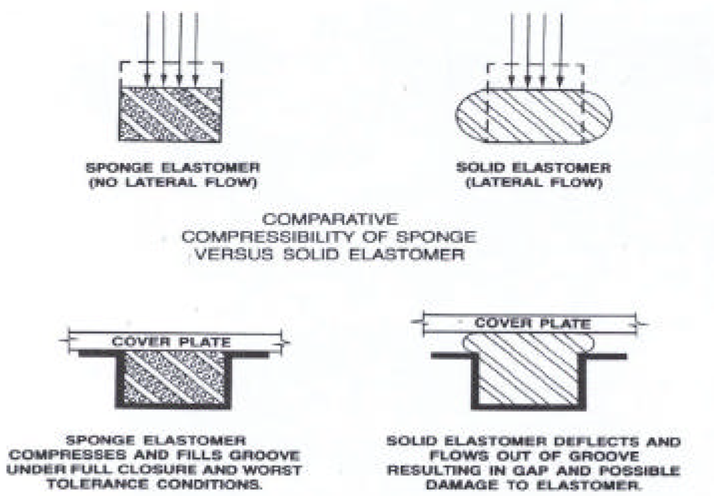
Groove Design for EMC Shielding
By David Carter

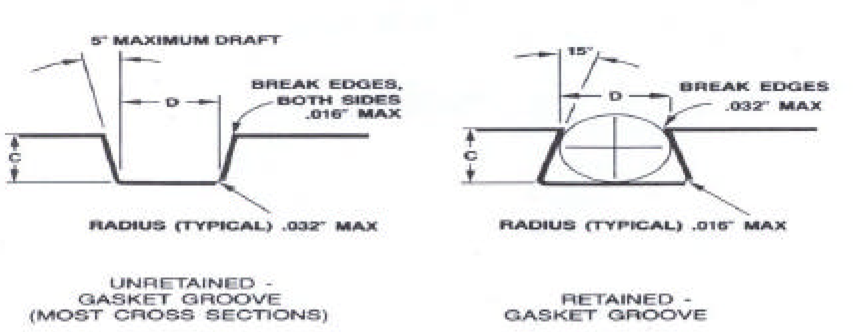
A groove for retaining a gasket assembly provides several advantages:

1. Can act as a compression stop.
2. Prevents over compression.
3. Provides a fairly constant closure force under repeated opening and closing.
4. Provides a moisture and pressure seal when properly designed.
5. Cost effective in lowering assembly time and cost of gasket material.
6. Best overall EMI gasket sealing performance.

Solid elastomers are not compressible. They are easily deformed but do not change in volume as do sponge elastomers. Therefore, allowance for material flow must be considered in the groove design. If the groove cross section (volume), when the cover flange is fully closed, is insufficient to contain the fully deflected material, proper closure of the flange may be difficult. In addition, over stressing of the material may degrade electrical and physical properties of the shielding material.



The figure below shows the design for two different grooves. The groove on the left depicts a typical rectangular groove, while the other shows a design which can mechanically retain circular cross section (cords) gaskets by side friction.



The design of the rectangular groove is relatively simple. The critical dimension is dimension "C", the depth of the groove.

Groove design must also take into account the dimensional tolerances of the groove and the elastomer gasket. For small gasket cross sections up to 2.5 mm (0.10"), the best tolerances are obtained from extruded materials.

Strip and Moulded Products:- (Table 7-2)

(1) Width Dimensions	**Tolerances**	
	Solid	**Sponge**
Up to 3.2mm (0.125”)	±0.4mm(0.016”)	±0.4mm(0.016”)
3.2 to 6.4mm (0.125” – 0.250”)	±0.4mm(0.016”)	±0.8mm(0.032”)
6.4 to 19mm (0.250” – 0.750”)	±0.8mm(0.032”)	±1.2mm(0.047”)
Over 19mm (0.750”)	±1.2mm(0.047”)	±1.6mm(0.063”)
(2) Height Dimension	**Tolerances**	
	Solid	**Sponge**
Up to 19mm (0.750”)	±0.25mm (0.010”)	±0.25mm(0.010”)

The table above lists typical standard tolerances for strip and molded products and the table below lists typical tolerances for extruded products such as CONSIL-E (Data Sheet D-9) and SC-CONSIL (Data Sheet D-15).

Extruded Products: (Table 7-3)

DIMENSIONS	TOLERANCES
Under 2.5mm (0.10”)	±0.13mm (0.005”)
2.5 to 5.1mm(0.10” to 0.20”)	±0.25mm(0.010”)
5.1 to 7.6mm(0.20” to 0.30”)	±0.38mm(0.015”)
Over 7.6mm (0.30”)	±0.51mm(0.020”)

Use the following steps to calculate the "C" and "D" groove dimensions:

1 . Determine the maximum useful compression as a percentage of the original gasket height. This value should be the maximum compression which will not result in permanent damage to the gasket shielding or sealing properties.

2. Determine the minimum useful compression value as a percentage.

Product	Maximum Compression	Minimum Compression
Elastomet	90%	93%
Elastofoam	60%	80%
Knitted wire mesh	60%	80%
Consil	91%	95%

3. Calculate the maximum cross section of the gasket by adding the plus tolerance to the nominal value. The table below provides form-factors for three common cross sections.

Table (7-4)

Shape	Maximum height (H max)	Minimum height (H min)	Form Factor	Maximum cross section area (S max)
Rectangular (H x W)	(H+Tol) *	(H – tol)	1	(H+Tol) x (H–tol)
Round (diameter)	Diameter + tol	(dia – tol)	0.785	$0.785(dia+tol)^2$
'D' shape (A)	(A + tol)	(A – tol)	0.893	$0.893(A+tol)^2$

*Tol=tolerance=one half of the total allowable tolerance around the nominal value.

After determining the maximum and minimum gasket height and the maximum cross section area of the gasket, the C-dimension can be calculated from the following relationships:

Cmin =minimum groove depth
Cmax, =maximum groove depth
Cnom =nominal groove depth (average)
C01 =maximum compression as a fraction of original height
C02 =minimum compression as a fraction of original height and

$$Cmin = (CO1)(Hmax),$$

where Hmax = nominal height (H0) of gasket before compression plus the upper tolerance (H0 + tol).

$$Cmax = (C02)(Hmin)$$

where Hmin, = nominal height (H0) of gasket before compression minus the lower tolerance (H0- tol).

$$Cnom = \frac{Cmin + Cmax}{2}$$

The D dimension (groove width) can be calculated from:

$$Dmin = \frac{Smax}{C'min}$$

where Smax =maximum cross sectional area of gasket and:

C'min=Cnom - lower tolerance
Dnom= Dmin +lower tolerance +allowance
Dmax= Dnom+ upper tolerance

where the upper tolerance is the value of the positive tolerance, and:

Dnom =nominal value of the groove width
Dmax =maximum value of the groove width

Allowance= an added value to account for the use of adhesives and for groove design features such as inside radii.

EXAMPLE, calculate the groove dimensions for a 3.175mm diameter round cross section solid elastomer gasket with a diameter tolerance of plus and minus 0.254mm. Determine first Cmin and Cmax from a 70% maximum compression (C01) and a 90% minimum compression (CO2):

Cmin=(CO1) (Hmax)=(0.7) (3.175+0.254)=3.429mm
Cmax= (CO2) (Hmin)=(0.9) (3.175-0.254)=2.63mm

$$\text{Cnom} = \frac{2.4+2.63}{2} = 2.5159 \pm 0.11\text{mm}$$

The tolerance on the C-dimension is critical in maintaining the compression range within the limits specified, especially for the smaller cross sections. A maximum tolerance for the C-dimension for this size gasket should be limited to ±0.11mm.

It is sometimes desirable to specify a unilateral (one directional) tolerance which is permitted to vary in only one direction from the nominal or design size. Unilateral tolerances should be used in the design of the groove depth where it is important to ensure that the design favours either the high compression or low compression forces. A negative (minus) unilateral tolerance tends to favour slightly higher compression forces while a positive (plus) unilateral tolerance tends to favour slightly lower compression forces. In the groove example, since the tolerance is tight, it is desirable to use a unilateral tolerance for the depth dimension to ensure that the gasket is not over compressed. Using a unilateral tolerance of + 0.1524mm, which should favour the lower compression forces, the C-dimension would be expressed as 2.44 + 0.1524/-0.000mm and the Cmin would equal 2.44mm, the Cmax would equal 2.6, well within the min/max dimensions calculated.

The groove width (D) can now be calculated using the groove width equations above and Table 7-4. For the above example:

$$\text{Dmin} = \frac{\text{Smax}}{\text{C'min}} = \frac{(0.785)(3.175 + 0.254)^2}{(2.44-0.00)} = 3.78\text{mm}$$

Dnom= Dmin + lower tolerance + allowance
= 3.78+ 0.1524+ 0.254= 4.19mm

where tolerance for the width dimension is ±0.1524mm, see Table 7-6.

Tables 7-5 (rectangular strips), Table 7-6 (round strips) and Table 7-7 ("D" shape strips) provide suggested values for "C" and "D" groove dimensions with suggested tolerances which will maintain the gasket within the suggested compression range of 70% to 90% of original height.

Groove Dimensions – Rectangular Gasket
C01 = 0.7 (maximum compression)
C02 = 0.9 (minimum compression) **Table 7-5.**

Strip		Groove Dimension (mm)	
H (mm)	**W (mm)**	**C± tol**	**D ±0.1524mm**
0.762 ± 0.127	3.175 ±0.254	0.5588 +0.051, -0.0	5.87
1.524 ±0.127	3.175 ±0.254	1.143 +0.1, -0.0	5.36
2.36 ±0.127	4.78 ±0.254	1.8 +0.1524,-0.0	7.34
3.175 ±0.254	6.35 ±0.381	2.44 +0.1524,-0.0	9.88
4.78 ±0.254	9.53 ±0.508	3.81 ±0.15	14.2
6.35 ±0.381	12.7 ±0.508	5.055 ±0.15	18.54

Groove Dimensions – Round Gasket **Table 7-6**
C01 = 0.7 (maximum compression)
C02 = 0.9 (minimum compression)

Diameter	Groove Dimensions (mm)	
	C ±Tol	**D ±0.1524**
1.575 ±0.127	1.168 +0.15,-0.0	2.36
2.36 ±0.127	1.8 +0.15,-0.0	3.01
3.175 ±0.254	2.43 +0.15,-0.0	4.2
4.78 ±0.254	3.81 ±0.15	5.84
6.35 ±0.381	5.05 ±0.15	7.67
9.53 ±0.508	7.57 ±0.15	11.07

Groove Dimensions – 'D' Shape **Table 7-7**
C01 = 0.7 (maximum compression)
C02 = 0.9 (minimum compression)

A	Groove Dimensions (mm)	
	C ±Tol	**D ±0.1524**
1.575 ±0.127	1.168 +0.15,-0.0	2.62
2.36 ±0.127	1.8 +0.15,-0.0	3.48
3.175 ±0.254	2.43 +0.15,-0.0	4.72
4.78 ±0.254	3.71 +0.15,-0.0	6.5
6.35 ±0.381	5.05 +0.15,-0.0	8.53
9.53 ±0.508	7.57 +0.15,-0.0	12.4