Vertex series

Vertex series

A small footprint with large capacity simultaneous five axes machining envelope

Mitsui Seiki renews the Vertex series machines with the essential objective of maintaining precise 5 axis processing. The optional HMI touch screen interface, the improved spindle thermal displacement function, along with structural enhancements aimed at increasing bed and column rigidity, and further improvement of the three-dimensional surface quality by applying micro line segment feed. Are all part of the new Vertex III series machines.

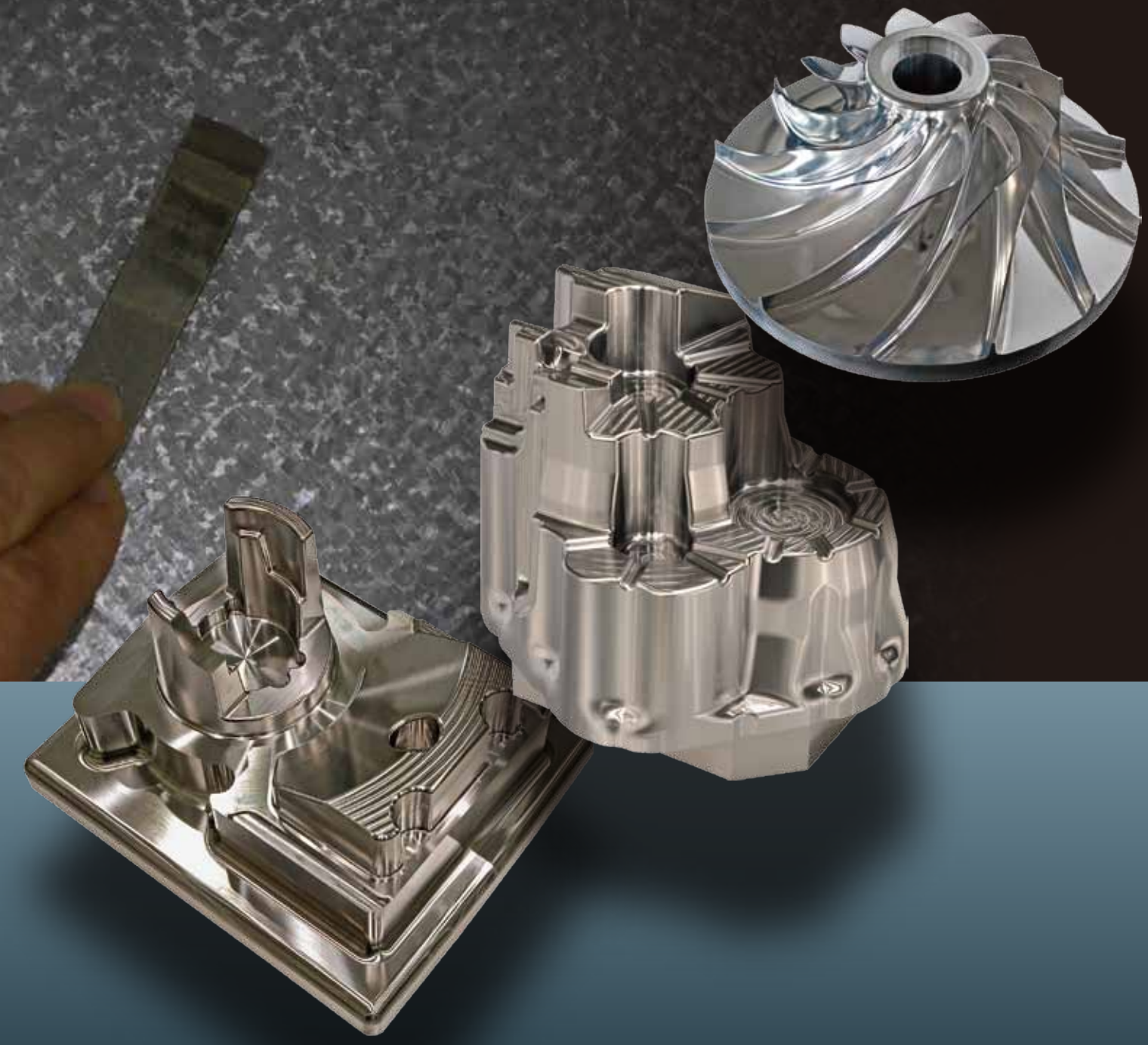
15"HMI Touch Screen Panel (option)

The Vertex series is the continuation of Mitsui Seiki's long history in the design and manufacture of high precision five axes machines. The Vertex is in a class of it's own for speed, rigidity and part accuracies.

Designed as a true five axes precision machine, the relationship of all five axes geometrical tolerances in rotary, linear and simultaneous motion control dramatically affectthe finished part tolerance. Unlike three axes machines that "add on" the 4th and 5th axes, the Vertex is designed for superior volumemetric accuracy for the highest tolerance parts production.

Vertex

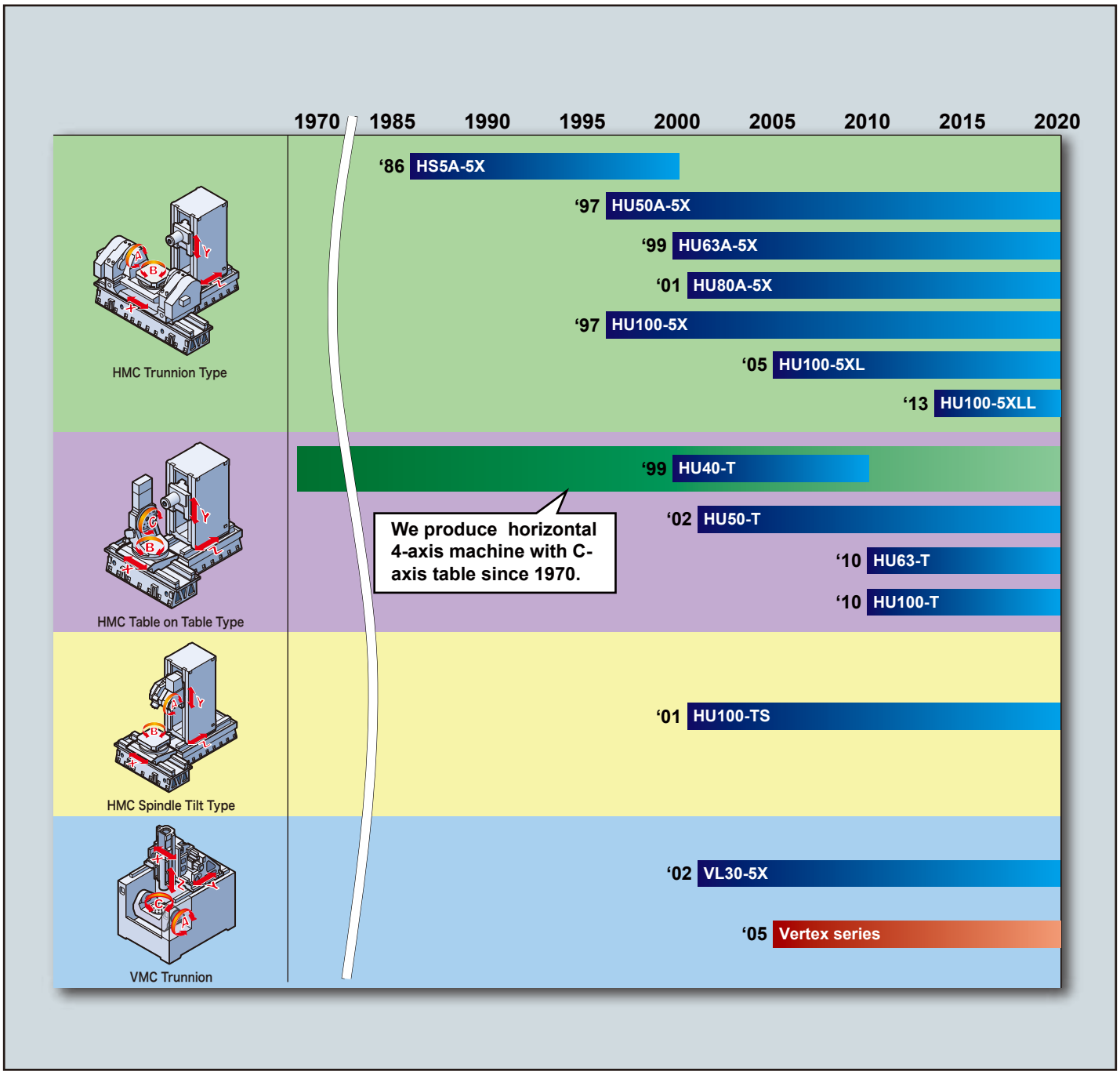
means Apex - The highest point to be reached.



Genealogy of Mitsui Seiki 5-axis Machining Centers

The history about Mitsui Seiki and 5 axes MC dates back to 1970 before 5 axis machines became popular as it is today.

Over 10 years since its launch, Vertex has been receiving high praise from customers as a machine with high precision and high rigidity. It is strong in the field of high value-added processing, and it is used not only for aluminum, but also for hard materials such as steels (mild and hardened), titanium, Inconel etc.



Shipment of M/C by Type of Industries

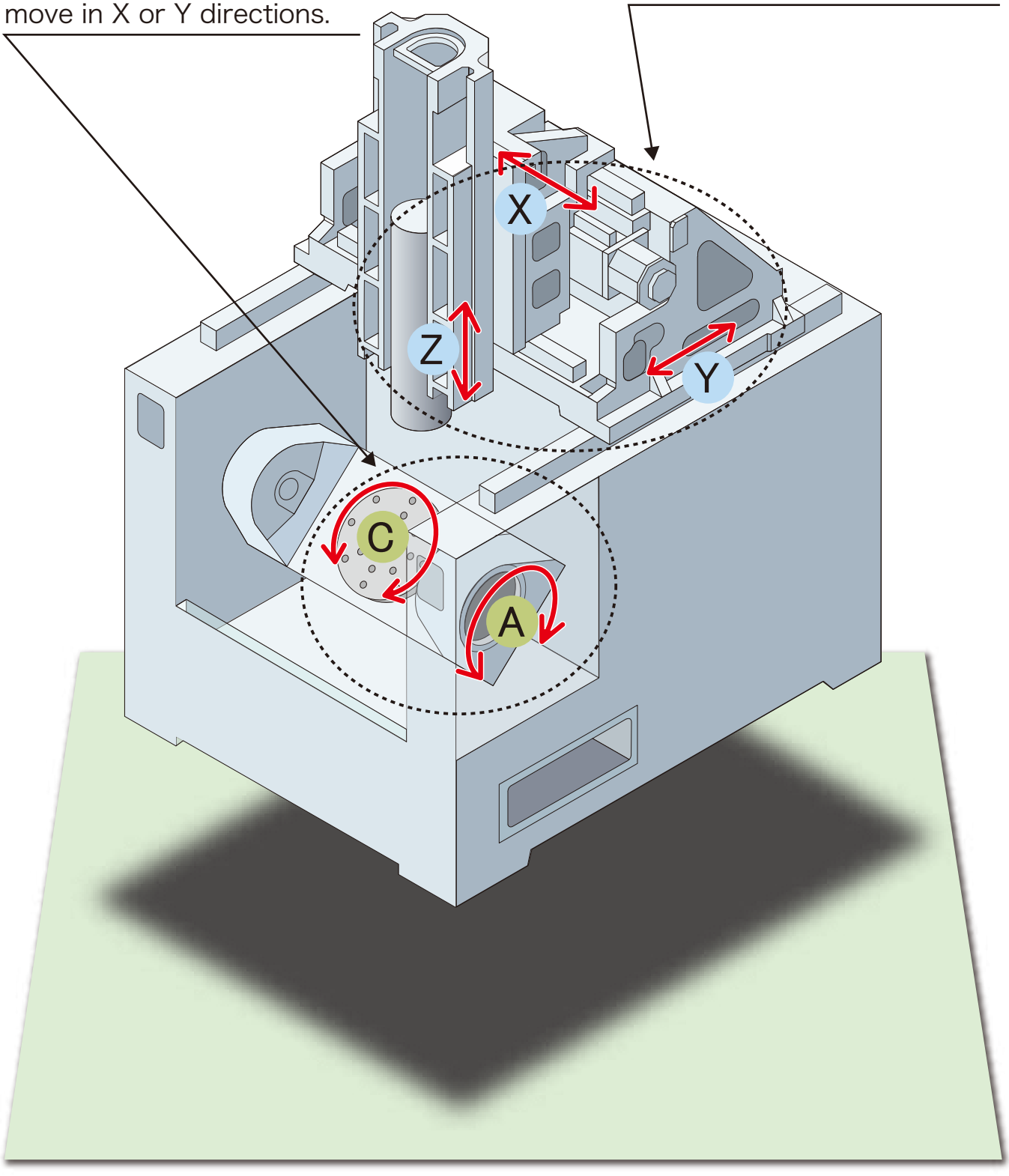
Mitsui Seiki's products are active in a variety of industries such as aircraft, automobiles, dies, molds and so on. In overseas markets,
we have been selected by many customers in the aircraft industry. The reason for selecting our company is high precision and high rigidity. This feature responds to the aircraft's life span, which is said to be twenty years, and promises the stability of accuracy in 24/7 production.

“Cube on” Structure

This unique design contributes to stiffness and volumetric accuracy.

The A-axis is driven and supported using both sidewalls of the "box" bed eliminating the need for the table to move in X or Y directions.

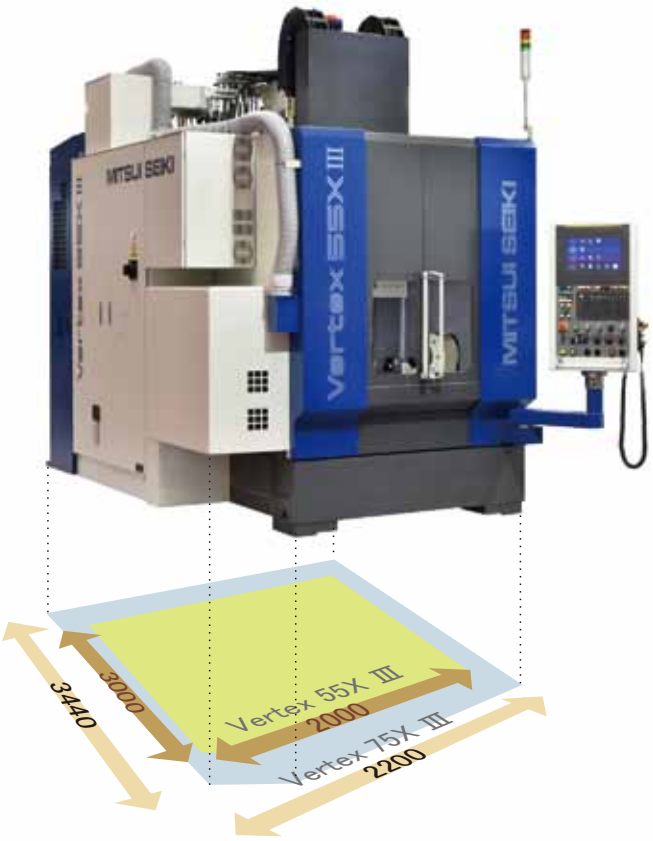
The three linear axes moves on "top of the box" providing the superior axes support.



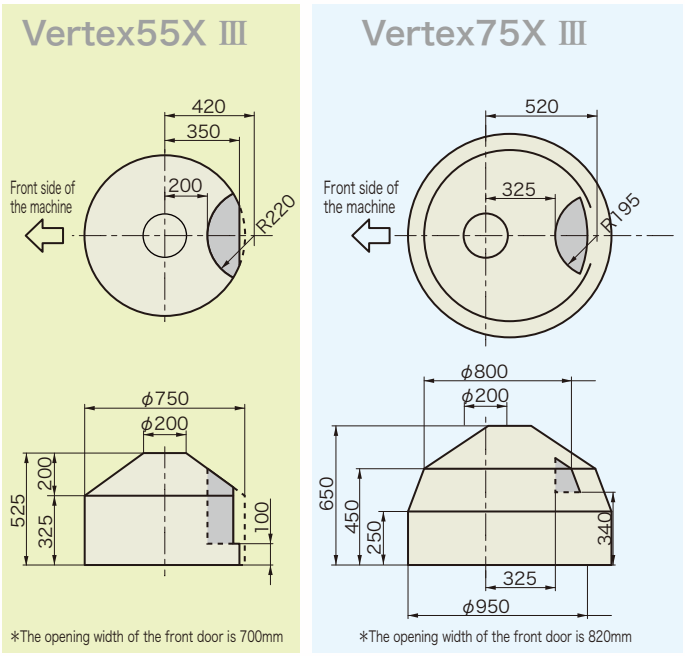
Reduced floor space increases your profitability

The Vertex provides the smallest machine footprint with the largest machining envelope of any machine in its class.

Footprint



Maximum size of loadable work piece



Interference area with maximum length and diameter tool at ATC

The Vertex55X III with its 2m x 3m footprint and part size capacity of ϕ750mm by 525 mm height provides outstanding space efficiency for a large capacity five-axes machine tool. Also, the compact design provides efficient machine installation or future machine re-location if necessary.

The rigid, compact bed is a cube structure that supports the X, Y, and Z axes along with the trunnion assembly providing stiffness for rapid axes travel.

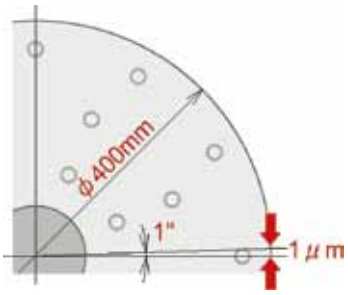
3 point support bed

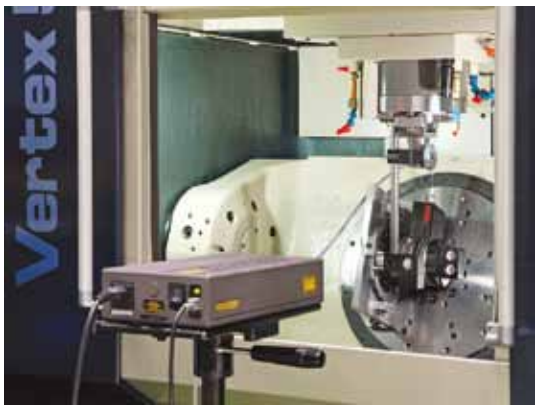
In-house manufacturing for the core components

The tilt rotary table is the core component of the five-axes machines.

■High accuracy indexing, high accuracy repeatability

Indexing accuracy and repeatability is very important in five axes machines.
An angle error of 1 arc second will result in an error of 1 μm in 200 mm away from the center of rotation. The figure on the right shows an example of ϕ 400 mm table being measured for accuracy.

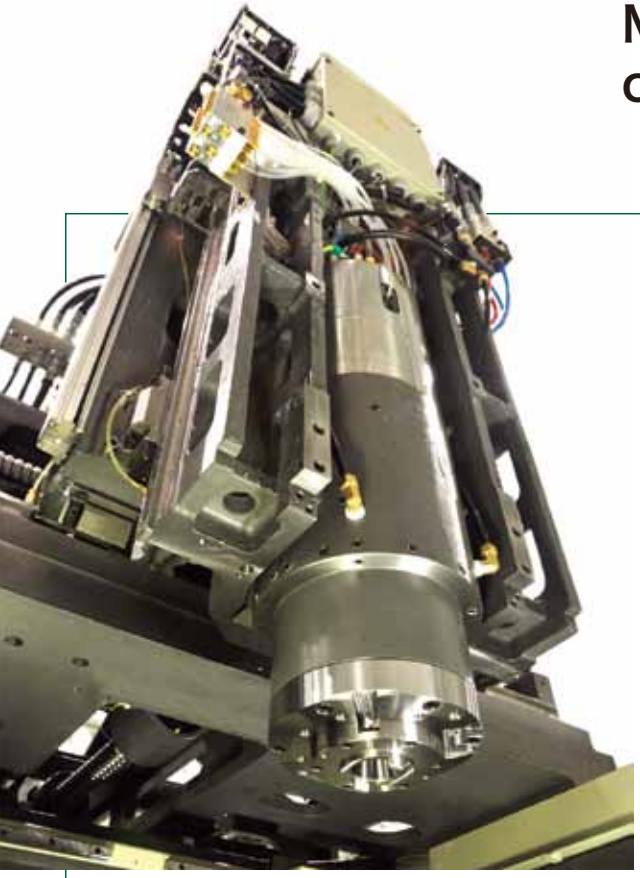




Indexing accuracy and repeatability measurement of 10 shipped units

		Unit	Standard value	#1	#2	#3	#4	#5	#6	#7	#8	#9	#10	Maximum	Minimum	Average
Indexing accuracy	C-axis	±sec.	2.0	0.9	0.7	1.3	1.0	0.6	0.6	0.5	0.7	2.0	0.7	2	0.5	0.9
	A-axis	±sec.	2.0	1.3	1.0	1.4	1.1	0.7	0.3	0.7	1.1	1.2	0.8	1.4	0.3	0.96
Repeatability	C-axis	±sec.	1.5	0.5	0.5	0.5	0.7	0.4	0.3	0.6	0.5	0.5	0.3	0.7	0.3	0.48
	A-axis	±sec.	1.5	0.3	0.4	0.5	0.6	0.5	0.2	0.7	0.4	0.4	0.4	0.7	0.2	0.44

Multiple spindles depending on your machining requirements

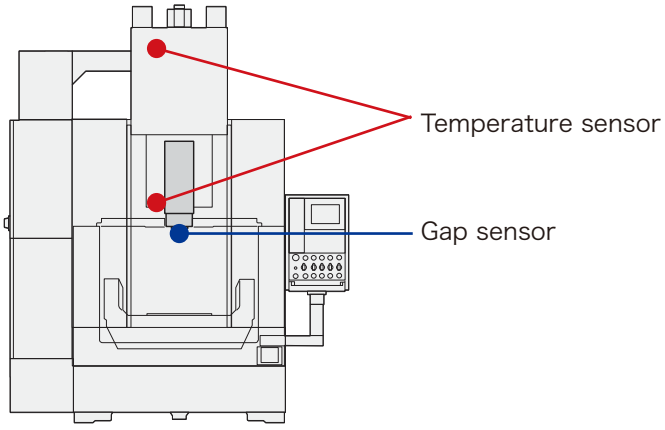


Rotation speed	15,000min^{-1}	25,000/30,000min^{-1} (optional)
Taper	BT40 or HSK63A (optional)	
Output (30min./cont.)	7.5/5.5kW	18.5/15kW
Torque	65Nm(25%ED)	28.6Nm(25%ED)
Spindle diameter	ϕ65mm	

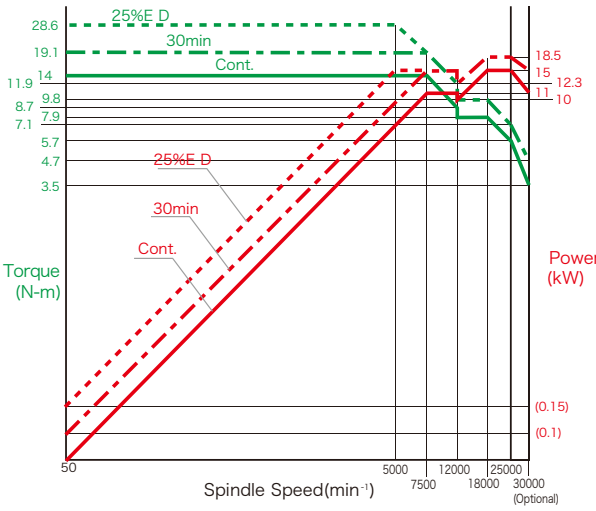
Improved spindle thermal displacement compensation

MAMS Mitsui Accurate Milling Support

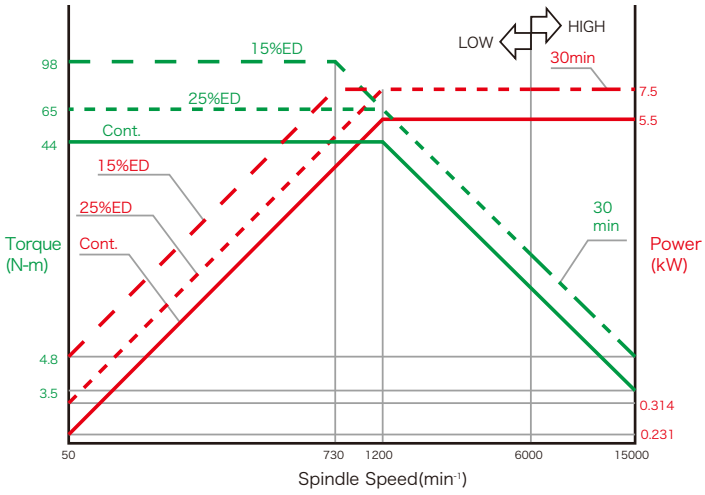
With this function, the time to stabilize the displacement in the Z axis direction during high speed cutting has been shortened. As shown in the figure, by adding a temperature sensor, in combination with detecting the elongation of the spindle displacement, the deviation in Z axis due to thermal displacement is instantly detected and corrected. This improved design is 33% more accurate than our previous and single gap monitoring systems.



25,000min^{-1} Torque-Power diagram
(Areas of 30,000min^{-1} is Optional.)



15,000min^{-1} Torque-Power diagram



High technology combined with expert skills

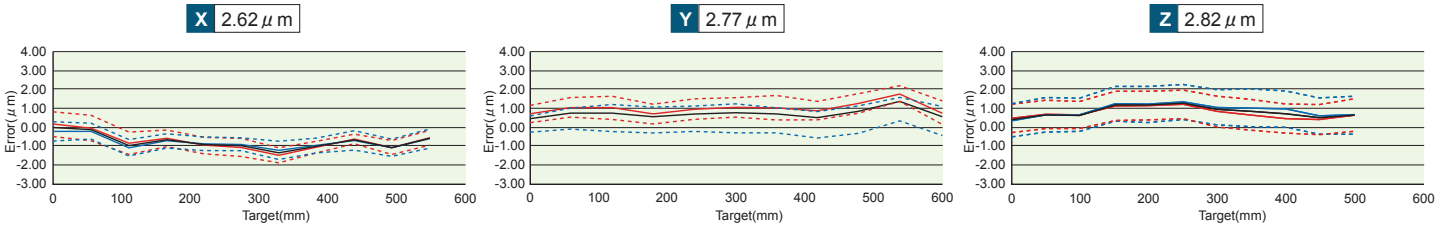
Extreme attention to details

Hand scraping of all the critical surfaces that the ways attached to provides straightness, parallelism, perpendicularity and flatness cannot be achieved without this methodology.

Examples of X, Y, and Z-axis positioning accuracy are based on the ISO230-2 Standard

Positioning accuracy values are usually based on JIS Standard. The measurements based on the ISO230-2 Standard reflect backlash and /or lost motion of the machines. The shown accuracies represent actual measured machines. The following figures are within 3μm at each axis.

ISO230-2

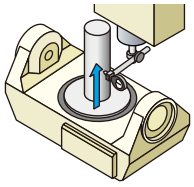


World class precision

Not only positioning accuracy, but also high volumetric accuracy

Extensive measuring and adjusting provided at final assembly assure the most accurate five axes vertical in its class.

The following are examples of perpendicularity and straightness between the spindle head movement in Z axis and table surface. (As measured on 8 shipped units.) Unit: μm



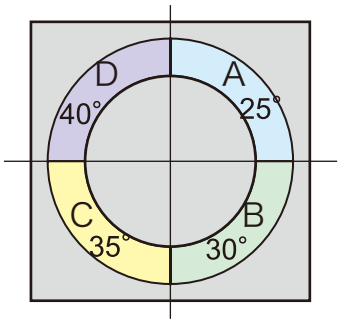
Item		Standard value	#1	#2	#3	#4	#5	#6	#7	#8	Maximum	Minimum	Average
Perpendicularity	X-axis direction	7μm/ 400mm	2	6	4	3	2	4	4	3	6	2	3.5
	Y-axis direction		4	4	5	4	4	5	6	4	6	4	4.5
Straightness	X-axis direction	5μm/ 400mm	4	4	3	2	4	2	3	3	4	2	3.1
	Y-axis direction		3	4	2	2	4	3	4	3	4	2	3.1

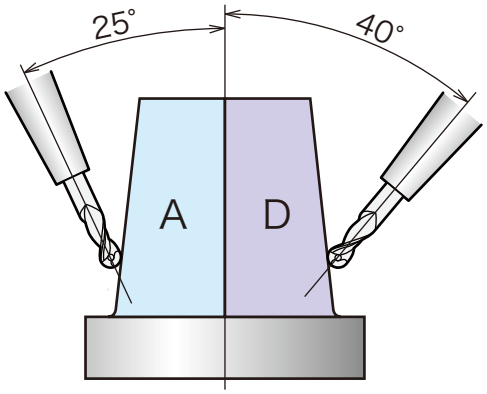
By Vertex55X III

Superior surface finish

Capability extends through position changes for both tool vectors and work pieces

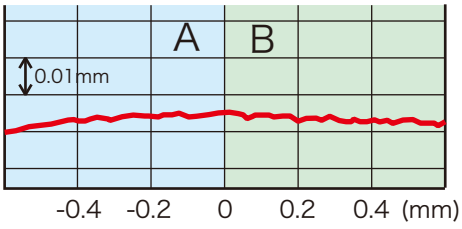
Tooling marks on mold surfaces are typically caused by changes over reversal positions on the indexing angles and tool direction changes. The Vertex is capable of minimizing tooling marks and provides superior surface finishes on complex mold surfaces.



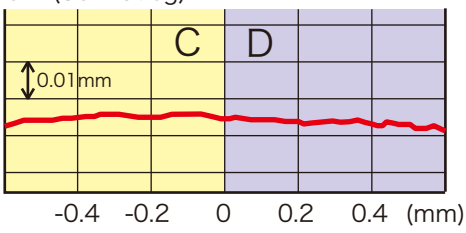


Accuracy of the parting line between surfaces

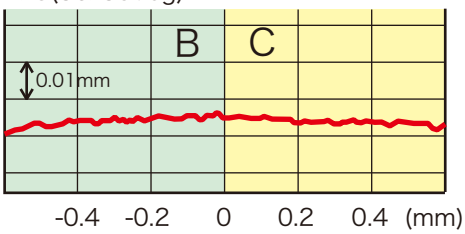
A>B(25>30deg)



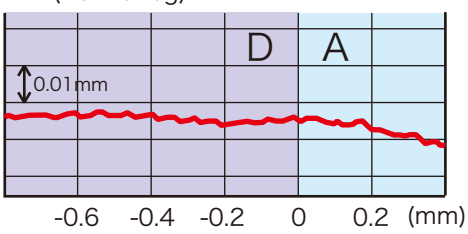
C>D(35>40deg)



B>C(30>35deg)



D>A(40>25deg)



Measured results of machined test pieces shows excellent tolerance capability

■Circularity of taper cone machining

The test taper cone is machined with simultaneous five-axes control using an end mill cutting a taper of 30 degrees.
The cones circumference is then measured at three locations (top, middle, and bottom). The results demonstrate the combined accuracies of X, Y, Z, A and C-axes. (Note: Circularity of a typical five-axes machining center is around 20μm.)

Machining accuracy (circularity) of 10 shipped units ＊Machined by Vertex550-5X

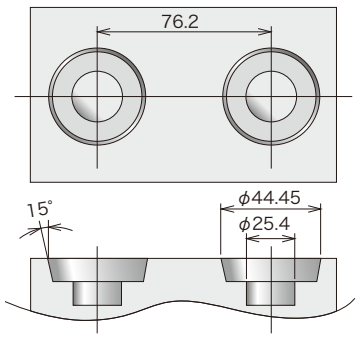
Unit: μm

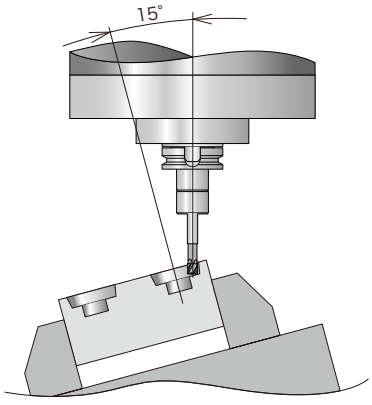
Measurement position	#1	#2	#3	#4	#5	#6	#7	#8	#9	#10	Minimum	Maximum	Average
Top	2.4	3.8	3.6	3.6	4.3	3.9	4.5	3.0	2.9	3.3	2.4	4.5	3.53
Middle	3.1	3.4	3.8	3.4	3.8	3.7	3.7	3.4	3.7	3.3	3.1	3.8	3.53
Bottom	3.9	3.1	3.7	4.4	3.9	3.3	4.1	3.4	4.1	3.5	3.1	4.4	3.74

■Pitch accuracy of tapered-hole machined by simultaneous four-axes control

By fixing the A-axis at a 15 degree angle and utilizing the X, Y, Z and C- axes in a simultaneous cutting motion on these two bores, the Vertex creates a tapered hole pitch accuracy of 5μm.

For a cylindrical (non-tapered) hole, the pitch positioning accuracy is 0.5μm.





【Material】STAVAX
【Tool used】ϕ12 end mill
【Machining conditions】Spindle speed : 7,247 min^{-1} Feed rate : 594 mm/min

No.	Measuring location and description	Dimensions	Error	
			Hole A	Hole B
1	Taper hole diameter difference	ϕ44.45mm	ϕ-0.0038mm	
2	Taper hole pitch	76.2mm	-0.0051mm	
3	Cylindrical hole diameter difference	ϕ25.4mm	ϕ-0.0016mm	
4	Cylindrical hole pitch	76.2mm	0.0005mm	

■Helical bevel gear tooth accuracy on a machined gear

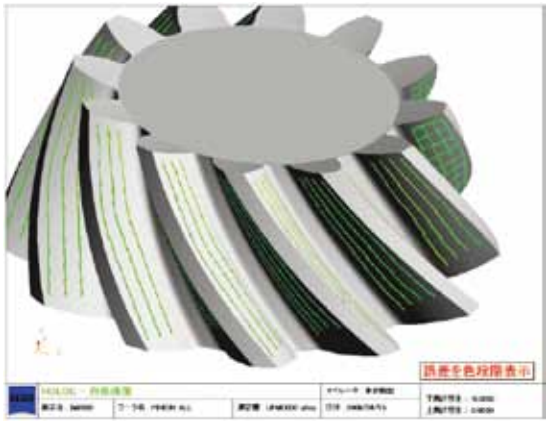
A beveled gear, typically processed on a gear cutting machine, was machined by simultaneous five-axes control on the Vertex. Accuracy results are excellent.

*The figure below shows color coded size errors of the teeth sur faces measured with a 3-D measurement instrument. The errors of all surfaces are within the accuracy ranges of 7.5μm or less.

Measurement results

Size errors (μm)

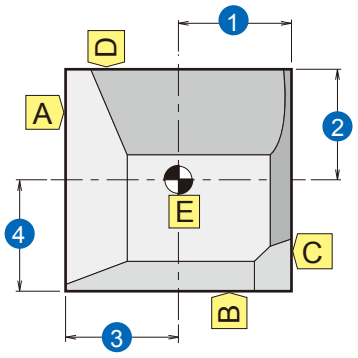
7.5	～11.3
3.7	～ 7.5
0.0	～ 3.7
-3.7	～ 0.0
-7.5	～ -3.7
-11.3	～ -7.5

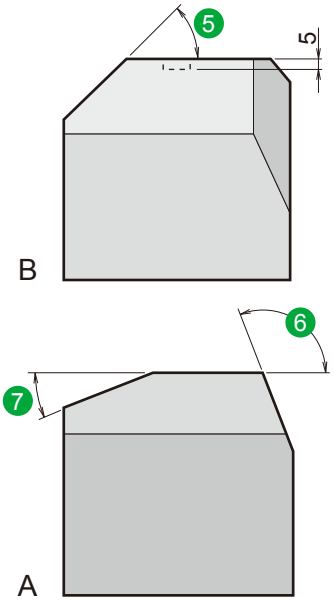


■Rotary/tilted indexing accuracies

The following accuracies were measured on a finished machined aluminum test piece (size: 110 mm×110 mm) using five-face indexing. This data proves the high indexing accuracy of the Vertex.

1. Distance between a tooling hole on the top surface (Surface E) and 4 side faces (Surfaces A to D)
2. Indexing angles at 45, 112.5 and 22.5 degrees
3. Perpendicularity between the top surface and each of the four side faces, and between the two adjacent faces of the four side faces.



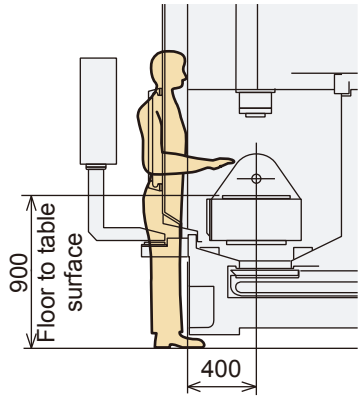


Measurement item	Positioning accuracy(unit:mm)				Angle(unit:degree)			Squareness(unit:mm)							
Mesurement point	1	2	3	4	5	6	7	E⊥A	E⊥B	E⊥C	E⊥D	A⊥B	B⊥C	C⊥D	D⊥A
Tolerance	55	55	55	55	45	112.5	22.5								
Error	-0.0051	0.0017	0.0063	0.0067	-0.0025	0.0003	0.0001	0.0009	0.0013	0.0025	0.0011	0.0013	0.0013	0.0015	0.0037

Ergonomically designed for easy access to both the control panel and machine envelope

Good accessibility

Access to the table surface is very easy and comfortable for the operator because of the stationary table design.



Retractable Y-axis cover

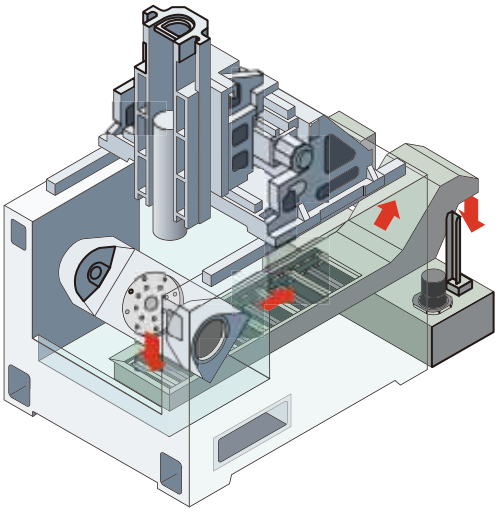
The Y-axis cover is retractable for overhead loading and unloading of heavy fixtures and work pieces with an overhead crane.

Tool loading

You can change the tools in the ATC magazine from the doors on the back of the machine. If the large coolant tank option is chosen the door for the ATC magazine tool change is available on the side of the machine.

Machine designed for efficient chip evacuation

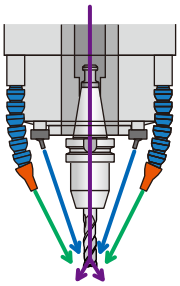
Optional chip discharge location available to fit your machine layout requirements



Effective chip clearing form the work zone

The cutting chips and coolant fall directly into the chip conveyor under the table. Then the chips are quickly discharged by a conveyance system, the coolant cleaned and re- circulated.

		Standard	Optional			
			type1	type2	type3	type4
Tank capacity	Main tank	200L	200L	400L	400L	700L
	Sub tank	—	250L	250L	—	—
Chip discharge direction		Rear of the machine			Right side of the machine	Right side → rear of the machine
Options available	Center through coolant	×	○	○	○	○
	Oil skimmer	△ (conditional)	○	○	○	○
	Work piece cleaning	○	○	○	○	○
	Drum filter	×	×	○	×	○
	Cyclonic filter	×	○	○	○	○
	Cutting oil cooler	×	○	○	○	○



■ Flood coolant(Standard)
■ Air blow or MQL(Option)
■ Through the spindle coolant(Option)

"Minimum Quantity Lubrication" (MQL) is generally called semi-dry processing. Air flow and a small amount of oil (2 to 16 ml per hour depending on the material being machined) is provided to the cutting tool edge. This method is an excellent approach when machining steel that requires superior surface finishes.

■Examples of coolant tank configurations

*Some of these examples are customized specifications and Mitsui Seiki will customize your special requirement.

《type2》

《type3》

《type4》

High-capacity coolant tank for grinding applications

Provided with bag filters and paper filters

■ATC

Complex part processing machines require an increased number of tools. The Vertex ATC is capable of loading 40 tools with our standard specification, 60 are optionally available and up to 130 by installing separate magazine extension unit at the back of the machine.

		Standard	Optional	
Number of loadable tools		40	60	130
Maximum tool length		300mm Vertex 55X-III	350mm Vertex 75X-III	
Maximum tool diameter	With adjacent tool	ϕ90mm		
	Without adjacent tool	ϕ125mm		
Maximum tool weight		10kgf		

■Maintenance

Machine maintenance access to all units is located at the rear of the machine permitting easy checking and maintenance of the machine.

The spindle chiller unit and hydraulic unit are placed inside the door at the rear of the machine.
This simple design permits a compact machine with minimized floor space.

Functions to support five axes parts processing

Pre-installed standard NC functions assist in five-axes processing

The Vertex includes the following NC functions essential to five-axes processing as standard

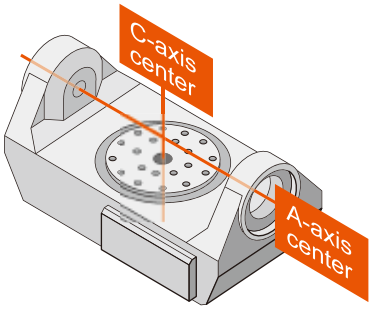
- Tool tip control for five-axis processing
- Slanted surface processing
- AI contour control 2
- Processing conditional selection functions

The following functions are also provided as standard to accommodate expanding program data volume.

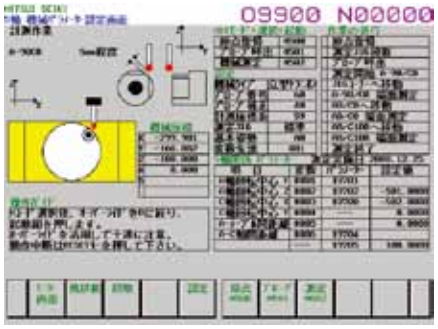
- Program memory capacity: 2 MB (5120 m)
- Additional program registration: 1 (up to 1000)
- Fast data server function (with 2 GB card)

Centering function for rotating/tilted axis

For highly-accurate five-axes processing, it is necessary to precisely determine a center of the rotating/tilted axes. It is desirable that centers of the two axes are measured on a regular basis, and is especially important to check them before a finishing process. A dedicated centering gauge, AMCS (Automatic Measurement Correction System), and set-up guidance screen are optionally available with the Vertex. By operating the machine in accordance with instructions on the screen, the center of A or C-axis can be precisely and easily located.

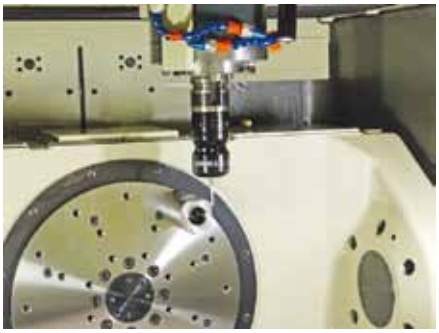


Dedicated centering gauge



Guidance screen

Determining C-axis center of rotation



Determining A-axis center of rotation

A and C axes rotating-coordinate calculation macro

To correct a positional point to the part program zero location as it indexes through a five-axes coordinate system, the combined indexing angle changes must be determined. This is very difficult to find. This software is designed to make automatic calculations for the correction. By determining the center of the rotating/tilted axis, in advance, using the "rotating/tilted axis centering function" in the previous section helps the user make the precise coordinate setup and point-of-origin correction of the work piece.

Mitsui Seiki Rotary Table Dynamic Fixture Offset

In the event that a machining part program point of origin (part program zero location) and a datum point of the work piece are not aligned, this function allows the machine to continuously correct the machining point of origin as the rotating axis moves, by presetting the misalignment scale in the fixture offset. It allows the user to have consistent simultaneous five-axes processing with the same part program, even when a work piece is misaligned every time it is loaded. This function is not the FANUC "Rotary table dynamic fixture offset" and is a Mitsui Seiki exclusive feature.

By packaging various options through continuous R&D work, Mitsui Seiki proposes the optimal solution to meet our customer's requirements.

High Speed simultaneous 5-axis control Package

■DD motor configuration for A axis table and ϕ400mm C axis table
■30,000RPM specification spindle

In the case of BLISK / IBR and impeller machining for jet engines, high responsiveness is required to accommodate the dynamic motion reversals of the axes.

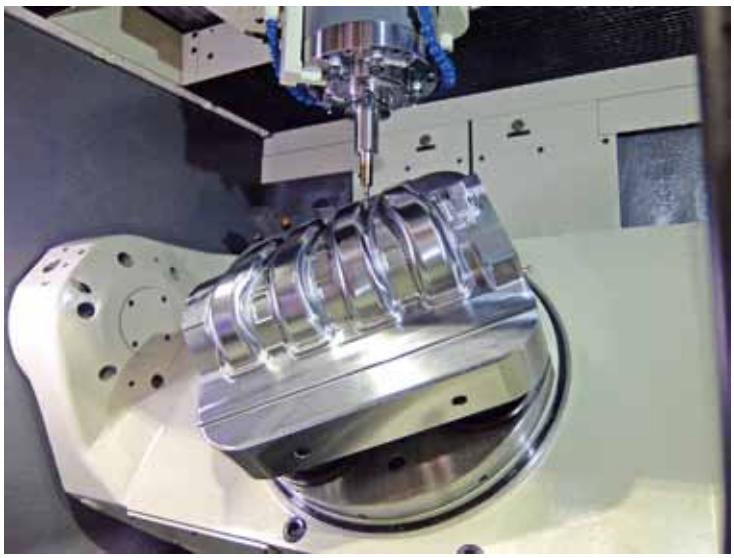
By adopting the DD motor for rotary/ tilting axis, high acceleration / deceleration for the axis reversals is realized. Since Vertex is designed with a high rigidity bed, sufficient rigidity against dynamic stress can be achieved easily.

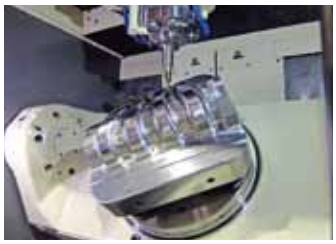
High Accuracy Package

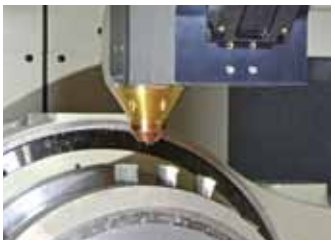
■Core cooling of ball screws
■Oil & Air lubrication of ball screws
■Tighter geometric accuracy

In the case of direct milling of hot forging dies, a very tight tolerance must be maintained. Therefore to stabilize has heat distortion, core cooling of ball screws have been adopted successfully.

Furthermore, regarding the bearing part of the ball screw, a cooling mechanism has been provided by changing from conventional grease type lubrication method to Oil & Air type lubrication method.





Blade machining specification

In the past, blades have been processed by Turning centers or tilt spindle type VMC. Our Blade machining machine places A axis tilt unit on the machine side wall, which is equipped with B axis rotary table on both sides.

This structure maintains the spindle rigidity and has advantage of machining hard-to-cut materials as well as achieving space efficiency.

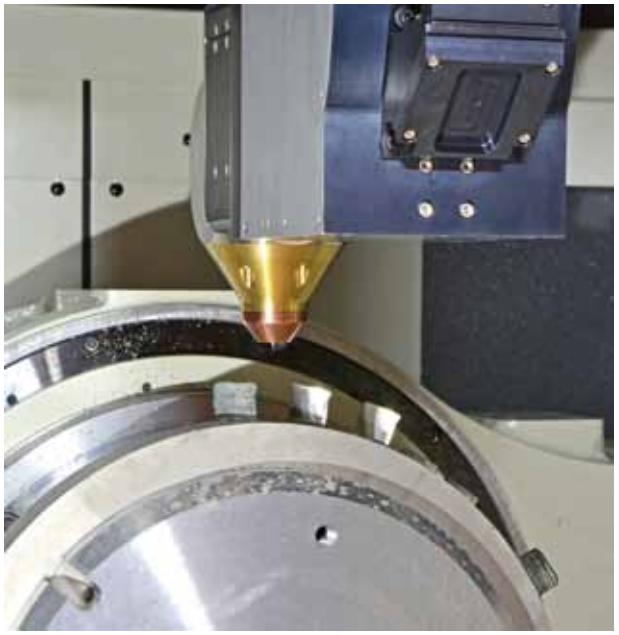
Additive Hybrid specification

Additive Manufacturing (AM)

The AM function adopted the method of Directed Energy Deposition (DED) . Using thermal laser energy, the powdered metal is melted and deposited layer by layer on the existing substrate.

After the additive metal deposition, the nozzle head goes back to the ATC magazine and the ATC picks up the cutting/ milling tools. The subsequent steps are the same as ordinary machining centers. The roughness of the surface finish is a disadvantage of AM but it has become possible to improve the quality of the surface finish by cutting/milling after deposition.

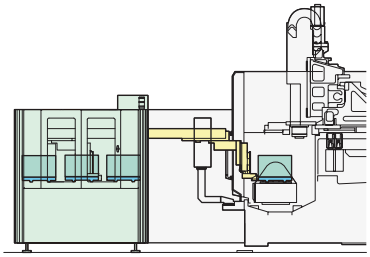
It can be a major benefit of having both additive and subtractive on the same machine and in the same setup.



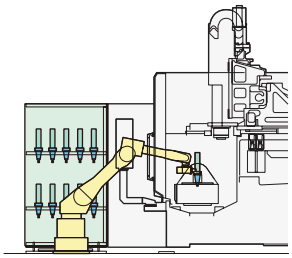
Designed for unmanned operations and "lights out" parts processing

Mitsui Seiki will design the automated system to fit your part processing requirements

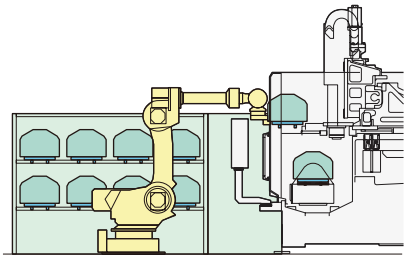
EROWA 6APC (□400 pallet) system



Robotic BT50 AWC (Auto Work Changer) system



Robotic □400 pallet FMS system



Support system that contributes to the improvement of machine availability.

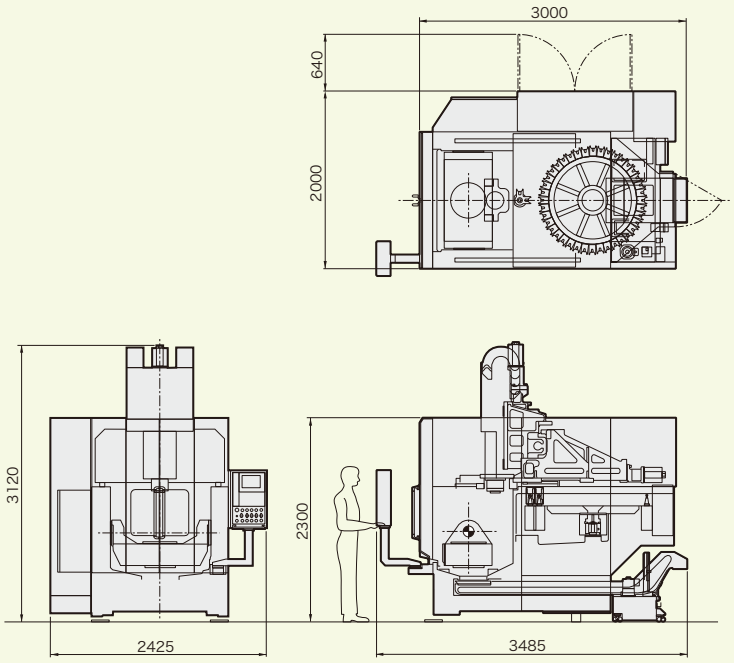
Mitsui Seiki's philosophy has always been to minimize down time of their machines and make a lasting contribution to the customer's uninterrupted production.

Spare parts such as long lead, critical parts and consumables are managed centrally within the premises of the head office as well as factory. By in-house production of major parts, we have set up a system that can shorten lead time and ship out spare parts quickly.

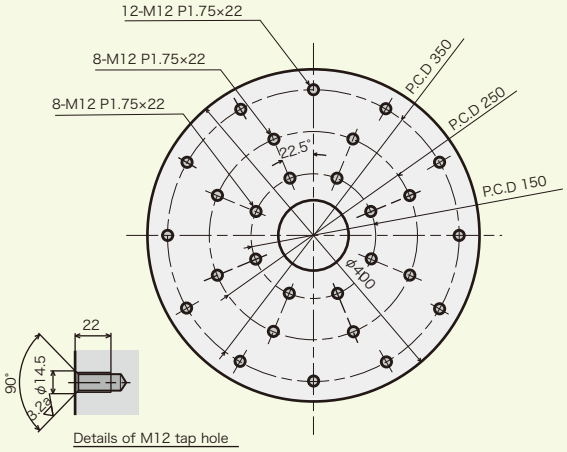
The head office and factory is a 2-hour drive to Tokyo / Narita airport. We are building a system that can quickly supply spare parts by making full use of the modern and well developed logistics network.

■Floor Layout Diagram (standard specifications)

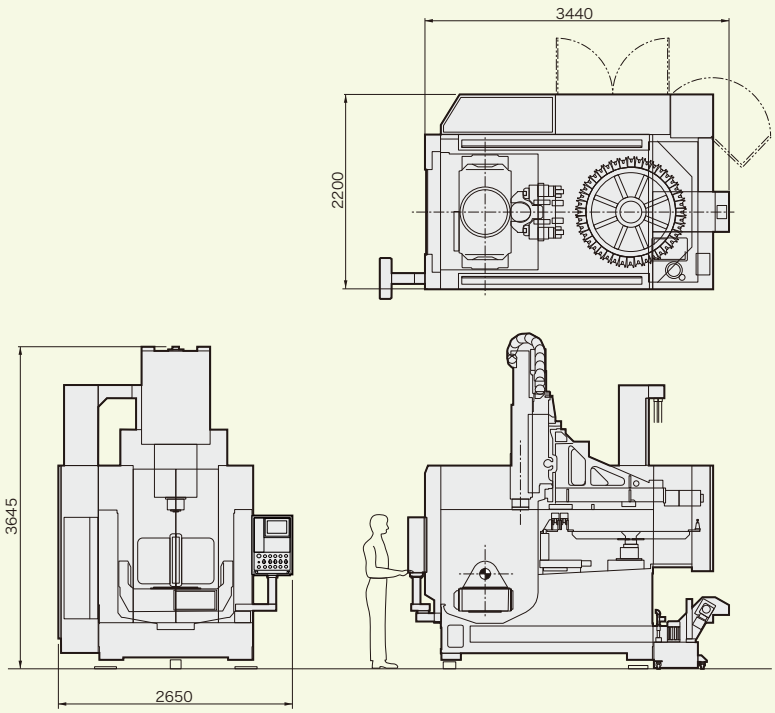
Vertex 55X Ⅲ

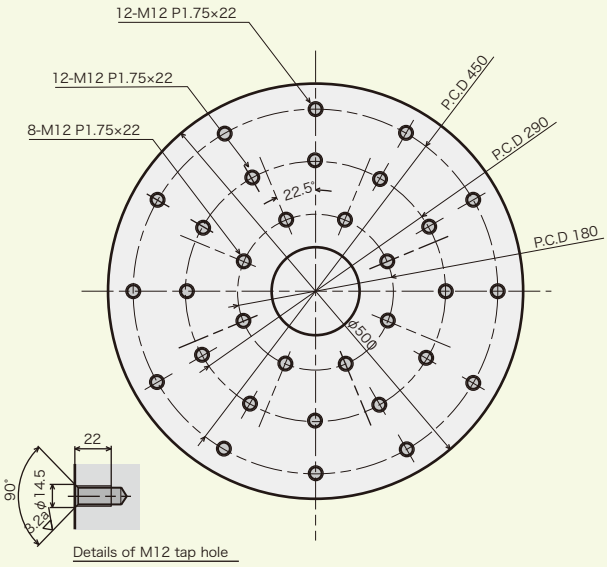


■Table Top Diagram (standard specifications)

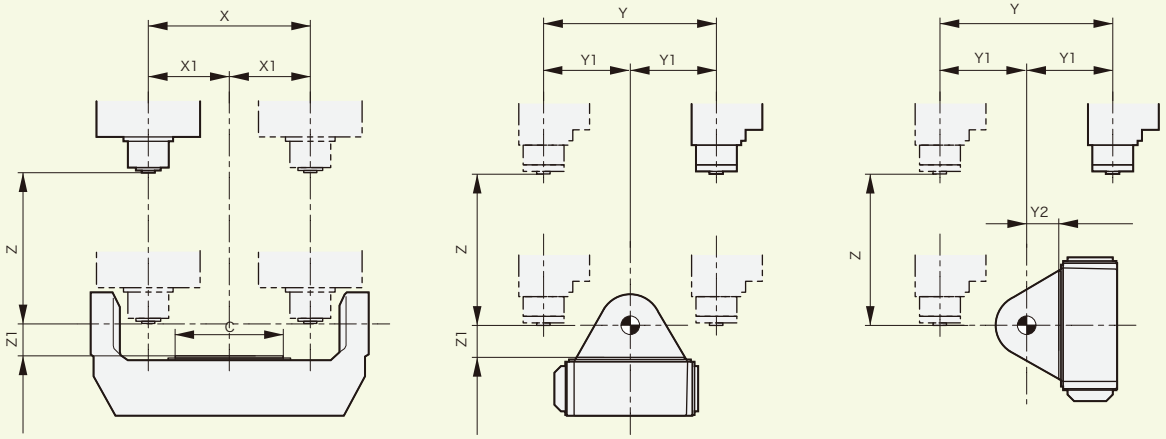


Vertex 75X Ⅲ





■Interference Diagram (standard specifications)

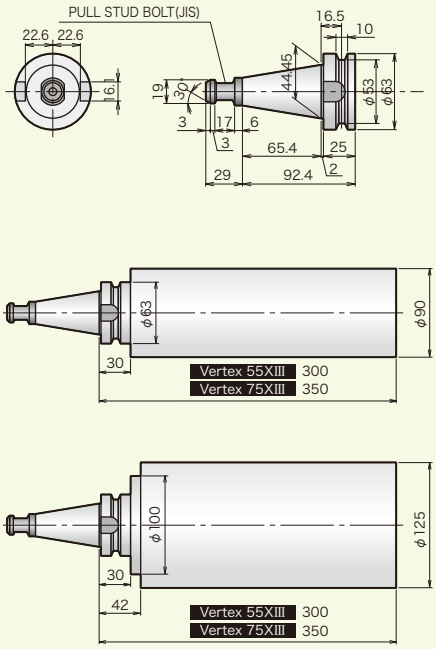


Unit：mm

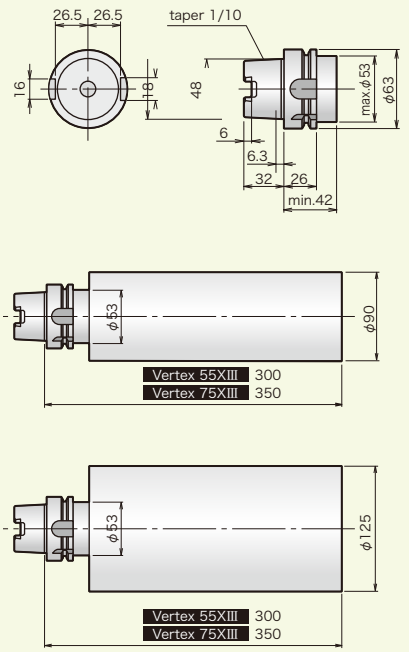
	X	X1	Y	Y1	Y2	Z	Z1	C
Vertex 55X Ⅲ	550	275	600	300	100	500	100	400
Vertex 75X Ⅲ	750	375	800	400	150	700	150	500

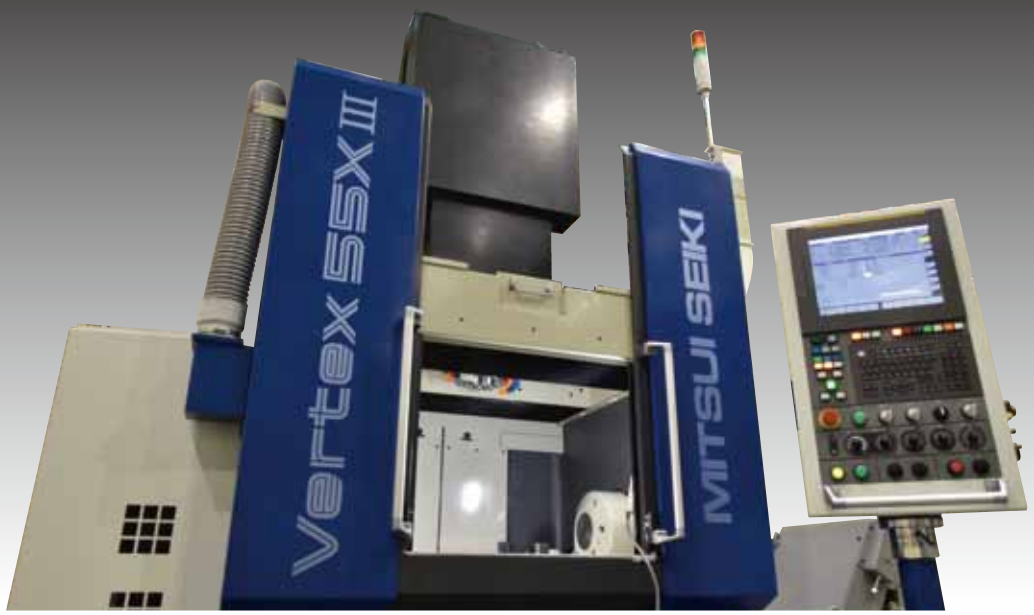
■Tools

BT40



HSK-A63(optional)





● SPECIFICATIONS

Item			Unit	Specification	
				Vertex 55X Ⅲ	Vertex 75X Ⅲ
Stroke	X-axis		mm	550	750
	Y-axis		mm	600	800
	Z-axis		mm	500	700
	A-axis		°	+15～-105(0.0001°dec.)	
	C-axis		°	360(0.0001°dec.)	
Table	Distance from table surface to spindle		mm	100～600	150～850
	Table size		mm	ϕ400	ϕ500
	Max. work size (diameter x height)		mm	ϕ750×525(with limitation)	ϕ950×650(with limitation)
	Max. permissible load		kg	350(A axis is horizontal)	500(A axis is horizontal)
	Surface of table			28-M12(PCD150&250&350)	32-M12(PCD180&290&450)
	Height from floor to table surface		mm	900	925
Spindle				《25,000 or15,000 is available》	《25,000 or15,000 is available》
	Spindle speed		min^{-1}	50～25,000 / 50～15,000	50～25,000 / 50～15,000
	Taper			ISO 7/24 Taper No.40	ISO 7/24 Taper No.40
	Spindle motor (30min/cont. rating)		kW	18.5/15 / 7.5/5.5	18.5/15 / 7.5/5.5
	Max. spindle torque (25%ED/cont.rating)		N-m	28.6/14 / 65/44	28.6/14 / 65/44
	Spindle diameter		mm	ϕ65	ϕ65
Feed rate	Rapid traverse	XYZ axis	mm/min	48,000	48,000
		AC axis	min^{-1}	A:40 C:50	A:30 C:40
	Cutting feed	XYZ axis	mm/min	0.1～48,000	0.1～48,000
		AC axis	min^{-1}	max A:30 C:50	max A:15 C:30
	Min. resolution	XYZ axis	mm	0.0001	0.0001
	Min. feedback	AC axis	°	0.0001	0.0001
Position Transducer	XYZ axis			Absolute linear scale	
	AC axis			Absolute inductsyn	
ATC	Tool storage capacity			40	
	Max. tool length		mm	300	350
	Max. tool diameter of tool to be changed		mm	ϕ90	
	Max. tool diameter of tool to be changed without adjacent tools		mm	ϕ125	
	Max. tool weight		kgf	10	
	Tool selection mode			Fixd pot number,randam selection	
NC unit				FANUC 31i (B5)	
Accuracy	Positioning accuracy	XYZ axis	mm	±0.001	
		AC axis	sec.	±2	
	Repeatability	XYZ axis	mm	±0.001	
		AC axis	sec.	±1.5	
Power and Air	Power required			50KVA	
	Air required			0.5MPa or more, 1200NL/min or more	
Machine size	Footprint (W×L×H)		mm	2,000×3,000×3,120	2,200×3,440×3,645
	Shipment size (W×L×H)		mm	2,000×3,485×2,800	2,200×3,800×3,190
	Machine weight		Kg	About 9,500	About 12,500

● Standard Machine Specifications

Whole machine cover	Automatic power breaker	Compensation of spindle thermal displacement function (sensor type)
Door Interlock (OP door & ATC)	Work light (LED x 1)	Machine leveling jack bolts and plate
Spindle chiller (Inverter control)	Signal tower (3 lights)	USB port
Coolant system (200L tank & pump)	Manual pulse handle (w/ e-stop)	
Scraper type chip conveyer x 1	Mitsui Operator Assistant (MOA)	

● Standard NC Specifications FANUC 31i Series (B5)

Stored stroke check 2, 3	Custom Macro	Number of registerable programs expansion 1 (1000)	
Stored limit check before move	Coordinate system rotation	Background editing	
Single direction positioning	Spindle override	Machining condition selection function	※AI contour control II
Helical Interpolation	Spindle orientation	Graphic display	※Additional custom macro common variables 600
High speed skip	Rigid tapping	External data input	※Tilted working plane command with guidance
3rd/4th reference position return	99 tool offset pairs	10.4 inch LCD color display	※Tool offset
Automatic corner deceleration	Tool compensation memory C		※High-speed smooth TCP
Optional block skip (1)	Cutter or tool nose radius compensation (G40, G41, G42)		※Part program storage 2MB (5-axis machine)
Workpiece coordinate system preset (G92.1)	Part program storage 128KB (3-axis machine)		※Fast data server + 2MB ATA flash card

※ is standard for 5-axis machine

● Optional Specification (Machine)

Pull stud	JIS	Sub tank (250L)	I/F for fire extinguisher
	MAS Ⅰ	Oil skimmer	RS232C I/F
	MAS Ⅱ	Mist collector	Part probing system AMCS-7S/7H
60/130 Tools ATC		Air blow (external nozzle type)	Tool probing system AMCS-7T
Ceiling shower coolant		MQL System	Tool breakage detection
Chip conveyer	400L tank	Chip bucket	Auto. Tool length measure (ATLS) with tool breakage detection
with drum filter	700L tank	Splash gun (For work cleaning)	Laser type tool length and diameter
Side discharge type chip conveyer (400L tank)		Air gun	Z-axis original position setting tool
Through the spindle coolant	1MPa	Circuit protection breaker	Reference square
	3MPa	Work counter	
Cyclone filter		Elapse meter	
Coolant chiller	1500Kcal/H	100V 2A outlet	※Rotary and tilting axis alignment gauge
	3000Kcal/H	Weekly timer	※Guidance function rotary and tilting axis original setting

●Optional Specification FANUC 31i Series (B5)

Cs contouring control	One-digit F code feed		Tool offset pairs	200
Inch / metric conversion	High-speed processing			400
Sequence number comparison and stop	Look ahead blocks expansion (Max. 1000)			499
Program restart	Polar coordinate command			999
Manual handle interruption	Workpiece coordinate	48 pairs	Part program storage size	4MB（10240m）
Exponential interpolation	system pair	300 pairs		8MB（20480m）
Polar coordinate interpolation	Interruption type custom macro		Number of registerable programs expansion 2 (4000)	
Cylindrical interpolation	Optional chamfering and corner R		15.0 inch Color LCD	
Involute interpolation	Automatic corner override		Fast Ethernet	
Hypothetical axis interpolation	Scaling			
Spiral interpolation, conical interpolation	Programmable mirror image			
Smooth interpolation	Figure copy			
Nano smoothing	F15 tape format			
NURBS interpolation	3 dimensional cutter compensation		※Mitsui Seiki rotary table dynamic fixture offset	
3 dimensional circular interpolation	Tool life management function (Max. 256 pairs)		※Cutter compensation for 5-axis machining	
Inverse time feed	Additional tool life management function (Max. 1024 pairs)		※Work setting error compensation	

※ is optional for 5-axis machine

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