

Great power in compact form Micro gearheads from maxon with improved efficiency.

maxon has developed a unique upgrade in the form of a new product series for its standard micro gearhead: A wide range of performance improvements offer new opportunities.

The first ideas for the UP-gearhead were inspired by ESA's Mars project 'ExoMars' and NASA's 'Mars 2020' project, where there was a need to ensure the highest possible availability even in extreme environmental conditions.

Pioneering technological advances are often made in connection with Formula 1 and then gradually find their way into everyday motoring - with maxon these advances often occur while working on aerospace projects and are then introduced into the industrial sector.

A great advantage of this new range of gearheads is their **efficiency**. This can be defined as the relationship between output and input power. Significantly reducing the friction produced in any mechanical system naturally leads directly to optimization of the drive. In the new GPX planetary gearhead in the UP series, a technical repositioning means that the planetary wheels, which in traditional planetary gearheads are on plain bearings directly on the carrying axle, are now positioned above the ball- or needle bearings. In mechanical engineering terms this is referred to as a 'transition from sliding friction to rolling friction'.

If we take a GPX32 UP in three-stage construction as an example, then a maximum efficiency of around 90% can be achieved. Comparable miniature gearheads achieve around 70%. Compared with conventional design, we can say that by means of the engineering advances mentioned above, an increase in efficiency by a factor of 1.3 - ie. 30% - is achieved (Fig. 3).

This also directly affects further parameters of the drive system: Given the same input power, ie. using the same motor and the same motor control system, the gearhead can deliver 30% more torque. Or put another way: the same output power will require 23% less input power for the drive. This results in longer potential action time until the next charge cycle, particularly for battery-driven applications.

As a result of the reduction in the input power required, the used motor can in addition be operated at a more favorable operating point. This factor also improves the efficiency of the motor, and with it the whole drive system.

As an alternative, smaller and/or lighter motors and electronics can be used, with advantages not only in terms of weight but also in terms of cost.

Significantly **longer gearhead service life**: as outlined above, friction in the planetary wheel - axle system could be considerably reduced. At the same time heat generation from operating the drive is noticeably reduced because there is less friction power. Particularly in applications where temperatures should not exceed a certain level (example: medical power tools), there is improved power output.

The durability of the lubricant plays an important part in terms of wear and tear on the gearhead's mechanical components. The greater the thermal stress, the more quickly its lubricating properties are lost, and the earlier

and more serious the abrasive behaviors in the mechanical system. The abraded metal particles also lead to an agglutination of the lubricant, potentially resulting in a breakdown in its lubricating action.

If the heat feed is checked, then in otherwise identical operating conditions a longer service life can be achieved. This effect is an outstanding feature of the GPX UP: the service life is 5 times greater compared with similar traditional maxon gearheads and when compared to competitors' models currently on the market it is 11 times greater.

As an alternative to longer service life, as a result of significant improvements in the torque to diameter ratio (power density), much smaller and lighter gearheads can be used.

The advantages of the new design are not only producing improvements in the gearhead specification's individual parameters. Further new applications for the GPX UP gearheads can also be seen, in particular the so-called **force-feedback applications**.

With these applications the advantages of the engineering of the GPX UP version come into play. The use of mounted planetary wheels makes smooth inverse rotation of the gearheads possible in normal operation and, if necessary, can provide operator feedback. Quantifiable and tangible mechanical feedback is in fact conveyed to the force and torque elements. To achieve this, the gearhead needs to be reversible, meaning the torque and changes to the torque which are in contact with the output side, need to be conveyed proportionally to the drive side.

The following example demonstrates this application: In electronic flight control (Fly-by-Wire), the pilot's steering movements are not transmitted to the actuators mechanically or hydraulically, as in conventional systems, but electronically. But with this the operator initially loses all tangible feedback on their steering movements. With the deployment of a drive in the control column, the electronically transmitted feedback is mechanically conveyed to the pilot's hand. Inverse rotation is particularly necessary in normal operation, because the additional drive installed should not hinder the movements of the control column.

A similar process applies to the innovative surgery robots in the micro- and telesurgery range (Fig. 5) Here it is also crucial that the operator receives direct and tangible feedback about the movements they have performed or healthy tissue that should be left untouched. Reversible drives are also in demand in plant construction. In setting mode the axles need to be movable from the output side, without current.

The new GPX UP models combine a range of important product advantages, such as: More power, more torque, improved efficiency, considerably longer service life, reduction in heat generation, less weight in the drive system as well as the additional reversibility function in multistate gearheads.

Taking only the first two factors into account, we might refer to them as ultra-power gearheads. But with the other properties listed here, we can easily coin a new title: **ultra performance**.

Ultra Performance GPX gearheads from maxon are already available in GPX22 UP und GPX32 UP diameters, and like all 'X-series' they are customizable and available to order online. The GPX42 UP version will follow in Spring of 2020. In addition, customizable gearheads in the Ultra Performance series are now available in sizes Ø 8 – 58 mm.

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