Laird

Smart Technology. Delivered.™

Elastomeric EMI Shielding

SOLUTIONS

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Smart Technology. Delivered.™

ABOUT **LAIRD**

Laird designs and manufactures customized, performance-critical products for wireless and other advanced electronics applications.

The company is a global market leader in the design and supply of electromagnetic interference (EMI) shielding, thermal management products, mechanical actuation systems, signal integrity components, and wireless antennae solutions, as well as radio frequency (RF) modules and systems.

Laird is the world leader in the design and manufacture of customized, performance-critical products for wireless and other advanced electronics applications. Laird partners with its customers to customize product solutions for applications in many industries including:

- Network Equipment
- Handsets
- Telecommunications
- Data Transfer & Information Technology
- Computers
- Automotive Electronics
- Aerospace
- Defense
- Medical Equipment
- Consumer Electronics
- Industrial

Laird offers its customers unique product solutions, dedication to research and development, as well as a seamless network of manufacturing and customer support facilities across the globe.

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All parts listed in this catalog are lead free and RoHS compliant.

This catalog contains a limited selection of Laird products. Refer to www.lairdtech.com for other products not included in this catalog.

Notice:

Information on the products described in this catalog is based on laboratory test data which Laird believes to be reliable. However, Laird has no control over the design of actual products which incorporate Laird' products or actual fabrication of devices using Laird' products. Accordingly, Laird cannot guarantee that the same test data as described herein will be obtained. Thus, it is recommended that each user make their own tests to confirm laboratory test data and determine suitability of Laird' products for their particular application.

INTRODUCTION

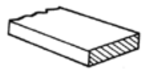
From concept to compliance, over 30 years of elastomer experience

Electrically conductive elastomers provide environmental sealing, and excellent mechanical and electromagnetic shielding properties. They are ideal for applications that demand both environmental sealing and EMI shielding, and can be used in a wide range of operating temperatures. Laird offers a wide variety of conductive filler materials in extruded, molded die-cut,dispensed form-in-place, printed and coated formats. We are constantly formulating new and custom compounds to provide you with more design options to meet your needs.

- Extrusion presses produce a multitude of conductive elastomer profiles in different compounds which are used in both military and commercial applications.
- Computerized multi axis form-in-place dispensing machines deposit conductive elastomer compounds onto miniaturized thin wall multi-compartment housing covers.
- Molding of EcE compounds is controlled from design through fabrication, from single cavity prototype to multi-cavity production or compression type molds.

VISUAL PART REFERENCE GUIDE

ELECTROSEAL CONDUCTIVE ELASTOMERS



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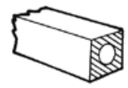

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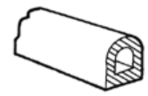

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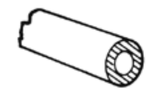

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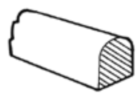

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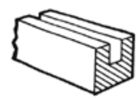

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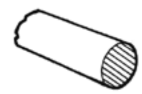

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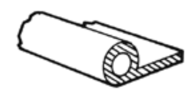

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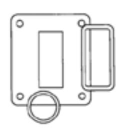

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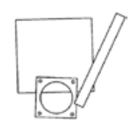

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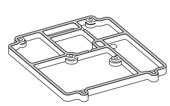

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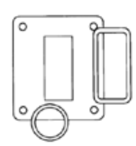

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INTRODUCTION TO ELECTRICALLY CONDUCTIVE ELASTOMERS

OVERVIEW

The electrically conductive elastomers are based on dispersed particles in elastomers, oriented wire in solid or sponge elastomers, impregnated wire mesh screens or expanded metals. They provide highly conductive, yet resilient gasketing materials for EMI sealing as well as pressure and environmental sealing.

Conductive elastomers are used for shielding electronic enclosures against electromagnetic interference (EMI). Usually, the shielding system consists of a conductive gasket sandwiched between a metal housing and lid. The primary function of these gaskets is to provide sufficient electrical conductivity across the enclosure/gasket/lid junction to meet grounding and EMI shielding requirements, as well as prevent intrusion of the fluids into the electrical components.

Laird offers conductive elastomers in the following forms:

1. ElectroSeal dispersed filler particles in elastomers
2. ElectroMet oriented wire in solid and sponge elastomers, and impregnated wire mesh and expanded metals

ELECTROSEAL™ GASKET INTRODUCTION

Conductive elastomer gaskets are EMI shielding and sealing devices made from highly conductive, mechanically resilient and conformable vulcanized elastomers. They are available in the following types:

1. Flat gaskets or die-cuts
2. Molded shapes such as O-rings or intricate parts
3. Extruded profiles or strips
4. Vulcanized-to-metal covers or flanges
5. Co-molded or reinforced seals
6. Form-in-place gaskets

When any two flat, but rigid surfaces are brought together, slight surface irregularities on each surface prevent them from meeting completely at all points. These irregularities may be extremely minute, yet may provide a leakage path for gas or liquid under pressure, and for high frequency electromagnetic energy. This problem remains in flange sealing even when very high closure force is applied.

However, when a gasket fabricated of resilient material is installed between the mating surfaces, and even minimal closure pressure is applied, the resilient gasket conforms to the irregularities in both mating surfaces. As a result, all surface imperfections and potential leak paths across the joint area are sealed completely against pneumatic and fluid pressure or penetration by environmental gases. If the gasket is conductive as well as resilient, with conductive matrix distributed throughout its total volume in mesh or particle form, the joint can be additionally sealed against penetration by, or exit of, electromagnetic energy.

DESIGN CONSIDERATIONS

The design requirements of the installation will usually narrow the choice considerably, particularly if the basic geometry of the enclosure is already established, or if military EMI shielding specifications are involved. In addition to choices of size and shape dictated by the enclosing structure and the joint geometry itself, the following four factors greatly influence the suitability of EMI gasket materials: shielding effectiveness, closure force, percent gland fill and compression/deflection.

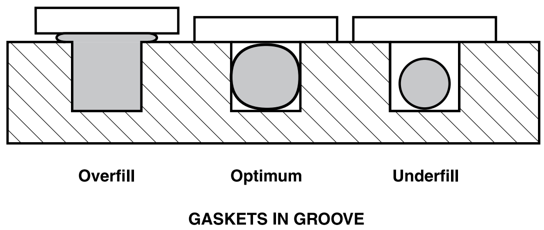
CLOSURE FORCE REQUIREMENTS

Solid conductive elastomer materials such as ElectroSeal stand up better to high closure forces, environmental pressures, and repeated opening and closing of the joint. Unlike sponge elastomers, solid conductive elastomers do not actually compress. They accommodate pressures by changing shape, rather than volume. This is an important difference in flange joint design requirements between the two material types, since additional gland volume must be allowed for the potential expansion of the elastomer under heat and/or pressure. Greater flange strength must often be provided to allow for increased closure force requirements. If low closure force is a consideration, however, the use of hollow extruded profiles such as the ElectroSeal hollow "O" and hollow "D" in conjunction with softer durometer elastomers will dramatically reduce closure force requirements.

PERCENT GLAND FILL (VOLUME/VOID RATIO)

Design of an elastomeric O-ring gland, or groove and contacting surfaces which make up the seal assembly, is as important as percent gland fill. For most static seal applications, it is necessary to calculate the area of the seal and the gland it will occupy, to determine whether the latter is large enough to receive the ring. Always try to avoid designs that stretch the elastomer more than 5%. If the seal element is stretched or compressed more than one or two percent, calculation based on the volume should be used unless volume swell is a factor. Irrespective of whether the calculations are based on volumes or cross-sectional areas, it is important to compare the largest possible seal cross-sectional area with the smallest gland, taking all tolerances into consideration. Never allow groove and seal tolerances to create an "overfilled" groove condition. Sufficient volume must be provided within the groove area to provide for a 90% to 95% gland fill. Figure 1 shows underfilled, overfilled, and optimum filled grooves.

FIGURE 1. GROOVE FILL LEVELS



GUIDELINES FOR GROOVE DIMENSIONS:

As a general rule we recommend a gland fill of 85% – 95% for optimum shielding effectiveness. However, for critical applications that require both shielding and environmental sealing, a 95% gland fill is suggested. For applications that require special design, please contact Laird applications engineering staff.

Recommended groove dimensions are provided on pages 18-19 for the solid D and solid O extruded profiles.

COMPRESSION/DEFLECTION

Compression/deflection data provide the engineer or designer with a qualitative comparison of the deformability of different profiles of conductive elastomers. Deflection is defined as the change in the cross-sectional height of a gasket under compressive load and is a function of material hardness and profile. The recommended deflection ranges of various conductive elastomer profiles are shown in Table 1. In no case however, should the amount of actual deflection be less than 10% for ElectroSeal materials. Remember that the minimum unevenness of the mating flanges must be taken into consideration in determining the original (uncompressed) and installed (compressed) height of the seal. Note that wall thickness of hollow profiles has a major effect on deflection

TABLE 1.
RECOMMENDED DEFLECTION FOR ELECTROSEAL PROFILES

CROSS SECTION SHAPE	DEFLECTION
Flat Strip	5-10 Percent
Solid O	20-25 Percent
Solid D	15-20 Percent
Hollow O	20-50 Percent
Hollow D	25-50 Percent
Hollow P	25-50 Percent
Interference Fit	15-25 Percent

Note: Selection of a proper profile has a bearing on the design and the performance of an EMI gasket.

INTRODUCTION TO ELECTRICALLY CONDUCTIVE ELASTOMERS

SERVICE LIFE

Three fundamental factors are involved when considering the service life of an EMI gasket:

1. The presence of detrimental chemicals and fluids, ozone aging and temperature extremes.
2. The number of times the joint will be opened and closed during the projected operating life of the equipment.
3. Potential exposure to inadvertent damage during initial installation and future maintenance.

ENVIRONMENTAL CONSIDERATIONS

Proper material selection for effective EMI shielding depends on the total environmental envelope within which the seal/shield will be expected to function. The material selection process should begin with a careful analysis of the following major environmental conditions:

- Temperature
- Aging/Shelf Life
- Pressure/Vacuum
- Fluid Compatibility
- Galvanic Compatibility

TEMPERATURE

Temperature, though seemingly elementary, is often the most misunderstood and exaggerated of all sealing environment parameters; hence, it is all too often over-specified.

Low Temperature

Low temperature induced changes in the elastomer properties are generally physical in nature. As the temperature decreases below allowable limits, the elastomeric properties are lost and the material becomes very hard and brittle. Duration of the effects of low temperature exposure is not significant and the original properties are regained upon resumption of moderate temperatures.

High Temperature

High temperatures also affect the properties of elastomers in the same way as the low temperatures. As the temperature begins to rise, the elastomer will soften, lowering its extrusion resistance. Tensile strength and modulus also decrease under high temperatures, and elongation is increased. But these initial changes reverse if exposure to high temperatures is brief. Changes due to prolonged high temperature exposure are chemical in nature rather than physical, and are not reversible.

The temperature capabilities of various ElectroSeal elastomers are shown in Table 2.

TABLE 2.
TEMPERATURE CAPABILITIES OF PRINCIPAL ELECTROSEAL ELASTOMERS

ELASTOMER TYPE	LOW TEMPERATURE	UPPER TEMPERATURE
EPDM	-58°F (-50°C)	257°F (125°C)
Silicone	-49°F (-45°C)	392°F (200°C)
Fluorosilicone	-67°F (-55°C)	347°F (175°C)

AGING/SHELF LIFE

Another major factor in the selection of any elastomer destined for sealing/shielding service is time, or more properly, seal life. The expected life of a seal may involve only a few seconds in the case of some highly specialized seals used in solid propellant rocket casings, to as much as 10 to 20 years and beyond in the case of seals used in deep-space vehicles.

Deterioration with time or aging relates to the type of polymer and storage conditions. Exposure may cause deterioration of elastomers whether installed or in storage. Resistance to deterioration in storage varies greatly between the elastomers. Military Handbook 695 (MIL-HDBK-695) divides synthetic elastomers in the following groups according to age resistance as shown in Table 3.

TABLE 3.
AGE RESISTANCE OF PRINCIPAL ELECTROSEAL ELASTOMERS

BASE POLYMER	ASTM DESIGNATION	SHELF LIFE (YEARS)
Ethylene Propylene Diene Monomer	EPDM	5 to 10 Years
Silicone MQ, VMQ,	PVMQ	Up to 20 Years
Fluorosilicone	FVMQ	Up to 20 Years

PRESSURE VACUUM

Conductive elastomer seals are rarely used for high-pressure systems, with the exception of waveguide seals. Pressure has a bearing on the choice of material and hardness. Low durometer materials are used for low pressure applications, whereas high pressure may require a combination of material hardness and design.

Outgassing and/or sublimation in a high vacuum system can cause seal shrinkage (loss of volume), resulting in a possible loss of sealing ability. When properly designed and confined, an O-ring, molded shape, or a molded-to-the-cover plate seal can provide adequate environmental sealing as well as EMI shielding for vacuum (to 1 x 10-6 Torr) applications.

FLUID COMPATIBILITY

The primary function of elastomeric EMI seals is to provide sufficient electrical conductivity across the enclosure/port/flange junction, while at the same time provide at least minimal environmental sealing capability. Consideration must be given to the basic compatibility between the elastomer seal/shield element and any fluids with which it may come in prolonged contact. Table 4 lists the general reaction to common fluid media for the polymer types commonly used in ElectroSeal conductive elastomers. Note that any proposed conductive material and design should be thoroughly tested by the user under all possible conditions prior to production.

The complex chemistry involved in the combination of the polymer and metallic fillers in conductive elastomers makes it imperative that such tests be conducted to determine suitability for use with a given fluid.

TABLE 4.
RESISTANCE OF PRINCIPAL ELECTROSEAL ELASTOMERS TO FLUIDS

FLUID	SILICONE	FLUOROSILICONE	EPDM
Impermeability to Gases	Poor	Fair	Good
Ozone and Ultraviolet	Excellent	Excellent	Excellent
ASTM 1 Oil	Fair	Good	Don't use
Hydraulic Fluids (Organic)	Fair	Good	Don't use
Hydraulic Fluids (Phosphate ester)	Fair	Fair	Excellent
Hydrocarbon Fuels	Don't use	Good	Don't use
Dilute Acids	Fair	Good	Good
Concentrated Acids	Don't use	Don't use	Fair/ Good
Dilute Bases	Fair	Good	Excellent
Concentrated Bases	Don't use	Don't use	Good
Esters/Ketones	Don't use	Don't use	Excellent
DS (Decontaminating Fluid)	Poor	Poor	Good
STB (Decontaminating Fluid)	Good	Good	Good
Low Temperature	Excellent	Excellent	Excellent
High Temperature	Excellent	Good	Good
Compression Set	Good	Good	Good
Radiation Resistance	Good	Poor	Good

GALVANIC COMPATIBILITY

Compatibility between the gasket and the mating flanges is another area which must be given proper attention when designing a gasket for sealing/shielding. This problem can be minimized by various means, the simplest and most effective of which is proper gasket and flange design. This must be coupled with the judicious selection of a gasket material compatible with the mating surfaces. A large difference in corrosion potential between the mating surface and the conductive elastomer and the presence of a conductive electrolyte, such as salt water or a humid environment, will accelerate galvanic corrosion.

Under dry conditions, such as the typical office environment, there will be little danger of galvanic corrosion. However, when the gasket is exposed to high humidity or salt-water environments, galvanic corrosion will occur between dissimilar metals. The likelihood of galvanic corrosion increases as the potential difference between the mating surface and the elastomer increases. The charts on pages 47-48 indicate which mating surfaces and elastomer combinations minimize the corrosion potential. In addition, the less permeable elastomers, such as EPDM and fluorosilicone, limit galvanic corrosion by restricting the access of the electrolyte to the conductive fillers in the gasket. For further details on galvanic corrosion of elastomeric materials, see pages 43-48.

INTRODUCTION TO ELECTRICALLY CONDUCTIVE ELASTOMERS

MATERIAL SELECTION GUIDE

Laird offers a series of products to meet a wide range of customer requirements for military and commercial applications. The classifications of the most common materials are based on cost and specific applications and are outlined in Table 5.

TABLE 5

PARAMETER	TEST METHOD										
ECE Name		ECE93	ECE72	ECE92	ECE115	ECE125	ECE85A	ECE116	ECE126	ECE118	ECE88
MIL-DTL-83528C Material Type					**Type M**			**Type B**	**Type D**	**Type A**	
Filler		Ni/C	Ni/C	Ni/C	Ag/Glass	Ag/Glass	Ag/Glass	Ag/Al	Ag/Al	Ag/Cu	Ag/Cu
Elastomer		Silicone	Silicone	Fluorosilicone	Silicone	Fluorosilicone	Silicone	Silicone	Fuorosilicone	Silicone	Fluorosilicone
Color		Black	Gray	Dark Gray	Tan	Tan	Tan	Tan	Tan	Tan	Tan
Electrical Properties											
Volume Resistivity, Ω cm, max	MIL-DTL-83528C para 4.5.10	0.1	0.1	0.1	0.006	0.01	0.004	0.008	0.01	0.004	0.01
Shielding Eff, 10 GHz, dB, min	MIL-DTL-83528C para 4.5.12	100	100	100	100	90	100	100	100	120	110
Physical Properties											
Density, g/cm3 (±0.25)	ASTM D792	1.9	2.3	2.2	1.9	2	2	2	2	3.3	4.1
Hardness, Shore A (±7)	ASTM D2240	55	75	75	65	75	70	65	70	70	75
Tensile Strength, psi, min	ASTM D412	150	280	150	200	200	200	200	200	450	180
Elongation	ASTM D412	100-300%	150%	60-250%	100-300%	60-200%	60%	100-300%	60-260%	100-300%	100-300%
Tear Strength, ppi, min	ASTM D624, die C	30	55	40	30	30	30	30	35	55	30
Compression Set, max	ASTM D395	30%	30%	30%	30%	30%		32%	30%	32%	35%
Compression / Deflection, %, min	ASTM D575	8	8	5	3.5	3		3.5	3.5	3.5	3.5
Max Oper. Temp., °C	MIL-DTL-83528C para 4.5.15	160	160	160	160	160	150	160	160	125	125
Min. Oper. Temp., °C	ASTM D1329	-55	-55	-55	-55	-50	-45	-55	-55	-55	-55
Flame Retardance	UL 94	HB	V0	-	V0	V0	-	V0	V0	V0	-
Fluid Immersion[1]	MIL-DTL-83528C para 4.5.17	N/S	-	SUR	N/S	SUR	-	-	SUR	-	SUR
Electrical Stability											
After Heat Aging, Ω cm, max	MIL-DTL-83528C para 4.5.15	0.2	-	0.2	0.015	-	-	0.01	0.015	0.01	0.015
After Break, Ω cm, max	MIL-DTL-83528C para 4.5.9	0.2	-	0.2	0.009	-	-	0.015	0.015	0.008	0.015
During Vibration, Ω cm, max	MIL-DTL-83528C para 4.5.13	0.2	-	0.2	0.009	-	-	0.015	0.015	0.006	0.015
After Exposure to EMP, Ω cm, max	MIL-DTL-83528C para 4.5.16	0.1	-	0.1	0.015	-	-	0.01	0.015	0.01	0.015
Manufacturing Processes											
Molded sheet / diecut parts		x	x	x	x	x	x	x	x	x	x
Molded shapes / O-rings		x	x	x	x	x	x	x	x	x	x
Extruded profiles		x	x	x	x	x		x	x	x	x

Notes:
N/S = Not Survivable
SUR = Survivable

INTRODUCTION TO ELECTRICALLY CONDUCTIVE ELASTOMERS

PARAMETER									
EcE Name	ECE82	ECE83	ECE84	ECE90	ECE87	ECE13	ECE95	ECE96	ECE89
MIL-DTL-83528C Material Type	**Type E**	**Type J**							
Filler	Ag	Ag	Ag/Ni	Ag/Ni	C	C	Ni/C	Ag/Al	Ag/Al
Elastomer	Silicone	Silicone	Silicone	Fluorosilicone	Silicone	EPDM	EPDM	EPDM	Fluorosilicone
Color	Beige	Beige	Tan	Tan	Black	Black	Black	Tan	Blue
Electrical Properties									
Volume Resistivity, Ω cm, max	0.002	0.01	0.005	0.005	5	30	0.15	0.01	0.012
Shielding Eff, 10 GHz, dB, min	120	80	100	100	30	30	70	90	100
Physical Properties									
Density, g/cm3 (±0.25)	3.5	1.8	4	4.1	1.3	1.2	2.2	2.2	2.2
Hardness, Shore A (±7)	65	45	75	75	75	80	80	80	70
Tensile Strength, psi, min	300	150	200	300	700	2000	200	200	180
Elongation	100-300%	50-250%	100-300%	100-300%	100-300%	100-400%	70-260%	70-260%	60-260%
Tear Strength, ppi, min	50	20	30	50	50	100	60	60	30
Compression Set, max	45%	35%	32%	25%	45%	30%	40%	50%	30%
Compression / Deflection, %, min	2.5	8	3.5	3	3.5	3	3	3	3.5
Max Oper. Temp., °C	160	160	125	160	160	125	125	125	160
Min. Oper. Temp., °C	-55	-55	-55	-50	-55	-40	-40	-40	-55
Flame Retardance	-	-	-	-	-	-	-	-	-
Fluid Immersion[1]	N/S	N/S	N/S	SUR	N/S	N/S	N/S	N/S	SUR
Electrical Stability									
After Heat Aging, Ω cm, max	0.01	0.015	0.01	0.01	7	40	-	-	0.015
After Break, Ω cm, max	0.01	0.02	0.01	0.01	7	-	-	-	0.015
During Vibration, Ω cm, max	0.01	0.015	0.01	0.01	-	-	-	-	0.015
After Exposure to EMP, Ω cm, max	0.01	0.015	0.01	0.01	-	-	-	-	0.015
Manufacturing Processes									
Molded sheet / diecut parts	x	x	x	x	x	x	x	x	x
Molded shapes / O-rings	x	x	x	x	x	x	x	x	x
Extruded profiles	x	x	x	x		x	x	x	x

INTRODUCTION TO ELECTRICALLY CONDUCTIVE ELASTOMERS

EMI GASKET MOUNTING TECHNIQUES

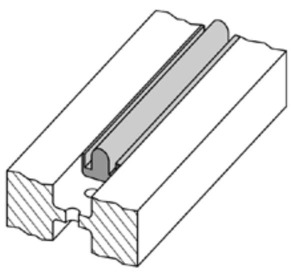
Common EMI gasket mounting techniques are:

POSITIONING IN A GROOVE

This is a highly recommended method if a suitable groove can be provided at a relatively low cost. Placing the EMI gasket in such a groove provides several advantages:

- **a.** metal-to-metal contact of mating flange surfaces provides a compression stop and prevents overcompression of the gasket material;
- **b.** is cost-effective by reducing assembly time;
- **c.** best overall seal for EMI, EMP, salt fog, NBC, and fluids by providing metal-to-metal flange contact and reducing exposure of the seal element to attack by outside elements.

FIGURE 2



INTERFERENCE FIT APPLICATIONS

Allow 0.005 in. (0,1 mm) to 0.100 in. (2,5 mm) interference for part to hold and eliminate the need for adhesive. Groove depth should be set to ensure that the channel is not over-filled.

WATER TIGHT APPLICATIONS

Fill channel with as much material as possible, taking tolerances into account. Use caution to avoid overfill conditions.

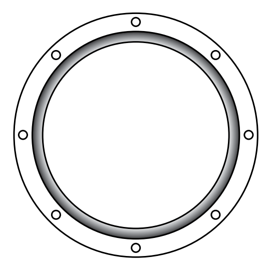
BONDING WITH ADHESIVES

The EMI gasket may be attached to one of the mating flanges by the application of pressure sensitive or permanent adhesives. A suitable conductive adhesive is always preferable over a nonconductive adhesive for mounting EMI gaskets as they can provide adequate electrical contact between the EMI gasket and the mounting surface.

BOLT-THROUGH HOLES

This is a common and inexpensive way to hold an EMI gasket in position. Locator bolt holes can be accommodated in the tab or in rectangular flat gaskets as shown in Figure 3.

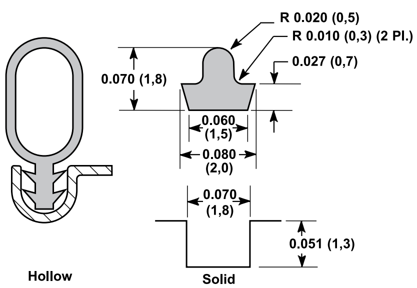
FIGURE 3



INTERFERENCE FIT

For applications such as face seals or where the gasket must be retained in the groove during assembly, interference fit is an excellent and inexpensive choice. The gasket is simply held in the groove or against a shoulder by mechanical friction as shown in Figure 4.

FIGURE 4

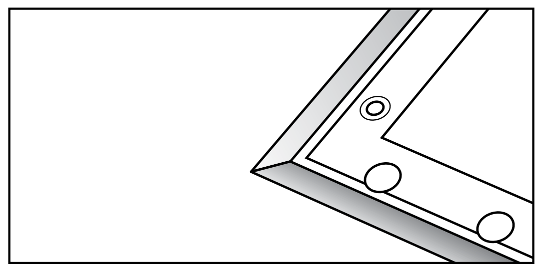


VULCANIZED MOUNTING

In this case, the seal element is vulcanized directly to the metal flange or cover under heat and pressure. The vulcanized to the-metal mounting offers a homogeneous one-piece gasket with superior conductivity between the gasket and the metal.

Laird provides EMI seals bonded to covers and retainers. Such devices may have the conductive element bonded in a groove or vulcanized to the edge of a thin sheet metal retainer. Figure 5 shows a vulcanized mounted and frame mounted gasket.

FIGURE 5



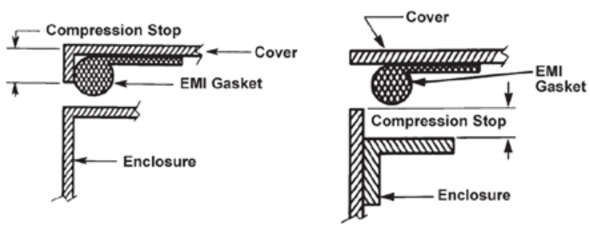
FRICTION, ABRASION AND IMPACT CONSIDERATIONS

The physical positioning of EMI gaskets in an environment where friction, abrasion and impact are possible needs special consideration. EMI gaskets in such an environment should be positioned so that they receive little or no sliding or side-to-side motion when being compressed. Examples of common attachments for access door gaskets are shown in Figure 6.

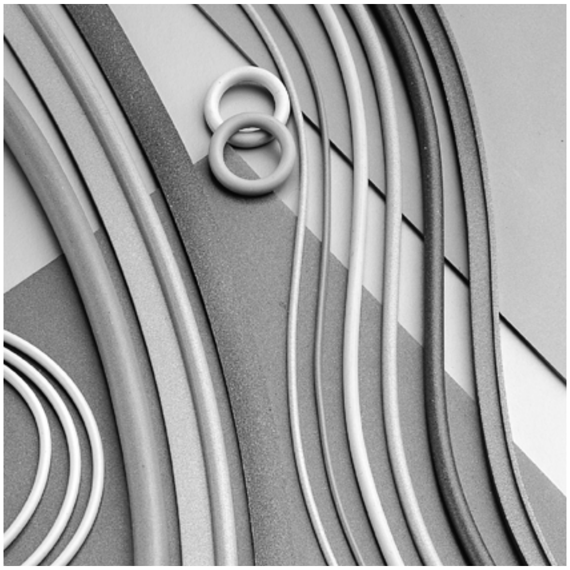
MOUNTING TIPS

Care should be taken to avoid excess handling of conductive elastomers, including excessive stretching, bending or exposure to grease.

FIGURE 6 COVER WITH COMPRESSION STOP



ELECTROSEAL CONDUCTIVE ELASTOMER MATERIAL



ELECTROSEAL™ CONDUCTIVE ELASTOMER EMI SHIELDING

Laird electrically conductive elastomer products are ideal for both military and commercial applications requiring both environmental sealing and EMI shielding. Compounds can be supplied in molded or extruded shapes, sheet stock, custom extruded, or die-cut shapes to meet a wide variety of applications.

Our conductive extrusions offer a wide choice of profiles to fit a large range of applications. The cross-sections shown on the following pages are offered as standard. Custom dies can be built to accommodate your specific design.

- Available in a wide variety of conductive filler materials
- Shielding effectiveness up to 120 dB at 10 GHz

SHEET MATERIAL

Table 1 lists thicknesses and sizes for our molded sheet material, while Table 2, pages 10-11, shows the compounds available for all of our conductive silicone elastomers.

HOW TO SPECIFY ECE

Decide on molded sheet stock or extruded shapes. Select the desired configuration and dimensions from Table 1 (for sheet stock) or Figures 1–8 (for extruded shapes). Select the desired material from Table 2. Insert material number from Table 2, |pages 14–17, in place of the letters XX in the Laird part number.

Example

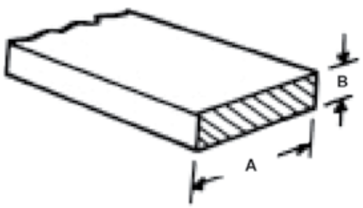
1. From Figure 1, on page 18, for a rectangular strip measuring 0.500 in. (12,7 mm) x 0.075 in. (1,9 mm), part number is 8861-0130-XX.
2. From Table 2, on page 16, for silver-nickel filler, material number is 84.
3. Ordering part number is 8861-0130-84.*

Note: Rectangular and D-shaped extrusions can be supplied with pressure sensitive adhesive tape.

THICKNESS	10 X 10 SHEET	10 X 15 SHEET	15 X 20 SHEET	18 X 18 SHEET
0.020 (0,5)	8860-0020-100-XX	8860-0020-150-XX	8860-0020-300-XX	N/A
0.032 (0,8)	8860-0032-100-XX	8860-0032-150-XX	8860-0032-300-XX	8860-0032-324-XX
0.045 (1,1)	8860-0045-100-XX	8860-0045-150-XX	8860-0045-300-XX	8860-0045-324-XX
0.062 (1,5)	8860-0062-100-XX	8860-0062-150-XX	8860-0062-300-XX	8860-0062-324-XX
0.093 (2,3)	8860-0093-100-XX	8860-0093-150-XX	8860-0093-300-XX	8860-0093-324-XX
0.100 (2,5)	8860-0100-100-XX	8860-0100-150-XX	8860-0100-300-XX	8860-0100-324-XX
0.125 (3,2)	8860-0125-100-XX	8860-0125-150-XX	8860-0125-300-XX	8860-0125-324-XX

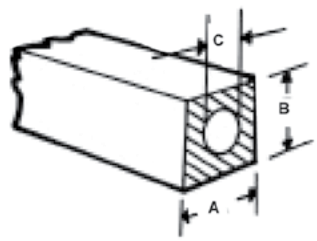
EXTRUSIONS GUIDE

Rectangular Strips



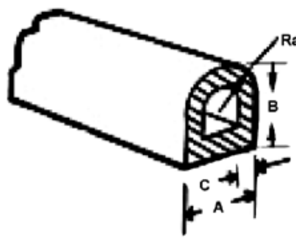
MIL-DTL-85328 PART NUMBER	PART NUMBER	NOMINAL DIMENSIONS INCH(MM)	
		A	B
M83528/009X001	8861-0100	0.063 (1,6)	0.042 (1,1)
	8861-0179	0.079 (2,0)	0.039 (1,0)
	8861-0181	0.079 (2,0)	0.059 (1,5)
M83528/009X002	8861-0105	0.095 (2,4)	0.062 (1,6)
M83528/009X003	8861-0110	0.120 (3,0)	0.075 (1,9)
M83528/009X004	8861-0115	0.125 (3,2)	0.062 (1,6)
M83528/009X005	8861-0120	0.156 (4,0)	0.062 (1,6)
	8861-0121	0.187 (4,8)	0.125 (3,2)
	8861-0167	0.188 (4,8)	0.062 (1,6)
	8861-0193	0.189 (4,8)	0.189 (4,8)
M83528/002X006	8861-0125	0.250 (6,4)	0.062 (1,6)
	8861-0173	0.250 (6,4)	0.125 (3,2)
	8861-0174	0.250 (6,4)	0.188 (4,8)
	8861-0136	0.250 (6,4)	0.200 (5,1)
	8861-0175	0.252 (6,4)	0.031 (0,8)
	8861-0183	0.378 (9,6)	0.063 (1,6)
	8861-0172	0.500 (12,7)	0.020 (0,5)
	8861-0131	0.500 (12,7)	0.042 (1,1)
	8861-0182	0.500 (12,7)	0.059 (1,5)
M83528/009X007	8861-0130	0.500 (12,7)	0.075 (1,9)
	8861-0188	0.500 (12,7)	0.094 (2,4)
M83528/009X008	8861-0135	0.500 (12,7)	0.125 (3,2)
M83528/009X009	8861-0140	0.500 (12,7)	0.188 (4,8)
	8861-0142	0.750 (19,1)	0.040 (1,0)
	8861-0141	0.750 (19,1)	0.042 (1,1)
M83528/009X010	8861-0145	0.750 (19,1)	0.062 (1,6)
	8861-0184	0.827 (21,0)	0.071 (1,8)
	8861-0189	0.827 (21,0)	0.094 (2,4)
M83528/009X011	8861-0150	0.880 (22,4)	0.062 (1,6)
	8861-0103	0.984 (25,0)	0.043 (1,1)
	8861-0169	1.00 (25,4)	0.062 (1,6)
	8861-0192	1.00 (25,4)	0.126 (3,2)
M83528/009X012	8861-0155	1.00 (25,4)	0.250 (6,4)
M83528/009X013	8861-0160	1.18 (30,0)	0.062 (1,6)

Hollow Rectangular Strips

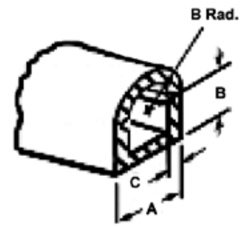


PART NUMBER	NOMINAL DIMENSIONS INCH(MM)		
	A	B	C
8862-0112	0.125 (3,2)	0.125 (3,2)	0.078 (2,0)
8862-0113	0.200 (5,1)	0.130 (3,3)	0.090 (2,3)
8862-0114	0.250 (6,4)	0.250 (6,4)	0.156 (4,0)
8862-0100	0.330 (8,4)	0.305 (7,7)	0.125 (3,2)
8862-0105	0.375 (9,5)	0.375 (9,5)	0.188 (4,8)

Hollow D-Strips



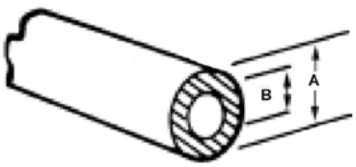
View A



View B

MIL-DTL-83528 PART NUMBER	PART NUMBER	DIMENSIONS INCH(MM)				
		A	B	RAD	C	VIEW
	8866-0135	0.093 (2,4)	0.093 (2,4)	0.046 (1,2)	0.027 (0,7)	A
	8866-0160	0.098 (2,5)	0.098 (2,5)	0.049 (1,2)	0.020 (0,5)	A
	8866-0130	0.100 (2,5)	0.094 (2,4)	0.050 (1,3)	0.025 (0,6)	A
	8866-0162	0.109 (2,8)	0.125 (3,2)	0.054 (1,4)	0.024 (0,6)	A
M83528/007X001	8866-0100	0.156 (4,0)	0.156 (4,0)	0.078 (2,0)	0.045 (1,1)	A
	8866-0111	0.156 (4,0)	0.156 (4,0)	0.078 (2,0)	0.027 (0,7)	A
	8866-0103	0.158 (4,0)	0.240 (6,1)	0.079 (2,0)	0.040 (1,0)	A
	8866-0136	0.160 (4,1)	0.120 (3,0)	0.080 (2,0)	0.025 (0,6)	A
M83528/007X002	8866-0105	0.187 (4,8)	0.187 (4,8)	0.093 (2,4)	0.050 (1,3)	A
	8866-0131	0.250 (6,4)	0.145 (3,7)	0.125 (3,2)	0.030 (0,8)	A
	8866-0050	0.250 (6,4)	0.250 (6,4)	0.125 (3,2)	0.050 (1,3)	B
M83528/007X007	8866-0110	0.250 (6,4)	0.250 (6,4)	0.125 (3,2)	0.065 (1,7)	A
M83528/007X005	8866-0120	0.312 (7,9)	0.312 (7,9)	0.112 (2,8)	0.062 (1,6)	A
M83528/007X004	8866-0116	0.312 (7,9)	0.312 (7,9)	0.156 (4,0)	0.062 (1,6)	B
	8866-0127	0.325 (8,3)	0.575 (14,6)	0.287 (7,3)	0.080 (2,0)	A
	8866-0168	0.358 (9,1)	0.374 (9,5)	0.179 (4,5)	0.039 (1,0)	A
	8866-0166	0.374 (9,5)	0.252 (6,4)	0.187 (4,8)	0.039 (1,0)	A
	8866-0134	0.375 (9,5)	0.250 (6,4)	0.090 (2,3)	0.050 (1,3)	B
	8866-0137	0.375 (9,5)	0.250 (6,4)	0.187 (4,8)	0.032 (0,8)	A
	8866-0169	0.421 (10,7)	0.427 (10,8)	0.210 (5,3)	0.039 (1,0)	A
	8866-0126	0.480 (12,2)	0.335 (8,5)	0.240 (6,1)	0.035 (0,9)	A
M83528/007X006	8866-0125	0.487 (12,4)	0.324 (8,2)	0.244 (6,2)	0.062 (1,6)	A
	8866-0148	0.488 (12,4)	0.312 (7,9)	0.244 (6,2)	0.055 (1,4)	A
	8866-0139	0.488 (12,4)	0.324 (8,2)	0.244 (6,2)	0.063 (1,6)	A
	8866-0129	0.500 (12,7)	0.312 (7,9)	0.250 (6,4)	0.050 (1,3)	A
	8866-0155	0.625 (15,9)	0.400 (10,2)	0.312 (7,9)	0.057 (1,4)	A

O-Strip Tubing

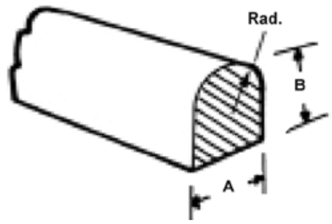


MIL-DTL-85328 PART NUMBER	PART NUMBER	NOMINAL DIMENSIONS INCH(MM)	
		A	B
	8864-0136	0.085 (2,2)	0.035 (0,9)
	8864-0060	0.085 (2,2)	0.040 (1,0)
	8864-0173	0.085 (2,2)	0.050 (1,3)
	8864-0156	0.090 (2,3)	0.040 (1,0)
	8864-0161	0.090 (2,3)	0.045 (1,1)
	8864-0090	0.090 (2,3)	0.050 (1,3)
M83528/011X007	8864-0095	0.103 (2,6)	0.040 (1,0)
	8864-0142	0.103 (2,6)	0.050 (1,3)
	8864-0172	0.110 (2,8)	0.062 (1,6)
	8864-0153	0.115 (2,9)	0.062 (1,6)
M83528/011X001	8864-0100	0.125 (3,2)	0.045 (1,1)
M83528/011X006	8864-0101	0.125 (3,2)	0.062 (1,6)
	8864-0102	0.130 (3,3)	0.062 (1,6)
	8864-0104	0.145 (3,7)	0.070 (1,8)
	8864-0171	0.149 (3,8)	0.125 (3,2)
M83528/011X002	8864-0105	0.156 (4,0)	0.050 (1,3)
	8864-0163	0.156 (4,0)	0.062 (1,6)
	8864-0139	0.168 (4,3)	0.069 (1,8)
	8864-0162	0.177 (4,5)	0.092 (2,3)

MIL-DTL-85328 PART NUMBER	PART NUMBER	NOMINAL DIMENSIONS INCH(MM)	
		A	B
M83528/011X008	8864-0143	0.177 (4,5)	0.079 (2,0)
	8864-0168	0.188 (4,8)	0.120 (3,0)
	8864-0147	0.216 (5,5)	0.125 (3,2)
	8864-0167	0.228 (5,8)	0.169 (4,3)
M83528/011X003	8864-0110	0.250 (6,4)	0.125 (3,2)
	8864-0160	0.312 (7,9)	0.188 (4,8)
M83528/011X004	8864-0120	0.312 (7,9)	0.192 (4,9)
	8864-0144	0.330 (8,4)	0.250 (6,4)
	8864-0050	0.375 (9,5)	0.235 (6,0)
M83528/011X005	8864-0125	0.375 (9,5)	0.250 (6,4)
	8864-0127	0.400 (10,2)	0.200 (5,1)
	8864-0170	0.422 (10,7)	0.319 (8,1)
	8864-0166	0.490 (12,4)	0.414 (10,5)
	8864-0135	0.513 (13,0)	0.438 (11,1)
	8864-0055	0.550 (14,0)	0.447 (11,4)
	8864-0159	0.623 (15,8)	0.366 (9,3)
	8864-0053	0.630 (16,0)	0.375 (9,5)

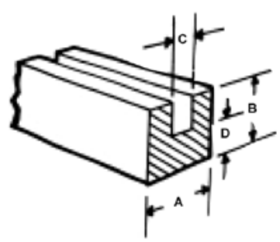
	8864-010462	0.146 (3.7)	0.091 (2.3)
	8864-3714	0.146 (3.7)	0.055 (1.4)
	8864-0103	0.138 (3.5)	0.071 (1.8)
	8864-0091	0.094 (2.4)	0.059 (1.5)
	8864-3515	0.138 (3.5)	0.059 (1.5)
	8864-2618	0.102 (2.6)	0.071 (1.8)
	8864-3824	0.150 (3.8)	0.094 (2.4)
	8864-0137	0.094 (2.4)	0.035 (0.9)
	8864-0141	0.126 (3.2)	0.087 (2.2)
	8864-0231	0.071 (1.8)	0.039 (1)
	8864-0180	0.063 (1.6)	0.039 (1)
	8864-3715	0.146 (3.7)	0.059 (1.5)

D-Strips



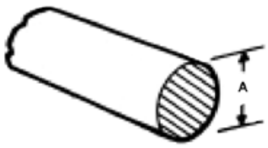
MIL-DTL-83528 PART NUMBER	PART NUMBER	DIMENSIONS INCH(MM)			RECOMMENDED GROOVE DIMENSIONS (±0.002)	
		A	B	RAD	WIDTH	DEPTH
	8865-0100	0.055 (1,4)	0.064 (1,6)	0.031 (0,8)	0.067 (1,7)	0.053 (1,3)
MB83528/003X001	8865-0105	0.062 (1,6)	0.068 (1,7)	0.031 (0,8)	0.074 (1,9)	0.057 (1,4)
MB83528/003X005	8865-0120	0.062 (1,6)	0.100 (2,5)	0.031 (0,8)	0.076 (1,9)	0.084 (2,1)
MB83528/003X010	8865-0140	0.075 (1,9)	0.178 (4,5)	0.089 (2,3)	0.093 (2,4)	0.150 (3,8)
MB83528/003X004	8865-0116	0.093 (2,4)	0.093 (2,4)	0.047 (1,2)	0.109 (2,8)	0.077 (2,0)
MB83528/003X002	8865-0110	0.094 (2,4)	0.078 (2,0)	0.047 (1,2)	0.109 (2,8)	0.065 (1,7)
MB83528/003X008	8865-0135	0.118 (3,0)	0.156 (4,0)	0.059 (1,5)	0.140 (3,6)	0.131 (3,3)
MB83528/003X007	8865-0130	0.122 (3,1)	0.135 (3,4)	0.061 (1,5)	0.141 (3,6)	0.113 (2,9)
MB83528/003X006	8865-0125	0.150 (3,8)	0.110 (2,8)	0.075 (1,9)	0.165 (4,2)	0.092 (2,3)
MB83528/003X003	8865-0115	0.178 (4,5)	0.089 (2,3)	0.039 (1,0)	0.182 (4,3)	0.074 (1,9)
MB83528/003X011	8865-0144	0.188 (4,8)	0.188 (4,8)	0.094 (2,4)	0.220 (5,6)	0.160 (4,1)
MB83528/003X012	8865-0145	0.250 (6,4)	0.250 (6,4)	0.125 (3,2)	0.286 (7,3)	0.212 (5,4)

Channel Strips



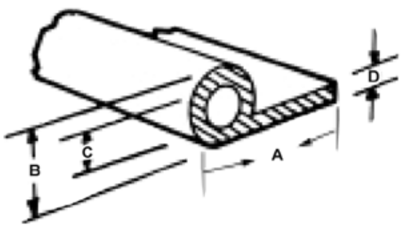
MIL-DTL-83528 PART NUMBER	PART NUMBER	DIMENSIONS INCH(MM)			
		A	B	C	D
M83528/010X001	8868-0100	0.100 (2,5)	0.100 (2,5)	0.034 (0,9)	0.033 (0,8)
	8868-0055	0.114 (2,9)	0.082 (2,1)	0.030 (0,8)	0.026 (0,7)
M83528/010X002	8868-0105	0.126 (3,2)	0.110 (2,8)	0.025 (0,6)	0.050 (1,3)
M83528/010X003	8868-0056	0.156 (4,0)	0.114 (2,9)	0.030 (0,8)	0.062 (1,6)
M83528/010X004	8868-0115	0.156 (4,0)	0.156 (4,0)	0.062 (1,6)	0.047 (1,2)
	8868-0067	0.175 (4,4)	0.500 (12,7)	0.047 (1,2)	0.075 (1,9)
M83528/010X005	8868-0120	0.175 (4,4)	0.156 (4,0)	0.047 (1,2)	0.075 (1,9)
	8868-0081	0.189 (4,8)	0.189 (4,8)	0.063 (1,6)	0.063 (1,6)
	8868-0084	0.250 (6,4)	0.250 (6,4)	0.062 (1,6)	0.062 (1,6)
	8868-0085	0.252 (6,4)	0.252 (6,4)	0.126 (3,2)	0.063 (1,6)
M83528/010X006	8868-0125	0.327 (8,3)	0.235 (6,0)	0.062 (1,6)	0.115 (2,9)
	8868-0070	0.395 (1,0)	0.120 (3,0)	0.275 (7,0)	0.060 (1,5)
	8868-0075	0.530 (13,5)	0.130 (3,3)	0.390 (9,9)	0.060 (1,5)

O-Strips



MIL-DTL-85328 PART NUMBER	PART NUMBER	DIMENSIONS INCH(MM)	RECOMMENDED GROOVE DIMENSIONS (±0.002)	
		A	WIDTH	HEIGHT
	8863-0184	0.032 (0,8)	0.036 (0,9)	0.026 (0,7)
M83528/001X001	8863-0100	0.040 (1,0)	0.045 (1,1)	0.032 (0,8)
M83528/001X002	8863-0105	0.053 (1,3)	0.059 (1,5)	0.042 (1,1)
M83528/001X003	8863-0110	0.062 (1,6)	0.066 (1,7)	0.050 (1,3)
M83528/001X004	8863-0115	0.070 (1,8)	0.076 (1,9)	0.056 (1,4)
M83528/001X005	8863-0120	0.080 (2,0)	0.086 (2,2)	0.064 (1,6)
M83528/001X006	8863-0125	0.093 (2,4)	0.100 (2,5)	0.074 (1,9)
	8863-0196	0.098 (2,5)	0.105 (2,7)	0.078 (2,0)
M83528/001X007	8863-0130	0.103 (2,6)	0.110 (2,8)	0.082 (2,1)
	8863-0135	0.112 (2,8)	0.119 (3,0)	0.089 (2,3)
M83528/001X008	8863-0140	0.119 (3,0)	0.126 (3,2)	0.095 (2,4)
M83528/001X009	8863-0145	0.125 (3,2)	0.133 (3,4)	0.100 (2,5)
	8863-0150	0.130 (3,3)	0.137 (3,5)	0.104 (2,6)
M83528/001X010	8863-0160	0.139 (3,5)	0.147 (3,7)	0.111 (2,8)
	8863-0165	0.150 (3,8)	0.158 (4,0)	0.120 (3,0)
	8863-0170	0.160 (4,1)	0.168 (4,3)	0.128 (3,3)
	8863-0197	0.186 (4,7)	0.197 (5,0)	0.149 (3,8)
M83528/001X011	8863-0183	0.188 (4,8)	0.200 (5,1)	0.150 (3,8)
	8863-0198	0.194 (4,9)	0.209 (5,3)	0.156 (4,0)
	8863-0199	0.197 (5,0)	0.210 (5,3)	0.158 (4,0)
M83528/001X0012	8863-0175	0.216 (5,5)	0.229 (5,8)	0.173 (4,4)
M83528/001X013	8863-0180	0.250 (6,4)	0.267 (6,8)	0.200 (5,1)
	8863-0200	0.256 (6,5)	0.274 (7,0)	0.205 (5,2)
	8863-0201	0.312 (7,9)	0.337 (8,6)	0.250 (6,4)
	8863-0202	0.374 (9,5)	0.400 (10,2)	0.300 (7,6)

P-Strips



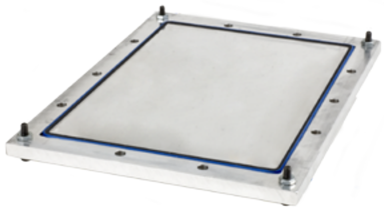
MIL-DTL-83528 PART NUMBER	PART NUMBER	DIMENSIONS INCH(MM)			
		A	B	C	D
	8867-0136	0.275 (7,0)	0.140 (3,6)	0.085 (2,2)	0.030 (0,8)
	8867-0147	0.290 (7,4)	0.095 (2,4)	0.062 (1,6)	0.025 (0,6)
	8867-0128	0.415 (10,5)	0.200 (5,1)	0.060 (1,5)	0.062 (1,6)
	8867-0141	0.425 (10,8)	0.250 (6,4)	0.151 (3,8)	0.050 (1,3)
M83528/008X007	8867-0101	0.475 (12,1)	0.200 (5,1)	0.080 (2,0)	0.062 (1,6)
	8867-0127	0.500 (12,7)	0.200 (5,1)	0.076 (1,9)	0.062 (1,6)
M83528/008X002	8867-0105	0.500 (12,7)	0.250 (6,4)	0.125 (3,2)	0.062 (1,6)
	8867-0126	0.600 (15,2)	0.250 (6,4)	0.125 (3,2)	0.062 (1,6)
M83528/008X004	8867-0102	0.640 (16,3)	0.208 (5,3)	0.080 (2,0)	0.072 (1,8)
	8867-0158	0.752 (19,1)	0.252 (6,4)	0.189 (4,8)	0.063 (1,6)
	8867-0165	0.752 (19,1)	0.437 (11,1)	0.347 (8,8)	0.060 (1,5)
M83528/008X006	8867-0130	0.780 (19,8)	0.360 (9,1)	0.255 (6,5)	0.070 (1,8)
M83528/008X001	8867-0100	0.850 (21,6)	0.200 (5,1)	0.080 (2,0)	0.062 (1,6)
	8867-0166	0.874 (22,2)	0.500 (12,7)	0.400 (10,2)	0.065 (1,7)
M83528/008X005	8867-0125	0.875 (22,2)	0.312 (7,9)	0.187 (4,8)	0.062 (1,6)

GEMINI™ COEXTRUSIONS

MULTI-EXTRUSION, BI-FUNCTIONAL ELASTOMER GASKET

Laird' Gemini™ product line is a high-performance gasket solution that combines a reliable environmental silicone elastomer seal with an electrically conductive elastomer. Conductive particle filler results in a product with lower material cost and an improved environmental seal against water, moisture, dust and mildly corrosive atmospheric conditions due to smog.

Our conductive extrusions offer a wide choice of profiles to fit a large range of applications. The cross-sections shown on the following pages are offered as standard. Custom dies can be built to accommodate your specific design.



FEATURES

- Combines the strength of silicone rubber with Laird' proprietary conductive elastomer EMI shielding materials and knowledge
- Improved environmental seal
- Improved EMI performance over lifetime
- Cost-effective
- Available in both standard and custom profiles
- Ability to use finite element analysis to design the best custom gasket for your application

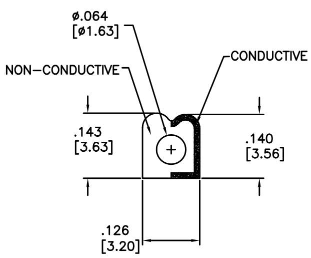
MARKETS

- Wireless infrastructure
- Remote radio units
- Telecom cabinets
- Radar
- IT cabinets
- All electronic cabinets or electronic chassis that require both an environmental seal and EMI shielding

		TYPICAL COEXTRUISON GASKET DESIGN						
		NONCONDUCTIVE ELASTOMER			CONDUCTIVE ELASTOMER			
PARAMETER	TEST METHOD	NCE220	NCE251	NCE250	ECE72	ECE93	ECE116	ECE115
Polymer matrix		Silicone	Silicone	Silicone	Silicone	Silicone	Silicone	Silicone
Filler					Ni/Graphite	Ni/graphite	Ag/Al	Ag/Glass
Color	Visual Inspection	Blue	Grey	Orange	Grey	Black	Tan	Tan
Hardness, Shore A	ASTM D2240	70	45	60	75	65	65	65
Density, g/cm3	ASTM D792	1.2	1.2	1.2	2.3	1.9	2	1.9
Tensile strength, psi, min.	ASTM D412	400	700	800	280	150	200	200
Elongation to break	ASTM D412	100-300%	100-300%	100-300%	150%	100-300%	100-301%	100-302%
Tear Strength, ppi, min.	ASTM D624, die C	30	60	60	50	30	30	30
Compression set, %, max.	ASTM D395	35%	10%	10%	30%	30%	32%	30%
Working Temperature								
Maximum, oC	"MIL-DTL-83528C (4.5.15)"	160	160	160	160	160	160	160
Minimum, oC	ASTM D1329	-55	-55	-55	-55	-55	-55	-55
Flame Retardance	UL94	NA	V0	V0	V0	HB	V0	V0

GEMINI COEXTRUSIONS

M



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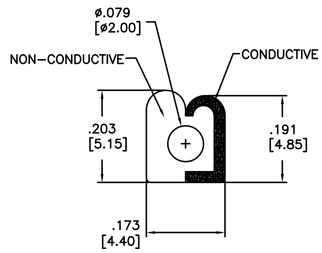

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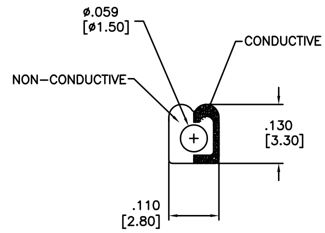

8890 0002 XX A

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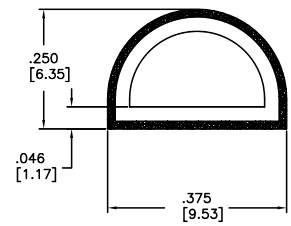

8894 0001 XX A

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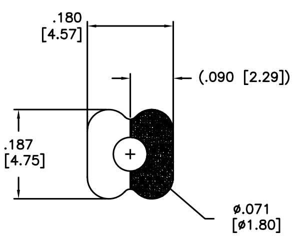
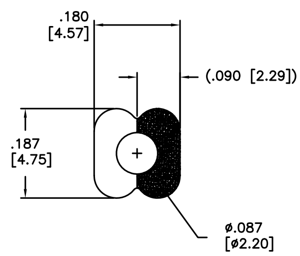


8898 0001 XX A



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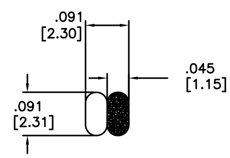
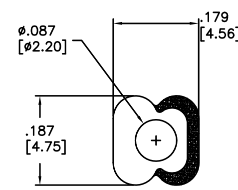


8899 0001 XX A



8898 0003 XX A

FABRICATED COMPONENTS GUIDE

OVERVIEW

Laird provides a full line of fabricated conductive elastomers. These products are offered in a wide range of materials to meet your particular application. In addition to the standard components shown, Laird can supply molded and vulcanized EcE gaskets to meet custom configurations required to package electronic components in either cast or sheet metal enclosures.

MOLDED O-RINGS

O-rings, when installed in a groove design that allows 10%–20% compression and 80%–95% gland fill, will provide both an EMI and moisture seal. Custom tools can be fabricated for prototypes and production quantities when diameters are larger than 2.000 in. (50,8 mm). Round strips can also be vulcanized to create O-rings to include parts with diameters larger than 3.000 in. (76,2 mm). Consult Laird sales department for sizes not shown in this catalog.

FLAT WASHERS

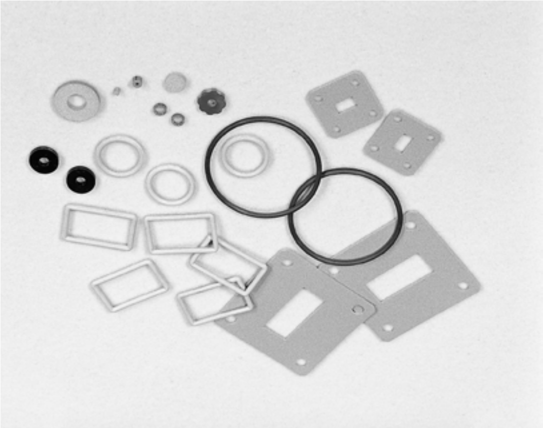
Table 3 shows some of the standard sizes of washers that can be die-cut from sheet material. Besides the circular shape, intricate shapes can be designed and die-cut to meet custom requirements.

MOLDED D-RINGS

Tables 4, 5 and 6 show standard sizes of molded rings. These components, as in the O-rings above, can be supplied spliced and vulcanized to dimensions in excess of two inches I.D.

FLAT WAVEGUIDE GASKETS

The die-cut gaskets shown in Tables 7 and 8 are designed to provide effective EMI shielding and pressure sealing for choke cover and contact flanges. Gaskets shown in this table can be supplied from the sheet materials shown in Table A.



SHEET MATERIAL

Table A lists thicknesses and sizes for our molded sheet material, while Table 2, pages 14–17, shows the compounds available for all of our conductive silicone elastomers.

HOW TO SPECIFY

1. Determine the standard Laird part number from Tables 1–8 on page 14 based upon configuration.

Molded EMI O-Rings

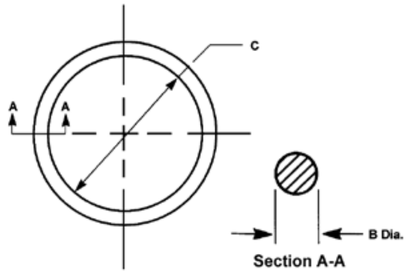


TABLE 1. MIL-DTL-83528 SERIES

MIL-DTL-83528 PART NUMBER	LAIRD PART NUMBER	DIMENSIONS INCH(MM)		MIL-DTL-83528 PART NUMBER	LAIRD PART NUMBER	DIMENSIONS INCH(MM)	
		C	B			C	B
	8563-0322-XX	0.050 (1,3)	0.063 (1,6)	M83528/002X018	8563-0075-XX	0.739 (18,8)	0.070 (1,8)
M83528/002X007	8563-0068-XX	0.145 (3,7)	0.070 (1,8)		8563-0218-XX	0.755 (19,2)	0.097 (2,5)
	8563-0143-XX	0.150 (3,8)	0.062 (1,6)	M83528/002X019	8563-0076-XX	0.801 (20,3)	0.070 (1,8)
	8563-0334-XX	0.176 (4,5)	0.070 (1,8)	M83528/002X020	8563-0077-XX	0.864 (21,9)	0.070 (1,8)
	8563-0326-XX	0.260 (6,6)	0.030 (0,8)		8563-0344-XX	0.921 (23,4)	0.139 (3,5)
	8563-0343-XX	0.270 (6,9)	0.070 (1,8)	M83528/002X021	8563-0078-XX	0.926 (23,5)	0.070 (1,8)
M83528/005X006	8563-0106-XX	0.295 (7,5)	0.048 (1,2)	M83528/002X022	8563-0079-XX	0.989 (25,1)	0.070 (1,8)
M83528/002X011	8563-0069-XX	0.301 (7,6)	0.070 (1,8)		8563-0213-XX	0.989 (25,1)	0.070 (1,8)
M83528/002X012	8563-0070-XX	0.364 (9,2)	0.070 (1,8)		8563-0279-XX	1.000 (25,4)	0.250 (6,4)
	8563-0243-XX	0.415 (10,5)	0.057 (1,4)		8563-0062-XX	1.100 (27,9)	0.070 (1,8)
M83528/002X013	8563-0071-XX	0.426 (10,8)	0.070 (1,8)	M83528/002X024	8563-0080-XX	1.114 (28,3)	0.070 (1,8)
M83528/005X008	8563-0108-XX	0.446 (11,3)	0.051 (1,3)	M83528/005X013	8563-0113-XX	1.182 (30,0)	0.068 (1,7)
M83528/002X014	8563-0072-XX	0.489 (12,4)	0.070 (1,8)	M83528/002X026	8563-0089-XX	1.239 (31,5)	0.070 (1,8)
	8563-0196-XX	0.492 (12,5)	0.070 (1,8)		8563-0161-XX	1.239 (31,5)	0.070 (1,8)
	8563-0327-XX	0.500 (12,7)	0.100 (2,5)	M83528/002X126	8563-0094-XX	1.362 (34,6)	0.103 (2,6)
M83528/002X015	8563-0073-XX	0.551 (14,0)	0.070 (1,8)	M83528/002X028	8563-0090-XX	1.364 (34,6)	0.070 (1,8)
M83528/005X016	8563-0116-XX	0.610 (15,5)	0.070 (1,8)		8563-0165-XX	1.366 (34,7)	0.070 (1,8)
M83528/002X114	8563-0091-XX	0.612 (15,5)	0.103 (2,6)		8563-0324-XX	1.463 (37,2)	0.080 (2,0)
	8563-0285-XX	0.632 (16,1)	0.062 (1,6)	M83528/002X128	8563-0095-XX	1.487 (37,8)	0.103 (2,6)
M83528/002X017	8563-0074-XX	0.676 (17,2)	0.070 (1,8)		8563-0164-XX	1.487 (37,8)	0.103 (2,6)
	8563-0211-XX	0.676 (17,2)	0.070 (1,8)		8563-0166-XX	1.489 (37,8)	0.070 (1,8)

TABLE 1. MIL-DTL-83528 SERIES (CONT'D)

MIL-DTL-83528 PART NUMBER	LAIRD PART NUMBER	DIMENSIONS INCH(MM)	
		C	B
M83528/005X022	8563-0122-XX	1.612 (40,9)	0.103 (2,6)
M83528/002X132	8563-0096-XX	1.737 (44,1)	0.103 (2,6)
	8563-0167-XX	1.739 (44,2)	0.070 (1,8)
M83528/005X023	8563-0123-XX	1.790 (45,5)	0.103 (2,6)
M83528/002X134	8563-0097-XX	1.862 (47,3)	0.103 (2,6)
	8563-0168-XX	1.989 (50,5)	0.070 (1,8)
	8563-0280-XX	2.000 (50,8)	0.250 (6,4)
	8563-0159-XX	2.050 (52,1)	0.103 (2,6)
M83528/002X142	8563-0098-XX	2.367 (60,1)	0.103 (2,6)
	8563-0232-XX	2.614 (66,4)	0.070 (1,8)
	8563-0180-XX	3.158 (80,2)	0.062 (1,6)
	8563-0241-XX	3.209 (81,5)	0.070 (1,8)
	8563-0216-XX	3.806 (96,7)	0.125 (3,2)
	8563-0281-XX	3.989 (101,3)	0.070 (1,8)
	8563-0274-XX	4.450 (113,0)	0.070 (1,8)
	8563-0139-XX	4.690 (119,1)	0.062 (1,6)
M83527/002X155	8563-0315-XX	5.858 (148,8)	0.070 (1,8)
	8563-0185-XX	6.000 (152,4)	0.103 (2,6)
	8563-0234-XX	6.312 (160,3)	0.070 (1,8)
	8563-0342-XX	7.322 (186,0)	0.103 (2,6)
	8563-0226-XX	7.491 (190,3)	0.070 (1,8)
	8563-0323-XX	8.750 (222,3)	0.250 (6,4)
	8563-0263-XX	9.370 (238,0)	0.103 (2,6)
	8563-0187-XX	9.984 (253,6)	0.139 (3,5)
	8563-0339-XX	10.303 (261,7)	0.103 (2,6)
	8563-0140-XX	12.812 (325,4)	0.125 (3,2)

O-rings with a diameter less than 3" (76,2 mm) will be molded.
O-rings with a diameter of 3" (76,2 mm) or more may be molded or spliced.

TABLE 2. MIL-DTL-83528/013 JAM NUT SEALS

SHELL SIZE	LAIRD PART NUMBER		DIMENSIONS INCH(MM)	
	MIL-DTL-38999/ MIL-DTL-26482	MIL-DTL-81511	C	B
6	8563-0073-XX		0.551 (14,0)	0.070 (1,8)
8	8563-0074-XX		0.676 (17,2)	0.070 (1,8)
8		8563-0075-XX	0.739 (18,8)	0.070 (1,8)
9, 10	8563-0076-XX		0.801 (20,3)	0.070 (1,8)
9, 10		8563-0077-XX	0.864 (21,9)	0.070 (1,8)
11, 12	8563-0079-XX		0.989 (25,1)	0.070 (1,8)
13, 14	8563-0080-XX	8563-0080-XX	1.114 (28,3)	0.070 (1,8)
15, 16	8563-0089-XX	8563-0089-XX	1.239 (31,5)	0.070 (1,8)
17, 18	8563-0090-XX	8563-0090-XX	1.364 (34,6)	0.070 (1,8)
19, 20	8563-0095-XX		1.487 (37,8)	0.103 (2,6)
23, 24	8563-0096-XX		1.737 (44,1)	0.103 (2,6)

Flat Washer Gaskets

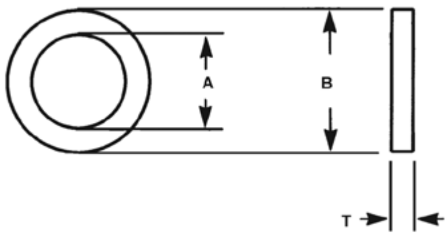


TABLE 3. MIL-DTL-83528 SERIES

MIL-DTL-83528 PART NUMBER	LAIRD PART NUMBER	DIMENSIONS INCH(MM)		
		A	B	T
	8560-0231-XX	0.120 (3,0)	0.260 (6,6)	0.030 (0,8)
	8560-0234-XX	0.171 (4,3)	0.390 (9,9)	0.060 (1,5)
	8560-0233-XX	0.218 (5,5)	0.468 (11,9)	0.030 (0,8)
M83528/012X001	8560-0097-XX	0.250 (6,4)	0.625 (15,9)	0.032 (0,8)
M83528/012X002	8560-0158-XX	0.250 (6,4)	0.562 (14,3)	0.060 (1,5)
	8560-0435-XX	0.250 (6,4)	0.750 (19,1)	0.032 (0,8)
	8560-0299-XX	0.319 (8,1)	0.422 (10,7)	0.075 (1,9)
M83528/012X004	8560-0143-XX	0.375 (9,5)	0.750 (19,1)	0.062 (1,6)
M83528/012X003	8560-0098-XX	0.375 (9,5)	0.750 (19,1)	0.031 (0,8)
	8560-0331-XX	0.375 (9,5)	0.750 (19,1)	0.032 (0,8)
	8560-0444-XX	0.380 (9,7)	0.960 (24,4)	0.065 (1,7)
	8560-0200-XX	0.433 (11,0)	0.508 (12,9)	0.045 (1,1)
M83528/012X005	8560-0099-XX	0.500 (12,7)	0.656 (16,7)	0.031 (0,8)
M83528/012X007	8560-0100-XX	0.500 (12,7)	0.875 (22,2)	0.031 (0,8)
M83528/012X006	8560-0144-XX	0.500 (12,7)	0.656 (16,7)	0.062 (1,6)
M83528/012X008	8560-0145-XX	0.500 (12,7)	0.875 (22,2)	s0.062 (1,6)
	8560-0330-XX	0.500 (12,7)	0.656 (16,7)	0.032 (0,8)
	8560-0311-XX	0.641 (16,3)	0.703 (17,9)	0.032 (0,8)
	8560-0505-XX	0.800 (20,3)	1.000 (25,4)	0.156 (4,0)
	8560-0453-XX	0.890 (22,6)	1.250 (31,8)	0.062 (1,6)

Molded Waveguide Gaskets

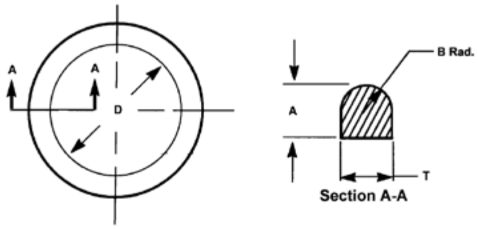


TABLE 4. CIRCULAR "D" SECTION

MIL-DTL-83528 PART NUMBER	LAIRD PART NUMBER	NOMINAL DIMENSIONS INCH(MM)			
		A	B	D	T
M83528/013X002	8563-0126-XX	0.056 (1,4)	0.041 (1,0)	0.410 (10,4)	0.082 (2,1)
M83528/013X004	8563-0127-XX	0.048 (1,2)	Full Radius	0.587 (14,9)	0.078 (2,0)
M83528/013X006	8563-0128-XX	0.125 (3,2)	Full Radius	0.885 (22,5)	0.155 (3,9)
M83528/013X008	8563-0129-XX	0.065 (1,7)	0.049 (1,2)	1.122 (28,5)	0.099 (2,5)
M83528/013X011	8563-0131-XX	0.088 (2,2)	Full Radius	1.340 (34,0)	0.095 (2,4)
M83528/013X012	8563-0130-XX	0.077 (2,0)	Full Radius	1.310 (33,3)	0.115 (2,9)
M83528/013X017	8563-0133-XX	0.078 (2,0)	Full Radius	1.550 (39,4)	0.105 (2,7)

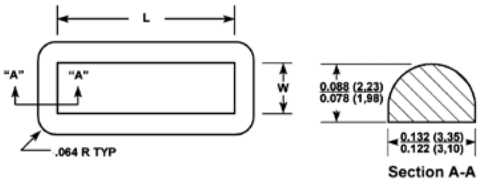


TABLE 5. RECTANGULAR "D" SECTION

MIL-DTL-83528 PART NUMBER	LAIRD PART NUMBER	WIDTH DIMENSIONS INCH(MM)		LENGTH DIMENSIONS INCH(MM)	
		MIN	MAX	MIN	MAX
M83528/006X001	8563-0253-XX	0.285 (7,2)	0.295 (7,5)	0.983 (25,0)	0.993 (25,2)
M83528/006X002	8563-0254-XX	0.485 (12,3)	0.495 (12,6)	0.983 (25,0)	0.993 (25,2)
M83528/006X003	8563-0255-XX	0.619 (15,7)	0.629 (16,0)	1.243 (31,6)	1.243 (31,6)
M83528/006X005	8563-0257-XX	1.325 (33,7)	1.355 (34,4)	5.265 (133,7)	5.295 (134,5)

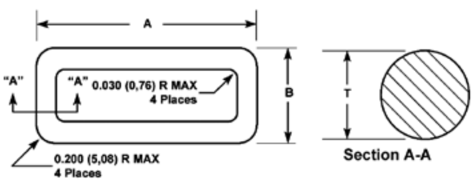
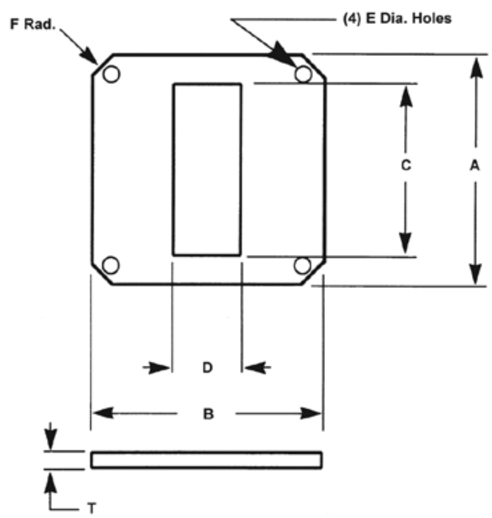


TABLE 6. RECTANGULAR "O" SECTION

MIL-DTL-83528 PART NUMBER	LAIRD PART NUMBER	DIMENSIONS INCH(MM)		
		A	B	T
M83528/013X013	8563-0248-XX	1.368 (34,7) ± 0.012 (0,3)	0.868 (22,0) ± 0.010 (0,3)	0.103 (2.6) ± 0.003 (0,1)
M83528/013X018	8563-0249-XX	1.616 (41,0) ± 0.015 (0,4)	0.991 (25,2) ± 0.010 (0,3)	0.103 (2,6) ± 0.003 (0,1)
M83528/013X023	8563-0250-XX	11.866 (301,4) ± 0.015 (0,4)	1.116 (28,3) ± 0.012 (0,3)	0.103 (2,6) ± 0.003 (0,1)
M83528/013X030	8563-0251-XX	2.449 (62,2) ± 0.020 (0,5)	1.449 (36,8) ± 0.013 (0,3)	0.139 (3,5) ± 0.004 (0,1)
M83528/013X037		3.451 (87,7) ± 0.024 (0,6)	1.951 (49,6) ± 0.004 (0,1)	0.139 (3,5) ± 0.004 (0,1)

Rectangular Waveguide Gaskets



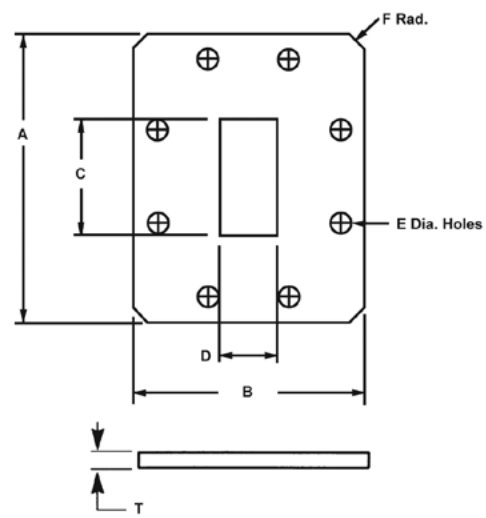


TABLE 7.

MIL-DTL-83528 PART NUMBER	LAIRD PART NUMBER	DIMENSIONS INCH(MM)						
		A	B	C	D	E	T	F RADIUS
M83528/013X001	8560-0104-XX Fig. 1	± 0.750 (19,1)	± 0.750 (19,1)	± 0.145 (3,7)	± 0.285 (7,2)	± 0.116 (2,9)	± 0.027 (0,7)	± 0.469 (11,9)
M83528/013X003	8560-0105-XX Fig. 1	0.875 (22,2)	0.875 (22,2)	0.175 (4,4)	0.425 (10,8)	0.116 (2,9)	0.027 (0,7)	0.563 (14,3)
M83528/013X005	8560-0106-XX Fig. 1	1.313 (33,4)	1.313 (33,4)	0.630 (16,0)	0.320 (8,1)	0.140 (3,6)	0.027 (0,7)	0.875 (22,2)
M83528/013X007	8560-0103-XX Fig. 1	1.496 (38,0)	1.496 (38,0)	0.760 (19,3)	0.385 (9,8)	0.155 (3,9)	0.027 (0,7)	0.450 (11,4)
M83528/013X009	8560-0107-XX Fig. 1	1.625 (41,3)	1.625 (41,3)	0.905 (23,0)	0.405 (10,3)	0.169 (4,3)	0.027 (0,7)	0.469 (11,9)
M83528/013X015	8560-0108-XX Fig. 1	1.875 (47,6)	1.875 (47,6)	1.130 (28,7)	0.505 (12,8)	0.180 (4,6)	0.027 (0,7)	1.150 (29,2)
M83528/013X016	8560-0113-XX Fig. 2	1.750 (44,5)	2.500 (63,5)	0.505 (12,8)	1.130 (28,7)	0.171 (4,3)	0.027 (0,7)	0.250 (6,4)
M83528/013X020	8560-0114-XX Fig. 2	1.937 (49,2)	2.687 (68,3)	0.633 (16,1)	1.380 (35,1)	0.206 (5,2)	0.027 (0,7)	0.250 (6,4)
M83528/013X027	8560-0116-XX Fig. 2	3.500 (88,9)	2.500 (63,5)	1.880 (47,8)	0.880 (22,4)	0.226 (5,7)	0.027 (0,7)	0.313 (8,0)
M83528/013X028	Fig. 2	1.764 (44,8)	2.781 (70,6)	0.882 (22,4)	1.882 (47,8)	0.156 (4,0) 0.141	0.027 (0,7)	0.125 (3,2)
M83528/013X031	Fig. 2	2.750 (69,9)	3.875 (98,4)	1.155 (29,3)	2.300 (58,4)	0.270 (6,9)	0.027 (0,7)	0.312 (7,9)
M83528/013X040	8560-0110-XX Fig. 2	4.188 (106,4)	6.344 (161,1)	2.160 (54,9)	4.310 (109,5)	0.266 (6,8) 0.281 (7,1)	0.027 (0,7)	0.250 (6,4)

FABRICATED COMPONENTS GUIDE

The waveguide gaskets listed in the Waveguide Gasket Selection Guide will fit standard UG, CPR and CMR flanges. The letters (A, B, C, D, E) shown in the "Gasket Config." column correspond to the MIL-DTL-83528/013 part configurations as follows:

Type A — Square & Rectangular Die-Cut Gaskets
Type B — Circular Die-Cut Gaskets
Type C — Molded Rectangular "O" Cross Section
Type D — Molded Circular "O" Cross Section
Type E — Molded Circular "D" Cross Section

TABLE 8. WAVEGUIDE GASKET SELECTION GUIDE

FREQUENCY RANGE GHZ.	BAND	EIA WAVEGUIDE SIZE	DESIGNATION MIL-W	FLANGE DESCRIPTION			FLANGE TYPE	GASKET CONFIG	MIL-DTL-83528/013 PAGE NO.
				UG	CPR	CMR			
26.5 - 40.0	Ka	WR28	RG-96U (Silver)	UG-599/U			Cover	A	001 (1)
				UG-600A/U			Choke	E	
18.0 - 26.5	K	WR42	RG-53/U (Brass) RG-121/U (Aluminum)	UG-595/U UG-597/U			Cover	A	003 (1)
				UG-596A/U UG-598A/U			Choke	E	004
12.4 - 18.0	Ku	WR62	RG-91/U (Brass) RG-107/U (Silver)	UG-419/U			Cover	A	005 (1)
				UG-541A/U			Choke	E	006
10.0 - 15.0		WR75		UG			Cover	A	007
					CPR-75F		Choke	E	008
8.2 -12.4	X	WR90	RG-52/U (Brass) RG-67/U (Aluminum)	UG-39/U UG-135/U			Cover	A	009
				UG-1736/U UG-1737/U	CPR-90F		Flat Contact	A	010 (2)
				UG-136A/U UG-40A/U			Choke	E	011
				UG-136B/U UG-40B/U			Choke	E	012
				UG-1360/U UG-1361/U	CPR-90G		Contact	C	013
7.0 - 11.0		WR102		UG-1494/U			Choke	E	014
7.05 - 10.0	X1	WR112	RG-51/U (Brass) RG-68/U (Aluminum)	UG-51/U UG-138/U			Cover	A	015
				UG-1734/U UG-1735/U	CPR-112F		Flat Contact	A	016
				UG-52B/U UG-137B/U			Choke	E	017
				UG-1358/U UG-1359/U	CPR-112G		Contact	C	018
5.85 - 8.2	Xb	WR137	RG-50/U (Brass) RG-108/U (Aluminum)	UG-344/U UG-138/U			Cover	B	019
				UG-1732/U UG-1733/U	CPR-137F		Flat Contact	A	020 (1)
						CMR-137	Flat Contact	A	021(1)
				UG-343B/U UG-440B/U			Choke	D	022
				UG-1356/U UG-1357/U		CPR-137G	Contact	C	023
4.9 - 7.05		WR159		UG-1730/U UG-1731/U		CPR-159F	Flat Contact	A	024 (1)
						CMR-159	Flat Contact	A	025 (1)
3.95 - 5.85	C	WR187	RG-49/U (Brass) RG-95/U (Aluminum)	UG-149A/U UG-407/U			Cover	B	026
				UG-1728/U UG1729/U		CPR-187F	Flat Contact	A	027 (1)
						CMR-187	Flat Contact	A	028 (1)
				UG-148C/U UG-406B/U			Choke	D	029
				UG-1352/U UG-1353/U		CPR-187G	Contact	C	030
3.30 - 4.90		WR229		UG-1726/U UG-1727/U		CPR-229F	Flat Contact	A	031 (1)
						CMR-229	Flat Contact	A	032 (1)
2.6 - 3.95	S	WR284	RG-48/U (Brass) RG-75/U (Aluminum)	UG-53/U UG-584/U			Cover	B	033
				UG-1724/U UG-1725/U		CPR-248F	Flat Contact	A	034 (1)
						CMR-284	Flat Contact	A	035 (1)
				UG-54B/U UG-585A/U			Choke	E	036
				UG-1348/U UG-1349/U		CPR-284G	Contact	C	037
2.2 - 3.3		WR340	RG-112/U (Brass) RG-112/U (Aluminum)	UG-533/U UG-554/U			Flat Contact	A	038 (1)
						CPR-340F	Flat Contact	A	039 (1)
1.7- 2.6	W	WR430	RG-104/U (Brass) RG-105/U (Aluminum)	UG-435A/U UG-437A/U			Flat Contact	A	040 (1)
						CPR-430F	Flat Contact	A	041 (1)
1.12 - 1.7	L	WR650	RG-69/U (Brass) RG-103/U (Aluminum)	UG-417A/U UG-418A/U			Flat Contact	A	042 (1)

AUTOMATED FORM-IN-PLACE EMI GASKET TECHNOLOGIES

INTRODUCTION

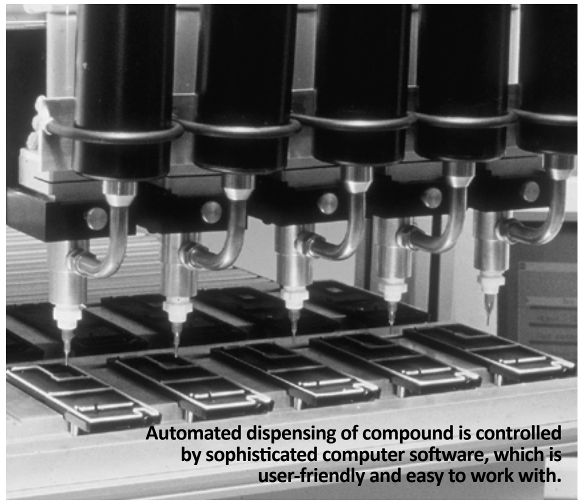
Laird form-in-place is an automated system for dispensing conductive elastomer EMI shielding and grounding gaskets onto metal or plastic substrates. Form-in-place is particularly well suited for cellularphones, PDAs, PC cards, telecom base stations, radios, and many other compartmentalized cast or plastic enclosures and packaged electronic assemblies.

Utilizing programmable 3-axis CNC dispensing equipment, the compound is dispensed accurately onto the substrate and creates a secure bond during the curing process. The repeatable computer-controlled dispensing pattern insures consistency between parts and rapid part program changes. In addition, it supports all levels of volume – from prototyping to high-volume electronic component production – via the use of one or multiple dispensing heads. The system is programmed to apply custom gasket configurations onto parts, to form multiple levelson the part, and on slopes up to approximately 70°.

Laird RXP compounds are Room Temperature Vulcanizing (RTV) elastomers and HXP compounds are High Temperature Vulcanizing (HTV) elastomers, both filled with proprietary conductive particles. Dispensed gasket beads of RXP compounds may be handled in 3 hours, and are cured in 24 hours, under conditions of standard temperature and 50% Relative Humidity. Dispensed gasket beads of HXP compounds can be handled after the materials are cured in an oven. The compounds have a working compression range from 10% to 50% of the gasket height, with a recommended design compression of 30% against a mechanical compression stop. Our product is designed to support low closure forces and is compatible with plastic, metal, and plated or chromate finished substrates.

The required force to compress a given bead is a function of the compound and the gasket size; i.e. smaller gaskets require less force than larger gaskets. Please refer to our technical data for details. Gaskets are dispensed on substrates within a placement tolerance of ± 0.001 inches and gasket cross-sectional tolerances from ± 0.003 to 0.007 inches. Refer to Table 1 on page 39 for typical gasket dimensions and tolerances. As a normal course of equipment operations, starting points and termination ends of the gaskets will have profiles that are approximately 25% larger than the running gaskets.

TYPICAL APPLICATION FOR FORM-IN-PLACE GASKETS:

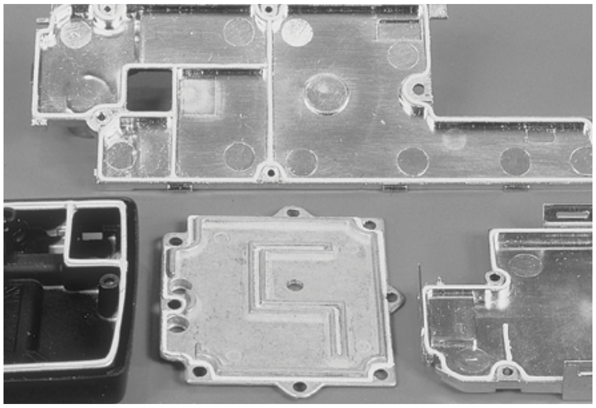


Automated dispensing of compound is controlled by sophisticated computer software, which is user-friendly and easy to work with.

FORM-IN-PLACE GASKETING FEATURES AND BENEFITS

- Form-in-place gasketing offers a total cost savings in the form of reduced raw materials, labor or assembly time
- Room temperature cure gasketing materials eliminate the need for costly heat curing systems, allowing the use of inexpensive plastic or metal substrates
- Single-component compounds eliminate the need for mixing ingredients, thereby shortening production cycles and eliminating related waste
- Easy to program operating system allows for quick part-to-part change-over, minimal tooling investment for new designs, and prototype development in 24 to 48 hours
- High shielding effectiveness: 85–100 dB up to 10 GHz
- The dispensing system supports prototyping and high volume production schedules in a space saving 4’ x 3’ [12 sq. ft.] (1,2 m x 0,9 m [1,1 sq. m]) footprint
- Form-in-place gaskets provide more critical packaging space for board level components and smaller package dimensions
- Excellent adhesion on a wide variety of metal and plastic substrates including:
  - aluminum and other casting alloys
  - stainless steel
  - nickel copper plating (on plastics)
  - copper, silver, and nickel filled paint (on plastics)
- Low compression force makes SN compounds an excellent selection where the mating surfaces lack mechanical stiffness

AUTOMATED FORM-IN-PLACE EMI GASKET TECHNOLOGIES



Laird form-in-place gasketing is ideal for hand held electronics applications.

PROGRAMMING SOFTWARE

Programming of the dispensing equipment can be facilitated utilizing part samples or part drawings. We also support the following CAD formats: AutoCAD®, DXF®, IGES®, Pro/ENGINEER®.

The software is user-friendly and includes several useful tools to simplify the path programming. These include scaling, symmetries, rotation, segment ends definition, and robotic dispensing instructions.

All production parameters are controlled by the software to include dispensing speed, start point, number of parts on the pallet, time needed to process one part, and automatic shut-down for cartridge reloading.

EXCEPTIONAL QUALITY

All material undergoes batch testing before application to guarantee superior mechanical and electrical properties. All dispensed products are manufactured to the exacting requirements of our ISO 9001 certified facility.

PACKAGING

To prevent damage to the substrate and gasket, and to facilitate handling, parts should be shipped in trays. Parts should be held securely to the tray to prevent movement during shipping, and packaged to avoid contact with each other. If required, Laird can design special packaging and trays to suit your specific part requirements. Store in the freezer prior to use.

AUTOMATED FORM-IN-PLACE EMI GASKET TECHNOLOGIES

TABLE 1. TYPICAL BEAD DIMENSIONS

HEIGHT INCH(MM)	WIDTH INCH(MM)	MINIMUM LANDING AREA
0.014 ± 0.003 (0,4 ± 0,1)	0.015 ± 0.003 (0,4 ± 0,1)	0.020 (0,5)
0.015 ± 0.003 (0,4 ± 0,1)	0.020 ± 0.003 (0,5 ± 0,1)	0.025 (0,6)
0.020 ± 0.003 (0,5 ± 0,1)	0.024 ± 0.003 (0,6 ± 0,1)	0.029 (0,7)
0.027 ± 0.004 (0,7 ± 0,1)	0.030 ± 0.004 (0,8 ± 0,1)	0.036 (0,9)
0.030 ± 0.004 (0,8 ± 0,1)	0.034 ± 0.004 (0,9 ± 0,1)	0.040 (1,0)
0.040 ± 0.004 (1,0 ± 0,1)	0.048 ± 0.005 (1,2 ± 0,1)	0.055 (1,4)
0.045 ± 0.005 (1,1 ± 0,1)	0.059 ± 0.006 (1,5 ± 0,2)	0.067 (1,7)
0.055 ± 0.006 (1,4 ± 0,2)	0.075 ± 0.007 (1,9 ± 0,2)	0.084 (2,1)

TABLE 2. ACCELERATED CURE AT HIGHER TEMPERATURES

CONDITIONS	50%RELATIVE HUMIDITY, 0.024 IN. (0,6 MM) BEAD		
Temperature °F (°C)	73 (23)	140 (60)	185 (85)
Time for 98% Cure (Hr.)	12	2	1

TABLE 3. MATERIAL SPECIFICATIONS

	TEST METHOD	UNIT	SNC70-RXP	SNK55-RXP	SNL60-RXP	SNN60-RXP	SIL25-RXP	SNC70-HXP	SNK60-HXP	SNL70-HXP	SNN65-HXP	SIL35-HXP
Elastomer			Silicone	Silicone	Silicone	Silicone	Silicone	Silicone	Silicone	Silicone	Silicone	Silicone
Filler			Nickel/ Graphite	Silver/ Copper	Silver/ Aluminium	Silver/ Nickel	Non-conductive	Nickel/ Graphite	Silver/ Copper	Silver/ Aluminium	Silver/ Nickel	Non-Conductive
Color			Gray	Tan	Tan	Tan	White	Gray	Tan	Tan	Tan	Transparent
Electric Properties												
Volume Resistivity		ohm-cm	0.03	0.002	0.003	0.005	NA	0.03	0.004	0.005	0.005	NA
Shielding effectiveness	MIL-DTL-83528C											
200MHz to 10GHz	Para. 4.5.12	dB	>100	>90	>100	>100	NA	>90	>90	>90	>100	NA
Mechanical Properties												
Hardness	ASTM D2240	Shore A	70	55	60	60	25	70	60	70	65	35
Density (cured)	ASTM D792	g/cm3	2.5	3	2.1	3.9	1.2	2.5	3.1	2	3.84	1.1
Compression set	ASTM D395	%	15	10	10	15	<20(a)	15	10	10	10(b)	<20(b)
Adhesion strength (Al)	LT-FIP-CLE-03	N/cm2	150	200	140	180	220	>180	200	200	200	285
Compression deflection	LT-FIP-CLE-07											
at 20% compression		lb/in	1.5	1.2	1.9	1.7	See note (b)	3.2	1.5	2.3		See note (c)
at 40% compression		lb/in	6.9	5.2	8.3	6.4		11.5	7.3	10.5		
Temperature Range		°C	-50 to 125	-50 to 100	-50 to 125	-50 to 125	See note (b)	-50 to 150	-50 to 125	-50 to 125	-50 to 125	See note (c)
UL rating	UL-94		V0	V0	V0	V0	TBD	V0	V0	V0	V0	TBD
Curing requirements												
Curing conditions			15°C to 40°C, 50% relative humidity	15°C to 40°C, 50% relative humidity	15°C to 40°C, 50% relative humidity	15°C to 40°C, 50% relative humidity	23°C, 50% RH	120°C	120°C	120°C	120°C	120°C
Handling time			1 hour	1 hour	1 hour	1 hour	10-25 minutes					
Cure time			24 hours	24 hours	24 hours	24 hours	12hrs/mm thick	1 hour	1.5 hours	1 hours	1.5 hours	1 hour

(a) Test method ASTM D575
(b) Contact Laird Application Engineering for test data.

METAL IMPREGNATED MATERIALS

ELECTROMET™ ORIENTED WIRE

ElectroMet oriented wire gaskets are EMI shielding and sealing composites. Monel® or aluminum wires mbedded in the elastomer and oriented perpendicular to the mating surfaces provide the EMI sealing. Solid or sponge silicone provides the weather sealing; however, solid silicone weather seals are recommended for high-pressure applications. Silicone based oriented wire composites are capable of withstanding temperature ranges from –70°F to 500°F (–56°C to 260°C).

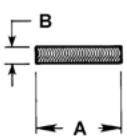
Oriented wire materials are available in sheet or strip form with a minimum thickness of 0.032 in. (0,8 mm). Material specifications and information for standard sheets and strips are provided in Tables 1 through 3.

TABLE 1.

MATERIAL CODE	ELASTOMER	WIRE SPECIFICATION
55	Silicone Sponge Per AMS 3195	Monel: Alloy Per QQ N281 Dia. 0.0045 (0,114)
56	Silicone Solid Per ZZR765 Class 2b Grade 40	Monel: Alloy Per QQ N281 Dia. 0.0045 (0,114)
58	Silicone Sponge Per AMS 3195	Aluminum: Alloy 5056 Per AMS 4182 Dia. 0.005 (0,127)
59	S ilicone Solid Per ZZR765 Class 2b Grade 40	Aluminum: Alloy 5056 Per AMS 4182 Dia. 0.005 (0,127)

Note: Wire density per sq. in.: 700–900; per sq. cm 108–139

TABLE 2. ELECTROMET SHEET MATERIALS

END VIEW	PART NUMBER	DIMENSIONS INCH(MM) A. WIDTH	B. THICKNESS
	8408-0296-XX	0.750 (19,1)	0.125 (3,2)
	8408-0200-XX	3.000 (76,2)	0.032 (0,8)
	8408-0203-XX	3.000 (76,2)	0.045 (1,1)
	8408-0206-XX	3.000 (76,2)	0.062 (1,6)
	8408-0209-XX	3.000 (76,2)	0.093 (2,4)
	8408-0212-XX	3.000 (76,2)	0.125 (3,2)
	8408-0213-XX	3.000 (76,2)	0.187 (4,8)
	8408-0215-XX	4.500 (114,3)	0.032 (0,8)
	8408-0218-XX	4.500 (114,3)	0.045 (1,1)
	8408-0221-XX	4.500 (114,3)	0.062 (1,6)
	8408-0224-XX	4.500 (114,3)	0.093 (2,4)
	8408-0227-XX	4.500 (114,3)	0.125 (3,2)
	8408-0230-XX	6.000 (152,4)	0.032 (0,8)
	8408-0233-XX	6.000 (152,4)	0.045 (1,1)
	8408-0236-XX	6.000 (152,4)	0.062 (1,6)
	8408-0239-XX	6.000 (152,4)	0.093 (2,4)
	8408-0242-XX	6.000 (152,4)	0.125 (3,2)
	8408-0245-XX	9.000 (228,6)	0.032 (0,8)
	8408-0248-XX	9.000 (228,6)	0.045 (1,1)
	8408-0251-XX	9.000 (228,6)	0.062 (1,6)
	8408-0254-XX	9.000 (228,6)	0.093 (2,4)
	8408-0257-XX	9.000 (228,6)	0.125 (3,2)

HOW TO SPECIFY

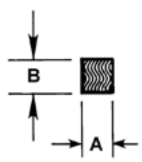
1. For PSA, change the fifth digit to 9 for items with tape. Example: 8408-0200-59 becomes 8408-9200-59.
2. Replace XX with material code from Table 1.

   Example: To request a 3.0 in. (76,2 mm) wide x 0.032 in. (0,8 mm) thick strip with aluminum wire in solid silicone sponge, use 8408-0200-59.

For further information or for product samples, please contact Laird Technologies sales department.

Monel® wire is bonded into a silicone elastomer for uniform surface and multiple "spring" effect with each contact point.

TABLE 3. ELECTROMET STRIP MATERIALS

END VIEW	PART NUMBER	DIMENSIONS INCH(MM) A. WIDTH	B. THICKNESS
	8408-0100-XX	0.125 (3,2)	0.062 (1,6)
	8408-0138-XX	0.125 (3,2)	0.062 (1,6)
	8408-0102-XX	0.125 (3,2)	0.125 (3,2)
	8408-0120-XX	0.125 (3,2)	0.125 (3,2)
	8408-0130-XX	0.125 (3,2)	0.250 (6,4)
	8408-0151-XX	0.187 (4,8)	0.020 (0,5)
	8408-0105-XX	0.187 (4,8)	0.062 (1,6)
	8408-0141-XX	0.187 (4,8)	0.125 (3,2)
	8408-0127-XX	0.187 (4,8)	0.187 (4,8)
	8408-0110-XX	0.250 (6,4)	0.062 (1,6)
	8408-0290-XX	0.250 (6,4)	0.093 (2,4)
	8408-0123-XX	0.250 (6,4)	0.125 (3,2)
	8408-0133-XX	0.250 (6,4)	0.250 (6,4)
	8408-0111-XX	0.312 (7,9)	0.062 (1,6)
	8408-0124-XX	0.312 (7,9)	0.125 (3,2)
	8408-0140-XX	0.312 (7,9)	0.250 (6,4)
	8408-0137-XX	0.375 (9,5)	0.032 (0,8)
	8408-0115-XX	0.375 (9,5)	0.062 (1,6)
	8408-0139-XX	0.394 (10,0)	0.032 (0,8)
	8408-0143-XX	0.500 (12,7)	0.032 (0,8)
	8408-0116-XX	0.500 (12,7)	0.062 (1,6)
	8408-0293-XX	0.500 (12,7)	0.093 (2,4)
	8408-0126-XX	0.500 (12,7)	0.125 (3,2)
	8408-0289-XX	0.500 (12,7)	0.187 (4,8)
	8408-0118-XX	0.625 (15,9)	0.062 (1,6)
	8408-0144-XX	0.625 (15,9)	0.062 (1,6)
	8408-0134-XX	0.625 (15,9)	0.093 (2,4)
	8408-0128-XX	0.625 (15,9)	0.125 (3,2)
	8408-0117-XX	0.750 (19,1)	0.062 (1,6)
	8408-0135-XX	0.750 (19,1)	0.250 (6,4)
	8408-0147-XX	1.000 (25,4)	0.062 (1,6)
	8408-0294-XX	1.000 (25,4)	0.093 (2,4)
	8408-0148-XX	1.000 (25,4)	0.125 (3,2)

COMPRESSION-DEFLECTION FOR SOLID SILICONE

MATERIAL THICKNESS	COMPRESSION FORCE PSI (MPA) AT DEFLECTION OF: 5%	*10%	15%	20%
0.045 (1,1)	40 (0,3)	100 (0,7)	155 (1,1)	280 (1,9)
0.062 (1,6)	85 (0,6)	165 (1,1)	240 (1,7)	345 (2,4)
0.125 (3,2)	115 (0,8)	180 (1,2)	245 (1,7)	290 (2,0)

*Recommended

Note: Compression force for silicone sponge is approximately 15 psi to 75 psi. Silicone sponge density is 0.02 lb/in3.

SPECIALTY PRODUCTS

ELECTROCOAT™

ElectroCoat is a thin, flexible surface coating consisting of a silver-filled silicone elastomer. The versatile coating can be easily applied to die-cut or molded foams for both gasket and non-gasket applications. It can also be applied to molded or extruded elastomers, other polymers, and a wide range of other materials.

- Excellent shielding effectiveness — greater than 90 dB measured by transfer impedance
- Solid, continuous, conductive coating over the entire gasket surface, including the inner die-cut surfaces of foam gaskets
- Coated foam gaskets have very low compression force
- Exceptionally wide compression range from 10% to 70% deflection to accommodate uneven gaps in enclosure housings
- Flexible coating withstands gasket compression with no decrease in shielding effectiveness after 1000 cycles of 40% compression
- Extruded profiles shown on pages 18–22 are available with neoprene core.

ORDERING INFORMATION

1. Determine if PSA is needed. If so, replace the 5th digit in the part number with “9”.
2. Select desired core material from Table 1 and insert in place of YY.
3. Select two digit ElectroCoat from Table 2 and insert in place of ZZ.
4. A unique custom identification number will be assigned by sales.

8550	-X	XXX	-YY	-ZZ
Standard Series Number	9 w/ PSA	Unique identification number assigned by Laird	Core Material*	ElectroCoat (Coating Material)

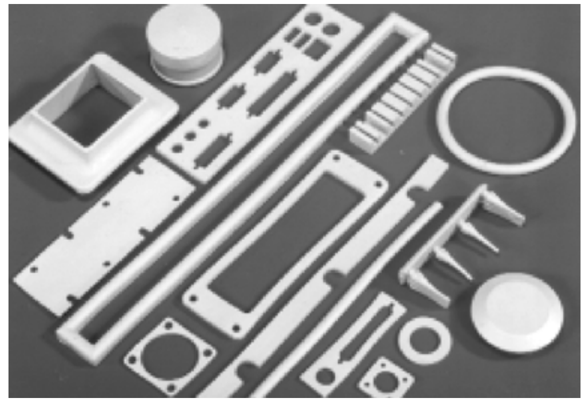
TABLE 1

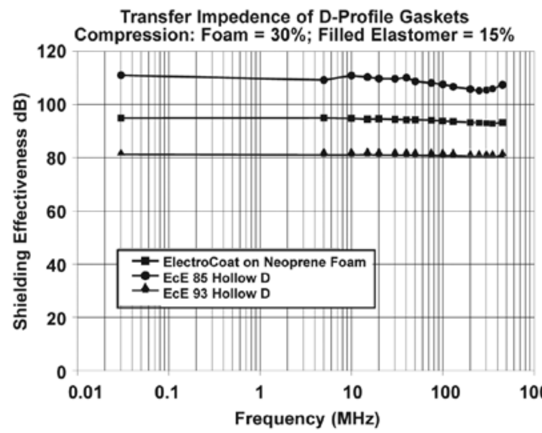
YY #	CORE MATERIAL*
50	Silicone Foam
51	Solid Silicone
52	Neoprene Foam

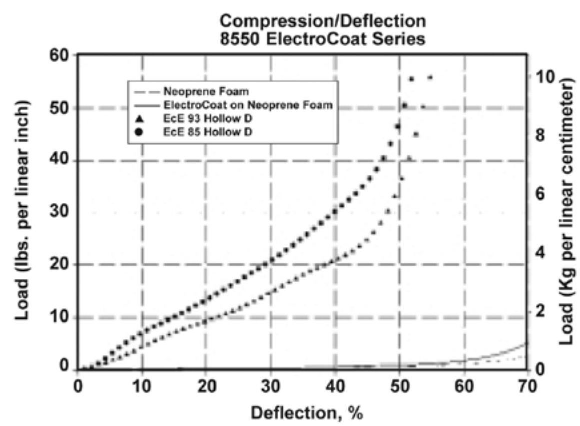
TABLE 2

ZZ COATING #	MATERIAL
10	Silver/Silicone

*Other core materials may be available. Consult Laird sales department.







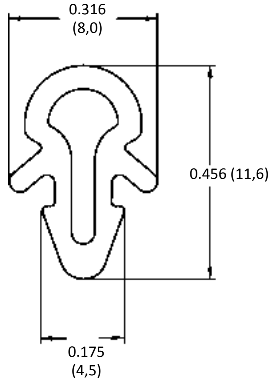
SPECIALTY PRODUCTS

BOARD TO CHASSIS CONDUCTIVE STAND-OFF

Laird offers a multi-functional grounding device that provides electrical contact between the bottom of printed circuit boards and enclosure housings. The snap in feature allows for easy assembly and secure retention. Once inserted, the part makes contact with the base of the printed circuit board on a grounding pad or trace, assuring superior grounding.

- Solves EMI and/or ESD problems via superior grounding (maximum 0.8 Ohm DC resistance)
- Provides damping of vibration and spacing between grounded surfaces
- Available in two standard lengths (custom lengths also available)
- Design of part facilitates simple robotic automation
- Minimum compression force required within operating range (see chart below)

PROFILE DIMENSION

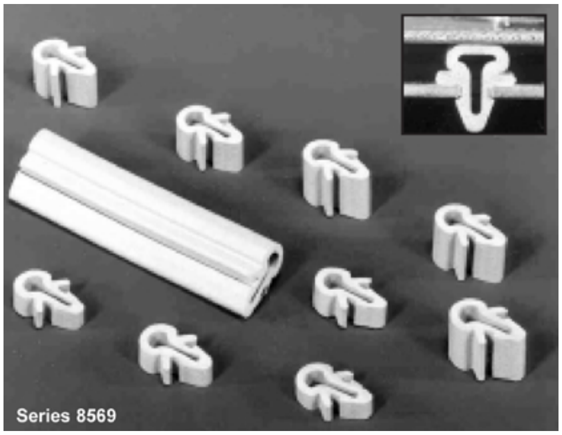


MOUNTING INFORMATION

ORDERING INFORMATION

Select part from table below. Insert desired compound number in place of XX. Custom lengths are also available.

PART NOUMBER	LENGTH
8569-0127-XX	0.250 (6,4)
8569-0131-XX	0.125 (3,2)
ECE COMPOUND 85	ECE COMPOUND 22
Silver/Glass	Nickel/Graphite



CORROSION OF EMI GASKETS

GALVANIC CORROSION

Corrosion can manifest itself in many forms. Some common forms are galvanic, pitting, and crevice corrosion. However, galvanic corrosion is the major concern in shielding applications. Galvanic corrosion is driven by the interaction of the gasket and the electronic enclosure, since in a shielded joint there are often two dissimilar materials in intimate contact.

BASIC GALVANIC CONDITIONS

There are three conditions that must exist for galvanic corrosion to occur:

1. Two electrochemically dissimilar materials present
2. An electrically conductive path between the two materials
3. An ionic conduction path (typically a corrosive environment) between the materials

If any of these three conditions is missing, galvanic corrosion will not occur. If we examine each of these conditions in detail, we will not only understand galvanic corrosion, but also know how to prevent it.

ELECTROCHEMICALLY DISSIMILAR METALS

Of the three conditions necessary for galvanic corrosion, the most important is the electrochemical difference between metals. Commonly available materials have different electrochemical potentials; even pure metal at the microscopic level. This is why a block of steel sitting by itself corrodes. The order in which metals will corrode is always from the most anodic (active) to the most cathodic (noble). This means that when two dissimilar metals are put together, only the more anodic metal will corrode.

This method is used extensively in preventing corrosion by plating a more anodic metal over a more cathodic metal. The more anodic metal will then sacrifice itself (corrode first) and protect the metal underneath from corrosion. This is the reason for the good corrosion resistance of zinc plated steel. Even when scratched, the zinc coating that surrounds the scratch protects the exposed steel from corroding until the zinc near the scratch is consumed.

ELECTRICAL CONDUCTION

The second condition required for galvanic corrosion, electrical conduction, is the hardest to prevent. Metals are all good conductors of electricity, and most joints between metals are made with metal fasteners. The amount of electrical current that flows is dependent on the rate of corrosion, but in most cases is very small.

Dramatically reducing the conductivity of an electrical path between two metals has little effect on the corrosion rates except where very strong electrolytes are involved.

Generally, effective RF joints depend on having very high conductivity; therefore, reducing conductivity to decrease corrosion may greatly reduce shielding effectiveness. Some new research has produced materials that are good RF conductors, but poor D.C. conductors. These materials may be able to reduce corrosion and still maintain high shielding levels. Laird is in the forefront of this research.

AN ION CONDUCTION PATH

The ionic conduction medium that is most responsible for corrosion is water. There are other ionic conductors such as moist air, but the majority of corrosion problems will be caused by water or water-based solutions. The basic principle is that the metals are slightly soluble in water. You can sometimes taste a metallic taste in water, especially if the water is a little acidic. In a good ionic conductor like salt water, or water with a high acid content, the ions are relatively stable, and more metal will dissolve into the water. A good ionic conductor like salt water will also allow dissolved ions to move freely in the solution. The dissolved ions tend to migrate through the water toward the electrode of opposite polarity. The positively charged ions will migrate towards the cathode while the negatively charged ions will migrate towards the anode.

The only way to totally prevent dissolved ions from migrating is to interrupt their path, such as with a vacuum or by maintaining them at very low temperatures. The speed at which they migrate can also be reduced by many orders of magnitude by using poor ionic conductors as barriers. Placing metals in dry air, or coating the metals with a poor ionic conductor such as paint, greatly reduces corrosion rates. Some metals form their own barriers that prevent or restrict ion migration. For example, under normal atmospheric conditions aluminum corrodes in air, producing a thin coating of aluminum oxide. The aluminum oxide is an extremely poor ionic conductor and chokes off the flow of oxygen to the aluminum metal beneath the oxide coating. This demonstrates how by-products of corrosion can dramatically reduce corrosion rates.

As in the above example of zinc coating on steel, the anodic material does not need to completely cover the more cathodic material to offer protection. It only needs to be close by. The effective distance between the anodic metal and the cathodic metal depends on the environment. This distance is generally dependent on the conductivity of the electrolyte. In the case of typical electronic equipment this distance is usually the size of the microdroplets of water formed by condensation. In severe environments, this distance can be 0.250 in. (6,4 mm) or more.

CORROSION OF EMI GASKETS

GALVANIC CORROSION OF ELECTRICALLY CONDUCTIVE ELASTOMERS

The galvanic series provides a relative ranking for selecting compatible metallic couples. However, electrically conductive elastomers are a composite material that behaves differently from metals due to diffusion rates and elastomeric nature of the gaskets. In addition, the presence of corrosion inhibitors which continuously coat the exposed flanges also affects the corrosion rate. Therefore, the direct application of the metallic-based galvanic series to the conductive elastomers could be misleading. The corrosion behavior of the conductive elastomers is affected by the nature of the filler particles, the permeability of the elastomer matrix, and the presence of corrosion inhibitors.

Electrically conductive elastomers are effective shielding materials because they provide good attenuation to electromagnetic radiation, while at the same time providing an environmental seal. When conductive elastomers are assembled in an enclosure, they are in intimate contact with some type of metal flange and readily conduct current. These two conditions, intimate contact with a metallic substrate and electrical conductivity, create a galvanic couple. Significant corrosion of one of the components of this couple can occur under suitable conditions of: 1) conductive environment (i.e., salt water, acid, etc.) and 2) corrosion potential difference between the elastomer-metal couple (the difference between the Electromotive Force (EMF) values of the two materials). If the elastomer corrodes, an insulating corrosion product is formed that reduces the conductivity of the elastomer.

On the other hand, if the metal substrate corrodes, the metal loss could threaten the integrity of the flange and the corrosion products could adversely effect the performance of the elastomer. When designing the enclosure it is important to avoid conditions that can lead to significant corrosion. The following data are intended to be a guide to help in choosing the appropriate type of couple(s) so as to avoid or minimize these conditions.

Corrosion Test – To evaluate the impact of corrosion on the elastomer/metal galvanic couples test samples were exposed to 500 hours of salt spray in accordance with missile specification MIS-47057. The test fixtures were assembled as per Figure 1. The dimensions of the electrically conductive elastomer washers are shown in Figure 2 and the metal coupons are shown in Figure 3.

The volume resistivity of the elastomers and the weight of the metal coupons were measured before, and then again after the salt spray test. From this data, the change in volume resistivity for the elastomer and the weight loss for the metal coupons were calculated. With these two pieces of data it is possible to assess the compatibility of the various elastomer/metal couples. This information can then be used as a design guidance tool to determine which combinations of conductive elastomer gasket and metal flange are appropriate for a particular application. The following corrosion data indicate the performance of the galvanic couples in a very corrosive environment and thus represent a worst-case scenario.

Weight Loss of Metal Coupons (Part 1 of Galvanic Couple) — Five different metallic materials were evaluated. The five metallic materials included chromated aluminum, Galvalume® (a 55% Al-45% Zn hot-dip coated steel), tin plated steel, zinc plated steel and stainless steel (Table 1). These materials represent some of the common types of sheet metal used to manufacture enclosures.

FIGURE 1. TEST ASSEMBLY PER MIS-47057

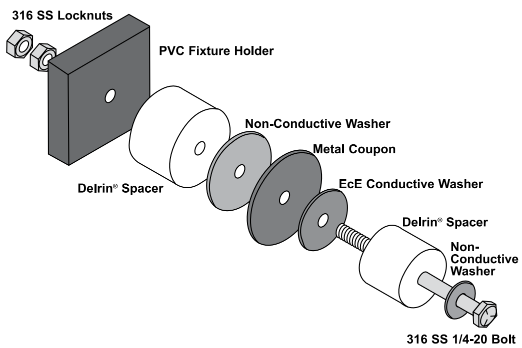


FIGURE 2. CONDUCTIVE WASHER

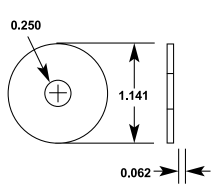
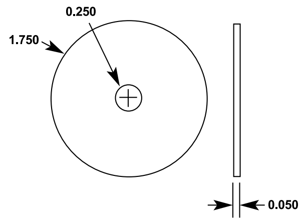


FIGURE 3. METAL COUPON



CORROSION OF EMI GASKETS

TABLE 1. METAL COUPONS TESTED

METAL COUPON	BASE METAL	COATING
Aluminum	6061-T6	Chromate
Galvalume®	1006	55% Al-45% Zn hot-dip coated
Tin Plated Steel	1010	Electroplated Tin
Zinc Plated Steel	1010	Electroplated Zinc
Stainless Steel	304	None

The percent weight loss was calculated for all of the metal coupons according to equation 1.

EQUATION 1

$$\%\ \text{Weight Loss} = \frac{\text{Weight}_{\text{Before}} - \text{Weight}_{\text{After}}}{\text{Weight}_{\text{Before}}} = \text{x } 100\%\ (1)$$

In equation 1, Weight Before is the weight of the metal coupon before the test and Weight After is the weight after the test once the corrosion products were removed. In Table 3 (page 55), a corrosion performance rating was developed from this data for the metal coupon part of the galvanic couple only. This table does not provide any information on how the elastomer part of the galvanic couple will hold-up.

The corrosion performance ratings, color coded for ease of recognition with a legend, are provided below the table. The divisions for the corrosion performance ratings were established by visual assessment to differentiate significant differences of metal loss on the coupons. The elastomer compound numbers are listed in columns across the top of the table, including the elastomer and filler material. The metal coupons are listed in rows along the side of the table. The intersection of a row and a column gives the weight loss rating for the metal coupon when used with that particular elastomer. For the galvanic couples in which the metal coupon experiences little weight loss (yellow rating), the metal coupon is probably the cathode (electrode where reduction occurs) and/or the couple has a small potential difference. In this case the metal substrate would not experience much corrosion, even in very corrosive environments.

At the other extreme, the galvanic couples in which the metal coupon experiences a large weight loss (dark green rating), the metal coupon would be the anode (electrode where oxidation occurs). In this case the metal substrate would experience extensive corrosion in the very corrosive environments. A large metal coupon weight loss (dark green rating) does not preclude the use of this galvanic couple, but in the design it would be critical to look at the relative anode (metal) to cathode (elastomer) areas, the thickness of the flange and the corrosiveness of the environment. It is not recommended that the galvanic couples with an extreme metal coupon weight loss rating (gray) be used under any conditions.

Volume Resistivity of Conductive Elastomers (Part 2 of Galvanic Couple) – Conductive elastomers are essentially a composite material made up of an elastomer matrix and small filler particles, usually metallic. Even the filler particles can have a composite nature since many are coated. This composite structure can result in a corrosion behavior that may not follow the well known galvanic series. The elastomer compounds that were evaluated are listed in Table 2.

TABLE 2. ELASTOMERS TESTED

ELASTOMER	FILLER
Silicone	Inert Al
Silicone	Ag Plated Cu
Silicone	Ag Plated Al
Silicone	Ag Plated Ni
Silicone	Ag Plated Glass
Fluorosilicone	Ag Plated Al
Fluorosilicone	Ni Plated Graphite
Silicone	Ni Plated Graphite
EPDM	Ag Plated Al

When exposed to a corrosive environment one of the most important characteristics of a conductive elastomer is its ability to maintain its initial shielding effectiveness. As corrosion products form in the elastomer it usually results in a loss of shielding effectiveness. Generally, as shielding effectiveness decreases there is a tendency for the conductivity of the elastomer to decrease (or resistance to increase). To assess the effect of very corrosive environments on the elastomer part of the galvanic couples, the volume resistivities of the elastomers were measured before and after the corrosion test. In Graphs 1–5 on page 54, a side-by-side comparison is presented for each elastomer of its volume resistivity before and after exposure to the corrosive environment. The change in volume resistivity is the difference between these bars (before and after). It is important to note that the Y-axis is a log scale. Each chart corresponds to a different metallic substrate. The change was usually positive which means a loss in conductivity. These charts do not provide any information on how the metal coupon part of the galvanic couple will hold up.

For some of the elastomers, the increase in the volume resistivity is large. In these cases, the conductive elastomer was probably the anode. This condition results in a significant amount of corrosion of the elastomer filler particles, which makes it much less conductive.

CORROSION OF EMI GASKETS

At the other extreme there were a number of elastomers in which there was only a very small percent increase in volume resistivity. In these cases, the conductive elastomer was probably the cathode or the galvanic couple had a very small corrosion potential difference. Under these conditions there was very little loss of conductivity after exposure to a corrosive environment.

Design Considerations – When choosing a conductive elastomer for a particular design, especially in a potentially corrosive environment, it is important to look at shielding requirements and the type of galvanic couple that will be created. In deciding which couple best serves the design requirements two factors will have to be considered:

1. The impact of the galvanic couple on the enclosure material (Table 3).
2. The impact of the galvanic couple on the volume resistivity of the elastomer, Graphs 1–5 on page 54.

The impact of the galvanic couple on the corrosion of the enclosure material can be gauged by the metal coupon weight loss rating on Table 3 (page 55). As the color changes, the flange area on the enclosure will experience increasing amounts of corrosion.

Metal substrate factors to consider when choosing a elastomer/metal couple:

- Allowable enclosure material(s)
- Effect of weight loss/corrosion on the function of the enclosure
- Area of exposed enclosure material close to elastomer

The impact of corrosion on the shielding effectiveness of the elastomer can be gauged by the change in volume resistivity, see Graphs 1–5 on page 47. The greater the increase in volume resistivity after exposure to a corrosive environment the greater should be the drop-off in shielding effectiveness.

Elastomer factors to consider when choosing an elastomer/metal couple:

- Shielding requirements
- Change in volume resistivity of elastomer in corrosive environments
- Environmental sealing requirements
- Required compression properties

How to Use the Charts – When deciding on a conductive elastomer, it is important to examine the potential impact of galvanic corrosion. From a corrosion standpoint, the best design is an elastomer/metal flange galvanic couple that will result in the lowest corrosion rate. The charts (Table 3 and Graphs 1–5) in this section are intended to be used as a guide for choosing the least corrosive galvanic couple (other design considerations should also be taken into account when using these charts, such as restrictions on enclosure materials and environmental sealing requirements). To arrive at the best choice(s) for a particular application the impact of corrosion on both halves of the galvanic couple must be examined. One half is the weight loss on the metal substrate and the other half is the change in volume resistivity for the elastomer. The combined effect will dictate the corrosion performance of the galvanic couple/ finished component.

In Table 3, pick out the appropriate row(s) based on the choice of the enclosure material(s) and then note the elastomer compound(s) that has the lowest metal coupon weight loss. Then go to the appropriate Graphs 1–5, based on the metal substrate(s) of choice, and find the change in volume resistivity for the elastomer compound(s) that you have just identified from Table 3.

The elastomers that have the lowest change in volume resistivity will represent the elastomer/metal substrate combination(s) that will create the least corrosive couple. If a combination of metal substrate with a very low weight loss and elastomer with a very small change in volume resistivity is not identified, then a compromise will have to be made. In that case go through the same process but, now look at metal substrates with slightly higher weight losses and/or elastomers with slightly larger changes in volume resistivity. After a candidate is selected it is always best to test the elastomer(s) in the specific application.

EXAMPLE

Assume the enclosure is aluminum.

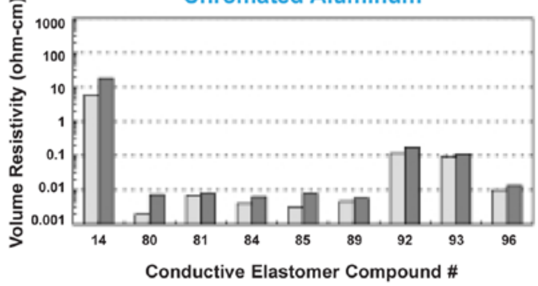
1. From the aluminum row in Table 3, elastomer compounds #89 and 96 will cause the lowest weight loss on the aluminum metal substrate.
2. From Graph 1 (Chromated Aluminum) compound #89 has the lowest change in volume resistivity and 96 is a close second
3. As long as the elastomer matrix and initial attenuations are acceptable, choose either compound #89 or 96.

CORROSION OF EMI GASKETS

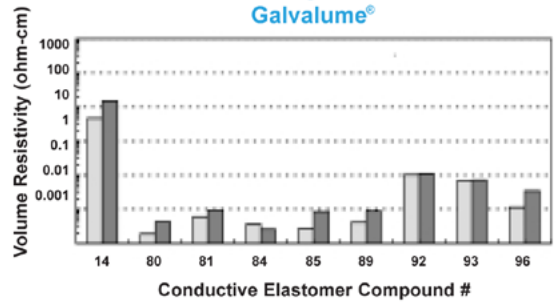
ELASTOMER VOLUME RESISTIVITY

(Salt spray is considered a very corrosive environment and represents a worst-case scenario)

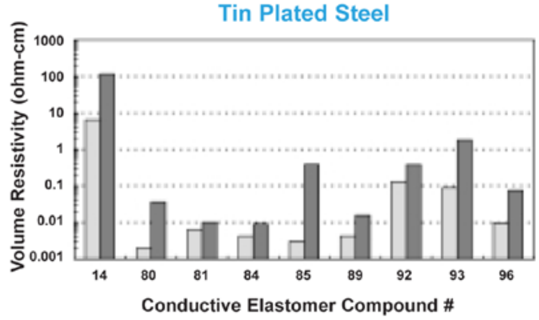
Graph 1
Chromated Aluminum



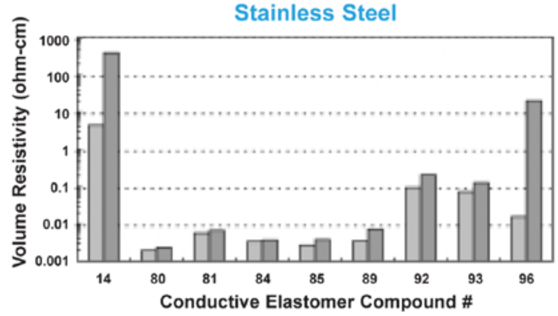
Graph 2
Galvalume®



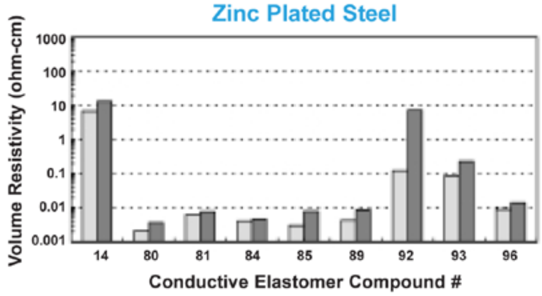
Graph 3
Tin Plated Steel

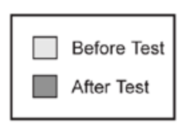


Graph 4
Stainless Steel



Graph 5
Zinc Plated Steel





EcE 14, EcE 80, EcE81 and EcE85 are legacy compounds.

ELASTOMER GALVANIC COMPATIBILITY CHART

TABLE 3. METAL COUPON WEIGHT LOSS RATING*

COMPOUND NUMBER: ELASTOMER AND FILLER MATERIAL

METAL SUBSTRATE	80 SIL AG/CU	81 SIL AG/AL	84 SIL AG/NI	85 SIL AG/ GLASS	89 FSIL AG/AL	92 FSIL NI/ GRAPHITE	93 SIL NI/ GRAPHITE	96 EPDM AG/AL
Chromated Al	•	•	•	•	•	•	•	•
Galvalume®	•	•	•	•	•	•	•	•
Tin Plated Steel	•	•	•	•	•	•	•	•
Zinc Plated Steel	•	•	•	•	•	•	•	•
Stainless Steel	•	•	•	•	•	•	•	•

*This chart to be used in conjunction with Graphs 1–5 on page 40.
EcE 14, EcE 80, EcE81 and EcE85 are legacy compounds.

Little to no weight loss on metal coupon; less than 0.25%. Acceptable in all environments.

Substantial amount of weight loss on metal coupon; between 0.50% and 1.25%. Not acceptable in corrosive environments; for less corrosive applications consult with Laird applications engineer.

Moderate amount of weight loss on metal coupon; between 0.25% and 0.50%. May not be acceptable in very corrosive environments.

Extreme amount of weight loss on metal coupon; greater than 1.25%. Not recommended in any environments.

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