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Gantry type
5-Axis Vertical
Machining Center
AXILE /ˈæksaɪl/, stands for “agile”

Agility is the best word to define the identity of AXILE. Motor agility is the ability to move quickly and precisely, which is the essence of high-speed machining. Mental agility is the ability to think and understand quickly, to be smart in other words.

AXILE provides agile smart machining.

Highly sophisticated part manufacturers face the same problems everywhere: lower selling prices every day, higher costs and a shortage of specialized labour. AXILE propose highly productive machines based on high-speed and 5-axis technologies at very competitive prices.

The new AXILE line is built with standard high-tech design and components from world-class suppliers to ensure the best quality and reliability. AXILE patented SMT technology attains reaching high levels of accuracy and embrases Industrie 4.0 technologies, reliability is upgraded, maintenance costs minimized and downtime avoided.

AXILE products are proudly designed and manufactured at Buffalo’s facilities, one of the leading technology manufacturers in Taichung (Taiwan). Taichung is the world’s biggest cluster of machine tool builders, thanks to abundant specialized workforce and a component supply chain far more efficient than in any other country. The rationalized range of 3X and 5X high-speed VMC’s covers only the most requested sizes to reach economies of scale to maintain reasonable market prices.

AXILE is conceived to conquer the premium market of 3X and 5X high-speed vertical machining centers. Such markets will grow and AXILE will be the real Asian big player amongst its European competitors.

AXILE, motor and mental agility at a competitive price.
Design concept

The structure

1. Spindle moved by 3 linear axes
   - No rotary axes between the tool and the machine body, for better machining rigidity.

2. Perfect U-shape closed-gantry design
   - Same stability in all travels of X and Y axes
   - Excellent accessibility to working area

3. Table moved by swivelling-rotary axes
   - Best accuracy with fixed relative position between 2 rotary axes.

“Gantry:
best dynamics, accuracy and ergonomics for 5X machines”

4. Massive gantry sliding on 2 symmetric synchronized axes
   - Best serve response to any milling forces

5. All body made of high-quality casting
   - Optimal damping of machining vibrations
   - Homogeneous thermal behaviour

6. Integrated chip disposal channel directly under the table
   - Quick evacuation of chips for high chip volume machining

7. 11

8. ""
**Agility**

### Linear axes

<table>
<thead>
<tr>
<th>Feature</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Direct driven servomotors (no belts/gears)</td>
<td>Best dynamic and minimal elasticity in the driving system</td>
</tr>
<tr>
<td>Double symmetric and synchronized axes (Y1, Y2)</td>
<td>Best dynamic for the gantry no matter the position of the machining force</td>
</tr>
<tr>
<td>Linear scales with 0.001 µm resolution in X, Y1, Y2 and Z axes</td>
<td>Ensures optimal synchronization in Y1 and Y2 axes, and best accuracy for all axes</td>
</tr>
<tr>
<td>Double roller type linear guideways</td>
<td>Best high-feed movement and vibration damping</td>
</tr>
<tr>
<td>Double pre-loaded double-nut ballscrews</td>
<td>Minimized back-lash allowing high-feed movements</td>
</tr>
</tbody>
</table>

### Swivelling-rotary axes

<table>
<thead>
<tr>
<th>Feature</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Integrated and ready-to-use hydraulic and pneumatic ports</td>
<td>Simplifying parts clamping process</td>
</tr>
<tr>
<td>Torque motor-driven rotary axis (C)</td>
<td>Highest dynamics</td>
</tr>
<tr>
<td>Torque motor-driven swivelling axis (A)</td>
<td>Highest accuracy</td>
</tr>
<tr>
<td>Brakes in every shaft</td>
<td>High-repeatability in 4+1x operation when using the brakes</td>
</tr>
<tr>
<td>High-resolution, direct absolute rotary measuring system</td>
<td>Zero-backlash and high accuracy</td>
</tr>
</tbody>
</table>
Smart Machining Technology (SMT)

High-speed and 5-axis technologies pursue lower manufacturing costs for complex products, but they also represent some serious challenges for accuracy and reliability. This is why Buffalo dedicated almost a decade to research the necessary knowledge to dominate such technologies. We call them SMT.

- **Tool-tip Positioning Control (TPC)**
  - Direct displacement measure and real-time monitoring and compensation technology

- **Metal Removal Rate Optimization (MRRO)**
  - Maximal metal removal rate, cutting force and chatter-free machining

- **Axial Accuracy Control (AAC)**
  - A machine thermo monitoring and compensation technology

- **Spindle Vibration Supervision (SVS)**
  - Spindle vibration monitoring and real-time control technology

Axile Reliability Technology (ART)

Axile also embraces Industrie 4.0 and is developing its own patented technologies called ART. The main components of the machine will be equipped with sensors that collect relevant data like vibration, acceleration or temperature, to monitor working conditions in real-time.

- **Reliability Maintenance (RM)**
  - Predictive maintenance

- **Energy Management (EM)**
  - ISO14955 (Eco-friendly)

- **Manufacturing Process (MP)**
  - Process & production planning

SMT and ART technologies are applied to predict Mean Time Between Failure (MTBF)

Reliability Maintenance (RM)

- Predictive maintenance

Energy Management (EM)

- ISO14955 (Eco-friendly)

Manufacturing Process (MP)

- Process & production planning

**How to real-time monitor the spindle vibration to maintain the machining accuracy under long time operation?**

**THREE LEVELS FOR SPINDLE VIBRATION MONITORING**

- **LEVEL 1** shows the warning message to notify the operator.
- **LEVEL 2** shows the error message and reduces spindle speed and feed rate.
- **LEVEL 3** automatically shuts down the machine to prevent crash.

**HIGH FINISH QUALITY**

- spindle life time 
- longer life time 
- easier maintenance 
- easy for maintenance 
- reduces spindle vibration and chatter vibration 
-0.5% improvement in tool life under chatter 
-0.3% improvement in tool life under chatter 
-0.1% improvement in tool life under chatter 
-0.05% improvement in tool life under chatter 
-0.01% improvement in tool life under chatter 

**LONGER LIFE TIME**

- spindle life time 
- longer life time 
- easier maintenance 
- easy for maintenance 
- reduces spindle vibration and chatter vibration 
-0.5% improvement in tool life under chatter 
-0.3% improvement in tool life under chatter 
-0.1% improvement in tool life under chatter 
-0.05% improvement in tool life under chatter 
-0.01% improvement in tool life under chatter 

**EASY FOR MAINTENANCE**

- spindle life time 
- longer life time 
- easier maintenance 
- easy for maintenance 
- reduces spindle vibration and chatter vibration 
-0.5% improvement in tool life under chatter 
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**AMPLIFIER**

- vibration sensor 
- MPU 
- memory 
- CNC 
- compensation command 

**VIBRATION SENSOR**

- detection of vibration 
- signal processing 
- transmission of data 
- analysis of data 
- visualization of data 
- feedback to machine 
- adjustment of parameters 
- optimization of performance 

**PROCESSOR**

- data processing 
- decision making 
- control of operations 
- optimization of process 
- adjustment of settings 
- feedback to machine 
- adjustment of parameters 
- optimization of performance

**MONITOR**

- display of data 
- visualization of condition 
- monitoring of status 
- alert of anomalies 
- prediction of failures 
- maintenance of system 
- optimization of performance 

**ANALYSIS & APPLICATION**

- analysis of data 
- interpretation of results 
- optimization of parameters 
- adjustment of settings 
- feedback to machine 
- adjustment of parameters 
- optimization of performance 

**FIELD DATA ACQUISITION**

- collection of data 
- transmission of information 
- monitoring of conditions 
- alert of anomalies 
- prediction of failures 
- maintenance of system 
- optimization of performance

**CLOUD**

- storage of data 
- processing of data 
- analysis of data 
- interpretation of results 
- optimization of parameters 
- adjustment of settings 
- feedback to machine 
- adjustment of parameters 
- optimization of performance
**Accuracy**

### Linear axes accuracy

| Ball screw’s thermal growth | 0.001µm resolution absolute linear scales in ALL axes |

#### Spindle thermal growth at high-speed

- **TPC**

#### Angular deformation in machine body causing linear errors

- **AAC**

#### Axial accuracy control

#### Tool-tip positioning control

### Rotary axes accuracy

- Elasticity and backlash of driving system
- Direct-driven torque motors with no back-lash

#### Angular error is multiplied by the distance from rotary axis to machining point

- +/- 5° accuracy absolute rotary scale feedback

### Thermal control

- Heat generated by spindle and torque motors
- Spindles and torque motors are cooled with a water chiller close-circuit and a cooling unit

### Linear-rotary axes relative positioning

- The swivelling-rotary table might shift its relative position to the 3 linear axes by many reasons generating an increasing error in the part
- CNC embedded compensating functions like Kinematics (Heidenhain), Kinematic chain (Siemens) and Tilted working plane indexing (Fanuc)

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**The Cornerstone of 5-Axis machining**
**Spindle**

High-performance built-in spindle selection

- **15,000 rpm**
- Double coil synchronous motor
- 130/187 Nm S1/S6-40%
- 27/39 kW S1/S6-40%
- HSK A63

- **20,000 rpm**
- Double coil synchronous motor
- 86/130 Nm S1/S6-40%
- 25/35 kW S1/S6-40%
- HSK A63

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**Chip management**

Flushing chips away

- Chip wash down
- Chip conveyor
- Air coolant at spindle nose
- Coolant through spindle
- Air flushing
- Coolant flushing

- High-quality stainless steel work area
- Long-lasting clean operation
- Sharp walls and no-corner design
- Easier to flush away chips by shower
**Ergonomics**

**Accessibility to work area**

- Large front door opening: Comfortable access to work area for workpiece preparation and supervision
- Short distance from operator to table: Ergonomic loading and unloading of small parts
- Automatic roof to open ceiling working area: Easy loading and unloading of heavy and bulky workpieces by overhead crane

**Automatic roof for overhead crane loading and unloading**

- Roof closed
- Automatic sliding of roof

**Tool management**

**Easier tooling management and maintenance**

"Travel arm type magazine with 60 or 120 tools capacity"

| 1 level (60 tools) or 2 level (120 tools) magazine are selectable within the same machine layout | Unmanned operation with automation, sister tools and complex parts can be machined with no worries on tool magazine capacity |
| Vertical tool magazine and arm-type automatic tool change | Next tool preparation is executed during automatic machining operation for time saving |
| Tool change is fast and non-cutting time is reduced |
| Tools are accessible from the front-left side of the machine and stored in vertically |
| Tools can be easily changed during automatic operation in the same area for machining supervision, CNC panel and workpiece loading and unloading |
| Smart tool: interface panel is used to select the tool. When finished, the system checks whether all tool HSK A-63 holders are in the right position |
| Avoid human failures when automatically change tool to spindle, protecting spindle and reducing down-time |

- Additional features:
  - Vertical tool magazine and arm-type automatic tool change
  - Travel arm type magazine
  - 60 or 120 tools capacity

1 level (60 tools) or 2 level (120 tools) magazine are selectable within the same machine layout.
Automation

Prepared for 24/7 unmanned operation

Flexible automation from back side of machine

Automation through the back side of the working area

Front area is always free for the operator for supervision and manual loading-unloading

Control unit

A controller for every user

Heidenhain iTNC530 HSCI
- Kinematics
- Dynamic Collision Monitoring
- Tool Center Point Management
- Tilted the Working Plane

Heidenhain TNC640
- Kinematics
- Dynamic Collision Monitoring
- Tool Center Point Management
- Tilted the Working Plane

Siemens 840D sl
- Kinematic chain
- Collision Avoidance
- 5-axis transformation with tool orientation
- Swivel the Coordinate System

Fanuc 31iMB5
- 3D Interference Check
- High Speed Smooth TCP
- Tilted Working Plane indexing

Siemens 840D sl

Fanuc 31iMB5
Standard & optional equipment

Standard details of a premium machine

All necessary consumables are located together in the back of the machine. Easier maintenance routine for operator.

Integrated and ready-to-use 8 hydraulic or pneumatic ports. Clamping and unclamping functions by softkeys in the control panel and/or by M-Function. Simplifies 5X workpiece clamping.


Chain-type chip conveyor with chip bucket, oil skimmer and built-in 20 bar through spindle coolant pump are standard equipments. They can be positioned either side of the machine for layout customization.

Customize the machine to your needs

Automatic workpiece measurement (with probe, receiver and reference ball)

Automatic compensation of the linear-rotary axis relative positioning: Kinematics (Heidenhain), Kinematic chain (Siemens) and Tilted working plane indexing (Fanuc)

For accurate workpiece positioning or in-process measuring of some machining features.

2 versions: U-type embedded in the table (for highest accuracy) or wall-to-wall type with protection gate (for best protection). Laser tool measurement. This option is used for:

- For accurate tool measurement in length, radius and shape
- For in-process tool measurement at working conditions (spindle running at thermal stable conditions)

Separate type cooling unit including:
- Cartridge filter
- Paper filter
- Through spindle 20 bar centrifugal pump or ...
- Through spindle 70 bar screw type pump with stepless programmable pressure
- Oil skimmer
- Coolant chiller

Recommended for high aluminum or cast iron material cutting.

Spin window

For easier view of working area when huge amount of coolant and chips are produced.
Layout and workspace

Interference

Maximum workspace
Technical data

### Basic parameters

<table>
<thead>
<tr>
<th>Linear Axes</th>
<th>mm</th>
<th>Linear Axes</th>
<th>Rollers</th>
</tr>
</thead>
<tbody>
<tr>
<td>X travel (carriage left and right)</td>
<td>650</td>
<td>Linear guideways size X/Y/Z</td>
<td>45/45/45</td>
</tr>
<tr>
<td>Y travel (gantry back and forth)</td>
<td>750</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Z travel (headstock up and down)</td>
<td>500</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Max feedrate X/Y/Z m/min</td>
<td>36</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Workpiece and Table</th>
<th>mm</th>
<th>Workpiece and Table</th>
<th>kg</th>
</tr>
</thead>
<tbody>
<tr>
<td>Max workpiece dia/height</td>
<td>600</td>
<td>Max workpiece dia/height</td>
<td>500</td>
</tr>
<tr>
<td>Table size (diameter)</td>
<td>600</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Max table load</td>
<td>500</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Rotary Axes</th>
<th>deg</th>
<th>Rotary Axes</th>
<th>rpm</th>
</tr>
</thead>
<tbody>
<tr>
<td>A range (swivelling)</td>
<td>+/- 120</td>
<td></td>
<td></td>
</tr>
<tr>
<td>C (rotary)</td>
<td>360 (unlimited)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Max swivelling (A) speed</td>
<td>rpm</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Max rotary (C) speed</td>
<td>rpm</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Spindle 15,000rpm</th>
<th>rpm</th>
</tr>
</thead>
<tbody>
<tr>
<td>Spindle taper</td>
<td>HSK A63</td>
</tr>
<tr>
<td>Max Speed</td>
<td>15000</td>
</tr>
<tr>
<td>Power S1/56–40%</td>
<td>kW</td>
</tr>
<tr>
<td>Torque S1/56–40%</td>
<td>Nm</td>
</tr>
<tr>
<td>Spindle 20,000rpm</td>
<td>rpm</td>
</tr>
<tr>
<td>Spindle taper</td>
<td>HSK A63</td>
</tr>
<tr>
<td>Max Speed</td>
<td>20000</td>
</tr>
<tr>
<td>Power S1/56–40%</td>
<td>kW</td>
</tr>
<tr>
<td>Torque S1/56–40%</td>
<td>Nm</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Tool Changer</th>
<th>rpm</th>
</tr>
</thead>
<tbody>
<tr>
<td>Magazine positions</td>
<td>60/96/120</td>
</tr>
<tr>
<td>Maximum length</td>
<td>300</td>
</tr>
<tr>
<td>Maximum tool diameter (with adjacent pot empty)</td>
<td>75 (125)</td>
</tr>
<tr>
<td>Maximum tool weight</td>
<td>kg</td>
</tr>
</tbody>
</table>

### Construction details

#### Linear Axes
- Linear guideways type: Rollers
- Linear guideways size X/Y/Z: 45/45/45
- Distance between X/Y/Z axes: 500/1110
- Ballscrew type: Ball
- Ballscrew diameter/pitch: 40/12
- X axis motor power/torque: kW/Nm 5/11.7
- Y axis motor power/torque (x2): kW/Nm 5/21.6 (x2)
- Z axis motor power/torque: kW/Nm 6/26.1

#### Workpiece and Table
- Number of hydraulic ports: 3
- Working pressure of hydraulic ports: bar 80
- Number of pneumatic ports: 1
- Working pressure of pneumatic port: bar 6

#### Rotary Axes
- Driving system in swivelling (A) axis: Torque motor
- Driving system in swivelling (C) axis: Torque motor
- Power and torque of swivelling (A) axis: kW/Nm 9.8/1040
- Power and torque of rotary (C) axis: kW/Nm 8.4/401
- Brake type of swivelling (A) axis: Hydraulic
- Braking torque of swivelling (A) axis: Nm 3200
- Brake type of rotary (C) axis: Hydraulic
- Braking torque of rotary (C) axis: Nm 2000

#### Spindle 15,000rpm
- Motor type: Synchronous
- Bearing type front/rear: Angular ball
- Bearing cooling and lubrication: Oil/Air

#### Spindle 20,000rpm
- Motor type: Synchronous
- Bearing type front/rear: Angular ball
- Bearing cooling and lubrication: Oil/Air

#### Tool Changer
- Change type: Arm
- Magazine type: OVC 1
- Carrousel driving system: Servomotor

#### Measuring Feedback
- Linear axes type: Linear scales
- Linear axes resolution: µm 0.001
- Rotary axes type: Rotary scale
- Rotary axes accuracy: +/- 3" in

#### External Coolant Supply
- External nozzles coolant supply (number) pressure: bar (4x) 3
- External nozzles coolant supply (number) pressure: bar (2x) 6
- Tank capacity: L 1500

#### Spindle Through Coolant Supply
- High pressure pump: bar 20
- Filter type: Cartridge
- Spindle Through Coolant Supply with separate tank (optional)
- High pressure pump: bar 70
- High pressure pump with stepless programable pressure: bar 0 - 70 stepless
- Filter type: Cartridge and oil skimmer

#### Additional Features
- Coolant chiller and oil skimmer