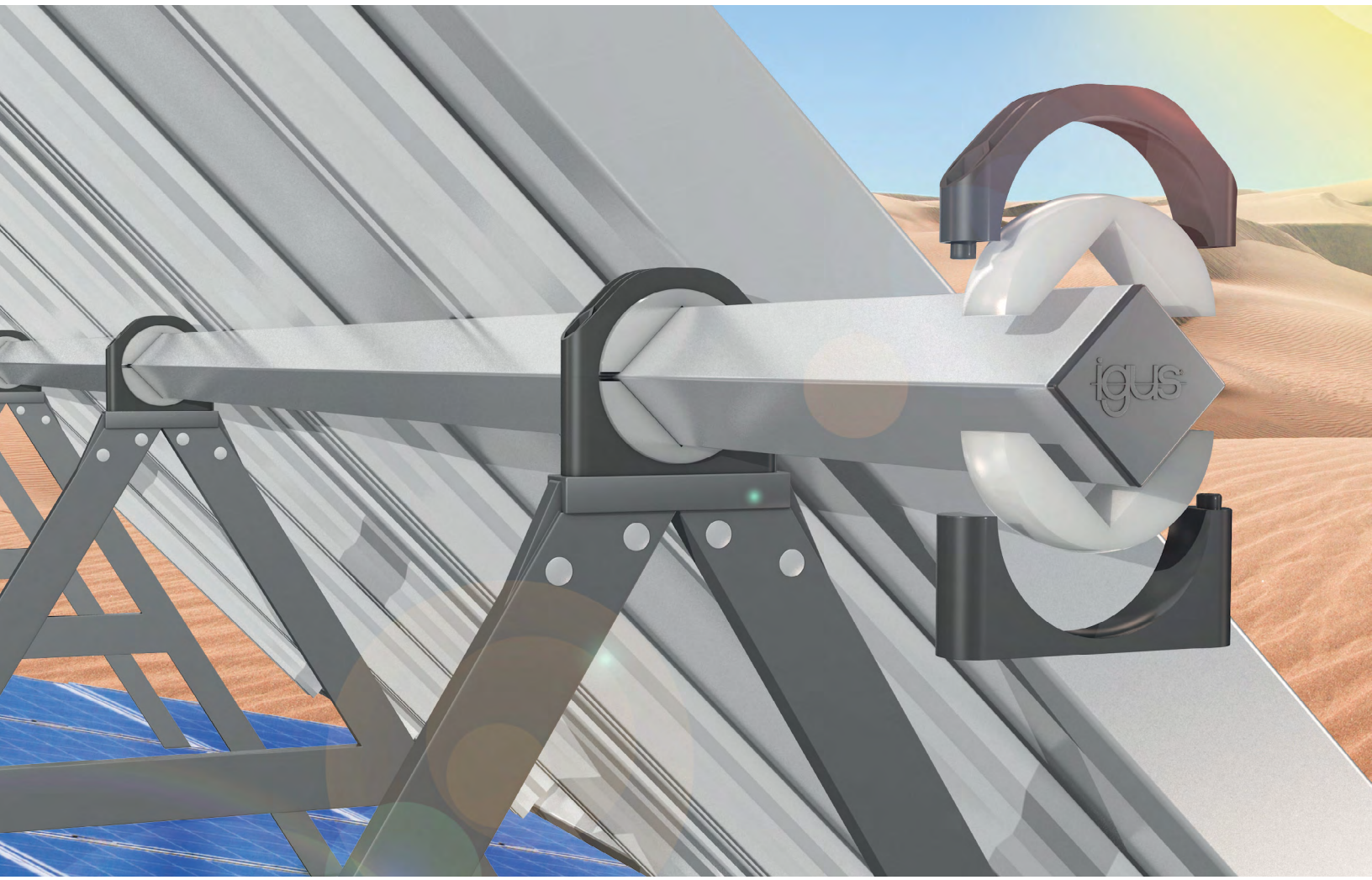
The 25-year solution for solar trackers

Tribologically optimized, maintenance-free polymer pillow block bearings

Introduction & background

The bearings of single axis solar trackers have to withstand harsh conditions like UV, extreme temperatures, exposure to dirt and dust, and more. All this over the course of an expected 25 year service life, ideally with no complete failures and minimal maintenance. Under these conditions, a pillow block bearing made of high-performance plastics with embedded lubricants is the ideal choice — as proven both by extensive test data and real-world experience.



Fixed tilt mounting **vs. tracker systems**

Utility-scale photovoltaic projects are often set up with fixed tilt mounting systems, where thousands of solar panels are mounted at the optimal direction in relation to the sun. Due to the demand for higher energy yield, tracker systems were introduced, and have remained a fundamental part of the photovoltaic industry for over a decade.

The most common tracker systems are single axis tracker systems using 1P (one in portrait) or 2P (two in portrait) configurations. These tracker systems allow up to +/- 60° of horizontal rotation of the solar panels in order to achieve optimal sun exposure throughout the day. This increases energy yield approximately 30% over fixed panels — paying off any additional costs of the tracking system rapidly. However, maintenance costs are still a concern.

Challenging **application conditions**

Utility-scale photovoltaic projects are often installed in very dry areas where environmental factors such as dirt, dust, UV radiation, and wind need to be considered. The structure of a tracker system includes a long steel shaft in various shapes and dimensions (round, square, or hexagonal) which supports the solar panels. This system is driven by a motor and swivels over the course of the day. Since these arrays can reach a length of about 150 meters, intermediate pillars are used to provide additional support for the system. Each supporting pillar is equipped with an individual bearing, which enables the rotation of the panels.

The majority of photovoltaic plants are designed for a lifetime of 25 years. Because of the poor access to these power plants, maintenance is a very important factor. One of the weak spots of a tracker system are the bearings. An unexpected break or premature wear can cause failures or even critical damage of the solar plant, requiring time consuming and costly maintenance.

First steps

A solar tracker is not considered an application with high dynamics. This was the basic thought of the igus engineers which influenced the first market investigations nearly 25 years ago. At first, the designs did not have bushings and they were not considered necessary. It was immediately confirmed that, although the dynamics were small (one cycle per day), it was an application that required some sort of anti-friction element.

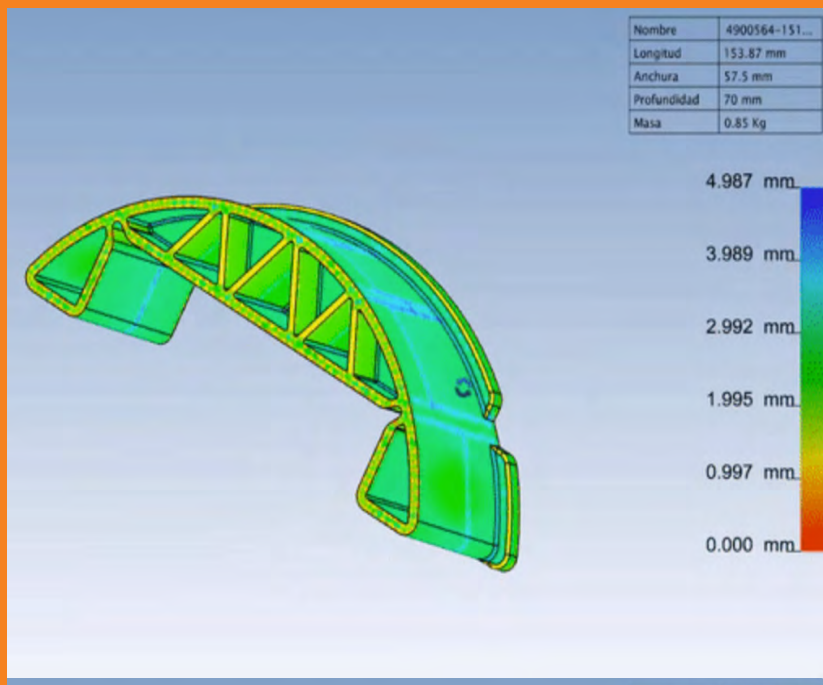
Early on basic plastics were used, but application requirements could not be met and the results were poor. Critical issues included fatigue due to constant load, temperature changes, and insufficient UV resistance. The first igus projects in the solar sector started in the late 90s, and since then numerous designs have been developed and iterated upon.

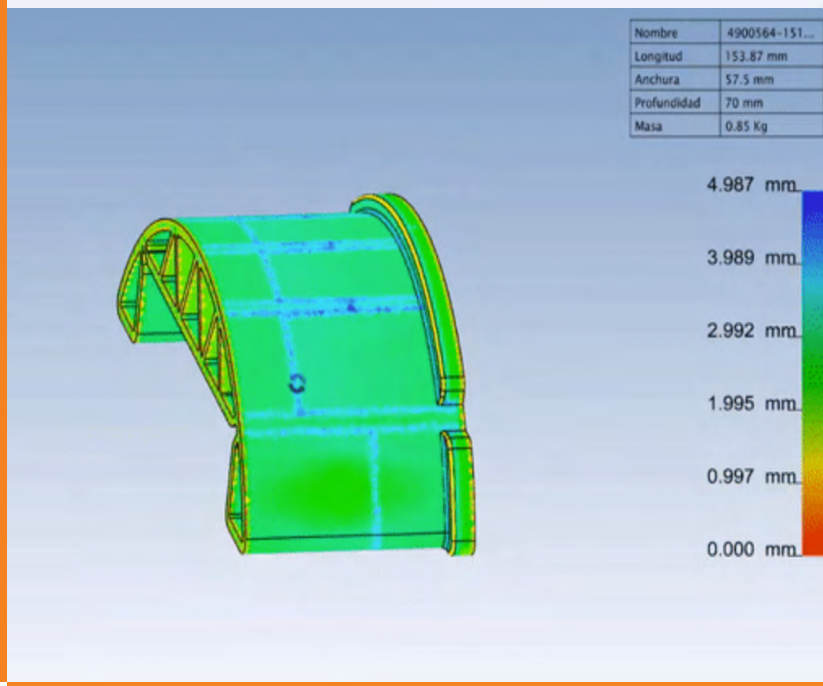
Pillow blocks made from **tribo-polymers**

As a base material, tribo-polymers from igus have proven to be an excellent solution. They consist of a high-quality base polymer, fibers to improve strength, and incorporated solid lubricants to maintain constant lubrication, low friction, and grease-free operation.

Components made of these performance plastics (of which there are dozens of different material compositions designed to withstand various conditions like temperature, moisture, and chemical substances), offer a combination of minimal friction, easy motion, high stability, quiet and low-vibration motion, maintenance-free operation, and no chance of lubricants entering the environment.

ESQM pillow block bearings from igus use these performance plastics and have been specifically designed for use in single-axis solar tracker systems. Since the demands of applications only grow more strict, igus performs numerous real-world tests to ensure its products can meet these demands.





Many tracker systems are built with standard half-shell bearings which need an additional metal housing — requiring an additional supplier and careful alignment of each of the individual parts. In contrast, the housing and spherical ball of ESQM pillow blocks are perfectly matched to each other, both in terms of material and dimensions. This guarantees easy installation, an essential factor in utility-scale solar projects.

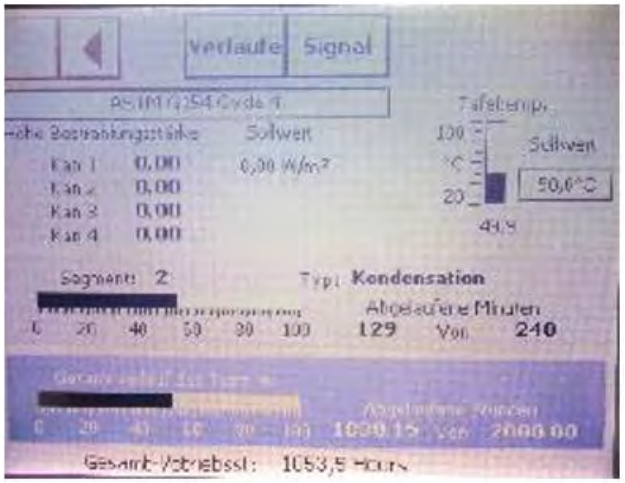
Developing new solutions through **extensive testing**

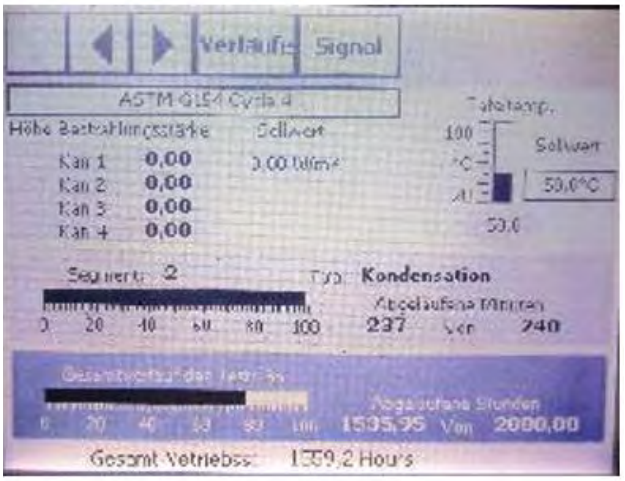
Reliability testing is one of the key aspects of the solar industry. Solar panels, materials, and components are constantly tested and certified according to various IEC and UL standards. Complete solar trackers are certified according to UL 3703. Unfortunately, there is no specific standard which qualifies or certifies individual components of solar trackers, such as bearings.

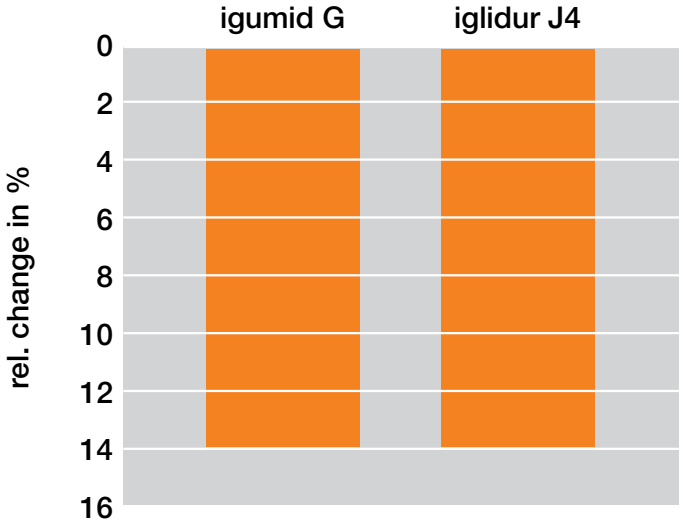
Due to its unique design, igus developed its own test to verify the durability of this specialized part. The ESQM pillow block bearing has been tested in the igus test lab for service life and load capacity. The results were surprising: a 72-year service life and 50kN load capacity, with no evidence of wear or material fatigue.

These values seem inflated, and in a real-world application it is unlikely such a long service life would be achieved. Taking into account other factors in real-world applications, along with the fact plastics deteriorate over many years, a suitable solution with a reliable 25-year service life was developed and brought to market.

The UV resistance of iglide materials has been extensively tested as well. All iglide materials have been tested according to the ASTM G154 with the laboratory's accelerated weathering tester, which is one of the most popular accelerated weathering tests. The test includes alternating cycles of UV light exposure followed by periods of darkness. Cycles of moisture can be distributed throughout the light exposure cycles as well.



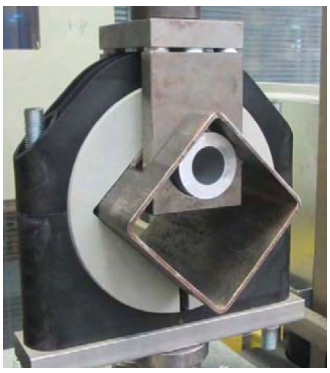


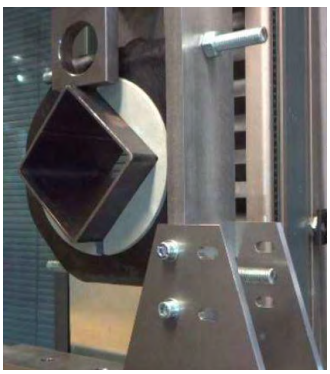


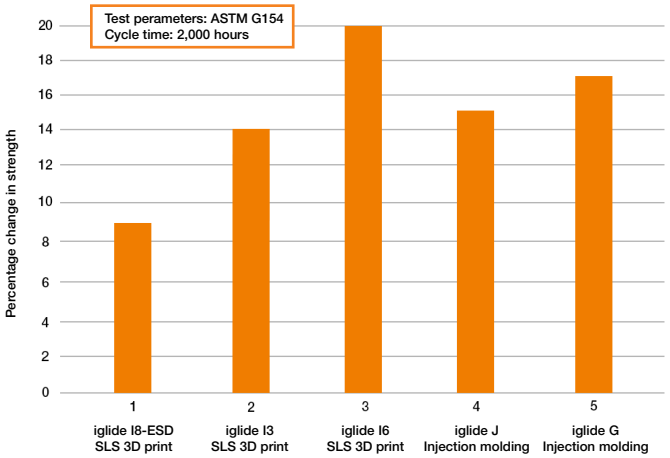
igus also set up a separate outdoor test area, where two pillow block bearings are constantly running throughout the day. They undergo 190 cycles daily with a load of 15kN.

Besides the UV resistance, the load capacity of the bearings is also an important factor. Tracker systems are often exposed to high speed winds, which can cause critical damage to the entire system. Maximum load tests for compression, tension, and lateral position have all been carried out for the ESQM to ensure adequate load capacity. The spherical ball portion of the bearing has also been tested at different positions: flat face at the bottom, gap at the bottom, and gap at 90° with a 9° misalignment.

One piece of data from those tests can be seen in the following graph. The load capacity of the pillow block bearing in tension and compression is about 50kN. Two important factors to note: in the compression test, the load limit of the machine used was 50kN. At that value, no alteration or deformation was detected. However, in the tensile test, a deformation of 2% was detected with values very close to 50kN.







Conclusion

The constant demand to produce energy more and more cost-effectively can lead to poor decision making by reducing the overall quality of solar tracker components. The cost of bearings may be a small part of the overall cost of a system, but despite this, it is an essential part that ensures precise movement — an essential part of consistently high energy output. If even a single component is damaged, the entire system needs to be checked and verified. This involves traveling to the solar system, potentially in a remote location, and potentially shutting down major parts of the system to conduct maintenance safely. Each of these factors will negatively impact energy generation and overall costs — and this is why choosing a slightly more expensive cost up front in the form of high-performance plastic bearings is more cost-effective in the long-term.