DOOSAN

DNM series
DNM 400 / 500 / 650

High Productivity Vertical Machining Center

DNM series
DNM 400 / 500 / 650

New series of vertical machining center
High quality and efficiency derived from high productivity analysis

DNM series are compact and durable machines created with the combination of optimized function and increased rigidity to satisfy the quality goal of global class and cost-saving. The high productivity analysis is the major principle of the DNM series which have been designed with the user's needs in mind.

High productivity

Basic concept structure and operation ensure its capability to get the best results of productivity regardless of any conditions and complexities

DNM 400 / 500 / 650

Comparison of Non Cutting Time

Previous Model	
DNM 500	

0 20% 40% 60% 80% 100%

19 %▼
Reduced by
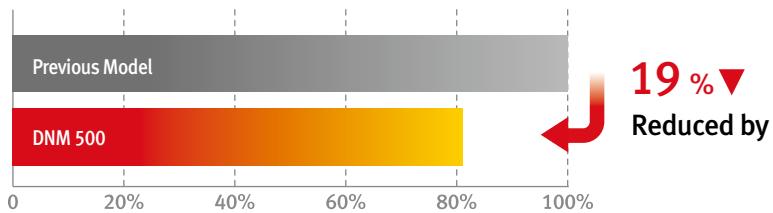
Material : Aluminum (Al6061-T6)
Size : 155×155×50 mm
         (6.1×6.1×2 inch)
No. of tools used : 14 tools

Comparsion of Cutting Time

M-company	
DNM 500	

0 20% 40% 60% 80% 100%

16 %▼
Reduced by

※ The results indicated in this catalog may not be obtained due to differences in cutting conditions.
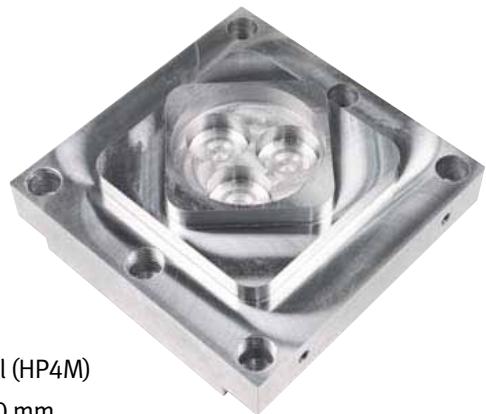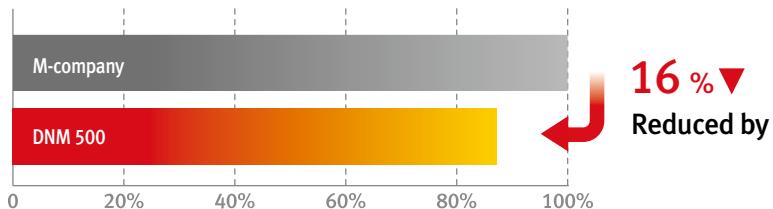
Material : Mold steel (HP4M)
Size : 270×270×100 mm
         (10.6×10.6×3.9 inch)
No. of tools used : 5 tools

Auto Tool Changer

Faster tool change time using cam increases productivity than previous model.

Tool change time (T-T-T)

Previous Model   DNM series

1.5 s   ▶   1.3 s

Tool storage capacity

30 tools

40 tools (opt.)

Maximum Chip Removal

	Cast Iron	SM45C	Aluminum
	33%	30%	37%
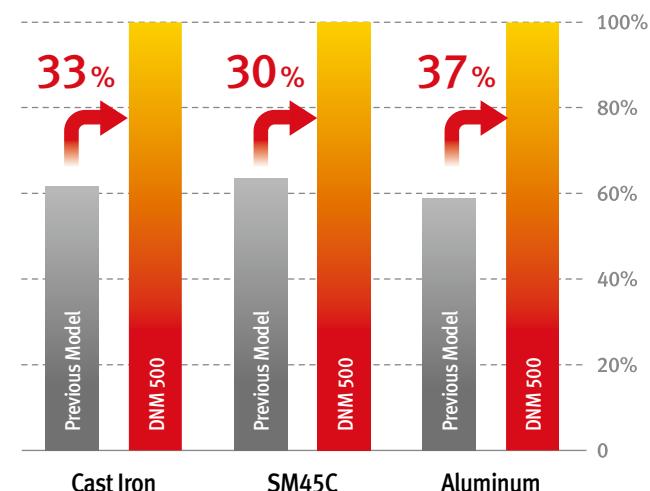
Rapid Traverse

Linear motion guide ways and high speed servomotors apply high rapid axis movement. This reduces non-cutting time and machining time for greater productivity.

Rapid traverse

|		DNM 400 / 500 / 650	DNM 400HS / 500HS / 650HS
X-axis	m/min (ipm)	36 (1417.3)	48 (1889.8)
Y-axis	m/min (ipm)	36 (1417.3)	48 (1889.8)
Z-axis	m/min (ipm)	30 (1181.1)	48 (1889.8)

## Minimum thermal transformation for high accuracy std. only DNM HS series

Machine units are designed minimum thermal transformation by ball screw nut with cooling jacket.

Ball screw nut with cooling jacket

Oil Cooler
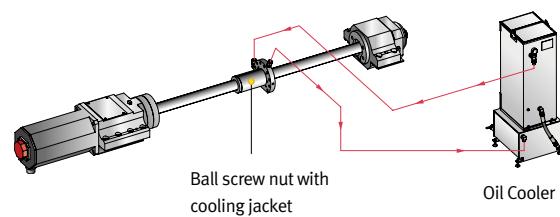
Machining Capacity

Provides high-productivity and high-accuracy in a variety of machining operations

Face mill   Carbon steel (SM45C)

- ø80mm (3.15 in.) Face mill (6Z)

2 mm (0.08 in.)   64mm (2.52 in.)
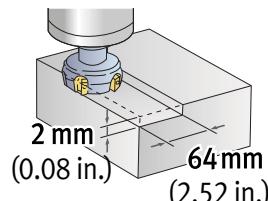
Machining rate	**432** cm³/min (26.4 in³/min)
Spindle speed	**1500** r/min
Feedrate	**2700** mm/min (106.3 ipm)

Face mill   Gray casting (GC25)

- ø80mm (3.15 in.) Face mill (6Z)

3 mm (0.12 in.)   64mm (2.52 in.)
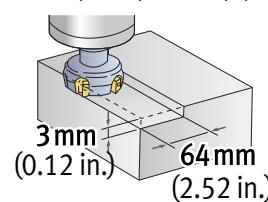
Machining rate	**691** cm³/min (42.2 in³/min)
Spindle speed	**1500** r/min
Feedrate	**3600** mm/min (141.7 ipm)

Face mill   Aluminum (AL6061)

- ø80mm (3.15 in.) Face mill (6Z)

5 mm (0.2 in.)   64mm (2.52 in.)
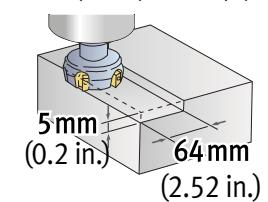
Machining rate	**1785** cm³/min (109 in³/min)
Spindle speed	**1500** r/min
Feedrate	**5580** mm/min (219.7 ipm)

End mill   Carbon steel (SM45C)

- ø30mm (1.2 in.) Endmill (6Z)

15 mm (0.59 in.)
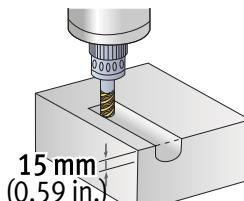
Machining rate	**36** cm³/min (2.2 in³/min)
Spindle speed	**222** r/min
Feedrate	**80** mm/min (3.1 ipm)

U-drill   Carbon steel (SM45C)

ø51 mm (2 in.)
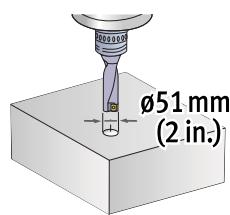
Machining rate	**172** cm³/min (10.5 in³/min)
Spindle speed	**750** r/min
Feedrate	**84** mm/min (3.3 ipm)

Tap   Carbon steel (SM45C)
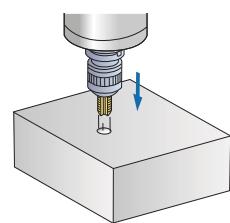
|	
Machining rate	**M30 X P3.5**
Spindle speed	**212** r/min
Feedrate	**742** mm/min (29.2 ipm)

Machining Accuracy   For increased repeatability and reliability

Designed for exceptional high accuracy and minimized thermal displacement and vibration.

Roundness

5.40 µm

- Model : DNM 500
- Material : A7075F
- Tool : Endmill ø16mm (ø0.6 in.)
         (4 blades)

90°
180°   0°
RTH TR3 Version 2.16   LS ROUNDNESS RESULTS
270°   10µm
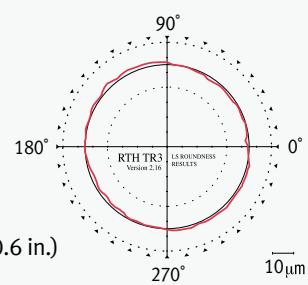
Roughness

Ra **0.12** µm

P - R - W - Profile leveled Filter ISO 11562 (M1)
Lc / Ls = 300   Lc = 0.800 mm
2.5
0
-2.5
[µm]
Pick-up TK300
LT = 4.80 mm   Vt = 0.50 mm/s
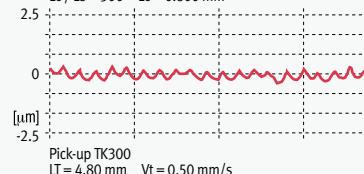
- Spindle speed : 8000 r/min
- Feedrate : 1000 mm/min (39.4 ipm)

- The results indicated in this catalog may not be obtained due to differences in environmental conditions during measurement and cutting conditions.

Easy Operation Package*

**These DOOSAN software packages have been customized to provide user friendly functions.**
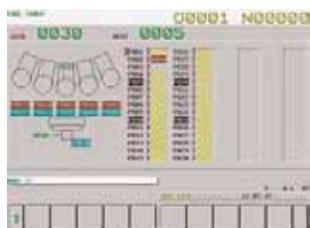
Tool Table
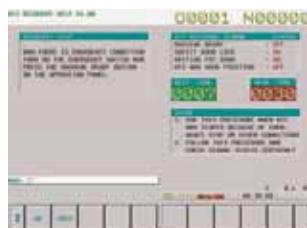
ATC Recovery Help
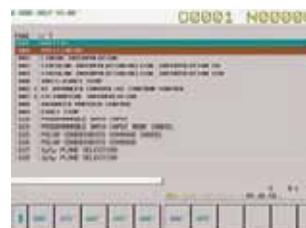
G-code Help
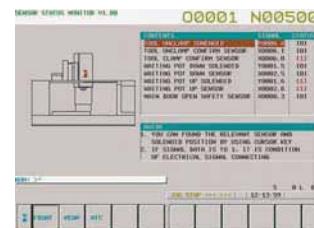
Sensor Status Monitor

Work-Piece Set up Table Moving
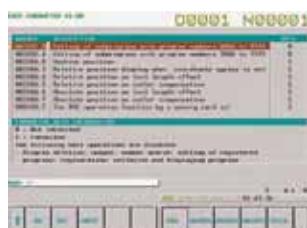
Easy Parameter
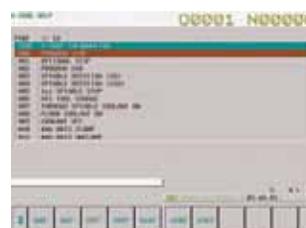
M-code Help

Tool Load Monitor **opt.**

* : Only available in 10.4" Color TFT LCD

Operating Panel

1. Swivelling Operating Console

The operator control panel is mounted on an adjustable pendant for easy view and accessibility during set-up and operation. The layout and location of the panel is ergonomically designed to be efficient and convenient for the operator.

90°
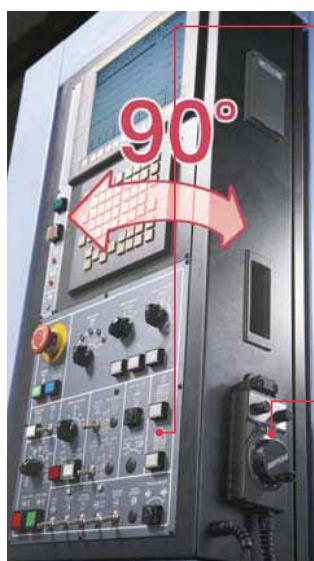
2. ATC operating button is arranged to Main Panel

This can give much easier operation and maintenance for ATC.

Magazine : CW

Magazine : CCW

3. Portable MPG

Portable MPG makes a workpiece setting easier for the operator.

Top Cover

Top cover can be opened to provide easy access for loading heavy workpieces to the center of the table.

Easy setup

DNM500

Unit : mm (inch)

835(32.9)

280 (11)

950 (37.4)
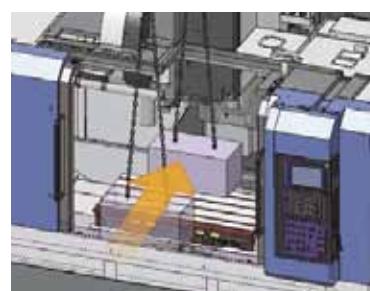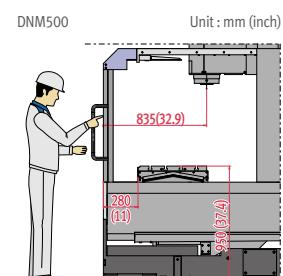
High Rigidity

Stable bed and column assembles are designed for high speed and heavy duty machining.

Compact Structure

* DNM 650 core machine

Travel axes

Wide machining range select according to workpiece size
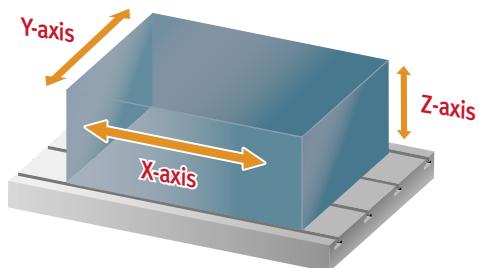
		DNM 400	DNM 500	DNM 650
X-axis	mm (inch)	762 (30.0)	1020 (40.2)	1270 (50.0)
Y-axis	mm (inch)	435 (17.1)	540 (21.3)	670 (26.4)
Z-axis	mm (inch)	510 (20.1)	510 (20.1)	625 (24.6)

The one piece bed is rigid and heavily ribbed Meehanite. These castings remain stable even under the heaviest cutting conditions. Fine grained Meehanite cast iron is used for its excellent vibration absorbing characteristics. The table is fully supported by the saddle in all positions and there is no table overhang. All axes have highly rigid and precise linear motion guideways.

Static rigidity

The high rigidity structure of DNM has raised the static rigidity up by 30% more than previous model with no weak point through FEM analysis.

Dynamic rigidity

Improving the frequency response and the damping ability of vibration makes it possible to increase the high eigenfrequency 35% up on the previous model.
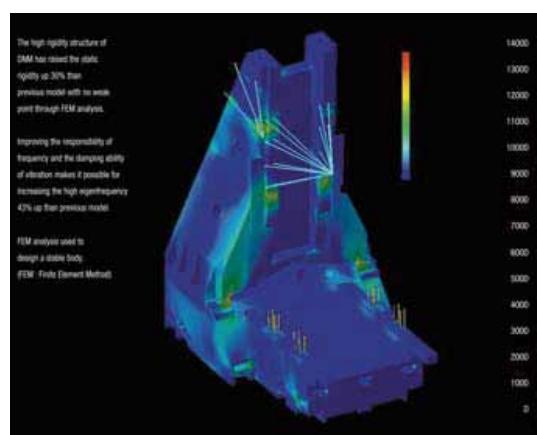
※ FEM analysis used to design a stable body.
(FEM : Finite Element Method)

High Speed

High speed spindle of high quality and rigidity helps increase the efficiency and performance of the machine.

Spindle Head

Max. spindle speed

DNM 400 / 500 / 650

8000 r/min
12000 r/min opt.

DNM 400HS / 500HS / 650HS

15000 r/min
20000 r/min opt.

The spindle of DNM HS series is driven by the powerful built-in motor which has 22 kW power and 167 N·m torque.

Heated Air
Fresh Air

This enables the thermal growth of Y-axis to be reduced by more than 40% of previous model by pulling the air heated by belt out using the FAN with standard function.

Spindle power-torque diagram

DNM 400 / 500
8000 r/min : 11/15 kW (14.8/20.1 Hp)
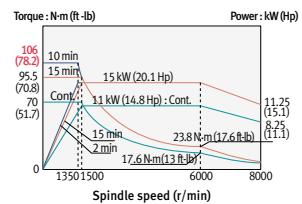
DNM 400 / 500
8000 r/min : 9/15 kW (12.1/20.1 Hp) opt.
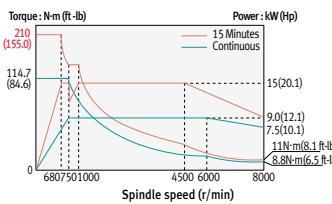
DNM 650
8000 r/min : 15/18.5 kW (20.1/24.8 Hp)
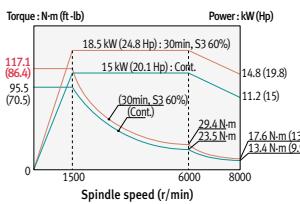
DNM 650
8000 r/min : 9/11 kW (12.1/14.8 Hp) opt.
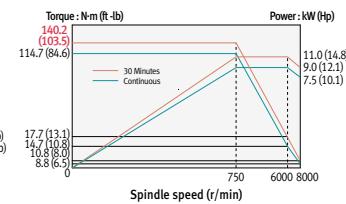
DNM 400 / 500 / 650
12000 r/min : 11/15 kW (14.8/20.1 Hp) opt.
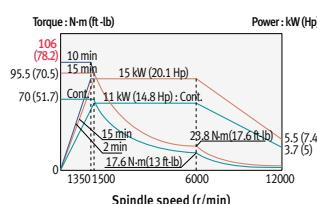
DNM 400HS / 500HS / 650HS
15000 r/min : 18.5/22 kW (24.8/29.5 Hp)
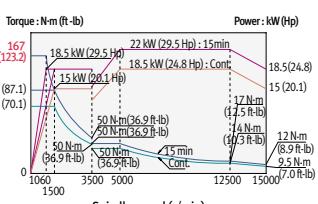
DNM 400HS / 500HS / 650HS
20000 r/min : 11/18.5 kW (14.8/24.8 Hp) opt.
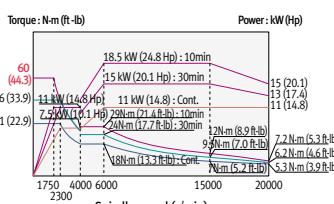
2-Face locking tool system (BIG PLUS) std.

The 2-Face locking tool system offers simultaneous dual contact between the machine spindle face and tool holder flange face.

Taper contact   Flange contact
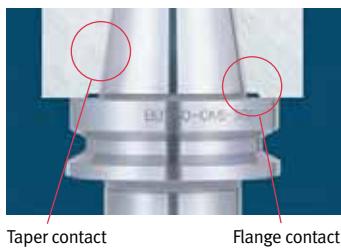
Spindle head cooling system

The refrigerated spindle cooling system circulates cooling oil to maintain a constant temperature for high accuracy, regardless of the ambient temperature or cutting conditions.

• DNM HS series std.
• DNM series opt.

Chip Disposal

Chip treatment from the viewpoint of productivity improvement and environmental countermeasure is important. DNM series offer a variety of chip control equipment to provide enhanced accuracy and better chip removal capabilities.

Easy chip removal structure

The completely enclosed DNM series guarantee the confinement of chips and coolant to the inside of the machining area. Chips fall into the removable forward mounted chip pan for easy disposal.
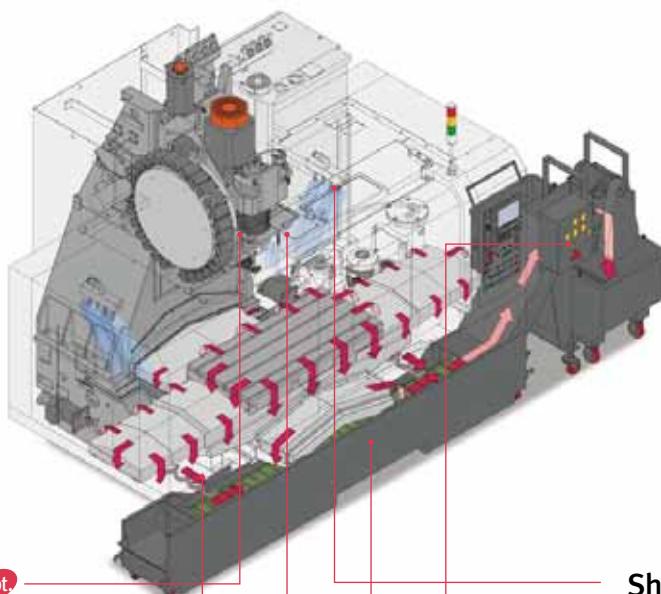
Through spindle coolant `opt.`

Middle pressure : 1.96 Mpa (284.2 psi)
High pressure : 6.86 Mpa (994.7 psi)

Screw conveyor

Flood coolant

Shower coolant `opt.`

Chip conveyor `opt.`

Hinge type	Scraper type	Drum filter type
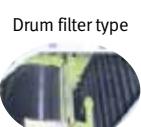
Large capacity coolant tank with chip pan and box filter

Coolant tank capacity DNM 400 : 300L
DNM 500 : 360L
DNM 650 : 380L

Easy to discard chips piled up
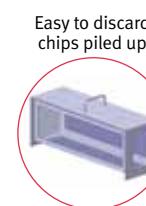
Optional Equipment

Various options available to meet customers' needs and to provide efficient work and convenience.

Interface for additional equipment

Connection example of additional 1 axis interface

Pneumatic

Hydraulic

Electronic
Servo driven function and device
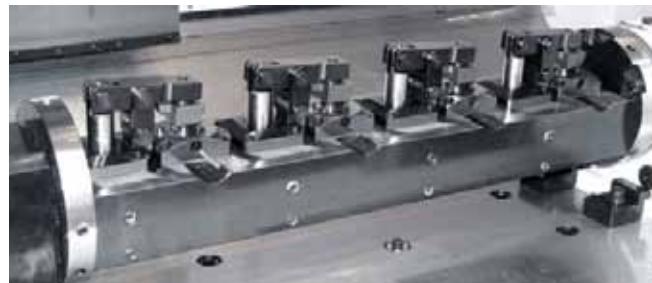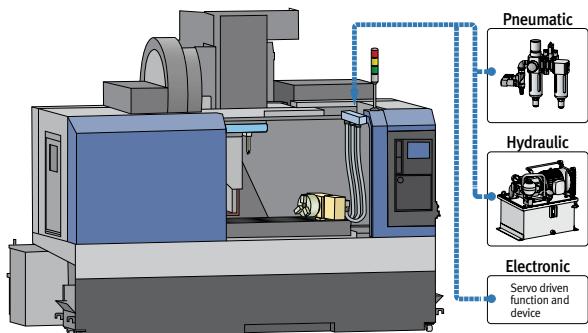
Recommandable rotary table size : DNM 400/500 : ø250 mm (9.84 inch)
DNM 650 : ø320 mm (12.6 inch)

Hydraulic power unit may be additionally necessary according to rotary table specifications.

Connection example of fixture interface

Pneumatic
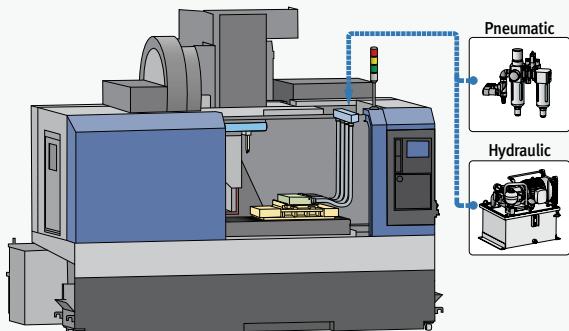
Hydraulic

Fixture check list (for hydraulic / pneumatic fixtures)

● **Pressure source**

Hydraulic ☐ P/T ☐ A/B

Pneumatic ☐ P/T ☐ A/B

● **Number of ports**

☐ 1pair (2-PT 3/8"port)

☐ 2pair (4-PT 3/8"port)

☐ 3pair (6-PT 3/8"port)

● **Hydraulic power unit**

Supply scope : ☐ User ☐ DOOSAN
(Please check the below detail specification, if you want Doosan to supply.)
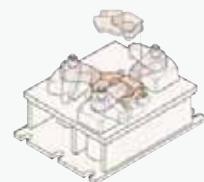
☐ Use Doosan standard unit
24 L/min (6.3 gal/min) / 4.9 MPa (711 psi)

☐ Special requirement
_____ L / min (gal/min) at _____MPa (psi)

※ Contact Doosan for more information

Automatic tool measurement

Automatic workpiece measurement

Minimum Quantity Lublication

Misting device
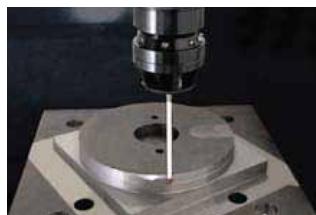
Oil skimmer

External Dimensions

DNM 400

Top View
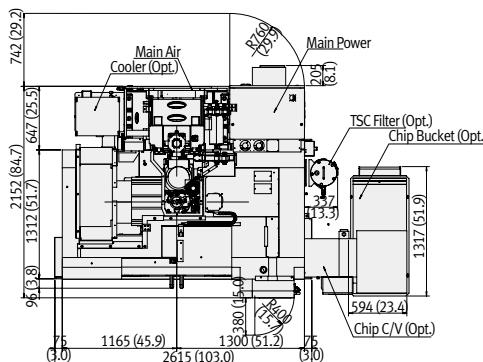
Front View
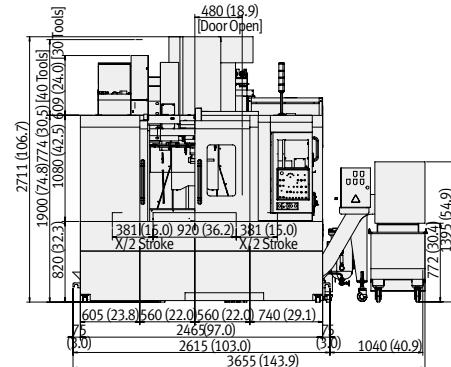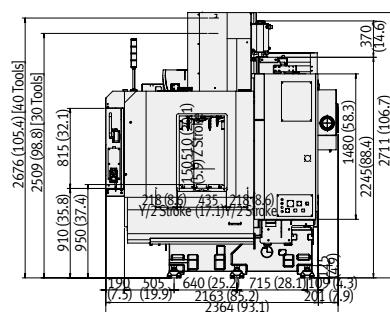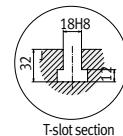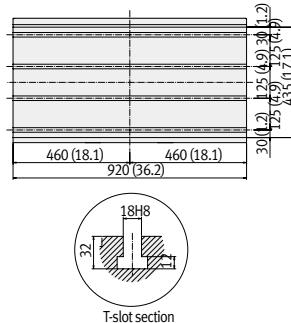
Side View

Table

DNM 500

Top View
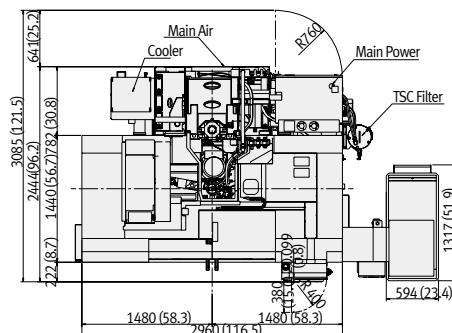
Front View
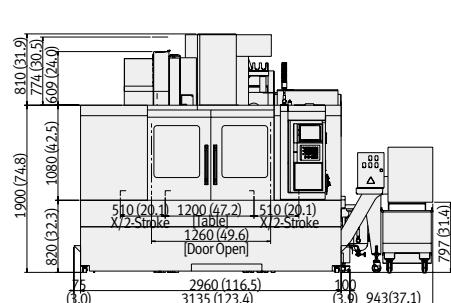
Side View

Table

DNM 650

Top View

Front View

Side View

Table

T-slot section
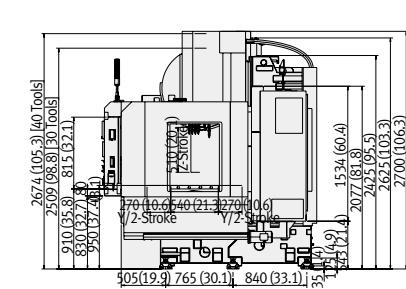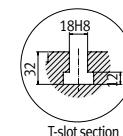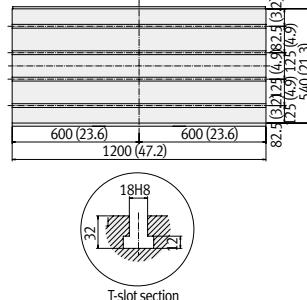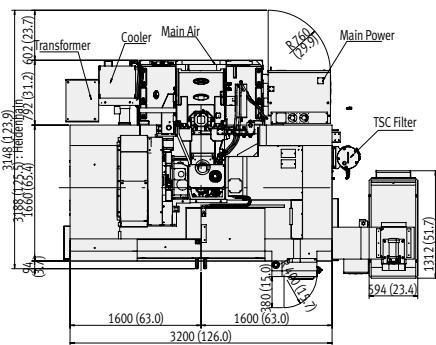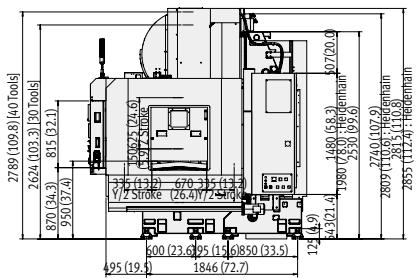
Tool Shank

Unit : mm (inch)

BT40
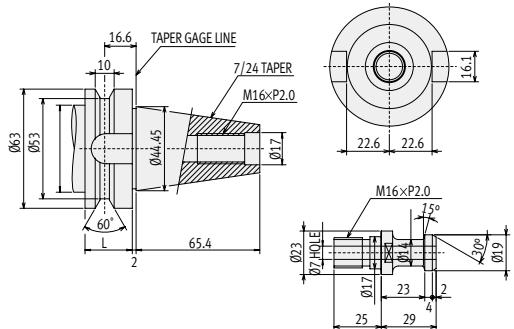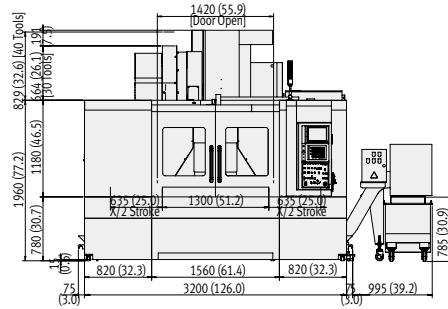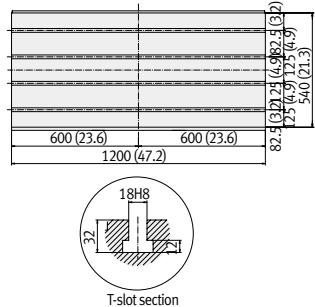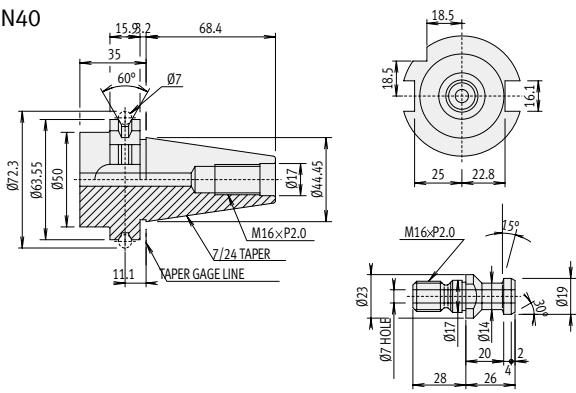
CAT40

DIN40
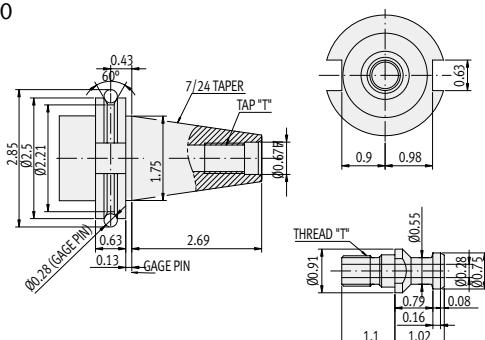
Machine Specifications

| Description		Unit	DNM 400	DNM 500	DNM 650
Travels	Travel distance X-axis	mm(inch)	762 (30.0)	1020 (40.2)	1270 (50.0)
	Y-axis	mm(inch)	435 (17.1)	540 (21.3)	670 (26.4)
	Z-axis	mm(inch)	510 (20.1)		625 (24.6)
	Distance from spindle nose to table top	mm(inch)	150-660 (5.9-30.5)		150-775 (5.9-30.5)
	Distance from spindle nose to column	mm(inch)	512 (20.2)	587 (23.1)	747 (29.4)
Feedrates	Rapid Traverse Rate X-axis	m/min(ipm)	36 (1417.3)		
	Y-axis	m/min(ipm)	36 (1417.3)		
	Z-axis	m/min(ipm)	30 (1181.1)		
	Max. Cutting feedrate	mm/min(ipm)	15000 (590.6)		
Table	Table size	mm(inch)	920*435 (36.2*17.1)	1200*540 (47.2*21.3)	1300*670 (51.2*26.4)
	Table loading capacity	kg(lb)	600 (1322.8)	800 (1763.7)	1000 (2204.6)
	Table surface type		4-125*18H8		5-125*18H8
Spindle	Max. Spindle speed	r/min	8000 {8000,12000}		8000 {12000}
	Spindle taper		ISO #40, 7/24 TAPER		
	Max. Spindle torque	N·m(ft-lbf)	106 {140,106}		117.7 {106}
Automatic Tool Changer	Type of took shank		BT40		
	Tool storage capa.	ea	30{40}		
	Max. tool diameter Continous	mm(inch)	Ø80 {Ø76} (Ø3.1 {Ø3.0})		
	Without Adjacent Tools	mm(inch)	Ø125 {Ø125} (Ø4.9 {Ø4.9})		
	Max. tool length	mm(inch)	300 (11.8)		
	Max. tool weight	kg(lb)	8 (17.6)		
	Tool selection		mermory random		
	Tool change time (Tool-to-tool)	s	1.3		
	Tool change time (Chip-to-chip)	s	3.7		3.9
Motors	Spindle motor power	kW(Hp)	15/11 (20.1/14.8)		18.5/15 (24.8/20.1)
	Coolant pump motor power	kW(Hp)	0.25 (0.3)		
Power source	Electric power supply(rated capacity)	kVA	33.5		42.55
	Compressed air supply	Mpa(psi)	0.54 (78.3)		
Tank capacity	Coolant tank capacity	L(gal)	300 (79.3)	380 (100.4)	
	Lubrication tank capacity	L(gal)	1.4 (0.4)		
Machine Dimensions	Height	mm(inch)	2703 (106.4)		2815 (110.8)
	Length	mm(inch)	2092 (82.4)	2284 (89.9)	2572 (101.3)
	Width	mm(inch)	2615 (103.0)	3350 (131.9)	
	Weight	kg(lb)	5000 (11023.0)	6500 (14329.8)	8500 (18739.0)

Note : { } are optional.

Standard Feature

- 10.4" Color TFT LCD
- Assembly & operation tools
- Ball screw nut cooling system
  (HS series)
- Coolant tank & chip pan
- Door interlock
- Flood coolant system
- Installation parts
- Screw conveyor
- Signal tower (red, yellow, green)
- Portable MPG
- Splash guard
- Work light
- X, Y, Z Absolute pulse coder

Optional Feature

- 4th axis preparation
- Automatic power off
- Automatic tool measurement
- Automatic workpiece measurement
- Cam ATC (40 tools)
- Chip conveyor & chip bucket
- EZ Guide i
- MQL (Minimum Quantity Lubrication)
- Spindle head cooling system*
- Oil skimmer
- Shower coolant
- Test bar
- Through spindle coolant

* : Standard on 12000 r/min
15000 r/min
20000 r/min

- The specifications and information above-mentioned may be changed without prior notice.
- For more details, please contact Doosan

NC Unit Specifications

DOOSAN FANUC-i series

AXES CONTROL

- Controlled axes	3 (X,Y,Z)
- Simultaneously controllable axes	
Positioning (G00) / Linear interpolation (G01) : 3 axes	
Circular interpolation (G02, G03) : 2 axes	
- Backlash compensation	
- Follow up	
- Least command increment	0.001mm (0.0001 inch)
- Least input increment	0.001mm (0.0001 inch)
- Machine lock	all axes / Z axis
- Mirror image	
Reverse axis movement (setting screen and M - function)	
- Stored pitch error compensation	
Pitch error offset compensation for each axis	
- Stored stroke check 1	Overtravel controlled by software
- Absolute pulse coder	

INTERPOLATION & FEED FUNCTION

- 2nd reference point return	G30
- Circular interpolation	G02, G03
- Cylindrical interpolation	G07.1
- Dwell	G04
- Exact stop check	G09, G61(mode)
- Feed per minute	
- Feedrate override (10% increments)	0-200 %
- Helical interpolation	
- Jog override (10% increments)	0-200 %
- Linear interpolation	G01
- Manual handle	(1 unit)
- Manual handle feedrate	x1, x10, x100 (per pulse)
- Override cancel	M48 / M49
- Positioning	G00
- Rapid traverse override	F0 (fine feed), 25 / 50 / 100 %
- Reference point return	G27, G28, G29
- Skip function	G31

SPINDLE & M-CODE FUNCTION

- M-code function	M3 digits
- Spindle orientation	
- Spindle serial output	
- Spindle speed command	S5 digits
- Spindle speed override	10 - 150 %

TOOL FUNCTION

- Cutter compensation C	G40, G41, G42
- Number of tool offsets	400 ea
- Tool length compensation	G43, G44, G49
- Tool life management	128 sets
- Tool number command	T2 digits
- Tool offset memory C	
Geometry / Wear and Length / Radius offset memory	
- Tool position offset	G45 - G48

PROGRAMMING & EDITING FUNCTION

- Absolute/Incremental programming	G90 / G91
- Auto. Coordinate system setting	
- Background editing	
- Canned cycle	G73, G74, G76, G80 - G89, G99
- Circular interpolation by radius programming	
- Custom macro B	
- Decimal point input	
- Extended part program editing	
- I/O interface	RS - 232C
- Inch/metric conversion	G20 / G21
- Label skip	
- Local / Machine coordinate system	G52 / G53
- Maximum commandable value	±99,999.999 mm
- No. of Registered programs	400ea
- Optional block skip	
- Optional stop	M01
- Part program storage	640m
- Program number	O4 - digits
- Program protect	
- Program stop / end	M00 / M02, M30
- Rigid tapping	G84, G74
- Sub program	Up to 4 nesting
- Tape code	ISO / EIA Automatic discrimination
- Thread cutting	
- Work coordinate system	G54 - G59

OTHERS FUNCTIONS (Operation, setting & Display, etc)

- 3rd/ 4th reference return	
- Additional work coordinate system	G54.1 P1 - 48 (48 pairs)
- AI APC (Advanced Preview Control)	20 block preview
- Alarm display	
- Alarm history display	
- Automatic corner override	G62
- Clock function	
- Coordinate rotation	G68, G69
- Cycle start/ Feed hold	
- Control axis detach	
- Display of PMC alarm message	
Message display when PMC alarm occurred	
- Dry run	
- Graphic display	Tool path drawing
- Help function	
- High speed skip function	
- Loadmeter display	
- Look ahead control	G08
- MDI/ DISPLAY unit	
10.4" Color TFT LCD, keyboard for data input (small), soft-keys	
- Memory card interface	
- Operation functions	Tape / Memory/ MDI / Manual
- Operation history display	
- Optional angle chamfering / corner R	
- Polar coordinate command	G15 / G16
- Program restart	
- Programmable data input	
Tool offset and work offset are entered by G10, G11	
- Programmable mirror image	G50.1/ G51.1
- Run hour and part number display	
- Scaling	G50, G51
- Search function	Sequence NO./ Program NO.
- Self - diagnostic function	
- Servo setting screen	
- Single block	
- Single direction positioning	G60
- Stored stroke check 2	

OPTIONAL SPECIFICATIONS

- Additional controlled axes	4 axes in total
- AICC (AI Contour Control) with Hardware	40 block preview
- Data server	1024 pairs
- Dynamic graphic display (w/10.4" Color TFT LCD)	
Machining profile drawing	
- Ethernet function	
- Remote buffer	
- EZ Guide i	
(Doosan Conversational Programming Solution) with 10.4" Color TFT LCD	
- Tool load monitoring function(doosan)	

FANUC 32i-A [opt.]

AXES CONTROL

- Controlled axes	3 (X,Y,Z)
- Simultaneously controllable axes	
Positioning (G00) / Linear interpolation (G01) : 3 axes	
Circular interpolation (G02, G03) : 2 axes	
- Backlash compensation	
- Emergency stop / overtravel	
- Follow up	
- Least command increment	0.001mm (0.0001 inch)
- Least input increment	0.001mm (0.0001 inch)
- Machine lock	all axes / Z axis
- Mirror image	
Reverse axis movement (setting screen and M - function)	
- Stored pitch error compensation	
Pitch error offset compensation for each axis	
- Stored stroke check 1	Overtravel controlled by software
- Absolute pulse coder	

INTERPOLATION & FEED FUNCTION

- 2nd reference point return	G30
- Circular interpolation	G02, G03
- Dwell	G04
- Exact stop check	G09, G61(mode)
- Feed per minute	
- Feedrate override (10% increments)	0-200 %
- Jog override (10% increments)	0-200 %
- Linear interpolation	G01
- Manual handle feed 1 unit	
- Manual handle feedrate	x1, x10, x100 (per pulse)
- Override cancel	M48 / M49
- Positioning	G00
- Rapid traverse override	F0 (fine feed), 25 / 50 / 100 %
- Reference point return	G27, G28, G29
- Skip function	G31
- Helical interpolation	
- DSQ1 (AICC II + Machine condition selection function)	80 block preview
- Thread cutting, synchronous cutting	
- Program restart	
- Automatic corner deceleration (Specify AI Contour control II)	
- Feedrate clamp by circular acceleration (Specify AI Contour control II)	
- Linear ACC / DEC before interpolation (Specify AI Contour control II)	
- Linear ACC / DEC after interpolation	
- Rapid traverse bell-shaped acceleration/deceleration	
- Smooth backlash compensation	

SPINDLE & M-CODE FUNCTION

- M-code function	M3 digits
- Spindle orientation	
- Spindle serial output	
- Spindle speed command	S5 digits
- Spindle speed override (10% increments)	10 - 150 %
- Spindle output switching	
- Retraction for rigid tapping	
- Rigid tapping	G84, G74

TOOL FUNCTION

- Tool nose radius compensation	G40, G41, G42
- Number of tool offsets	64 ea
- Tool length compensation	G43, G44, G49
- Tool number command	T2 digits
- Tool life management	
Geometry / Wear and Length / Radius offset memory	
- Tool offset memory C	
- Tool length measurement	

PROGRAMMING & EDITING FUNCTION

- Absolute/Incremental programming	G90 / G91
- Auto. Coordinate system setting	
- Background editing	
- Canned cycle	G73, G74, G76, G80 - G89, G99
- Circular interpolation by radius programming	
- Custom macro B	
- Custom size 512Kb	
- Decimal point input	
- I/O interface	RS - 232C
- Inch/metric conversion	G20 / G21
- Label skip	
- Local / Machine coordinate system	G52 / G53
- Maximum commandable value	±99999.999 mm (±9999.9999 inch)
- No. of Registered programs	500ea
- Optional stop	M01
- Part program storage	640 m (2,100 ft) [256 kB] m
- Program number	O4 - digits
- Program protect	
- Program stop / end	M00 / M02, M30
- Programmable data input	
Tool offset and work offset are entered by G10, G11	
- Sub program	Up to 4 nesting
- Tape code	ISO / EIA Automatic discrimination
- Work coordinate system	G54 - G59
- Additional work coordinate system (48 Pair)	G54.1 P1 - 48 pairs
- Coordinate system rotation	G68, G69
- Extended part program editing	
- Optional angle chamfering / corner R	
- Macro executor	

OTHERS FUNCTIONS (Operation, setting & Display, etc)

- Alarm display	
- Alarm history display	
- Clock function	
- Cycle start / Feed hold	
- Control axis detach	
- Display of PMC alarm message	
Message display when PMC alarm occurred	
- Dry run	
- Ethernet function (Embeded)	
- Graphic display	Tool path drawing
- Help function	
- Loadmeter display	
- MDI/ DISPLAY unit	
10.4" Color TFT LCD, keyboard for data input (small), soft-keys	
- Memory card interface	
- Operation functions	Tape / Memory/ MDI / Manual
- Operation history display	
- Program restart	
- Run hour and part number display	G15 / G16
- Search function	Sequence NO. / Program NO.
- Self - diagnostic function	
- Servo setting screen	
- Single block	
- External data input	
- Multi language display	
- Stored stroke check 2	

OPTIONAL SPECIFICATIONS

- 3-dimensional coordinate conversion	
- 3-dimensional tool compensation	
- 3rd / 4th reference return	
- Addition of tool pairs for tool life management	1024 pairs
- Additional controlled axes	Max. 5 axes in total
- Additional work coordinate system	G54.1 P1 - 300 (300 pairs)
- DSQ 2	80 block preview
(AICC II + Machine condition selection function + Data server + 1GB)	
- Automatic corner override	G62
- Chopping function	G81.1
- Cylindrical interpolation	G07.1
- Dynamic graphic display	Machining profile drawing
- Exponential interpolation	
- Interpolation type pitch error compensation	
- EZ Guide i (Doosan infracore Conversational Programming Solution)	
with 10.4" Color TFT	
⇒ When the EZ Guide i is used, the Dynamic graphic display cannot application	
- Tape format for FS15	
- Increment system 1/10	
- Figure copying	G72.1, G72.2
- Handle interruption	
- High speed skip function	
- Involute interpolation	G02.2, G03.2
- Machining time stamp function	
- No. of Registered programs	1000 ea
- Number of tool offsets	99 / 200 / 400 pairs
- Optional block skip addition	9 blocks
- Part program storage	512K / 1M / 2M byte
- Playback function	
- Polar coordinate command	G15 / G16
- Polar coordinate interpolation	G12.1 / G13.1
- Programmable mirror image	G50.1 / G51.1
- Single direction positioning	G60
- Tool load monitoring function (Doosan)	
- Tool position offset	G45 - G48
- Position switch	

*) Pre discussion required
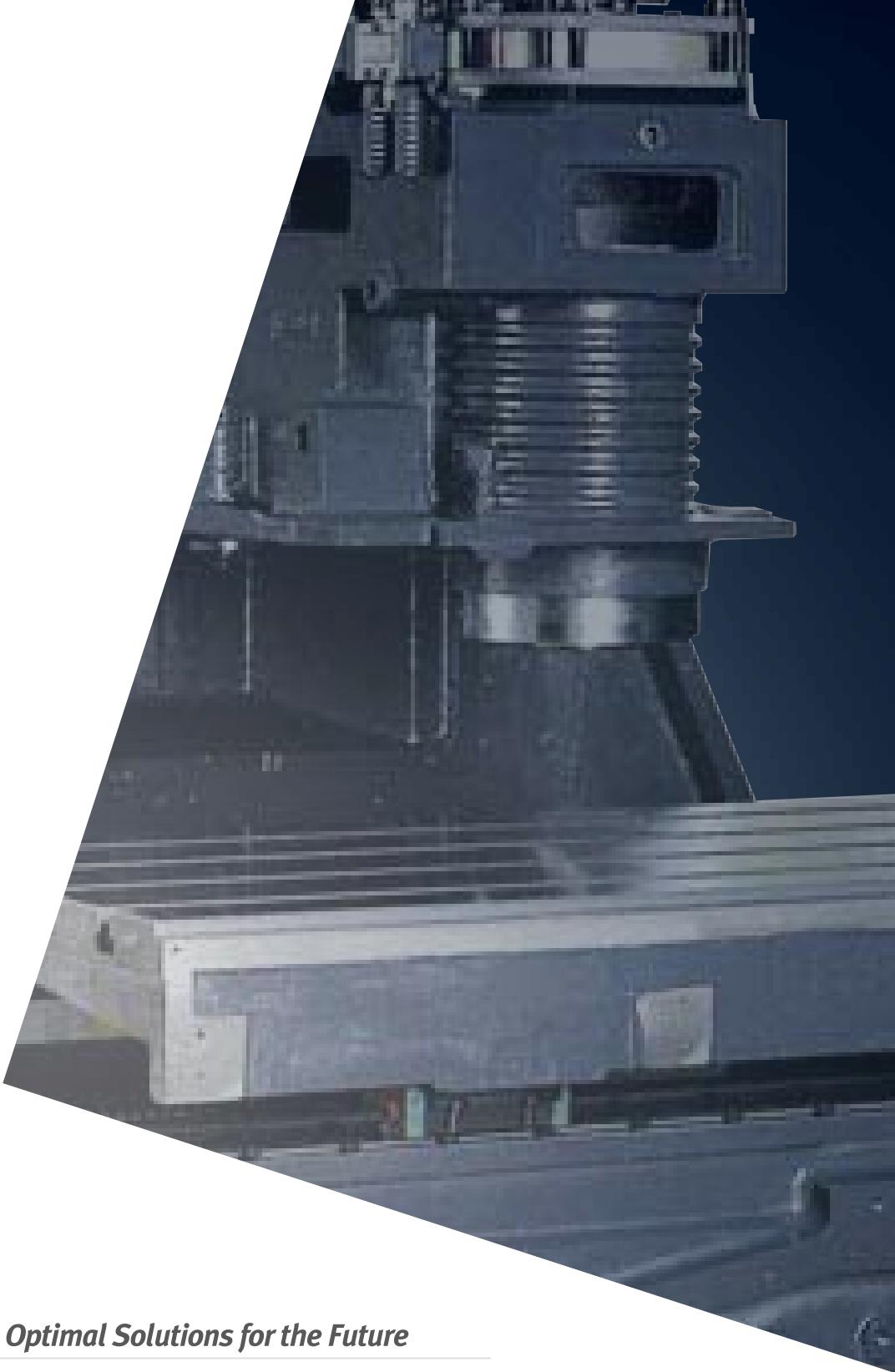
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