HIGH PRECISION, LOW ENERGY, NO HEAT

Whether machining sintered cutting inserts, coins or small parts for watches or jewels – the result always requires the highest precision and has to last for a long time. Start-up KLM Microlaser has developed the E1 laser machining centre for working with the hardest materials. The renowned Kern Evo machining centre serves as the machine base and an ultrashort-pulsed femtosecond laser is used as a high-tech tool, one which is perfectly suited to inserting highly precise and detailed shapes into small-format products such as stamps and pressing tools. In one case, the production time of sintered inserts was reduced from eight hours to two.

Introduction

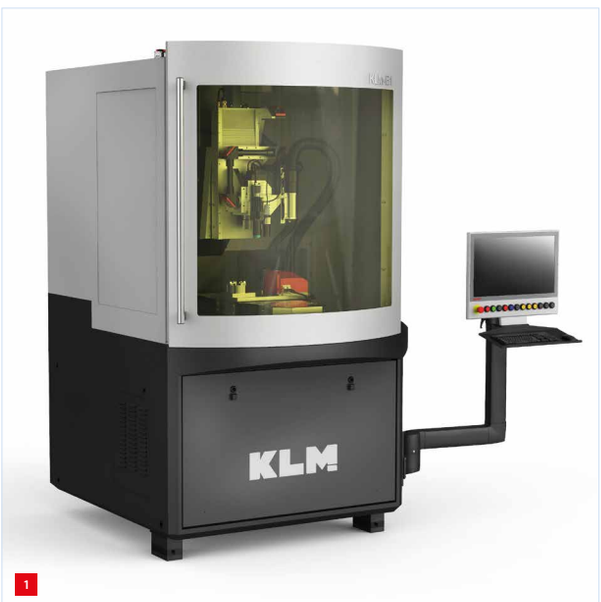
The KLM E1, available since the beginning of 2020, is a modern high-tech laser machine that is of particular interest for the mould and tool and the watch and coin industries. When it comes to machining small parts, the KLM E1 excels in terms of productivity, long-term precision, freedom from wear, energy efficiency and usability.

System overview

Several key components in the KLM E1 (Figure 1) are crucial for this: the basic construction, including the axes and drives of the established Kern Evo milling machine; the use of a pulsed femtosecond (fs) laser source; a mirror-based laser beam guidance from Lightmotif; and software that makes operation easy, with a simple transfer of the CAD data to the machine control. With regard to manufacturing accuracy, two unique features have been developed: ASPM (Automatic Spot + Power Measurement) and Adaptive Machining.

A mineral cast stand in a monobloc construction and an X-Y cross-table, which is manufactured by Kern, are the solid basis of the E1. They ensure the highest precision in the sub-µm range, which is important for the positioning and measuring of the parts. A mirror construction from the laser source to the scanner, with mirrors that are attached to the machine frame, is used because optical fibres are not suitable for guiding fs lasers.

The power of the laser source is 20 W, which means that the E1 can process a wide variety of materials. When layers are removed, the short pulse duration ensures that little energy



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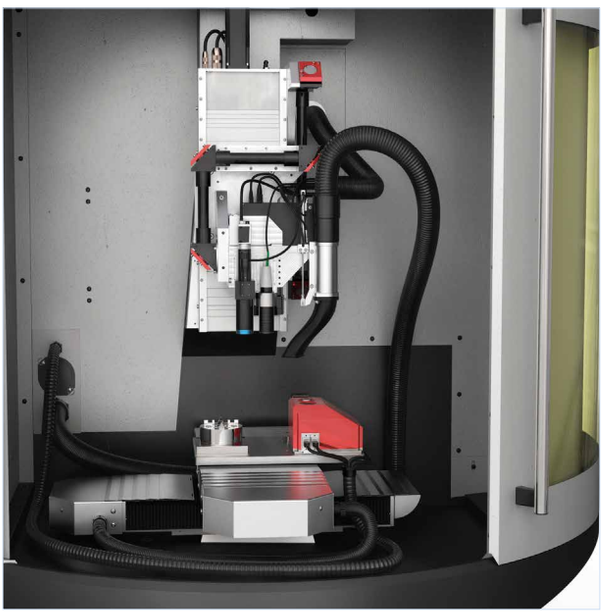
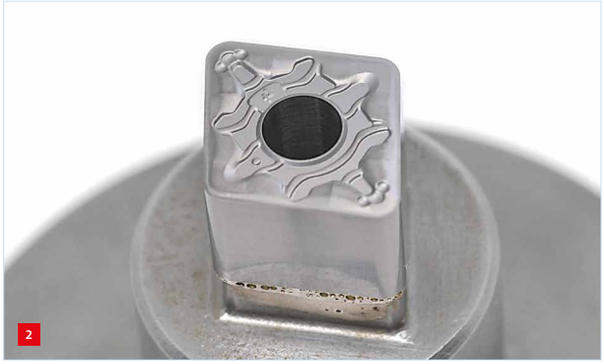


The new KLM E1 laser machining centre, specially designed for processing small parts from hard materials, is equipped with a femtosecond laser.

EDITORIAL NOTE

This article was contributed by KLM Microlaser, based in Eschenlohe (Germany) and represented in the Netherlands bij Encoma. The company was founded in 2019 by Ekkehard Alschweig, engineer, co-owner and former head of Kern Microtechnik, bundling his mechanical engineering knowledge with the know-how of the Dutch laser specialists from Lightmotif, located in Enschede. KLM Microlaser develops and produces a new generation of triaxial laser machining centres called E1, with Kern Microtechnik taking over the mechanical engineering and service of the entire system.

www.klm-microlaser.com
www.lightmotif.nl
www.encoma.nl



A typical product for the E1, an unpolished stamp.

is injected with each pulse, thus preventing any heat penetrating into the workpiece, as heat could cause a change in the material structure. As with all fs laser systems, the removal depth of the E1 is low, usually between 0.3 µm and 2 µm per layer. This enables an extremely high precision.

Automatic calibration

ASPM (Automatic Spot + Power Measurement) is a system that makes the machine stable over the long term. As is every other machine, the E1 is subject to thermal and other influences that do not have an immediate but rather a creeping effect – that is, over a certain period of, typically, a few hours. As a consequence, workpieces are produced with less precision. These influences and resulting inaccuracies are minimal, but nevertheless have to be prevented. When working with fs laser machines, two main challenges with an effect on precision over a long term may arise.

Firstly, the zero point of the laser spot can shift from its originally calibrated X-Y position, just in the µm range, but this is enough to cause inaccuracies. The reason for this is that the light-guide mirrors for controlling the laser beam are mechanically attached to the machine frame. If heat is applied to the frame, the frame extends, the spot shifts and inaccuracies occur. As a result, the light-guide mirrors have to be re-adjusted.

Secondly, the power of the laser beam reaching the workpiece can vary. The output power of a laser is never really stable and, in the long term, contamination on mirrors and lenses can also cause small losses. This means that after a certain time, the laser power originally calculated is no longer available. As a result, the material removal rate can change.

With ASPM, the E1 has a simple and efficient solution for these two potential challenges. ASPM can be started automatically or with just the push of a button. ASPM then recalibrates the entire system within two minutes, which means that it can be done every time production starts or even once a day.

Depth accuracy

Another distinctive feature of the E1 is Adaptive Machining. The fs laser removes material in layers with an average depth of 1 µm, with exact values having to be defined in individual cases. Adaptive Machining optically measures the machined depth and compares the actual, measured values with the target values. The machine then adjusts the laser parameters accordingly and ensures that the target values are achieved.

Without Adaptive Machining, the depth accuracy depends on the total machining depth and is usually between +/–3% and +/–5% of the machining depth. At a typical depth of 0.5 mm, this results in an expected inaccuracy of around +/– 25 µm. With Adaptive Machining, the depth accuracy is independent of the machining depth. The E1 achieves accuracies better than +/– 10 µm and has even reached values of less than +/– 5 µm in many tests.

Production time reduction

Test runs have demonstrated the potential of the KLM E1, for example in producing stamps (Figure 2). In one instance, a manufacturer of sintered cutting inserts formerly worked with a combination of an electrical discharge machining and a milling process. Now they have converted the traditional process for press punches to produce blanks in green-state carbide. With the new KLM E1 they only run one process. The pressing tools that were previously produced within an average of eight hours now only take two (Figure 3).

A test customer reduced the production time of sintered inserts from eight hours (with classic electrical discharge machining and milling) to two hours (with the KLM E1).