Customer…

KERN EVO Ultra Precision Machining Centre

The KERN EVO is an ultra precision machining centre with the highest level of accuracy in standard 3 and 5 axis configurations. The working envelope is 300 x 280 x 250 mm.

The machine bed is manufactured from a thermally stable and vibration dampening polymer concrete material as a single mono-block unit. The table in 3 axis configuration can carry loads up to 50kg and in 5 axis configuration 5kg. The machine has an integrated air-feed system to allow workpiece clamping via workpiece reference systems (System 3R and Erowa are examples) in 3 and 5 axis operation.

A vector controlled HSK25 spindle with a speed range from 500 to 50,000 rpm is fastened to the Z axis. The spindle is temperature controlled to ensure the highest level of accuracy when machining. The power of the spindle is 6.4kW and it is a permanently grease packed spindle. Automatic compensation of the spindle position due to expansion by thermal and dynamic conditions is included to ensure the highest precision of machines faces in the Z axis.

The KERN EVO machine is fully thermally stable as the polymer concrete is known to have 50% lower heat conductivity than that of steel or cast iron. Polymer concrete does not react to short temperature fluctuations. The very low thermal conductivity minimises the deformation due to temperature fluctuations, this in turn increases the workpiece accuracy. The vibration dampening characteristics and design of the mono-block unit absorb up to 10 times more vibration than cast iron resulting in up30% longer tool life and higher surface finishes.

The machine working area is easily accessible through a hemi spherical sliding door on the front of the machine, which is interlocked for safety when the machine is working in automatic operation. The Heidenhain iTNC control unit is also positioned on the front of the machine on a swivelling pedestal that reaches to the optimum position by the doors when setting-up.

The tool magazine is situated on the right side of the machine and the doors can be opened while the machine is working but a tool change is prevented by the machine operation safety system. The standard capacity is 32 tool positions (which include positions for the tool touch probe and laser tool measurement system calibration unit). Additionally the magazine capacity can be increased to either 63 or 95 tool positions.

A double gripper tool change arm allows tools to be changed into the spindle within 3 seconds, with a chip to chip time of 7 seconds.

A Heidenhain iTNC530 control system on the KERN EVO is a powerful 5 axis control, very user friendly and particularly suitable for both prototype and medium batch manufacturing. It can be programmed by using MDI in Heidenhain language with lots of canned cycles for quick and easy input of information, as well as ISO language. The control includes many features required as standard in the modern machine shop environment.

Automatic workpiece changing systems are available and can be retro-fitted at a later date. There are 2 types of palletisation system:

- An external workpiece changing system (example System 3R or Erowa) with pallets up to 240 x 240 mm (number of pallets limited by the capacity of the magazine).
- Finally by using a 6 axis robot loading system, combined with a "bookcase magazine", pallets of different dimensions can be automatically positioned in the machine working area in either the chuck on the 3 axis table or the chuck on the $4^{th}/5^{th}$ axis table. The pallet grippers can also be changed automatically.

System 3R Workpal Compact Workpiece Magazine

5 axis Operation

The $4^{th}/5^{th}$ axis table can be equipped to hold components with 3 systems:

1. Collet chuck with 20 mm diameter clamping capacity
2. System 3R Macro clamping system
3. Erowa ITS 50 clamping system

Each system is an integral part of the table spindle to ensure the highest of accuracies when rotating the component. The tilting range is from -10 to +100 while the rotation axis is continuous movement. An accuracy of better than 5 seconds of arc on the workpiece is possible.

Accuracy

The smallest programmable increment is 0.0001 mm (0.1 µm) and the axis positioning is via a closed loop feed-back from linear glass scales with a low pressure air purge to ensure absolute cleanliness.

KERN, being a German machine tool manufacturer, use VDI/DGQ3441 as a standard for the measurement of accuracy on their range of machining centres. Positional accuracy is ±0.0005 mm.

It is important to understand the differences between German VDI and Japanese JIS national standards when comparing data. A good example is the data for Umax the maximum reversal error for hitting a certain point by approaching that point from both directions of movement.

Additionally KERN use the Heidenhain KGM measurement system to check both the positional accuracy and circular interpolation of movement. I attach a test result sheet for circular interpolation movement, again you will note reversal error results show a slight difference (circular interpolation moving clockwise to circular interpolation moving counter-clockwise). It would be very nice for me to say we can machine a circle by circular interpolation better than 0.001 mm and this is possible using a slow feedrate. However we are a company that bases its test results on practical applications and in the test results shown we are using a feedrate of 500 mm/minute and therefore expect a deviation greater than 0.001 mm. The critical results for us include a consistency when machining clockwise and counter-clockwise.

The spindle test sheet results show run-out at the spindle nose to be 0.001 mm and at 100 mm away from the spindle nose 0.002 mm, ensuring the cutting tools run at the highest of concentricities.

Automated tool setting is controlled by a BLUM laser measuring system with a beam width of 30 µm. The BLUM system is programmable to enable users to determine what is checked on each individual tool. Length, diameter, concentricity are standard examples and when using small or critical tools, tolerances can be set to check for tool breakage or tool wear. When detecting that breakage or wear is outside of the defined limits “sister tools” can be brought in from the tool magazine or the operation terminated. Within the Heidenhain iTNC control features for tool life monitoring can be used to measure the amount of “actual cutting time” a tool has performed, again if the tool life monitor reaches a defined limit a “sister tool” can be brought in automatically the next time this tool is programmed to be used.

A Renishaw OMP40 optical machine probe is our standard probe with a repeatability of 1 µm and is used to check the positions of features on workpieces and can also include in-process workpiece measurement.

The data transfer from the probe to the machine control is via an infra-red data transmission receiver situated at the rear of the machine working area. The probe can be transferred automatically from the tool magazine. Importantly when touching on a workpiece e.g. a square form, the probe will always use the same point on the probe stylus. It touches one face, when it moves to the adjacent face the probe rotates through 90 degrees to use the same position on the stylus, thus ensuring the highest of accuracies are maintained in the position of the workpiece to the centreline of the spindle.

KERN use a “tele-service” system for quick diagnostics of machine tool problems with the service department linking directly into the machine via the internet. Additionally within the Heidenhain iTNC control there are lots of service alarms for advice on errors whether machine tool or programming. Members of the KERN application engineering and the KERN service department all speak English and are available to discuss methods of manufacture, programming strategies, offer advice on cutting tools or answer questions re machine maintenance.

Comprehensive training is offered to machine setters/operators to polish their existing manufacturing skills to a high level.

Additional Information

Additional information that is important for producing to the highest levels of accuracy on components include:

Spindle Tooling

KERN can offer five systems for holding cutting tools, three are collet chucks:

1. The most accurate system grips the shank of the cutting tool in a D14 collet with a very small close down. It is therefore important that tools of sufficient quality are used, with shanks having a tight diameter tolerance.
2. The second level holds an E14 collet which allows for more tolerance on the cutting tool shank.
3. The third system is ESX collets which have a close down of either 0.5 mm or 1.0 mm depending on diameter. These are the least accurate when needing to maintain good concentricity on the cutting tool.
4. Heat shrink holders from 3 mm diameter to 10 mm diameter are available.
5. Schunk Tribos Systems.

Cutting tools should not be clamped in collet chucks while in the machine spindle. It is better to clamp the cutting tool with the collet chuck held in a special clamping fixture for HSK25 outside of the machine and to ensure consistency a torque wrench should be used.