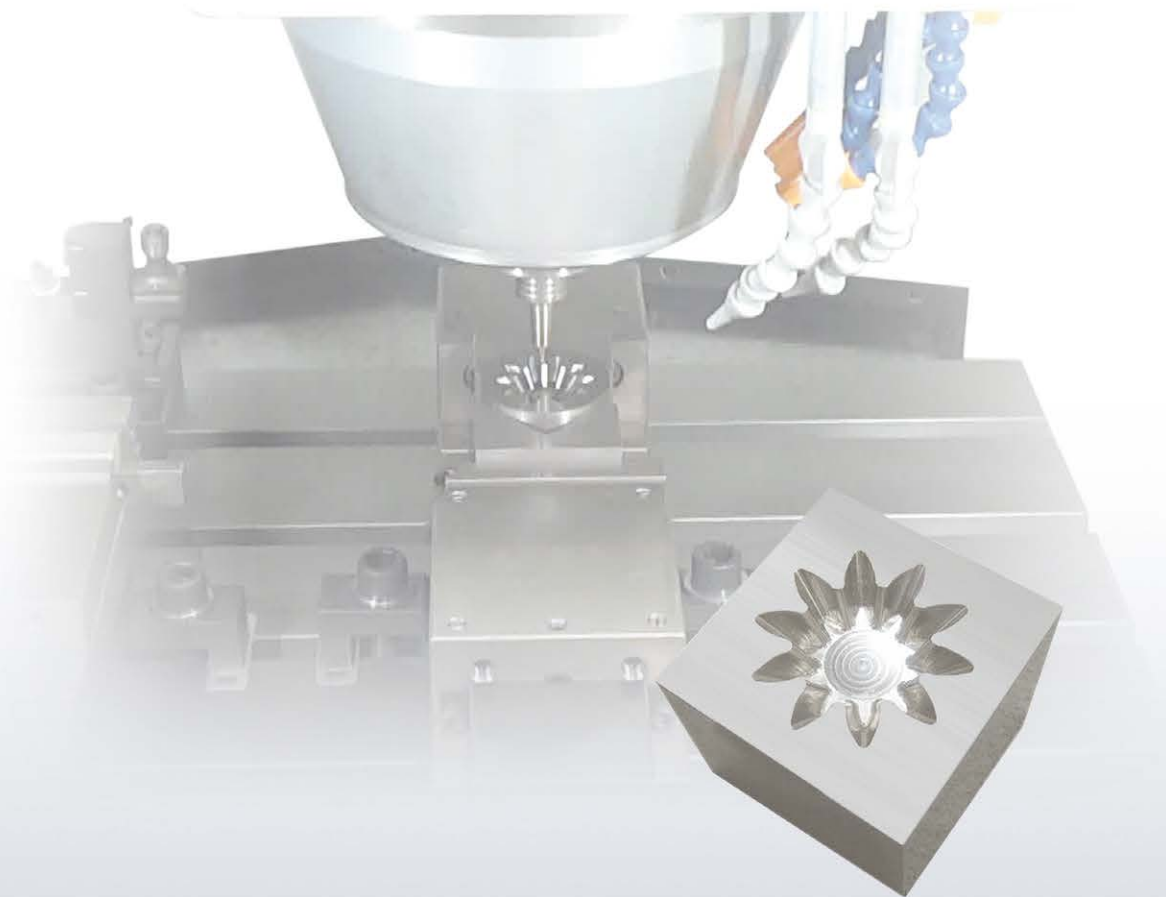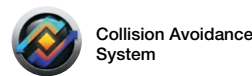Vertical Machining Center

MP-46V

[For High-Precision Parts and
 Die/Mold Applications]

Vertical Machining Center
MP-46V
[For High-Precision Parts and Die/Mold Applications]

Intelligent Technology

Thermo-Friendly Concept

Collision Avoidance System

Machining Navi

ServoNavi

43% * reduced cycle times provided
by fast spindle and quick accel/decel structural design.

* Actual data from an Okuma machined workpiece (die/mold)

A higher level of machined surface finish in machining of
high-precision parts and die/mold components.

A vertical machining center that approaches the
ultimate in quality and efficiency.

MP-46V

Photographs used in this brochure may show optional equipment.

Die/mold and high-precision parts productivity greatly increased

Huge increases in productivity for die/mold machining

Machine	MP-46V	MP-46V	An Okuma Vertical Machining Center
	30,000 min⁻¹ spec	20,000 min⁻¹ spec	20,000 min⁻¹ spec
Cycle time	**3 hr, 31 min**	**5 hr, 10 min**	6 hr, 12 min
Time reduction	**43%** Reduction Greater increases in productivity with high speed spindle lineup	**17%** Reduction Shorter times thanks to increased acceleration	–

■ **Cycle time greatly reduced with increased feed axis acceleration**

Axis acceleration: **30% higher**
(Compared with Okuma vertical machining center)

■ **Higher productivity with high-speed spindle specs**

● Spindle speeds
· 20,000 min⁻¹ (Standard)
· 30,000 min⁻¹ (Optional)
· 15,000 min⁻¹ (Optional)

● Lens array
● Size: 60 x 60 x 30 mm
● Material: Prehardened steel

Achieves the high surface quality demanded for precision parts

■ **Machining surface roughness**

Ra: 0.033 μm
Rz: 0.180 μm

● Mirror finishing workpieces
● Size: 50 x 50 x 30 mm
● Material: A7075
● Tool: Single crystal diamond tool Ball end mill R3, single flute

■ **High performance provides high accuracies**

		MP-46V	Okuma VMC
Accuracy	Straightness	**1 μm**	2 μm
	Perpendicularity	**1 μm**	3 μm
Efficiency	Cycle time reduction	**17%** Reduction	–
Stability	Machining dimensional change over time; 8 ℃/8 hrs	**5 μm**	8 μm

Note: The "actual data" referred to in this brochure represent examples, and may not be obtained due to differences in specifications, tooling, cutting, and other conditions.

Achieves high accuracy machining with advanced technology

The unique approach of "accepting temperature changes."
## Thermo-Friendly Concept

Okuma's Thermo-Friendly Concept (TFC) achieves incredible machining accuracy based on unique structural designing and thermal deformation control technology. It frees the CNC machine tool operator from troublesome dimensional compensation and warm-up operations, while providing for outstanding dimensional stability through long continuous runs and environmental temperature changes inside the factory.

Machining dimensional change over time (actual data)
Full table range: 5 μm (room temp change: 8℃)

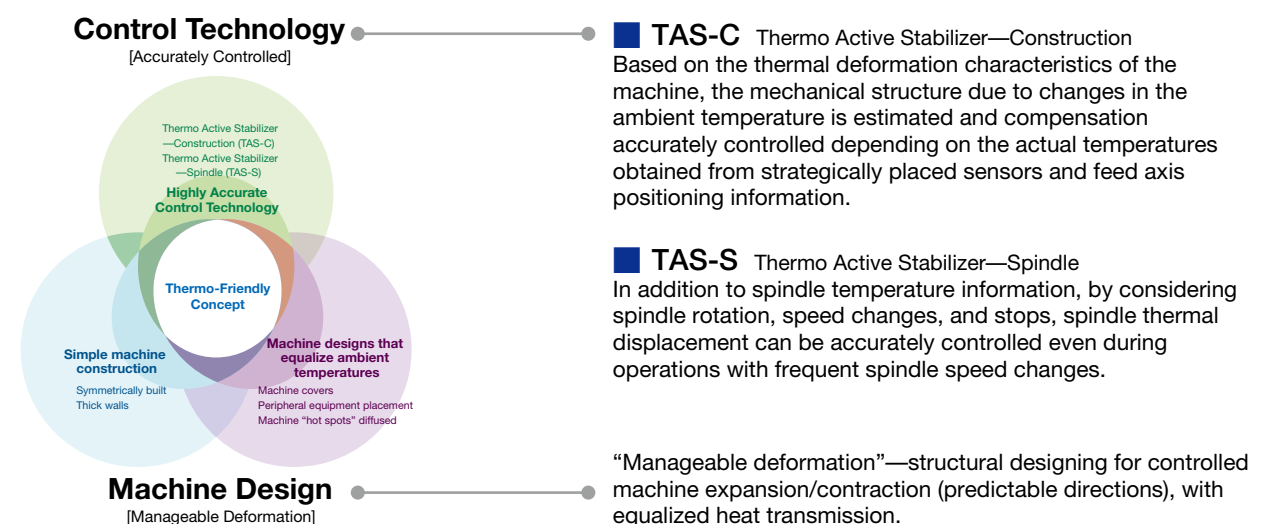### Thermo-Friendly Concept reduces wastefulness (muda)

In addition to maintaining high dimensional stability when room temperatures change, the Thermo-Friendly Concept also achieves high dimensional stability at machine startup and restart operations. The warm-up time to stabilize thermal deformation is shortened, and the burden of dimension compensation for a machining restart is reduced.
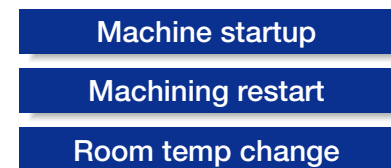
Machine startup
Machining restart
Room temp change
↓
High dimensional stability

Super thermostability minimizes machining dimensional changes over time

Accurate control of thermal displacement for high accuracy

Control Technology
[Accurately Controlled]

Thermo Active Stabilizer
—Construction (TAS-C)
Thermo Active Stabilizer
—Spindle (TAS-S)
Highly Accurate Control Technology

Thermo-Friendly Concept

Simple machine construction
Symmetrically built
Thick walls

Machine designs that equalize ambient temperatures
Machine covers
Peripheral equipment placement
Machine "hot spots" diffused

Machine Design
[Manageable Deformation]

■ **TAS-C** Thermo Active Stabilizer—Construction
Based on the thermal deformation characteristics of the machine, the mechanical structure due to changes in the ambient temperature is estimated and compensation accurately controlled depending on the actual temperatures obtained from strategically placed sensors and feed axis positioning information.

■ **TAS-S** Thermo Active Stabilizer—Spindle
In addition to spindle temperature information, by considering spindle rotation, speed changes, and stops, spindle thermal displacement can be accurately controlled even during operations with frequent spindle speed changes.

"Manageable deformation"—structural designing for controlled machine expansion/contraction (predictable directions), with equalized heat transmission.

Stable dimensional accuracy over full table range

In high-volume machining, placement of the workpiece can cause variation in dimensional accuracy.

Thermo Active Stabilizer—Construction (TAS-C) controls dimensional changes due to heat expansion of the table to achieve stable, high accuracy over the full table range, regardless of the position of the workpiece.

〈Table expansion dimensional change〉

Dim change
Big Small Big

Table thermal expansion
(from room temp change, cutting heat)
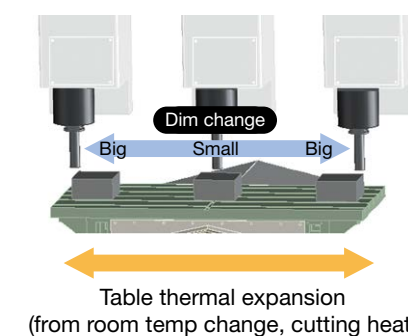
Fast and accurate spindle contributes to huge productivity gains

Highly accurate and reliable spindle

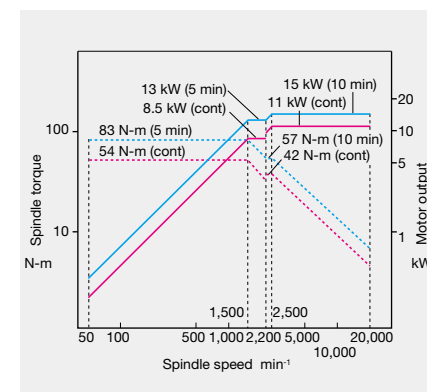### ■ Fast and rigid spindles available to match machining needs
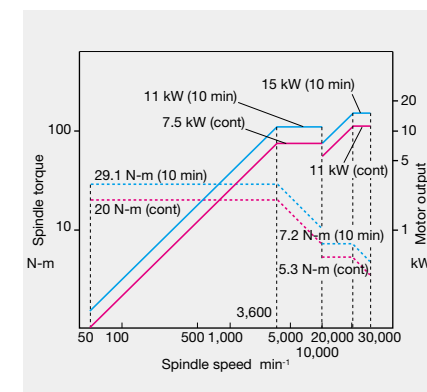

20,000 min⁻¹ spindle

30,000 min⁻¹ spindle

Die/mold semi-roughing, high-quality surface finishing	Die/mold high-speed, high-quality surface finishing	High-end general purpose high-speed spindle
● Spindle speed: 20,000 min⁻¹ (Std)	● Spindle speed: 30,000 min⁻¹ (Opt)	● Spindle speed: 15,000 min⁻¹ (Opt)
● HSK-A63	● HSK-E50, HSK-F63	● BT40, HSK-A63
● Max output: 15/11 kW (10 min/cont)	● Max output: 15/11 kW (10 min/cont)	● Max output: 22/18.5 kW (10 min/cont)
● Max torque: 83/54 N-m (5 min/cont)	● Max torque: 29.1/20 N-m (10 min/cont)	● Max torque: 199/146 N-m (5 min/cont)
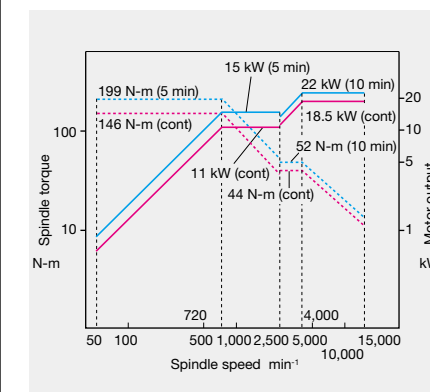
■ Heavy-duty cutting conditions

● **20,000 min⁻¹ spindle** (Std)
  Chip volume: **120 cm³/min**
              (prehardened steel)

● Cutting conditions
  Tool: ø40-mm radial cutter, 4 flutes
  Spindle speed: 1,000 min⁻¹
              (cutting speed: 126 m/min)
  Cutting width: 30 mm
  Cutting depth: 1 mm
  Cutting feed: 4,000 mm/min
              (1 mm/flute)

● **30,000 min⁻¹ spindle** (Opt)
  Chip volume: **80 cm³/min**
              (prehardened steel)

● Cutting conditions
  Tool: ø25-mm radial cutter, 3 flutes
  Spindle speed: 1,530 min⁻¹
              (cutting speed: 120 m/min)
  Cutting width: 17 mm
  Cutting depth: 1 mm
  Cutting feed: 4,710 mm/min
              (1 mm/flute)

● **15,000 min⁻¹ spindle** (Opt)
  Chip volume: **420 cm³/min**
              (S45C)

● Cutting conditions
  Tool: ø100-mm face mill, 5 blades
  Spindle speed: 650 min⁻¹
              (cutting speed: 205 m/min)
  Cutting width: 70 mm
  Cutting depth: 4 mm
  Cutting feed: 1,500 mm/min
              (0.5 mm/blade)

Note: The "actual data" referred to in this brochure represent examples, and may not be obtained due to differences in specifications, tooling, cutting, and other conditions.

Spindle shaft cooling to minimize effects of heat on tools
For 20,000 min⁻¹, 30,000 min⁻¹ spindles

Spindle warm-up is **3 min** and boundary errors are minimized (actual data)
Achieved with use of spindle shaft cooling and Thermo Active Stabilizer—Spindle TAS-S

■ Spindle shaft cooling

Spindle shaft cooling stabilizes tool length by cooling the spindle to minimize temperature changes and decrease thermal deformation. Increases in spindle and tool temperature are inhibited, making higher accuracy machining possible. The thermal deformation saturation time is also shortened, and warming-up can be reduced.

Boundary errors with different tools, such as in corner machining, are greatly reduced. This makes it possible to shorten the finishing time for dies and molds.
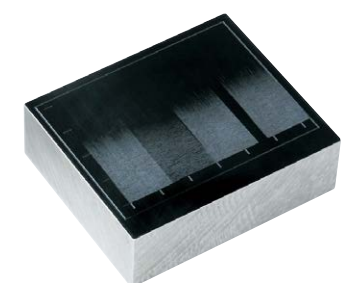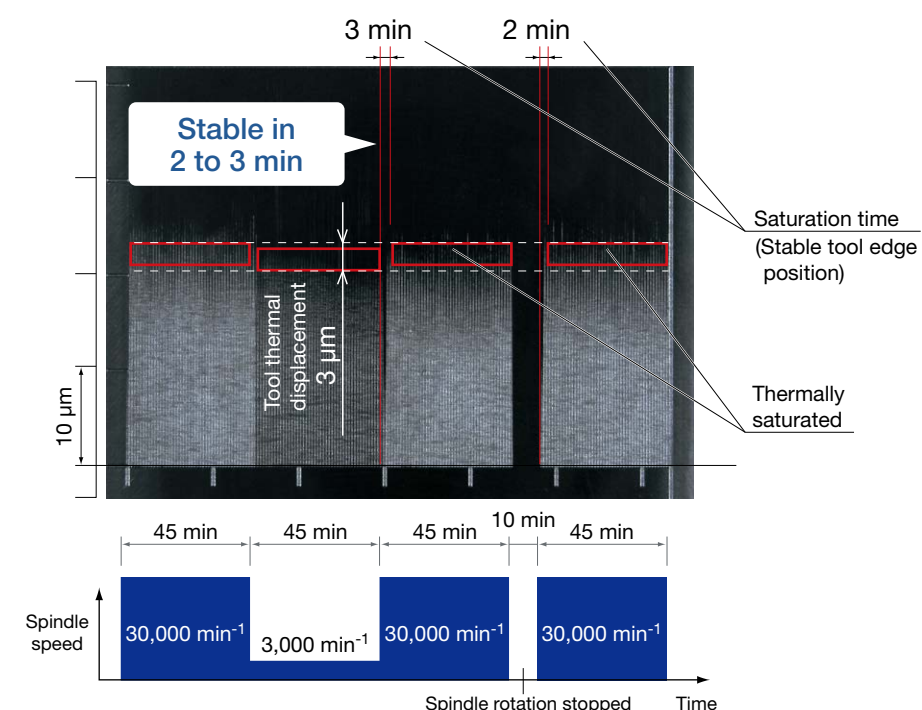
Coolant is applied to spindle for direct cooling
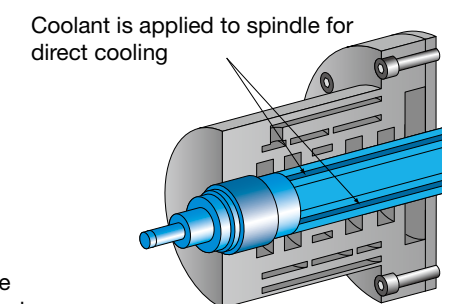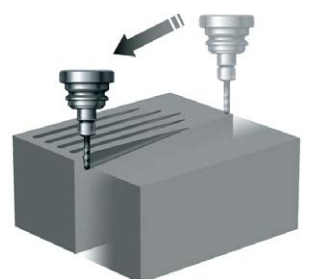

Spindle shaft cooling

● Verifying the benefits of spindle shaft cooling

In the sample below (spindle thermal matrix), straight grooves with a gentle slope are cut in a flat surface every minute with a small diameter end mill. Thermal displacement of the spindle shows up as changes in the straight groove length.

Normally, thermal deformation occurs when the spindle speed is changed or until thermal saturation is reached when machining from a stop. Inhibiting spindle temperature changes with spindle shaft cooling reduces thermal deformation so that the time until heat saturation can be shortened.

Stable in 2 to 3 min

3 min | 2 min

Tool thermal displacement 3 μm

10 μm

Saturation time (Stable tool edge position)

Thermally saturated

Spindle speed: 30,000 min⁻¹ | 3,000 min⁻¹ | 30,000 min⁻¹ | 30,000 min⁻¹

45 min | 45 min | 45 min | 10 min | 45 min

Spindle rotation stopped | Time


Sample (Spindle thermal matrix)

Straight grooves with a gentle slope are cut in a flat surface every minute with a small diameter end mill
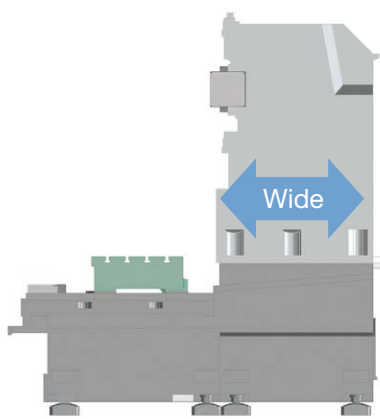
Advanced machine structure designing achieves reduced cycle times and high surface quality

Accleration/deceleration increased 30% with highly rigid construction
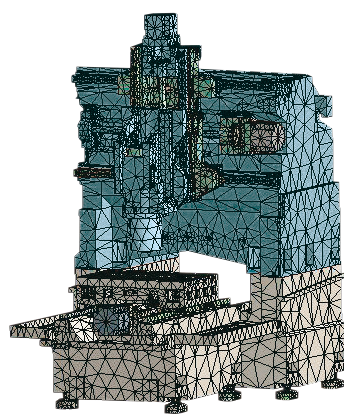(Okuma vertical machining center comparison)

- Low vibration, high-rigidity with low center of gravity
- Improved mounting rigidity on crossrail (column) and bed
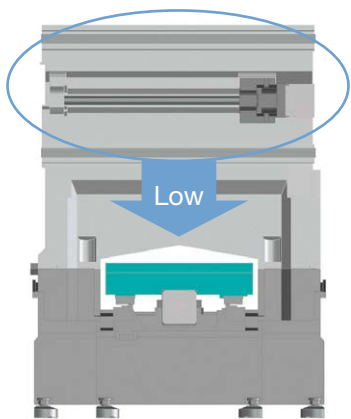
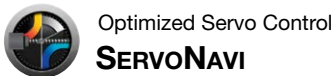Low center of gravity   Improved mounting rigidity   Effectively using 3D-CAD and FEM analysis

High surface quality achieved with low vibration machine design

- Uses low "pulsation" (vibration) roller guides
- Optimal use of major components (large castings)
- Separately mounted, detachable vibration sources, such as oil temperature controller and CNC cabinet

X axis

Ram saddle

Crossrail

Spindlehead

Z axis

Table

Y axis

Bed
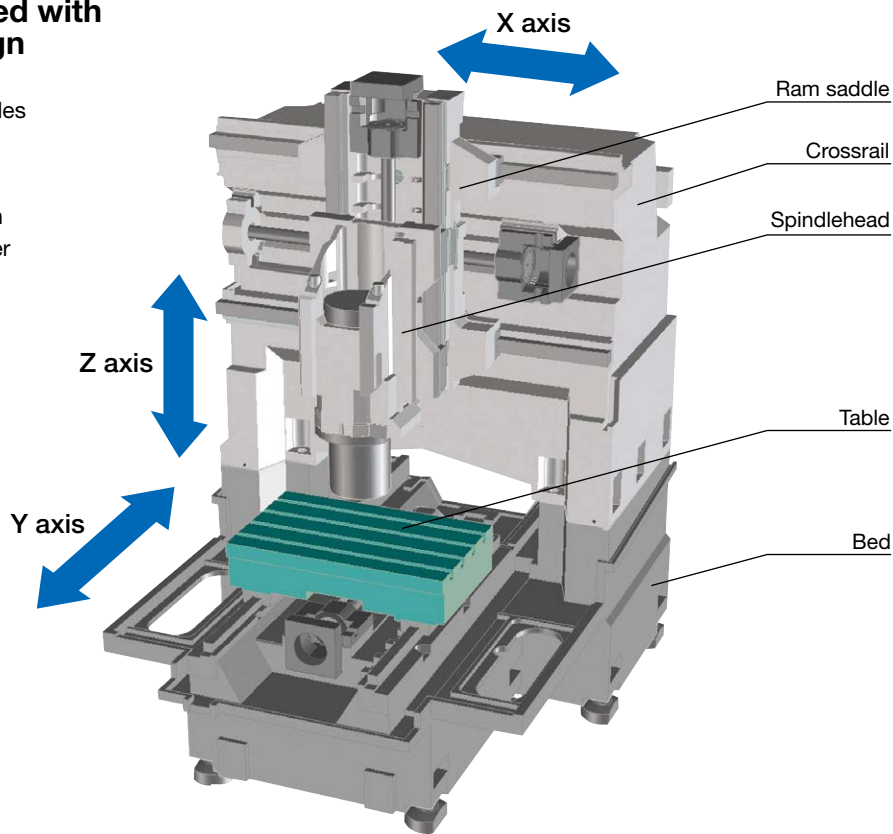
Okuma Intelligent Technology for competitive machine shops

Optimized Servo Control
SERVONAVI

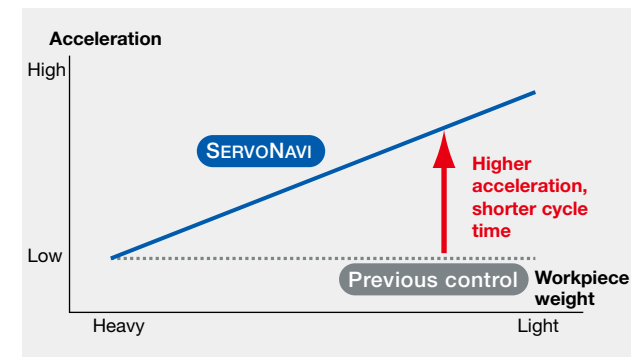Achieves long term accuracy and surface quality

SERVONAVI AI (Automatic Identification)

■ Workpiece Weight Auto Setting
Reducing cycle times by increasing acceleration

With table moving machining centers, the conventional method uses the same table feed acceleration regardless of the weight of workpiece and fixtures mounted on the table.

SERVONAVI's Workpiece Weight Auto Setting function automatically sets servo parameters including acceleration by estimating the weight of the workpiece and fixtures on the table, which shortens the cycle time while maintaining the required machining accuracy.

Acceleration

High

SERVONAVI

Higher acceleration, shorter cycle time

Low

Previous control

Workpiece weight

Heavy   Light

SERVONAVI SF (Surface Fine-tuning)

■ Reversal Spike Auto Adjustment
Maintains machining accuracy and surface quality

With a machine tool, feed axis resistance changes with its service life, causing servo parameter deviations from the initial optimal settings. As a result, inverted operations may produce visible ridgelines that affect machining accuracy and surface quality.

SERVONAVI's Reversal Spike Auto Adjustment maintains the required machining and surface quality by optimizing the servo parameters according to the change in the resistance of the feed axis.

■ Vibration Auto Adjustment
Contributes to longer machine life

When aging changes machine performance, noise, vibration, ridgelines, or fish scales may appear.

Vibration Auto Adjustment can quickly eliminate noise and vibration even from machines with years of operation.

Hyper-Surface (Optional)

■ Auto machining data compensation, easy and improved die/mold surface quality

There is no need to modify machining data. Ridgelines and uneven surface edges are reduced, the machined surface quality is improved, and hand-polishing times are eliminated. In addition to the Sculptured-Surface Adaptive Acceleration Control featured in the previous Super-NURBS function, the new Hyper-Surface — while maintaining the required shape accuracy — automatically compensates for those edges and adjacent cutter path positioning errors caused by remnants of "disturbances" found in the CAM machining data.

Automatically compensates for misalignment between adjacent cutter paths

Hyper-Surface OFF   Hyper-Surface ON
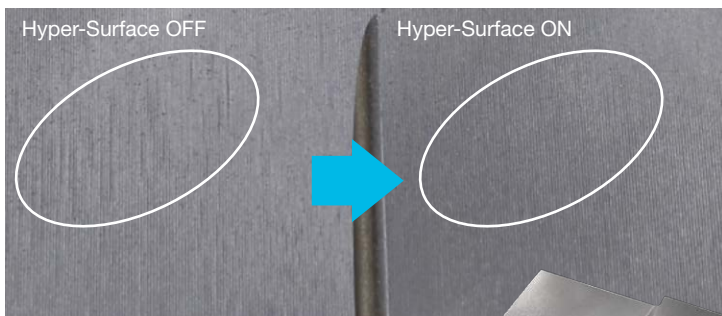
Material: FC matereial
Size: 150 × 150 × 30 mm

■ Machine Specifications

	Item	Unit	MP-46V
Travels	X-axis (ram saddle R/L)	mm (in)	660 (25.98) (ATC stroke not included)
	Y-axis (table B/F)	mm (in)	460 (18.11)
	Z-axis (spindle U/D)	mm (in)	360 (14.17)
	Table top to spindle nose	mm (in)	150 to 510 (5.91 to 20.08)
Table	Dimensions	mm (in)	760 x 460 (29.92 x 18.11)
	Floor to table top	mm (in)	800 (31.50)
	Max load capacity	kg (lb)	350 (770)
Spindle	Speed	min^{-1}	20,000 [30,000, 15,000]
	Speed ranges		Infinitely variable
	Tapered bore		HSK-A63 [HSK-F63/HSK-E50, 7/24 taper No. 40/HSK-A63]
	Bearing dia	mm (in)	ø80 (ø3.15) [ø60 (2.36), ø70 (2.76)]
Feed rate	Rapid traverse	m/min (ipm)	X-Y-Z : 24 (944.88)
	Cutting feed rate	mm/min	X-Y-Z : 1 to 24,000
Motors	Spindle (10 min/cont)	kW (hp)	15/11 (20/15) [15/11 (20/15), 22/18.5 (30/25)]
	Feed axes	kW (hp)	X-Y-Z : 3.5 (4.67)
ATC	Tool shank		HSK [BT40 15,000 min^{-1} only]
	Pull stud		[MAS 2 15,000 min^{-1} only]
	Magazine capacity	tools	20 [32, 48]
	Max tool dia (w/ adjacent)	mm (in)	ø90 (3.54)
	Max tool dia (w/o adjacent)	mm (in)	ø125 (4.92)
	Max tool length	mm (in)	250 (9.84)
	Max tool weight	kg (lb)	7 (15.4)
	Max tool moment	N-m	6.9
	Tool selection		Memory random
Machine size	Height	mm (in)	2,630 (103.54)
	Required floor space; width x depth	mm (in)	2,224 x 2,734* (87.56 x 107.64)
	Mass	kg (lb)	7,000 (15,400) [tank weight not included]
Control			OSP-P300MA

* Ball screw cooler not included   [   ]: Optional

■ Standard Specifications

Spindle speed 50 to 20,000 min^{-1}	15/11 kW (10 min/cont) HSK-A63 only	ATC air blower (blast)	
		Chip air blower (blast)	Nozzles
Rapid traverse; X-Y-Z: 24 m/min		Work lamp	LED lamps
Spindle shaft cooling		Chip pan	Effective 10 L x 2
Spindlehead cooler	Oil temperature controller	Foundation blocks	8 pcs (with jack bolts)
Air cleaner (filter)	Regulator included	3-lamp status indicator	Type C (LED signal tower) Red (alarm), yellow (end) Green (running)
Auto lube system (ALS)	Ball screw, guideway		
Color LCD operation panel			
Pulse handle	Minimum unit 0.1 μm, 4 speeds	20-tool ATC	HSK-A63
TAS-S	Thermo Active Stabilizer—Spindle	ATC magazine shutter	
		Full enclosure shielding	With ceiling
TAS-C	Thermo Active Stabilizer—Construction	Chemical anchors	
		Tapered bore cleaning bar	
Linear scale detector	X-Y-Z axes 0.01 μm	Hand tools	
Ball screw cooler	X-Y-Z axes	Tool box	
0.1 μm control			
Coolant tank capacities *1	Tank 227 L (Effective 153 L) Pump 250 W		

*1. It may be necessary to increase the pump capacity in some cases when using oil-based coolant
Note: Fire prevention measures are necessary, as oil-based coolants may cause fire. Never operate machine unattended.

■ Optional Specifications

Wide-range spindle 50 to 15,000 min^{-1} △		22/18.5 kW [10 min/cont] *2
High-speed spindle 50 to 30,000 min^{-1} △		15/11 kW [10 min/cont] *3
Dual contact spindle	△	BIG-PLUS® (15,000 min^{-1} spec only)
Optional ATC tool sets	△	32-tool, 48-tool
Pull stud specs	△	MAS/JIS/CAT/DIN (15,000 min^{-1} spec only)
High-crossrail specs (+200 mm)	△	
Thru-spindle coolant	*1	Designated from 1.5 MPa or 7.0 MPa
Chip air blower (adapter)		N/A with thru-spindle; which uses spindle-rotation thru-air spec
Oil mist unit		By oil mist or semi-dry system
Shower coolant		
Workpiece wash gun		
In-machine chip conveyor (coil)	△	
Lift-up chip conveyor	△	Floor, scraper, drum filter types
Chip bucket for above	△	
Hyper-Surface		Auto compensation of machining data High-speed contouring
Tool breakage detection, auto tool length comp		By touch sensor or laser sensor
Auto zero offset, auto gauging		By touch probe (Renishaw)
Tool life management		(time counter, etc)
Overload monitor		(w/ feed adaptive control)
Automatic door		
Sub-table		

Auto tool length compensation (laser sensor)

Measurements on minimum 0.1-mm drills possible during rotation

△ : Corresponding standard specification is deleted
*1. Okuma pull stud required (general commercial products have different end-face grinding, ring, and through hole diameter)
*2. For spindle tapered bore, 7/24 taper No. 40 (BT40, BIG-PLUS®, CAT40, DIN40) or HSK-A63 are available.
*3. For spindle tapered bore, HSK-F63, E50 are available.

■ Recommended chip conveyors (Please contact an Okuma sales representative for details)

○: Recommended
△: Recommended with conditions

Material		Steel	FC	AL/Nonferrous metal	Mixed (general use)
Chip shape					
In-machine chip discharge (Optional)	Coil	○	○ (dry/wet)	—	○
	Chip flusher; front discharge	—	○ (wet)	○	—
Off-machine chip discharge (Optional)	Hinge	○	—	—	△ (*4)
	Scraper	—	○ (dry)	—	—
	Scraper (drum filter)	—	○ (wet) with magnet	△ (*3)	—
	Hinge + Scraper (drum filter)	△ (*1)	△ (wet) (*2)	○	○

*1. When there are many fine chips   *2. When chips are longer than 100 mm   *3. When chips are not longer than 100 mm   *4. When there are few fine chips
Note: When chips are dry, clean out chips that have accumulated under the pallet or elsewhere in the machine as needed.
Note: When selecting an off-machine chip discharge chip conveyor, the appropriate in-machine chip conveyor should also be selected.

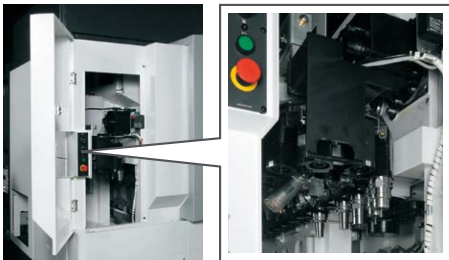## ■ Typical off-machine chip discharge (lift-up chip conveyors)

Type	Hinge	Scraper	Scraper (drum filter)	Hinge + Scraper (drum filter)
Shape				

Creating user- and earth-friendly environments

A variety of applications for efficient work

■ Good operability

● Front operation of ATC magazine

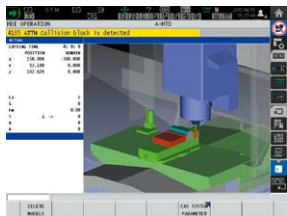● Pulse handle: 4 levels (minimum unit: 0.1 μm)
  (CE compliant)

■ Assurance with long-run continuous operation

● Centralized auto lube supplier

Collision prevention
Collision Avoidance System (Optional)

■ World's first "Collision-Free Machine"

CAS prevents collisions in automatic or manual mode, providing risk-free protection for the machine and great confidence for the operator.

■ Easy chip discharge improves workability

● Shower coolant (Optional)

● In-machine chip conveyor coil type
  (Optional)

● Off-machine lift-up chip conveyor
  (Optional)
● Mist collector (Optional)

Cutting condition search for milling
Machining Navi M-*i*, M-*g*Ⅱ+ (Optional)

■ Searches for the best cutting conditions

● Machining Navi M-*i* automatically changes to optimum spindle speed
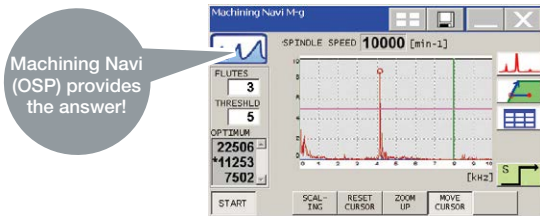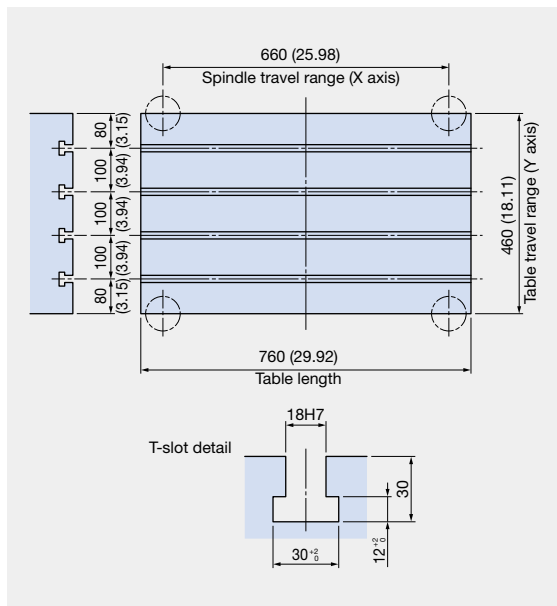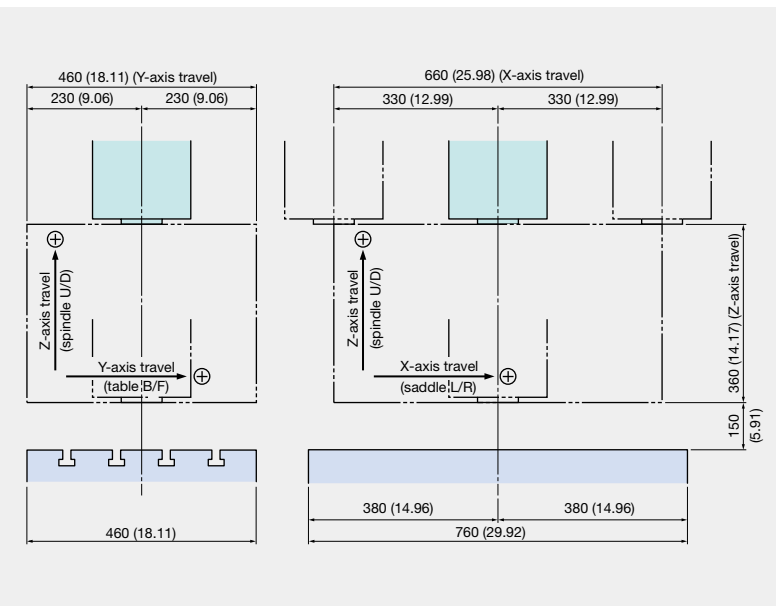● Machining Navi M-*g*Ⅱ+ shows several candidate cutting speeds

Machining Navi (OSP) provides the answer!

Next-Generation Energy-Saving System
ECO suite

A suite of energy saving applications for machine tools

ECO Idling Stop Accuracy ensured, cooler off

Intelligent energy-saving function with the Thermo-Friendly Concept.

The machine itself determines whether or not cooling is needed and cooler idling is stopped with no loss to accuracy. Electricity consumption during non-machining time greatly reduced with "ECO Idling Stop", which shuts down each piece of auxiliary equipment not in use. (Standard application on machines with Thermo-Active Stabilizer—Spindle)

ECO Power Monitor On-the-spot check of energy savings

Power is shown individually for spindle, feed axes, and auxiliaries on the OSP operation screen. The energy-saving benefits from auxiliary equipment stopped with ECO Idling Stop can be confirmed on the spot.

ECO Operation (Optional)

Intermittent/continuous operation of chip conveyor and mist collector during operation

---

■ Table Size
Unit: mm (in)

■ Working Ranges
Unit: mm (in)

■ Dimensional Drawing, Installation Drawing

Unit: mm (in)

The Next-Generation Intelligent CNC
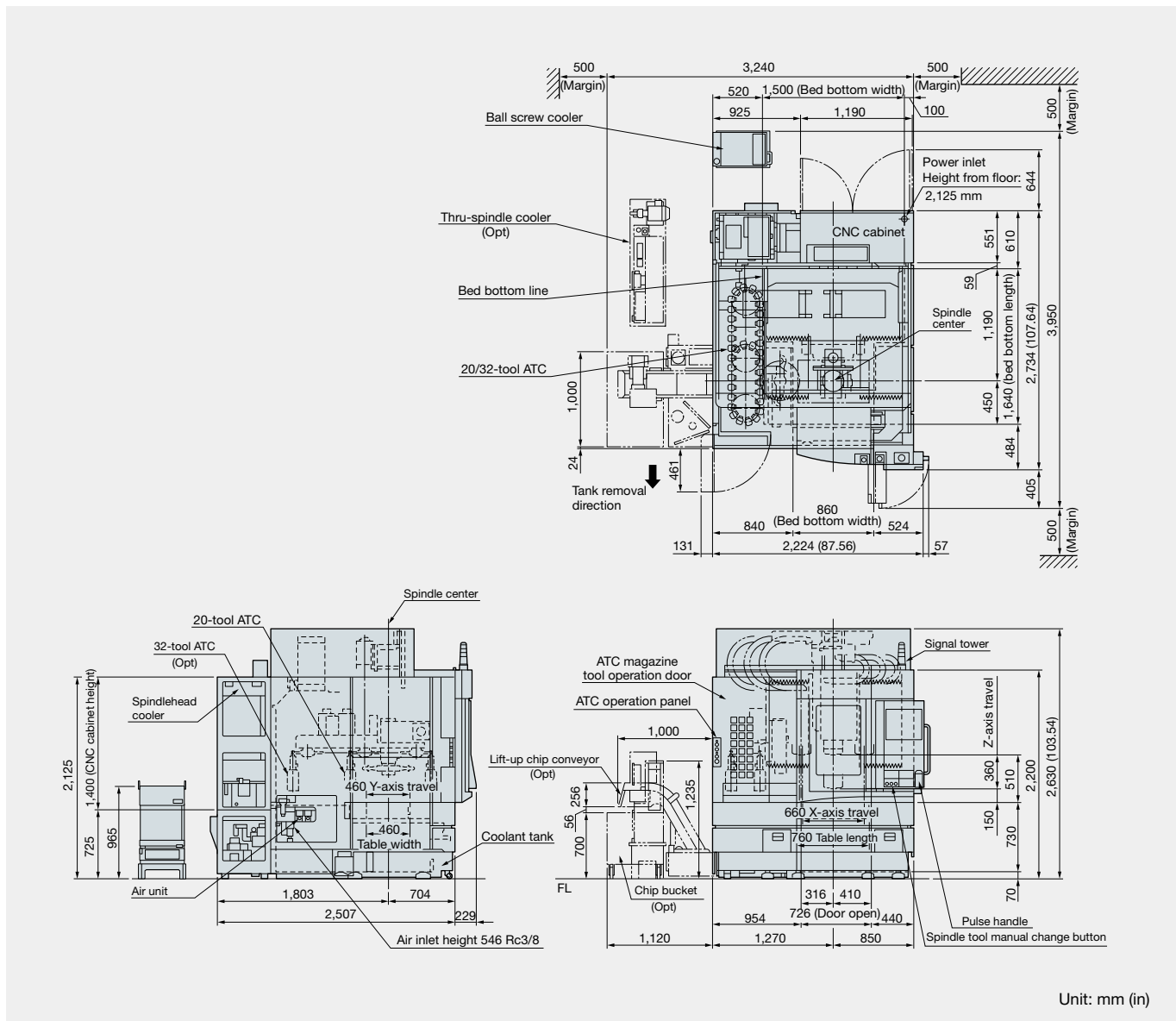
OSP suite OSP-P300MA

With revamped operation and responsiveness—ease of use for machine shops first!

Smart factories are using advanced digitization and networking (IIoT) in manufacturing to achieve enhanced productivity and added value. The OSP has evolved tremendously as a CNC suited to advanced intelligent technology. Okuma's new control uses the latest CPUs for a tremendous boost in operability, rendering performance, and processing speed. The OSP suite also features a full range of useful apps that could only come from a machine tool manufacturer, making smart manufacturing a reality.

Smooth, comfortable operation with the feeling of using a smart phone

Improved rendering performance and use of a multi-touch panel achieve intuitive graphical operation. Moving, enlarging, reducing, and rotating 3D models, as well as list views of tool data, programs, and other information can be accomplished through smooth, speedy operations with the same feel as using a smart phone. The screen display layout on the operation screen can also be changed to suit operator preferences and customized for the novice and/or veteran machinists.

Smooth operations even with wet or work-gloved hands

Enlarge
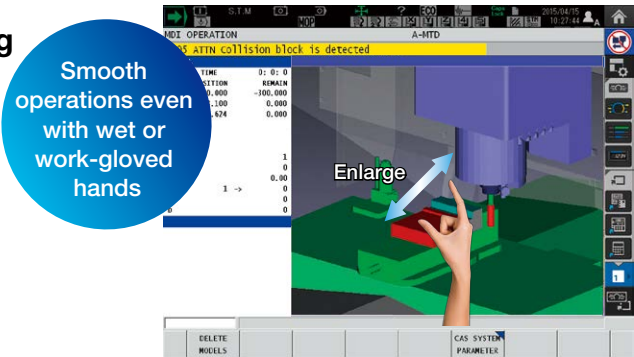
Note: Collision Avoidance System (Optional) shown above.

"Just what we wanted."— Refreshed OSP suite apps

This became possible through the addition of Okuma's machining expertise based on requests we heard from real, machine-shop customers. The brain power packed into the CNC, built by a machine tool manufacturer, will "empower shop floor" management.

Routine inspection support
Maintenance Monitor

The Maintenance Monitor displays items for inspections before starting daily operation and regular inspections and the rough estimate of inspection timing. Touching the [INFO] button displays the PDF instruction manual file of relevant maintenance items.

[INFO] button

Increased productivity through visualization of motor power reserve
Spindle Output Monitor

Monitoring operating status even when away from the machine
E-mail Notification

Comment display for greater ease of use and faster work
Common Variable Monitor

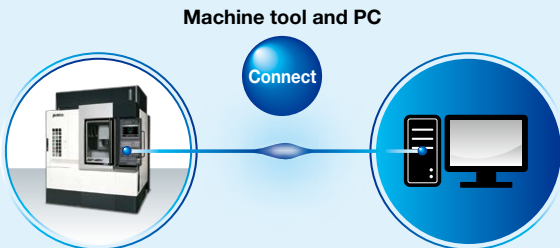Automatic saving of recorded alarms
Screen Capture

Easy programing without keying in code
Scheduled Program Editor

Get Connected, Get Started, and Get Innovative with Okuma "Monozukuri" Connect Plan

Connect, Visualize, Improve

Okuma's Connect Plan is a system that provides analytics for improved utilization by connecting machine tools and visual control of factory operation results and machining records. Simply connect the OSP and a PC and install Connect Plan on the PC to see the machine operation status from the shop floor, from an office, from anywhere. The Connect Plan is an ideal solution for customers trying to raise their machine utilization.

Machine tool and PC

Connect

■ Standard Specifications

Basic Specs	Control	X, Y, Z, simultaneous 3 axis, spindle control (1 axis)
	Position feedback	OSP full range absolute position feedback (zero point return not required)
	Coordinate functions	Machine coordinate system (1 set), work coordinate system (20 sets)
	Min / Max command	±99999.999 mm, ±9999.9999° 8-digit decimal, command unit: 0.001 mm, 0.01 mm, 1 mm (0.0001°, 0.001°, 1°)
	Feed	Cutting feed override 0 to 200%, rapid traverse override 0 to 100%
	Spindle control	Direct spindle speed commands override 30 to 300%, multi-point indexing
	Tool compensation	No. of registered tools: Max 999 sets, tool length/radius compensation: 3 sets per tool
	Display	15-inch color LCD + multi-touch panel operations
	Self-diagnostics	Automatic diagnostics and display of program, operation, machine, and NC system faults
Programming	Program capacity	Program storage capacity: 4 GB; operation backup capacity: 2 MB
	Program operations	Program management, editing, multitasking, scheduled program, fixed cycle, G-/M-code macros, arithmetic, logic statements, math functions, variables, branch commands, coordinate calculate, area machining, coordinate convert, programming help
Operations	"suite apps"	Applications to graphically visualize and digitize information needed on the shop floor
	"suite operation"	Highly reliable touch panel suited to shop floors. One-touch access to suite apps.
	Easy Operation	"Single-mode operation" for a series of operations for a single screen. Easy-to-use operation panel supports complete machine control
	Machine operations	MDI, manual (rapid traverse, manual cutting feed, pulse handle), load meter, operation help, alarm help, sequence return, manual interrupt/auto return, pulse handle overlap, parameter I/O, PLC monitor, cycle time reduction—easy setting
	MacMan	Machining management: machining results, machine utilization, fault data compile & report, external output
Communications / Networking		USB (2 ports), Ethernet
High speed/accuracy specs		Hi-G Control, Hi-Cut Pro, pitch error compensation, SERVONAVI, Machining Time Shortening Function, TAS-S (Thermo Active Stabilizer—Spindle), TAS-C (Thermo Active Stabilizer—Construction)
Energy-saving function	ECO suite	ECO Idling Stop [*1], ECO Power Monitor [*2]

*1. Spindle cooler Idling Stop is used on TAS-S machines.
*2. The power display shows estimated values. When precise electrical values are needed, select the wattmeter option.

■ Optional Specifications

Item	Kit Specs[*1]	NML E	NML D	3D E	3D D	AOT E	AOT D
Interactive functions							
Advanced One-Touch IGF-M (Real 3D simulation included)						●	●
Interactive MAP (I-MAP)				●	●		
Programming							
Auto scheduled program update		●	●	●	●	●	●
G-/M-code macros							
Common variables (Std: 200 pcs)	1,000 pcs						
	2,000 pcs						
Program branch; 2 sets							
Program notes (MSG)			●	●			●
Coordinate system selection (Std: 20 sets)	100 sets	●		●		●	
	200 sets		●		●		●
	400 sets						
Helical cutting (within 360°)		●	●	●	●	●	●
3D circular interpolation							
Synchronized Tapping II		●	●	●	●	●	●
Arbitrary angle chamfering		●	●	●	●	●	●
Cylindrical side facing							
Slope machining							
Tool grooving (flat-tool free-shaped grooving)							
Tool max rotational speed setting							
F1-digit feed	4 sets, 8 sets, parameter						
Programmable travel limits (G22, G23)		●	●	●	●	●	●
Skip (G31)							
Axis naming (G14)							
3D tool compensation							
Tool wear compensation			●		●		●
Drawing conversion	Programmable mirror image (G62)		●		●		●
	Enlarge/reduce (G50, G51)		●		●		●
User task 2	I/O variables (16 each)						
Tape conversion[*2]							
Monitoring							
Real 3D simulation				●	●	●	●
Simple load monitor	Spindle overload monitor	●	●	●	●	●	●
NC operation monitor	Hour meter, work counter	●	●	●	●	●	●
Hour meters	Power, spindle, NC, cutting						
Operation end buzzer	With M02, M30, and END commands						
Work counter	With M02 and M30 commands						
MOP-TOOL	Adaptive control, overload monitor						
AI Machine Diagnosis Function	Feed axes / Spindle						
Machining Status Logger							
Cutting Status Monitor							
Tool life management	Hour meter, No. of workpieces	●	●	●	●	●	●

Item	Kit Specs[*1]	NML E	NML D	3D E	3D D	AOT E	AOT D
Gauging							
Auto gauging	Touch probe (G31)		Included in machine specs				
Auto zero offset	Includes auto gauging		Included in machine specs				
Tool breakage detection	Touch sensor (G31)		Included in machine specs				
	Includes auto tool offset						
Gauging data printout	File output						
Manual gauging (w/o sensor)		●	●	●	●	●	●
Interactive gauging (Touch-sensor, touch-probe required)							
External I/O communication							
RS-232C connector							
DNC-T3							
DNC-B (RS-232C-Ethernet transducer used on OSP side)							
DNC-DT							
DNC-C/Ethernet							
Additional USB (Additional 2 ports, Std: 2 ports)							
Automation / untended operation							
Auto power shut-off	M02 and END alarms Work preps done → OFF	●	●	●	●	●	●
Warm-up (calendar timer)							
External program selection	Button, rotary switch, digital switch, BCD (2-digit, 4-digit)						
Cycle time reduction (Ignores certain commands)		●	●	●	●	●	●
Robot, loader I/F							
High-speed, high-accuracy							
Hyper-Surface[*3]							
ECO suite (energy saving functions)							
ECO Operation							
ECO Power Monitor	On-machine wattmeter						
Other							
Control cabinet lamp (inside)							
Circuit breaker							
Sequence operation	Sequence stop	●	●	●	●	●	●
Upgraded sequence restart	Mid-block return	●	●				●
Pulse handle	2 pts, 3 pts (standard 1 pt)						
External M code	4-point, 8-point						
Collision Avoidance System[*3]							
Machining Navi M-i, M-gII+ (cutting condition search)							
One-Touch Spreadsheet							
Block skip; 3 sets							
OSP-VPS (Virus Protection System)							

*1. NML: Normal, 3D: Real 3D simulation, AOT: Advanced One-Touch IGF-M
E: Economy, D: Deluxe
*2. Technical consultation needed for specifications
*3. There are limitations when Hyper-Surface and Collision Avoidance System are used simultaneously.

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