SPECIFICATION

108-120069

Oriented Wire In Silicone

Oriented wire in silicone articles designed for Electromagnetic Interference (EMI) shielding. This range of products consists of sheet materials comprised of a specified silicone or fluorosilicone elastomer, with oriented wires running perpendicular to the plane of the rubber sheet.
The elastomer provides the environmental sealing component, whilst the wires provide electrical grounding and the shielding aspect of the product.
The wires are crimped to aid compression and are chemically bound within the rubber to ensure retention within the sheet. Under compression the wires have the ability to bite into the mating surface, and penetrate through thin oxide layers providing low contact resistance.

RoHS and REACH compliant.

Typical continuous operating temperature: -60°C to 200°C (-76°F to 392°F), -55°C to 200°C(-67°F to 392°F) if in Fluorosilicone elastomer.

Please consult 9.1 Appendix 1 Material Specific Data Table at the end of this document for material specific data.

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1 SCOPE

This specification establishes the quality standard of manufacture of oriented wire in silicone and fluorosilicone, used in the design of EMI seals. These materials are bespoke in design and therefore, this specification adopts industry standard methods to verify and test the materials. The performance of materials tested in accordance with this specification do not represent application-based performance.

2 REVISION HISTORY

Revision number	Change request	Date	Incorporated By
A	-	06/10/22	James Martin

3 RELATED DOCUMENTS

This specification takes precedence over documents referenced herein. Unless otherwise specified, the latest issue of referenced documents applies. The following documents form a part of this specification to the extent specified herein.

3.1 STANDARD MATERIAL SPECIFICATIONS

QQ-N-281 NICKEL-COPPER ALLOY BAR, ROD, PLATE, SHEET, STRIP WIRE, FORGINGS, AND STRUCTURAL AND SPECIAL SHAPED SECTIONS

A-A-59588 RUBBER, SILICONE

MIL-R-25988B RUBBER, FLUOROSILICONE ELASTOMER, OIL-AND-FUEL-RESISTANT, SHEETS, STRIPS, MOLDED PARTS, AND EXTRUDED SHAPES.

(Copies of standard material specifications can be found through various online retailers.)

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3.2 AMERICAN SOCIETY FOR TESTING AND MATERIAL (ASTM)

ASTM-D412	Standard Test Methods for Rubber Vulcanized and Thermoplastic Elastomers – Tension
ASTM-D624	Standard Test Methods for Rubber and Thermoplastic Elastomers, Tear Strength of Conventional Vulcanized

(Copies of these documents are available online at http://www.astm.org.)

3.3 MILITARY DETAILS (MIL-DTL)

MIL-DTL-83528 GENERAL SPECIFICATION FOR GASKETING MATERIAL, CONDUCTIVE, SHIELDING GASKET, ELECTRONIC, ELASTOMER, EMI/RFI.

(For shielding test specification only.)

Copies of MIL-DTL publications may be obtained from retailers of specifications and standards.)

4. REQUIREMENTS

4.1 COMPOSITION AND APPEARANCE

The formed and finished components covered by this specification are rubber sheets of specified thickness with encapsulated wires perpendicular to the sheet plane. Articles cut from sheet materials may also be included within this specification.

The following characteristics describe the composition and appearance of the components covered by this specification:

a) A continuous rubber sheet of specified dimensions, with a regular uniform pattern of encapsulated wires running through the thickness of the sheet.
b) The sheet should be of consistent thickness across the surface area of the sheet and within the bounds of the tolerance limits defined by the drawing.
c) All wires should be well bonded within the sheet of rubber.

d) The sheet should be free from flash, mould faults, oils, greases, other fluids and other foreign debris.

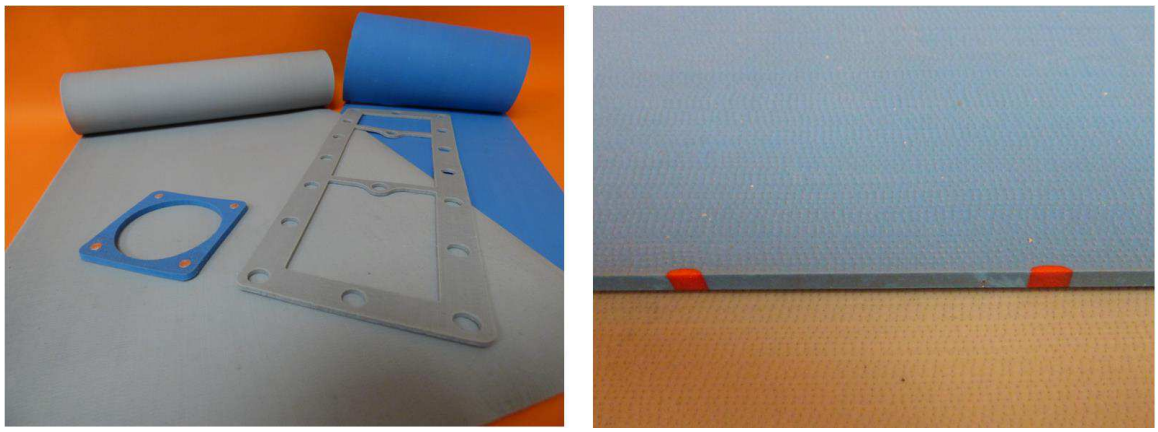
4.2 MATERIAL SELECTION

The range of standard materials for the production of components is detailed in the table below:

TE Material Code	Material Description	Sheet Colour (With Colour ID Markers)
410	Monel in 40 Shore Solid Silicone	Light Grey with Red
420	Aluminium in 40 Shore Solid Silicone	Light Grey with Green
450	Monel in 50 Shore Fluorosilicone	Blue with Red
460	Aluminium in 50 Shore Fluorosilicone	Blue with Green
470	Monel in 20 Shore Solid Silicone	Light Grey with Blue
480	Aluminium in 20 Shore Solid Silicone	Light Grey with Yellow

Material selection for the required component is application specific. Therefore, please consult technical documentation carefully and if you are in need of assistance please seek advice from a customer service representative.

More detail on the performance of materials will be specified in 9.1 Appendix 1 Material Specific Data Table



Images of some Oriented Wire In Silicone Materials (left) and an example of Colour ID markers on sheet materials (right).

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5. QUALITY ASSURANCE PROVISIONS

5.1 CLASSIFICATION OF TESTS

5.1.1 Validation Tests

Validation tests are those which are conducted periodically at our discretion to confirm that the materials manufactured perform in accordance with this specification.

5.1.3 Acceptance Tests

Acceptance Tests are those that are performed on each batch of finished formed product to confirm that the production requirements have been met.

5.2 SAMPLE PREPARATION

Details of the sample preparation for each of the different types of tests are detailed below.

5.2.1 Validation Test Samples

Samples are prepared from a randomly selected batch of material and are moulded or cut from standard stock to meet the specified dimensions for each test method.

5.2.3 Acceptance Test Samples

The acceptance test for oriented wire sheet material are defined by dimensional and visual inspection of each part. The criteria of these acceptance tests are detailed in 5.3.3.1 Oriented Wire In Silicone Sheet.

| Indicates Change

5.3 TEST PROCEDURES

All test procedures referenced from hereon are conducted at our discretion or by an approved test provider.

5.3.1 Validation Tests

5.3.1.1 Wire Count

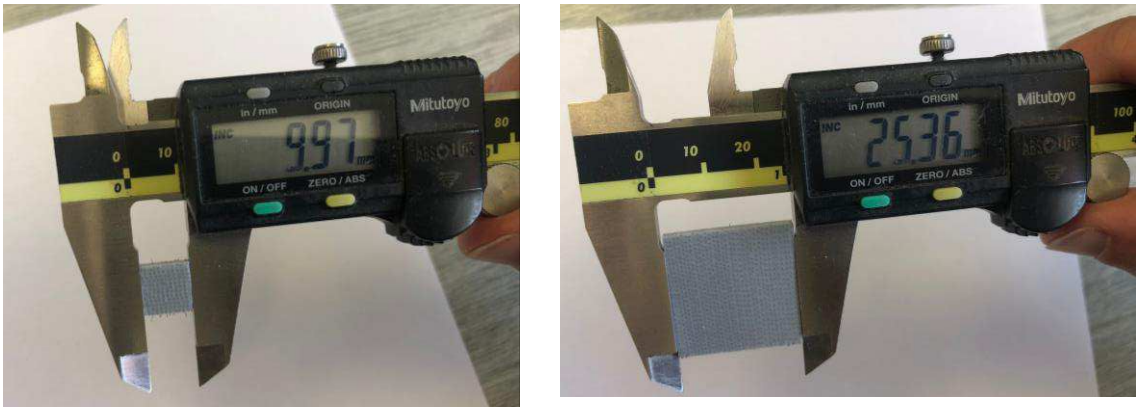
Cut a specified surface area of sheet material to either of the following dimensional schemes:

- $1cm^2$ – 1cm x 1cm square (10mm x 10mm)
- 1 $inch^2$ – 1" x 1" square (25.4mm x 25.4mm)]

Using a microscope, magnifying glass or other visual aid, count the number of wires present across the surface area of the cut sample. The value obtained should be consistent with 9.1 Appendix 1 Material Specific Data Table. Wire count values can be controlled in the material manufacturing process.

5.3.1.2 Tensile Strength & Elongation (ASTM D412)

Five dumbbells shaped (Die C) samples are cut from sheet stock of oriented wire in silicone.



Measurement of standard samples in preparation for wire count measurement.

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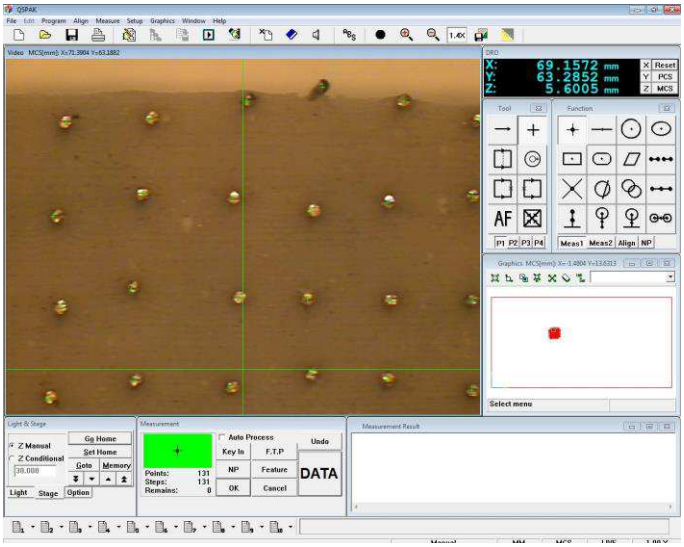

Non-contact measurement and counting of wires present in a 1cm2 sample of oriented wire in silicone.

Each sample is measured for thickness and width at the narrowest point of the dumbbell. These values are recorded.
The sample is then placed between the grips of a Tensile test machine and the auxiliary elongation clamps are gripped around the sample at a spacing of 20mm. The sample is extended at a rate of 500mm/min and the resultant forces and % extension is recorded.
The mean values for the 5 samples are calculated for each parameter and reported. In the case of elongation values, the force measured at a defined elongation will be reported.

5.3.1.3 Tear Strength (ASTM D624)

Five 90º bent samples (Die C) are cut from oriented wire in silicone sheet stock. The thickness of each sample across the apex of the 90º bend is measured and recorded.
Each sample is then placed in the grips of a Tensile test machine. The sample is stretched under a constant rate of extension of 500 mm/minute. The force results of the extension are recorded and the force at rupture (tear) through the 90º bend is noted. Reported values are averaged and the Tear strength is calculated from the Force divided by the sample thickness (N/mm).

5.3.1.4 Compression Set (ASTM D395 Method B)

Samples of each of the elastomer binders are moulded independent of the wires. Six samples of material should be prepared for each test. These samples should be cylinders 13.0 ± 0.2mm in diameter & 6.0 ± 0.2mm in thickness.

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The samples are placed between steel plates and compressed to ≈ 25% compression.
Once under compression, the samples are placed in a fan assisted oven at 100°C ± 1°C for 72 hours.
The samples are removed after this exposure period, released from compression and allowed to cool and relax for 30 minutes.
The final thickness of each plied sample is recorded, and the results are averaged.

Compression set is then calculated as follows:

$$C_B = \left[\frac{t_0 - t_i}{t_0 - t_n}\right] \times 100$$

Where;

$$C_B = Compression\ Set\ (\%\ of\ original\ deflection)$$
$$t_0 = original\ thickness\ of\ test\ sample\ (average)$$
$$t_i = final\ thickness\ of\ test\ sample\ (average)$$
$$t_n = thickness\ of\ compression\ limiter\ used\ (actual)$$

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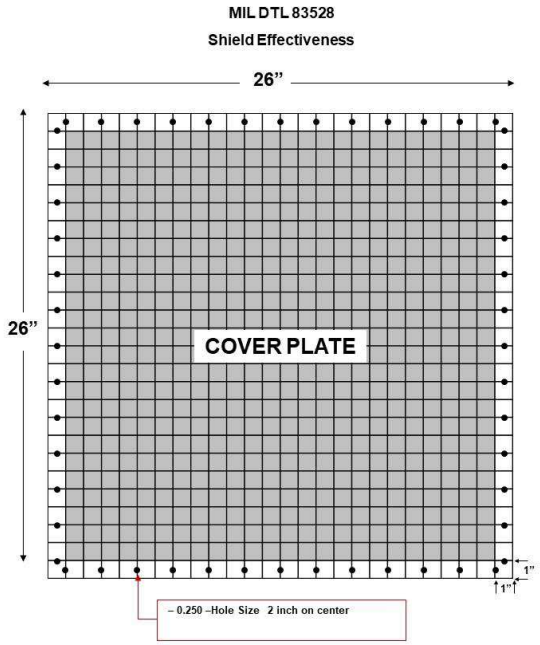
5.3.1.5 Shielding Effectiveness 20MHz – 10GHz (MIL-DTL-83528)

Shielding effectiveness testing is performed on a gasket fabricated from oriented wire sheet to the following schematic:



The gasket is then placed over the flange of the shielded enclosure.
The effectiveness of the gasket to shield from EMI frequencies through the enclosure wall, is then measured and reported across the frequency range.

5.3.2 Acceptance Tests

5.3.3.1 Oriented Wire In Silicone Sheet

The acceptance criteria for oriented wire sheet material are as follows:

1. Sheet dimensions match the drawing specification and are within the accepted tolerance limits.

2. All wires should be sufficiently bonded within the sheet and that under standard applicational function, the wires remain bonded within the sheet.

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5.3.3.2 Custom Oriented Wire Parts

If a part deviates from the standard product offering, the part should be inspected to the appropriate drawing and tolerance scheme. Dimensions can be assessed using a vernier caliper where appropriate. If dimensions are difficult to interpret using standard production measurement systems, the first-off inspection should be conducted by a member of the quality team trained in the use of the non-contact measuring machine.

6 DIMENSIONS

The dimensions of all parts should be in accordance with the appropriate drawings referenced below:

- C-400-WIRE-SHEET

6.1 Oriented Wire In Silicone Sheet

Sheet widths are shown in the table below, all sheets are of standard nominal length of 1000mm and the nominal thickness is by the part number and drawing.

TE Material Code	Sheet Width (mm)
410	225
420	225
450	150
460	150
470	225
480	225

| Indicates Change

7 PRODUCT HANDLING

Care should be taken when handling oriented wire products to protect the function of the product.

Oriented wire products are designed for use under compressive conditions.
They are not suitable for stretch or strain application, as under these conditions the integrity of the encapsulated wire matrix can become compromised. Loss of wires or damage to the wires may impact upon the shielding performance of the material.

Protective gloves should be worn when handling oriented wire to prevent any sharp or loose wires around the cut edges or faces of the material from becoming dislodged from the material.

Oriented wire products can be cut to further form them for end applications. It is advised that cutting process are designed so that lubricants are not required. Sharp steel blades free from any oils, grease or dirt are typically used.
After oriented wire in silicone sheet materials have been cut, there may be some wires hanging or broken from the cut edge, it is recommended that these loose wires are removed to prevent them from impacting upon the function of any assemblies.

8 PACKAGING & STORAGE

8.1 PACKAGING & HANDLING

Oriented wire in silicone materials should be packaged in clean & dry clear polythene bags. The bags should be sealed and prevent exposure of the product to debris, dirt, flash, grease, oils or any other fluid contaminants.

When handling or repackaging, care should be taken not to stretch the material, particularly in the case of sheets with a low nominal thickness (<1.0 mm).
Protective gloves should be worn when handling the elastomer, to prevent damage or contamination of the product, and to protect the handler from sharp wire cuts or abrasions.

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8.2 STORAGE & SHELF-LIFE

Oriented wire in silicone should be stored under the following conditions:

- In original packaging
- At ambient temperature and humidity
- Isolated from corrosive materials
- Isolated from direct sunlight

Under these conditions, conductive elastomers have a shelf-life of 20 years.

| Indicates Change

9 APPENDICES

9.1 Appendix 1 Material Specific Data Table

Test Specification / Material Code	410	420	450	460	470	480
Recommended Operating Temperature Range (°C)	-60 to 200	-60 to 200	-55 to 200	-55 to 200	-60 to 200	-60 to 200
Average Wire Density (per cm^2 / per $inch^2$)	140 / 903	140 / 903	140 / 903	140 / 903	100 / 645	100 / 645
[1]Elastomer Shore A Hardness	40	40	50	50	20	20
[2]Minimum Tensile Strength (ASTM D412) (lbs/in^2 / MPa)	360 / 2.5	360 / 2.5	500 / 3.5	500 / 3.5	180 / 1.3	180 / 1.3
[2]Minimum Force @ 100% Elongation (lbs/in^2 / MPa)	145 / 1.00	145 / 1.00	210 / 1.50	210 / 1.50	29 / 0.20	29 / 0.20
[2]Minimum Tear Strength ASTM D624 (lbf/in / N/mm)	54 / 9.5	54 / 9.5	97 / 17.0	97 / 17.0	54 / 9.5	54 / 9.5
[3]Maximum Compression Set (%) (ASTM D395 – 70hrs @ 100°C)	15	15	10	10	20	20
[4]Minimum Shielding Effectiveness @ Specified Frequency (dB) (MIL-DTL-83528)						
20 MHz	94	95	94	95	97	94
40 MHz	96	95	96	95	99	96
60 MHz	100	97	100	97	99	100
80 MHz	99	98	99	98	100	100
100 MHz	111	105	111	105	109	111
200 MHz	111	105	111	105	109	111
400 MHz	112	107	112	107	105	110
600 MHz	110	103	110	103	102	108
800 MHz	116	110	116	110	109	116
1 GHz	111	111	111	111	107	111
2 GHz	106	112	106	112	112	112
4 GHz	98	97	98	97	95	101
6 GHz	91	90	91	90	89	90
8 GHz	90	90	90	90	87	92
10 GHz	84	89	84	89	84	88

| Indicates Change

1) **Shore hardness is the specified nominal of the purchased elastomer. These results are confirmed upon the certificate of conformity for the incoming material.**
2) **Based on cut samples of 1.6mm thick.**
3) **Suggested compression set based on results for the elastomer material only at the specified test conditions.**
4) **Shielding effectiveness as measured using MIL-DTL-83528 method. As Shielding Effectiveness is directly related to wire type and wire count and the elastomers have similar properties the data is the same for 410/450 & 420/460. Only one of these materials from each pair have been subjected to testing to collect this data.**

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