

Technical white paper - Geometry-  
Driven EMI Shielding with Form-In-Place  
Gaskets



## EXECUTIVE SUMMARY

Electromagnetic interference (EMI) leakage through gaps in electronic enclosures poses a significant challenge in the electronics industry. While conductive silicone gaskets are employed for shielding, the incorporation of conductive particles often results in rigid gaskets requiring substantial compressive force for effective sealing. This rigidity can lead to increased assembly complexity, higher weight, and a risk of damage to sensitive electronic components. This paper explores the limitations of conventional conductive silicone gaskets and presents an innovative solution: Trishield®, a magnetically shaped form-in-place (FIP) gasket developed by Nolato Silikonteknik. This technology utilizes a magnetic field to orient conductive and magnetic particles within a liquid silicone matrix, enabling the creation of compressible and flexible gaskets with a high height-to-width ratio. This unique, magnetically shaped geometry enables high EMI shielding effectiveness while reducing material usage, lowering required assembly forces, and increasing design flexibility relative to conventional gasket profiles.

## INTRODUCTION

### THE GROWING NEED FOR EFFECTIVE EMI SHIELDING

The proliferation of electronic devices across various industries, including telecommunications, automotive, medical, and aerospace, has intensified the focus on electromagnetic compatibility (EMC). Electronic equipment must operate reliably without emitting unacceptable levels of EMI that could disrupt the functionality of nearby devices. Furthermore, these devices must be immune to external EMI sources to ensure their own stable operation. A critical aspect of achieving EMC is the effective shielding of electronic components within enclosures. Gaps and seams in these enclosures can act as pathways for electromagnetic interference, compromising the overall shielding effectiveness. Conductive gaskets are commonly employed to seal these gaps and provide a continuous conductive path, thereby forming a Faraday's cage that attenuates electromagnetic radiation.

## THE CHALLENGE

### BALANCING CONDUCTIVITY AND FLEXIBILITY IN EMI SHIELDING GASKETS

Form-in-place (FIP) gaskets, dispensed directly onto the enclosure surface and cured in place, offer advantages in terms of design flexibility and automated application. These gaskets are often made of silicone rubber due to its excellent environmental resistance, flexibility, and long-term stability. To achieve EMI shielding, conductive particles, such as silver, nickel, or carbon-based materials, are incorporated into the silicone matrix. However, this approach presents a significant challenge: the addition of a sufficient volume fraction of conductive particles to achieve the required electrical conductivity often results in a substantial increase in the hardness and stiffness of the gasket material. This increased rigidity necessitates the use of numerous fasteners (e.g., screws) to apply the high compressive forces necessary for electrical contact across irregular gaps required for effective EMI shielding.

This requirement for high clamping forces leads to several drawbacks:

- **Increased assembly complexity and time:** Installing and tightening a large number of fasteners is time-consuming and labor-intensive.
- **Higher weight:** The increased number of fasteners contributes to the overall weight of the electronic assembly, which is a critical concern in weight-sensitive applications such as aerospace, telecommunications, and portable electronics.
- **Risk of component damage:** Uneven or excessive clamping forces can induce stress on the enclosure and the enclosed electronic components, potentially leading to deformation or damage.
- **Limited design flexibility:** The need for substantial flat surfaces and numerous mounting points can restrict the design of the enclosure and the placement of components.

Furthermore, achieving a good seal with rigid gaskets over irregular or non-planar surfaces can be challenging. The gasket may not conform perfectly to the contours of the mating surfaces, leading to gaps and reduced shielding effectiveness.

## THE INNOVATION

### MAGNETICALLY SHAPED FIP GASKETS FOR ENHANCED PERFORMANCE

To address the limitations of conventional conductive silicone gaskets, Nolato Silikonteknik has developed a magnetically shaped form-in-place (FIP) gasket concept, implemented as Trishield®, an innovative FIP gasket solution that leverages magnetic field shaping to achieve a high height-to-width ratio. This unique geometry provides increased compressibility and flexibility while maintaining effective EMI shielding properties.

### TRISHIELD® TECHNOLOGY

Trishield® gaskets are formulated using a liquid silicone matrix filled with particles that are both electrically conductive and magnetically responsive. The system is typically (but not limited to) a two-component addition-cured silicone formulation. The silicone material is designed to be self-bonding to the surface of the electronic enclosure, ensuring a secure and continuous conductive interface.

The key innovation lies in the application of a magnetic field after the dispensing and before the curing phase of the gasket. After the conductive silicone material has been dispensed onto the enclosure, a carefully controlled magnetic field is applied. This field interacts with the embedded particles, causing them to align along the field lines. Consequently, the FIP gasket is elongated in the direction of the magnetic field, resulting in a tailored geometry. This geometry is then fixed during the curing phase.

### ACHIEVING A HIGH HEIGHT-TO-WIDTH RATIO TRIANGULAR SHAPE

By precisely shaping the magnetic field, the dispensed silicone material can be formed into a triangular cross-section with a significantly higher height-to-width ratio compared to conventional D-shaped or rectangular gaskets. This unique geometry offers several advantages:

- **Enhanced compressibility:** The tall, narrow triangular shape allows for greater deflection under compression. This increased compressibility enables the gasket to effectively seal irregular gaps with lower applied force.
- **Improved flexibility:** The high height-to-width ratio also contributes to the overall flexibility of the gasket, allowing it to conform more readily to non-planar surfaces and accommodate dimensional variations between mating parts.
- **Efficient material usage:** For a given sealing area, a triangular gasket with a high height-to-width ratio requires less material compared to a wider, flatter gasket. This translates to lower material costs and a lighter overall assembly.

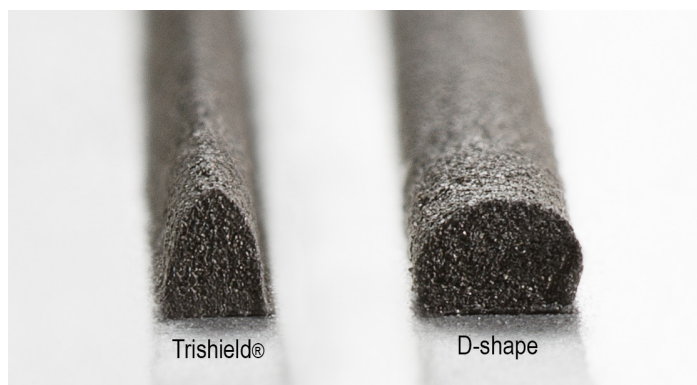


Figure 1. The Nolato Trishield® technology enables an increased height-to-width ratio, resulting in several advantages over the traditional D-shaped profile.

## THIXOTROPIC PROPERTIES FOR PRECISE DISPENSING AND SHAPE RETENTION

The Trishield® material is engineered to exhibit thixotropic behavior before curing. This means that the viscosity of the material decreases under shear stress (e.g., during dispensing through a needle) and recovers when the shear stress is removed. This property is crucial for:

- **Precise dispensing:** The low viscosity during dispensing allows for accurate and controlled application of the gasket material onto the enclosure surface.
- **Shape retention:** After dispensing and during the application of the magnetic field, the thixotropic nature of the material ensures that the shaped gasket maintains its high height-to-width ratio and does not collapse before the silicone matrix is fully cured.

## ADVANTAGES OF TRISHIELD® COMPARED TO CONVENTIONAL EMI SHIELDING GASKETS

The magnetically shaped Trishield® gasket demonstrates several measurable advantages over conventional conductive silicone gaskets, particularly D-shaped profiles:

- **Enables EMI shielding in highly miniaturized designs:** Trishield® enables effective EMI shielding where the available dispensing area is limited. Unlike conventional D-shaped profiles, in which gasket height scales directly with footprint width, the Trishield® geometry allows increased gasket height to be achieved without increasing the required footprint. This decoupling of gasket height from footprint width supports EMI shielding in highly compact electronic architectures.
- **Reduced material usage and cost:** The high height-to-width ratio of the triangular shape allows for effective sealing with less material, leading to lower material costs per unit. Nolato Trishield® reduces material use by 48% compared to traditional D-shaped gaskets (see Table 1).
- **Lighter assembly:** Less material in the gasket and the potential for fewer required fasteners contribute to a lighter overall electronic assembly. This is particularly beneficial in weight-sensitive applications. For instance, a case study involving an electronic shielding showed a 13% reduction in total weight (see Table 1).
- **Lower assembly force:** The enhanced compressibility of the Trishield® gasket allows for effective sealing with significantly lower clamping forces. This translates to easier assembly, the potential for using fewer and smaller fasteners, and a reduced risk of damage to sensitive electronic components and enclosures (see Table 1 and 2).
- **Improved conformability to irregular gaps:** The flexibility of the high aspect ratio gasket enables better conformity to non-planar surfaces and irregular gaps, ensuring a more consistent and effective EMI shielding.
- **Faster dispensing needle movement:** Compared to dispensing techniques that rely on rotating the needle to create a specific gasket shape, the magnetic shaping process allows for faster linear movement of the dispensing needle. This can significantly reduce manufacturing cycle times. Figure 3 demonstrates that the Trishield® forming method maintains the shielding effectiveness of conductive rubber gaskets, performing just as well as the more complex rotating needle technique.
- **Improved start/stop accuracy and reduced “tails”:** The controlled shaping provided by the magnetic field allows for cleaner start and stop points during dispensing, minimizing the formation of unwanted material “tails” that can occur with moving needle techniques. The presence of “tails” necessitates manual trimming. Manual trimming of “tails” risks leaving residual material on the PCB, which can cause short circuits and damage electronics.
- **Smaller radius possible:** The precise shaping capabilities of the magnetic field enable the creation of gaskets with tighter inner radius compared to limitations encountered with rotating needle dispensing. This offers greater design flexibility for complex enclosure geometries.

- **Higher Shielding Effectiveness (SE) compared to reference gasket:** Figure 4 compares the Shielding Effectiveness (SE) of Nolato Trishield® product 8950, which uses conductive nickel-coated graphite particles, against a competitor's similar nickel-graphite gasket made with a rotary head. With comparable size and compression, Nolato Trishield® demonstrates higher SE under the tested conditions.

The results presented are based on controlled laboratory measurements using defined gasket geometries, materials, and compression levels, and are intended to illustrate relative performance trends under the tested conditions.

Table 1. Nolato Trishield® vs. D-shaped gaskets: weight and assembly requirements.

Profile	Gasket weight (g/m)	Number of assembly screws required*	Total shielding cover weight (g)*
D-shape	3.28	23	135
Nolato Trishield®	1.70	13	117

\*A case study compared a dispensed D-shaped shielding gasket with a Nolato Trishield® gasket for use as a cover on electronic PCBs, such as those in telecom.

Table 2. The compression force, measured in N/cm, required to compress three parallel silicone gaskets (Nolato materials 8210 and 8952) in Trishield® and traditional D-shapes. The test method is described in the Appendix.

Sample	Gasket dimensions		Compression degree				
	Height (mm)	Width (mm)	10%	20%	30%	40%	50%
Nolato 8210 Material Trishield® shape	0.81	0.40	0.26	1.41	3.51	5.82	6.38
Nolato 8210 Material D-shape	0.83	0.91	0.51	1.88	4.47	8.67	12.80
Nolato 8952 Material Trishield® shape	0.79	0.59	0.20	1.01	2.40	4.35	6.67
Nolato 8952 Material D-shape	0.82	1.04	0.42	1.80	4.07	7.13	10.93

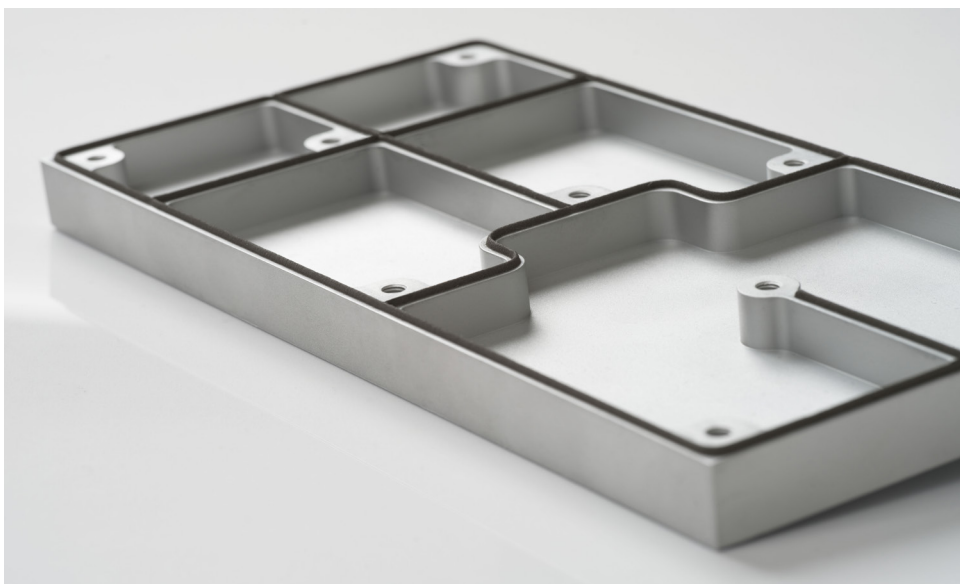


Figure 2. Example of a die-cast metal enclosure with a dispensed form-in-place EMI gasket.

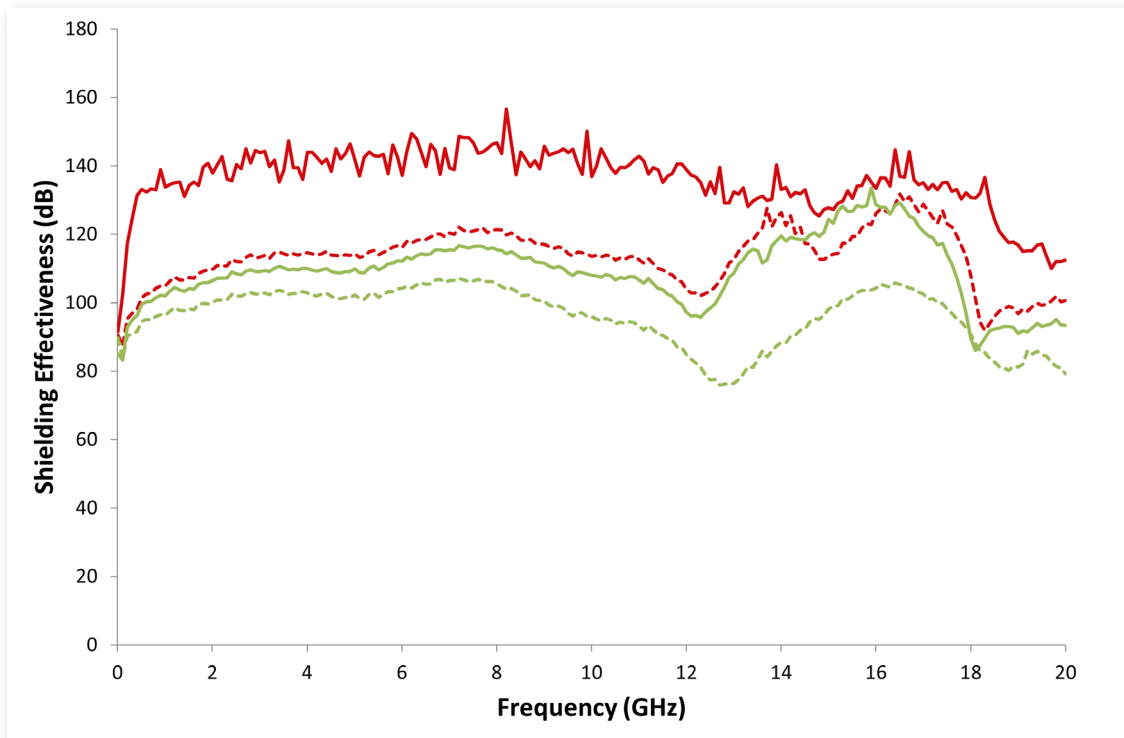


Figure 3. Shielding Effectiveness (SE) at 0–20 GHz for dispensed gaskets (0.9 mm, dashed; 1.6 mm, solid) is shown using Trishield® (red) and rotary head (green) forming methods. All gaskets use the same conductive silicone. The test method is described in the Appendix.

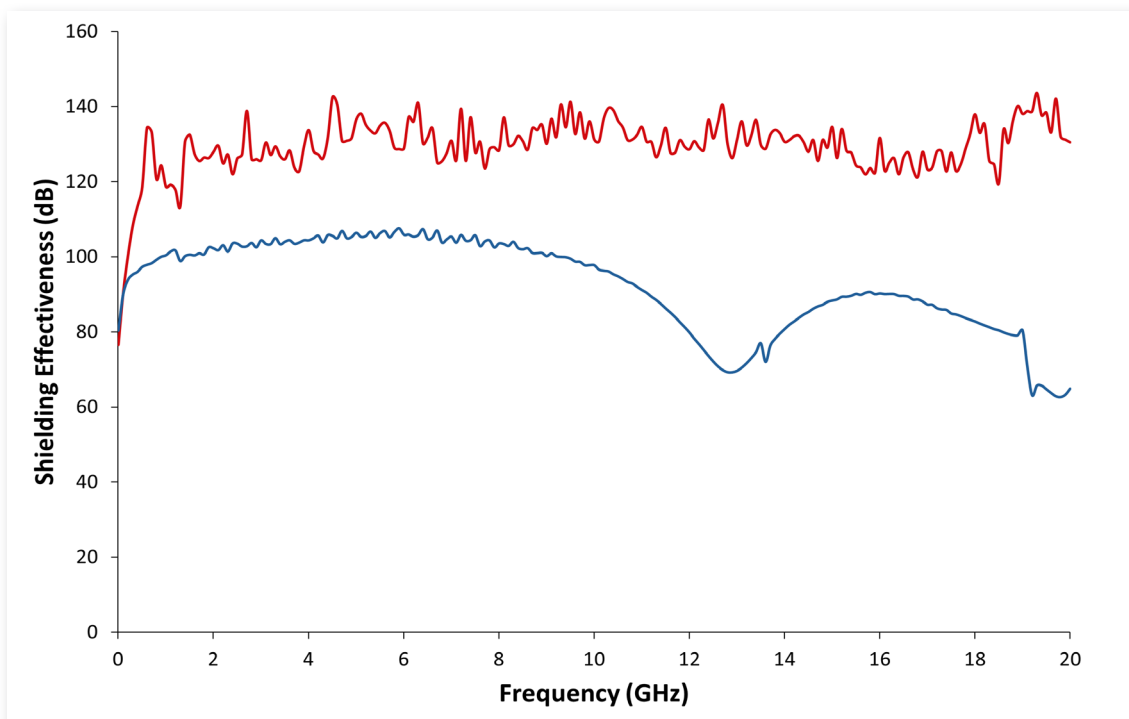


Figure 4. Shielding Effectiveness (SE) of the Nolato Trishield® product 8950 (red) and a reference gasket (blue). Both products used similar nickel-coated graphite particles for conductivity. The reference gasket measured 1.80 mm in width, while the 8950 gasket was 1.71 mm wide. Both gaskets originally had a height of 1.67 mm and were compressed by 40% to a final height of 1.00 mm during shielding measurements in the cavity-to-cavity fixture. SE was recorded across a frequency range from 0 to 20 GHz. The test method is described in the Appendix.

## TARGET APPLICATIONS AND INDUSTRIES

Trishield® magnetically shaped FIP gaskets provide effective EMI shielding across the frequency range from 0 – 20 GHz (Figures 3 and 4). Their unique properties make them ideally suited for a wide range of applications in industries where effective EMI shielding, lightweight designs, and ease of assembly are critical, including:

- **Telecommunications:** Shielding of base stations, network equipment, and mobile communication devices.
- **Automotive:** EMI/RFI shielding in Central Control Units (CCUs), Electronic Control Units (ECUs), Advanced Driver-Assistance Systems (ADAS), infotainment systems, and sensors.
- **Surveillance and security systems:** Ensuring the reliable operation and preventing signal interference in devices such as surveillance cameras, alarm systems, and access control units, where signal integrity is paramount for security and monitoring effectiveness.
- **Medical devices:** Shielding of sensitive diagnostic and therapeutic equipment.
- **Aerospace and defense:** Lightweight and high-performance shielding solutions for avionics, radar systems, and military electronics.
- **Electronics:** Optical transceivers, electrical active cables (AEC), Enterprise SSD, high-speed connectors, shielding laptops, tablets, smartphones, wearables, and other portable devices.
- **Industrial automation:** Protecting sensitive control systems and industrial PCs from electromagnetic interference.

## CONCLUSION: ENABLING NEXT-GENERATION EMI SHIELDING SOLUTIONS

The Trishield® magnetically shaped FIP gasket technology represents an advancement in EMI shielding solutions. By leveraging the unique interaction of magnetic fields with conductive and magnetic particles within a liquid silicone matrix, this innovative approach overcomes the limitations of traditional conductive gaskets. Optimized height-to-width ratio triangular gasket offers improved compressibility, flexibility, and shielding effectiveness with reduced material usage and lower assembly forces. This translates to lighter, more cost-effective, and easier-to-assemble electronic devices with enhanced reliability and performance. As the demand for smaller, lighter, and more powerful electronic devices continues to grow, Trishield® technology provides engineers with a powerful tool to address the ever-increasing challenges of electromagnetic compatibility.

## APPENDIX: TEST METHODS

### SHIELDING EFFECTIVENESS (SE)

The measurement fixtures, comprising a cavity plate and a top plate, were fabricated in-house from aluminum. Measurement cables were securely attached to the fixture using a torque wrench, ensuring the cable did not twist during installation. The network analyzer was calibrated and set for the 0.3–20 GHz frequency band, and ten sweeps were performed across the region to determine the average S21 response. The average S21 response was recorded.

### COMPRESSION FORCE VS. COMPRESSION DEGREE

A tensile testing machine was employed to measure the compression force at increments ranging from 10% to 50%. The materials were arranged in three rows, each measuring 50 mm, on an aluminum plate, utilizing both D-shape and Trishield® shape formats. Compression of the FIP rows was performed with a probe that covered all three rows completely. The test conditions were as follows: speed of 1.0 mm/min, preload of 0.07 N, and a load cell capacity of 500 N.



Nolato Silikonteknik AB  
Bergsmansvägen 4, SE-694 91 Hallsberg, Sweden  
Tel +46 582 889 00 | Fax +46 582 889 99  
[silikonteknik@nolato.com](mailto:silikonteknik@nolato.com) | [www.nolato.com/silikonteknik](http://www.nolato.com/silikonteknik)