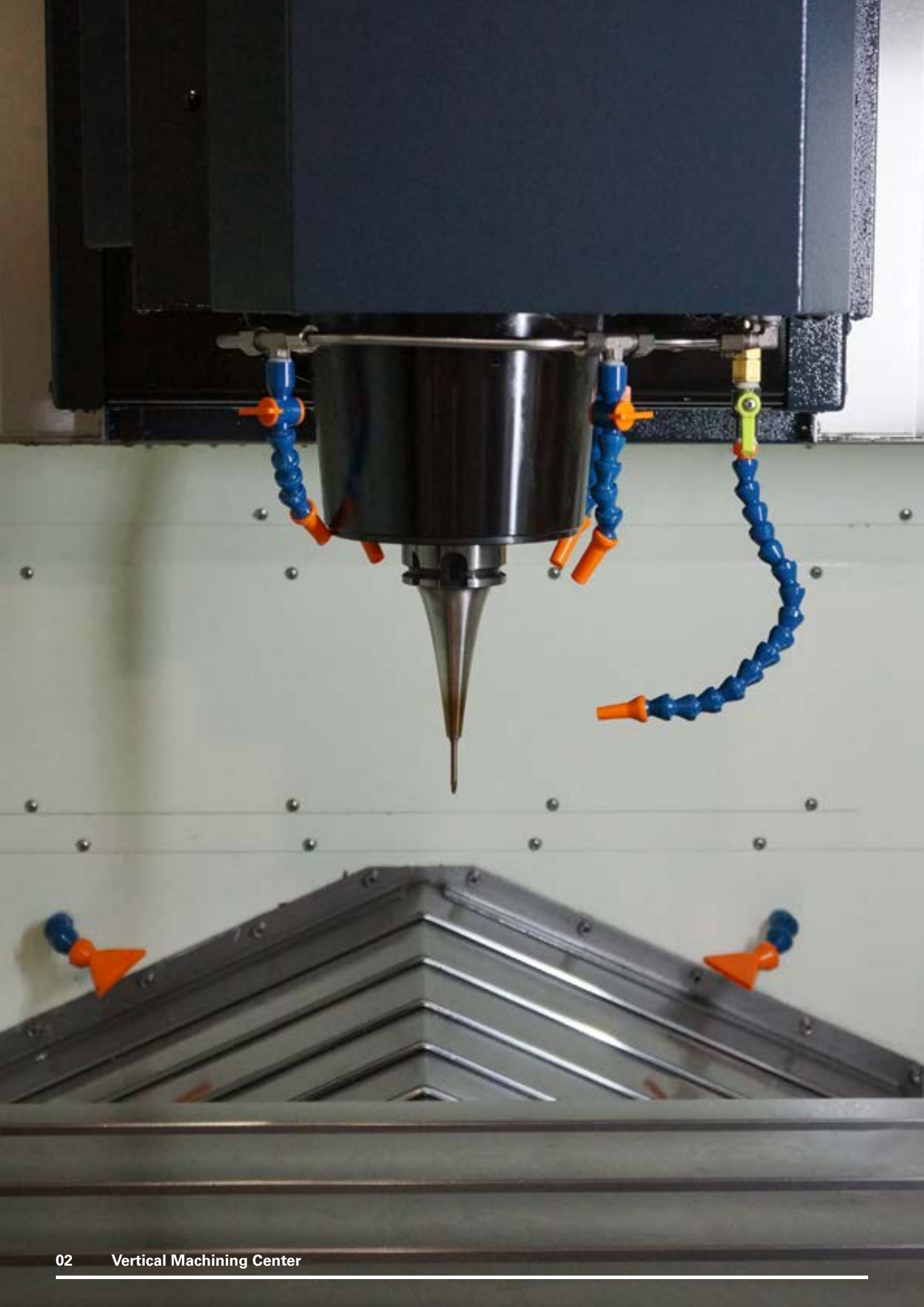
F5

Vertical Machining Center

MAKINO



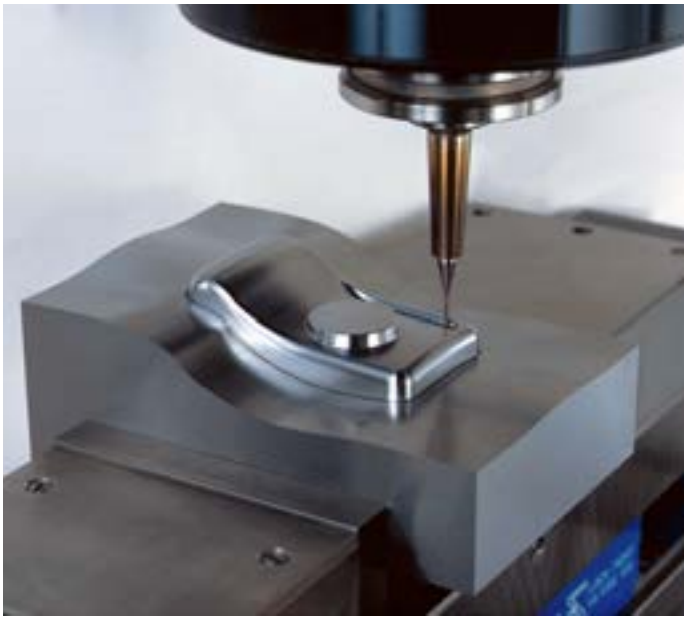
“Defining the art of precision mold making”

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 mold making solution to automotive, aerospace, 3C & medical 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. These elements make this possible:

- **Rigid Structure**
- **Thermal Stability**
- **Advanced Spindle Technology**
- **Motion Technology**

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.



COMPETITIVE SOLUTIONS FOR DIE & MOLD

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.5 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.

The F-series machine is designed to provide stiffness and rigidity for chatter-free cutting, agility expected from a hard milling machine and accuracies for tight-tolerance blends and matches typical of complex, 3-D contoured geometry associated with :

- Plastic, die cast to blow molds
- Stamping to forging
- Prototype to production
- Medical, electronics, aerospace, optical consumer products, to packaging

UNBEATABLE PERFORMANCE

DIE CAST DIE

DIE CAST DIE

PLASTIC MOLD

FORGING DIE

STAMPING DIE

COPPER ELECTRODE

RIGID STRUCTURE

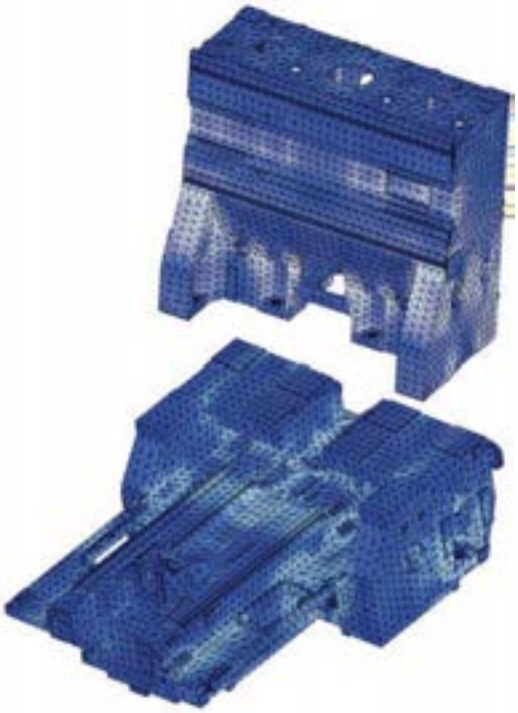
Heavy cast iron construction and a unique axis configuration provides outstanding stiffness, rigidity, thermal stability, accuracy and unequaled axis support throughout the full travel of each axis:

• 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 ensure optimized structural rigidity and tortional 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.

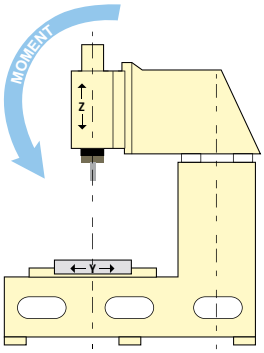


Figure 1

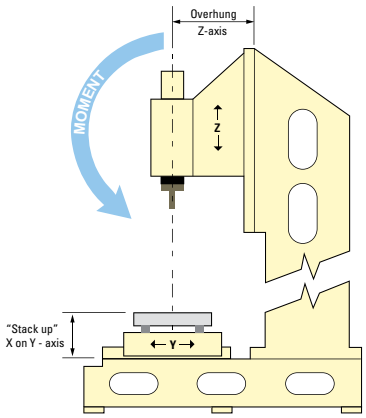


Figure 2

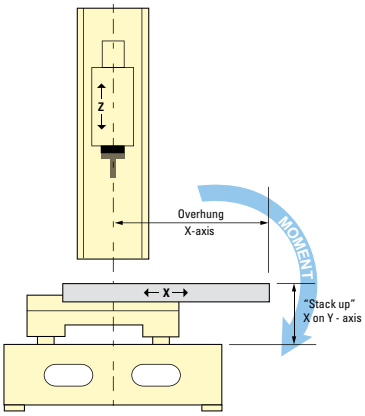


Figure 3

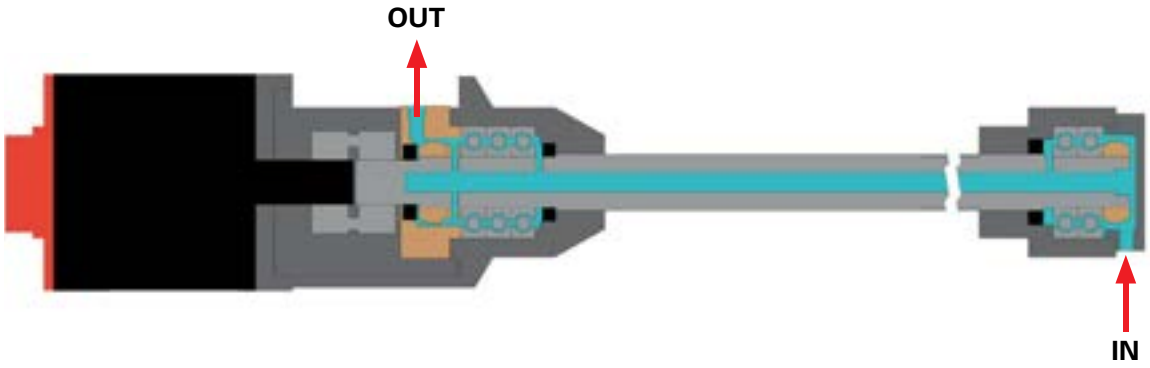
THERMAL STABILITY

Ball screw core cooling

- Cooling oil controlled to the machine temperature is circulated through the inside of the ball screws to minimise or control heat generation during high-speed movement.
- In addition, cooling oil is also circulated to the support bearings providing the dual effect of cooling and increasing the life.

Motor flange cooling

- Cooling oil is circulated through the motor flange to prevent motor heat from being transferred to the machine.



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

Fine ball screw motion provides greater precision for blends, matches and complex geometry applications.

Achieving High Precision Accuracy Through Mechanical Means

Parts are accurately manufactured, meticulously adjusted and assembled with exacting precision.

Scrapping is incorporated in the machine assembly in order to achieve better profile accuracy and surface matching which results to mechanical accuracy in order to further enhance and increase the machine performance and increase the machine life at the same time.

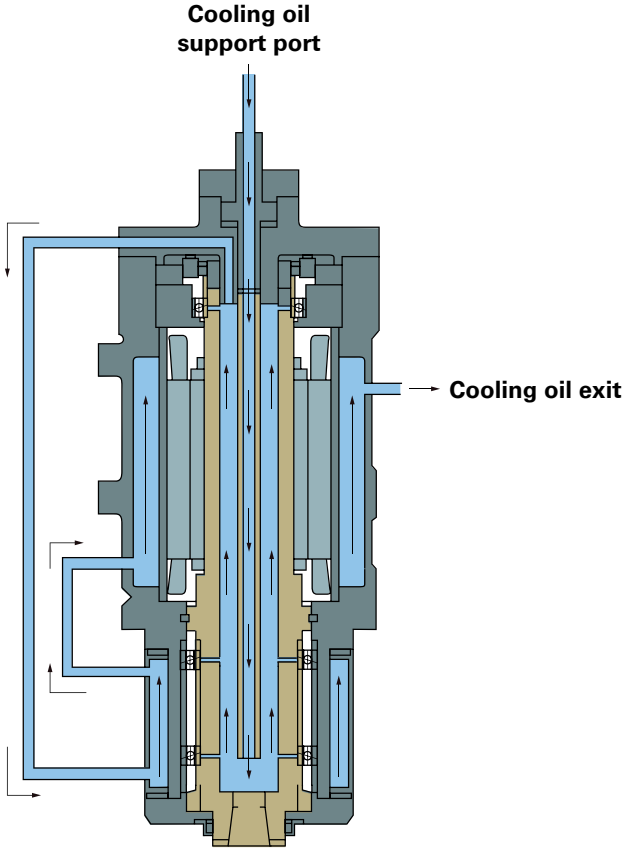
ADVANCE SPINDLE TECHNOLOGY

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.

Both 20,000 rpm & Optional 30,000 rpm spindles incorporate Makino's patented spindle technology:

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

The spindle provides characteristics required in any number of high-speed machining applications typical of the die and mold industry. 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.



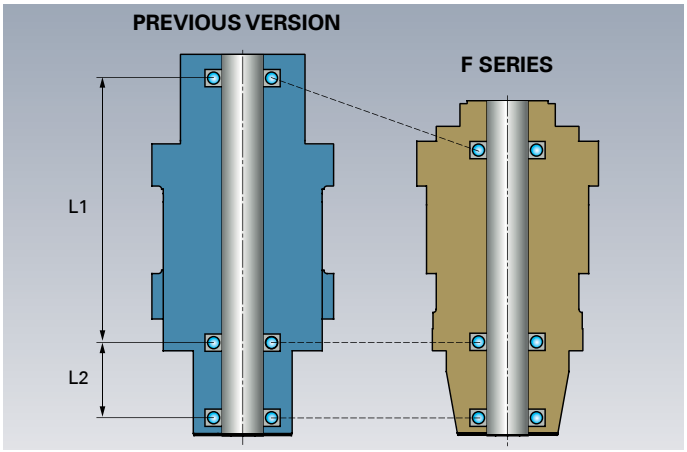
Spindle Temperature Controller

The F-series machine is the only machine of its class to combine a large capacity, heat dissipating spindle chiller, and the Makino technologies mentioned above. This maintains tight control over the spindle, 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.

HSK-A63 holder
*Available for
20,000 rpm spindle

HSK-F63 holder
*Available for
30,000 rpm spindle

New Version of 30,000 rpm spindle

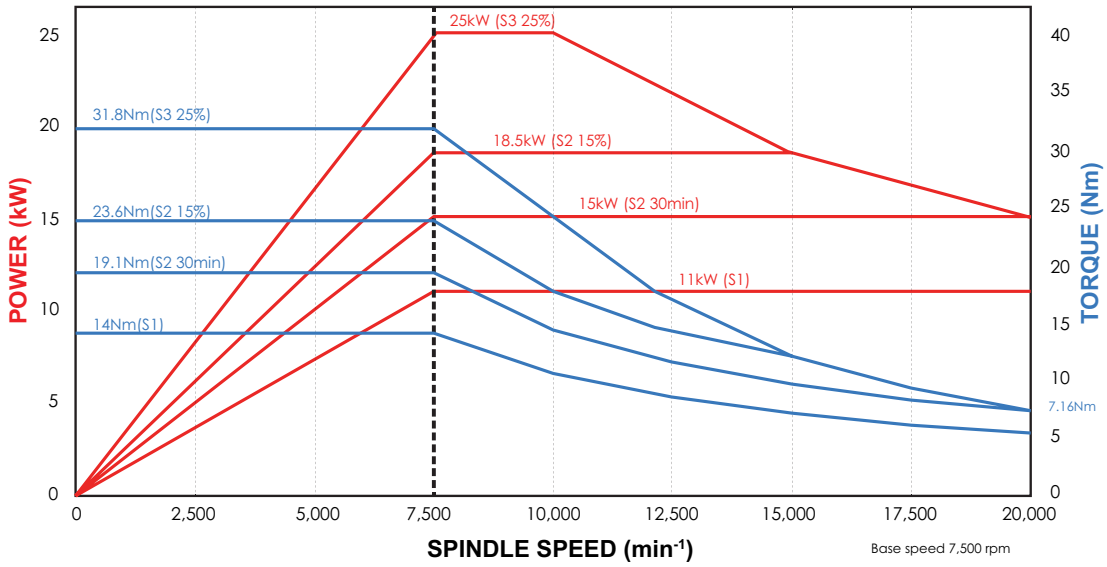


As shown in the diagram, the ideal bearing layout is achieved by reducing the distance (L1) between the bearings to obtain a uniform arrangement. This layout effectively suppresses spindle vibration at high speed.

The overall length of the new 30,000 rpm spindle was substantially shortened to reduce the 25% compared with previous version. This markedly reduces spindle vibration for enhanced machined surface quality and longer tool life. The overall spindle weight was also lightened by 30% to reduce lost motion in the XY axes of spindle travel.

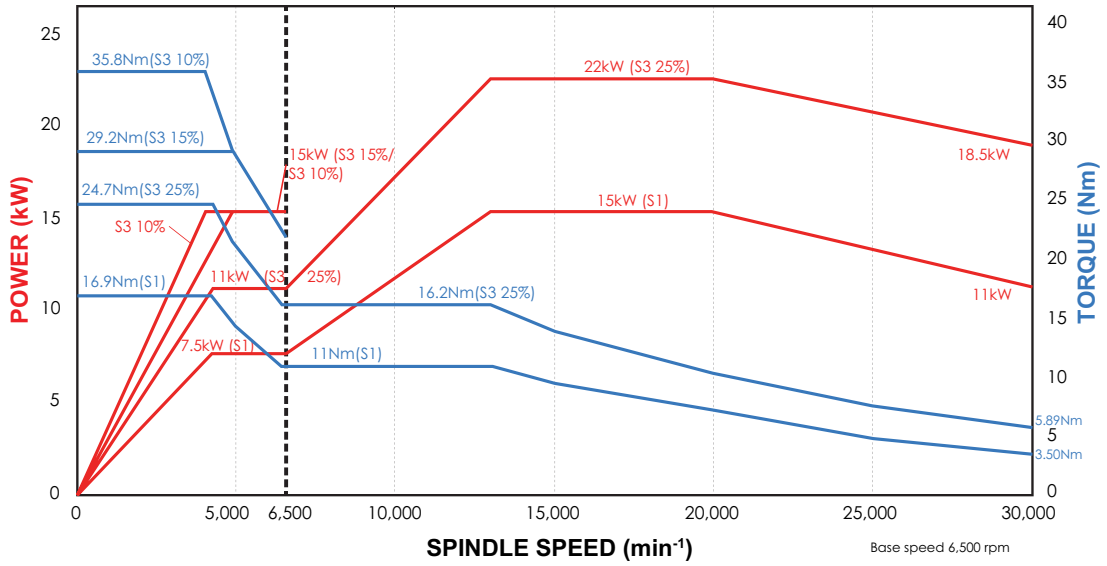
50 ~ 20,000 rpm Spindle

This high-speed spindle is ideal for high-speed machining. Versatile for handling a wide range of medium to small diameter tools.



50 ~ 30,000 rpm Spindle

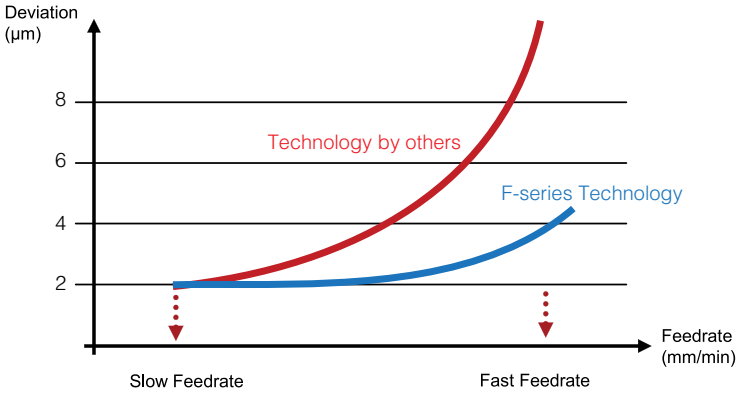
This new high-speed spindle is ideal for high-speed machining with small diameter tools, such as hair-line machining.



MOTION TECHNOLOGY

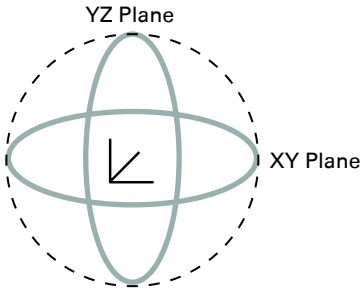
Super Geometric Intelligence (SGI.5) software - developed specifically for high feedrate, tight tolerance machining of complex, 3D-contoured shapes involving continuous tiny blocks of NC data. It ensures production rates faster than standard CNC systems while maintaining high profile accuracy. SGI.5 facilitates improved cycle times.

- Fine motion control even at high feedrate
- F-series provides advanced acceleration and deceleration control technology
- High-Speed & High-Accuracy machining made possible



G.I. & S.G.I.

- Enhanced cutting point accuracy
- Cutting mode selection
- CMD optimized machine
- Look ahead
- AICC II (Artificial Intelligence Contour Control)



Dynamic Calibration of 3 Axes

The machining mode that optimally matches the machining job can be selected with M code commands, which facilitates to achieve desired surface quality and shape accuracy, which in turn increase machining efficiency & improving productivity

The machining mode that optimally matches the machining job can be selected with M code commands.

Ultra High Performance Mode M256	High Performance Mode M251	High Accuracy Mode M250	Ultra High Accuracy Mode M252	Super High Accuracy Mode M254

High Speed ◄——————————————————► **High accuracy**

Without GI control

With Super GI.5 control

Pro 6 Controller

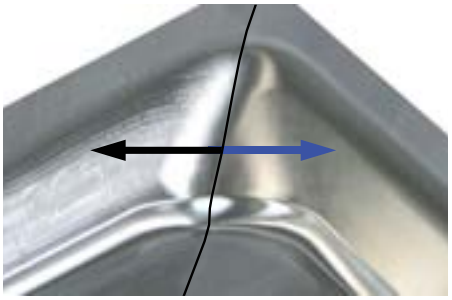
With a perfect blend of the proven stability of FANUC hardware and Microsoft Windows Embedded Standard 7 OS, the cutting-edge Pro6 provides:

- Streamlined operation -The screen layout matches the operator's process flow from setup to production.
- Operator assistance - Guidance functions, parameters, code and manual search function are available on screen when and where they're needed.
- Additional standard functionality is now available to make sure operators are ready for any job.
- Enhanced safety - Dual check safety, 3-D graphic viewer, maintenance screens and easy access to machine information are included.

Professional 6

5 Step Screens for streamlined ease of operation

GI Smoothing*



Intelligent GI-Smoothing function optimises tool path when CAM tolerances are too rough and thus eliminates the undesired marks at the surfaces to be machined, achieving excellent surface quality.

Crash avoidance function

Collision Safeguard*

Interference check is done in real time in tandem with the machine, thereby to prevent collisions.

i-Setup*

- Quick and easy measuring setup for intuitive operation
- Code-free programming on dialogue screen

*Optional

EFFICIENT CHIP REMOVAL

5 nozzles supply device (standard specification)
• 4 coolant nozzles and 1 air blower nozzle are effectively positioned around the spindle.

Through-spindle air (optional specification)
• Air is supplied from the tool tip and holder.

Through-spindle coolant (1.5 MPa and 3.0 MPa) (optional specification)
• Coolant is supplied from the inside of the holder through the tool tip.

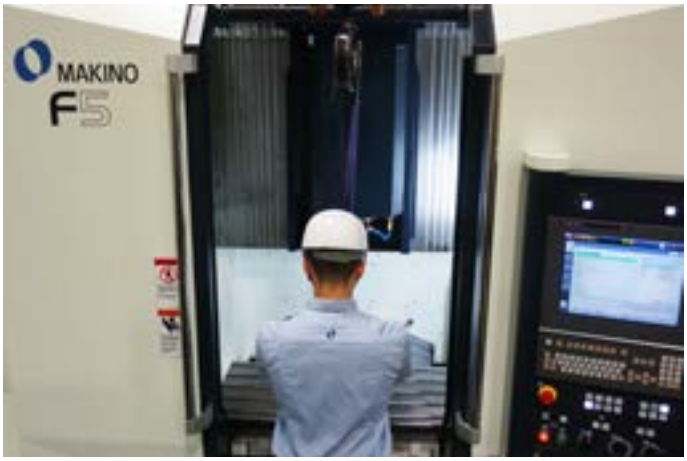
Unmanned machining application and highly efficient machining processes generate high volume of chips. Therefore, a quick, good and reliable machine chip evacuation system is required. In F-series, optional two spiral type chip conveyors are used in transporting chips from the machining zone to the rear of the machine.This efficient system will enable operator to focus on the machining tasks and hence improve his work efficiency.

Chip Tray is located at the front of the machine and can be emptied even during machining.

An optional Rear Tank is equipped with 2 x spiral conveyors to evacuate chips to the rear side of the machine.

An optional lift up chip conveyor can be installed along with the rear tank to further improve the chip management of the machine.

EASE OF OPERATON



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 machine significantly reduces part exchange load times and operator fatigue.

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

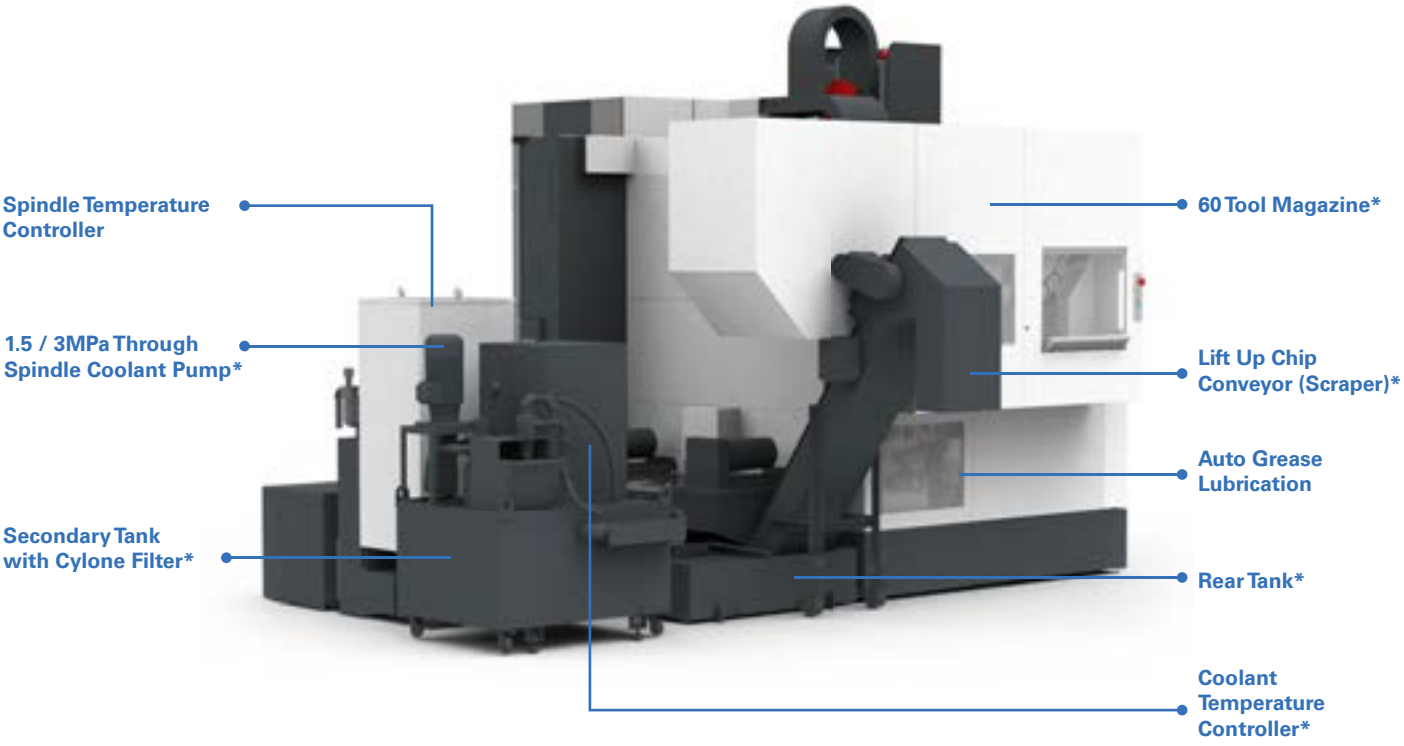
The tool changer door provides ready access for easy loading and unloading of tooling to the machine magazine. An ATC control panel is located adjacent to the tool changer door to assist the operator in manual operation of the tool magazine. Pneumatic driven auto tool clamp & unclamp push button is ergonomically located for convenient operation.

Centralized panel has the pneumatic, hydraulic & lubrication points for ease of maintenance.

AUTOMATION READY

Robot integration for unattended continuous operation provides numerous opportunities to improve the efficiency of the mold machining multi-fold.

F-series machines are ready with options to support Automation.



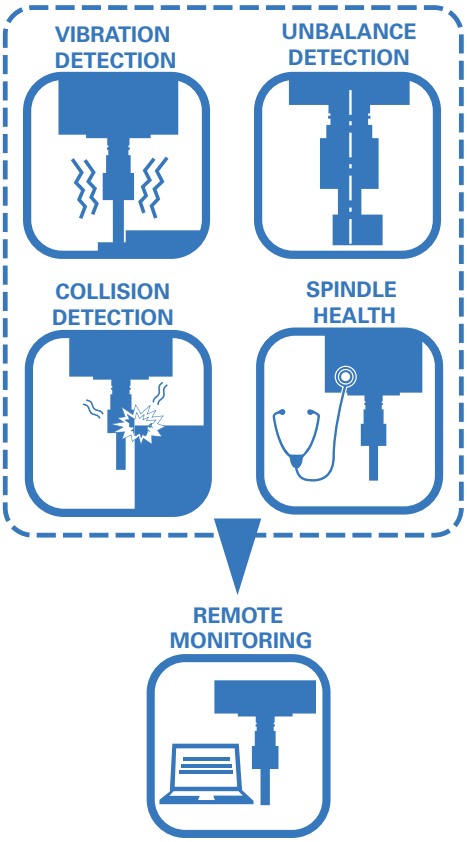
*Optional

INTELLIGENT TECHNOLOGY

SPINDLE ACTIVE CARE (SAC)*

Spindle Active Care allows more effective monitoring of spindle health and machining condition to achieve following benefits :

- Eliminate unplanned downtime due to spindle catastrophic failure, which can be detected at early stage of defects
- Prolong spindle life by protecting the spindle from extreme vibration or unbalance
- Ease optimization of machining productivity, without compromising spindle health / life
- Improve tool life management through progressive evaluation of tool cutting performance



Status – Real time monitoring of machining vibration, spindle health and spindle-related events

Utilization – Accurate evaluation and understanding of spindle utilization

Machining – Historical recording of programs and tool machining performance

Screen shot from machine (image above).
Remote Monitoring PC also has also similar Screen shot

*Optional

Machine Specifications			F5
Travels	X x Y x Z axes	mm	900 x 500 x 450
	Distance from table surface to spindle gauge line plane	mm	150 ~ 600
Table	Table working area (WxD)	mm	1,000 x 500
	Maximum table load (Evenly distributed)	kg	1,000
	Table surface configuration		5 x T-slots, size 18H8 mm, pitch 100 mm
Spindle	Spindle speed range	rpm	50 ~ 20,000
	Spindle taper hole		HSK - A63
	Spindle drive motor power (25% ED / cont.)	kW	25 / 11
	Spindle drive motor torque (25% ED / cont.)	Nm	31.8 / 14
	Spindle bearing diameter (inner/outer)	mm	Ø65 / Ø100
Feedrates	Rapid traverse	mm/min	20,000
	Cutting feed	mm/min	1 - 20,000
Automatic tool changer	Tool storage capacity		30 tools
	Maximum tool diameter (with adjacent pots occupied)	mm	Ø75
	Maximum tool diameter (with adjacent pots empty)	mm	Ø125
	Maximum tool length	mm	300
	Maximum tool weight	kg	8
Coolant tank	Tank capacity	L	160
	Flowrate	L/min	80
Power supply (Standard)	Incoming Voltage	V	380 - 440, 3 Phase, 50 / 60 Hz
	Installation	kVA	52
Air supply	Pressure	MPa	Min 0.5 ~ 0.8
	Consumption	L/min	400
Machine accuracy (Tolerance measured at Makino's assembly plant)	Positioning (Full stroke without / with scale feedback)	mm	±0.0025 / ±0.0015 (JIS B 6336); ≤0.010 / ≤0.006 (ISO 230.2 - 2006)
	Repeatability (Full stroke without / with scale feedback)	mm	±0.0014 / ±0.0010 (JIS B 6336); <0.006 / <0.004 (ISO 230.2 - 2006)
Machine size (Standard)	Height (H)	mm	3,065
	Floor space (W x D)	mm	2,565 x 3,145
	Weight	kg	7,500

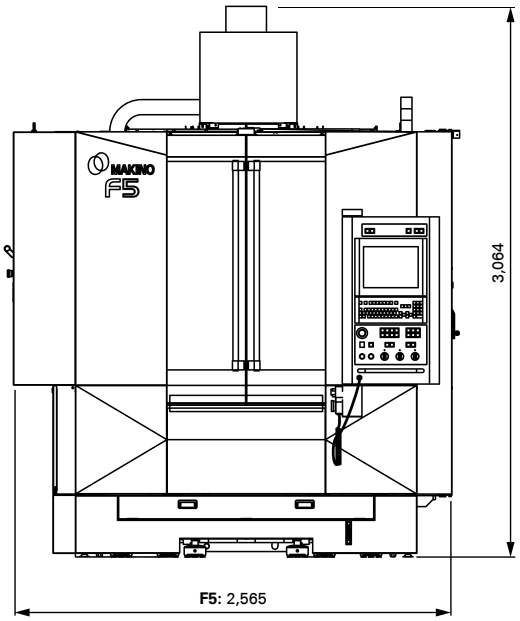
Standard Specifications

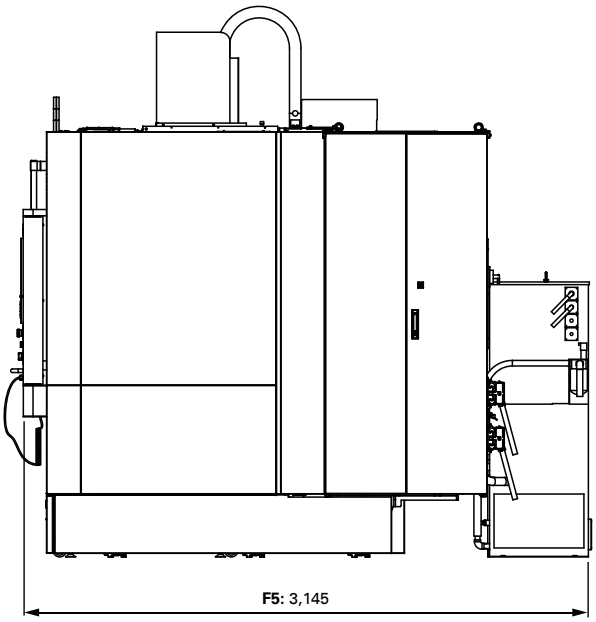
- 20,000 min^{-1}, HSK-A63 spindle
- 30-tool ATC
- Spindle temperature controller
- Ballscrew core cooling
- Ballscrew support bearings cooling
- Motor flange cooling
- LED lighting within splash guard
- 3 layer signal light
- Splash guard and ATC door inter-lock with lock
- Automatic air blow
- Centralized auto grease
- Portable manual pulse generator with the handle enable button
- Rigid tapping
- Professional 6 controller
- Super GI.5 control
- Linear interpolation positioning
- User memory 2GB + 1GB
- 1,000 Registerable programs
- Tool offset memory type C
- Tool offset 400 pairs
- Custom macro variables, 600 numbers
- Auto power out
- ECO mode functions
- Power fail monitor

• Optional Specification & ▲ Equipment

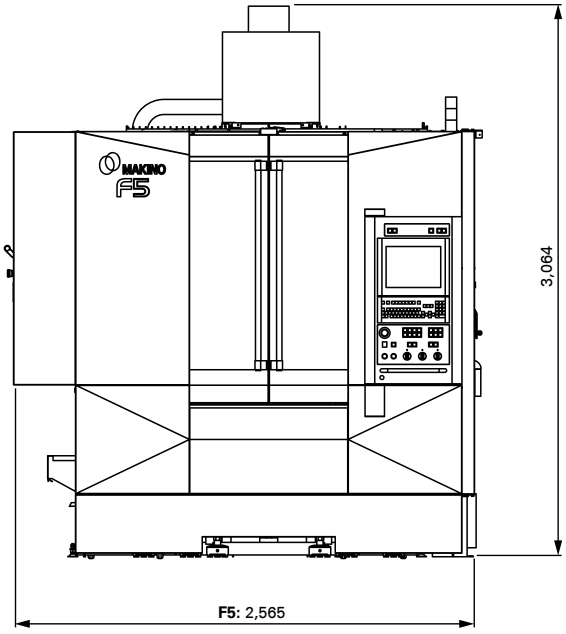
- • 60-tool ATC on F5
- • HSK-F63 Spindle (for 30,000rpm spindle)
- • Through Spindle Air
- • Through Spindle Coolant (1.5/3 Mpa) on 20,000 rpm spindle
- • i-Setup
- ▲ 4th Axis NC rotary table interface
- ▲ 4+1 Axis NC tilting rotary table interface
- ▲ ATLM (Automatic tool length measuring device)
- ▲ AWM (Automatic workpiece measuring device)
- ▲ Lift-up chip conveyor (scrapper-left discharge)
- ▲ Chip bucket for lift-up chip conveyor
- ▲ Air dryer
- ▲ Mist collector
- ▲ MTC cabinet for door interlock
- ▲ Rear coolant tank (Tank capacity: 420L)
- ▲ Coolant temperature controller
- ▲ Scale feedback 0.05 um (X, Y & Z axes)
- ▲ Work wash gun
- ▲ Robot interface
- ▲ Spindle active care
- ▲ GI smoothing
- ▲ Collision safeguard

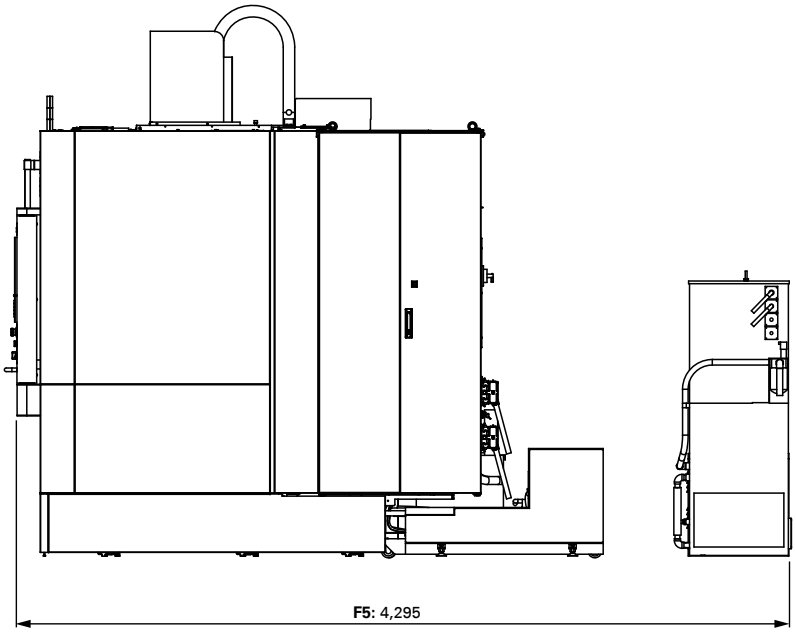
Machine Layout for front tank





Machine Layout for optional rear tank





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