Electrically Conductive Elastomer

Conductive Elastomer EMI Gaskets are to point to in the silicone base material, surface treatment technology is used to change the pure silver, silver plated copper, silver, nickel, aluminum, silver plated nickel plating graphite conductive particles filled in the silica gel, the formation of homogeneous mixture, then through chemical crosslinking to form excellent shielding performance and environmental sealing function of the product.

FRD can produced extruded strip , co-extruded conductive silicone (conductive and non-conductive), compression molding products, transfer mounding, co-molding, sheet cutting, form in place(FIP) gaskets and other series conductive products, and we are more proficient in according to customer requirements, designs and manufactures custom products you need.

In addition to choices of size and shape dictated by the enclosing structure and the joint geometry itself, the following factors greatly influence the suitability of ECE gasket materials:

1. Shielding Effectiveness

Design Consideration should include intensity and frequency of interference source, the intensity and frequency of the interference present, the predominance of electrical (E) or magnetic (H) fields, and system power and signal attenuation requirements will automatically exclude certain types of EMI shielding materials.

2. Closure Force

Solid electrically conductive elastomer materials stand up better to high closure forces, environment pressure and repeated opening and closing of the joint. Elastomers accommodate pressure by change shapes rather than volume to get environmental sealing. Therefore, a potential space for shape changes at heat or pressure situation should be taken into account. Closure forces accommodate sealing requirements. For example, 6 pounds/inch force is enough for electromagnetic shielding. To meet water proof as well as electromagnetic shielding, the closure force should be 8 pound/inch or more. If low closure force is a consideration, however, the use of hollow extruded profiles such as hollow "O" and hollow "D" in conjunction with softer durometer elastomers will dramatically reduce closure force requirements.

3. Percent Gland Fill

Design of an elastomeric O-ring gland, or groove and contacting surfaces which make up the seal assembly, is as important as percent gland fill. For most static seal applications, it is necessary to calculate the area of the seal and the gland it will occupy, to determine whether the latter is large enough to receive the ring. Overfill and underfill may cause sealing failure.

As a general rule we recommend a gland fill of 70% –85% for optimum shielding effectiveness. However, for critical applications that require both shielding and environmental sealing, a 95%-98% gland fill is suggested.

4. Compression

Compression data provide the engineer or designer with a qualitative comparison of the deformability of different profiles of electrically conductive elastomer. Deflection is defined as the change in the cross-sectional height of a gasket under compressive load and is a function of material hardness and profile.

Profiles	Compression %
Rectangle	5~10
Solid O	20~25
Solid D	15~20
Hollow O	20~50
Hollow D	25~50
Hollow P	25~50
Overfill	15~25

Note： That wall thickness of hollow profiles has a major effect on deflection.

The recommended deflection ranges of various electrically conductive elastomer profiles are shown in Table 1. In no case however, should the amount of actual deflection be less than 10% for Electro Seal materials. Remember that the minimum unevenness of the mating flanges must be taken into consideration in determining the original (uncompressed) and installed (compressed) height of the seal.

5. Galvanic Compatibility

- Two different conductive materials are directly contacted or through conductor;
- Conductive environment is existed. Such as electrolyte, salty spray, water vapor, etc.
- Huge electric potential difference between the two materials.

All the 3 conditions are compiled; galvanic corrosion will happen and influence environmental sealing. Otherwise, penetrability of polymer will limit the electrolyte to get inside of electrically conductive elastomer to avoid galvanic corrosion.

6. Other

- Always try to avoid stretch the elastomer more than 5% when assemble. Because in an over stretch condition, conductive particles will disconnect inside the electrically conductive elastomer and lead to conductivity and shielding effectiveness failure;
- Do not choose O shape when shearing force exists, use D, O or P shape instead;
- The less compression set, the better performance. Generally compression set should be less than 30%.

Application Environments

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

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

Gaskets Install Guide

- Electrically conductive elastomer need to be compressed to get good conductivity, therefore the structure should be designed to provide proper pressure but not over pressed.
- Generally grooves are needed to install conductive elastomer. And the dimensions of groove should be right to keep compression within defined limits.
- The D shape and rectangle profiles have both with and without adhesive type to be according with adhesive or groove mount types.

FRD Products' Dimension

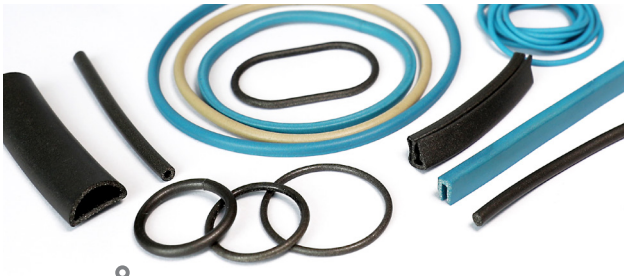
Extruded Products		Compression Molded Products	
Conductive Filler	Ni/C, Ag/Glass, Ag/Al	Conductive Filler	Ni/C, Ag/Glass, Ag/Al, Ag/Cu
Max Diameter (mm)	Conductive: 0.7~12 Non Conductive: 0.5~20	Max Thickness (mm)	Conductive: 0.3~20 Non Conductive: 0.1~25
Min Thickness(mm)	Conductive: 0.2 Non Conductive: 0.1	Max Dimension(mm)	500*500

Extruded Product Characteristics

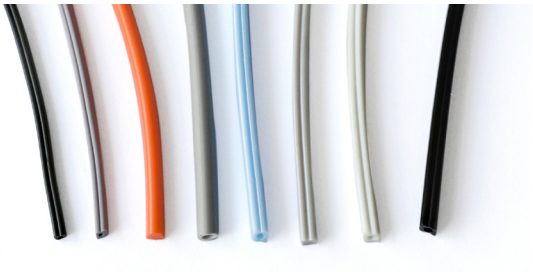
Extrusion Series

Item	Test Method	AS5G-70-V0	AS3T-50-V0	AS1B-65-HB	AS2T-60-HB	AS8D-40-V1
Filler		Ni/C	Ag/Cu	Ag/Al	Ag/Glass	Carbon Black
Color	Visual	Grey	Tan	Blue	Tan	Dark
Electrical Property						
Volume Resistivity (ohm-cm)	ENG-WI-550RevA2	0.1	0.002	0.004	0.005	5.0
Shielding Effectiveness (dB)	MIL-DTL-83528E	＞70	＞80	＞70	＞70	＞30
Electrical Stability						
Heat Aging Test (100°C ,168H) (ohm-cm)	ENG-WI-550RevA2	0.2	0.005	0.006	0.006	12
Mechanical Property						
Hardness (shore A)	ASTM D2240	70±5	50±5	65±5	60±5	45±5
Density (g/cm^3)	ASTM D792	1.9±0.1	3.5±0.1	2.0±0.1	1.9±0.1	1.2±0.1
Tensile Strengt (MPa)	ASTM D412	1.6	1.7	1.3	1.3	5.0
Elongation (%)	ASTM D412	110	220	350	450	400
Tear Strength (KN/m)	ASTM D624	8.0	11.0	8.5	4.8	18
Compression Set (100°C ,24H)%	ASTM D395	⩽20	⩽20	⩽20	⩽35	⩽25
Environment						
Operating Temperature (°C)		-40~160	-40~160	-40~160	-40~160	-40~160
Environment	RoHS 2.0	OK	OK	OK	OK	OK
Flame Rating	UL 94	V0	V0	V0	V0	V1

- Low resistivity and excellent EMI shielding
- Low compression set and good sealing
- High distortion efficiency, continuous production.
- Temperature extremes - heat, cold.
- Conform RoHS 2.0 & Halogen-free.
- Apply to communication, medical, military and etc.



Extruded Product (EMI Strip/Ring)



Silicon Rubber Extruded Product (Sealing Strip)

Co-extruded Strip/Ring Characteristics

Co-extruded Series

Item	Test Method	428C (Conductive)	AS5G (Conductive)	428AB (Non-conductive)	629AB (Non-conductive)
Color	Visual	Silver White	Grey	Orange	Purle
Filler	/	Al/Al	Ni/C	/	/
Density（g/cm^3）	ASTM D792	2.5±0.1	2.0±0.1	1.1±0.1	1.4±0.1
Tensile Strength（MPa）	ASTM D412	2.2	2.4	4.0	4.5
Elongation（%）	ASTM D412	200	300	340	200
Tear Strength（KN/m）	ASTM D642	6.5	14.5	14	25
Compression Set (100°C ,24H) %	ASTM D395	＜30	＜30	＜15	＜25
Operating Temperature (°C)	/	-40～160	-40～160	-40～160	-35～160

- Low resistivity and excellent EMI shielding
- Low compression set and good sealing
- Impermeability –exposure to gases.
- Apply to communication, medical, military and etc.
- Temperature extremes - heat, cold.
- Conform RoHS 2.0 & Halogen-free.

Co-extruded Strip/Ring Aging Test

SS-428C-428AB-02 Compression Set and Resistivity after Heat Aging Test

Item		Condition	1	2	3	4	5	AVE
Compression Set（%）		100°C ,168H； 30% Compressed	4.64	5.64	6.14	5.64	5.63	5.54
Surface Resistivity（Ω/inch）	Before		0.19	0.16	0.15	0.16	0.12	0.16
	After		0.44	0.46	0.28	0.32	0.24	0.35

SS-428C-428AB-01 IPX7 Test

Item	Test Data			Requirement	Result
IPX7 Waterproof Test	No Leaking Phenomenon			No Leaking	Pass
Gas-tightness	0.137kPa			⩽ 0.45 kPa	Pass
Surface Resistivity（Ω-inch）	0.68	0.82	0.89	AVE ⩽ 8，MAX ⩽ 20	Pass
Compression Set（%）	15.24	14.29	15.24	＜ 20%	Pass

SS-428C-428AB-01 UL60950 Aging Test

Item		428C Test Data	428AB Test Data	Requirement	Test Standard
Tensile Strength (Comparison Value)%	70°C ,168H	88.1	88.8	Not Less Than 75%	UL 60950-22
Elongation (Comparison Value)%		86.3	88.2	Not Less Than 60%	
Compression Set (Comparison Value)%	Room Temperature	95.2	98.7	Not Less Than 50%	
	High Temperature (70°C ,120H)	93.7	97.8		
	Low Temperature (-30°C ,24H)	91.7	97.0		

Note: Comparison Value =（After the aging /Before the aging）*100%。

SS-428C-428AB-01 UV Aging Test

Material	Grey Scale Rating
428C	4~5
428AB	4~5

SS-428C-428AB-01 Mould proof Test

Fungi-growth Grade	Fungi-growth Level	Test Standard
0 Grade	Magnified 50 times, no fungi-grade	GB/T 2423.16-2008

SS-428C-428AB-01 Ozone Resistance Test

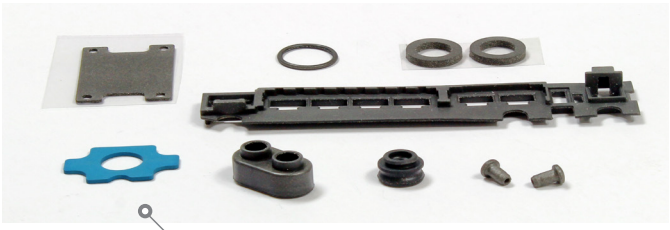
Material	Performance	Test Standard
428C	No Crack	ASTM D1149-07
428AB	No Crack	ASTM D1149-07

Molding Product Characteristics

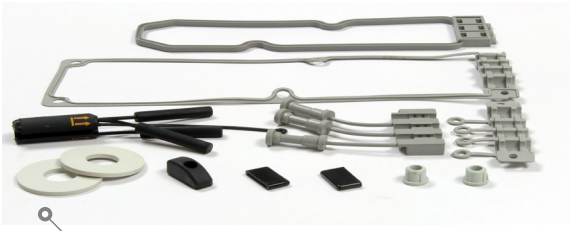
Molded Series

Item	Test Method	MS5G-55-HB	MS5G-60-V0	MS5G-70-V0	MS1B-65-HB	MS3T-50-V0	MS8D-60-V0
Filler		Ni/C	Ni/C	Ni/C	Ag/Al	Ag/Cu	Carbon Black
Color		Grey	Grey	Dark	Blue	Tan	Dark
Electrical Property							
Volume Resistivity （ohm-cm）	ENG-WI-550RevA2	0.1	0.08	0.1	0.004	0.002	5.5
Shielding Effectiveness （dB）	MIL-DTL-83528E	＞70	＞70	＞70	＞70	＞80	＞30
Electrical Stability							
Heat Aging Test (100°C ,168H) (ohm-cm)	ENG-WI-550RevA2	0.2	0.2	0.2	0.006	0.004	6.0
Mechanical Property							
Hardness （shore A）	ASTM D2240	55±5	60±5	70±5	65±5	50±5	60±5
Density （g/cm^3）	ASTM D792	1.9±0.1	1.9±0.1	2.0±0.1	1.95±0.1	3.5±0.1	1.2±0.1
Tensile Strength （MPa）	ASTM D412	1.2	1.8	1.8	1.3	1.7	5.0
Elongation （%）	ASTM D412	200	120	120	350	220	300
Tear Strength （KN/m）	ASTM D624	8.0	9.5	9.5	8.5	11.0	14.0
Compression Set （100°C ,24H) %	ASTM D395	⩽20	⩽20	⩽20	⩽20	⩽20	⩽25
Environment Standard							
Operating Temperature(°C)		-40~160	-40~160	-40~160	-40~160	-40~160	-40~150
Environment		OK	OK	OK	OK	OK	OK
Flame Rating		HB	V0	V0	HB	V0	V0

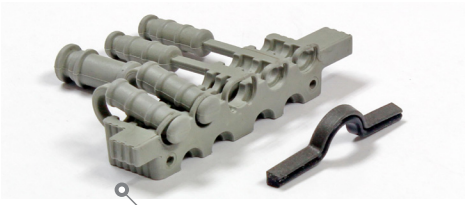
- Low resistivity and good EMI shielding.
- Molded at high temperature and high pressure.
- Molded shapes such as O-rings or intricate parts.
- Temperature extremes - heat, cold.
- Conform RoHS 2.0 & Halogen-free.
- Apply to communication, medical, military and etc.



Compression Molded Parts （Shielding Gaskets）



Silicone Rubber Molded Product
（Sealing Block、Dustproof Plug）



Co-molding Product
（Sealing Block、Sealing Gasket）

Using the process of compressed molding. Electrically conductive elastomer and non-conductive elastomer co-molding, then producing product with shielding and sealing. Or non-conductive elastomer and metal co-molding, then producing product with sealing and rugged construction.

Form-In-Place (FIP) Series

Item	Test Standard	FS5G-70-V0	FS5G-50-V0	FS4T-60-V0	FS3T-50-V0
Material Forms		2 part	2 part	1 part	1 part
Mixing Ratio (Mass Ratio)		A : B=1:1	A : B=1:1	/	/
Crosslinking Mechanisms		Addition Type	Addition Type	Addition Type	Condensation Type (Moisture)
Crosslinking Temperature		LTV	LTV	LTV	RTV
Conductive Filler		Ni/C	Ni/C	Ag/Ni	Ag/Cu
Mechanical Property					
Density (g/cm^3)	ASTM D792	2.0±0.2	2.0±0.2	3.8±0.2	2.4±0.2
Hardness(shore A)	ASTM D2240	70±5	50±5	60±5	50±5
Compression Set (%)	QA-WI-1048	25	25	25	30
Tensile Strength(MPa)	ASTM D412	1.5	1.2	1.2	1.2
Elongatio(%)	ASTM D412	100	150	150	150
Tear Strength (KN/m)	ASTM D624	8	8	8	8
Adhesion Strength (N/cm^2)	QA-WI-1049	150	150	150	120
Applicable Temperature		-50°C ~125°C	-50°C ~125°C	-50°C ~125°C	-50°C ~125°C
Electrical Properties and Stability					
Surface Resistance (Ω/inch)	QA-WI-1052	⩽ 0.3	⩽ 0.3	⩽ 0.3	⩽ 0.3
Volume Resistivity (Ω-cm)	MIL-DTL-83528E	0.05	0.05	0.004	0.004
100°C , 168H (Ω-cm)	MIL-DTL-83528E	0.06	0.08	0.008	0.02
85°C , 85%RH, 168H (Ω-cm)	MIL-DTL-83528E	0.08	0.10	0.006	0.03
Salt Spray,168H Ω-cm)	MIL-DTL-83528E	0.06	0.06	0.008	0.06
Curing Conditions		Low temperature vulcanized, usually 150°C *40min; The cure time decreases by warming up, better no more than 180°C .		100°C， 40~60min	Surface dry at room temperature for 30 min; 24 h crosslinking degree is 98%; Improving the rate of warming and humidifying will improve crosslinking.
Storage Condition		-25°C ~ 5°C			
Shelf Life					
Sealed (unmixed)		6 Month	6 Month	6 Month	3 Month
Unsealed (mixed)		7 Day	7 Day	7 Day	3 Day

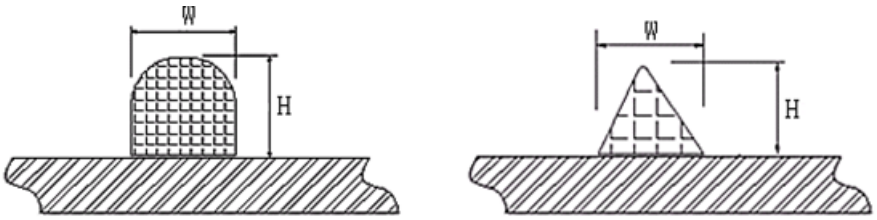
Note: Unsealed product expiring shelf life can still be used normally when test qualified. The environment has a great influence upon crosslinking cycle of this kind rubber, the appropriate storage and shelf life can be based on the actual experiment.

FIP Conductive Gaskets

FRD FSXX series material is a kind of liquid conductive silicone rubber, suitable for programmed CNC automatic dispensing equipment, can be cross-linked to elastomer material at room temperature or slightly heated by contact with moisture or blending with another component.

Form in place (FIP) is to disperse liquid conductive silicone rubber precisely onto the base material using programmed CNC dispensing equipment, and unite the chassis as an organic whole through the cross-linking process. Repeatable programming design ensures the consistency of product size and mass production.

FIP liquid conductive silicone molding is suitable for mobile phones, PC, telecommunication infrastructure, cars etc. which have partition requirement for metal, electroplated shell or electronic components.
The forming section is D shape or triangle, as shown in the figure below.

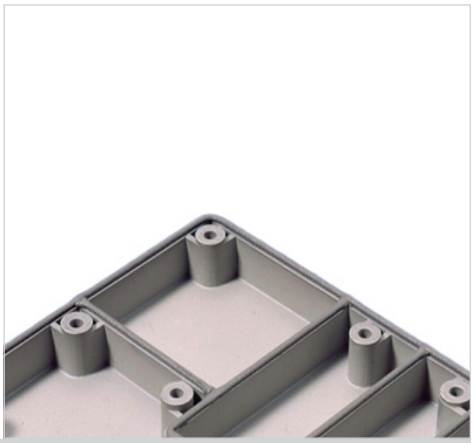


The differences between D section triangle sections are as follows:

Section Shape	Characteristics
D Section	① H/W <1 ② If the height of FIP gasket is the same, larger force at the same compression compared with triangle section. ③ If the height of FIP gasket is the same, more material is required compared with triangle section.
Triangle Section	① H/W ⩾ 1 (usually) ② If the height of FIP gasket is the same, smaller force at the same compression compared with D section. ③ If the height of FIP gasket is the same, less material is required compared with D section.

FIP Gaskets Characteristics

- It crosslinks without high temperature. At room temperature and moisture contact or with slightly heating it can be cross-linked to elastomer, saving energy and equipment investment.
- High SE, 100 dB of plane wave shielding effectiveness at 10 GHz.
- Automated batch production available. The material preparation, product molding and crosslinking can all be automated and operated continuously.
- Proofing cycle is short. Do not need mold, able to form only after defining the route.
- The material integrated with the matrix in place, do not need extra assembling.
- FRD FSXX series materials suit the surface of all kinds of base materials, have good adhesion performance.
- The equipment covers small area, saves space.



Typical Product

SMT EMI Gaskets

SMT EMI Gaskets are mounted on the PCB by surface mount technology (SMT), they can solve EMI, electrical grounding and electrical connection problem, and they also offer buffering.

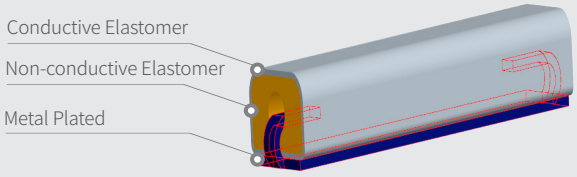
Characteristics:

- Low electrical resistance, used for shielding, grounding, and electrical connection;
- Excellent elasticity, used for buffering;
- Due to reflow soldering, it has good electrical connection to PCB;
- Carrier tape packaging, massive automatic installing, and high production efficiency.

Structure:

The SMT EMI Gaskets consist of three parts, see figure;

- The blue is metal base used for reflow-soldering;
- The gray is conductive elastomer;
- The middle part golden is unconducive elastomer.



O Ring

Electrically Conductive Elastomer product—O ring meet US MIL-DTL-83528. In aviation, aerospace, and other military are widely used in electronic equipment. Can achieve environmental sealing and electromagnetic sealing at the same time.

Especially applicable for following:

- Military electronic chassis and microwave waveguide system;
- Electronic products (such as computer cases, mobile phone), telecom, high frequency control equipment, etc;
- Aerospace, aviation, ships, military application and military electronic equipment;
- The electric power, railway and other harsh electronic equipment.