

# SHIELDING AIDS

EMI gasket design theory and practice is a specific application of the principles and procedures that apply to the design of any gasketed joint. Therefore, a very generalized gasket design theory is presented first as the basis for the specific EMI gasket design procedures. The EMI gasket design theory and procedures follow and are presented as a specific application of general gasket design.

## GASKET DESIGN—WHAT GASKETS DO

All gaskets whether they seal EMI, high pressure fluid, make a container dunk proof or simply keep forced ventilating air from escaping at a door-to-cabinet joint, do so by conforming to the unavoidable irregularities of the mating surfaces of a joint. Some examples are:

- The joint between a garden hose and water faucet.
- Housing for an emergency radio to be dropped into the sea.
- Joint between the cover and enclosure for a radar pulse modulator.

In each example the joint has two relatively rigid mating surfaces, and neither surface will be perfectly flat. When they are mated without a gasket, even very high closing forces will not cause the two surfaces to comply completely with each other, and the resultant gaps will allow leaks. A gasket resilient enough to comply to both surfaces under reasonable force will eliminate these leaks. The garden hose example makes this point very well; just try to prevent a leak by force alone without a gasket, but with a gasket in the hose fitting compressing against the faucet, even hand torque results in a watertight joint. To try to get the same watertightness by accurate machining of both surfaces would be prohibitively expensive. In most cases, the least expensive way to obtain a tight joint (watertight, oil-tight, or EMI tight) is to make the mating surfaces to normal tolerances on flatness, rigidity, and tolerance build-up and add a gasket to compensate for the resulting misfits between the two surfaces.

## GASKET DESIGN THEORY

The degree of misfit needs to be defined so that design procedures can be clearly outlined. This misfit is commonly called "joint unevenness" and is designated as  $H$  and is defined in Figure 1. It is the maximum separation between the two surfaces when they are just touching. If the surfaces are not rigid, then the joint unevenness would also include any additional separation between the two surfaces due to the distortion of the joint when pressure is applied.

Figure 2 shows the same joint with a gasket installed. The dashed lines indicate the height of the gasket,  $H_g$ , before it was compressed. The minimum compressed gasket height,  $H_{min}$ , occurs at the point where the surfaces would touch without a gasket. Maximum compressed gasket height,  $H_{max}$ , is at the point of maximum joint unevenness. Note that the joint unevenness of the mating surfaces is equal to  $H_{max} - H_{min}$ . This concept must be kept in mind in all gasket design.

## REQUIRED COMPRESSION PRESSURE

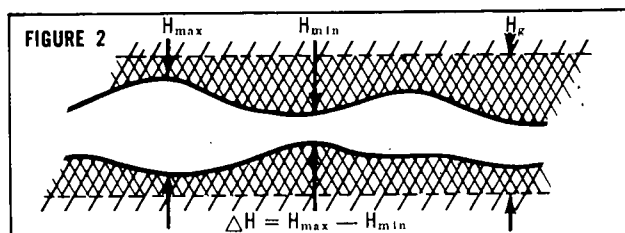
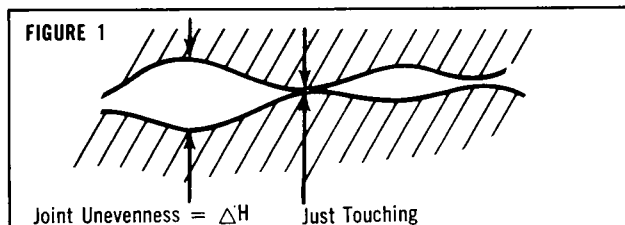
Three factors determine the required compression pressure on a gasket; its resiliency, the minimum pressure required for a seal, and the total joint unevenness.

**Resiliency**—This is the amount a gasket compresses per unit applied compression pressure. Resiliency is usually expressed in (% of original gasket height)/psi. A soft gasket would compress more than a hard gasket with the same applied pressure. Or stated the other way, a soft gasket would require less pressure than a hard gasket to compress the same % of gasket height. For instance a sponge neoprene gasket might compress 10% under an applied compression pressure of only 6 psi, but a solid neoprene gasket would require 50 psi for the same 10% deflection.

**Minimum Pressure for Seal**—As already stated, a gasket must at least make contact at the point of maximum separation between the mating surfaces ( $H_{max}$   $H_g$ ). Actually in most cases the pressure at this point must be a stated minimum in order to assure a seal. This would be rather easy to understand in the case of a high pressure hydraulic system. If there is not at least some required minimum pressure at the point of  $H_{max}$  the oil would

blow by between the flange and the gasketing material. The pressure at  $H_{max}$  point must be high enough to prevent blow-by. For EMI gaskets this minimum pressure is determined by the pressure required to break through corrosion films and to make a suitable low resistance contact. For most EMI gaskets this is 20 psi, but can be as little as 5 psi.

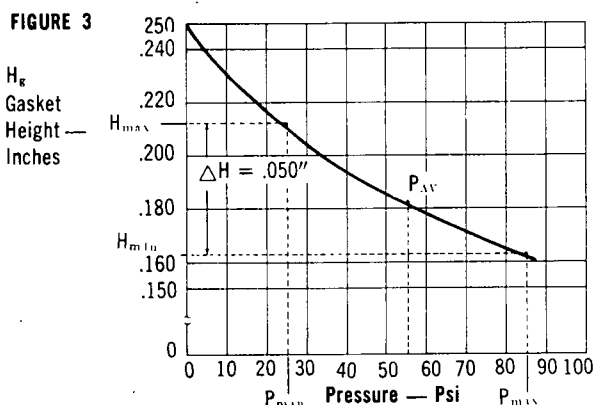
**Average Pressure**—The average pressure applied to the gasket must also be large enough to compress the gasket so that the minimum gasket height subtracted from the maximum gasket height (which was determined by the minimum pressure required from the previous paragraph) is equal to the joint unevenness, that is  $H_{max} - H_{min} = \Delta H$ .



## GASKET HEIGHT

To obtain the required seal from a gasketed joint, the gasket height must meet these criteria:

1. The pressure at point of maximum separation must be at least the minimum pressure to obtain the required seal.
2. The difference between maximum and minimum gasket compressed heights must be equal to the joint unevenness of the mating surfaces ( $\Delta H = H_{max} - H_{min}$ ).

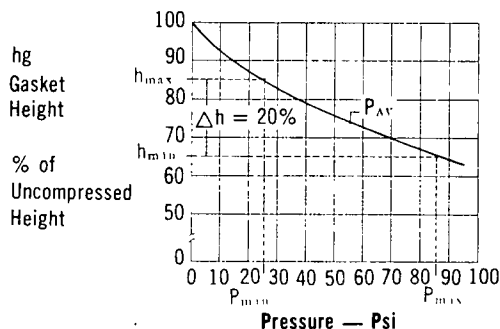


These principles are illustrated by reference to Figures 2 and 3. Figure 3 is the compression characteristic for the gasket material used in the joint illustrated in Figure 2. In this example the minimum pressure for a reliable seal is 20 psi. As shown, minimum pressure is actually 25 psi; the minimum pressure requirement has been met. Gasket height at this point is .212". Joint unevenness is .050" so the minimum gasket height is  $.212 - .050 = .162$ . The second requirement has been met. From the curve, the pressure at this point is 85 psi. Average pressure is estimated by  $\frac{P_{min} + P_{max}}{2}$ , in this case  $\frac{25 + 85}{2} = 55$  psi.

Average pressure is important in estimating total force required to compress the gasket.

Gasket compression characteristics are most frequently given in terms of percent of gasket height so that one curve can be used for many actual gasket heights. Figure 4 is a plot of the characteristics shown in Figure 3 except heights are given in percent of gasket height. To distinguish actual heights from heights expressed in percent of gasket height, the latter are designated by lower case h.

FIGURE 4



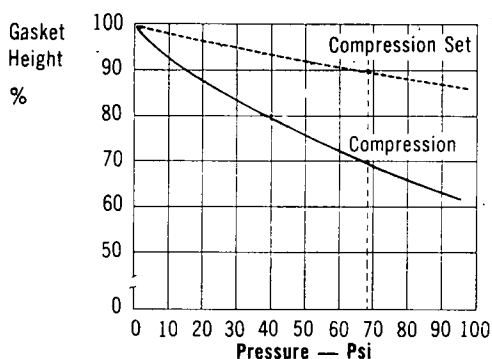
## COMPRESSION SET

Some gasket materials take a compression set; that is, they do not return to original gasket height after compression. This is illustrated in Figure 5. The compressed height is indicated by the solid line. When compression pressure is removed, the gasket returns to the height indicated by the broken line. This is compression set. The importance of compression set depends on how the gasket is used.

**CLASS A, PERMANENTLY CLOSED**—If the gasket is used under a component that will, in all probability never be removed, the compression set is unimportant. It would show up only on disassembly. This type of joint is called "permanently closed" and identified as Class A.

**CLASS B, REPEATED IDENTICAL OPEN-CLOSE CYCLES**—Many gaskets are used in joints that are frequently opened and closed but always in the same manner (hinged door or symmetrical cover, etc.). In this case minimum compressed gasket height will always occur at the same place. This will also be the point of maximum compression set. In effect, original gasket height has been reduced at this point, but the gasket is still being compressed. For instance, Figure 5 shows compression and compression set characteristics for a gasket material (set is more severe than normal for emphasis).

FIGURE 5



**CLASS C, COMPLETELY INTERCHANGEABLE**—The problem of compression set is much more severe when there is complete freedom of positioning on repeat closures. A specific example would be a round gasket in a waveguide that might be removed and reused in almost any position relative to points of minimum and maximum compression. The compression set height at point of maximum compression may actually be less than minimum compressed height! It would therefore be possible to not make contact at all between gasket and mating surfaces at this point.

## USING STANDARD GASKETS

The designer should know or estimate:

1. Joint unevenness.
2. Available compression.
3. Shielding required.

The object of EMI gasket design procedure is to fit the application requirements (joint unevenness, available compression forces, and shielding requirement) to the gasket characteristics (compressibility and EMI shielding capability).

**Average Shielding Problems**—In general the same reasoning outlined for maximum shielding will apply; choice of gasket material and contact surface is most important, pressure is secondary. If low frequency magnetic shielding is not a severe problem, then a minimum pressure of 5 to 20 psi may well be adequate. This reduction of minimum pressure can be very important because it increases the  $\Delta h$  (gasket compression range) significantly for the same average compression pressure.

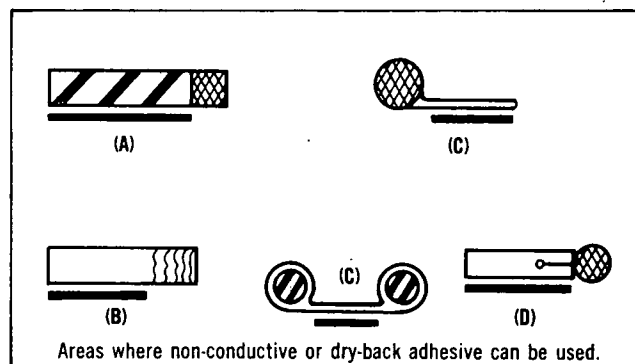
**Minimum Shielding Problems**—Especially when little or no low frequency magnetic shielding is required the minimum pressure could be as little as 1 to 5 psi.

**Pressure Sensitive Adhesive**—This is often the least expensive method for attaching EMI gasket materials; installation costs are often drastically reduced with only a slight increase in cost over a material without adhesive backing. As a matter of fact, most sales of sponge elastomer materials are for applications that do not require any pressure sealing; the adhesive backed rubber portion serves only as an inexpensive attachment method for the EMI portion!

In all cases the designer specifying non-conductive adhesive attachment must include adequate warnings in the applicable drawings and standard procedures for production personnel that the adhesive is to be applied only to the portion of the gasket material not involved with the EMI gasketing function. Experience teaches that installation workers will, either through carelessness or a misguided desire to do a better job ("This gasket would hold better if I glued all of it rather than half of it"), apply the non-conductive adhesive to the EMI gasket portion also. This will seriously degrade the EMI performance.

**Bond Non-EMI Portion of Gasket**—Since many very good non-conductive adhesives are now available, bonding a gasket product in position by applying the adhesive to the portion that is not the EMI gasket (which can be insulated from the mating surfaces by a non-conductive material) is often a very good way of mounting EMI gaskets.

FIGURE 6



All aluminum EMI gasket products should be avoided since they make poor electrical contact. They should be used only when equipment specification explicitly require that only aluminum EMI gaskets be used against aluminum shields. Secondly, mating contact surfaces should be treated for best conductivity (tin coated, cadmium plated, conductive treatments of aluminum). Non-conductive protective coating such as paints and anodizing of aluminum are prohibited in all EMI gasket contact areas.

(The above material has been furnished courtesy of the Metex Corporation).

# CONDUCTIVE ELASTOMERS

Electrically conductive silicone elastomers have, in the past eight years, achieved general popularity as EMI/environmental gaskets. By simultaneously protecting electronic packages against environmental corrosion and electromagnetic interference, they have become an essential tool of the electronic packaging engineer.

Correct application of conductive elastomers as EMI/environmental gaskets requires a knowledge and understanding of the material's behavior under load, the mating flange characteristics, the shielding requirements at each frequency, and the environment in which the package must function.

## SELECTING THE RIGHT MATERIAL

Virtually all conductive silicones intended for EMI gasketing incorporate silver fillers in one form or another. Other fillers have appeared and disappeared, generally because of electrical instability (copper, tin), or poor shielding performance (carbon, nickel). Of the popular silver-bearing silicones, some use pure silver (and are therefore expensive) while others use silver-plated copper or silver-plated glass. The silver-plated copper fillers are granular in shape (which keeps them "locked into" the elastomer), and generally offer the best performance at the lowest cost. Their limitations are temperature (125°C continuous) and durometer (60-80 Shore A), but proper design can often neutralize the durometer problem.

When continuous temperatures above 125°C will be encountered, a pure silver or silver-plated glass filler is required. The silver-plated glass, although low in cost, is subject to electrical degradation under repeated mechanical loading (i.e., opening and closing the gasketed door or panel), and is not recommended for high-reliability military/aerospace applications.

Material density plays an important role in shielding performance. Generally the denser the material, the better the shielding. Of course, high density means high durometer, and the objective should be to use the highest-density material which will deflect enough to seal flange gaps. Often a dense, hard gasket can be made to seal effectively by proper selection of shape, size or flange design.

## GASKET AND FLANGE DESIGN

Good shielding effectiveness requires low interface resistance across gasketed flanges. The best way to achieve low interface resistance is to design for as much metal-to-metal contact as possible. Conductive elastomer gaskets installed in grooves in one flange member allow this metal-to-metal contact (see Fig. 1), to a degree depending on how flat the flange surfaces are machined. This gasket approach has three other major advantages:

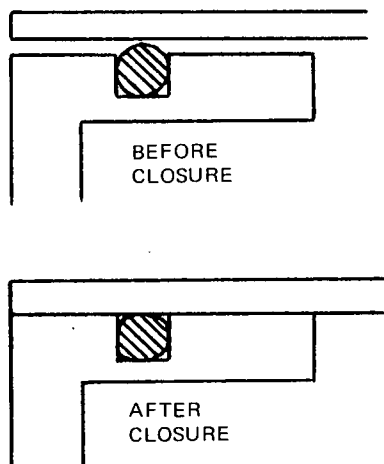


Figure 1: Grooves allow metal-to-metal contact

- The gasket can usually be in the form of a low-cost extrusion fitted around the groove
- Such extruded strips can have cross sections (round, hollow) which provide high deflection under modest closure force (under 10 lbs. per linear inch)

- The metal-to-metal contact provides a natural compression stop, protecting the gasket from damage caused by over-torqued bolts.

Conductive elastomer "O"-strip gaskets installed in grooves should be deflected 10-25% for best performance. The "D" gaskets should be deflected 5-15%. For example, a groove measuring .090" deep should take an "O"-strip gasket .100" to .120" high. Groove cross section area should be greater than gasket cross section area by about 5%. Of course, both the groove and gasket dimensions will have tolerances associated with them, and the designer must look at worst-case tolerance possibilities to make certain that the groove cannot be overfilled, or that the gasket cannot sit too deeply in the groove (see Fig. 2).

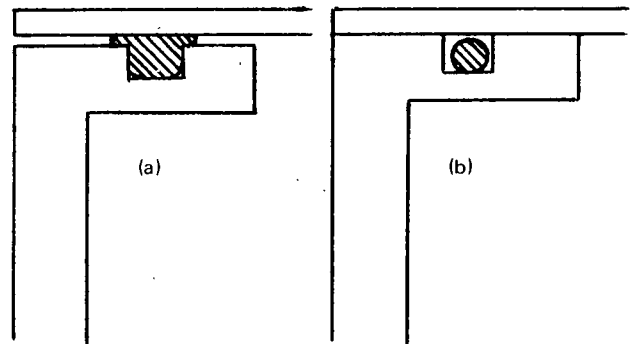


Figure 2: Obvious design errors—overfilled groove (a) and zero gasket pressure (b). Both conditions can result from tolerance variations not accounted for in design.

The gasket size will depend on the amount of deflection required or on the amount of closure force available. If flange stiffness, finish and flatness is such that gaps will be .010" maximum, a gasket height of .100" and groove depth of .080" should be selected (see Fig. 3). This should result in deflections between 10% and 20%. Remember that thin flanges will bow between fasteners, and this condition must be accounted for when determining maximum gaps.

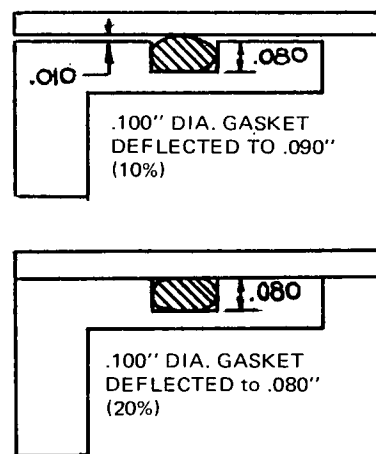


Figure 3: Groove depth of .080" and gasket diameter of .100" results in 10% deflection where gap is .010" and 20% deflection where no gap exists

Suppose a .100" gasket in the material selected requires more closure force to reach the maximum desired deflection than happens to be available? Figure 4 is a load-deflection curve for a .100" dia. "O"-strip in 60 durometer silver-plated-copper filled silicone. Notice that 20% deflection (.020") requires 6.5 lbs/inch of closure force. If the groove periphery happens to be 10", a total of 65 lbs of uniformly distributed closure force is required. If this force cannot be provided, three alternatives are available:

- Switch to a softer gasket material, such as a 40-durometer reticular structure (which requires only 4 lbs/in for 20% deflection of a .100" dia. "O"-strip). This would increase gasket price by about 25%.
- Switch to a larger gasket. For example, a .139" dia. "O"-strip (60 durometer) deflected 15% (.020") requires only 5 lbs/in. This would increase gasket price by about 45%.
- Switch to a hollow gasket. A .125" dia. hollow "O"-strip (60 durometer) will deflect 18% (.020") with only 2.7 lbs/in. Hollow gaskets generally cost the same or slightly less than solid gaskets of the same size, but are not available under .125" dia. In this case, therefore, there would be a gasket price increase of about 20%.

Shape plays an important role in grooved flange designs. For a given load, O-strips will deflect more than D-strips of the same height. So, if closure force is marginal or limited, an O-strip might work where a D-strip will not. An O-strip is also easier to install, because slight twisting will not affect the seal. Gaskets with flat sides (or bottoms) must be positioned correctly in the groove. When closure force is not a problem, D-strips provide a slight advantage in shielding performance. Since they are stressed higher than an equivalent-sized O-strip under a given closure load, they will provide lower interface resistance across the gasket flange. A "D"-strip should also be used when groove dimensions (width or depth) rule out an "O"-strip. Generally, "D"-strips require closer groove tolerances to seal effectively. Other shapes (double "D", delta, rectangular, hollow "O" or "D", etc.) are useful in special circumstances, and are easily produced by extrusion.

Two other design considerations apply to extruded strip gaskets installed in grooves. The first is corner radii. To bend an extruded strip around a corner, the radius should be at least one-half the width (or dia.) of the strip. The larger the radius, the easier the installation. Molded gaskets do not have this limitation. When many corners, bends or complex groove layouts are required, one-piece molded gaskets will greatly simplify installation. Even square groove corners are acceptable if the gasket is molded with square corners.

The other consideration is strip ends—should they be spliced or merely butted? Again, the difference is one of installation ease. Spliced strips can be installed in a groove quite rapidly. Butting requires careful positioning to assure a reliable seal at the gasket ends. Installed properly, a butted joint will be just as effective as a spliced joint.

### Gasketing Without Grooves

Many designers do not have the luxury of grooved flanges. Sheet metal enclosures, or enclosures too large to machine economically, must be gasketed by sandwiching a conductive elastomer strip or die-cut between the flange surfaces. Without metal-to-metal contact, the gasket becomes the sole path for conducting induced shield currents across the flange. For this reason, high gasket conductivity and electrical stability under repeated loading are essential.

When die-cut conductive elastomer gaskets are required, a good deal of design flexibility is lost. Die cuts, unlike extruded or molded "O" and "D" cross sections, can only be deflected about 10%. Strangely, the load-deflection characteristics of die-cut shapes is not always dependent on durometer. An .032"-thick 78 durometer material might deflect more under 100 psi than an .032"-thick 63 durometer material. Because these materials are *deforming* rather than *compressing*, shape plays a crucial role in their deflection behavior. Suffice it to say that most conductive silicon die-cuts deflect between 7% and 10% (maximum), and require at least 100 psi to reach even these modest deflection levels.

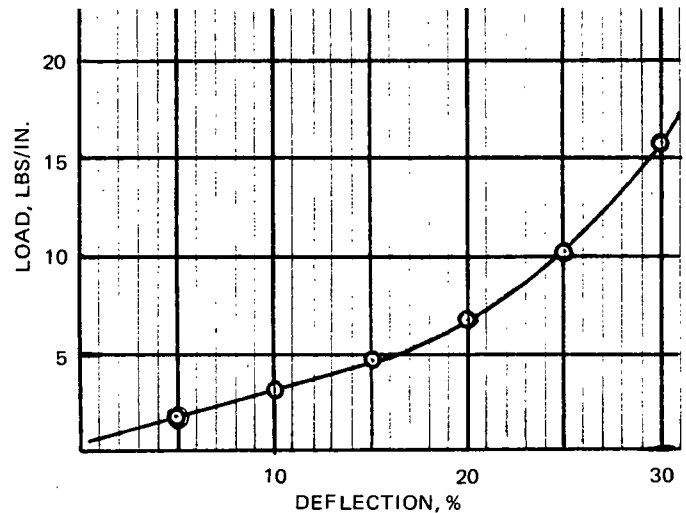


Figure 4: Load-deflection curve for .100" diameter "O" strip (60 durometer)

### Compression Set

When any rubber is deformed for a period of time, some of the deformation is retained permanently even after the load is removed. The amount of permanent deformation, as measured by ASTM D395, is termed "Compression Set". For gasket design purposes, compression set is measured most conveniently under conditions of constant deflection and is expressed as a percentage of the initial thickness.

For gaskets that are used once, or for gaskets where the gasket/flange peripheral relationship is constant, such as in a door gasket, compression set is of no significance if the original load condition and the service temperature are within the design limitations of the gasket material. For gaskets that are randomly resealed one or more times in normal service life, it is important only that the maximum change in gasket thickness does not exceed twice the maximum mismatch between the opposing mating surfaces.

### Compression Deflection

While standard test procedures have been established for measuring the deflection of elastomers under compressive loads, the practical use of such data is to provide a qualitative comparison of the deformability of different elastomeric materials when in the particular configuration of the test sample.

Solid (non-foam) elastomers are essentially incompressible materials. That is, they cannot be squeezed into a smaller volume. When a solid elastomer is subjected to a compressive load, it yields by deformation of the part as a whole. Because of this behavior, the actual deflection of a gasket under a compressive load depends upon the size and shape of the gasket as well as upon its modulus and the magnitude of the load.

The design of a seal should be such that it will be subjected to the minimum squeeze sufficient to provide the required mechanical and electrical performance. The designed deflection of the gasket should never exceed the maximum deflection specified for the material used. The permissible maximum deflection varies widely with different conductive elastomer materials. There is an approximate relationship between the force required to deflect a pure elastomer a given amount and the hardness of the elastomer. In general, the harder the elastomer, the greater the force required.

### Stress Relaxation

Probably more important than Compression Set or Compression-Deflection is the Stress Relaxation characteristic of a gasket. If a rubber is deformed by applying a load, it will deflect. There is a stress/strain relationship, which for rubbers is generally non-linear except for very small deflections. After the load is applied, a stress decay occurs within the polymer resulting from the internal rearrangement of the molecular structure. An approximate rule is that the relaxed stress for cured silicone will finally settle at 70-75% of the initial stress.

There are two ways in which a rubber gasket can be loaded to a desired value. One way is to load it to a point, let it relax, and reapply the load to restore the original stress. The next time it will relax, but not as much. If this is repeated a sufficient number of times, the correct static load on the gasket will reach equilibrium. A more practical way to reach the design value of stress is to load the gasket to 125% of its final design value, so that after the relaxation process is completed the gasket will settle to 100% of the design load. This is very reproducible.

### Tensile Strength

Tensile strength is the term used to describe the ability of an elastomer to resist a stretching force. Tensile strength is usually expressed in pounds per square inch. It is determined by measuring the force required to rupture a sample of the material, and dividing this force by the cross-sectional area of the sample perpendicular to the direction of the applied force. Except as an indication of the capability of the material to stand up to stretching during the handling process, the tensile strength of elastomers is of minor importance in static sealing applications. In dynamic sealing applications, however, the tensile strength may become important. Changes in tensile strength after immersion in liquids or gases can be used to obtain an indication of the probable life of the material when used in such environments.

### Tear Strength

The tear strength of conductive composite gasketing materials range between 20 and 80 pounds per linear inch. Thus they are reasonably tough materials, but because they are used in thin sections, care must be exercised to avoid nicking, or cutting the edges of a seal. Joints should be designed so that seals can be assembled without sustaining damage from rough or sharp edges of associated components.

### Elongation

By definition, elongation is the increase in length, expressed as a percent of the original length, when the sample breaks from tensile loading. This property states how far the material may be stretched before it will break, but it does not indicate to what extent the seal may be electrically damaged. For conductive elastomeric gaskets, the hazard of overstretching is electrical rather than mechanical, and stretching in excess of 10% can result in impaired electrical performance. Nevertheless, both tensile strength and elongation are used by the manufacturer as quality control parameters.

### Temperature Range

The life of silicone materials with silver plated copper-fillers is essentially infinite if they are used at temperatures below 260°F (125°C). Life is reduced to approximately 8 hours at 600°F, and to about 20 seconds at 1200°F. Pure silver-filled silicones may be used continuously at temperatures as high as 400°F (200°C). All silicone materials as a minimum will meet the -55°C requirement of military specifications.

The temperature-life cycle has an inflection point at which the mode of failure changes. Below this point, the mode of failure is gradual embrittlement of the silicone rubber; e.g., the gasket actually becomes friable, and cracks develop which break up the electrical network within the gasket, resulting in the eventual loss of conductivity. Above this inflection point, the temperature is high enough so that the failure mode is actual decomposition of charring of the polymer, i.e., the material foams, chars, and may ablate, which again destroys the electrical properties of the gasket.

### Outgassing

Conductive silicones will show a weight loss of about 1% under conventional outgassing tests. Approximately one-half is present as condensable volatiles. Once the outgassing test is performed, the material becomes virtually free of further outgassing. For special applications where outgassing is a primary problem, special post-cure treatments can be devised to reduce outgassing to the required level. In some cases an alteration of electrical and physical properties may also result.

### Gas Permeability

A unique property of conductive silicones is that the permeability of the material is actually less than the permeability of the base silicone itself. Gas permeability is the property which permits the passage of gas through the molecular structure of the material. In helium leak tests, with a 1 atmosphere pressure differential, ordinary silicone diffuses at the rate of approximately 48 cc per hour. Conductive silicone leaks at the rate of 6 cc per hour. As a comparison, butyl leaks at a rate of 4 cc per hour.

### Flammability

All conductive elastomers are flammable, but they are self-extinguishing when tested per ASTM D635 for flammability of rigid plastics. Conductive silicone gaskets are approved by NASA for use in space. The gaskets will sustain combustion as long as the high temperature ignition source is sustained. They are not instantly self-extinguishing. On the other hand, they tend to extinguish themselves in relatively short periods, depending upon the configuration of the gasket. Configurations with small cross-sections and large surface areas will burn for a longer period than those with large cross-sections and small surface areas.

### Heat Aging

All polymers are effected deleteriously by extremes of temperature, both high and low. A very important distinction between low temperature and high temperature behavior is that low temperature behavior is a function of temperature; i.e., the polymer becomes glassy the instant its temperature is reduced below the glass transition temperature for the particular polymer, whereas at high temperatures, the polymer response is time dependent and its rate of degradation is a function of the temperature.

At low temperatures, the failure mode invariably is one of embrittlement. The polymer becomes glassy and readily fractures under "g" loadings which are quite small compared to the loads which could be sustained at higher temperatures. At high temperatures, polymers may degrade by either of two different processes. By one process, the polymer gradually embrittles, and its resistance to impact loadings diminish with time. By the other process, the polymer "reverts", that is, it tends to depolymerize and to gradually take on the characteristics of a viscous fluid.

In general, the behavior of elastomeric polymers with respect to temperature can be controlled over reasonably wide limits by utilizing properly designed compound formulations. Beyond these formulation limits, however, the various elastomers have inherent temperature-dependent properties which ordinarily are the prime consideration when selecting an elastomeric compound to provide maximum service life in a specific temperature environment.

The wide temperature range called out in many military specifications limits the selection of an elastomer to silicone rubbers.

### Water Aging

The degradation of elastomers with time is an oxidation process and therefore does not occur at a significant rate in pure water, wherein no free oxygen is available. If, however, the water contains oxidizing chemicals, or if it leaches from the elastomer ingredients which ordinarily would protect it from degradation, then such degradation can, and will occur at a rate depending upon the concentration of oxidants and/or the rate of dissolution of protective ingredients from the compound. This degradation would be temperature dependent as well and would occur more rapidly in hot water than in cold water.

Moisture transmission rates are accelerated if capillary routes are present. Care should be taken to avoid the use of elastomeric compounds which are finely porous, or which contain fibers or filaments within the structure. In general, the use of homogeneous or reticulate structured composites is recommended, with the modulus selected to provide the necessary conformity to mating surfaces under the applied load.

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*The above material has been excerpted with permission from the Chomerics EMI "Gasket Design Manual". Free copies of the manual are available to qualified requests.*

## FINGER STOCK

Another form of EMI/RFI gasket used in many applications is contact fingers, often referred to as finger stock. They are available in various configurations including straight strips, corner strips and circular rings with inside or outside contact tips.

### APPLICATIONS:

The fingers are most often used as a RF gasket where frequent access through the opening is required. They can be found around the periphery of most shielded room doors in parallel rows—two and three deep. Here, their wiping action as it is compressed, is a most desirable feature since it cuts through film and dirt which can build up along the mating surfaces. Figure 7 illustrates the wiping action of finger stock.

The fingers can also be used behind panels and drawers where it not only provides RF shielding, but also assures a good ground contact across the mating surfaces. Circular finger rings can be used to ground metal shafts where they penetrate a panel and protect against RF leakage. Their wiping action allows the shaft to rotate without appreciable drag.

### CHARACTERISTICS:

Finger stock is made of high-performance beryllium copper which has a relative electrical conductivity of 22 to 28. It can be

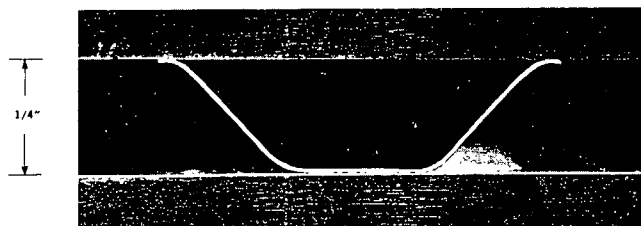
purchased in many standard finishes including gold flashed, gold plated, silver plated, bright finish or as heat-treated ready for the user to apply the finish. The ring fingers are also available with localized deposits of silver or gold on the contact tips.

The finger strips feature a mechanically balanced design to provide high dynamic range, long endurance life and multiple lines of contact under relatively light pressure. Attenuation against electric fields of more than 100dB at 200kHz, 400kHz, 400MHz and 10GHz has been measured for a single rectangular enclosure.

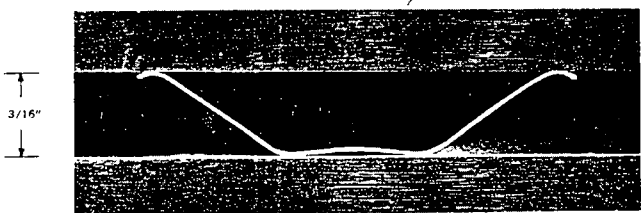
Finger stock can be fastened in place with rivets, clips, and epoxy or can be soldered. The newest technique is finger strips with a self-adhesive backing. Referred to as "Sticky Fingers" by Instrument Specialties, the pressure-sensitive adhesive was developed to provide an extremely tight permanent bond. The adhesive strengthens as it cures with age. Sticky fingers are unaffected in temperature ranges from -65° F. to 160° F. The adhesive also meets most salt spray, shock and humidity cycle tests.

To provide for an increase in the shielding effectiveness against magnetic fields, the sticky fingers can be furnished with a magnetic core insert. As an example, tests have shown that magnetic field shielding effectiveness has been increased from 14 to 18dB at 400Hz and from 46 to 59dB at 14kHz using the magnetic insert.

end views of linear gasket 97-436 compressed between flat surfaces



Three lines of contact occur when gap is 1/4". (Note: This photo was made after the gasket had been compressed to 1/64", and released.)



At 3/16" gap there are four lines of contact due to arching of center.



Note increased arching of center at 1/16" gap. This produces wiping contact with the mounting surface.



At 1/32" gap the tips of the fingers are in contact with the mounting surface, and the center arch is in contact with the closing surface, making a total of seven lines of contact.



At least nine lines of contact occur when the gasket is compressed to 1/64". (Note: Recovery from this deflection is excellent. See top illustration.)