



F3 · F5

Vertical Machining Centers





In the evolution of consumer goods, there is a demand for continuous improvement in aesthetics, styling, cost and performance. It is a tremendous challenge for manufacturers to provide an efficient and competitive solution to production, aerospace, medical, and die/mold industries. Each industry has its own demanding requirements on surface finish, contouring accuracy, and tool life, with the ultimate goal being a lower cost per part with improved quality.

Makino is well-established in bringing this value to these markets through the reliability of our product line, the innovation of the technologies employed in them, and the expertise of our engineering and applications personnel.

Makino's F-series vertical machining centers is another example of Makino's ability to bring the finest machining solutions to the marketplace. Three elements make this possible:

- Rigid Machine Construction
- Patented High-Performance Spindle Technology
- Software Control

The F-series combines these advantages with an ergonomic design and an efficient chip evacuation system. This line was designed with the customer and operator in mind. Parts are easily loaded, programs easily run, and high-quality machining finishes are achieved - all at a lower cost per part.



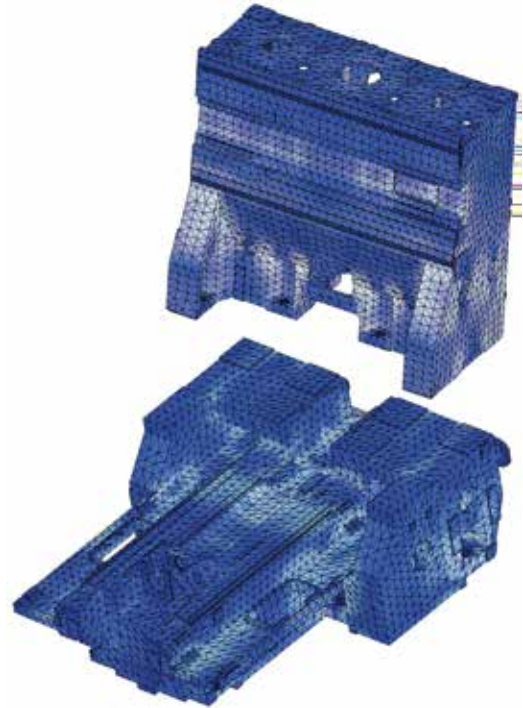
Rigid Machine Construction

Heavy cast iron construction and a unique axis configuration provides outstanding stiffness, rigidity, thermal stability, accuracy and unequalled axis support throughout the full travel of each axis:

- X and Z on the column
 - Constant spindle support distance
 - Fully supported throughout travel
- Y under table
 - No "stack-up" of X and Y
 - No off-center table load condition
 - Fully supported throughout travel

Finite Element Analysis (FEA) of the basic components insure optimized structural rigidity and torsional stiffness for ultimate performance characteristics and consistent results.

This structural rigidity is the foundation for superior cutting performance, provides damping against vibration, and sustained accuracy for the life of the machine.



Most competitive machines feature some variation of a traditional "C-frame" design. Therefore, in most die and mold applications, by virtue of the machine configuration and associated geometry, the machine tool elements significantly overhang their support structure:

- The Z axis is cantilevered from the X axis (Figure 1)
- The X axis is "stacked up" on the Y axis (Figure 2)
- The X axis is overhung from the Y axis (Figure 3)

As a result, cutting forces - combined with these long, unsupported, cantilevered distances - create stiffness, rigidity and dynamic distortion issues that produce vibration and chatter. Such instabilities, inertial factors and bending moments during cutting dramatically impact surface finish, final part accuracy, cutting speeds and feeds, achievable depth of cut, cycle time, tool life, and productivity. By virtue of the unique F-series construction, the machine provides a stiffer, more rigid, highly accurate, chatter-free platform for even the most difficult of cuts.

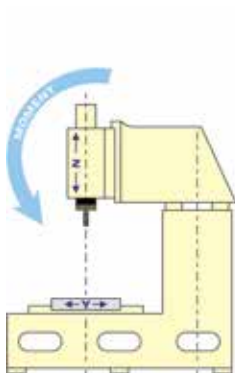


Figure 1

Z axis cantilevered from X axis

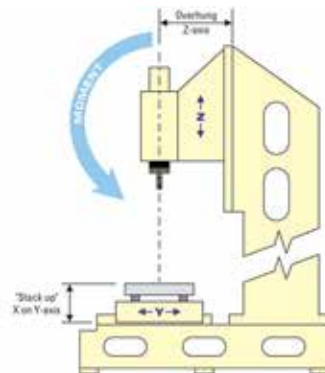


Figure 2

Spindle overhung from Z axis
and X axis stacked on Y axis

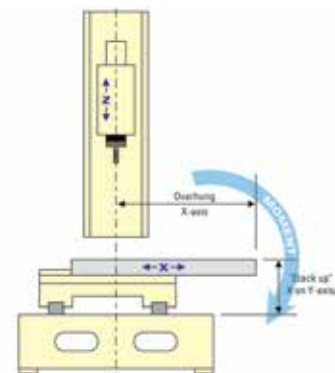


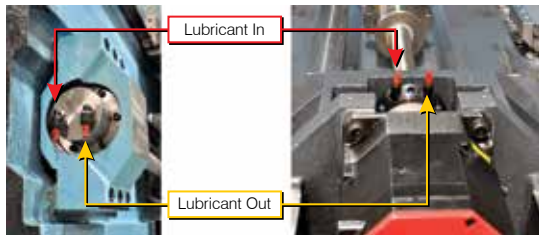
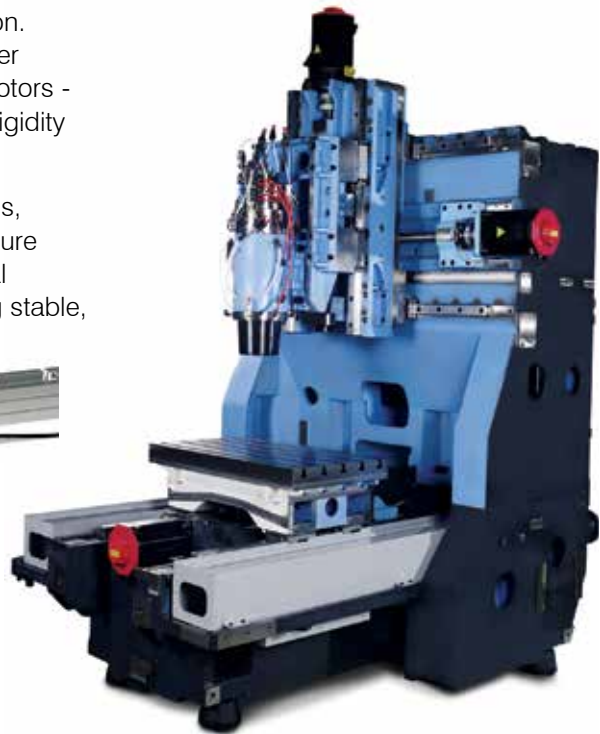
Figure 3

X axis and table overhung
from Y axis

High performance linear guideways (utilizing “caged ball” technology) provide extremely precise, anti-friction motion. In addition, pre-tensioned, dual supported, large diameter ballscrews and powerful, direct-coupled, digital servo motors - tuned for peak performance - provide the stiffness and rigidity for the most challenging applications.

Fine-pitch ballscrews provide greater precision for blends, matches and complex geometry applications. Temperature controlled, lubrication maintains and controls the thermal stability of the ballscrew bearing mounting area, insuring stable, long cycle time cutting accuracy.

In addition, the F-series machines are equipped with scale feedback (i.e. 0.05 micron) as a standard feature - enhancing machine precision and insuring long-term machine accuracy.



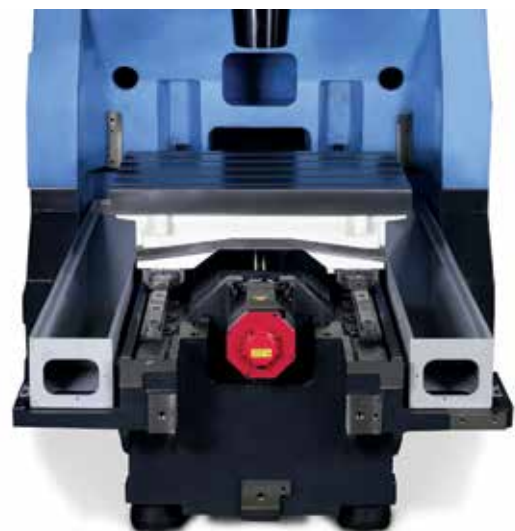
Together, these machine design features reduce variability for hours of continuous, tight tolerance machining - providing the F-series machines with micron level performance.

- Linear Positioning Accuracy $\pm 0.0015\text{mm}$ ($\pm 0.000060''$)
- Repeatability $\pm 0.0010\text{mm}$ ($\pm 0.000040''$)

To insure highest function and productivity, with minimal operator intervention and associated downtime, F-series machines are equipped with an automatic lubrication system for the guideway and ballscrew systems.

The table utilizes a “bridge” type design that provides full support over the entire travel of the Y axis. The table load is always centered between the guideways, providing the highest accuracy - even under maximum table loads and off-center positions. This approach eliminates overhangs, table droop, and “stack up” of axes common with other machine designs. The design approach also enhances the machine ergonomics:

- Provides a user-friendly table load height (900mm/35.4")
- Shorter reach to the table since it moves forward toward the operator



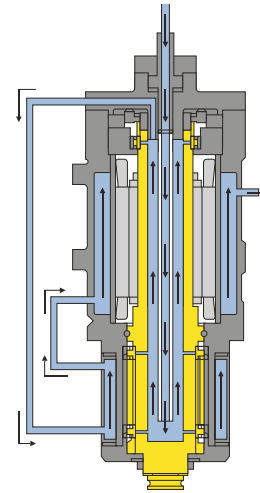
Spindle and Control Technology

High-Performance Spindle

Makino's leadership in spindle technology is renowned throughout the world. Spindle rigidity, higher rpm, constant pre-load, multi-plane balancing, minimizing vibration, and controlling thermal growth are all issues that Makino has solved through years of experience and application of spindle design, manufacture, and assembly.

The F-series incorporates Makino's patented spindle technology:

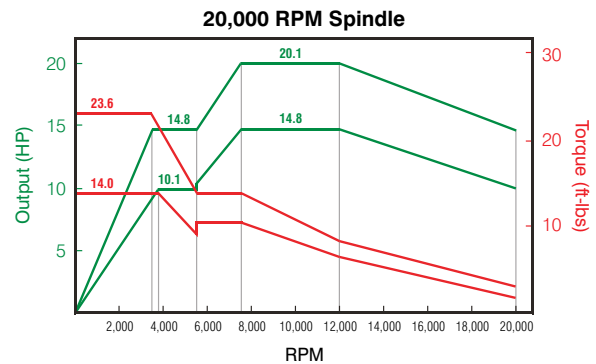
- Spindle core cooling
- Under-race bearing lubrication
- Closed loop oilmatic temperature control



Blend of Speed, Power, and Torque

Included in the standard configuration of the F-series machine is a highly productive 20,000 rpm, HSK-63A spindle that incorporates Makino's patented core-cooling, under-race lubrication, and jacket spindle temperature control system.

The spindle provides characteristics required in any number of machining applications. The two-range, unique integral design provides wide-range capability with stiffness and rigidity at lower ranges (roughing operations) to vibration & chatter-free production of small details and fine features when using small tools at a high rpm.



Spindle Temperature Controller

The F-series machine is the only machine of its class to combine a large capacity, heat dissipating spindle chiller, and the patented Makino technologies mentioned above. This maintains tight control over the spindle core, bearings, and motor area, thus minimizing any spindle thermal growth effects upon spindle pre-load that impacts spindle stiffness and rigidity, tool life, surface finish, and ultimately final part accuracy.

- Stiffness and rigidity for roughing and hardmilling operations
- High-speed for small tools, finishing operations and graphite
- Thermal control for precision



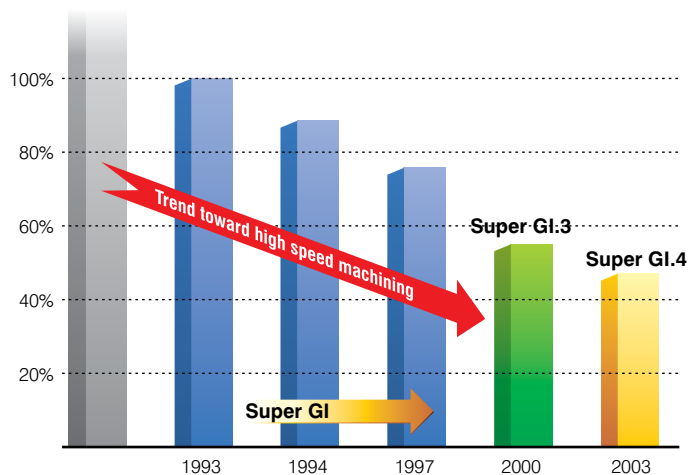
Makino Professional 5 Control (PRO5)

The F-series utilizes the Makino Professional 5 Control which affords the perfect blend of a Windows CE™ graphical user interface (GUI), touch-screen selection that provides instant access to information literally at your fingertip, user-friendly, efficient PC-like capability for data management and editing, and the networking and storage capability of a Makino proprietary data center.



Super Geometric Intelligence (SGI.4)

Also featured in the F-series is Makino's proprietary, next generation Super Geometric Intelligence (SGI.4) software - developed specifically for high feedrate, tight tolerance machining of complex, 3D contoured shapes involving continuous tiny blocks of NC data. It insures production rates faster than standard CNC systems while maintaining high accuracy. SGI.4 helps provide the lowest cycle times and costs



Ease of Operation and Efficient Chip Removal



The chip and splashguard fully encloses the machining area to prevent flying chips and coolant from escaping outside the machine during high-speed cutting. The large windows provide outstanding visibility of the workzone.

The chip and splashguard doors, as well as the machine ceiling, open together to facilitate easy handling of large, heavy workpieces that require an overhead crane. Combined with the movement of the table, and the convenient table loading height, the F-series machines significantly reduces part exchange load times and operator fatigue. An opening to provide “toe clearance” for the operator, or for “cherry picker” use is included in the chip and splashguard design.



The machine control is on a pivot that provides 90° of swing. This assures the operator will always have easy access to the control during set-up, program prove-out, operation, and even manual tool loading through the front of the machine.

Equipped with a 30-tool magazine, the F-series machine offers sufficient capacity for a wide variety of tooling applications. The Automatic Tool Changer (ATC) is a highly-reliable, field-proven bi-directional, random access design that provides a very quick and reliable tool exchange.



An integral ATC shutter separates the machine workzone from the tool magazine, assuring the chips and coolant from the machining area do not migrate into the tool magazine.



The tool changer door provides ready access for easy loading and unloading of tooling to the machine magazine. An ATC control panel is located adjacent to the tool changer door to assist the operator in manual operation of the tool magazine and double gripper for tool replenishment and maintenance.



Within the workzone, chip and coolant recovery is very quick and efficient due to a number of design features. All internal chip and splashguard surfaces are steeply sloped. High-center or "teepee" shaped tele-covers and flushing nozzles insure that all chips and coolant are directed into the integral chip troughs and dual, spiral screw, chip management system.



Chips and coolant are transferred to a large capacity chip and coolant recovery system conveniently located at the rear of the machine.



Makino F-series Vertical Machining Centers

The F-series machine delivers positioning accuracies and repeatability in the microns. The spindle assures the capability to address a wide variety of tooling and machining applications, and SGI.4 provides unsurpassed accuracy and speed in tough, challenging, and complex geometries. This platform is an ideal choice for shops looking to get "top-shelf" machining performance and superior machining results at a reasonable investment - a true value proposition.

From....

- Prototype to production...
- Injection molds, stampings, to forgings...
- High-speed, hardmilling to graphite...
- Medical, electronics, aerospace, automotive, optic, consumer products, to packaging...



Lens mold



Forging die



Stamping die



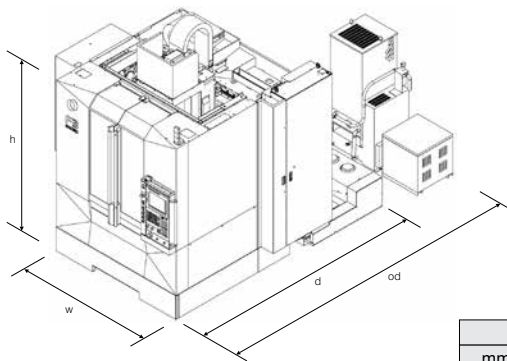
Medical & Five-axis



Plastic mold

Machine Specifications

	F3	F5
Travels		
X:	650mm (25.6")	900mm (35.4")
Y:	500mm (19.7")	500mm (19.7")
Z:	450mm (17.7")	450mm (17.7")
Table Size	850 x 500mm (33.5" x 19.7")	1,000 x 500mm (39.4" x 19.7")
Table Load Capacity	650 kg (1,432 lbs.)	
Type of Axis Drives:	AC Digital Servo Motors	
Bed Construction:	Meehanite Cast Iron	
Ballscrew (pitch):	8mm (0.315")	
X and Y diameter:	40mm (1.57")	
Z diameter:	45mm (1.77")	
Linear Positioning Accuracy (with proper foundation and environmental control):		
With Moiré Scales (Standard):	±0.0015mm (±0.000060")	
Repeatability:		
With Moiré Scales (Standard):	±0.0001mm (±0.000040")	
Scales:	0.05 micron	
Feeds		
Rapid Traverse:	20,000mm/min (787 ipm)	
Feed Rate:	0 to 20,000mm/min (0 to 787 ipm)	
Jog Feed:	0 to 8,000 mm/min (0 to 315 ipm)	
Rapid Traverse Override:	Min. to 100%	
Cutting Feed Override:	0 to 200%	
Automatic Tool Changer		
Capacity	30 tools	
Maximum Tool Diameter (30 ATC)		
All Fill	76.2mm (3.0")	
Adjacent	120mm (4.72")	
Maximum Tool Length	300mm (11.8")	
Maximum Tool Weight	8 kg (17.6 lbs.)	
Coolant Tank		
Dual Workzone Chip Augers		
Rear Tank		
Tank Capacity	420 liters (110.9 gallons)	
Machine		
Weight	7300 kg (16,089 lbs.)	7500 kg (16,530 lbs.)



	h		w		d		od	
	mm	inch	mm	inch	mm	inch	mm	inch
F3 machine	3,065	121	2,440	96	3,245	128	4,295	169
F5 machine	3,065	121	2,565	101	3,245	128	4,295	169

Optional Features:

30 tools (20 ATC), 13K & 30K rpm spindles, 217 PSI Through Spindle Coolant, 435 PSI Through Spindle Coolant, Through Spindle Air, Wash Gun, Oil Skimmer, Left Discharge Lift-up Chip Conveyor, Graphite Package, Chip Bucket, ATLM Touch Probe, Work Touch Probe, Rotating Window, Portable MPG, 3-layer Signal Light, Vertical Rotary Tables, Five (5) Axis, Various Control Options.

Spindle Specifications

Spindle	Standard	Optional 13k	Optional 30k
Spindle Nose Interface:	HSK A63	CAT 40	HSK F63
Tool Clamping Force:	17,652 N (3,968 lbs.)	8,826 N (1,984 lbs.)	10,787 N (2,425 lbs.)
Tool Clamping Method:	Disc spring clamp/hydraulic unclamp	Disc spring clamp/hydraulic unclamp	Disc spring clamp/hydraulic unclamp
Spindle Drive Motor - AC:			
30 Minute Rating:	15 kW (20 hp)	22 kW (29.5 hp)	15 kW (20 hp)
Continuous Rating:	11 kW (14.75 hp)	18 kW (24.1 hp)	11 kW (14.75 hp)
Spindle Torque Characteristics:			
5 Minute Rating:	32 Nm (23.6 ft. lbs.)	117 Nm (86.3 ft. lbs.)	20.4 Nm (15 ft. lbs.)
Continuous Rating:	19 Nm (14 ft. lbs.)	95 Nm (70 ft. lbs.)	14.6 Nm (10.7 ft. lbs.)
Spindle Speed Range:	200 to 20,000 rpm	120 to 13,000 rpm	300 to 30,000 rpm
Spindle Speed Increment:	1 rpm	1 rpm	1 rpm
Number of Spindle Speed Ranges:	2	2	2
Obtain Full Horsepower:	7,500 rpm	5,000 rpm	15,000 rpm
Constant Torque Range:	200 to 3,300 rpm	120 to 1,500 rpm	300 to 3,000 rpm
Bearing Lubrication:	Core cooled, under-race, jacket cooling	Grease, jacket cooling	Core cooled, under-race, jacket cooling
Spindle Temperature Controller:	Oilmatic (spindle and motor jacket)	Oilmatic (jacket)	Oilmatic (spindle and motor jacket)
Spindle Front Bearing Type:	Angular contact, ceramic ball type	Angular contact, ceramic ball type	Angular contact, ceramic ball type
Spindle Nose to Table:	150 to 600mm (5.9" to 23.6")	150 to 600mm (5.9" to 23.6")	150 to 600mm (5.9" to 23.6")



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