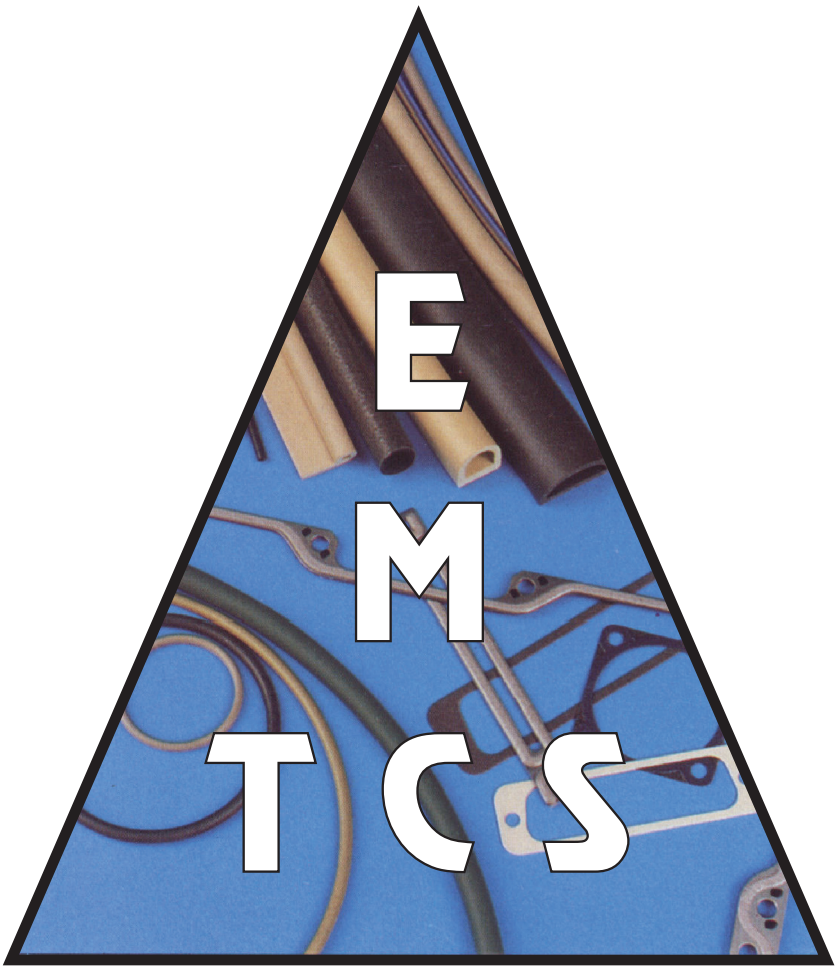
T C SHIELDING LTD

"The Problem Solvers"



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Company Profile

T C Shielding Ltd specialise in the manufacture of conductive elastomers typically used in EMC applications. The product and materials are designed, developed and manufactured by T C Shielding, to ISO 9001 approved standards, at its site in Ross-on-Wye, Herefordshire.

PRODUCT RANGE

(Conductive Elastomers and EMC solutions)

Our products fall into one of four categories:

Screen Printing: A novel way of producing gaskets either as discrete components or by depositing a gasket directly to a component hardware.

Extrusion: A wide range of standard and special profile product is produced - from simple 'O' ring cord down to 1 mm diameter, to complex (inc. hollow) forms 20mm in section. Extrudate can be supplied in continuous length, cut length, joined or fabricated to form door seals.

Moulding: Compression moulding is used to produce complex components of various shapes, sizes and gaskets of three dimensional forms.

Other Products: Including fabric wrap, mesh, vent panels, windows and foil tapes.

SALES/MARKETING

T C Shielding has a wide customer base covering a broad range of markets:-

Telecommunication, aerospace & defence, medical, railways and industrial electronics. Our customers include *Selex, Chelton Defence, GEC Marconi, Westinghouse, Siemens, Nortel, Ericsson, Nokia, Lucent Technologies, BAE Systems and Thalis*. Some 40% of T C Shielding's business is exported.

T C Shielding offers comprehensive technical and sales support direct from its UK manufacturing plant at Ross-on-Wye. We will be pleased to offer technical advice and prices, or arrange visits to customers' facilities to discuss applications in more detail.

T C Shielding customer support activity is further enhanced in the UK and overseas by a network of agents dedicated to service the EMC business section.

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Introduction

At T C Shielding we realise that customers are often faced with difficult and demanding design parameters.

With the profusion of EMC products that are currently flooding the marketplace, it can be difficult to decide which solution to use.

Now, more than ever before, the major questions you need to ask are:-

- Does the product meet/exceed your requirements?
- Does the product offer a 'cost effective' solution?

Our policy at T.C. Shielding is to provide the best possible solution to each and every problem at a price that our competitors cannot match.

Polymer chemistry is a complex subject in which we specialise using unique manufacturing processes. Whether it is a printed, extruded or moulded solution, we excel when working with your design team at the prototype stage of development, supplying information on materials choice, galvanic compatibility and hardware design.

The final working environment is often as important as the shielding performance, especially when equipment is designed to perform for many years in extreme conditions.

We know that well designed equipment will lead to the future success of all concerned and the recipe for this is 'teamwork'.

In summary, we can help you to

Get it right - first time!

Product Range

- Conductive / Non Conductive Elastomer Seals & Gaskets in Silicone / Fluorosilicone. Wide materials choice, including non-flam IEC 60695-11-10 V0/V1 Nickel Graphite Silicone, and non standard designs available.
- UL 94 - VO , TPE, PU, and Neoprene Foam Profiles wrapped with 'Met Cloth' — Metalised Fabric. .....(Ref: 1/9)
- Oriented Wires in Solid Silicone. .....(Ref: 1/8)
- Conductive Optical Film for Windows. .....(Ref: 1/10)
- Bake & Peel Tape in Tin Clad Copper. .....(Ref: 1/11)
- Die Cut Conductive PTFE Material. .....(Ref: 1/12)
- Conductive EMC Windows - Many options available. .....(Ref: 1/13)
- Aluminium & Copper Tapes with Conductive Adhesive. .....(Ref: 1/16)
- Attenuating Honeycomb Vent Panels / Dust Filters. .....(Ref: 1/18)
- Neoprene & Silicone Foams wrapped with mesh products Stainless Steel / Copper / Monel / Aluminium Mesh. .....(Ref: 1/19)
- Microwave Absorbing Foam Materials. .....(Ref: 1/21)
- Beryllium Copper / Stainless Steel Finger Strips.
- Ferrite EMI Suppressors - many options available.
- Conductive & Decorative Spray Coating.
- PCB Level EMI / RFI Screening Cans.
- EMC Cable Glands.

Shielding Theory - Basics

Electromagnetic compatibility (EMC) refers to the inter-relationship between various electrical/electronic systems within a component as well as the relationship between the component and the electromagnetic environment.

There are three causes of problems which may occur individually or together:

- **Effects of Conducted interference**

Conducted interference occurs as a result of an unintentional effect on an electrical system of voltage drops, pulses/spikes and high frequency currents. (eg. electric motors)

- **Effects of Near field**

The near field of a system is influenced by galvanic, inductive and capacitive coupling resulting in emissions in close proximity to the source.

- **Effects of Far field**

The far field of a system is influenced by environmental factors (eg. radio and TV transmitters) which in turn can influence the system.

Note: An electrical/electronic system may be both the source and the victim of electromagnetic interference (EMI).

The near field and the far field are the most relevant for gasket shielding, we shall therefore concentrate on these aspects.

Wave theory

Typically a generating source will produce a wave with two components, a magnetic field and an electric field.
The relationship between the magnetic (H) field and the electrical (E) field is dependent upon the nature of the source and the distance from that source.
The ratio of the two fields is important and is expressed as wave impedance Z.
Certain sources generate strong magnetic fields and are said to have low impedance.
Similarly a high impedance source generates electric fields.
At long distances from the source the components of E and H become equal. The wave is then classed as plane wave.
This relationship is applicable to a variety of devices that generate electromagnetic waves, from those whose function it is to do so, for example radio transmitters and microwaves, to those which create it as a by product, for example power cables.

Shielding

When a wave encounters an object some energy will be reflected, some will be absorbed (converted to heat and create residual internal current flow) and a certain amount will leak through.

Many factors govern the proportions of the above relationship; the impedance of the wave and the object is particularly important. The greater the difference, the more energy is reflected.

When the wave impedance is low (ie. magnetic field) a greater proportion of energy is absorbed. This is the main reason magnetic fields are difficult to shield effectively.

Any internal current flow can create a field on the internal side of the barrier.

Therefore, the ideal method of shielding is to reflect the wave energy. Any absorbed energy can create residual current.

Shielding Effectiveness.

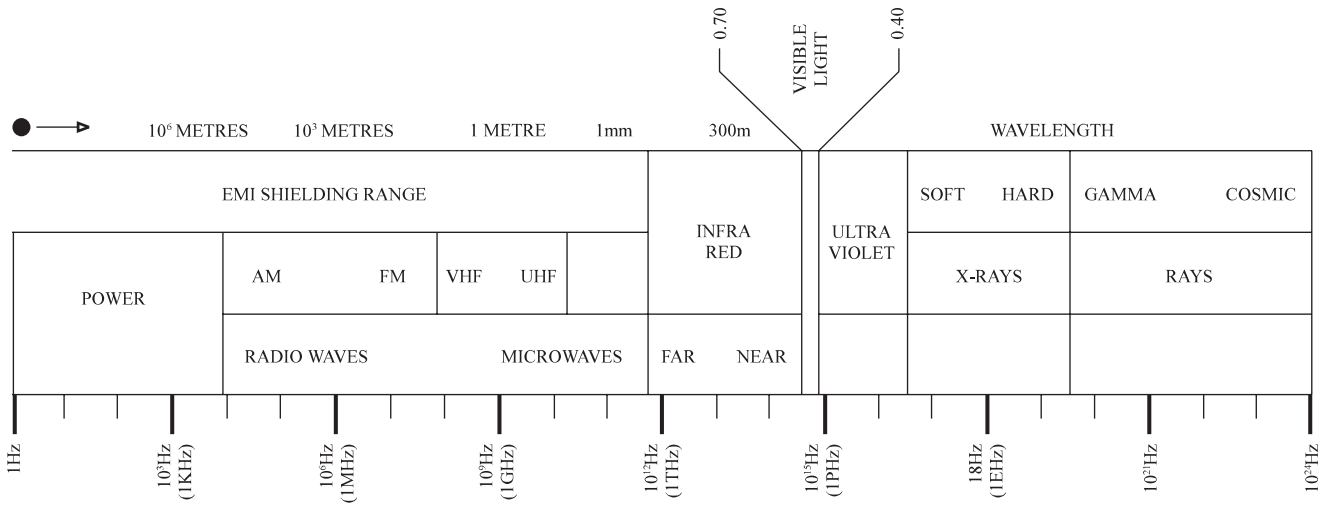
Shielding effectiveness is a measure of the attenuation or reduction of energy across a component or test piece. The unit is a decibel or dB.

The relationship is logarithmic, that is:

$$\text{N dB} = 10 \log \frac{P1}{P2}$$

where the fraction P1/P2 is a unitless power ratio of the relevant values of measurement.

ELECTROMAGNETIC SPECTRUM

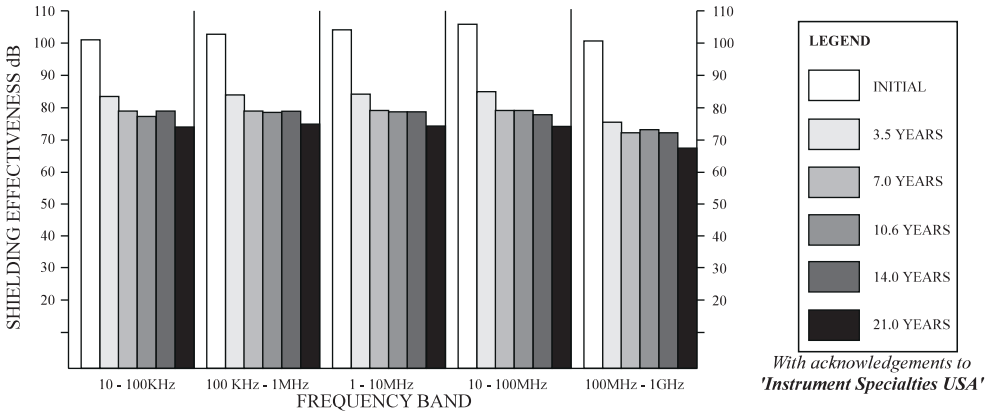


RFI - Radio Frequency Interference: Unwanted radiated electronic noise 10kHz to 1000MHz
EMP - Electromagnetic pulse: Broadband, High Intensity Transient Phenomena, such as lightning or nuclear explosion (NEMP).
HERF - High Energy Radio Frequency
EMI - Electromagnetic Interference: DC to 300GHz
ESD - Electrostatic Discharge: A transient phenomena involving static electricity

Gasket Shielding Performance

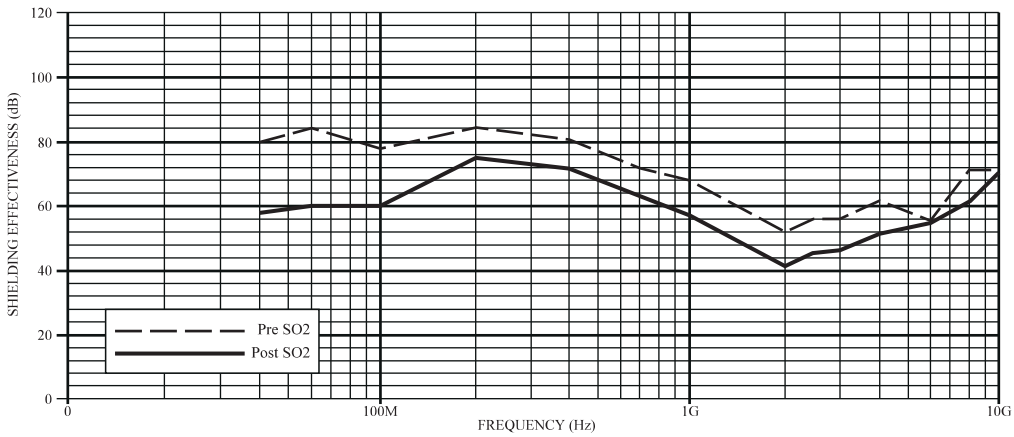
Shielding effectiveness is typically expressed in dB mean attenuation, i.e., the ratio of energy loss. Throughout the industry, there are many specifications, e.g., MIL-G-83528, MIL-STD-285 and SAE-ARP-1705, each one having a particular relevance to a specific field of operation. Space does not permit us to publish all the data available, but the charts below show typical shielding effectiveness values for differing materials.

- **Life Performance**
  Figure 1: Shows typical attentuation values across the frequency band including extrapolated life values.
  Test method: transfer impedance to SAE-ARP-1705. Material: silver aluminium silicone (TC Ref 1D/1 and 3D).
  Test jig material: 6061 aluminium with chromate surface.

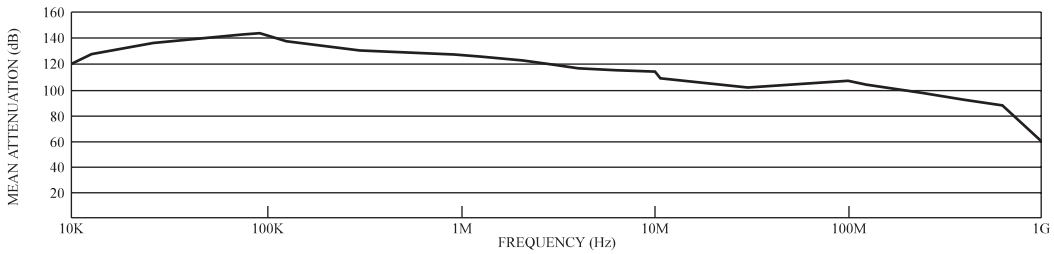


With acknowledgements to
'Instrument Specialties USA'

- **Environmental Performance**
  Figure 2: Refers to shielding effectiveness to MIL-G-83528/Mil-285 procedure for silver/aluminium loaded silicone (TC Ref 1D and 3D), before and after SO_2 laden 5% salt spray (192 hours immersion).



- **Printed Material Performance**
  Figure 3: Relates to mean attenuation to SAE-ARP-1705 for Nickel/Graphite loaded silicone (TC Ref 3J/2)



Note: Reduction in attenuation occurring towards 1GHz frequency is not material performance related but is due to resonances within ARP-1705 fixture arrangement.

These charts refer to a small proportion of data available at T. C. Shielding.
If you require any further details, please contact our Technical Department.

Guide to Conductive Elastomers

Base Polymers available are: Silicone and Fluorosilicone

Silver/Copper *(Ag/Cu)* grades are tan in colour and are compounded to offer the greatest level of shielding performance. They also have excellent resistance to EMP and offer very high current transfer plus good thermal transfer characteristics. Working temperature range -50° to +125°C.

Silver/Aluminium *(Ag/Al)* grades are tan in colour and selected on the basis of their excellent shielding performance and low density for weight sensitive applications. Working temperature -50° to +160°C.

Silver/Glass *(Ag/Glass)* grades are tan in colour and have the lowest density of all the high performance grades, specifically recommended for application where weight is critical and shielding requirements are less demanding. Silver glass is not recommended in high current transfer applications such as EMP. Working temperature range -50° to +160°C.

Pure Silver *(Ag)* loaded materials are tan in colour and exhibit the highest level of electrical conductivity with good shielding performance. This grade is particularly useful for offering a low resistance to current flow. Working temperature range -50° to +160°C.

Silver/Nickel *(Ag/Ni)* loaded grades are tan in colour offering excellent shielding performance. Generally an expensive material due to inherent high cost and high S.G. Working temperature range -50° to +160°C.

Nickel/Graphite *(Ni/Gr)* loaded grades are grey in colour and are selected for their good shielding performance and their resistance to galvanic corrosion. Working temperature range -50° to +160°C.

Aluminium Compatible loaded silicone is black in colour and available as a **printing grade only**. The material offers good levels of shielding with excellent galvanic compatibility in contact with aluminium in salt spray environments. Working temperature range -50° to +160°C.

Fluorosilicone is not available on printing systems.

Aspects of Corrosion & Design Recommendations

The Problem and the Dilemma

To achieve a high reflection loss at a sealing interface in an enclosure, and thus effective sealing and shielding of the joint, a low impedance material is required. A low impedance material is one which conducts electricity well. Good conductors such as silver and nickel have very low or even negative electrode potentials. When they are placed in an electrolyte such as sea water with dissimilar metals such as steel or aluminium, electrolytic action takes place, causing corrosion and degraded shielding at the joint interface. According to the potential difference between the two metals, one electrode in the galvanic cell will be the donor and become gradually eroded.

The potential diffference (PD) between metals and shielding materials commonly used in enclosures is normally expressed in volts. Typical values for the PD of metals are measured using a standard calomel electrode in sea water (see table for values).

T C Shielding has carried out tests on the most commonly used conductive elastomers and values for their PD are listed alongside the values for various metals (see table on page 10).

The industry norm for acceptable PD between differing metals in a salt spray environment is 0.5v and in a military environment 0.3v is often used.

Thus the potential for galvanic corrosion can exist in applications when faced with utilising highly conductive metal loaded elastomers such as silver, and to a lesser extent nickel and carbon, in contact with aluminium.

The Solution

Two potential solutions exist for the designer to minimise or totally overcome corrosion problems.

1) Choice of elastomer is made giving due consideration to the level of shielding required, and other matters such as commercial implications.

   Consideration should then be given to using a metallic coating on the surface of the enclosure hardware in contact with the seal.

   In the case of silver based elastomer materials, the hardware should be silver plated. In the case of nickel graphite or carbon, nickel plating is recommended.

   Nickel plating can be considered a possible compromise with silver based elastomer materials

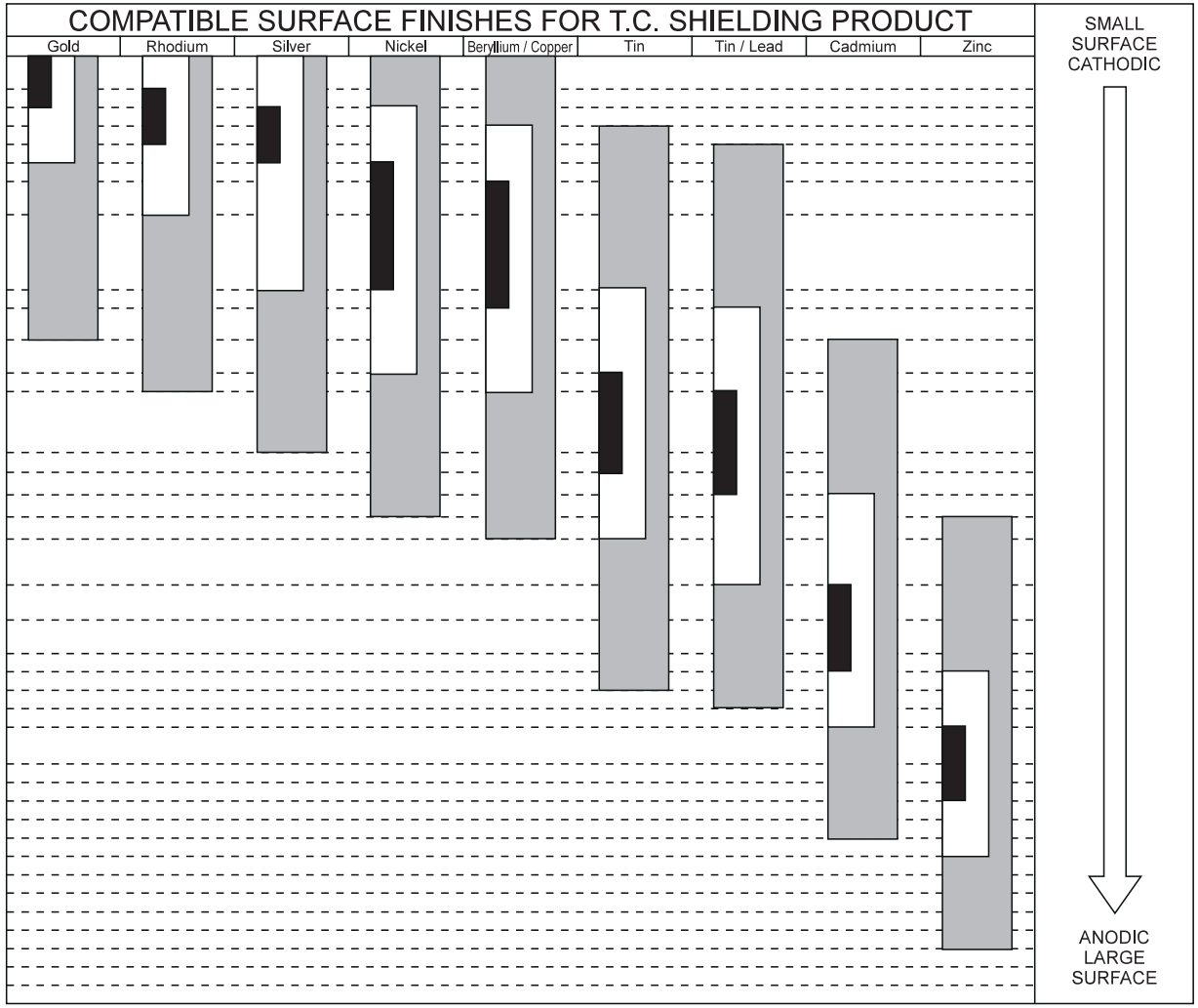
2) **'Duo Seal' design option**
   (see separate data sheet - pages 31, 32, 33 and 34)

   Where design constraints allow, it may be possible to accommodate a 'duo-seal' design of jointed ring. This principle is based on a traditional groove captivating a co-extruded profile which comprises two sealing elements. The outer sealing element is a silicone or fluorosilicone material that effectively seals the outside environment and eliminates the potential for corrosion. The inner sealing element comprises conductive elastomer to achieve low impedance electrical contact, and give shielding of the enclosure and joint interface.

   Choice of materials should be made based on commercial and performance considerations relating to the application and design.

METALS GALVANIC COMPATIBILITY

GROUP NUMBER	COMMON METAL SURFACES METALLURGICAL CATEGORY	ANODIC INDEX, V
1	Gold; Au-Pt Alloys; Wrought Platinum Graphite Carbon	0.00
2		0.05
3	Rhodium Plating	0.10
4	Silver; High-Silver Alloys	0.15
5		0.20
6		0.25
7	Nickel; Nickel-Copper Alloys; Titanium Titanium Alloys; Monel	0.30
8	Beryllium Copper; Low Brasses or Bronzes; Silver Solder; Copper; Ni-Cr Alloys; Austenitic Corrosion Resistant Steels; Most Chrome-Moly Steels; Specialty High Temp. Stainless Steels	0.35
9	Commercial Yellow Brasses and Bronzes	0.40
10	High Brasses and Bronzes; Naval Brass; Muntz Metal	0.45
11	18% Cr type Corrosion Resistant Steels; Common 300 Series Stainless Steels	0.50
12		0.55
13	Chromium or Tin Plating; 12% Cr type Corrosion Resistant Steels; Most 400 Series Stainless Steels, i.e., 410 and some cast Stainless Steels	0.60
14	Terne Plate; Tin-Lead Solder	0.65
15	Lead; High-Lead Alloys	0.70
16	Wrought 2000 Series Aluminium Alloys	0.75
17		0.80
18	Wrought Gray or Malleable Iron; Plain Carbon and Low Alloy Steels; Armco Iron; Cold Rolled Steel	0.85
19	Wrought Aluminium Alloys except 2000 Series Al-Si Alloys; 6000 Series Aluminium	0.90
20	Cast Aluminium Alloys other than Al-Si; Cadmium Plating	0.95
21		1.00
22		1.05
23		1.10
24		1.15
25	Cast Aluminium Alloys other than Al-Si; Cadmium Plating	1.20
26	Wrought Zinc; Zinc Diecasting Alloys	1.25
27		1.30
28		1.35
29		1.40
30		1.45
31		1.50
32		1.55
33		1.60
34		1.65
35		1.70
36	Wrought and Cast Magnesium Alloys	1.75
37		1.80
38	Beryllium	1.85



For harsh environments (presence of fair to good ionic conductors), all metals in contact with each other should be no more than one level of the chart apart to minimise corrosion. Outdoor applications, high humidity and salt air fall into this category

For normal environments (storage in warehouses or non-temperature/humidity controlled environments, etc). The difference between dissimilar metals should not exceed 0.25 volts (5 chart levels counting the origin).

For office (temperature and humidity controlled) environments. 0.50 volts can be tolerated (10 chart levels counting the origin). Caution should be maintained when deciding that your application is temperature and humidity controlled. Many devices intended for use in office environments are stored in warehouses for extended periods of time before and in between use.

THESE ARE GENERAL GUIDELINES WHICH APPLY UNDER MOST CIRCUMSTANCES, BUT CORROSION IS A VERY COMPLEX SUBJECT WHOSE DETAILS COULD NOT POSSIBLY FIT IN THIS SPACE. IF YOU ARE NOT SURE WHICH METALS ARE COMPATIBLE, PLEASE FEEL FREE TO CONTACT TC SHIELDING LTD. AND TALK TO OUR TECHNICAL DEPARTMENT. With acknowledgements to Instrument Specialities, USA

Environmental Compatibility

TC REF	FILLER TYPE	ENCLOSURE MATERIAL: ALUMINIUM ALLOYS	MAGNESIUM ALLOYS	STAINLESS STEEL	COPPER ALLOYS	CADMIUM PLATING	TIN PLATING
A	SILVER/NICKEL	✖	✖	●	●	✖	❑
B	SILVER/COPPER	✖	✖	●	●	✖	✖
D	SILVER/ALUMINIUM	❑	❑	●	●	❑	❑
K	INERT ALUMINIUM (A1 COMPATIBLE)	●	❑	●	●	❑	●
I	SILVER/GLASS	✖	✖	●	●	✖	❑
G	SILVER	✖	✖	●	●	✖	❑
J	NICKEL/GRAPHITE	❑	❑	●	●	❑	●

TC REF	FILLER TYPE	ENCLOSURE MATERIAL: NICKEL PLATING	CHROMIUM PLATING	SILVER PLATING	ZINC PLATED GALVANISED STEEL	TITANIUM
A	SILVER/NICKEL	●	●	●	✖	●
B	SILVER/COPPER	❑	●	●	✖	●
D	SILVER/ALUMINIUM	❑	●	●	❑	●
K	INERT ALUMINIUM (A1 COMPATIBLE)	●	●	●	❑	●
I	SILVER/GLASS	●	●	●	✖	●
G	SILVER	●	●	●	✖	●
J	NICKEL/GRAPHITE	●	●	●	❑	●

LEGEND : ● GOOD : ❑ SATISFACTORY : ✖ NOT RECOMMENDED

Flammability of Silicones

When silicone rubber burns as it would in an intense fire, the polymer decomposes to form silica which, along with the fillers, forms a non-conducting ash.

While burning, it will yield a comparatively low level of smoke. Carbon Monoxide will be a component of the smoke. However, unlike other materials containing halogens, sulphur or nitrogen, it cannot evolve hydrogen chloride, fluorides, sulphur dioxide, nitric oxide or other noxious chemicals which can irritate the eyes, nose or throat.

Silicone rubber is capable of withstanding temperatures of up to 500°C for several minutes while still exhibiting good insulation properties.

Silicones typically have a flame rating of UL94 HB when tested in accordance with the underwriters laboratory Flame Test (UL94).

Typical comparative smoke generation values for a range of polymers are as given in the chart below:

MATERIAL	Dm	Tc (min)	GASES INVOLVED			
			CO	HCL	HCN	SO2
Silicone (MVQ)	43	7	yes	no	no	no
Polyvinyl Chloride (PVC)	180	1.4	yes	yes	trace	no
Polychlorprene (CR)	161	1.6	yes	yes	trace	no
Ethylene Propylene (EPDM)	196	1.1	yes	yes	no	yes

In the table above Dm represents Maximum Specific Optical Density or maximum smoke accumulation over a 20 minute period. Tc is the time taken to reach a Specific Optical Density of 16 (i.e., light transmittance of 16%).

This report serves as a reference guide only.
For specific details, please refer to T C Shielding Limited.

Please Note: A new Nickel/Graphite Silicone material Ref: 1J/8 has been developed meeting IEC V1 rating (please see Property Chart on page 36).

Storage and Shelf Life

Introduction

Conductive rubber seals and gaskets can be expected to provide excellent service over many years. However, one can expect certain physical properties to change during storing - in certain cases poor storage can render the rubber unusable due to excessive degradation of the physical or electrical properties.

The purpose of this document is to provide general recommendation on the storage of conductive rubbers in all forms, to ensure that any degradation is kept to a minimum.

Certain factors have a major effect on shelf life. Below are listed these factors in more detail.

Temperature
Recommended range 5° to 25°C

Below 5°C no permanent damage will be experienced, but the product may be more rigid - hence care in handling. At elevated temperatures above 25°C deterioration may occur more readily.

Light

Under no circumstances should the product be subject to light - natural or artificial. The product is to be stored in light proof, sulphur free packaging.

Humidity

<75% Relative humidity without condensation.

Contact with other Materials

During storage the product should not come into contact with any of the following:-

1. Solvents
2. Oils and greases
3. Material containing sulphur
4. Metals, particularly copper and its alloys
5. PVC
6. Different rubber materials

(Continued on Page 14)

Storage and Shelf Life (cont)

Packing Method

It is important that the product is stored in a relaxed condition without being subject to stretching (i.e. hanging on pegs) or crushing. If the product is printed on to a metal carrier it is important that the parts are not allowed to contact violently such that physical damage of the gasket could result. The best packaging method is black, light proof, sulphur free polythene bags and sulphur free supporting card as necessary.

Shelf Life

The base elastomers used by T C Shielding are:-

Silicone	MVQ
Fluorosilicone	MFQ

Due to the specialised nature of the conductive elastomers it is recommended that the product be subjected to routine periodic inspection on a sample basis to ensure that the product remains in serviceable condition.

The inspection, at six monthly intervals, would consist of the following:

a) Visual checks:

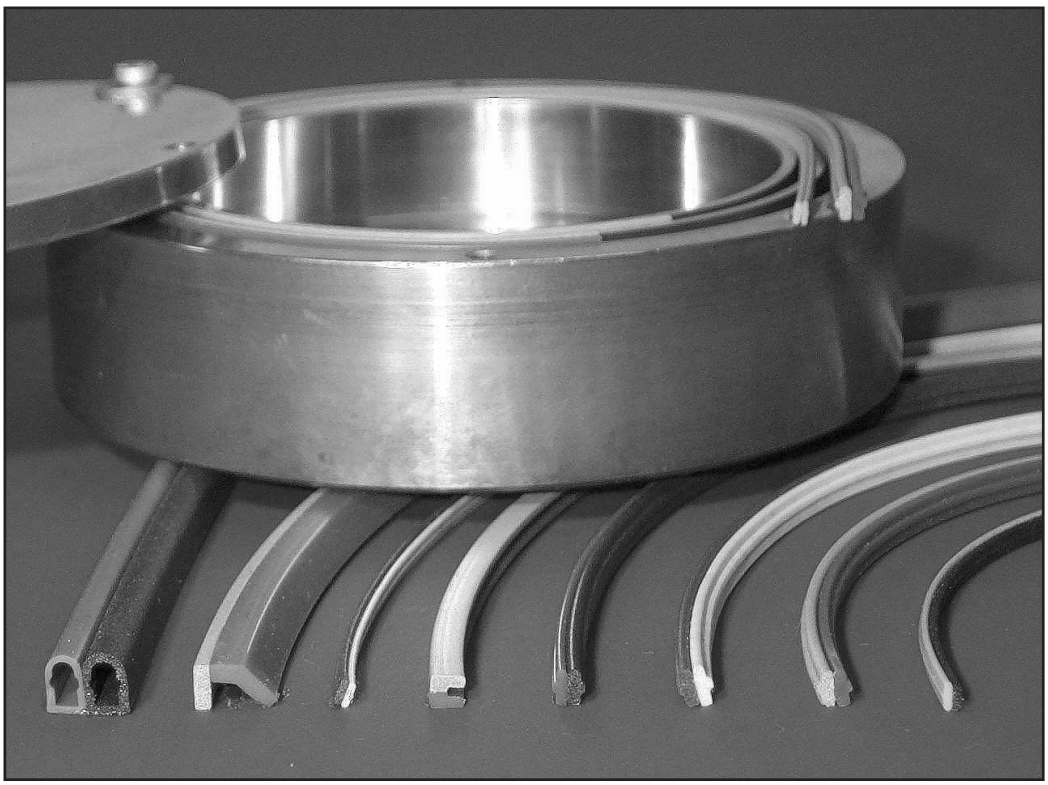
- Surface cracks or splits
- Nicks or cuts
- Flats
- Permanent distortion

b) Electrical conductivity to a specific standard.

In the event of finding such defects the product should not be used.

If there is any doubt about serviceability of a particular product, please contact T C Shielding Limited, whereupon we will be pleased to offer assistance.

Extruded Component Technology



The technique of extruding conductive elastomers has a wide range of benefits. This area of technology utilises both polymer and profile development, solving a wide range of shielding and sealing problems. Below is a list of the major advantages of this process:

- Profiles can be developed for areas where low closure forces exist.
- Profiles can be mitre jointed to ease assembly and prevent leakage (both RF and Environmental).
- Profiles can be butt joined in the form of 'O' rings to ease assembly, prevent emissions, susceptibility and effects on environmental sealing.
- Product can be adhesive backed (dependent on profile type).
- Product can have rivet holes (dependent on profile type).
- Secondary environmental sealing can be incorporated into gasket.
- Two part duo systems can be manufactured to give complete environmental protection and thus eliminate the galvanic corrosion potential.
- Silicones and fluorosilicones plus wide range of conductive fillers.

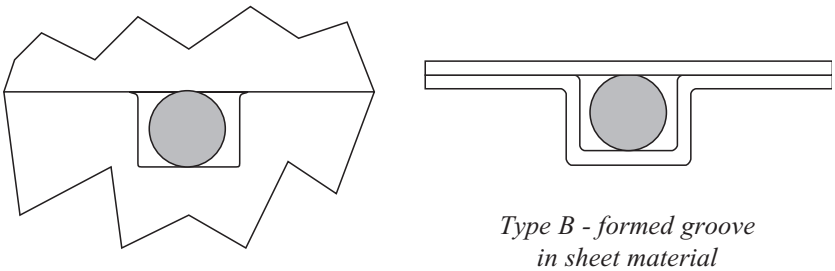
Extruded Forms - Application Details

Standard or special extrudate can be supplied in a variety of forms, cut to a discrete length, continuous length or fabricated. Fabrication involves joining the extrudate to form a continuous seal. The joint is fully vulcanised with a conductive jointing material. Fabrication covers a multitude of configurations from a simple 'O' ring to complex panel flange gaskets up to 1.5 metres in size.

• *Installation*

To effect a mechanical and electrical seal the gasket needs to be compressed. Insufficient compression can result in fluid leakage and poor electrical performance. Excessive compression will result in physical and electrical failure of the joint. The best method for controlling compression is by locating the gasket in a groove - typical configurations are shown below.

Correct Assembly



Type A - Machined or cast/moulded groove

Type B - formed groove in sheet material

If grooves are not possible, compression control can be achieved by alternative means, e.g., shouldered fixings, washers, spacer plates and in certain cases limiters built into the gasket.

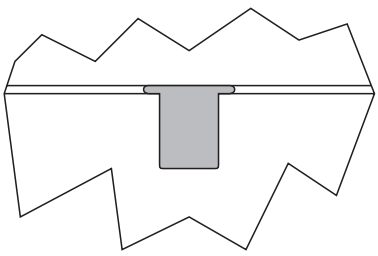
• *Compression*

Gaskets have a finite working compression range. Each sectional profile has its own loading characteristic primarily due to its stiffness and shape. Conductive 'O' rings typically have a range between 10 and 25%. Hollow profiles have very low load requirements and are therefore ideally suited for applications where the flange is insufficiently stiff or where low clamping loads are prevalent - depending upon section, hollow profiles have a compression range of 7.5 to 50%.

• *Groove dimensions*

When assembling gaskets into fully enclosed grooves it is important to remember that rubbers behave as 'incompressible' fluids. Therefore sufficient allowance has to be given for volume displacement.

Incorrect Assembly



gasket damage, nibbling

Groove overfill condition

As a general guide allow a minimum of 5% free volume at extremes of tolerance.

• *Retention*

Many components require that the gasket is securely retained in both assembly and service. There are many ways of achieving this involving self retaining forms, pressure sensitive adhesives, or by retaining portions of gasket by clips or fixings.

Space limitations prevent us from covering all the above aspects in detail. However, if you require specific details or recommendations on groove sizes, clamping load, etc., please do not hesitate to contact T. C. Shielding Technical Department.

Comparative Properties
Extruded Materials

General Description								
EcE Material Reference (Type)			***1A/1***	***1B/1***	***1B/2***	***1D/1***	***1I/1***	***1I/3***	***1I/4***
Elastomer Type (Sil - Silicone, F/Sil - Fluorosilicone)			Sil	Sil	Sil	Sil	Sil	Sil	Sil
Filler Material (Silver on Aluminium,Nickel,Copper,Glass & Nickel Graphite)			Ag/Ni	Ag/Cu	Ag/Cu	Ag/Al	Ag/Glass	Ag/Glass	Ag/Glass
Colour			Tan	Tan	Tan	Tan	Tan	Tan	Tan
Electrical Properties	**Tol**	**Test Method**							
Volume Resistivity (ohm.cm) (as supplied)	Max		0.047	0.005	0.008	0.008	0.050	0.005	0.050 - 0.100
Shielding Effectiveness (dB) 200 KHz (H-Field)		MIL-G-83528	70	70	70	70	50	55	55
100 MHz (E-Field)		MIL 285	105	115	115	110	65	95	95
500 MHz (E-Field)			105	115	115	105	70	95	90
2 GHz (Plane Wave)			100	115	115	100	70	95	90
10 GHz (Plane Wave)			100	115	115	100	65	95	90
Physical Properties									
Specific Gravity (g/cmΔ)	±5%	ASTM D-792	4.32	3.32	3.02	2.11	1.85	1.80	1.75
Hardness (Shore A)	± 5	ASTM D-2240	65	75	61	70	65	65	60
Tensile Strength (MPa)	Min	ASTM D-412	1.25	1.25	1.00	0.90	0.55	0.35	0.90
Elongation (%)	Min	ASTM D-412	100	100	100	100	60	75	80
Compression Set (%)	Max	ASTM D-395	30	30	30	30	30	30	30
Upper Operating Temperature (°C)	-		160	125	125	160	160	160	160
Lower Operating Temperature (°C)	-	ASTM D-1329	-50	-50	-50	-50	-50	-50	-50

General Description								
EcE Material Reference (Type)			***1J/2***	***1J/3***	***1D/2***	***2A***	***2B***	***2D***	***2J***
			New Materials						
Elastomer Type (Sil - Silicone, F/Sil - Fluorosilicone)			Sil	Sil	Sil	F/Sil	F/Sil	F/Sil	F/Sil
Filler Material (Silver on Aluminium,Nickel,Copper,Glass & Nickel Graphite)			Ni/Gr	Ni/Gr	Ag/Al	Ag/Ni	Ag/Cu	Ag/Al	Ni/Gr
Colour			Grey	Grey	Tan	Tan	Tan	Lt Grn	Dk Grn
Electrical Properties	**Tol**	**Test Method**							
Volume Resistivity (ohm.cm) (as supplied)	Max		0.050	0.100 - 0.500	0.008	0.005	0.005	0.010	0.050
Shielding Effectiveness (dB) 200 KHz (H-Field)		MIL-G-83528	70	70	70	75	75	70	70
100 MHz (E-Field)		MIL 285	95	95	100	110	110	110	100
500 MHz (E-Field)			90	90	100	110	120	105	100
2 GHz (Plane Wave)			90	90	100	105	120	100	100
10 GHz (Plane Wave)			90	90	100	100	120	100	100
Physical Properties									
Specific Gravity (g/cmΔ)	±5%	ASTM D-792	2.45	1.99	2.00	4.60	5.00	2.70	3.25
Hardness (Shore A)	± 5	ASTM D-2240	80	60	65	80	75	70	80
Tensile Strength (MPa)	Min	ASTM D-412	2.00	1.00	0.90	1.25	1.25	0.55	0.75
Elongation (%)	Min	ASTM D-412	150	100	175	100	100	100	100
Compression Set (%)	Max	ASTM D-395	30	30	30	30	30	30	30
Upper Operating Temperature (°C)	-		160	160	160	160	125	160	160
Lower Operating Temperature (°C)	-	ASTM D-1329	-50	-50	-50	-50	-55	-55	-55

NOTE: Elongation is not electrically related. Materials should not be stretched over 3.0% to ensure electrical properties are not negated.

For Carbon loaded (1F) and non-flammable Nickel/Graphite (1J/8) silicones, please see page 36.

Extruded 'O' Ring Gaskets Installation Guidelines

'O' Rings are extremely reliable and cost effective seals provided care is taken in the installation. Many similarities exist between conductive and non conductive 'O' Rings and how they are utilised eg. lead in chamfers, removal of sharp edges on hardware etc.

However, in certain aspects conductive 'O' Rings require special attention. Below are the most important factors:-

Stretching During assembly or when finally located, the stretch should not exceed 5% of the original inside diameter. Above this value filler dispersal can be re-oriented resulting in degradation of electrical properties.

Compression As with stretching above, compression should not exceed 25% for solid sections. For hollow sections (i.e.. tube) 100% compression of void is acceptable.

Joints To produce 'O' Rings from hollow forms it is necessary to join extrudate, T C Shielding uses special materials and methods in which the joining material is inherently conductive - not simply an adhesive. The joint itself is fully vulcanised and exhibits comparable characteristic to the extrudate.

Galvanic Corrosion The choice of ring material relative to the mating parts is important, particularly in hostile environments e.g.. marine. Please refer to T C Shielding compatibility charts for information (pages 8, 9, 10 and 11).

Cleanliness Conductive materials are susceptible to both chemical and particulate contamination during handling. This can have an effect on electrical properties. It is recommended that clean cotton gloves are used during assembly.

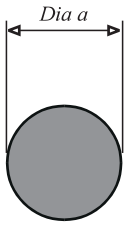
Storage As with all elastomeric products storage is important. With conductive materials certain aspects (e.g.. light) can be particularly detrimental to electrical properties. Please refer to T C Shielding data sheets for further information.

This document serves as a brief reference guide only. If there is any aspect of installation for which you require further information, please consult T C Shielding Technical Department.

Standard Extruded Profiles

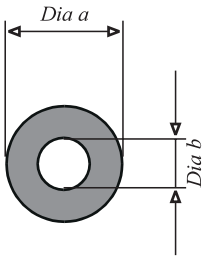
A comprehensive range of cross sections and materials are available in extruded form. The profiles shown below are preferred standard sizes that are readily available. T. C. Shielding also manufacture many customer specials for applications that are not satisfied by standard profiles. Typical cross sectional tolerance: ± 0.15mm. All dimensions shown in mm.

'O' Section
Ordering Ref:
EA-XX-XXX



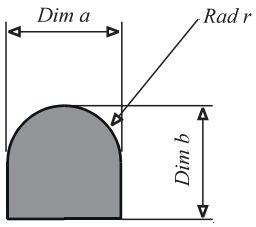
TC Ref.	*Dia. a*	TC Ref.	*Dia. a*
010	1.02	**019**	3.18
011	1.35	**020**	3.30
012	1.57	**021**	3.53
013	1.78	**022**	3.81
014	2.03	**023**	4.06
015	2.36	**024**	4.78
016	2.62	**025**	5.49
017	2.84	**026**	6.35
018	3.02		

Hollow 'O' Section
Ordering Ref:
EB-XX-XXX



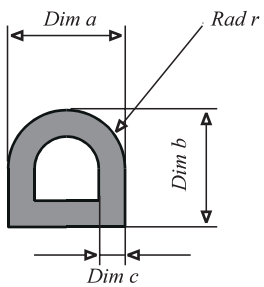
TC Ref.	*Dia. a*	*Dia. b*
027	2.40	0.80
028	3.18	1.14
029	3.96	1.27
030	6.35	3.18
031	7.92	4.88
032	9.53	6.35

'D' Section
Ordering Ref:
EC-XX-XXX



TC Ref.	*Dim. a*	*Dim. b*	*Rad. R*
033	1.40	1.63	0.70
034	1.57	1.73	0.79
035	2.39	1.98	1.19
036	1.98	2.26	0.99
037	1.57	2.54	0.79
038	3.81	2.79	1.91
039	3.00	3.96	1.50
040	4.52	4.45	2.26
041	3.96	3.96	1.98

Hollow 'D' Section
Ordering Ref:
ED-XX-XXX

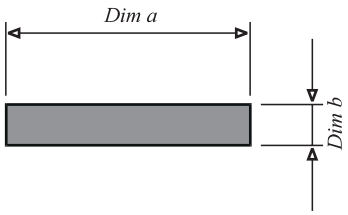


TC Ref.	*Dim. a*	*Dim. b*	*Dim. c*	*Rad R*
042	3.96	3.96	1.14	1.98
043	4.75	4.72	1.27	2.36
044	7.92	7.92	1.27	3.96
045	7.92	7.92	1.57	3.96
046	12.37	8.23	2.03	6.20
047	6.35	6.35	1.65	3.18

Standard Extruded Profiles

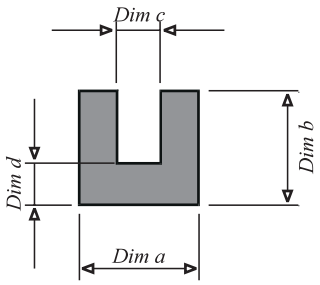
Ordering Ref: EA-XX-XXX		
Example		
EA	1D/1	010
Extruded	Silver	1.02 Dia.
'O' Sect.	Aluminium/Silicone	'O' Sect.

Flat Strip Section
Ordering Ref:
EE-XX-XXX



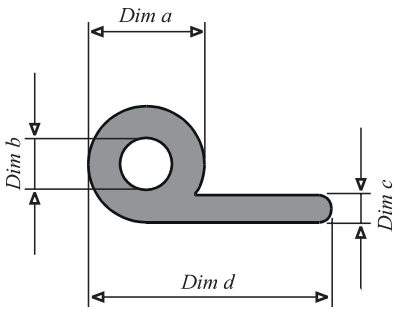
TC Ref.	*Dim a*	*Dim.b*	TC Ref.	*Dim. a*	*Dim b*
048	1.60	1.07	**067**	12.70	1.91
049	2.41	1.57	**068**	12.70	3.18
050	3.05	1.91	**069**	12.70	4.78
051	3.18	1.57	**070**	19.05	1.57
052	3.96	1.57	**071**	22.35	1.57
053	6.35	1.57	**072**	25.40	6.35

Channel Section
Ordering Ref:
EF-XX-XXX



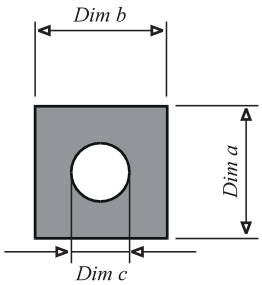
TC Ref.	*Dim. a*	*Dim b.*	*Dim. c*	*Dim d*
054	2.54	2.54	0.86	0.84
055	3.20	2.79	0.66	1.27
056	3.20	5.72	0.51	1.91
057	3.96	3.94	1.57	1.19
058	4.45	3.96	1.19	1.91
059	8.31	5.94	1.57	2.92

Hollow 'P' Section
Ordering Ref:
EG-XX-XXX



TC Ref.	*Dim. a*	*Dim b.*	*Dim. c*	*Dim d*
060	5.08	2.03	1.57	12.70
061	5.08	2.03	1.57	21.59
062	6.35	3.18	1.57	12.70
063	6.35	3.18	1.57	15.88
064	6.35	3.18	1.57	22.22
065	7.92	4.75	1.57	22.22
066	9.14	6.48	1.79	19.81

Hollow Rectangular Section
Ordering Ref:
EH-XX-XXX



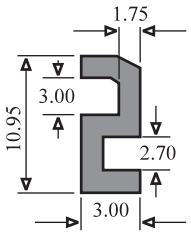
TC Ref.	*Dim. a*	*Dim. b*	*Dia. c*
073	7.75	8.38	3.18
074	9.53	9.53	4.78

NOTE: Sharp corners will have radii 0.15 - 0.30mm

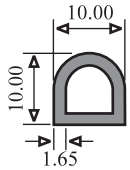
Special Extruded Profiles

Non standard profiles that have all been developed to suit specific customer applications for **conductive** elastomer seals.

ES-XX-101



ES-XX-118



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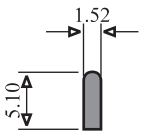

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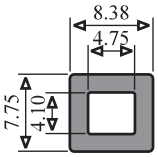

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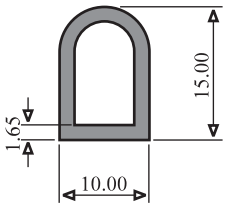

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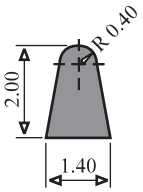
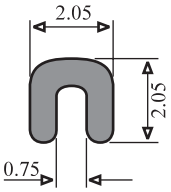
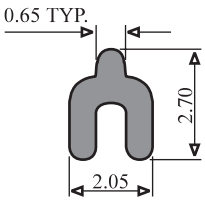


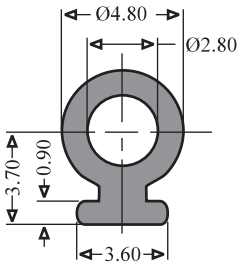
ES-XX-177



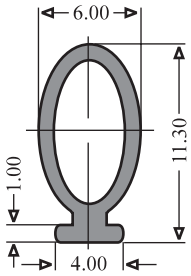
ES-XX-190



ES-XX-218



ES-XX-229



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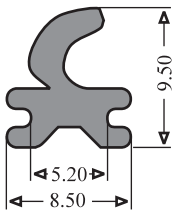

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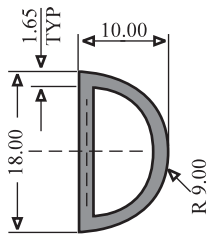

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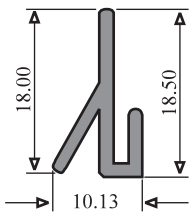

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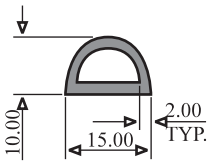

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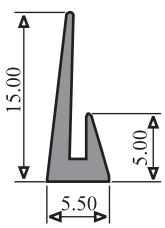

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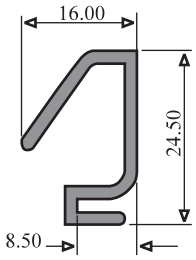
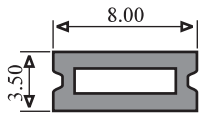


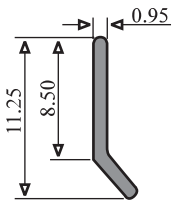
Special Extruded Profiles

Non standard profiles that have all been developed to suit specific customer applications for **conductive** elastomer seals.

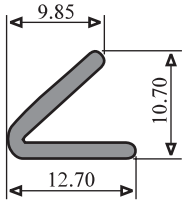
ES-XX-285



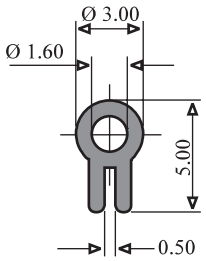
ES-XX-318



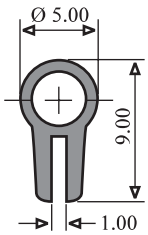
ES-XX-353



ES-XX-380



ES-XX-390



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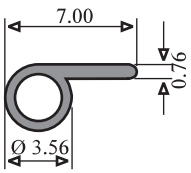

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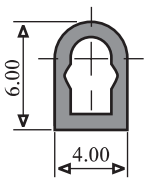
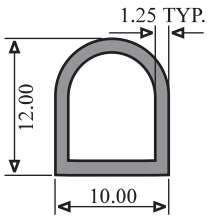
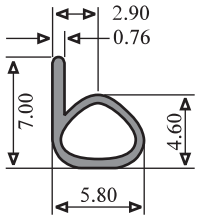


ES-XX-446



ES-XX-480



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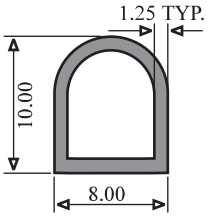

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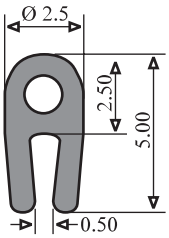

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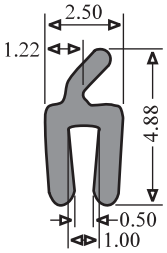

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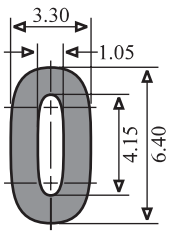

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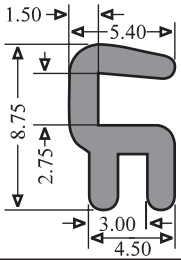

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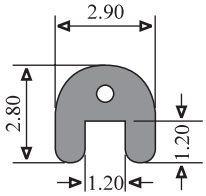
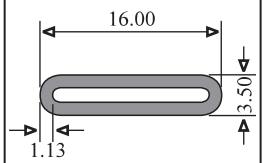
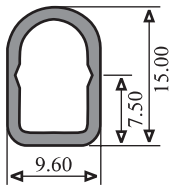
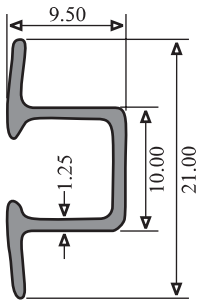
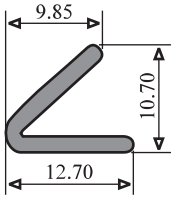
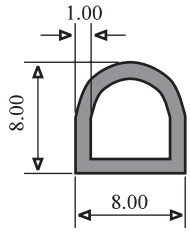


ES-XX-597



Special Extruded Profiles

Non standard profiles that have all been developed to suit specific customer applications for **carbon loaded** elastomer seals.

ES-XX-298	ES-XX-332	ES-XX-353	ES-XX-428
			
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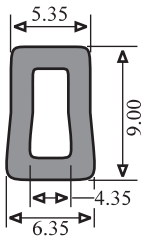	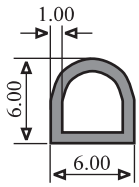	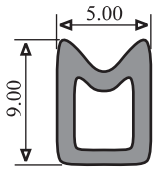	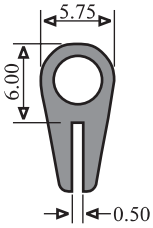
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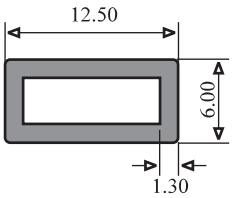
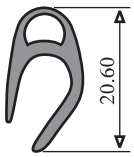
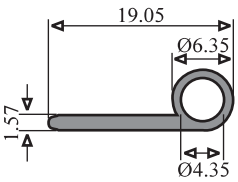
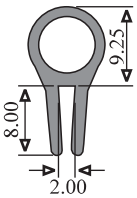
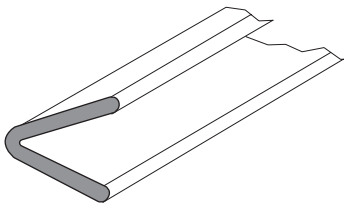
			

T C Shielding Ltd has designed and developed a range of special lower cost profiles for EMC related enclosures.

Based on carbon loaded silicone, a range of clip-on, rivet mounted and P.S.A. backed extrusions can be supplied as extruded lengths or mitre jointed to suit cabinets,

Shielding is a minumum of 30-65dB from 200KHz-10GHz and environmental sealing performance of IP65 and beyond.

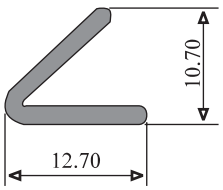
Product Fact Sheet - Lip Form



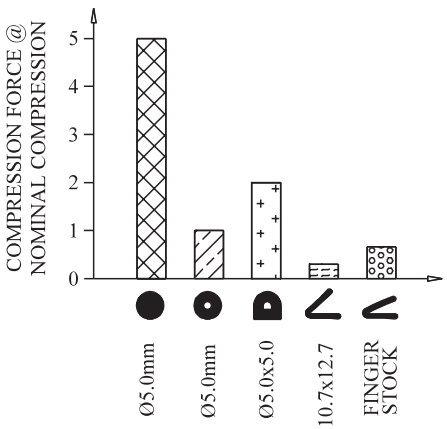
Most elastomeric gaskets require a finite compression range to effect a seal. With solid and hollow sections problems can arise with the constraints of low clamping load and wide dimensional variance of hardware.

T C Shielding can now offer a special profile specifically developed for applications of this nature.

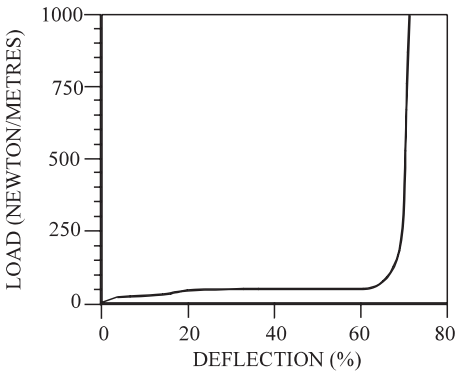
STANDARD SECTION



COMPARATIVE LOAD CHARACTERISTICS



COMPRESSION DEFLECTION TEST ON LIP SECTION



- Compression deflection range of 4 to 8mm.
- Clamping load less than 50N per metre linear length.
- Good repeated assembly characteristics.
- Can be used with lightweight flanges with minimal clamping load.
- Available in a comprehensive range of materials.
- Can be attached with PSA, rivets or clips.
- Not only EMC shielding to 60dB typical but also environmental sealing to IP55 and beyond.

The lip is produced by continuous extrusion and can be supplied in strip, roll or fabricated to form an enclosure gasket with fully vulcanised joints.

PLEASE CONTACT OUR SERVICE DEPARTMENT. Tel. 01989 563941 FOR DETAILS

Product Fact Sheet - "Duo Extrusion"

Freedom from galvanic corrosion of joints at a sealing interface using conductive elastomeric gaskets is a fundamental consideration in certain environments. In some cases it is possible to select a suitable combination of materials to mitigate the effects, but sometimes it is necessary to include an additional environmental seal.

The duplicity of seals can perform extremely well but has a fundamental problem of packaging. Two gaskets require a large amount of volume, particularly if one uses two 'O' ring grooves.

T C Shielding has specifically developed "duo-extrusion" to offer a compact, space efficient gasket. The duo-extrusion comprises two materials with a vulcanised seamed joint. One component is conductive, providing an effective EMC gasket, the other component is an environmental seal in non-conductive silicone or fluorosilicone. The environmental component effectively protects the EMC gasket from external contaminants, including moisture, thus preventing galvanic corrosion.

Materials used can be silver aluminium, silver copper or nickel graphite silicones for the conductive seal, and silicone or fluorosilicone for the non-conductive sealing element.

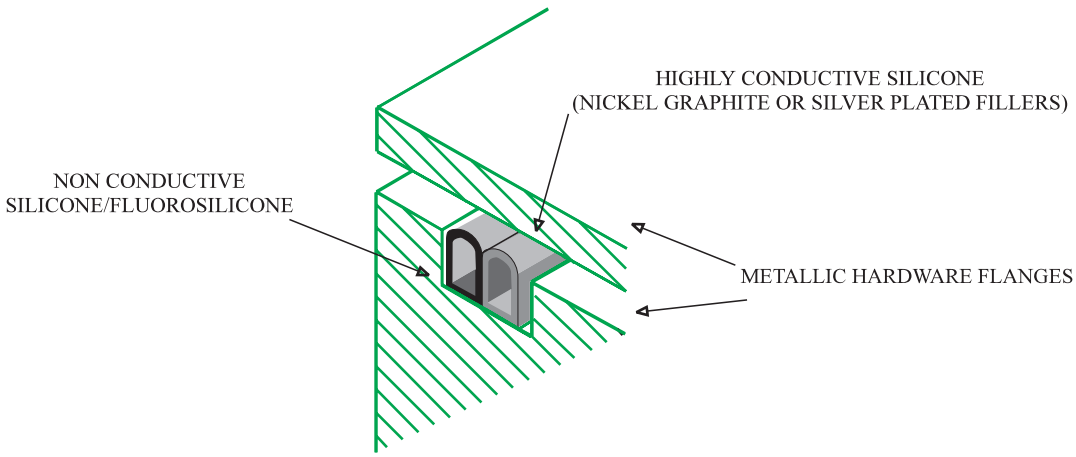
Summary of features:

- Compact use of a single rectangular groove.
- Low clamping load.
- Custom design capability to suit hardware.
- Self retaining capability.
- Available in a comprehensive range of materials.
- Environmental sealing up to 5 bar is possible.

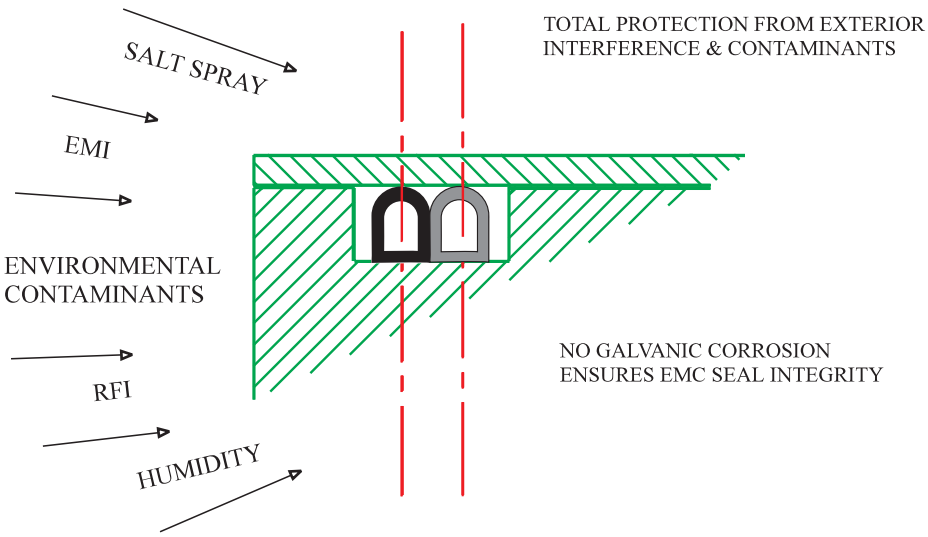
The product is produced by continuous process and can be supplied in strip, roll or conductive vulcanised to form a jointed ring.

The Solution

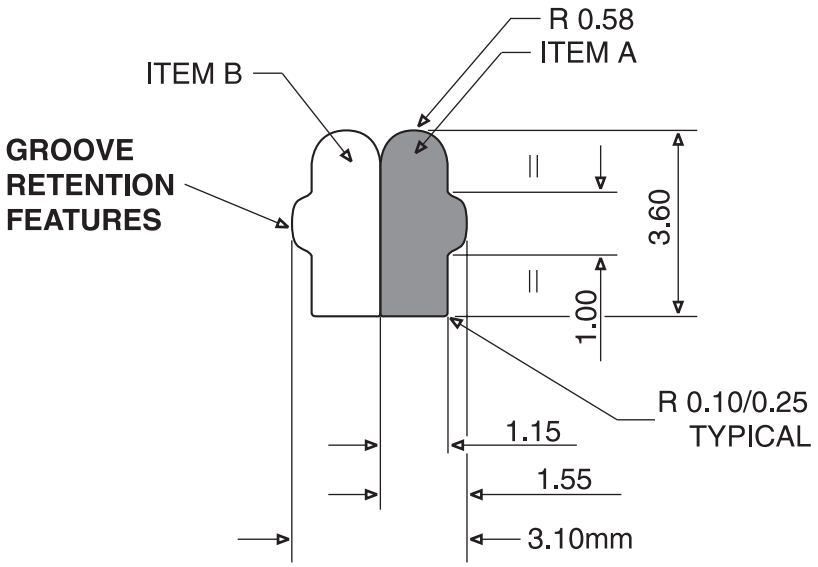
Developed to address the dual requirements of environmental sealing and high levels of AEMC shielding.
Eliminates the potential for galvanic corrosion associated with highly conductive materials when used with dissimilar metallic hardware.



'DUO SEAL' FROM T C SHIELDING - THE ULTIMATE PROTECTION



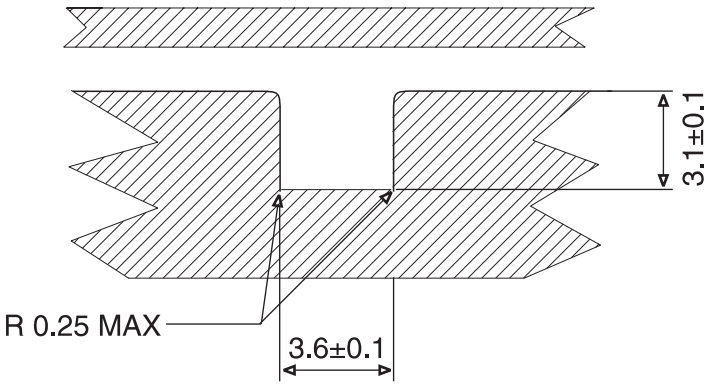
Typical Duo Seal & Groove Detail



ITEM A : CONDUCTIVE R/F SEAL
ITEM B : NON-CONDUCTIVE SEAL

NOTES:
MAXIMUM SECTIONAL AREA = 5.13mm PER SECTION
ITEMS A AND B ARE CO-VULCANISED
DUO SEAL PART No. ES-XX-176

RECOMMENDED GROOVE DETAIL FOR DUO SEAL REF ES-XX-176

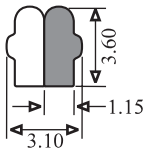
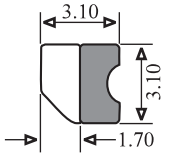
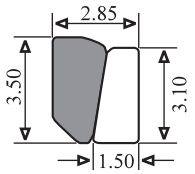
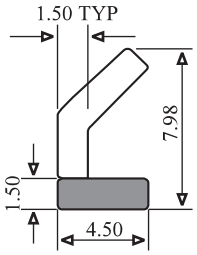
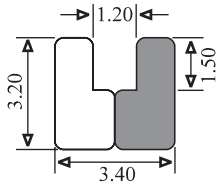
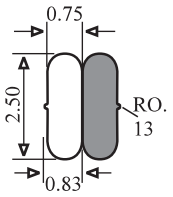
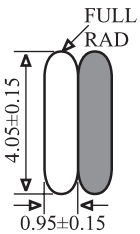
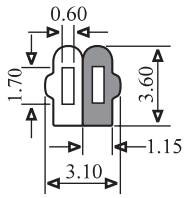
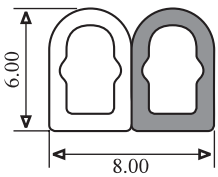


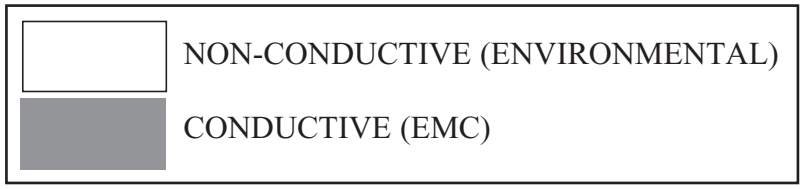
NOTES ON DUO SEAL REF: ES-XX-176

- MAX COMPRESSION: 20%
- MIN COMPRESSION: 7.2%
- GROOVE TOLERANCE: ±0.10mm
- DUO SEAL TOLERANCE: ±0.15mm
- MAX SEAL SECTIONAL AREA: 10.26mm^2
- SEAL MAX/MIN HEIGHT: 3.75mm/3.45mm
- GROOVE MAX/MIN HEIGHT: 3.2mm/3.0mm
- MIN GROOVE SECTIONAL AREA: 10.50mm^2

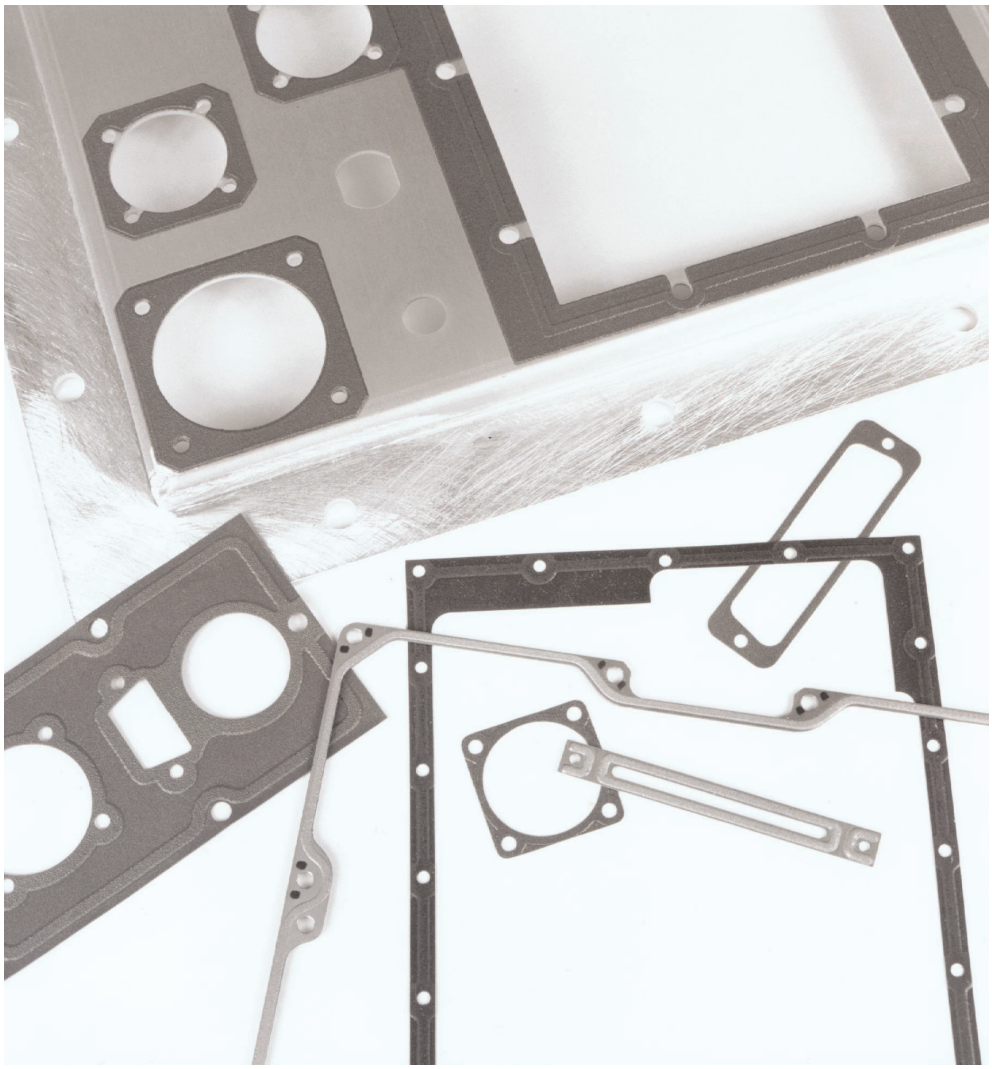
Special Duo Extruded Profiles

Non standard profiles that have been developed to suit specific customer applications for high spec RFI / IP applications. Made from co extruded conductive and non conductive elastomer profiles.

ES-XX-176 	ES-XX-204 	ES-XX-233 
ES-XX-281 	ES-XX-662 	ES-XX-667 
ES-XX-743 	ES-XX-753 	ES-XX-970 



Printed Gasket Component Technology



The technique of printing conductive elastomers is a novel and very cost effective method of producing gaskets when compared to conventional means. The printed process produces a highly selective deposit resulting in negligible wastage. Below are its major advantages:

- Cost effective versus conventional gaskets, e.g., die cut from moulded or calendered sheet.
- Printed raised beads improve stress contact in lightly loaded flanges on hardware.
- The gasket can be printed onto a conductive carrier (e.g., metal or plastic) to ease assembly.
- Component hardware (e.g., panels, covers, providing the surface the gasket is to be located on is flat), can have the gasket printed direct onto the relevant surface, greatly improving assembly.
- Secondary environmental sealing can be incorporated into the gasket.

Printed Gaskets - Design Guidelines

Standard connector gaskets produced by printing are readily available and are covered in detail on the standard products information sheets. The flexibility of the printing process makes this method ideal for custom made special designs.

• *Gasket Variants*

Pure Print - this particular type of gasket is a very cost effective method of producing relatively small, simple gaskets. The gasket is merely printed to the correct form and design without any punching. Material wastage is minimal. Typical thickness - 0.5mm.

Punched gasket - to cater for more complex forms and offer clean edge definition, punching is utilised. However, the method does not generate excessive wastage of material as one would expect with die cutting from sheet. A special printing screen is used to minimise waste. Typical thicknesses of 1.00/1,50mm are possible.

Substrate gasket - as certain designs of gasket increase in size and complexity it is often necessary to use a rigid carrier to improve handling and assembly. The printing process is ideal for this method. The substrate can be a variety of materials, e.g., metallic, plastic, glass, etc., provided they are flat (i.e., free from protrusions) and able to withstand the curing temperature of the printing polymer. The substrate will have to be intrinsically conductive or have a conductive coating.

The ability to print on substrates lends itself to printing directly on component hardware. This can give major benefits in terms of handling, ease of assembly, serviceability and cost when compared to conventional gasket methods. The physical constraints of the component are 600mm x 800mm x 25mm deep.

Traditional flat gaskets can suffer limitations due to uneven contact stress (and hence sealing/shielding) due to the large contact area of the gasket joint.

Printed gaskets offer a solution and are unique in that the gasket can be produced with a stress raising bead (typically 2 to 4mm wide). The bead can be configured to provide optimum contact stress with the minimum clamping load.

The printing process can also provide the following

1: Additional environmental sealing from a sealing bead in conventional elastomer, protecting the EMC bead from the effects of fluid degradation and corrosion.
2: Compression limiting by printing hard stop pads in relevant areas thus preventing over compression of the sealing bead.

• *Gasket configuration*

Printed gaskets can have a variety of forms, from simple pure prints to complex sub-assemblies. However, there are certain rules that apply to the profile and positioning of the bead and its base, namely:

a) Beads, due to the meniscus effect, have a distinct relationship between height and width. Therefore, to achieve optimum performance, the bead width should be between 1.5 and 5.0mm.
b) Adjacent beads should be separated by at least 1.0mm. When printing on to substrates (or hardware) a minimum clearance of 0.5mm should be applied to the edge of the component (including fixing holes and cut outs).
c) It is possible to print a second bead onto a primary print but always allow for a maximum print thickness in the region of 0.3 to 0.5mm.

• *Design*

T. C. Shielding Ltd. offer complete technical service in the layout and design of printed gaskets, from simple punched forms to complex multi-gasket sub-assemblies.
To gain optimum benefit from printed product design, it is recommended that T. C. Shielding Ltd. be consulted at the earliest stage of any design programme. This will ensure that all aspects of design, cost and function are realised.

• *Materials*

A comprehensive range of highly conductive materials are available for the printing process - please refer to the material fact sheet.

T C SHIELDING LTD
"The Problem Solvers"

Comparative Properties
Printed Materials

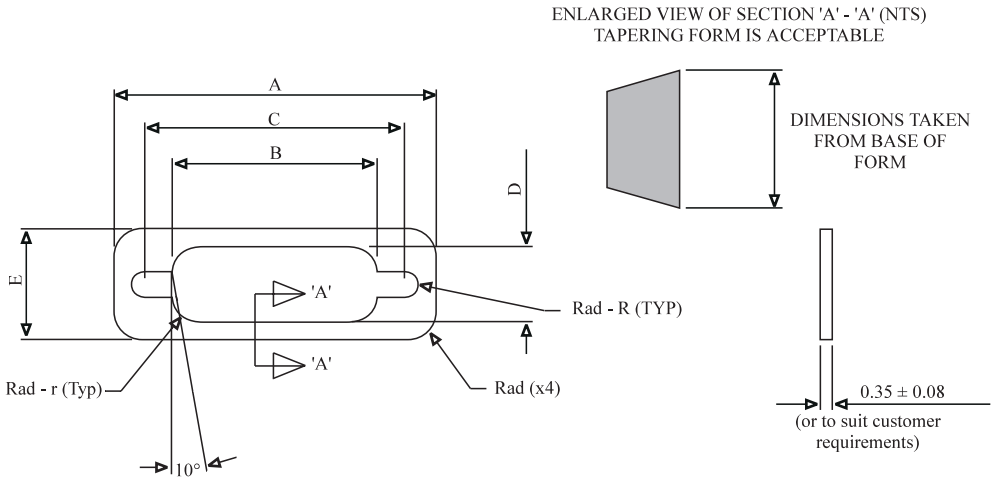
General Description								
EcE Material Reference (Type)			***3A***	***3B***	***3D***	***3G***	***3I***	***3J***	***3K***
Elastomer Type (Sil - Silicone)			Sil	Sil	Sil	Sil	Sil	Sil	Sil
Filler Material (Silver on Aluminium,Nickel,Copper,Glass & Nickel Graphite)			Ag/Ni	Ag/Cu	Ag/Al	Ag	Ag/Glass	Ni/Gr	Al comp
Colour			Tan	Tan	Tan	Tan	Tan	Grey	Black
Electrical Properties		**Test Method**							
Volume Resistivity (ohm.cm) (as supplied)			0.005	0.005	0.008	0.005	0.050	0.050	12.000
Shielding Effectiveness (dB)									
10 KHz		Transfer	106.80	112.00	111.50	92.99	83.15	106.80	58.16
to		Impedance	to	to	to	to	to	to	to
700 MHz		ARP-1105	121.00	128.30	122.60	100.70	91.48	121.80	65.31
(Min/Max)									
Shielding Effectiveness (dB)									
200 KHz (H-Field)			70	70	70	70	55	70	50
100 MHz (E-Field)			105	115	110	115	95	95	72
500 MHz (E-Field)		MIL-G-83528	105	115	105	115	95	90	70
2 GHz (Plane Wave)		MIL 285	100	115	100	115	95	90	65
10 GHz (Plane Wave)			100	115	100	115	95	90	65
Physical Properties									
Specific Gravity (g/cmΔ)	±5%	ASTM D-792	3.00	2.75	1.75	3.00	1.65	2.25	1.95
Hardness (Shore A)	± 5	ASTM D-2240	80	80	70	75	80	90	80
Tensile Strength (MPa)	Min	ASTM D-412	3.00	3.00	1.35	2.00	4.00	3.00	2.50
Elongation (%)	Min	ASTM D-412	35	35	30	30	20	10	10
Compression Set (%)	Max	ASTM D-395	30	30	30	30	30	30	30
Upper Operating Temperature (°C)	-		160	125	160	160	160	160	160
Lower Operating Temperature (°C)	-	ASTM D-1329	-50	-50	-50	-50	-50	-50	-50

General Description			***Self Bonding/Primerless Types***					
EcE Material Reference (Type)			***3A/1***	***3B/1***	***3D/1***	***3I/1***	***3J/2***	***3K/1***
Elastomer Type (Sil - Silicone)			Sil	Sil	Sil	Sil	Sil	Sil
Filler Material (Silver on Aluminium,Nickel,Copper,Glass & Nickel Graphite)			Ag/Ni	Ag/Cu	Ag/Al	Ag/Glass	Ni/Gr	Al comp
Colour			Tan	Tan	Tan	Tan	Grey	Black
Electrical Properties		**Test Method**						
Volume Resistivity (ohm.cm) (as supplied)			0.005	0.005	0.010	0.010	0.050	20.000
Shielding Effectiveness (dB)								
10 KHz		Transfer	90.82		98.15	86.99	86.99	
to		Impedance	to	*N/T*	to	to	to	*N/T*
700 MHz		ARP-1105	102.80		105.60	94.82	95.99	
(Min/Max)								
Shielding Effectiveness (dB)								
200 KHz (H-Field)			70	70	70	55	70	50
100 MHz (E-Field)			105	115	110	95	95	72
500 MHz (E-Field)		MIL-G-83528	105	115	105	95	90	70
2 GHz (Plane Wave)		MIL 285	100	115	100	95	90	65
10 GHz (Plane Wave)			100	115	100	95	90	65
Physical Properties								
Specific Gravity (g/cmΔ)	±5%	ASTM D-792	2.75	2.50	1.75	1.85	2.25	1.95
Hardness (Shore A)	± 5	ASTM D-2240	70	70	75	80	85	70
Tensile Strength (MPa)	Min	ASTM D-412	2.00	2.00	1.75	2.00	3.00	2.00
Elongation (%)	Min	ASTM D-412	40	35	20	25	20	50
Compression Set (%)	Max	ASTM D-395	30	30	30	30	30	30
Upper Operating Temperature (°C)	-		160	125	160	160	160	160
Lower Operating Temperature (°C)	-	ASTM D-1329	-50	-50	-50	-50	-50	-50

Pure Print Sub 'D' Connector Gaskets
(Flange Mounting)

T C SHIELDING LTD
"The Problem Solvers"

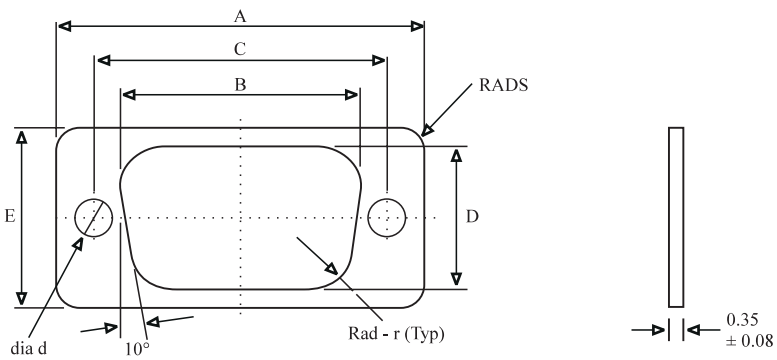
Ordering Ref: PA-XX-XXX		
Example		
PA	3D	021
Printed Gasket	Silver Aluminium/Silicone	Shell Size 1



SHELL SIZE	No. of Contacts	**TCS REF**	A ±0.38mm	B ±0.38mm	C ±0.20mm	D ±0.20mm	E ±0.38mm	Rad - r ±0.20mm	Rad - R ±0.20mm
1	9	**021**	32.70	17.50	25.00	9.50	14.00	2.00	1.60
2	15	**022**	41.00	25.60	33.30	9.50	14.00	2.00	1.60
3	25	**023**	54.75	39.60	47.05	9.50	14.00	2.00	1.60
4	37	**024**	71.20	55.90	63.50	9.50	14.00	2.00	1.60
5	50	**025**	68.80	53.00	61.10	12.00	16.50	2.00	1.60

Standard Miniature Sub 'D' Connector Gaskets
(Flange Mounting)

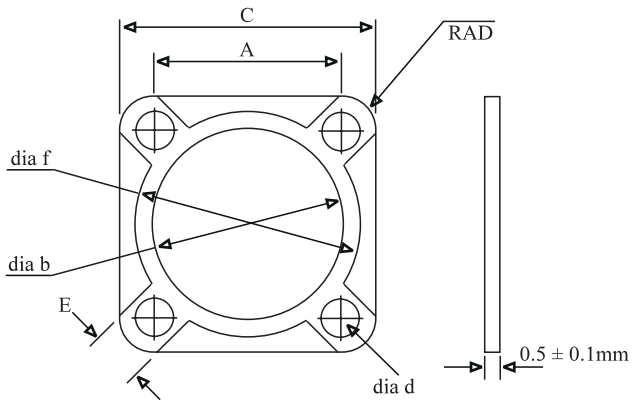
Ordering Ref: PB-XX-XXX		
Example		
PB	3A	001
Printed Gasket	Silver Aluminium/Silicone	Shell Size 1



SHELL SIZE	No. of Contacts	**TCS REF**	A ±0.38mm	B ±0.38mm	C ±0.08mm	D ±0.18mm	E ±0.38mm	Dia d +0.12mm	Rad r
1	9	**001**	30.81	20.45	25.00	11.34	14.91	3.12	3.56
2	15	**002**	39.14	28.57	33.30	11.34	14.91	3.12	3.56
3	25	**003**	53.03	42.29	47.05	11.34	14.91	3.12	3.56
4	37	**004**	69.32	58.80	63.48	11.34	14.91	3.12	3.56
5	50	**005**	66.93	56.64	61.14	14.23	17.83	3.12	3.56

Mil Spec Printed Back Shell Connector Gaskets

(with raised sealing bead)



Ordering Ref: PD-XX-XXX		
Example		
PD	3D	001
Printed	Silver	Shell Size
Gasket	Aluminium/Silicone	8

MIL-C-38999 Connector Gaskets *(Flange Mounting)*							
SHELL SIZE	**TC REF**	A mm ±0.20	Dia b mm ±0.20	C mm ±0.25	Dia d mm ±0.15	E mm ±0.20	Dia f mm ±0.20
8	**001**	15.09	16.25	21.34	3.43	7.00	20.75
9+10	**002**	18.26	19.30	24.51	3.43	7.00	23.80
11+12	**003**	20.62	22.48	26.92	3.58	7.50	26.98
13+14	**004**	23.01	25.78	29.29	3.43	7.00	30.28
15+16	**005**	24.61	29.05	31.95	3.96	7.50	33.55
17+18	**006**	26.97	32.25	34.32	3.96	7.50	36.75
19+20	**007**	29.36	35.18	38.10	3.58	7.50	39.68
21+22	**008**	31.75	38.35	41.28	3.58	7.50	42.85
23+24	**009**	34.93	41.53	44.45	4.37	8.00	46.03
25	**010**	38.10	44.70	47.63	4.37	8.00	49.20
MIL-C-5015/26482/81511 Connector Gaskets							
SHELL SIZE	**TC REF**	A mm ±0.20	Dia b mm ±0.20	C mm ±0.25	Dia d mm ±0.15	E mm ±0.20	Dia f mm ±0.20
MIL-C-5015/26482							
8	**011**	15.09	12.95	22.23	3.96	7.50	17.45
10	**012**	18.26	16.08	25.40	3.96	7.50	20.58
12	**013**	20.65	19.30	27.79	3.58	7.00	23.80
14	**014**	23.01	22.48	30.18	3.96	7.50	26.98
16	**015**	24.61	25.65	32.54	3.96	7.50	30.15
18	**016**	26.97	29.08	34.93	3.96	7.50	33.58
20	**017**	29.36	32.00	38.10	4.37	8.00	36.50
22	**018**	31.75	35.18	41.28	4.37	8.00	39.68
24	**019**	34.93	38.35	44.45	5.16	9.00	42.85
MIL-C-5015 ONLY							
28	**020**	39.67	44.70	50.80	5.16	9.00	49.20
32	**021**	44.45	51.05	57.15	5.56	9.50	55.55
36	**022**	49.23	57.40	63.50	5.56	9.50	61.90
40	**023**	55.58	63.75	69.85	5.56	9.50	68.25
44	**024**	60.33	70.89	76.20	5.56	9.50	75.39
48	**025**	66.68	77.24	82.55	5.56	9.50	81.74
MIL-C-81511							
8	**026**	15.09	14.68	20.62	3.18	7.00	19.18
10	**027**	18.26	17.52	23.80	3.18	7.00	22.02
14	**028**	23.01	24.08	28.58	3.18	7.00	28.58
16	**029**	24.61	27.25	31.75	3.18	7.00	31.75
18	**030**	26.97	30.45	34.11	3.18	7.00	34.95
20	**031**	29.36	33.57	37.26	3.18	7.00	38.07
22	**032**	31.75	36.75	39.67	3.18	7.00	41.25
24	**033**	34.93	39.95	43.26	3.86	7.00	44.45
NON-MIL-STANDARD CONNECTOR GASKETS							
17	**034**	26.97	29.00	34.93	3.58	7.50	33.50

Expanded Nickel Graphite Silicone (ref: 3J/1)

Expanded nickel graphite silicone is a unique, soft, compliant sealing material which becomes highly conductive in the "Z" axis only when compressed 25-50%. Shielding effectiveness when compressed is in the range 70 - 95dB across a frequency range 200 KHz-10GHz.

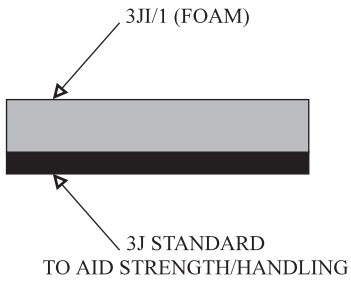
The material comprises a nickel graphite base skin, with a foam laminate upper surface. It can be produced as a discrete gasket or as sheet for die cutting at up to 2.0mm thick. Hardware can also be printed direct provided it has a flat surface and is a maximum of 25mm thick.

3J/1 material has an operating temperature of -50 to +160°C, and meets UL94HB flammability requirements.

Galvanic compatibility with aluminium is good and can be further enhanced if the aluminium hardware is nickel plated.

Major advantages

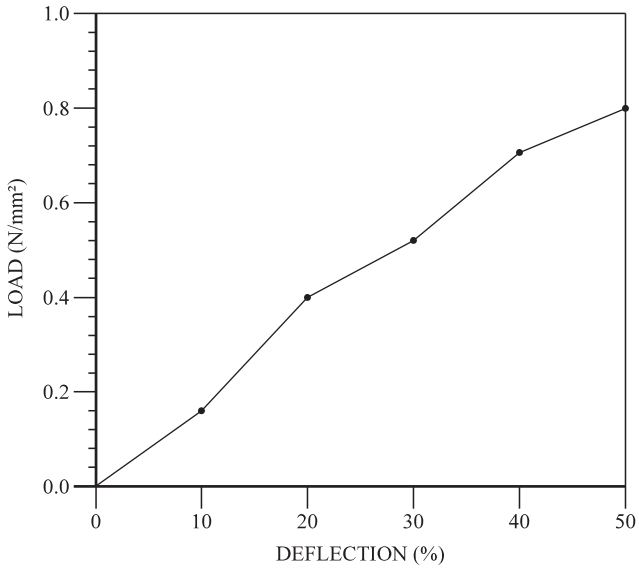
- Highly conductive when compressed a minimium of 25%
- Effective shielding and grounding to 95dB
- Causes minimal flange distortions
- Galvanically compatible with aluminium
- Meets UL94HB flammability requirements
- Thickness available up to 2.0mm
- Approved by Boeing, ABB, GEC Marconi and B.R.B.
- Material (sheet only) can be conductive PSA backed



Material 3J/1 Load Deflection

Sample thickness - 1.40mm
Sample area - 1cm≈

LOAD/DEFLECTION GRAPH



Typical values

Load (N/mm≈)	Deflection %
0.165	10
0.40	20
0.55	30
0.70	40
0.80	50

Physical Properties (Typical)

Specific gravity (g/cmΔ)	1.37
Tensile Strength (MPa)	0.25
Elongation (%)	10
Stress to achieve 25% compression (N/mm≈)	0.5 - 1.0

D.C. Resistance through 1.5mm specimen under min 25% compression is 0.1 ohms
D.C. Resistance after heat ageing 168 hrs @ 100°C is 0.15 ohms

Moulded Component Technology

The technique of moulding conductive elastomers has a wide range of benefits. This process allows T C Shielding to manufacture components that have a very accurate tolerance requirement. Below is a list of its major advantages:

- Odd and 3D shaped components are easily made.
- Accurate tolerances can be held.
- Small products are easy to manufacture.
- Product can be adhesive backed (dependent upon moulding type).
- Silicones and fluorosilicones plus wide range of conductive fillers.

Comparative Properties

Moulded Materials

General Description			※			※		
EcE Material Reference (Type)			***1A***	***1B***	***1D***	***1F***	***1G***	***1I***
Elastomer Type (Sil - Silicone, F/Sil - Fluorosilicone)			Sil	Sil	Sil	Sil	Sil	Sil
Filler Material (Silver on Aluminium,Nickel,Copper,Glass & Nickel Graphite)			Ag/Ni	Ag/Cu	Ag/Al	Carbon	Ag	Ag/Glass
Colour			Tan	Tan	Tan	Black	Tan	Tan
Electrical Properties	**Tol**	**Test Method**						
Volume Resistivity (ohm.cm) (as supplied)	Max		0.005	0.005	0.008	9.000	0.002	0.005
Shielding Effectiveness (dB) 200 KHz (H-Field)		MIL-G-83528	70	70	70	30	70	55
100 MHz (E-Field)		MIL 285	105	115	110	65	115	95
500 MHz (E-Field)			105	115	105	60	115	95
2 GHz (Plane Wave)			100	115	100	40	115	95
10 GHz (Plane Wave)			100	115	100	30	115	95
Physical Properties								
Specific Gravity (g/cmΔ)	±5%	ASTM D-792	3.71	3.32	2.19	1.19	3.20	2.00
Hardness (Shore A)	± 5	ASTM D-2240	70	75	70	70	75	75
Tensile Strength (MPa)	Min	ASTM D-412	1.25	1.25	1.25	5.00	1.25	1.25
Elongation (%)	Min	ASTM D-412	100	100	100	150	100	100
Compression Set (%)	Max	ASTM D-395	30	30	30	20	30	30
Upper Operating Temperature (°C)	-		160	125	160	160	160	160
Lower Operating Temperature (°C)	-	ASTM D-1329	-50	-50	-50	-50	-50	-50

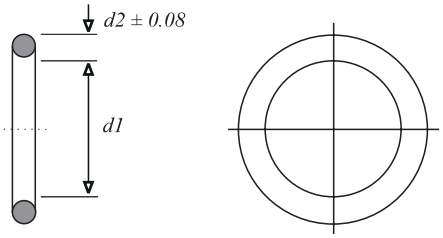
General Description				※				
EcE Material Reference (Type)			***1J***	***1J/8***	***2A***	***2B***	***2D***	***2J***
				Non Flam				
Elastomer Type (Sil - Silicone, F/Sil - Fluorosilicone)			Sil	Sil	F/Sil	F/Sil	F/Sil	F/Sil
Filler Material (Silver on Aluminium,Nickel,Copper,Glass & Nickel Graphite)			Ni/Gr	Ni/Gr	Ag/Ni	Ag/Cu	Ag/Al	Ni/Gr
Colour			Grey	Grey	Tan	Tan	Green	Green
Electrical Properties	**Tol**	**Test Method**						
Volume Resistivity (ohm.cm) (as supplied)	Max		0.050	0.050-0.100	0.005	0.005	0.010	0.050
Shielding Effectiveness (dB) 200 KHz (H-Field)		MIL-G-83528	70	70	75	75	70	70
100 MHz (E-Field)		MIL 285	95	95	110	110	110	100
500 MHz (E-Field)			90	90	110	120	105	100
2 GHz (Plane Wave)			90	90	105	120	100	100
10 GHz (Plane Wave)			90	90	100	120	100	100
Physical Properties								
Specific Gravity (g/cmΔ)	±5%	ASTM D-792	2.45	2.30	4.60	5.00	2.70	3.25
Hardness (Shore A)	± 5	ASTM D-2240	80	75	80	75	70	80
Tensile Strength (MPa)	Min	ASTM D-412	2.00	1.40	1.25	1.25	0.55	0.75
Elongation (%)	Min	ASTM D-412	150	125	100	100	100	100
Compression Set (%)	Max	ASTM D-395	30	30	30	30	30	30
Upper Operating Temperature (°C)	-		160	160	160	125	160	160
Lower Operating Temperature (°C)	-	ASTM D-1329	-50	-50	-50	-55	-55	-55

Please Note: 1J/8 meets IEC V1 rating technical construction file ref. U.L. testing held at TC Shielding Limited.

※ *Can also be extruded*

Standard Connector Products

Rear Mounting Jam Nut Receptacle 'O' Rings



Ordering Ref: MA-XX-XXX		
Example		
MA	1D	001
Moulded Ring	Silver Aluminium/Silicone	Shell Size 6

SHELL SIZE	MIL C 38999 MIL C 26482	MIL C 81511	*d1*	*Tolerance on d1 ±*	*d2*
	TC REF	**TC REF**	mm	mm	mm
6	**001**	-	14.00	0.13	1.78
8	**002**	-	17.16	0.13	1.78
8	-	**003**	18.77	0.13	1.78
9	**004**	-	20.35	0.15	1.78
10	-	**005**	21.95	0.15	1.78
11+12	**006**	-	25.12	0.15	1.78
13+14	**007**	**007**	28.30	0.15	1.78
15+16	**008**	**008**	31.47	0.15	1.78
17+18	**009**	**009**	34.65	0.15	1.78
19+20	**010**	-	37.77	0.15	2.62
21+22	**011**	-	40.95	0.25	2.62
23+24	**012**	-	44.12	0.25	2.62

Cost Effective Alternative To Conductive Moulded O-Rings

T.C.Shielding have developed a range of extruded/jointed O-Rings that offer a cost effective alternative to traditionally moulded items with added benefits, and compatible tolerancing. The following are benefits of this new process.

- Low tooling cost
- Reduced production scrap rate
- Advantage of hollow forms which help to reduce compression force
- Zero flash on profile
- Compatible tolerancing
- Shorter lead times
- Minimum ID of 18.00mm

The points detailed above allow us to manufacture an improved product at a lower cost with minimal tooling. The materials offered are conductive/non-conductive silicone or fluorosilicone with a variety of conductive particle fillers to suit specific requirements.

Below is a comparison between moulded and jointed tolerances:

Moulded O-ring

ID=25.12+/-0.15
Section=1.78+/-0.08
Developed Length=84.04/84.98

Ext./Jointed O-ring

ID=25.12+/-0.16
Cross Section=1.78+/-0.10
Developed Length=84.00/85.00

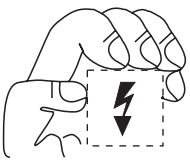
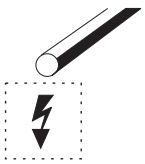
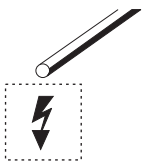
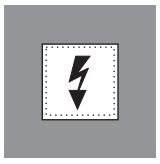
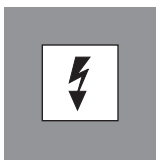
"IP Rating"

protection against ingress of dust, liquids & impacts

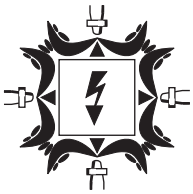
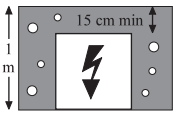
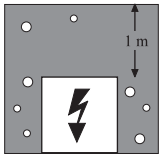
■ the degree of protection conferred by the enclosures of electrical equipment (up to 1000 V ~ and 1500 V == are defined by the French standard NF C 20-010 and DIN 40050.

■ to symbolise degrees of protection the letters IP followed by three numbers are used. These numbers are characterised as follows.

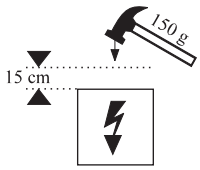
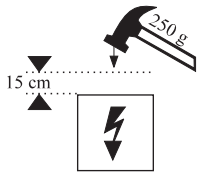
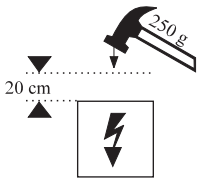
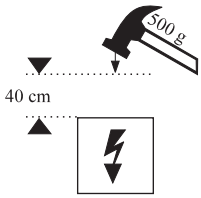
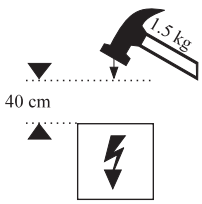
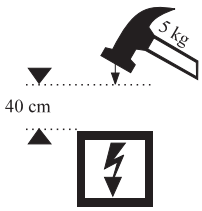
first number
protection against solid objects

IP		tests
0		no protection
1		protected against solid objects greater than 50 mm, e.g. accidental touch by hands
2		protected against solid objects greater than 12 mm, e.g. fingers
3		protected against solid objects greater than 2.5 mm (tools and wires)
4		protected against solid objects greater than 1 mm (tools, wires, small wires)
5		protected against dust, limited ingress permitted (no harmful deposit)
6		totally protected against dust

second number
protection against liquids

IP		tests
0		no protection
1		protected against vertically falling drops of water (e.g. condensation)
2		protected against direct sprays of water up to 15° from the vertical
3		protected against sprays to 60° from the vertical
4		protected against water sprayed from all directions - limited ingress permitted
5		protected against low pressure jets from all directions - limited ingress permitted
6		protected against strong jets of water - limited ingress permitted
7		protected against the effects of immersion between 15 cm and 1 m
8		m protected against long periods of immersion under pressure

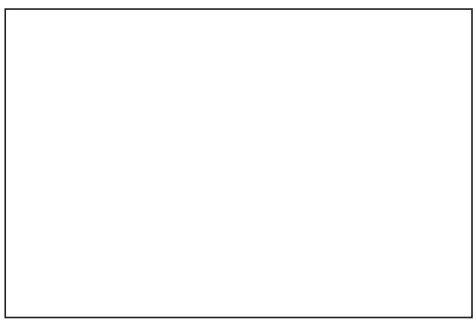
third number
protection against mechanical impacts

IP		tests
0		no protection
1		impact 0.225 joule
2		impact 0.375 joule
3		impact 0.500 joule
5		impact 2.00 joules
7		impact 6.00 joules
9		impact 20.00 joules

Engineer's Notes

Engineer's Notes

Agents & Distributors



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