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TEST REPORT

Comparison of SOFT-SHIELD® 1000, 2000 and CHO-SEAL® S6305 EMI Gaskets and Competitive EMI Gaskets

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EMI Gasket
Comparison Test Report

Chomerics SOFT-SHIELD® 1000, 2000, 4000 and CHO-SEAL® S6305

VS.

Gaskets from Other Manufacturers

This report presents performance data on EMI gaskets rated for commercial equipment in indoor (office) environments. Tests included are: shielding effectiveness, surface resistance, through resistance, multi-deflections and compression set.

Purpose

The purpose of this test program is to establish relative performance levels of Chomerics commercial EMI gaskets vs. gaskets produced by other manufacturers.

Summary of Results

The data generated in this series of tests demonstrates that Chomerics EMI gasket materials compare favorably with gaskets produced by other manufacturers, and that Chomerics materials offer a broad range of performance options. Readers of this report should be cautioned that not all performance characteristics were evaluated during this test sequence. Characteristics such as use temperature range, tear strength, abrasion, etc., may be of concern in a specific application

It should also be noted that the EMI gaskets evaluated included a mix of gasket types. While most of the samples incorporated foam-filled cores, CHO-SEAL S6305 material is a conductive elastomer and competitor samples 131, B2, and B3 are conductive elastomer materials extruded over a non-conductive core.

Also note that there are differences in cross sectional sizes and shapes among the gaskets tested. In such cases, comparisons may not be perfectly valid.

Scope

The scope of the testing included the following electrical and mechanical properties:

-shielding effectiveness
-surface resistance
-through resistance
-multi-deflections
-compression set

The EMI gaskets chosen for the test program include foam based gaskets produced by various manufacturers vs. Chomerics SOFT-SHIELD 1000, 2000, and 4000 series gaskets. Also tested was CHO-SEAL S6305 nickel-plated-graphite filled silicone extrusion vs. a conductive elastomer extrusion produced by another manufacturer. Details on all gaskets tested are provided on the following pages.

Test Procedures

Shielding Effectiveness - Testing conducted by Chomerics Test Services. -Standard CHO-TM TP08 "Shielding Effectiveness Test Method for Commercial Style EMI Gaskets". -The gasket configuration is a square "picture frame" assembled from 4 mitered strips (each a nominal 24 inches long). Gaskets are mounted to a 0.25 in. thick 6061-T6 aluminum test plate. The test plate is placed over the open 24 inch square brass test fixture. Nonconductive fasteners and various non-conductive compression stop spacers provide 50% deflection of gaskets. -Shielding Effectiveness measurements were performed at 15 different frequencies (20 MHz to 10 GHz).

Data Recorded:

-Reference level and gasketed panel level.

Data Calculated/Reported:

-Shielding Effectiveness = reference level gasketed panel level.

Surface Resistance -Surface Resistance measurements were made using the surface probe method, MIL-G-83528, para. 4.6.1 1. *Only the measured surface resistance is reported (not the calculated volume resistivity.)*

Data Recorded:

-Surface resistance.

Data Calculated/Reported:

-Surface resistance

Through Resistance

-Through resistance measurements are made with two 3 - inch diameter x 0.25 in. thick disks. The disk set for these samples consisted of one aluminum and one brass disk. Each gasket sample was 2.5 inches long, compressed to 50% of initial height during the test.

Data Recorded: -Resistance level for each sample/disk combination.

Data Calculated/Reported:

-Average of resistance levels

Multi-deflection

• Deflect samples 10,000 cycles. Load on each 3 - inch sample is 0.6 pounds per linear inch (50 psi pressure setting for two 3 inch samples.) No compression stops used.

• Modified ASTM C165 test procedure.

-Crosshead speed of 0.1 inch/minute.

Data Recorded:

-Graph resistance vs. crosshead travel and load vs. crosshead travel for each sample.

Data Calculated/Reported: -Visually evaluate the change in load and the change in resistance. Rank the change from 0 to 5 (0 = no change, 5 = significant change). Add the ranking in load change to the ranking in resistance change (0 = no change in either load or resistance and 10 = significant change in both load and resistance.).

Compression Set (at low and high humidity)

• Standard ASTM D395, Method B, Unmodified.

• Compression Set - compressed 25% for 22 hours at 85°C and 70°C.

• Low relative humidity (RH) - 3 samples placed in an air circulating oven.

• High relative humidity (RH) - 3 samples placed in a Tenney environmentally controlled chamber at 85% relative humidity.

Data Recorded: -Initial height, height at 25% deflection, and final height.

Data Reported/Calculated: -Compression Set (%) = f (t; -tf)/(t; - t25%)1 x 100; t; = initial height, tf = final height, t25% = height at 25% deflection.

Gaskets Tested

Chomerics

-Material: SOFT-SHIELD 1000 gasket
-Size/Shape: 0.25 inch x 0.25 inch square profile strip
-Part No: 01-0901-6595
-Knitted Ferrex™ mesh over urethane foam core (Ferrex is Chomerics' tradename for tin-plated-copper clad steel wire)

Chomerics

-Material: SOFT-SHIELD 2000 gasket
-Size/Shape: 0.25 inch x 0.25 inch square cross section strip
-Part No: 01-1392-6791
-Silver plated yarn over thermoplastic foam core

Chomerics

-Material: SOFT-SHIELD 4000 (CWA) gasket
-Size/Shape: 0.15 inch x 0.30 inch rectangular cross section strip
-Part No: Custom size for test
-Fiberglass reinforced aluminum foil over urethane foam core

Chomerics

-Material: SOFT-SHIELD 4000 (CWF) gasket
-Size/Shape: 0.15 inch x 0.30 inch rectangular cross section strip
-Part No: Custom size for test
-Nickel-plated fabric over urethane foam core

Chomerics

-Material: CHO-SEAL S6305 gasket
-Size/Shape: 0.15 inch x 0.25 inch "D" shape profile extruded strip
-Part No: 19-05-1 1441-S6305:
-Nickel-plated graphite filled silicone

Competitor A

-Material: A1
-Size/Shape: 0.5 inch x 0.5 inch "V" cross section strip
-Nickel-plated fabric over foam core

Competitor A

-Material: A2
-Size/Shape: 0.13 inch x 1.19 inch rectangular cross section strip
-Nickel-plated fabric over foam core

Competitor A

-Material: A3
-Size/Shape: 0.14 inch x 0.25 inch "D" cross section strip
-Nickel-plated fabric over foam core

Competitor B

-Material: 131 -Size/Shape: 0.15 inch diameter hollow "0" cross section strip -Appearance: beige-colored exterior over orange-colored elastomer core. -Silver-plated-aluminum filled elastomer extruded over silicone core

Competitor B

-Material: B2
-Size/Shape: 0.19 inch x 0.18 inch hollow "D" cross section strip
-Silver-plated-aluminum filled elastomer over silicone core

Competitor B

-Material: B3
-Size/Shape: 0.13 inch diameter hollow "0" cross section strip
-Silver-plated-aluminum filled elastomer over silicone core

Competitor C

-Material: C1
-Size/Shape: 0.20 inch x 0.20 inch square cross section strip
-Silver-plated fabric over foam core

Competitor C

-Material: C2
-Size/Shape: 0.5 inch x 0.5 inch "V" cross section strip
-Silver-plated fabric over foam core

Competitor C

-Material: C3
-Size/Shape: 0.24 inch x 0.23 inch rectangular cross section strip
-Silver-plated fabric over foam core

Competitor C

-Material: C4
-Size/Shape: 0.16 inch x 0.25 inch "D" cross section strip
-Silver-plated fabric over foam core

Results

-Average Shielding Effectiveness (20 MHz - 10 GHz) The test results in Table 1 show the superiority of the Chomerics' CHO-SEAL S6305 nickel-plated-graphite filled silicone elastomer. Note that the SOFT-SHIELD 4000 series gaskets of reinforced aluminum foil or conductive fabric over foam demonstrate superior shielding effectiveness. All Chomerics gaskets tested provide at least 75 dB average shielding effectiveness.

-Surface Resistance The results shown in Table 2 show the extremely low surface resistance of the SOFT-SHIELD 4000 family of gaskets. Note, however, that despite the relatively high surface resistance of CHO-SEAL S6305 conductive elastomer material, its shielding effectiveness (as shown in Table 1) is higher than all other gaskets tested. This result clearly indicates the danger of considering only surface resistance to predict shielding effectiveness.

-Through Resistance Table 3 shows the low through resistance of SOFT-SHIELD 4000 and CHO-SEAL S6305 gaskets. Through resistance is a better indicator of shielding effectiveness than surface resistance, but is still not a recommended method of predicting shielding performance, as can be seen by the CHOSEAL S6305 material data.

- **Multi-Deflection** Table 4 shows that none of the EMI gaskets tested degrade appreciably in a 10,000 cycle deflection test.

-Compression Set

Table 5 shows the results of compression set testing per ASTM D 395, Method B, which is a standard rubber test. This particular test method requires the compression set to be expressed as a percentage of the deflection, not of the initial height. To determine percent recovery, subtract 1 /4 of the ASTM D 395 Method B stated compression set from 100%. Table 6 shows this recalculation as per cent recovery. ASTM D 3574 might be considered a more appropriate test method for foam based products. ASTM D 3574 requires a

22 hr. test at 50%, 75% or 90% deflection at 70°C. The results are expressed both as a percentage of deflection like ASTM D 395 Method B and as a percent of initial height. In order to clarify the results of this test program, Table 6 shows the ASTM D 395 method B results at 70 °C expressed as a percent of initial height.

- Summary

Table 7 summarize the results from all tests.

Conclusion

Chomerics' EMI gaskets show good to excellent performance vs. gaskets produced by other manufacturers. SOFT-SHIELD 4000 (CWA and CWF) and CHO-SEAL S6305 gaskets showed consistently superior performance. As already mentioned, direct comparison of different types of EMI gaskets and/or different cross sections is not always possible. The reader is cautioned when making direct comparisons.

Table 1 **Electrical Performance - Average Shielding**

Vendor	Material	Surface Resistance (ohm)	Through Resistance (ohm)	Average Shielding 20MHz to 10GHz (dB)	Average Shielding 200MHz to 10GHz (dB)
Chomerics	S6305	1.15	0.017	106	115
A	A3	0.22	0.012	104	108
Chomerics	SOFT-SHIELD 4000 (CWA)	0.005	0.001	99	103
Chomerics	SOFT-SHIELD 4000 (CWF)	0.08	0.006	99	103
A	A2	0.268	0.014	95	96
B	B3	3.7	0.036	89	89
B	B1	0.789	0.014	83	80
C	C1	0.358	0.021	82	85
C	C3	0.238	0.031	80	83
Chomerics	SOFT-SHIELD 1000	1.02	0.088	78	78
Chomerics	SOFT-SHIELD 2000	0.37	0.047	75	73
C	C4	0.494	0.041	73	74
B	B2	3.7	30.5	50	47
C	C2	0.164	0.386	47	51
A	A1	0.67	16.65	40	48

Table 2		Electrical Performance - Surface Resistance			
Vendor	Material	Surface Resistance (ohm)	Through Resistance (ohm)	Avg Shielding 20MHz to 10GHz (dB)	Avg Shielding 200MHz to 10GHz (dB)
Chomerics	SOFT-SHIELD 4000 (CWA)	0.005	0.001	99	103
Chomerics	SOFT-SHIELD 4000 (CWF)	0.080	0.006	99	103
C	C2	0.164	0.386	47	51
A	A3	0.220	0.012	104	108
C	C3	0.238	0.031	80	83
A	A2	0.268	0.014	95	96
C	C1	0.358	0.021	82	85
Chomerics	SOFT-SHIELD 2000	0.370	0.047	75	73
C	C4	0.494	0.041	73	74
A	A1	0.670	16.65	40	48
B	B1	0.789	0.014	83	80
Chomerics	SOFT-SHIELD 1000	1.020	0.088	78	78
Chomerics	S6305	1.150	0.017	106	115
B	B3	3.700	0.036	89	89
B	B2	3.700	30.5	50	47

Table 3		Electrical Performance - Through Resistance			
Vendor	Material	Surface Resistance (ohm)	Through Resistance (ohm)	Avg Shielding 20 MHz to 10GHz (dB)	Avg Shielding 200 MHz to 10GHz (dB)
Chomerics	SOFT-SHIELD 4000 (CWA)	0.005	0.001	99	103
Chomerics	SOFT-SHIELD 4000 (CWF)	0.080	0.006	99	103
A	A3	0.220	0.012	104	108
A	A2	0.268	0.014	95	96
B	B1	0.789	0.014	83	80
Chomerics	S6305	1.150	0.017	106	115
C	C1	0.358	0.021	82	85
C	C3	0.238	0.031	80	83
B	B3	3.700	0.036	89	89
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Chomerics	SOFT-SHIELD 2000	0.370	0.047	75	73
Chomerics	SOFT-SHIELD 1000	1.020	0.088	78	78
C	C2	0.164	0.386	47	51
A	A1	0.670	16.65	40	48
B	B2	3.700	30.5	50	47

Table 4		*Multi Deflection*
Vendor	*Material*	0 = No Change 10 = Significant Change
A	A1	0
Chomerics	SOFT-SHIELD 2000	1
Chomerics	SOFT-SHIELD 4000 (CWA)	1
Chomerics	S6305	1
A	A3	1
B	B2	1
C	C1	1
C	C2	1
C	C4	1
Chomerics	SOFT-SHIELD 1000	2
Chomerics	SOFT-SHIELD 4000 (CWF)	2
A	A2	2
C	C3	2
B	B1	n/a
B	B3	n/a

Table 5		Compression Set- as % of deflection		
Vendor	Material	25%, 22 hrs @ 85°C	25%, 22 hrs @ 85°C, 85% RH	25%, 22 hrs, 70°C
B	B2	9%	21%	10%
B	B3	10%	34%	10%
C	C3	10%	58%	11%
B	B1	14%	17%	23%
Chomerics	S6305	22%	31%	20%
C	C1	28%	79%	15%
Chomerics	SOFT-SHIELD 4000 (CWF)	38%	33%	55%
Chomerics	SOFT-SHIELD 4000 (CWA)	42%	25%	38%
C	C4	45%	92%	26%
Chomerics	SOFT-SHIELD 1000	57%	114%	41%
A	A2	59%	77%	76%
Chomerics	SOFT-SHIELD 2000	63%	72%	43%
A	A3	66%	64%	76%

Table 6		Compression Set- as % of initial height	
Vendor	Material	25%, 22 hrs @ 70°C (%)	
B	B2	2.5	
B	B3	2.5	
C	C3	2.8	
C	C1	3.8	
Chomerics	S6305	5	
B	B1	5.8	
C	C4	6.5	
Chomerics	SOFT-SHIELD 4000 (CWA)	9.5	
Chomerics	SOFT-SHIELD 1000	10.3	
Chomerics	SOFT-SHIELD 2000	10.8	
Chomerics	SOFT-SHIELD 4000	13.8	
A	A2	19	
A	A3	19	

Table 8
Summary Sheet for All Tests

Vendor	Material	Compression Set			Electrical Performance				Multi-Deflection
		25%, 22 hrs, 85°C	25%, 22 hrs, 85°C, 85% RH	25%, 22 Hrs, 70°C (% initial height)	Surface Resistance (ohm)	Through Resistance (ohm)	Avg Shielding 20MHz to 10GHz (dB)	Avg Shielding 200MHz to 10GHz (dB)	0= No Change 10= Significant Change
A	A1	n/a	n/a	76% (19%)	0.670	16.65	40	48	0
A	A2	59%	77%	76% (19%)	0.268	0.014	95	96	2
A	A3	66%	64%	76% (19%)	0.220	0.012	104	108	1
B	B1	14%	17%	23% (5.8%)	0.789	0.014	83	80	n/a
B	B2	9%	21%	10% (2.5%)	3.700	30.5	50	47	1
B	B3	10%	34%	10% (2.5%)	3.700	0.036	89	89	n/a
C	C1	28%	79%	15% (3.8%)	0.358	0.021	82	85	1
C	C2	n/a	n/a	20% (5%)	0.164	0.386	47	51	1
C	C3	10%	58%	11% (2.8%)	0.238	0.031	80	83	2
C	C4	45%	92%	26% (6.5%)	0.494	0.041	73	74	1

Vendor	Material	Compression Set			Electrical Performance				Multi Deflection
		25%, 22 hrs @ 85°C	25%, 22 hrs @ 85°C, 85% RH	25%, 22 Hrs, 70°C (% initial height)	Surface Resistance (ohm)	Through Resistance (ohm)	Avg Shielding 20MHz to 10GHz (dB)	Avg Shielding 200MHz to 10GHz (dB)	0= No Change 10= Significant Change
Chomerics	S6305	22%	31%	2% (5%)	1.150	0.017	106	115	1
Chomerics	SOFT-SHIELD 4000 (CWA)	42%	25%	25% (9.5%)	0.005	0.001	99	103	1
Chomerics	SOFT-SHIELD 4000 (CWF)	38%	33%	33 % (13.8%)	0.080	0.006	99	103	2
Chomerics	SOFT-SHIELD 1000	57%	114%	41% (10.3%)	1.020	0.088	78	78	2
Chomerics	SOFT-SHIELD 2000	63%	72%	43% (10.8%)	0.370	0.047	75	73	1