



## 1. INTRODUCTION

This specification covers the requirements for application of RFI/EMI Conductive Elastomer articles which are designed to provide Radio Frequency Interference / Electro-Magnetic Interference (RFI/EMI) shielding / sealing solutions.

The articles referred to herein are formed to a specified shape and size and therefore considerations of application must be made to ensure that the appropriate product is selected and utilized correctly, so that the performance of the article in service is optimized.

This specification will provide technical advice on article selection & design considerations when implementing RFI/EMI Conductive Elastomer articles.

## 2. REFERENCE MATERIAL

### 2.1. Engineering Drawings

TE Connectivity Customer Drawings for specific products are available from the service network. The information contained in Customer Drawings takes priority if there is a conflict with this specification or with any other technical documentation supplied by TE Connectivity/Kemtron Ltd.

The appropriate drawings for the product referenced herein are detailed as follows:

- Customer Drawing C-1201-ECE-CORD
- Customer Drawing C-1202-ECE-TUBE
- Customer Drawing C-1210-ECE-SHEET
- Customer Drawing C-1212-ECE-SHEET

### 2.2. Specifications

Product specification 108-120068 provides material specific product performance and test specification details.

### 2.3. Instructional Material

The TE Connectivity/Kemtron Ltd catalogue provides extensive instruction on the range of product alternative shapes and sizes that are on offer. If an alternative dimension or shape of product is required that is not covered by the scope of this specification, please consult the catalogue and seek technical sales advice from your customer service representative.

## 3. REQUIREMENTS

### 3.1. Safety

Please use sulfur-free protective gloves when handling RFI/EMI Conductive Elastomer products. This will provide protection for the product from contamination, as well as protection for the product handler.

Some products contain sensitive metals which can tarnish or degrade when exposed to contamination, whilst others may cause skin sensitization / allergic reactions when the product is handled.

## 3.2. Storage

### A. Ultraviolet Light

The products should be stored in their original packaging & isolated from direct sunlight to prevent premature degradation of the product.

### B. Chemical Exposure

Do not store product near any of the chemicals listed below as they may cause corrosion or other degradation of the material.

Acids	Alkalines	Sulfur Compounds	Ammonia	Amines
Acyl Halides	Dissimilar rubbers or plastics (excluding original product packaging)			

### C. Shelf-Life

When stored according to the conditions above at ambient temperature and humidity, conductive elastomers have a shelf-life of 20 years.

## 3.3. Surface Mounted Gaskets

Flat gaskets are cut from moulded sheet using state of the art reciprocation knife cutting technology or rule dies. Larger gaskets can be cut from moulded or fabricated picture frames. This option has the advantage of saving material and allows larger gaskets to be produced most efficiently. Fabricated frames use either extruded or moulded flat section that is joined by vulcanizing the polymer. We use the same conductive polymer compound to vulcanize the joints ensuring complete electrical conductivity is maintained across the joint.

This process has allows production of gaskets up to 2 meters long, with the same mechanical and electrical integrity as is found in a single part gasket cut from sheet. This method of manufacture often offers cost savings over cutting from sheet with subsequent loss of waste material. Our in-house production facilities are suitable for prototype, short and medium production runs, up to commercial quantities.

This mounting method is typically suited to “flat-strip” gaskets or gaskets with a flat mounting face and self-adhesive backing (SAB). An optional CSAB (a conductive variant of SAB) is also available. SAB is offered as an assembly aid only and should be used on silicone conductive elastomers only (SNG SSA etc..). For fluorosilicone based conductive elastomers (FNG, FSA etc..), we do not recommend SAB. This is due to the SAB’s component chemical’s ability to perform in line with the fluorosilicone elastomer. Typically, SAB and CSAB are supplied with a shelf life of 6 months.

Minimum material width should not be less than 2mm or at least the material thickness in any part of the gasket. If this cannot be achieved around fixing holes, consider using a slot or horseshoe cut-out. Particular attention is required if specifying compression collars in holes.

Selection of the gasket dimensions is critical to ensure that an effective EMI seal is achieved, but also to ensure that the gasket is not over compressed in service which could damage the gasket and ultimately impact upon its performance. Consideration must be given to compression forces, hole centres, size and number of fixings and rigidity of mating flanges.

Integral compression stops or collars should be considered to limit over compression if external controls cannot be applied. Recommended minimum sheet thickness for integral limits is 1.5mm.



### 3.4. Groove Mounted Gaskets

For the typical electronic enclosure, groove mounted gaskets are better than surface mounted gaskets. When the gasket is compressed within the groove, the two mating flanges come into contact with each other. This enhances the EMC performance and allows the groove to act as a compression limiter, therefore protecting the gasket from damage.

It is important to note that when accommodating an EMC gasket in the design of an enclosure, the principles of O-Ring design for pressure sealing do not necessarily apply. The groove depth dimension is the most important, as it is this that limits the gasket compression. Technically, the groove width has no maximum dimension and is only there for gasket location purposes. Tighter groove dimensions using volume calculations may be employed to enhance environmental sealing, however this will increase the compression forces required.

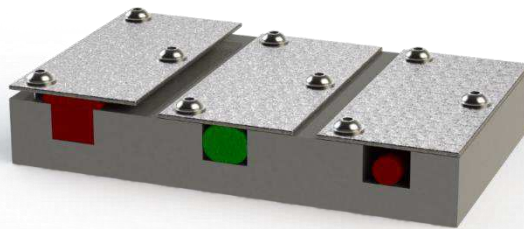
The optimal calculation is based on reducing the depth of the groove by a given compression % and increasing the width by the same amount less 5%.

**Cord example: 20% reduction in depth and 15% increase in width.**

When choosing a tube section as a gasket, it is recommended that consideration be given to the lower compression forces, making sure that there is enough resilience in the gasket to ensure a good RFI/EMI seal. In these cases, it is sometimes better to use the volume groove size calculation, with the groove side walls offering support for the tube.

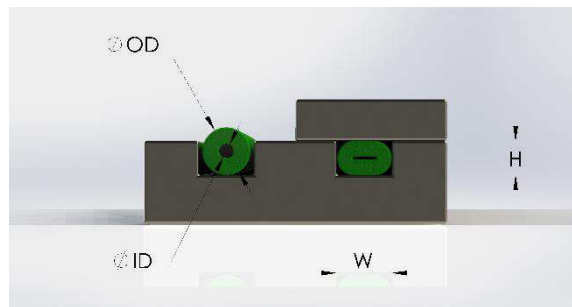
**Tube example: 20% reduction in depth and 5-35% increase in width.**

Because there are so many variables with tube cross sections, it is difficult to give precise information on this subject. Kemtron are able to supply material samples for evaluation purposes.



### 3.5. Solid & Hollow Profiles

Because solid and tubular style gaskets, when compressed, cannot change their volume the groove has to be larger in width to accommodate the change in shape, otherwise severe gasket damage can be caused when the flanges are fixed together. This can result in loss of compression on the gasket and “compression set” occurring. This will give a reduction of shielding effectiveness, coupled with the possibility of environmental leakage. The groove width should be from 5% to 35% larger than the gasket width, but this is dependent upon the gasket profile being used. For example, a round section gasket has less volume than a square section gasket of the same diameter/width.



It is important to consider the worst-case scenario. If you have a gasket that has been supplied on bottom tolerance limits, combined with a groove in the enclosure that has been produced on top tolerance limit, the required compression may not be achieved therefore leading to a poor RFI / EMI seal.

### 3.6. Knife Edge into Groove Mounting

Large applications, such as cabinets, may use a tubular type of gasket fitted into a groove and have a mating flange known as a knife edge. The knife edge plunges into the gasket creating the seal. With tubular gaskets the knife edge collapses the gasket rather than compressing it. The knife edge should not penetrate the gasket by more than 50% of its diameter or there may be a danger of the gasket being unable to recover due to the excess pressure applied by the knife edge. This method is dependent on the size of the internal bore being fairly large in comparison to the outer diameter.



**Example: A tube with an outer diameter of 10mm and an internal diameter of 6mm will work well. A tube with an outer diameter of 10mm and an internal diameter of 1mm will not work well and may damage the gasket.**

### 3.7. Compression/Deflection Forces

With surface mounted elastomeric gaskets, the aim should be to limit the compression of the gasket to between 10% and 20%. 10% being the minimum with a solid silicone style of gasket. (Some form of compression-stop or limit is essential with surface mounted gaskets to prevent over compression).

**Example: A 3mm thick gasket should be compressed down to 2.4mm – 2.7mm.**

15   20% Compression Forces	0.8mm Thick	1.2mm Thick	1.6mm Thick
Sheet	10 / 20 N/cm <sup>2</sup>	15 / 29 N/cm <sup>2</sup>	14 / 25 N/cm <sup>2</sup>

15   20% Compression Forces	OD 1.0mm	OD 1.6mm	OD 1.8mm	OD 2.0mm
Cord	1.6 / 2.3 N/cm	1.5 / 2.5 N/cm	1.5 / 2.5 N/cm	2.3 / 3.2 N/cm

15   20% Compression Forces	OD 1.6mm / ID 0.5mm	OD 2.6mm / ID 1.1mm	OD 3.2mm / ID 1.1mm
Tube	1.1 / 1.5 N/cm	1.2 / 1.6 N/cm	1.5 / 2.2 N/cm

OD = Outer Diameter, ID = Internal Diameter

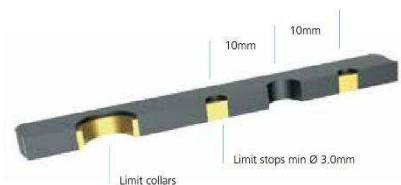
Note, all compression force figures are subject to material tolerance deviations on raw materials that lie outside of our control.

The compressive force needs to be applied evenly across the entire length or surface of the gasket. Use a suitable number of fixings to achieve this. Using an insufficient number of fixings may lead to improper compression of the gasket and may lead to enclosure deformation.

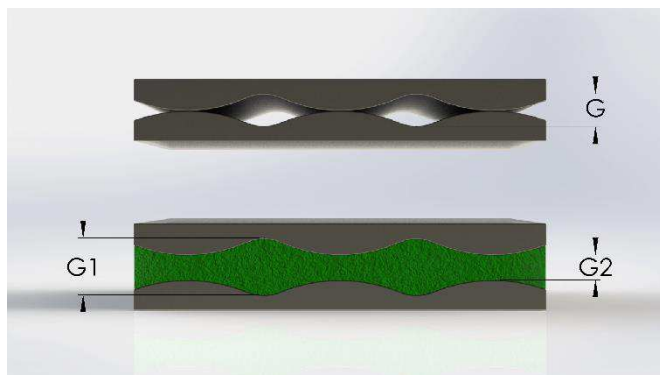
We consider it best practice to request samples and conduct your own trials, and to always add a good margin to your force calculations.

### 3.8. Compression Limiting

Compression stops can be built into many styles of gasket or made as an integral part of the flange. Their height should equal that of the maximum compressed height of the gasket. Compression stops fitted into gaskets can be in the form of compression collars so that fixing bolts can pass through them or as compression stops located either side of a fixing bolt.



The thickness of the gasket for a known application can be calculated as follows e.g. Consider a gasket which can be compressed between 10% and 20% to be used on flanges which are not perfectly flat (G2), i.e. the flanges without gaskets touch at some points and leave gaps in others.



Since the gasket will compress between 10% and 20%, we will require 20% compression at the high points (G2) and 10% at the low points (G1). The greatest gap is therefore 15% of the gasket thickness (G1).

**Example: We should aim to maintain a minimum of 10% compression between the low points at G1. We should not exceed 20% compression at the high points G2.**

This theory is acceptable, provided that the flanges do not “bow” when placed under load. To overcome flange distortion, fixings may need to be added, the number of which will be determined by the flange stiffness/rigidity.

### 3.9. Minimum Bend Radii

**Cord:** The minimum internal bend radius of a solid cord gasket is 1.5x outer diameter (OD) of a cord.

**Example:** 3mm outer diameter (OD) cord being formed around a minimum of a 4.5mm radius.

$$3 \times 1.5 = 4.5$$

**Minimum Radius for 3mm cord = R4.5mm**



**Tube:** The minimum internal bend radius of a tube gasket depends not only on the outer diameter (OD) of a tube it also depends on the size of the internal diameter (ID).

Firstly, where possible try to ensure the internal diameter (ID) of the tube is less than 30% of the outer diameter (OD). By increasing the internal diameter (ID) over 30% of the outer diameter (OD), you could possibly kink the tube when installing, which will mean a larger bend radius will be required.

Secondly, the minimum internal bend radius should not be less than 2.5x the outer diameter (OD) where the internal diameter (ID) is less than 30% of the outer diameter (OD).

**Example:** A tube where the outer diameter (OD) is 3mm, and the internal diameter (ID) is 0.8mm, which is 26% of the outer diameter (OD) being bent around an absolute minimum of a 7.5mm radius.

$$3 \times 2.5 = 7.5$$

**Minimum Radius for 3mm tube = R7.5mm**



### 3.10. Mating Surface Galvanic Compatibility

When operating in service, the galvanic compatibility of the conductive elastomer materials must be considered.

Galvanic corrosion is a process where dis-similar metals undergo electro-chemical reactions in the presence of an electrolyte.

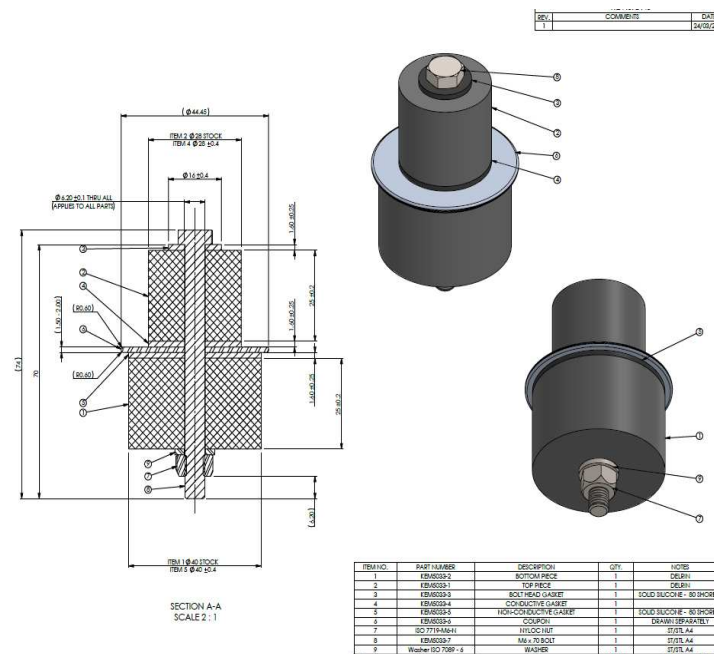
“In-service” conditions such as exposure to saline environments or washdown fluids may cause galvanic corrosion between the conductive elastomer gasket and the mating surface of the electronic enclosure.

If galvanic corrosion does occur this may impact upon the performance of the gasket.

The galvanic compatibility of materials can be investigated through experimentation in a salt fog chamber. Gasket samples are compressed against a defined mating surface. The assemblies are then subjected to 504 hours of salt fog exposure according to ASTM B117.

The mass loss of the sample of the mating surface provides quantifiable data on the performance of the gasket / surface combination.

For testing and reporting purposes the standard mating surface was passivated Aluminium 6061 – T6. Please note, a higher mass-loss in milligrams represents a more corroded sample and therefore poorer galvanic compatibility.



**A schematic of the assembly used to hold a gasket under compression against a defined mating surface for salt-fog testing.**

The effects of galvanic corrosions can be mitigated using the following methods:

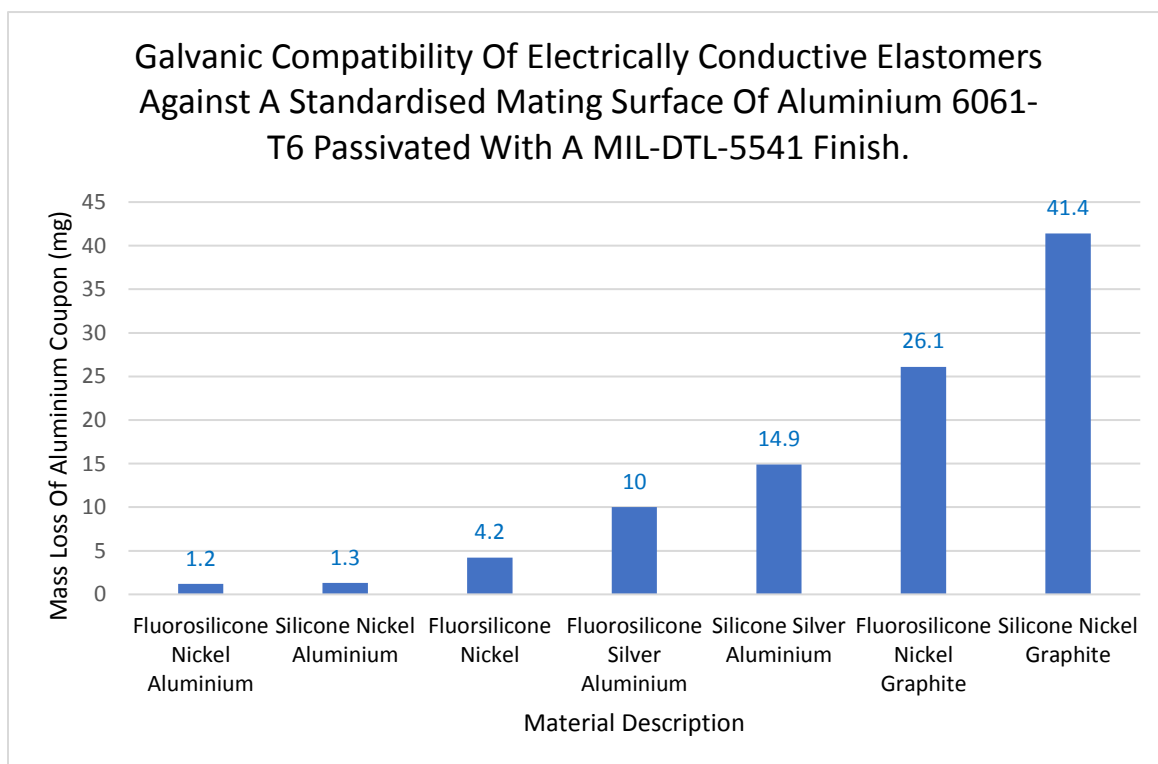
- Selecting a compatible gasket material that suits the enclosure mating surface
- Selecting a compatible surface finish or passivation coating of the mating surface to suit the selected gasket
- Incorporation of an environmental seal to protect the EMI seal from exposure to the conditions of galvanic corrosion.



The data below is only to provide a reasonable comparison between materials and does not represent all design scenarios.

It is advised that application testing is performed to justify the choice of gasket / mating surface combination, as well as testing within expected "in-service" environmental conditions.

If unsure on the requirements for a particular application, the advice of a customer service representative should be sought.





Aluminium 6061-T6 coupons and their associated Silicone Nickel Graphite gaskets after 504 hours of salt-fog exposure.



Aluminium 6061-T6 coupons and their associated Silicone Silver Aluminium gaskets after 504 hours of salt-fog exposure.

#### 4. REVISION HISTORY

Revision number	Change request	Date	Incorporated By
A	-	21-Jun-2022	Dominic Hemmings
B	15% compression force included	5-Jul-2022	Dominic Hemmings

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