RADIOMETRICS
Midwest Corporation

Shielding Effectiveness Test Report

Tests Performed on an IMS-AMCO

Shielded Rack Test Unit #2

Part Number S40469

Radiometrics Document RP-5760B

Test Specifications
MIL-STD-285
IEEE-299-1997

Tests Performed For:	*Test Facility:*
IMS-AMCO Engineered Products, LLC 3801 Rose St. Schiller Park, Illinois 60176-3152	**Radiometrics Midwest Corporation** 12 East Devonwood Romeoville, IL 60446

Test Date(s):
February 7 and 8, 2006

RP-5760B Revisions:

Rev.	Issue Date	Affected Pages	Revised By
0	July 17, 2006		

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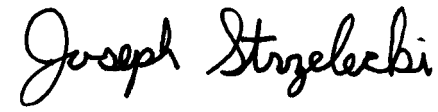
1 ADMINISTRATIVE DATA

Equipment Under Test: Mfr: IMS-AMCO Engineered Products, LLC Test unit #2; S40469 This item will hereafter be referred to as the EUT in this Report	
Dates EUT Received at Radiometrics: (Month-Day-Year) January 30, 2006	*Test Date(s): (Month-Day-Year)* February 7, 8 and 21, 2006
Test Report Written By: Joseph Strzelecki Senior EMC Engineer	*Test Witnessed By:* Personell from IMS-AMCO Engineered Products, LLC did not witness the tests.
Radiometrics' Personnel Responsible for Test:  July 17, 2006 Date Joseph Strzelecki Senior EMC Engineer NARTE EMC-000877-NE	

2 INTRODUCTION

Electromagnetic shielding effectiveness tests were performed on an electronic equipment cabinet. The tests were performed by Radiometrics Midwest Corporation of Romeoville, Illinois. The cabinet is identified as the IMS-AMCO S40469. The cabinet shall hereinafter be referred to as the Equipment Under Test (EUT).

3 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 testing and calibration laboratories". Radiometrics' Lab Code is 121191 and Certification Number is 1495.01. A copy of Radiometrics scope of 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 test chambers were used to perform this test:

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 E: Is a semi-anechoic chamber that measures 52' L X 30' W X 18' H. The walls and ceiling are fully lined with ferrite absorber tiles and/or dielectric absorbing cones. Proshield of Collinsville, Oklahoma manufactured the chamber.

A complete list of the test equipment is provided herein. The calibration due dates are indicated on the equipment list. The equipment is calibrated at regular intervals with traceability to the National Institute of Standards and Technology (NIST).

4 TEST SPECIFICATION

The procedures defined in IEEE-299-1997 and MIL-STD-285 were used in the performance of the tests, to the extent defined herein.

5 TEST DESCRIPTION

Tests were performed in an anechoic test chamber. The tests included attenuation measurements of magnetic fields, electric fields, and plane wave fields over the frequency ranges defined in the following table:

Electromagnetic Field Type	Frequency Range (MHz)
Magnetic	0.001 to 10.0
Electric	10.0 to 30.0
Plane Wave	30.0 to 18,000

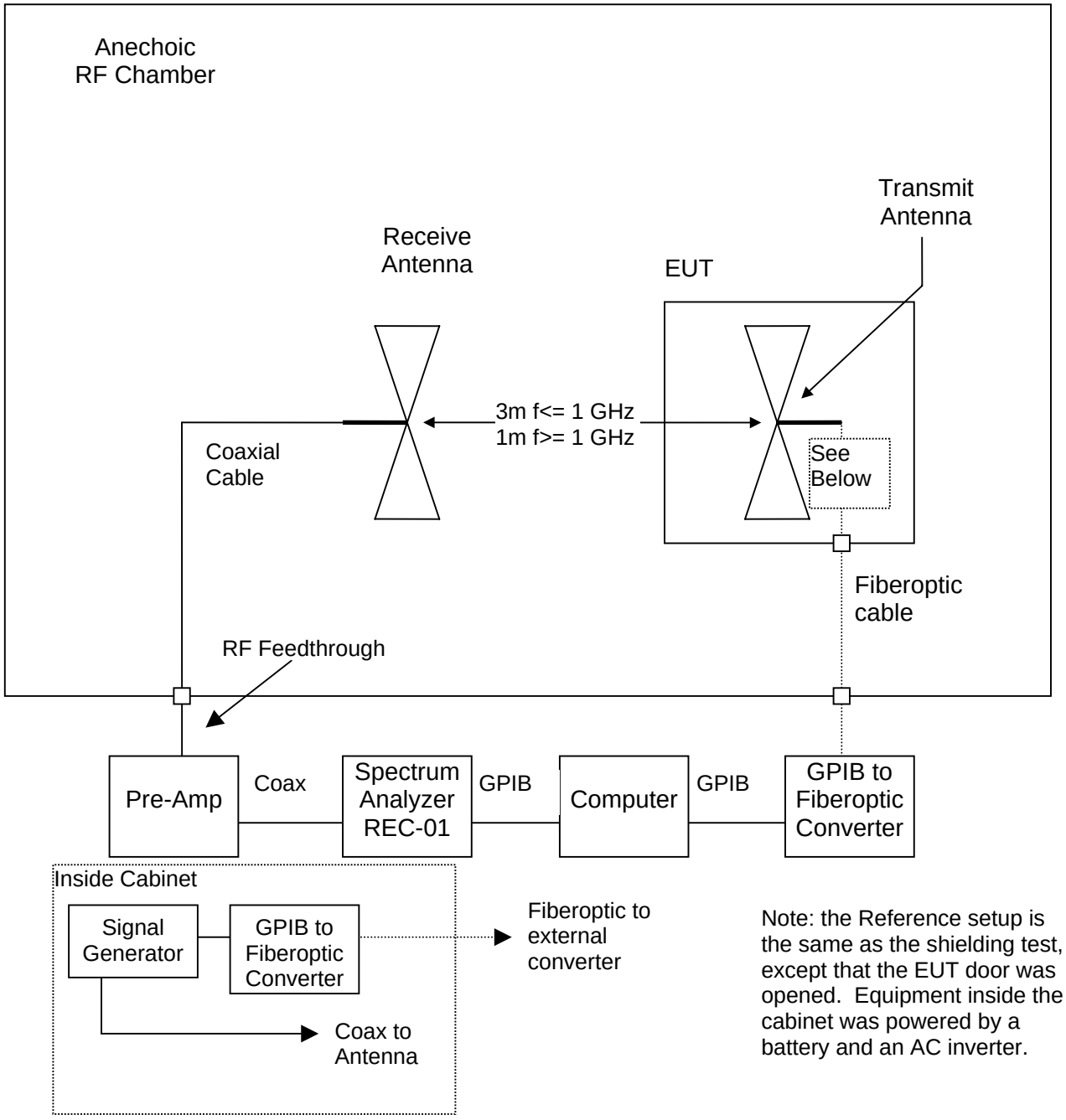
The tests were performed at discrete frequencies spaced logarithmically within each decade, with sampling density as follows:

Frequency Range	Frequency Step size
10 kHz to 30 MHz	10 %
30 MHz to 18 GHz	5 %

6 TEST SETUP

All tests were performed inside of an RF anechoic test chamber. RF signals were generated from equipment located inside of the EUT. The equipment in the EUT received power from a lead-acid battery and an AC inverter. The equipment in the EUT was controlled during the test by commands sent via fiber optic cables. The optical fibers penetrated the EUT through a waveguide-below-cutoff adaptor that was mounted on a cover panel at the top of the EUT. Antennas located in the EUT were used to generate the radiated fields.

Figure 1. Block Diagram of Shielding Tests



Frequency Range	Transmit Antenna	Receive Antenna	Signal Generator	Pre-Amplifier	Notes
0.01 - 1.0 MHz	ANT-40	ANT-41	SIG-10	-----	H-Fields
1.0 - 10 MHz	ANT-40	ANT-41	SIG-03	AMP-22	H-Fields
10 - 30 MHz	ANT-38	ANT-01	SIG-03	AMP-22	E-Fields
30 - 200 MHz	ANT-11 (1012)	ANT-25	SIG-03	AMP-22	Plane Waves
200 - 1000 MHz	ANT-11 (1014)	ANT-25	SIG-03	AMP-22	Plane Waves
1 - 10 GHz	ANT-13	ANT-36	SIG-07	AMP-05	Plane Waves

7 TEST PROCEDURES

The test equipment and the EUT were set up as described above. RF leakage signals were generated with an antenna positioned inside the EUT. Reference measurements were performed with the EUT removed from the setup. The reference measurements were performed using the same antennas, cables and signal amplitudes as were used in the measurements of the leakage signals. The shielding effectiveness was calculated by subtracting the leakage signal levels (in decibels) from the reference readings (in decibels) at each frequency.

7.1 E-field Tests from 10 kHz to 30 MHz

When testing the front and back of the EUT, measurements were performed with a rod antenna that was oriented vertically within the EUT. When testing the front and back of the EUT, the antenna was visually centered within the EUT. When testing the top, the EUT and both antennas were oriented horizontally, with the EUT resting on its left side. The transmit rod antenna length was reduced to 34 inches to maintain adequate clearance to the EUT. The antenna was oriented vertically, and centered visually within the cabinet.

A passive rod antenna was used to transmit inside the cabinet for this test. An active rod antenna was used to receive the signal outside the cabinet. The antennas were vertically polarized and were separated by three meters. Horizontal measurements made at the top of the cabinet were made using the rod antenna, shortened to enable the placement of the antenna horizontally across the middle of the cabinet. A one-watt amp was used inside the cabinet.

7.2 Plane Wave Tests from 30 MHz to 1000 MHz

A bi-log antenna was used to receive outside the cabinet. A dipole antenna was used to transmit the signal inside the cabinet. The dipole antenna length was reduced as needed to maintain adequate clearance to the EUT. A one-watt amp was used inside the cabinet.

7.3 Plane Wave Tests from 1.0 to 18 GHz

A double-ridged horn antenna was used to receive outside the cabinet. A double-ridged horn antenna was used to transmit the signal inside the cabinet.

7.4 Magnetic Field Tests from 1 kHz to 10 MHz

Two electrically shielded loop antennas were used for this test. The antennas were located adjacent to each other in the same plane and were separated by one meter.

8 Certification

Radiometrics Midwest Corporation certifies that the data contained herein was obtained using calibrated instruments and valid measurement procedures.

9 EQUIPMENT LIST

RMC ID	Manufacturer	Description	Model No.	Serial No.	Frequency Range	Cal Period	Cal Date
AMP-22	Anritsu	Pre-amplifier	MH648A	M23969	0.1-1200MHz	12 Mo.	12/21/05
AMP-30	Quinstar	Pre-Amp	7814001	QLJ-008184540-J0	0.5-18 GHz	12 Mo.	02/06/06
ANT-11	RMC	Dipole Antenna Set	HW1010	201	25-1000MHz	24 Mo.	07/12/04
ANT-13	EMCO	Horn Antenna	3115	2502	1.0-18GHz	24 Mo.	10/13/04
ANT-25	ARA	Super Log Antenna	LPB-2520/A	1116	20-2000MHz	N/A	NCR
ANT-36	Ailtech (Eaton)	Horn Antenna	96001	2013	1.0-18GHz	N/A	NCR
ANT-40	RMC	Loop Antenna	SELP1	1001	100Hz-10MHz	N/A	NCR
ANT-41	RMC	Loop Antenna	SELP1	1002	100Hz-10MHz	N/A	NCR
ANT-42	EMCO	Bicon Antenna	3104C	9512-4713	25-300MHz	24 Mo.	01/26/06
ANT-43	Imp Machine	Super Log Antenna	SL-20M2G	1001	20-2000MHz	24 Mo.	3/30/05
ATT-09	Inmet	20 dB SMA Atten.	18AH	N/A	DC-18GHz	24 Mo.	04/13/05
REC-01	HP / Agilent	Spectrum Analyzer	8566A	2106A02115, 2209A01349	30Hz-22GHz	12 Mo.	08/19/05
SIG-03	Gigatronics	RF Synthesizer	6061A	5130395	0.01-1050MHz	24 Mo.	12/29/04
SIG-07	Wiltron	RF Synthesizer	6647A	320019	0.01-18GHz	12 Mo.	09/06/05

Note: All calibrated equipment is subject to periodic checks.
NCR – No Calibration Required. Device monitored by calibrated equipment. N/A: Not Applicable.

10 PHOTOGRAPHS OF TEST

Figure 2. Photographs of H-field Shielding Test (0.01 to 10 MHz)


IMS AMCO
Cabinet #2
5760
2. 8. 2006

Figure 3. Photographs of E-field Shielding Test (0.01 to 30 MHz)

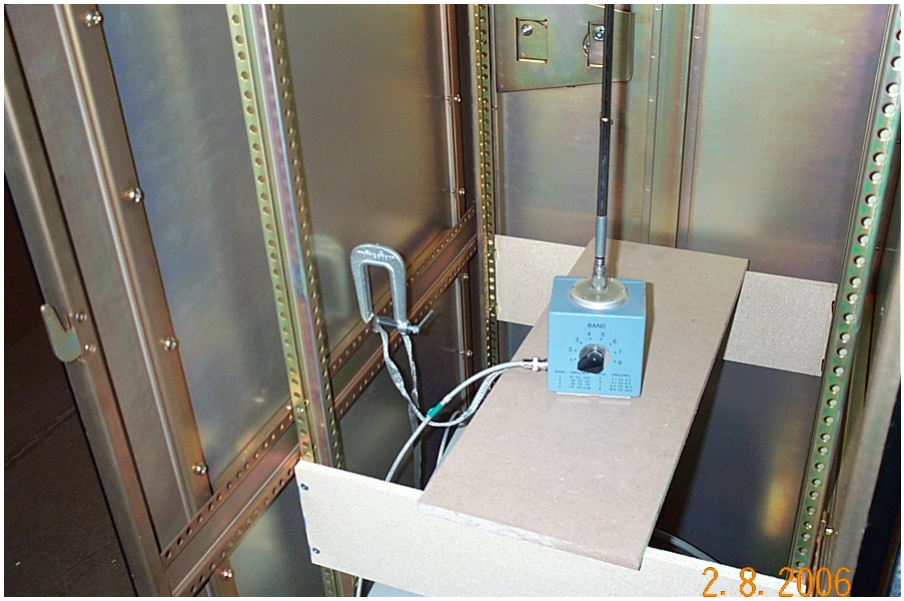


Figure 4. Photograph of Plane wave Shielding Test (30 to 1000 MHz)

Figure 5. Photograph of Plane wave Shielding Test (1 to 18 GHz)

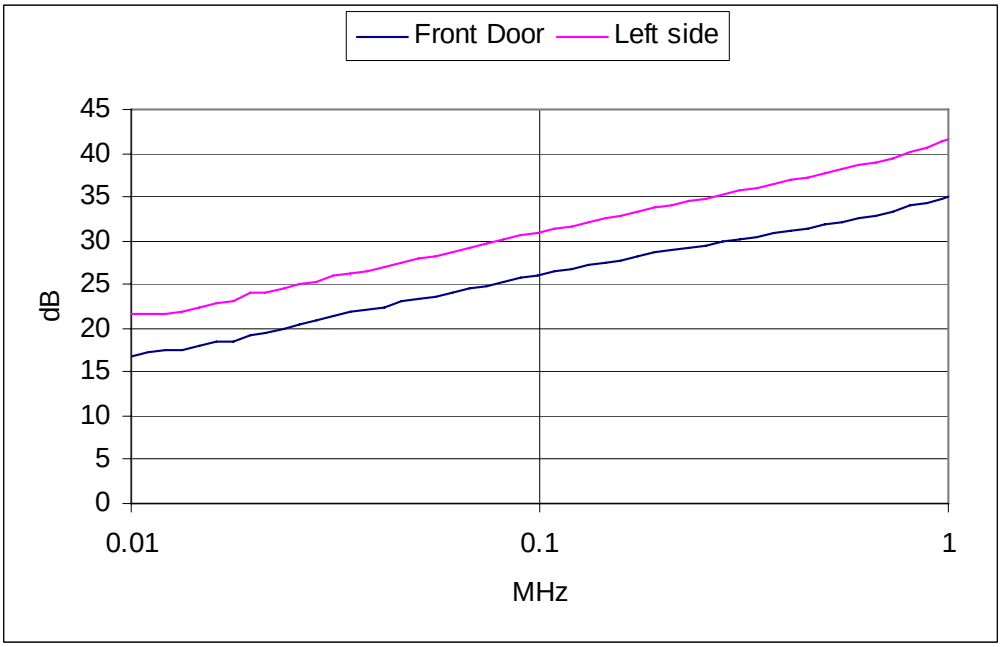
11 TEST RESULTS

The data after each graph show a handpicked sample of the worst-case results. Some of the lowest values shown on the plots were obtained at the band edges where the dynamic range of the test was limited to just above the specification requirement, and were omitted from the hand selected list.

The complete tabulated data is presented in a separate Microsoft Excel file.

11.1 H-field Test Results

Test Date: February 8, 2006



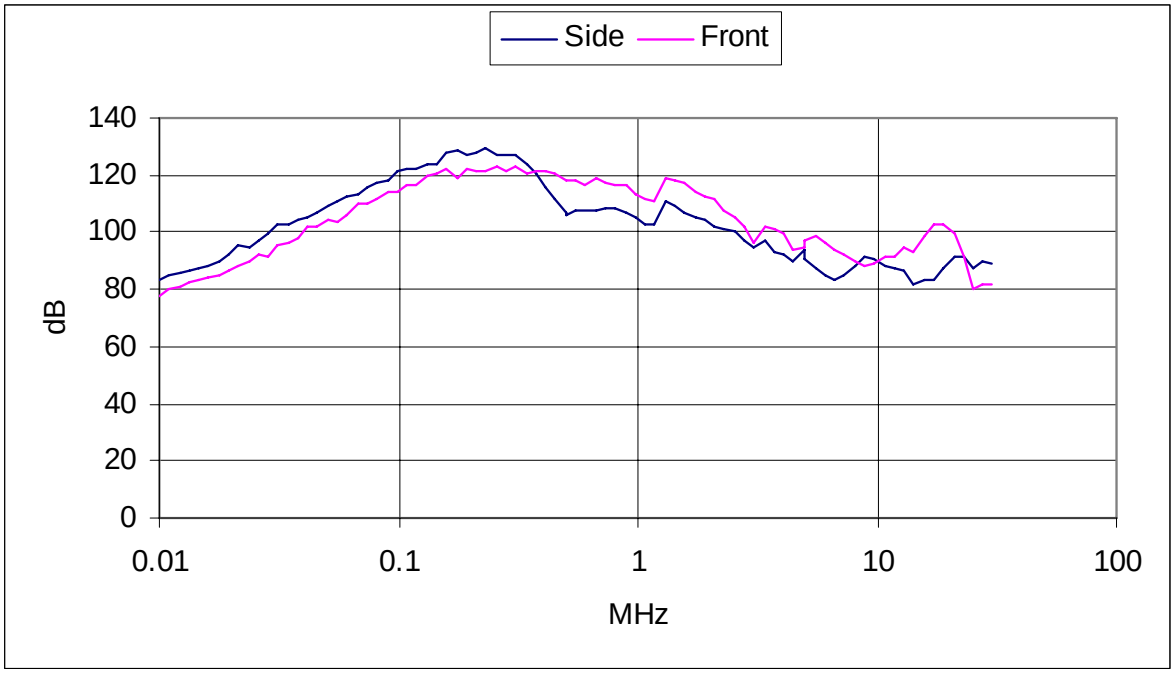
Shielding Effectiveness

	Front Door	Left side
Min	20.8	21.6
Average	18.7	23.2
MHz	dB	dB
16.9	21.6	16.9
17.3	21.7	17.3
17.5	21.7	17.5
17.5	22	17.5
18.1	22.3	18.1
18.5	22.9	18.5
18.6	23.2	18.6
19.2	24	19.2
19.4	24	19.4
19.9	24.6	19.9
20.5	25	20.5
20.8	25.4	20.8
21.3	26	21.3
21.9	26.3	21.9
22.1	26.6	22.1
22.5	27.1	22.5
23	27.6	23
23.4	28	23.4
23.7	28.3	23.7
24.1	28.7	24.1
24.5	29.3	24.5
24.9	29.7	24.9
25.3	30.1	25.3
25.7	30.6	25.7
26.1	30.8	26.1

26.4	31.4	26.4
26.8	31.7	26.8
27.2	32.2	27.2
27.5	32.5	27.5
27.8	32.9	27.8
28.3	33.3	28.3
28.6	33.7	28.6
28.9	34.1	28.9
29.2	34.5	29.2
29.5	34.9	29.5
29.9	35.2	29.9
30.2	35.7	30.2
30.5	36	30.5
30.8	36.5	30.8
31.1	36.9	31.1
31.5	37.2	31.5
31.9	37.7	31.9
32.2	38.2	32.2
32.7	38.7	32.7
32.9	39	32.9
33.4	39.5	33.4
34	40.2	34
34.4	40.7	34.4
34.9	41.3	34.9
35.1	41.6	35.1

11.2 E-field Test Results

Test Date: February 7 and 8, 2006
Notes: The readings below 500 kHz are the dynamic range of the test setup
The actual shielding is higher than the indicated values
The actual shielding should continue to increase below 500 kHz



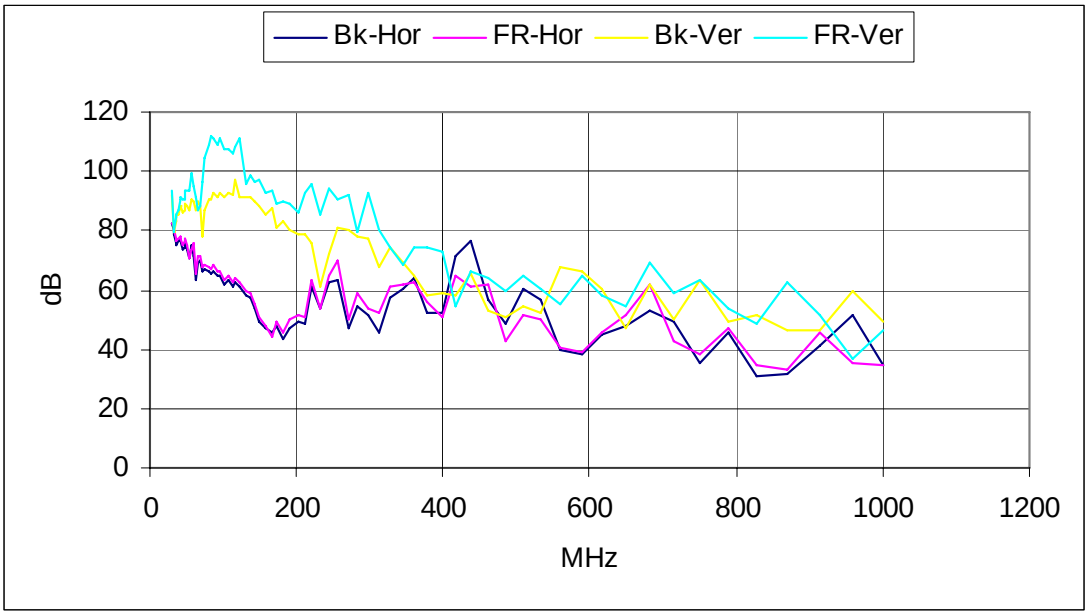
	Side	Front
Min	81.4	78.0
Average	102.6	104.0
MHz	dB	dB
0.01	83.5	78
0.011	84.6	80
0.0121	85.4	81.2
0.0133	86.4	82.2
0.0146	87.3	83.2
0.0161	88	84.3
0.0177	90.1	85
0.0195	92.5	86.3
0.0214	95.3	88.5
0.0236	94.5	90
0.0259	97	91.9
0.0285	99.6	91.8
0.0314	102.7	95.7
0.0345	102.4	96.6
0.038	104.6	97.9
0.0418	105.5	101.6
0.0459	106.8	102.3
0.0505	109.2	104.6
0.0556	111	103.3
0.0612	112.7	106.4
0.0673	113.4	109.8
0.074	115.9	109.9
0.0814	117.2	111.7

0.0895	118.2	113.9
0.0985	121.6	113.7
0.1083	122.1	116.4
0.1192	122	116.6
0.1311	123.7	120
0.1442	123.8	120.7
0.1586	128.2	122
0.1745	128.8	119.1
0.1919	127	122
0.2111	127.7	121.5
0.2323	129.1	121.3
0.2555	126.9	123.3
0.281	127.2	121.7
0.3091	127.4	122.7
0.34	124.1	120.5
0.374	120.2	121.7
0.4114	115.9	121.3
0.4526	111.3	120.4
0.4979	106.8	118.1
0.5	106	117.8
0.55	107.6	118.3
0.605	107.9	116.5
0.6655	108	118.7
0.7321	108.8	117.2
0.8053	108.1	116.5
0.8858	106.8	116.4
0.9744	105.3	113.6
1.0718	102.8	111.5
1.179	103	111.1
1.2969	110.6	118.6
1.4266	108.9	118.4
1.5692	107	117.1
1.7261	104.9	114.5
1.8987	104.4	112.1
2.0886	102.3	111.4
2.2975	101.5	107.8
2.5272	100.1	104.8
2.78	97.3	102.2
3.058	94.9	96.7
3.3637	97.1	101.9
3.7001	93.2	101.3
4.0701	92.5	99.7
4.4772	89.7	93.8
4.9249	94	94.3
5	90.6	97.2
5.5	87.6	98.8
6.05	85	96.5
6.655	83.5	93.5
7.3205	85.1	92.3
8.0526	88.1	89.7
8.8578	91.5	88.5
9.7436	90.4	89
10.7179	88	91.8
11.7897	87.1	91.4
12.9687	86.3	94.9
14.2656	81.4	93.1

15.6921	83	99
17.2614	83.5	102.4
18.9875	87.4	102.8
20.8862	91.1	99.7
22.9749	91.1	91.7
25.2723	87.8	79.8
27.7996	89.6	81.5
30	88.7	82

11.3 Plane Wave Test Results

Test Date: February 7, 2006

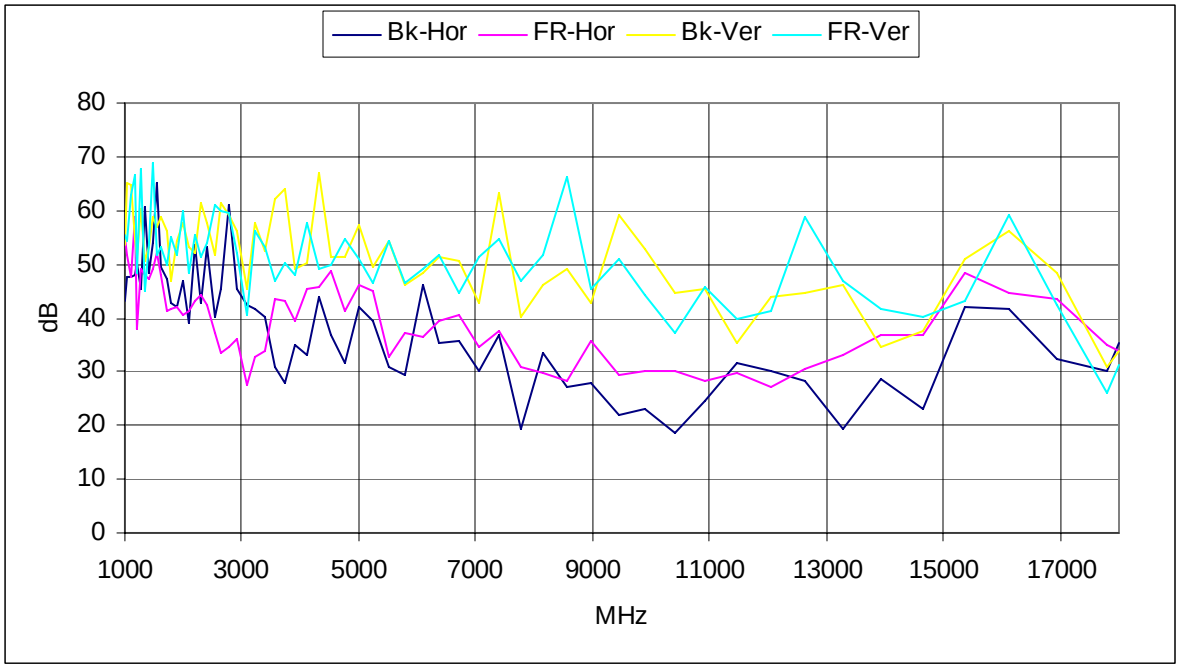


Notes	Back	Front	Back	Front
Pol	Horz	Horz	Vert	Vert
Min	31.2	33.1	46.3	36.5
Average	58.9	59.7	76.2	83.5
MHz	dB	dB	dB	dB
30	82.8	82.8	92.2	93.5
31.5	80.4	81.5	79.4	79.8
33.075	78.5	80	79.6	80
34.7288	76	77.4	83.2	84.4
36.4652	75.3	76.9	85.5	85.1
38.2885	76.8	77.2	85.7	86.6
40.2029	77.2	78.3	88.5	90.6
42.213	76.2	77.6	88.1	91.4
44.3237	73.7	75	86.4	90.9
46.5398	74.7	76.2	86.8	90.5
48.8668	75.8	77.4	89	93.5
51.3102	73.8	75.2	88.1	93.7
53.8757	70.4	71	86.7	93.2
56.5695	75.1	73.4	90.2	99.5
59.3979	71.7	76.1	90.1	94.9
62.3678	63.6	65.8	87.2	91.2
65.4862	69.5	71.1	90	87

68.7606	69.9	71.6	88	88
72.1986	66.1	67.9	78.4	96.4
75.8085	66.9	68.7	87.1	104.8
79.5989	66	67.6	90.5	108.8
83.5789	65.2	67	90.4	111.7
87.7578	66.4	68.3	92.5	110.8
92.1457	64.5	66.2	91.4	109.1
96.753	64.5	66.2	92.6	110.9
101.5907	62.1	63.6	91.2	107.7
106.6702	63	64.5	92.9	107.7
112.0037	61.3	62.6	91.8	105.8
117.6039	62.7	64.3	97.3	108.3
123.4841	61.1	62.6	91	111.3
129.6583	58.3	59.6	91.2	95.6
136.1412	57.3	58.6	91.6	98.5
142.9483	54	55	89.8	96.6
150.0957	49	50.9	88.2	97.1
157.6005	47.1	47.6	85.7	93
165.4805	45.4	44.3	87.8	93.8
173.7545	47.9	49.2	81.1	88.8
182.4423	43.4	45.9	83.4	89.9
191.5644	47.3	50.4	80.4	88.9
201.1426	49.5	51.7	78.7	86.5
211.1997	48.8	50.5	78.8	92.5
221.7597	60.8	63.2	75.7	95.4
232.8477	53.4	53.8	60.8	85.7
244.4901	62.7	65	72.3	94.6
256.7146	63.2	69.9	81	90.8
269.5503	47.1	49.9	80.2	92
283.0278	54.8	59.2	78.4	79.6
297.1792	51.6	53.6	77.6	92.5
312.0382	45.3	52	67.7	80.4
327.640	57.1	60.9	74	74.1

1				
344.0221	60.1	61.5	69.3	68.8
361.2232	63.8	62.8	64.8	74.4
379.2843	52.2	56.3	58.1	74
398.2485	52	51.1	59.2	73
418.1609	71.1	64.5	58.5	54.4
439.069	76.7	61.4	65.4	66.6
461.0225	56.9	61.9	53.1	64.3
484.0736	48.8	42.4	50.7	59.8
508.2773	60.3	51.8	54.4	64.7
533.6911	57	49.7	52.4	60.6
560.3757	39.6	40.8	67.9	54.9
588.3945	38.4	39.2	66.2	64.8
617.8142	44.7	45.9	60.5	58.1
648.7049	47.9	51.3	47.4	54.4
681.1401	52.8	62	61.9	69.4
715.1971	49.5	42.6	49.7	59.2
750.957	35.6	38.5	63	63
788.5048	45.5	47.2	49.5	53.9
827.9301	31.2	34.8	51.2	48.7
869.3265	31.9	33.1	46.3	62.9
912.7928	40.9	46	46.5	51.6
958.4325	51.4	35.1	59.4	36.5
1000	34.3	34.8	49.2	46.3

Test Date: February 8, 2006



Notes	Back-Horz	Front - Horz	Back - Vert	Front - Vert
Min	65.3	58.9	67	68.7
Average	38.5	39.6	51.7	50.9
MHz	dB	dB	dB	dB
1000.0	43	54.9	53.5	55.4
1050.0	47.7	51.9	65.1	54.4
1102.5	47.8	47.5	64.9	62.9
1157.6	48	58.9	54.6	66.5
1215.5	50.3	38	51.4	48.2
1276.3	45.3	49.1	60.1	67.9
1340.1	60.7	48.1	50.7	45
1407.1	48.2	47.3	53.3	53.5
1477.5	54	49.3	58.9	68.7
1551.3	65.3	52	57	51.9
1628.9	49.6	47.9	58.7	53.2
1710.3	47.2	41.3	56.1	50
1795.9	42.7	41.7	47	55.1
1885.6	42.1	41.9	54.3	51.9
1979.9	46.9	40.7	57.8	59.8
2078.9	38.9	41.4	53.2	48.5
2182.9	53.6	43.1	52.1	55.6
2292.0	42.7	44.2	61.5	51.4
2406.6	53.2	42.4	57.8	54.1
2527.0	40.1	37.2	51.8	61.2
2653.3	45.4	33.5	61.5	59.9
2786.0	61.2	34.6	59.1	59.4
2925.3	45.5	36	56.3	52.1
3071.5	42.5	27.6	45.5	40.6
3225.1	41.8	32.7	57.7	56.3
3386.4	40.2	33.8	52.3	53.2

3555.7	30.9	43.7	62.3	46.9
3733.5	27.8	43.1	64.1	50.2
3920.1	35.1	39.3	49.1	48
4116.1	33.1	45.3	50.2	57.6
4321.9	43.9	45.7	67	49
4538.0	36.8	48.6	51.2	49.7
4764.9	31.7	41.3	51.3	54.8
5003.2	42	46	57.4	51.1
5253.3	39.6	45.2	49.4	46.5
5516.0	31	32.6	54.5	54.3
5791.8	29.4	37.1	46	46.5
6081.4	46.1	36.6	48.3	49.1
6385.5	35.3	39.3	51.3	51.6
6704.8	35.8	40.6	50.5	44.7
7040.0	30.3	34.7	42.9	51.5
7392.0	36.8	37.7	63.3	54.7
7761.6	19.4	31	40.2	47
8149.7	33.4	29.9	46.3	51.9
8557.1	27.1	28.4	49.3	66.4
8985.0	28	35.8	42.8	45.3
9434.3	22	29.5	59.1	50.8
9906.0	23	30.3	53	44.2
10401.3	18.6	30	44.5	37.1
10921.3	24.5	28.1	45.3	45.9
11467.4	31.6	29.9	35.4	39.7
12040.8	30.1	27.2	43.8	41.2
12642.8	28.1	30.4	44.5	58.9
13275.0	19.5	33	46.1	47
13938.7	28.7	36.8	34.5	41.7
14635.6	23.2	36.7	37.4	40.1
15367.4	42.1	48.2	51	43.1
16135.8	41.6	44.5	56.2	59.3
16942.6	32.5	43.6	48.5	42.4
17789.7	30	34.8	30.8	26.2
18000.0	35.4	33.7	33.7	31.2