

## **PERFORMANCE MATERIALS**

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TE Connectivity's (TE) Performance Materials business offers products enabling and protecting high performance electronics. With a broad portfolio of heat shrink tubing and EMI shielding materials, we help customers achieve mechanical and electrical performance in a wide array of markets including mission critical applications.

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# PERFORMANCE MATERIALS

Providing EMI/RFI & environmental sealing solutions to address growing compliance and performance challenges in today's high growth megatrends.

## Transportation Solutions



### Automotive and Transportation

- Adv. Driver Assi. System (ADAS)
- EV Power Management



### Connectivity and Control

- 5G Infrastructure
- Enterprise Server
- Hyperscale Data



### IoT Cloud

- 5G Infrastructure
- Enterprise Server
- Hyperscale Data

## Industrial and Commercial Solutions



### Medical

- Medical Devices
- Medical Imaging



### Aerospace

- Communication Systems
- Aircraft Line Replaceable Unit



### Industrial

- Industrial Controls
- Power Electronics
- Machinery

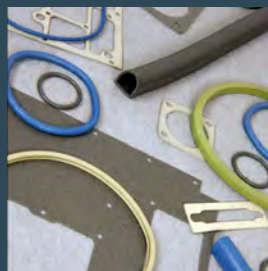


### Renewable Energy

- Wind
- Solar



Heat Shrink Tubing



EMI/RFI Shielding



Environmental Sealing

HIGH PERFORMANCE ENGINEERED MATERIALS

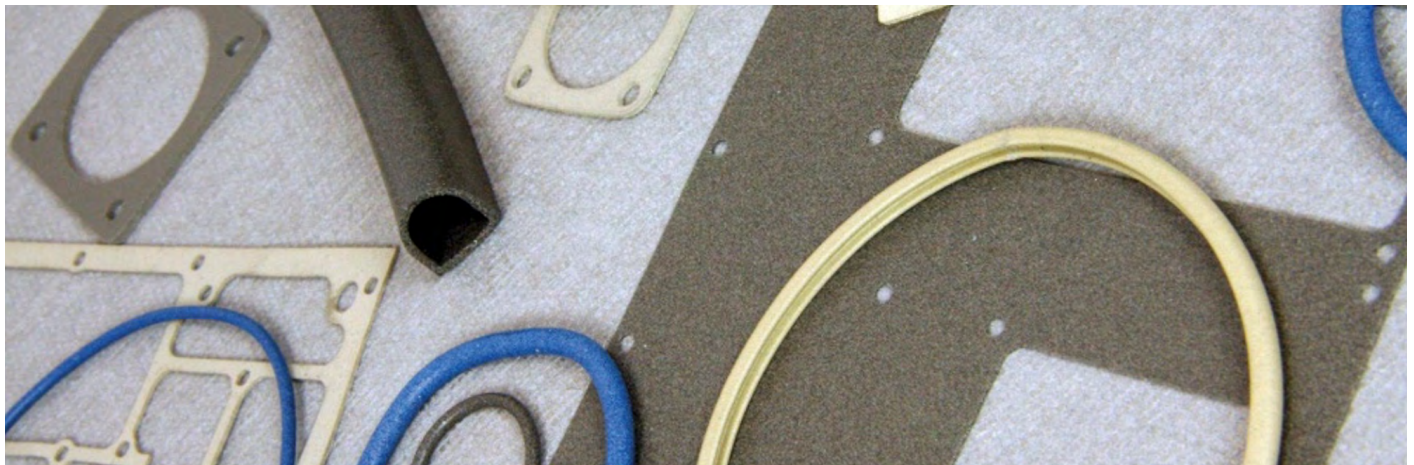
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# GENERAL OVERVIEW



## Heat Shrink Tubing

Manufacturers face countless design requirements to meet the most rugged of performance demands, as well as new challenges brought on by ever-changing market trends and evolving market needs. TE Connectivity's (TE) heat shrink tubing solutions are designed to help manufacturers meet a wide range of needs and conditions. Through deep engineering capabilities and a commitment to testing, specific design requirements and certifications are achieved with reliability and dependability. With three major manufacturing sites to cover key regions globally, TE offers strong global sales services for heat shrink tubing solutions, including great channel partner support.



## RFI/EMI Shielding Materials

RFI/EMI shielding gaskets and components provide exceptional EMC shielding solutions to address regulatory compliance and performance needs. Our shielding solutions include electrically conductive gaskets, EMI shielding ventilation panels, shielded windows, cable shielding and shielding components.



## HEAT SHRINK TUBING

Heat shrink tubing provides electrical insulation, mechanical protection, environmental sealing, and strain relief. Available in single wall tubing and dual wall tubing, our Raychem heat shrink tubing is engineered for use in numerous applications, including back-end connector sealing, breakouts, and connector-to-cable transitions. It is a solid alternative to taping, molding, or potting. When heated, our Raychem heat sleeves conform to the size and shape of the substrate beneath, enabling quick and easy installation. Its high expansion ratio makes it possible to repair most damaged cable jackets without removing connectors. Available in a wide range of materials, colors, and sizes, heat shrink tubing is delivered in forms such as spools, 1.2m lengths, and cut pieces. Clear types permit inspection of covered components and offer excellent transmittance of light.

### TE's Raychem Heat Shrink Tubing - Product Portfolio



#### Single Wall Tubing

- Bundling protection
- Abrasion resistant
- Strain relief
- Quick installation
- Variety of colors available for coding
- Low shrink temperature
- MIL-SPEC
- Meets ULVW1-flammability
- Meets UL/CSA-electrical insulation
- Cost effective
- UL rating-minimize catastrophic failure of a system
- Rapid production time
- Flexible



#### Dual Wall Tubing

- Waterproof-submersion
- Cable repair-bonding and sealing
- Splice sealing strain relief
- Direct burial waterproofing
- Underground water protection
- Electrical insulation
- MIL-SPEC
- UL rating-minimize catastrophic failure of a system
- Protects from harsh environments
- Meets UL VW-1 flammability rating
- Superior abrasion and chemical resistant
- Color differentiation
- Flexible and shiny tubing options



#### Specialty Tubing

- Bundling protection
- Abrasion resistant
- Strain relief
- Quick installation
- Variety of colors available for coding
- Low shrink temperature
- MIL-SPEC
- Meets ULVW1-flammability
- Meets UL/CSA-electrical insulation
- Cost effective
- UL rating-minimize catastrophic failure of a system
- Rapid production time
- Flexible

## Heat Shrink Tubing - 6 Key Functionalities

### PROTECTION WHERE YOU NEED IT



### Why choose TE's Heat Shrink Tubing?

#### Versatility and Durability

Designed to keep out moisture, harsh chemicals, and protect from mechanical interface.

#### Easy and Quick Installation

When heated, heat shrink tubing conforms to the size and shape of the substrate beneath, enabling quick and easy installation. It provides shorter application time, improves yield, and provides higher operating temperature.

#### Safety

Thick-tubing to secure extra protection, many color options for easy identification, and various levels of flame retardancy to meet UL VW-1 flammability standards.

#### Reliable, Robust Cross-linking Technology

Cross-linking technology modifies the molecular structure of a polymer, allowing the tubing to withstand high temperatures without melting - a critical factor in harsh environments.



Sealing



Vibration



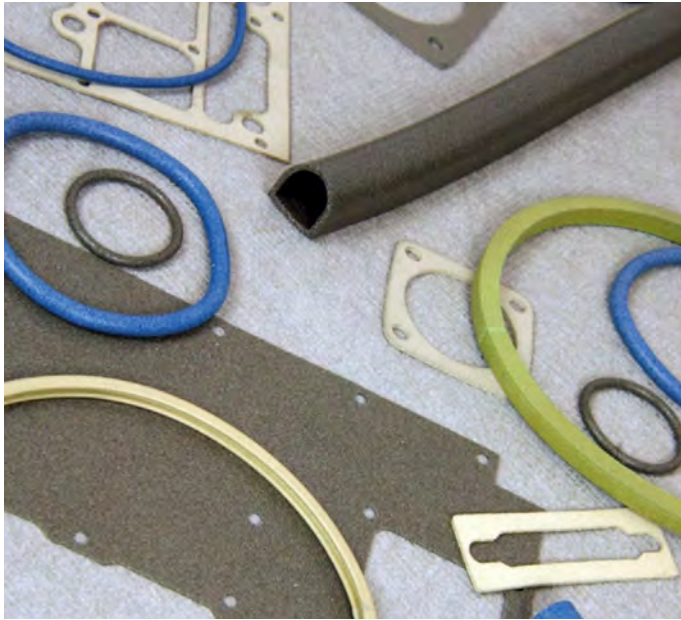
Temperature



## Uses of Heat Shrinkable Tubing



- Mechanical protection and strain relief for wire and cable connectors
- Shielded splice protection and sealing
- Electric insulation and high voltage identification
- Waterproof and environmental sealing
- Bundle and fixture for wire and cable protection and ease of assembly
- Battery terminal identification and sealing
- Mechanical protection for hoses
- Noise reduction for pipes
- Moisture, fungus and weather resistant for outdoor applications
- Color code wiring and circuits
- Insulation and strain relief for fine gauge wire and fiber optic cables
- Mechanical protection for lighting components



## RFI/EMI SHIELDING MATERIALS

RFI/EMI shielding gaskets and components provide exceptional EMC shielding solutions to address regulatory compliance and performance needs. Our shielding solutions include electrically conductive gaskets, EMI shielding ventilation panels, shielded window, cable shielding and shielding components.

### Why is EMI shielding important

#### Electromagnetic Interference - EMI

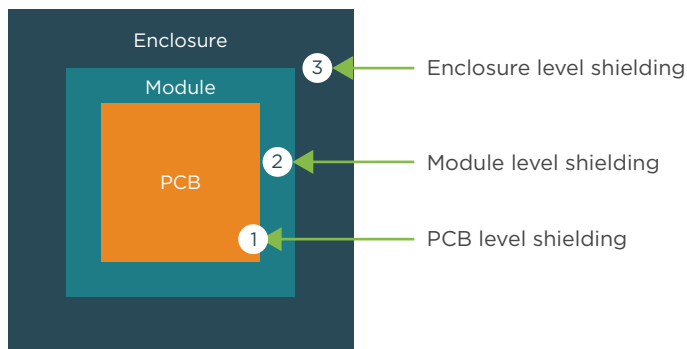
All active electronic devices have the potential to emit electromagnetic radiation. EMI shielding products protect critical electronic components and systems from EM interference.

- EMC compliance required by law/performance specifications
- EMC non-compliance causes system level redesign late in product development process

### Where is EMI shielding used

EMI shielding gaskets are applied at the seams of an enclosure to establish a low resistance conductive path to block radiated emissions into and out of the enclosure.

- Conductive gaskets/windows/vents at enclosure assembly level
- Conductive gaskets for module assembly
- Conductive gasket at board level cans at PCB level



### How we address electromagnetic compatibility (EMC)

**Electromagnetic compatibility:** Enables a device, equipment or system to function satisfactorily in its electromagnetic environment without introducing intolerable electromagnetic disturbance to anything in that environment

# Electromagnetic Compatibility & Performance Considerations

Electromagnetic Compatibility (EMC): The ability of a device, equipment, or system to function satisfactorily in its electromagnetic environment without introducing intolerable electromagnetic disturbance to anything in that environment.

Here are some of the factors affecting electromagnetic compatibility:

**Design for EMC:** Consider EMC early in the design process, from careful layout of PCB's and components ensuring good signal integrity. Design with the accommodation of EMI gaskets for enclosure seams and covers, I/O connections, doors etc. Retrofit is expensive.



**Mechanical:** Closure forces of gaskets vary dependant on material, profile, and size. Enclosure panel rigidity will dictate the minimum number of fixings. Compression limits should be used to protect the gasket from damage caused by over compression/deflection.

**RFI/EMI Shielding:** The basis of RFI/EMI shielding to make a faraday cage of the enclosure and ensure good grounding, this can be at PCB level for discreet components, modular and the final enclosure. Enclosures can vary in size from small handheld devices up to large cabinets and architectural rooms/buildings.



**Shielding Effectiveness:** To ensure good shielding effectiveness, low contact resistance is required between the gasket and the mating surface of the enclosure. For optimum shielding it is best to ensure metal to metal contact by using gaskets in grooves or incorporate labyrinth designs.

**Environmental:** Dust and moisture sealing is often a requirement alongside the EMC needs. Electrically conductive elastomers (ECE) provide this up to IP66 and above if the design is to achieve this. ECE fluorosilicones will seal against fuels, oils etc. For very harsh environments non-conductive seals can be incorporated in the design.



**Chemical or Galvanic Compatibility:** Two dissimilar metals in the presence of an electrolyte e.g. salt fog will act as a battery and create a flow of electric current. This effect can cause corrosion of the less noble material and will increase contact resistance between the gasket and enclosure causing a reduction in shielding effectiveness.

**Electromagnetic Fields:** When shielding magnetic fields generally the requirement is 10 kHz and above, high permeability metal type gaskets are needed these gaskets have a high current carrying capacity and are suitable for EMP protection. High frequency electric field 1 GHz and above require highly conductive more noble materials such as conductive elastomers with silver plated particles.



## Conductive Elastomers

Standard silicone has excellent temperature range performance and is resistant to compression set. Fluorosilicone has superior resistance to fuel oils and solvents.



## Oriented Wire in Silicone

Provides excellent shielding with EMP survivability and will also provide an environmental seal.



## Knitted Wire Mesh






Knitted wire mesh gaskets provide an excellent cost-effective EMI gasket, providing shielding in the magnetic as well as electrical fields.



## EMI Shielding Ventilation Panels

Made from aluminum honeycomb mounted into a frame.



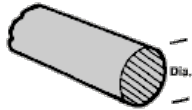
Product	 Datacomm	 AD&M	 Industrial	 Transportation	 Medical
Conductive Elastomers	●	●	●	●	●
Oriented Wire in Silicone	●	●	●	●	●
Knitted Wire Mesh		●	●		
EMI Shielding Ventilation Panels	●	●	●		

## Conductive Elastomers



### Base Polymer

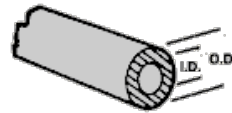
- Silicone
- Fluorosilicone
- Silicone with Nickel Plated Graphite



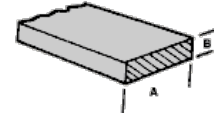
Cord

### Conductive Fillers

- Silver Plated Aluminium
- Nickel Plated Graphite



Tube



Flat strip/sheet



Silicones or fluorosilicones filled with conductive particles to form an electrically conductive elastomer

- Good temperature range -55 to +160
- Long shelf life 20+ years
- Oxygen and ozone resistant
- UV and mould resistant
- Fluorosilicone offers the additional advantage of being resistant to fuels etc

## Oriented Wires in Silicone



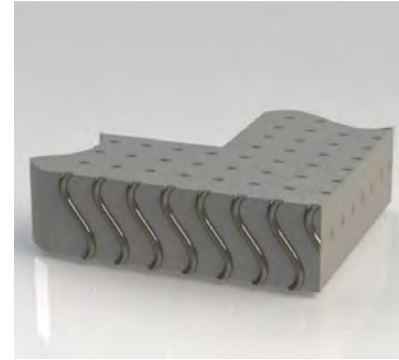
### Materials

- Solid Silicone
- Sponge Silicone
- Solid Fluorosilicone



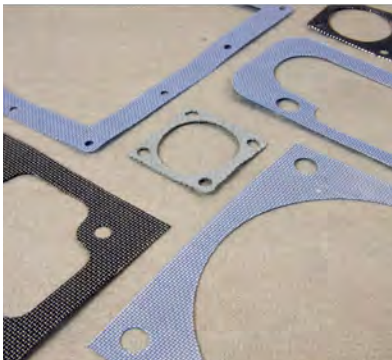
### Wire types and population

- Monel wire
- Aluminium wire
- 140 wires per cm<sup>2</sup> for solid silicone
- 95 wires per cm<sup>2</sup> for sponge silicone



Wires are crimped to aid compression and aid recovery but the gasket is not recommended for repeated openings

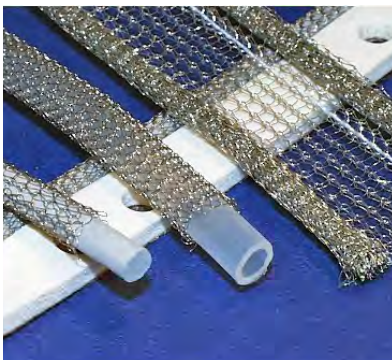
## Woven & Expanded metal filled with Silicone



Suitable for military grade connector gaskets and where thin gaskets can be used. Combined flatness tolerance 0.1mm max. Available in rolls 300mm wide or die cut gaskets

- Thin gasket material 0.5mm and 0.8mm thick
- Expanded Monel
- Expanded Aluminium
- Woven Aluminium
- Silicone
- Fluorosilicone
- Neoprene

## Knitted wire mesh



### Wire types

- Monel
- Tin Plated Copper Clad Steel
- Stainless Steel
- Aluminium

### Options available

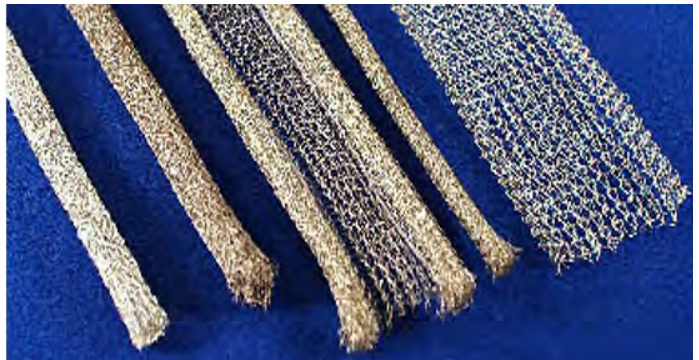
- Solid knitted wire mesh
- Elastomer cored knitted wire mesh
- Knitted wire mesh with an additional environmental seal
- Fabricated to custom shapes

Summary	Solid knitted wire mesh	Elastomer cored knitted wire mesh	Knitted wire mesh with an additional environmental seal
RFI/EMI shield	•	•	•
EMP Survivability	•	•	•
Environmental seal	Dust only	Dust only	•
Frequent openings		•	•
Continuous lengths	•	•	•
Compression limits			•
Fabricated gasket			•

### Knitted Wire Mesh Profiles



Round Rectangular D shape/custom



Twin round (railroad) Solid mesh Flat tape

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