Dugard X-5 High Speed 5-axis Vertical Machining Centre
With Heidenhain TNC 530i CNC system

Machine Specification
Table diameter 400mm
Max. table load 600kg
Travels
X axis (longitudinal) 500mm
Y axis (cross) 600mm
Z axis (vertical) 465mm
A axis (tilt) +/- 95°
C axis (rotation) n*360°
Spindle speeds 10,000 rpm
Spindle speed options 18,000 / 24,000 rpm
ATC – No. of stations 24
Accuracy of positioning of linear axes ± 0,005 mm
Repeatability of linear axes 0,005 mm
Accuracy of positioning of rotary axes +/- 2,5°
CNC system Heidenhain TNC 530i with CNC

Range of the most effective applications
X-5 HS 5-axis belongs to the most modern high speed 5-axis machining centres and it has been developed as a response to our customer’s requirements for machine tool being capable for 5-sided machining with high spindle speeds.
The machine is perfectly suited for complex mould / die applications as well as for machining of very accurate parts for automotive, medical and aerospace industries.
Application of this machine for one-of work as well as for batch production is effective.

Ability of 5-axis simultaneous machining enables maintaining an ideal tool position across part surfaces while machining at higher speeds can greatly reduce semi-finishing work. Five-axis work also allows the use of shorter, more rigid tools producing better surface finish quality.
Flexibility and efficiency of machining are considerably increased when compared with standard 3-axis machining centres. Manual handling and set-up times are reduced to minimum making cycle times shorter and enabling one operator to operate a few machines. Thanks to the one-hit machining ability accuracy of parts is greatly improved.
Perfect surface finish on wide variety of materials is achieved by the application of 10,000 rpm belt driven or electro spindles (motor spindles) with top spindle speeds of 18,000 or 24,000 rpm. Efficiency of roughing is secured by high max power and torque rates up to 27 kW and 129 Nm (18,000 rpm spindle at S6 – 40% duty cycle). High rapid traverse rates of 40 m/min in all 3 linear axes plus 100 rpm on the rotary table as well as the top Heidenhain iTNC 530 CNC system and 2.5 sec tool-to-tool change time provide the right base for high efficiency at any kind of work.

Design features of the machine
X-5 HS 5-axis vertical machining centre is built in traditional configuration of a bed type machine with the saddle/table unit and with the head travelling on the column.
The integrated rotary-tilting table of heavy-duty design with built-in torque motors is guided directly on the X-axis guide ways. This unit replaces the standard table.
The design of the castings has been optimized using the Finite Elements Method. Extra rigidity, vibration damping and geometrical accuracy are achieved.

Axis drives
Very high accuracy is achieved due to the entirely digital CNC-Servo system combined with the direct drives (direct couplings) and the linear guide ways in all three linear axes (widely spaced for better stability). Rigidity of the roller-type linear guide ways applied in all three axes is doubled comparing to ball-type linear guide ways.

Ballscrews
All ball screws are of double nut-preloaded type are applied in order to achieve superior positioning accuracy and avoid backlash effect. Ball screws are anchored at both ends.

Spindles
1. Belt driven
The cartridge-housed spindle is supported in angular contact ball bearings of the high precision class enabling continuous work with high spindle speeds – max 10,000rpm.
A digitally controlled servo-drive motor is used to drive the spindle. Spindle orientation and rigit taping are part of the package.
The machine is provide with a pneumatically operated tool clamping unit, with ISO 7388/2 type B system or pull studs and ripping fingers.
2. Motor spindle
We have selected two high speed electrospindles meeting the most advance machining applications requirements. These state-of-the art built in motor spindles are supported in super hybrid bearings designed for long life high-speed rotation.
The electro spindles are permanently fluid cooled and thermo stabilized. Spindle taper HSK 63A is used. The machine is provided with a hydraulically operated tool-clamping unit for ISO 12164A/ DIN 69893A tool holders.

18 000 rpm CyTec electro spindle with its high max power of 27 kW and torque of 129 Nm is the most versatile solution for complex work, from roughing to finishing, on wide variety of materials.
24 000 rpm **Cy electro spindle** is the most effective solution for machining parts made out of hardened steel and for any application requiring excellent surface finish.

**Electro spindle CYTEC 24 000 rpm - VMC HS 5-axis series**

![Graph showing power and torque vs. rpm](image)

**Integrated rotary tilting table**

Rotary tilting table of heavy-duty design is used instead of standard table. It is guided directly on the X-axis guide ways, which means much more rigidity and loading capacity comparing to detachable rotary tilting tables. Very high accuracy has been achieved thanks to application of built-in motors (torque motors) driving rotary and tilting axes (+/- 2.5° positioning accuracy of rotary and tilting axes). Zero - clearance design ensures long life of the table without any maintenance or service activities. Excellent features of such kind of design benefits on machining capabilities. Very high max. load capacity of 600 kg as well as high rotational speed of C axis performing of turning operations is possible) have been achieved.
Automatic tool changer
Being in constant touch with our customers, we know the problems connected with the application of pneumatically driven tool changers. Therefore we have selected electrically driven ATC for our X-5 HS 5-axis vertical machining centre.

Cam type automatic tool changer with the swinging arm provides 2,5 sec tool-to-tool change time and has the capacity of 24 tools. This type of ATC is the best choice for complex machining of parts as well as for mould making and wherever a quick tool change time and large storage capacity are required.

CNC system
We have selected the world’s leading CNC system Heidenhain TNC 530i with CNC equipped with the conversational NC programming with graphic interface. Preparation and testing of technological tasks is supported with 3-D, 5-axis program simulation.

General Information
X-5 HS 5-axis machining centre is equipped with the top software version of TNC 530i CNC system (software 1 + software 2 options are included). The machine operates with linear interpolation in up to 5 axes and circular interpolation in up to 3 axes. Helical and spline interpolations are also part of the package. Option of Dynamic Collision Monitoring (DMC) is also available. Absolute encoders are used for position feedback. Positioning of the machine after its restart is not necessary.

Programming
The user friendly Heidenhain plain language format is used for programming. The CNC system accepts also DIN/ISO programming format, what is very useful when external programming takes place. The programs for machining of moulds and similar oddly shaped parts may be made using CAD/CAM technique. Spline interpolation may be used in such programs, what quite considerably simplifies and shortens the program.

Any program may be transferred from a PC into the CNC system. This may be done block wise during machining or the whole program may be loaded before starting machining. The second method enables working with a very short block processing time of 0,5 ms.
There are a number of fixed cycles available, what simplifies programming. Availability of SL cycles for variable contour pockets and islands makes programming of preliminary machining of moulds much easier.

Parameter programming is also possible. It is very useful by machining parts with shapes, which may be described mathematically. This feature may as well be used for creating the „custom made” fixed cycles by the machine user.
Mirror imaging, use of scaling factor, datum shift and rotation of coordinate system, together with subprogram and program part repeat routines make possible to simplify and shorten the program. Graphical display and program test routine are available for program checking.
HR-410 portable electronic hand wheel is used for manual positioning during setting up the machine to work. Application of the work piece probe (option) with infrared beam data transmission makes possible to use an automatic work piece alignment and saving on set-up time.

**Tool management**

X-5 HS 5-axis offers some very useful features enabling the most effective tool management. Tools may be automatically measured and checked using the tool setting probe (option). Large capacity tool data library is available. The tool offsets include data used by 3-D machining. The CNC system calculates then automatically a 3-D tool path compensation for ball-nose end mills.

The tool management includes systems for calculating the optimal cutting data, tool life monitoring and automatic tool replacement with a spare tool stored in the tool magazine.

<table>
<thead>
<tr>
<th><strong>CNC system specification</strong></th>
<th>iTNC 530 - software option 1 and option 2 included</th>
</tr>
</thead>
<tbody>
<tr>
<td>Controlled axes + spindle:</td>
<td>5 +1</td>
</tr>
<tr>
<td>5 axis machining</td>
<td>yes</td>
</tr>
<tr>
<td>Linear interpolation</td>
<td>5axes</td>
</tr>
<tr>
<td>Circular interpolation</td>
<td>3 axes</td>
</tr>
<tr>
<td>Helical interpolation</td>
<td>yes</td>
</tr>
<tr>
<td>Spline interpolation</td>
<td>yes</td>
</tr>
<tr>
<td>Program memory – hard disc</td>
<td>30 GB</td>
</tr>
<tr>
<td>Number of programs in memory max.</td>
<td>No limitation</td>
</tr>
<tr>
<td>Block processing time</td>
<td>0.5 ms</td>
</tr>
<tr>
<td>Thermal expansions compensation</td>
<td>yes</td>
</tr>
<tr>
<td>Programming format Heidenhain dialog</td>
<td>yes</td>
</tr>
<tr>
<td>Programming format DIN/ISO</td>
<td>yes</td>
</tr>
<tr>
<td>Program transfer from/to PC</td>
<td>yes</td>
</tr>
<tr>
<td>Graphic simulation: plan view, projection in 3 plans, solid-model 3-D view, magnification of details</td>
<td>yes</td>
</tr>
<tr>
<td>Parameters programming</td>
<td>yes</td>
</tr>
<tr>
<td>Tilting the working plane</td>
<td>yes</td>
</tr>
<tr>
<td>Electric hand wheel availability</td>
<td>yes</td>
</tr>
<tr>
<td>Work piece probe installation availability</td>
<td>yes</td>
</tr>
<tr>
<td>Tool setting probe installation availability</td>
<td>yes</td>
</tr>
<tr>
<td>RS 232 interface</td>
<td>standard</td>
</tr>
<tr>
<td>Ethernet interface</td>
<td>standard</td>
</tr>
<tr>
<td>Display</td>
<td>15,1”</td>
</tr>
<tr>
<td>TCPM- Tool Centre Point Management</td>
<td>yes</td>
</tr>
<tr>
<td>3-D tool compensation</td>
<td>yes</td>
</tr>
</tbody>
</table>
### Fixed cycles

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
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<tbody>
<tr>
<td>- rigid tapping</td>
<td>yes</td>
</tr>
<tr>
<td>- tapping with a floating tap holder</td>
<td>yes</td>
</tr>
<tr>
<td>- deep hole drilling</td>
<td>yes</td>
</tr>
<tr>
<td>- pecking</td>
<td>yes</td>
</tr>
<tr>
<td>- reaming</td>
<td>yes</td>
</tr>
<tr>
<td>- back boring</td>
<td>yes</td>
</tr>
<tr>
<td>- slot milling</td>
<td>yes</td>
</tr>
<tr>
<td>- pocket milling –circular and rectangular</td>
<td>yes</td>
</tr>
<tr>
<td>- stud milling</td>
<td>yes</td>
</tr>
<tr>
<td>- multi-pass milling</td>
<td>yes</td>
</tr>
</tbody>
</table>

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**Chip management**

An effective, complex chip management system is used with this machine. There is a system of flushing nozzles installed along the bottom part of the side and rear walls of the machine. The chip flushing system pump delivers coolant through these nozzles in order to wash away the chips to the swarf conveyor, placed inside the machine at its front bottom part. Through the outlet, located at the L.H. side of the machine, the swarf is then transported outside the machine to a swarf bin.

A splash gun and air gun are provided to enable the operator removing any remaining chips and finally clean the inside of the cabin, after finishing the work.

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**Lubrication of the machine**

Lubrication of the machine is fully automatic. The central lubrication supplying oil in function of both: the travel length along controlled axes and the time of operation is used for lubrication of guide ways.

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Chip conveyor | Splash gun & air gun | Chip splashing system

**Lubrication of the guide ways** and ball screws Central lubrication tank
Safety of operation
The working area of the machine is totally enclosed. A cabin is used for this purpose. Its sliding doors are fitted with interlocks, preventing work with open doors or opening of the doors while machining is in cycle.

Windows are made from high-resistant polycarbonate.
System of software limit switches is used for machine protection. Absolute rotary encoders are used with this machine.

The tool clamping system is protected against faulty operation.

The spindle is equipped with an effective braking system, acting also in the case of power failure.

The electrical cabinet with servo controllers is bolted to the column.

The machine is designed and built in accordance with CE requirements and ISO 9001:2000 quality management systems.

Technical data

<table>
<thead>
<tr>
<th>TECHNICAL SPECIFICATION</th>
<th>X-5 HS 5-AXIS</th>
</tr>
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<tbody>
<tr>
<td>TABLE:</td>
<td></td>
</tr>
<tr>
<td>Table surface:</td>
<td>mm Ø400</td>
</tr>
<tr>
<td>T-slots: number / width / spacing</td>
<td>mm 8 / 12 / 45°</td>
</tr>
<tr>
<td>Max. table load</td>
<td>kg 600</td>
</tr>
<tr>
<td>TRAVELS:</td>
<td></td>
</tr>
<tr>
<td>Longitudinal (X)</td>
<td>mm 500</td>
</tr>
<tr>
<td>Cross (Y)</td>
<td>mm 600</td>
</tr>
<tr>
<td>Vertical (Z)</td>
<td>mm 465</td>
</tr>
<tr>
<td>Tilt (A)</td>
<td>Deg. +95° / -95°</td>
</tr>
<tr>
<td>Rotation (C)</td>
<td>Deg. n°360°</td>
</tr>
<tr>
<td>Spindle nose to table distance min / max</td>
<td>mm 60 / 710</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>ELECTROSPINDLES AVAILABLE:</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>CyTec electro spindle</td>
<td></td>
</tr>
<tr>
<td>Max spindle speeds: 18 000 rpm</td>
<td></td>
</tr>
<tr>
<td>Max power at S1 / S6 (40%) duty cycle: 21 kW / 27 kW</td>
<td>Available</td>
</tr>
<tr>
<td>Max torque at S1/S6 (40%) duty cycle: 100 Nm / 129 Nm</td>
<td></td>
</tr>
<tr>
<td>Spindle taper: HSK 63A</td>
<td></td>
</tr>
<tr>
<td>CyTec electro spindle</td>
<td></td>
</tr>
<tr>
<td>Max spindle speeds: 24 000 rpm</td>
<td></td>
</tr>
<tr>
<td>Max power at S1 / S6 (40%) duty cycle: 34 kW / 43 kW</td>
<td>Available</td>
</tr>
<tr>
<td>Max torque at S1/S6 (40%) duty cycle: 72 Nm / 91 Nm</td>
<td></td>
</tr>
<tr>
<td>Spindle taper: HSK 63A</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>AUTOMATIC TOOL CHANGER:</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Swing arm type ATC-24 tools capacity, 2,5 sec. tool-to-tool change time</td>
<td>Standard</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>RAPID TRAVERSE:</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>X / Y / Z</td>
<td>m/min 40/40/40</td>
</tr>
<tr>
<td>Rotary Table</td>
<td>100 rpm</td>
</tr>
</tbody>
</table>
CNC SYSTEM:
Heidenhain TNC 530i with CNC

MISCELLANEOUS:
Accuracy of Positioning of linear axes* mm ±0,005
Repeatability of linear axes* mm 0,005
Accuracy of Positioning of rotary axes ° +/- 2,5

CAPACITY
10,000 rpm Spindle
18,000/24,000 rpm Spindle

Spindle Nose to Table Top (Horizontal) MIN / MAX
84mm / 595mm
15mm / 465

Spindle Centre Line to Table Surface (Vertical) MAX 300mm
MAX 300mm

Weight: net / gross (transportation weight) kg 5000 / 5250

STANDARD:
- roller-type linear guide ways for all three linear axes
- directly driven ball screws in all axes (direct couplings)
- direct drives of rotary and tilting axes
- 24 station swing arm automatic tool changer (cam type – electrically driven)
- electronic hand wheel
- hydraulically operated tool clamping system
- 20 BAR TSC
- lighting system with lamps
- complete coolant installation
- chip flushing system
- swarf conveyor
- coolant wash gun
- compressed air gun
- spindle taper cleaning air-blow device
- operator’s and programming manuals

OPTIONS:
- Heidenhain linear scales for all three axes
- tool probes
- dynamic collision monitoring (DCM)
- cooling by compressed air (5bar)
- other upon request
- work piece probes

* acc. to ISO 230-2

Floor plans
Note: the height of the machine is shown with the spindle head in its top position.

**Standard execution**

For power supply 3 x 400V, 50 Hz  
Control voltage 230V  
Total power installed 50 kVA  
CNC systems:  
Heidenhain TNC 530i with CNC  
-spindle motor & axes servo drives: Heidenhain  
-display: 15,1” TFT colour  
-3-D program simulation  
-Option software 1  
-Option software 2  
Execution in accordance with CE regulations

**Standard equipment**

24-position automatic tool changer with swinging tool-change arm  
20 Bar Through Spindle Coolant  
Scraper Type Swarf Conveyor  
Portable electronic hand wheel HR 410  
Complete coolant installation and chip flushing system  
Coolant splashing gun  
Air gun  
Spindle taper cleaning air-blow device  
Spindle thermo stabilization  
Hydraulically operated tool clamping system  
Lighting system with lamps  
Working area enclosure (cabin)  
Machine lifting brackets  
Operator’s spanners  
Operator’s handbook and programming manual  
CE conformity statement
Machine Options for X-5 5-axis

Description
18,000 rpm 21Kw Cytec Motor Spindle
24,000 rpm 34Kw Cytec Motor Spindle
Heidenhain linear scales LS 486
Compressed air unit to linear scales
Coolant through spindle 20 bar
Tool cooling with compressed air 5 bar
Tool probe TT 130
Work piece probe TS 640 (infrared)
Data transmission cable TNC/PC RS232 (25/09) 5 m
Dynamic collision monitoring

Maximum and minimum capacities 10,000rpm machine
Spindle nose to table surface vertical and spindle nose to centre line vertical
10,000rpm machine

Maximum and minimum capacities 18,000 and 24,000rpm machines
Spindle nose to table surface vertical and spindle nose to centre line vertical 18,000 and 24,000rpm machine