MAKINO

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a71.a81

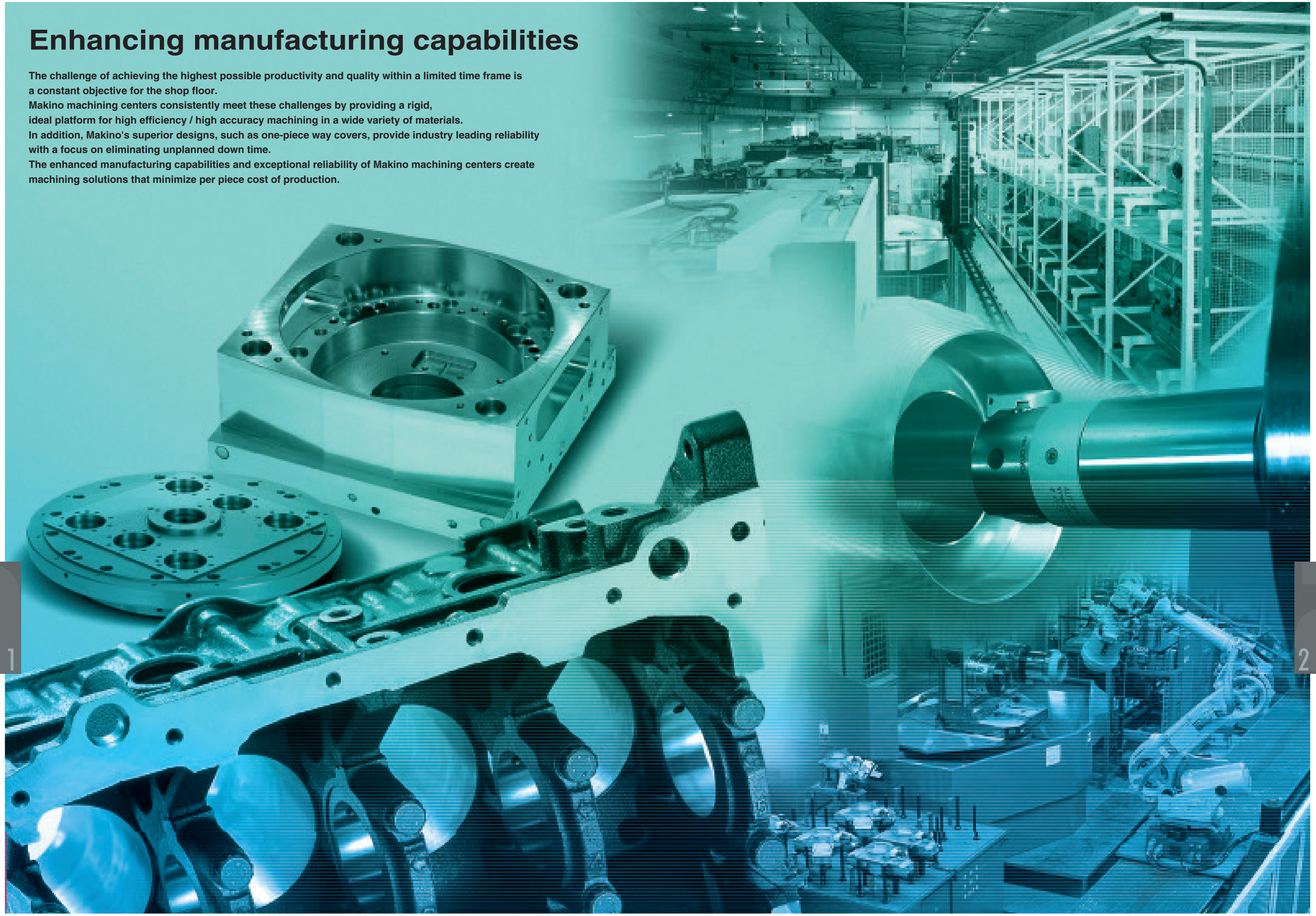
Horizontal Machining Centers

No.50 Taper Spindle

MAKINO

Enhancing manufacturing capabilities

The challenge of achieving the highest possible productivity and quality within a limited time frame is a constant objective for the shop floor.
Makino machining centers consistently meet these challenges by providing a rigid, ideal platform for high efficiency / high accuracy machining in a wide variety of materials.
In addition, Makino's superior designs, such as one-piece way covers, provide industry leading reliability with a focus on eliminating unplanned down time.
The enhanced manufacturing capabilities and exceptional reliability of Makino machining centers create machining solutions that minimize per piece cost of production.



Machining performance

[Face mill]

Case: 1

Standard spindle 488 N·m (25%ED), BT50 (a8I)

Metal removal rate: 792 cm³/min

When machining around -200 mm on Y axis

Metal removal rate: 792 cm³/min

When machining at higher position on Y axis

- Material — Ductile cast iron (FCD450)
- Spindle speed — 630 min⁻¹
- Feed rate — 1320 mm/min
- Tool used — 125 mm diameter face mill
- Axial depth of cutting — 6 mm
- Radical depth of cutting — 100 mm

Photo: Standard spindle (a8I)

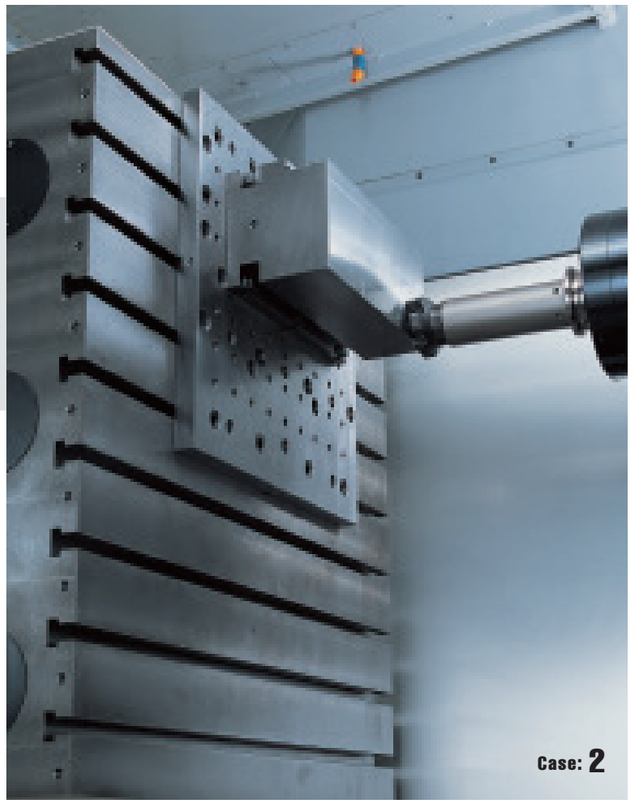


Photo: Standard spindle (a8I)

Case: 2

Standard spindle 488 N·m (25%ED), BT50 (a8I)

- Material — Ductile cast iron (FCD450)
- Spindle speed — 800 min⁻¹
- Feed rate — 1440 mm/min
- Tool used — 80 mm diameter face mill
- Tool length — 275 mm
- Axial depth of cutting — 4 mm
- Radial depth of cutting — 60 mm

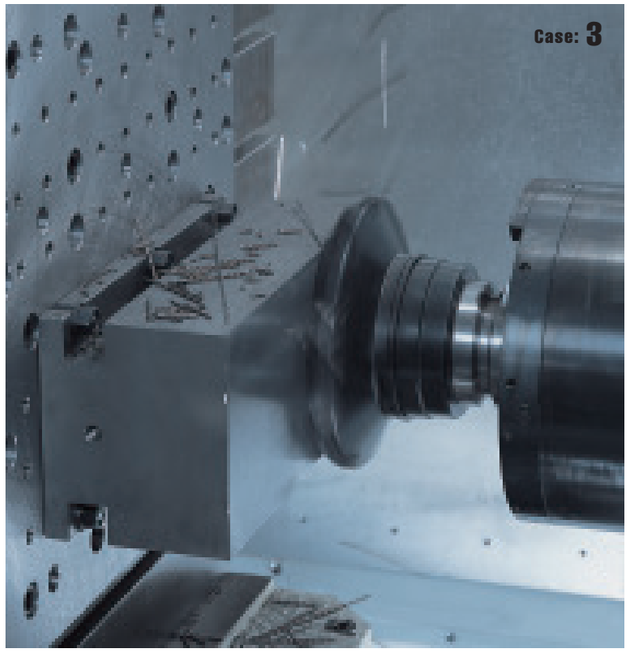


Photo: High torque spindle* (a8I)

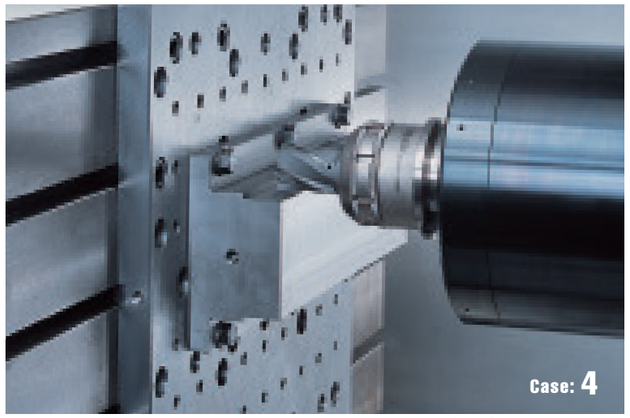


Photo: Standard spindle (a8I)

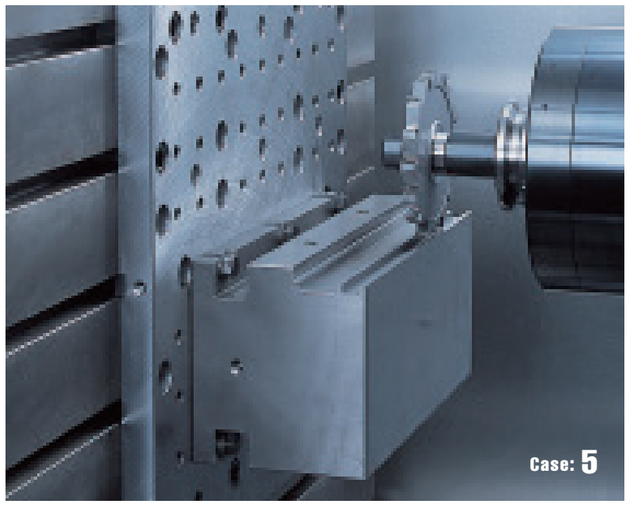


Photo: Standard spindle (a8I)

*: optional specification

Machining performance

[Face mill, End mill, Side milling cutter]

Case: 3

High torque spindle* 1009 N·m (15%ED), BT50 (a8I)

Metal removal rate: 896 cm³/min

- Material — Ductile cast iron (FCD450)
- Spindle speed — 320 min⁻¹
- Feed rate — 1280 mm/min
- Tool used — 200 mm diameter face mill
- Axial depth of cutting — 4 mm
- Radial depth of cutting — 175 mm

Metal removal rate: 870 cm³/min

- Material — Carbon steel (S50C)
- Spindle speed — 320 min⁻¹
- Feed rate — 1280 mm/min
- Tool used — 200 mm diameter face mill
- Axial depth of cutting — 4 mm
- Radial depth of cutting — 170 mm

* High torque spindle* is optional specification

Case: 4

Standard spindle 488 N·m (25%ED), BT50 (a8I)

- Material — Ductile cast iron (FCD450)
- Spindle speed — 1200 min⁻¹
- Feed rate — 480 mm/min
- Tool used — 40 mm diameter end mill
- Axial depth of cutting — 50 mm
- Radial depth of cutting — 6 mm

Case: 5

Standard spindle 488 N·m (25%ED), BT50 (a8I)

- Material — Ductile cast iron (FCD450)
- Spindle speed — 95 min⁻¹
- Feed rate — 152 mm/min
- Tool used — 150 mm diameter staggered tooth side milling cutter (16-insert)
- Axial depth of cutting — 4 mm
- Radial depth of cutting — 15 mm

Machining performance

[Boring, Reverse spot facer]

Case: 6

Standard spindle 488 N·m (25%ED), BT50 (a8I)

- Radical depth of cutting (one side) — 5.0 mm
- Material — Ductile cast iron (FCD450)
- Spindle speed — 207 min^{-1}
- Feed rate — 83 mm/min
- Tool used — 200 mm diameter and 400 mm length boring bar

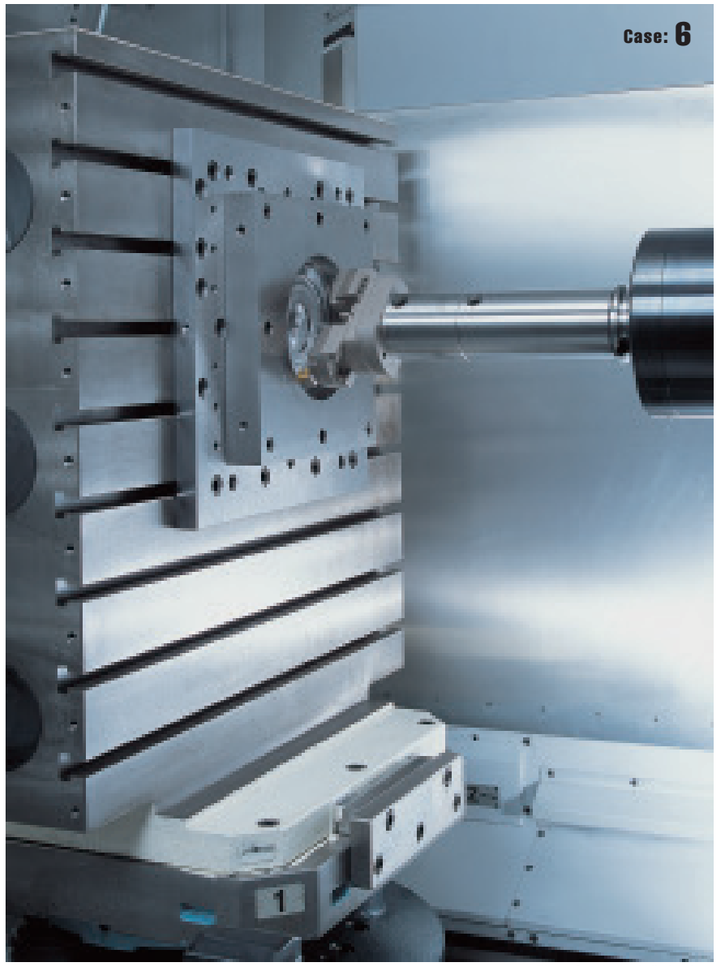


Photo: Standard spindle (a8I)

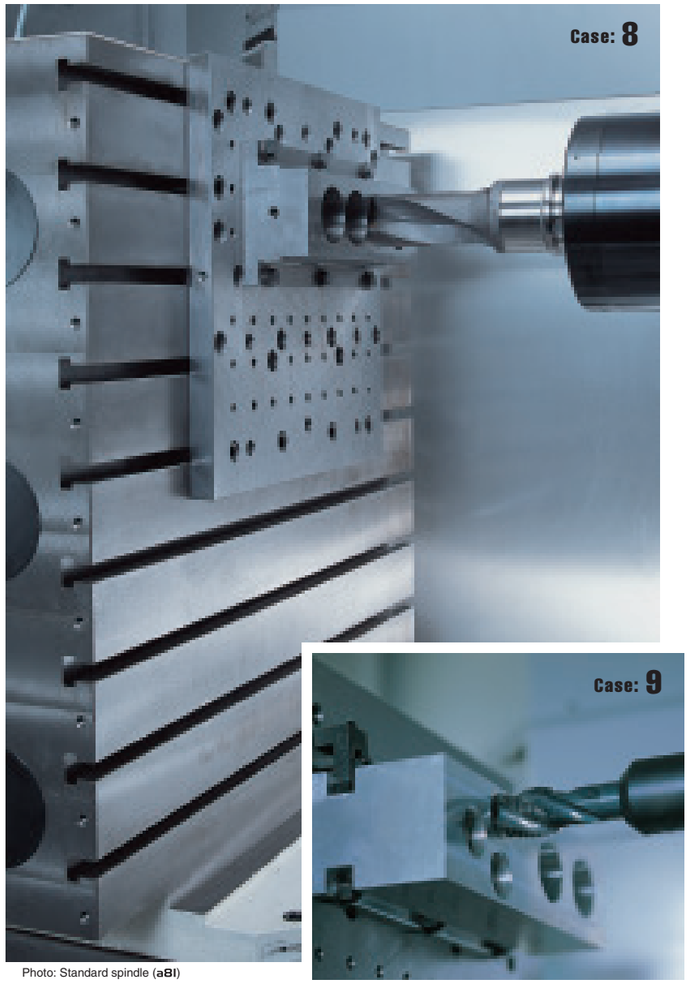


Photo: Standard spindle (a8I)

Machining performance

[Drilling, Tapping]

Case: 8

Standard spindle 488 N·m (25%ED), BT50 (a8I)

Metal removal rate: 679 cm³/min

- Material — Gray cast iron (FC250C)
- Spindle speed — 935 min^{-1}
- Feed rate — 187 mm/min
- Tool used — 68 mm diameter insert drill

High torque spindle* 1009 N·m (15%ED), BT50 (a8I)

Metal removal rate: 384 cm³/min

- Material — Ductile cast iron (FCD450)
- Spindle speed — 702 min^{-1}
- Feed rate — 106 mm/min
- Tool used — 68 mm diameter insert drill

* High torque spindle* is optional specification for a81

High torque spindle* 1009 N·m (15%ED), BT50 (a8I)

- Material — Carbon steel (S50C)
- Spindle speed — 60 min^{-1}
- Spindle load — 35%
- Feed rate — 270 mm/min
- Tool used — M42-4.5 tap

High torque spindle* 1009 N·m (15%ED), BT50 (a8I)

- Material — Ductile cast iron (FCD450)
- Spindle speed — 76 min^{-1}
- Spindle load — 25%
- Feed rate — 342 mm/min
- Tool used — M42-4.5 tap

Case: 7

Standard spindle 488 N·m (25%ED), BT50 (a8I)

- Radical depth of cutting (one side) — 10 mm

When machining at higher position on Y axis

- Material — Ductile cast iron (FCD450)
- Spindle speed — 282 min^{-1}
- Feed rate — 57 mm/min
- Tool used — 65 mm diameter back spot facer

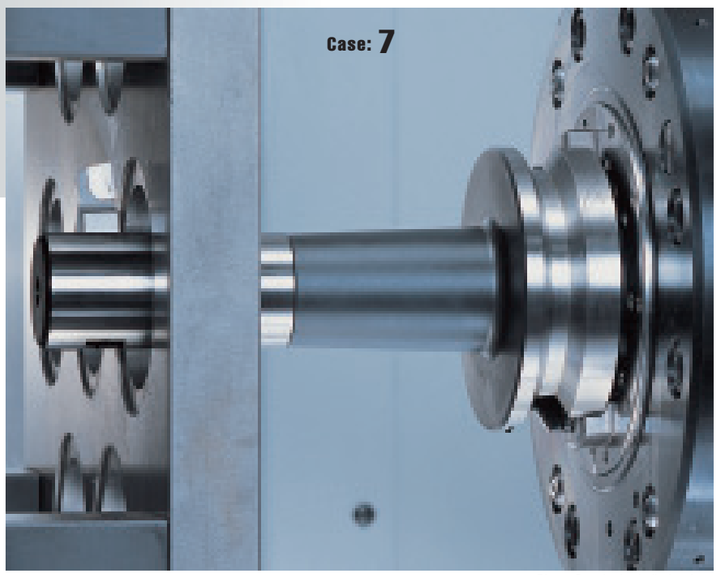
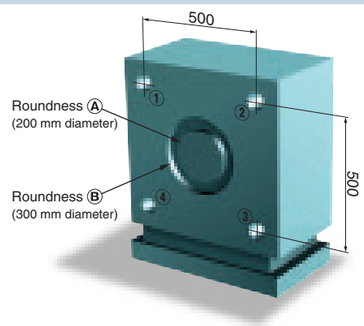


Photo: Standard spindle (a8I)

■ Pitch

Measured position	Target values	Measured values	Errors
Holes ①—②	500.0000 mm	499.9992 mm	−0.0008 mm
②—③	500.0000 mm	500.0011 mm	+0.0011 mm
③—④	500.0000 mm	500.0026 mm	+0.0026 mm
④—①	500.0000 mm	499.9992 mm	−0.0008 mm

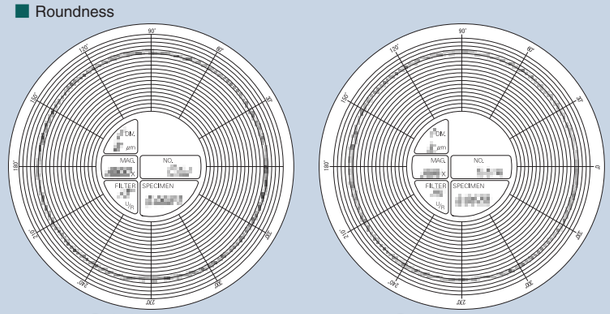
Actual values measured in Makino facility.



Accuracy

[Pitch and roundness]

■ Roundness



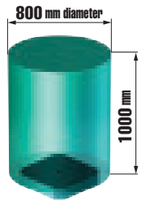
Ⓐ 2.3 μm (CW)　Ⓑ 2.8 μm (CCW)

The both were actual values measured in Makino facility.

*: optional specification

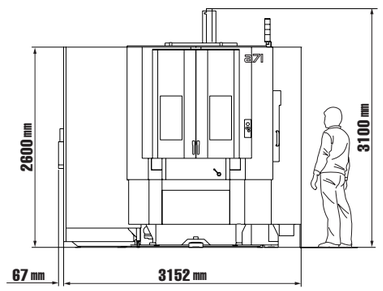
a71

- Axis travels (X×Y×Z) — **730 × 730 × 800 mm**
- (B) — **360 degree** (cont.)
- Pallet size — **500 × 500 mm**
- Maximum pallet load — **700 kg**
- Spindle taper hole — **7/24 No.50 taper**

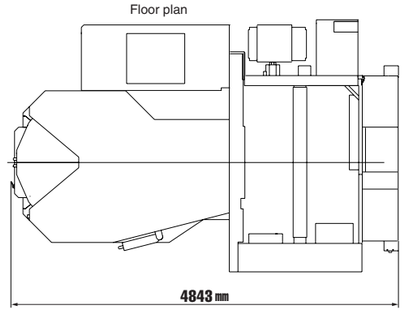


Maximum workpiece size when pallet is changed.

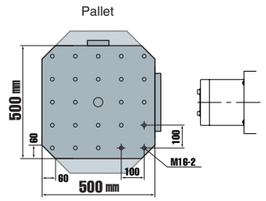
Front view

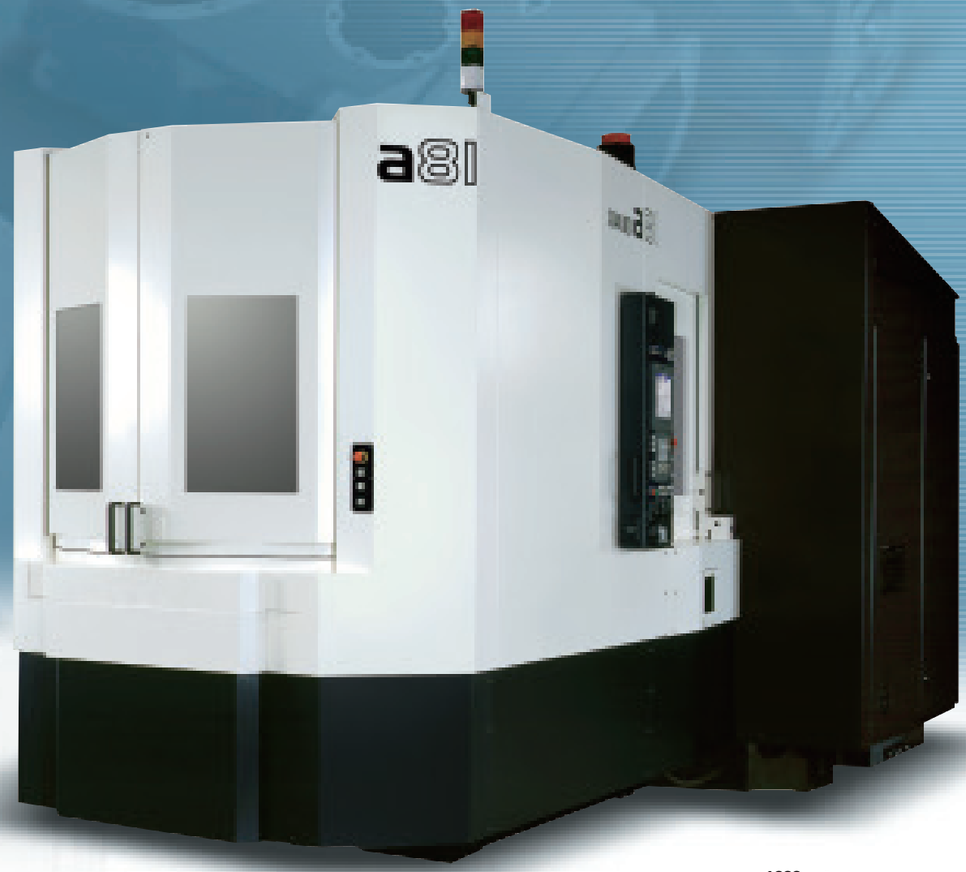


Floor plan



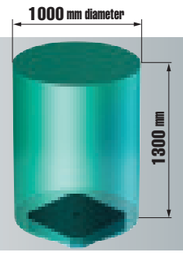
Pallet





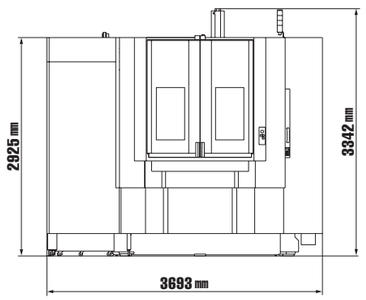
a81

- Axis travels (X×Y×Z) — **900 × 800 × 1020 mm**
- (B) — **360 degree** (cont.)
- Pallet working area — **630 × 630 mm**
- Maximum pallet load — **1200 kg**
- Spindle taper hole — **7/24 No.50 taper**

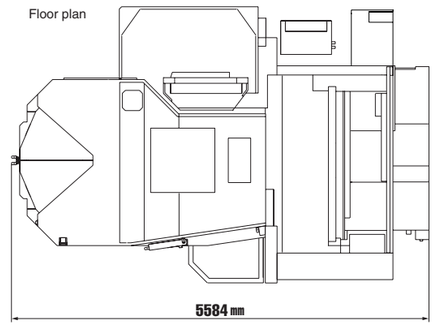


Maximum workpiece size when pallet is changed.

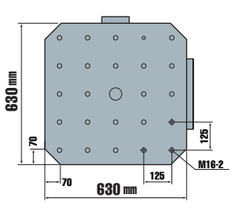
Front view



Floor plan



Pallet



Aiming for the highest level of machining capabilities

High speed machining using advanced machining centers has dramatically improved productivity on the manufacturing shop floor. It has also revolutionized production processes and the level of accuracy attained. The key to high speed machining is the spindle, which constitutes the essence of a machining center.
Three types of spindle variations, designed for use in a variety machining fields under the severest conditions, are offered on a71/a81 machines.

Makino products are continually advancing toward ever higher levels of productivity.

Standard spindle

The standard spindle is well suited to handling a wide variety of machining jobs, ranging from high volume cast iron parts for automobiles, construction equipment and agricultural machinery to steel and aluminum components. Providing powerful output of 35 kW, the standard spindle achieves low vibration for superior machining quality. This spindle delivers an optimum balance of impressive cutting capabilities in many different machining fields, including rigid taping at 3000 min⁻¹.

- Speed range ——— **20 ～ 10000 mim⁻¹**
- Drive motor output 15min/cont. — **35 / 25 kW**
- Bearing inner / outer diameter — **110 / 170 mm**
- Acceleration time —— 10000 min⁻¹ **3.8 sec**
  5000 min⁻¹ **1.4 sec**
- Torque 25%ED/cont. ——— **488 / 304 N·m**

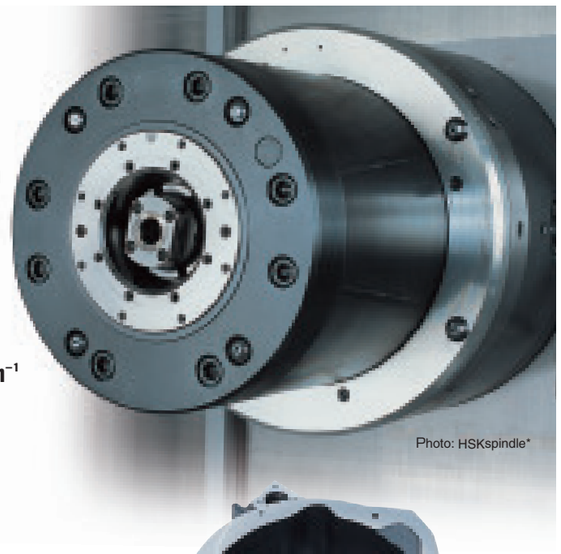
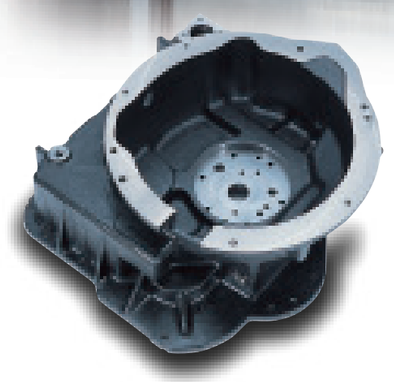


Photo: HSKspindle*

BT50 holder

HSK-A100 holder

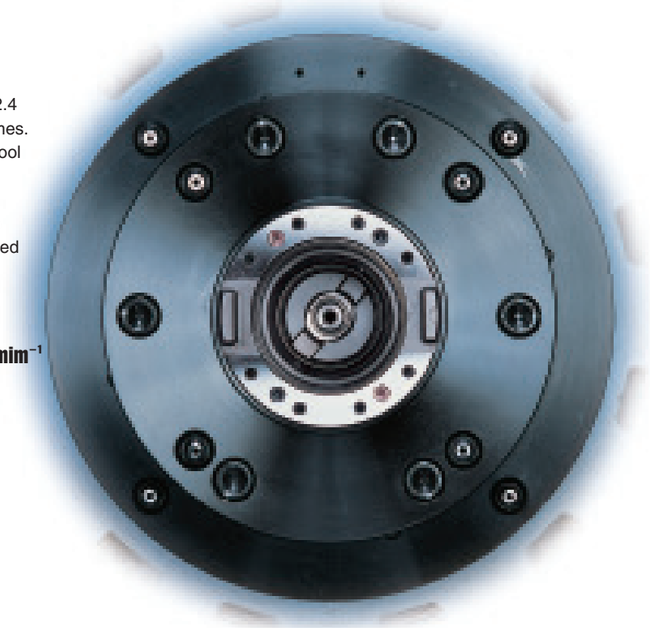


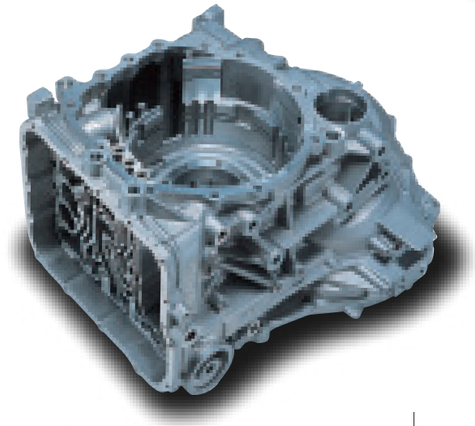
*: optional specification

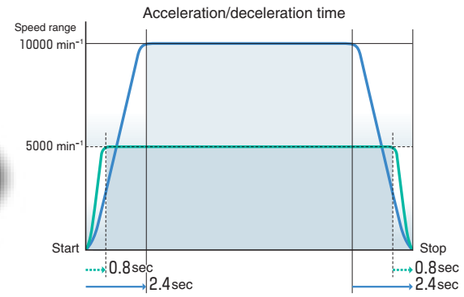
High acceleration spindle*

This spindle accelerates rapidly to its top speed within 2.4 seconds. Quick acceleration helps to reduce non-cut times. This is especially critical on parts that require frequent tool changes such as gear boxes, automotive engine and transmission components. Supported by highly rigid bearings with an inner diameter of 110 mm, this spindle combines powerful machining capabilities with high speed performance.

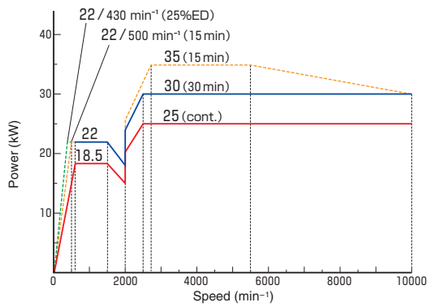
- Speed range ——— **50 ～ 10000 mim⁻¹**
- Drive motor output 15min/cont. — **22 / 18.5 kW**
- Bearing inner / outer diameter — **110 / 150 mm**
- Acceleration time —— 10000 min⁻¹ **2.4 sec**
  5000 min⁻¹ **0.8 sec**
- Torque 25%ED/cont. ——— **226 / 143 N·m**

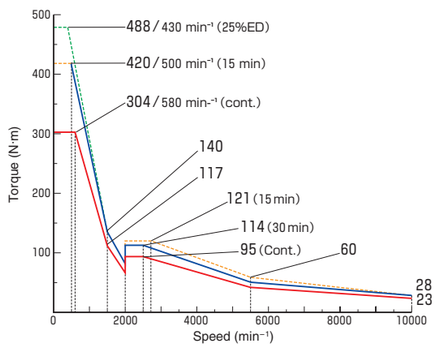






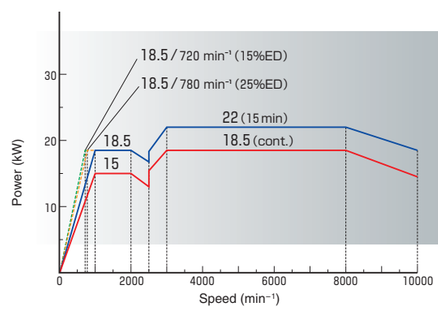
Standard spindle characteristics

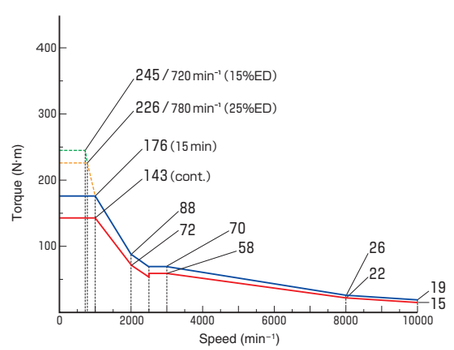




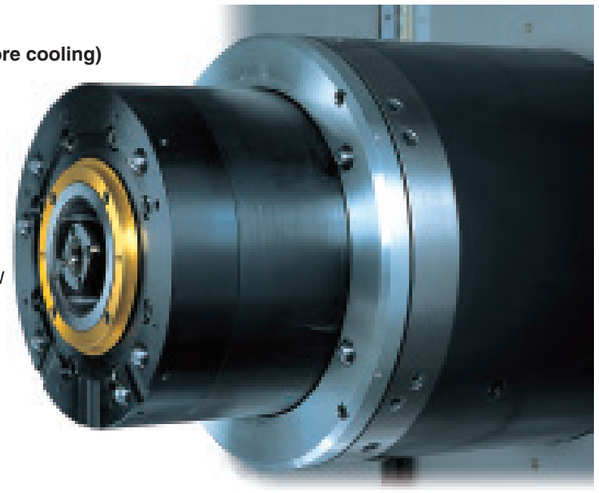
*: selectable specification

High acceleration spindle characteristics





20000 min⁻¹ spindle (core cooling)
20000 min⁻¹ high power spindle (core cooling)



Makino's unique spindle core cooling and under race lubrication system is used to cool and lubricate this spindle. This advanced system minimizes spindle thermal distortion during high speed operation, maintaining stable high accuracy even over long hours of continuous machining. Configured with this spindle, the machine is ideally suited for deep pocket machining, common in aluminum prototype and billet parts like vacuum chambers and aerospace structural components. Additionally, the 20,000 min⁻¹ spindle has two variants; the 30kW high acceleration and a 55 kW high power spindle delivering impressive machining performance.

- Speed range ——— **50 ～ 20000 mim⁻¹**
- Taper hole ——— **HSK-A100**
- Drive motor output 10min/cont.

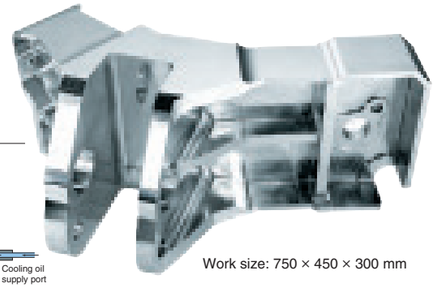
20000 min⁻¹ spindle	20000 min⁻¹ high power spindle
30 / 25 kW	**55 / 50 kW**

- Acceleration time

	20000 min⁻¹ spindle	20000 min⁻¹ high power spindle
10000 min⁻¹	**6.5 sec**	**4.4 sec**
18000 min⁻¹	**16.5 sec**	**8.7 sec**
20000 min⁻¹	**22.0 sec**	**10.4 sec**

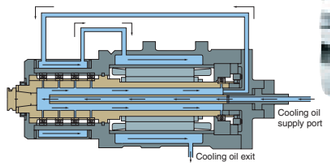
- Torque

20000 min⁻¹ spindle 10 min/ cont.	20000 min⁻¹ high power spindle 25%ED/cont.
350 / 238 N·m	**350 / 190 N·m**



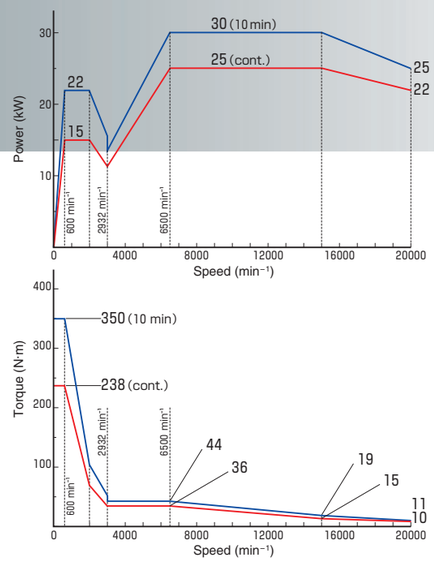
Work size: 750 × 450 × 300 mm

Spindle cooling and lubrication system

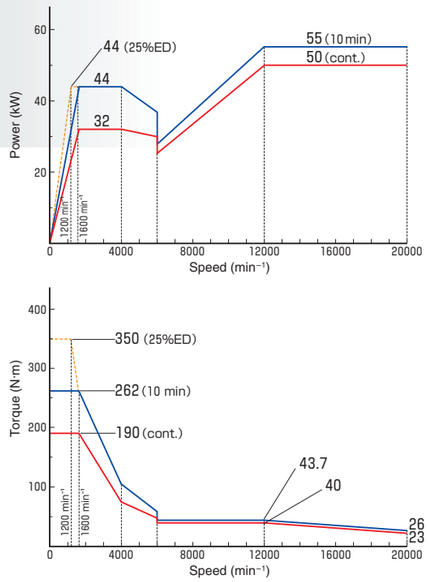


Makino's spindle core cooling system circulates a large volume of temperature controlled cooling oil through the center of the rotating spindle to provide direct internal cooling. This unique system cools the rigid spindle and large 100 mm inner diameter bearings, effectively minimizes thermal distortion even during sustained high speed operation. The cooling oil first travels through the spindle core. The oil temperature increases slightly as it moves through the core and circulates through the spindle stator housing. This creates an intentional temperature difference between the spindle and housing. This consistent temperature difference and the superior cooling capability facilitate higher spindle preloads ideal for heavy duty cutting even in ferrous materials. With under race lubrication, the cooled oil circulates through the center of the spindle and then flows through holes in the inner race of the spindle bearings. Centrifugal forces distribute the oil from the inner race throughout the bearing package; providing reliable lubrication even when the spindle bearings are rotating at high speed. (patented)

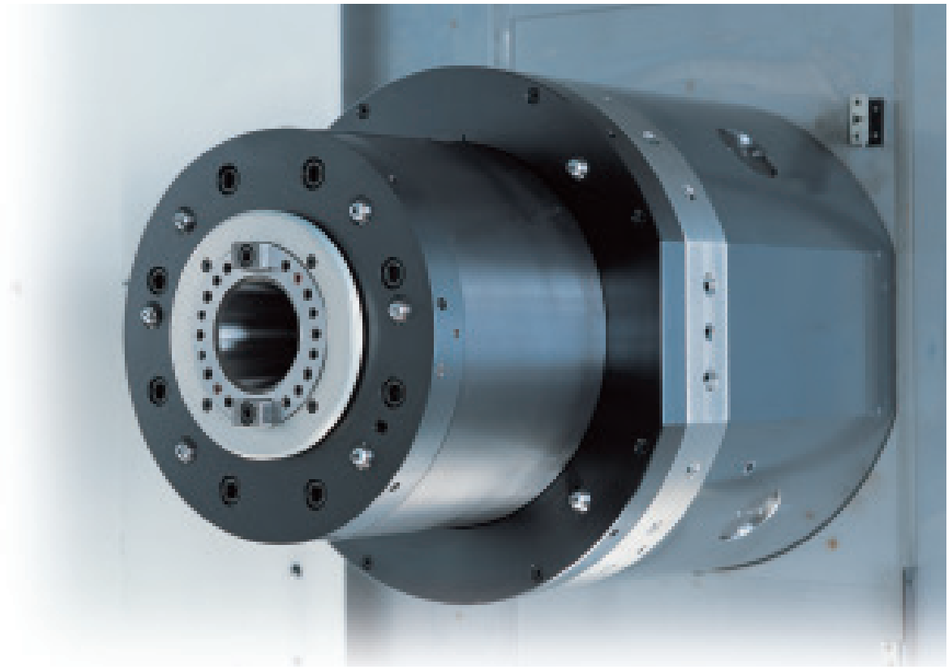
20000 min⁻¹ spindle characteristics



20000 min⁻¹ high power spindle charcteristics



The all items on 11 page are the optional specifications.



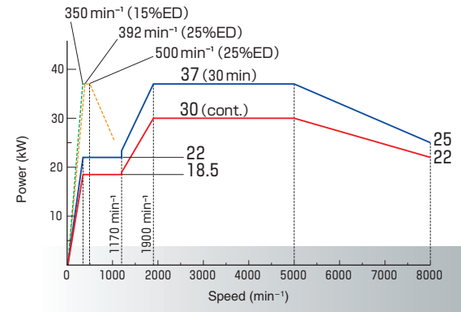
High torque spindle* * available only when a81.

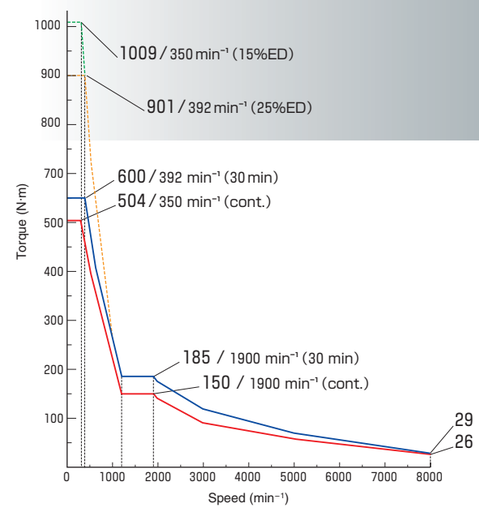
8,000 min⁻¹ high torque spindle generates an impressive 1,009 N·m of torque. The powerful direct drive spindle motor features large 120 mm inner diameter spindle bearings. Torque and rigidity of this spindle make it ideal solution for large feature heavy duty milling, drilling, boring and tapping of ferrous materials. Gearless, direct drive spindle design also provides exceptionally fast acceleration that minimizes non cut time in tapping and high speed finishing applications.

- Speed range ——— **20 ～ 8000 mim⁻¹**
- Drive motor output 15min/cont. ——— **37 / 30 kW**
- Bearing inner / outer diameter ——— **120 / 180 mm**
- Acceleration time 8000min⁻¹ ——— **4.3 sec**
  4000min⁻¹ ——— **1.5 sec**
- Torque 15%ED/cont. ——— **1009 / 504 N·m**

The all items on 12 page are the optional specifications.

High torque spindle characteristics





Rigid machine construction supports high acceleration and accuracy

Table

Indexing table

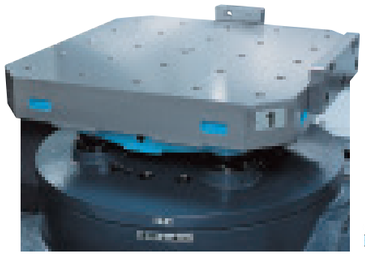
- Minimum index angle ——— **1 degree**
- Indexing time (90/180 degree) a71 ——— **1.7 / 2.2 sec**
  a81 ——— **1.9 / 2.7 sec**

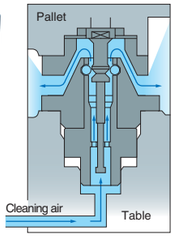
NC rotary table*

- Minimum index angle ——— **0.0001 degree**
- Indexing time (90/180 degree) a71 ——— **1.25 / 1.7 sec**
  a81 ——— **1.6 / 2.3 sec**

- Pallet positioning method **4 taper cone bushings**

The pallet is positioned with high accuracy by four taper cones. Each taper cone incorporates a clamping mechanism and pallets are securely clamped with a total force of 10 tons.
The well-balanced support system enhances cutting capabilities in the uppermost region on Y axis of the machining range.

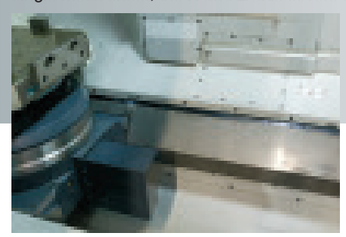




When pallets are changed, the four taper cones on the table discharge strong jets of air to prevent chips from getting on the locating cones.

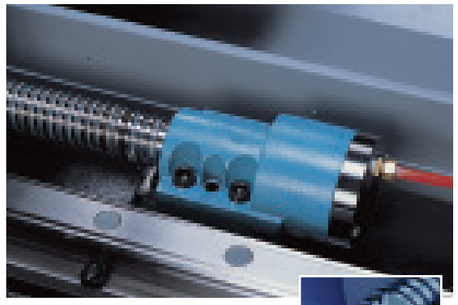
Telescopic covers

Faster feedrates also require quicker movement of the telescopic covers that protect the slideways and ball screws. Constructed of a single metal sheet, the X and Z axis covers enhance the reliability of high speed movement by eliminating the risk of damage due to the incursion of chips. The Y axis cover is driven by a pantograph to prevent collisions with the other axis covers.



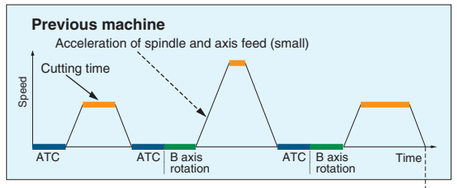
Feedrate

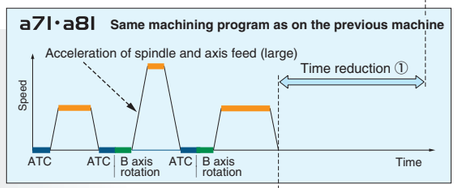
- Rapid traverse ——— **50 m/min**
- Cutting feed ——— **50 m/min**

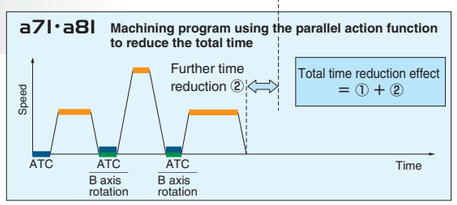


Ball screw cooling system
High speed movement of the ball screws during long hours of operation generates heat that can affect accuracy and machining performance. To eliminate thermal expansion, temperature controlled oil that's matched to the bed temperature is circulated through the hollow ball screws.

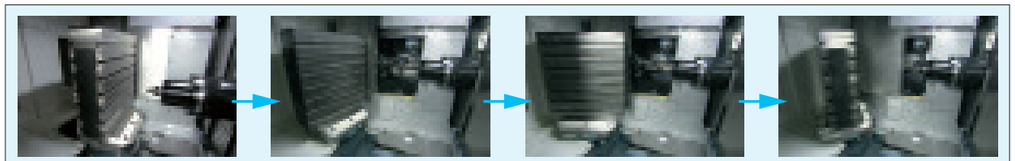
◎ **Reduction of non-cutting time for high productivity**







◎ **Machining time reduction function**



Functions for reducing machining times can be specified with one M code command, such as simultaneous ATC operation and table rotation or simultaneous execution of spindle stop/tool orientation and coolant off.

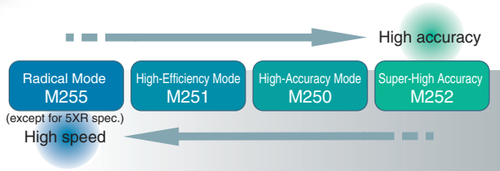
*: optional specification

Three points support

Rigidity is designed into the bed castings allowing a71 and a81 horizontal machining centers to sit on only three points. Three point support reduces installation time and eliminates periodic alignment maintenance. If shop floor layouts need to change, a71 / a81 machines can be quickly moved and returned to production.

GI.4 control

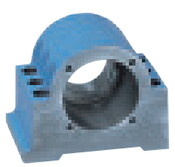
Both machines are equipped with GI.4 control that maintains excellent shape accuracy even at high cutting feeds. Four control modes can be selected to match the machining job, depending on whether speed or accuracy is the priority.

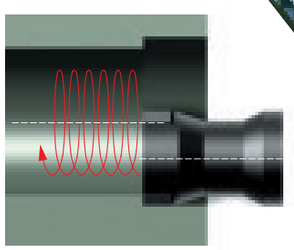


High contouring accuracy facilitates process concentration

Machine parts have traditionally been produced mainly in boring operations involving the use of many tools, which has required considerable time and effort for tool maintenance and management. By contrast, contouring improves work efficiency on the shop floor because holes of different diameters can be machined with one tool.

Machining operations that were previously done on a lathe can be replaced by a contouring process executed on a machining center. This concentration of machining processes substantially reduces setup time for greater efficiency.



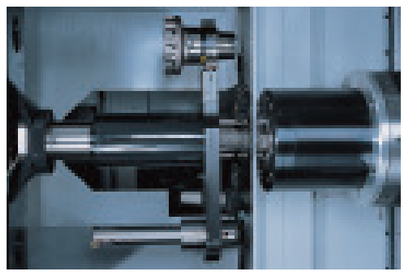


Automatic workpiece measurement

Automatic workpiece measurement boosts productivity by minimizing the need for operator intervention to check and adjust machined diameters.

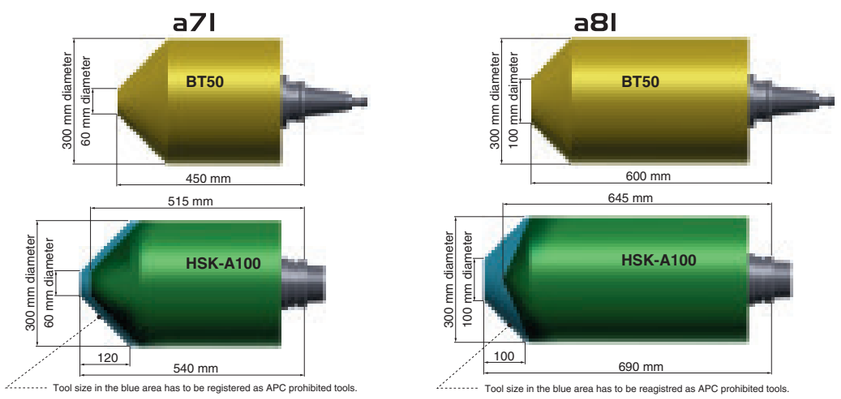
High speed / reliable tool change and monitoring solutions

ATC rotating arm is supported at both ends



- Tool to tool ——— **1.7 sec**
- Chip to chip (a71) ——— **3.8 sec** (MAS measurement system)
  (a81) ——— **4.2 sec** (MAS measurement system)

Maximum tool size when tool is changed automatically



Maximum tool length mm

Shank	a71	a81
BT50	450	600
HSK-A100*	540	690

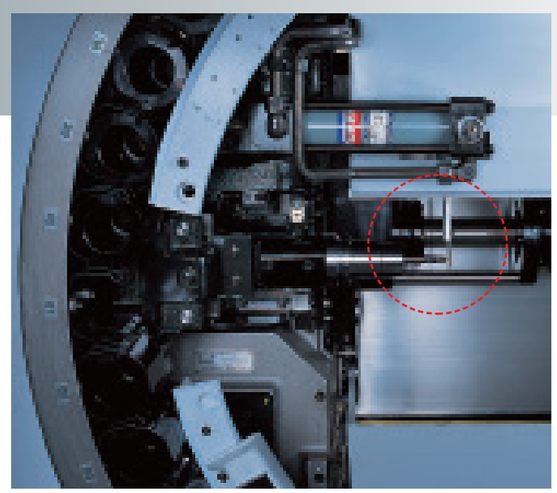
Maximum diameter and weight, moment

Number of tool storage		–	40 and 60*	97* and 137*, 186*, 242*, 300*
Maximum diameter	with conditions	mm	115	100
	without conditions		300	
Maximum weight		kg	20	30
Maximum moment		N·m	19.6	45

60 tools magazine for 30 kg weight (mass), 45 N·m is available as the optional specification only when a81. In detail, please contact Makino representative staff in your area.

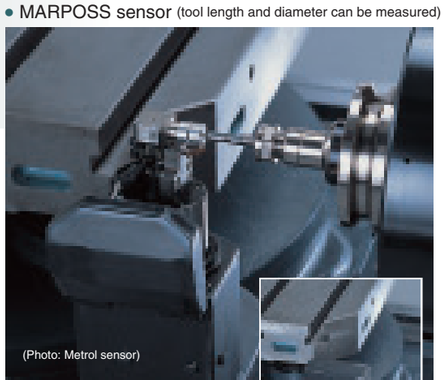
Broken tool sensor on ATC side*

Because broken tool detection is performed at the stand-by position of the tool magazine, machining time is unaffected.



Retractable tool length measurement device*

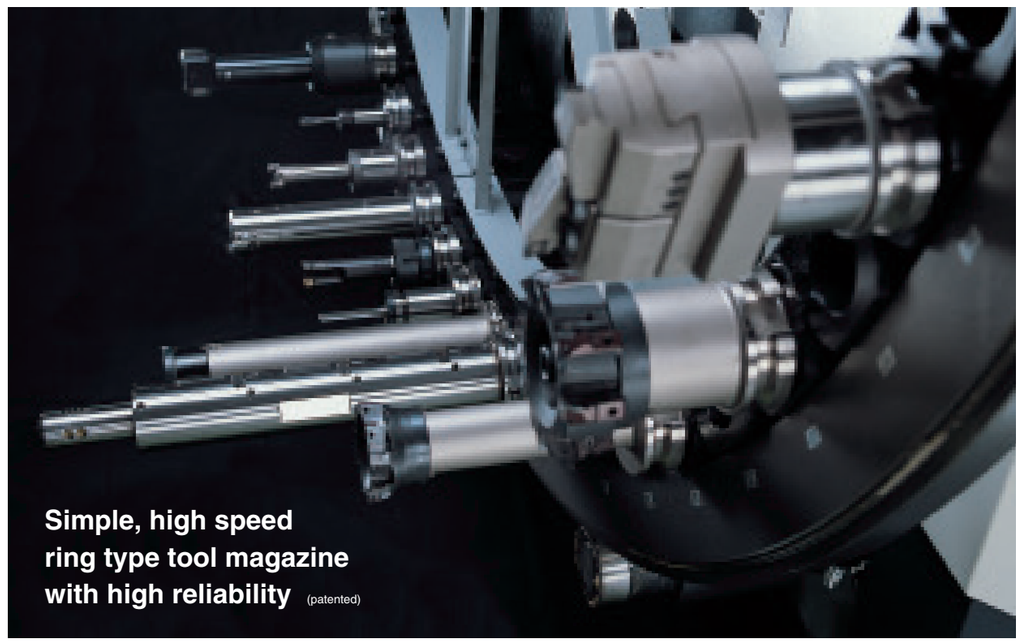
- Metrol sensor (tool length can be measured)
- MARPOSS sensor (tool length and diameter can be measured)



The measurement head is retracted to a lower position than the table surface so that there is almost no interfere with the tool during machining.

*: optional specification

High speed ring type tool magazine substantially reduces tool preparation time

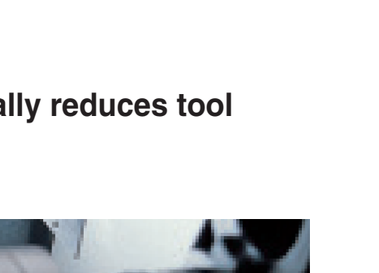


- Tool preparation time (minimum/maximum) ——— 40 tools magazine — **5.0/9.0 sec**
  60 tools magazine* — **5.5/10 sec**

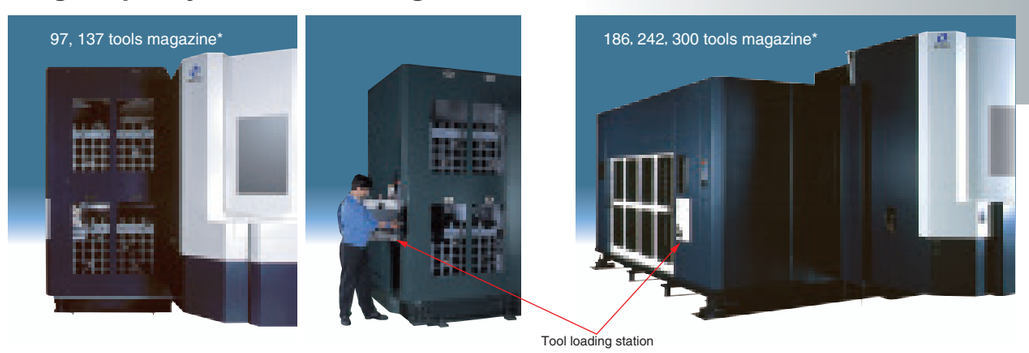
Makino's ring type tool magazine supports high speed machining with smooth and fast indexing of the next tool. Tool seek time as fast as 5 seconds means that spindle wait time for the next tool is virtually eliminated. After each machining operation the tools are returned to their original pot location. Consistent tool location simplifies periodic tool inspections and reduces the risk of tools being put in the wrong pot.

Selection of tool changing speed

The automatic tool changer (ATC) can be set to operate at three different speed levels (normal setting is high speed). Medium and low speed levels can be selected while changing heavy or unbalanced tools or when changing the head used for making measurements.



Large capacity matrix tools magazine* (patented)



- Tool storage capacity ——— **97* and 137*, 186*, 242*, 300* tools**

Servomotors are used in all axes to ensure quick operation.
Tool preparation time: 11 seconds at minimum
(only when 97 or 137 tools magazine)

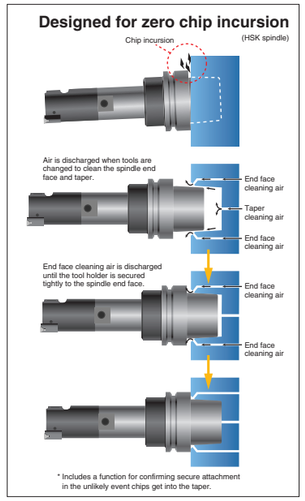
Matrix tool magazines include a tool loading station for safe, efficient tool loading and inspection.

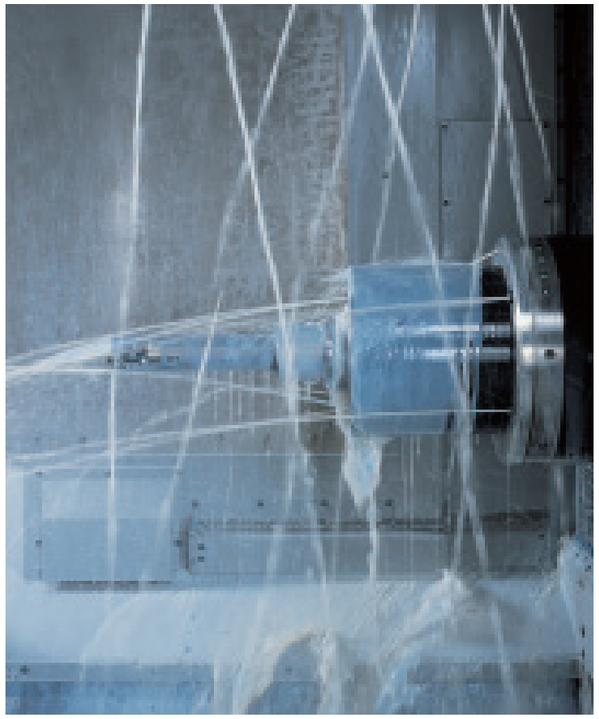
*: optional specification

Center chip trough can evacuate large volumes of chips effectively from the machine during continuous machining

Standard features ensure reliable chip evacuation

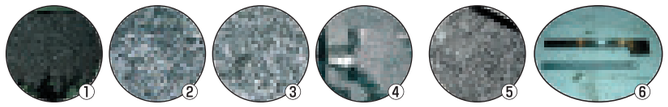
- 8-nozzle coolant supply device
- Overhead shower coolant system
- Base coolant (center trough)
- Chip conveyor (with drum filter)





Chip conveyor

Makino offers a variety of chip conveyor solutions designed for efficient chip removal. Common types are: Scraper, Double type (Scraper / Hinge) and magnetic.Chip formation is determined by the type of material and manufacturing operations. Optimal conveyor selection should be based on the type of chips created. Consult your Makino representative for assistance with conveyor selection.



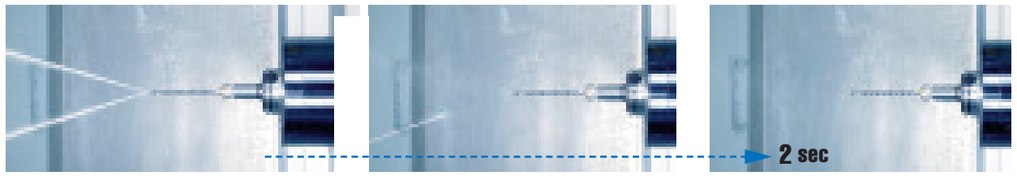
Chips	Less than 50 mm		Larger than or equal to 50 mm		⑥
	① Powders	②needles ③curls	④ clumps	⑤ splinters	Large fragments
Aluminum based	○	○	○	○	○
Steel based	○	○	○	○	○
Ductile cast iron	○	○		—	

Inner	Base coolant	Hinge conveyor
Outer	Chip conveyor (scraper)	Double chip conveyor (scraper and hinge)
	(standard specification)	(optional specification)

Please refer to the chip conveyor selection for detail criteria.

Through spindle coolant（1.5MPa / 2.2MPa : 50Hz / 60Hz）

1.5 MPa through spindle coolant is standard feature for substantially reducing hole machining time. (optional specifications: 3 MPa* or 7 MPa*)



Coolant draw back (patented)

The through spindle coolant system includes a unique coolant drawback circuit. The coolant stop command activates a draw back system that vacuums excess coolant from the tool and spindle. This system reduces tool change time and minimizes coolant contamination of the tool magazine.

*: optional specification

5XR spec.* for 5 axis machining


Photo: a71

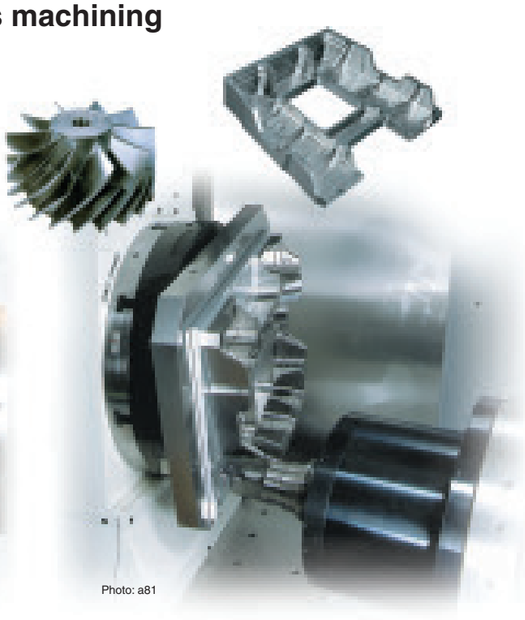
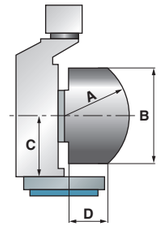


Photo: a81

5XR spec. (Tapped hole)*

Photo: a71

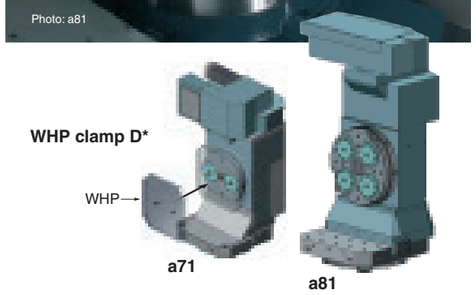


Workpiece limitations size

Machne			a71	a81
Spherical radius	A	mm	400	500
Diameter	B		700	850
Height	C		380	455
	D		193.649	183.4
Weight		kg	150	520

5XR spec. (WHP clamp D)*


Photo: a81



Please contact Makino representative staff in you area of the workpiece size dimension in detail when WHP clamp D* is selected.

*: optional specification

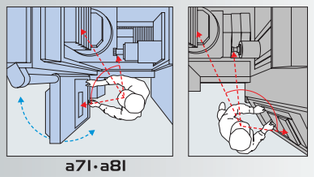
Machine uptime is enhanced by better maintainability and accessibility

The control panel is mounted on the left side of the operator door and can be rotated 180 degree. This provides ideal visibility to the tool, fixture and work piece during process prove out.

Excellent spindle accessibility

Tool load and unload

The door of the tools magazine has a wide opening to allow tools to be replaced easily.



a71·a81

Clean working environment

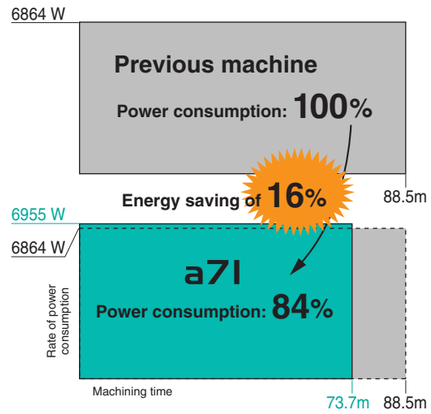
Two chip evacuation ports are in the pallet loading station (PLS), where work is loaded and unloaded. Chips and coolant that fall into these ports are automatically evacuated to the chip conveyor via the center chip trough.

Easy to clean coolant tank

A sediment collector is provided in an easily accessible location to simplify the task of cleaning out fine chip particles that accumulate at the bottom of the tank.

Energy-saving effect of high speed machines

High speed machining reduces part cycle time and therefore reduces power consumption. A comparison was made between a previous machine and a71 for machining the same part. As seen at the right, a71 showed only a slight increase in the rate of power consumption, compared with its large benefit of reducing the machining time. This indicates that a high speed machine consumes less power per product or per unit time, thereby providing substantial energy savings.



Energy-saving measures

◎Reduction of power consumption

- Use of a centralized coolant pump (nozzles, overhead shower and base coolant)
- Activation of the chip conveyor when the spindle is turning or when coolant is used
- Automatic power shutoff function

◎Reduction of lubricant consumption

- Adoption grease

Easy maintenance and inspection

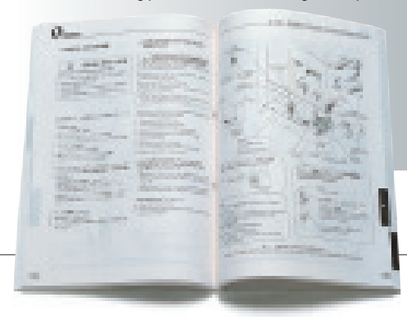
Units that require daily checking of oil levels or air pressures are concentrated in one location for easy confirmation.

Improved operating manuals for supporting effective machine use

Makino also provides improved manuals for explaining the operation of the machine, programming, maintenance, parts list and other aspects to ensure that Makino machining centers are easy to understand, use and operate.

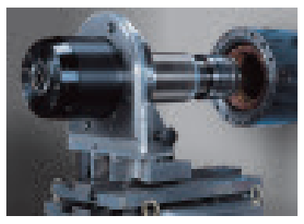
◎User's Manual
This manual mainly explains how to operate the machine and how to create part machining programs for high speed machining.

◎Technical Manual
This manual mainly describes regular maintenance operations, a list of alarms and troubleshooting procedures for recovering from a problem.



Quick spindle replacement

a71 and a81 feature an independent mechanism (patent pending) that allows the spindle bearings and rotor to be pulled out and quickly replaced, thereby minimizing the downtime if the spindle has to be replaced for some reason.



Pallet magazine specifications for automation

Various pallet magazines for automation

Flat pallet magazines *

- **7 pallets + 1 work setting station (WSS)**
- **8 pallets + 8 WSS**

*) In the case of 60 tools magazine, one of the pallet stocker is limited. Please contact Makino representative in your area in detail.

Vertical 2-tier pallet magazines (a71)

- **14 pallets + 1 WSS**
- **12 pallets + 2 WSS**

Vertical 3-tier pallet magazines (a71)

- **21 pallets + 1 WSS**
- **18 pallets + 2 WSS**

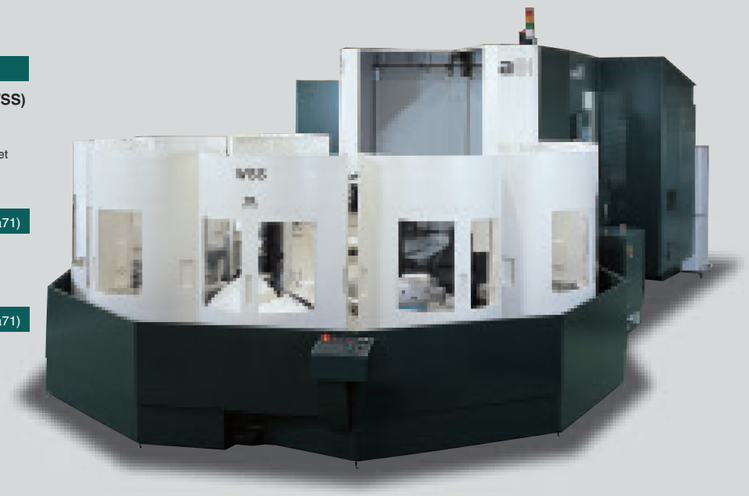


Photo: Flat pallet magazine (7 pallets + 1 WSS)

Continuous Pressure Hydraulics: A flexible, continuous coupled fixture clamping system

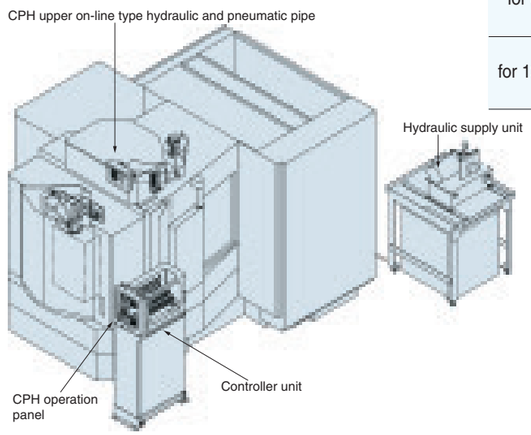
Ordinary connection method

CPH upper on-line type hydraulic and pneumatic pipe

The customer or integrator needs to supply the hydraulic unit and control unit or select jig controller for *CPH upper on-line hydraulic and pneumatic pipe (optional specification) *CPH is an abbreviation for Continuous Pressure Hydraulic.

6+6 ports, 12+12 ports

A maximum of 12 ports of hydraulic or pneumatic can be supplied to each pallet. In addition one line of coolant can be provided for fixture locator wash.



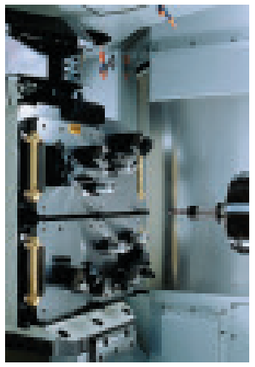
The maximum height of work is lower when CPH upper on-line hydraulic and pneumatic pipe is selected. Please refer to the specifications in detail. The customer or integrator needs to design, manufacture and installed jig to be connected with CPH upper on-line hydraulic and pneumatic pipe.

Fixture control

Jig controller for CPH

Jig controller for CPH (optional specification) can be selected according to the following table, when CPH upper on-line type hydraulic and pneumatic pipe (optional specification) is selected. The jig controller for CPH consists of hydraulic supply unit, the CPH control panel, and the control unit for jig.

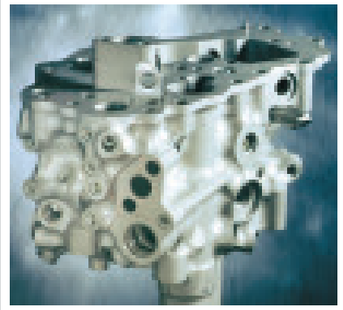
	Maximum hydraulic pressure	Pipe details (H: hydraulic P: pneumatic)
for 6+6 ports	7 MPa	(H:4 + P:2) × 2
	21 MPa	(H:4 + P:2) × 2
for 12+12 ports	7 MPa	(H:8 + P:4) × 2
	21 MPa	(H:8 + P:4) × 2

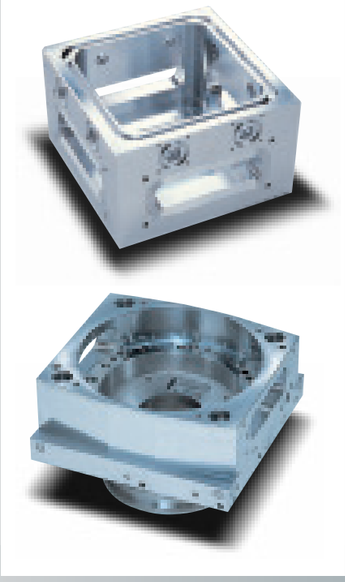


(photo: a51)

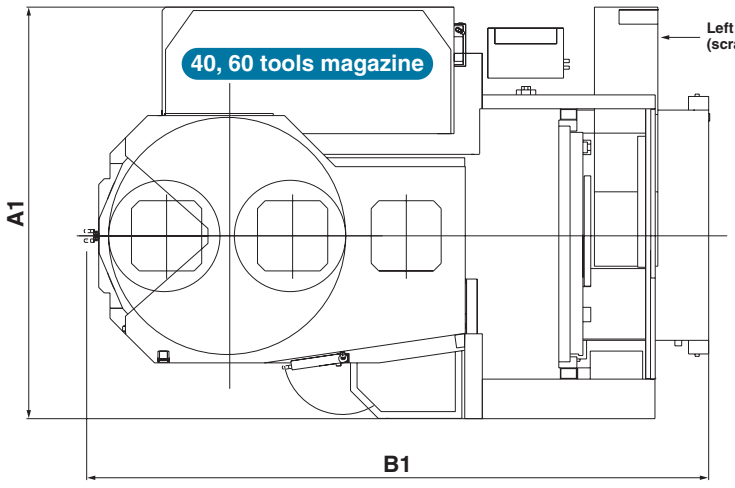
The all items on 21 page are the optional specifications.

Responding to a wide variety of machining needs





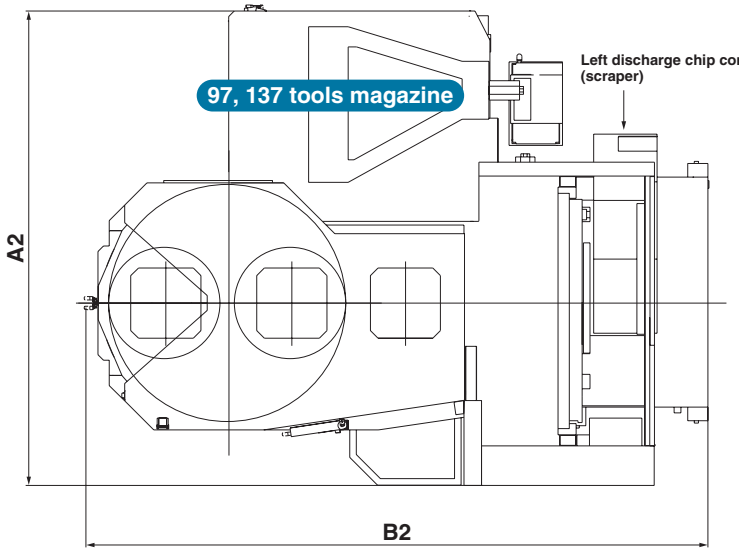
Floor plans



40, 60 tools magazine

	a71	a81
A1	3152 mm	3693 (3991) mm
B1	4843 mm	5584 mm

( ): when step for operator is included.



97, 137 tools magazine

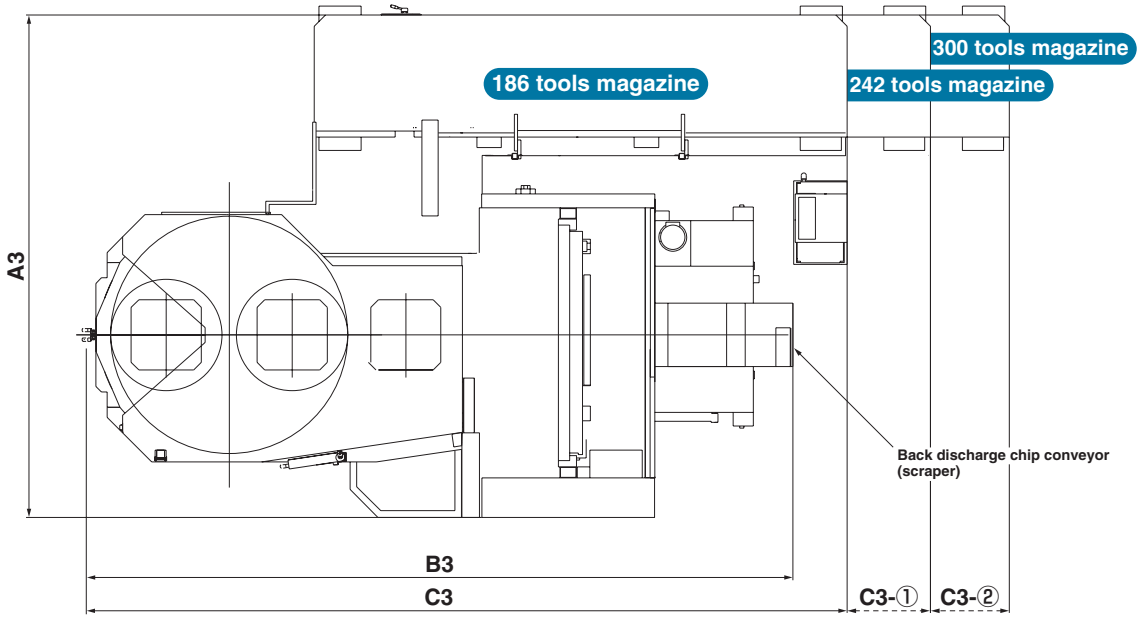
	a71	a81
A2	3904 mm	4262 (4560) mm
B2	4843 mm	5584 mm

( ): when step for operator is included.

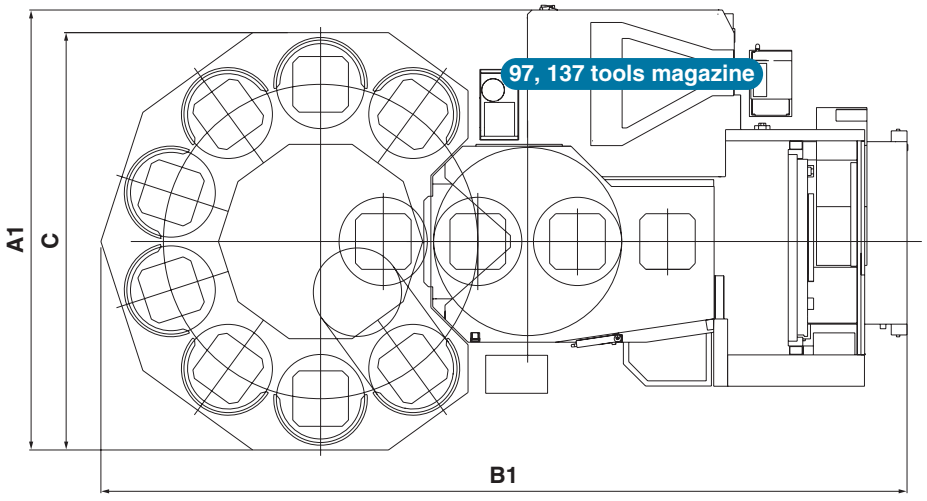
186, 242, 300 tools magazine

	a71	a81
A3	3980 mm	4511 (4809) mm
B3	5910 mm	6652 mm
C3	6269 mm	6830 mm
C3-①	750 mm	
C3-②	709 mm	

( ): when step for operator is included.



Floor plans when flat pallet magazine is connected with.

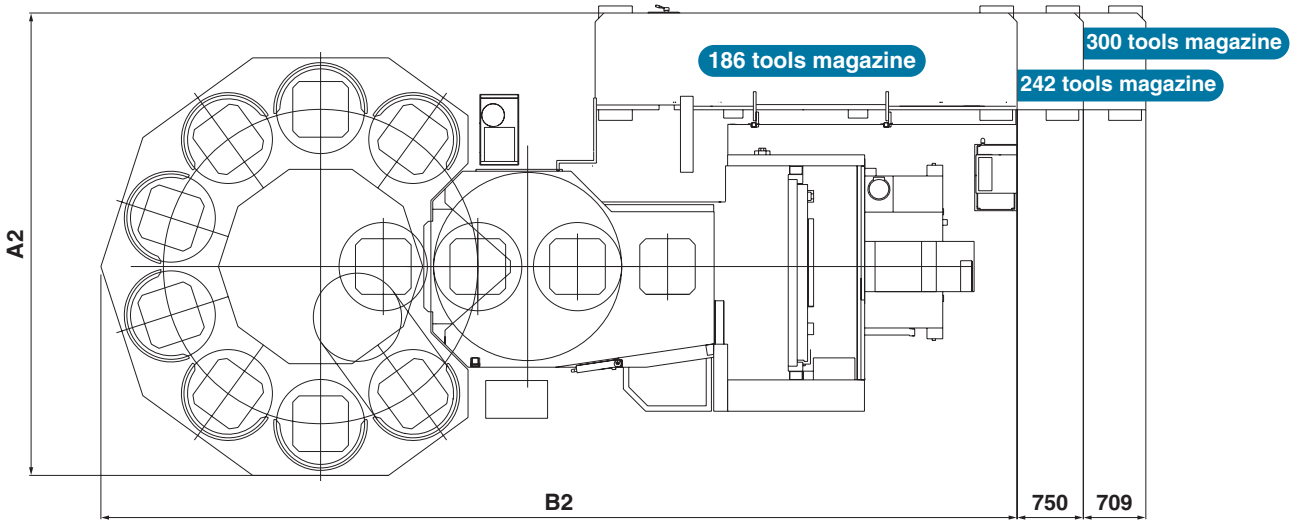


■ 97, 137 tools magazine

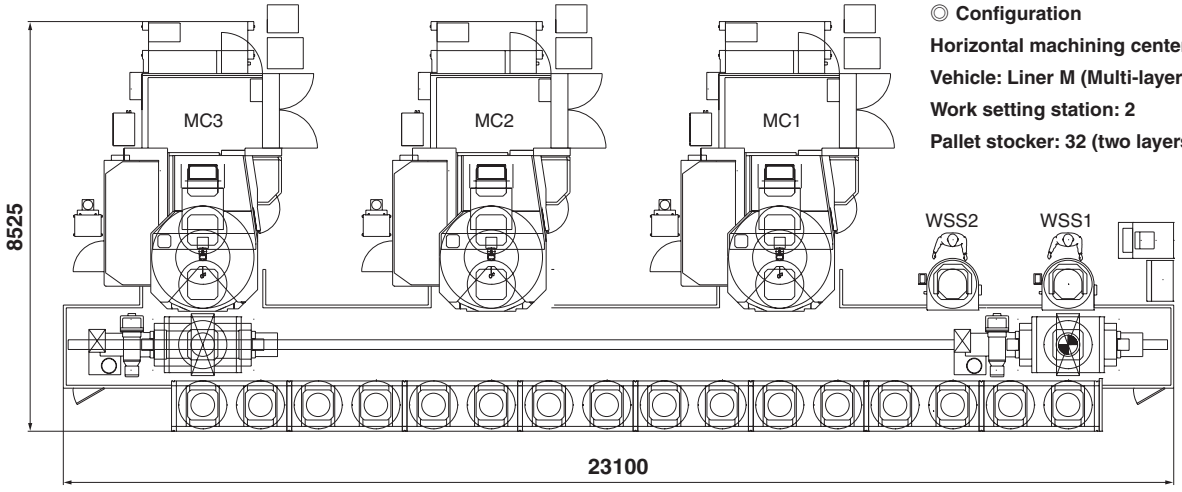
	a71	a81
A1	4517 mm	4987 mm
B1	7801 mm	9132 mm
C	3960 mm	4730 mm

■ 186, 242, 300 tools magazine

	a71	a81
A2	4593 mm	5236 mm
B2	9277 mm	10378 mm



Floor plan when Module MMC is connected with.



◎ Configuration
Horizontal machining center: a81 x 3
Vehicle: Liner M (Multi-layer)
Work setting station: 2
Pallet stocker: 32 (two layers)

a71 a81 specifications

			a71	a81
Travels	X × Y × Z axis	mm	730 × 730 × 800	900 × 800 × 1020
	B axis (pallet table rotation)	degree	360 (continuous)	
	Distance to spindle center from pallet surface	mm	80 ～ 810	80 ～ 880
	Distance to spindle gauge line from pallet center	mm	50 ～ 850	50 ～ 1070
Pallet	Size	mm	500 × 500	630 × 630
	Maximum work size (diameter × height)	mm	800 × 1000	1000 × 1300
	Maximum pallet weight load	kg	700	1200 (1500*)
	Surface configuration		24 × M16 tapped hole (18 mm T slots*)	24 × M16 tapped hole (22 mm T slots*)
	Index angle unit	degree (division)	1 (360)	
	Indexing time 90 / 180 degree (when NC rotary table* is selected.)	second	1.7 (1.25*) / 2.2 (1.75*)	1.9 (1.6*) / 2.7 (2.3*)
	Height to pallet surface	mm	1200	1300
Spindle	Speed range	min^{-1}	20 ～ 10000	
	Taper hole		7/24 No.50 (HSK-A100*)	
	Motor rated output power (15 min / continuous)	kW	35 / 25	
	Torque (25%ED / continuous)	N•m	488 / 304	
	Acceleration time (10000 / 6000 min^{-1})	second	3.8 / 1.4	
	Lubrication / cooling		Oil air / Jacket	
Feedrates	Rapid traverse	mm/min	50000	
	Cutting	mm/min	1 ～ 50000	
Automatic tool changer	Number of tool storage capacity		40 and 60*, 97*, 137*, 186*, 242*, 300*	
	Maximum tool diameter no condtion / with condition	mm	115 (only when 40 and 60* tools magazine) / 300 100 (only when 97* and 137*, 186*, 242*, 300* tools magazine) / 300	
	Maximum tool length	mm	450 (540* only when HSK-A100*)	600* (690* only when HSK-A100*)
	Maximum tool weight	kg	20 (only when 40 and 60* tools magazine) 30 (only when 97* and 137*, 186*, 242*, 300* tools magazine)	
	Maximum tool moment	N•m	19.6 (only when 40 and 60* tools magazine) 45 (only when 97* and 137*, 186*, 242*, 300* tools magazine)	
	Tool change time tool to tool / chip to chip (MAS method)	second	1.7 / 3.8	1.7 / 4.2
Machine size standard specification	Width × Depth	mm	3152 × 4843	3693 × 5584
	Height	mm	3100	3342
	Weight when 40 tools magazine	kg	13100	16000
	Number of support point		3	

*: optional specification

Standard specifications

- 10000 min^{-1} spindle
- Spindle temperature controller
- 40 tools magazine
- (Automatic) Pallet changer (APC)
- (A) PC safety cover (with door interlock)
- 360-division indexing table
- Pallets with tapped holes (2 pallets)
- Ball screw core cooling
- ECO mode functions
- Operator door lock (operation mode)
- 8-nozzle coolant supply
- Through spindle coolant and air (1.5 MPa / 2.2 MPa: 50 Hz / 60Hz)
- Base coolant (center trough)
- Overhead shower coolant system
- Chip Conveyor LSW880 (left discharge, scraper)
- Signal lights 3-layer
- Splash guard (with fluorescent lamp 1pc)
- Portable manual pulse generator with the handle enable button
- I/O interface and 100 V power outlet
- Automatic fire extinguisher interface
- Rigid tap (3000 min^{-1})
- GI.4 control
- Tool life monitoring function
- Automatic power shutoff
- CE regulation (European area)

Optional specifications (●) equipment (★)

- ☐ ● HSK-A100 spindle
- ☐ ● 20000 min^{-1} spindle (core cooling) (HSK-A100)
- ☐ ● 20000 min^{-1} high power spindle (core cooling) (HSK-A100)
- ☐ ● High acceleration spindle (22 / 18.5 kW)
- ☐ ● High torque spindle (37 / 30 kW) available only when a81
- ☐ ● 60 tools magazine (ring type)
- ☐ ● 60 tools magazine (for 30 kg mass, 45 N·m moment) (a81)
- ☐ ● 97, 137, 186, 242, 300 tools magazine (matrix type)
  *186 or larger tools magazine: Left discharge chip conveyor is not available
- ☐ ● Scale feedback (0.1 micron)
- ☐ ● NC rotary table (0.0001 degree)
- ☐ ● 5XR spec.
- ☐ ● T slot pallet specification (2 pallets)
- ☐ ● Pallet clamp confirmation function
- ☐ ★ Pallet random calling function
  *Standard only when pallet magazine is selected.
- ☐ ★ 4-face program random calling function
- ☐ ● CPH upper on-line type hydraulic and pneumatic pipe: 6+6 ports
- ☐ ● CPH upper on-line type hydraulic and pneumatic pipe: 12+12 ports
- ☐ ● Jig controller for CPH (7 MPa / 6+6 ports)
- ☐ ● Jig controller for CPH (21 MPa / 12+12 ports)
- ☐ ● 6-pallet flat pallet magazine (1 WSS) (a71)
- ☐ ● 7-pallet flat pallet magazine (1 WSS)
- ☐ ● 7-pallet flat pallet magazine (7 WSS) (a71)
- ☐ ● 8-pallet flat pallet magazine (8 WSS)
- ☐ ● 12-pallet vertical 2-tier pallet magazine (2 WSS) (a71)
- ☐ ● 14-pallet vertical 2-tier pallet magazine (1 WSS) (a71)
- ☐ ● 18-pallet vertical 3-tier pallet magazine (2 WSS) (a71)
- ☐ ● 21-pallet vertical 3-tier pallet magazine (1 WSS) (a71)
- ☐ ● 6-pallet track type pallet magazine (1 WSS) (I / T-type)
- ☐ ● 8-pallet track type pallet magazine (1 WSS) (I / T-type)
- ☐ ● 10-pallet track type pallet magazine (1 WSS) (I / T-type)
- ☐ ● 12-pallet track type pallet magazine (1 WSS) (I / T-type)
- ☐ ● Module MMC specification
- ☐ ★ 1, 2, 4-face angle plates (T slot)
- ☐ ★ Air blower
- ☐ ★ Workpiece washing gun
- ☐ ★ Coolant temperature controller (with heater)
- ☐ ● Through spindle coolant and air (3 MPa or 7 MPa)
- ☐ ● 8-nozzle coolant flow switch
- ☐ ● Through spindle coolant flow switch
- ☐ ● Chip Conveyor BSW990 (rear discharge, scraper)
- ☐ ● Chip Conveyor LDW955 (left discharge, scraper and hinge)
  This is not available when 186, 242 or 300 tools magazine.
- ☐ ● Chip Conveyor BDW1030 (rear discharge, scraper and hinge)
- ☐ ● Magnet drum Chip Conveyor C-LSW955 (for cast iron, left discharge, scraper)
  This is not available when 186, 242 or 300 tools magazine.
- ☐ ● Magnet drum Chip Conveyor C-BSW1030 (for cast iron, rear discharge scraper)
- ☐ ● Center trough chip conveyor (hinge)
- ☐ ★ Chip bucket
- ☐ ● Mist collector
- ☐ ● Connecting port for mist collector
- ☐ ● Operator door lock & APC door lock (with power shut off)
- ☐ ● ATC door lock (with power shut off)
- ☐ ● Automatic door for (A) PC cover
- ☐ ● Rotary wiper for splash guard window
- ☐ ● Positioning block
- ☐ ● Automatic workpiece measuring device (MARPOSS probe)
- ☐ ● Retractable automatic tool length measuring device (Metrol probe)
- ☐ ● Retractable automatic tool length measuring device (MARPOSS probe)
- ☐ ● ATC side broken tool sensor
- ☐ ● Measuring data print-out function
- ☐ ● 3D Shape Measuring Function
  *Automatic workpiece measuring device, measuring data print-out function and custom macro are required.
- ☐ ● Automatic grease supply unit
- ☐ ★ Air dryer
- ☐ ★ Lighting device inside of electric enclosure and 100V outlet
- ☐ ★ Run hour meter
- ☐ ★ Warm-up timer
- ☐ ★ Super GI.4 control
- ☐ ★ Surper GI.3 (This is available only when a81.)
- ☐ ★ Customer specified machine color

Printed in Japan M360Eh-1 1301/1 (V-T-F)

Professional 5 specifications

Standard (•) / Optional eqipment (□)

NC specifications

Controlled axes
- • Simultaneous 3 axes
- □ Simultaneous 4 axes (NC rotary table)
- □ Simultaneous 5 axes

Programmings
- • Programming unit (0.0001 mm)
- • Programmable maximum ±9 digits (99999.9999)
- • Absolute/incremental programming (G90 / G91)
- • Pocket calculator type decimal point programming
- • Tape code ISO / EIA automatic recognition
- □ Inch/metric conversion (G20 / G21)

Interpolations functions
- • Positioning (non linear interpolation type positioning)*1 (G00)
- □ Positioning (linear interpolation type positioning)*2 (G00)
- • Linear (G01)
- • Circular(G02, G03)
- • Nano
- □ Helical (Circular + 2 axes linear) (G02, G03)
- □ Polar coordinate*3 (G12.1, G13.1)
- □ Cylindrical*3 (G07.1)
- □ Involutes
- □ Conical/spiral
- □ Hypothetical axis
- □ NURBS
- □ 3 dimensional circular

Feeds function
- • Cutting feed F5-digit
- • Dwell (G04)
- • Rapid traverse override
- • Cutting feed override (0 - 200 %)
- • Feedrate override cancel (M49 / M48)
- □ 1-digit F code feed (F1 - F9)
- □ Automatic corner override (G62)
- □ Inverse time feed (G93)

Program editing operation
- • Part program storage size (total) 320 m
- □ Additional (total): 640 m
- □ Additional (total): 1280 m
- □ Additional (total): 2560 m
- □ Additional (total): 5120 m
- □ Additional (total): 10240 m
- □ Additional (total): 20480 m
- • Number of registerable program (total) 63
- □ Additional (total): 250
  (available only when 320 m part program storage size.)
- □ Additional (total): 500
  (available only when 640 m part program storage size.)
- □ Additional (total): 1000
  (available only when 1280 m or more part program storage size.)
- □ Additional (total): 2000
  (available only when 2560 m part program storage size.)
- □ Additional (total): 4000
  (available only when 5120 m part program storage size.)
- • Part program editing
- • Program number search
- • Sequence number search
- • Address word search

Display
- • 12.1" color TFT LCD with touch panel
- • MDI operation
- • Clock function
- • Operation history display
- □ Machining time stamp
  (Only when FS310is, Run hour and parts count display has to be selected with)
- □ Run hour and parts count display

I/O
- • RS232 interface
- □ HSSB connecting kit
  (for μCell Expert, μCell Expert + or μDMS5)

S/T/M functions
- • Spindle speed function
  (direct commanding, S5 digit)
- • Tool function: T4 digit
- □ Tool function: T8 digit
- • M code function

Tool compensation
- • Length offset (G43, G44 / G49)
- • Radius · nose radius compensation
  (G41, G42 / G40)
- □ Tool offset pairs (total): 99
- □ Additional (total): 200
- □ Additional (total): 400
- □ Additional (total): 499
- □ Additional (total): 999
- • Tool offset memory A
- □ Tool offset memory B
- □ Tool offset memory C
- □ 3-dimensional tool compensation

Coordinate
- • Manual reference position return
- • Reference position return (G28)
- • 2nd reference position return*4
- □ 3rd/4th reference position return
- • Reference position return check (G27)
- • Return from reference position return (G29)
- • Coordinate system setting (G92)
- • Local coordinate system setting (G52)
- • Machine coordinate system setting (G53)
- • Workpiece coordinate system (G54-G59)
- □ Floating reference position return (G30.1)
- □ Addition of workpiece coordinate system 48 pairs
- □ Addition of workpiece coordinate system 300 pairs
- □ Workpiece coordinate system preset (G92.1)

5 axis functions*5
- • Workpiece setting function
  (includes tilted working plane indexing command.)
- • Tool center point control
- • High-speed smooth TCP*6
- • 3-demensional cutter compensation*6
- □ 3-demensional manual feed*7
- □ 3-dimensional coordinate conversion
- □ Rotary table dynamic fixture offset
- □ 5-axis machining package*8 (for 5XR spec.)

Operating support functions
- • Label skip
- □ High-speed skip (function)
- • Control in / out
- • Single block
- • Program stop (M00)
- • Optional stop (M01)
- • Optional block skip 1(/)
- □ Additional optional block skip (/ 1 - / 9)
- • Dry run
- • Machine lock
- • Freeze Z axis
- • Auxiliary function lock (S / T / M)
- • Mirror image (M21, M22 / M23)
- • Manual absolute on and off
- □ Program restart
- • Tool length measurement
- □ Handle interruption
- □ Sequence number comparison and stop

Programming support functions
- • Circular interpolation by R programming (12 digit)
- • Canned cycle
- • Sub program call (10 folds nested)
- • Exact stop (G09)
- • Exact stop mode (G61)
- • Tapping mode (G63)
- • Cutting mode (G64)
- • Rigid Tap
- • Programmable data input (G10)
- • Tape format for FS-15M
- • Custom macro common variables (total): 100
- □ Additional common variables (total): 600
- □ Additional common variables (total): 1000*9
- □ Optional chamfering corner R
- □ Programmable mirror image (G51.1 / G50.1)
- □ Scaling (G51 / G50)
- □ Coordinate system rotation (G68 / G69)
- □ Figure copying (G72.1 / G72.2)
- □ Polar coordinate command (G15 / G16)
- □ Normal direction control
- □ Chopping function (G81.1)
  (Please contact us whenever this will be selected.)

Error compensations
- • Stored pitch error compensation
- • Backlash compensation
- □ Single direction positioning (G60)

Maintenance & Safety
- • Emergency stop
- • Over travel
- • Stored stroke check 1
- □ Stored stroke check 2
- • Self-diagnostics function
- • ECO mode functions*10
- □ TSC 7.0 MPa Inverter Drive Specification*10
  (avairable only for through spindle coolant 7 MPa)
- □ ECO mode of air consumption volume*10
- □ Power consumption monitoring*10
- • Interlock
- • Alarm history display
- • Help function
- • Spindle-table crash avoidance function
- • Standard tool length function

*1 This is not available when 5XR spec. , a51-5XU or a61nx-5E is selected.
*2 This is standard when 5XR spec. , a51-5XU or a61nx-5E is selected.
*3 NC rotary table has to be selected with this.
*4 2nd reference position return is a fixed position on machine tool (ATC etc.) and cannot be altered arbitrary.
*5 These are available only when 5XR spec. , a51-5XU or a61nx-5E is selected.
*6 This is not standard but option equipment only when a61nx-5E.
*7 This is standard equipment only when a51-5XU is selected.
*8 This is available only when 5XR spec. and includes 3-dimensional manual feed and, function of the coordinate calculation, setting based on rotary angle axis.
*9 This is not available only when a51, a51-5XU, a61, a81, a81M, a82 or a82M.
*10 This is not available only when a51, a51-5XU or a61.

Professional 5 specifications

Standard (•) / Optional equipment (□)

MTC specifications

Display
- 12.1 inches color TFT LCD with touch panel

High speed, High precision
- GI.4 control
- □ Super GI.4 control *1
- □ Super GI.3 control *2
- □ FT function *3
- □ Nano smoothing *3

Editing function
- Program Preview
- Back ground editing
  (equivalent to FANUC "Backgrund editing")
- Cut & Paste and Replace function
  (equivalent to FANUC "Extended part program editing")
- 2-program simultaneous edit function
- G code Insert function
- M code Insert function
- Fixed program Insert function
- Final MDI program Insert function
- Coordinate value Insert function
  (equivalent to FANUC "Playback")
- Other program Insert function
- □ Alphanumeric Program file name input (32 characters)

Monitor
- Spindle load display
- Spindle load monitoring function (SL)
- Tool life monitoring function (TL)
- Direct spare tool selection function
- Product count function *4
  (equivalent to FANUC "Run hour and parts count display")
- Machining result function *5
  (equivalent to FANUC "Machining time stamp")
- □ Adaptive control function (AC)

Data input/output
- Data center (Standard memory: 4 MB)
- File management function (NC programs, various data files)
- DNC simple schedule function (Multiple main programs executable)
- Automatic fire extinguisher interface
- □ Data center expansion function type A (total): 360 MB
- □ Data center expansion function type A (total): 800 MB
- □ Data center expansion function type C (total): 1.6 GB
- □ Twist-pair cable (10 m)
- □ Twist-pair cable (20 m)
- □ Twist-pair cable (30 m)
- □ Twist-pair cable (40 m)
- □ Twist-pair cable (50 m)
- □ 8-port HUB
- □ Special User I/O Interface
- □ Macro variable file output function

Easy push-button -operation
- Registered tool automatic selection and changing function
- All axis automatic return to reference point
- Automatic return to work setting position
- Z axis retraction
- □ Automatic Z-axis retract and restart function

Guidance
- Self-diagnostics and instruction display
- Number and position of limit switches and solenoid display for alarm
- Alarm History function (machine side and NC side)
- Automatic display for regular maintenance advice
- User create function for regular maintenance

Software
- □ Pallet random calling function
- □ 4-face program random calling function
- □ FF-path package
  (includes helical interpolation)
- □ External setting orientation
- □ Function of the coordinate calculation and setting based on the rotary axis angle *6
- □ 3D shape measuring function A *7

Module MMC specification
- □ Ethernet I/F

For μCell Expert and μDMS5
- □ HSSB connecting kit

*1 This is standard when 5XR spec. or a51-5XU is selected.

*2 This is available only when a51, a61, a81, a81M, a82 or a82M.

*3 Super GI.4 control has to be selected with this.

*4 When the run hour and parts quantity are got by using the FANUC FOCAS Library, FANUC "run hour and parts display" (option equipment) has to be selected.

*5 When the machine time is got by using the FANUC FOCAS Library, FANUC "machining time stamp" (option equipment) has to be selected.

*6 This is standard only when a51-5XU.

*7 Automatic workpiece measuring device has to be selected with this.

The specifications in this catalogue may be changed without prior notice to incorporate improvements resulting from ongoing R&D programs.

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