3M™ Friction Shims for Automotive Applications

3M™ Friction Shims create possibilities for lightweight and compact design while increasing potential load and peak torque in bolt connections.

Introduction
Especially in the automotive industry, there is a general trend toward compact, lightweight designs that nevertheless must be highly reliable. Typical applications include central bolt designs in crankshaft and camshaft applications, continuous variable timing, balancer shaft modules, and shaft-to-collar connections. The demand for maximum power density, i.e. the transmission of ever greater forces and torque in increasingly compact designs, poses a major challenge to engineers. In friction joints, the given coefficient of static friction imposes definite physical limits on power transmission capabilities. These limits can be overcome by enhancing friction in the joint. When friction joints are designed, physical parameters such as overall size and surface pressure typically can only be varied within a tight window. Load transmission capability in friction joints is thus limited by the friction coefficient of the mating materials. However, many applications require higher levels of power transmission. One way to achieve this is to apply a nickel diamond coating to friction shims for installation in the joint. Depending on other application parameters, the coefficient of static friction can be increased to 0.6 or even higher, resulting in a greatly increased load transmission capacity.

3M™ Friction Shim Diagram

![Diagram](image)

Figure 1. Tribosystem with 3M™ Friction Shim. (This figure is intended as a guide. On request, we can provide you with a drawing frame for your specification.)

Processing
3M friction shims are metal foils with a coating of electroless nickel matrix embedded with a specified quantity of diamond particles of defined size. 3M friction shims are thin enough to fit within close engineering tolerances, creating possibilities for lightweight compact design while increasing potential load and peak torque in bolt connections.

Assembly
Assembly, i.e. applying the bolt preload on a crankshaft with a central bolt design, causes the diamond particles to press into the softer surface of the counterpart. As a result, a micro scale form fit is created between the base part and its counterpart (Figures 1 and 2). The key parameters influencing the extent of micro scale form fit are the counterpart material, the counterpart surface roughness and the applied surface pressure. Figure 3 shows typical coefficients of static friction for various material combinations with and without a 3M friction shim.

**Typical Coefficient of Friction**
(Not for specification purposes)

<table>
<thead>
<tr>
<th>Coefficient</th>
<th>EN-GJS700 / S690QL with 3M™ Friction Shims</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.1</td>
<td>0.3</td>
</tr>
<tr>
<td>0.2</td>
<td>0.6</td>
</tr>
<tr>
<td>0.3</td>
<td>0.8</td>
</tr>
<tr>
<td>0.4</td>
<td>0.8</td>
</tr>
<tr>
<td>0.5</td>
<td>0.8</td>
</tr>
<tr>
<td>0.6</td>
<td>0.8</td>
</tr>
<tr>
<td>0.7</td>
<td>0.8</td>
</tr>
<tr>
<td>0.8</td>
<td>0.8</td>
</tr>
</tbody>
</table>

Figure 3. Results of a series of tests on the coefficient of static friction with and without 3M™ Friction Shims. The shaded areas of the bar show the variation.
Handling Instructions

- Store 3M™ Friction Shims only in original packaging.
- Don't handle 3M friction shims as bulk unless a clip variant is used that has been specifically designed for bulk storage.
- Don't expose 3M friction shims to temperatures above 400°C.
- Avoid contact of 3M friction shims with corrosive substances unless a stainless steel substrate is used.
- Don't bend 3M friction shims.
- No mechanical treatment of 3M friction shims.
- Before assembling 3M friction shims, make sure no dirt residue is present.
- Ensure a minimum contact pressure of 50 MPa.
- Check correct quantity during assembly.
- Avoid relative movement of shims on surface when disassembling.
- 3M Technical Ceramics offers support in defining a suitable assembly concept.

Applications

3M friction shims offer a simple but very cost-effective way to transmit up to four times higher torques than conventional systems – with no need to modify the joint design. We currently produce parts for a variety of engine applications, mainly focusing on crankshafts, camshafts and balancer shaft modules. Further applications include steering, suspension, transmission, chassis and body.

A significant number of car manufacturers have incorporated 3M friction shims into their designs. There are millions of 3M friction shims on the road today, both in automotive and demanding motor sports applications.

Warranty, Limited Remedy, and Disclaimer: Many factors beyond 3M’s control and uniquely within user’s knowledge and control can affect the use and performance of a 3M product in a particular application. User is solely responsible for evaluating the 3M product and determining whether it is fit for a particular purpose and suitable for user’s method of application. User is solely responsible for evaluating third party intellectual property rights and for ensuring that user’s use of 3M product does not violate any third party intellectual property rights. Unless a different warranty is specifically stated in the applicable product literature or packaging insert, 3M warrants that each 3M product meets the applicable 3M product specification at the time 3M ships the product. 3M MAKES NO OTHER WARRANTIES OR CONDITIONS, EXPRESS OR IMPLIED, INCLUDING, BUT NOT LIMITED TO, ANY IMPLIED WARRANTY OR CONDITION OF MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE OR ANY IMPLIED WARRANTY OF NON-INFRINGEMENT OR ANY IMPLIED WARRANTY OR CONDITION ARISING OUT OF A COURSE OF DEALING, CUSTOM OR USAGE OF TRADE. If the 3M product does not conform to this warranty, then the sole and exclusive remedy is, at 3M’s option, replacement of the 3M product or refund of the purchase price.

Limitation of Liability: Except where prohibited by law, 3M will not be liable for any loss or damages arising from the 3M product, whether direct, indirect, special, incidental or consequential, regardless of the legal theory asserted, including warranty, contract, negligence or strict liability.

Technical Information: Technical information, recommendations, and other statements contained in this document or provided by 3M personnel are based on tests or experience that 3M believes are reliable, but the accuracy or completeness of such information is not guaranteed. Such information is intended for persons with knowledge and technical skills sufficient to assess and apply their own informed judgment to the information. No license under any 3M or third party intellectual property rights is granted or implied with this information.