Trishield® GUIDELINE

FOR THE PRODUCTION OF TRISHIELD® GASKETS

Nolato

CONFIDENTIAL MATERIAL

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CONTENT

1. INTRODUCTION

Trishield® is the trademark for the patented narrow dispensed gaskets based on conductive silicone rubber from Nolato. Production of Trishield® gaskets can be made under licence from Nolato. The purpose of this document is to present general guidelines that should be used to set up and operate a production of Trishield® gaskets.

1.1 EMI SHIELDING WITH SILICONE RUBBER

EMI shielding of the components on a printed circuit board is an important part of the design of any electronic equipment. One popular method of shielding is to create a Faraday´s cage around the components with a conductive housing that is electrically connected to the ground path of the PCB. Traditionally the connection was arranged by soldering the housing to the PCB or with a metal finger or wire mesh gasket. A more innovative solution is to use a conductive silicone gasket to close the gap between the housing and the PCB.

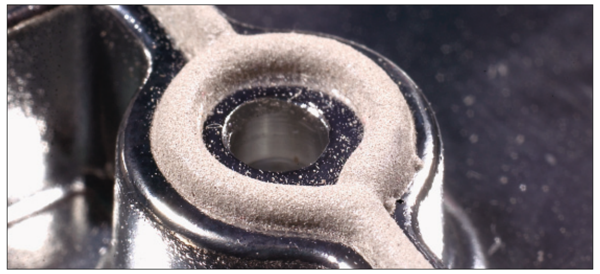
An early type of silicone gasket was the extruded gasket that was put in groove during assembly of the conductive housing. This gasket was effective in shielding but it required a space consuming design and high cost for assembly.

One other method to avoid the handling of a separate gasket is to mould the silicone gasket onto the conductive housing. This method is called mould-in-place or over-moulding. It is used with good results in high volume production for smaller components but the method has drawbacks for production of large covers in small or medium size series due to the need of precision tooling for the moulding process.

A second method to avoid handling of a separate gasket is to dispense the silicone onto the housing and cure it in place. This is called dispensed gaskets or form-in-place gasket. Nolato has delivered and dispensed its own gasket material for the mobile communication industry since 1993.

1.2 DISPENSED GASKETS

Dispensed gaskets are produced with a XYZ – robots that are programmed to dispense a bead of conductive silicone directly onto the rim of a conductive housing. The bead height is normally between 0,5 to 2,0 mm.



Picture 1. Example of a dispensed gasket.

The dispensed silicone, which is a thixotropic liquid, is cured in place. There are two types of curing available on the market. Room temperature curing systems which require several hours or days to cure, and heat curing systems which cure in a shorter time by heating the material. Nolato material cures in an oven within 30 minutes at 100 °C. By using heat for curing we can offer shorter lead times, quicker feedback and quality control, better compression set and no risk for silicone bleeding.

Dispensed gaskets have been used in large volume in covers to mobile phones and base stations since it offers many advantages to other technologies:

Compared to soldered metal cans:
- Ease to assemble and disassemble when repair or adjustments are required
- Allows several EMI shielded chambers in one part
- Possibility to combine environmental sealing and EMI shielding

Compared to metal finger gasket:
- No assembly work, dispensed gaskets adheres to the cover
- Superior flexibility in gasket to close any gap
- No scrap material as in die cutting or etching a metal gasket

Compared to die cut gaskets:
- No assembly work, dispensed gaskets adhere to the cover
- Dispensed gaskets are thin and less space consuming
- No scrap material as in die cutting

Compared to extruded or wire mesh gaskets:
- No assembly work, dispensed gaskets adhere to the cover
- Dispensed gaskets are thin and less space consuming
- Dispensed gaskets do not require grooves

Compared to moulded-in-place gaskets:
- No expensive moulding tool required
- Cost effective also in small series
- Minimal risk for damaging sensitive surface of covers.

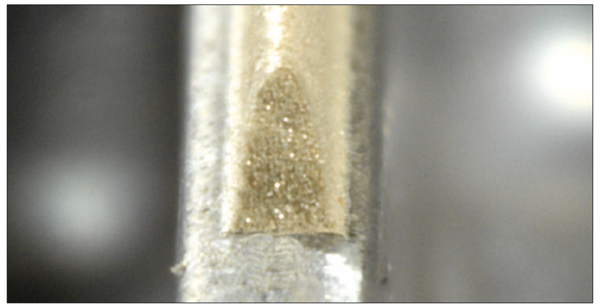
1.3 TRISHIELD® GASKETS

Traditional dispensed gaskets have had a strong market position in for instance mobile phone base station applications. A limiting factor for this technology is the fact that the gasket profile can not be fully controlled. The gaskets are shaped like a lying D and are wider than what is required for shielding.

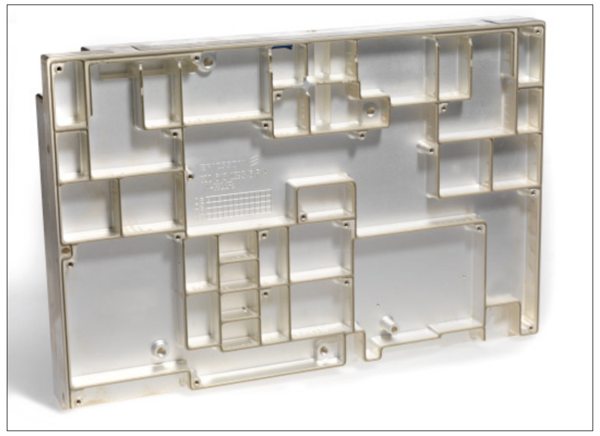
A wide gasket requires more valuable silver filled material and results in high compression forces. To make high gaskets a double bead is required. This costs cycle time in the dispensing and may cause patent problems in Germany and the US.

In 2002 Nolato invented the triangular shaped Trishield® gasket to overcome these problems while retaining the benefits of the traditional dispensed gaskets. Trishield® can be seen as a new method to produce high and narrower dispensed gaskets. Trishield® can be used on most applications that have been designed or can be designed for traditional dispensing. It offers several advantages to the traditional dispensed gaskets.

- Less material consumption
- Shorter cycle times
- Lower cost
- Less compression force
- No patent problems



Picture 2. Trishield® the dispensed gasket shaped like a triangle. Example of a cross section.

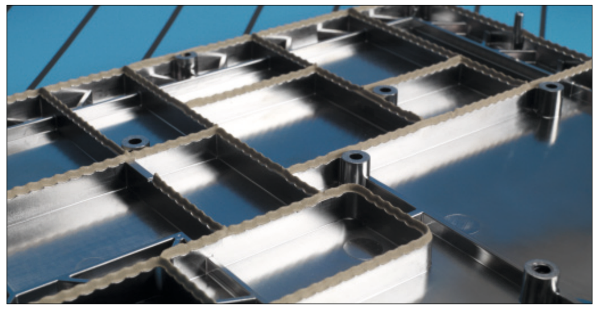


Picture 3. Example of application of Trishield® on a shielding cover for a mobile phone base station.

Nolato has patented the production and use of Trishield® gaskets. Today there are approved patents in Europe, USA and China.

1.4 TRISHIELD WAVE®

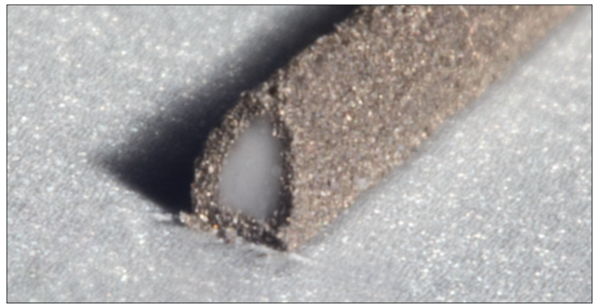
Trishield Wave® is a patented development of the Trishield® gasket where the gasket is dispensed on a serrated surface. In the forming step the gasket obtains a wave shapes profile. In the application the gasket is compressed to the bottom of the valleys. This means that less gasket material has to be compressed and the compression forces are reduced 20-30 %. This could be helpful on for instance plastic covers.



Picture 4. Example of a Trishield Wave® gasket.

1.5 TRISHIELD SOFT®

Trishield Soft® is a new development of the patented Trishield® gasket where two materials are co-dispensed. One soft non-conductive core material and one highly conductive shell material. This gasket offers very good mechanical properties as low compression forces and compression set.



Picture 5. Example of a Trishield Soft® gasket.

1.6 THE PROCESS FLOW FOR PRODUCTION OF TRISHIELD® GASKETS

- Storage of material
- Mixing of material
- Dispensing
- Trishield® forming
- Curing
- Final inspection
- Packaging

2. INSTALLATION NEEDED FOR TRISHIELD® PRODUCTION

Most of the equipment needed is available on the open market from a number of machine suppliers. The only unique equipment is the forming unit. This equipment is provided by Nolato against a yearly rental fee. Customers can also rent mixing and quality inspection and soft dispensing head equipment from Nolato.

2.1 LIST OF EQUIPMENT

2.1.1 Storage of material

The dispensing material from Nolato is delivered as A and B component in 1 litre cartridges. These cartridges should be stored in a freezer at -18 °C. This freezer can also be used to store mixed material that is not consumed in the day of mixing. A standard household freezer of from for instance Electrolux can be used.

The size of the freezer depends on the expected material flow but typically 1 or 2 freezers of 200-500 litres are used at larger production sites.

2.1.2 Mixing of material

In northern Europe the silicone rubber can be delivered ready to use with cool transport. To other production sites the material is delivered as a two component system. In these cases a mixing unit will be required. This mixing unit shall be able to mix component A and B in an exact ratio without adding any air bubbles into the material.

There are basically four different methods that could be used for mixing the compounds.

For prototypes only the component A and B can be mixed and filled into dispensing cartridges by hand. Typical batch size from 0,1 and up to 1 kg. A balance to weigh up the components is needed. To remove air-bubbles mixed into the material is a vacuum pump and a vacuum chamber needed. The size of the chamber is set by the size of the mixing vessel.

For production volumes is a mixing machine needed. The low cost machine is a fixed ratio static mixer that is available from Nolato. Press A and B components in a fixed ratio over a static mixer and directly into the dispensing cartridge.

A description is found in document "Data sheet on Trishield mixer for fixed 1:1 and 1:2,5 ratio".

This type of mixer can only be used for material designed for 1:1 or 1:2,5 ratio. This mixer is thus suitable for all Nolato materials except 8710 and 8801.

Picture 6. The fixed ration static mixer from Nolato.

One alternative is to use a static mixer with variable mixing ratio. Also in this equipment A and B components are mixed over a static mixer and pressed directly into the dispensing cartridge. To allow mixing of all different kinds of material the mixer is equipped for control of different speed of A and B. One supplier is Scanrex in Sweden. A description is found in document "Data sheet on Trishield mixing unit"

The fourth alternative is a versatile batch mixer. Component A and B are mixed under vacuum in a planetary mixer. The mixed material is pressed directly into the dispensing cartridges from the mixing vessel. Typical batch size is 6 to 10 kg. A balance to weigh up the components into the mixing vessel is also needed.

2.1.3 Dispensing machine

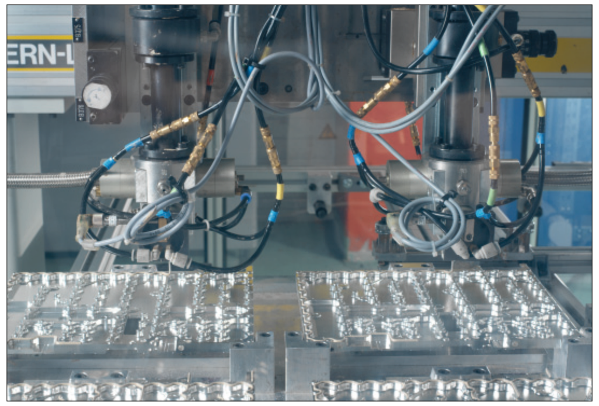
Almost any type of XYZ robot equipped with a dosing system can be used. The size of cover to be dispensed and the number of dispensing head decides the size of the machine. For accurate material dosing is a dosing pump or hydraulic dosing system recommended. Pneumatic dosing systems are less expensive but they typically require manual trimming of the final gasket. The number of dispensing heads per machine and degree of automation depends on the application.

There are many different suppliers of dispensing machines. One high quality and well known German supplier is Datron. Example of less expensive machines can be found at the Chinese suppliers Second and Rasem.

The cycle time i.e. the capacity of a dispensing machine depends partly on the dispensing speed but mainly on the product size with the dispensed length and the number of starts and stops.

The dispensing machine is the most expensive piece of equipment in the Trishield production. A new dispensing company typically start with one machine and add more machines as volumes increases.

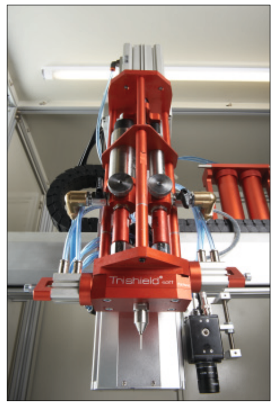
Picture 7. Example of a manually feed dispensing unit.



Picture 8. Example of an automated production cell with two head dispensing.

2.1.4 Trishield Soft® dispensing head

Trishield Soft® Dispensing Head is a patented devise for making very soft dispensed Form-in-Place gaskets. It is a complete, ready-to use devise intended to be mounted direct onto a standard dispensing machine. This equipment is only needed for Trishield Soft® production. It is not needed for standard Trishield® gaskets.



Picture 9. Example of a Trishield Soft® dispensing head.

Trishield Soft® Dispensing Head over-all measurement is 550x270 x180 mm. Total weight is 6 kg. Trishield Soft® Dispensing Head is available for hire to all Trishield® Licensees after separate agreement. For further details see "Data sheet Trishield Soft® dispensing head".

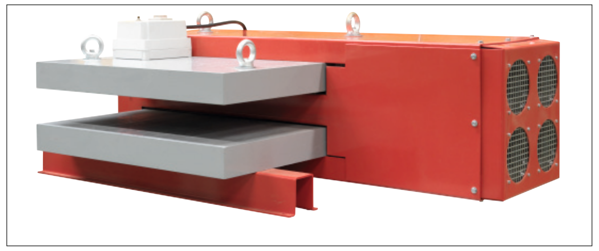
2.1.5 Trishield® forming unit

The dispensed gasket is placed into the forming unit. It is basically a specially developed electro magnet. Nolato calibrates and supplies this equipment. If automation is required it can be equipped with a sledge or a belt conveyor by the user for an easier production. The unit must be placed or hung on a suitable support close to the dispensing unit since treatment preferably should be made within 5 minutes after dispensing. The forming step that gives the triangular shape takes 15 seconds. During this time the part needs to be stationary. The short cycle time allows one forming unit to serve several dispensing machines. After forming the part should preferably be placed into the curing oven within 5 minutes.

The small standard forming unit has a total area of 385x440 mm. The large standard forming unit has a total area of 380x640 mm. Both units have a gap of 90 mm in height. There is an X-large unit 380x640 mm but with an increased gap height of 120 mm. There is also an XX-large unit 500x640 mm, in height 120 mm.

No gasket should be placed closer than 20 mm from the three open sides. The working area is thus 365x400 mm, 360x600 mm and 480x600 mm. At delivery the unit is equipped with a push button time relay, set on 15 seconds, for manual operation. The small unit needs a power supply of 1-phase, 220 V, 10 A. The large and X-large need 16 A.

When building the support for the unit it is important to note that no iron or other magnetic material is allowed inside the treatment unit. This would disturb the treatment. Minimum distance from the three open sides to iron is 250 mm. Minimum distance above and below the unit to iron support is 50 mm.



Picture 10. Example of a forming unit

2.1.6 Curing oven

The gasket is typically cured in a circulating hot air oven at 100-150 °C for 30-40 minutes. Curing can for small series production be made in batch ovens. For larger production is a conveyor belt oven needed for a smooth operation.

The exact time and temperature in the oven depends on the oven construction and the heat transfer. The basic requirement from Nolato is to achieve a part surface temperature of more than 100 °C for 25 minutes.

- For volume production preferably a belt conveyor oven is used. The length and width of the oven depends on the size of the parts and the expected production speed. The size of the oven should be enough to give a heating period of at least 30 minutes at full production.
- The oven should have a capacity to keep temperature stable at 100-150 °C even at maximum production.
- The oven should be equipped with air circulation for a quick heat transfer.
- A ventilation of at least 100 litres per minute and kg rubber, is required to remove solvent and short-chain silicones.
- Conveyor ovens should have a variable speed drive to allow adjustment in the range of 20-40 minutes of heating time.
- At the end of the oven a conveyor and cooling fans are recommended to bring down the part temperature enough to allow handling and inspection. As an alternative parts can be placed on racks or in a pallet for a cooling period.

One oven is typically used for several dispensing machines.

Picture 11. Example of hot air conveyor oven with forced ventilation.

2.1.7 Measurement equipment

The final inspection includes visual inspection of all parts. If needed gasket can be manually trimmed to adjust excess material in start and stop. A table of suitable size should be arranged for this operation.

Once every second hour one part is taken from production for measurement. Typical measurements are gasket height and width and adhesion and electrical resistance.

Gasket height and width are measured with an optical measuring machine. There are several brands on the market. One popular machine is the American OGP.

Gasket adhesion is measured with a hand held adhesion tester. Details in “Data sheet for Nolato Trishield adhesion tester”

Electrical resistance is measured with a standard ohm-meter and a test fixture supplied from Nolato. Details in “Data sheet for Trishield R1-tester”

For collecting and analysing and storing the measuring data is a computerised SPC program recommended. Details in “Data sheet SPC-light software”.

The Adhesion tester and the R1 resistance fixture and the SPC program can be rented from Nolato.

2.1.8 Packaging equipment

Packaging methods differs from product to product. Typically the covers are packed in pallets with foam boards to protect the gasket during transportation. Sufficient space must be planned for the packaging and handling of materials.

2.1.9 Options

Automating

For high volume production in countries with high cost of labour, a conveyor system can be installed for automatic transportation of parts between different process steps. For small scale production the parts can be hand carried from one process step to the other.

Flaming and brushing and priming

To improve adhesion of the gasket the parts are sometimes treated before dispensing the gasket. In most cases no treatment is needed but on difficult surfaces as silver, Nolato recommends to use flaming and brushing and priming.

Flaming

The surface to be dispensed is flamed with an open flame from a gas-burner to remove organic contaminants.

Brushing

A metal brush is used to mechanically remove impurities as release agent and oil and dust and plating chemicals from the cover surface. Brushing can be made manually or in a machine.

Priming

A thin layer of primer is applied on the surface of the cover. After evaporation of solvent the primer acts as an adhesive. Priming can be applied manually or in a bench-top XY machine.

2.1.10 Investment calculation

The investment needed to start a production of Trishield gaskets has to be calculated in each specific case since the type and size of equipment have to be decided for each production site.

Main factors are:

- The size and shape of the cover to be dispensed.
- The number of covers to be delivered per day.
- The country and possibilities to buy locally made machines.
- The possibility to use existing equipment
- The need for automating
- The plans for expansion
- The availability of money for investment

2.2 BUILDING REQUIREMENT

Production can be done in any standard industrial building. The production is preferably separated from other type of production to avoid problems with dust and dirt on covers. The lay-out of the FIP room should be designed to allow a good material flow. The minimum size of the room depends on the oven and other equipment but enough space should be included for efficient handling of pallets with in-coming covers and for packaging of final product.

Power supply is mainly set by the requirement from the electrically heated curing oven. Compressed air at 6 bars is needed in small volumes for most types of dispensing machines. General ventilation is required to remove excess heat from the curing oven.

Process ventilation is required from the oven with 100 litres of air per minute and kg rubber.

2.3 SAFETY AND ENVIRONMENTAL CONSIDERATION

Most conductive silicone rubber from Nolato are not dangerous to man or the environment. The exceptions are the Ni/C filled materials as for instance 8812 and 8813 and 8817. These materials may cause skin sensation by repeated skin contact. It is advisory to never touch the gasket without gloves. Material safety data sheet can be sent on request.

The delivered silicone compounds contain a small amount of solvent. In the curing oven the solvent together with short-chain silicone molecules will evaporate. These gases need to be removed from the oven with a process ventilation system to avoid problems in the working area. The amount is equal to 35 g of petroleum distillate and 35 g of silicone per kilo of rubber sent into the oven.

The cured Trishield® gasket contains silicone rubber and silver and nickel and carbon. The gasket could after the lifetime be removed from the shield and sent for metal recovery but due to the low weight of each gasket this is normally not economically feasible.

The gasket is not harmful to the environment and can be deposited as normal industrial waste as is often the case when it is dispensed on a combined product such as a metallized plastic shield.

If the gasket is dispensed on aluminium housing it can in most cases follow the housing for melting and aluminium recovery. The gasket will then leave traces of silica, silver and nickel in the melt that can be handled as normal impurities.

The forming unit is a DC Electro magnet. The magnetic field around the equipment when it is used is small and can not be measured at distances greater than 0,5 meter from the unit. It should be noted that the field is a DC field and not an AC field. To our knowledge there are no known hazards to man associated with a magnetic DC field.

3. CONDUCTIVE SILICONE RUBBER FROM NOLATO

3.1 GENERAL

Trishield EMI shielding gaskets are produced using Nolato conductive silicone rubber. This material is developed and manufactured by Nolato Silikonteknik in Sweden. In the production process, silicone rubber, conductive particles and additives are mixed together. The material is inspected and filled in 1 litre cartridges for delivery as A and B components to producers of Trishield® gaskets.

Main characteristics

- The materials are two-component, thermal cure silicone system.
- It is used to produce integrated EMI shielding gaskets by dispensing and Trishield forming directly on telecom or other industrial components.
- The patented Trishield® gasket offers a triangularly shaped narrow gasket with less material consumption and less compression force.
- Low viscosity offers short cycle times in any dispensing machine.
- Excellent shielding combined with good mechanical properties.
- Operating temperatures between -55 °C and +125 °C.
- Good adhesion to most metal and metallised surfaces.
- Typical gasket height from 0,8 to 2,0 mm. Width to height ratio is < 1.
- Recommended compression between 10 and 50 %.
- All materials fulfil the RoHS requirements.

Table 1. Overview of typical conductive silicone rubber materials from Nolato.

	Test procedure	Unit	8520	8700	8710
Base material			Silicone rubber	Silicone rubber	Silicone rubber
Conductive filler			None	Ag/Cu	Ag/Al
Volume resistivity	Mil-DTL-83528C	mohmcm	n.a.	2	8
Density	ISO 2781	g/cm^3	1,1	2,9	1,9
Hardness	ISO 7619	Shore A	40	55	65
Tensile strength	ISO 37	Mpa	5,6	2,1	2,0
Elongation at break	ISO 37	%	570	310	140
Tear strength	ISO 34-1C	N/mm	24	12	14
Compression set, 72 hours, 100 °C	ISO 815	%	25	25	35
Avg. shielding effect, 0,3 – 20 GHz. Gasket on aluminium cover	Nolato cavity to cavity test method	dB	n.a.	75	70
Flammability	UL 94		V0	V0	V0
Compression modulus, 10 % strain 20 % strain	ISO 7743	MPa	3,8 3,5	7,5 9,3	7,5 8,1

	Test procedure	Unit	8800	8813	8817
Base material			Silicone rubber	Silicone rubber	Silicone rubber
Conductive filler			Ag/Ni	Ni/C	Ni/C
Volume resistivity	Mil-DTL-83528C	mohmcm	15	8	12
Density	ISO 2781	g/cm^3	3,1	2,1	1,9
Hardness	ISO 7619	Shore A	55	73	63
Tensile strength	ISO 37	Mpa	2,9	2,5	2,6
Elongation at break	ISO 37	%	240	170	260
Tear strength	ISO 34-1C	N/mm	14	15	16
Compression set, 72 hours, 100 °C	ISO 815	%	25	55	30
Avg. shielding effect, 0,3 – 20 GHz. Gasket on aluminium cover	Nolato cavity to cavity test method	dB	70	130	110
Flammability	UL 94		V0	V0	V0
Compression modulus, 10 % strain 20 % strain	ISO 7743	MPa	3,8 6,5	15 20	8,2 9,3

3.2 DATA SHEETS

A data sheet with all important features is available on all materials. It should be noted that the 85XX and 87XX series of material are of the traditional type that do not use the forming step. It is only the 88XX series of material that can be formed in the Trishield forming unit.

3.3 ORDERING AND DELIVERY

Inside northern Europe the silicone rubber could be delivered ready to use with cool transport. To all other customers the material is delivered as two components A+B. Component A contains a platinum catalyst and component B the crosslinking agent needed for the curing.

The components are delivered in cardboard boxes each with 6 pieces of 1 litre cartridges. The preferred order size is a multiple of a full box.

Picture 12. Cardboard box and standard cartridges.

Table 2. Dimensions of the standard delivery cartridge.

Fabrication	Material	Volume, ml	Height, mm	Diameter, mm	Thread, mm	Wall thick, mm
Ritter RG 100	PE	1000	324,5	66,6	S3,2x3	1,4

Order on material should be placed on both component A and component B. The mixing ratio between A and B component is given in the table below.
One example: If a customer needs 12 kg of 8520 it can be seen in the table that mixing ratio is 1:1.
The order should then be for 6 kg of component A and 6 kg of component B.

Table 3. Order information of standard materials.

Product	Part number	Mix ratio by weight	Cartridge, kg	Box content, kg
Nolato 8510, component A	10851002	1	1	6
Nolato 8510, component B	10851003	1	1	6
Nolato 8520, component A	10852002	1	1	6
Nolato 8520, component B	10852003	1	1	6
Nolato 8700, component A	10870002	1	1	6
Nolato 8700, component B	10870003	7,0	2,5	15
Nolato 8710, component A	10871002	1	1	6
Nolato 8710, component B	10871003	5,4	1,5	9
Nolato 8800, component A	10880005	1	1	6
Nolato 8800, component B	10880006	7,2	3	18
Nolato 8801, component A	10880102	1	1	6
Nolato 8801, component B	10880103	8,7	2,5	15
Nolato 8812, component A	10881201	1	1,5	9
Nolato 8812, component B	10881202	1	1,5	9
Nolato 8813, component A	10881301	1	1,5	9
Nolato 8813, component B	10881302	1	1,5	9
Nolato 8817, component A	10881704	1	1,5	9
Nolato 8817, component B	10881705	1	1,5	9
Nolato 8818, component A	10881802	1	1,5	9
Nolato 8818, component B	10881803	1	1,5	9

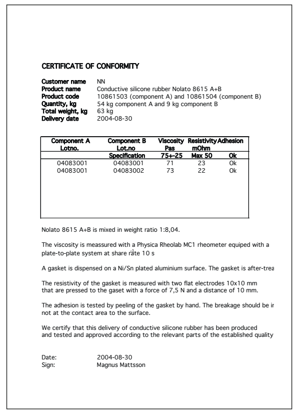
3.4 QUALITY CONTROL

Each batch of material is inspected and approved before delivery from Nolato. A certificate of conformity showing the test results is sent with the delivery.

In the inspection the A and B are first mixed in the correct mixing ratio. The material is tested for viscosity in a rheometer with a plate-to-plate system. The viscosity is reported in Pas at a share rate of 10-1s.

The mixed material is also used to produce a handmade dispensed gasket on a nickel-tin plated aluminium surface. The gasket is formed and cured. The electrical resistance of the gasket is measured in the R1-fixture described in chapter 6.2. The adhesion to the Ni/Sn surface is inspected on the handmade gasket. When peeling off the gasket there should be a breakage inside the gasket and not in the contact area to the surface.

A back-up sample of each batch is kept at Nolato during 6 months in case of a need for further investigation of a batch.



CERTIFICATE OF CONFORMITY

Customer name	NN
Product name	Conductive silicone rubber Nolato 8615 A+B
Product code	10861503 (component A) and 10861504 (component B)
Quantity, kg	54 kg component A and 9 kg component B
Total weight, kg	63 kg
Delivery date	2004-08-30

Component A Lotno.	Component B Lot.no	Viscosity Pas	Resistivity mOhm	Adhesion
	Specification	75+-25	Max 50	Ok
04083001	04083001	71	23	Ok
04083001	04083002	73	22	Ok

Nolato 8615 A+B is mixed in weight ratio 1:8,04.

The viscosity is meassured with a Physica Rheolab MC1 rheometer equiped with a plate-to-plate system at share rate 10 s

A gasket is dispensed on a Ni/Sn plated aluminium surface. The gasket is after-trea

The resistivity of the gasket is measured with two flat electrodes 10x10 mm that are pressed to the gaset with a force of 7,5 N and a distance of 10 mm.

The adhesion is tested by peeling of the gasket by hand. The breakage should be ir not at the contact area to the surface.

We certify that this delivery of conductive silicone rubber has been produced and tested and approved according to the relevant parts of the established quality

Date: 2004-08-30
Sign: Magnus Mattsson

Picture 13. Example of Certificate of Conformity.

3.5 STORAGE

The materials can be transported and handled at room temperature during a few weeks.
For any planed storage time it is recommended to store the material in a freezer.

Each cartridge is marked with a "best-before-date" of 4-6 month from production date, if stored colder than -18 °C. This time includes up to four weeks of handling and transportation at room temperature. During too long storage the filler can settle causing an inhomogeneous product which may cause production difficulties.

Mixed material, ready to use, should be stored in a freezer at -18 °C. There the shelf life time is minimum 1 month.

If material has been stored for longer periods than indicated above it may not be bad but product properties should be checked before use.

3.6 MIXING

Component A and B should be mixed with the correct weight ratio of A and B. If mixing is done on a volume basis it is advisory to check by weighing cartridges that the correct weight ratio was reached. The expected volume ratios for different materials are given in table 3.

A different ratio of A:B generally leads to incomplete curing. The rubber then remains soft or even tacky. The mechanical and electrical properties are much lower. Although it has been found that deviations of up to 10 % hardly have any noticeably effect.

Mixing is preferably made in a machine that is capable of pressing material from cartridge A and B in the exact mixing ratio through a static mixer and into the production cartridge. A detailed operating description of the fixed ratio machine from Nolato is found in document "Operating instructions for Trishield Mixer 1:1 and 1:2,5".

When mixing the material in a batch mixer component A and B are mixed under vacuum in a planetary mixer. The mixed material is pressed directly into the dispensing cartridges from the mixing vessel. The important factor is to have a good vacuum during mixing to avoid that air bubbles enters the material and dispensing cartridges. General mixing instruction for this type of mixer is found in document "Mixing of Nolato material in a batch mixer".

One alternative for small prototype production is to mix component A and B in an open vessel by hand or with a slowly moving mechanical agitator for 2-5 minutes until the material is thoroughly mixed.

The mixed material should be placed in a vacuum chamber to remove all air-bubbles that was introduced during mixing. Air-bubbles do not affect the curing but they may give open "holes" in the dispensed gasket. These holes may on prototypes be repaired manually after dispensing but it is not a suitable method for mass production. A treatment in vacuum for 3 minutes at 15 mbar is normally enough to remove all air-bubbles. Vacuum treatment is preferably performed both on the mixed material and on the filled dispensing cartridges.

Independent of mixing system used cleaning is very important. Make sure to clean every part of the mixing machine that has come in contact with mixed material after use. Even tiny amounts of component A is enough to start a reaction if it comes in contact with component B. The uncured material will then cure by time. Depending on the contamination it could be complete cure to hard rubber or partly cure to soft lumps up to several centimetres in diameter in the rubber. Any piece of cured rubber that follows mixed material into a dispensing cartridge could cause blockage of dispensing needle giving production problems.

One alternative to cleaning is to keep the part of the machinery that is in contact with mixed material in a freezer between uses.

3.7 POT LIFE

The pot life is the period of time over which the mixed material can still be dispensed. The pot-life depends greatly on the temperature and to some extent also to the dispensing unit.

In general Nolato guaranties a pot life of 12 hours for its materials. This is defined as a period under which the material can be stored at 20 °C and still have a viscosity of maximum 150 Pas and an ok curing at 100 °C for 30 minutes.

It is a known fact that storing the mixed material at room temperature will shorten the pot-life. This could be seen as bad adhesion, high resistance and a soft and tacky gasket. Increase of temperature and time in the curing oven may be needed.

Another fact is that keeping A and B component at room temperature for long time before mixing will shorten the pot-life. After mixing the material may have normal viscosity and curing but after keeping mixed material at 20 °C for some hours the viscosity will increase over time. This could lead to a low flow of material from the dispensing cartridge. Machines that use compressed air to feed the dispensing needle are sensible to small changes in viscosity. An adjustment of air pressure or dispensing speed may be required. Dispensing machines that use pumps or hydraulic pressure to feed the dispensing needles are more robust and do not suffer directly.

3.8 CURING

Normal curing takes place in a hot air circulating owen at 100 °C during 30 minutes. Longer times or higher temperatures may be required if the heat transfer in the oven is low. Increasing temperature can shorten the curing time. Maximum recommended temperature is dependent on the substrate the dispensed gasket is applied upon. The gasket itself is unaffected after several hours at temperatures up to 180 °C.

The criteria for a well cured product are that the gasket has hardened and that further heat treatment does not change the resistance, adhesion or gasket weight.

During the curing at elevated temperature some short chain and cyclic silicone molecules and petroleum distillate evaporates. For this reason the furnaces should be well ventilated to avoid nuisance and danger for the operators.

A number of substances which impair the action of the platinum-complex catalyst can inhibit the curing. These impurities may be present on the surface of the substrate or in the ambient air. The most important inhibitors are sulphur and sulphur containing molecules, amines, urethanes, various oils, waxes and many release agents.

We strongly recommend carrying out preliminary trials to identify those materials that may come in contact with the uncured rubber.

Adhesion of the rubber is very good on several surfaces as for instance aluminium covered with tin on nickel as well as chromated or passivated aluminium. For good adhesion the surface must be clean and free from dirt, oils and organic material. Bad adhesion is in most cases caused by a contaminated surface. In case of problems try to clean the surface by washing or wiping with a cloth soaked in solvent. Organic contaminants may also be removed by flaming the surface shortly before application of the silicone.

Increasing the curing temperature to 150 °C and increasing the curing time to 60 minutes may sometimes help to develop adhesion to difficult surfaces.

Adhesion on difficult surfaces as for instance silver plated aluminium is improved with the help of a primer that is painted on the surface and allowed to dry before dispensing. Nolato can recommend the use of "Silopren bonding agent TP3621" from Momentive or "OS 1200 primer" from Dow Corning.

3.9 CLEANING

A grease-dissolving solvent, such as petroleum distillate, will remove uncured rubber from containers and clothing. Cured material can only be removed mechanically. It can not be re-dissolved. First swell it in solvent and then scrape it of.

Take care that the workplace is well ventilated when you handle solvents, and also follow the appropriate safety instructions.

It is often best to allow surplus material on any hard surface to cure after which it can be readily removed mechanically.

Uncured product could possibly be collected and reused. Cured product can be disposed as normal industrial waste according to local regulations.

4. PRODUCT DESIGN

4.1 HOUSING

The shielding housing is generally made of metal or plastic, depending on the mechanical requirement of the application. Commonly used metals are aluminium and magnesium.

If plastic is to be used it is important to select a material that can withstand the curing at least 100 °C for 30 minutes without deformation or warping.

The Trishield® process is very flexible and can handle almost any size and shape of substrate. The only limitation is that the part should be able to fit into the forming unit. The time needed for set-up and the production throughput is however dependent on the part design. It is advisory to use the following checklist when designing the part.

- How can the part be exactly positioned in dispensing fixture? Is there a possibility to use a through-hole for a pin positioner or use well defined corners without gate marks for guiding? Can vacuum be applied to hold down the part in the fixture?
- Is the part to part reproducibility of the ribs to be dispensed ok? X and Y dimensions should generally be reproducible within 0,2 mm.
- Is the part to part height reproducibility ok? Z dimension i.e. the flatness should generally be reproducible within 0,4 mm.
- Is the width of the ribs to be dispensed large enough? A rule of thumb is that the rib should be at least 0,5 mm wider than the gasket dispensed width.
- Is the surface for the gasket flat? Grooves may give problem to keep height and width tolerances.
- Any sloping surfaces? Dispensing on surfaces with more than a 45 degree angel from horizontal is difficult.
- Can short gasket segments with open ends be avoided? This may give problems with height tolerances.
- Is the dispensing route obstructed by a sidewall or a pin etc? Use of short needles is good for high speed dispensing. A distance of min 0,25 mm is recommended between gasket and any obstruction.
- Are there dead end holes? If holes are drilled through the part there will be less contamination in surface treatment and later on fewer problems with gasket adhesion.
- Is there any ferromagnetic material on the housing? This may disturb the gasket shape in the post treatment.

4.2 SURFACE TREATMENT

Aluminium can, in a mild environment, be used for a shield without surface treatment. For harsh environment it can be passivated or plated with Nickel/Tin or Copper/Silver. The surface treatment may improve the electrical contact and thus the shielding effect. The rule of thumb is that the lower the surface resistance is on the part the better shielding you will achieve.

Magnesium parts should always be plated to stop oxidation of surface. Electroplating of copper and nickel and possibly a topcoat of black chrome or white bronze or similar is often used.

Housings of plastic must always be metallized in order to act as an EMI shield. The most common methods are electrolytic or electroless copper/nickel, vacuum deposited aluminium and conductive painting. The different methods all have their advantages and disadvantages. For the selection of surface treatment it is important to consider shielding requirement, ageing requirement, cost and logistics.

In the selection of surface treatment it is also important to consider the adhesion of the gasket. The adhesion promoters inside Nolato materials are optimised for use on aluminium covers. Adhesion of the rubber is also very good on most surface treatments provided that the surfaces are clean and free from dirt, oils and organic solvents.

Because of the individual surface properties each new type of surface treatment must be tested for adhesion before mass production.

Adhesion may be improved by using a primer before dispensing but this process adds costs and should be avoided.

4.3 GASKET DESIGN

The most important parameter to decide is the gasket height. To achieve an electrical contact with a PCB a dispensed gasket needs to be compressed 5-10 % of its original height. Increased compression does not improve the electrical contact to a larger extent.

In a construction the gasket should be designed to take up the tolerances and close any gap between the housing and the PCB. To achieve a good seal and electrical contact it is recommended that the gasket is compressed between 10 and 50 %. The nominal value could be 20-30 %. Mechanical compression stops are recommended.

Once the tolerances of the mechanical system are known the gasket height should be calculated. Normal gasket heights are between 0,5 and 2,0 mm.

The width of the gasket is linked to the height due to the free forming process and the viscosity of the material. Traditional D-shaped gaskets as Nolato 8700 and 8710 are quite wide. Trishield gaskets as Nolato 8800, 8812, 8813 and 8817 are designed as narrow gaskets to reduce cost and compression force. Please note that increasing the gasket width does not improve shielding performance.

To allow the dispenser to focus on the important height it is recommended to specify only a maximum width.

The selection of gasket materials is made by end-customer and Nolato based on technical requirements as shielding effect, compression forces, corrosion properties, cost and earlier experiences. Typical applications for different materials are shown in the table below.

Plan the dispensing for shortest and quickest possible needle travel. Place start and stops close to screws to avoid problems with compression. Start and stop where possible against another gasket. Minimise number of start and stop in "open air".

Table 5 Typical applications for different materials.

Product	Application
Product	Application
Nolato 8510	Core material in Trishield Soft® gaskets used for very soft gaskets
Nolato 8520	Traditional silicone for environmental seals
Nolato 8700	Traditional Ag/Cu filled gasket for plated surfaces
Nolato 8710	Traditional Ag/Al filled gasket for applications in corrosive environment
Nolato 8800	Trishield Ag/Ni filled gasket for plated surfaces
Nolato 8801	Shell material in Trishield Soft® gaskets used for very soft gaskets on plated surfaces
Nolato 8812	Trishield® Ni/C filled gasket for passivated aluminium. Excellent shielding and ageing
Nolato 8813	Trishield® Ni/C filled gasket for passivated aluminium. Excellent shielding and ageing, softer than 8812
Nolato 8817	Trishield® Ni/C filled gasket for passivated aluminium. Good shielding and ageing, softer than 8813
Nolato 8818	Shell material in Trishield Soft® gaskets used for very soft gaskets on passivated aluminium

4.4 SPECIFICATION AND TOLERANCES ON GASKET

Specification and tolerances of the gasket should be discussed with the end-customer in all new applications. Typically there are specifications on gasket height and width as well as resistance and adhesion. In this chapter we give examples of how Trishield® gaskets can be specified.

The most important specification is on the gasket height. In the production there will be variation in gasket height due to variation in the dimensions of the part and variations in the dispensing parameters. A good vacuum fixture that can flatten warped parts during dispensing is a good help in keeping variations low.

The width of the gasket is linked to the height due to the free forming process and the viscosity of the material. Trishield® formed gaskets are designed as narrow gaskets to reduce cost and compression force. It is strongly recommended to focus on gasket height and have wide tolerances on gasket width. Typical tolerances on height and width of Trishield® formed gaskets are shown in table 6 and 7.

Table 6 Suggested specification on gasket height

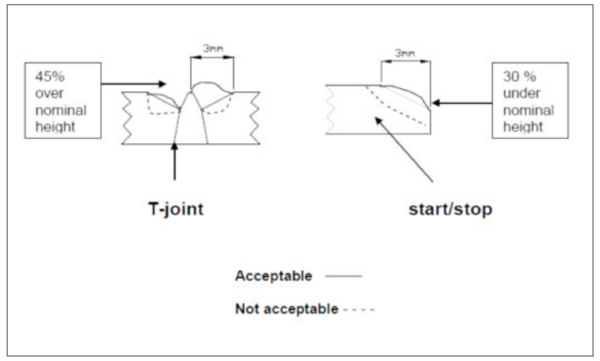
Nominal gasket height, mm	Height tolerance, mm
< 1 mm	+-0,10
1-1,5 mm	+-0,15
> 1,5 mm	+0,25 -0,15

Table 7 Suggested specification on gasket width

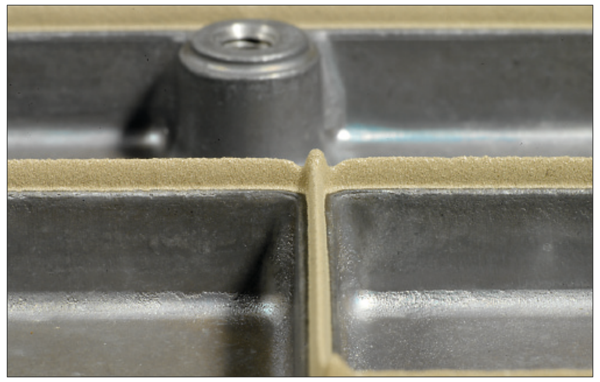
Nominal gasket height, mm	Gasket shape	Maximum width
All	Trishield®	Gasket height -0,1 mm
< 1 mm	D-shape	Gasket height +0,2 mm
> 1 mm	D-shape	Gasket height +0,3 mm

The above mentioned gasket dimensions are achieved on the steady-state dispensing on straight runs. In the start and stop zones there will be a slight difference in the gasket cross section. The start and stop zones are defined as an area 3 mm in each direction around the location of a start or stop or T-joint. In these areas the height may differ from -30 up to +45 %.

Below we can see two figures, displaying the T-joint and the start/stop situation.



Picture 14. Sketch of defects in start and stop locations.



Picture 15. Example of typical defects in start and stop locations.

The electrical resistance that can be measured on the gasket depends very much of the surface conductivity of the part and the measurement method. Nolato recommends the measuring fixture R1, described in chapter 6.2.

When a Trishield® gasket of for instance 8800 is dispensed on a Ni/Sn plated part a resistance of less than 50 mohm is measured. If the same gasket is placed on an insulating material a resistance of a few ohms is measured. It is therefore very important to check resistance on any new combination of material and surface before setting up a specification for the part.

There is not any big difference in measured resistance between different gasket heights. Typical specifications of resistance on a gasket on different surfaces are listed below. Note that there are many different types of passivated surfaces. With a thicker layer of passivation, the resistance will be higher.

There is no direct link between the resistance level and good shielding. The important factor is to produce gaskets of the same resistance level as was found to be ok in first verification tests at the end-customer. The main purpose of following the resistance in the production is that a stable resistance is a very good indicator of a stable process. Occasions of high resistance is on the other hand a sign of an unstable process and indicates a potential shielding problem.

Table 8 Typical resistance specification on different surfaces measured with Nolato R1 method.

Surface	Max resistance, mohm
Ni/Sn plated Al	50
Al or passivated Al	200-600

Adhesion of the gaskets is normally specified as minimum 0,6 N/mm^2 in shear force. Calculated on the nominal gaskets width the adhesion could be expressed in N/cm gasket length. To survive normal transportation a minimum of 7 N/cm is recommended.

Table 9 Typical adhesion specifications.

Nominal gasket height, mm	Min adhesion, N/cm
0,8	7
1,3	7
1,6	10

4.5 PRODUCTION COST CALCULATION

The production cost for Trishield® gaskets is influenced by a number of factors.

Cost for dispensing
Length of gasket, number of start and stop, speed of dispensing, availability for the machine and hourly cost for the machinery including personnel.

Cost for material
Lengths of gasket, height of gasket, width of gasket, yield and cost per kg of material.

Cost for overhead
Supporting organisation.

One important factor for the cost is the material consumption per meter of gasket length. This number can vary greatly depending on how optimised the dispensing unit is. It is advisory to do actual dispensing of the part and weigh the wet material to accurately define the material consumption in each project.

5. TRISHIELD® PRODUCTION

5.1 DISPENSING

To make the Trishield® gasket you can use any dispensing machine, the Nolato unique part is the forming step process. For operation and maintenance of the dispensing machine please consult the machine manufacturer. In this document we focus on the Trishield® process.

All Trishield® gaskets are made using a single bead dispensed gasket. All gasket defects such as piles of material, tips, and gaps will increase in size in the forming step. Therefore it is important to have a fault-free gasket from the dispensing at the start. It is also important to have the gasket as narrow as possible. A narrow bead will give a narrow Trishield® gasket. By adjusting the needle dimension, feeding of material and speed of machine you can get the height and width you need. If for special reasons you do not want to have a narrow gasket, the bead must be wider from the start.

It should be noted that the Nolato 8800 material gives a narrower gasket than the 8812, 8813 and 8817 materials.

In this document we focus on three height dimensions of the gasket. These dimensions represent the normal range of gasket design.

In the table below you can see what approximate dimensions on wet gasket you need to have before the forming step, in order to achieve the standard dimensions for the final gasket. It should be noted that the gasket shrinks and loses about 7 % of its weight during curing.

Table 10. Typical gasket dimensions of Nolato 8800 at different production stages.

Dispensed gasket dimensions		Formed gasket dimensions		Cured gasket dimensions	
Height, mm	Width, mm	Height, mm	Width, mm	Height, mm	Width, mm
0,53	0,72	0,84	0,45	0,80	0,43
0,87	1,17	1,37	0,74	1,30	0,70
1,20	1,62	1,89	1,02	1,80	0,97

Table 11. Typical gasket dimensions of Nolato 8812, 8813, 8817 at different production stages.

Dispensed gasket dimensions		Formed gasket dimensions		Cured gasket dimensions	
Height, mm	Width, mm	Height, mm	Width, mm	Height, mm	Width, mm
0,68	0,91	0,85	0,68	0,80	0,63
1,11	1,49	1,39	1,11	1,30	1,03
1,53	2,06	1,92	1,53	1,80	1,43

Remember to do the dispensing very carefully since all small defects in the wet gasket will increase in the forming step process. In Start/stop and T-joints it is easy to get tips in the gasket. To avoid tips at start, let the needle start to move first and then start feeding the material. Keep the needle just above the gasket. At stop sequence stop the material first and continue then the move of needle about 10 mm, lower the needle to the gasket height and go back and forth to sweep the gasket even. This will erase most of the unevenness in the bead.

To improve adhesion for the gasket it is sometimes useful to treat the product before dispensing with an open flame from a gas burner. The flame will burn off some organic residues and oxidize the surface.

In general dispensing with Trishield Soft® Dispensing Head is no different from dispensing with normal Trishield® material. The process with applying the material, the post processing and curing in oven is the same. For detailed instruction for handling the equipment see "Operating instruction Trishield Soft®".

5.2 TRISHIELD® FORMING

The special triangular and narrow shape of the Trishield® gasket is achieved at the forming step. The forming unit is simple to operate and the unit has no need for regular maintenance. The magnetic field is set to 1100+-200 Gauss by Nolato in standard applications. In applications where a wide gasket is requested Nolato can set the unit on a lower level to 750+-150 Gauss. The setting of magnetic force is to be done by qualified Nolato personnel only. The forming units should be calibrated by Nolato at least once each 3 years.

The unit will always give the same magnetic field unless there is some iron part inside or too close to the forming unit as described in 2.1.2. The only possible production problem is in the power supply. This would be seen as no magnetic field at all, and can easily be detected with a piece of iron.

During operation the part is placed inside the unit. Make sure that the gasket is more than 20 mm from the three open sides. Turn on the power and treat the part for 15 seconds. Turn off the power. Remove the part and cure it. Long waiting times, i.e. more than 5 minutes before and after the forming step will result in a lower gasket and that could give problems with the height tolerance.

The treatment time has an effect on the shielding properties as well as the shape of the gasket. Shorter treatment time will decrease electrical properties of the gasket. Longer time will not improve electrical properties. The recommended standard setting is 15 +-10 seconds. This gives optimum height/with ratio and the best shielding properties.

For special applications where a wider gasket or a higher output is required, a solution may be to shorten the treatment time down to 5 seconds. If this is done it is highly recommended that the electrical properties of the gasket are measured carefully before volume production.

5.3 CURING

Trishield® gaskets are normally cured in a hot air circulation oven at 100-150 °C for 30 minutes. During the curing the polymer is chemically cross-linked. During this process the gaskets harden, adhesion to the surface is developed and electrical resistance decreases. The exact temperature and time need for curing depends on the oven design and part design. Ovens are typically controlled by a thermocouple sensing the inside air temperature. The required set-point depends on the oven construction and it has to be found for each oven. To do this a temperature logger is required. There are several suppliers on the market. One example is the profiler from www.circuitmaster.co.uk.

- Adjust the ventilation from the oven.
- Adjust the oven speed to the required production speed.
- Set the oven temperature. Use a minimum of 100 °C for sensitive surfaces and up to 150 °C for quicker curing and improved adhesion.
- Fill up half the oven with dispensed parts.
- Place the logger in the oven. Measure both the air temperature and the surface temperature of a dispensed part.
- Fill up the rest of the oven with dispensed parts.
- Compared the recorded surface temperature with the requirement.
- Check the produced parts for possible defects from the heat and adhesion and resistance.
- If the minimum requirement of the surface temperature or the product is not ok, change oven settings and repeat the test.
- After a suitable setting has been found it is advisable to regularly check the actual surface temperature to detect any changes in the process.

For a proper curing of Trishield® gasket should the surface temperature of the part be:

- > 100 °C for at least 25 minutes or,
- > 120 °C for at least 20 minutes or,
- > 140 °C for at least 15 minutes or,
- > 160 °C for at least 10 minutes.

The requirement should be seen as a minimum to assure good curing of the gasket.
Bad curing is first seen as bad adhesion and an increased resistance when gasket is compressed. In severe cases also resistance at normal compression increases.

Use of increased temperature or longer times than above requirement may improve adhesion on difficult surfaces. If a primer is used, a minimum surface of 130 °C for 5 minutes is needed for the primer action.

The Trishield® gaskets are not sensitive to high curing temperatures. Several hours at temperatures up to 180 °C will not affect the gasket properties.

5.4 CLEANING

If the gasket is damaged or out of tolerance it is normal practice to remove the gasket and re-use the part. It is easier to remove the gasket after curing. There is then no need for solvent and less risk for spilling material on unwanted areas.

The cured gasket is scraped off with a sharp piece of plastic. As long as the surface treatment is left undamaged performance or adhesion on a reworked part is not affected.

Removal of a cured gasket is very easy if the gasket has been cured at temperatures of 50 to 90 °C. At those temperatures the gasket cures but the adhesion promoters in the rubber are not active.

5.5 CHECK LIST

This is a short check list that can be used in an audit to check that the Trishield® production is ok.

1. Is the Component A and B stored in a freezer?
2. Is the freezer temp colder than -10 °C?
3. Is the components used before the “best-before-date”.
4. Is FIFO applied for the component A+B?
5. Is the mixing equipment mixing A and B in correct ratio +-10 %?
6. Is the mixed material free from air-bubbles?
7. Is the mixing machine properly cleaned after use?
8. Is the mixed material stored max 12 hours at room temperature before use?
9. Is mixed material that is not consumed the same day stored in a freezer?
10. Is FIFO applied for the mixed material?
11. Is the dispensing machine capable of accurate movements in XYZ axis?
12. Is the dosing speed well controlled and matched to the dispensing speed?
13. Is the product fixture capable of a reproducible placement of the part in XYZ axis?
14. Is the dispensing program ok with smooth dispensing in start and stop?
15. Is the part placed in the forming unit within 5 minutes?
16. Is the forming unit calibrated to 1100+-200 Gauss?
17. Is the part well inside the forming unit and allowed to stay still during the forming?
18. Is the forming time 15+-10 seconds?
19. Is the part sent to the oven within 5 minutes?
20. Is the oven calibrated to give a surface temperature above 100 °C for at least 25 minutes?
21. Is 100 % of the produced parts visually inspected and in case of need trimmed or repaired?
22. Is the gasket height and width regularly measured?
23. Is the resistance and adhesion regularly measured?
24. Are the measurement results recorded?
25. Are the measurements quickly fed back to the dispensing machine for optimisation?
26. Are the equipments for measuring gasket dimensions and resistance and adhesion calibrated?
27. Is the packaging method protecting the gasket for transportation damages?

5.6 TROUBLE SHOOTING

This is a list of the most common problems and causes.

Height or width out of tolerance

- Improper adjustment of the dispensing
- Needle size and height
- Speed of dispensing and material feed
- Too long waiting time
- Use short and even waiting time before forming step
- Use short and even waiting time before curing

Height or width out of tolerance at start and stop

- Improper adjustment the dispensing
- Needle height
- Speed of dispensing and material feed
- Adjust overlapping of beads in joints

Bad adhesion

- Bad curing
- Too low oven temperature, increase the set point
- Too short time in the oven, adjust the time in the oven
- Check mixing equipment and mixing ratio
- Dirt on surface
- Flame the surface with an open flame
- Wipe surface with a solvent
- Wash the part in a alkali wash

Poor conductivity

- Bad curing
- Too low oven temperature, increase the set point
- Too short time in the oven, adjust the time in the oven
- Check mixing equipment and mixing ratio
- Low surface conductivity on the part
- Clean the part
- Contact the surface treatment supplier

6. QUALITY ASSURANCE IN PRODUCTION

In the production of the dispensed gasket it is normal to perform 100 % visual inspection of the gasket appearance. The main factors are:

- The gasket location on the dispensing route.
- That the gasket is present everywhere it is supposed to be.
- That there are no gaps or visible defects on the gasket.
- That the start and stops are ok in height
- That the gasket adheres to the surface with a light pressure sideways with a finger.

The gasket height is regularly inspected and controlled. Gasket width, electrical resistance and adhesion are also inspected regularly. Nolato typically does these inspections once every second hour. Results are stored in a SPC database for a good overview of results and to have a possibility to react if the process turns unstable.

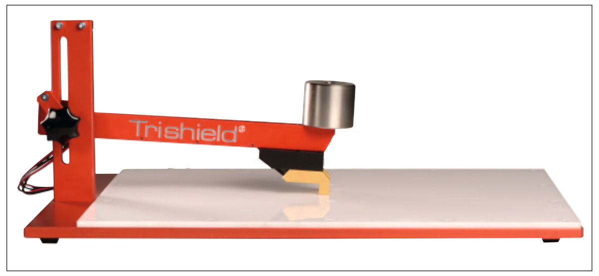
6.1 HEIGHT AND WIDTH MEASURMENT

Dimensions are best measured using an optical measuring machine. There are several manufacturers such as OGP Smart Scope and Mitutoyo.

Picture 16. An optical measuring machine could be used for height and width measurement

6.2 RESISTANCE MEASUREMENTS

The electrical resistance is measured by pressing two square electrodes 10x10 mm with a distance of 10 mm to the gasket with a force of 7,5N.



Picture 17. Example of Nolato resistance measurement, method R1.

6.3 ADHESION MEASUREMENTS

Adhesion is measured with a square push bar with a width of 10 mm that is pressed to the gasket base until it is sheared off the part or bends over.

Picture 18. Example of a Trishield® adhesion tester

7. ASSISTANCE

If there are any questions on how to design or produce a Trishield® gasket, do not hesitate to contact your contact person at Nolato Silikonteknik or the Market department for assistance. Updated contact information can always be found on our web site www.nolato.com/silikonteknik.

Trishield®

Nolato Silikonteknik AB
Bergsmansvägen 4, 694 91, Hallsberg
Tel +46 582 889 00. Fax +46 582 889 99. E-post: silikonteknik@nolato.se
www.nolato.com/silikonteknik

2012-11-22 www.npp-reklam.se