



Electromagnetic Compatibility Test Report

Tests Performed on a Federal Signal Corporation

Wireless Intercom, Model AD-27W

Radiometrics Document RP-4755



Product Detail:

FCC ID: **HVVAD27W**

Equipment type: Low Power Transciever

Test Standards:

US CFR Title 47, Chapter I, FCC Part 15 Subpart C

FCC Part 15 CFR Title 47: 2001

Industry Canada RSS-210, Issue 5 as required for Category I Equipment

This report concerns: Original Grant for Certification FCC Part 15.249

Tests Performed For:

Federal Signal Corporation

18606 S. 81st Street

Tinley Park, IL 60477

Test Facility:

Radiometrics Midwest Corporation

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Romeoville, IL 60446

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Test Date(s): (Month-Day-Year)

March 13, 2002

Document RP-4755 Revisions:

Rev.	Issue Date	Affected Pages	Revised By	Authorized Signature for Revision
0	April 17, 2002			
1	May 16, 2002	All	Joseph Strzelecki	
2	May 17, 2002	All	Joseph Strzelecki	<i>Joseph Strzelecki</i>

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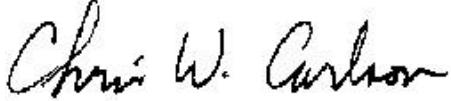
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1 ADMINISTRATIVE DATA

<p><i>Equipment Under Test:</i> A Federal Signal Corporation, Wireless Intercom Model: AD-27W Serial Number: None This will be referred to as the EUT in this Report</p>	
Date EUT Received at Radiometrics: (Month-Day-Year) 3/13/02	Test Date(s): (Month-Day-Year) March 13, 2002
<i>Test Report Written By:</i> Joseph Strzelecki Senior EMC Engineer	<i>Test Witnessed By:</i> Pat Morason
<i>Radiometrics' Personnel Responsible for Test:</i>  Joseph Strzelecki Senior EMC Engineer NARTE EMC-000877-NE	<i>Test Report Approved By</i>  Chris W. Carlson Director of Engineering NARTE EMC-000921-NE

2 TEST SUMMARY AND RESULTS

The EUT (Equipment Under Test) is a Wireless Intercom, Model AD-27W, manufactured by Federal Signal Corporation. The detailed test results are presented in a separate section. The following is a summary of the test results.

Emissions Tests Results

Environmental Phenomena	Frequency Range	Basic Standard	Test Result
RF Radiated Emissions	30-9300 MHz	RSS-210 & FCC Part 15	Pass
Conducted Emissions, AC Mains	0.45 - 30 MHz	RSS-210 & FCC Part 15	Pass
Occupied Bandwidth Test	Fundamental Freq.	RSS-210 & FCC Part 15	Pass

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3 EQUIPMENT UNDER TEST (EUT) DETAILS

3.1 EUT Description

The EUT is a Wireless Intercom, Model AD-27W, manufactured by Federal Signal Corporation. The EUT was in good working condition during the tests, with no known defects.

3.2 Related Submittals

Federal Signal Corporation is not submitting any other products simultaneously for equipment authorization related to the EUT.

4 TESTED SYSTEM DETAILS

4.1 Tested System Configuration

The system was configured for testing in a typical fashion. The EUT was placed on an 80-cm high, nonconductive test stand. The testing was performed in conditions as close as possible to installed conditions. Since the EUT is wall mounted, it was placed in an upright configuration during the tests. It had a 1.9 meter unshielded power cord attached to it during the tests. The EUT was tested as a stand-alone device. Power was supplied at 115 VAC, 60 Hz single-phase to its external power supply.

Three operating frequencies were tested: 903.37, 909.37 and 921.37 MHz

4.2 Equipment Modifications

No modifications were made to the EUT at Radiometrics' test facility in order to comply with the standards listed in this report.

5 TEST SPECIFICATIONS AND RELATED DOCUMENTS

Test Specifications

Document	Date	Title
FCC CFR Title 47	2001	Code of Federal Regulations Title 47, Chapter 1, Federal Communications Commission, Part 15 - Radio Frequency Devices
ANSI C63.4-1992	1992	Methods of Measurement of Radio Noise Emissions from Low-Voltage Electrical and Electronic Equipment in the Range of 9 kHz to 40 GHz
IC RSS-210 Issue 5	2001	Low Power Licence-Exempt Radiocommunication Devices (All Frequency Bands)
IC RSS-212 Issue 1	1998	Test Methods For Radio Equipment

The test procedures used are in accordance with the ANSI document C63.4-1992, (July 17, 1992) "Methods of Measurement of Radio Noise Emissions from Low-Voltage Electrical and Electronic Equipment in the Range of 9 kHz to 40 GHz". The specific procedures are described herein. Radiated testing was performed at an antenna to EUT distance of 3 meters. The antenna was raised and lowered from 1 to 4 meters.

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6 RADIOMETRICS' TEST FACILITIES

The results of these tests were obtained at Radiometrics Midwest Corp. in Romeoville, Illinois, USA. Radiometrics has been accredited by A2LA (American Association for Laboratory Accreditation) to conform to ISO/IEC 17025: 1999 "General Requirements for the Competence of Calibration and Testing Laboratories". Radiometrics' Lab Code is 121191 and Certification Number is 1495.01. Radiometrics' scope of accreditation includes all of the "basic standards" listed herein. A copy of the accreditation can be accessed on our web site (www.radiomet.com). Radiometrics accreditation status can be verified at A2LA's web site (www.a2la.org).

The following is a list of shielded enclosures located in Romeoville, Illinois used during the tests:

Chamber A: Is an anechoic chamber that measures 24' L X 12' W X 12' H. The walls and ceiling are fully lined with ferrite absorber tiles. The floor has a 10' x 10' section of ferrite absorber tiles in the located in the center. Panashield of Rowayton, Connecticut manufactured the chamber. The enclosure is NAMAS certified.

Chamber B: Is a shielded enclosure that measures 24' L X 12' W X 8' H. Erik A. Lindgren & Associates of Chicago, Illinois manufactured the enclosure.

A separate ten-foot long, brass plated, steel ground rod attached via a 6 inch copper braid grounds each of the above chambers. Each enclosure is also equipped with low-pass power line filters.

Open Area Test Site (OATS): Is located on 8625 Helmar Road in Newark, Illinois, USA and measures 56' L X 24' W X 17' H. The entire open field test site has a metal ground screen. The FCC has accepted these sites as test site number 31040/SIT 1300F2. The FCC test site Registration Number is 90897. Details of the site characteristics are on file with the Industry Canada as file number IC3124.

A complete list of the test equipment is provided herein. The calibration due dates are indicated on the equipment list. The equipment is calibrated in accordance to ANSI/NCSL Z540-1 with traceability to the National Institute of Standards and Technology (NIST).

7 DEVIATIONS AND EXCLUSIONS FROM THE TEST SPECIFICATIONS

There were no deviations or exclusions from the test specifications.

8 TEST PROCEDURES

The test procedures used are in accordance with the Industry Canada RSS-212 and ANSI document C63.4-1992, (July 17, 1992) "Methods of Measurement of Radio Noise Emissions from Low-Voltage Electrical and Electronic Equipment in the Range of 9 kHz to 40 GHz". The specific procedures are described herein. Radiated testing was performed at an antenna to EUT distance of 3 meters. The antenna was raised and lowered from 1 to 4 meters.

8.1 Radiated RF Emissions Measurement Procedures

Radiated emission measurements were performed with linearly polarized broadband antennas. The results obtained with these antennas can be correlated with results obtained with a tuned dipole antenna. Below 1 GHz, when a radiated emission is detected approaching the specification limit, the measurement of the emission is repeated using a tuned dipole antenna with a Roberts Balun.

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The radiated emission measurements were performed with a spectrum analyzer. The bandwidth used from 450 kHz to 30 MHz is 9 or 10 kHz and the bandwidth from 30 MHz to 1000 MHz is 100 or 120 kHz. Above 1 GHz, a 1 MHz bandwidth is used. A 10 dB linearity check is performed prior to start of testing in order to determine if an overload condition exists.

From 30 to 1000 MHz, an Anritsu Spectrum analyzer and a MITEQ AM-1431 amplifier with a 10 dB attenuator connected to the input were used. The out of band emissions and the ambient emissions were below the level of input overload (80 dBuV).

For tests from 1 to 9300 GHz, an HP8566A spectrum analyzer was used with a Celeritek uWave amplifier. The fundamental emission, out of band emissions and the ambient emissions were below the level of input overload (72 dBuV). In addition, a high pass filter was used to reduce the fundamental emission, for measurements above 1.8 GHz.

Preliminary radiated emission tests were performed inside of an anechoic enclosure. The frequency range from 30 to 9300 MHz was scanned and plotted using the peak detector function. The test antennas were positioned 3 meters from the EUT. The results of the preliminary scans were only used to identify the frequencies being emitted from the EUT and were not used to determine compliance with the test specification. Radiated emission measurements are performed with linearly polarized broadband antennas.

Final radiated emissions measurements were performed in the open area test site at a test distance of 3 meters. Measurements were performed using the peak or quasi-peak detector function. The detected emission levels were maximized by rotating the EUT, adjusting the positions of all cables, and by scanning the measurement antenna from 1 to 4 meters above the ground. The open area test site used to collect the radiated data is located on 8625 Helmar Road in Newark, Illinois. The open field test site has a metal ground screen. All other tests are performed at 12 East Devonwood Ave. Romeoville, Illinois EMI test lab.

The entire frequency range from 30 to 9300 MHz was slowly scanned with particular attention paid to those frequency ranges which appeared high in the preliminary emission scan. Measurements were performed using two antenna polarizations, (vertical and horizontal). The worst case emissions were recorded.

8.1.1 Field Strength Calculation

The field strength is calculated by adding the Antenna Factor and Cable Loss, and by subtracting the Amplifier Gain from the measured reading. The basic equation with a sample calculation is as follows:

$$FS = RA + AF + CF - AG$$

Where: FS = Field Strength

RA = Receiver Amplitude

AF = Antenna Factor

CF = Cable Attenuation Factor

AG = Amplifier Gain

Assume a receiver reading of 49.5 dBuV is obtained. The Antenna Factor of 8.1 and a Cable Factor of 1.7 is added. The Amplifier Gain of 23.3 dB is subtracted, giving a field strength of 36 dBuV/m. The 36 dBuV/m can be mathematically converted to its corresponding level in uV/m.

$$FS = 49.5 + 8.1 + 1.7 - 23.3 = 36.0 \text{ dBuV/m}$$

$$\text{Level in uV/m} = \text{Common Antilogarithm} [(36 \text{ dBuV/m})/20] = 63.1 \text{ uV/m}$$

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8.1.2 Conducted Emission Measurement Procedures

A computer-controlled analyzer was used to perform the conducted emissions measurements. The frequency range was divided into 500 subranges equally spaced on a logarithmic scale. The computer recorded the peak of each subrange. This data was then plotted on semi-log graph paper generated by the computer and plotter. Adjusting the positions of the cables and orientation of the test system then maximizes the highest emissions.

Mains Conducted emission measurements were performed using a 50 Ohm/50 uH Line Impedance Stabilization Network (LISN) as the pick-up device. Measurements were repeated on both leads within the power cord. If the EUT power cord exceeded 80 cm in length, the excess length of the power cord was made into a 30 to 40 cm bundle near the center of the cord. The LISN was placed on the floor at the base of the test platform and electrically bonded to the ground plane.

Broadband conducted emissions may exceed the following limits by no more than 13 dB. An emission is defined as broadband if the average detector amplitude is 6 dB or more under the quasi-peak detector amplitude.

9 CERTIFICATION

Radiometrics Midwest Corporation certifies that the data contained herein was taken under conditions that meet or exceed the requirements of the test specification. The results relate only to the EUT listed herein. Any modifications made to the EUT subsequent to the indicated test date will invalidate the data and void this certification.

10 TEST EQUIPMENT TABLE

RMC ID	Manufacturer	Description	Model No.	Serial No.	Frequency Range	Cal Period	Cal Date
AMP-05	RMC/Celeritek	Pre-amplifier	MW110G	1001	1.0-12GHz	12 Mo.	11/28/01
AMP-12	MITEQ	Pre-amplifier	AM-1431	530935	0.01-1000MHz	12 Mo.	12/28/01
ANT-03	Tensor	Biconical Antenna	4104	2231	20-200MHz	24 Mo.	08/07/01
ANT-06	EMCO	Log-Periodic Ant.	3146	1248	200-1000MHz	24 mo	08/07/01
ANT-11	RMC	Dipole Antennas	HW1010	201	25-1000MHz	12 Mo.	07/10/01
ANT-13	EMCO	Horn Antenna	3115	2502	1.0-18GHz	24 Mo.	09/28/00
ANT-25	ARA	Super Log Antenna	LPB-2520/A	1116	20-2000MHz	24 Mo.	8/30/01
HPF-01	Solar	High Pass Filter	7930-100	HPF-1	0.15-30MHz	24 Mo.	12/28/00
HPF-02	Microwave Cir.	High Pass Filter	H2G09G02	HPF-2	1.5-11 GHz	24 Mo.	05/29/01
LSN-01	Electrometrics	LISN	FCC/VDE 50/2	1001	0.01-30MHz	24 Mo.	01/10/02
REC-01	Hewlett Packard	Spectrum Analyzer	8566A	2106A02115, 2209A01349	30Hz-22GHz	12 Mo.	06/08/01
REC-03	Anritsu	Spectrum Analyzer	MS2601B	MT94589	0.01-2200MHz	12 Mo.	10/12/01
THM-01	Extech Inst.	Temp/Humid Meter	4465CF	001106557	N/A	12 Mo.	12/26/01

Note: All calibrated equipment is subject to periodic checks.

NCR – No Calibration Required. Device monitored by calibrated equipment. N/A: Not Applicable.

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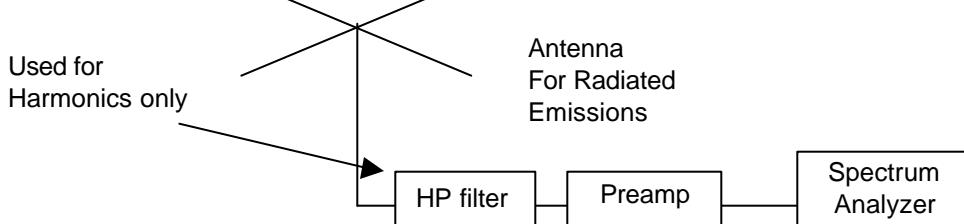
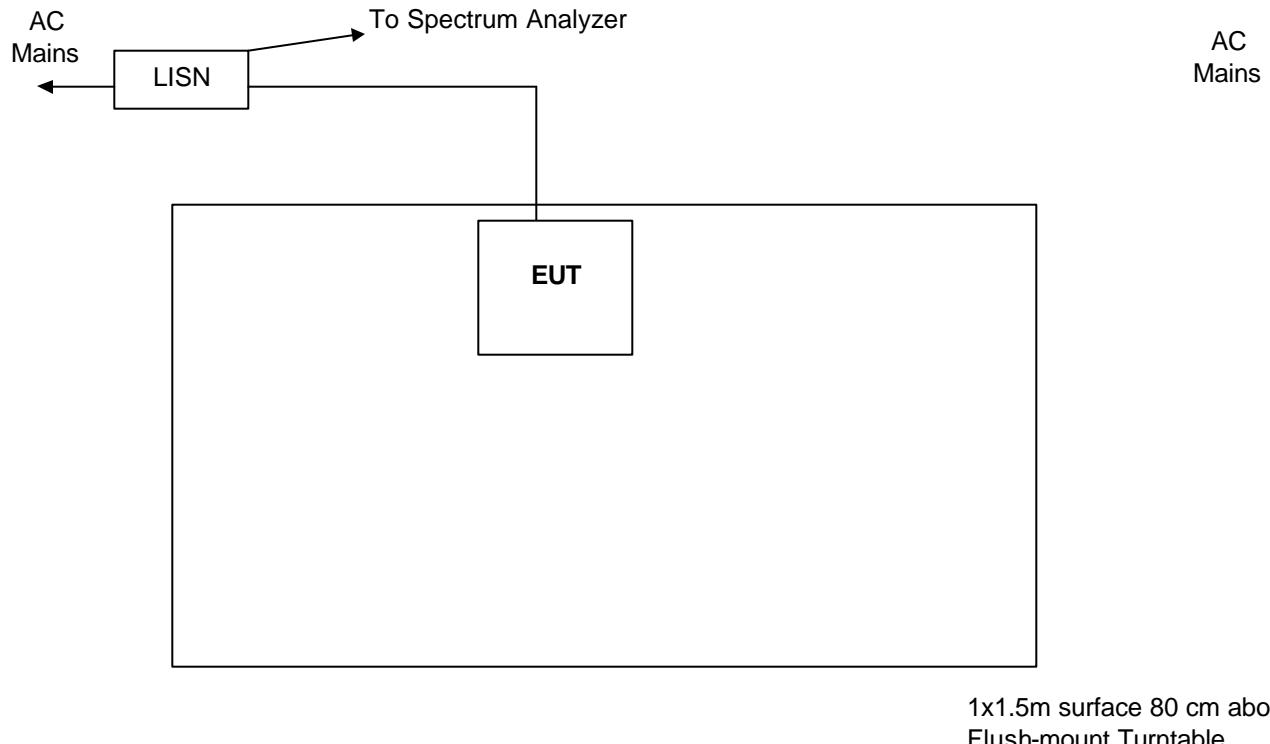
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11 TEST SETUP DOCUMENTATION

Figure 1. Configuration of Tested System



Radiated Emissions:

- LISN's not used
- AC outlet with low-pass filter at the base of the turntable
- No vertical conductive wall
- Antenna height varied from 1 to 4 meters
- Distance from antenna to tested system is 3 meters

Notes:

- Not to Scale

Conducted Emissions:

- LISN's at least 80 cm from EUT chassis
- Vertical conductive plane 40 cm from rear of table top
- EUT power cord bundled
- Test platform is not rotated

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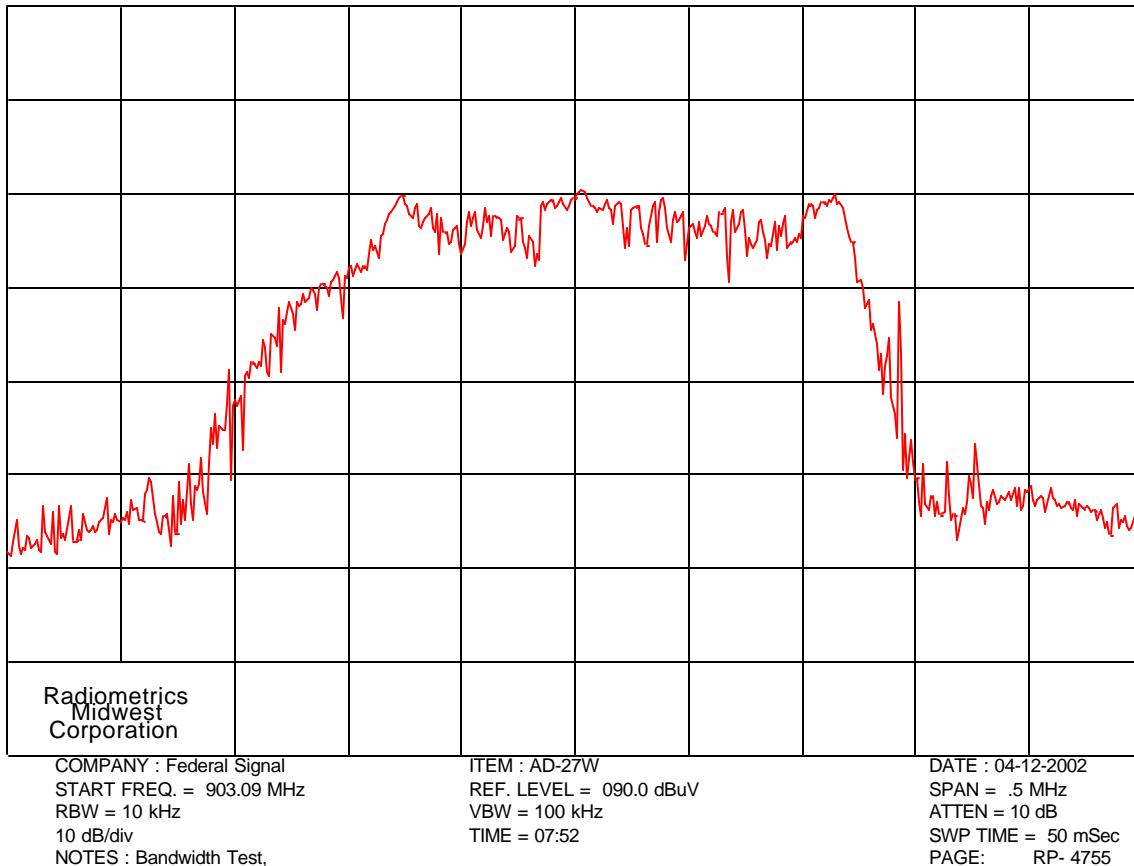
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12 OCCUPIED BANDWIDTH DATA

The occupied bandwidth of the RF output was measured using a spectrum analyzer. The bandwidth was measured using the peak detector function and a narrow resolution bandwidth.

A broadband antenna was used to receive the modulated signal. The spectrum analyzer was set to the "MAX HOLD" mode to record the worst case of the modulation. The spectrum analyzer display was digitized and plotted. A limit was drawn on the plots based on the level of the modulated carrier. The plots of the occupied bandwidth for the EUT are supplied on the following pages. The lowest and highest frequencies are shown.

Figure 2. Occupied Bandwidth Plots



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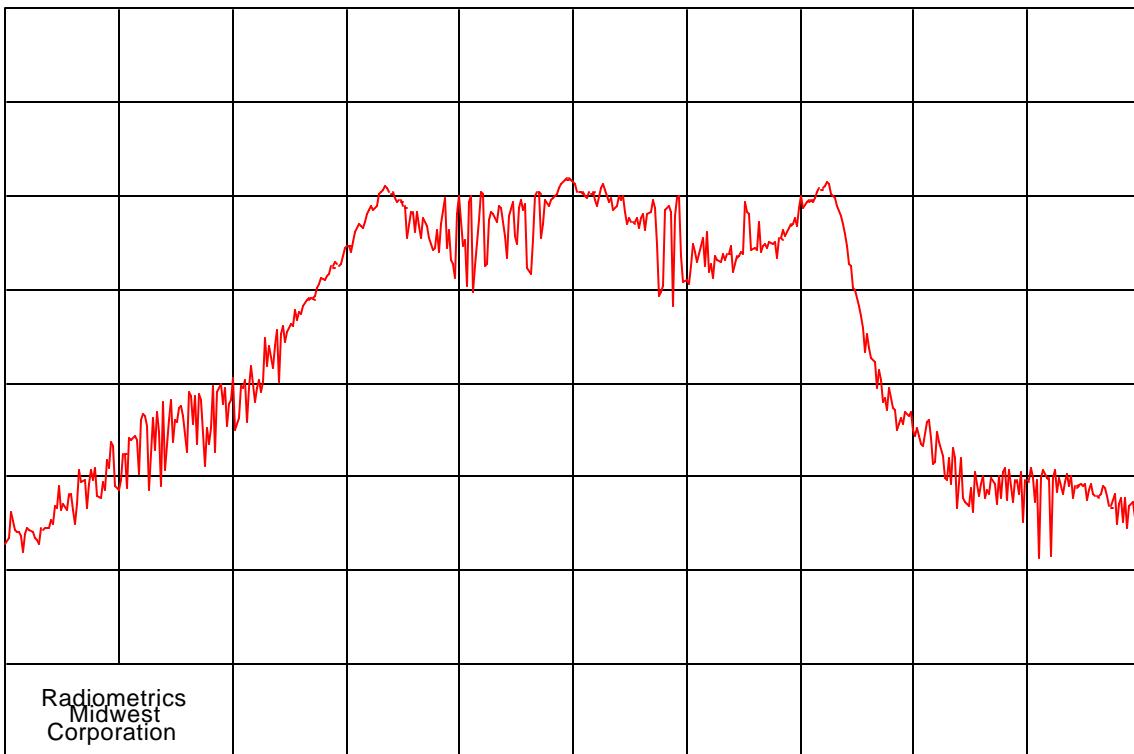
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COMPANY : Federal Signal
START FREQ. = 921.098 MHz
RBW = 10 kHz
10 dB/div
NOTES : Bandwidth Test,

ITEM : AD-27W
REF. LEVEL = 090.0 dBuV
VBW = 100 kHz
TIME = 07:50

DATE : 04-12-2002
SPAN = .5 MHz
ATTEN = 10 dB
SWP TIME = 50 mSec
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13 DETAILED TEST RESULTS

13.1 Radiated Emissions Test Results

Manufacturer	Federal Signal Corporation	Specification	FCC Part 15 Subpart C & RSS-210
Model	AD-27W	Test Date	03/13/2002
Serial Number	None	Test Distance	3 Meters
Abbreviations	Pol = Antenna Polarization; V = Vertical; H = Horizontal; BC = Biconical (ANT-3); LP = Log-Periodic (ANT-6); HN = Horn (ANT-13) P = peak; Q = QP		
Notes			

Freq MHz	Peak Analyzer Reading dBuV	Antenna Factor dB	Antenna Polarity/ Type	Amp Gain dB	Cable Loss dB	High Pass Filter dB	Field Strength of Signal dBuV/m	Limit Field Strength dBuV/m	Margin under Limit dB
903.37	56.9	23.8	V/LP	0	9.6	0	90.3	94	3.7
1806.74	30.4	27.6	V/HN	29	2.2	13	44.2	54	9.8
2710.11	32.6	30.9	V/HN	29	2.7	5.7	42.9	54	11.1
3613.48	32.2	32.8	V/HN	29	3.3	5	44.3	54	9.7
4516.85	29.3	33.8	V/HN	29	3.9	4.2	42.2	54	11.8
5420.22	25.3	35.5	V/HN	29	4.5	2.8	39.1	54	14.9
6323.59	23.5	36.8	V/HN	29	4.9	2.6	38.8	54	15.2
903.37	51.3	23.8	H/LP	0	9.6	0	84.7	94	9.3
1806.74	34.3	27.6	H/HN	29	2.2	13	48.1	54	5.9
2710.11	35	30.9	H/HN	29	2.7	5.7	45.3	54	8.7
3613.48	31.8	32.8	H/HN	29	3.3	5	43.9	54	10.1
4516.85	27	33.8	H/HN	29	3.9	4.2	39.9	54	14.1
5420.22	22.5	35.5	H/HN	29	4.5	2.8	36.3	54	17.7
6323.59	23.7	36.8	H/HN	29	4.9	2.6	39	54	15
909.37	58.5	23.9	V/LP	0	9.7	0	92.1	94	1.9
1818.74	35.7	27.6	V/HN	29	2.2	12.7	49.2	54	4.8
2728.11	31.8	30.9	V/HN	29	2.7	5.7	42.1	54	11.9
3637.48	35.3	32.8	V/HN	29	3.3	5	47.4	54	6.6
4546.85	28.5	33.8	V/HN	29	3.9	4.2	41.4	54	12.6
5456.22	26.1	35.5	V/HN	29	4.5	2.8	39.9	54	14.1
6365.59	24.3	36.8	V/HN	29	4.9	2.6	39.6	54	14.4
909.37	51.8	23.8	H/LP	0	9.7	0	85.3	94	8.7
1818.74	37.1	27.6	H/HN	29	2.2	12.7	50.6	54	3.4
2728.11	30.6	30.9	H/HN	29	2.7	5.7	40.9	54	13.1
3637.48	33.7	32.8	H/HN	29	3.3	5	45.8	54	8.2
4546.85	27.3	33.8	H/HN	29	3.9	4.2	40.2	54	13.8
5456.22	23.3	35.5	H/HN	29	4.5	2.8	37.1	54	16.9
6365.59	24.9	36.8	H/HN	29	4.9	2.6	40.2	54	13.8

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Radiated Emissions Test Results (Continued)

Freq MHz	Peak Analyzer Reading dBuV	Antenna Factor dB	Antenna Polarity/ Type	Amp Gain dB	Cable Loss dB	High Pass Filter dB	Field Strength of Signal dBuV/m	Limit Field Strength dBuV/m	Margin under Limit dB
921.37	58.1	23.8	V/LP	0	9.8	0	91.7	94	2.3
1842.74	38.9	27.6	V/HN	29	2.2	10.2	49.9	54	4.1
2764.11	31.3	30.9	V/HN	29	2.7	5.7	41.6	54	12.4
3685.48	28.6	32.8	V/HN	29	3.3	5	40.7	54	13.3
4606.85	25.6	33.8	V/HN	29	3.9	4.2	38.5	54	15.5
5528.22	22.7	35.5	V/HN	29	4.5	2.8	36.5	54	17.5
6449.59	22	36.8	V/HN	29	4.9	2.6	37.3	54	16.7
921.37	50.3	23.8	H/LP	0	9.8	0	83.9	94	10.1
1842.74	34.6	27.6	H/HN	29	2.2	10.2	45.6	54	8.4
2764.11	32.8	30.9	H/HN	29	2.7	5.7	43.1	54	10.9
3685.48	32.4	32.8	H/HN	29	3.3	5	44.5	54	9.5
4606.85	25.1	33.8	H/HN	29	3.9	4.2	38	54	16
5528.22	23.8	35.5	H/HN	29	4.5	2.8	37.6	54	16.4
6449.59	24.7	36.8	H/HN	29	4.9	2.6	40	54	14

The emissions were manually scanned from 30 to 9300 and the worst-case emissions are shown above. There were no other emissions detected within 15 dB of the limit. The limits are established Below:

Frequency Range (MHz)	Test Distance (meters)	Field Strength Limit (dBuV/m)
30 - 88	3	40
88 - 216	3	43.5
216 - 960	3	46.0
>960	3	54.0
Fundamental	3	94.0

No preamp was used when measuring the fundamental emissions at 903, 909 and 921 MHz. A lower loss cable was used above 1 GHz.

Judgment: Passed by 1.9 dB

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13.2 Conducted Emission Test Results

The initial step in collecting conducted data is a peak detector scan and the plotting of the measurement range. Significant peaks are then marked as shown on the following table, and these signals are then measured with the quasi-peak detector.

Test Date : April 11, 2002

Corr. Factors = cable loss + LISN Loss

Line Tested	Freq. MHz	Strength of Signal dBuV		Margin Under Limit dB
		EUT	Limit	
AC Hot	0.57	38.5	48	9.5
AC Hot	0.86	35.5	48	12.5
AC Hot	20.9	31.9	48	16.1
AC Neutral	0.54	44.7	48	3.3
AC Neutral	0.57	44.3	48	3.7
AC Neutral	0.51	44.6	48	3.4
AC Neutral	0.60	41.5	48	6.5
AC Neutral	23.5	31.5	48	16.5

Since the EUT passed by more than 3 dB; there was no determination of broadband emissions.

* All reading are quasi-peak with a 9 kHz bandwidth and no video filter.

The above represents the worst case emissions from the EUT power cord, operating at 903.37, 909.37 and 921.37 MHz. Each frequency was tested separately.

Judgment: Passed by 3.3 dB