Doosan Machine Tools

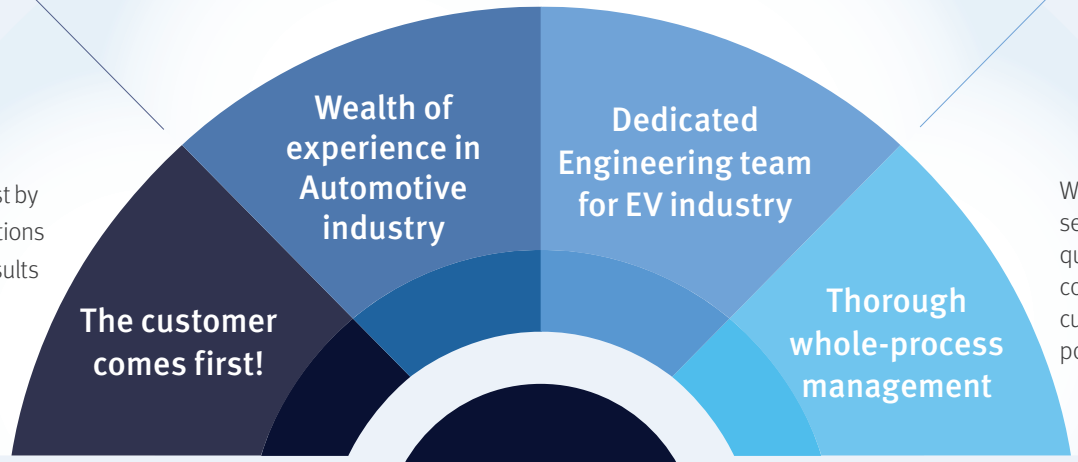
# Doosan Electric Vehicle Solution Reference

**ver.** EN 210716 SU

We can provide best solution for EV industry based on a lot of experience in Automotive industry

Doosan have prepared a special AE engineering team for EV from the early stage of the industry.

We always put our customers first by providing them with unique solutions designed to produce the best results under all conditions.



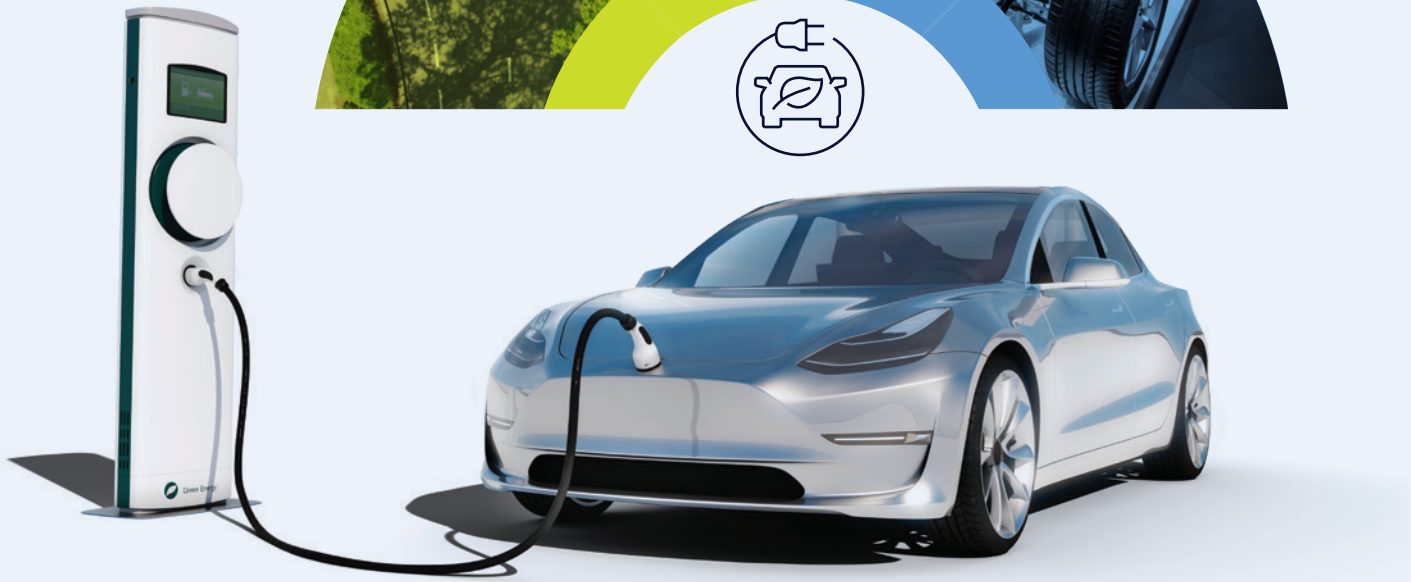

We provide the best full-process service, ranging from pre-order qualification to on-time delivery with continuous consideration of customer needs, and a comprehensive post-delivery service.

# Mobility Innovation : Electric car



- As combustion engine vehicles reduce in number, many parts will disappear. However, as EV's increase, new parts will emerge
- There is a high risk that the overall number of parts required will reduce, but nevertheless there will be many new parts required for EV's
- Many new solutions will have to be developed for the new parts required for EV's.

- It is estimated that EV's will take 31% of total global sales in 2030
- Conversion to EV's is inevitable due to global environmental regulation
- Efficiency of EV's will continuously increase due to high R&D investment

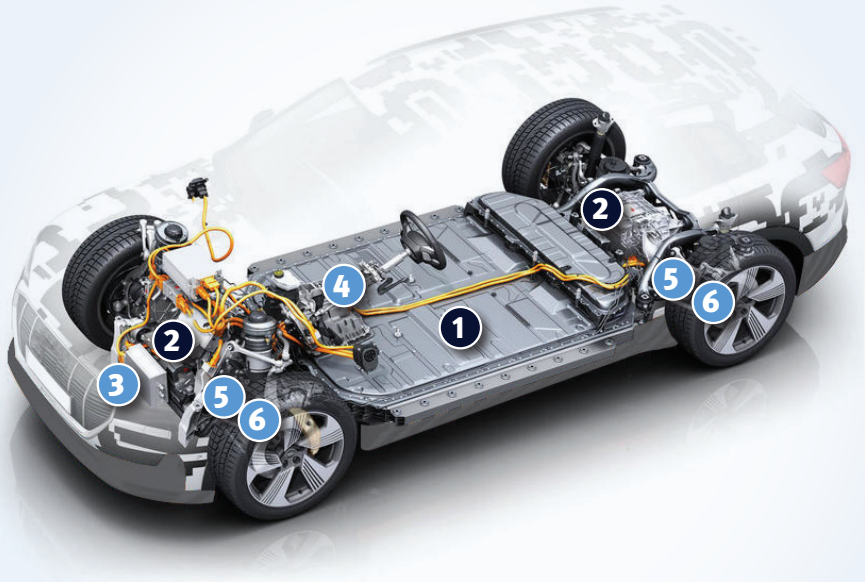



# EV Parts Analysis



New
1. Battery
2. PE System

Retained
3. Thermal System
4. Steering
5. Axle & Drive
6. Suspension/Brake




## *Retained Equipment*

Co-existence equipments in gasoline&diesel car and EV

- 3 Thermal System
- 5 Steering
- 4 Axle & Drive
- 6 Suspension/Brake

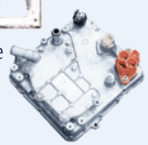
## *New Equipment*

New equipment not in combustion engine car

### 1 Battery

- New power system that replaces fuel tank
- Machining requirements: various design and production processes from manufacturers


End plate


Control box


T series

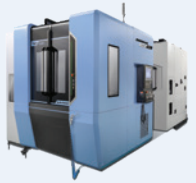

Battery pack case


DNM series

### 2 PE System(Power Electric System)

- New power system that replaces combustion engine
- Machining requirements : design variations by manufacturers/mainly machining of die castings


Motor housing

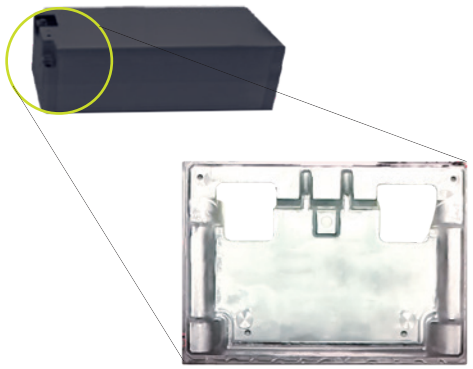

NHP series


Supportring


PUMA V400 series

## Workpiece

### END PLATE



**Material**

**Aluminum**

### Manufacturing Specialty

- Small size part
- Light cutting
- Mass production : Robot automation
- Special demand : 4-axis machining

## Solution

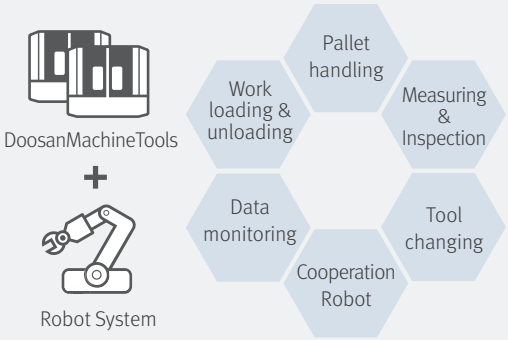
### T series

High-Speed, High-Productivity
Tapping Center

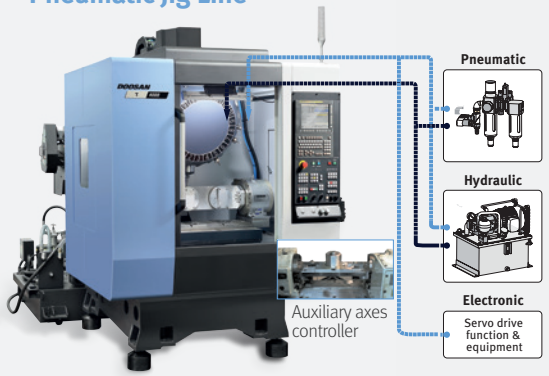

High Speed
Compact
High Productivity

### Operation

**OP#10** Face milling, Drilling
**OP#20** Chamfering, Face milling, Drilling




### 4-axis Auxiliary device Interface/ Hydraulic & Pneumatic Jig Line




• T 4000L recommendation Rotary Table : Ø200(7.9inch)

## Workpiece

### MODULE CASE

**Material**

**Aluminum**

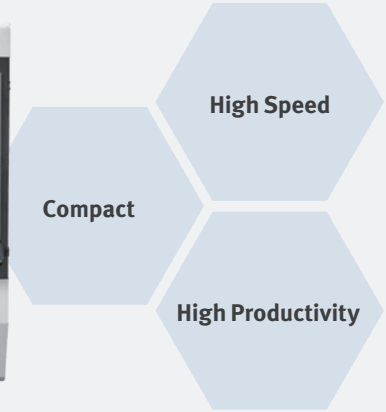
### Manufacturing Specialty

- Small size part
- Light cutting
- Mass production

## Solution

### T series

High-Speed, High-Productivity
Tapping Center


### New, High-Precision Spindle

The spindle length has been minimized to reduce the time required for acceleration/ deceleration and idle time, resulting in greater productivity and reduced vibration and noise.

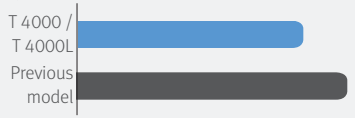
### FANUC 31i

The FANUC 31i is designed to satisfy users' demands for higher machining accuracy and ultra-fine cutting.

**Maximize productivity**

| Description | Unit | FANUC 31i |
|---|---|---|
| Rapid traverse | m/min | 48 |

**Cycle Time**



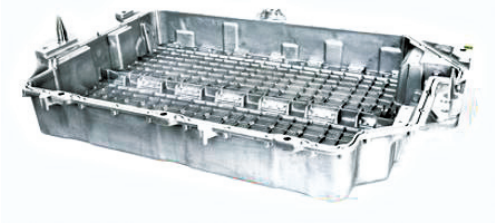

**Cycle Time reduced by**
**15%**
**than previous models**

# Pack case



## Workpiece

### BATTERY PACK CASE



**Material**

**Aluminum**

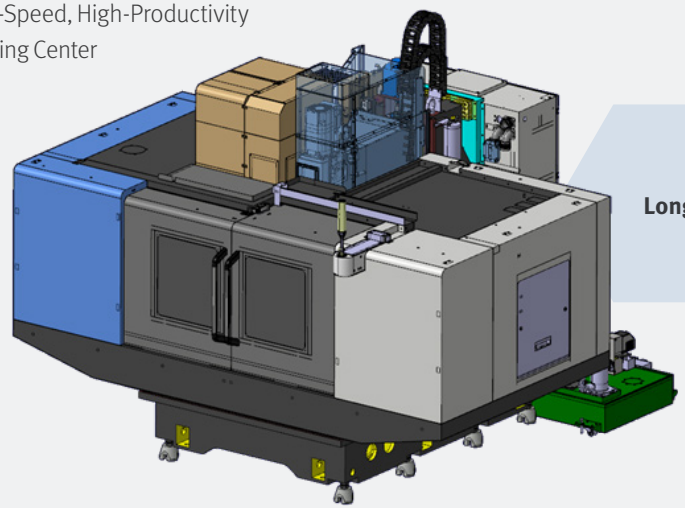
### Manufacturing Specialty

- Light cutting
- Large size parts
- Various type of machining

## Solution

### T7500

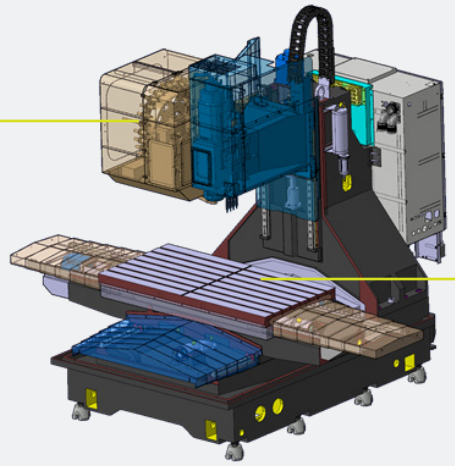
High-Speed, High-Productivity
Tapping Center



High Speed

Long

ATC



**30 Tool**
**Cam type ATC**
**(BT30)**

**Table size**

**T7500**

**1600 x 800 mm**
**(51.2 X 23.6 inch)**

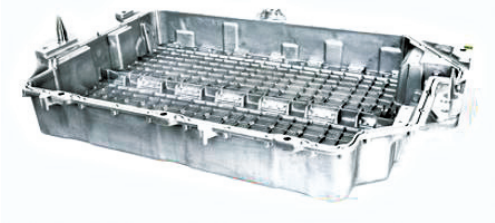
**200 kg (440.9 lb)**

# Pack case



## Workpiece

### BATTERY PACK CASE



**Material**

**Aluminum**

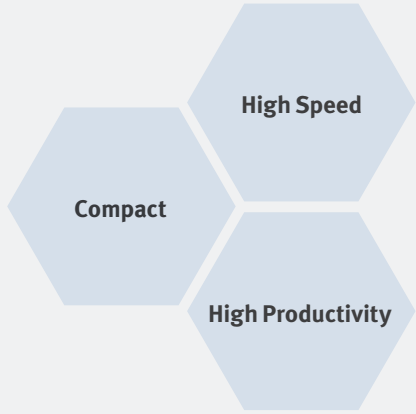
### Manufacturing Specialty

- Large size part
- Various type of machining
- Side machining : Rotary table+Rasing block
- compensation for high precision

## Solution

### DNM series

Global Standard Vertical Machining Center


### High precision through S/W

**Tool load monitoring**

During cutting operation, abnormal load caused by wear and tear of the tool is detected and an alarm is triggered to prevent further damage.

**Thermal compensation function**

A thermal error compensation function is provided as a standard feature to secure stable cutting safe from potentially harmful environmental factors..

### Wide machining area

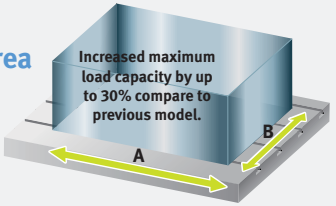



**Table size (A x B)**

DNM 4500/L
**1000**{1050} **x450**mm
(39.4{41.3} x 17.7 inch)

DNM 5700/L
**1300**{1050} **x570**mm
(51.2{59.1} x 21.3 inch)

DNM 6700/L/XL
**1500** {1600/2200}**x 670**mm
(59.1{63.0/86.6} x 26.4 inch)

**Max weight on Table**

DNM 4500/4500L
**600**kg (1322.8 lb)

DNM 5700/5700L
**1000**kg (2204.6 lb)

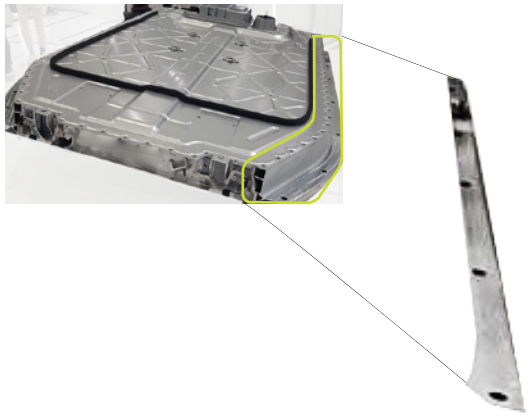
DNM 6700/6700L/6700XL
**1300**kg (2866.0 lb)

# Pack tray



## Workpiece

### PROFILE_1



Material

**Aluminum**

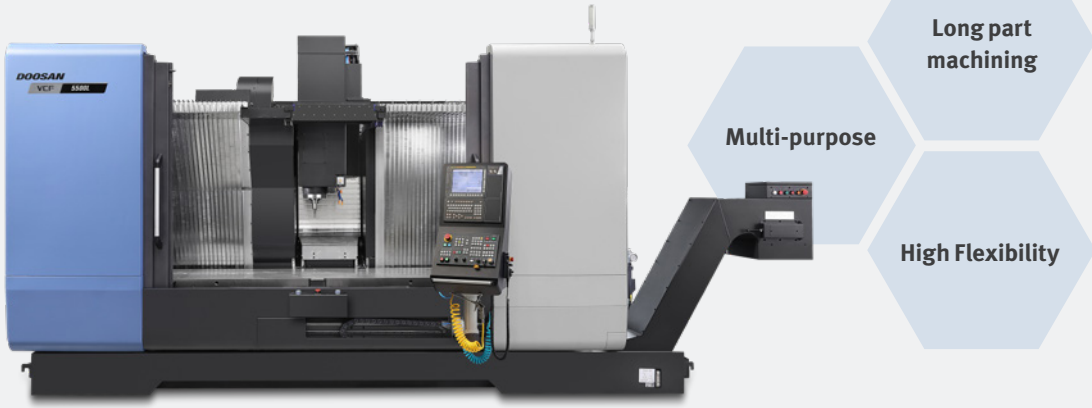
### Manufacturing Specialty

- Long parts
- Twin spindle rotary table needed
- Machining a single side of extruded profile
- Light cutting
- Special demand: optimal solution for easy chip disposal

## Solution

### VCF 5500L

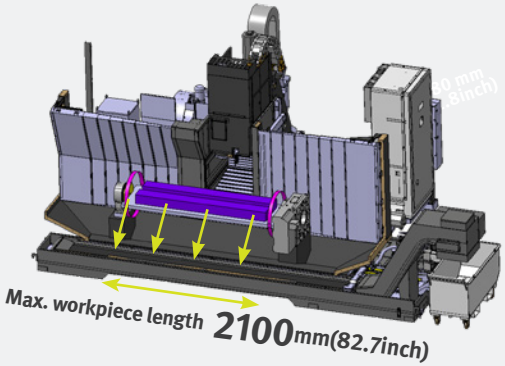
Multi-purpose Vertical Machining Center




### Long parts solution

**Speical bed for easy chip disposal**
Workpiece to chip conveyor directly

**Twin spindle Rotary table**
Productivity : Set up two workpieces at the same ime




### Rotary table

Equipped with dual driving rotary table for powerful cutting and improved accuracy.

**Left/ Right A axis**
- Synchro mode On : Simultaneous operation of left and right A-axis
- Synchro mode Off : Separated operation of left and right A-axis

**Rapid traverse** A-axis **60** r/min

**Travel distance** **360** deg

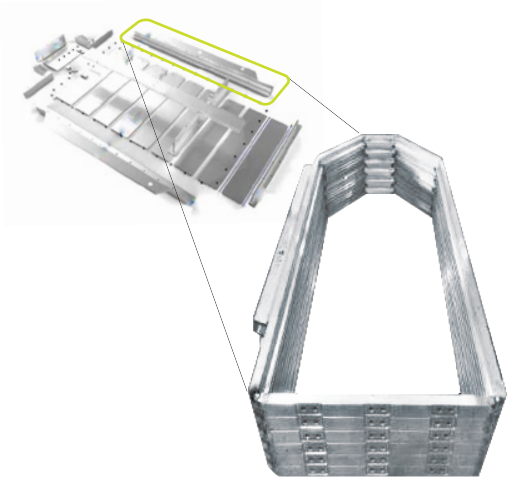
**Dual pinion**
There is no backlash by applying dual pinion structure to increase rigidity.

# Pack tray



## Workpiece

### PROFILE_2



**Material**

**Aluminum**

### Manufacturing Specialty

- Assembling machined parts of various lengths
- Mass production
- Maintain high and stable production

## Solution

### T series

High-Speed, High-Productivity Tapping Center


### DNM series

Global Standard Vertical Machining Center


### Optimal Design for the User Environment

The machine's compact design delivers greater user convenience and requires minimal floor space.

**Equipment Layout**

| Specification | Unit | T 4000 | T 4000L |
|---|---|---|---|
| Width | mm (inch) | 1600 | 2050 |
| Length | mm (inch) | 2560 | 2574 |
| Height | mm (inch) | 2324 | 2324 |
| Distance to table | mm (inch) | 799 | 799 |

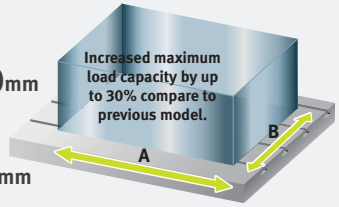

### Wide machining area

**Table size (A x B)**

DNM 4500/L
**1000{1050} x450mm**
(39.4{41.3} x 17.7 inch)

DNM 5700/L
**1300{1050} x570mm**
(51.2{59.1} x 21.3 inch)

DNM 6700/L/XL
**1500{1600/2200}x670mm**
(59.1{63.0/86.6} x 26.4 inch)



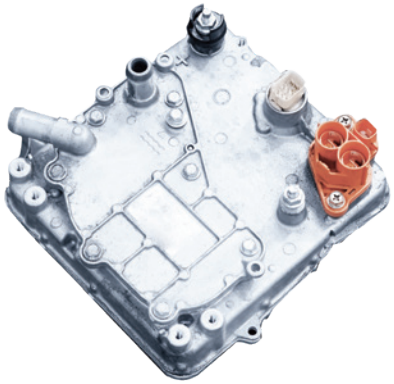

**Rapid traverse rate (X/Y/Z axis)**

DNM 4500/5700/6700/6700L
**36/36/30m/min**
(1417.3/1417.3/1181.1 ipm)

DNM 6700XL
**30/30/30m/min**
(1181.1/1181.1/1181.1 ipm)
{42/42/36(1653.5 /1653.5/1417.3 ipm)} Option

## Workpiece

### CONTROL BOX



**Material**

**Steel, Aluminum**

### Manufacturing Specialty

Light cutting

Mass production

## Solution

### DNM series

Global Standard Vertical Machining Center


### T series

High-Speed, High-Productivity Tapping Center


### Automatic tool change arm

**Tool to Tool time**
**1.2s**

**Chip to Chip* time**
**3.2s**

* The Chip-to-Chip time has been tested in accordance with Doosan's strict testing conditions, but may vary depending on the user's operating conditions.

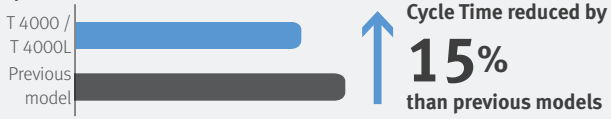
### FANUC 31i

The FANUC 31i is designed to satisfy users' demands for higher machining accuracy and ultra-fine cutting.

**Maximize productivity**

| Description | Unit | FANUC 31i |
|---|---|---|
| Rapid traverse | m/min | 48 |

**Cycle Time**




**Cycle Time reduced by**
**15%**
**than previous models**

# Extra items



## Workpiece

### ACCUMULATOR

**Material**

**Aluminum**

### Manufacturing Specialty

Mass production

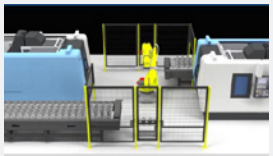
Maintain high and stable production

## Solution

### XC series

High productivity 2spindle column moving VMC


### XC Automation Solution



**Robot system** (1cell)

**1Cell configuration**
**OP#10**
XC4000-2SP (1unit)
**OP#20**
XC4000-2SP (1unit), Robot (1unit)

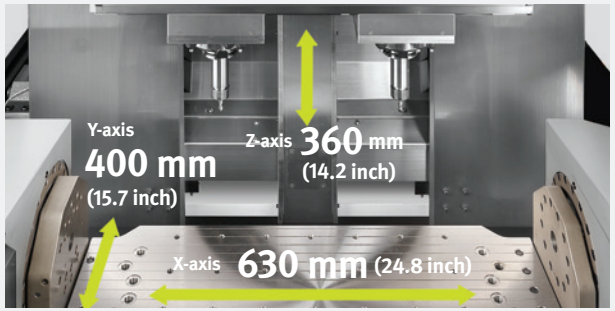
**Gantry loader system** (1cell)

**1Line configuration**
**OP#10**
XC4000-2SP (1unit)
**OP#20**
XC4000-2SP (1unit), Gantry loader (1unit)

### Axis System

To optimize durability and stiffness, dual ballscrews are included. Linear scales on XYZ axes are applied as standard. Productivity is maximized by high speed acc/dec rates on all axes.

**Axis acceleration (X,Y,Z)** **7/10/11** m/s²



# Motor



## Workpiece

### MOTOR HOUSING

**Material**

**Steel, Aluminum**

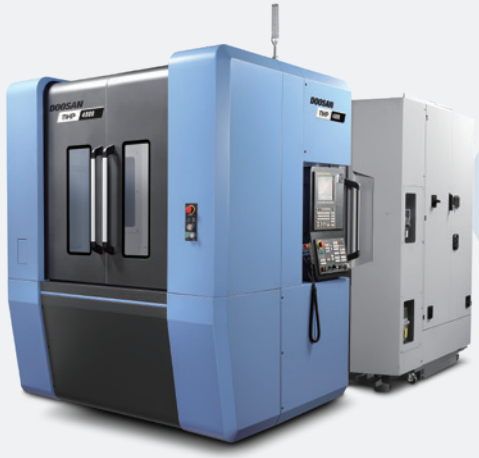
### Manufacturing Specialty

- High precision
- Optimal solution by various size of parts
- Cooperation with tooling companies

## Solution

### NHP 4000/5000 series

High productivity Horizontal Machining Center

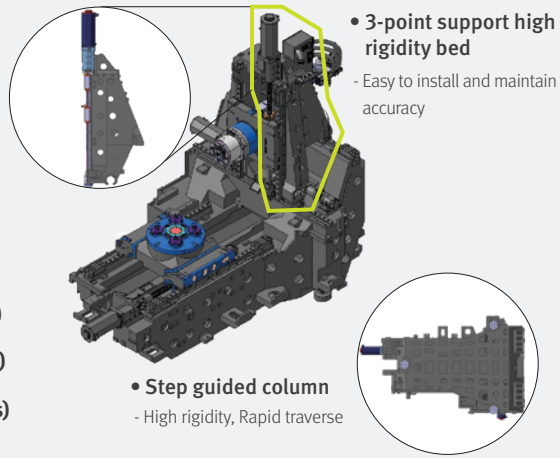


High Precision
High Productivity
Stability

### Spindle

| Max. spindle speed | Max. spindle motor power | Max. spindle motor torque |
|---|---|---|
| 15000 r/min | 30kW (40.2 Hp) | 230 N·m (169.7 ft-lbs) |
| 15000 r/min | 37kW (49.6 Hp) | 303 N·m (223.6 ft-lbs) |
| 20000 r/min | 37kW (49.6 Hp) | 221 N·m (1633.1 ft-lbs) |

### 3-point support high rigidity bed



- 3-point support high rigidity bed
  - Easy to install and maintain accuracy
- Step guided column
  - High rigidity, Rapid traverse

## Workpiece

### MOTOR HOUSING

**Material**

**Steel, Aluminum**

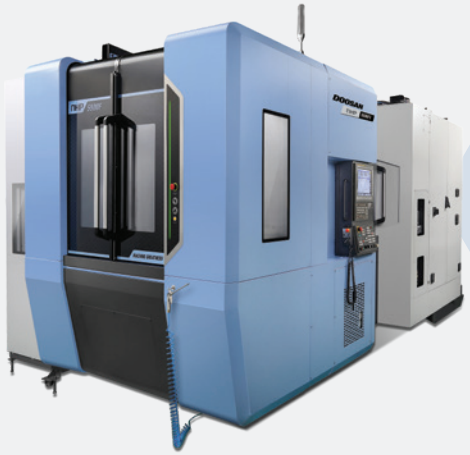
### Manufacturing Specialty

- More high Precision
- Optimal solution by various size of parts
- Cooperation with tooling companies

## Solution

### NHP 5500/ NHP 5500F

New Fine version Horizontal Machining Center



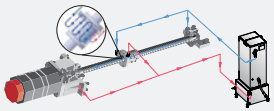
High Productivity

Finishing Solution

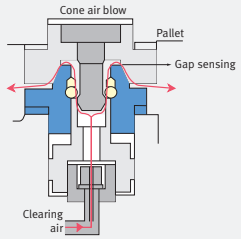
Stability

### NHP series High Precision Option

Cooling system



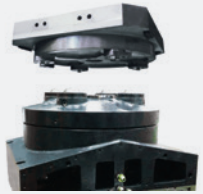
Corn air blow



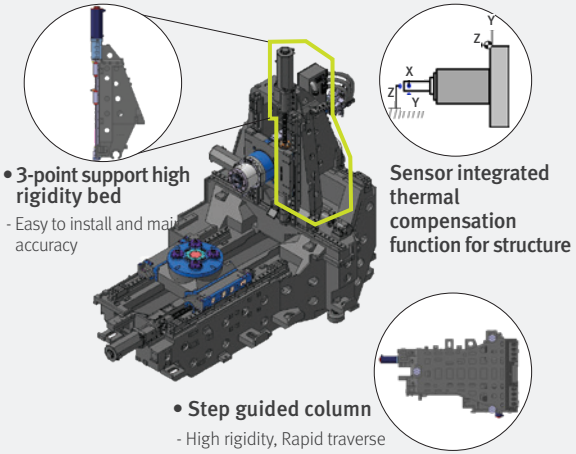

Linear scale

Coolant Chiller

Dust collector



### Basic structure for high precision



- 3-point support high rigidity bed
  - Easy to install and mai accuracy

Sensor integrated thermal compensation function for structure

- Step guided column
  - High rigidity, Rapid traverse

# Motor



## Workpiece

### MOTOR HOUSING COVER

**Material**

**Steel, Aluminum**

### Manufacturing Specialty

- Mass production
- Keep the high productivity stably

## Solution

### T series

High-Speed, High-Productivity
Tapping Center



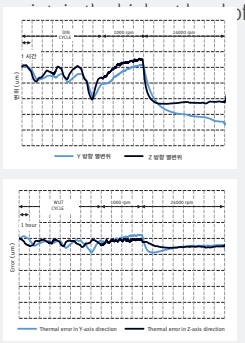
### New, High-Precision Spindle

**Max. spindle speed** **12000/24000** r/min

### Spindle Thermal Error Compensation System (standard)

Thermal error of the spindle is calculated with the spindle temperature feedback and automatically compensated to

of work accuracy.



**Before thermal error compensation**

* T 4000, 18000 r/min, In-house measurement

**After thermal error compensation***

## Workpiece

### SUPPORT RING

Material

**Aluminum**

### Manufacturing Specialty

- Light cutting
- Mass production

## Solution

### DNM series

Global Standard Vertical Machining Center

High Productivity
High Speed
Easy Operation

### PUMA V400 series

High Performance Vertical Turning Center

High Speed
Compact
High Productivity

### Wide machining area

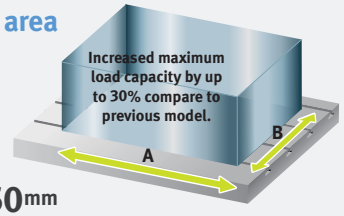



Table size (A x B)

DNM 4500/L
**1000{1050} x450mm**
(39.4{41.3} x 17.7 inch)

DNM 5700/L
**1300{1050} x570mm**
(51.2{59.1} x 21.3 inch)

DNM 6700/L/XL
**1500{1600/2200}x 670mm**
(59.1{63.0/86.6} x 26.4 inch)

Max weight on Table

DNM 4500/4500L
**600kg (1322.8 lb)**

DNM 5700/5700L
**1000kg (2204.6 lb)**

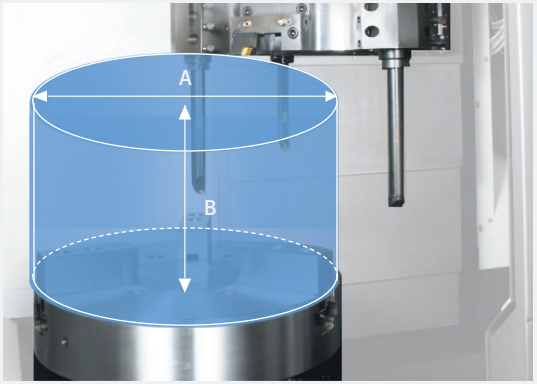
DNM 6700/6700L/6700XL
**1300kg (2866.0 lb)**

Max. turning diameter (A)

PUMA V400/ V400M
**Ø496/420 mm**
(19.53/16.54 inch)

Max. turning length (B)

PUMA V400/ V400M
**461/400 mm**
(18.15/15.75 inch)

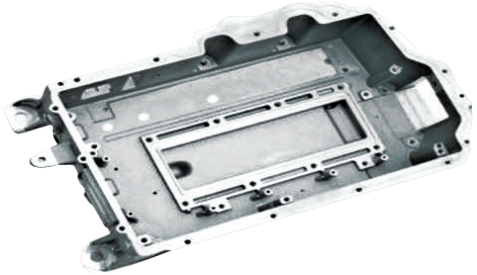


# Inverter



## Workpiece

### INVERTER CASE



**Material**

**Steel, Aluminum**

### Manufacturing Specialty

- Small size part
- Light cutting
- Optimal solution by various size of parts

## Solution

### T series

High-Speed, High-Productivity Tapping Center


### DNM series

Global Standard Vertical Machining Center


### Optimal Design for the User Environment

The machine's compact design delivers greater user convenience and requires minimal floor space.

**Equipment Layout**

| Specification | Unit | T 4000 | T 4000L |
|---|---|---|---|
| Width | mm (inch) | 1600 | 2050 |
| Length | mm (inch) | 2560 | 2574 |
| Height | mm (inch) | 2324 | 2324 |
| Distance to table | mm (inch) | 799 | 799 |


### Wide machining area

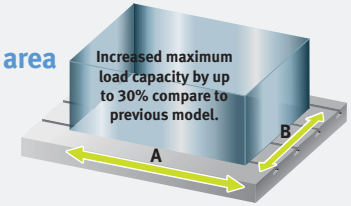



**Table size (A x B)**

DNM 4500/L
**1000**{1050} **x450**mm
(39.4{41.3} x 17.7 inch)

DNM 5700/L
**1300**{1050} **x570**mm
(51.2{59.1} x 21.3 inch)

DNM 6700/L/XL
**1500** {1600/2200}**x 670**mm
(59.1{63.0/86.6} x 26.4 inch)

**Max weight on Table**

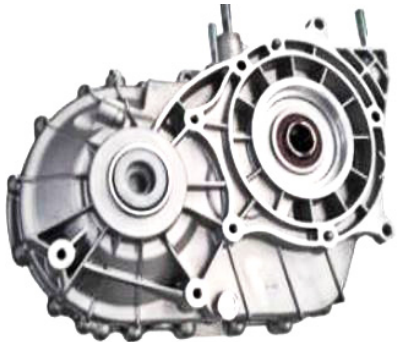
DNM 4500/4500L
**600**kg (1322.8 lb)

DNM 5700/5700L
**1000**kg (2204.6 lb)

DNM 6700/6700L/6700XL
**1300**kg (2866.0 lb)

## Workpiece

### MOTOR REDUCER HOUSING



**Material**

**Steel, Aluminum**

### Manufacturing Specialty

- HSK recommended
- Mass production
- High productivity & precision

## Solution

### DNM series

Global Standard Vertical Machining Center



### Wide machining area

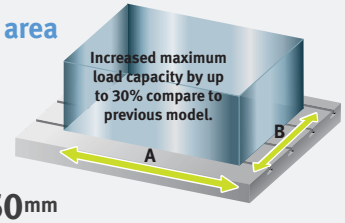



**Table size (A x B)**

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(39.4{41.3} x 17.7 inch)

DNM 5700/L
**1300**{1050} **x570**mm
(51.2{59.1} x 21.3 inch)

DNM 6700/L/XL
**1500**{1600/2200}**x 670**mm
(59.1{63.0/86.6} x 26.4 inch)

**Max weight on Table**

DNM 4500/4500L
**600**kg (1322.8 lb)

DNM 5700/5700L
**1000**kg (2204.6 lb)

DNM 6700/6700L/6700XL
**1300**kg (2866.0 lb)

### Various Spindle

**Max. spindle speed**
**8000** r/min
**12000** r/min Option
**15000** r/min Option

**Max. spindle motor power**
**18.5** kW (24.8 Hp)

**Max. spindle motor torque**
**117.8** N·m (86.9 lbf-ft)
(8000 r/min, 12000 r/min, 15000 r/min)
**286** N·m (211.1 lbf-ft) Option
(8000 r/min high torque

# Body



## Workpiece

### MEMBER

**Material**

**Aluminum**

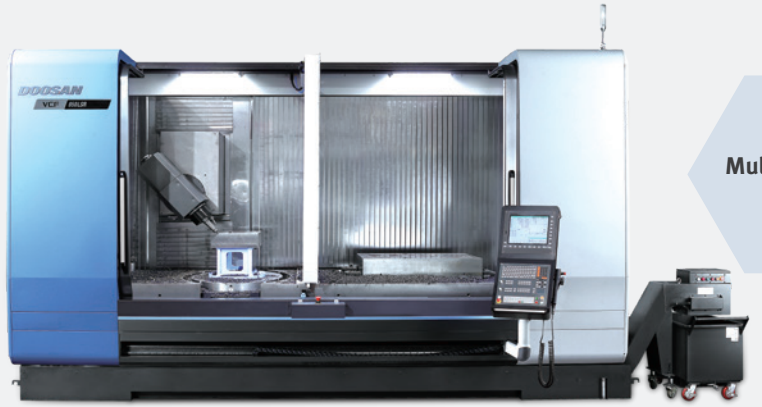
### Manufacturing Specialty

- Symmetrical designed parts
- Middle and Large size parts
- Light cutting

## Solution

### VCF 850LSR II

Multi-purpose Vertical Machining Center

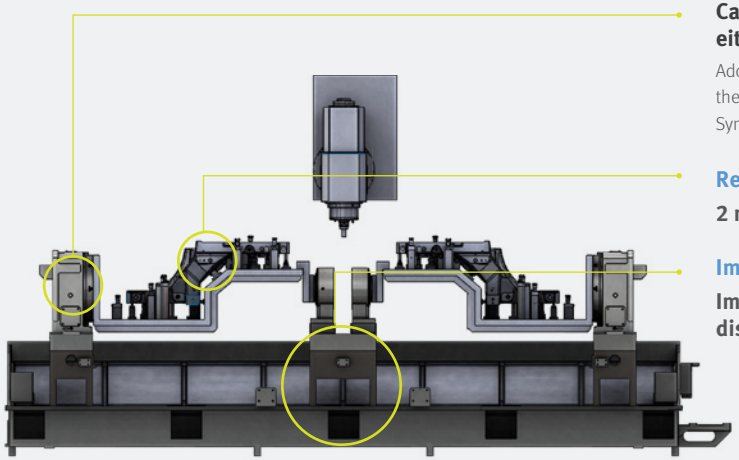



Long part machining

Multi-purpose

High Flexibility

### Dual Rotary Table Solution



**Operational flexibility**

**Capable of controlling the two A axes either simultaneously or individually**

Additional 6th Axis (Addition of an additional axis to the 5 axes : Control Otp.)
Synchro control (For sync control : Control Otp.)

**Reduced investment cost**

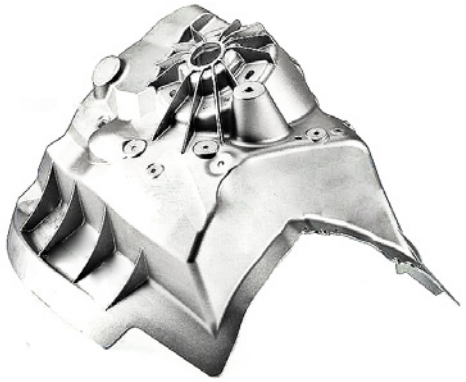
**2 machines → a single machine**

**Improved operating stability**

**Improved jig rigidity and smooth chip discharge by applying a special bed**

## Workpiece

### SHOCK TOWER



**Material**

**Aluminum**

### Manufacturing Specialty

- Complex shaped workpiece
- Light cutting
- High productivity

## Solution

### VC 630/5AX

Simultaneous 5-axis Vertical Machining Center


Simultaneous 5-axis

High accuracy

High productivity

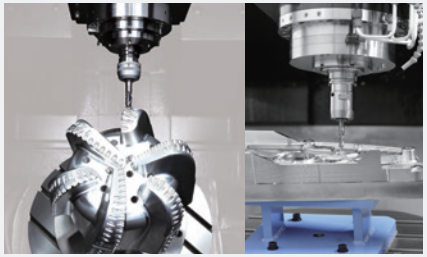
### Spindle

Built-in motor minimizes vibration and noise generated.

**Max. spindle speed**

**12000 {20000 Option} r/min**

**30000 Option r/min**

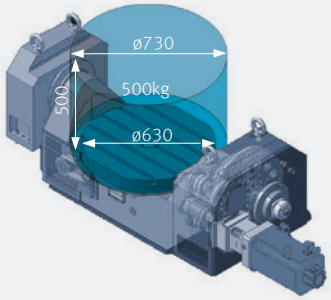


### Rotary Table

Large workpiece capacity allows a variety of parts to be machined in one set up.

**Max. Workpiece Size**

**ø730 x 500mm**
**(Ø28.7 x 19.7 inch)**




**Max. weight**

**500kg (1102.3 lb)**

**Wider Machining Area**

A wide machining area allows access to machine many features of large workpieces.

# Differential Gear



## Workpiece

### DIFF GEAR HOUSING

**Material**

**Aluminum**

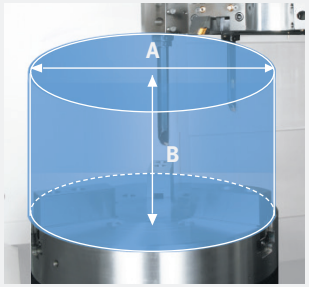
### Manufacturing Specialty

- Minimizing Cycle tile by optimization of various machining process
- Stable mass production
- 4-axis rotary table installed on VMC

## Solution

### PUMA V series

High Performance Vertical Turning Center




**Max. turning diameter (A)**

PUMA V400(P) / M

**Ø496/420 mm**

**(19.53/16.54 inch)**

**Max. turning length (B)**

PUMA V400(P) / M

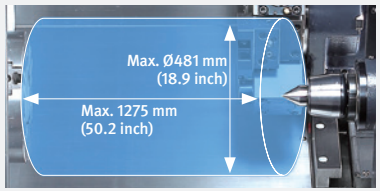
**461/400 mm**

**(18.15/15.75 inch)**

### PUMA GT series

Global standard Horizontal Turning Center

**Machining area**




| Model group (unit : mm (inch)) | Max. turning dia. (2axis/M) | Bar working dia. |
|---|---|---|
| PUMA GT2100 | 390 / 300 (15.4 / 11.8) | 65 (2.6) |
| PUMA GT2100B | | |
| PUMA GT2600 | 460 / 410 (18.1 / 16.1) | 81 (3.2) |
| PUMA GT2600L | | |
| PUMA GT2600XL | | |
| PUMA GT2600XLB | | 102 (4.0) |
| PUMA GT3100A | 481 / 376 (18.9 / 14.8) | 81 (3.2) |
| PUMA GT3100LA | | |
| PUMA GT3100 | | 102 (4.0) |
| PUMA GT3100L | | |

| Model group (unit : mm (inch)) | Max. turning length (2axis/M) |
|---|---|
| PUMA GT2100 | 562 / 513 (22.1 / 20.2) |
| PUMA GT2100B | 550 / 501 (21.7 / 19.7) |
| PUMA GT2600 | 658 / 610 (25.9 / 24.0) |
| PUMA GT2600L | 1078 / 1030 (42.4 / 40.6) |
| PUMA GT2600XL | 1603 / 1555 (63.1 / 61.2) |
| PUMA GT2600XLB | 1573 / 1525 (61.9 / 60.0) |
| PUMA GT3100A | 790/760 (31.1 / 29.9) |
| PUMA GT3100LA | 1310/1280 (51.6 / 50.4) |
| PUMA GT3100 | 755 / 725 (29.7 / 28.5) |
| PUMA GT3100L | 1275 / 1245 (50.2 / 49.0) |

### DNM series

Global Standard Vertical Machining Center

**4th-axis rotary table**

The compact high-precision, highlyrigid designed system enables vertical and horizontal use, and delivers a strong clamping force.

## Workpiece

### BEARING SUPPORT

**Material**

**Aluminum**

### Manufacturing Specialty

- Stable mass production
- Separated Gantry Loader
- Various types of machining process

## Solution

### PUMA 2100M

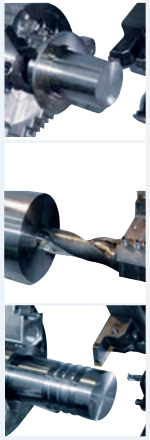
High performance horizontal turning center


High Speed
Heavy duty
High productivity

### Cutting Performance

| | Unit | PUMA 2100 BMT55P | PUMA 2600 BMT65P |
|---|---|---|---|
| **End mill** Carbon steel (SM45C) | | | |
| Chip removal rate | $cm^3$/min ($inch^3$/min) | 90 (35.43) | 105 (41.34) |
| Tool Dia. | mm (inch) | 18 (0.71) | 20 (0.79) |
| Cutting Depth | mm (inch) | 20 (0.79) | 21 (0.83) |
| Feedrate | mm/min | 250 (9.8) | 250 (9.8) |
| **Tapping** Carbon steel (SM45C) | | | |
| Rotary tool spindle speed | r/min | 240 | 240 |
| Tap Size | mm (inch) | M20 x P2.5 | M24 x P3 |
| Feedrate | mm/min (ipm) | 600 (23.6) | 600 (23.6) |
| **Face mill** Carbon steel (SM45C) | | | |
| Chip removal rate | $cm^3$/min ($inch^3$/min) | 41.9 (16.5) | 53.9 (21.2) |
| Tool Dia. | mm (inch) | 63 (2.5) | 63 (2.5) |
| Cutting Depth | mm (inch) | 3.5 (0.1) | 4.5 (0.2) |
| Feedrate | mm/min (ipm) | 190 (7.5) | 190 (7.5) |

| | Unit | PUMA 2100 BMT55P | PUMA 2600 BMT65P |
|---|---|---|---|
| **O.D turning** Carbon steel (SM45C) | | | |
| Chip removal rate | $cm^3$/min ($inch^3$/min) | 528 (207.9) | 616 (242.5) |
| Cutting Depth | mm (inch) | 4.3 (0.2) | 5.0 (0.2) |
| Feedrate | mm/min (ipm) | 0.55 (0.022) | 0.55 (0.022) |
| | Unit | PUMA 2100 | PUMA 2600 |
| **U-Drill dia. (ø63 mm (2.5 inch))** Carbon steel (SM45C) | | | |
| Chip removal rate | $cm^3$/min ($inch^3$/min) | 472 (185.8) | 630 (248.0) |
| Feedrate | mm/min (ipm) | 0.15 (0.006) | 0.2 (0.008) |
| **Grooving** Carbon steel (SM45C) | | | |
| Chip removal rate | $cm^3$/min ($inch^3$/min) | 169 (66.54) | 241 (94.9) |
| Cutting Depth | mm (inch) | 8 (0.3) | 8 (0.3) |
| Feedrate | mm/rev (ipr) | 0.14 (0.006) | 0.2 (0.008) |



# Doosan Machine Tools in the World

In an effort to provide solutions that fit each partners' unique needs, we constantly innovate our thinking, processes, and the way we do business.
These optimal solutions lay the foundation for the success of our partners, which adds value to our partners' businesses.

## Global Sales and Service Support Network

**4** Corporations

**167** Dealer Networks

**51** Technical Centers

**200** Service Post

**3** Factories

Technical Center: Sales Support, Service Support, Parts Support


### Supplying Parts
- Supplying parts without charges
- Supplying parts with charges
- Parts repair

### Field Services
- On-site services
- Installment and trials
- Scheduled maintenance/ Preventive maintenance
- Repairs with/without charges

### Technical Support
- Supporting machining technology
- Responding to technical inquiries
- Providing technical materials

### Training
- Programming / Machine operation
- Maintenance
- Application engineering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**Fire Safety Precautions** | There is a high risk or fire when using non-water-soluble cutting fluids, processing flammable materials, neglecting use coolants and modifying the machine without the consent of the manufacturer. Please check the SAFETY GUIDANCE carefully before using the machine.

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