	9329.177	9330.685	9332.359	9334.054	9335.74	9337.241	9338.931
0	9327.507	9329.194	9330.693	9332.374	9334.072	9335.758	9337.258	9338.945
10	9327.502	9329.191	9330.691	9332.369	9334.064	9335.75	9337.25	9338.938
20	9327.474	9329.161	9330.661	9332.339	9334.034	9335.72	9337.223	9338.908
30	9327.432	9329.116	9330.614	9332.292	9333.989	9335.675	9337.18	9338.863
40	9327.367	9329.056	9330.554	9332.23	9333.927	9335.617	9337.115	9338.8
50	9327.271	9328.96	9330.458	9332.138	9333.835	9335.526	9337.022	9338.713
60	9327.205	9328.888	9330.386	9332.065	9333.757	9335.439	9336.906	9338.628
70	9327.098	9328.784	9330.288	9331.926	9333.66	9335.344	9336.844	9338.533

Results: There were no out of tolerance frequency variations as a result of temperature extremes from -55C to +70C

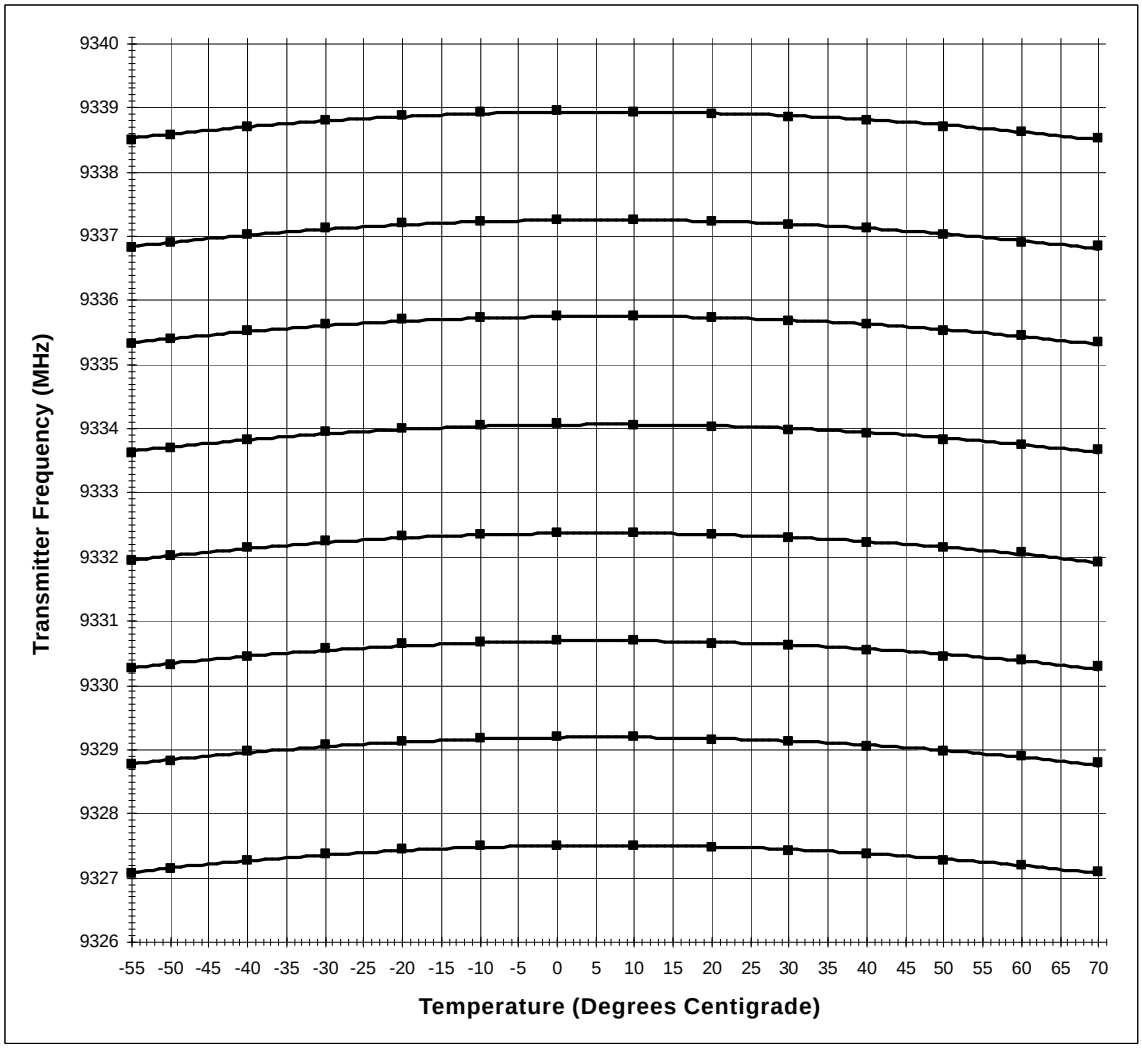


Figure F-6. Transmitter Frequency Stability vs. Temperature

F.6 WXR-2100 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 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 WXR-2100 was measured using test equipment connected to the WRT-2100 antenna terminal. The equipment used for the Occupied Bandwidth Test is shown in Table F-9.

Table F-9. Equipment Used for Occupied Bandwidth Tests

Equipment	Manufacturer/Model Number	Specific Identification
Receiver/Transmitter	Rockwell Collins WRT-2100X (822-1710-950)	S/N 1JLTL
Indicator/Control	Rockwell Collins WXI-711 (622-6514-301)	S/N 133
Control Panel	Rockwell Collins WCP-702 (622-5130-208)	S/N 1529
Antenna Pedestal	Rockwell Collins WMA-701X (622-5136-803)	S/N L4TF
Test Harness	Rockwell Collins J-Box System Test Harness	N/A
Power Source	HP 6812A AC/Power Source/Analyzer	SN US37290132 469-0068-857
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 8563EC	SN 4111A01362 460-0132-667
Personal Computer	IBM Compatible with National Instruments GPIB Interface and Agilent E4444A Benchlink Software	Gateway 2000 P5-120 SN 4250149
Laptop P.C.	IBM Compatible with EM320 Terminal Emulation Software	HP OmniBook 4150 SN 94281113 4500000897

Test Setup:

A functional block diagram of the equipment setup for the Occupied Bandwidth Test is shown in Figure F-7. The actual test equipment setup is shown in Figure F-8.

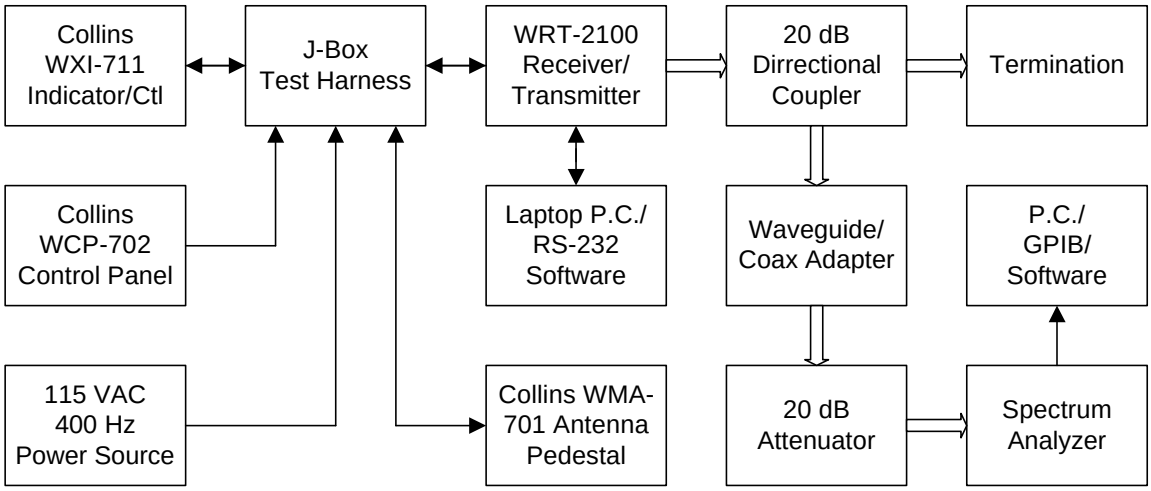


Figure F-7. Occupied Bandwidth Test Setup

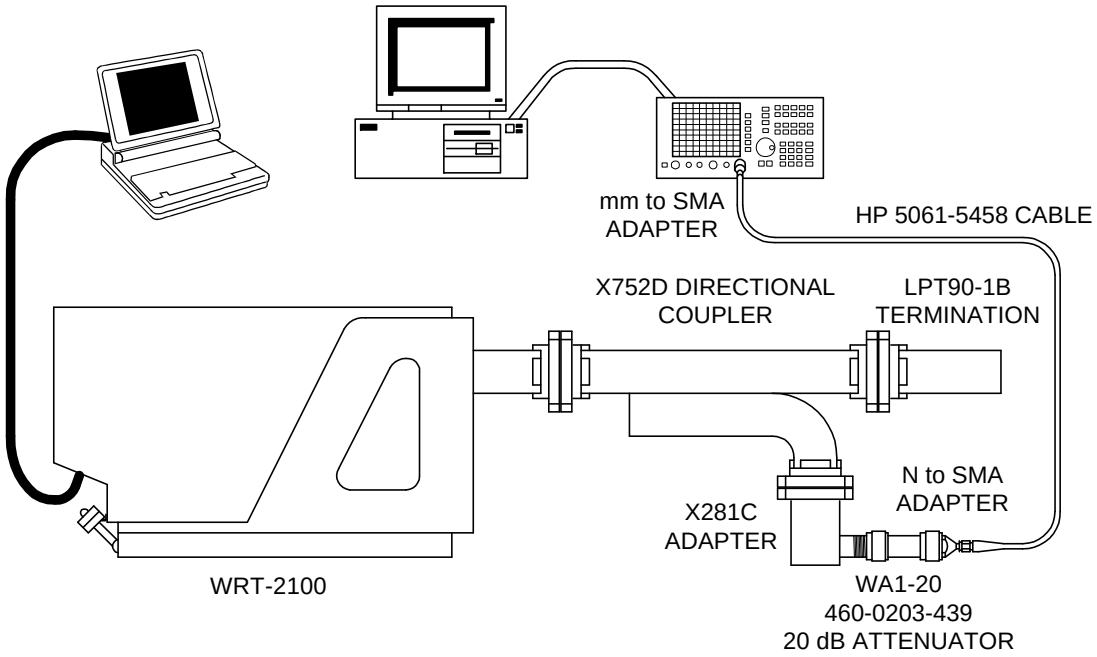


Figure F-8. Setting Up for Occupied Bandwidth Test

Measurement Objectives:

The WXR-2100 radar system is designed to operate on 64 separate frequencies. The two highest frequencies are used for testing the WRT-2100 on the bench with specialized radar test equipment. The 62 remaining frequencies, channels 0 through 61 in the band from 9.327424486 GHz to 9.338861986 GHz. are utilized for normal operation. 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 62 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 62 channels, it is desired to have FCC certification for use of all 62 channels within the specified range. A complete description of the frequency selection, pulse repetition frequencies, and pulse width selection is provided in Section 9.2 *WXR-2100 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-9. 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 9.2 Special FCC Test Conditions. The Occupied Bandwidth plot for this Maximum Channel Frequency configuration is shown in Figure F-10. 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 8563EC 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.

Table F-10. WXR-2100 Occupied Bandwidth Measurement Results

Normal Operation	Test Condition	99% Occupied Bandwidth	Reference Figure
Weather plus Turbulence plus Windshear	Normal Selection	4.417 MHz	Figure F-9
	Maximum Channel Span	12.05 MHz	Figure F-10

The occupied bandwidth measurement for Weather plus Turbulence plus Windshear mode is shown in Figure F-9 and Figure F-10.

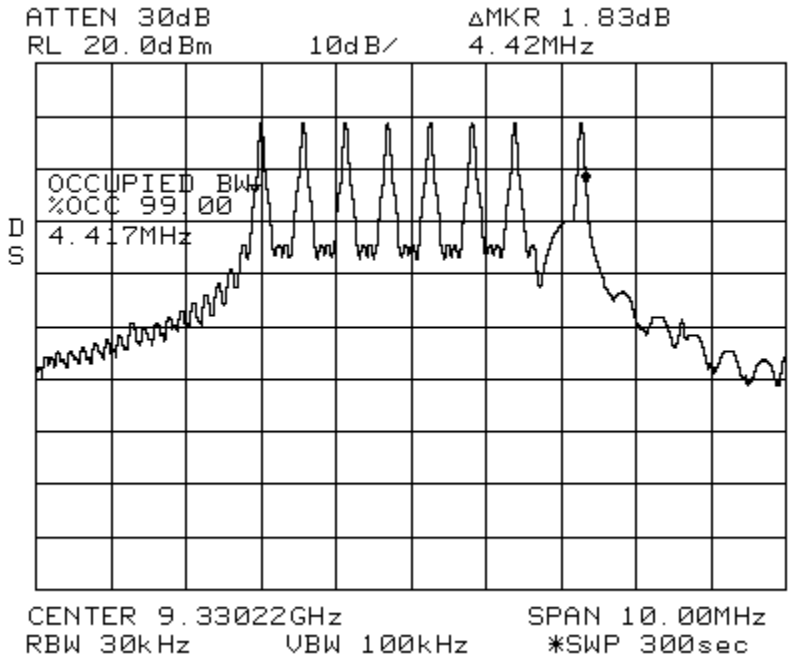


Figure F-9. Occupied Bandwidth - Normal Channel Selections

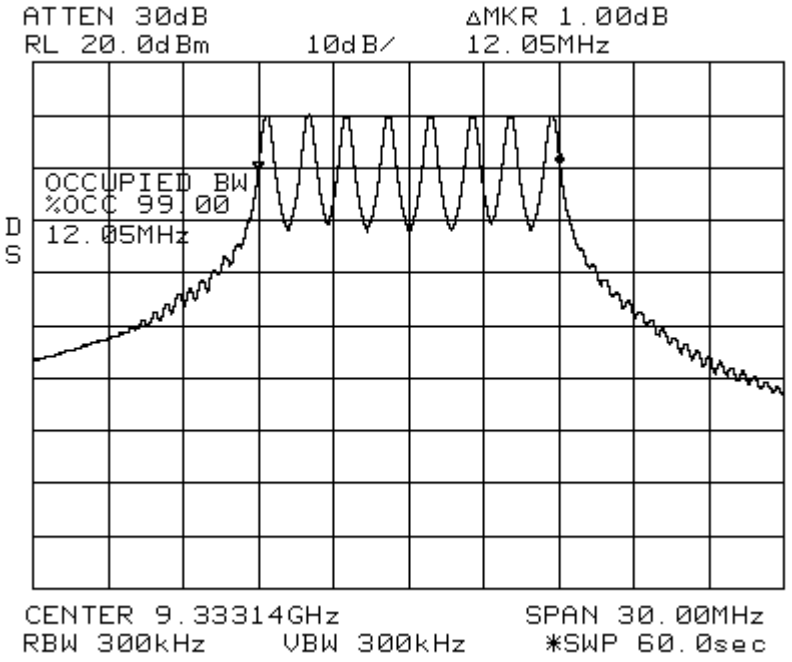


Figure F-10. Occupied Bandwidth - Maximum Channel Span

Additional Occupied Bandwidth Plots

Eight additional scans were completed for reference purposes to show the Occupied Bandwidth for individual fixed channels 0, 9, 17, 26, 35, 44, 52, and 61

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

Table F-11. WXR-2100 Occupied Bandwidth Measurement Results - Fixed Channels

Bench Test	99% Occupied Bandwidth	Reference Figure
Channel 0 9,327.424486 MHz	1.083 MHz	Figure F-11
	833.3 kHz	Figure F-12
Channel 9 9,329.111986 MHz	950.0 kHz	Figure F-13
	833.3 kHz	Figure F-14
Channel 17 9,330.611986 MHz	983.3 kHz	Figure F-15
	836.7 kHz	Figure F-16
Channel 26 9,332.290255 MHz	950.0 kHz	Figure F-17
	833.3 kHz	Figure F-18
Channel 35 9,333.986986 MHz	866.7 kHz	Figure F-19
	833.3 kHz	Figure F-20
Channel 44 9,335.674486 MHz	983.3 kHz	Figure F-21
	833.3 kHz	Figure F-22
Channel 52 9,337.174486 MHz	900.0 kHz	Figure F-23
	866.7 kHz	Figure F-24
Channel 61 9,338.861986 MHz	1.033 MHz	Figure F-25
	866.7 kHz	Figure F-26

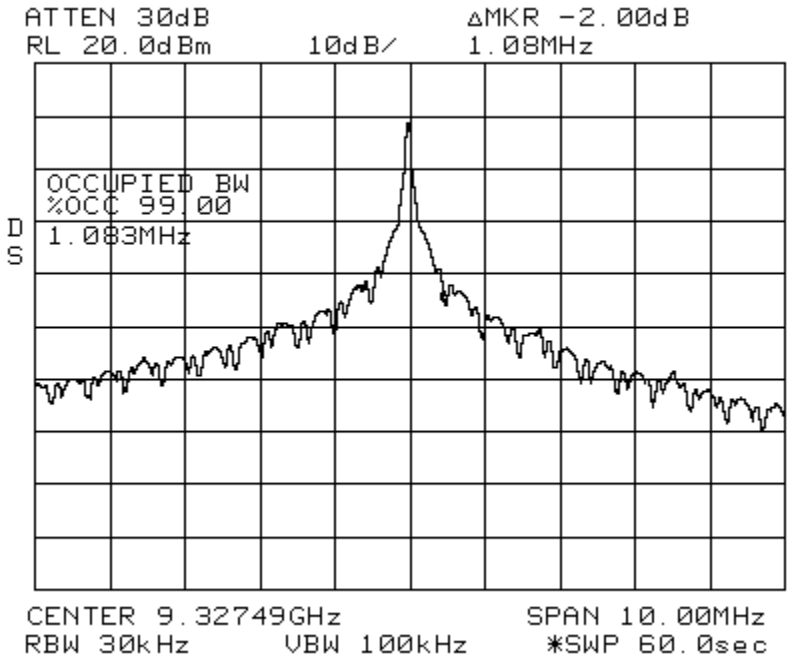


Figure F-11. Channel 0, Occupied Bandwidth

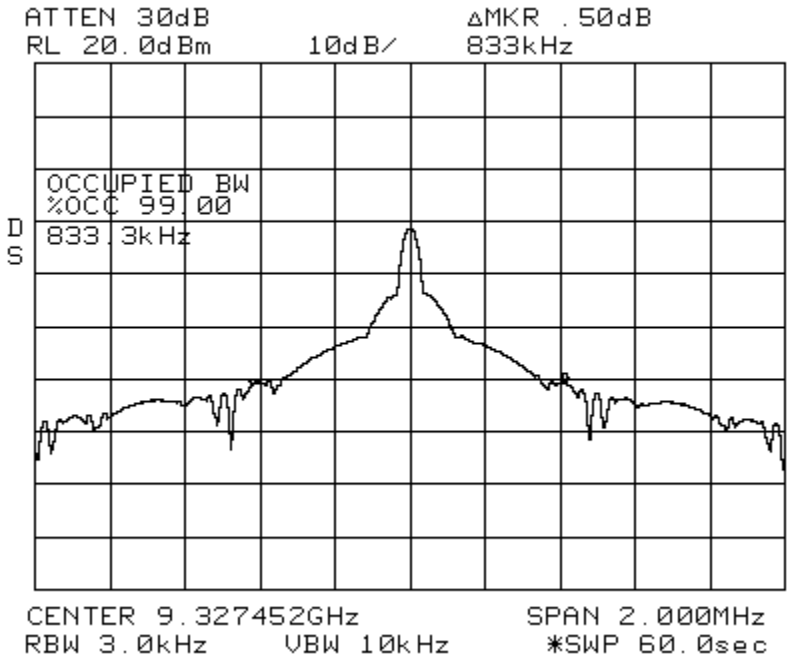


Figure F-12. Channel 0, Occupied Bandwidth

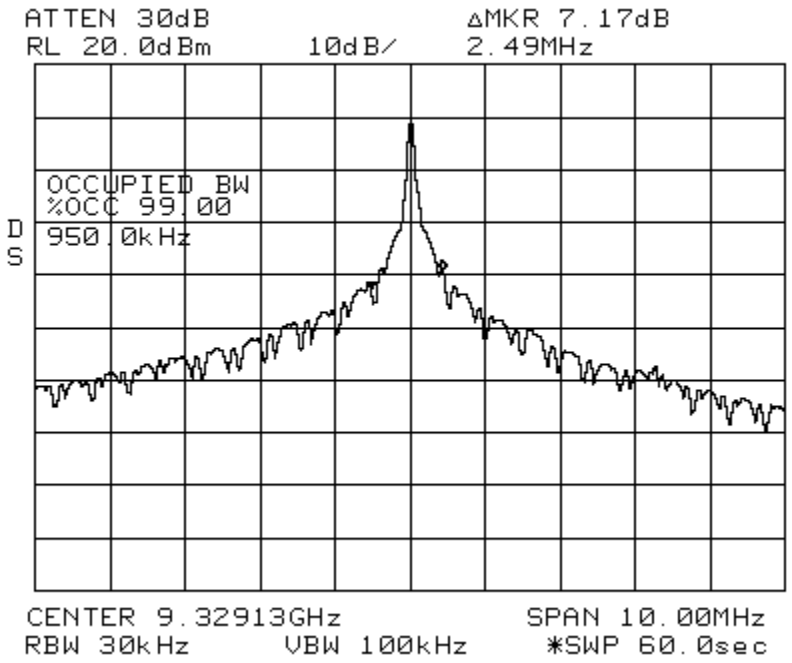


Figure F-13. Channel 9, Occupied Bandwidth

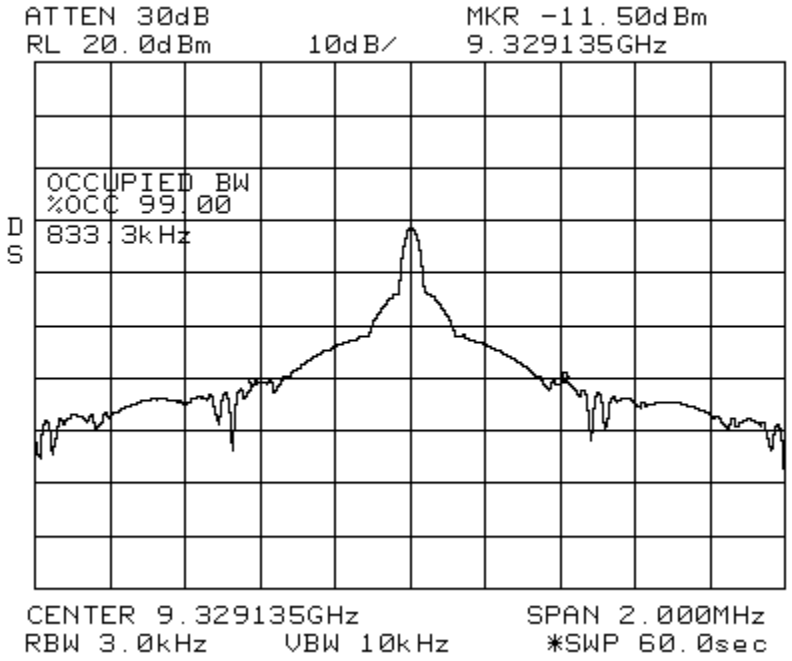


Figure F-14. Channel 9, Occupied Bandwidth

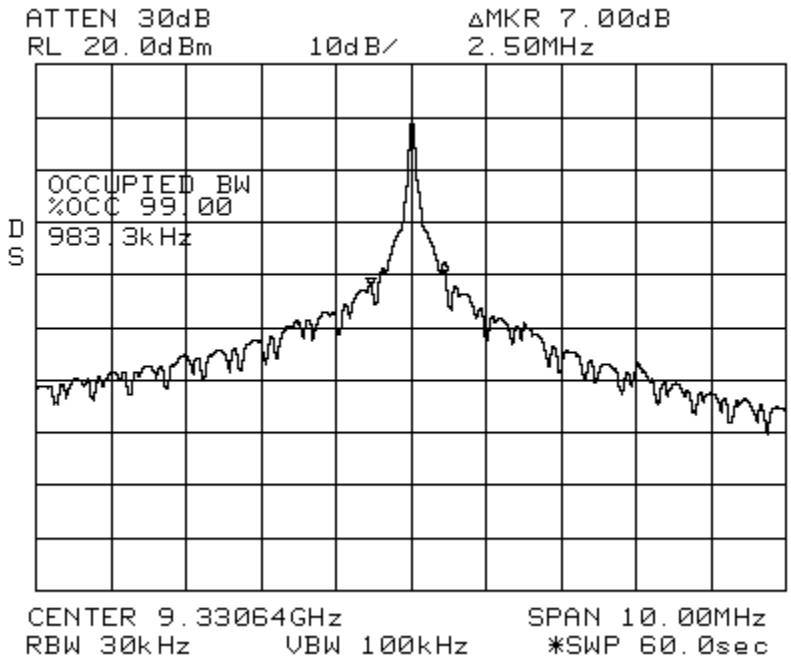


Figure F-15. Channel 17, Occupied Bandwidth

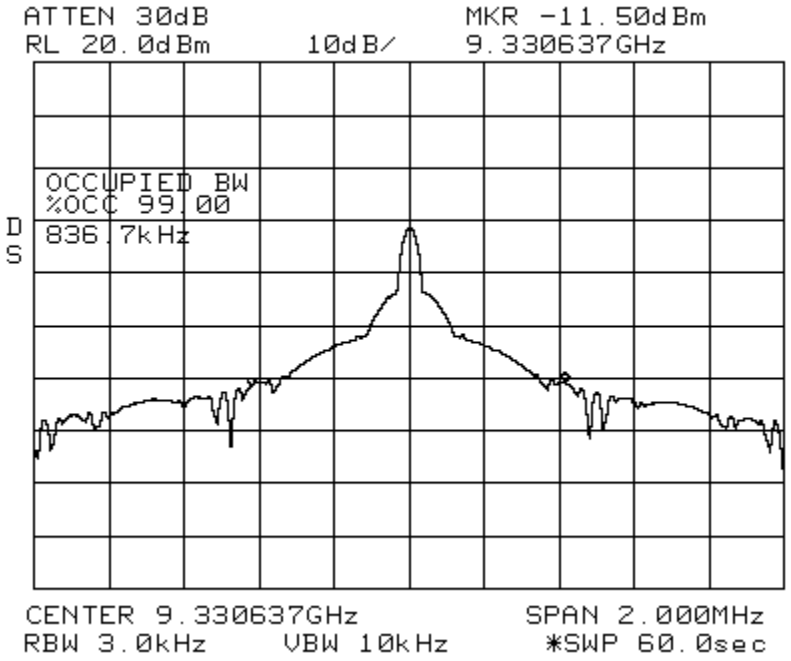


Figure F-16. Channel 17, Occupied Bandwidth

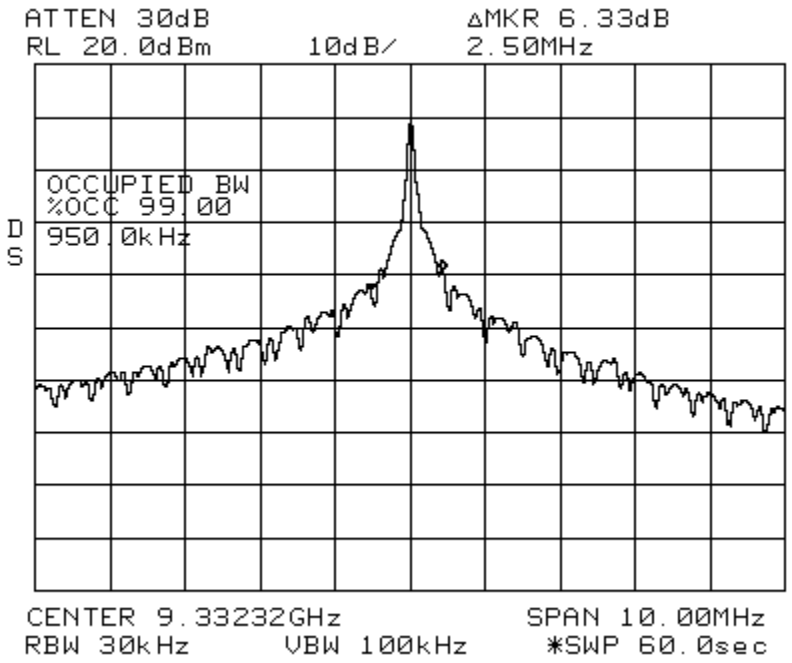


Figure F-17. Channel 26, Occupied Bandwidth

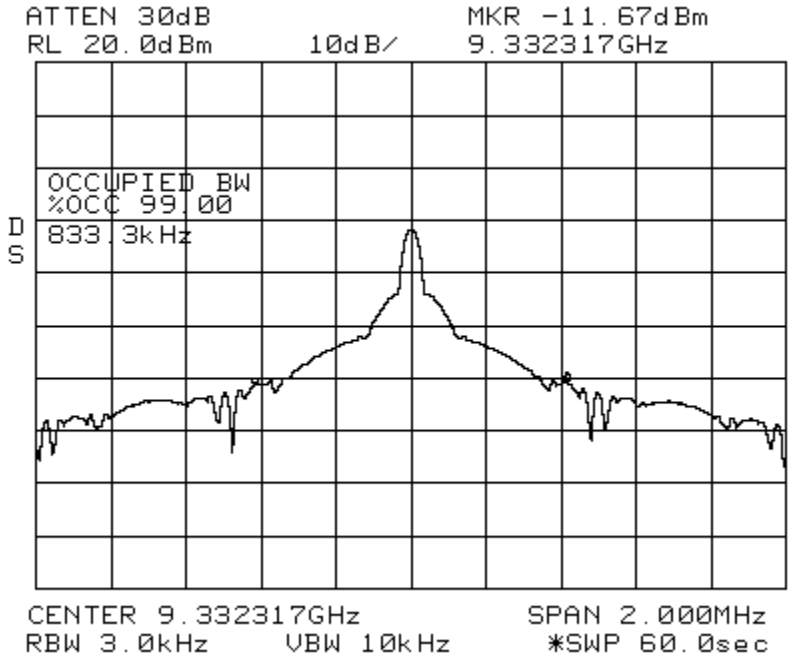


Figure F-18. Channel 26, Occupied Bandwidth

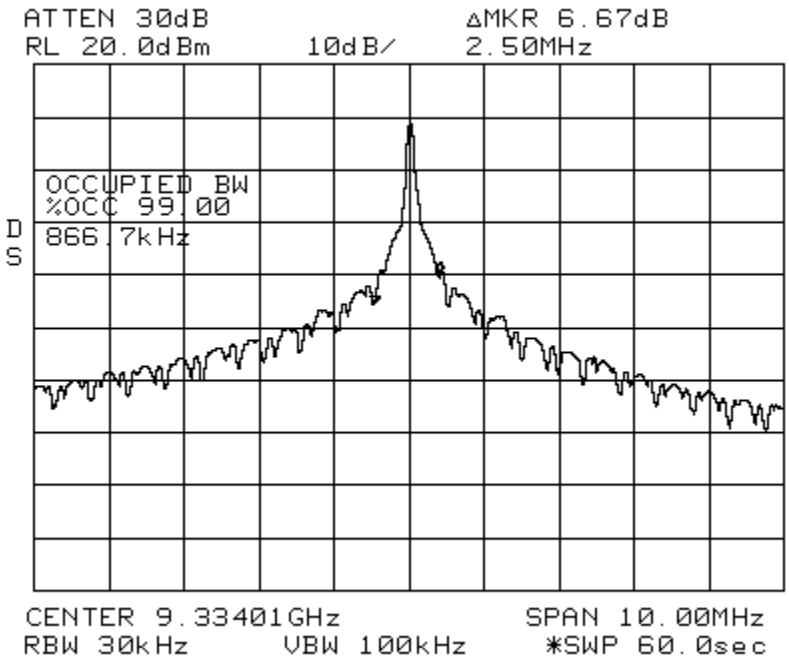


Figure F-19. Channel 35, Occupied Bandwidth

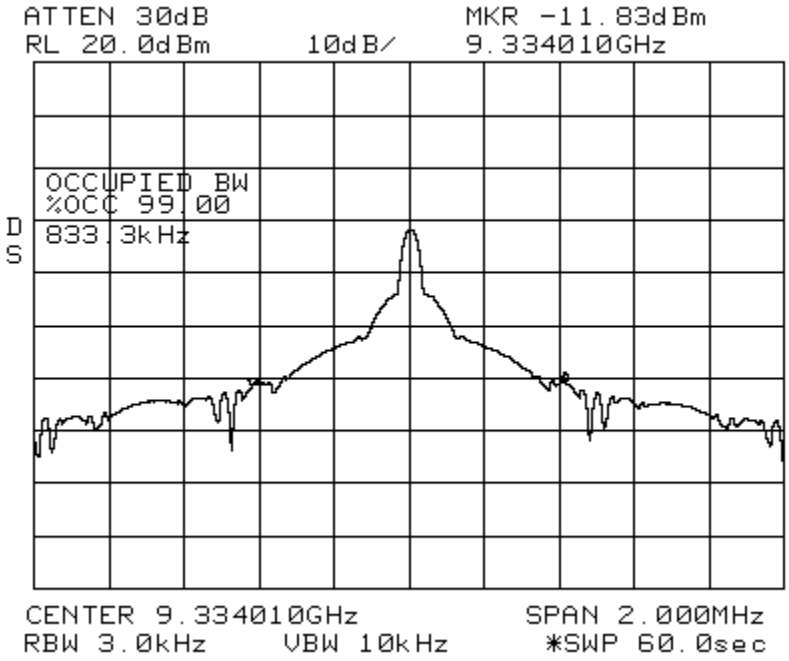


Figure F-20. Channel 35, Occupied Bandwidth

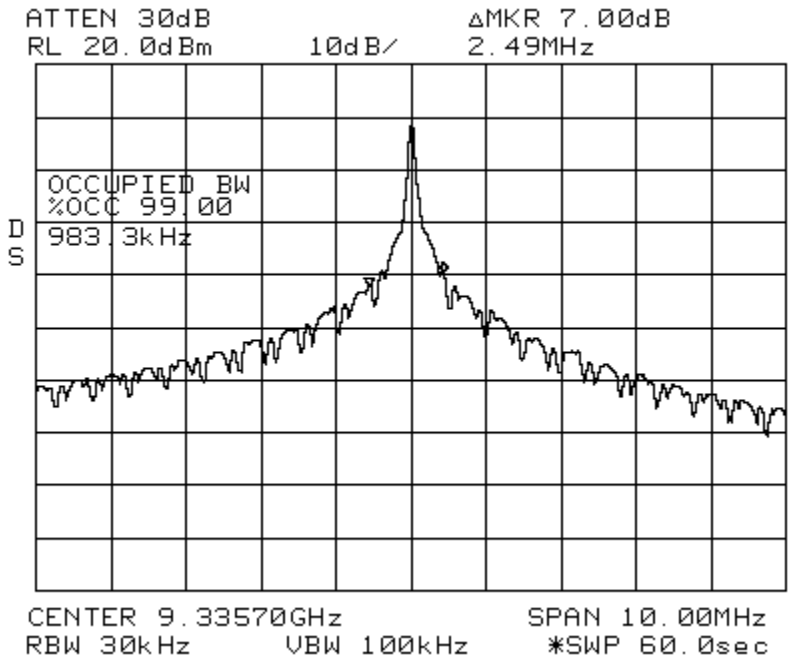


Figure F-21. Channel 44, Occupied Bandwidth

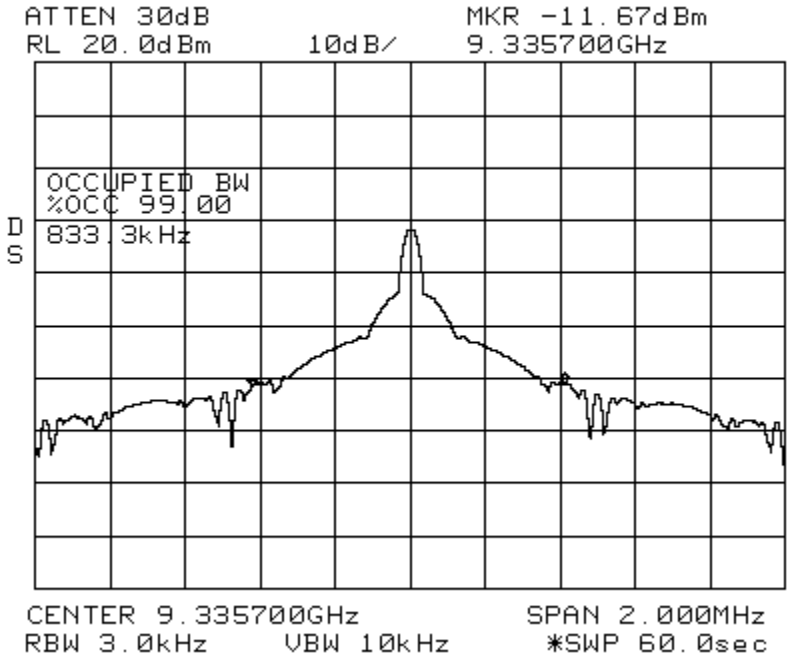


Figure F-22. Channel 44, Occupied Bandwidth

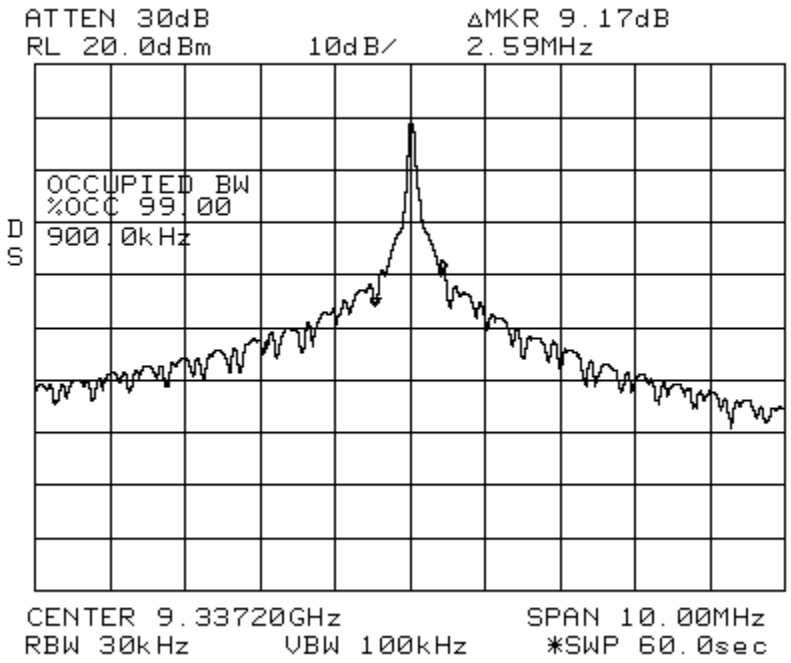


Figure F-23. Channel 52, Occupied Bandwidth

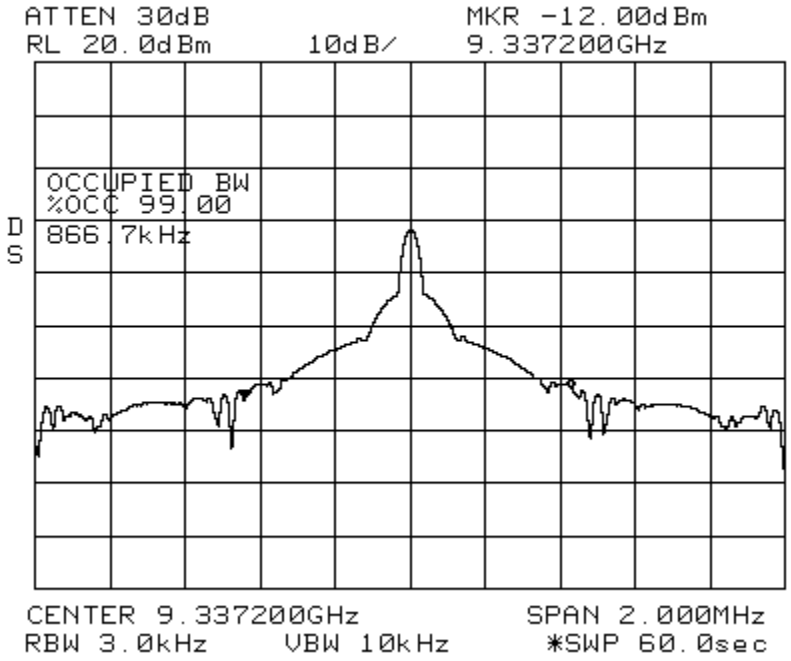


Figure F-24. Channel 52, Occupied Bandwidth

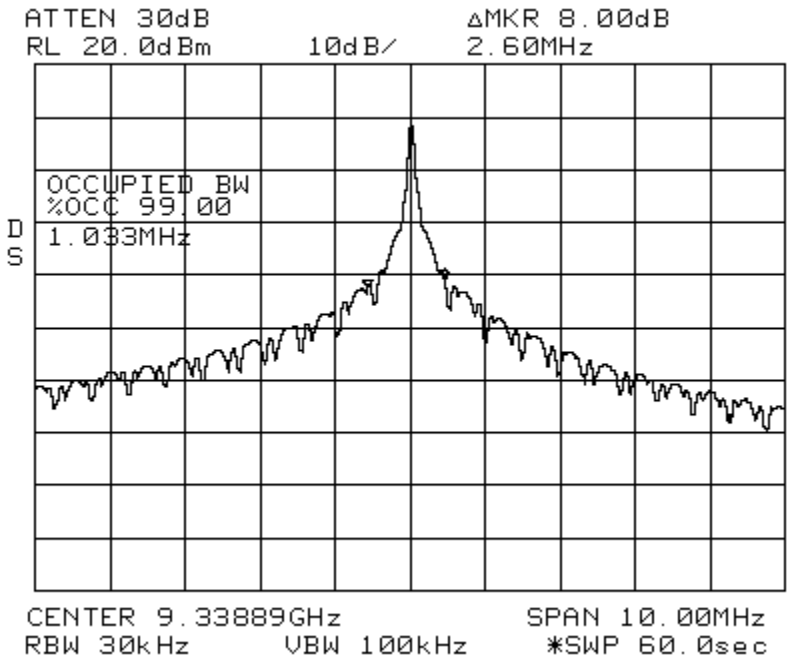


Figure F-25. Channel 61, Occupied Bandwidth

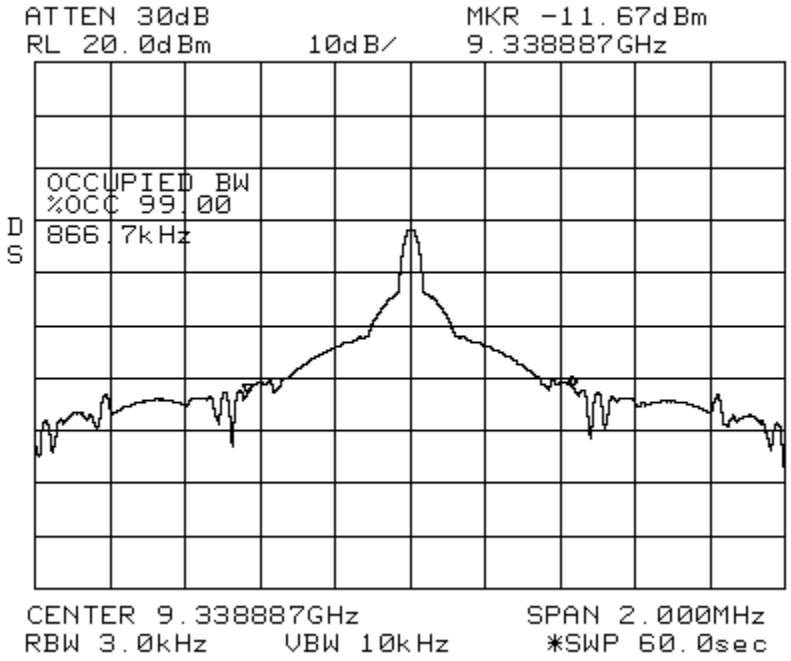


Figure F-26. Channel 61, Occupied Bandwidth

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 WRT-2100 clearly falls under the definition of an aircraft station transmitter defined in Section 2.101, 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 WRT-2100 Test Article had a peak power output of 180 watts. Based on this power level, the absolute limits are calculated as follows using 40 dBc as an example.

Ptx-peak = 180 Watts or 22.55 dBW = 52.55 dBm in all ranges.

FCC Limit = 40 dBc

Absolute Limit = Ptx-peak (dBm) – FCC Limit (dBc) = +12.55 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. Spurious Emission 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

Spurious Emission Corrections for Antenna and Transmission Line Components:

The WFA-701X Antenna Flatplate radiator is a required part of the radar system along with the WMA-701X Antenna Pedestal and transmission line components. All conducted emissions (desired and spurious) must pass through the antenna before being radiated into space.

Each of these elements provides attenuation to spurious emissions radiated into space. The following paragraphs describe these attenuation factors. These factors will then be applied to the spurious emission levels.

Flatplate Antenna Attenuation for Spurious Frequencies:

The WFA-2100X Flatplate Antenna is a tuned waveguide structure with 34.5 dB of gain at the center frequency of 9333 MHz. The WFA-701X has substantial attenuation at frequencies removed from the center frequency.

Antenna gain measurements were made on the flatplate at spurious frequencies up to 18.666 GHz. The highest response was 12.49 dB at 11.666 GHz. Other frequencies were significantly lower.

Therefore, the attenuation for spurious outputs due to the antenna response is:

Attenuation Due To Antenna Response = 34.5 dB - 12.5 dB = 22 dB.

Other attenuating factors for spurious outputs include mismatch loss into the antenna and loss through the antenna pedestal transmission line and rotary joints. These losses will not be included here but serve to add extra margin to the 22 dB attenuation from the flatplate.

The Antenna Correction Factor of 22 dB will be applied to all spurious emissions recognizing that this is a conservative number and that the actual attenuation is larger in most cases.

60 dBc Limit:

For reference, the spurious emissions will be compared to a 40 dBc limit and a 60 dBc limit.

The limit for a 60 dBc attenuation is:

Absolute Limit (60 dBc) = Ptx-peak - 60 = 52.55 dBm - 60 = -7.45 dBm

Procedure:

The spurious emissions at the antenna terminal of the WXR-2100 were measured using test equipment connected to the Receiver/Transmitter antenna waveguide port on the rear of the R/T mount. The equipment used for the Spurious Emissions at the Antenna Terminal test is shown in Table F-13 through Table F-17.

Table F-13. Equipment Used for Spurious Emissions Tests

Equipment	Manufacturer/Model Number	Specific Identification
Receiver/Transmitter	Rockwell Collins WRT-2100X (822-1710-950)	S/N 1JLTL
Indicator/Control	Rockwell Collins WXI-711 (622-6514-301)	S/N 133
Control Panel	Rockwell Collins WCP-702 (622-5130-208)	S/N 1529
Antenna Pedestal	Rockwell Collins WMA-701X (622-5136-803)	S/N L4TF
Test Harness	Rockwell Collins J-Box System Test Harness	N/A
Power Source	Agilent 6812A AC Power Source/Analyzer	SN US37290132 469-0068-857
Personal Computer	IBM Compatible with National Instruments GPIB Interface and Agilent E4444A Benchlink Software	Gateway 2000 P5-120 SN 4250149
Laptop P.C.	IBM Compatible with EM320 Terminal Emulation Software	HP OmniBook 4150 SN 94281113 4500000897
Spectrum Analyzer	Agilent 8563EC (9 kHz to 26.5 GHz)	SN 4111A01362 460-0132-667
	Agilent 8565EC (30 Hz to 50 GHz)	SN 3946A00238 460-0131-236

Table F-14. Additional Test Equipment Used for X Band (8.2 to 12.4 GHx) Spurious Emissions Tests

Equipment	Manufacturer/Model Number	Specific Identification
Directional Coupler (20dB)	HP X752D	SN 622 460-0132-809
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

Table F-15. Additional Test Equipment Used for P Band (Ku) (12.4 to 18.0 GHz) Spurious Emissions Test

Equipment	Manufacturer/Model Number	Specific Identification
Directional Coupler (20dB)	HP P752D	SN 359 460-0132-825
Waveguide Taper (X to P Band)	Space Machine & Engineering	460-0133-402 Component of 460-0132-825
Waveguide Termination	CMT LPT62-1B	SN 970005-002 460-0133-414 Component of 460-0132-825
Waveguide to Coax Adapter	HP P281B	460-0133-418 Component of 460-0132-825

Table F-16. Additional Test Equipment Used for K Band (18.0 to 26.5 GHz) Spurious Emissions Test

Equipment	Manufacturer/Model Number	Specific Identification
Directional Coupler (20dB)	HP K752D	SN 177 460-0132-826
Waveguide Taper (X to K Band)	Space Machine & Engineering	460-0133-404 Component of 460-0132-826
Waveguide Termination	CMT LPT42-1B	SN 970005-003 460-0133-416 Component of 460-0132-826
Waveguide to Coax Adapter	HP K281C	SN3032A-09068 460-0133-412 Component of 460-0132-826

Table F-17. Additional Test Equipment Used for R Band (Ka) (26.5 to 40.0 GHz) Spurious Emissions Test

Equipment	Manufacturer/Model Number	Specific Identification
Directional Coupler (20dB)	HP R752D	SN 463 460-0132-827
Waveguide Taper (X to R Band)	Space Machine & Engineering	460-0133-406 Component of 460-0132-827
Waveguide Termination	CMT LPT28-1B	SN 970005-004 460-0133-415 Component of 460-0132-827
Waveguide to Coax Adapter	HP R281A	SN 02136 460-0133-417 Component of 460-0132-827

Setup:

A functional block diagram of the equipment setup for the X Band (8.2 to 12.4 GHz) Spurious Emissions at Antenna Terminal test is shown in Figure F-27. The actual test equipment setup is shown in Figure F-28.

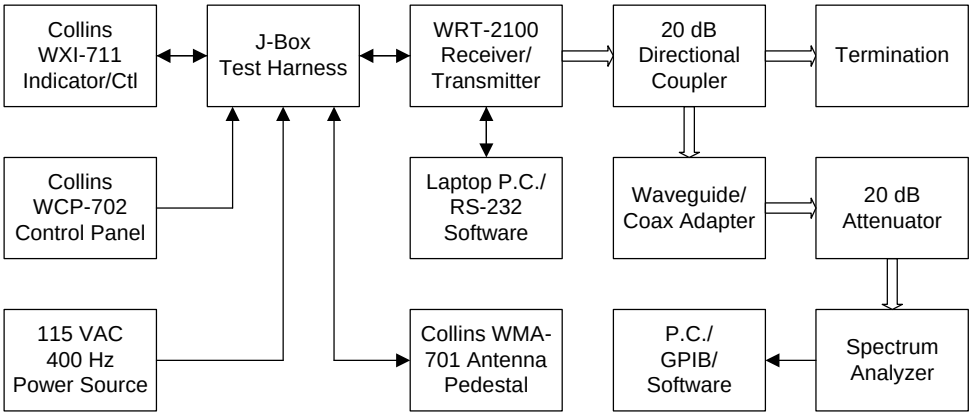


Figure F-27. Spurious Emissions of Antenna Terminal Test Setup (8.2 to 12.4 GHz)

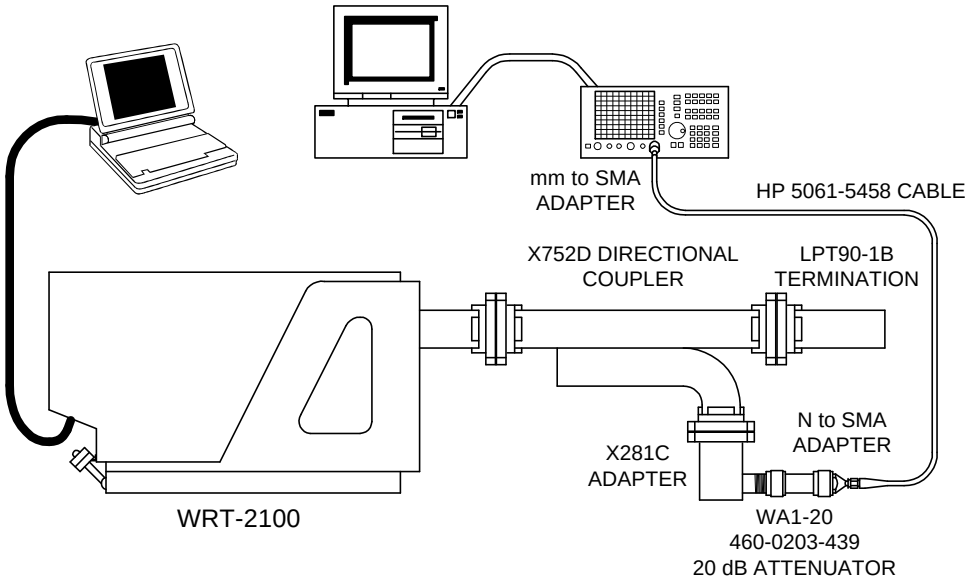


Figure F-28. Setting Up for Spurious Emissions at Antenna Terminal Tests (8.2 to 12.4 GHz)

A functional block diagram of the equipment setup for the P Band (Ku) (12.4 to 18.0 GHz), K Band (18.0 to 26.5 GHz), and R Band (Ka) (26.5 to 40.0 GHz) Spurious Emissions at Antenna Terminal Tests is shown in

Figure F-29. The actual test equipment setup is shown in Figure F-30.

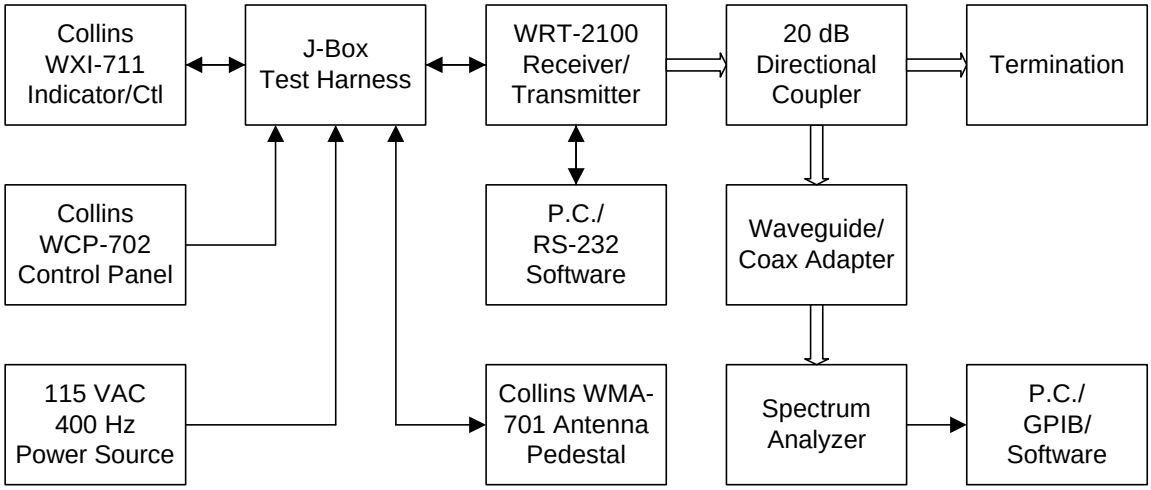


Figure F-29. Spurious Emissions at Antenna Terminal Test Setup (12.4 t0 18.0 GHz), (18.0 to 26.5 GHz), and (26.5 to 40 GHz)

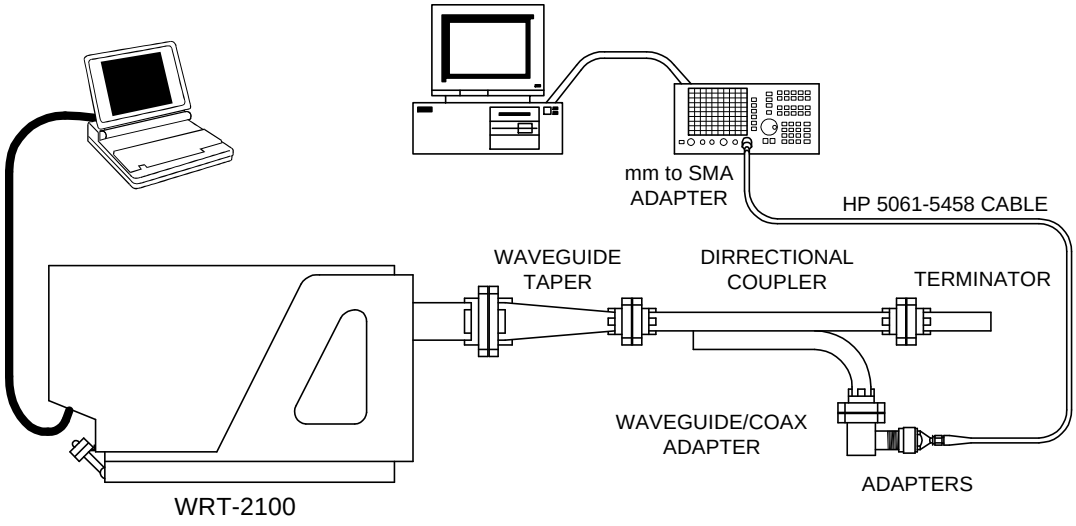


Figure F-30. Setting Up for Spurious Emissions at Antenna Terminal Tests (12.4 to 18.0 GHz), (18.0 to 26.5 GHz), and (26.5 to 40 GHz)

Measurements:

Spurious Antenna Emission Test data was takes for nine conditions:

Normal Frequency Switching
Fixed Channel 0
Fixed Channel 9
Fixed Channel 17
Fixed Channel 26
Fixed Channel 35
Fixed Channel 44
Fixed Channel 52
Fixed Channel 61

In each case, the radar was operating at the maximum operational mode:

Weather + Turbulence + Windshear.

Results:

When corrected for attenuation due to the Antenna Response to Spurious Frequencies described above, there were no emissions within 20 dB of the FCC Limit of 40 dBc. When compared to the 60 dBc limit included for reference, there were no emissions that exceeded the 60 dBc limit.

Note: Since the antenna terminal is X-Band waveguide (WR-90), frequencies below the cutoff frequency (7 GHz) were not measured.

The test results for the nine conditions are listed in Table F-18 through Table F-26. The tables contain all data that was within 20 dB of the FCC limit before correction with the Antenna Correction Factor (22 dB). Reference plots for each scan are indexed in the tables.

Table F-18. Conducted Spurious Emissions - Normal Mode

Emission Band	Spurious Frequency (GHz)	Emission Level (dBm)	Corrected Emission Level (-22dB)	40 dBc Limit (dBm)	60 dBc Limit (dBm)	Margin (dB) vs 40 dBc Limit	Margin (dB) vs 60 dBc Limit	Reference Figure
8.2 to 12.4 GHz	10.027	-39.33 +0.67	-21.33	+12.55	-7.45	+33.88	+13.88	Figure F-31
12.4 to 18.0 GHz	12.904	-68.50 -48.500	-70.500	+12.55	-7.45	+83.05	+63.05	Figure F-32
18.0 to 26.5 GHz	18.666	-36.17 -16.17	-38.17	+12.55	-7.45	+50.72	+30.72	Figure F-33
26.5 to 40.0 GHz	27.99	-40.67 -20.67	-42.67	+12.55	-7.45	+55.22	+35.22	Figure F-34

Table F-19. Conducted Spurious Emissions - Fixed Channel 0

Emission Band	Spurious Frequency (GHz)	Emission Level (dBm)	Corrected Emission Level (-22dB)	40 dBc Limit (dBm)	60 dBc Limit (dBm)	Margin (dB) vs (40 dBc) imit	Margin (dB) vs (60 dBc) imit	Reference Figure
8.2 to 12.4 GHz	8.361	-39.50 +0.50	-21.50	+12.55	-7.45	+34.05	+14.05	Figure F-35
12.4 to 18.0 GHz	15.331	-68.50 -48.50	-70.5	+12.55	-7.45	+83.05	+63.05	Figure F-36
18.0 to 26.5 GHz	18.666	-36.50 +16.50	-38.50	+12.55	-7.45	+51.05	+31.05	Figure F-37
26.5 to 40.0 GHz	27.99	-44.50 -24.50	-46.50	+12.55	-7.45	+59.05	+39.05	Figure F-38

Table F-20. Conducted Spurious Emissions - Fixed Channel 9

Emission Band	Spurious Frequency (GHz)	Emission Level (dBm)	Corrected Emission Level (-22dB)	40 dBc Limit (dBm)	60 dBc Limit (dBm)	Margin (dB) vs (40 dBc) Limit	Margin (dB) vs (60 dBc) Limit	Reference Figure
8.2 to 12.4 GHz	9.551	-39.17 +0.83	-21.17	+12.55	-7.45	+33.72	+13.72	Figure F-39
12.4 to 18.0 GHz	16.451	-68.00 -48.00	-70.00	+12.55	-7.45	+82.55	+62.55	Figure F-40
18.0 to 26.5 GHz	18.666	-51.17 -31.17	-53.17	+12.55	-7.45	+66.72	+45.72	Figure F-41
26.5 to 40.0 GHz	27.99	-43.00 -23.00	-45.00	+12.55	-7.45	+57.55	+37.55	Figure F-42

Table F-21. Conducted Spurious Emissions - Fixed Channel 17

Emission Band	Spurious Frequency (GHz)	Emission Level (dBm)	Corrected Emission Level (-22dB)	40 dBc Limit (dBm)	60 dBc Limit (dBm)	Margin (dB) vs (40 dBc) Limit	Margin (dB) vs (60 dBc) Limit	Reference Figure
8.2 to 12.4 GHz	8.207	-40.00 0.00	-22.00	+12.55	-7.45	+34.55	+14.55	Figure F-43
12.4 to 18.0 GHz	14.976	-68.33 -48.33	-70.33	+12.55	-7.45	+82.88	+62.88	Figure F-44
18.0 to 26.5 GHz	18.666	-36.33 -16.33	-38.33	+12.55	-7.45	+50.88	+30.88	Figure F-45
26.5 to 40.0 GHz	27.99	-42.83 -22.83	-44.83	+12.55	-7.45	+57.38	+37.38	Figure F-46

Table F-22. Conducted Spurious Emissions - Fixed Channel 26

Emission Band	Spurious Frequency (GHz)	Emission Level (dBm)	Corrected Emission Level (-22dB)	40 dBc Limit (dBm)	60 dBc Limit (dBm)	Margin (dB) vs (40 dBc) Limit	Margin (dB) vs (60 dBc) Limit	Reference Figure
8.2 to 12.4 GHz	9.782	-39.83 +0.17	-21.83	+12.55	-7.45	+34.38	+14.38	Figure F-47
12.4 to 18.0 GHz	15.741	-68.17 -48.17	-70.17	+12.55	-7.45	+82.72	+62.72	Figure F-48
18.0 to 26.5 GHz	18.666	-36.50 -16.50	-38.50	+12.55	-7.45	+51.05	+31.05	Figure F-49
26.5 to 40.0 GHz	27.99	-41.50 -21.50	-43.50	+12.55	-7.45	+56.05	+36.05	Figure F-50

Table F-23. Conducted Spurious Emissions - Fixed Channel 35

Emission Band	Spurious Frequency (GHz)	Emission Level (dBm)	Corrected Emission Level (-22dB)	40 dBc Limit (dBm)	60 dBc Limit (dBm)	Margin (dB) vs (40 dBc) Limit	Margin (dB) vs (60 dBc) Limit	Reference Figure
8.2 to 12.4 GHz	9.894	-39.83 +0.17	-21.83	+12.55	-7.45	+34.38	+14.38	FigureF-51
12.4 to 18.0 GHz	15.331	-68.33 -48.33	-70.33	+12.55	-7.45	+82.88	+62.88	Figure F-52
18.0 to 26.5 GHz	18.680	-39.17 -19.17	-41.17	+12.55	-7.45	+53.72	+33.69	Figure F-53
26.5 to 40.0 GHz	28.01	-40.17 -20.17	-42.17	+12.55	-7.45	+54.72	+34.72	Figure F-54

Table F-24. Conducted Spurious Emissions - Fixed Channel 44

Emission Band	Spurious Frequency (GHz)	Emission Level (dBm)	Corrected Emission Level (-22dB)	40 dBc Limit (dBm)	60 dBc Limit (dBm)	Margin (dB) vs (40 dBc) Limit	Margin (dB) vs (60 dBc) Limit	Reference Figure
8.2 to 12.4 GHz	9.152	-39.67 +0.33	-21.67	+12.55	-7.45	+34.22	+14.22	Figure F-55
12.4 to 18.0 GHz	12.745	-68.50 -48.50	-70.50	+12.55	-7.45	+83.05	+63.05	Figure F-56
18.0 to 26.5 GHz	18.680	-37.67 -17.67	-39.67	+12.55	-7.45	+52.22	+32.22	Figure F-57
26.5 to 40.0 GHz	28.01	-41.83 -21.83	-43.83	+12.55	-7.45	+56.38	+36.38	Figure F-58

Table F-25. Conducted Spurious Emissions - Fixed Channel 52

Emission Band	Spurious Frequency (GHz)	Emission Level (dBm)	Corrected Emission Level (-22dB)	40 dBc Limit (dBm)	60 dBc Limit (dBm)	Margin (dB) vs (40 dBc) Limit	Margin (dB) vs (60 dBc) Limit	Reference Figure
8.2 to 12.4 GHz	9.950	-39.83 +0.17	-21.83	+12.55	-7.45	+34.38	+14.38	Figure F-59
12.4 to 18.0 GHz	17.104	-68.17 -48.17	-70.17	+12.55	-7.45	+82.72	+62.72	Figure F-60
18.0 to 26.5 GHz	18.680	-38.33 -18.33	-40.33	+12.55	-7.45	+52.88	+32.88	Figure F-61
26.5 to 40.0 GHz	28.01	-41.00 -21.00	-43.00	+12.55	-7.45	+55.55	+35.55	Figure F-62

Table F-26. Conducted Spurious Emissions - Fixed Channel 61

Emission Band	Spurious Frequency (GHz)	Emission Level (dBm)	Corrected Emission Level (-22dB)	40 dBc Limit (dBm)	60 dBc Limit (dBm)	Margin (dB) vs (40 dBc) Limit	Margin (dB) vs (60 dBc) Limit	Reference Figure
8.2 to 12.4 GHz	9.488	-39.17 +0.83	-21.17	+12.55	-7.45	+33.72	+13.72	Figure F-63
12.4 to 18.0 GHz	12.811	-68.67 -48.67	-70.67	+12.55	-7.45	+83.22	+63.22	Figure F-64
18.0 to 26.5 GHz	18.680	-39.33 -19.33	-41.33	+12.55	-7.45	+53.88	+33.88	Figure F-65
26.5 to 40.0 GHz	28.01	-41.50 -21.50	-43.50	+12.55	-7.45	+56.05	+36.05	Figure F-66

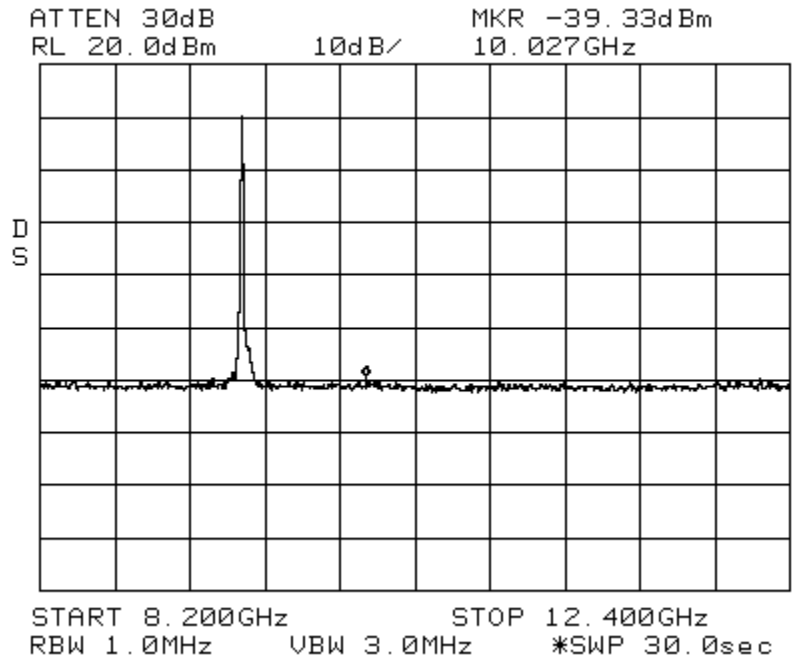


Figure F-31. Conducted Spurious Emissions, Normal, 8.2 to 12.4 GHz

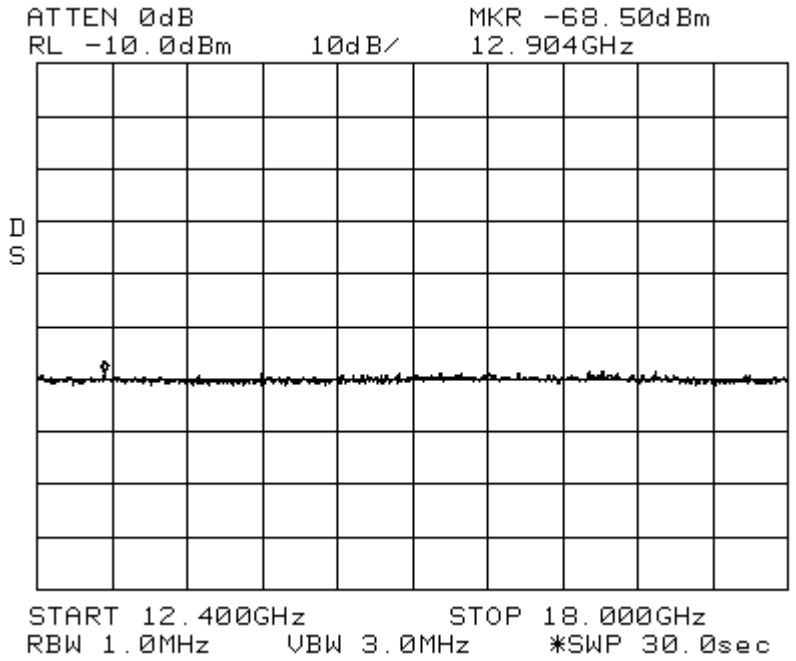


Figure F-32. Conducted Spurious Emissions, Normal, 12.4 to 18.0 GHz

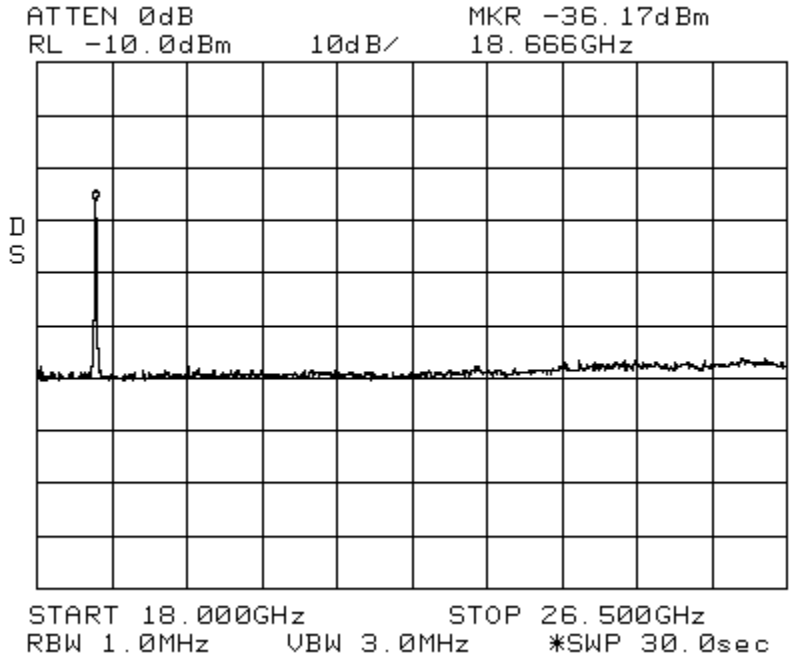


Figure F-33. Conducted Spurious Emissions, Normal, 18.0 to 26.5 GHz

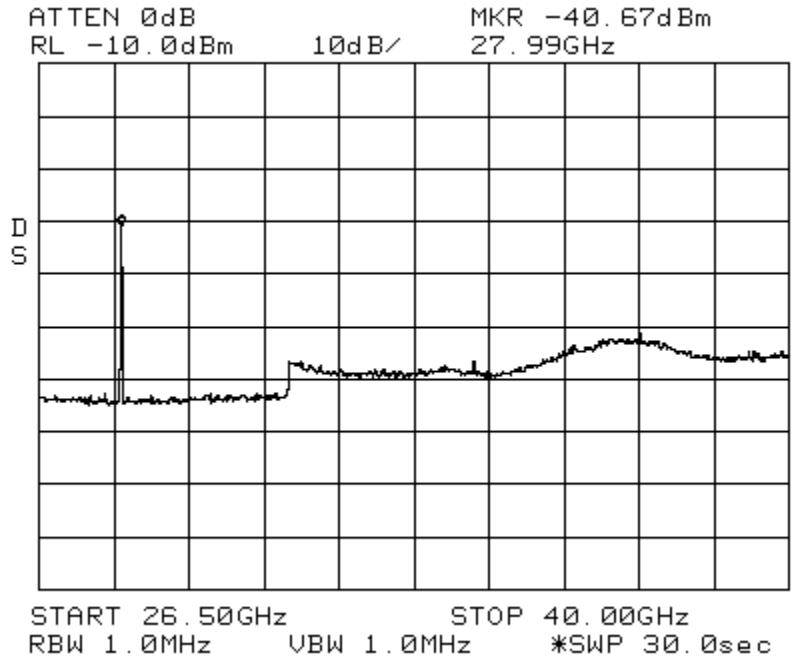


Figure F-34. Conducted Spurious Emissions, Normal, 26.5 to 40.0 GHz

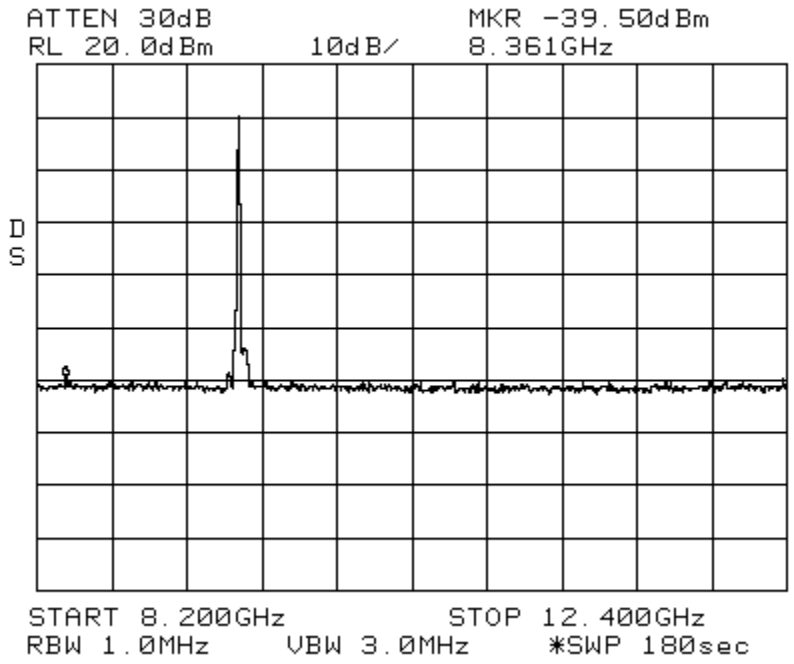


Figure F-35. Channel 0, Conducted Spurious Emissions, 8.2 to 12.4 GHz

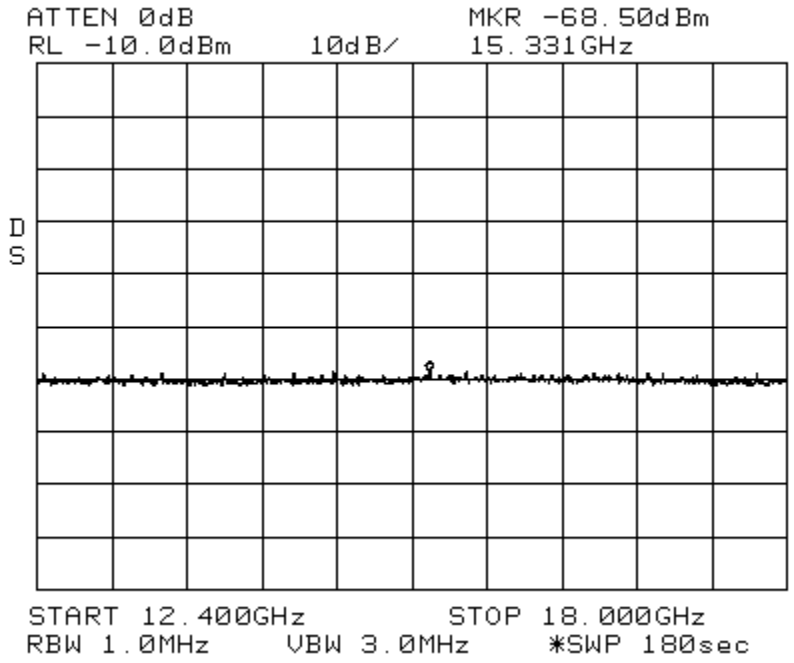


Figure F-36. Channel 0, Conducted Spurious Emissions, 12.4 to 18.0 GHz

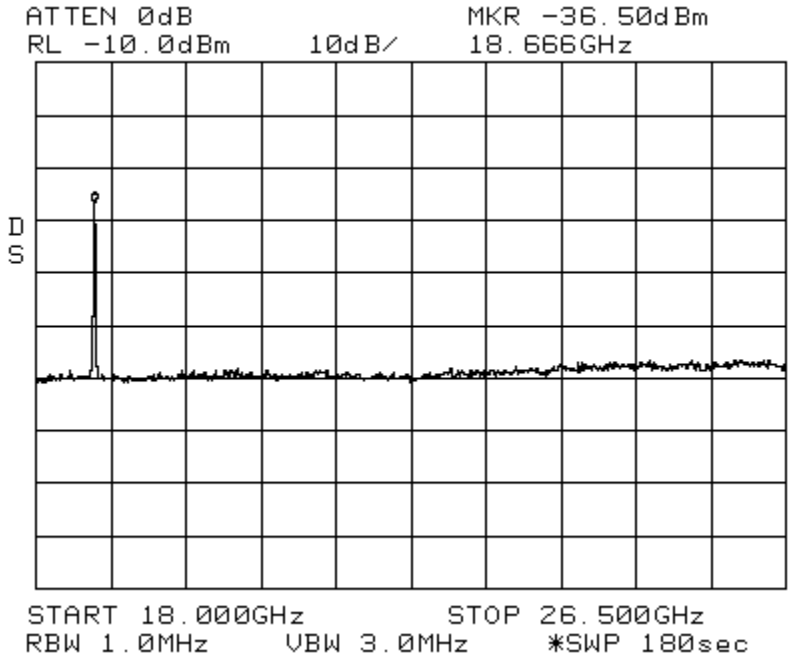


Figure F-37. Channel 0, Conducted Spurious Emissions, 18.0 to 26.5 GHz

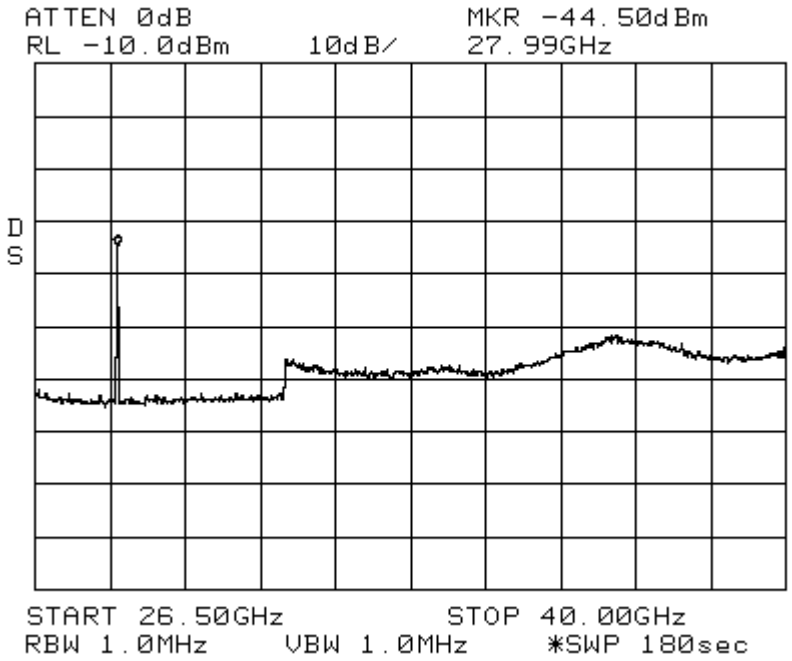


Figure F-38. Channel 0, Conducted Spurious Emissions, 26.5 to 40.0 GHz

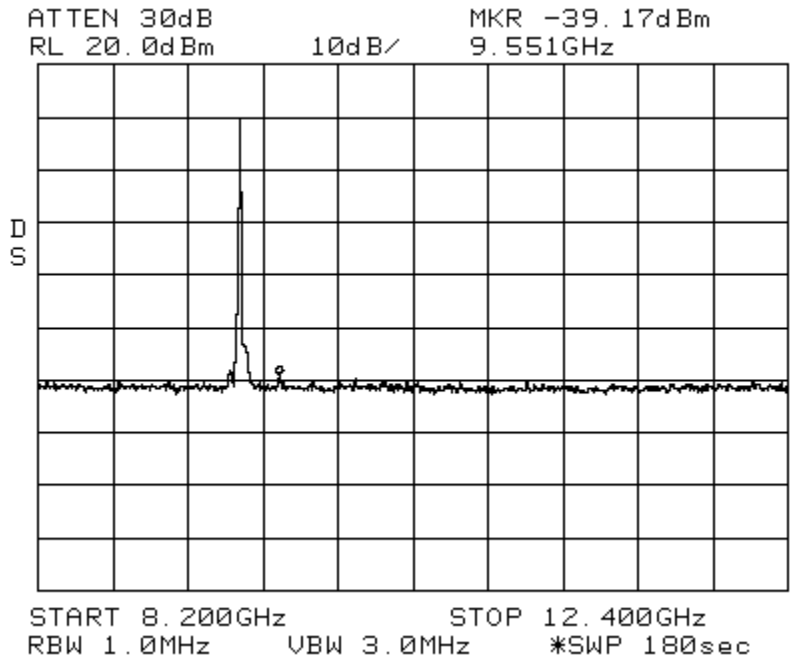


Figure F-39. Channel 9, Conducted Spurious Emissions, 8.2 to 12.4 GHz

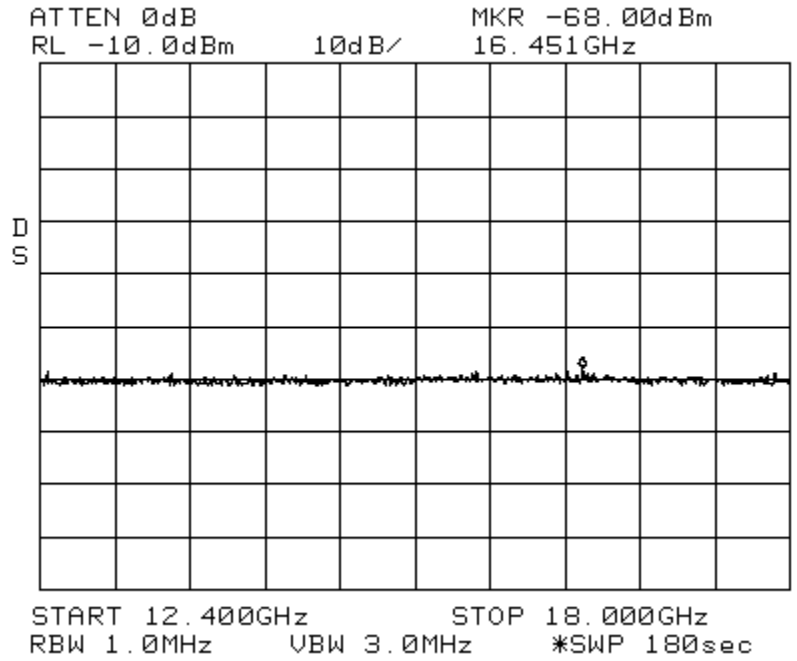


Figure F-40. Channel 9, Conducted Spurious Emissions, 12.4 to 18.0 GHz

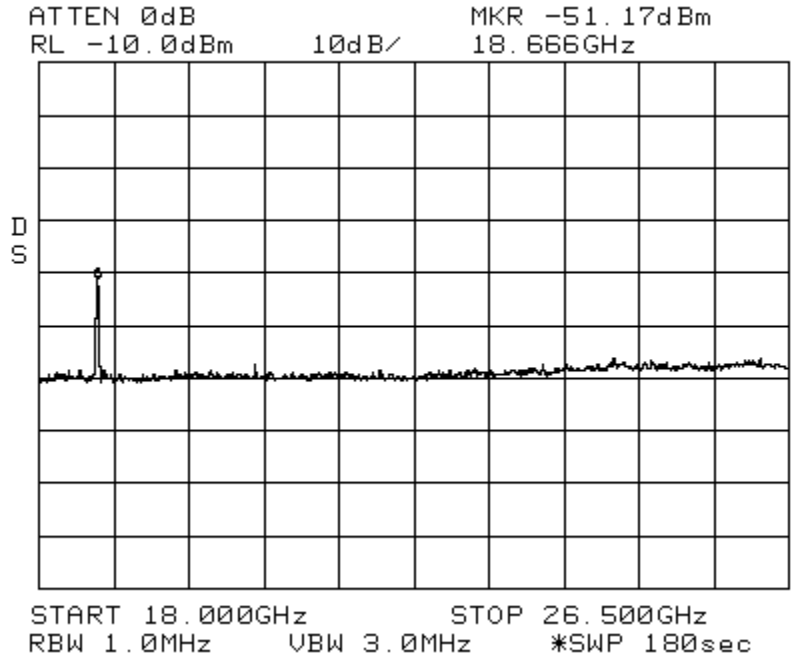


Figure F-41. Channel 9, Conducted Spurious Emissions, 18.0 to 26.5 GHz

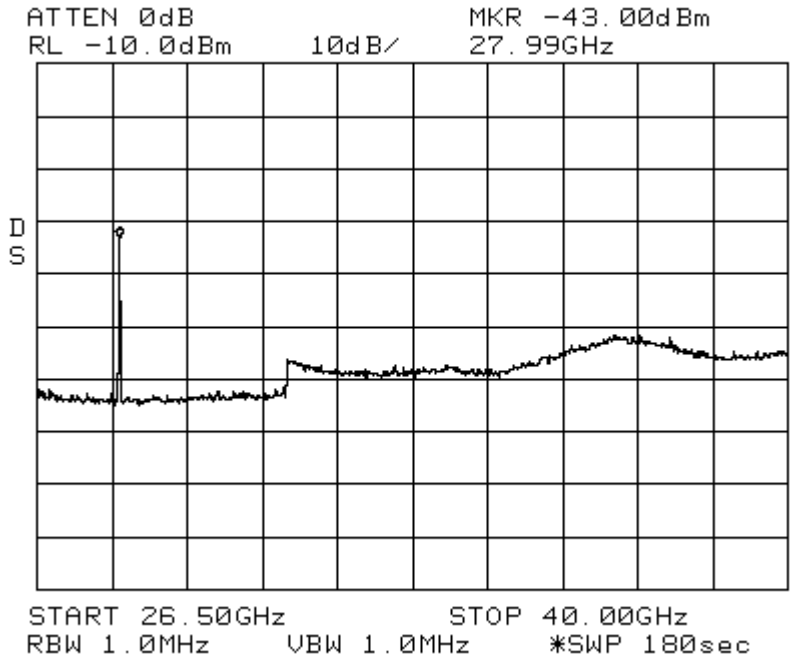


Figure F-42. Channel 9, Conducted Spurious Emissions, 26.5 to 40.0 GHz

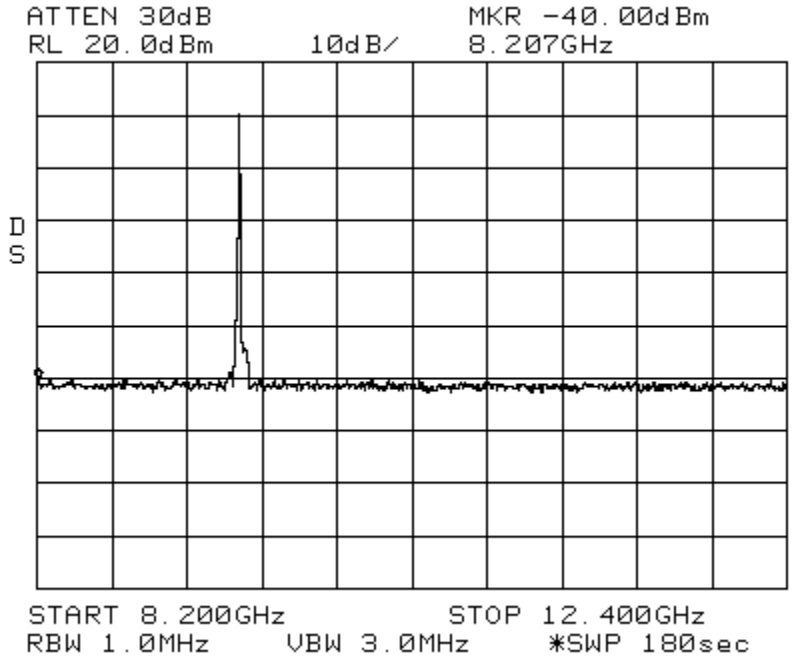


Figure F-43. Channel 17, Conducted Spurious Emissions, 8.2 to 12.4 GHz

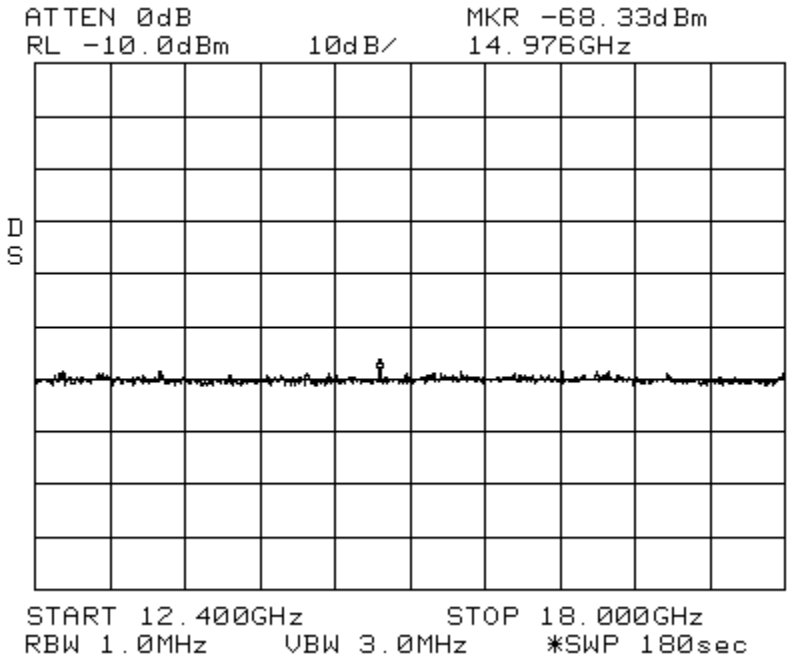


Figure F-44. Channel 17, Conducted Spurious Emissions, 12.4 to 18.0 GHz

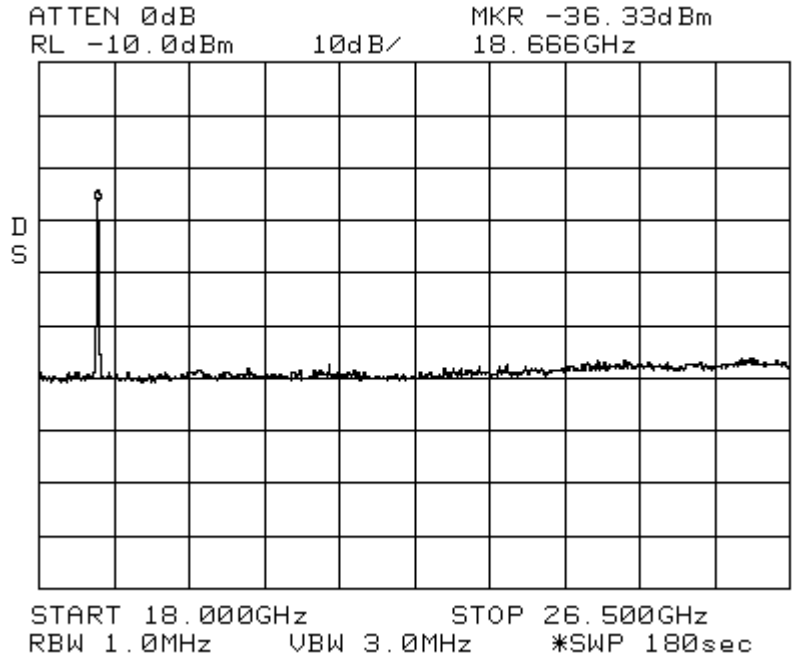


Figure F-45. Channel 17, Conducted Spurious Emissions, 18.0 to 26.5 GHz

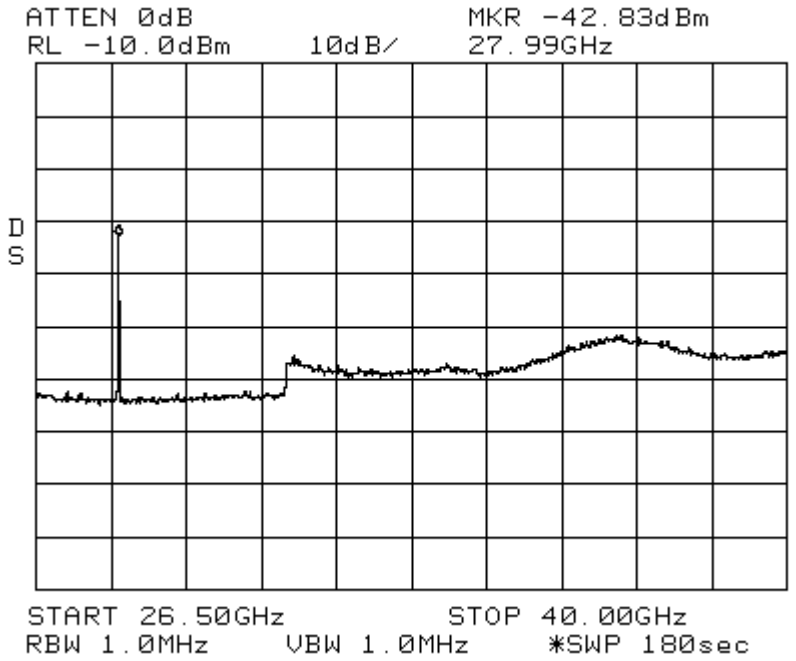


Figure F-46. Channel 17, Conducted Spurious Emissions, 26.5 to 40.0 GHz

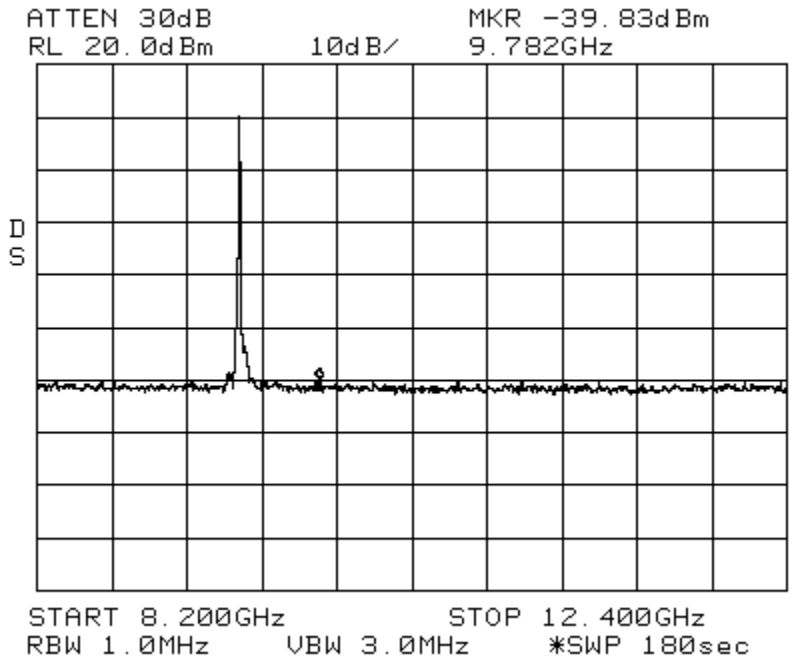


Figure F-47. Channel 26, Conducted Spurious Emissions, 8.2 to 12.4 GHz

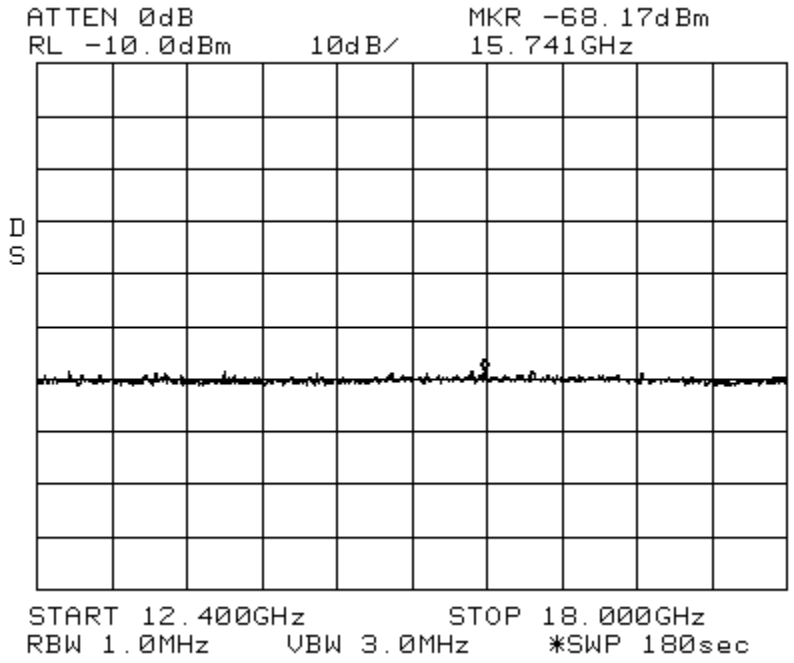


Figure F-48. Channel 26, Conducted Spurious Emissions, 12.4 to 18.0 GHz

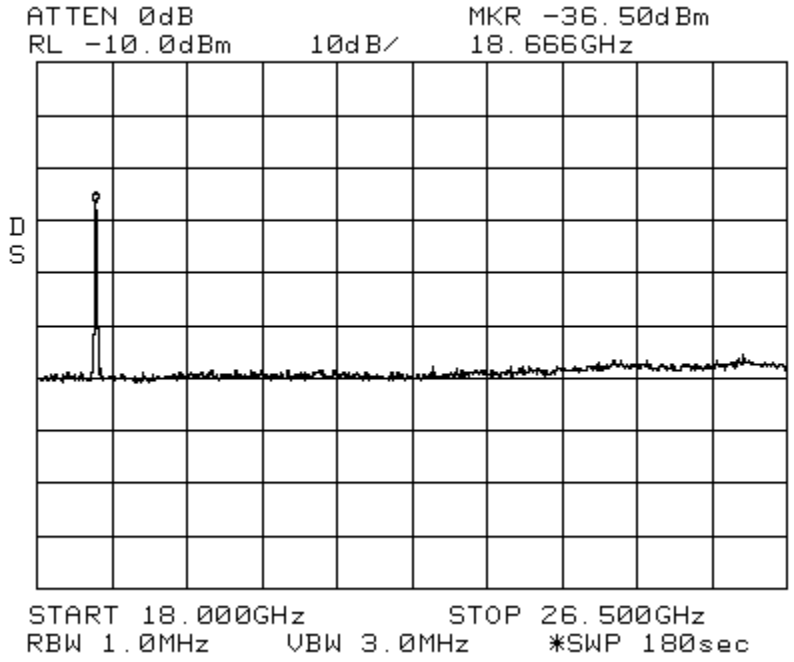


Figure F-49. Channel 26, Conducted Spurious Emissions, 18.0 to 26.5 GHz

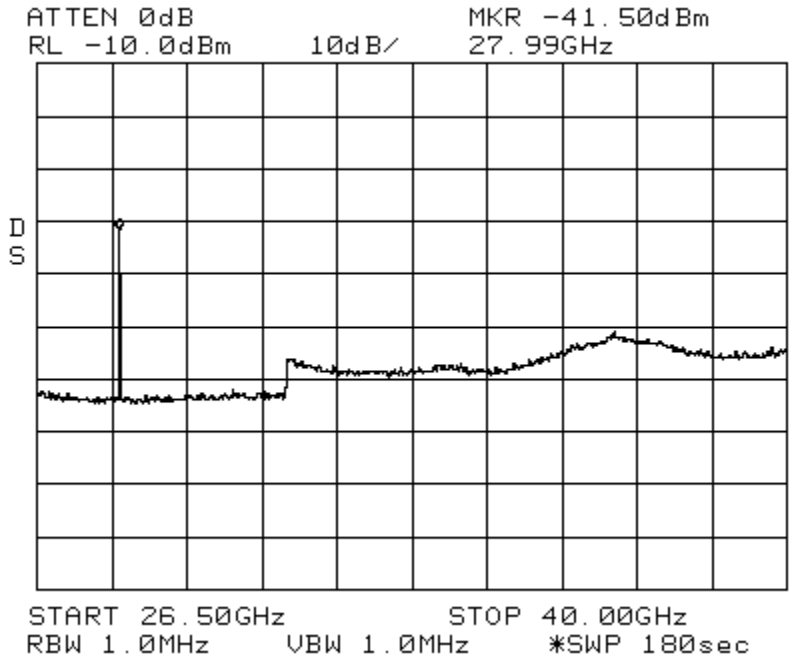
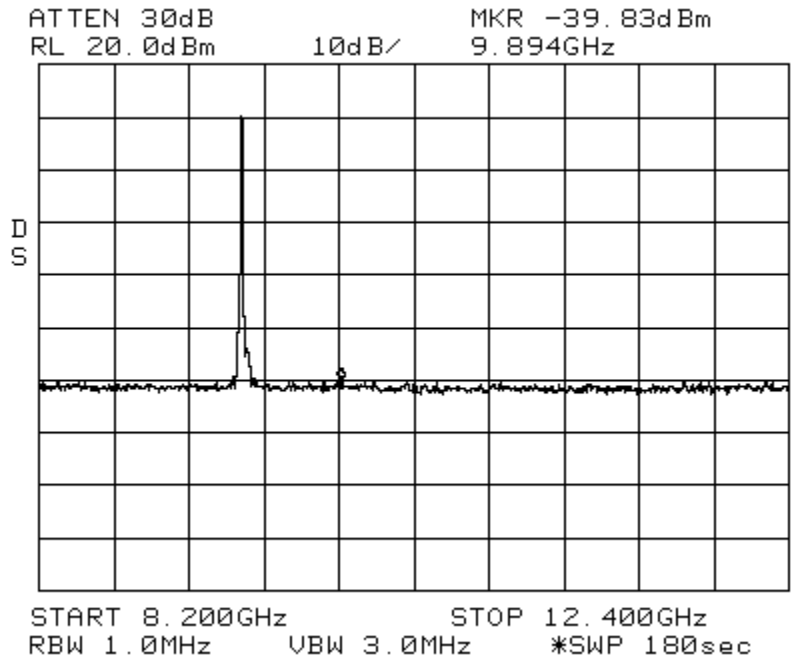


Figure F-50. Channel 26, Conducted Spurious Emissions, 26.5 to 40.0 GHz



FigureF-51. Channel 35, Conducted Spurious Emissions, 8.2 to 12.4 GHz

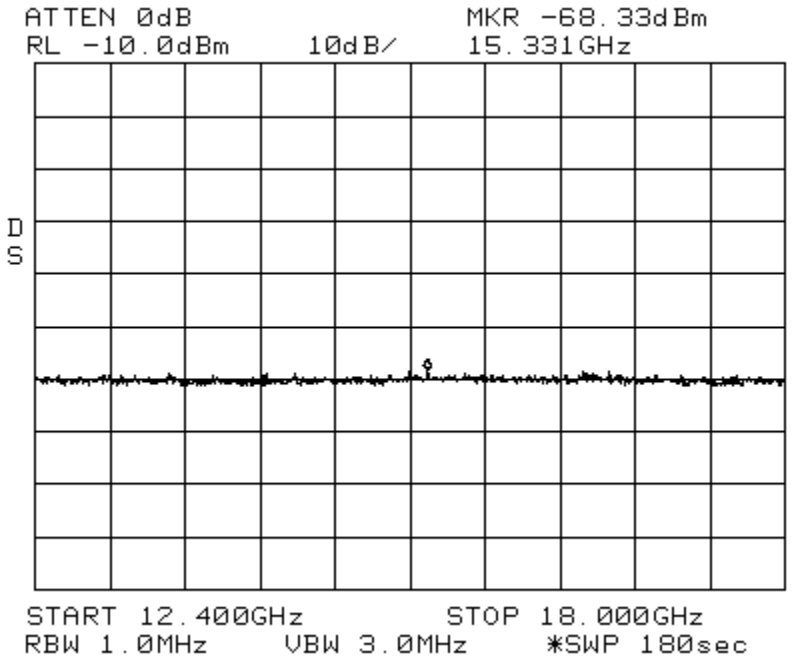


Figure F-52. Channel 35, Conducted Spurious Emissions, 12.4 to 18.0 GHz

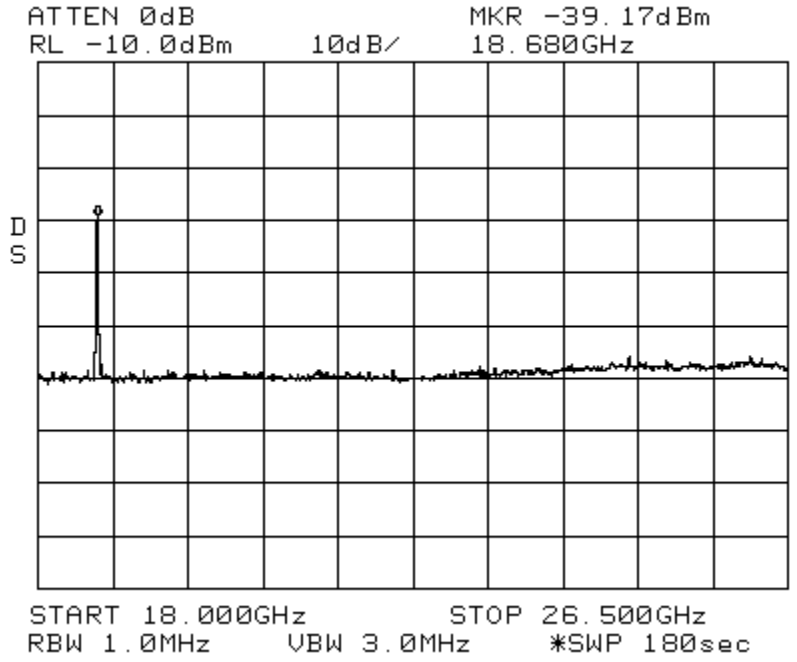


Figure F-53. Channel 35, Conducted Spurious Emissions, 18.0 to 26.5 GHz

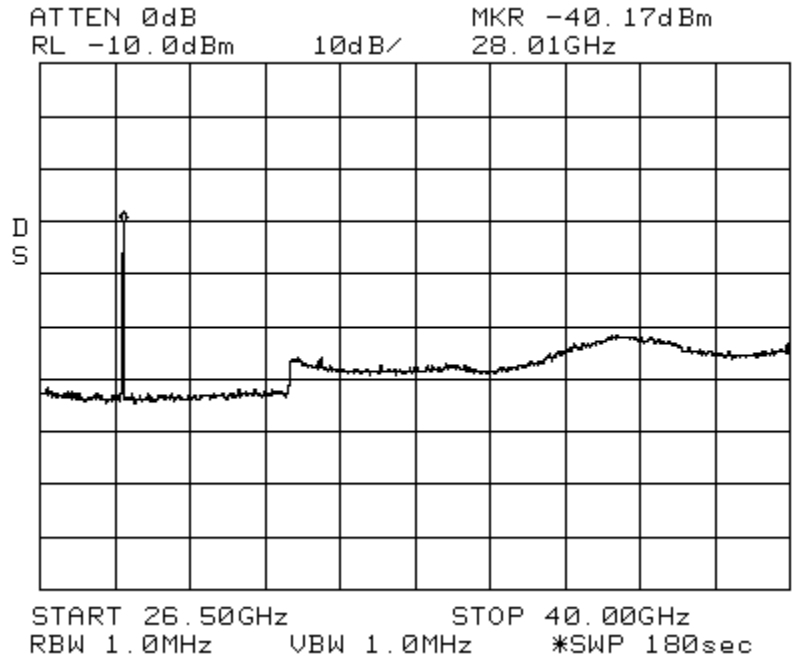


Figure F-54. Channel 35, Conducted Spurious Emissions, 26.5 to 40.0 GHz

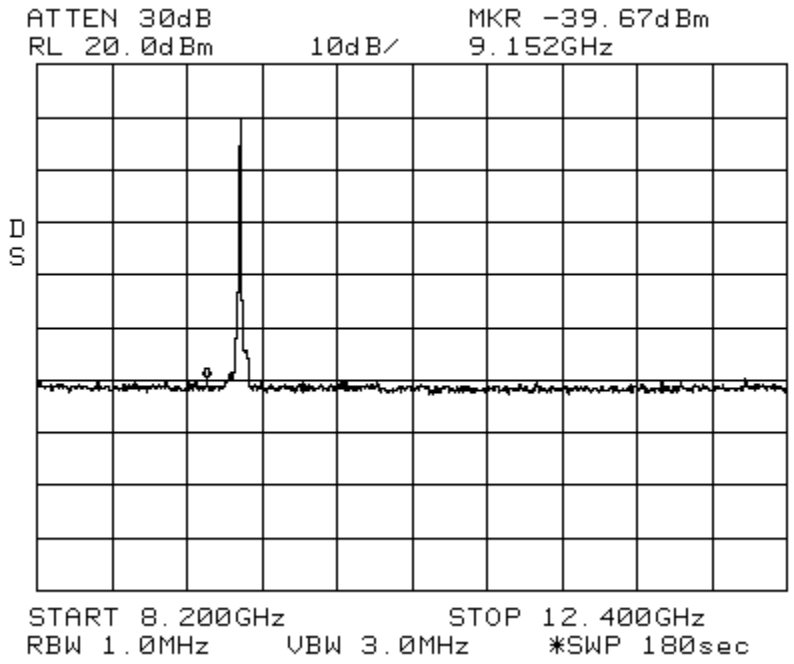


Figure F-55. Channel 44, Conducted Spurious Emissions, 8.2 to 12.4 GHz

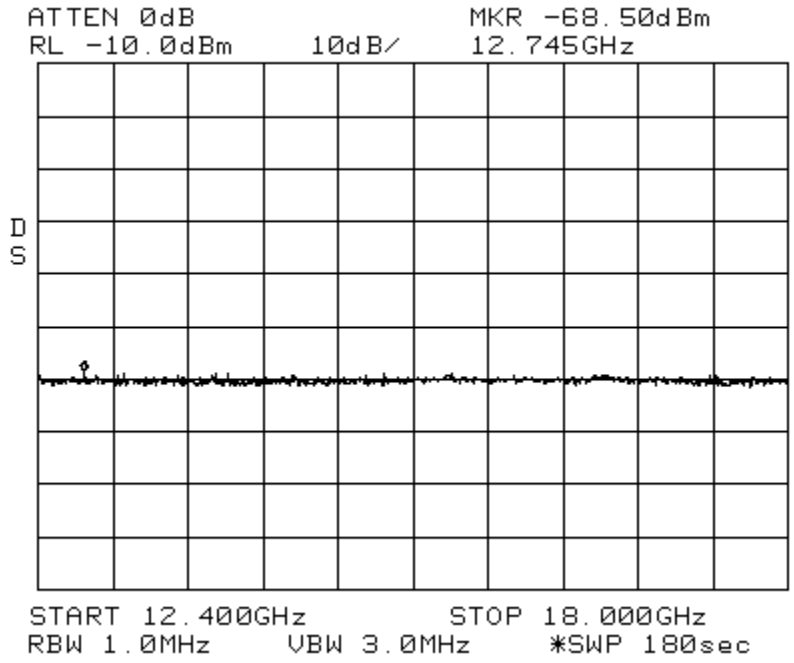


Figure F-56. Channel 44, Conducted Spurious Emissions, 12.4 to 18.0 GHz

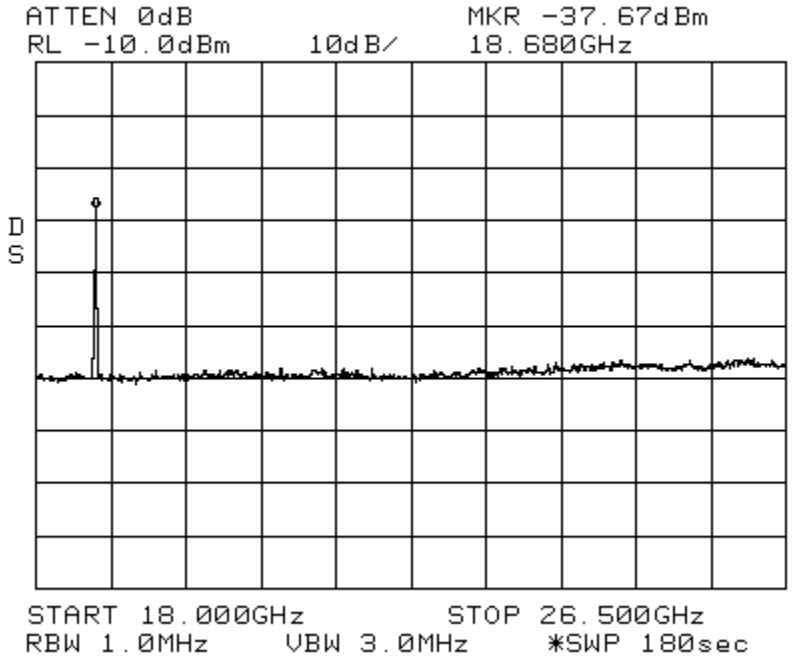


Figure F-57. Channel 44, Conducted Spurious Emissions, 18.0 to 26.5 GHz

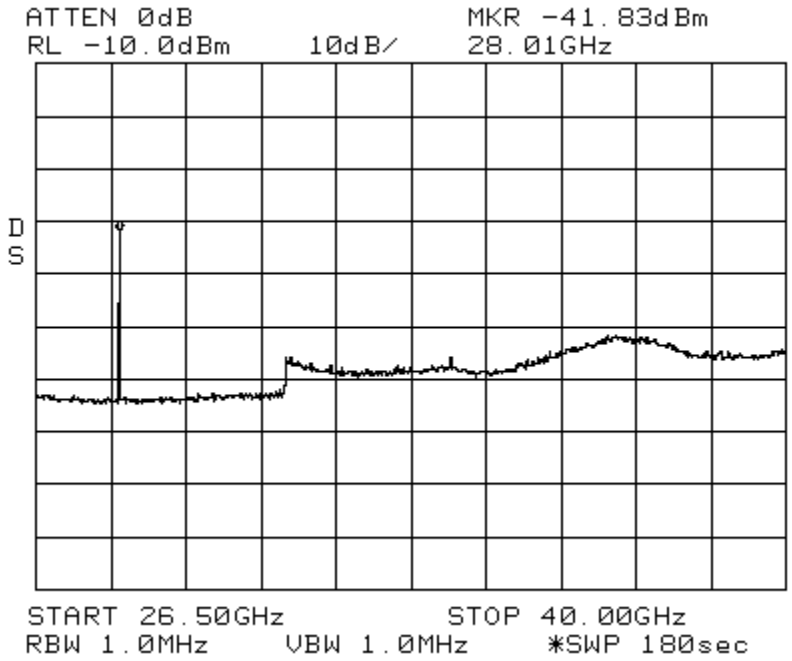


Figure F-58. Channel 44, Conducted Spurious Emissions, 26.5 to 40.0 GHz

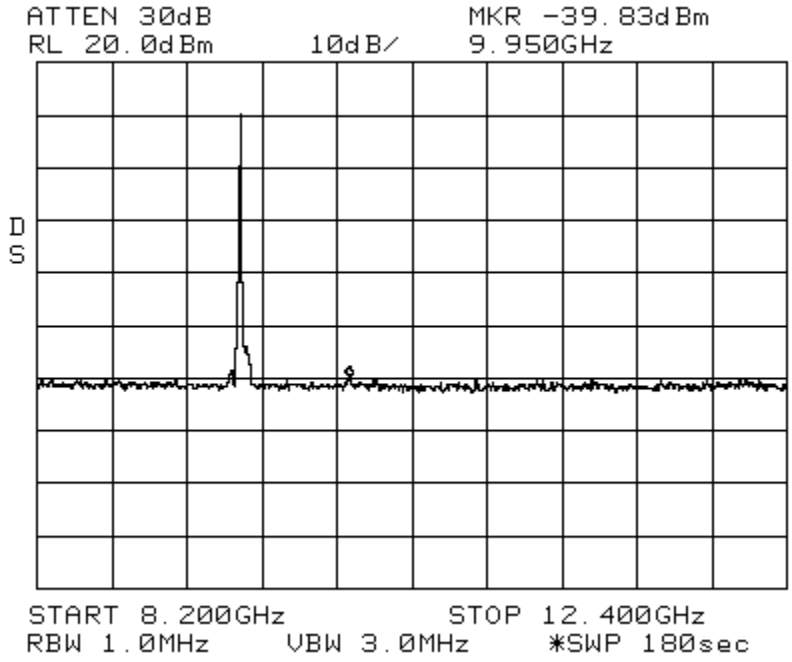


Figure F-59. Channel 52, Conducted Spurious Emissions, 8.2 to 12.4 GHz

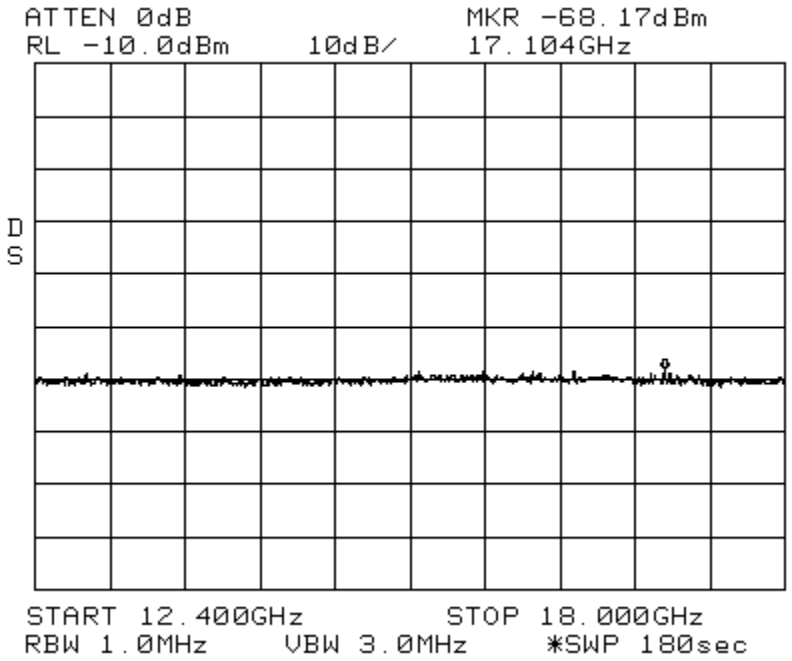


Figure F-60. Channel 52, Conducted Spurious Emissions, 12.4 to 18.0 GHz

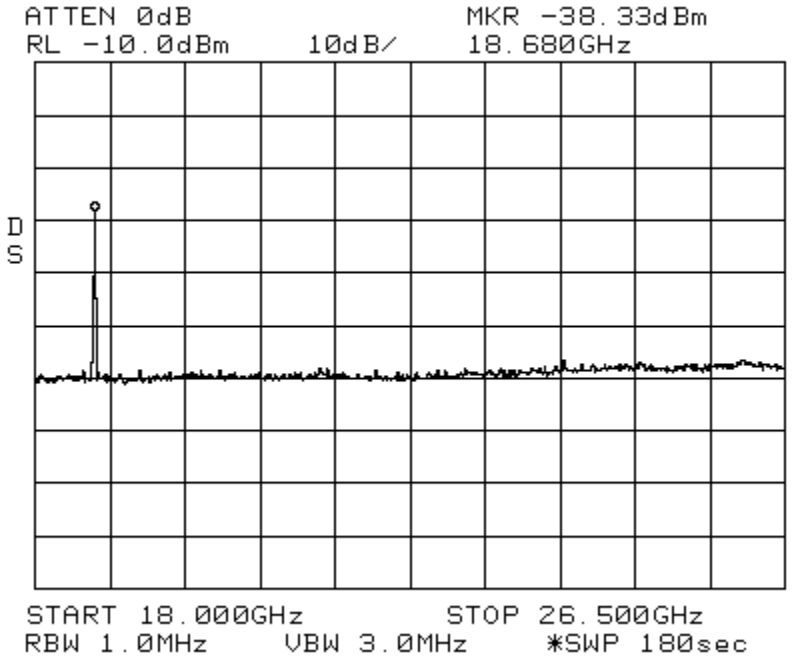


Figure F-61. Channel 52, Conducted Spurious Emissions, 18.0 to 26.5 GHz

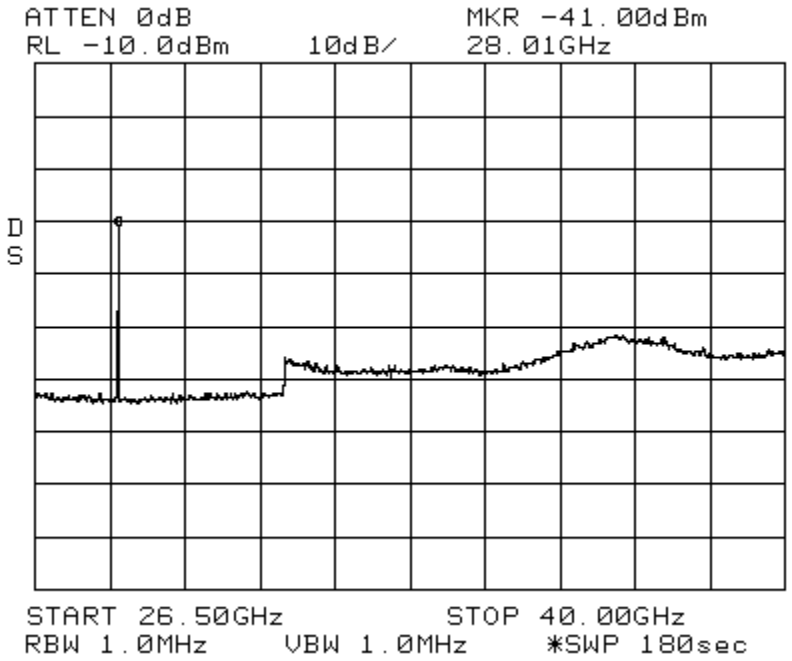


Figure F-62. Channel 52, Conducted Spurious Emissions, 26.5 to 40.0 GHz

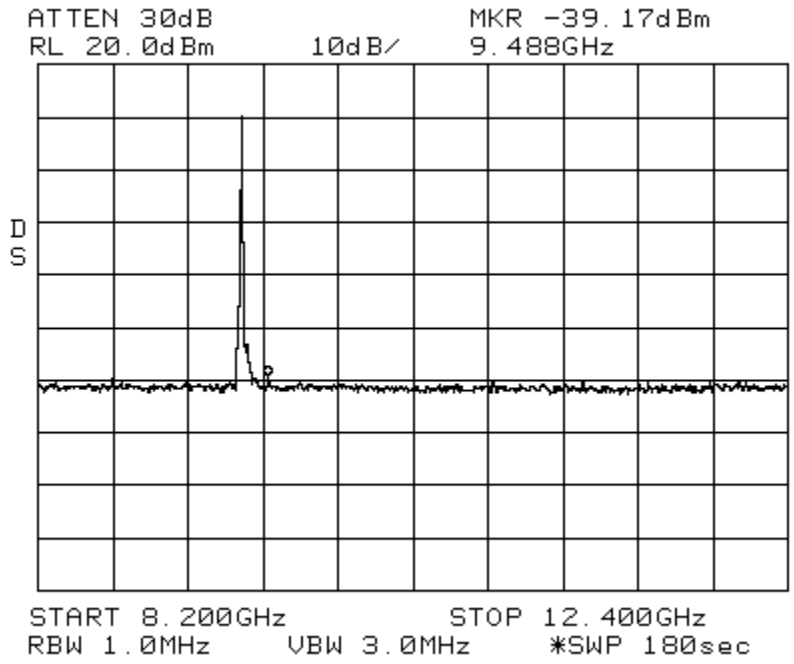


Figure F-63. Channel 61, Conducted Spurious Emissions, 8.2 to 12.4 GHz

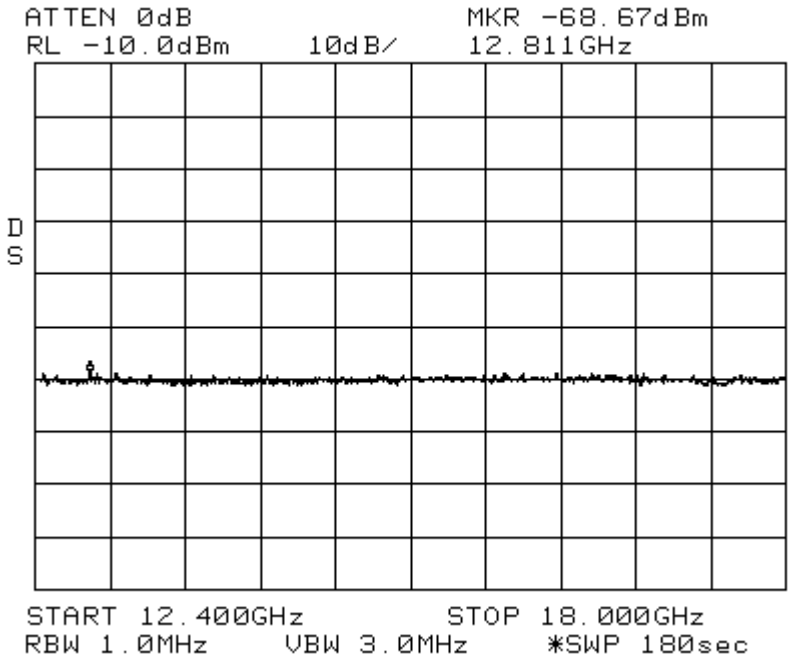


Figure F-64. Channel 61, Conducted Spurious Emissions, 12.4 to 18.0 GHz

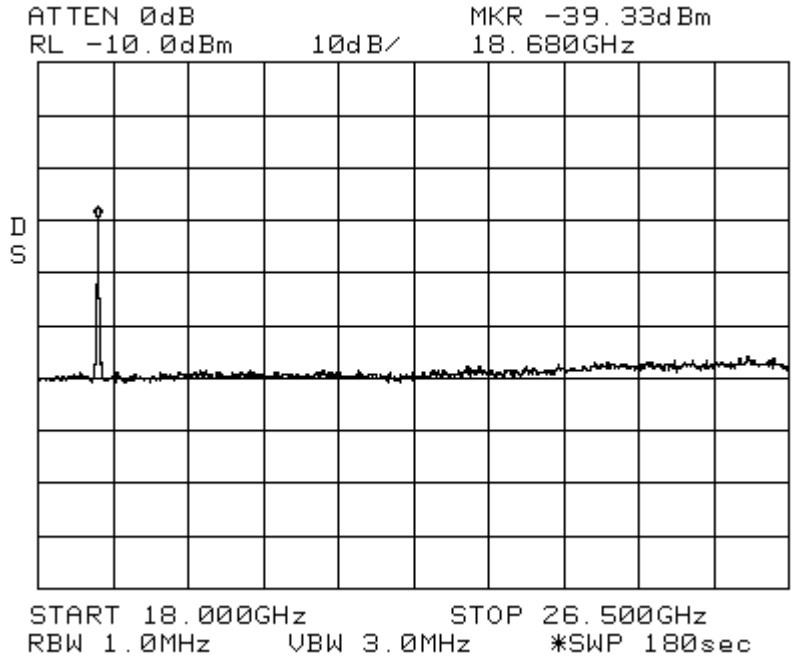


Figure F-65. Channel 61, Conducted Spurious Emissions, 18.0 to 26.5 GHz

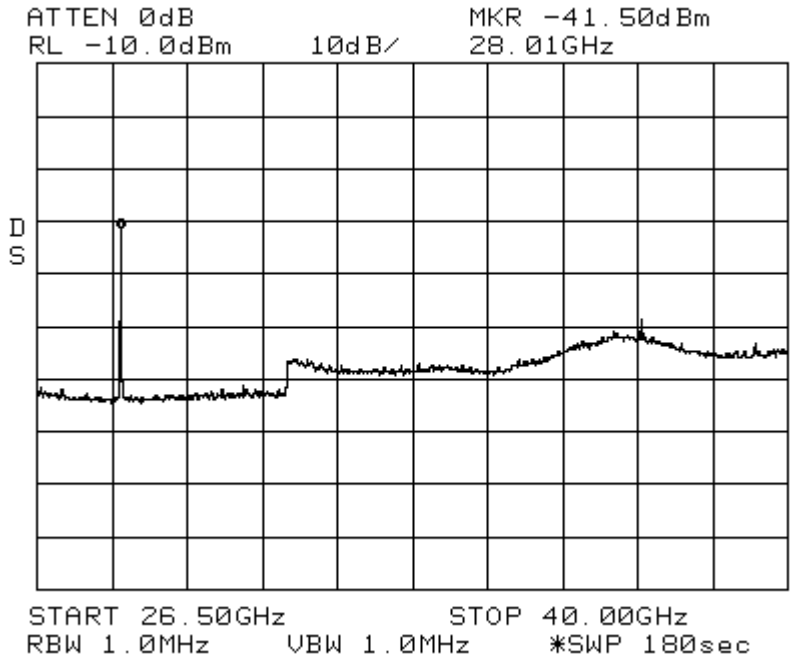


Figure F-66. Channel 61, Conducted Spurious Emissions, 26.5 to 40.0 GHz

F.8 Field Strength of Spurious Radiation (2.1053)

Requirement:

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 that 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+log10(pY) dB.

The WRT-2100X Test Article used for Field Strength of Spurious Radiation testing had a peak power of 180 Watts.

Table F-27. Spurious Emission 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

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

FCC Limit = 40 dBc

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

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

E2 = (30*G*L)/R Where: G = 1.64 (dipole gain)
L = Limit (Watts)
R = 1 meter (Test distance)
E = Field strength (volts/meter).

The WRT-2100X Test Article used for Field Strength of Spurious Radiation testing had a peak power of 180 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.)

Peak Power = 52.55 dBm, Assumed Duty Cycle = 0.05

Ptx(average) = 9.00 Watts average

FCC Limit (dBc) = 40

Limit (Watts) = $9.00\times10^{-40/\ 10}$ = 9.00×10^{-4} W average

E2 = $30\times1.64\times9.00\times10^{-4}$ = 4.428×10^{-2}

E (V/m) = $\sqrt{4.428\times10^{-2}}$ = 210428.135 μV/m average

E (dBμV/m) = 20 $\times$ log (210428.135 μV/m) = 106.462 dBμV/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 dBμV/m.

Method 1:

Limit (average) = 106.462 dBµV/m

Limit (average) = $10^{106.462/20}$ = 210426.291 µV/m

Limit (peak) = $\frac{210426.291^2}{0.05}$ = 8.8558×10^{11} µV/m

Limit (peak) = $10 \times \log(8.8558 \times 10^{11}$ µV/m) ***= 119.472 dBmV/m***

Method 2:

Limit (average) = 106.462 dBµV/m

Peak Power (mW) = $10^{(52.55/10)}$ = 179,887.092 mW

Average Power (mW) = 179,887.092 mW × .05 = 8994.355 mW

Average Power (dBm) = 10 log (8994.355 mW) = 39.540 dBm

Difference (dB) = 52.550 dBm(peak) – 39.540 dBm(average) = 13.01 dB

Limit (peak) = 106.462 dBµV/m + 13.01 dB ***= 119.472 dBmV/m***

Therefore, the absolute limit of ***119.472 dBmV/m*** was used for these tests.

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 WRT-2100 was operated in Weather + Turb + Windshear + Auto modes. These modes represent the maximum operating condition for the unit.

Range 40 NM/160 NM
Mode WX+TURB/Windshear
Altitude 1000 FT
W/S Enabled
Auto Selected

The WRT-2100 Radiated Emissions Data was taken with the unit operating on each of the four operating conditions specified in Table F-28. The “Mode 1” condition represents the normal operating mode of the WRT-2100 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-28. WRT-2100 Radiated Emissions Test Operating Conditions

Test Condition	Channel	Tx Freq (MHz)	Remarks
Mode 1	Auto	Multiple	
Fixed 0	0	9327.424486	Lowest Freq
Fixed 61	61	9338.861986	Highest Freq

The equipment used for the Field Strength of Spurious Radiation test is listed in Table F-29.

Table F-29. Test Equipment Used for Field Strength of Spurious Radiation Test

Equipment	Manufacturer/Model Number	Specific Identification	Calibration Due Date
Receiver/Transmitter	Rockwell Collins WRT-701X (822-1710-950)	SN 1JLTL	N/A
Indicator/Control (Qty 2)	Rockwell Collins WXI-711 (622-5128-301) (622-6514-203)	SN 2206, SN 421	N/A N/A
Control Pannel	Rockwell Collins WCP-701 (622-5129-801)	SN 5184	N/A
Antenna Pedestal	Rockwell Collins WMA (622-5735-803)	SN 753T	N/A
ARINC Bus Transmitter Receiver (Qty 2)	JCAir 429E	460-0206-166 (SN 181) 460-0206-290 (SN 249)	N/A
28 VDC Power Supply	Sorensen QRD40-2	460-0055-340 SN 00003454	N/A
Test Harness	Rockwell Collins Test Harness	N/A	N/A
LapTop P.C.	Toshiba 430CDT	SN 01768919	N/A
Power Supply VariAC	Collins AC Control 779-9459-006	460-0062-208	10-31-2005
RF Dummy Load	AirTron 252126	SN 7019	N/A
Active Monopole Antenna (150KHz - 25MHz)	Electro-Metrics RVA30	460-0118-546	04-30-2005
Antenna (1GHz - 18GHz)	Emco 3115	460-0078-854	04-30-2007
Biconical Antenna (25 MHz – 200 MHz)	Emco 3104C	460-0133-792	02-28-2006
Antenna (200MHz - 1GHz)	Emco 3106	460-0133-794	N/A
Gain Horn (18 GHz – 26.5 GHz)	Emco 3160-9	N/A	N/A
Gain Horn (26 GHz – 40 GHz)	MI Technologies 12A-26	460-1213-955	N/A
Amplifier (18 - 26.5 GHz)	R & S 032001/002	N/A	N/A
Amplifier (26.5 - 40 GHz)	R & S 032001/003	N/A	N/A
EMI Test Receiver	Rohde & Schwarz ESIB40	460-0212-537 SN 8378081001	11-30-2005
Antenna	Emco 3101	460-0113-396	05-31-2005
LISN	FCC 5-10-01 Def Stn 59-41C	460-0211-578	11-30-2007

Equipment Setup:

The test setup for the Field Strength of Spurious Radiation test is shown in Figure F-67.

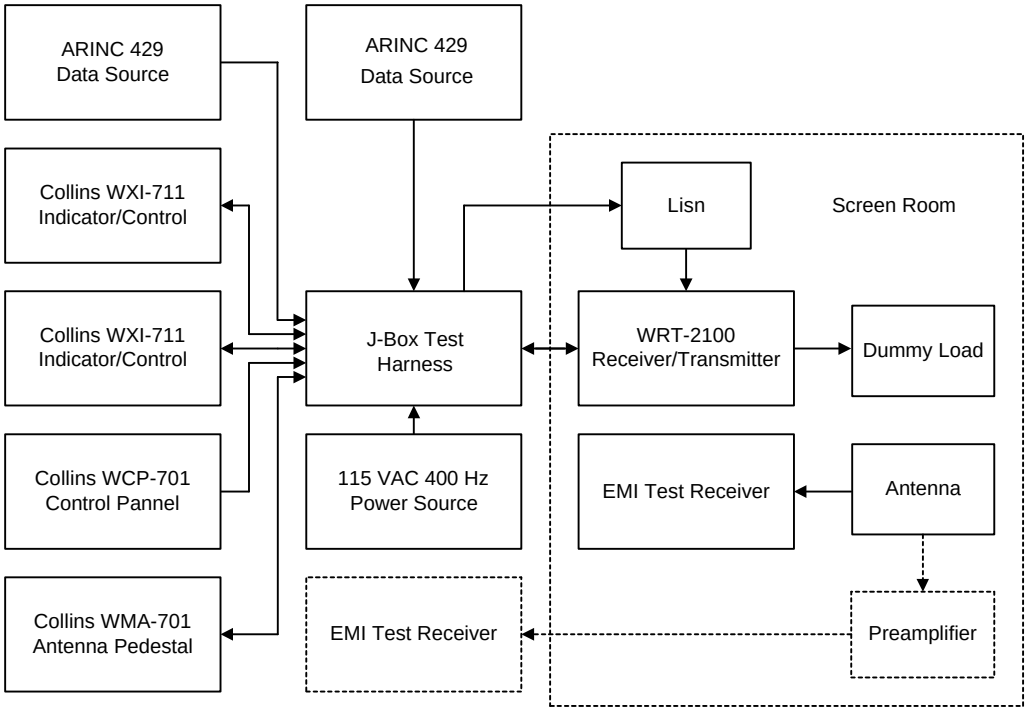


Figure F-67. Field Strength of Spurious Radiation Test Setup

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***.

Emissions Measurements (Normal Mode):

Spectrum measurements for the normal mode of operation are presented in Table F-30.

Spectrum plots for the normal mode of operation are provided as Figure F-68 through Figure F-73.

Table F-30. Field Strength of Spurious Radiation - Normal Mode

Field Strength of Spurious Radiation					
Transmitter Frequency	Measurement Band	Polarization	Peak Emission		Reference
			Frequency (MHz)	Level (dBuV/m)	
Normal Mode	150 KHz to 200 MHz	Vertical	N/A	All emissions < 50	Figure F-68
	25 MHz to 1 GHz	Horizontal	N/A	All emissions < 80	Figure F-69
	1 GHz to 18 GHz	Vertical	N/A	All emissions < 110	Figure F-70
		Horizontal	N/A	All emissions < 100	Figure F-71
	18 GHz to 40 GHz	Vertical	N/A	All emissions < 110	Figure F-72
		Horizontal	N/A	All emissions < 100	Figure F-73

Spectrum Plots (Normal Mode):

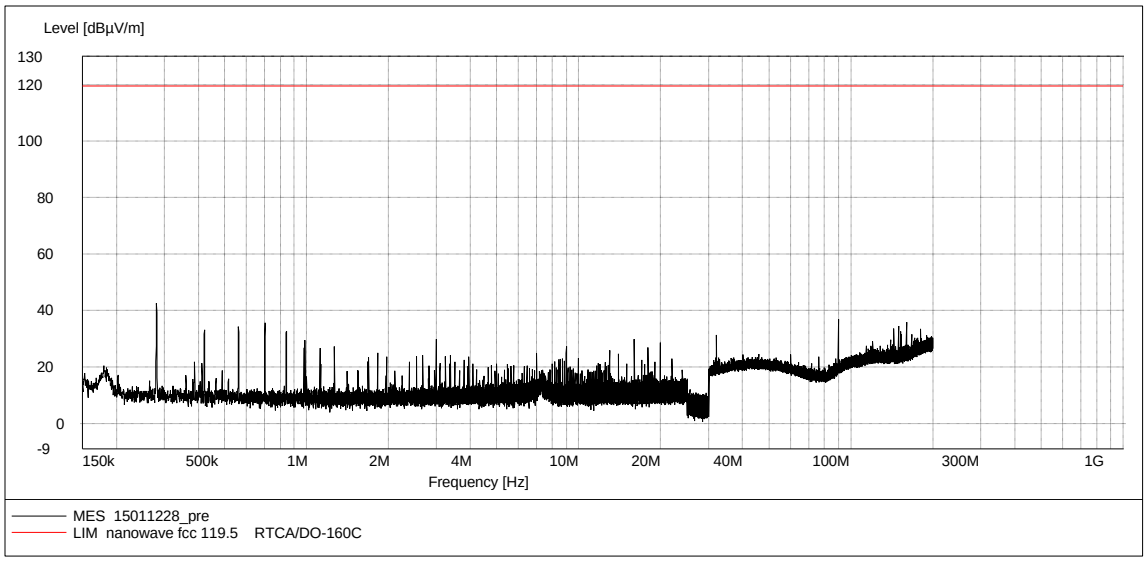


Figure F-68. Radiated Spurious Emissions, Normal Mode, 150 KHz to 200 MHz, (Vertical Polarization)

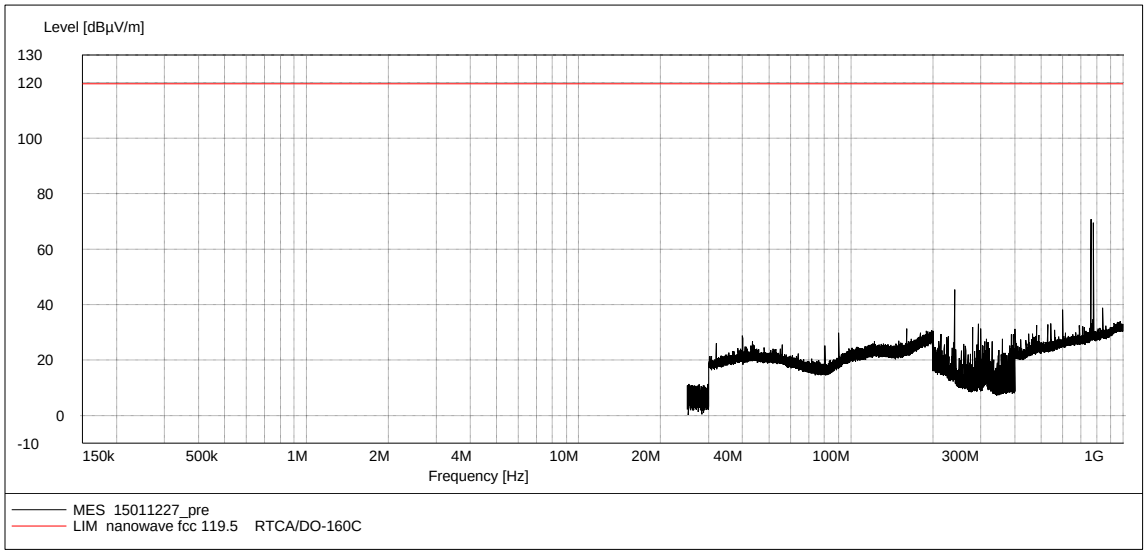


Figure F-69. Radiated Spurious Emissions, Normal Mode, 25 MHz to 1 GHz, (Horizontal Polarization),

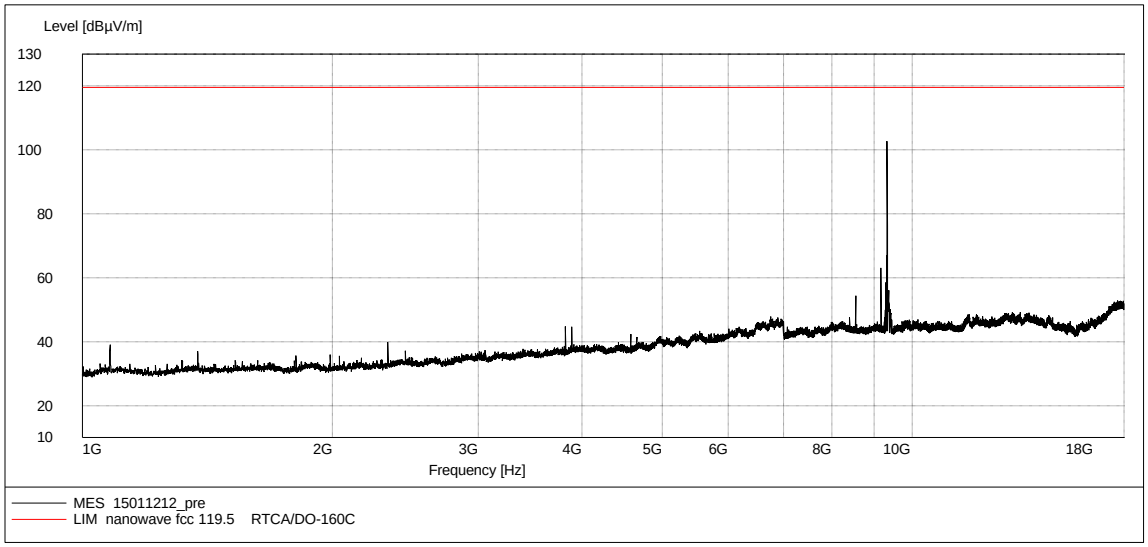


Figure F-70. Radiated Spurious Emissions, Normal Mode, 1 GHz to 18 GHz, (Vertical Polarization

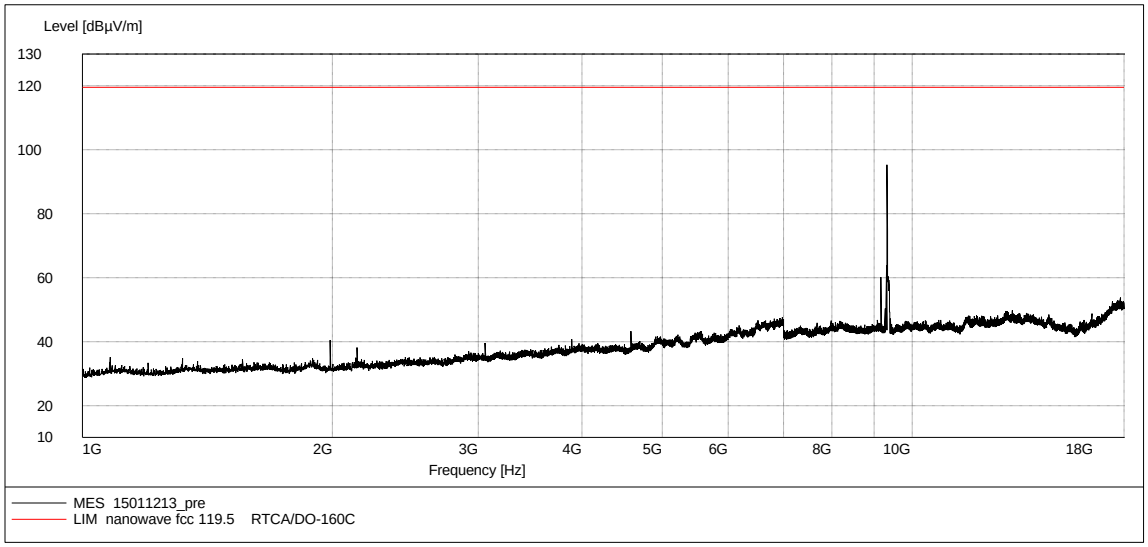


Figure F-71. Radiated Spurious Emissions, Normal Mode, 1 GHz to 18 GHz, (Horizontal Polarization)

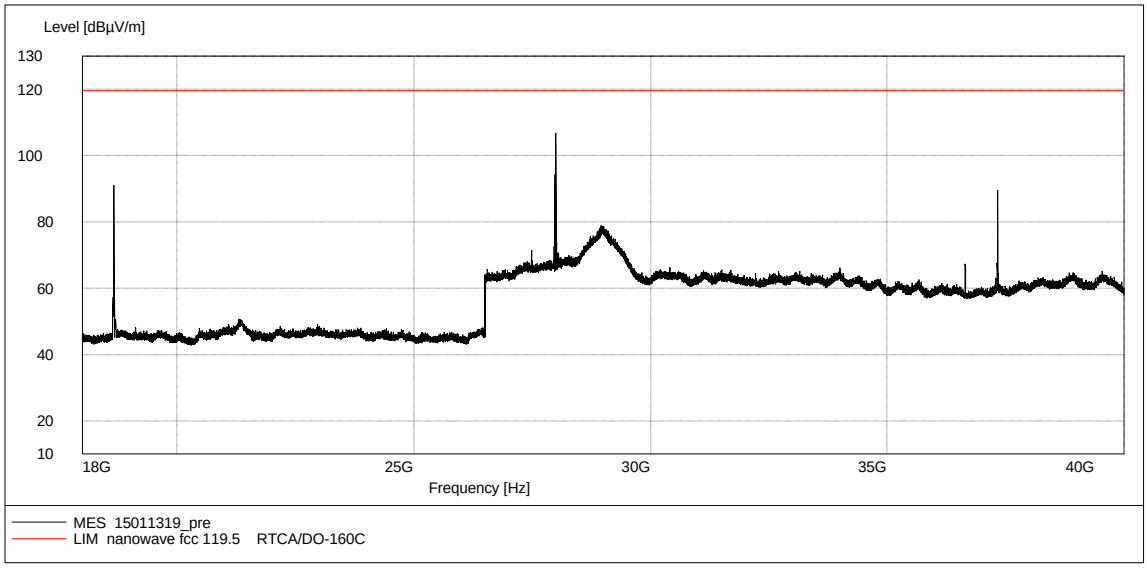


Figure F-72. Radiated Spurious Emissions, Normal Mode, 18 GHz to 40 GHz, (Vertical Polarization)

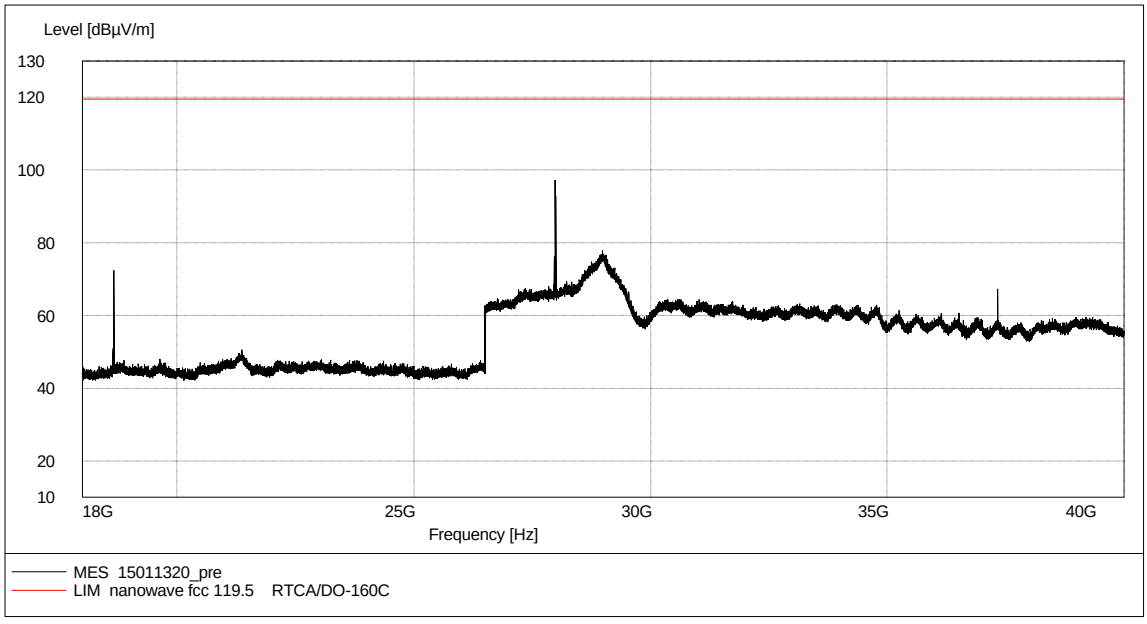


Figure F-73. Radiated Spurious Emissions, Normal Mode, 18 GHz to 40 GHz, (Horizontal Polarization)

Emissions Measurements (Fixed Channels):

The following data are additional measurements with the Receiver/Transmitter operating on each of 2 fixed channels: Channel 0 and 61. These fixed channels represent the lowest and highest frequency extremes for the WRT-2100.

Spectrum measurements for the fixed channel modes of operation are presented in Table F-31.

Spectrum plots for the fixed channel modes of operation are provided as Figure F-74 through Figure F-85.

Table F-31. Field Strength of Spurious Radiation – Fixed Frequency Mode

Field Strength of Spurious Radiation					
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 < 50	Figure F-74
	25 MHz to 1 GHz	Horizontal	N/A	All emissions < 80	Figure F-75
	1 GHz to 18 GHz	Vertical	N/A	All emissions < 110	Figure F-76
		Horizontal	N/A	All emissions < 100	Figure F-77
	18 GHz to 40 GHz	Vertical	27,982.00	110.60	Figure F-78
		Horizontal	N/A	All emissions < 80	Figure F-79
Normal Mode Channel 61	150 KHz to 200 MHz	Vertical	N/A	All emissions < 50	Figure F-80
	25 MHz to 1 GHz	Horizontal	N/A	All emissions < 80	Figure F-81
	1 GHz to 18 GHz	Vertical	N/A	All emissions < 90	Figure F-82
		Horizontal	N/A	All emissions < 90	Figure F-83
	18 GHz to 40 GHz	Vertical	N/A	All emissions < 110	Figure F-84
		Horizontal	N/A	All emissions < 90	Figure F-85

Spectrum Plots (Channel 0):

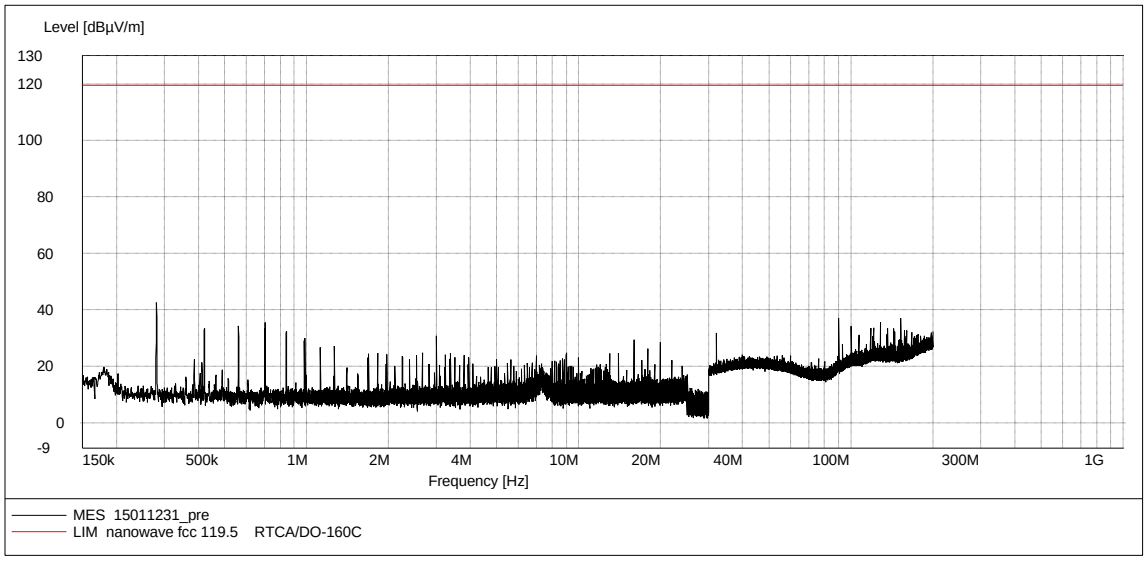


Figure F-74. Radiated Spurious Emissions, Channel 0, 150 KHz to 200 MHz, (Vertical Polarization)

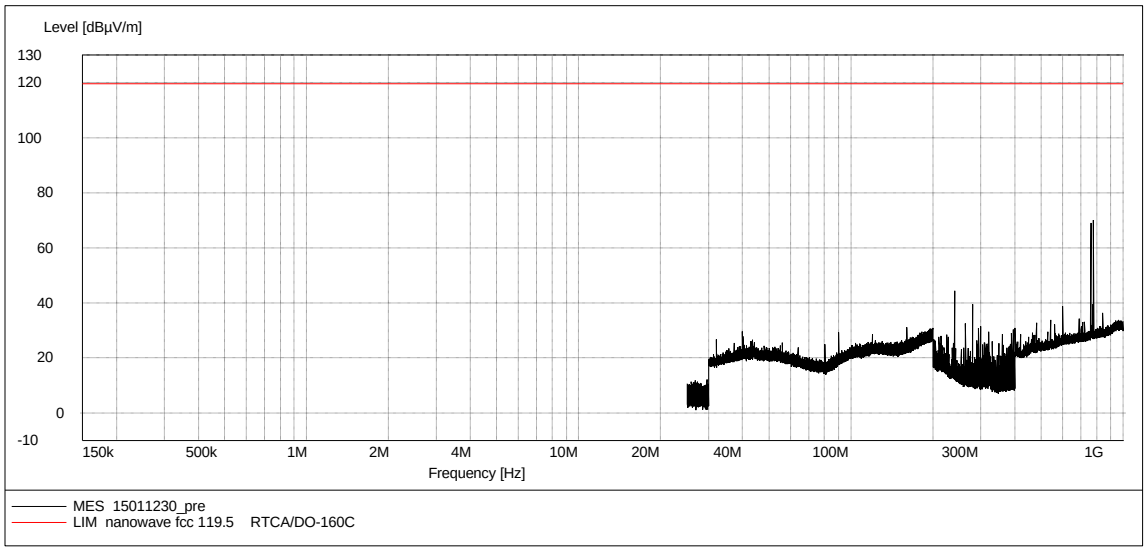


Figure F-75. Radiated Spurious Emissions, Channel 0, 25 MHz to 1 GHz, (Horizontal Polarization)

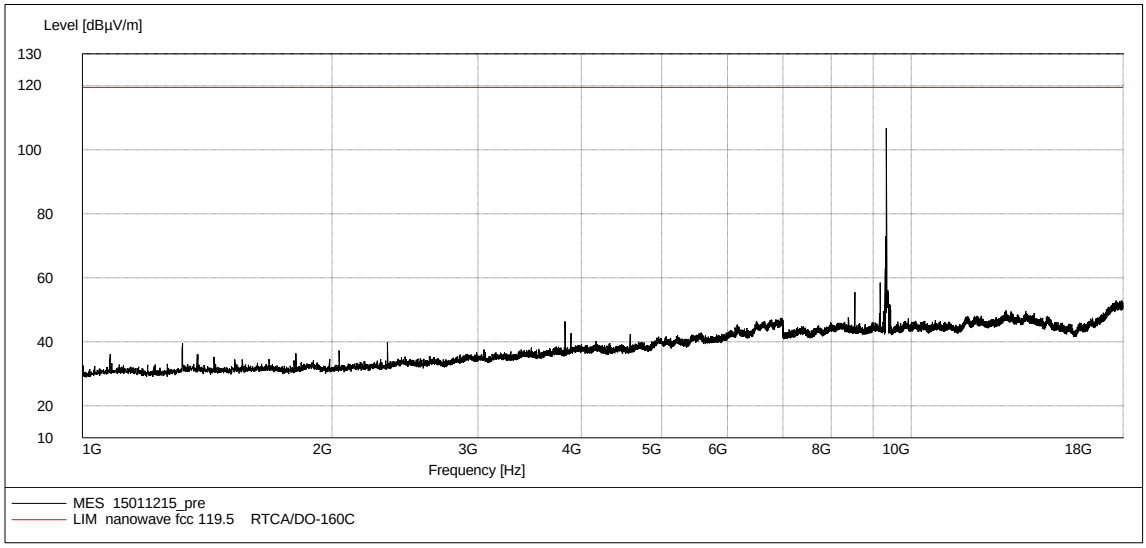


Figure F-76. Radiated Spurious Emissions, Channel 0, 1 GHz to 18 GHz, (Vertical Polarization)

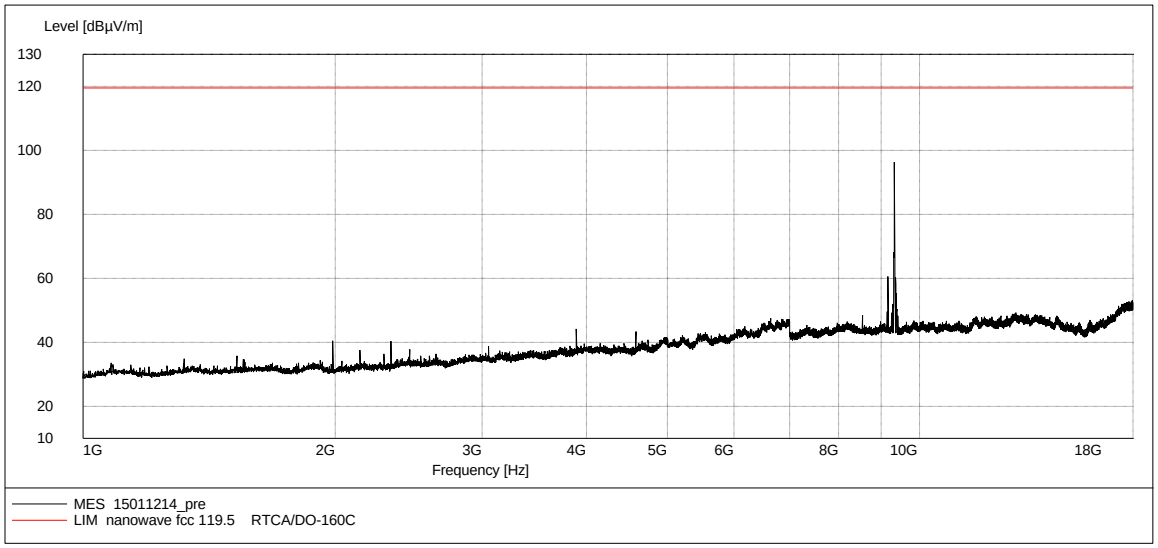


Figure F-77. Radiated Spurious Emissions, Channel 0, 1 GHz to 18 GHz, (Horizontal Polarization)

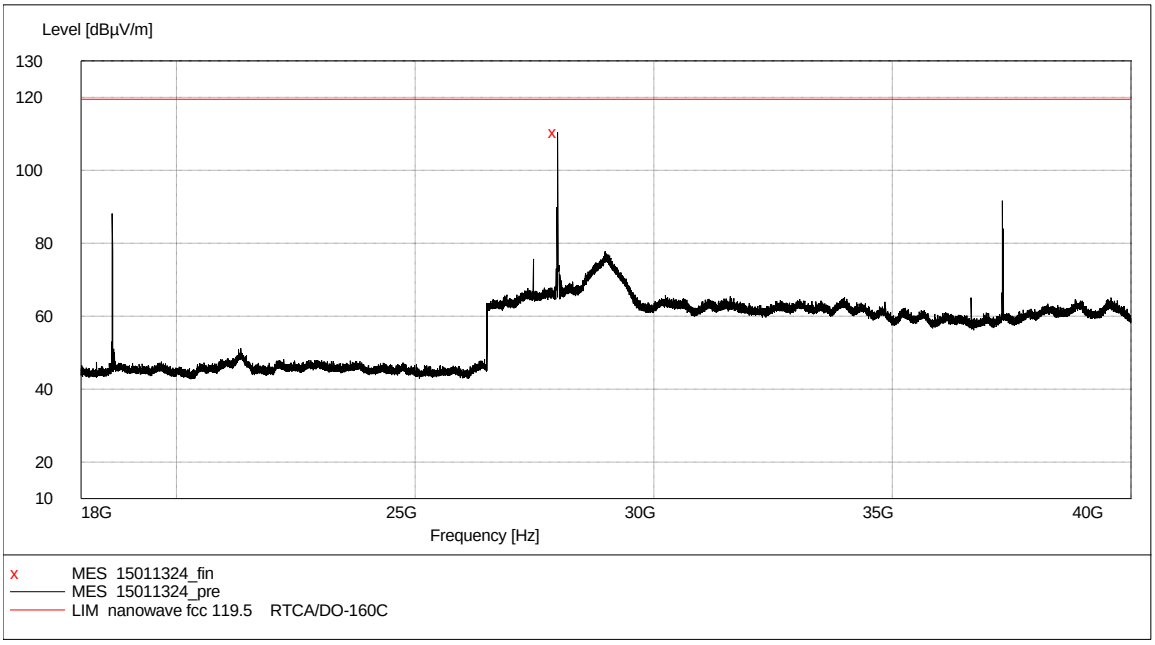


Figure F-78. Radiated Spurious Emissions, Channel 0, 18 GHz to 40 GHz, (Vertical Polarization

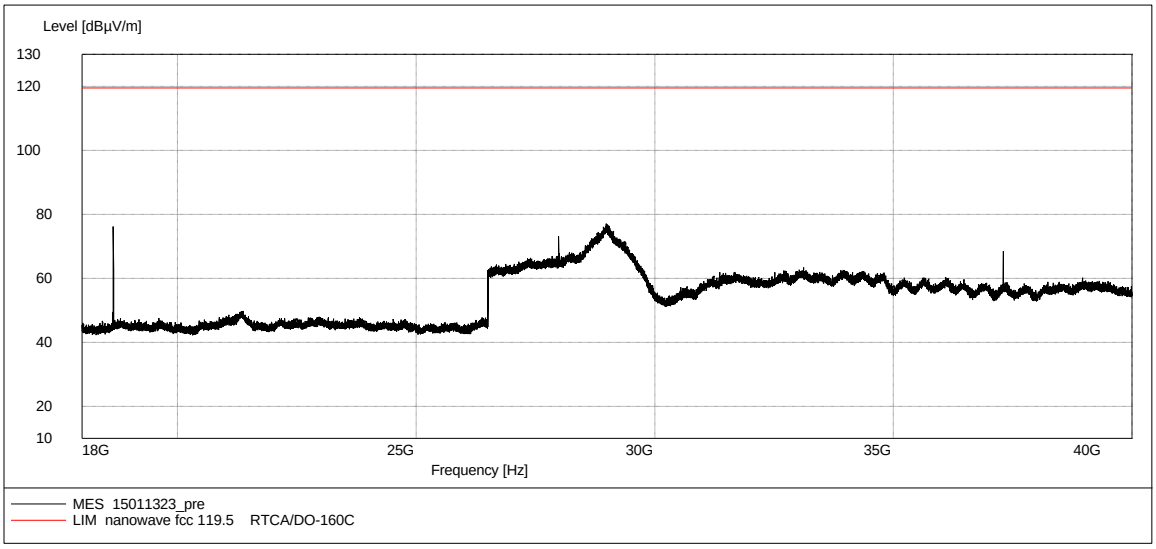


Figure F-79. Radiated Spurious Emissions, Channel 0, 18 GHz to 40 GHz, (Horizontal Polarization)

Spectrum Plots (Channel 61):

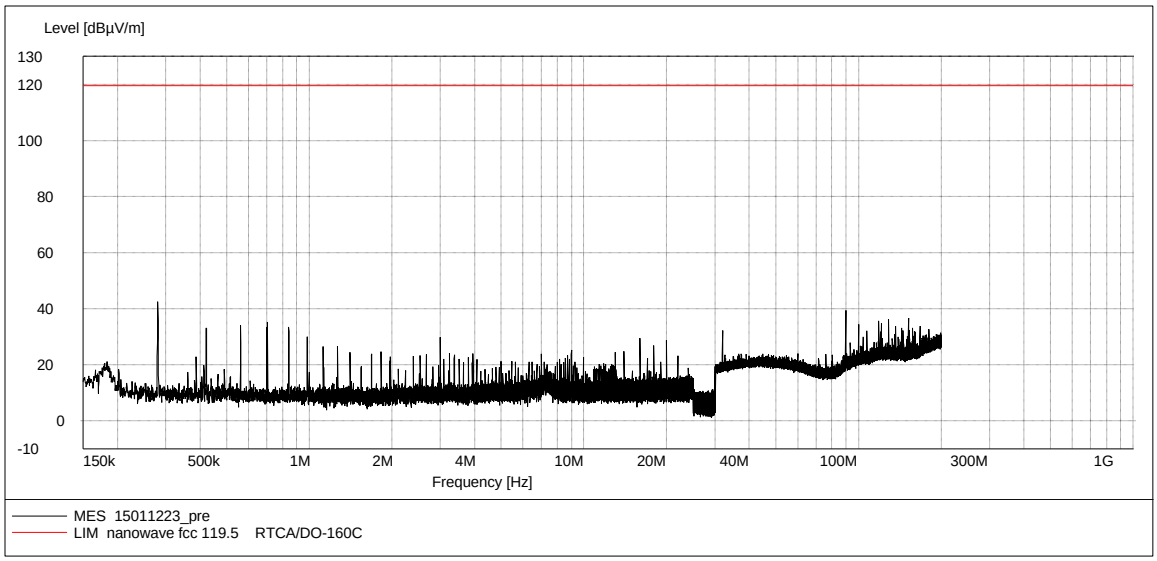


Figure F-80. Radiated Spurious Emissions, Channel 61, 150 KHz to 200 MHz, (Vertical Polarization)

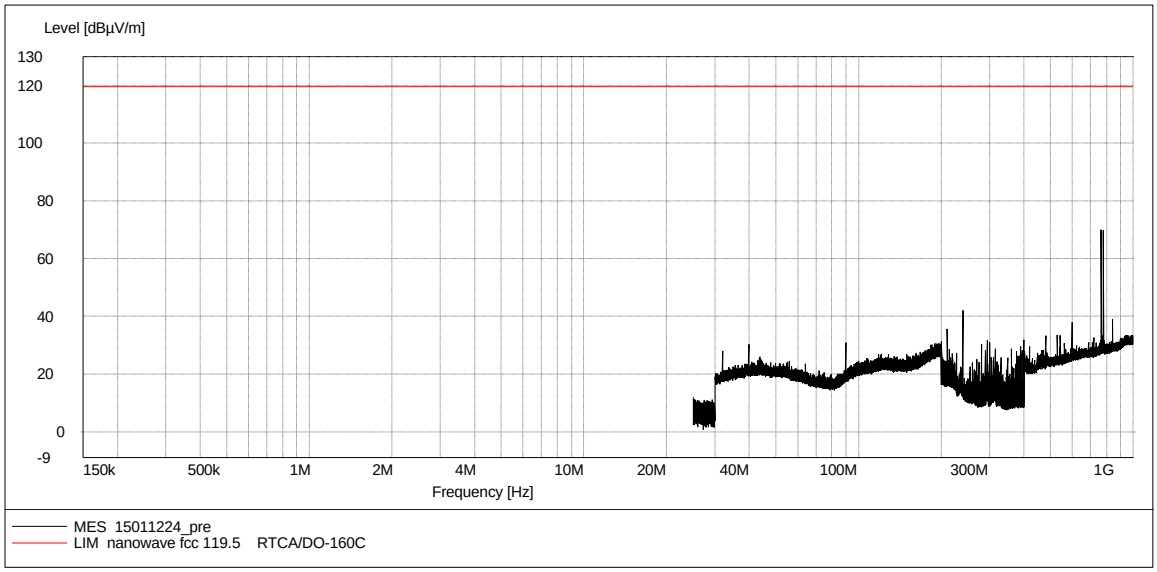


Figure F-81. Radiated Spurious Emissions, Channel 61, 25 MHz to 1 GHz, (Horizontal Polarization)

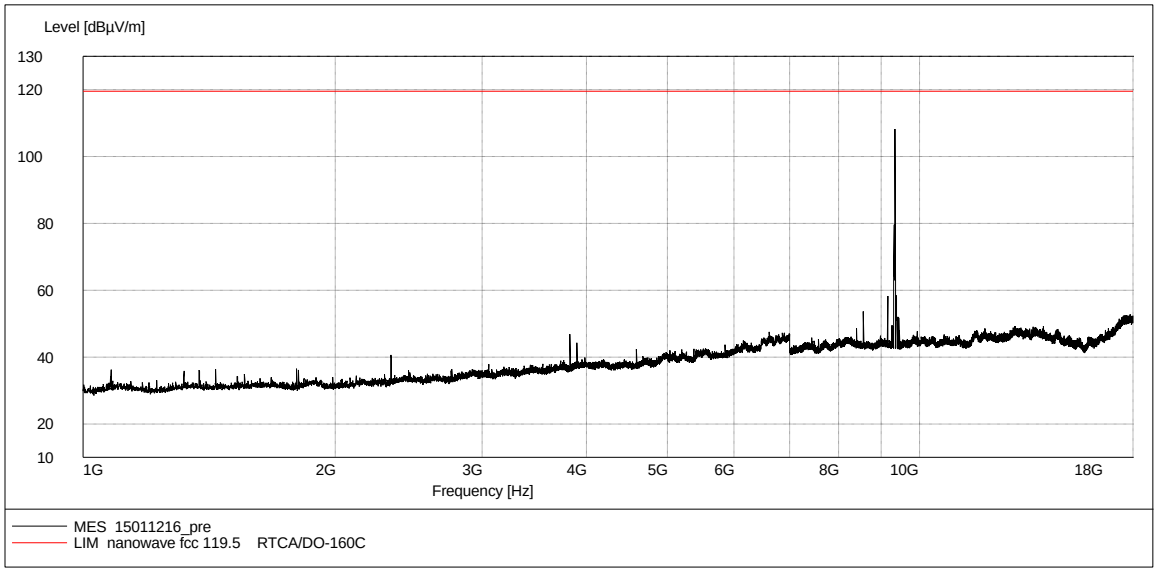


Figure F-82. Radiated Spurious Emissions, Channel 61, 1 GHz to 18 GHz, (Vertical Polarization)

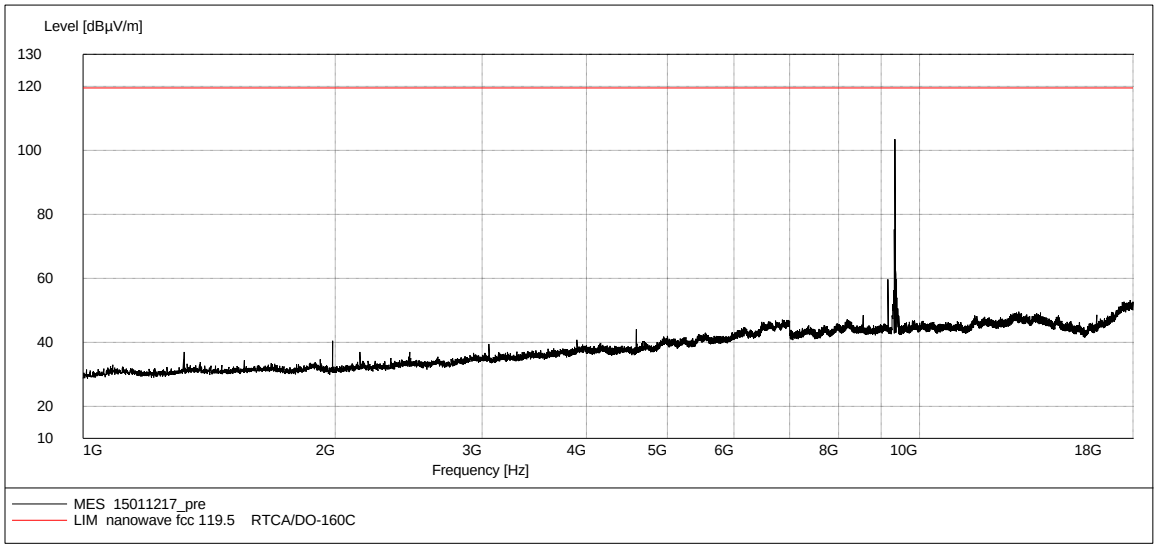


Figure F-83. Radiated Spurious Emissions, Channel 61, 1 GHz to 18 GHz, (Horizontal Polarization)

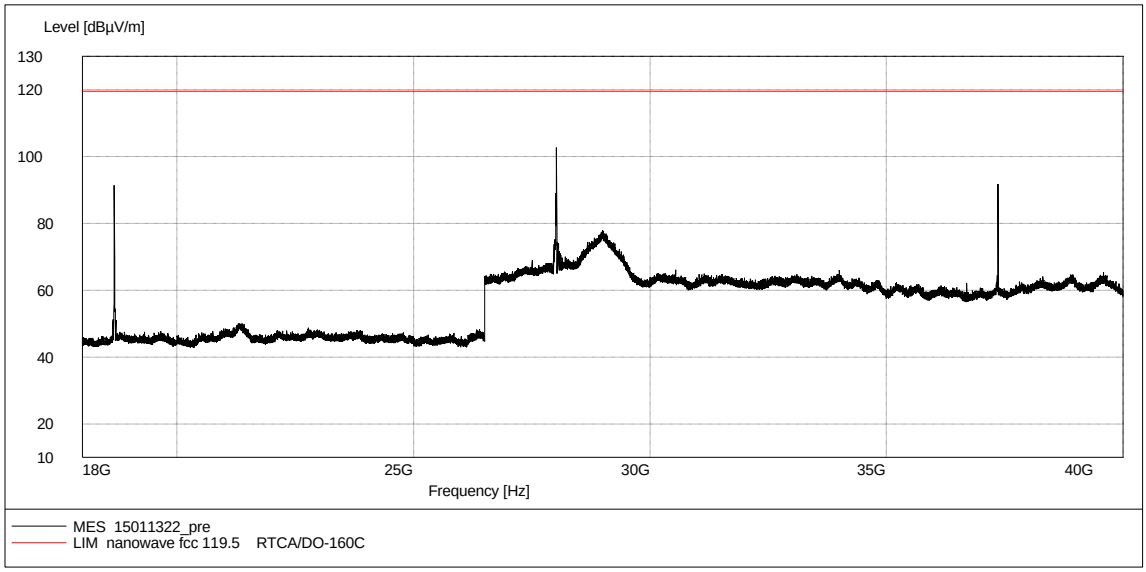


Figure F-84. Radiated Spurious Emissions, Channel 61, 18 GHz to 40 GHz, (Vertical Polarization)

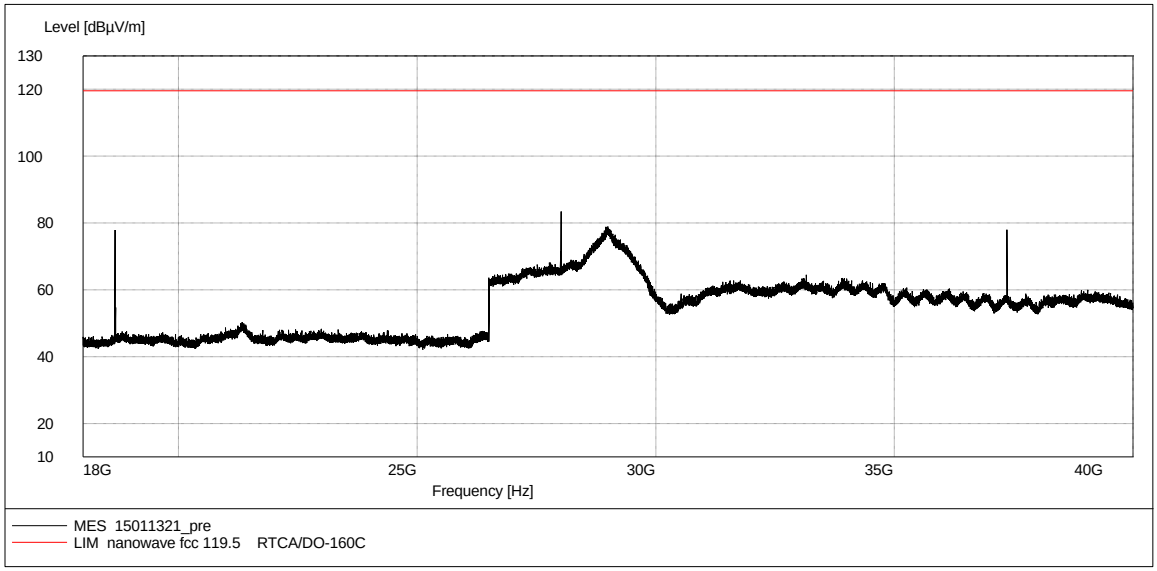


Figure F-85. Radiated Spurious Emissions, Channel 61, 18 GHz to 40 GHz, (Horizontal Polarization)