# RAINFORD PRECISION

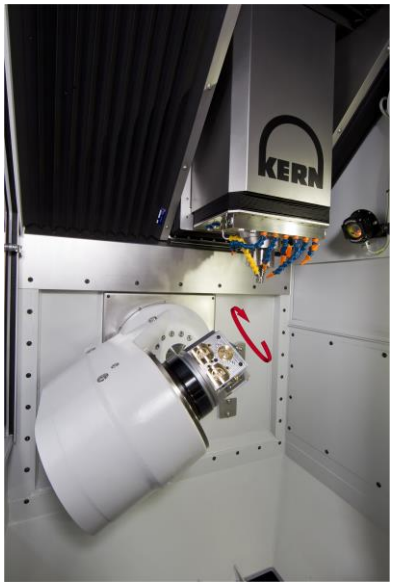
**Customer……**

## KERN MICRO 5 axis Ultra Precision Machining Centre

The KERN MICRO is an ultra precision machining centre with the highest level of accuracy in 5 axis configuration. The working envelope is 350 x 220 x 250 mm.

The machine bed is a KERN Amorith bridge construction with the bridge (X axis) carrying the cross axis (Y) and the vertical axis (Z).

The 5 axis configured table is 350 mm diameter and is of the latest knuckle joint design and can carry component weights up to 50 kg. While being able to be programmed in 0.0001° increments the "C" axis also has a rotational speed of 200 rpm. The tilting axis "B" has a swivel range of ± 110° with an option of +170° to - 110°. The machine has an integrated air-feed system to allow workpiece clamping via workpiece reference systems (System 3R and Erowa are examples).

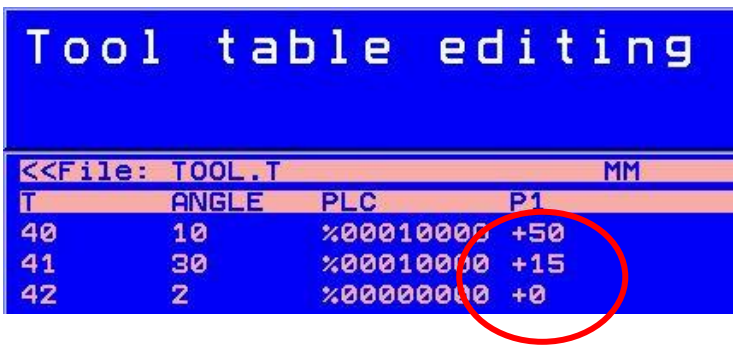


The machine working area is easily accessible through two sliding doors –one at the front of the machine and one to the left side, which are interlocked for safety when the machine is working in automatic operation. The Heidenhain iTNC control unit is also positioned on the front of the machine on a swivelling pedestal that reaches to the optimum position by the doors when setting-up.

There are two spindle versions available, HSK25 or HSK40.

A vector controlled HSK25 spindle with a speed range from 500 to 50,000 rpm. 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 machined faces in the Z axis.

The alternative HSK40 vector controlled spindle has a speed range from 500 to 42,000 rpm with 15kW power and incorporates a through the tool coolant facility (80 bar for water based emulsions and 10 bar for dry air blow). It is also temperature controlled. The pressure for the through the tool coolant supply can be individually set for each tool in the tool table.



# RAINFORD PRECISION

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.

The tool cabinet 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.

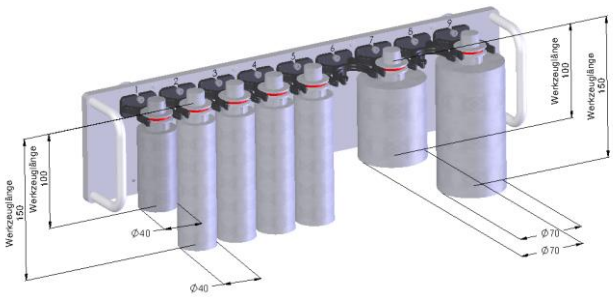
The standard tool capacity for HSK25 spindles is 101 tool positions (which include positions for the tool touch probe and laser tool measurement system calibration unit) with options of 20 and 209 positions.

For HSK40 spindles the cabinet capacity is 90 (standard), 18 and 186 positions.

The spindle tooling is held on easily removable pallets, which hold 9 tools per pallet (HSK25 spindle) and 8 tools per pallet (HSK40). Both (HSK25 and40) magazines can be easily increased in capacity at a later date.

The tool holding pallets are of a unique design to enable tools to be loaded on the pallets whilst outside the machine with a fool proof and quick method of locating the pallets inside the cabinet.


Whether HSK25 or HSK40 the maximum tool length (including the tool holder) is 150 mm. While a maximum diameter of 70 mm is possible with adjacent tool positions vacant in the pallet.




Designated softkeys enable the easy integration of the freshly loaded pallet tooling information to be organised with the control system.

Coolant and swarf are prevented from dropping on to the tool holders below by sloping metal guards which direct any droplets towards the centre of the cabinet and into a collecting tray.

A specially patented double gripper tool change arm allows tools to be changed into the spindle, with a chip to chip time of 4.5 seconds. Importantly the arm has a unique reset capability if is there any interference in the tool changing operation. This feature withdraws the arm and resets all the operation sensors by the push of a single button.

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 and 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.

***Automation***

Automatic workpiece changing systems are available and can be retro-fitted at a later date. There are 3 types of palletisation system:

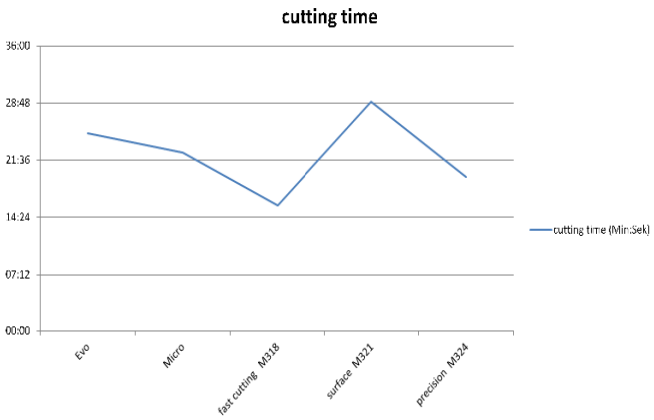
- A 30 position integrated pallet magazine (pallets up to 70 x 70 mm) situated in the lower half of the tool cabinet.
- An external workpiece changing system (example Erowa or System 3R) with pallets up to 240 x 240 mm (number of pallets limited by the capacity of the magazine).
- Finally by using a 6 axis robot loading system, combined with a “bookcase magazine”, pallets of different dimensions can be automatically positioned in the machine working area on the $4^{th}/5^{th}$ axis table chuck. The pallet grippers can also be changed automatically.

***Performance adjustments***

Not all components need machining to the highest of accuracies and it is this point that is crucial in decision making. If you know and understand that your machining centre can easily achieve consistently the tolerances on your component, then adjustment of the machining parameters are possible.

Kern use 3 pre-set M-Code parameters to help optimise the machining process to that which is required. In short they are:

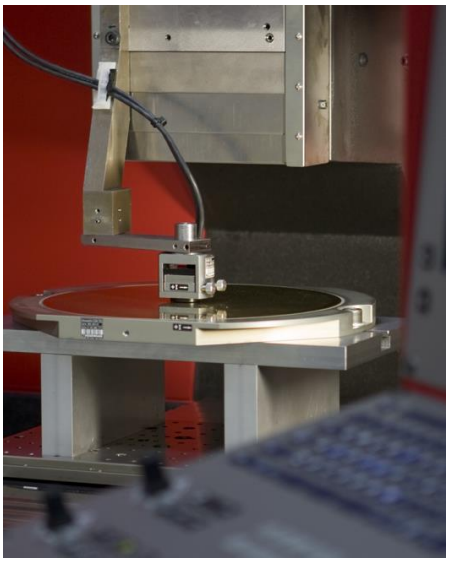
- Optimum speed
  -Fastest cycle time
- Surface finish
  – To achieve the best surface finish
- Precision
  – For the highest possible accuracy



It can be seen that when using the M-Code for fastest production speed the cycle time is approximately 15 minutes while to achieve the best surface finish the time is 28 minutes – all by using one simple command.

***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, uses VDI/DGQ3441 as a standard for the measurement of accuracy on their range of machining centres. Positional accuracy (Ps) is ±0.0005 mm. Attached are axis measurement certificates for all three axes, X, Y and Z.

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 uses 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 concentricity's.

The machine has its own integrated central temperature management system to ensure constant control of the spindle, axes, coolant and electrical cabinet which can link either to a factory's cold water systems or to a Kern supplied chiller (this can be positioned up to 30 metres away from the machine).

KERN uses 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.

Access to the machine working component is through easily removed panels situated on the left side of the machine.

Comprehensive training is available for machine setters/operators and maintenance personnel to polish their existing skills to a higher level, initially this is best done on site at KERN, Germany but also can be performed on site at the customer's premises.

Additional Information

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

**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/D20 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/E20 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 for both HSK25 and HSK40 spindles.

Recently it possible to purchase tool holders from different manufacturers not specified by Kern and it is the customer's responsibility to ensure they are of the correct quality for his work.

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 HSK25/40 outside of the machine and to ensure consistency a torque wrench should be used.

**Through the Tool Coolant**

Kern Micro machines with HSK40 spindles can have through the tool coolant supply. The coolant is supplied from an external tank which has a paper band filtration system with a maximum pressure of 80 bar (individual pressure can be set for each tool). The coolant is temperature controlled.

**New Features**

An **ENERGY SAVINGS PACKAGE** is available for reducing energy consumption when the machine is in a non-productive state. The machine is controlled into a "sleep mode" and the main energy consuming units switched off to minimise the amount of energy used during the period. The machine can then be started at a programmed time and set to go through a warm up cycle ready for the shift or work to begin.

To prevent damage to cutting tools and workpieces Kern have available a **LIFT-OFF FUNCTION** that works in case of power failures. In the tool library tools are identified and in case of a power failure they are lifted from the workpiece contour by residual energy. This function does not work when the emergency stop button is activated.