High Speed, High Precision and High Efficiency Nano Control Servo

FANUC AC SERVO MOTOR αi series
FANUC AC SPINDLE MOTOR αi series
FANUC SERVO AMPLIFIER αi series
High Speed, High Efficiency Nano Control Servo

**FANUC** AC SERVO MOTOR \( \alpha_i \) series

**FANUC** AC SPINDLE MOTOR \( \alpha_i \) series

**FANUC** SERVO AMPLIFIER \( \alpha_i \) series

\( \alpha_i \) series SERVO is high speed, high precision and high efficiency servo system to make machine tools high speed and high precision, compact and energy saving.

### Nano Control

- Servo motor with ultra smooth rotation
- Super high resolution Pulseencoder with 16,000,000/rev.
- Servo amplifier with high precision current detector
- High speed and high precision with SERVO HRV Control

### High Speed, High Efficiency

- High speed and high acceleration spindle motor by winding switching control
- Quick acceleration and high response with SPINDLE HRV Control
Compact and Reduced Wiring

- Servo and spindle motor with shorter length
- Compact and space saving servo amplifier

Enhanced Maintenance

- Quick maintenance realized by ID and motor thermal information
- Connectors for Amplifier power connection

Best fit selectable according to application

- For various machine tools such as machining center, lathe, etc.
- Smooth rotation and quick acceleration
  - FANUC AC SERVO MOTOR αi series
- High power at high speed
  - FANUC AC SPINDLE MOTOR αi series
- Compact and energy saving
  - FANUC SERVO AMPLIFIER αi series
- Quick and smart tuning for Servo and Spindle
  - FANUC SERVO GUIDE

Energy Saving Servo System

- Farther advanced energy saving servo system as a succession to α series which won a prize of 1999 MITI Award for Energy Saving Equipment
- FANUC Large Servo Motor αi series won a prize of 2003 Chief of Agency for Natural Resources and Energy Award for Energy Saving Equipment

Conformance to Safety Standards (EN, UL/CSA)

- Conform to UL/CSA standard for North America, and Safety standards and EMC standards required for complying to CE Marking of machines shipped to European market

200V and 400V Input

- Line-up with both 200V input and 400V input
- Expansion of input voltage to AC480V
Compact, Reduced Wiring and Easy Maintenance
Advanced Technology on Hardware Configuration

FANUC AC SERVO MOTOR
αiS series/αiF series

FANUC AC SPINDLE MOTOR
αi series/αiL series
αiL series/αiIL series

FANUC SERVO AMPLIFIER
αiPS series/αiSP series/αiSV series

FANUC BUILT-IN SPINDLE MOTOR
Bi series/BiS series

FANUC SERIAL
Servo Bus (FSSB)

Optical fiber cable

FANUC Linear Motor
LiS series

FANUC SYNCHRONOUS
BUILT-IN SERVO MOTOR
DiS series

FANUC I/O Link

FANUC SERVO AMPLIFIER
βIS series (I/O Link Option)

FANUC AC SERVO MOTOR
βIS series

*1) “α” of αiS means “Strong motor with neodymium magnets”, “F” of αiF means “Motor with Ferrite magnets”.


*3) “SV” of αiSV means “Servo”, “SP” of αiSP means “Spindle”, and “PS” of αiPS means “Power Supply”.

 LCD display incorporated CNC

I/O module mounted for power magnetic cabinet

Machine operator's panel
Servo Motor
Smooth Rotation and Quick Acceleration

**FANUC AC SERVO MOTOR αiS series/αiF series**

**Ultra smooth rotation and quick acceleration AC SERVO MOTOR suited to axis feed in machine tools**

- **Compact size**
  New structure design makes axial length of the motor shorter, contribute to downsizing of machine tools.

- **Intelligent Servo Motor**
  αi series Servo Motor has ID information of the motor and the Pulse coder, contribute to quick maintenance.

- **Line-up with both 200V input and 400V input**
  Various models with both 200V input and 400V input are available. Flexible selection is possible according to the input voltage of the delivery area.

**Large Servo Motor**

**Large Servo Motor suited to electric drive of large industrial machines**

- **Suited to electric drive of large industrial machines**
  Suited to electric drive of as press machines, injection molding machines, etc.

- **Large torque and large output**
  Large torque up to 3000Nm and large output up to 220kW are available.

- **Technologies for large output**
  Further output torque is enabled by “Multi drive with standard servo amplifiers” and driving one axis by “Multi motors drive technology”.

**High Speed Servo Motor for Live Tool**

**AC SERVO MOTOR suited to live tool axis in machine tools**

- **Compact, high cost-performance**
  Compact, high cost-performance servo motor. The motors are suited to live tool axis in compact machine tools.

- **High speed**
  Maximum speed is 6000min⁻¹

- **Driven by standard servo amplifier**
  The motors are driven by standard servo amplifier. High cost-performance servo system is achieved using 2-axes or 3-axes servo amplifier.
Spindle Motor
High Power at High Speed

High performance AC SPINDLE MOTOR with high power at high speed suited to spindles in machine tools

- **High power and high acceleration**
  The motors have constant power up to high speed and can be accelerated quickly, by optimum winding designing and effective cooling structure.

- **Increased torque at low speed range**
  Higher spindle torque available by increased torque at low speed range.

- **Line-up with both 200V input and 400V input**
  Various models with both 200V input and 400V input are available. Flexible selection is possible according to the input voltage of the delivery area.

Large Spindle Motor

AC SPINDLE MOTOR suited to spindle of large size machine tools

- **Suited to spindle of large size machine tools**
  Suited to spindle of large size vertical lathes, large bridge type M/Cs, large M/Cs etc.

- **Large output and large torque**
  Large output up to 200kW and large torque up to 2000Nm are available.

- **Technologies for large output**
  Further output is enabled by “Multi drive with standard servo amplifiers” and driving one axis by “Multi motors drive technology”.

Coolant Through Spindle Motor

AC SPINDLE MOTOR for direct connection with spindle of machining center

- **Center-through-coolant**
  Center-through-coolant is available by direct connection with spindle of machining center. Air cooled αIT series and oil cooled αIL series are available.

- **High mechanical precision and low vibration**
  Suited to direct connecting by high mechanical precision and low vibration (V3).

- **High acceleration**
  Acc./Dec. time is much reduced by high power.
Servo Amplifier
Compact and Energy Saving

FANUC SERVO AMPLIFIER αiSV series / αiSP series / αiPS series

Compact and Energy Saving Servo Amplifier
- **Compact size**
  - Width is reduced by 20% (average) and depth is reduced by 11% to contribute to cabinet downsizing.
- **Energy saving and high power**
  - Output power is increased, and also energy consumption is reduced by adopting the latest low loss power device.
- **Line-up with both 200V input and 400V input**
  - Various models with both 200V input and 400V input are available. Flexible selection is possible according to the input voltage of the delivery area.

High Accuracy Current Control and High Power
- **High precision for further improvements in the feed axis**
  - Control capability of motors is improved by SERVO HRV4 using high-speed and high-accuracy current detection.
- **Higher power and larger torque in the spindle axis**
  - Torque in short-time operating zone is enlarged.
- **Increasing maximum output power of common power supply**
  - Increase of the maximum output power and the maximum short-term output power contributes to downsizing.

Machine Protection Function at Power Failure
**Protecting damage of work and tools at power failure**
This function prevents the damage of work pieces and tools at power failure in the area where a stable electrical power supply cannot be expected.

- **Gravity-axis drop prevention function**
  - Motor brake is activated quickly at power failure using built-in power failure detection function.
- **Stop distance reduction function** *1)
  - This function stops the table quickly to prevent feed axis to crash in case of high speed machine tools.
- **Retract function** *2)
  - Retract function on a gear cutting machine helps retract a tool from the work pieces keeping synchronization.

*1), *2) Power Failure Backup Module is required.
High Speed, High Precision and High Efficiency
State-of-the-art Servo Control Technology

**SERVO HRV (High Response Vector) Control**

**High speed and high precision servo control**
In combination with “Smooth command by Nano CNC” and “High gain servo system by SERVO HRV Control”, high speed and high precision control with nano-meter level is ensured. Mechanical resonance can be suppressed by Automatic Following HRV Filter even though its frequency is changed.

**Ultra smooth rotation**
Ultra smooth servo feed is ensured by combination of “Servo motor with ultra smooth rotation”, “Accurate current detection”, “High response and high resolution Pulse coder”, and “High speed and high precision servo control”.

**SPINDLE HRV (High Response Vector) Control**

**High precision and low heat generation of spindle**
SPINDLE HRV achieves high response, high precision and high efficiency control for spindle of machine tool. Higher cycle current control reduces heat generation of high speed spindle motors. And Optimum Orientation function minimizes positioning time by deceleration according to load inertia. Position control supports Nano Interpolation and achieves high precision Cs contouring and rigid tapping.

**Learning Control**

**High speed and high precision for repetitive command**
Learning control realizes both high speed and high precision with high level. In addition of applying to grinding machine and gear cutting machines, it is possible to apply Rigid Tapping. Synchronous error between Spindle axis and Z-axis is minimized by learning control, as a result Z axis follows to spindle axis.

New Function Compact Learning Control enables normal ISO code programming instead of binary code programming with standard hardware.
**Tandem Control**

**High gain and high stability in twin motor drive**

Tandem control enables accurately synchronized driving of two motors, in case of one axis drive by two screws or linear motor parallel drive. This is original control technology of FANUC with sharing control status between two axes.

Tandem Disturbance Elimination Control, cancels interference of each axis and it achieves both high gain and stability.

Tandem control can be applied to also spindle axis. With Spindle Tandem Control, larger output of spindle is realized, maintaining stability.

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**Servo Tuning Tool**

**Integrated tuning tool of Servo and Spindle**

SERVO GUIDE provides the integrated environment for making test programs, setting parameters, and data measurement needed for servo and spindle tuning. Connection from PC to CNC is easy and direct, through PCMCIA-LAN card, attached on the CNC front panel.

Tuning Navigator supports automatic tuning of gains, filters, and others, and it reduces tuning time. Automatic tuning function for tuning of quadrant protrusion reduces the tuning time for high speed and high precision drastically.

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It is useful not only for servo tuning but also for the measurement of spindle characteristic.
Minimizing Downtime

Practical Measures for Minimizing Downtime

In order to reduce machine downtime and enhance operation rate, “preventive diagnosis before failure” and “identification of defective part for the quick recovery” are essential.

FANUC developed “Leakage Detection Module” for preventive diagnosis, and “Encoder Communication Check Circuit” for quick identification of defective part at communication alarm of the encoder.

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<th>Methods for Minimizing Downtime</th>
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<td>1) Longer MTBF *1)</td>
<td>Higher reliability against harsh environment</td>
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<td>2) PMBF *2)</td>
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<td>3) Shorter MTTR *3)</td>
<td>Quick identification of defective part</td>
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<td>• Encoder Communication Check Circuit</td>
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*1) MTBF : Mean Time Between Failure
*2) PMBF : Preventive Maintenance Before Failure
*3) MTTR : Mean Time To Repair

Leakage Detection Module

Preventive diagnosis
Insulation deterioration sometimes causes machine stop when cutting fluid infiltrates the motor, especially in a severe machining environment. The Leakage Detection Module automatically measures insulation resistance of the motor, detects insulation deterioration, and gives a signal when insulation deteriorates to an abnormal level, thereby preventing machine from unexpected stop.

Encoder Communication Check Circuit

Quick identification of defective part
As there are three possible sources at communication alarm of the encoder, which include encoder, feedback cable and servo amplifier, it can take a longer time to identify the source, thereby extending down time. The Encoder Communication Check Circuit outputs compatible signals of the encoder in order to identify the source of the defect quickly.
Energy Saving

Promoting Energy Saving

FANUC has been promoting the energy saving. By this activity, SERVO MOTOR α series won a prize of 1999 MITI Award for Energy Saving Equipment. FANUC is also promoting the electrification of molding machine and press machine and contributing the energy saving of industrial machine. This time FANUC Large Servo Motor αl series won a prize of 2003 Chief of Agency for Natural Resources and Energy Award for Energy Saving Equipment.

Technology for Energy Saving

FANUC has been promoting Energy Saving of Servo System through both sides of “Direct Energy Consumption Reduction” by improving efficiency of the servo system, and “Indirect Energy Consumption Reduction” by shortening cycle time.

Direct Energy Consumption Reduction

1. Power source regeneration technology
   Power source regeneration is the technology to return regeneration energy of the motor to a power source. Compared with the resistor regeneration, power consumption is largely reduced.

2. Use of the latest power device
   FANUC applies the latest power device at any time and realizes the low loss of the amplifier.

Indirect Energy Consumption Reduction

Indirect energy, such as coolant pump or lighting is consumed depending on time and regardless of the machine tool movement itself. So, by reducing machining time, indirect energy also reduced.

1. High speed and high precision of feed axes
   By combination of high response control and high resolution feedback, high accuracy with high speed machining is achieved.

2. Shortening non-processed time of spindle axis
   (Optimum orientation)
   Shortest time orientation is always achieved with maximum torque, including the case of inertia of work piece is changed.
FANUC operates customer service and support network worldwide through subsidiaries and affiliates. FANUC provides the highest quality service with the prompt response at any location nearest you.

FANUC Training Center operates versatile training courses to develop skilled engineers effectively in several days.

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