FM linear series

Ultra-high-speed, High-precision Vertical Machining Center Equipped with Linear Motors

FM linear series
FM 200/5AX linear
FM 350/5AX linear
FM 400 linear

ver. EN 160502 SU
The FM Linear Series offers super-fast traveling and great reliability with its high-speed spindle and linear axes driven by linear motors, in addition to excellent stability in cutting operation due to the adoption of anti-vibration materials.
Stable bed and structure design
Stable cutting based on anti-vibration materials and symmetrical gantry structure.

Stable cutting based on anti-vibration materials and symmetrical gantry structure. Outstanding productivity and cutting accuracy are delivered with 40,000 rpm spindles, linear motors, and direct-drive motors.

Heidenhain controller for maximum reliability
The adoption of Heidenhain controllers optimized for high-speed processing enhances machine reliability, visibility, and display applicability.
Basic Structure

Stable cutting based on symmetrical gantry structure and anti-vibration materials (mineral casting).

Structural and Material Features

- **Gantry structure**: Horizontally-symmetrical structure suitable for high-speed, high-precision machining. Guaranteed structural stability.
- **Built with a mineral cast bed for stable performance**: The X / Y / Z linear axes are driven by linear motors to realize high speed and accuracy, as well as superior positioning and repeatability. The rotary table is equipped with a direct drive motor for rapid rotation coupled with rapid acceleration and deceleration. Thermal error is minimized by the water cooling system.

### Linear Axes Equipped with Linear Motors

The X / Y / Z linear axes are driven by linear motors to realize high speed and accuracy, as well as superior positioning and repeatability. **Up to 2G**

<table>
<thead>
<tr>
<th>Description</th>
<th>FM 200/5AX linear</th>
<th>FM 350/5AX linear</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rapid X / Y / Z</td>
<td>50 / 50 / 50 (1968.5 / 1968.5 / 1968.5)</td>
<td>80 / 80 / 80 (3149.6 / 3149.6 / 3149.6)</td>
</tr>
<tr>
<td>Acc. / Deceleration</td>
<td>14.7 / 14.7 / 14.7 [1.5G / 1.5G / 1.5G]</td>
<td>9.8 / 9.8 / 19.8 [1G / 1G / 2G]</td>
</tr>
</tbody>
</table>

### Rotary Axes Equipped with Direct Drive Motors*

The rotary table is equipped with a direct drive motor for rapid rotation coupled with rapid acceleration and deceleration. Thermal error is minimized by the water cooling system.

<table>
<thead>
<tr>
<th>Description</th>
<th>Unit</th>
<th>FM 200/5AX linear</th>
<th>FM 350/5AX linear</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rapid A / C</td>
<td>r/min</td>
<td>100 / 200</td>
<td>50 / 100</td>
</tr>
<tr>
<td>Travel A / C</td>
<td>deg</td>
<td>140 / 360</td>
<td>240 / 360</td>
</tr>
<tr>
<td>Load Capacity</td>
<td>kg (lb)</td>
<td>15 (33)</td>
<td>100 (220)</td>
</tr>
</tbody>
</table>

* For 5 axes only.
Spindle

The spindle provides incomparably high productivity and machining accuracy.

**Ultra-high-speed Spindle**

One of the highest-speed spindles in its class, the ultra-high-speed enhances productivity and machining accuracy.

**HSK-E40**

40000 r/min

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**Magazine**

The machine’s structure has been simplified with the addition of a direct-drive motor, while the operator’s convenience has been enhanced by manual magazine operation for tool storage.

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**Tool Magazine**

- **Description**
  - NO:
    - Unit: ea
    - FM 200/SAX linear: 24
    - FM 350/SAX linear: 40
  - Max tool diameter:
    - mm (inch)
    - FM 200/SAX linear: 50 (2.0)
  - Max tool length:
    - mm (inch)
    - FM 200/SAX linear: 180 (7.1)
  - Tool change time:
    - s
    - FM 200/SAX linear: 8
    - FM 350/SAX linear: 10

* FM 200/SAX model
### Standard / Optional Specifications

Diverse optional features are available for customer-specific requirements.

<table>
<thead>
<tr>
<th>NO.</th>
<th>Description</th>
<th>Features</th>
<th>FM 200/5AX linear</th>
<th>FM 350/5AX linear</th>
<th>FM 400 linear</th>
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<tbody>
<tr>
<td>1</td>
<td>Tool magazine</td>
<td>24 tools</td>
<td>●</td>
<td>X</td>
<td>X</td>
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<td>40 tools</td>
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<tr>
<td>3</td>
<td>Tool shank type</td>
<td>HSK-E40</td>
<td>●</td>
<td>●</td>
<td>●</td>
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<tr>
<td>4</td>
<td>Auto door lock</td>
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<td>●</td>
<td>●</td>
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<tr>
<td>5</td>
<td>Rotary table</td>
<td>Ø200</td>
<td>●</td>
<td>X</td>
<td>X</td>
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<td>6</td>
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<td>Ø150</td>
<td>X</td>
<td>●</td>
<td>X</td>
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<td>●</td>
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<td>9</td>
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<td>Z-axis</td>
<td>●</td>
<td>●</td>
<td>●</td>
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<td>10</td>
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<td>●</td>
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<td>12</td>
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<td>●</td>
<td>●</td>
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<td>13</td>
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<td>●</td>
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<td>○</td>
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<td>CALIBRATION TOOL_BLUM (HSK E40)</td>
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<td>○</td>
<td>○</td>
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<td>18</td>
<td>Coolant</td>
<td>FLOOD (0.7kW_0.8MPa)</td>
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<td>X</td>
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<td>●</td>
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<td>○</td>
<td>○</td>
<td>○</td>
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<td>21</td>
<td>Chip bucket</td>
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<td>○</td>
</tr>
<tr>
<td>22</td>
<td>Chip conveyor</td>
<td>Chip pan</td>
<td>●</td>
<td>●</td>
<td>●</td>
</tr>
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<td>23</td>
<td></td>
<td>Hinged type</td>
<td>X</td>
<td>○</td>
<td>○</td>
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<tr>
<td>24</td>
<td>Drum type</td>
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<td>○</td>
<td>X</td>
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<tr>
<td>25</td>
<td>Table</td>
<td>500 x 600 mm</td>
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<td>X</td>
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<td>Test bar</td>
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<td>AIR</td>
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<td>○</td>
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<td>28</td>
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<td>○</td>
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<td>○</td>
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<td>MQL</td>
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<tr>
<td>30</td>
<td>NC system</td>
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<td>●</td>
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<td>31</td>
<td></td>
<td>BELT TYPE</td>
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<td>32</td>
<td>Oil Skimmer</td>
<td>TUBE TYPE</td>
<td>X</td>
<td>○</td>
<td>○</td>
</tr>
</tbody>
</table>

**F M linear series**
**Standard / Optional Specifications**

Diverse options for enhanced work efficiency and operator convenience.

**Convenient operation panel**
The ergonomically-designed Heidenhain operation panel and 19-inch large screen enhance the operator’s convenience.

**Tool length measurement device**
The standard tool length laser measuring device secures the highest degree of accuracy even at super-high-speed operation. (The touch probe is optional.)

**Roller LMG**
The roller-type LM Guideway has been adopted to ensure excellent rigidity and accuracy of the linear travel axes.

**Linear scale (standard for all axes)**
All axes are equipped with the linear scale as a standard feature to maintain the highest degree of accuracy over many hours of operation.

**Gantry loader**
Information on detailed specifications required prior to ordering.

**OMP 400**
FM 200/SAX implementation

**Recommendations for Machine Operation**

Unlike ball-screw-type machines, a water chiller is used to cool down the linear motors and direct-drive motors. As such, the machine is sensitive to the control temperature of the chiller. Since the water chiller is controlled according to the ambient temperature, machine accuracy can be maintained and guaranteed in a constant temperature environment.

- Recommended operating conditions: Ambient temperature: 20±1.5°C, Temperature change: 0.4 °C/hr or less, ±1.5°C/24hr, Relative humidity: 20~80%
Convenient Features

Data are controlled in the folder structure; convenient communication enabled by USB devices.

Various built-in pattern cycles for a wider scope of application.

Tool length, diameter and work pieces are measured using stored tool measurement graphic cycles.

Graphic simulation

Before starting the actual cutting process, graphic process simulation of the NC program can be carried out using TEST RUN. The cutting time can be estimated.

Kinematic Opt (rotary axes center correction)

The interactively (graphically) supported fixed cycle enables easy measurement of the centers of the rotary axes.

Collision Protection System

The motion of the machine can be simulated on a 3D basis to substantially prevent mechanical interference. (Tool length is also recognized.)
External Dimensions

**FM 200/5AX linear**

Top View

[Top View Diagram]

Front View

[Front View Diagram]
External Dimensions

**FM 400 linear**

**FM 350/5AX linear**

Top View

Front View
### Table

**Table / Tool Shank**

**Unit: mm (inch)**

<table>
<thead>
<tr>
<th>Tool Shank</th>
<th>FM 200/5AX linear</th>
<th>FM 350/5AX linear</th>
<th>FM 400 linear</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>P1 LINE</strong></td>
<td><img src="image1" alt="Diagram" /></td>
<td><img src="image2" alt="Diagram" /></td>
<td><img src="image3" alt="Diagram" /></td>
</tr>
<tr>
<td><strong>P2 LINE</strong></td>
<td><img src="image4" alt="Diagram" /></td>
<td><img src="image5" alt="Diagram" /></td>
<td><img src="image6" alt="Diagram" /></td>
</tr>
<tr>
<td><strong>CENTER BUSH</strong></td>
<td><img src="image7" alt="Diagram" /></td>
<td><img src="image8" alt="Diagram" /></td>
<td><img src="image9" alt="Diagram" /></td>
</tr>
<tr>
<td><strong>Ø200 (7.9)</strong></td>
<td><img src="image10" alt="Diagram" /></td>
<td><img src="image11" alt="Diagram" /></td>
<td><img src="image12" alt="Diagram" /></td>
</tr>
<tr>
<td><strong>Ø175 (6.9)</strong></td>
<td><img src="image13" alt="Diagram" /></td>
<td><img src="image14" alt="Diagram" /></td>
<td><img src="image15" alt="Diagram" /></td>
</tr>
<tr>
<td><strong>Ø135 (5.3)</strong></td>
<td><img src="image16" alt="Diagram" /></td>
<td><img src="image17" alt="Diagram" /></td>
<td><img src="image18" alt="Diagram" /></td>
</tr>
<tr>
<td><strong>Ø95 (3.7)</strong></td>
<td><img src="image19" alt="Diagram" /></td>
<td><img src="image20" alt="Diagram" /></td>
<td><img src="image21" alt="Diagram" /></td>
</tr>
<tr>
<td><strong>12</strong></td>
<td><img src="image22" alt="Diagram" /></td>
<td><img src="image23" alt="Diagram" /></td>
<td><img src="image24" alt="Diagram" /></td>
</tr>
<tr>
<td><strong>Ø350 (13.8)</strong></td>
<td><img src="image25" alt="Diagram" /></td>
<td><img src="image26" alt="Diagram" /></td>
<td><img src="image27" alt="Diagram" /></td>
</tr>
<tr>
<td><strong>45°</strong></td>
<td><img src="image28" alt="Diagram" /></td>
<td><img src="image29" alt="Diagram" /></td>
<td><img src="image30" alt="Diagram" /></td>
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<tr>
<td><strong>P3 LINE</strong></td>
<td><img src="image31" alt="Diagram" /></td>
<td><img src="image32" alt="Diagram" /></td>
<td><img src="image33" alt="Diagram" /></td>
</tr>
<tr>
<td><strong>CENTER BUSH</strong></td>
<td><img src="image34" alt="Diagram" /></td>
<td><img src="image35" alt="Diagram" /></td>
<td><img src="image36" alt="Diagram" /></td>
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<tr>
<td><strong>Ø95 (3.7)</strong></td>
<td><img src="image37" alt="Diagram" /></td>
<td><img src="image38" alt="Diagram" /></td>
<td><img src="image39" alt="Diagram" /></td>
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<tr>
<td><strong>Ø135 (5.3)</strong></td>
<td><img src="image40" alt="Diagram" /></td>
<td><img src="image41" alt="Diagram" /></td>
<td><img src="image42" alt="Diagram" /></td>
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<tr>
<td><strong>Ø175 (6.9)</strong></td>
<td><img src="image43" alt="Diagram" /></td>
<td><img src="image44" alt="Diagram" /></td>
<td><img src="image45" alt="Diagram" /></td>
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<td><strong>Ø200 (7.9)</strong></td>
<td><img src="image46" alt="Diagram" /></td>
<td><img src="image47" alt="Diagram" /></td>
<td><img src="image48" alt="Diagram" /></td>
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<td><strong>12</strong></td>
<td><img src="image49" alt="Diagram" /></td>
<td><img src="image50" alt="Diagram" /></td>
<td><img src="image51" alt="Diagram" /></td>
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<tr>
<td><strong>Ø350 (13.8)</strong></td>
<td><img src="image52" alt="Diagram" /></td>
<td><img src="image53" alt="Diagram" /></td>
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<tr>
<td><strong>45°</strong></td>
<td><img src="image55" alt="Diagram" /></td>
<td><img src="image56" alt="Diagram" /></td>
<td><img src="image57" alt="Diagram" /></td>
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</tbody>
</table>

### Tool Shank

**Unit: mm (inch)**

**HSK E40**

<table>
<thead>
<tr>
<th>Tool Shank</th>
<th>FM 200/5AX linear</th>
<th>FM 350/5AX linear</th>
<th>FM 400 linear</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>TAPER</strong></td>
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<td><img src="image59" alt="Diagram" /></td>
<td><img src="image60" alt="Diagram" /></td>
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<tr>
<td><strong>1:10</strong></td>
<td><img src="image61" alt="Diagram" /></td>
<td><img src="image62" alt="Diagram" /></td>
<td><img src="image63" alt="Diagram" /></td>
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</tbody>
</table>
# Machine Specifications

## FM linear series

<table>
<thead>
<tr>
<th>Description</th>
<th>Unit</th>
<th>FM 200/5AX linear</th>
<th>FM 350/5AX linear</th>
<th>FM 400 linear</th>
</tr>
</thead>
<tbody>
<tr>
<td>Travel distance</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>X-axis</td>
<td>mm (inch)</td>
<td>200 (7.9)</td>
<td>400 (15.7)</td>
<td></td>
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<tr>
<td>Y-axis</td>
<td>mm (inch)</td>
<td>340 (13.4)</td>
<td>600 (23.6)</td>
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<tr>
<td>Z-axis</td>
<td>mm (inch)</td>
<td>300 (11.8)</td>
<td>350 (13.8)</td>
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</tr>
<tr>
<td>A-axis</td>
<td>deg</td>
<td>140 (-10 ~ +130)</td>
<td>240</td>
<td>-</td>
</tr>
<tr>
<td>C-axis</td>
<td>deg</td>
<td>360</td>
<td></td>
<td>-</td>
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<tr>
<td>Distance from spindle center to table top</td>
<td>mm (inch)</td>
<td>110<del>410 (4.3</del>16.1)</td>
<td>50<del>400 (2.0</del>15.7)</td>
<td>150<del>500 (5.9</del>19.7)</td>
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<tr>
<td>Distance from spindle center to column</td>
<td>mm (inch)</td>
<td>230 (9.1)</td>
<td>300 (11.8)</td>
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</tr>
<tr>
<td>Feed rate</td>
<td></td>
<td></td>
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<tr>
<td>Rapid traverse rate</td>
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<tr>
<td>X-axis</td>
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<td>50 (1968.5)</td>
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<td>Y-axis</td>
<td>m/min (rpm)</td>
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<td>A-axis</td>
<td>r/min</td>
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<td>50</td>
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<tr>
<td>C-axis</td>
<td>r/min</td>
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<td>Cutting feed rate</td>
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<tr>
<td>Table size</td>
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<td>ø 350 (ø 13.8)</td>
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<td>Tool change time (tool to tool)</td>
<td>s</td>
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<tr>
<td>Tool change time (chip to chip)</td>
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<td>13</td>
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<tr>
<td>Motor</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Spindle motor power</td>
<td>kW (Hp)</td>
<td>12.6 (16.9)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Coolant pump motor power</td>
<td>kW (Hp)</td>
<td>0.7 (0.9)</td>
<td>1.5 (2.0)</td>
<td></td>
</tr>
<tr>
<td>Power Source</td>
<td></td>
<td></td>
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<tr>
<td>Power consumption</td>
<td>kVA</td>
<td>66.4</td>
<td>88.3</td>
<td>63.5</td>
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<tr>
<td>Compressed air pressure</td>
<td>MPa (psi)</td>
<td>0.54 (78.3)</td>
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<tr>
<td>Tank Capacity</td>
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<td></td>
<td></td>
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<tr>
<td>Coolant tank capacity</td>
<td>L</td>
<td>310</td>
<td>300</td>
<td></td>
</tr>
<tr>
<td>Lubricant tank capacity</td>
<td>L</td>
<td>5</td>
<td></td>
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<tr>
<td>Tank Capacity</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Height</td>
<td>mm (inch)</td>
<td>2375 (93.5)</td>
<td>2775 (109.3)</td>
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<tr>
<td>Length</td>
<td>mm (inch)</td>
<td>2249 (88.5)</td>
<td>2585 (101.8)</td>
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</tr>
<tr>
<td>Width</td>
<td>mm (inch)</td>
<td>1972 (77.6)</td>
<td>2669 (105.1)</td>
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<tr>
<td>Weight</td>
<td>kg (lb)</td>
<td>6800 (14991.2)</td>
<td>12000 (26455.1)</td>
<td></td>
</tr>
</tbody>
</table>

**Recommended operating conditions:**
- Ambient temperature: 20 ± 1.5°C
- Temperature change: ±0.4°C/h ±1.5°C/24h
- Relative humidity: 20~80%
HEIDENHAIN
 iTNC 530

AXES CONTROL
- Controlled axes X, Y, Z, C, A axes
- Simultaneously controllable axes X, Y, Z, C, A
Positioning / Linear interpolation 5 axes
Circular interpolation 2 axes
Helical interpolation 5 axes
- Feedrate override 0 - 150 %
- Least command increment 0.0001 mm (0.0001 inch)
- Least input increment 0.0001 mm (0.0001 inch)
- Maximum commandable value ±99999.999 mm (±3937 inch)
- Pulse handle feed Portable manual pulse generator
Machine Model : FM400 linear / FM350 / SAK linear
Portable manual pulse generator
Linear / non-linear axis error, backlash
Reversal spikes during circular movement
Offset, thermal expansion, stiction, sliding friction

SPINDLE FUNCTION
- Spindle orientation
- Spindle speed command 55 digits
- Spindle speed override 0 - 150 %

TOOL FUNCTION
- 3-dimensional tool compensation
- Number of tool offsets 999 ea
- Tool length compensation
- Tool management (tool table)
- Tool management (tool table) Tool numbers and names
- Tool management (tool table) Tool length L and tool radius R
- Tool management (tool table) Tool life management & replacement tool
- Tool number command
- Tool radius compensation

PROGRAMMING & EDITING FUNCTION
- Background editing
- Heidenhain conversational format programming
- Program memory Hard disk with 266GB for NC programs
- 3-D touch probe application
  Touch probe functions for compensating workpiece misalignment
  Touch probe functions for setting data
  Touch probe functions for automatic workpiece measurement
- Block processing time 0.5 m [s]
- Contour elements
  Straight line, chamfer, circular arc,
  circle center, circle radius
  Corner rounding, tangentially connecting circle, B spline
- Coordinate transformation
  Coordinate shift, coordinate rotation

OPTIONAL SPECIFICATIONS
- Controlled axes Max. 12 axes in total
- Digitizing with 3-D triggering touch probe
- Digitizing with 3-D measuring touch probe

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Responding to Customers Anytime, Anywhere

Global Service Support Network

<table>
<thead>
<tr>
<th>Corporations</th>
<th>Dealer Networks</th>
<th>Technical Centers</th>
<th>Factories</th>
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<tbody>
<tr>
<td>5</td>
<td>122</td>
<td>18</td>
<td>3</td>
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</tbody>
</table>

Technical Center: Sales Support, Service Support, Parts Support
Doosan Machine Tools’ Global Network, Responding to Customer’s Needs nearby, Anytime, Anywhere

Doosan machine tools provides a system-based professional support service before and after the machine tool sale by responding quickly and efficiently to customers’ demands. By supplying spare parts, product training, field service and technical support, we can provide top class support to our customers around the world.

Customer Support Service

We help customers to achieve success by providing a variety of professional services from pre-sales consultancy to post-sales support.

Supplying Parts

- Supplying a wide range of original Doosan spare parts
- Parts repair service

Field Services

- On site service
- Machine installation and testing
- Scheduled preventive maintenance
- Machine repair

Technical Support

- Supports machining methods and technology
- Responds to technical queries
- Provides technical consultancy

Training

- Programming / machine setup and operation
- Electrical and mechanical maintenance
- Applications engineering

Domestic Service Support Network

Integrated Support Centers 2
Sales Branch Offices 7
Post-Sales Service Centers 6
Designated Repair Service Centers 31

CHINA (Shanghai)
CHINA (Yantai)
JAPAN
Head Office Changwon Factory
INDIA

CHINA (Yantai)
### FM linear series

<table>
<thead>
<tr>
<th>Description</th>
<th>UNIT</th>
<th>FM 200/5AX linear</th>
<th>FM 350/5AX linear</th>
<th>FM 400 linear</th>
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<tbody>
<tr>
<td>Max. spindle speed</td>
<td>r/min</td>
<td>40000</td>
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</tr>
<tr>
<td>Motor power</td>
<td>kW</td>
<td>12.6 (16.9)</td>
<td></td>
<td></td>
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<tr>
<td>Tool taper</td>
<td></td>
<td></td>
<td>HSK E 40</td>
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<tr>
<td>Travel distance (X / Y / Z)</td>
<td>mm (inch)</td>
<td>200 / 340 / 300 (7.9 / 13.4 / 11.8)</td>
<td>400 / 600 / 350 (15.7 / 23.6 / 13.8)</td>
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<tr>
<td>Tool storage capacity</td>
<td>ea</td>
<td>24</td>
<td>40</td>
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</tr>
<tr>
<td>Table size</td>
<td>mm (inch)</td>
<td>Ø 200 (Ø 7.9)</td>
<td>Ø 350 (Ø 13.8)</td>
<td>500 x 600 (19.7 x 23.6)</td>
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<tr>
<td>Table tilting / rotation angle (A / C)</td>
<td>deg</td>
<td>140 / 360</td>
<td>240 / 360</td>
<td>-</td>
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<tr>
<td>NC system</td>
<td></td>
<td></td>
<td>HEIDENHAIN</td>
<td></td>
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</tbody>
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**Doosan Machine Tools**

http://www.doosanmachinetools.com  
www.facebook.com/doosanmachinetools

*Optimal Solutions for the Future*

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