

High Speed, High Precision and 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**



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$\alpha i$  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 Pulsecoder with 16,000,000/rev.

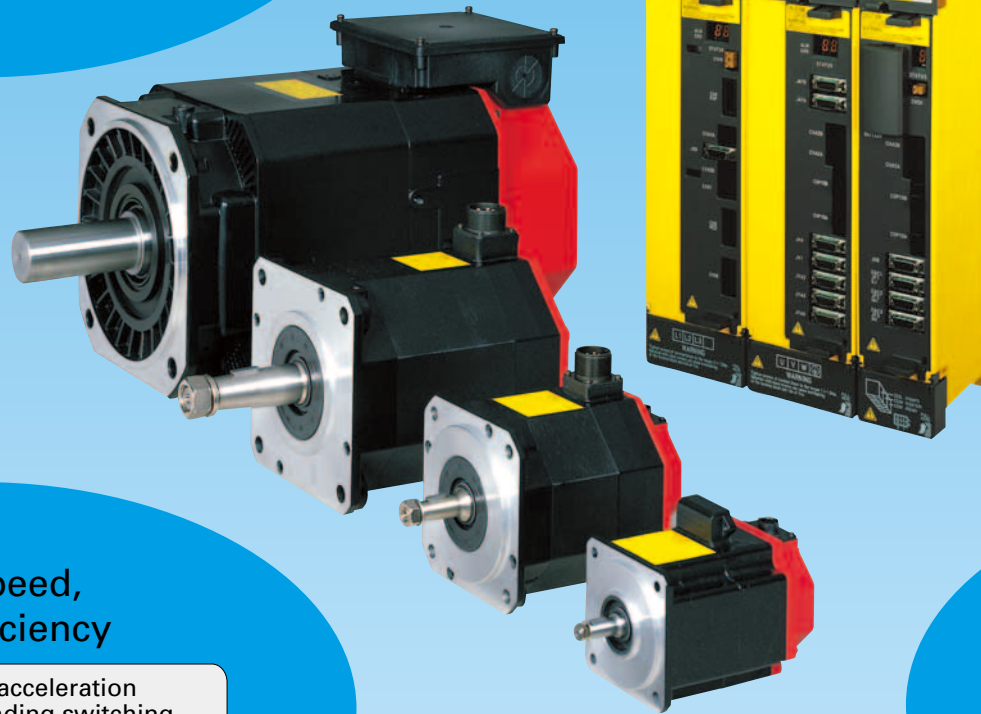
Servo amplifier with high precision current detector

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



## Full Line-up

Full line-up from small to large scale models

Full line-up with both 200V and 400V input

## 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

Leakage Detection Function for preventive maintenance

## 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

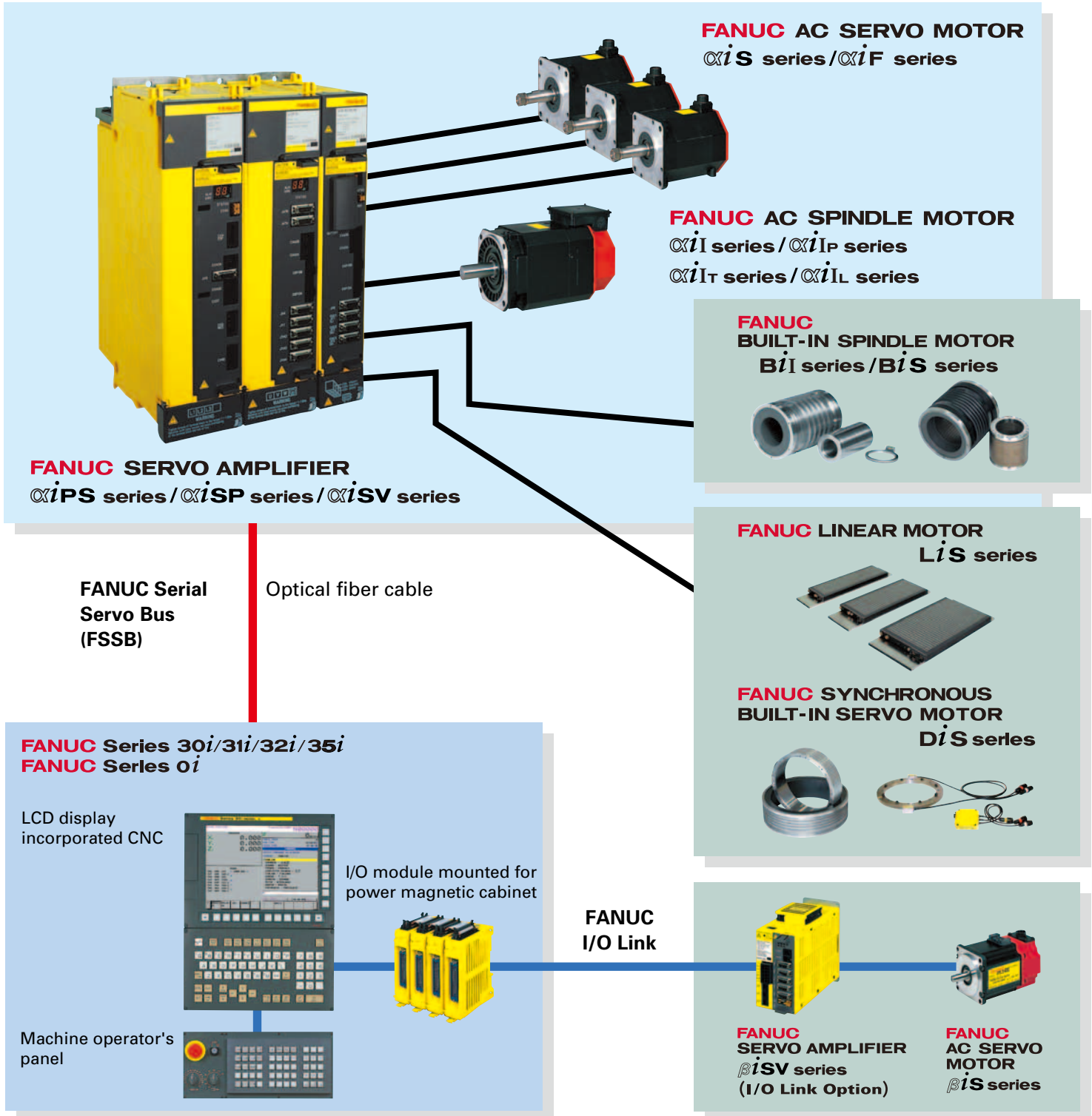
- Farther advanced energy saving servo system as a succession to *α*series which won a prize of 1999 MITI Award for Energy Saving Equipment
- FANUC Large Servo Motor *αi* series won a prize of 2003 Chief of Agency for Natural Resources and Energy Award for Energy Saving Equipment

## 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

# Compact, Reduced Wiring and Easy Maintenance

## Advanced Technology on Hardware Configuration



- \* “S” of αiS means “Strong motor with neodymium magnets”. “F” of αiF means “Motor with Ferrite magnets”.
- \* “I” of αii means “Induction”. “P” of αiiP means “wide constant Power range”. “T” of αiiT means “coolant Through”. “L” of αiiL means “Liquid cooling”.
- \* “SV” of αiSV means “SerVo”, “SP” of αiSP means “SPindle”, and “PS” of αiPS means “Power Supply”.

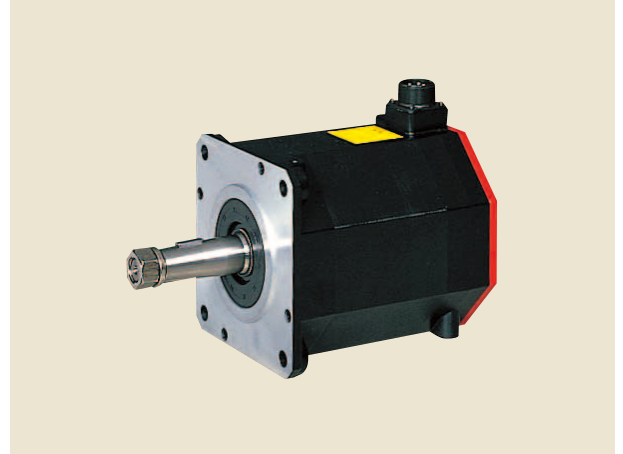
# Servo Motor

## Smooth Rotation and Quick Acceleration

### FANUC AC SERVO MOTOR $\alpha$ iS series / $\alpha$ iF series

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

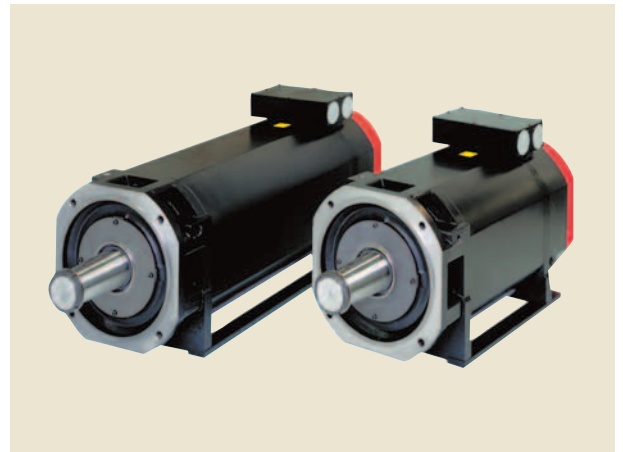
- **Compact size**  
New structure design makes axial length of the motor shorter, contribute to downsizing of machine tools.
- **Intelligent Servo Motor**  
 $\alpha$ i series Servo Motor has ID information of the motor and the Pulsecoder, contribute to quick maintenance.
- **Line-up with both 200V 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

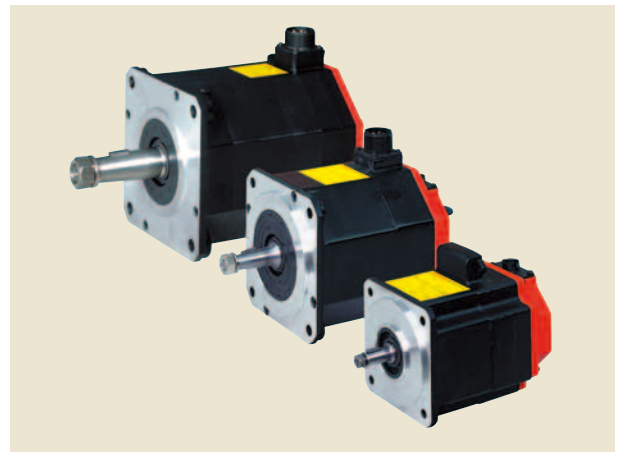
- **Suited to electric drive of large industrial machines**  
Suited to electric drive of as press machines, injection molding machines, etc.
- **Large torque and large output**  
Large torque up to 3000Nm and large output up to 220kW are available.
- **Technologies for large output**  
Further output 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<sup>-1</sup>
- **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

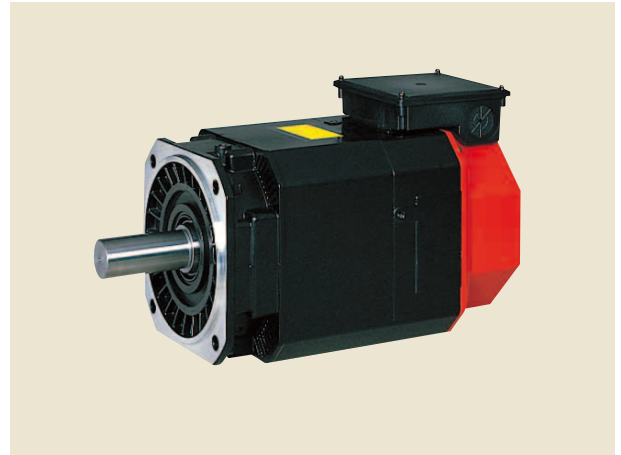
## High Power at High Speed

### FANUC AC SPINDLE MOTOR

$\alpha$ I series /  $\alpha$ IP series /  $\alpha$ IT series /  $\alpha$ IL series

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

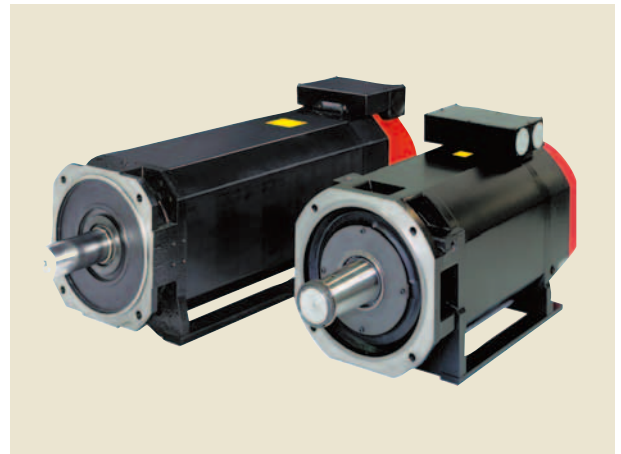
- **High power and high acceleration**  
The motors have constant power up to high speed and can be accelerated quickly, by optimum winding designing and effective cooling structure.
- **Increased torque at low speed range**  
Higher spindle torque available by increased torque at low speed range.
- **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  $\alpha$ IT series and oil cooled  $\alpha$ IL 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 $\alpha$ iSV series / $\alpha$ iSP series / $\alpha$ iPS series

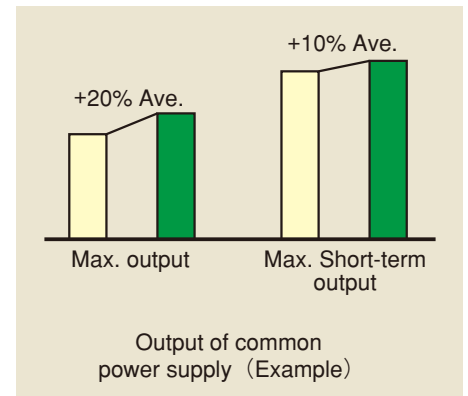
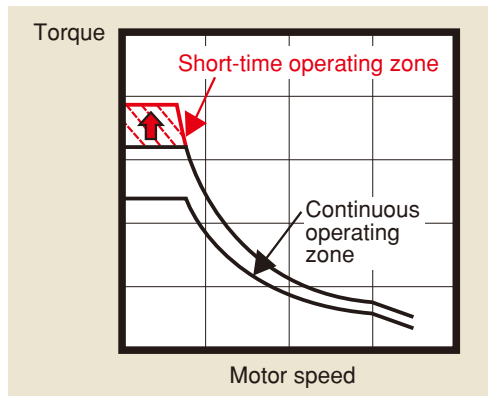
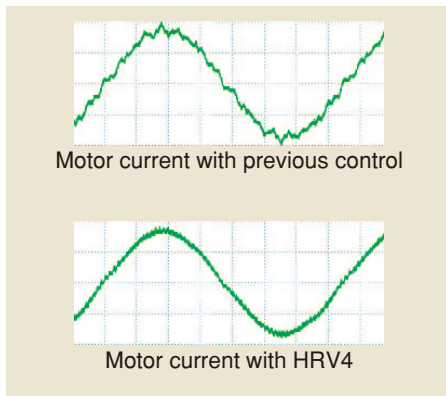
#### Compact and Energy Saving Servo Amplifier

- **Compact and Reduced wiring**  
Line-up of multi-axes amplifier is expanded and it contributes to cabinet downsizing. FSSB connection of servo amplifier and spindle amplifier realizes simple wiring.
- **Energy saving and high power**  
Output power is increased, and also energy consumption is reduced by adopting the latest low loss power device.
- **Expanded Line-up**  
3 axes servo models are added to the 400V input Line-up.  
The Servo/Spindle multi-axes amplifier with servo 3 axes and spindle 1 axis best suited to automatic lathes is added to Line-up.



#### 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

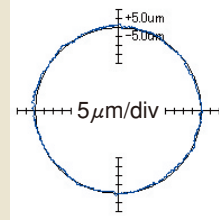
### SERVO HRV (High Response Vector) Control

#### High speed and high precision servo control

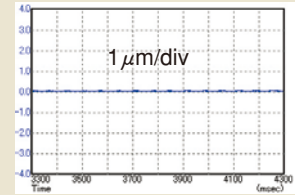
In combination with "Smooth command by Nano CNC" and "High gain servo system by SERVO HRV Control", high speed and high precision control with nano-meter level is ensured. Mechanical resonance can be suppressed by Automatic Following HRV Filter even though its frequency is changed.

#### 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 Pulsecoder", and "High speed and high precision servo control".



Circle (Example)  
R100mm F30m/min

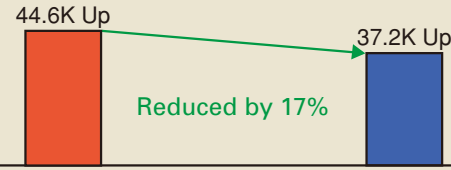


Position deviation at constant speed (Example)

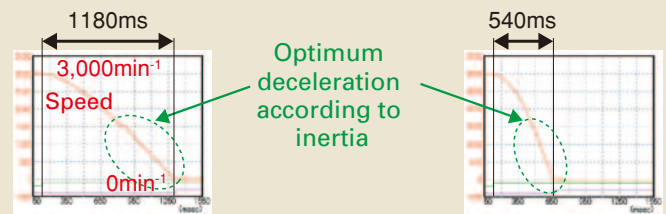
### SPINDLE HRV (High Response Vector) Control

#### 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.



Former current control      High cycle current control  
Temperature rise of motor winding  
at continuous acceleration/deceleration (Example)



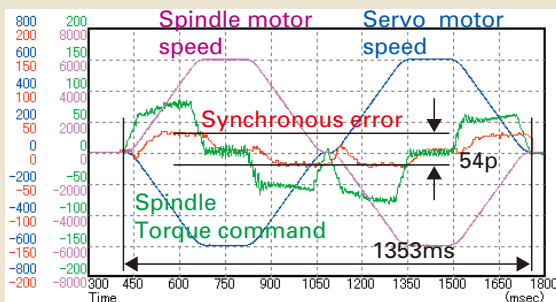
Large load inertia      Small load inertia  
Optimum Orientation (Example)

### FSSB High Speed Rigid Tap

#### High speed rigid tap achieved by using FSSB

The spindle amplifiers for 30i-B series CNC are connected to CNC by FSSB. High performance rigid tap in the synchronization point of view is achieved by direct transferring of servo position data to spindle axis with high speed FSSB communication. It realizes high speed and high accuracy rigid tap with maximum acceleration power of spindle motor

#### FSSB High-speed Rigid Tapping OFF

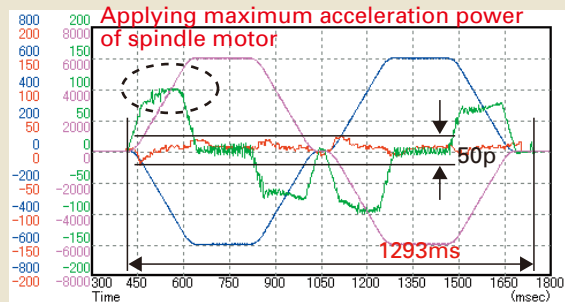


Keeping high accuracy



Time constant for acc./dec. 18.2% shorter

#### FSSB High-speed Rigid Tapping ON



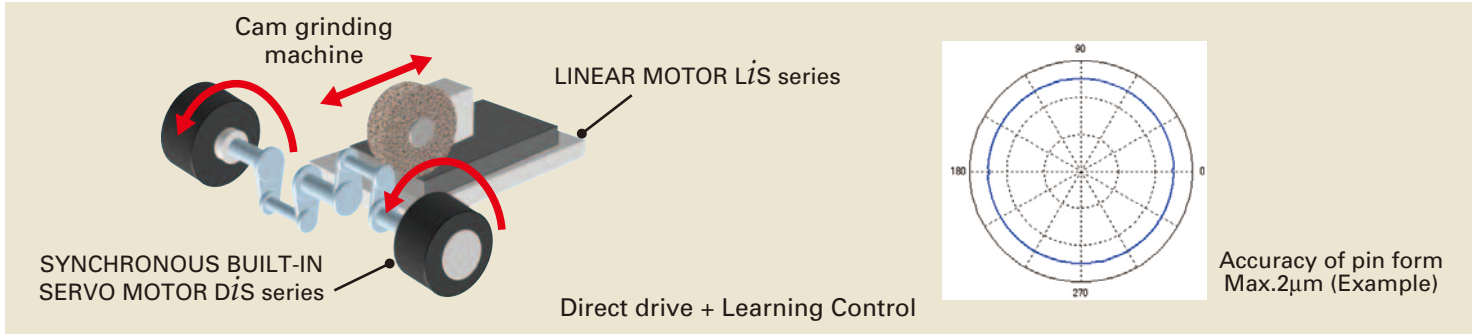
FSSB High-speed Rigid Tapping (Example)



## Learning Control

### High speed and high precision for repetitive command

Learning control realizes both high speed and high precision with high level. New Function High Precision Learning Control enables normal ISO code programming with standard hardware, in addition to binary code programming as heretofore.



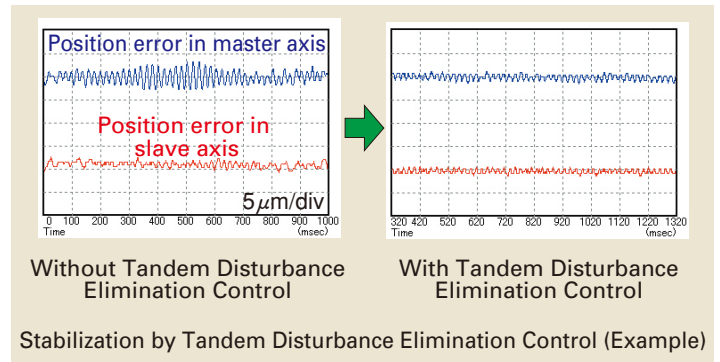
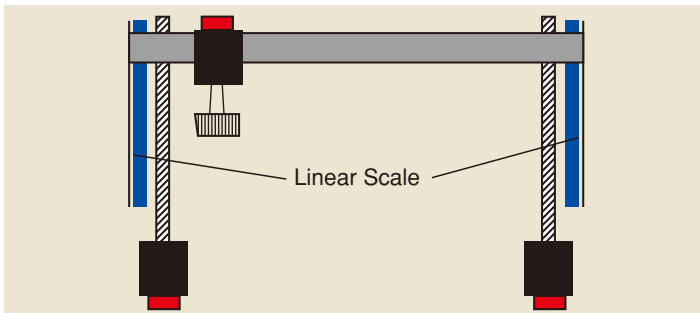
## Servo Tandem Control / Spindle Tandem Control

### 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.



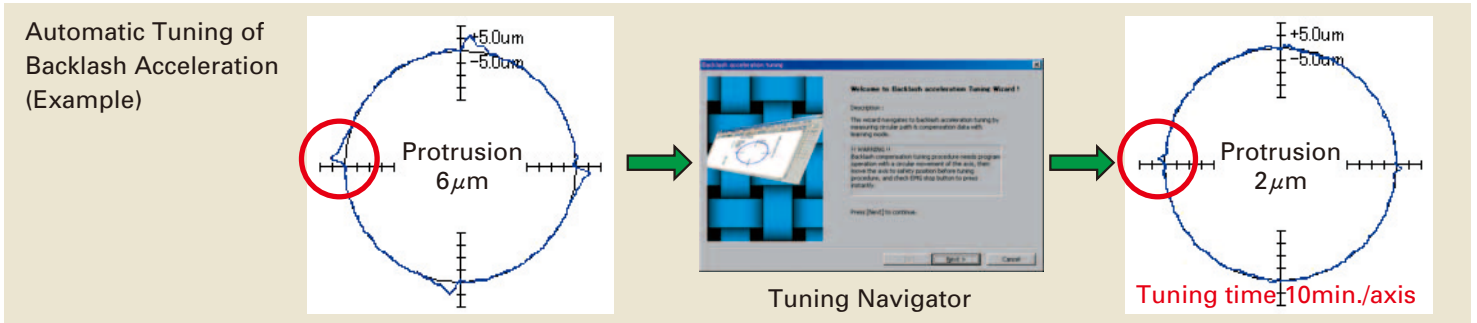
## Servo Tuning Tool

### SERVO GUIDE

### 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.



# 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 Function" for preventive diagnosis, and "Encoder Communication Check Circuit" for quick identification of defective part at communication alarm of the encoder.

| Methods for Minimizing Downtime | Practical Measures  |
|---------------------------------|---|
| 1) Longer MTBF *1)              | Higher reliability against harsh environment<br><ul style="list-style-type: none"> <li>• High Reliability Servo Motor / Servo Amplifier</li> </ul>                      |
| 2) PMBF *2)                     | Preventive diagnosis<br><ul style="list-style-type: none"> <li>• Leakage Detection Function</li> </ul>  |
| 3) Shorter MTTR *3)             | Quick identification of defective part<br><ul style="list-style-type: none"> <li>• Trouble Diagnosis Function</li> <li>• Encoder Communication Check Circuit</li> </ul> |

\*1) MTBF : Mean Time Between Failure

\*2) PMBF : Preventive Maintenance Before Failure

\*3) MTTR : Mean Time To Repair

## Leakage Detection Function

### Contribution to preventive diagnosis

Insulation deterioration sometimes causes machine stop by cutting fluid infiltrates the motor, especially in a severe machining environment.

The leakage detection function built in amplifier automatically measures insulation resistance of the motor, and detects insulation deterioration when it comes to an abnormal level, thereby preventing machine from unexpected stop.

## Trouble Diagnosis Function

### Quick finding cause of alarms

The trouble diagnosis function is prepared in combination with the 30i-B series CNC.

The diagnostic information which is useful for trouble shooting at the time of alarm occurrence can be seen on a CNC screen.

- "Trouble diagnosis guidance screen"

- "Trouble diagnosis monitor screen"

- "Trouble diagnosis graphic screen"

## Encoder Communication Check Circuit

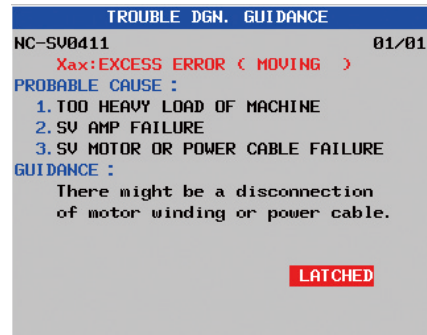
### Quick identification of defective part

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.

Sending insulation resistance value to CNC (30i-B series)



Auto check of insulation resistance



# Energy Saving

## Promoting Energy Saving

FANUC has been promoting the energy saving. By this activity, SERVO MOTOR  $\alpha$  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  $\alpha i$  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

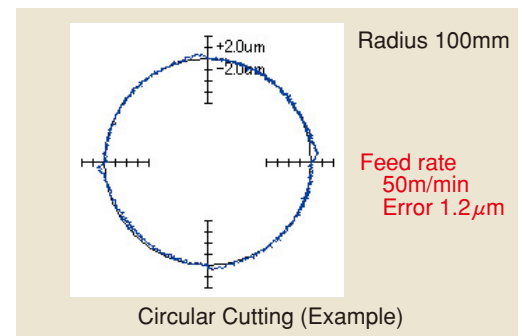
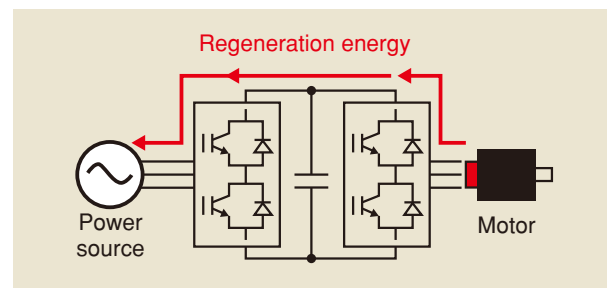
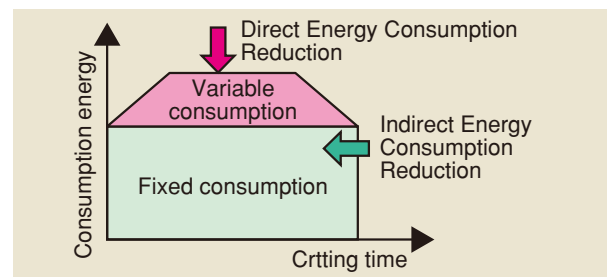
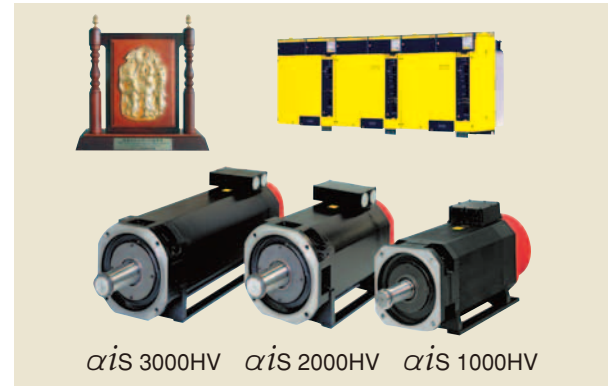
Indirect energy, such as coolant pump or lighting is consumed depending on time and regardless of the machine tool movement itself. So, by reducing machining time, indirect energy also reduced.

### 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.



# Maintenance and Customer Support

## Worldwide Customer Service and Support

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## FANUC Training Center

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

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